JLG GRADALL®

SERVICE MANUAL

GRADALL®

522 532C-6
524 534C-6

2460-4128

July 2002

522 524 Starting S/N
0177165 thru 0177189
532C-6 534C-6
Starting S/N
0388247 thru 0388349

CORPORATE OFFICE

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JLG® GRADALL®

OWNER/OPERATOR MANUAL

GRADALL®

522 532C-6
524 534C-6

2460-4169

July 2002

522 524 Starting
S/N 0177165
532C-6 534C-6
Starting S/N
0388247

Form #20039 Original Issue 3/01

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GRADALL®
MATERIAL HANDLERS

522, 522-3S, 524, 524-3S 532C-6 & 534C-6

OPERATION & LUBRICATION MANUAL

IMPORTANT

Read and understand this manual, the Gradall Material Handler Safety Manual, and the EMI Rough Terrain Forklift Safety Manual before starting, operating or performing maintenance procedures on this machine.

KEEP THESE MANUALS IN CAB.

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

ATENCION!
Si no lee ingles, pre-guntele a su supervisor para las instrucciones de seguridad!

VORSICHT!
Wen Sie kein Englisch lesen, bitten Sie ihren Vorgesetzten um die Sicherheitsvorschriften!

Gradall is a registered trademark for hydraulic excavators, hydraulic material handlers and attachments manufactured by The Gradall Company.

Form No. 20039 - Original Issue 3/01

Covers Units Starting Serial No.:
522 & 524 Handlers – 0177165
532C & 534C Handlers – 0388247

Part No. 2460-4169

IMPORTANT SAFETY NOTICE

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

Strict attention to, and compliance with instructions provided in this manual, the EMI Rough Terrain Forklift Safety Manual, the Gradall Material Handler Safety Manual, the Gradall/EMI Operator Orientation Video, as well as instructional decals and plates affixed to the machine, will help you avoid personal injury and damage to the equipment. The information provided is not intended to cover all situations; it would be impossible to anticipate and evaluate all possible applications and methods of operation for this equipment.

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

Do not modify this machine without written permission from The Gradall Company. Use only genuine Gradall replacement parts.

OTHER NOTICES

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

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

Gradall is a registered trademark for hydraulic excavators, hydraulic material handlers and attachments manufactured by The Gradall Company.

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

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INTRODUCTION

General

This manual provides important information to familiarize you with safe operating procedures and operator maintenance requirements for Gradall 522, 522-3S, 524, 524-3S, 532C-6 & 534C-6 Handlers.

If you have any questions regarding the material handler, contact your Gradall Material Handler Distributor.

Operator Qualifications

Operators of the material handler must be in good physical and mental condition, have normal reflexes and reaction time, good vision and depth perception and normal hearing. He/she* must not be using medication which could impair his abilities nor be under the influence of alcohol or any other drug during the work shift.

The operator should also possess a valid, applicable driver's license and must have completed a course of training in the safe operation of this type of material handling equipment.

In addition, the operator must read/view, understand and comply with instructions in the following:

- This Operator's Manual
- EMI Rough Terrain Forklift Safety Manual
- Gradall Material Handler Safety Manual
- Gradall/EMI Operator Orientation Video
- All instruction decals & 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.

Regardless of previous experience operating similar equipment, the operator must be given sufficient opportunity to practice with the Material Handler in a safe, open area (not hazardous to people or property) to develop the skills and "feel" required for safe, efficient operation.

*Though no offense or discrimination is intended, only the masculine pronouns will be used throughout the remainder of this manual.

Orientation

When used to describe location of components in the material handler, the directions front, rear, right and left relate to the orientation of a person sitting in the operator's seat.

Related Manuals & Decals

Separate publications are furnished with the material handler to provide information concerning safety, replacement parts, maintenance procedures, theory of operation and vendor components. Replacement manuals, decals and instruction plates can be ordered from your Gradall Material Handler Distributor.

Models Covered

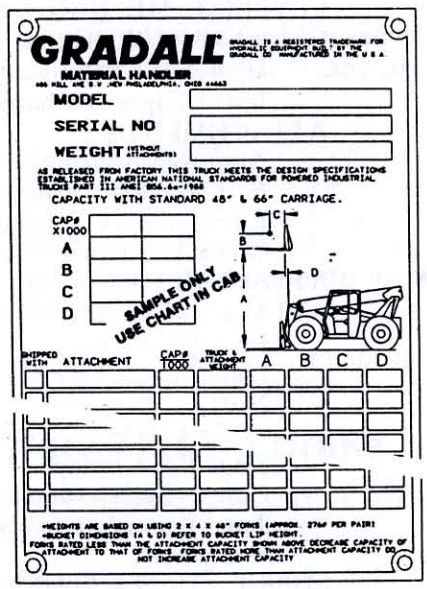
This manual covers six Gradall Material Handler Models:

- 522 with 2 section boom & 2 wheel drive
- 522-3S with 3 section boom and 2 wheel drive
- 524 with 2 section boom and 4 wheel drive
- 524-3S with 3 section boom and 4 wheel drive
- 532C-6 with 3 section boom and 2 wheel drive
- 534C-6 with 3 section boom and 4 wheel drive

Variations between handlers will be covered as required in appropriate sections of manual.

Serial Number Location

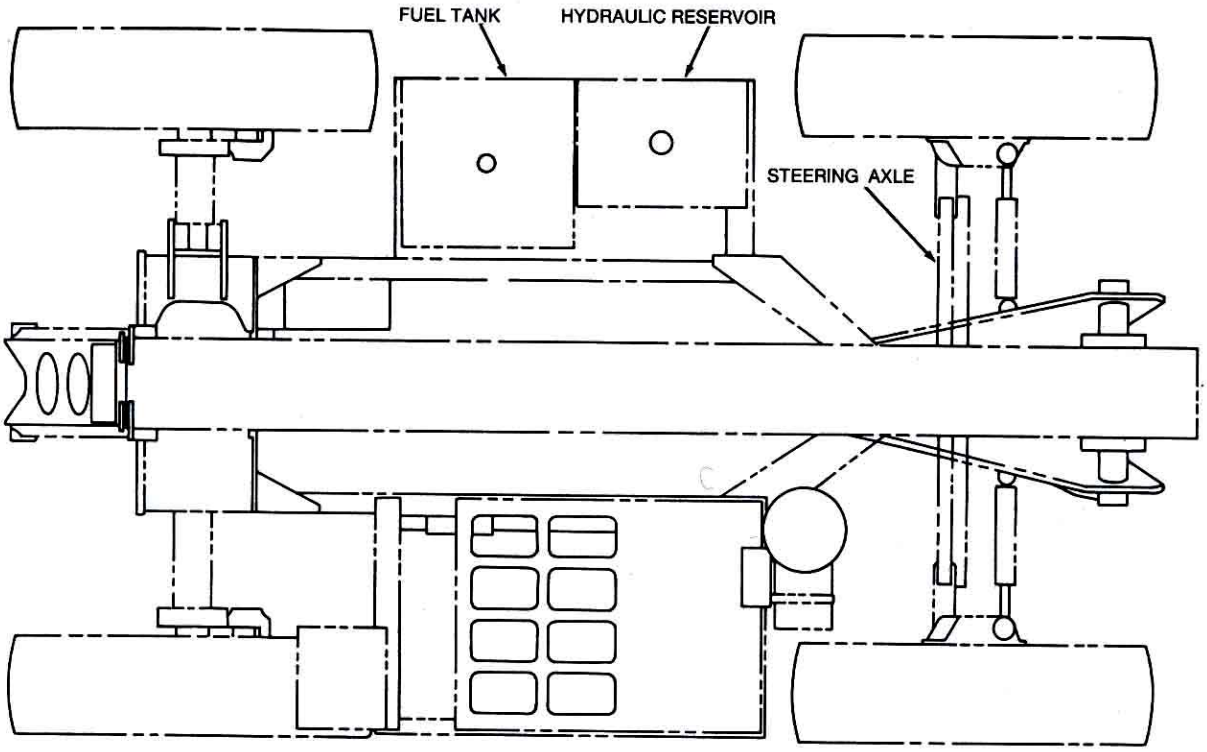
Specify Model and Serial Numbers when ordering parts and when discussing specific applications and procedures with your distributor. The model/serial number plate is located on the cab wall to the right of the operator's seat.

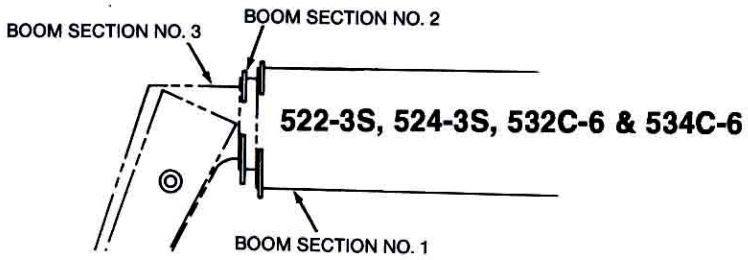


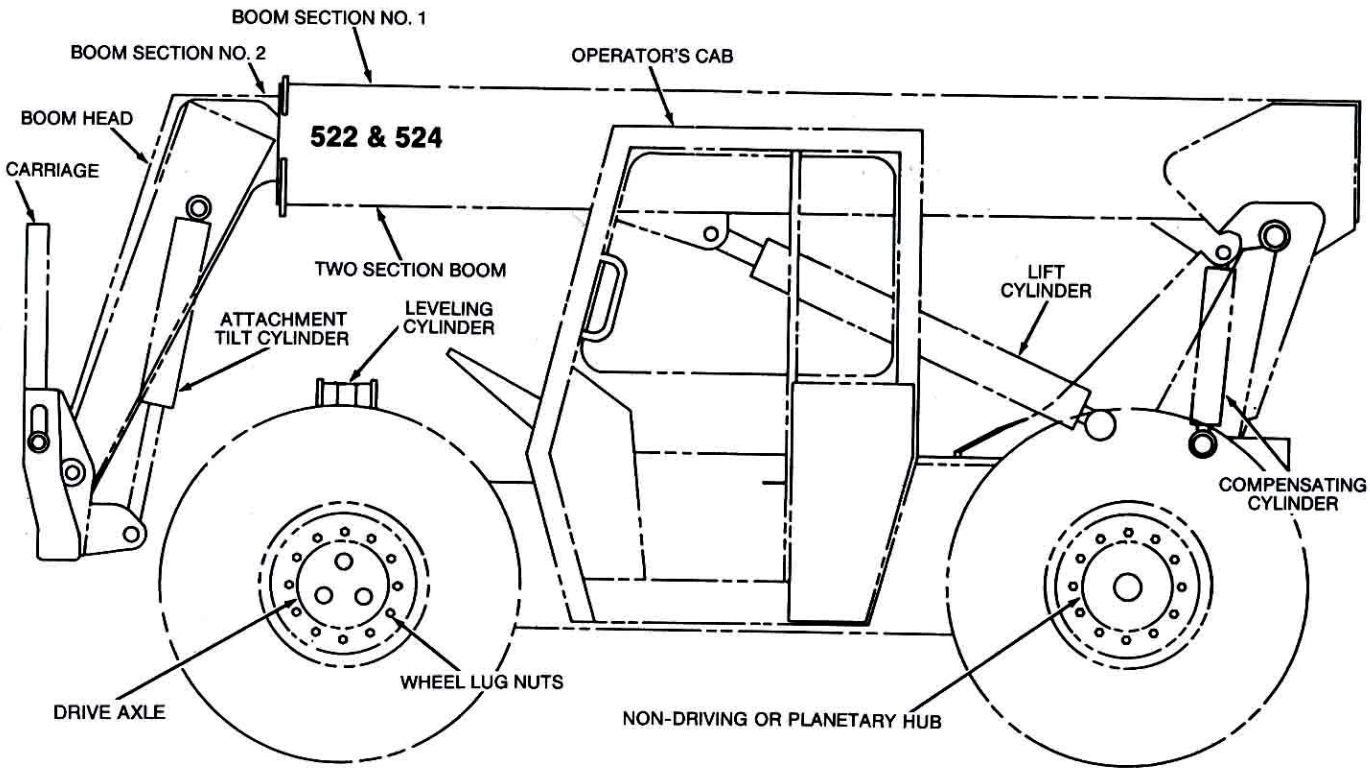
Nomenclature

The illustrations on page 3 include nomenclature applied to major components of the material handler. The term "handler" will be used throughout the balance of this manual in place of the words "material handler".

Nomenclature







SAFETY HIGHLIGHTS

Read and understand all manuals and instructional material listed on cover, inside front cover and page 2 of this manual before starting, operating or performing maintenance procedures on this equipment.

Safety information in this manual is specific to models covered. Other publications listed describe general safety precautions relating to material handling.

Operators of this equipment must have successfully completed a training program in the safe operation of this type of material handling equipment.

Regardless of previous experience operating similar equipment, the operator must be given sufficient opportunity to practice with the handler in a safe, open area (not hazardous to people or property) to gain operating skills and proper "feel" for controls and operating clearances required for safe efficient operation.

The Gradall Material Handler is equipped with a right-side rear view mirror. This mirror is intended as an operator's aid and does not replace the requirement for line of sight. Certain jobsite and machine conditions may require use of a signal person to help operator when picking, placing or transporting a load. Never operate the handler until you know pick-up point, line of travel and landing point are clear. Always be aware that objects in mirror may be closer than they appear.

Safety Precautions

- **This symbol indicates an extreme hazard which would result in high probability of death or serious injury if proper precautions are not taken.**
- **This symbol indicates a hazard which could result in death or serious injury if proper precautions are not taken.**
- **This symbol indicates a hazard which could result in injury or damage to equipment if proper precautions are not taken.**

⚠ DANGER

⚠ WARNING

⚠ CAUTION

Watch for these symbols; they call your attention to safety notices.

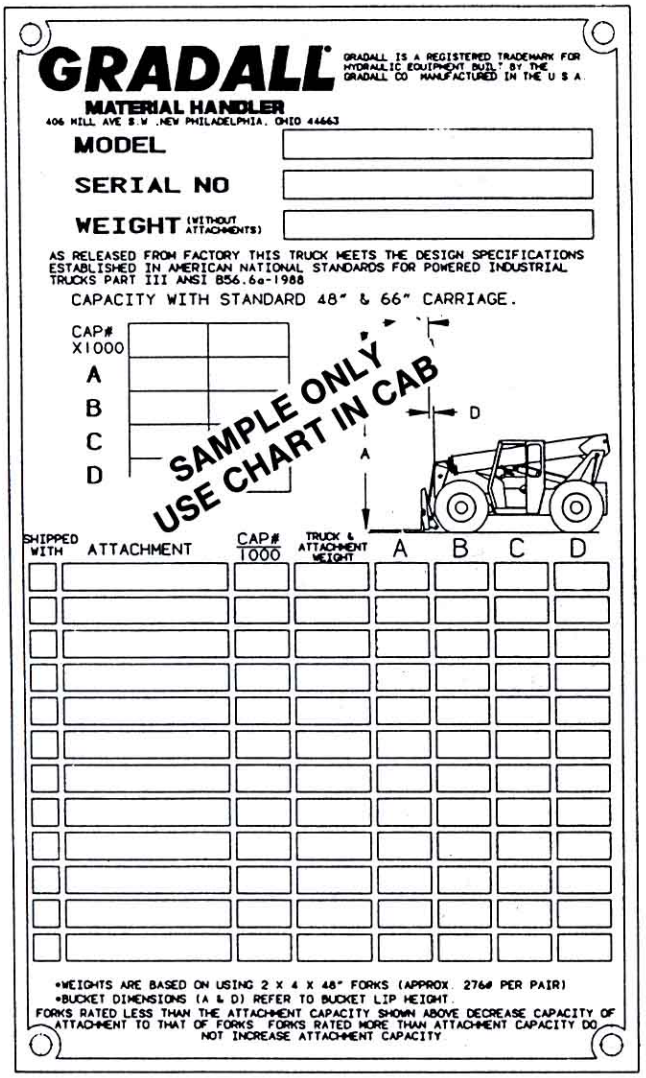
The following precautions are in addition to those included in Gradall Rough Terrain Safety Manual and EMI Rough Terrain Forklift Safety Manual. Study all precautions and observe them carefully.

⚠ WARNING

Operator must be seated with seat belt fastened, forward reverse lever in neutral position, parking brake applied and all hydraulic controls in neutral position before starting engine.

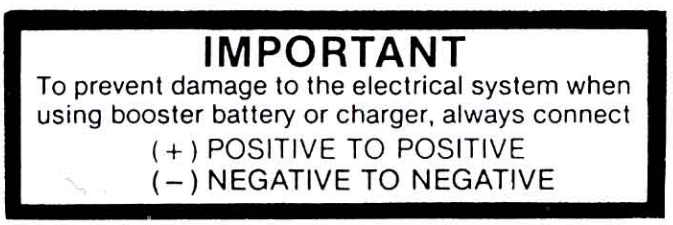
- Be certain forklift is on a firm, level surface before lifting or placing load. Have surface leveled if necessary. **Unit can tip over if load is raised with forklift on a soft or uneven surface.**
- Always look in the direction of travel. **Reduce speed and be especially careful when traveling in reverse and/or turning.**
- If load or conditions obstruct view, **use a signal man** when lifting, carrying or placing a load.
- Loose clothing can get caught in moving machinery and can also cause accidental actuation of controls. **Dress properly for the job.**
- **Be alert for any unusual response to controls.** If unusual response is noticed, position unit in a safe area if possible, lower forks to rest, apply parking brake, stop engine and remove key from ignition switch. Tag steering wheel to forbid operation and **notify maintenance personnel.**
- Keep hands, gloves, shoes, control knobs and pedals clean. **Slippery controls can cause accidents.** Keep a firm grip on steering wheel when traveling.
- **Load capacities are based on load center being within 24 inches from front vertical face of forks.**
- **Never service unit with engine running.**
- **Release trapped pressure** before disconnecting, opening or removing any hydraulic component.
- **Whenever leaving cab,** position unit in a safe location, apply parking brake, lower forks to ground, move all controls to neutral, stop engine and remove key from ignition. Chock wheels if parking on a slope.
- **Never permit diesel engine to run out of fuel.** Doing so can cause severe damage.

Decals

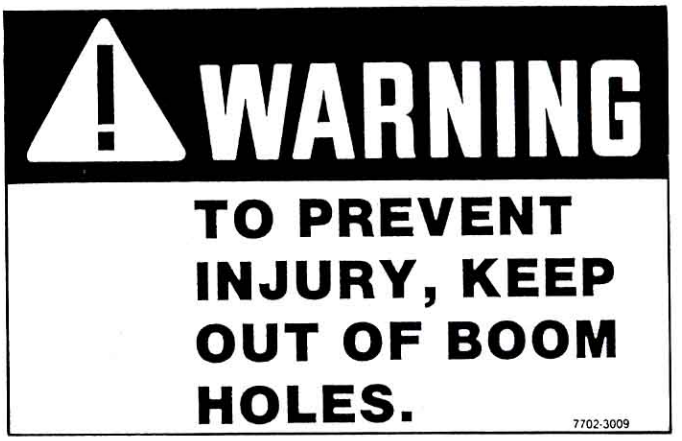


Located Inside Cab
Model 522 Part no. 9109-3010
Model 522-3S Part No. 9109-3011
Model 524 Part No. 9108-3457
Model 524-3S Part No. 9108-3458
Model 532C-6 Part No. 9113-3003
Model 534C-6 Part No. 9112-3010

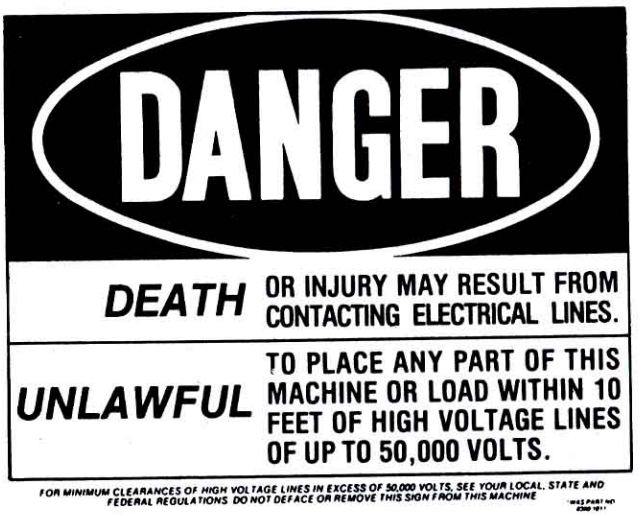
Located on Hydraulic Tank
Part No. 7702-3006



Located on Battery Cover
Part No. 7702-3007



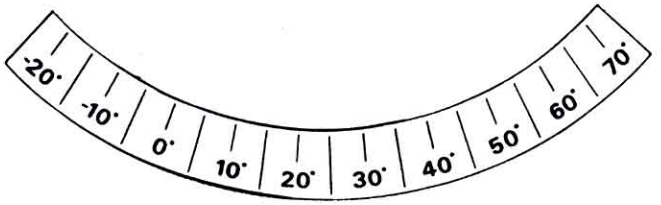
For 3 Section Boom Units Only
Located on Both Sides of Boom
Part No. 7702-3009



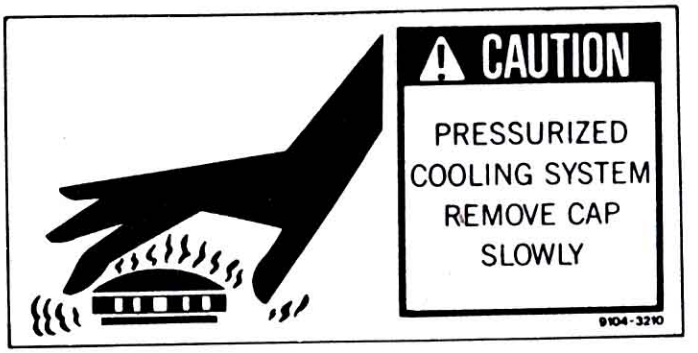
Located on Mud Guard
Part No. 8360-1011

Located on Fuel Tank
Part No. 9100-3052

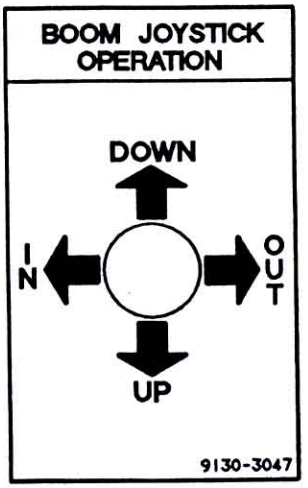
Decals



Located on Side of Boom
Part No. 9100-3031



Located on Engine Cover
Part No. 9104-3210



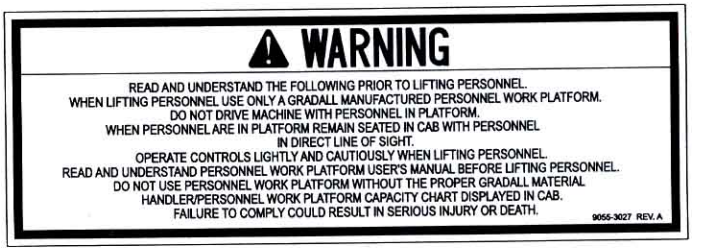
Located on Joystick Pedestal
Part No. 9130-3047 (Std.)

Located Outside Cab
Part No. 9104-3211

Located on Engine Compartment
Part No. 9103- 3011

Located on Engine Compartment
Part No. 7734-3018

Located on Right & Left Rear Frame
Part No. 9104-3209

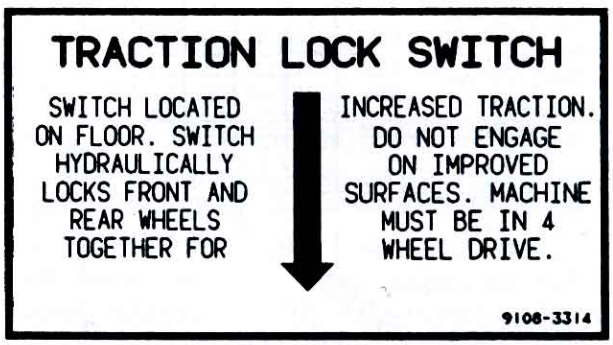


Located on mud guard
Part No. 9055-3027

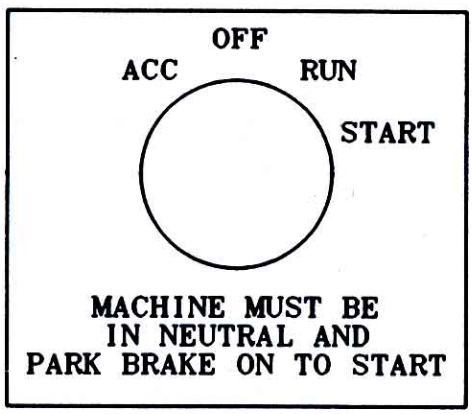
Decals

Located on right side of cab wall
Part No. 9055-3028

Located on Forward/Reverse Switch
Part No. 9108-3428

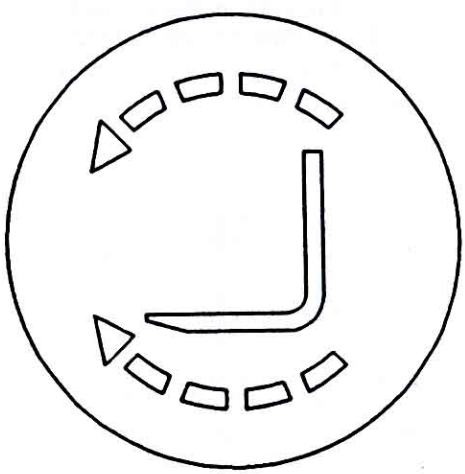


Located on Instrument Console
Part No. 9108-3314



Located on Instrument Console
Part No. 9114-3120

Located on Lever Knob
Part No. 9108-3318



Located on Lever Knob
Part No. 9108-3317

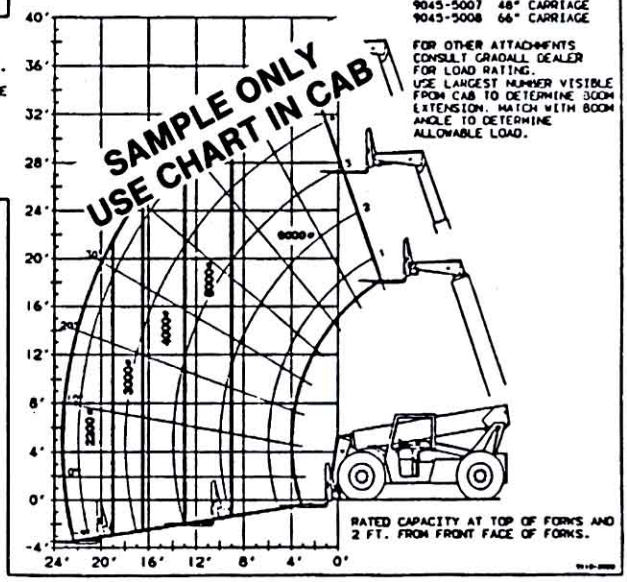
Decals

BOOM EXTENSION IN FEET FROM TIRE TO LOAD CENTER (24" IN FRONT OF FORK FACE).
FIGURES SHOWN ARE STACKING CAPACITY TRUCK LEVEL.
RATED LIFTING CAPACITIES SHOWN ARE WITH MACHINE ON A FIRM, LEVEL SURFACE WITH UNDAMAGED, PROPERLY INFLATED TIRES. MACHINE SPECIFICATIONS AND STABILITY ARE BASED ON RATED LIFT CAPACITIES AT SPECIFIC BOOM ANGLES AND BOOM LENGTHS. IF SPECIFICATIONS ARE CRITICAL, THE PROPOSED APPLICATION SHOULD BE DISCUSSED WITH YOUR DEALER.
DO NOT EXCEED RATED LIFT CAPACITY LOADS. AS UNSTABLE AND DANGEROUS MACHINE CONDITIONS WILL RESULT.
DO NOT TIP THE MACHINE FORWARD TO DETERMINE ALLOWABLE LOAD.
CAPACITY LIMITS FOR THIS UNIT ARE BASED IN ACCORDANCE WITH ANSI B56.6a-1968
LEVEL GRADALL HANDLER BEFORE LIFTING ABOVE 4 FT.

CAPACITY CHART
MODEL 532C-6 & 534C-6

USE WITH:
9108-6080 48" CARRIAGE
9045-5007 48" CARRIAGE
9045-5008 66" CARRIAGE

FOR OTHER ATTACHMENTS CONSULT GRADALL DEALER FOR LOAD RATING.
USE LARGEST NUMBER VISIBLE FROM CAB TO DETERMINE BOOM EXTENSION. MATCH WITH BOOM ANGLE TO DETERMINE ALLOWABLE LOAD.



Located on Instrument Console
Models 522 & 524 Part No. 9108-3321
Models 522-3S & 524-3S Part No. 9108-3438
Models 532C-6 & 534C-6 Part No. 9112-3039

GRADALL HANDLER
SERVICE INSTRUCTIONS
FOR: 522 & 524
532C-6 & 534C-6

SERVICE INTERVALS

	DAILY OR 10 HRS	WEEKLY OR 50 HRS	EVERY 3 MO. OR 250 HRS	3 MO. OR 500 HRS	6 MO. OR 1000 HRS	ANNUALLY OR 1500 HRS	TYPE OR EQUIVALENT
DIESEL ENGINE							
AIR CLEANER ELEMENT	**						
FUEL FILTERS				CHANGE			
OIL FILTER			CHANGE				
OIL (12 QT.)	CHECK		CHANGE				SE 15W-40-CD ***
DIESEL FUEL (40 GAL.)	FILL						DIESEL FUEL #2
HYDRAULIC SYSTEM							
OIL (43 GAL.)	CHECK			INSPECT			46 OR EQUAL
FILTERS	*						
HYD. TANK BREATHER/FILTER CAP			CHECK				
FRONT AXLE 4 GAL. 1 PT.			CHECK				MOBIL 424
REAR AXLE WHEEL END LUBE (4 PT.)							GL-5 80-90
WHEEL NUT TORQUE-350/400 FT-LBS							
RADIATOR 2.2 GAL. WATER 2.2 GAL. ANTI-FREEZE							ETHYLENE GLYCOL ANTI-FREEZE
TIRES: 522 & 524 (8 PLY) 45 PSI							
TIRES: 534C-6 & 532C-6 (12 65 PSI							
TIRES: RADIAL 70 PSI							
CYLINDER FITTINGS		GREASE					EP 2 H-152
REAR AXLE (12)		GREASE					EP 2 H-152
FRONT AXLE P		GREASE					EP 2 H-152
ALL BEARI			GREASE				EP 2 H-152
FRONT		GREASE	CHECK				EP 2 H-152
BOO		GREASE					EP 2 H-152
K		GREASE					EP 2 H-152
OU TTING		GREASE					EP 2 H-152
RETA CABLE SEE O INTENANCE MANUAL			CHECK				
JS BOOM & EXTEND CABLE SHEAVES		GREASE					EP 2 H-152

SAMPLE ONLY
Refer to lubrication section of manual

THIS CHART MUST BE USED IN CONJUNCTION WITH SERVICE MANUAL AND RECOMMENDED PROCEDURE.
* CHECK INDICATOR ON HYDRAULIC FILTER. CHANGE FILTER IF NEEDLE IS IN RED AT FULL THROTTLE & AT OPERATING TEMPERATURE.
** CHECK AIR CLEANER RESTRICTION INDICATOR. CLEAN OR CHANGE IF NECESSARY.
*** CONSULT DEALER FOR RECOMMENDATIONS AT EXTREME TEMPERATURES.
**** DAILY SERVICE MAY BE REQUIRED FOR OPTIMUM LIFE DEPENDING UPON APPLICATION SEVERITY.

Located on Manual Holder
Part No. 9108-3522

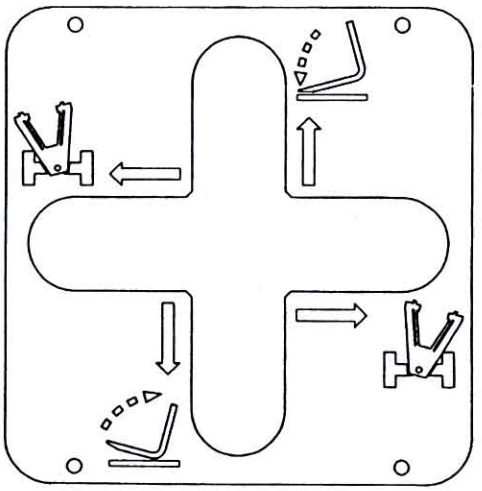
⚠ WARNING

READ AND UNDERSTAND THE FOLLOWING PRIOR TO LIFTING PERSONNEL.
WHEN LIFTING PERSONNEL USE ONLY A GRADALL MANUFACTURED PERSONNEL WORK PLATFORM.
ALL PERSONNEL IN PLATFORM MUST WEAR A FULL BODY HARNESS WITH LANYARD ATTACHED TO A DESIGNATED ANCHORAGE POINT.
READ AND UNDERSTAND PERSONNEL WORK PLATFORM USER'S MANUAL BEFORE OCCUPYING PERSONNEL WORK PLATFORM.
FAILURE TO COMPLY COULD RESULT IN SERIOUS INJURY OR DEATH.

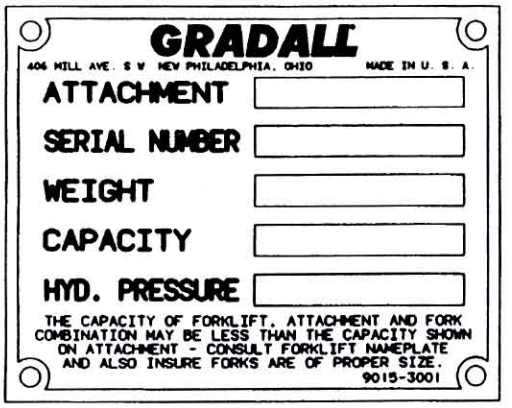
9055-3026 REV. A

Located on personnel work platform and boom head
Part No. 9055-3026

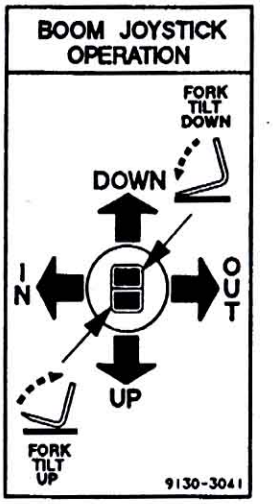
Optional Equipment Decals



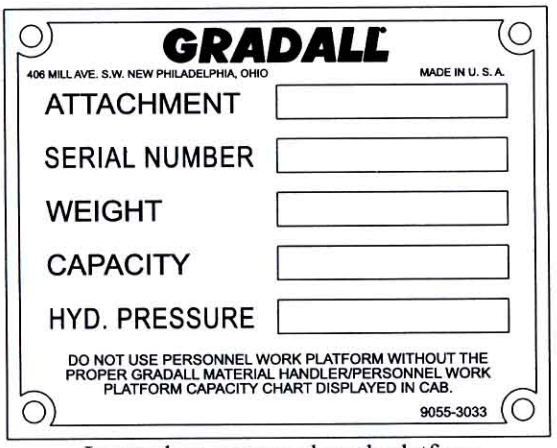
Located on Instrument Console
Part No. 9108-3341



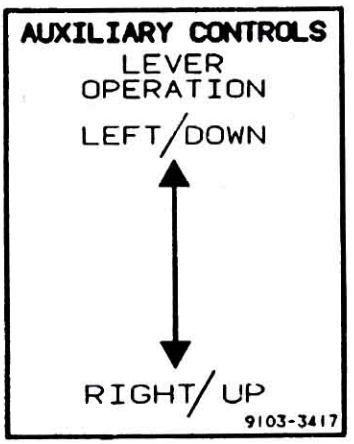
Located on Attachment
Part No. 9015-3001



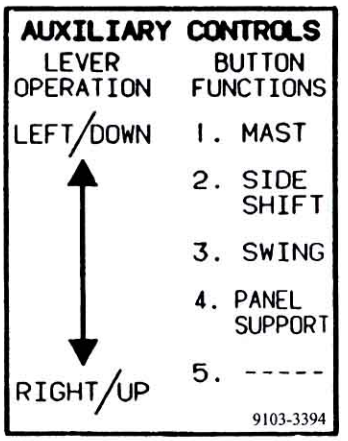
Located on Joystick Pedestal
Part No. 9130-3041



Located on personnel work platform
Part No. 9055-3033



Located on Instrument Console
Part No. 9103-3394



Located on instrument console
Part No. 9103-3394

Located on personnel work platform
Part No. 9055-3032

Located on personnel work platform
Part No. 9055-3031

OPERATOR'S CAB

The standard cab permits vision from all sides and includes an overhead guard to provide protection from falling objects.

⚠ WARNING

Never operate the handler unless the overhead guard is in place and in good condition.

A fully enclosed cab with windows and a lockable door is available as an option. The cab door can be secured in the fully opened or closed position. Be sure the door is fully secured when operating the handler.

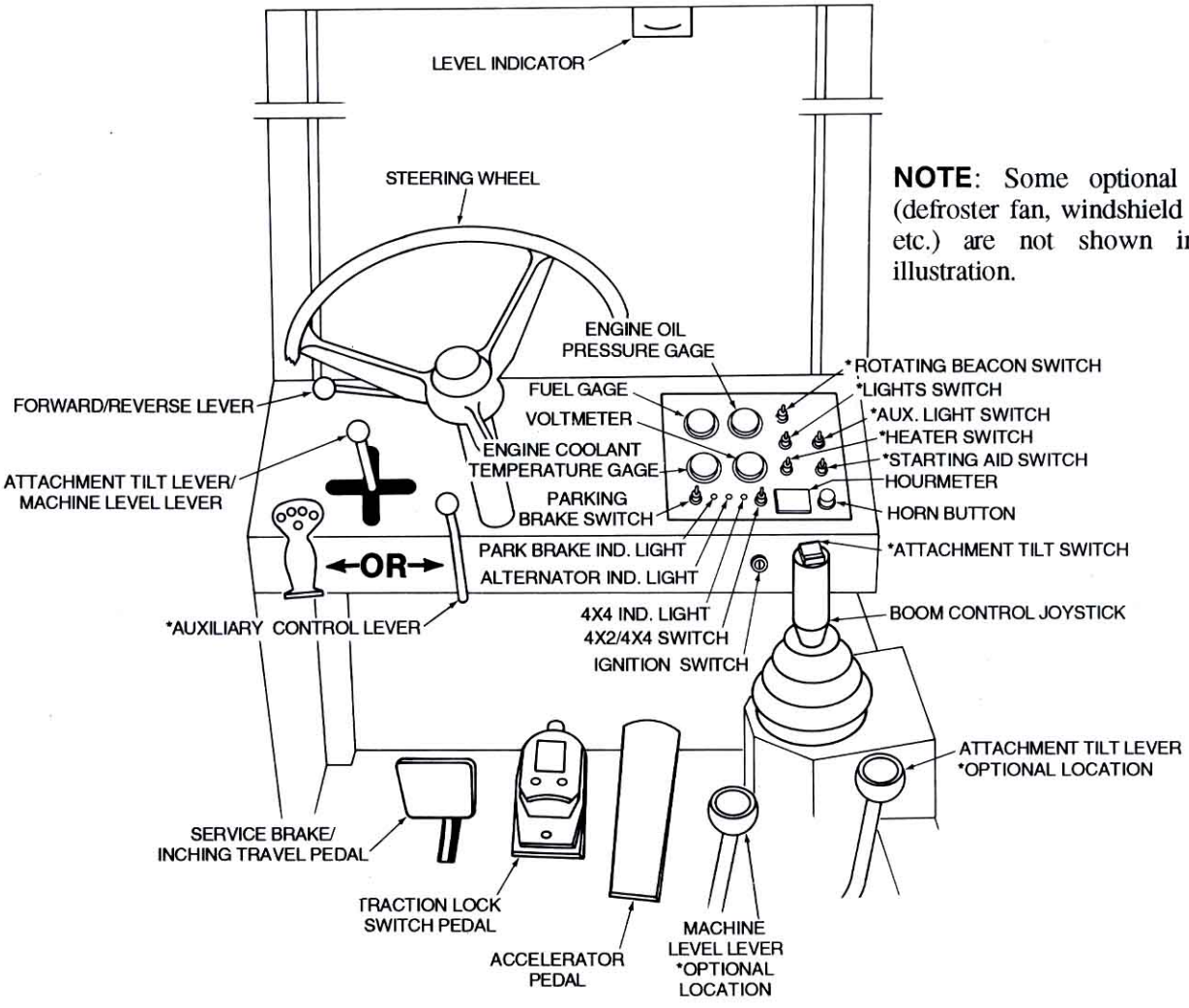
The operator's seat is equipped with a seat belt and includes fore and aft adjustment to compensate for variations in operator size. The adjustment release/lock is located beneath front edge of seat. **Wear seat belt when operating machine.**

An optional windshield wiper is available for use with enclosed cabs. An ON/OFF control switch is located on the wiper motor.

A variable speed defroster fan is available for use with enclosed cabs. An ON/OFF control switch and speed control are located on the base of the fan.

A variable speed heater fan is available for use with units equipped with a heater. An ON/OFF/SPEED CONTROL knob is located on the dashboard. Hot water to the heater can be controlled by a valve at the engine.

CONTROL AND INSTRUMENT IDENTIFICATION



NOTE: Some optional items (defroster fan, windshield wiper, etc.) are not shown in this illustration.

***ITEMS PRECEDED BY AN ASTERISK ARE OPTIONAL AND MAY NOT BE FURNISHED ON YOUR HANDLER.**

⚠ WARNING

A brief description of controls and instruments is provided here as a convenience for the operator. These descriptions DO NOT provide complete operating instructions. Read and understand this manual, the EMI Rough Terrain Forklift Safety Manual and the Gradall Material Handler Safety Manual.

NOTE: These descriptions are provided in alphabetical sequence in accordance with the nomenclature shown on the facing page.

Accelerator Pedal: The accelerator pedal is connected to the engine speed control by a cable to provide accurate engine speed control. Depress pedal to increase speed and release pedal to decrease speed.

Alternator Indicator Light: Glows (red) to indicate alternator is not charging.

Attachment Tilt Lever (Std.): This lever controls tilt of the fork carriage. Speed is proportional to lever actuation. Push lever forward to tilt down or pull lever to rear to tilt up.

Attachment Tilt Switch (optional): Depress front of switch to tilt down or depress rear of switch to tilt up.

Auxiliary Control Lever (optional): This lever is used to control optional hydraulic attachments. Follow decal instructions for lever/handler movements.

Auxiliary Light Switch: This switch turns auxiliary lights on and off.

Boom Control Joystick: This joystick controls boom elevation and extension. Pull joystick to rear to raise boom or push forward to lower boom. Move joystick to right to extend boom or move to left to retract boom. Speed of boom movement is proportional to joystick actuation.

Engine Coolant Temperature Gage: This gage displays engine coolant temperature.

Engine Oil Pressure Gage: This gage displays engine oil pressure.

Forward/Reverse Lever: This lever engages forward or reverse travel. Push lever fully forward for forward travel; pull lever fully to rear for reverse travel or move lever to centered position for neutral.

Fuel Gage: This gage displays level of fuel in fuel tank.

Heater Fan Switch (optional): This rotary switch controls heater fan. Rotate clockwise to start fan. Continued clockwise rotation controls fan speed.

Horn Button: Depress button to sound horn.

Hourmeter: This meter indicates total time of engine operation in hours and tenths of hours.

Ignition Switch: This switch is actuated by a key. In ON position (turned clockwise) voltage is available for all electrical functions. Full clockwise rotation engages starter motor. Turn key counterclockwise to stop engine and remove voltage from all electrical functions.

Level indicator: This indicator (a bubble level) enables the operator to determine the left to right level condition of the handler.

Lights Switch (optional): This switch controls optional lighting which may be provided with the handler.

Machine Level Lever (Std.): This lever controls the relationship of the handler frame to the front axle. Move the lever to left to tilt frame to left or move lever to right to tilt frame to right.

Parking Brake Switch: This switch controls the application and release of the parking brake.

Parking Brake Indicator Light: Glows (red) to indicate parking brake is applied.

Rotating Beacon Switch (optional): This switch controls operation of rotating beacon.

Seat Lock Release Lever: This lever unlocks and locks seat position adjustment. **(not shown)**

Service Brake/Inching Travel Pedal: This pedal operates the service brakes on front axle. It also 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. Full depression of pedal causes service brake application.

Starting Aid Switch (optional): This switch engages and disengages cold weather starting aid.

Steering Wheel: The steering wheel controls the angle of rear axle wheels. Turning the steering wheel to the right causes a right turn by angling rear wheels to left. A left turn is caused by angling rear wheels to right.

Traction Lock Switch Pedal: This pedal operates traction lock valve which functions to restore traction when a wheel spins in four wheel drive.

Voltmeter: This gage indicates alternator output and battery condition.

4X2/4X4 Switch: This switch engages and disengages rear wheel drive motors. Rear drive motors are engaged for four wheel drive.

4X4 Indicator Light: Glows (amber) to indicate four wheel drive is engaged. When park brake is applied, this light will not glow.

CHECKS AND SERVICES BEFORE STARTING ENGINE

(To be performed at beginning of each work shift)

⚠ WARNING

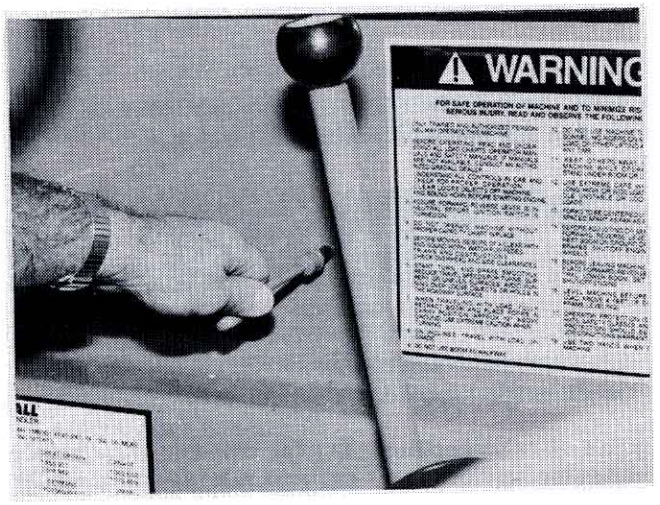
Use extreme caution when checking items beyond your normal reach. Use an approved safety ladder.

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

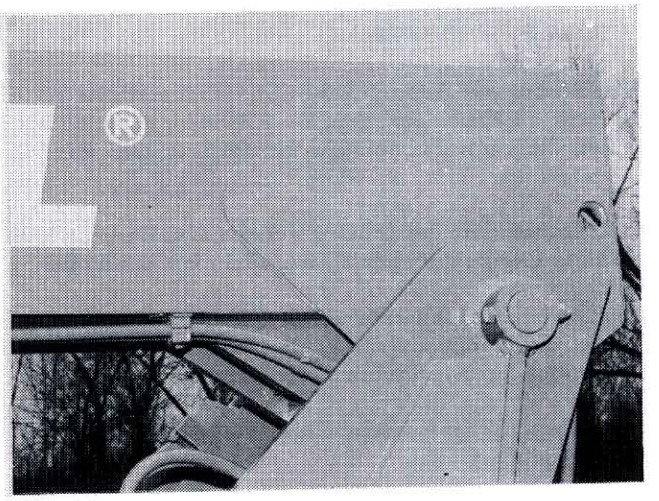
When adding fluids or changing filter elements, refer to the lubrication section of this manual to determine the proper type to be used.

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

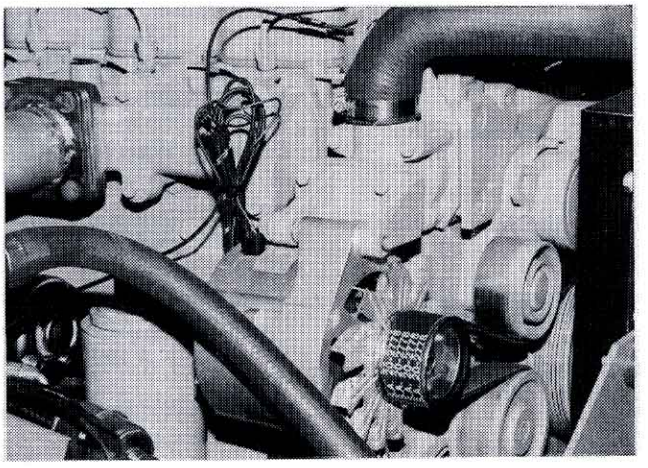
Complete all required maintenance before operating unit.



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



Inspect all structural members, including attachment, for signs of damage.



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

NOTE: If engine is being started at beginning of work shift be sure to perform all "CHECKS AND SERVICES BEFORE STARTING ENGINE" (page 12).

Starting Engine

1. Check to be sure that all controls are in neutral and that all electrical components (lights, heater, defroster, etc.) are turned off. Set parking brake.

NOTE: Engine will not start unless forward/reverse lever is in neutral and parking brake switch is in applied position.

2. Turn ignition key clockwise to ON position.

⚠ CAUTION

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

3. Depress accelerator pedal approximately 1/4 to 1/3 of travel from top.
4. Turn ignition switch to START position 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.

NOTE: If temperature requires the use of a starting aid, and if your handler is equipped with a factory-installed ether starting aid, depress button and release while cranking engine. Repeat if necessary. **CAUTION: Excessive ether can cause serious damage to engine.**

5. After engine starts, observe oil pressure gage. If gage remains on zero for more than ten seconds, stop engine and determine cause. Correct cause of malfunctioning before restarting engine. Minimum pressure at operating temperature:
   Low idle: ..... 10 psi (69kPa)
   Full throttle under load: ..... 30 psi (207kPa)
6. Warm up engine at approximately 1/2 throttle until engine coolant temperature reaches operating range.

Cold Weather Starting Aids

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

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

FOR COLD STARTING
1. TURN IGNITION SWITCH TO ON POSITION
2. HOLD COLD START SWITCH ON FOR 20 SECONDS
3. TURN KEY TO START WHILE KEEPING SWITCH ON. IF ENGINE FAILS TO START IN 15 SECONDS RETURN KEY TO ON AND RELEASE SWITCH. WAIT 20 SECONDS AND REPEAT STEPS 2 & 3.

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

Normal Engine Operation

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

The voltmeter shows the charge/discharge rate of the battery charging system. With the engine running, meter indicates alternator output (13.5 to 14 volts). With engine stopped, meter indicates battery charge (12 volts).

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

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

⚠ CAUTION

Always keep engine covers closed while engine is running.

continued . . .

Stopping the Engine

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

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

To stop engine, apply parking brake, allow engine to run at idle for one minute and then turn key counterclockwise to stop position. Be sure to remove key from ignition switch before leaving cab.

WARM UP & OPERATIONAL CHECKS

(To be performed at beginning of each work shift)

Complete all required maintenance before operating unit.

The safety, efficiency and service life of your unit will be increased by performing the operational checks listed below. Items preceded by an asterisk (*) are optional and may not be furnished on your machine. **Check items during warm-up period.**

*1. Heater, defroster and windshield wiper

*2. Operating lights and rotating beacon

3. Voltmeter - should show 13.5 to 14 volt charging rate.

When engine warms to operating range, check the following items:

4. Service brake and parking brake.

5. Forward and reverse travel in all gears

6. "Inching" travel - should be smooth through full pedal travel.

7. Horn and back-up alarm

8. All boom and attachment functions - full stroke in both directions

9. Hydraulic Filter Condition Indicator - observe engine coolant temperature gage after starting normal operation. When needle has been in operating range for an hour or so, stop handler in a safe area, move forward/reverse lever to neutral position, set parking brake and chock wheels. With engine running at full throttle, check hydraulic filter condition indicator. When needle is in red area, filter is clogged and hydraulic oil is bypassing filter. Filter must be changed before reaching bypass condition (change before needle reaches red area).

⚠ CAUTION

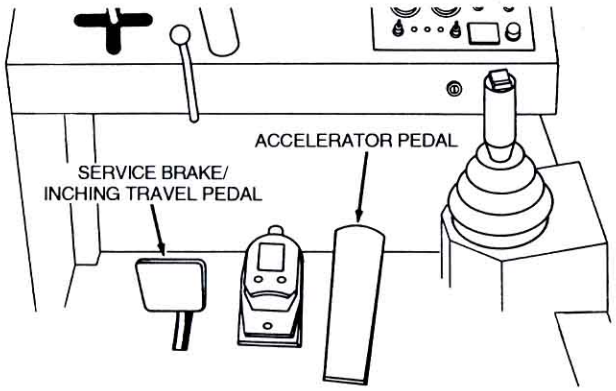
Continued operation with hydraulic fluid by-passing the filter can cause severe damage to hydraulic system components.

General

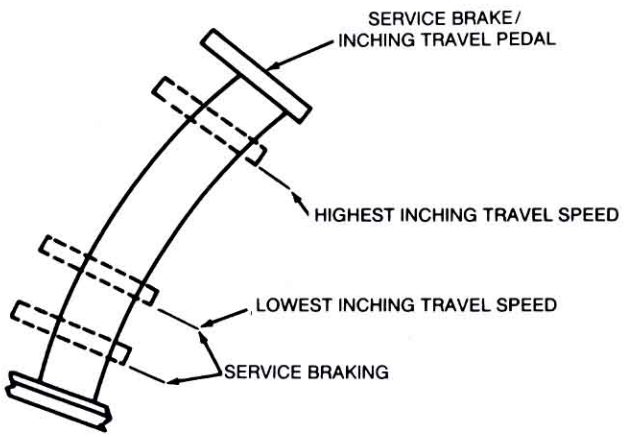
The brake system includes a service brake and a parking brake. Service and parking brakes are applied thru wet disc brake packs located within differential housing.

Because service braking and "inching" (slow travel) functions overlap, some features of inching will be discussed here. Refer to Drive Train Section for additional information on inching travel.

Inching Travel



Overlap between braking and inching occurs because the same pedal controls both functions, and also because both functions control travel speed. However, the methods of controlling travel speed are quite different: service braking involves a controlled stopping force applied to the front wheels while inching involves a controlled driving force applied to driving wheels.



Most of the inching travel pedal stroke controls the speed of inching travel. As the pedal nears the bottom of its stroke, it causes service brake application.

⚠ WARNING

Practice inching/braking in a safe, open area until you are thoroughly familiar with response of machine to pedal travel.

Service Brakes

⚠ WARNING

If power assist feature should fail for any reason IT WOULD REQUIRE GREATER EFFORT TO APPLY SERVICE BRAKE. It is extremely important that you NEVER TURN ENGINE OFF WHILE TRAVELING.

If power assist fails, stop as soon as possible. Do not drive unit until problem has been corrected.

The wet disc power service brake is applied only to wheels of the front axle. This brake is hydraulically applied.

Hydraulic power to apply the power-assist service brake is provided by hydraulic system.

Depressing the service brake/inching travel pedal to the braking portion of the pedal stroke activates service brake. Brakes are applied in proportion to pedal force.

If power assist fails, it will require much greater force on pedal to apply brake and stopping distance will be greater.

Parking Brakes

⚠ WARNING

Always move parking brake switch to applied position before leaving cab.

Never stop engine while traveling. Parking brake will be fully applied and will stop unit abruptly.

The parking brake is spring applied and hydraulically released.

Hydraulic power to release the parking brake is provided by hydraulic system and is controlled by parking brake switch located on dashboard.

PARKING THE HANDLER

Precautions:

Avoid parking on slopes or near an excavation.

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

Position boom head or attachment on ground; never leave machine with boom in air.

Park on level ground and block wheels.

If parking on a slope cannot be avoided, position unit at right angle to slope and block wheels.

Parking procedure

1. Using service brake, stop unit in appropriate parking area.
2. Move parking brake switch to applied position.
3. Shift forward/reverse lever to neutral position.
4. Position boom head or attachment on ground.
5. Allow engine to cool at idle speed for a few minutes and then turn off.
6. Block wheels as an extra precaution against rolling.
7. Fill fuel tank to minimize condensation. Remove ignition key.
8. Lock cab and install protective covers if so equipped.
9. Disconnect batteries if unit is in an area where tampering seems possible.

STEERING SYSTEM

Ninety degree rear wheel power steering is provided to reduce operator fatigue and to permit high maneuverability in close quarters.

It is important that the operator practice maneuvering the handler in a safe, open area until he becomes thoroughly familiar with steering response and clearance required for tailswing and load when turning.

⚠ WARNING

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

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

General

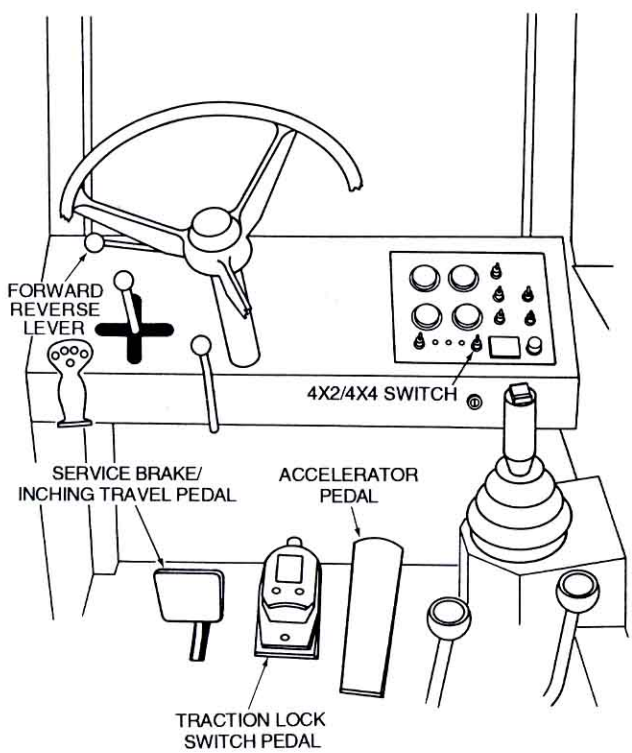
All models covered by this manual are equipped with hydrostatic drive. From the operator's standpoint, operation is similar to a vehicle with an automatic transmission.

