



SERVICE MANUAL

G6-42P

9140-4002

November 2008

Starting Serial No.
0189001 thru 0189345
& 0160000230 thru Current

CORPORATE OFFICE

JLG INDUSTRIES, INC.
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Operation & Safety Manual

Keep this manual with machine at all times.

Model G6-42P

S/N 0160004018 & After

31200148

*Original
November 25, 2008*



CALIFORNIA PROPOSITION 65
BATTERY WARNING

**Battery posts,
terminals and related
accessories contain
lead and lead compounds,
chemical known to the
State of California
to cause cancer and
reproductive harm.**

**WASH HANDS
AFTER HANDLING!**

CALIFORNIA PROPOSITION 65
EXHAUST 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.**

REVISION LOG

November 25, 2008 - A - Original Issue of Manual

Read This First

This manual is a very important tool! Keep it with the machine at all times.

The purpose of this manual is to provide owners, users, operators, lessors, and lessees with the precautions and operating procedures essential for the safe and proper machine operation for its intended purpose.

Due to continuous product improvements, JLG Industries, Inc. reserves the right to make specification changes without prior notification. Contact JLG Industries, Inc. for updated information.

Operator Qualifications

The operator of the machine must not operate the machine until this manual has been read, training is accomplished and operation of the machine has been completed under the supervision of an experienced and qualified operator. Operation within the U.S.A. requires training per OSHA 1910.178.

Operators of this equipment must possess a valid, applicable driver's license, be in good physical and mental condition, have normal reflexes and reaction time, good vision and depth perception and normal hearing. Operator must not be using medication which could impair abilities nor be under the influence of alcohol or any other intoxicant during the work shift.

In addition, the operator must read, understand and comply with instructions contained in the following material furnished with the material handler:

- This Operation & Safety Manual
- Telehandler Safety Manual (as required)
- All instructional decals and plates
- Any optional equipment instructions furnished

The operator must also read, understand and comply with all applicable Employer, Industry and Governmental rules, standards and regulations.

Modifications

Any modification to this machine must be approved by JLG.

This product must comply with all safety related bulletins. Contact JLG Industries, Inc. or the local authorized JLG representative for information regarding safety-related bulletins which may have been issued for this product.

JLG Industries, Inc. sends safety related bulletins to the owner of record of this machine. Contact JLG Industries, Inc. to ensure that the current owner records are updated and accurate.

JLG Industries, Inc. must be notified immediately in all instances where JLG products have been involved in an accident involving bodily injury or death of personnel or when damage has occurred to personal property or the JLG product.

FOR:

- Accident Reporting and Product Safety Publications
- Current Owner Updates
- Questions Regarding Product Applications and Safety
- Standards and Regulations Compliance Information
- Questions Regarding Product Modifications

CONTACT:

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Hagerstown, MD 21742
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Phone: +1-717-485-5161

E-mail: ProductSafety@JLG.com

Other Publications Available

Service Manual	91404002
Illustrated Parts Manual.....	91404001

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SECTION 1 - GENERAL SAFETY PRACTICES

1.1 HAZARD CLASSIFICATION SYSTEM

Safety Alert System and Safety Signal Words



DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.



WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.



CAUTION indicates a potentiality hazardous situation which, if not avoided, may result in minor or moderate injury.

1.2 GENERAL PRECAUTIONS

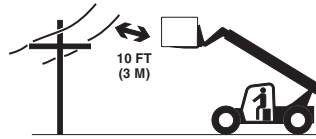
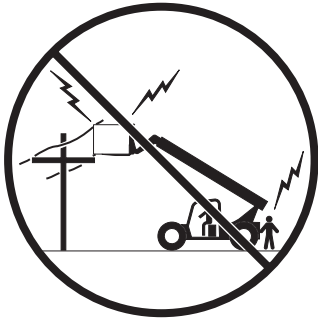


Before operation, read and understand this manual. Failure to comply with the safety precautions listed in this manual could result in machine damage, property damage, personal injury or death.

Section 1 - General Safety Practices

1.3 OPERATION SAFETY

Electrical Hazards



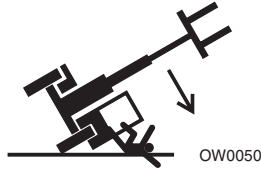
OW0040

- This machine is not insulated and does not provide protection from contact or being near electrical current.
- **NEVER** operate the telehandler in an area where overhead power lines, overhead or underground cables, or other power sources may exist without ensuring the appropriate power or utility company de-energizes the lines.
- Always check for power lines before raising the boom.
- Follow employer, local and governmental regulations for clearance from powerlines.

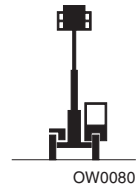
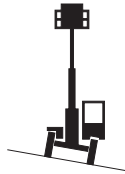
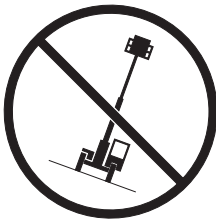
Tip Over Hazard

General

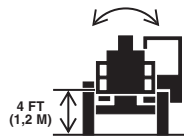
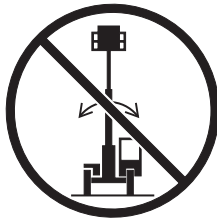
- For additional load requirements, refer to the appropriate capacity chart.



- Never use an attachment without the appropriate JLG approved capacity chart installed on the telehandler.
- Understand how to properly use the capacity charts located in cab.
- DO NOT** exceed rated lift capacity.
- Be sure that the ground conditions are able to support the machine.

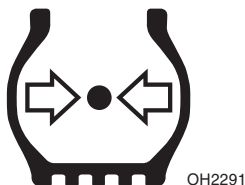


- DO NOT** raise boom unless frame is level (0 degrees), unless otherwise noted on capacity chart.



- DO NOT** level machine with boom/attachment above 4 ft (1,2 m).
(AUS - **DO NOT** level machine with load more than 11.8 in. (300 mm) above ground surface).

Section 1 - General Safety Practices



- **MAINTAIN proper tire pressure** at all times. If proper tire pressures are not maintained, this machine could tip over.
- Refer to manufacturer's specifications for proper fill ratio and pressure requirements for tires equipped with ballast.



- Always wear the seat belt.
- Keep head, arms, hands, legs and all other body parts inside operator's cab at all times.



If the telehandler starts to tip over:

- **DO NOT JUMP**
- **BRACE YOURSELF** and **STAY WITH THE MACHINE**
- **KEEP YOUR SEAT BELT FASTENED**
- **HOLD ON FIRMLY**
- **LEAN AWAY FROM THE POINT OF IMPACT**

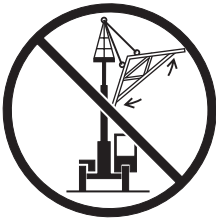
Non-Suspended Load



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- **DO NOT** drive with boom raised.

Suspended Load

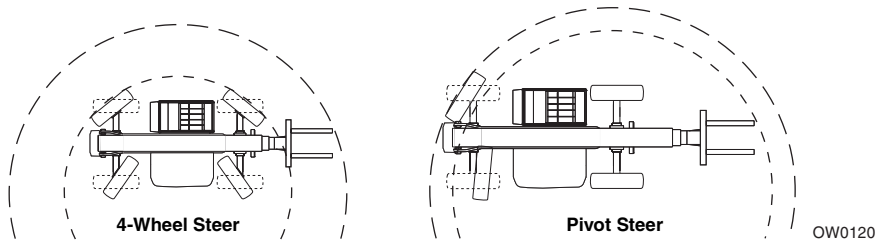


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- Tether suspended loads to restrict movement.
- **DO NOT** raise the load more than 11.8 in (300 mm) above ground surface or the boom more than 45°.
- Weight of all rigging (slings, etc.) must be included as part of load.
- Start, travel, turn and stop slowly to prevent load from swinging.
- When driving with the boom raised, **DO NOT** exceed walking speed.
- Beware of wind. Wind can cause a suspended load to swing and cause dangerous side loads - even with tag lines.
- **DO NOT** attempt to use telehandler frame-leveling to compensate for load swing.
- Keep heavy part of load closest to attachment.
- Never drag the load; lift vertically.

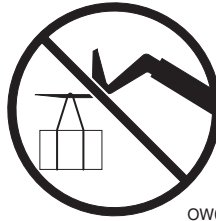
Section 1 - General Safety Practices

Travel Hazard



- Steering characteristics differ between 4-Wheel Steer & Pivot Steer telehandlers as shown above. Identify the telehandler you are operating & others on the jobsite.
- Ensure that adequate clearance is provided between both rear tail swing and front fork swing.
- Unlike a conventional 4-wheel steer telehandler the rear wheels of a pivot steer telehandler turn a wider circle than the front wheels.
- Look out for and avoid other personnel, machinery and vehicles in the area. Use a spotter if you DO NOT have a clear view.
- Before moving be sure of a clear path and sound horn.
- When driving, retract boom and keep boom/attachment as low as possible while maintaining visibility of mirrors and maximum visibility of path of travel.
- Always look in the direction of travel.
- Always check boom clearances carefully before driving underneath overhead obstructions. Position attachment/load to clear obstacles.

Load Falling Hazard



OW0130

- Never suspend load from forks or other parts of carriage.
- **DO NOT** burn or drill holes in fork(s).
- Forks must be centered under load and spaced apart as far as possible.

Section 1 - General Safety Practices

Lifting Personnel



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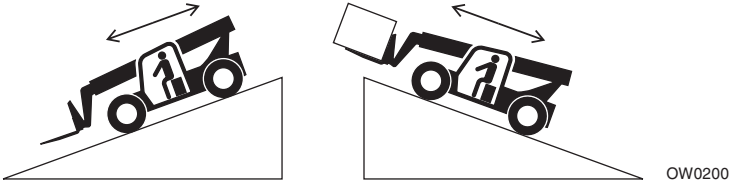
- When lifting personnel, **USE ONLY** a JLG approved personnel work platform, with proper capacity chart displayed in the cab.



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- **DO NOT** drive machine from cab when personnel are in platform.

Driving Hazards on Slopes



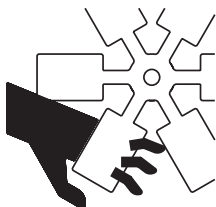
To maintain sufficient traction and braking capabilities, travel on slopes as follows:

- When unloaded, the rear of the machine is the “heavy end.” Drive with forks pointed downhill.
- When loaded, the front of the machine is the “heavy end.” Drive with the forks pointed uphill.
- For additional travel requirements, refer to the appropriate capacity chart.
- To avoid overspeeding the engine and drivetrain when driving down slopes, downshift to a lower gear and use the service brake as necessary to maintain a slow speed. **DO NOT shift into neutral and coast downhill.**
- Avoid excessively steep slopes or unstable surfaces. To avoid tip over **DO NOT** drive across excessively steep slopes under *any* circumstances.
- Avoid turning on a slope. Never engage “inching” or shift to “Neutral” when going downhill.
- **DO NOT** park on a slope.

Section 1 - General Safety Practices

Pinch Points and Crush Hazards

Stay clear of pinch points and rotating parts on the telehandler.



OW0210

- Stay clear of moving parts while engine is running.



OW0220

- Keep clear of steering tires and frame or other objects.



OW0230

- Keep clear from under boom.



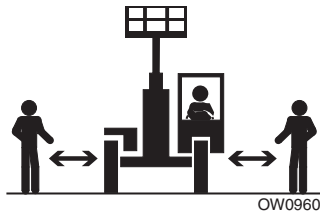
- Keep clear of boom holes.



- Keep arms and hands clear of attachment tilt cylinder.



- Keep hands and fingers clear of carriage and forks.



- Keep others away while operating.

Section 1 - General Safety Practices

Fall Hazard



OW0280

- Enter using the proper hand holds and steps provided. Always maintain 3-point contact when mounting or dismounting. Never grab control levers or steering wheel when mounting or dismounting the machine.
- **DO NOT** get off the machine until the shutdown procedure on page 4-4 has been performed.



OW0290

- **DO NOT** carry riders. Riders could fall off machine causing death or serious injury.

Chemical Hazards

Exhaust Fumes

- **DO NOT** operate machine in an enclosed area without proper ventilation.
- **DO NOT** operate the machine in hazardous environments unless approved for that purpose by JLG and site owner. Sparks from the electrical system and the engine exhaust can cause an explosion.
- If spark arrestors are required, ensure they are in place and in good working order.

Flammable Fuel



- **DO NOT** fill the fuel tank or service the fuel system near an open flame, sparks or smoking materials. Engine fuel is flammable and can cause a fire and/or explosion.

Hydraulic Fluid



- **DO NOT** attempt to repair or tighten any hydraulic hoses or fittings while the engine is running or when the hydraulic system is under pressure.
- Stop engine and relieve trapped pressure. Fluid in the hydraulic system is under enough pressure that it can penetrate the skin.
- **DO NOT** use your hand to check for leaks. Use a piece of cardboard or paper to search for leaks. Wear gloves to protect hands from spraying fluid.

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SECTION 2 - PRE-OPERATION AND INSPECTION

2.1 PRE-OPERATION CHECK AND INSPECTION

Note: Complete all required maintenance before operating unit.

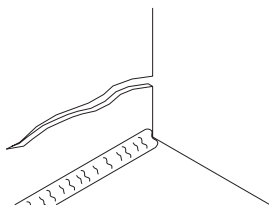


WARNING

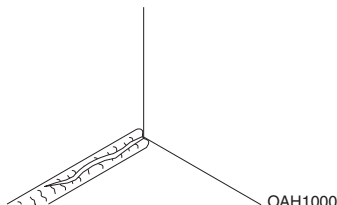
FALL HAZARD. Use extreme caution when checking items beyond your normal reach. Use an approved ladder.

The pre-operation check & inspection, performed at beginning of each work shift or at each change of operator, should include the following:

1. **Cleanliness** - Check all surfaces for leakage (oil, fuel or battery fluid) or foreign objects. Report any leakage to the proper maintenance personnel.
2. **Structure** - Inspect the machine structure for dents, damage, weld or parent metal cracks or other discrepancies.



PARENT METAL CRACK



WELD CRACK

3. **Safety Decals** - Ensure all safety decals are legible and in place. Clean or replace as required. See page 2-3 for details.
4. **Operation and Safety Manuals** - Operation and Safety Manual and AEM Safety Manual (as required) are located in cab manual holder.
5. **Walk-Around Inspection** - See page 2-6 for details.
6. **Fluid Levels** - Check fluids, including fuel, hydraulic oil, engine oil and coolant. When adding fluids, refer to Section 7 - Lubrication and Maintenance and Section 9 - Specifications to determine proper type and intervals. Before removing filler caps or fill plugs, wipe all dirt and grease away from the ports. If dirt enters these ports, it can severely reduce component life.
7. **Attachments/Accessories** - Ensure correct load charts are installed on the telehandler. If provided, reference the Operation and Safety Manual of each attachment or accessory installed for specific inspection, operation and maintenance instructions.

Section 2 - Pre-Operation and Inspection

8. **Operational Check** - Once the walk-around inspection is complete, perform a warm-up and operational check (see page 2-8) of all systems in an area free of overhead and ground level obstructions. See Section 3 - Controls and Indicators for more specific operating instructions.

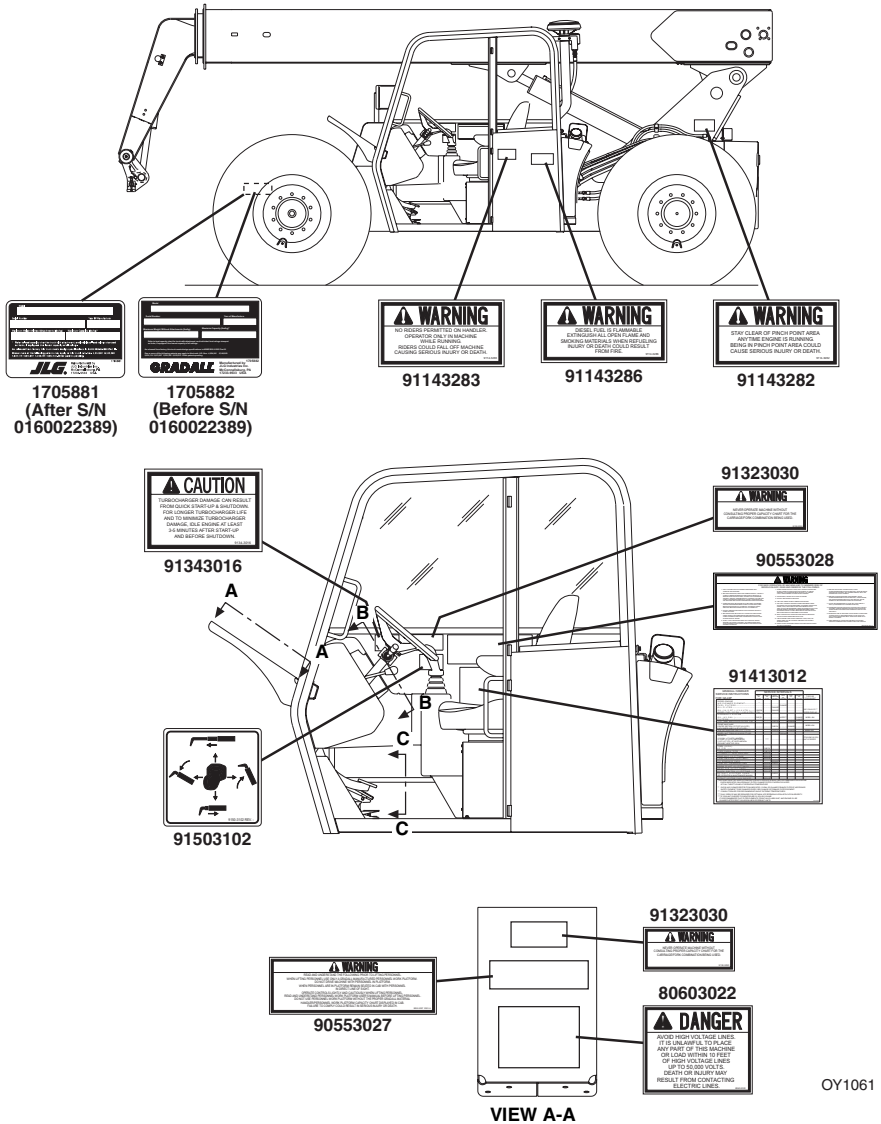


WARNING

If telehandler does not operate properly, immediately bring machine to a stop, lower boom and attachment to ground and stop the engine. Determine cause and correct before continued use.

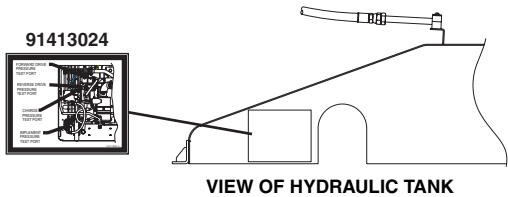
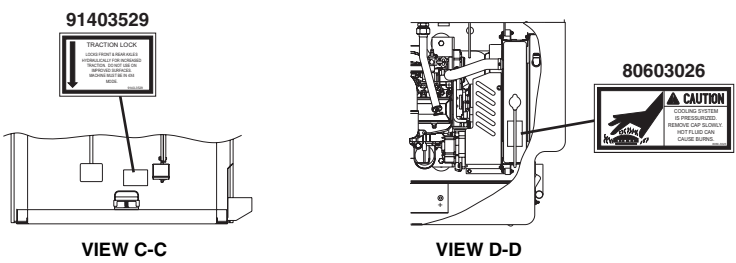
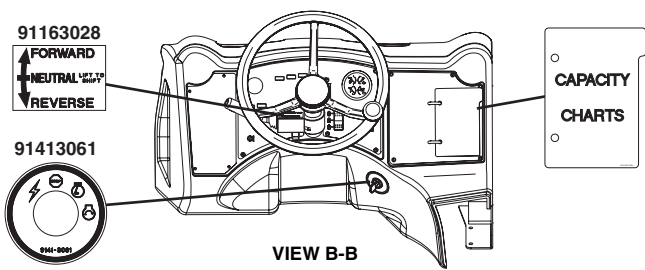
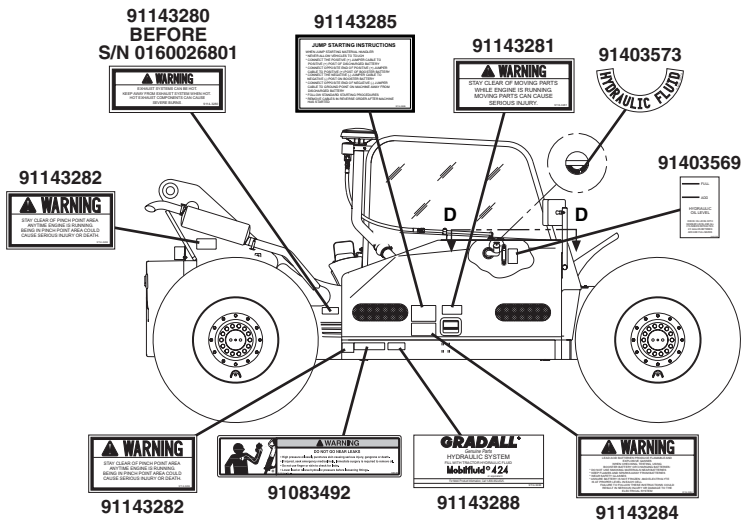
2.2 SAFETY DECALS

Ensure all **DANGER**, **WARNING**, **CAUTION** and instructional decals and proper capacity charts are legible and in place. Clean and replace as required.



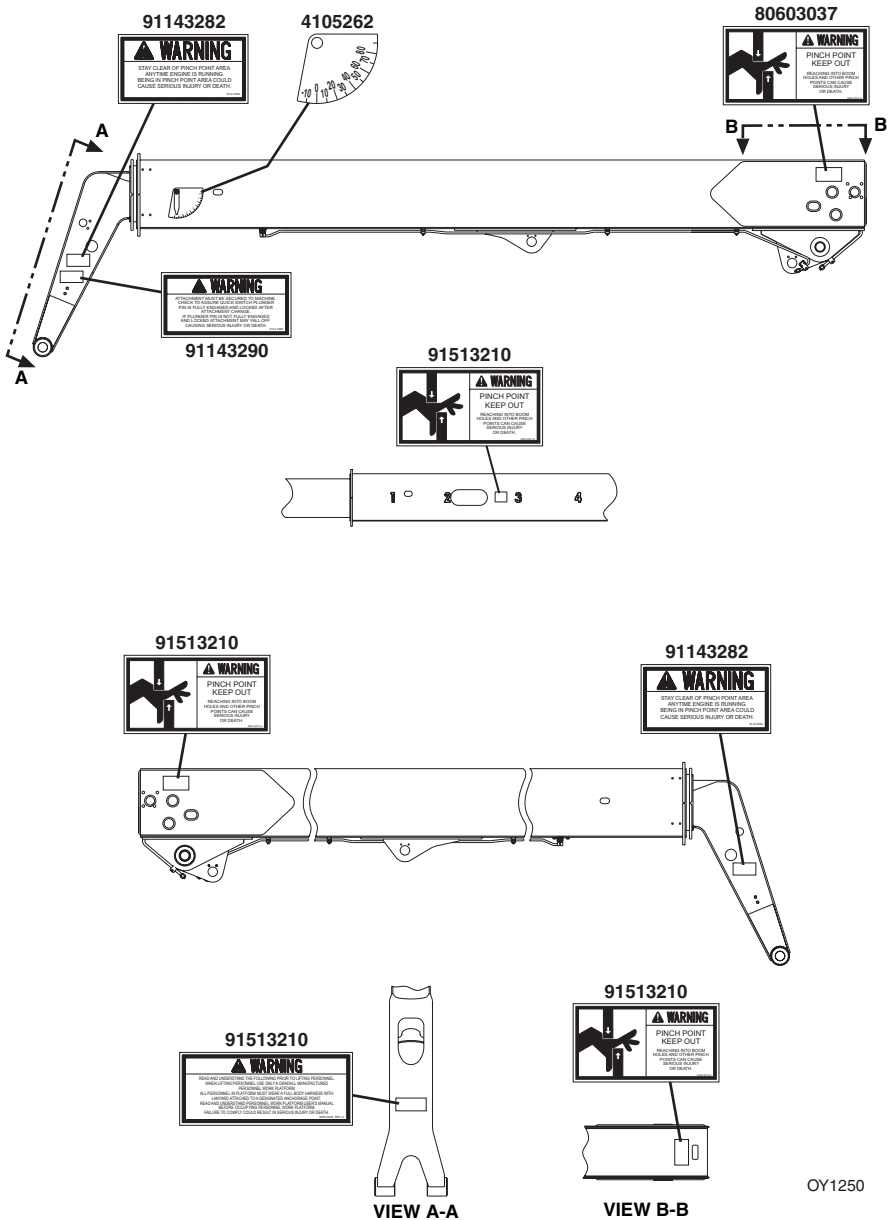
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Section 2 - Pre-Operation and Inspection

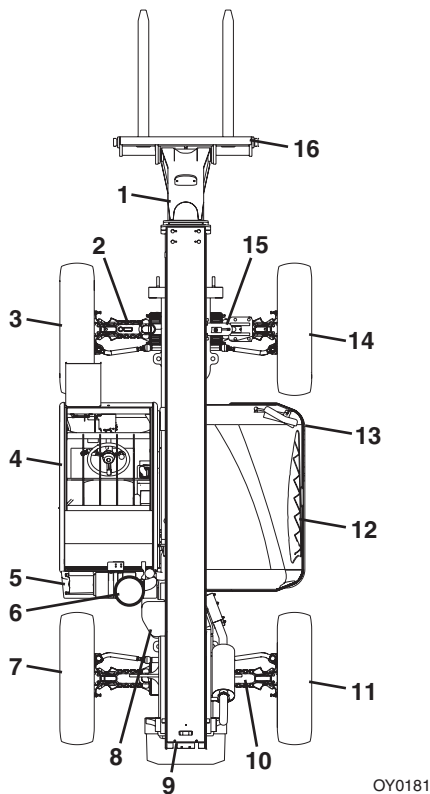


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2.3 WALK-AROUND INSPECTION



OY0181

Begin your walk-around inspection at item 1, as noted below. Continue to your right (counterclockwise when viewed from top) checking each item in sequence.

INSPECTION NOTE: On all components, make sure there are no loose or missing parts, that they are securely fastened and no visible leaks or excessive wear exists in addition to any other criteria mentioned. Inspect all structural members including attachment for cracks, excessive corrosion and other damage.

1. Boom Sections & Lift, Tilt, Extend/Retract, Compensating (Slave) Cylinders -

- Check front, top, side & rear slider pads for adequate grease.
- Pivot pins secure; hydraulic hoses undamaged, not leaking.
- Check extend/retract cables and adjustment blocks for adequate tension.

2. Front Axle - Pivot pins secure; hydraulic hoses undamaged, not leaking.

3. Wheel/Tire Assembly - Properly inflated and secured; no loose or missing lug nuts. Inspect for worn tread, cuts, tears or other discrepancies.

Section 2 - Pre-Operation and Inspection

4. **Cab & Electrical** -
 - Check window glass is in place and clean; gauges, switches, joysticks, foot controls & horn operational.
 - General appearance; no visible damage; proper load charts and applicable Operator & Safety manual located in manual holder.
 - Make sure emergency escape hammer is in place (enclosed cabs only).
 - Check seat belt for damage, replace belt if frayed or cut webbing, damaged buckles or loose mounting hardware.
5. **Fuel Tank** - Check fluid level, refill as required; filler cap is securely fastened.
6. **Air Cleaner** - Air cleaner element condition indicator, check for clogged condition. Replace element as required.
7. **Wheel/Tire Assembly** - Properly inflated and secured; no loose or missing lug nuts. Inspect for worn tread, cuts, tears or other discrepancies.
8. **Main Control Valve** - See Inspection Note.
9. **Back-up Alarm** - See Inspection Note.
10. **Rear Axle** - Steer cylinders undamaged, not leaking; pivot pins secure; hydraulic hoses undamaged, not leaking.
11. **Wheel/Tire Assembly** - Properly inflated and secured; no loose or missing lug nuts. Inspect for worn tread, cuts, tears or other discrepancies.
12. **Engine Compartment** -
 - Engine Crankcase and Radiator, check level & refill as required.
 - Drive belts, check condition & replace as required.
 - Hydraulic pump & reservoir, recommended fluid level on sight gauge (lubricant must be cool), breather cap secure and working.
 - Engine cover properly secured.
13. **Mirrors** - Clean and undamaged.
14. **Wheel/Tire Assembly** - Properly inflated and secured; no loose or missing lug nuts. Inspect for worn tread, cuts, tears or other discrepancies.
15. **Sway Cylinder** - Pins secure; hydraulic hoses undamaged, not leaking.
16. **Attachment** - Properly installed, see “Attachment Installation” on page 5-7.

Section 2 - Pre-Operation and Inspection

2.4 WARM-UP AND OPERATIONAL CHECKS

Warm-Up Check

During warm-up period, check:

1. Heater, defroster and windshield wiper (if equipped).
2. Check all lighting systems (if equipped) for proper operation.
3. Voltmeter should show 13.5 to 14 volts.
4. Adjust mirror(s) for maximum visibility.



WARNING

CUT/CRUSH/BURN HAZARD. Keep engine cover closed while engine is running except when checking hydraulic filter condition indicator.

Operational Check

When engine warms, perform an operational check:

1. Service brake and parking brake operation.
2. Forward and reverse travel.
3. Steering in both directions with engine at low idle.
4. Horn and back-up alarm. Must be audible from inside operators cab with engine running.
5. All boom and attachment functions - operate smoothly and correctly.
6. Perform any additional checks described in Section 8.
7. Hydraulic Filter Condition Indicator.

2.5 OPERATOR CAB

The telehandler is equipped with a standard open ROPS/FOPS cab. An optional enclosed ROPS/FOPS cab is available.



WARNING

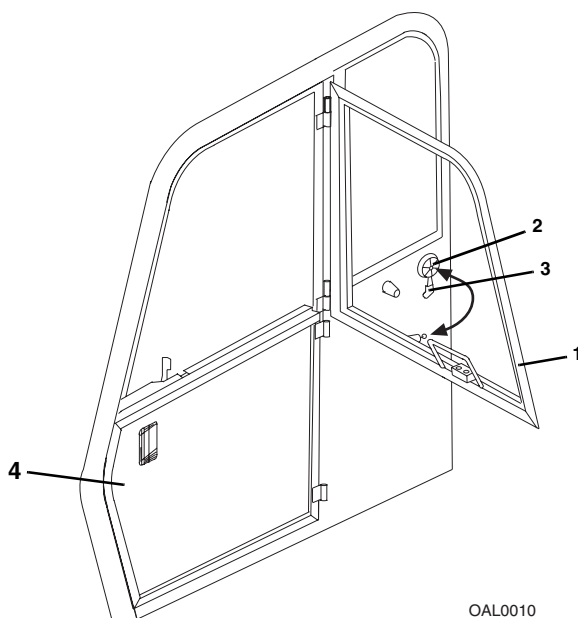
Never operate telehandler unless the overhead guard and cab structure are in good condition. Any modification to this machine must be approved by JLG to assure compliance with ROPS/FOPS certification for this cab/machine configuration. If damaged, the **CAB CANNOT BE REPAIRED**. It must be **REPLACED**.

Section 2 - Pre-Operation and Inspection

2.6 WINDOWS

Keep all windows and mirrors clean and unobstructed.

Cab Door Window (if equipped)



OAL0010

- During operation the window must either be latched open or closed.
- Open the cab door window (1) and secure it in the latch.
- Press the release button (2) inside the cab or pull on the lever (3) outside the cab to unlatch the window.
- During operation the lower door (4) must be closed.

SECTION 3 - CONTROLS AND INDICATORS

3.1 GENERAL

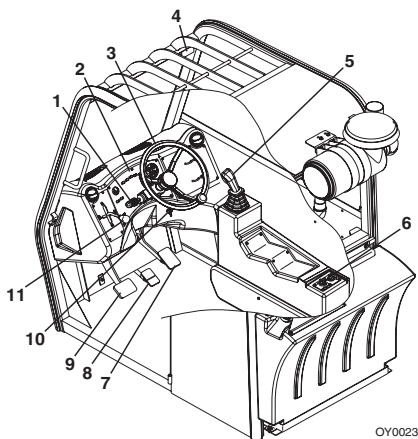
This section provides the necessary information needed to understand control functions.

Note: *The manufacturer has no direct control over machine application and operation. The user and operator are responsible for conforming with good safety practices.*

NOTICE

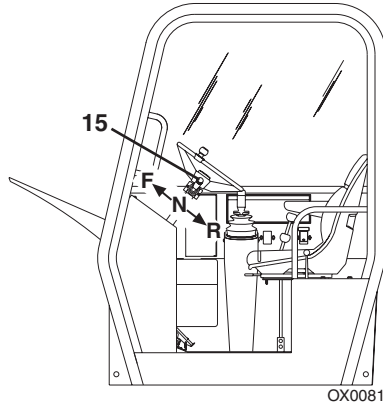
EQUIPMENT DAMAGE. When a red light illuminates, immediately bring machine to a stop, lower boom and attachment to ground and stop the engine. Determine cause and correct before continued use.

3.2 CONTROLS



1. Transmission Control Lever: See page 3-3.
2. Instrument Panel: See “Dash Controls and Indicators” on page 3-8.
3. Steering Wheel: Turning the steering wheel to the left or right steers the machine in the corresponding direction.
4. Frame Level Indicator: Enables the operator to determine the left to right level condition of the telehandler.
5. Boom Joystick: See page 3-5.
6. Heater Control (if equipped): See page 3-10.
7. Accelerator Pedal: Pressing down the pedal increases engine and hydraulic speed.
8. Traction Lock Pedal: Operates traction-lock valve which functions to restore traction when a wheel spins.
9. Service Brake Pedal/Inching Travel Pedal: Operates the service brakes on the front axle. Permits slow travel speed while engine speed is kept high for other handler functions. The further the pedal is depressed, the slower the travel speed.
10. Ignition Switch: Key activated. See page 3-4.
11. Attachment Tilt and Frame Sway Lever: See page 3-6
Auxiliary Control Joystick (if equipped): See page 3-7

Transmission Control Lever



Transmission control lever (15) engages forward or reverse travel.

- Lift and push lever forward for forward travel; lift and pull lever rearward for reverse travel. Move lever to centered position for 'Neutral'.
- When traveling in REVERSE, the back-up alarm will automatically sound.
- Drive in reverse and turn only at slow rates of speed.
- Do not increase engine speed with the transmission in forward or reverse and the service brake depressed in an attempt to get quicker hydraulic performances. This could cause unexpected machine movement.

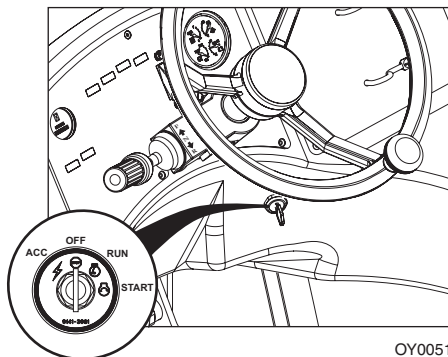


WARNING

TIP OVER/CRUSH HAZARD. Bring telehandler to a complete stop before shifting transmission control lever. A sudden change in direction of travel could reduce stability and/or cause load to shift or fall.

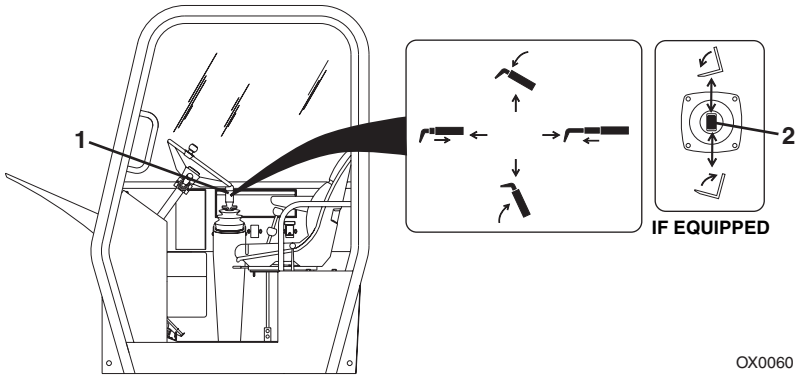
Section 3 - Controls and Indicators

Ignition Switch



- In "ACC" or "RUN" position, voltage is available for all electrical functions.
- Full clockwise rotation to "START" engages starter motor.
- Counter-clockwise rotation to "OFF" stops engine and removes voltage from all electrical functions.

Boom Joystick



The boom joystick (1) controls the boom and attachment tilt (if equipped) functions.

Boom Functions

- Move the joystick back to lift boom; move joystick forward to lower boom; move joystick right to extend boom; move joystick left to retract boom.
- The speed of boom functions depends upon the amount of joystick travel in corresponding direction. Increasing engine speed will also increase function speed.
- For two simultaneous boom functions, move the joystick between quadrants. For example; moving the joystick forward and to the left will lower and retract boom simultaneously.

Attachment Functions (if equipped)

Tilt control is actuated by the switch (2).

- Depress the rear of the switch to tilt up; depress the front of switch to tilt down.

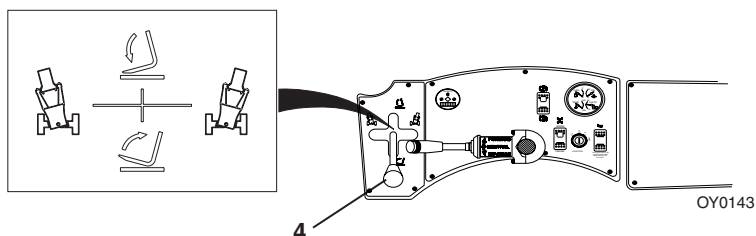


WARNING

TIP OVER/CRUSH HAZARD. Rapid, jerky operation of controls will cause rapid, jerky movement of the load. Such movements could cause the load to shift or fall or could cause the machine to tip over.

Section 3 - Controls and Indicators

Attachment Tilt and Frame Sway Lever



This lever (4) controls the attachment tilt and the left to right frame sway.

Attachment Tilt Function

- Move lever forward to tilt attachment down; move lever back to tilt attachment up.

Sway Function

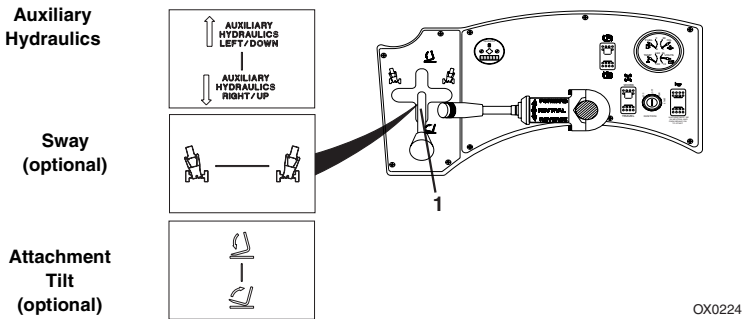
- Move the lever left to sway frame left, move the lever right to sway frame right.
- A level indicator is located in the upper front window frame to permit operator to determine whether the telehandler frame is level.



WARNING

TIP OVER HAZARD. Always move boom as low as possible while allowing for best visibility of right hand mirror before leveling frame. Attempting to level machine with boom raised could cause it to tip over.

Auxiliary Control Joystick (if equipped)



The auxiliary control joystick (1) controls the auxiliary hydraulic functions, left to right frame sway (if equipped), and attachment tilt (if equipped).

Auxiliary Hydraulics Function

- Controls function of attachments that require hydraulic supply for operation. See Section 5 - Attachments for approved attachments and control instructions.

Frame Sway (if equipped)

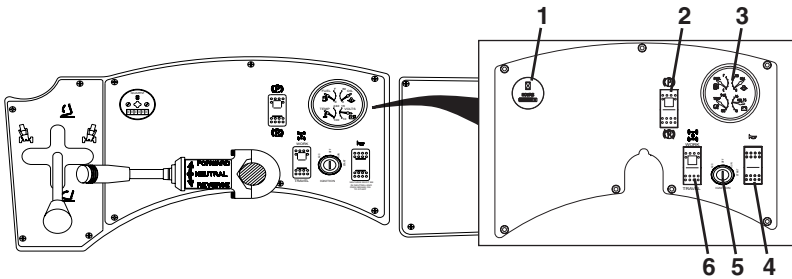
- Move the joystick left to sway frame left, move the joystick right to sway frame right.
- A level indicator is located in the upper front window frame to permit operator to determine whether the telehandler frame is level.

Attachment Tilt (if equipped)

- Move joystick up to tilt down; move joystick down to tilt up.

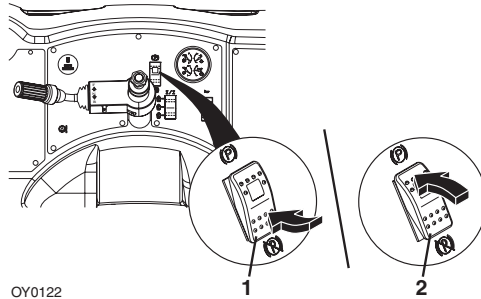
Section 3 - Controls and Indicators

Dash Controls and Indicators



1. Hourmeter: Indicates total time of engine operation in hours and tenths of hours.
2. Park Brake Switch: See page 3-9.
3. 4-in-1 Gauge:
 - a. Engine Coolant Temperature Gauge
 - b. Engine Oil Pressure Gauge
 - c. Fuel Gauge
 - d. Voltmeter indicates alternator output and battery condition.
4. Horn Button: Depress button to sound horn.
5. Ignition Switch: See page 3-?.
6. 4X2/4X4 Switch: Engages and disengages rear-wheel drive motors. Rear drive motors are engaged for four-wheel drive. Indicator light on switch glows (amber) to indicate four-wheel drive is engaged. When park brake is applied, light will not glow.

Park Brake Switch



Park brake switch controls the application and release of the park brake. Indicator light illuminates to indicate brake is applied.

- With the engine running and the park brake switch in "OFF" position (1), park brakes are disengaged.
- With switch in "ON" position (2), park brake is engaged and transmission will not engage forward or reverse.



WARNING

MACHINE ROLL-AWAY HAZARD. Always move park brake switch to "ON" position, lower boom to ground and stop engine before leaving cab.



WARNING

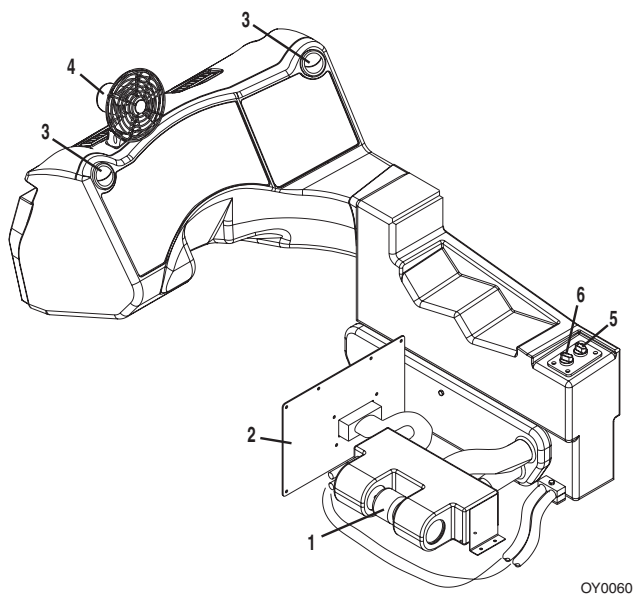
CRUSH HAZARD. Turning engine off applies the park brake. Applying park brake or turning engine off while traveling will cause unit to stop abruptly and could cause load loss. Either may be used in an emergency situation.

Parking Procedure

1. Using service brake, stop telehandler in an appropriate parking area.
2. Follow "Shut-Down Procedure" on page 4-4.

Section 3 - Controls and Indicators

Heater

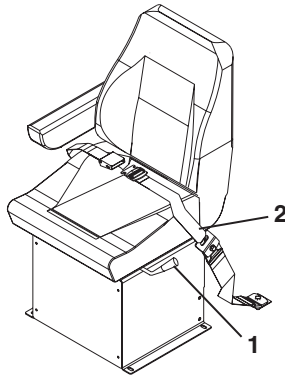


1. Heater
2. Access Cover/Heat Vent
3. Air Vents
4. Defroster Fan: Two speed fan. Press fan switch down for slow speed; press switch up for fast speed. Return switch to middle position to turn off.
5. Temperature Control Switch
6. Heater Fan Switch: On/Off switch.

3.3 OPERATOR SEAT

Seat Adjustments

Before S/N 0160016100



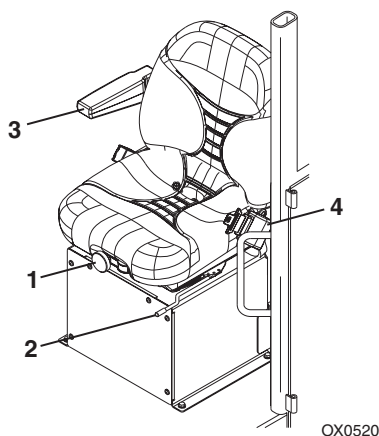
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Prior to starting engine adjust seat for position and comfort as follows:

1. Use handle to move seat fore and aft
2. A two inch seat belt is standard equipment. If required, an optional three inch belt is available.

Section 3 - Controls and Indicators

S/N 0160016100 & After



Prior to starting engine adjust seat for position and comfort as follows:

1. Turn the knob on the front of seat to adjust the suspension. Turn the knob clockwise to increase stiffness. Turn the knob counterclockwise to reduce stiffness.
2. Pull up on handle to move seat fore and aft.
3. Arm rest can be moved up or down for comfort.
4. A two inch seat belt is standard equipment. If required, an optional three inch belt is available.

Seat Belt

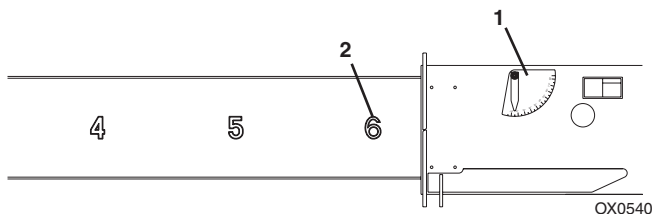


Fasten seat belt as follows:

1. Grasp both free ends of the belt making certain that belt webbing is not twisted or entangled.
2. With back straight in the seat, couple the retractable end (male end) of the belt into the receptacle (buckle) end of the belt.
3. With belt buckle positioned as low on the body as possible, pull the retractable end of the belt away from the buckle until it is tight across the lap.
4. To release belt latch, depress red button on the buckle and pull free end from buckle.

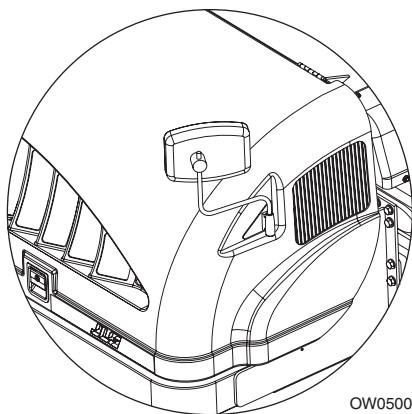
Section 3 - Controls and Indicators

3.4 BOOM ANGLE AND EXTENSION INDICATORS



- The boom angle indicator (1) is located on the left side of the boom. Use this indicator to determine the boom angle when using the capacity chart (see “Use of the Capacity Chart” on page 5-4).
- The boom extension indicators (2) are located on the left side of the boom. Use these indicators to determine boom extension when using the capacity chart (see “Use of the Capacity Chart” on page 5-4).

3.5 MIRROR



- Keep all windows and mirror(s) clean and unobstructed.
- Adjust mirror(s) as required for maximum visibility, before and during operation.

SECTION 4 - OPERATION

4.1 ENGINE

Starting the Engine

This machine can be operated under normal conditions in temperatures of 0°F to 104°F (-20°C to 40°C). Consult JLG for operation outside this range or under abnormal conditions.

1. Make sure all controls are in “Neutral” and all electrical components (lights, heater, defroster, etc.) are turned off. Set parking brake.
2. Turn ignition switch to “START” to engage starting motor. Release key immediately when engine starts. If engine fails to start within 20 seconds, release key and allow starting motor to cool for a few minutes before trying again.
3. After engine starts, observe oil pressure gauge. If gauge remains on zero for more than ten seconds, stop engine and determine cause before restarting engine. Reference engine manual for minimum pressure at operating temperature.
4. Warm up engine at approximately 1/2 throttle.

Note: Engine will not start unless transmission control lever is in “Neutral” and park brake switch is applied.



WARNING

UNEXPECTED MOVEMENT HAZARD. Always ensure that transmission control lever is in neutral and the service brake is applied before releasing park brake. Releasing park brake in either forward or reverse could cause the machine to move abruptly, causing an accident.

Section 4 - Operation

Cold Weather Starting Aids

JLG approved starting aids employ ether. If your telehandler is equipped with an ether starting aid, the following applies:

- Injection of ether is triggered by temperature sensor located on engine.
- At start-up, temperature sensor on engine will detect if ether is needed. Follow normal start-up procedure.
- Ether will be automatically injected if needed, to keep engine running.
- A second battery is added for additional cold-cranking capacity.



WARNING

ENGINE EXPLOSION. If your telehandler is equipped with a cold start aid, do not spray additional ether into air cleaner. If machine is not equipped with cold start aid, follow instructions listed in the engine manual supplied with the telehandler.

Battery Boosted Starting



OW0530

If battery-boost starting (jump-start) is necessary, proceed as follows:

- Never allow vehicles to touch.
- Connect the positive (+) jumper cable to positive (+) post of discharged battery.
- Connect the opposite end of positive (+) jumper cable to positive (+) post of booster battery.
- Connect the negative (-) jumper cable to negative (-) post on booster battery.
- Connect opposite end of negative (-) jumper cable to ground point on machine away from discharged battery.
- Follow standard starting procedures.
- Remove cables in reverse order after machine has started.



WARNING

BATTERY EXPLOSION HAZARD. Never jump start or charge a frozen battery as it could explode. Keep sparks, flames and lighted smoking materials away from the battery. Lead acid batteries generate explosive gases when charging. Wear safety glasses.

Section 4 - Operation

Normal Engine Operation

- Observe gauges frequently to be sure all engine systems are functioning properly.
- **Be alert for unusual noises or vibration.** When an unusual condition is noticed, park machine in safe position and perform shut-down procedure. Report condition to your supervisor or maintenance personnel.
- **Avoid prolonged idling.** If the engine is not being used, turn it off.

Shut-Down Procedure

When parking the telehandler, park in a safe location on flat level ground and away from other equipment and/or traffic lanes.

1. Apply the park brake.
2. Shift the transmission to "Neutral."
3. Lower forks or attachment to the ground.
4. Operate engine at low idle for 3 to 5 minutes. **DO NOT over rev engine.**
5. Shut off engine and remove ignition key.
6. Exit telehandler properly.
7. Block wheels (if necessary).

4.2 OPERATING WITH A LOAD

Lift Load Safely

- You must know the weight and load center of every load you lift. If you are not sure of the weight and load center, check with your supervisor or with the supplier of the material.



WARNING

TIP OVER HAZARD. Exceeding lift capacity of the telehandler could damage the equipment and/or cause tip over.

- Know the rated load capacities (refer to Section 5) of the telehandler to determine the operating range in which you can safely lift, transport and place a load.

Picking Up a Load

- Note the conditions of the terrain. Adjust travel speed and reduce amount of load if conditions warrant.
- Avoid lifting double-tiered loads.
- Make sure load is clear of any adjacent obstacles.
- Adjust spacing of forks so they engage the pallet or load at maximum width. See *"Adjusting/Moving Forks"* on page 5-9.
- Approach load slowly and squarely with fork tips straight and level. **NEVER** attempt to lift a load with just one fork.
- **NEVER** operate telehandler without a proper and legible Capacity Chart in the operator's cab for the telehandler/attachment combination you are using.

Section 4 - Operation

Transporting the Load



After engaging the load and resting it against the backrest, tilt the load back to position it for travel. Travel in accordance with the requirements set forth in Section 1 - General Safety Practices and Section 5 - Attachments.

Leveling Procedure

1. Position machine in best location to lift or place load.
2. Apply parking brake and move transmission control lever to NEUTRAL.
3. Move boom/attachment to 4 ft (1,2 m) off ground.
4. Observe level indicator to determine whether machine must be leveled prior to lifting load.

Important things to remember:

- Never raise the boom/attachment more than 4 ft (1,2 m) above ground unless telehandler is level.
- The combination of sway and load could cause the telehandler to tip over.

The telehandler is designed to permit swaying the main frame 8° to left or right to compensate for uneven ground conditions.

Placing the Load

Before placing any load be sure that:

- The landing point can safely support the weight of the load.
- The landing point is level; front to back and side to side.
- Use the capacity chart to determine safe boom extension range. See *"Use of the Capacity Chart"* on page 5-4.
- Align forks at the level load is to be placed, then position boom slowly until load is just above area where it is to be placed.
- Lower the boom until the load rests in position and the forks are free to retract.

Disengaging the Load

Once the load has been placed safely at the landing point, proceed as follows:

1. With the forks free from the weight of the load, the boom can be retracted and/or the telehandler can be backed away from under the load if surface will not change level condition of telehandler.
2. Lower the carriage.
3. The telehandler can now be driven from the landing location to continue work.

Section 4 - Operation

4.3 OPERATING WITH A SUSPENDED LOAD

Lift Load Safely

- You must know the weight and load center of every load you lift. If you are not sure of the weight and load center, check with your supervisor or with the supplier of the material.



WARNING

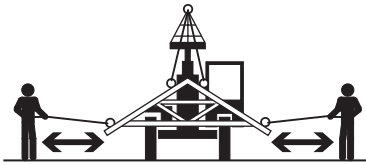
TIP OVER HAZARD. Exceeding lift capacity of the telehandler could damage the equipment and/or cause tip over.

- Know the rated load capacities (refer to Section 5) of the telehandler to determine the operating range in which you can safely lift, transport and place a load.

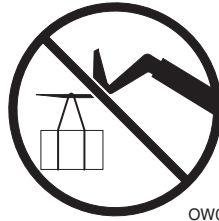
Picking Up a Suspended Load

- Note the conditions of the terrain. Adjust travel speed and reduce amount of load if conditions warrant.
- Avoid lifting double-tiered loads.
- Make sure load is clear of any adjacent obstacles.
- **NEVER** operate telehandler without a proper and legible capacity chart in the operator cab for the telehandler/attachment combination you are using.
- Only use approved lifting devices rated for the lifting of the load.
- Identify the proper lifting points of the load, taking into consideration the center of gravity and load stability.
- Ensure to always properly tether loads to restrict movement.
- Refer to See *"Use of the Capacity Chart"* on page 5-4. for proper lifting guidelines in addition to the appropriate capacity chart in the operator cab.

Transporting a Suspended Load



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- Travel in accordance with the requirements set forth in Section 1 - General Safety Practices and Section 5 - Attachments.
- For additional requirements, refer to the appropriate capacity chart in the operator cab.

Important things to remember:

- Ensure the boom is fully retracted.
- Never raise the load more than 11.8 in (300 mm) above ground surface or the boom more than 45°.
- The combination of frame leveling and load could cause the telehandler to tip over.
- The guide men and operator must remain in constant communication (verbal or hand) and be in visual contact with the operator at all times.
- Never place the guide men between the suspended load and the telehandler.
- Only transport the load at walking speed, 0.9 mph (0.4 m/s), or less.

Leveling Procedure

1. Position machine in best location to lift or place load.
2. Apply parking brake and move transmission control lever to NEUTRAL.
3. Move boom so load is no more than 11.8 in (300 mm) above ground surface and boom/or boom is raised no more than 45°.
4. Observe level indicator to determine whether machine must be leveled prior to lifting load. Level machine with frame level joystick.

The telehandler is designed to permit leveling the main frame 8° to left or right to compensate for uneven ground conditions.

Section 4 - Operation

Placing a Suspended Load

Before placing any load be sure that:

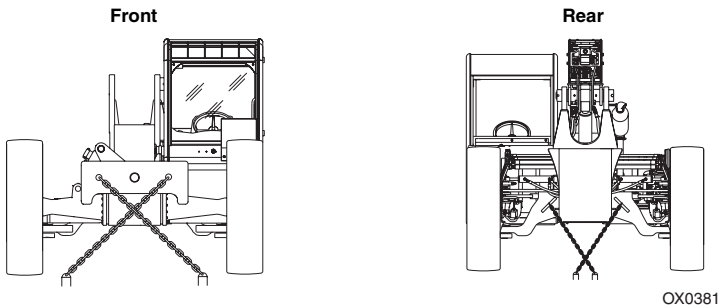
- The landing point can safely support the weight of the load.
- The landing point is level; front to back and side to side.
- Use the capacity chart to determine safe boom extension range. See *"Use of the Capacity Chart"* on page 5-4.
- Align load at the level load is to be placed, then position boom slowly until load is just above area where it is to be placed.
- Ensure that the guide men and operator remain in constant communication (verbal or hand) when placing the load.

Disengaging a Suspended Load

- Never place the guide men between the suspended load and the telehandler.
- Once at the destination of the load, ensure to bring the telehandler to a complete stop and apply the park brake prior to disengagement of the lifting devices and tethers.

4.4 LOADING AND SECURING FOR TRANSPORT

Tiedown



1. Level the telehandler prior to loading.
2. Using a spotter, load the telehandler with boom as low as possible.
3. Once loaded, apply parking brake and lower boom until boom or attachment is resting on deck. Move all controls to "Neutral," stop engine and remove ignition key.
4. Secure machine to deck by passing chains through the designated tiedown points as shown in the figure.
5. Do not tiedown front of boom.

Note: The user assumes all responsibility for choosing the proper method of transportation and tie-down devices, making sure the equipment used is capable of supporting the weight of the vehicle being transported and that all manufacturer's instructions and warnings, regulations and safety rules of their employer, the Department of Transportation and/or any other state or federal laws are followed.



WARNING

TELEHANDLER SLIDE HAZARD. Before loading telehandler for transport, make sure deck, ramps and telehandler wheels are free of mud, snow and ice. Failure to do so could cause telehandler to slide.

Section 4 - Operation

Lifting

- When lifting machine, it is very important that the lifting device and equipment is attached only to designated lifting points. If machine is not equipped with lifting lugs contact JLG Product Safety for information.
- Make adjustments to the lifting device and equipment to ensure the machine will be level when elevated. The machine must remain level at all times while being lifted.
- Ensure that the lifting device and equipment is adequately rated and suitable for the intended purpose. See Section 9 - Specifications for machine weight.
- Remove all loose items from machine prior to lifting.
- Lift machine with smooth, even motion. Set machine down gently. Avoid quick or sudden motions that could cause shock loads to machine and/or lifting devices.

SECTION 5 - ATTACHMENTS

5.1 APPROVED ATTACHMENTS

To determine if an attachment is approved for use on the specific telehandler you are using, perform the following prior to installation.

Before S/N 0160037689

- The attachment model/option number on the attachment identification plate must match the attachment number on a capacity chart located in the operator cab.
- The model on the capacity chart must match the model telehandler being used.
- The load center of the fork (if equipped) must match the load center as indicated on the capacity chart.
- Hydraulically powered attachments must only be used on machines equipped with auxiliary hydraulics.
- Hydraulically powered attachments that require auxiliary electrics must only be used on machines equipped with auxiliary hydraulics and electrics.

S/N 0160037689 & After

- The attachment type, weight, dimensions and load center must be equal to or less than the data shown on a capacity chart located in the operator cab.
- The model on the capacity chart must match the model telehandler being used.
- Hydraulically powered attachments must only be used on machines equipped with auxiliary hydraulics.
- Hydraulically powered attachments that require auxiliary electrics must only be used on machines equipped with auxiliary hydraulics and electrics.

If any of the above conditions are not met, do not use the attachment. The telehandler may not be equipped with the proper capacity chart or the attachment may not be approved for the model telehandler being used. Contact JLG or a local distributor for further information.

Section 5 - Attachments

5.2 UNAPPROVED ATTACHMENTS

Do not use unapproved attachments for the following reasons:

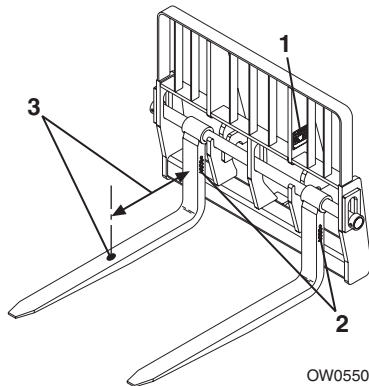
- Range and capacity limitations for “will fit,” homemade, altered, or other non-approved attachments cannot be established.
- An overextended or overloaded telehandler can tip over with little or no warning and cause serious injury or death to the operator and/or those working nearby.
- The ability of a non-approved attachment to perform its intended function safely cannot be assured.



WARNING

Use only approved attachments. Attachments which have not been approved for use with your telehandler could cause machine damage or an accident.

5.3 TELEHANDLER/ATTACHMENT/FORK CAPACITY



Prior to installing the attachment verify it is approved and the telehandler is equipped with the proper capacity chart. See “*Approved Attachments*” on page 5-1.

To determine the maximum capacity of the telehandler and attachment, use the **smallest** of the following capacities:

- Capacity stamped on the attachment identification plate (1).
- Fork capacities and load centers are stamped on the side of each fork (2) (if equipped). This rating specifies the maximum load capacity that the individual fork can safely carry at the maximum load center (3). Total attachment capacity is multiplied by the number of forks on the attachment (if equipped), up to the maximum capacity of the attachment.
- Maximum capacity as indicated on the proper capacity chart. See “*Approved Attachments*” on page 5-1.
- When the load rating of the telehandler differs from the capacity of the forks or attachment, the lower value becomes the overall load capacity.

Use the proper capacity chart to determine maximum capacity at various machine configurations. Lifting and placing a load may require use of more than one capacity chart based on machine configuration.

Other than block forks, all forks should be used in matched pairs, block forks used in matched sets.



WARNING

Never use an attachment without the appropriate JLG approved capacity chart installed on the telehandler.

Section 5 - Attachments

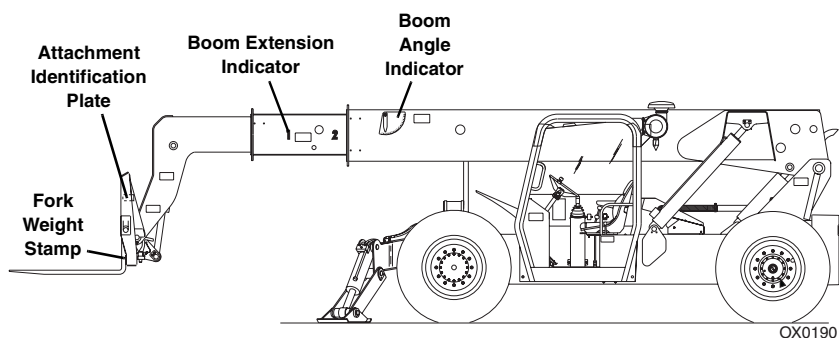
5.4 USE OF THE CAPACITY CHART

To properly use the capacity chart (see page 5-5), the operator must first determine and/or have the following:

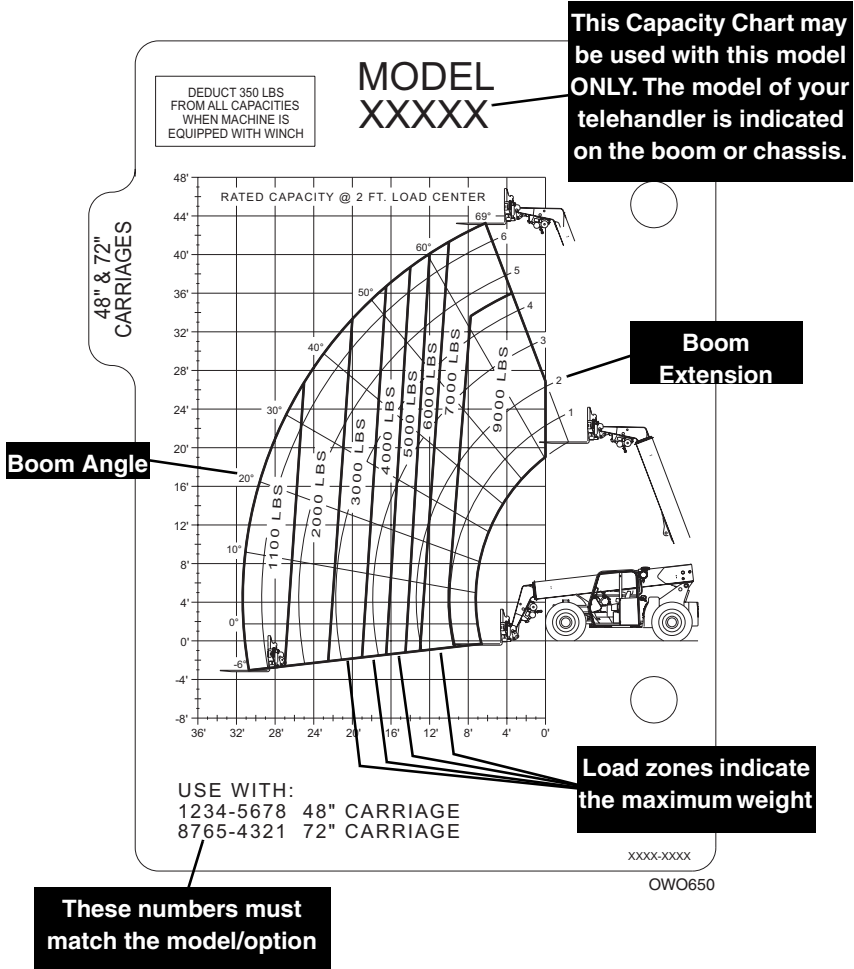
1. A JLG approved attachment. See “*Approved Attachments*” on page 5-1.
2. The proper Capacity Chart(s).
3. Weight of the load being lifted.
4. Load placement information:
 - a. HEIGHT where the load is to be placed.
 - b. DISTANCE from the front tires of the telehandler where the load is to be placed.
5. On the Capacity Chart, find the line for the height and follow it over to the distance.
6. The number in the load zone where the two cross is the maximum capacity for this lift. If the two cross at a division between zones, the smaller number must be used.

The number in the load zone must be equal to or greater than the weight of the load to be lifted. Determine the limits of the load zone on the Capacity Chart and keep within these limits.

Capacity Indicator Locations



Sample Capacity Chart



Note: This is a sample capacity chart **only!** **DO NOT** use this chart, use the one located in your operator cab.



WARNING

TIP OVER HAZARD. All loads shown on rated capacity chart are based on machine being on firm ground with frame level (see page 4-6); the forks being positioned evenly on carriage; the load being centered on forks; proper size tires being properly inflated; and the telehandler being in good operating condition.

Section 5 - Attachments

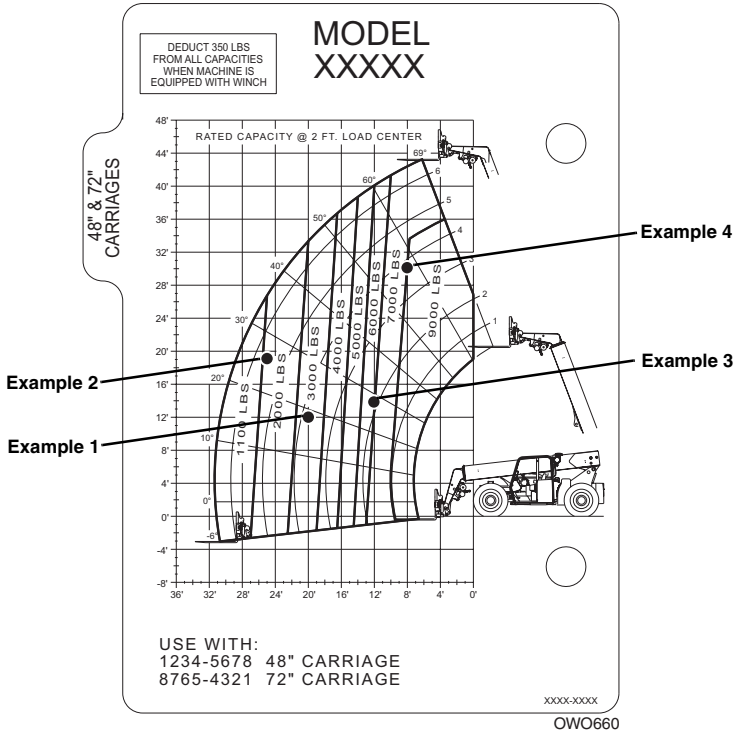
Example

A contractor owns a model xxxxx telehandler with a 48" Carriage. He knows this attachment may be used with his model since:

- The attachment model/option number, matches the attachment number on the capacity chart.
- The capacity chart is clearly marked for model xxxxx and corresponds with machine configuration being used.

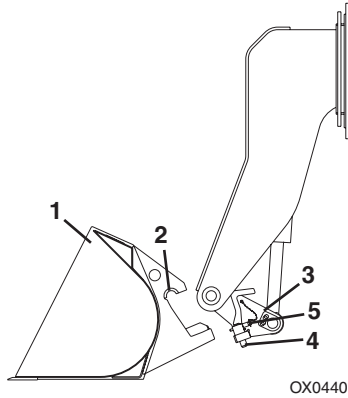
Below are examples with various conditions the contractor may encounter and whether or not the load may be lifted.

	Load Weight	Distance	Height	OK to Lift
1	2000 lbs (907 kg)	20 ft (6,1 m)	12 ft (3,6 m)	Yes
2	3000 lbs (1361 kg)	25 ft (7,6 m)	19 ft (5,8 m)	NO
3	6000 lbs (2722 kg)	12 ft (3,6 m)	14 ft (4,3 m)	Yes
4	8000 lbs (3629 kg)	8 ft (2,4 m)	30 ft (9,1 m)	NO



Note: This is a sample capacity chart **only!** **DO NOT** use this chart, use the one located in your operator cab.

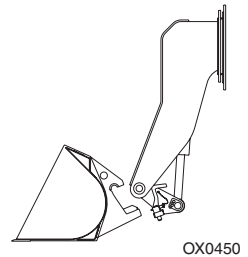
5.5 ATTACHMENT INSTALLATION



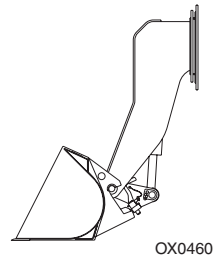
1. Attachment
2. Attachment Pivot Pin Recess
3. Quick Switch
4. Lock Pin
5. Retaining Pin

This installation procedure is designed for one-person operation.

1. Retract Quick Switch™ to provide clearance.
Check to be sure lock pin is secured in out position with retainer pin.

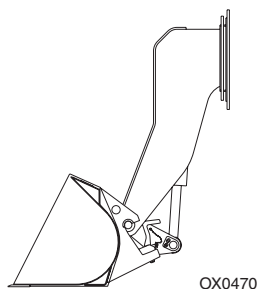


2. Align attachment pivot pin with recess in attachment. Raise boom slightly to engage attachment pivot pin in recess.

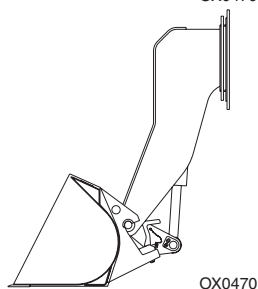


Section 5 - Attachments

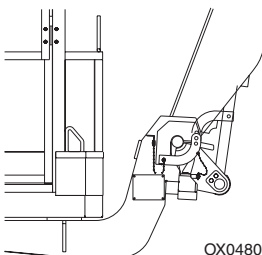
- Engage Quick Switch™.



- Shut off engine. Exit cab and remove retainer pin and slide lock pin in fully. Secure lock pin in locked position using retainer pin.



- If equipped, swing attachment saddles down and pin in place.



- If equipped, connect auxiliary hydraulic hoses.
- If equipped, connect auxiliary electric harness.



WARNING

CRUSH HAZARD. Always be certain that carriage or attachment is properly positioned on boom and is secured by lock pin and retainer pin. Failure to ensure proper installation could permit carriage/attachment/load to disengage.

5.6 ADJUSTING/MOVING FORKS

Carriages may have different locations where forks can be positioned. Two different methods can be used for repositioning, depending upon the carriage structure.

Note: *Apply a light coating of appropriate lubricant to ease sliding of forks or fork bar.*

To slide forks:

1. Ensure attachment is properly installed. Refer to “Attachment Installation” on page 5-7.
2. Elevate attachment to approximately 5 ft (1,5 m) and tilt carriage forward until fork heel is free from attachment.
3. Stand at the side of the carriage. To slide fork toward the center of the carriage, push the fork near the fork eye. To slide fork toward the edge of the carriage, pull the fork near the fork eye. To avoid pinching, do not place fingers or thumb between the fork and carriage structure.

If removing fork bar is necessary:

1. Rest forks on ground.
2. Remove fork bar.
3. Reposition forks.
4. Reinstall the fork bar and fork bar retaining mechanism(s).

5.7 ATTACHMENT OPERATION

- Capacities and range limits for the telehandler change depending on the attachment in use.
- Separate attachment instructions must be kept in Manual Holder in cab with this Operation & Safety Manual. An additional copy must be kept with the attachment if it is equipped with a manual holder.

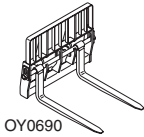
NOTICE

EQUIPMENT DAMAGE. Some attachments may contact the front tires or machine structure when the boom is retracted and the attachment is rotated. Improper use of attachment may result in attachment or machine structural damage.

NOTICE

EQUIPMENT DAMAGE. Avoid contact with any structure or object when lifting a load. Maintain clearance around boom structure and load. Failure to maintain clearance may result in attachment or machine structural damage.

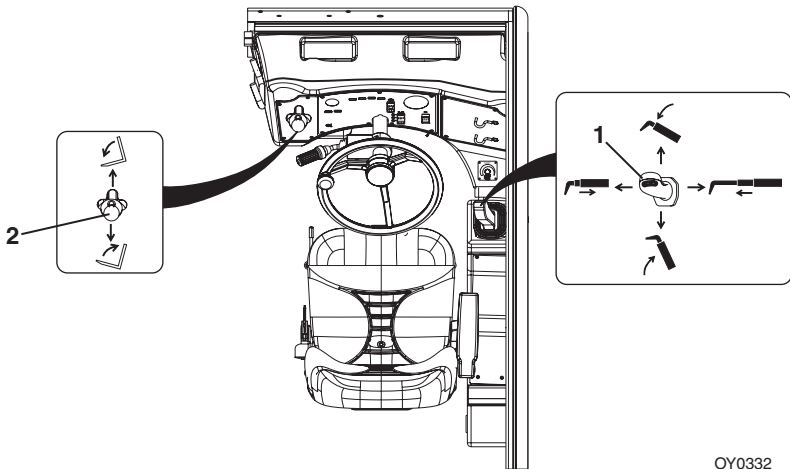
Carriage w/Forks



<u>Description</u>	<u>P/N</u>
Carriage, 48 in	91405073
Carriage, 72 in	91405074
Carriage, Drywall	91405077
Fork, Cubing 2x2x48 in.....	91403359
Fork 1-3/4x4x48 in.....	91403364
Fork, Drywall 1-3/4x4x48 in	91403366
Fork 2x6x60 in	91403580
Fork 2-1/4x5x48 in.....	91563141
Fork 2-1/4x6x60 in.....	91563142

Use Carriage Attachment Capacity Chart

To determine maximum capacity, refer to “Telehandler/Attachment/Fork Capacity” on page 5-3.



OY0332

The joystick (1) controls lift/lower and the extend/retract movement of the boom.

The tilt lever (2) controls the fork tilt.

- Move joystick forward to tilt down.
- Move joystick back to tilt up.

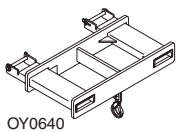
Installation Procedure:

Refer to “Attachment Installation” on page 5-7.

•

Section 5 - Attachments

Crane Hook

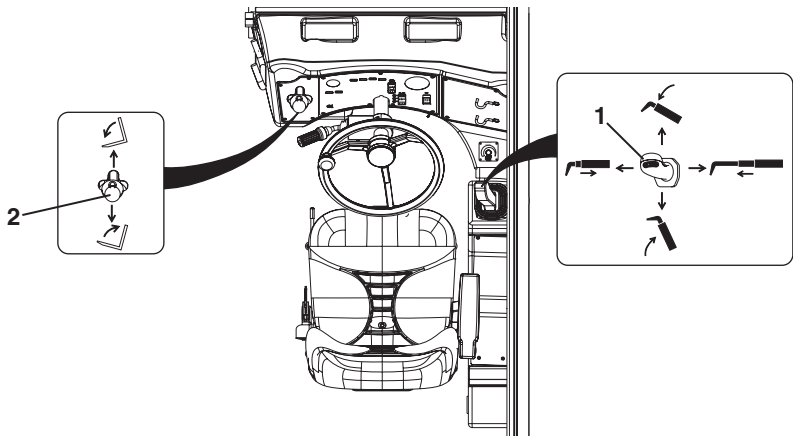


Description	P/N
Crane Hook.....	91565094

Use Appropriate Carriage Attachment Capacity Chart

To determine maximum capacity, refer to “Telehandler/Attachment/Fork Capacity” on page 5-3.

Suspend loads in accordance with requirements set forth in Section 1 - General Safety Practices.



The joystick (1) controls lift/lower and the extend/retract movement of the boom.

The tilt lever (2) controls the crane hook tilt.

- Move lever forward to tilt down.
- Move lever back to tilt up.

Installation Procedure:

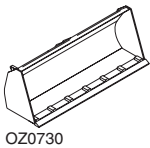
- Refer to “Attachment Installation” on page 5-7.
- Secure the crane hook to the forks by sliding the crane hook onto the parent forks and install the retaining pin behind the vertical shank of the fork.

Operation:

- Pallet or lumber forks of an appropriate load rating must be used. Do not use with cubing or block forks.
- Weight of crane hook and rigging must be included as part of total load being lifted.
- Do not use crane hook with attachments capable of rotating (i.e. side tilt and swing carriages) without disabling the rotation feature(s).

Section 5 - Attachments

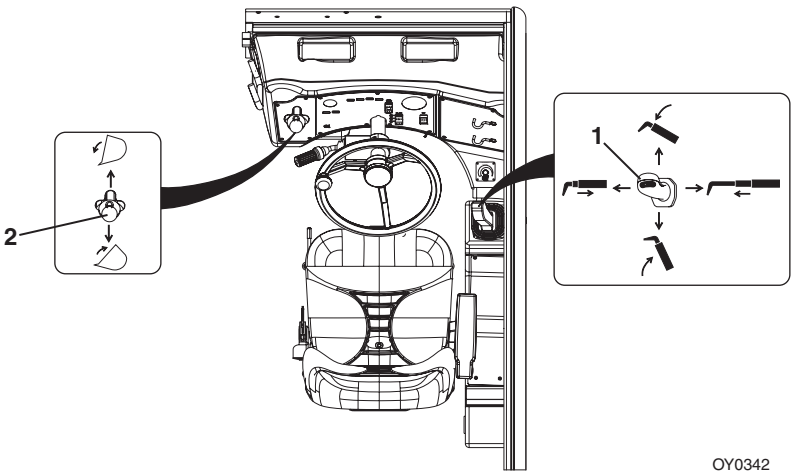
Bucket



Description	P/N
Bucket 60 in - 3/4 yd ³	91405054
Bucket 74 in - 1-1/4 yd ³	91405055
Bucket 102 in - 1-1/4 yd ³	91405071

Use Appropriate Bucket Capacity Chart

To determine maximum capacity, refer to “Telehandler/Attachment/Fork Capacity” on page 5-3.



The joystick (1) controls lift/lower and the extend/retract movement of the boom.

The tilt lever (2) controls bucket tilt.

- Move joystick forward to tilt down.
- Move joystick back to tilt up.

Installation Procedure:

- Refer to “Attachment Installation” on page 5-7.

Equipment Damage Precautions

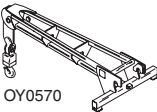
- Drive into stockpile smoothly with boom fully retracted to load bucket. Loading bucket with boom extended could damage boom or extension chains/cables. Do not corner-load bucket.
- Do not use bucket as a lever to pry material. Excessive prying forces could damage bucket.
- Do not use bucket for "back dragging." This could cause severe damage to quick switch and retraction cables/chains.

Operation:

- Raise or lower boom to appropriate height for loading material from stockpile.
- Align telehandler with face of stockpile and drive slowly and smoothly into pile to load bucket.
- Tilt bucket up far enough to retain load and back away from pile.
- Travel in accordance with requirements set forth in Section 1 - General Safety Practices.
- Tilt bucket down to dump load.

Section 5 - Attachments

Truss Boom

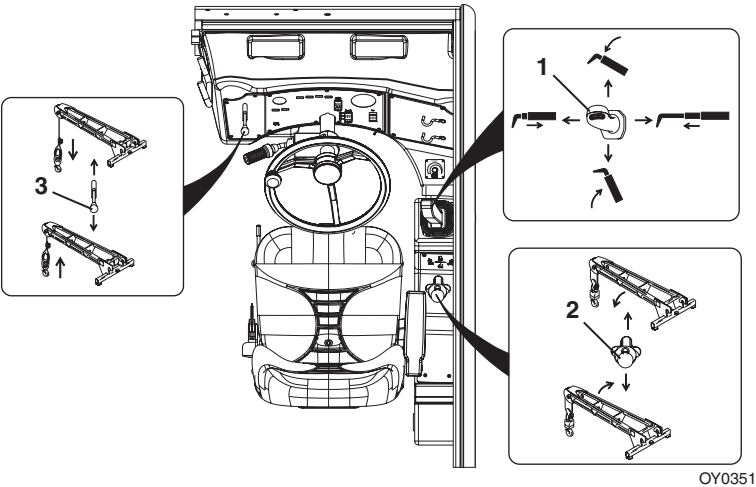


Description	P/N
Truss Boom 10 ft w/winch	91405081
Truss Boom 10 ft.....	91405083
Truss Boom 15 ft w/winch	91405080
Truss Boom 15 ft.....	91405082

Use Truss Boom Attachment Capacity Chart

To determine maximum capacity, refer to “Telehandler/Attachment/Fork Capacity” on page 5-3.

Suspend loads in accordance with requirements set forth in Section 1 - General Safety Practices.



The joystick (1) controls lift/lower and the extend/retract movement of the boom.

Truss Boom Control:

The rear joystick (2) controls truss boom tilt.

- Move joystick forward to tilt down.
- Move joystick back to tilt up.

Truss Boom W/Winch Control:

The auxiliary joystick (3) controls the truss boom mounted winch.

- Move joystick up to lower cable.
- Move joystick down to raise cable.

Installation Procedure:

- Refer to “Attachment Installation” on page 5-7.

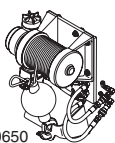


WARNING

CRUSH HAZARD. Maintain a minimum of three wraps of wire rope on the cable drum at all times. Failure to comply could cause object or load to fall.

Section 5 - Attachments

Boom Head-Mounted Winch

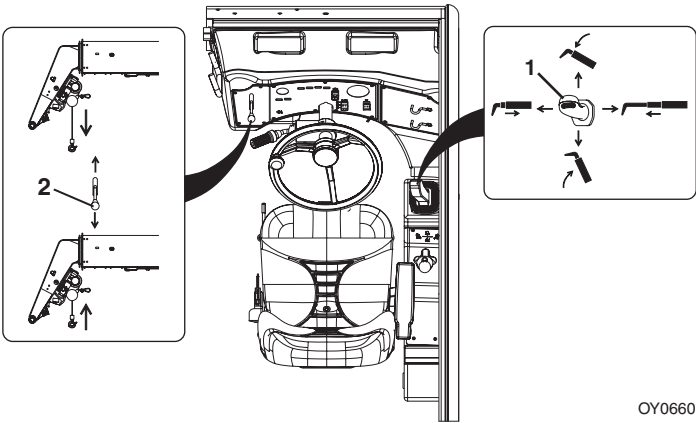


Description	P/N
Winch.....	91515036

Use Carriage Attachment Capacity Chart

To determine maximum capacity, refer to “Telehandler/Attachment/Fork Capacity” on page 5-3.

Suspend loads in accordance with requirements set forth in Section 1 - General Safety Practices.



The joystick (1) controls lift/lower and the extend/retract movement of the boom.

Winch Control:

The auxiliary control joystick (2) controls the winch.

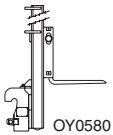
- Move joystick up to lower cable.
- Move joystick down to raise cable.



WARNING

CRUSH HAZARD. Maintain a minimum of three wraps of wire rope on the cable drum at all times. Failure to comply could cause object or load to fall.

6 ft (1,8 m) Mast with 48 or 72 in (1,2 & 1,8 m) Carriage



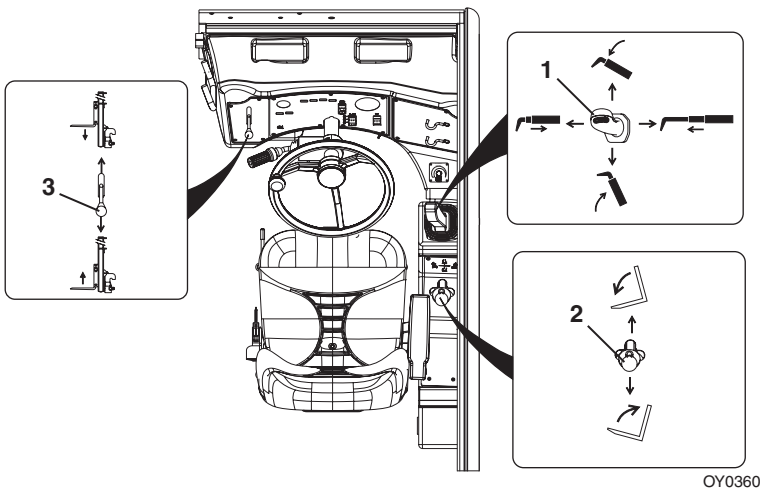
Description

P/N

Mast 48 in	91405060
Mast 72 in	91405061

Use 6 ft Mast Attachment Capacity Chart

To determine maximum capacity, refer to “Telehandler/Attachment/Fork Capacity” on page 5-3.



OY0360

The joystick (1) controls lift/lower and the extend/retract movement of the boom.

The rear joystick (2) controls the mast tilt.

- Move joystick forward to tilt down.
- Move joystick back to tilt up.

To Raise/Lower Mast:

The auxiliary control joystick (3) controls the lift/lower movement of the mast.

- Move joystick up to lower forks.
- Move joystick down to raise forks.

Section 5 - Attachments

Installation Procedure:

- Refer to “Attachment Installation” on page 5-7.



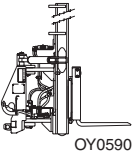
WARNING

CRUSH HAZARD. Do not use mast to push or pull objects or load. Failure to comply could cause object or load to fall.

Operation:

- Lower forks fully in mast before engaging load.
- Travel in accordance with requirements set forth in Section 1 - General Safety Practices.
- Use a signal person to assist in positioning of load if necessary.

6 ft (1,8 m) - 100° Swing Mast W/Side Shift



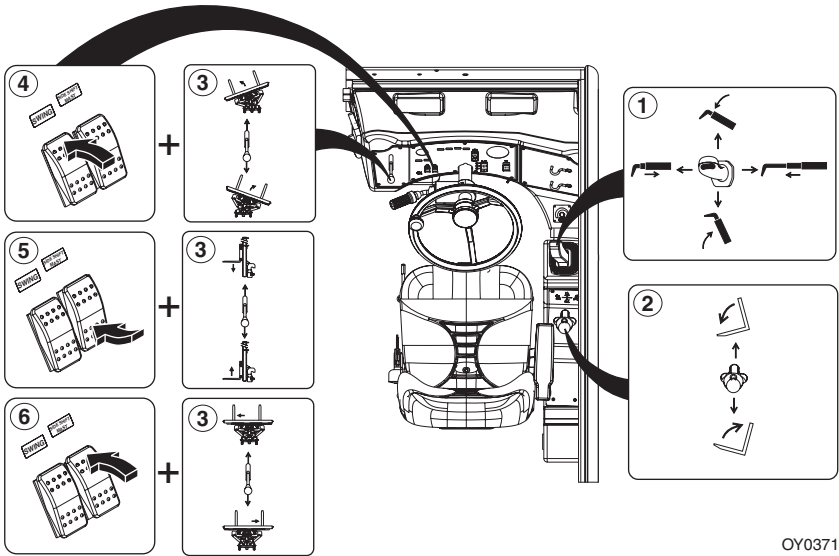
Description

P/N

Mast w/ 48 in Fork	91405070
Mast w/ 60 in Fork	91415026

Use 6 ft Swing Mast Attachment Capacity Chart

To determine maximum capacity, refer to “Telehandler/Attachment/Fork Capacity” on page 5-3.



OY0371

The joystick (1) controls lift/lower and the extend/retract movement of the boom.

The rear joystick (2) controls the mast tilt.

- Move joystick forward to tilt down.
- Move joystick back to tilt up.

Section 5 - Attachments

To Swing:

- Pull Swing Switch (4) back, located on dash panel to activate Swing function. With Swing Switch activated, move the auxiliary control joystick (3) down to swing forks right or up to swing forks left.

To Raise/Lower Mast:

- Pull Forks Raise/Lower Switch (5) back, located on dash panel to activate Forks Raise/Lower function. With Forks Raise/Lower Switch activated, move the auxiliary control joystick (3) down to raise forks or up to lower forks.

To Side Shift:

- Press Side Shift Switch (6) forward, located on dash panel to activate Side Shift function. With Side Shift Switch activated, move the auxiliary control joystick (3) down to shift forks right or up to shift forks left.

Installation Procedure:

- Refer to “Attachment Installation” on page 5-7.



WARNING

CRUSH HAZARD. Always level forks (horizontally) and telehandler frame before swinging load to side. Swinging unlevel forks could cause load to slide off forks.



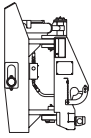
WARNING

CRUSH HAZARD. Do not use mast to push or pull objects or load. Failure to comply could cause object or load to fall.

Operation:

- Always lower forks fully in mast and position forks straight ahead before engaging load.
- To drive with a load, lower forks fully in mast, keep forks pointed forward and travel in accordance with the requirements set forth in Section 1 - General Safety Practices.
- Use a signal person to assist in positioning load if necessary.

Swing Carriage



OY0670

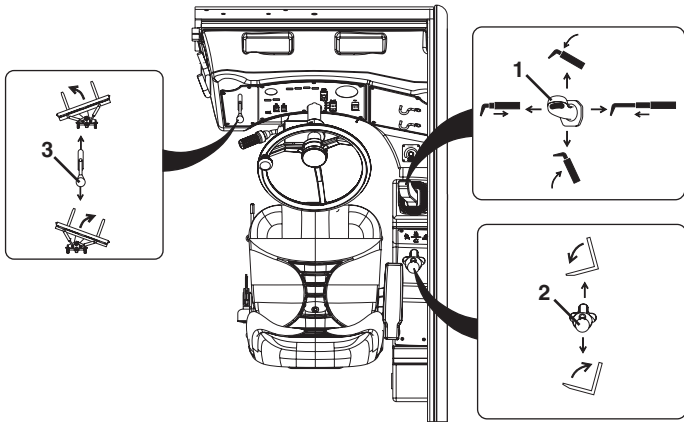
Description

P/N

100° Swing Carriage	91405075
100° Swing Drywall Carriage	91405078
180° Swing Carriage	91563146

Use Swing Carriage Attachment Capacity Chart

To determine maximum capacity, refer to “Telehandler/Attachment/Fork Capacity” on page 5-3.



OY0680

The joystick (1) controls lift/lower and the extend/retract movement of the boom.

The rear joystick (2) controls the carriage tilt.

- Move joystick forward to tilt down.
- Move joystick back to tilt up.

To Swing:

The auxiliary control joystick (3) controls the Swing function.

- Move joystick up to swing left.
- Move joystick down to swing right.



WARNING

CRUSH HAZARD. Always level forks (horizontally) and telehandler frame before swinging load to side. Swinging unlevel forks could cause load to slide off forks.



WARNING

CRUSH HAZARD. Do not use swing carriage to push or pull objects or load. Failure to comply could cause object or load to fall.



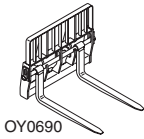
WARNING

CRUSH HAZARD. Use retaining pin (if equipped) for locking swing frame to fixed frame when carrying loads greater than 5000 lb. Failure to comply could cause object or load to fall.

Operation:

- To drive with a load, keep forks pointed forward and travel in accordance with the requirements set forth in Section 1 - General Safety Practices.

Side Tilt Carriage



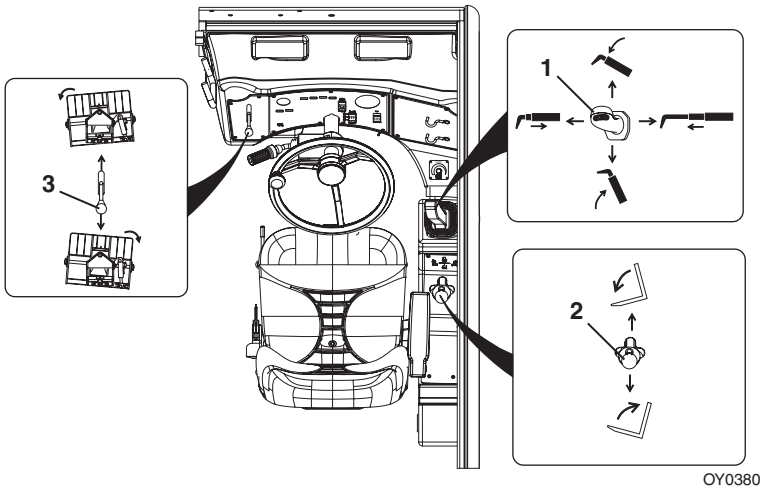
Description

P/N

Side Tilt 48 in.....	91405101
Side Tilt 72 in.....	91405079

Use Side Tilt Attachment Capacity Chart

To determine maximum capacity, refer to *“Telehandler/Attachment/Fork Capacity”* on page 5-3.



The joystick (1) controls lift/lower and the extend/retract movement of the boom.

The rear joystick (2) controls the mast tilt.

- Move joystick forward to tilt down.
- Move joystick back to tilt up.

To Side Tilt:

The auxiliary control joystick (3) controls the carriage side tilt.

- Move joystick up to (side) tilt carriage left.
- Move joystick down to (side) tilt carriage right.

Section 5 - Attachments

Installation Procedure:

- Refer to “*Attachment Installation*” on page 5-7.

Operation:

- Approach load with forks centered on load and stop telehandler.
- Level telehandler before side tilting carriage to engage load.
- Side tilt carriage to left or right to align forks with load and engage load.
- Raise load slightly and then level carriage side to side.
- Travel in accordance with requirements set forth in Section 1 - General Safety Practices.

Personnel Work Platform

The operator and personnel in platform must read and understand the separate personnel work platform manual prior to installing and using a platform.

Preparation and Setup

1. Check to ensure the personnel platform is securely attached at the Quick Switch™ or is securely attached to the forks and/or carriage is using a fork mounted personnel work platform. Follow installation procedure on page 5-7 for JLG Quick Switch™ mounted personnel work platforms.
2. Ensure the telehandler is on a firm surface and is level.
3. Engage the park brake. Blocking the wheels is also recommended.
4. Level the platform, both side to side (frame sway) and front to back (attachment tilt).
5. Keep area under the platform free from personnel.
6. When personnel are on platform, the operator must remain seated in cab with personnel in direct line of sight.
7. **DO NOT** lift or carry persons in the bucket or on forks.

Never tilt the platform forward, rearward, or sway the machine when the platform is occupied. Serious injury or death could result.

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SECTION 6 - EMERGENCY PROCEDURES

6.1 TOWING A DISABLED PRODUCT

The following information assumes the telehandler cannot be moved under its own power.

- Before moving the telehandler, read all of the following information to understand options available. Then select the appropriate method.
- The steering system permits manual steering if engine or power assist feature fails; however, **steering will be slow and will require much greater force.**
- **DO NOT** attempt to tow a telehandler that is loaded or the boom/attachment is raised above 4 ft (1,2 m).

Moving Short Distances

- If it is only necessary to move telehandler a short distance, less than 100 ft (30 m), it is permissible to use a vehicle of sufficient capacity to tow the unit with no previous preparation.

Moving Longer Distances

- If the telehandler must be moved longer distances, it must be loaded onto a trailer of sufficient capacity.

Contact your local Authorized Distributor for specific instructions if neither of these methods are applicable.

Section 6 - Emergency Procedures

6.2 EMERGENCY LOWER OF BOOM

In the event of total loss of engine power or hydraulic pump failure with an elevated load, the situation must be properly evaluated and dealt with on an individual basis.

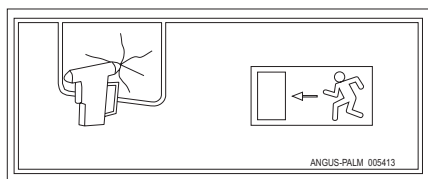
Contact your local Authorized Distributor for specific instructions.

Secure the telehandler using the following procedures:

1. Clear the area around telehandler of all personnel.
2. Engage the parking brake. Place the transmission control lever in "NEUTRAL".
3. Block all four wheels.
4. Section off a large area under the boom with string or tape to restrict any personnel from entering this area.

6.3 EMERGENCY EXIT FROM ENCLOSED CAB

In an emergency, an escape hammer, located directly below the rear window in an enclosed cab, can be used to exit the telehandler.



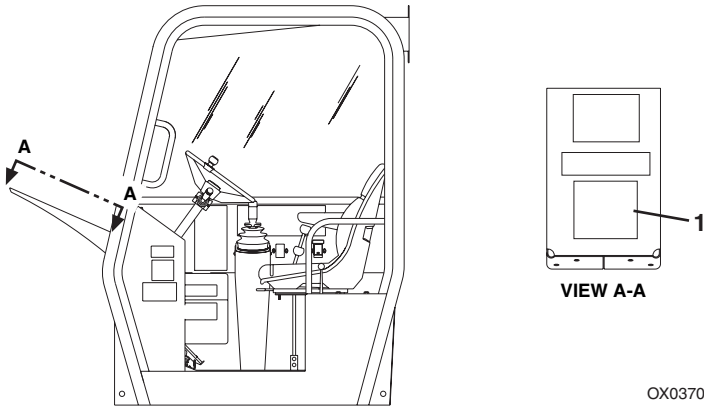
OWO740

SECTION 7 - LUBRICATION AND MAINTENANCE

7.1 INTRODUCTION

Service the product in accordance with the maintenance schedule on the following pages.

Service intervals are based on machine usage of 1500 hours annually. Use of your product may vary significantly and you must adjust service frequency for your usage to obtain maximum service life.



The Service Instruction Plate (1) is located as indicated in figure. It contains general service instructions that must be followed to keep this product in good operating condition. The Operation & Safety Manual and Service Manual contain more detailed service information with specific instructions.

Clothing and Safety Gear

- Wear all the protective clothing and personal safety devices issued to you or called for by job conditions.
- **DO NOT** wear loose clothing or jewelry that can get caught on controls or moving parts.

Section 7 - Lubrication and Maintenance

7.2 GENERAL MAINTENANCE INSTRUCTIONS

Prior to performing any service or maintenance on the telehandler, follow the shut-down procedure on page 4-4 unless otherwise instructed. Ensure telehandler is level, for proper fluid readings.

- Clean lubrication fittings before lubricating.
- After greasing telehandler, cycle all functions several times to distribute lubricants. Perform this maintenance procedure without attachment installed.
- Apply a light coating of engine oil to all linkage pivot points.
- Intervals shown are for normal usage and conditions. Adjust intervals for abnormal usage and conditions.
- Drain engine and gear cases after operating when oil is hot.
- Check all lubricant levels when lubricant is cool. For ease of filling hydraulic reservoir, use a funnel with a hose or flexible tube for best results.

Note: Be certain to check boom cable adjustment every 5 weeks or 250 hours and adjust as required. Cable damage can occur if cable is not adjusted properly.



WARNING

CUT/CRUSH/BURN HAZARD. Do not perform service or maintenance on the machine with the engine running, with the exception of the transmission level and hydraulic return filter indicator checks.

7.3 SERVICE AND MAINTENANCE SCHEDULES

10 & 1st 50 Hour Maintenance Schedule

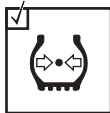


EVERY

10 



Check Fuel
Level



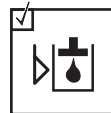
Check Tire
Pressure



Air Filter
Restriction
Indicator



Check Engine
Oil Level



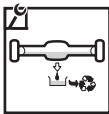
Check Hydraulic
Oil Level



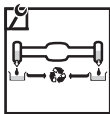
Check Hydraulic
Return Filter
Indicator

1st

50 



Change
Axle Oil



Change Wheel
End Oil



Change Engine
Oil & Filter



Check Wheel
Lug Nut
Torque



Check Boom
Cable Tension

OX0201

Section 7 - Lubrication and Maintenance

50, 250 & 500 Hour Maintenance Schedule

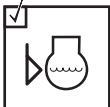


EVERY

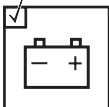
50



Drain Fuel/
Water
Separator



Check Engine
Coolant Level



Check
Battery



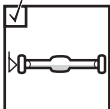
Lubrication
Schedule

EVERY

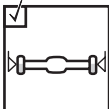
250



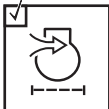
Change Engine
Oil and
Filter*



Check Front
Axle
Oil Level



Check Front &
Rear Wheel
End Oil Levels



Air Filter
Vacuator
Valve



Check
Fan Belt



Check Boom
Cable
Tension



Check Boom
Bearing
Pads



Check
Rear Axle
Stabilization

EVERY

500



Change Fuel
Filter



Check Wheel
Lug Nut
Torque

OX0530

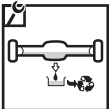
Note: Engine oil & filter service interval can be extended, see page 7-12 for details.

Section 7 - Lubrication and Maintenance

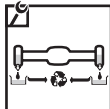
1000 & 1500 Hour Maintenance Schedule



EVERY
1000 



Change Front
Axle Oil



Change Front &
Rear Wheel
End Oil

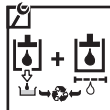


Change
Hydraulic Tank
Breather

EVERY
1500 



Change
Engine Coolant



Change
Hydraulic
Fluid & Filters

OY1041

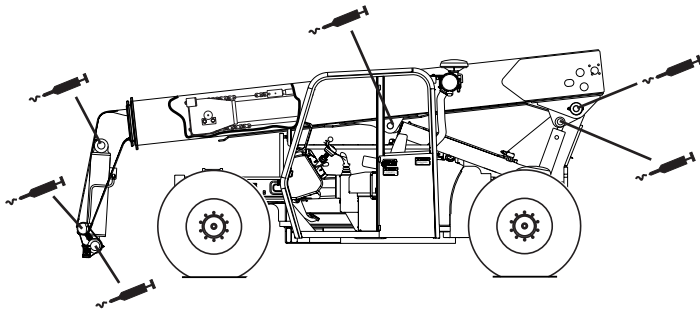
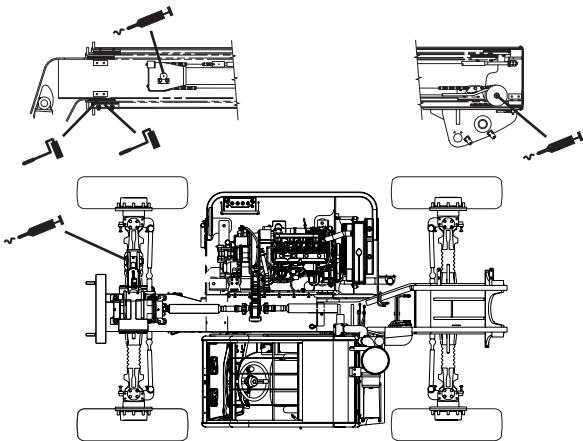
7.4 LUBRICATION SCHEDULES

50 Hour Lubrication Schedule



EVERY
50 ⌚

Mystik Tetrimoly Grease
(NLGI 2 GC-LB)

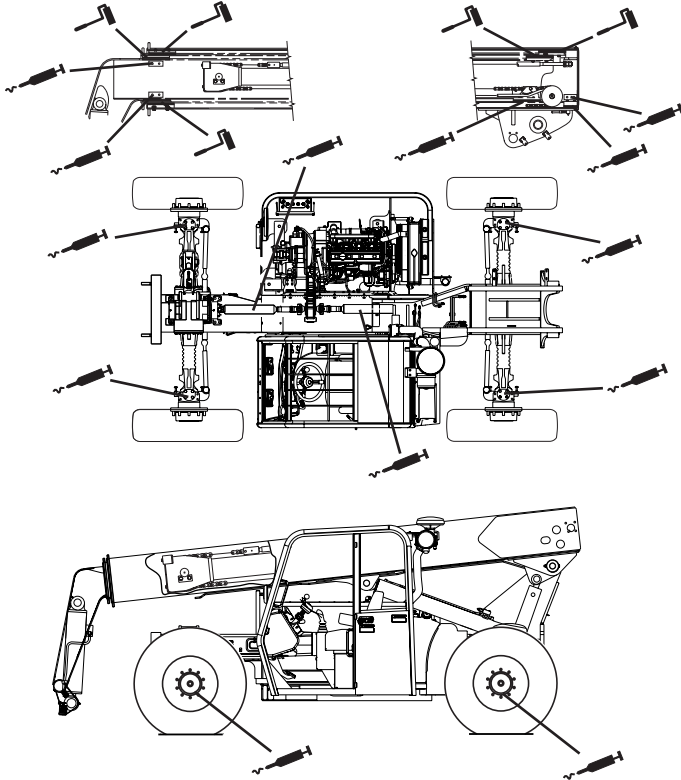


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250 Hour Lubrication Schedule

EVERY
250 

Mystik Tetrimoly Grease
(NLGI 2 GC-LB)



0700290

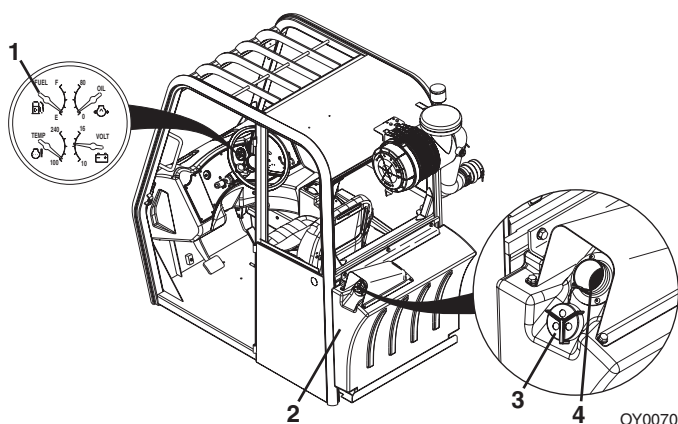
Section 7 - Lubrication and Maintenance

7.5 OPERATOR MAINTENANCE INSTRUCTIONS

Fuel System

A. Fuel Level Check

10 
OW0970

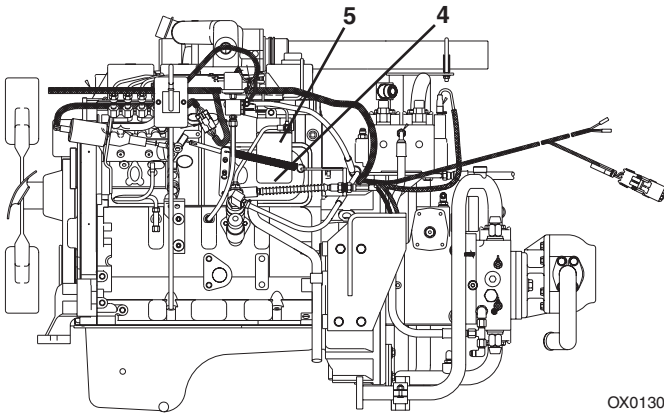


1. Check fuel gauge (1) located on instrument panel in cab.
2. If fuel is low, proceed to fuel source and perform “Shut-Down Procedure” on page 3-5.
3. Locate fuel tank (2), turn fuel tank cap (3) and remove from filler neck (4). Add diesel fuel as needed. Replace fuel tank cap.

Note: Replenish diesel fuel at end of each work shift to minimize condensation.

B. Drain Fuel/Water Separator

50



OX0130

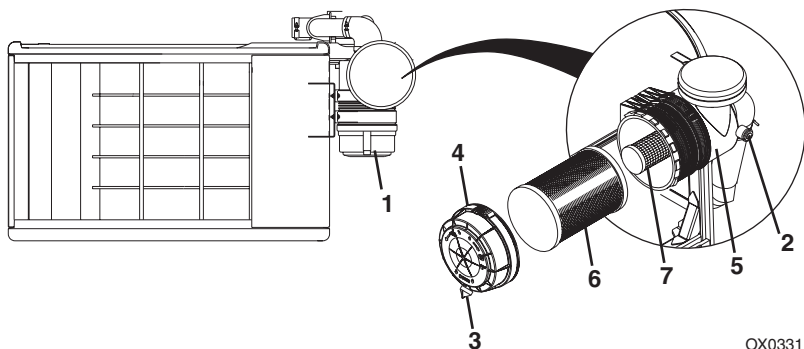
1. Perform "Shut-Down Procedure" on page 4-4.
2. Open the engine cover.
3. Loosen drain cock (4) on underside of fuel filter (5) and allow all water to drain into a glass until clear fuel is visible. Tighten drain cock.
4. Close and secure the engine cover.

Section 7 - Lubrication and Maintenance

Air Intake System

A. Air Filter Restriction Indicator Check

10 



1. Perform "Shut-Down Procedure" on page 4-4.
2. Locate air cleaner (1) and check restriction indicator (2). If red band is visible, filter(s) must be replaced.
3. Remove dust from vacuator valve (3) by squeezing bottom of valve to allow loose particles to fall out.

Note: Only remove canister cover to service the elements as restriction indicator indicates. Excessive access to check an element can lead to premature element failure.

B. Element Change (as restriction indicator indicates)

1. Unlock air cleaner cover (4), turn counterclockwise and remove from air cleaner canister (5).
2. Remove outer primary element (6) and inspect for damage. Damaged elements should not be reused.
3. Thoroughly clean the interior of the air cleaner canister and vacuator valve.
4. Replace inner safety element (7) after every third primary element change. If replacing the inner safety element at this time, carefully slide the element out and replace with new element.
5. Slide the new primary element over the inner element making sure the sealing edge is flush with the base of the air cleaner.
6. Position air cleaner cover in place, turn clockwise and lock into position.
7. Depress button on restriction indicator to reset.

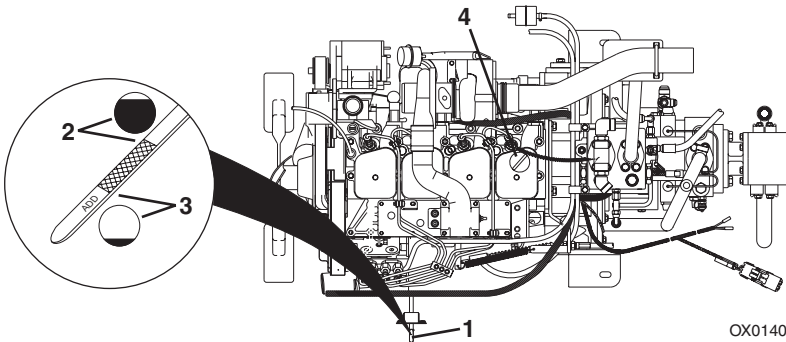
Note: *An inner safety element should never be washed or reused. Always install a new element.*

Section 7 - Lubrication and Maintenance

Engine Oil

A. Engine Oil Level Check

10 



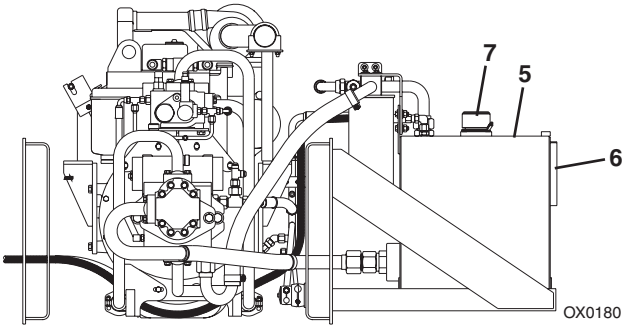
1. Perform “Shut-Down Procedure” on page 4-4.
2. Remove dipstick (1) and check oil mark. The oil should be between the full (2) and add (3) marks within the crosshatched area of the dipstick. Replace dipstick.
3. If oil is low, open the engine cover, remove oil fill cap (4) and add motor oil to bring oil up to the full mark in the crosshatch area.
4. Replace oil fill cap.
5. Close and secure the engine cover.

Note: The standard service interval for engine oil and filter is 250 hours maximum. If an extended service interval is desired, see the engine manual for specific guidelines for optimizing oil change intervals.

Hydraulic Oil

A. Hydraulic Oil Level Check

10 ⌚



1. Be sure all cylinders are fully retracted and machine is level.
2. Perform “*Shut-Down Procedure*” on page 4-4.
3. Check level of hydraulic oil in tank at the sight gauge (6) on the hydraulic tank (5). The oil level should be visible in the gauge window.
4. If hydraulic oil is low, open the tank cover and remove oil fill cap (7) from filler neck. Add hydraulic fluid to bring oil up to the upper mark on the sight gauge.
5. Replace hydraulic oil fill cap.
6. Close and secure the tank cover.

Tires

A. Tire Air Pressure Check



- 1. Perform “Shut-Down Procedure” on page 4-4.
- 2. Remove valve stem cap.
- 3. Check tire pressure using a good quality gauge.
- 4. Add air if required.
 - 13.00 x 24, G-2/L-2 Bias-Ply Traction - 12 Ply65 psi (4.5 bar)
 - 13.00 x 24, G-3/L-3 Bias Ply Rock - 12 Ply65 psi (4.5 bar)
 - 13.00 x 24, G-2/L-2 Radial - 1 Star70 psi (4.8 bar)
 - 15.50 x 25, G-2/L-2 Bias-Ply Traction - 12 Ply58 psi (4.0 bar)
 - 15.50 x 25, G-3/L-3 Bias Ply Rock - 12 Ply65 psi (4.5 bar)
 - 15.50 x 25, G-2/L-2 Radial - 1 Star70 psi (4.8 bar)
- 5. Replace valve stem cap.

B. Tire Damage

For pneumatic tires, JLG recommends that when any cut, rip or tear is discovered that exposes sidewall or tread area cords in the tire, measures be taken to remove the JLG product from service immediately. Arrangements must be made for replacement of the tire or tire assembly.

For polyurethane foam filled tires, JLG recommends that when any of the following are discovered, measures must be taken to remove the product from service immediately. Arrangements must be made for replacement of the tire or tire assembly.

- A smooth even cut through the cord piles which exceeds 3 in (7.5 cm) in total length.
- Any tears or rips (ragged edges) in the cord plies which exceeds 1 in (2.5 cm) in any direction
- Any punctures which exceed 1 in (2.5 cm) in diameter.

If a tire is damaged but within the above noted criteria, the tire must be inspected daily to ensure the damage has not propagated beyond the allowable criteria.

C. Tire and Wheel Replacement

JLG recommends a replacement tire to be the same size, ply and brand as originally installed. Refer to the appropriate parts manual for ordering information. If not using a JLG approved replacement tire, JLG recommends that replacement tires have the following characteristics:

- Equal or greater ply/load rating and size of original.
- Tire tread contact width equal or greater than original.
- Wheel diameter, width and offset dimensions equal to the original.
- Approved for the application by the tire manufacturer (including inflation pressure and maximum tire load).

Unless specifically approved by JLG, do not replace a foam filled or ballast filled tire assembly with a pneumatic tire. Due to size variations between tire brands, when selecting and installing a replacement tire ensure both tires on the axle are the same.

The rims installed have been designed for stability requirements which consist of track width, tire pressure and load capacity. Size changes such as rim width, center piece location, larger or smaller diameter, etc., without written factory recommendations, may result in unsafe condition regarding stability.

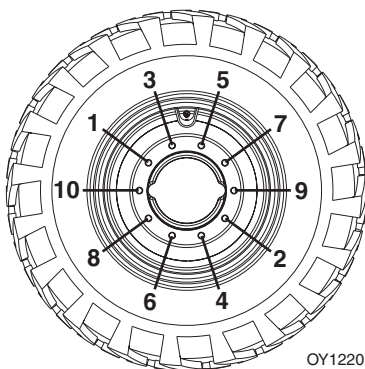
Section 7 - Lubrication and Maintenance

E. Wheel Installation

Torque lug nuts before first use and after each wheel removal.

Note: If machine is equipped with directional tire assemblies, the wheel and tire assemblies must be installed with the directional tread pattern "arrows" facing in the direction of forward travel.

1. Start all nuts by hand to prevent cross threading. DO NOT use a lubricant on threads or nuts.
2. Tighten lug nuts in an alternating pattern as indicated in figure. Torque to 350-400 lb-ft (475-543 Nm).



OY1220



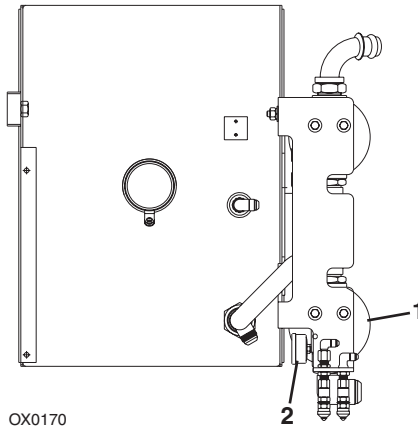
WARNING

TIP OVER HAZARD. Lug nuts must be installed and maintained at the proper torque to prevent loose wheels, broken studs and possible separation of wheel from the axle.

Hydraulic Return Filter

A. Hydraulic Return Filter Indicator Check

10 ⌚

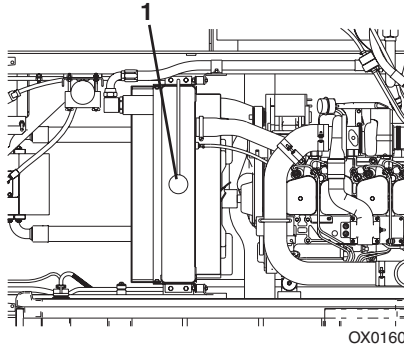


1. Apply park brake, shift transmission to "Neutral" and lower forks or attachment to horizontal position.
2. Check hydraulic return filter indicator with engine at normal operating temperature.
3. Have an assistant open the tank cover.
4. With the engine at full throttle and the assistant observing the indicator (2) located on the hydraulic return filter (1), extend and retract the boom 10-12 ft (3,0-3,7 m). The gauge should be within the green area.
5. Replace filter before the gauge reaches the red area on the indicator. If it reaches the red area, the filter is too dirty and hydraulic oil is bypassing the filter.
6. Close and secure the tank cover.

Engine Cooling System

A. Engine Coolant Level Check

50 ⌚

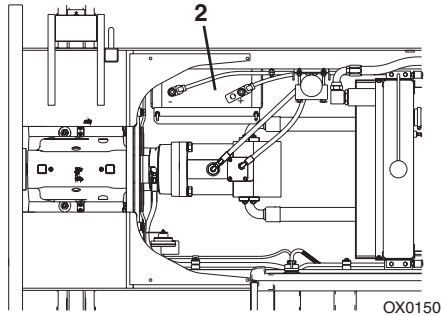


1. Perform “*Shut-Down Procedure*” on page 4-4.
2. Open the engine cover.
3. When coolant is cool, remove cap (1). Check coolant level in radiator.
4. If coolant is low, add coolant (50/50 mixture of ethylene glycol and water) as required.
5. Replace radiator cap.
6. Close and secure the engine cover.

Battery

A. Battery Check

50 ⌚



1. Perform “*Shut-Down Procedure*” on page 4-4.
2. Remove the front cover.
3. Wearing eye protection, visually inspect the battery (2). Check terminals for corrosion. Replace battery if it has a cracked, melted or damaged case.
4. Replace the front cover.

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SECTION 8 - ADDITIONAL CHECKS

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SECTION 9 - SPECIFICATIONS

9.1 PRODUCT SPECIFICATIONS

Fluid and Lubrication Capacities

Engine Crankcase Oil

Capacity with Filter Change 15.5 quarts (14,7 liters)

Type of Oil 15W-40 CD

Fuel Tank

Capacity38 gallons (143,8 liters)

Type of Fuel..... #2 Diesel

Cooling System

System Capacity 15.5 quarts (14,7 liters)

Type of Coolant 50/50 ethylene glycol & water

Hydraulic System

System Capacity43 gallons (163 liters)

Reservoir Capacity to Full Mark20 gallons (75,7 liters)

Type of Oil Mobilfluid® 424 Tractor Hydraulic Fluid (ISO 46)

Axles

Housing Capacity (Front Axle)5 gallons (18,9 liters)

Hubs (Rear Axle).....3 pints each (1,6 liters)

Type of Fluid Mobilfluid® 424 Tractor Hydraulic Fluid (ISO 46)

Section 9 - Specifications

Tires

Pressure

13.00 x 24, G-2/L-2 Bias-Ply Traction - 12 Ply

Pneumatic	65 psi (4.5 bar)
542 lb (246 kg) Foam	60 psi (4.1 bar)

13.00 x 24, G-3/L-3 Bias Ply Rock - 12 Ply

Pneumatic	65 psi (4.5 bar)
542 lb (246 kg) Foam	65 psi (4.5 bar)

13.00 x 24, G-2/L-2 Radial - 1 Star

Pneumatic	70 psi (4.8 bar)
542 lb (246 kg) Foam	70 psi (4.8 bar)

15.50 x 25, G-2/L-2 Bias-Ply Traction - 12 Ply

Pneumatic	58 psi (4.0 bar)
600 lb (272 kg) Foam	58 psi (4.0 bar)

15.50 x 25, G-3/L-3 Bias Ply Rock - 12 Ply

Pneumatic	65 psi (4.5 bar)
600 lb (272 kg) Foam	65 psi (4.5 bar)

15.50 x 25, G-2/L-2 Radial - 1 Star

Pneumatic	70 psi (4.8 bar)
600 lb (272 kg) Foam	70 psi (4.8 bar)

Wheel Lug Nut

Torque..... 350-400 lb-ft (475-542 Nm)

Performance

Maximum Lift Capacity6,600 lb (2.994 kg)

Maximum Lift Height..... 42.79 ft (13.04 m)

Capacity at Maximum Height.....6,000 lb (2.722 kg)

Maximum Forward Reach..... 28.14 ft (8.58 m)

Capacity at Maximum Forward Reach..... 1,000 lb (454 kg)

Reach at Maximum Height 5.05 ft (1.54 m)

Carriage Rotation 128 degrees

Maximum Travel Speed20.5 mph (33.0 kmph)

Towing Capacity18,000 (8.165 kg)

Frame Leveling8 degrees

Dimensions

Overall Height.....	95.40 in (2.423 mm)
Overall Width.....	96.23 in (2.444 mm)
Cab Width.....	37 in (940 mm)
Track Width.....	82.24 in (2.089 mm)
Wheelbase	128 in (3.251 mm)
Length at Front Wheels	183.5 in (4.661 mm)
Overall Length (less Forks)	212.59 in (5.4 mm)
Ground Clearance	17 in (432 mm)
Turning Radius Over Tires.....	141.25 in (3.588 mm)
Turning Radius at Forks	182.4 in (4.633 mm)
Gross Vehicle Weight with Forks.....	20,400 lb (9.253 kg)
Front Axle Weight.....	9,695 lb (4.398 kg)
Rear Axle Weight	10,705 lb (4.856 kg)
Maximum Ground Bearing Pressure	
13.00 x 24 Foam Filled	98.2 lbs/in ² (6,90 kg/cm ²)
15.50 x 25 Foam Filled	70.8 lbs/in ² (4,98 kg/cm ²)

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TRANSFER OF OWNERSHIP

To Product Owner:

If you now own but ARE NOT the original purchaser of the product covered by this manual, we would like to know who you are. For the purpose of receiving safety-related bulletins, it is very important to keep JLG Industries, Inc. updated with the current ownership of all JLG products. JLG maintains owner information for each JLG product and uses this information in cases where owner notification is necessary.

Please use this form to provide JLG with updated information with regard to the current ownership of JLG products. Please return completed form to the JLG Product Safety & Reliability Department via facsimile or mail to address as specified below.

Thank You,
Product Safety & Reliability Department
JLG Industries, Inc.
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Hagerstown, MD 21742
USA
Telephone: +1-717-485-6591
Fax: +1-301-745-3713

NOTE: Leased or rented units should not be included on this form.

Mfg. Model: _____

Serial Number: _____

Previous Owner: _____

Address: _____

Country: _____ Telephone: (_____) _____

Date of Transfer: _____

Current Owner: _____

Address: _____

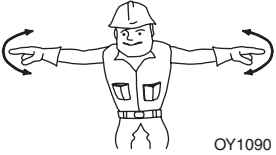

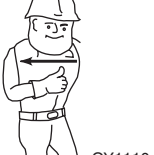
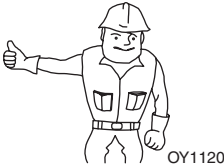
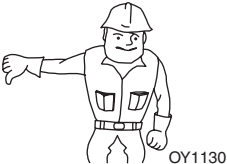

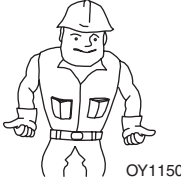
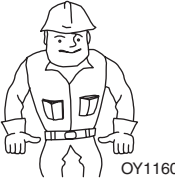

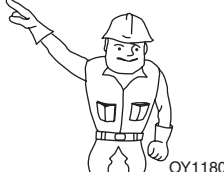
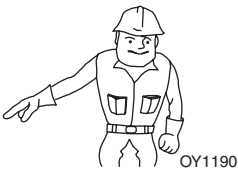
Country: _____ Telephone: (_____) _____

Who in your organization should we notify?

Name: _____

Title: _____

Hand Signals

 <p>OY1090</p> <p>EMERGENCY STOP - With both arms extended laterally, hands open downward, move arms back and forth.</p>	 <p>OY1100</p> <p>STOP - With either arm extended laterally, hand open downward, move arm back and forth.</p>	 <p>OY1110</p> <p>STOP ENGINE - Draw thumb or forefinger across throat.</p>
 <p>OY1120</p> <p>RAISE BOOM - With either arm extended horizontally, fingers closed, point thumb upward.</p>	 <p>OY1130</p> <p>LOWER BOOM - With either arm extended horizontally, fingers closed, point thumb downward.</p>	 <p>OY1140</p> <p>MOVE SLOWLY - Place one hand motionless in front of hand giving motion signal. (Raise load slowly shown)</p>
 <p>OY1150</p> <p>EXTEND BOOM - With both hands clenched, point thumbs outward.</p>	 <p>OY1160</p> <p>RETRACT BOOM - With both hands clenched, point thumbs inward.</p>	 <p>OY1170</p> <p>THIS FAR TO GO - With hands raised and open inward, move hands laterally, indicating distance to go.</p>
 <p>OY1180</p> <p>TILT FORKS UP - With one arm held at side, extend other arm upward at about 45 degrees.</p>	 <p>OY1190</p> <p>TILT FORKS DOWN - With one arm held at side, extend other arm downward at about 45 degrees.</p>	

Special Signals - When signals for auxiliary equipment functions or conditions not covered are required, they shall be agreed upon in advance by the operator and signalman.



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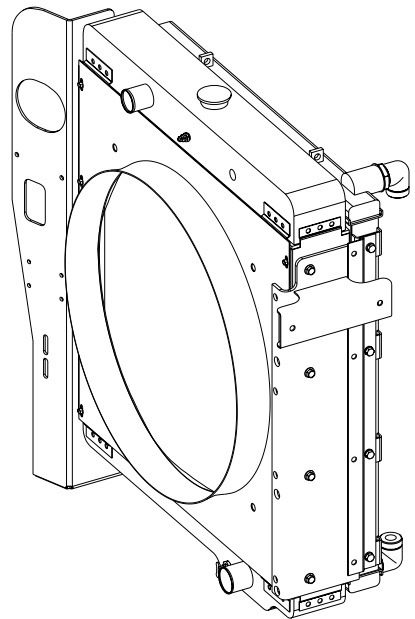
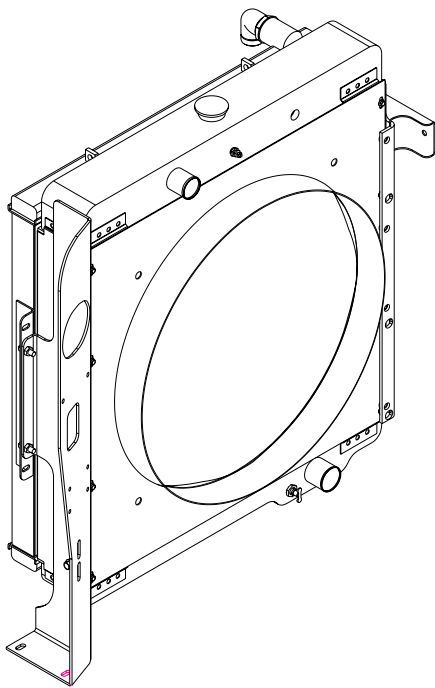
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Liquid Coolant

Test Manual



John Deere Liquid Coolant Conditioner

ENGINE COOLANT SPECIFICATIONS

Engine coolants are a combination of three chemical components: ethylene glycol, (antifreeze), inhibiting coolant additives and quality water.

Coolant solutions of quality water, ethylene glycol concentrate, (antifreeze), and supplemental coolant additives, (SCAs), **MUST** be used year-round to protect against freezing, boil-over, liner erosion or pitting, and to provide a stable, non-corrosive environment for seals, hoses and metal engine parts.

Some products, including John Deere PREDILUTED ANTIFREEZE/SUMMER COOLANT and John Deere COOL-GARD, are fully formulated coolants that contain all three components in their correct concentrations. Do not add an initial charge of supplemental coolant additives to these fully formulated products.

Some coolant concentrates, including John Deere ANTIFREEZE/SUMMER COOLANT CONCENTRATE, contain both ethylene glycol antifreeze and inhibiting coolant additives. Mix these products and quality water, but do not add an initial charge of supplemental coolant additives.

Coolants meeting ASTM D5345, (prediluted coolant) or ASTM D4985, (coolant concentrate), require an initial charge of supplemental coolant additives.

Water Quality:

Water quality is important to the performance of the cooling system. Distilled, deionized or demineralized water is recommended for mixing with ethylene glycol base engine coolant concentrate. All water used in the cooling system should meet the following minimum specifications for quality:

Water Quality Specifications

Item	Parts Per Million	Grains Per U.S. Gallon
Chlorides (maximum).....	40	2.5
Sulfates (maximum).....	100	5.9
Total Dissolved Solids (maximum)...	340	20
Total Hardness.....	170	10
pH Level.....	5.5-9.0	

Ethylene Glycol Concentrate (Antifreeze):

IMPORTANT: Do not use cooling system sealing additives or use antifreeze that contains sealing additives.

The use of John Deere coolant products is **strongly recommended**.

If John deere coolant products are not used, other low silicate ethylene glycol base coolants for heavy-duty diesel engines may be used when mixed with quality water and supplemental coolant additives, (SCAs), if they meet one of the following specifications:

- * ASTM D5345 (prediluted coolant)
- * ASTM D4985 (coolant concentrate) in a 40% to 60% mixture of concentrate with quality water.

Coolants meeting these specifications require addition of supplemental coolant additives, (SCAs), formulated for heavy-duty diesel engines, for protection against corrosion and cylinder liner erosion and pitting.

IMPORTANT: Never use automotive-type coolants, (such as those meeting ASTM D3306 or ASTM D4656). These coolants do not contain the correct additives to protect heavy-duty diesel engines. They often contain a high concentration of silicates and may damage the engine cooling system.

ENGINE COOLANT SPECIFICATIONS--CONTINUED

Supplemental Coolant Additives (SCAs):

IMPORTANT: DO NOT over-inhibit antifreeze solutions, as this can cause silicate-dropout. When this happens, a gel-type deposit is created which retards heat transfer and coolant flow, causing engine to overheat.

NOTE: John Deere Pre-diluted Antifreeze/Summer Coolant concentrate, and John Deere COOL-GARD contain supplemental coolant additives (SCAs). However, as the coolant solution loses its effectiveness, additives will need to be added.

Operating without proper coolant additive will result in increased corrosion, cylinder liner erosion and pitting, and other damage to the engine and cooling system. A simple mixture of ethylene glycol and water WILL NOT give adequate protection.

The use of supplemental coolant additives reduces corrosion, erosion and pitting. These chemicals reduce the number of vapor bubbles in the coolant and help form a protective film on cylinder liner surfaces. This film acts as a barrier against harmful effects of collapsing vapor bubbles.

Inhibit the antifreeze-coolant mix with a non-chromate inhibitor. John Deere Liquid Coolant Conditioner is recommended as a supplemental coolant additive in John Deere engines.

IMPORTANT: Check inhibitors between drain intervals every 600 hours or 12 months of operation. Replenish inhibitors by the addition of a supplemental coolant additive as necessary.

DO NOT use a soluble oil.

Additives eventually lose their effectiveness and must be recharged with additional supplemental coolant additives available in the form of liquid coolant conditioner. See TESTING DIESEL ENGINE COOLANT and REPLENISHING SUPPLEMENTAL COOLANT ADDITIVES (SCAs) BETWEEN COOLANT CHANGES, as described later in this group.



John Deere Liquid Coolant Conditioner

TESTING DIESEL ENGINE COOLANT

Maintaining adequate concentrations of glycol and inhibiting additives in the coolant is critical to protect the engine and cooling system against freezing, corrosion and cylinder liner erosion and pitting.

Test the coolant solution at 600 hours or 12 month intervals and whenever excessive coolant is lost through leaks or overheating to ensure the necessary protection.

Coolant Test Strips

Coolant test strips are available from your John Deere dealer. These test strips provide a simple, effective method to check the freeze point and additive levels of your engine coolant.

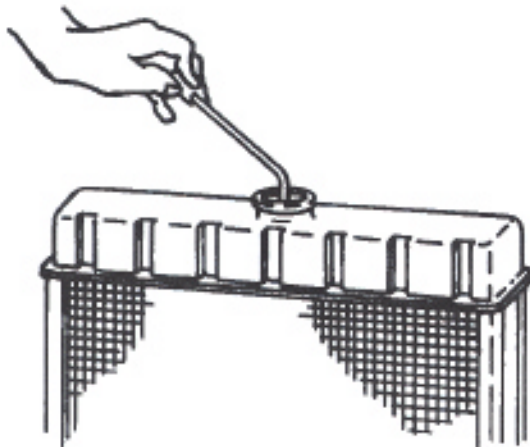
Compare the results to the supplemental coolant additive (SCA) chart to determine the amount of inhibiting additives in your coolant and whether more John Deere Liquid Coolant Conditioner should be added.

COOLSCAN

For a more thorough evaluation of your coolant, perform a COOLSCAN analysis where available. See your John Deere distributor or servicing dealer for information about COOLSCAN.



REPLENISHING SUPPLEMENTAL COOLANT ADDITIVES (SCAs) BETWEEN COOLANT CHANGES



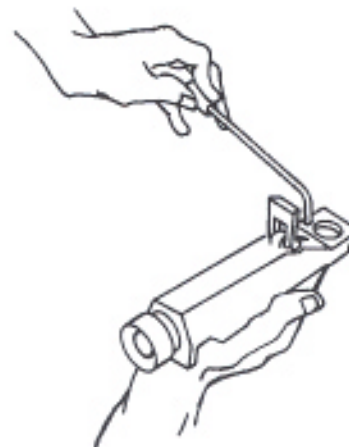
IMPORTANT: Do not add supplemental coolant additives when the cooling system is drained and refilled with John Deere ANTIFREEZE/SUMMER COOLANT or John Deere COOL-GARD.

Through time and use, the concentration of coolant additives is gradually depleted during engine operation. Periodic replenishment of inhibitors is required, even when John Deere ANTIFREEZE/SUMMER COOLANT or John Deere COOL-GARD is used. The cooling system must be recharged with additional coolant additives available in the form of liquid coolant conditioner.

Maintaining the correct coolant conditioner concentration (SCAs) and freeze point is essential in your cooling system to protect against rust, liner pitting and corrosion, and freeze-ups due to incorrect coolant dilution.

John Deere LIQUID COOLANT CONDITIONER is recommended as a supplemental coolant additive in John Deere engines.

Test the coolant solution at 600 hours or 12 months of operation using either John Deere coolant test strips or a CoolScan analysis. If a CoolScan analysis is not available, recharge system per instructions printed on label of John Deere Liquid Coolant Conditioner.



IMPORTANT: ALWAYS maintain coolant at correct level and concentration. DO NOT operate engine without coolant for even a few minutes.

If frequent coolant makeup is required, the glycol concentration should be checked with JT05460 Refractometer to assure that the desired freeze point is maintained. Follow manufacturer's instructions provided with refractometer.

Add the manufacturer's recommended concentration of supplemental coolant additive. DO NOT add more than the recommended amount.

The use of non-recommended supplemental coolant additives may result in additive drop-out and gelation of the coolant.

If other coolants are used, consult the coolant supplier and follow the manufacturer's recommendation for use of supplemental coolant additives.

See ENGINE COOLANT SUPPLEMENTS earlier in this group for proper mixing of coolant ingredients before adding to the cooling system.

OPERATING IN WARM TEMPERATURE CLIMATES

John Deere engines are designed to operate using glycol base engine coolants.

Always use a recommended glycol base engine coolant, even when operating in geographical areas where freeze protection is not required.

IMPORTANT: Water may be used as coolant *in emergency situations only*.

Foaming, hot surface aluminum and iron corrosion, scaling and cavitation will occur when water is used as the coolant, even when coolant conditioners are added.

Drain cooling system and refill with recommended glycol base engine coolant as soon as possible.

FLUSH AND SERVICE COOLING SYSTEM



IMPORTANT: CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns.

Shut off engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing cap completely.

IMPORTANT: Air must be expelled from cooling system when system is refilled. Follow procedure given in your operator's manual.

The ethylene glycol base, (antifreeze), can become depleted of SCAs allowing various acids to form that will damage engine components. In addition, heavy metals, such as lead, copper and zinc accumulate in the ethylene glycol base. The heavy metals come from corrosion that occurs to some degree within a cooling system. When a coolant is saturated to the point where it can no longer hold heavy metals and other dissolved solids, they settle out and act as abrasives on engine parts.

NOTE: Refer to your operator's manual for a specific service interval.

Flush cooling system and replace thermostats as described in your operator's manual. Clean cooling system with clean water and TY15979 John Deere Heavy-Duty Cooling System Cleaner or an equivalent cleaner such as FLEETGUARD RESTORE or RESTORE PLUS. Follow the instructions provided with the cleaner. Refill the cooling system with the appropriate coolant solution. See ENGINE COOLANT SPECIFICATIONS, earlier in this group.

IMPORTANT: NEVER overfill the system. A pressurized system needs space for heat expansion without overflowing at the top of the radiator. Coolant level should be at bottom of radiator filler neck.

Air must be expelled from cooling system when the system is refilled. Loosen temperature sending unit fitting at rear of cylinder head or plug in thermostat housing to allow air to escape when filling system. Re-tighten fitting or plug when all the air has been expelled.

After adding new coolant solution, run engine until it reaches operating temperature. This mixes the coolant solution uniformly and circulates it through the entire system. After running engine, check coolant level and entire cooling system for leaks.

Contact your authorized servicing dealer or engine distributor if there are further questions.

DISPOSING OF COOLANT

Improperly disposing of engine coolant can threaten the environment and ecology.

Use leakproof containers when draining fluids. Do not use food or beverage containers that may mislead someone into drinking from them.

Do not pour waste onto the ground, down a drain, or into any water source.

Inquire on the proper way to recycle or dispose of waste from your local environmental or recycling center, or from your John Deere dealer.



MACHINE START-UP PROCEDURE - HYDROSTATIC DRIVE MACHINES

P/N 9140-9025

1. CHECK "G" PORT ON BOTTOM OF FRONT MOTOR. THIS PORT MUST BE PLUGGED.
2. CHECK AND FILL ALL FLUID LEVELS.
3. WITH FILTER BUGGY, FILL SUCTION HOSE TO CHARGE PUMP WITH 1440-4225 MOBIL 424 HYD. TRACTOR FLUID. (NOTE: HYDROSTATIC DRIVE SYSTEM CAN BE SEVERELY DAMAGED BY A SMALL AMOUNT OF DIRT. CLEAN ALL FITTING AND HOSE ENDS SO THAT DIRT IS NOT INTRODUCED INTO THE SYSTEM.)
4. ON FRONT AND REAR MOTORS CRACK CASE DRAIN LINES.
5. REMOVE MINI-CHECK IN CHARGE SYSTEM, LOCATED IN ENGINE COMPARTMENT, AND CONNECT LINE FROM PRIMING PUMP. PUMP 1440-4825 MOBIL 424 HYD. TRACTOR FLUID INTO CHARGE SYSTEM UNTIL GAGE ON PUMP READS 350-480 PSI. REMOVE HOSE FROM PUMP AND REINSTALL MINI-CHECK. (NOTE: IF 350 PSI IS NOT REACHED, THERE IS A PROBLEM WITH THE HYDROSTATIC DRIVE. DO NOT START MACHINE).
6. DISCONNECT PRIMING PUMP, REINSTALL MINI-CHECK, AND INSTALL 500 PSI PRESSURE GAGE IN CHARGE SYSTEM MINI-CHECK.
7. ATTACH FILTER BUGGY TO QUICK DISCONNECT IN IMPLEMENT CIRCUIT. PUMP OIL UNTIL HYDRAULIC TANK IS FULL.
8. TIGHTEN CASE DRAIN LINES IN MOTORS WHEN OIL STARTS TO SEEP OUT.
9. WHILE MONITORING CHARGE PRESSURE GAGE, START ENGINE AND RUN AT IDLE (TRANSMISSION TO REMAIN IN NEUTRAL). CHARGE PRESSURE SHOULD RISE TO 350-480 PSI WITHIN 10 SECONDS AFTER MACHINE HAS BEEN STARTED. IF THIS DOES NOT OCCUR, SHUT OFF ENGINE BECAUSE THERE IS A PROBLEM WITH THE HYDROSTATIC SYSTEM. DO NOT RESTART ENGINE UNTIL PROBLEM IS CORRECTED. DURING THE FIRST MINUTE OF RUNNING, CHARGE PRESSURE WILL DROP OCCASIONALLY DUE TO AIR IN THE LINES. PRESSURE SHOULD STABILIZE AFTER APPROXIMATELY ONE MINUTE OF RUNNING AT IDLE.
10. THE CHARGE PRESSURE SHOULD BE MONITORED DURING THE REMAINING PROCEDURE AND MUST REMAIN BETWEEN 350-480 PSI AT ALL TIMES. IF THE CHARGE PRESSURE IS NOT IN THIS RANGE, THERE IS A PROBLEM WITH THE HYDROSTATIC DRIVE AND THE ENGINE MUST BE SHUT OFF UNTIL THE PROBLEM IS CORRECTED.
11. PLACE MACHINE IN TWO WHEEL DRIVE AND RELEASE PARK BRAKE. SHIFT MACHINE INTO FORWARD AND SLOWLY INCREASE ENGINE RPM TO APPROXIMATELY HALF THROTTLE. MAINTAIN FOR ONE MINUTE. FRONT WHEELS SHOULD TURN. RETURN ENGINE TO IDLE AND SHIFT INTO REVERSE. BRING ENGINE SLOWLY UP TO APPROXIMATELY HALF THROTTLE. MAINTAIN FOR ONE MINUTE. FRONT WHEELS SHOULD TURN. RETURN ENGINE TO IDLE. REPEAT ABOVE, GOING SLOWLY TO FULL THROTTLE.

-1-

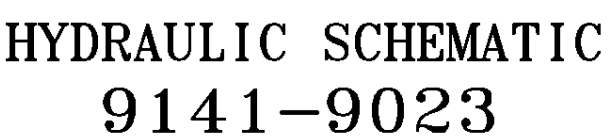
START-UP PROCEDURE - HYDROSTATIC DRIVE MACHINES (CONTINUED)

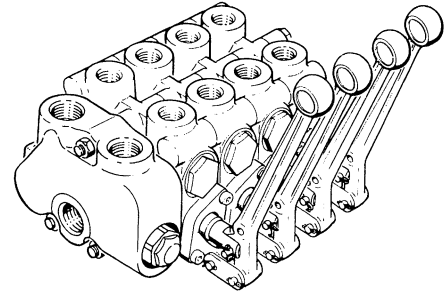
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12. WITH ENGINE AT IDLE ENGAGE PARK BRAKE AND SHIFT MACHINE INTO FORWARD. INCREASE ENGINE RPM TO FULL THROTTLE. (DO NOT HOLD AT FULL THROTTLE FOR MORE THAN TEN SECONDS). RETURN TO IDLE AND REPEAT IN REVERSE. FRONT WHEELS SHOULD NOT TURN. (THIS CONCLUDES TESTING ON A TWO WHEEL DRIVE MACHINE. PROCEED TO STEP 13).
13. RELEASE PARK BRAKE, SHIFT MACHINE INTO FOUR WHEEL DRIVE AND FORWARD. INCREASE ENGINE SPEED TO HALF THROTTLE AND HOLD FOR THIRTY SECONDS. (ONE OR BOTH REAR WHEELS MAY NOT TURN.) RETURN ENGINE TO IDLE. SHIFT TO REVERSE AND REPEAT ABOVE.
14. WITH ALL WHEELS STOPPED, ENGAGE TRACTION LOCK SWITCH AND RAISE ENGINE SPEED SLOWLY TO FULL THROTTLE IN FORWARD. FRONT AND REAR DRIVE WHEELS SHOULD TURN AT APPROXIMATELY THE SAME SPEED; VISUALLY CHECK. RETURN ENGINE TO IDLE. REPEAT ABOVE IN REVERSE. (ONE REAR WHEEL MAY NOT TURN. IF ONLY ONE REAR WHEEL IS TURNING, IT WILL TURN TWICE AS FAST AS THE FRONT WHEELS.)
15. SHUT OFF ENGINE. REMOVE GAGE IN CHARGE SYSTEM. FILL HYDRAULIC OIL TANK WITH 1440-4825 MOBIL 424 HYD. TRACTOR FLUID.

-2-

MACHINE START-UP PROCEDURE
9140-9025





Model **V20**

Sectional Body Directional Control Valve

Service and Parts Manual

GRESEN®



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SECTION I

INTRODUCTION

This manual contains pertinent step-by-step maintenance instructions plus parts ordering information and a complete part and service kit listing for the Model V20 Directional Control Valve.

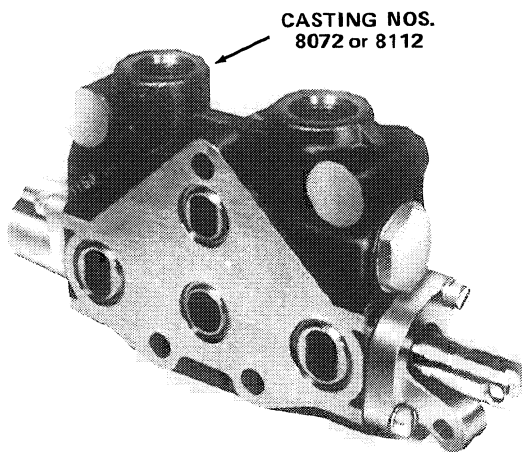
If further assistance is required, contact:

Your Gresen Distributor or Representative.

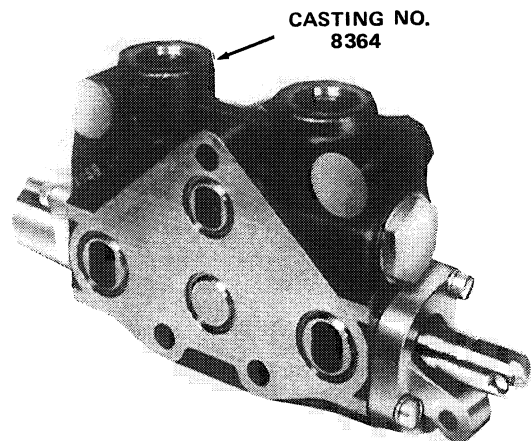
WARNING

There is a visual similarity between Gresen's Model V20 Directional Control Valve covered in this manual and Gresen's V20C Closed Center Directional Control Valve.

Work sections for these two valve assemblies should *NEVER* be *intermixed* or *interchanged* without prior consultation with the factory. Intermixing a V20C closed center work section with a V20P or V20T work section will convert the complete valve bank to closed center operation and in some cases, could render the valve assembly inoperable and cause damage to components in the hydraulic circuit.



Model V20P or V20T
Work Section.



Model V20C
Work Section.

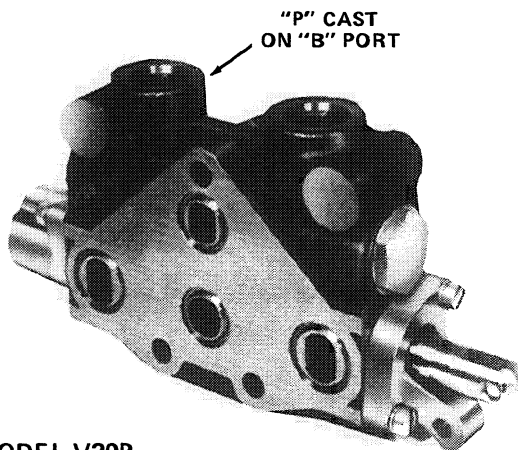
SECTION II

DESCRIPTION

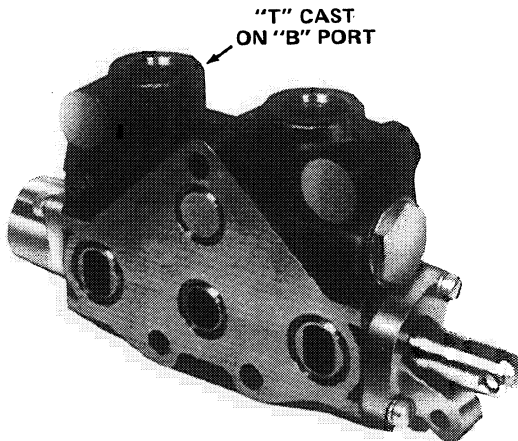
Gresen Model V20 Directional Control Valves may be purchased with five different valve sections, plus various options, to meet the desired job specification.

The following paragraphs describe the five sections and any options with reference to the parts illustrations in Section IV in this manual.

Gresen's Models CP, CT, V20P and V20T work sections are interchangeable and may be intermixed within a complete directional control valve assembly. When Models CP or CT work sections are used, maximum pressure is limited to 2500 PSI.



MODEL V20P



MODEL V20T

Figure 2-1. Model V20P (Parallel Circuit) and Model V20T (Tandem Circuit) Work Sections.

Table 2-1. Casting Part Numbers

Description	Model CP/CT	Model V20
Parallel Center Section	7697-	8072-
Tandem Center Section	7698-	8112-
Series Center Section	—	11483-
V20R Center Section	—	10954-
V20R Tandem Center Section	—	10762-
LO Center Section	6732-	11571-
Mid-Inlet Section	6825-	6825-
Inlet Cover (Standard)	1815-	8398-
Inlet Cover (Top Ports)	1862-	8398-
Inlet Cover w/Flow Control	7736-	7736-
Outlet Cover (End Outlet)	6770-	6770-
Outlet Cover (Top Outlet)	8644-	8644-

Numbers shown for sections and covers are base casting numbers, not ordering numbers. Refer to Parts Ordering Information, Section III, for ordering information.

MODEL V20P

4-WAY, 3-POSITION VALVE SECTION

This section provides control of double-acting cylinders without the floating action plus hydraulic motor start, stop and reverse control where free-wheeling is NOT required. Cylinder ports are blocked in neutral position.

MODEL V20P

3-WAY, 3-POSITION VALVE SECTION

This section provides control of single acting cylinders or start and stop of non-reversible hydraulic motors where free-wheeling of motor is not required. The cylinder port is blocked in neutral position.

MODEL V20P

4-WAY, 3-POSITION VALVE SECTION WITH PRESSURE DETENT RELEASE

This section provides automatic return to neutral position as soon as work cycle is completed.

The spool is held in either power position by a detent assembly until released. When pressure in the power circuit reaches a predetermined setting, the detent assembly releases and the centering spring returns the spool to neutral.

MODEL V20P

4-WAY, 4-POSITION, FLOAT VALVE SECTION

This section provides control of double-acting cylinders requiring a floating action such as: loaders, dozers, snow plows, etc.

Incorporated into the valve section is a 4-position float positioner. Three positions are standard double-acting with spring return to neutral. The fourth position is detented to hold control in float (both cylinder ports open to tank).

MODEL V20-T

TANDEM (PRIORITY) SECTION, 3-WAY, 4-WAY, OR 4-WAY FLOAT

This section allows any upstream valve sections to have priority. Only when the upstream sections are in neutral or metering position will oil be available to this section.

SPOOL ACTION OPTIONS:

A. SPRING RETURN TO NEUTRAL, (Standard).

Spool will return to neutral position from A or B power position when handle is released.

B. "R" OPTION, Detent with Spring Return to Neutral

Can be used on either 3-way, 4-way or free flow spool. Has detent position for either spool "in", spool "out" or 2-position detent for both spool "in" and spool "out" positions, with spring return to neutral position.

Recommended for hydraulic motors where the motor operates continuously in one direction (detent position) with only intermittent operation in the opposite direction.

C. "D" Option, 3-Position Detent

Used when manual placement (NO spring return to neutral) is desired in any of three positions—spool in, spool out, and neutral. An optional detent stop (part no. 1889-001) may be used to convert spool action to "neutral" and "spool out" positions only or for "neutral" and "spool in" position only, thus giving a two-position spool action.

D. "A" OPTION, Spring Extended Spool

This feature eliminates spring return to neutral. The spring returns to the spool "out" position only, usually used for cam operation of spool.

Customer must supply cam follower mechanism.

HANDLE ASSEMBLIES

Provides choice of either horizontal or vertical handle assemblies.

INLET and OUTLET COVERS (Refer to Section III, Parts Ordering Information)

**CYLINDER PORT CHECK and RELIEF VALVE OPTION
(Refer to Figures 4-30 through 4-42)**

SECTION III

MAINTENANCE

REPLACING, ADDING OR REMOVING SECTION ASSEMBLIES

NOTE

For clarification, we shall call the inlet cover containing the main relief the left side of the valve assembly. Refer to Figure 3-1.

1. Before disassembly, it is suggested that each valve section be marked numerically to avoid incorrect reassembly.
2. Remove three assembly stud nuts (Item 32, Figure 4-1) from the left end section using a 9/16" thin wall socket.
3. Remove valve sections by sliding from assembly studs (Item 1, Figure 4-1).

4. If valve sections are to be added or removed, use the proper length assembly studs from the chart below.

No. of Sections	Assembly Stud Kit No.*
1	K-6104-D
2	K-6105-D
3	K-6106-D
4	K-6107-D
5	K-6108-C
6	K-6109-C
7	K-6110-C
8	K-6111-C
9	K-6112-C

*Each Kit contains 3 assembly studs and 3 9310-006 hex nuts.

NOTE: When using 8644 Right End Cover, add one section to assure proper stud length.

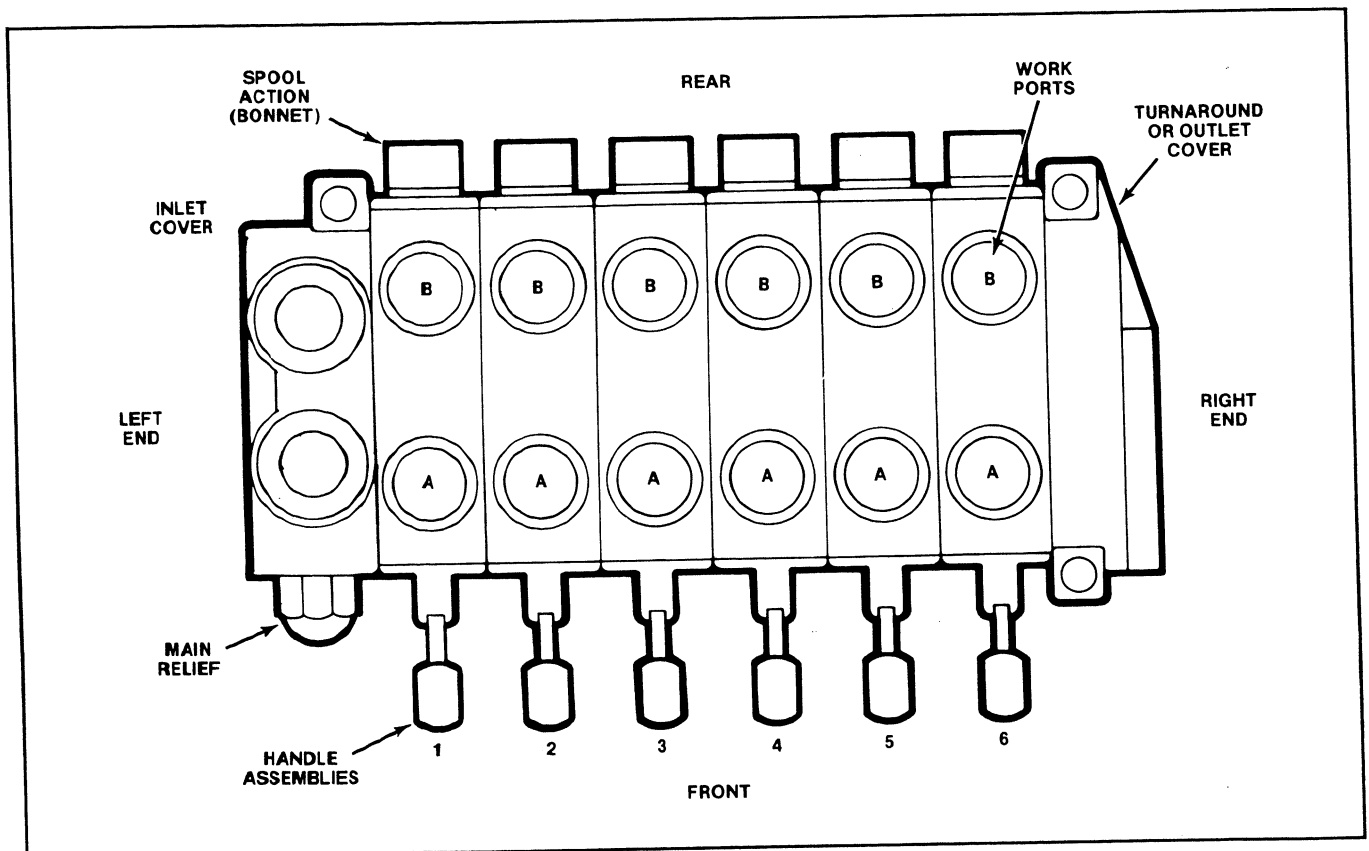


Figure 3-1. Schematic-View of Typical Control Valve Assembly.

NOTE

Use assembly nuts (part no.9310-006), 3 required, with all assembly studs. **NO LOCK WASHERS!** All studs are stress-proof material and should be replaced only with original equipment replacement parts.

5. Thoroughly clean O-ring counterbores and ground surfaces of each section.
6. Replace the four O-rings. For closed center sections use two 21733-001 (new) and two 21857-001 seals per section. For open center, use three 21733-001 and one 21857-001. For closed center, load sensing, sections use two 21857-001, two 21733-001 and one 21866-001. Buna-N seals are standard. For optional viton seals, see cross-reference chart on pg. 4-37. See chart on pg. 3-2 for old seal numbers.
7. Replace valve sections on assembly studs in the same order in which they were removed. O-ring counterbores should be to the left when facing "A" port-end of valve.

NOTE

Use care in replacing valve sections to avoid dislodging O-rings from counterbores.

8. When all valve sections are positioned on assembly studs, replace stud nuts and tighten evenly to 32 ft. lbs. [43 Nm] torque.

CAUTION

If stud nuts are not tightened to the proper torque, valve spools may bind or stick, or cause section seals to extrude.

REPLACING SPOOL SEALS

Valve sections and covers are identified by numbers cast into the body. Refer to Table 2-1, page 2-0.

Figure 3-2 shows spool assembly—less the complete handle assembly. When handle bracket is furnished, retainer plates and screws (items 1 and 4, Figure 3-2) are omitted. Seal assembly is retained by the handle bracket which will also retain the optional wiper seal.

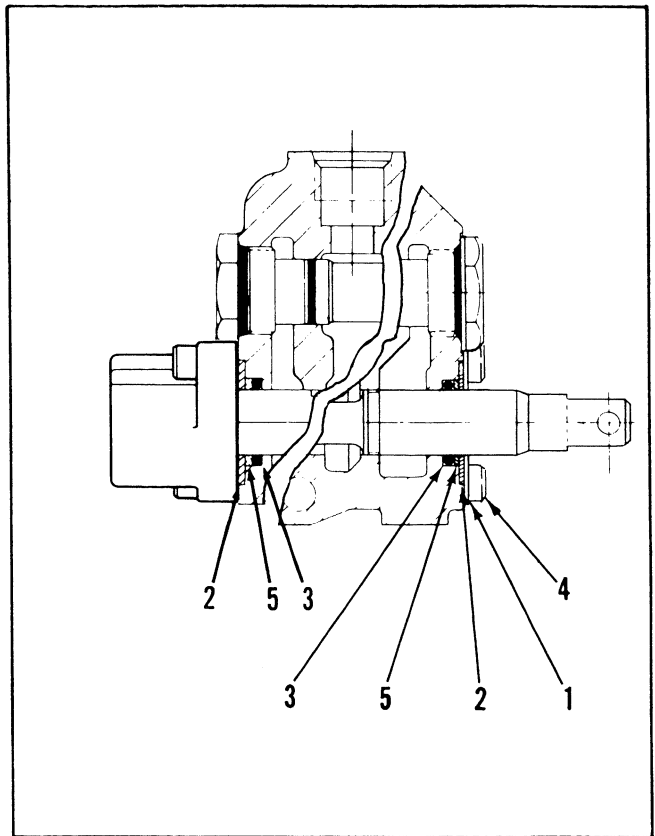


Figure 3-2. Spool Seal Assembly

2. Remove all parts connected to the spool on the front of the valve, either the complete handle bracket assembly, or the seal retainer assembly if a handle bracket is not furnished.

NOTE

DO NOT REMOVE the spool as the seals can be replaced externally. Prevent spool from turning or moving by inserting a screw driver through clevis slot, or running a rod through the pin hole and using as a handle. **DO NOT** hold the spool with a wrench. This will destroy the finish.

3. Remove retainer plate (Item 1, Figure 3-2), retainer plate washers (Item 2), back-up washers (Item 5), and spool seals (Item 3).
4. Thoroughly clean counterbore.
5. Lightly oil new seals. Slide over valve spool and insert in seal counterbore.

1. Remove bonnet assembly parts from back of valves and keep in order of disassembly.

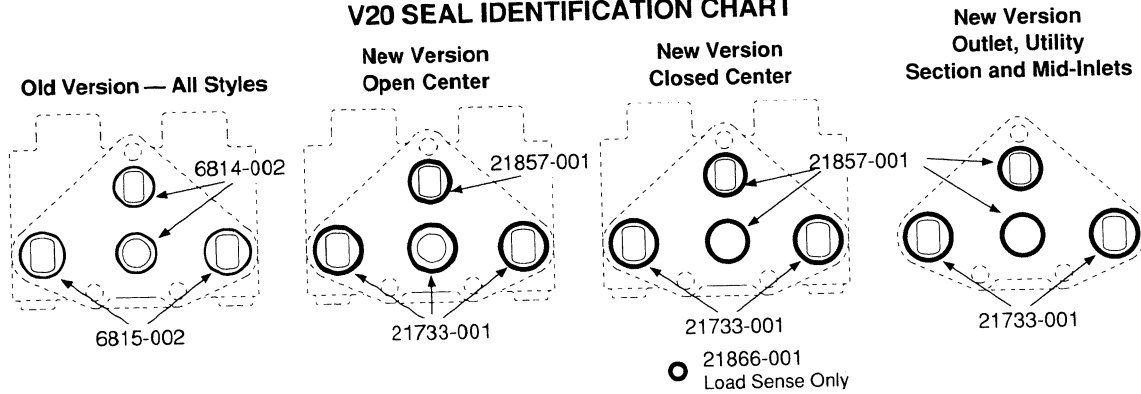
PARTS ORDERING INFORMATION

As of April 1, 1991, the section seals for the V20 changed. The new versions have larger cross section (old was .070, new is .103) and different configurations for open center and closed center sections. The old design utilized the same seals for all versions (two .801 I.D. and two .926 I.D.). The new design uses one configuration for open center (three .924 I.D. and one

.799 I.D.) and another configuration for closed center, load sensing and all outlet covers (two .924 I.D. and two .799 I.D., with one .237 I.D. for load sensing).

The following chart is provided to aid in selection of the proper seals. It is important to note that the seal kits include all O-rings (new and old), therefore there will be some left unused.

V20 SEAL IDENTIFICATION CHART



The following section seals are included in the Kits:

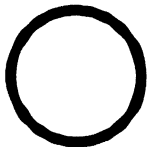
Standard Kits		Viton Kits	
Old	New	Old	New
(2)6814-002	(2)21857-001	(2)7450-001	(2)9003-117
(2)6815-002	(3)21733-001	(2)7451-001	(3)9002-119
Load sensing kits (additional seals)			
(1)8316-001	(1)21866-001	(1)9002-011	(1)9002-108

Seal kit changes.

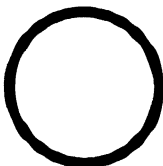
K-6121 Section Seal Kit, One Section
K-6027 Complete Seal Kit, 3 or 4 Way Section
K-6028 Complete Seal Kit, 4 Way Float Section
K-6209 Complete Seal Kit, Series 3 or 4 Way Section
K-6210 Complete Seal Kit, Series 4 Way Float Section
K-6154 Complete Seal Kit, Load Sensing 4 Way Float
K-6155 Complete Seal Kit, Load Sensing 3 or 4 Way Section
K-6156 Section Seal Kit, Load Sensing-One Section
K-6160 Viton Section Seal Kit, One Section

* Complete Seal Kits include spool seals and O-rings for check plugs.

OLD



6814-002....STD
7450-001....VITON

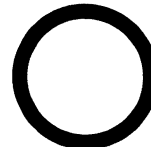


6815-002....STD
7451-001....VITON

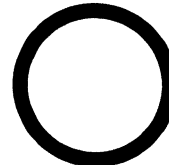


8316-001....STD
9002-011....VITON

NEW



21857-001....STD
9003-117....VITON



21733-001....STD
9002-119....VITON



21866-001....STD
9002-108....VITON

THESE SEALS ARE NOT INTERCHANGEABLE. OLD AND NEW STYLE SECTIONS MAY BE USED IN THE SAME ASSEMBLY PROVIDED THE CORRECT SEALS ARE USED FOR EACH SECTION.

INLET COVERS — Two Inlet Covers are available. All inlet covers are machined to accept the Model WH differential poppet relief cartridge or Model RP51 pilot-operated relief cartridge. If an outlet port is not used in the inlet cover, the outlet port in the right end cover of the valve must be used for tank return line. The inlet cover may be machined

with several different combinations of port sizes and locations. NPT and SAE threads cannot be intermixed in the same casting.

Use the following porting charts to arrive at the desired machining modification number.

Inlet Cover, Part No. 8398

Port Location	NPT *						SAE					
End Inlet	1/2	3/4	1/2	—	3/4	—	12	12	—	10	10	—
Top Inlet**	1/2	3/4	1/2	1/2	3/4	3/4	12	12	12	10	10	10
Top Outlet**	1/2	3/4	1/2	1/2	3/4	3/4	12	12	12	10	10	10
End Outlet	1/2	3/4	—	—	—	—	12	—	—	10	—	—
SAE 4 Gage Port	—	—	—	—	—	—	No	Yes	Yes	No	Yes	No
1/4" Gage Port	No	No	No	Yes	Yes	No	—	—	—	—	—	—
Machining Modification Number	018	014	019	012	023	016	008	025	013	024	021	002

* Pipe ports not recommended for pressures over 2000 PSI [138 bar].

** Top ports are cored and will be plugged if end inlet and outlet are specified.

Inlet Cover, Part No. 7736 With Flow Control

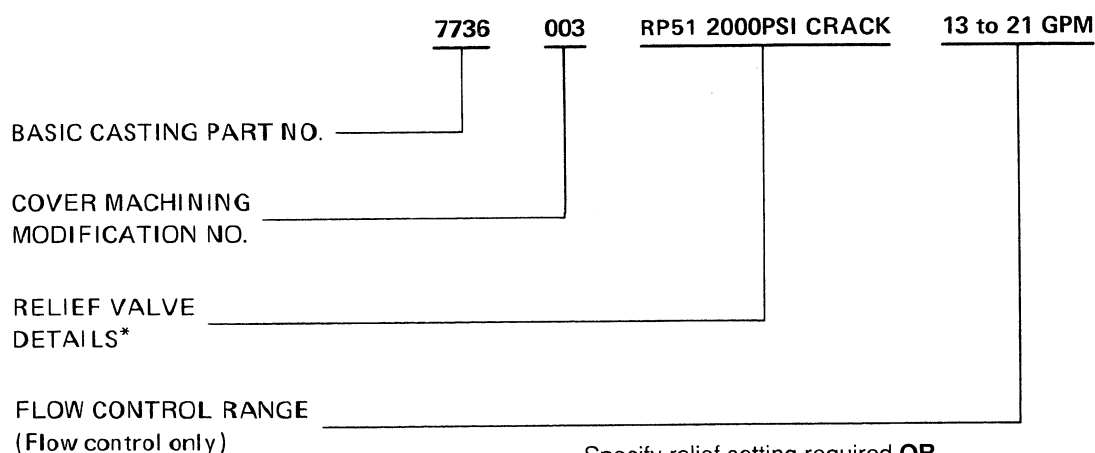
Inlet cover, part number 7736, is equipped with an adjustable flow control assembly. Refer to Figure 4-42 for complete parts breakdown.

A Power Beyond option in this cover will allow excess flow to be used downstream only when upstream valve is activated and controlled flow is being used. When upstream valve is in neutral position, all flow is directed through the open center.

Port Location		NPT*	SAE		
End In		3/4	10	12	10
Top In		3/4	10	12	10
End Out		3/4	10	12	12
Machining Modification Number	Without Power Beyond	011	016	009	—
	With Power Beyond	013	—	012	017

* Pipe ports not recommended for pressures over 2000 PSI [138 bar].

ORDERING EXAMPLE FOR INLET COVERS WITH FLOW CONTROL



Flow Control Ranges

(For inlet cover with flow control only)

- 3 to 16 GPM [11 to 60 litres/min]
- 8 to 25 GPM [30 to 95 litres/min]
- 13 to 21 GPM [49 to 79 litres/min]

*Specify model number of relief valve to be installed; either WH or RP51.

Specify relief setting required **OR**

Specify "NR" (no relief) plug installed **OR**

Specify plastic shipping plug, installed in relief cavity.

Example: If a left inlet cover with a SAE 10 inlet, a SAE 12 outlet, with RP51 relief set at 2000 PSI [138 bar] crack and flow control range of 13-21 GPM [49-79 litres/min] is required, order 7736-003-RP51 2000 PSI [138 bar] crack — 13-21 GPM [49-79 litres/min].

OUTLET COVERS — Two Outlet Covers are available.

Outlet covers may be machined with several different combinations of port sizes and locations. NPT and SAE threads cannot be intermixed in the same casting. If an outlet port is not used in the outlet cover, the outlet port in the left end cover must be used for tank return line.