Major components of the system include a front drive axle with a differential and planetaries. The differential receives torque from variable-displacement piston pump and motor.

This combination of components eliminates the need for a conventional mechanical transmission and also provides inching travel.

These handlers also include piston motors to provide torque to rear wheel drive hubs and an electrically controlled valve which functions to restore traction if conditions cause a wheel to spin.

Operation



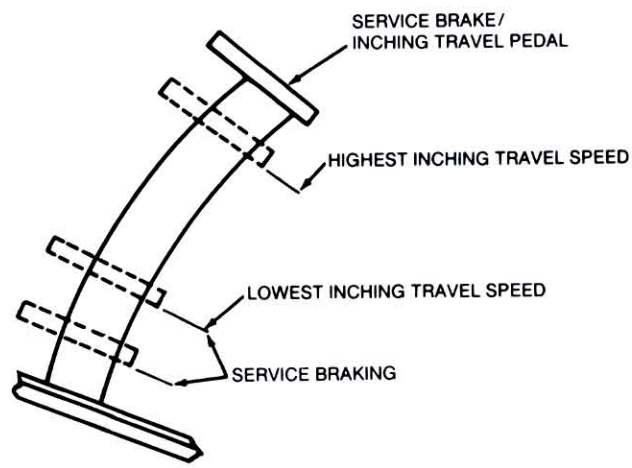
Normal Travel: Direction of travel is selected by moving forward / reverse lever forward for forward travel or to rear for reverse travel. Move lever to center position for neutral.

⚠ WARNING

Bring unit to a complete stop before shifting forward/reverse lever when carrying a load. A sudden change in direction of travel can reduce stability and/or cause load to shift or fall.

If hydrostatic drive system senses increased travel load, the system will compensate automatically by reducing travel speed to match load and engine rpm.

Inching Travel: Inching travel is provided to permit slow travel speed while maintaining high engine speed for other handler functions.



The service brake/inching travel pedal controls inching travel. The upper portion of pedal travel actuates a valve which controls travel pump output. The greater the pedal travel, the less the pump flow; the less the pump flow, the slower the travel.

The lower portion of pedal travel actuates service brake. The greater the pedal travel, the stronger the brake application. Travel flow is reduced when brakes begin to apply.

⚠ WARNING

Practice inching/braking in a safe, open area until you are thoroughly familiar with response of machine to pedal travel.

continued . . .

Four-Wheel-Drive: Units designed for four wheel drive are equipped with piston motors to provide torque to drive hubs of rear axle wheels.

When required by travel conditions, rear wheel (4 wheel) drive can be engaged by moving 4X2/4X4 switch to 4X4 position. Return unit to two-wheel-drive by moving switch to 4X2 position.

Four-wheel-drive can be engaged and disengaged while traveling.

⚠ CAUTION

Never disengage rear hubs except for emergency towing (page 35).

Traction Lock Switch (four wheel drive units only): Units equipped for four-wheel-drive are also equipped with a traction lock valve. This valve functions to restore traction when a wheel tends to spin when in four wheel drive.

The traction lock valve is controlled by traction lock switch (pedal).

When switch pedal is depressed, lock valve functions to permit delivery of full drive pressure to wheels of other axle, regardless of low pressure at spinning wheel.

BOOM

Major differences between Model 522, 522-3S, 524, 524-3S, 532C-6 and 534C-6 Handler booms are shown in the table below.

The boom is raised and lowered by a hydraulic cylinder anchored to chassis frame and boom section no. 1.

Raise boom by pulling boom control lever to rear and lower boom by pushing lever forward.

Two section booms (Models 522 & 524) are extended by a cylinder within boom anchored at rear of boom section no. 1 and near front of boom section no. 2.

Three section booms (Models 522-3S, 524-3S, 532C-6 & 534C-6) are extended by a cylinder within boom anchored at rear of boom section no. 1 and 2. A pair of cable and sheave arrangements function to cause equal extension of boom sections 2 and 3.

Extend boom by moving boom control lever to right and retract boom by moving lever to left.

A cylinder is located within the boom head to tilt fork carriage (or other attachment) back and forth as required.

Push tilt lever forward to tilt carriage forward and pull lever to rear to tilt carriage back.

All cylinders related to boom/carriage movement (attachment tilt, boom up/down and boom in/out) are protected by counterbalance valves which prevent cylinder from retracting in event of a broken hydraulic hose or tube.

BOOM CHARACTERISTICS	REF. NOTE	MODEL					
		522	522-3S	524	524-3S	532C-6	534C-6
Number of sections	A	2	3	2	3	3	3
Elevation Above Horizontal	B	67°	67°	67°	67°	70°	70°
Depression below Horizontal	B	9°	9°	9°	9°	9°	9°
Fork Height Above Grade	C	24.5'	32'	24.5'	32'	36'	36'
Fork Depth Below Grade	C	2'	3'	2'	3'	3.5'	3.5'
Horizontal Reach (at 0°)	D	12'9"	21'	12'9"	20'3"	23'	23'

Note A: All booms are extended hydraulically.
Note B: Measured from horizontal plane at boom pivot with handler resting on horizontal surface.
Note C: Measured from horizontal plane at bottom of tires to top surface of horizontal forks.
Note D: Measured from vertical plane at front of front tires to 24" load center.

Boom Cable Adjustment

Checking and adjusting boom cables:

1. Position Gradall material handler in a safe, level, open area away from persons and equipment. Apply parking brake, shift forward/reverse lever to neutral position and turn rear wheels to straight forward position.
2. With boom horizontal, extend boom four to five feet and then retract boom partially so that extend cable flats are accessible thru hole in top of boom (approximately two feet of extension).
3. Stop engine and block all wheels.
4. At rear of boom, measure gap between flat washer at **extend** cable anchor and strong back (rear plate). If gap is greater than 1/8 inch, **extend cables must be adjusted.**

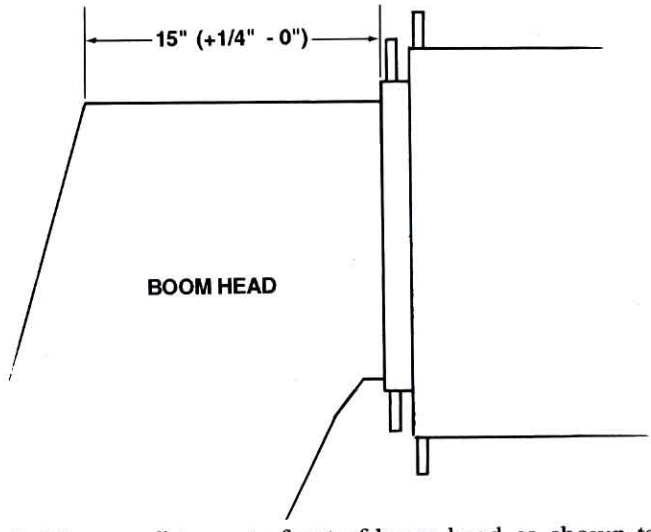
NOTE: Always use wrenches to prevent boom cable from turning when turning adjusting nut or tightening jam nut.

5. To adjust **extend** cable, loosen jam nut on each **extend** cable. Tighten **extend** cable adjusting nut until gap between cable flat washer and strong back is 1/32 to 1/16 inch. When both cables are properly adjusted, gap between washers and strong back on both must be equal. Torque jam nuts to 100 ft-lbs. Be certain to perform this check/adjustment every five weeks or 250 hours.

NOTE: After several adjustments of **extend** cables, boom sections may be mis-aligned and holes in side of boom will no longer be aligned with pins in boom. When this condition occurs, **retract cable must be adjusted.** If required, perform following procedure to align boom sections:

Aligning boom sections:

1. Position unit as described in step 1. of **Checking and adjusting boom cables:** procedure. Then retract boom fully, stop engine and block all wheels.



2. Measure distance to front of boom head as shown to determine extent of mis-alignment. Subtract 15 inches from measurement to determine amount of adjustment required.

   Example: If result of subtraction is 1 inch, it will require 2 inches of adjustment to **retract** cable to return boom to its original position.

3. Position boom as instructed in step 2 of **Checking and adjusting boom cables:** procedure.
4. Loosen both **extend** cable adjusting nuts (at rear of boom) far enough to permit realignment determined in step 2 and Example.
5. Loosen **retract** cable jam nut (located inside boom at bottom front of first (main) boom section. Tighten the **retract** cable adjusting nut as required to obtain proper boom alignment. Tighten jam nut to 100 ft. - lbs. to secure adjustment.
6. Readjust **extend** cables as described in steps 4 and 5 of **Checking and adjusting boom cables:** procedure.
7. Retract boom fully and again check dimension at boom head. Readjust if necessary.

LEVELING THE HANDLER

⚠ WARNING

Raising the boom (loaded or unloaded) when handler is leaning to the side can cause machine to tip over with little or no warning and cause serious injury or death.

"LEVELING" means positioning the handler so that it is level from side to side (left to right with respect to a man sitting in operator's seat).

A level indicator is located on upper portion of front window frame to permit operator to determine that handler frame is, or is not, level.

There are four very important things to remember about handler leveling:

1. Never engage a load or lift a load more than four feet above ground level unless the handler is level.
2. A handler with the boom raised and/or an attachment installed is a partially loaded handler.
3. Once the handler frame has been leveled, and has raised a load more than four feet above ground level, it must not be moved from its position if such movement could change the level condition.
4. The combination of side tilt and load can cause the handler to tip over.

There are two ways to level the handler:

1. The surface which will support the handler can be leveled. This method must be chosen if it will be necessary to move the handler from its position after the load has been raised over four feet from ground level - **AND** - such movement could change the level condition.

   Remember, the supporting surface must be large enough, smooth enough and firm enough to keep handler level when it is moved from its position.

2. The handler may be leveled by means of the frame leveling system. This method may be chosen when it will not be necessary to move the handler from its position after the load has been raised above four feet from ground level - **OR** - when such movement will not change the level condition of the handler.

Always determine best positions for handler to raise load from its present location and also to position load at its destination. **THEN**, determine which method of leveling will be required at each location.

FINALLY, consider terrain between present location of load and its destination. Never attempt to transport a load across terrain which could cause handler to tip over.

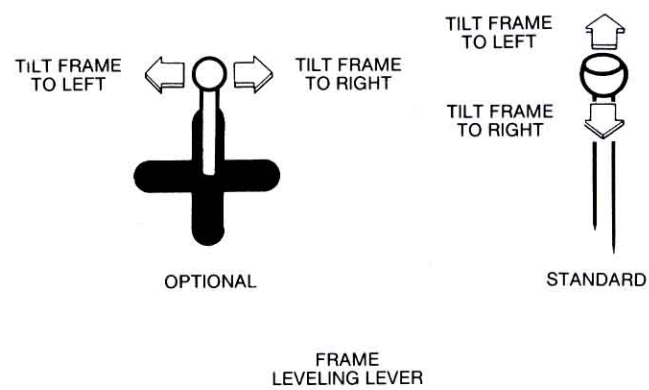
Leveling Handler Frame:

The handler is designed to permit tilting main frame eight degrees to left or right to compensate for uneven ground conditions.

The rear axle pivots at the midpoint of the main frame to help assure that wheels will remain in contact with ground. A hydraulic cylinder provides a rigid connection between front axle and main frame to help assure a solid work platform and permit tilting main frame to left or right.

Procedure:

1. Position machine in best location to lift or place load and apply parking brake.
2. Observe level indicator to determine whether machine must be leveled. Note position of indicator for later realignment.



3. If necessary to level handler, position boom in carry position and move machine level lever to level machine.
4. Lift or place load as appropriate.
5. Retract and lower boom to carry position.
6. Realign frame to position noted in step 2.

⚠ WARNING

If handler cannot be leveled using leveling system, do not attempt to raise or place load. Have surface leveled.

OPERATING PROCEDURES & TECHNIQUES

This section highlights some common procedures and discusses areas which may be new to even the experienced operator.

Hydraulic Controls

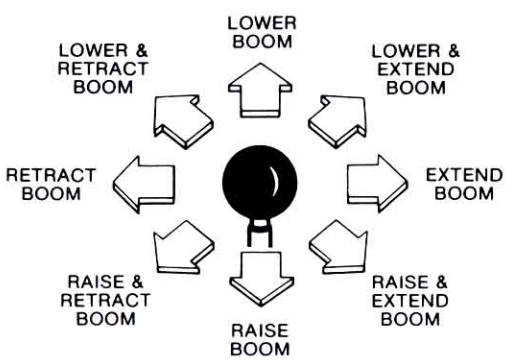
All boom and attachment movements are governed by hydraulic controls. Rapid, jerky operation of hydraulic controls will cause rapid, jerky movement of the load. Such movements can cause the load to shift or fall or may cause the machine to tip over.

Feathering

Feathering is a control operation technique used for smooth load handling. To feather controls, move control lever very slowly until load begins to move, then gradually move lever further until load is moving at desired speed. Gradually move lever toward neutral as load approaches destination. Continue to reduce load speed to bring load to a smooth stop. Feathering effect can be increased by lowering engine speed at beginning and near end of load movement.

Boom Control Lever

The boom control lever can be positioned to cause individual boom movements or combinations of boom movements as illustrated.



With boom raised above horizontal, forks can be inserted under a load by moving boom control lever forward and to the right until forks move forward horizontally.

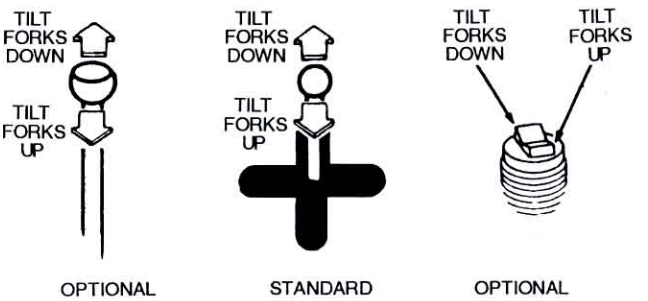
With boom raised above horizontal, forks can be removed from a load by moving boom control lever back and to the left until forks move rearward horizontally.

With boom lowered below horizontal, forks can be inserted under a load by moving boom control lever back and to the right until forks move forward horizontally.

With boom lowered below horizontal, forks can be removed from a load by moving boom control lever forward and to the left until forks move rearward horizontally.

The closer the boom to horizontal, the less boom raise/lower movement required for inserting and removing forks.

Carriage Tilt Lever



Move lever forward to tilt forks down and move lever to rear to tilt forks up.

⚠ WARNING

Always move boom to carry position (horizontal or below) before leveling frame. Attempting to level machine with boom raised may cause it to tip over.

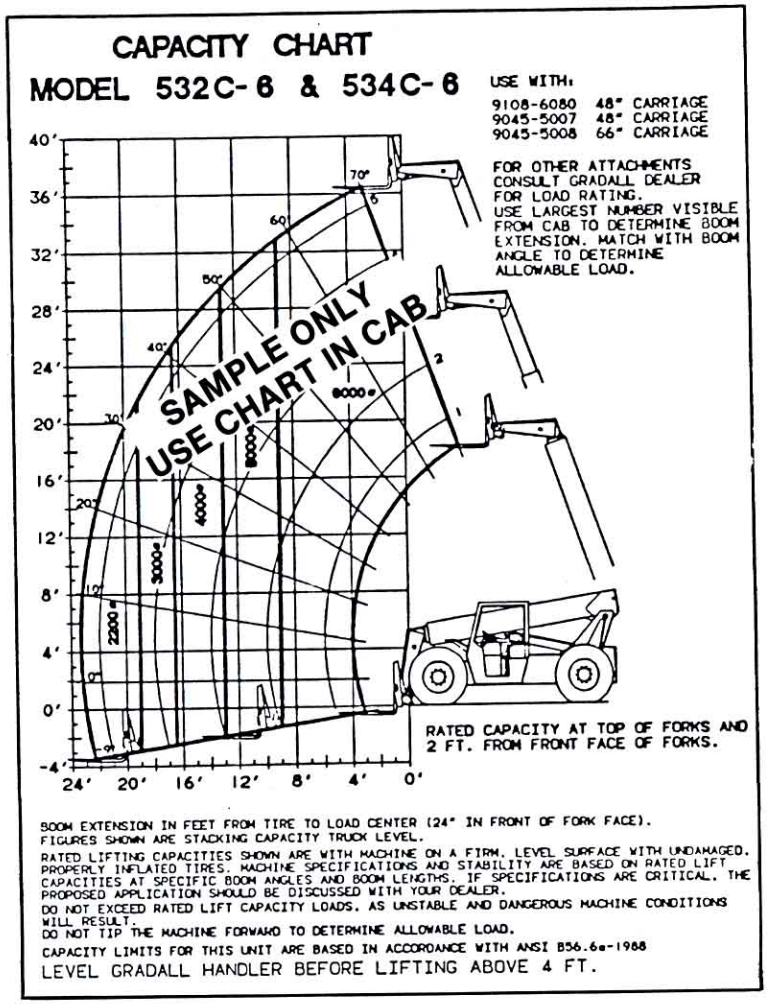
Rated Capacity Chart

The rated capacity chart, located on dashboard, indicates maximum load capacities for handlers equipped with Gradall-furnished carriage/fork combination. These capacities apply to the standard carriage/fork combinations except as stated on the capacity chart.

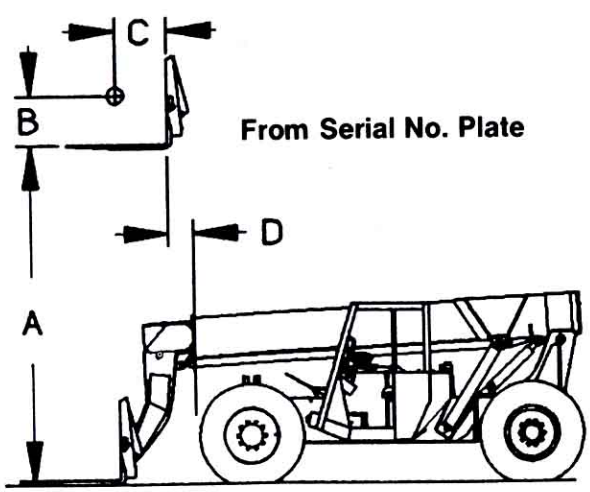
⚠ WARNING

All loads shown on rated capacity chart are based on machine being on firm, level ground; the forks being positioned evenly on carriage; the load being centered on forks; proper size tires being properly inflated; and the handler being in good operating condition.

Elevation:



Numbers at left side of sample chart (-4′ to 36′) represent elevation to top of horizontal fork as measured from level ground. Elevation relates to dimension "A" shown on serial number plate located on right cab wall.



From Serial No. Plate

Boom Extension

Numbers across bottom of sample chart (0′ to 24′) and numbers parallel to boom (1 to 5) represent boom reach as measured from front of tires to extended position.

Number decals on boom (1, 2, 3, 4 & 5) relate directly to boom extension. The largest number which can be read from operator's seat indicates total boom extension and must be matched with boom angle to determine capacity.

Boom extension relates to dimension "D" shown on serial number plate.

Boom Angle

Numbers at ends of angled lines (-9° to 70°) represent angle of boom to horizontal as measured from horizontal plane. Maximum angles are 9° below horizontal with boom fully lowered to 70° above horizontal with boom fully raised.

A boom angle indicator is located on left side of boom section number one to show boom angle. Be sure machine is level from front to rear or indicator will provide incorrect reading.

Load Center

Loads shown on rated capacity chart are based on the load center being two feet above and two feet forward of surfaces of horizontal forks as indicated by dimensions "B" and "C" on serial number plate.

The load center of a load is the center of gravity of the load. For regularly shaped loads of the same material, such as a pallet of blocks, the center of gravity can be located by measuring the load to find its center. For irregular loads, or loads of dissimilar materials, keep the heaviest part of the load as close to the heel of the forks as possible.

In all cases, the load center must be centered between the forks.

Load Limits

Some capacities shown on the rated capacity chart are based on machine stability and some are based on hydraulic lift capacity. The "common sense" or "feel" an experienced operator might apply in regard to "tipping loads" **DOES NOT APPLY to hydraulic load limits.** Exceeding load limits can cause damage or in some cases, the machine to tip over.

Approved Attachments

Although the carriage/fork combination is most frequently used, several other Gradall-approved attachments are available for use with these material handlers. Contact your Gradall Material Handler Distributor for information on approved attachments designed to solve special material handling problems.

Refer to serial number plate for list of attachments approved for use with your handler.

Non-Approved Attachments

⚠ WARNING

Attachments which have not been approved for use with your handler may cause machine damage or an accident resulting in injury or death. All attachments approved for use with your handler are listed on the handler serial number plate (located on right cab wall.

Do not use non-approved attachments for the following reasons:

- Gradall cannot establish range and capacity limitations for "will fit", homemade, altered or other non-approved attachments.
- An overextended or overloaded handler can tip over with little or no warning and cause serious injury or death to the operator and/or those working near the handler.
- Gradall cannot assure the ability of a non-approved attachment to perform its intended function safely.
- Non-approved attachments may cause structural or other damage to the handler. Such damage could cause dangerous operating conditions resulting in serious injury or death.

Carriage/Fork Capacities

The standard carriage/fork capacity chart (located on the dashboard) indicates maximum reach and load capacities for handlers equipped with an approved carriage fork combination. **These limitations apply to standard, approved carriage/fork combination except as stated on the capacity chart.**

Non standard carriage/fork combinations (greater or lesser capacity) may be furnished by the Gradall Co. at customer request or may be available for installation because they were furnished for a different application.

If a carriage/fork combination of lesser capacity is used, **the overall machine capacity is reduced** to carriage/fork capacity as indicated on carriage/fork serial number plate.

If a carriage/fork combination of greater capacity is used, the overall machine capacity may be reduced because of additional attachment weight and/or other considerations. **Contact your local Gradall Distributor to determine capacity limitations.**

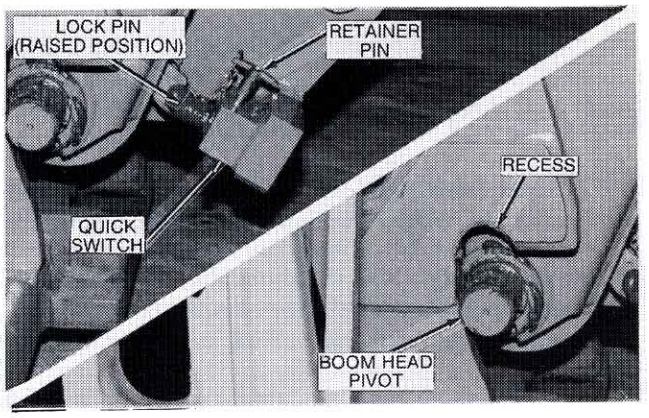
Other Attachment Capacities

A serial number/capacity plate is attached to all Gradall-furnished attachments. **Do not assume that any Gradall attachment may be used on any Gradall Material Handler.**

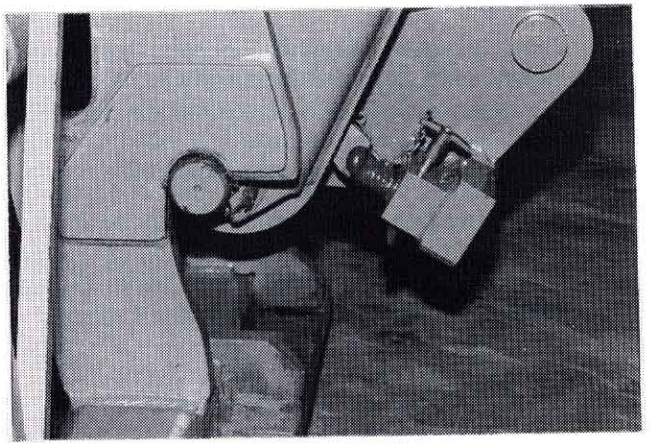
First, check the listing of approved attachments on handler serial number plate (located on right cab wall). If the attachment in question is not included in the list, it was **not approved for use** at time of machine shipment. Contact your local Gradall Distributor for possibility of use with special limitations.

Next, **if the attachment is approved for use** with your handler, compare maximum capacity from approved **attachment** serial number plate to maximum capacity for that attachment as indicated on **material handler** serial number plate. **The smallest of these capacities is correct for your handler.**

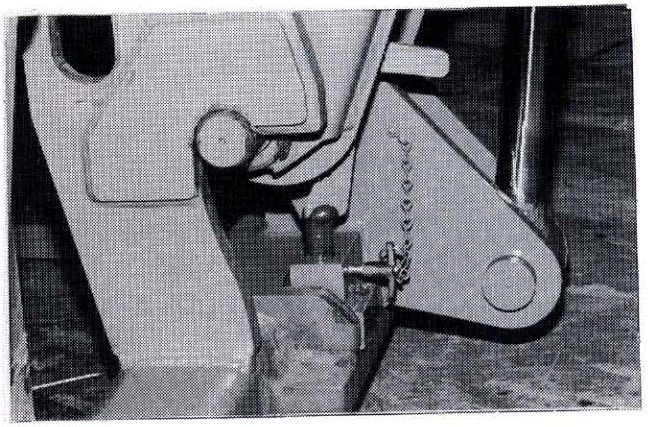
Attachment Installation (only for units equipped with quick switch)



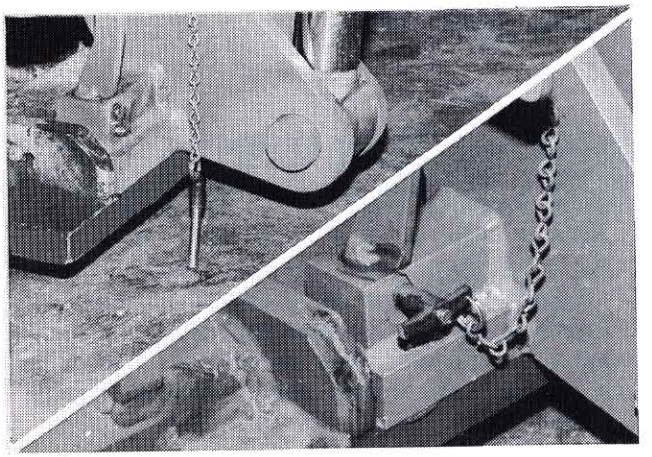
1. Retract quick switch (attachment tilt lever forward) to provide clearance. Check to be sure lock pin is secured in raised position with retainer pin.
2. Align boom head pivot with recess in attachment.



3. Raise boom slightly to engage boom head pivot in recess.



4. Engage quick switch (attachment tilt lever to rear).



5. Remove retainer pin and lower lock pin fully.
6. Secure lock pin in locked position using retainer pin.

⚠ WARNING

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

Attachment Operation

Operation of the handler equipped with carriage/fork combination is covered in the Gradall Material Handler Safety Manual, the EMI Rough Terrain Forklift Safety Manual and this manual.

Operation of the handler when equipped with other approved attachments is covered in this section or in separate instructions furnished with the attachment. Such separate instructions must be kept in manual holder with operator's manual.

When an attachment is installed on the handler, take extra care when engaging, securing, manipulating, transporting and positioning the load.

Operate a handler equipped with an attachment as a partially loaded handler. Pay special attention to capacity and range limits for the handler/attachment combination.

Practice operation of handler and attachment in a safe, open area, not hazardous to yourself, other persons, equipment or property. Become thoroughly familiar with response of handler and attachment to controls before operating in a work situation.

Always consider terrain between present location of load and delivery point. Never attempt to transport a load across terrain which could cause handler to tip over.

FORK POSITIONER

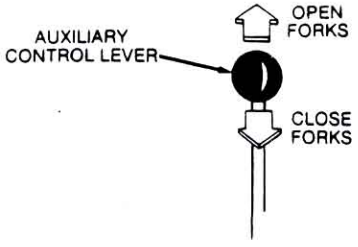
PRECAUTIONS

- **Always adjust fork position before engaging load.**
- **As with all other attachments, handler must be level before handling a load more than four feet above ground level (refer to page 20).**

Capacity:

Maximum load capacity for fork positioner carriage is the same as standard carriage without fork positioner (refer to basic Capacity Chart located on dashboard.) Capacity varies with boom extension and elevation positions.

Controls:



If your unit is equipped with a multi-function auxiliary control lever, refer to page 31.

The auxiliary control lever is used to adjust fork position. Pull lever to rear to close forks and push lever forward to open forks.

Procedure:

1. Remove standard carriage/fork combination or other attachment from boom head (refer to Attachment Installation - page 24).
2. Install carriage/fork combination with positioner.
3. Connect auxiliary hydraulic hoses to positioner cylinders.

⚠ WARNING

Observe all precautions and load capacity limits (listed previously) when handling loads with carriage/fork positioner.

4. Always adjust fork position before engaging load. Moving forks after engaging load could cause load to fall from forks.

LIGHT MATERIAL BUCKET

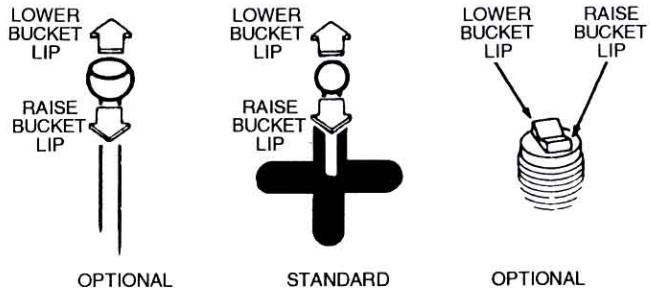
PRECAUTIONS

- **Handler must be level when handling a load more than four feet above ground level (refer to page 20).**
- **Retract boom fully before loading bucket. Loading bucket with boom extended could damage structural members or extension cables.**
- **Avoid shock loads; drive into stockpile smoothly to load bucket.**
- **Do not use bucket as a lever to pry heavy material. Excessive prying forces could damage the bucket.**

Capacity:

Maximum capacity of light material bucket is shown on serial number plate (located on right cab wall) and may be used in areas where it **does not exceed** capacities shown on standard carriage/fork capacity chart. **Capacity must be reduced** for areas where maximum bucket capacity would exceed standard carriage/fork capacity chart.

Controls:



Because the carriage tilt cylinder is used to tilt the bucket, the carriage tilt lever is used to control the bucket. Pull lever to rear to raise bucket lip and push lever forward to lower bucket lip.

Procedure:

1. Remove carriage/fork combination or other attachment from boom head (refer to Attachment Installation - page 24).

continued . . .

2. Install light material bucket on boom head.

⚠ WARNING

Observe all precautions and load capacity limits (listed previously) when handling loads with light material bucket.

3. Retract boom fully and tilt bucket up or down as required to position bottom of bucket parallel with ground.
4. Raise or lower boom to appropriate height for loading material from stockpile.
5. Align handler with face of stockpile and drive slowly and smoothly into pile to load bucket.
6. Tilt bucket up far enough to retain load and back away from pile.
7. Lower bucket to carry position (approximately one foot above ground) and travel carefully to unloading point. Tilt bucket down to dump load.

⚠ CAUTION

Light back-blading of loose material is permissible but heavier grading operations may damage the bucket and structural members.

MAST (6' with 48" or 66" carriage)

PRECAUTIONS

- **Read additional capacity information under Capacity heading.**
- **Because the mast increases lift height, it is especially important to level the handler before lifting a load more than four feet above ground level (refer to page 20).**

Capacity:

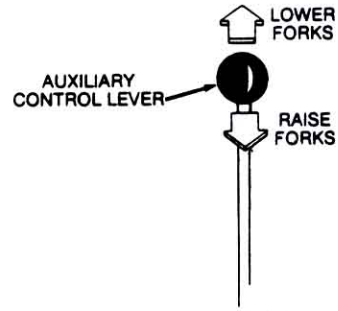
Maximum lift capacity for the mast is shown on serial number plate (located on right cab wall). However, maximum lift capacity applies only to certain areas within boom extension/elevation pattern of handler/mast combination. A separate capacity chart must be used for handlers equipped with mast. Study this chart carefully before attempting to handle a load with mast attachment.

⚠ WARNING

Do not attempt to handle a load with mast attachment until you have studied mast capacity chart carefully. If your handler does not have a mast capacity chart, ask your supervisor to get one.

Controls:

The carriage tilt cylinder is used to tilt the mast and the carriage tilt lever controls mast tilt.



If your unit is equipped with a multi-function auxiliary control lever, refer to page 31.

The auxiliary control lever is used to raise and lower the forks in the mast. Pull lever to rear to raise forks and push lever forward to lower forks.

Procedure:

1. Remove carriage fork combination or other attachment from boom head (refer to Attachment Installation - page 24).
2. Install mast on boom head.
3. Connect auxiliary hydraulic hoses to mast cylinder.
4. Always level the handler before raising the boom or the forks, with or without a load.
5. To travel with a load, lower forks fully in mast and lower boom to position load approximately one foot above ground.
6. Use mast as required to increase vertical reach of handler.
7. Use a signal man to assist in positioning the load if necessary.

SWING FORKS

PRECAUTIONS

- **Read additional capacity information under Capacity heading.**
- **Always level forks (horizontally) before swinging load to side. Swinging unleveled forks may result in load slipping from forks.**
- **Because the swing forks can swing the load to the side, it is especially important that the handler be level when handling a load more than four feet above ground level (refer to page 20).**

Capacity:

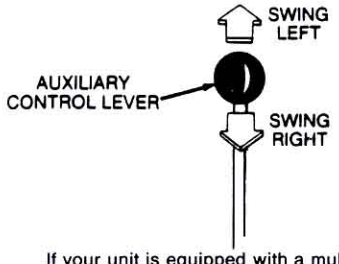
Maximum lift capacity for swing forks is shown on serial number plate (located on right cab wall). However, maximum lift capacity applies only to certain areas within boom extension/elevation pattern of handler/swing fork combination. A separate capacity chart must be used for handlers equipped with swing forks. Study this chart carefully before attempting to handle a load with swing fork attachment.

⚠ WARNING

Do not attempt to handle a load with swing fork attachment until you have studied swing fork capacity chart carefully. If your handler does not have a swing fork capacity chart, ask your supervisor to get one.

Controls:

The carriage tilt cylinder is used to tilt the swing forks up and down and the carriage tilt lever controls fork tilt.



If your unit is equipped with a multi-function auxiliary control lever, refer to page 31.

The auxiliary control lever is used to swing the forks to the left and right. Pull lever to rear to swing forks right and push lever forward to swing forks left.

Procedure:

1. Remove carriage/fork combination or other attachment from boom head (refer to Attachment Installation - page 24).
2. Install swing fork attachment on boom head.
3. Connect auxiliary hydraulic hoses to swing fork attachment.

⚠ WARNING

Observe all precautions and load capacity limits (listed previously) when handling loads with swing fork attachment.

4. Always position forks straight ahead before engaging load.
5. To travel with a load, keep forks in straight ahead position and lower load to approximately one foot above ground.
6. Inspect supporting surface at delivery point and have it leveled if necessary.

⚠ WARNING

Always bring forks to level (horizontal) position before swinging load to side. Swinging unleveled forks may result in load slipping from forks.

7. Use a signal man to assist in positioning the load if necessary.

SLOPE PILE CARRIAGE

PRECAUTIONS

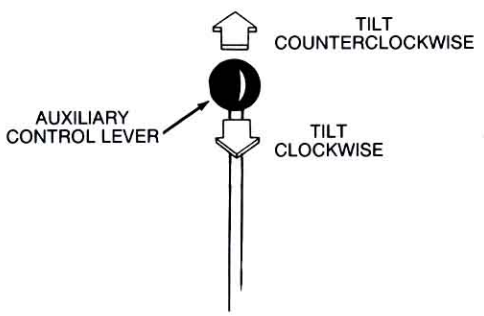
- **Level handler before tilting carriage to engage load (refer to page 20).**
- **Always level handler before lifting a load more than four feet above ground.**

Capacity:

Maximum load capacity for slope pile carriage is shown on serial number plate (located on right cab wall). However, maximum capacity may be used only in areas where it does not exceed capacities shown on standard carriage/fork capacity chart (located on dashboard). Follow standard chart to determine capacities for other areas of boom extension/elevation pattern.

Controls

The carriage tilt lever controls carriage tilt.



If your unit is equipped with a multi-function auxiliary control lever, refer to page 31.

The auxiliary control lever is used to tilt slope carriage. Push lever forward to tilt carriage counter-clockwise or pull lever to rear to tilt clockwise.

Procedure:

1. Approach load with forks centered on load and stop handler.
2. Level handler before tilting carriage to engage load.
3. Tilt carriage to left or right to align forks with load and engage load.
4. Raise load slightly and then level carriage.
5. Travel with load lowered to travel position (load approximately one foot above ground).

QUICK - SWITCH MOUNTED WINCH

PRECAUTIONS

- **Maximum winch load capacity is reduced from normal carriage/fork load rating (refer to next heading - Capacity).**
- **Always level the handler before lifting a load more than four feet above ground level (refer to page 20).**
- **Travel with load and boom lowered to travel position (load approximately one foot above ground).**
- **Always lower load to rest before leaving handler.**

Capacity:

The winch maximum load capacity is shown on serial number plate (located on right cab wall). However, maximum capacity may be used only in areas where it does not exceed capacities shown on standard carriage/fork capacity chart (located on dashboard). Also note that maximum winch capacity is less than carriage/fork maximum capacity. Capacity rating is based on load being lifted and suspended vertically from the boom and with no load on forks.

⚠ WARNING

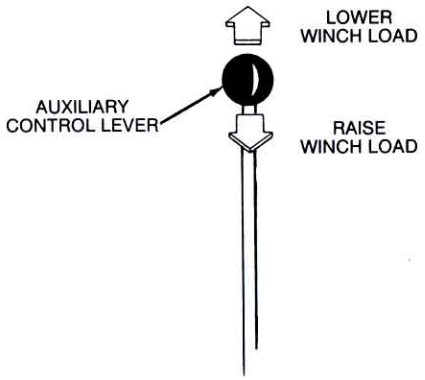
A side load or a swinging load can cause the handler to tip over and/or damage the boom.

Observe the following Special Precautions:

SPECIAL PRECAUTIONS

- **Never drag the load; lift vertically.**
- **Use tag lines to guide and steady a suspended load. Tag lines must be long enough to keep helpers clear of load and handler.**
- **Beware of wind; wind can cause a suspended load to swing and cause dangerous side loads - even with tag lines.**
- **Start, travel, turn and stop slowly to prevent load from swinging.**
- **Weight of all rigging (slings, etc.) must be included as part of load.**

Controls:



If your unit is equipped with a multi-function auxiliary control lever, refer to page 31.

The auxiliary control lever is used to control the winch. Pull the lever to rear to raise winch load and push the lever forward to lower winch load.

Procedure:

1. Remove carriage/fork combination or other attachment.
2. Install winch on boom head and connect hydraulic hoses at winch motor.
3. Position winch hook directly above balance point of load and secure using appropriate rigging.
4. Attach tag lines to load and transport load to delivery site.
5. While helpers guide load with tag lines, position load at delivery point.

TRUSS BOOM & TRUSS BOOM WITH WINCH

PRECAUTIONS

- **Because the truss boom extends the reach of the handler, maximum load capacity is reduced (refer to next heading - Capacity).**
- **Because of extended reach, it is especially important to level the handler before lifting a load more than four feet above ground level (refer to page 20).**
- **Travel with load and boom lowered to travel position (load approximately one foot above ground).**
- **Always lower load to rest before leaving handler.**

Capacity:

Maximum lift capacity for the truss boom (with or without winch) is shown on serial number plate (located on right cab wall). However, maximum lift capacity applies only to certain areas within boom extension/elevation pattern of handler/truss boom combination. A separate capacity chart must be used for handlers equipped with truss boom. Study this chart carefully before attempting to handle a load with truss boom.

⚠ WARNING

A side load or a swinging load can cause the handler to tip over and/or damage the boom.

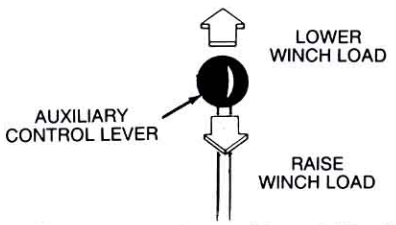
Observe the following Special Precautions:

SPECIAL PRECAUTIONS

- **Never drag the load; lift vertically.**
- **Use tag lines to guide and steady a suspended load. Tag lines must be long enough to keep helpers clear of load and handler.**
- **Beware of wind; wind can cause a suspended load to swing and cause dangerous side loading - even with tag lines.**
- **Start, travel, turn and stop slowly to prevent load from swinging.**
- **Weight of all rigging (slings, etc.) must be included as part of load.**

Controls:

The carriage tilt cylinder is used to tilt the truss boom up and down from the handler boom head. The carriage tilt lever controls truss boom tilt.



If your unit is equipped with a multi-function auxiliary control lever, refer to page 31.

The auxiliary control lever is used when the truss boom is furnished with a winch. Pull the lever to rear to raise winch load and push the lever forward to lower winch load.

continued . . .

Procedure:

1. Remove carriage/fork combination or other attachment from boom head (refer to attachment installation - page 24).
2. Install truss boom on boom head.
3. If truss boom winch is furnished, connect auxiliary hydraulic hoses to winch.
4. Approach truss or truss bundle with boom above and parallel to load.
5. Position truss boom approximately parallel with main boom.
6. Position truss boom/winch hook as close as possible to balance point of load and secure load to boom using short slings or other rigging. Be sure rigging will not allow load to slip in any direction.
7. Open clamps at heel of truss boom far enough to clear load and tilt truss boom up until truss/bundle contacts heel of truss boom.
8. Close clamps to hold load lightly and secure clamps.
9. Transport load to delivery site and attach tag lines if load will be freely suspended.

SWING MAST

PRECAUTIONS

- **Always level forks (horizontally) before swinging load to side. Swinging unleveled forks may result in load slipping from forks.**
- **The swing mast attachment has a smaller load capacity than the standard carriage/fork attachment. Study the swing mast capacity chart carefully before handling a load with swing mast.**
- **Read additional capacity information under Capacity heading.**
- **Because the swing mast increases lift height and can swing load to side, it is especially important to level handler before lifting a load more than four feet above ground level (refer to page 20).**

Capacity

Maximum lift capacity is shown on serial number plate (located on right cab wall). However, maximum lift capacity applies only to certain areas within boom extension/elevation pattern of handler/swing mast combination. A separate capacity chart must be used for handlers equipped with swing mast. Study this chart carefully before attempting to handle a load with swing mast attachment.

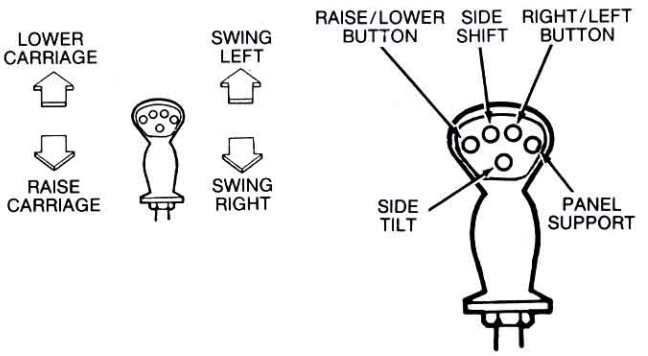
NOTE: When swing mast is equipped with an optional panel handler attachment, additional restrictions in operation and capacity will apply. Refer to Swing Mast Capacity Chart or contact your Gradall Material Handler Distributor for complete instructions and restrictions on use.

⚠ WARNING

Do not attempt to handle a load with swing mast attachment until you have studied swing mast capacity chart carefully. If your handler does not have a swing mast capacity chart, ask your supervisor to get one.

Controls:

The carriage tilt cylinder is used to tilt mast and the carriage tilt lever controls mast tilt.



MULTI-FUNCTION AUXILIARY CONTROL LEVER

A special auxiliary control lever is furnished on units equipped with swing mast attachment. The lever handle includes five push-button switches. Two of these switches are used for swing mast operation.

To raise or lower fork carriage, depress Raise/Lower button (No.1) and hold while moving lever in appropriate direction as shown.

To swing forks to left or right, depress Right/Left button (No.3) and hold while moving lever in appropriate direction as shown.

Procedure:

1. Remove carriage/fork combination or other attachment from boom head (refer to Attachment Installation (page 24).

2. Install swing mast on boom head and connect auxiliary hydraulic hoses to swing mast diversion valve hoses. Also connect electrical cable at boom head.

⚠ WARNING

Observe all precautions and load capacity limits (listed previously) when handling load with swing mast.

3. Always lower carriage fully in mast and position forks straight ahead before engaging load.

4. To travel with a load, keep forks straight ahead and lower load to approximately one foot above ground.

5. Inspect supporting surface at delivery point and have it leveled if necessary.

6. Level handler before raising load.

7. If necessary, perform a "dry-run" (unloaded) of delivery to determine best position for handler.

8. Use a signal man to assist in positioning the load if necessary.

Personnel Work Platform

The material handler operator and personnel in the platform must read and understand the separate personnel work platform manual (part number 9055-4001) prior to using the platform.

Capacity

The Gradall personnel work platform is designed to carry a maximum of three occupants. The load includes personnel, materials, tools, etc. The maximum capacity of your work platform is based on specific model material handler/work platform combination. To determine maximum load capacity for given operating ranges, consult the proper load capacity chart (furnished with platform) for the material handler and work platform in use. **If your handler is not equipped with the proper personnel work platform capacity chart, get one before using the attachment.**

Installation Procedure:

1. Remove carriage/fork combination or other attachment from boom head. **Refer to *Personnel Work Platform Manual* for installation procedures.**

Operation:

- Gradall Personnel Work Platforms are approved for use **only** on Gradall Material Handlers equipped with the proper platform capacity chart.
- When lifting personnel, **use only a Gradall manufactured personnel work platform**. No other platform is approved for use on Gradall Material Handlers.

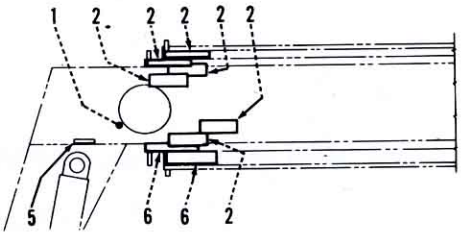
⚠ WARNING

Do not use the Personnel Work Platform until you study and understand the "Capacity Chart." If your handler does not have the correct "Personnel Work Platform Capacity Chart," ask your supervisor to get one before using the attachment.

⚠ WARNING

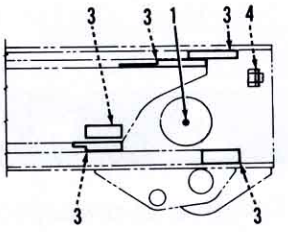
Do not use a boom mounted winch while the platform is mounted to the boom.

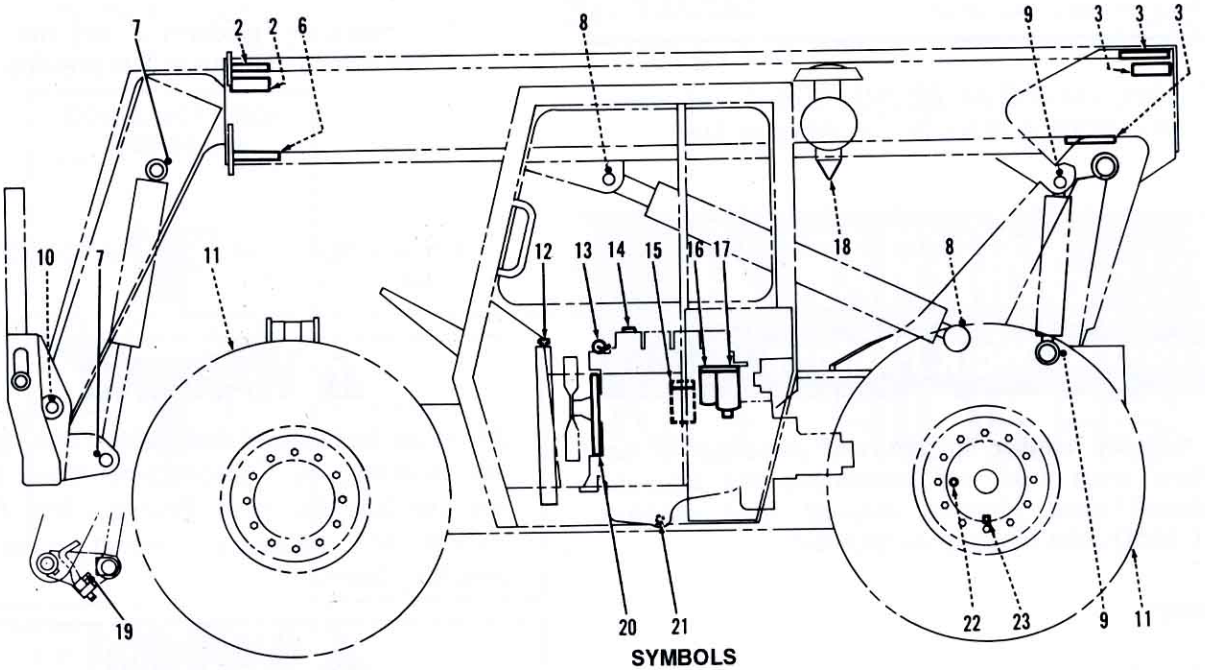
LUBRICATION & MAINTENANCE DIAGRAM



Lubricant Symbols

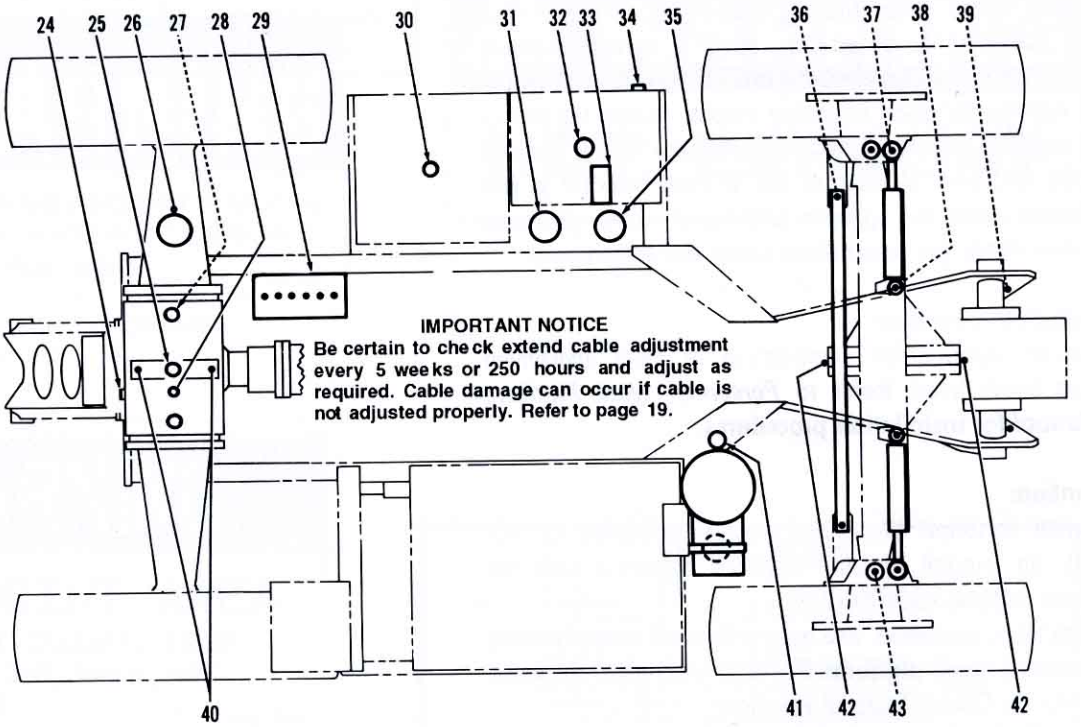
CG - GREASE (extreme pressure)
DF - DIESEL FUEL
EO - ENGINE OIL
GO - MULTI- PURPOSE LUBE
HF - HYDRAULIC FLUID
MG - MOLY LUBE (extreme pressure)
MY - MOLY LUBE (cable threads)
SL - SPECIAL LUBE (differential)





SYMBOLS

● = Lube Fitting
⟶ = Other Service
⟶ = Service Both Sides



IMPORTANT NOTICE

Be certain to check extend cable adjustment every 5 weeks or 250 hours and adjust as required. Cable damage can occur if cable is not adjusted properly. Refer to page 19.

FAILURE TO USE GRADALL HYDRAULIC FILTER ELEMENTS COULD VOID WARRANTY.

SEE MANUFACTURERS COMPONENT LITERATURE FOR ADDITIONAL LUBRICATION AND MAINTENANCE INFORMATION.

CAUTION

Service intervals are based on machine usage of 1500 hours annually. Use of your unit may vary significantly and you must adjust service frequency for your usage to obtain maximum service life. Frequency headings in the following schedule indicate a calendar limit and an operating hour limit. Perform service at whichever interval occurs first.

Item	Lube Symbol	No. of Points
Daily or Shift (10 Hour Maximum) Lubrication & Maintenance (Service at whichever interval occurs first)		
13 Engine Crankcase Dipstick (level Handler & check level - refill as req'd - item 14 is filler cap)	EO	1
30. Fuel Filler Cap (fill at end of work shift to minimize condensation)	DF	1
31. Hydraulic Return Filter Condition Indicator (check indicator with oil at normal operating temperature and engine running at full throttle - replace filter element before by-pass indication is reached or at least annually)	-	1
34. Hydraulic Level Sight Gages (level handler, retract all other cylinders & check sight gages - refill as req'd)	HF	1
35. Hydraulic Suction Filter (replace filter element when return filter element is replaced)	-	1
41. Air Cleaner Element Condition Indicator (check for clogged condition (red band showing) & clean or replace element as req'd)	-	1
Weekly (or 50 Hour) Lubrication & Maintenance (Service at whichever interval occurs first). (include all previous periodic services)		
1. Extend/Retract Cable Sheaves	CG	3
6. Boom Bottom, Front Slide Bearings (extend boom fully & lube all wear paths - retract & extend boom fully three times & wipe excess lube from bearings)		
2 stage boom:	MG	2
3 stage boom:	MG	4
7. Carriage Tilt Cylinder Pivots	CG	2
8. Boom Hoist Cylinder Pivots	CG	2
9. Compensating Cylinder Pivots	CG	2
10. Boom Head/Carriage Pivot	CG	2
11. Tires (check for damage & proper inflation) Std. for 522 & 524:1300 x 24, 8 ply - 45 psi Std. for 532C & 534C: 1300 x 24, 12 ply - 65 psi Optional: - 13.00 x 24 Radial - 70 psi	-	4
12. Radiator Fill Cap (check level & refill as req'd)	-	1
17. Fuel/Water Separator (drain water)	-	1
19. Quick Switch Latch	CG	1
26. Leveling Cylinder Pivots	CG	2
29. Battery (check terminals)	-	1
36. Tie Rod Ends	CG	2
37. Steering Cylinder rod Pivots	CG	2
38. Steering Cylinder Barrel Pivots	CG	2
39. Boom Pivots	CG	2
40. Front Axle Pivots	CG	2
42. Rear Axle Pivot	CG	2
43. King Pins	CG	4
At End of First 50 Hours Only		
23. Planetary Drain Plugs (drain while draining differential)	SL	2
25. Differential Drain Plug (drain & refill)	SL	1
At End of First 30 Days Only (250 Hours Maximum) Lubrication & Maintenance		
• Check torque of **all items** listed in Torque Table (pg 34)	-	-

Item	Lube Symbol	No. of Points
5 Week (or 250 Hour) Lubrication & Maintenance (Service at whichever interval occurs first) (include all previous periodic services)		
2. Boom Front, Top & Side Slide Bearings (extend boom fully & lube all wear paths - retract & extend boom fully three times & wipe excess lube from bearings)		
2 stage boom:	MG	4
3 stage boom	MG	12
3. Boom Rear Slide Bearings (lube paths)	MG	12
4. Boom Extend Cables (check adjustment & adjust as req'd - refer to page 19 for procedure)	-	2
6. Boom Front Bottom Slide Bearings (to be performed by experienced maintenance person - check for damage & excessive wear - no wear permitted past bevel - maximum clearance at top bearing is 1/8 inch, shim or replace as req'd; when these bearings require service, check all other slide bearings - shims are 1/16 inch thick)		
2 stage boom:	-	2
3 stage boom	-	4
15. Engine Oil Filter (replace filter element)	-	1
18. Vacuator Valve (rubber cone on bottom - check to be sure cone is clear and undamaged)	-	1
20. Drive Belts (check condition - replace as req'd)	-	1
21. Engine Crankcase Drain Plug (drain & refill top level)	EO	1
22. Rear Hub level Plug (check level & refill as req'd)	SL	2
24. Drive Axle Level Plug (check level & refill as req'd)	SL	1
• Check torque of items indicated in torque table - page 34)	-	-
Quarterly (or 500 Hour) Lubrication & Maintenance (Service at whichever interval occurs first) (include all previous periodic services)		
16. Fuel Filter (replace element)	-	1
17. Fuel/Water Separator (replace element)	-	1
32. Hydraulic System (we recommend that hydraulic fluid be analyzed to determine condition - drain & refill reservoir if req'd - ref. page 35)	HF	1
33. Hydraulic Reservoir Screen (remove, clean & install when hydraulic oil is drained)	-	1
Semi-Annual (or 1000 Hour) Lubrication & Maintenance (Service at whichever interval occurs first) (include all previous periodic services)		
23. Rear Hub Drain Plug (drain & refill - item 22 is fill plug)	SL	2
25/27. Differential & Planetary Drain Plugs (drain, fill to level, wait 5 minutes and fill to level again - item 24 is fill/level plug)	SL	3
28. Front Axle Breather (clean or replace)	-	1
32. Hydraulic Reservoir Breather Cap (clean or replace)	-	1
Annual (or 1500 Hour) Lubrication & Maintenance (Service at whichever interval occurs first) (include all previous periodic services)		
12. Engine Cooling System (drain, flush & refill on basis of period suggested by anti-freeze manufacturer)	-	1
31. Hydraulic Return Filter (replace filter element)	-	1
32. Hydraulic System (unless fluid is analyzed quarterly to determine degree of contamination, reservoir must be drained and refilled on an annual basis)	HF	1
33. Hydraulic Reservoir Screen (remove, clean & install when hydraulic oil is drained)	-	1
35. Hydraulic Suction Filter (replace filter element)	-	1

Lubrication Notes

- Lubricate points indicated by dotted leaders on both sides of unit.
- Intervals shown are for normal (8 hour day) usage and conditions. Adjust intervals for abnormal usage and conditions.
- See recommended lubricants (page 34).
- Apply a light coating of engine oil to all linkage pivot points.
- Clean lubrication fittings before lubricating.
- Clean filter housings using diesel fuel. Dry components thoroughly using a lint free cloth.
- Check lubricant levels when lubricant is cool. Also check appearance for contamination.
- Drain engine and gear cases only after operation when lubricant is hot.
- Refer to page 35 for procedure to obtain oil sample for analysis.

Failure to use Gradall Hydraulic Filter Elements could void Warranty.

Recommended Lubricants & Capacities

APPLICATION	SYMBOL	WHEN USED	GRADE	SPECIFICATION	CAPACITY*	
					ENGLISH	LITERS
Boom Cable Adj. Threads	MY (moly lube)	All Year	-	P/N 1440-3323	-	-
Boom Slide Bearing Paths	MG (extreme pres. moly lube)	All Year	NLGI #2	**	-	-
Engine Cooling System	50% Anti-Freeze / 50 % Water	All Year	Permanent	-	17.6 qts.	16.6
Engine Crankcase	EO (engine oil)	All Year	15W-40-CD	MIL-L-2104D	12 qts.	11.4
Front Axle	SL (special lube)	All Year	***	***	33 pints.	15.6
Fuel Tank	DF (diesel fuel)	All Year	#2	-	38 gal.	144
Grease Fittings	MG (extreme pres. moly lube)	All Year	NLGI #2	**	-	-
Hydraulic System	HF (hydraulic fluid)	All Year	46	****	45 gal.	170.3
Rear Hubs	SL (special lube)	All Year	***	***	4 pints ea.	1.9

*Capacities are approximate; check level to be sure.

**Union 76 Megaplex XD2

***Tractor Hydraulic Fluid:
Pour point -46° F.; SSU @ 100° F. 275; Flash Point 442° F.
Approved Supplier & Type: Mobile Mobilfluid 424 **ONLY**

****Hydraulic Fluid Specifications:
Pour point -46° F.; SSU @ 100° F. 275; Flash Point 442° F.
Approved Supplier & Type: Mobile Mobilfluid 424 **OR** Citgo Tractor Hydraulic Fluid #33310

TORQUE CHART

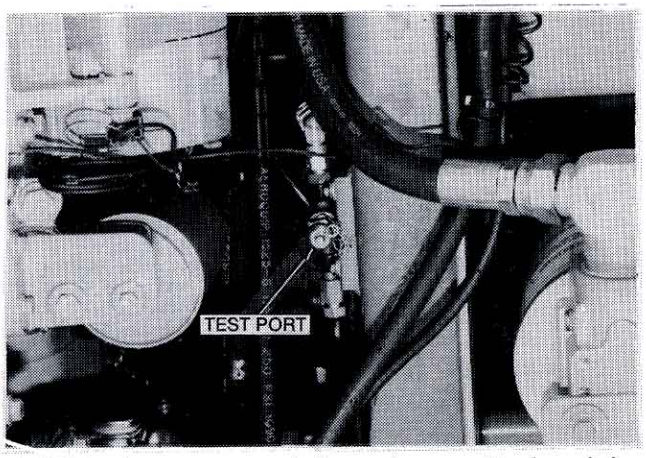
**Check torque using an accurate torque wrench to apply maximum torque value shown.
DO NOT EXCEED MAXIMUM TORQUE. Exceeding maximum torque may cause failure of fastener.**

ITEM	FREQUENCY *	THREAD SIZE (GRADE)	TORQUE (lubricated)			
			POUND/FEET		NEWTON/METRES	
			MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
BOOM SLIDE BRGS. (front)	5 Weeks (250 Hours)	⅜-24 (5)	32	37	43	50
	5 Weeks (250 Hours)	½-20 (5)	68	78	92	106
BOOM SLIDE BRGS. (rear)	**	⅜-24 (5)	32	37	43	50
	**	½-20 (5)	68	78	92	106
BOOM EXTEND CABLE (at rear)						
Adjusting Nut	5 Weeks (250 Hours)	1-8 (-)	†	†	†	†
Jam Nut	5 Weeks (250 Hours)	1-8 (-)	100	110	137	150
Wheel Lug Nuts	3 Months (500 Hours)	-	350	400	476	544

*Check torque at whichever interval occurs first.
**Check rear slide bearings if front bearing have loosened.
†Refer to page 19 for procedure to check and adjust cables.

Obtaining Hydraulic Oil Sample for Analysis

1. Operate unit until hydraluic oil reaches normal operating temperature.
2. Apply parking brake, lower boom to rest and shift forward/reverse lever to neutral. Observe hydraulic filter by-pass indicator with engine running at full throttle Replace filter elements if necessary.
3. Obtain a container to receive waste oil and a **CLEAN** container to receive oil sample.



4. With gage removed from hose, attach mini-check and hose to test port near right wall of engine compartment. Hose end must be positioned in waste oil container.
5. Allow at least one pint of oil to flow into waste oil container to eliminate any contamination from hose.
6. Move hose to **CLEAN** container to collect sample for analysis.
7. Return hose to waste oil container and disconnect adapter from mini-check test port.
8. Cover sample container immediately with **CLEAN** cap.
9. Stop engine and check oil level in reservoir and replenish as required.
10. Contact your Gradall Distributor for information concerning oil analysis.

Oil sample containers are available from several sources:

- Oil companies
- Oil suppliers
- Sampling labs

OIL CLEANLINESS IS A MUST. The filtration system is designed to maintain an ISO cleanliness ratio of 18/15 or better.

MOVING HANDLER IN EMERGENCY

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

Before moving the handler, read all of the following information to understand options available and then select a method appropriate to your situation.

The safest way to move a disabled handler is to use a trailer of sufficient capacity.

The ability to steer handler increases the safety of moving the unit in some situations. The steering system permits manual steering if engine or power assist feature fails. However, **remember the following:**

- Although manual steering is possible without power assist, **steering will be slow and will require much greater force.**
- **Rear drive hubs must be disengaged**
- **Response to manual steering will be increased** if parking brake is released and front axle drive is by-passed to permit front wheels to roll.

MOVING SHORT DISTANCES

If it is only necessary to move handler a short distance (less than 100 feet) it is permissible to use a vehicle of sufficient capacity to tow the unit with no previous preparation. Drive wheels will not roll.

If the unit must be moved more than 100 feet (but less than 200 yards) it is permissible to use a vehicle of sufficient capacity to tow unit after completing following preparations:

- Disengage rear hubs.
- By-pass front drive system.
- Release parking brake.

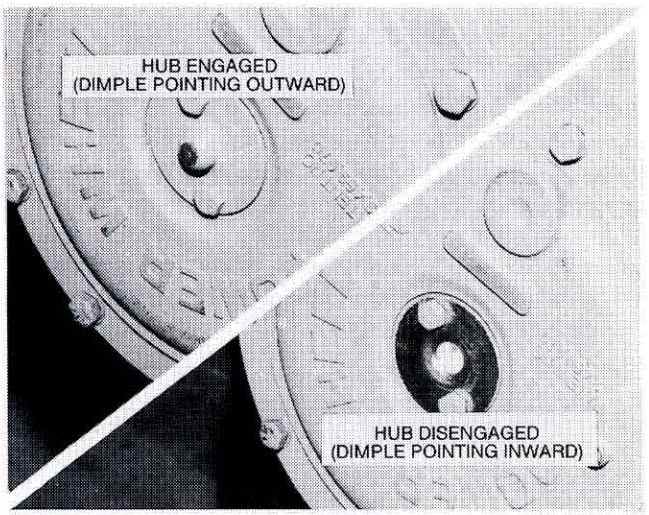
continued. . .

Towing handler with all wheels on ground for more than 200 yards can cause serious damage to hydraulic drive components.

MOVING LONGER DISTANCES

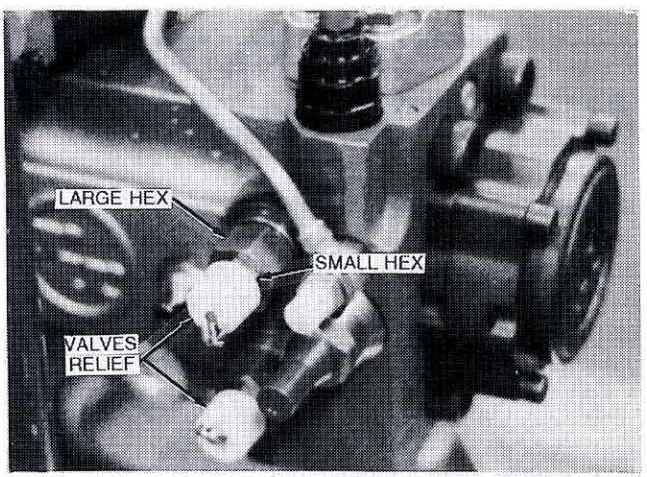
If unit must be moved more than 200 yards it should be loaded on a trailer of sufficient capacity.

To Disengage Rear Hubs



Secure both rear hub engage/disengage plates with dimple pointing inward to disengage rear drive hubs.

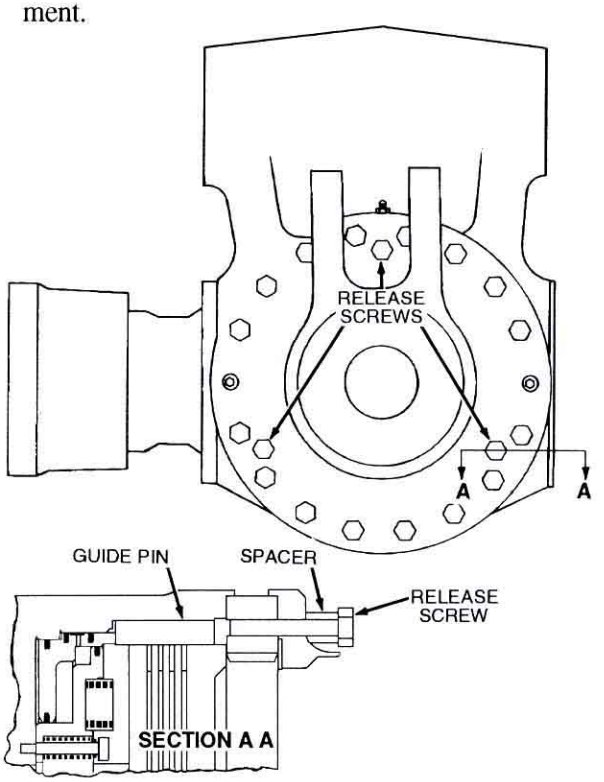
To By-Pass Front Drive



1. Mark position of relief valve cartridges (small hex).
2. Hold large hex to prevent movement and loosen one relief valve cartridge (small hex) two full turns.
3. Repeat procedure for other relief valve. Front axle drive is now by-passed.
4. Before returning machine to service, be certain to return relief valve cartridges to original position and re-engage rear drive hubs.

To Release Parking Brake

1. If possible, position unit on level ground, lower attachment to approximately one foot from ground, move forward/reverse lever to neutral position, apply parking brake and stop engine.
2. Install wheel chocks at all wheels to prevent movement.



3. Working one side at a time, remove three release screws and spacers from side of differential housing (located at 12 o'clock, 4 o'clock and 8 o'clock).
4. Put spacers aside and install release screws. Tighten each screw lightly until it just makes contact with guide pin.
5. Working carefully, tighten each release screw **only 1/4 turn (90 degrees)** at a time, in sequence, until all three screws have been turned one full turn (360 degrees [approximately 50 lb./ft]). **Larger turns could cause components to bind and cause brake failure.**
6. Repeat this procedure on other side of differential. Parking brakes should be released.

To Restore Parking Brake

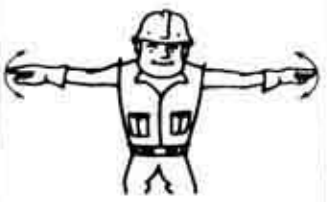
1. Check to be certain engine is stopped and all wheels are chocked to prevent movement.
2. Loosen each release screw, **only 1/4 turn at a time,** in sequence, until each screw has lost contact with guide pin. Then remove release screws.
3. Install spacers and release screws and torque to 50 **- 70** lb/ft.
4. Repeat procedure on other side of differential. Parking brake should be restored to operation.

HAND SIGNALS

Standard Signals - When handler work conditions require hand signals, they shall be provided or posted conspicuously for the use of both signalman and operator. No handler motions shall be made unless signals are clearly understood by both signalman and operator.

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.

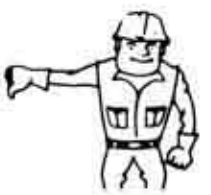
Instructions - When it is desired to give instructions to the operator other than provided by the established signal system, all handler motions shall first be stopped.



EMERGENCY STOP - With both arms extended laterally, hands open downward, move arms back and forth

STOP - With either arm extended laterally, hand open downward, move arm back and forth

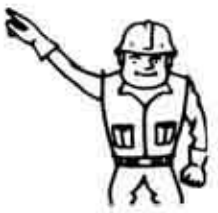
RAISE BOOM - With either arm extended horizontally, fingers closed, point thumb upward



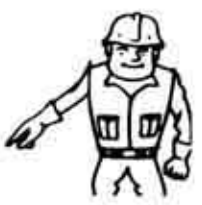
LOWER BOOM - With either arm extended horizontally, fingers closed, point thumb downward

EXTEND TELESCOPIC BOOM - With both hands clenched, point thumbs outward.

RETRACT TELESCOPIC BOOM - With both hands clenched, point thumbs inward.



TILT FORKS UP - With one arm held at side, extend other arm upward at about 45°



TILT FORKS DOWN - With one arm held at side, extend other arm downward at about 45°.

CLOSE BUCKET - Hold one hand closed and stationary. Rotate other hand in small vertical circle with forefinger pointing horizontally at closed hand.

OPEN BUCKET - Hold one hand open and stationary. Rotate other hand in small vertical circle with forefinger pointing horizontally at open hand.

MOVE SLOWLY - Place one hand motionless in front of hand giving motion signal. (Raise load slowly is shown.)

THIS FAR TO GO - With hands raised and open inward, move hands laterally, indicating distance to go.

STOP ENGINE - Draw thumb or forefinger across throat.

CALIFORNIA

Proposition 65 Warning

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

CALIFORNIA

Proposition 65 Warning

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

Wash hands after handling!

GRADALL® Material Handlers

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Phone (330) 339-2211 Fax (330) 339-8468
Web www.gradall.com

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Printed in USA

LEGEND

- MAIN PRESSURE & RETURN LINES
- PILOT LINES
- DRAIN LINES
- ELECTRICAL LINES

12 VOLT BATTERY

FORWARD REVERSE SELECTOR SWITCH

FORWARD

NEUTRAL

REVERSE

INCHING VALVE

F/R SECTION

FLUSHING VALVE SECTION

FRONT DRIVE MOTOR (DA CONTROL)

DRIVE PUMP (DA CONTROL)

SUCTION FILTER 8 MICRON ABSOLUTE

RETURN FILTER 8 MICRON ABSOLUTE

FILLER/ BREATHER

100 MESH

RESERVOIR (NON-PRESSURIZED)

TO 32 ON F-N-R SWITCH

TO 6A ON CONNECTOR

12 VOLT BATTERY

PARK BRAKE SWITCH

IMPLEMENT PUMP 2.5 CU. IN./REV.

UPPER PRIORITY FLOW DIVIDER (BRAKES)

LOWER PRIORITY FLOW DIVIDER (STEERING)

STEERING ORBITROL

STEER CYLINDERS

PARK BRAKE SOLENOID VALVE

BRAKE VALVE

SERVICE BRAKE

PARK BRAKE

SWAY CYLINDER

COMPENSATING CYLINDER

TILT CYLINDER

AUXILIARY HYDRAULICS

AUX.

SWAY

TILT

CROWD

LIFT

3000 PSI

MAIN CONTROL VALVE

JOY STICK

LIFT CYLINDER

CROWD CYLINDER

STABILIZER CYLINDER

REAR AXLE STABILIZER VALVE (532C-6 ONLY)

STABILIZER SWITCH

12 VOLT BATTERY

HYDRAULIC SCHEMATIC

522 532C-6

9109-9012

LEGEND

MAIN PRESSURE & RETURN LINES
PILOT LINES
DRAIN LINES
ELECTRICAL LINES

12 VOLT BATTERY
FORWARD REVERSE SELECTOR SWITCH
FORWARD
NEUTRAL
REVERSE
2/4 WHEEL DRIVE SWITCH
TRACTION LOCK SWITCH
2/4 WHEEL DRIVE VALVE
INCHING VALVE
F/R SECTION
REAR DRIVE MOTOR
.046
REAR DRIVE MOTOR
.046
FLUSHING VALVE SECTION
220 PSI
FRONT DRIVE MOTOR (DA CONTROL)
DRIVE PUMP (DA CONTROL)
5500 PSI
5500 PSI
320-480 PSI
REV.
FWD.
TO 32 ON F-N-R SWITCH
TO 8A ON CONNECTOR
12 VOLT BATTERY
PARK BRAKE SWITCH
IMPLEMENT PUMP 2.5 CU.IN./REV.
UPPER PRIORITY FLOW DIVIDER (BRAKES)
625 PSI
LOWER PRIORITY FLOW DIVIDER (STEERING)
2500 PSI
STEERING ORBITROL
STEER CYLINDERS
PARK BRAKE SOLENOID VALVE
BRAKE VALVE
SERVICE BRAKE
PARK BRAKE
SUCTION FILTER 8 MICRON ABSOLUTE
25 PSI
RETURN FILTER 8 MICRON ABSOLUTE
FILLER/ BREATHER
100 MESH
RESERVOIR (NON-PRESSURIZED)
5800 PSI
5800 PSI
.039
50
50
TRACTION LOCK VALVE
SWAY CYLINDER
.062
.062
COMPENSATING CYLINDER
TILT CYLINDER
3500 PSI
AUX.
2000 PSI
5000 PSI
AUXILIARY HYDRAULICS
SWAY
TILT
2800 PSI
2800 PSI
CROWD
LIFT
3000 PSI
MAIN CONTROL VALVE
JOY STICK
LIFT CYLINDER
3500 PSI
CROWD CYLINDER
3800 PSI
STABILIZER CYLINDER
1000 PSI
.03
.03
STABILIZER SWITCH
12 VOLT BATTERY
REAR AXLE STABILIZER VALVE (534C-6, 534C-6T ONLY)

HYDRAULIC SCHEMATIC
524 534C-6 534C-6T
9108-9026

SUNDSTRAND SAUER

Series 40

REAR DRIVE MOTORS

524 / 534C-6

M46-Axial Piston Pumps and Motors Service Manual

Fig. 29 - Removing Shaft Seal

Fig. 30 - Shaft Seal Removed

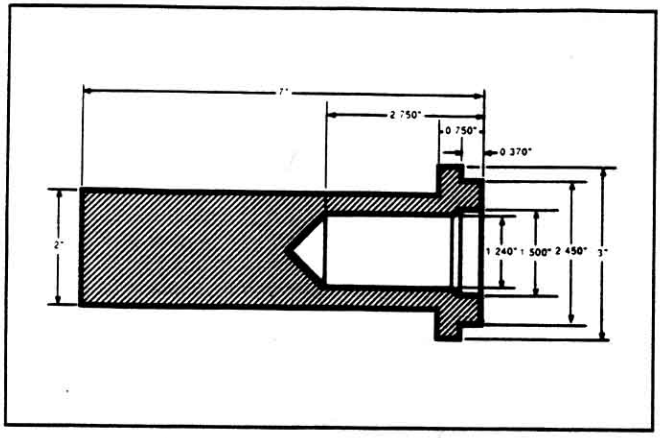


Fig. 31 - Shaft Seal Installation Tool Dimensions

Shaft Seal

Lip type shaft seals are used on the Series 40 - M46 pumps and motors. These seals can be replaced without major disassembly of the unit. However, replacement of the shaft seal requires removal of the pump or motor from the machine.

Remove the retaining ring from the housing.

Carefully remove the seal from the housing bore. The face of the seal may be punctured with a sharp instrument (such as a screw driver) to aid in prying the seal out, or a slide hammer type puller may be used to remove the seal. Care must be taken so as not to damage the housing bore or shaft. Once removed, the seal is not reusable.

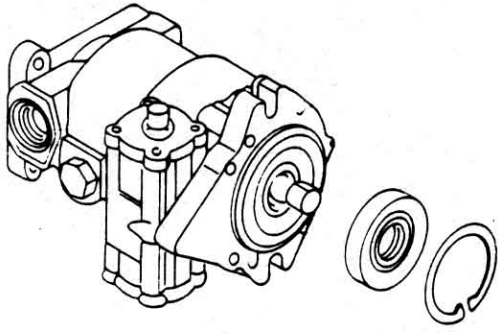
Prior to installing the new seal, inspect the sealing area on the shaft for rust, wear, or contamination. Polish the sealing area on the shaft if necessary.

Wrap the spline or key end of shaft with thin plastic to prevent damage to the seal lip during installation. Lubricate the inside diameter of the new seal with petroleum jelly.

Slide the new seal over the shaft and press it into the housing bore. Be careful not to damage seal. A seal installer tool can be made to aid in installing the seal. Dimensions for this tool are shown in the accompanying drawing.

Reinstall the seal retaining ring.

M46 Variable Displacement Motor -- MV (Minor Repair)

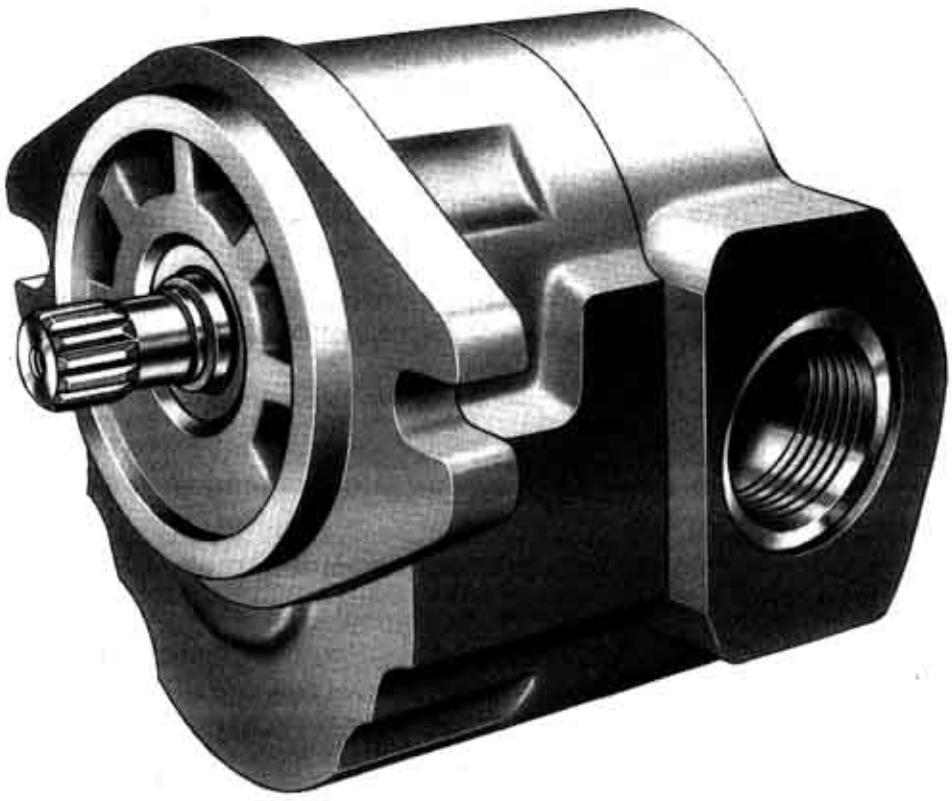


REXROTH
WORLDWIDE HYDRAULICS

SERVISCRIPT

S30 Series — Hydraulic Gear Pumps

RA
MOBILE
64-789-S
Issue Date 1/83



S30 SERIES HYDRAULIC GEAR PUMPS

MODELS

S30S-13
S30S-17
S30S-20
S30S-24
S30S-29
S30S-33

PREPARATION FOR DISASSEMBLY

Overhaul pump only in a clean, dust-free location, using clean tools and equipment. Dirt or grit will damage the highly machined surfaces and will result in leakage or premature failure of the pump.

Before beginning disassembly, scribe match marks on the inlet side of the body and cover to insure that the pump will be reassembled in the same manner as it was shipped from the factory. If the body or rear cover is replaced during overhaul, scribe a match mark on the new part in the same location as on the part it replaced.

DISASSEMBLY OF PUMP

NOTE

All reference numbers refer to items illustrated in the exploded view provided with the parts list section of this publication.

1. Clean outside of pump with a good grade solvent and dry thoroughly.
2. On models with splined drive shaft, proceed to step 3. On models with keyed drive shaft, remove woodruff key (9) from drive shaft. Using a file or stone, remove any burns from shaft end, or key way, lightly grease key way before removal of gear.
3. Secure unit in soft jawed vise (use light clamping pressure) with shaft end down; remove cap screws (1) and washers (2).

NOTE

During disassembly, take special note of the wear patterns on the wear plate (6) and thrust plate (4). Relate these patterns to the inlet side of the pump. The large port in the rear cover (10) always corresponds to the inlet side of the pump. The inlet side can be further identified by the gear contact pattern in the gear bore. The wear plate (6) will have a somewhat heavier wear pattern on the inlet side. The thrust plate (4) will also have a pattern that can be established for reassembly. Also note that the long journal of the driven gear (11) is toward the front of the pump.

4. Separate rear cover (10) from body (13) by supporting pump, shaft end up, on mounting flanges and pressing on drive shaft end in arbor press.

CAUTION

Use one hand to support rear cover from underneath, since cover and internal parts will drop suddenly when dowels are disengaged.

An alternate method of removing the rear cover is to pry simultaneously with two large screwdrivers in the relieved areas between body and cover, or lightly tapping drive shaft with a plastic mallet.

CAUTION

At no time should screwdrivers be inserted further into pump than the depth of the relieved areas. Any burr or upset metal must be removed from the body (13) and/or cover (10) after this operation to assure a good seal between body and cover.

5. Holding pump shaft end down, remove rear cover (10). Dowel pins (5) may remain either with body or rear cover.

NOTE

Gasket seal (3) and thrust plate (4) may or may not remain with rear cover. Should they remain with body, remove gasket and lift out thrust plate before proceeding.

6. Lift out driven gear (11), drive gear (12), and wear plate (6).

7. Invert pump body with shaft seal up. Remove shaft seal (8) by prying it out with a large screwdriver.

CAUTION

Care should be taken not to damage the shaft seal bore as this would result in seal leakage.

PARTS INSPECTION

1. Wash all parts and dry thoroughly.

2. Inspect wear plate (6) and thrust plate (4). Replace if scoring or uneven wear is observed.

NOTE

Somewhat heavier wear pattern is normal on the low pressure (inlet) side of the wear plate (6). However, there should be no heavy scoring in this area.

3. Remove pressure loading seal (7 & 14) from wear plate and discard, see enlarged view on page 7 for proper assembly. These seals may be of two or one PC design. In either case, discard the old seals and replace with the new.

4. Inspect bushings in body and cover. Replace cover or body if bushings are heavily scored or burned.

5. Inspect gear journals and faces. Replace if faces or journals are scored or worn, or if shaft jounral wear exceeds 0.001 inch (.025mm).

6. Inspect body for wear and scoring. If gear contact wear on low pressure side (inlet) exceeds 0.005 inch (.127mm) depth, replace body. If the body is usable, remove wipe burr with suitable burring tool.

PUMP REASSEMBLY

NOTE

The installation of new parts contained in Seal Kit is recommended at each overhaul of the pump.

⊙ 1. Place body (13) on flat plate with shaft seal bore up. Install new shaft seal (8). Press seal until it is 9/64" below face of pilot diameter. Pack the area between the double lip of the seal with Lubriplate or equivalent.

2. Invert body so that gear bores are up. Install wear plate (6) in bottom of bore, making sure that pressure loading seals are positioned properly in seal grooves and installed against bottom of bore surface, ref. to page 7.

3 Lubricate bushings in body and face of wear plate with SAE 10 oil.

* 4. Apply Lubriplate or equivalent to outer surface of drive shaft installation sleeve. Insert sleeve into shaft seal from front of pump until sleeve contacts drive gear bushing. Install drive gear (12). Install driven gear (11), with long journal toward front of pump.

5. Lubricate rear gear faces and journals with SAE 10 oil and install thrust plate (4) in its original position.

6. Apply a small amount of grease to rear cover seal groove and install new gasket seal (3) into groove.

7. Lubricate rear cover bushings with SAE 10 oil and install rear cover (10), matching scribe marks on cover and body.

8. Position pump with shaft end down, and install the rear cover (10).

9. Insert cap screws (1) and washers (2); torque to 34 to 38 ft-lb (46 to 51 M.M.).

10. On models equipped with keyed drive shaft, install woodruff key (9).

11. Check that drive shaft turns with adjustable wrench without evidence of mechanical bind.

BREAK-IN PROCEDURE

Test stand methond: See NOTE § before testing on application.

1. Run pump for 1 minute at minimum pressure.

2. Raise discharge pressure to 500 psi (34.5 bars) for 5 seconds, then lower to minimum pressure for 5 seconds. Continue cycle for 1 minute.

3. Repeat step 2 but increase pressure in 500 psi (34.5 bars) increments until maximum operating pressure is obtained. Check flow by any method available.

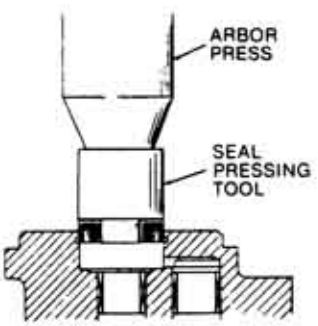
Alternate on-equipment method:

1. Mount pump on equipment and operate for 2 minutes at minimum pressure and one-quarter engine speed.
2. Increase discharge pressure to relief setting with control valve. Hold for 5 seconds and release. Continue cycle for 2 minutes.
3. Repeat step 2 for 3 minutes at one-half engine speed.
4. Repeat step 2 for 3 minutes at full engine speed.
5. With engine at idle speed, check pump and hydraulic system for leaks. No shaft seal leakage sufficient to form a drop is permissible. No external leakage is permissible.

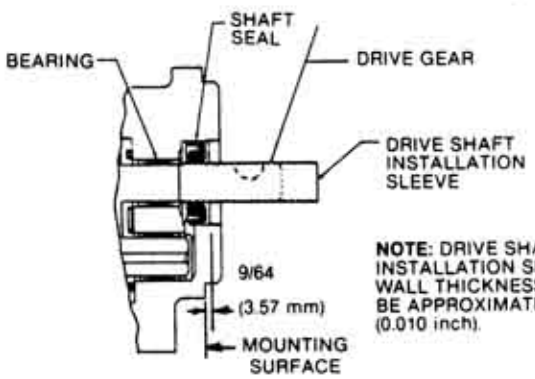
Output flow of an overhauled pump should meet or exceed the following:

MODEL NO.	DISPLACEMENT (IN³/REV)	cm³/u	SPEED (RPM)	PRESSURE (PSI)	bars	FLOW-MIN (GPM)	liters/min	GEAR WIDTH (IN.)	mm
S30S-13	1.52	24.9	1800	3000 ± 50	207 ± 3.4	9.8	37.1	0.68	17.27
S30S-17	1.95	32.0	1800	3000 ± 50	207 ± 3.4	13.2	50.0	0.87	22.10
S30S-20	2.32	38.0	1800	3000 ± 50	207 ± 3.4	16.0	60.6	1.04	26.42
S30S-24	2.74	44.9	1800	3000 ± 50	207 ± 3.4	19.2	72.7	1.22	30.99
S30S-29	3.30	54.1	1800	3000 ± 50	207 ± 3.4	23.8	90.1	1.47	37.34
S30S-33	3.80	62.3	1800	3000 ± 50	207 ± 3.4	27.8	105.2	1.69	42.92

BELOW IS A SKETCH CLARIFYING THE RECOMMENDED SHAFT SEAL PRESSING TOOL AND PROPER PRESSING DEPTH OF SHAFT SEAL

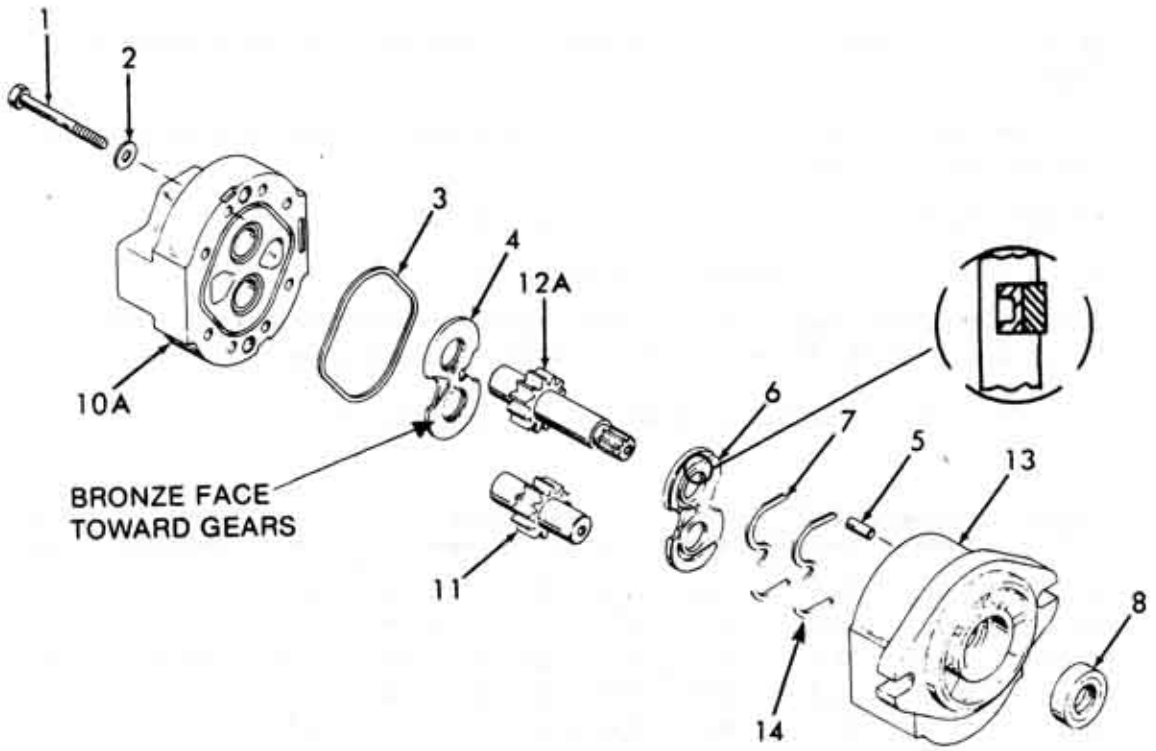


◉ **FIGURE 1**
SEAL INSTALLATION TOOL



* **FIGURE 2**
DRIVE SHAFT INSTALLATION SLEEVE

IF SLEEVE NOT AVAILABLE, GREASE KEY WAY & ASSEMBLE BEING VERY CAREFUL NOT TO CUT SHAFT SEAL.



NOTE: This unit positioned for left hand rotation. To change to R (right hand) rotate items 6, 7, 14 and 10A.

Open Center HYDRAULIC POWER BRAKE VALVE

SERVICE MANUAL

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SYSTEM SCHEMATIC (TYPICAL)

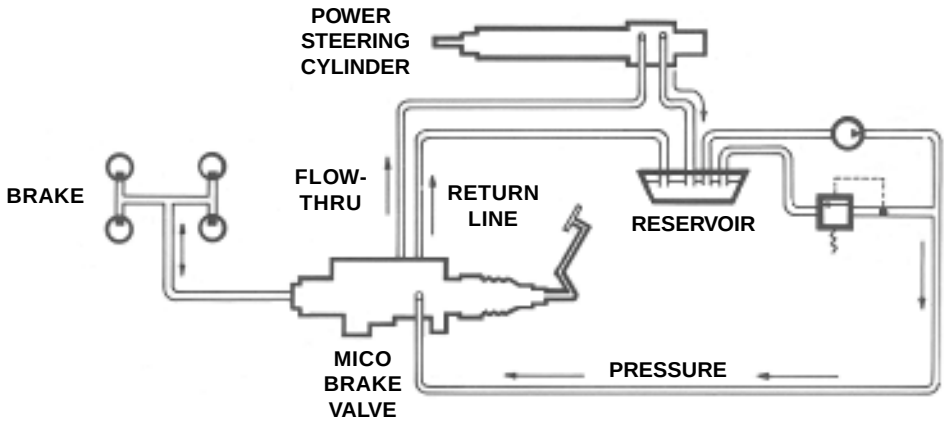


FIGURE 1

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.

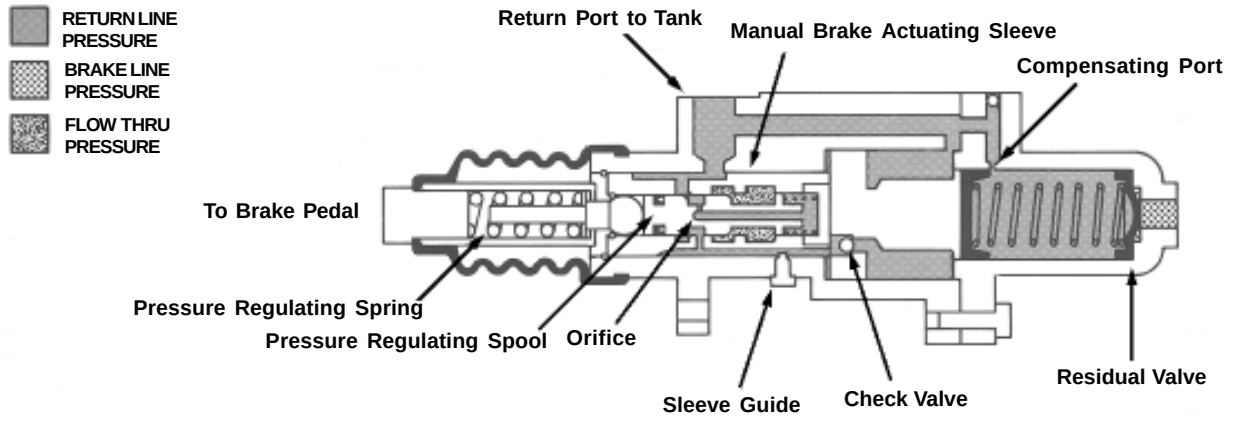
The manner in which the hydraulic power brake valve funtions will be discussed in the following paragraphs.

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

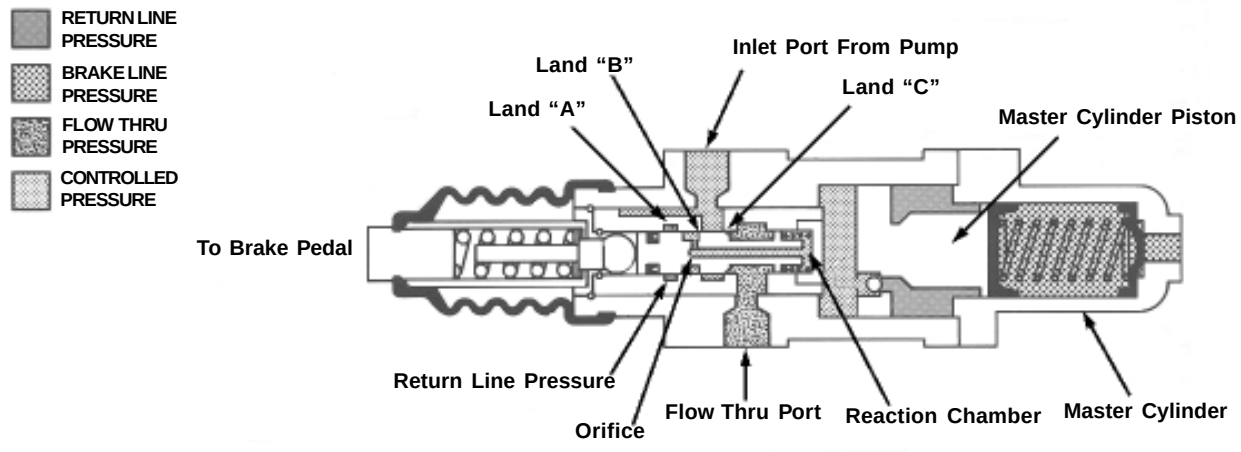
Schematic of Brake Valve in Neutral

FIGURE 2

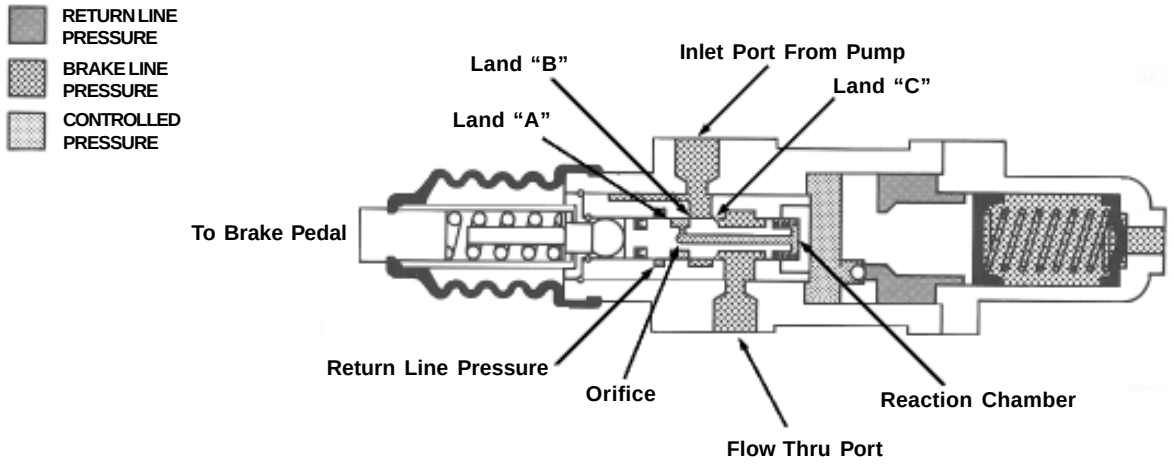


Brake Valve Actuated -- Power Steering in Neutral

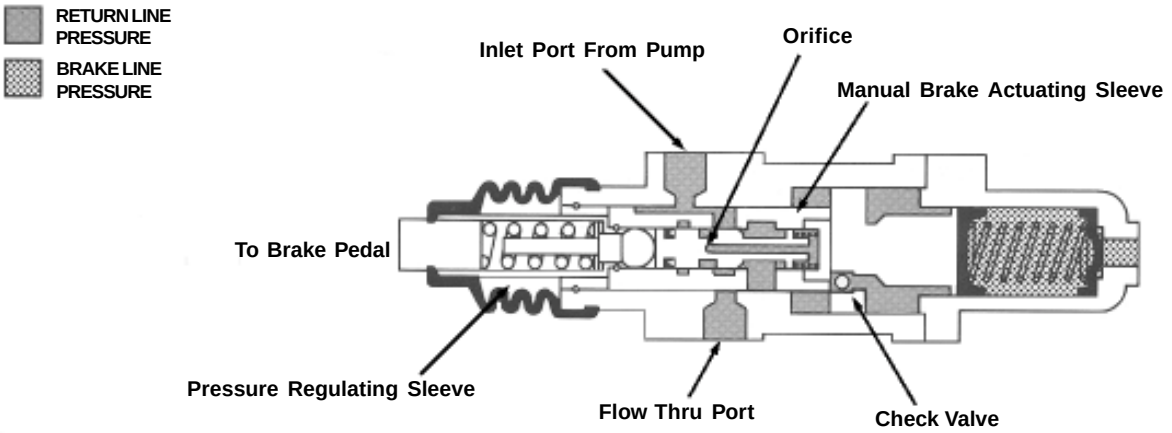
FIGURE 3



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.

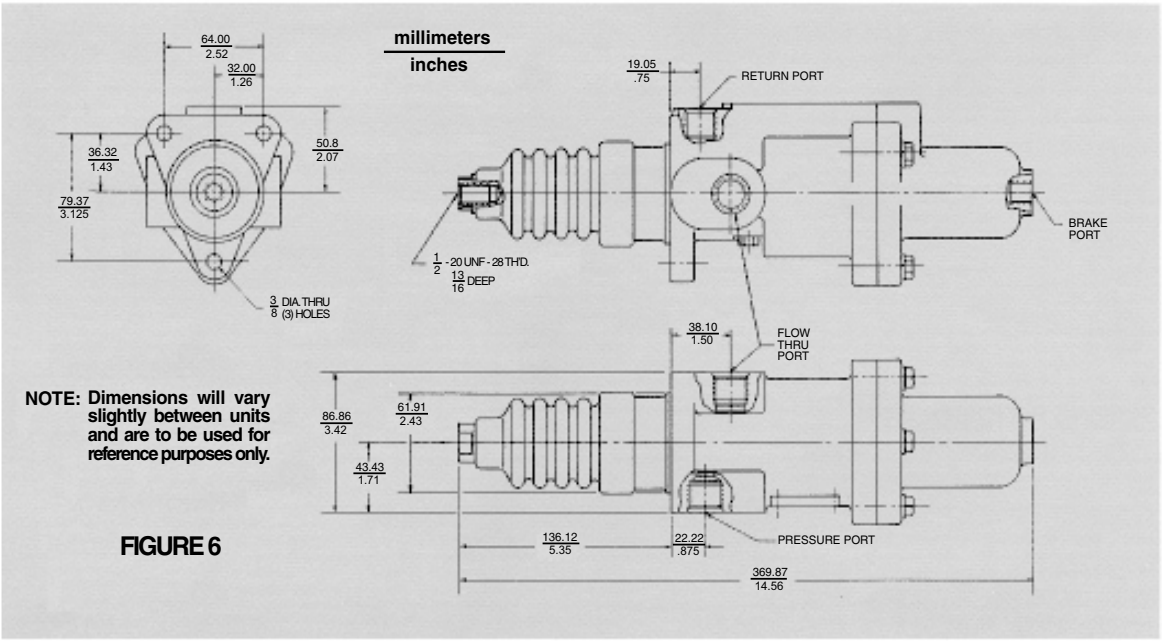


FIGURE 6

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.

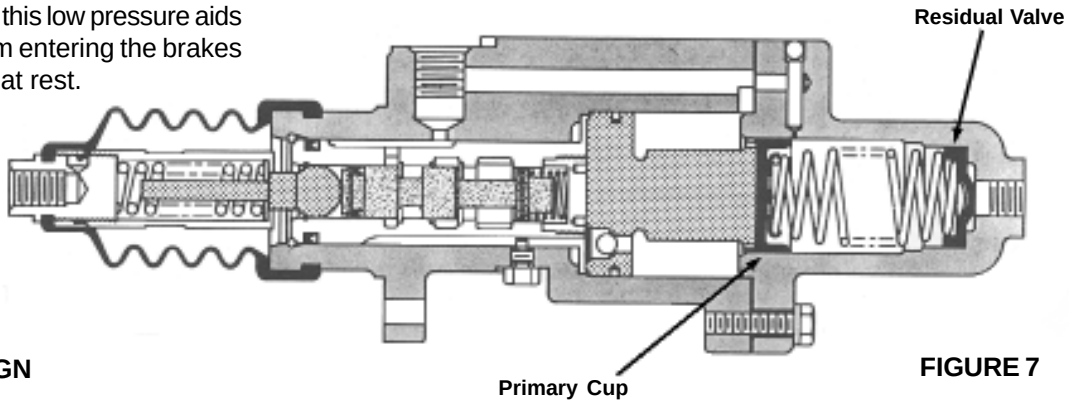


FIGURE 7

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.

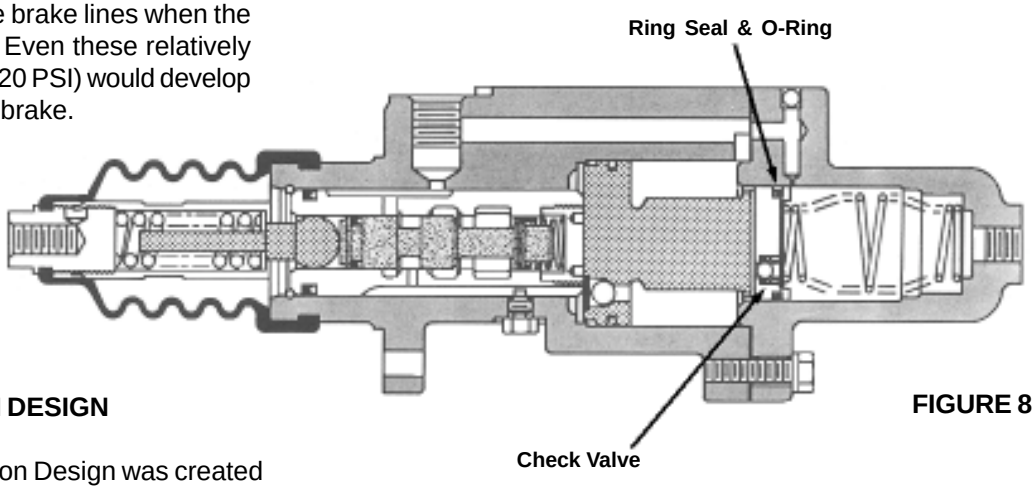


FIGURE 8

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.

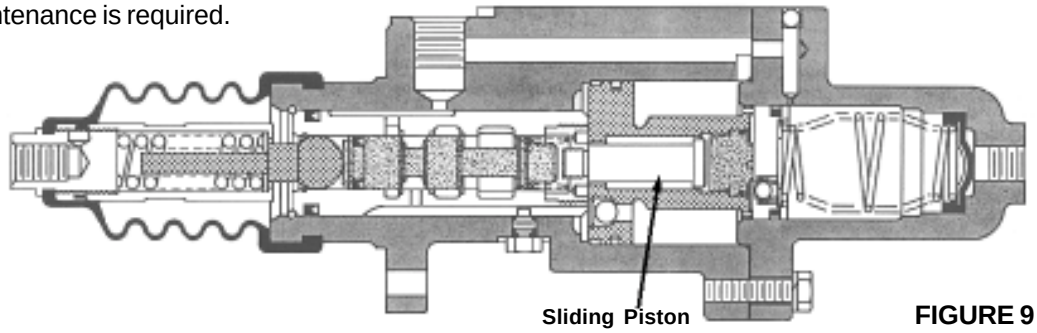


FIGURE 9

SPECIFICATIONS CHART

Part Number	Brake Port	Pressure Port	Flow Thru Port	Return Port	Brake Line Pressure (with power)	Flow Capacity
* 06-460-520	1/2-20 UNF	SAE No. 10	SAE No. 10	1/2-14 NPTF	1850 psi ± 50 psi	3-24 gpm
Complete unit replaced by 06-460-658						
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	1/2-20 UNF	SAE No. 10	SAE No. 10	1/2-14 NPTF	1500 psi ± 50 psi	3-24 gpm
Complete unit replaced by 06-460-656						
* 06-460-560	1/2-20 UNF	SAE No. 8	SAE No. 8	SAE No. 10	1550 psi ± 50 psi	3-24 gpm
Complete unit replaced by 06-460-656						
* 06-460-570	9/16-18 UNF	SAE No. 8	SAE No. 8	SAE No. 10	1550 psi ± 50 psi	3-24 gpm
Complete unit replaced by 06-460-662						
* 06-460-580	1/2-20 UNF	SAE No. 10	SAE No. 10	SAE No. 10	1500 psi ± 50 psi	3-24 gpm
Complete unit replaced by 06-460-656						
* 06-460-588	1/2-20 UNF	SAE No. 10	SAE No. 10	SAE No. 10	1550 psi ± 50 psi	3-24 gpm
Complete unit replaced by 06-460-664						
* 06-460-610	9/16-18 UNF	SAE No. 10	SAE No. 10	1/2-14 NPTF	950 psi ± 50 psi	3-24 gpm
Complete unit replaced by 06-460-666						
* 06-460-620	1/2-20 UNF	SAE No. 10	SAE No. 10	SAE No. 10	1500 psi ± 50 psi	3-24 gpm
Complete unit replaced by 06-460-656						
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	1/2-20 UNF	SAE No. 10	SAE No. 10	1/2-14 NPTF	1500 psi ± 50 psi	3-24 gpm
Complete unit replaced by 06-460-656						
* 06-460-654	9/16-18 UNF	SAE No. 8	SAE No. 8	SAE No. 10	1500 psi ± 50 psi	3-12 gpm
Complete unit replaced by 06-460-676						
* 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	1/2-20 UNF	SAE No. 8	SAE No. 8	SAE No. 10	1550 psi ± 50 psi	3-8 gpm
Complete unit replaced by 06-460-670						
06-460-682	1/2-20 UNF	SAE No. 8	SAE No. 8	SAE No. 10	750 psi ± 50 psi	3-24 gpm
Complete unit replaced by 06-460-672						
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	1/2-20 UNF	SAE No. 10	SAE No. 10	1/2-14 NPTF	1500 psi ± 50 psi	3-12 gpm
Complete unit replaced by 06-460-674						
06-461-520	1/2-20 UNF	SAE No. 10	SAE No. 10	1/2-14 NPTF	1850 psi ± 50 psi	3-24 gpm
Complete unit replaced by 06-461-658						
06-461-550	1/2-20 UNF	SAE No. 10	SAE No. 10	1/2-14 NPTF	1500 psi ± 50 psi	3-24 gpm
Complete unit replaced by 06-461-656						
06-461-610	9/16-18 UNF	SAE No. 10	SAE No. 10	1/2-14 NPTF	950 psi ± 50 psi	3-24 gpm
Complete unit replaced by 06-461-666						
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 (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).

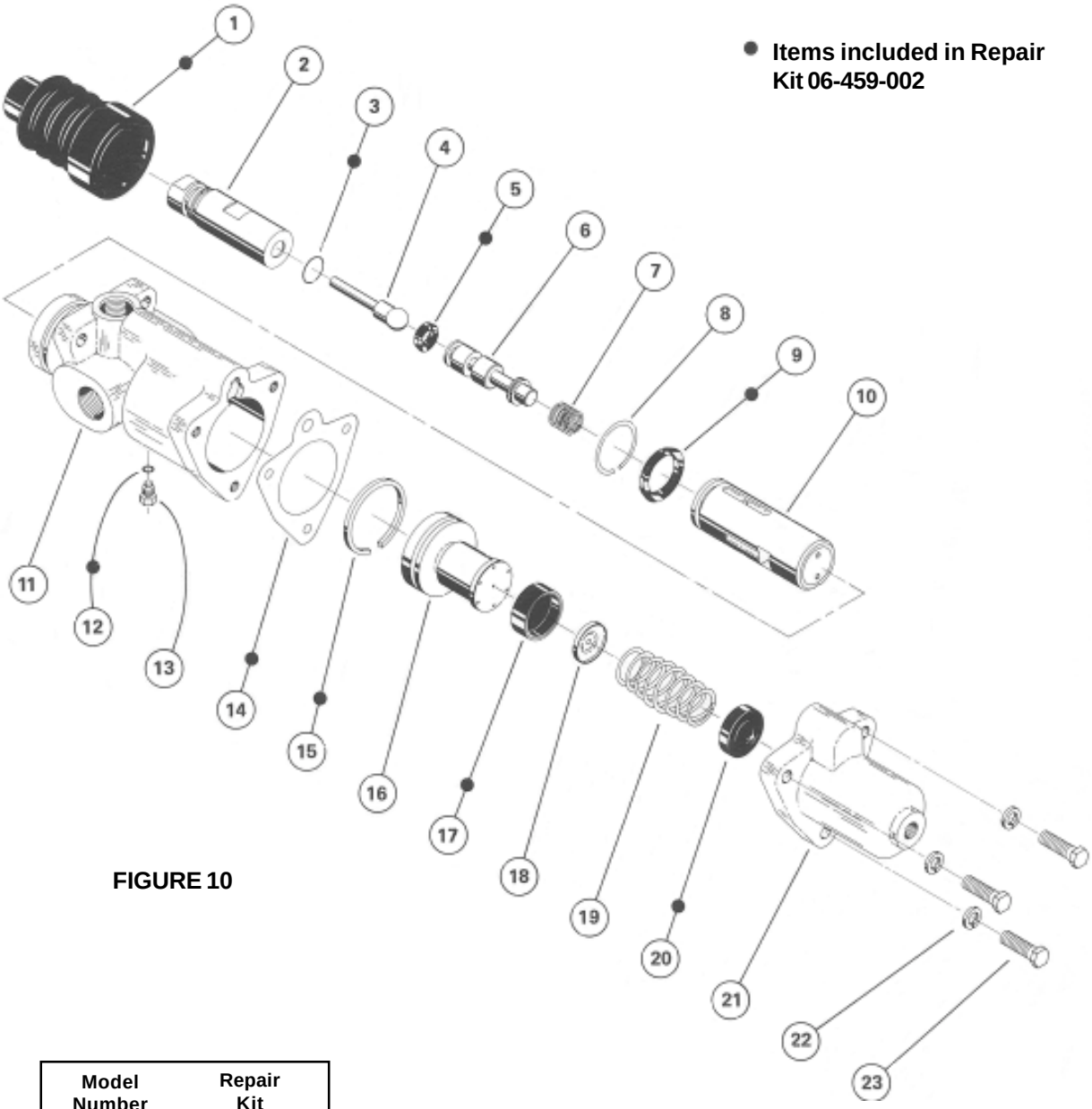
   CAUTION: Residual valve must be checked for proper seating in end cap.