Use the following porting charts to arrive at the desired machining modification number.

Outlet Cover, Part No. 8644

Standard machining provides an outlet port (top, end or bottom) for open center applications. Closed center or top power beyond options are available. For power beyond, the top power beyond port is machined, and the core between the open center and exhaust passages is tapped and plugged. Plugging the power beyond port (and the internal core) converts the cover to closed center.

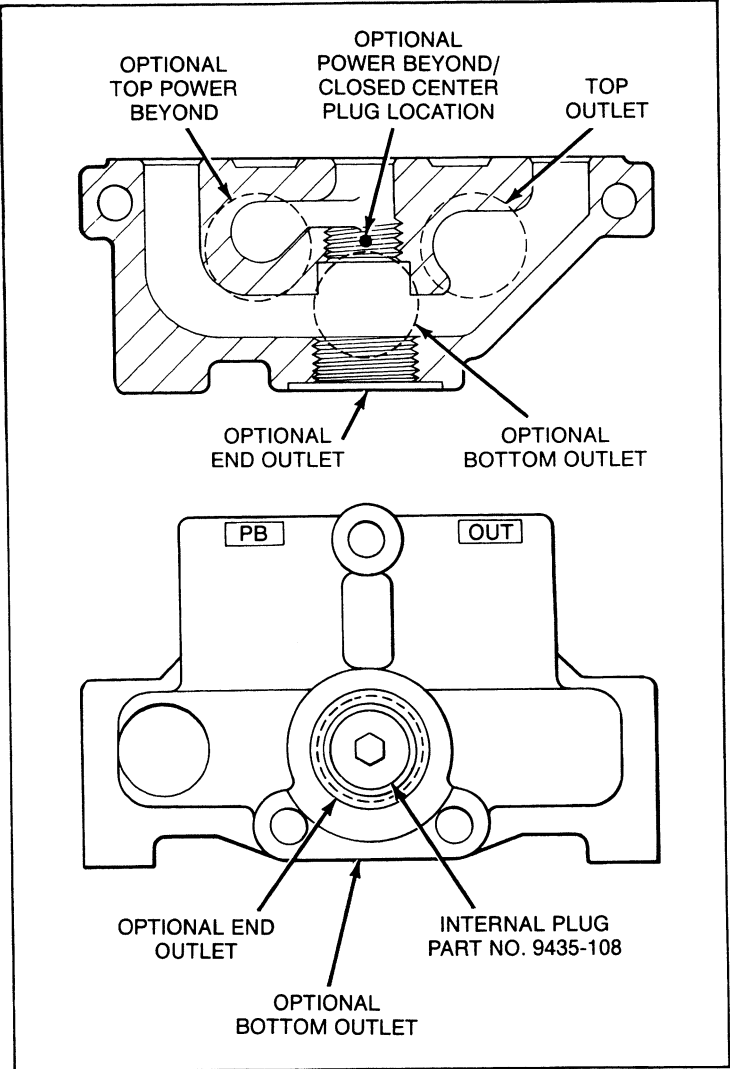


Figure 3-3. Outlet Cover Part No. 8644

Port Location	NPT			SAE				
Top Outlet*	3/4	3/4	3/4	12	12	12	12	12
End Outlet	—	—	3/4	—	—	12	12	12
Bottom Outlet	—	3/4	—	—	12	—	—	12
Top Power Beyond	—	—	3/4	—	—	10	12	12
Machining Modification Number	008	005	006	007	010	012	004	013

*Top outlet is cored and will be plugged if end or bottom outlet is specified.

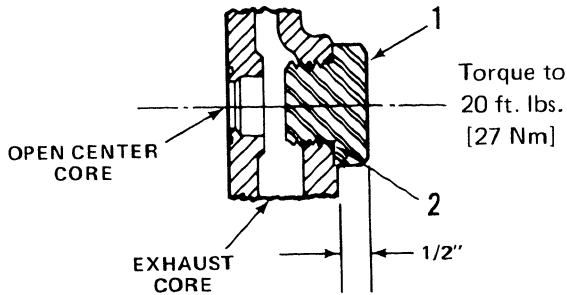
Outlet Cover, Part No. 6770.

Port Size Available	End Outlet Port Only	Machined for Power Beyond Sleeve, Closed Center Plug or Conversion Plug.	
		With End Outlet	No End Outlet
1/2-14 NPT	6770-004	6770-009	6770-007
3/4-14 NPT	6770-001	6770-005	
SAE 10 (7/8-14 UNF)	6770-002	6770-006	
SAE 12 (1-1/16 12 UNF)	6770-003	6770-013	

6770 OUTLET COVER OPTIONS

No. 1727 Conversion Plug

Provides for conversion from "Power Beyond" or "Closed-Center" usage to "Open-Center" or vice-versa.



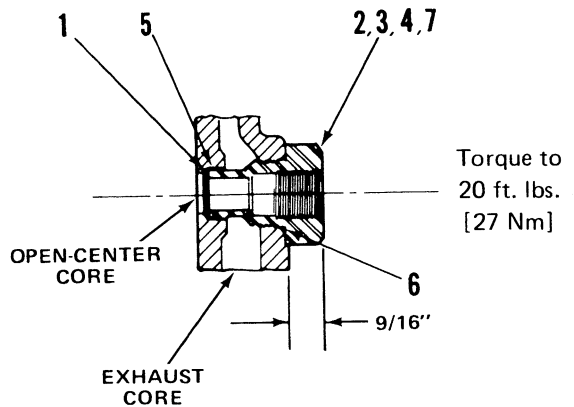
SERVICE KIT K-6016

(Contains 1 Each of Items 1 and 2)

Item No.	Part No.	Description	No. Required
1	1727-001	Conversion Plug	1
2	2709-001*	O-Ring Seal	1

No. 1833, 1835 or 1836 Power Beyond Sleeve Options.

Provides for proper hook-up of an additional valve "down-stream". The Power Beyond Sleeve prevents subjecting the exhaust core of the valve to back pressure.



SERVICE KITS

K-6017-B* (1/2 NPT — Contains 1 Each of Items 1, 2, 5, 6)

K-6018-B* (SAE 8 — Contans 1 Each of Items 1, 3, 5, 6)

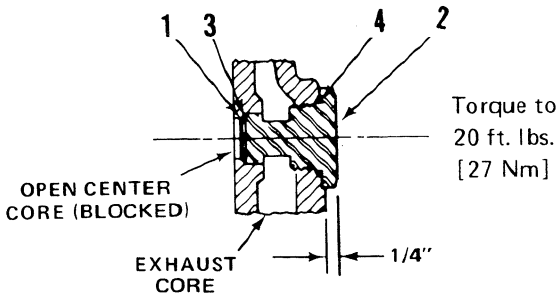
K-6019-B* (SAE 10 — Contans 1 Each of Items 1, 4, 5, 6)

K-6060-B (SAE 16 — Contains 1 Each of Items 1, 5, 6, 7)

Item No.	Part No.	Description	No. Required
1	1721-001*	Seal	1
2	1833-001	P.B. Sleeve (1/2-14 NPT)	1
3	1835-001	P.B. Sleeve SAE 8 (3/4-16 UNF)	1
4	1836-001	P.B. Sleeve SAE 10 (7/8-14 UNF)	1
5	9020-017	Back-Up Washer	1
6	2709-001*	O-Ring Seal	1
7	7706-001	P.B. Sleeve SAE 16 (1" Tube) Male Fitting	1

No. 1830 Closed-Center Plug Option.

Provides a "Closed-Center" System by plugging the open-center flow passage. It is normally used with a variable displacement pump.



SERVICE KIT K-6015

(Contains 1 Each of Items 1, 2, 3 and 4)

Item No.	Part No.	Description	No. Required
1	1721-001*	Seal	1
2	1830-001	Closed-Center Plug	1
3	9020-017	Back-Up Washer	1
4	2709-001*	O-Ring Seal	1

NOTE

To convert from Power Beyond usage to "Open-Center" usage, NEVER ATTEMPT TO PLUG THE POWER BEYOND SLEEVE, as this would convert to "Closed-Center" Valve.

ORDERING EXAMPLE
FOR RIGHT COVER PLATE:

BASIC CASTING

COVER MACHINING
MODIFICATION

OPTION DETAILS

6770

006

Cover with SAE 8 Power
Beyond Sleeve Installed

Example: If a right cover with a SAE 10 outlet and a SAE 8 power beyond sleeve was required, then order: per the above description.

*Buna-N seals are standard for all Gresen valve assemblies. Optional Viton seals are available. See Cross Reference Tables on Page 4-37.

V20P, V20T and V20S VALVE CENTER SECTIONS

The following information is necessary for proper specification for each V20P, V20T or V20S Valve Center Section:

1. Function of Section
2. Options
3. Work port sizes

4. Work port "A" Options
5. Work port "B" Options
6. Handle end Options

The chart shown below will help in identifying the Options available and the information needed for proper ordering. Refer to product catalog No. PC-1106 for complete information on options available.

CIRCUIT	PARALLEL – V20P <input type="checkbox"/> Casting No. 8072 (See Page 2-0) TANDEM – V20T <input type="checkbox"/> Casting No. 8112 (See Page 2-0) SERIES – V20S <input type="checkbox"/> Casting No. 11483 (See Page 2-0)
FUNCTION OF SECTION	FUNCTION OF SECTION (Check one for each section) • 3-Way (Work port on handle end will be plugged) <input type="checkbox"/> • 4-Way <input type="checkbox"/> • 4-Way Float (K) <input type="checkbox"/> • _____ <input type="checkbox"/>
OPTIONAL FEATURES	ADDITIONAL OPTIONS • Free Flow (F) <input type="checkbox"/> • 3-Position Detent (D) <input type="checkbox"/> • _____ <input type="checkbox"/> • _____
WORK PORT SIZES	"A" and "B" WORK PORT SIZES 3/8, 1/2 NPT; SAE 8, 10
WORK PORT "A" OPTIONS	OPTIONS AVAILABLE (Specify) • Relief (RC or RCA*) _____ • Anti-Cavitation (A-C) _____ • Combination Relief and Anti-Cavitation (CRA) _____ Specify Relief Setting, Crack or Full Flow *RCA cannot be used with valve handle or bracket.
WORK PORT "B" OPTIONS	OPTIONS AVAILABLE (Specify) • Relief (RC or RCA*) _____ • Anti-Cavitation (A-C) _____ • Combination Relief and Anti-Cavitation (CRA) _____ Specify Relief Setting, Crack or Full Flow *RCA cannot be used with valve handle or bracket.
HANDLE-END OPTIONS	Location: "A" Work Port End <input type="checkbox"/> "B" Work Port End <input type="checkbox"/> Handle Type: No. 1802, Vert. <input type="checkbox"/> No. 3249, Horiz. <input type="checkbox"/> Less Complete Handle Assy (LCHA) <input type="checkbox"/> Less Handle Only (LHO) <input type="checkbox"/> Handle Bracket Only (HBO) <input type="checkbox"/> Bracket: No. 1801 <input type="checkbox"/> No. 7355 <input type="checkbox"/> Rotate 180° From Standard <input type="checkbox"/> Float Section: Pull Handle to Float <input type="checkbox"/> Push Handle to Float <input type="checkbox"/> Heavy Duty Retainer <input type="checkbox"/> Spool Protector Boot <input type="checkbox"/> Spool Wiper <input type="checkbox"/>

SECTION IV PARTS LISTING

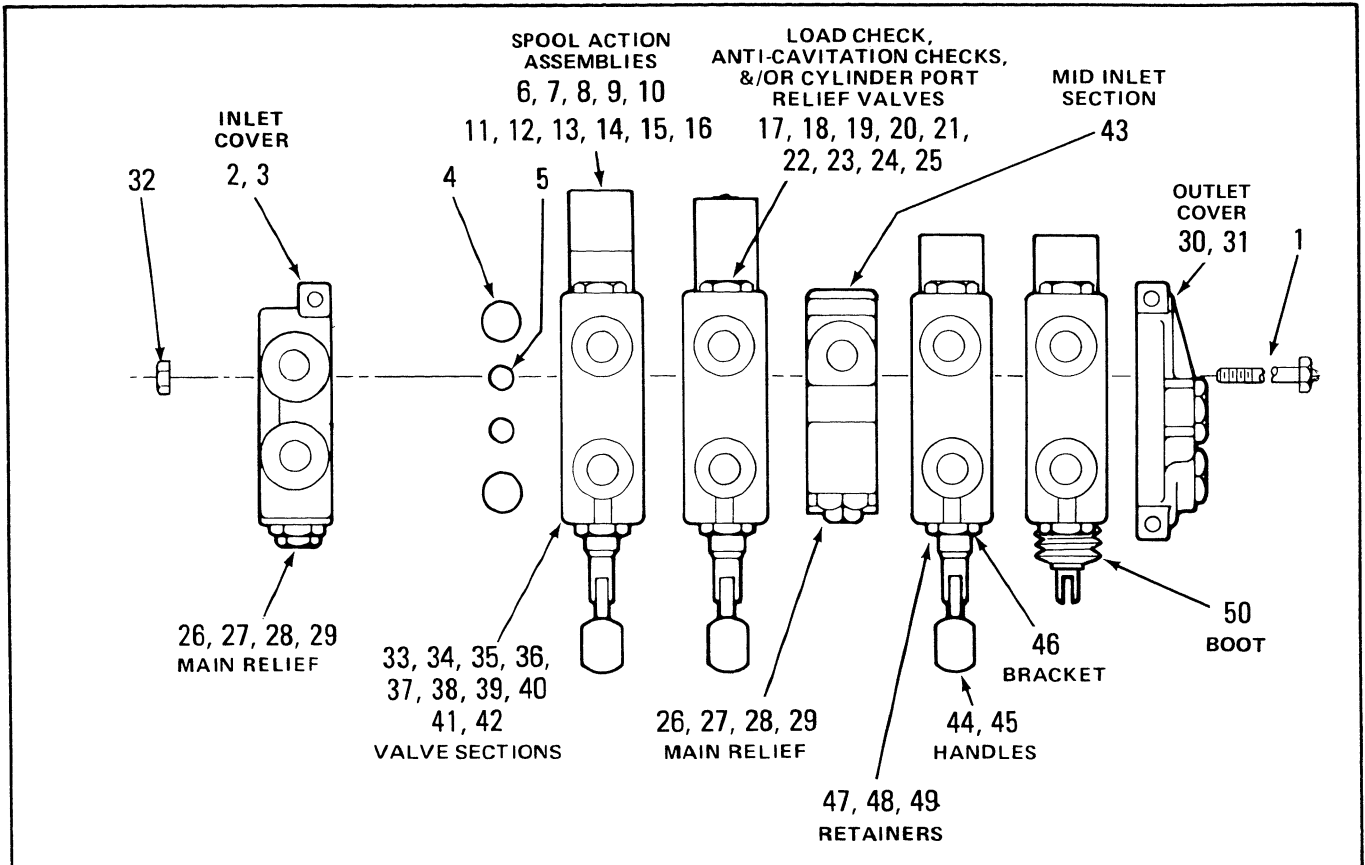


Figure 4-1: Model V20 Directional Control Valve, Typical Main Assembly.

MODEL V20 DIRECTIONAL CONTROL VALVE, TYPICAL MAIN ASSEMBLY

Item No.	Part No.	Description	Quantity Per Assembly
1	K-6104-D	STUD KIT, 1-Section	1
	K-6105-D	STUD KIT, 2-Section	1
	K-6106-D	STUD KIT, 3-Section	1
	K-6107-D	STUD KIT, 4-Section	1
	K-6108-C	STUD KIT, 5-Section	1
	K-6109-C	STUD KIT, 6-Section	1
	K-6110-C	STUD KIT, 7-Section	1
	K-6111-C	STUD KIT, 8-Section	1
	K-6112-C	STUD KIT, 9-Section	1
2	8398-	COVER, Left (Refer to Page 3-3)	1
3	7736-	COVER, Left, with flow control (Refer to Page 3-3 and Figure 4-43)	1
4	21733-001*	O-RING, Exhaust, Large (new)	**
	6815-002*	O-RING, Exhaust, Large (old)	**

Each Stud Kit
Contains 3
Assembly Studs
and 3 Stud Nuts

Note:
Torque Stud Nuts
to 32 ft. lbs. [43.5 Nm]

*Buna-N seals are standard for all Gresen valve assemblies. Optional Viton seals are available. See Cross Reference Tables on page 4-37.

**All old versions include two exhaust and two small O-rings. All new open center versions include three large and one small O-ring. Other new versions including outlet, utility section and mid-inlets contain two of each.

MODEL V20 DIRECTIONAL CONTROL VALVE, TYPICAL MAIN ASSEMBLY (Continued)

Item No.	Part No.	Description	Quantity Per Assembly
5	21857-001*	O-RING, Pressure, Small (new)	**
	6814-002*	O-RING, Pressure, Small (old)	**
	21866-001*	O-RING, Load Sensing (new)	**
	8316-001*	O-RING, Load Sensing (old)	**
6		POSITIONER, Standard Spool (See Figure 4-12)	A/R
7		POSITIONER, Manual Spool (See Figure 4-13)	A/R
8		POSITIONER, Float Detent, 4-Way, 4-Position (See Figure 4-14)	A/R
9		DETENT, Option "R", With Spring Return To Neutral (See Figure 4-15)	A/R
10		DETENT, Option "D", 3-Position (See Figure 4-16)	A/R
11		SPRING EXTENDED SPOOL, Option "A" (See Figure 4-17)	A/R
12		ELECTRO-MAGNETIC SPOOL RELEASE (See Figure 4-18)	A/R
13		POSITIONER, Pressure Detent Release (See Figure 4-19)	A/R
14		POSITIONER, Rotary, Option "W" (See Figure 4-20)	A/R
15		POSITIONER, Standard Spool, V20S or V20R (See Figure 4-21)	A/R
16		POSITIONER, Float Detent, 4-Way, 4-Position, V20S (See Figure 4-22)	A/R
17		CHECK, Lockout (See Figure 4-29)	A/R
18		CHECK, Anti-Cavitation (See Figure 4-30)	A/R
19		CHECK, Anti-Cavitation, V20S (See Figure 4-31)	A/R
20		PLUG, Load Check, (See Figure 4-32)	A/R
21		PLUG, Load Check, V20S (See Figure 4-33)	A/R
22		RELIEF, Work Port, Model RC (See Figure 4-34)	A/R
23		RELIEF, Work Port, Model RCA (See Figure 4-35)	A/R
24		RELIEF/ANTI-CAVITATION CHECK, Work Port, Model CRA (See Figure 4-37)	A/R
25		RELIEF, Work Port, Model RCS (See Figure 4-38)	A/R
26		RELIEF, Main, Model WH (See Figure 4-39)	A/R
27		RELIEF, Main, Model WHA (See Figure 4-40)	A/R
28		RELIEF, Main, Model RP5 1 (See Figure 4-41)	A/R
29		PLUG, No Main Relief (NR) (See Figure 4-43)	A/R
30	6770-	COVER, Right (See pages 3-3 & 3-4)	1
31	8644-	COVER, Right (See page 3-3)	1
32	9310-006	NUT, Stud (Not sold separately. See Item No. 1)	
33	8072-	VALVE SECTION, 4-Way, 4-Position, Float (See Figure 4-2)	A/R
34	8072-	VALVE SECTION, 4-Way, 3-Position (See Figure 4-3)	A/R
35	8072-	VALVE SECTION, 3-Way, 3-Position (See Figure 4-4)	A/R
36	8072-	VALVE SECTION, 4-Way, 3-Position, With Pressure Detent Release (See Figure 4-5)	A/R
37	11571-	VALVE SECTION, 4-Way, 3-Position, With Pilot Operated Checks (See Figure 4-6)	A/R
38	8112-	VALVE SECTION, Tandem (See Figure 4-7)	A/R
39	10954-	VALVE SECTION, Low Pressure Drop (See Figure 4-8)	A/R
40	10762-	VALVE SECTION, Tandem, Low Pressure Drop (See Figure 4-9)	A/R
41	11483-	VALVE SECTION, Series (See Figure 4-10)	A/R
42	11483-	VALVE SECTION, Series, 4-Way, 4-Position, Float (See Figure 4-11)	A/R
43	6825-001	MID-INLET SECTION, Split Flow, Top Inlet 3/4—14 NPT	A/R
	6825-004	MID-INLET SECTION, Split Flow, Top Inlet 1/2—14 NPT	A/R
	6825-007	MID-INLET SECTION, Split Flow, Top Inlet SAE 12 (1-1/16—12 UNF)	A/R
	6825-011	MID-INLET SECTION, Split Flow, Top Inlet SAE 10 (7/8—14 UNF)	A/R
	6825-005	MID-INLET SECTION, Combined Flow, Top Inlet 3/4—14 NPT	A/R
	6825-008	MID-INLET SECTION, Combined Flow, Top Inlet 1/2—14 NPT	A/R
	6825-013	MID-INLET SECTION, Combined Flow, Top Inlet SAE 10 (7/8—14 UNF)	A/R
	6825-016	MID-INLET SECTION, Combined Flow, Top Inlet SAE 12 (1-1/16—12 UNF)	A/R
	6825-002	MID-INLET SECTION, Top Cored Hole Plugged with 3/8—18 NPT Plug	A/R
44		HANDLE ASSEMBLY, Vertical (See Figure 4-26)	A/R
45		HANDLE ASSEMBLY, Horizontal (See Figure 4-27)	A/R
46		BRACKET, Standard Handle (See Figure 4-25)	A/R
47	K-6033-B	RETAINER, Seal, Standard (See Figure 4-23)	A/R
48	K-6029-B	RETAINER, Seal, Heavy Duty (See Figure 4-24)	A/R
50	K-6056-B	BOOT ASSEMBLY, Spool Protective (See Figure 4-28)	A/R

*Buna-N seals are standard for all Gresen valve assemblies. Optional Viton seals are available. See Cross Reference Tables on page 4-37.

**All old versions include two exhaust and two small O-rings. All new open center versions include three large and one small O-ring. Other new versions including outlet, utility section and mid-inlets contain two of each.

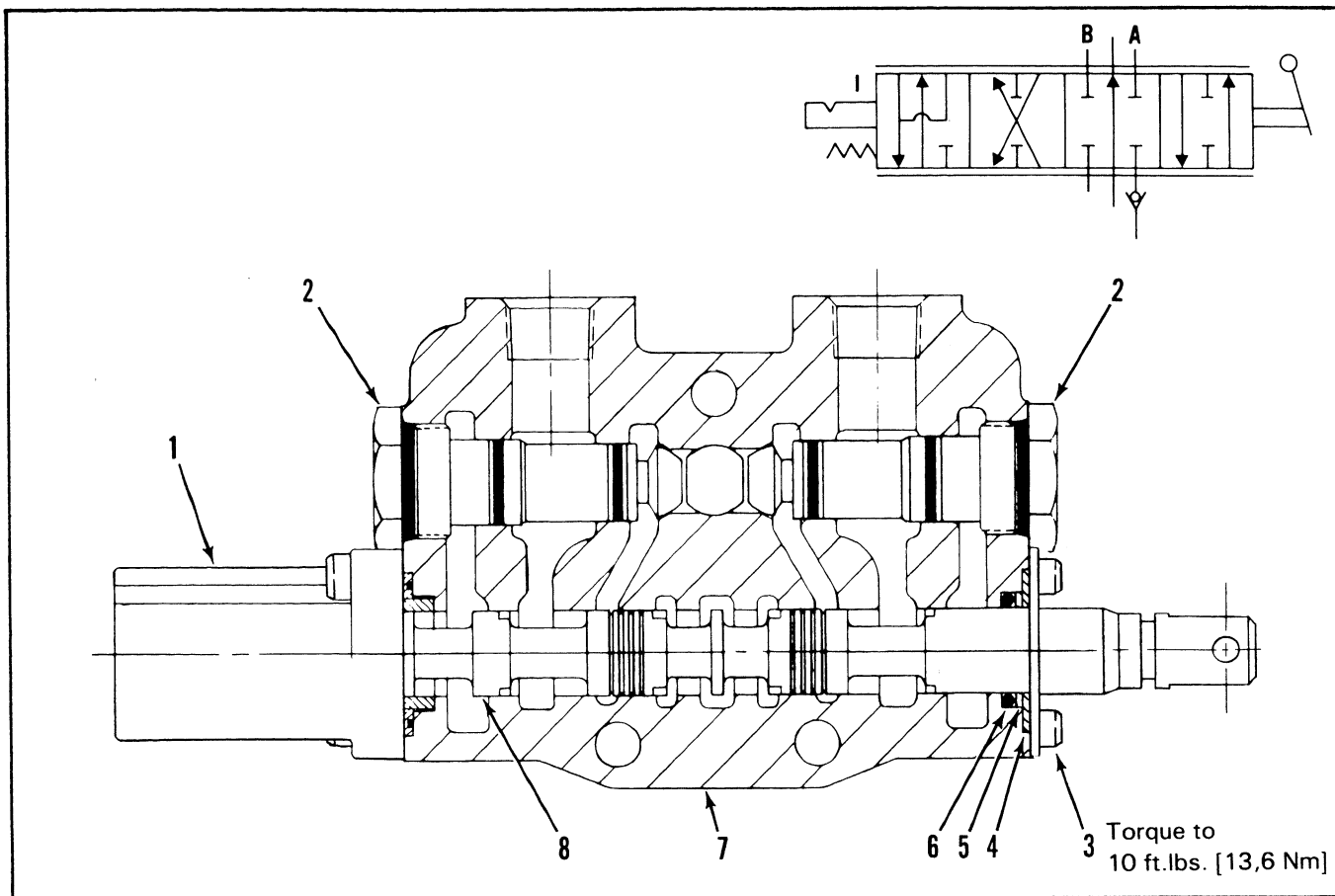


Figure 4-2. 4-Way, 4-Position Float Valve Section.

4-WAY, 4-POSITION FLOAT VALVE SECTION

Item No.	Part No.	Description	Quantity Per Section
1	K-6127-A	POSITIONER, Float (See Figure 4-14)	1
2	K-6030-C	CHECK, Load (See Figure 4-32)	2
3	K-6033-B	RETAINER ASSEMBLY, Standard, Includes Screws (See Figure 4-23. See Figures 4-24 through 4-28 for optional assemblies.)	1
4	6752-001	RETAINER, Plate Washer	1
5	3265-001	WASHER, Back-Up	1
6	7700-001*	SEAL, O-Ring	1
7	8072-	HOUSING, V20 Valve	1
8	8085-001	SPOOL, Float	1

Notes:

1. Seal and washer not sold separately. Order Seal Kit No. K-6035-A.

2. These are matched parts and are not sold separately. Refer to Ordering Instructions, page 3-6 for complete section.

*Buna-N seals are standard for all Gresen valve assemblies. Optional Viton seals are available. See Cross Reference Tables on page 4-37.

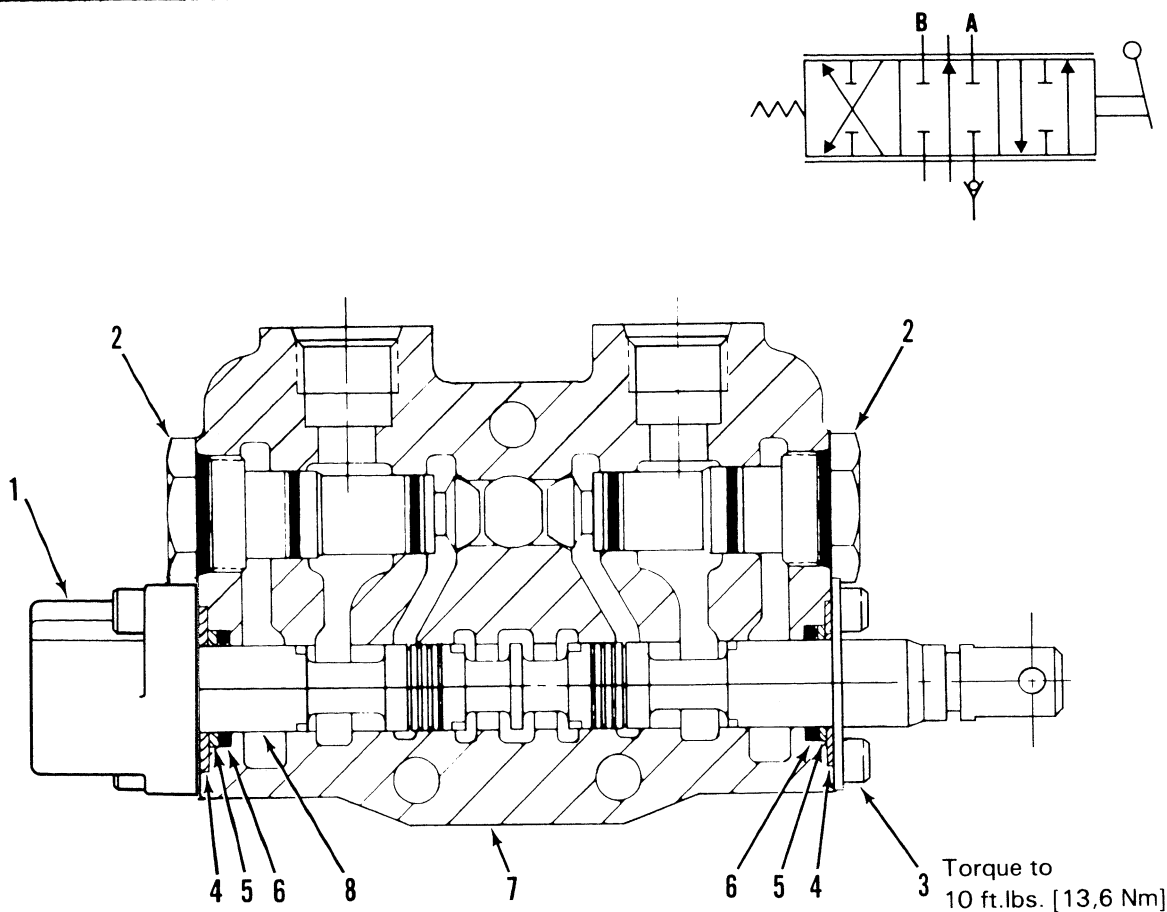


Figure 4-3. 4-Way, 3-Position Valve Section.

4-WAY, 3-POSITION VALVE SECTION

Item No.	Part No.	Description	Quantity Per Section
1	K-6125-B	POSITIONER, Spool, Standard (See Figure 4-12)	1
2	K-6030-C	CHECK, Load (See Figure 4-32)	2
3	K-6033-B	RETAINER ASSEMBLY, Standard, Includes Screws (See Figure 4-23. See Figure 4-24 thru 4-28 for optional assemblies.)	1
4	6752-001	RETAINER, Plate Washer	2
5	3265-001	WASHER, Back-Up	2
6	7700-001*	SEAL, O-Ring	2
7	8072-	HOUSING, Standard	1
8	8084-001	SPOOL, 4-Way	1

Notes:

1. Seal and washer not sold separately. Order Seal Kit No. K-6035-A.

2. These are matched parts and are not sold separately. Refer to Ordering Instructions, page 3-6 for complete section.

*Buna-N seals are standard for all Gresen valve assemblies. Optional Viton seals are available. See Cross Reference Tables on page 4-37.

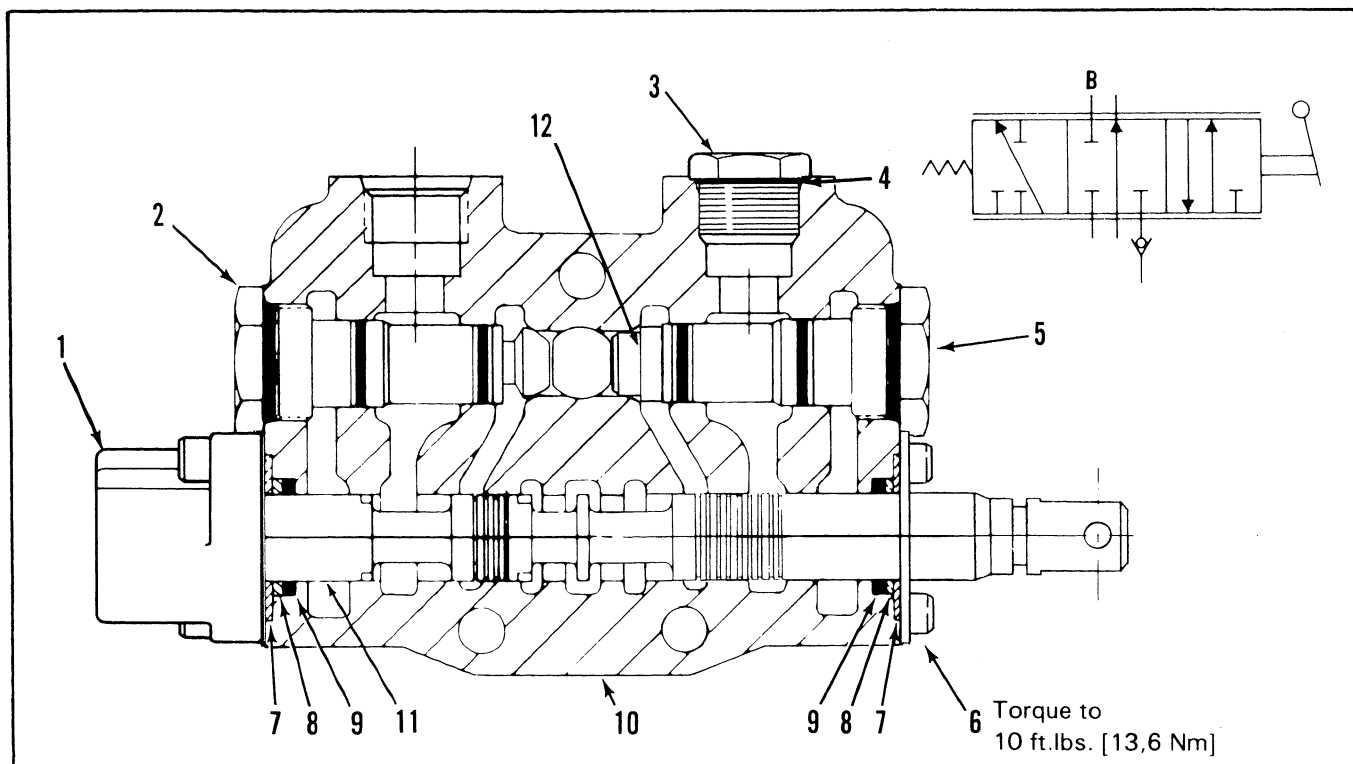


Figure 4-4. 3-Way, 3-Position Valve Section.

3-WAY, 3-POSITION VALVE SECTION

Item No.	Part No.	Description	Quantity Per Assembly
1	K-6125-B	POSITIONER, Spool, Standard (See Figure 4-12)	1
2	K-6030-C	CHECK, Load (See Figure 4-32)	1
3	2684-001	PLUG, 3-Way Conversion, SAE 8 (3/4"–16 UNF)	A/R
	1458-001	PLUG, 3-Way Conversion, SAE 10(7/8"–14 UNF)	A/R
	0073-001	PLUG, 3-Way Conversion, 3/8"–18 NPT	A/R
	0947-001	PLUG, 3-Way Conversion, 1/2"–14 NPT	A/R
4	2706-001	SEAL, O-Ring, SAE 8 Plug	A/R
	2707-001	SEAL, O-Ring, SAE 10 Plug	A/R
5	K-6030-C	PLUG, Check (Load Check and Spring are not used)	1
6	K-6033-B	RETAINER ASSEMBLY, Standard, Includes Screws (See Figure 4-23. See Figures 24 thru 4-28 for optional assemblies)	1
7	6752-001	RETAINER, Plate Washer	2
8	3265-001	WASHER, Back-Up	2
9	7700-001*	SEAL, O-Ring	2
10	8072-	HOUSING	1
11	8083-001	SPOOL, 3-Way	1
12	6754-001	PLUG, 3-Way	1

Notes:

1. Seal and washer not sold separately. Order Seal Kit No. K-6035-A.

2. These are matched parts and are not sold separately. Refer to Ordering Instructions, page 3-6 for complete section.

*Buna-N seals are standard for all Gresen valve assemblies. Optional Viton seals are available. See Cross Reference Tables on page 4-37.

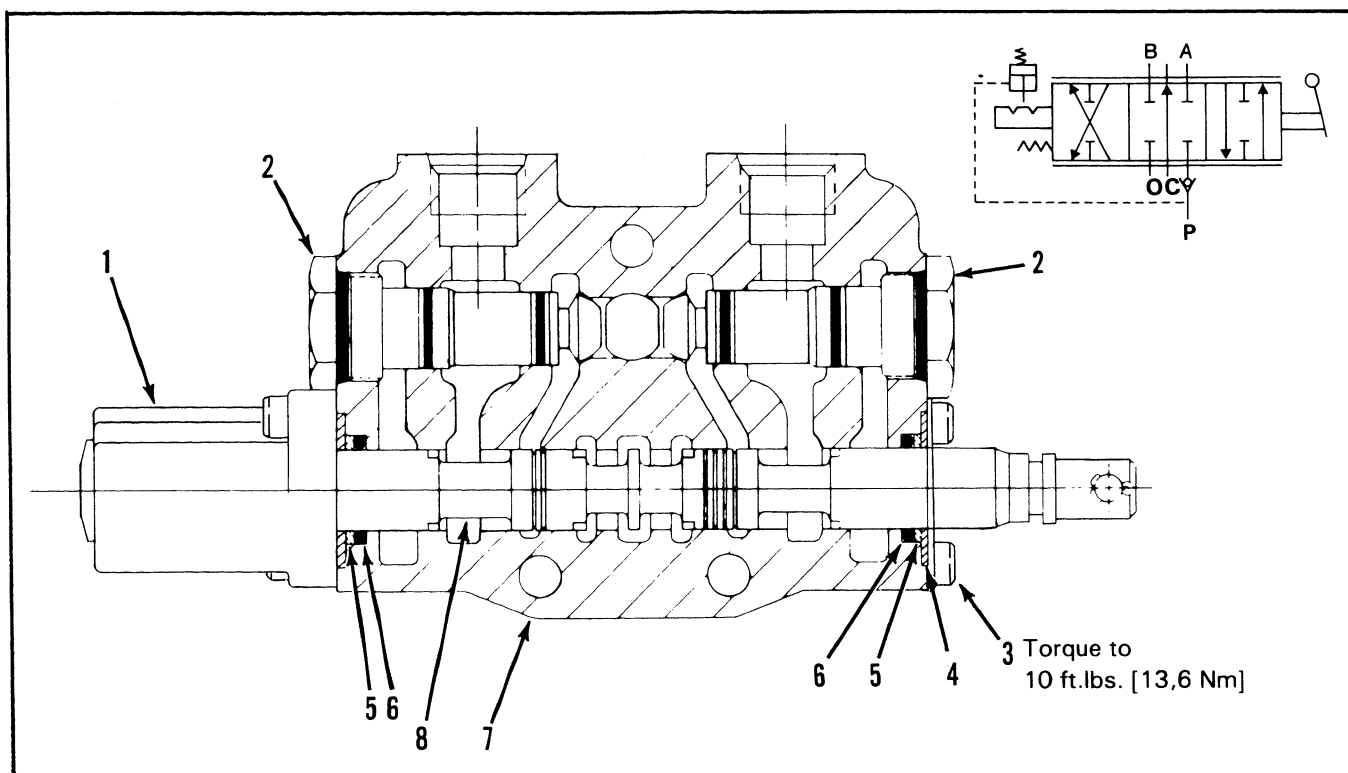


Figure 4-5. 4-Way, 3-Position Valve Section with Pressure Detent Release.

4-WAY, 3-POSITION VALVE SECTION WITH PRESSURE DETENT RELEASE (KO)

Item No.	Part No.	Description	Quantity Per Section
1		POSITIONER, Pressure Detent Release (See Figure 4-19)	1
2	K-6030-A	CHECK, Load (See Figure 4-32)	2
3	K-6033-B	RETAINER ASSEMBLY, Standard, Includes Screws, (See Figure 4-23. See Figures 4-24 thru 4-28 for optional assemblies.)	1
4	6752-001	RETAINER, Plate Washer	1
5	3765-001	WASHER, Back-Up	2
6	7700-001*	SEAL, O-Ring	2
7	8072-	HOUSING	1
8	8534-001	SPOOL, 4-Way	1

Notes:

1. Seal and washer not sold separately. Order Seal Kit No. K-6035-A.

2. These are matched parts and are not sold separately. Refer to Ordering Instructions, page 3-6 for complete section.

*Buna-N seals are standard for all Gresen valve assemblies. Optional Viton seals are available. See Cross Reference Tables on page 4-37.

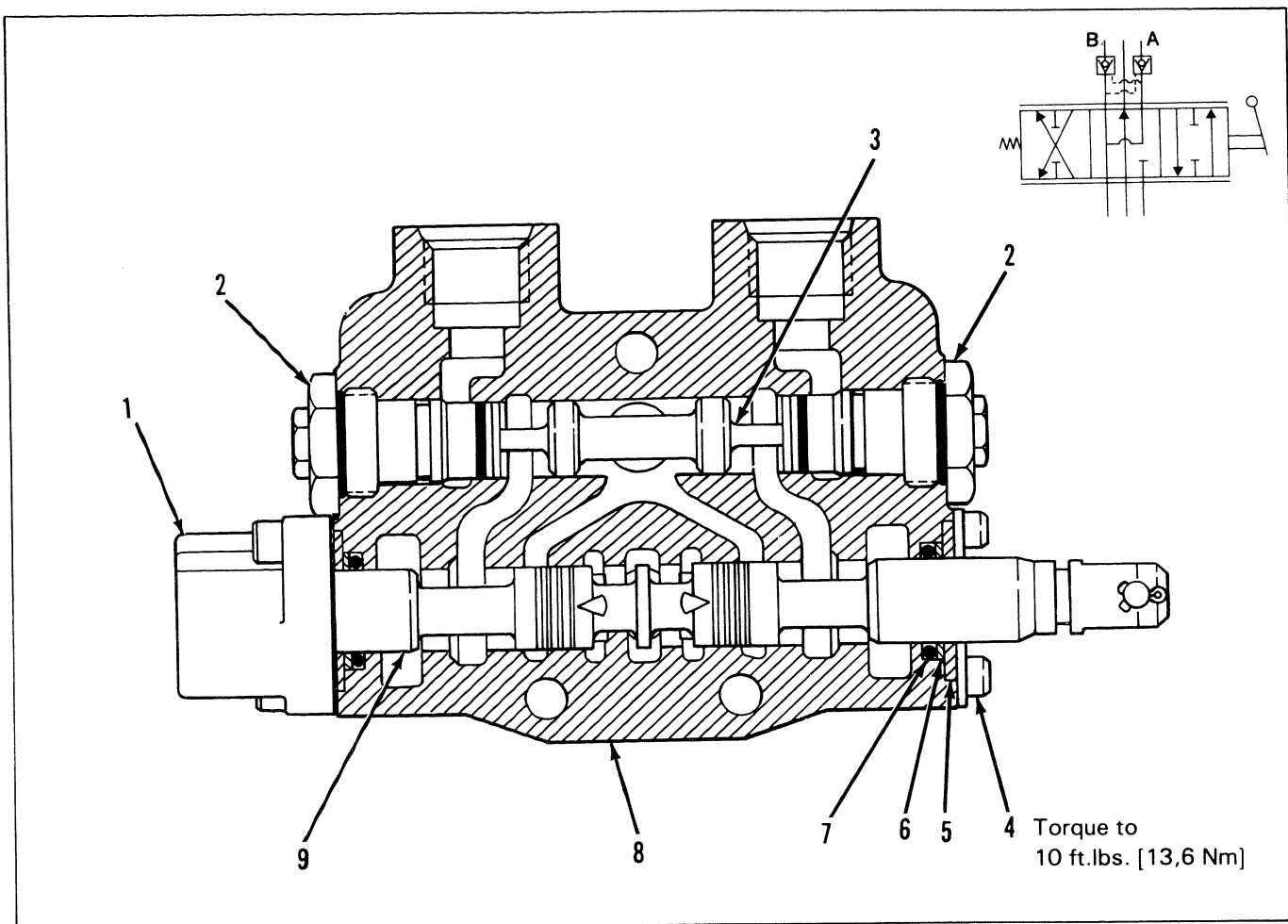


Figure 4-6. 4-Way, 3-Position Lockout Valve Section.

4-WAY, 3-POSITION LOCKOUT VALVE SECTION

Item No.	Part No.	Description	Quantity Per Section
1	K-6125-B	POSITIONER, Spool, Standard (See Figure 4-12)	1
2	K-6024-D	CHECK, Lockout (See Figure 4-29)	2
3	8648-001	PISTON, Unlocking	1
4	K-6033-B	RETAINER ASSEMBLY, Standard, Includes screws (See Figure 4-23. See Figure 4-24 thru 4-28 for optional assemblies.)	1
5	6752-001	RETAINER, Plate Washer	2
6	3265-001	WASHER, Back-Up	2
7	7700-001*	SEAL, O-Ring	2
8	11571-	HOUSING, V20 Lockout	1
9	8397-001	SPOOL, Modified 4-Way Free Flow	1

Not sold separately. Order K-6035-A

See Note

Note: These are matched parts and are not sold separately. Refer to Ordering Instructions, page 3-6 for complete section.

*Buna-N seals are standard for all Gresen valve assemblies. Optional Viton seals are available. See Cross Reference Tables on page 4-37.

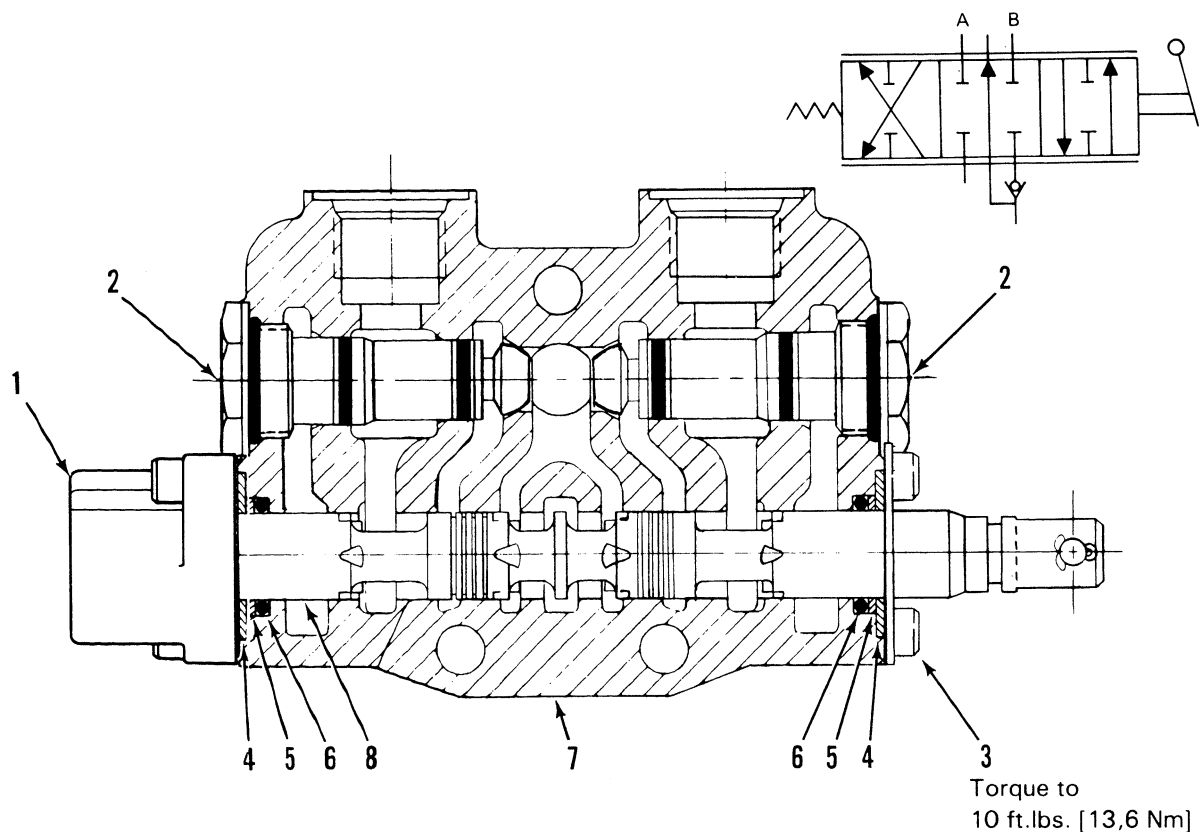


Figure 4-7. 4-Way, 3-Position Tandem Valve Section (shown with 4-way spool).

4-WAY, 3-POSITION TANDEM VALVE SECTION

Item No.	Part No.	Description	Quantity Per Section
1	K-6125-B	POSITIONER, Spool, Standard (See Figure 4-12)	1
2	K-6030-C	CHECK, Load (See Figure 4-32)	2
3	K-6033-B	RETAINER ASSEMBLY, Standard, Includes Screws (See Figure 4-23. See Figures 4-24 thru 4-28 for optional assemblies.)	1
4	6752-001	RETAINER, Plate Washer	2
5	3265-001	WASHER, Back-Up	2
6	7700-001*	SEAL, O-Ring	2
7	8112-	HOUSING	1
8	8084-001	SPOOL, 4-Way	1

Notes:

1. Seal and washer not sold separately. Order Seal Kit No. K-6035-A.

2. These are matched parts and are not sold separately. Refer to Ordering Instructions, page 3-6 for complete section.

*Buna-N seals are standard for all Gresen valve assemblies. Optional Viton seals are available. See Cross Reference Tables on page 4-37.

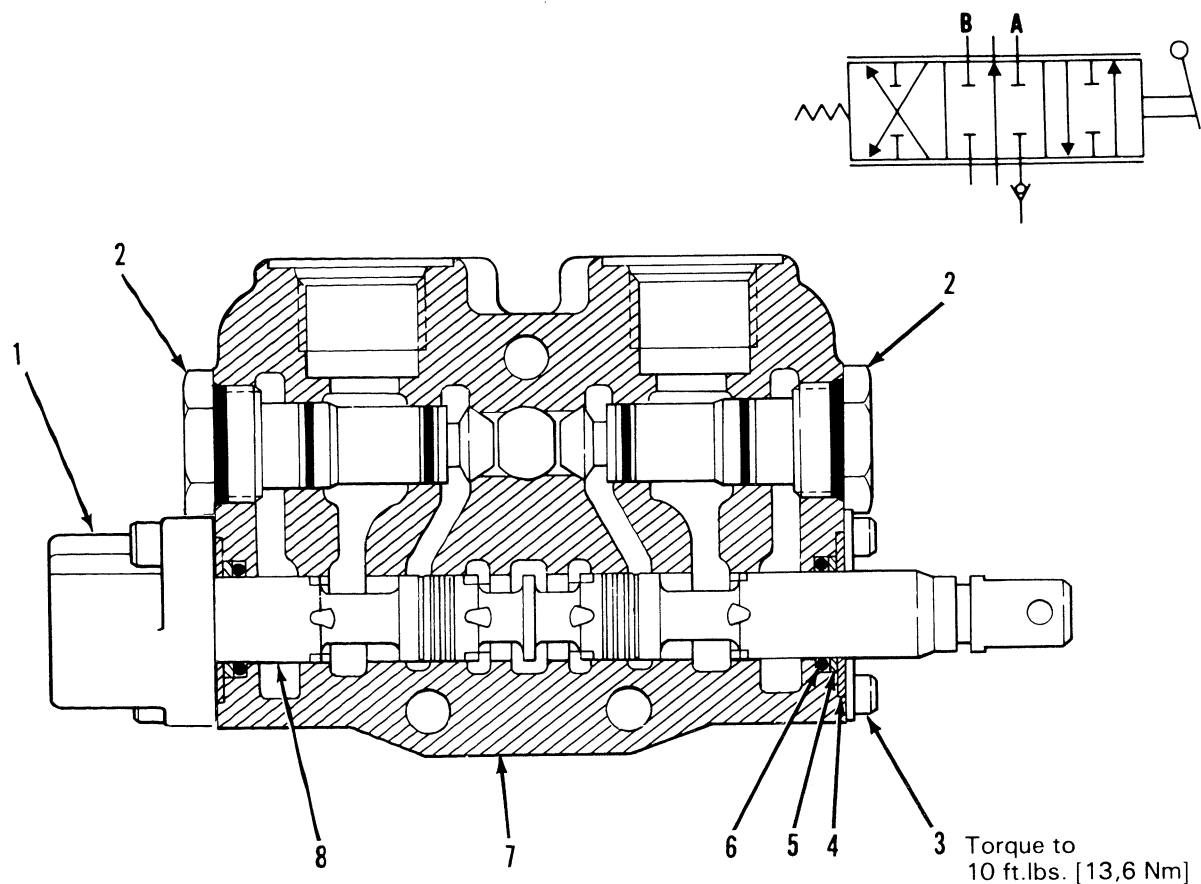


Figure 4-8. 4-Way, 3-Position, Low Pressure Drop Valve Section.

4-WAY, 3-POSITION, LOW PRESSURE DROP VALVE SECTION

Item No.	Part No.	Description	Quantity Per Section
1	K-6207-A	POSITIONER, Spool, Standard (See Figure 4-21)	1
2	K-6030-C	CHECK, Load (See Figure 4-32)	2
3	K-6033-B	RETAINER ASSEMBLY, Standard, Includes screws (See Figure 4-23. See Figure 4-24 thru 4-28 for optional assemblies.)	1
4	6752-001	RETAINER, Plate Washer	2
5	3265-001	WASHER, Back Up	2
6	7700-001*	SEAL, O-Ring	2
7	10954-	HOUSING, V20 Low Pressure Drop	1
8	8084-001	SPOOL, 4-Way	1

Note: These are matched parts and are not sold separately. Refer to Ordering Instructions, page 3-6 for complete section.

*Buna-N seals are standard for all Gresen valve assemblies. Optional Viton seals are available. See Cross Reference Tables on page 4-37.

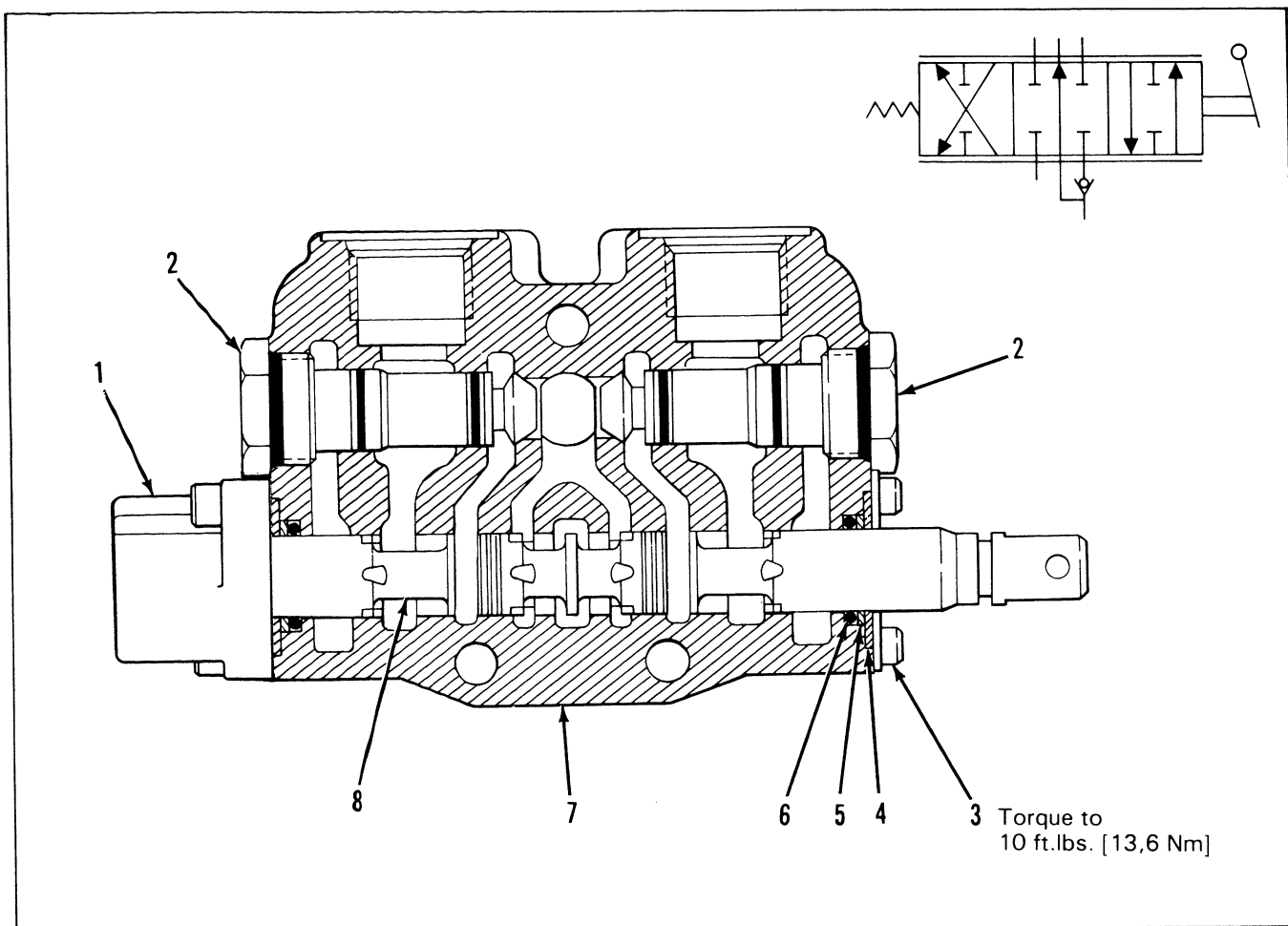


Figure 4-9. 4-Way, 3-Position, Tandem, Low Pressure Drop Valve Section.

4-WAY, 3-POSITION, TANDEM, LOW PRESSURE DROP VALVE SECTION

Item No.	Part No.	Description	Quantity Per Section
1	K-6207-A	POSITIONER, Spool, Standard (See Figure 4-21)	1
2	K-6030-C	CHECK, Load (See Figure 4-32)	2
3	K-6033-B	RETAINER ASSEMBLY, Standard, Includes screws (See Figure 4-23. See Figure 4-24 thru 4-28 for optional assemblies.)	1
4	6752-001	RETAINER, Plate Washer	2
5	3265-001	WASHER, Back-Up	2
6	7700-001*	SEAL, O-Ring	2
7	10762-	HOUSING, Tandem, Low Pressure Drop	1
8	8084-001	SPOOL, 4-Way	1

Note: These are matched parts and are not sold separately. Refer to Ordering Instructions, page 3-6 for complete section.

*Buna-N seals are standard for all Gresen valve assemblies. Optional Viton seals are available. See Cross Reference Tables on page 4-37.

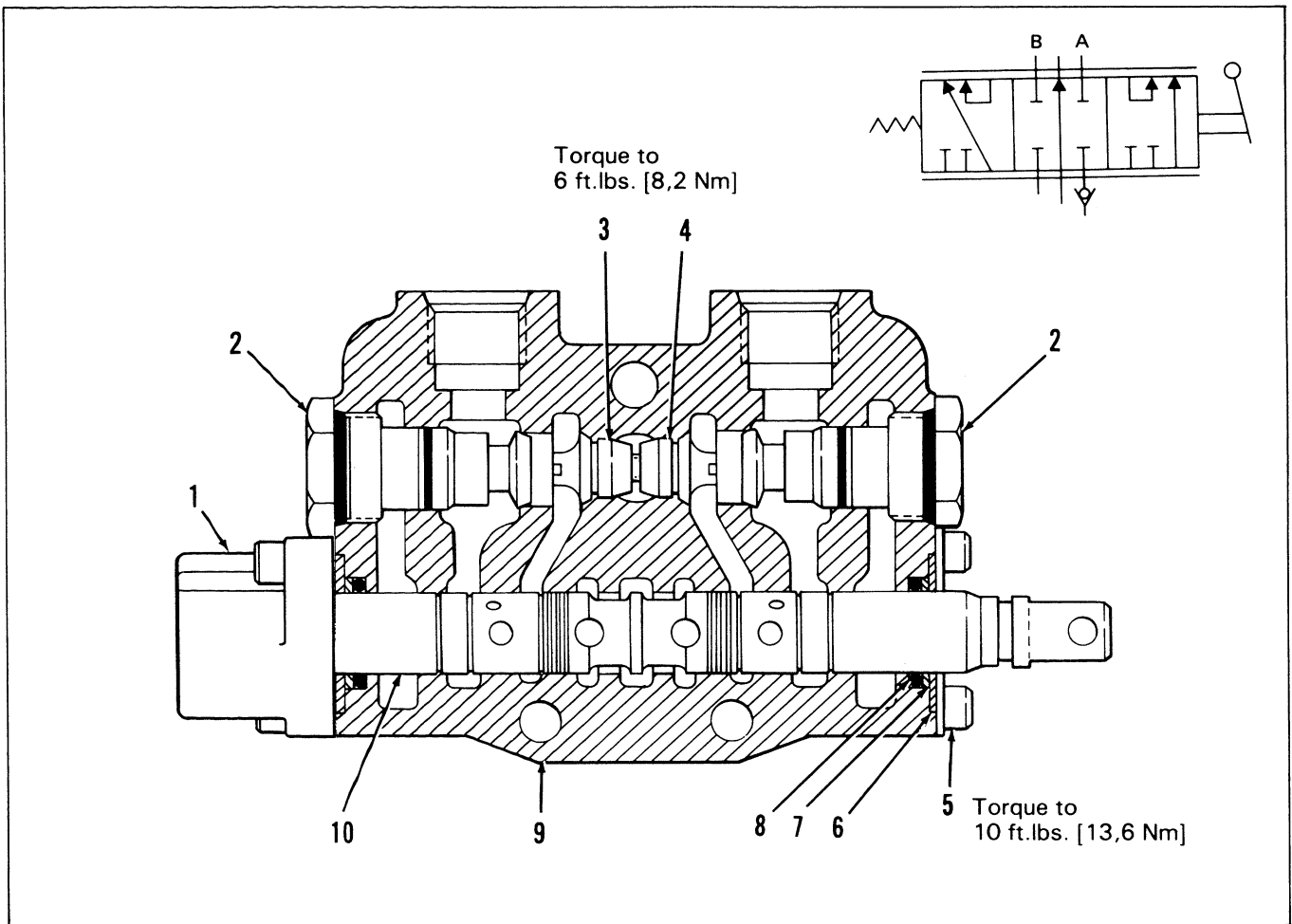


Figure 4-10. 4-Way, 3-Position, Series Valve Section.

4-WAY, 3-POSITION, SERIES VALVE SECTION

Item No.	Part No.	Description	Quantity Per Section
1	K-6207-A	POSITIONER, Spool, Standard (See Figure 4-21)	1
2	K-6203	CHECK, Load (See Figure 4-33)	2
3	11246-001	PLUG, Power Core	1
4	11716-001	PLUG, Power Core	1
5	K-6033-B	RETAINER ASSEMBLY, Standard, Includes screws (See Figure 4-23. See Figure 4-24 thru 4-28 for optional assemblies.)	1
6	6752-001	RETAINER, Plate Washer	2
7	3265-001	WASHER, Back-Up	2
8	7700-001*	Seal, O-Ring	2
9	11483-	HOUSING, V20 Series	1
10	11245-001	SPOOL, Series, 4-Way	1

Notes:

1. Parts not sold separately. Order K-6200-A. Power core plug assembly is only used in Series housings manufactured prior to May 1, 1985 (Series housing #8072).

2. These are matched parts and are not sold separately. Refer to Ordering Instructions, page 3-6 for complete section.

*Buna-N seals are standard for all Gresen valve assemblies. Optional Viton seals are available. See Cross Reference Tables on page 4-37.

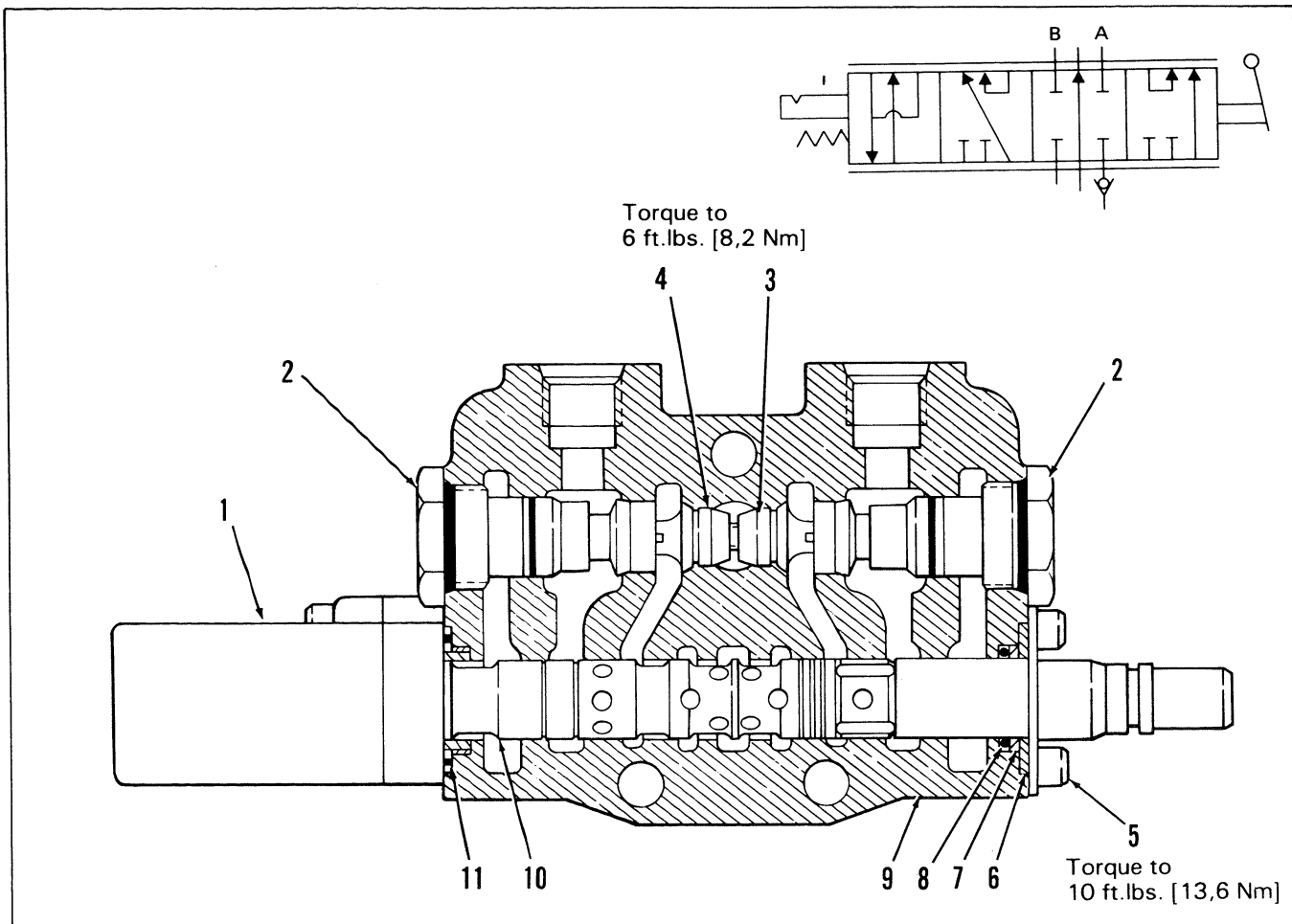


Figure 4-11. 4-Way, 4-Position Float, Series Valve Section.

4-WAY, 4-POSITION FLOAT, SERIES VALVE SECTION

Item No.	Part No.	Description	Quantity Per Section
1	K-6208	POSITIONER, Float Out (See Figure 4-22)	1
2	K-6203	CHECK, Load (See Figure 4-33)	2
3	11246-001	PLUG, Power Core	1
4	11716-001	PLUG, Power Core	1
5	K-6033-B	RETAINER ASSEMBLY, Standard, Includes screws (See Figure 4-23. See Figure 4-24 thru 4-28 for optional assemblies.)	1
6	6752-001	RETAINER, Plate Washer	1
7	3265-001	WASHER, Back-Up	1
8	7700-001*	SEAL, O-Ring	1
9	11483-	HOUSING, V20 Series	1
10	11377-001	SPOOL, Series, Float	1
11		SPOOL SEAL ASSEMBLY (See Figure 4-22)	1

Notes:

1. Parts not sold separately. Order K-6200-A. Power core plug assembly is only used in Series housings manufactured prior to May 1, 1985 (series housing #8072).
2. These are matched parts and are not sold separately. Refer to Ordering Instructions, page 3-2 for complete section.

*Buna-N seals are standard for all Gresen valve assemblies. Optional Viton seals are available. See Cross Reference Tables on page 4-37.

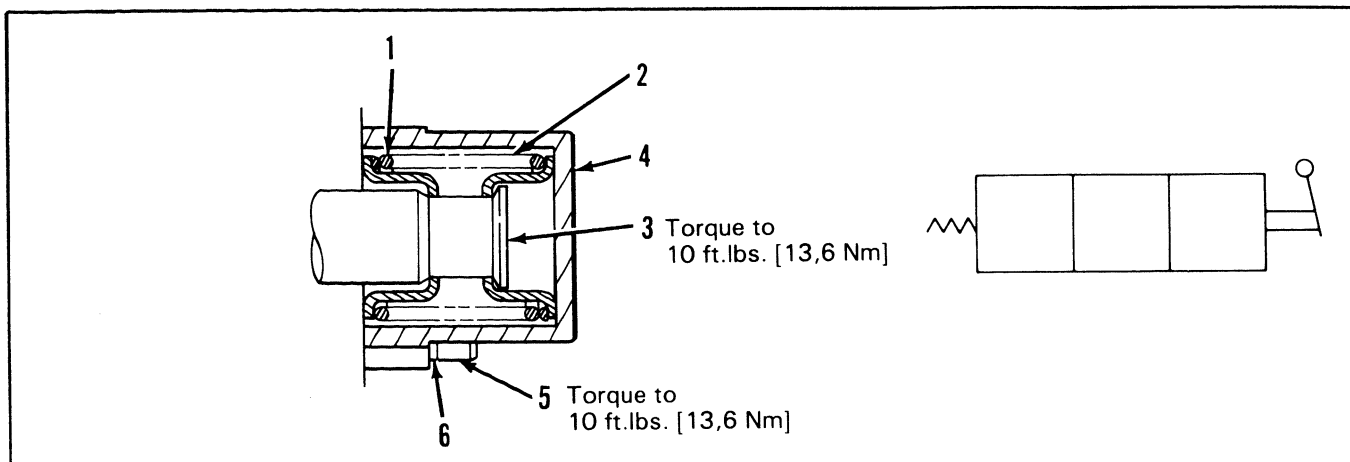


Figure 4-12. Standard Spool Positioner.

STANDARD SPOOL POSITIONER

Item No.	Part No.	Description	Quantity
	K-6125-B	REPLACEMENT KIT (Contains all items listed below)	
1	7433-001	Spring, Return	1
2	1809-001	COLLAR, Spring	2
3	10892-001	COLLAR, Spool	1
4	1811-001	BONNET	1
5	3731-101	SCREW, HSHC, 1/4-20 x 7/8 inch long	2
6	0563-001	WASHER, Lock	2

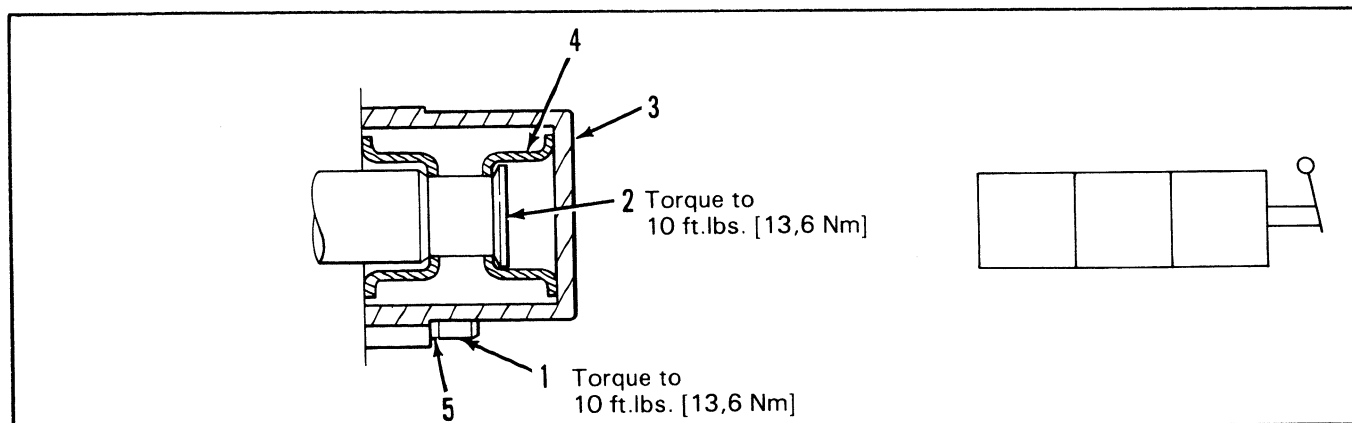


Figure 4-13. Manual Spool Positioner.

MANUAL SPOOL POSITIONER

Item No.	Part No.	Description	Quantity
1	3731-101	SCREW, HSHC, 1/4-20 x 7/8 inch long	2
2	10892-001	COLLAR, Spool	1
3	1811-001	BONNET	1
4	1809-001	COLLAR, Stop	2
5	0563-001	WASHER, Lock	2

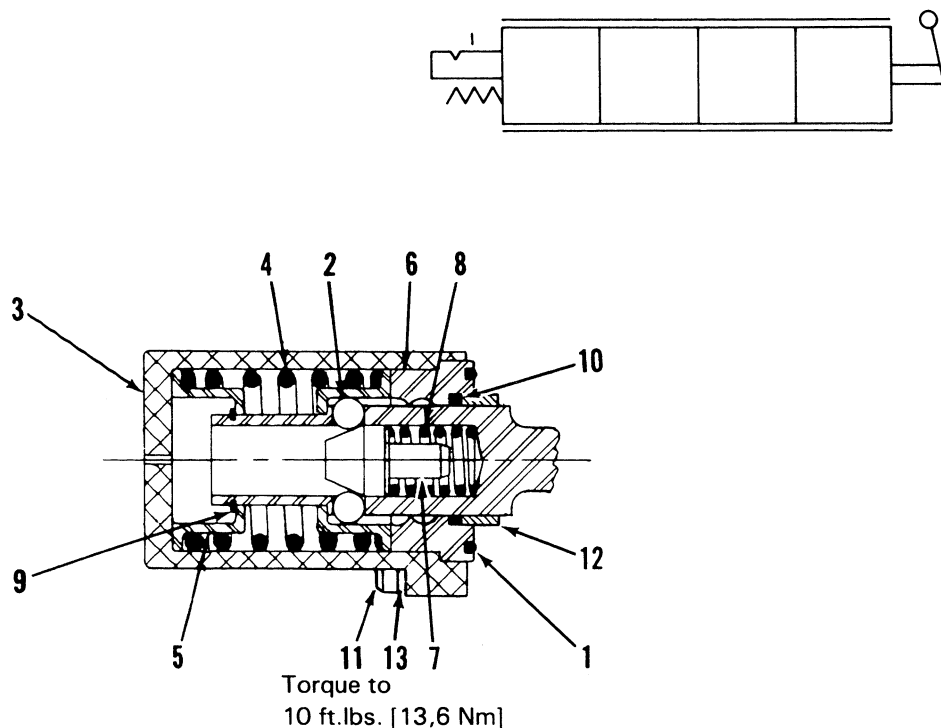


Figure 4-14. 4-Way, 4-Position Float Detent Positioner.

4-WAY, 4-POSITION FLOAT DETENT POSITIONER

Item No.	Part No.	Description	Quantity
	K-6127-B	REPLACEMENT KIT (Contains all items listed below)	
1	21047-001*	O-RING, Seal	1
2	1700-001	BALL, Detent	4
3	8082-001	BONNET, Float	1
4	8099-001	SPRING, Centering (See Note)	1
5	1826-001	COLLAR, Stop	2
6	8077-001	SLEEVE, Detent	1
7	1828-001	FOLLOWER, Detent Ball	1
8	8098-001	SPRING, Detent (See Note)	1
9	1852-001	RING, Retaining	1
10	1853-001*	SEAL, Spool	1
11	3731-101	SCREW, HSHC, 1/4-20 x 7/8 inch long	2
12	8079-001	SLEEVE, Retainer	1
13	0563-001	WASHER, Lock	2

*Buna-N seals are standard for all Gresen valve assemblies. Optional Viton seals are available. See Cross Reference Tables on page 4-37.

Note:

Springs shown are standard. Heavy duty springs are available:

Order No. 3091-001 Heavy Duty Centering Spring.

Order No. 1829-001 Heavy Duty Detent Spring.

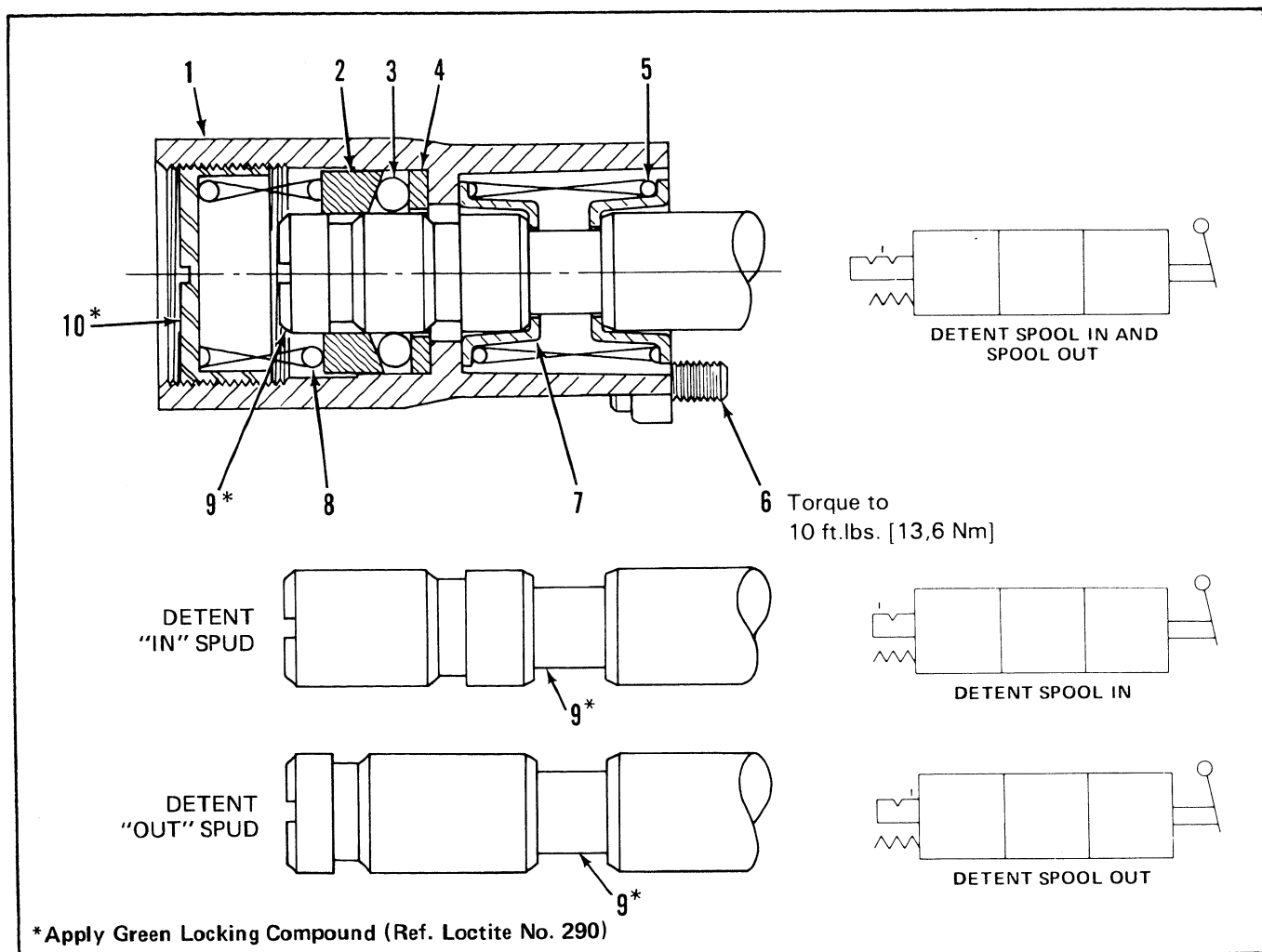


Figure 4-15. Option "R" Detent with Spring Return to Neutral.

OPTION "R" DETENT with SPRING RETURN TO NEUTRAL

Item No.	Part No.	Description	Quantity
	K-6152-A	REPLACEMENT KIT, Detent Spool "IN" position only	
	K-6151-A	REPLACEMENT KIT, Detent Spool "OUT" position only	
	K-6153-A	REPLACEMENT KIT, Detent Spool "IN" and "OUT" positions (Replacement Kits contain all of the items listed below with the correct spud (item 9) for each kit)	
1	8325-001	BONNET, R Detent	1
2	8571-001	RACE, Ball	1
3	1700-001	BALL, Steel	12
4	7994-001	PLATE, Thrust	1
5	3250-001	SPRING, Centering	1
6	3731-099	SCREW, HSHC, 1/4-20 by 5/8 inch long	2
7	1809-001	COLLAR, Spring	2
8	3252-001	SPRING	1
9	8573-001	SPUD, R Detent "IN"	1
	8572-001	SPUD, R Detent "OUT"	1
	8574-001	SPUD, R Detent "IN" and "OUT"	1
10	20443-001	CAP, Adjusting	1

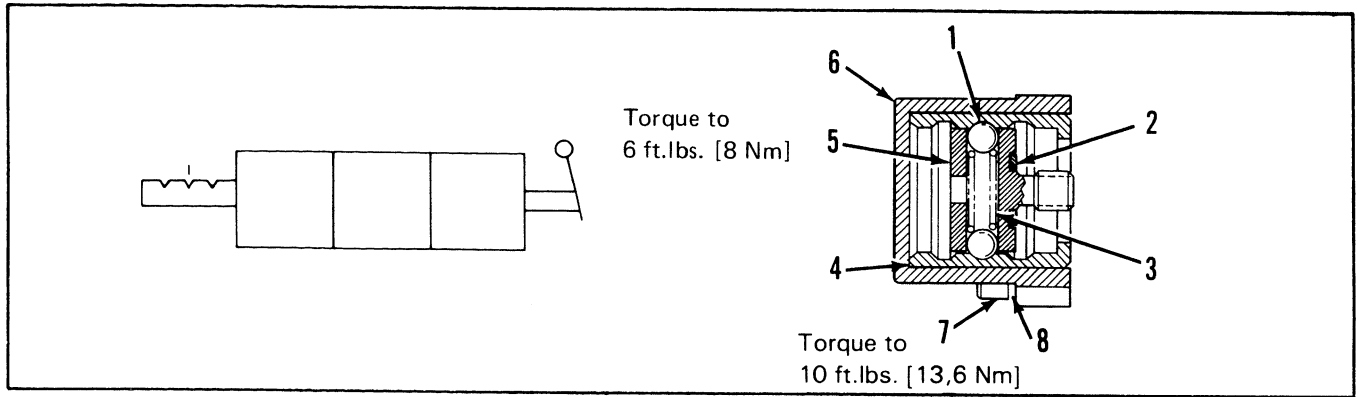


Figure 4-16. Option "D" 3-Position Detent Spool.

OPTION "D" 3-POSITION DETENT SPOOL

Item No.	Part No.	Description	Quantity
	K-6012-E	REPLACEMENT KIT (Contains all items listed below except item 8)	
1	0023-001	BALL, Detent	2
2	1837-001	WASHER, Lock	1
3	1838-001	SPRING, Detent	1
4	6812-001	SLEEVE, Detent, 3-position	1
5	1840-001	HOLDER, Detent	1
6	1811-001	BONNET	1
7	3731-101	SCREW, HSHC, 1/4-20 x 7/8 inch long	2
8	0563-001	WASHER, Lock	2
9	1889-001	STOP, Detent, optional (not shown)	1

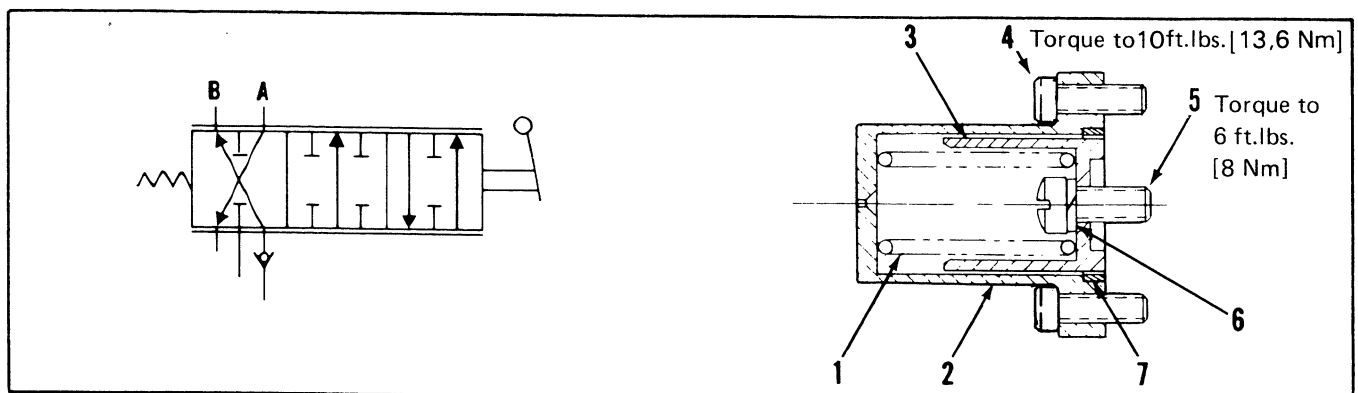


Figure 4-17. Option "A" Spring, Extended Spool.

OPTION "A" SPRING, EXTENDED SPOOL

Item No.	Part No.	Description	Quantity
	K-6150-A	REPLACEMENT KIT (Contains all items listed below)	
1	8666-001	SPRING, Return	1
2	1824-001	BONNET	1
3	1860-001	COLLAR, Stop	1
4	9161-407	SCREW, HSHC, 1/4-20 by 7/8 inch long	2
5	1812-001	SCREW, Cap	1
6	1813-001	WASHER, Lock	1
7	6756-001	SLEEVE, Bonnet	1

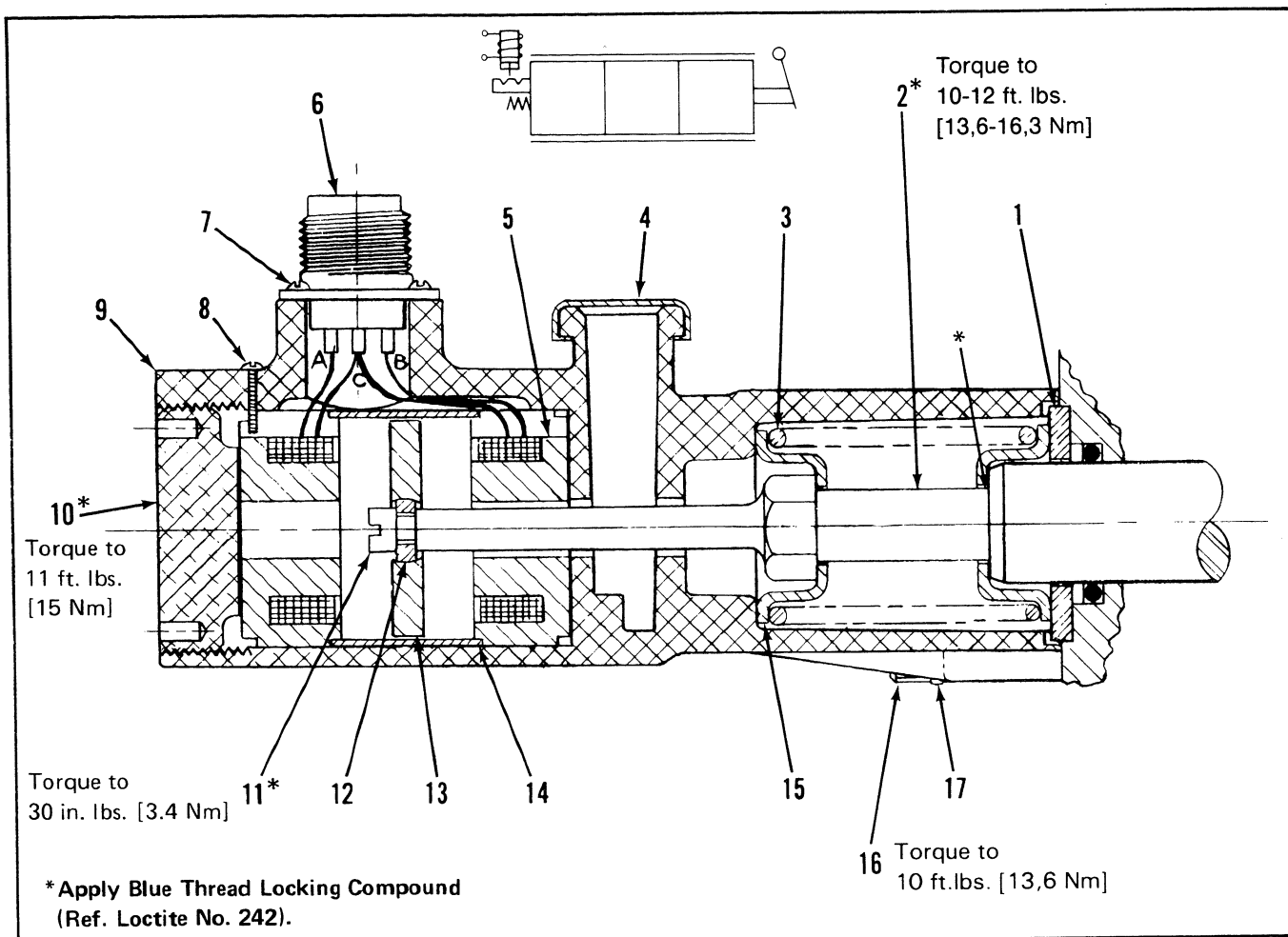


Figure 4-18. Electro-Magnetic Spool Release Positioner.

ELECTRO-MAGNETIC SPOOL RELEASE POSITIONER

Item No.	Part No.	Description	Quantity
	K-6064-A	REPLACEMENT KIT (Contains Items 2, 5, 11, 12, 13)	
1	7572-001	RETAINER, Spool Seal	1
2	7954-001	SPUD, Positioner	1
3	3250-001	SPRING, 1.114 OD x 0.095 WD	1
4	7589-001	CAP, Seal	1
5	7752-001	ELECTRO-MAGNET	2
6	7955-001	CONNECTOR, Electrical	1
7	7593-001	SCREW, Thread-Cutting	4
8	7956-001	SCREW, Thread-Cutting	1
9	7583-004	BONNET, Electric Detent	1
10	7957-001	PLUG, Bonnet	1
11	7756-001	SCREW, Shoulder, .188 x 0.156 inch long	1
12	7755-001	WASHER, Alignment	1
13	8555-001	ARMATURE	1
14	7958-001	SPACER	1
15	7573-001	COLLAR, Spring	2
16	3731-103	SCREW, Housing, .250 x 1.25 inches long	2
17	0563-001	WASHER, Lock, 0.250 ID	2

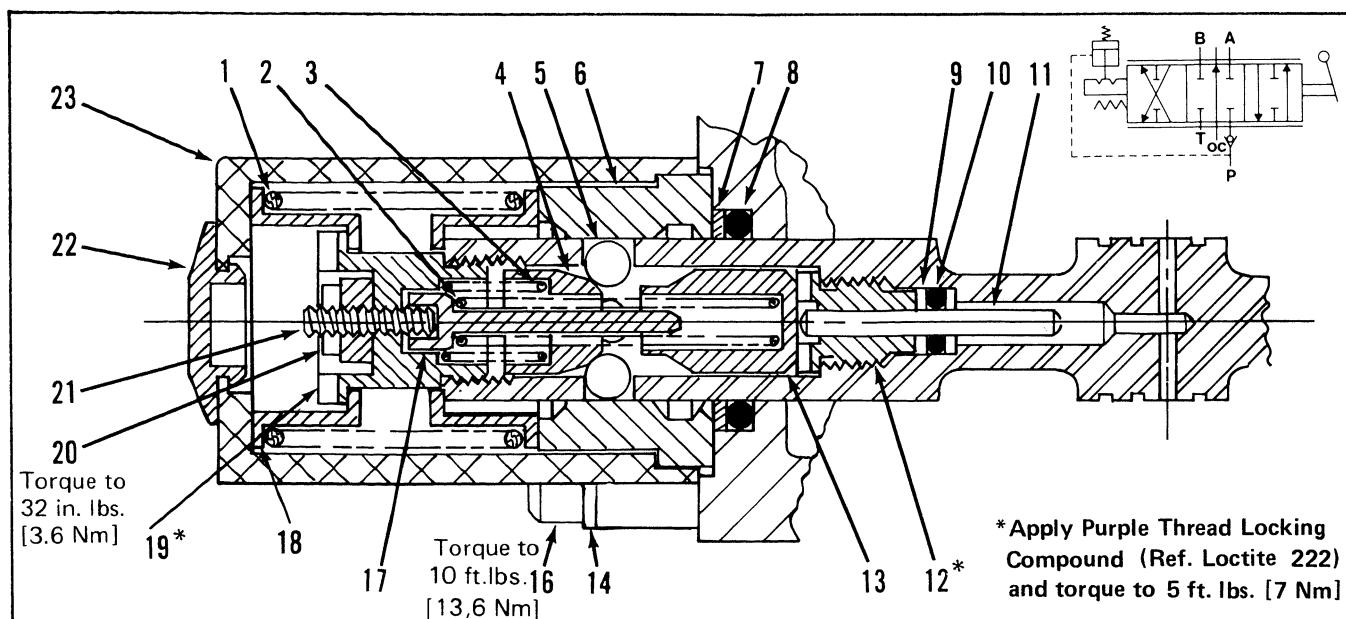


Figure 4-19. Optional Pressure Detent Release (KO) Positioner.

OPTIONAL PRESSURE DETENT RELEASE (KO) POSITIONER

Item No.	Part No.	Description	Quantity
	K-6061-B	SEAL KIT (Contains items 7, 8, 9 and 10 listed below)	
1	7433-001	SPRING, Centering	1
2	8047-001	SPRING, Standard (500-1600 PSI [35-110 bar] Crack)	1
	8010-001	SPRING, Optional (1601-2400 PSI [111-165 bar] Crack)	1
	8538-001	SPRING, Optional (2401-3000 PSI [166-207 bar] Crack)	1
	8537-001	SPRING, Optional (3001-3500 PSI [166-207 bar] Crack)	1
3	7898-001	SPRING, 0.385 O.D.x.054 W.D.	1
4	7897-001	FOLLOWER, Ball	1
5	1700-001	BALL, Steel	4
6	8007-001	SLEEVE, Detent	1
7	3265-001	RING, Back-Up	Not Sold Separately Order K-6061-B
8	7700-001*	SEAL, O-Ring	
9	7907-001	RING, Back-Up	
10	3328-001	SEAL, O-Ring	1
11	7908-001	ROLLER, Needle	1
12	7906-001	GUIDE, Piston	1
13	7896-001	PLUNGER, Knockout	1
14	7904-001	PLATE, Bearing	2
16	9161-407	SCREW, HSHC, 1/4-20 by 7/8 inch long	2
17	7899-001	GUIDE, Spring	1
18	8536-001	COLLAR, Spring	2
19	8535-001	COLLAR, Spool	1
20	6229-001	LOCKNUT	1
21	8014-001	SCREW, Hex Set, No. 10-24x0.62	1
22	7902-001	PLUG, Button, Flush Head	1
23	1824-002	BONNET	1

*Buna-N seals are standard for all Gresen valve assemblies. Optional Viton seals are available. See Cross Reference Tables on page 4-37.

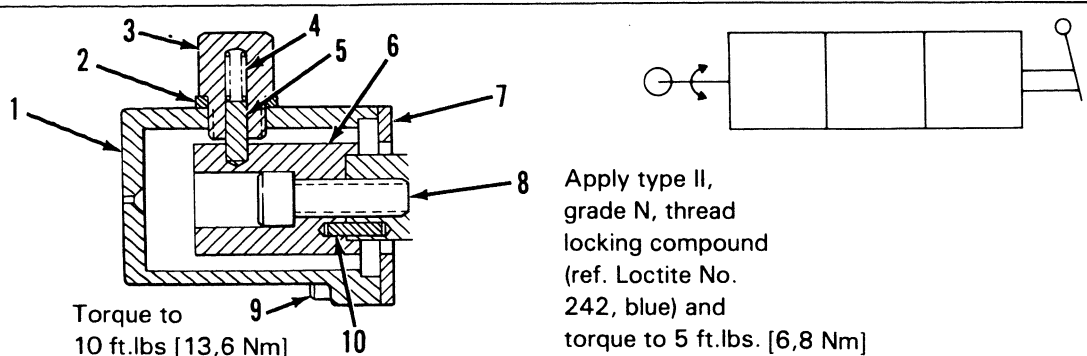


Figure 4-20. Option "W" Rotary Spool Positioner.

OPTION "W" ROTARY SPOOL POSITIONER

Item No.	Part No.	Description	Quantity
	K-6141-C	REPLACEMENT KIT (Contains all items listed below)	
1	1824-006	BONNET, Rotary	1
2	8743-001	WASHER, Detent Cap	1
3	8744-001	CAP, Rotary Detent	1
4	8808-001	SPRING, Detent	1
5	2676-001	PIN, Detent	1
6	8746-001	BODY, Rotary Cam	1
7	6552-001	PLATE, Seal Retainer	1
8	3731-150	SCREW, HSHC, 5/16-18 by 1 inch long	1
9	9161-407	SCREW, HSHC, 1/4-20 by 7/8 inch long	2
10	0888-001	PIN, Dowel	1

NOTE: Apply heavy duty, general purpose grease to the helical groove of Cam Body (Item 6) and Pin (Item 5). For standard assembly, hole in spool clevis must be horizontal with valve spool in neutral.

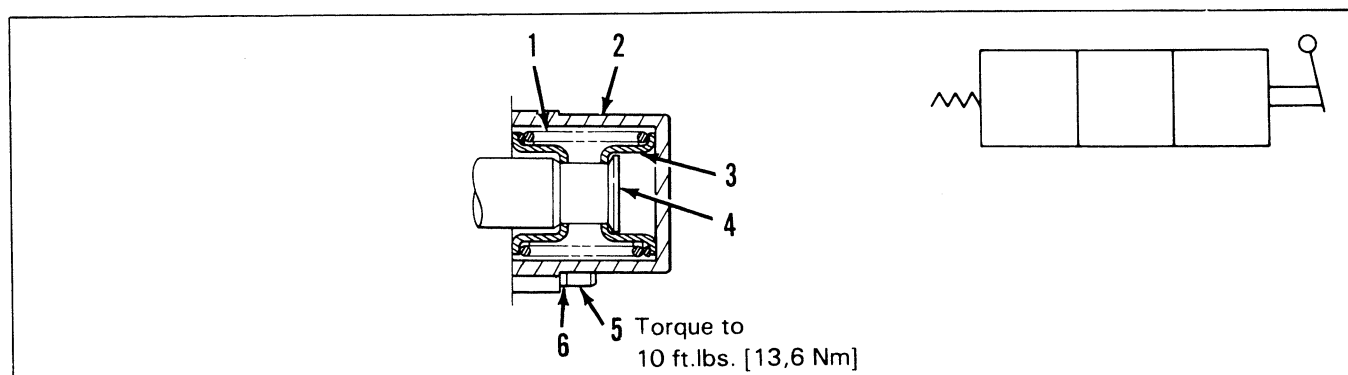


Figure 4-21. Series or Low Pressure Drop, Standard Spool Positioner.

SERIES OR LOW PRESSURE DROP, STANDARD SPOOL POSITIONER

Item No.	Part No.	Description	Quantity
	K-6207-A	REPLACEMENT KIT (Contains all items listed below)	
1	10956-001	SPRING, Return	1
2	1811-001	BONNET	1
3	1809-001	COLLAR, Spring	2
4	10892-001	COLLAR, Spool	1
5	3731-101	SCREW, HSHC, 1/4-20 x 7/8 inch long	2
6	0563-001	WASHER, Lock	2

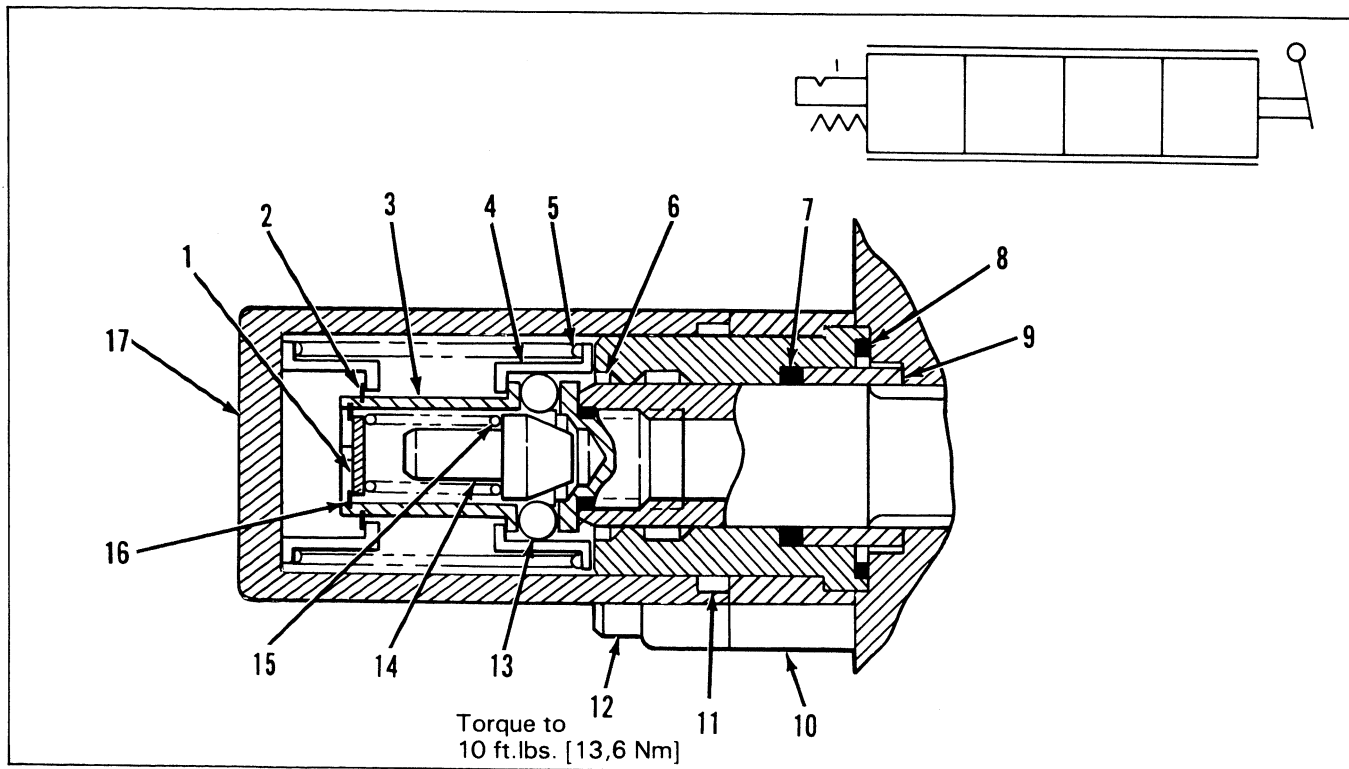


Figure 4-22. V20S 4-Way, 4-Position Float (out) Detent Positioner.

V20S 4-WAY, 4-POSITION FLOAT (OUT) DETENT POSITIONER

Item No.	Part No.	Description	Quantity
	K-6208	REPLACEMENT KIT (Contains all items listed below)	
1	11371-001	SHIM	1
2	1852-001	RING, Retaining	1
3	11373-001	COLLAR, Spool	1
4	1826-001	COLLAR, Spring	2
5	1807-001	SPRING, Centering	1
6	0449-001*	SEAL, O-Ring	1
7	1853-001*	SEAL, Four Lobed	1
8	21047-001*	SEAL, O-Ring	1
9	8079-001	SLEEVE, Retainer	1
10	7905-001	SPACER, Bonnet	1
11	11372-001	SLEEVE, Detent	1
12	9161-412	SCREW, HSHC, 1/4-20 by 1½ inch long	2
13	1700-001	BALL, Detent	4
14	1828-001	FOLLOWER, Ball	1
15	1829-001	SPRING, Detent	1
16	9320-016	RING, Retaining	1
17	8082-001	BONNET	1

*Buna-N seals are standard for all Gresen valve assemblies. Optional Viton seals are available. See Cross Reference Tables on page 4-37.

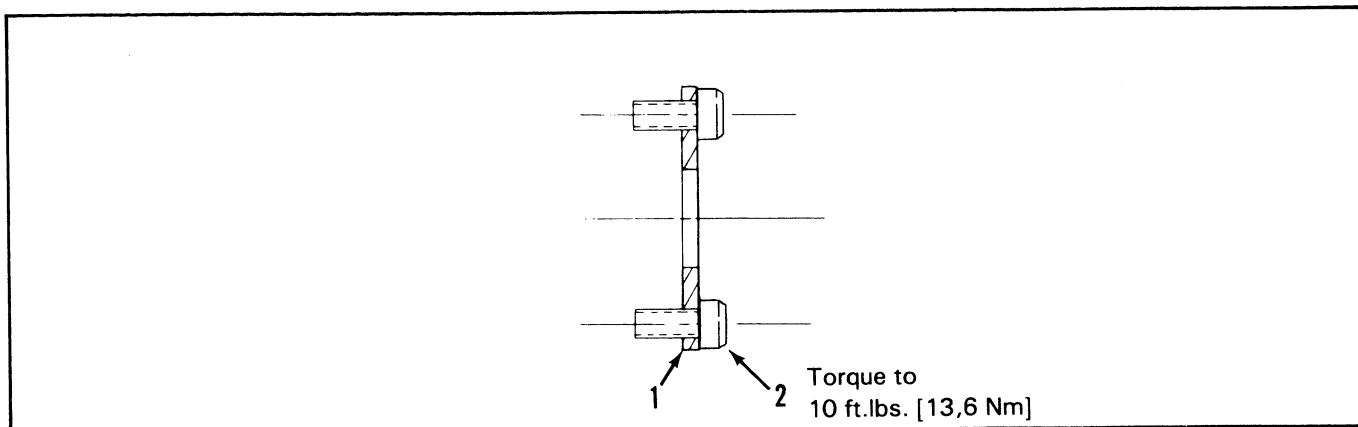


Figure 4-23. Standard Seal Retainer.

STANDARD SEAL RETAINER

Used when handle bracket is not furnished and tank line pressures are below 200 PSI [14 bar].

Item No.	Part No.	Description	Quantity
	K-6033-B	REPLACEMENT KIT (Contains items 1 and 2)	
1	6552-001	PLATE	1
2	3731-098	SCREW, HSHC, 1/4-20 by 1/2 inch long	2

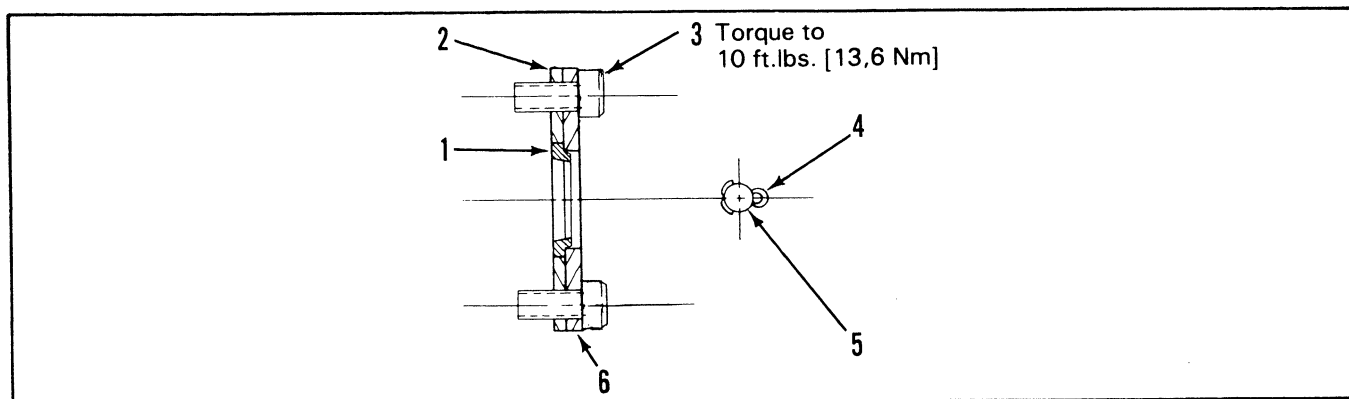


Figure 4-24. Optional Heavy Duty Seal Retainer.

OPTIONAL HEAVY DUTY SEAL RETAINER WITH OPTIONAL SPOOL WIPER

Used when handle bracket is not furnished and tank line pressure is below 1000 PSI, [69 bar], and when wiper seal is desired.

Item No.	Part No.	Description	Quantity
	K-6029-B	REPLACEMENT KIT (Contains all items listed below)	
1	1800-001	WIPER, Spool (Optional)	1
2	6802-001	PLATE, Seal	1
3	3731-098	SCREW, HSHC, 1/4-20 by 1/2 inch long	2
4	0086-001	PIN, Cotter	1
5	1857-001	PIN	1
6	6552-001	PLATE	1

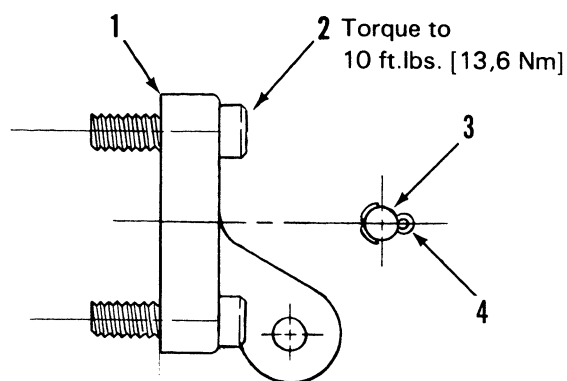


Figure 4-25. Handle Bracket Assembly.

HANDLE BRACKET ASSEMBLY

Item No.	Part No.	Description	Quantity
	K-6031-A	REPLACEMENT KIT, Standard, (Contains items 1, 2, 3 and 4)	
	K-6037-A	SERVICE KIT, Heavy Duty, (Contains items 1 and 2)	
1	1801-001	BRACKET, Die Cast (Standard)	1
	1801-002	BRACKET, Die Cast (Optional, for use with CRA Relief)	1
	7355-001	BRACKET, Cast Iron (Optional, Heavy Duty)	1
2	9161-407	SCREW, HSHC, 1/4-20 by 7/8 inch long	2
3	1857-001	PIN	1
4	0086-001	PIN, Cotter	1
5	1800-001	SEAL, Wiper, optional (not shown)	1

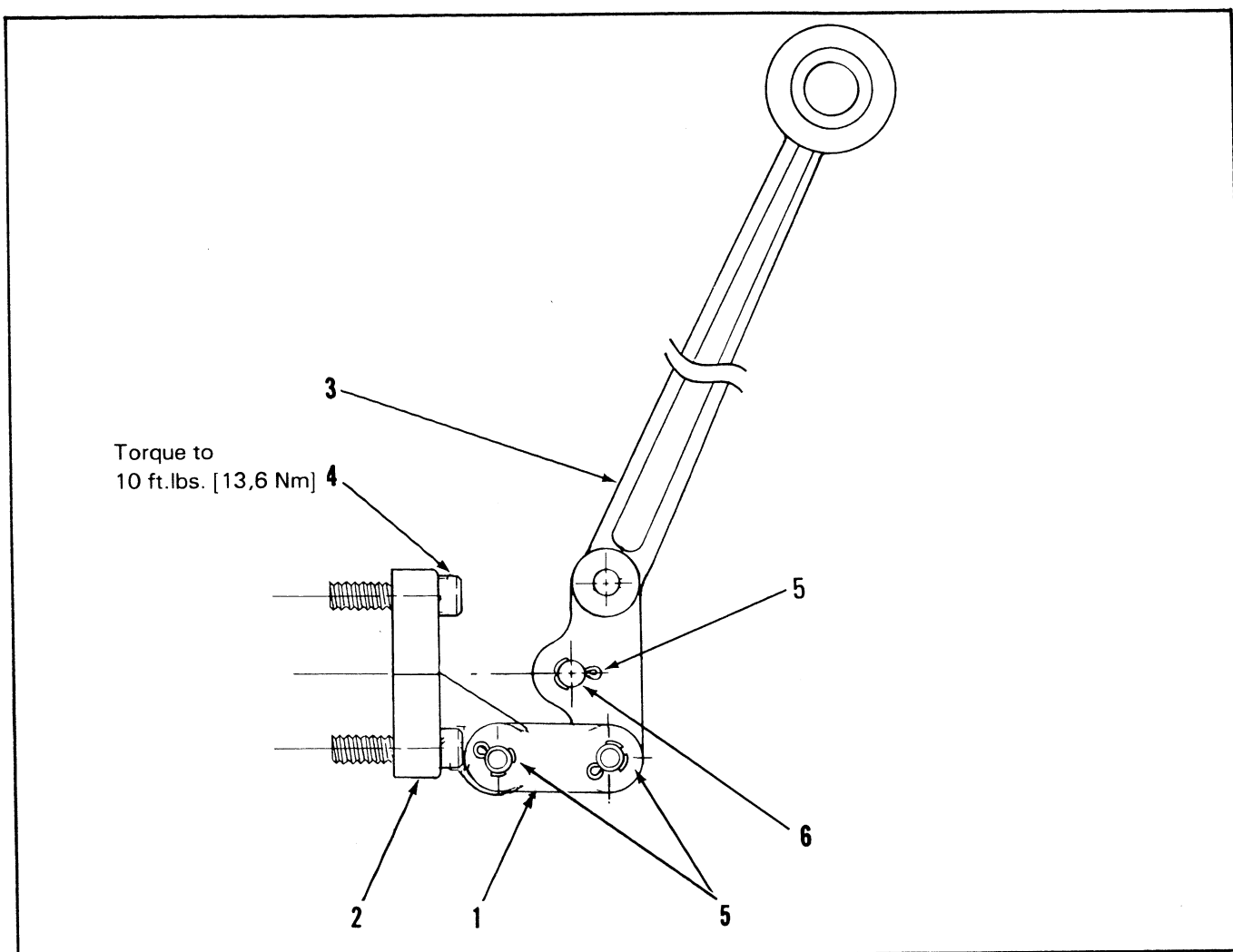


Figure 4-26. Optional Vertical Handle and Bracket Assembly.

OPTIONAL VERTICAL HANDLE and BRACKET ASSEMBLY

Item No.	Part No.	Description	Quantity
	K-6004-B	REPLACEMENT KIT, Standard (Black plastic coated handle)	
	K-6137-A	REPLACEMENT KIT, Optional (Plain handle)	
		All Replacement Kits contain all items listed below except No. 7355-001, Bracket	
1	11393-001	LINK	1
	11392-001	PLATE, Link	1
2	1801-001	BRACKET, Die Cast (Standard)	1
	7355-001	BRACKET, Cast Iron (Optional, Heavy Duty)	1
3	1802-001	HANDLE, Standard Vertical, Black plastic coated	1
	1802-003	HANDLE, Optional Vertical, Plain	1
4	9161-407	SCREW, HSHC, 1/4-20 by 7/8 inch long	2
5	0086-001	PIN, Cotter	3
6	1857-001	PIN	1
7	1800-001	SEAL, Wiper, optional (not shown)	1

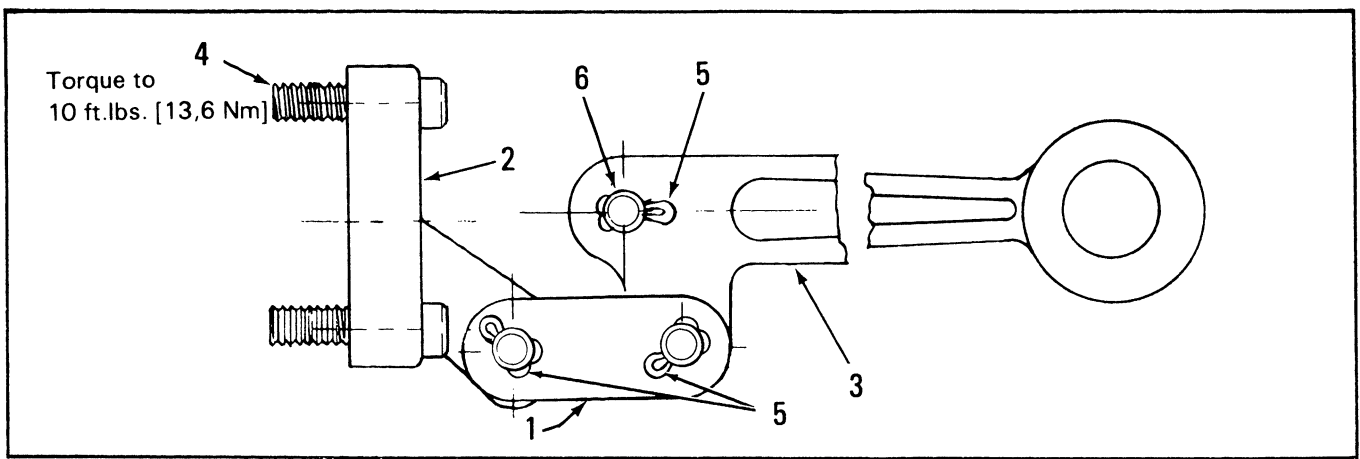


Figure 4-27. Optional Horizontal Handle and Bracket Assembly.

OPTIONAL HORIZONTAL HANDLE and BRACKET ASSEMBLY

Item No.	Part No.	Description	Quantity
	K-6007-B	REPLACEMENT KIT, Standard (Black plastic coated handle)	
	K-6139-A	REPLACEMENT KIT, Optional (Plain handle)	
	All Replacement Kits contain all items listed below except No. 7355-001, Bracket		
1	11393-001	LINK	1
	11392-001	PLATE, Link	1
2	1801-001	BRACKET, Die Cast (Standard)	1
	7355-001	BRACKET, Cast Iron (Optional Heavy Duty)	1
3	3249-001	HANDLE, Standard Horizontal, Black plastic coated	1
	3249-003	HANDLE, Optional Horizontal, Plain	1
4	9161-407	SCREW, HSHC, 1/4-20 by 7/8 inch long	2
5	086-001	PIN, Cotter	3
6	1857-001	PIN	1
7	1800-001	SEAL, Wiper, optional (not shown)	1

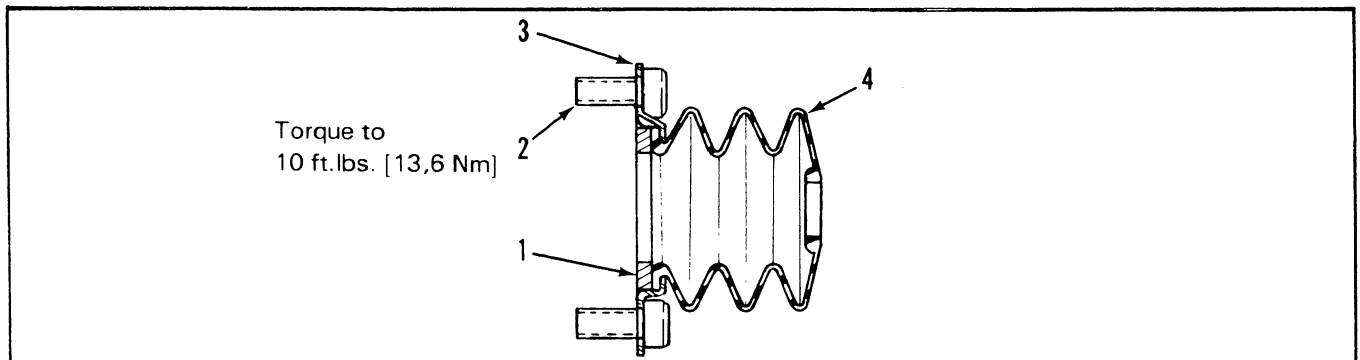


Figure 4-28. Spool Protective Boot Assembly.

SPOOL PROTECTIVE BOOT ASSEMBLY

Item No.	Part No.	Description	Quantity
	K-6056-B	REPLACEMENT KIT (Contains all items listed below)	
1	7624-001	WASHER, Breather	1
2	3731-098	SCREW, HSHC, 1/4-20 by 1/2 inch long	2
3	7623-001	RETAINER, Boot	1
4	7622-001	BOOT	1

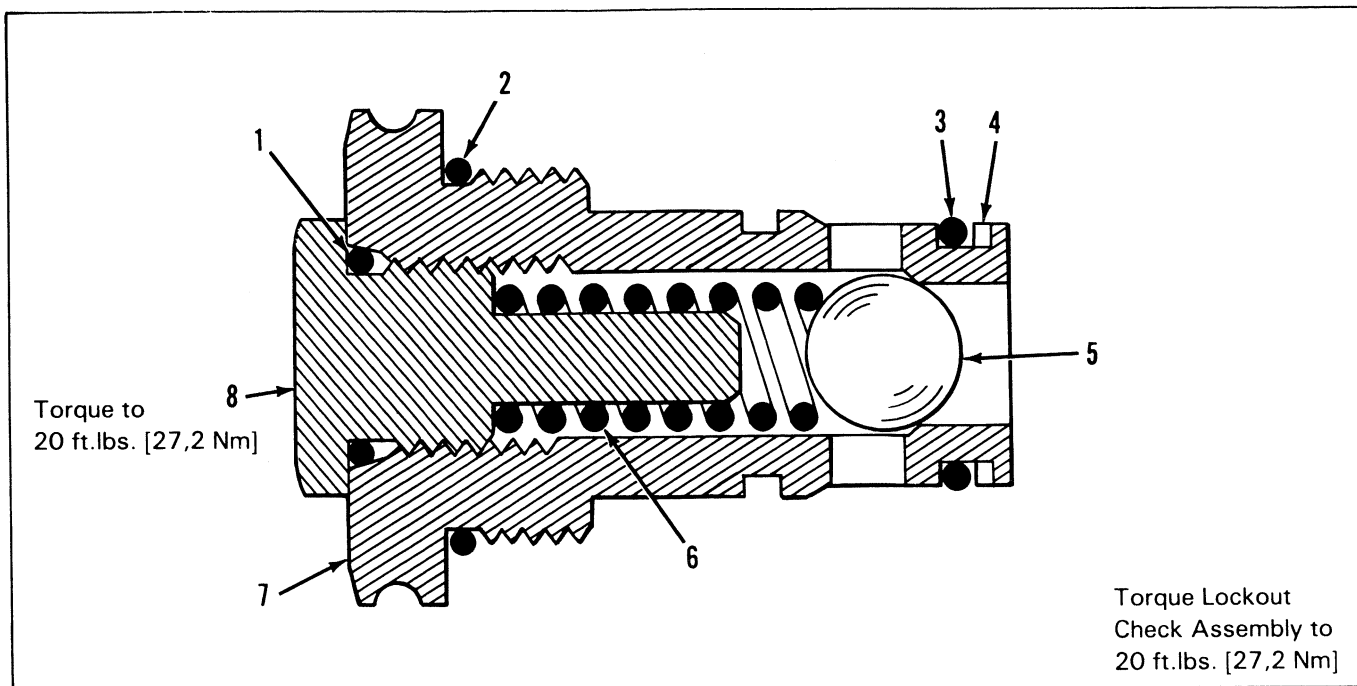


Figure 4-29. Lockout Check Assembly.

LOCKOUT CHECK ASSEMBLY

Item No.	Part No.	Description	Quantity Per Check
	K-6024-D*	REPLACEMENT KIT (Contains all items listed below)	
	K-6039*	SEAL KIT (Contains items 1 thru 4)	
1	0449-001*	SEAL, O-Ring	1
2	2707-001*	SEAL, O-Ring	1
3	1818-001*	SEAL, O-Ring	1
4	3092-001	RING, Back-Up, Cut	1
5	0071-001	BALL, Steel	1
6	1571-001	SPRING	1
7	11466-001	BODY, Check	1
8	0216-001	CAP, Check	1

*Buna-N seals are standard for all Gresen valve assemblies. Optional Viton seals are available. See Cross Reference Tables on page 4-37.

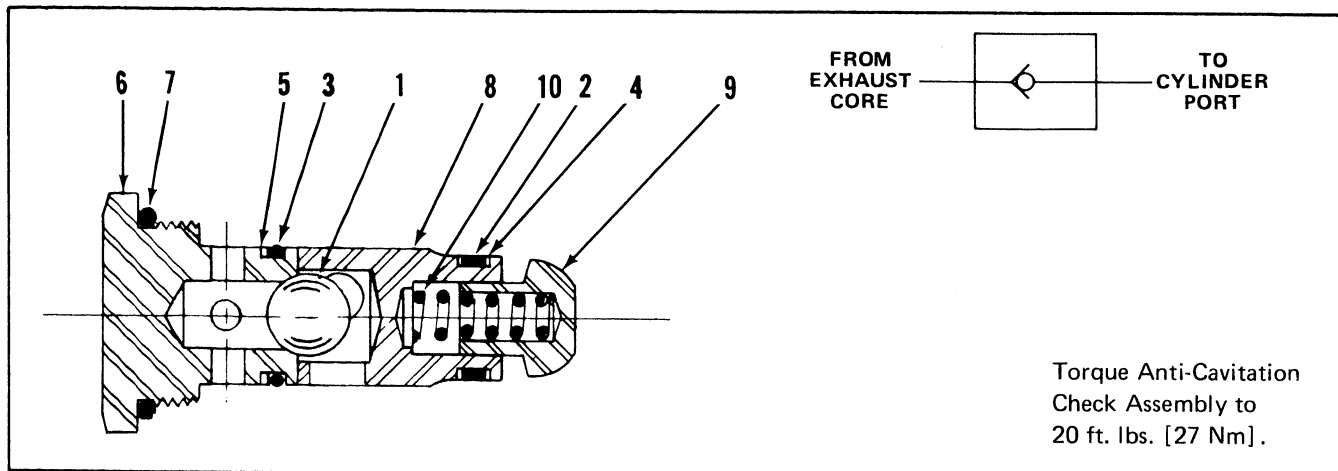


Figure 4-30. Optional Anti-Cavitation Check Assembly.

OPTIONAL ANTI-CAVITATION CHECK ASSEMBLY

Item No.	Part No.	Description	Quantity Per Check
	K-6021-A*	REPLACEMENT ANTI-CAVITATION ASSEMBLY (Contains all items listed below)	
	K-6032*	SEAL KIT (Contains items 2, 3, 4, 5 and 7 listed below)	
1	0071-001	BALL, Steel, 7/16 inch	1
2	1818-001*	SEAL, O-Ring	1
3	1819-001*	SEAL, O-Ring	1
4	1820-001	WASHER, Back-Up, inner, Check Plug	2
5	1821-001	WASHER, Back-Up, Outer, Check Plug	1
6	1822-001	BODY, Check, Anti-Cavitation	1
7	2707-001*	SEAL, O-Ring	1
8	1823-001	RETAINER, Ball, Check	1
9	2781-001	CHECK, Steel	1
10	1868-001	SPRING, Check	1

Not Sold
Separately
Order K-6032

*Buna-N seals are standard for all Gresen valve assemblies. Optional Viton seals are available. See Cross Reference Tables on page 4-37.

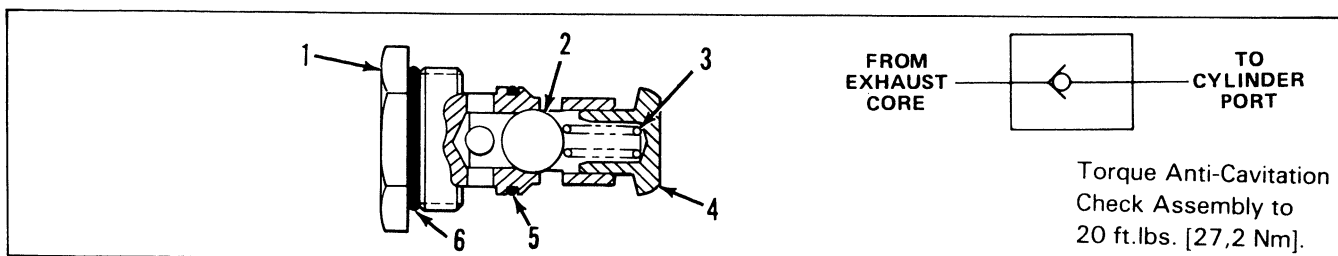


Figure 4-31. Optional, V20S Anti-Cavitation Check Assembly.

OPTIONAL, V20S ANTI-CAVITATION CHECK ASSEMBLY

Item No.	Part No.	Description	Quantity Per Check
	K-6205*	REPLACEMENT KIT (Contains all items listed below)	
	K-6206*	SEAL KIT (Contains items 5 and 6)	
1	11340-001	BODY, Check	1
2	0071-001	BALL, Steel, 7/16 inch	1
3	11343-001	SPRING, Check	1
4	7791-002	POPPET, Check	1
5	1819-001*	SEAL, O-Ring	1
6	2707-001*	SEAL, O-Ring	1

Not sold separately.
Order K-6206

*Buna-N seals are standard for all Gresen valve assemblies. Optional Viton seals are available. See Cross Reference Tables on page 4-37.

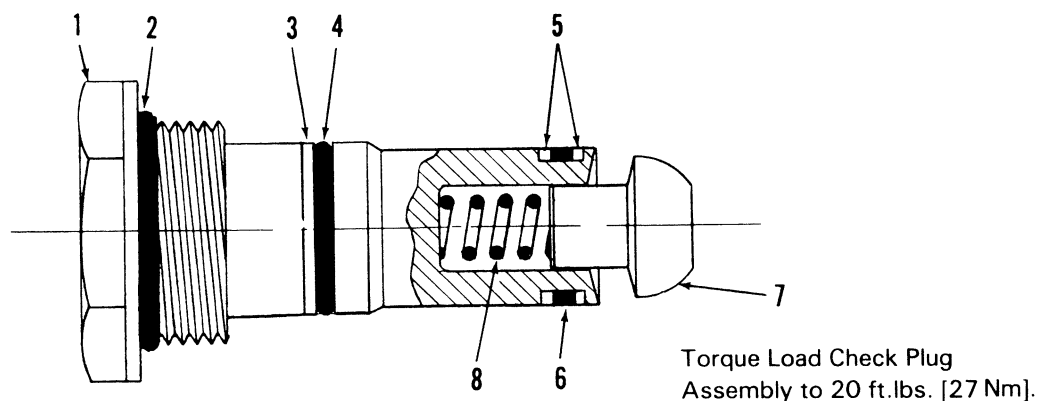


Figure 4-32. Load Check Plug Assembly.

LOAD CHECK PLUG ASSEMBLY

Item No.	Part No.	Description	Quantity Per Plug Assembly	
	K-6030-A*	REPLACEMENT LOAD CHECK PLUG ASSEMBLY.		
	K-6032*	SEAL KIT, (Contains items 2, 3, 4, 5 and 6)		
1	3411-001	Plug, Lift Check, Steel (Heavy Duty)	1	
2	2707-001*	SEAL, O-Ring	1	
3	1821-001	WASHER, Back-Up, Outer	Not Sold Separately Order K-6032	1
4	1819-001*	SEAL, O-Ring, Outer		1
5	1820-001	WASHER, Back-Up, Inner		2
6	1818-001*	SEAL, O-Ring		1
7	2781-001	POPPET, Lift Check		1
8	1868-001	SPRING, Lift Check		1

*Buna-N seals are standard for all Gresen valve assemblies. Optional Viton seals are available. See Cross Reference Tables on page 4-37.

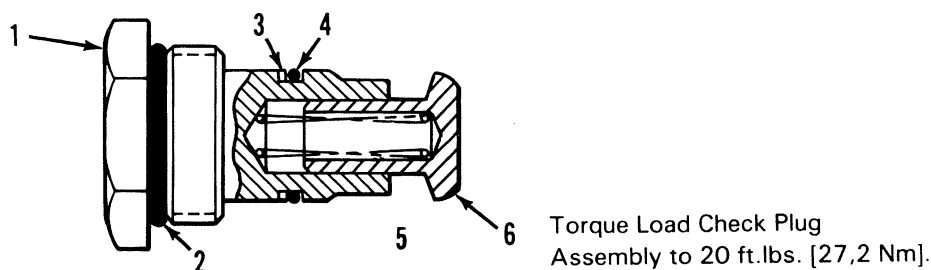


Figure 4-33. V20S Load Check Plug Assembly.

V20S LOAD CHECK PLUG ASSEMBLY

Item No.	Part No.	Description	Quantity Per Plug Assembly	
	K-6203*	REPLACEMENT KIT (Contains all items listed below)		
	K-6204*	SEAL KIT (Contains items 2, 3 and 4)		
1	11241-001	PLUG, Load Check	1	
2	2707-001*	SEAL, O-Ring	Not sold separately. Order K-6204	1
3	1821-001	RING, Back-Up		1
4	1819-001*	SEAL, O-Ring		1
5	1868-001	SPRING, Load Check		1
6	7791-001	POPPET, Load Check		1

*Buna-N seals are standard for all Gresen valve assemblies. Optional Viton seals are available. See Cross Reference Tables on page 4-37.

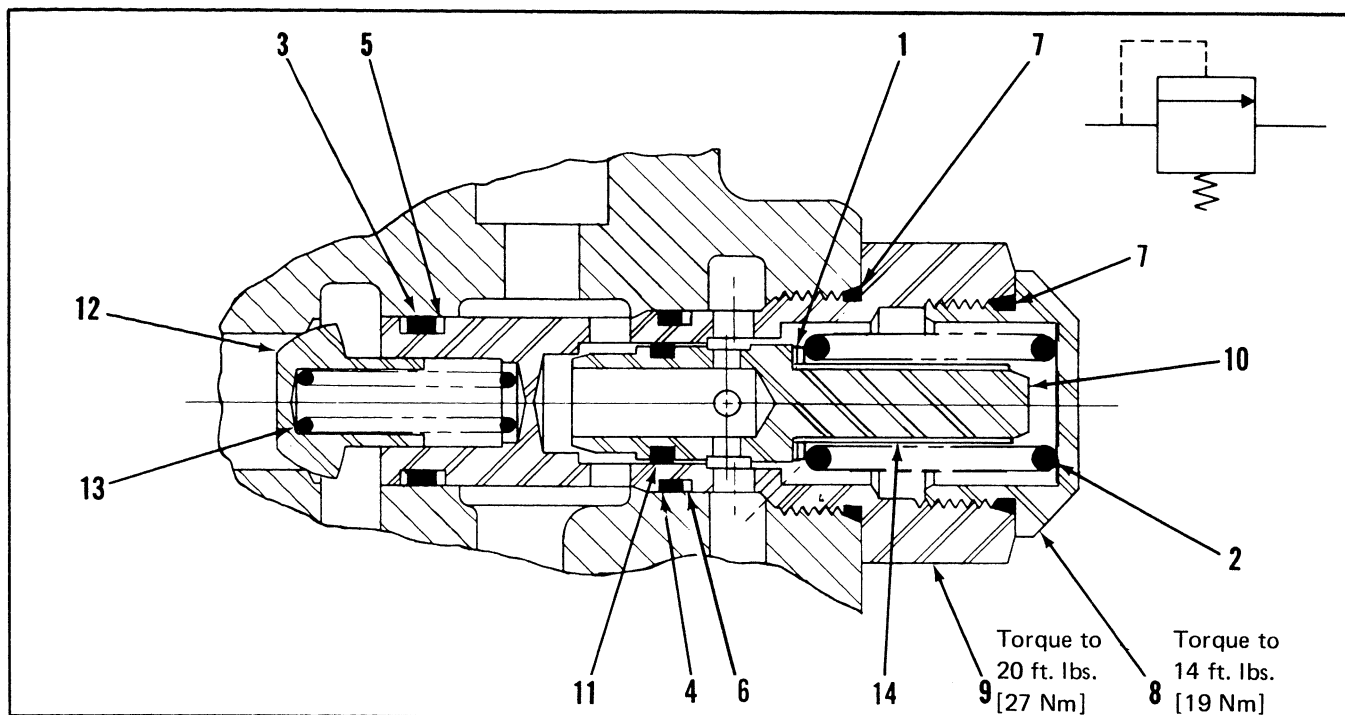


Figure 4-34. Optional Model RC Cylinder Port Relief (non-adjustable type).

OPTIONAL MODEL RC CYLINDER PORT RELIEF (Non-Adjustable Type)

For replacement Model RC Relief Cartridge, specify pressure setting required.

Item No.	Part No.	Description	Quantity Per Relief
	K-19002	SERVICE KIT (Contains items 10 and 11)	
	K-6005A*	SEAL KIT (Contains all seals - items 3, 4, 5, 6 and 7)	
1	0458-001	SHIM (.040 inch [1,0 mm] thick)	A/R
	0459-001	SHIM (.020 inch [0,5 mm] thick)	A/R
	0462-001	SHIM (.010 inch [0,25 mm] thick)	A/R
2	1450-001	SPRING (500-1350 PSI [35-93 bar] Crack)	1
	1869-001	SPRING (500-1249 PSI [34-86 bar] Crack)	1
	7638-001	SPRING (1250-1749 PSI [86-121 bar] Crack)	1
	7078-001	SPRING (1750-1999 PSI [121-138 bar] Crack)	1
	1870-001	SPRING (2000-2599 PSI [138-179 bar] Crack)	1
3	1818-001*	SEAL, O-Ring	1
4	1819-001*	SEAL, O-Ring	1
5	1820-001	WASHER, Back-Up, Inner, Check Plug	Not Sold Separately Order K-6005A
6	1821-001	WASHER, Back-Up, Outer, Check Plug	
7	2707-001*	SEAL, O-Ring	
8	1880-001	CAP, Relief	1
9	1884-001	BODY, Relief	1
10	1881-001	POPPET, Relief	Not Sold Separately Order K-19002
11	1883-001	RING, Piston	
12	2781-001	CHECK, Steel	1
13	1868-001	SPRING, Check	1
14	7874-001	SLEEVE, Dampening (Not to be used with 1450-001 and 1451-001 Springs)	1

*Buna-N seals are standard for all Gresen valve assemblies. Optional Viton seals are available. See Cross Reference Tables on page 4-37.

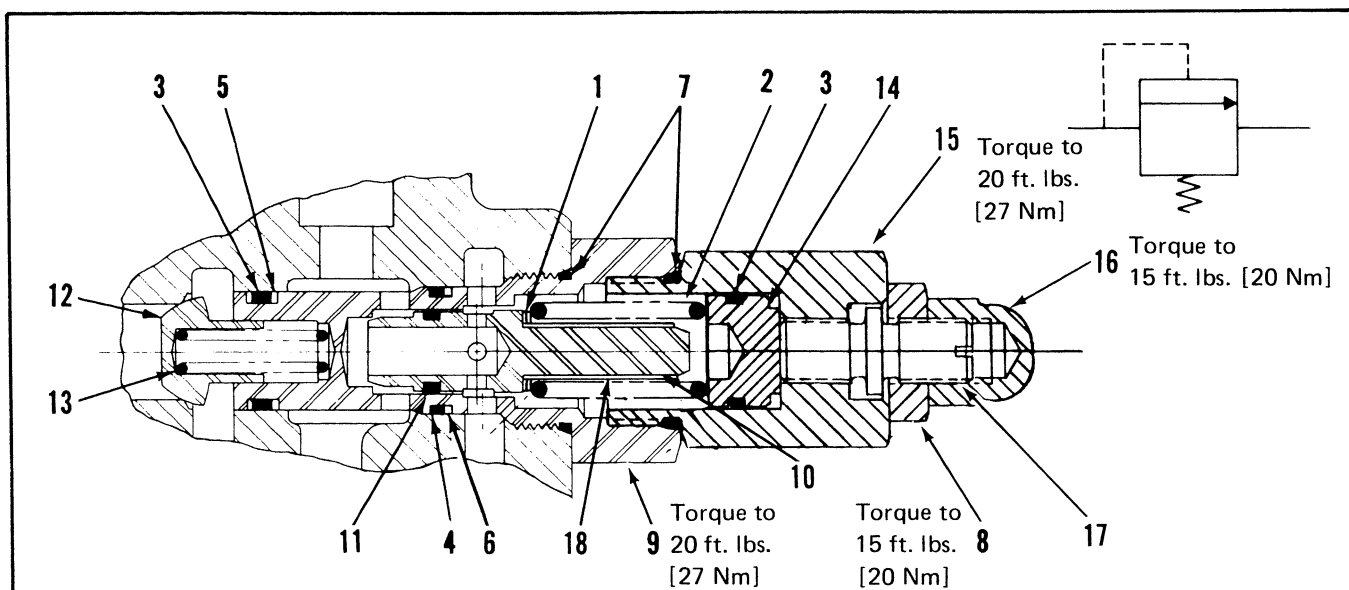


Figure 4-35. Optional RCA Relief Assembly.

OPTIONAL RCA RELIEF ASSEMBLY

All V20 Valves are machined to accept this assembly without modification. Simply remove load check assembly and install RCA combination.

Model RCA cannot be used on handle end of valve section with No. 1802-001 Vertical Handle due to interference.

Item No.	Part No.	Description	Quantity Per Relief
	K-19002	SERVICE KIT (Contains items 10 and 11)	
	K-6005A*	SEAL KIT (Contains all seals, items 3, 4, 5, 6 and 7)	
1	0458-001	SHIM (.040 inch [1,0 mm] thick)	A/R
	0459-001	SHIM (.020 inch [0,5 mm] thick)	A/R
	0462-001	SHIM (.010 inch [0,25 mm] thick)	A/R
2	7638-001	SPRING, S.S., 750-1500 PSI [52-103 bar]	1
	7078-001	SPRING, S.S., 1250-2000 PSI [86-138 bar]	1
	1870-001	SPRING, S.S., 1500-2500 PSI [103-172 bar]	1
	7497-001	SPRING, S.S., 2000-3000 PSI [138-207 bar]	1
3	1818-001*	SEAL, O-Ring	2
4	1819-001*	SEAL, O-Ring	1
5	1820-001	WASHER, Back-Up, Inner	2
6	1821-001	WASHER, Back-Up, Outer	1
7	2707-001*	SEAL, O-Ring	2
8	3500-001	NUT, Jam	1
9	1884-001	BODY, Relief	1
10	1881-001	POPPET, Relief	1
11	1883-001	RING, Piston	1
12	2781-001	CHECK, Steel	1
13	1868-001	SPRING, Check	1
14	11481-001	PISTON	1
15	3498-001	CAP, Adjustable Relief	1
16	3497-001	NUT, Acorn	1
17	3496-001	STEM, Adjustable	1
18	7874-001	SLEEVE, Dampening (Not to be used with 1450-001 or 1451-001 Springs)	1

*Buna-N seals are standard for all Gresen valve assemblies. Optional Viton seals are available. See Cross Reference Tables on page 4-37.

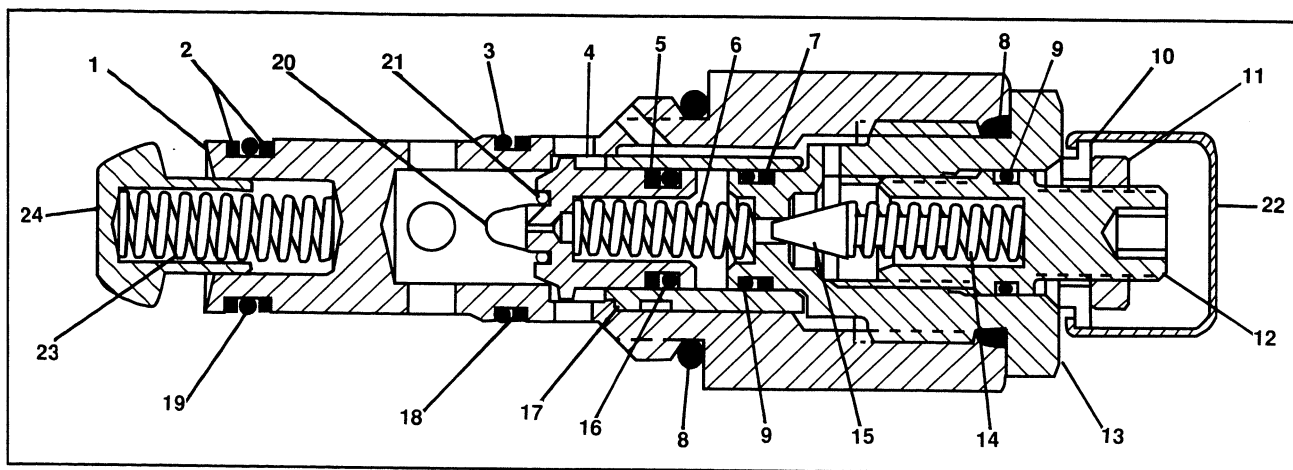


Figure 4-36. Optional RP 20-N Relief Assembly.

OPTIONAL RP 20-N CYLINDER PART RELIEF

All V20 valves are machined to accept this assembly without modification. Simply remove load check assembly and install RCA combination.

Item No.	Part No.	Description	Quantity Per Relief
	K-6192	SEAL KIT (Contains items 2, 3, 5, 7, 8, 9, 16, 18 and 19)	
1	20497-001	BODY, Relief	1
2	1820-001	RING, Back-Up	2
3	01819-001*	SEAL, O-Ring	1
4	20499-001	POPPET, Main	1
5	21581-001	RING, Back-Up	1
6	20503-001	SPRING	1
7	21582-001	RING, Back-Up	1
8	02707-001*	SEAL, O-Ring	2
9	09001-012*	SEAL, O-Ring	2
10	10035-001	WASHER	1
11	09302-006	NUT, Hex Jam	1
12	08956-001	SCREW, Adjustment	1
13	20500-001	BODY, Pilot	1
14	10059-001	SPRING	1
15	08475-001	POPPET, Relief	1
16	07830-001*	SEAL, O-Ring	1
17	20125-001	SLEEVE, Relief	1
18	01821-001	RING, Back-Up	1
19	01818-001*	SEAL, O-Ring	1
20	11839-001	SCREEN, Filter	1
21	11840-001	RING, Retaining	1
22	10034-001	COVER, Tamper Proof	1
23	01868-001	SPRING	1
24	02781-001	POPPET	1

*Buna-N seals are standard for all Gresen valve assemblies. Optional Viton seals are available. See Cross Reference Tables on page 4-37.

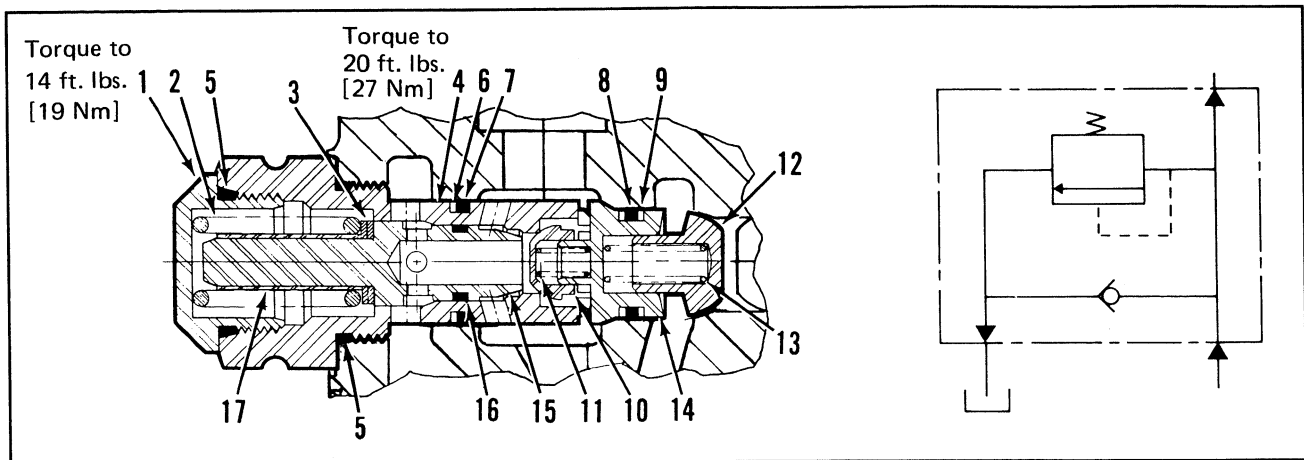


Figure 4-37. Optional Combination Relief and Anti-Cavitation Check Assembly (CRA)

OPTIONAL COMBINATION RELIEF and ANTI-CAVITATION CHECK ASSEMBLY (CRA)

All V20 Valves are machined to accept this assembly without modification. Simply remove load check assembly and install RCA combination.

Item No.	Part No.	Description	Quantity Per Relief
	K-19002	SERVICE KIT (Contains items 15 and 16)	
	K-6005A*	SEAL KIT (Contains items 5, 6, 7, 8 and 9)	
1	1880-001	CAP, Relief	1
2	1869-001	SPRING (500-1249 PSI [34-86 bar] Crack)	1
	7638-001	SPRING (1250-1749 PSI [86-121 bar] Crack)	1
	7078-001	SPRING (1750-1999 PSI [121-138 bar] Crack)	1
	1870-001	SPRING (2000-2599 PSI [138-179 bar] Crack)	1
3	0458-001	SHIM (.040 inch [1,0 mm] thick)	A/R
	0459-001	SHIM (.020 inch [0,5 mm] thick)	A/R
	0462-001	SHIM (.010 inch [0,25 mm] thick)	A/R
4	7741-001	BODY, Combination	1
5	2707-001*	SEAL, O-Ring	2
6	1821-001	WASHER, Back-Up Outer	1
7	1819-001*	SEAL, O-Ring	1
8	1818-001*	SEAL, O-Ring	1
9	1820-001	WASHER, Back-Up Inner	2
10	7743-001	POPPET, Anti-Cavitation	1
11	7744-001	SPRING, Anti-Cavitation	1
12	6015-001	POPPET	1
13	6016-001	SPRING, Check	1
14	7742-001	RETAINER, Poppet	1
15	1881-001	POPPET, Relief	1
16	1883-001	RING, Piston	1
17	7874-001	SLEEVE, Dampening (not to be used with 1450-001 or 1451-001 Springs)	1

Notes:

1. Replacement Model CRA Cartridge includes items 12 and 13. Specify pressure setting.

*Buna-N seals are standard for all Gresen valve assemblies. Optional Viton seals are available. See Cross Reference Tables on page 4-37.

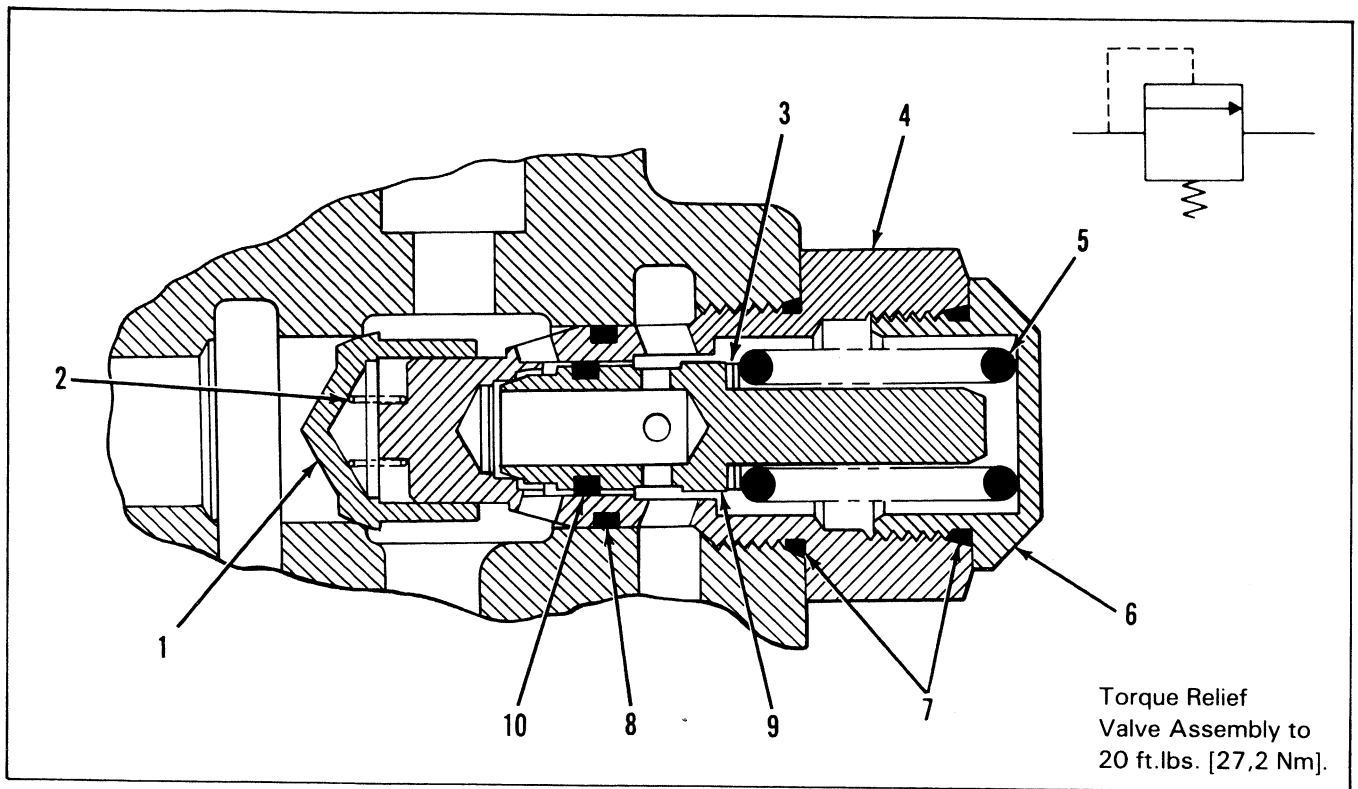


Figure 4-38. Optional V20S Work Port Relief. Model RCS (Non-Adjustable).

OPTIONAL V20S WORK PORT RELIEF, MODEL RCS (Non-Adjustable)

Item No.	Part No.	Description	Quantity Per Relief
	K-19002	SERVICE KIT (Contains items 9 and 10)	
	K-6206*	SEAL KIT (Contains items 7 and 8)	
1	11469-001	POPPET, Check	1
2	11470-001	SPRING, Check	1
3	0458-001	SHIM (.040 inch [1,0 mm] thick)	A/R
	0459-001	SHIM (.020 inch [0,5 mm] thick)	A/R
	0462-001	SHIM (.010 inch [0,25 mm] thick)	A/R
4	11471-001	BODY, RCS Relief	1
5	1869-001	SPRING (500-1249 PSI [35-86 bar] Crack)	1
	7638-001	SPRING (1250-1749 PSI [86-121 bar] Crack)	1
	7078-001	SPRING (1750-1999 PSI [121-138 bar] Crack)	1
	1870-001	SPRING (2000-2599 PSI [138-179 bar] Crack)	1
6	1880-001	CAP, Relief	1
7	2707-001*	SEAL, O-Ring	1
8	1819-001*	SEAL, O-Ring	1
9	1881-001	POPPET, Relief	1
10	1883-001	RING, Piston	1

*Buna-N seals are standard for all Gresen valve assemblies. Optional Viton seals are available. See Cross Reference Tables on page 4-37.

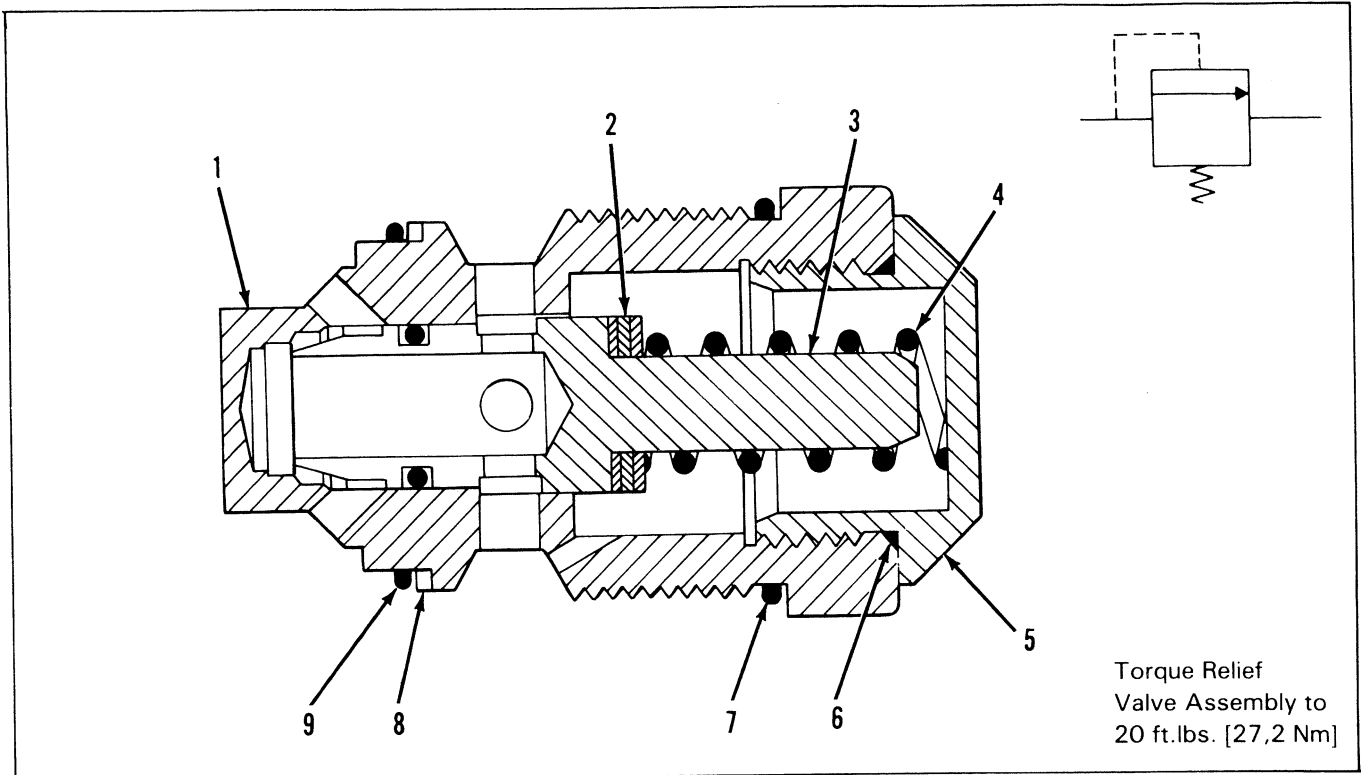


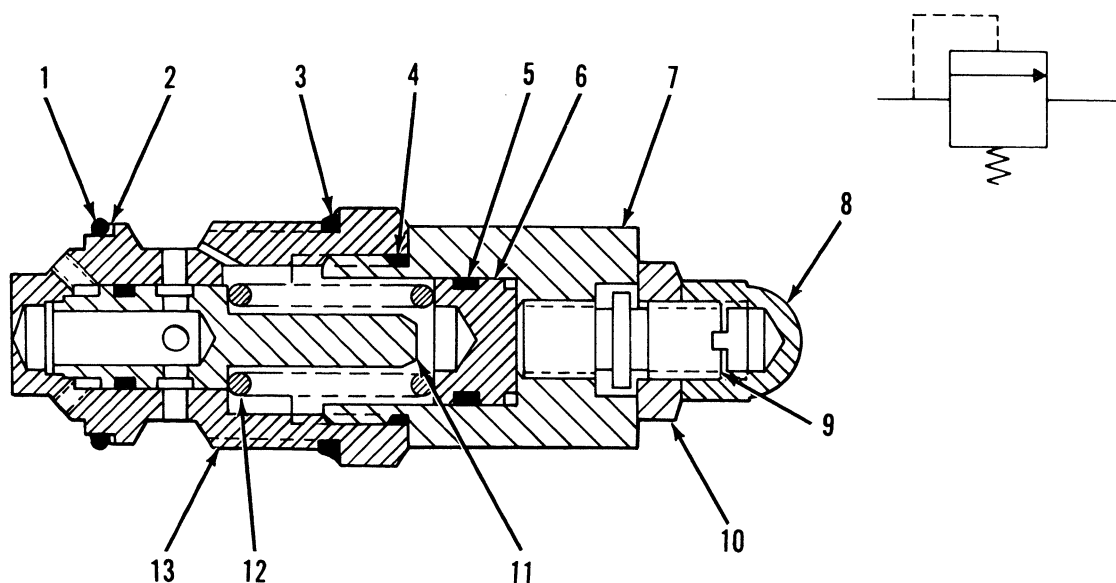
Figure 4-39. Model WH Differential Popper Main Relief Valve (Non-Adjustable).

MODEL WH DIFFERENTIAL POPPET MAIN RELIEF VALVE (Non-Adjustable)

Item No.	Part No.	Description	Quantity Per Relief
	K-19003-A*	SEAL KIT (Contains items 6 thru 9)	
1	6533-001	BODY, WH Relief	1
2	0458-001	SHIM (.040 inch [1,0 mm] thick)	A/R
	0459-001	SHIM (.020 inch [0,5 mm] thick)	A/R
	0462-001	SHIM (.010 inch [0,25 mm] thick)	A/R
3	3936-001	POPPET	1
4	1869-001	SPRING (500-1249 PSI [35-86 bar] Crack)	1
	7638-001	SPRING (1250-1749 PSI [86-121 bar] Crack)	1
	7078-001	SPRING (1750-1999 PSI [121-138 bar] Crack)	1
	1870-001	SPRING (2000-2599 PSI [138-179 bar] Crack)	1
5	1880-001	CAP, Relief	1
6	2707-001*	SEAL, O-Ring	1
7	1615-001*	SEAL, O-Ring	1
8	9020-022	RING, Back-Up	1
9	1718-001*	SEAL, O-Ring	1

Not sold
separately.
Order K-19003-A

*Buna-N seals are standard for all Gresen valve assemblies. Optional Viton seals are available. See Cross Reference Tables on page 4-37.



Torque Relief
Valve Assembly
to 20 ft.lbs. [27,2 Nm]

Figure 4-40. Model WHA Differential Poppet Main Relief Valve (Adjustable within the spring range).

MODEL WHA DIFFERENTIAL POPPET MAIN RELIEF VALVE (Adjustable within the spring range)

Item No.	Part No.	Description	Quantity Per Relief
	K-19012*	SEAL KIT (Contains items 1 thru 5)	
1	1718-001*	SEAL, O-Ring	1
2	9020-022	RING, Back-Up	1
3	1615-001*	SEAL, O-Ring	1
4	2707-001*	SEAL, O-Ring	1
5	1818-001*	SEAL, O-Ring	1
6	3495-001	PISTON	1
7	3498-001	CAP	1
8	3497-001	NUT, Acorn	1
9	3496-001	STEM, Adjusting	1
10	3500-001	NUT, Hex Jam	1
11	3936-001	POPPET	1
12	7638-001	SPRING, S.S., 750-1500 PSI [52-103 bar] Crack	1
	7078-001	SPRING, S.S., 1250-2000 PSI [86-138 bar] Crack	1
	1870-001	SPRING, S.S., 1500-2500 PSI [103-172 bar] Crack	1
	7497-001	SPRING, S.S., 2000-3000 PSI [138-207 bar] Crack	1
13	6533-001	BODY, WH Relief	1

*Buna-N seals are standard for all Gresen valve assemblies. Optional Viton seals are available. See Cross Reference Tables on page 4-37.

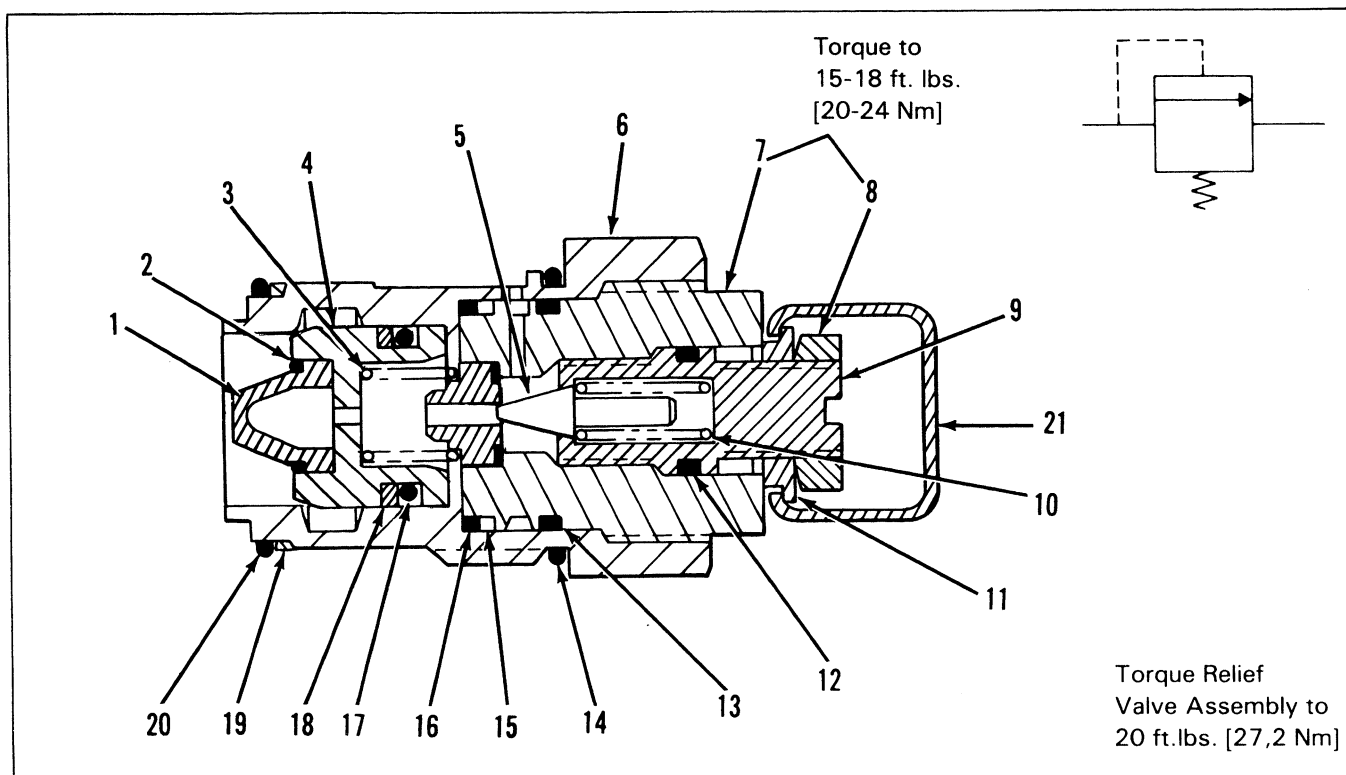


Figure 4-41. Model RP51 Pilot Operated Main Relief Valve.

MODEL RP51 PILOT OPERATED MAIN RELIEF VALVE

Item No.	Part No.	Description	Quantity
	K-19005*	SEAL KIT (Contains items 12-20)	
1	12675-001	FILTER	1
2	10298-001	RING, Retaining	1
3	20254-001	SPRING	1
4	20209-001	POPPET, Main	1
5	8475-001	POPPET, Relief	1
6	8954-001	BODY, Relief Valve	1
7	11059-001	BODY, Pilot Assembly	1
8	9302-006	NUT, Hex Jam	1
9	8956-001	SCREW, Adjustment	1
10	10059-001	SPRING, Pilot	1
11	10035-001	WASHER, RP5 1-N (Shown)	1
	10852-001	WASHER, ID, RP5 1-A (Not Shown)	1
12	6884-001*	SEAL, O-Ring	1
13	6814-002*	SEAL, O-Ring	1
14	1615-001*	SEAL, O-Ring	1
15	9020-019	RING, Back-Up	1
16	1660-001*	SEAL, O-Ring	1
17	9000-113*	SEAL, O-Ring	1
18	20903-001	RING, Back-Up	1
19	9020-022	RING, Back-Up	1
20	1718-001*	SEAL, O-Ring	1
21	10034-001	COVER, Tamperproof (RP5 1-N only)	1

NOTE

Due to close tolerances on working parts, Model RP51 is not field serviceable. If service other than seal replacement is required, contact the factory.

*Buna-N seals are standard for all Gresen valve assemblies. Optional Viton seals are available. See Cross Reference Tables on page 4-37.

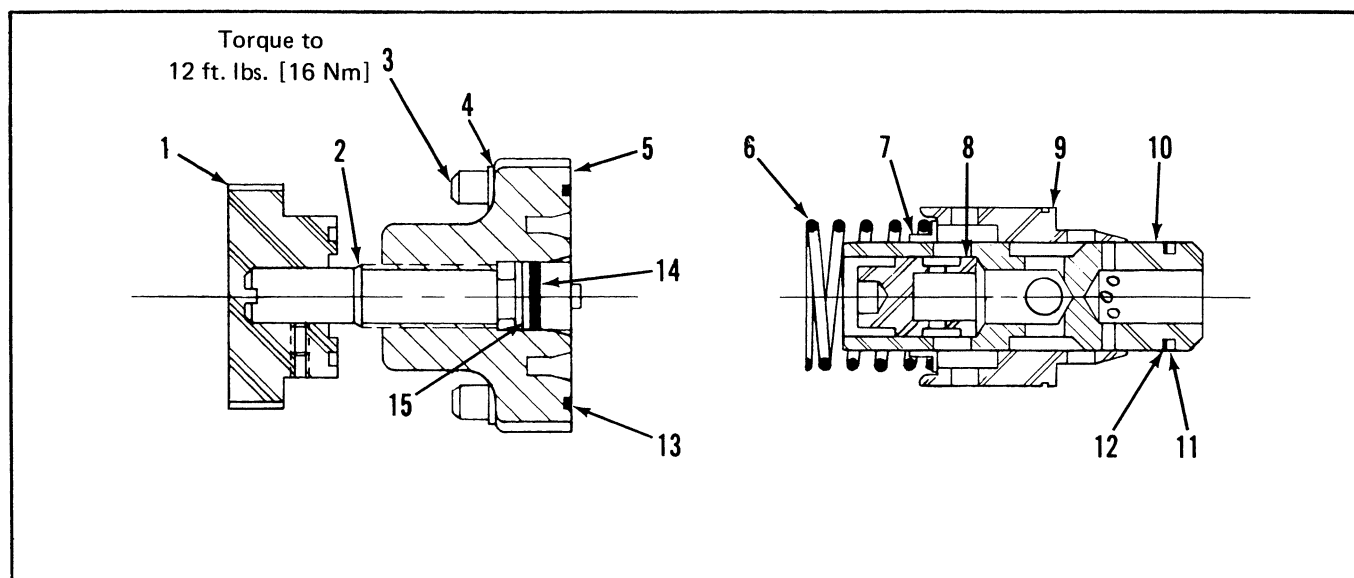


Figure 4-42. Flow Control Assembly, Inlet Cover.