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



● **Items included in Repair Kit 06-459-002**

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.

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

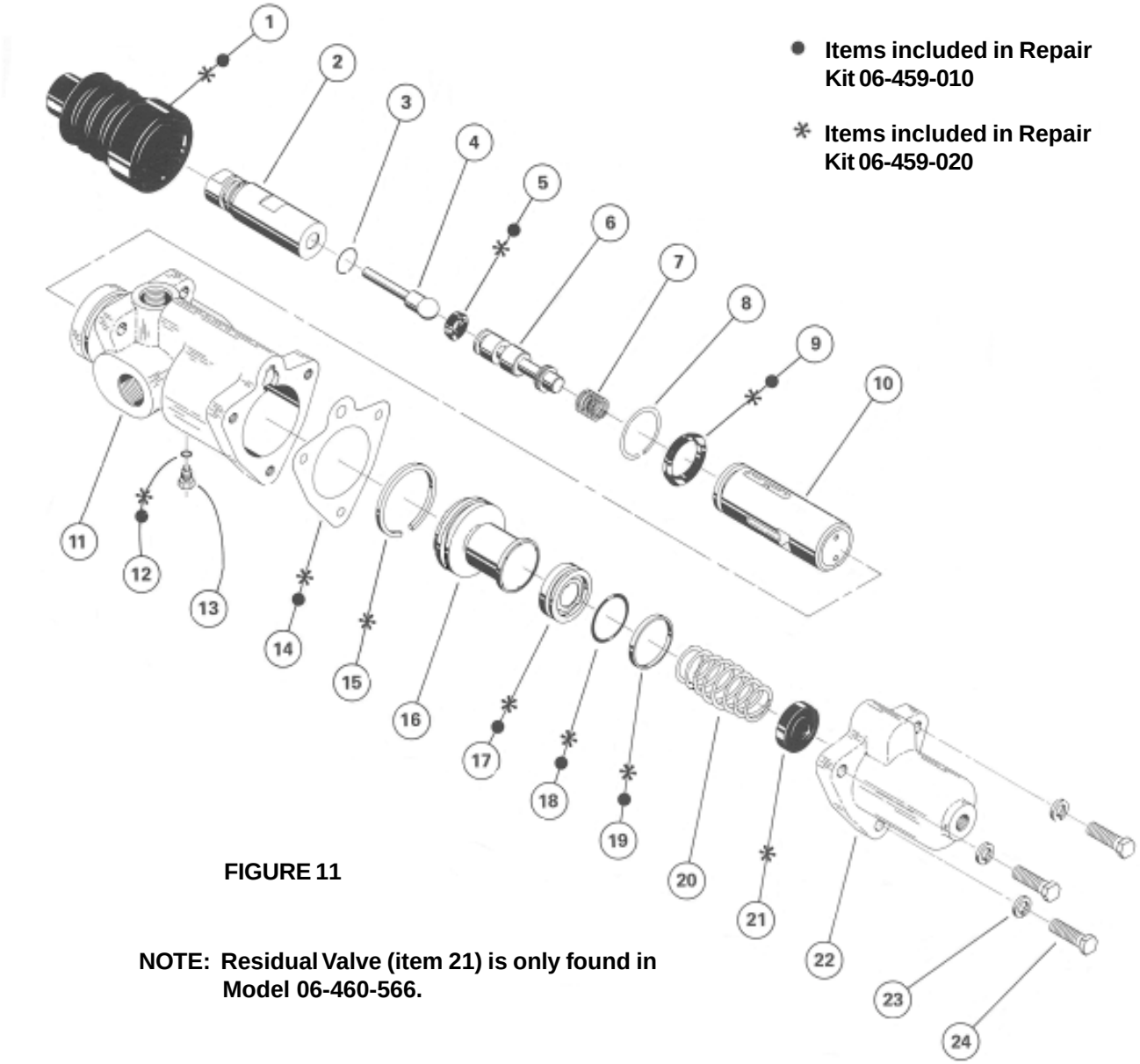


FIGURE 11

NOTE: Residual Valve (item 21) is only found in Model 06-460-566.

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

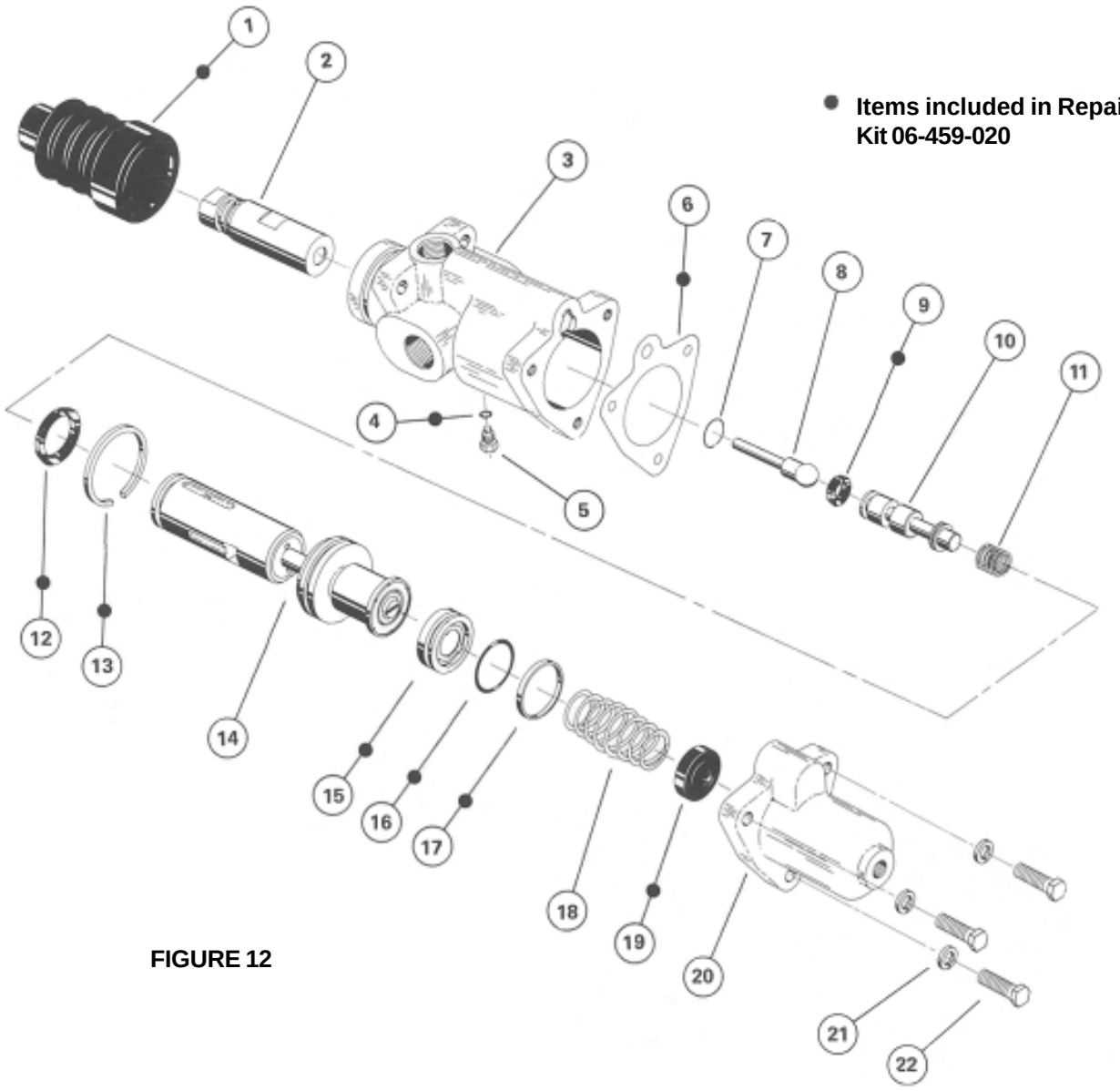


FIGURE 12

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**
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.**

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**

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.

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 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.

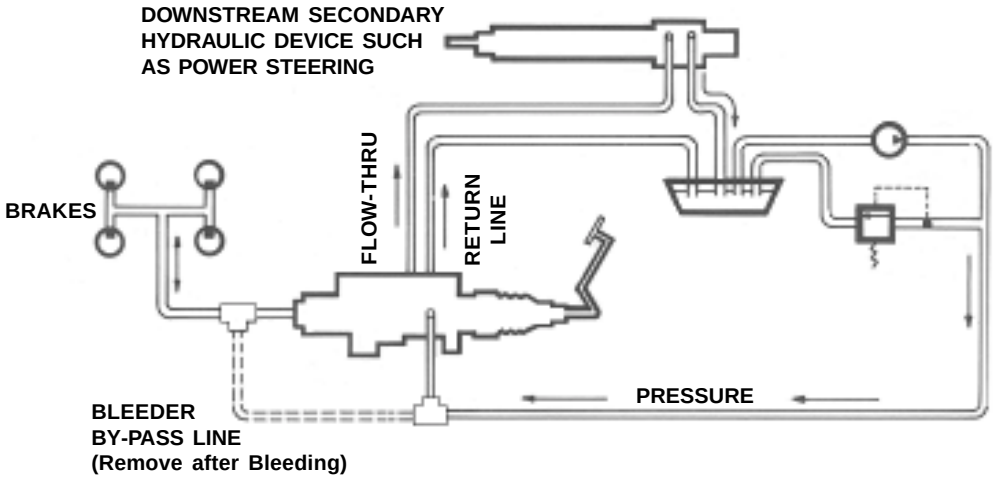
MANUAL BLEEDING PROCEDURES

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 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.
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.

FIGURE 13



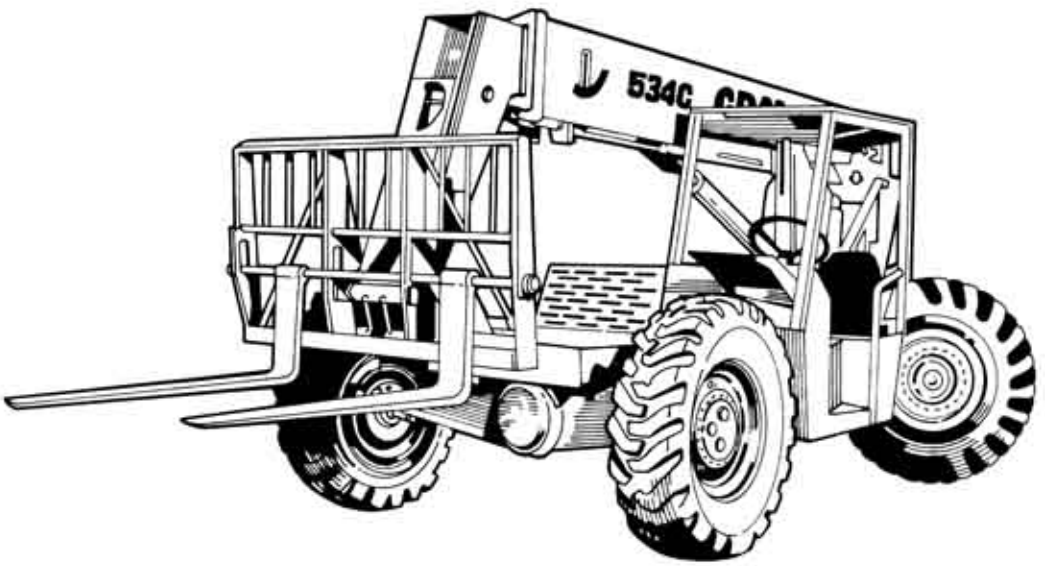
BLEEDING SCHEMATIC

MICO has made every attempt to present accurate information in catalogs, brochures and other printed material. MICO can accept no responsibility for errors from unitentional oversights that may exist. Due to a continuous program of product improvement, both materials and specifications are subject to change without notice or obligation.

522, 524, 532C-6 & 534C-6

GRADALL®

MATERIAL HANDLER
HYDRAULIC SYSTEM MANUAL



IMPORTANT NOTICES

Read and understand this manual, the 522, 524, 532C-6 & 534C-6 Operation and Lubrication Manual, the EMI Rough Terrain Forklift Safety Manual, the Gradall Material Handler Safety Manual and all appropriate sections of the Gradall Service Manual before starting, operating or performing maintenance procedures on this machine.

Be certain to read and understand the revision notices on pages i and ii at the beginning of this manual. Following the instructions in these notices will enable you to find the proper information for your machine.

Gradall is a registered trademark for hydraulic excavators, hydraulic material handlers and attachments manufactured by The Gradall Company.

Covers units having Serial Numbers:
522 & 524 Handlers - 0177005 thru 0177189
532C-6 & 534C-6 - 0188002 thru 0388349
Refer to page i for more Serial No. information.

Form No. 29101 - Revised 11/94 & 11/96
Reprinted 6/99

IMPORTANT SAFETY NOTICE

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

Strict attention to, and compliance with instructions provided in this manual, the EMI Rough Terrain Forklift Safety Manual, the Gradall Material Handler Safety Manual, as well as instructional decals and plates affixed to the machine, will help you avoid personal injury and damage to the equipment. The information provided is not intended to cover all situations; it would be impossible to anticipate and evaluate all possible applications and methods of operation for this equipment.

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

Do not modify this machine without written permission from The Gradall Company. Use only genuine Gradall replacement parts.

OTHER NOTICES

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

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

Gradall is a registered trademark for hydraulic excavators, hydraulic material handlers and attachments manufactured by The Gradall Company.

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

REVISION INFORMATION

Just prior to the original publication of this manual, a joystick was made available as an option to control boom functions. At that time, information was included at the end of the manual to cover the joystick. This information was not added to the basic circuit diagrams provided throughout the manual.

Since that time (in early 1992), the joystick has become standard equipment and other changes have been made to these material handlers.

The circuit diagrams shown in the main body of this manual are basically correct and have not been changed. They still illustrate the circuits as they were before changes were made.

Additional diagrams and details are provided near the end of this manual to cover changes.

It is important that users of this manual be aware of the kind of changes that have been made. This awareness can help prevent users from using incorrect information.

Some differences are obvious and can be detected by looking at your machine. Other changes are not obvious and cannot be detected visually.

Differences which are not obvious can be determined only by knowing the Serial Number of your machine. Where appropriate, differences will be identified by serial number.

A NOTE ABOUT SERIAL NUMBERS: Serial Numbers for **522 & 524** Handlers have progressed from the starting number **0177005** thru ending number **0177189.**

Serial Numbers for **532C-6 & 534C-6** Handlers progressed from starting number **0188002 thru 0188269** then **0288270 thru 0288949** and finally, from **0388001 thru 0388349.**

KNOW YOUR SERIAL NUMBER

Users Of this manual must be aware of the following areas of change:

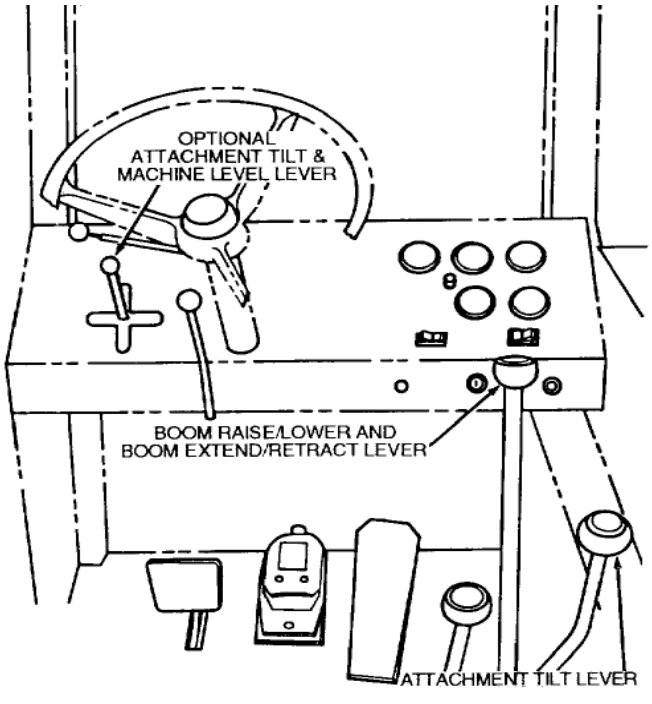
With or without Boom Control Joystick

Early or recent Traction Lock Valve

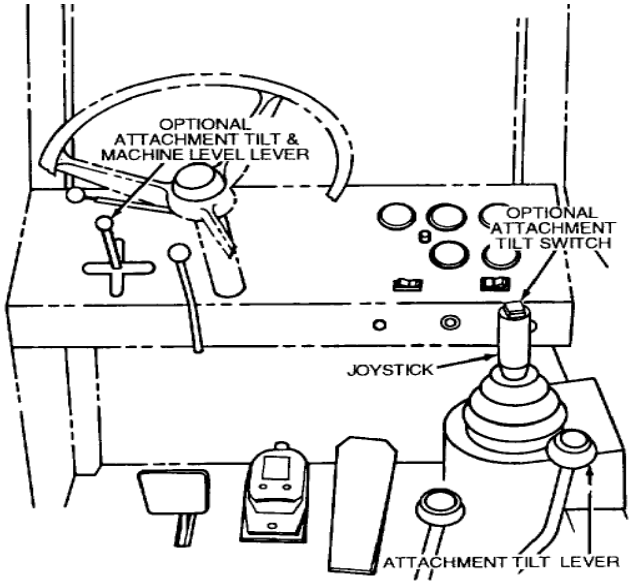
Changes in some Operating Pressures

Lever or Joystick Boom Control

LEVER BOOM CONTROL



JOYSTICK BOOM CONTROL



A quick glance at your controls determines the type of boom control provided on your unit.

Although the joystick is now standard equipment, the attachment tilt switch is provided only as an option. This switch may be present on your joystick but if the attachment tilt lever is provided, the switch will be inoperative.

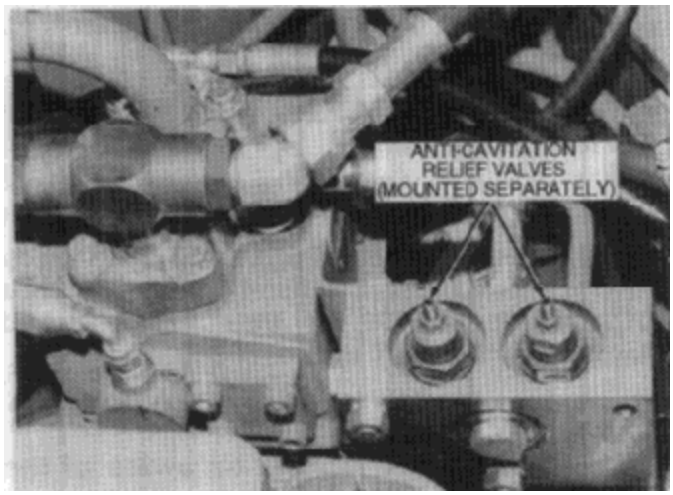
Refer to information starting on page 79 for details covering joystick operation, piping, trouble shooting and testing.

continued. . .

New/Old Traction Lock Valve

(Change affects 524 & 534C-6 units only)

OLD STYLE TRACTION LOCK VALVE

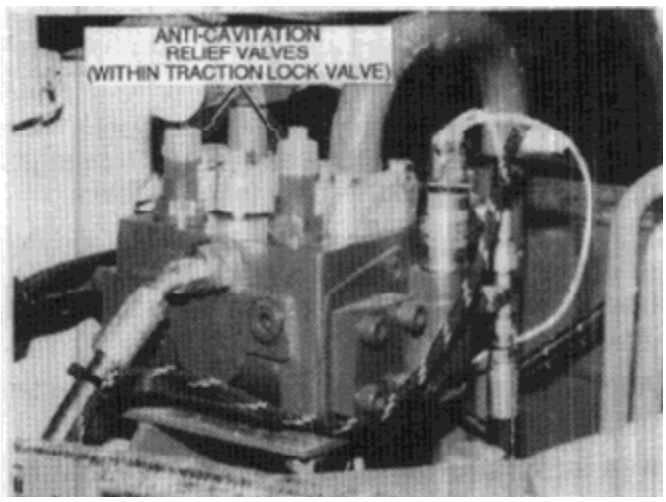


The change from old to new style traction lock valves occurred at Serial Number **0177074** for **524** Handlers and at Serial Number **0288251** for **534C-6** Handlers.

Originally, the traction lock solenoid valve and the anti-cavitation relief valves were mounted separately from the traction lock valve as shown on pages 4 and 55.

New style traction lock valves include the solenoid and anti-cavitation reliefs within the traction lock valve body as shown on page 82 and inside back cover of this manual.

NEW STYLE TRACTION LOCK VALVE



The photos clearly depict the differences between old and new style traction lock valves.

Refer to information starting on page 82 for details covering operation, piping, trouble shooting and testing.

Operating Pressure Changes

There is no obvious visual indication to identify machines which fall on either side of operating pressure changes. It is **absolutely necessary to identify your machine by Serial Number** when text indicates a difference in operating pressure.

Never attempt to apply pressures specified for one group of machines to the other group of machines. **Serious damage to hydraulic system components could occur.**

Operating pressure changes occurred at Serial Number **0177107** for **522 & 524** Handlers and at Serial Number **0288587** for **532C-6 & 534C-6** Handlers.

Pressures shown in text for early machines are still correct and will be shown in the original type face. Pressures for recent machines (changed pressures) will be added to text and will be shown in bold italic text within parentheses.

EXAMPLES

5000 psi-correct for appropriate Serial Numbers

(5500 psi) correct for appropriate Serial Numbers.

INTRODUCTION

General

This manual provides important information for those who are responsible for understanding, trouble shooting, testing and adjusting the hydraulic system of the Models 522, 524, 532C-6 and 534C-6 Material Handlers.

Regardless of previous experience, the mechanic must read and understand the information provided in this manual before attempting hydraulic maintenance procedures on this equipment. **Improper maintenance can cause dangerous operating conditions which could result in serious injury or death.**

If you have any questions regarding the unit, contact your Gradall Material Handler Distributor.

Related Manuals & Decals

Separate publications are furnished with the handler to provide information concerning safety, replacement parts, maintenance procedures and vendor components. Replacement manuals, decals and instruction plates can be ordered from your Gradall Material Handler Distributor.

Orientation

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

Models Covered

This manual covers four Gradall Material Handler Models:

- 522 with two section boom and 2 wheel drive
- 524 with two section boom and 4 wheel drive
- 532C-6 with three section boom and 2 wheel drive
- 534C-6 with three section boom and 4 wheel drive

Variations between handlers will be covered as required in appropriate sections of manual.

522 & 524 Only
522 & 532C Only
524 & 534C Only
532C & 534C Only

These notices are used to guide you to the proper information for your unit.

SAFETY HIGHLIGHTS

IMPORTANT NOTICE

Read and understand this manual, the 522, 524, 532C-6 & 534C-6 Operation and Lubrication Manual, the EMI Rough Terrain Forklift Safety Manual, the Gradall Material Handler Safety Manual and all appropriate sections of the Gradall Service Manual before starting, operating or performing maintenance procedures on this machine.

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

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

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

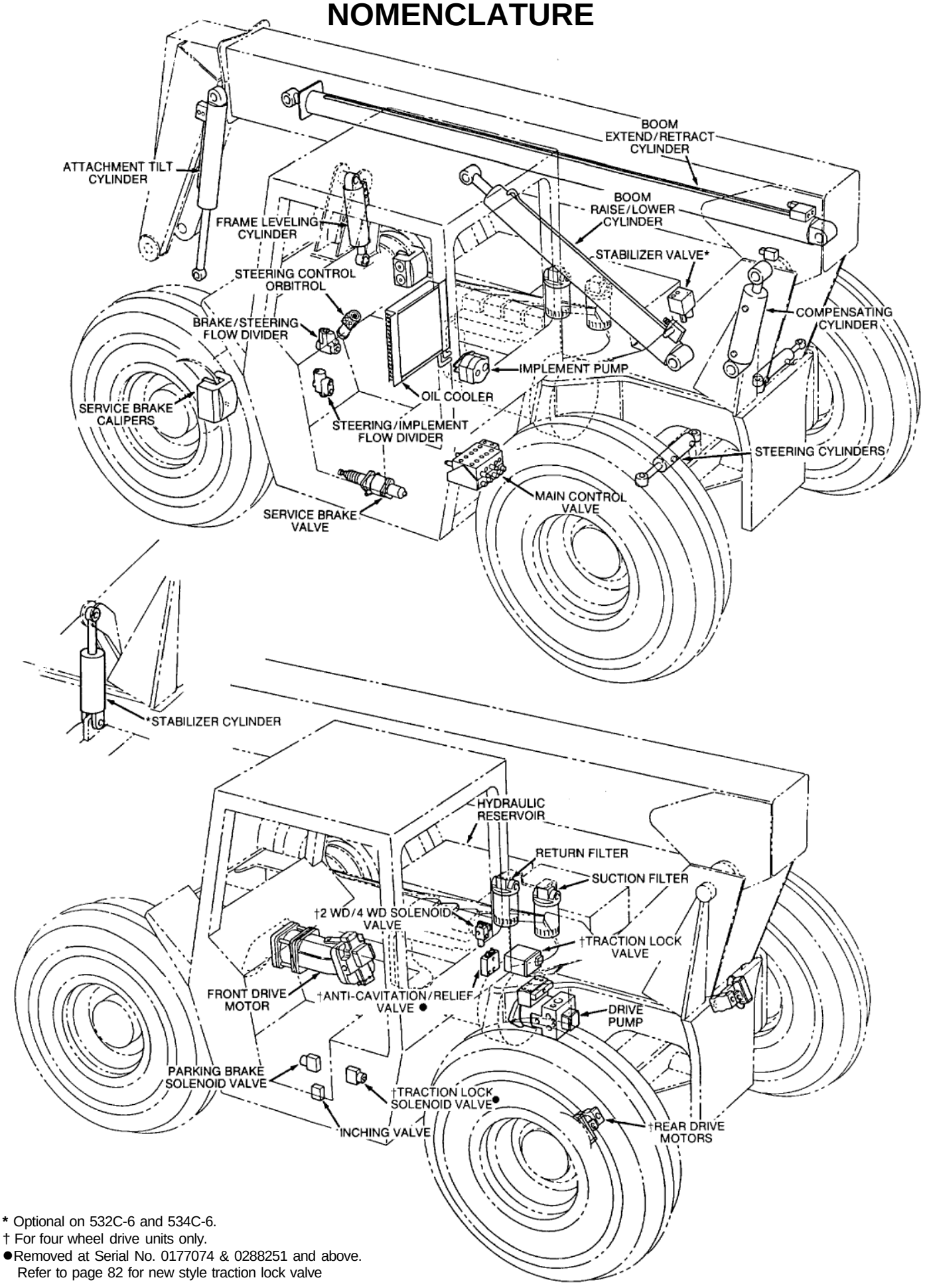
CAUTION — This symbol Indicates a hazard which could result in injury or damage to equipment or property if proper precautions are not taken.

TESTING & ADJUSTING PRECAUTIONS

- **Always stop engine and remove ignition key before leaving operator's cab. Never perform services or make adjustments with engine running.**

- **Read and understand Manuals named under SAFETY HIGHLIGHTS heading (above). Be sure you are familiar with machine response to controls.**
- **Read and understand all material relating to circuit to be checked. Be sure you understand circuit to be checked.**
- **Always relieve trapped pressure before open ing or disconnecting any portion of a hydraulic circuit. Oil at operating temperature can cause serious burns. Oil released at operating or trapped pressure can cause serious injury or death.**
- **If you are working with a helper, be sure he understands the procedure. Be certain each of you knows what to expect from the other and when to expect it.**
- **Be sure you understand all steps of procedure before testing and/or adjusting any circuit. Follow the procedure carefully.**
- **Always wear safety glasses when performing testing and adjusting procedures.**
- **Clean up oil spills immediately. Slippery surfaces can cause serious accidents.**
- **Always check to be sure engine R.P.M. is correct before performing testing and adjustment procedures.**
- **Never exceed proper relief valve settings.**
- **Always check to be sure hydraulic oil level in reservoir is correct and that oil is at normal operating temperature before testing and adjusting circuits.**

NOMENCLATURE

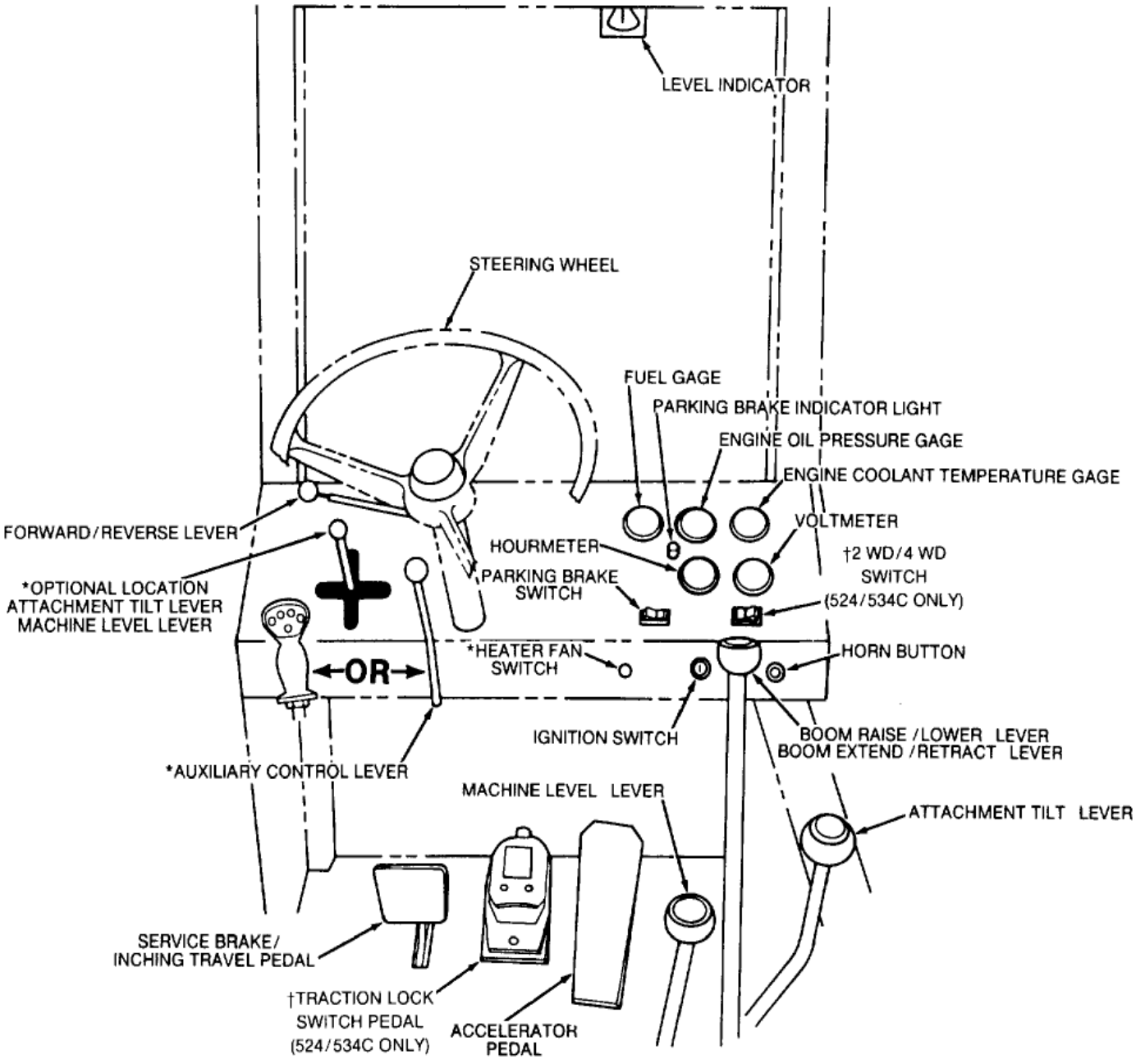


***** Optional on 532C-6 and 534C-6.

† For four wheel drive units only.

●Removed at Serial No. 0177074 & 0288251 and above.
Refer to page 82 for new style traction lock valve

CONTROL AND INSTRUMENT IDENTIFICATION



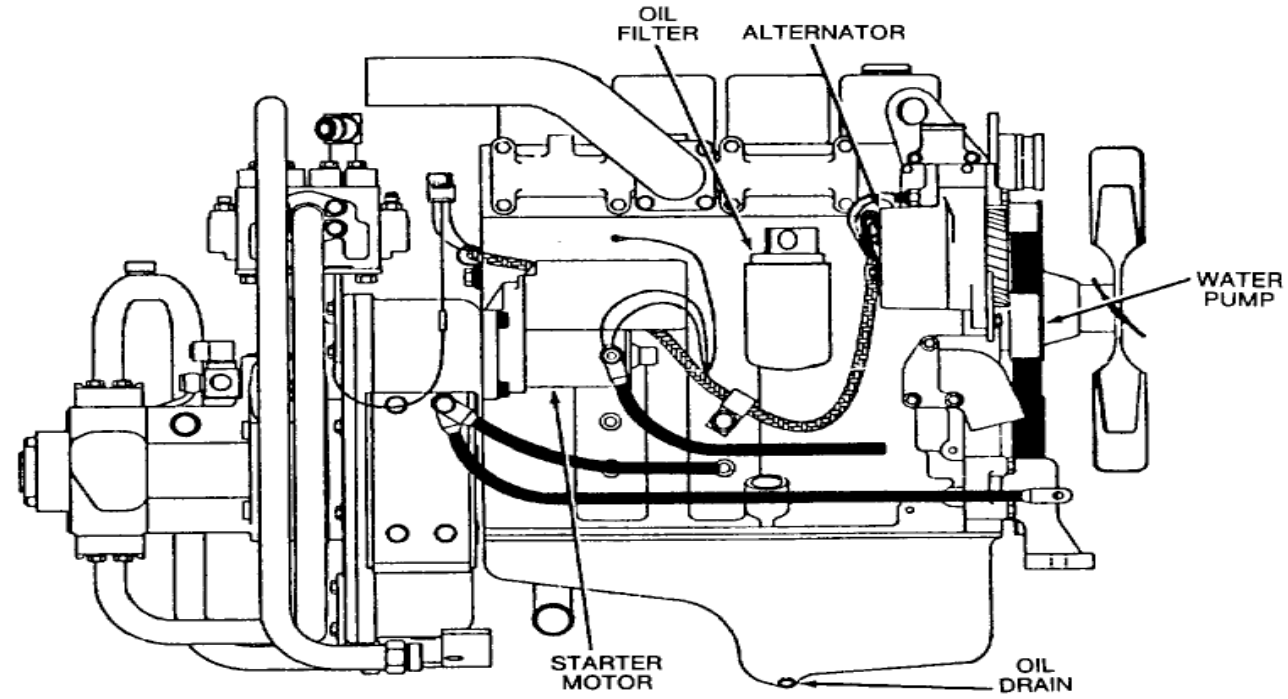
***Items preceded by an asterisk are optional and may not be furnished on your handler.**

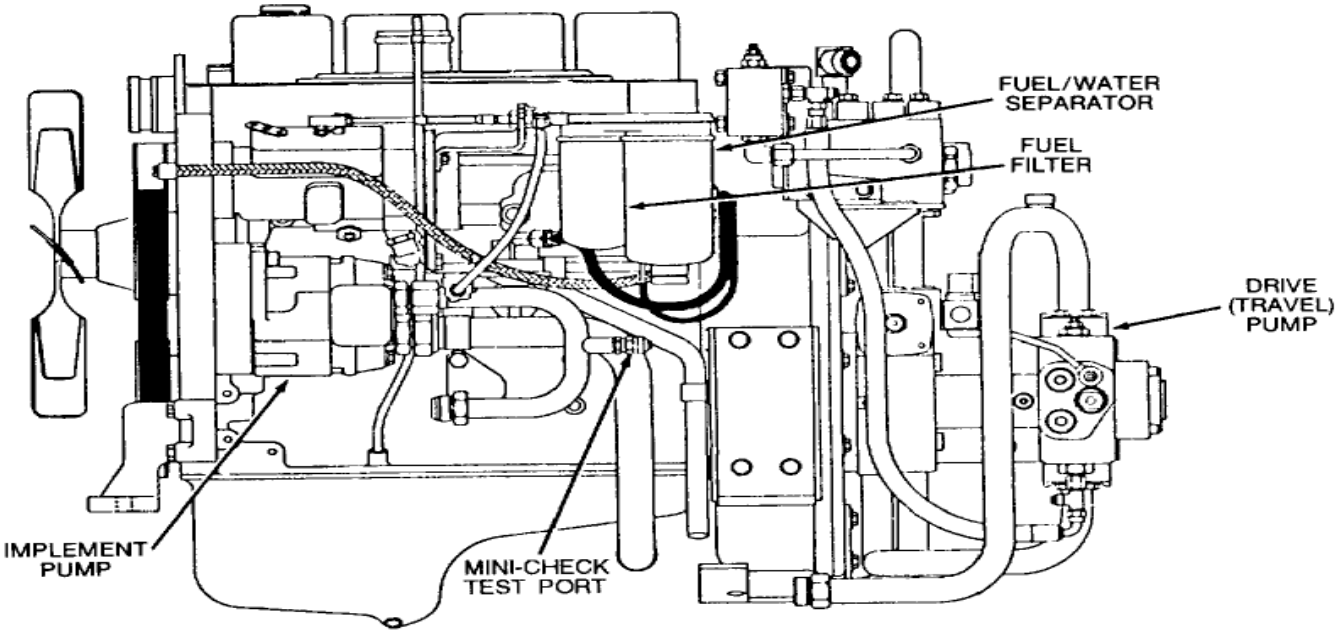
†For four wheel drive units only.

NOTE: Refer to Joystick Circuit (page 79) for additional information if your unit is equipped with joystick for boom control.

DRIVE TRAIN & TRAVEL COMPONENTS

Power Unit



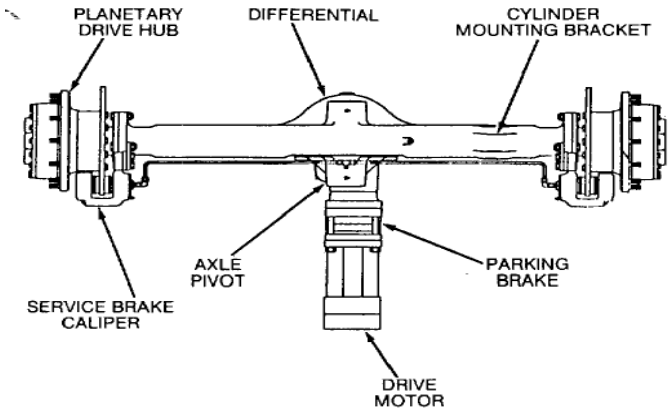


A normally aspirated diesel engine is used to provide power for travel and all implement functions.

Operating Temperature Range .....180-200°F. (82-93°C.)
Oil Pressure Range (minimum) 10-30psi (240-345kPa)
Low Idle .....800-9900 RPM
High Idle (no load) .....2500-2700 RPM
Moderate Load .....2500 RPM
Gross BHP @2500 RPM 76
Stall Speed .....100 RPM
Fuel Filter .....Replaceable Element
Oil Filter .....Replaceable Element
Air Cleaner .....Two stage w/ cleanable/ replaceable element and continuous dust ejector

Always check for proper engine rpm before testing and adjusting hydraulic system pressures. Operator complaints often involve the speed of a circuit function. The speed of a function depends on hydraulic flow, not hydraulic pressure. Setting engine to proper governed rpm will resolve some complaints.

Front Drive Axle



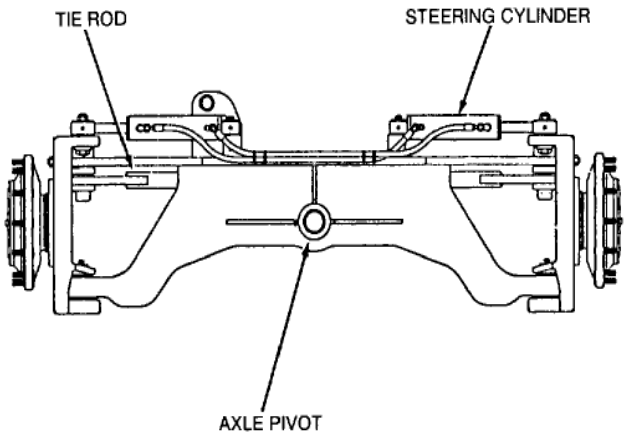
The rear driving axle assembly includes planetary hubs, and axle pivot which allows the wheels to pivot in a vertical plane.

The axle is also attached to the main frame by a double-acting hydraulic cylinder. The cylinder serves dual purposes; it locks the axle to the frame to provide a rigid work platform for material handling functions and also permits the operator to level the handler frame (from side to side).

The cylinder is equipped with a pad-mounted, double pilot-operated check valve to lock the cylinder in position when it is not being actuated (refer to Machine Leveling Circuit).

Rear Steering Axle (non driving)

522 & 532C Only

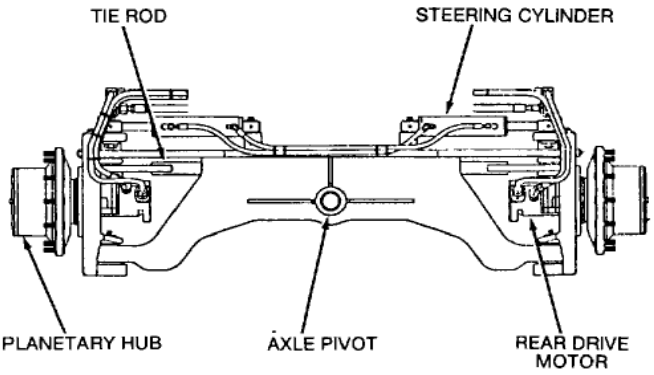


The non-driving rear axle assembly includes a pair of steering cylinders and tie rod which control the angle of wheels during straight travel and turns (refer to Steering Circuit).

The axle is attached to the frame by an axle pivot which permits the wheels to follow ground contours.

Rear Steering Axle (driving)

524 & 5342C Only



The rear driving axle assembly includes planetary hubs with piston motors. The drive motors are engaged by the 2WD-4WD switch located on the instrument console.

The assembly also includes a pair of steering cylinders and tie rod which control the angle of wheels during straight travel and turns.

The axle is attached to the frame by an axle pivot which permits the wheels to follow ground contours.

Tires

522 & 524 Only

Standard: 13.00 x 24, 8 ply rating - 45 psi
Optional: 13.00 x 24 radial - 70 psi

532C & 534C Only

Standard: 13:00 x 24, 12 ply rating - 65 psi
Optional: 13.00 x 24 radial - 70 psi

Service Brake

The service brake consists of a hydraulic dry disc brake on each front wheel. The braking is applied progressively during final 1/3 of service brake/inching travel pedal stroke.

Refer to page 37 for details.

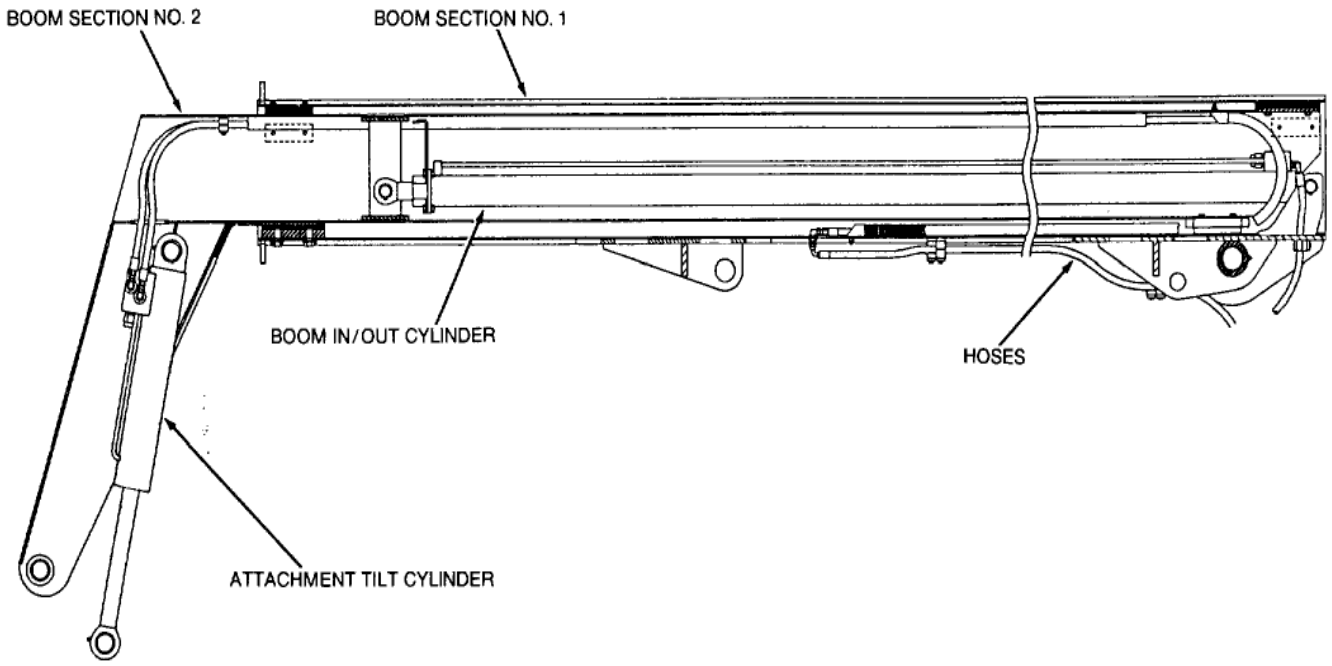
Parking Brake

The spring-applied electro/hydraulic release parking brake is engaged by a rocker switch located on instrument console. A parking-brake-engaged indicator light is also located on instrument console.

Inching Travel

Inching is progressively engaged during initial 2/3 of service brake/inching travel pedal stroke. Refer to appropriate Hydrostatic Drive Circuit for details.

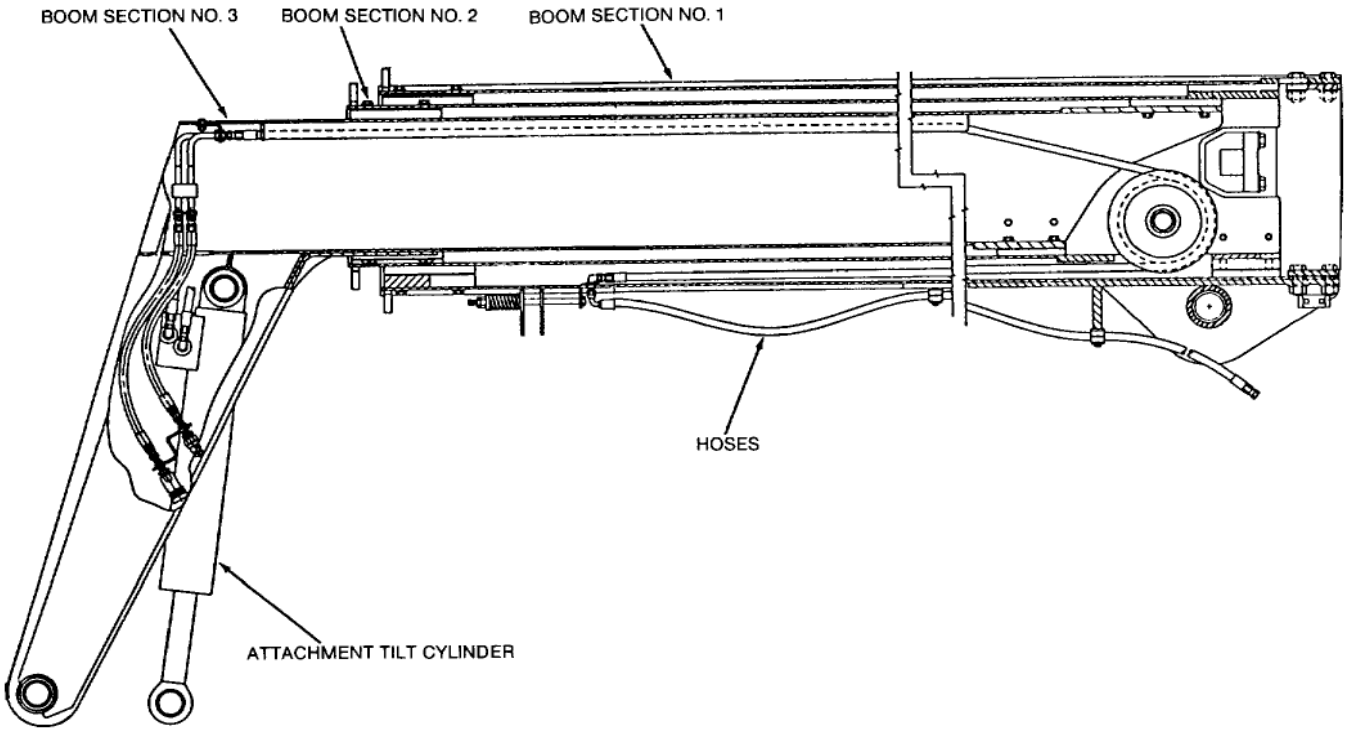
522 & 524 Only



Two pairs of hoses are routed through the length of the two section extendable boom. One pair serves the fork carriage tilt cylinder and the other pair, when furnished, serves hydraulically operated optional attachments.

A hose carrier composed of hinged segments is provided to guide and protect the hose as the boom is extended and retracted.

532C & 534C Only



Extension of sections 2 and 3 remains equal as boom is extended.

General

This section describes and illustrates each hydraulic circuit of the 522, 524, 532C-6 & 534C-6 Material Handler. Following each description, trouble shooting, testing and adjustment information is provided as appropriate.

Testing & Adjusting Precautions

- **Read and understand the Operator's Manual. Be sure you are familiar with machine response to controls.**
- **Read and understand this section of Service Manual. Be sure you understand circuit to be tested.**
- **Always relieve trapped pressure before opening or disconnecting any portion of a hydraulic circuit. Oil at operating temperature can cause serious burns. Oil released at operating or trapped pressure can cause serious injury or death.**
- **If your are working with a helper, be sure he understands the procedure. Be certain each of you knows what to expect from the other and when to expect it.**
- **Be sure you understand all steps of procedure before testing and/or adjusting any circuit. Follow the procedure carefully.**
- **Always wear safety glasses when performing testing and adjusting procedures.**
- **Clean up oil spills immediately. Slippery surfaces can cause serious accidents.**
- **Always check to be sure hydraulic oil level in correct and that oil is at normal ment procedures.**
- **Always check to be sure hydraulic oil level in reservoir is correct and that oil is at normal operating temperature before testing and adjusting circuits.**
- **<u>Always</u> stop engine and remove ignition key before leaving operator's cab. <u>Never</u> perform services or make adjustments with engine running.**

Trapped Hydraulic Pressure

WARNING

Always relieve trapped pressure before opening or disconnecting any portion of a hydraulic circuit. Oil at operating temperature can cause serious burns and oil released under pressure can cause serious injury or death.

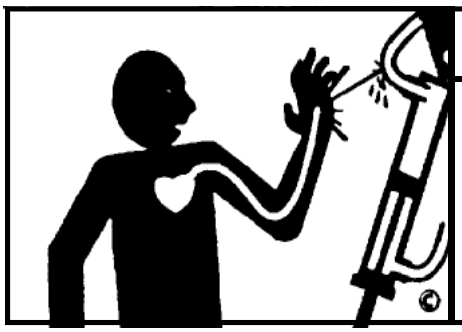
NOTE: It is not necessary to relieve trapped pressure in order to install mini-ckeck adapter/hose/gage combination. Always check to be sure gage and adapter are securely tightened on hose. Also check to be sure seating surfaces and threads of mini-check and adapter are clean and undamaged.

Areas of Trapped Hydraulic Pressure

All circuits can trap very high hydraulic pressure under certain conditions.

Relieving Trapped Hydraulic Pressure

Specific instructions for relieving trapped pressure from some areas is provided under individual circuit headings.



WARNING

DO NOT GO NEAR LEAKS

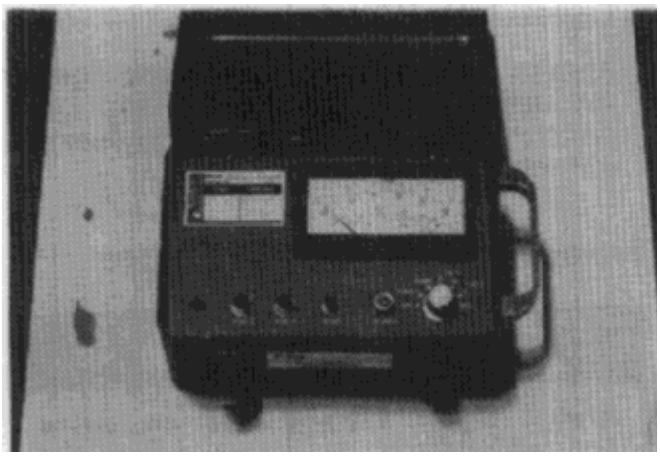
- **High pressure oil easily punctures skin causing serious injury, gangrene or death.**
- **If injured, seek emergency medical help. Immediate surgery is required to remove oil.**
- **Do not use finger or skin to check for leaks.**
- **Lower load or relieve hydraulic pressure before loosening fittings.**

10514B

Located beneath seat & right engine cover
Part No. 9108-3492

Special Tools Needed to Test System

Hydraulic Flow Meter. This meter measures pump flow under varying pressure conditions. You can measure actual pump output, both with no resistance and with resistance imposed against it. Contact your Gradall Distributor for a flow meter test.



Hydraulic Pressure Gages: Most hydraulic testing on these material handlers will involve pressures in the range of 100 to 480 psi and 1500 to 3000 psi. Maximum hydrostatic drive pressure is 5000)* psi ***(5500* psi)***

Appropriate mini-check adapter and hose will be needed to permit viewing gage from operator's seat during testing.

Some hydrostatic drive testing will require appropriate adapters for connection to drive pump/motor test ports.

The Handler has test ports for pump and circuit relief valve testing for most circuits. Mini-check type test ports have a one-way check valve to prevent loss of oil when the cap is removed.

Stopwatch: A stopwatch is used to time handler cycles as a preliminary test of system efficiency.

Preliminary Field Testing

By using a stopwatch to time handler cycles it is possible to determine that specific circuits are, or are not, operating satisfactorily.

If all movements are performed within the specified times it can be assumed that associated components (pump, valve/s, and cylinder/s) are performing adequately.

If a single function requires more time than specified it means that there is a leakage of flow somewhere in the associated circuit. It will require additional testing to determine where the leakage is occuring. which would cause unusual friction.

These tests are performed with no load and with no external resistance applied. **While there may be no significant leakage under these conditions, greater loading could cause increased leakage.**

Testing Conditions:

- All relief valves adjusted to specifications.
- Hydraulic reservoir filled to correct level with proper fluid and warmed to normal operating temperature (at least 120°F. / 49°C.
- Machine properly lubricated and has no condition which would cause unusual friction.
- Engine running at full throttle with properly adjusted governor (2500 - 2700 high idle).

WARNING

Position handler in a safe area to perform all work. Be sure to allow safe clearances for all functions. Be sure park brake is applied and wheels ar chocked.

HANDLER FUNCTION*	522 & 524 (in seconds)	532C & 534C (in seconds)
Boom Up (fully retracted)	10.00	14.00
Boom Down (fully retracted)	7.00	10.25
Boom Extend (boom level)	9.50	14.00
Boom Retract (boom level)	6.75	10.75
Attachment Tilt Up	3.00	3.25
Attachment Tilt Down	3.50	3.75

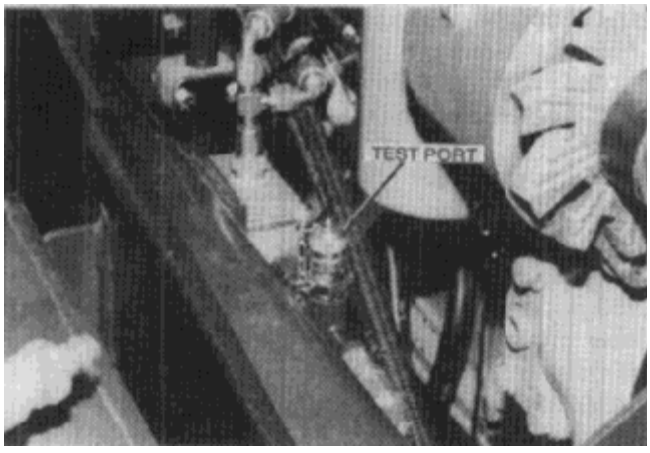
*Handler must be positioned to permit cylinder to bottom in both directions.