FLOW CONTROL ASSEMBLY, INLET COVER

Item No.	Part No.	Description	Quantity
	K-6066-C	REPLACEMENT KIT, Actuator (Contains items 1 thru 5 and 13 thru 15)	
	K-6067-A	REPLACEMENT KIT, Flow Control, 3-16 GPM [11-60 litres/min]	
	K-6068-A	REPLACEMENT KIT, Flow Control, 8-25 GPM [30-95 litres/min]	
	K-6069-A	REPLACEMENT KIT, Flow Control, 13-21 GPM [49-79 litres/min]	
		(Flow Control Replacement Kits contain items 6 thru 12)	
	K-6065	SEAL KIT (Contains items 11 thru 15)	
1	3236-001	KNOB	1
2	6309-001	ADJUSTER, Flow (Standard)	1
	3902-001	ADJUSTER, Flow (Optional, 3-inch [76 mm] stem)	1
3	3731-101	SCREW, Hex Head	4
4	0563-001	WASHER, Lock	4
5	3906-001	CAP, Control	1
	3906-002	CAP, Control (For use with optional dust boot)	1
6	3882-001	SPRING, Control	1
7	6665-001	COLLAR	
8	3897-001	PISTON, Control 3-16 GPM [11-60 litres/min]	1
	7740-001	PISTON, Control, 8-25 GPM [30-95 litres/min]	1
	7483-001	PISTON, Control, 13-21 GPM [49-79 litres/min]	1
9	3891-001	SLEEVE, Metering, 3-16 GPM [11-60 litres/min]	1
	7484-001	SLEEVE, Metering, 8-25 and 13-21 GPM [30-95 and 49-79 litres/min]	1
10	3888-001	GUIDE, Sleeve, 3-16 GPM [11-60 litres/min]	1
	7485-001	GUIDE, Sleeve, 8-25 and 13-21 GPM [30-95 and 49-79 litres/min]	1
11	1821-001	WASHER, Back-Up	1
12	1819-001*	SEAL, O-Ring	1
13	3911-001	SEAL, O-Ring	1
14	9001-012	SEAL, O-Ring	1
15	3908-001	WASHER, Back-Up	1
16	10957-001	BOOT (Not shown, cannot be used with knob)	1

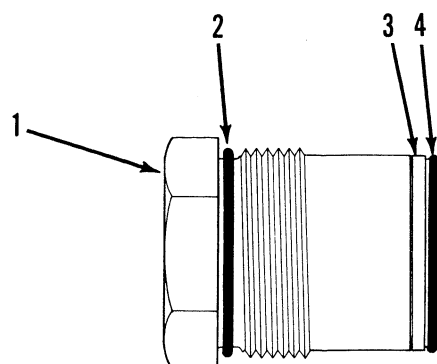
See
Note

Not sold
separately.
Order K-6065

Note:

These are matched parts and are not sold separately. Order appropriate Replacement Kit for required GPM flow control.

*Buna-N seals are standard for all Gresen valve assemblies. Optional Viton seals are available. See Cross Reference Tables on page 4-37.



Torque Main Relief
Plug to 20 ft. lbs. [27 Nm]

Figure 4-43. Main Relief Plug.

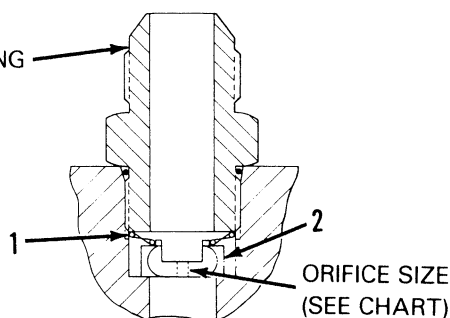
"NR" MAIN RELIEF PLUG

Item No.	Part No.	Description	Quantity
	K-6132-A	REPLACEMENT PLUG ASSEMBLY (Contains all items listed below)	
	K-28062-A	SEAL KIT (Contains items 2, 3 and 4)	
1	6760-001	PLUG, Relief	1
2	1615-001*	SEAL, O-Ring	1
3	9020-022	WASHER, Back-Up	1
4	1718-001	SEAL, O-Ring	1

Not Sold
Separately
Order K-28062

*Buna-N seals are standard for all Gresen valve assemblies. Optional Viton seals are available. See Cross Reference Tables on page 4-37.

SAE TUBE FITTING



"Restrict in" configuration
shown. For "restrict out"
flip Orifice Plate and
Spring.

Figure 4-44. Work Port Restrictors.

WORK PORT RESTRICTORS

Item No.	Port No.	Description	Quantity
	11031-xxx*	RESTRICTOR ASSEMBLY, SAE 8 Port (Contains items 1 and 2)	
	10098-xxx*	RESTRICTOR ASSEMBLY, SAE 10 Port (Contains items 1 and 2)	
1	10821-001	SPRING, Conical (SAE 8 Port)	1
	10064-001	SPRING, Conical (SAE 10 Port)	1
2	10817-xxx*	PLATE, Orifice (SAE 8 Port)	1
	10063-xxx*	PLATE, Orifice (SAE 10 Port)	1

*The last three digits of the Restrictor Assembly and Orifice Plate part numbers are the same as the orifice hole size. Example: .062 hole is part number XXXXX-062.

ORIFICE HOLE SIZES AVAILABLE

SAE 8 PORT	SAE 10 PORT
015, 028, 032, 046, 055, 062, 074, 082, 095, 109, 125, 141, 156, 172, 189, 220	015, 032, 037, 047, 053, 062, 070, 076, 082, 086, 095, 109, 125, 141, 156, 189, 203, 220, 281

Standard Buna-N Seals and O-Rings

All standard Gresen products utilize Buna-N seals which are compatible with petroleum base, water-in-oil emulsions, and water-glycol fluids. Phosphate ester type fire-resistant fluids will cause Buna-N seals to swell. This swelling is not normally detrimental to static seals, but will be a problem for dynamic seals such as valve spool seals. Swelling of these seals can result in binding. The temperature range of Buna-N seals is -40°F to $+200^{\circ}\text{F}$ [-40°C to $+93^{\circ}\text{C}$].

Table 4-1. Cross Reference For Seals and O-Rings, Buna-N to Viton

Buna-N Part No.	Viton Part No.	Application
1129-001	None	
1615-001	7447-001	Section Seal, Exhaust
1718-001	7446-001	WC Relief, NR Plug
1721-001	7612-001	Power Beyond Sleeve, Inner
1800-001	None	
1818-001	7444-001	Inner Check Plug Seal
1819-001	7445-001	Outer Check Plug Seal
1853-001	7613-001	Quad Seal, Float
2706-001	None	
2707-001	7448-001	Check Plug Seal
2709-001	6277-001	Power Beyond Sleeve, Outer
6806-001	None	
21857-001	9003-117	Section Seal, Pressure (new)
6814-002	7450-001	Section Seal, Pressure (old)
21733-001	9002-119	Section Seal, Exhaust (new)
6815-002	7451-001	Section Seal, Exhaust (old)
21866-001	9002-108	Section Seal, Load Sensing (new)
8316-001	9002-011	Section Seal, Load Sensing (old)

Optional Viton Seals and O-Rings

Viton seals are recommended for most applications that use phosphate-ester type fluids. Viton seals are also recommended for applications that have a continuous operating temperature of $+200^{\circ}\text{F}$ [$+93^{\circ}\text{C}$] or more.

Table 4-2. Cross Reference For Seal Kits, Buna-N to Viton

Buna-N Kit No.	Viton Kit No.	Application
K-6001-A	None	
K-6002-A	None	
K-6005-A	K-6041	RC Relief
K-6017-B	K-6053-A	Power Beyond (1/2 NPTF)
K-6018-B	K-6054-A	Power Beyond (SAE 8)
K-6019-B	K-6055-A	Power Beyond (SAE 10)
K-6021-A	K-6043	Anti-Cavitation Check
K-6027-A	K-6046	Section Seal, 3-Way, 4-Way
K-6028-C	K-6049-A	Section Seal, Float
K-6030-C	K-6047	Check Plug
K-6032	K-6041	Load Check, Anti-Cav. Check, RC Relief
K-6034-D	None	
K-6035-A	K-6048	Spool Seal
K-6039	None	
K-6040-C	None	

Product Warranty

Dana Corporation's Gresen Hydraulics Division warrants its standard products, such as those listed in its catalogs, against defects in materials and workmanship when properly installed and maintained for 18 months from the earlier of the date the product is first put into service or for 24 months from the date of shipment.

(Products must be returned to the Dana location from which it was shipped, freight prepaid, for inspection and, if appropriate, repair or replacement by Dana.) Dana will replace or repair free of charge any part of any product that its inspection shows not to be in compliance with this warranty. Valid claims will receive freight reimbursement.

This warranty is null and void if in the judgement of Dana, the part had been used in the wrong application, damaged, improperly maintained or repaired, subjected to inappropriate environmental and operating conditions, repaired by a non-Dana party without prior authorization from Dana, not used in accordance with Dana operational and service recommendations, or repaired with other than Dana approved parts.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED AND MAY BE VARIED ONLY BY A SEPARATE AGREEMENT SIGNED BY A DULY AUTHORIZED REPRESENTATIVE OF DANA. NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE IS MADE BY DANA CORPORATION. THE FOREGOING STATES DANA CORPORATION'S ENTIRE AND EXCLUSIVE LIABILITY AND BUYER'S EXCLUSIVE AND SOLE REMEDY IN CONNECTION WITH THE SALE OF THE PARTS HEREUNDER. IN NO EVENT SHALL DANA CORPORATION BE LIABLE FOR ANY SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES WHATSOEVER INCLUDING LOSS OF USE OR TRAVEL, LABOR OR MATERIAL COSTS TO REMOVE OR REINSTALL THE PRODUCT.

(This warranty voids all previous issues)

GRESEN[®]



GRESEN HYDRAULICS DIVISION • DANA CORPORATION

PO Box 1313 • Minneapolis, MN 55440 • Phone (612) 623-1960 • Fax (612) 623-1537

Catalog No. GSD-1102 Rev. 2/92

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People Finding A Better Way™



Hydrostatic Steering Unit
OSPB/OSPC

HN.21.AD.02 replaces HN.21.AC.02

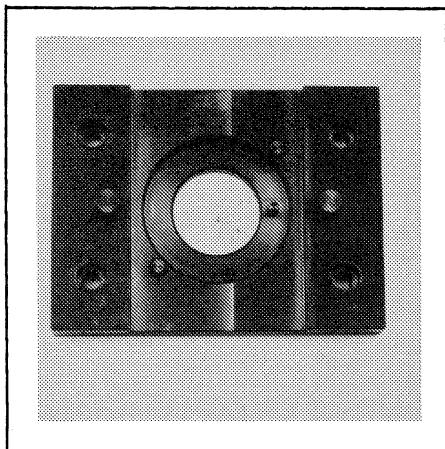


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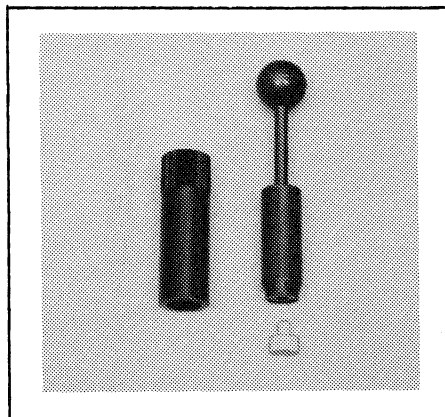
Cost-free repairs

We would point out that cost-free repairs as mentioned in Danfoss General Conditions of Sale, are carried out only at Danfoss Nordborg or at service shops authorized by Danfoss (page 29).

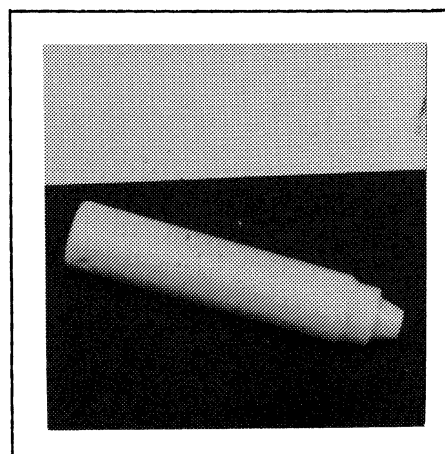
TOOLS



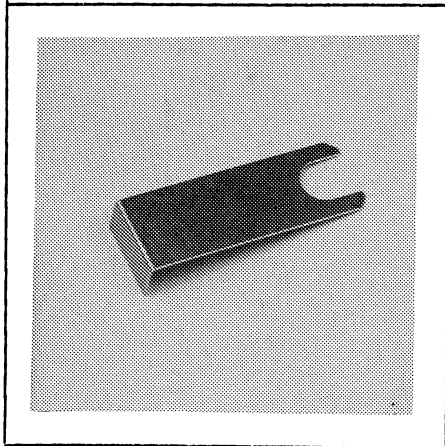
A Holding tool. Code no.: SJ 150-9000-2.



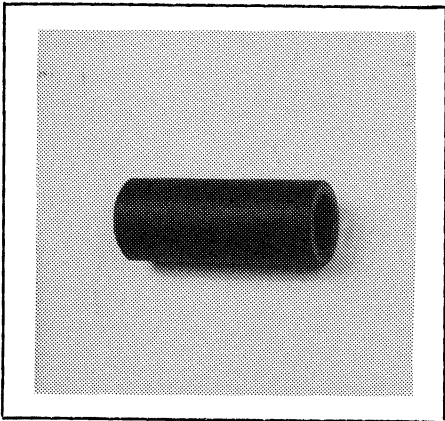
B Assembly tool for o-ring and kin-ring.
Code no. SJ 150-9000-11.



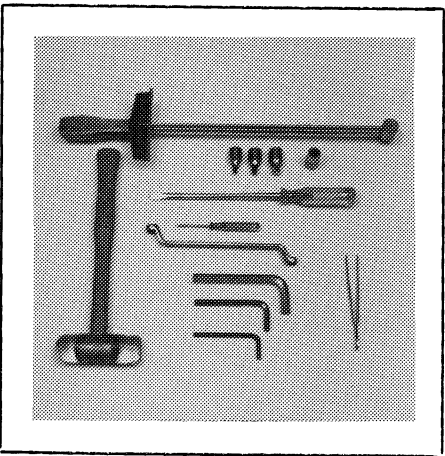
C Assembly tool for lip seal.
Code no. SJ 150-9000-17.



D Assembly tool for cardan shaft.
Code no. SJ 150-9000-3.



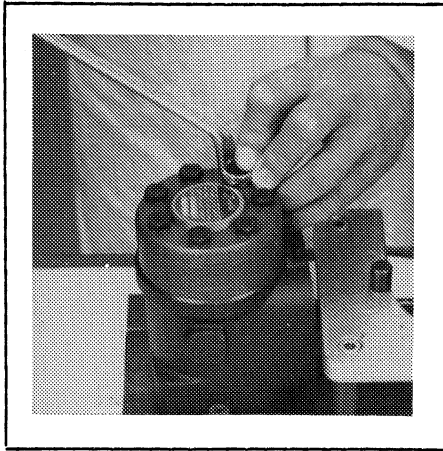
E Assembly tool for dust seal.
Code no. SJ 150-9000-22.



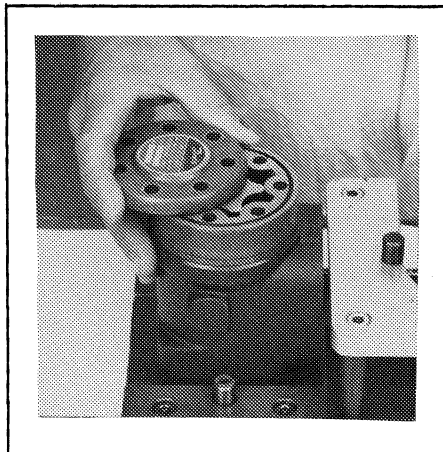
F Torque wrench 0-7 daNm.
13 mm socket spanner.
6, 8 and 12 mm hexagon sockets.
12 mm screwdriver.
2 mm screwdriver.
13 mm ring spanner.
6, 8 and 12 mm hexagon socket spanners.
Plastic hammer.
Tweezers.

The tools named under point F are not available from Danfoss.

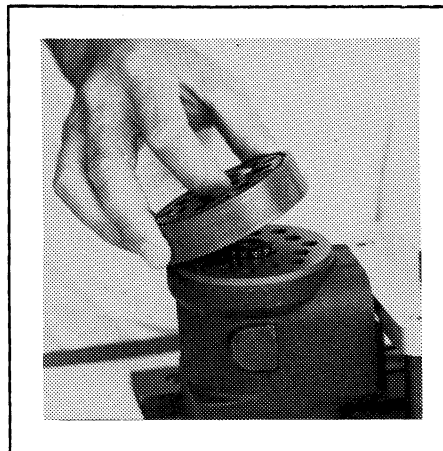
DISMANTLING



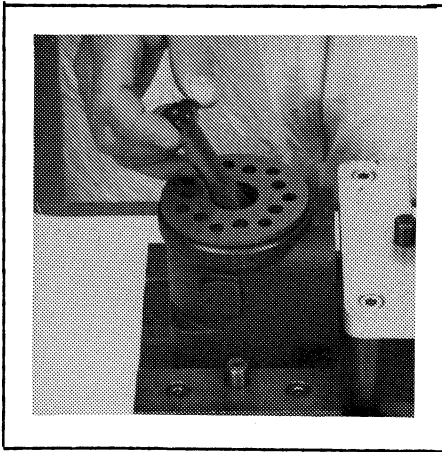
- 1 Dismantle steering column from steering unit and place the steering unit in the holding tool. Screw out the screws in the end cover (6-off plus one special screw).



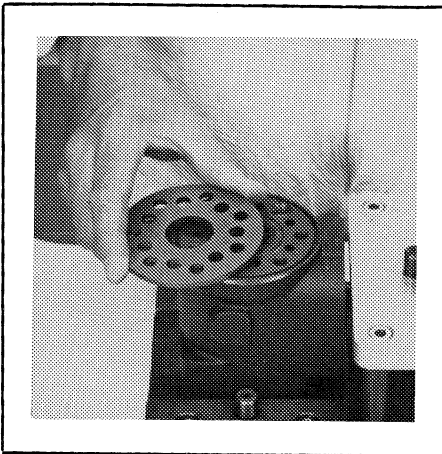
- 2 Remove the end cover, sideways.



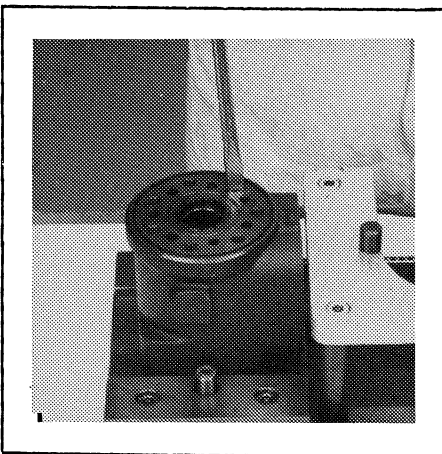
- 3 Lift the gearwheel set (with spacer if fitted) off the unit. Take out the two o-rings.



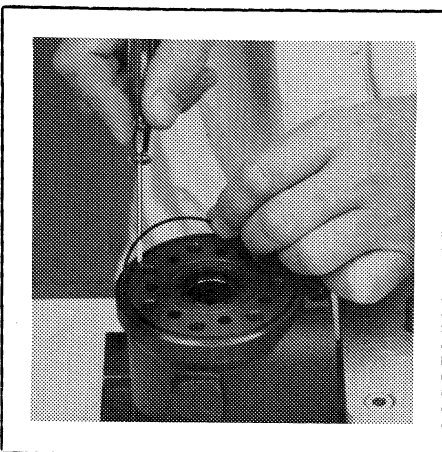
4 Remove cardan shaft.



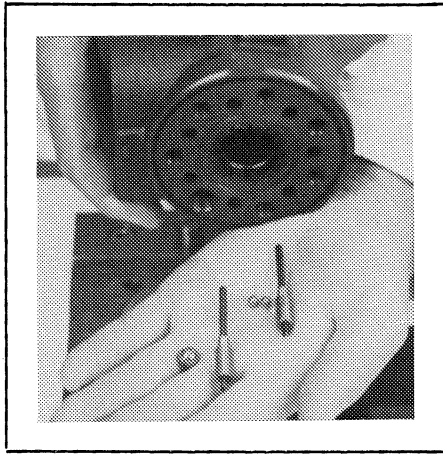
5 Remove distributor plate.



6 Screw out the threaded bush over the check valve.



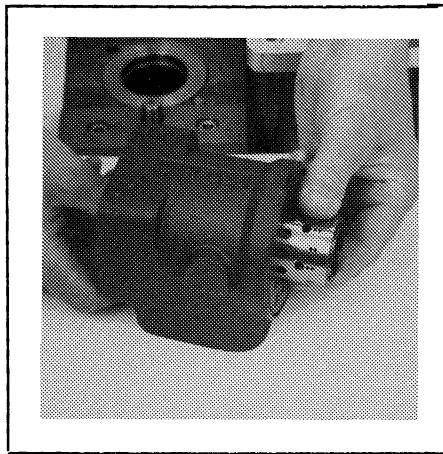
7 Remove o-ring.



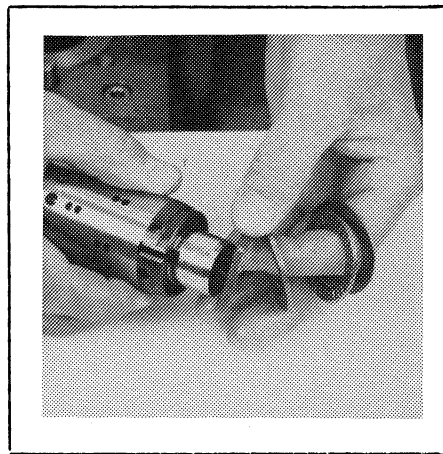
8 OSPB; OSPB LS; OSPBX LS:
Shake out the check valve ball (\varnothing 8 mm).

OSPC; OSPC LS; OSPC LSR:
Shake out the check valve ball and suction
valve pins and balls.

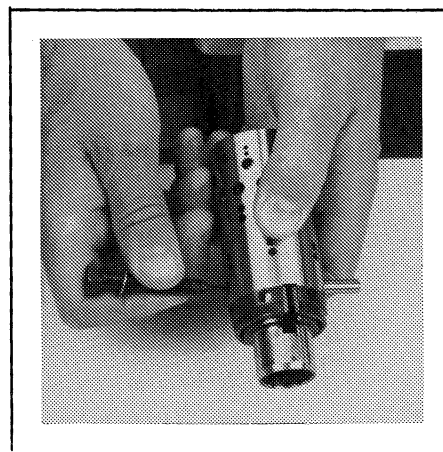
Note: On some pins in the OSPC there are two
springs (see page 30, pos. 28). See also
spare parts list for OSPC HN.21.CA.52.



9 Take care to keep the cross pin in the sleeve
and spool horizontal. The pin can be seen
through the open end of the spool. Press the
spool inwards and the sleeve, ring, bearing
races and needle bearing will be pushed out
of the housing together.

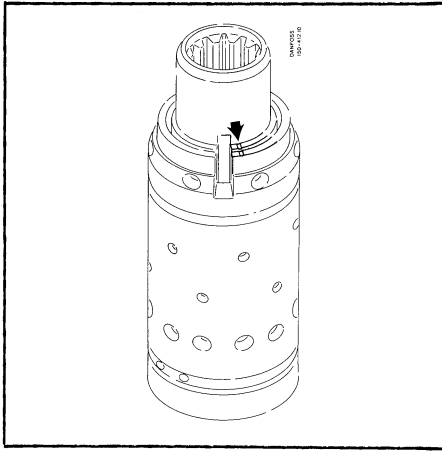


10 Take ring, bearing races and needle bearing
from sleeve and spool. The outer (thin)
bearing race can sometimes "stick" in the
housing, therefore check that it has come
out.



11 Press out the cross pin. Use the special
screw from the end cover.

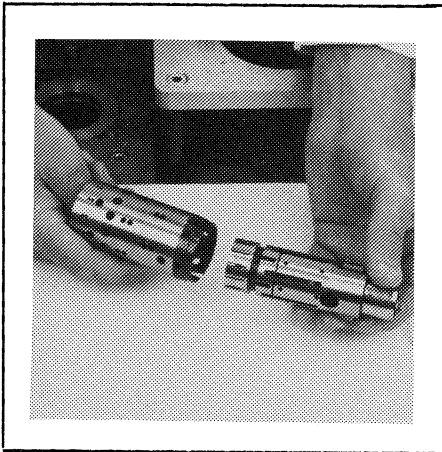
Note 11a!



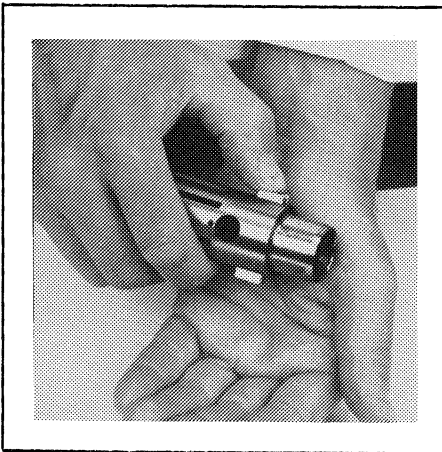
11a OSPB CN and OSPC CN

A small mark has been made with a pumice stone on both spool and sleeve close to one of the slots for the neutral position springs (see drawing).

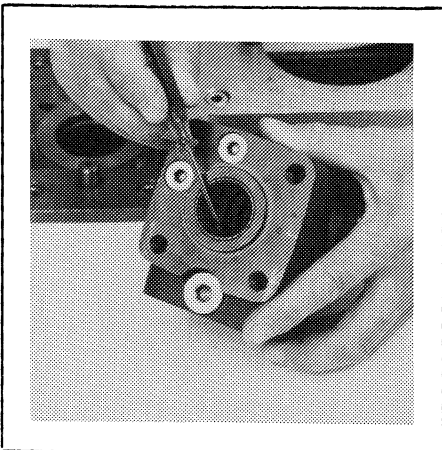
If the mark is not visible, remember to leave a mark of your own on sleeve and spool before the neutral position springs are dismantled.



12 Carefully press the spool out of the sleeve.

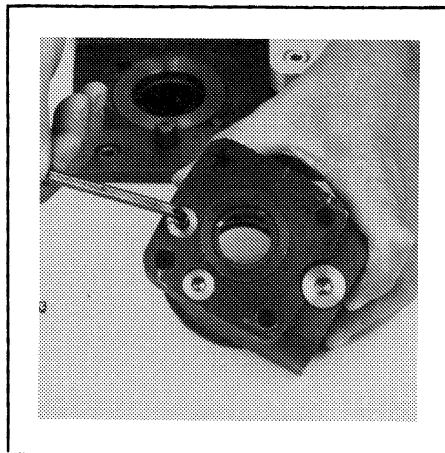


13 Press the neutral position springs out of their slots in the spool.

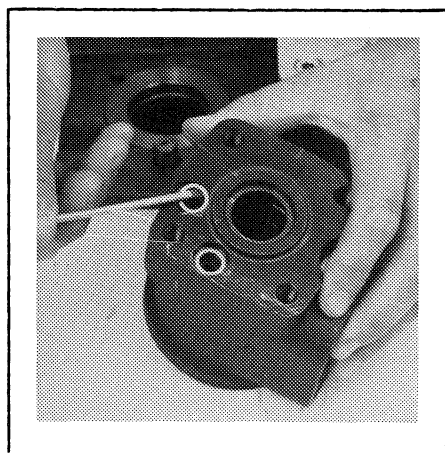


14 Remove dust seal and o-ring/kin-ring.

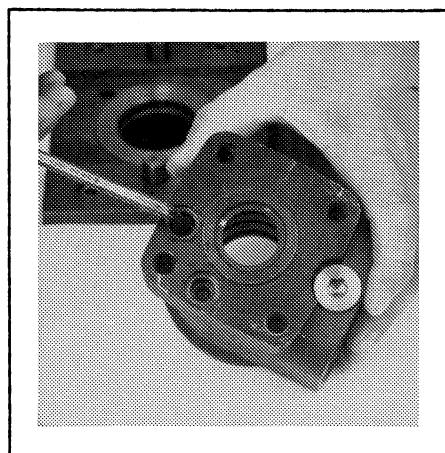
Dismantling the dual shock valves for OSPC/OSPC LS



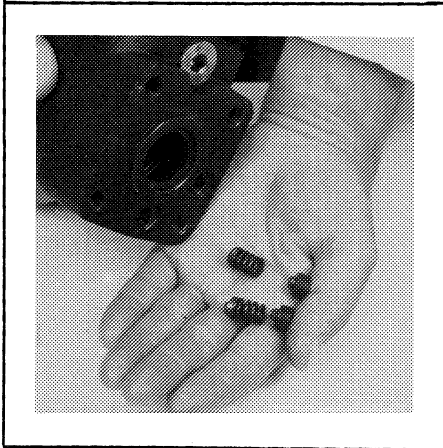
15 Remove plugs from shock valves using a 6 mm hexagon socket spanner.



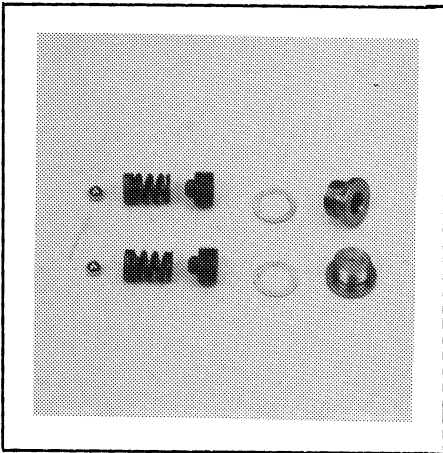
16 Remove seal washers (2-off).



17 Unscrew the setting screws using a 6 mm hexagon socket spanner.

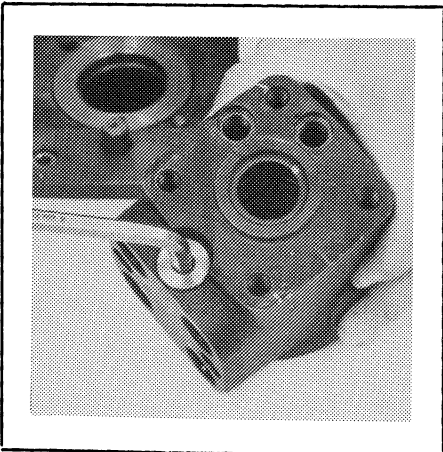


18 Shake out the two springs and two valve balls into your hand. The valve seats are bonded into the housing and cannot be removed.

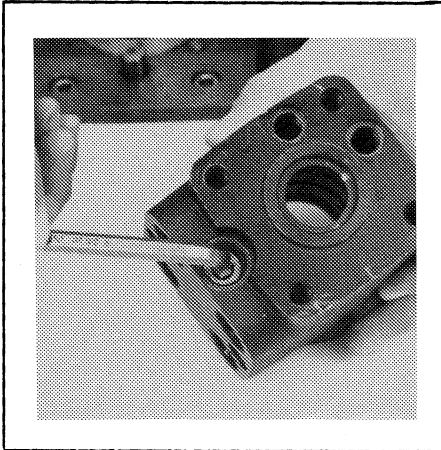


19 The dual shock valves are now dismantled.

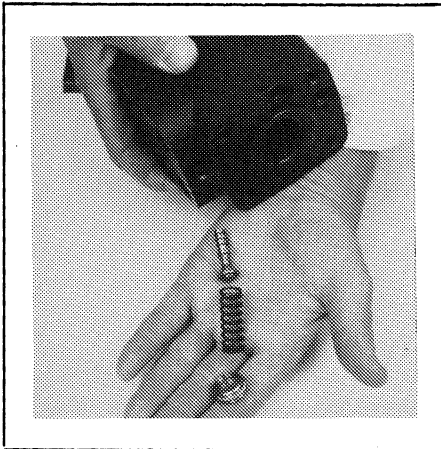
Dismantling the pressure relief valve (cartridge) for OSPC



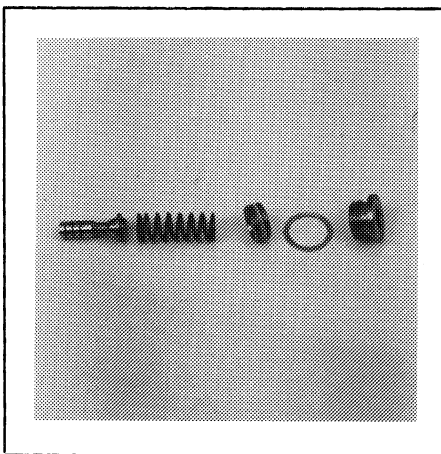
20 Screw out the plug using an 8 mm hexagon socket spanner. Remove seal washers.



21 Unscrew the setting screw using an 8 mm hexagon socket spanner.

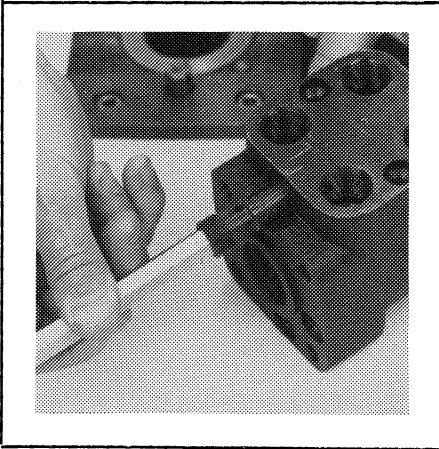


22 Shake out spring and piston. The valve seat is bonded into the housing and cannot be removed.

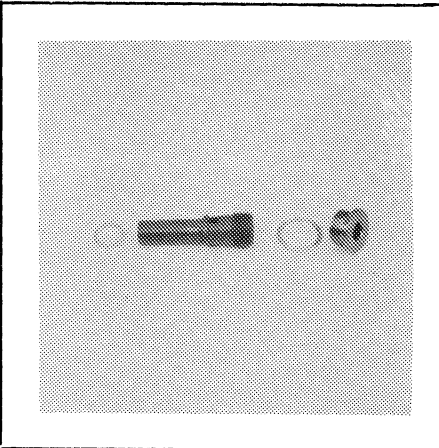


23 The pressure relief valve is now dismantled.

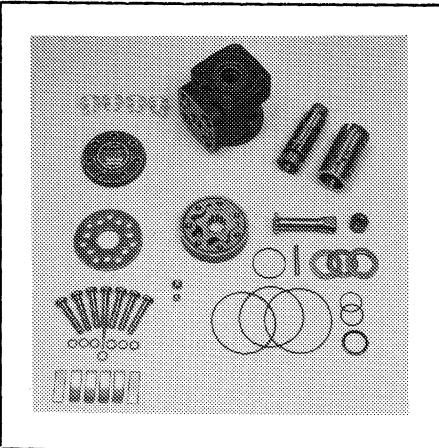
Dismantling the pressure relief valve (cartridge) for OSPC LS/OSPC LSR



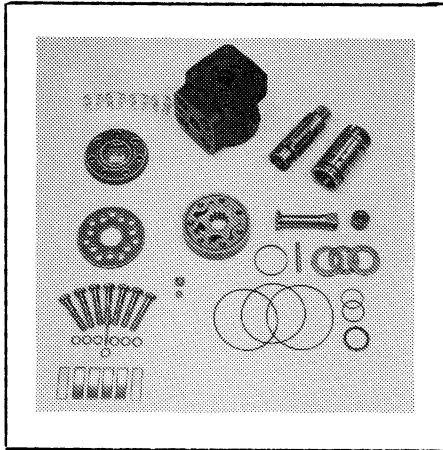
24 Screw out the pressure relief valve using an 8 mm hexagon socket spanner. Remove the seal ring. If the valve is defective it must be replaced (see OSPC spare parts list, HN.21.CA.52).



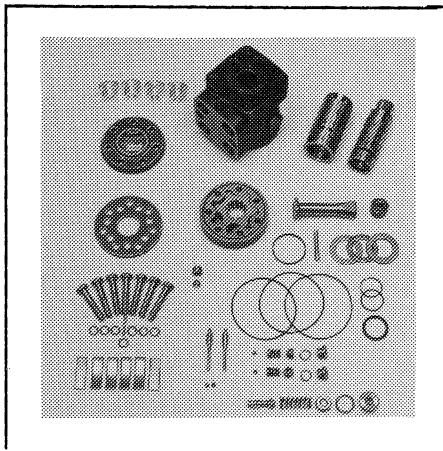
25 The pressure relief valve is now dismantled.



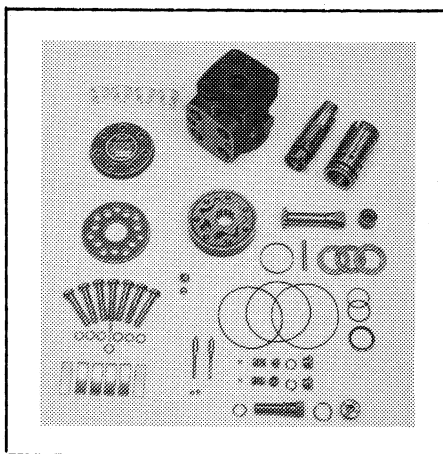
26 The steering unit OSPB is now completely dismantled.



27 The steering unit OSPB LS is now completely dismantled.



28 The steering unit OSPC is now completely dismantled.



29 The steering unit OSPC LS is now completely dismantled.

Cleaning

Clean all parts carefully in Shellsol K or the like.

Inspection and replacement

Replace all seals and washers. Check all parts carefully and make any replacements necessary.

Lubrication

Before assembly, lubricate all parts with hydraulic oil.

Assembly pattern and colour code for neutral position springs for
OSP-steering units



DANFOSS
150-386.10

STANDARD SPRINGS (GREY)

2-off flat, grey: code no. 150-0720

4-off curved, grey: code no. 150-0721

GREY SET

Spare set: code no. 150-4209



WEAK SPRINGS (BLUE)

2-off flat, blue: code no. 150-0748

2-off curved, blue: code no. 150-0749

BLUE SET

Spare set: code no. 150-4265



STRONG SPRINGS (GREY AND BLUE)

2-off flat, grey: code no. 150-0720

4-off curved, blue: code no. 150-0749

GREY/BLUE SET

Spare set: code no. 150-4207



STIFF SPRINGS (YELLOW)

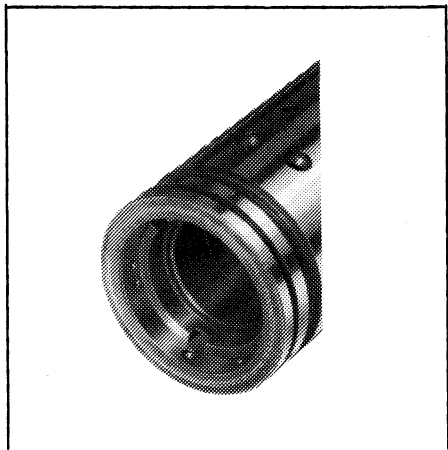
2-off flat, yellow: code no. 150N0602

2-off curved, yellow: code no. 150N0603

YELLOW SET

Spare set: code no. 150-4269

REASSEMBLY



30 Assemble spool and sleeve.

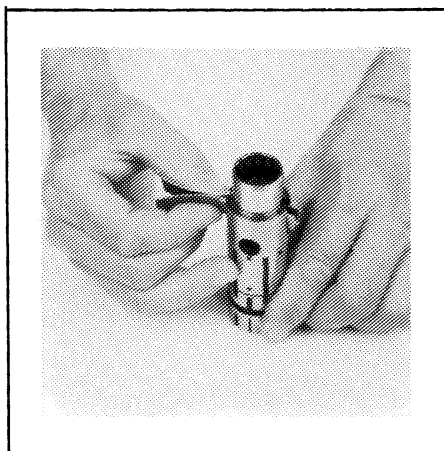
Note

OSPB LS, OSPBX LS, OSPC LS and OSPC LSR

When assembling spool and sleeve only one of two possible ways of positioning the spring slots is correct. There are three slots in the spool and three holes in the sleeve in the end of the spool/sleeve opposite to the end with spring slots. Place the slots and holes opposite each other so that parts of the holes in the sleeve are visible through the slots in the spool.

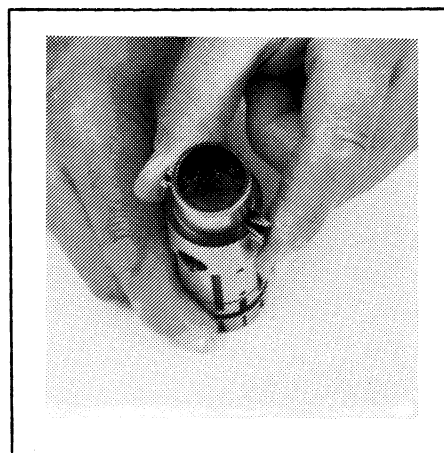
OSPB CN and OSPC CN

Assemble the spool/sleeve and make sure the marks on spool and sleeve are opposite each other (see drawing page 7).

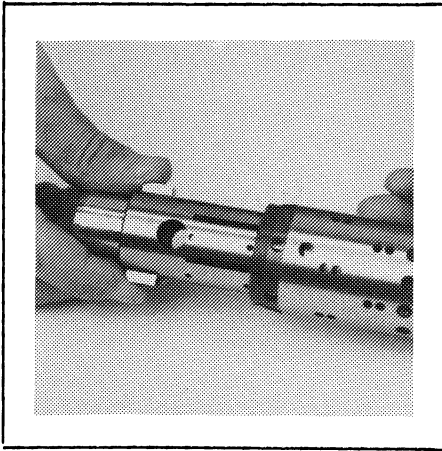


31 Place the two flat neutral position springs in the slot.

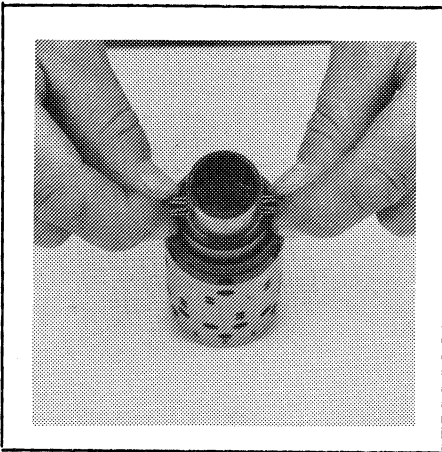
Place the curved springs between the flat ones and press them into place (see assembly pattern, page 13).



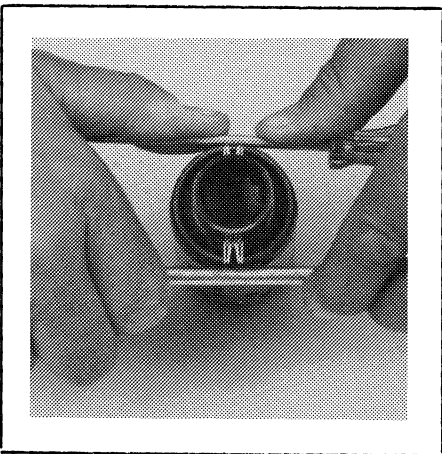
32 Line up the spring set.



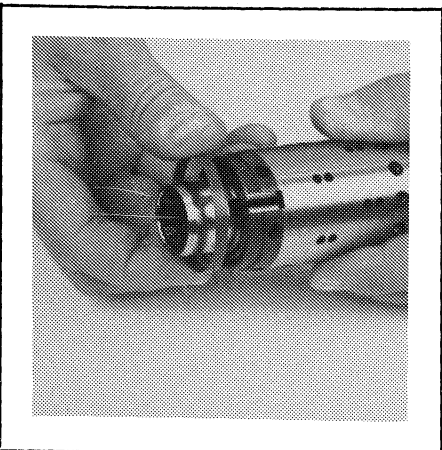
33 Guide the spool into the sleeve. Make sure that spool and sleeve for OSPB LS, OSPBX LS, OSPC LS and OSPC LSR are placed correctly in relation to each other (see page 14).



34 Press the springs together and push the neutral position springs into place in the sleeve.

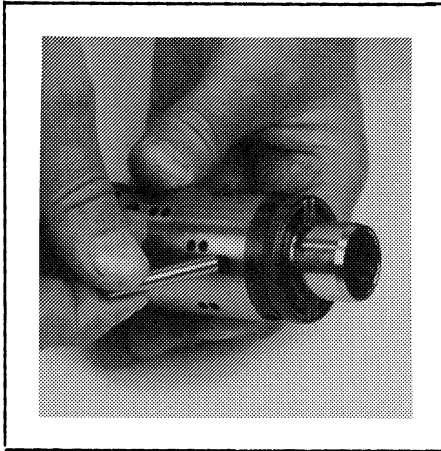


35 Line up the springs and centre them.

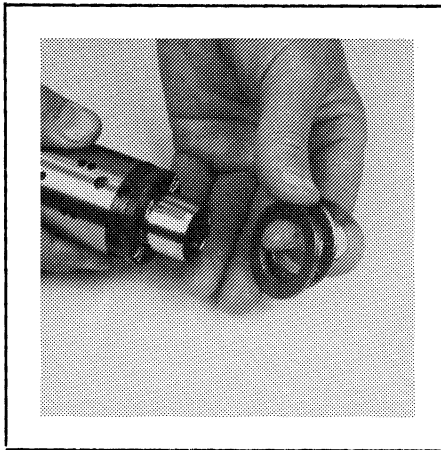


36 Guide the ring down over the sleeve.

Note: The ring should be able to rotate - free of the springs.



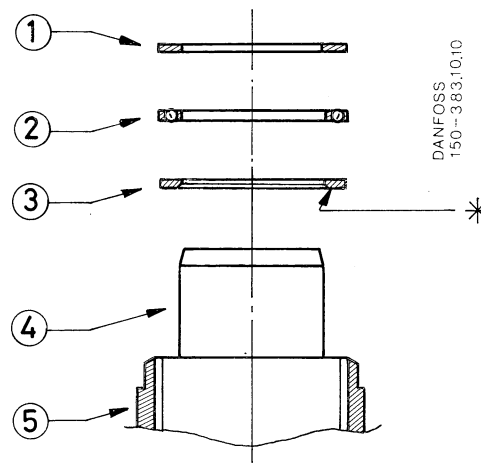
37 Fit the cross pin into the spool/sleeve.



38 Fit bearing races and needle bearing as shown on below drawing.

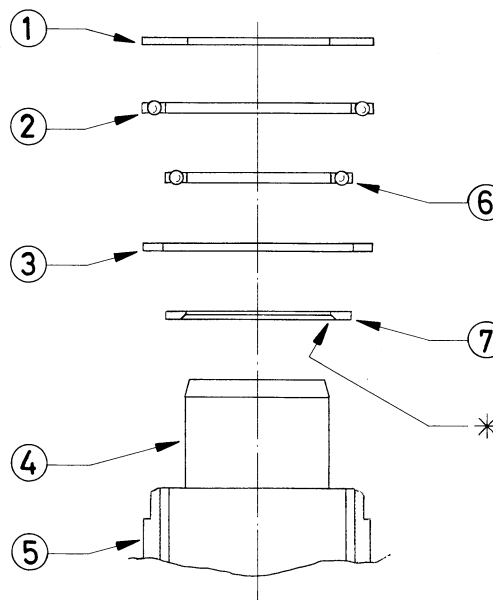
Assembly pattern for standard bearings

- 1 Outer bearing race
- 2 Needlebearing
- 3 Inner bearing race
- 4 Spool
- 5 Sleeve



Assembly pattern for double bearings

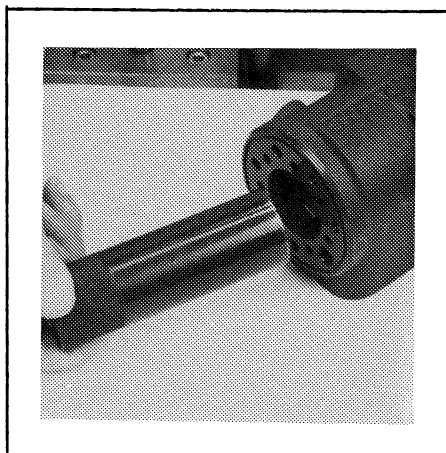
- 1 Washer for axial bearing
- 2 Outer needlebearing
- 3 Outer bearing race
- 4 Spool
- 5 Sleeve
- 6 Inner needlebearing
- 7 Inner bearing race



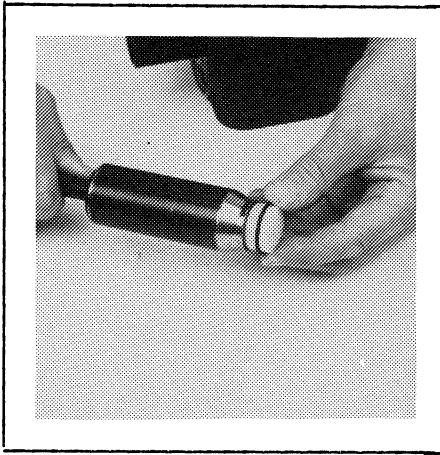
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The inside chamfer on the inner bearing race must face the inner spool.

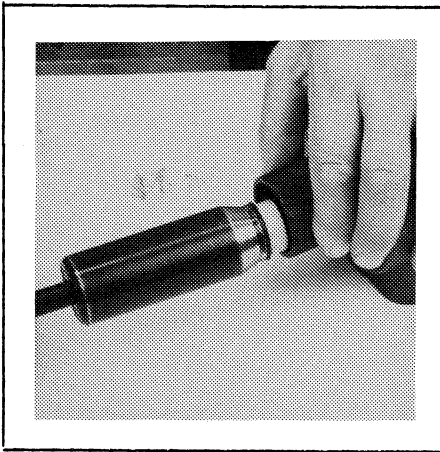
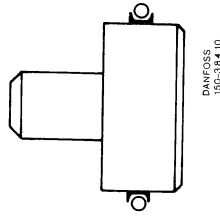
Installation instructions for o-ring/kin-ring (standard)



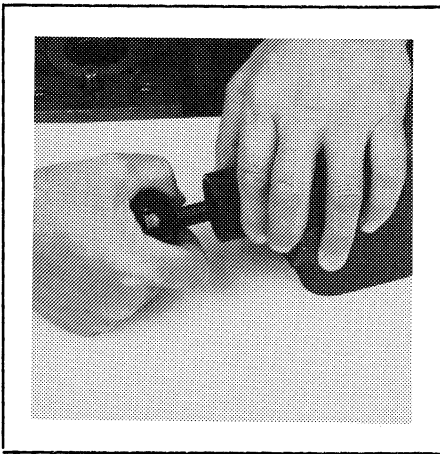
- 39 Turn the steering unit until the bore is horizontal. Guide the outer part of the assembly tool into the bore for the spool/sleeve.



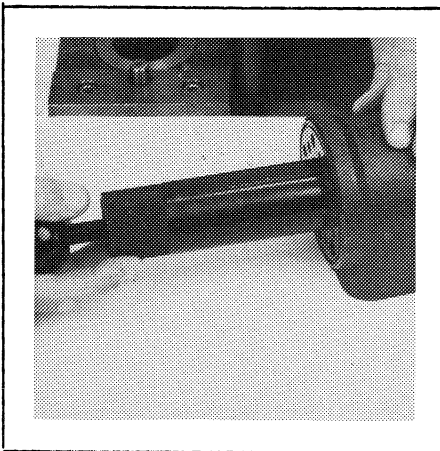
- 40 Grease o-ring and kin-ring with hydraulic oil and place them on the tool.



- 41 Hold the outer part of the assembly tool in the bottom of the steering unit housing and guide the inner part of the tool right to the bottom.

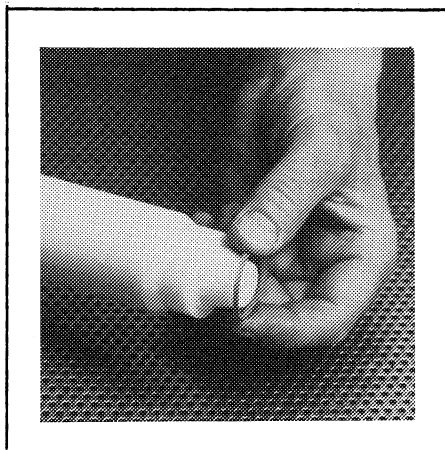


- 42 Press and turn the o-ring/kin-ring into position in the housing.

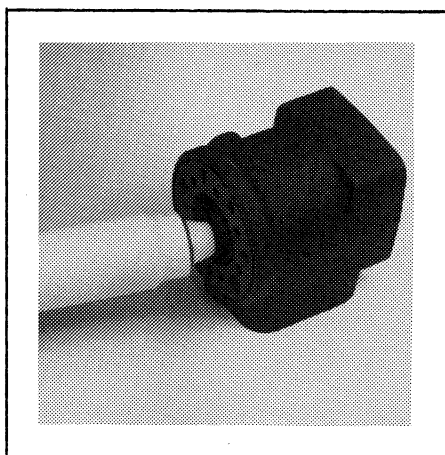
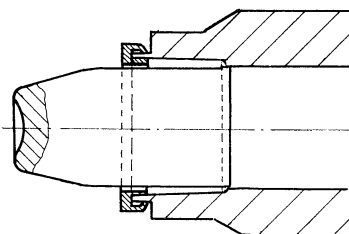


- 43 Draw the inner and outer parts of the assembly tool out of the steering unit bore, leaving the guide from the inner part in the bore.

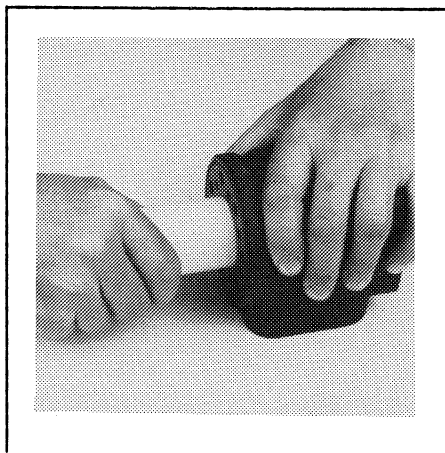
Installation instructions for lip seal



- 44 Lubricate the lip seal with hydraulic oil and place it on the assembly tool.



- 45 Guide the assembly tool right to the bottom.

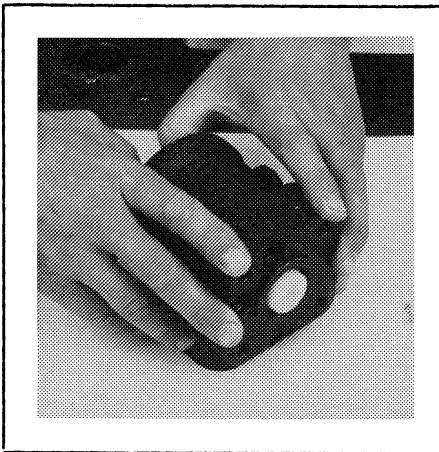


- 46 Press and turn the lip seal into place in the housing.

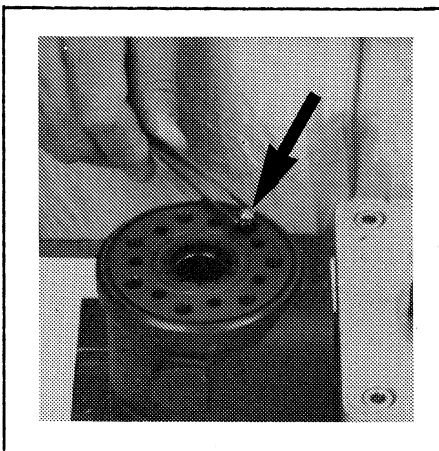


47 With a light turning movement, guide the spool and sleeve into the bore.

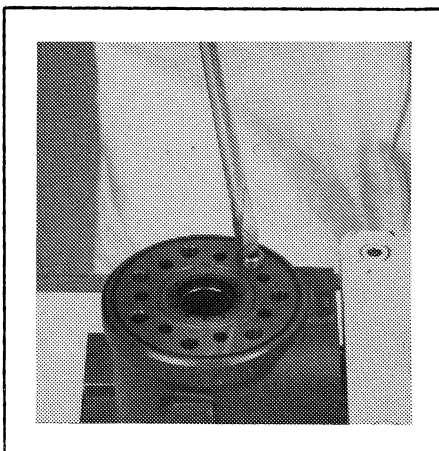
Note: Fit the spool set holding the cross pin horizontal.



48 The spool set will push out the assembly tool guide. The o-ring and kin-ring are now in position.

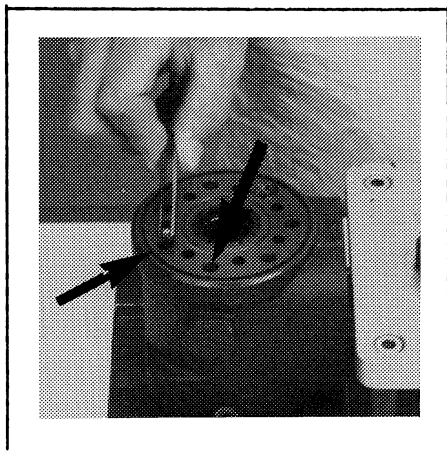


49 Turn the steering unit until the bore is vertical again. Put the check valve ball into the hole indicated by the arrow.

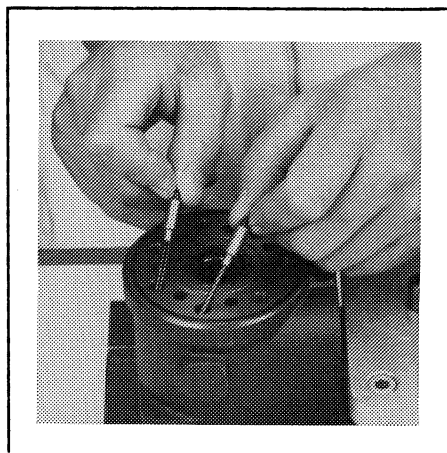


50 Screw the threaded bush lightly into the check valve bore. The top of the bush must lie just below the surface of the housing.

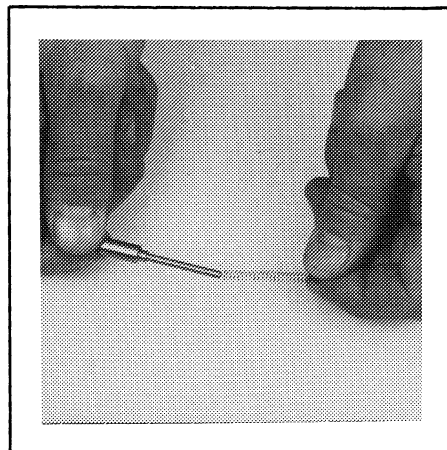
Assembly of the two suction valves for OSPC/OSPC LS/OSPC LSR



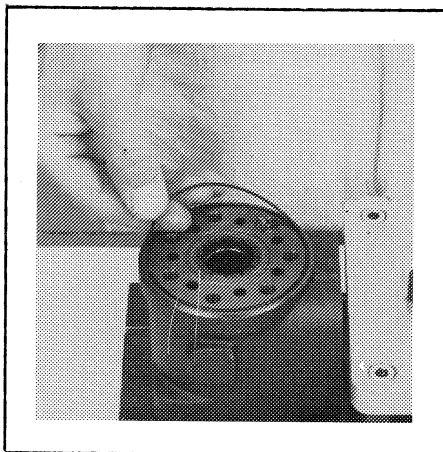
51 Place a ball in the two holes indicated by the arrows.



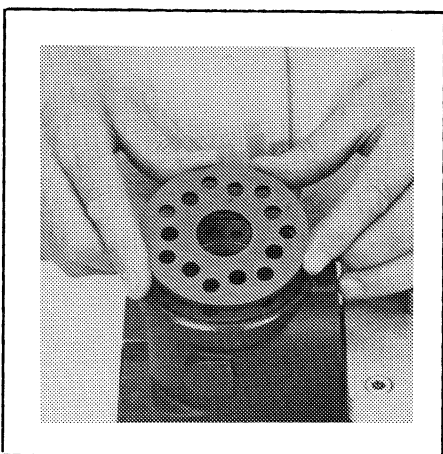
52 Place a pin in the same two holes.



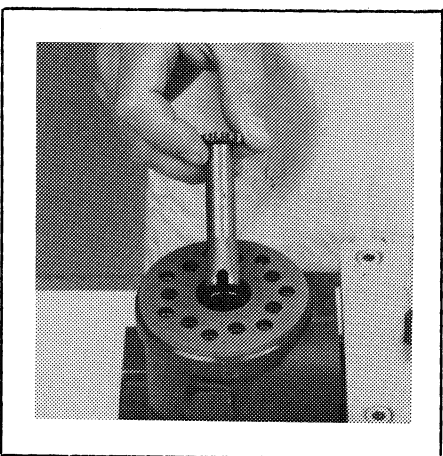
53 In some cases a spring has to be fitted (see page 30, pos. 28) on the pin before it is placed in the housing. (See OSPC spare parts list, HN.21.CA.52).



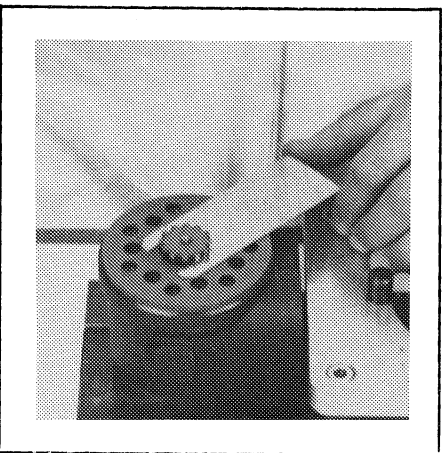
54 Grease the o-ring with mineral oil approx. viscosity 500 cSt at 20°C.



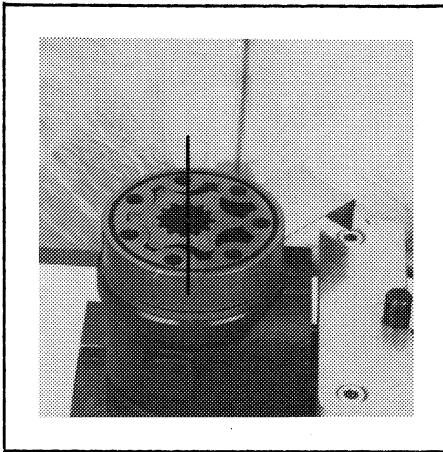
55 Place the distributor plate so that the channel holes match the holes in the housing.



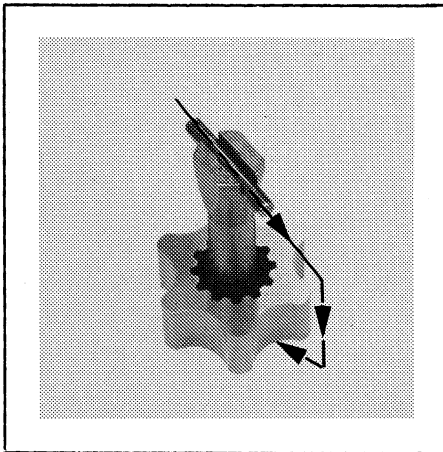
56 Guide the cardan shaft down into the bore so that the slot is parallel with the connection flange.



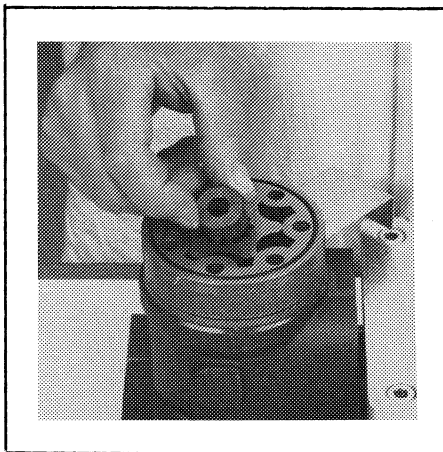
57 Place the cardan shaft as shown - so that it is held in position by the mounting fork.



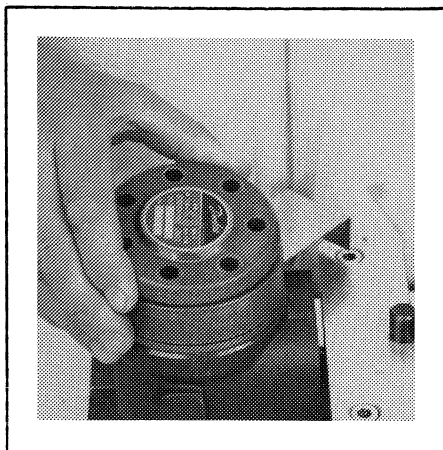
58 Grease the two o-rings with mineral oil approx. viscosity 500 cSt at 20°C and place them in the two grooves in the gear rim. Fit the gearwheel and rim on the cardan shaft.



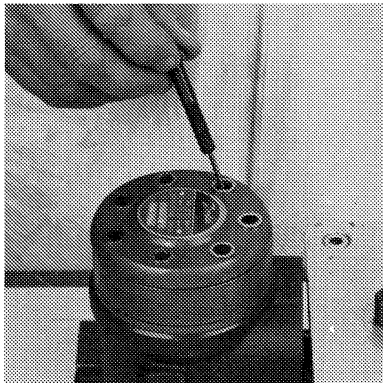
59 Important: Fit the gearwheel (rotor) and cardan shaft so that a tooth base in the rotor is positioned in relation to the shaft slot as shown. Turn the gear rim so that the seven through holes match the holes in the housing



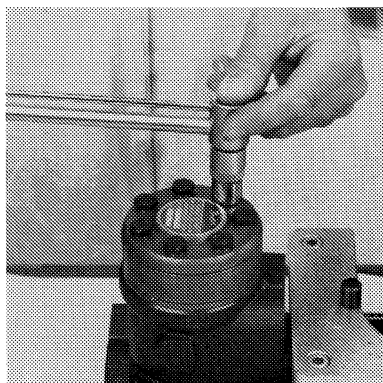
60 Fit the spacer, if any.



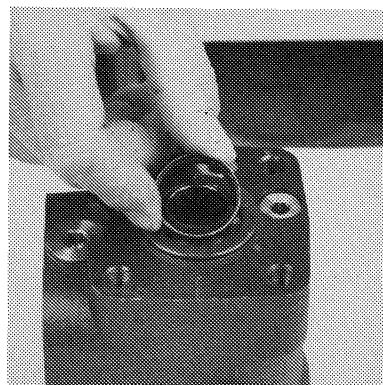
61 Place the end cover in position.



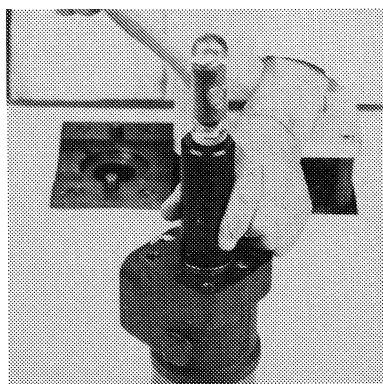
- 62 Fit the special screw with washer and place it in the hole shown.



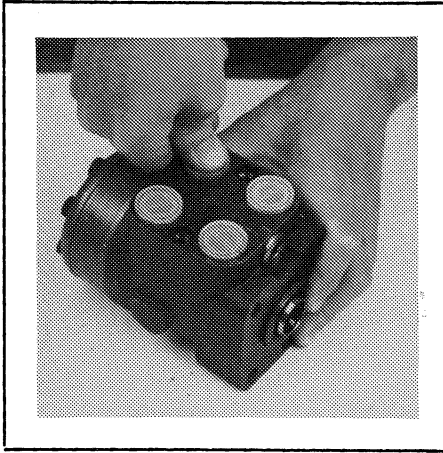
- 63 Fit the six screws with washers and insert them. Cross-tighten all the screws and the rolled pin with a torque of 3.0 ± 0.6 daNm. The OSPB, OSPB LS and OSPBX LS can now be function tested.



- 64 Place the dust seal ring in the housing. With the OSPC, PSPC LS and OSPC LSR the dust seal ring must be placed only after the pressure relief valve and shock valves have been fitted.

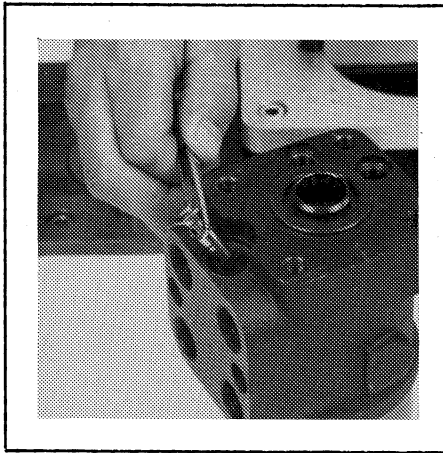


- 65 Fit the dust seal ring in the housing using special tool SJ 150-9000-22 (see page 3; E) and a plastic hammer.

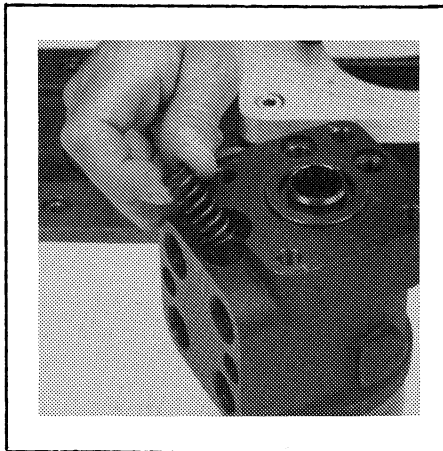


66 Press the plastic plugs into the connection ports. Do not use a hammer!

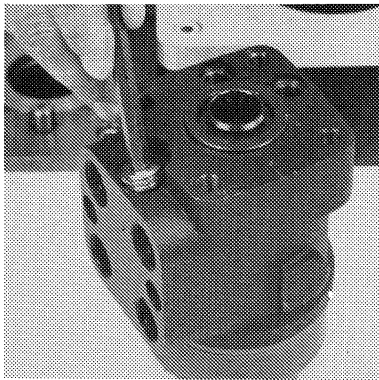
Assembly of the pressure relief valve for OSPC



67 Fit the piston.



68 Fit the spring.



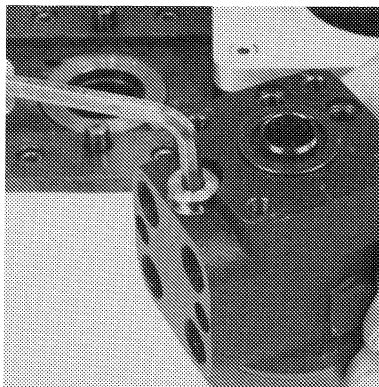
- 69 Screw in the setting screw with an 8 mm hexagon socket spanner. Make the pressure setting on a panel or the vehicle.

Ø 1.7 spring for 50 - 70 bar.

Ø 1.9 spring for 70 - 105 bar.

Ø 2.1 spring for 110 - 155 bar.

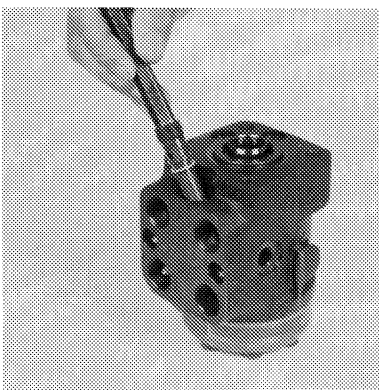
(See OSPC spare parts list HN.21.CA.52).



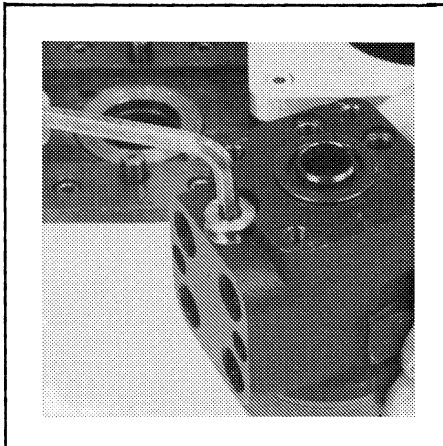
- 70 Screw plug with dust seal into the housing using an 8 mm hexagon socket spanner.

Tightening torque: 5 +/-1 daNm.

Assembly of the pressure relief valve (cartridge) for OSPC LS/OSPC LSR



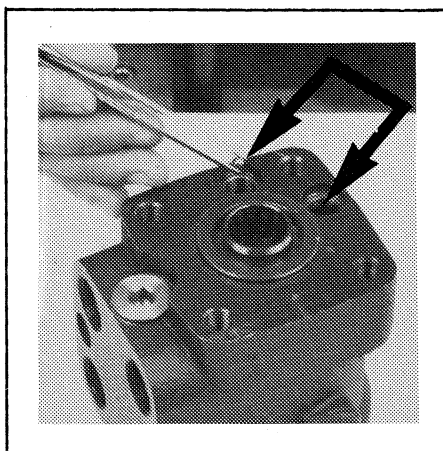
- 71 Place the seal ring on the cartridge and screw the cartridge into the housing using a 12 mm hexagon socket spanner. Tightening torque: 5 +/-1 daNm. Make the pressure setting on a panel or the vehicle. The cartridge is factory-set at 175 bar. Use a 4 mm hexagon socket spanner. (See OSPC spare parts list HN.21.CA.52 for setting range).



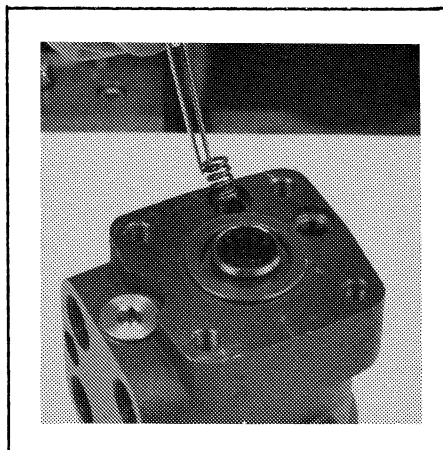
72 Screw plug with seal ring into the housing using an 8 mm Allen key.

Tightening torque: 5 +/-1 daNm.

Assembly of the dual shock valves for OSPC/OSPC LS/OSPC LSR



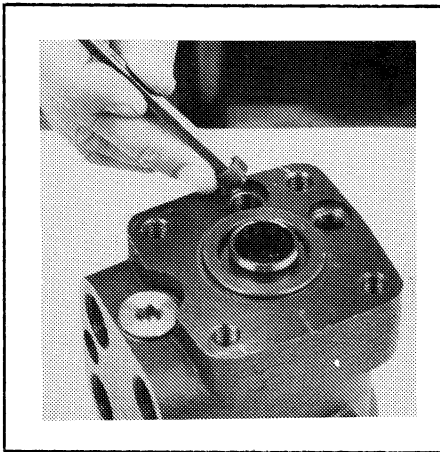
73 Put a ball in the two holes indicated by the arrows.



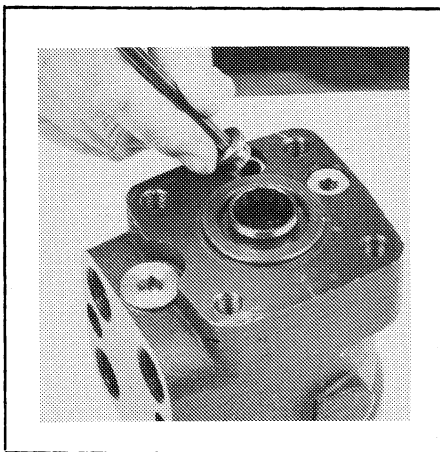
74 Place springs and valve cones over the two balls.

Note:

The blue spring applies to setting range 90-180 bar. The untreated spring applies to setting range 190-260 bar. (See OSPC spare parts list HN.21.CA.52).



75 Screw in the two setting screws using a 6 mm hexagon socket spanner. Make the pressure setting on a panel or the vehicle. (See OSPC spare parts list HN.21.L1.52).



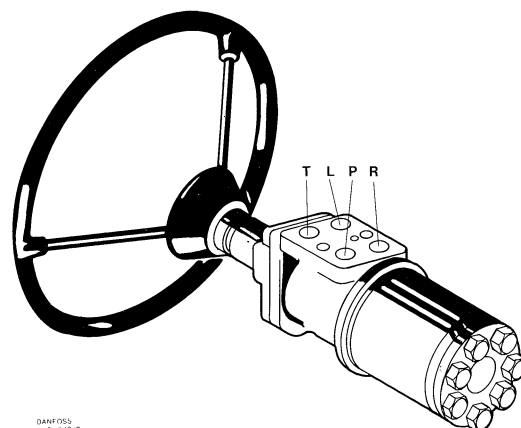
76 Screw plug with seal ring into the two shock valves and tighten them with a torque of 3 ± 0 daNm using a 6 mm hexagon socket spanner.

Steering unit type OSPB, OSPB LS, OSPBX LS, OSPC, OSPC LS or OSPC LSR is now assembled.

Max. tightening torque and hydraulic connections

Screwed connection	Max. tightening torque daNm (lbf in)			
	With cutting edge	With copper washer	With aluminium washer	With O-ring
1/4 BSP.F	4 (350)	2 (180)	3 (270)	
3/8 BSP.F	6 (530)	2 (180)	5 (440)	
1/2 BSP.F	10 (900)	3 (270)	8 (700)	
7/16-20 UNF				2 (180)
3/4-16 UNF				6 (530)
M 12 x 1,5	4 (350)	2 (180)	3 (270)	2 (180)
M 18 x 1,5	7 (620)	2 (180)	5 (440)	5 (440)
M 22 x 1,5	10 (900)	3 (270)	8 (700)	7 (620)

L: Left port
R: Right port
T: Tank
P: Pump



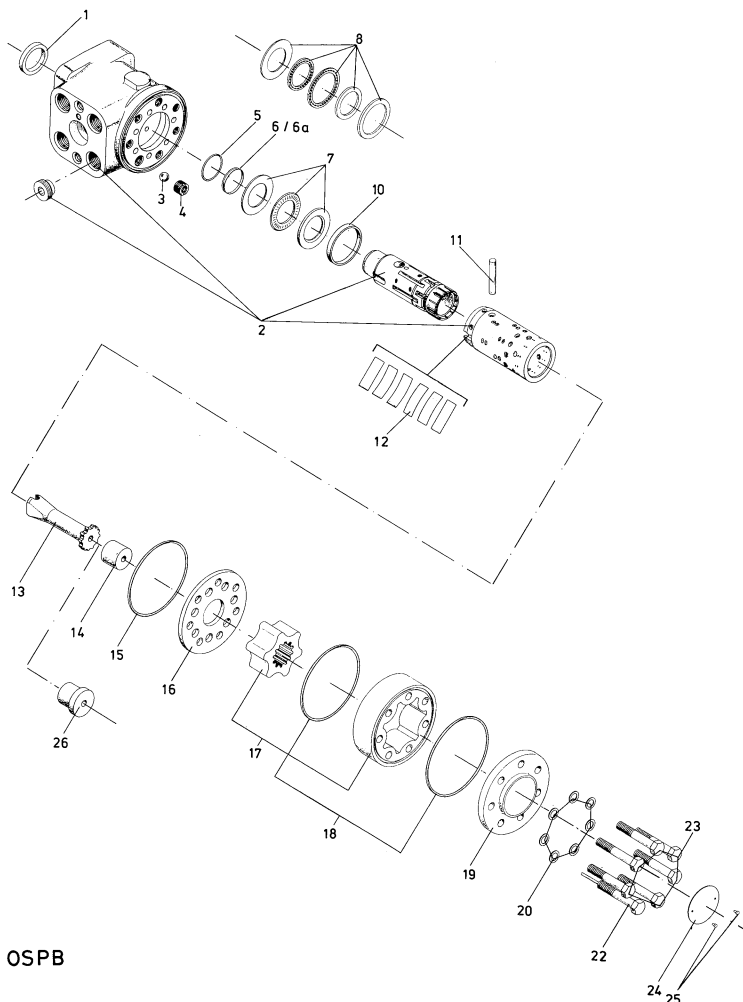
Authorized service shops:

Asean	:	Danfoss Industries Pte. Ltd., Singapore
Australia	:	Danfoss (Australia) Pty. Ltd., Melbourne
Austria	:	Hainzl Industriesysteme, Gesellschaft m.b.H, Linz
Belgium	:	N.V. Danfoss S.A., Bruxelles
Canada	:	Danfoss Mfg. Co. Ltd., Mississauga
Denmark	:	H. Søndergaard A/S, Måløv
Finland	:	OY Danfoss AB, Espoo
France	:	Danfoss S.a.r.l., Trappes (Paris)
FRG (W. Germany)	:	Danfoss GmbH, Offenbach/Main
Great Britain	:	Danfoss Limited, Greenford
Iceland	:	Velsmidjan Hedinn, Reykjavik
Italy	:	Sordella & C. Oleodinamica s.r.l., Torino
Japan	:	Danfoss (Japan) Manufacturing Co., Ltd., Gotemba
Netherlands	:	ITHO B.V., Schiedam
New Zealand	:	Danfoss (New Zealand) Limited, Auckland
Norway	:	Danfoss Norge A/S, Skui
Spain	:	Danfoss S.A., Madrid
Sweden	:	Transventor Hydraulik AB, Mölndal, Göteborg
Switzerland	:	Werner Kuster AG, Frenkendorf
U.S.A.	:	Danfoss Inc., Rockford, Illinois

Service shops:

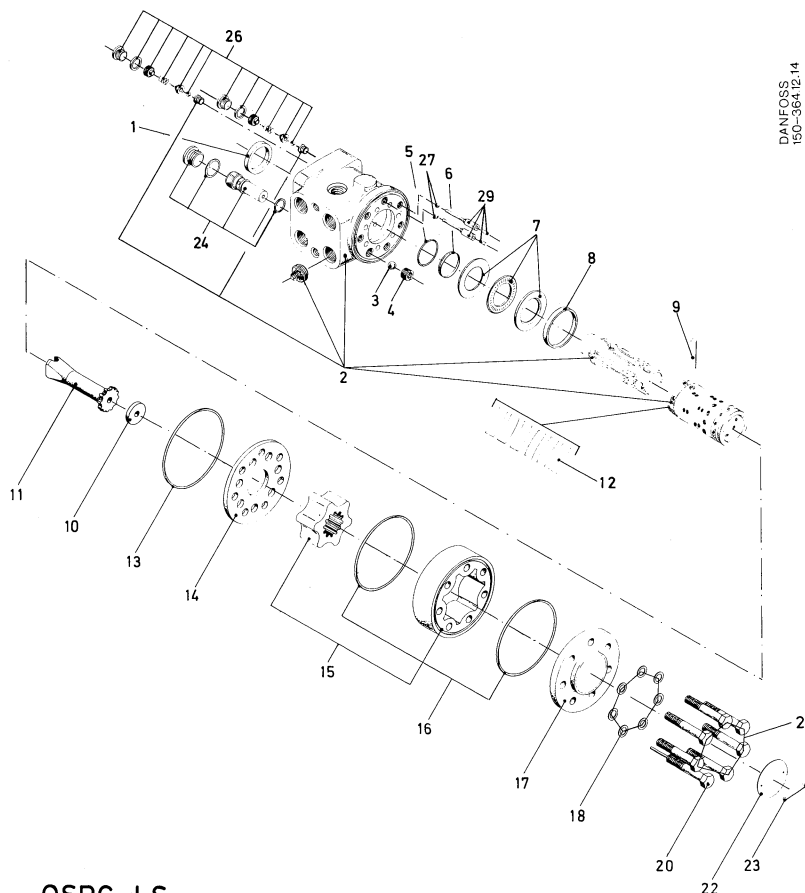
Greece	:	A. Skoura & Co. E.E., Athens
Norway	:	Servi Produksjon A.S., Trondheim

Item	Spare Parts
1	Dust seal ring
2	Housing + spool + sleeve
3	Ball \varnothing 8,5 mm
4	Thread bushing
5	O-ring 25, 12x1,78 mm, is used with kin-ring (item 6)
6	Kin-ring
6a	Lip seal
7	Bearing assembly
8	Bearing assembly
10	Ring I/D 39,6x0,7x4,5 mm
11	Cross pin \varnothing 6x41 mm
12	Neutral position spring
13	Cardan shaft
14	Spacer
15	O-ring \varnothing 80,5x1,5 mm
16	Distributor plate
17	Gearwheel
18	O-ring \varnothing 75,92x1,78 mm
19	End cover
20	Washer \varnothing 8,2x11,9x1,0 mm
22	Special screw
23	Screw
24	Rating plate
25	Drive screw
26	Spacer



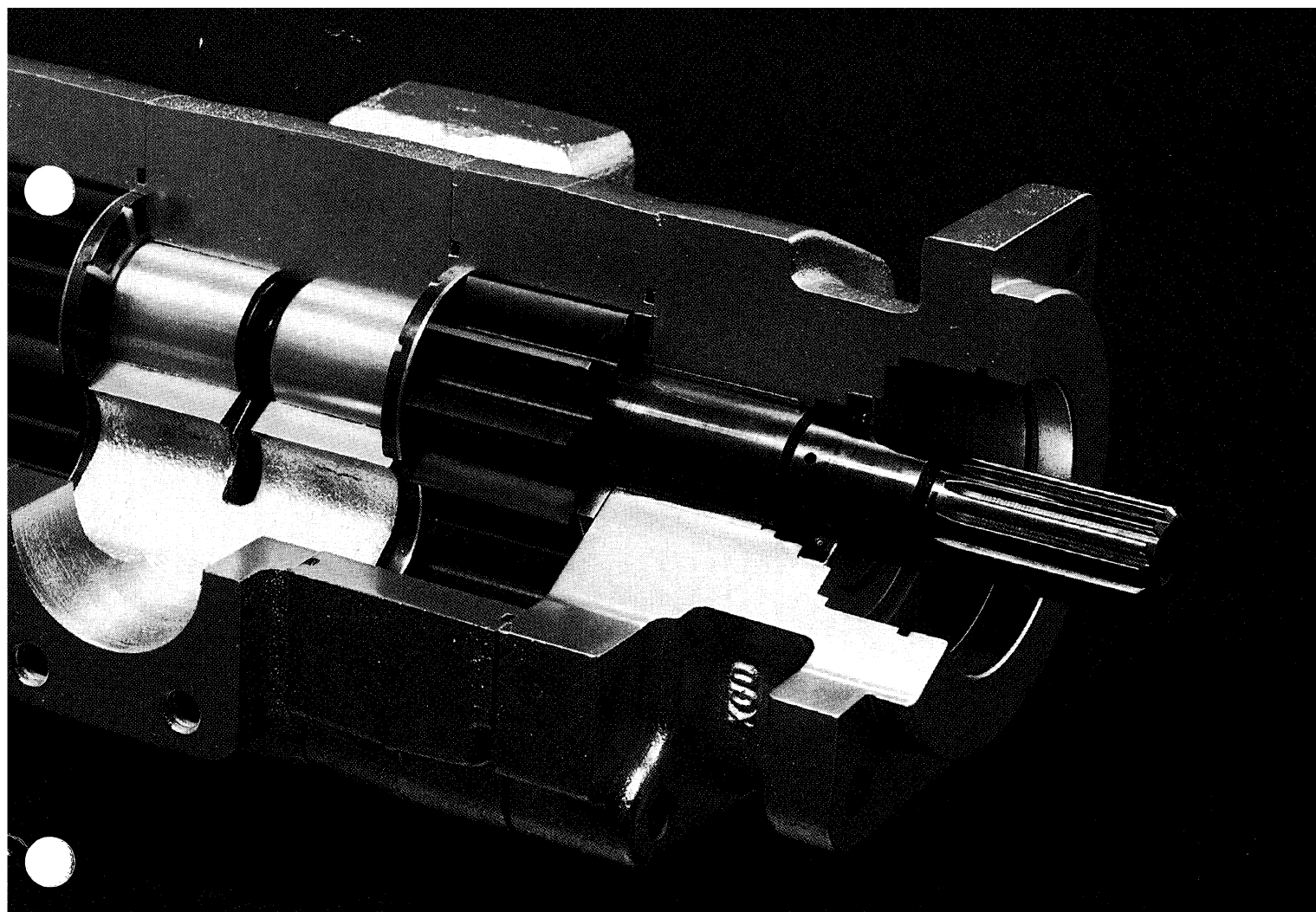
Item	Spare Parts
1	Dust seal ring
2	Housing, spool and sleeve Check valve and the seats for relief and dual shock valves are locktited
3	Ball $\varnothing 8,5$ mm
4	Thread bushing
5	O-ring used with kin-ring (item 6)
6	Kin-ring
7	Bearing assembly
8	Ring
9	Cross pin
10	Spacer
11	Cardan shaft
12	Set of springs
13	O-ring
14	Distributor plate
15	Gearwheel set
16	O-ring
17	End cover
18	Washer
20	Special screw
21	Screw
22	Name plate
23	Drive screw
24	Complete relief valve
25	Spring wire $\varnothing 1,7 \times 36,6$ long
26	Complete dual shock valve
27	Ball $\varnothing 3/16$ in
28	Spring
29	Rolled pin

OSPC



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**Commercial
Intertech**

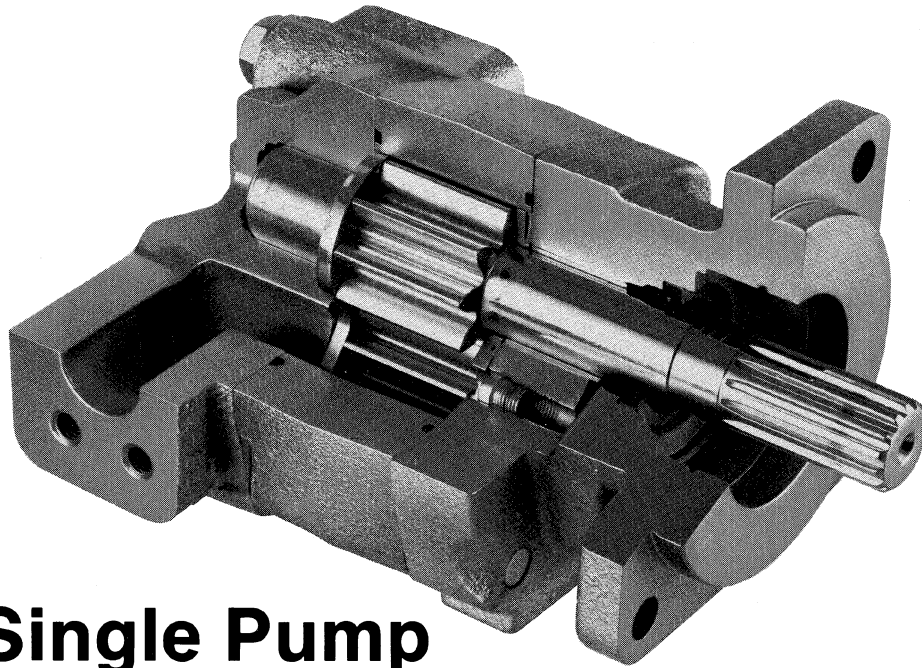
Service Manual

315/330/350/365

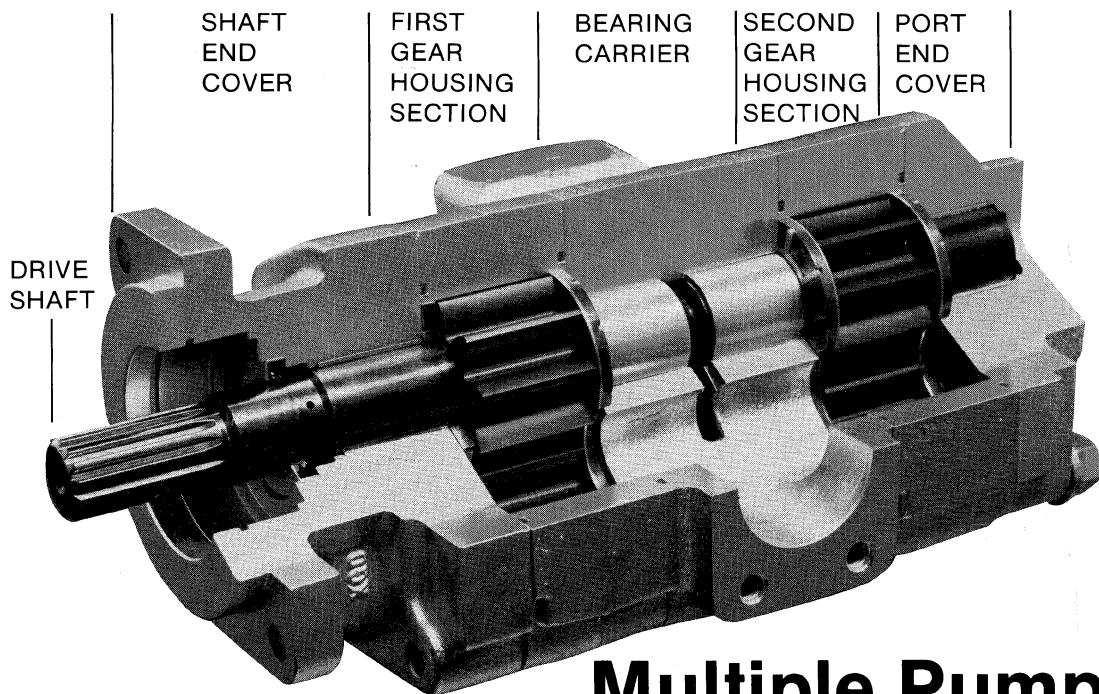
- Single & Tandem Oil Hydraulic Pumps & Motors
- General Instructions & Tool List
- Disassembly & Assembly Instructions
- Lubrication & Oil Recommendations
- Recommended Test Procedure

P

PUMPS



Single Pump



Multiple Pump

**Use Genuine Commercial
Replacement Parts**

315 / 330 350 / 365 Service Manual HS-19

GENERAL INSTRUCTIONS

These service instructions will familiarize you with Commercial's single and multiple pumps — their component parts — the relative position of each part — proper methods for assembly or disassembly of the units — care and use 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 365. 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.

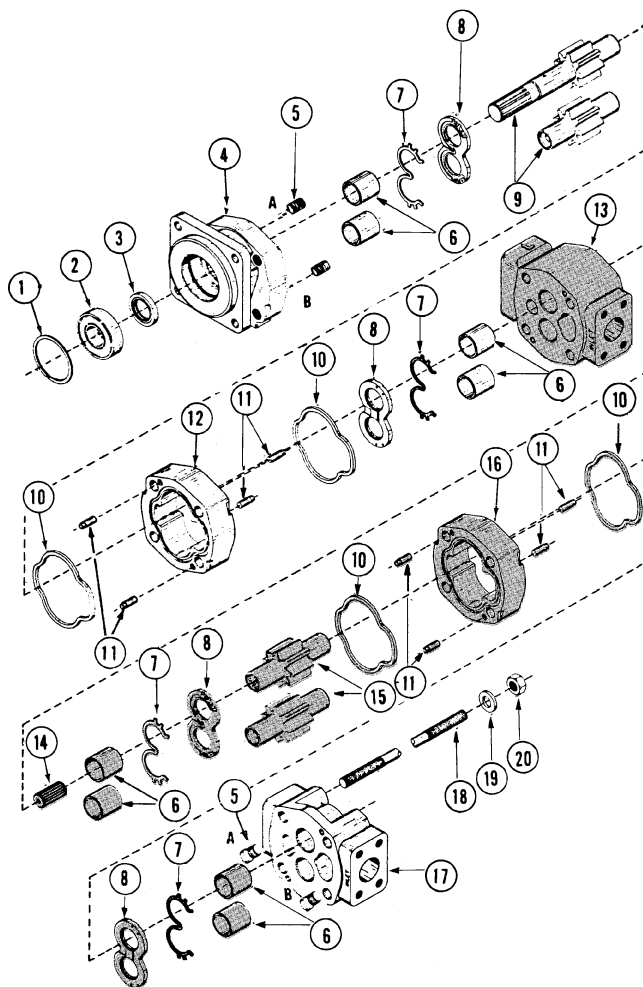
USE CAUTION IN GRIPPING ALL PARTS IN THE VISE TO AVOID DAMAGING MACHINED SURFACES.

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 and notes at right 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.**

Check all replacement parts before installing them to be certain they were not damaged in shipment.



NOTE:

For P315 and P330 ONLY - Plug 5 required in position A and position B.

For P350 and P365 ONLY - Plug 5 in position B gives clockwise rotation. Plug 5 in position A gives counterclockwise rotation.

PARTS LIST

- | | |
|--------------------------------------|---|
| 1. Snap Ring | 11. Dowel Pins (Solid for P315, P330 and P350. Hollow for P365 - ONLY.) |
| 2. Outboard Bearing | 12. Gear Housing |
| 3. Seal | 13. Bearing Carrier |
| 4. Shaft End Cover | 14. Connecting Shaft |
| 5. Plug | 15. Matched Gear Set |
| 6. Bushings | 16. Gear Housing |
| 7. Channel Seal | 17. Port End Cover |
| 8. Thrust Plates | 18. Studs or Cap Screws |
| 9. Integral Drive Shaft and Gear Set | 19. Washers |
| 10. Gasket Seal | 20. Nuts |

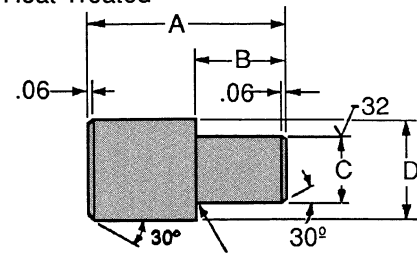
Items shaded apply to multiple assemblies only.

Tool List

- Arbor press
- Awl
- 1 1/2" Dia. steel ball
- Bearing puller (Owatonna Tool Co. MD - 956 or equivalent)
- Bushing remover tool (See sketch)
- Clean lintless cloths
- Deburring tool (an old file with 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
- Seal removal tool (see sketch)
- Oil and grease
- Snap ring pliers
- Prick punch
- Bushing installation tool (see sketch)
- Scale (1/32" or 1/64" graduations)
- Small screw driver
- Torque wrench
- Vise with 6" minimum opening.
- Bar for lip seal installation
 - Note: For 315 use 1 5/8" dia. x 2" bar.
 - For 330 use 1 3/4" dia. x 2" bar.
 - For 350 use 2 1/2" dia. x 2" bar.
 - For 365 use 2 1/2" dia. x 2" bar.
- Special steel sleeve (see sketch)

Bushing Installation Tool

A.I.S.I. 8620 Bearing Quality Steel
Heat Treated



Grind Relief Allowable

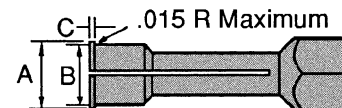
	A	B	C Dia.	D. Dia.
P315	2.312	1.15	.937 +.000 -.002	1.250
P330	3.00	1.47	1.054 +.000 -.002	1.250
P350	3.00	1.47	1.282 +.000 -.002	1.625
P365	3.00	1.73	1.492 +.000 -.002	1.750

Seal Removal Tool

Easily made from old screw driver. Heat tip and bend as shown. Grind tip to fit notch behind the shaft seal.

Bushing Puller: The bushings in P315, P330, P350 and P365 pumps may be removed from their bores using blind hole collet-type bushing pullers similar to those manufactured by Owatonna Tool Co. The table below illustrates the modifications necessary to adapt the OTC collets to this task. Equivalent pullers from other suppliers may be modified in similar fashion.

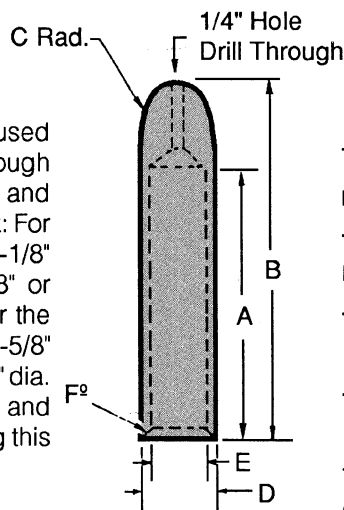
Typical Collet



Pump/Motor	A	B	C	Make From OTC Collet No.
315	.900 .890	.800 .790	.100 .090	33863
330	.980 .970	.875 Ref.	.100 .090	33863
350	1.122 1.122	1.000 0.990	.072 .052	33864
365	1.382 1.372	1.260 1.250	.100 .120	33865

Special Steel Sleeve

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 P315 use a 1" dia. x 3-1/8" bar; for the P330 use a 1-1/8" or 1-1/4" dia. x 4- 5/8" bar; for the P350 use a 1-3/8" dia. x 4-5/8" bar; for the P365 use a 1-1/2" dia. x 4-5/8" bar. The drawing and chart give details for making this special tool.



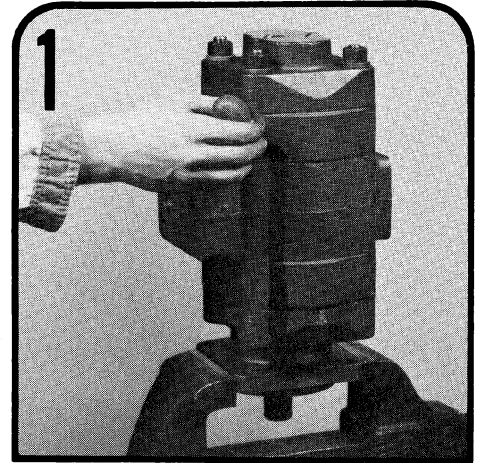
	A	B	C Rad	D Dia.	E. Dia.	F² chamfer
P315	1-7/8"	3"	9/16"	.944 +.000 -.002	.885 +.002 -.000	.050" x 60°
P330	3-3/8"	4-1/2"	9/16"	1.065 +.000 -.002	1.002 +.002 -.000	.015" x 45°
P350	3-3/8"	4-1/2"	9/16"	1.290 +.000 -.002	1.250 +.002 -.000	.015" x 60°
P365	3-3/8"	4-1/2"	9/16"	1.377 +.000 -.002	1.250 +.002 -.000	.015" x 60°

All external surfaces must be free of scratches and burrs.

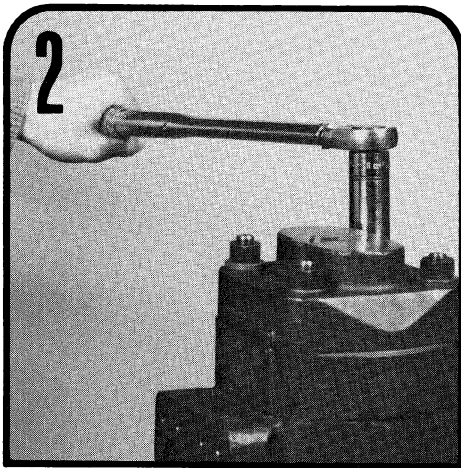
CAUTION:

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 difficult to fit during assembly, tap gently with a soft hammer (never use 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. Avoid touching gear journals.
4. Never hammer bushings into bores, use an arbor press.

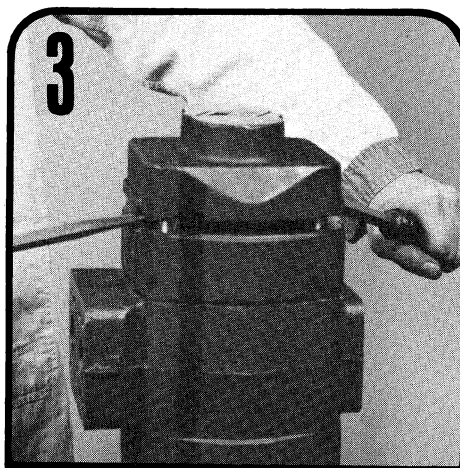
start disassembly here



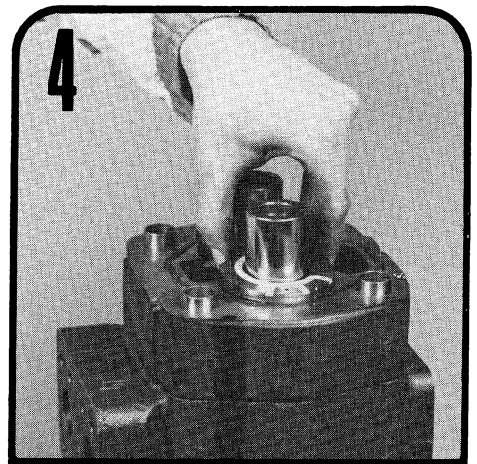
Place the pump in a vise with the drive shaft pointing down. Caution: DO NOT GRIP ON OR NEAR ANY MACHINED SURFACES DURING ASSEMBLY OR DISASSEMBLY. Match-mark all sections. Be sure to align these marks when reassembling.



Use a socket wrench to remove the 4 cap screws on single units or the 4 hex nuts, studs and washers of multiple units.



Lift off the port end cover. If prying is necessary, be careful not to damage the machined surfaces. Dowel pins will remain in either port end cover or gear housing. **Do not remove.**

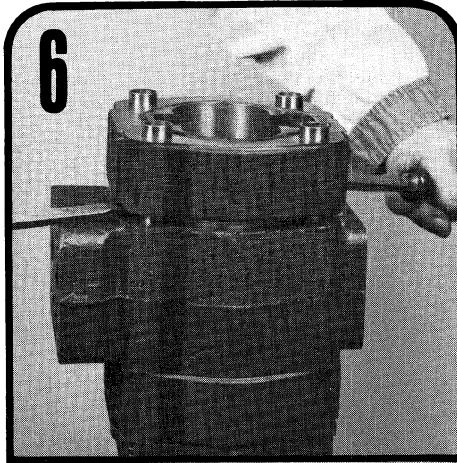


Remove the thrust plate. Examine and replace if necessary. See wear guide page 12.



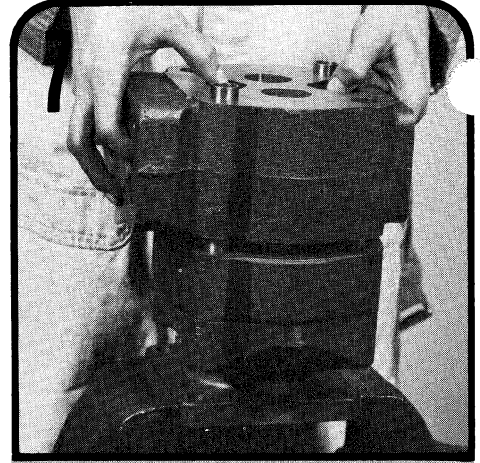
Carefully remove the drive and driven gears. Avoid tapping the gear teeth together or against other hardened surfaces. Keep these gears together because they are a matched set. Examine and replace if necessary. (See page 12). Remove the thrust plate from the bearing carrier. Examine and replace if necessary. *See below.

FOR MULTIPLE ASSEMBLIES ONLY.



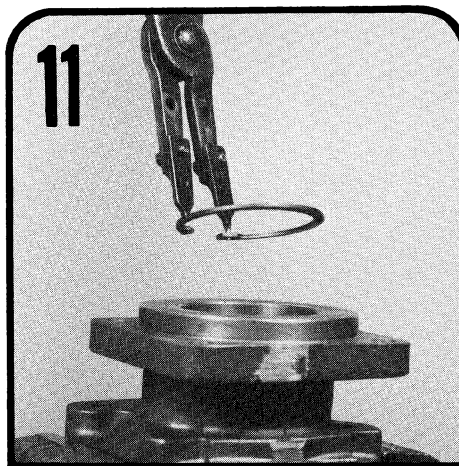
Lift the gear housing from the bearing carrier. If prying is necessary, take care not to damage machined surfaces. Examine and replace if necessary (see page 12).

FOR MULTIPLE ASSEMBLIES ONLY.

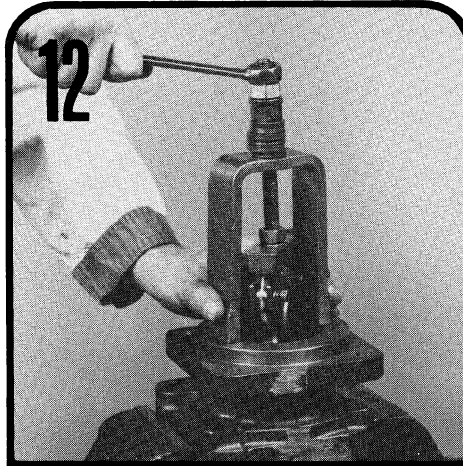


Carefully lift or pry off the bearing carrier to prevent damage to contact face and edges. Dowel pins will remain in either the bearing carrier or the gear housing. **DO NOT REMOVE THEM.**

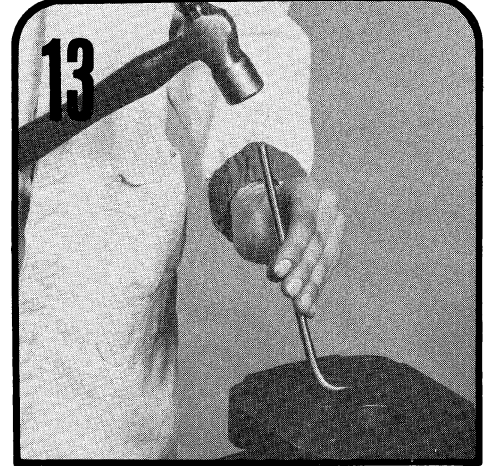
FOR MULTIPLE ASSEMBLIES ONLY.



If the pump is equipped with an out-board bearing, place the shaft end cover in the vise with the mounting face up. Remove the snap ring with snap ring pliers. If unit is equipped with a spiral lock retaining ring, remove with a small screwdriver or awl.

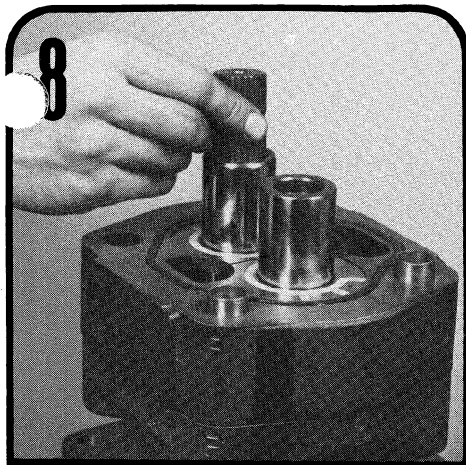


Use a bearing puller to remove the out-board bearing.

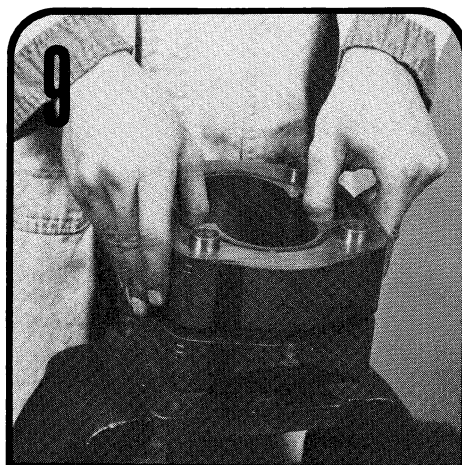


Grip the shaft end cover in a vise with the mounting face down. Remove double lip seal by inserting the special seal removal tool (see Tool List) into the notch between the double lip seal and the shaft end cover. Tap the seal out and discard.

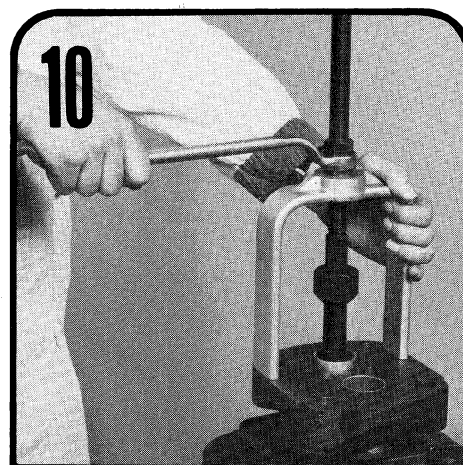
Remove and discard all rubber and polymer seals.



Remove the connecting shaft. Remove the thrust plate. Examine and replace if necessary. (See page 12). 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 page 12. Be careful not to damage the machined surfaces of the gears.

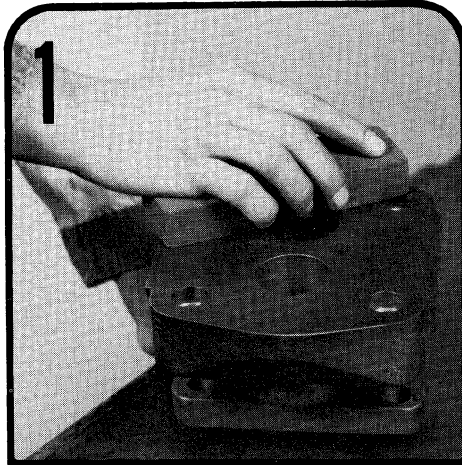


Lift or pry off the first section gear housing. Be careful not to damage machined surfaces. Examine and replace if necessary (see page 12).

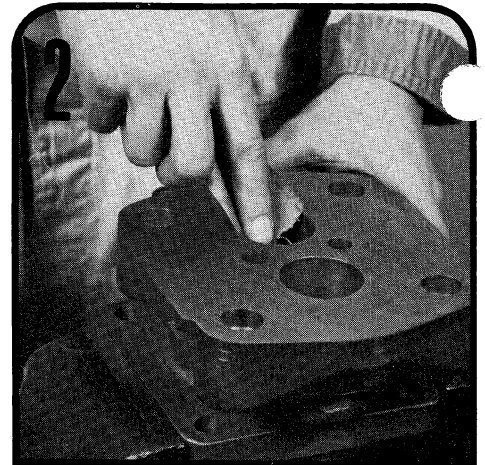


Inspect all bushings for scoring or discoloration and replace if necessary. Use a bushing puller as shown in the tool list to remove bushings (see page 12).

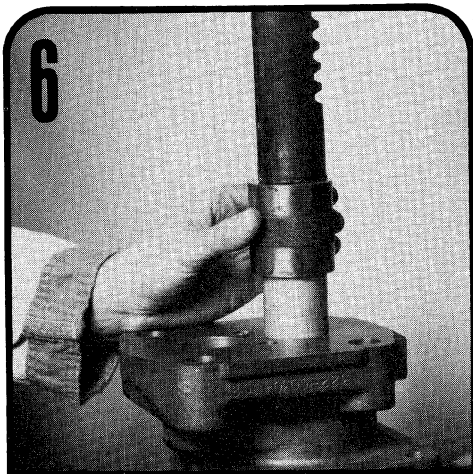
start assembly here



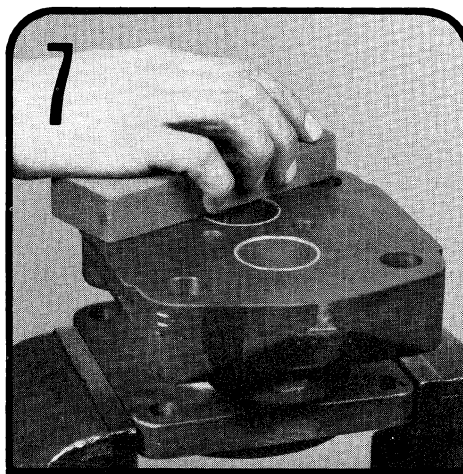
Stone all machined surfaces with a medium grit carborundum stone.



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



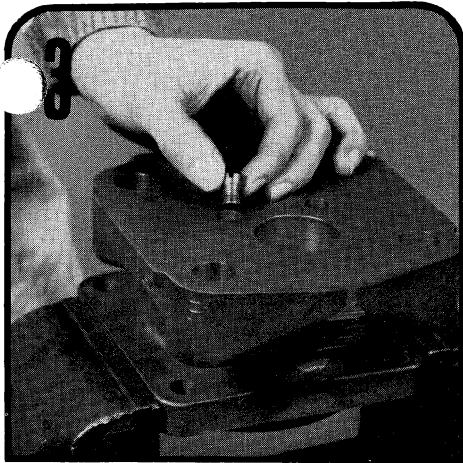
Bushings should be pressed into the bores, one at a time using the special installation tool and an arbor press. Be sure the grooves (or seams) are positioned as stated in Step #5. Bushings must be pressed into the bores flush with the casting face. Be sure to support the castings so they are square and level.



Repeat Steps 1 and 2, stone and rinse parts.

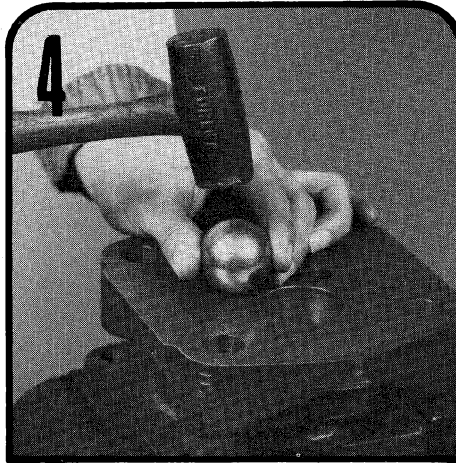


See that dowel pins are in place in any new castings. Examine all dowels. (See page 12). Before inserting make certain the hole is clean and free from burrs. Gently start pin straight into hole and tap lightly with a soft hammer.



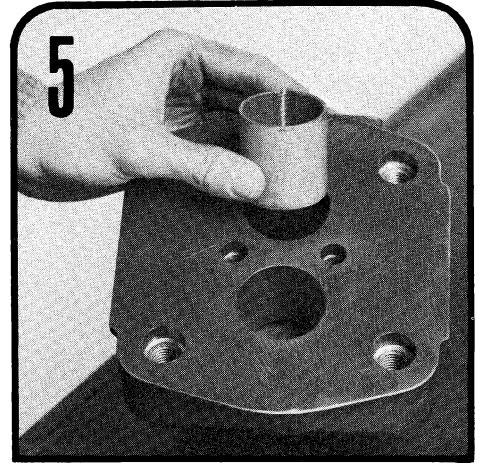
Grip shaft end cover in vise with mounting face down. Examine plug or plugs* to be sure they're tightly in place. Replacement is necessary only if parts are damaged. Remove with screwdriver.

*P315 and P330 have two plugs in both the shaft end and port end covers. P350 and P365 have one plug on the outlet side of their shaft end and port end covers.



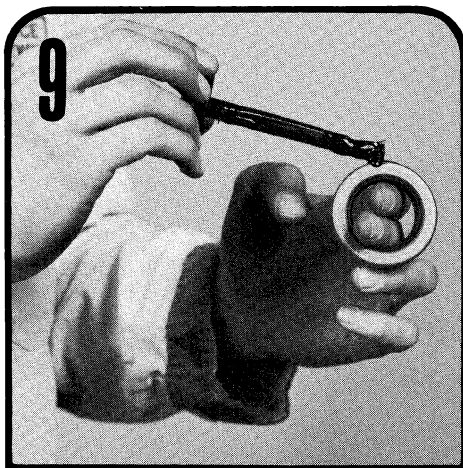
New plugs should be screwed in tightly. Stake plug with prick punch at both ends of screwdriver slot and around edges. Peen edge of hole $\frac{1}{32}$ " to $\frac{1}{16}$ " with $\frac{1}{2}$ " diameter steel ball.

NOTE: If new plug or plugs are being installed coat threads with Loctite thread sealant.



ASSEMBLY STEPS 5, 6, 7 AND 8 APPLY TO SHAFT END COVER, BEARING CARRIERS AND PORT END COVER.

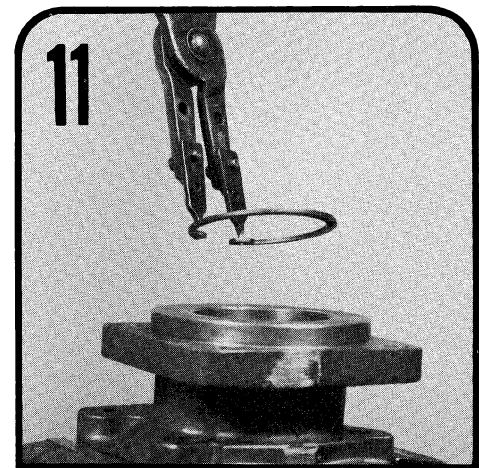
Any bushings removed from the shaft end cover, port end cover or bearing carrier should be assembled in drive bores with groove to the top of unit (12 o'clock). Assemble bushings in driven bores with the groove to bottom of unit (6 o'clock). The P315 does not have grooved bushings, therefore the bushing seams should be placed at the 12 and 6 o'clock positions.



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). Be careful not to damage the lip of the seal. Press in until flush with the recess. Wipe off excess sealant.



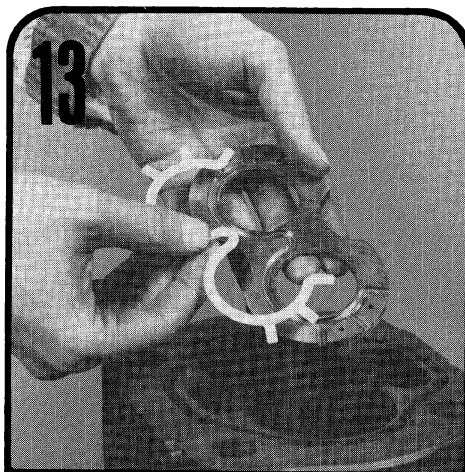
If the unit is equipped with an outboard bearing, guide the bearing into its recess in the shaft end cover. This is a light press fit. It may be necessary to lightly tap the bearing into the bore.



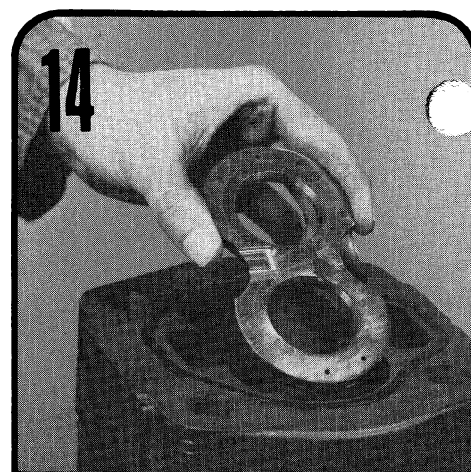
If the pump is equipped with an outboard bearing, place the shaft end cover in the vise with the mounting face up. Install the snap ring in the groove to retain the outboard bearing.



Grease the new gasket seals and insert them into the grooves in both sides of all gear housings. Position the first gear housing over the shaft end cover and dowels. Tap it with a soft hammer until it rests tightly against the shaft end cover. Be careful not to pinch the gasket seal. Also be sure the large rounded core is on the inlet side.



Assemble the channel seals into the grooves in the thrust plates with the flat side of the seal facing away from the thrust plate as shown below.



Gently slip the thrust plate through the gear housing and into place on the shaft end cover. The channel seal from Step #13 should face the shaft end cover. The relief groove in the plate should face the outlet side of the pump.



Insert the connecting shaft in the spline of the drive gear. Position and place the second gear housing on the bearing carrier as outlined in Step #12.

FOR MULTIPLE ASSEMBLIES ONLY.



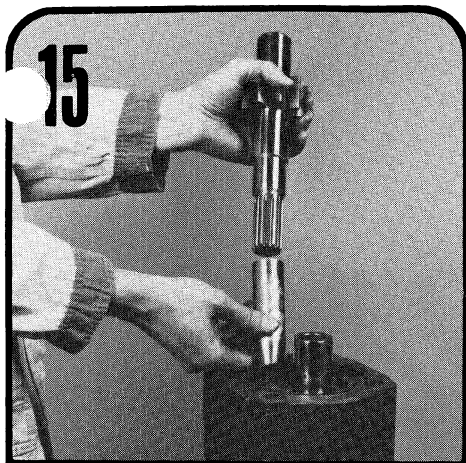
Place the thrust plate in the gear housing per Step #14. Insert the drive and driven gears of the second section in their respective bearings. Make certain gears are in contact with thrust plate face. Place the port end cover plate in the housing per Step #16.

FOR MULTIPLE ASSEMBLIES ONLY.

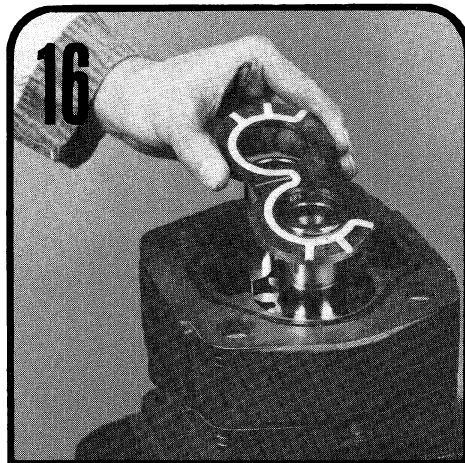


Check the plug or plugs in the port end cover to be sure they are tight. Follow procedure outlined in Step #4 for new plugs.

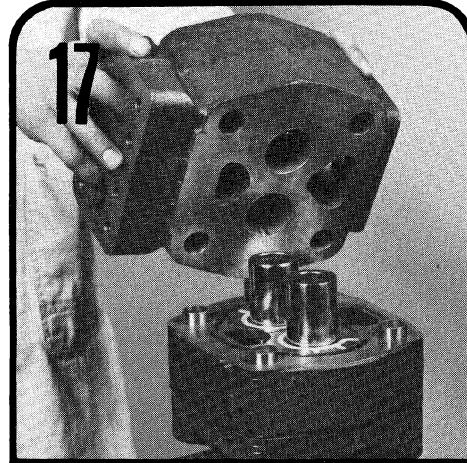
FOR MULTIPLE ASSEMBLIES ONLY.



Slide the driven gear through the housing and into the bushing in the shaft end cover. Coat the steel sleeve tool with grease. Place the lightly greased drive shaft inside the sleeve and slide both through the shaft end cover with a twisting motion until the integral gear rests against the thrust plate. Avoid damaging the double lip seal. Remove the steel sleeve. Squirt clean oil over the gears.



Slip thrust plate with seal over gear journals and into housing bore. The flat side of the seal should face up with the relief groove facing the outlet side. For single pump assemblies go directly to Step #21 as your next step.



Position the bearing carrier over the gear housing so that the bushings receive the journals of the drive and driven gears. Be sure to line up the dowel holes over the dowel pins. When the parts are parallel, squeeze them together or alternately tap over each dowel until the parts are together.

FOR MULTIPLE ASSEMBLIES ONLY.

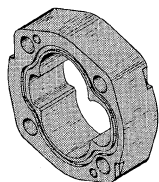


Place the port end cover over the gear journals. Align the dowels with the holes in the mating casting. Being careful not to pinch the gasket seal, tap the port end cover lightly in the center between bearing bores to engage the dowels and to move parts together in final seating.



Thread the fasteners into the shaft end cover and tighten alternately or cross corner. Rotate the drive shaft with a 6" wrench to check for binding. If there is no internal binding, torque diagonally opposed fasteners to 200 ft. lbs. (2400 in. lbs.); 141 ft. lbs. (1700 in. lbs.) for P/M315 models; 450 ft. lbs. (5400 in. lbs.) for M365.

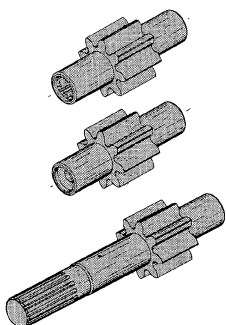
***As a guide in answering the question, "How much wear is allowed before the part should be replaced?", We offer the following suggestions...**



GEAR HOUSINGS:

Wear in excess of .007" cut-out necessitates replacement of the gear housing. Place a straight-edge across bore. If you can slip a .007" 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 bushings 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, .007" or less, gear housing is in good condition and may be reused.



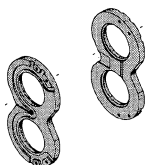
GEARS:

Any scoring on gear hubs 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 area or at the drive coupling. .002" wear is the maximum allowable.

Wear in the shaft seal area indicates 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.

A maximum of .002" 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.



DOWEL PINS:

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

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



BUSHINGS:

If gears are replaced, bushings must be replaced. Bushings should fit into bore with a heavy press fit.



SEALS AND GASKETS:

Replace all rubber and polymer seals, including all "O" rings, thrust plate channel seals, shaft seal and gasket seals.



PLUGS:

Examine the plugs in the shaft end and port end cover to make sure they are in the proper position and tight. The P315 and P330 should have two plugs in both the shaft end and port end in tandem units only. The P350 and P365 have one plug in their shaft and port ends high pressure side only.

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.

Filtration: 10 micron recommended for maximum pump life.

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 20°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 Fluids:

- 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: 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 FLUID RECOMMENDATIONS FROM YOUR FLUID SUPPLIER.

recommended start-up procedure for new or rebuilt pump

Before installing a new or rebuilt pump, 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, fill all ports with clean oil to provide initial lubrication. This is particularly important if the unit is located above the oil reservoir.

After connecting the lines and mounting the replacement unit, operate the pump at least two minutes at no load and at low rpm (400 min.) 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.**

recommended test procedure

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.

Feeding hot oil into a cold pump may cause the pump to seize. Jog the pump by momentarily starting the driving engine or motor to gradually equalize pump and oil temperatures.

Run the pump at least two minutes at no load and moderate speed (not over 1500 rpm). If the pump becomes excessively hot, shut down immediately and locate the problem source.

Gradually increase pressure on pump, in 500 psi increments 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 reuse, 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 reused parts.

GPM DELIVERY at 1800 rpm	GPM DROP OFF AT...		
	1000 psi/70 bar	2000 psi/140 bar	3000 psi/210 bar
10-30	1 ¹ / ₂ -3	2-3 ¹ / ₂	2 ¹ / ₂ -4
30-50	2-3	2 ¹ / ₂ -4	3-4 ¹ / ₂
50-70	2 ¹ / ₂ -3 ¹ / ₂	3-5	3 ¹ / ₂ -5 ¹ / ₂

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.

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.

Pump Division

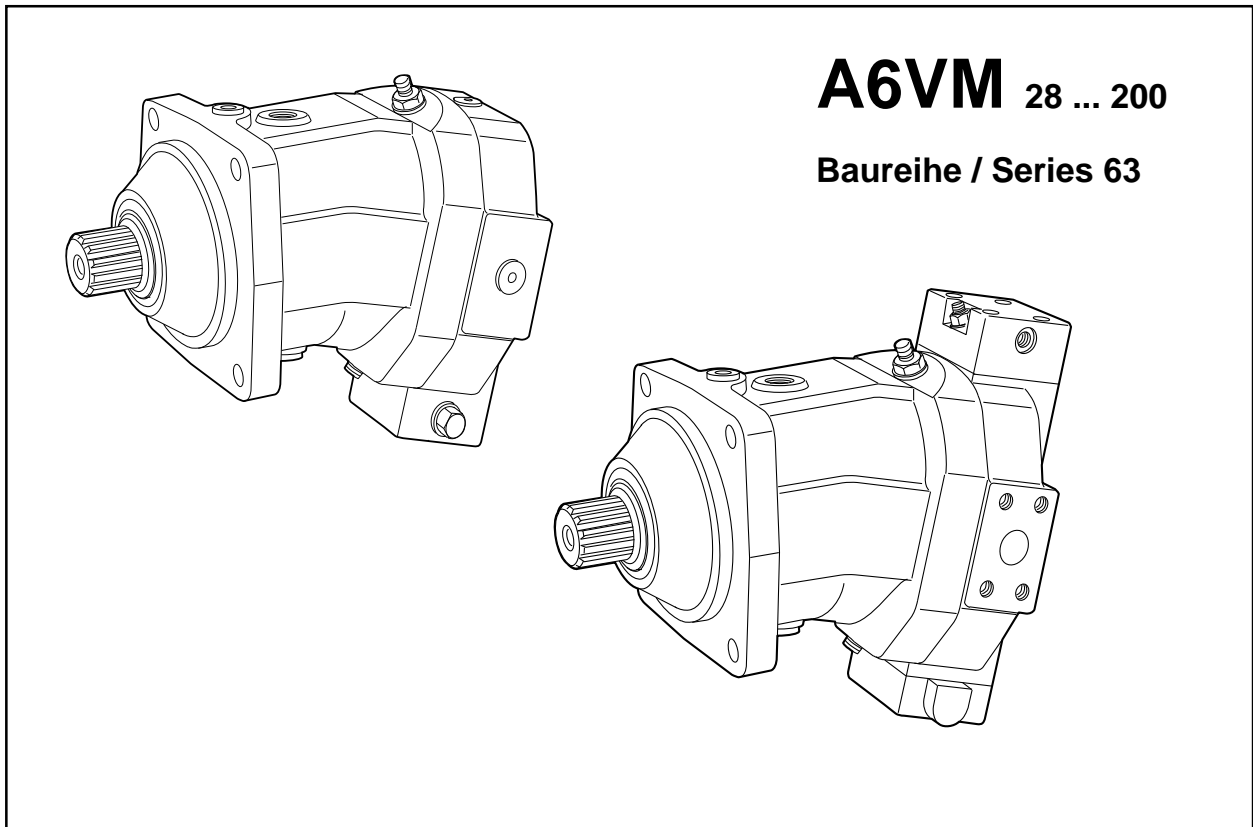


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FAX (330) 746-1148

Commercial Intertech Corp. is an international manufacturer of hydraulic systems and their component pumps, motors, valves, and cylinders.

R

Reparaturanleitung
Repair Instructions



A6VM 28 ... 200

Baureihe / Series 63

Typschlüssel **A6V M / 6 3 W****Axialkolbenmaschine**

Schrägscheibenbauart, verstellbar

A6V**Betriebsart**

Motor

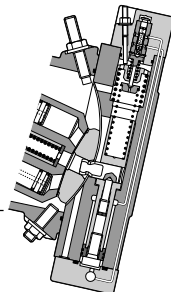
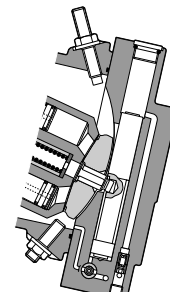
M**Nenngröße** \equiv Schluckvolumen $V_{g \max}$ in cm^3

NG 250 - 1000 siehe RD 91603

Regel- und Versteleinrichtung

28 55 80 107 140 160 200

Hydraulische Verstellung, steuerdruckabhängig	HD	1			●	●	●	●	●	●	●	HD1
	HD	2			●	●	●	●	●	●	●	HD2
	HD	1	D		●	●	●	●	●	●	●	HD1D
	HD	2	D		●	●	●	●	●	●	●	HD2D
Steuerdruckanstieg $\Delta p = 10$ bar				mit Druckregelung								
Steuerdruckanstieg $\Delta p = 25$ bar												
Hydraulische Zweipunktverstellung	HZ1				●	-	-	-	●	●	●	HZ1
	HZ3				-	●	●	●	-	-	-	HZ2
Elektrische Verstellung mit Proportionalmagnet	EP	1			●	●	●	●	●	●	●	EP1
	EP	2			●	●	●	●	●	●	●	EP2
	EP	1	D		●	●	●	●	●	●	●	EP1D
	EP	2	D		●	●	●	●	●	●	●	EP2D
Steuerspannung 12 V				mit Druckregelung								
Steuerspannung 24 V												
Elektr. Zweipunktverstellung mit Schaltmagnet	EZ	1			●	-	-	-	●	●	●	EZ1
	EZ	2			●	-	-	-	●	●	●	EZ2
	EZ	3			-	●	●	●	-	-	-	EP3
	EZ	4			-	●	●	●	-	-	-	EP4
Steuerspannung 12 V												
Steuerspannung 24 V												
Automatische Verstellung, hochdruckabhängig	HA	1			●	○	○	○	●	●	●	HA1
	HA	2			●	●	●	●	●	●	●	HA2
	HA	3			-	●	●	●	-	-	-	HA3
Ausführung ohne Druckanstieg												
Ausführung mit Druckanstieg $\Delta p = 100$ bar												
				Übersteuerung								
				HA1 HA2 HA3								
				ohne Übersteuerung (kein Zeichen)								T
				mit hydraulischer Übersteuerung								U1
				mit elektrischer Übersteuerung, 12 V								U2
				mit elektrischer Übersteuerung, 24 V								R1
				mit el. Überst. + el. Fahrtrichtungsventil, 12 V								R2
				mit el. Überst. + el. Fahrtrichtungsventil, 24 V								
Hydraulische Verstellung, drehzahlabhängig												
$p_{ST}/p_{HD} = 5/100$, hydraulisches Fahrtrichtungsventil				●	●	●	●	●	●	●	●	DA1
el. Fahrtrichtungsventil (12 V) + el. Q_{\max} Schaltung (12 V)				●	●	●	●	●	●	●	●	DA2
el. Fahrtrichtungsventil (24 V) + el. Q_{\max} Schaltung (24 V)				●	●	●	●	●	●	●	●	DA3
$p_{ST}/p_{HD} = 8/100$, hydraulisches Fahrtrichtungsventil				●	●	●	●	●	●	●	●	DA4
el. Fahrtrichtungsventil (12 V) + el. Q_{\max} Schaltung (12 V)				●	●	●	●	●	●	●	●	DA5
el. Fahrtrichtungsventil (24 V) + el. Q_{\max} Schaltung (24 V)				●	●	●	●	●	●	●	●	DA6

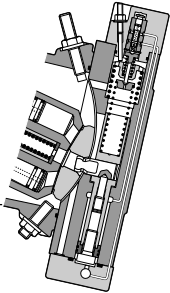
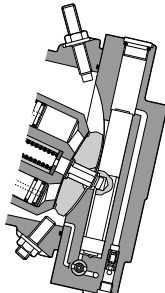
Gleichgang-
kolbenDifferential-
kolben

Typschlüssel

Reparaturanleitung A6VM

Type code

Repair Instructions A6VM

Type code		A6V M / 6 3 W																																																																																																																																																																																																																																																																																																																																																																	
Axial piston unit		Bent axis design, variable displacement A6V																																																																																																																																																																																																																																																																																																																																																																	
Mode of operation		Motor M																																																																																																																																																																																																																																																																																																																																																																	
Size		\equiv Displacement $V_{g \max}$ in cm^3 <table border="1"> <tr> <td>28</td> <td>55</td> <td>80</td> <td>107</td> <td>140</td> <td>160</td> <td>200</td> </tr> </table>										28	55	80	107	140	160	200																																																																																																																																																																																																																																																																																																																																																	
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Q_{max} switch (12 V)		●	●	●	●	●	●	●	DA2	el. valve for travel direction (24 V) + el. Q_{max} switch (24 V)		●	●	●	●	●	●	●	DA3	$p_{ST}/p_{HD} = 8/100$, hydraulic valve for travel direction		●	●	●	●	●	●	●	DA4	el. valve for travel direction (12 V) + el. Q_{max} switch (12 V)		●	●	●	●	●	●	●	DA5	el. valve for travel direction (24 V) + el. Q_{max} switch (24 V)		●	●	●	●	●	●	●	DA6
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<table border="1"> <thead> <tr> <th colspan="2">Override</th> <th>HA1</th> <th>HA2</th> <th>HA3</th> <th></th> </tr> </thead> <tbody> <tr> <td colspan="2">without override (no code)</td> <td>●</td> <td>●</td> <td>●</td> <td>T</td> </tr> <tr> <td colspan="2">hydraulic override</td> <td>●</td> <td>●</td> <td>●</td> <td></td> </tr> <tr> <td colspan="2">electrical override, 12 V</td> <td>●</td> <td>●</td> <td>●</td> <td>U1</td> </tr> <tr> <td colspan="2">electrical override, 24 V</td> <td>●</td> <td>●</td> <td>●</td> <td>U2</td> </tr> <tr> <td colspan="2">el. override + el. valve for travel direction, 12 V</td> <td>○</td> <td>○</td> <td>-</td> <td>R1</td> </tr> <tr> <td colspan="2">el. override + el. valve for travel direction, 24 V</td> <td>○</td> <td>○</td> <td>-</td> <td>R2</td> </tr> </tbody> </table>											Override		HA1	HA2	HA3		without override (no code)		●	●	●	T	hydraulic override		●	●	●		electrical override, 12 V		●	●	●	U1	electrical override, 24 V		●	●	●	U2	el. override + el. valve for travel direction, 12 V		○	○	-	R1	el. override + el. valve for travel direction, 24 V		○	○	-	R2																																																																																																																																																																																																																																																																																																															
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HINWEIS

Bezeichnungen, Beschreibungen und Darstellungen entsprechen dem Informationsstand zum Zeitpunkt der Drucklegung dieser Unterlage.

Änderungen können den Service am Produkt beeinflussen, Verpflichtungen entstehen uns daraus nicht.

Methoden und Vorrichtungen sind Empfehlungen, für deren Resultat wir keine Haftung übernehmen können.

BRUENINGHAUS HYDROMATIK- Baugruppen, mit Angabe der Fabrik-Nr. bestellt, sind die Basis guter Reparaturen.

Einstell- und Prüfarbeiten sind bei Betriebstemperatur auf dem Teststand vorzunehmen.

Schutz von Personen und Eigentum ist durch Vorkehrungen sicherzustellen.

Sachkenntnis, die Voraussetzung für jede Servicearbeit, vermitteln wir in unseren Schulungskursen.

NOTICE

Specifications, descriptions and illustrative material shown herein were as accurate as known at the time this publication was approved for printing.

BRUENINGHAUS HYDROMATIK reserves the right to discontinue models or options at any time or to change specifications, materials, or design without notice and without incurring obligation.

Optional equipment and accessories may add cost to the basic unit, and some options are available only in combination with certain models or other options.

For the available combinations refer to the relevant data sheet for the basic unit and the desired option.

Adjustment and tests have to be carried out on the test bench under operating temperatures.

Protection of personnel and property has to be guaranteed by appropriate measures.

Expert knowledge, the precondition of any service work, can be obtained in our training courses.

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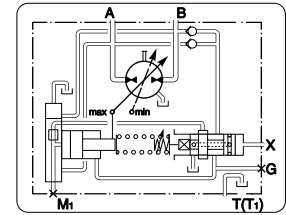
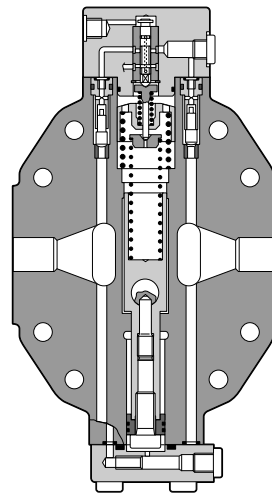
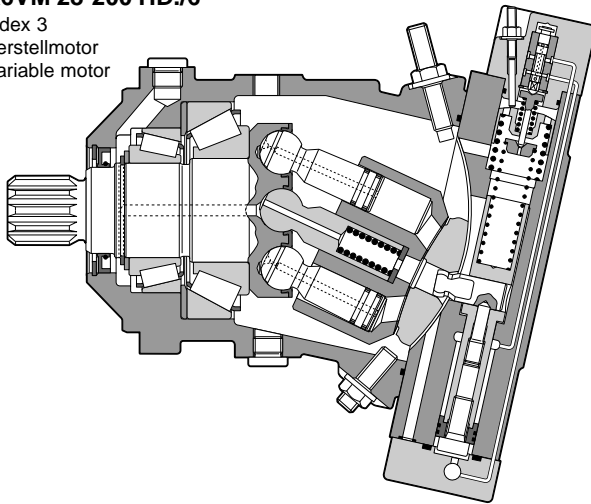
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Replace seal nut
Sealing of the cover plate
Sealing of the control parts
Sealing of the hydraulic parts
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Remove of the positioning piston
Remove rotary group
Exchanging of the rotary group
Inspection notes
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Rotary group adjustment
Assembly of the port plate
Tightening torques
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Schnittbild
Sectional drawing

Reparaturanleitung A6VM
Repair Instructions A6VM

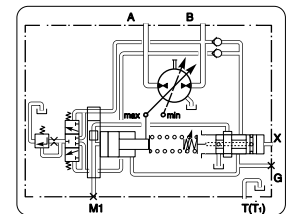
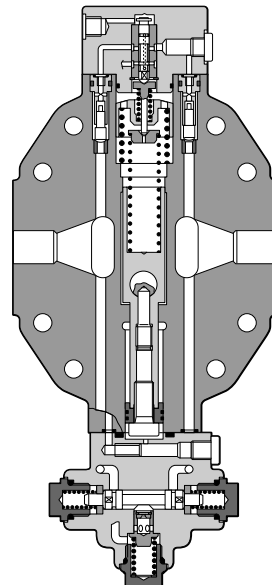
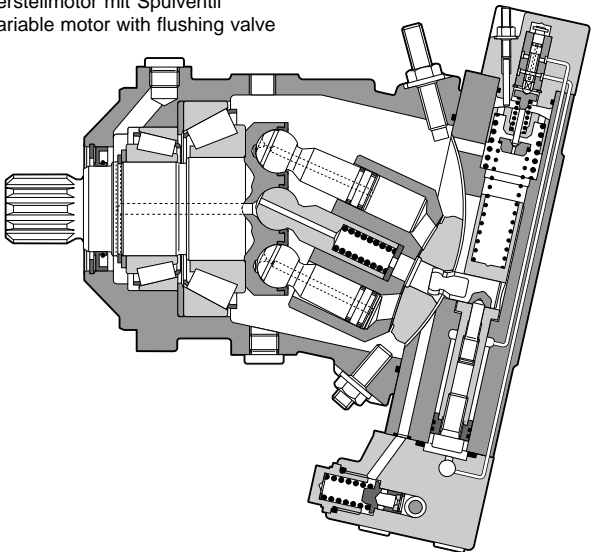
A6VM 28-200 HD./6

Index 3
Verstellmotor
Variable motor



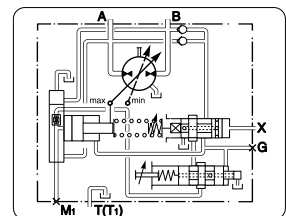
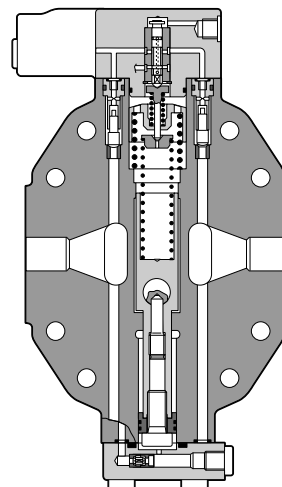
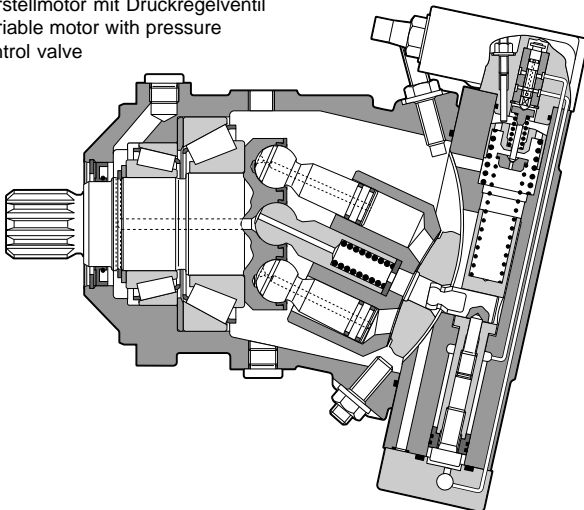
A6VM 28-200 HD./6

Index 3
Verstellmotor mit Spülventil
Variable motor with flushing valve



A6VM 28-200 HD1D/6

Index 3
Verstellmotor mit Druckregelventil
Variable motor with pressure control valve

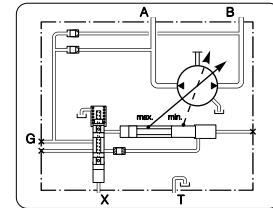
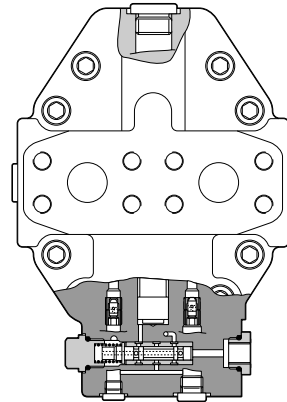
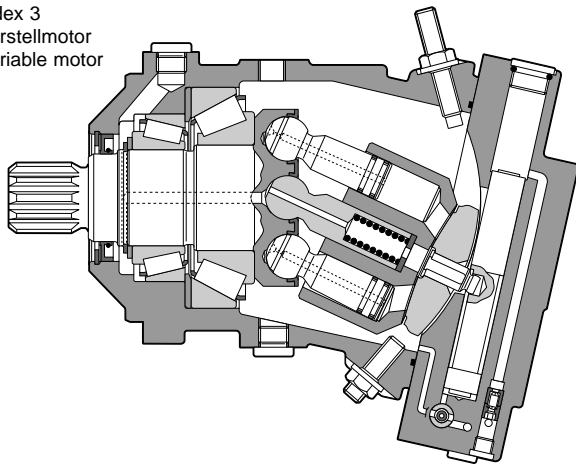


Schnittbild
Sectional drawing

Reparaturanleitung A6VM
Repair Instructions A6VM

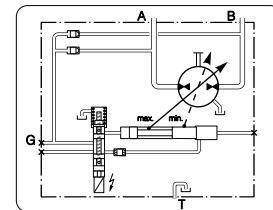
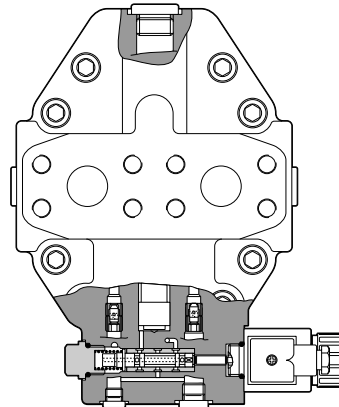
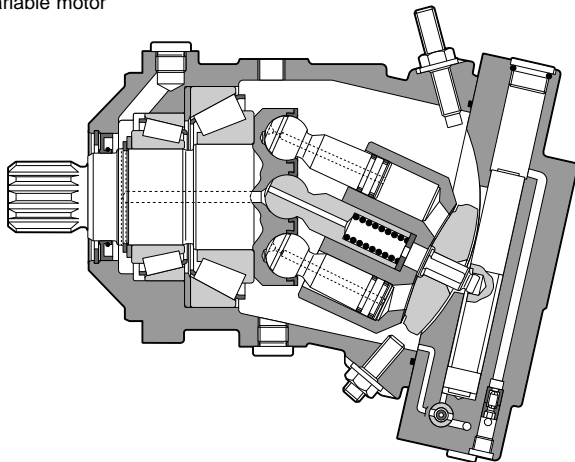
A6VM 55-107 HZ3/6

Index 3
Verstellmotor
Variable motor



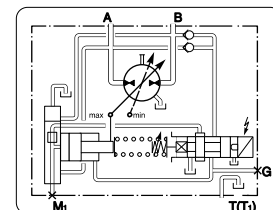
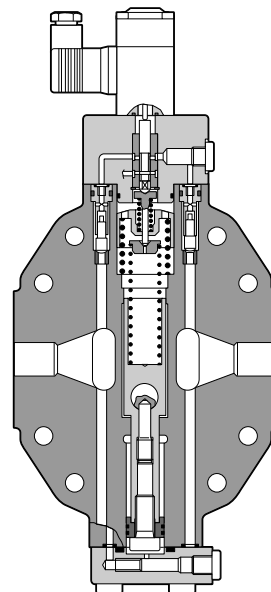
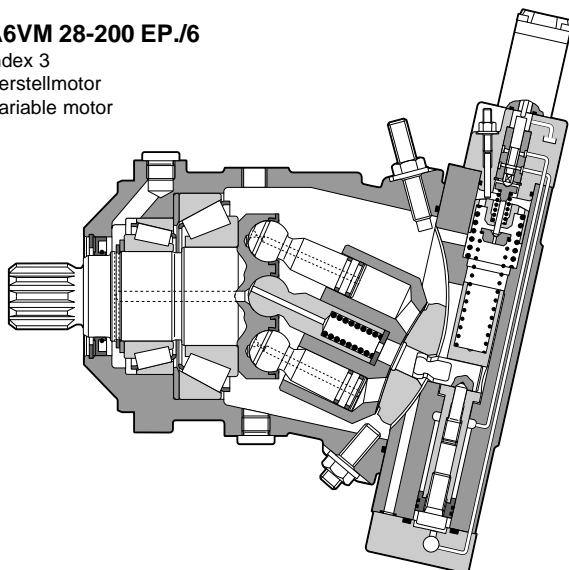
A6VM 55-107 EZ3/6

Index 3
Verstellmotor
Variable motor



A6VM 28-200 EP./6

Index 3
Verstellmotor
Variable motor



Schnittbild
Sectional drawing

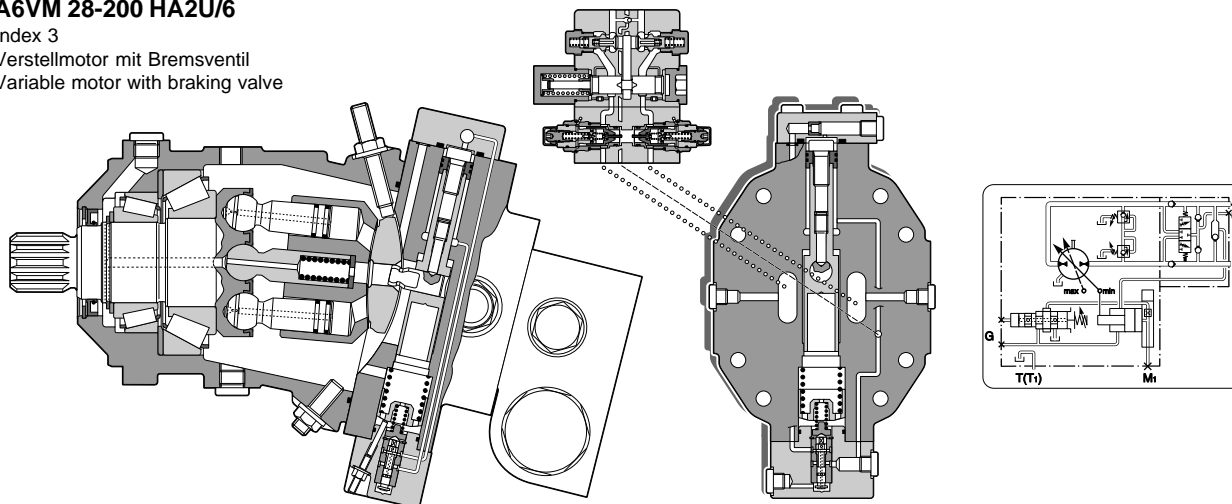
Reparaturanleitung A6VM
Repair Instructions A6VM

A6VM 28-200 HA2U/6

Index 3

Verstellmotor mit Bremsventil

Variable motor with braking valve

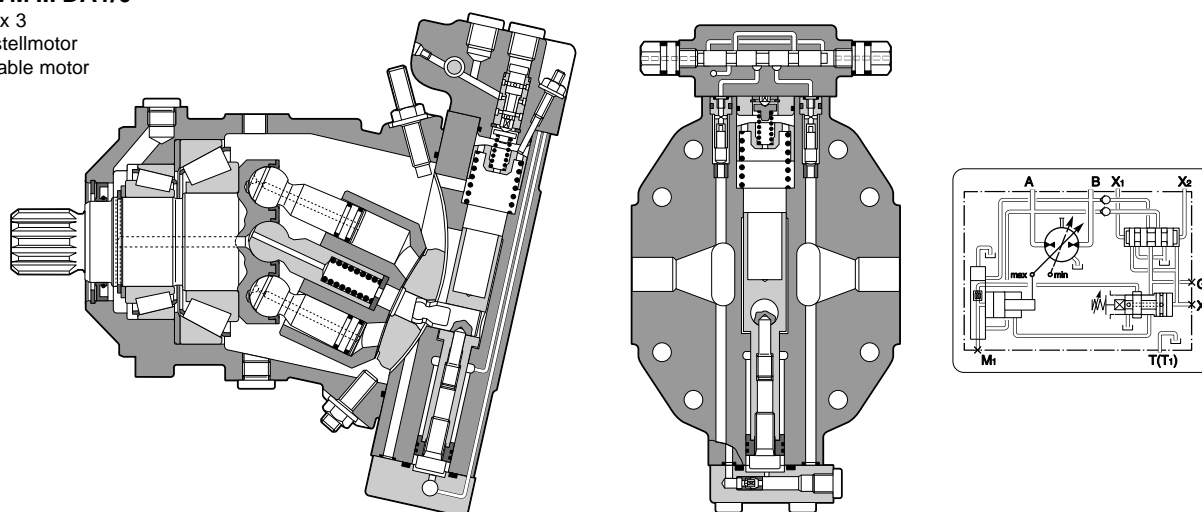


A6VM ... DA1/6

Index 3

Verstellmotor

Variable motor

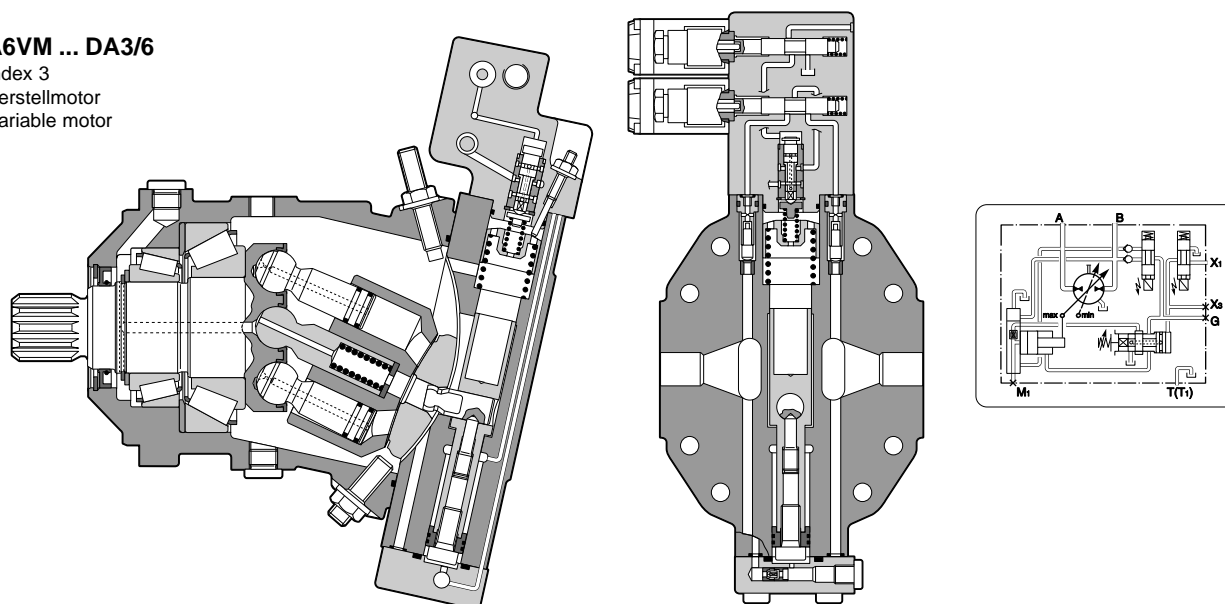


A6VM ... DA3/6

Index 3

Verstellmotor

Variable motor

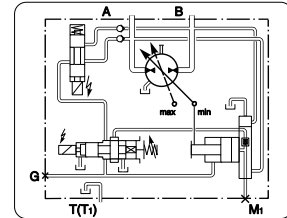
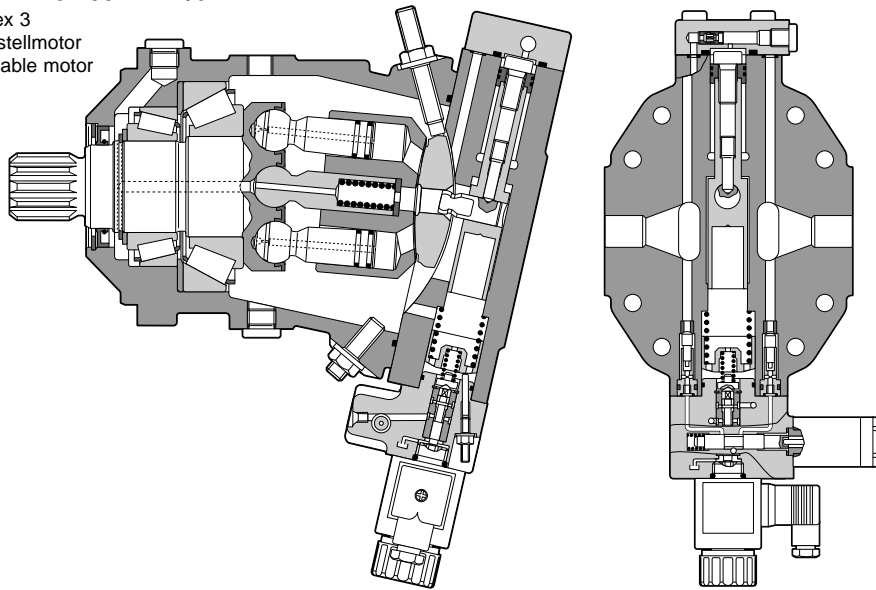


Schnittbild
Sectional drawing

Reparaturanleitung A6VM
Repair Instructions A6VM

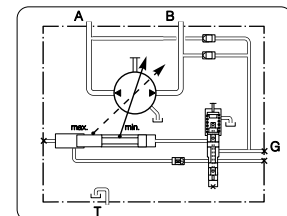
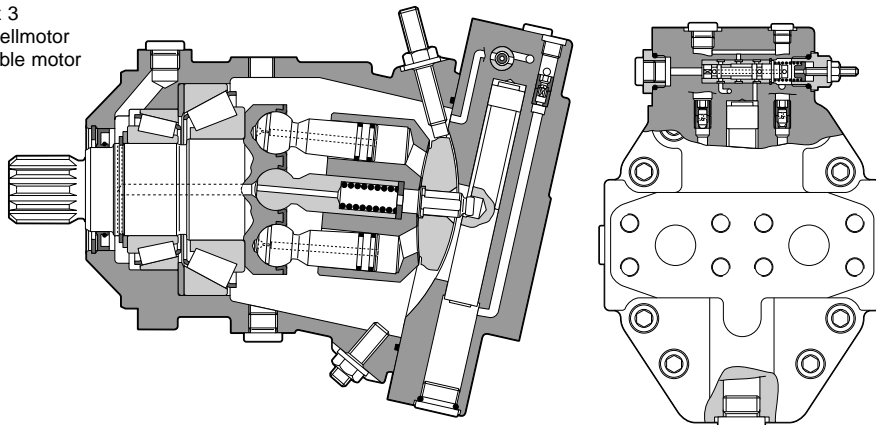
A6VM 28-200 HA2R/6

Index 3
Verstellmotor
Variable motor



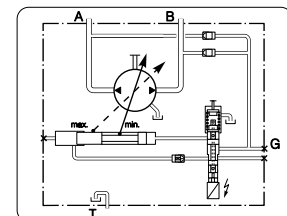
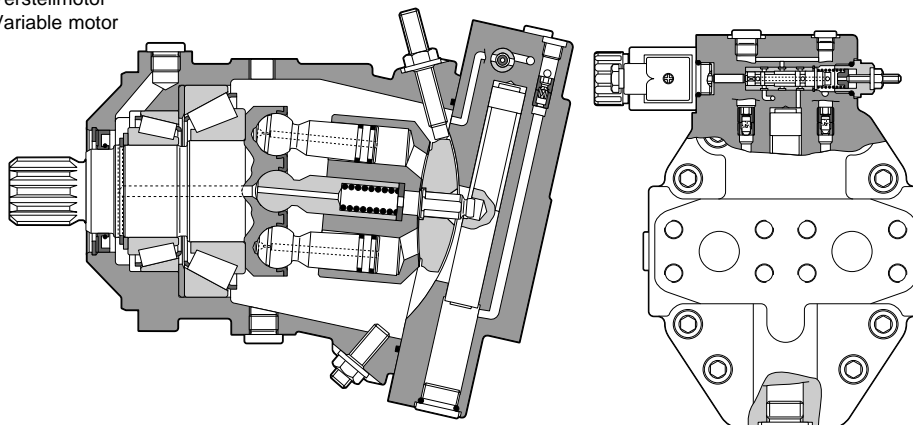
A6VM 55-107 HA3/6

Index 3
Verstellmotor
Variable motor



A6VM 55-107 HA3U/6

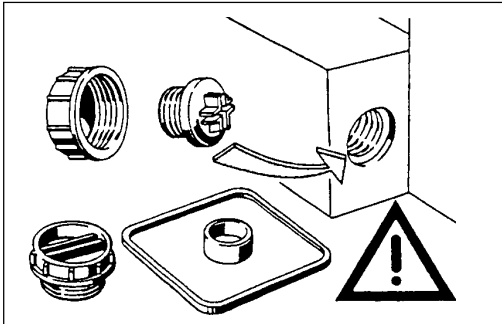
Index 3
Verstellmotor
Variable motor





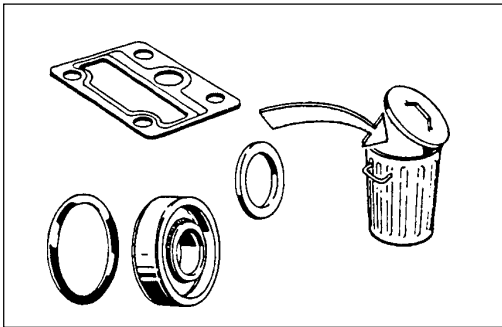
Achtung!
Nachfolgend Hinweise bei allen Reparaturarbeiten
an Hydraulikaggregaten beachten!

Attention!
Observe the following notices when carrying out repair
work at hydraulic aggregates!



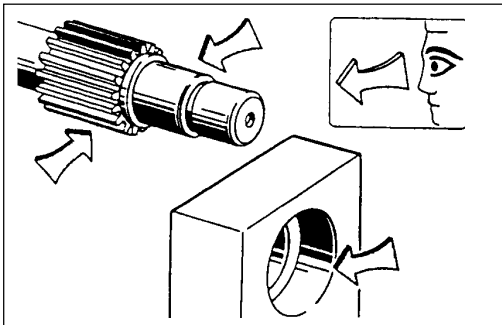
Alle Öffnungen der Hydraulikaggregate verschließen.

Close all ports of the hydraulic aggregates.



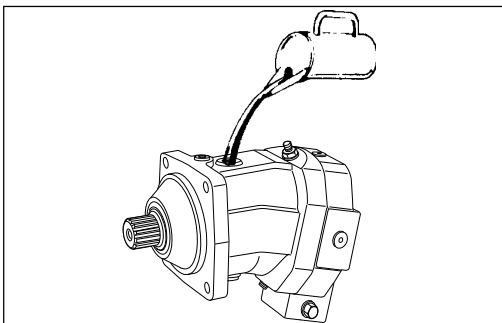
Alle Dichtungen erneuern.
Nur original HYDROMATIK-Ersatzteile verwenden.

Replace all seals.
Use only original HYDROMATIK spare parts.



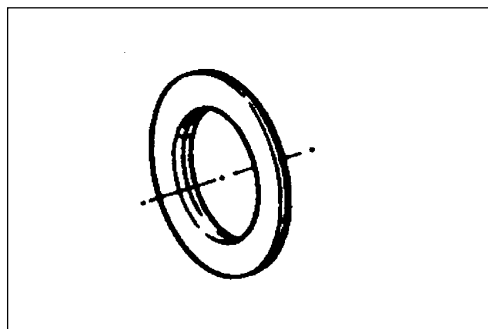
Alle Dicht- und Gleitflächen auf Verschleiß prüfen.
Achtung: Nacharbeiten an Dichtflächen z.B. durch
Schleifpapier kann die Oberfläche beschädigen.

Check all seal and sliding surfaces for wear.
Attention: Rework of sealing area f. ex. with abrasive
paper can damage surface.

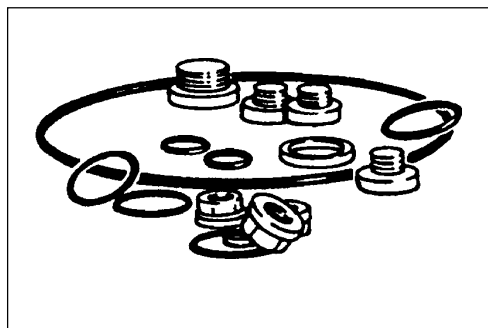


Hydraulikaggregate vor Inbetriebnahme mit
Betriebsmedium befüllen.

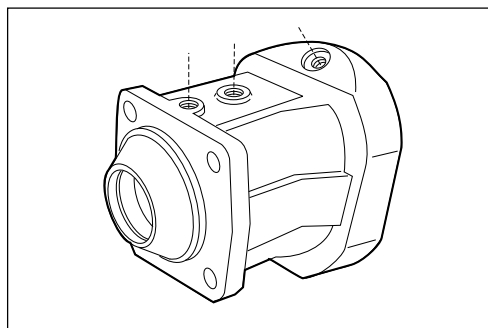
Fill up hydraulic aggregates with medium
before start- up.



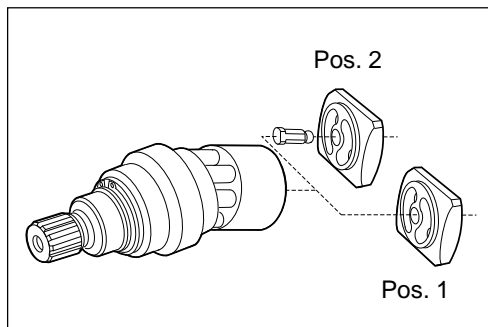
- 1 Dichtsatz für Triebwelle.
Seal kit for drive shaft.



- 2 Äußerer Dichtsatz.
External seal kit.