Obtaining Hydraulic Oil Sample for Analysis

1. Operate unit until hydraulic oil reaches normal operating temperature (120°F. / 49°C.)

2. Apply parking brake and observe hydraulic filter by-pass indicator with engine running at full throttle. Replace filter elements if necessary.

3. Obtain a container to receive waste oil and a **CLEAN** container to receive oil sample.



4. With gage removed from hose, attach mini-check and hose to test port near right wall of engine compartment. Hose end must be positioned oil waste oil container.

5. Allow at least one pint of oil to flow into waste oil container to eliminate any contamination from hose.

6. Move hose to **CLEAN** container to collect sample for analysis.

7. Return hose to waste oil container and disconnect adapter from mini-check test port.

8. Cover sample container immediately with **CLEAN** cap.

9. Stop engine and check oil level in reservoir and replenish as required.

10. Contact your Gradall Distributor for information concerning oil analysis.

Oil sample containers are available from several sources:

- Oil companies
- Oil suppliers
- Sampling labs
- Gradall

Hydrualic fluid specifications:

ISO Grade 46,Pour Point, °F-20 to-40
SSU @ 100° F,200-240
Flash Point, COC, °F 280 min.
Cleanliness Requirement: ISO 18/15
Approved Supplier & Type: Union 46, Conoco Grade 46

OIL CLEANLINESS IS A MUST The filtration system is designed to maintain an ISO cleanliness ratio of 18/15 or better.

TROUBLE SHOOTING TIPS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

It will be helpful to remember that a system having an internal leak large enough to cause a noticeable problem will sometimes show a higher than normal fluid temperature.

A restriction in the system is simply a condition where something is blocking normal flow. A partial restriction in a circuit may cause the machine function involved to be slowed because of the reduced flow.

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

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

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

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

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

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

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

GENERAL TROUBLE SHOOTING TABLE

IMPORTANT NOTES

This trouble shooting table provides information which applies to the hydraulic system in general but does not cover hydrostatic drive portion of the system. Hydrostatic drive trouble shooting is covered under its own circuit heading.

Trouble shooting checks are listed in order of easiest to-check to most-difficult-to-check.

Refer to individual supply and working circuits for additional trouble shooting information.

NOTE: Refer to Joystick Circuit (page 79) for additional information if your unit is equipped with joystick for boom control.

Possible Cause	Remedy
NO MOVEMENT IN ANY CIRCUIT	
● Low hydraulic fluid level	Fill hydraulic reservoir to level and check for leaks
● External pressure leak downstream from implement pump (look for puddle)	Repair
● Pump flow by-passing thru pump relief valve	Adjust, repair or replace as required
● Suction leak upstream from implement pump	Repair
● Implement pump failure	Repair or replace
NO MOVEMENT IN INDIVIDUAL CIRCUIT	
● External leak in working hose, tube or fitting	Repair or replace
● Linkage binding or worn	Repair or replace as required
● Kinked or crushed working hose or tube	Replace
● Mechanical friction or bind restricting movement	Lubricate, adjust or repair as required
● Pump flow by-passing thru circuit relief valve	Check for proper adjustment (refer to Testing heading under appropriate circuit heading for procedure). Also check relief valve for contamination or damage. Adjust, clean, repair or replace as required.
SLOW MOVEMENT IN ALL CIRCUITS	
● Low engine RPM	Check and adjust as required (rated speed is 2500 RPM)
● External pressure leak downstream from implement pump (look for puddle)	Repair
● Pump flow by-passing thru pump relief valve	Adjust, repair or replace as required
● Suction leak upstream from implement pump	Repair
● Implement pump flow by-passing thru relief valve or spool in brake/steering or steering/ implement flow divider valve	Check for contamination or damage and clean or replace as required
● Worn or damaged implement pump	Replace

Possible Cause	Remedy

SLOW MOVEMENT IN INDIVIDUAL CIRCUIT

● External leak in working hose, tube or fitting	Replace
● Linkage binding or worn	Repair or replace as required
● Kinked or pinched working hose or tube	Replace
● Mechanical friction or bind restricting movement	Lubricate, adjust or repair as required
● Implement pump flow by-passing thru circuit relief valve (if used)	Check for contamination or damage and clean or replace as required
● Implement pump flow by-passing thru cylinder	Refer to appropriate circuit heading for test procedure
● Counterbalance valve sticking or by-passing	Replace cartridge. **Do not attempt to recondition counterbalance cartridge. Improper servicing could cause unexpected machine movement.**

WEAK MOVEMENT IN INDIVIDUAL CIRCUIT (movement stalls under normal load)

● Circuit relief valve improperly adjusted (if used)	Check for proper adjustment (refer to appropriate circuit heading for procedure)
● Mechanical friction or bind restricting movement	Lubricate, adjust or repair as required

MOVEMENT CONTINUES WHEN CONTROL IS RELEASED

● Linkage improperly adjusted, binding or worn	Adjust, repair or replace as required
● Broken control valve centering spring	Replace
● Control valve spool sticking	Check for contamination or damage. Clean, repair or replace as required.

ERRATIC MOVEMENT

● Pump and/or circuit relief valves improperly adjusted	Adjust relief valves (refer to appropriate circuit heading/s for procedure)
● Pump or circuit relief valve sticking	Check for contamination or damage. Clean, repair or replace as required.
● Control valve mounting bolts loose	Tighten
● Control valve spool sticking	Repair or replace valve as required
● Counterbalance valve sticking or by-passing	Replace cartridge. **Do not attempt to recondition counterbalance cartridge. Improper servicing could cause unexpected machine movement.**

continued . . .

Possible Cause	Remedy

DRIFT

● Counterbalance valve cartridge leaking	Replace cartridge. **Gradall does not recommend that the service technician attempt to recondition counterbalance cartridges. Improper servicing could cause unexpected machine movement.**
● Cylinder by-pass	Refer to appropriate circuit heading for test procedure

HYDRAULIC FLUID AERATION

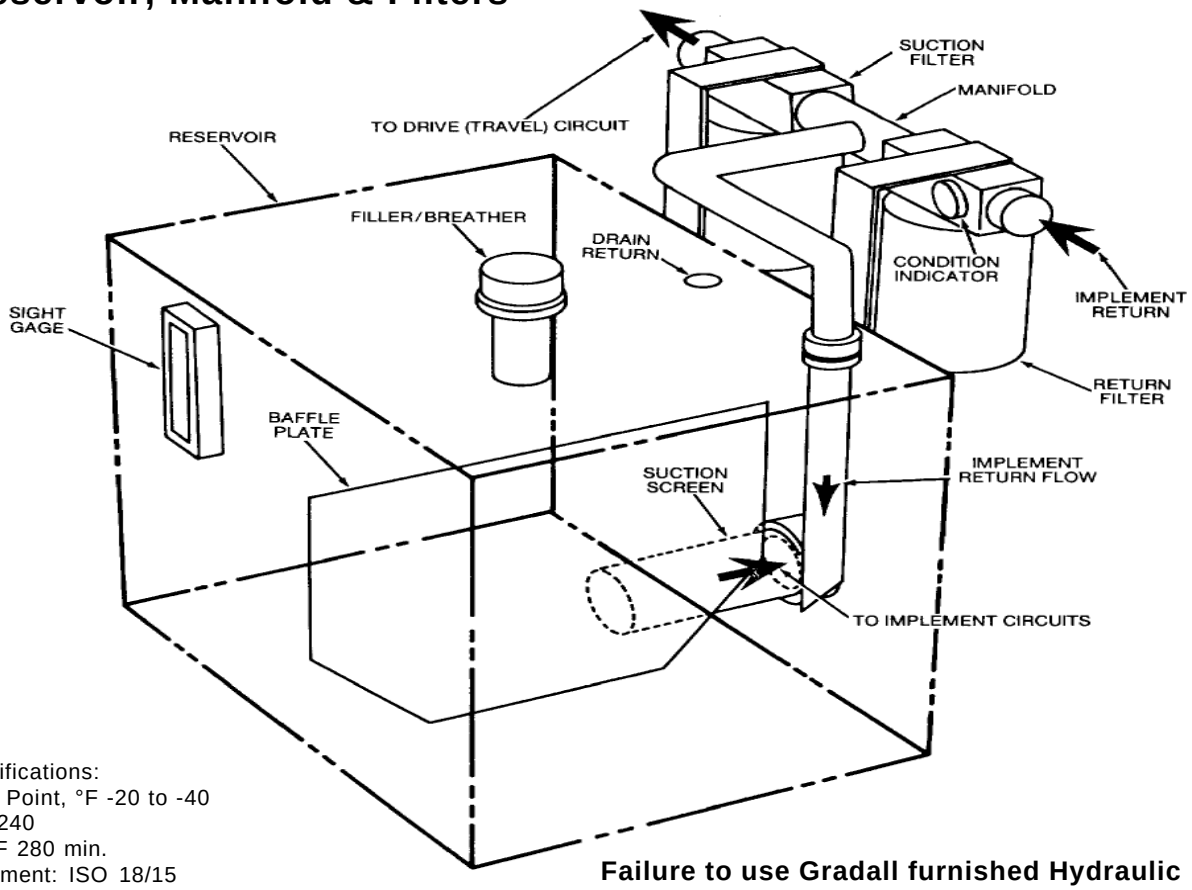
● Air leakage on suction side of pump	Tighten or replace leaking component
● Improper hydraulic fluid	Drain, flush and refill system using proper fluid (page 17)

OVERHEATING

NOTE: Oil temperature should not be permitted to exceed 180°F. (82.2°C.) for extended periods. When necessary, adjust duty cycle to maintain temperature.

● Low oil level in reservoir	Fill to proper level
● Oil cooler blocked externally Clean	Clean
● Engine RPM too high	Adjust (should be 2500/2700 RPM-high idle)
● Flow restriction in circuit (kinked or pinched hose or tube)	Repair or replace as required
● By-pass thru relief valve	Adjust, clean, repair or replace valve
● By-pass thru cylinder	Repair or replace
● Oil cooler blocked internally	Flush
● Internal leak in valve bank	Repair or replace component
● Improper hydraulic oil in system	Drain and refill using oil to proper specifications
	Drain and flush system. Replace damaged components. Replace filter elements and fill system with oil to proper specification. Refer to Hydrostatic Drive heading for procedure for filling drive loop.

Hydraulic Reservoir, Manifold & Filters



Hydraulic fluid specifications:
ISO Grade 46, Poor Point, °F -20 to -40
SSU @ 100°F, 200-240
Flash point, COC, °F 280 min.
Cleanliness Requirement: ISO 18/15
Approved Supplier & Type: Union 46, Conoco Grade 46

Failure to use Gradall furnished Hydraulic Filter Elements could void warranty.

Reservoir

The hydraulic reservoir includes several features which serve important system functions:

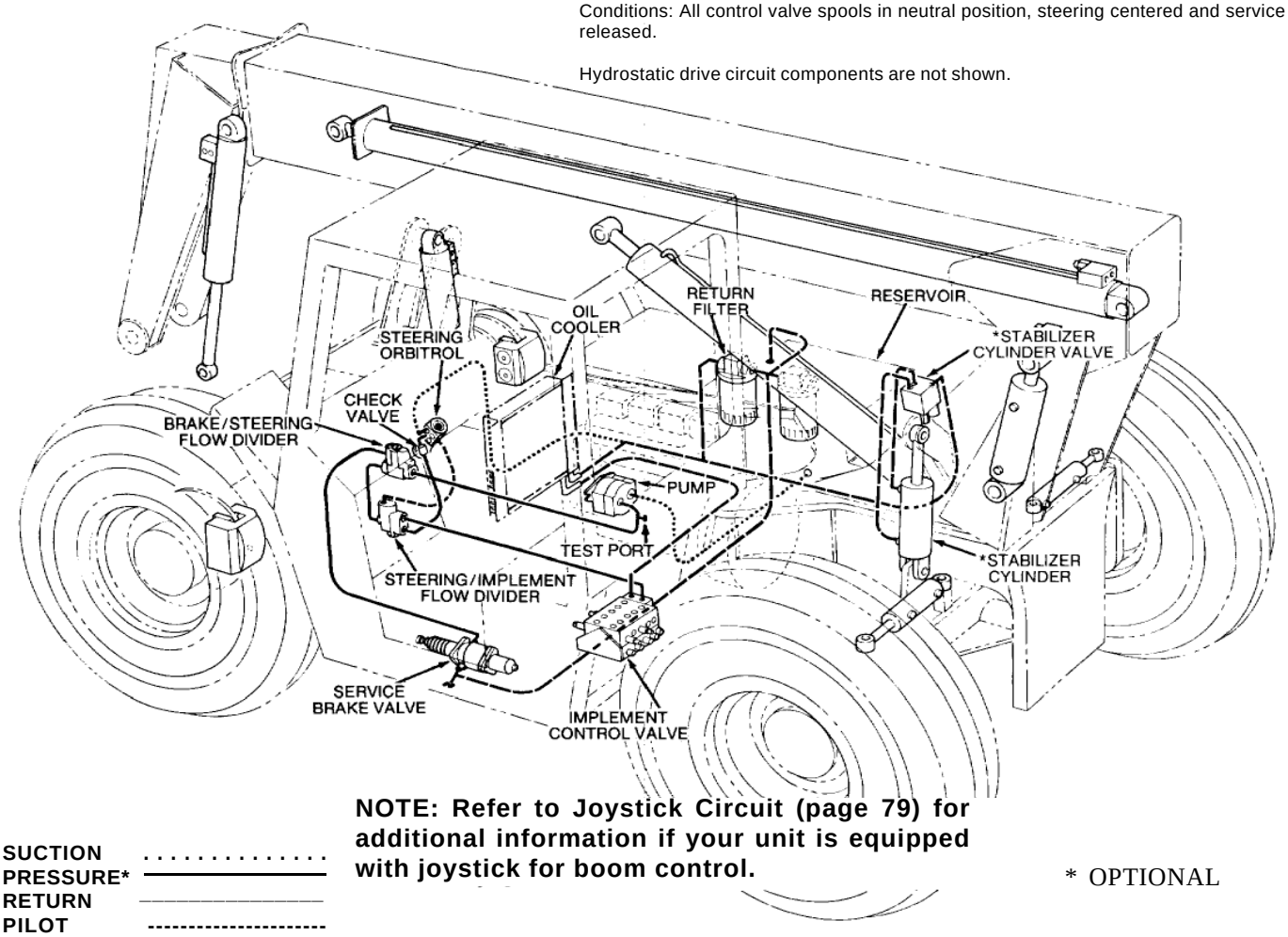
- Provides storage for volume of oil required to extend cylinders as well as a reserve volume (30 gallon capacity when filled to level).
- Includes sight gages to display oil level.
- External surface assists in dispersing heat from oil.
- Internal baffle plate inhibits sloshing which could result in foaming and entrapped air in oil.
- Non-pressurizing breather maintains atmospheric pressure in reservoir and assists in release of entrained air from oil.
- Main return from implement circuits flows thru return filter.
- Some drain flow returns directly through manifold into reservoir to minimize back pressure.
- Flow to drive (travel) circuit passes thru suction filter.
- Flow to implement circuits passes thru 100 mesh suction screen
- Pressure differential increases as return filter becomes clogged with foreign material.
- When differential pressure reaches 25 psi, by-pass valves allows unfiltered oil into reservoir.
- Condition indicator gage pointer moves in proportion to degree of by-pass.
- Suction filter has no by-pass valve. Complete restriction will prevent flow to drive (travel) circuit charge pump.

Implement Pump Supply Circuit

NOTES

Conditions: All control valve spools in neutral position, steering centered and service brake released.

Hydrostatic drive circuit components are not shown.



NOTE: Refer to Joystick Circuit (page 79) for additional information if your unit is equipped with joystick for boom control.

* OPTIONAL

SUCTION . . . . . .
PRESSURE* ——————
RETURN ——————
PILOT ----------
DRAIN ....

***OR POTENTIAL PRESSURE**

The implement supply circuit provides flow/pressure for eight circuits: service brake, steering, boom up/down, boom in/out, attachment tilt, frame leveling, auxiliary hydraulics** and rearl axle stabilizer**.

**When furnished

Flow for implement circuits is drawn thru a 100 mesh suction screen in reservoir to the implement pump. Pump flow is routed to service brake/steering flow divider valve which directs controlled flow to service brake and excess flow to steennng/implement flow divider valve.

Whether used or not, flow from service brake valve is returned to reservoir.

Controlled flow from steering/implement flow divider valve is routed thru a one-way check valve to steering Orbitrol.

Drain/return flow from steering Orbitrol is returned to reservoir thru return filter.

Excess flow from steering/implement flow divider is routed to implement control valve bank.

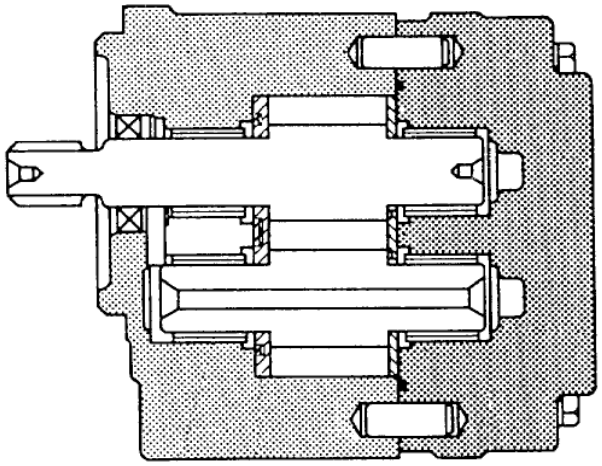
Whether used or not, return flow from control valve bank is returned to reservoir thru oil cooler and return filter.

On units equipped with rear axle stabilizer, a portion of return flow is diverted to stabilizer cylinder thru stabilizer valve to prevent cavitation. This flow is under back-pressure caused by return filter.

Reservoir & Filters

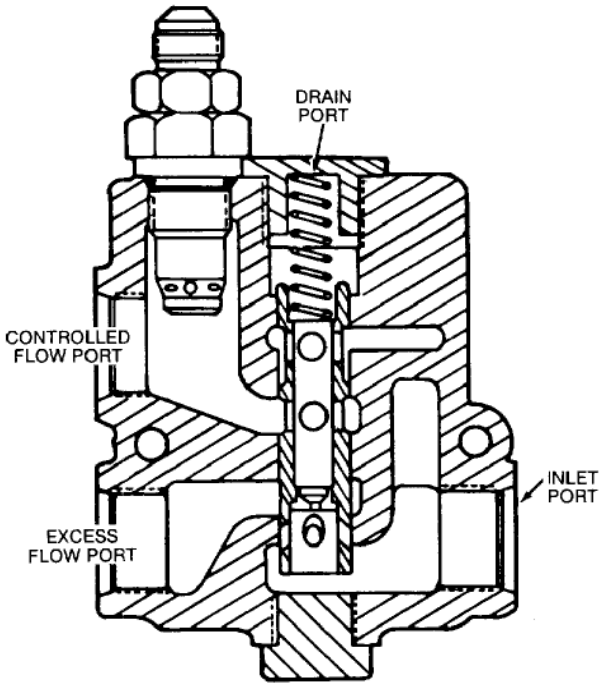
Refer to Hydraulic Reservoir, Manifold & Filters heading for details.

Implement Pump



The implement pump is of the positive-displacement, gear-type and is mounted on engine accessory drive pad. At range engine speed (2500 RPM) the pump delivers approximately 24 gpm at 2800 psi.

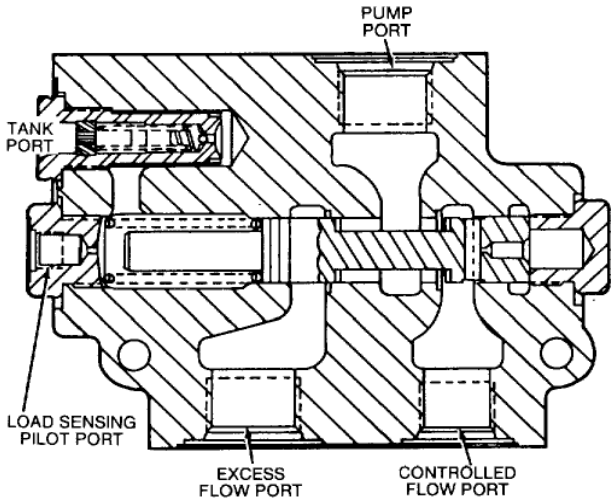
Brake/Steering Flow Divider Valve



The brake/steering flow divider valve is designed to provide a maximum of 3 gpm to service brake valve thru controlled flow port. An integral relief valve is provided to limit brake system boost pressure to 850 psi.

The remainder of pump flow (approximately 21 gpm) is routed thru excess flow port to steering/ implement flow divider valve. This flow is not governed by 850 psi relief valve.

Steering/Implement Flow Divider Valve



The steering/implement flow divider is designed to provide whatever flow is needed for steering circuit thru controlled flow port. An integral relief valve is provided to limit steering system pressure to 2500 psi. If used for steering, flow is returned to reservoir thru return filter.

Any flow not required for steering is routed thru excess flow port to implement control valve bank. Whether used or not, return flow from valve bank is routed thru oil cooler and return filter to reservoir.

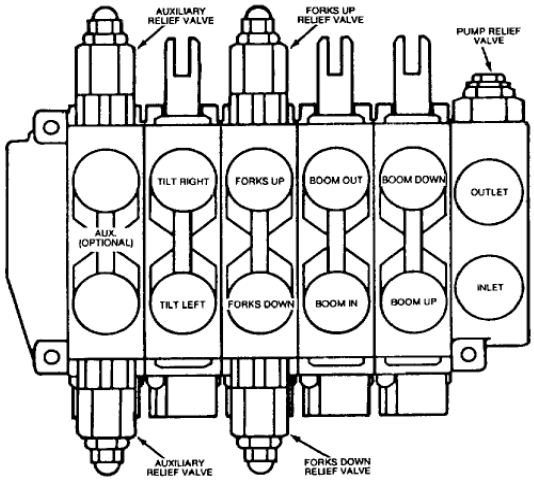
Service Brake Valve

Refer to Service Brake Circuit heading for details.

Steering Orbitrol

Refer to Steering Circuit heading for details.

Main Control Valve Bank



The implement control valve bank consists of an inlet/outlet section, four or five control valve sections (auxiliary section is optional) and an end cover.

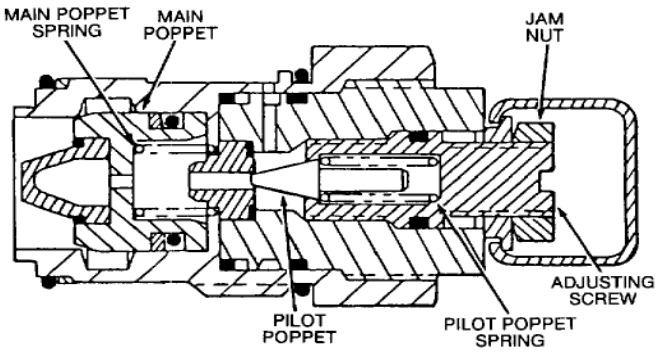
General information on valve bank and pump relief valve is provided in this section of manual. Information on individual control valve sections and associated circuit relif valves is provided under appropriate circuit headings.

Inlet/Outlet Section

The inlet/outlet section routes pump flow to all control valve sections. Valves are supplied in parallel (all functions can be operated simultaneously). However, simultaneous operation will reduce speed of functions.

Flow from last valve section is routed thru end cover to return galleries of valve sections. Return galleries are connected to outlet port of inlet/outlet section.

Pump Relief Valve



The control valve bank inlet/outlet section includes a pilot-operated relief valve to limit implement pump pressure to 3000 psi. A brief description of pilot-operated relief valve operation follows.

Circuit pressure acts on both the main poppet and pilot poppet at all times.

At pressures lower than relief setting:

- Circuit pressure is insufficient to force pilot poppet to compress its spring (spring pre-load determines relief setting).
- Main poppet cannot move because circuit pressure exists on both sides of poppet, creating a hydraulic balance.
- No relief occurs because both poppets remain seated.

When circuit pressure reaches relief setting:

- Circuit pressure forces pilot poppet to compress its spring and move away from its seat.
- Circuit pressure behind main poppet is vented past stem of pilot poppet creating a pressure drop in spring chamber behind floating poppet.
- High circuit pressure easily unseats main poppet permitting full relief flow.
- As circuit pressure is reduced, both poppets return to their seats to block relief flow.

Trouble Shooting

Trouble shooting for individual implement functions is covered under respective circuit headings.

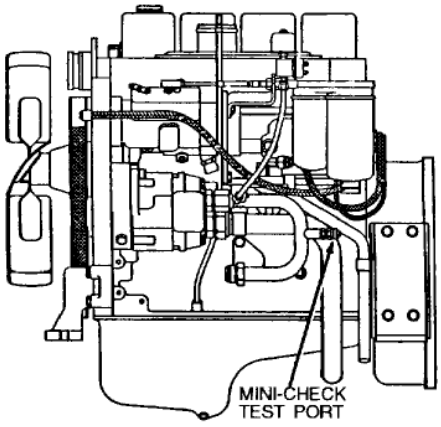
Before performing trouble shooting procedures, check operation of all implement circuits to determine extent of malfunction. Information provided under Preliminary Field Testing heading will be helpful in evaluating circuit performance.

When extent of malfunction is determined, refer to General Trouble Shooting Table.

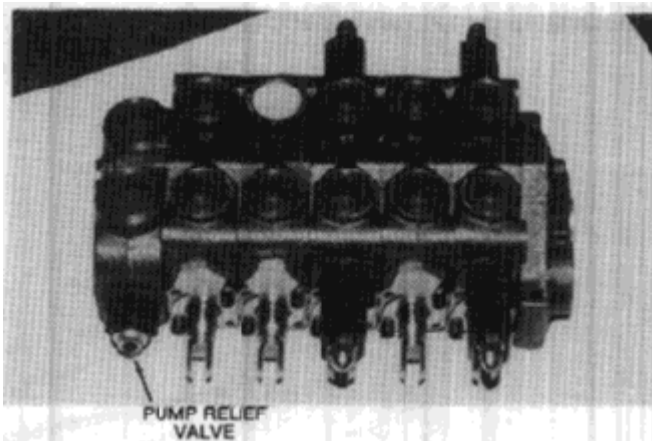
Testing & Adjusting Pump Relief Valve

1. Position unit in a safe area for work to be performed, apply parking brake and move forward/reverse lever to neutral position.

2. Extend boom fully and rest carriage/forks on ground. Stop engine.



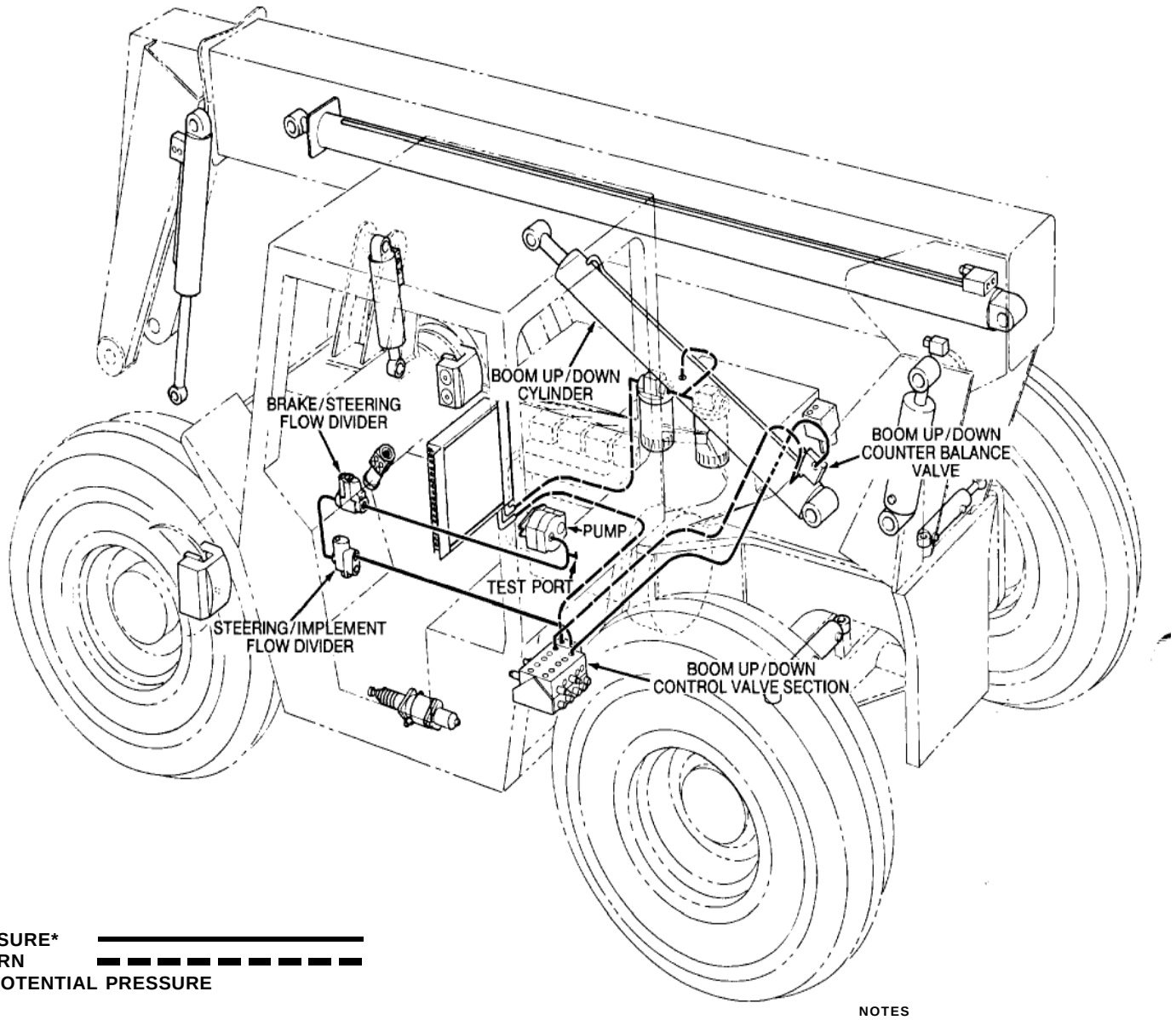
3. Install adapter, hose and gage combination on mini-check test port shown and position gage in cab for observation.



4. Start engine and run at full throttle. Observe gage and move boom in/out lever fully to right. Gage should indicate 3000 psi.

5. If necessary, loosen pump relief valve locknut and turn adjusting screw clockwise to increase pressure or counterclockwise to decrease pressure. Tighten locknut.

Boom Up/Down Circuit



PRESSURE* ——————
RETURN — — — — — — —
***OR POTENTIAL PRESSURE**

NOTES

Refer to implement Pump Supply Circuit heading for implement pump supply and return details

BOOM DOWN circuit is shown-reverse pressure and return lines between control valve and cylinder for **BOOM UP**

NOTE: Refer to Joystick Circuit (page 79) for additional information if your unit is equipped with joystick for boom control.

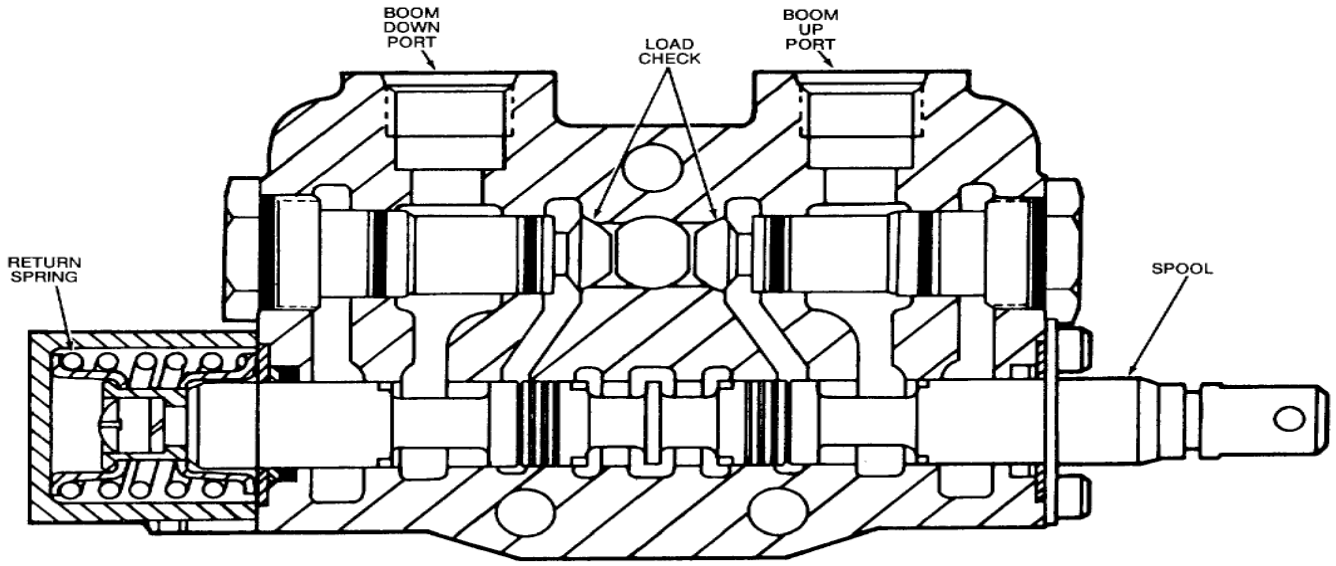
The boom up/down control valve section receives flow to operate cylinder from implement pump. Refer to Implement Supply Circuit heading for details.

Pushing boom up/down lever forward retracts cylinder to lower boom and pulling lever extends cylinder to raise boom.

An integral counterbalance valve is located at barrel end of up/down cylinder to prevent boom from falling in event of a damaged line or fitting.

This circuit does not include circuit relief valves. Circuit pressure is limited to 3000 psi by pump relief valve.

Boom Up/Down Control Valve Section



The boom up/down control valve section is an open-center, four-way, three-position valve with a spring-centered, manually-operated spool.

The valve section includes a pair of load check valves, one for each side of cylinder circuit. These valves block flow paths to cylinder until pump pressure exceeds pressure caused by boom load.

Counterbalance Valve

Counterbalance valves are provided to minimize cylinder drift and to prevent cylinder movement in event of damage to a line or fitting.

Do not attempt to recondition counterbalance valve cartridges. Improper servicing could cause unexpected machine movement. Replace a leaking cartridge with a new cartridge

Trouble Shooting

Observe operation of all implement circuits to determine extent of malfunction. Information provided under Preliminary Field Testing heading will be helpful in evaluating circuit performance.

When extent of malfunction is determined, refer to General Trouble Shooting Table heading.

Testing

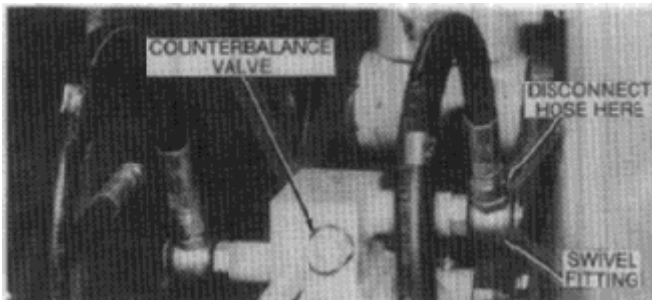
Testing Cylinder for Leakage Past Piston:

NOTE: When testing for cylinder by-pass, all wheels must rest firmly on supporting surface and neither boom head nor carriage may contact ground. It necessary, remove carriage for additional clearance.

1. Position unit in a safe area for work to be performed. With unloaded boom fully retracted, position boom head/carriage over a depression -OR - remove fork carriage. Lower boom until cylinder bottoms.

2. Apply parking brake, move forward/reverse lever to neutral position and stop engine.

3. Move boom up/down lever back and forth fully a few times to relieve any trapped pressure between control valve an counterbalance valve.



4. Disconnect hose at counterbalance valve at point shown and plug hose. Keep swivel fitting in 12 o'clock position~t~on to prevent dripping.

5. Position a container to receive any by-pass flow and use or hose or shallow container to guide flow container.

6. Start engine and run at full throttle.

NOTE: Different values are provided for units with two section booms (522 and 524) and units with three section booms (532C and 534C). **Be sure to use the proper figures for your unit.**

522 & 524 Only

7. Move boom up/down lever fully forward and hold for 7.00 seconds and release lever.

8. With no other circuit activated, boom in/out circuit receives approximately 21 gpm. Since a new machine requires approximately 7.00 seconds to fully lower boom from raised position, this operation should use approximately 314 ounces (2.45 gallons).

   Leakage of 10% (31.4 ounces) would slow cycle by 0.7 seconds and probably would not be noticed by operator. Depending on application of machine, greater leakage could indicate need to re-seal (cylinder).

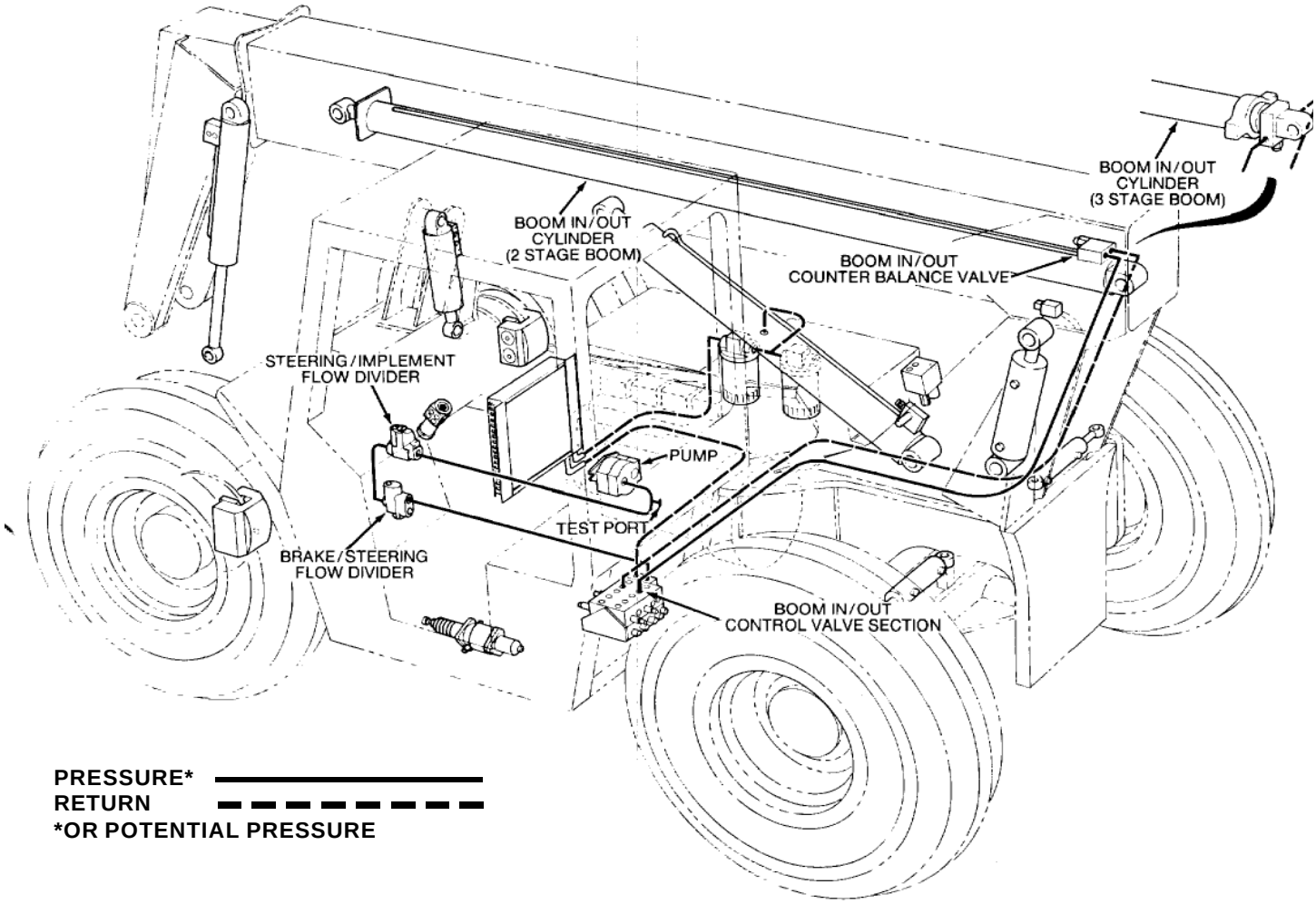
532C & 534C Only

7. Move boom up/down lever fully forward and hold for 10.25 seconds and release lever.

8. With no other circuit activated, boom in/out circuit receives approximately 21 gpm. Since a new machine requires approximately 10.25 seconds to fully lower boom from raised position,this operation should use approximately 459 ounces (3.6 gallons).

   Leakage of 10% (46 ounces) would slow cycle by 1 second and probably would not be noticed by operator. Depending on application of machine, greater leakage could indicate need to re-seal (cylinder).

Boom In/Out Circuit



NOTES

Refer to implement Pump Supply Circuit heading for implement pump supply and return details.

BOOM IN circuit is shown-reverse pressure and return lines between cryntrol valve and cylinder for **BOOM OUT**

NOTE: Refer to Joystick Circuit (page 79) for additional information if your unit is equipped with joystick for boom control.

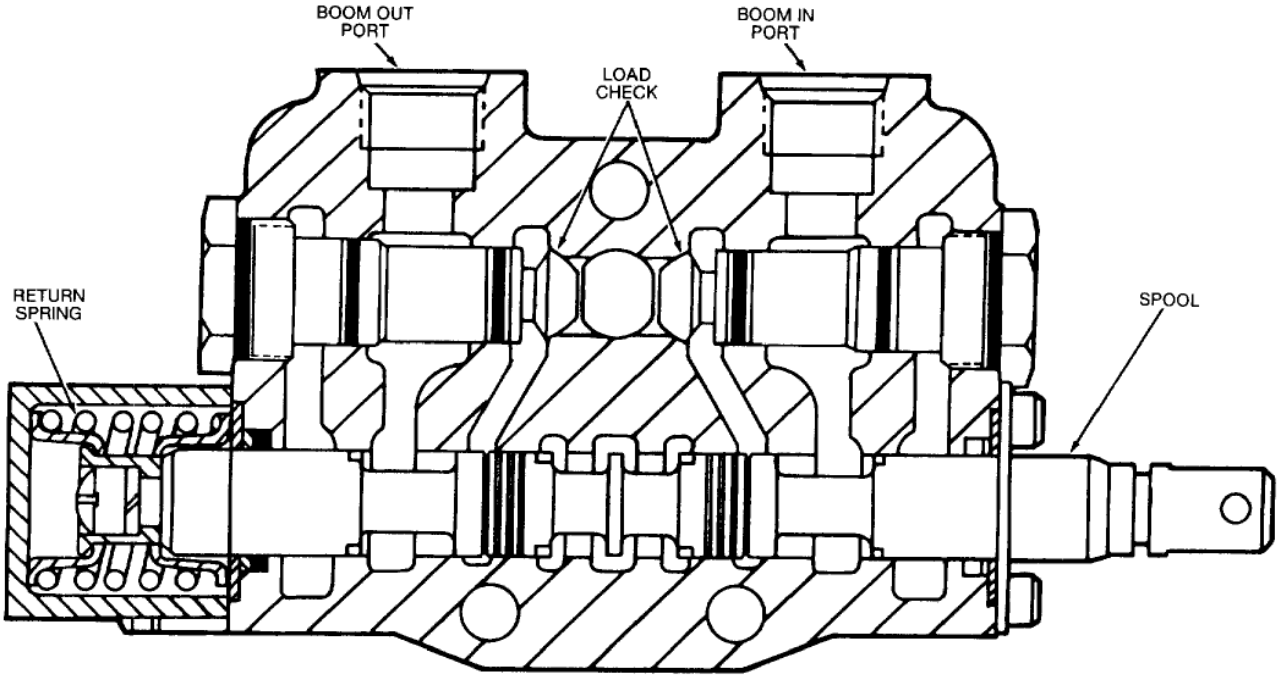
The boom in/out control valve section receives flow to operate cylinder from implement pump. Refer to Implement Supply Circuit heading for details.

Moving boom in/out rever to right extends boom and moving rever to left retracts boom.

An integral counterbalance valve is located at barrer end of cylinder to prevent retraction in event of a damaged fine or fitting.

This circuit does not include circuit relief valves. Circuit pressure is limited to 3000 psi by pump relief valve.

Boom In/Out Control Valve Section



The boom in/out control valve section is an open-center, four-way, three-position valve with a spring-centered, manually-operated spool.

The valve section includes a pair of load-check valves, one for each side of cylinder circuit. These valves block flow path to cylinder until pump pressure exceeds pressure caused by boom load.

Counterbalance Valve

Counterbalance valves are provided to minimize cylinder drift and to prevent cylinder movement in event of damage to a fine or fitting.

Do not attempt to recondition counterbalance valve cartridges. Improper servicing could cause unexpected machine movement. Replace a leaking cartriege with a new cartridge.

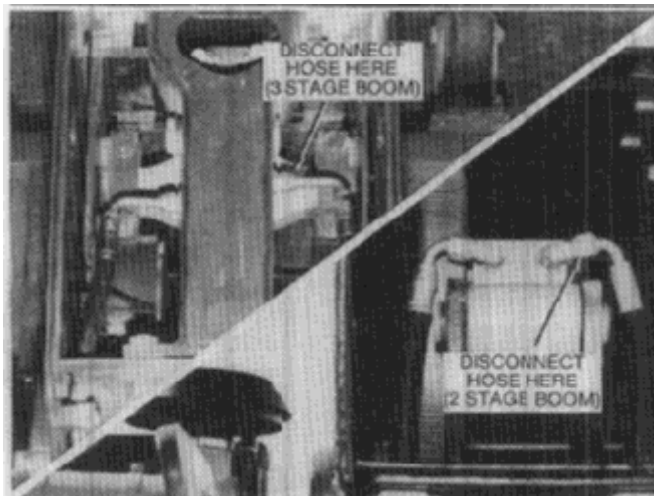
Trouble Shooting

Observe operation of all implement circuits to determine extent of malfunction. Information provided under Preliminary Field Testing heading will be helpful in evaluating circuit performance.

When extent of malfunction is determined, refer to General Trouble Shooting Table heading.

Testing

1. Position unit in a safe area for work to be performed. Apply parking brake and move for ward/reverse lever to neutral position.
2. With unloaded boom level retract boom fully. Stop engine.
3. Move boom in/out rever fully left and right a few times to relieve any trapped pressure between counterbalance valve and control valve.



4. Disconnect hose at counterbalance valve at point shown and plug or cap hose as appropriate.
5. Position a container to receive any by-pass flow and use a hose to guide flow to container.
6. Start engine and run at full throttle.

NOTE: Different values are provided for units with two section booms (522 and 524) and units with three section booms (532C and 534C). **Be sure to use the proper figures for your unit.**

522 & 524 Only

7. Move boom in/out lever fully forward and retract boom and hold for 6.75 seconds and release lever.

8. With no other circuit activated, boom in/out circuit receives approximately 21 gpm. Since a new machine requires approximately 6.75 seconds to fully lower boom from extended position, this operation should use approximately 302 ounces (2.4 gallons).

   Leakage of 10% (30 ounces) would slow cycle by 0.7 seconds and probably would not be noticed by operator. Depending on application of machine, greater leakage could indicate need to re-seal (cylinder).

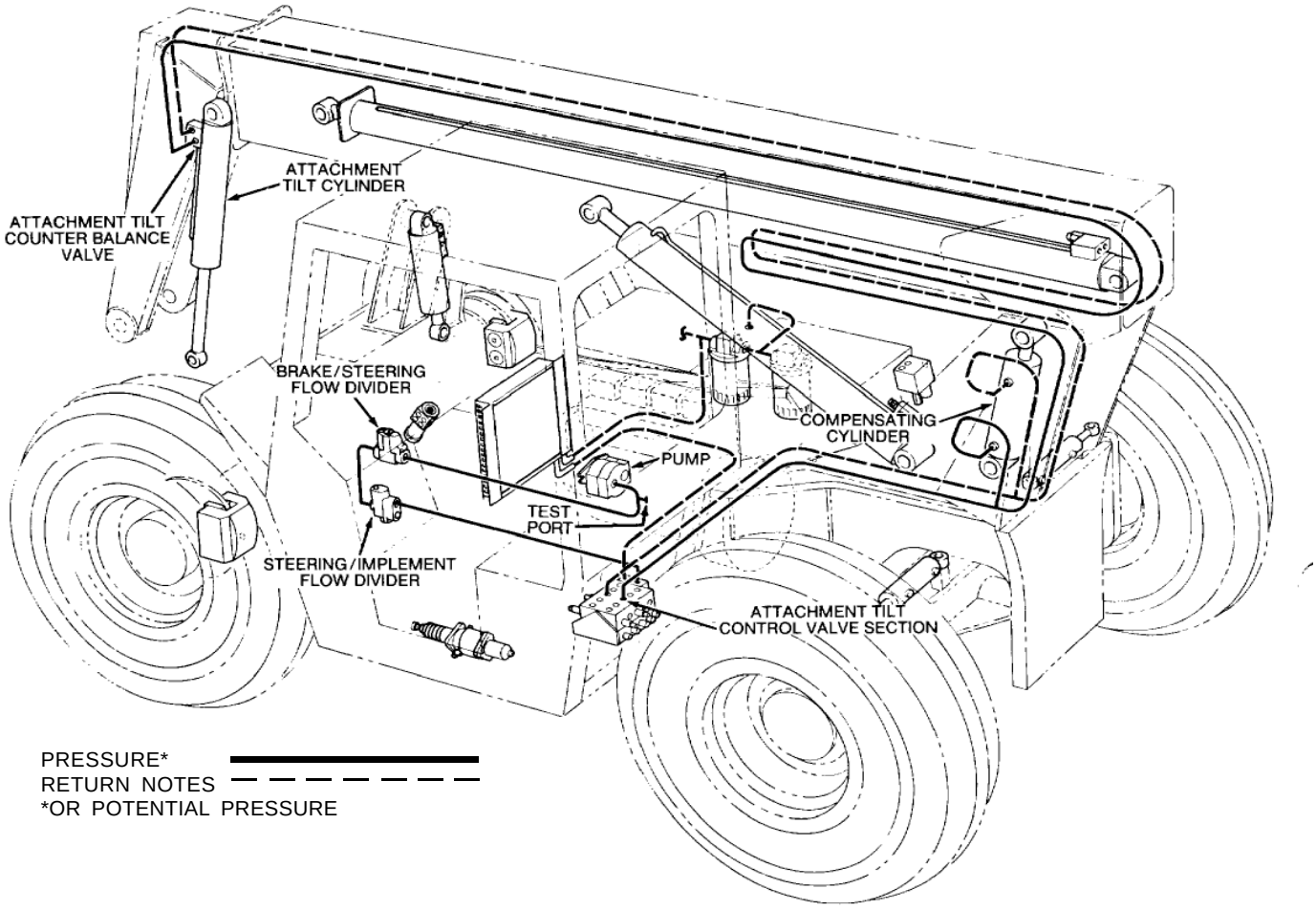
532C & 534C Only

7. Move boom in/out lever fully to left and to retract boom and hold for 10.25 seconds and release lever.

8. With no other circuit activated, boom in/out circuit receives approximately 21 gpm. Since a new machine requires approximately 10.75 seconds to fully retract boom from extended position, this operation should use approximately 482 ounces (3.6 gallons).

   Leakage of 10% (48 ounces) would slow cycle by 1.1 second and probably would not be noticed by operator. Depending on application of machine, greater leakage could indicate need to re-seal cylinder.

Attachment Tilt Circuit



NOTES

Refer to Implement Pump Supply Circuit heading for implement pump supply and return details.

FORKS DOWN circuit is shown-reverse pressure and return lines between control valve and cylinder for **FORKS UP**

NOTE: Refer to Joystick Circuit (page 79) for additional information if your unit is equipped with joystick for boom control.

The attachment tilt control valve section receives

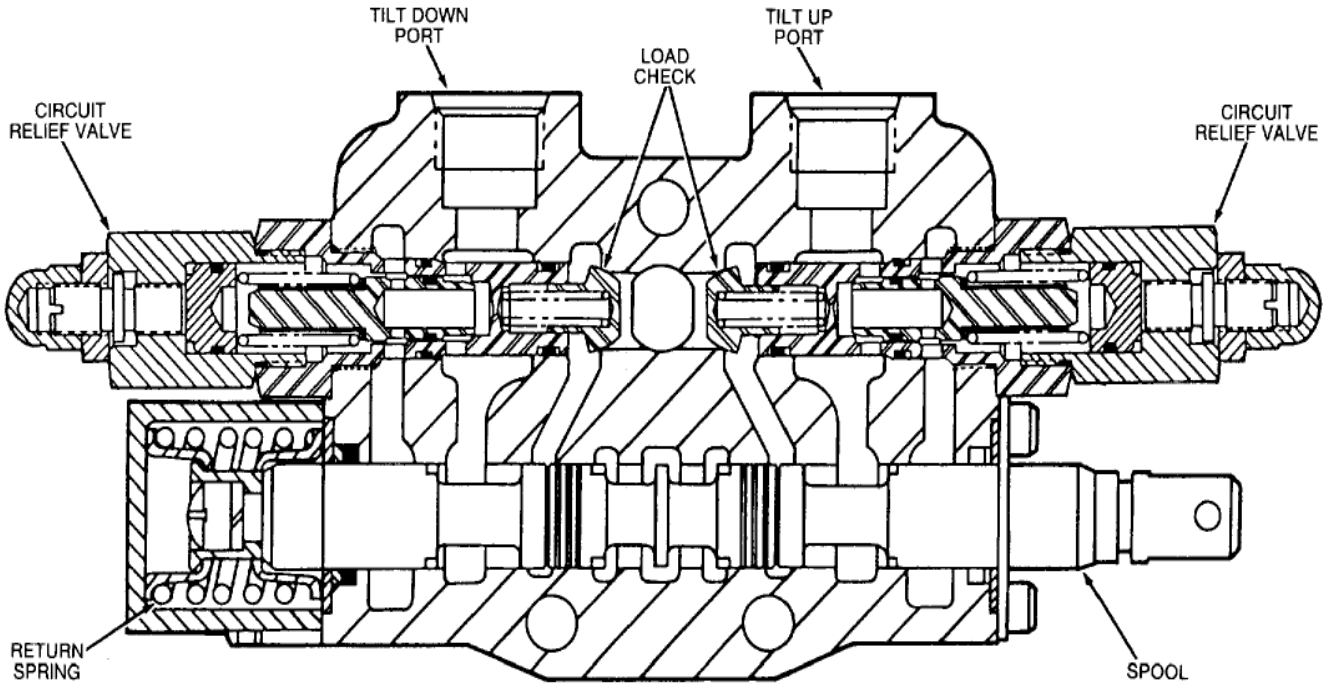
Push attachment tilt lever forward to tilt down or pull lever to rear to tilt up.

An integral counterbalance valve is located at barrel end of cylinder to prevent attachment from drifting downward in event of a damaged line or fitting.

A compensating cylinder is included in circuit to automatically maintain level of attachment set by operator. As boom is raised or lowered, compensating cylinder is extended or retracted. Flow expelled from compensating cylinder is delivered to appropriate end of tilt cylinder to maintain selected angle. Flow expelled from tilt cylinder is returned to compensating cylinder.

A pair of circuit relief valves are provided in control valve section, one for each side of cylinder circuit.

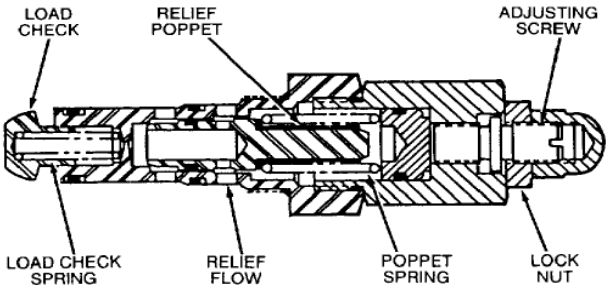
Attatchment Tilt Control Valve Section



The attachment tilt control valve section is an open-center, four-way, three-position valve with a spring-centered, manually-operated spool.

Circuit relief valves provide protection for each side of cylinder circuit.

Circuit Relief Values



Circuit relief valves are direct acting and are set at 2800 psi. They include a load check valve to block flow path to cylinder until pump pressure exceeds. pressure caused by attachment load. A brief description of valve operation follows:

At pressures lower than relief setting:

- Circuit pressure is insufficient to force relief poppet to compress its spring (spring preload determines relief setting.)
- No relief flow occurs because relief poppet maintains sealing contact with its seat.

When circuit pressure reaches relief setting:

- Circuit pressure acts against shoulder of relief causing compression of poppett spring
- As poppet raises from its seat circuit pressure/flow passes thru bore of poppet to return gallery.

As circuit pressure is reduced, relief poppet returns to sealing contact with its seat.

Counterbalance valves

Counterbalance valves are provided to minimize cylinder drift and to prevent cylinder movement in event of damage to a line or fitting.

Do not attempt to recondition counterbalance valve cartridges. Improper servicing could cause unexpected machine movement. Replace a leaking cartridge with a new cartridge.

Trouble Shooting

Observe operation of all implement circuits to determine extent of malfunction. Information provided under Preliminary Field Testing heading will be helpful in evaluating circuit performance.