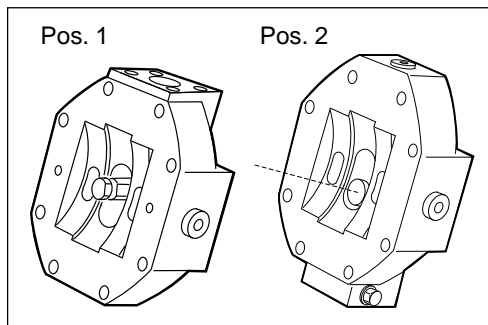


- 3 Gehäuse
Housing



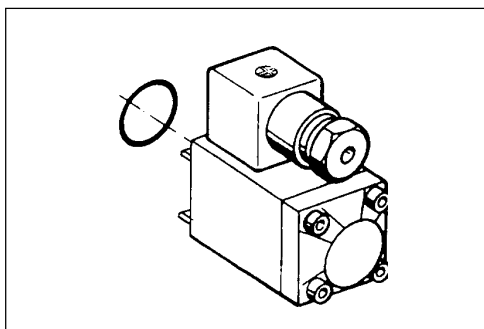
- 4 Triebwerk komplett
Hinweis: Pos. 1 - Für Anschlußplatte mit Differentialkolben
Pos. 2 - Für Anschlußplatte mit Gleichgangkolben

Complete rotary group
Note: Pos. 1 - For port plate with differential piston
Pos. 2 - For port plate with synchronizing piston

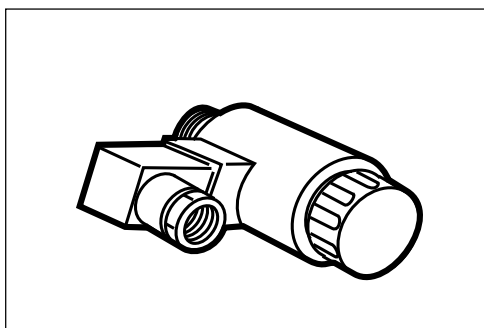


- 5 Anschlußplatte mit Stellkolben
Hinweis: Pos. 1 - Für Anschlußplatte mit Differentialkolben
Pos. 2 - Für Anschlußplatte mit Gleichgangkolben

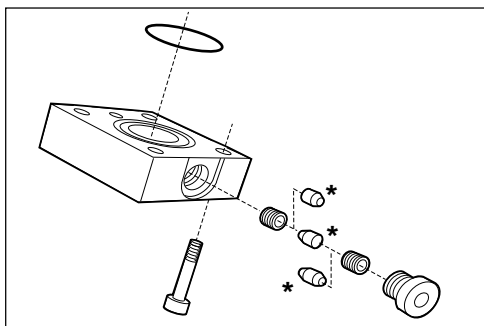
Port plate with control piston
Note: Pos. 1 - For port plate with differential piston
Pos. 2 - For port plate with synchronizing piston



- 6 Proportionalmagnet (EP)
Proportional solenoid (EP)

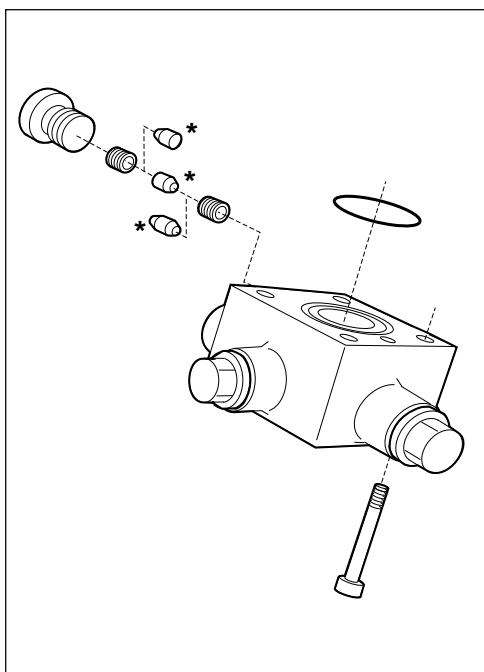


- 7 Schaltmagnet
Solenoid



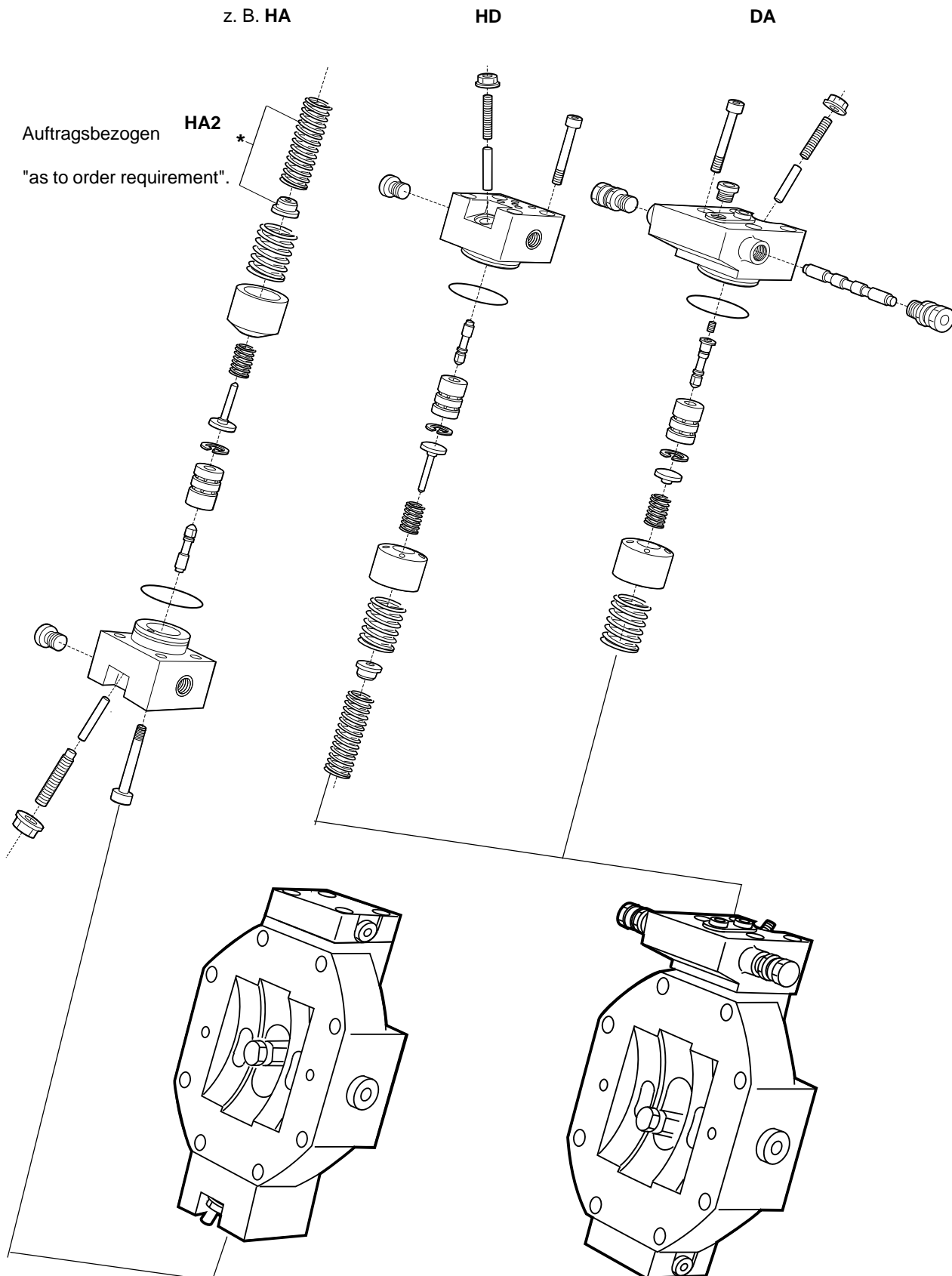
- 8 Deckel mit * Drosselstift.
* Drosselstift "Auftragsbezogen".

Cover with * throttle pin.
* Throttle pin "as to order requirement".

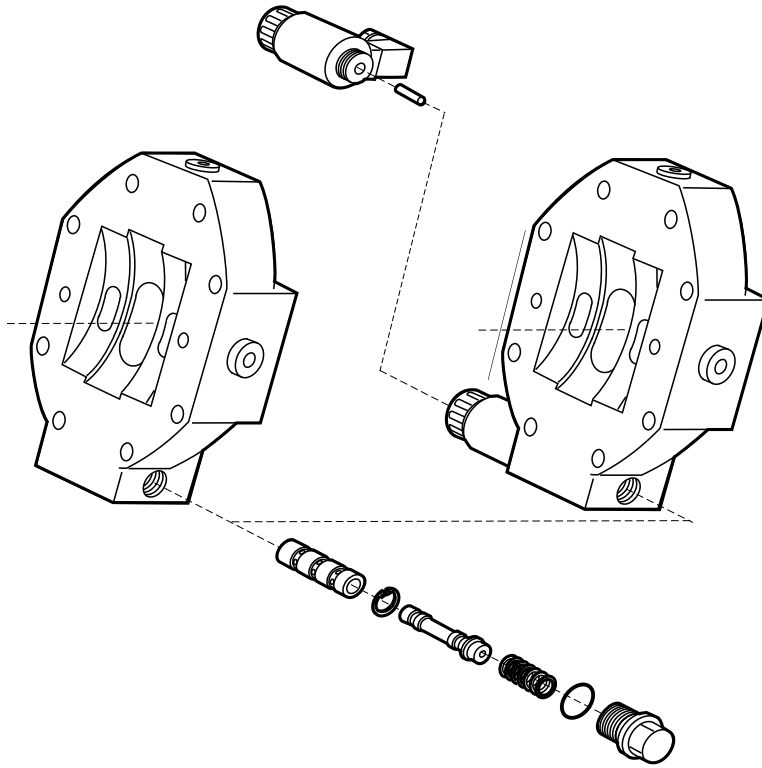


- 9 Deckel mit Spül- und Speisedruckventil und * Drosselstift
* Drosselstift "Auftragsbezogen".

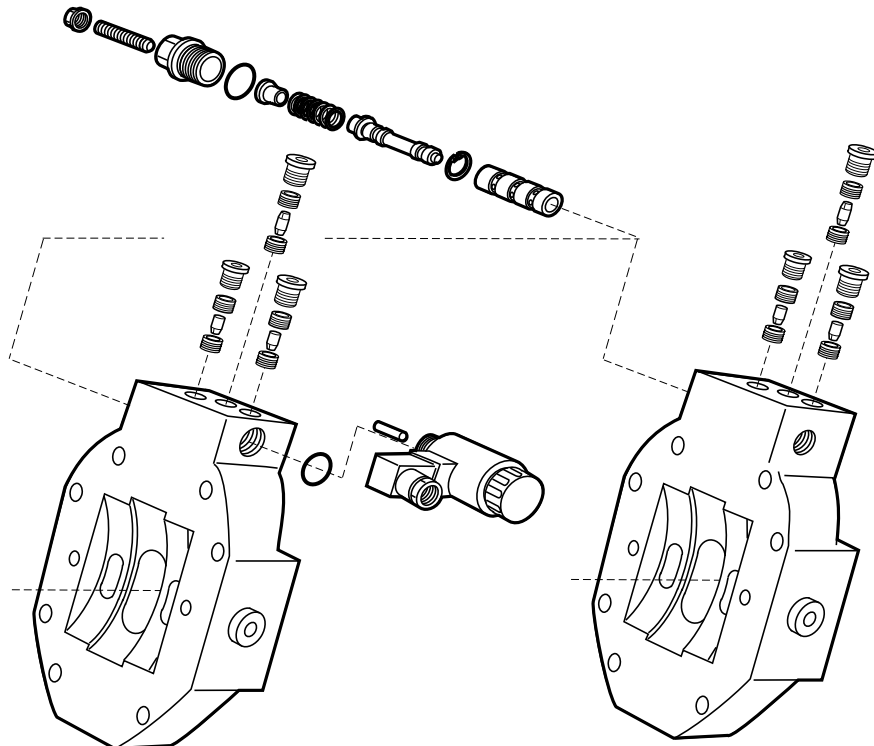
Cover with flushing and boost pressure valve and
* throttle pin.
* Throttle pin "as to order requirement".

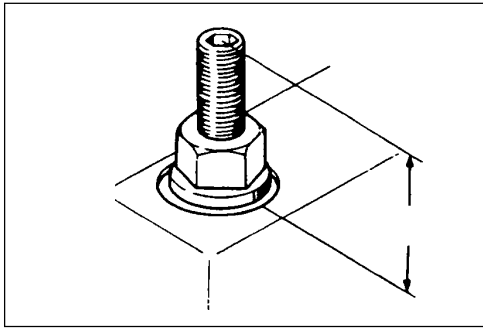


z. B. HZ3 / EZ3

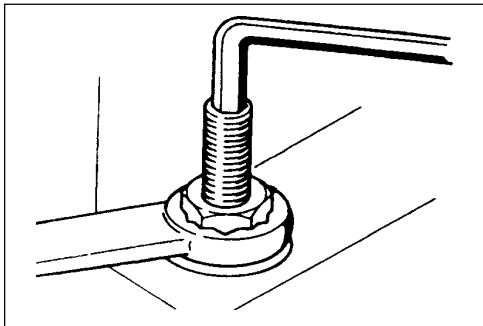


HA3 / HA3U

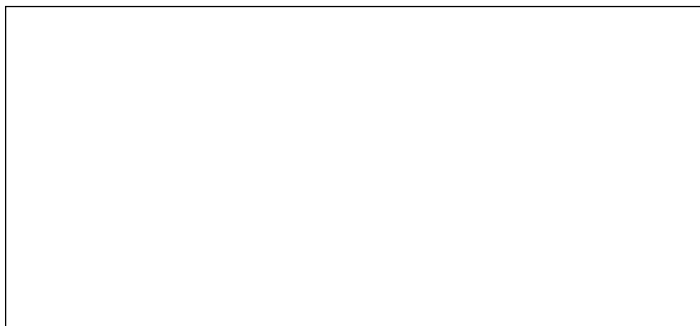
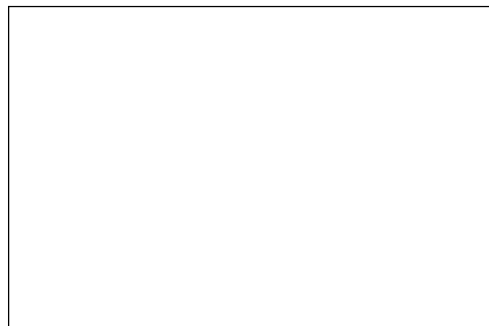


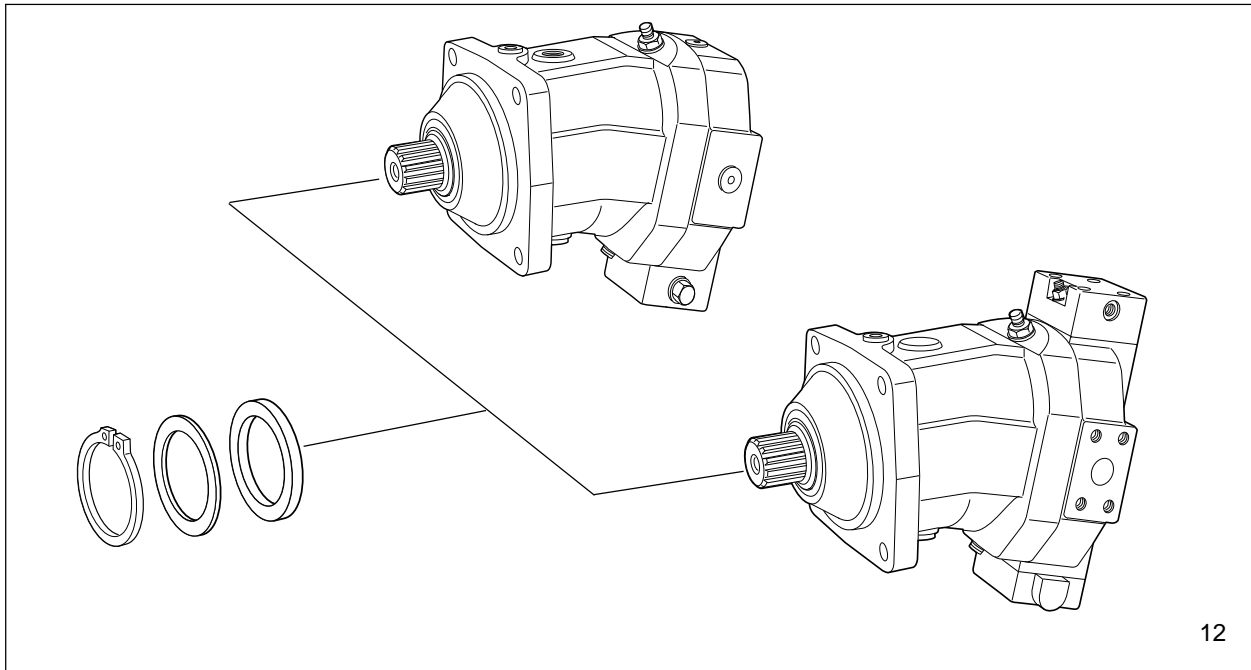


- 10 Dichtmutter austauschen.
Zuerst Einstellhöhe messen und festhalten.
- Replace seal nut.
First measure and record setting height.

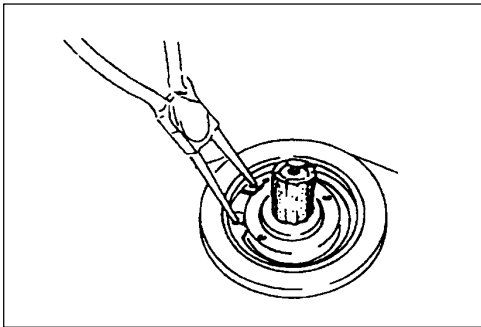


- 11 Beim Anziehen Einstellschraube gegenhalten,
anschließend Einstellhöhe kontrollieren.
- When tightening, counterhold setting screw, then
check setting height.



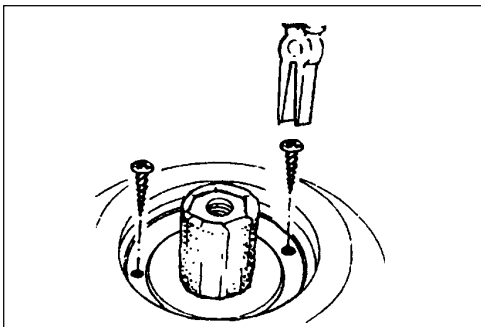


12



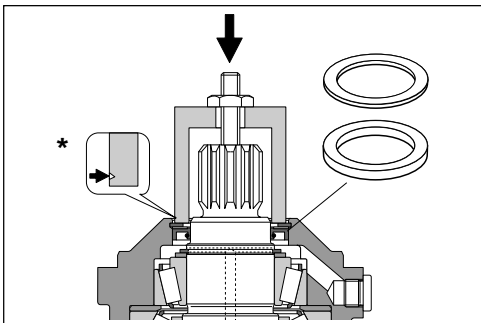
- 13 Triebwelle abkleben.
Sicherungsring und Scheibe ausbauen.

Protecting the drive shaft.
Remove retaining ring and shim.



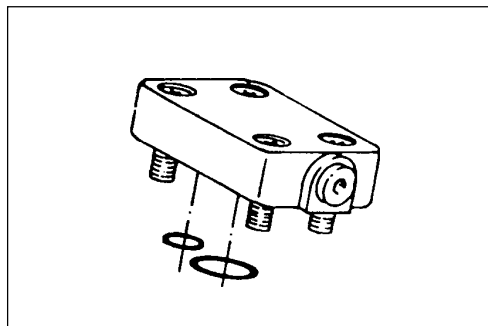
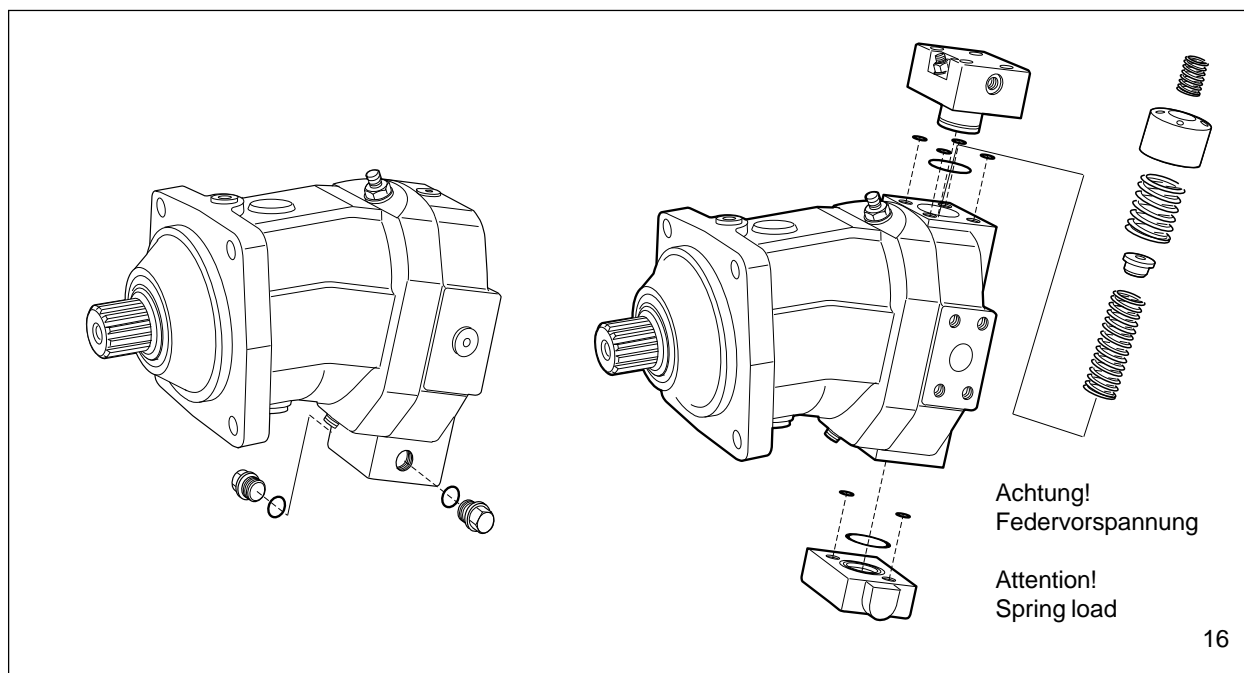
- 14 Blechschraube in die mit Gummi gefüllten
Löcher eindrehen.
Mit Zange WDR herausziehen.

Screw in sheet metal screw into the holes
fitted with rubber.
Pull out seal with pliers.



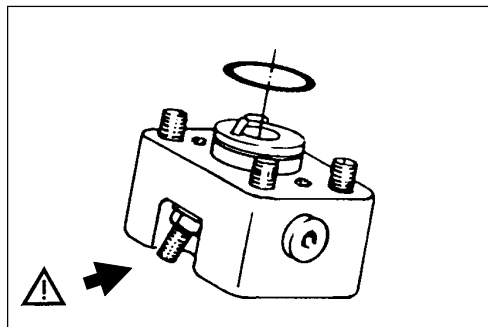
- 15 Wellendichtring und Scheibe mit Montagehülse einpressen.
⚠ Einpresstiefe beachten! * Marke für Einpresstiefe.
Sicherungsring einbauen.

Press in shaft seal ring and shim with bush to stop.
Take note of press-in depth!
⚠ Install mark for press-in depth of safety ring.




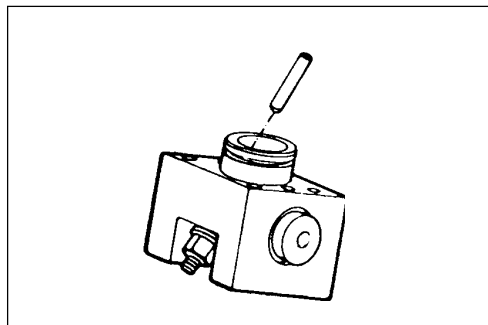
- 17 Kontrolle
Bohrung im Gehäuse, O-Ring, Nut.

Inspect
Drilling in housing, O-ring, groove.



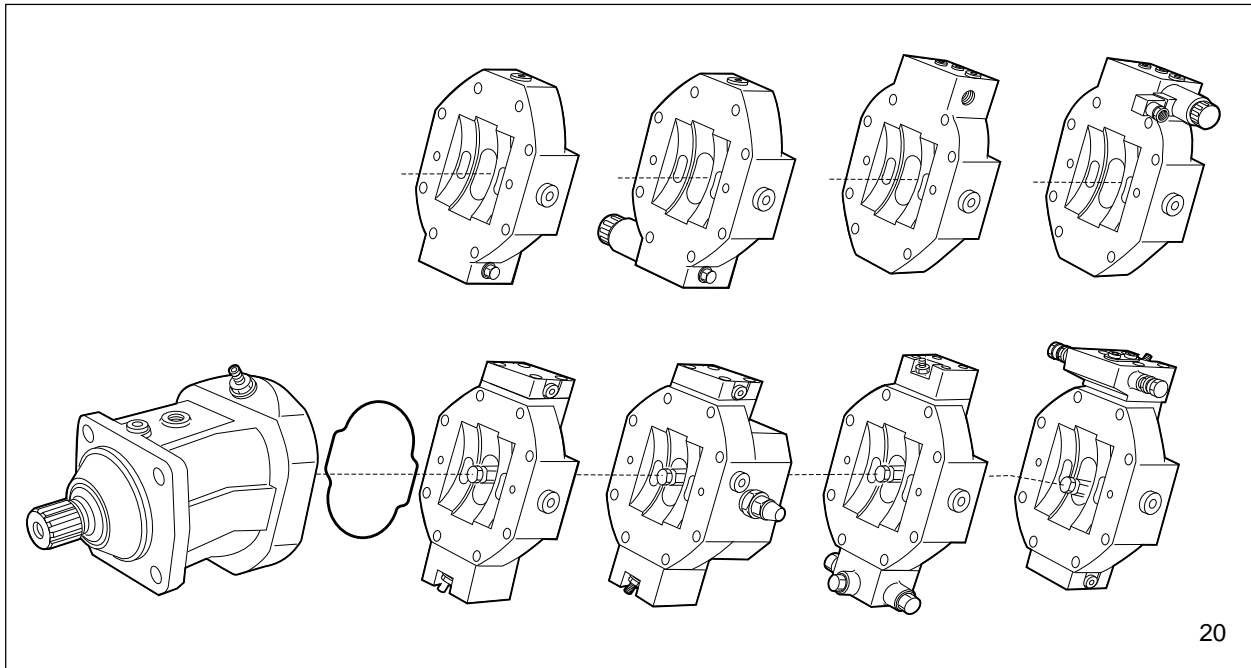
- 18  Einstellschraube nicht ausbauen.
Kontrolle
O-Ring, O-Ring-Nut, Gehäuse

 Do not remove adjustment screw.
Inspect
O-ring, O-ring groove, housing

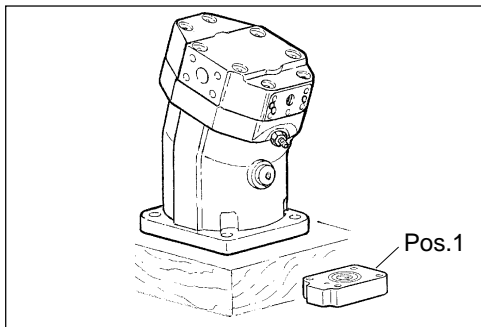


- 19 Montagehilfe
Stift mit Fett einkleben.

Assembly aid
Insert pin with grease.

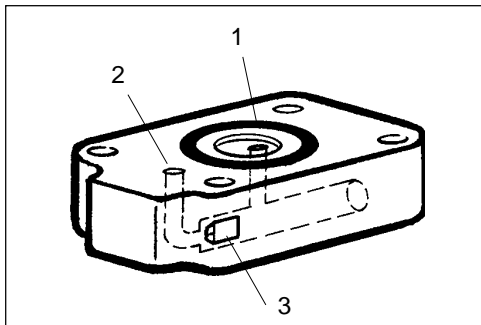


20



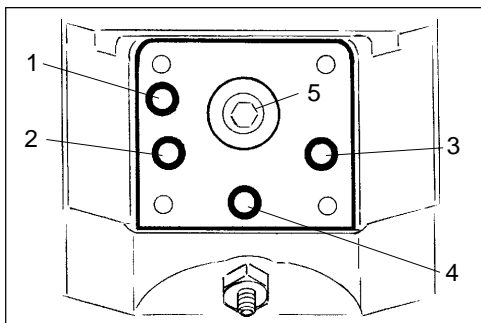
- 21 Beispiel: A6VM ... HD Verstellung
Demontageposition:
Deckel Pos. 1 abbauen.

Example: A6VM ... HD control
Disassembly position:
Remove cover pos. 1

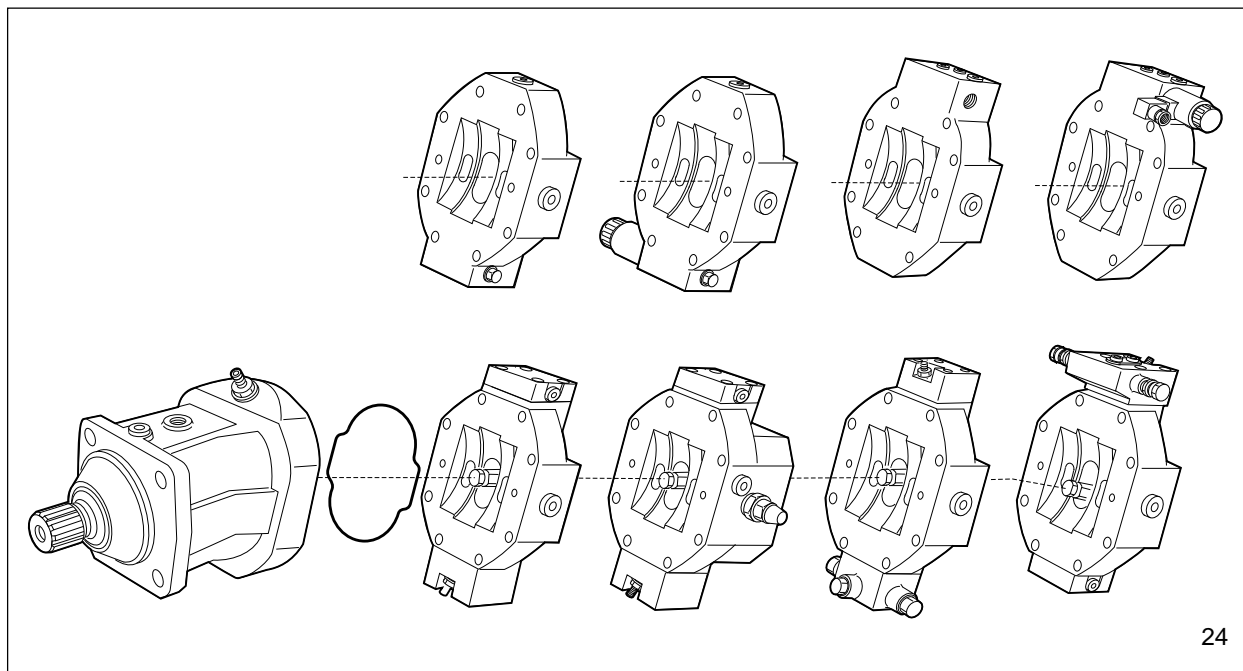


- 22 1. O-Ring
2. Stellölzulauf
3. Drosselstift
⚠ Einbaulage je nach Steuerteil verschieden.

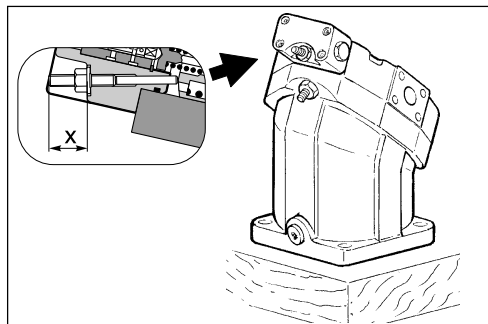
1. O-ring
2. Input flow of oil control
3. Throttle pin
⚠ Installation position differs according to the control components



- 23 1. Stellölzulauf
2. Hochdruck bzw. Niederdruck
3. Hochdruck bzw. Niederdruck
4. Lecköl
5. Stellkolben
1. Input flow of oil control
2. High pressure / low pressure
3. High pressure / low pressure
4. Leakage oil
5. Control piston



24



25

Beispiel: A6VM ... Verstellung - **Differentialkolben**

Demontageposition: Deckel Pos. 2 abbauen.

⚠ Achtung! Federvorspannung.

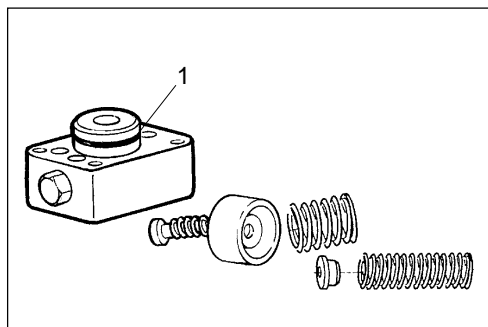
Maß x: Maß festhalten (Regelbeginn).

Example: A6VM... control - **differential piston**

Disassembly position: Remove cover pos. 2.

⚠ Attention! Spring load.

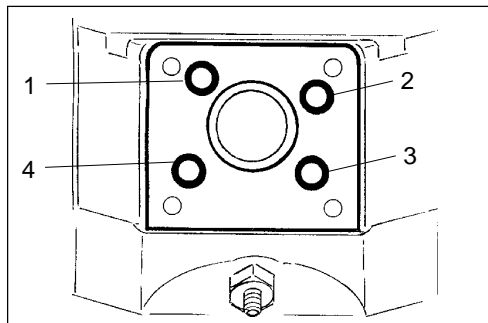
Dimension x: Note dimension (begin of regulation).



26

1. O-Ring Kontrolle

1. Check of O-ring



27

1. Hochdruck - kleine Stellkolbenseite

2. Stelldruck

3. Hochdruck - Rückschlagventil

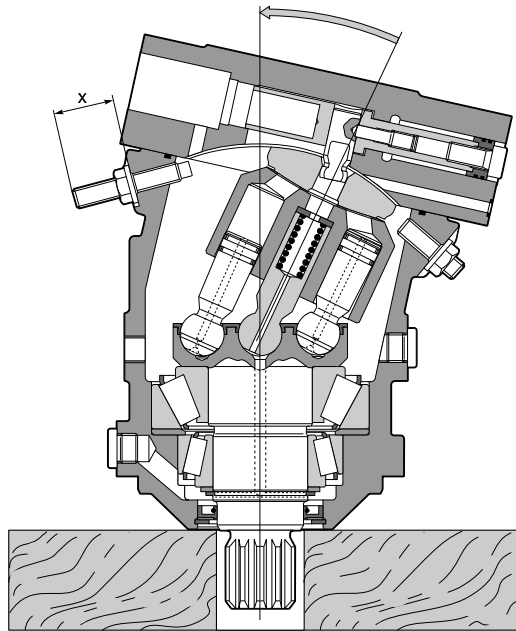
4. Hochdruck - Rückschlagventil

1. High pressure - small control piston side

2. Control pressure

3. High pressure - check valve

4. High pressure - check valve



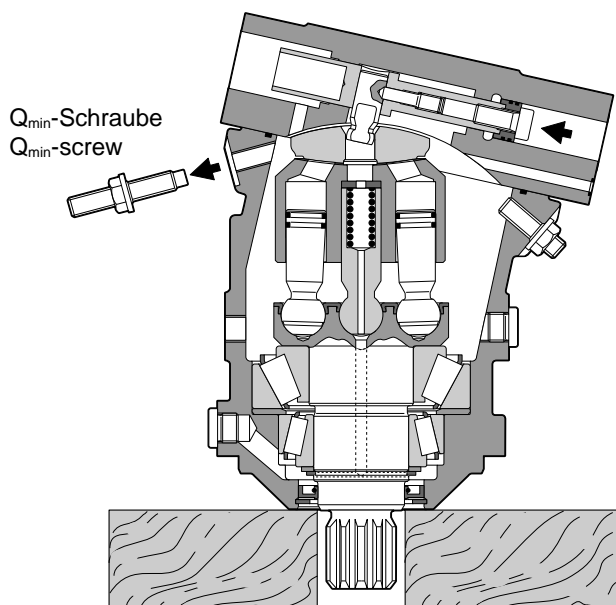
Differentialkolben:
Maß X festhalten.

Diferential piston:
Note dimension x



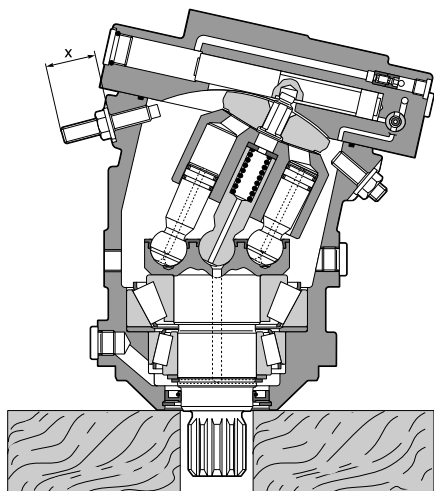
Bei "Demontage" der Anschlußplatte
"Triebwerk" immer auf Null schwenken.
Kolbenringe hängen aus der Zylinder-
bohrung aus.

For disassembly of the port plate, swivel
always rotary group to zero position.
Piston rings to hang out of the cylinder
boring.



Q_{min} -Schraube ausbauen.
Triebwerk auf 0° schwenken.

Remove Q_{min} -screw.
Swivel rotary group to 0°.



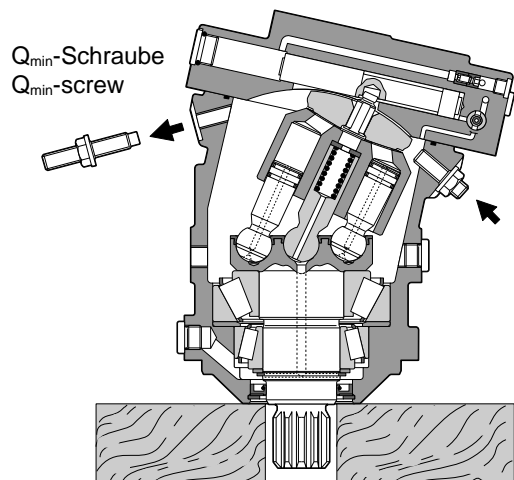
Gleichgangkolben:
Maß X festhalten.

Synchronizing piston:
Note dimension x.



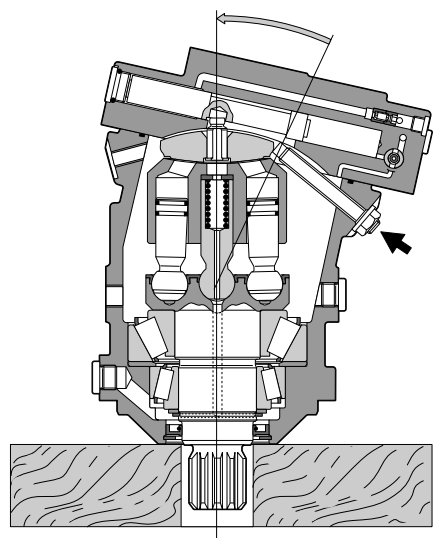
Bei "Demontage" der Anschlußplatte
"Triebwerk" immer auf Null schwenken.
Kolbenringe hängen aus der Zylinder-
bohrung aus.

For disassembly of the port plate, swivel
always rotary group to zero position.
Piston rings to hang out of the cylinder
boring.



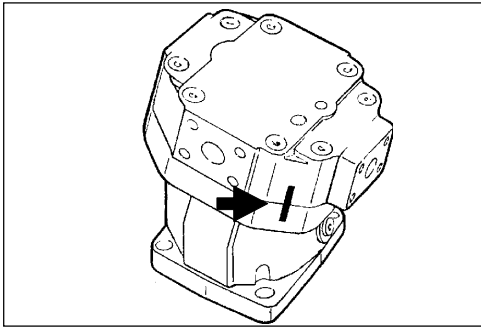
Q_{min} -Schraube und Verschußschraube ausbauen.

Remove Q_{min} -screw and plug.



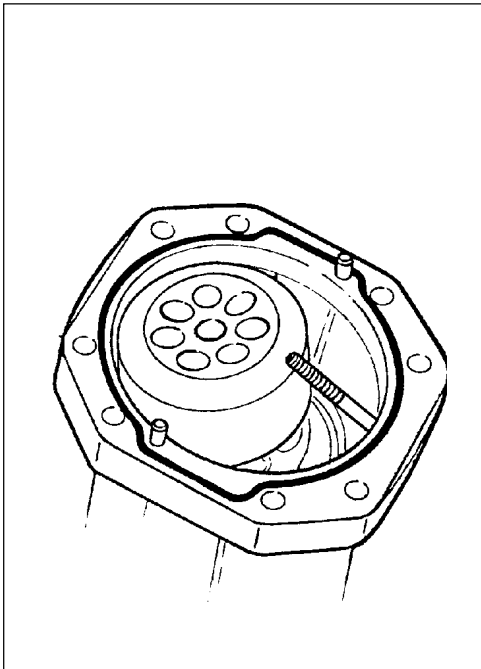
Mit Schraube Q_{min} Triebwerk auf 0°
schwenken.

Swivel rotary group to zero position
with screw Q_{min} .



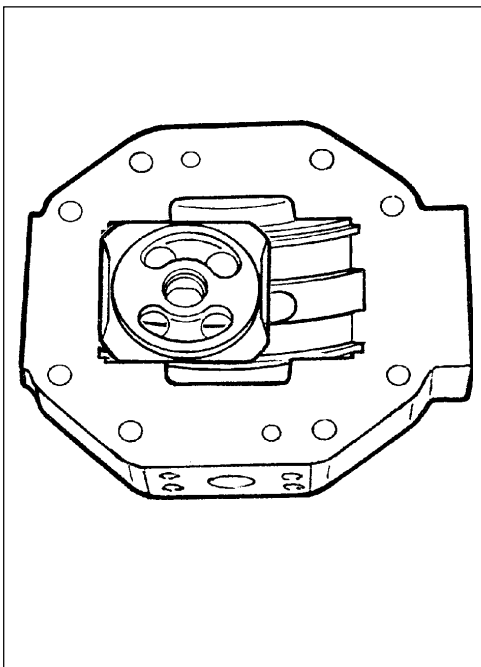
- 28 Anschlußplatte
Lage markieren. Schrauben lösen.
Abbauen

Port plate
Mark position. Loosen screws.
Removal

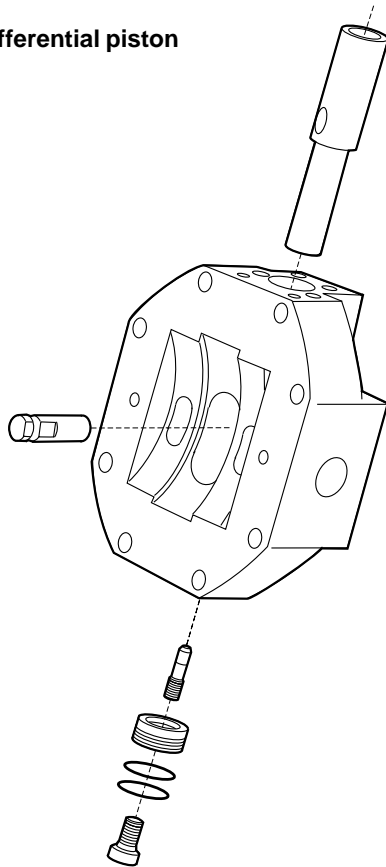
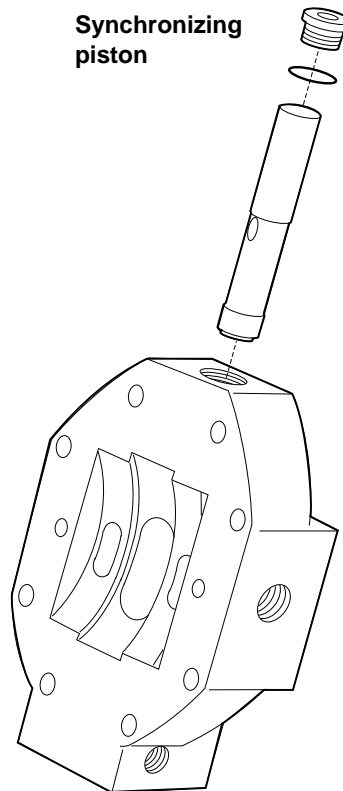


- 29 O-Ring austauschen.
Neuer O-Ring mit etwas Fett einkleben.
⚠ Treibwerk nicht ausschwenken.
⚠ Kolbenringe hängen aus der Zylinderbohrung aus.

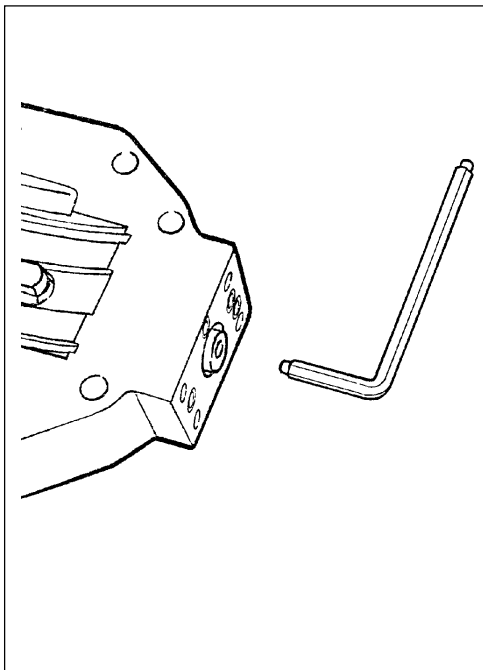
Check O-ring.
Stick new O-ring with some grease.
⚠ Do not swivel rotary group.
⚠ Piston rings to hang out from the cylinder boring.



- 30 ⚠ Steuerlinse in Gleitbahn mit Fett einkleben.
Fertigmontage in umgekehrter Reihenfolge.
Anschlußplatte aufsetzen.
⚠ Triebwerk senkrecht.
⚠ Stick control lens in sliding surface with grease.
Assembly in reversal order.
Mount port plate.
⚠ Rotary group vertical.

Differentialkolben**Differential piston****Gleichgangkolben****Synchronizing piston**

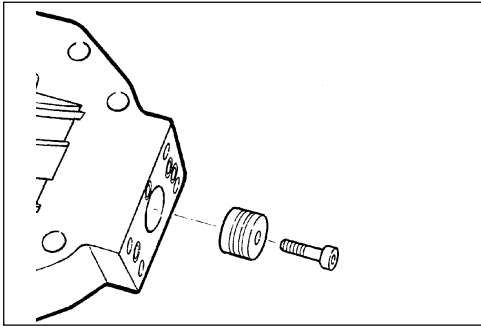
31



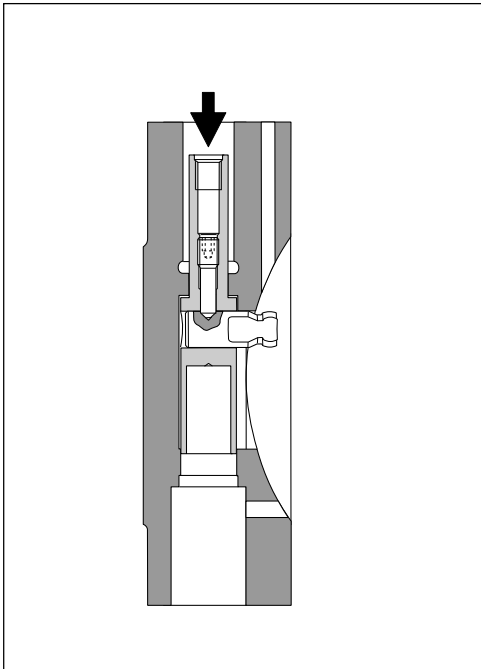
32

Befestigungsschraube lösen.
Nur Zapfenschlüssel verwenden.

Loosen fixing screw.
Use only socket wrench.



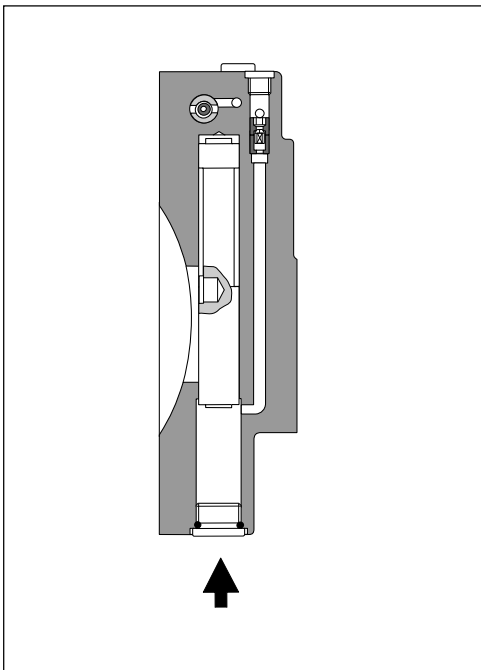
- 33 Kolben mit Kolbenring ausbauen.
Remove piston with piston ring



- 34 **Differentialkolben**
Befestigungsschraube für Stellzapfen über Bohrung erwärmen. (Schraube geklebt - herausdrehen)
Neue Schraube verwenden
Precote Beschichtung
⚠ Anziehdrehmomente beachten!

Differential piston

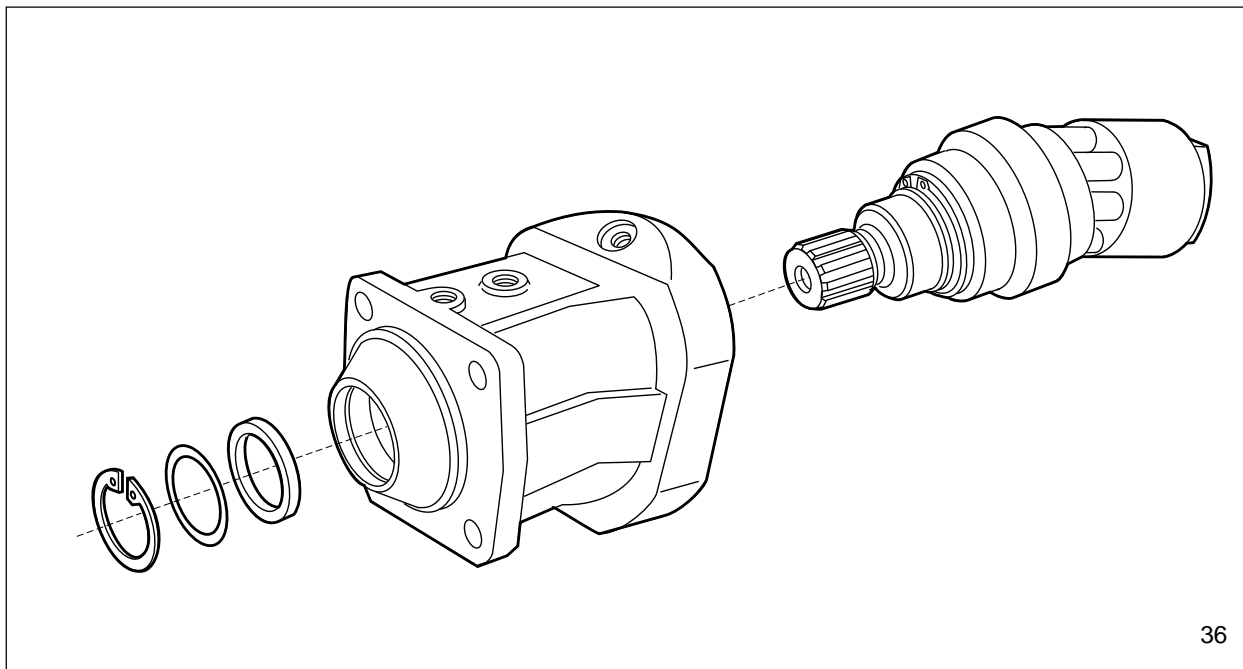
Warm up fixation screw for positioning plug via boring (screw glued - to turn out).
Use new screw.
Precote coating.
⚠ Note tightening torque!



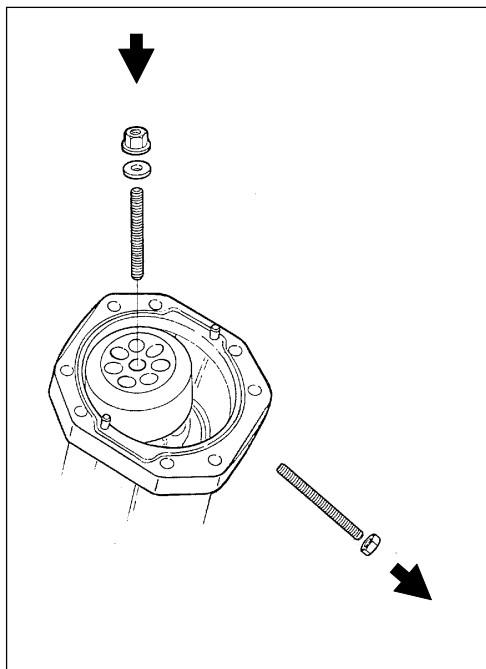
- 35 **Gleichgangkolben**
Schraube ausbauen.
Kolben ausbauen.
⚠ Einbaulage beachten.

Synchronizing piston

Remove screw.
Remove piston.
⚠ Note installation position.



36

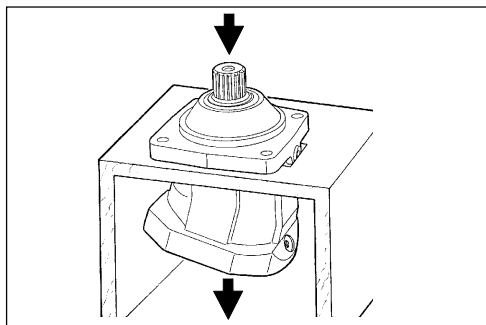


37

Gewindestift in Mittelzapfen einschrauben,
mit Scheibe und Mutter Zylinder befestigen.
Q_{max} - Anschlagschraube ausbauen.

Screw in threaded pin into center pin.
Fix the cylinder with disc and locknut.
Remove Q_{max} -stop screw.

Nenngröße / Size	28 : M4 x 58 mm
	55 : M5 x 71 mm
	80 : M6 x 82 mm
	107 : M6 x 92 mm
	140 : M8 x 105 mm
	160 : M8 x 105 mm
	200 : M8 x 109 mm



38

Triebwerk auspressen!



Bei Wiederverwendung der Lager
nicht schlagen.

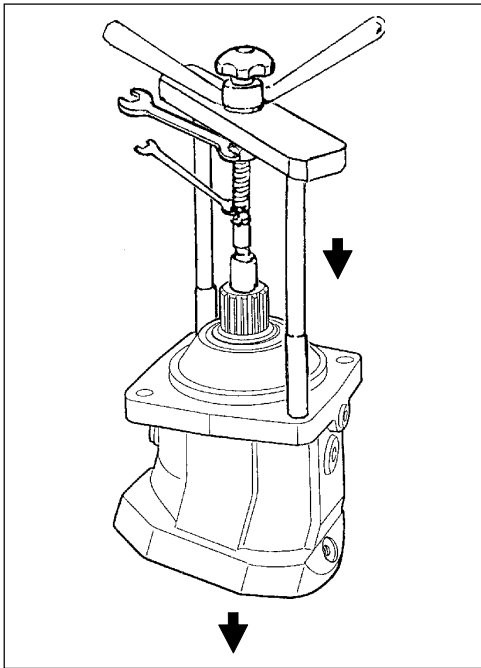
Press out rotary group!



If the bearings are used again
do not hit on the drive shaft.

Triebwerk ausbauen
Remove rotary group

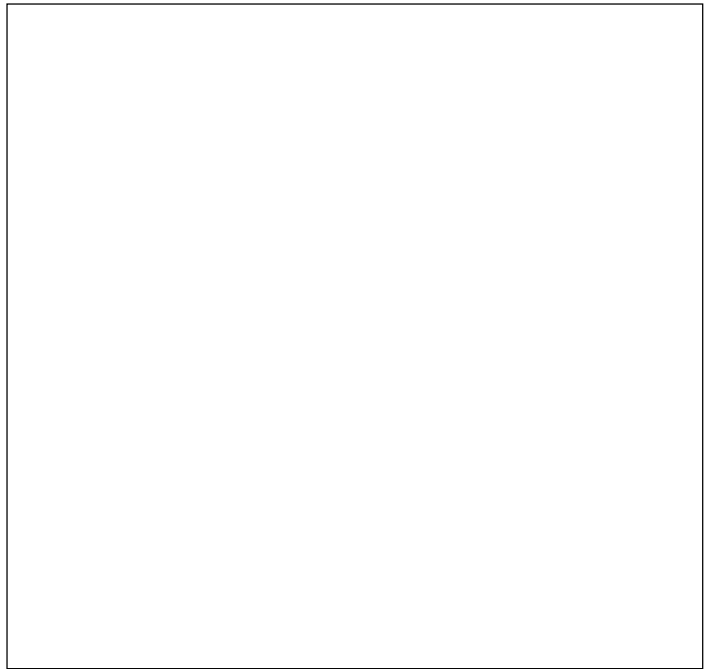
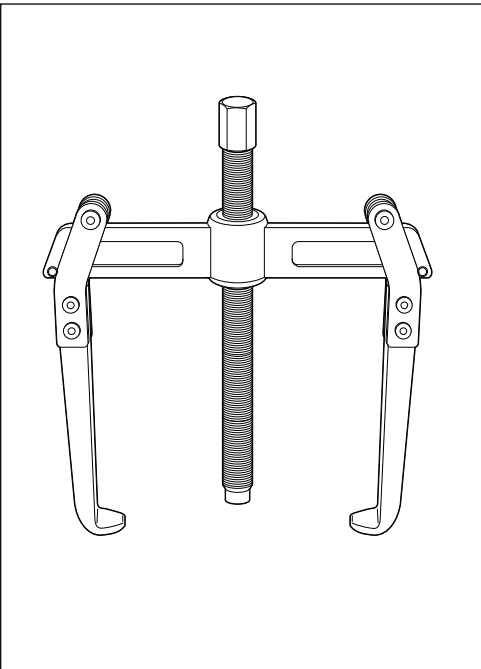
Reparaturanleitung A6VM
Repair Instructions A6VM

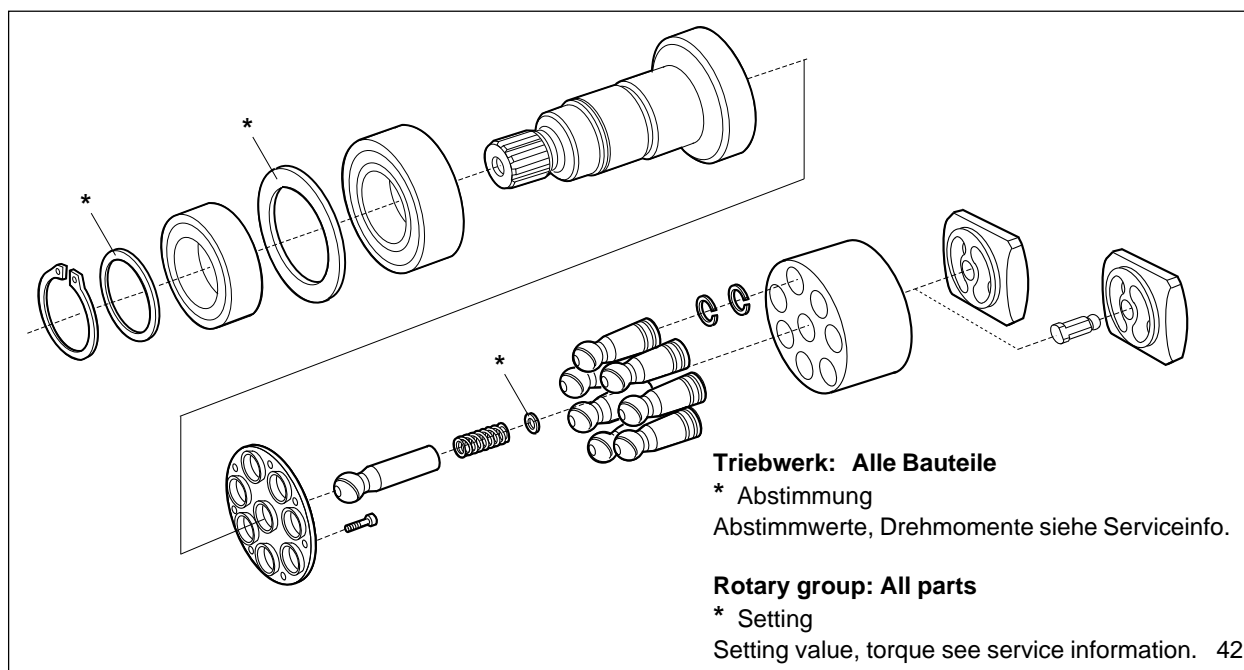
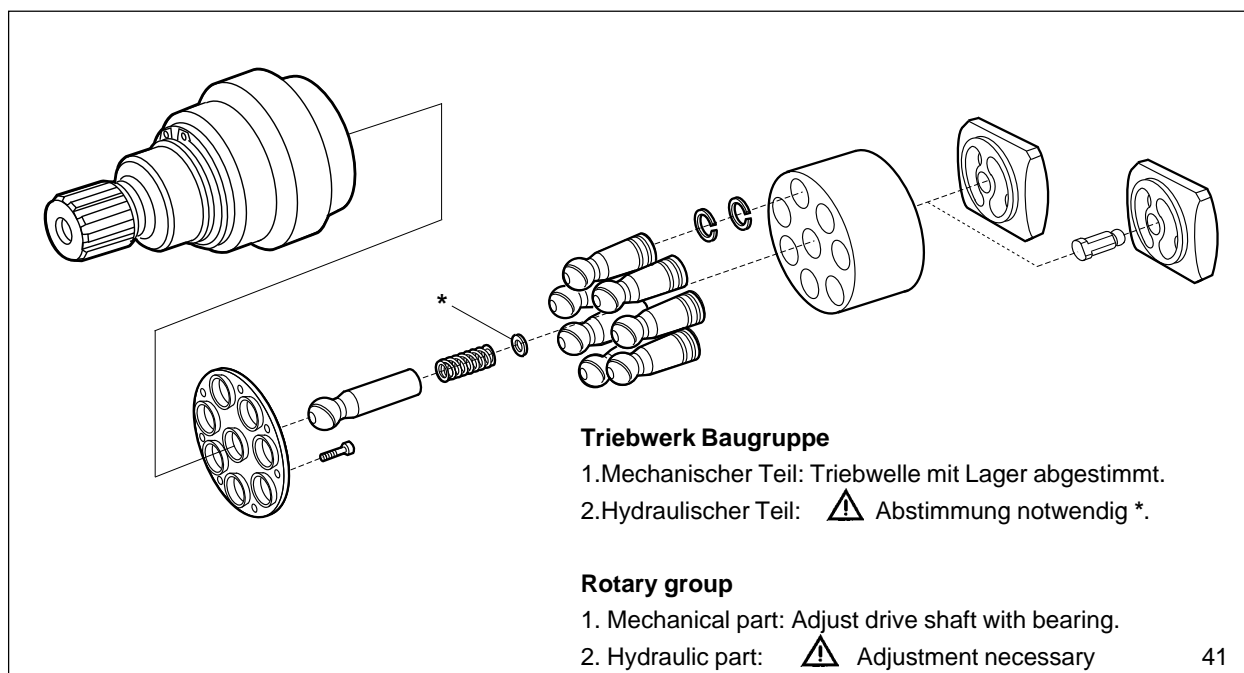
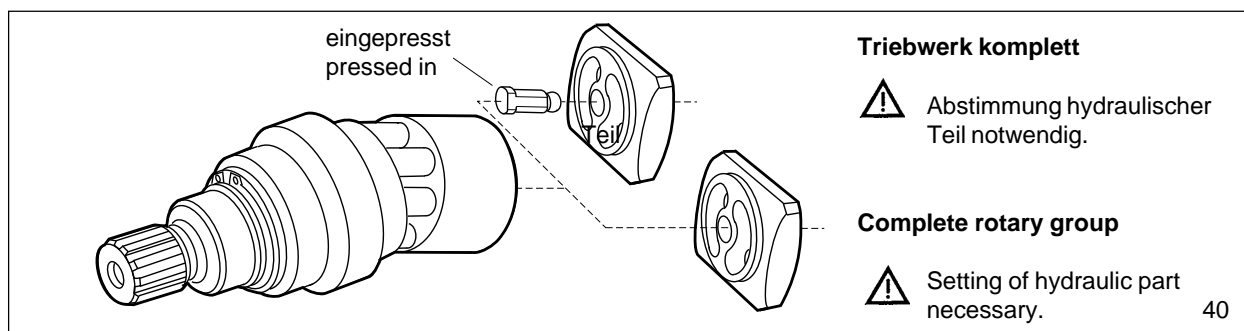


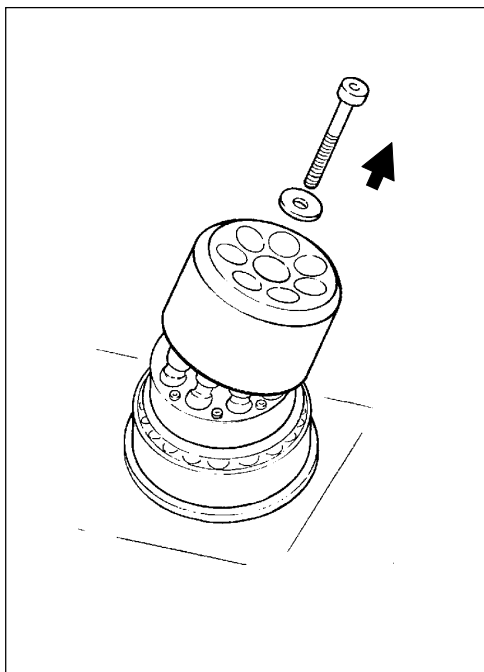
39

Oder mit Abziehvorrichtung ausdrücken.

Or press-out with extraction device.

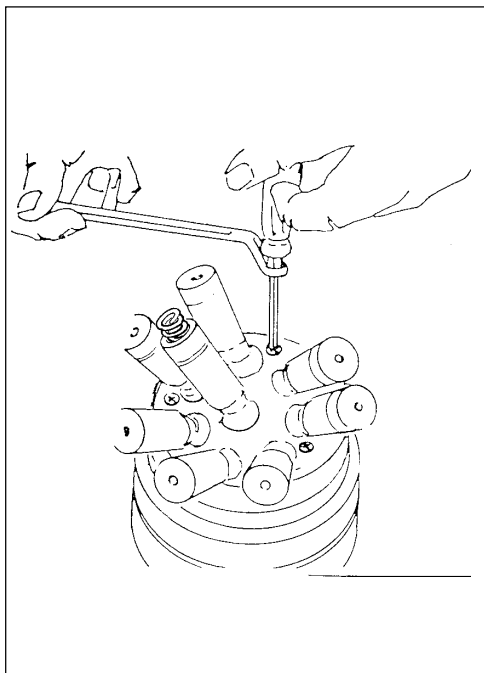






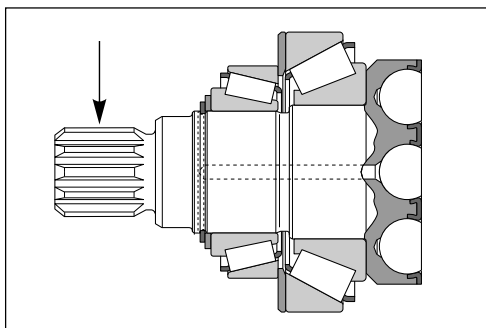
- 43 Befestigungsschraube (Zylinder) ausbauen.
Zylinder abheben.

Remove fixing screw (cylinder).
Remove cylinder.

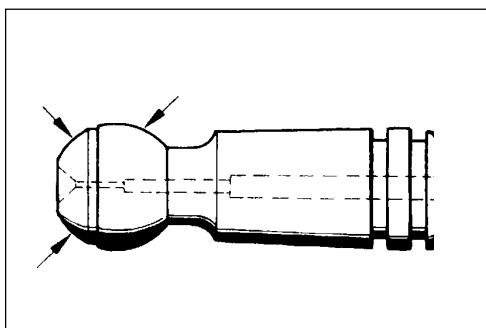


- 44 Rückzugplatte demontieren.
⚠ Schrauben sind eingeklebt.
Torx-Werkzeug verwenden.

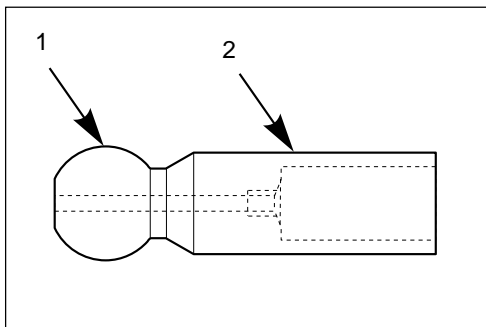
Disassemble retaining plate.
⚠ Screws are glued.
Use Torx-tools.



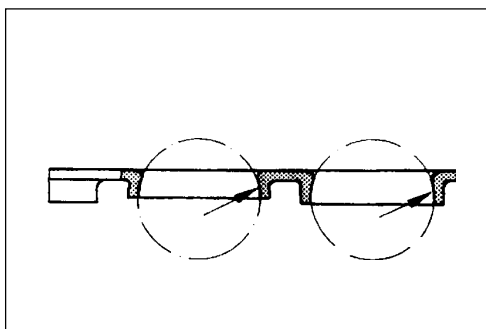
- 45 Kein Passungsrost, nicht ausgeschlagen.
Free of corrosion, erosion or fretting; no damage to splines or keyways.



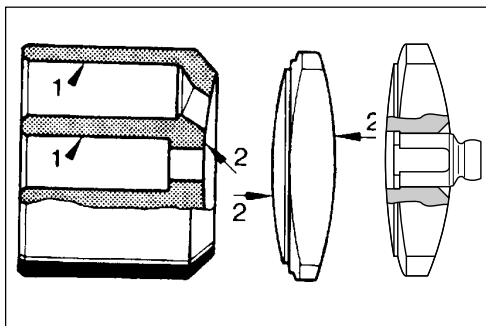
- 46 Kolben
Riefenfrei und keine Pittings.
Pistons
No scoring and no pittings.



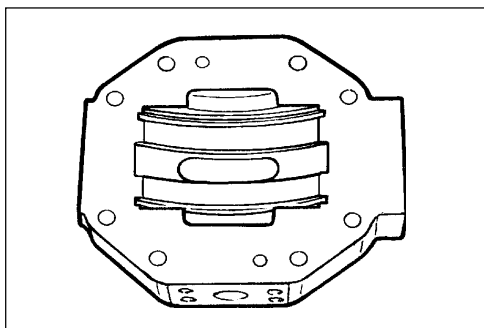
- 47 Mittelzapfen
Riefenfrei und keine Pittings.
Center pin
No scoring and no pittings.



- 48 Rückzugplatte
Riefenfrei und keine Ausbrüche.
Retaining plate
No scoring and no evidence of wear

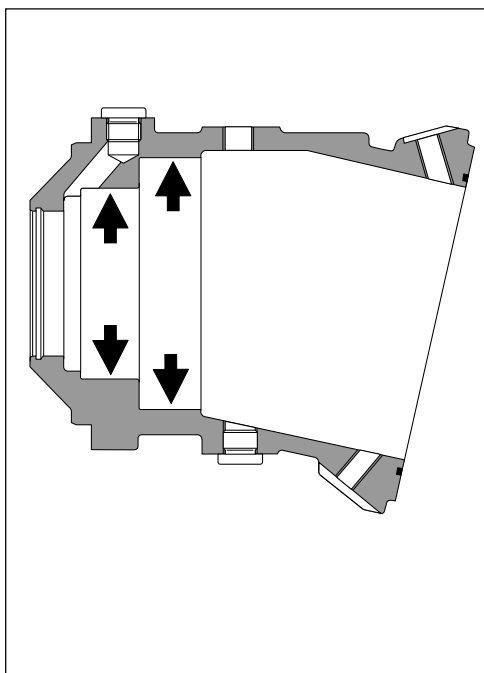


- 49 Zylinder / Steuerlinse
1 Bohrungen riefenfrei, nicht ausgelaufen.
2 Gleichmäßiges Tragbild, riß- und riefenfrei.
Cylinder block / control lens
1 Bores free of scoring, no evidence of wear.
2 Faces smooth and even, free of cracks and scoring.



- 50 Reglergehäuse
Gleitbahn und Seitenführung riefenfrei,
nicht ausgelaufen.

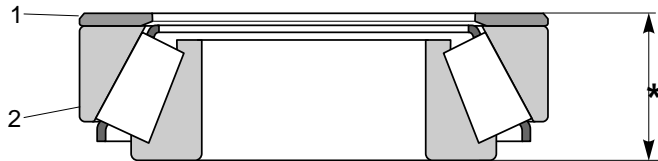
Control housing
Sliding surface and side guides free of scoring
and no wear.



- 51 Sichtkontrolle:
Im Lagerbereich riefenfrei und keine Einlaufspuren.

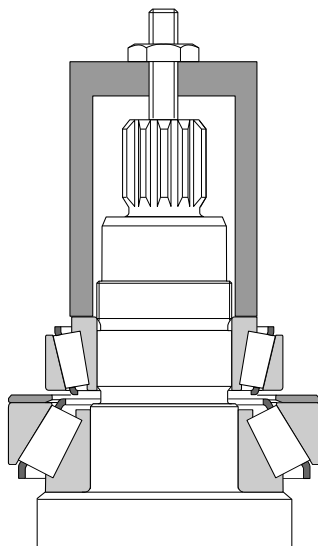
Visual check:
Bearing areas free of scoring and no evidence of wear.

Triebwelle: mechanischer Teil
Rotary group: mechanical part



Abstimmung Maß *
 und Lagerdrehmomente
 siehe Serviceinfo.

Adjustment dimension *
 and bearing torque
 see service information.

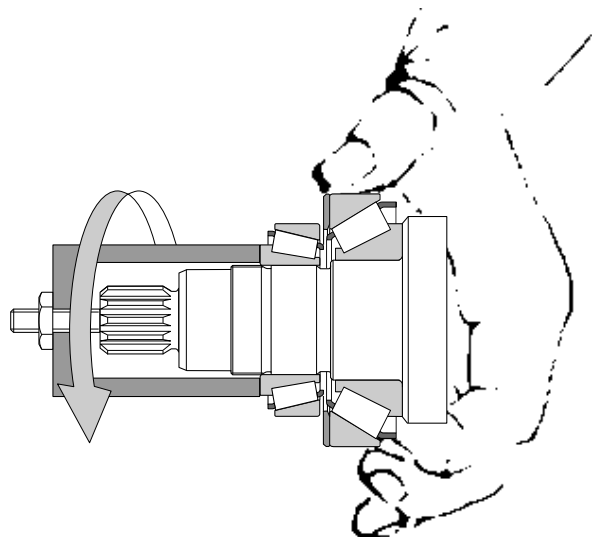
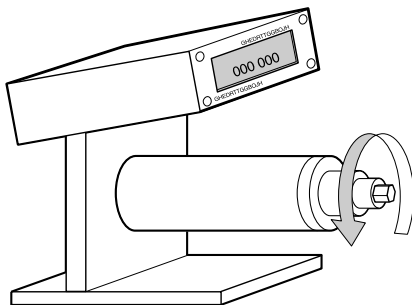


Lager aufpressen.
 Beim Aufpressen Lager-
 drehmoment nicht überschreiten.

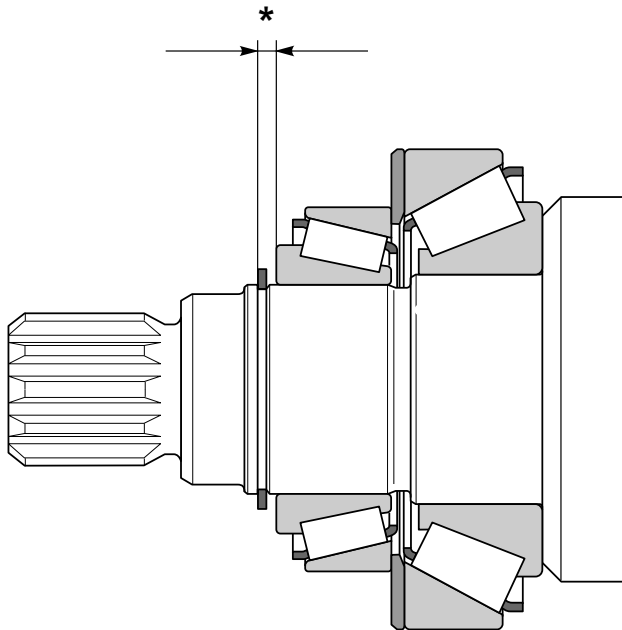
Press on bearing.
 Do not exceed bearing torque
 during press-on.

Lager mit Montagehülse vorspannen
 und laufende Drehmomentenkontrolle.

Preload bearing with assembly sleeve
 and steady control of the torque.

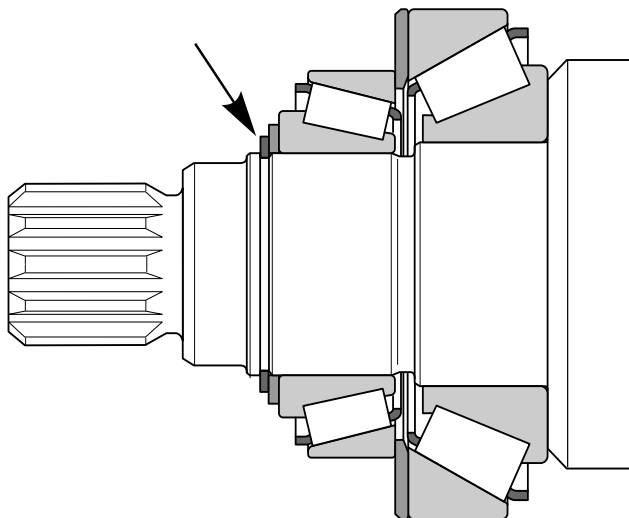


Triebwelle: mechanischer Teil
Rotary group: mechanical part



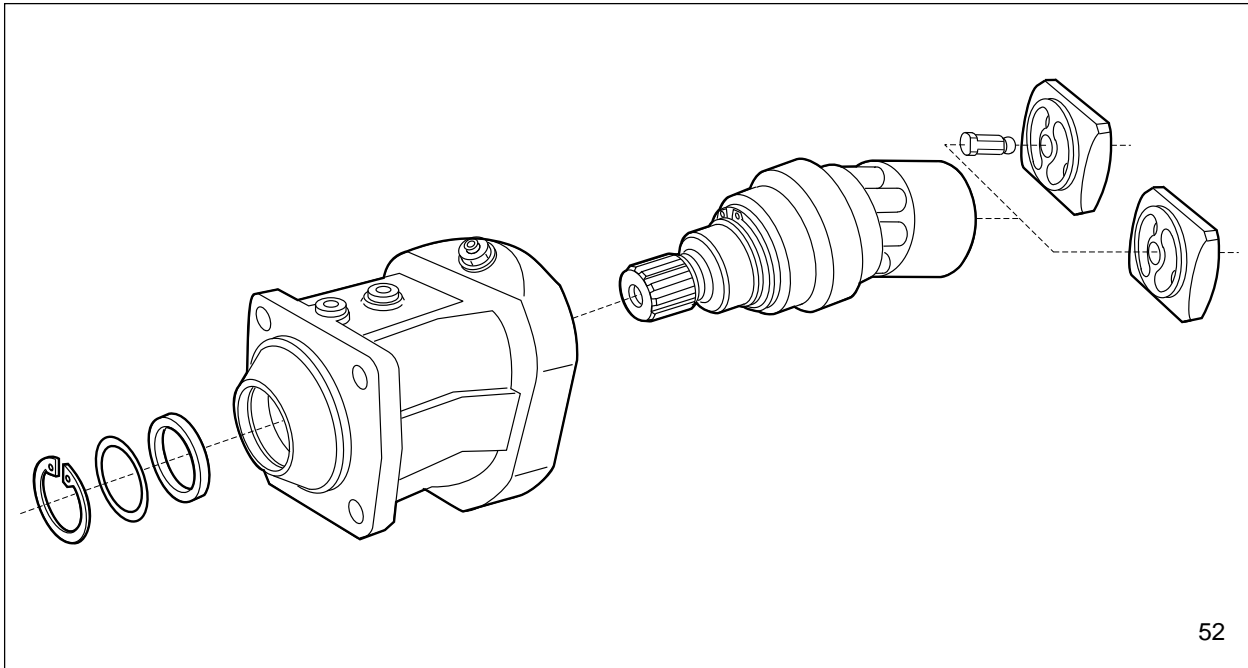
Sicherungsring montieren.
Maß * für Abstimmsscheibe mit
Endmaßen ermitteln (überkreuz).

Assemble safety ring.
Determine dimension for
adjustment disc with final
dimensions (crossover).

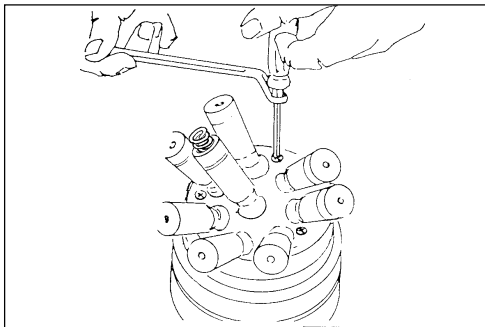


Abstimmsscheibe einbauen.
Sicherungsring montieren.
Triebwelle einbaufertig.

Install adjustment disc.
Assemble safety ring.
Drive shaft ready for assembly.

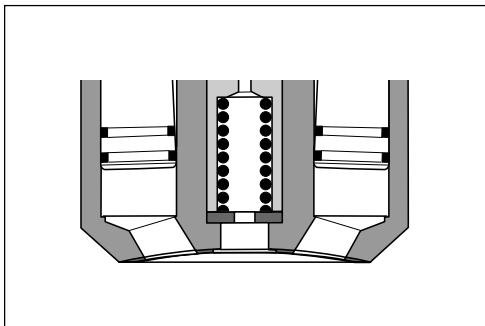


52

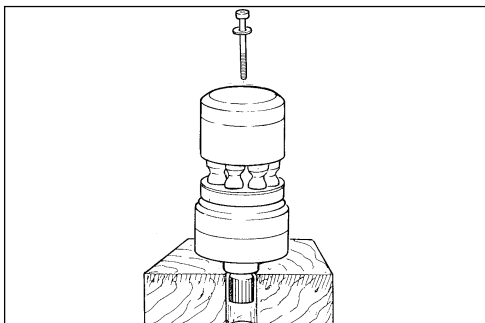


- 53 Rückzugplatte mit Kolben und Mittelzapfen einsetzen.
Schrauben mit Precote-Beschichtung verwenden.

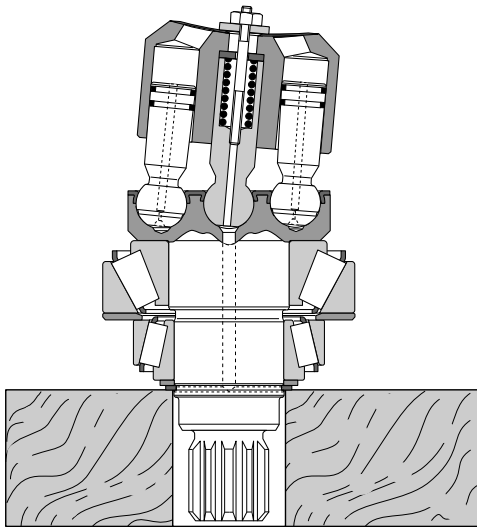
Insert retaining plate with piston and center pin.
Use screw with Precote-coating.



- 54 Auf richtige Schichtung aller Teile achten.
Make sure all parts are fitted in correctly.

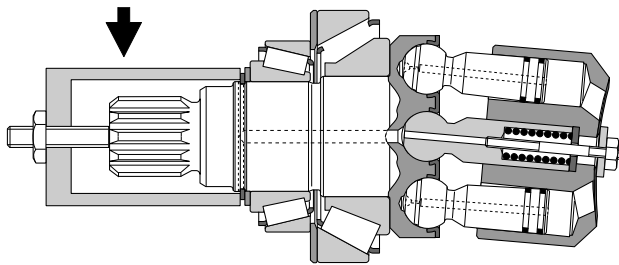


- 55 Triebwerk max. ausschwenken und Zylinder befestigen.
Swivel cylinder block to max. and fix the cylinder.



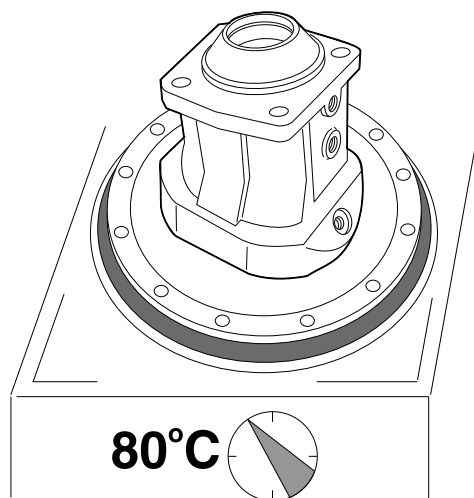
Triebwerk komplett zum
Einbau fertig.

Rotary group completely assembled
ready for assembly.



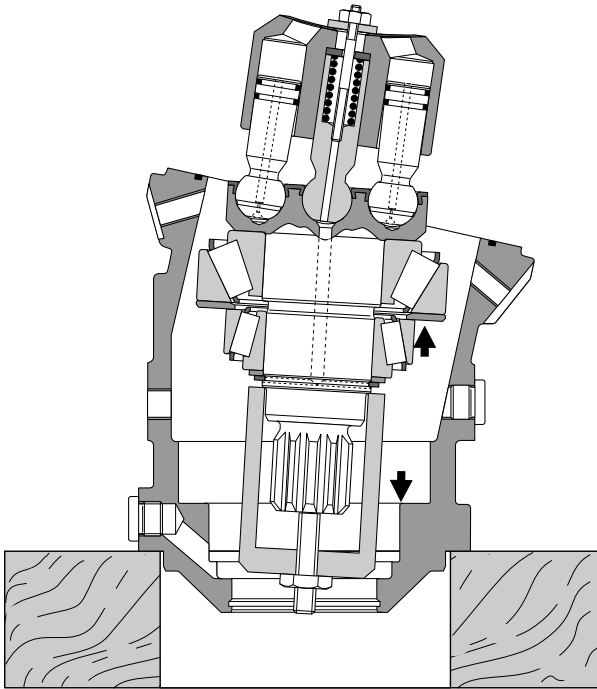
Montagehülse montieren.

Place assembly sleeve.



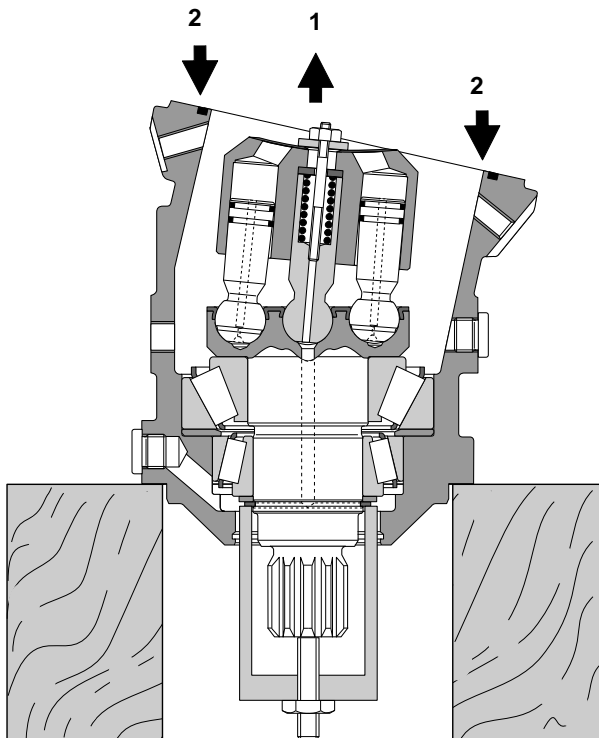
Gehäuse auf 80°C erwärmen.

Warm up housing to 80°C.



Triebwerk ins Gehäuse auf
Anschlag einsetzen.

Insert rotary group into housing
to seat position.

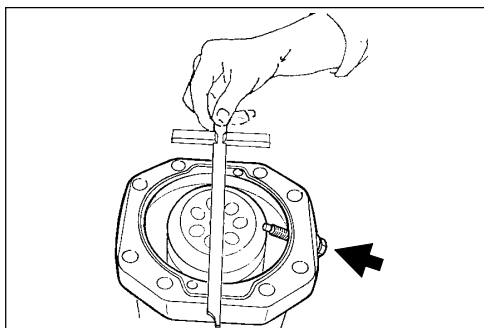


Zylinder in Nullposition
ausrichten.

1. Zylinderbefestigungsschraube
demonstrieren.
2. O-Ring einsetzen.

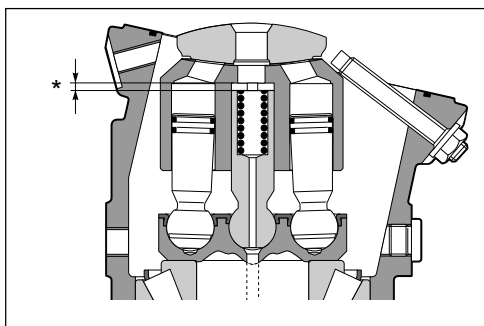
Fix zero position of cylinder
with Q_{max} -screw.

1. Disassemble cylinder
fixing screw.
2. Insert O-ring.



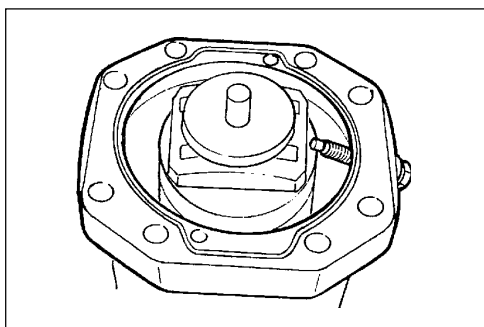
56 Mit Schraube Zylinderausschwenkung vermitteln.

Determine cylinder swivel range to max. angle with screw.



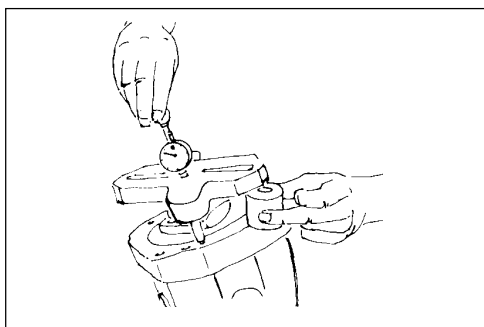
57 * Scheibe

* Disc



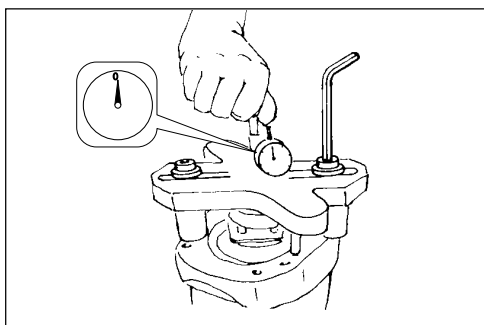
58 Zentrierscheibe aufsetzen.

Place centering disc.



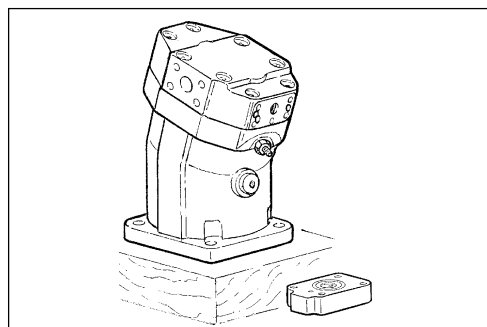
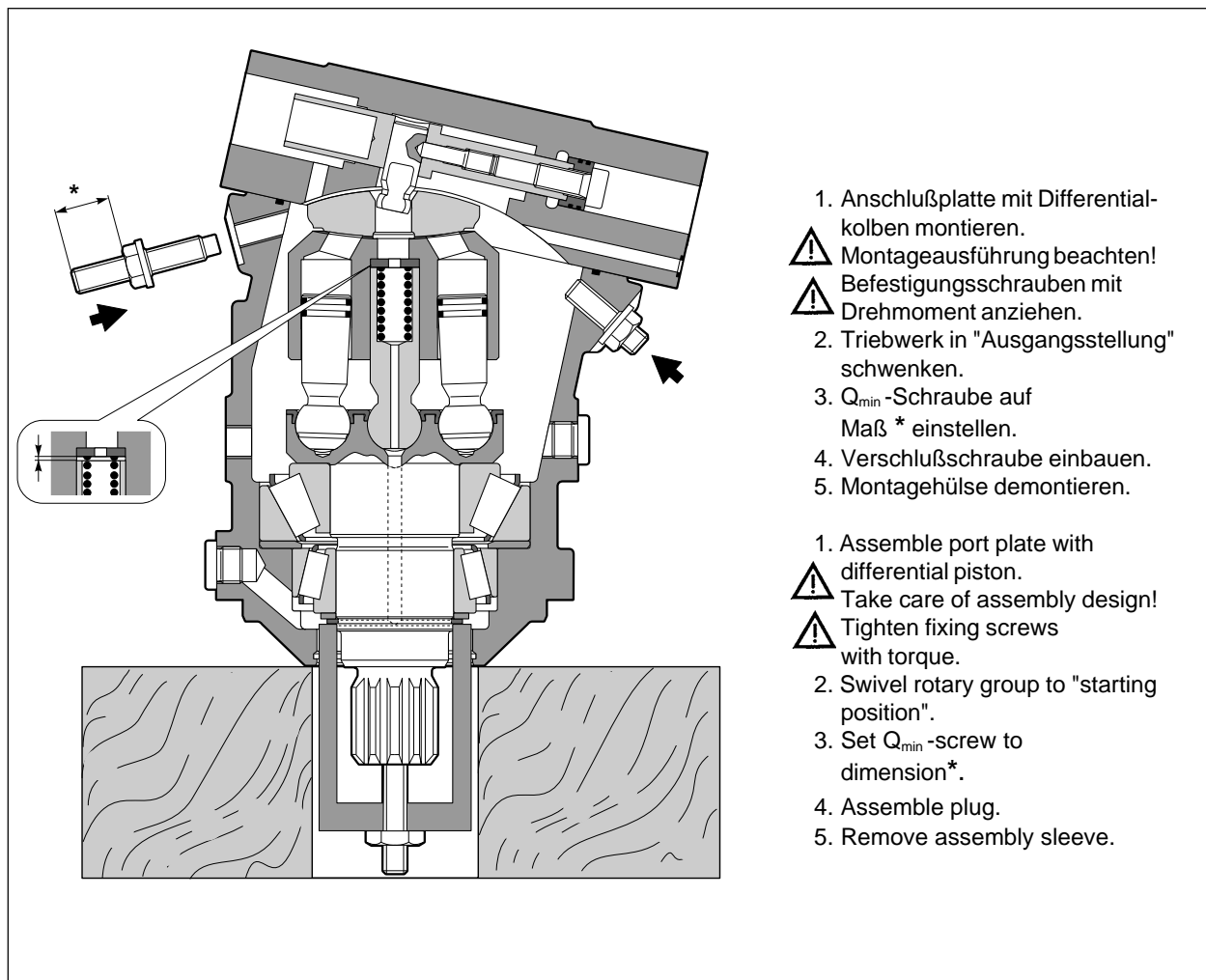
59 Meßvorrichtung aufbauen.

Mount measuring device.



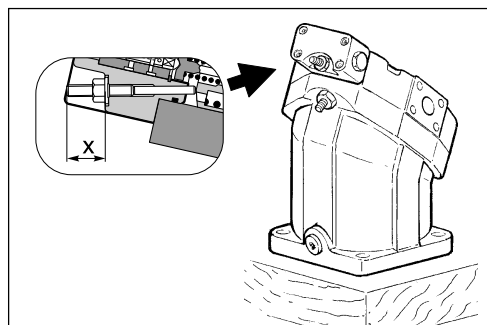
60 Maß X überprüfen.

Check dimension X.

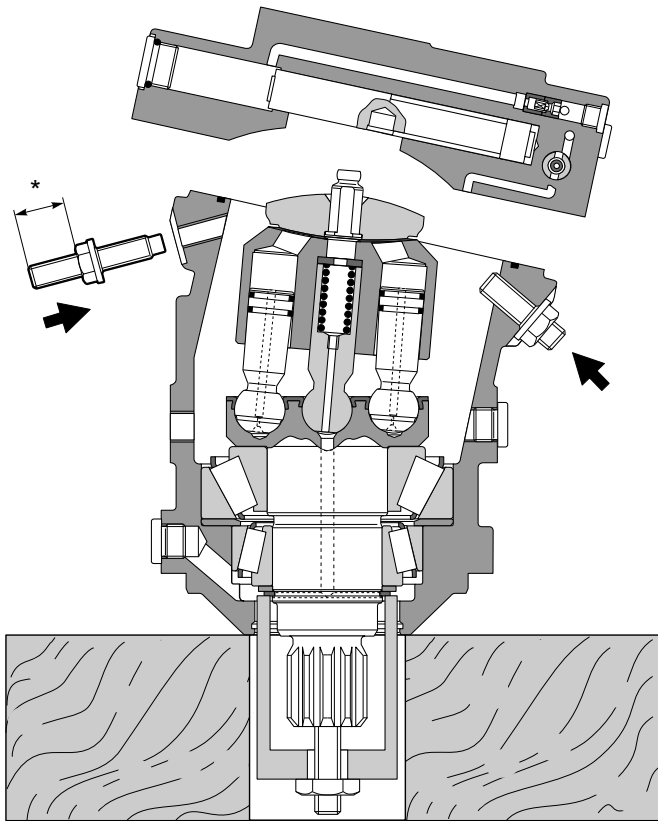


- 62 Deckel montieren.
 Assemble cover.

61

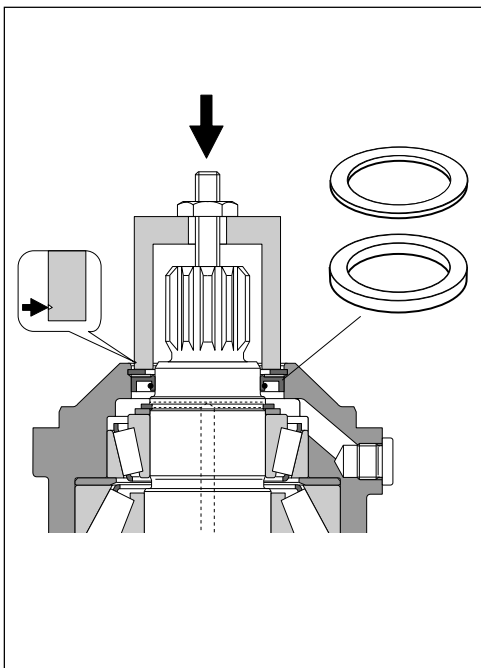


- 63 Steuerteil montieren.
 Assemble control components.



1. Anschlußplatte mit Gleichgangkolben montieren.
⚠ Montageausführung beachten!
- ⚠ Befestigungsschrauben mit Drehmoment anziehen.
2. Triebwerk in "Ausgangsstellung" schwenken.
3. Q_{min} -Schraube auf Maß * einstellen.
4. Verschlussschraube einbauen.
5. Montagehülse demontieren.

1. Assemble port plate with synchronizing piston.
⚠ Take care of assembly design!
- ⚠ Tighten fixing screws with torque.
2. Swivel rotary group to "starting position".
3. Set Q_{min} -screw to dimension *.
4. Assemble plug.
5. Remove assembly sleeve.



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Wellendichtring, Scheiben und Sicherungsring montieren.
Mit Montagehülse einpressen.

- ⚠ Einpresstiefe beachten!

Assemble shaft seal, disc and safety ring.
Press-in with assembly sleeve.

- ⚠ Take care of press-in depth.

64

Anziehdrehmomente Tightening torques

Reparaturanleitung A6VM Repair Instructions A6VM

Anziehdrehmomente für Schaftschrauben (Metrisches ISO-Regelgewinde)

Die nebenstehenden Werte für Anziehdrehmomente gelten nur für Schaftschrauben mit metrischem ISO-Regelgewinde und Kopfauflagemmaßen nach DIN 912, DIN 931 und DIN 933. Außerdem gelten diese Werte nur für leicht oder nicht geölte, unbehandelte Oberflächen, sowie nur bei Verwendung von Drehmoment- und Kraftbegrenzungsschlüsseln.	Gewindegröße	Festigkeitsklassen		
		8.8	10.9	12.9
	Anziehdrehmoment(Nm)			
	M 3	1,1	1,6	1,9
	M 4	2,9	4,1	4,9
	M 5	6	8,5	10
	M 6	10	14	17
	M 8	25	96	41
	M10	49	69	83
	M12	86	120	145
	M14	135	190	230
	M16	210	295	355
	M18	290	405	485
	M 20	410	580	690
	M 22	550	780	930
	M 24	710	1000	1200
	M 27	1050	1500	1800
	M 30	1450	2000	2400

Tightening torques for shaft bolts (Metric ISO Standard Thread)

The values for tightening torques shown in the table are valid only for shaft bolts with metric ISO- standard threads and head support surface dimensions in accordance with DIN 912, DIN 931 and DIN 933. These values are also valid only for light or uncoiled, untreated surface as well as for use only with torque-indicating wrenches and force limiting tools.	Thread size	Strength Classes		
		8.8	10.9	12.9
	Tightening Torque (lb.ft)			
	M 3	0,8	1,2	1,4
	M 4	2,1	3,0	3,6
	M 5	4,4	6,3	7,4
	M 6	7,4	10,3	12,5
	M 8	18,4	25,8	30,2
	M10	36,1	50,9	61,2
	M12	63,4	88,4	106,9
	M14	99,5	140,0	169,5
	M16	154,8	217,4	261,6
	M18	213,7	298,5	357,4
	M 20	302,2	427,5	508,5
	M 22	405,4	574,9	685,4
	M 24	523,5	737,0	884,4
	M 27	773,9	1105,5	1326,6
	M 30	1068,7	1474,0	1768,8

Anziehdrehmomente für Verschlussschrauben VSTI (Metrisches Feingewinde)

Gewindegröße	Bezeichnung	Anziehdrehmoment(Nm)
M 8 x 1	VSTI 8 x 1 -ED/SA	= 5
M 10 x 1	VSTI 10 x1 -ED	= 10
M 12 x 1,5	VSTI 12 x 1,5 -ED	= 20
M 14 x 1,5	VSTI 14 x 1,5 -ED	= 30
M 16 x 1,5	VSTI 16 x 1,5 -ED/SA	= 30
M 18 x 1,5	VSTI 18 x 1,5 -ED/SA	= 40
M 20 x 1,5	VSTI 20 x 1,5 -ED/SA	= 50
M 22 x 1,5	VSTI 22 x 1,5 -ED	= 60
M 26 x 1,5	VSTI 16 x 1,5 -ED/SA	= 70
M 27 x 2	VSTI 27 x 2 -ED	= 90
M 30 x 1,5	VSTI 30 x 1,5 -ED/SA	= 100
M 33 x 2	VSTI 33 x 2 -ED/SA	= 120
M 42 x 2	VSTI 42 x 2 -ED/SA	= 200
M 48 x 2	VSTI 48 x 2 -ED	= 300

Tightening torques for locking screws VSTI (Metric ISO fine thread)

Thread size	Designation	Tightening torques (lb.ft)
M 8 x 1	VSTI 8 x 1 -ED/SA	= 4
M 10 x 1	VSTI 10 x1 -ED	= 7
M 12 x 1,5	VSTI 12 x 1,5 -ED	= 15
M 14 x 1,5	VSTI 14 x 1,5 -ED	= 22
M 16 x 1,5	VSTI 16 x 1,5 -ED/SA	= 22
M 18 x 1,5	VSTI 18 x 1,5 -ED/SA	= 29
M 20 x 1,5	VSTI 20 x 1,5 -ED/SA	= 37
M 22 x 1,5	VSTI 22 x 1,5 -ED	= 44
M 26 x 1,5	VSTI 16 x 1,5 -ED/SA	= 51
M 27 x 2	VSTI 27 x 2 -ED	= 66
M 30 x 1,5	VSTI 30 x 1,5 -ED/SA	= 74
M 33 x 2	VSTI 33 x 2 -ED/SA	= 88
M 42 x 2	VSTI 42 x 2 -ED/SA	= 147
M 48 x 2	VSTI 48 x 2 -ED	= 220

Anziehdrehmomente für Seal-Lock Bundmuttern (Metrisches ISO-Regelgewinde)

Die nebenstehenden Werte für Anziehdrehmomente gelten nur für Seal-Lock Bundmuttern der Festigkeitsklasse 8.8 mit metrischem ISO-Regelgewinde.	Gewindegröße	Festigkeitsklassen		
		8.8	10.9	12.9
	Anziehdrehmoment (Nm)			
	M 6	10		
	M 8	22		
	M 10	40		
	M 12	69		
	M 14	110		
	M 16	170		

Tightening torques for seal-lock nuts (Metric ISO-Standard Thread)

The values for tightening torques shown in the table are valid only for seal-lock nuts of the strength class 8.8 and with metric ISO-standard thread.	Thread size	Strength classes		
		8.8	10.9	12.9
	Tightening torque (lb.ft)			
	M 6	7,4		
	M 8	16,2		
	M 10	29,5		
	M 12	50,9		
	M 14	81,1		
	M 16	125,3		

Anziehdrehmomente für Linsenschrauben mit Kreuzschlitz DIN 7985 (Metrisches ISO-Regelgewinde)

Die nebenstehenden Werte für Anziehdrehmomente gelten nur für Linsenschrauben mit Kreuzschlitz DIN 7985 der Festigkeitsklasse 8.8 mit metrischem ISO-Regelgewinde	Gewindegröße	Festigkeitsklassen		
		8.8	10.9	12.9
	Anziehdrehmoment(Nm)			
	M 3	1,1		
	M 4	2,9		
	M 5	6		
	M 6	10		
	M 8	25		
	M10	49		

Tightening torques for cross-slotted lens head screws DIN 7985 (Metric ISO- Standard Thread)

The values for tightening torques shown in the table are valid only for cross-slotted lens head screws DIN 7985 of the strength class 8.8 and with metric ISO-standard thread.	Thread size	Strength classes		
		8.8	10.9	12.9
	Tightening torques (lb.ft)			
	M 3	0,8		
	M 4	2,1		
	M 5	4,4		
	M 6	7,4		
	M 8	18,4		
	M10	36,1		

Allgemein

- Machen Sie sich mit der Ausstattung der Maschine vertraut.
- Fahren Sie die Maschine nur, wenn Sie sich völlig mit den Bedien- und Steuerelementen sowie der Arbeitsweise der Maschine vertraut gemacht haben.
- Benutzen Sie Ihre Schutzausrüstung wie Schutzhelm, Sicherheitsschuhe und Gehörschutz.
- Machen Sie sich mit Ihrem Arbeitsgebiet vertraut.
- Benutzen Sie die Maschine nur für den ihr zugeordneten Zweck.

Beachten Sie bitte die Richtlinien der Berufsgenossenschaft und des Maschinenherstellers



General advice

- Make yourself familiar with the equipment of the machine.
- Only operate the machine if you are completely familiar with the operating and control elements as well as the functioning of the machine.
- Use your safety equipment like helmet, safety shoes and hearing protection.
- Make yourself familiar with your working field.
- Only operate the machine for its intended purpose.

Please observe the guidelines of the Professional Association and the machine manufacturer.



Vor dem Start

- Beachten Sie die Bedienungshinweise vor dem Starten.
- Prüfen Sie die Maschine auf auffällige Fehler.
- Fahren Sie die Maschine nicht mit defekten Instrumenten, Kontrollleuchten oder Steuerorganen.
- Alle Schutzvorrichtungen müssen fest auf ihrem Platz sein.
- Nehmen Sie keine losen Gegenstände mit bzw. befestigen Sie diese an der Maschine.
- Halten Sie die Maschine von öligem und zündfähigem Material frei.
- Prüfen Sie vor dem Besteigen der Maschine, ob sich Personen oder Hindernisse neben oder unter der Maschine befinden.
- Vorsicht beim Besteigen der Maschine, benutzen Sie Treppen und Griffe.
- Stellen Sie vor dem Start Ihren Sitz ein.

Before starting

- Observe the operating instructions before starting.
- Check the machine for remarkable faults.
- Do not operate the machine with defective instruments, warning lights or control elements.
- All safety devices must be in a secure position.
- Do not carry with you movable objects or secure them to the machine.
- Keep oily and inflammable material away from the machine.
- Before entering the driver's cabin, check if persons or obstacles are beside or beneath the machine.
- Be careful when entering the driver's cabin, use stairs and handles.
- Adjust your seat before starting.

Starten

- Beim Starten müssen alle Bedienhebel in "Neutralstellung" stehen.
- Die Maschine nur vom Fahrersitz aus Starten.
- Prüfen Sie die Anzeigeeinstrumente nach dem Start, um sicher zu gehen, daß alles ordnungsgemäß funktioniert.
- Lassen Sie die Maschine nicht unbewacht, während der Motor läuft.
- Beim Start mit Batterieverbindingskabeln verbinden Sie Plus mit Plus und Minus mit Minus. Massekabel (Minus) immer zuletzt anschliessen und zuerst abtrennen.

Vorsicht

- Auspuffgase sind lebensgefährlich. Bei Start in geschlossenen Räumen für ausreichende Luftzufuhr sorgen!

Hydraulikanlage

1. Hydraulikanlage steht unter hohem Druck!



Unter hohem Druck austretende Hochdruck-Flüssigkeiten (Kraftstoff, Hydrauliköl) können die Haut durchdringen und schwere Verletzungen verursachen. Daher sofort einen Arzt aufsuchen, da anderenfalls schwere Infektionen entstehen können!

2. Bei der Suche nach Leckstellen wegen Verletzungsgefahr geeignete Hilfsmittel verwenden!
3. Vor Arbeiten an der Hydraulikanlage diese unbedingt drucklos machen und angebaute Geräte absenken!
4. Bei Arbeiten an der Hydraulikanlage unbedingt Motor abstellen und Traktor gegen Wegrollen sichern (Feststellbremse, Unterlegkeil)!
5. Beim Anschließen von Hydraulikzylindern und -motoren ist auf vorgeschriebenen Anschluß der Hydraulikschläuche zu achten!
6. Bei Vertauschen der Anschlüsse umgekehrte Funktionen (z.B. Heben/Senken) - Unfallgefahr!
7. Hydraulikschlauchleitungen regelmäßig kontrollieren und bei Beschädigung und Alterung austauschen! Die Austauschschlauchleitungen müssen den technischen Anforderungen des Geräteherstellers entsprechen!



Öle, Kraftstoffe und Filter ordnungsgemäß entsorgen!

Start

- When starting all operating levers must be in "neutral position".
- Only start the machine from the driver's seat
- Check the indicating instruments after start to assure that all functions are in order.
- Do not leave the machine unobserved when the motor is running.
- When starting with battery connection cables connect plus with plus and minus with minus. Always connect mass cable (minus) at last and cut off at first.

Attention

- Exhaust gas is dangerous. Assure sufficient fresh air when starting in closed rooms!

Hydraulic equipment

1. Hydraulic equipment is standing under high pressure.



High pressure fluids (fuel, hydraulic oil) which escape under high pressure can penetrate the skin and cause heavy injuries. Therefore immediately consult a doctor as otherwise heavy infections can be caused.

2. When searching leakages use appropriate auxiliary devices because of the danger of accidents.
3. Before working at the hydraulic equipment, lower pressure to zero and lower working arms of the machine.
4. When working at the hydraulic equipment, absolutely stop motor and secure tractor against rolling away (parking brake, shim)!
5. When connecting hydraulic cylinders and motor pay attention to correct connection of hydraulic flexible hoses.
6. In case of exchanging the ports, the functions are vice versa (f. ex. lift-up/lower) - danger of accidents!
7. Check hydraulic flexible hoses regularly and replace them in case of damage or wear! The new hose pipes must comply with the technical requirements of the machine manufacturer!



Orderly disposal or recycling of oil, fuel and filters!

Hinweis!

Um eine ordnungsgemäße Abwicklung von Ersatzteil-Aufträgen sicherzustellen, muß die Bestellung folgende Angaben enthalten:

Typenschlüssel
Typ-Nr.
Fabrikations-Nr.
Baugruppe
Position
Benennung

Zur Reparatur des Gerätes empfehlen wir die Verwendung von vormontierten und teilgeprüften Baugruppen.

Note!

In order to supply proper spare parts, please provide following specifications when ordering spares:

Type Code
Type Number
Serial Number
Assembly Group
Item
Designation

In repairing the unit, we recommend the use of pre-assembled partially tested assembly groups.

HYPROMATIK GmbH

Glockeraustraße 2
D-89275 Elchingen
Postanschrift: Postfach 22 60, D-89012 Ulm
Telefon (0 73 08) 8 20
Telex 712538

Telefax (0 73 08) 72 74, 72 73

PRA 352 Series Planetary Axles

Maintenance Manual No. 9D



Planetary Axle Models

PRA 352 W2H
PRA 352 G2H
PRA 352 G2M
PRA 353 G2H
PRA 353 G2M
PRA 383 G2H
PROA 352 W2H
PROA 382 W2H

Service Notes



This publication provides maintenance and service procedures for Meritor PRA 352 series planetary axles. The information contained in this publication was current at the time of printing and is subject to revision without notice or liability.

1. You must understand all procedures and instructions before you begin maintenance and service procedures.
2. You must follow your company's maintenance and service guidelines.
3. You must use special tools, when required, to avoid serious personal injury and damage to components.

Meritor uses the following notations to alert the user of possible safety issues and to provide information that will help to 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 can help to make service quicker and easier.



This symbol indicates that fasteners must be tightened to a specific torque value.

Visit Our Web Site

Visit the Technical Library section of www.meritorauto.com for additional product and service information on Meritor's Heavy Vehicle Systems component lineup.

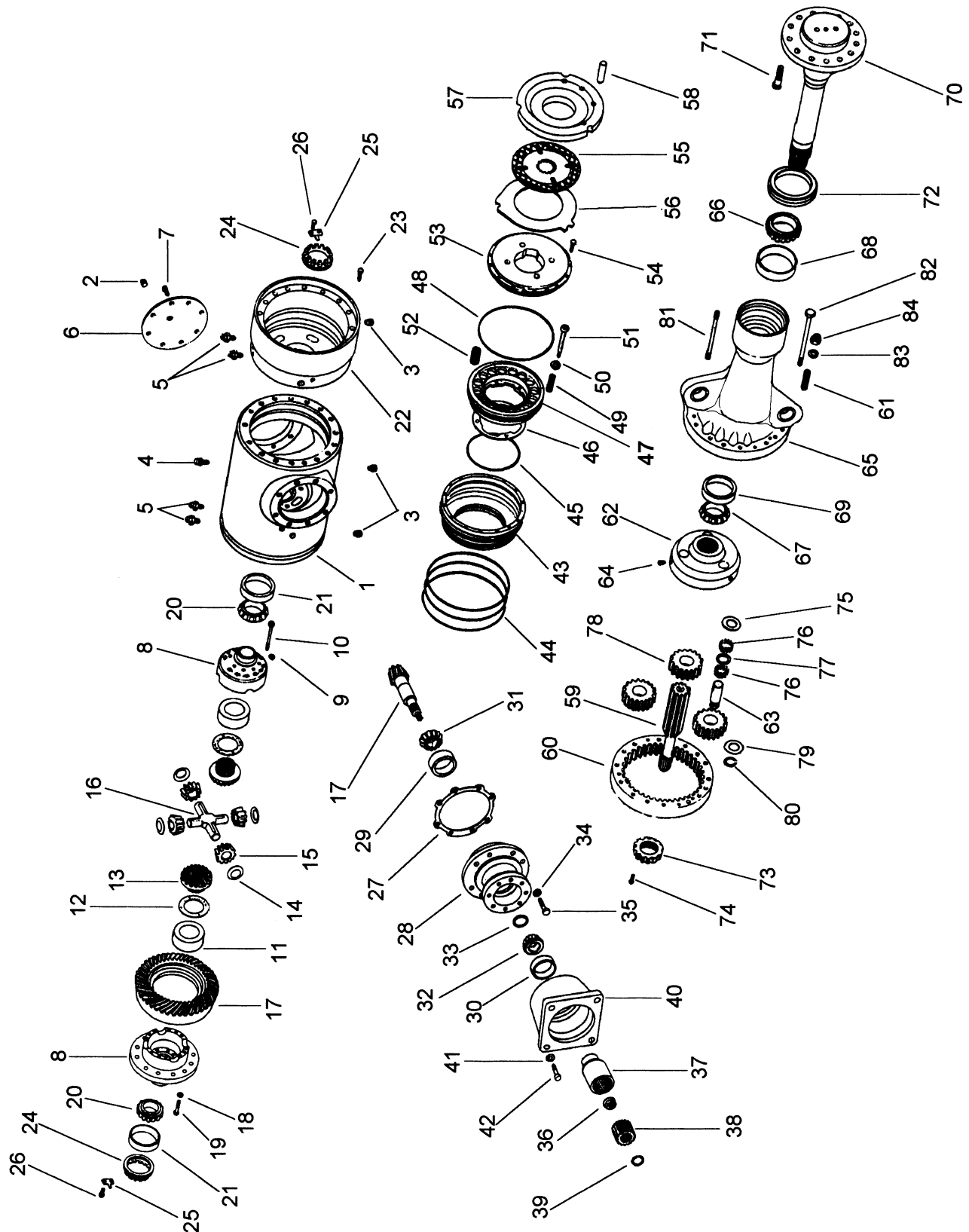
How to Order

Call Meritor's Customer Service Center at 800-535-5560.

Drivetrain Plus™ Technical Electronic Library (TEL) on CD

The CD includes product and service information on Meritor's Drivetrain Plus™ component lineup. \$20. Order TP-9853.

PRA 352 - Trumpet Variation No. 1

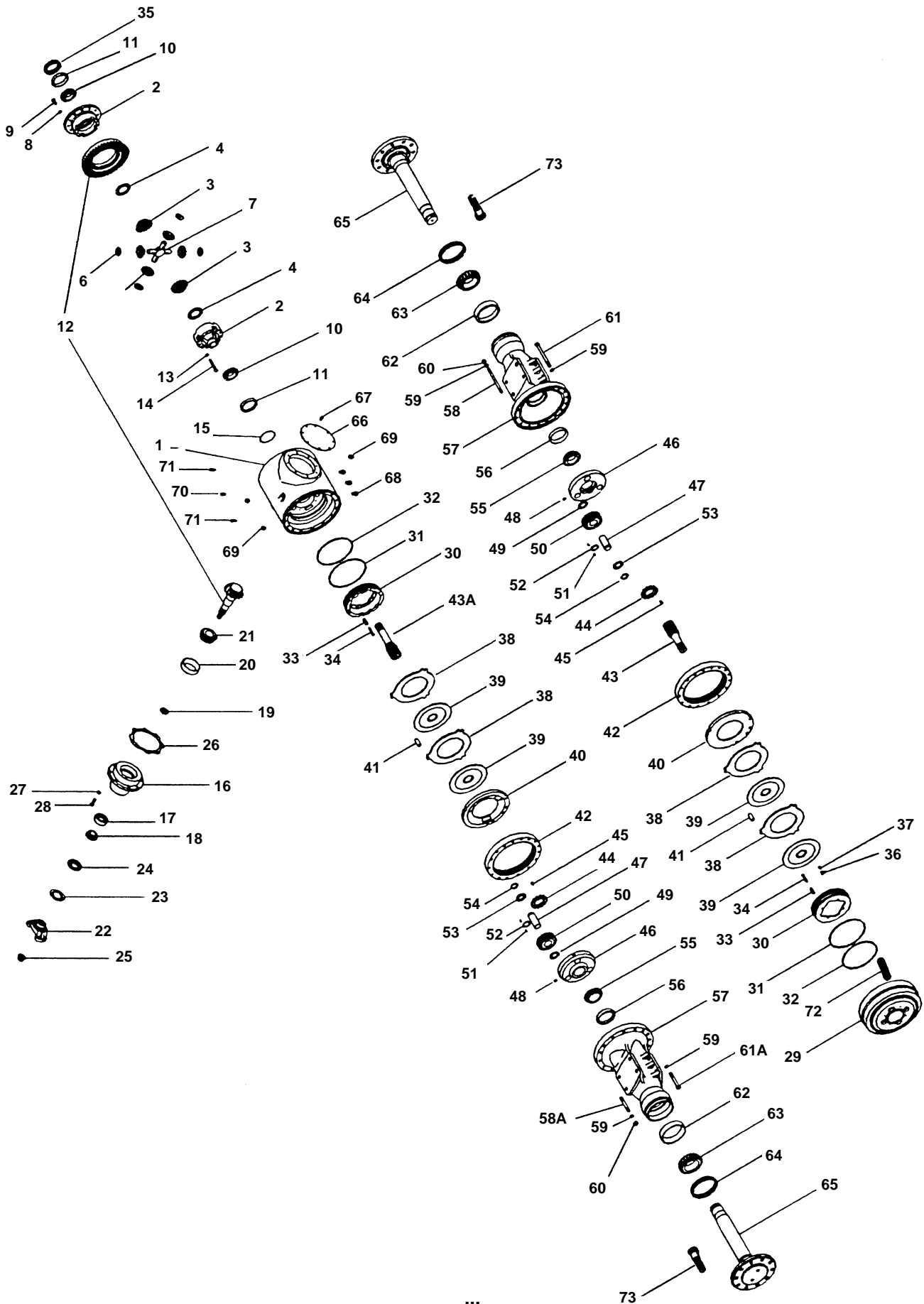


PRA 352 – Trumpet Variation No. 1

Item	Description
1	Central Housing
2	Level Plug
3	Drain Plug
4	Vent Plug
5	Hydraulic Line Bleeder
6	Cover
7	Capscrew
8	Differential Case Assembly
9	Washer
10	Capscrew
11	Spacer
12	Thrust Washer
13	Side Gear
14	Thrust Washer
15	Pinion Gear
16	Spider
17	Spiral Gear & Pinion
18	Washer
19	Capscrew
20	Bearing Cone
21	Bearing Cup
22	Brake Housing
23	Capscrew
24	Adjuster Ring
25	Adjuster Ring Lock
26	Capscrew
27	Pinion Cage Shim
28	Pinion Cage Assembly
29	Bearing Cup
30	Bearing Cup
31	Bearing Cone
32	Bearing Cone
33	Drive Pinion Shim
34	Washer
35	Capscrew
36	Pinion Nut
37	Driven Sleeve
38	Drive Sleeve
39	Snap Ring
40	Motor Adapter Flange
41	Washer
42	Capscrew

Item	Description
43	Outer Piston
44	Piston O-ring
45	Piston O-ring
46	Piston Brake Shim
47	Inner Piston
48	O-ring Piston
49	Spring
50	Washer
51	Bolt-Return Spring
52	Spring
53	Brake Actuating Plate
54	Capscrew
55	Friction Disc
56	Stationary Disc
57	Brake Reaction Plate
58	Brake Disc Lock Pin
59	Sun Gear
60	Ring Gear
61	Capscrew
62	Planetary Pinion Spider
63	Planetary Pinion Shaft
64	Capscrew
65	Housing
66	Bearing Cone
67	Bearing Cone
68	Bearing Cup
69	Bearing Cup
70	Output Axle Shaft
71	Wheel Bolt
72	Axle Shaft Oil Seal
73	Adjusting Nut
74	Adjusting Nut Lock Capscrew
75	Thrust Washer
76	Kit Rollers
77	Roller Spacer
78	Planetary Pinion
79	Washer
80	Snap Ring
81	Stud
82	Capscrew
83	Washer
84	Nut

PRA 352 – Trumpet Variation No. 2

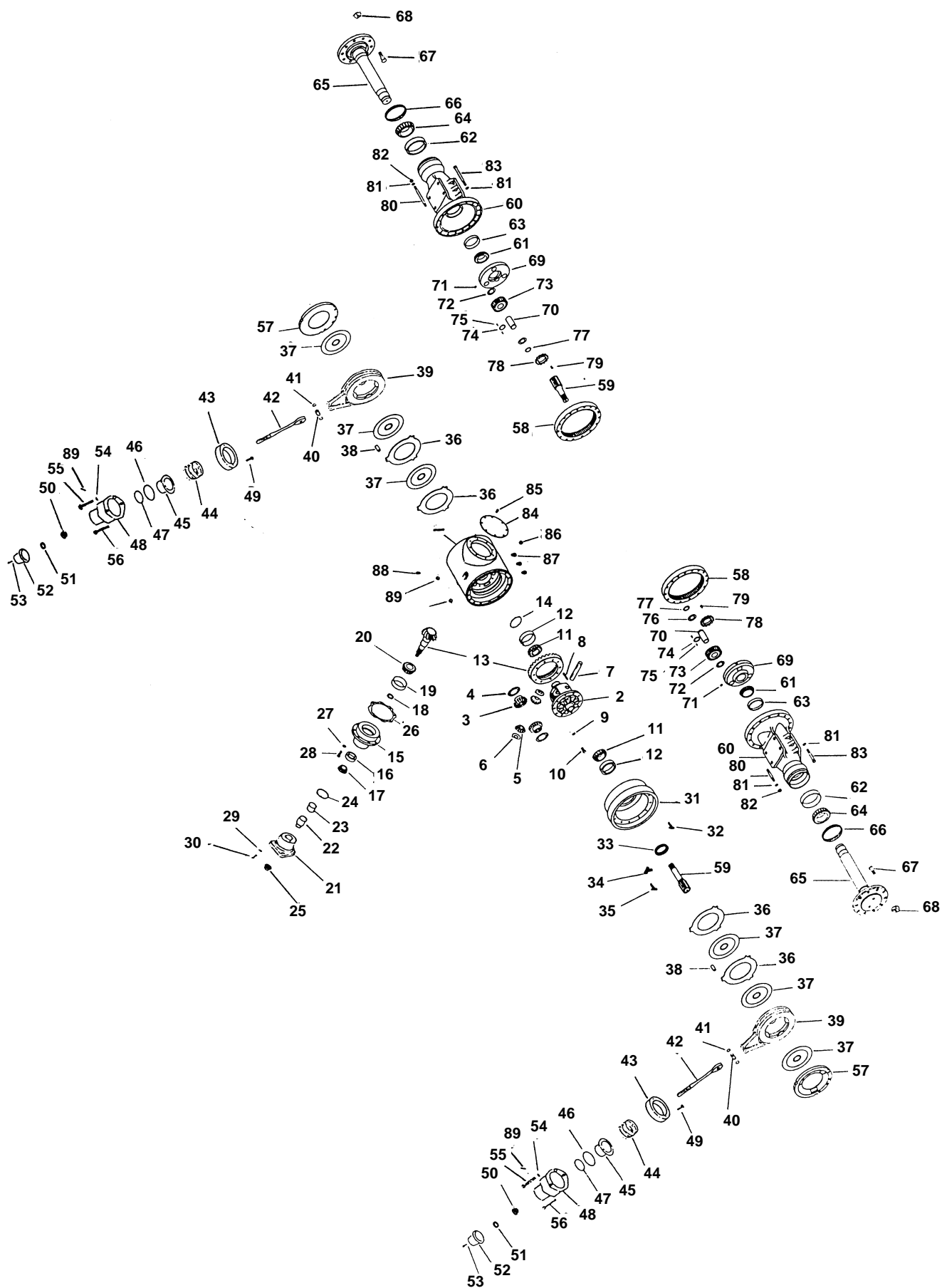


PRA 352 – Trumpet Variation No. 2

Item	Description
1	Center Housing
2	Differential Case Assembly
3	Side Gear
4	Side Gear Thrust Washer
5	Pinion Gear
6	Pinion Gear Thrust Washer
7	Spider Differential
8	Spiral Gear Capscrew Plain Washer
9	Spiral Gear Capscrew
10	Bearing Cone
11	Bearing Cup
12	Spiral Gear & Pinion Assembly
13	Differential Case Plain Washer
14	Differential Case Capscrew
15	Shim Differential Case
16	Pinion Cage
17	Bearing Cup
18	Bearing Cone
19	Pinion Bearing Spacer
20	Bearing Cup
21	Bearing Cone
22	Universal Joint Yoke
23	Oil Slinger
24	Oil Seal
25	Pinion Nut
26	Shim Pinion Cage
27	Pinion Cage Washer
28	Pinion Cage Capscrew
29	Brake Housing
30	Brake Piston
31	Oil Seal Piston
32	Oil Seal Piston
33	Piston Return Spring
34	Return Spring Bolt
35	Adjuster Ring
36	Adjuster Ring Lock
37	Adjuster Ring Lock Capscrew
38	Stationary Disc

Item	Description
39	Friction Disc
40	Brake Reaction Plate
41	Brake Disc Lock Pin
42	Ring Gear
43	Sun Gear, Short
43A	Sun Gear, Long
44	Adjusting Nut
45	Adjusting Nut Lock Capscrew
46	Planetary Pinion Flange
47	Shaft Planetary Pinion
48	Planetary Pinion Axle Capscrew
49	Planetary Pinion Thrust Washer
50	Planetary Pinion
51	Rollers
52	Spacer Rollers
53	Planetary Pinion Plain Washer
54	Snap Ring
55	Bearing Cone
56	Bearing Cup
57	Housing
58	Center Housing Stud
58A	Center Housing Stud
59	Washer
60	Center Housing Stud Nut
61	Center Housing Capscrew
61A	Center Housing Capscrew
62	Bearing Cup
63	Bearing Cone
64	Axle Shaft Oil Seal
65	Axle Shaft
66	Center Housing Cover
67	Center Housing Cover Capscrew
68	Drain Plug
69	Level Plug
70	Vent Plug
71	Hydraulic Bleeder
72	Capscrew
73	Wheel Bolt

PRA 353/383

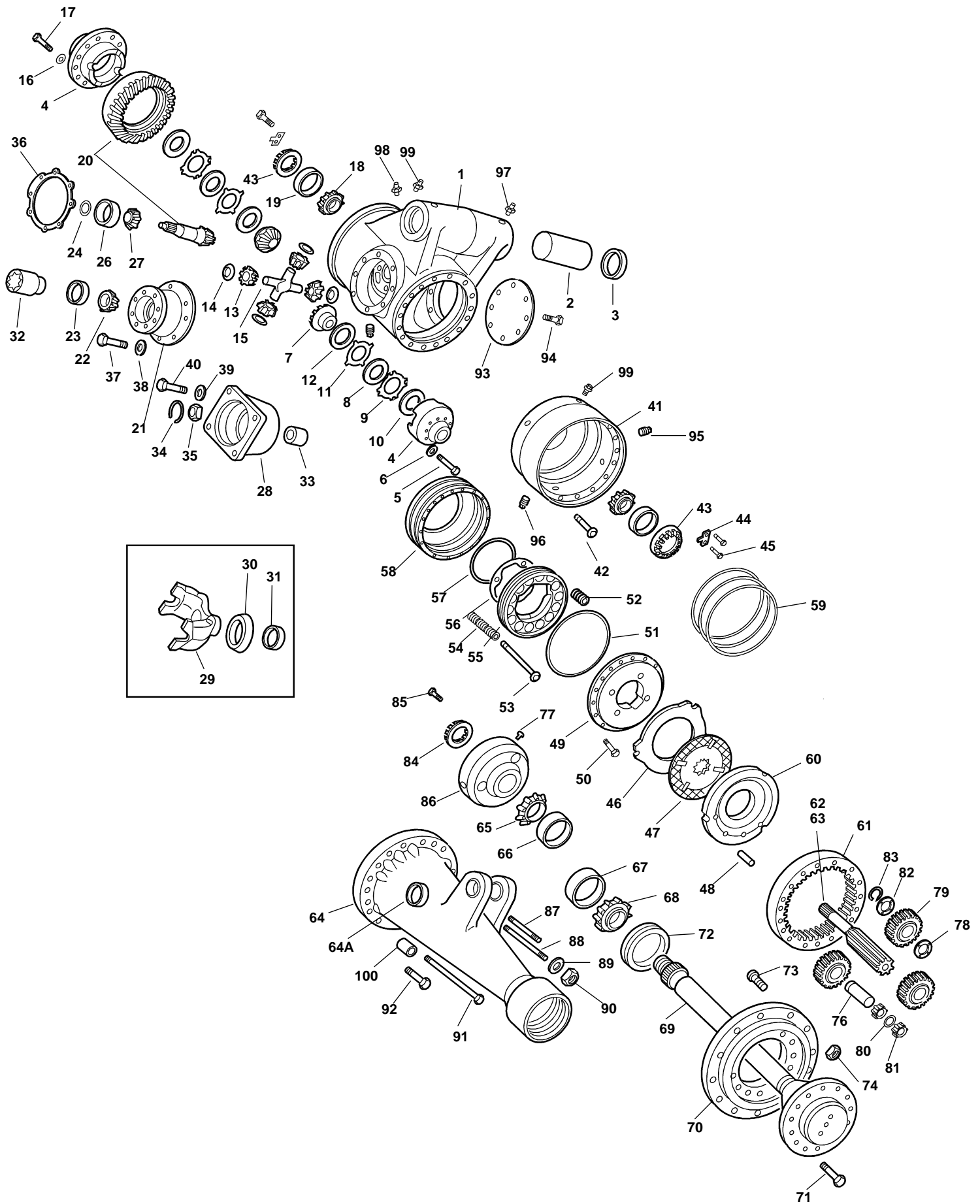


PRA 353/383

Item	Description
1	Center Housing
2	Differential Case
3	Side Gear
4	Thrust Washer
5	Pinion Gear
6	Thrust Washer
7	Differential Pinion Shaft
8	Pinion Shaft Lock Pin
9	Washer
10	Capscrew
11	Bearing Cone
12	Bearing Cup
13	Spiral Gear and Pinion
14	Differential Case Shim
15	Pinion Cage
16	Bearing Cup
17	Bearing Cone
18	Drive Pinion Shim
19	Bearing Cup
20	Bearing Cone
21	Motor Adapter Flange
22	Driven Sleeve
23	Drive Sleeve
24	Snap Ring
25	Pinion Nut
26	Pinion Cage Shim
27	Washer
28	Capscrew
29	Washer
30	Capscrew
31	Brake Housing
32	Capscrew
33	Adjuster Ring
34	Adjuster Ring Lock
35	Capscrew
36	Stationary Disc
37	Friction Disc
38	Brake Disc Lock Pin
39	Brake Assembly
40	Pin
41	Circlip
42	Brake Control Rod
43	Brake Cylinder Support
44	Spring
45	Brake Piston

Item	Description
46	O-ring
47	O-ring
48	Brake Cylinder
49	Capscrew
50	Adjusting Nut
51	Nut
52	Brake Cylinder Cover
53	Capscrew
54	Washer
55	Capscrew
56	Capscrew
57	Reaction Brake Plate
58	Ring Gear
59	Sun Gear
60	Housing
61	Bearing Cone
62	Bearing Cup
63	Bearing Cup
64	Bearing Cone
65	Axle Shaft
66	Axle Shaft Oil Seal
67	Wheel Bolt
68	Wheel Nut
69	Planetary Pinion Spider
70	Planetary Pinion Shaft
71	Capscrew
72	Thrust Washer
73	Planetary Pinion
74	Spacer
75	Kit Rollers
76	Washer
77	Snap Ring
78	Adjusting Nut
79	Adjusting Nut Lock Capscrew
80	Stud M14
81	Washer
82	Nut
83	Capscrew
84	Cover
85	Capscrew
86	Level Plug
87	Drain Plug
88	Vent Plug
89	Hydraulic Line Bleeder

PROA 352/382 (With Mechanical Drive Option)

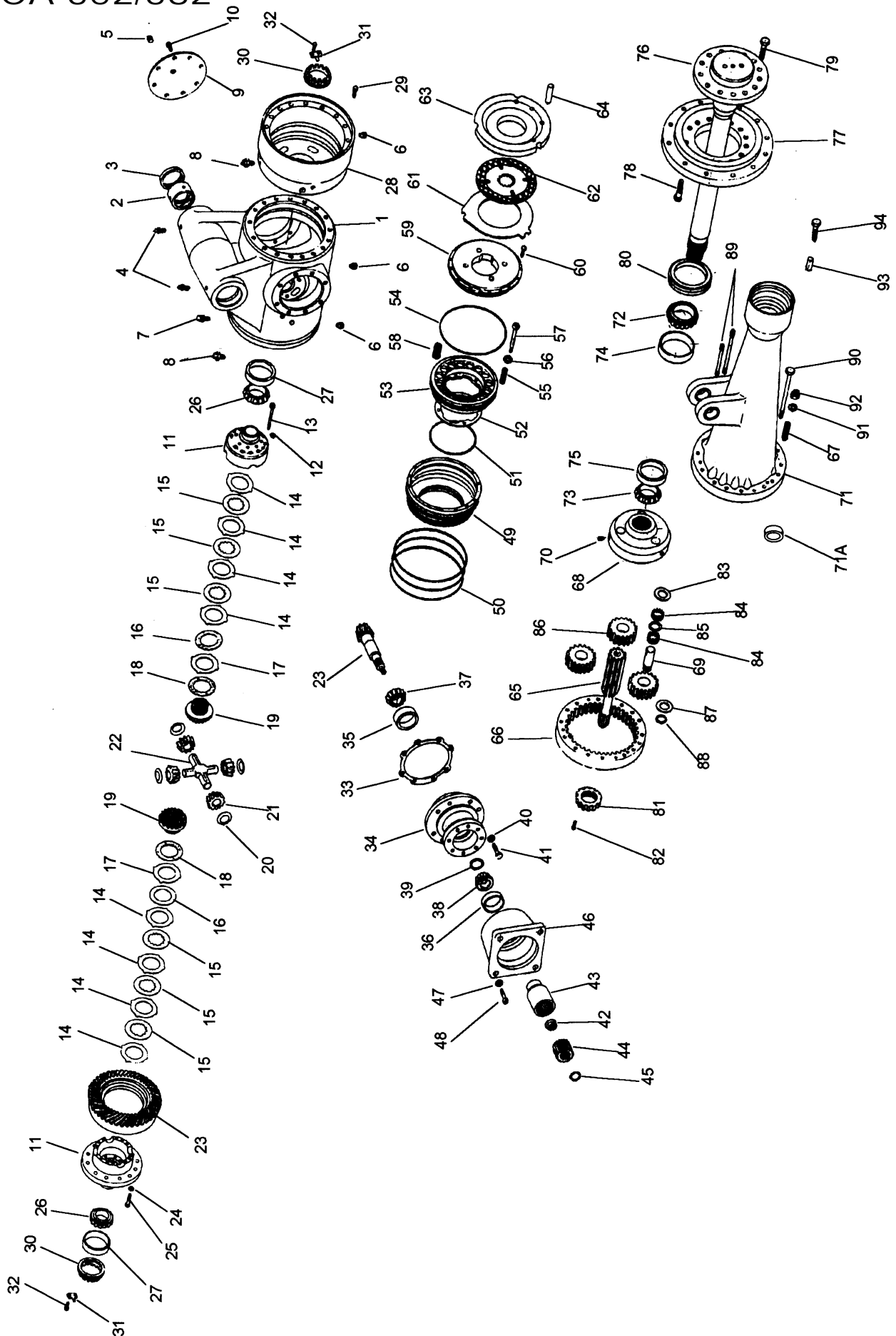


PROA 352/382 (With Mechanical Drive Option)

Item	Description
1	Main Housing
2	Bushing
3	Trunnion Oil Seal
4	Differential Case Assembly
5	Differential Case Capscrew
6	Differential Case Washer
7	Side Gear
8	Friction Discs Shim Pack
9	Friction Drive Disc
10	Friction Driven Discs
11	Compression Discs
12	Thrust Washer
13	Pinion Gear
14	Pinion Gear Thrust Washer
15	Spider
16	Gear Capscrew Washer
17	Gear Capscrew
18	Differential Case Cone Bearing
19	Differential Case Cup Bearing
20	Gear and Pinion Assembly
21	Pinion Bearing Case
22	Shaft Side Cone Bearing
23	Shaft Side Cup Bearing
24	Pinion Bearing Spacer
25	Not Shown
26	Head Side Cup Bearing
27	Head Side Cone Bearing
28	Adapter Flange
29	Universal Joint Yoke
30	Deflector
31	Pinion Oil Seal
32	Driven Sleeve
33	Drive Sleeve
34	Snap Ring
35	Pinion Nut
36	Pinion Bearing Cage Shim
37	Bearing Cage Capscrew Washer
38	Bearing Cage Capscrew
39	Flange Capscrew Washer
40	Flange Capscrew
41	Brake Housing
42	Brake Housing Capscrew
43	Adjusting Ring
44	Adjusting Ring Lock
45	Lock Capscrew
46	Stationary Disc
47	Friction Disc
48	Brake Disc Lock Pin
49	Action Plate
50	Bolt
51	Medium Oil Seal

Item	Description
52	Spring
53	Return Spring Capscrew
54	Return Spring
55	Inner Piston
56	Shim Pack
57	Small Oil Seal
58	Outer Piston
59	Oil Seal
60	Reaction Plate
61	Ring Gear
62	Short Sun Gear
63	Long Sun Gear
64	Axle Shaft Housing
64A	Bushing
65	Bearing Cone
66	Bearing Cup
67	Bearing Cup
68	Bearing Cone
69	Axle Shaft
70	Wheel Flange
71	Flange Capscrew
72	Axle Shaft Oil Seal
73	Wheel Capscrew
74	Wheel Nut
75	Not Shown
76	Planetary Gear Pin
77	Pin Capscrew
78	Flange Side Thrust Washer
79	Planetary Gear
80	Rollers Spacer
81	Rollers Kit
82	Thrust Washer
83	Snap Ring
84	Adjusting Nut
85	Adjusting Nut Lock Capscrew
86	Planetary Spider
87	Short Stud
88	Long Stud
89	Washer
90	Nut
91	Bolt
92	Brake Release Bolt
93	Main Housing Cap
94	Cap Capscrew
95	Level Plug
96	Drain Plug
97	Grease Plug
98	Vent Plug
99	Bleeder
100	Spacer

PROA 352/382



PROA 352/382

Item	Description
1	Center Housing
2	Bushing
3	Trunnion Oil Seal
4	Lubrication Fitting
5	Level Plug
6	Drain Plug
7	Vent Plug
8	Hydraulic Line Bleeder
9	Cover
10	Capscrew M8x1,25x16,0
11	Differential Case Assembly
12	Washer
13	Capscrew M10x1,5x80,0
14	Drive Disc
15	Driven Friction Disc
16	Clutch Disc Shim
17	Compression Disc
18	Thrust Washer
19	Side Gear
20	Thrust Washer
21	Pinion Gear
22	Spider
23	Spiral Gear & Pinion
24	Washer
25	Capscrew
26	Bearing Cone
27	Bearing Cup
28	Brake Housing
29	Capscrew
30	Adjuster Ring
31	Adjuster Ring Lock
32	Capscrew
33	Pinion Cage Shim
34	Pinion Cage
35	Bearing Cup
36	Bearing Cup
37	Bearing Cone
38	Bearing Cone
39	Drive Pinion Shim
40	Washer
41	Capscrew
42	Pinion Nut
43	Driven Sleeve
44	Drive Sleeve
45	Snap Ring
46	Motor Adapter Flange
47	Washer
48	Capscrew

Item	Description
49	Brake Piston Assembly
50	O-ring Piston
51	O-ring Piston
52	Piston Brake Shim
53	Brake Piston
54	O-ring Piston
55	Spring
56	Washer
57	Bolt-Return Spring
58	Spring
59	Brake Actuating Plate
60	Capscrew
61	Stationary Disc
62	Friction Disc
63	Brake Reaction Plate
64	Brake Disc Lock Pin
65	Sun Gear
66	Ring Gear
67	Capscrew
68	Planetary Pinion Spider
69	Planetary Pinion Shaft
70	Capscrew
71	Housing
71A	Bushing
72	Bearing Cone
73	Bearing Cone
74	Bearing Cup
75	Bearing Cup
76	Output Axle Shaft
77	Wheel Flange
78	Wheel Bolt
79	Capscrew
80	Axle Shaft Oil Seal
81	Adjusting Nut
82	Adjusting Nut Lock Capscrew
83	Thrust Washer
84	Kit Rollers
85	Spacer
86	Planetary Pinion
87	Washer
88	Snap Ring
89	Stud
90	Capscrew
91	Washer
92	Nut
93	Spacer
94	Brake Release Capscrew

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Description


The Meritor PRA 352 Series Planetary Axle is a double reduction single speed unit that has:

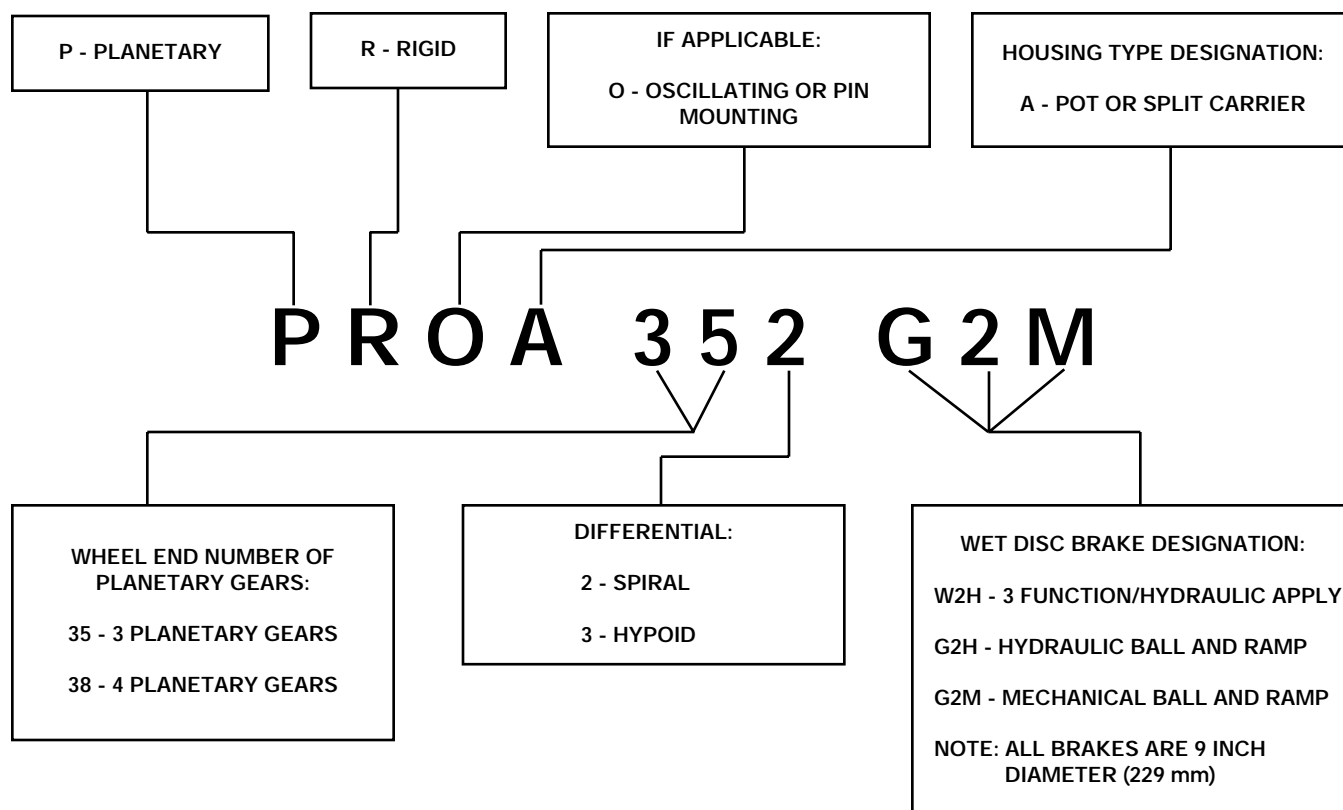
- A hypoid or spiral pinion and ring gear set
- Bevel gears in the differential assembly with 2 or 4 differential pinion gears
- A differential case assembly mounted on two tapered roller bearings
- A planetary system with 3 or 4 planetary pinion gears
- A trunnion mounting option
- An oil bath disc brake system in three different designs:
 1. Ball and Ramp
 2. Hydraulic Apply Wet Disc
 3. Three Function Brake

Identification

A tag on the main housing correctly identifies basic axle specifications.

When ordering parts, be sure to specify information stamped on the name plate. This information will allow easy identification of correct parts.

 MERITOR™ <small>A Heritage of Rockwell Technology</small>	
MODEL	
CUST. NO.	
PART NO. _____	RATIO
SER. NO. _____	DATE



Section 2 Removal and Disassembly



Remove Axle

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

WARNING

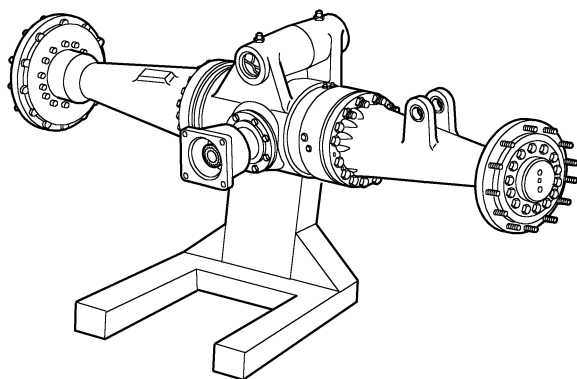
Support vehicle with safety stands. Do not work under a vehicle only supported by jacks. Jacks can slip or fall over and cause serious personal injury.

NOTE

While the housing configuration of the axle you service may differ from the figures shown, service instructions remain the same for all axle models addressed in this manual.

1. Make sure vehicle is on level surface.
2. Place blocks under wheels not being serviced to keep vehicle from moving.
3. Raise vehicle so that wheels to be serviced are off the ground. Support vehicle with safety stands.
4. Remove axle from vehicle.
5. Plug fluid lines that were connected to axle.
6. Place axle in appropriate repair stand. Center main housing on stand. **Figure 2.1.**
7. Remove drain plugs from brake housing and main housing with 12 mm Allen wrench. Drain axle oil.

Figure 2.1



The PROA 352 axle is shown to illustrate procedures in this maintenance manual

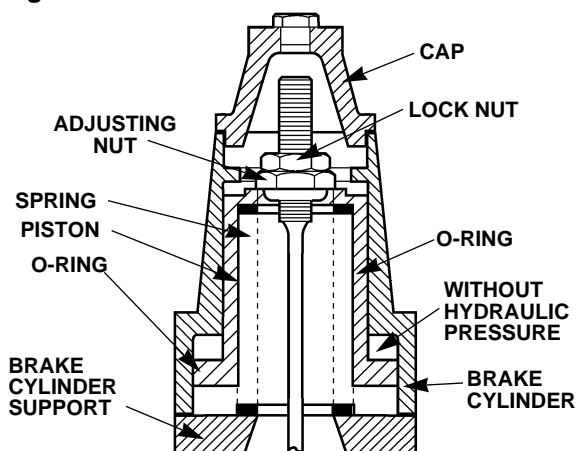
Disassemble Ball and Ramp Brake

NOTE

- *Identify all parts before disassembly to ensure proper reassembly.*
- *To disassemble hydraulic apply wet disc brake, go to page 5.*
- *To disassemble three function brake, go to page 5.*

Figure 2.2.

Figure 2.2



1. Remove brake cylinder cover.
2. Remove nut and nut lock.
3. Loosen brake cylinder capscrews.
4. Remove brake cylinder assembly from main housing.

⚠ CAUTION

Loosen and remove brake cylinder capscrews alternately to avoid spring load damage to parts.

5. Disassemble brake cylinder assembly. Remove brake release capscrew. Loosen and remove brake cylinder capscrews alternately to avoid spring load to be supported by only one capscrew.
6. Remove spring, piston and O-ring seals. Do not cut or scratch them.
7. Clean cylinder and brake support surfaces. Do not damage ground surfaces.
8. Put parts of each brake cylinder assembly in separate plastic bags to avoid mixing them.

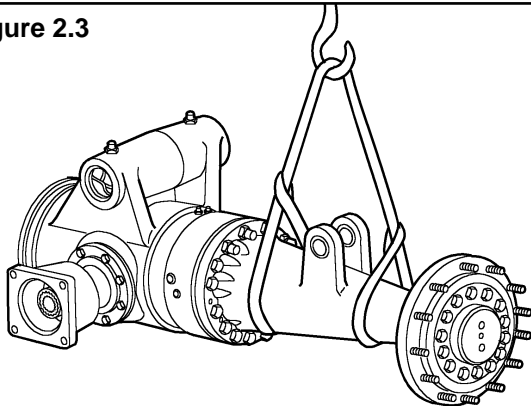
Disassemble Trumpet Assembly

⚠ WARNING

To avoid serious personal injury and possible damage to components, be very careful when using lifting devices during removal and disassembly procedures.

- Inspect to make sure that neither lifting strap is damaged.
 - Do not subject lifting straps to any shock or drop loading.
1. Support trumpet to be serviced with lifting device. **Figure 2.3.**
 2. Loosen and remove trumpet nuts and bolts.

Figure 2.3



NOTE

For three function brake design: If bleeder and pressure ports of brake piston are open, the trumpet assemblies and ring gear will come off the center section easily without using puller holes. Cover pressure ports with rags to avoid contact with escaping oil.

3. Use two puller holes in trumpet flange to remove trumpet assembly from main housing.

NOTE

Use steps 1 through 3 to remove second trumpet assembly.

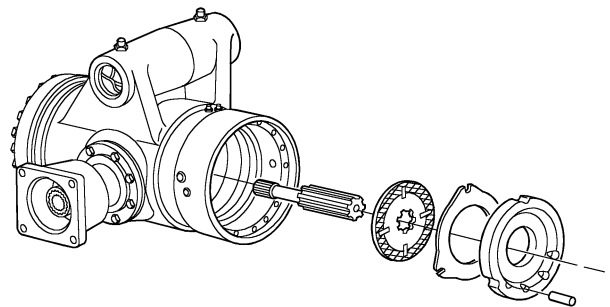
4. Remove ring gears from both sides through the two threaded puller holes.
(Thread: M14 x 1.5 x 6 g).

⚠ WARNING

Do not hit steel parts with a steel hammer during removal and disassembly procedures. Parts can break and cause serious personal injury.

5. From main housing, remove sun axle shaft, spacers (if used), compression plates, stationary discs, friction discs, lock pins and expansive plate assemblies. To make lock pin removal easier, hit main housing with brass hammer. **Figure 2.4.**

Figure 2.4



Section 2

Removal and Disassembly

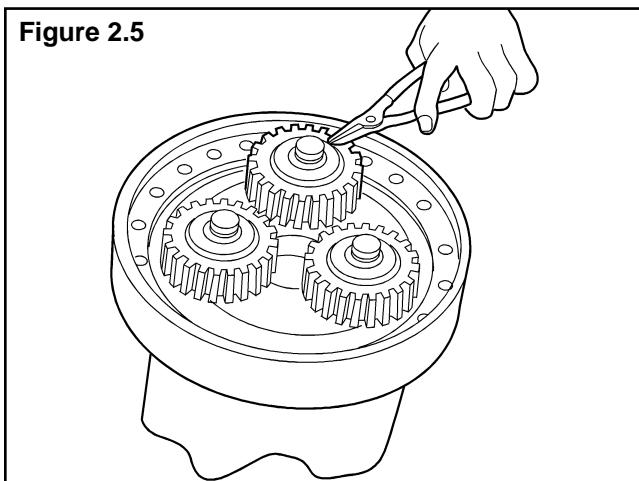


Disassemble Planetary System and Axle Shaft

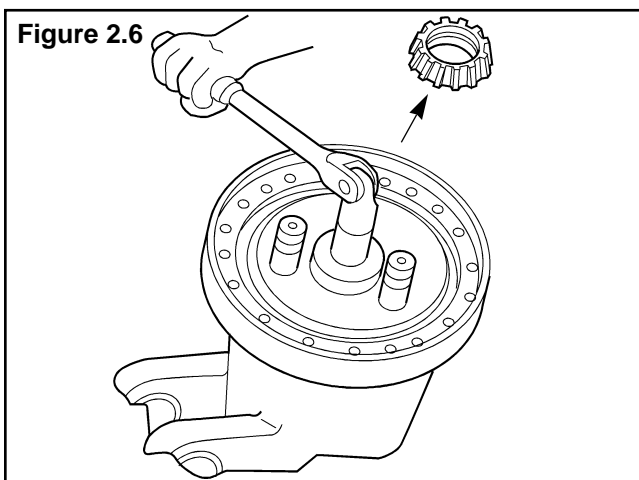
NOTE

Before removing planetary gears, place housing in horizontal position or place cloth between pinion gear flange and housing flange to keep rollers from falling down into housing. To avoid mixing them, be sure to put rollers and spacers of each planetary gear in separate plastic bags.

1. With pliers, remove snap rings. Disassemble planetary gears and rollers.
Figure 2.5.

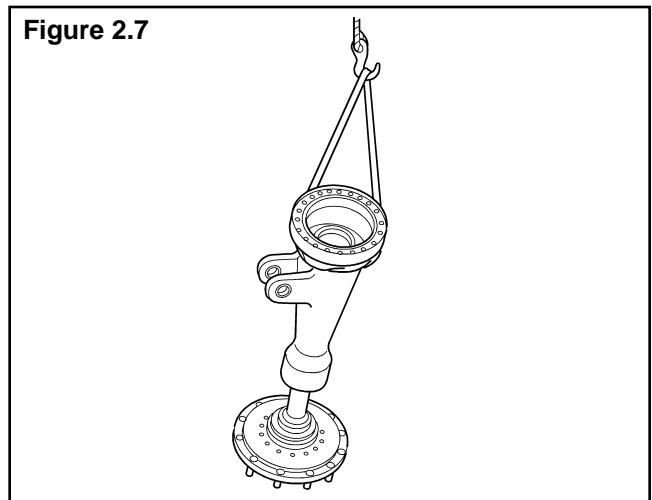


2. Remove axle shaft adjusting nut lock.
3. Remove axle shaft adjusting nut lock with special tool, illustrated in Section 6. **Figure 2.6.**



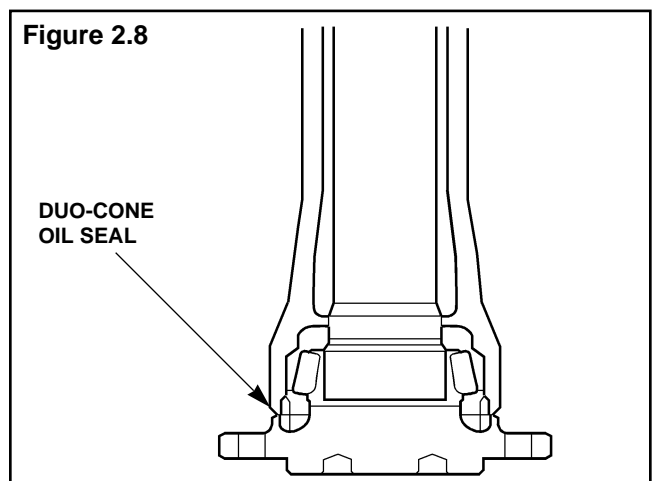
4. Remove pinion gear flange. Lift it through planetary gear pins.
5. Remove axle shaft assembly and cone bearing. If necessary, use press. **Figure 2.7.**

Figure 2.7



6. If necessary to change bearing cups, remove them with correct puller.
7. If necessary to replace DUO-CONE oil seal or axle shaft roller bearing cone, use correct puller.
Figure 2.8.

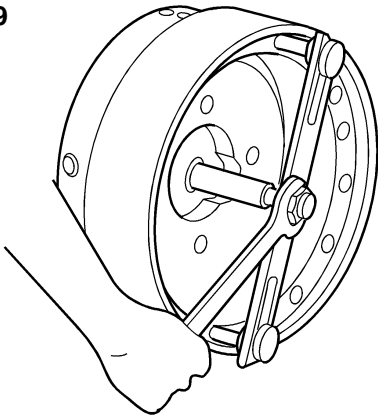
Figure 2.8



Disassemble Hydraulic Apply Wet Disc Brake

1. Remove piston return spring capscrews.
2. Remove return springs.
3. Remove brake piston assembly. **Figure 2.9.**

Figure 2.9

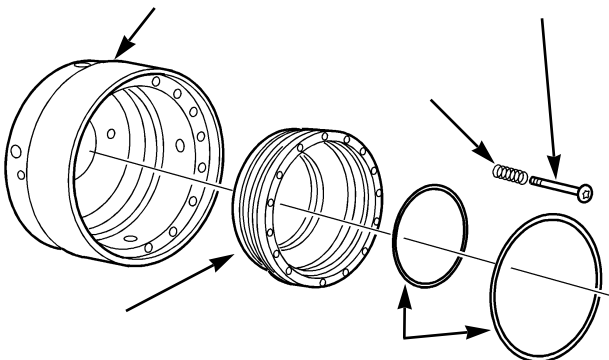


CAUTION

Ground oil seal surfaces must be properly protected to avoid damage. Whenever necessary, use No. 600 sandpaper to correct any damage.

4. If necessary, replace brake piston oil seals. **Figure 2.10.**

Figure 2.10



5. Follow steps 1 through 4 to disassemble the second brake piston.

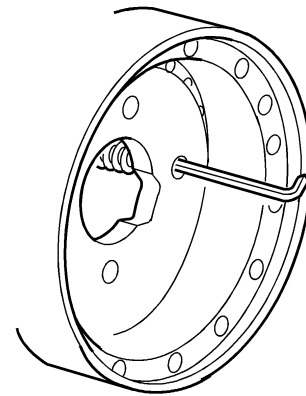
Disassemble Three Function Wet Disc Brake

NOTE

Do not disassemble brake piston unless necessary.

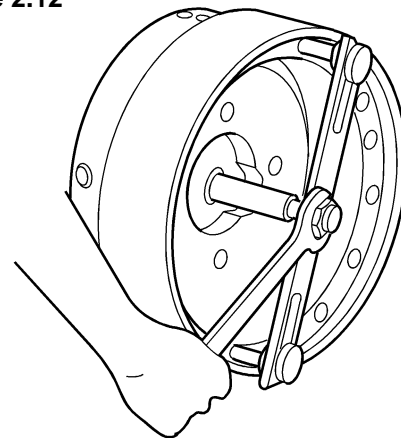
1. Remove return spring capscrews with 4 mm Allen wrench. Remove return springs and washers. **Figure 2.11.**

Figure 2.11



2. Remove brake piston assembly from brake housing as shown in **Figure 2.12** or place brake housing on a bench with the opening turned down. Inject 80 psi (5.5 bar) compressed air through inlet of service brake to eject brake piston.
3. Remove shims.

Figure 2.12



Section 2 Removal and Disassembly



WARNING

- *Use a special tool or press to compress the brake assembly to avoid serious personal injury from the spring pressure.*
 - *Observe all WARNINGS and CAUTIONS provided by the press manufacturer concerning press operation to avoid serious personal injury and damage to components.*
4. Compress brake piston assembly as shown in **Figure 2.13**; or place assembly in press and apply 1000 lbs. (450 kg) pressure.
 5. Remove action plate capscrews. **Figures 2.13 and 2.14.**

Figure 2.13

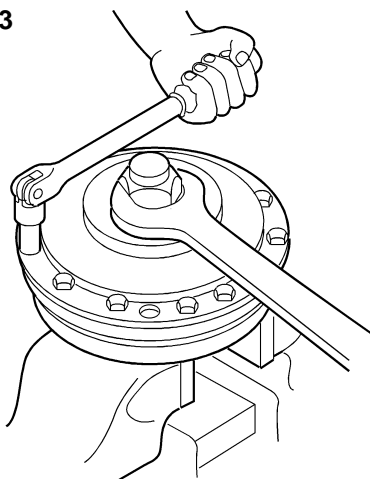
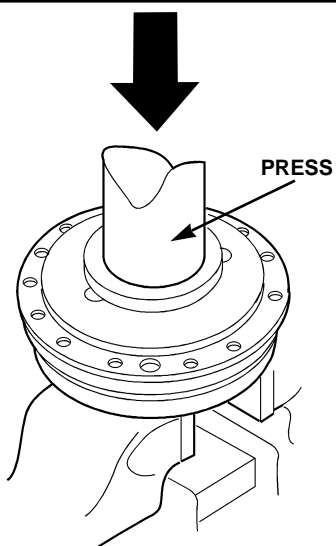


Figure 2.14

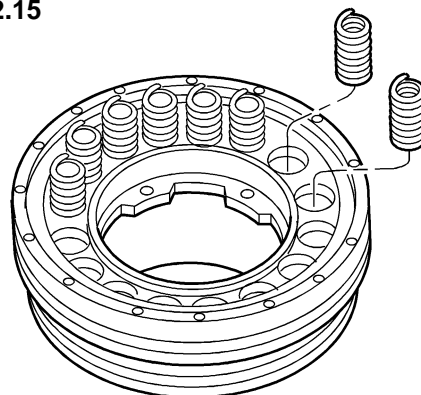


CAUTION

Before removing action plate and other parts, mark the original assembly positions of all brake piston assembly parts. This procedure will make reassembly easier.

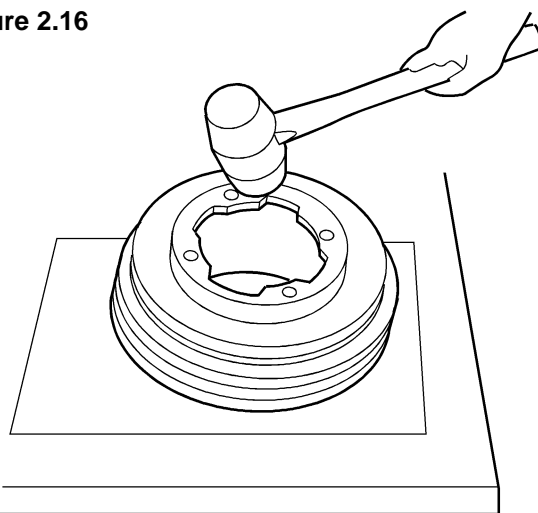
6. Remove action plate and springs. **Figure 2.15.**

Figure 2.15



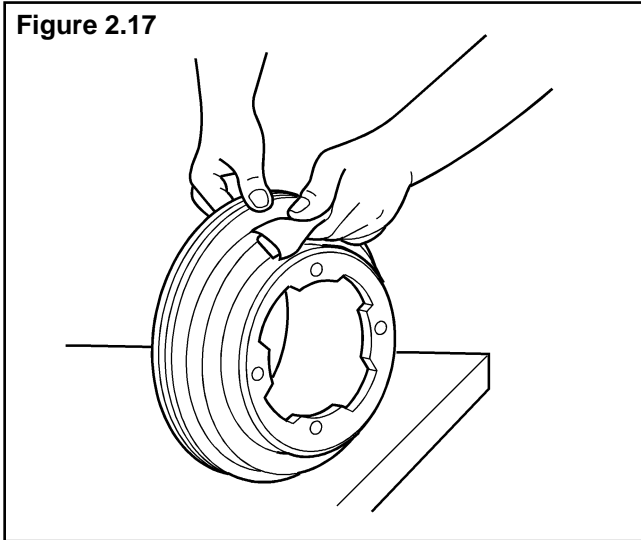
7. Remove internal piston by placing brake piston assembly on bench with action plate support surface turned down. Tap internal piston with rubber mallet. **Figure 2.16.**

Figure 2.16



8. Use sand paper on piston surfaces if they have nicks or hits. **Figure 2.17.**

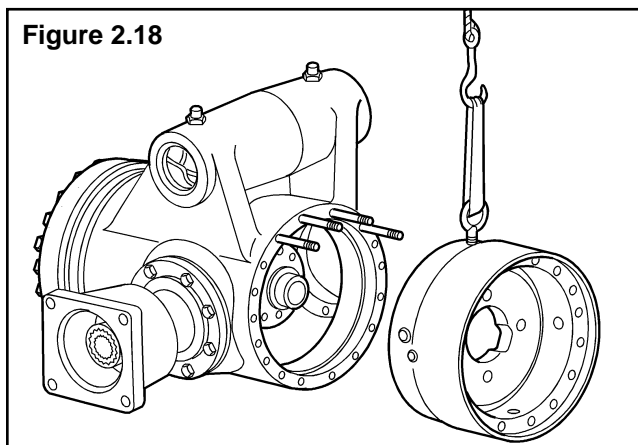
Figure 2.17



Disassemble Main Housing

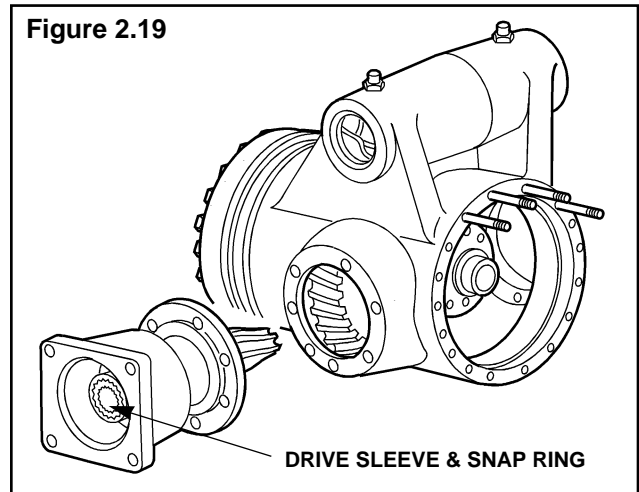
1. Remove adjusting nut capscrew lock.
2. Remove adjusting nut capscrew and adjusting nut.
3. Remove brake housing capscrews that are set deep in brake housing flange. Use long 6mm Allen wrench.
4. Remove brake housing from main housing. Hit brake housing with brass hammer or use two slots to remove it from main housing. Be careful not to hit ring gear. **Figure 2.18.**

Figure 2.18



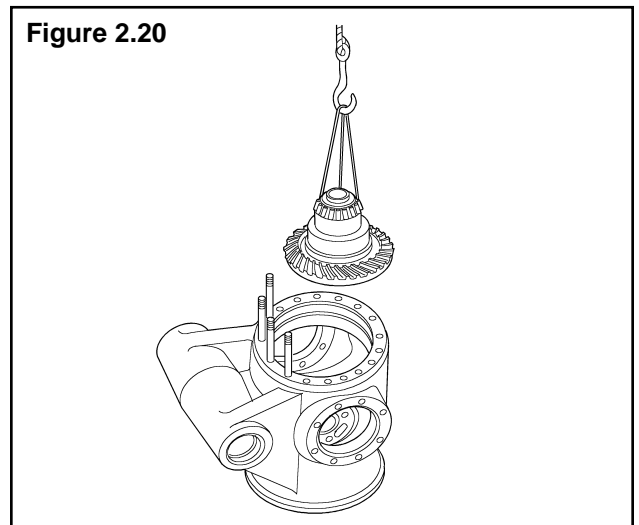
5. Depending on ring gear position, remove pinion bearing cage capscrews.
6. Remove pinion bearing cage assembly from main housing. **Figure 2.19.**
7. Remove drive sleeve and snap ring. **Figure 2.19.**

Figure 2.19



8. Remove differential case assembly. **Figure 2.20.**

Figure 2.20



9. Remove main housing cover.

Section 2

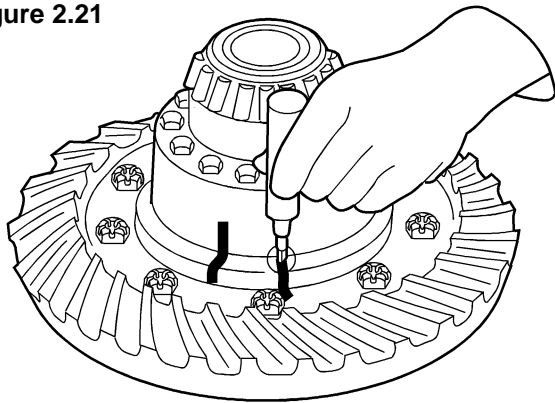
Removal and Disassembly



Disassemble Differential Case

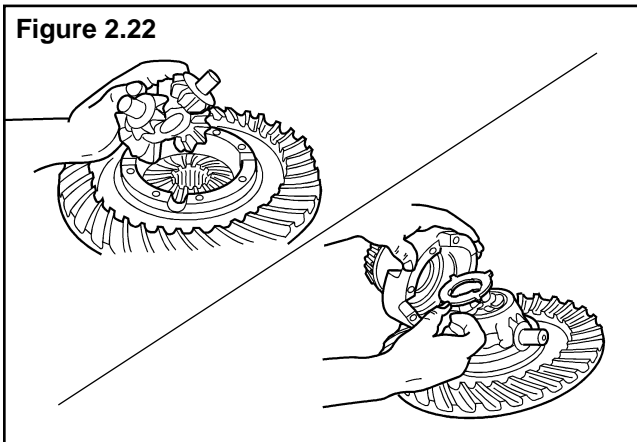
1. Before disassembling differential case, mark position of both halves and spider cross for easier reassembly. **Figure 2.21.**

Figure 2.21



2. Remove differential case capscrews.
3. Separate differential case halves. If necessary use a brass or rubber hammer to separate halves.
4. Remove spider cross, differential pinions, side gears and washers. If differential case is "Limited Slip," remove friction disc pack. **Figure 2.22.**

Figure 2.22



5. If differential case is "integral," remove differential pinion axle lock capscrew and differential pinion axle. Then turn side gears and remove differential pinions, side gears and washers. **Figures 2.23, 2.24 and 2.25.**

Figure 2.23

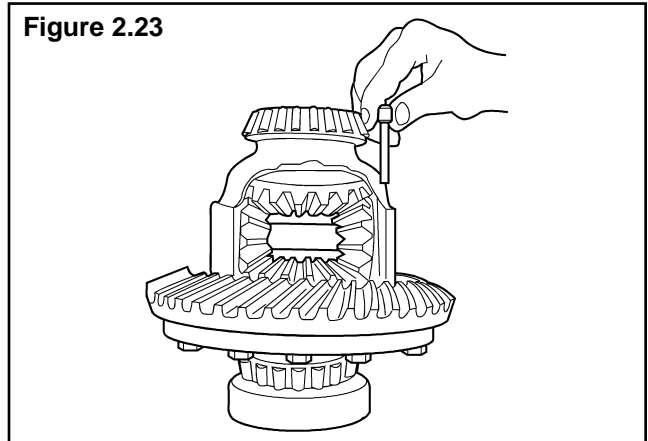


Figure 2.24

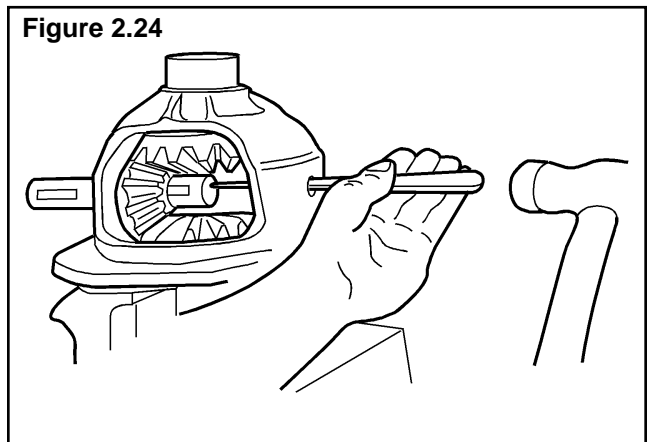
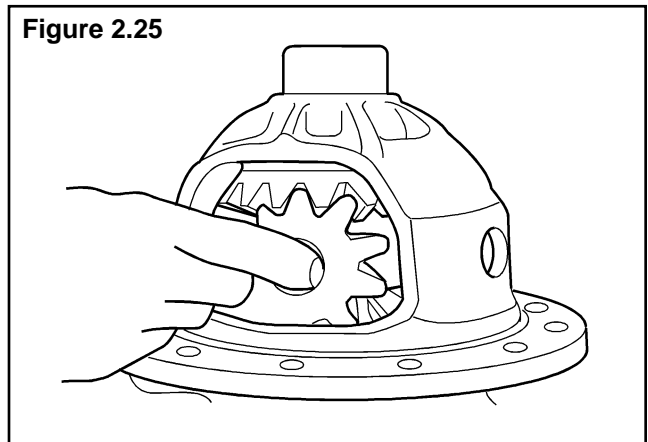


Figure 2.25



6. If necessary, separate ring gear from differential case. Remove capscrews and washers that fasten ring gear. With brass hammer, tap ring gear to separate it from differential case. **Figures 2.26 and 2.27.**

Figure 2.26

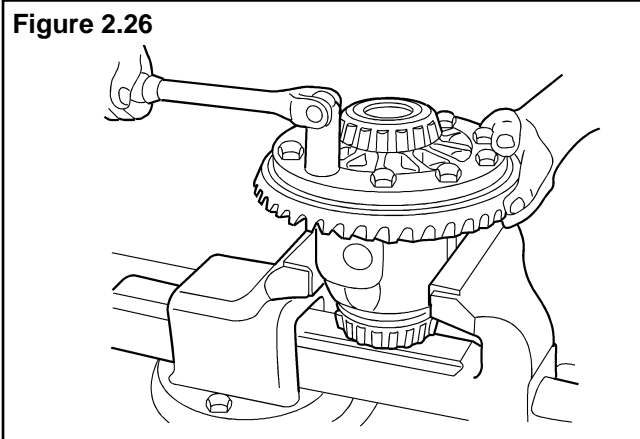
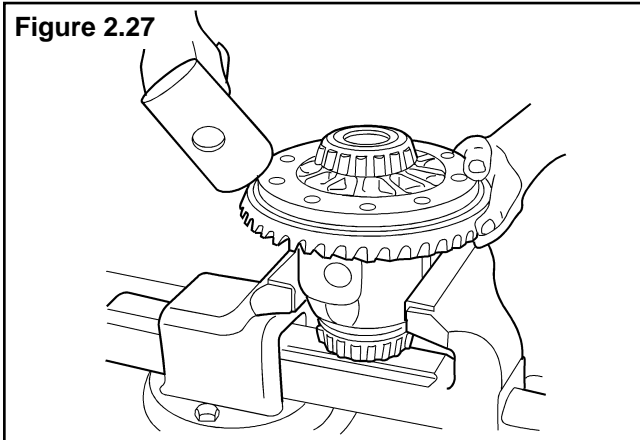


Figure 2.27

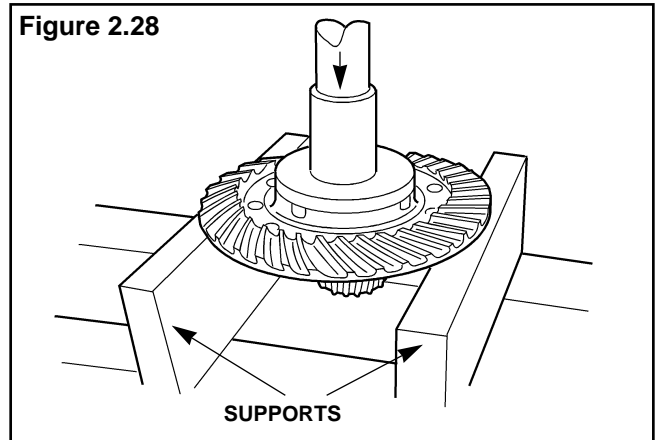


WARNING

Observe all WARNINGS and CAUTIONS provided by the press manufacturer concerning press operation to avoid serious personal injury and possible damage to components during removal and disassembly procedures.

7. If differential case has two halves, remove ring gear with a press after capscrews have been removed (**Figure 2.26**). Use appropriate metal or wood supports. **Figure 2.28.**

Figure 2.28



8. If necessary, remove cone bearings from differential case. Use appropriate puller or press. **Figures 2.29, 2.30 and 2.31.**

Figure 2.29

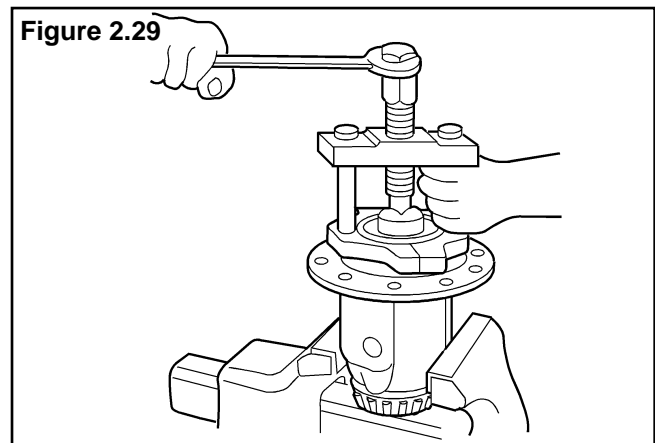


Figure 2.30

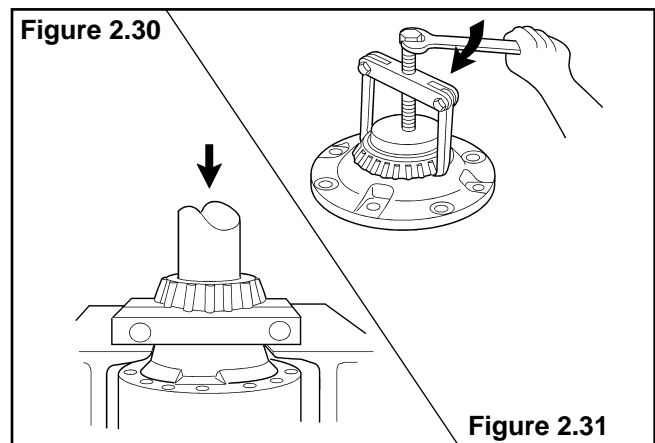


Figure 2.31

Section 2

Removal and Disassembly

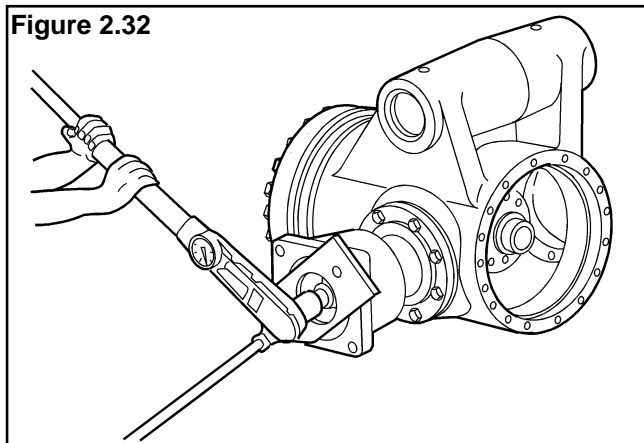


Disassemble Pinion Bearing Cage

1. If pinion bearing cage was not removed, hold yoke, flange or splined sleeve with appropriate holder to remove pinion nut. **Figure 2.32**

If pinion bearing cage was already removed, place it on main housing and fasten with two capscrews.

Figure 2.32

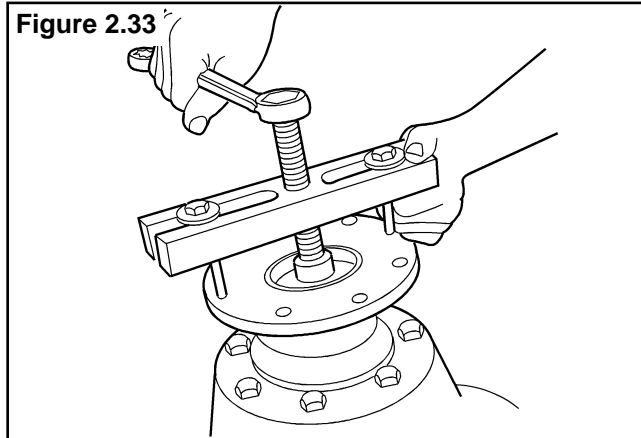


CAUTION

Do not use a hammer or mallet to loosen or remove yoke, flange or splined sleeve. The hammer or mallet can damage the parts or cause alignment problems. Do not damage the oil seal surface area.

2. Remove yoke, flange or splined sleeve from drive pinion with appropriate puller tool. **Figure 2.33.**

Figure 2.33

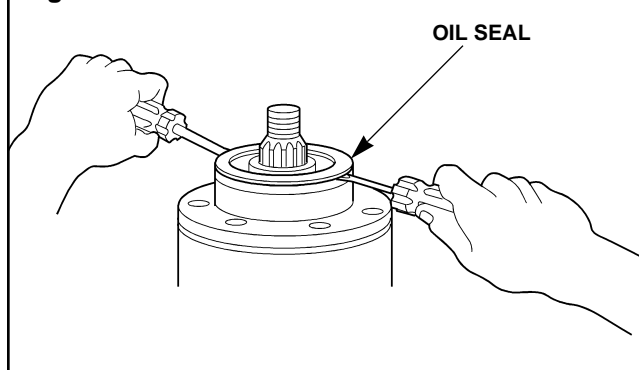


CAUTION

To avoid oil leaks, be careful not to damage the mounting surface of the bearing cage.

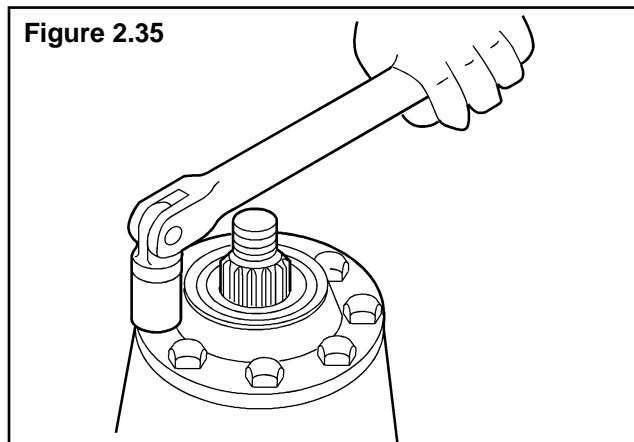
3. Remove pinion oil seal. Pry at several points around circumference between seal, flange and bearing cage. **Figure 2.34.**

Figure 2.34



4. Remove capscrews and washers that fasten pinion bearing cage on main housing. **Figure 2.35.**

Figure 2.35

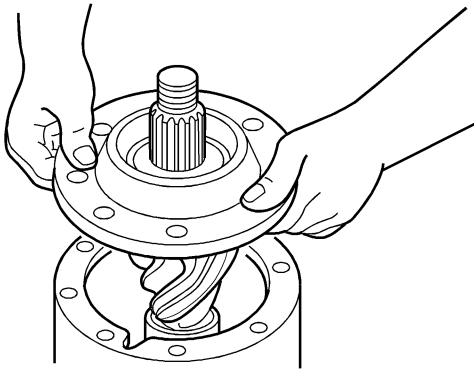


CAUTION

Do not use pry bar to remove bearing cage from carrier. A pry bar can damage bearing cage, shims and main housing.

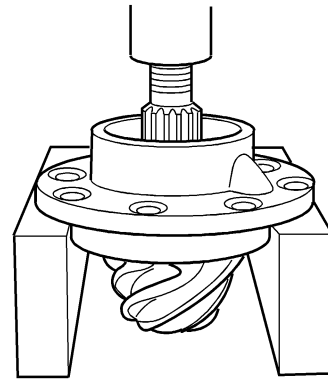
5. Remove pinion bearing cage and shims from main housing. If bearing cage is tight within the main housing, hit bearing cage at several points around flange area with leather, plastic or rubber mallet. **Figure 2.36.**

Figure 2.36



6. If shims are in good condition, keep them together for use later when main housing is reassembled.
7. Before damaged shims are discarded, measure and record total thickness of the pack. The dimension will be needed to calculate depth of drive pinion in main housing when gear set is installed.
8. Place drive pinion and bearing cage in press with pinion shaft toward top assembly. Support bearing cage under flange area with metal or wood blocks. Press drive pinion through bearing cage. **Figure 2.37.**

Figure 2.37



NOTE

The inner bearing cone and bearing spacer will remain on the pinion shaft.

9. If pinion bearing needs to be replaced, remove inner and outer bearing cups from inside of cage. Use a press and sleeve, bearing puller or small drift and hammer. **Figures 2.38 and 2.39.**

Figure 2.38

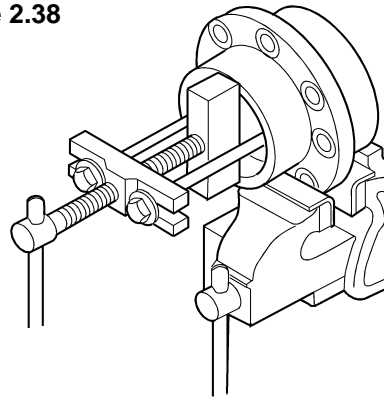
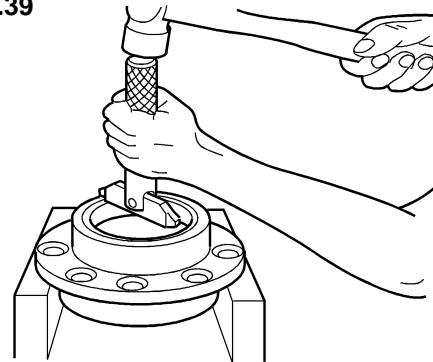


Figure 2.39

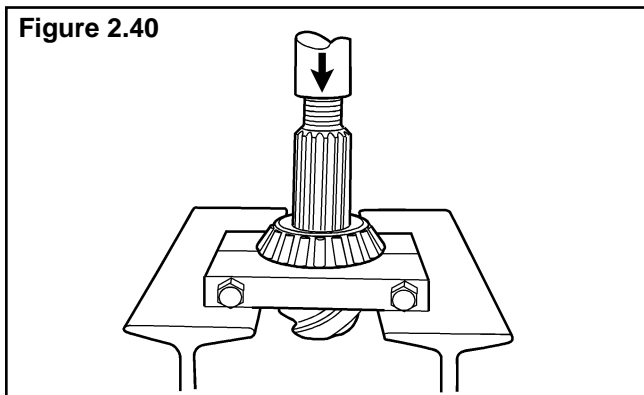


Section 2

Removal and Disassembly



10. If pinion bearings need to be replaced, remove inner bearing cone from drive pinion with press or bearing puller. Puller must fit under inner face of cone to remove cone correctly without damage. **Figure 2.40.**



NOTE

If bearing cup is changed, the bearing cone must also be replaced. The cup and cone must come from the same manufacturer.

Clean Ground and Polished Parts

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

WARNING

If you use cleaning solvents, hot solution tanks or alkaline solutions incorrectly, serious personal injury can occur. To prevent serious personal injury, follow the instructions supplied by the manufacturer of these products. Do not use gasoline to clean parts. Gasoline can explode and cause serious personal injury.

- Use a cleaning solvent to clean ground or polished parts or surfaces. Kerosene or diesel fuel oil can be used for this purpose. NEVER USE GASOLINE.
- Remove gasket material from parts. Be careful not to damage ground surfaces.
- DO NOT clean ground or polished parts in a hot solution tank, water, steam or alkaline solution.

Clean Parts With Rough Finish

- Parts with a rough finish can be cleaned with cleaning solvent or in a hot solution tank with a weak alkaline solution.
- Parts must remain in hot solution tanks until completely cleaned and heated.
- Parts must be washed with water until the alkaline solution is removed.

Clean Axle Assemblies

- A complete axle assembly can be steam cleaned on the outside to remove dirt.
- Before the axle is steam cleaned, close or put a cover over all openings in the axle assembly. Examples of openings are breathers and hydraulic inlets.

Dry Cleaned Parts

- Dry the parts immediately after cleaning and washing.
- Dry the parts with soft clean paper or rags.

CAUTION

Damage to bearings can be caused if dried by rotating with compressed air.

- Except for bearings, parts can be dried with compressed air.

Prevent Corrosion

- Apply axle lubricant to cleaned and dried parts that are not damaged and are to be assembled.
- Apply a special material that prevents corrosion to all surfaces. If parts are to be stored, wrap the parts in special paper that prevents rust and corrosion.

Inspect Parts

It is very important to inspect all parts carefully and completely before the axle or carrier is assembled. Check all parts for wear and replace damaged parts. Replacement of damaged or worn parts will prevent breakdown of assembly later.

Section 3

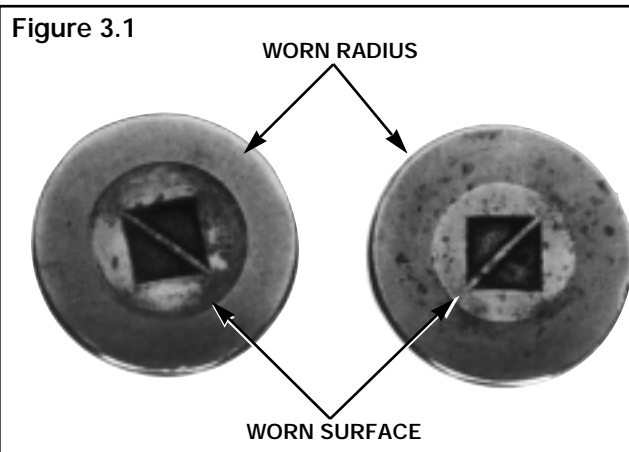
Prepare Parts for Assembly



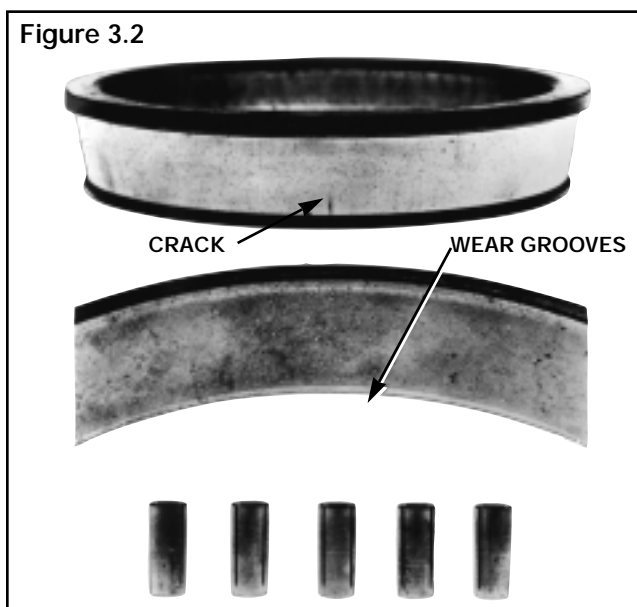
Inspect Tapered Roller Bearings

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:

- The center of the large diameter end of the rollers are worn level with, or below the surface.
- The center of the large diameter end of the rollers are worn to a sharp edge. **Figure 3.1.**



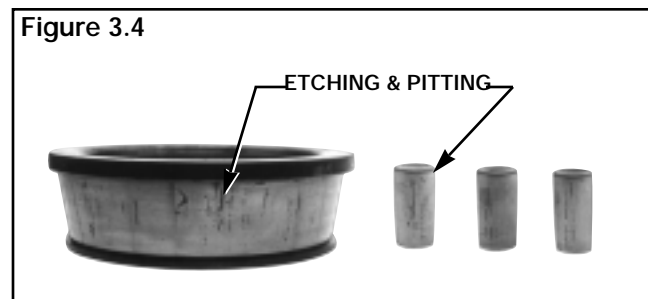
- A visible roller groove in the cup or cone inner race surfaces. The groove can be seen at the small or large diameter end of both parts. **Figure 3.2.**



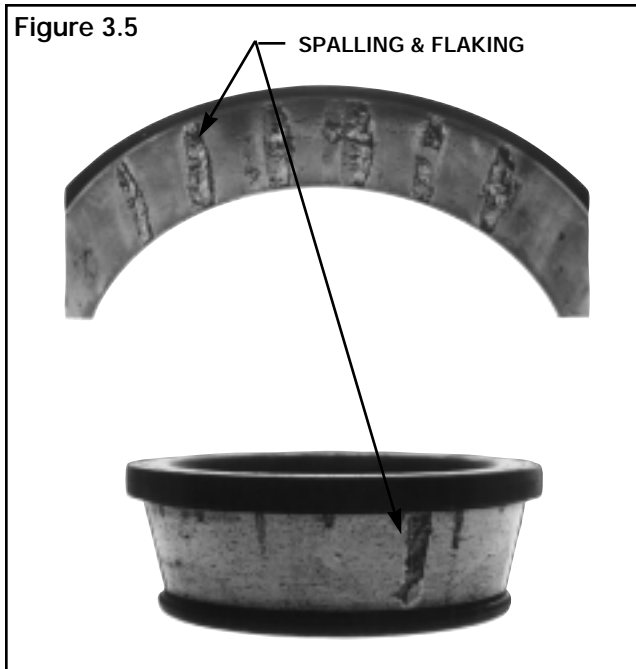
- Deep cracks or breaks in the cup, cone inner race or roller surfaces.
- Bright wear marks on the outer surface of the roller cage. **Figure 3.3.**



- Damage on rollers and on surfaces of the cup and cone inner race that touch the rollers. **Figure 3.4.**



- Damage on the cup and cone inner race surfaces that touch the rollers. **Figure 3.5.**



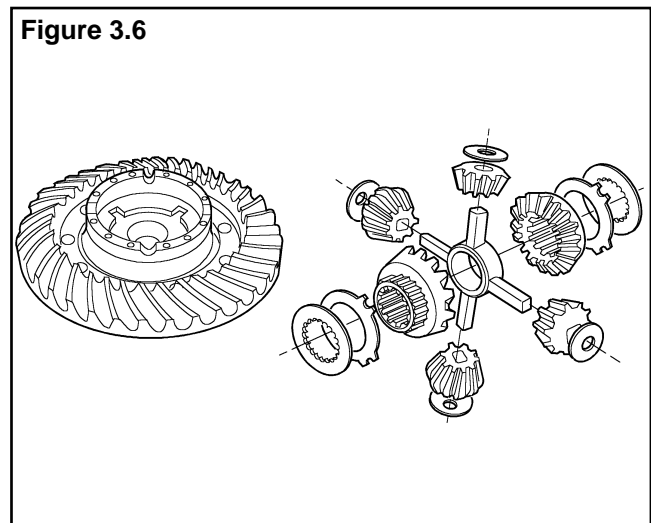
Inspect Hypoid Pinion and Ring Gear Sets

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.*
- *Inspect hypoid pinions and gears for wear and damage. Gears that are worn or damaged must be replaced. Also verify the cone bearing seats and spline in the pinion shaft.*

Inspect Main Differential Assembly

Parts that are damaged must be replaced. Inspect the following parts for wear or stress. **Figure 3.6.**



- Inside surfaces of both case halves
- Both surfaces of all thrust washers
- Four trunnion ends of spider cross
- Teeth and splines of both side gears
- Teeth and bore of all differential pinions
- Friction disc packs if used

CAUTION

Always replace old or worn thrust washers, differential side gears and pinion gears in sets to avoid higher stress and early damage to parts.

Inspect Axle Shafts

- For wear and cracks at flange, shaft and splines. Replace axle shaft if required.

Section 3

Prepare Parts for Assembly



Inspect Main Housing

- For fractures and burrs in machined areas.

Inspect Yoke

- For wear at seal journal area. Replace yoke, flange or sleeve if either shows too much wear at seal journal area.

Inspect Planetary System Parts

- For existence of cracks, pitting, breaks or sharp edges on planetary gear teeth, planetary gear axles and rollers.

Inspect Brakes

- For condition of friction discs, brake piston springs and internal brake housing surfaces.

Repair or Replace Parts


General Information

Replace worn or damaged parts of an axle assembly. The following are some examples to check for repair and possible replacement:

- Replace any fastener if corners of the head are worn.
- Replace washers if damaged.
- Replace gaskets, oil seals or grease seals at the time of axle repair.
- Clean parts and apply new liquid gasket material where required when axle is assembled.
- Remove nicks, marks and burrs from parts having machined or ground surfaces. Use a fine file, India stone, emery cloth or crocus cloth for this purpose.
- Clean and repair threads of fasteners and holes. Use a die or tap of the correct size or a fine file for this purpose.

CAUTION

Threads must be without damage and clean so that accurate adjustment and correct torque values can be applied to fasteners and parts.

- Tighten all fasteners to correct torque values. See chart in Section 6 for fastener torque values. 

WARNING

Do not repair axle housings by bending or straightening. Repair of axle housings by bending or straightening can cause poor performance and possible unsafe operation of the axle. This can cause serious personal injury.

Repair Welding

In the interest of safety and preserving the service life of drive axle assemblies, Meritor recommends that assemblies are not repair welded. Repair welding can detract from the structural integrity of a component, particularly to heat treated parts where the benefit of heat treatment may be nullified by welding.

Since it can be extremely hazardous and detrimental to repair weld components of any kind, repair welding can be approved only where stringent controls are imposed and equipment, customarily located at manufacturing facilities, is employed, so as to minimize the potentially detrimental effects of repair welding.

Liquid Adhesive

Meritor uses the following liquid adhesives to retain threaded fasteners:

Product	Type	Color	Cure Time
Loctite	271 High	Red	2 hours
	241 Medium	Blue	6 hours
	221 Low	Violet	6 hours
Three Bond	1305 High	Red	5 hours
	1334 Medium	Green	5 hours
	1341 Low	Blue	10 hours

Disassemble Locked Sets



Do not use impact wrenches or strike components with a hammer.

To disassemble sets originally locked with liquid adhesive, use the regular mechanical disassembly procedure.

If the removal of a capscrew, for example, becomes difficult due to a worn head or unusually high breakaway torque, the locking strength can be reduced by heating the threaded area to approximately 300°F (150°C). Heat slowly to avoid thermal stresses on the differential case and gears.

Cleaning



To avoid serious personal injury, trichloroethylene must not come in contact with your skin. Do not smoke and avoid breathing vapors in closed rooms without ventilation. Do not use trichloroethylene near flames, welding operations or hot surfaces exceeding 900°F (482°C).

Clean capscrew, nut or bolt tapped hole and fastener thread carefully. Use a cleaning solvent such as trichloroethylene or equivalent to remove dirt, oil, grease or moisture.

Reassembly

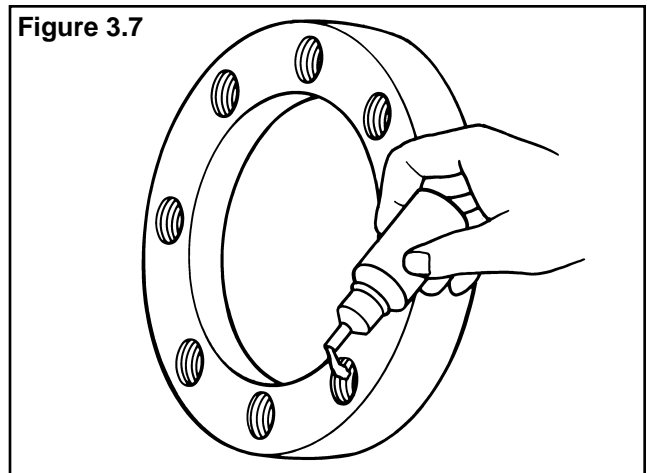
- Check the type of liquid adhesive to be used and where the adhesive is to be applied.
- In threaded holes where fasteners did not require removal, check each one for tightness by applying the minimum amount of specified torque.
- If fasteners do not rotate, they are tightened properly.
- If fasteners rotate to any degree, they must be removed and liquid adhesive must be applied.

Application

1. Apply liquid adhesive to:

- Bolt threads when component has open hole. Before installing bolts, visually check to make sure that liquid adhesive has filled gap between threads.
- Threaded hole when component has blind hole. Allow 4 to 6 drops to run down side of each hole. If liquid adhesive is applied to bolt, trapped air in hole will create back pressure and “blow out” liquid adhesive as bolt advances. **Figure 3.7.**

Figure 3.7



2. Tighten fasteners with recommended torque. **T**

Section 3

Prepare Parts for Assembly



Apply Silicone Gasket Material

Liquid gasket material used by Meritor:

- Loctite FAG 3
- Neutral Silicon, Dow Corning 768 or Rhodia 567/666
- Three Bond 1134
- Loctite 515

WARNING

Small amounts of acid vapor are present when applying some gasket materials. To prevent possible serious personal injury, make sure there is good ventilation in the work area. If liquid gasket material gets in your eyes, flush eyes with water for 15 minutes. Have eyes checked by doctor.

CAUTION

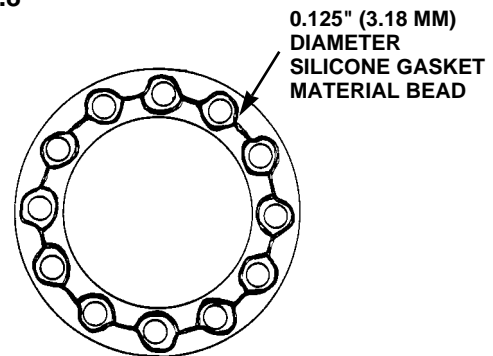
The amount of liquid gasket material applied must not exceed 0.125 in. (3.18 mm) diameter bead. Too much gasket material can block lubrication passages and result in damage to component.


1. Remove all old gasket material from both surfaces.
2. Clean the surfaces where liquid gasket material will be applied. Remove all oil, grease, dirt and moisture.
3. Thoroughly dry both surfaces.
4. Apply according to the following procedures:
 - **Three Bond 1134 or Loctite 515:** Apply approximately a 0.125 inch (3.18 mm) diameter continuous bead of liquid gasket material around one surface.
 - **Loctite FAG 3:** Apply to one surface with a paint brush.

Also apply all gasket material around edge of all fastener holes on that surface. **Figure 3.8.**

5. Assemble components quickly to permit gasket material to compress evenly between parts.

Figure 3.8



6. Tighten fasteners with required torque. See Torque Chart, Section 6. 

DUO-CONE Oil Seal: Mount and Install

NOTE

- *Always follow correct procedures when mounting and installing DUO-CONE oil seals. Many DUO-CONE oil seal leaks result from errors made during mounting or installation of oil seal components.*
- *Never let oil touch Toric ring or lodging ramps before both oil seal rings are installed in their mounting position.*

⚠ WARNING

To avoid serious personal injury, trichloroethylene must not come in contact with your skin. Do not smoke and avoid breathing vapors in closed rooms without ventilation. Do not use trichloroethylene near flames, welding operations or hot surfaces exceeding 900°F (482°C).

1. Remove any dust, oil or foreign material from Toric ring (2), lodging ramps (4, 7), ring retention lips (3, 8), oil seal ring (1) and ring bore (5). Clean components with trichloroethylene and a clean cotton cloth or a paper towel. **Figures 3.9 and 3.10.**

Figure 3.9

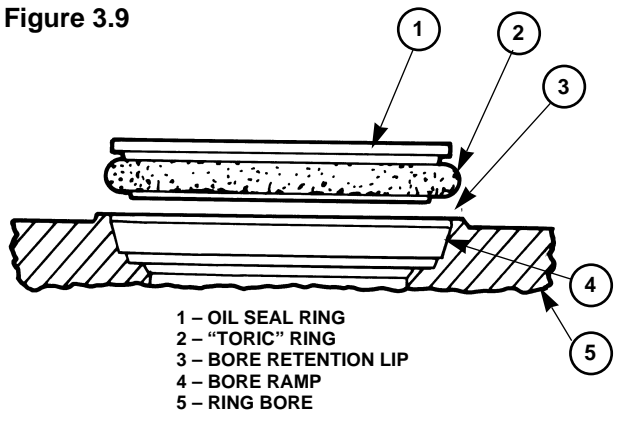
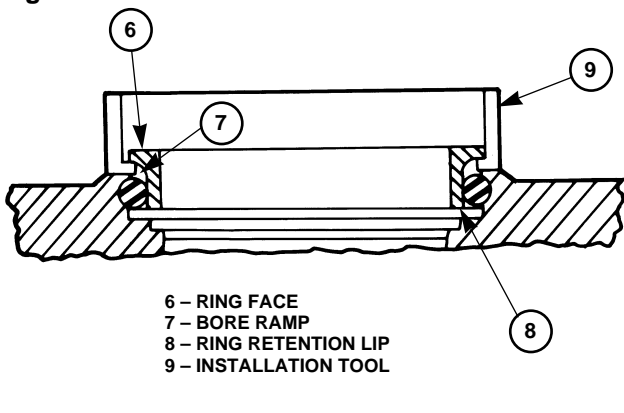


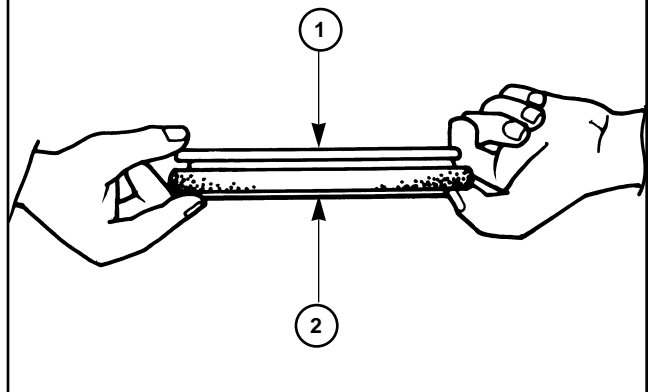
Figure 3.10



⚠ CAUTION

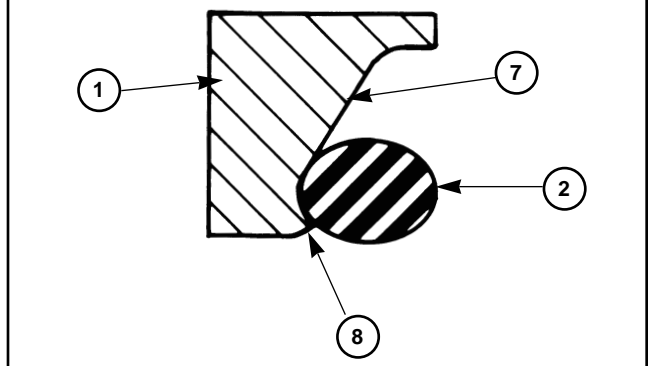
Make sure that Toric ring (2) is seated in oil seal ring (1). Be careful when you work with Toric ring. Cuts and scratches in Toric ring may cause leaks. Figure 3.11.

Figure 3.11



2. Place Toric ring (2) in oil seal ring (1) in button of ring ramps (7) and against ring retention lip (8). **Figure 3.12.**

Figure 3.12



Section 3

Prepare Parts for Assembly

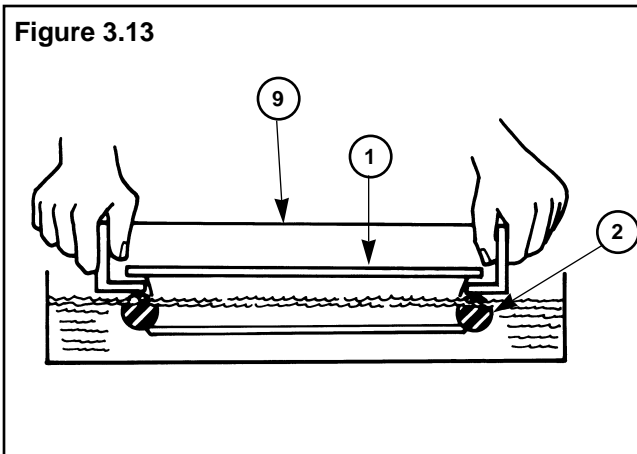


NOTE

Do not use any liquid that leaves a film of oil or does not evaporate quickly.

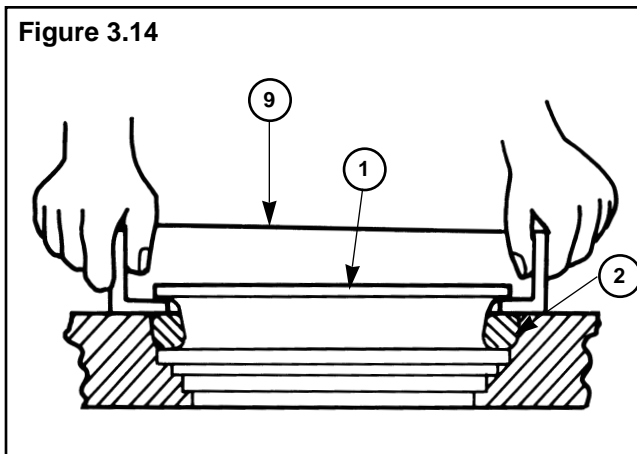
3. Place installation tool (9) under oil seal ring with Toric ring (2). Submerge ring in receptacle filled with trichloroethylene until entire surface of Toric ring is wet. **Figure 3.13.**

Figure 3.13



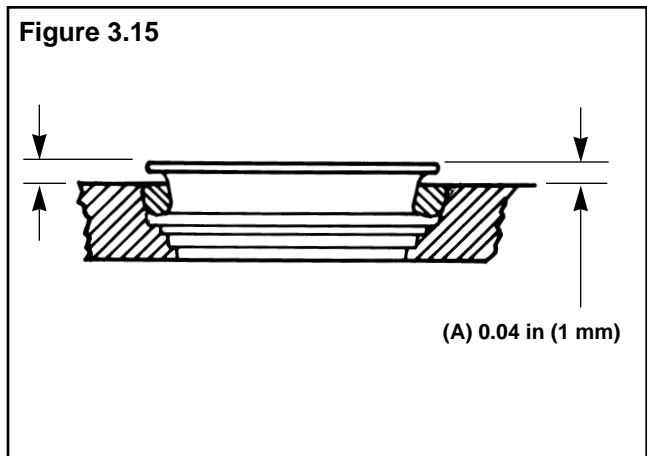
4. With Toric ring surface wet (2), use installation tool (9) to install oil seal ring and Toric ring perpendicular to ring bore. Use a rapid and uniform pressure to push Toric ring under ring retention lip. **Figure 3.14.**

Figure 3.14



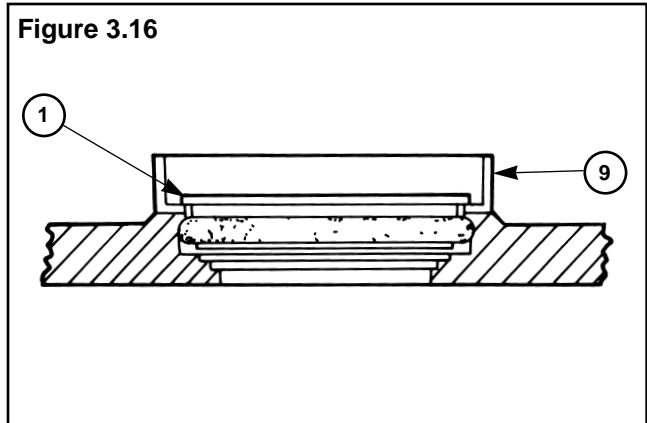
5. Verify mounting distance (A) in at least four places spaced 90 degrees apart. The difference in the mounting distance (A) around ring cannot be more than 0.04 inches (1 mm). **Figure 3.15.**

Figure 3.15



6. If adjustments are necessary, use installation tool (9) to push ring. Do not use your hands. **Figure 3.16.**

Figure 3.16

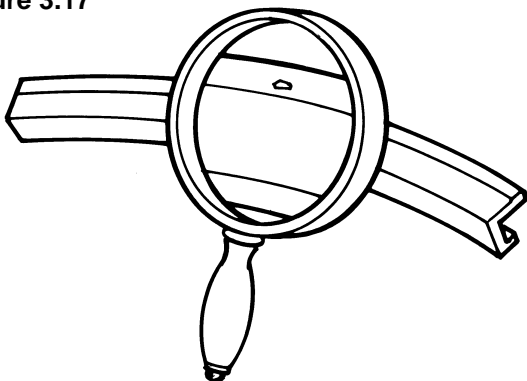


7. Toric ring may become distorted if not entirely wet or if there is a sharp edge on the retention lip and bore.

CAUTION

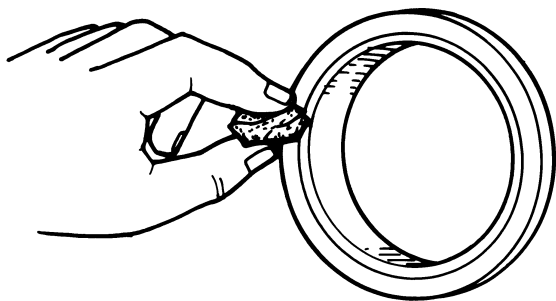
- *Misalignment or a twisted Toric ring may cause leakage in the DUO-CONE oil seal. If installation was not correct, remove oil seal from bore and repeat steps 3-6.*
- *A Toric ring must never slide on any ramp of oil seal ring or bore. To prevent sliding, wait at least two minutes for trichloroethylene to evaporate before continuing with installation. When in the correct position, Toric ring must roll only on ramps.*
- *A small piece of lint can separate the oil seal surfaces and cause leaks. Figure 3.17.*

Figure 3.17



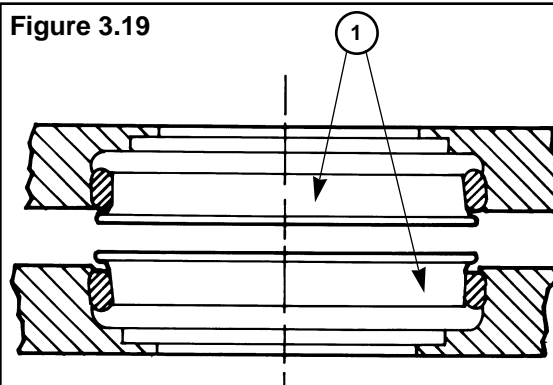
8. Clean oil seal surfaces with lint-free cloth or paper.
9. Apply a thin, uniform film of clean oil on oil seal surfaces with cloth or clean finger. Do not get oil on Toric ring. **Figure 3.18.**

Figure 3.18



10. Make sure both bores are correctly aligned and concentric. Move slowly and carefully. **Figure 3.19.**

Figure 3.19



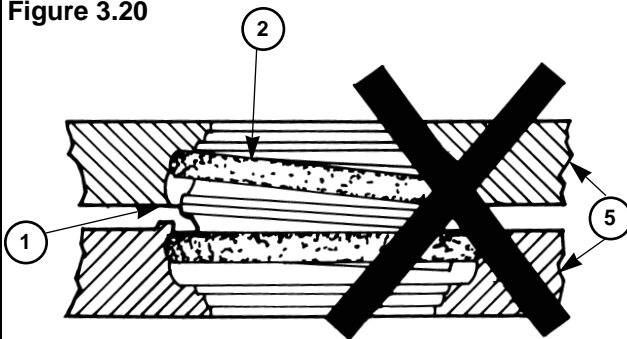
CAUTION

Do not force rings abruptly against each other. A strong impact may break the oil seal components. When seal is installed properly, fasten all components well.

If DUO-CONE oil seal is installed incorrectly, these conditions can result:

- Toric ring can warp. **Figure 3.20.**

Figure 3.20



Section 3

Prepare Parts for Assembly



- Warped ring can cause irregular pressure on ring surface resulting in oscillating movements of oil seal.
- Different pressures on oil seal surfaces can cause seepage, wear and leaks.
- Oscillating oil seals allow dirt to enter.

Figure 3.21 shows an incorrect installation of an oil seal in its mounting position. The upper bore is stopped and the lower lodge is rotating.

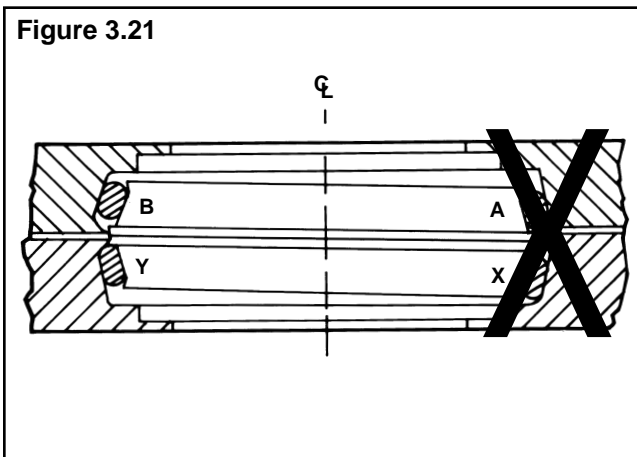
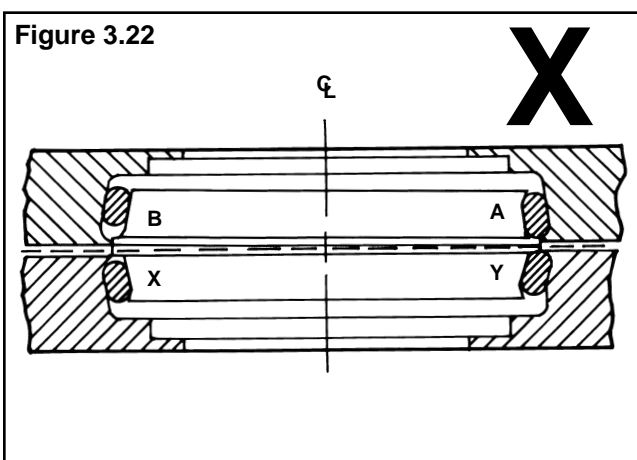


Figure 3.22 shows the same lower bore after rotation of 180 degrees. In this position, high pressure occurs on points "A" and "Y". This high pressure variation may damage rings. Points "B" and "X" will develop low pressure and possible leakage.



Assemble Differential Case

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

1. Apply specified lubricant on all parts of differential case assembly before installation.

CAUTION

Never attempt to press a cold ring gear on the flanged half of the differential case. A cold ring gear will damage the case because of the tight fit. The tight fit can cause misalignment or excessive runout and will make final backlash and teeth contact adjustments very difficult.

WARNING

Wear safe clothing and gloves to protect yourself from serious personal injury when you touch the hot ring gear.

2. Expand ring gear bore by heating ring gear in tank of water heated 160°F to 180°F (71°C to 82°C) for 10 to 15 minutes. DO NOT USE AN OPEN FLAME SUCH AS A TORCH FOR THIS PROCEDURE.
3. Install ring gear on case half or in the integral differential case.

WARNING

To avoid serious personal injury be careful when using Loctite or Three Bond adhesive during assembly and installation procedures. Follow the manufacturer's instructions for safe use to prevent irritation to eyes and skin. Wash after skin contact. If the Loctite or Three Bond adhesive gets in the eyes, flush the eyes with water for 15 minutes. Have eyes checked by doctor.


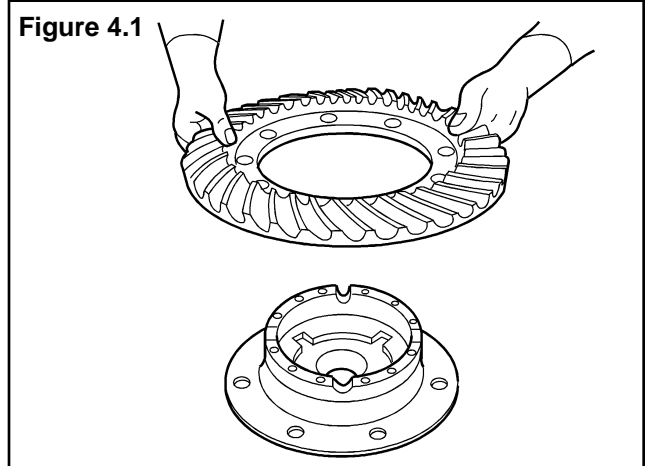
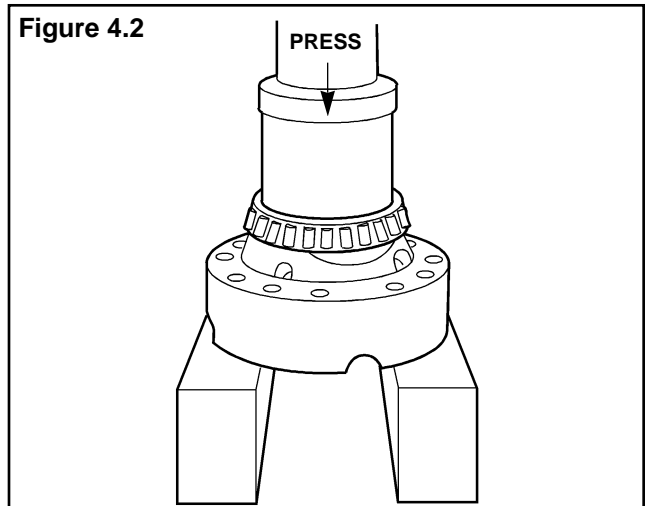
4. Apply Loctite 271 or Three Bond 1305 adhesive to ring gear fasteners. See Section 3, "Liquid Adhesive." Install ring gear fasteners and fasten with the specified torque, 66-75 lb-ft (90-100 N•m). **Figure 4.1.** 

Figure 4.1



5. Assemble new cone bearings in both halves of differential case or in both sides if it is an integral differential case. **Figure 4.2.**
6. Install side gear in flanged case half.

Figure 4.2



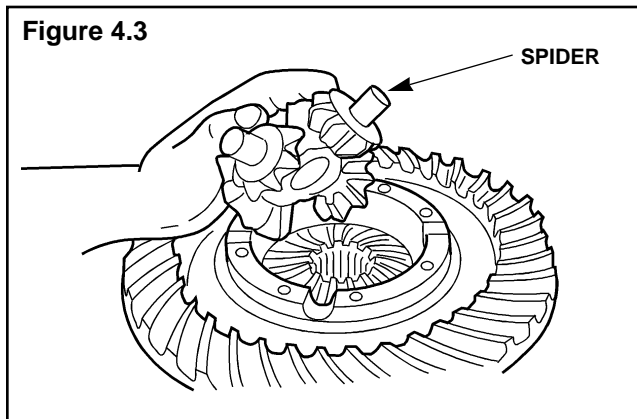
Section 4 Assembly and Installation



NOTE

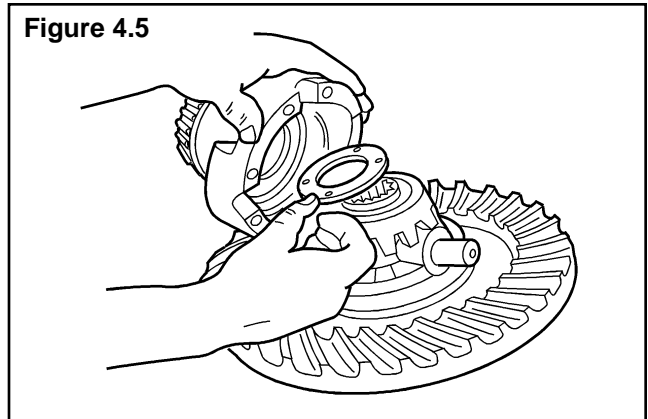
For limited slip differential, go to step 12.

7. Install spider cross, differential pinions and washers on original assembly position. **Figure 4.3.**

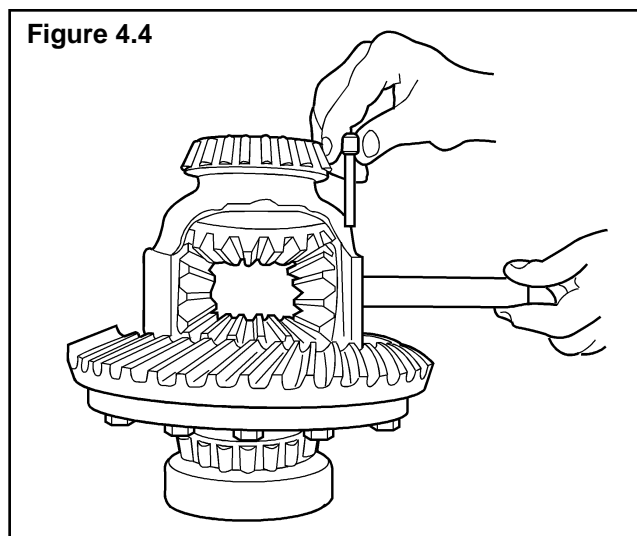


- d. Install differential pinion axle and lock capscrew. Fasten capscrew to specified torque 17-23 lb-ft (23-31 N•m). **T**

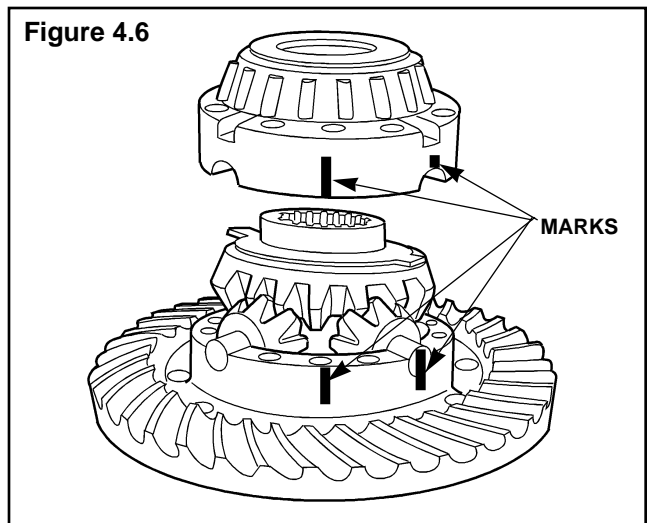
8. Install other side gear over spider and differential pinions. **Figure 4.5.**



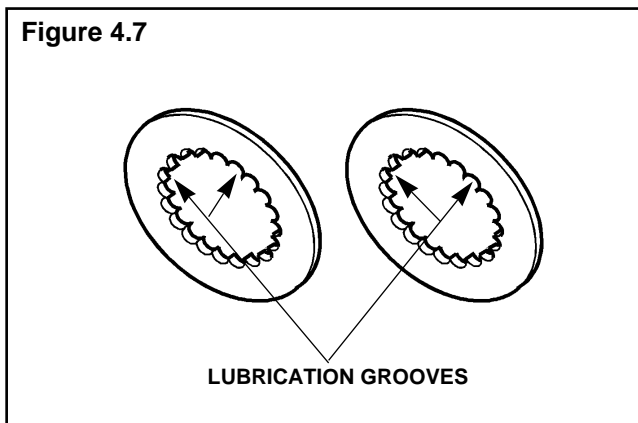
- a. If you have an integral differential case, install side gears and washers in each original assembly side.
- b. Install differential pinions in the correct position by turning side gears until pinion holes are aligned with differential pinion axle holes. **Figure 4.4.**
- c. Install differential pinion washers.



9. Place plain half of differential over flanged half. Rotate plain half as needed to align match marks. **Figure 4.6.**



10. Apply Loctite 271 or Three Bond 1305 liquid adhesive to capscrews. Install four capscrews into case halves equally spaced and tighten to 48-64 lb-ft (64-87 N•m). **T**
11. Install other capscrews into case halves. Tighten the capscrews to 48-64 lb-ft (64-87 N•m). **T**
12. Assemble Limited Slip Differential Case.
 - a. Follow steps 1 to 5.
 - b. Place flanged case half on bench.
 - c. Begin stacking of the disc pack with a drive disc followed by driven friction discs. Make sure lubrication grooves are aligned. **Figure 4.7.**



Maintain the following sequence:

- 1) Drive disc
- 2) Driven friction disc
- 3) Drive disc
- 4) Driven friction disc
- 5) Drive disc
- 6) Driven friction disc
- 7) Drive disc
- 8) Shims (Do not stack until measurements are complete.)
- 9) Compression disc
- 10) Thrust washer (on side gear side)

- d. Place disc pack stack in vise. Use micrometer to determine "D", the height (thickness) of limited slip disc stack (includes thrust washer and compression disc). Take four readings, one at each of four points. Average readings to determine "D". **Figures 4.8 and 4.9.**

Figure 4.8

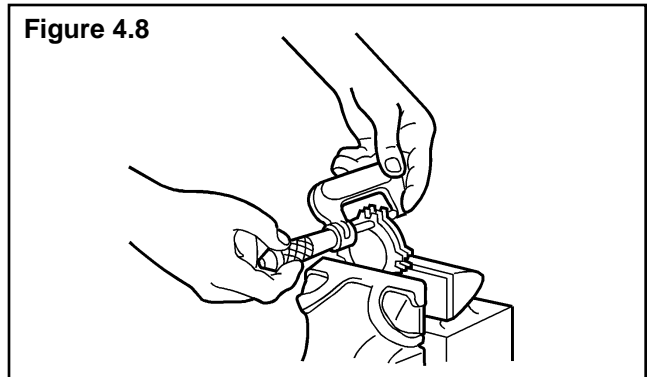
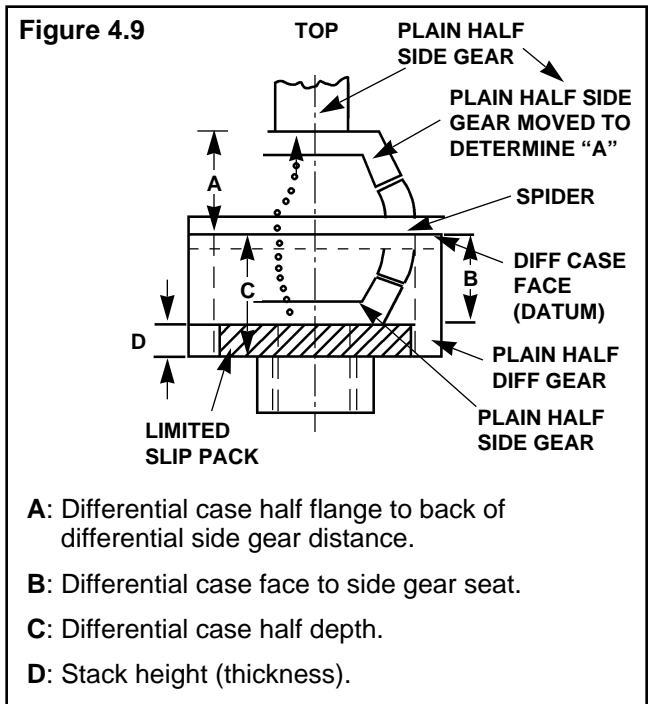


Figure 4.9

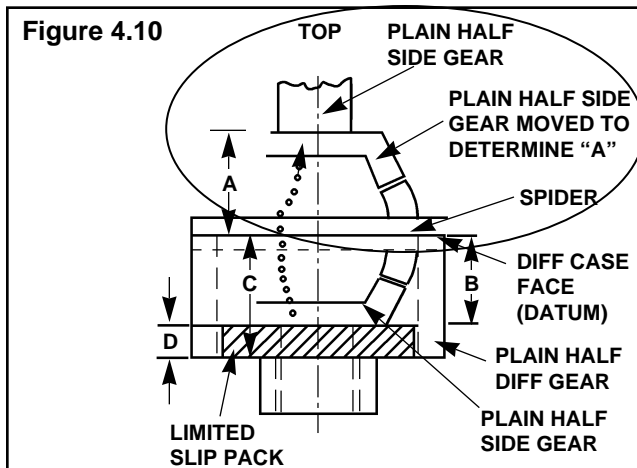


- e. Use depth gauge to determine "C", depth of differential case half. Take four readings. Average readings for result. **Figure 4.9.**

Section 4 Assembly and Installation



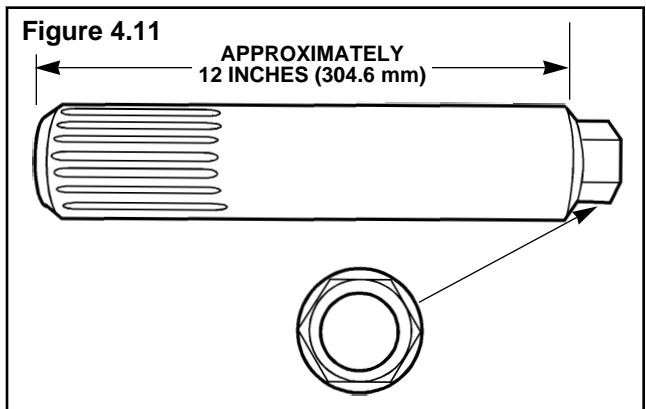
- f. Place removed plain half side gear on top as shown in **Figure 4.10**. Use depth gauge to determine "A", distance from differential case half flange to backside of differential side gear. Take four readings. Average readings for result. **Figure 4.10**.
- g. Determine clearance dimension: $B-A=(C-D)-A$. Clearance dimension must be greater than 0.05 mm and less than 0.15 mm.
- h. Use proper shim thickness to achieve clearance specified in step G.
- i. Assemble friction discs in differential case using sequence in step C including shims. Make sure discs are lubricated.
- j. Drop side gear spline through disc pack.
- k. Repeat steps "A" through "I" for the plain differential case half.
- l. Follow steps 9 through 11 to assemble differential case.



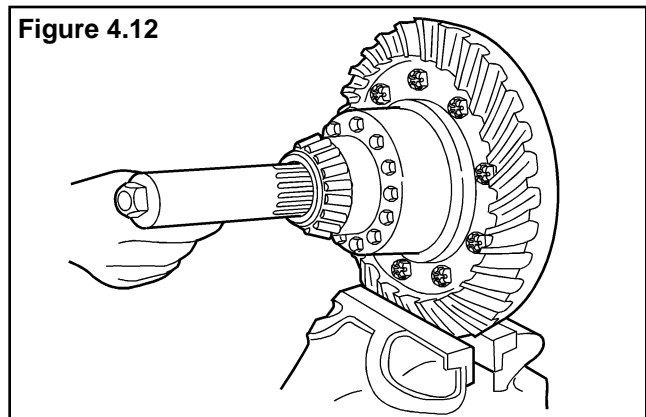
Check Rotating Resistance of Differential Gears (Not Limited Slip)

NOTE

Make tool to check rotating resistance of the differential gears, 50 lb-ft (68 N•m). The tool can be made from a sun gear that matches the spline of the differential side gear. Figure 4.11.



1. Place differential case assembly in a vise with soft metal covers on the vise jaws. Install the tool into differential until splines of tool and one side gear are engaged. **Figure 4.12**.




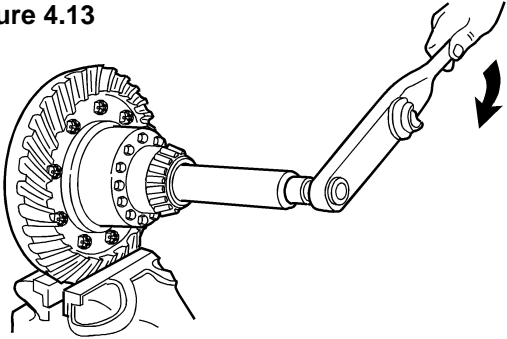

2. Attach torque wrench to the tool nut and rotate differential gears. As differential rotates, read torque value indicated on dial. **Figure 4.13.** 

Figure 4.13



3. If torque value exceeds specification of 50 lb-ft (68 N•m), disassemble gears from differential case. 
4. Check differential case halves, spider, gears and thrust washers for problem that causes excessive torque value. Repair or replace parts.
5. After parts are repaired or replaced, assemble parts and repeat steps 1 to 4.

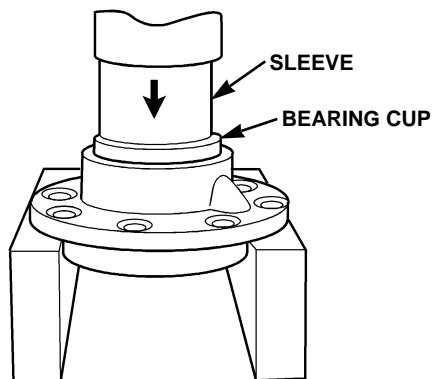
Assemble Drive Pinion and Bearing Cage

WARNING

Observe all WARNINGS and CAUTIONS provided by the press manufacturer concerning press operation to avoid serious personal injury and possible damage to components during assembly and installation procedures.

1. Place bearing cage in press. **Figure 4.14.**

Figure 4.14.



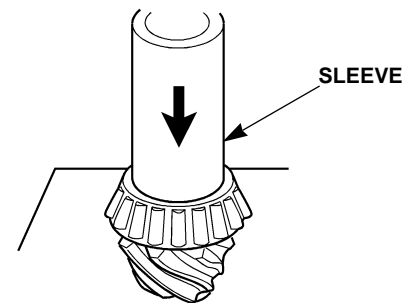
2. Support bearing cage with metal or wood blocks.
3. Press the bearing cup into bore of bearing cage until cup is flat against bottom of bore. Use correct size sleeve to install bearing cup.

NOTE

Use same procedure for both bearing cups.

4. Put drive pinion in press. The gear head (teeth) must face toward the bottom.
 5. Press inner bearing cone on shaft of drive pinion until cone is flat against gear head. Use a sleeve of the correct size against bearing inner race.
- Figure 4.15.**

Figure 4.15

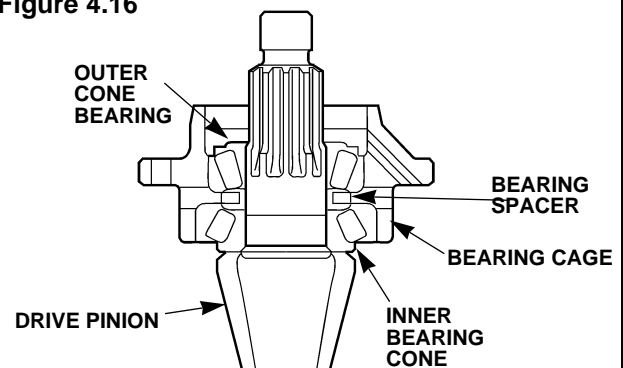


6. Apply axle lubricant on bearing cups in cage and bearing cones.
7. Install drive pinion into bearing cage.
8. Install bearing spacer(s) in pinion shaft against inner bearing cone. **Figure 4.16.**

NOTE

Spacer(s) controls preload adjustment of drive pinion bearings.

Figure 4.16



Section 4 Assembly and Installation



9. Install outer bearing cone on pinion shaft against spacer. **Figure 4.16.**

NOTE

Do not install pinion oil seal in bearing cage before bearing preload adjustment. Continue adjusting preload of pinion bearings.

10. Press outer cone bearing with 10 ton force and check preload of bearings. **Figure 4.16.**

Adjust Pinion Bearing Preload (Without Press)

NOTE

- **If the preload value is below the specified range, install a thinner bearing spacer.**
- **If the preload value is over the specified range, install a thicker bearing spacer.**

Calculation Example:

Data:

Radius: 9.3 cm (3.65 in)

Load: 2.3 Kg (5.0 lbs)

Calculation Procedure:

$2.3 \text{ Kg} \times 9.3 \text{ cm} = 21.4 \text{ Kg-cm}$

$5.0 \text{ lb} \times 3.65 \text{ in} = 18.25 \text{ lb-in.}$

Conversion to N•m:

$21.4 \times 0.098 = 2.1 \text{ N•m}$

$18.25 \times 0.113 = 2.1 \text{ N•m}$

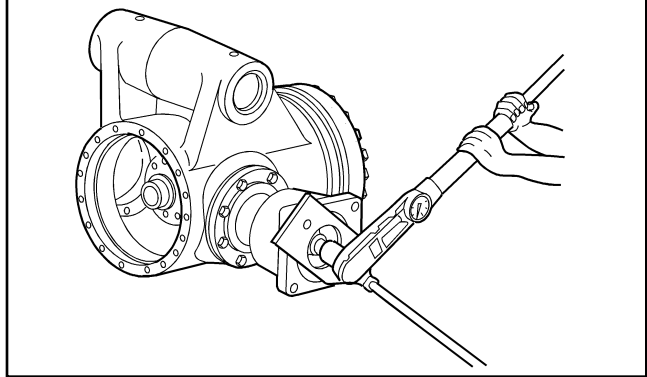
NOTE

- **To convert lb-in to N•m: multiply by 0.113**
- **Kg-cm to N•m: multiply by 0.098**

1. Lubricate bearing cups and cones with specified oil.
2. Install yoke or flange without pinion oil seal.
3. Install pinion bearing cage assembly on main housing without bearing cage shims.
4. Fasten bearing cage assembly on main housing with two capscrews. Apply minimum specified torque of 67 lb-ft (90 N•m). **T**

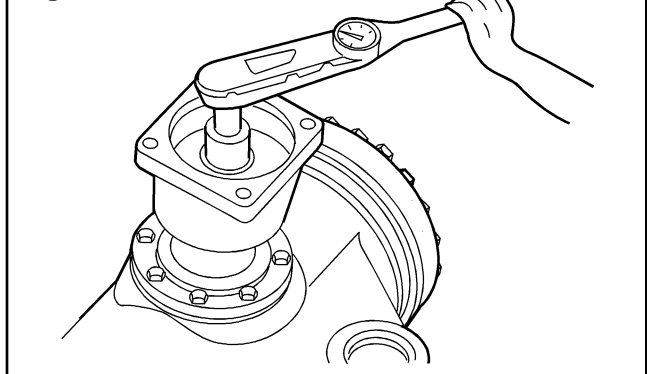
5. Use appropriate tool to fasten pinion through yoke, flange or splined sleeve. **Figure 4.17.**

Figure 4.17



6. Tighten pinion nut with minimum torque value of 465 lb-ft (630 N•m). **T**
7. Rotate pinion bearing cage several times so bearings make normal contact.
8. Attach torque wrench on drive pinion nut. Rotate pinion and check if preload is in specified range. Make the reading during the rotation, not the starting value. **Figure 4.18.**

Figure 4.18



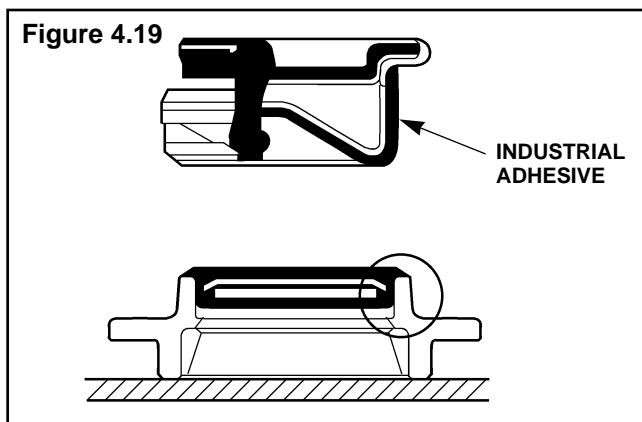
9. If the pinion bearing preload torque value is under or above the specified preload torque of 5-20 lb-in (0.55-2.2 N•m), change shims to thick or thinner size as necessary. Repeat pinion bearing preload check. **T**

10. After getting specified preload, remove bearing cage from main housing and disassemble yoke or input flange.

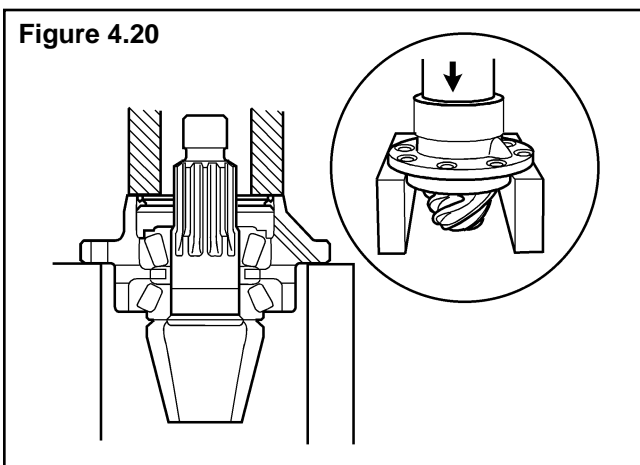
CAUTION


Make sure oil seal lips are clean and free from dirt. Dirt can cause leakage between seal and yoke or flange.

11. Install pinion oil seal with the appropriate tool:
 - a. Apply extreme pressure lithium soap grease to oil seal lips. **Figure 4.19.**



- b. Apply 3M Industrial Adhesive or equivalent to oil seal outer surfaces. **Figure 4.19.**
- c. Press oil seal into bearing until seal flange is flat against top of bearing cage. Use the correct size sleeve or seal driver that fits against metal flange of seal. The diameter of the sleeve must be larger than diameter of flange. **Figure 4.20.**

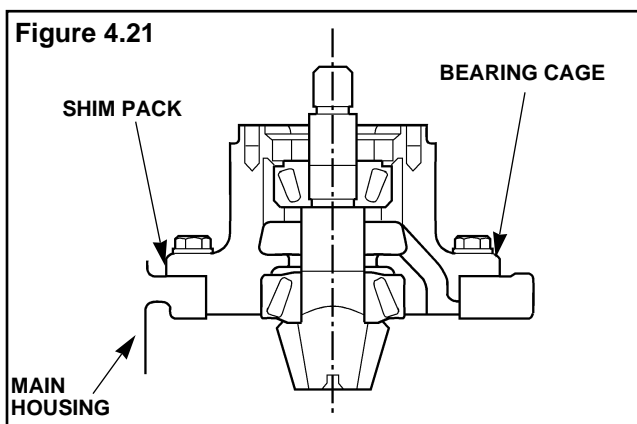


- d. Install yoke or flange and pinion nut into pinion.
- e. Tighten pinion nut to specified torque after installing pinion bearing cage into main housing of 465-570 lb-ft (630-775 N•m). 

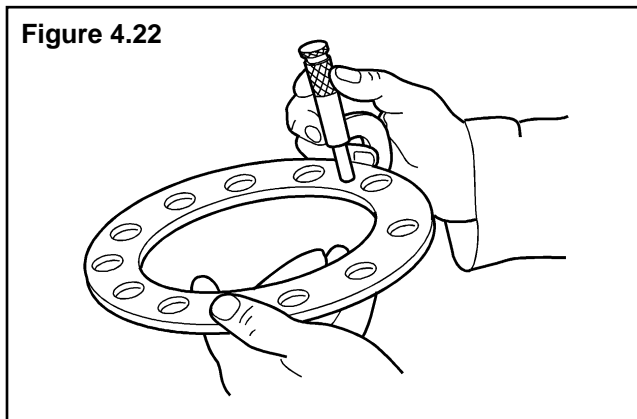
Adjust Thickness of Pinion Bearing Cage Shim Pack (Depth of Pinion)

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 4.21.



1. Use a micrometer to measure the thickness of the old shim pack that was removed from under the pinion cage. Record the measurement for later use. **Figure 4.22.**

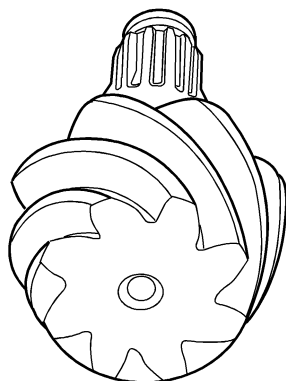


Section 4 Assembly and Installation



2. Record the pinion cone (PC) variation number on the old drive pinion that is being replaced. If the PC variation number cannot be located, assemble the gear set with the shim pack found in step 1. **Figure 4.23.**

Figure 4.23



NOTE

The pinion cone number (PC) can be either 1,000ths of an inch (0.000 inch) or 100ths of a millimeter (0.00 mm). Examples:

*PC+3, PC-3, +3 OR -3 = .003 inch (.076 mm)
PC+.03, PC-.03MM, +.03 OR -.03 = .03 mm*

- *To change inches to millimeters, multiply inches by 25.40*
 - *To change millimeters to inches, multiply millimeters by 0.039.*
3. If the old pinion cone number is a plus (+), 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 (-), 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 (+), 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 (-), 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 a new shim pack that will be installed.

EXAMPLES	Inches	mm
----------	--------	----

1.		
Old shim pack thickness	0.030	0.76
Old PC number, PC+2 (+0.05mm)	<u>-0.002</u>	<u>-0.05</u>
Standard shim pack thickness	0.028	0.71
New PC number, PC+5 (+0.13mm)	<u>+0.005</u>	<u>+0.13</u>
New shim pack thickness	0.033	0.84

2.		
Old shim pack thickness	0.030	0.76
Old PC number, PC-2 (-0.05mm)	<u>+0.002</u>	<u>+0.05</u>
Standard shim pack thickness	0.032	0.81
New PC number, PC+5 (+0.13mm)	<u>+0.005</u>	<u>+0.13</u>
New shim pack thickness	0.037	0.94

3.		
Old shim pack thickness	0.030	0.76
Old PC number, PC+2 (+0.05mm)	<u>-0.002</u>	<u>-0.05</u>
Standard shim pack thickness	0.028	0.71
New PC number, PC-5 (-0.13mm)	<u>-0.005</u>	<u>-0.13</u>
New shim thickness	0.023	0.58

4.		
Old shim pack thickness	0.030	0.76
Old PC number, PC-2 (-0.05mm)	<u>+0.002</u>	<u>+0.05</u>
Standard shim pack thickness	0.032	0.81
New PC number, PC-5 (-0.13mm)	<u>-0.005</u>	<u>-0.13</u>
New shim pack thickness	0.027	0.68

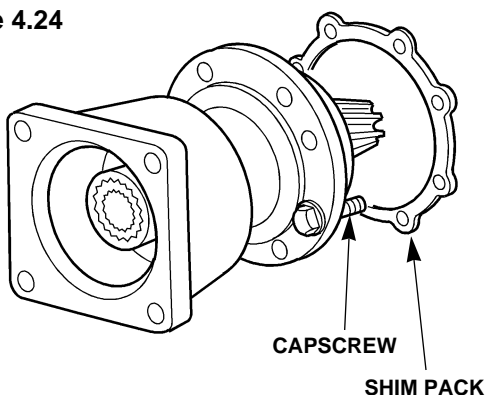
Install Pinion Bearing Cage Assembly on Main Housing

NOTE

Use minimum of three shims in pack. If pack is made from different thickness shims, install thinnest shims on both sides of pack for maximum sealing.

1. Install correct shim pack between bearing cage and main housing. **Figure 4.24.**

Figure 4.24

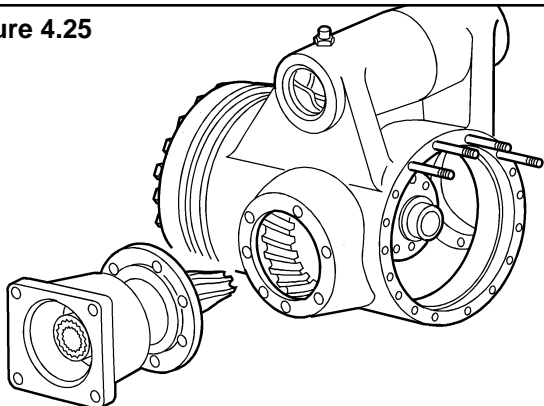


WARNING

Do not hit steel parts with a steel hammer during assembly and installation procedures. Parts can break and cause serious personal injury.

2. Install drive pinion and bearing cage into carrier. If necessary, use rubber, plastic or leather mallet to tap assembly into position. **Figure 4.25.**

Figure 4.25




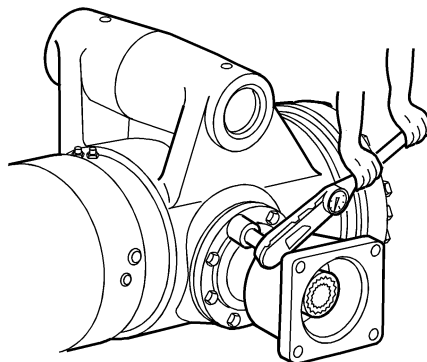
3. Install two capscrews and washers that fasten bearing cage. Tighten to minimum torque of 67 lb-ft (90 N•m). **Figure 4.26.** 

Figure 4.26




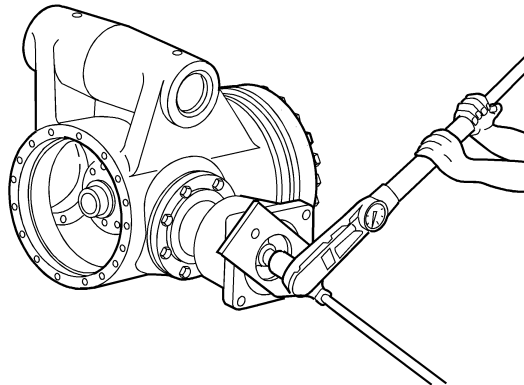
4. Install yoke or flange and pinion nut. Fasten yoke or flange with appropriate tool. Tighten pinion nut to minimum specified torque of 465-570 lb-ft (630-775 N•m). **Figure 4.27.** 

Figure 4.27



CAUTION

The fit between input yoke or flange splines and drive pinion is tight. To install yoke or flange into pinion, use pinion nut and appropriate tool to fasten it. Never use hammer or mallet. A hammer or mallet will damage yoke or flange.

Section 4

Assembly and Installation

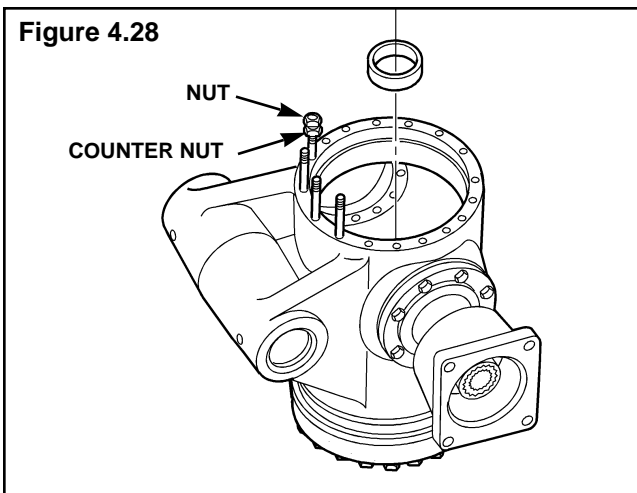


5. If ring gear is mounted on opposite brake housing side, loosen two capscrews that fasten pinion bearing cage. Remove cage and mount it after differential case is assembled.

If ring gear is mounted on brake housing side, install other capscrews that fasten pinion bearing cage. Tighten the capscrews to a torque of 67-91 lb-ft (91-120 N•m). **T**

Install Differential Housing Assembly into Main Housing (With Shims)

1. The preload of differential bearings is adjusted by selecting proper shim pack to obtain a torque of 15-35 lb-in (1.7-4.0 N•m). **T**
2. Install shims. Combine two shims to obtain desired thickness. **Figure 4.28.**



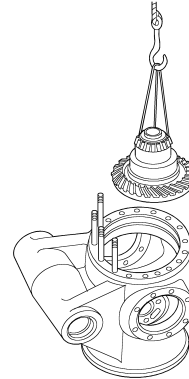
NOTE

Usually a 0.102-0.104 inch (2.60-2.65 mm) shim pack thickness is enough to obtain specified backlash and differential bearing preload.

3. Install differential case bearing cup, axle shaft housing and brake housing studs into main housing until the thread is completely attached. Apply Three Bond 1134 liquid gasket material on stud threads. **Figure 4.28.**

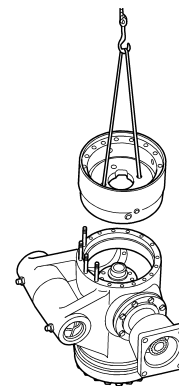
4. Install differential case assembly. **Figure 4.29.**

Figure 4.29



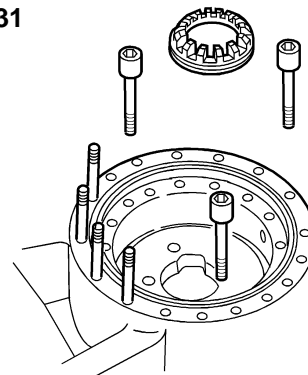
5. Install brake housing and other differential case bearing cup. **Figure 4.30.**

Figure 4.30



6. Install three bolts to adjust differential on brake housing. Tighten to a torque of 19-26 lb-ft (26-36 N•m). **Figure 4.31.** **T**

Figure 4.31



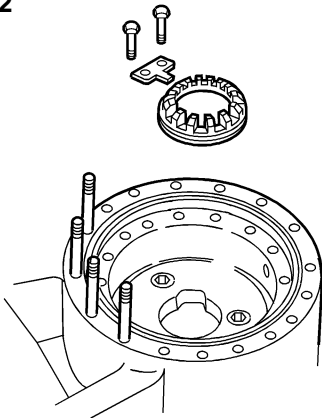
7. Install differential case bearing adjusting nut on brake housing. **Figure 4.31.**
8. Install pinion bearing cage assembly and shim pack.
9. Check backlash, differential preload and teeth contact. See Section 5, "Adjustments."

! WARNING

Small amounts of acid vapor are present when applying some liquid gasket materials during assembly and installation procedures. To prevent possible serious personal injury, make sure there is good ventilation in the work area. If the liquid gasket material gets in eyes, flush eyes with water for 15 minutes. Have eyes checked by doctor.

10. If all adjustments are within specifications, remove brake housing. Apply liquid gasket material to main housing surface.
11. Install three bolts into the brake housing to adjust differential. Tighten them to 19-26 lb-ft (26-36 N•m). **T**
12. Apply medium torque liquid adhesive, Loctite 241 or Three Bond 1334, to lock capscrews. Install adjusting nut lock and capscrews. Tighten capscrews to 80-115 lb-in (9-13 N•m). **Figure 4.32. T**

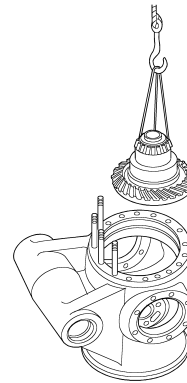
Figure 4.32



Install Differential Housing Assembly into Main Housing (With Adjusting Ring 2 Sides)

1. Install adjusting ring into main housing.
2. Install bearing cup.
3. Install differential case assembly into main housing. **Figure 4.33.**

Figure 4.33



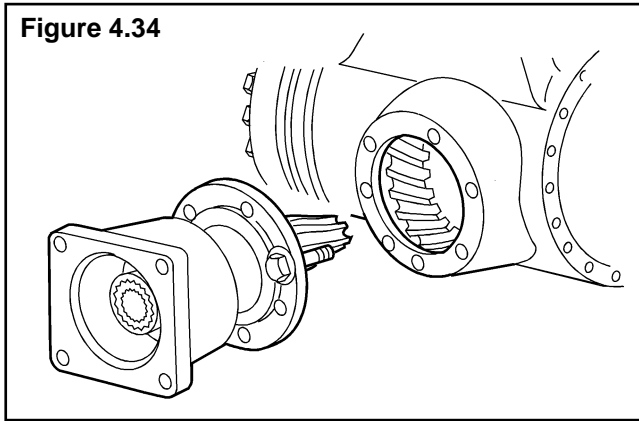
4. Install brake housing and other differential case bearing cup. **Figure 4.30.**
5. Install three bolts to adjust the differential on brake housing. Tighten to 19-26 lb-ft (26-36 N•m). **Figure 4.31. T**
6. Install differential case bearings adjusting nut into brake housing. **Figure 4.31.**

Section 4 Assembly and Installation



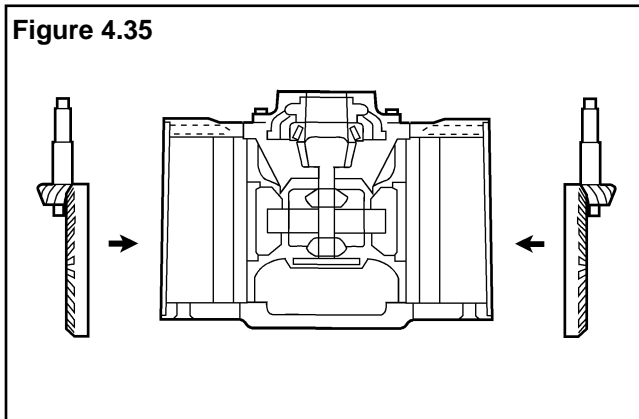
7. Install pinion bearing cage assembly and shim pack. **Figure 4.34.** See "Install Pinion Bearing Cage Assembly on Main Housing," page 31.

Figure 4.34



8. Adjust adjusting rings with the following procedure. **Figure 4.35.**

Figure 4.35



- a. Tighten ring gear side adjusting ring to eliminate backlash between ring gear and pinion.
- b. Unfasten same adjusting ring from four to five slots.
- c. Tighten opposite side adjusting ring to obtain a preload of 15-35 lb-ft (1.7-4.0 N•m). Discount pinion bearing preload measured before. **T**

9. Check backlash, differential preload and teeth contact. See Section 5, "Adjustments."
10. If all adjustments are within specifications, remove brake housing. Apply liquid gasket material to main housing surface.

! WARNING

To avoid serious personal injury, be careful when using Loctite. Follow the manufacturer's instructions for safe use to prevent irritation to eyes and skin. Wash after skin contact. If the Loctite gets in eyes, flush with water for 15 minutes. Have eyes checked by a doctor.

11. Apply high torque liquid adhesive, Loctite 271 or Three Bond 1334, on stud threads.
12. Install studs that fasten brake housing and axle shaft housing to main housing. Tighten studs until resistance is met.
13. Install bearing cup and brake housing into main housing. Align holes at mark made during disassembly.
14. Install 3 bolts into the brake housing to adjust differential. Tighten them to 19-26 lb-ft (26-36 N•m). **Figure 4.31. T**
15. Apply medium torque liquid adhesive, Loctite 241 or Three Bond 1334, to lock capscrews. Install adjusting nut lock and capscrews. Tighten capscrews to 80-115 lb-in (9-13 N•m). **T**

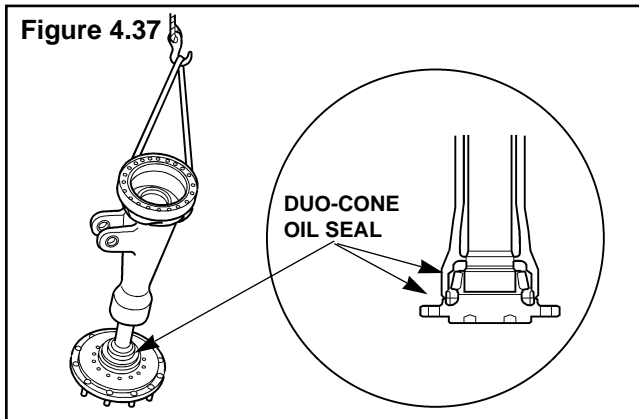
Assemble Axle Shaft

1. Use correct size sleeves to install cups into bores in axle shaft housing until cups are flat against bottom of bores. **Figure 4.36.**

Figure 4.36



2. Install Duo-Cone oil seal into axle shaft and into axle shaft housing bore as specified on page 18. **Figure 4.37.**



3. With a correct size sleeve, use a press to install flange side cone bearing. Install axle shaft into axle shaft housing. **Figure 4.37.**

Assemble Trumpet Assembly

WARNING

Observe all WARNINGS and CAUTIONS provided by the press manufacturer concerning press operation to avoid serious personal injury and possible damage to components during assembly and installation procedures.

1. Use press to install new planetary pin into spider. Make sure proper dimensions are used and holes are aligned. **Figures 4.38 and 4.39.**

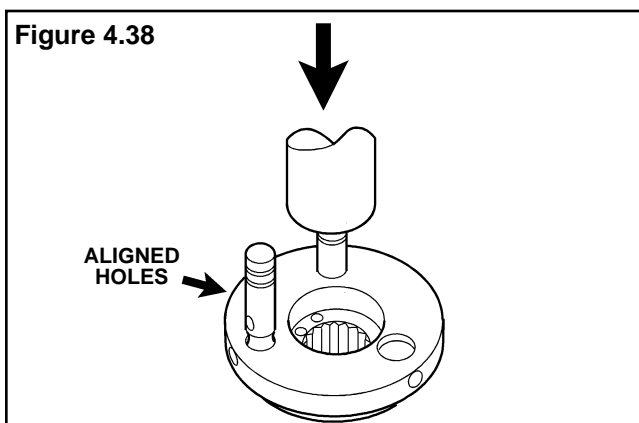
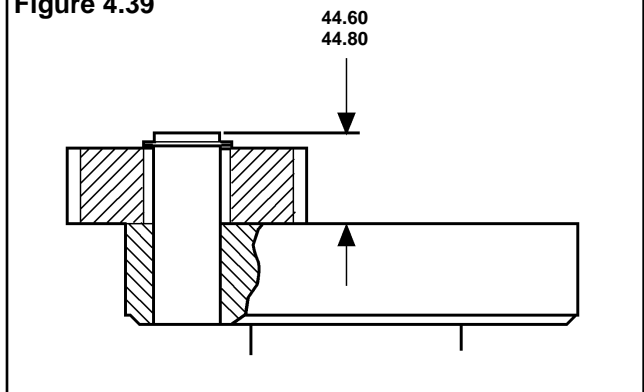



Figure 4.39



WARNING

To avoid serious personal injury, be careful when using Loctite. Follow the manufacturer's instructions for safe use to prevent irritation to eyes and skin. Wash after skin contact. If the Loctite gets in eyes, flush with water for 15 minutes. Have eyes checked by a doctor.

2. Apply Medium Torque liquid adhesive, Loctite 241 or Three Bond 1334, to threads of planetary gear axle lock capscrews. Install and tighten to 17-23 lb-ft (23-31 N•m). 

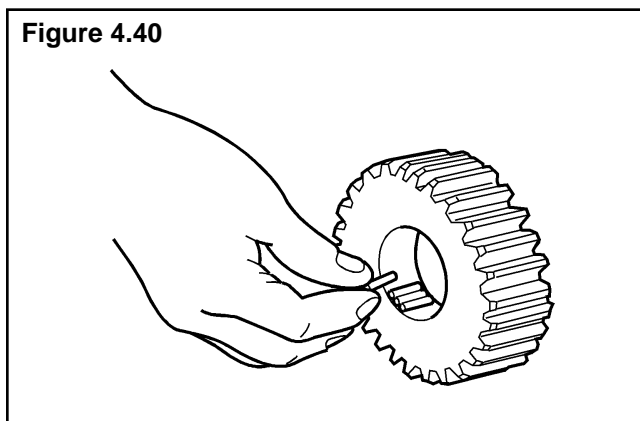
Section 4 Assembly and Installation



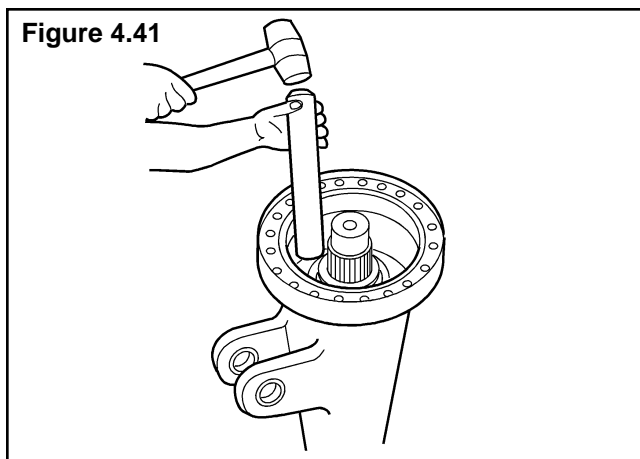
CAUTION

Rollers must come from the same manufacturer and have the same tolerance range. Replace spacers and washers when a new roller is used.

3. Apply grease, Shell-71032 Alvania EP-2 or Texaco - 995 Multifak EP-2, on each gear hole. Install rollers and spacers into planetary gears. **Figure 4.40.**



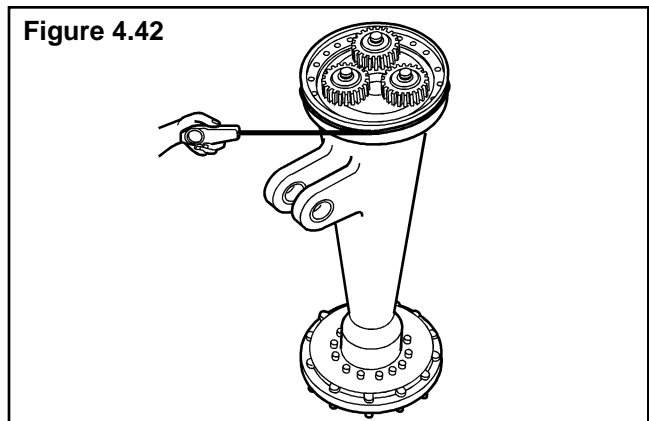
4. Install bearing cone. **Figure 4.41.**



5. Install planetary spider and axle shaft bearing adjusting nut.
6. Measure trumpet flange radius. With a spring scale, check the trumpet assembly preload before tightening adjusting nut.

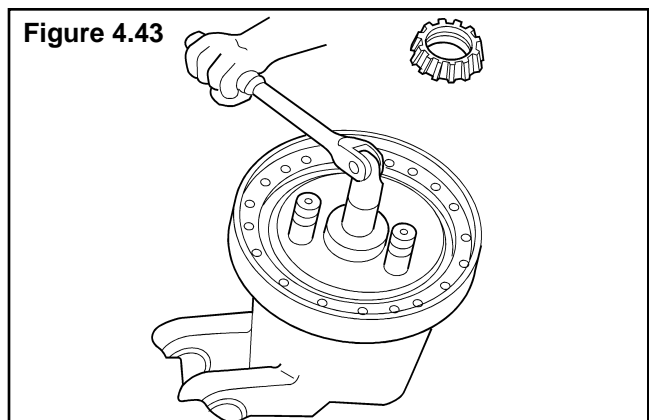
The value will be obtained by multiplying the number read on the spring scale dial by the flange radius. Make note of the value. **Figure 4.42.**

Figure 4.42



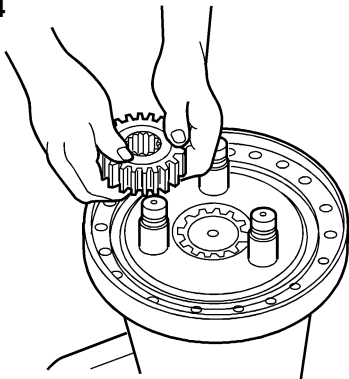
7. Tighten adjusting nut with special tool shown on page 60. At the same time, manually rotate the trumpet to assure a correct fit between bearing cups and cones and get desired preload. **Figure 4.43.**

Figure 4.43



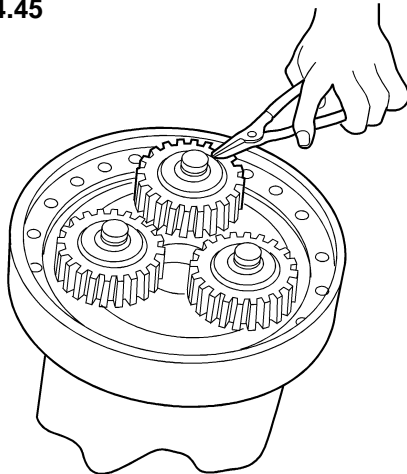
8. Check trumpet assembly preload and subtract value obtained before tightening adjusting nut. Value must be 15-35 lb-in (1.7-4 N•m). **T**
9. Apply Medium Torque liquid adhesive, Loctite 241 or Three Bond 1334, on adjusting nut lock capscrow threads. Install adjusting nut lock capscrow. Tighten to 17-23 lb-ft (23.0-30.5 N•m). **T**
10. Install inner washer, planetary gears and rollers into flange. **Figure 4.44.**

Figure 4.44



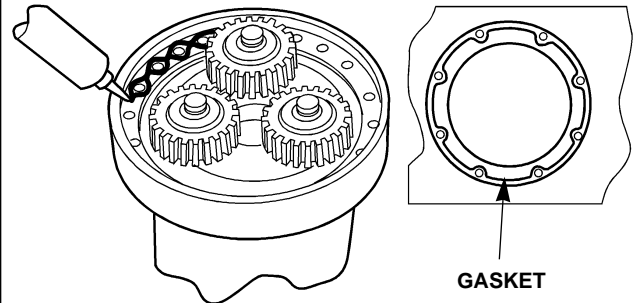
11. Install outer washers.
12. With correct pliers, install snap rings. **Figure 4.45.**

Figure 4.45



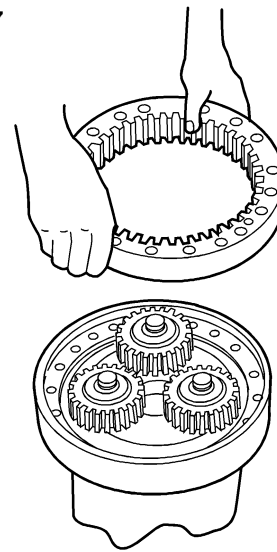
13. Apply liquid gasket material on contact surfaces of trumpet and ring. **Figure 4.46.**

Figure 4.46



14. Install ring gear into trumpet. Use reference marks made during disassembly to align holes and contact surface. **Figure 4.47.**

Figure 4.47



Section 4 Assembly and Installation



Assemble Hydraulic Apply Brake Housing Assembly

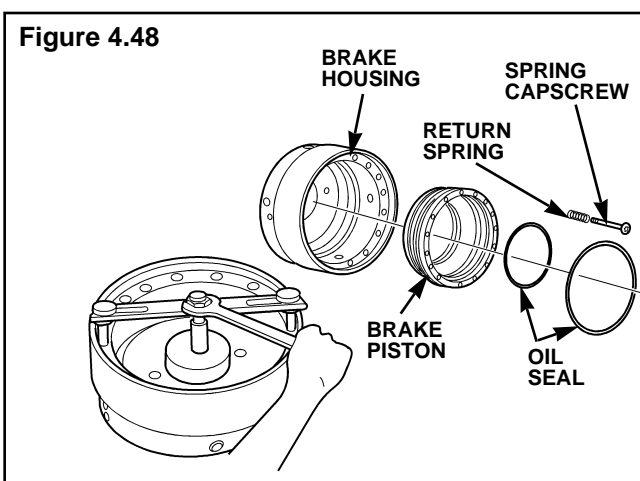
NOTE

- To assemble three function brake, see page 39.
 - To assemble ball and ramp brake, see page 43.
1. Check to see if the piston lodging surfaces on brake housing is free of sharp edges, nicks and burrs. Repair any damage if possible or replace the part.
 2. Repeat Step 1 on outer surfaces of brake piston.
 3. Apply a thin film of oil, SAE W140 or SAE 90, to piston and bore. Apply a dense layer of oil to brake housing chamfer.
 4. Carefully install piston oil seals.

NOTE

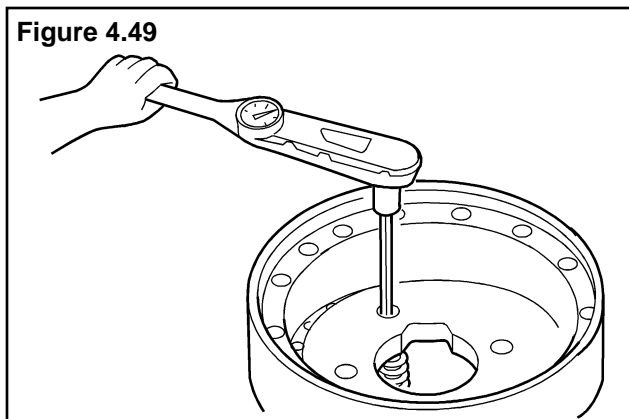
Before pressing piston into brake housing, rotate piston 15 to 20 degrees. If piston does not turn easily, disassemble the piston and find the cause of the interference.

5. With a manual press, carefully install piston into brake housing. Do not damage oil seals. If there is resistance in installing the piston, do not proceed. **Figure 4.48.**



6. Apply high torque liquid adhesive, Loctite 271 or Three Bond 1305, to capscrew threads. Install return springs and return spring capscrews. Tighten to 80-115 lb-in (9.0-13.0 N•m). **Figure 4.49.**

Figure 4.49



Hydraulic Apply Brake Housing Functional Test

NOTE

- *This test procedure is only for the hydraulic apply brake system.*
 - *To perform this test, it is necessary to use a device which permits the observation of possible leaks through oil seals and if the piston return system is working. For an accurate evaluation, the device must allow piston displacement of 0.157 to 0.197 inch (4-5 mm).*
1. Connect brake housing assembly into hydraulic system equipped with 1000 psi (69 bar) manometer.
 2. Activate the cylinder at least five times with 600 psi (41.4 bar). Check for leaks.
 - If there are no leaks, proceed to Step 3.
 - If there are leaks, disassemble brake housing assembly, find and correct the problem.
 3. Wait five minutes, then apply 600 psi (41.4 bar) to the cylinder again.

- If there are no leaks, proceed to Step 4.
 - If there are leaks, disassemble brake housing assembly, find and correct the problem. Repeat Steps 1 to 3.
4. Wait five minutes, then apply 75 to 110 psi (5.1 to 7.6 bar) to the cylinder again.
- If there are no leaks, the assembly is assembled correctly.
 - If there are leaks, find and correct the problem. Repeat the test again.

Assemble Three Function Brake Housing Assembly

NOTE

Before assembling brake housing assembly, make sure that all surfaces and bores of brake housing and piston are free of dirt, burrs and nicks.

1. Select piston shim pack with the following procedure:
 - a. Position parts of piston assembly in a press. Measure the dimension "A" under 441 lb (200 Kg) pressure. **Figure 4.50.**
 - b. Measure the dimension "B". **Figure 4.51.**

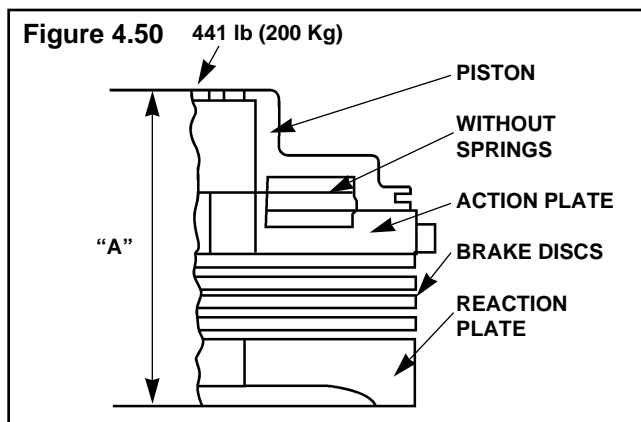
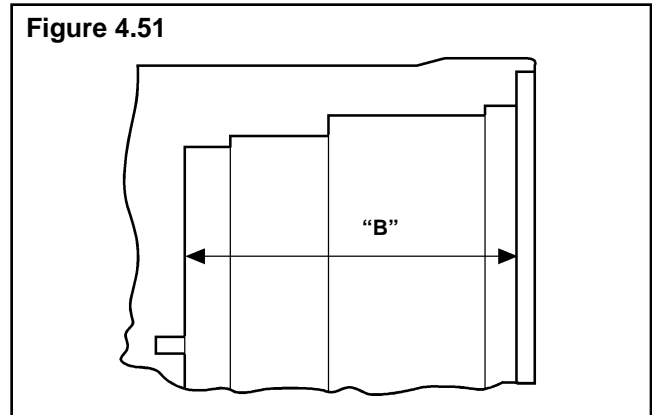


Figure 4.51



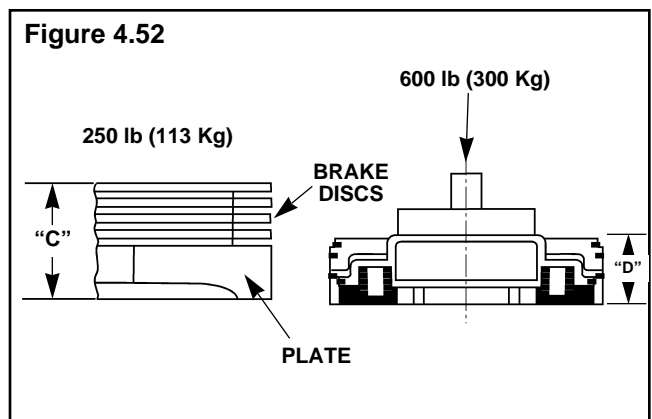
- c. The shim pack thickness is the difference between dimension "B" and dimension "A" minus 0.06 in. (1.5 mm):

$$B - A - 0.06 \text{ in. (1.5 mm)} = \text{shim pack thickness}$$

- d. If brake piston is assembled, the shim pack thickness, under press pressure of 441 lbs (200 Kg), is the difference between dimension "B" minus the sum of dimensions "C" and "D" minus 0.06 in. (1.5 mm):

$$B - (C + D) - 0.06 (0.15) = \text{shim pack thickness.}$$

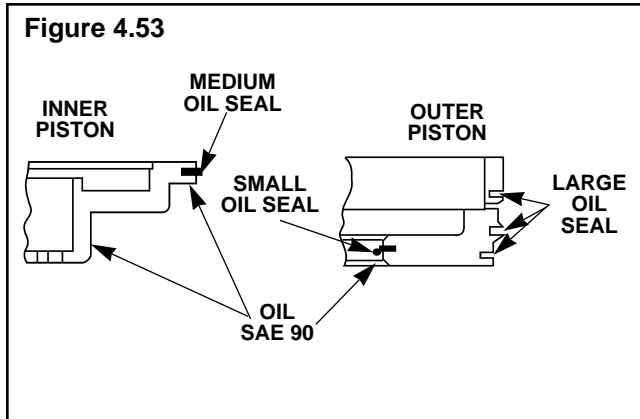
Figure 4.52.



Section 4 Assembly and Installation



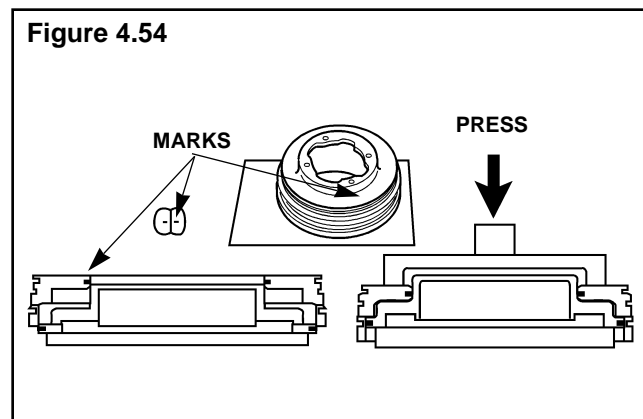
2. Lubricate internal brake housing surfaces, inner and outer piston surfaces and oil seal bores with SAE 90 oil. **Figure 4.53.**



NOTE

Each piston assembly has three different sizes of oil seals: three large, one medium, one small.

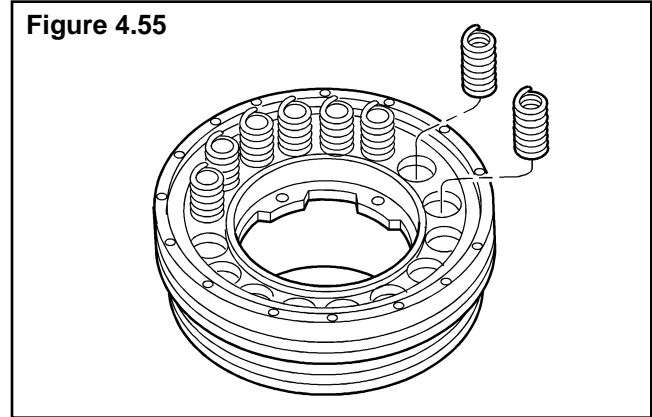
3. Install medium oil seal into inner piston bore and install the small oil seal into the outer piston bore. **Figure 4.53.**
4. ONLY use a manual press to install inner piston into outer piston. Be careful not to damage oil seals. Do not force the inner piston assembly. **Figure 4.54.**



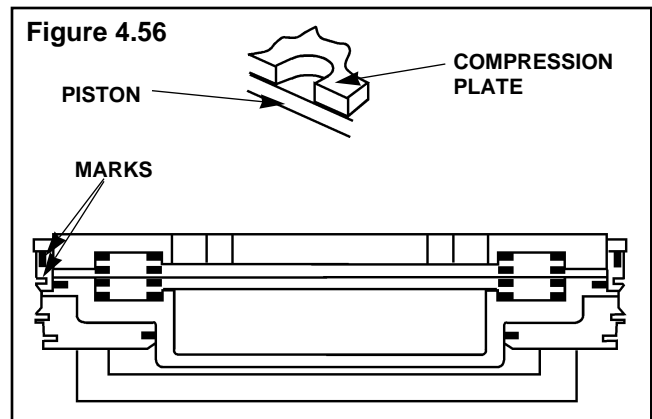
NOTE

*Rotate pistons until marks are aligned. If inner piston does not rotate easily, disassemble it and find the cause. **Figure 4.54.***

5. Install springs into bores in inner piston. **Figure 4.55.** For brake with 12 springs, jump one bore each three. **Figure 4.55.**



6. Install compression plate on piston. Correctly align the fastener holes. Use marks on piston and lock pin slot. **Figure 4.56.**



7. Apply pressure to the compression plate until it is flat against the piston.

WARNING

To avoid serious personal injury, be careful when using Loctite. Follow the manufacturer's instructions for safe use to prevent irritation to eyes and skin. Wash after skin contact. If the Loctite gets in eyes, flush with water for 15 minutes. Have eyes checked by a doctor.


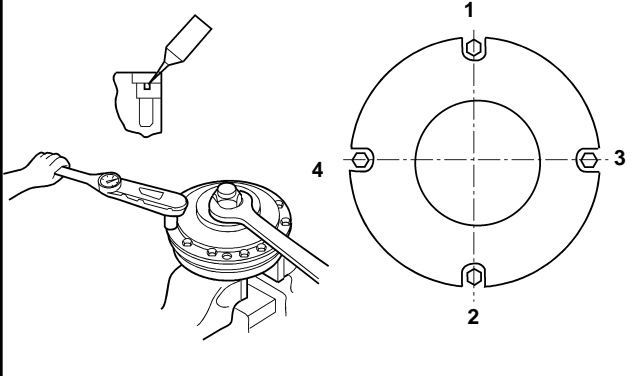
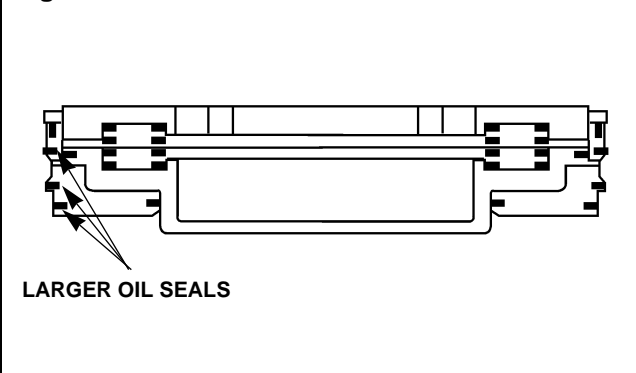
8. Apply medium torque liquid adhesive, Loctite 241 or Three Bond 1334 in threaded external piston bolt holes. Install action plate bolts as shown in **Figure 4.57** and apply a pretorque of 30 lb-in (3.3 N•m). Tighten to specified torque of 120-140 lb-in (13.5-16 N•m). 

Figure 4.57



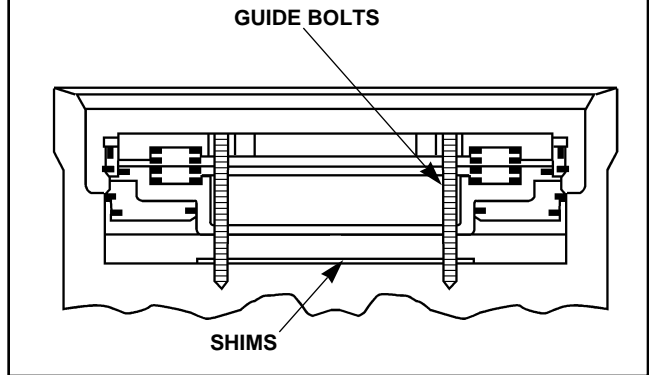
9. Install three larger oil seals into outer piston. Make sure the oil seals fit in the bores. **Figure 4.58.**

Figure 4.58



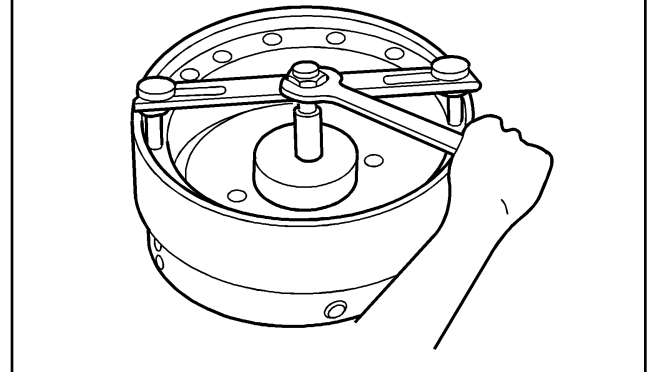
10. Install shim pack into brake housing. Use bolts to align holes. **Figure 4.59.**

Figure 4.59



11. Remove guide bolts and manually install brake piston assembly into brake housing. Rotate piston assembly 15 to 20 degrees. The rotation must be easy and without resistance. If there is any resistance, disassemble the brake piston assembly and find the cause.
12. Use bolts as guide and align piston and holes. Use marks made during disassembly as reference. **Figure 4.60.**

Figure 4.60



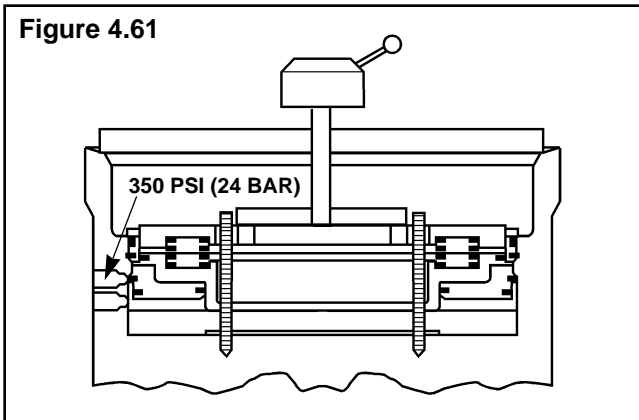
13. With a manual press on brake housing, apply pressure to brake piston until the springs compress. Make sure oil seals fit in bores. **Figure 4.60.**

Section 4 Assembly and Installation




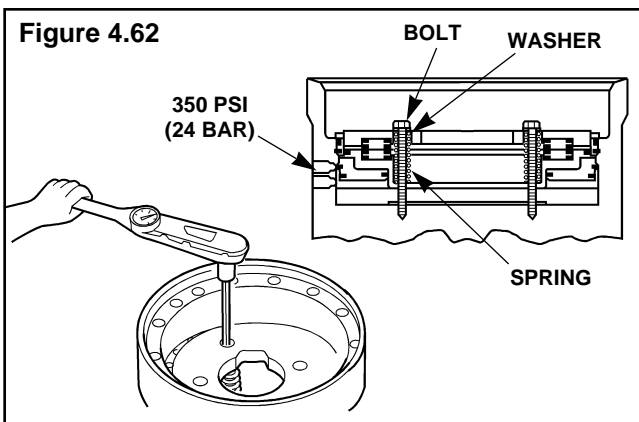
14. With piston still compressed, apply 350 psi (24 bar) into parking brake to make sure oil seals fit in bores. **Figure 4.61.**

Figure 4.61



15. Keep the parking brake under 350 psi (24 bar) pressure and remove the manual press and guide pins.
16. Apply medium torque liquid adhesive, Loctite 241 or Three Bond 1334, to return spring holes and bolt threads. Install return springs, washers and return spring bolts into brake housing. Tighten bolts to 80-115 lb-in (9-13 N•m).

Figure 4.62. 



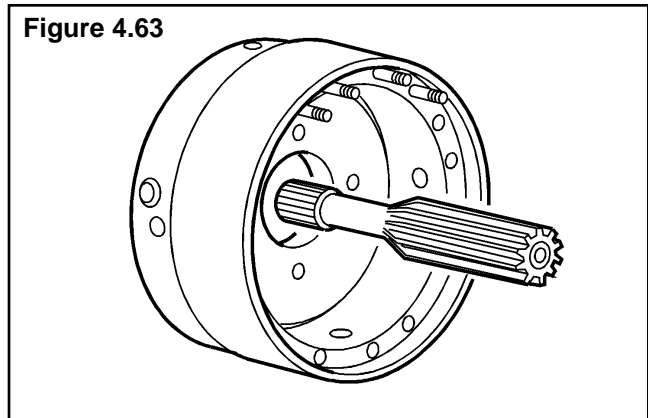
NOTE

Use same procedure to install other brake piston assemblies into main housing.

Assemble Ball and Ramp Brakes, Brake Discs, Reaction Plate and Pins

1. Install sun gear. **Figure 4.63.**

Figure 4.63

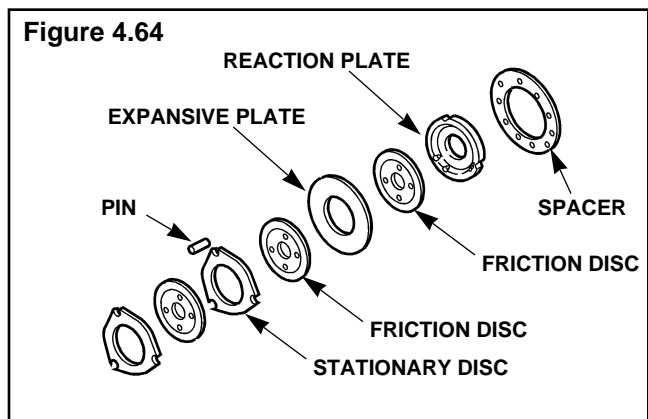


NOTE

After assembly, friction disc lubrication holes must be perfectly aligned.

2. Install friction and stationary discs alternately. Make sure friction disc is against brake piston.
3. For ball and ramp brakes, discs must be installed alternately and a friction disc must be on each side of the expansive plate. **Figure 4.64.**

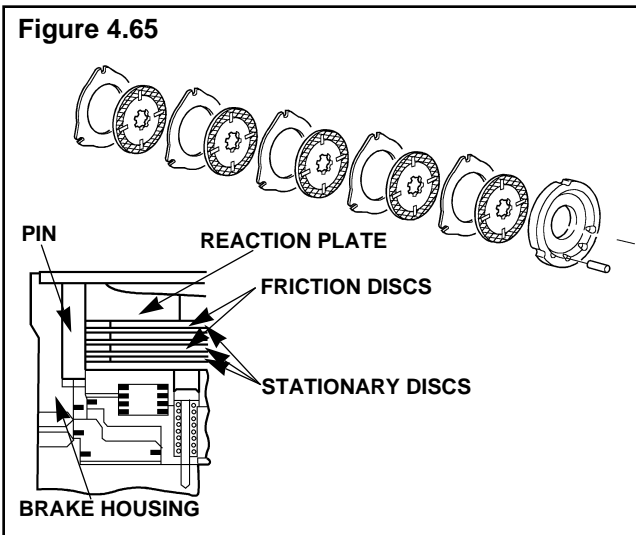
Figure 4.64



4. Install stationary disc lock pins.
5. Install reaction plate with lubrication hole on down side of axle.
6. If there is an outer spacer, install it on brake housing surface. Use liquid gasket material.

Assemble Three Function Brakes, Brake Discs, Reaction Plate and Pins

1. Lubricate all brake components with same oil specified for axle. See page 53.
2. Install sun gear. **Figure 4.63.**
3. Apply 350 psi (24 bar) into parking brake.
4. Install friction and stationary discs, guide pins and reaction plate. **Figure 4.65.**

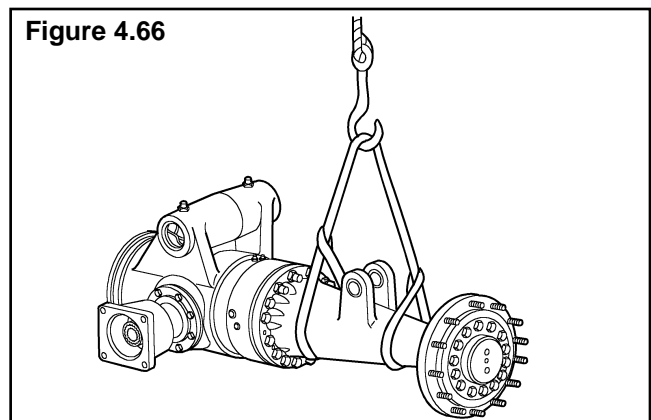


Install Housing Assembly into Main Housing

NOTE

If axle is equipped with three function brake, keep parking brake pressurized.

1. Install housing assembly. Make sure that the mark made during disassembly is correctly positioned to ensure alignment of the fastener holes. **Figure 4.66.**



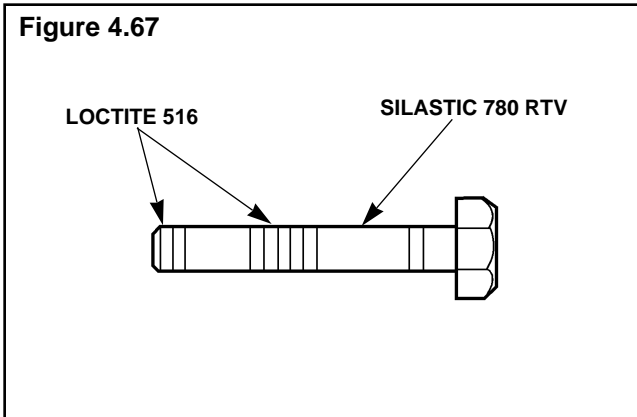
2. Install capscrews and nuts that fasten housing to main housing.
 - Tighten grade 12.9 capscrew 170-200 lb-ft (230-271 N•m). **T**
 - Tighten grade 10.9 capscrew 135-170 lb-ft (183-230 N•m). **T**
 - Tighten stud nuts 120-150 lb-ft (160-205 N•m). **T**
3. Release pressure from parking brake.
4. Apply liquid gasket material, Loctite 515 or Three Bond 1134, on surface of cover that fastens to main housing and on capscrew threads. Install cover and capscrews on main housing. Tighten capscrews to 20-27 lb-ft (27-36 N•m). **T**

Section 4 Assembly and Installation



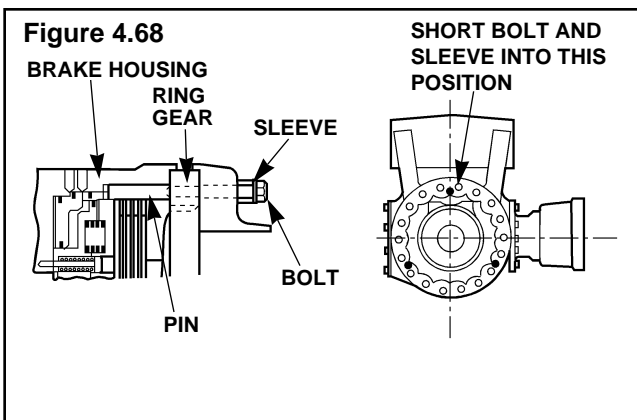
Assemble Three Function Brake Release Bolts and Sleeves

1. Apply Loctite 516 on bolt threads. **Figure 4.67.**



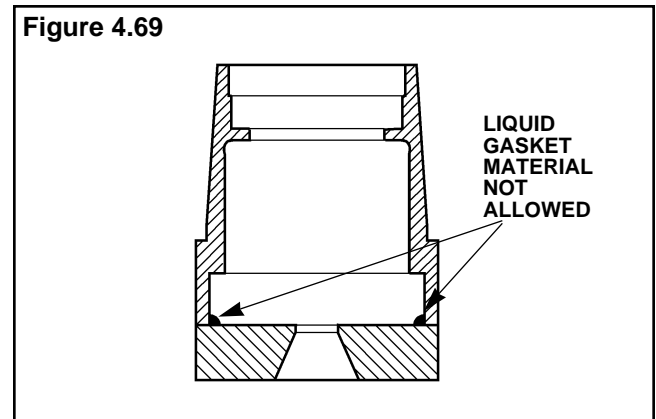
2. Apply liquid gasket material, Silastic 780 RTV Dow Corning, on non-threaded bolt shaft. **Figure 4.67.**
3. Install bolts and sleeves. Tighten to 25-34 lb-ft minimum (34-46 N•m). **Figure 4.68.**

 - Assemble 2 larger bolts, 3.346 in. (85 mm) with larger sleeves, 1 in. (26 mm)
 - Assemble shorter bolt, 3.070 in. (78 mm) with shorter sleeve, 0.750 in. (19 mm).

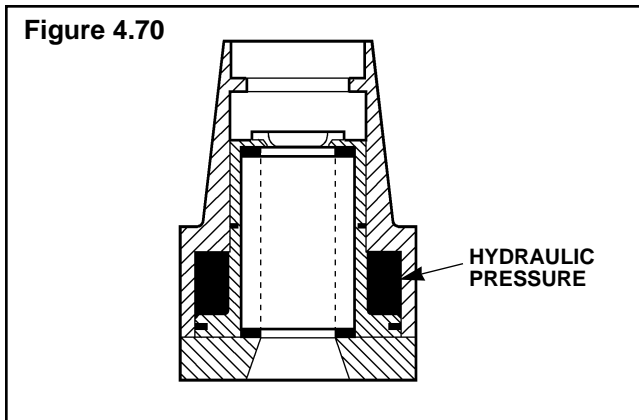


Assemble Ball and Ramp Brake Cylinder Assembly and Install on Main Housing

1. Apply liquid gasket material FAG-3 on brake cylinder surface that fastens to brake cylinder support. Assemble brake cylinder, oil seals, piston and brake cylinder support. Tighten capscrews that fasten brake cylinder support 19-26 lb-ft (26-36 N•m). **Figure 4.69.**



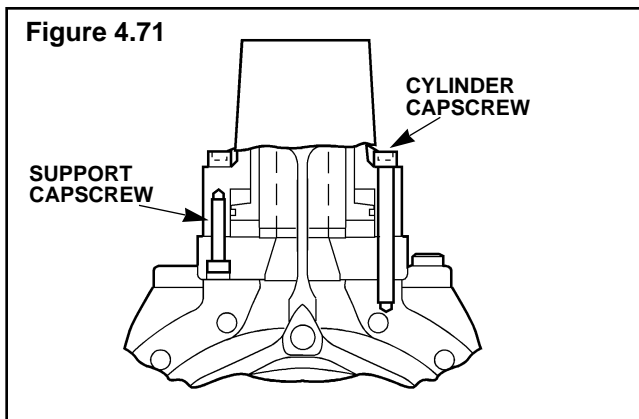
- While out of the axle, connect cylinder assembly to hydraulic system. Apply 400 psi (27.6 bar) pressure to compress spring until piston is against brake cylinder. Repeat this operation four to five times to make sure there is no leakage. **Figure 4.70.**



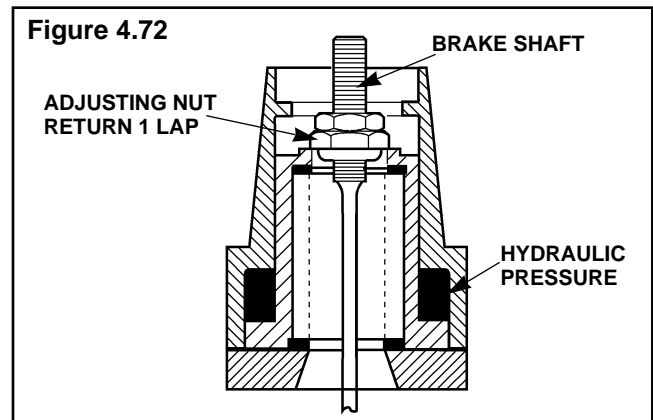
CAUTION

Do not use brake fluid in the hydraulic system. Use Shell Donax TD or Shell Tellus 32 or equivalent.

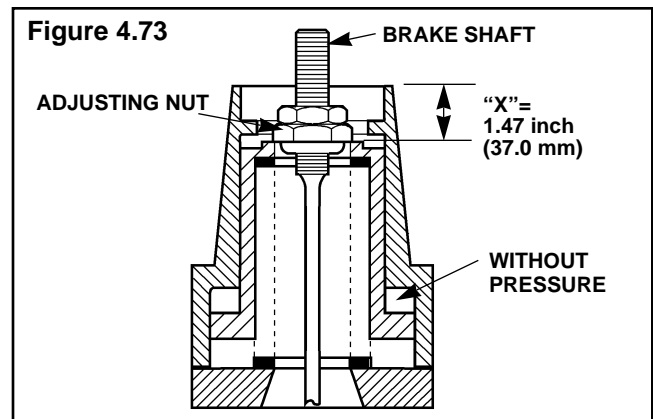
- Install brake cylinder assembly onto main housing. **Figure 4.71.**



- While the cylinder is pressurized with 400 psi (27.6 bar), apply liquid adhesive, Loctite 221 or Three Bond 1341, on threads of brake shaft. Install adjusting nut until it rests against piston. **DO NOT TIGHTEN ADJUSTING NUT.** Loosen the adjusting nut one full turn. **Figure 4.72.**



- Release cylinder pressure to ZERO so piston returns back against adjusting nut. Check dimension "X" as shown in **Figure 4.73.**



If dimension "X" is smaller than 1.47 inch (37.0 mm), tighten adjusting nut until the dimension is reached. If dimension gets larger, unfasten the nut. This adjustment must be made with piston activated.

Section 4 Assembly and Installation



6. After 1.47 inch (37.0 mm) dimension is obtained, apply specified pressure to brake and check the brake torque on pinion as shown in chart.

Torque Reduction	Disc No.	Pressure	Torque
PRA-382 17.08:1	06	275 psi min (19 bar min)	950-1200 lb-ft (1288.0-1559.0 N•m)
PRA-353 46.00:1	06	275 psi min (19 bar min)	350-500 (474.5-678.0 N•m)

NOTE

To obtain the desired brake torque, fasten or unfasten the adjusting nut. For each 0.04 inch (1 mm) turned on dimension "X", the variation in torque is 4%.


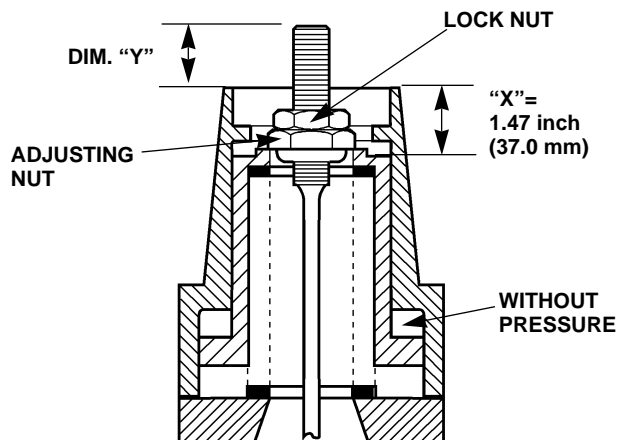
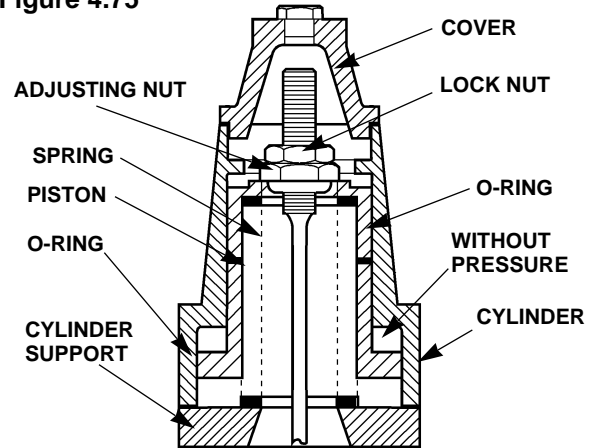
7. After obtaining the desired brake torque, install nut lock as shown in **Figure 4.74**. Tighten to 60-90 lb-in (80-120 N•m). 

Figure 4.74



8. Install cover. **Figure 4.75**.

Figure 4.75



9. The dimension "Y" must be equal with ± 0.02 inch (0.5 mm) on each side. If dimension is larger on one of the sides after adjustment, disassemble and find the cause.

NOTE

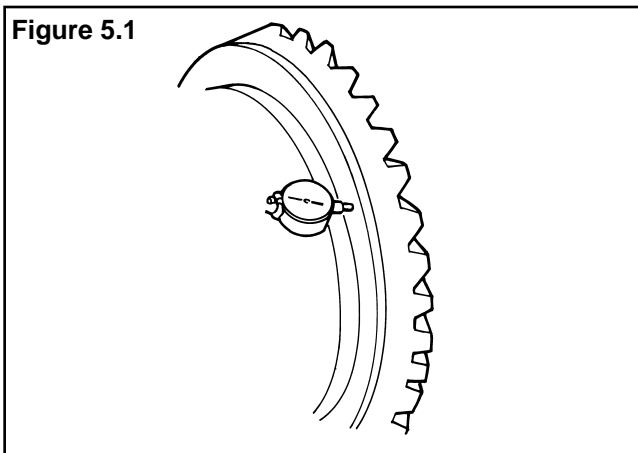
Do not check the brake torque before the wheel has turned at least two times with the brake activated.

Check Ring Gear Runout Specification: 0.008 inch (0.20 mm)

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

1. Attach magnetic base dial indicator to mounting flange of main housing. **Figure 5.1.**



2. Set dial indicator so plunger or pointer is against back surface or ring gear. **Figure 5.1.**
3. Set dial indicator to **ZERO**.
4. Rotate differential and ring gear assembly while you read dial indicator. Ring gear runout must not exceed 0.008 inch (0.20 mm). If runout exceeds specifications, remove differential and ring gear assembly from main housing.
5. Check differential parts including carrier for problem that caused ring gear runout to exceed specifications. Repair or replace parts if necessary.

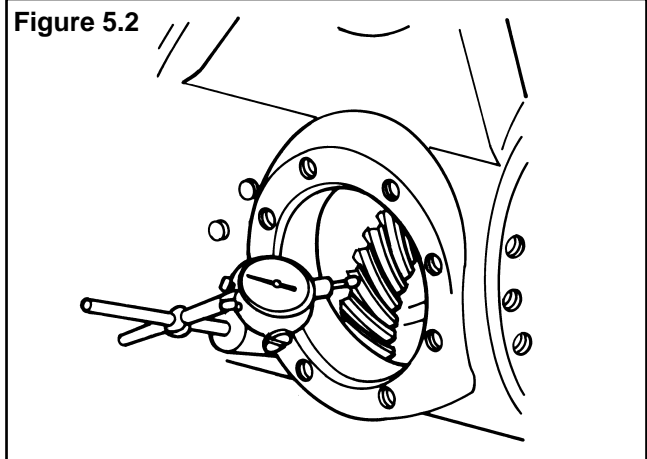
CAUTION

Shock load failure will distort the differential case flange and transfer damage to ring gear. In this case, differential carrier must be discarded.

6. After parts are repaired or replaced, install main differential case and ring gear assembly into carrier. Repeat steps 1 to 5.

Adjust Pinion and Ring Gear Backlash Specification: 0.005-0.015 inch (0.13-0.38 mm)

1. Attach dial indicator on mounting flange of carrier.
2. Set dial indicator so plunger is against a tooth surface. **Figure 5.2.**
3. Set dial indicator to **ZERO**.



NOTE

- *When you adjust backlash, only move ring gear. Do not move drive pinion.*
- *If you are using old ring gear and pinion, it is recommended that you maintain original backlash.*

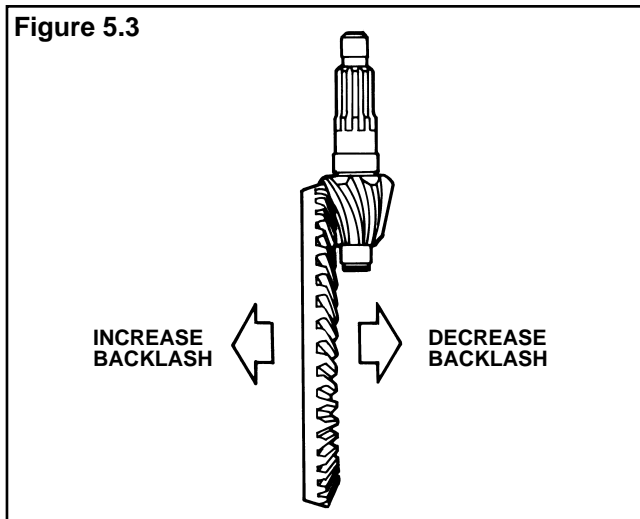
4. Hold drive pinion in position.
5. While you read dial indicator, rotate differential and ring gear a small amount in both directions against teeth of the drive pinion. If backlash reading is within specified range of 0.005-0.015 inch (0.13-0.38 mm), continue by checking tooth contact patterns. If backlash reading is not within specifications, adjust backlash as needed.

Section 5 Adjustments



- Loosen one bearing adjusting ring one notch, then tighten opposite ring the same amount to keep differential roller bearing preload.

Figure 5.3.



NOTE

When you adjust backlash, only move ring gear. Do not move drive pinion.

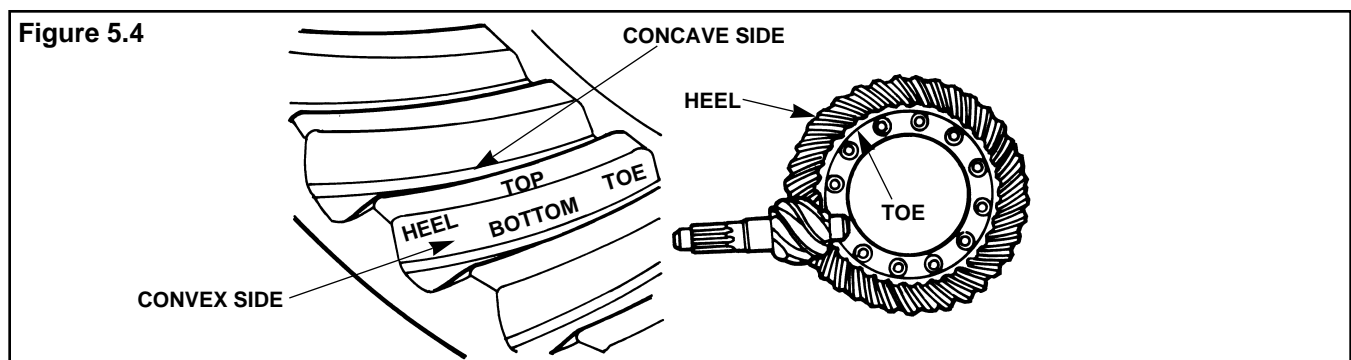
- Backlash is increased by moving ring gear away from drive pinion.*
- Backlash is decreased by moving ring gear toward drive pinion.*

- Repeat steps two to six until backlash is within specifications. Record setting for use when you adjust pinion bearing preload.

Teeth Contact Patterns

In the following procedures, movement of the contact pattern along length of tooth is indicated as toward the “heel” or “toe” of the ring gear.

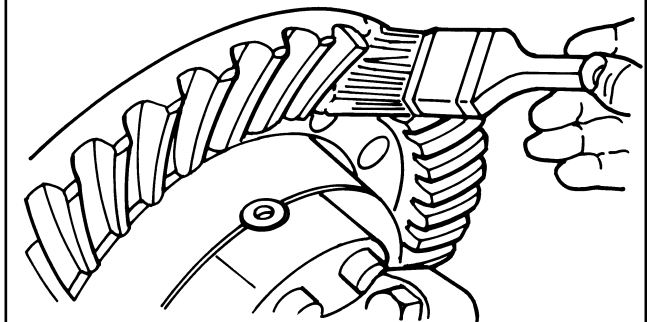
Figure 5.4.



Verification Procedure

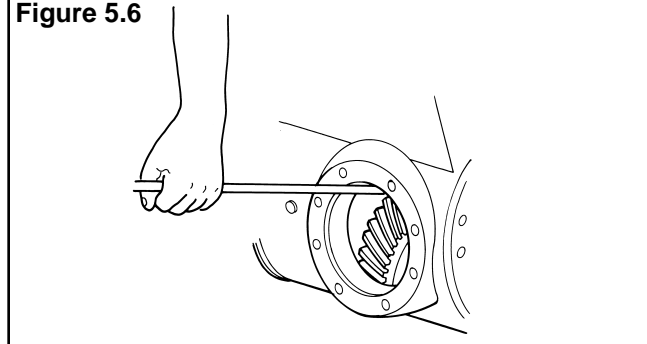
- Apply a marking compound to approximately 12 teeth of ring gear. Rotate ring gear so that the 12 gear teeth are next to drive pinion. **Figure 5.5.**

Figure 5.5

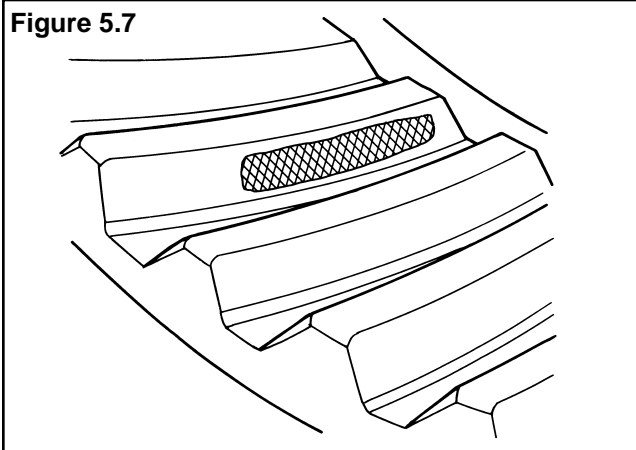


- Apply load on ring gear with wood pry bar. Rotate gear forward and backward so 12 gear teeth go past the drive pinion six times to get contact patterns. Repeat if needed to get a more clear pattern. **Figure 5.6.**

Figure 5.6



3. Compare contact patterns on ring gear teeth to good contact patterns in **Figure 5.7**. If contact patterns are not satisfactory, go to Incorrect Contact Patterns on this page.



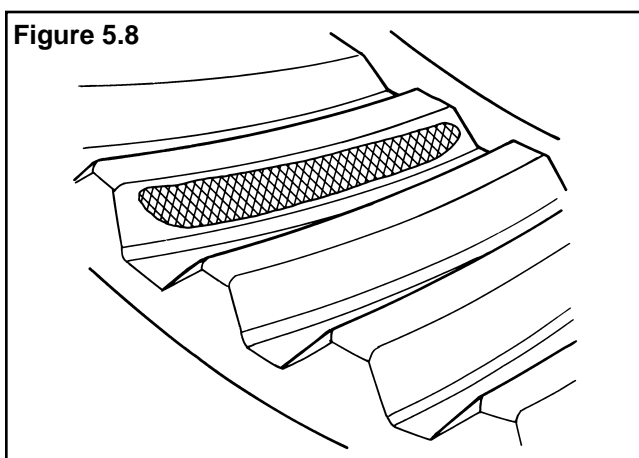
Correct Contact Patterns

The location of a good hand-rolled contact pattern for a new gear set is toward toe of gear tooth and in center, between top and bottom of tooth.

Figure 5.7.

When carrier is being operated under load, pattern will extend approximately the full length of tooth. The top of pattern will be near top of gear tooth.

Figure 5.8.

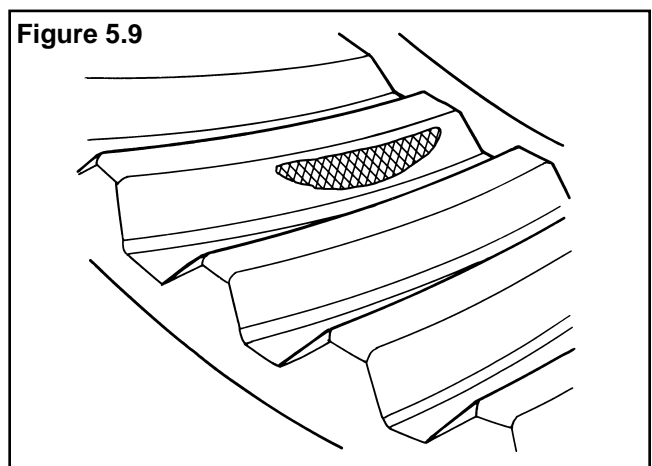


The location of a good hand-rolled pattern for a used gears set must match wear pattern in ring gear. The contact pattern will be smaller in area than the wear pattern.

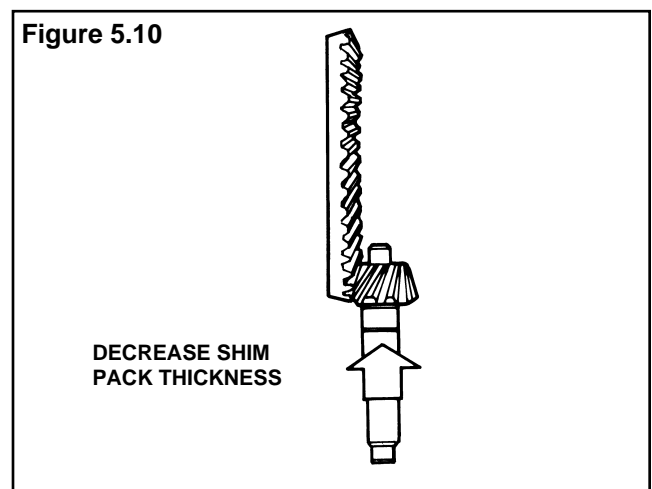
Incorrect Contact Patterns

High Contact Pattern:

A high contact pattern indicated that drive pinion was not installed deep enough into carrier. **Figure 5.9.**



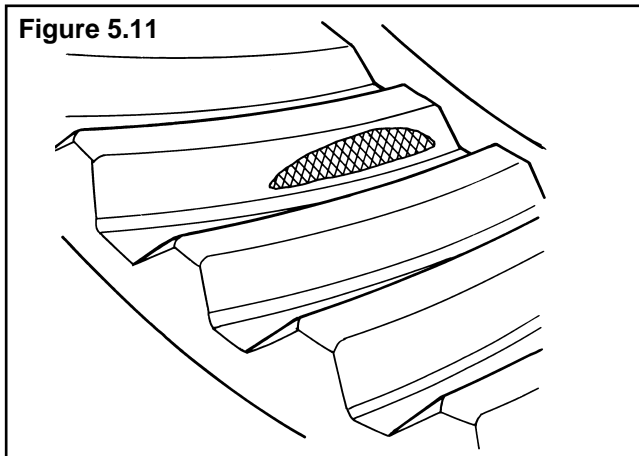
- To correct a high-contact pattern, decrease thickness of shim pack under bearing cage. This will move drive pinion toward ring gear. **Figure 5.10.**



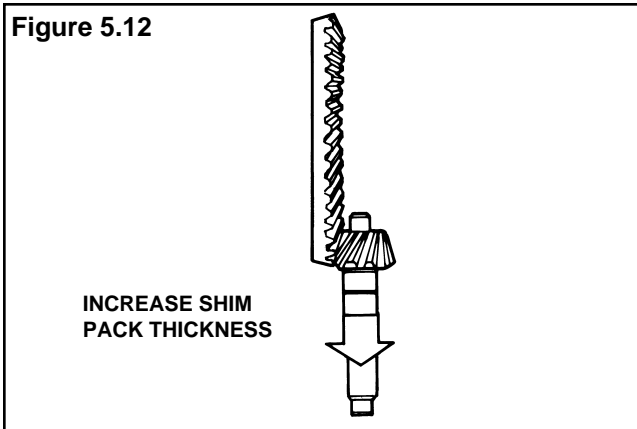
Deep Contact Pattern

A deep contact pattern indicates that the drive pinion was installed too far in the carrier.

Figure 5.11.

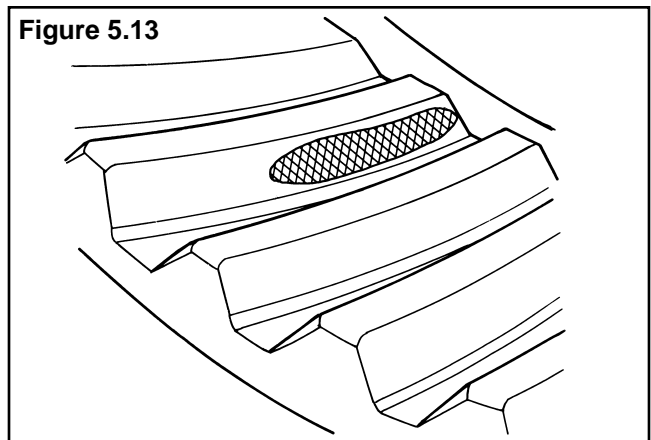


- To correct a deep contact pattern, increase thickness of shim pack under bearing cage. This will move the drive pinion away from the ring gear. **Figure 5.12.**



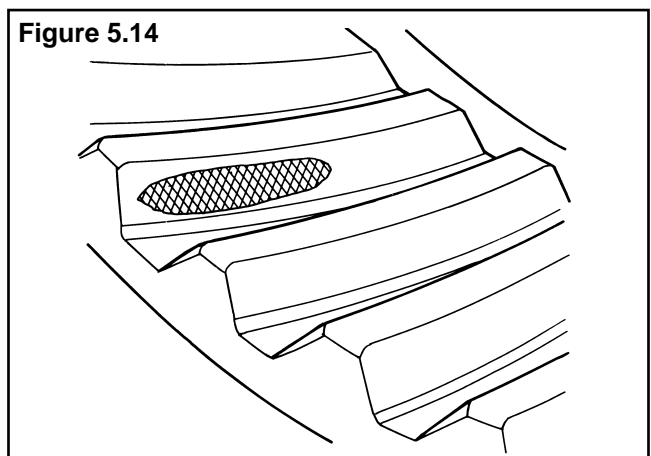
Variations Along Length of Gear Teeth

Adjust backlash of ring gear within specification range to move contact patterns to correct location along length of gear teeth. When toe contact pattern indicates that backlash is very low and gear is too close to drive pinion: **Figure 5.13.**



- Withdraw ring gear by decreasing shim pack thickness or loosening the gear side adjusting ring and tightening opposite side adjusting ring.

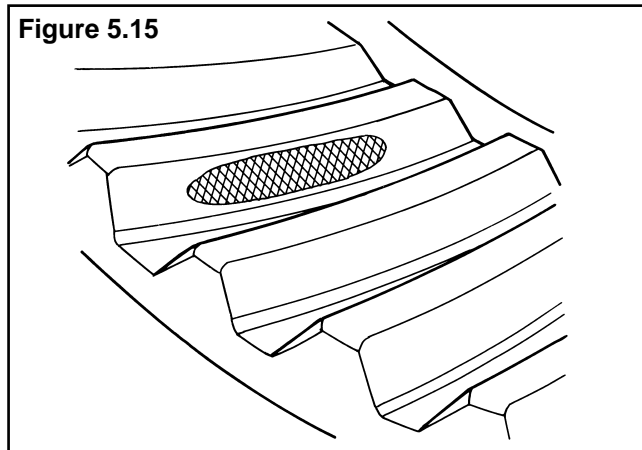
When heel contact pattern indicates that backlash is very high and gear is too far away from drive pinion: **Figure 5.14.**



- Approach ring gear by increasing shim pack thickness or loosening gear opposite side adjusting ring and tightening gear side adjusting ring.

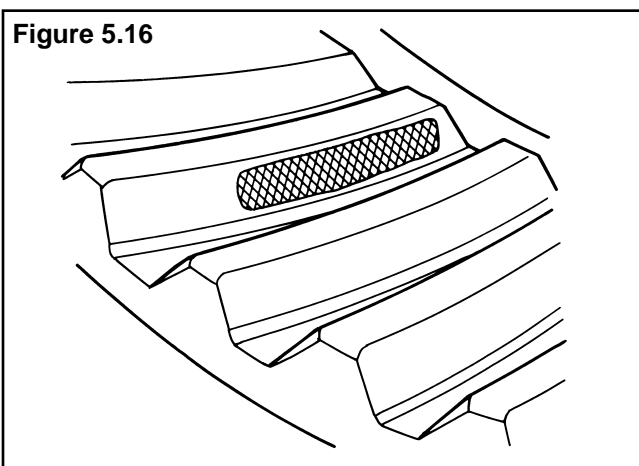
An acceptable contact pattern is centralized between toe and heel along the length of gear teeth.

Figure 5.15.




In cases where it is not possible to get a good contact pattern, the contact pattern shown in **Figure 5.15** is acceptable. If the acceptable contact pattern is not achieved, change the ring gear and pinion set.


Figure 5.16 indicates a good contact pattern. It is toward the toe and centralized between the top and bottom of the gear teeth.



Replace Lubricant

1. Install and tighten drain plug in central housing and brake housing. 
2. Clean area around fill/level plug. Remove fill/level plug from carrier inspection cover.

WARNING

- *Use only the type of fluid specified by the equipment manufacturer. Do not use or mix different types of fluid. The wrong fluid will damage the rubber parts of the assemblies which could cause loss of braking and serious personal injury.*
 - *Do not reuse fluid. Used fluid can be contaminated and can cause incorrect operation which could result in serious personal injury.*
3. Add specified oil until oil level is even with bottom of fill/level hole. See Section 6, "Specifications."
 4. Install and tighten fill/level plugs. 
 5. Road test vehicle in an unloaded condition for one-two miles (1.6-3.2 km) at speeds not more than 25 mph (40 kph). Check the lubricant levels and the torque of all fasteners.

PRA 352 Series Planetary Drive Axle Oil Change Intervals and Specifications

Off-Highway Operation Intervals ①				Meritor Specification	Military Specification	Oil Description
Initial Oil Change	Check Oil Level	Petroleum Oil Change	Synthetic Oil Change			
100 operating hours ① or 1240-3100 miles (2000-5000 km) (whichever comes first)	250 operating hours ①	1,500 operating hours or twice a year (which- ever comes first)	—	0-84	—	Petroleum Base SAE 10W, 20W or 10W/30 ②

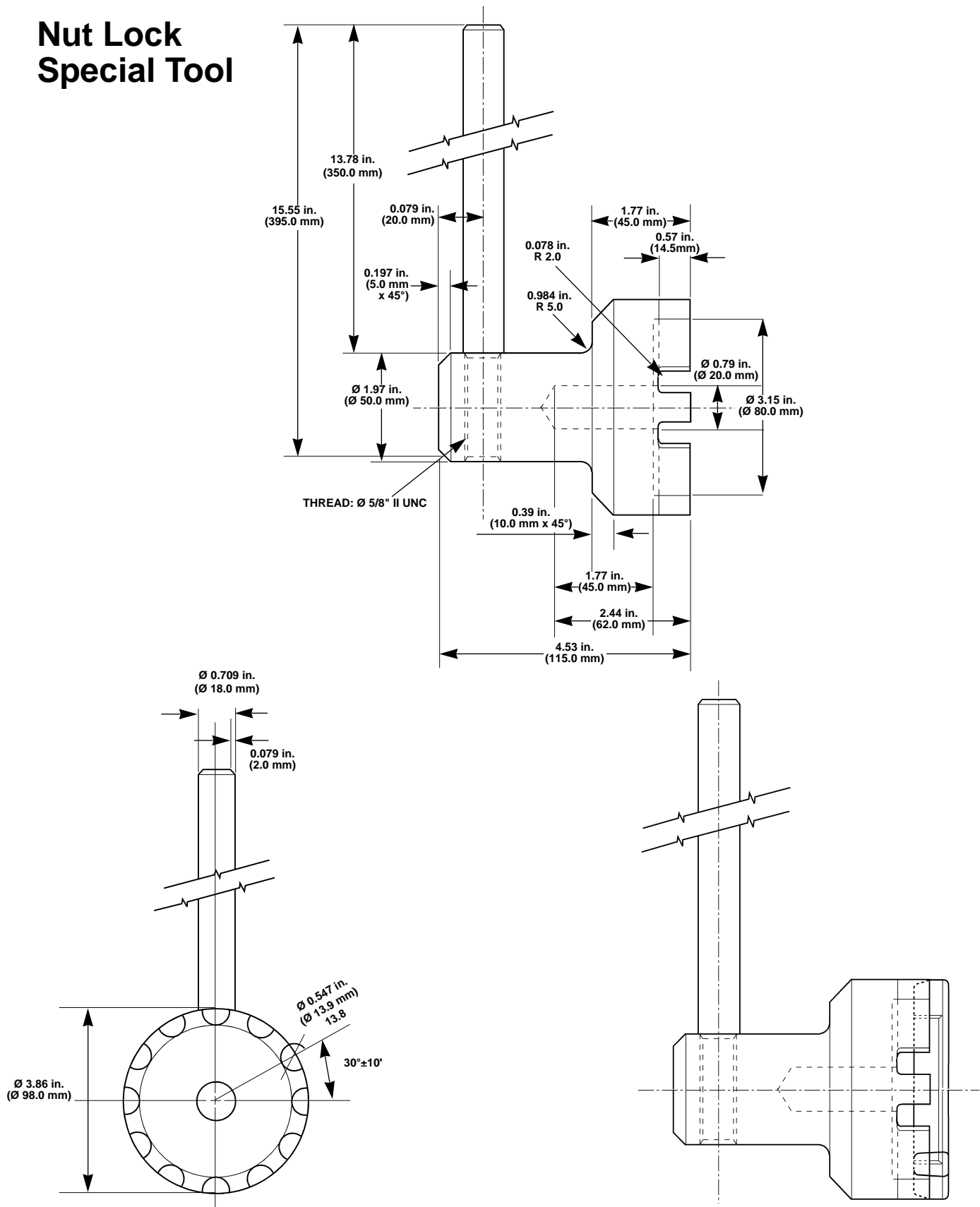
NOTES:

- ① The checking interval depends on the individual operating conditions, speeds and loads. Severe operating conditions may require more frequent intervals.
- ② Tractor oil universal fluid, 'TOU' types formulated for wet disc brakes, is recommended for use in the wet disc brake housing. Make sure that the specifications of the tractor fluid are the same as the recommended specifications of the vehicle manufacturer.

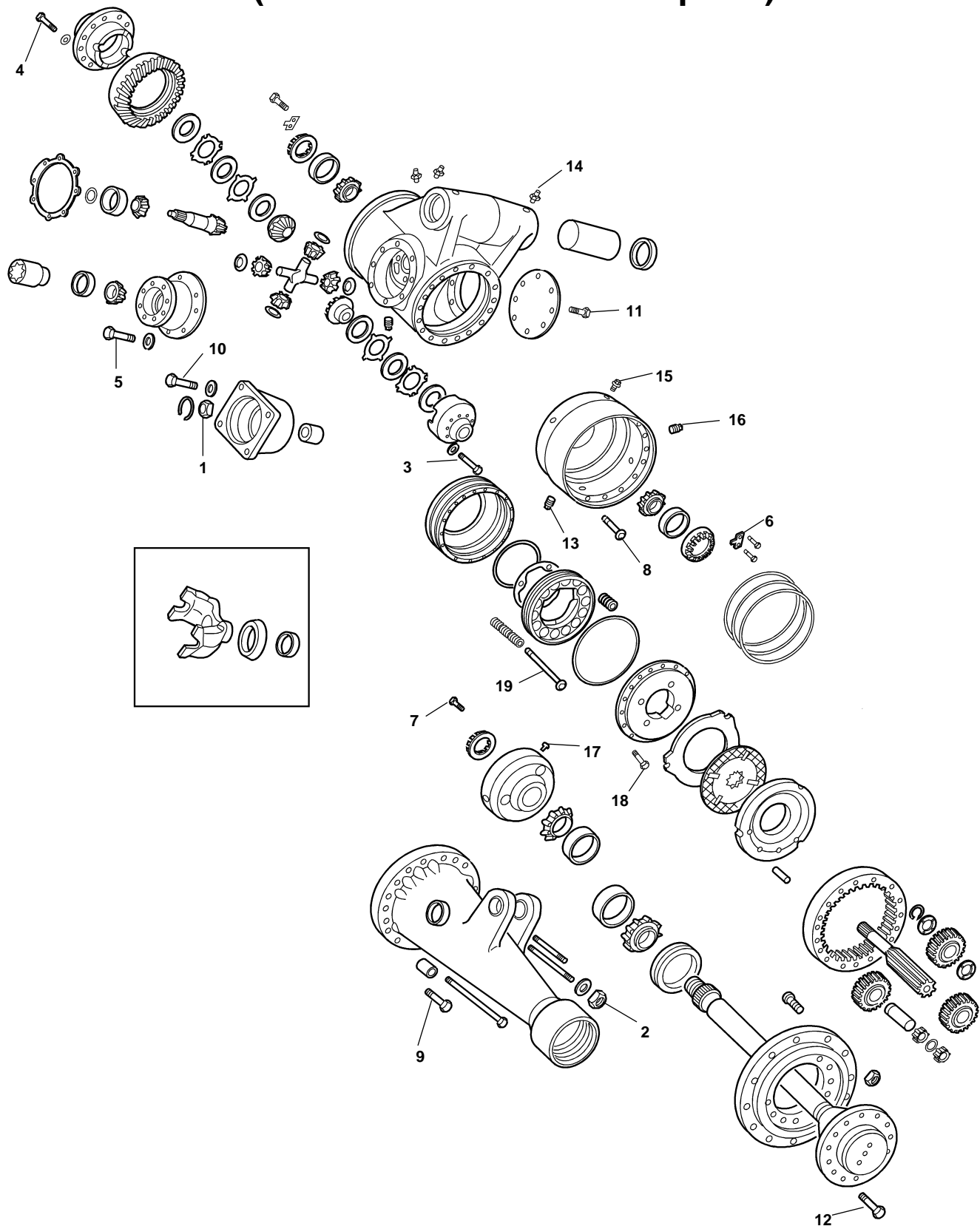
CAUTION

- **The operating temperature of the coolant must never reach or exceed 250°F (120°C). If the operating temperature of the coolant reaches or exceeds 250°F (120°C), the internal components of the brake will be damaged. A forced cooling system may be required to assure the coolant temperature remains below 250°F (120°C).**
- **Use only the brake hydraulic fluid specified by the manufacturer of the vehicle. Do not use different hydraulic fluids. The wrong fluid will damage the seals on the piston.**

Nut Lock Special Tool



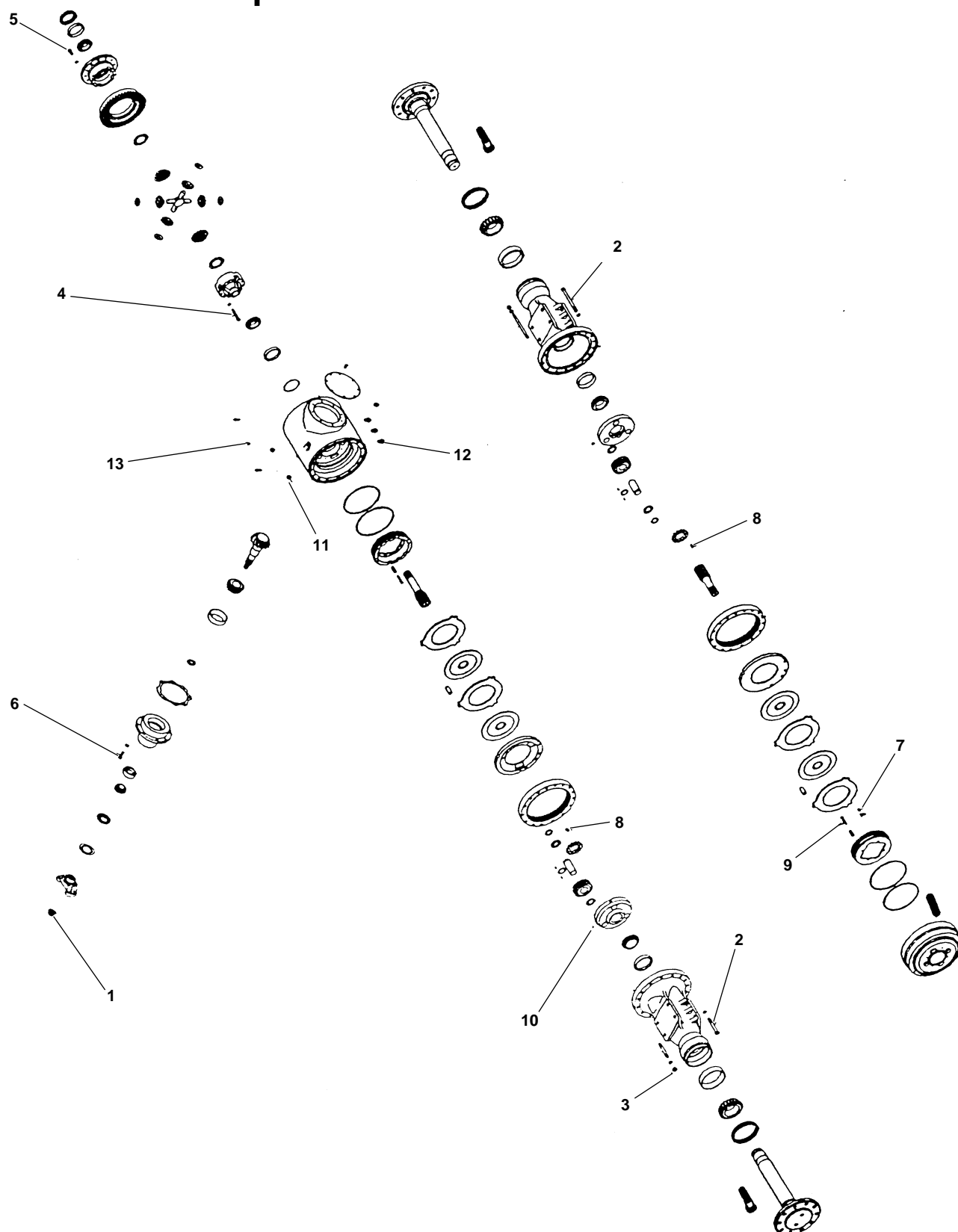
PROA 352/382 (With Mechanical Drive Option)



Torque Chart - PROA 352/382

ITEM	DESCRIPTION/THREAD	TORQUE
1	Pinion Nut - M24 x 1.5-6H	465-570 lb-ft (630-775 N•m)
2	Nut (Stud - Center Housing) M14 x 1.5-6H	120-150 lb-ft (160-205 N•m)
3	Capscrew (Differential Case) M10 x 1.5-8G	48-64 lb-ft (64-87 N•m)
4	Capscrew (Spiral Gear) M10 x 1.0-6G	66-75 lb-ft (90-100 N•m)
5	Capscrew (Pinion Cage) M12 x 1.75-8G	67-91 lb-ft (91-120 N•m)
6	Capscrew (Lock Adjuster Ring) M6 6G	80-115 lb-in (9.0-13.0 N•m)
7	Capscrew (Adjusting Nut Lock) M8 x 1.25-6G	17-23 lb-ft (23-30 N•m)
8	Capscrew (Brake Housing) M8 x 1.25-6G	19-26 lb-ft (26-36 N•m)
9	Capscrew (Brake Releaser) M12 x 1.75-6G	25-34 lb-ft (34-46 N•m)
10	Capscrew (Flange Adapter) .3750" x 16UNC2A	39.0-53.0 lb-ft (53-72 N•m)
11	Capscrew (Center Housing Cover) M8 x 1.25-6G	20-27 lb-ft (27-36 N•m)
12	Capscrew (Axle Shaft Flange) M20 x 1.5-6G	470-575 lb-ft (635-780 N•m)
13	Drain Plug	35 lb-ft (47 N•m)
14	Grease Fitting	31-40 lb-in (3.5-4.5 N•m)
15	Vent Plug	15 lb-ft (20 N•m)
16	Level Plug	35 lb-ft (47 N•m)
17	Capscrew (Planetary Pinion Axle) M10 x 1.5-6G	17-23 lb-ft (23-31 N•m)
18	Bolt (Action Plate) M6 x 1.5-6G	120-140 lb-in (13.5-16.0 N•m)
19	Capscrew (Return Spring) M6 x 1.0-6G	80-115 lb-in (9.0-13.0 N•m)

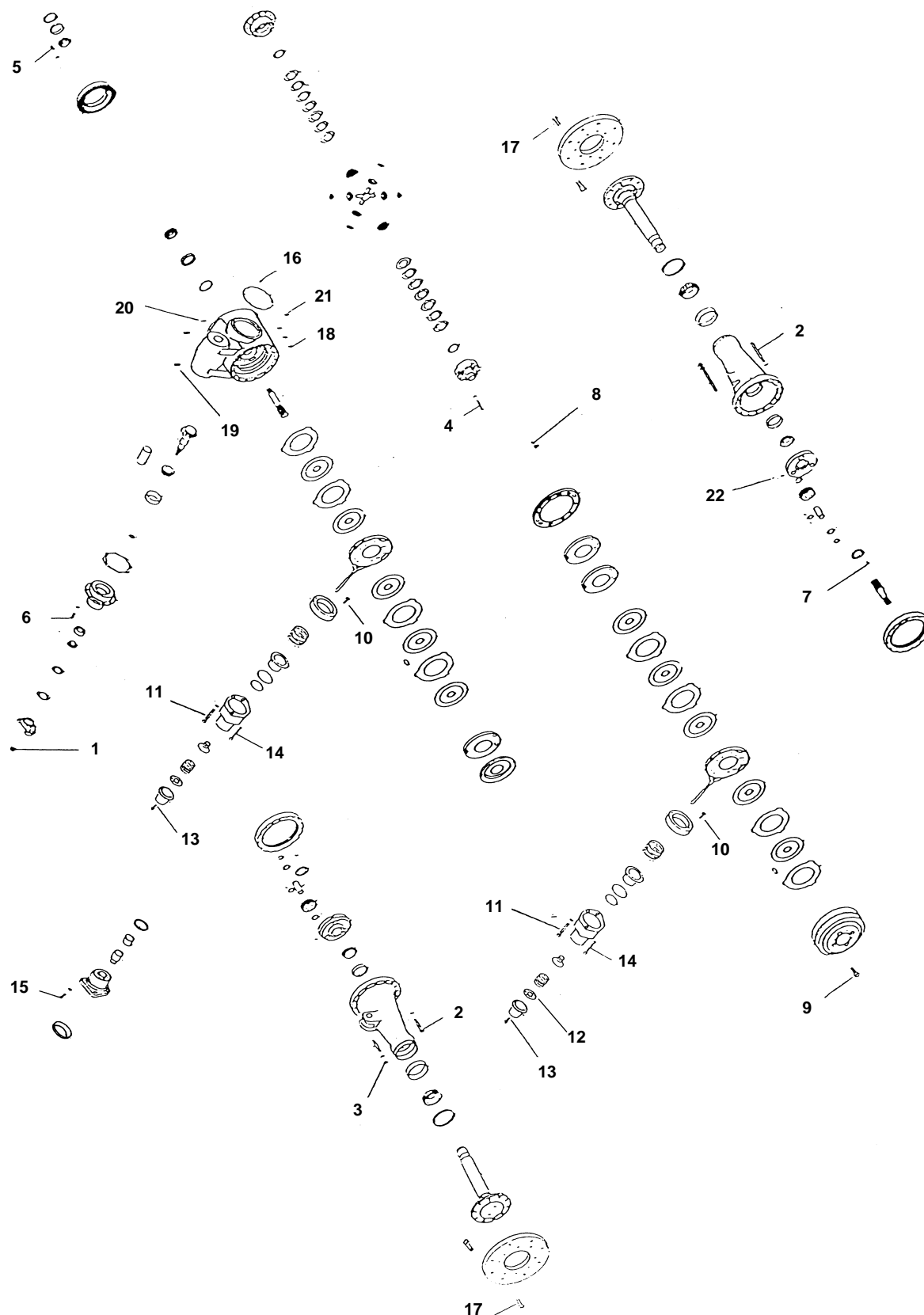
PRA 352 – Trumpet Variation No. 2



Torque Chart - PRA 352

ITEM	DESCRIPTION/THREAD	TORQUE
1	Pinion Nut - M24 x 1.5-6H	465-570 lb-ft (630-775 N•m)
2	Capscrew (Center Housing) - M14 x 1.5-6G	150-185 lb-ft (205-250 N•m)
3	Nut (Stud - Center Housing) - M14 x 1.5-6H	120-150 lb-ft (160-205 N•m)
4	Capscrew (Differential Case) - M10 x 1.5-6G	48-64 lb-ft (64-87 N•m)
5	Capscrew (Spiral Gear) - M10 x 1.0-6G	66-75 lb-ft (90-100 N•m)
6	Capscrew (Pinion Cage) - M12 x 1.75-6G	67-91 lb-ft (90-125 N•m)
7	Capscrew (Lock - Adjuster Ring) - M6-6G	80-115 lb-in (9-13 N•m)
8	Capscrew - Adjusting Nut Lock - M8 x 1.25-6G	17-23 lb-ft (23-31 N•m)
9	Bolt - Return Spring - M6 x 1.0-6G	80-115 lb-in (9.0-13.0 N•m)
10	Capscrew (Planetary Pinion Axle) - M10 x 1.5-6G	17-23 lb-ft (23-31 N•m)
11	Plug - Level - M24 x 1.5	35 lb-ft min. (47 N•m min.)
12	Plug - Drain - M24 x 1.5	35 lb-ft min. (47 N•m min.)
13	Plug - Vent - M12 x 1.5	15 lb-ft min. (20 N•m min.)