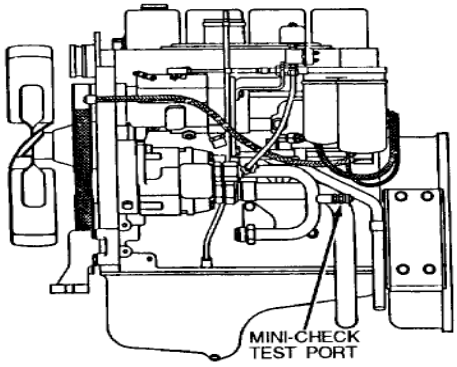
When extent of malfunction is determined, refer to General Trouble Shooting Table heading.

Testing

Testing & Adjusting Circuit Relief Valves

1. Position unit in a safe area for work to be performed, apply parking brake and move forward/reverse lever to neutral position.

   Lower unloaded forks or other attachment until. cylinder has bottomed and lower boom until forks make light contact with ground.



3. Stop engine and install gage, hose and mini-check adapter combination on implement pump supply test port. Position gage in cab for observation.

4. Time engine and run at low idle. Observe gage while holding attachment tilt lever fully forward. Gage should indicate 2800 psi.

5. Raise forks or other attachment until cylinder has bottomed.

6. Observe gage while holding attachment tilt lever fully to rear. Gage should indicate 2800 psi.

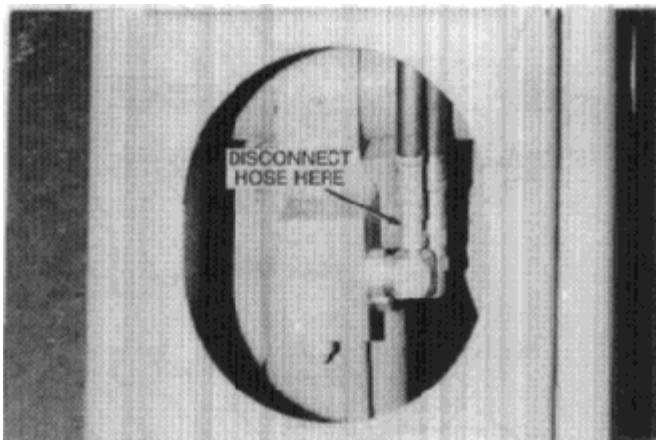
7. If necessary loosen lock nut/s and turn adjusting screw/s clockwise to increase pressure or counterclockwise to reduce pressure.

Testing Cylinder for Leakage Past Piston

Position unit in a safe area for work to be performed. Apply parking brake and move forward/reverse lever to neutral position.

2. Remove fork carriage or other attachment and move carriage tilt lever forward to retract cylinder fully.

3. Stop engine and move attachment tilt lever back and forth fully a few times to relieve any trapped pressure between counterbalance valve and control valve.



4. Disconnect hose at counterbalance valve at point shown and plug hose.

5. Position a container to receive any by-pass flow and connect a hose to open port to guide flow to container.

6. Start engine and run at full throttle.

NOTE: These handlers are equipped with a 4 inch bore (4.5 inch outside diameter) tilt cylinder. Your unit may have an optional 5 inch bore (5-5/8 inch outside diameter) tilt cylinder. Measure the outside diameter of your cylinder to determine which cylinder you have. **Be sure to use the proper figures for your unit.**

7. Move attachment tilt lever fully forward, hold for time specified below and then release lever.

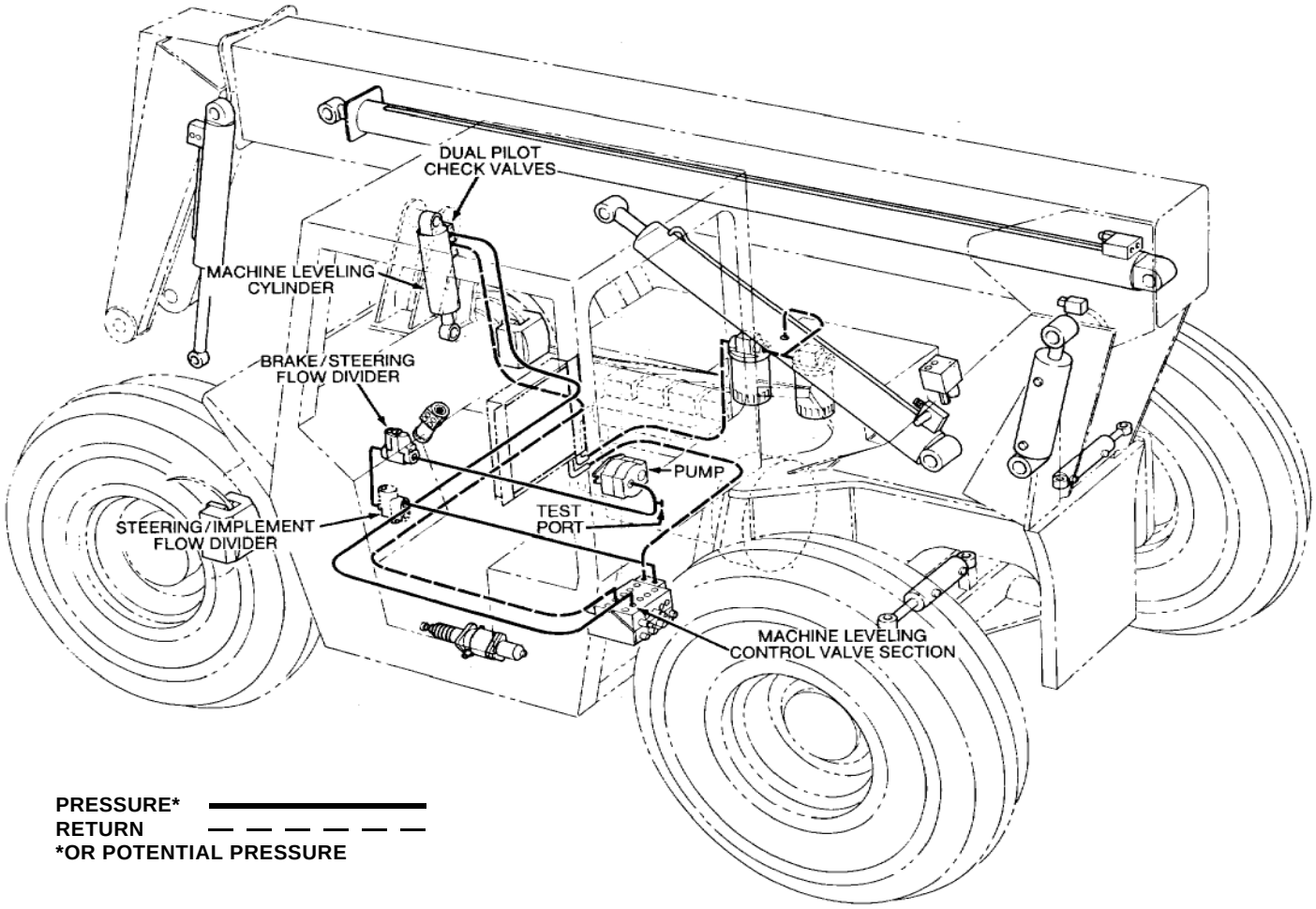
   4 inch bore cylinder-3.5 seconds
   5 inch bore cylinder-4.5 seconds

8. With no other circuit activated, attachment tilt circuit receives approximately 21 gpm. Approximately 3.5 seconds are required to fully retract 4 inch tilt cylinder or 4.5 seconds for 5 inch cylinder. This operation requires 157 ounces for 4 inch bore cylinder or 202 ounces for 5 inch bore cylinder.

   By-pass leakage of 10% (16 ounces for 4 inch cylinder or 20 ounces for 5 inch bore cylinder) would slow cycle by .4 seconds for 4 inch cylinder or .5 seconds for 5 inch cylinder. This probably would not be noticed by operator.

   Depending on application of machine, greater leakage could indicate need to re-seal cylinder.

Machine Leveling Circuit



NOTES

Refer to Implement Pump Supply Circuit heading for implement pump supply and return details.

TILT to LEFT circuit is shown-reverse pressure and return lines between control valve and
cylinder for **TILT to RIGHT**

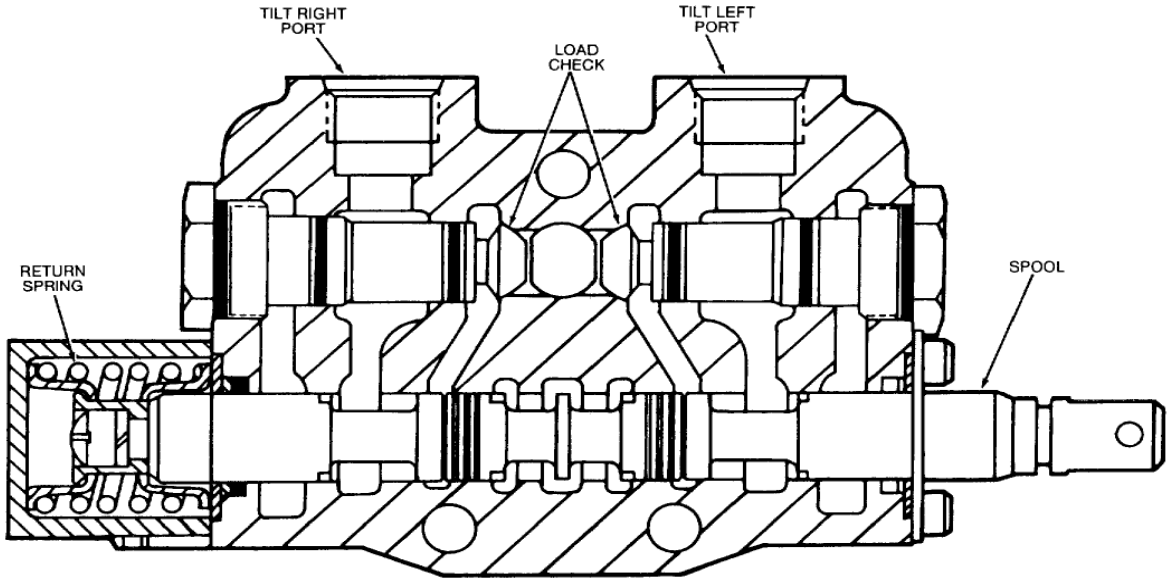
The machine leveling control valve section receives flow to operate cylinder from implement pump. Refer to Implement Supply Circuit heading for details.

Moving machine level lever forward tilts frame to left; moving lever to rear tilts frame to right.

A dual pilot-operated check valve is pad-mounted at barrel end of machine leveling cylinder to prevent cylinder movement in event of a damaged line or fitting.

This circuit does not include circuit relief valves. Circuit pressure is limited to 3000 psi by pump relief valve.

Machine Leveling Control Valve Section



The machine leveling control valve section is an open-center, four-way, three-position valve with a spring-centered, manually-operated spool.

The valve section includes a pair of load check valves, one for each side of cylinder circuit. These valves block flow paths to cylinder until pump pressure exceeds pressure caused by machine load.

Dual Pilot-Operated Check Valves

Dual pilot-operated check valves prevent flow from either side of cylinder until a pilot signal from controlled pump flow unseats check valve on downstream side of cylinder.

Do not attempt to recondition pilot check cartridges. **Improper servicing could cause unexpected machine movement.** Replace a leaking pilot check cartridge with a new cartridge.

Trouble Shooting

Observe operation of all implement circuits to determine extent of malfunction. Information provided under Preliminary Field Testing heading will be helpful in evaluating circuit performance.

When extent of malfunction is determined, refer to General Trouble Shooting Table heading.

Testing

Testing Cylinder for Leakage Past Piston

1. Position machine in a safe, level area for work to be performed. With unloaded boom fully retracted and level, tilt frame to left until cylinder bottoms and then lower boom until attachment rests firmly on ground.

2. Apply parking brake, move forward/reverse lever to neutral position and stop engine.

3. Move machine leveling lever from side to side fully a few times to relieve any trapped pressure between control valve and dual pilot-operated check valve.

4. Disconnect hose at dual pilot-operated check valve as shown and plug hose.

5. Position a container to receive any by-pass flow and attach a hose to open port to guide flow to container.

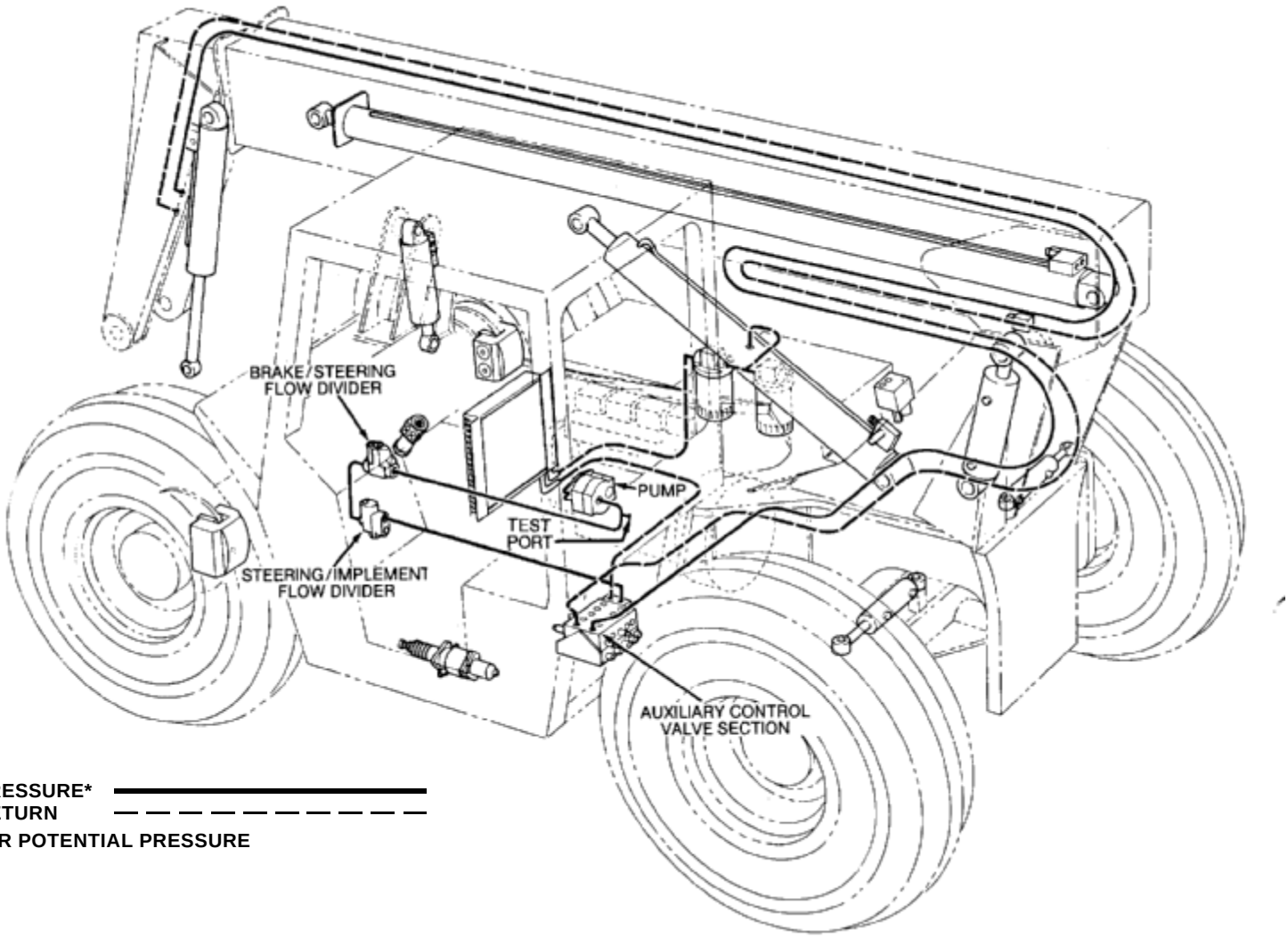
6. Start engine and run at full throttle.

7. Move machine leveling lever fully to left and hold for 5.5 seconds and then release lever.

8. With no other circuit activated, machine leveling control valve section receives approximately 21 gpm. Since a new machine requires approximately 5.5 seconds to move from full right tilt to full left tilt, this operation should use approximately 246 ounces (1.9 gallons).

   Leakage of 10% (25 ounces) would slow cycle by .56 seconds and probably would not be noticed by operator. Depending on application of machine, greater leakage could indicate need to re-seal cylinder.

Auxiliary Hydraulics Circuit (optional)



PRESSURE* ——————————

RETURN — — — — — — — — — —

***OR POTENTIAL PRESSURE**

NOTE

Refer to Implement Pump Supply Circuit heading for implement pump supply and return details

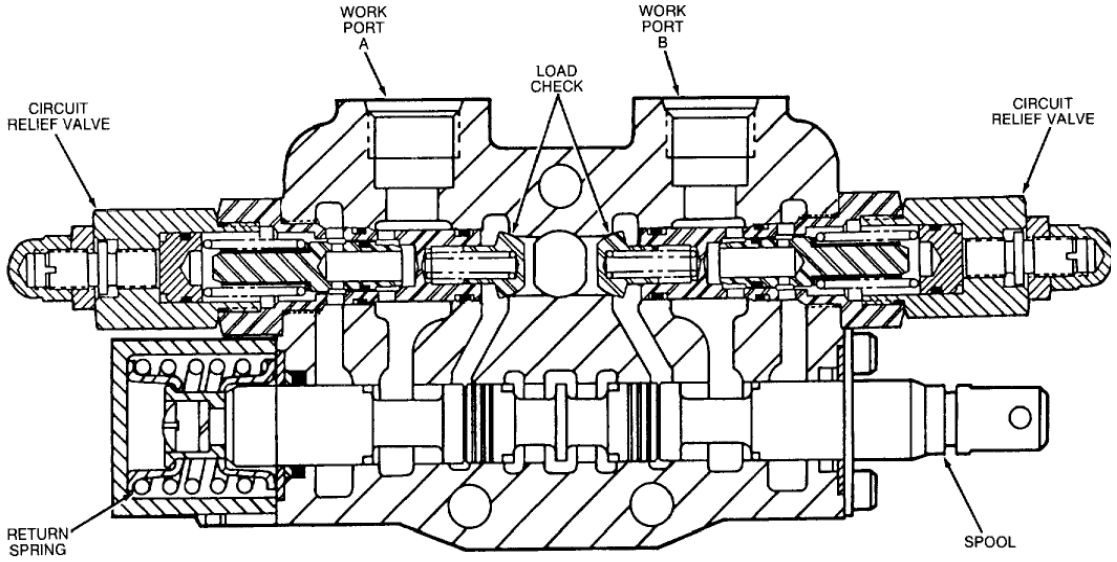
The auxiliary hydraulic circuit receives flow to operate attachment from implement pump. Refer to Implement Supply Circuit heading for details.

Refer to decal adjacent to auxiliary control lever for operating instructions.

A pair of circuit relief valves is included in control valve section, one for each side of circuit.

Auxiliary circuit hose ends at boom head are equipped with quick-disconnect fittings, one male and one female to ensure that attachment is connected properly.

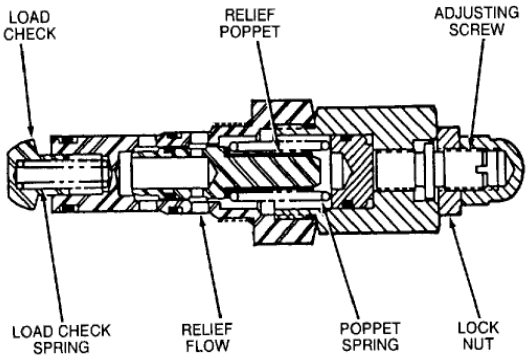
Auxiliary Control Valve Section



The auxiliary control valve section is an open-center, four-way, three-position valve with a spring-centered, manually-operated spool.

Circuit relief valves provide protection for each side of circuit.

Circuit Relief Valves



Circuit relief valves are direct-acting and are set at 1500 psi. They include a load check valve to block flow path to actuator (cylinder/motor) until pump pressure exceeds pressure caused by attachment load. A brief description of valve operation follows:

At pressures lower than relief setting:

- Circuit pressure is insufficient to force relief poppet to compress its spring (spring preload determines relief setting).
- No relief flow occurs because relief poppet maintains sealing contact with its seat.

When circuit pressure reaches relief setting:

- Circuit pressure acts against shoulder of relief poppet causing compression of poppet spring.
- As poppet raises from its seat, circuit pressure/ flow passes thru bore of poppet to return gallery.

As circuit pressure is reduced relief poppet returns to sealing contact with its seat.

Trouble Shooting

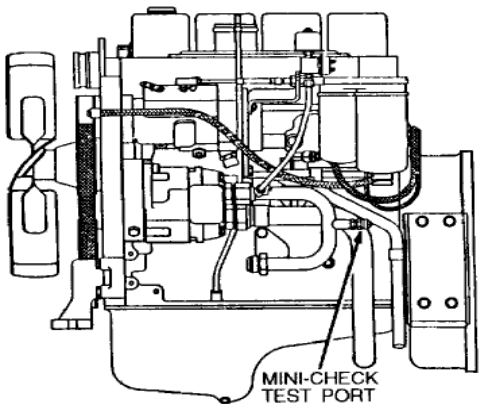
Observe operation of all implement circuits to determine extent of malfunction. Information provided under Preliminary Field Testing heading will be helpful in evaluating circuit performance.

When extent of malfunction is determined, refer to General Trouble Shooting Chart heading.

Testing

Testing & Adjusting Circuit Relief Valves

1. Position unit in a safe area for work to be performed, apply parking brake and move forward/reverse lever to neutral position.
2. Lower unloaded forks or other attachment to ground and stop engine.
3. Inspect quick-disconnect fitting at boom head for signs of leakage. Replace leaking fittings.



4. Install gage, hose and adapter combination on implement pump supply test port. Position gage in cab for observation.

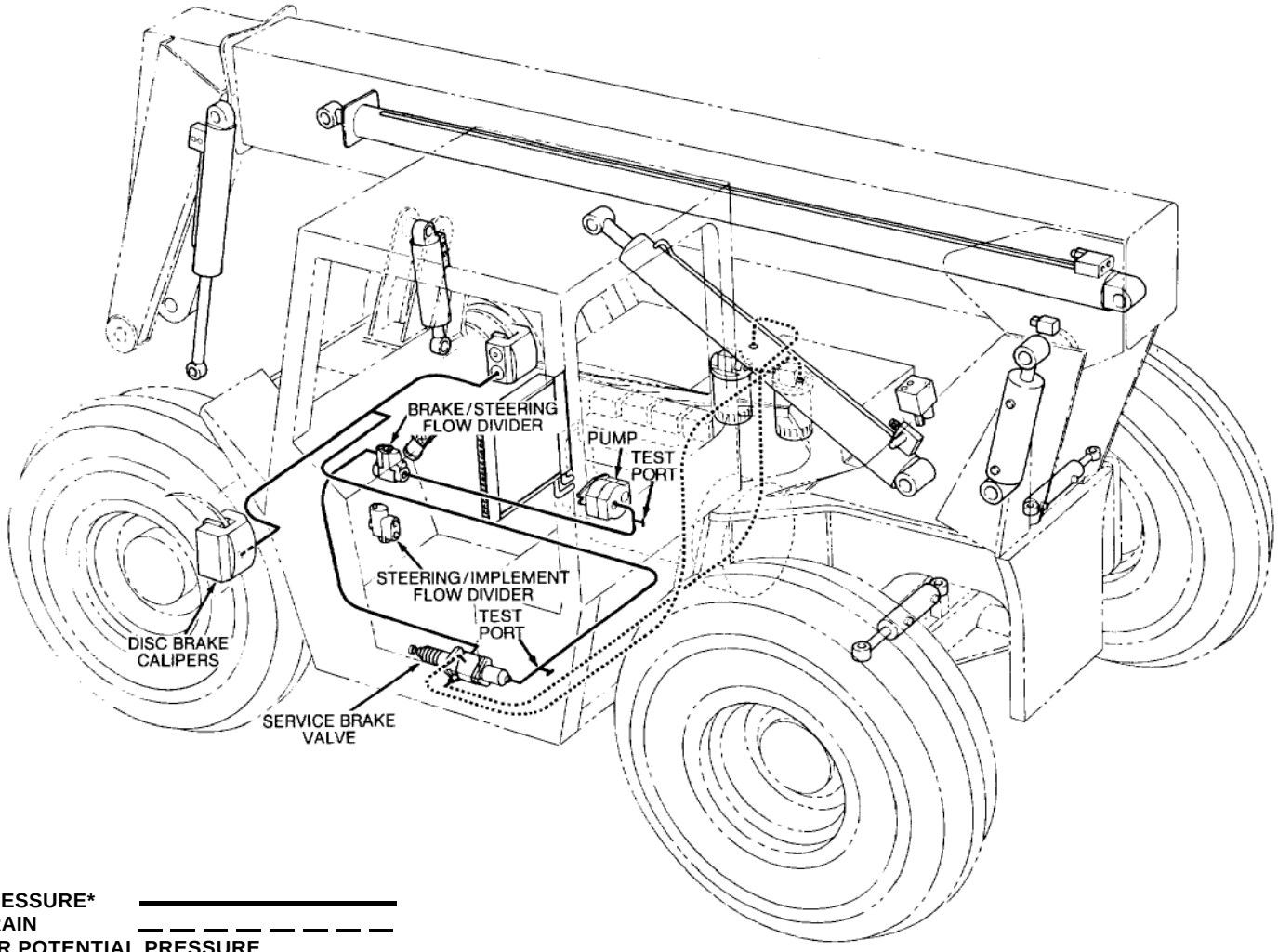
5. Start engine and run at low idle.

6. Observe gage while holding auxiliary control lever fully forward to pressurize front port (work port A). This port is protected by front circuit relief valve. Note pressure reading and release lever.

7. Observe gage while holding auxiliary control lever fully to rear to pressurize rear port (work port B). This port is protected by rear circuit relief valve. Note pressure reading and release lever.

8. If necessary, loosen lock nut/s and turn adjusting screw/s clockwise to increase pressure or counter-clockwise to reduce pressure.

Service Brake Circuit



PRESSURE* ——————————

DRAIN — — — — — — — —

***OR POTENTIAL PRESSURE**

NOTES

Refer to Implement Pump Supply Circuit heading for implement pump supply and return details.

SERVICE BRAKE APPLIED circuit is shwon-lines between brake calipers and service brake valve become drain line when **SERVICE BRAKE IS RELEASED.**

The power-assist service brake valve receives flow to operate brakes from implement pump. Refer to Implement Supply Circuit heading for details.

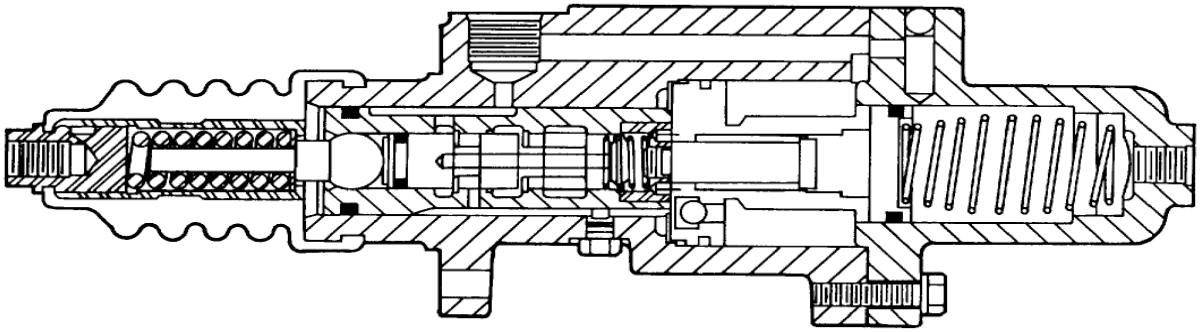
Service brakes are applied to a pair of dry discs on front drive axle.

Brakes are applied progressively during final 1/3 of service brake/inching travel pedal stroke. The upper 2/3 of pedal stroke controls inching travel.

If pump flow or power-assist fails, brakes can be applied manually but it will require much greater pedal force and stopping distance will be greater.

Supply to service brake valve is limited to 800 psi by relief valve in brake/steering flow divider.

Service Brake Valve



Trouble Shooting

Observe operation of all implements to determine extent of malfunction. Information provided under Preliminary Field Testing heading will be helpful in evaluating circuit performance.

When extent of malfunction is determined refer to General Trouble Shooting Table heading if appropriate.

The following trouble shooting checks are limited to those items which apply only to this circuit.

These checks are listed in order of easiest-to-check to most-difficult-to-check.

WITH ENGINE STOPPED:

Pedal Goes to Floor

- Leaking brake line or fitting-repair
- Air in system-bleed brakes
- Brakes defective-repair
- Worn brake valve primary cup-replace cup
- Improper push rod adjustment-adjust

Spongy Pedal

- Air in system-bleed brakes

Pedal Firm but Low

- Brakes worn - replace
- Improper push rod adjustment - adjust

WITH ENGINE RUNNING

Pedal Goes Part Way Down & Bounces Back

- Air in system - bleed brakes
- Insufficient supply from flow divider-brake valve should receive 3 gpm with engine running at 2550 rpm.

Decreased Braking Efficiency

- Glazed or contaminated brake pads-replace
- Low pressure from flow divider-flow divider relief valve improperly adjusted-refer to next heading (Testing)

Testing

Testing & Adjust Flow Divider Relief Valve

1. Position unit in a safe area for work to be performed, apply parking brake and move forward/ reverse lever to neutral position.

2. Rest unloaded forks or other attachment on ground and stop engine.

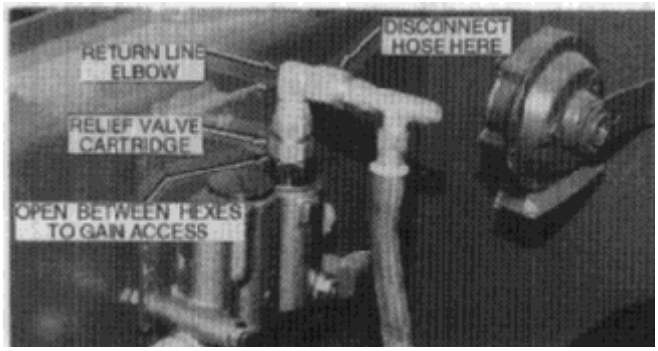
3. Attach gage, hose and adapter combination as shown on service brake system mini-check test port. Position gage in cab for observation.

4. Start engine and run at full throttle.

5. Observe gage while depressing service brake pedal fully. Note pressure reading and releas pedal. Pressure should be between 1250 and 1500 psi.

NOTE: If proper pressure is not indicated, further testing is required before attempting adjustment of relief cartridge.

6. Stop engine and depress service brake pedal fully a few times.



7. Disconnect hose at point shown and install a mini-check test port in open port of flow divider valve.

8. Install gage, hose and mini-check adapter combination on test port.

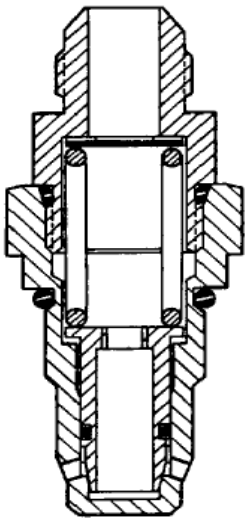
9. Start engine, run at full throttle and observe gage. Gage should indicate 850 psi. Stop engine as soon as gage reading is taken.

NOTE: Relief valve cartridge is located below return line elbow. If adjustment is required, elbow must be removed to gain access to relief valve. Loosen and remove top hex to gain access to shims (available in .021 & .005" thicknesses. Install thinner shims against spring.

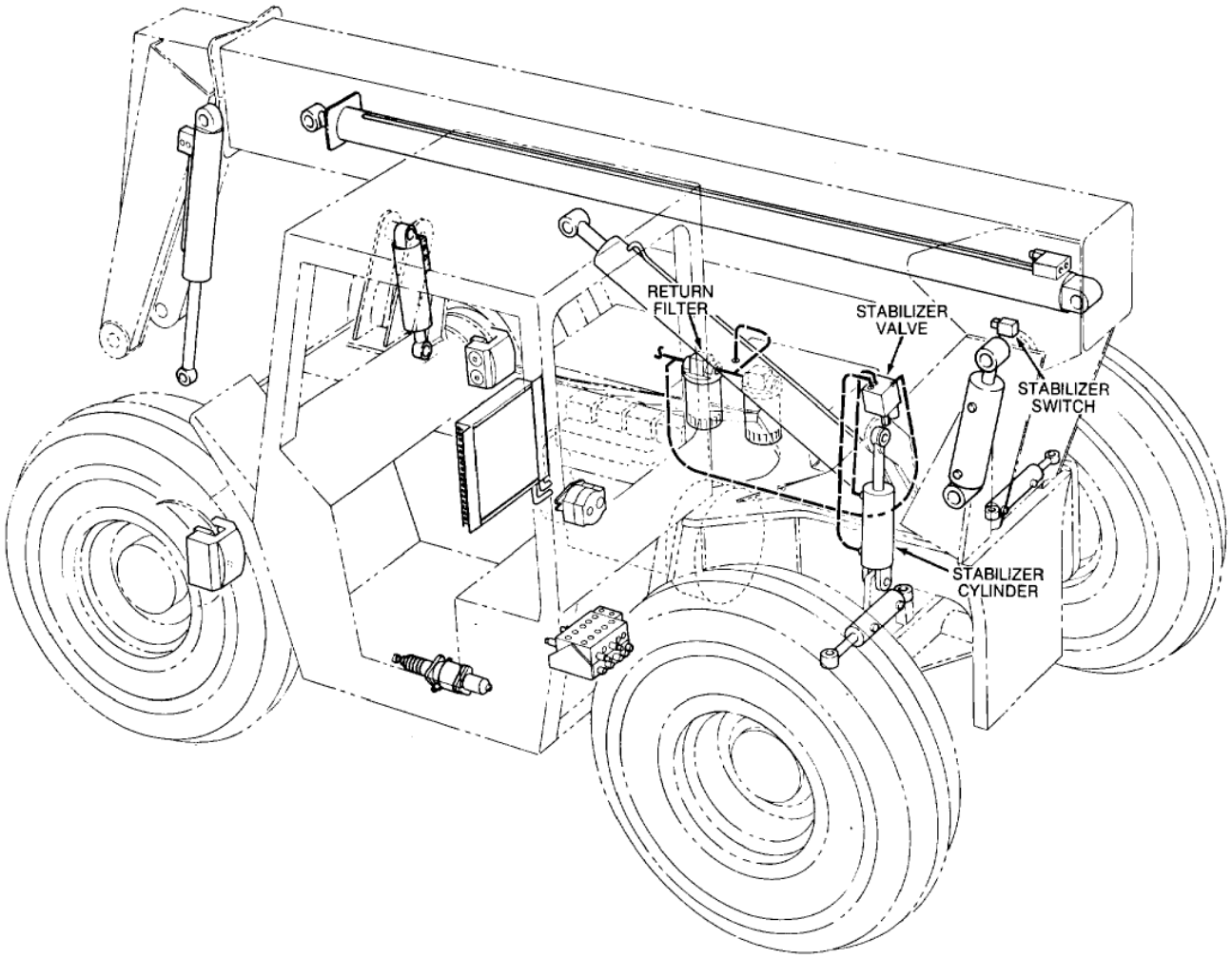
If adjustment is required, stop engine and remove elbow from relief valve. Open valve between hexes to gain access to shims. Add or remove shims as required and assemble. **Be certain to install elbow before retesting.**

⚠ WARNING

If elbow was removed for adjustment, be certain to install elbow before retesting Hydraulic oil under pressure can penetrate skin and cause serious injury or death.



Rear Axle Stabilizer Circuit (optional on 532C & 534C)



RETURN

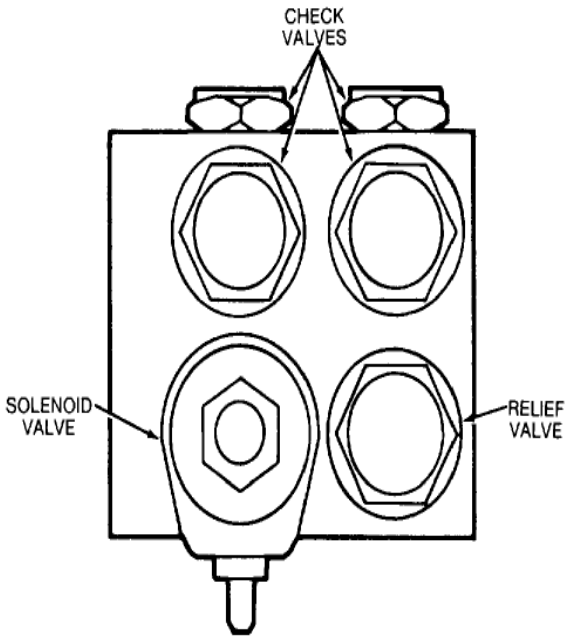
The rear axle stabilizer circuit is provided as an option to increase stability in certain applications. It functions as a stiff shock absorber to snub rear axle oscillation when traveling over uneven ground. Snubbing action occurs when ignition switch is turned on and boom is elevated to approximately 45° or higher.

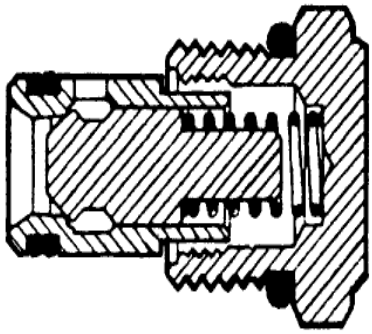
A normally-open limit switch is closed when boom is raised to 43 to 47 above horizontal. Limit switch energizes solenoid-operated stabilizer valve.

When energized, stabilizer valve does not block but restricts flow from both ends of stabilizer cylinder.

When de-energized, valve permits free flow between ends of cylinder.

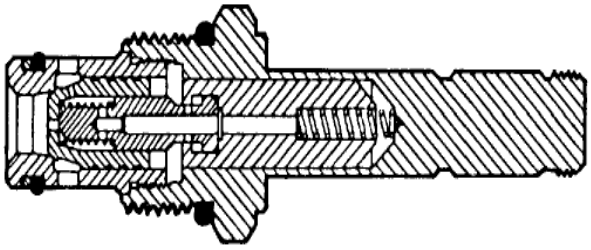
Return flow is routed from upstream side of return filter to stabilizer valve. Return back pressure is sufficient to prevent cylinder cavitation.



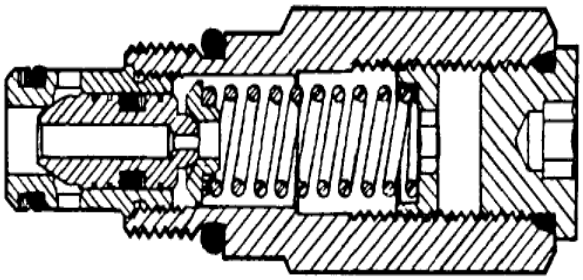


CHECK VALVE

The stabilizer valve includes a normally-open solenoid valve, four check valves and a relief valve to limit cylinder pressure to 1000 psi.

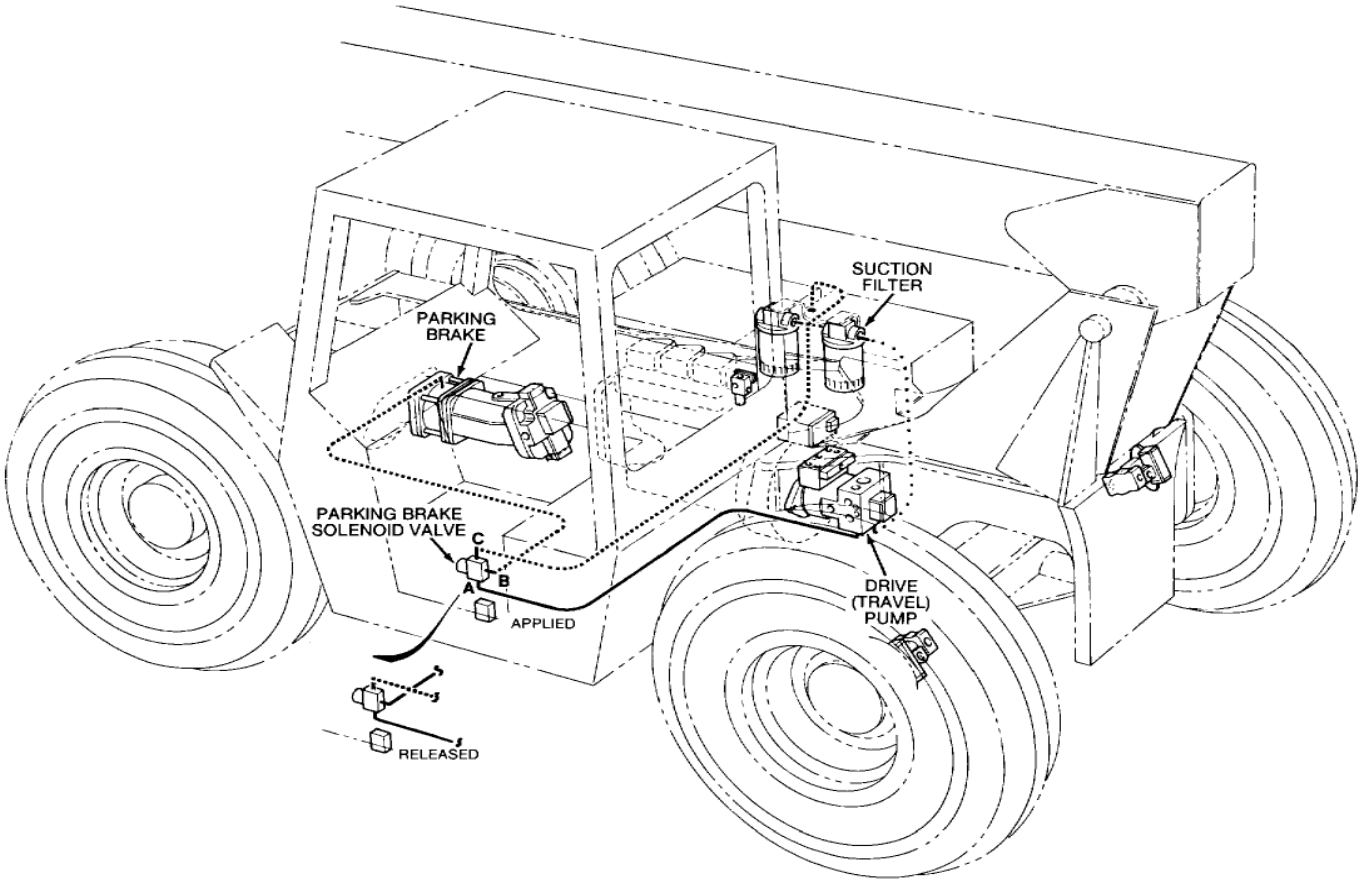


SOLENOID VALVE



RELIEF VALVE

Parking Brake



SUCTION .....
PRESSURE* ━━━━━
DRAIN .....

***OR POTENTIAL PRESSURE**

NOTE

Parking brake is shown **APPLIED**-line between parking brake and solenoid valve is pressurized to **RELEASE** parking brake.

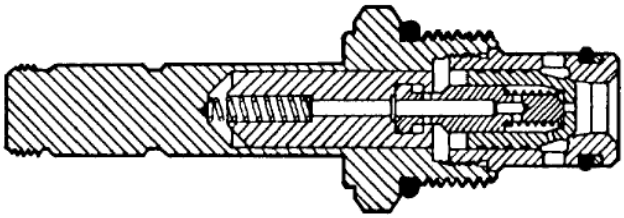
The spring-applied, electro/hydraulic-release parking brake is controlled by a rocker switch located on instrument panel.

Voltage to switch is supplied thru a 15 amp circuit breaker which is energized when ignition switch is turned on.

Hydraulic pressure/flow to release brake is supplied by charge pump section of main drive (travel) pump assembly. Flow is delivered thru port G of pump.

Pressure required to release parking brake fully is 230 psi Charge pump provides 320 psi with engine at idle (800 - 900 rpm).

Parking Brake Solenoid Valve



CARTRIDGE SHOWN MINUS COIL & VALVE BLOCK

With parking brake switch in ON position, solenoid is not energized and port **B** is open to port **C** to vent pressure and apply parking brake.

With parking brake switch in OFF position, solenoid is energized and port **A** is open to port **B** to apply charge pump pressure and release parking brake.

Trouble Shooting

Parking Brake Will Not Release

- Damaged hose or fitting - replace
- Defective electrical circuit - check for 12 VDC at solenoid (wire 42B-located beneath cab floor)
- Defective solenoid coil - check for 6.2 ohms resistance thru coil
- Defective valve cartridge - repair or replace
- Inadequate pressure - see next heading (Testing)

Testing

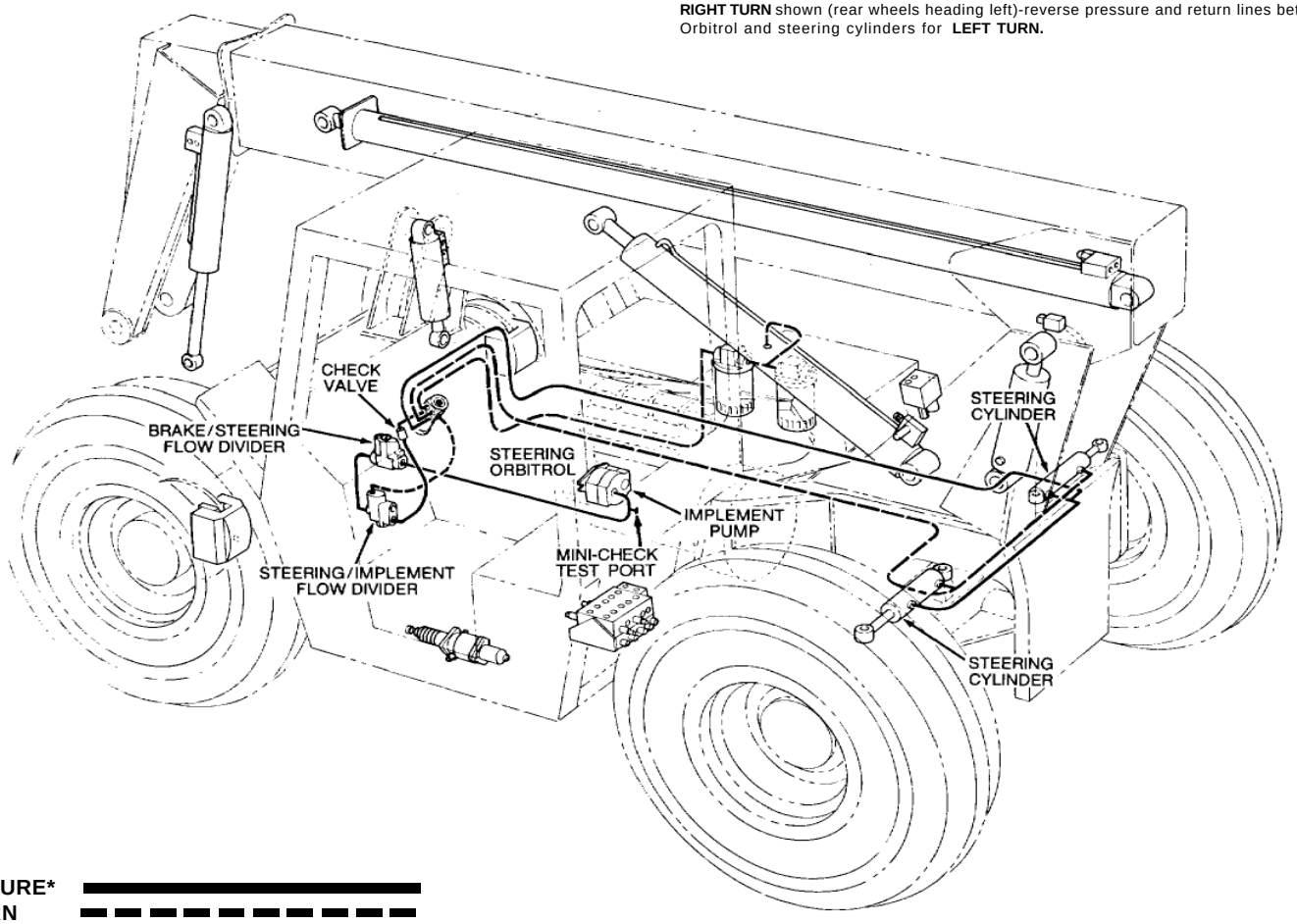
Refer to page 73 for procedure used to test and adjust charge pump pressure.

Steering Circuit

NOTES

Refer to Implement Pump Supply Circuit heading for implement pump supply and return details.

RIGHT TURN shown (rear wheels heading left)-reverse pressure and return lines between Orbitrol and steering cylinders for **LEFT TURN.**



PRESSURE*
RETURN
PILOT

***OR POTENTIAL PRESSURE**

Implement pump flow/pressure is routed to steering Orbitrol thru brake/steering and steering/implement flow divider valves (see Implement Supply Circuit for details).

The steering/implement flow divider receives approximately 21 gpm from brake/steering flow divider valve (at rated engine rpm).

Because the Orbitrol is supplied from the controlled (priority) flow port of steering/implement flow divider, there is always ample flow available for steering. Any flow not required for steering is routed to implement control valve bank.

With steering in neutral, slight hydraulic flow supplied to Orbitrol is returned to reservoir.

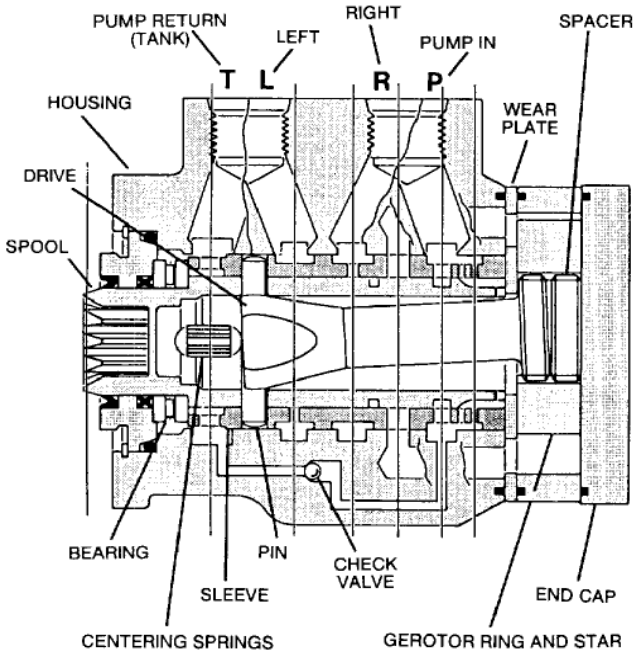
When steering wheel is turned to right or left, steering Orbitrol directs hydraulic flow to appropriate ends of steering cylinders.

A pilot signal from the Orbitrol controls the division of flow provided by flow divider valve. The flow divider always provides adequate flow to satisfy steering system demand. Any pump flow not required handler functions.

Hydraulic flow expelled from steering cylinders is returned thru Orbitrol t reservoir

A check valve in Orbitrol inlet line prevents steering wheel kick-back.

Steering Orbitrol



The steering Orbitrol functions as a rotary control valve (composed of spool and sleeve) and a fixed displacement metering gear (composed of the Geroter ring and star).

Steering wheel torque is applied to position spool in sleeve to direct flow to appropriate ends of steering cylinders and is also applied to Geroter to meter flow to steering cylinders.

When steering wheel movement stops, centering springs return spool and sleeve to neutral relationship.

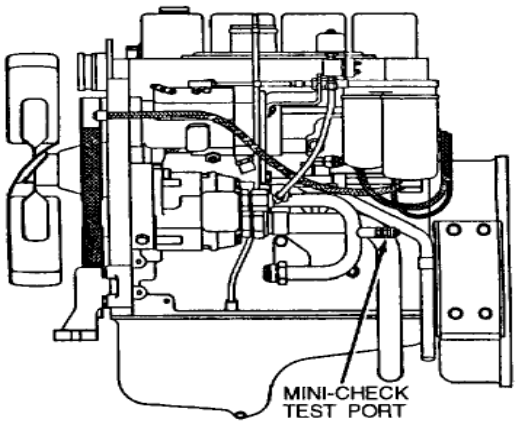
In the event of engine or pump failure, a check valve within Orbitrol opens to permit limited manual steering. Manual steering requires much greater operator effort.

Trouble Shooting

Refer to Eaton/Char-Lynn Trouble Shooting pamphlet included in service manual.

Testing

Steering circuit pressure is governed by a relief valve located in reservoir port of priority flow divider valve. Perform following procedure to test steering system pressure.



1. Connect adapter, hose and gage combination to mini- check test port in outlet tube of main pump.

2. Start engine (with no load on handler) and turn steering wheel fully in either direction until steering is bottomed.

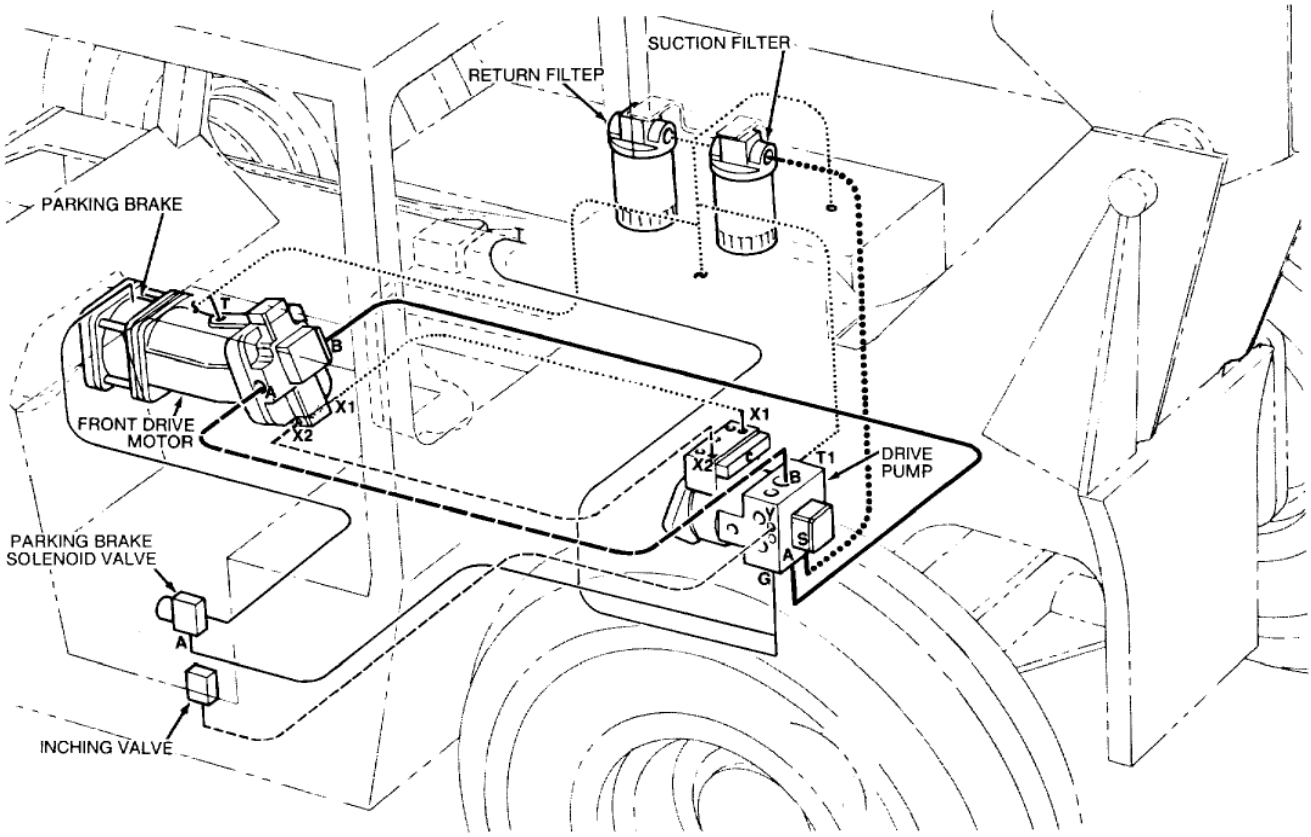
3. With engine running at low idle, observe gage while holding steering in full turn position (should indicate 2500 psi). Do not hold steering in full turn position longer than necessary.

4. If adjustment is required, turn steering slightly in opposite direction and stop engine.

5. Remove hose and straight adapter fitting from reservoir port of flow divider valve to gain access to relief valve socket head adjusting screw. Turn screw clockwise to increase pressure or counterclockwise to reduce pressure.

Hydrostatic Drive Circuit (Forward travel)

522 & 532C Only



SUCTION
CHARGE PUMP PRESSURE
CONTROL PRESSURE
DRIVE PUMP PRESSURE
DRIVE CIRCUIT RETURN
DRAIN

NOTES

Forward travel is shown, refer to next circuit for reverse travel.

Conditions: Parking brake released, inching travel valve closed and engine running at 1100 RPM or higher.

Implement circuit components are not shown.

Model 522 and 532C handlers are equipped with hydrostatic drive to the front axle. From the operator's standpoint, operation is similar to a vehicle with an automatic transmission; once direction of travel has been selected, engine speed determines vehicle speed.

The following general description provides a discussion of what happens within the circuit under - varying conditions. Greater detail of how things happen is provided under component descriptions.

The hydrostatic drive circuit can be considered as two separate circuits which interface in several areas. After a discussion of the drive loop we will cover the charge pump section of the circuit.

Three distinctly different pressures are discussed in following description:

Circuit Pressure = pressure delivered from drive pump to drive motor to propel vehicle (limited to 5000* psi *(5500* psi)*.