PROA 352 G2H, G2M



Torque Chart - PROA 352, G2H, G2M

ITEM	DESCRIPTION/THREAD	TORQUE
1	Pinion Nut - M24 x 1.5-6H	465.0-570 lb-ft (630-775 N•m)
2	Capscrew (Center Housing) M14 x 1.5-6G	180.0-215.0 lb-ft (245-290 N•m)
3	Nut (Stud - Center Housing) M14 x 1.5-6H	120-150 lb-ft (160-205 N•m)
4	Capscrew (Differential Case) M10 x 1.5-6G	48-64 lb-ft (64-87 N•m)
5	Capscrew (Spiral Gear) M10 x 1.0-6G	66-75 lb-ft (90-100 N•m)
6	Capscrew (Pinion Cage) M12 x 1.75-6G	67.0-91.0 lb-ft (91-120 N•m)
7	Capscrew (Lock Adjuster Ring) M6 6G	80.0-115.0 lb-in (9-13 N•m)
8	Capscrew (Adjusting Nut Lock) M8 x 1.25-6G	17-23 lb-ft (23-31 N•m)
9	Capscrew (Brake Housing) M8 x 1.25-6G	19-26 lb-ft (26-36 N•m)
10	Capscrew (Brake Cylinder Support) M8 x 1.25-6G	19-26 lb-ft (26-36 N•m)
11	Capscrew (Brake Cylinder) M10 x 1.5-6G	48-64 lb-ft (64-87 N•m)
12	Cover (Brake Cylinder) M80 x 1.5-6G	60-90 lb-ft (80-120 N•m)
13	Capscrew (Brake Cylinder Cover) M12 x 1.75-6G	22-30 lb-ft (30-41 N•m)
14	Capscrew (Brake Releaser) M12 x 1.75-6G	22-30 lb-ft (30-41 N•m)
15	Capscrew (Flange Adapter) .3750" x 16UNC2A	39.0-53.0 lb-ft (53-72 N•m)
16	Capscrew (Center Housing Cover) M8 x 1.25-6G	19-26 lb-ft (26-36 N•m)
17	Capscrew (Axle Shaft Flange) M20 x 1.5-6G	470-575 lb-ft (635-780 N•m)
18	Drain Plug	35.0 lb-ft (47 N•m)
19	Grease Fitting	10.0 lb-ft (14 N•m)
20	Vent Plug	15.0 lb-ft min. (20 N•m min.)
21	Level Plug	35.0 lb-ft min. (47 N•m min.)
22	Capscrew (Planetary Pinion Axle) M10 x 1.5-6G	17.0-23.0 lb-ft (23-31 N•m)



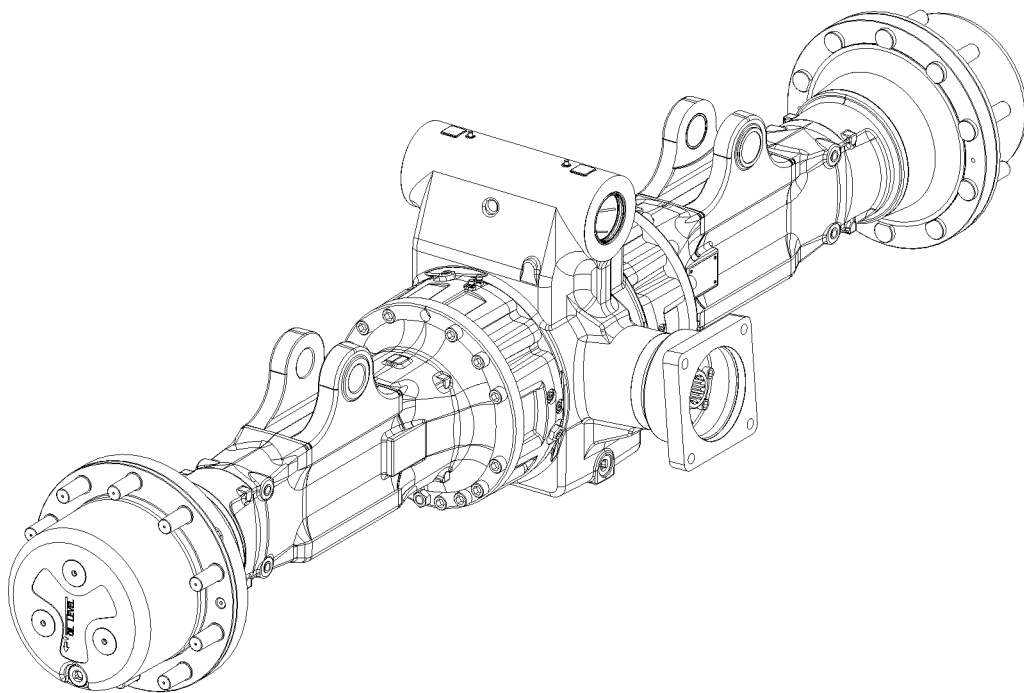
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MANUALE DI RIPARAZIONE
REPAIR MANUAL

ASSALE ANTERIORE - *FRONT AXLE*

Mod. 28.46M

Rif. CA144840

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A

INFORMAZIONI GENERALI

A

GENERAL INFORMATION

A.1 Utilizzo del manuale

Destinatari

- Installatore.
- Utilizzatore.
- Manutentore.

Manutenzione

PRENDERE VISIONE DI TUTTO IL MANUALE poiché il buon funzionamento ed il rendimento degli organi meccanici dipendono principalmente da una costante e corretta manutenzione e assicurano la durata e l'integrità del prodotto.

Nell'eventualità di guasti od anomalie il tempestivo intervento da parte di personale specializzato garantisce una durata più lunga del gruppo, evitando danni maggiori nel tempo.

Riparazione

Le procedure per lo smontaggio/montaggio consentono di eseguire la revisione totale del prodotto e sono descritte in sequenza con l'ausilio di illustrazioni, per una guida completa e sicura all'esecuzione di ogni operazione.

Nella descrizione delle operazioni si presuppone che il gruppo sia stato rimosso dal veicolo. Per la rimozione dal veicolo si dovrà consultare il manuale fornito a tale proposito dal costruttore del veicolo stesso.

La conoscenza approfondita del prodotto consente la corretta valutazione del tipo di intervento da eseguire, che può richiedere solamente lo smontaggio di alcuni componenti operando solo parzialmente nel gruppo.

A.1 Manual use

End users

- *Installer*
- *User*
- *Maintenance operator*

Maintenance

CONSULT THIS MANUAL THOROUGHLY, as proper functioning and good efficiency of mechanical organs depends mostly on constant and correct routine maintenance ensuring product integrity and expected life duration.

In case of any damages or anomalies, quick intervention of specialized personnel can avoid future impairment and lengthen the working life.

Repair

The disassembly/assembly procedures have been outlined for a total product overhauling. They have also been described in sequence through photographs with relevant explanation for specific interventions, thus obtaining a complete and safe guide for each and every phase of an operation.

Operation description presumes that the unit has already been removed from the vehicle. The manual supplied by the vehicle manufacturer should be consulted in case of a overhauling or maintenance intervention requiring the removal of the machine.

Moreover, the attentive product inspection leads to a correct repair work estimation that could merely require dismounting only few components, and thus operating partially on the group.

A.2 Proprietà delle informazioni

Questo manuale contiene informazioni di proprietà riservata. Tutti i diritti sono riservati.

Questo manuale non può essere riprodotto o fotocopiato, tutto o in parte, senza il preventivo consenso scritto di CARRARO S.p.A. L'uso di questo materiale documentale è consentito solo al cliente a cui il manuale è stato fornito come corredo del prodotto, e solo per scopi di uso, manutenzione e riparazione.

CARRARO S.p.A. dichiara che le informazioni contenute in questo manuale sono congruenti con le specifiche tecniche e di sicurezza della macchina a cui il manuale si riferisce. Il fabbricante non si assume alcuna responsabilità per danni diretti o indiretti a persone, cose o animali, conseguenti all'uso di questo materiale documentale o della macchina in condizioni diverse da quelle previste.

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A.3 Convenzioni e definizioni

Convenzioni

Le illustrazioni nel manuale NON sono in scala quindi NON sono attendibili valutazioni delle dimensioni dei componenti basate sulle stesse.

Le illustrazioni hanno il compito di evidenziare le corrette procedure da condurre sulla macchina e sui suoi componenti, per questo potrebbero non rappresentare esattamente gli elementi di questa macchina ma componenti meccanici simili.

Definizioni

Lato sinistro: parte sinistra del gruppo vista nel senso di marcia del veicolo.

Lato destro: parte destra del gruppo vista nel senso di marcia del veicolo.

Convenzioni tipografiche

Nota: informazioni importanti, evidenziate al di fuori del testo a cui si riferiscono.

Attenzione: procedure la cui totale o parziale inosservanza può produrre danni alla macchina o alle apparecchiature ad essa collegate.

Pericolo: procedure la cui totale o parziale inosservanza può produrre lesioni o danni alla salute dell'operatore.

Unità di misura

Nel manuale si utilizzano le unità di misura del sistema internazionale (SI). Per la conversione al sistema anglosassone riferirsi alla seguente tabella.

Tabella di conversione

S.I.		GB/USA SYSTEM	
1	(mm)	0.03937	(in)
10	(mm)	0.3937	(in)
25.4	(mm)	1	(in)
6.4516	(cm ²)	1	(sq. in)
1	(m ²)	1550	(sq. in)
16.378	(cm ²)	1	(cu. in)
0.473	(dm ²)	1	(U.S. pint)
1	(l)	61.02	(cu. in)
1	(l)	0.2642	(U.S. gal)
1.772	(g)	1	(oz)
0.4536	(kg)	1	(lb)
0.00070308	(kg/mm ²)	1	(lb/sq. in)
1	(bar)	14.51	(psi)
1	(kg.m)	7.246	(lb.ft)
1(daN)= 10 (N)= 1,02 (kg.f)		2.24	(lb.f)

A.3 Agreements and definitions

Agreements

Illustrations like pictures, drawings and components of this manual are NOT in scale, because of limited space and editing limits, therefore they are NOT reliable to obtain values about size or weight.

Illustrations are supposed to point out the correct methods to working on the machine and its components, therefore they could not display exactly the same elements.

Definitions

Left side: it is the left side of the unit considering the vehicle running conditions.

Right side: it is the right side of the unit considering the vehicle running conditions.

Typographic agreements

Note: The notes, pointed out externally to the text they refer, include important information.

Warning: Warning indications point out the procedures, whose partial or complete non-observance can damage the machine or the connected equipment.



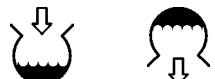
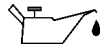




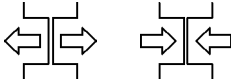
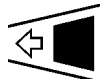

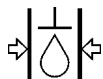
Danger: Danger indications point out the procedures, whose partial or complete non-observance can injure the operator.

Measurements

This manual indicates all measurements in International System (SI). Use the following conversion table to convert Imperial Measure.

Conversion table

Simbologia**Symbology**

DESCRIZIONE	SIMBOLI / SYMBOLS	DESCRIPTION
ATTENZIONE/PERICOLO		WARNING/DANGER
RIMOZIONE/INSTALLAZIONE anelli-guarnizioni-filtri		REMOVE/INSTALL seals-gaskets-filters
RIEMPIMENTO o RABBOCCO OLIO/ SCARICO OLIO		OIL FILLING OR OIL LEVEL/OIL DRAIN
LUBRIFICAZIONE/INGRASSAGGIO		LUBRICATION/GREASING
REGOLAZIONE/MISURAZIONE coppie di serraggio-precarichi-giochi		ADJUSTMENTS/MEASUREMENTS tightening torques-preloads-backlash
ATTREZZATURE SPECIALI		SPECIAL TOOLS
APPLICAZIONE SIGILLANTI/COLLANTI		SEALING/LOCKING FLUIDS APPLICATION
TRACCIATURA		MARKING
SMONTAGGIO/MONTAGGIO DI PARTICOLARI INGOMBRI O SOTTOGRUPPI		DISASSEMBLY/ASSEMBLY OF BULKY PARTS OR SUBASSEMBLIES
ATTENZIONE: rispettare il verso di montaggio		WARNING: respect assembly orientation
PULIRE ACCURATAMENTE		CLEANING CAREFULLY
IMMETTERE FLUIDO IN PRESSIONE		APPLY PRESSURIZED FLUID

A.4 Indicazioni generali

La macchina deve essere controllata e/o riparata solo da personale tecnico specializzato che sia a conoscenza delle sue particolari caratteristiche e delle relative norme di sicurezza (prevenzione infortuni).

Prima di svolgere qualsiasi operazione, pulire accuratamente il gruppo rimuovendo eventuali incrostazioni ed accumuli di terriccio e/o grasso.

Tutti gli organi meccanici smontati devono essere accuratamente puliti con prodotti adeguati, per evitare possibili danni. Verificarne l'integrità, sostituendoli in caso di danni, usura, incrinature, grippaggi o difetti che potrebbero comprometterne il buon funzionamento.

In particolar modo si deve verificare l'integrità delle parti in movimento (cuscinetti, ingranaggi, alberi) e delle parti di tenuta (anelli OR, anelli di tenuta), soggette a maggiori sollecitazioni, usura, invecchiamento.

Si raccomanda di sostituire ad ogni revisione o riparazione gli organi di tenuta.

Si ricordi che l'eventuale sostituzione di un componente della coppia conica comporta la sostituzione anche dell'altro.

Utilizzare solo le parti di ricambio e la viteria indicate, inoltre usare utensili metrici per la viteria metrica e inglesi per la viteria inglese.

Come indicato, alcune operazioni sono distruttive per gli elementi rimossi. Leggere attentamente le descrizioni delle varie fasi dell'intervento ed operare con attenzione per non compromettere la funzionalità di altri elementi.

A.4 General description

The machine should be checked and/or repaired only by qualified technicians, acquainted with its peculiar features and well aware of all safety instructions.

Before performing any operation it is advisable to carry out unit cleaning accurately by removing oil/ grease encrustations and accumulation.

All disassembled mechanical parts must be cleaned accurately with suitable products to avoid possible damage. Parts should be replaced if damaged, worn out, cracked, seized, etc. as they could affect proper working.

Rotating parts (bearings, gears, shafts) and that of hardware/fasteners (O-Ring, oil seals) should be examined carefully, as they are subject to major stress, wearing and ageing.

We highly advise to replace tightening parts during every teardown or repair.

In case of replacement of one part of the bevel gear set this operation requires the replacement of the other part too.

Use appropriate spare parts, nuts and bolts to avoid any other problems. Moreover, use metric tools for metric nuts and bolts and Imperial tools for the others.

Some repairs are destructive for some axle components. Carefully reading and thorough understanding of these instructions will avoid damage to other components unnecessarily.

A.5 Indicazioni generali per le operazioni di riparazione

Prima di iniziare le operazioni di smontaggio e montaggio leggere attentamente le seguenti avvertenze.

Anelli di tenuta per alberi

Per il montaggio degli anelli di tenuta attenersi alle seguenti raccomandazioni:

- Pulire accuratamente l'albero ed assicurarsi che non sia danneggiato, rigato od ovalizzato nelle zone di contatto con gli anelli.
- Montare gli anelli in modo che il labbro sia rivolto verso il lato olio.
- Lubrificare il labbro degli anelli (usare preferibilmente olio) e riempire per 3/4 di grasso la camera degli anelli stessi.
- Montare gli anelli usando un appropriato calettatore. Non usare il martello direttamente sugli anelli.
- Non danneggiare gli anelli durante il montaggio dell'albero.

Anelli OR

Lubrificarli adeguatamente prima di inserirli nella propria sede evitando "arrotolamenti" durante il montaggio dell'albero.

Spessori di registro

Per le registrazioni utilizzare gli appropriati spessori di registro, misurandoli singolarmente.

La misurazione del pacco completo o la stampigliatura riportata sugli spessori stessi può risultare non sempre affidabile: verificare.

Cuscinetti

Per un corretto montaggio è consigliabile riscaldarli in forno ad una temperatura di 80°C - 90°C prima di montarli sui rispettivi alberi o raffreddarli prima di inserirli nelle relative sedi con piantaggio esterno.

Usare sempre gli estrattori idonei per rimuovere i cuscinetti.

Prima di rimontarli, pulirli, ispezionarli e lubrificarli.

Spine elastiche

Al montaggio delle spine elastiche ad intaglio assicurarsi che l'intaglio delle stesse sia orientato nel senso dello sforzo sollecitante la spina. Le spine elastiche a spirale invece non necessitano di alcun orientamento.

Sigillante

Usare sigillanti secondo le specifiche. Assicurarsi che le parti da sigillare siano pulite, asciutte e completamente prive di grasso.

A.5 Recommendations for repair operations

Before starting any disassembly and assembly operations, read carefully the following recommendations.

Shafts seals

Respect the following recommendations during shaft seal assembly:

- Clean shaft very carefully and ensure that the part in contact with the shaft seal is not damaged, cut or out of roundness.*
- Assemble the seals so that the lip is fitted towards the oil side.*
- Lubricate seal lips (use oil) and fill 3/4 of seal cavity with grease.*
- Use appropriate drivers. Do not use a hammer directly on the seals.*
- Do not damage the seals while assembling the shaft.*

O-rings

Lubricate adequately before inserting them at the right place and avoid o-ring rolling while inserting the shaft.

Adjusting shims

Use appropriate adjusting shims and measure each one separately.

Complete group measurement or stampings on the shims are not always reliable: check.

Bearings

It's advisable to heat up bearings to 80°C - 90°C before assembling them onto their respective shafts or to cool them (dry ice) before inserting them into corresponding bore.

Always use suitable extractors to remove the bearings. Before reassembling the bearings, clean, check and lubricate them.

Split pins

Before assembling elastic pins, make sure that the notch is oriented towards the stressing force.

Spiral elastic pins do not need orientation.

Sealing

Use sealing as advised by specifications. Ensure that parts to be sealed are clean, dry and completely grease free.

Scarico dell'olio

Prima di intervenire sul prodotto è necessario scaricare l'olio dal gruppo.

Attenzione: smaltire gli oli esausti nel rispetto delle vigenti norme.

Pulizia

Lavare accuratamente tutte le parti in movimento relativo (ingranaggi, cuscinetti, ecc.) utilizzando gasolio o cherosene.

E' da evitare l'uso di benzina e soluzioni acquose alcaline. Evitare lavaggi con vapore o acqua calda perché sarebbe difficile eliminare completamente l'umidità superficiale.

Asciugare accuratamente tutti i particolari mediante un getto d'aria o stracci per evitare di rigare le superfici con residui abrasivi.

Tutte le superfici devono essere ricoperte da un leggero strato di lubrificante per proteggerle da eventuali ossidazioni.

Controlli

Verificare accuratamente tutti i cuscinetti, gli anelli esterni eventualmente ancora piantati nelle proprie sedi e i perni su cui rotolano i rullini. Sostituire quei particolari che presentano tracce di usura o di danneggiamento.

Controllare che tutti gli ingranaggi non presentino avarie od usure eccessive delle dentature: gli smussi dei denti non devono essere deteriorati.

Controllare che tutti i tratti scanalati siano privi di usure eccessive o di altri danneggiamenti.

Sostituire i particolari avariati con ricambi originali.

Dopo ogni smontaggio è buona norma sostituire le guarnizioni di tenuta sugli alberi rotanti.

Estremità di flange ed attrezzi

Prestare la massima attenzione quando si martellano le estremità di attrezzi o di flange per evitare di compromettere la funzionalità e l'integrità sia degli attrezzi che dei componenti su cui si opera.

Metodi di riassettaggio

Per riassembleare il gruppo si deve impiegare un'adeguata attrezzatura di sostegno.

Per posizionare il gruppo, per smontare e rimontare la corona dentata e per sostenere la scatola ingranaggi è necessario un sistema di sollevamento.

Per facilitare le operazioni di smontaggio e montaggio utilizzare un disegno di assieme del gruppo.

Impiego di lubrificante

Per ottenere una corretta lubrificazione ed una esatta temperatura di funzionamento negli assali CARRARO, è importante usare i lubrificanti raccomandati (Sez.C.4), mantenendone il livello costante secondo quanto indicato nel presente manuale.

Oil drain

Before disassembly, oil should be drained out.

Warning: disposal of used oil must be done according to laws.

Cleaning

Wash all moving parts (gears, bearings, etc.) accurately with diesel fuel or kerosene.

Avoid gasoline and watery alkaline solutions. Do not wash with steam or hot water, as it will be very difficult to eliminate surface humidity.

Dry all parts with a rag or air jet to avoid scratching from abrasive residuals.

All surfaces should be covered with lubricant so as to protect it from future oxidation.

Checks

Examine accurately all bearings, external rings which may be still stuck in their position and pivot pins on which rolls rotate. Replace those which are worn out or damaged.

Gears should not be spoiled and teething should not be excessively worn out. Teeth smoothing should not be deteriorated.

Check all grooves: assure that they are not worn out or damaged.

Replace spoiled parts with original spare parts.

Replace seals on rotating shafts, before reassembly.

Ends of flanges and tools

Be careful when hammering tool or flange ends, in order to avoid jeopardizing functionality and integrity of either the tools or the components on which you are operating.

Reassembly methods

In order to reassemble the group, an appropriate fixture must be used.

In order to position the group, to disassemble and reassemble the ring gear and to support the gear housing, a lifting system is needed.

To make disassembling and assembling operations easier, use a group assembly drawing.

Lubricant use

In order to lubricate the CARRARO axles correctly and to reach the exact operation temperature, it is important to use the recommended lubricants (Section C.4), keeping their level constant as indicated in this manual.

B

INFORMAZIONI SULLA SICUREZZA

B

SAFETY INSTRUCTIONS

B.1 Indicazioni generali per la sicurezza

IMPORTANTE:

Prima di iniziare qualsiasi tipo di operazione leggere attentamente questo capitolo.



Precauzioni per la sicurezza:

Il corretto uso e la corretta riparazione dei prodotti Carraro e dei loro componenti sono molto importanti per la sicurezza e l'affidabilità.

Le procedure raccomandate e descritte in questo manuale sono testate, quindi sono effettivi metodi operativi. Seguire strettamente ogni procedura facendo uso sia del testo che delle illustrazioni.

Alcune di queste procedure mostrano l'uso di appositi strumenti progettati perché le operazioni vengano condotte in modo chiaro e corretto.

Alcuni strumenti specifici devono essere usati dove necessario per eseguire determinate operazioni.

E' impossibile trattare ogni metodo di lavoro o tutte le possibili metodologie per svolgerlo e le rischiose conseguenze di ognuna, perciò chi usa procedure o strumenti non consigliati deve sapere che la sicurezza dell'operatore e del veicolo saranno messi a repentaglio.

Pericolo

Gli occhiali di sicurezza devono essere indossati sempre durante l'esecuzione di tutte le operazioni di montaggio o smontaggio.



B.1 General safety recommendations

IMPORTANT:

Before proceeding with any operations please read this chapter very carefully.



Safety precautions:

Correct use and repair of Carraro products and of their components is very important for safety and reliability. Recommendations and all described procedures given in this manual have been experimented and hence are effective operational methods. Please follow every procedure. Use the text as well as the illustrations.

Certain procedures show use of special tools, designed so that the operations can be carried out in a clear and correct manner.

Special tools must be used when a particular operation is being carried out.

It is impossible to advise every working method or know all possible methodologies for carrying it out or to predict risky consequences of each operation. Hence, performing procedures or using instruments which have not been advised could be dangerous for the operator/mechanic as well as the vehicle.

Danger

Safety goggles must be worn while carrying out every assembling or disassembling operations.



B.2 Simboli di sicurezza

Identificazione delle informazioni sulla sicurezza



Questo è il simbolo di allarme per la sicurezza; quando lo trovate sulla macchina o sul manuale, siete avvisati del pericolo potenziale di incidenti o danni alla persona. Seguite i suggerimenti e le raccomandazioni per operare in sicurezza.

Significato delle scritte di avvertimento



Una scritta di avvertimento (PERICOLO, AVVISO o ATTENZIONE), viene usata sulla macchina insieme al simbolo di allarme per la sicurezza. I segnali PERICOLO o AVVISO sono utilizzati vicino ad aree pericolose. PERICOLO identifica la situazione più pericolosa. Precauzioni generali sono invece segnalate da ATTENZIONE.

Seguire le istruzioni di sicurezza !

Leggere con cura tutti i messaggi sulla sicurezza di questo manuale.



Modifiche non autorizzate possono compromettere il funzionamento, la sicurezza d'impiego e la durata. Se non comprendete le istruzioni del manuale, contattate il rappresentante a voi più vicino.

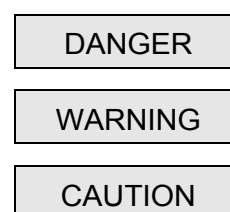
B.2 Safety symbols

Recognize safety information



This is the safety alarm symbol; whenever you find it in the manual or see it on the machine, you are being warned about potential danger of accidents or harm to personnel. Follow the do's and don't's to operate in total safety.

Understanding written warnings



Written warning (DANGER, WARNING or CAUTION) is used along with an alarm symbol on the machine. DANGER or WARNING signs are used near danger zones, while CAUTION sign indicates general precaution.

Follow safety instructions !

Read all suggestions given in this instruction manual very carefully.



Unauthorized changes could endanger the functioning, work safety and work span. If you do not understand this instruction manual, contact the nearest sales representative.

B.3 Precauzioni generali

In ogni movimento dovranno essere osservate le norme sulla prevenzione infortuni, tutte le regole generali di sicurezza e di medicina del lavoro.

Prima di procedere nelle operazioni di manutenzione o sistemazione di eventuali problemi, assicurarsi del buon stato e del buon funzionamento delle attrezzature quali banchi di sostegno, cavalletti, martelli, leve, estrattori e chiavi apposite facilitando le operazioni da svolgere in modo ottimale riducendo i rischi sia per gli organi ed i componenti del prodotto che della incolumità dell'operatore.

Tutte le modifiche arbitrarie apportate al prodotto sollevano la CARRARO SpA da ogni responsabilità per qualsiasi danno o incidente.

Il prodotto, se utilizzato in un impiego diverso da quello previsto, è da considerarsi soggetto a "uso non previsto". CARRARO SpA declina ogni responsabilità per danni o incidenti risultanti da un uso diverso da quello previsto; tali conseguenze saranno a carico esclusivo del cliente.

Norme per la manutenzione in sicurezza

- 1 Operare in ambiente pulito e asciutto.
- 2 Non lubrificare, manipolare o registrare il gruppo in moto.
- 3 Tenere lontani mani, piedi, indumenti da parti in movimento.
- 4 Essere sempre pronti per i principi di incendio. Tenere a portata di mano estintore e cassetta di pronto soccorso.
- 5 Tenere in evidenza il n° di telefono di un medico, ambulanza, ospedale e vigili del fuoco presso il proprio telefono.



- 6 Usare indumenti e protezioni adatte allo scopo come: tuta, guanti protettivi e cuffie.
- 7 Usare protezioni auricolari appropriate a salvaguardare l'udito, come tappi o cuffie per le orecchie contro rumori molesti o fastidiosi.

B.3 General precautions

Observe safety instructions, accident prevention rules and all general safety regulations in each and every step at work.

Before going ahead with maintenance or repair work ensure that all the tools, the supporting bench, stands, levers, extractors and spanners are in good condition so that the work can be carried out easily.

Risks to various parts and components will also be reduced in this way and working condition for the operator will also be safer.

CARRARO SpA declines any responsibility in case of an accident or damage resulting due to changes made arbitrarily on product.

The product is used for any other purpose different from the one foreseen, than CARRARO SpA declines any responsibility.

In this case all consequences will be at the customer's expense.

Safety maintenance rules

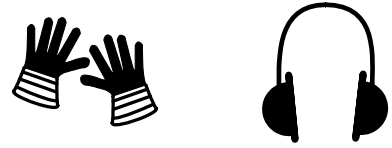
- 1 *Operate in a clean and dry environment.*
- 2 *Do not lubricate, handle or adjust the group under-way.*
- 3 *Keep your hands, feet and clothing away from moving parts.*
- 4 *Always be prepared for fires. Keep the extinguisher and the first aid kit within reach.*
- 5 *Keep the phone numbers of a doctor, an ambulance, a hospital and the fire department within reach near the telephone set.*

- 6 *Wear suitable clothing and protection such as overalls, safety gloves and ear safety devices.*
- 7 *Use suitable ear protection, like ear plugs, to keep out noise and prevent injury to the ears.*

Una prolungata esposizione al rumore può danneggiare l'udito.



A prolonged exposure to noise can damage your hearing.



- 8 Le attrezzature richiedono la piena attenzione dell'operatore. Non usare cuffie per ascoltare musica mentre si interviene sul prodotto o gruppo.

- 8 *The operator must be very careful with the equipment. Do not use headphones to listen music while you are working on the product or on the group.*

Eliminazione dei rischi residui

- Rischio di schiacciamento e cesoiamento dovuto alla presenza di elementi in movimento.

Attenzione

Eseguire tutte le operazioni di manutenzione a macchina ferma.

- Rischio dovuto all'inalazione di gas nocivi che si possono sviluppare scaldando le vernici durante eventuali saldature.

Attenzione

Utilizzare postazioni di lavoro dotate di sistemi di evacuazione di polveri e fumi.

Lasciate disperdere i fumi per almeno 15 minuti prima di saldare o riscaldare, o riprendere a lavorare sul gruppo.

- Rischio di incendio dovuto ai solventi utilizzati e all'olio presente.

Attenzione

Tenere lontano dalla zona di lavoro ogni fonte di calore.

Quando si usano solventi o svernicianti, rimuoverli con acqua e sapone prima di saldare.

Rimuovere i contenitori di solvente, sverniciante o altri prodotti infiammabili dall'area di lavoro.

- Rischio dovuto alla caduta, allo sganciamento o alla violenta espulsione di oggetti od olio.

Attenzione

Questi rischi residui e le procedure per eliminarli completamente, sono evidenziati dettagliatamente nelle procedure di montaggio e smontaggio. Seguire attentamente, durante la manutenzione, tutte le procedure di sicurezza indicate nel manuale.

Residual risk elimination

- *Risk of squashing and shearing due to the presence of moving parts.*

Warning

Carry out all maintenance operations when the machine is stationary.

- *Risk due to inhalation of poison gases that can be produced by heating the varnishes during any welding.*

Warning

Use work stations equipped with dust and fume discharging systems.

Let the fumes disperse for at least 15 minutes, before welding or reheating, or working on the group again.

- *Risk of fire due to the solvents used and to the oil in the machine.*

Warning

Keep away any heat sources from the working area. When solvents or paint removers are used, they should be removed with soap and water, before welding.

Remove any containers of solvent, paint remover or any other inflammable products from the working area.

- *Risk due to fall, drop or violent ejection of objects or oil.*

Warning

These residual risks and the suitable relative procedures to eliminate them completely are pointed out, in detail, in the assembly and disassembly procedures. During maintenance, follow carefully all the safety procedures indicated in the manual.



C

CARATTERISTICHE GENERALI



C

GENERAL SPECIFICATIONS

C.1 Usi previsti

Questo assale è stato progettato e costruito, secondo specifiche fornite dal cliente, per essere installato in veicoli di tipo industriale con la funzione di trasmettere la potenza dal motore alle ruote, consentendo anche:

- l'aumento della forza di trazione con riduzione del numero di giri;
- la compensazione della velocità delle ruote interne con quelle esterne durante la sterzata.

Non installare mai questo assale su macchine diverse da quelle per cui è stato progettato e costruito.

L'assale, se utilizzato in un impiego diverso da quello previsto, è da considerarsi soggetto ad "uso non previsto".

CARRARO SpA declina ogni responsabilità per danni o incidenti risultanti da un uso diverso da quello previsto; tali conseguenze saranno a carico esclusivo del cliente. Costituisce inoltre un elemento essenziale, nell'ambito dell'uso previsto, l'osservanza scrupolosa delle modalità di funzionamento e delle regolari manutenzioni e riparazioni specificate da CARRARO SpA.

C.1 Foreseen uses

This axle has been designed and manufactured, according to the customer's technical specifications, to be mounted on industrial machines to transmit the power from the engine to the wheels and to allow:

- *increasing of tractive force, reducing the number of revolutions*
- *adjusting of inner wheels' speed with outer wheels' speed during steering.*

Never mount this axle on machines different from the ones for which it has been designed and manufactured

If the axle is used for any other purpose than the one foreseen, CARRARO SpA declines any responsibility regarding damages or accidents caused by it. All consequences will be at the expense of the client.

However, when used as foreseen, operational formalities as well as regular maintenance repair specifications given by CARRARO SpA are to be observed strictly.

C.2 Identificazione del prodotto

C.2 Product identification

Targhetta di identificazione dell'assale

Axle serial plate

TIPO DI ASSALE AXLE TYPE	COD. CLIENTE CUSTOMER REF.	N/S CARRARO CARRARO S/N
N° CARRARO CARRARO N°	AXLE TYPE	SERIAL N°
SENSO DI ROTAZIONE INPUT ROTATION	CARRARO N°	CUSTOMER N°
TIPO OLIO DIFFERENZIALE DIFFERENTIAL OIL TYPE	INPUT ROTATION	TOTAL RATIO
	OIL SPECIFICATION	DIFFERENTIAL TYPE
	LOCAT.	LIT.
	TIPO OLIO RIDUTTORE EPICICLOIDALE EPICYCLIC REDUCTION GEAR OIL TYPE	QUANTITÀ OLIO RIDUTTORE EPICICLOIDALE EPICYCLIC REDUCTION GEAR OIL CAPACITY

MADE IN ITALY

CARRARO

RAPPORTO DI TRASMISSIONE TOTALE
TOTAL TRANSMISSION RATIO

TIPO DIFFERENZIALE
DIFFERENTIAL TYPE

QUANTITÀ OLIO DIFFERENZIALE
DIFFERENTIAL OIL CAPACITY

C.3 Descrizione generale

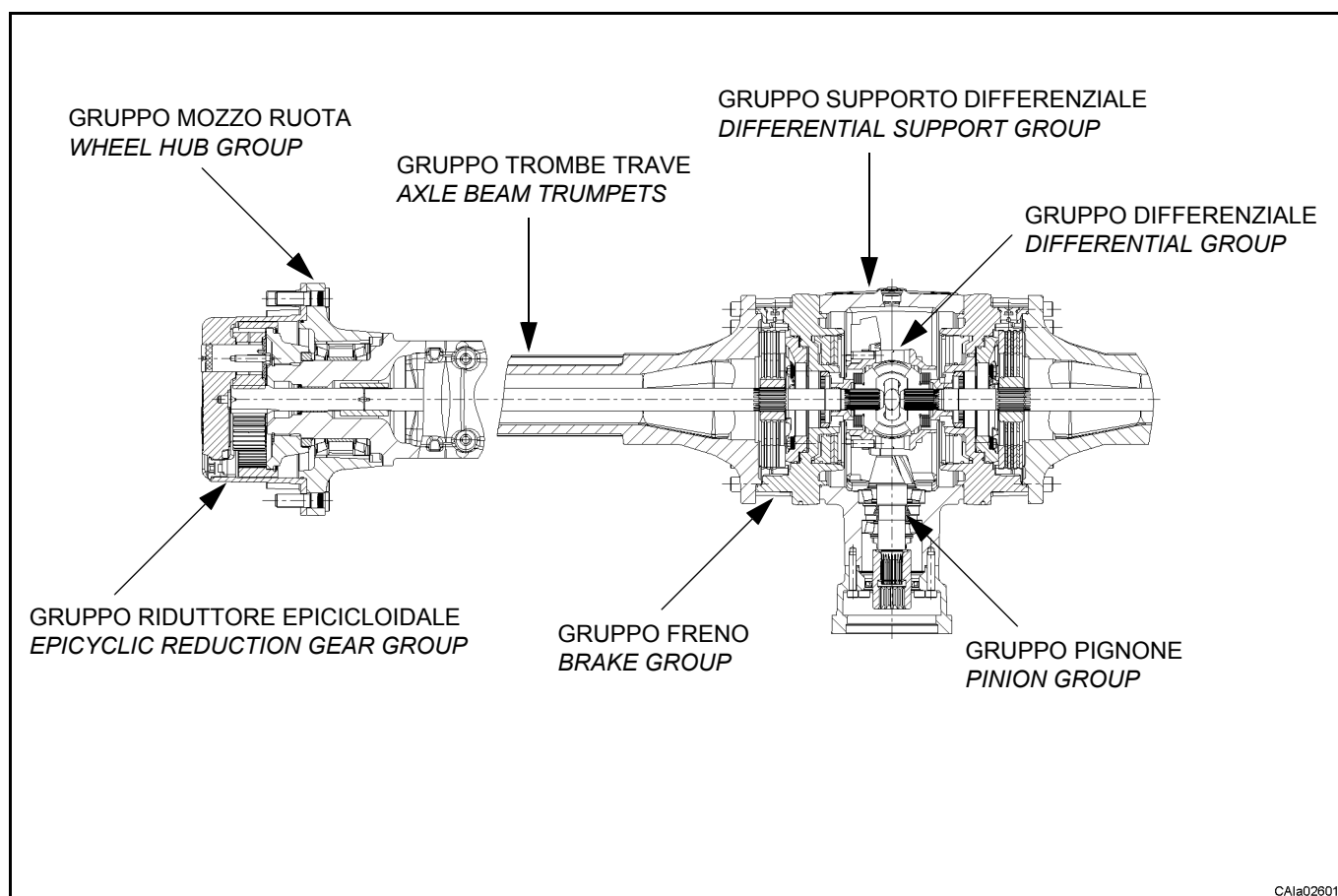
L'assale descritto in questo manuale è costituito dai seguenti gruppi

- **MOZZO RUOTA:** elementi di supporto della ruota e del riduttore epicicloidale
- **RIDUTTORE EPICICLOIDALE:** treno portasatelliti con elementi di riduzione
- **TROMBE TRAVE:** struttura di supporto principale dell'assale
- **SUPPORTO DIFFERENZIALE:** struttura di supporto del differenziale e di registrazione della coppia conica
- **DIFFERENZIALE:** scatola differenziale e corona della coppia conica
- **GRUPPO PIGNONE:** pignone con gli elementi di registrazione e supporto
- **GRUPPO FRENO:** componenti del freno con gli elementi di supporto

C.3 General description

The axle described in this manual consists mainly of following groups

- **WHEEL HUB:** wheel support parts containing the epicyclic reduction gears
- **EPICYCLIC REDUCTION GEAR:** planetary carrier with reduction/transmission parts
- **AXLE BEAM TRUMPETS:** load-bearing shell structure of the axle
- **DIFFERENTIAL SUPPORT GROUP:** differential housing with ring bevel gear adjusting system
- **DIFFERENTIAL GROUP:** differential parts with ring bevel gear
- **PINION GROUP:** pinion with adjusting and support parts
- **BRAKE GROUP:** brake parts and brake shell structure

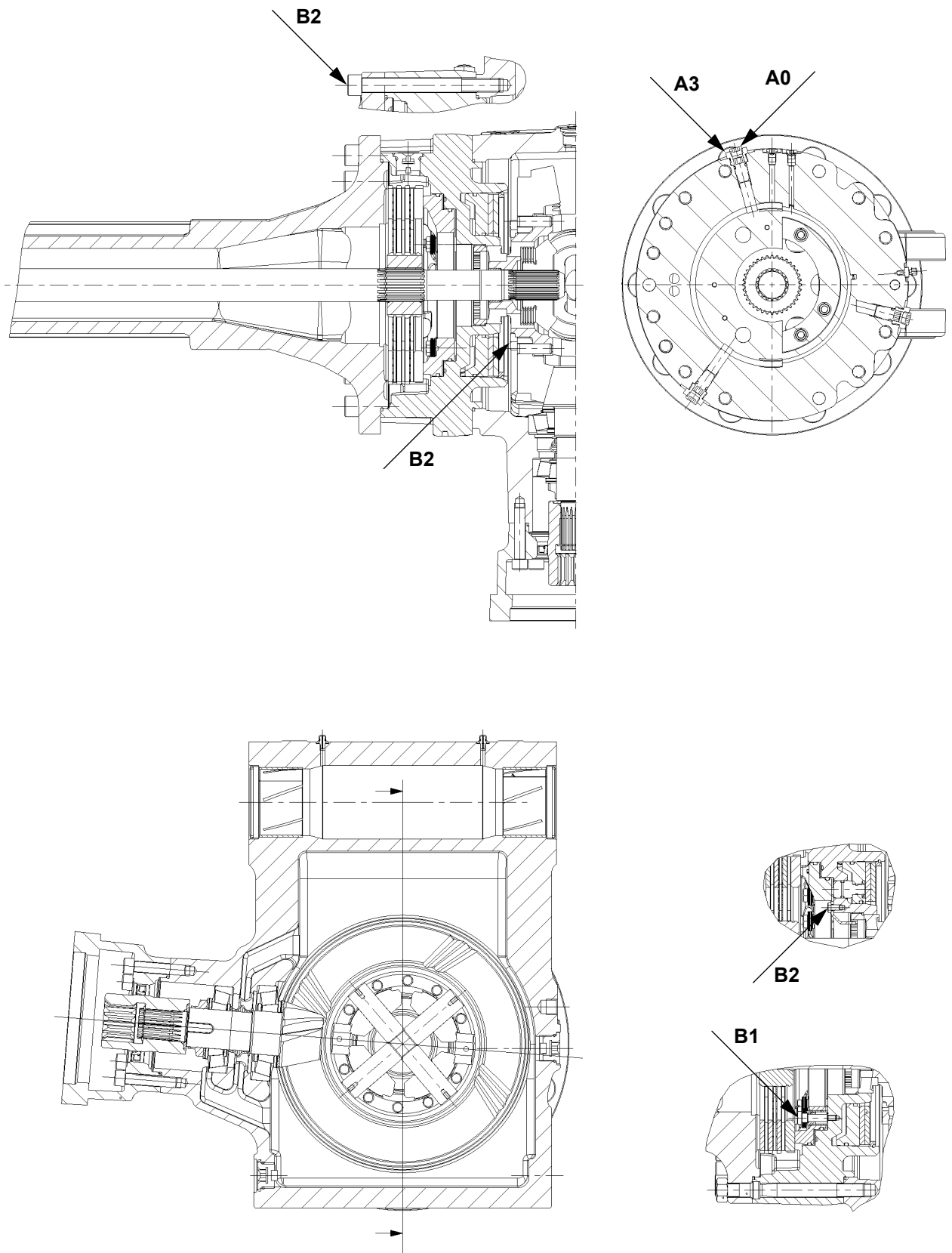


C.4 Caratteristiche Tecniche**C.4 Technical Features**

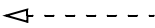
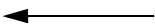
MACCHINA	Assale Anteriore - Front Axle	MACHINE
CODICE	CA144840	CODE
MODELLO	28.46M	MODEL
TIPO DIFFERENZIALE	Limited slip	DIFFERENTIAL TYPE

DESCRIZIONE	VALORI VALUES	DESCRIPTION
Riduzione coppia conica	4.777 / 1	Bevel gear ratio
Riduzione riduttore epicicloidale	6.923 / 1	Epicyclic reduction gear ratio
Riduzione totale	33.076 / 1	Total ratio
Peso a secco	646 Kg	Dry weight
Rotazione in entrata		Input rotation
SENSO ORARIO	●	CLOCK WISE (C.W.)
SENSO ANTIORARIO	○	COUNTER CLOCK WISE (C.C.W.)
Gioco di accoppiamento coppia conica	0.15÷0.25 mm	Bevel gear set backlash
Precarico cuscinetti pignone conico (misurato sul D=35 mm senza anelli di tenuta)	P= 9.2÷13.7 N	Pinion bearings preloading (measured on D=35 mm without seals)
Precarico totale cuscinetti corona-pignone (misurato sul D=35 mm senza anelli di tenuta)	T= (P+1.9)÷(P+2.9) N	Total pinion-ring gear bearing preloading (measured on D=35 mm without seals)
Spessore nominale disco differenziale	2.7 / 1.6 mm	Nominal differential disk thickness
Usura max disco differenziale (per ogni disco)	0.15 / 0.30 mm	Maximum differential disk wearing (each disk)
Spessore nominale controdisco differenziale	1.3 mm	Nominal differential counterdisk thickness
Tipo freno	A dischi in bagno d'olio Wet discs brake	Type of brake
Numero dischi freno per lato	3	Number of brake disks each side
Spessore nominale disco freno	4.83 mm	Nominal brake disk thickness
Usura max disco freno (per ogni disco)	0.8 mm	Maximum brake disk wearing (each disk)
Spessore nominale controdisco freno	5/10.8 mm	Nominal brake counterdisk thickness
Temperatura di esercizio freni	-40 °C ÷ 130 °C	Brakes operating temperature
Pressione max di esercizio	44 bar	Maximum operating pressure
Pressione disinnesto freni	18 bar	Brakes disengagement pressure
Quantità olio freni	Vedi manuale veicolo See vehicle manual	Brakes oil capacity

DESCRIZIONE	VALORI VALUES	DESCRIPTION
Specifica olio freni: USARE I TIPI DI OLIO INDICATI OPPORTUNAMENTE ADDITIVATI.	Vedi manuale veicolo <i>See vehicle manual</i>	<i>Brakes oil specification: USE RECOMMENDED OIL ENRICHED IN ADDITIVES.</i>
Quantità olio differenziale	16 litri/litres	<i>Differential oil capacity</i>
Quantità olio riduttore epicicloidale per lato	1.5 litri/litres	<i>Epicyclic reduction gear oil capacity each side</i>
Specifica olio: USARE I TIPI DI OLIO INDICATI OPPORTUNAMENTE ADDITIVATI. Nota: NON USARE OLIO DI SINTESI O VEGETALE SENZA IL CONSENSO DEL COSTRUTTORE DELL'ASSALE	API GL4	<i>Oil specification: USE RECOMMENDED OIL ENRICHED IN ADDITIVES. Note: DO NOT USE SYNTHETIC OR VEGETABLE OIL WITHOUT CONSENT OF THE AXLE MANUFACTURER</i>
Specifica grasso *usare solo per manicotto scanalato (vedi: sezione D.1)	TECNOLUBE SEAL POLYMER 400/L (DIN = KHER1R ISO-I-XMR-XM2) ROCOL SAPPHIRE-2*	<i>Grease specification</i> <i>*use on splined sleeve only (see: section D.1)</i>
Sigillante scatola (A0) Vedi: Sigillanti e collanti	SILASTIC 30849 DOW CORNING 7091	<i>Housing sealant (A0) See: Sealing compounds and adhesives</i>

Sigillanti e collanti**Sealing compounds and adhesives**

CAIa02607

Posizione Applicazione Adesivi/Sigillanti <i>Adhesive/Sealant Application Position</i>	
	Applicare sulle superfici a contatto <i>Apply on the contact surfaces</i>
	Applicare sulla filettatura delle viti / sui perni <i>Apply on bolts thread / on pins</i>

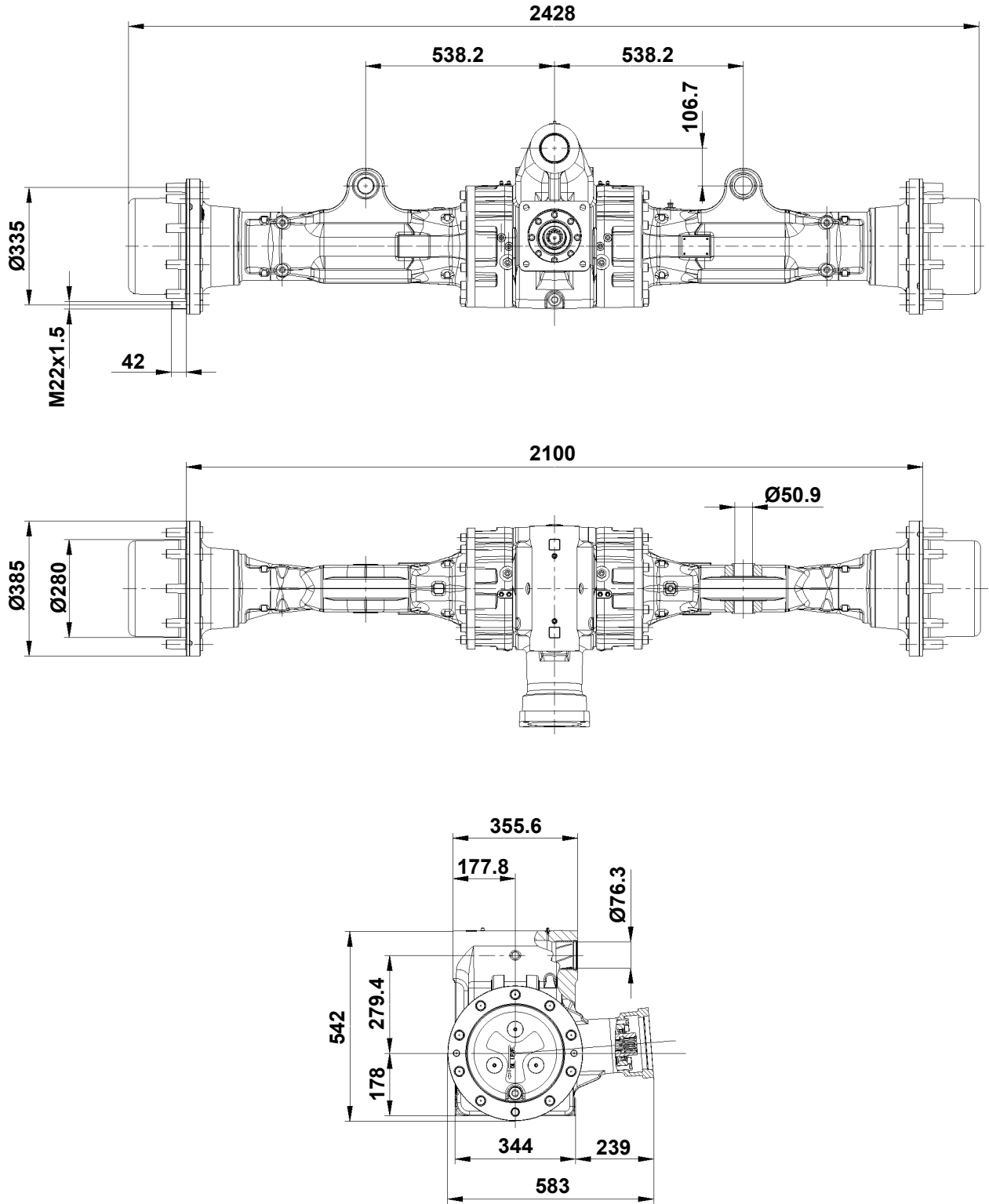
Sigillante per guarnizioni <i>Gasket sealant</i>				
Rif.Carraro <i>Carraro Ref.</i>	Presenza <i>Presence</i>	Marca e tipo di adesivo <i>Adhesive make and type</i>	Caratteristiche tecniche <i>Technical characteristics</i>	Resistenza <i>Strength</i>
A1	○	Loctite® 510 Superbond® 529	Sigillatura superfici piane Flat surface sealing	Alta High
A2	○	Loctite® 573 Superbond® 519	Sigillatura superfici piane Flat surface sealing	Bassa Low
A3	●	Loctite® 518 Superbond® 539	Sigillatura superfici irregolari Uneven surface sealing	Alta High

Adesivi per frenatura organi filettati <i>Thread parts sealant</i>				
Rif.Carraro <i>Carraro Ref.</i>	Presenza <i>Presence</i>	Marca e tipo di adesivo <i>Adhesive make and type</i>	Caratteristiche tecniche <i>Technical characteristics</i>	Resistenza <i>Strength</i>
B1	●	Loctite® 542 Superbond® 321	Frenatura organi filettati Locking of threaded parts	Media Medium
B2	●	Loctite® 270 Superbond® 331	Frenatura organi filettati Locking of threaded parts	Alta High
B3	○	Loctite® 986/AVX Superbond® 438	Frenatura organi filettati Locking of threaded parts	Alta, appl. speciali High, special appl.

Adesivi per fissaggio particolari <i>Fixing parts sealant</i>				
Rif.Carraro <i>Carraro Ref.</i>	Presenza <i>Presence</i>	Marca e tipo di adesivo <i>Adhesive make and type</i>	Caratteristiche tecniche <i>Technical characteristics</i>	Resistenza <i>Strength</i>
C1	○	Loctite® 405 Superbond® istant 25	Adesivo per fissaggio Fixing adhesive	Fissaggio medio Medium bond
C2	○	Loctite® 638 Superbond® 433	Adesivo per fissaggio Fixing adhesive	Fissaggio forte Strong bond
C3	○	Loctite® 542 Superbond® 321	Adesivo per fissaggio Fixing adhesive	Fissaggio medio Medium bond
C4	○	Loctite® 496 Superbond® SB14	Adesivo per fissaggio gomma Rubber fixing adhesive	Fissaggio forte Strong bond

Dimensioni d'ingombro
(Millimetri)

Overall dimensions
(Millimeters)



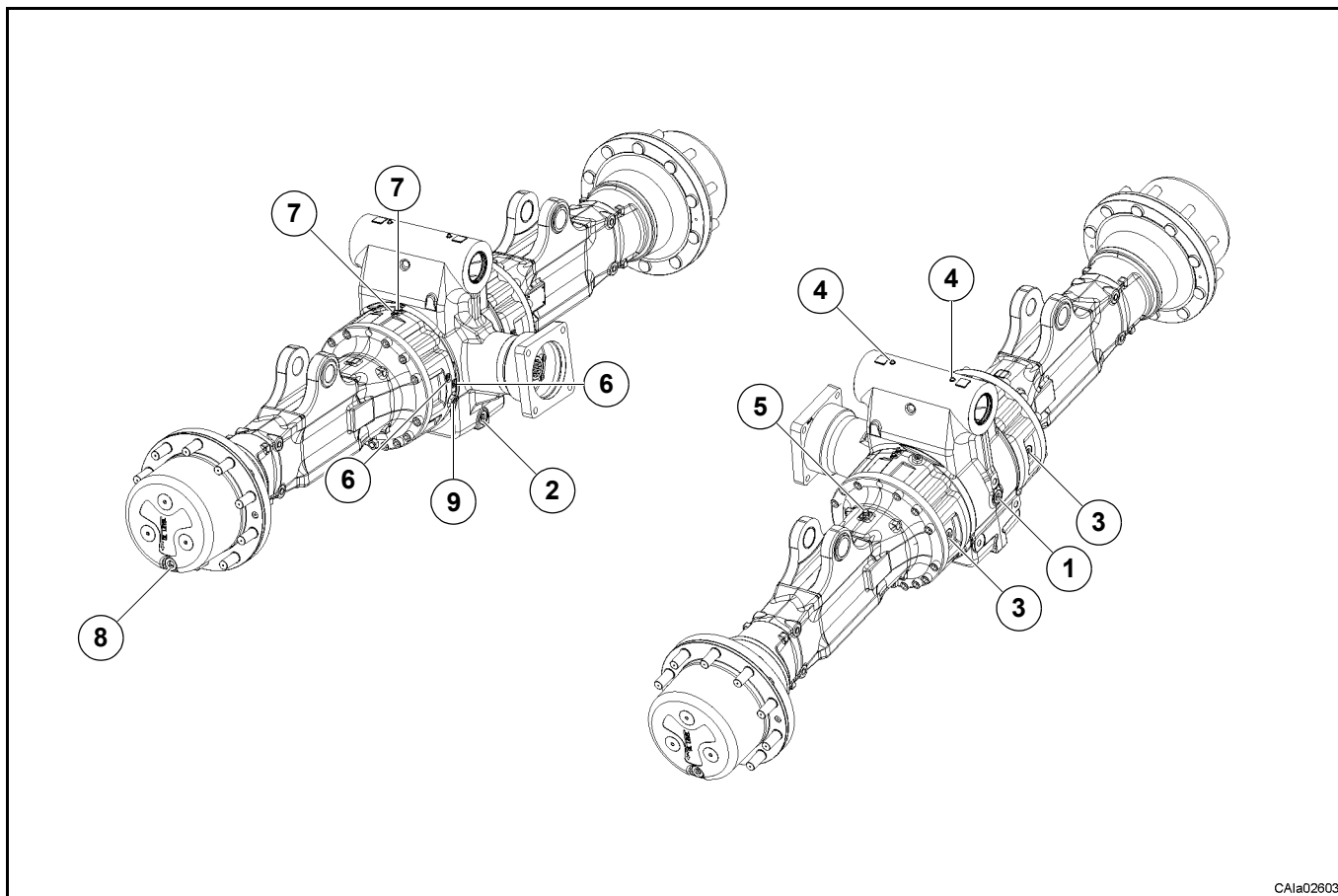
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C.5 Cambio olio e verifiche

Alcune figure che seguono potrebbero non mostrare esattamente il vostro assale, ma la procedura rimane la stessa.

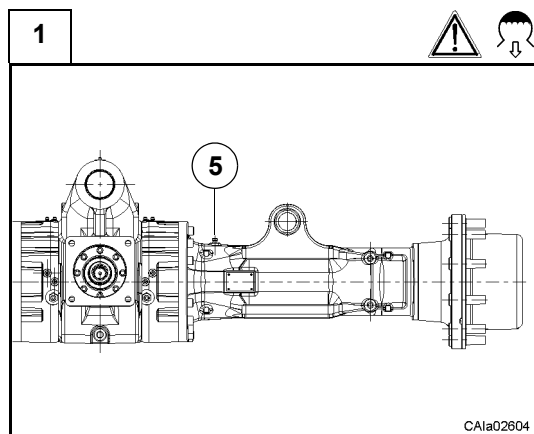
C.5 Oil change and checks

Some of the following pictures may not show exactly your axle, but the procedure is the same.



CA1a02603

DESCRIZIONE	POSIZIONE / POSITION	DESCRIPTION
Tappo carico e livello olio	1	Oil filling and level plug
Tappo scarico olio	2	Oil drain plug
Foro ispezione freni	3	Brake inspection hole
Punti di ingrassaggio	4	Greasing point
Sfiato olio	5	Oil breather
Porte ingresso olio freni	6	Service brakes oil port
Sfiati olio freni	7	Brakes bleeding plug
Tappo carico, livello e scarico olio riduttore epicicloidale	8	Filling, level and drain plug of epicyclic reduction gear oil
Sistema di sgancio freno parcheggio	9	Parking brake disengagement system



Pericolo: rischio di violenta espulsione di getti d'olio, seguire tutte le procedure di sicurezza indicate in questo manuale e dal costruttore del veicolo.

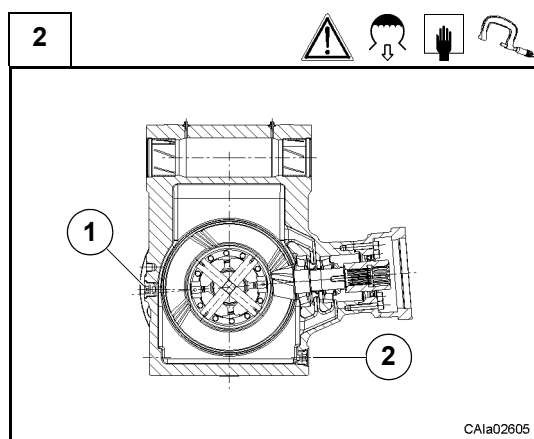
Vedi: cap.B - INFORMAZIONI SULLA SICUREZZA

Prima di scaricare l'olio dal corpo dell'assale, agire sull'apposito sfiato (5) per eliminare l'eventuale pressione interna.

Danger: risk of violent oil ejection, follow carefully all the safety procedures indicated in this manual and in the vehicle manual.

See: cap.B - SAFETY INSTRUCTIONS

Before draining the oil from axle housing, use the breather (5) to release possible internal pressure.



Per scaricare l'olio dal corpo centrale svitare prima il tappo di livello (1) e poi il tappo di scarico (2).

Pericolo: rischio di violenta espulsione di getti d'olio.

Vedi: punto precedente.

Scaricare completamente l'olio.

Pulire il tappo (2) e richiuderlo alla coppia prevista (Sez.C.6).

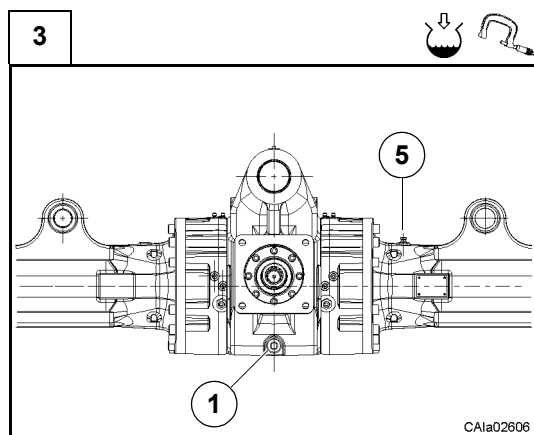
To drain the oil remove the level plug (1) and the drain plug (2).

Danger: risk of violent oil ejection.

See: the first point.

Drain all oil.

Clean the plug (2) and tighten it to the prescribed torque (Sec.C.6).



Prima di svitare il tappo di livello dell'olio (1), agire sempre sull'apposito sfiato (5) per eliminare l'eventuale pressione interna.

Riempire con l'olio prescritto a filo del foro di carico.

Attendere che l'olio fluisca nell'assale quindi verificare il livello e rabboccare se necessario.

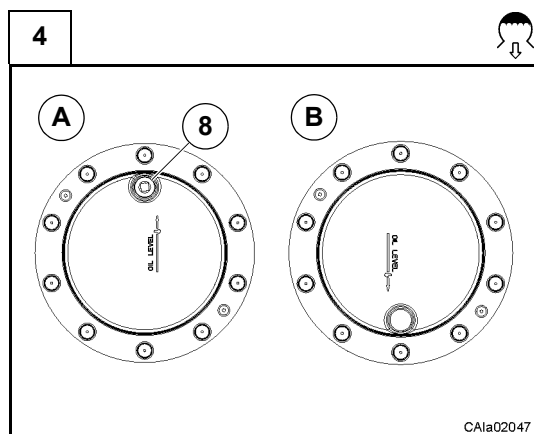
Riavvitare il tappo (1) alla coppia prevista (Sez.C.6).

Before draining the oil from the plug (1), always use the breather (5) to release possible internal pressure.

Fill to the bottom of the fill plug hole with the specified oil.

Wait to allow the oil to flow through the axle. Check oil level and fill to the specified level if necessary.

Close the plug (1) to the prescribed torque (Sec.C.6).



Prima di scaricare l'olio dal riduttore epicicloidale, ruotarlo in modo da portare il tappo olio (8) nel punto più alto [posizione A].

Svitare il tappo parzialmente per eliminare l'eventuale pressione interna.

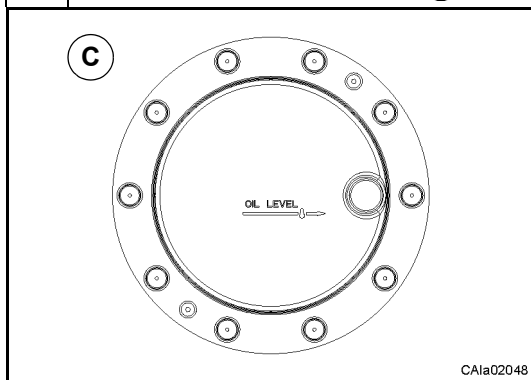
Ruotare il riduttore con il tappo (8) rivolto verso il basso [posizione B].

Togliere il tappo e lasciar defluire tutto l'olio.

Before draining the oil from wheel end rotate the wheel end so that the plug (8) is at the highest position [pos.A] and partially unscrew to release possible pressure.

Rotate the wheel end so that the plug (8) is toward the ground [pos.B].

Remove the plug and drain the oil.

5

Ruotare il riduttore fino a portare la linea “livello olio” parallela al suolo [pos.C].

Riempire con olio prescritto (Sez.C.4). Il livello dell'olio deve essere a filo del foro.

Serrare il tappo alla coppia prevista (Sez.C.6).

Rotate the wheel end so that the “oil level” line is parallel to the ground.

Fill to the bottom of the fill plug hole with specified oil (Sec.C.4).

Tighten the plug to the prescribed torque (Sec.C.6).

Programma di lubrificazione

Gli intervalli di lubrificazione indicati sono per un impiego normale della macchina, nel caso di impieghi particolarmente gravosi lubrificare con maggior frequenza.

Service schedule

Specified lubrication intervals are for standard-duty use.

Severe operating conditions require shorter lubrication intervals.

Operazione	▲ Primo Intervento <i>First time</i>	◆ Ad ogni stagione od ogni 1500 ore ⁽¹⁾ <i>Seasonally or every 1500 operating hours⁽¹⁾</i>	Operation
Cambio olio assale	150 - 200 ore/hours ●	◆	Axle oil change
Operazioni di lubrificazione	▲	◆	Lubrication works
Controllo e rabbocco olio	50 - 100 ore/hours ■	mensilmente/monthly ●	Check and adjust oil level
Pulizia tappo magnetico scarico olio	150 - 200 ore/hours ■	ad ogni cambio olio/ every oil change ●	Clean magnetic oil plugs
Pulizia sfiato olio	▲	mensilmente/monthly ●	Clean oil breather
Ingrassaggio	150 - 200 ore/hours ●	settimanalmente/weekly ●	Greasing

● operazioni eseguibili solamente da personale autorizzato dal costruttore

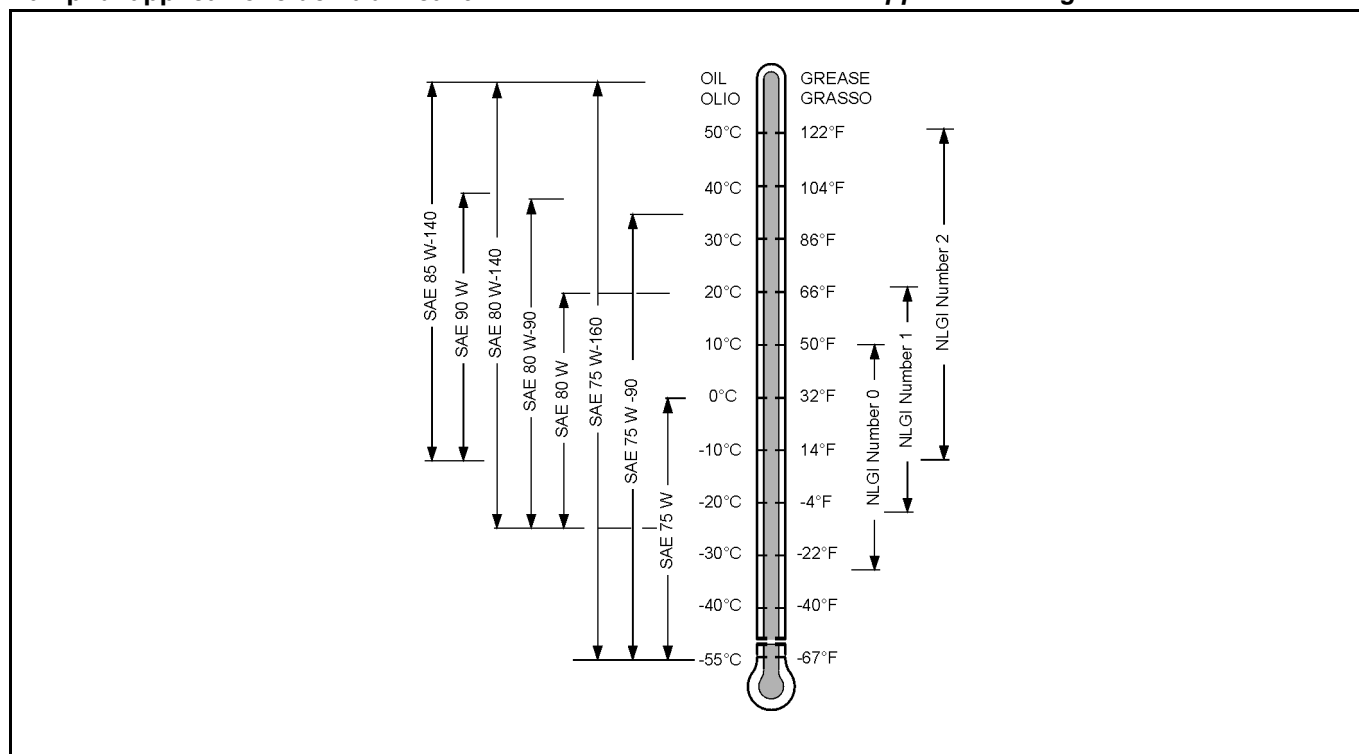
■ operazioni eseguibili solamente da personale addestrato

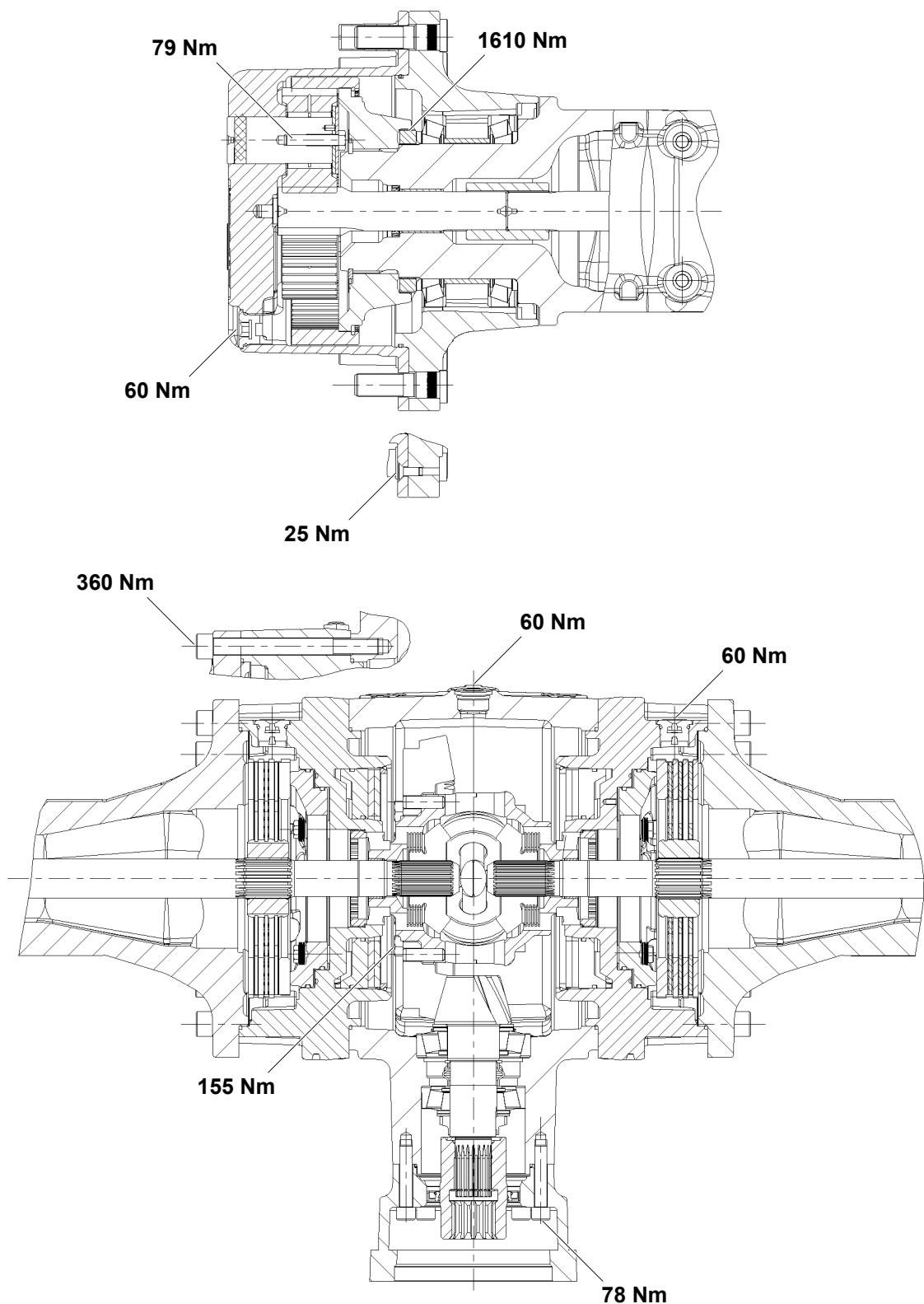
⁽¹⁾ quale delle due condizioni si verifica prima

● *this operation must be performed only by personnel authorized by the manufacturer*

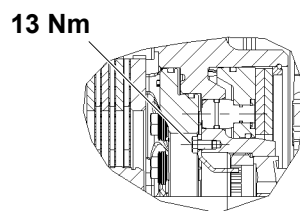
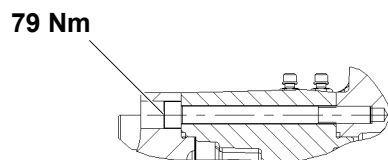
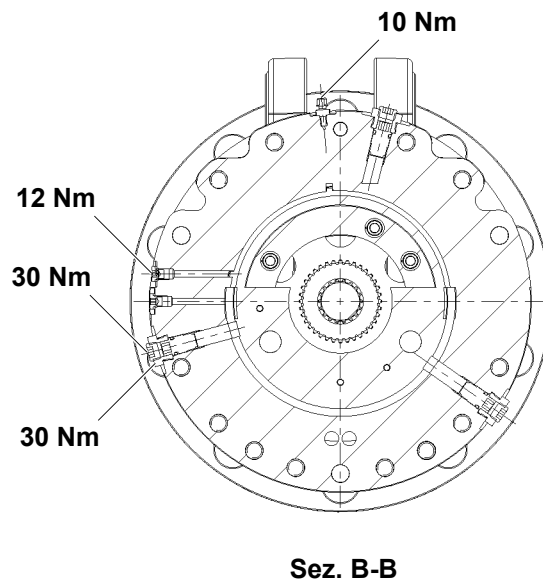
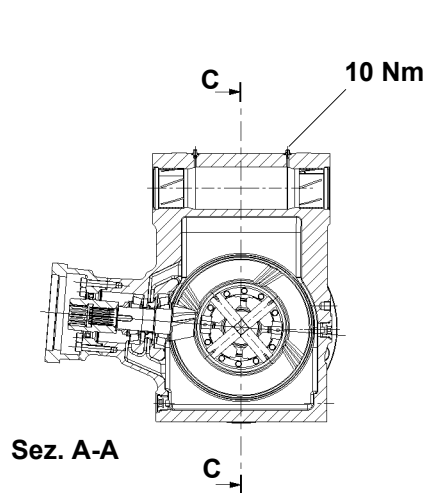
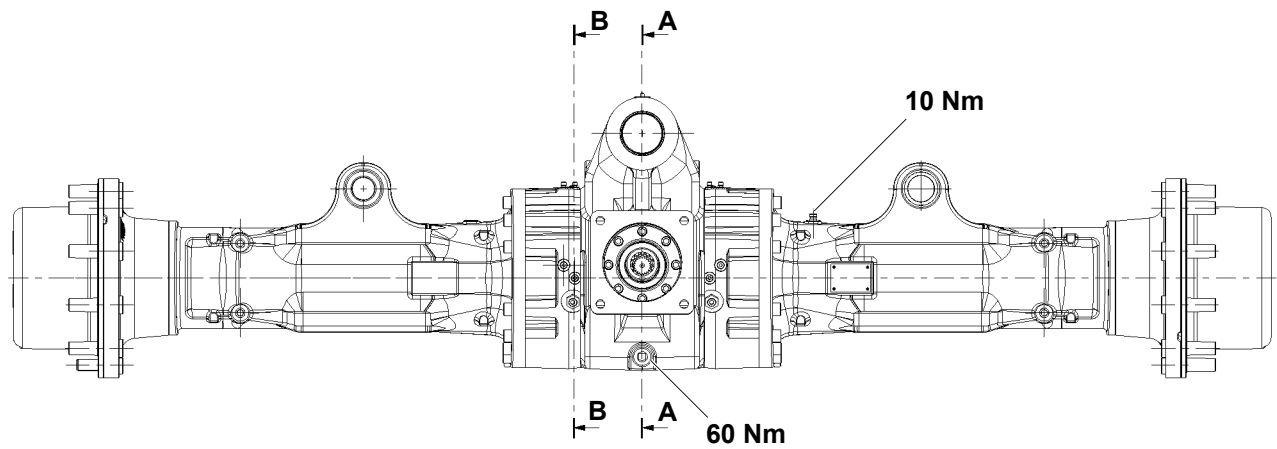
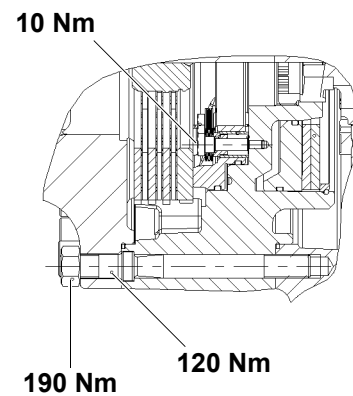
■ *this operation must be performed only by trained personnel*

⁽¹⁾ *which of both conditions comes first*

Campi di applicazione dei lubrificanti**Lubricants application range**

C.6 Coppie di serraggio**C.6 Tightening torques**

CAIa02608

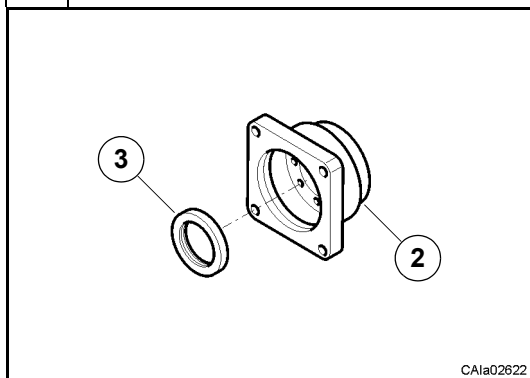
**Sez. C-C**

D

OPERAZIONI DI MONTAGGIO E SMONTAGGIO

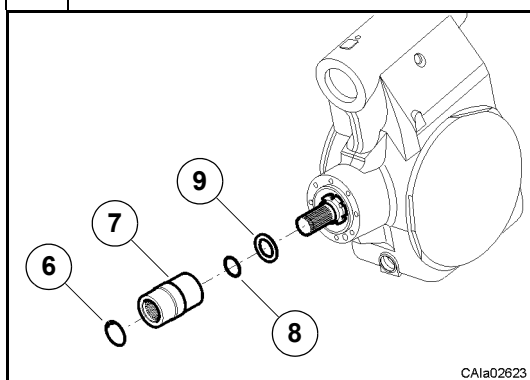
D

DISASSEMBLY AND ASSEMBLY OPERATIONS

2

CAIa02622

Rimuovere l'anello di tenuta (3) dalla flangia (2).

Nota: è un'operazione distruttiva per l'anello di tenuta (3).*Remove the seal ring (3) from the flange (2).***Note:** this is a destructive operation for the seal ring (3).**3**

CAIa02623

Rimuovere l'anello d'arresto (6) dal codolo del pignone (10).

Nota: è un'operazione distruttiva per l'anello d'arresto (6).

Sfilare il manicotto (7) e recuperare l'anello OR (8) e la rondella (9).

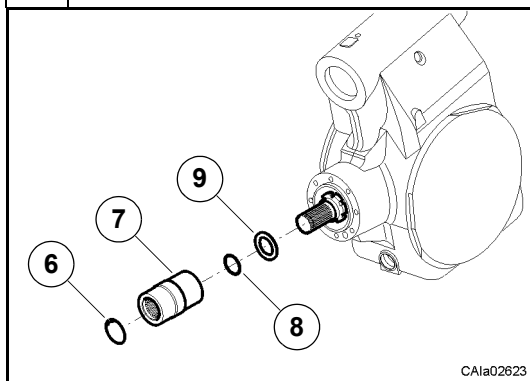
*Remove the lock ring (6) from the pinion end (10).***Note:** this is a destructive operation for the lock ring (6).*Take the splined sleeve (7) out, then collect the O-Ring (8) and washer (9).*

D.1.2 Montaggio

Alcune figure che seguono potrebbero non mostrare esattamente il vostro assale, ma la procedura rimane la stessa.

D.1.2 Assembly

Some of the following pictures may not show exactly your axle, but the process is the same.

1

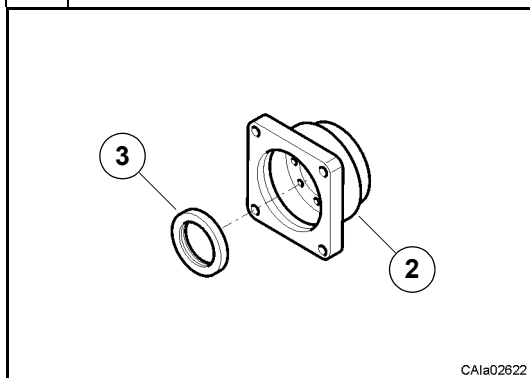
CAIa02623

Inserire la rondella (9) ed un nuovo anello OR sul codolo del pignone (8).

Assemblare il manicotto scanalato (7) al codolo del pignone.

Assemblare l'anello d'arresto (6) al codolo del pignone (10).

*Insert the washer (9) and new O-Ring (8) onto the pinion end.**Assemble the splined sleeve (7) to the pinion end.**Assemble the lock ring (6) to the pinion end (10).*

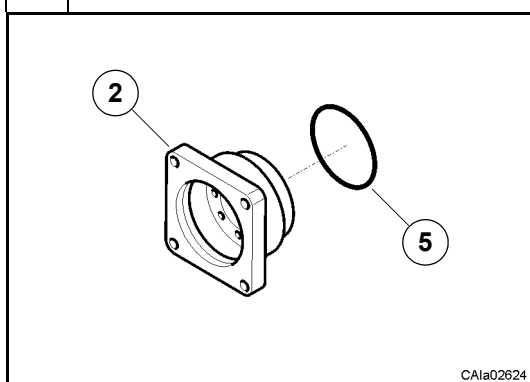
2

Assemblare l'anello di tenuta (5) nella flangia (2) con il battitoio CA715632 ed un martello.

Nota: lubrificare l'anello di tenuta (5) con grasso (Sez. C.4).

Insert the seal ring (5) into the flange (2) with the special tool CA715632 and a hammer.

Note: grease carefully the seal ring (5) (Sec. C.4).

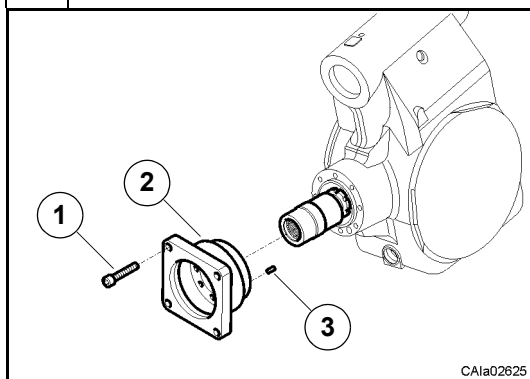
3

Montare un nuovo anello OR (5) nella flangia (2).

Nota: lubrificare l'anello OR (5) con grasso specifico (Sez. C.4).

Assemble a new O-Ring (5) in the flange (2).

Note: grease carefully the O-Ring (5) (Sec. C.4).

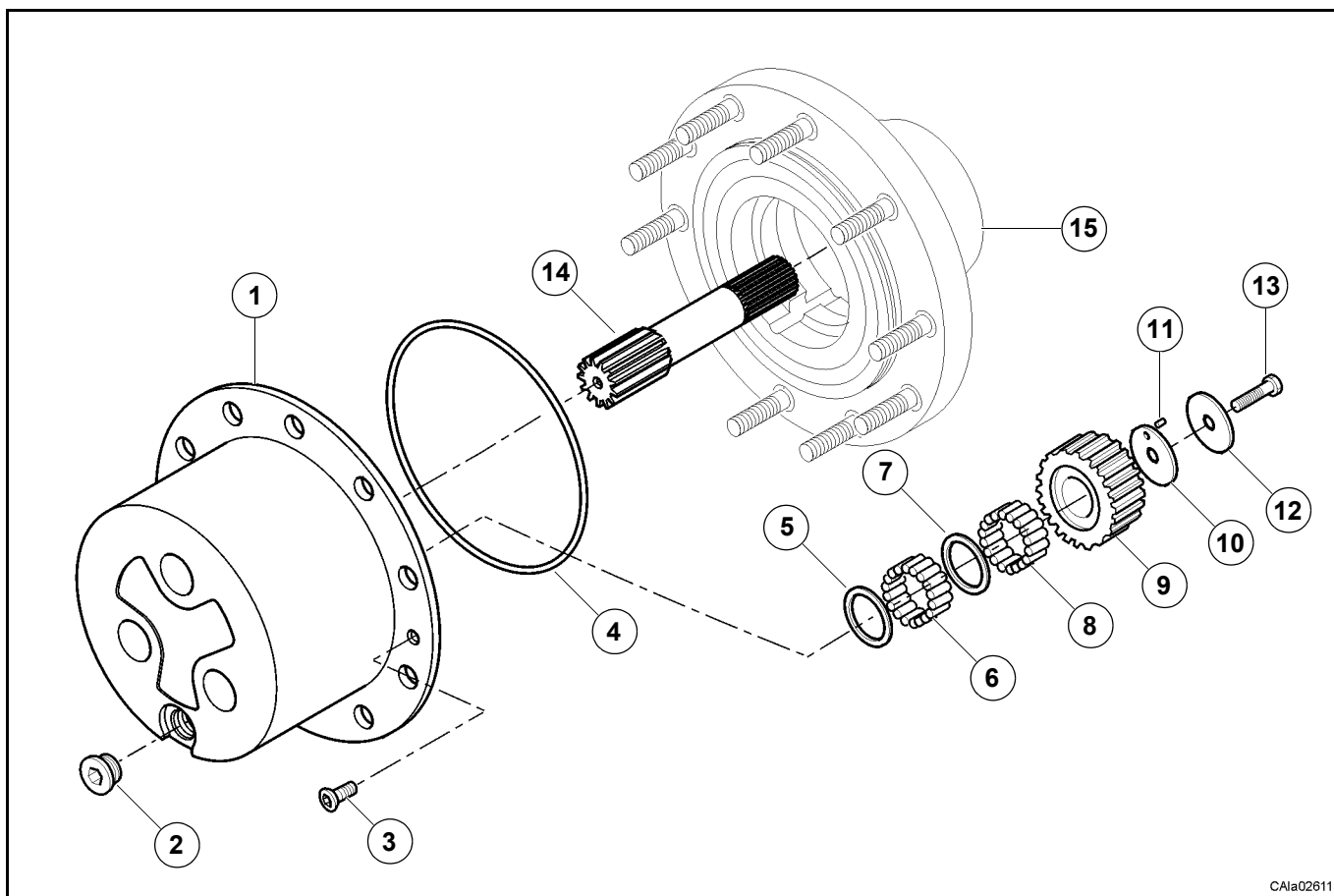
4

Assemblare la flangia (2) con la spina (4) al supporto differenziale.

Assemblare le viti di fissaggio (1) della flangia (2) alla coppia prescritta (Sez.C.6).

Assemble the flange (2) and the pin (4) to the differential support.

Assemble the fastening screw (1) of the flange (2) to the specified torque (Sez.C.6).

D.2 Gruppo riduttore epicicloidale**D.2 Epicyclic reduction gear group**

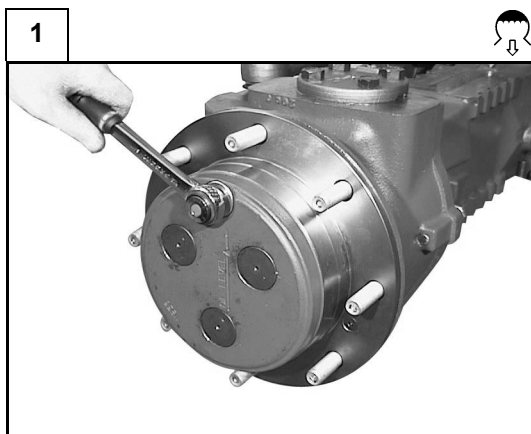
CAIa02611

D.2.1 Smontaggio

Alcune figure che seguono potrebbero non mostrare esattamente il vostro assale, ma la procedura rimane la stessa.

D.2.1 Disassembly

Some of the following pictures may not show exactly your axle, but the process is the same.

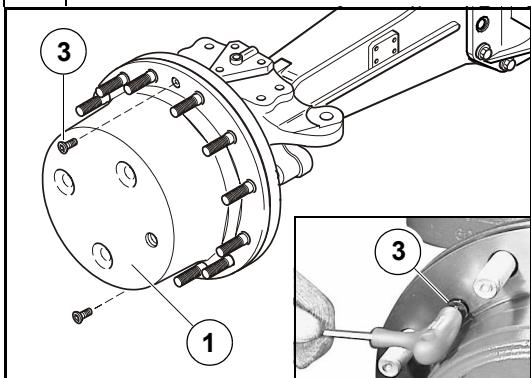


Scaricare completamente l'olio dal riduttore epicicloidale e dal corpo dell'assale.

Vedi: sezione C.5.

*Drain the oil completely from the epicyclic reduction gear and axle body.
See: section C.5.*

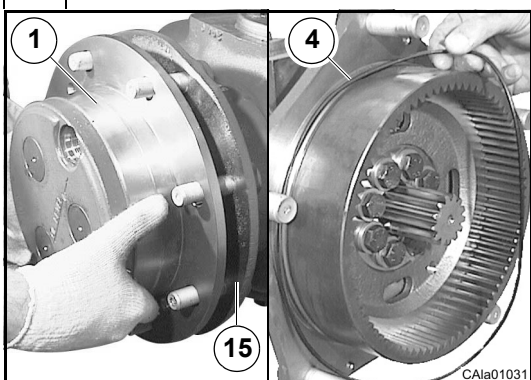
2



Svitare le due viti di fissaggio (3) del treno portasatelliti (1).

Unscrew both fastening screws (3) of the planetary carrier (1).

3



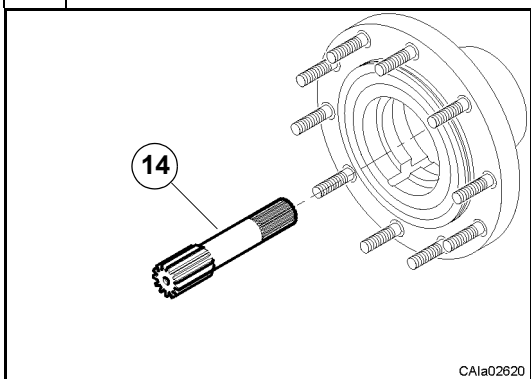
Rimuovere il treno portasatelliti (1) dal mozzo ruota (15) e recuperare il relativo anello OR (4).

Posizionare il treno portasatelliti (1) su di un piano e verificarne le condizioni di usura.

Remove the planetary carrier (1) from the wheel hub (15) and collect the relative O-Ring (4).

Position the planetary carrier (1) on a workbench and check its wear conditions.

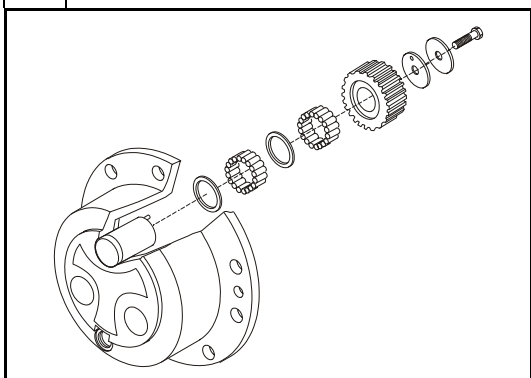
4



Rimuovere l'albero (14) dal mozzo ruota (15).

Remove the shaft (14) from the wheel hub (15).

5



Per eseguire l'eventuale sostituzione degli ingranaggi satelliti (9):

- rimuovere la vite di fissaggio (13) di ogni ingranaggio satellite (9);
- rimuovere le rondelle (12) e (10);
- estrarre i satelliti (9) dai perni;
- recuperare i relativi rullini (8) e (6) verificandone le condizioni;
- recuperare le rondelle di rasamento (7) e (5).

To carry out any possible replacements of the planetary gears (9):

- remove the fastening screws (13) on every planetary gear (9);
- remove the washers (12) and (10);
- take the planetary gears (9) out of the pins;
- collect the needle bearings (8) and (6) checking their conditions;
- collect the thrust washers (7) and (5).

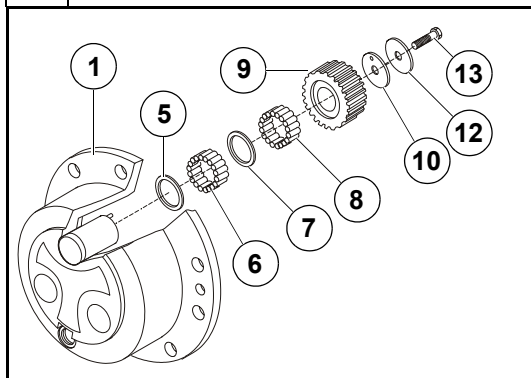
D.2.2 Montaggio

Alcune figure che seguono potrebbero non mostrare esattamente il vostro assale, ma la procedura rimane la stessa.

D.2.2 Assembly

Some of the following pictures may not show exactly your axle, but the process is the same.

1



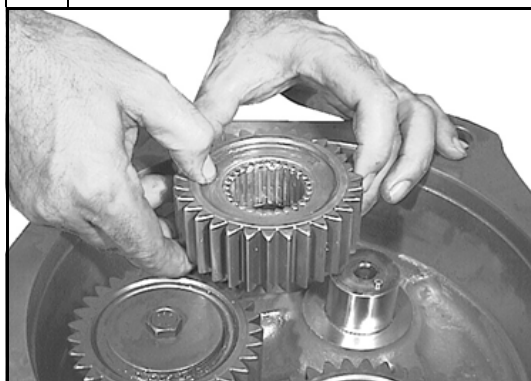
Recuperare tutti i componenti del riduttore epicycloidale: il treno portasatelliti (1), le ralle di rasamento (5) e (7), l'ingranaggio satellite (9) ed i relativi rullini (6) e (8), le ralle (10) e (12), la vite di fissaggio (13) di ogni perno.

Nota: con nuovi satelliti (9) è consigliabile montare nuovi rullini (8) e (6).

Collect all epicyclic reduction gear parts: the planetary carrier (1), the thrust washers (5) and (7), the planetary gear (9) with the roller bearings (6) and (8), the washers (10) and (12), the fixing screw (13) of every planetary carrier pin.

Note: with new planetary gears (9) it is advisable to assembly new roller bearings (8) and (6).

2



Posizionare su un banco di lavoro il treno porta satelliti (1).

Inserire i rullini (6) e (8) con interposta la ralla di rasamento (7) all'interno degli ingranaggi satelliti (9).

Nota: ingrassare bene i rullini (6) e (8).

Inserire nei perni del treno porta satelliti (1) le ralle di rasamento (5) e gli ingranaggi epicycloidali (9) completi.

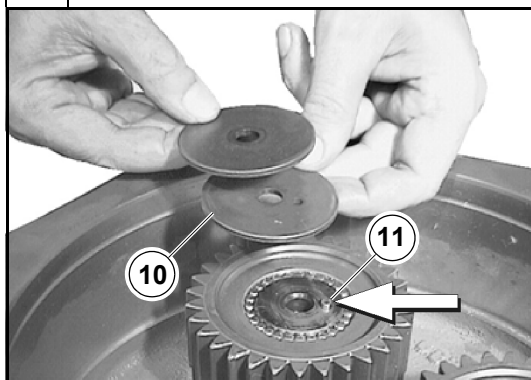
Position the planetary carrier (1) on a workbench.

Insert the needles bearing (6), (8) and the thrust washer (7) in the epicyclic gears (9).

Note: grease well the needles (6) and (8).

Insert the thrust washers (5) and the assembled epicyclic gears (9) in the planetary carrier (1) pins.

3



Montare le ralle di rasamento (10) e (12) nei perni del treno porta satelliti (1).

Nota: la ralla intermedia (10) ha un foro che serve da centraggio con la spina (11) piantata sui perni del treno portasatelliti (1).

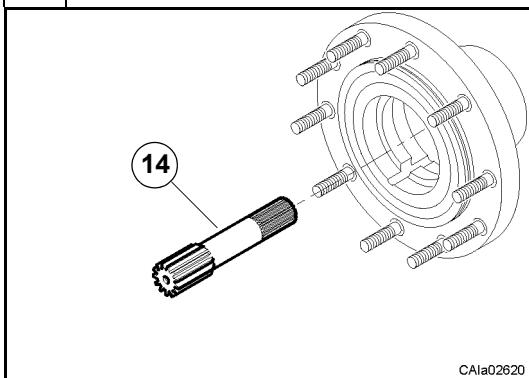
Montare le relative viti di arresto (13), serrandole con chiave dinamometrica alla coppia prevista (Sez.C.6).

Fit the thrust washers (10) and (12) to the planetary carrier (1) pins.

Note: the intermediate thrust washers (10) has a hole for centering with the dowel pin (11) fitted on the planetary carrier (1) pins.

Assemble the retaining screw (13), then tighten them with dynamometric wrench to the requested torque (Sec. C.6).

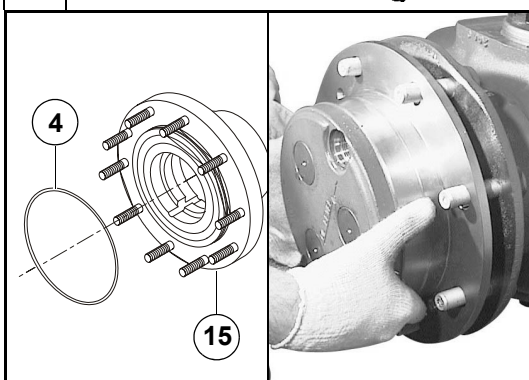
4



Assemblare l'albero (14) al mozzo ruota (15).

Assemble the shaft (14) to the wheel hub (15).

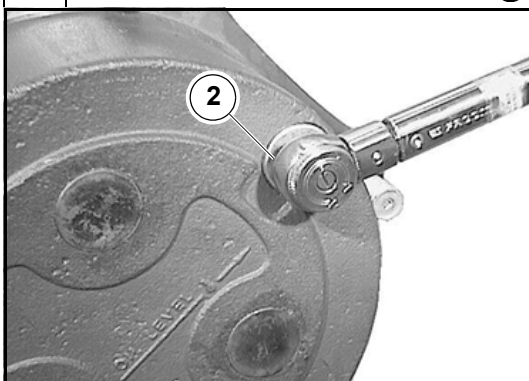
5



Inserire un nuovo anello OR (4) lubrificato sul mozzo ruota (15).
Montare il gruppo riduttore epicicloidale sul mozzo ruota (15).
Assemblare le viti di fissaggio (3) e serrarle alla coppia prevista (Sez.C.6).

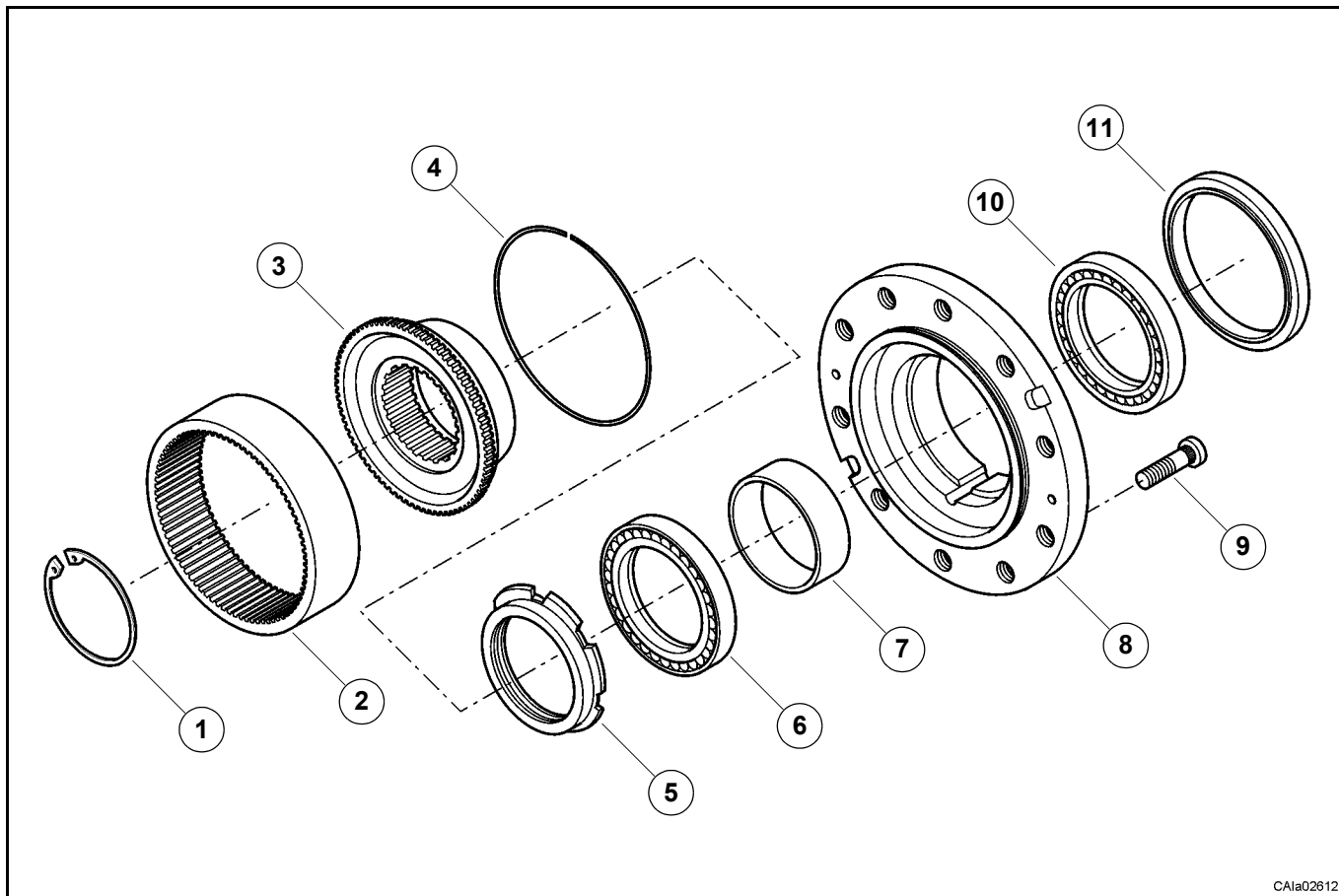
*Assemble a new lubricated O-Ring (4) on the wheel hub (15).
Fit the epicyclic reduction gear assembly to the wheel hub (15).
Assemble the screws (3) and tighten them to the prescribed torque (Sec.C.6).*

6



Ripristinare l'olio nel riduttore epicicloidale e nel corpo dell'assale.
Vedi: sezione C.5.
Montare il tappo (2) sul treno portasatelliti (1), e serrare alla coppia prevista (Sez.C.6) con chiave dinamometrica.

*Top up the oil in the epicyclic reduction gear and axle body.
See: section C.5.
Fit the plug (2) on the epicyclic reduction gear (1) and tighten to the prescribed torque using a torque wrench (Sec.C.6).*

D.3 Gruppo mozzo ruota**D.3 Wheel hub group**

CAIa02612

D.3.1 Smontaggio

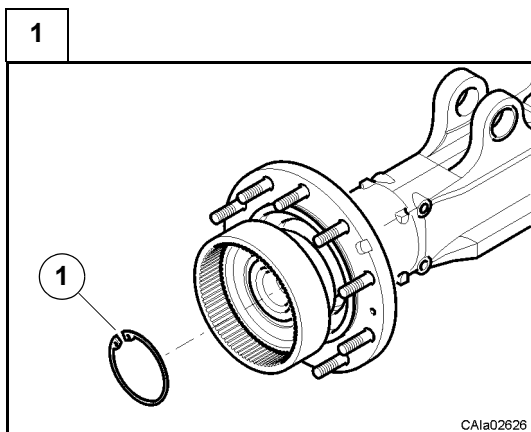
Alcune figure che seguono potrebbero non mostrare esattamente il vostro assale, ma la procedura rimane la stessa.

Nota: per lo smontaggio del gruppo mozzo ruota vedi prima le procedure descritte alla sezione D.2.

D.3.1 Disassembly

Some of the following pictures may not show exactly your axle, but the process is the same.

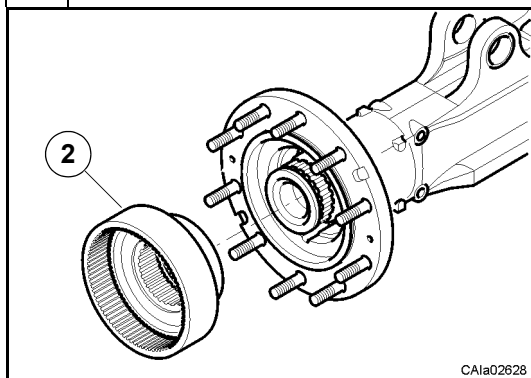
Note: before disassemble the wheel hub group see the procedure described in the section D.2.



CAIa02626

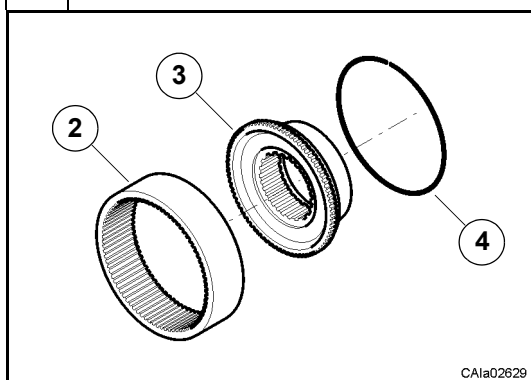
Rimuovere l'anello d'arresto (1) dall'estremità della tromba trave.

Remove the lock ring (1) from the beam trumpets end.

2

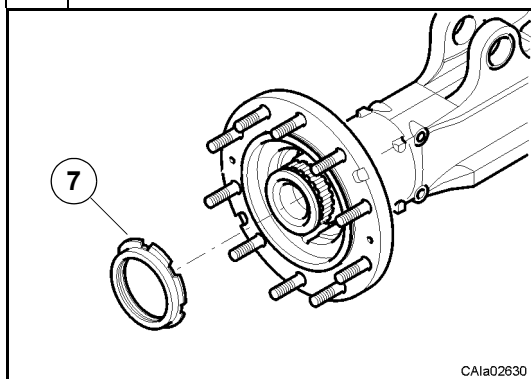
Sfilare la corona dentata (2) con il mozzo fermo corona (3).
Nota: potrebbe essere necessario l'utilizzo di un estrattore.

*Remove the ring gear (2) and the wheel carrier (3).
Note: may be necessary the use of an extractor.*

3

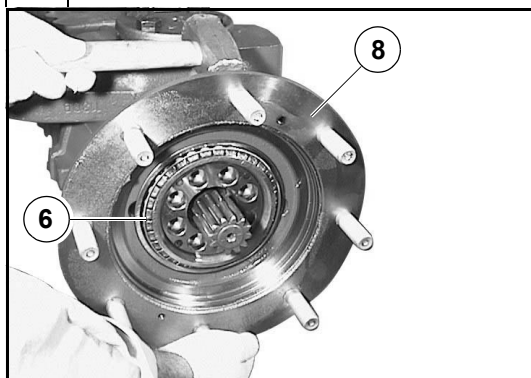
Rimuovere l'anello d'arresto (4) dalla corona (2).
Separare il mozzo (3) dalla corona dentata (2).
Verificare lo stato di usura dei particolari.

*Remove the lock ring (5) from the ring gear (2).
Disassemble the ring gear (2) from the wheel carrier (3).
Check the wear conditions of the components.*

4

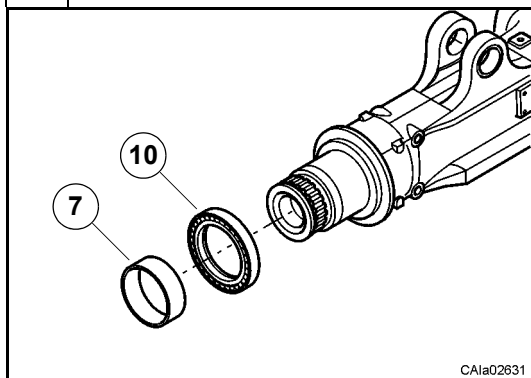
Svitare la ghiera (5) con la chiave speciale CA715631.
Nota: si consiglia l'utilizzo di un moltiplicatore di coppia meccanico.

*Remove the ring nut (5) using the special wrench CA715631.
Note: it's advisable to use a mechanical torque multipliers.*

5

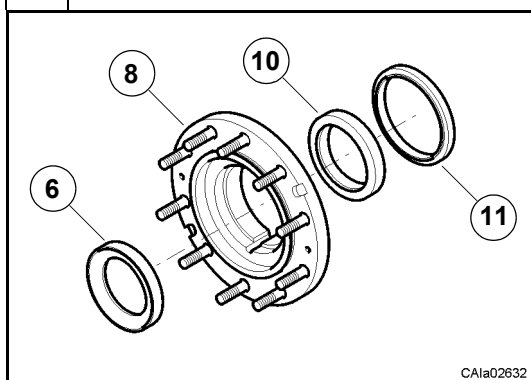
Sfilare il mozzo ruota (8) facilitando lo smontaggio con leve e martello.
Nota: recuperare il cono del cuscinetto (6).

*Remove the wheel hub (8) using levers and a hammer to facilitate the operation.
Note: collect the bearing cone (6).*

6

Rimuovere il distanziale (7) ed il cono del cuscinetto (10) dall'estremità della tromba trave.

Remove the spacer (7) and bearing cone (6) from the beam trumpets end.

7

Posizionare su di una superficie piana il mozzo ruota (8) ed estrarre l'anello di tenuta (11) con una leva.

Nota: è un'operazione distruttiva per l'anello di tenuta (11).

Rimuovere le coppe dei cuscinetti (6) e (10), da entrambi i lati del mozzo ruota (8).

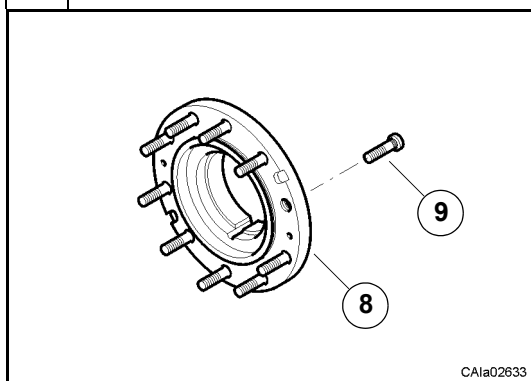
Togliere il cono del cuscinetto (10) dalla tromba trave, utilizzando un estrattore da commercio.

Position the wheel hub (7) on a flat surface and take the seal ring (11) out with a lever.

Note: this is a destructive operation for the seal ring (11).

Take the bearing cups (6) and (10) out, on both sides of the wheel hub (8).

Remove the bearing cone (10) from the axle beam trumpet, using a suitable extractor.

8

Esaminare le condizioni della filettatura delle colonnette (9).

Rimuovere le colonnette (9) danneggiate dal mozzo ruota (8) con un battitoio ed un martello.

Nota: è un'operazione distruttiva per le colonnette (9).

Check the condition of the stud bolts thread.

Remove the damaged stud bolts (9) from the wheel hub (8), using a pad and a hammer.

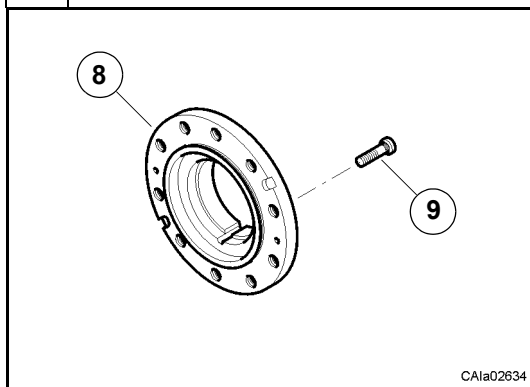
Note: this is a destructive operation for the stud bolts (9).

D.3.2 Montaggio

Alcune figure che seguono potrebbero non mostrare esattamente il vostro assale, ma la procedura rimane la stessa.

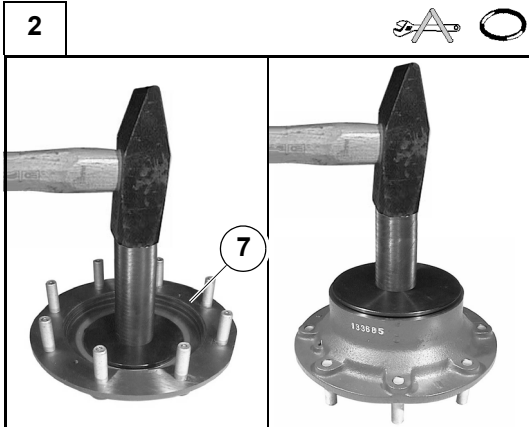
D.3.2 Assembly

Some of the following pictures may not show exactly your axle, but the process is the same.

1

Assemblare le colonnette (9) al mozzo ruota (8) con un battitoio ed un martello.

Assemble the stud bolts (9) to the wheel hub (8), using a pad and a hammer.

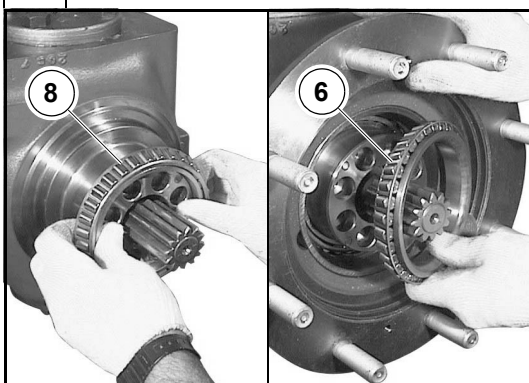
2

Piantare le coppe dei cuscinetti a rulli conici (6) e (10) sul mozzo ruota (8) utilizzando l'attrezzo speciale CA715118 sotto l'azione di una pressa o di un martello.

Inserire l'anello di tenuta (11) nel mozzo ruota (8) con il battitoio CA715633 ed un martello.

Force both bearing cups (6) and (10) to their wheel hub (8) housings, using the special tool CA715118 under a press or with a hammer.

Insert the seal ring (11) into the wheel hub (8) with the special tool CA715633 and a hammer.

3

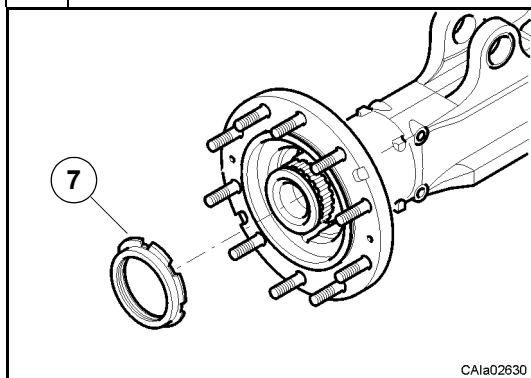
Montare il cono del cuscinetto a rulli conici (10) ed il distanziale (7) sul codolo della tromba trave.

Assemblare il mozzo ruota (8) alla tromba trave e posizionare l'altro cono del cuscinetto (6).

Assemble the bearing cone (10) and spacer (7) on the axle beam trumpet end.

Assemble the wheel hub (8) on the axle beam trumpet and fit the other bearing cone (6) in position.

4



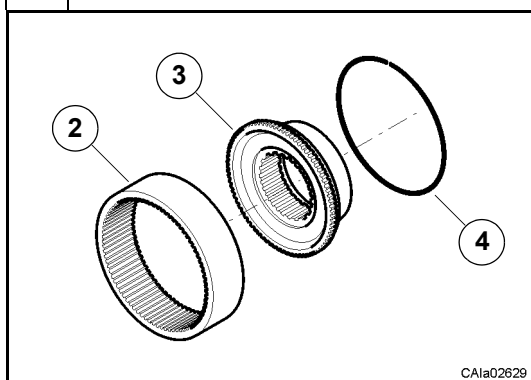
Assemblare la ghiera (5) con la chiave speciale CA715631.
Serrare la ghiera alla coppia prevista (Sez.C.6).

Nota: si consiglia l'utilizzo di un moltiplicatore di coppia meccanico.

*Assemble the ring nut (5) using the special wrench CA715631.
Tighten the ring nut to the requested torque (Sec.C.6).*

Note: it's advisable to use a mechanical torque multipliers.

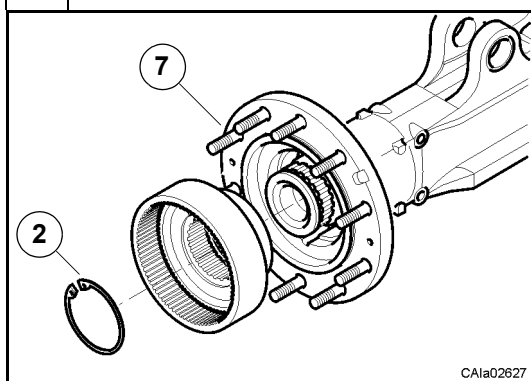
5



Preassemblare il mozzo fermo corona (3) e la corona epicicloidale (2) con l'anello d'arresto (4).

Preassemble the wheel carrier (3) and the epicyclic ring gear (2) with the lock ring (4).

6



Montare il gruppo mozzo fermo corona sul mozzo ruota (7).

Vedi: punto successivo.

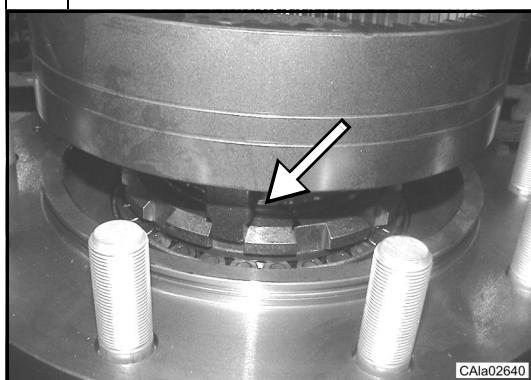
Assemblare l'anello d'arresto (1) all'estremità della tromba trave.

Assemble the wheel carrier group on the wheel hub (7).

See: next point.

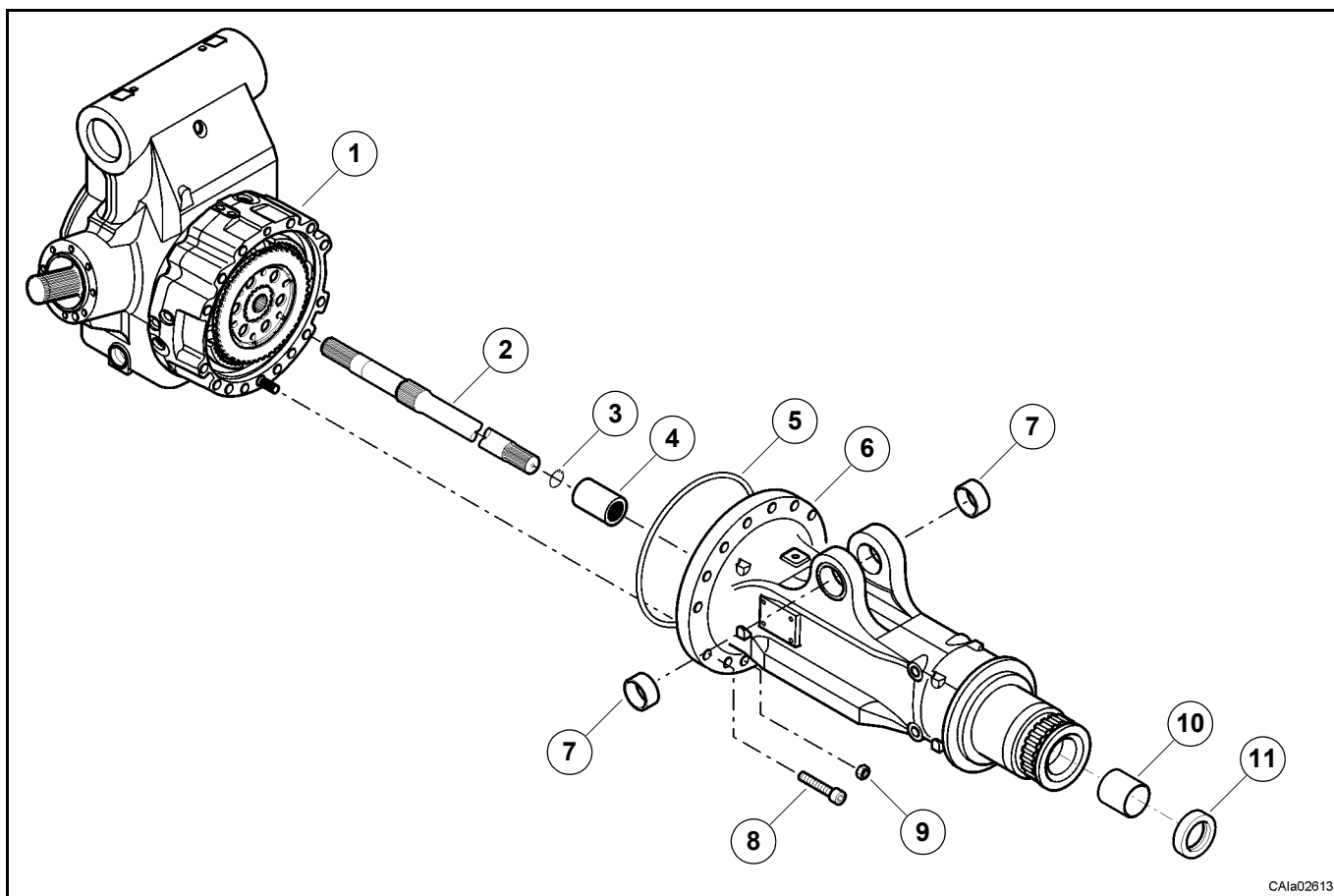
Assemble the lock ring (1) to the beam trumpets end.

7



Nota: verificare la corretta posizione del mozzo fermo corona (3).

Note: check the wheel carrier (3) position.

D.4 Gruppo trombe trave**D.4 Axle beam trumpets group**

CAIa02613

D.4.1 Smontaggio

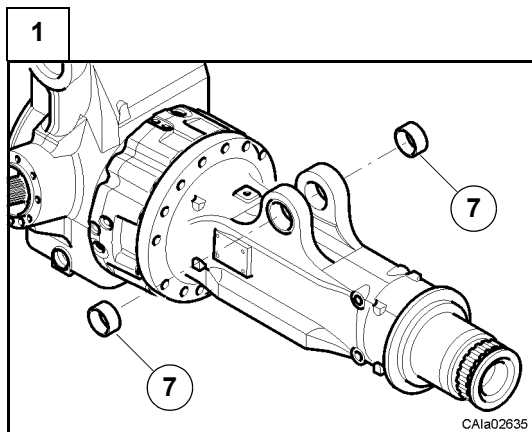
Alcune figure che seguono potrebbero non mostrare esattamente il vostro assale, ma la procedura rimane la stessa.

Nota: per lo smontaggio del gruppo trombe trave vedi prima le procedure descritte alla sezione D.3.

D.4.1 Disassembly

Some of the following pictures may not show exactly your axle, but the process is the same.

Note: before disassemble the axle beam trumpets group see the procedure described in the section D.3.



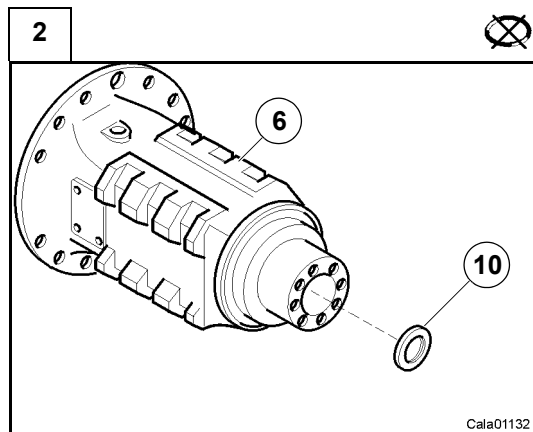
CAIa02635

Estrarre le boccole (7) dalla tromba trave (6) con un punzone ed un martello.

Nota: è un'operazione distruttiva per le boccole.

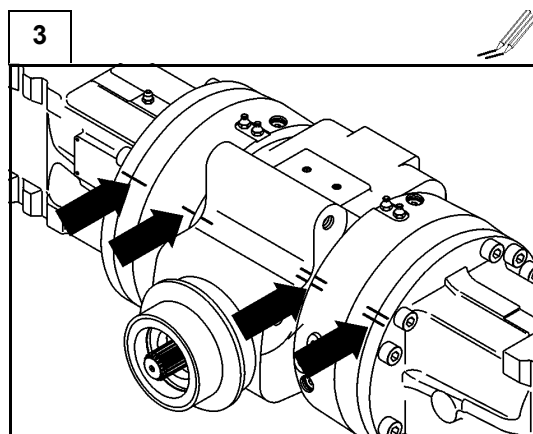
Take the bushes (7) out of the beam trumpet (6) with a punch and a hammer.

Note: this is a destructive operation for the bushes.



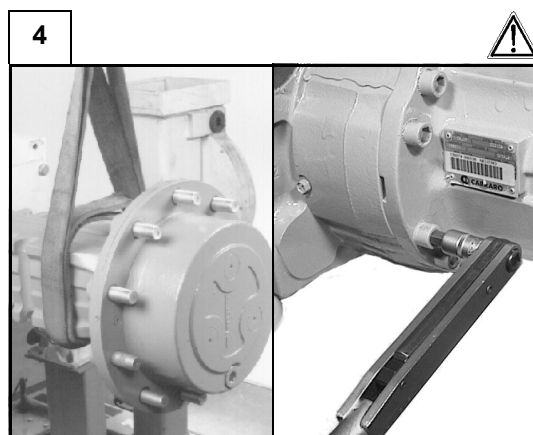
Estrarre l'anello di tenuta (10) dalla tromba trave (6) con una leva.
Nota: è un'operazione distruttiva per l'anello di tenuta.

*Take the seal ring (10) out of the beam trumpet (6) with a lever.
Note: this is a destructive operation for the seal ring.*



Fare dei segni di riferimento indelebili sulle trombe trave, sui cilindri freno e sul corpo centrale trave, per identificare con sicurezza parte destra e parte sinistra.

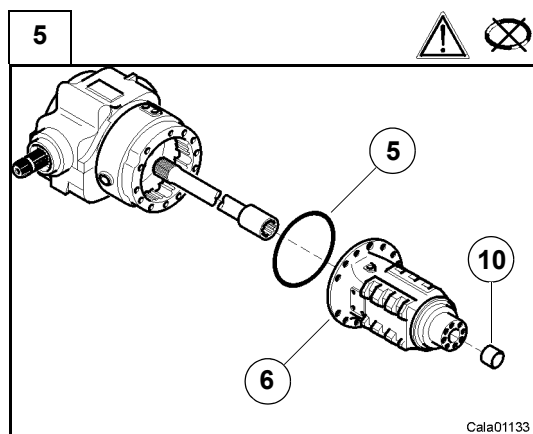
Put alignment marks on the beam trumpets, on the brake cylinders and on the central body, in order to identify the right side and the left side with certainty.



Attenzione: disporre l'assale su supporti adatti a sostenere sia il corpo centrale trave che le due trombe trave, anche dopo la loro separazione, o assicurare i gruppi separatamente con funi o cinghie ad un sistema di sollevamento.

Svitare e togliere le viti di fissaggio (8) ed il dado (9).

Warning: Position the axle on supports fitted to hold either the central body and the two beam trumpets, even after their disjunction, or secure the disjointed groups to a lifting device with ropes or belts. Unscrew and remove the fastening screws (8) and nut (9).



Staccare la tromba trave (6) e recuperare l'anello OR (5).

Attenzione: rimossa la tromba trave, il gruppo freno ed il semiasse lungo sono liberi.

Estrarre la bronzina (10) dalla tromba trave (6) solo se le condizioni di usura lo richiedono.

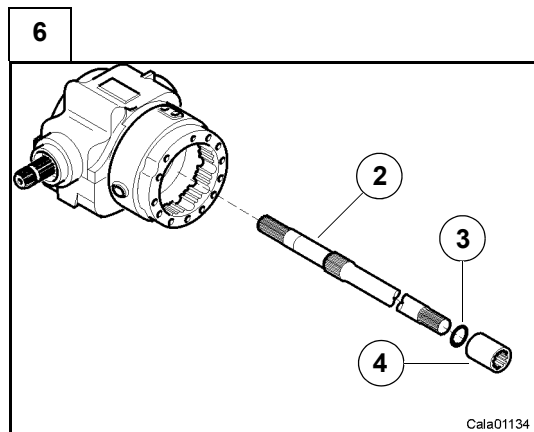
Attenzione: non rovinare la sede della bronzina.

Remove the beam trumpet (6) and collect the O-Ring (5).

Warning: once the beam trumpet has been removed, the brake group and the long half-shaft are free.

Remove the bush (10) from the beam trumpet (6) only if the wear conditions require this.

Warning: be careful not to damage the bush housing.



Estrarre l'albero (2) con il manicotto scanalato (4).
Solo se necessario rimuovere l'anello d'arresto (3) dal manicotto scanalato.

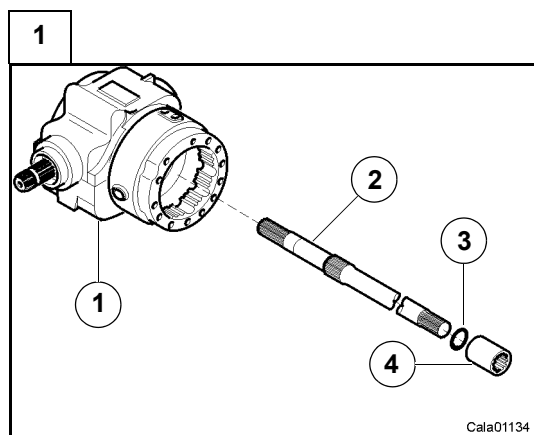
*Remove the shaft (2) and the splined sleeve (4).
Only if necessary remove the snap ring (3) from the splined sleeve.*

D.4.2 Montaggio

Alcune figure che seguono potrebbero non mostrare esattamente il vostro assale, ma la procedura rimane la stessa.

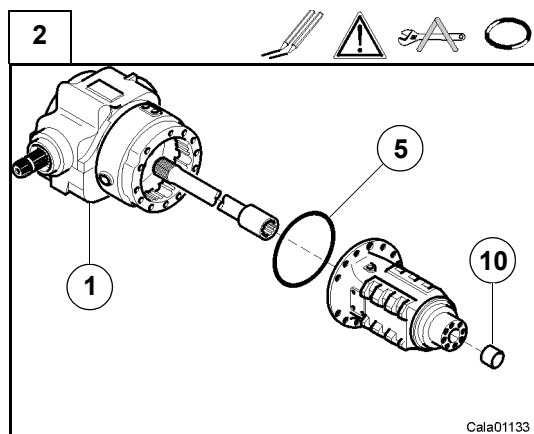
D.4.2 Assembly

Some of the following pictures may not show exactly your axle, but the process is the same.



Verificare che l'anello d'arresto (3) sia montato nel manicotto scanalato (4).
Preassemblare il gruppo albero (3) / manicotto scanalato (4) ed inserirlo nel corpo trave centrale (1).

*Check that the snap ring (3) is already assembled on the splined sleeve (4).
Pre-assemble the group shaft (3) / splined sleeve (4) and insert it on the central body (1).*



Montare nella tromba trave (6) la bronzina (10) utilizzando il battitoio CA715531 ed un martello.

Montare un nuovo anello OR (5) nella tromba trave.

Nota: prima del montaggio, verificare i segni di riferimento eseguiti in fase di smontaggio per il corretto posizionamento delle trombe trave.

Attenzione: sostenere opportunamente i gruppi come già indicato nella fase di smontaggio.

Montare la tromba trave sul corpo centrale (1), facendo attenzione all'allineamento dei fori di fissaggio.

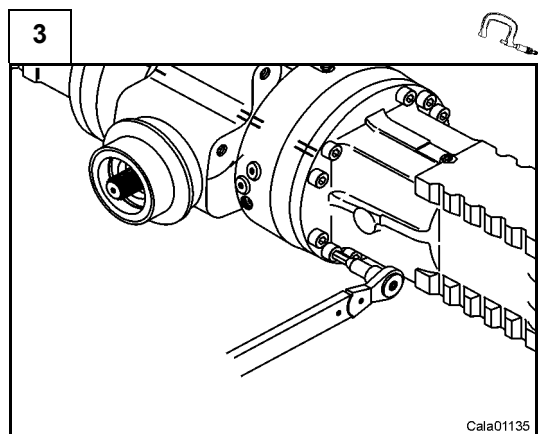
Assemble on the beam trumpet (6) the bush (10) with the special tool CA715531 and a hammer.

Assemble a new O-Ring (5) into the beam trumpet.

Note: in order to place precisely the beam trumpet, before assembly, check the reference marks carried out during disassembly.

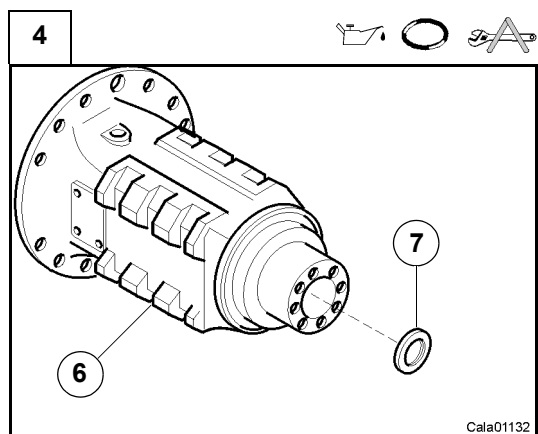
Warning: support the groups properly as already pointed out for disassembly phase.

Assemble the beam trumpet on the central body (1), being careful to the fastening holes alignment.



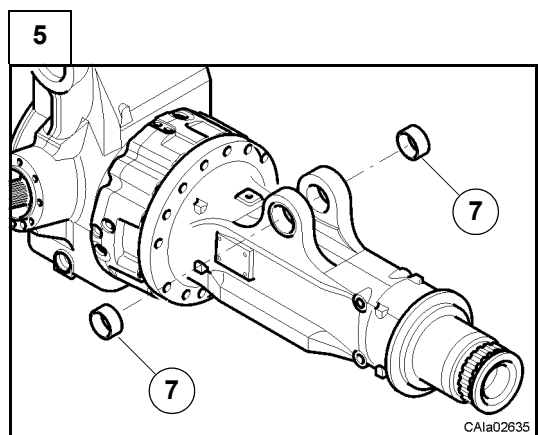
Avvitare il dado (9) e le viti di fissaggio (8) e serrarli alla coppia prevista (Sez.C.6)

Screw in the nut (9) and fastening screws (8) to the requested torque (Sec.C.6).



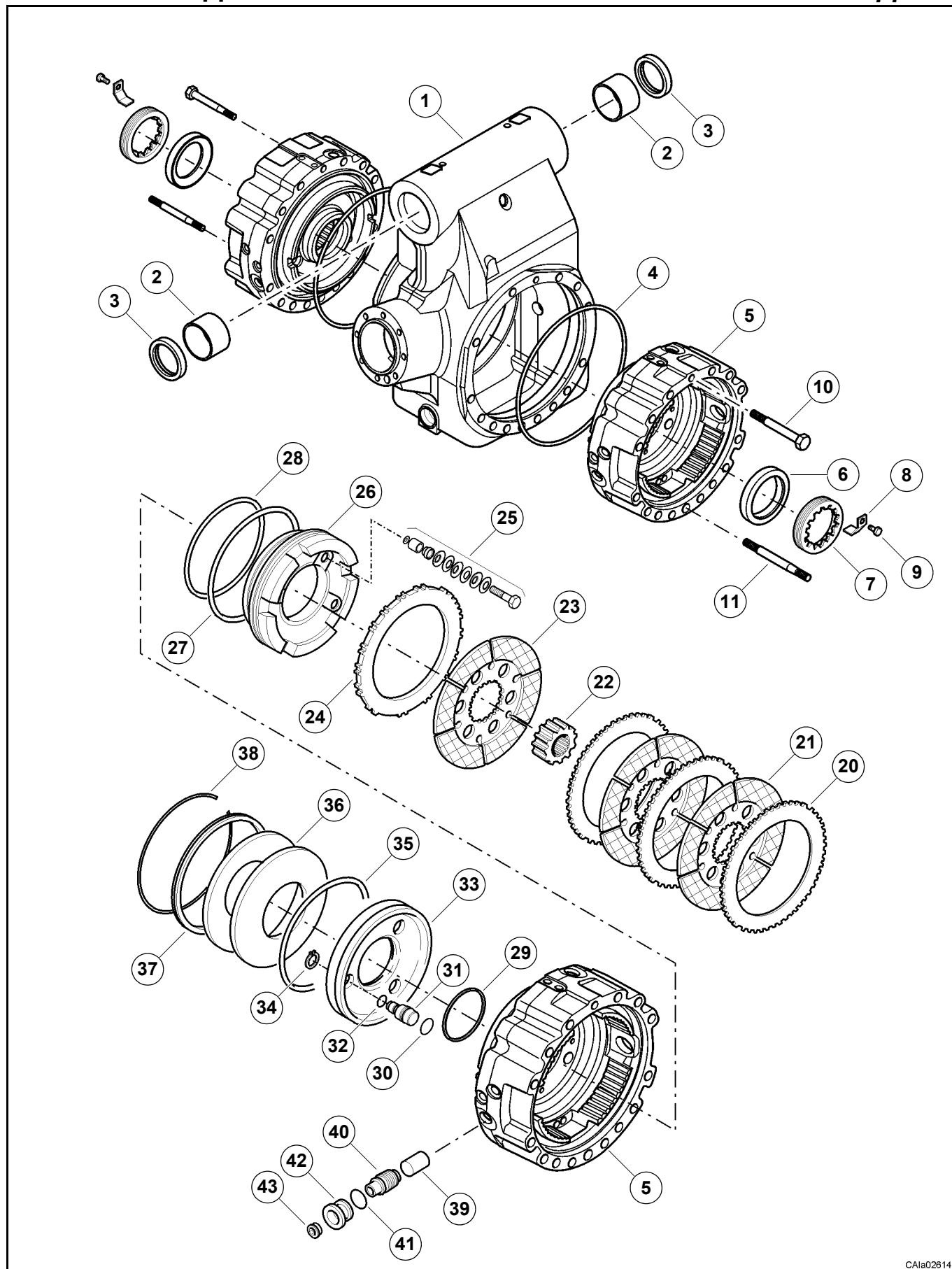
Montare un nuovo anello di tenuta (11) ben lubrificato nella tromba trave (6) con l'attrezzo CA715636 ed un martello.

Assemble a new well lubricate seal ring (11) in the beam trumpet (6) using the special tool CA715636 and a hammer.



Inserire le boccole (7) nella tromba trave (6) con l'attrezzo CA715635 ed un martello.

Assemble the bushes (7) to the beam trumpet (6) with the special tool CA715635 and a hammer.

D.5 Freno e supporto differenziale**D.5 Brake and differential support**

CAIa02614

D.5.1 Smontaggio

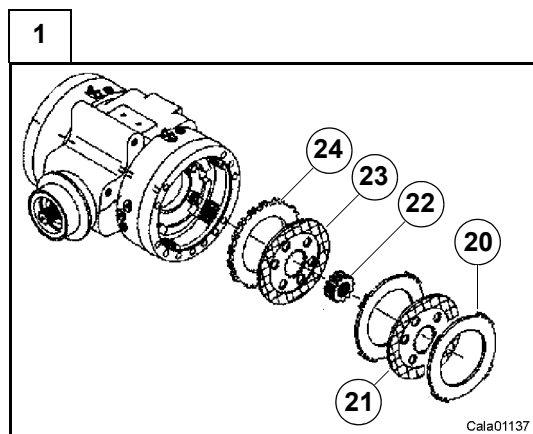
Alcune figure che seguono potrebbero non mostrare esattamente il vostro assale, ma la procedura rimane la stessa.

Nota: per lo smontaggio del gruppo freno e supporto differenziale vedi prima le procedure descritte alla sezione D.4.

D.5.1 Disassembly

Some of the following pictures may not show exactly your axle, but the process is the same.

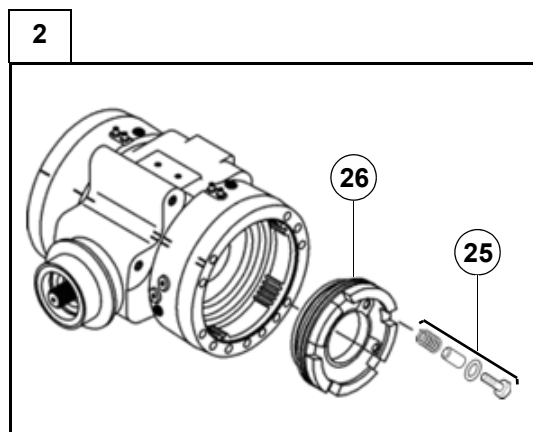
Note: before disassemble the brake and differential support group see the procedure described in the section D.4.



Rimuovere i componenti: controdischi freno (20) e dischi freno (21), mozzo traino dischi freno (22), disco freno (23) e controdisco freno (24).
Nota: ricordare la posizione del mozzo scanalato per il montaggio.

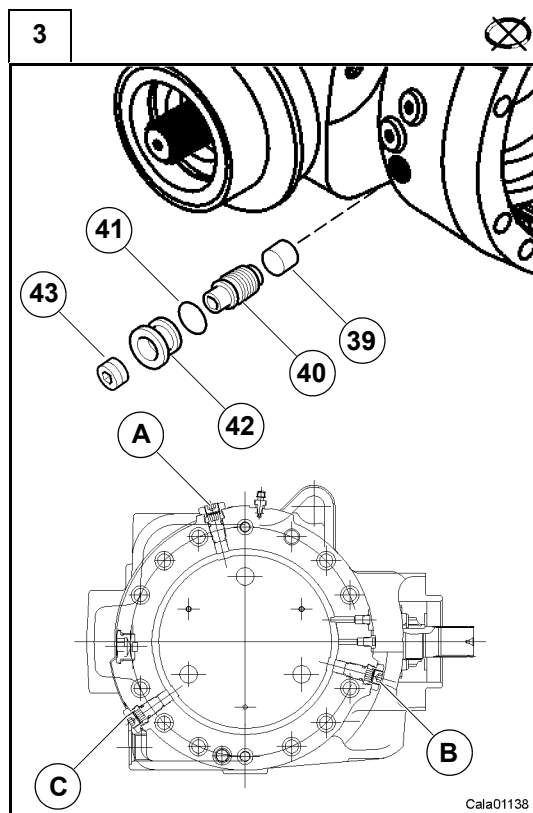
Remove the components: brake counter plates (20) and brake plates (21), brake disk carrier (22), brake plate (23) and brake counter plate (24).

Note: remember the position of the the splined disk carrier, it must be reassembled in the same position.



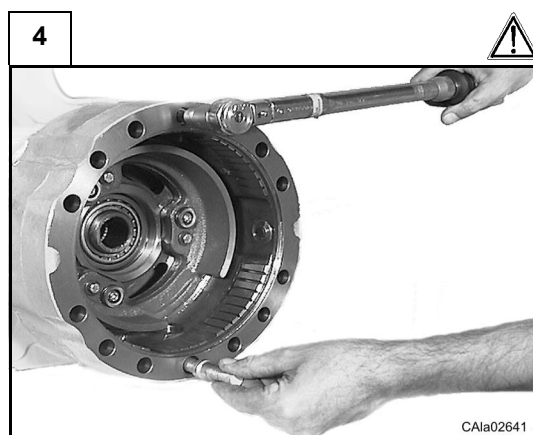
Svitare e togliere le viti del kit self-adjust (25) recuperandone tutti i componenti.
Recuperare il pistone freno positivo (26).

*Unscrew and remove the self-adjust kit's (25) screw and collect all the components.
Collect the brake piston positive (26).*



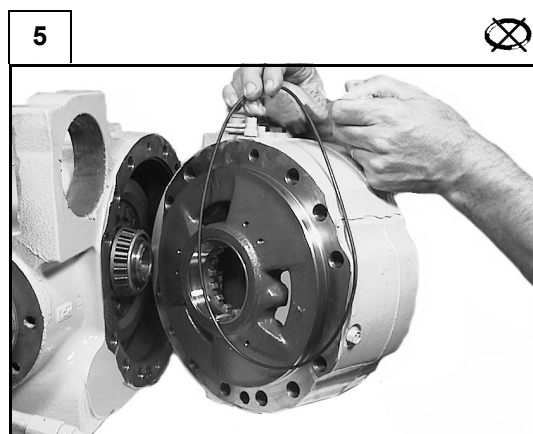
Togliere i tappi (43) e svitare completamente le viti (42) dalle viti freno parcheggio (A, B e C).
Svitare alternativamente le viti (40) fino a rimuoverle completamente.
Recuperare gli anelli OR (41) ed i perni (39).

*Remove the plugs (43) and unscrew completely the screws (42) from the parking brake screws (A, B and C).
Unscrew alternately the screw (40) until they are completely removed.
Collect the O-Rings (41) and the pins (39).*



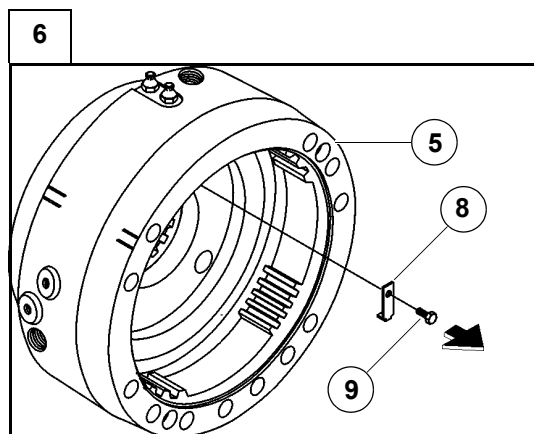
Assicurare il cilindro freno (5) ad un paranco con funi o cinghie di sicurezza.
Svitare e togliere il prigioniero (11) e la vite di fissaggio (10).
Attenzione: questa operazione libera la scatola differenziale.

*Secure the brake cylinder (5) to a hoist with ropes or safety belts.
Unscrew and remove the fastening stud bolt (11) and screw (10).
Warning: the differential box is free.*



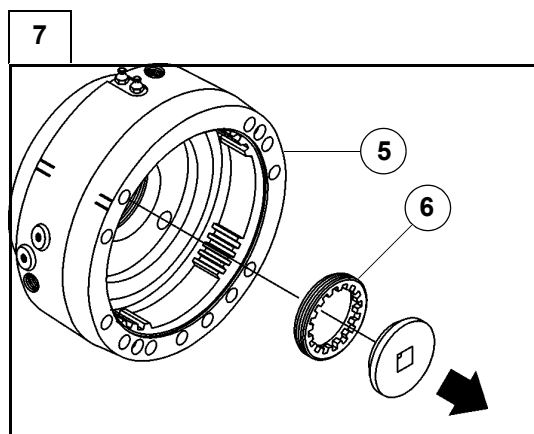
Recuperare l'anello OR (4) dal cilindro freno (5).

Collect the O-Ring (4) from the brake cylinder (5).



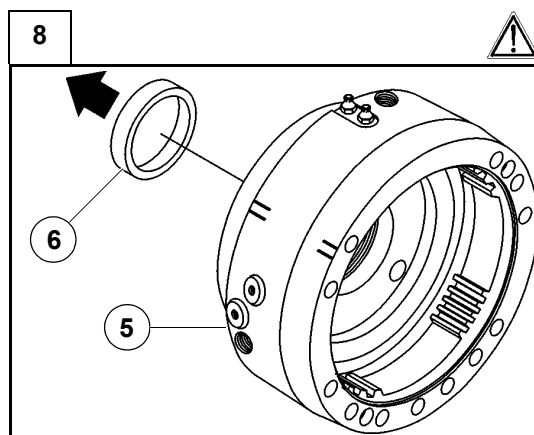
Svitare e togliere la vite (9) ed il fermo ghiera (8) dal cilindro freno (5).

Unscrew and remove the screw (9) and the ring nut retainer (8) from the brake cylinder (5).



Svitare e togliere la ghiera (7) dal cilindro freno (5) con l'attrezzo CA119030.

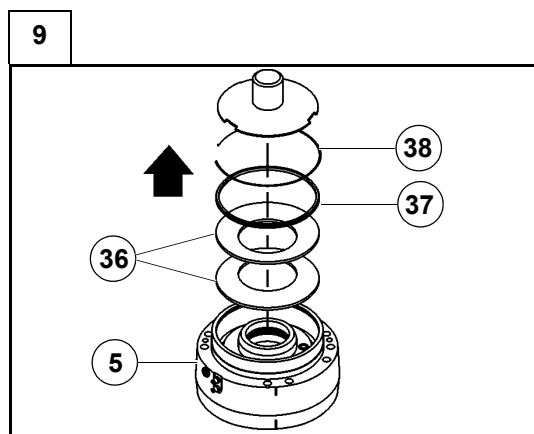
Unscrew and remove the adjuster ring nut (7) from the brake cylinder (5) with the tool CA119030.



Estrarre la coppa del cuscinetto (6) dal cilindro freno (5) con un battitoio.

Attenzione: non invertire le coppe dei cuscinetti se non vengono sostituiti.

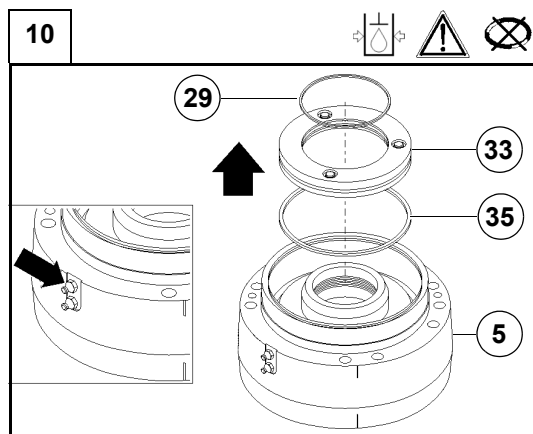
*Use a driver to remove the bearing cup (6) from the brake cylinder (5).
Warning: do not mismatch the bearings cup if they are not going to be replaced.*



Posizionare il cilindro freno (5) sotto l'azione di una pressa e con l'ausilio dell'attrezzo CA715056 togliere l'anello d'arresto (38).

Eseguire un rilascio della spinta della pressa lento e graduale, recuperare quindi il manicotto (37) e le molle a tazza (36).

*Position the brake cylinder (5) under a press and with the tool CA715056 remove the snap ring (38).
Release the load of the press slowly and gradually, then collect the sleeve (37) and the Belleville washers (36).*



Per l'estrazione del pistone freno negativo (33) utilizzare il foro di mandata del freno applicando la minima pressione d'olio o aria necessaria per l'espulsione.

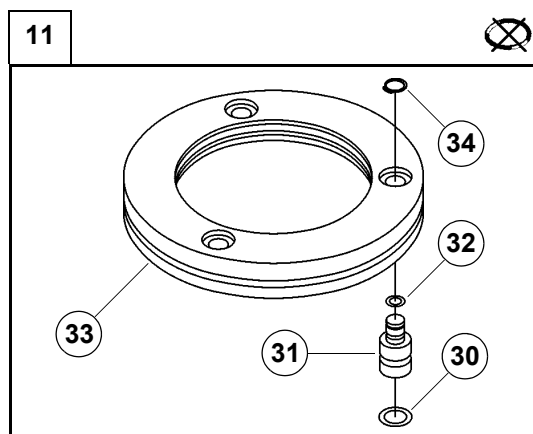
Attenzione: questa operazione deve essere condotta con la massima cautela.

Recuperare gli anelli OR (29) e (35) dal pistone freno negativo.

In order to extract the negative brake piston (33) use the hydraulic connection applying the lowest oil or air pressure necessary to dislodge the piston.

Warning: this operation must be performed with extreme care.

Collect the O-Rings (29) and (35) from the negative brake piston.

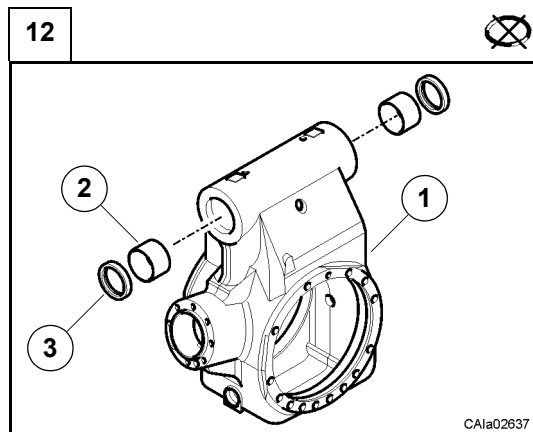


Togliere l'anello d'arresto (34) dal pistone freno negativo (33) ed estrarre il perno di spinta (31).

Recuperare gli anelli OR (30) e (32) dal perno di spinta.

Remove the snap ring (34) from the negative brake piston (33) and extract the thrust pin (31).

Collect the O-Rings (30) and (32) from the thrust pin.



Estrarre l'anello di tenuta (3) dal corpo centrale (1) con una leva.

Nota: è un'operazione distruttiva per gli anelli di tenuta.

Rimuovere le boccole (2).

Take the seal ring (3) out of the central body (1) with a lever.

Note: this is a destructive operation for the seal rings.

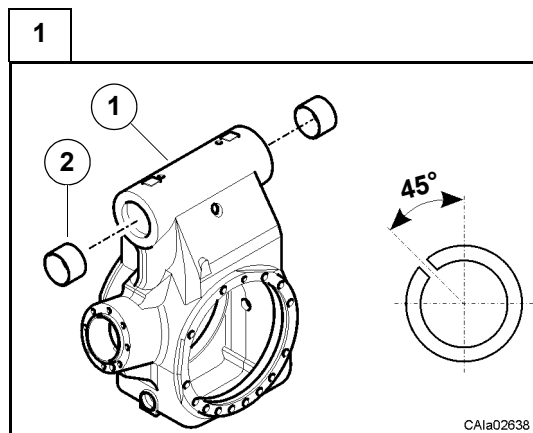
Remove the bushes (2).

D.5.2 Montaggio

Alcune figure che seguono potrebbero non mostrare esattamente il vostro assale, ma la procedura rimane la stessa.

D.5.2 Assembly

Some of the following pictures may not show exactly your axle, but the process is the same.

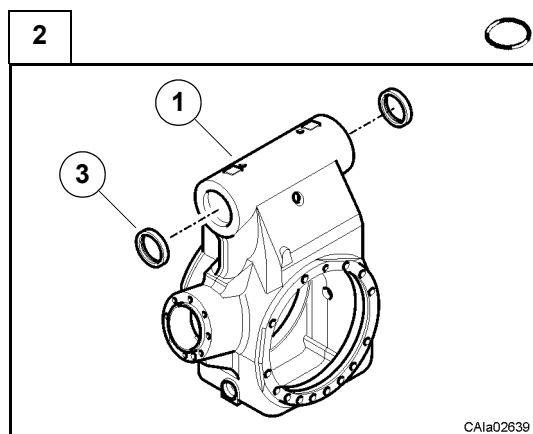


Assemblare le boccole (2) al corpo centrale (1) utilizzando l'attrezzo speciale CA715634 ed un martello.

Nota: rispettare la posizione indicata.

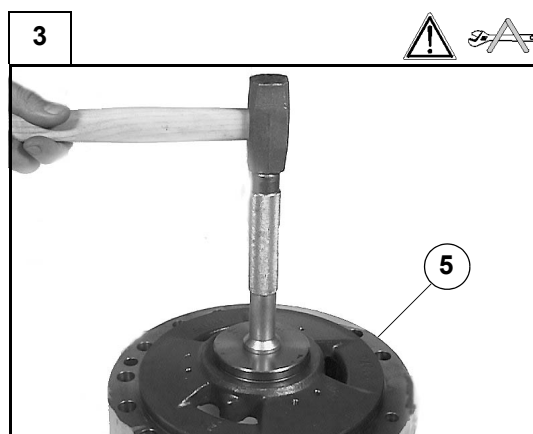
Assemble the bushes (2) to the central body (1) with the special tool CA715634 and a hammer.

Note: position the bushes as shown.



Assemblare l'anello di tenuta (3) al corpo centrale (1) con l'attrezzo speciale CA715181 ed un martello.

Assemble the seal ring (3) to the central body (6) with the special tool CA715181 and a hammer.

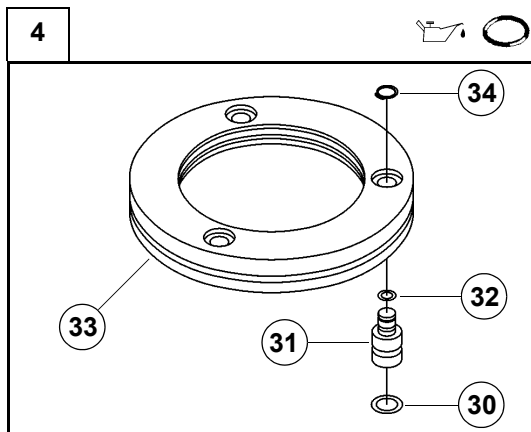


Posizionare il cilindro freno (5) su di una superficie piana e piantare la coppa (6) del cuscinetto con il battitoio CA715583.

Attenzione: non invertire le coppe dei cuscinetti se non vengono sostituiti.

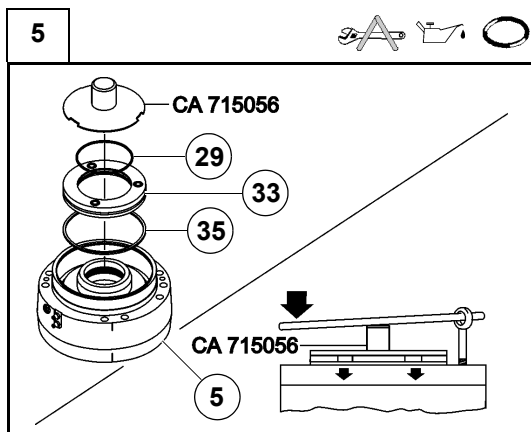
Position the brake cylinder (5) on a flat surface and force the bearing cup (6) using the special tool CA715583.

Warning: do not mismatch the bearings cup if they are not going to be replaced.



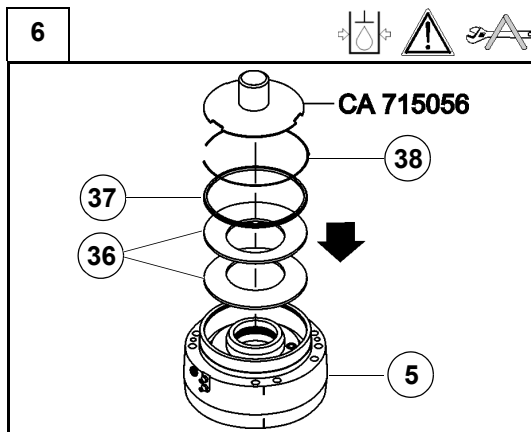
Montare nuovi anelli OR (30) e (32) ben lubrificati nei perni di spinta (31).
Inserire i perni di spinta nel pistone freno negativo (33) e bloccarli con gli anelli d'arresto (34).

*Assemble new well lubricated O-Rings (30) and (32) to the thrust pins (31).
Insert the thrust pins into the negative brake piston (33) and lock them with the snap rings (34).*



Montare nuovi anelli OR (29) e (35) ben lubrificati nel pistone freno negativo (33).
Inserire il pistone freno negativo nel cilindro freno (5) utilizzando l'attrezzo CA715056 ed una leva come illustrato in figura.

*Assemble new well lubricated O-Rings (29) and (35) to the negative brake piston (33).
Insert the negative brake piston into the brake cylinder (5) using the tool CA715056 and a lever as is shown in figure.*

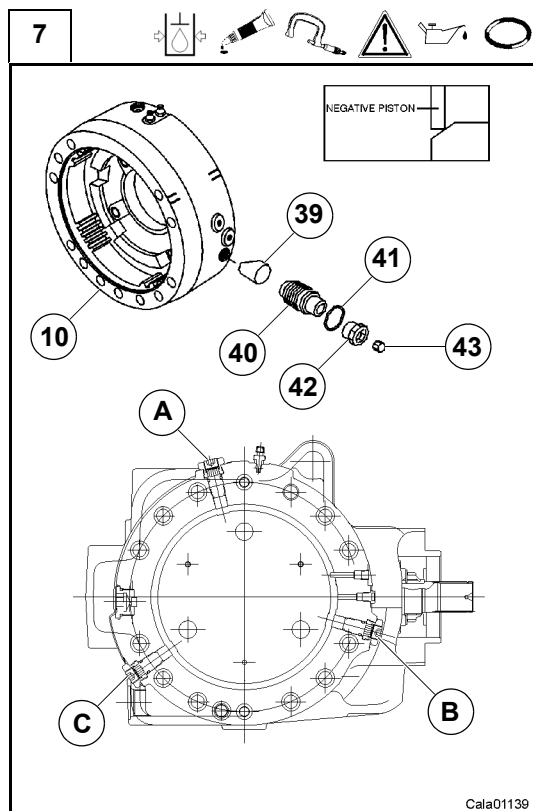


Posizionare le molle a tazza (36) ben centrate, in modo che l'ultima sia concava, il manicotto (37) con la sede per l'anello d'arresto (38) verso l'esterno, e l'attrezzo CA715056 nel cilindro freno (5).
Sotto l'azione di una pressa esercitare una spinta tale da poter montare l'anello d'arresto (38).

Pericolo: possibile rapida espulsione delle molle a tazza.
Utilizzando la pressa come protezione di sicurezza, allontanare con cautela e solo di pochi millimetri l'attrezzo CA715056 dalle molle a tazza. Applicare olio alla pressione di circa 20 bar alla mandata olio freno e far compiere almeno tre corse di lavoro al pistone freno (5) verificandone la tenuta idraulica degli anelli OR ed il corretto inserimento dell'anello d'arresto (38).

*Position the belleville washer (36) well matched, with the last disc on top must be concave side up, the sleeve (37) with the snap ring seat outermost, and the tool CA715056 into the brake cylinder.
Using a press, apply a pressure on the entire assembly until the snap ring (38) can be fitted.*

Danger: it is possible a rapid ejection of the belleville washer.
Using the press as safety protection, move away with caution and only for few millimetres the special tool CA715056 from the belleville washer. Apply an oil pressure of about 20 bar through the hydraulic connection, in order to do at least three stroke of the brake piston (8) and check the tightness of the O-Rings and the correct insertion of the snap ring (38).



Montare nuovi anelli OR (41) ben lubrificati nelle viti (42).

Montare i perni (39) e le viti (40) al cilindro freno (5) nelle posizioni **A**, **B** e **C**.

Attraverso la mandata applicare una pressione d'olio di circa 20 bar nel cilindro freno ed avvitare le tre viti (40) fino al contatto con il pistone freno negativo (33).

Attenzione: il piano inclinato dei perni (39) deve appoggiarsi contro il pistone freno negativo (33), come indicato in figura.

Completare l'operazione chiudendo con un ulteriore quarto di giro le tre viti (40).

Applicare sigillante (A3) sotto la testa delle viti (42) (Sez.C.4).

Tolta la pressione, completare l'operazione di assemblaggio avvitando le viti (42) ed i tappi (43) alle coppie previste (Sez.C.6).

Assemble new well lubricated O-Ring (41) to the screws (42).

*Assemble the pins (39) and the screws (40) into the brake cylinder (5) to the positions **A**, **B** and **C**.*

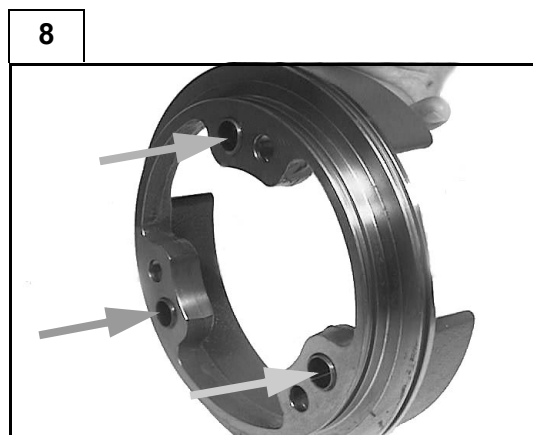
Apply an oil pressure of about 20 bar through the hydraulic connection of the brake cylinder and screw the three screws (40) till to touch the negative brake piston (33).

Warning: the pin's ramp (39) must seat against the negative brake piston (33), as is shown in figure.

Carry out the adjustment tightening the three screws (40) a further of quarter turn.

Apply sealant (A3) under the screw heads (42) (Sec.C.4).

Drop the oil pressure and complete the assembly screwing and tightening the screws (42) and the plugs (43) to the prescribed torques (Sec.C.6).



Recuperare il pistone freno (26).

Spingere le boccole nelle sedi dei self-adjust con l'attrezzo CA715033 ed un martello, fino a pareggiarle con la superficie interna di appoggio del pistone.

Collect the brake piston (26).

With special tool CA715033 and a hammer, push the washers into the self-adjust housings till they are aligned with the piston supporting inner surface.

9



Inserire il pistone (26) nel cilindro freno (5) e posizionare l'attrezzo cod. CA715056 o un disco piano sul pistone.

Nota: posizionare il pistone freno positivo (26) con una cava in corrispondenza al foro di ricircolo olio del cilindro freno (5).

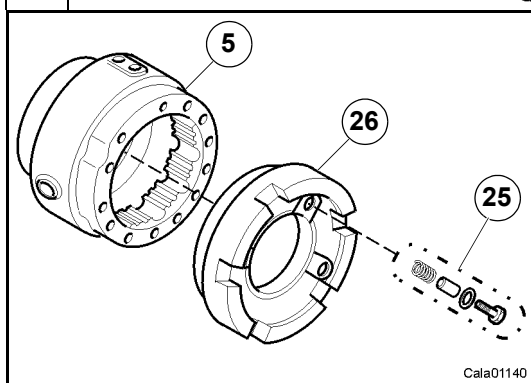
Con una leva ben ancorata, magari ad un golfare, esercitare una pressione appena sufficiente ad inserire il pistone nella flangia freno.

Insert the piston (26) into the brake cylinder (5) and position the special tool code CA715056 or a flat disk on the piston.

Note: position the positive brake piston (26) with a slot aligned with the hydraulic connection on the brake cylinder (5).

With a lever anchored to an eyebolt, exert a pressure just enough to insert the piston into the brake flange.

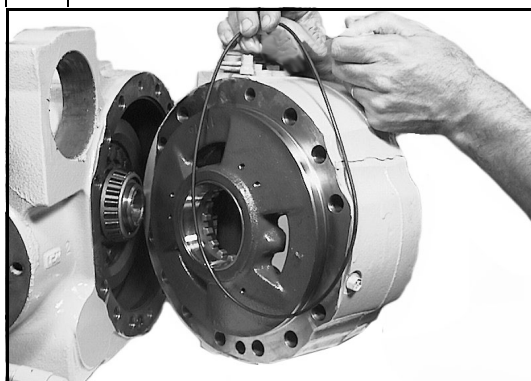
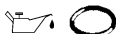
10



Montare i componenti del kit self-adjust (25) e serrare le viti alla coppia prevista (Sez. C.6).

Assemble the self-adjust kit (25) and tighten the screws to the prescribed torque (Sec. C.6).

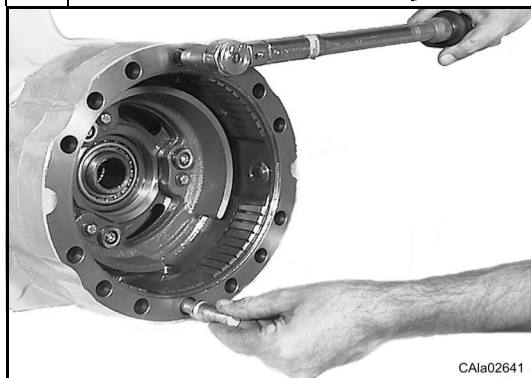
11



Montare un nuovo anello OR (4) ben lubrificato nella sede del cilindro freno (5).

Assemble a new well lubricated O-Ring (4) on the brake cylinder (5) housing.

12



Montare il cilindro freno (5) sinistro sul corpo centrale (1). Serrare il prigioniero (11) e la vite (10) di fissaggio alla coppia prevista (Sez.C.6).

Nota: verificare che i segni di riferimento fatti allo smontaggio tra il cilindro freno (5) ed il corpo centrale (1) coincidano.

Assemble the left brake cylinder (5) on the central body (1). Tighten the fastening stud bolt (11) and screw (10) to the requested torque (Sec.C.6).

Note: check that the reference marks made during the disassembly between the left brake cylinder (5) and the central body (1) coincide.

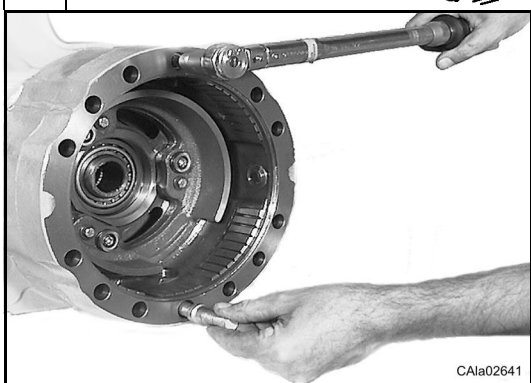
13

Montare la scatola differenziale.

Attenzione: verificare che la corona dentata sia montata dal lato giusto.

Assemble differential housing.

Warning: check the correct assembly side of the bevel gear.

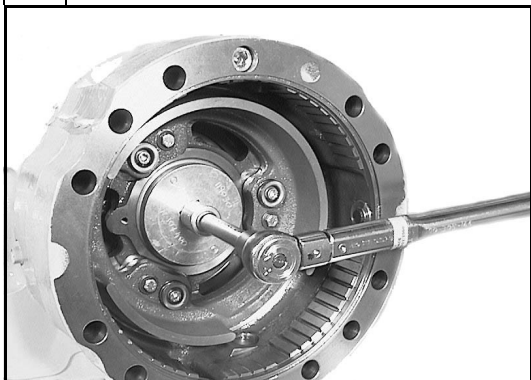
14

Montare il cilindro freno (5) destro sul corpo centrale (1). Serrare il prigioniero (11) e la vite (10) di fissaggio alla coppia prevista (Sez. C.6).

Nota: verificare che i segni di riferimento fatti allo smontaggio tra il cilindro freno (5) destro ed il corpo centrale (1) coincidano.

Assemble the right brake cylinder (5) on the central body (1). Tighten the fastening stud bolt (11) and screw (10) to the requested torque (Sec. C.6).

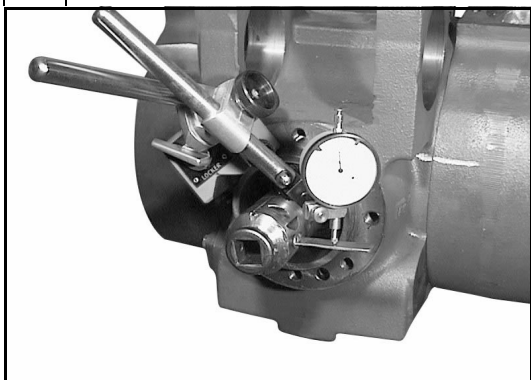
Note: check that the reference marks made during the disassembly between the right brake cylinder (5) and the central body (1) coincide.

15

Avvitare entrambe le ghiere di registrazione (7) utilizzando l'attrezzo CA119030 fino ad eliminare il gioco e precaricare leggermente i cuscinetti del differenziale.

Screw both adjuster ring nuts (7) using the tool CA119030 till the backlash is eliminated and the differential bearings are slightly preloaded.

16



Montare l'attrezzo CA715146 sul codolo del pignone.

Muovere il codolo del pignone alternativamente ed annotare il gioco fra pignone e corona, rilevato con un comparatore, in modo che il tastatore sia a contatto ed a 90° con la superficie della staffa dell'attrezzo CA715146 in corrispondenza della tacca di riferimento.

Verificare se il valore del gioco rilevato rientra nel campo predefinito:

0.15÷0.25 mm

Effettuare la registrazione agendo sulle due ghiera di registrazione (7) con l'attrezzo CA119030.

Assemble the tool CA715146 on the pinion end.

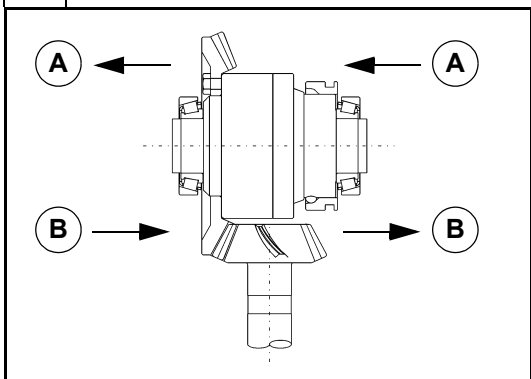
Move the pinion end alternatively and note the pinion-ring gear backlash, measured with a comparator, so that the feeler stylus is in contact and at 90° with the bracket surface of the tool CA715146 in correspondance to the reference mark.

Check if the measured backlash value is within the requested range:

0.15÷0.25 mm

Carry out the adjustment by operating on the two adjuster ring nuts (7) with the tool CA119030.

17



Registrazione le ghiera (7) ricordando che:

- se il **gioco rilevato è inferiore** al campo di tolleranza dato, avvitare la ghiera dal lato opposto alla corona e svitare la ghiera opposta della stessa quantità (A);

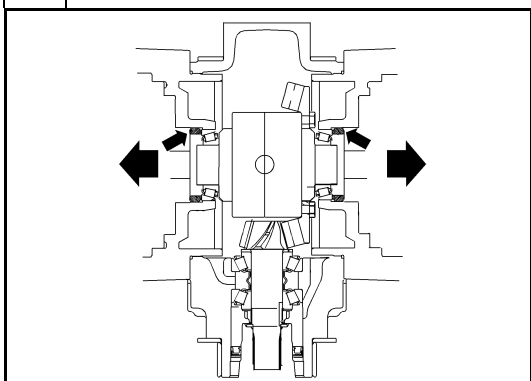
- se il **gioco rilevato è superiore** al campo di tolleranza dato, avvitare la ghiera dal lato della corona e svitare la ghiera opposta della stessa quantità (B).

Adjust the ring nuts (7), remembering that:

- if **the measured backlash is less** than the given tolerance range, screw the ring nut from the side opposite to the ring gear and unscrew the opposite one of the same measure (A);

- if **the measured backlash is greater** than the given tolerance range, screw the ring nut from the side of the ring gear and unscrew the opposite one of the same measure (B).

18



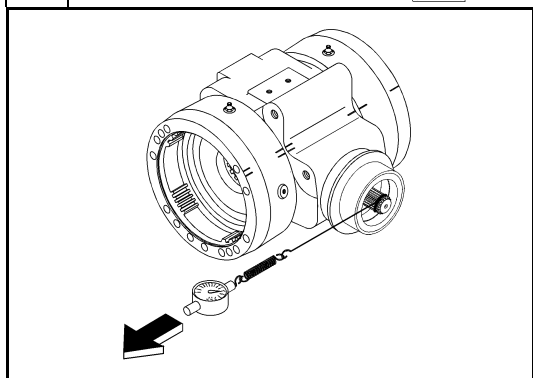
Effettuata la registrazione del gioco pignone-corona verificare anche che ci sia un minimo di precarico sui cuscinetti della scatola differenziale

Ripetere l'intera sequenza delle operazioni citate fino al raggiungimento delle condizioni indicate.

Once the adjustment of the pinion-bevel gear backlash has been carried out, check also that there is a minimum preloading on the differential housing bearings.

Repeat the whole sequence of the above mentioned operations till the indicated conditions are reached.

19



Stabilito il gioco pignone-corona, misurare il precarico totale **T** dei cuscinetti (sistema pignone-corona), utilizzando un dinamometro con la corda avvolta sul codolo scanalato del pignone. Il valore misurato deve rientrare nel seguente campo:

$$T = (P + 1.9) \div (P + 2.9) \text{ daN}$$

dove **P** è il precarico effettivo misurato sul pignone.

Attenzione: tutti i precarichi vanno misurati senza anelli di tenuta.

Vedi: procedure descritte alla sezione D.7

*Once the pinion-ring gear backlash has been established, measure the total preloading **T** of the bearings (pinion-crown bevel gear system), using a dynamometer whose cord is wound on the pinion splined end. The measured value should be within the following range:*

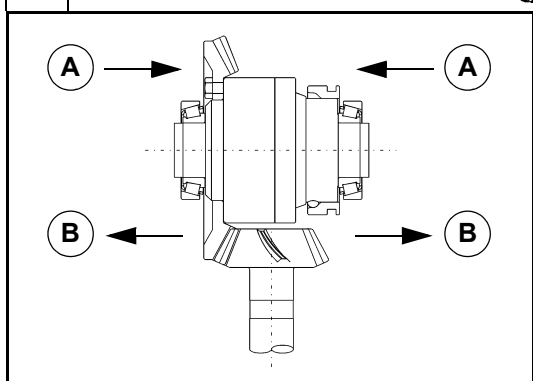
$$T = (P + 1.9) \div (P + 2.9) \text{ daN}$$

where **P** is the effectively measured pinion preloading.

Warning: all the preloadings should be measured without the seal rings.

See: procedure described in the section D.7.

20



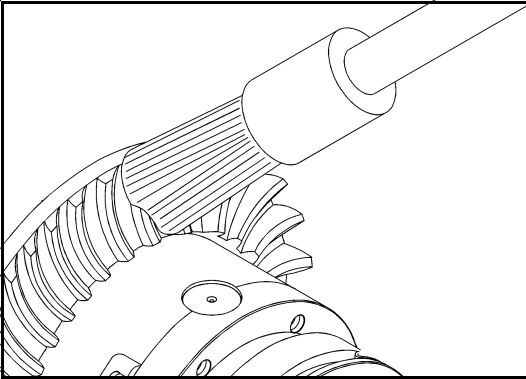
Se la misurazione non rientrasse nel campo prescritto, controllare bene l'assemblaggio di ogni singolo componente ed intervenire sulle ghiere di registrazione (7) del supporto differenziale:

- se il **precarico totale è inferiore** al campo dato, avvitare della stessa quantità le ghiere di registrazione, mantenendo inalterato il valore del gioco pignone-corona (**A**);
- se il **precarico totale è superiore** al campo dato, svitare della stessa quantità le ghiere di registrazione, mantenendo inalterato il valore del gioco pignone-corona (**B**).

If the measurement is not within the requested range, check well the assembly of each component and operate on the adjuster ring nuts (7) of the differential support:

- if the **total preloading is less** than the given range, screw in both adjuster ring nuts by the same measure, keeping the pinion-ring gear backlash value unchanged (**A**);
- if the **total preloading is greater** than the given range, unscrew both adjuster ring nuts by the same measure, keeping the pinion-ring gear backlash value unchanged (**B**).

21

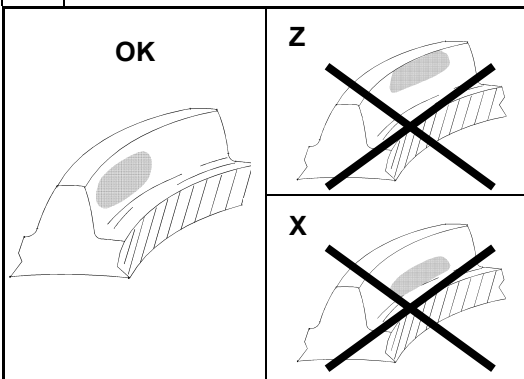
**NOTA**

Per verificare l'impronta di contatto dei denti della coppia conica, sporcare con minio la corona e rilevare il contatto.
L'esame dell'impronta di contatto deve essere eseguito sempre sui denti della corona conica, e su ambedue i fianchi.

NOTE

*To test the marks of the bevel gear teeth, paint the ring gear with red lead paint.
The marking test should be always carried out on the ring bevel gear teeth and on both sides.*

22

**OK -> Contatto corretto:**

Se la registrazione della coppia conica è ben fatta, il contatto delle superfici delle dentature risulterà regolare.

Z -> Eccessivo contatto sulla cresta del dente:

Avvicinare il pignone alla corona ed allontanare poi la corona dal pignone per regolare il gioco.

X -> Eccessivo contatto alla base del dente:

Allontanare il pignone dalla corona ed avvicinare poi la corona al pignone per regolare il gioco.

OK -> Correct contact:

If the bevel gear is well adjusted, the mark on the teeth surfaces will be regular.

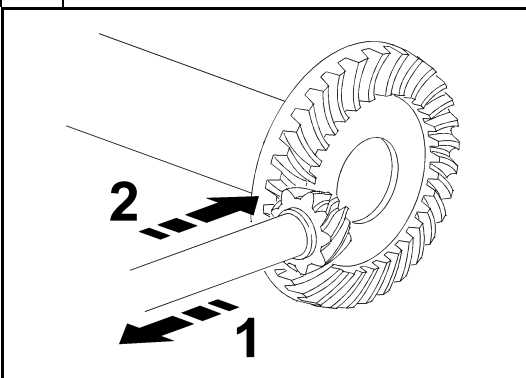
Z -> Excessive contact on the tooth tip:

Approach the pinion to the ring bevel gear and then move the ring bevel gear away from the pinion in order to adjust the backlash.

X -> Excessive contact at the tooth base:

Move the pinion away from the ring bevel gear and then approach the ring bevel gear to the pinion in order to adjust the backlash.

23

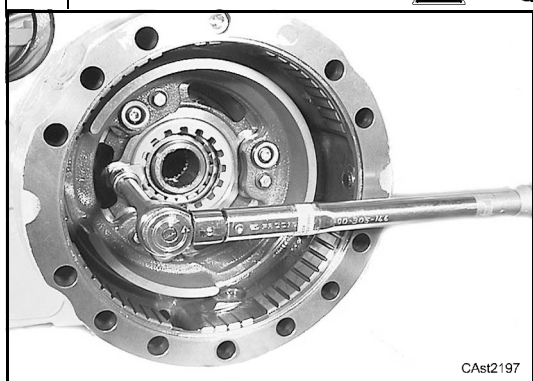
**Spostamenti per le correzioni:**

- 1 -> spostare il pignone per modifica contatto tipo X
- 2 -> spostare il pignone per modifica contatto tipo Z

Movements to correct:

- 1 -> move the pinion for type X contact adjustment
- 2 -> move the pinion for type Z contact adjustment.

24



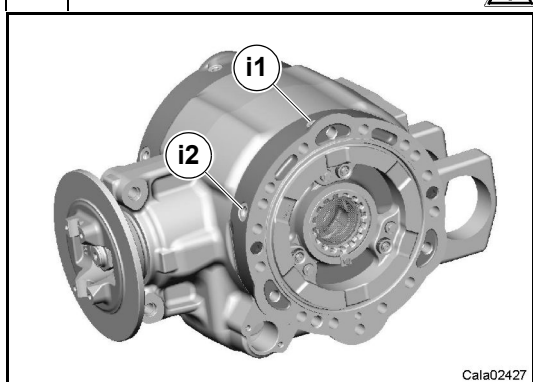
Dopo aver completato tutte le operazioni di registro, montare i fermi ghiera (8) e le rispettive viti (9) serrandole alla coppia prevista (Sez.C.6).

Attenzione: ruotare le ghiera di registrazione (7) il minimo indispensabile per permettere il montaggio.

Once all the adjustment operations have been completed, fit the adjuster ring nut retainers (8) and their respective screws (9), tightening them to the requested torque (Sec.C.6).

Warning: turn the adjuster ring nuts (7) slightly in order to allow the assembly.

25



Rimuovere attacchi, sfiatatoi ed eventuali tappi dagli ingressi olio freni (i1) e (i2).

Vedi: (6) e (7) in sezione C.5

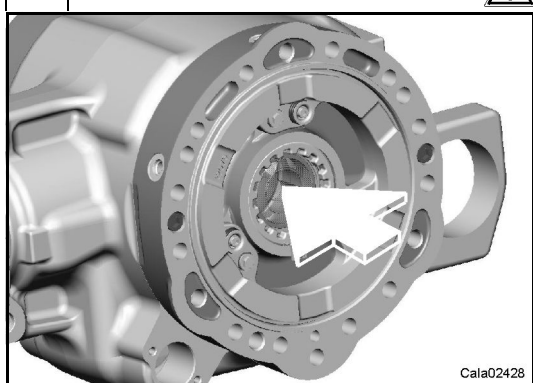
Pericolo: possibile espulsione di olio dall'assale.

Remove straight threads, bleeds or plugs from the service brake oil port (i1) and (i2).

See: (6) and (7) in section C.5

Danger: risk of ejection of oil from the axle.

26



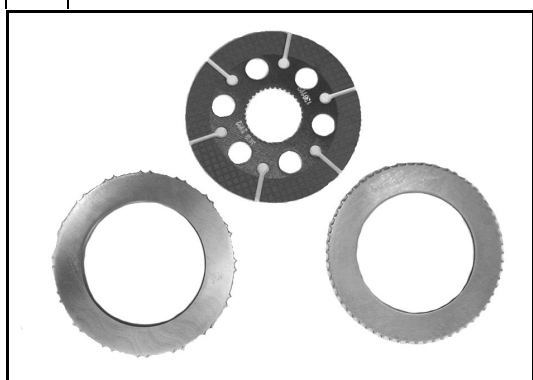
Spingere il pistone (26) del freno in battuta utilizzando il tampone speciale CA715056 con il manico intercambiabile CA119033 ed un martello.

Attenzione: posizionare il tampone con cura per non danneggiare il pistone.

Push the brake piston (26) at the end of stroke using the special pad CA715056 and the handle CA119033 with a hammer.

Warning: position the pad with accuracy to do not damage the brake piston.

27

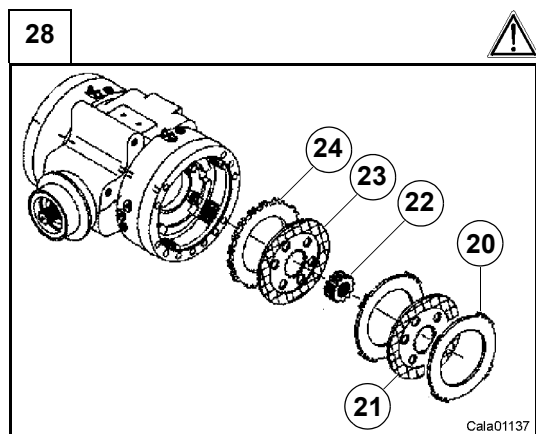


Verificare che i dischi freno (21 e 23) ed i controdismi freno (20 e 24) non presentino tracce di bruciatura; in caso contrario sostituirli. Verificare inoltre l'usura dei dischi freno (Sez.C.4) e sostituirli se necessario.

Nota: se si installano nuovi dischi freno, prima del montaggio immergerli nell'olio prescritto (Sez.C.4).

Check that the brake plate (21 and 23) and the brake drive plate (20 and 24) do not present any sign of burning; on the contrary, replace them. Furthermore check brake plate wear (Sec.C.4) and if necessary replace it.

Note: if new brake plate are installed, before assembling they should be dipped in the prescribed oil (sec.C.4).



Rimontare tutti gli elementi del gruppo freno come indicato in figura: controdisco freno (24) e disco freno (23), mozzo traino dischi freno (29) e controdischi freno (20) e dischi freno (21).

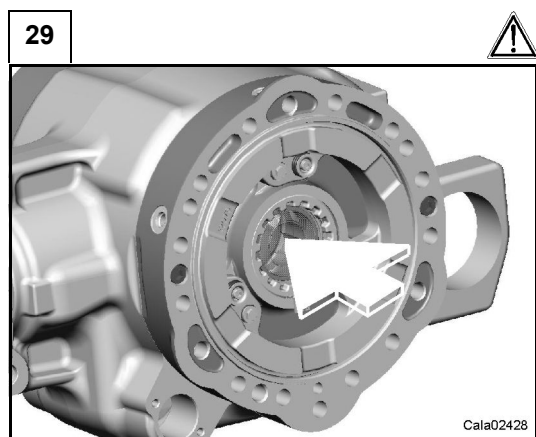
Attenzione: alla corretta posizione del gradino sul diametro esterno del mozzo traino dischi freno (22).

Nota: inserire i dischi freno con i fori allineati.

Reassemble all the components of the brake group as is shown in figure: brake counterplate (24), brake plate (23), brake disk carrier (22), brake counterplates (20) and brake plates (21).

Warning: to the correct position of the step on the external diameter of the brake disk carrier (22).

Note: assemble brake disks with holes aligned.

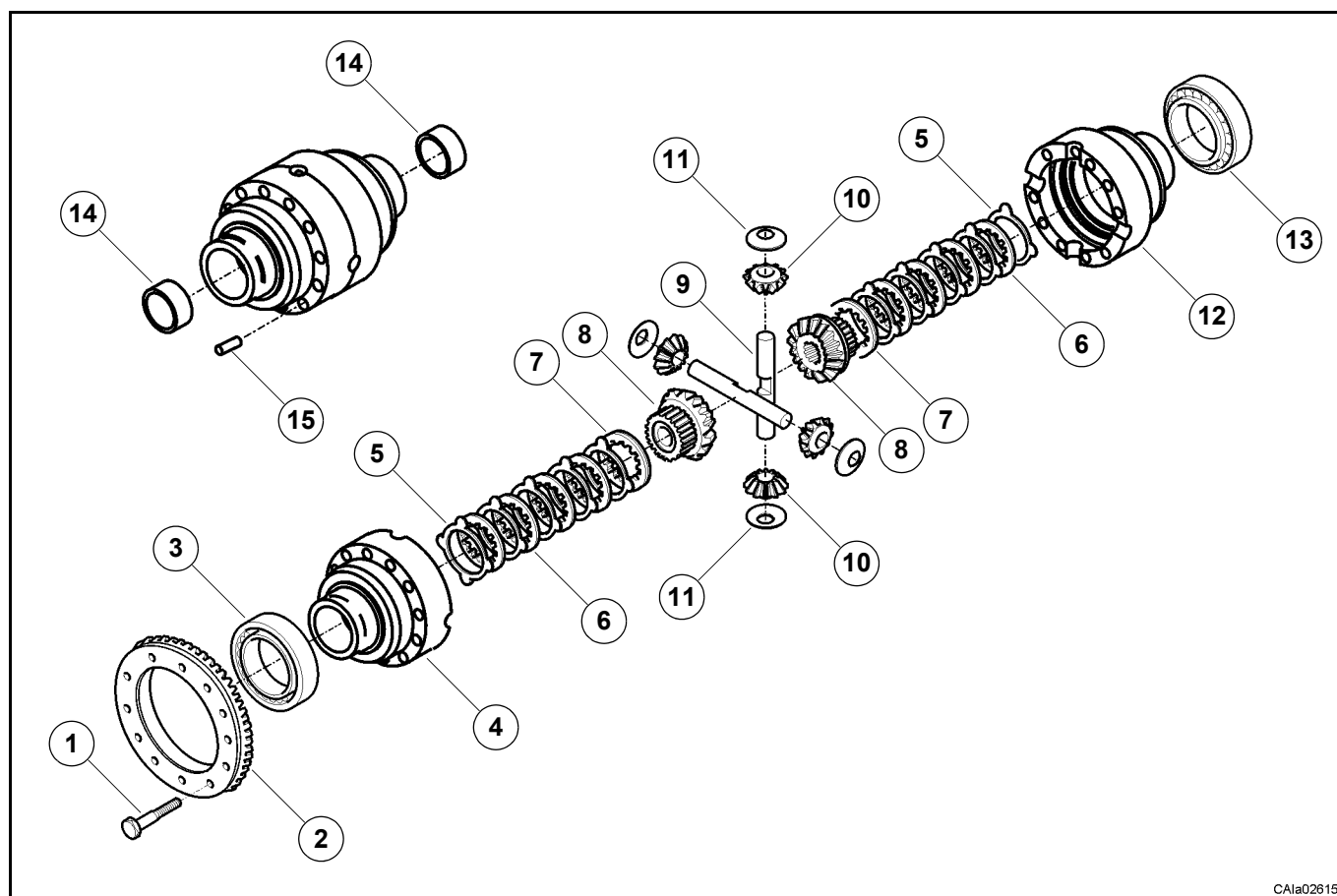


Attenzione: nel caso si sostituiscano solo i dischi freno, spingere il pistone (26) del freno in battuta utilizzando il tampone speciale CA715056 con il manico intercambiabile CA119033 ed un martello.

Nota: posizionare il tampone con cura per non danneggiare il pistone.

Warning: when replace the brake disk only, push the brake piston (26) at the end of stroke using the special pad CA715056 and the handle CA119033 with a hammer.

Note: position the pad with accuracy to do not damage the brake piston.

D.6 Gruppo differenziale**D.6 Differential group**

CAIa02615

D.6.1 Smontaggio

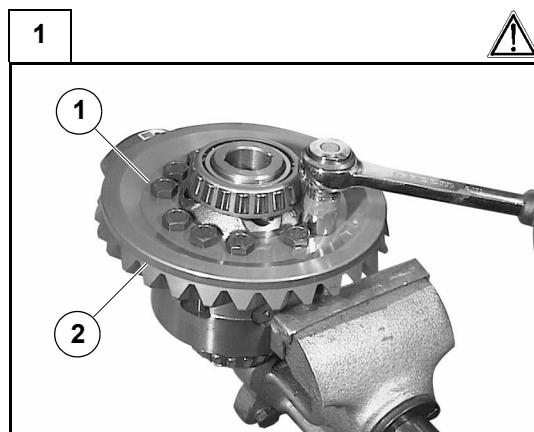
Alcune figure che seguono potrebbero non mostrare esattamente il vostro assale, ma la procedura rimane la stessa.

Nota: per lo smontaggio del gruppo differenziale vedi prima le procedure descritte alla sezione D.5.

D.6.1 Disassembly

Some of the following pictures may not show exactly your axle, but the process is the same.

Note: before disassemble the differential group see the procedure described in the section D.5.



Bloccare il differenziale in una morsa.

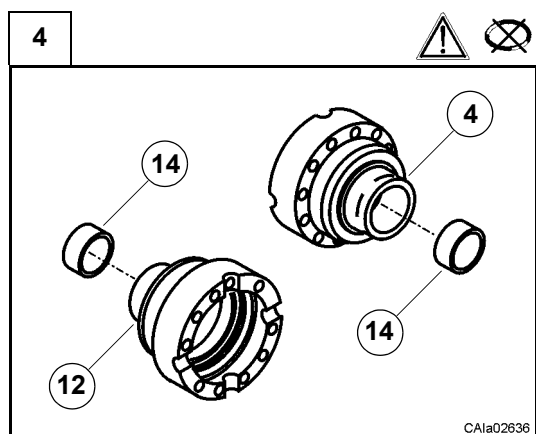
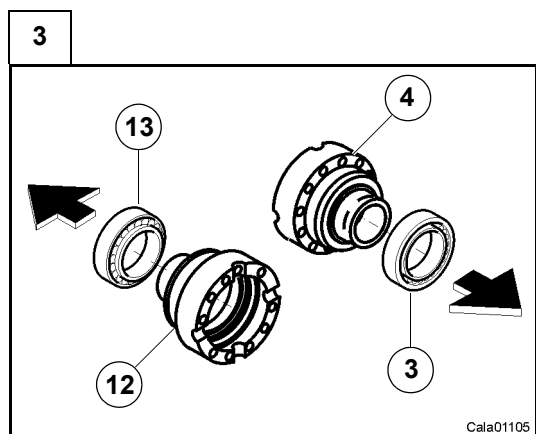
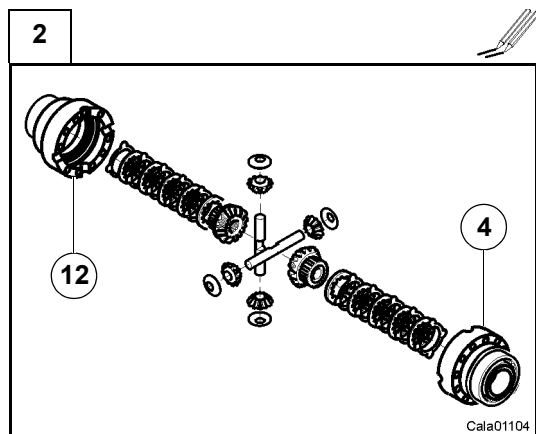
Svitare le viti (1) di fissaggio e rimuovere la corona conica (2).

Attenzione: questa operazione libera anche le due semiscatole differenziale (4) e (12), non disperderne i componenti.

Lock the differential with a clamp.

Unscrew the fastening screws (1) and remove the bevel gear crown (2).

Warning: this will make both differential half boxes (4) and (12) free, so take care not to drop the internal components.

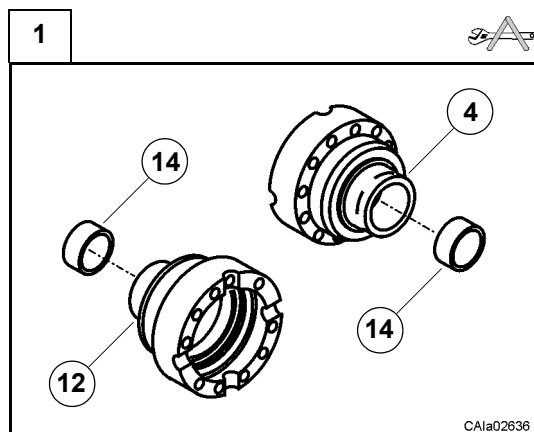


D.6.2 Montaggio

Alcune figure che seguono potrebbero non mostrare esattamente il vostro assale, ma la procedura rimane la stessa.

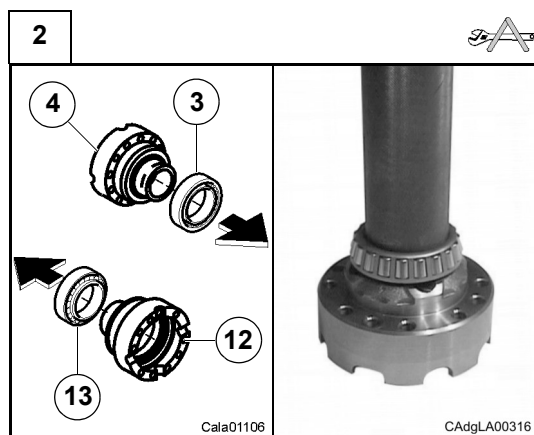
D.6.2 Assembly

Some of the following pictures may not show exactly your axle, but the process is the same.



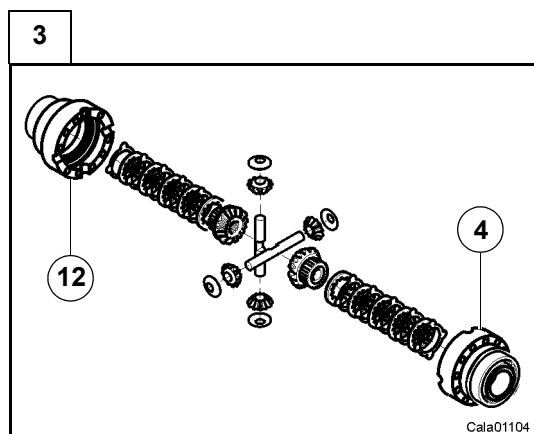
Assemblare le boccole (14) alle semiscatole (4) e (12) con l'attrezzo speciale CA715637 ed un martello.

Assemble the bushes (14) to the half boxes (4) and (12) with the special tool CA715637 and a hammer.



Montare le piste interne dei nuovi cuscinetti a rulli conici (3) e (13) sulle semiscatole (4) e (12), utilizzando il battitoio CA119230 ed un martello.

Assemble the cones of the new taper roller bearings (3) and (13) on the half boxes (4) and (12), using the special tool CA119230 and a hammer.



Posizionare una semiscatola differenziale (4) o (12) sul banco di lavoro ed assemblare con attenzione gli elementi interni (controdismi bloccaggio differenziale (5), dischi bloccaggio differenziale (6) e (7), ingranaggi planetari (8), perni portasatelliti (9), ingranaggi satelliti (10), rondelle di rasamento (11)) come in figura.

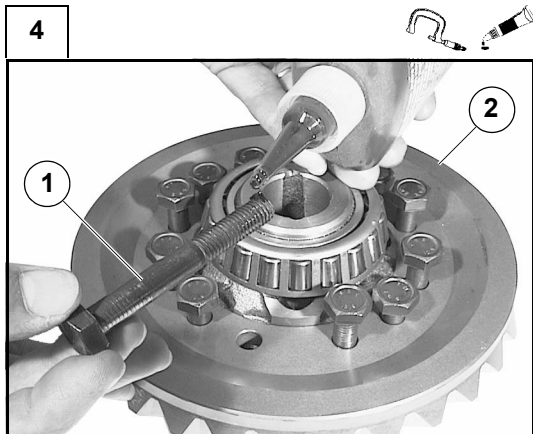
Nota: il primo disco (7) deve essere orientato con il materiale d'attrito verso i dischi e la superficie liscia verso il planetario (8).

Unire le due semiscatole, allineando i riferimenti praticati sulle stesse.

Position a half box (4) or (12) on a workbench and assemble all inner components (locking differential counterdiscs (5), locking differential discs (6) and (7), sun gears (8), spiders (9), spider gears (10), thrust washers (11)), as shown in figure.

Note: the first disk (7) must be assembled with friction material on the disks side and the flat surface on the sun gear (8) side.

Join the two half boxes, aligning the reference marks made upon them.

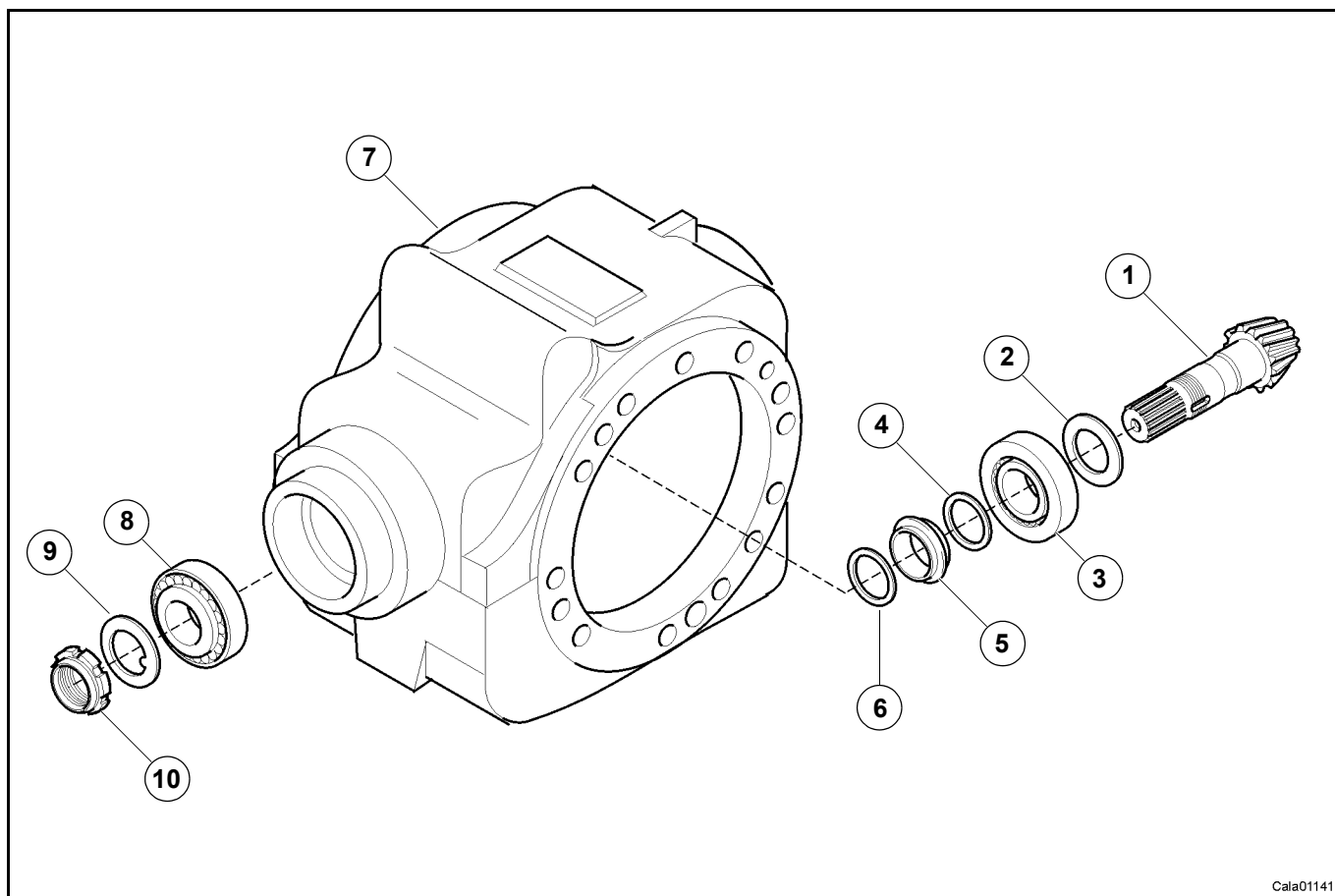


Posizionare la corona conica (2) sulla semiscatola differenziale (4).
Nota: verificare la posizione delle spine di centraggio (15).
Applicare sigillante (B2) sul filetto delle viti (1) (Sez.C.4) e serrarle alla coppia prevista (Sez.C.6).

Position the bevel crown gear (2) on the half box (4).

Note: check dowel pins (15) position.

Apply sealant (B2) on the thread (Sec.C.4) and tighten the screws (1) to the requested torque (Sec.C.6).

D.7 Gruppo pignone**D.7 Pinion group**

Cala01141

D.7.1 Smontaggio

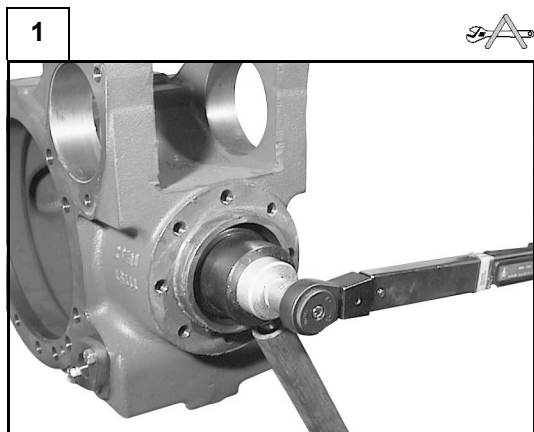
Alcune figure che seguono potrebbero non mostrare esattamente il vostro assale, ma la procedura rimane la stessa.

Nota: per lo smontaggio del gruppo pignone vedi prima le procedure descritte alla sezione D.6

D.7.1 Disassembly

Some of the following pictures may not show exactly your axle, but the process is the same.

Note: before disassemble the pinion group see the procedure described in the section D.6.

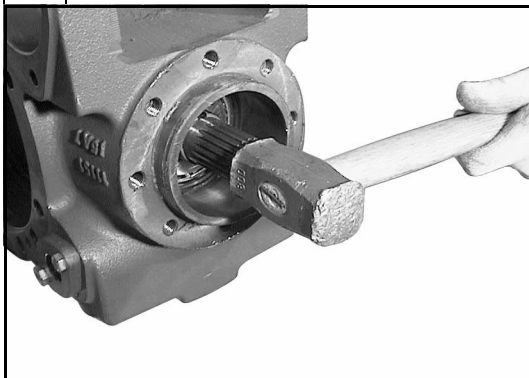


Svitare la ghiera (10) di serraggio utilizzando le attrezzature CA119060 e CA715022.

Nota: operazione distruttiva per la ghiera (10).
Togliere la ghiera e recuperare la rondella fermo ghiera (9).

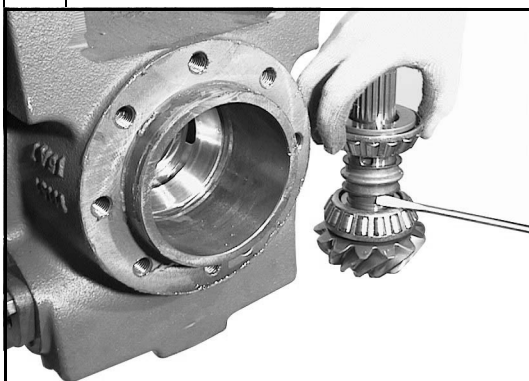
Unscrew the lock nut (10) using special tools CA119060 and CA715022.

Note: this operation will irretrievably damage the lock nut (10).
Remove the lock nut and collect its retaining washer (9).

2

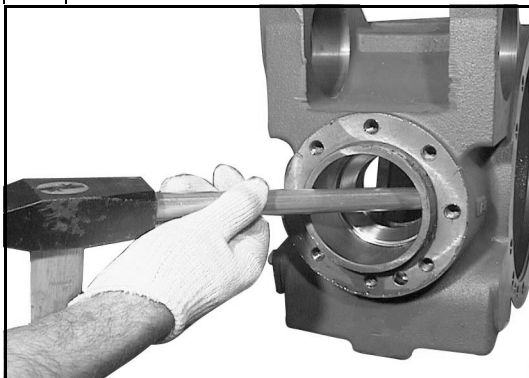
Battere con un martello di materiale tenero sul codolo per sfilare il pignone conico (1).

Tap the end shaft with a soft hammer to remove the bevel pinion (1).

3

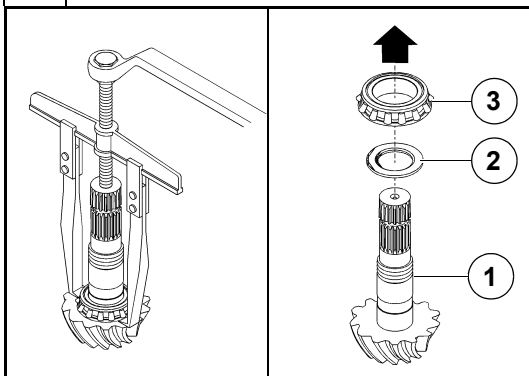
Tolto il pignone conico (1) recuperare le rondelle (4) e (6), il distanziale elastico (5) ed il cono del cuscinetto (8).

Once the bevel pinion (1) has been removed, collect the washers (4) and (6), the collapsible spacer (5) and the bearing cone (8).

4

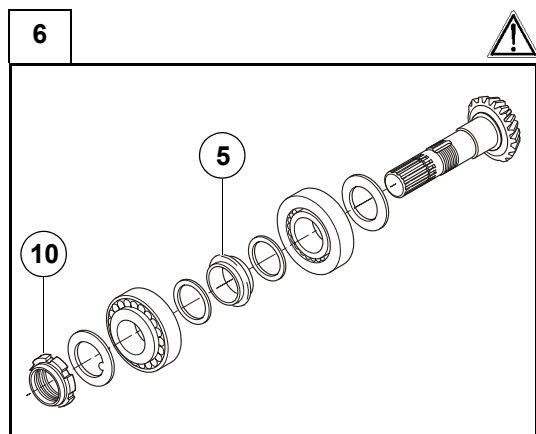
Estrarre le coppe dei cuscinetti a rulli conici (3) e (8) con un battitoio ed un martello.

Remove bearing cups (3) and (8) from central body with a drift and a hammer.

5

Togliere il cono del cuscinetto (3) dal pignone conico (1) utilizzando un estrattore di presa da commercio. Recuperare lo spessore (2) sottostante.

Remove the bearing cone (3) of the bevel pinion (1) with a standard extractor. Collect the shim (2).



Controllare le condizioni di tutti i particolari del pignone.

Attenzione: la ghiera (10) ed il distanziale elastico (5) in fase di rimontaggio devono essere sostituiti.

Check all pinion components for wear.

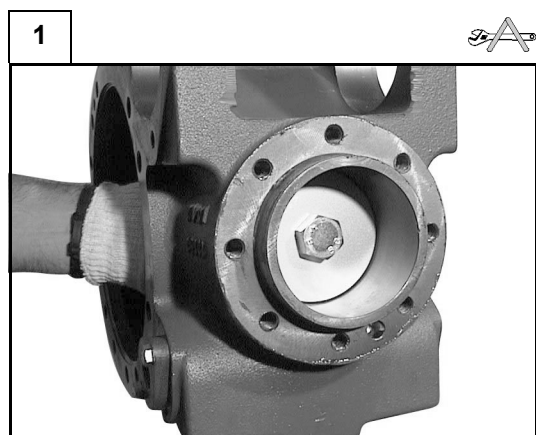
Warning: the ring nut (10) and the collapsible spacer (5) must be replaced when reassembling the unit.

D.7.2 Montaggio

Alcune figure che seguono potrebbero non mostrare esattamente il vostro assale, ma la procedura rimane la stessa.

D.7.2 Assembly

Some of the following pictures may not show exactly your axle, but the process is the same.

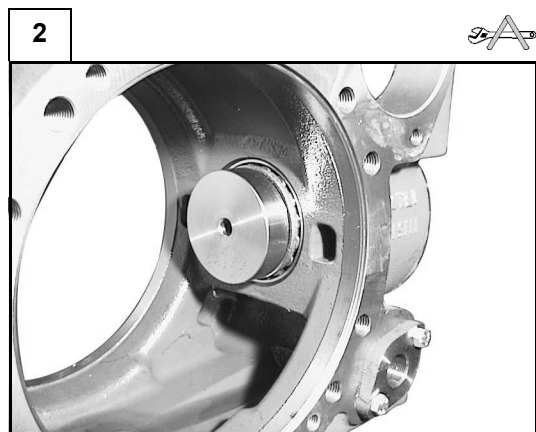


Posizionare su un banco di lavoro il corpo centrale (7).

Piantare le coppe dei cuscinetti (3) e (8) nelle proprie sedi con il kit attrezzature speciali CA715639.

Place the central body (7) on a workbench.

Fit the bearing cups (3) and (8) into their seats using the special tools kit CA715639.

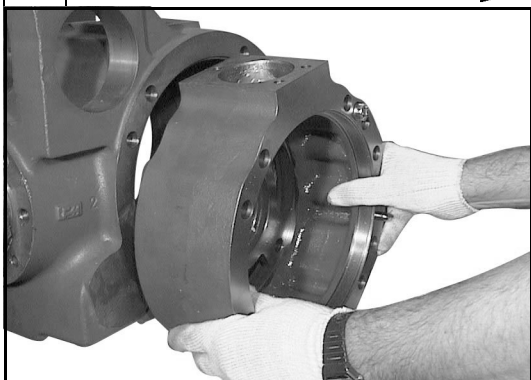


Inserire nelle sedi i coni dei cuscinetti (3) e (8) ed il falso pignone CA715638.

Serrare con la ghiera (10) fino ad eliminare il gioco.

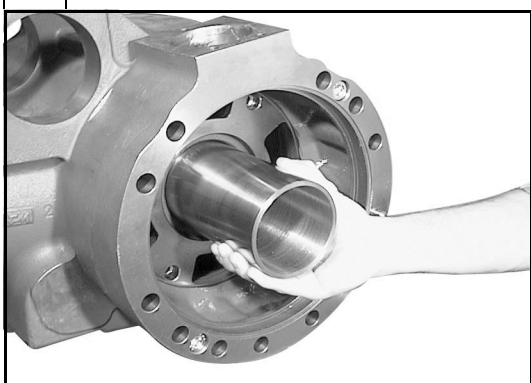
Insert into the seats the bearing cups (3) and (8) and the false pinion CA715638.

Tighten the ring nut (10) to eliminate the backlash.

3

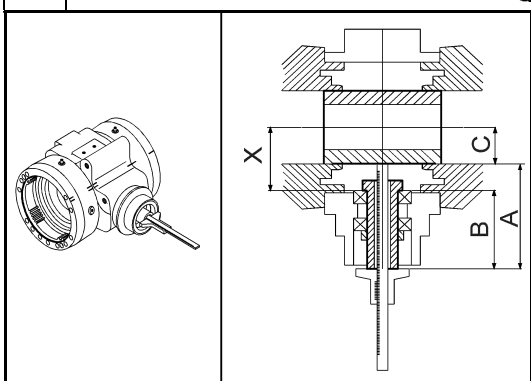
Verificare il corretto posizionamento dei cilindri freno destro e sinistro utilizzando i riferimenti riportati sui medesimi e sul corpo centrale (7). Montare i cilindri freno fissandoli con le rispettive viti (avvitarne almeno due diametralmente opposte per ogni cilindro).

Check the correct positioning of the right and left brake cylinder, using the reference marks on them and on the central body (7). Assemble the brake cylinders and fix them with their screws (screw in at least two ones diametrically-opposed for each cylinder).

4

Introdurre nel corpo centrale (7) la falsa scatola differenziale CA715578. Verificare che la falsa scatola differenziale sia inserita in entrambe le sedi dei cilindri freno.

Insert the false differential box CA715578 into the central body (7). Check that the false differential box is inserted in both brake cylinder's housings.

5

Per registrare la coppia conica misurare con un calibro di profondità la distanza "A".

Determinare il valore "X" come segue:

$$X = (A + C) - B \text{ mm}$$

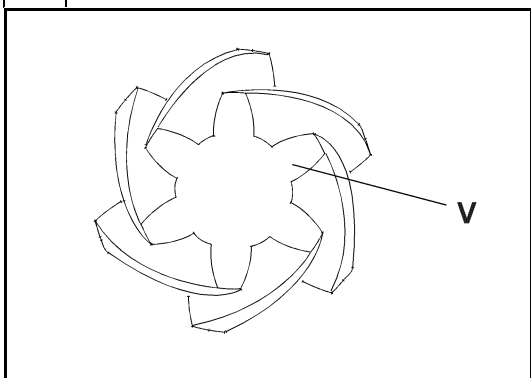
dove "B" e "C" sono valori noti.

To adjust bevel gear/pinion measure the distance "A" with a depth gauge.

Calculate the value "X" as follows:

$$X = (A + C) - B \text{ mm}$$

where "B" and "C" are known.

6

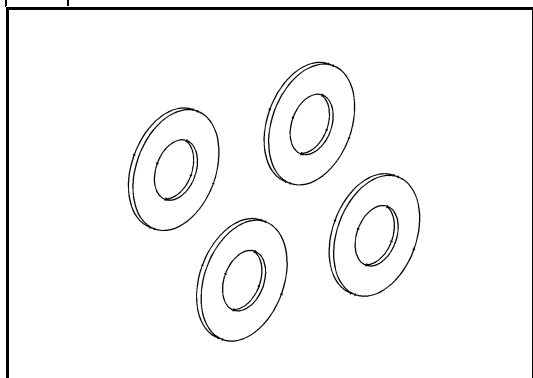
Dal valore "X" sottrarre il valore "V" (stampigliato sulla testa del pignone) per ottenere il valore "S".

$$S = X - V \text{ mm}$$

From the value "X" deduct the value "V" (stamped on the pinion head) to get the value "S".

$$S = X - V \text{ mm}$$

7



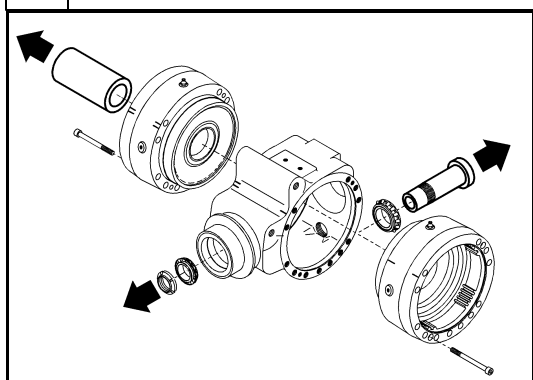
Scegliere uno spessore di valore (**S**) tra la gamma di spessori a disposizione ed inserirlo sul codolo sotto la testa del pignone.

GAMMA SPESSORI - SHIMS RANGE

Spess./Thick. (mm)	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4
Q.ty	---	---	---	---	---	---	---	---	---	---

Select a shim with thickness equal to (**S**) among the range available and fit it on the shaft under the pinion head.

8



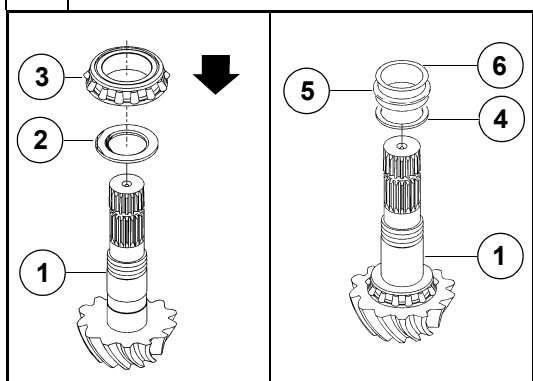
Rimuovere il falso pignone CA715638, i cuscinetti (3) e (8) e la ghiera (10) dal corpo centrale (7).

Smontare la falsa scatola differenziale CA715578 dai cilindri freno e successivamente svitare le viti per rimuovere i cilindri freno.

Remove the false pinion CA715638, the bearings (3) and (8) and the ring nut (10) from the central body (7).

Disassemble the false differential box CA715578 from the brake cylinders and then unscrew the screws to remove the brake cylinders.

9



Dopo aver scelto ed inserito lo spessore (2) adatto con lo smusso rivolto verso l'ingranaggio, piantare il cuscinetto (3) nell'albero del pignone (1) sotto l'azione di una pressa con il battitoio CA715433, assicurandosi che sia ben assestato.

Inserire gli spessori (4) e (6) ed un nuovo distanziale elastico (5).

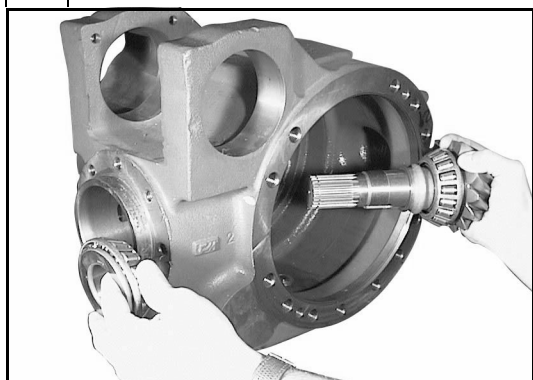
Nota: utilizzare sempre un distanziale elastico (5) nuovo.

Once you have chosen and inserted the suitable shim (2) with the chamfer against the gear, force the bearing (3) into the pinion shaft (1) with the special tool CA715433 under a press, making sure that it is well set.

Insert the shims (4) and (6) and a new collapsible spacer (5).

Note: use always a new collapsible spacer (5).

10



Inserire il gruppo pignone conico (1) preassemblato nel corpo centrale (7) ed il cuscinetto (8) sul codolo pignone, come in figura.

Per eseguire il piantaggio del cuscinetto (8), utilizzare il battitoio CA715433 ed un martello.

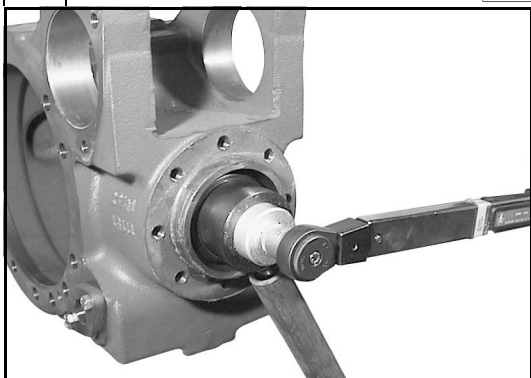
Si consiglia di contrapporre un'azione resistente alla forza battente ad esempio con una mazza.

Insert the bevel pinion (1) unit into the central body (7) and the bearing (8) into the pinion shaft, as shown in figure.

In order to force the bearing (8) into position, use the special tool CA715433 and a hammer.

It is advisable to offer resistance, for example with a sledge, to the beating force.

11



Inserire la rondella fermo ghiera (9) ed avvitare una nuova ghiera di serraggio (10) sul codolo del pignone.

Avvitare la ghiera (10) utilizzando le chiavi per ghiera CA119060 e fermo pignone CA715022.

Attenzione: la coppia di serraggio è data dalla misurazione del precarico sui cuscinetti (3) e (8); serrare la ghiera (10) progressivamente.

Nota: se il serraggio è eccessivo il distanziale elastico (5) dovrà essere sostituito e la procedura ripetuta.

Al momento di verificare il precarico è opportuno dare piccoli colpi con martello in materiale tenero alle estremità del pignone (1) per favorire l'assestamento dei cuscinetti (3) e (8).

Insert the ring nut washer (9) and screw a new lock ring nut (10) on the pinion end.

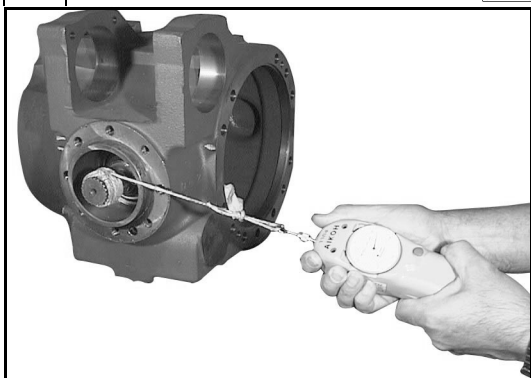
Screw the ring nut (10) in, using the wrench for ring nut CA119060 and for pinion retainer CA715022.

Warning: the torque setting is given by the preloading measurement on bearings (3) and (8); tighten the ring nut (10) gradually.

Note: if the tightening is excessive, the elastic spacer (5) must be replaced and the procedure repeated.

When you check the preloading, it is advisable to beat slightly both pinion ends (1) with a soft hammer, so as to help setting the bearings (3) and (8).

12



Effettuare la misurazione del precarico **P** dei cuscinetti conici (3) e (8), utilizzando un dinamometro con la corda, avvolta sul codolo scanalato del pignone (1).

La regolazione si effettua aumentando gradualmente il serraggio della ghiera (10), facendo attenzione a non eccedere.

Attenzione: tutti i precarichi devono essere misurati senza anello di tenuta.

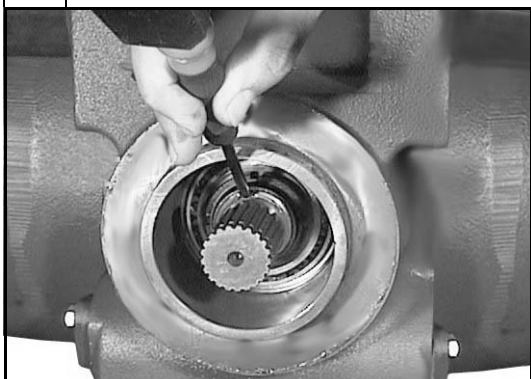
$$P=9.2\div13.7 \text{ daN}$$

*Carry out the preloading measurement **P** of the pinion taper roller bearings (3) and (8), using a dynamometer whose cord is wound on the end of pinion spline (1).*

The adjustment is carried out by increasing the ring nut (10) torque gradually, being careful not to exceed.

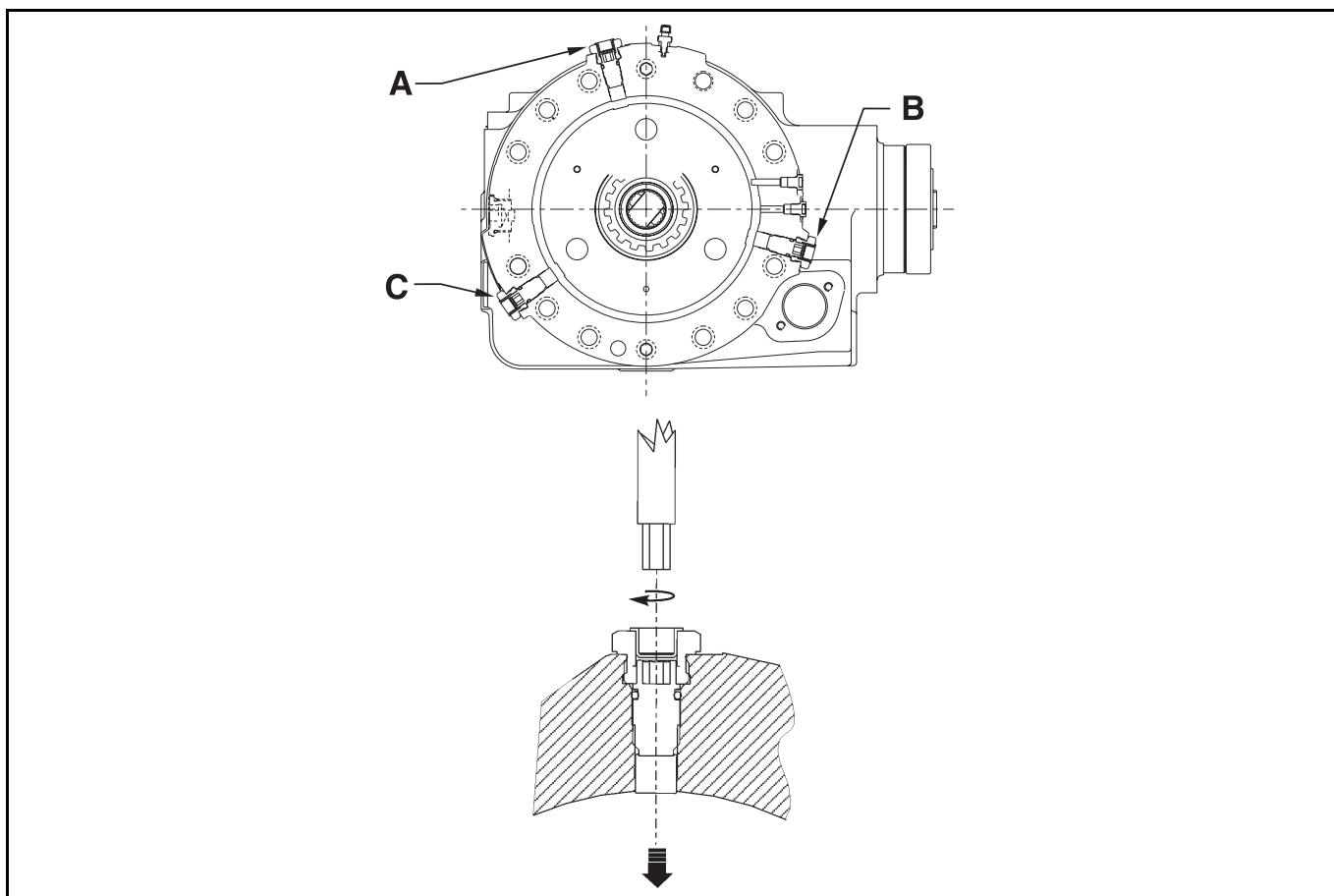
Warning: all preloadings must be measured without the seal ring.

13



Ottenuto il prescritto valore di precarico, cianfrinare la ghiera (10) utilizzando martello e punzone.

Once the requested preloading value is achieved, stake the ring nut (10), using a hammer and a chisel.

D.8 Sbloccaggio freno parcheggio**D.8 Parking brakes release****ATTENZIONE**

BLOCCARE LE RUOTE. Il non farlo può essere molto pericoloso o addirittura mortale per l'operatore. Bloccare tutte e quattro le ruote per impedire il movimento del veicolo una volta che il freno è stato disinserito.

Per disabilitare i freni di parcheggio è necessaria una chiave a brugola da 8 mm.

Fare un segno sulla testa delle viti per poter contare il numero di giri che ciascuna vite dovrà fare mentre eseguite la procedura.

Sdraiarsi sotto l'assale ed individuate le sei viti di rilascio (tre per ciascun lato) alla base dell'assale.

Avvitare alternativamente di 1/2 giro alla volta in senso orario le viti di rilascio freno A, B e C fino a quando si inizia a sentire una certa resistenza.

Avvitare alternativamente di 1/2 giro alla volta le viti A, B e C per 5 ÷ 5.5 giri.

Spostarsi da sotto il veicolo e liberare l'area circostante dal personale non coinvolto dalle operazioni.

Rimuovere con attenzione i ceppi di bloccaggio dalle quattro ruote e trainare il veicolo in un luogo sicuro.

Bloccare nuovamente le quattro ruote e continuare con le operazioni che necessitano.

WARNING

BLOCK ALL FOUR WHEELS. Failure to do so could result in death or serious injury from vehicle roll away. Block all four wheels to prevent the vehicle from moving once the parking brake is disabled.

An 8 mm allen head socket will be needed to properly disable the parking brakes.

Mark a line on the socket so you can accurately count the number of turn each bolt makes as you perform the procedure.

Lie down under the axle and locate the six brake release bolts (three bolts per side) at the base of the axle.

Alternately screw 1/2 turn brake release bolts A, B & C inward direction (clockwise) until you first begin to feel resistance.

Alternately screw 1/2 turn the bolts A, B and C inward direction of 5 ÷ 5.5 turns.

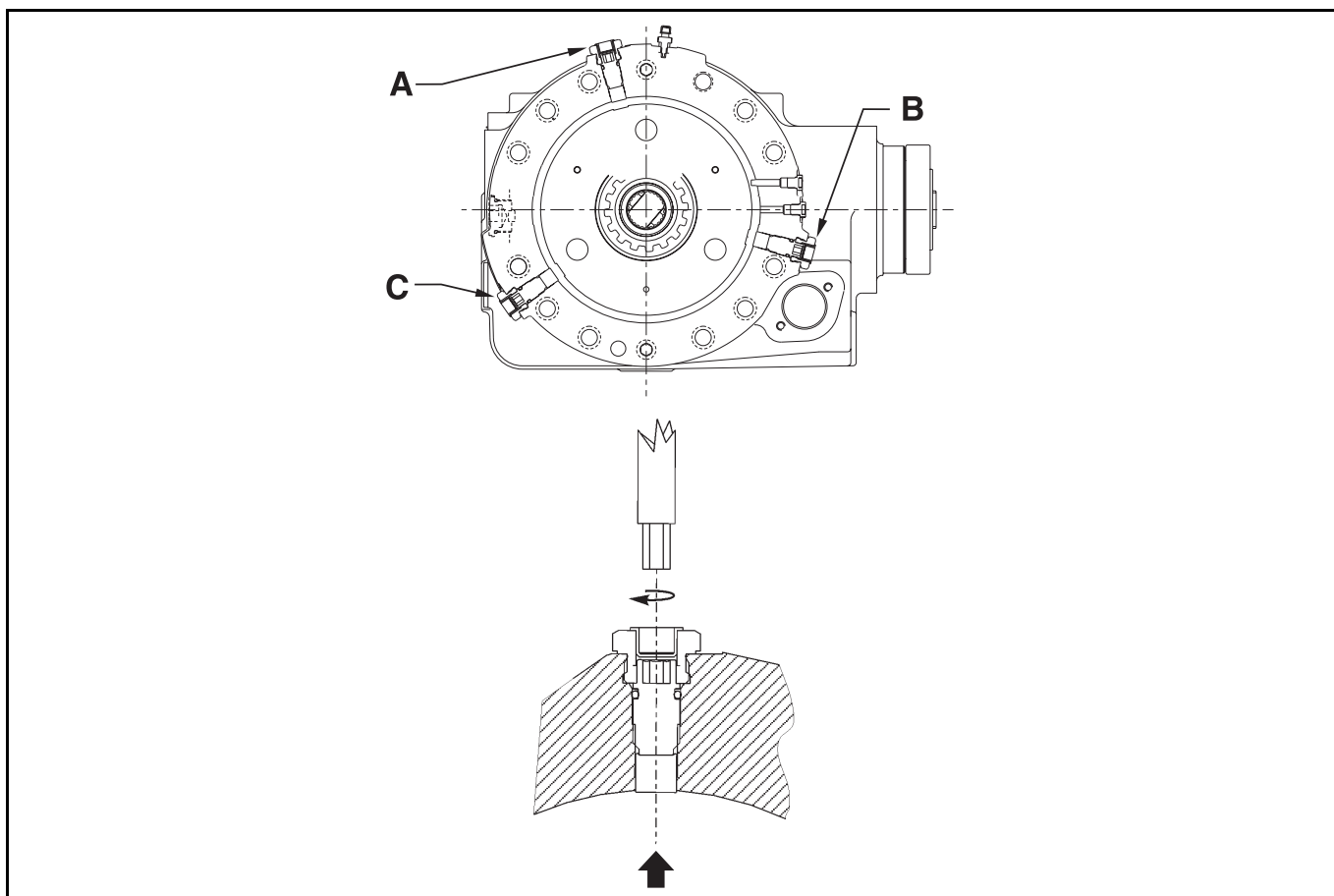
To get out from under the vehicle and clear the area of any unnecessary personnel.

Carefully remove the blocking from each of the four tires and tow the vehicle to a secure location.

Block all four wheels and continue following the procedure.

D.9 Riattivazione freno parcheggio

D.9 Re-activating parking brakes



ATTENZIONE

BLOCCARE LE QUATTRO RUOTE. Il non farlo può essere molto pericoloso o addirittura mortale per l'operatore. Bloccare tutte e quattro le ruote, sdraiarsi sotto l'assale e, utilizzando la chiave dinamometrica, svitare alternativamente le viti di rilascio A, B e C (in senso antiorario) di 1/2 giro.

Di nuovo svitare alternativamente di 1/2 giro le viti A, B e C fino a quando la coppia si riduce bruscamente. Continuare a svitare alternativamente le viti A, B e C fino a quando si avverte che la testa della vite va a contatto con la vite speciale. Riavvitare poi in senso inverso le viti A, B e C di 1/4 di giro.

I freni di parcheggio sono a questo punto riattivati e le ruote bloccate.

Rimuovere quindi i ceppi dalle quattro ruote.

Verificare l'efficienza del freno di parcheggio.

Rimuovere i cartelli di pericolo o di avviso dal volante e dalla chiave d'accensione.

WARNING

BLOCK ALL FOUR WHEELS. Failure to do so could result in death or serious injury from vehicle roll away. After you have locked all four wheels, lie down under the axle. Using the torque wrench, alternately unscrew brake release bolts A, B and C outward direction (counterclockwise) 1/2 turn.

Again, alternately unscrew brake release bolts A, B and C outward direction 1/2 turn until the torque drops off sharply. Alternately unscrew brake release bolts A, B and C outward direction (counterclockwise) until feel the bolts flange begin to contact against the special screw. Screw the bolts A, B and C inward direction 1/4 turn.

The parking brakes should now be re-activated and the wheels are locked.

Remove the blocking from the four tires.

Verify that parking brake works properly.

Remove any warning tags from the ignition lock key and from the steering wheel.

D.10 Prove dopo montaggio

D.10 Testing after assembly

D.10.1 Procedure di collaudo

Passo 1

A motore spento, sollevare l'assale della ruota motrice sino a che i pneumatici si siano staccati da terra.

Passo 2

Ingranare la marcia in modo che il pignone sia bloccato.

Passo 3

Con l'aiuto di un'altra persona collocata al lato opposto, iniziare la prova di montaggio ruotando per quanto possibile entrambe le ruote nel senso di marcia avanti. (Entrambe le ruote dovrebbero bloccarsi dopo poco)

Passo 4

Con il pignone sempre bloccato, liberare la ruota di destra e ruotare la ruota di sinistra nel senso (marcia avanti).

Se il montaggio è corretto si dovrà verificare che la ruota giri liberamente senza eccessivi sforzi, e la ruota di destra ruoti in senso opposto.

Ripetere l'operazione nel senso opposto (retro marcia).

SE UNA DELLE RUOTE NON GIRA LIBERAMENTE IN ENTRAMBE LE DIREZIONI, ricontrollare passo passo il montaggio.

Controllare anche che i freni siano regolati in modo da consentirne il corretto funzionamento.

D.10.1 Testing methods

Step 1

With engine off, lift the axle so that the tyres get away from the ground.

Step 2

Engage the gear so that the pinion gets locked.

Step 3

With the help of another person standing on the opposite side, begin the assembly testing by rotating as much as possible both the wheels forward. (Both the wheels should get blocked after a while.)

Step 4

Keeping the pinion locked, free the right wheel and rotate the left one in the line of march. Rotate the right wheels in the opposite direction.

The wheel will move freely without difficulty and the right wheel will move in the opposite direction if the assembly has been carried out correctly.

Repeat the same operation in the opposite direction (reverse gear).

IF ONE WHEEL DOES NOT ROTATE FREELY IN BOTH DIRECTIONS, then check step by step all assembly operations.

Check and see that the brakes are regulated correctly and functioning properly.

E

RICERCA GUASTI

E

TROUBLESHOOTING

PROBLEMA	POSSIBILI CAUSE										
	1	2	3	4	5	6	7	8	9	10	11
- Vibrazioni delle ruote; resistenza del pneumatico anteriore; rottura del/i semiasse/i.	•	•	•		•						•
- Difficoltà nello sterzare; il veicolo tende ad andare dritto mentre è in curva.	•	•	•	•							•
- Non vi è azione del differenziale; inceppamento in curva.	•			•	•						•
- Rumore eccessivo nella trasmissione.	•	•	•	•	•		•		•		•
- Usura eccessiva del pneumatico.	•	•	•	•	•	•	•				•
- Rumore di attrito.	•			•	•			•	•	•	•
- In marcia avanti si avvertono vibrazioni, rumore intermittente.	•	•	•		•						•

PROBLEMS	POSSIBLE CAUSES										
	1	2	3	4	5	6	7	8	9	10	11
- Wheel vibration; front tyre resistance; halfshaft breakage.	•	•	•		•						•
- Steering is difficult; vehicle goes straight while its turning.	•	•	•	•							•
- No differential action; jamming while steering.	•			•	•						•
- No differential action; jamming while steering.	•	•	•	•	•		•		•		•
- Uneven wear of tyre.	•	•	•	•	•	•	•				•
- Friction noise.	•			•	•			•	•	•	•
- Vibration during forward drive, intermittent noise.	•	•	•		•						•

1 Installazione scorretta / assale difettoso

Correggere l'installazione oppure, se il differenziale non supera una delle fasi di prova, ripararlo o sostituirlo.

2 Sovraccarico / distribuzione scorretta del peso

Togliere il peso in eccesso e ridistribuire il carico, rispettando le istruzioni relative al veicolo.

1 Incorrect installation / defective axle

Correct installation or repair or replace the differential in case it does not survive any one of the test phases.

2 Overloading / incorrect weight distribution

Remove excessive weight and redistribute load, following instructions related to the vehicle.

3 Raggio di rotazione dei pneumatici diversi

Un pneumatico con raggio più piccolo provoca un parziale slittamento della ruota quando si applica energia. L'altro pneumatico con raggio maggiore dovrà sopportare tutto il lavoro. Sostituire il pneumatico o regolare la pressione di entrambi sino a che il raggio di rotazione sia uguale.

4 Semiasse rotto

E' sconsigliato usare un veicolo con un solo semiasse. E' possibile tuttavia spostare il veicolo a vuoto con il differenziale bloccato per pochi metri.

5 Semiasse piegato

Sostituire i semiassei.

6 Differenziale bloccato

Funzionamento anomalo del differenziale e/o rottura del dispositivo di comando del bloccaggio di comando. Verificare l'installazione, eventualmente smontare e verificare i componenti.

I veicoli impostati per angoli di sterzata ampi, possono procedere a scatti, avere difficoltà di sterzo e provocare un consumo del pneumatico nelle curve strette.

Ridurre l'angolo di sterzata minimo e decelerare quando il motore inizia a procedere a scatti.

7 Allineamento scorretto della ruota

Verificare l'integrità della struttura, e cuscinetti lato ruota.

8 Parti dell'assale consumate o difettose

Controllare le condizioni della corona dentata, dell'ingranaggio del pignone, dei cuscinetti, delle guarnizioni, ecc. Sostituire dove necessario.

9 Corpi estranei nella scatola dell'assale o montaggio scorretto di alcune sue parti

Controllare se vi sono corpi estranei. Controllare il montaggio delle parti dell'assale.

10 Regolazioni della coppia conica scorrette: parti di trasmissione consumate

(ingranaggi di trasmissione, giunti, ecc.). Sostituire o regolare secondo necessità.

11 Uso scorretto del prodotto

Rivedere le istruzioni rilasciate dal produttore del veicolo.

3 Different rotation radius of the tyres

If one tyre has a smaller radius, it will cause partial wheel slipping when force is applied. The other tyre with bigger radius will have to support all the work. Replace the tyre or adjust pressure to have same radius on both tyre.

4 Broken halfshaft

It is not advisable to operate the vehicle with a broken halfshaft. It is acceptable to move the vehicle (engine off unloaded) a few meters away only.

5 Bent halfshaft

Replace halfshaft.

6 Blocked differential

Abnormal functioning of the differential or breakage/blockage of command device. Verify assembly and all components.

Vehicles with wide steering angle may proceed with kicks, have steering difficulty or cause pneumatic wearing at sharp turns. Reduce the steering angle to minimum and decelerate when the vehicle begins to kick.

7 Incorrect wheel adjustment

Verify group integrity and wheel side bearings. Adjusting according.

8 Spoiled or worn out axle parts

Check the condition of ring gear, pinion gear, bearings etc. Replace when ever necessary.

9 Contamination in the axle box or incorrect assembly of parts

Look for foreign particles. Check assembly of the various parts of the axle.

10 Incorrect adjustment of bevel gear set: Parts of the transmission worn out.

*(transmission gears, U joints, etc.)
Replace or adjust as required.*

11 Incorrect use of the product

See the vehicle producer's instructions once again.

E.1 Controllo ed esame dei guasti

Questo capitolo offre una guida descrittiva ed esplicativa di problemi che si possono comunemente riscontrare sugli assali o di avarie che si possono verificare. La guida suggerisce anche le corrette procedure di riparazione.

Problema	Causa	Azione consigliata
Rottura verso l'estremità esterna del dente corona dentata	<ol style="list-style-type: none"> 1. Carico dell'ingranaggio eccessivo rispetto a quello previsto 2. Regolazione ingranaggio scorretto (gioco eccessivo) 3. Dado del pignone allentato. 	Sostituire la coppia conica. Seguire attentamente le operazioni raccomandate di regolazione del gioco della corona dentata e del pignone e per la rilevazione dell'impronta del dente.
Rottura verso l'estremità interna del dente corona dentata	<ol style="list-style-type: none"> 1. Urto da carico 2. Regolazione ingranaggio scorretto (gioco insufficiente) 3. Dado del pignone allentato 	Sostituire la coppia conica. Seguire attentamente le operazioni raccomandate di regolazione del gioco della corona dentata e del pignone e per la rilevazione dell'impronta del dente
Denti del pignone e della corona dentata erosi o rigati	<ol style="list-style-type: none"> 1. Lubrificazione insufficiente 2. Lubrificante sporco 3. Lubrificante errato o con additivi impoveriti 4. Cuscinetti del pignone consumati che provocano un gioco assiale del pignone e un contatto tra pignone e corona scorretto. 	Sostituire la coppia conica. Sostituire i cuscinetti del pignone facendo attenzione a sistemare correttamente la corona, il pignone e i precarichi dei cuscinetti. Usare il lubrificante corretto, riempire fino al giusto livello e sostituirlo agli intervalli raccomandati.
Denti della corona e del pignone surriscaldati. Guardare se i denti dell'ingranaggio hanno perso la colorazione	<ol style="list-style-type: none"> 1. Funzionamento prolungato a temperatura eccessiva. 2. Lubrificante scorretto 3. Livello dell'olio basso 4. Lubrificante sporco. 	Sostituire la coppia conica. Usare il lubrificante corretto, riempire fino al giusto livello e sostituirlo agli intervalli raccomandati.
Denti del pignone di comando butterati	<ol style="list-style-type: none"> 1. Uso estremamente intenso 2. Lubrificazione insufficiente 	Sostituire la coppia conica. Usare il lubrificante corretto, riempire fino al giusto livello e sostituirlo agli intervalli raccomandati.
Corpo trave dell'assale piegato	<ol style="list-style-type: none"> 1. Sovraccarico del veicolo 2. Veicolo incidentato 3. Urto da carico 	Sostituire il corpo trave dell'assale
Cuscinetti consumati o butterati	<ol style="list-style-type: none"> 1. Lubrificazione insufficiente 2. Lubrificante sporco 3. Uso estremamente intenso 4. Consumo normale 5. Dado del pignone allentato. 	Sostituire i cuscinetti. Usare il lubrificante corretto, riempire fino al giusto livello e sostituirlo agli intervalli raccomandati.
Le guarnizioni perdono olio	<ol style="list-style-type: none"> 1. Funzionamento prolungato con temperatura dell'olio eccessiva. 2. Guarnizione dell'olio montata male 3. Bordo della guarnizione tagliata o intaccata 4. Lubrificante sporco 	Sostituire la guarnizione e la superficie di accoppiamento se danneggiata. Usare il lubrificante corretto, riempire fino al giusto livello e sostituirlo agli intervalli raccomandati.
Usura eccessiva della scanalatura della flangia di entrata.	<ol style="list-style-type: none"> 1. Uso intenso 2. Dado del pignone allentato 3. Gioco assiale del pignone 	Sostituire la flangia Controllare che la scanalatura del pignone non sia eccessivamente consumata Sostituire la coppia conica, se necessario.
Rottura per fatica del dente dell'ingranaggio del pignone. Guardare se la linea di frattura ad onda è ben delineata (linea di arresto).	<ol style="list-style-type: none"> 1. Uso intenso 2. Sovraccarico continuo 	Sostituire la coppia conica.

Problema	Causa	Azione consigliata
Rottura denti pignone e corona	Carico d'urto dei componenti del differenziale	Controllare e/o sostituire altri componenti differenziale.
Scanalature dell'ingranaggio planetario consumate (gioco eccessivo)	Uso intenso	Sostituire il gruppo ingranaggi differenziale. Sostituire il semiasse, se necessario.
Superfici della ralla di rasamento consumate o graffiate	1. Lubrificazione insufficiente 2. Lubrificazione scorretta 3. Lubrificante sporco	Sostituire tutte le ralle graffiate e quelle con uno spessore di 0,1 mm inferiore a quello delle ralle nuove. Usare il lubrificante corretto, riempire fino al giusto livello e sostituirlo agli intervalli raccomandati.
Diametro interno del cuscinetto a rulli conici del pignone consumato	1. Uso intenso 2. Gioco assiale del pignone eccessivo 3. Lubrificazione inadeguata 4. Lubrificante sporco	Sostituire il cuscinetto Controllare il gioco assiale del pignone Usare il lubrificante corretto, riempire fino al giusto livello e sostituirlo agli intervalli raccomandati.
Semiasse ritorto o rotto	Funzionamento intenso del veicolo, sovraccarico	Sostituire il semiasse
Semiasse spezzato presso la flangia ruota	1. Supporto della ruota allentato 2. Corpo trave piegato	Sostituire il semiasse Controllare la distorsione del corpo trave. Accertarsi che il sostegno della ruota non sia consumato o mal regolato.

E.1 Troubleshooting

This chapter is a descriptive and explanatory guide to common axle problems. This guide suggests the correct repair procedures to be followed.

Problem	Cause	Action
Ring gear tooth broken on the outer side	<ol style="list-style-type: none"> 1. Excessive gear load compared to the one foreseen 2. Incorrect gear adjustment (excessive backlash) 3. Pinion nut loosened 	Replace bevel gear set Follow carefully the recommended operations for the adjustment of bevel gear set backlash
Ring gear tooth broken on the inner side	<ol style="list-style-type: none"> 1. Load bump 2. Incorrect gear adjustment (insufficient backlash) 3. Pinion nut loosened 	Replace bevel gear set Follow carefully the recommended operations for the adjustment of bevel gear set backlash.
Pinion or ring gear teeth worn	<ol style="list-style-type: none"> 1. Insufficient lubrication 2. Contaminated oil 3. Incorrect lubrication or depleted additives 4. Worn out pinion bearings that cause an incorrect pinion axle backlash and wrong contact between pinion and ring. 	Replace bevel gear set. Follow carefully the recommended operations for the adjustment of bevel gear set backlash. Use correct lubricants, fill up to the right levels and replace according to the recommended program.
Overheated ring and pinion teeth. See if gear teeth have faded	<ol style="list-style-type: none"> 1. Prolong ed functioning at high temperatures 2. Incorrect lubrication 3. Low oil level 4. Contaminated oil 	Replace bevel gear set. Use proper lubrication, fill up to right level and replace at recommended program.
Pinion teeth pitting	<ol style="list-style-type: none"> 1. Excessive use 2. Insufficient lubrication 	Replace bevel gear set. Use correct lubrication, fill up to the right level and substitute at recommended intervals
Axle beam body bent	<ol style="list-style-type: none"> 1. Vehicle over loaded 2. Vehicle's accident 3. Load bump 	Replace axle beam body
Worn out or pitted bearings	<ol style="list-style-type: none"> 1. Insufficient lubrication 2. Contaminated oil 3. Excessive use 4. Normal wear out 5. Pinion nut loosened 	Replace bearings. Use correct lubrication fill up, to the right level and replace at recommended intervals
Oil leakage form gaskets and seals	<ol style="list-style-type: none"> 1. Prolonged functioning at high temperature of the oil 2. Oil gasket assembled incorrectly 3. Seal lip damaged 4. Contaminated oil 	Replace the gasket or seal and matching surface if damaged. Use correct lubrication and replace at recommended intervals.
Excessive wearing out of input flange spline	<ol style="list-style-type: none"> 1. Exhaustive use 2. Pinion nut loosened 3. Pinion axle backlash 	Replace the flange. Check that the pinion spline is not excessively worn out. Replace bevel gear set if required.
Fatigue failure of pinion teeth See if the fracture line is well defined (wave lines, beach lines)	<ol style="list-style-type: none"> 1. Exhaustive use 2. Continuous overload 	Replace bevel gear set
Pinion and ring teeth breakage	<ol style="list-style-type: none"> 1. Crash load of differential components 	Check and/or replace other differential components.

Problem	Cause	Action
Side gear spline worn out. Replace all scratched washers (Excessive backlash)	Excessive use	Replace differential gear group. Replace halfshaft if required
Thrust washer surface worn out or scratched.	1. Insufficient lubrication 2. Incorrect lubrication 3. Contaminated oil	Use correct lubrication and fill up to right level. Replace at intervals recommended. Replace all scratched washers and those with 0,1mm thickness lower than the new ones.
Inner diameter of tapered roller bearing worn out.	1. Excessive use 2. Excessive pinion axial backlash 3. Insufficient lubrication 4. Contaminated oil	Replace bearing. Check pinion axial backlash. Use proper lubrication, fill up to right level and replace at recommended intervals.
Bent or broken halfshaft	Vehicle intensively operated or overloaded	Replace
Halfshaft broken at wheel side	1. Wheel support loosened 2. Beam body bent	Replace Check that wheel support is not worn out or wrongly adjusted.

E.2 Diagnosi per problemi all'assale

Problema	Causa	Azione consigliata
Rumore durante la guida	1. Gioco tra corona dentata e pignone eccessivo 2. Pignone e corona dentata consumati 3. Cuscinetti del pignone consumati 4. Cuscinetti del pignone allentati 5. Gioco assiale del pignone eccessivo 6. Cuscinetti del differenziale consumati 7. Cuscinetti del differenziale allentati 8. Eccessiva scenteratura della corona dentata 9. Livello lubrificante basso 10. Lubrificante di grado povero od errato 11. Semiasse piegato	1. Regolare 2. Sostituire 3. Sostituire 4. Regolare 5. Regolare 6. Sostituire 7. Regolare 8. Sostituire 9. Rabboccare 10. Sostituire 11. Sostituire
Rumore durante l'andatura in folle	1. I rumori provenienti dall'assale con il veicolo in movimento di solito si sentono durante l'andatura in folle anche se non molto forti 2. Errato gioco tra pignone e corona (il rumore che si sente decelerando sparisce all'aumentare della velocità). 3. Usura scanalatura pignone o flangia entrata	1. Regolare o sostituire (vedere sopra) 2. Regolare 3. Sostituire
Rumore intermittente	1. Corona dentata danneggiata 2. Bulloni della scatola del differenziale allentati	1. Sostituire coppia conica 2. Serrare a coppia
Rumore costante	1. Danni sui denti della corona dentata o del pignone 2. Cuscinetti usurati 3. Scanalature del pignone consumate 4. Semiasse piegato	1. Sostituire coppia conica 2. Sostituire 3. Sostituire 4. Sostituire
Rumore in curva	1. Satelliti planetari differenziale consumati 2. Scatola differenziale e/o perni del differenziale consumati 3. Ralle di rasamento del differenziale consumate 4. Scanalature del semiasse consumate	1. Sostituire 2. Sostituire 3. Sostituire 4. Sostituire

E.2 Axle problems and diagnosis

Problem	Cause	Action
Noise while driving	<ol style="list-style-type: none"> 1. Excessive backlash between pinion and ring gear 2. Worn out pinion and gear ring 3. Worn out pinion bearings 4. Pinion bearings loosened 5. Excessive axial pinion backlash 6. Worn out differential bearings 7. Differential bearings loosened 8. Ring gear out of roundness 9. Low lubricant level 10. Poor or wrong lubricant 11. Bent halfshaft 	<ol style="list-style-type: none"> 1. Adjust 2. Replace 3. Replace 4. Adjust 5. Adjust 6. Replace 7. Adjust 8. Replace 9. Oil level 10. Replace 11. Replace
Noise while driving in neutral	<ol style="list-style-type: none"> 1. Noise coming from axle are usually heard when vehicle moves in neutral gear but are not loud. 2. Incorrect backlash between pinion and ring (sound heard while decelerating disappears while increasing the speed) 3. Pinion or input flange worn out 	<ol style="list-style-type: none"> 1. Replace or adjust (see above) 2. Replace 3. Adjust
Intermittent noise	<ol style="list-style-type: none"> 1. Ring gear damaged 2. Differential box bolts loosened 	<ol style="list-style-type: none"> 1. Replace bevel gear set 2. Tighten to torque
Constant noise	<ol style="list-style-type: none"> 1. Ring gear teeth or pinion damaged 2. Worn out bearings 3. Pinion spline worn out 4. Bent halfshaft 	<ol style="list-style-type: none"> 1. Replace bevel gear set 2. Replace 3. Replace 4. Replace
Noise while seering	<ol style="list-style-type: none"> 1. Worn out differential gears 2. Worn out differential box or spider 3. Differential thrust washers worn out 4. Half shaft spline worn out 	<ol style="list-style-type: none"> 1. Replace 2. Replace 3. Replace 4. Replace

F

ATTREZZATURE SPECIALI

F

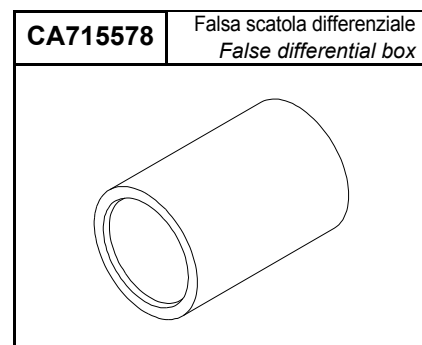
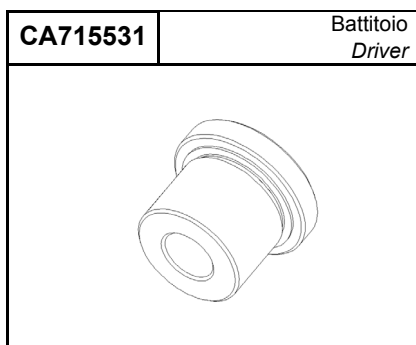
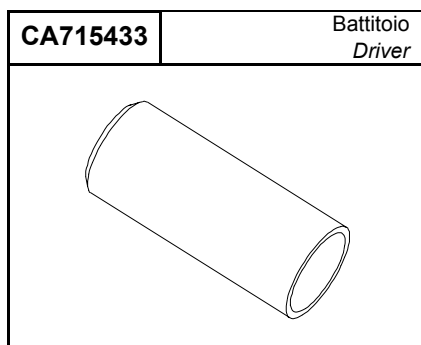
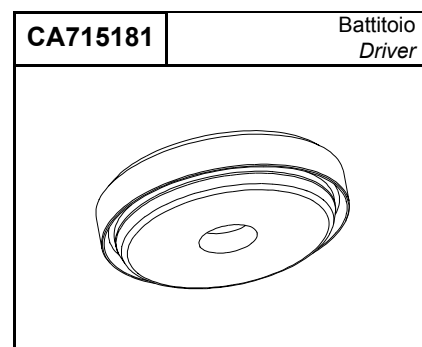
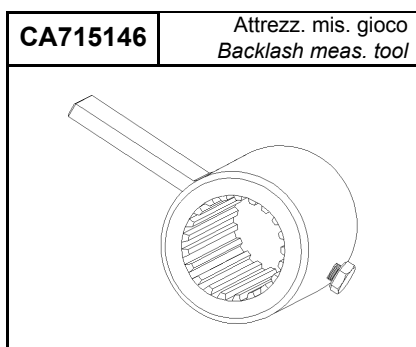
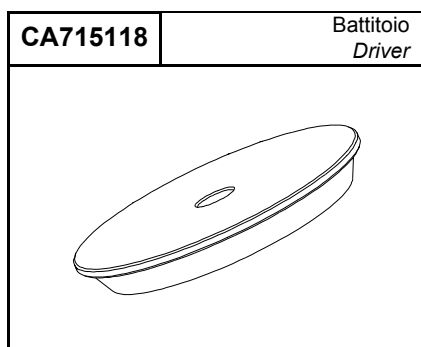
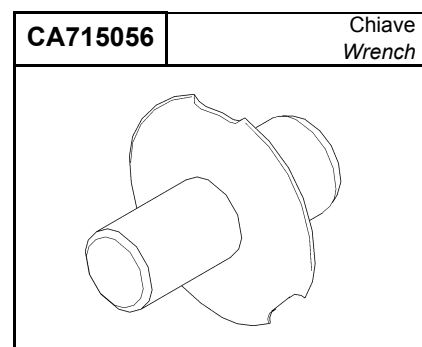
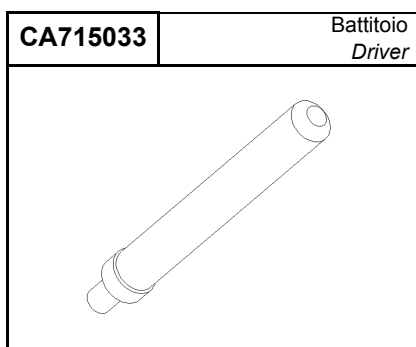
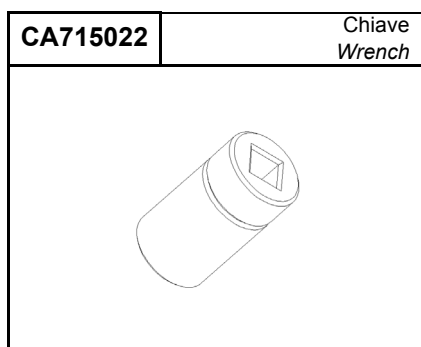
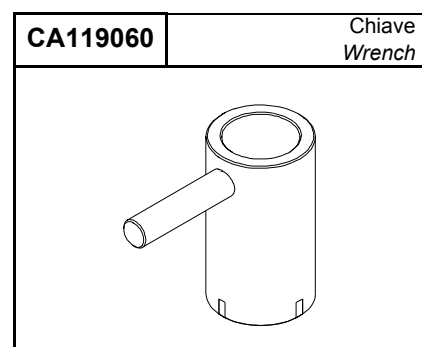
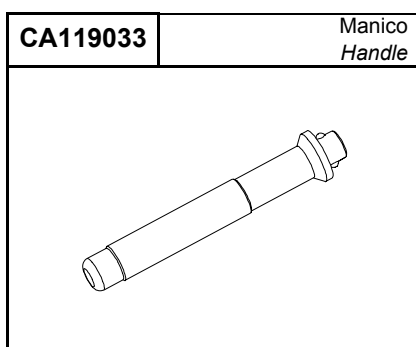
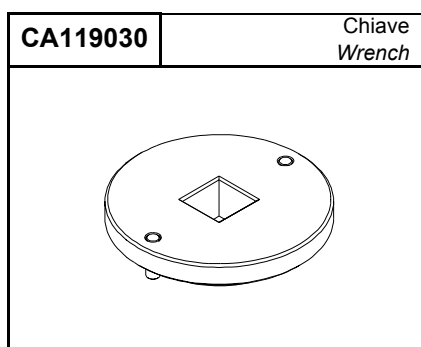
SPECIAL TOOLS

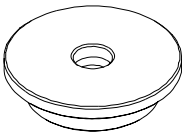
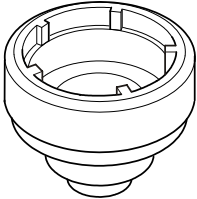
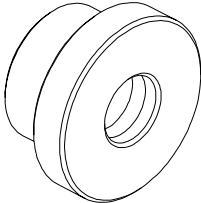
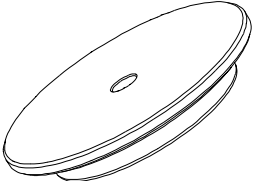
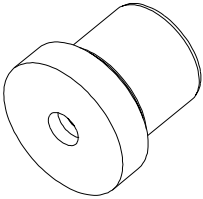
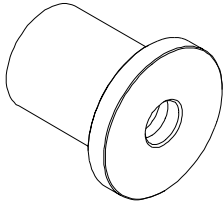
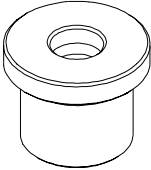
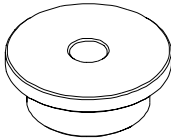
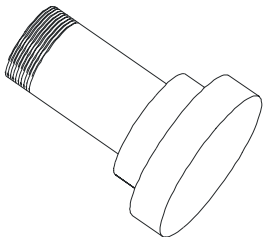
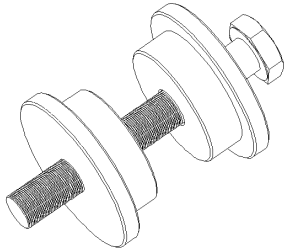
F.1 Attrezzature speciali

Battitoi e tamponi per il montaggio di tenute, cuscinetti e bronzine devono essere utilizzati con il manico intercambiabile CA119033; se ne raccomanda l'uso abbinato ad un'impugnatura di sicurezza per la protezione delle mani (da commercio).

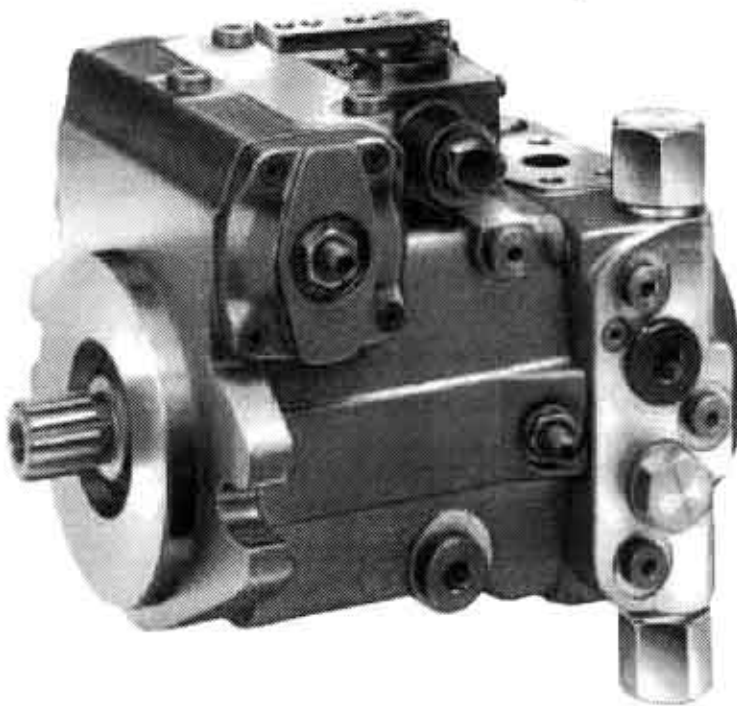
F.1 Special tools

The special drifts/pad used to assembly the seals, bearings and bushes should always be used with the interchangeable handle CA119033; its use is recommended together with a suitable safety handle in order to protect the hands.



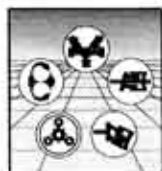
CA715583	Battitoio <i>Driver</i>	
CA715631	Chiave <i>Wrench</i>	
CA715632	Battitoio <i>Driver</i>	
CA715633	Battitoio <i>Driver</i>	
CA715634	Battitoio <i>Driver</i>	
CA715635	Battitoio <i>Driver</i>	
CA715636	Battitoio <i>Driver</i>	
CA715637	Battitoio <i>Driver</i>	
CA715638	Falso pignone <i>False pinion</i>	
CA715639	Kit inserimento cuscinetti <i>Bearing insertion kit</i>	

Application & Service Manual



AA4VG

Series 3.2
Size 28...250

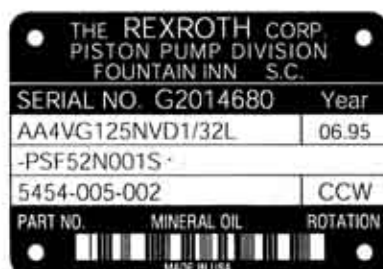


Ordering of Parts

For Rexroth to supply the correct parts for your unit, please include all of the following information along with your parts order.

Model Code
Serial Number
Unit Number
Part Name
Part Number

Due to modifications and improvements to our products, minor changes can occur to the parts, even though the type code may not necessarily reflect these changes. The type number and serial number will guarantee that the correct parts for your unit are supplied.



Ordering Example

To order a replacement rotary group for an AA4VG variable displacement pump having the above nameplate, the following information would be required.

+ Model Code	AA4VG125NVD1/32LPSFN001S
+ Serial Number	G2014680
+ Unit Number	5454-005-002
* Part Name	Charge Pressure Relief Valve
* Part Number	HU00434856

+ This information is taken from the nameplate on the pump.

* This information is taken from the Application and Service Manual.

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Variable Displacement Pump AA4VG, Series 3

Ordering Code

Hydraulic Fluid

Petroleum Oil (For operation with other fluids, consult a Rexroth Application Engineer)

Axial Piston Unit

Variable swashplate design. Nominal pressure 5800 psi; peak pressure 6500 psi

AA4V

Mode of Operation

Pump in closed circuit

G

Size

= Displacement $V_{g \max}$ (cm³)

28 40 56 71 90 125 180 250

Size 28, see RA 92002

Size 250, see RA 92000

Control Options

		40	56	71	90	125	180	
None	NV	●	●	●	●	●	●	NV
Hydraulic Control-Direct Operated	DG	●	●	●	●	●	●	DG
Electrical Control-Proportional	EP	●	●	●	●	●	●	EP
Electrical Control-Non Proportional	EZ	●	●	●	●	●	●	EZ
Rotary Manual Servo Control	HW	●	●	●	●	●	●	HW
Hydraulic Control-Pilot Operated	HD	●	●	●	●	●	●	HD
Hydraulic Control-Speed Dependent	DA	●	●	●	●	●	●	DA

Solenoid Voltage (EP, EZ, or DA only)

12 Volt DC	●	●	●	●	●	●	1
24 Volt DC	●	●	●	●	●	●	2

Pressure Cut-Off

With Pressure Cut-Off	●	●	●	●	●	●	D
-----------------------	---	---	---	---	---	---	---

Neutral Position Switch (HW control only)

Without Neutral Position Switch (no code)	●	●	●	●	●	●	Omit
With Neutral Position Switch	●	●	●	●	●	●	L

Mechanical Stroke Limiter

Without Stroke Limiter	●	●	●	●	●	●	Omit
With Stroke Limiter	●	●	●	●	●	●	M

Ports X₃, X₄ for Stroking Pressure

Without Ports X ₃ , X ₄ (no code)	●	●	●	●	●	●	Omit
With Ports X ₃ , X ₄	●	●	●	●	●	●	T

Regulating (DA) Cartridge

	NV	EZ	DG	EP	HW	HD	DA	40	56	71	90	125	180	
Without DA Cartridge	●	●	●	●	●	●	—	●	●	●	●	●	●	1
With DA Cartridge, fixed adjustment	—	●	●	●	●	●	●	●	●	●	●	●	●	2
With DA Cartridge, mech. adjustable w/lever	—	●	●	●	●	●	●	●	●	●	●	●	●	3
With DA Cartridge, fixed adjustment and Hydraulic Inching Valve built on	—	—	—	—	—	—	●	●	●	●	●	●	●	4
With DA Cartridge, mech. adjust. w/lever and Hydraulic Inching Valve built on	—	—	—	—	—	—	●	●	●	●	●	●	●	5
With DA Cartridge, fixed adjustment and connection for TH7 master controller	—	●	●	●	●	●	●	●	●	●	●	●	●	7

Series

	3
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Index

	2
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Direction of Rotation

(As viewed from drive shaft)	clockwise	R
	counter-clockwise	L

① Shaft Option "S" is standard for the front pump of tandem units.

② See Page 6.

③ With "Cold Start" bypass valve. See page 7.

● Available
○ On Request;
Consult Factory
— Not Available

Variable Displacement Pump AA4VG, Series 3

AA4V	G			/	3	2	-			52			
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Axial Piston Unit
 Operation
 Displacement
 Control & Options
 Regulating Cartridge
 Design Series
 Index
 Direction of Rotation

Seals

NBR	P
NBR, FPM shaft seal	N

Shaft Type (For maximum permissible shaft torque refer to page 33)

	40	56	71	90	125	180	
Spline-SAE (Standard for single pump)	●	●	●	●	●	●	S
Spline-SAE (Standard for tandem pump, 1 st pump)	①	●	●	①	●	●	T
Spline-SAE (Only for tandem pump, 2 nd pump)	●	-	-	-	-	-	U
Spline-DIN 5480 (For tandem pump, 2 nd pump)	-	-	-	●	-	-	Z

Mounting Flange

	40	56	71	90	125	180	
SAE 2-bolt	●	●	-	-	-	-	C
4-bolt	-	-	-	-	-	●	D
2 + 4 bolt	-	-	●	●	●	-	F

Port Connections

	40	56	71	90	125	180	
Ports A & B (SAE 4-bolt flange), on top and bottom	●	●	●	●	●	●	52

Charge Pump

	40	56	71	90	125	180	
With Charge Pump & without Through-Drive	●	●	●	●	●	●	F00
Without Charge Pump & without Through-Drive	●	●	●	●	●	●	N00
With Charge Pump & with Through-Drive	●	●	●	●	●	●	F...
Without Charge Pump & with Through-Drive	○	○	○	○	○	○	K...

Through-Drive

Shaft	Flange	40	56	71	90	125	180	
SAE A (¾" 9T-16/32P)	SAE A, 2-bolt	●	●	●	●	●	●	...01
SAE B (¾" 13T-16/32P)	SAE B, 2-bolt	●	●	●	●	●	●	...02
SAE B-B (1" 15T-16/32P)	SAE B, 2-bolt	●	●	●	●	●	●	...04
SAE B-B (1" 15T-16/32P)	SAE C, 2-bolt	●	-	-	-	-	-	...09
SAE C (1¼" 14T-12/24P)	SAE C, 2-bolt	-	●	●	●	●	●	...07
DIN (N35x2x30x16x9H DIN 5480)	SAE D, 2+4-bolt	-	-	-	●	-	-	...73
SAE D (1¼" 13T-8/16P)	SAE D, 2+4-bolt	-	-	-	-	●	●	...69
SAE D (1¼" 13T-8/16P)	SAE E, 4-bolt	-	-	-	-	-	○	...72

Relief Valves ②

	Adjustment Range	40	56	71	90	125	180	
W/high press. relief valves, pilot oper.	1450...6100 psi with bypass	-	-	●	●	●	●	1
With high pressure relief valves	4000...6100 psi without bypass	●	●	-	-	-	-	3
Direct operated, fixed setting	with bypass	●	●	-	-	-	-	5
	1450...3600 psi without bypass	●	●	-	-	-	-	4
	with bypass	●	●	-	-	-	-	6

Filtration

	40	56	71	90	125	180	
Filtration in Charge Pump suction line	●	●	●	●	●	●	S
Charge Pressure Filtration (Ports Fe and Fa)	●	●	●	●	●	●	D
Cold start valve and ports for external charge circuit filter (Ports Fe and Fa)	○	○	○	○	○	○	K
Mounted Filter (Without contamination indicator) ③	●	●	●	●	●	●	F
Filter with visual contamination indicator ③	●	●	●	●	●	●	P
Filter with electrical contamination indicator ③	●	●	●	●	●	●	L
Filter with visual and electrical contamination indicator ③	●	●	●	●	●	●	M
External Charge Supply (Units without charge pump-N00 or K...)	●	●	●	●	●	●	E

Technical Data

Description

The AA4VG is a swashplate design, variable displacement, over center, axial piston pump. It has been designed exclusively for closed circuit hydrostatic transmissions where a self-contained pump package is required. The pump design incorporates a charge pump, a charge pressure relief valve, two combination high pressure relief and make-up check valves, and an integrated pressure cut-off valve.

Installation

The AA4VG pump may be mounted in any position around the horizontal (drive shaft) axis. Other mounting orientations (e.g. drive shaft vertical) are possible, but should be reviewed with a Rexroth Application Engineer prior to finalizing the design. The case drain line should be connected to the highest case drain port (T_1 or T_2) so that the pump case always remains full of oil. The case drain piping, or hose, should be sized to accept the full flow of the charge pump at the maximum anticipated drive speed, with minimal pressure drop.

Fluid Recommendations

The AA4VG pumps are supplied as standard for use with good quality, petroleum oil based, anti-wear hydraulic fluids. More detailed information regarding the selection of hydraulic fluids and their application limits can be found in our Data Sheets RA 90220 (Petroleum Oil), RE 90221 (Biodegradable Fluids) and RA 90223 (Type HF—Fire Resistant/Synthetic Fluids).

For applications with biodegradable or Type HF fluids, possible reduction of the operating specifications may be required. Please consult Rexroth and your oil supplier.

Operating Viscosity Range

In order to obtain optimum efficiency and service life, we recommend that the operating viscosity (at normal loop operating temperature) be selected from within the range:

Optimum Viscosity (V_{opt}) 80...170 SUS (16...36 mm²/S)

Viscosity Limits

Max. Viscosity at startup (V_{max}) 7273 SUS (1600 mm²/S)

Min. Viscosity for short duration (V_{min}) 42 SUS (5 mm²/S)

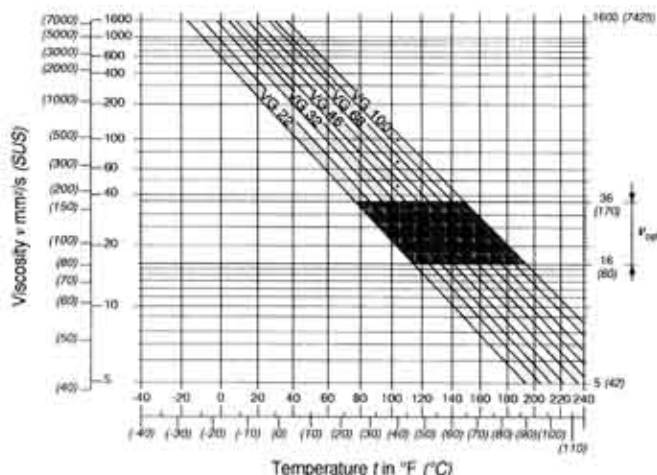
Operating Temperature Limits

Min. operating temperature -13°F (-25°C)

Absolute min. temperature -40°F (-40°C)

Max. operating temperature for short duration 239°F (115°C)

Selection Diagram



Notes on hydraulic fluid selection

In order to select the correct fluid, it is necessary to know the normal operating temperature in the circuit (closed loop), when the system is operated at the design ambient temperature.

The hydraulic fluid should be selected so that, within the operating temperature range, the fluid viscosity is within the optimum range V_{opt} (see shaded area of the selection diagram). We recommend that the higher viscosity grade is selected in each case.

Example: At an ambient temperature of X°F the closed circuit fluid temperature is 140°F (60°C). Within the optimum operating viscosity range V_{opt} (shaded area), this corresponds to ISO viscosity grades VG 46 or VG 68. VG 68 should be selected.

Important: The leakage oil (case drain oil) temperature is influenced by pressure and pump speed and is typically higher than the circuit temperature. However, maximum temperature at any point in the system must be limited to 239°F (115°C).

If it is not possible to comply with the above conditions because of extreme operating parameters or high ambient temperatures please consult Rexroth.

Fluid Cleanliness Levels

In order to ensure proper and reliable operation, the hydraulic fluid must be maintained at a minimum cleanliness level of 18/15 (ISO/DIS 4406; SAE J1165). Axial piston pump component life is directly affected by the cleanliness of the fluid in the system.

Temperature Range	-40...195°F (-40...90°C)	195...240°F (90...115°C)
Cleanliness Recommendations:	Class	Class
ISO/DIS 4406 (SAE J1165)	18/15	17/14
NAS 1638	9	8
SAE, ASTM, AIA	6	5

Operating Pressures Ranges

Main pump:

Nominal charge pressure; p_{sp} 20 bar (290 psi)

Nominal pressure (port A or B); p_N 400 bar (5800 psi)

Peak pressure (port A or B); p_{max} 450 bar (6525 psi)

Maximum case drain pressure (T_1, T_2, T_3 , and T_4)

p_L 2 bar abs. (30 psia)

short term (cold start) 3 bar abs. (43.5 psia)

Charge pump:

Nominal pressure p_{sp} 20 bar (290 psi)

Peak pressure p_{Hmax} 40 bar (580 psi)

Min. pressure at charge pump inlet port (S):

at $V = 141$ SUS (30 cSt) $p \geq 0.8$ bar abs. (6.3 in-Hg.)

at cold start $p \geq 0.5$ bar abs. (15.2 in-Hg.)

Variable Displacement Pump AA4VG, Series 3

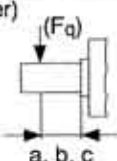
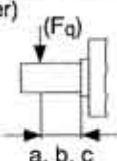
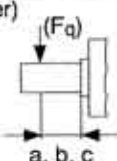
Technical Data

AA4VG Specifications (Theoretical values; rounded)

Size				40	56	71	90	125	180
Displacement	Variable pump	$V_{g \max}$	cm ³ /rev	40	56	71	90	125	180
			in ³ /rev	2.44	3.42	4.33	5.49	7.63	10.98
	Charge pump	V_{gH}	cm ³ /rev	8.4	11.1	18.7	18.7	25.7	36.9
			in ³ /rev	0.51	0.68	1.14	1.14	1.56	2.25
Speed	max. rpm at $V_{g \max}$	$n_{\max \text{ cont}}$	rpm	4000	3600	3300	3050	2750	2400
	limited max. rpm ①	$n_{\max \text{ limit}}$	rpm	4200	3900	3600	3300	3100	2900
	intermittent max. rpm ②	$n_{\max \text{ interm}}$	rpm	5000	4500	4100	3800	3450	3000
	minimum rpm	n_{\min}	rpm	500	500	500	500	500	500
Flow	at $n_{\max \text{ cont}}$ and $V_{g \max}$	Q_{\max}	L/min	160	202	234	275	344	432
			gpm	42.3	53.4	61.8	72.7	90.9	114.1
Power	at $n_{\max \text{ cont}}$	$\Delta p = 400 \text{ bar}$	P_{\max} kW	107	134	156	183	229	288
		$\Delta p = 5800 \text{ psi}$	hp	144	180	209	245	307	386
Torque (without charge pump)	at $V_{g \max}$	$\Delta p = 400 \text{ bar}$	M_{\max} Nm	254	356	451	572	795	1144
		$\Delta p = 5800 \text{ psi}$	lb-ft	187	263	333	423	586	844
		$\Delta p = 100 \text{ bar}$	M Nm	63.5	89	112.8	143	198.8	286
		$\Delta p = 1450 \text{ psi}$	lb-ft	46.8	65.6	83.2	105.5	146.6	210.9
Moment of inertia (about drive axis)		J	kgm ²	0.003	0.0051	0.0072	0.0106	0.0164	0.0323
			lb-ft ²	0.0712	0.1210	0.1709	0.2515	0.3892	0.7665
Weight (standard model without through drive)	m		kg	31	38	50	66	80	104
			lbs.	68	84	110	145	176	229

① Limited maximum rpm: – at half corner power (e.g. at $V_{g \max}$ and $p_N/2$)② Intermittent maximum rpm: – at high idle speed
– during engine overspeed: $\Delta p = 70\text{--}150 \text{ bar}$ (1015–2176 psi) and $V_{g \max}$
– with reversing loads: $\Delta p < 300 \text{ bar}$ (4350 psi) and $t < 5 \text{ seconds}$ V_g = Displacement (cm³ or in³) per revolution Δp = Differential pressure n = Speed (rpm)

Input Drive (Permissible axial and radial loading on drive shaft)

Size				40	56	71	90	125	180
Distance of F_q (from shaft shoulder)		a	mm	17.5	17.5	20.0	20.0	22.5	25.0
		a	in	0.69	0.69	0.79	0.79	0.89	0.98
		b	mm	30	30	35	35	40	45
		b	in	1.18	1.18	1.38	1.38	1.57	1.77
		c	mm	42.5	42.5	50	50	57.5	60
		c	in	1.67	1.67	1.97	1.97	2.26	2.36
Max. permissible radial load at distance		a	$F_{q \max}$ N	3600	5000	6300	8000	11000	16000
		a	lbs.	809	1124	1416	1798	2473	3597
		b	$F_{q \max}$ N	2891	4046	4950	6334	8594	12375
		b	lbs.	650	910	1113	1424	1932	2782
		c	$F_{q \max}$ N	2416	3398	4077	5242	7051	10150
		c	lbs.	543	764	917	1178	1585	2282
Max. permissible axial load		$\pm F_{q \max}$	N	1500	2200	3500	3500	4800	6000
			lbs.	337	495	787	787	1079	1349

Filtration Options

Many factors influence the selection of a filter to achieve the desired cleanliness level, including: dirt ingress rate, required cleanliness level, and system complexity. We have found the following filter Beta (β) ratios (ISO 4572) to be satisfactory:

Suction Filtration..... $\beta_{10} \geq 2.0$ & $\beta_{30} \geq 100$
 Charge Pressure Filtration..... $\beta_{10} \geq 10.0$ & $\beta_{20} \geq 100$

Machine testing is necessary to confirm the ability of the selected filter to maintain the desired fluid cleanliness levels.

Charge Flow Suction Filtration (standard model)...S

Filter type: Filter without bypass

Filter element pressure drop:

at $v = 141 \text{ SUS}$ (30 cSt); $n = n_{\max}$ $\Delta p \leq 0.1 \text{ bar}$ (1.5 psi)
 at $v = 4635 \text{ SUS}$ (1000 cSt); $n = 1000 \text{ rpm}$ $\Delta p \leq 0.3 \text{ bar}$ (4.5 psi)

Min. pressure at charge pump inlet port (S):

at $v = 141 \text{ SUS}$ (30 cSt) $p \geq 0.8 \text{ bar abs.}$ (6.3 in-Hg.)
 at cold start $p \geq 0.5 \text{ bar abs.}$ (15.2 in-Hg.)

The filter should be fitted with a Δp indicator and/or switch.

Variable Displacement Pump AA4VG, Series 3

Filtration Options

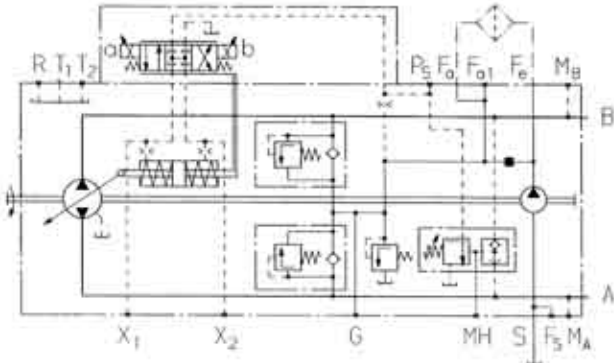
Charge Pressure Filtration...D (Ports Fe & Fa)

Filter type: Filter **without** bypass

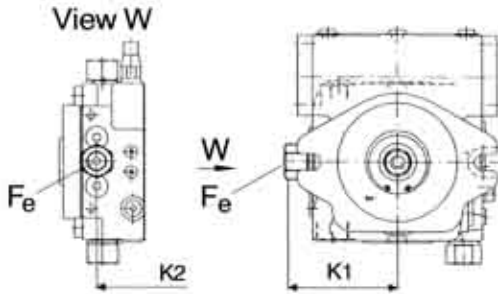
Filter element pressure drop (line mounted filter):
at $v=141$ SUS (30 cSt); $n=n_{max}$ $\Delta p \leq 1$ bar (14.5 psi)
at cold start $\Delta p_{max}=3$ bar (43.5 psi)
(valid for entire speed range $n_{min}-n_{max}$)

- Please note:
- With Direct Operated Hydraulic Control–Type DG, control pressure should be supplied from the P_s port.
 - The filter should be fitted with a ΔP indicator and/or switch set at ≤ 3 bar (43.5 psid).

Circuit Diagram...D (Ports Fe & Fa)



Dimensions...D (Ports Fe & Fa)



Size	K1	K2	Fe
40	112	198.7	3/4"-16 UNF-2B; 15 deep
56	115	215.4	3/4"-16 UNF-2B; 15 deep
71	134	239.0	1 1/16"-12 UN; 20 deep
90	128	248.5	1 1/16"-12 UN; 20 deep
125	147	267.9	1 5/16"-12 UN-2B; 20 deep
180	148	311.9	1 5/16"-12 UN-2B; 20 deep

Charge Pressure Filtration...K (with cold start valve)

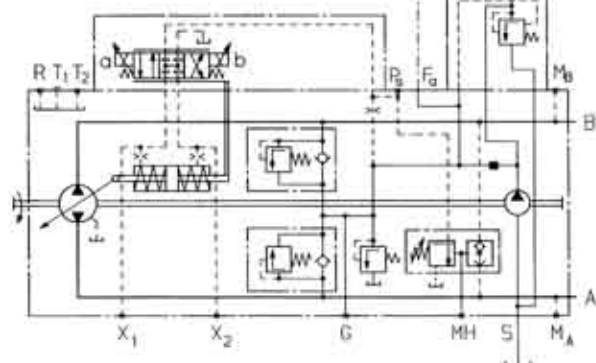
Similar to option D, except with cold start valve, providing filter bypass function and charge pump protection.

Bypass valve:
Bypass setting $\Delta p \geq 3.5$ bar (50 psi)
Bypass flow To charge pump inlet

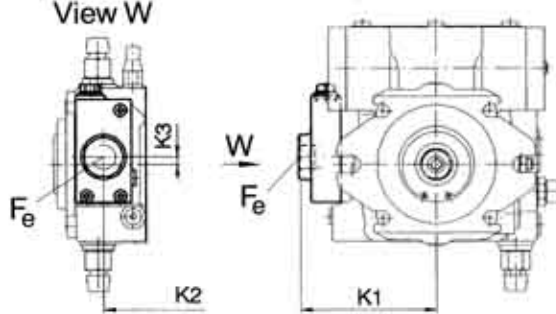
Port F_e To line mounted filter
Port F_a From line mounted filter

The filter should be fitted with a ΔP indicator and/or switch set at ≤ 3 bar (43.5 psid).

Circuit Diagram...K (with cold start valve)



Dimensions...K (with cold start valve)

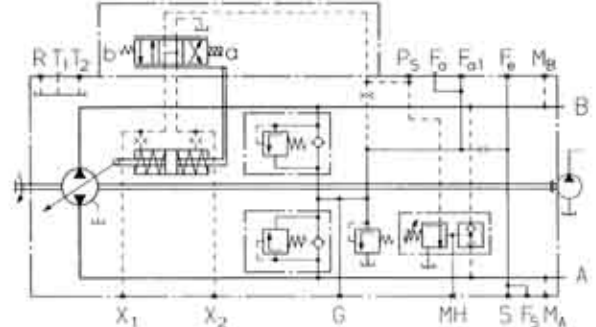


Size	K1	K2	K3	Fe
40	122.5	198.7	0	3/4"-16 UNF-2B; 15 deep
56	125.5	215.4	0	3/4"-16 UNF-2B; 15 deep
71	145.5	239.0	8	1 1/16"-12 UN; 20 deep
90	139.5	248.5	24	1 1/16"-12 UN; 20 deep
125	172.0	267.9	20	1 5/16"-12 UN-2B; 20 deep
180	173.0	311.9	3	1 5/16"-12 UN-2B; 20 deep

External Charge Supply...E (without charge pump)

On units supplied without an integrated charge pump (N00 or K...) the suction port (S) is plugged, and the external charge supply is connected at port F_a . Please note that the externally supplied charge flow must be maintained at the cleanliness levels indicated on page 4.

Circuit Diagram...E (without charge pump)



Filtration Options

Charge Pressure Filtration...F (mounted filter) (Without contamination indicator)

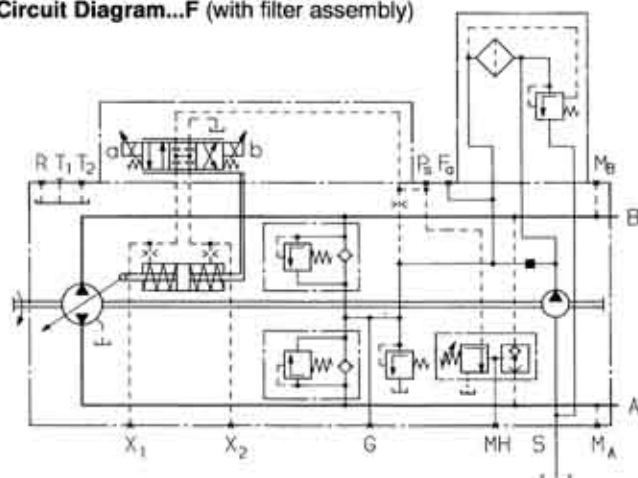
Filter type:Filter **without** bypass
Integral bypass valve:
Bypass setting $\Delta p \geq 3.5$ bar (50 psi)
Bypass flow To charge pump inlet

Filter element pressure drop (mounted filter):
at $v = 141$ SUS (30 cSt); $n = n_{\max}$ $\Delta p \leq 1$ bar (14.5 psi)
at cold start $\Delta p_{\max} = 3$ bar (43.5 psi)
(valid for entire speed range $n_{\min} - n_{\max}$)

Please note:

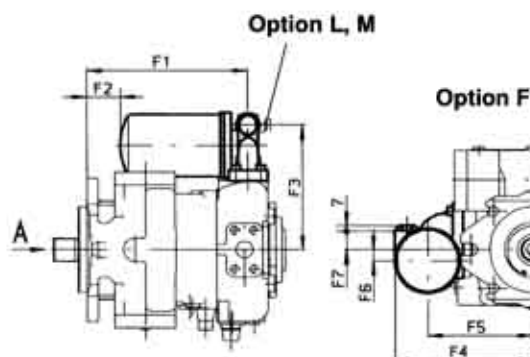
- Max. perm. charge pressure for sizes 40 and 56:
 $p_{Sp \max} = 510$ psi (35 bar)
- With Direct Operated Hydraulic Control-Type DG, control pressure should be supplied from the P_S port.
- The filter should be fitted with a Δp indicator and/or switch set at ≤ 3 bar (43.5 psid).

Circuit Diagram...F (with filter assembly)



Dimensions...F, P, L, M (with filter assembly)

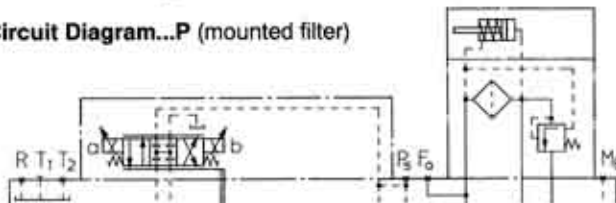
Size	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
40	198.7	46.7	160	175	135	0	42	78.5	122	125
56	215.4	63.4	163	178	138	0	42	78.5	122	125
71	239	50	185	203.5	155	16	29	65.5	109	112
90	248.5	59.4	179	197.5	149	0	53	89.5	133	136
125	267.9	62.8	201	219.5	171	0	53	89.5	133	136
180	311.9	37.9	202	220.4	171.9	17	36	72.5	116	119



Charge Pressure Filtration...P (mounted filter) (With visual contamination indicator)

Similar to option F, except model P includes visual contamination indicator. Indication: Green/Red window.
Indicator switching pressure. $\Delta p = 3$ bar (43.5 psi)

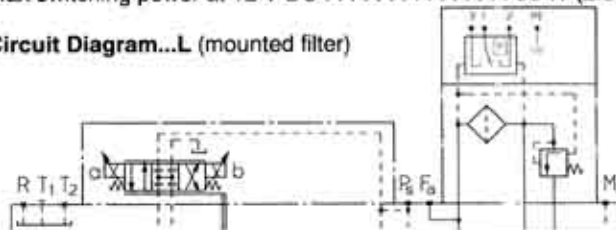
Circuit Diagram...P (mounted filter)



Charge Pressure Filtration...L (mounted filter) (With electrical contamination indicator)

Similar to option F, except model L includes electrical contamination indicator. Indication: Electrical.
Indicator switching pressure. $\Delta p = 3$ bar (43.5 psi)
Max switching power at 24 V DC 60 W (2.5 A)
Max switching power at 12 V DC 30 W (2.5 A)

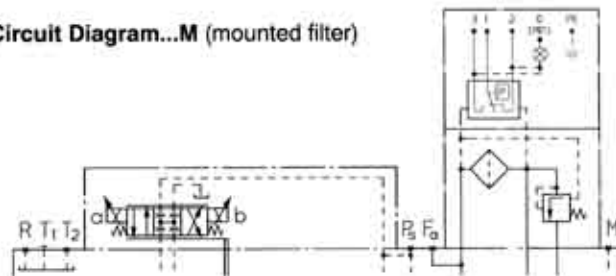
Circuit Diagram...L (mounted filter)



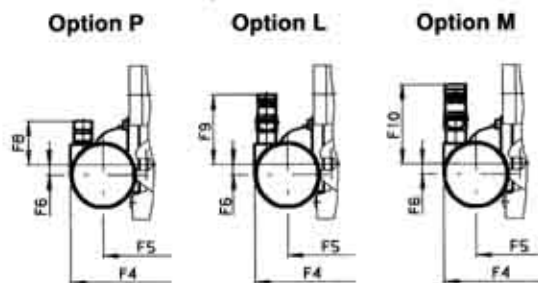
Charge Pressure Filtration...M (mounted filter) (With visual and electrical contamination indicator)

Similar to option F, except model M includes visual and electrical contamination indicator. Indication: ep. and visual by lamp.
Indicator switching pressure. $\Delta p = 3$ bar (43.5 psi)
Max switching power at 24 V DC 60 W (2.5 A)
Max switching power at 12 V DC 30 W (2.5 A)

Circuit Diagram...M (mounted filter)

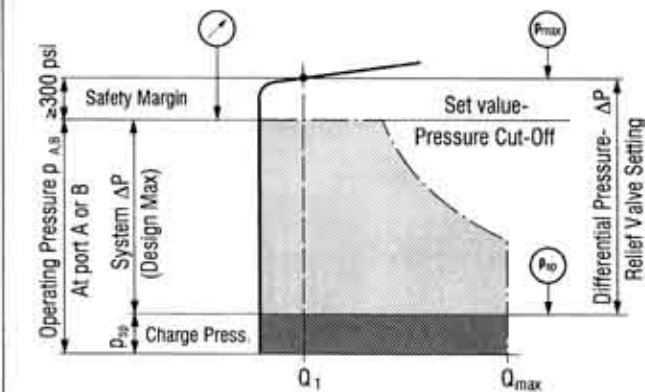


View A, rotated 90°



High Pressure Relief Valve

Adjustment diagram with Pressure Cut-Off



Note: Relief valves are adjusted at a flow rate of:
Q₁ = 6–10 l/min (1.6–2.6 gpm), depending on size

Example: Charge pressure 30 bar (435 psi)
Operating pressure 410 bar (5945 psi)
(Pressure cut-off setting)
Safety margin 20 bar (290 psi)

Operating press. $p_{A,B}$ – Charge press. p_{sp} + Safety Margin = Differential press. Δp
410 bar – 30 bar + 20 bar = 400 bar
(5945 psi) – (435 psi) + (290 psi) = (5800 psi)

High pressure relief valve Pilot Operated (size 71...180)	Differential pressure settings (Δp_{HD})
Setting range valve 1	420 bar (6090 psi)
Δp 100–420 bar	400 bar (5800 psi) *
Δp 1450–6090 psi (see model code)	350 bar (5075 psi)
	320 bar (4640 psi)
	300 bar (4350 psi)
	270 bar (3915 psi)
	250 bar (3625 psi)
	230 bar (3335 psi)
	200 bar (2900 psi)
	150 bar (2175 psi)
	100 bar (1450 psi)

* Standard setting if not specified otherwise

High pressure relief valve Direct Operated (size 40, 56)	Differential pressure settings (Δp_{HD})
Setting range valve 3, 5	420 bar (6090 psi)
Δp 270–420 bar	400 bar (5800 psi) *
Δp 3915–6090 psi (see model code)	350 bar (5075 psi)
	320 bar (4640 psi)
	300 bar (4350 psi)
	270 bar (3915 psi)
Setting range valve 4, 6	250 bar (3625 psi)
Δp 60–250 bar	230 bar (3335 psi) *
Δp 870–3625 psi (see model code)	200 bar (2900 psi)
	150 bar (2175 psi)
	100 bar (1450 psi)

Bypass Function

Size 40, 56: HD-valves direct operated (3), (4): without bypass
Size 40, 56: HD-valves direct operated (5), (6): with bypass
Size 71...180: HD-valves pilot operated (1): with bypass

Simplification: The bypass function is not shown in the circuit diagrams.
The pilot operated HD-valves (sizes 71...180) are not shown in the circuit diagrams.

Please state in clear text when ordering:

High pressure relief valve A
Differential pressure setting: Δp_{HD} = ...psi
Pressure value of the HD-valve (at Q_1) p_{max} = ...psi
($p_{max} = \Delta p_{HD} + p_{Sp}$)

High pressure relief valve B
Differential pressure setting: Δp_{HD} = ...psi
Pressure value of the HD-valve (at Q_1) p_{max} = ...psi

Pressure Cut-Off

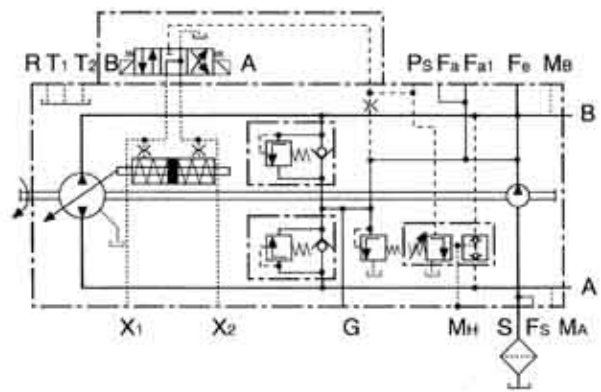
The pressure cut-off valve varies the swashplate angle, as required, to limit the maximum pressure at port A or B.

The pressure cut-off valve prevents continuous dumping of excessive flow, at load pressure, through the cross port relief valves in the pump. This eliminates unnecessary heating of the oil and protects the pump and motor during rapid acceleration or deceleration, or when the drive stalls, causing the pump to dead-head.

The pressure peaks that occur with rapid swivel angle changes, and also the maximum system pressure, are further protected by the high pressure relief valves.

The pressure cut-off valve should be set 20–30 bar (290–435 psi) less than the high pressure relief valve settings.

Standard Adjustment Range: 2175–6500 psi (150–450 bar)



Electrical Control–Non Proportional, EZ1D/EZ2D with Pressure Cut-Off

Variable Displacement Pump AA4VG, Series 3

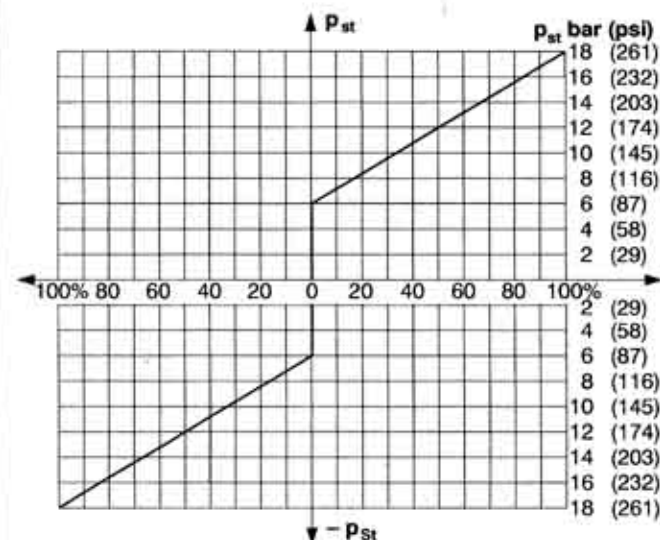
HD Hydraulic Pilot Control

The flow output of the pump is infinitely varied between 0 and 100%, proportional to the difference in pilot pressure applied to the two control ports (Y_1 and Y_2), in the range of 6 to 18 bar (87 to 261 psi).

The pilot signal, which originates from an external, remote source, is pressure only. Flow is negligible as the pilot signal is only acting on the spool of the control valve.

This spool then directs control oil into and out of the stroking cylinder to adjust pump displacement as required.

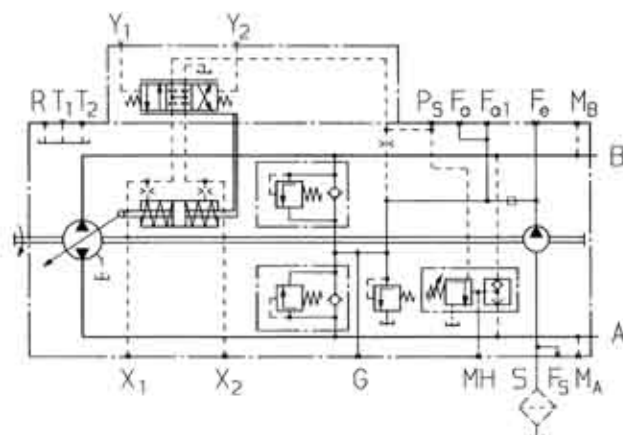
A feedback lever, connected to the stroking piston, maintains the pump flow for any given pilot signal.



Pilot pressure p_{st} : 6–18 bar (87–261 psi) at ports Y_1 , Y_2
 Begin of regulation: 6 bar (87 psi)
 End of regulation: 18 bar (261 psi)

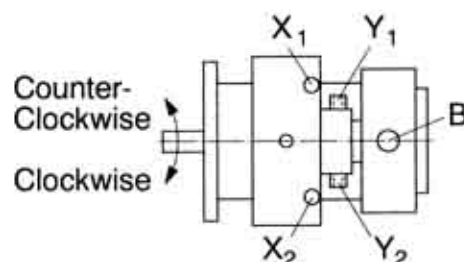
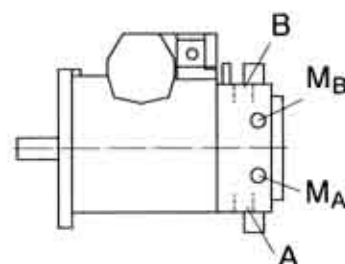
If the pump is also fitted with a DA control valve, automotive control of the vehicle transmission is possible.
 For DA control valve see page 12, 13, 28, & 29.

Standard model

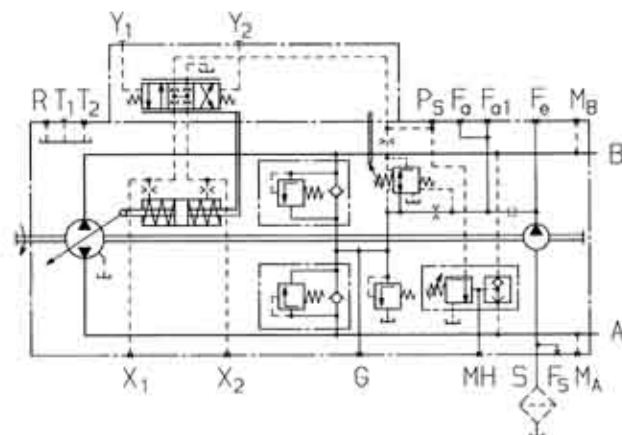


Data Table – AA4VG...HD
 Direction of rotation – Control – Output flow direction

	Size	Pilot Pressure	Control Pressure	Direction of Flow	Operating Pressure
Direction of Rotation Clockwise	40, 56	Y_1	X_1	A to B	M_B
		Y_2	X_2	B to A	M_A
	71, 90, 125, 180	Y_1	X_1	B to A	M_A
		Y_2	X_2	A to B	M_B
Direction of Rotation Counter-Clockwise	40, 56	Y_1	X_1	B to A	M_A
		Y_2	X_2	A to B	M_B
	71, 90, 125, 180	Y_1	X_1	A to B	M_B
		Y_2	X_2	B to A	M_A



Model with DA control valve

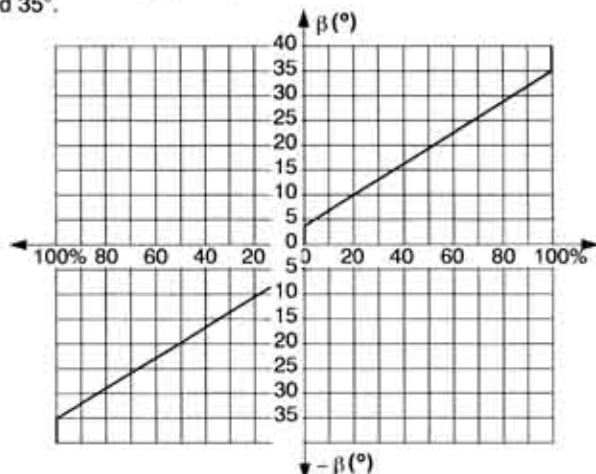


Variable Displacement Pump AA4VG, Series 3

HW Rotary Manual Servo Control

The flow output of the pump is infinitely varied in the range of 0 to 100%, proportional to the rotation of the control lever between 0° and ±35° from the spring centered zero flow position.

A feedback lever, connected to the stroking piston, maintains the pump flow for any given position of the control lever between 0° and 35°.



Swivel angle of the control lever:

from 0 to ± $V_{q \max}$ or $\beta = 0^\circ$ to ± 35°

mechanical stop: size 40–71 ± 40°
size 90–180 ± 35°

Required lever torque: 85–210 Ncm (7.5–19 lb-in)

Maximum lever torque: 250 Ncm (22 lb-in)

If the pump is also fitted with a DA valve, automotive control of the vehicle transmission is also possible.

For DA control valve see page 12, 13, 28, & 29.

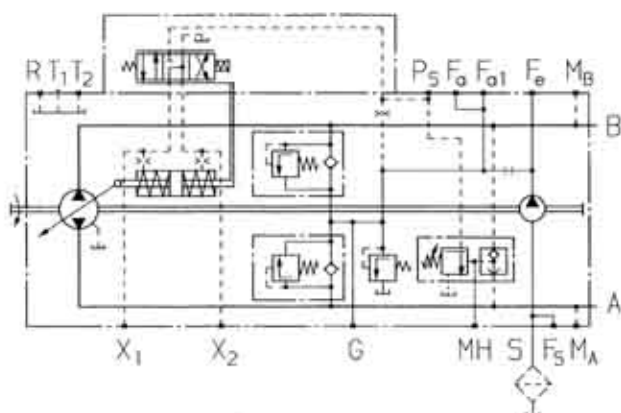
For pressure cut-off see page 8.

Option: Neutral position switch...HWDL

When the HW control lever is in the neutral position, the neutral position switch is closed. The switch opens if the control lever is moved out of neutral in either direction.

The neutral position switch provides a safety function for systems that require zero flow under certain operating conditions. (e.g. engine start).

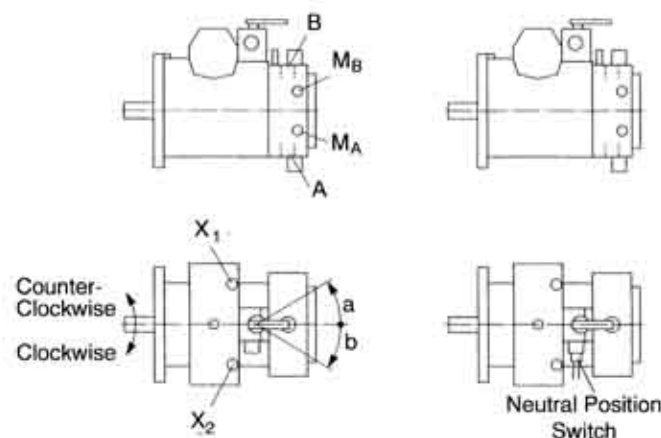
Standard model



Data Table – AA4VG...HW

Direction of rotation – Control – Output flow direction

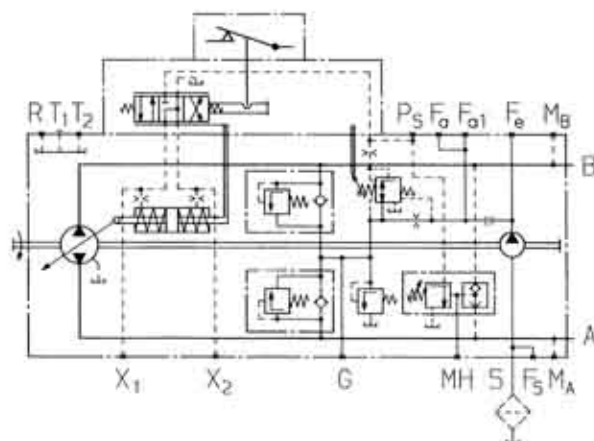
	Size	Lever Direction	Control Pressure	Direction of Flow	Operating Pressure
Direction of Rotation	Clockwise	a	X ₂	B to A	M _A
		b	X ₁	A to B	M _B
	Counter-Clockwise	a	X ₂	A to B	M _B
		b	X ₁	B to A	M _A



Technical data for neutral position switch

Load performance	20A (continuous)
Switch performance	15A / 32V (DC)
	4A / 32V (AC - inductive)

Model with DA control valve and neutral position switch

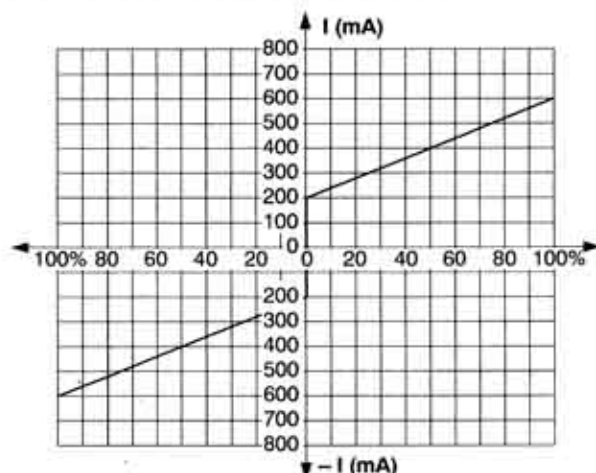


EP Proportional Electrical Control

The flow output of the pump is infinitely varied in the range of 0 to 100%, proportional to an electrical current, in the range of 200–600 mA at 24 volts DC, supplied to solenoid a or b. (A current of 400 to 1200 mA is required for the 12 volt solenoids.)

The electrical energy is converted to a force acting on the control spool. The spool then directs control oil in and out of the stroking piston to stroke the pump as required. A feedback lever, connected to the stroking piston, maintains the pump flow for any given current within the control range.

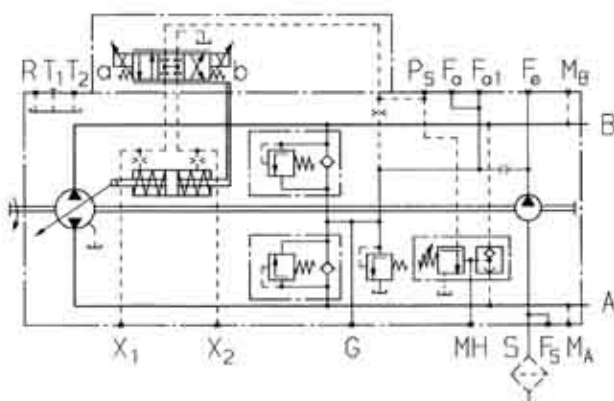
Proportional amplifiers MDSD, PVR-PVRS and special function amplifier EDA are available to control the proportional solenoids. As well, electronic control of the solenoids can be achieved by using a microcontroller with software that is programmed to perform special functions for custom applications.



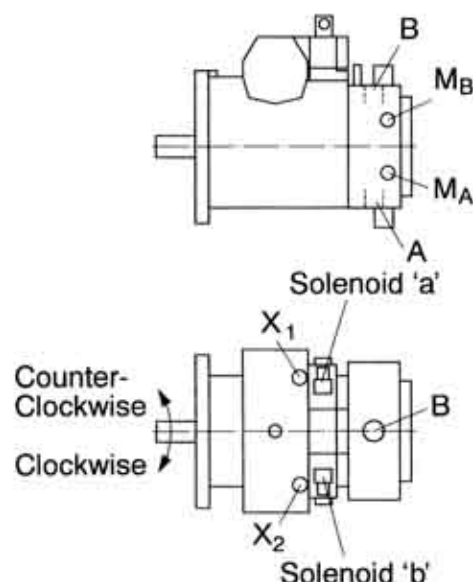
Control current (24 vdc; EP2): $I = 200\text{--}600\text{ mA}$
 Begin of control: $I = 200\text{ mA}$ (V_{g0})
 End of control: $I = 600\text{ mA}$ ($V_{g\max}$)
 Control current (12 vdc; EP1): $I = 400\text{--}1200\text{ mA}$
 Begin of control: $I = 400\text{ mA}$ (V_{g0})
 End of control: $I = 1200\text{ mA}$ ($V_{g\max}$)

If the pump is also fitted with a DA control valve, automotive control of the vehicle transmission is possible.
 For DA control valve see page 12, 13, 28, & 29.

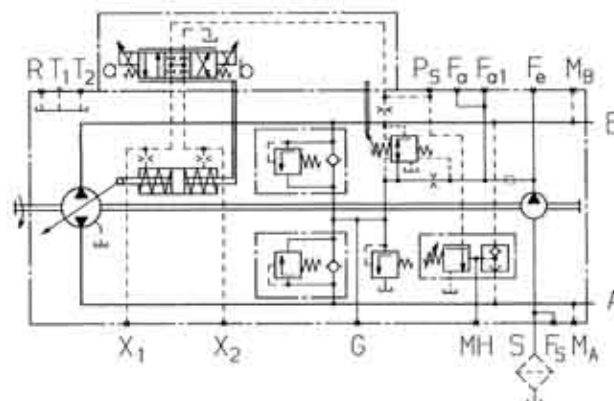
Standard model



Data Table – AA4VG...EP					
Direction of rotation – Control – Output flow direction					
Direction of Rotation	Size	Solenoid	Control Pressure	Direction of Flow	Operating Pressure
	40, 56	a	X ₁	A to B	M _B
		b	X ₂	B to A	M _A
	71, 90, 125, 180	a	X ₁	B to A	M _A
		b	X ₂	A to B	M _B
	40, 56	a	X ₁	B to A	M _A
		b	X ₂	A to B	M _B
Counter-Clockwise	71, 90, 125, 180	a	X ₁	A to B	M _B
		b	X ₂	B to A	M _A



Model with DA control valve



DA Hydraulic Control Speed Dependent

Pilot pressure from the DA regulating cartridge is directed to the stroking piston of the pump by a 4/3 way directional valve. Pump displacement is infinitely variable in each direction of flow, proportional to both pump drive speed and discharge pressure. Flow direction (i.e. Machine forward or reverse) is controlled by energizing solenoid a or b (refer to flow direction data table at right).

Increasing pump drive speed generates a higher pilot pressure from the DA cartridge, with a subsequent increase in pump flow and/or pressure.

Dependent on the pump operating curve, increasing system pressure causes the pump to swivel back towards a smaller displacement.

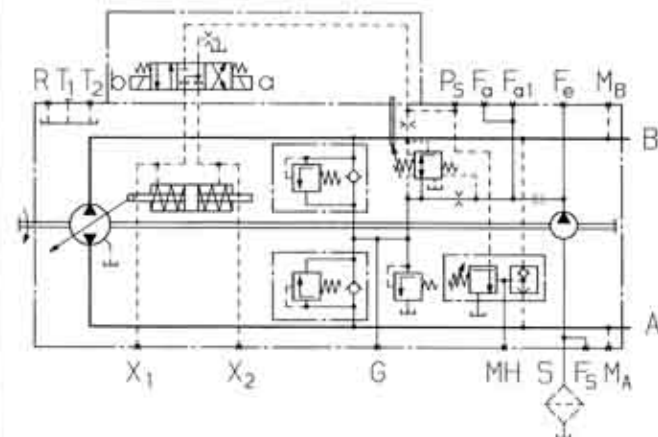
A relatively constant torque input to the pump is achieved by this combination of de-stroking the pump as the operating pressure increases and the response to the "pull-down" of the prime mover (reduced pilot pressure).

Any additional power requirements, such as implement hydraulics, may result in engine pull down. This leads to a reduction in pilot pressure and therefore pump displacement (i.e. power). The power thus released is then available to supply that demanded by the implement hydraulics. Automatic power division and full utilization of available power is thus achieved for both the vehicle transmission and the implement hydraulics.

Minimizing the engine pull down provides optimum usage of the available drive power. This can be achieved by "partial inching", using the adjustable regulating cartridge with lever (catalog code options 3 and 5). With partial inching, the DA cartridge is mechanically coupled to the accelerator pedal. This means that when a certain engine speed is reached, (movement of the accelerator pedal), the control curve is offset parallel to the engine speed curve.

Application of the DA Control is only appropriate on certain types of vehicle drive systems, and requires a careful review of the engine and vehicle parameters to ensure that the pump is set up correctly. All DA applications must therefore be reviewed by a Rexroth Application Engineer.

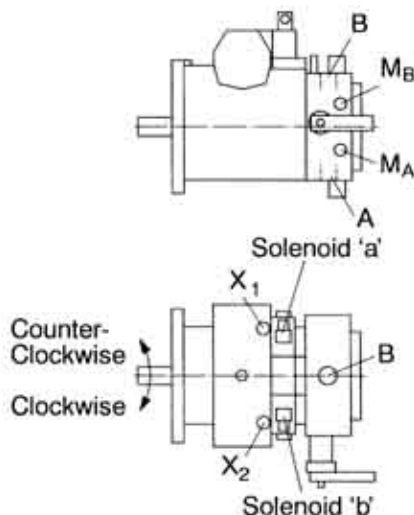
Hydraulic Control, Speed Dependent (DA) control valve, mech. adjustable with control lever DA1D3/DA2D3



Data Table – AA4VG...DA

Direction of rotation – Control – Output flow direction

	Size	Solenoid	Control Pressure	Direction of Flow	Operating Pressure
Direction of Rotation	Clockwise	a	X ₂	B to A	M _A
		b	X ₁	A to B	M _B
	71, 90, 125, 180	a	X ₂	A to B	M _B
		b	X ₁	B to A	M _A
	40, 56	a	X ₂	A to B	M _B
		b	X ₁	B to A	M _A
Counter-Clockwise	71, 90, 125, 180	a	X ₂	B to A	M _A
		b	X ₁	A to B	M _B



Rotary Inching Valve

This valve is used to provide vehicle inching function, and is used in conjunction with the DA Regulating Cartridge with fixed adjustment.

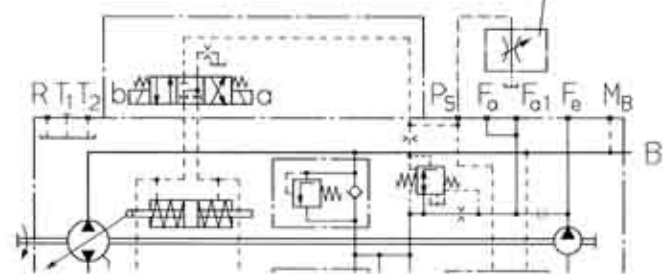
It permits the pilot pressure (speed dependent) to be reduced as necessary, independently of the pump drive speed, controlled by rotation of the inching lever.

Maximum angle of lever operation is 90°. The position of the lever is optional (inching operation clockwise or counter-clockwise).

The valve is mounted separately from the pump and connected to the P_S port. Maximum line length should be limited to approximately 2 meters (79').

Hydraulic Control, Speed Dependent (DA) with separate rotary inching valve

Rotary inching valve (see ordering code)



DA Hydraulic Control Speed Dependent

Function and control of DA valves.

Rotary Inching Valve

The rotary inch valve is to be ordered separately.

Size	Ordering Code
40, 56, 71, 90	438 553/470.05.31.01
125	438 554/470.05.31.02
180	438 555/470.05.31.03

Please state your requirements in clear text: Inching, clockwise or counter-clockwise operation of the lever (this is determined on assembly).

Attention: The rotary inch valve can be used independently from the control device.

DA regulating cartridge, fixed adjustment (2)

Pilot pressure is generated in relation to drive speed. There are no provisions for inching with this cartridge. The pump is factory preset as determined by engine/vehicle requirements.

DA regulating cartridge, mechanically adjustable w/lever (3)

Pilot pressure is generated in relation to drive speed. The pump is factory preset as determined by engine/vehicle requirements. Pilot pressure may be reduced (independently of drive speed) as required, by operation of the control lever (inching function).

Maximum angle of lever operation is 70°. The position of the lever is optional (inching operation clockwise or counter-clockwise).

Hydraulic inching valve (4, 5)

This valve is used to provide vehicle inching function, and is used in conjunction with the DA Regulating Cartridge, either with fixed adjustment or mechanically adjustable with lever.

Model with throttle valve used on Size 40, 56, & 71.

Model with pressure reducing valve used on size 90, 125, & 180.

It permits the pilot pressure (speed dependent) to be reduced as necessary, independently of the pump drive speed, by applying a hydraulic pressure at Port Z. This is normally supplied from the vehicle braking system using the brake fluid of the power brakes.

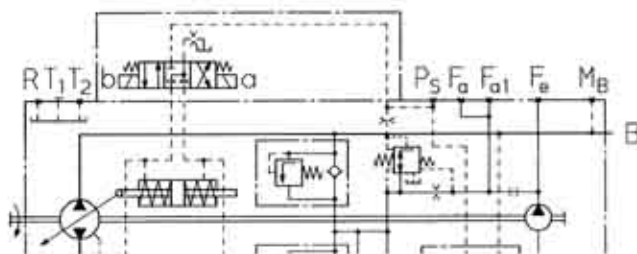
Master controller TH7 as inching valve (7)

This valve is used to provide vehicle inching function, and is used in conjunction with the DA control valve, fixed setting.

Any reduction of control pressure, independent from the input speed through the mechanical operation of the master controller TH7.

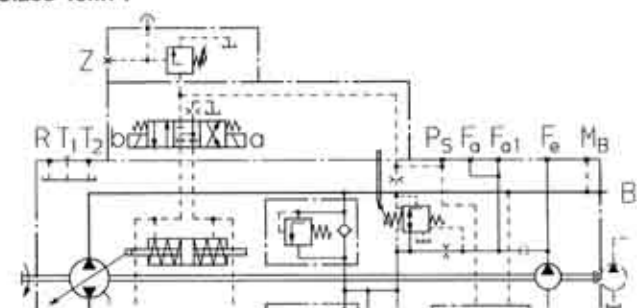
The master controller is installed separately from the pump connected with the pump by 2 hydraulic control lines at ports P_s and Y. The master controller is to be ordered separately (see data sheet RE 64558)

Hydraulic Control, Speed Dependent (DA) fixed setting, DA1D2/DA2D2

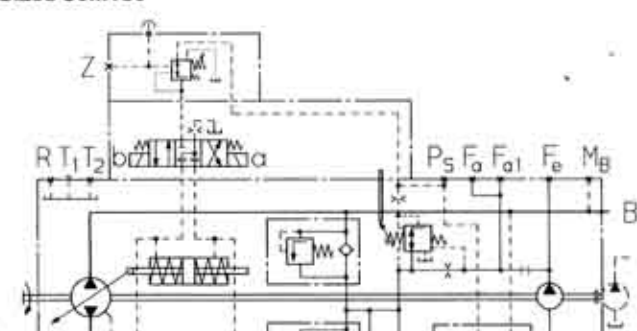


Hydraulic Control, Speed Dependent (DA) mechanically adjustable with control lever, with hydraulic inching valve, DA1D5/DA2D5

with throttle valve
Sizes 40...71

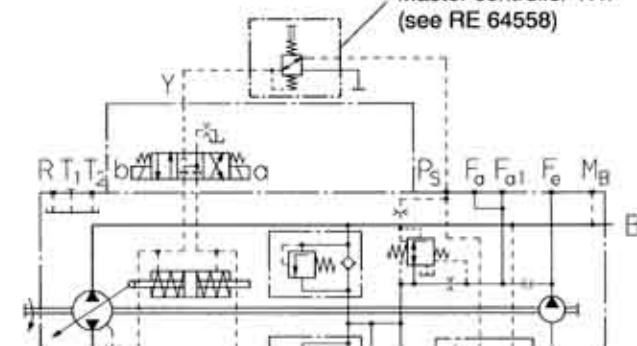


with pressure reducing valve
Sizes 90...180



Hydraulic Control, Speed Dependent (DA) fixed setting, with separately installed master controller TH7 as inching valve, DA1D7/DA2D7

Master controller TH7
(see RE 64558)



EZ Electrical Control Non-Proportional

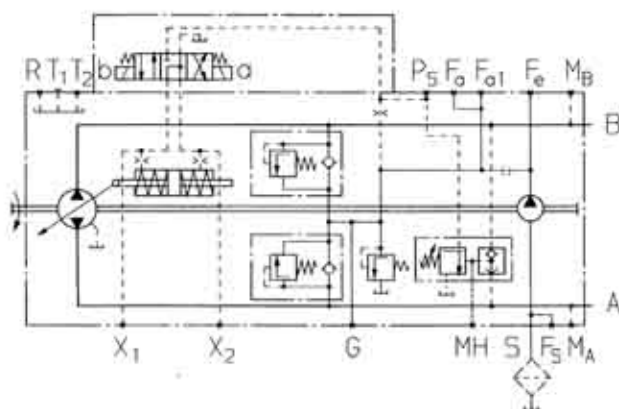
By energizing either solenoid a or b, internal control pressure is connected directly to the stroking piston, and the pump swivels to maximum displacement.

With the EZ control pump flow is switchable from zero flow (neither solenoid energized) to maximum flow. Flow direction is determined by which solenoid is energized (please refer to the data table at the top of page 12).

EZ1 12 vdc solenoids
EZ2 24 vdc solenoids

Pressure Cut-Off: Refer to page 8.

Standard model



DG Hydraulic Control Direct Operated

Pumps supplied with the DG control have no control module. The module is replaced by a cover plate.

Pump output is controlled by hydraulic control pressure (P_{st}), typically supplied by a remote pilot controller, applied directly to the stroking piston through either the X_1 or X_2 port. The DG control is not a positive displacement control, as there is no control feedback device.

While pump displacement is infinitely variable between 0 and 100%, a given swashplate position can be affected by system pressure and/or pump drive speed, as well as the stroking piston centering springs.

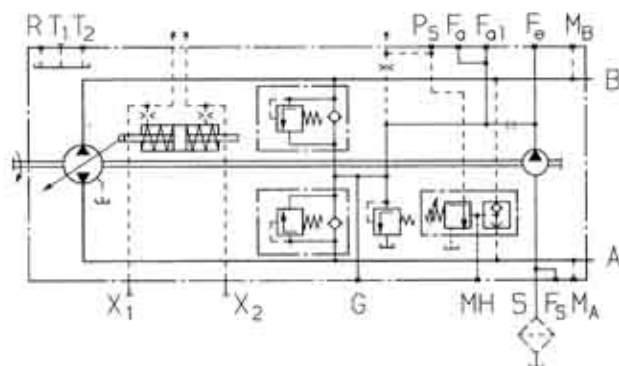
Flow direction is determined by which pilot port is pressurized (please refer to the data table at the top of page 9; Control Pressure column- X_1 ; X_2).

Nominal characteristics:

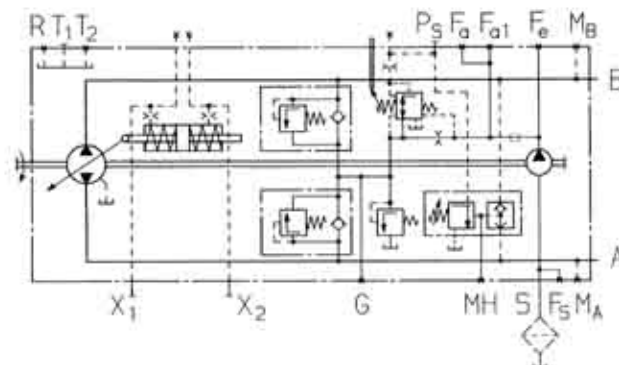
Begin of regulation- $P_{st \min}$ 5–8 bar (73–116 psi)
End of regulation (full stroke)- $P_{st \max}$ 22–25 bar (320–363 psi)

Application of the DG Control is only appropriate on certain types of vehicle drive systems, and requires a careful review of the engine and vehicle parameters to ensure that the pump is set up correctly. All DG applications should be reviewed by a Rexroth Application Engineer.

Standard model



Standard model with DA control valve

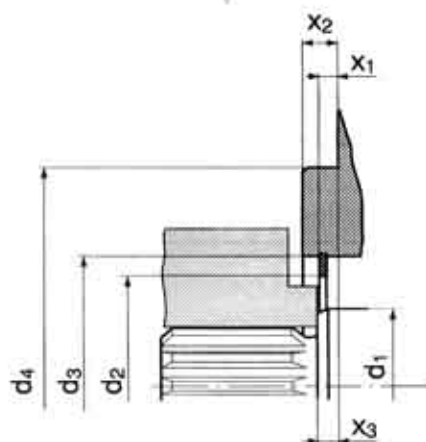


Installation Situation for Coupling Assembly

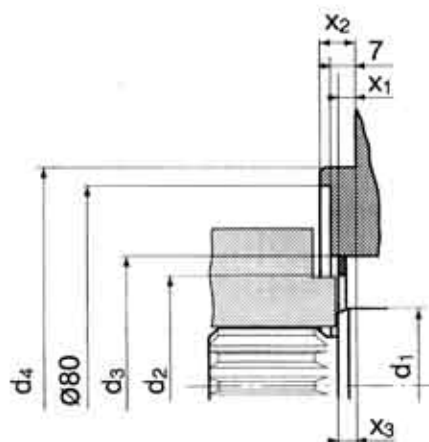
In order to assure that rotating parts (coupling hub) and fixed parts (housing circlip) do not contact each other the installation situations are described in this data sheet have to be observed. The installation situation depend upon the sizes and the spline.

For SAE spline shaft (shaft S or T) the outer diameter of the coupling hub must be smaller than the inner diameter of the circlip d_3 at the zone of the drive shaft shoulder (measure $X_2 - X_3$).

SAE Spline



Sizes 56–180



Size 40 only

Size	ϕd_1	$\phi d_{2 \text{ min}}$	ϕd_3	ϕd_4	X_1	X_2	X_3
40	40	51.4	63 ± 0.1	127	4.3 ± 0.2	$12.7_{-0.5}$	$8_{-0.6}^{+0.9}$
56	40	54.4	68 ± 0.1	127	7.0 ± 0.2	$12.7_{-0.5}$	
71	45	66.5	81 ± 0.1	127	7.0 ± 0.2	$12.7_{-0.5}$	
90	50	66.5	81 ± 0.1	152.4	6.8 ± 0.2	$12.7_{-0.5}$	
125	55	76.3	91 ± 0.1	152.4	7.0 ± 0.2	$12.7_{-0.5}$	
180	60	88	107 ± 0.1	165.1	7.4 ± 0.2	$15.9_{-0.5}$	

Combination Pump

Combination pumps provide two independent closed circuits without the need for splitter gear boxes. When ordering combination pumps the individual model codes should be connected by a '+' sign:

Code: Pump #1 (front pump) + Code: Pump #2 (rear pump)

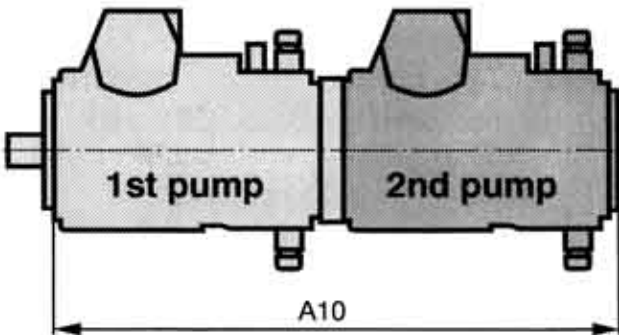
Code example: AA4VG 56 EP1D1/32 R – PTC 52 F073S + AA4VG 56 EP1D1/32 R – PSC 52 F003S

External support for combination pumps of the same frame size is not required, if the dynamic acceleration does not exceed 10g (=98.1 m/s²).

The 4-bolt mounting flange is recommended for size 71 and larger pumps.