Charge Pump Pressure = pressure delivered by functions (limited to 320 - 480 psi)-this setting is established at 320 psi with engine at 800 RPM flow characteristics of relief cartridge will allow charge pump pressures to reach 480 psi under certain conditions

Control Pressure = charge pump pressure as modified by control pressure cartridge (DA cartridge). This pressure (under varying conditions) will almost always be lower than charge pump pressure; it will never exceed charge pump pressure.

***Refer to page ii to determine proper pressure.**

Major components of the drive loop include a variable-displacement, axial piston pump which delivers flow to a variable-displacement, bent-axis, piston motor. The motor delivers torque thru a parking brake assembly to the differential of front drive axle equipped with planetary wheel ends.

Direction of travel is controlled by a solenoid-controlled forward/reverse module mounted on top surface of drive pump. Solenoids are controlled by a switch mounted on steering column.

The drive circuit is a closed loop which includes a flushing circuit. For forward travel, oil is routed from pump port **A** to motor port **B**. Return flow is from motor port **A** to pump port **B**.

Regardless of the direction of travel, a portion of return oil (up to 2 gpm) is returned to reservoir thru a flushing valve mounted on rear face of drive motor and port T of motor housing. This oil is replaced by cooled filtered oil from charge pump circuit.

Forward and reverse sides of drive loop are protected by a pair of relief valves to limit pressure to 5000* psi *(5500* psi)*. These valves include an anti-cavitation feature which permits charge pump to provide make-up oil to return side of drive loop.

Since charge pump pressure will be between 320 and 480 psi, oil in return side of loop would be raised to a similar pressure. Return oil eliminates cavitation and provides positive supply to inlet side of drive pump.

As with other piston equipment, the greater the pump displacement and the less the motor displacement, the greater the vehicle speed. Reducing pump displacement and increasing motor displacement, reduces vehicle speed while increasing drive torque.

The hydrostatic drive circuit receives all required flow thru the suction filter and most oil reaching the suction filter has already passed thru the return filter.

Oil is drawn from suction filter to port **S** of drive pump by a charge pump mounted on rear face of drive pump. Flow/pressure from charge pump is always directly proportional to engine RPM

The charge pump circuit performs several important functions:

- Provides pilot pressure for joystick Control
- Provides pilot pressure to release parking brake
- Provides proper control pressure to stroke drive pump and motor displacement for varying conditions
- Provides cooled make-up oil as required to prevent cavitation and overheating in drive loop
- Pressurizes return flow for positive supply to inlet side of drive pump

At low idle (approximately 800 RPM) charge pump provides 320 psi which is ample to release parking brake. Oil is routed thru port **G** to drive pump to port **A** of parking brake solenoid valve. When valve is energized, oil is routed thru port **B** to parking brake.

The charge pump circuit includes a control pressure cartridge (DA cartridge) to modify charge pump pressure and provide proper control (stroking) pressure for drive pump and motor.

When engine speed is raised to 1100 RPM, charge pump pressure is sufficient to activate control pressure cartridge which senses engine speed by measuring charge pump flow/pressure.

The control pressure cartridge converts charge pump pressure to control (stroking) pressure. Control pressure is also directly proportional to engine speed and is used to adjust drive pump and motor displacement properly for conditions of the moment.

The greater the control pressure, the greater the vehicle speed; under high control pressure, drive pump is stroked toward maximum displacement and drive motor is stroked toward minimum displacement.

Control pressure is routed to drive pump stroking piston within pump housing and control pressure is routed to drive motor stroking piston thru ports X2 of drive pump and motor.

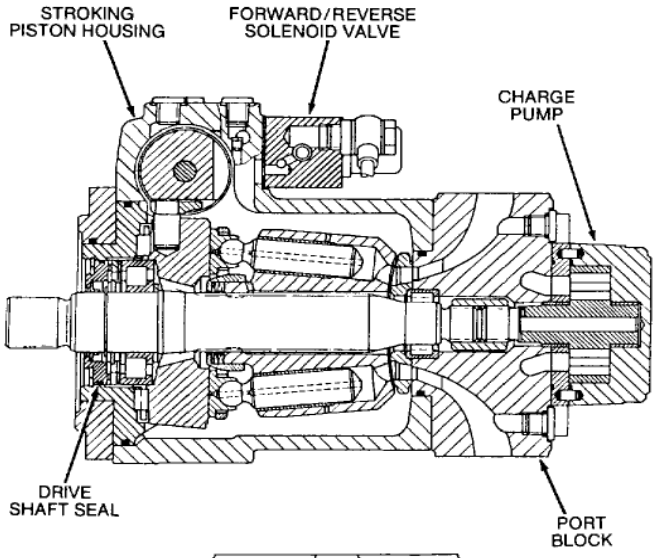
When actuated (opened), inching travel valve directs control pressure to reservoir. The greater the actuation the greater the pressure loss. With no control pressure, the drive pump and motor provide no drive torque to differential.

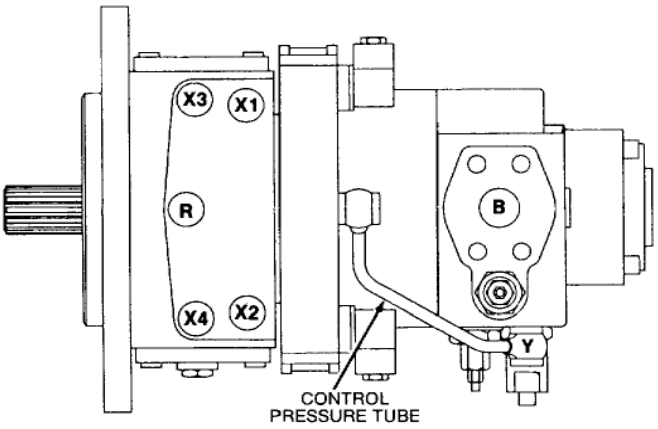
Drive circuit pressure also affects displacement of front drive motor. As circuit pressure increases (as in traveling an up-grade) circuit pressure can alter control pressure applied to stroking piston; under high circuit pressure, motor displacement will be increase driving torque while reducing vehicle speed.

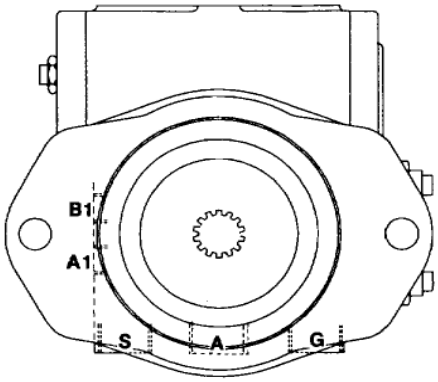
Any charge pump flow not required to replenish drive loop flows over charge pump relief valve (located on upper surface of drive pump) and returns to reservoir thru port **T1** of drive pump. This flow serves to further prevent overheating of drive circuit.

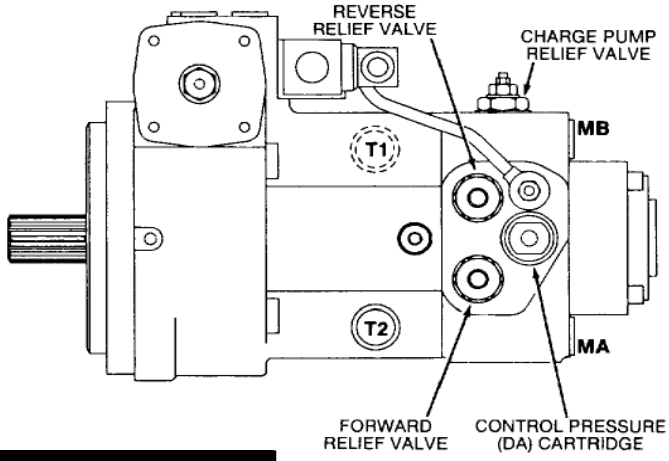
***Refer to page ii to determine proper pressure.**

DRIVE PUMP









ATTENTION

The drive pump manufacture (Rexroth) may not honor the one year warranty on pump if it has been disassembled far enough to expose the piston rotary group.

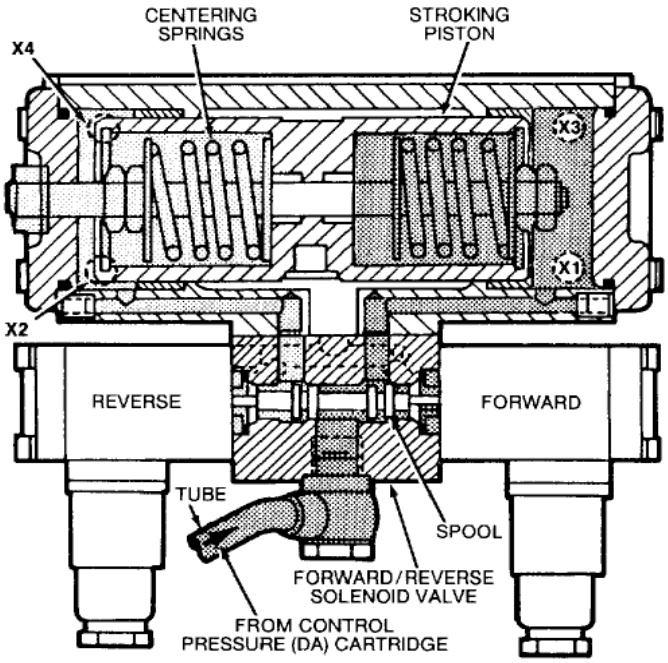
Any service, repair or replacement must be performed under absolutely clean conditions.

Note: On recent units, plugs in ports **MA & MB** have been replaced with Mini-Check Test Ports.

Port Identification

A	Forward work port
A1	Forward auxiliary port*
B	Reverse work port
B1	Reverse auxiliary port*
G	Charge pump pressure port
MA	Forward test port*
MB	Reverse test port*
R	Case vent port*
S	Charge pump suction port
T1	Case drain port
T2	Case drain port*
X1	Reverse control pressure port
X2	Forward control pressure test port*
X3	Reverse control pressure test port*
X4	Forward control pressure port
Y	Control pressure port

*Plugged port



Control pressure is routed from control pressure cartridge thru tube to forward/reverse solenoid.

With forward/neutral/reverse switch in neutral position, control pressure is blocked at solenoid valve spool and centering springs hold stroking piston in neutral position.

The position of stroking piston determines two things:

- The direction pump swash plate will be stroked orifice (for forward travel or for reverse travel)
- The extent to which swash plate will be stroked (from minimum displacement to maximum displacement)

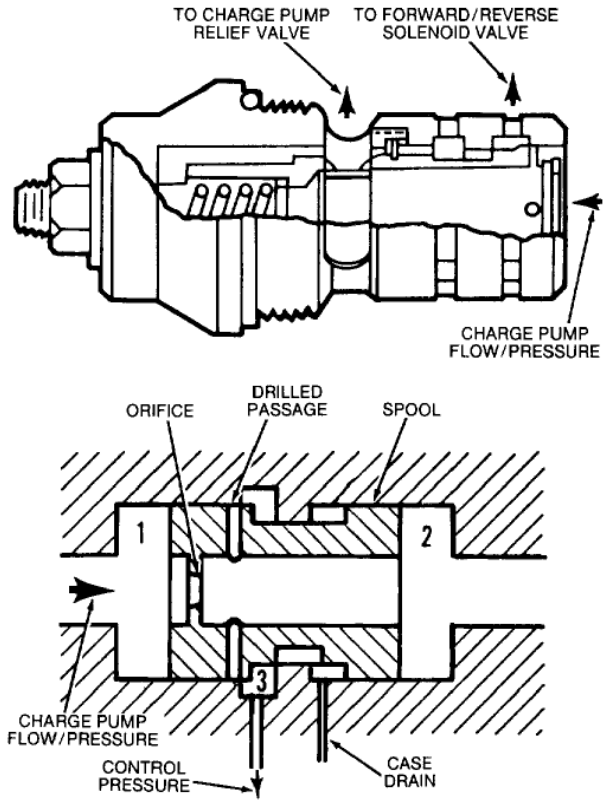
With forward/neutral/reverse switch in reverse position, solenoid valve spool directs control pressure to **X1** side of stroking piston.

As stated earlier, control pressure is in direct proportion to engine RPM. If the operator wants more more; more pedal = more engine RPM = more control pressure = more pump displacement = more vehicle speed.

With **X1** side of stroking piston pressurized, **X2** side of piston is open to pump case drain (**T1** port).

To prevent sudden changes in vehicle speed (potentially dangerous for material handler operation) "swivel time orifices" are provided on each side of stroking piston to slow movement of stroking piston. Although sudden braking is available, orifices prevent abrupt changes in vehicle speed caused by inappropriate use of accelerator pedal.

CONTROL PRESSURE (DA) CARTRIDGE



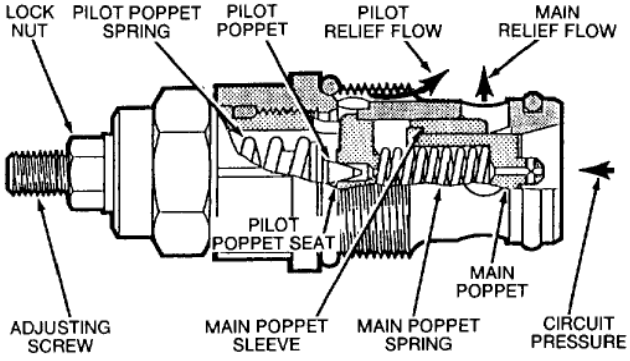
Control Pressure (DA) Cartridge

Charge pump flow/pressure enters control pressure cartridge and flows thru orifice in spool. With spool area at " l " and "2" being equal, pressure drop across orifice causes spool to shift toward area "2". As spool shifts, pump flow is metered thru drilled passage to area "3".

When the sum of forces in areas "2" and "3" equals force in area "l", spool remains in position and control pressure in area "3" remains constant" until engine RPM changes.

In this manner, control pressure cartridge provides a control pressure in proportion to engine speed.

Forward & Reverse Circuit Relief Valves



The drive pump port block includes a pair of pilot-operated relief valves to limit pressure to 5000)* psi

continued...

(5500* psi) in forward and reverse sides of circuit. A brief description of relief valve operation follows.

Circuit pressure acts on both the pilot poppet and main poppet at all times.

At pressure lower than relief setting:

- Circuit pressure is insufficient to force pilot poppet to compress its spring (spring preload determines relief setting).
- Main poppet cannot move because circuit pressure. exists on both sides of poppet, creating a hydraulic balance.
- No relief occurs because both poppets remain seated.

When circuit pressure reaches relief setting:

- Circuit pressure forces pilot poppet to compress its spring and move away from its seat.
- Circuit pressure behind floating poppet is vented past pilot poppet creating a pressure drop behind main poppet.
- High circuit pressure easily unseats main poppet permitting full relief flow.

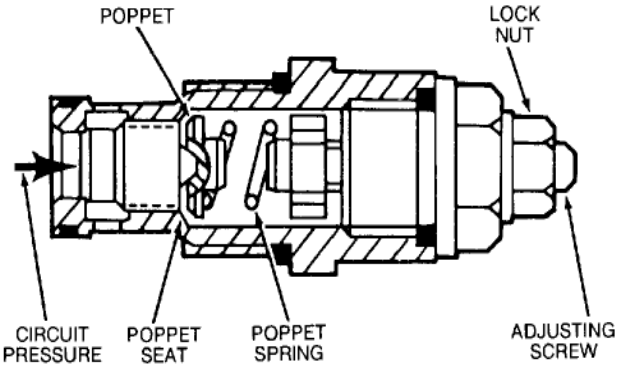
As circuit pressure is reduced, both poppets return to their seats to block relief flow.

These relief valves also serve an anti-cavitation function.

Cavitation in a circuit is normally accompanied by reduced pressure in that portion of circuit. Reduced pressure on both sides of main poppet permits return flow pressure to move main poppet sleeve to raise main poppet from its seat. This permits pressurized return flow to overcome cavitation.

***Refer to page ii to determine proper pressure.**

Charge Pump Relief Valve



The drive pump port block also includes a charge pump direct acting relief valve. A brief description of valve operation follows.

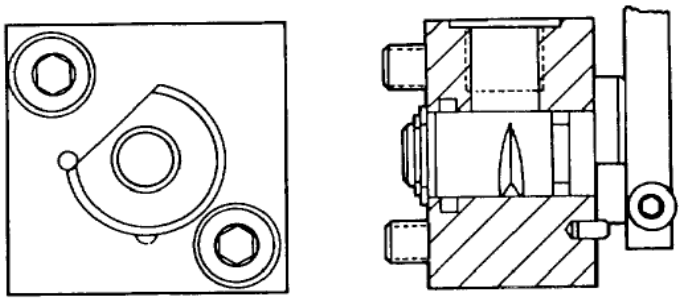
At pressures lower than relief setting:

- Circuit pressure is insufficient to force poppet to compress its spring (spring pre-load determines relief setting).
- With poppet resting on its seat, no relief flow occurs.

When Circuit Pressure Reaches Relief Setting:

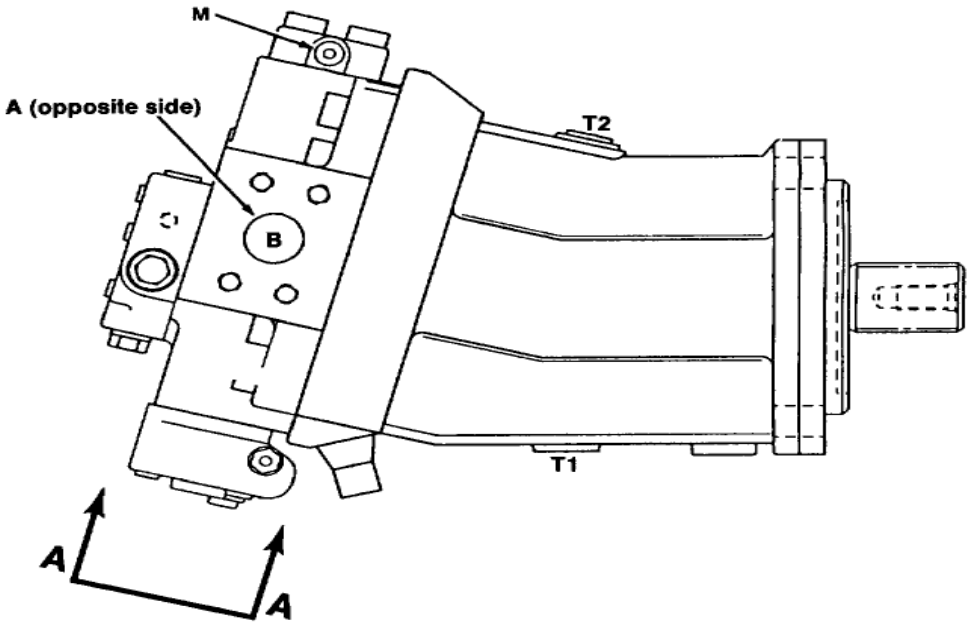
- Circuit pressure raises poppet from its seat.
- Relief flow is vented into pump case and returns to reservoir thru port T1. this flow helps to prevent overheating in drive circuit.

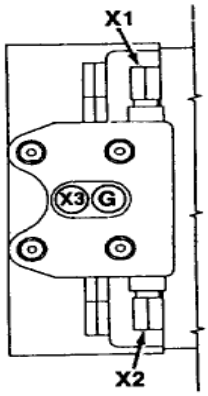
Inching Travel Valve



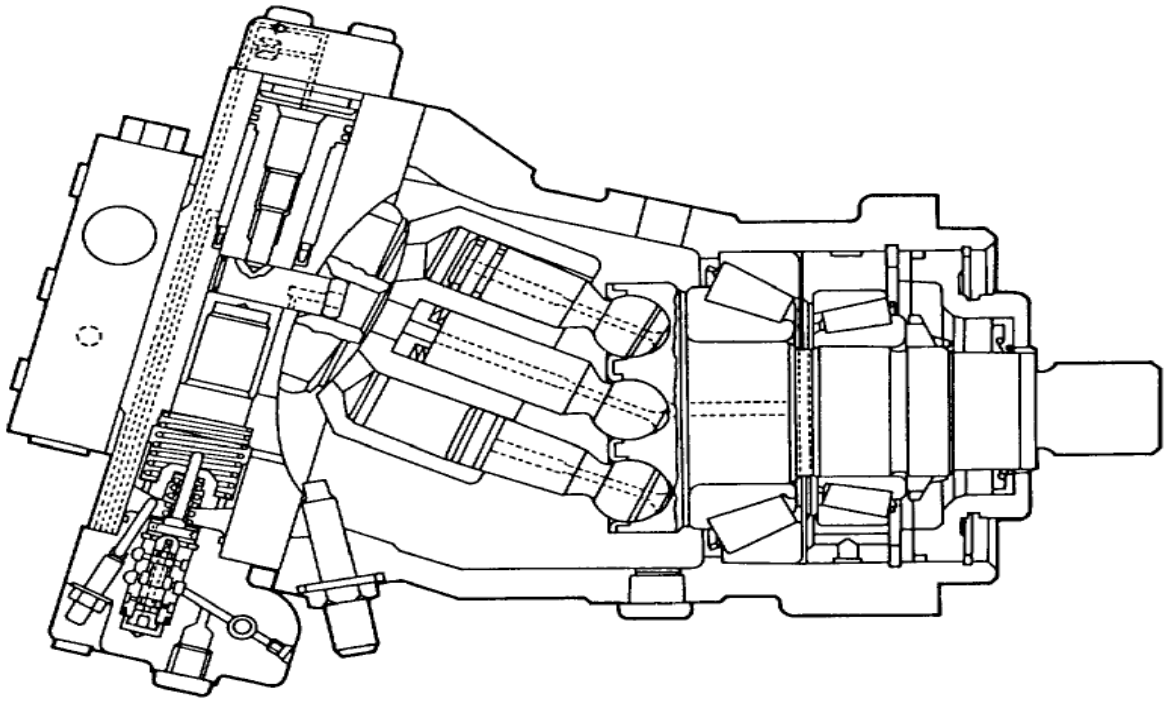
The inching travel valve is a simple rotary variable orifice valve. With valve arm fully forward flow between inlet port (control pressure) and outlet port is blocked. As arm is rotated to rear progressively greater flow is metered to outlet port. At full arm travel, all control pressure is being vented to reservoir and drive pump is at zero displacement.

Front Drive Motor





VIEW AA



ATTENTION

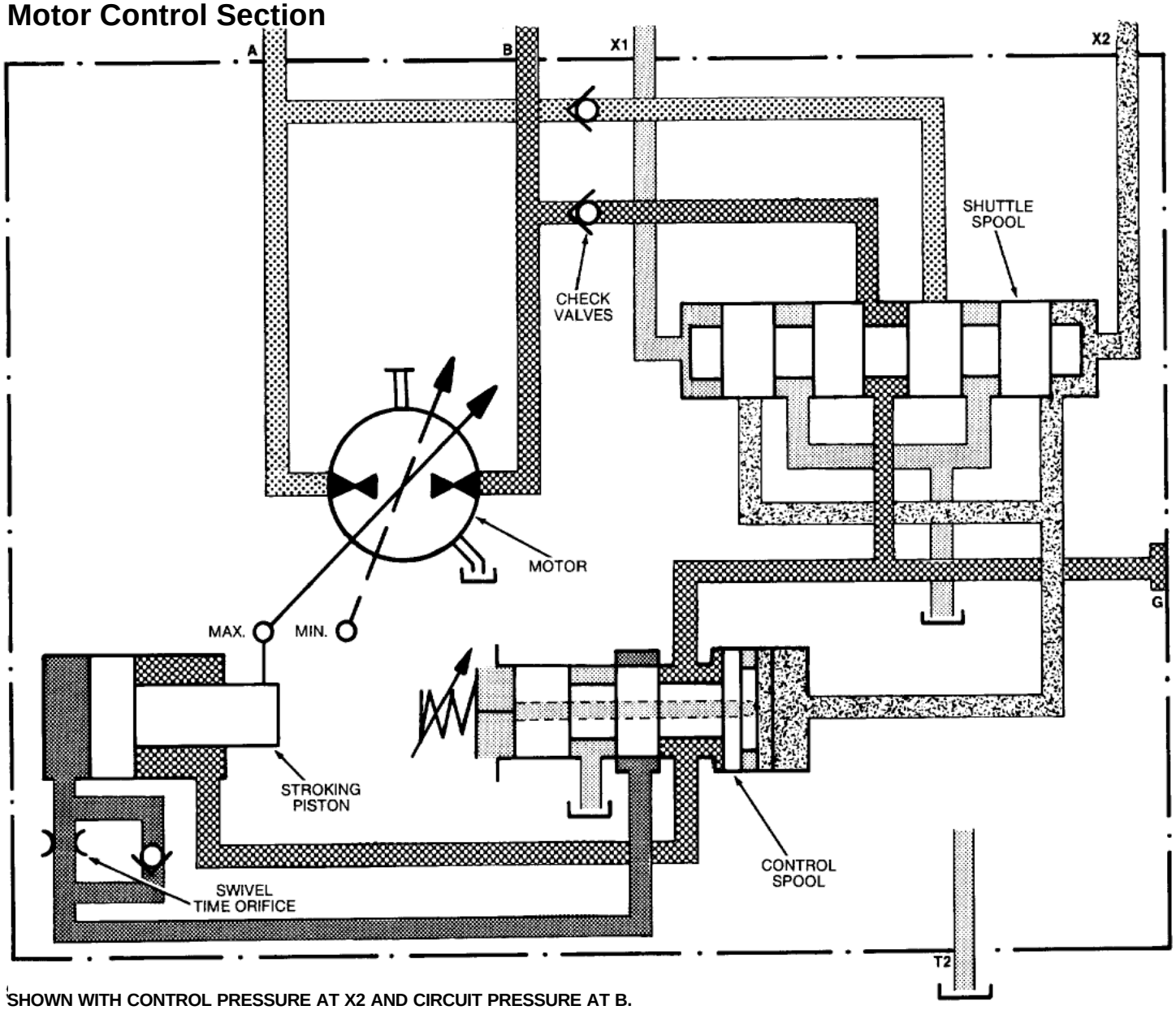
The front drive motor manufacturer (Rexroth) may not honor the one year warranty if motor is disassembled far enough to expose the piston rotary group.

Any service, repair or replacement must be performed under absolutely clean conditions

Port Identification

A Reverse work port
B Forward work port
G Forward/Reverse test port*
M Stroking pressure test port*
T1 Case drain port*
T2 Case drain port*
X1 Reserve control pressure port
X2 Forward control pressure port
X3 Control pressure test port*
*Plugged port

Motor Control Section



SHOWN WITH CONTROL PRESSURE AT X2 AND CIRCUIT PRESSURE AT B.

CONTROL PRESSURE CIRCUIT PRESSURE STROKING PRESSURE RETURN PRESSURE DRAIN

With drive circuit pressure at motor port **B**, control pressure is present at port **X2**.

Control pressure shifts shuttle spool to proper position for direction of travel. Control pressure also positions control spool for conditions.

Once shuttle spool has been shifted, drive circuit pressure will flow thru a 220 psi check valve and thru shuttle spool to arrive at control spool.

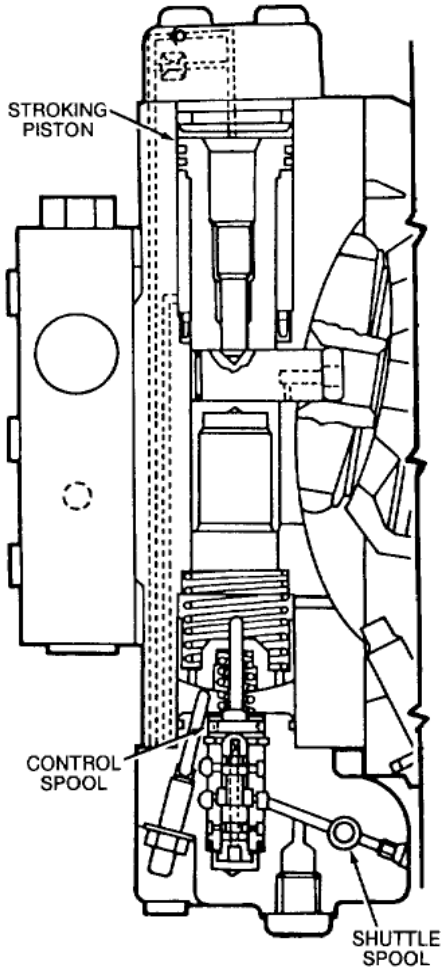
The control spool (positioned by control pressure) performs two functions:

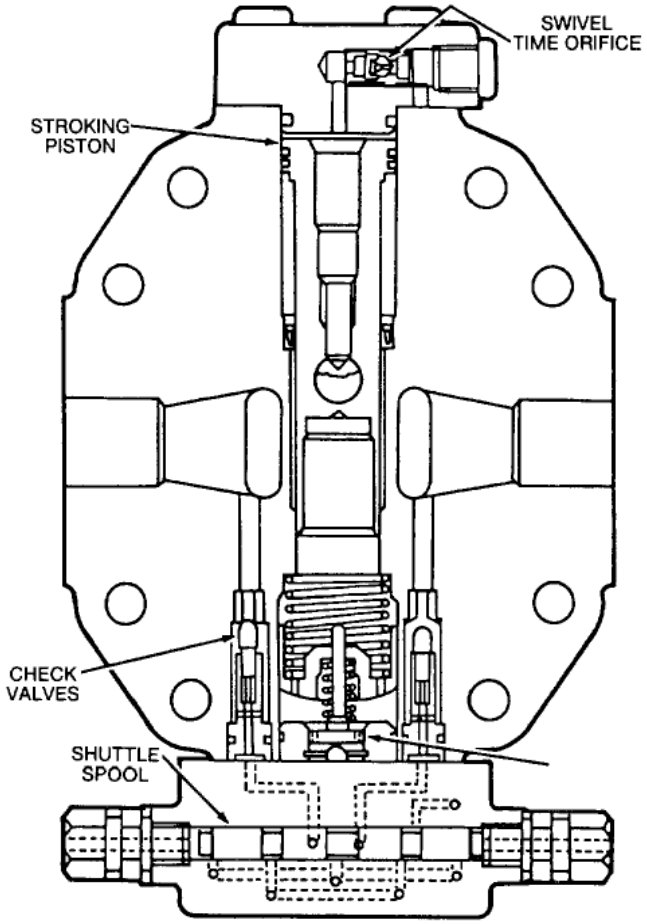
- It direct actual circuit pressure to small side (annular area) of stroking piston.
- It directs modified circuit pressure (stroking pressure) to large side (annular area) of stroking piston. Stroking pressure varies with control pressure; the greater the control pressure, the greater the shift of control spool; greater control spool shift causes greater stroking pressure.

The difference between annular areas of stroking piston causes a stroking ratio of 33:1 (3 psi control pressure equals 100 psi circuit pressure).

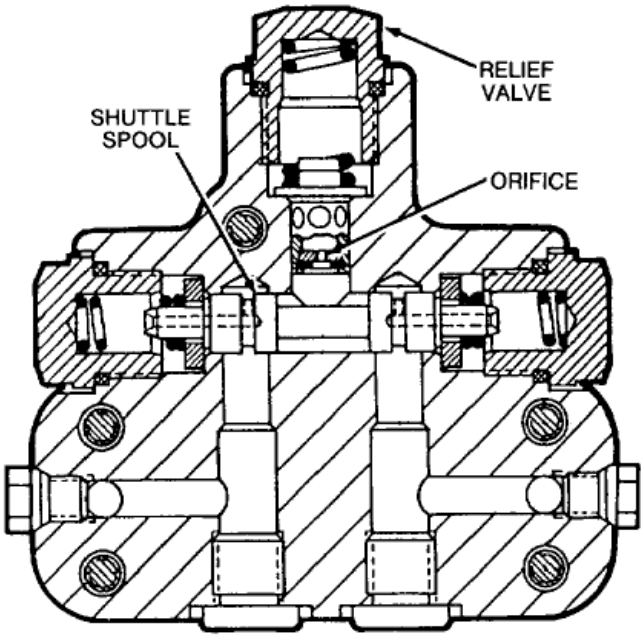
When starting from a standstill, circuit pressure will be high (resistance to acceleration) and control pressure will be low (low engine speed). These conditions cause circuit pressure to overcome control pressure and stroke motor toward maximum displacement (maximum torque).

As resistance to acceleration decreases and engine speed increases, control pressure shifts stroking piston against circuit pressure to decrease motor displacement and increase vehicle speed.





Flushing Valve Section



The flushing valve section is mounted on rear face of front drive motor and is ported directly to motor end cover. A pair of ports alternate as circuit pressure/ return connections and a third port connects to case drain.

The valve section includes a spring-centered shuttle spool and a direct-acting relief valve.

There is no flow thru flushing valve unless handler is traveling.

When drive circuit is operating in either forward or reverse, one of the circuit ports will receive circuit (drive pump) pressure and other circuit port will receive return pressure (320-480 psi).

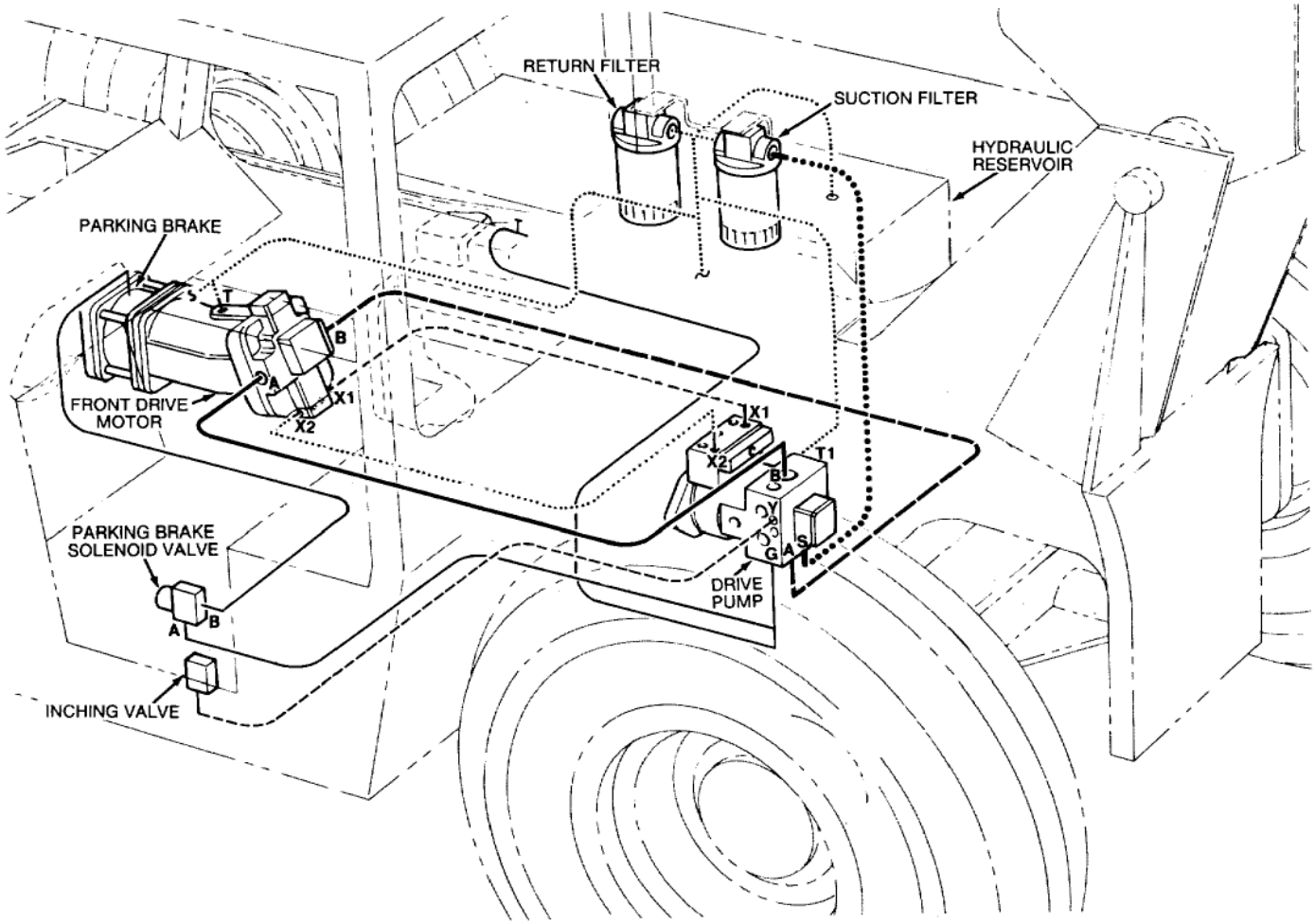
High pressure pasees thru drilled passages in shuttle spool and shifts spool to route return flow thru an orifice to relief valve.

Return flow easily unseats relief valve (set at 220 psi) to route relief flow to motor case. Relief valve orifice limits this flow to 2 gpm.

Relief flow returns to reservoir thru motor port **T2.**

Hydrostatic Drive Circuit (Reverse travel)

522 & 532C Only



SUCTION NOTE .....
CHARGE PUMP PRESSURE ———
CONTROL PRESSURE — — — — — — —
DRIVE PUMP PRESSURE ▬▬▬
DRIVE PUMP RETURN ▬ ▬ ▬ ▬ ▬ ▬
DRAIN .....

NOTE

REVERSE TRAVEL is shown-refer to previous circuit for **FORWARD TRAVEL.**

IMPORTANT NOTE

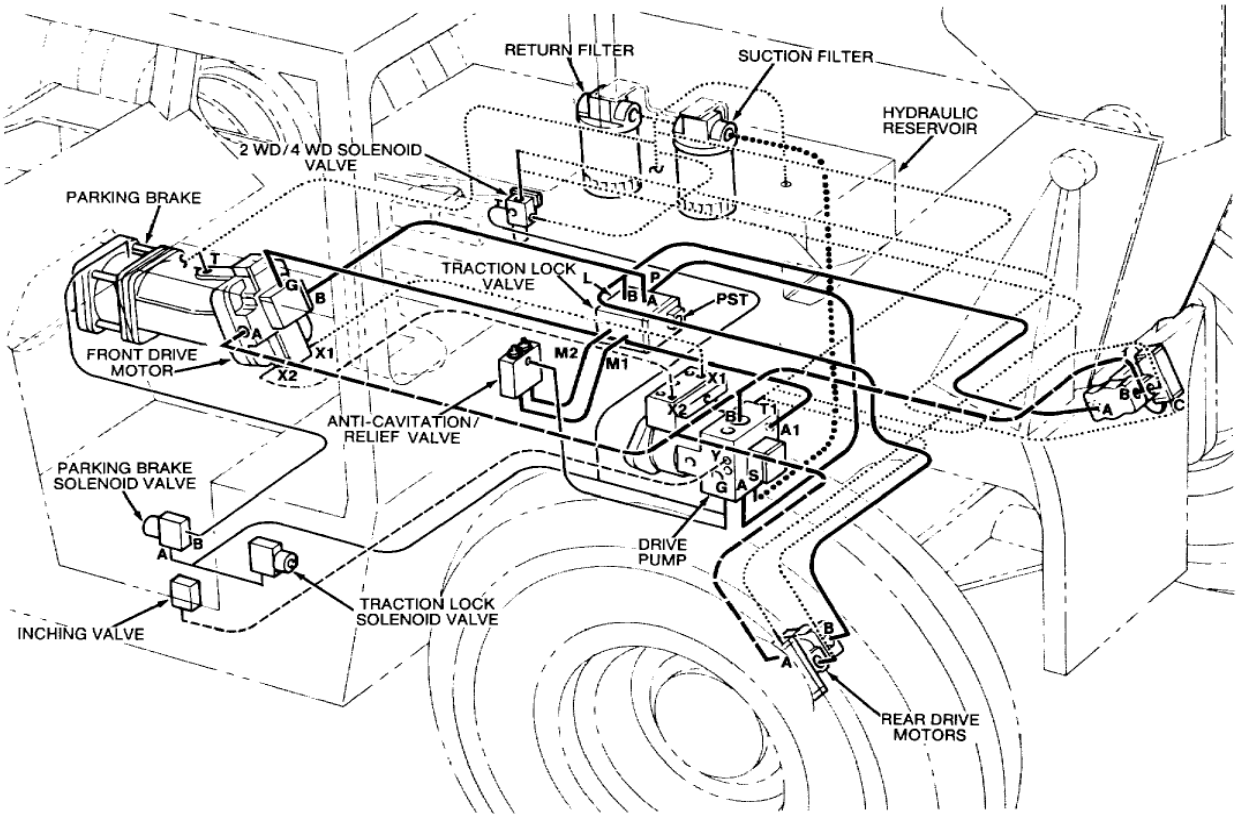
The forward travel version of this circuit provides detailed description of circuit. Information provided here covers only the differences between forward and reverse circuits.

For reverse travel, oil is routed from drive pump port **B** to drive motor port **A**. Return flow is from motor. port **B** to pump port **A**.

Control pressure is routed to drive motor thru ports **X1** of drive pump and motor.

Hydrostatic Drive Circuit (Forward travel)

For 524 units thru S/N 0177073 and For 534C-6 units thru S/N 0288250



SUCTION NOTE .....
CHARGE PUMP PRESSURE ———
CONTROL PRESSURE — — — — — — —
DRIVE PUMP PRESSURE ▬▬▬
DRIVE PUMP RETURN ▬ ▬ ▬ ▬ ▬ ▬
DRAIN .....

Model 524 and 534C handlers are equipped with hydrostatic drive to the front and rear axles. From the operator's standpoint, operation is similar to a vehicle with an automatic transmission; once direction of travel has been selected, engine speed determines vehicle speed.

The following general description provides a discussion of **what** happens within the circuit under - varying conditions. Greater detail of **how** things happen is provided under component descriptions.

The hydrostatic drive circuit can be considered as two separate circuits which interface in several areas. After a discussion of the drive loop we will cover the charge pump section of the circuit.

Three distinctly different pressures are discussed in following description:

NOTES

Forward travel is shown; refer to next circuit for reverse travel.

Conditions. Parking brake released, inching travel valve closed four wheel drive selected, traction lock switch Off and engine running at 1100 RPM or higher.

Implement circuit components are not shown.

- **Circuit Pressure** = pressure delivered from drive pump to drive motor to propell vehicle (limited to 5000* psi (5500* psi)

- **Charge Pump Pressure** = pressure delivered by charge pump to perform various charge circuit functions (limited to 320 - 480 psi)-this setting is established at 320 psi with engine at 800 RPM -flow characteristics of relief cartridge will allow charge pump pressures to reach 480 psi under certain conditions.

- **Control Pressure** = charge pump pressure as modified by control pressure cartridge (DA cartridge). This pressure (under varying conditions) will almost always be lower than charge pump pressure; it will never exceed charge pump pressure.

***Refer to page ii determine proper pressure.**

Major components of the drive loop include a variable-displacement axial piston pump which delivers flow thru a traction lock valve to a variable-displacement, bent-axis, piston-type front drive motor and a pair of two-position, piston-type rear drive motors.

The front drive motor delivers torque thru a parking brake assembly to the differential of front drive axle equipped with planetary wheel ends.

Rear drive motors are mounted directly to planetary hubs.

Also associated with rear drive are a pair of anti-cavitation relief valves, a traction lock solenoid valve and a two/four wheel drive solenoid valve.

Direction of travel is controlled by a solenoid-controlled forward/reverse module mounted on top surface of drive pump. Solenoids are controlled by a switch mounted on steering column.

The drive circuit is a closed loop which includes a flushing circuit. For forward travel, oil is routed from drive pump port **A**. thru traction lock valve to front and rear drive motors. Return oil from motors is routed directly to drive pump port **B.**

It should be noted that routing is different for reverse travel. Oil is routed from pump port **B** directly to motors and then thru traction lock valve to port **A** of pump.

Regardless of the direction of travel, a portion of return oil (up to 2 gpm) is returned to reservoir thru a flushing valve mounted on rear face of drive motor and port **T** of motor housing. This oil is replaced by cooled, filtered oil from charge pump circuit.

Forward and reverse sides of drive loop are protected by a pair of relief valves in drive pump to limit pressure to 5000* psi (***5500*psi***). These valves include an anti-cavitation feature which permits charge pump to provide make-up oil to return side of drive loop.

Since charge pump pressure will be between 320 and 480 psi, oil in return side of loop would be raised to a similar pressure. Return oil eliminates cavitation and provides positive supply to inlet side of drive pump.

The pair of block-mounted anti-cavitation relief valves is used to provide additional protection to rear drive motors when operating with traction lock feature engaged.

As with other piston equipment, the greater the pump displacement and the less the motor displacement, the greater the vehicle speed. Reducing pump displacement and increasing motor displacement, reduces vehicle speed while increasing drive torque.

However, when unit is operating in four wheel drive mode, rear drive motors are stroked to maximum displacement by internal spring loading. When two wheel drive is selected, charge pressure is applied control (C) ports of motors to overcome springs and shift to minimum displacement.

The hydrostatic drive circuit receives all required flow thru the suction filter and most oil reaching the suction filter has already passed thru the return filter.

Oil is drawn from suction filter to port S of drive pump by a charge pump mounted on rear face of drive pump. Flow/pressure from charge pump is always directly proportional to engine RPM.

The charge pump circuit performs several important functions:

- Provides pilot pressure for joystick control
- Provides pilot pressure to release parking brake
- Provides proper control pressure to stroke drive pump and motor displacement for varying conditions
- Provides cooled make-up oil as required to prevent cavitation and overheating in drive loop
- Pressurizes return flow for positive supply to inlet side of drive pump
- Provides pilot pressure thru traction lock solenoid valve to engage traction lock valve
- Provides pilot pressure thru 2/4 wheel drive solenoid valve to shift rear drive motors to minimum displacement

At low idle (approximately 800 RPM) charge pump provides 320 psi which is ample to release parking brake. Oil is routed thru port **G** of drive pump to port **A** of parking brake solenoid valve. When valve is energized, oil is routed thru port **B** to parking brake.

The charge pump circuit includes a control pressure cartridge (DA cartridge) to modify charge pump pressure and provide proper control (stroking) pressure for drive pump and motor.

*Refer to page ii to determine proper pressure.

When engine speed is raised to 1100 RPM, charge pump pressure is sufficient to activate control pressure cartridge which senses engine speed by measuring charge pump flow/pressure.

The control pressure cartridge converts charge pump pressure to control (stroking) pressure. Control pressure is also directly proportional to engine speed and is used to adjust dave pump and front drive motor displacement properly for conditions of the moment.

The greater the control pressure, the greater the vehicle speed; under high control pressure, drive pump is stroked toward maximum displacement and front drive motor is stroked toward minimum displacement.

Control pressure is routed to drive pump stroking piston within pump housing and control pressure is routed to drive motor stroking piston thru ports **X2** of front drive pump and motor.

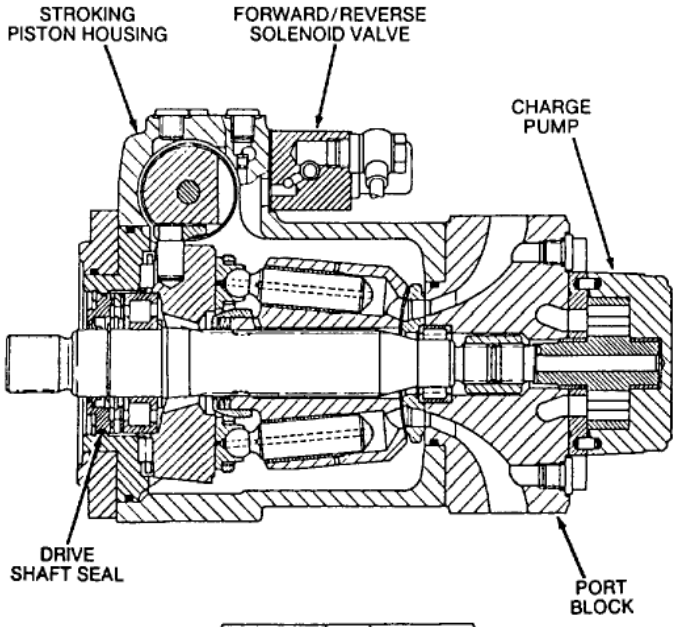
When actuated (opened), inching travel valve directs control pressure to reservoir. The greater the actuation the greater the pressure loss. With no control pressure, the drive pump and motor provide no drive torque to differential.

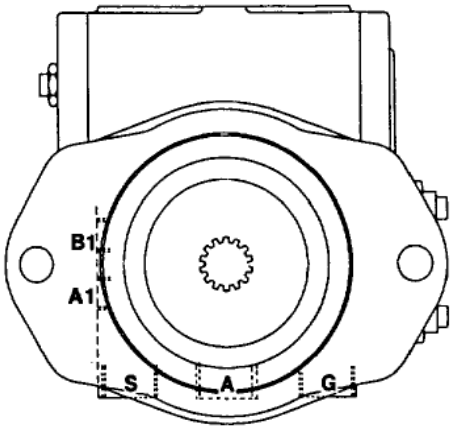
Drive circuit pressure also affects displacement of front drive front drive motor. As circuit pressure increases (as in traveling an up-grade) circuit pressure can alter control pressure applied to stroking piston; under high circuit pressure, motor displacement will be vehicle speed;

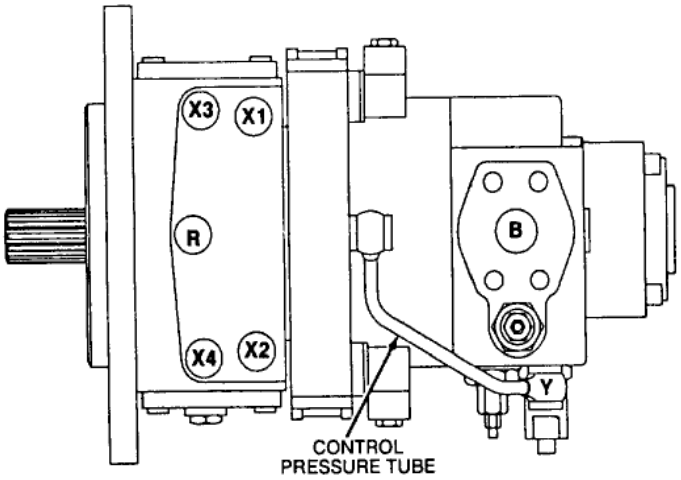
Any charge pump flow not required to replenish drive loop flows over charge pump relief valve (located on upper surface of drive pump) and returns to reservoir thru port **T1** of drive pump. This flow serves to further prevent overheating of drive circuit.

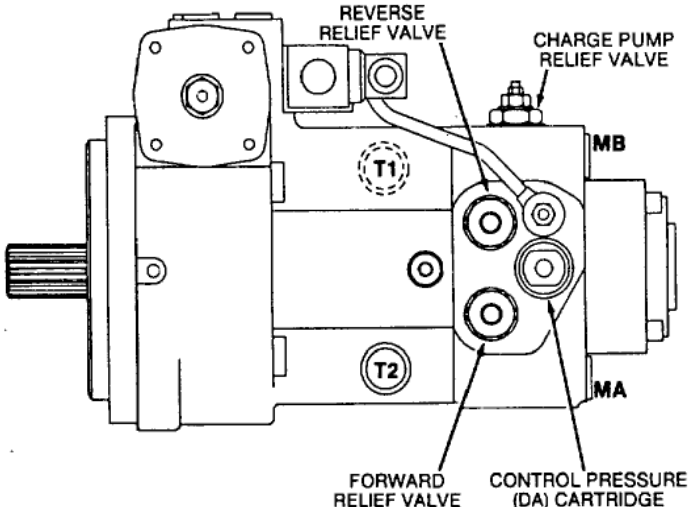
continued...

DRIVE PUMP









Note: On recent units, plugs in ports **MA & MB** have been replaced with Mini-Check Test Ports.

ATTENTION

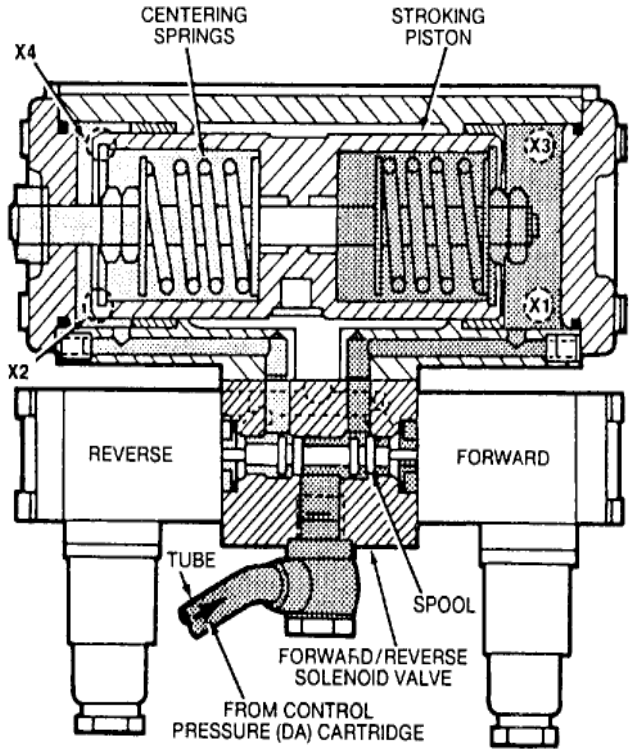
The drive pump manufacturer (Rexroth) may not honor the one year warranty on pump if it has been disassembled far enough to expose the piston rotary group.

Any service, repair or replacement must be performed under absolutely clean conditions.

Port Identification

A Forward work port
Al Forward auxiliary port*
B Reverse work port
B1 Reverse auxiliary port*
G Charge pump pressure port
MA Forward test port*
MB Reverse test port*
R Case vent port*
S Charge pump suction port
Tl Case drain port
T2 Case drain port*
X2 Forward control pressure test port*
X3 Reverse control pressure test port*
X4 Forward control pressure port
Y Control pressure port

* Plugged port



Control pressure is routed from control pressure cartridge thru tube to forward/reverse solenoid.

With forward/neutral/reverse switch in neutral position, control pressure is blocked at solenoid valve spool and centering springs hold stroking piston in neutral position.

The position of stroking piston determines two things:

- The direction pump swash plate will be stroked (for forward travel or for reverse travel)
- The extent to which swash plate will be stroked (from minimum displacement to maximum displacement)

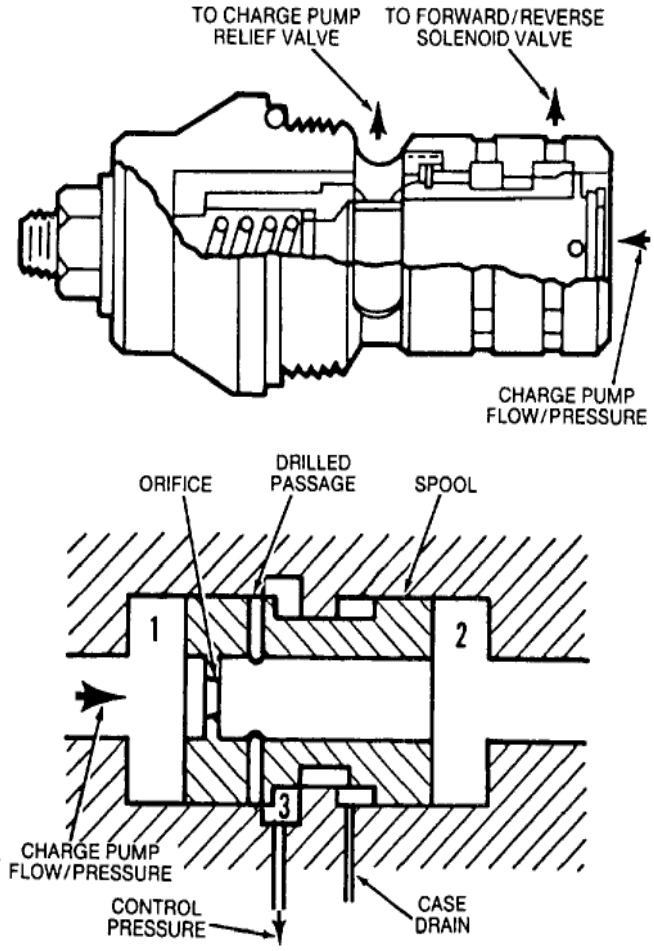
With forward/neutral/reverse switch in reverse position, solenoid valve spool directs control pressure to **X1** side of stroking piston.

As stated earlier, control pressure is in direct proportion to engine RPM. If the operator wants more vehicle speed, he depresses the accelerator pedal more; more pedal = more engine RPM = more control pressure = more pump displacement = more vehicle speed.

With **X1** side of stroking piston pressurized, **X2** side of piston is open to pump case drain (**T1** port).

To prevent sudden changes in vehicle speed (potentially dangerous for material handler operation) "swivel time orifices" are provided on each side of stroking piston to slow movement of stroking piston. Although sudden braking is available, orifices prevent abrupt changes in vehicle speed caused by inappropriate use of accelerator pedal.

CONTROL PRESSURE (DA) CARTRIDGE



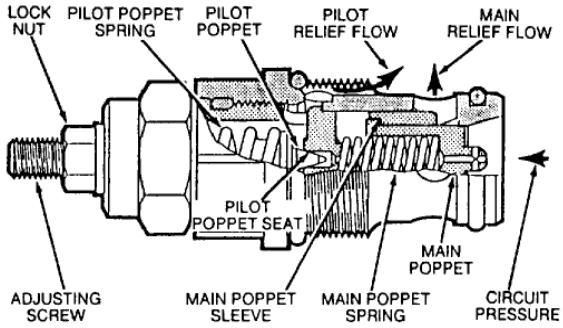
Control Pressure (DA) Cartridge

Charge pump flow/pressure enters control pressure cartridge and flows thru orifice in spool. With spool area at "l" and "2" being equal, pressure drop across orifice causes spool to shift toward area"2". As spool shifts, pump flow is metered thru drilled passage to area "3".