Combination pump of the same size
(2nd pump without through drive and with auxiliary pump, F00)

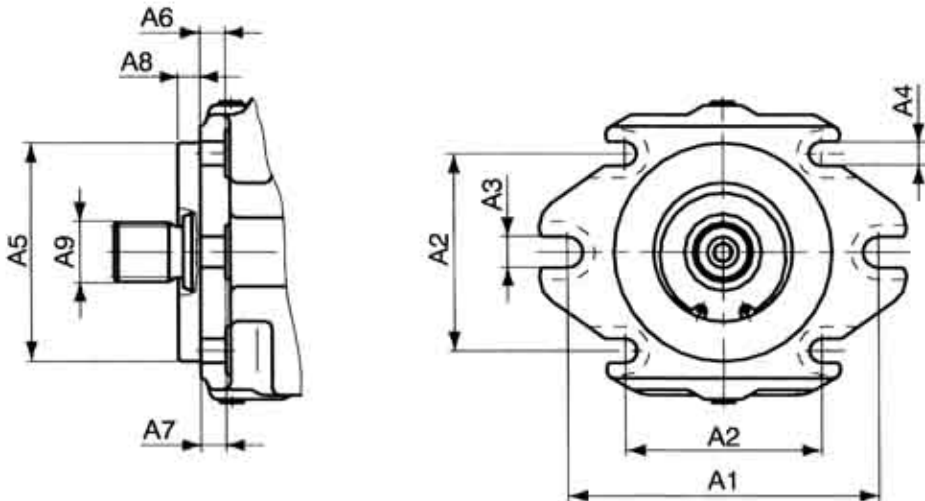
Size	40	56	71	90	125	180
A10	475.5	521.2	596.4	608.8	669.1	764



Mounting flanges & shaft options (of single and combination pumps)

										Combination pump of same size		
Size	Mtg. flange	A1	A2	A3	A4	A5	A6	A7	A8	Single pump	1st Pump	2nd Pump
										A9	A9	Through drive
40	SAE C (2-Bolt)	181	–	18	–	ø127	–	15	12.7	S (SAE 1 1/8")	S (SAE 1 1/8")	F09/K09
56	SAE C (2-Bolt)	181	–	18	–	ø127	–	18	12.7	S (SAE 1 1/8")	T (SAE 1 3/8")	F07/K07
71	SAE C (2+4-Bolt)	181	114.6	18	14	ø127	15	15	12.7	S (SAE 1 1/8")	T (SAE 1 3/8")	F07/K07
90	SAE D (2+4-Bolt)	228.6	161.4	22	21	ø152.4	17	20	12.7	S (SAE 1 3/4")	S (SAE 1 3/4")	F73/K73
125	SAE D (2+4-Bolt)	228.6	161.4	22	21	ø152.4	20	20	12.7	S (SAE 1 3/4")	T (SAE 2")	F69/K69
180	SAE E (4-Bolt)	–	224.5	–	21	ø165.1	22	–	15.9	S (SAE 1 3/4")	T (SAE 2 1/4")	F72/K72

Mounting Flange



Start-Up Procedure

The following procedure has been developed based on experience with most types of applications, however certain applications may require a departure from or variation to this procedure.

For the start-up of new or overhauled installations.

1. If the prime mover is:

Internal combustion engine: (Diesel, gasoline or LP)- Remove the coil wire, close the injector rack or leave the gas turned off and turn the engine over until the charge pressure reaches 50 psi or more.

Electric Motor: Jog the starting circuit until the charge pressure reaches 50 psi or more.

2. Start the prime mover, and if possible, maintain a pump speed of approximately 750 rpm for 5 minutes. This will allow the system to be filled.
3. Listen for any abnormal noises.
4. Check for oil leaks.
5. Run prime mover to 1800 rpm. (Adjust to the design speed if less than 1800 rpm.)
6. Set charge and pilot pressure as required for the application. (Refer to circuit schematic)
7. For the HD control, bleed the pilot lines by loosening the connections at Y1 and Y2 and then actuate the remote control unit in both directions until oil seeps from the connections.
8. Retighten all connections.
9. Operate the control to work the hydrostatic transmission at approximately 20% of maximum speed.
10. Deaerate system by venting a bleed valve or by cracking the highest connection until fluid seeps out without bubbles.
11. Check fluid level and add fluid if necessary.
12. Continue operating transmission and gradually increase to full speed, still with no load.
13. With controls neutralized, check for creep in neutral. If evident, center the control in accordance with the instructions in the pump service manual.
14. Check that the controls are connected so that the transmission operates in the correct direction related to the control input.
15. Continue to monitor all pressure gauges and correct any irregularities.
16. Apply brakes and set high pressure relief valves (and pressure override if installed) to levels required for the application by stroking the pump to approximately 20% of maximum displacement.

17. Check security of high pressure connections.
18. Check oil level and temperature.
19. Remove and inspect high pressure filter elements, if so equipped. Replace with new elements.
20. Operate transmission under no load conditions for about 15 minutes to stabilize the temperature and remove any residual air from the fluid.
21. Again remove and inspect high pressure filter elements, if so equipped. If clean, the high pressure, bi-direction filters may be removed from the circuit. If contamination is still evident, fit new elements and continue flushing until the system is clean.
22. Replace the elements in the charge pump suction or pressure filter, whichever is installed.
23. Operate the transmission under full and normal load conditions.
24. Erratic operation may indicate there is still air trapped in the system. By working the pump control to one or both sides the remaining air can be eliminated. The system is free of air when all functions can be operated smoothly and when the oil in the reservoir is no longer aerated. (Usually less than 1 hour of operation).

Note:

If, after following the Pre-Start and Start-up procedures, the transmission does not perform correctly, refer to the relevant sections of the trouble-shooting procedures on pages 20-23.

Variable Displacement Pump AA4VG, Series 3

Troubleshooting Procedure

To aid in troubleshooting, refer also to the diagnostic port connections for test gauge installation information. Procedure assumes gauges are installed.

This procedure was written to aid the troubleshooter in following a logical approach to a system fault.

1...Transmission does not Drive with the Prime Mover Running

- | | | | |
|-----|---|-----|--|
| 1.1 | Is there oil in the reservoir? | No | Fill reservoir. |
| | | Yes | Proceed to step 1.2. |
| 1.2 | Is engine clutch engaged? | No | Engage clutch. |
| | | Yes | Proceed to step 1.3. |
| 1.3 | Is the hydraulic piping in accordance with the hydraulic circuit? | No | Correct the piping. |
| | | Yes | Proceed to step 1.4. |
| 1.4 | Is the pump direction of rotation correct? | No | Fit pump having the correct direction of rotation. |
| | | Yes | Proceed to step 1.5. |
| 1.5 | Is there a broken pipe, loose fitting or burst hose? | No | Proceed to step 1.6. |
| | | Yes | Repair the fault. |
| 1.6 | Are the brakes released? | No | Check brake release circuit or mechanism. |
| | | Yes | Proceed to step 1.7. |

Charge Pump & Relief Valve

- | | | | |
|-----|--|-----|---|
| 1.7 | Is there any charge pressure at port G? | No | Proceed to step 1.10. |
| | | Yes | Proceed to step 1.8. |
| 1.8 | Is the charge pressure at least 300 psi while the pump is running at normal operating speed? | No | Proceed to step 1.9. |
| | | Yes | Proceed to step 1.19. |
| 1.9 | Can charge pressure be adjusted by adding or removing relief valve spring shims or by adjusting charge pressure relief valve setting screw if so equipped. | No | Proceed to step 1.10. |
| | | Yes | Adjust charge pressure to 300 psi and proceed to step 1.19. |

Note: If flushing valve is used in circuit, it should set at 25 psi less than charge pump relief. Refer to data sheet on flushing valve for information and setting procedure.

- | | | | |
|------|--|-----|-------------------------------|
| 1.10 | Is the suction line shut-off? | No | Open valve |
| | | Yes | Proceed to step 1.11. |
| 1.11 | Is the charge pump suction pressure within the recommended limits? (0.8 bar abs or 6.3 in-Hg.) | No | Proceed to step 1.12. |
| | | Yes | Proceed to step 1.16. |
| 1.12 | Is the suction filter element plugged. | No | Proceed to step 1.13. |
| | | Yes | Replace filter element |
| 1.13 | Does the reservoir design ensure that suction pipe is always covered with oil. | No | Correct the reservoir design. |
| | | Yes | Proceed to step 1.14. |

- | | | | |
|------|---|-----|---|
| 1.14 | Is the suction pipe size adequate for the flow? | No | Run at lower speed and return to point 1.7, or rework suction piping. |
| | | Yes | Proceed to step 1.15. |
| 1.15 | Is the reservoir air breather blocked or undersized? | No | Proceed to step 1.16. |
| | | Yes | Clean or Replace air breather. |
| 1.16 | Remove charge pressure relief valve cartridge and inspect. Is it damaged? | No | Refit cartridge and proceed to step 1.17. |
| | | Yes | Fit a new cartridge and return to step 1.7. |
| 1.17 | Remove and inspect charge pump assembly. Is it damaged? | No | Proceed to step 1.18. |
| | | Yes | Repair or replace damaged components and return to step 1.7. |
| 1.18 | Is the charge pump installed for correct direction of rotation? | No | Refit charge pump. Return to step 1.7. |
| | | Yes | With proper charge pressure, and transmission still does not operate, proceed to step 1.19. |

Pump Control

- | | | | |
|------|---|-----|---|
| 1.19 | Is control medium connected to pump control? HD...pilot pressure HW...mechanical cable or linkage. EP...12 or 24 volts dc, electrical current. | No | Connect appropriate medium and check that control signal is actually being applied to the pump control valve. |
| | | Yes | Proceed to step 1.20. |
| 1.20 | If variable displacement motors are installed, is maximum displacement selected? (If not done automatically). | No | Select maximum displacement. |
| | | Yes | Proceed to step 1.21. |
| 1.21 | Actuate the control in both directions. Does pump stroke? Does it go to full stroke? | No | Refer to the pump service manual and then proceed to step 1.22. |
| | | Yes | Operate the transmission. |
| 1.22 | Remove stroking orifices in X1 and X2. Stroke the pump in both directions. Do the pressures at X1 and X2 Alternate between 30 and 250 psi during cycle? | No | Remove control module and replace it with a new unit. Repeat step 1.21. |
| | | Yes | Proceed to step 1.23 |

Troubleshooting Procedure

1...Transmission does not Drive with the Prime Mover Running (Continued from page 20)

1.23 Is the pressure at port R less than 2 bar abs. or 30 psia?	No	Repipe pump case drain line so that case pressure at port R is less than 8 bar abs. or 30 psia. Return to step 1.21.	1.25 Is it possible to adjust high pressure relief valves using the 0...10,000 psi gages at MA and MB to monitor pressure? (Refer to relief valve adjustment).	No	Replace high pressure relief valve cartridges and return to step 1.21.
	Yes	Proceed to step 1.24.		Yes	Adjust high pressure relief valves to required or design pressure. Proceed to step 1.26.
1.24 Stroke pump in both directions. Does any pressure greater than 350 psi alternate between parts M _A and M _B ?	No	Verify that loading of the pump will cause system pressure to increase above charge pressure. Proceed to step 1.19.	1.26 Actuate Control in both directions. Does transmission run?	No	Check if motor sizing is adequate for application. Check for mechanical faults in the drive beyond the motor shaft.
	Yes	Proceed to step 1.25.		Yes	operate the transmission.

2...Transmission Drive is Sluggish or Erratic

2.1 Is the control medium in good condition? For example: control medium is not in good condition if: HD...control-air in pilot lines. HW...Control-sticking cable or linkage. EP...Control-fluctuating control current.	No	Rectify the control fault. HD...Bleed pilot lines. HW...Lubricate or free the cable or linkage. EP...Check control current.	2.5 Does the charge pressure fluctuate more than 30 psi when stroking the pump?	No	Proceed to step 2.9.
	Yes	Proceed to step 2.2.		Yes	Proceed to step 2.6.
2.2 Are the brakes fully released?	No	Check brake release circuit or mechanism.	2.6 If the charge pump output is used to operate auxiliary functions, do these other functions cause fluctuations in charge pressure?	No	Proceed to step 2.8.
	Yes	Proceed to step 2.3.		Yes	Proceed to step 2.7.
2.3 Are the stroking time orifices correctly sized for the application?	No	Remove the plugs in ports X ₁ and X ₂ and remove control orifices with 3mm allen wrench, for size 71 and a 5mm allen wrench for size 250. Try various sizes until desired pump stroking rate is attained.	2.7 Isolate the auxiliary function and run the transmission. Are the charge pressure fluctuations reduced or eliminated?	No	Proceed to step 2.8
	Yes	Proceed to step 2.4.		Yes	Operate transmission and return to step 2.1.
2.4 With HD control, is the control curve of the remote pilot valve correctly matched to the pump?	No	Change spring to suit.	2.8 Are there system pressure fluctuations which are synchronous with the charge pressure fluctuations?	No	Proceed to step 2.9.
	Yes	Proceed to step 2.5.		Yes	Determine the cause of system pressure fluctuations.
			2.9 If variable displacement motor is used, is the motor stroking time correct for the application?	No	Add motor stroking time adjustment valve or orifice to the variable motor, or modify the control circuit to provide desired stroking time.

Variable Displacement Pump AA4VG, Series 3

Troubleshooting Procedure**3...Transmission Drives in One Direction Only**

3.1 With control lines lines switched does pump drive in opposite direction only?	No Yes	Proceed to step 3.2. Control signal from one side does not work properly. Repair as necessary.	3.4 Check flushing valve (If Installed). Is shuttle spool stuck in one position?	No Yes	(Not installed) Proceed to step 3.5. Remove flushing valve and clean or replace.
3.2 With control lines still switched does pump drive in initial direction only?	No Yes	proceed to step 3.3. Problem is one side of control module or the pump. Proceed to step 3.3.	3.5 Switch relief valves. does transmission drive in other direction only?	No Yes	Proceed to step 3.6. Repair or replace relief valve on nondriving side.
3.3 Is there control pressure or current from both control lines?	No Yes	Correct control signal problem. Proceed to step 3.4.	3.6 Replace control module and reconnect control lines. Does pump operate properly?	No Yes	Replace or repair pump. Operate transmission.

4...Transmission Drives in the Wrong Direction

4.1 Pump with HD control.	Switch control lines on ports Y ₁ and Y ₂ .	4.3 Pump with HW Control.	Rework linkage or cable to give correct drive direction.
4.2 Pump with EP Control.	Switch electrical connectors on solenoids A & B.		

5...Pump Does Not Find or Hold Neutral (Also refer to pages 24 & 25)

5.1 Does pump return to neutral with control lines removed?	No Yes	Proceed to step 5.2. Check control for electrical signal problem (EP control) or back pressure in the pilot lines (HD Control).	5.2 Check mechanical centering of pump and control per pages 24 & 25. Does pump return to neutral with control lines removed?	No Yes	Repair or replace pump. Replace control module if needed. Operate transmission.
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6...Transmission Drives at a High Noise Level

6.1 Are the drive gearboxes filled with correct grade of oil?	No Yes	Fill gearbox with correct grade of oil to the prescribed level. Proceed to step 6.2.	6.4 Is the suction pressure at the charge pump inlet within recommended limits?	No Yes	Return to step 1.7. Proceed to step. 6.5.
6.2 Is the drive coupling correctly installed and aligned?	No Yes	Install coupling per manufacturer's instructions and tolerances. Proceed to step 6.3.	6.5 Is there air in the hydraulic oil? This may be indicated by foaming or milky colored oil.	No Yes	Proceed to step 6.6. Deaerate the oil and inspect system for cause of air induction.
6.3 Is rigid piping connected to the pump and motor?	No Yes	Proceed to step 6.4. Install short length of hose between pressure ports and the system piping.	6.6 Is the hydraulic motor operating at excessive speed?	Yes	Check motor sizing in relation to available oil flow from the pump. Check motor minimum displacement. See page 20.

Variable Displacement Pump AA4VG, Series 3

Troubleshooting Procedure

7...Transmission Operates at a Higher Than Normal Temperature

7.1	Is the operating temperature above 195°F?	No	195°F is the upper limit. If temperature is close to 195°F, the oil cooler may need to be cleaned.	7.4	Check differential pressure across oil cooler as compared to the manufacturer's specs at charge pump flow. Is ΔP higher than it should be?	No	Proceed to step 7.5
		Yes	Proceed to step 7.3.			Yes	Check piping from oil cooler to reservoir. Check for plugged or damaged oil cooler.
7.2	Is the hydraulic motor stalling intermittently?	No	Proceed to 7.3.	Note: See page 7 for case pressure rating.			
		Yes	Hydraulic oil is being heated through system relief valves. Shut down system and rectify cause of the motor stall.				
7.3	Does temperature remain above 195°F after cleaning oil cooler?	No	Operate transmission. Check oil cooler more often.	7.5	Disconnect pump case drain from oil cooler and check flow from charge pump. Is flow normal?	No	Refer to charge pump removed and inspection procedure.
		Yes	Proceed to step 7.4.			Yes	Check oil cooler location.

8...Pump Does Not Develop Maximum Horsepower (Flow & Pressure)

8.1	Does charge pressure meet specification	No	Return to step 1.9.	8.3	Are high pressure relief valves adjusted to the required pressure so that they do not bypass?	No	Adjust or replace relief valve cartridge.
		Yes	Proceed to 8.2.			Yes	Replace the pump.
8.2	Is the case pressure less than 2 bar abs or 30 psia?	No	Check sizing of return line from T port of pump and cooler sizing related to flow.	Note: If pressure override valve is fitted to pump, check that pressure setting is sufficient for the application.			
		Yes	Proceed to 8.3.				

Charge Pressure Relief Valve Adjustment

For AA4VG28...AA4VG56

With pressure gauge installed at G port run pump at normal operating speed and temperature. If pressure is low, remove relief valve and add shim(s). If pressure is high, remove relief valve and take shim(s) out.

Note: 1 mm = 56.5 psi (3.9 bar)

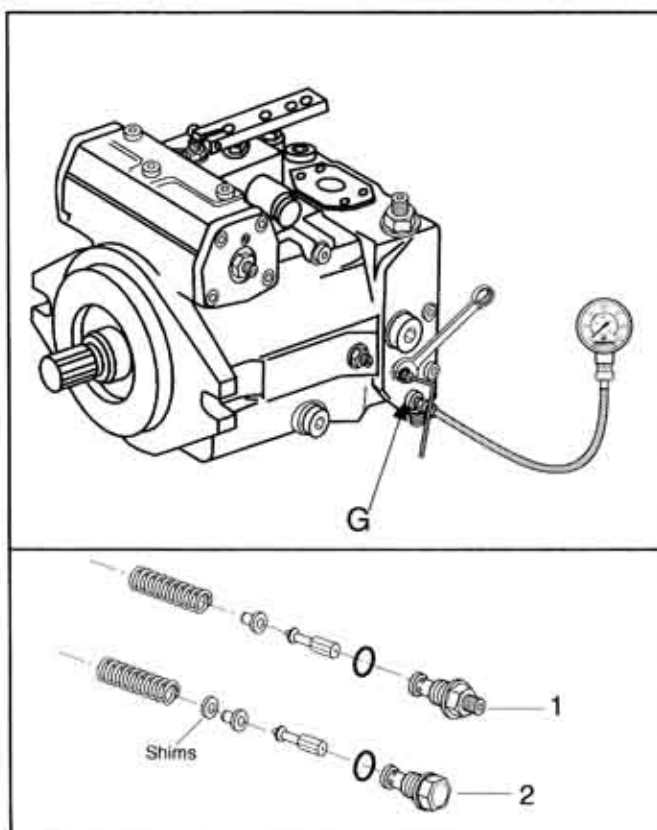
For AA4VG71...AA4VG250

With pressure gauge installed at G port run pump at normal operating speed and temperature. If pressure is low loosen jam nut and turn set screw clockwise. If pressure is high loosen jam nut and turn set screw counterclockwise.

Note: 1 turn = 55 psi (3.8 bar) for sizes 71 thru 125.

Note: 1 turn = 43.5 psi (3.0 bar) for sizes 180 thru 250.

Pump Size	Allen Wrench	Box Wrench	Wrench To Remove
28 - 56	N/A	N/A	27 mm
71 - 125	5 mm	17 mm	27 mm
180 - 250	5 mm	17 mm	32 mm



1. Adjustable charge pressure relief valve for sizes 71...180.
2. Shim charge relief for sizes 28 and 56.

Mechanical Centering of Pump

Preparation for Adjustment

The control piston has strong centering springs to ensure that once the pump is adjusted for the neutral position it will always return to neutral. If an adjustment is necessary follow the steps listed below.

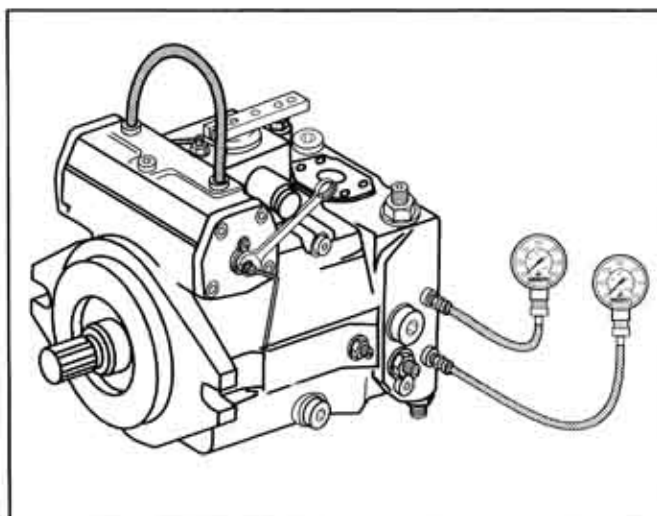
To ensure there is equal pressure on both sides of the control module during the centering operation, it is necessary to connect the X_1 and X_2 ports together by means of hose or tubing (No less than a 1/4 inch ID). The port sizes are as follows:

Size 28...90	7/16"-20 UNF
Size 125 & 250	9/16"-18 UNF

Pump Size	Allen Wrench	Wrench
28...56	6 mm	19 mm
71...90	6 mm	24 mm
125...250	8 mm	24 mm

With pressure gauges installed at M_A and M_B , and with A and B ports blocked (or motor stalled), and with the pump running, loosen the jam nut. Turn the mechanical centering adjusting screw until 1000 psi is read on M_A or M_B then turn screw opposite direction until 1000 psi is read on other pressure port. Turn the screw back, splitting the distance between the previous two positions. This should be the neutral position. Pressure on M_A and M_B should be equal.

Tighten jam nut, stop the pump drive, remove the hose connecting ports X_1 and X_2 .



Hydraulic Centering of Control Modules

Preparation for Adjustment

When control modules are exchanged or replaced, it is generally necessary to center the new module. This is done by running the pump with gauges installed at ports X_1 , X_2 , M_A and M_B . Release the jam nut and turn the adjustment screw on top of the control module valve body.

The adjustment screw is an eccentric, therefore, turning more than 90° in either direction will have no further centering effect, and could cause damage to the eccentric pin.

Pump Size	Allen Wrench	Wrench
28...71	Screw Driver	10 mm
90...250	4mm	13 mm

Centering the HD Control Module

With Y_1 and Y_2 ports vented to atmosphere, neutral position of the HD control is correctly adjusted when any or all of the following conditions exist:

1. Approximately, when equal control pressures are obtained at control pressure ports X_1 and X_2 .
2. The hydraulic motor does not turn when the brake is released.
3. Charge pressure is registered equally at ports M_A and M_B , when flow output of the pump is deadheaded against a locked motor, or a valve.

Centering the HW Control Module

With the control lever allowed to freely spring to its center position, the HW control module is correctly adjusted when any or all of the following conditions exist:

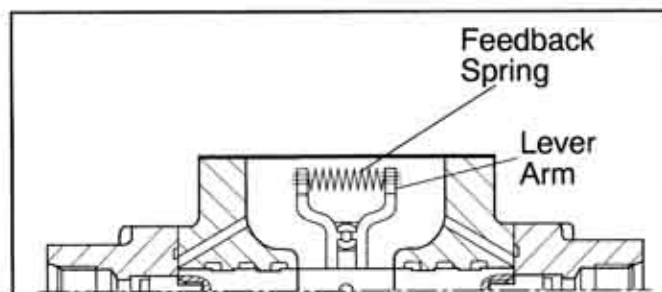
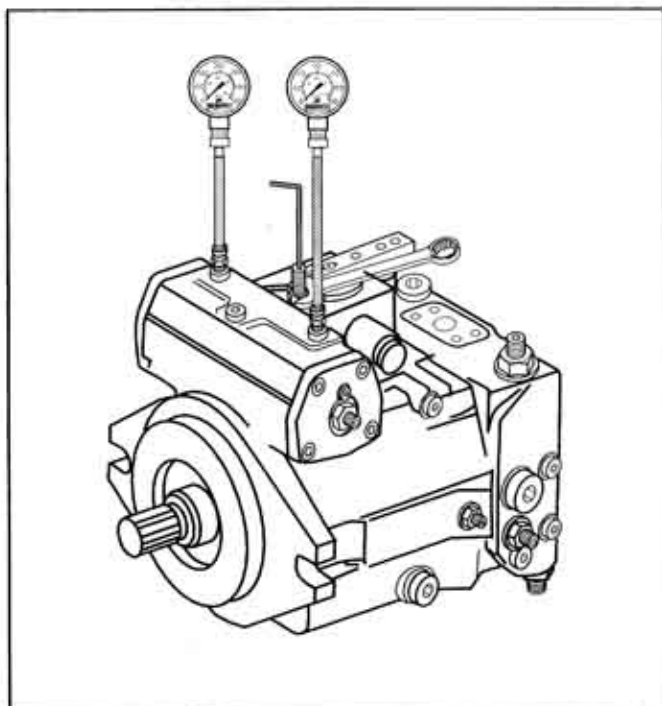
1. Approximately, when equal control pressures are obtained at control pressure ports X_1 and X_2 .
2. The hydraulic motor does not turn when the brake is released.
3. Charge pressure is registers equally at ports M_A and M_B , when the flow output of the pump is deadheaded against a locked motor, or a valve.

Centering the EP Control Module

With no electrical signal to solenoids A and B, (remove both plug-in connectors), the EP control module is correctly adjusted when any or all of the following conditions exist:

1. Approximately, when equal control pressures are obtained at control pressure ports X_1 and X_2 .
2. The hydraulic motor does not turn when the brake is released.
3. Charge pressure is registered equally at ports M_A and M_B , when the flow output of the pump is deadheaded against a locked motor or a valve.

If difficulties are encountered in obtaining neutral position of the HD or EP control modules, check that the ends of the control spring are correctly located in the grooves near the end of the feedback lever arms.



Pressure Override Valve Adjustment

Function of Pressure Override

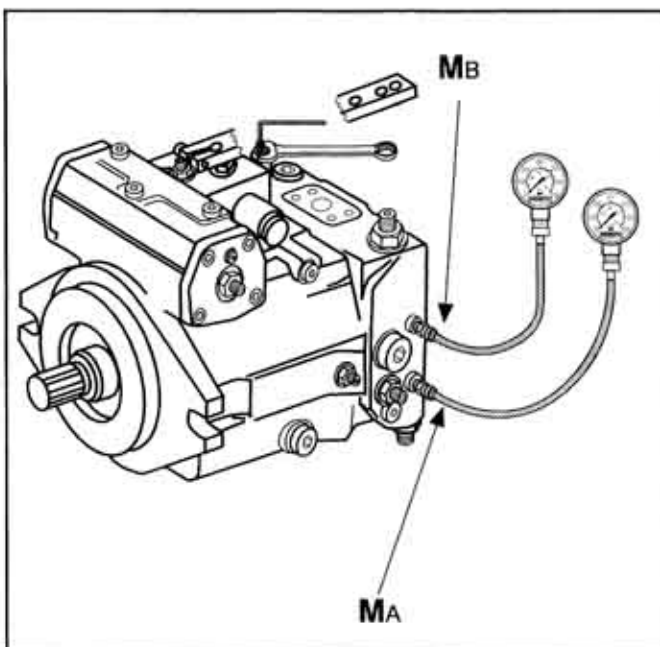
The pressure override valve varies the swashplate angle, as required, to limit the maximum pressure at port A or B. The override valve prevents continuous dumping of excessive flow, at load pressure, through the cross port relief valves contained in the pump. This eliminates unnecessary heating of the oil and protects the pump and motor from heavy-handed operators, or, if the drive stalls causing the pump to deadhead. The pressure override valve should be adjusted to a pressure at least 500 psi less than the setting of the main relief valves.

Adjustment Procedure

1. Neutralize the pump control and turn P.O.R. adjusting screw counterclockwise, all the way out.
2. Stroke the pump fully in either direction, then turn the P.O.R. adjusting screw in (clockwise) until the desired pressure setting is achieved.
3. Stroke the pump for opposite flow direction to that used in step 2 and check the operation of the P.O.R. Equal maximum pressures should be seen both sides of center.

Note: One turn of screw equals 1200 psi.

Note: All adjustments require a 4 mm allen wrench and a 13 mm box wrench.



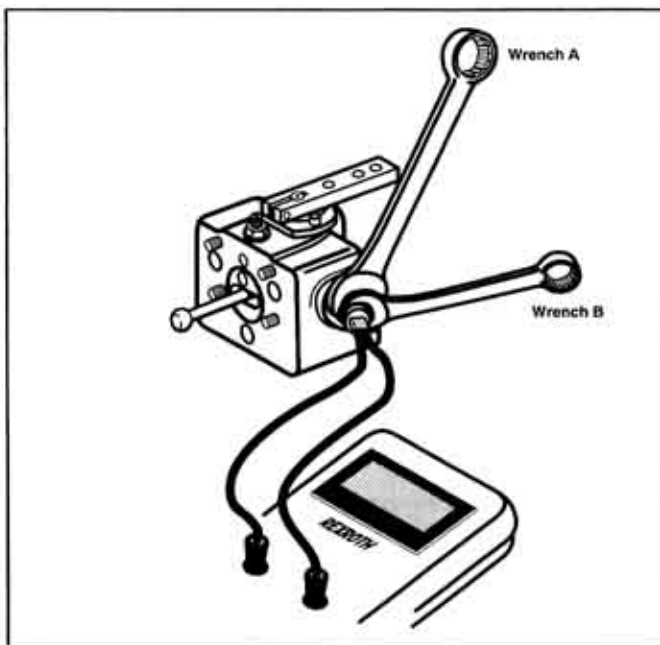
Adjustment of P.O.R. valve on pumps with remote hydraulic pilot control (type HD), manual rotary servo (type HW), and proportional electric control (type EP).

Neutral Start Switch Adjustment Procedure

Note: Before adjusting neutral start switch pump should be centered.

1. To adjust neutral safety switch, disconnect linkage from control handle and connect an ohm meter across the two leads from the neutral safety switch adjust the ohm meter to read continuity.
2. Then loosen the jam nut with wrench A and turn the switch (wrench B) in until you lose Continuity.
3. Then back the switch out until you complete the circuit and tighten jam nut.
4. Block vehicle to prevent movement. Return HW control to neutral. Install gages in M_A and M_B and start engine. Slowly bring pump on stroke, switch must open before pressure is developed in M_A or M_B port.

Note: All adjustments require a 23 mm box wrench and a 30 mm box wrench.

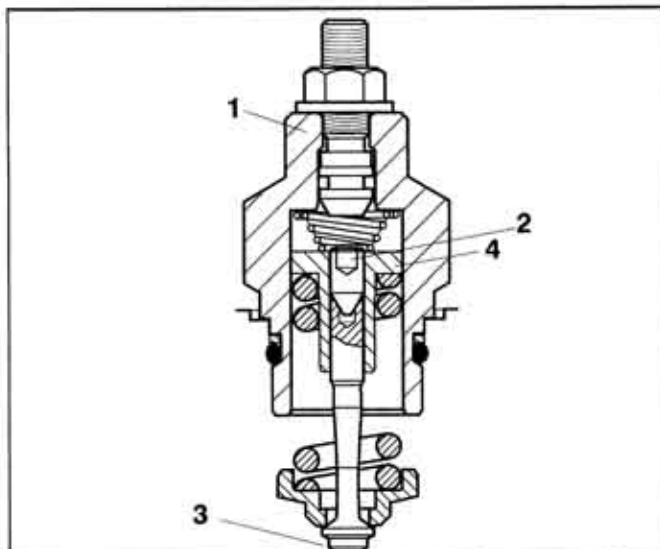


High Pressure Relief Valve Adjustments

High Pressure Relief Valve Adjustment Procedure AA4VG40 & AA4VG56

1. Remove relief valve cover from pump (ref. item 1).
2. Loosen jam screw (ref. item 2).
3. Holding spring loading nut (ref. item 4) adjust valve spindle (ref. item 3). One turn equals approx. 630 psi (44 bar).
4. After adjustment is completed tighten jam screw (ref. item 2) to 5 ft-lbs. (7 Nm).
5. Install relief valve assembly into pump, tighten cover (ref. item 1) to 66 ft-lbs. (90 Nm).

Note: All high pressure relief valve adjustments on size 40 and 56 to be done with a 3 mm allen wrench and a 5 mm box wrench.



High pressure relief valve with tow option used in AA4VG40 and AA4VG56

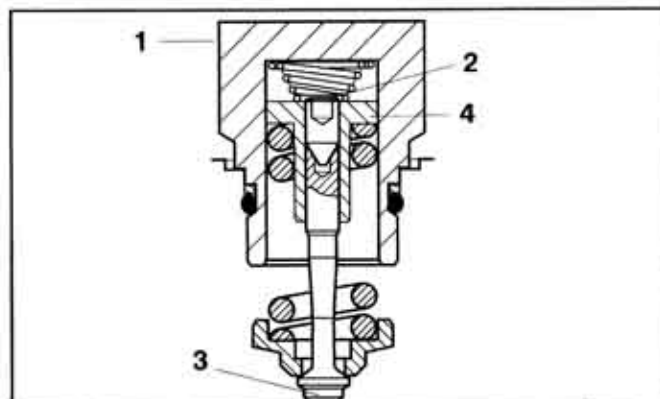
High Pressure Relief Valve Adjustment Procedure AA4VG71...AA4VG250

Following is a suggested procedure for adjusting the relief valves. It is assumed that high pressure gauges are connected to ports M_A and M_B . Some applications may require a slight departure from the procedure.

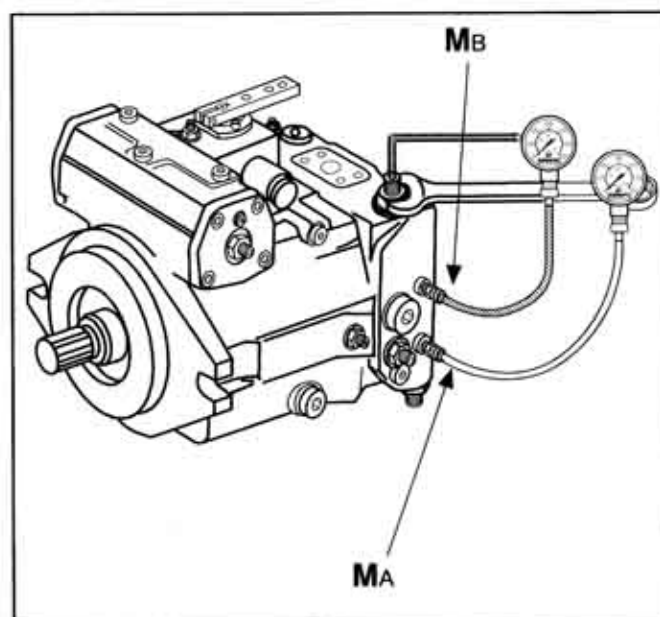
1. Block the output flow from the high pressure ports A & B, or lock the hydraulic motor by applying the brake.
2. Turn both high pressure relief valve adjusting screws counterclockwise until the spring tension is completely relieved, then turn both adjusting screws one full turn clockwise.
3. Turn the P.O.R. adjusting screw in (clockwise) until firm resistance is encountered. Do not force the adjustment beyond this point.
4. Stroke the pump to approximately 20 percent of full flow in one direction and adjust the high pressure relief for that flow direction to a pressure which is 500 psi higher than the required P.O.R. pressure setting. For the AA4VG71 and AA4VG90 one turn equals 2200 psi (150 bar).
5. Repeat step 4 for the opposite direction of flow.

Note: Perform steps 4 & 5 as quickly as possible to prevent overheating of the pump. Flow should not be permitted to spill over the high pressure relief valves for longer than 10 seconds, especially at higher pressures.

Note: High pressure relief valve adjustments on size 71 and 90 to be done with a 11 mm box wrench and a 19 mm box wrench, 125 and 180 to be done with a 5 mm allen wrench and a 17 mm box wrench.



High pressure relief valve with out tow option used in AA4VG40 and AA4VG56

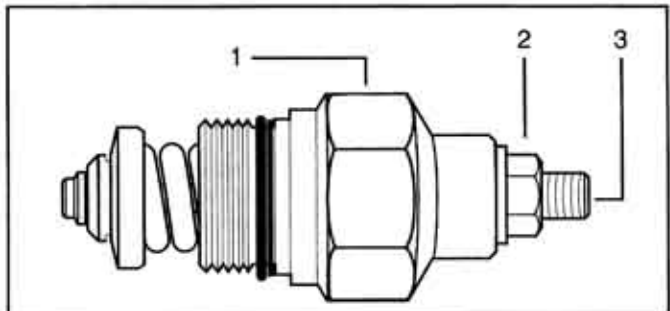


Engagement of Relief Valve Tow Option

Tow Option Engagement for AA4VG40 and AA4VG56
To actuate tow option loosen lock nut (ref. item 2). Turn tow option engagement screw (ref item 3) in six turns and tighten lock nut.

To disengage tow option loosen lock nut and turn tow option screw all the way out until it stops.

Note: Use a 4 mm allen wrench and a 13 mm box wrench to adjust.

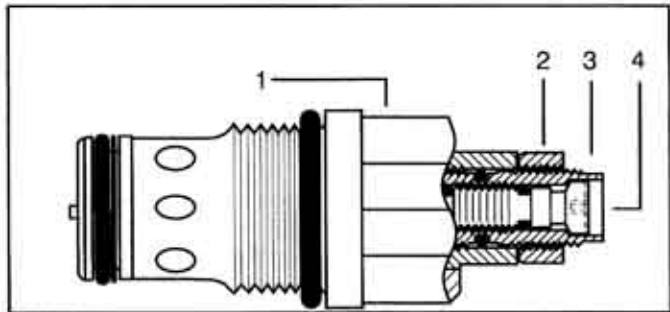


Relief valve for AA4VG40 and AA4VG56.
1...Nut used to torque relief valve into port block.
2...Lock nut for tow option engagement.
3...Tow option engagement screw.

Tow Option Engagement for AA4VG71 and AA4VG90
To actuate tow option turn tow option engagement screw (ref. item 4) out three turns.

To disengage tow option turn tow option engagement screw in until it stops.

Note: Use a 4 mm allen wrench to adjust.



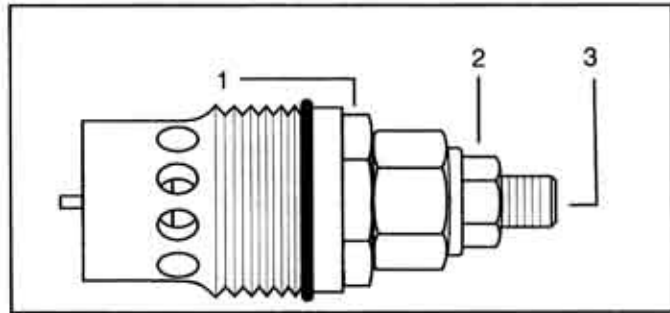
Relief valve for AA4VG71 and AA4VG90.
1...Nut used to torque relief valve into port block.
2...Lock nut for high pressure relief adjustment.
3...Adjustment screw for high pressure adjustment.
4...Tow option engagement screw.

Tow option Engagement for AA4VG125 and AA4VG180
To actuate tow option turn relief valve (ref. item 1) out two turns.

To disengage tow option tighten relief valve.

Note: Use a 36 mm box wrench to adjust.

Note: Tow options are meant to be used for a short time period only. Tow options are not to be used for extended tows.



Relief valve for AA4VG125 and AA4VG180.
1...Nut used to torque relief valve into port block and engage tow option.
2...Lock nut for high pressure relief adjustment.
3...Adjustment Screw for high pressure relief adjustment.

Torque Specs for Relief Valves into Port Block		
Pump Size	Wrench Size	Torque
28...56	32 mm	66 ft.lb. (90 Nm)
71...90	32 mm	110 ft.lb. (150 Nm)
125...180	36 mm	147 ft.lb. (200 Nm)

Warning: Tow option bypasses high pressure relief valves. Catastrophic motor damage can occur if hydraulic circuit empties or overheats.

Variable Displacement Pump AA4VG, Series 3

Removal and Inspection of Charge Pump

Before removing cap screws, mark the position of the charge pump housing and separator plate in relation to the port block.

Loosen screws with metric allen wrench.

Pump Size	Allen Wrench
28...125	6 mm
180...250	10 mm

Remove charge pump housing and inspect for wear or damage to gear set and O-ring seals. Grease O-rings prior to reassembly. Make sure O-rings are completely seated in their grooves.

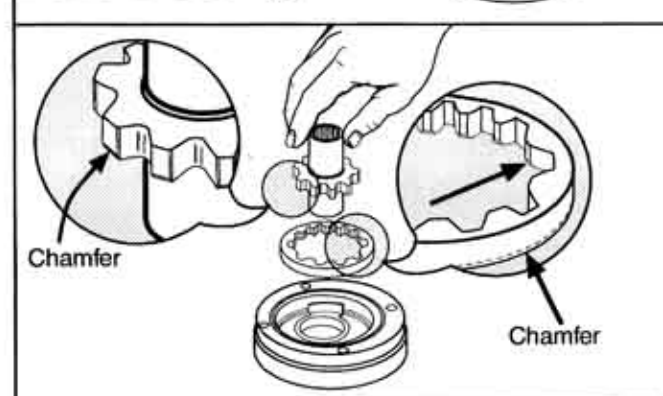
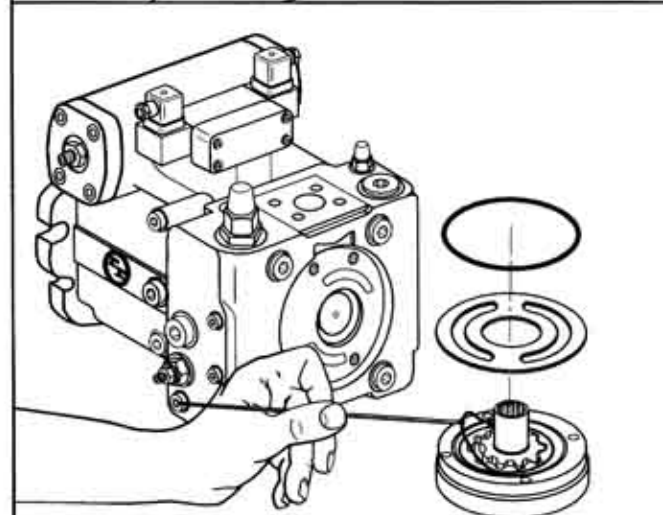
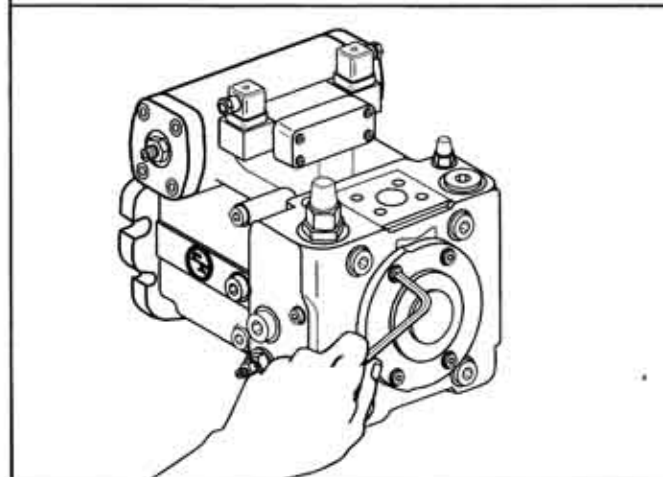
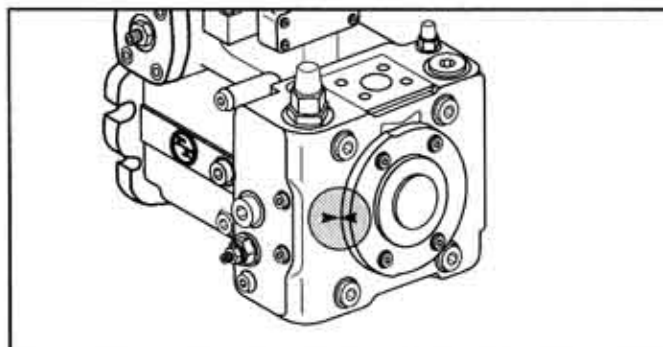
Withdraw pinion shaft and inspect gear teeth and bearing surfaces for abnormal wear.

When reassembling, make sure chamfer (on outer edge of driven gear and drive gear) is installed into housing per illustration.

Torque value for bolts when replacing charge pump.

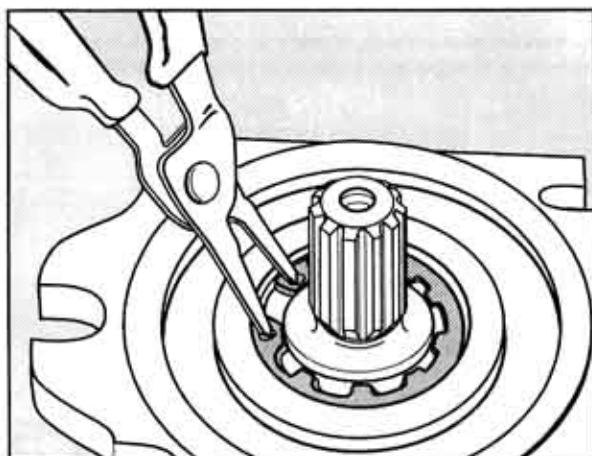
Pump Size	Torque
28...125	18 ft-lbs (24 Nm)
180...250	62 ft-lbs (24 Nm)

Note: If serious wear or damage has occurred to one component, the complete charge pump assembly must be replaced because they are matched components.



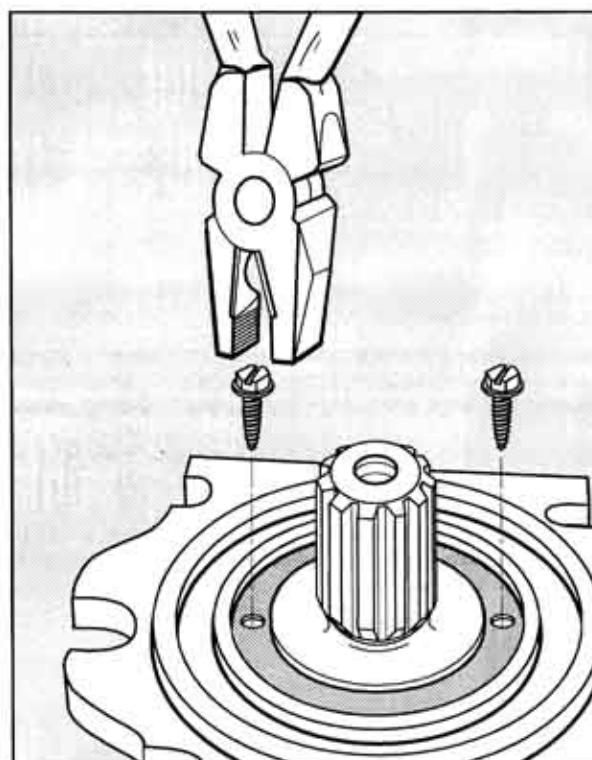
Removal and Installation of Shaft Seal

Remove the retaining ring with snap ring pliers.

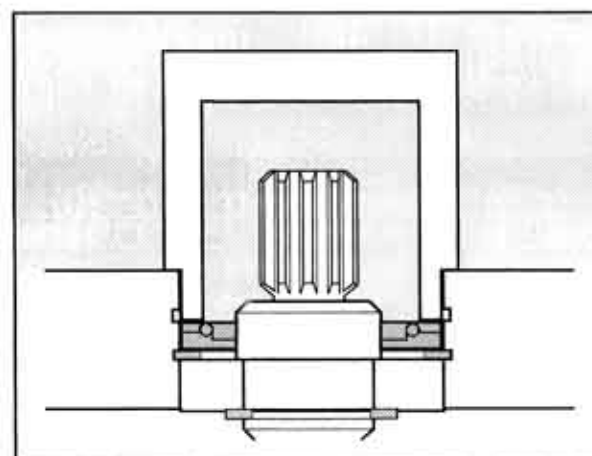


Screw in sheet metal screw into the holes fitted with rubber.

Pull out shaft seal with pliers.

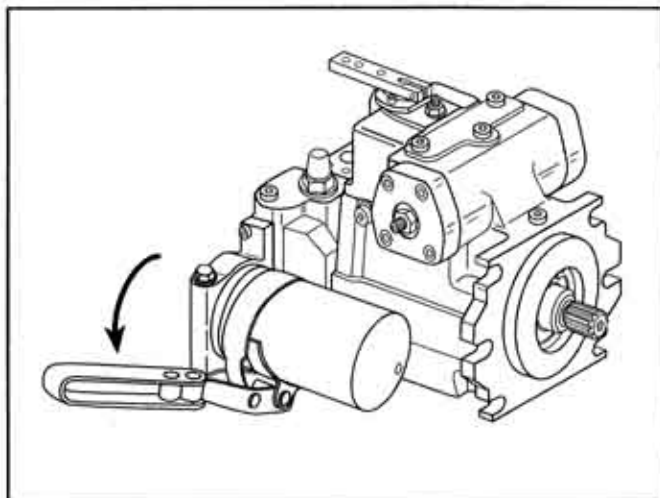


Press-in shaft seal with bushing to the stop.
Then replace snap ring.

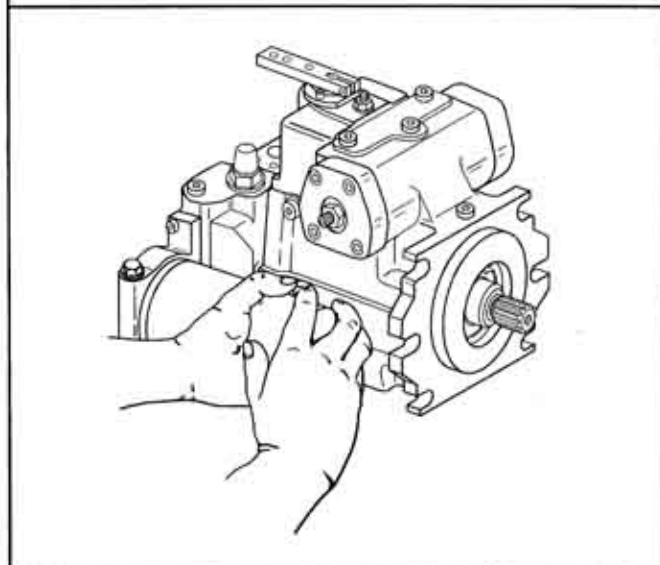


Changing Charge Filter

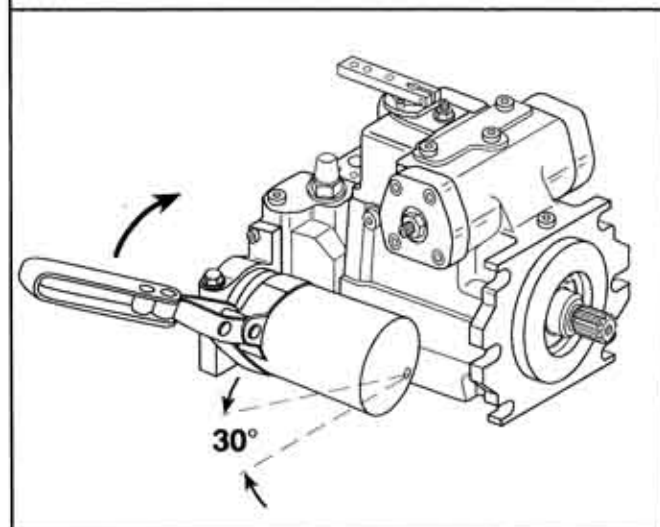
Remove charge filter (turn counter clockwise) with filter wrench.



Apply a small amount of oil to seal.
Screw on new filter (Clockwise) until seal touches housing.



Turn charge filter 30 degrees (clockwise) to tighten.



Routine Maintenance

The AA4VG variable pumps are relatively maintenance free. Maintenance work is confined to the system, by way of oil changes and renewal of filter elements. Both of these measures promote system cleanliness. Monitoring and periodic maintenance of the system can prevent premature breakdowns and repairs. Under normal application conditions, the following maintenance intervals are suggested:

1. Renewal of Filter Elements

- After commissioning.
- At every 500 operating hours, or when filter indicator shows a dirty element.
- With suction filtration, the filter element should be renewed as soon as a charge pump inlet pressure of less than -3.2 psi (0.8 bar absolute) becomes evident with the transmission in warm running condition (indicates contamination).
- With charge flow filtration, watch for high pressure differential across the filter element (Refer to filter manufacturer's specifications).

Caution: Only filter elements capable of meeting or exceeding the fluid cleanliness level requirements (reference page 9) should be used.

Note: Paper inserts cannot be cleaned; use throwaway cartridges (maintain a stock).

2. Hydraulic Oil Change

- After 2000 operating hours (1st oil change).
- Thereafter every 2000 operating hours or annually irrespective of operating hours achieved.

The oil change should be carried out with the system in warm running condition. Before re-filling, the reservoir should be cleaned to remove any sludge.

Caution: Rags or other threading material must not be used.

Note: The recommended interval between oil changes is based on various factors and should be carried out according to the type of fluid, the degree of aging and contamination of the fluid. The water content is also a contributory factor.

Under application conditions with a heavy occurrence of dust or severe temperature fluctuations the intervals between oil changes should be shortened accordingly.

Caution: Practical experience shows that most maintenance errors occur during an oil change due to:

- Use of an unsuitable hydraulic oil.
- Use of oil contaminated due to faulty storage.
- Failure to clean reservoir.
- Inadequate cleanliness when filling (dirty drums or containers).

3. Leakage Inspection

- After commissioning.
- The complete transmission (pump, motor and all pipelines, filters, valves, etc.) should be checked for leakage at regular intervals.

Caution: Leaking joints and connections must only be tightened in pressure less conditions

4. Cleanliness Inspection

The oil tank breather should be regularly cleaned of dirt and dust to prevent clogging. The cooling surfaces should be cleaned at the same time.

Caution: If hose couplings are used in the high pressure lines, it is imperative that the utmost care be taken that no foreign bodies infiltrate the oil circuit when coupling and uncoupling (danger of damage to rotary group, and even possibility of total breakdown).

5. Oil level Inspection

Inspect oil level in reservoir after commissioning, thereafter daily.

Caution: Top up only with specified oil type. Do not mix fluids.

Hydraulic Fluid

Most good quality, mineral oil based, hydraulic fluids exhibiting the following characteristics are suitable for use in a Rexroth hydrostatic transmission.

Good antiwear performance
Resistant to oxidation deprecation
Protection against rust and corrosion
Resistance to foaming
Ability to separate water rapidly
Suitable for widely varying temperature conditions
good low temperature flow properties
Retains viscosity-temperature characteristics in service
Universally available

The prime consideration in the selection of hydraulic fluid is the expected oil temperature extremes that will be experienced in service. The extremes should be considered when selecting a fluid, so that the most suitable temperature-viscosity characteristics are obtained.

The fluid chosen should permit the system to operate within the following viscosity ranges.

Maximum viscosity at start-up 4600 SUS (1000 cSt)
Normal operating viscosity range 66–464 SUS (12–100 cSt)
Optimum viscosity range 81–141 SUS (16–30 cSt)
Absolute minimum viscosity 60 SUS (10 cSt)

When the fluid viscosity is greater than 1000 SUS (216 cSt) the transmission should be operated at reduced speed until the oil has been warmed to a temperature of 40°F (4.5°C).

For applications that will operate near the extremes of viscosity and/or temperature, the fluid manufacturer should be consulted for assistance in selection of the most suitable type and grade of fluid for your application.

Rexroth strongly recommends the selection and use of fluids from reputable and established suppliers.

Replacement Subassemblies and Parts

Control Modules

Control Module	Size		
	28	40	56
HW	HU00606886	HU00606886	HU00606888
HWD	HU00607224	HU00607224	HU00607226
HD	HU00601717	HU00601717	HU00433487
EP1	HU00601622	HU00601622	HU00429169
EP2	HU00601621	HU00601621	HU00429168
EZ1	HU00600074	HU00600074	HU00600074
EZ2	HU00600076	HU00600076	HU00600076

Control Module	Size		
	71	90	125
HW	HU00606891	HU00608523	HU00608522
HWD	HU00607228	HU00608526	HU00608525
HD	HU00429114	HU00602225	HU00602238
EP1	HU00428139	HU00602227	HU00602236
EP2	HU00428138	HU00602226	HU00602237
EZ1	HU00600074	HU00437191	HU00437191
EZ2	HU00600076	HU00437190	HU00437190

Control Module	Size	
	180	250
HW	HU00608521	HU02008008
HWD	HU00608524	▲
HD	HU00602245	▲
EP1	HU00602248	HU02007246
EP2	HU00602247	HU02007245
EZ1	HU00437191	HU00437191
EZ2	HU00437190	HU00437190

Note: To add neutral start switch to an existing HW control add kit 5400-635-009

▲ Part numbers not released at time of printing

Control Module Size

Control module housing for sizes AA4VG28...AA4VG71 and AA4VG90...AA4VG250 are the same. To determine size of control module feedback lever length (dimension "A") can be measured. To convert control modules within a housing size feed back levers can be changed (Reference page 33).

Pump Size	"A" Dimension
28...40	See page 33
56	1.45 in. (36.8 mm)
71	See page 33
90	1.36 in. (34.5 mm)
125	1.55 in. (39.4 mm)
180	2.15 in. (54.6 mm)
250	2.88 in. (73.2 mm)

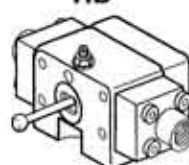
HW



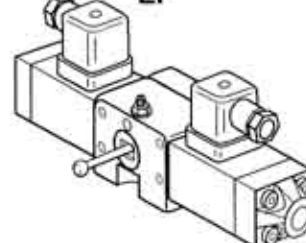
HWD



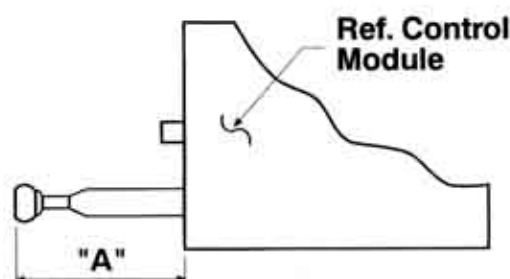
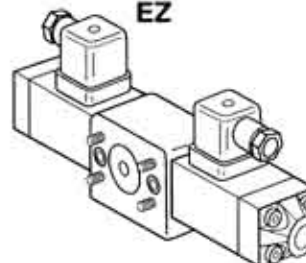
HD



EP



EZ



Variable Displacement Pump AA4VG, Series 3

Replacement Subassemblies and Parts

Control Module Size

Control module housing for sizes AA4VG28, AA4VG40, AA4VG56 and AA4VG71 are the same. To determine size of control module feedback lever length (dimension "A" or "B") can be measured. To convert control modules within a housing size feedback levers can be changed (Reference page 33).

Pump Size	"A" Dimension	"B" Dimension
28...40	2.27 in. (57.7 mm)	2.62 in. (66.5 mm)
71	2.31 in. (58.7 mm)	2.66 in. (67.5 mm)

Feedback Levers

Pump Size	Feedback lever HW Control	Feedback lever HD & EP Control
28...40	HU00432448	HU00432509
56	HU00432489	HU00430310
71	HU00432256	HU00430319
90	HU02008032	HU00436442
125	HU02008033	HU00445730
180	HU02008034	HU02008036
250	HU02008006	HU02006296

Pressure Override Valve Part Numbers

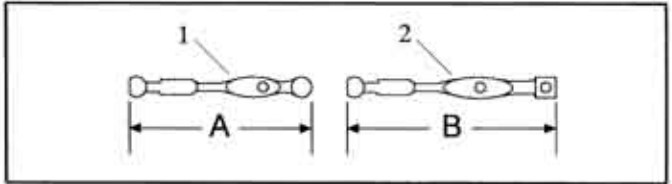
Pump Size	Pressure Override Valve
28	HU00447281
40	HU00447281
56	HU00446763
71	HU00437084
90	HU00437363
125	HU00433834
180	HU00433834
250	▲

▲ Part numbers not released at time of printing

Charge Pressure Relief Valves

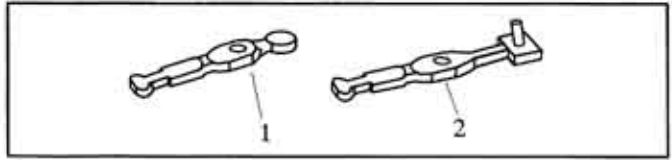
Pump Size	Pressure Range	Part Number
28	215...435 psi (15...30 bar)	5400-635-007①
40	215...435 psi (15...30 bar)	5400-635-007①
56	215...435 psi (15...30 bar)	5400-635-007①
71	215...435 psi (15...30 bar)	HU00434856
90	215...435 psi (15...30 bar)	HU00434856
125	215...435 psi (15...30 bar)	HU00434856
180	215...435 psi (15...30 bar)	HU00437151
250	215...435 psi (15...30 bar)	HU00437151

① Adjustment kit 5400-635-007 consists of charge pressure relief valve HU00434636 and shims.



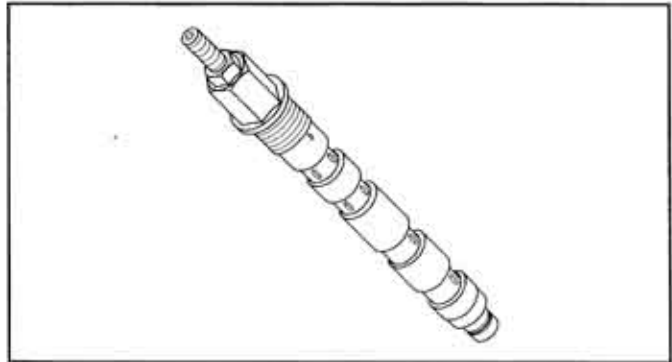
Feedback Control Levers.

- 1...Feedback lever for HW control.
- 2...Feedback lever for HD and EP controls.

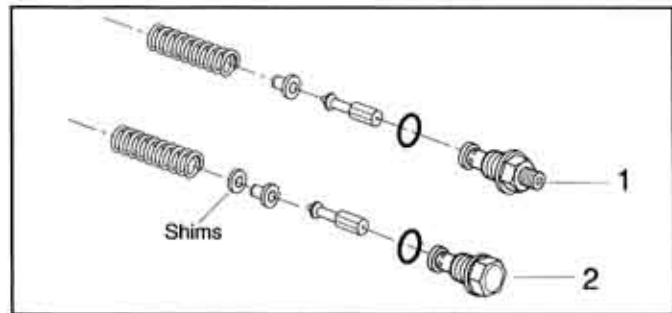


Feedback Control Levers.

- 1...Feedback lever for HW control.
- 2...Feedback lever for HD and EP controls.



Pressure Override Valve



Charge Pressure Relief Valves

- 1...Adjustable Charge relief for sizes 71 thru 180.
- 2...Shim charge relief for sizes 40 and 56 only, 1 mm equals 56 psi (3.9 bar).

Variable Displacement Pump AA4VG, Series 3

Replacement Subassemblies and Parts

High Pressure Relief Valve Part Numbers

Pump Size	Part Number	Pressure Range	Type of Relief Valve
40	HU00447133	3600-6000 psi	Direct acting without tow option
	HU00447134	3600-6000 psi	Direct acting with tow option
56	HU00429458	3600-6000 psi	Direct acting without tow option
	HU00434301	3600-6000 psi	Direct acting with tow option
71...90	HU02600466	1450-6000 psi	Pilot operated with tow option
125...180	HU00832121	1450-6000 psi	Pilot operated with tow option
250	▲	▲	▲

▲ Part number not released at time of printing

EP Solenoids (Proportional)

Pump Size	24 Volts DC	12 Volts DC
All	HU00441692	HU00441691

EZ Solenoids (Non-Proportional)

Pump Size	24 Volts DC	12 Volts DC
All	HU00428266	HU00428265

Plug-in Connectors

Pump Size	Gray	Black
All	HU00152503	HU0085290

Ammeter with Sandwich Plug

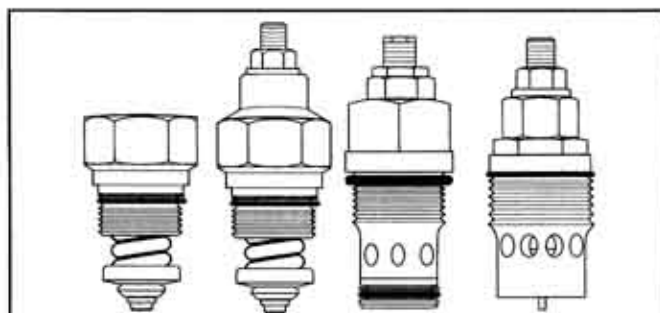
Pump Size	Part Number
All EP Controls	5956-001-018

Stroking Time Orifices for Sizes 28...71

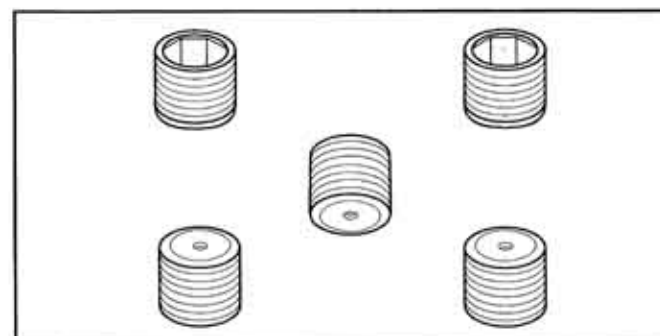
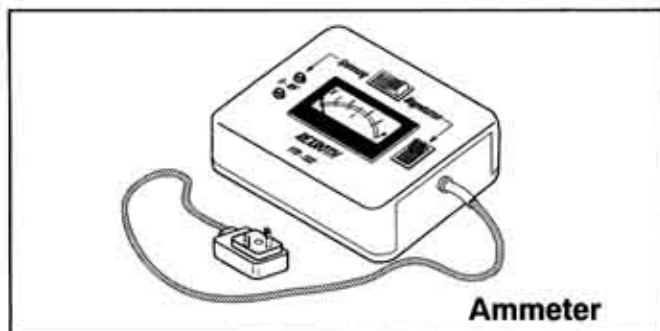
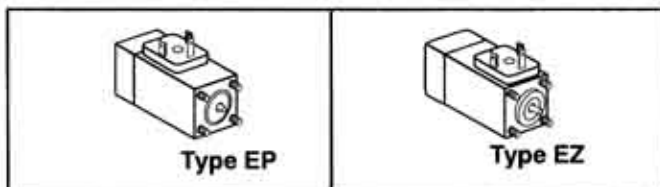
Part Number	Orifice Size	Thread Size
HU00156492	0.8 mm DIA.	M 6
HU00156493	1.0 mm DIA.	M 6
HU00156494	1.2 mm DIA.	M 6
HU00156495	1.4 mm DIA.	M 6
HU00156496	1.6 mm DIA.	M 6
HU00156497	1.8 mm DIA.	M 6

Stroking Time Orifices for Sizes 90...250

Part Number	Orifice Size	Thread Size
HU00426701	0.8 mm DIA.	M 10
HU00426702	0.9 mm DIA.	M 10
HU00426700	1.0 mm DIA.	M 10
HU00426703	1.2 mm DIA.	M 10
HU00426704	1.4 mm DIA.	M 10
HU00426705	1.6 mm DIA.	M 10
HU00426706	1.8 mm DIA.	M 10
HU00426707	2.0 mm DIA.	M 10
HU00426708	2.2 mm DIA.	M 10
HU00439372	2.4 mm DIA.	M 10
HU00426709	2.5 mm DIA.	M 10



High Pressure relief valves for AA4VG28...AA4VG180



Stroking Time Orifices

Variable Displacement Pump AA4VG, Series 3

Replacement Subassemblies and Parts

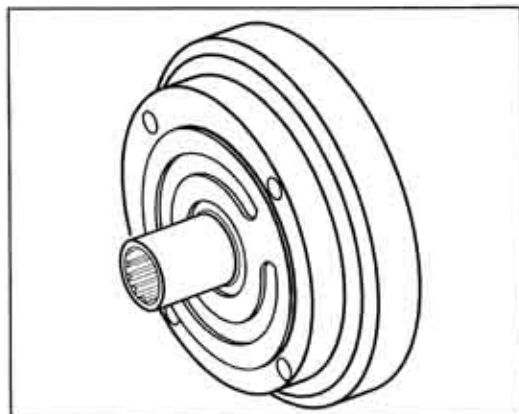
Charge Pumps and Through Drives

Type Code	AA4VG28	AA4VG40	AA4VG56	AA4VG71
F00	▲	HU00606688	HU00606382	HU00606657
F01	▲	HU00606691	HU00606386	HU00606655
F02	▲	HU00606694	HU00606390	HU00606661
F04	▲	HU00606700	HU00606393	HU00606658
F09	▲	HU00606687	○	○
F07	▲	○	HU00606379	HU00606660
F69	▲	○	○	○
F73	▲	○	○	○

Type Code	AA4VG90	AA4VG125	AA4VG180	AA4VG250
F00	HU00606811	HU00606320	HU00606233	▲
F01	HU00606803	HU00606309	HU00606225	▲
F02	HU00606809	HU00606312	HU00606228	▲
F04	HU00606807	HU00606314	HU00606226	▲
F09	○	○	○	▲
F07	HU00606801	HU00606317	HU00606214	▲
F69	○	HU00606330	HU00606245	▲
F73	HU00606805	○	○	▲

○ Not Available

▲ Part numbers not released at time of printing.



Charge Pump

Seal Kits and Shaft Seals for AA4VG/32 – Size 28...250

Pump Size	Seal Kits			Shaft Seal	
	AA4VG/32...P Buna	AA4VG/32...V FPM	AA4VG/32...N FPM Shaft Seal with Buna Seals	Buna	FPM
28	5470-635-023	5470-635-024	5470-635-025	HU00830425	HU00830742
40	5410-635-033	5410-635-035	5410-635-034	HU00831285	HU00831284
56	5420-635-028	5420-635-031	5420-635-029	HU00830970	HU00830976
71	5430-635-025	5430-635-027	5430-635-026	HU00830971	HU00830977
90	5440-635-033	5440-635-040	5440-635-038	HU00830972	HU00830978
125	5450-635-031	5450-635-033	5450-635-032	HU00830974	HU00830980
180	5480-635-007	5480-635-009	5480-635-008	HU00830973	HU00830979
250	○	5460-635-022	5460-635-023	○	HU02600118

○ Not Available

Charge Pressure Filtration Kits and Filter Elements

Pump Size	"F" Standard	"P" Visual Indicator	"L" Electrical Indicator	"M" Visual & Electrical Indicator	Filter Element Only	Cold Starting Valve
28	▲	▲	▲	▲	▲	▲
40...56	HU00434508	HU00441717	HU00606914	HU00606305	HU00830024	HU02007002
71...90	HU00434509	HU00446438	HU00434984	N/A	HU00157926	HU02006412
125	HU00434510	HU00447605	HU00601330	HU00602557	HU00157926	HU02006413
180	HU00434511	HU00600111	HU00447472	HU00606008	HU00157956	HU02006413
250	▲	▲	▲	▲	▲	▲

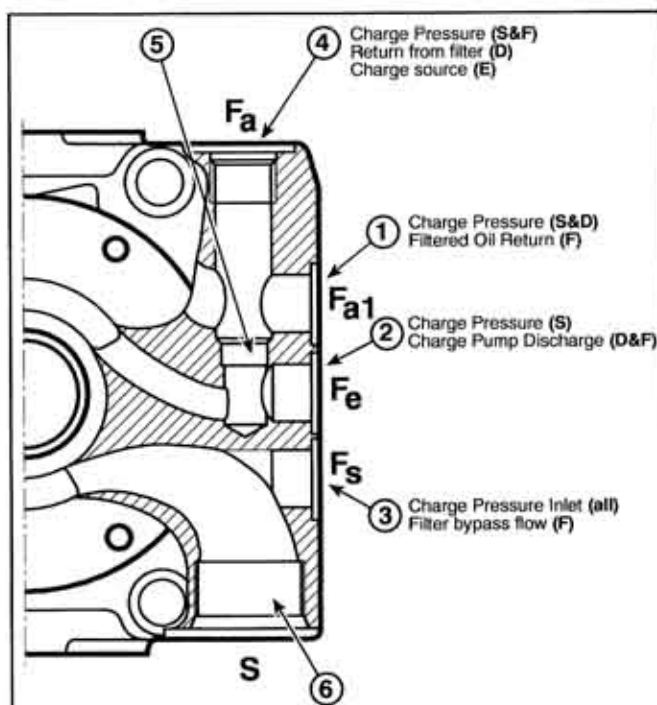
▲ Part numbers not released at time of printing

Variable Displacement Pump AA4VG, Series 3

Filtration Configurations for AA4VG, Series 32

Filtration Configuration	Port Configuration	AA4VG40 AA4VG56		AA4VG71 AA4VG90		AA4VG125 AA4VG180	
		Port Size	Part Number	Port Size	Part Number	Port Size	Part Number
Suction Filtration "S"	1 Plugged	M18 x 1.5	76116-010	M22 x 1.5	76116-009	M33 x 2	76116-008
	2 Plugged	M18 x 1.5	76116-010	M22 x 1.5	76116-009	M33 x 2	76116-008
	3 Plugged	M18 x 1.5	76116-010	M22 x 1.5	76116-009	M33 x 2	76116-008
	4 Plugged	3/4" - 16 UN	76107-008	1 1/16" - 12 UN	76107-012	1 5/16" - 12 UN	76107-016
	5 Open	M14 x 1.5		M18 x 1.5		M20 x 1.5	
	6 Open	1 5/16" - 12 UN		1 5/8" - 12 UN		1 7/8" - 12 UN	
Charge Pressure Filtration "D"	1 Plugged	M18 x 1.5	76116-010	M22 x 1.5	76116-009	M33 x 2	76116-008
	2 Open	3/4" - 16 UN	HU00607033 ^①	1 1/16" - 12 UN	HU00448824 ^①	1 5/16" - 12 UN	HU00442847 ^①
	3 Plugged	M18 x 1.5	76116-010	M22 x 1.5	76116-009	M33 x 2	76116-008
	4 Open	3/4" - 16 UN		1 1/16" - 12 UN		1 5/16" - 12 UN	
	5 Plugged	M14 x 1.5	76117-001	M18 x 1.5	76117-007	M20 x 1.5	76117-008
	6 Open	1 5/16" - 12 UN		1 5/8" - 12 UN		1 7/8" - 12 UN	
Mounted Filter "F" or Cold Start Valve "K"	1 Open	M18 x 1.5	Filter Port	M22 x 1.5	Filter Port	M33 x 2	Filter Port
	2 Open	M18 x 1.5	Filter Port	M22 x 1.5	Filter Port	M33 x 2	Filter Port
	3 Open	M18 x 1.5	Filter Port	M22 x 1.5	Filter Port	M33 x 2	Filter Port
	4 Plugged	3/4" - 16 UN	76107-008	1 1/16" - 12 UN	76107-012	1 5/16" - 12 UN	76107-016
	5 Plugged	M14 x 1.5	76117-001	M18 x 1.5	76117-007	M20 x 1.5	76117-008
	6 Open	1 5/16" - 12 UN		1 5/8" - 12 UN		1 7/8" - 12 UN	
External Charge Supply "E"	1 Plugged	M18 x 1.5	76116-010	M22 x 1.5	76116-009	M33 x 2	76116-008
	2 Plugged	M18 x 1.5	76116-010	M22 x 1.5	76116-009	M33 x 2	76116-008
	3 Plugged	M18 x 1.5	76116-010	M22 x 1.5	76116-009	M33 x 2	76116-008
	4 Open	3/4" - 16 UN		1 1/16" - 12 UN		1 5/16" - 12 UN	
	5 Open	M14 x 1.5		M18 x 1.5		M20 x 1.5	
	6 Plugged	1 5/16" - 12 UN	76107-016	1 5/8" - 12 UN	76107-020	1 7/8" - 12 UN	76107-024

① Adapts metric "Fe" port to SAE size indicated.



Specifications, descriptions, and illustrative material shown herein were as accurate as known at the time this publication was printed. Rexroth reserves the right to discontinue models or options at any time or to change specifications, materials, or designs without notice and without incurring obligation.

Optional equipment and accessories may add cost to the basic unit, and some options are available only in combination with certain models or other options.

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USER FORK WEAR STANDARDS

Reprinted from ASME/ANSI B56. 1-1993

6.2.8 Inspection and Repair of Forks in Service on Fork Lift Trucks

(a) Forks in use shall be inspected at intervals of not more than 12 months (for single shift operations) or whenever any defect or permanent deformation is detected. Severe applications will require more frequent inspection.

(b) *Individual Load Rating of Forks.* When forks are used in pairs (the normal arrangement), the rated capacity of each fork shall be at least half of the manufacturer's rated capacity of the truck, and at the rated load center distance shown on the lift truck nameplate.

6.2.8.1 Inspection. Fork inspection shall be carried out carefully by trained personnel with the aim of detecting any damage, failure, deformation, etc., which might impair safe use. Any fork which shows such a defect shall be withdrawn from service, and shall not be returned to service unless it has been satisfactorily repaired in accordance with para. 6.2.8.2.

(a) *Surface Cracks.* The fork shall be thoroughly examined visually for cracks and if considered necessary, subjected to a non-destructive crack detection process, special attention being paid to the heel and welds attaching all mounting components to the fork blank. This inspection for cracks must also include any special mounting mechanisms of the fork blank to the fork carrier including bolt type mountings and forged upper mounting arrangements for hook or shaft type carriages. The forks shall not be returned to service if surface cracks are detected.

(b) *Straightness of Blade and Shank.* The straightness of the upper face of the blade and the front face of the shank shall be checked. If the deviation from straightness exceeds 0.5% of the length of the blade and/or the height of the shank, respectively, the fork shall not be returned to service until it has been repaired in accordance with para. 6.2.8.2.

(c) *Fork Angle (Upper Face of Blade to Load Face of the Shank).* Any fork that has a deviation of greater than 3 deg. from the original specification shall not be returned to service. The rejected fork shall be reset and tested in accordance with para. 6.2.8.2.

(d) *Difference in Height of Fork Tips.* The difference in height of one set of forks when mounted on the fork carrier shall be checked. If the difference in tip heights exceeds 3% of the length of the blade, the set of forks shall not be returned to service until repaired in accordance with para. 6.2.8.2.

(e) *Positioning Lock (When Originally Provided).* It shall be confirmed that the positioning lock is in good repair and correct working order. If any fault is found, the fork shall be withdrawn from service until satisfactory repairs have been effected.

(f) *Wear.*

(1) *Fork Blade and Shank.* The fork blade and shank shall be thoroughly checked for wear, special attention being paid to the vicinity of the heel. If the thickness is reduced to 90% of the original thickness, the fork shall not be returned to service.

(2) *Fork Hooks (Where Originally Provided).* The support face of the top hook and the retaining faces of both hooks shall be checked for wear, crushing, and other local deformations. If these are apparent to such an extent that the clearance between the fork and the fork carrier becomes excessive, the fork shall not be returned to service until repaired in accordance with para. 6.2.8.2.

(g) *Legibility of Marking (When Originally Provided).* If the fork marking in accordance with para. 7.25.2 is not clearly legible, it shall be renewed. Marking shall be renewed per instructions from original supplier.

6.2.8.2 Repair and Testing

(a) *Repair.* Only the manufacturer of the fork or an expert of equal competence shall decide if a fork may be repaired for continued use, and the repairs shall only be carried out by such parties. It is not recommended that surface cracks or wear be repaired by welding. When repairs necessitating resetting are required, the fork shall subsequently be subjected to an appropriate heat treatment, as necessary.

Courtesy of Kenhar Products Inc.



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.

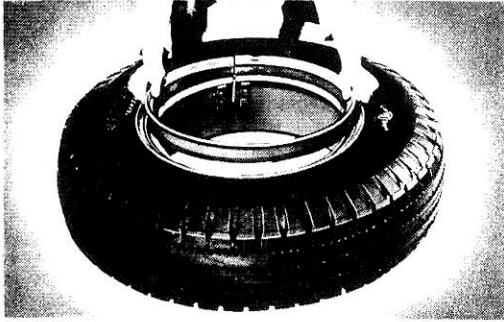
After first 50 to 100 miles of service re-check clamp and wheel nut torque. Loose wheel nuts can cause excessive wear around bolt holes, dangerous wheel vibration, and metal fatigue failure. Excessive torque is also dangerous in that it can cause stud or wheel breakage.

How to mount and demount ACCU-RIDE 5° Commander and 3-piece convertible rims

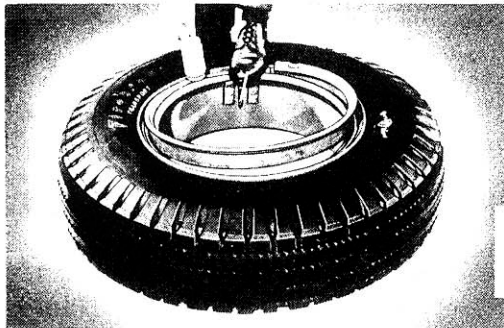
(Procedure applies to tires on both demountable rims and disc wheels)

Tools required: 1 rim mallet / 1 rim tool

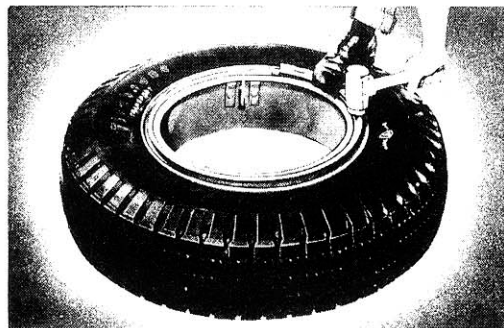
MOUNTING



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.

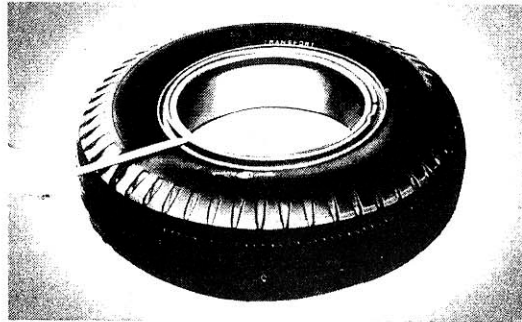


To fasten lock ring, hold with foot at one end of split and hammer end of ring into place with rim mallet.

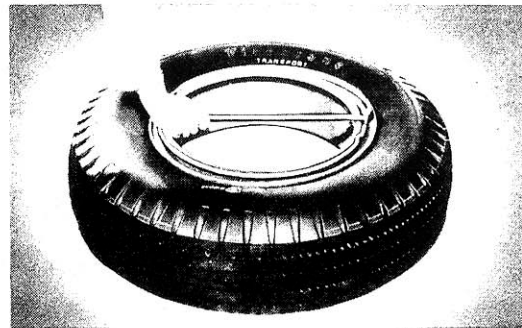


Continue progressively around the rim, holding ring with foot and hammering until entire ring is seated. Check seating of rings and inflate tire to recommended pressure.

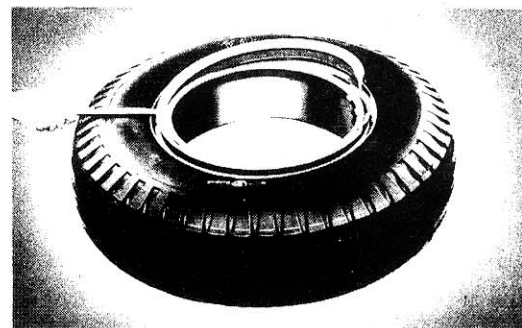
DEMOUNTING



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.

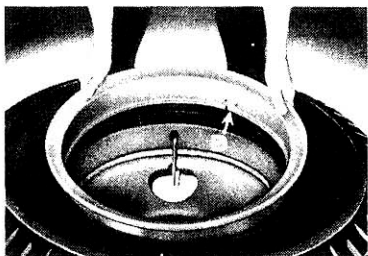
SAFETY PRECAUTIONS

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 reassembled before reinflating tire.

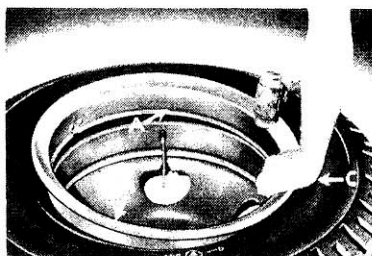
How to mount and demount ACCU-RIDE RH5° rims

Tools Required: 1 Rim Mallet
1 Rim Tool

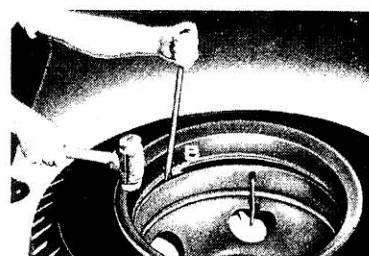
MOUNTING



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.

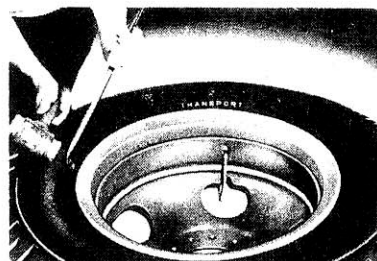


The two cutaway portions opposite each other in the inner diameter of the ring (points A) are placed so as to span the rim gutter. At point C, opposite valve, force half of ring into the gutter as far as possible using hand and rim mallet.

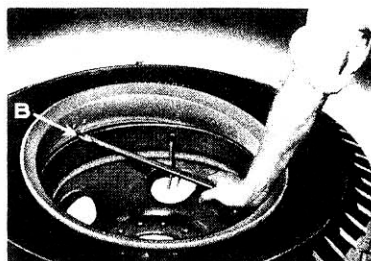


Insert straight end of rim tool in operating notch (point B), then pull in direction indicated by arrow. Retain pressure with tool and strike ring downward with mallet at point between tool slot and cutaway portion, thereby engaging ring over rim gutter at that point. Remove tool and strike additional 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.

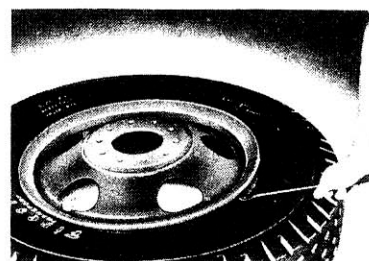
DEMOUNTING



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.



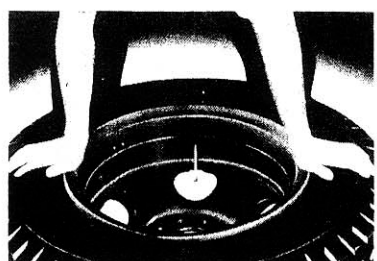
Remove ring by putting straight end of rim tool into notch in ring located between embossings (point B). Push ring downward at point opposite operating notch. Force tool handle downward as illustrated, causing ring to disengage from rim gutter. Continue operation, prying away from rim gutter with flat 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

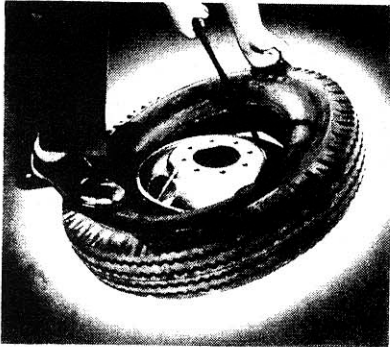
safety device is not available, use clip-on type air chuck so that operator may stand aside during inflation.

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.

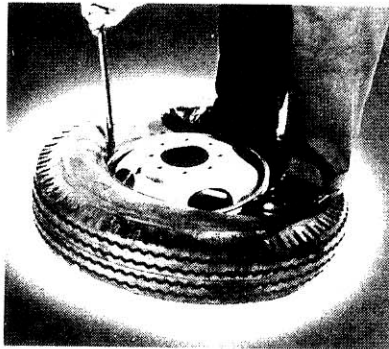
How to mount and demount ACCU-RIDE RHP rims

Tools required: 2 rim tools
 1 rim mallet
 1 tire tool (thin end)

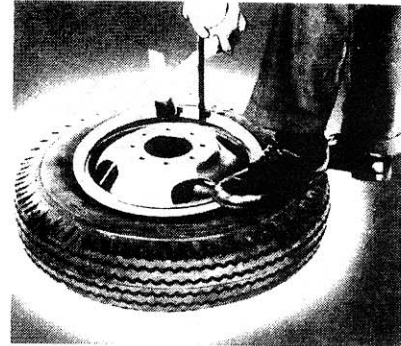
MOUNTING



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.

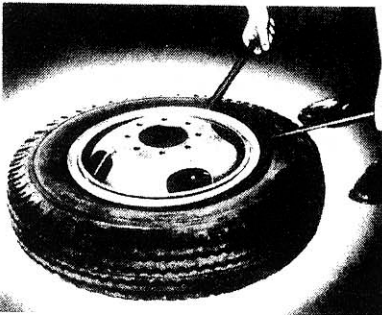


To apply second bead, start at point opposite valve and press bead toe over rim gutter and into rim well with foot pressure. Mount remainder of bead over rim gutter by means of thin tire tool, being careful not to pinch tube.

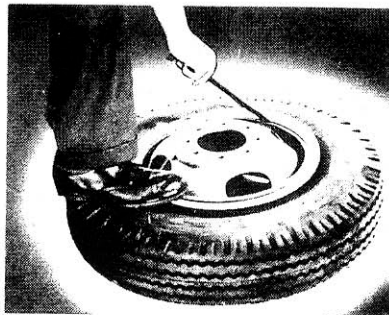


Place half of side ring in rim gutter with cutaway portions in position as shown. Insert thin end of rim tool or heavy screw driver and pull ring outward toward centered position. Strike with mallet, forcing rim into gutter.

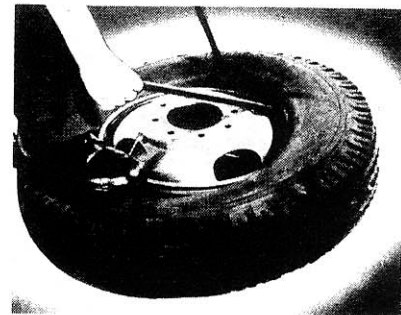
DEMOUNTING



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.



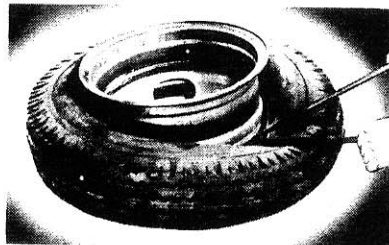
To remove ring, insert tool in notch and force ring opposite of notch into gutter, then pry off. Pry out and up on side ring, carefully but firmly. (Be careful not to bend side ring.)



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.

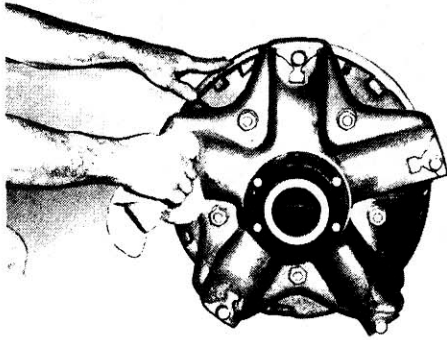
How to properly install ACCU-RIDE rims and wheels

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.

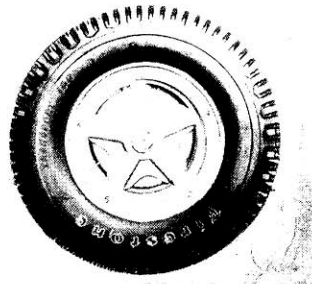
RECOMMENDED INSTALLATION PROCEDURE

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.

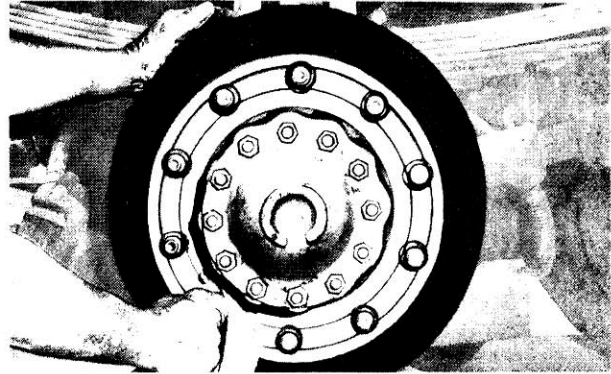
SPOKE WHEELS*	
Thread Size	Torque Ft.-Lbs. (Dry)
5/8 - 11	150 - 175
3/4 - 10	200 - 250
1 - 8	400 - 450
1 - 14	400 - 450

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.

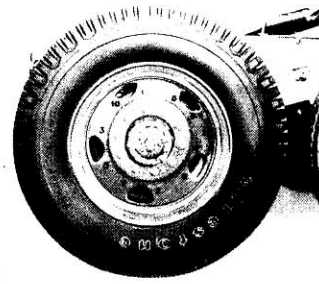
Wrenches for Demountable Rims and Disc Wheels: Double-end socket wrenches for rims and disc wheels normally are adequate to install and remove Accu-Ride rims and wheels, when used with a 3-foot bar. A 150-pound man, exerting his entire weight, 2.5 feet out on a bar, can apply 375 foot-pounds of torque 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 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
Piloted Mtg.	11/16-16	1-pc. nut 200-250 2-pc. nut 300-350
	3/4-16	450-500
	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.

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

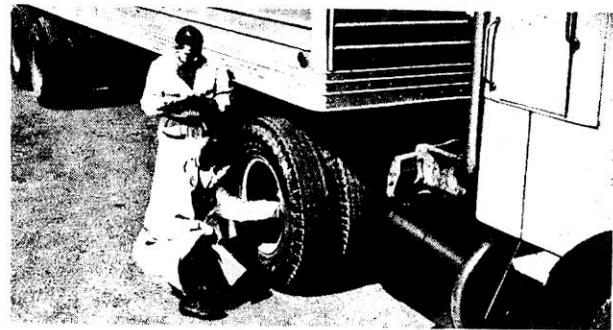
1. Check all metal surfaces thoroughly while making tire inspections, including areas between duals and on inboard side of wheel. Watch for:

- 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.

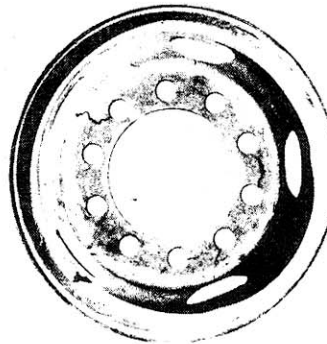
RIM AND WHEEL MAINTENANCE DURING TIRE CHANGES

1. Check all metal surfaces as in No. 1, above. A more thorough check may be made, however, after the tire has been

dismounted. 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.

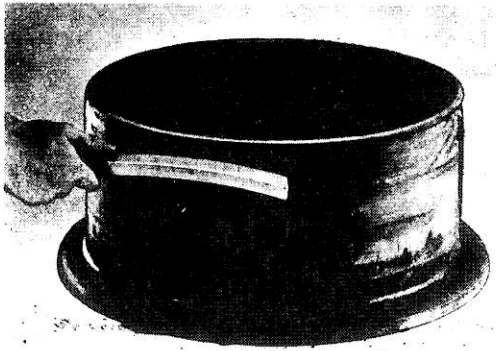
CAUTION: Insure that replacements are made with the proper sizes and types of rims and rings.

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)

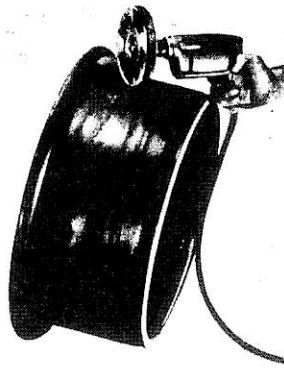
Proper maintenance of ACCU-RIDE rims and wheels

(continued)

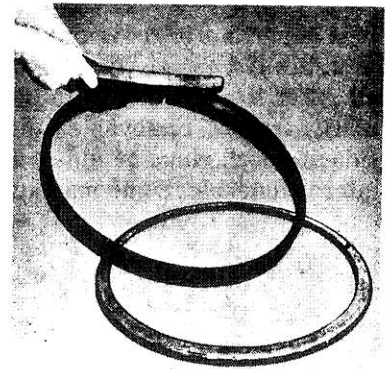


3. Thoroughly remove rust, dirt and other foreign materials from all surfaces. Hand or electric wire brushes, sand blasting or chemical baths may be used.

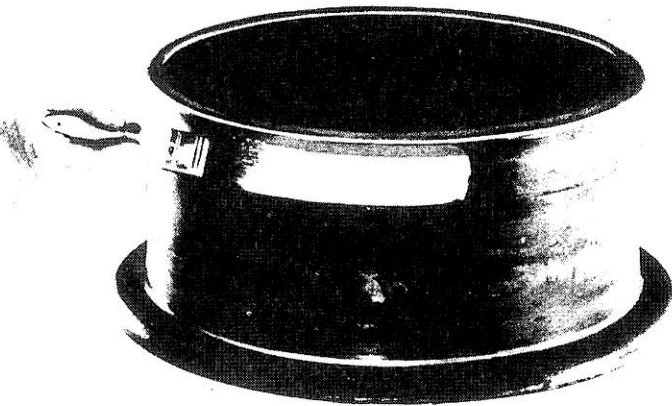
Gutter of rim base should be cleared of rust and other materials obstructing safe, positive seating of rings.



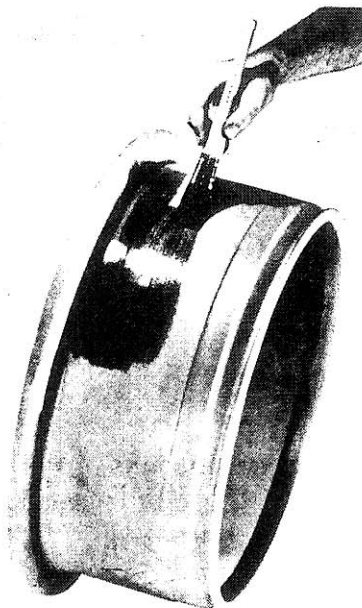
Bead seat areas of rim should be free of rust and rubber deposits. This is especially important for drop-center tubeless rims, because the 15° bead seat is the air-sealing element.



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.

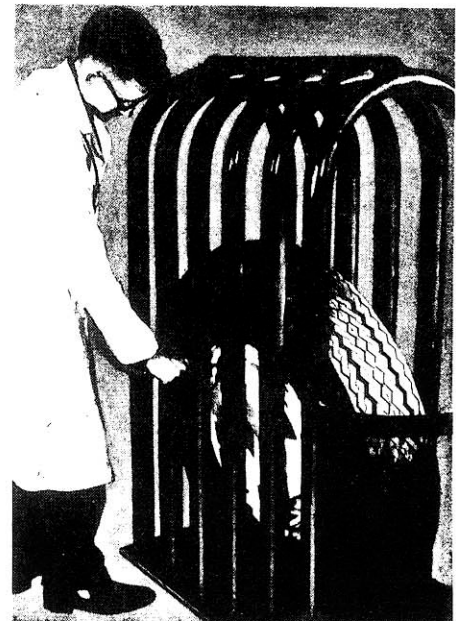


5. Lubricate tire side of rim base just prior to mounting tire. Avoid the use of any lubricant which contains water or solvent that is injurious to rubber. A combination lubricant and rust-preventive compound is preferable. This protective measure is of particular importance with drop-center tubeless 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.



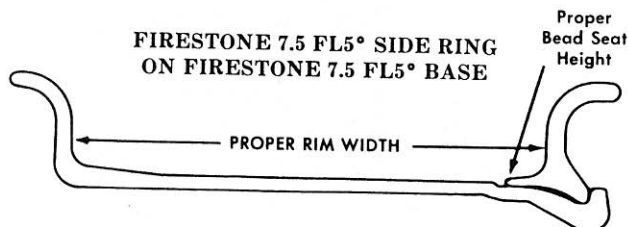
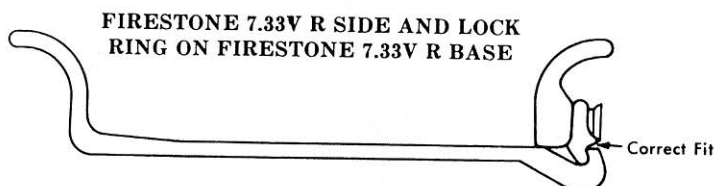
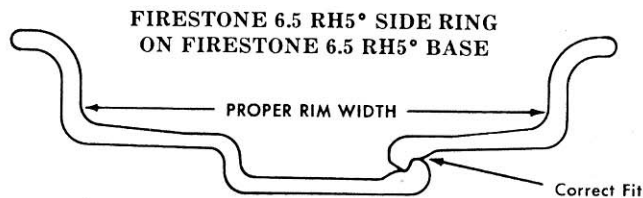
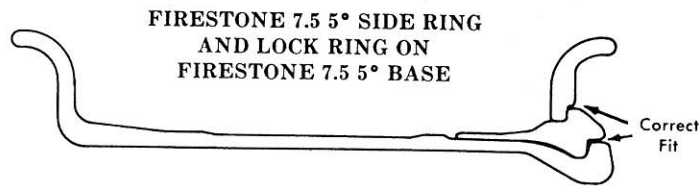
How to Insure Greater Safety and Service by Properly Matching Side and Lock Rings

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

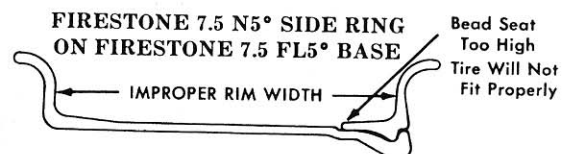
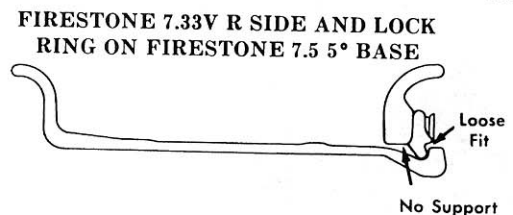
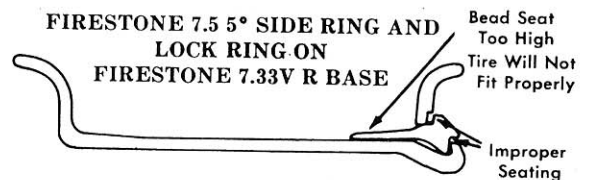
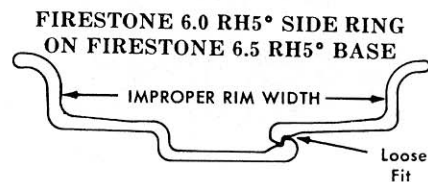
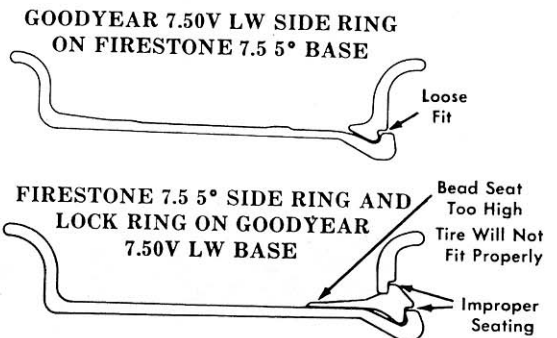
actually do not fit properly on the rim base. Serious accidents to personnel have resulted from the use of mismatched rings.

The drawings below illustrate a few of the potentially dangerous conditions which can result from the mismatching of rings and bases.

CORRECT

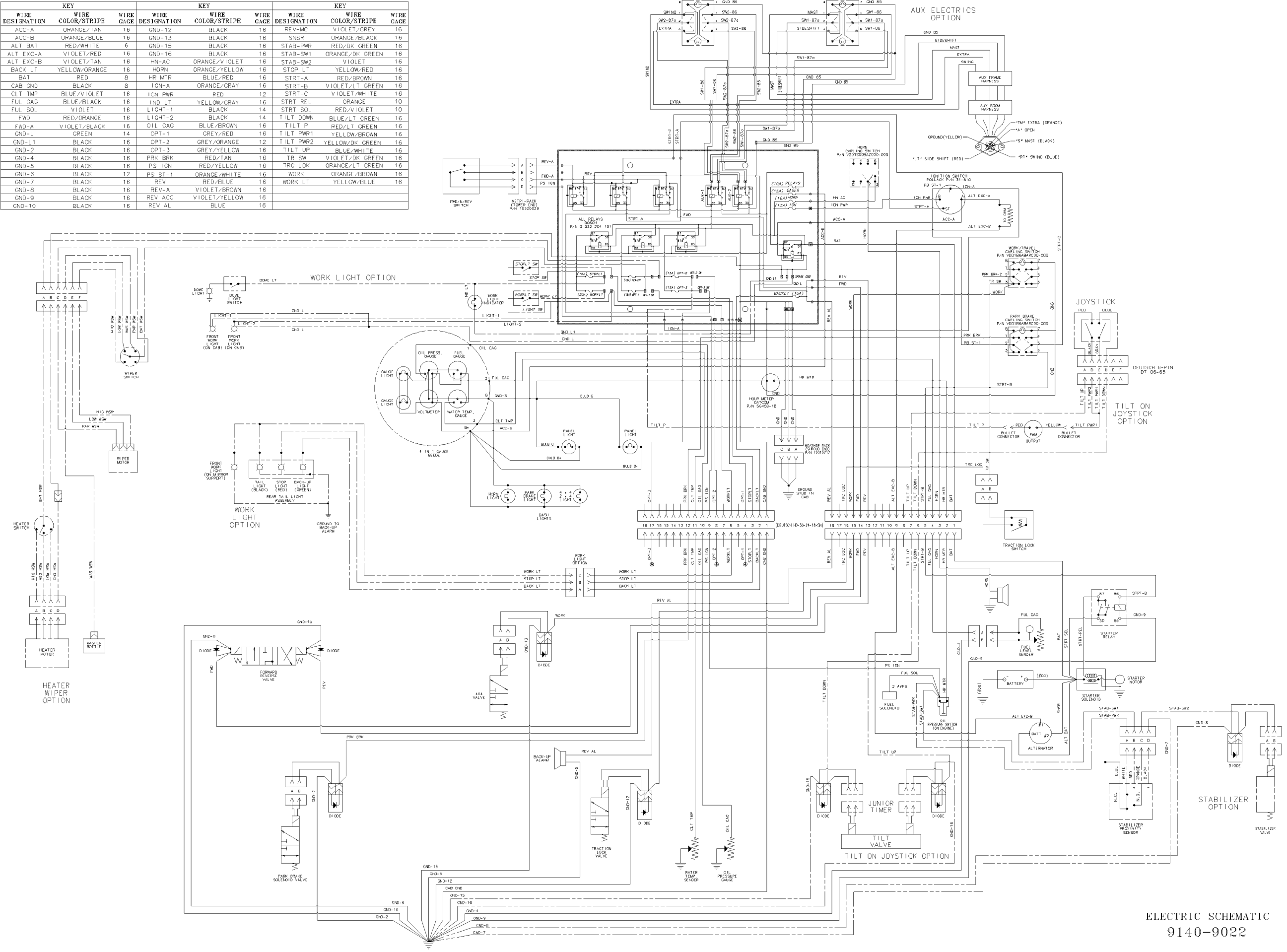


INCORRECT



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.

KEY			KEY			KEY		
WIRE DESIGNATION	WIRE COLOR/STRIPE	WIRE GAGE	WIRE DESIGNATION	WIRE COLOR/STRIPE	WIRE GAGE	WIRE DESIGNATION	WIRE COLOR/STRIPE	WIRE GAGE
ACC-A	ORANGE/TAN	16	GND-12	BLACK	16	REV-MC	VIOLET/GREY	16
ACC-B	ORANGE/BLUE	16	GND-13	BLACK	16	SNSR	ORANGE/BLACK	16
ALT EXC-A	RED/WHITE	6	GND-15	BLACK	16	STAB-PWR	RED/DK GREEN	16
ALT EXC-B	VIOLET/RED	16	GND-16	BLACK	16	STAB-SW1	ORANGE/DK GREEN	16
ALT EXC-B	VIOLET/TAN	16	HRN-AC	ORANGE/VIOLET	16	STAB-SW2	VIOLET	16
BACK LT	YELLOW/ORANGE	16	HORN	ORANGE/YELLOW	16	STOP LT	YELLOW/RED	16
BAT	RED	8	HR MTR	BLUE/RED	16	STRT-A	RED/BROWN	16
CAB GND	BLACK	8	IGN-A	ORANGE/GRAY	16	STRT-B	VIOLET/LT GREEN	16
CLT TMP	BLUE/VIOLET	16	IGN PWR	RED	12	STRT-C	VIOLET/WHITE	16
FUL GAG	BLUE/BLACK	16	IND LT	YELLOW/GRAY	16	STRT-REL	ORANGE	10
FUL SOL	VIOLET	16	LIGHT-1	BLACK	14	STRT SOL	RED/VIOLET	10
FWD	RED/ORANGE	16	LIGHT-2	BLACK	14	TILT DOWN	BLUE/LT GREEN	16
FWD-A	VIOLET/BLACK	16	OIL GAG	BLUE/BROWN	16	TILT P	RED/LT GREEN	16
GND-L	GREEN	14	OPT-1	GREY/RED	16	TILT PWR1	YELLOW/BROWN	16
GND-L1	BLACK	16	OPT-2	GREY/ORANGE	12	TILT PWR2	YELLOW/DK GREEN	16
GND-2	BLACK	16	OPT-3	GREY/YELLOW	16	TILT UP	BLUE/WHITE	16
GND-4	BLACK	16	PRK BRK	RED/TAN	16	TR SW	VIOLET/DK GREEN	16
GND-5	BLACK	16	PS IGN	RED/YELLOW	16	TRC LK	ORANGE/LT GREEN	16
GND-6	BLACK	12	PS ST-1	ORANGE/WHITE	16	WORK	ORANGE/BROWN	16
GND-7	BLACK	16	REV	RED/BLUE	16	WORK LT	YELLOW/BLUE	16
GND-8	BLACK	16	REV-A	VIOLET/BROWN	16			
GND-9	BLACK	16	REV ACC	VIOLET/YELLOW	16			
GND-10	BLACK	16	REV AL	BLUE	16			



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:

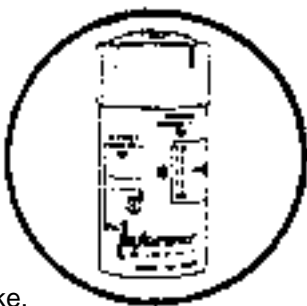
A) Over Servicing. New filter elements increase in dust cleaning efficiency as dust builds up on the

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.

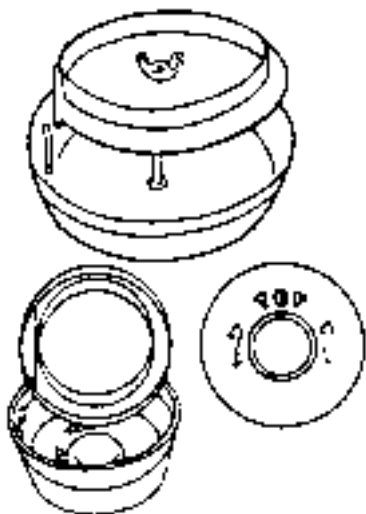


One of two conditions will exist

- (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

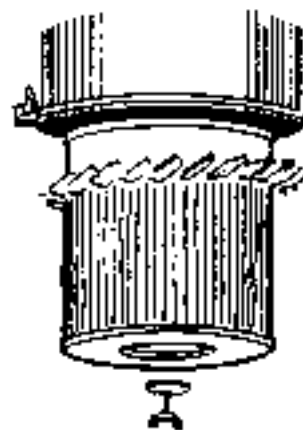
Dust should not be allowed to build up closer than one inch from the baffle. On models equipped with a Donaldson Vacuator valve, dust cup service is cut to a minimum; all that is necessary is a quick check to see that the Vacuator valve is not inverted, damaged, or plugged.



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.

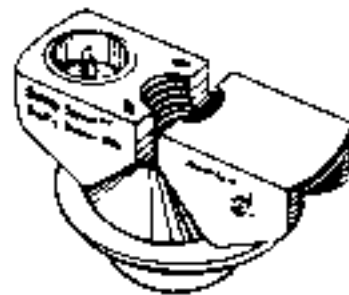


Cover the Inlet

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.

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

The Important "Don't"

Don't remove filter for inspection.



Never rap a filter to clean it. Rapping only damages the filter.



Never judge the filter's life by looking at it. Measure how restricted its airflow is.



Never leave an air cleaner open longer than necessary.

Don't 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

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Open Center HYDRAULIC POWER BRAKE VALVE



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SYSTEM SCHEMATIC (TYPICAL)

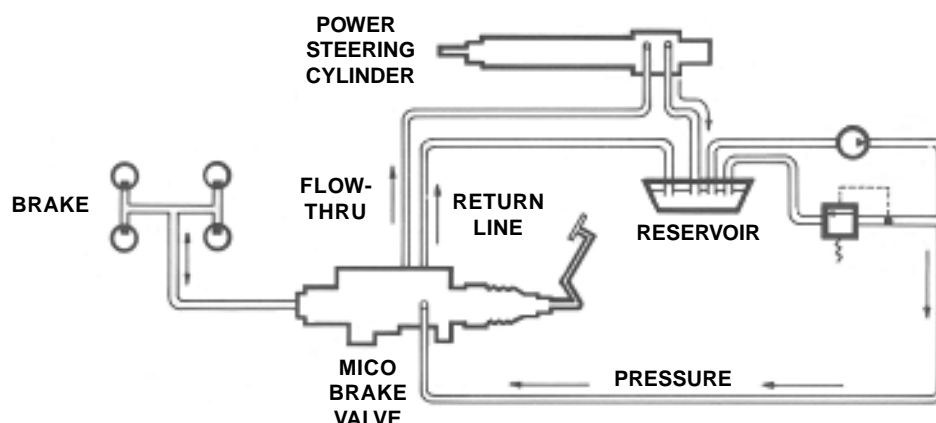


FIGURE 1

PERFORMANCE DATA (Typical)

Flow capacity.....	See Specification Chart (page 7)
System pressure.....	0 - 2000 psi
Brake line pressure.....	See Specification Chart (page 7)
Master cylinder, capacity.....	3.1 in. ³
Push rod travel with power.....	0.2" (approx.)
Push rod force with power.....	.340 lbs. at 1500 psi brake line pressure 225 lbs. at 250 psi brake line pressure (Model 06-460-652 only)
Push rod travel without power.....	1.844" (approx.)
Push rod force without power.....	1500 lbs. at 725 psi 518 lbs. at 250 psi (Model 06-460-652 only)

NOTE: Brake system rubber parts (Buna-N) must be compatible with mineral based hydraulic oil.

DESCRIPTION AND OPERATION OF THE MICO OPEN CENTER HYDRAULIC POWER BRAKE VALVE

The MICO Open Center Brake Valve will provide hydraulic power braking when installed in an open center hydraulic circuit. It can be used in conjunction with other hydraulic devices such as power steering, also installed in the same circuit. Using a single pump to provide flow and pressure, the brake valve should be installed in the system circuitry, in series, between the pump relief valve and the other hydraulic devices. The entire pump flow is directed thru the brake valve and is available to actuate the downstream devices. The brake valve requires a very small volume of oil for its operation; therefore, it does not interfere with the rest of the circuit, nor does usual actuation of the downstream hydraulic devices affect operation of the brake valve.

Full system pressure is always available for operating the rest of the system.

The MICO Brake Valve provides a single-fluid system using the systems hydraulic oil to operate the brakes. Synthetic rubber wheel-cylinder cups must be used to prevent swelling.

This valve reduces the braking effort to any required degree depending on pedal ratio. Brake pedal force is directly proportional to brake line pressure, thus giving a sense of feel in the operation of the brakes. Manual braking is always available whenever the hydraulic power system is not functioning. This is accomplished by a mechanical follow through within the

brake valve. A longer pedal stroke, usually with increased pedal effort, will be expected when braking in this condition.

The manner in which the hydraulic power brake valve functions will be discussed in the following paragraphs.

Oil from the pump flows through the brake valve and on to the downstream hydraulic unit as indicated (Figure 3). Sections of the valve which are communicated to the return port and the tank when the valve is not operating are shown (Figure 2). The compensating port (Figure 2) provides for thermal expansion of the oil in the brake lines and the master cylinder.

The residual valve (Fig. 2), if used, maintains pressure of 12-20 PSI in the brake lines when the pedal

Schematic of Brake Valve in Neutral

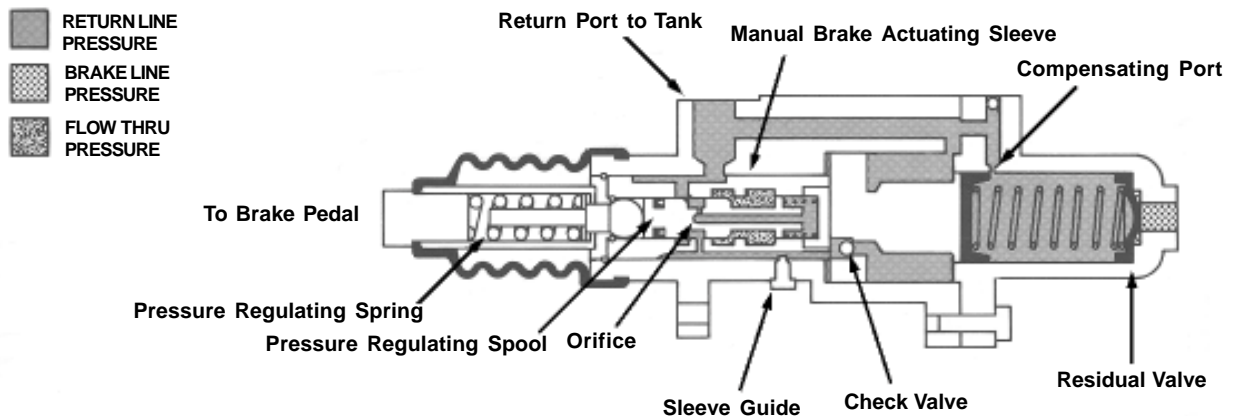


FIGURE 2

Brake Valve Actuated -- Power Steering in Neutral

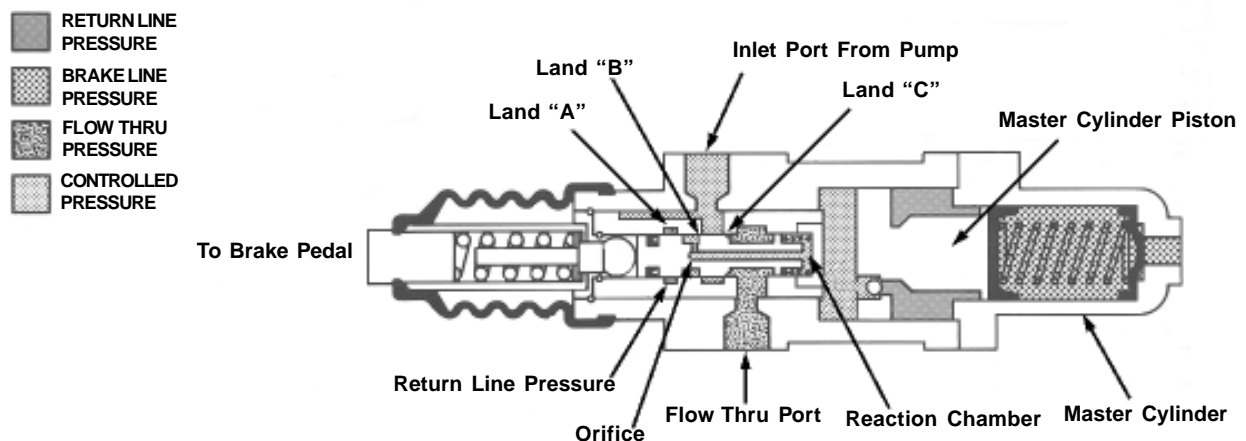
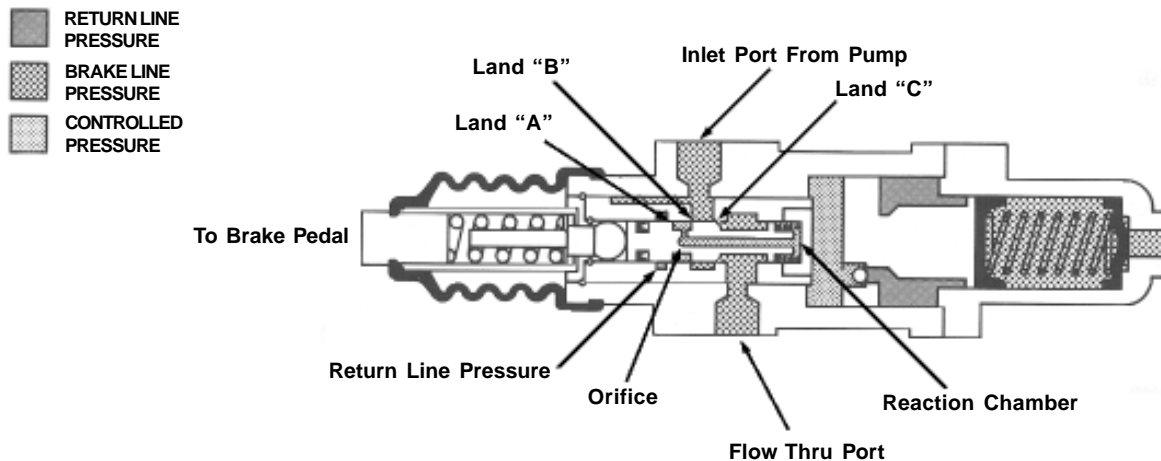


FIGURE 3

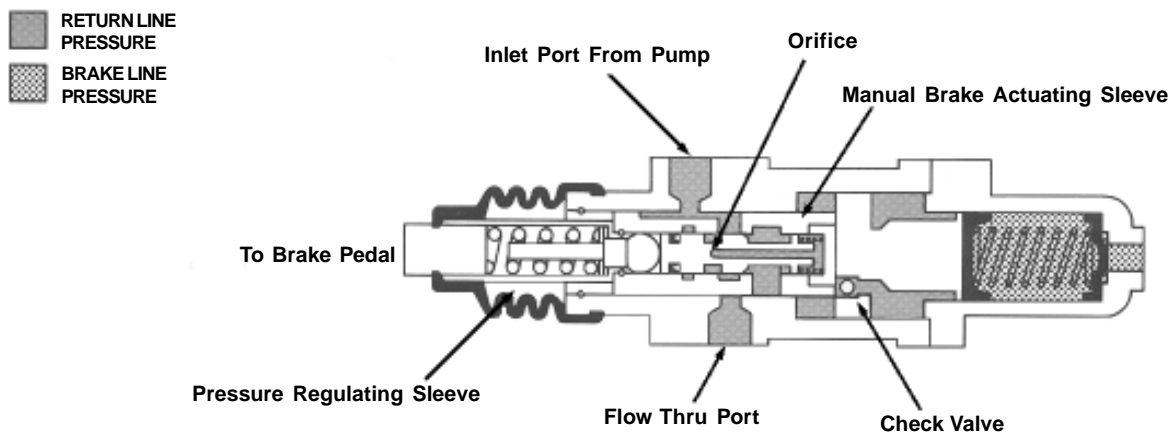
Hydraulic System Pressure Equal to Brake Line Pressure

FIGURE 4



Schematic of Brake Valve in Manual Operation

FIGURE 5



is released. In drum brake systems, this low pressure aids in preventing air from entering the brakes when the vehicle is at rest. The residual valve is removed from models designed for disc brake systems because of the drag which would develop in this type of brake, even at these relatively low pressures.

When force is applied to the brake pedal, this force acts through the PRESSURE REGULATING SPRING to shift the PRESSURE REGULATING SPOOL restricting the flow of oil at LAND "C" to build up pressure when there is no requirement for pressure to the power steering or other hydraulic device (Figure 3). As the pressure builds up, a small amount of oil flows through the ORIFICE and down through the passage inside the spool to the REACTION CHAMBER

(Figure 3). At the same time, oil flows along a groove in the outside diameter of the MANUAL BRAKE ACTUATING SLEEVE into the chamber ahead of the MANUAL BRAKE ACTUATING SLEEVE (Figure 2). Flow to the area ahead of the MANUAL BRAKE ACTUATING SLEEVE moves the MASTER CYLINDER PISTON, building up pressure in the MASTER CYLINDER which, in turn, builds pressure in the brake lines. Pressure in the REACTION CHAMBER moves the SPOOL back a small amount against the PRESSURE REGULATING SPRING, and when the hydraulic pressure balances against the PRESSURE REGULATING SPRING the pressure is controlled to the MASTER CYLINDER. The ORIFICE controls the rate of flow to

the REACTION CHAMBER; hence, the rate of pressure increases and stability of the pressure regulating spool is controlled. Therefore, system efficiency is maintained since the power brake valve does not momentarily take all of the fluid from the pump. When the pedal effort is released, the spring in the REACTION CHAMBER returns the pressure regulating spool to neutral. This closes LAND "B" to pressure and opens LAND "A" which allows the oil ahead of the spool in the REACTION CHAMBER to flow to the return port as well as the oil ahead of the MANUAL BRAKE ACTUATING SLEEVE. The spring in the MASTER CYLINDER returns the MASTER CYLINDER PISTON.

In case the downstream power hydraulic system requires a pressure that is equal to or greater than

one-half the brake line pressure, the PRESSURE REGULATING SPOOL shifts a minute amount and the pressure is regulated across LAND "A" and LAND "B" (Figure 4).

If the pressure required by the brake valve is lower than that required by the power steering, the power steering will not normally interfere with the operation of the brake (Figure 4).

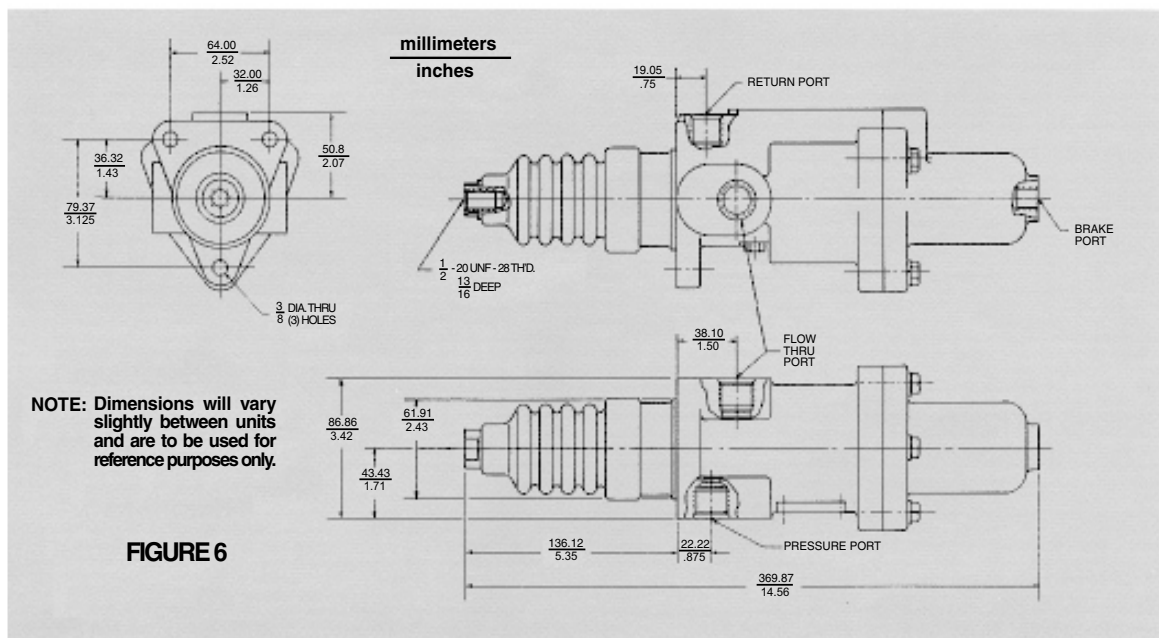
NOTE: Brake line pressure can exceed preset specifications in the unusual condition of a simultaneous brake application and sudden elevation of the steering pressure above the value.

In the standard MICO Open Center Valve, the pressure in the REACTION CHAMBER and ahead of the MASTER CYLINDER PISTON

is equal to one-half of the brake line pressure. To accomplish this, the area of the MASTER CYLINDER PISTON is twice the area of the MASTER CYLINDER. Therefore, any pressure that is applied to the MASTER CYLINDER PISTON will be multiplied by two to determine the master cylinder pressure. The pressure regulating spring can be factory set to normally limit brake line pressure regardless of system pressure.

This valve will act as a manual brake master cylinder, in the event of failure in the hydraulic circuit supplying power to it. The PRESSURE REGULATING SLEEVE contacts the MANUAL BRAKE ACTUATING SLEEVE which, in turn, pushes directly on the master cylinder piston, thereby building pressure in the MASTER CYLINDER (Figure 5). This requires

a longer stroke in the pedal. This amount of pressure that can be generated in the brake lines in manual operation is proportional to the pedal ratio and the effort which the operator is able to exert on the pedal. In most cases, the operator is not able to build as much pressure in the brake line as can be done in power operations. The ports from the pump are restricted when the valve is actuated manually; however, as soon as the engine is started, hydraulic pressure will push the MANUAL BRAKE ACTUATING SLEEVE back against the retaining ring which contains it and the valve again functions with power. This is rather an abrupt action when the engine is started, causing the brake pedal to return to its power mode position, and it is suggested that the brakes not be applied manually when starting the engine.



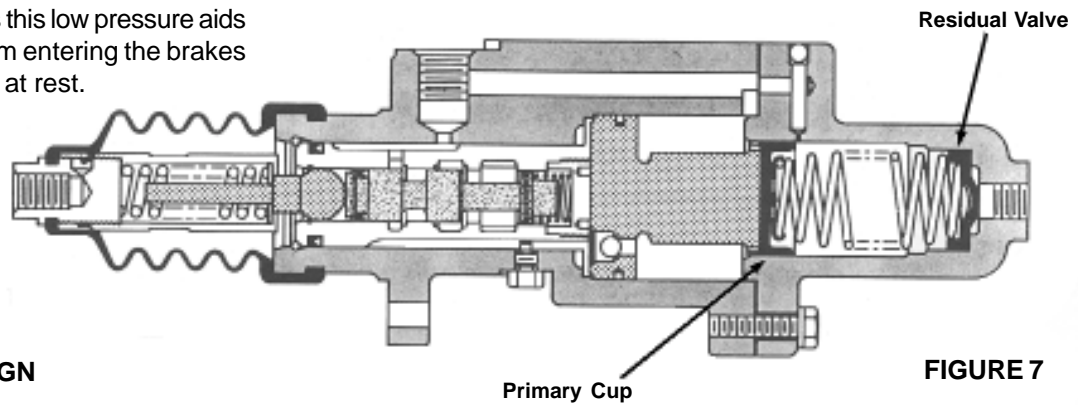
INSTALLATION INSTRUCTIONS

1. Mount MICO Open Center Power Brake Valve on vehicle and complete push rod and pedal hook-up. NOTE: It is important that the system reservoir be mounted above the brake valve, or that the return line have a vertical section of one foot directly above the valve.
2. The pedal assembly must have its own return spring. DO NOT rely on the internal spring in the valve for this function.
3. Pedal should be adjusted to allow 1/32" clearance between pressure regulating rod and actuator.
4. Bleed system (see bleeding instruction on page 14).
5. Be sure all hydraulic fittings are tight and visually check system for leaks with power applied.

THREE OPEN CENTER HYDRAULIC POWER BRAKE VALVE DESIGNS

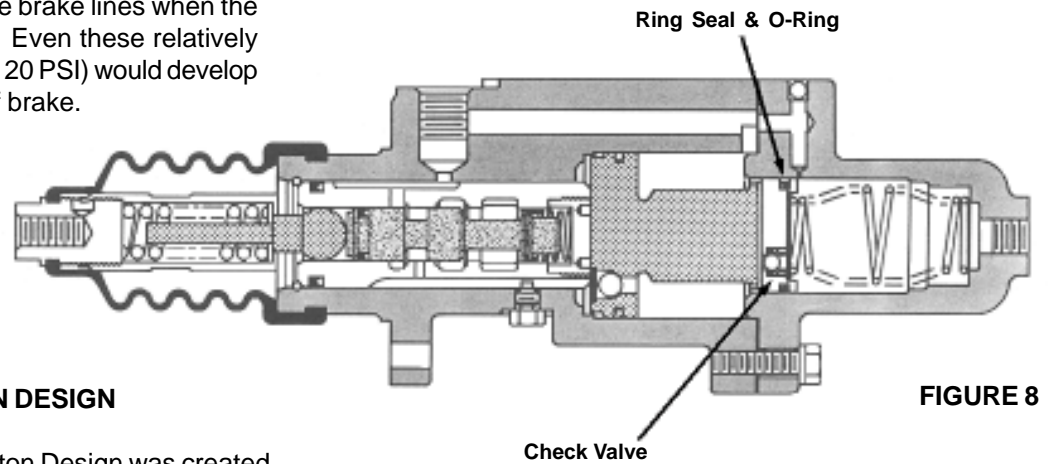
PRIMARY CUP DESIGN

The Primary Cup Design uses a residual valve. This valve will maintain a pressure of 12 - 20 PSI in the brake lines when the pedal is released. When used in drum brake systems this low pressure aids in preventing air from entering the brakes when the vehicle is at rest.



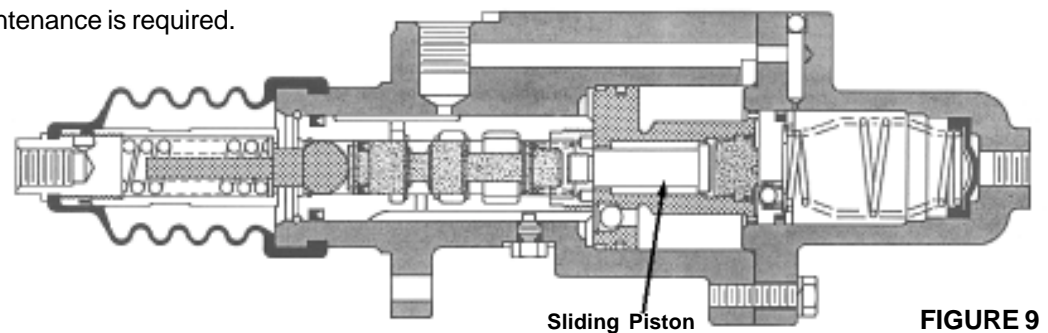
RING SEAL DESIGN

The Ring Seal Design is used mainly in disc brake systems. The residual valve is removed from models designed for disc brake systems because of the pressure they maintain in the brake lines when the pedal is released. Even these relatively low pressures (12 - 20 PSI) would develop drag in this type of brake.



SLIDING PISTON DESIGN

The Sliding Piston Design was created with a specific function in mind. A specially designed piston slides inside the primary piston when the brake pedal is actuated. If primary piston strokes too far, the brake pedal will be pulled down with a short abrupt stroke. This indicates to the operator that maintenance is required.



SPECIFICATIONS CHART

Part Number	Brake Port	Pressure Port	Flow Thru Port	Return Port	Brake Line Pressure (with power)	Flow Capacity
* 06-460-520 Complete unit replaced by 06-460-658	1/2-20 UNF	SAE No. 10	SAE No. 10	1/2-14 NPTF	1850 psi ± 50 psi	3-24 gpm
06-460-522	9/16-18 UNF	SAE No. 10	SAE No. 10	SAE No. 10	1850 psi ± 50 psi	3-24 gpm
* 06-460-550 Complete unit replaced by 06-460-656	1/2-20 UNF	SAE No. 10	SAE No. 10	1/2-14 NPTF	1500 psi ± 50 psi	3-24 gpm
* 06-460-560 Complete unit replaced by 06-460-656	1/2-20 UNF	SAE No. 8	SAE No. 8	SAE No. 10	1550 psi ± 50 psi	3-24 gpm
* 06-460-570 Complete unit replaced by 06-460-662	9/16-18 UNF	SAE No. 8	SAE No. 8	SAE No. 10	1550 psi ± 50 psi	3-24 gpm
* 06-460-580 Complete unit replaced by 06-460-656	1/2-20 UNF	SAE No. 10	SAE No. 10	SAE No. 10	1500 psi ± 50 psi	3-24 gpm
* 06-460-588 Complete unit replaced by 06-460-664	1/2-20 UNF	SAE No. 10	SAE No. 10	SAE No. 10	1550 psi ± 50 psi	3-24 gpm
* 06-460-610 Complete unit replaced by 06-460-666	9/16-18 UNF	SAE No. 10	SAE No. 10	1/2-14 NPTF	950 psi ± 50 psi	3-24 gpm
* 06-460-620 Complete unit replaced by 06-460-656	1/2-20 UNF	SAE No. 10	SAE No. 10	SAE No. 10	1500 psi ± 50 psi	3-24 gpm
06-460-642	1/2-20 UNF	SAE No. 10	SAE No. 10	SAE No. 10	1550 psi ± 50 psi	3-24 gpm
* 06-460-650 Complete unit replaced by 06-460-656	1/2-20 UNF	SAE No. 10	SAE No. 10	1/2-14 NPTF	1500 psi ± 50 psi	3-24 gpm
* 06-460-654 Complete unit replaced by 06-460-676	9/16-18 UNF	SAE No. 8	SAE No. 8	SAE No. 10	1500 psi ± 50 psi	3-12 gpm
* 06-460-656	1/2-20 UNF	SAE No. 10	SAE No. 10	SAE No. 10	1500 psi ± 50 psi	3-24 gpm
* 06-460-658	1/2-20 UNF	SAE No. 10	SAE No. 10	SAE No. 10	1850 psi ± 50 psi	3-24 gpm
* 06-460-660	1/2-20 UNF	SAE No. 10	SAE No. 10	SAE No. 10	1150 psi ± 50 psi	3-24 gpm
* 06-460-662	9/16-18 UNF	SAE No. 10	SAE No. 10	SAE No. 10	1550 psi ± 50 psi	3-24 gpm
* 06-460-664	1/2-20 UNF	SAE No. 10	SAE No. 10	SAE No. 10	1500 psi ± 50 psi	3-12 gpm
* 06-460-666	9/16-18 UNF	SAE No. 10	SAE No. 10	SAE No. 10	950 psi ± 50 psi	3-24 gpm
06-460-668	1/2-20 UNF	SAE No. 10	SAE No. 10	SAE No. 10	1000 psi ± 50 psi	3-12 gpm
* 06-460-670	1/2-20 UNF	SAE No. 10	SAE No. 10	SAE No. 10	1550 psi ± 50 psi	3-8 gpm
06-460-672	1/2-20 UNF	SAE No. 10	SAE No. 10	SAE No. 10	750 psi ± 50 psi	3-24 gpm
* 06-460-674	1/2-20 UNF	SAE No. 10	SAE No. 10	SAE No. 10	1500 psi ± 50 psi	3-12 gpm
06-460-676	9/16-18 UNF	SAE No. 10	SAE No. 10	SAE No. 10	1500 psi ± 50 psi	3-12 gpm
06-460-678	1/2-20 UNF	SAE No. 10	SAE No. 10	SAE No. 10	1700 psi ± 50 psi	3-24 gpm
* 06-460-680 Complete unit replaced by 06-460-670	1/2-20 UNF	SAE No. 8	SAE No. 8	SAE No. 10	1550 psi ± 50 psi	3-8 gpm
06-460-682 Complete unit replaced by 06-460-672	1/2-20 UNF	SAE No. 8	SAE No. 8	SAE No. 10	750 psi ± 50 psi	3-24 gpm
06-460-684	1/2-20 UNF	SAE No. 10	SAE No. 10	SAE No. 10	1100 psi ± 50 psi	3-12 gpm
* 06-460-686 Complete unit replaced by 06-460-674	1/2-20 UNF	SAE No. 10	SAE No. 10	1/2-14 NPTF	1500 psi ± 50 psi	3-12 gpm
06-461-520 Complete unit replaced by 06-461-658	1/2-20 UNF	SAE No. 10	SAE No. 10	1/2-14 NPTF	1850 psi ± 50 psi	3-24 gpm
06-461-550 Complete unit replaced by 06-461-656	1/2-20 UNF	SAE No. 10	SAE No. 10	1/2-14 NPTF	1500 psi ± 50 psi	3-24 gpm
06-461-610 Complete unit replaced by 06-461-666	9/16-18 UNF	SAE No. 10	SAE No. 10	1/2-14 NPTF	950 psi ± 50 psi	3-24 gpm
06-461-656	1/2-20 UNF	SAE No. 10	SAE No. 10	SAE No. 10	1500 psi ± 50 psi	3-24 gpm
06-461-658	1/2-20 UNF	SAE No. 10	SAE No. 10	SAE No. 10	1850 psi ± 50 psi	3-24 gpm
06-461-660	1/2-20 UNF	SAE No. 10	SAE No. 10	SAE No. 10	1150 psi ± 50 psi	3-24 gpm
06-461-666	9/16-18 UNF	SAE No. 10	SAE No. 10	SAE No. 10	950 psi ± 50 psi	3-24 gpm
06-461-674	1/2-20 UNF	SAE No. 10	SAE No. 10	SAE No. 10	1500 psi ± 50 psi	3-12 gpm

- For use with drum brakes (has residual check valve)

NOTE: The valves should be used within the flow capacities indicated above for optimum performance. Valves are functional at lower flows but response is reduced. At the higher flow operation higher pressure drops are seen.

OPEN CENTER HYDRAULIC BRAKE VALVE PRIMARY CUP DESIGN (Refer to Figure 10)

Disassembly

1. Remove boot (item 1) and pressure regulating spring assembly (item 2).

CAUTION: Pressure regulating spring assembly has been set at the factory and should never be disassembled, re-adjusted or interchanged with another valve.

2. Separate end cap (item 21) from housing (item 11).

CAUTION: Care must be taken as end cap is under tension of spring (item 19).

Remove gasket (item 14).

3. Remove primary cup (item 17), retainer (item 18), spring (item 19) and residual valve (item 20) from end cap (item 21).
4. Remove cap screw (item 13) from under side of housing (item 11). Remove o-ring (item 12) from cap screw.
5. Remove retaining ring (item 8) from housing (item 11).
6. Remove sleeve (item 10) by pulling on push rod (item 4). Remove cup (item 9) from sleeve.
7. Remove piston (item 16) from housing (item 11). Remove piston ring (item 15) from piston.
8. Remove retaining ring (item 3) carefully with a small flat tool. Do not scratch bore of sleeve (item 10).
9. Remove push rod (item 4), spool (item 6) and spring (item 7) from sleeve (item 10). Remove cup (item 5) from spool (item 6).

Inspection

Clean and inspect all component parts for scratches, cracks or wear. Replace any parts that are excessively worn or damaged.

CAUTION: If spool (item 6), sleeve (8)

(item 10) or bore of housing (item 11) are in any way damaged, scratched or broken, the entire assembly must be replaced. These parts are select-fitted and are not interchangeable or replaceable with service items.

Assembly

1. Install new cup (item 9) on sleeve (item 10) and new cup (item 5) on spool (item 6).

CAUTION: Lips on cups (items 5 & 9) should be away from ends of spool (item 6) and sleeve (item 10).

2. Place spring (item 7) in sleeve (item 10).
3. Install spool (item 6) in sleeve (item 10). Note direction of spool.
4. Install push rod (item 4) in sleeve (item 10) and secure it with new retaining ring (item 3).
5. Install new o-ring (item 12) on cap screw (item 13) and install in housing (item 11).
6. Carefully install sleeve (item 10) into housing (item 11).

CAUTION: Make sure that groove on sleeve will engage cap screw (item 13).

Install retaining ring (item 8).

7. Install new piston ring (item 15) on piston (item 16) and install in housing (item 11).
8. Place new residual valve (item 20), spring (item 19) and retainer (item 18) in end cap (item 21).

CAUTION: Residual valve must be checked for proper seating in end cap.

9. Place new gasket (item 14) on mounting face of end cap (item 21) and new primary cup (item 17)

on end of spring (item 19).

10. Assemble end cap (item 21) with its components to housing (item 11) making sure lip on primary cup (item 17) has properly engaged bore of housing.
11. Install lock washer (items 22) and bolts (items 23). Torque 16 to 18 ft. lbs.
12. Install pressure regulating spring assembly (item 2) on push rod (item 4). Install new boot (item 1).

SEE BLEEDING SECTION FOR COMPLETE BLEEDING INSTRUCTIONS

PARTS LIST

ITEM	DESCRIPTION
1	• BOOT
2	PRESSURE REGULATING SPRING ASSEMBLY
3	• RETAINING RING
4	PUSH ROD
5	• CUP
6	SPOOL
7	SPRING
8	RETAINING RING
9	• CUP
10	SLEEVE
11	HOUSING
12	• O-RING
13	CAP SCREW
14	• GASKET
15	• PISTON RING
16	PISTON
17	• PRIMARY CUP
18	RETAINER
19	SPRING
20	• RESIDUAL VALVE
21	END CAP
22	LOCKWASHERS
23	BOLTS

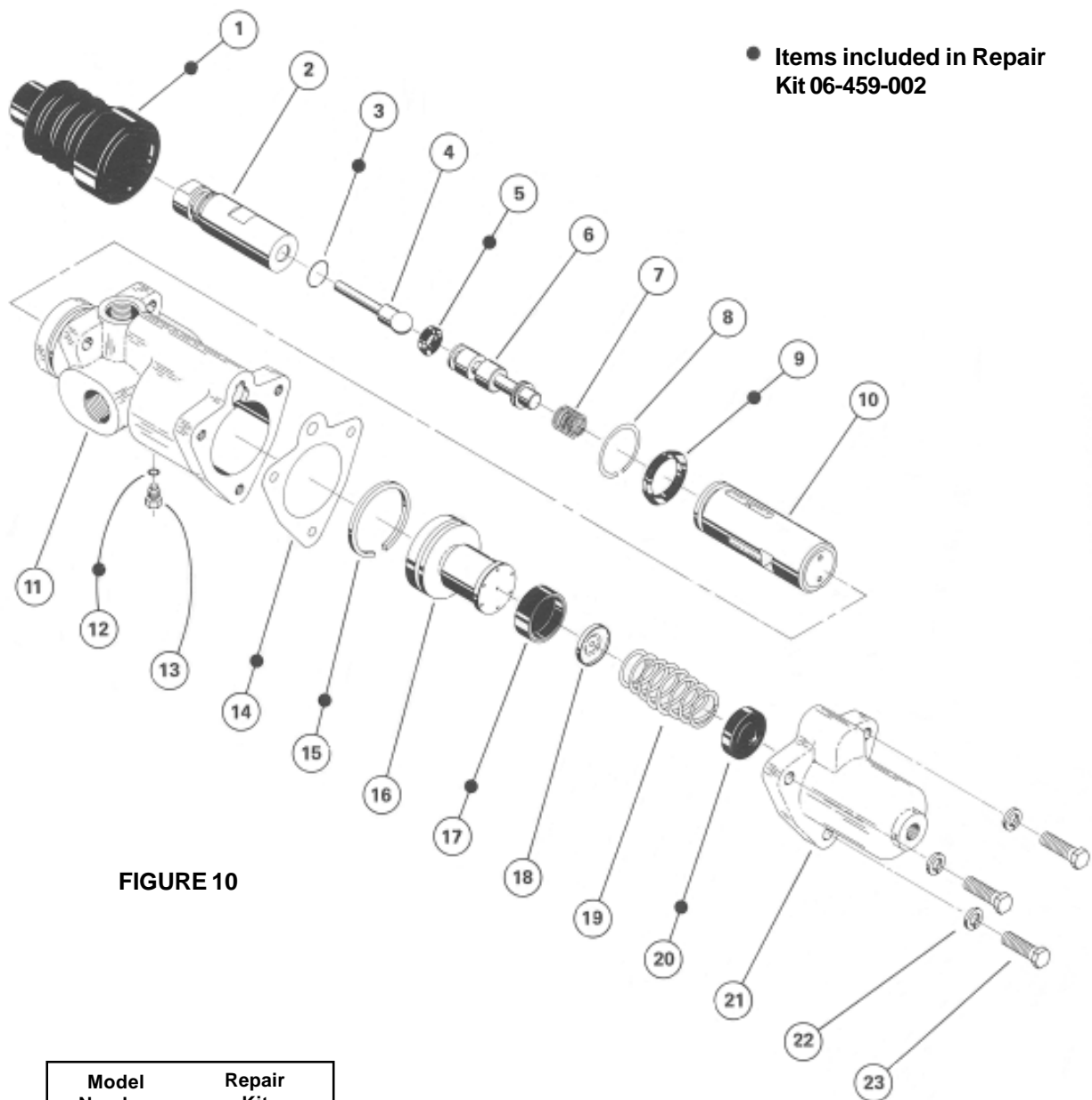


FIGURE 10

Model Number	Repair Kit
06-460-520	06-459-002
06-460-522	06-459-002
06-460-550	06-459-002
06-460-560	06-459-002
06-460-570	06-459-002
06-460-580	06-459-002
06-460-588	06-459-002
06-460-610	06-459-002
06-460-620	06-459-002
06-460-650	06-459-002
06-460-680	06-459-002
06-460-686	06-459-002

OPEN CENTER HYDRAULIC BRAKE VALVE RING SEAL DESIGN (Refer to Figure 11)

Disassembly

1. Remove boot (item 1) and pressure regulating spring assembly (item 2).

CAUTION: Pressure regulating spring assembly has been set at the factory and should never be disassembled.

2. Separate end cap (item 21) from housing (item 11).

CAUTION: Care must be taken as end cap is under tension of spring (item 20).

Remove gasket (item 14).

3. Remove piston & poppet assembly (item 17) and spring (item 20) from end cap (item 22).

CAUTION: If you have model 06-460-566, you will also have to remove residual valve (item 21).

4. Remove cap screw (item 13) from under side of housing (item 11). Remove o-ring (item 12) from cap screw.
5. Remove retaining ring (item 8) from housing (item 11).
6. Remove sleeve (item 10) by pulling on push rod (item 4). Remove cup (item 9) from sleeve.
7. Remove piston (item 16) from housing (item 11). Remove piston ring (item 15) from piston.
8. Remove retaining ring (item 3) carefully with a small flat tool. Do not scratch bore of sleeve (item 10).
9. Remove push rod (item 4), spool (item 6) and spring (item 7) from sleeve (item 10). Remove cup (item 5) from spool (item 6).

Inspection

Clean and inspect all component parts for scratches, cracks or wear. Replace any parts that are excessively worn or damaged.

(10)

CAUTION: If spool (item 6), sleeve (item 10) or bore of housing (item 11) are in any way damaged, scratched or broken, the entire assembly must be replaced. These parts are select-fitted and are not interchangeable or replaceable with service items.

Assembly

1. Install new cup (item 9) on sleeve (item 10) and new cup (item 5) on spool (item 6).

CAUTION: Lips on cups (items 5 & 9) should be away from ends of spool (item 6) and sleeve (item 10).

2. Place spring (item 7) in sleeve (item 10).
3. Install spool (item 6) in sleeve (item 10). Note direction of spool.
4. Install push rod (item 4) in sleeve (item 10) and secure it with retaining ring (item 3).
5. Install new o-ring (item 12) on cap screw (item 13) and install in housing (item 11).
6. Carefully install sleeve (item 10) into housing (item 11).

CAUTION: Make sure that groove on sleeve will engage cap screw (item 13)

Install retaining ring (item 8).

7. Install piston ring (item 15) on piston (item 16) and install in housing (item 11).
8. Install new o-ring (item 18) and new ring seal (item 19) on new piston & poppet assembly (item 17).
9. Install spring (item 20) and piston & poppet assembly (item 17) in end cap (item 22).

NOTE: If you have model 06-460-566, you will have to install new residual valve (item 21). You must also check

residual valve for proper seating in end cap.

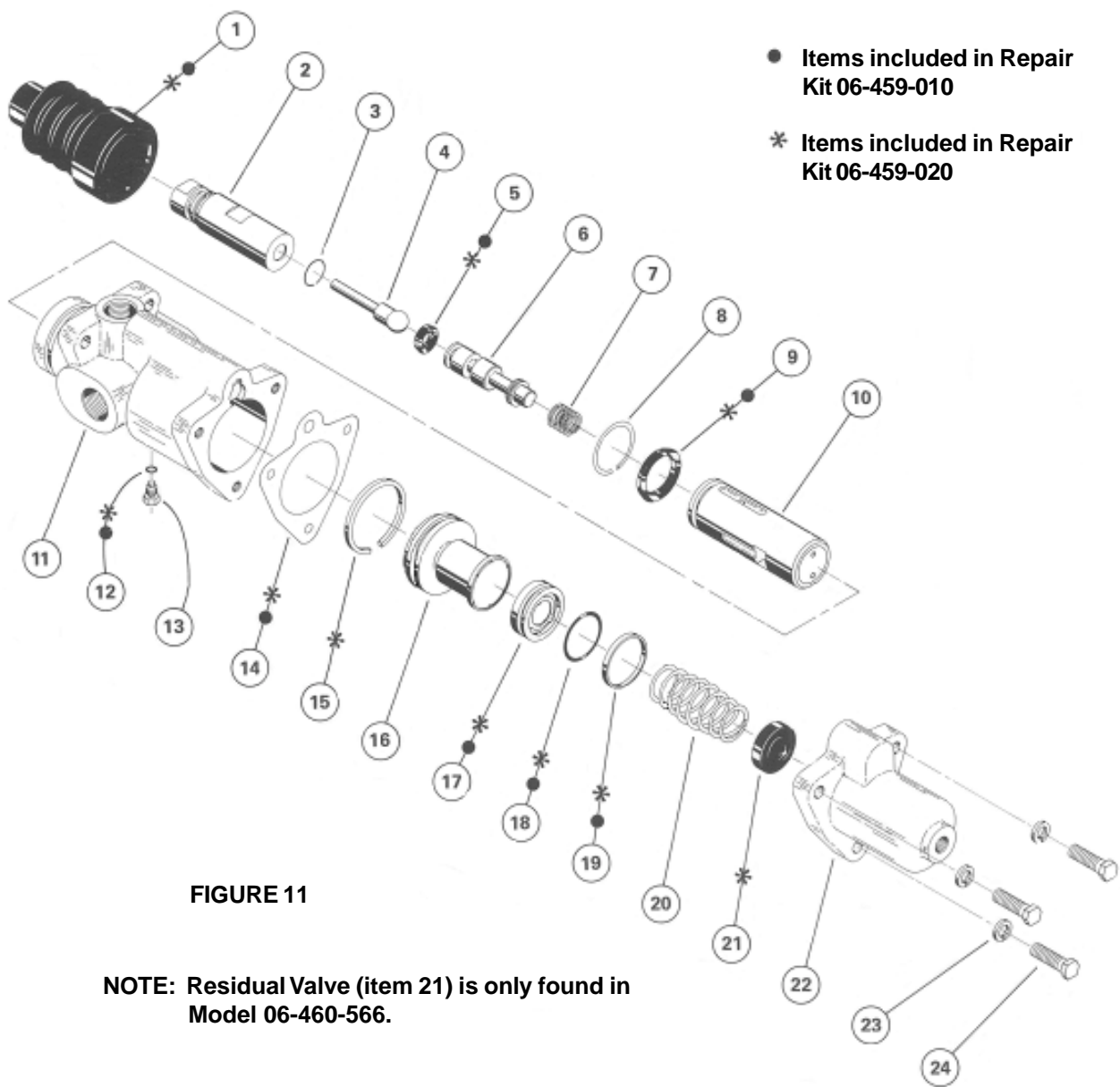
CAUTION: Extreme care must be taken so as not to scratch teflon seal (item 19) when installing piston & poppet assembly (item 17) in end cap (item 22).

10. Place new gasket (item 14) on mounting face of end cap (item 22) and assemble, with its components, to housing (item 11).
11. Install lock washers (item 23) and bolts (item 24). Torque 16 to 18 ft. lbs.
12. Install pressure regulating spring assembly (item 2) on push rod (item 4). Install new boot (item 1).

SEE BLEEDING SECTION FOR COMPLETE BLEEDING INSTRUCTIONS

PARTS LIST

ITEM	DESCRIPTION
1 * •	BOOT
2	PRESSURE REGULATING SPRING ASSEMBLY
3	RETAINING RING
4	PUSH ROD
5 * •	CUP
6	SPOOL
7	SPRING
8	RETAINING RING
9 * •	CUP
10	SLEEVE
11	HOUSING
12 * •	O-RING
13	CAP SCREW
14 * •	GASKET
15 *	PISTON RING
16	PISTON
17 * •	PISTON & POPPET ASSEMBLY
18 * •	O-RING
19 * •	RING SEAL
20	SPRING
21 *	RESIDUAL VALVE
22	END CAP
23	LOCKWASHERS
24	BOLTS



Model Number	Repair Kit
06-460-654	06-459-010
06-460-656	06-459-020
06-460-658	06-459-020
06-460-660	06-459-020
06-460-662	06-459-020
06-460-664	06-459-020
06-460-666	06-459-020
06-460-668	06-459-010
06-460-670	06-459-020
06-460-672	06-459-010
06-460-674	06-459-020
06-460-676	06-459-010
06-460-678	06-459-020
06-460-682	06-459-010

OPEN CENTER HYDRAULIC BRAKE VALVE SLIDING PISTON DESIGN (Refer to Figure 12)

Disassembly

1. Remove boot (item 1) and pressure regulating spring assembly (item 2).

CAUTION: Pressure regulating spring assembly has been set at the factory and should never be disassembled.

2. Separate end cap (item 20) from housing (item 3).

CAUTION: Care must be taken as end cap is under tension of spring (item 18).

Remove gasket (item 6).

3. Remove piston & poppet assembly (item 15), spring (item 18) and residual valve (item 19) from end cap (item 20).
4. Remove cap screw (item 5) from under side of housing (item 3). Remove o-ring (item 4) from cap screw.
5. Remove sleeve & piston assembly (item 14) from housing (item 3). Remove cup (item 12) and piston ring (item 13) from sleeve & piston assembly (item 14).
6. Remove retaining ring (item 7) carefully with a small flat tool. Do not scratch bore of sleeve & piston assembly (item 14).
7. Remove push rod (item 8), spool (item 10) and spring (item 11) from sleeve & piston assembly (item 14). Remove cup (item 9) from spool (item 10).

Inspection

Clean and inspect all component parts for scratches, cracks or wear. Replace any parts that are excessively worn or damaged.

CAUTION: If spool (item 10), sleeve (item 14) or bore of housing (item 3) are in any way damaged, scratched

or broken, the entire assembly must be replaced. These parts are select-fitted and are not interchangeable or replaceable with service items.

Assembly

1. Install new cup (item 12) and new piston ring (item 13) on sleeve & piston assembly (item 14).

CAUTION: Lips on cup (item 12) should be away from end of sleeve (item 14).

2. Install new cup (item 9) on spool (item 10).

CAUTION: Lips on cup (item 9) should be away from end of spool (item 10).

3. Insert spool (item 10) and push rod (item 8) into sleeve & piston assembly (item 14). Secure with retaining ring (item 7).
4. Carefully install sleeve & piston assembly (item 14) into housing (item 3).

CAUTION: Make sure that groove on sleeve will engage screw (item 5).

5. Install new o-ring (item 4) on cap screw (item 5) and install in housing (item 3).
6. Install new o-ring (item 16) and new ring seal (item 17) on new piston & poppet assembly (item 15).
7. Place residual valve (item 19), spring (item 18) and piston & poppet assembly (item 15) in end cap (item 20).

NOTE: Residual valve must be checked for proper seating in end cap.

CAUTION: Extreme care must be taken so as not to scratch ring seal (item 17) when installing piston & poppet assembly (item 15) in end cap (item 20).

8. Place new gasket (item 6) on mounting face of end cap (item 20) and assembly, with its components, to housing (item 3).
9. Install lock washers (items 21) and bolts (items 22). Torque 16 to 18 ft. lbs.
10. Install pressure regulating spring assembly (item 2) on push rod (item 8). Install new boot (item 1).

SEE BLEEDING SECTION FOR COMPLETE BLEEDING INSTRUCTIONS

PARTS LIST

ITEM	DESCRIPTION
1	• BOOT
2	PRESSURE REGULATING SPRING ASSEMBLY
3	HOUSING
4	• O-RING
5	CAP SCREW
6	• GASKET
7	RETAINING RING
8	PUSH ROD
9	• CUP
10	SPOOL
11	SPRING
12	• CUP
13	• PISTON RING
14	SLEEVE & PISTON ASSEMBLY
15	• PISTON & POPPET ASSEMBLY
16	• O-RING
17	• RING SEAL
18	SPRING
19	• RESIDUAL VALVE
20	END CAP
21	LOCKWASHERS
22	BOLTS

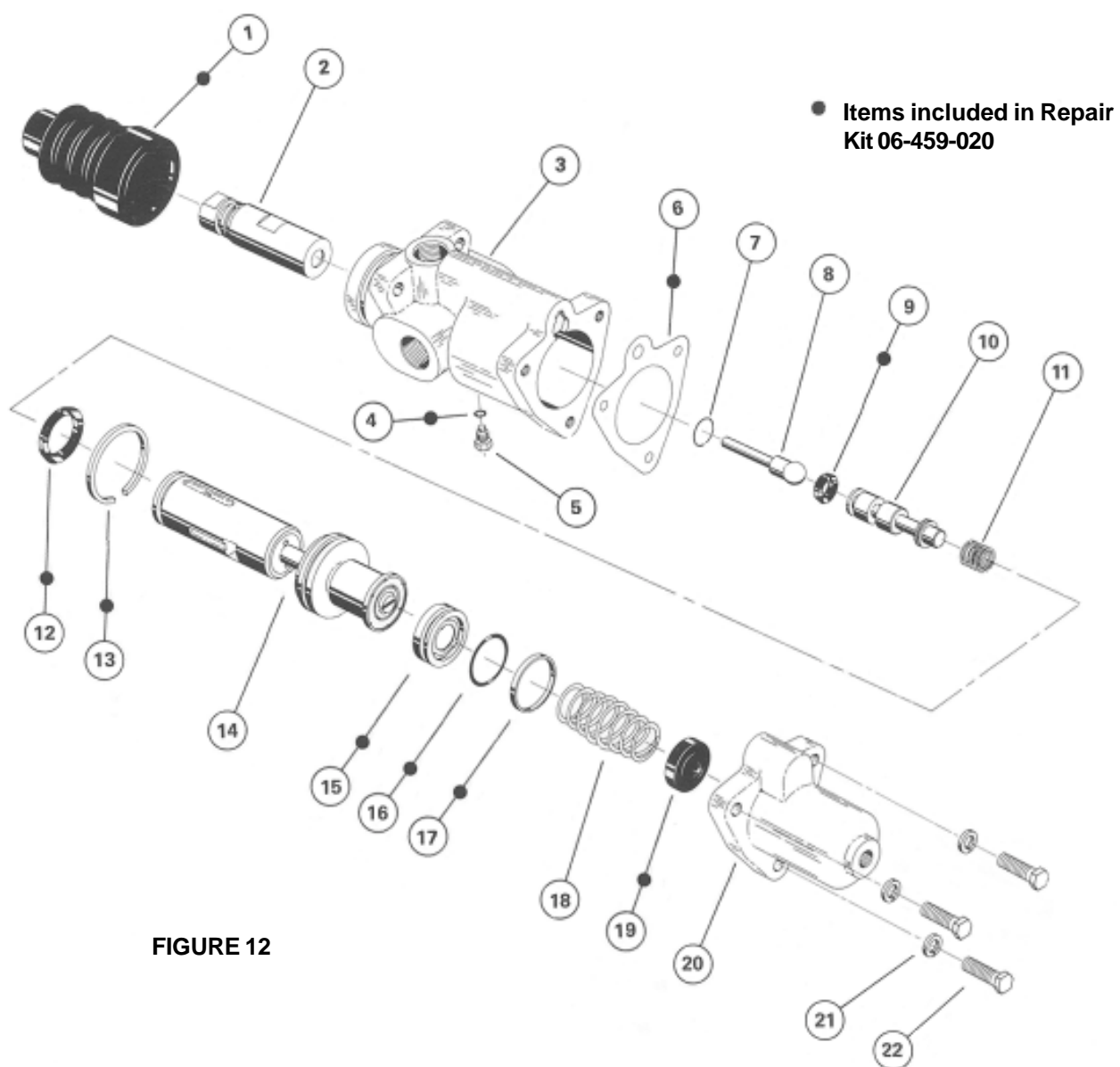


FIGURE 12

Model Number	Repair Kit
06-460-642	06-459-020
06-460-684	06-459-020

GENERAL SERVICE DIAGNOSIS

With Engine Off --

PEDAL GOES TO FLOOR

1. Brake not adjusted
1. **Check adjustment**
2. Air in system
2. **Bleed brakes**
3. Inoperative brakes
3. **Check brakes**
4. Blown hydraulic line
4. **Check brake line**
5. Worn out primary cup
5. **Check by making sure brakes are properly adjusted, in good operating condition, and system well bled. If pedal continues to go to the floor, service brake valve.**

SPONGY PEDAL

1. Air in system
1. **Bleed brakes**

PEDAL IS FIRM BUT STOPS TOO NEAR FLOOR

1. Brakes out of adjustment
1. **Adjust brakes**

2. Inoperative brakes
2. **Check for wear**
3. Displacement problem
3. **Wheel cylinders too large for valve to handle properly. Consider alternate braking valve.**

PEDAL IS FIRM BUT BRAKING IS INADEQUATE TO STOP VEHICLE IN EVENT OF ENGINE FAILURE

1. Pedal ratio too small
1. **Increase pedal ratio**
2. Brakes inoperative
2. **Check brakes for wear or oily brakes**

With Engine Running --

PEDAL GOES DOWN PART WAY THEN BOUNCES BACK

1. Insufficient flow from pump
1. **Check and fill reservoir**
2. Small volume from pump at idle
2. **Crack throttle and recheck**

3. Brakes not adjusted
3. **Check adjustment**
4. Air in system
4. **Bleed system**

NO POWER STEERING OR OTHER DOWNSTREAM HYDRAULIC ACTION AT ANY TIME

1. Hydraulic lines crossed
1. **Recheck circuit**
2. No hydraulic action at any time
2. **Check and fill reservoir. Check relief valve setting on pump. Check for proper rotation at pump, vee belt, sheared keys, etc.**

NO OR SLOW POWER STEERING WITH BRAKES APPLIED

1. Recheck relief valve on pump for proper setting
2. Check and fill reservoir
3. Check and tighten pump belt if necessary

BLEEDING

The MICO Open Center Power Brake Valve and remaining brake system are sometimes difficult to bleed. The difficulty arises when the hydraulic oil used does not flow easily through lines and small holes by means of gravity. Generally, to effectively remove air, oil must be forced into the brake valve master cylinder cavity and the rest of the system.

MANUAL BLEEDING PROCEDURES

1. Start engine and allow enough time to pass for the system to become filled and thoroughly flushed with oil.
2. With engine still running, one person can stroke the brake pedal while another person opens and closes the brake bleeder screws.
3. Only on the down stroke of the brake pedal, open bleeder screw

CAUTION: Make sure the machine is in a safe and controlled state before attempting any servicing including bleeding the brake system.

Manual and pressure bleeding are two methods of bleeding a brake system. MICO recommends using

- on the brake closest to brake valve first. When all flow stops from bleeder, close it and allow pedal to return to rest.
4. Wait at least 30 seconds and repeat the process until all air has been expelled from that brake. Then go on to the next closest brake bleeder and repeat process until all brakes have been bled.

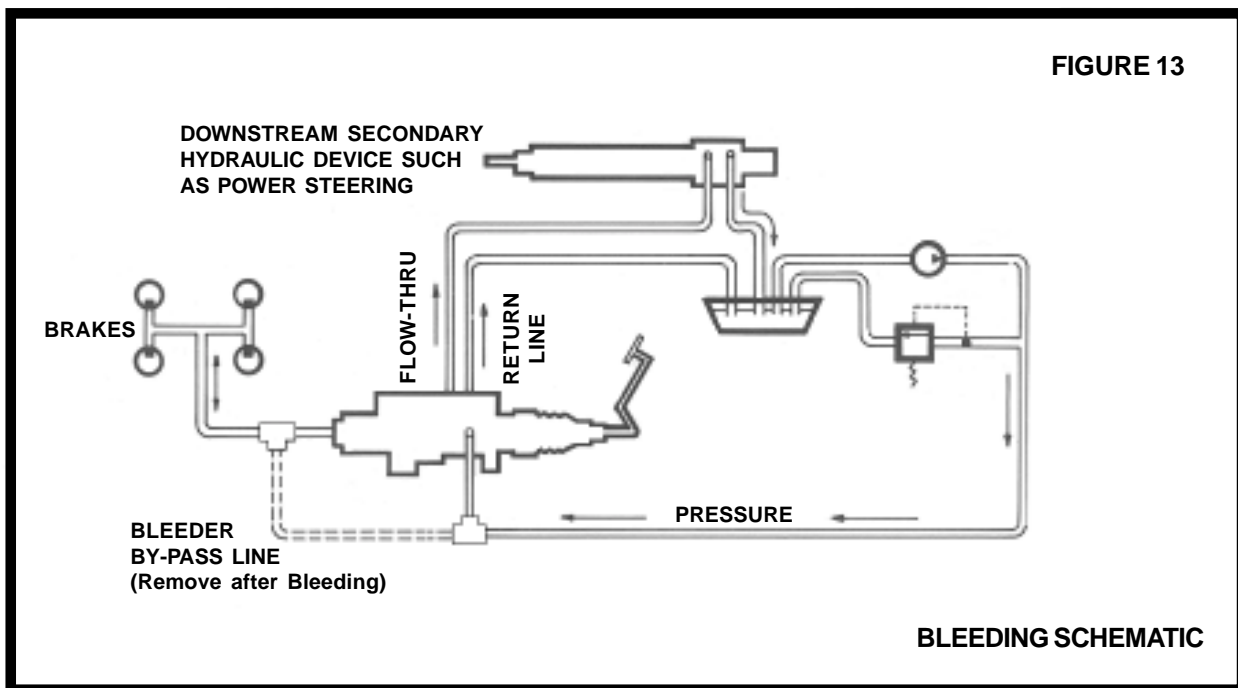
one of these two methods of bleeding the Open Center Power Brake Valve and the rest of the brake system.

CAUTION: Be sure brake valve is installed properly and brakes adjusted correctly before beginning bleeding procedures.

5. Stop engine and depress brake pedal. Pedal should be hard, not spongy, and fairly high. If pedal is too spongy and/or travels too far, repeat bleeding process.
6. It is a characteristic of the brake valve to kick the pedal back when actuated if system is not bled with engine running.

PRESSURE BLEEDING PROCEDURE

1. Refer to Figure 13. Install a small BLEEDER BY-PASS LINE as shown. A 1/4" size line or hose is sufficient.
2. Start engine and allow enough time to pass for the system to become filled and thoroughly flushed with oil.
3. It is necessary to develop between 50-200 PSI at the inlet to brake valve. A method to throttle the oil will be needed if the system does not already have a secondary hydraulic device downstream from the brake valve. THIS PRESSURE SHOULD BE HELD THROUGHOUT THE BLEEDING PROCESS AND SHOULD NOT EXCEED 250 PSI.
4. DO NOT STEP ON THE BRAKE PEDAL DURING THIS BLEEDING PROCESS.
5. Oil will now be forced directly into the brake line by the pump and fill the brake valve master cylinder cavity. This may take a minute or two.
6. Continue to hold the bleed pressure while bleeding each brake starting with the line and brake closest to the brake valve.
7. Allow a sufficient amount of fluid to pass at brake bleeder screw to insure all air is removed from each bleeder point.
8. Continue this method until all brakes and lines are bled.
9. When all brakes are bled and fittings tight, release the 50-200 PSI pressure and SHUT OFF ENGINE.
10. Remove the bleeder by-pass line and plug the connections. Be sure not to lose fluid or ingest air at the brake line connection when removing bleeder by-pass line.
11. With engine off, step on brake pedal. It should be fairly high and hard. If a spongy pedal is felt, the system still contains air. If pedal strokes downward too far, check and readjust brakes and repeat bleeding process.
12. When the pedal is satisfactory, restart engine and actuate brake pedal several times. Now check for leaks.



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