When the sum of pressures in areas "2" and "3" equals pressure in area "1" spool remains in position and control pressure in area "3" remains constant until engine RPM changes.

In this manner, control pressure cartridge provides a control pressure in proportion to engine speed.

Forward & Reverse Circuit Relief Valves



The drive pump port block includes a pair of pilot-operated relief valves to limit pressure to 5000* psi

(5500* psi) in forward and reverse sides of circuit. A brief description of relief valve operation follows.

Circuit pressure acts on both the pilot poppet and main poppet at all times.

At pressure lower than relief setting:

Circuit pressure is insufficient to force pilot poppet to compress its spring (spring preload determines relief setting).

Main poppet cannot move because circuit pressure exists on both sides of poppet, creating a hydraulic balance.

No relief occurs because both poppets remain seated.

When circuit pressure reaches relief setting:

- Circuit pressure forces pilot poppet to compress its spring and move away from its seat.
- Circuit pressure behind floating poppet is vented past pilot poppet creating a pressure drop behind main poppet.
- High circuit pressure easily unseats main poppet permitting full relief flow.

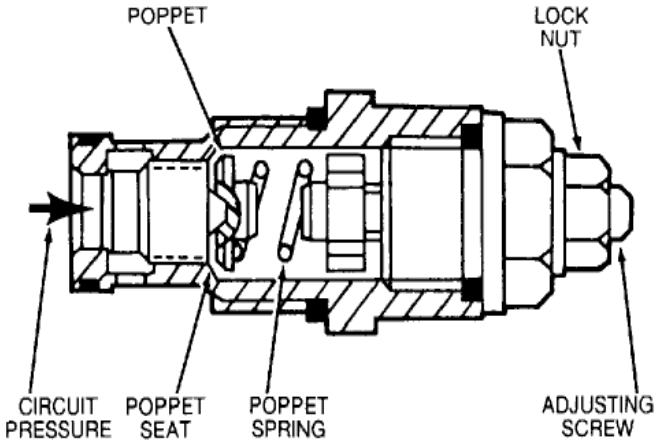
As circuit pressure is reduced, both poppets return to their seats to block relief flow.

These relief valves also serve an anti-cavitation function.

Cavitation in a circuit is normally accompanied by reduced pressure in that portion of circuit. Reduced pressure on both sides of main poppet permits return flow pressure to move main poppet sleeve to raise main poppet from its seat. This permits pressurized return flow to overcome cavitation.

***Refer to page ii to determine proper pressure**

A Charge Pump Relief Valve



The drive pump port block also includes a charge pump direct acting relief valve. A brief description of valve operation follows.

At pressures lower than relief setting:

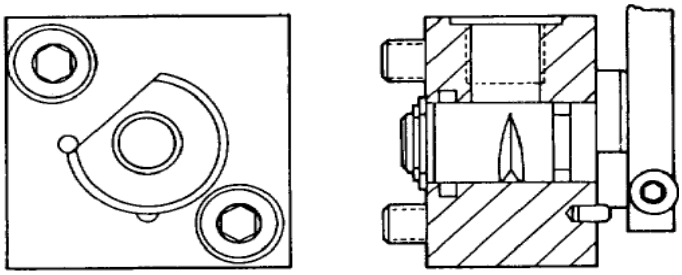
- Circuit pressure is insufficient to force poppet to compress its spring (spring pre-load determines relief setting).
- With poppet resting on its seat, no relief flow occurs.

When circuit pressure reaches relief setting:

Circuit pressure raises poppet from its seat.

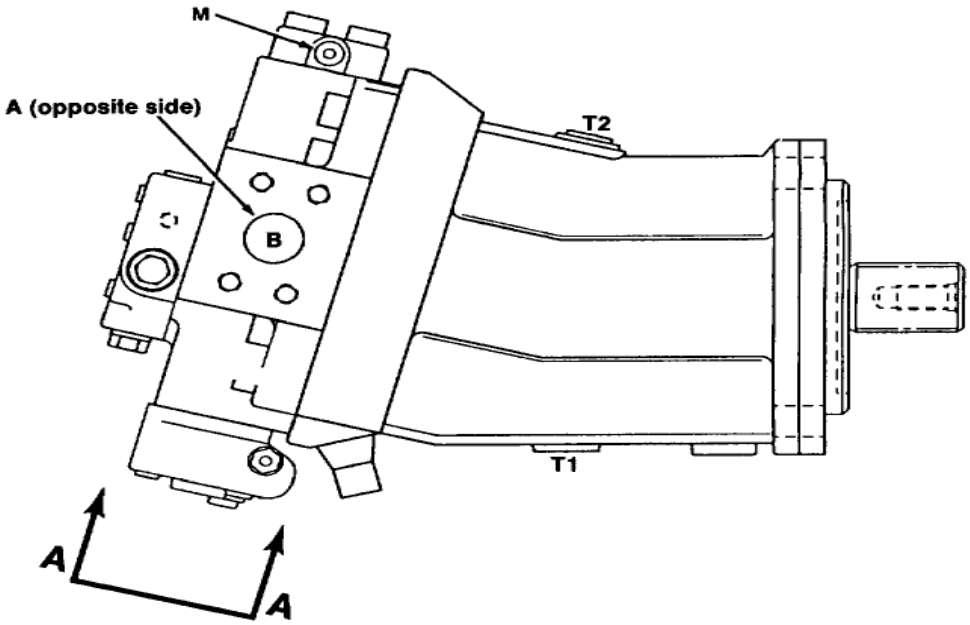
Relief flow is vented into pump case and returns to reservoir thru port T1. This flow helps to prevent overheating in drive circuit.

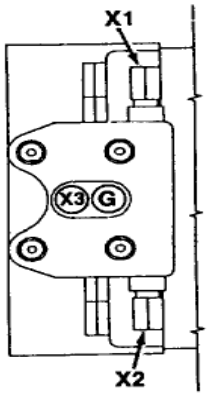
Inching Travel Valve



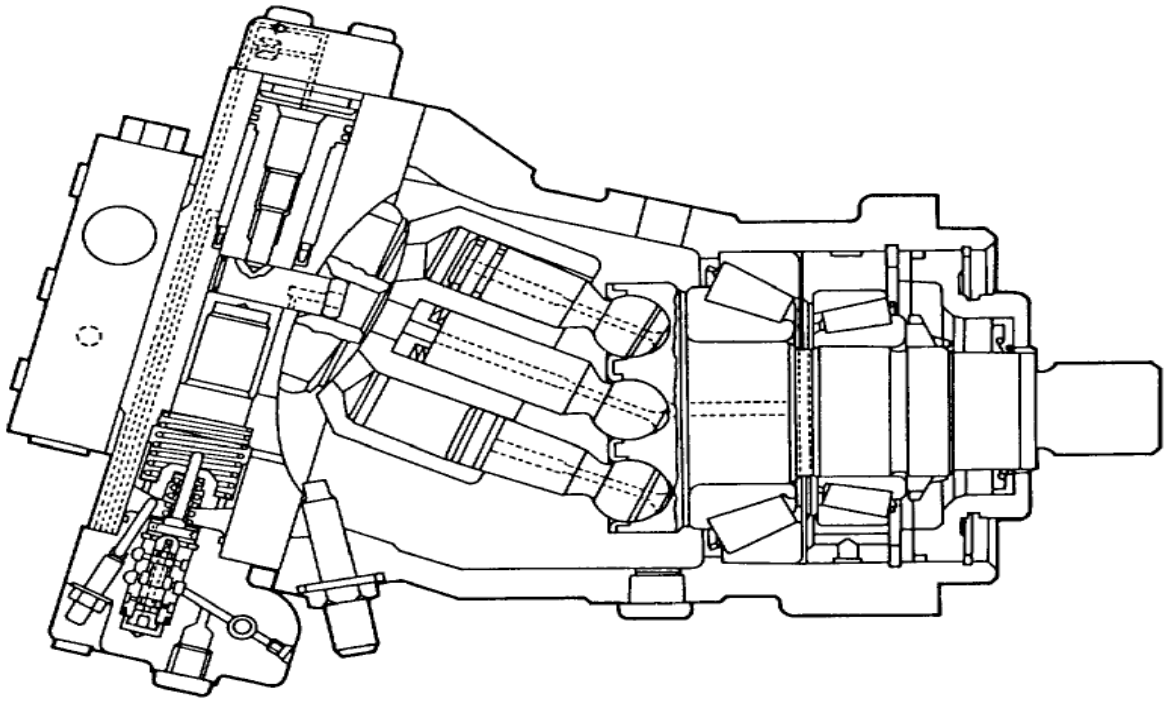
The inching travel valve is a simple rotary variable orifice valve. With valve arm fully forward flow between inlet port (control pressure) and outlet port is blocked. As arm is rotated to rear progressively greater flow is metered to outlet port. At full arm travel, all control pressure is being vented to reservoir and drive pump is at zero displacement.

Front Drive Motor





VIEW AA



ATTENTION

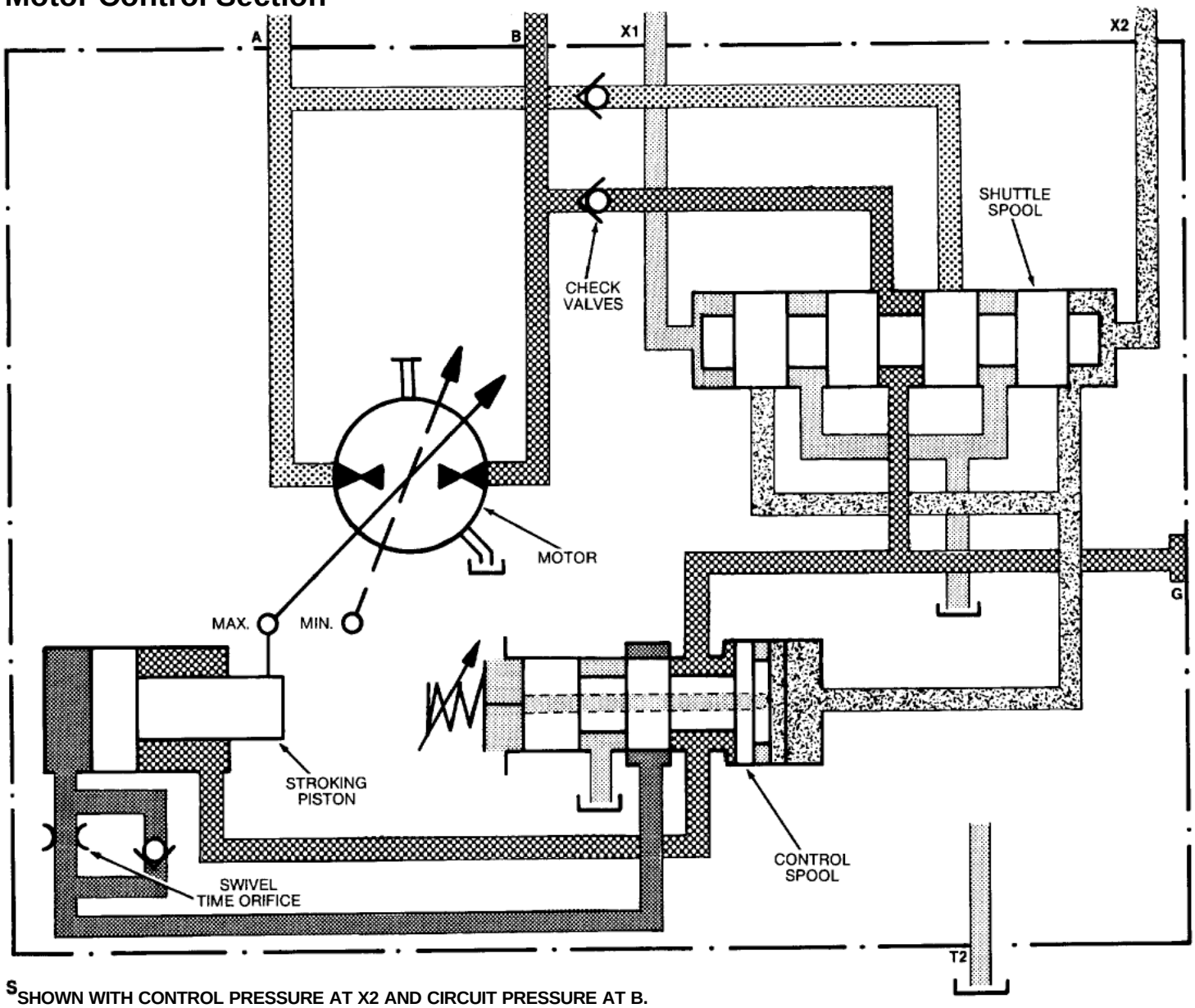
The front drive motor manufacturer (Rexroth) may not honor the one year warranty if motor is disassembled far enough to expose the piston rotary group.

Any service, repair or replacement must be performed under absolutely clean conditions

Port Identification

A Reverse work port
B Forward work port
G Forward/Reverse test port*
M Stroking pressure test port*
T1 Case drain port*
T2 Case drain port*
X1 Reserve control pressure port
X2 Forward control pressure port
X3 Control pressure test port*
*Plugged port

Motor Control Section



SHOWN WITH CONTROL PRESSURE AT X2 AND CIRCUIT PRESSURE AT B.

CONTROL PRESSURE | CIRCUIT PRESSURE | STROKING PRESSURE | RETURN PRESSURE | DRAIN

With drive circuit pressure at motor port **B**, control pressure is present at port **X2**.

Control pressure shifts shuttle spool to proper position for direction of travel. Control pressure also positions control spool for conditions.

Once shuttle spool has been shifted, drive circuit pressure will flow thru a 220 psi check valve and thru shuttle spool to arrive at control spool.

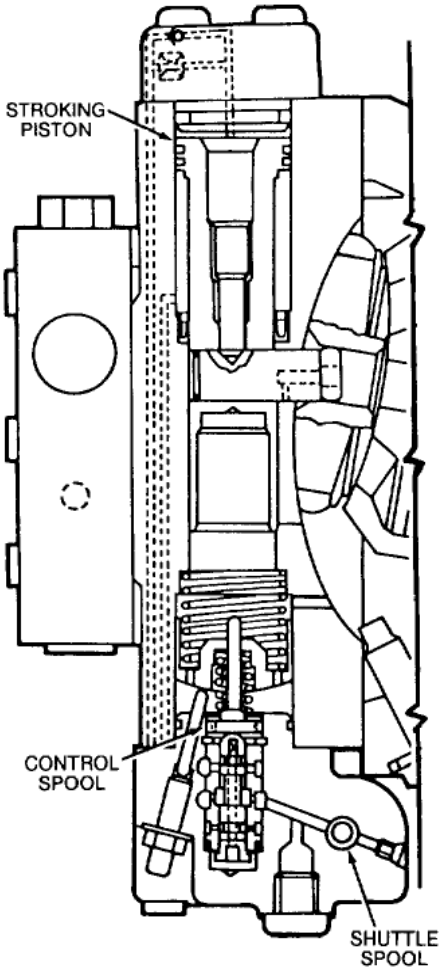
The control spool (positioned by control pressure) performs two functions:

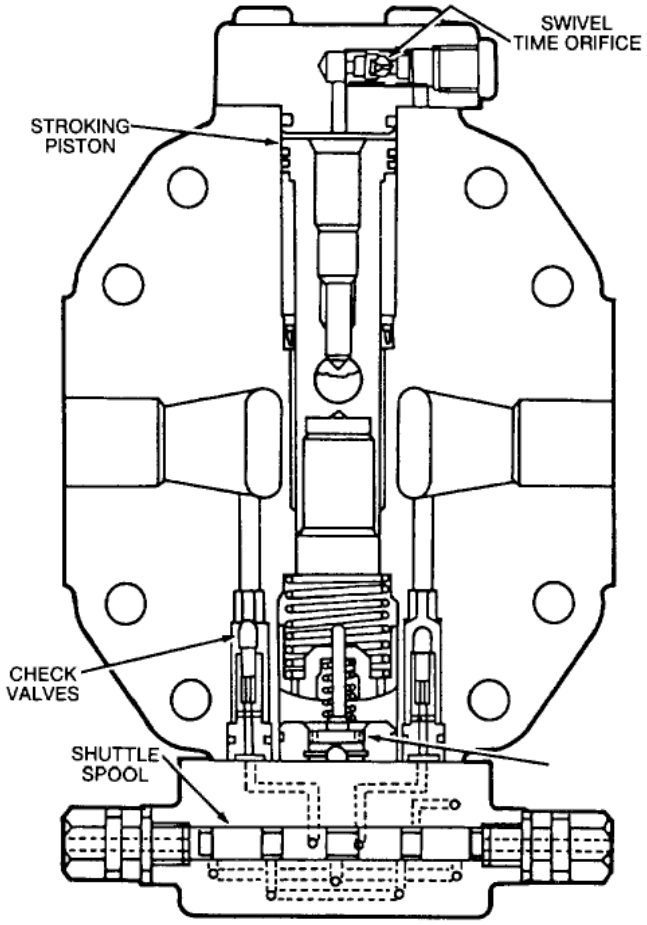
- It direct actual circuit pressure to small side (annular area) of stroking piston.
- It directs modified circuit pressure (stroking pressure) to large side (annular area) of stroking piston. Stroking pressure varies with control pressure; the greater the control pressure, the greater the shift of control spool; greater control spool shift causes greater stroking pressure.

The difference between annular areas of stroking piston causes a stroking ratio of 33:1 (3 psi control pressure equals 100 psi circuit pressure).

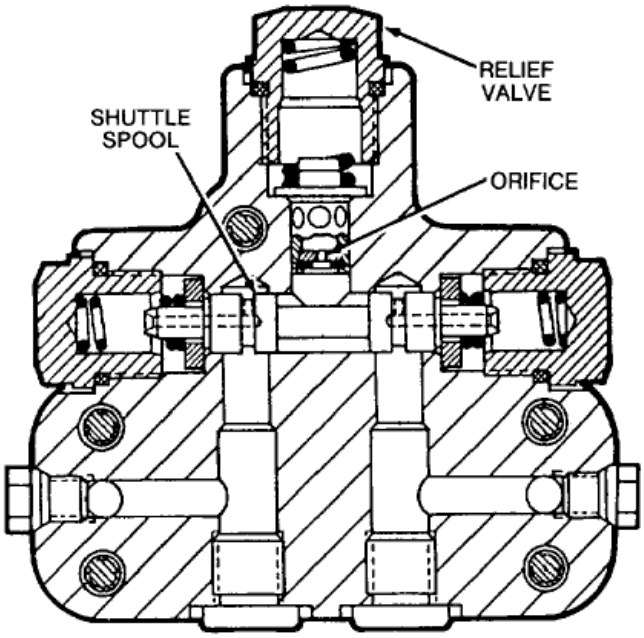
When starting from a standstill, circuit pressure will be high (resistance to acceleration) and control pressure will be low (low engine speed). These conditions cause circuit pressure to overcome control pressure and stroke motor toward maximum displacement (maximum torque).

As resistance to acceleration decreases and engine speed increases, control pressure shifts stroking piston against circuit pressure to decrease motor displacement and increase vehicle speed.





Flushing Valve Section



The flushing valve section is mounted on rear face of front drive motor and is ported directly to motor end cover. A pair of ports alternate as circuit pressure/ return connections and a third port connects to case drain.

The valve section includes a spring-centered shuttle spool and a direct-acting relief valve.

There is no flow thru flushing valve unless handler is traveling.

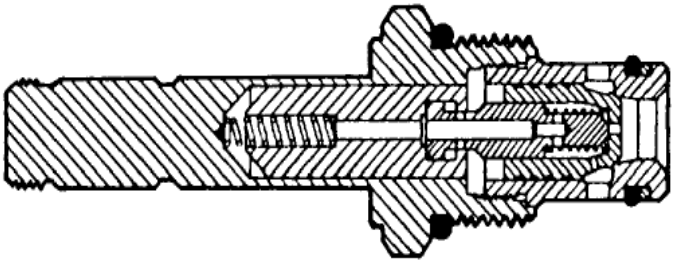
When drive circuit is operating in either forward or reverse, one of the circuit ports will receive circuit (drive pump) pressure and other circuit port will receive return pressure (320-480 psi).

High pressure pasees thru drilled passages in shuttle spool and shifts spool to route return flow thru an orifice to relief valve.

Return flow easily unseats relief valve (set at 220 psi) to route relief flow to motor case. Relief valve orifice limits this flow to 2 gpm.

Relief flow returns to reservoir thru motor port **T2.**

Traction Lock Solenoid Valve

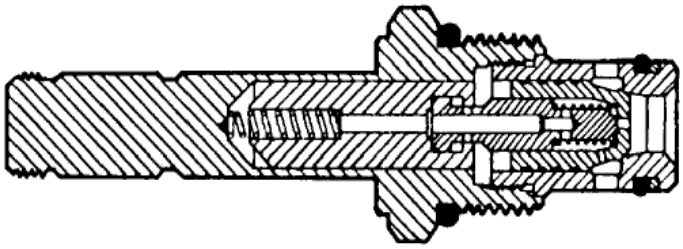


CARTRIDGE SHOWN MINUS COIL & VALVE BLOCK

With traction lock solenoid valve in OFF (released) position, solenoid is not energized and port **B** is open to port **C** to vent pilot signal from traction lock valve and deactivate valve.

With traction lock solenoid valve in ON (depressed) position, solenoid is energized and port **A** is open to port **B** to provide pilot signal and activate traction lock valve.

2/4 Wheel Drive Solenoid Valve

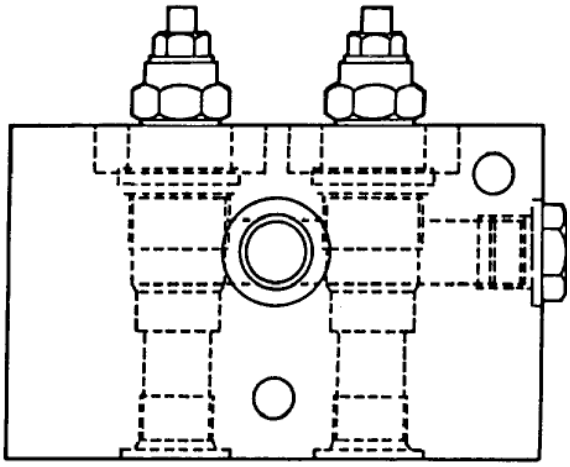


CARTRIDGE SHOWN MINUS COIL & VALVE BLOCK

With 2/4 wheel drive solenoid valve switch in 2WD position, solenoid is not energized and port **C** is open to port **B** to apply charge pressure to control ports of rear drive motors to shift motors to minimum displacement.

With 2/4 wheel drive solenoid valve switch in 4WD position, solenoid is energized and port **B** is open to to port **A** to vent pilot signal from rear drive motors and permit springs to shift motors to maximum displacement.

High Pressure Relief Anti-Cavitation Valves



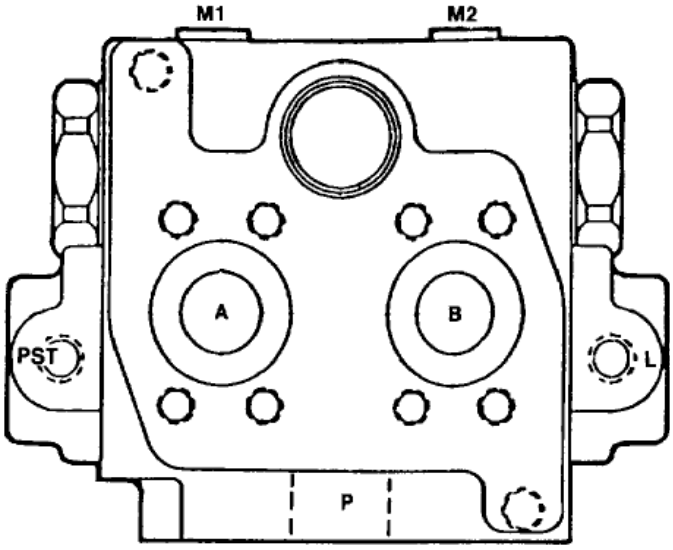
As stated earlier, the primary function of these valves is to provide additional protection when operating with traction lock feature engaged.

The valve cartridges are nearly identical to those described on page 49 and method of operation is exactly the same . There are two differences to be observed:

- These valves are set to relieve at *5220 psi (*5800 psi).
- Relief flow overcomes charge pump pressure and relieved pressure is vented thru charge pump relief valve.

***Refer to page ii to determine proper pressure.**

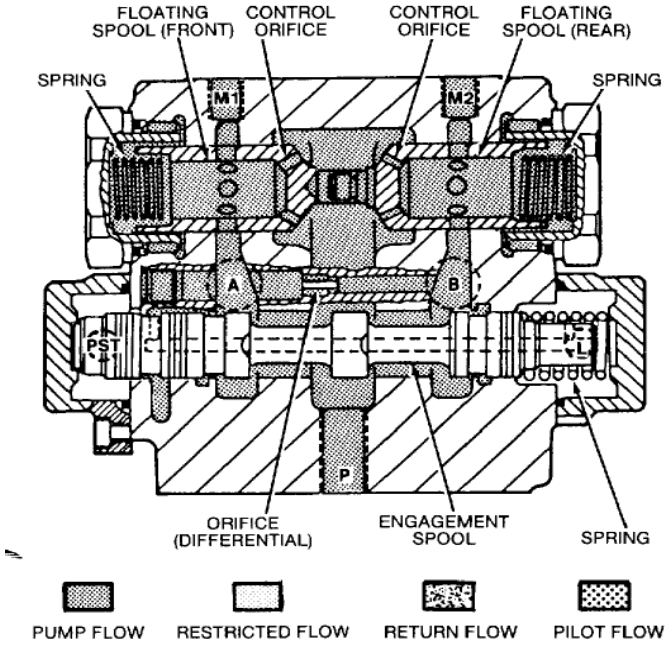
Traction Lock Valve



Port Identification

A Pump pressure to front drive motor (forward)
A Return from front drive motor (reverse)
B Pump pressure to rear drive motors (forward)
B Return from rear drive motors (reverse)
L Drain
M1 Rear drive circuit pressure to relief valve
M2 Front drive circuit pressure to relief valve
P Drive pump pressure/flow
PST Pilot from solenoid valve

The circuit flow diagram for this circuit (page 55) shows the traction lock valve disengaged. If valve were engaged, flow diagram would include a pilot signal from traction lock solenoid valve port **B** to traction lock valve port **PST**. Also, a drain fine would be shown from traction lock valve port **L**.

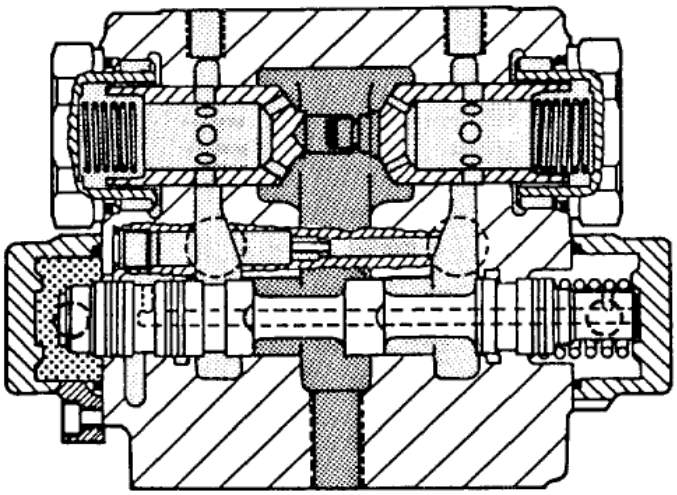


CONDITIONS: Forward travel, traction lock valve **disengaged** and **no** wheels spinning.

With traction lock valve disengaged, engagement spool routes pump flow directly to work port **A** (front drive) and **B** (rear drive). In this conditions, very little flow passes thru floating spools.

A drilled passage between chambers **A** and **B** contains an orifice to permit a slight flow between the chambers. This flow acts as a hydraulic inter-axle differential by providing make-up oil as needed.

If a wheel were to lose traction and spin, it would continue to spin until traction is restored.



CONDITIONS:Forward travel, traction lock valve **engaged** and **no** wheels spinning.

With traction lock switch depressed, solenoid valve is energized and charge pump pressure is routed to traction lock valve port **PST.**

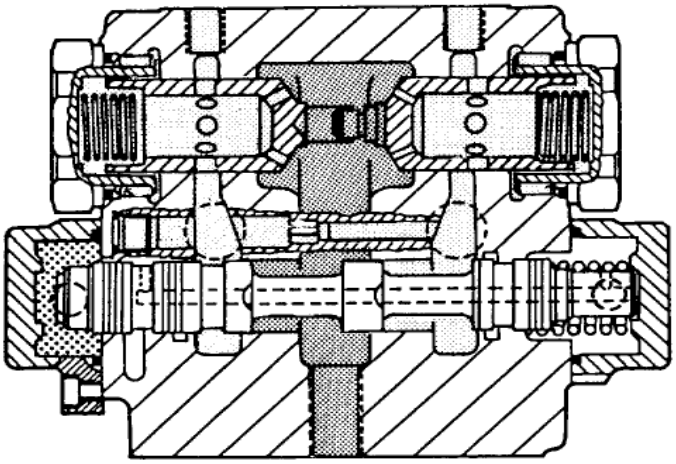
Pressure shifts engagement spool to block direct pump flow to work ports **A** and **B.** Now pump flow must pass thru floating spools to reach work ports.

Note that control orifice in rear drive floating spool is smaller than that in forward drive floating spool.

A pressure-drop occurs on the downstream (spring side) of both floating spools.

Spool shift (determined by size of control orifice) is designed to provide *35% (*50%) of pump flow to rear drive motors and *65% (*50%) to front motor. This flow causes equal speed of frongt and rear wheels with motors at maximum displacement.

***Refer to page ii to determine proper percentage.**



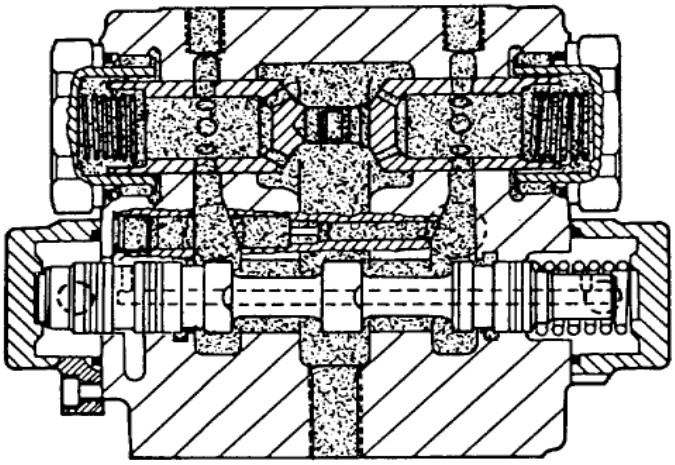
CONDITIONS: Forward travel, traction lock valve **engaged** and one or both **rear wheels spinning.**

Note that, with one or both rear wheels spinning, flow thru rear drive control orifice increases (path of least resistance). The greater the flow, the greater the pressure-drop. The greater the pressure-drop, the greater the spool shift against spring.

Under these conditions, rear drive floating spool shifts far enough to block most flow to rear drive motors; there will be only enough flow to maintain lubrication and cooling.

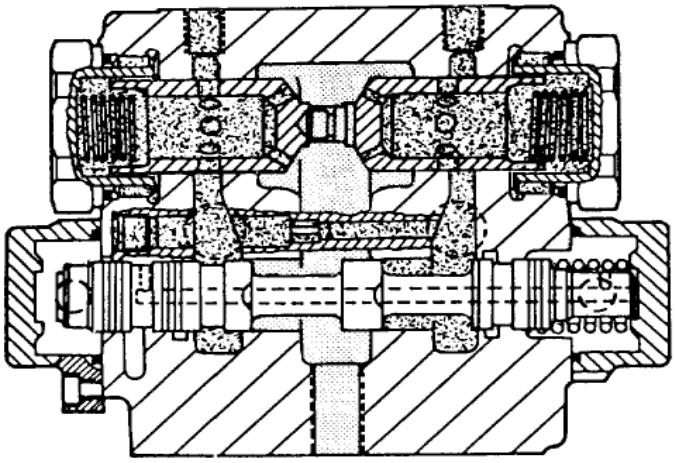
Blockage of flow to rear motors is sufficient to maintain pressurized flow to drive front motor.

Alternatively, if a **front wheel** were spinning, **front floating spool** would shift to ensure adequate pressure/flow to rear drive motors.



CONDITIONS: Reverse travel, traction lock valve **disengaged** and **no wheels spinning.**

Under these conditions, return flow is **from** drive motors, thru traction lock valve to pump. In this case, flow thru floating spool control orifices causes spools to move toward each other rather than apart.

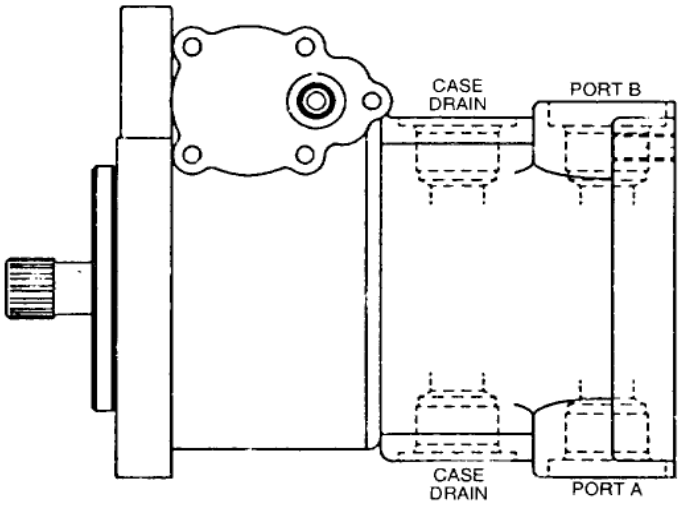


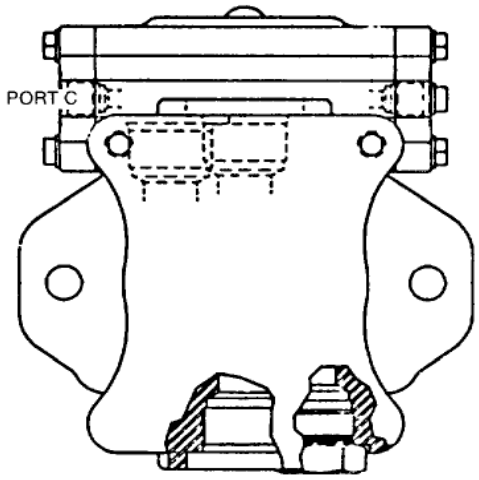
CONDITIONS: Reverse travel, traction lock valve **engaged** and one or both **rear wheels spinning.**

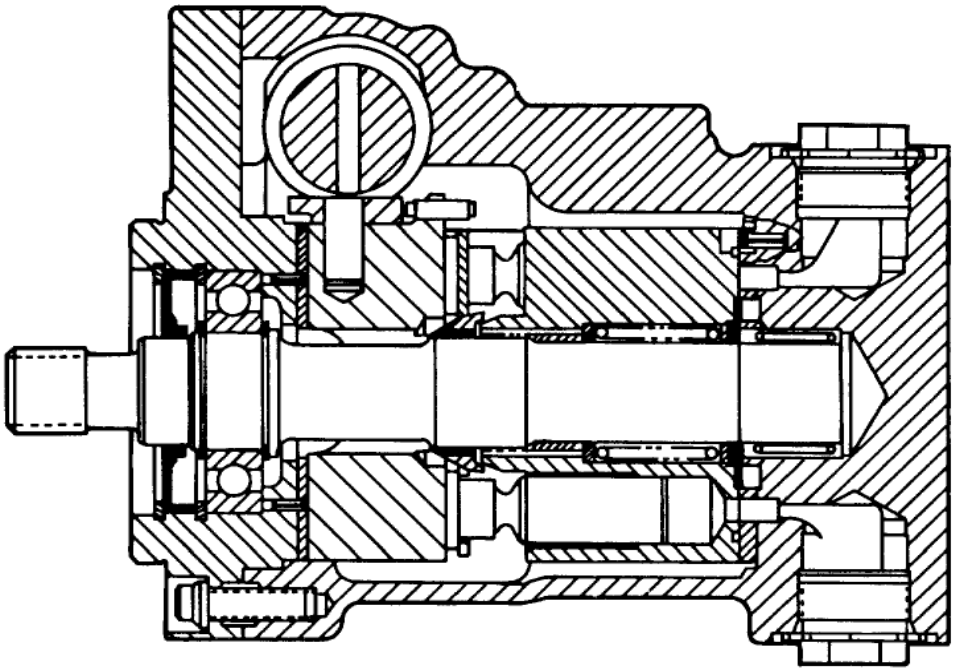
Under these conditions, rear drive floating spool shifts far enough to block most flow from rear drive motors; there will be only enough flow to maintain lubrication and cooling.

Blockage of flow from rear motors is sufficient to maintain pressurized flow to drive front motor.

Rear Drive Motors







Rear drive motors are two-position, piston-type motors.

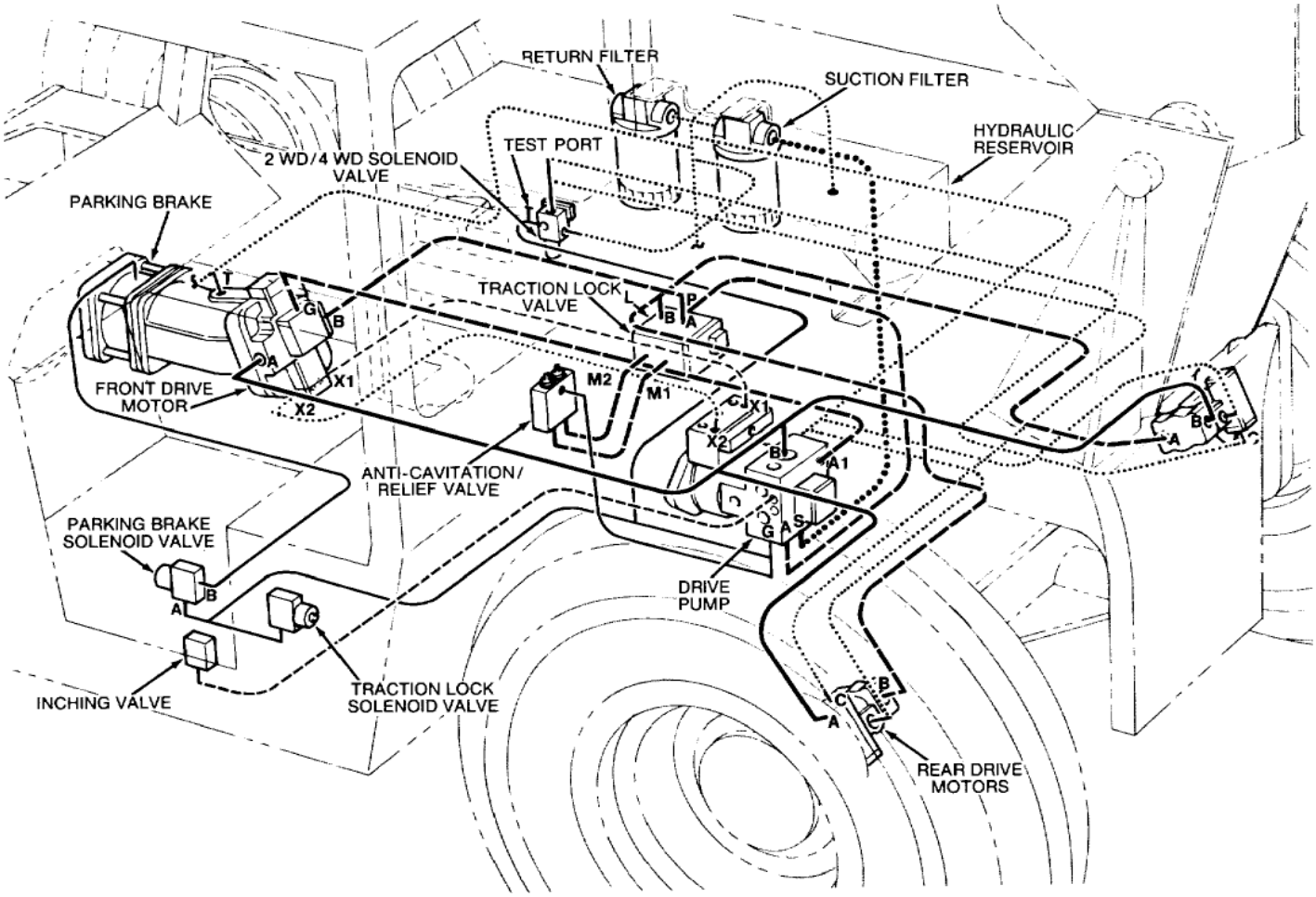
In four wheel drive mode, spring-loaded stroking piston positions motor swash plate for maximum displacement (maximum torque).

If two wheel drive mode has been selected (2/4 wheel drive switch) 2/4 wheel drive solenoid valve is de-energized and port **C** is open to port **B** to deliver charge-pump-pressure pilot pressure to **C** (control) ports of rear drive motors.

Pilot pressure at motor port **C** overcomes stroking piston spring and positions swash plate for minimum displacement. Motors receive enough flow for lubrication and cooling but not enough to actually drive motors.

Note that control pressure does not affect rear drive motors; they are at minimum or maximum displacement, depending on position of 2/4 wheel drive switch.

Hydrostatic Drive Circuit (Reverse travel)
For 524 units thru S/N 0177073 and
For 534C-6 units thru S/N 0288250



SUCTION NO.
CHARGE PUMP PRESSURE
CONTROL PRESSURE
DRIVE PUMP PRESSURE
DRIVE CIRCUIT RETURN
Drain

NOTE

REVERSE TRAVEL is shown-refer to previous circuit for **FORWARD TRAVEL.**

IMPORTANT NOTE

The forward travel version of this circuit provides detailed description of circuit. Information provided here covers only the differences between forward and reverse circuits.

For reverse travel, oil is routed from drive pump port **B** to front drive motor port **A,** and also to right rear drive motor port **B** and left rear drive motor port A.

Return flow from front drive motor is through traction lock valve ports **A** and **P** to drive pump port **A.**

Return flow from rear drive motors is through traction lock valve ports **B** and **P** to drive pump port **A**.

Control pressure is routed to front drive motor through ports **X1** of drive pump and front drive motor.

HYDROSTATIC DRIVE TROUBLE SHOOTING TABLE

IMPORTANT NOTES

This trouble shooting table covers both two-wheel-drive units (522 & 532C) and four-wheel-drive units (524 & 534C). For those having a two-wheel-drive unit, ignore references to components not furnished on your unit.

It is assumed that drive circuit is piped in accordance with circuit flow diagram.

The following trouble shooting information is presented in a logical sequence intended to lead trouble shooter to cause of problem as quickly as possible.

Before performing trouble shooting checks, test all hydrostatic drive functions to determine extent of malfunction.

Each general heading describes a specific malfunction (example: Transmission Does Not Drive in Either Direction).

All sub-headings under general heading could be a cause of that malfunction (examples: Preliminary Checks and Inadequate Charge Pump Pressure).

A sub-heading may have one or several possible causes listed under it.

If a fault is discovered and repaired, test function which had malfunctioned to determine that problem has been or has not been corrected. Consider that fault may have caused contamination which could require system be drained and flushed.

If drive loop must be drained or if oil has been lost during service procedures, refill system in accordance with instructions under Servicing Hydrostatic Drive Loop heading.

If malfunction has been corrected and system is clean operate the unit in normal manner.

If a fault has been discovered and corrected-and-system still does not function properly. continue trouble shooting under appropriate heading or sub-heading.

Component locations are illustrated under NOMENCLATURE heading and also in circuit diagram in this section.

Port locations are shown in port identification illustrations in this section.

Testing procedures are covered under Testing heading in this section.

Transmission Does Not Drive in Either Direction:

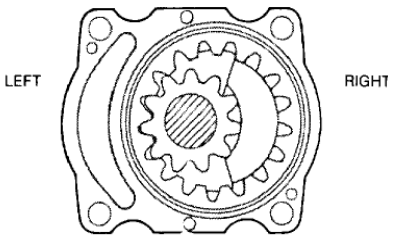
Preliminary Checks:

Possible Cause	Remedy
Forward/reverse switch lever is in neutral position.	Move lever to forward or reverse position as appropriate.
Parking brake switch is ON position.	Move switch to OFF position.
Hydraulic fluid level is low.	Fill hydraulic reservoir to proper level.
A damaged hose, tube fitting or other component is permitting external leakage.	Inspect for signs of external leakage and replace damaged component.
A crushed or kinked hose or tube is restricting flow.	Only complete restriction would prevent movement. Check lines connecting A, B X1 and X2 ports of drive pump and front drive motor. Also check lines between port G of drive pump and port A of parking brake solenoid valve; also port B of solenoid valve to parking brake.

Inadequate Charge Pump Pressure

NOTE: With engine running at low idle, gage should indicate a minimum of 320 psi at charge pump test port. Pressure must not exceed 480 psi with engine at high idle.

Possible Cause	**Remedy**
Plugged suction filter is restricting flow.	Replace both filter elements.
Leak in suction line to charge pump is hampering supply flow.	Inspect and repair as required.
Charge pump relief valve is improperly adjusted or defective..	Adjust relief valve(refer to Testing heading for procedure). If proper pressure cannot be obtained, replace relief valve. Do not discard original valve; it may not be defective.
Defective solenoid valve (parking brake, 2/4 wheel drive or traction lock)	Repair or replace.
Defective joystick	Check and repair or replace as required. Refer to Testing heading under Joystick Circuit.
If it has been replaced, charge pump may be improperly installed	Install pump properly (illustration shows proper orientation as seen from rear, if charge pump housing were glass).



Charge pump is excessively worn or damaged.	Inspect charge pump for excessive wear or damage and replace as required. If test facilities are available, a new pump should deliver approximately 11.5-12.0 gpm at 480 psi and 2500 RPM.

continued...

Possible Cause	Remedy
Charge pressure leaking internally thru defective drive pump.	If previous checks under this subheading failed to restore charge pressure, it is probably being lost thru a defect in drive pump. Refer to Testing heading in this section of manual.
Charge pressure leaking internally thru defective internally thru defective	Check drive motor/s for internal leakage (refer to Testing heading for procedure).

Drive Wheels/Axle Locked

NOTES: Prepare handler for towing as described on page 36 of Operator's Manual (parking brake switch in OFF position, forward/reverse switch lever in neutral position, forward and reverse relief valves backed off and engine running at low idle). **Test assumes adequate charge pump pressure.**

Observe drive wheels while unit is towed on a dry, paved, level surface.

lf a rear drive wheel drags, it would be an indication of motor or planetary hub failure.

If front drive wheels rotate, skip the following checks and proceed to next subheading (Control Pressure Inadequate, Drained or Blocked).

If drive wheels do not rotate, perform the following checks:

*If so equipped

Possible Cause	Cause Remedy
Parking brake solenoid valve is not energized.	Check for 12 VDC at parking brake solenoid valve (wire 42B to ground). if no voltage, use Electrical Schematic Diagram to locate electrical fault.
Parking brake solenoid valve coil is defective.	Check for 8.0 ohms resistance between coil terminals. Replace coil or valve assembly as required. Also check continuity to ground.
Crushed or kinked line between drive pump port G and solenoid valve or valve to parking brake housing.	Inspect lines and replace as required.
Parking brake is locked in applied condition.	Check for freespool movement, damage or contamination which could restrict spool movement. Replace components as required.
Service brake is locked in applied condition.	Check for pressure at service brake test port. If pressure exists in brake line, release pressure and check for jammed linkage or defect in service brake valve.
Parking brake assembly is defective.	Remove and separate front drive motor and parking brake assemblies. With 270 psi applied to parking brake pressure port, shaft should rotate freely. Repair or replace as required.
Front drive motor is defective.	With work ports open and 100 inch/pounds torque applied to input spline, motor should rotate freely .
Mechanical defect exists in front drive axle.	Repair

Control Pressure Inadequate, Drained or Blocked

NOTES: This portion of trouble shooting table assumes adequate **charge** pump pressure.

With adequate charge pump pressure and engine running at 1100 to 1200 RPM, drive pump port Y should have approximately 100 psi control pressure.

Possible Cause	Remedy
Control pressure is being drained thru inching travel valve.	Disconnect hose to inching travel valve at drive pump port Y and cap port fitting. If transmission drives properly, control pressure was being drained. Inspect inching valve and linkage and correct fault.
Control pressure is inadequate.	Remove cap installed in previous step and install adapter, gage and hose combination. If pressure is missing or low, replace control pressure (DA) cartridge and repeat test.
Failure of voltage to forward/reverse valve solenoids blocks control pressure at valve.	Check for 12 VDC at forward/reverse solenoid valve with ignition switch ON: Switch set for reverse - wire 25B or white Switch set for forward - wire 16B or green.
Open circuit at forward/reverse solenoid valve coils blocks control pressure at valve.	Unlikely that both would fail at same time -but - check for 6.2 ohms resistance at coil terminals. Replace as required. Also check continuity to ground.
Sticking spool in forward/reverse solenoid valve blocks control pressure at valve.	If spool responds to control approximately 100 psi will be shown at 1100 to 1200 engine RPM as follows: At drive pump port X4 with forward/reverse switch set in forward position. At drive pump port X3 with forward/reverse switch set in reverse position. If proper pressure isn't indicated, inspect spool/valve and repair or replace as required.
Drive motor shuttle spool sticking.	Inspect shuttle spool and bore for damage and repair or replace as required.
Drive motor control spool sticking.	Inspect control spool and bore for damage and repair or replace as required.
Drive motor stroking piston sticking	Inspect stroking piston for free movement and repair or replace as required.
Drive pump stroking piston sticking.	Inspect stroking piston for free movement and repair or replace as required.

Drive Pump Pressure Inadequate

Possible Cause	Remedy
Forward/reverse circuit relief valves improperly adjusted or defective.	Refer to Testing heading in this section of manual.
Pump pressure is leaking thru a defective drive motor.	Refer to Testing heading in this section of manual.
Drive pump defective	Refer to Testing heading in this section of manual.

Transmission Drives in One Direction Only:

Preliminary Checks

Possible Cause	Remedy
A damaged hose, tube, fitting or other component is permitting external leakage.	Inspect for signs of external leakage and replace damaged component.
Crushed or kinked line be- I tween drive pump and front drive motor.	Inspect lines between X1 and X2 ports in drive pump and motor and replace as required.

Control Pressure Function Checks

Possible Cause	Remedy
No voltage to one side of drive pump forward/ reverse solenoid valve.	Check for 12 VDC at appropriate solenoid with ignition switch ON: Switch set for forward - wire 16B or green Switch set for reverse - wire 25B or white Use Electrical Schematic Diagram to trace circuit.
Open circuit at forward/ reverse solenoid valve coil.	Check for 6.2 ohms resistance at coil terminals and replace coil or valve as required. Also check continuity to ground.
Sticking spool in forward/ reverse solenoid valve.	If spool responds to control pressure, approximately 100 psi will be shown at 1100 to 1200 engine RPM as follows: At drive pump port X4 with forward/ reverse switch set in forward position. At drive pump port X3 with forward/ reverse switch set in reverse position. If proper pressure isn't indicated, inspect spool/valve and repair or replace as required.
Drive motor shuttle spool sticking.	Inspect shuttle spool and bore and repair or replace as required.
Drive motor control spool sticking.	Inspect control spool and bore and repair or replace as required.

Drive Pump/Motor Checks

Possible Cause	Remedy
Forward/reverse circuit relief valve leaking.	Switch circuit relief valves. If unit now drives only in opposite direction, repair or replace relief valve in non-driving circuit.
Drive pump or motor defective.	Refer to Testing heading in this section of manual.

Transmission Drives in Wrong Direction

Possible Cause	Remedy
Wires switched at forward reverse solenoid valve.	Wire 16 Borgreen (forward) goes to right side of valve and wire 25B or white goes to left side.
Hoses switched between drive pump and motor.	Pump port X1 (reverse) should be connected to motor port X1; X2 should be connected to X2.

Transmission Drive is Weak, Sluggish or Erratic

NOTE: One or more of these symptoms can occur in response to most Possible Causes listed under general trouble shooting heading Transmission Does Not Drive in Either Direction.

The degree to which a possible cause occurs can make the difference between no movement and weak, sluggish or erratic movement.

Refer to Transmission Does Not Drive in Either Direction heading and check all appropriate possible causes.

Transmission Does Not Return to Neutral (with neutral selected)

Possible Cause	Remedy
Improper electrical signal at forward/reverse solenoid valve.	With forward/reverse switch lever in neutral position, check for voltage at wire 25B or white (reverse) and 16B orgreen (forward). If voltage is present, inspect switch for defect.
Possible stroking piston improperly adjusted (centered).	Check and adjust as required (refer to Testing heading in this section of manual).
Pump defective.	Check for defect which prevents stroking piston or rotarty group from returning to neutral position and repair or replace as required.

Rear Drive Wheels Will Not Engage*

Possible Cause	Remedy	Possible Cause	Remedy
Rear drive hubs disengaged.	Secure hub engage/disengage plates with dimples pointing outward (refer to page 36 operator's manual).	2/4 Wheel drive solenoid valve coil is defective.	Check for 8 ohms resistance between coil terminals. Replace coil or valve assembly as required. Also check for continuity to ground.
2/4 Wheel drive solenoid valve is not energized.	Check for 12 VDC at 2/4 wheel drive solenoid valve(wire 18 B to ground). If no voltage, use Electrical Schematic Diagram to locate electrical fault.	2/4 Wheel drive solenoid valve spool is sticking.	Check for free spool movement, damage or contamination which could restrict spool movement. Replace components as required.

Rear Drive Wheels Will Not Disengage*

Possible Cause	Remedy	Possible Cause	Remedy
Improper e;ectrical signal to 2/4 wheel drive solenoid valve.	With 2/4 wheel drive switch in 2 wheel position, there should be no voltage at wire 18 B. if voltage is present, check for defective switch, improper wiring or short circuit. Use Electrical Schematic Diagram to trace circuit.	2/4 wheel drive solenoid valve spool sticking.	Check for free spool movement, damage or contamination which could restrict spool movement. Replace components as required.

Excessive Transmission Noise

Possible Cause	Remedy	Possible Cause	Remedy
Low hydraulic fluid level.	Check level in reservoir and replenish as required.	Air in hydraulic fluid.	Check sight gage for milky appearance or foaming. these conditions could be caused by leakage on suction side of charge pump or clogged suction filter.

Excessive Operating Temperature

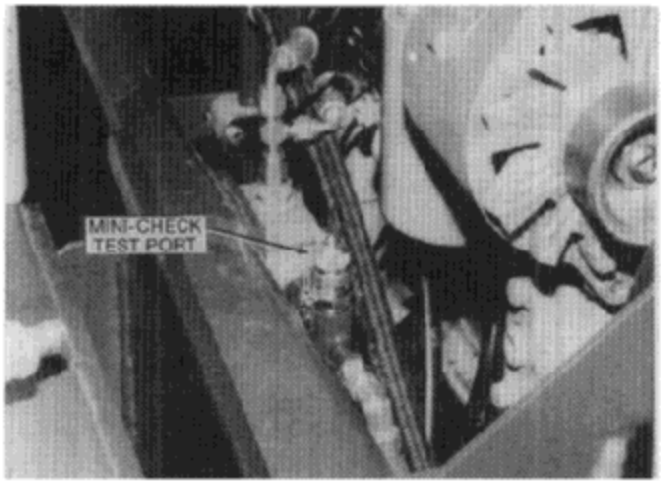
NOTE: Hydrostatic transmission circuit draws oil from handler hydraulic system. Refer to General Trouble Shooting Table for possible causes of overheating. Check possible causes in both implement and drive circuits where appropriate.

*If so equipped

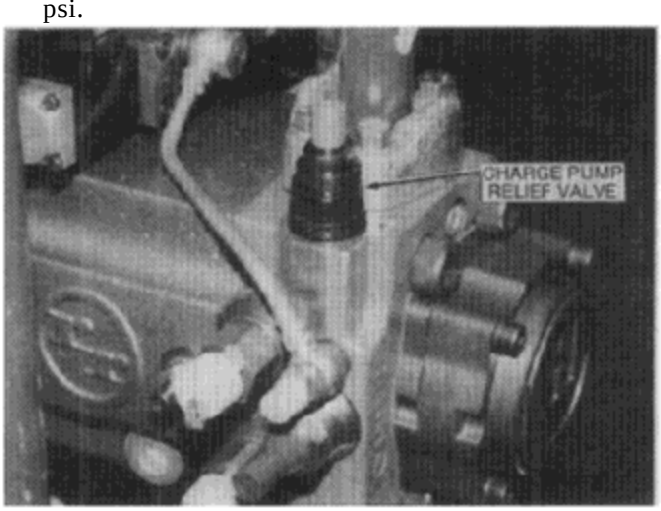
NOTE: Adjustment points are sealed by color-coded plastic caps. If a Gradall Distributor performs an adjustment he will sea] the adjustment using a blue cap. Color-coded caps are not provided to owners

Testing Charge Pump Pressure engine.

1. Position unit in a safe area for work to be performed, apply parking brake and move forward/reverse lever to neutral position.
2. Lower boom/attachment to rest on ground and stop engine.



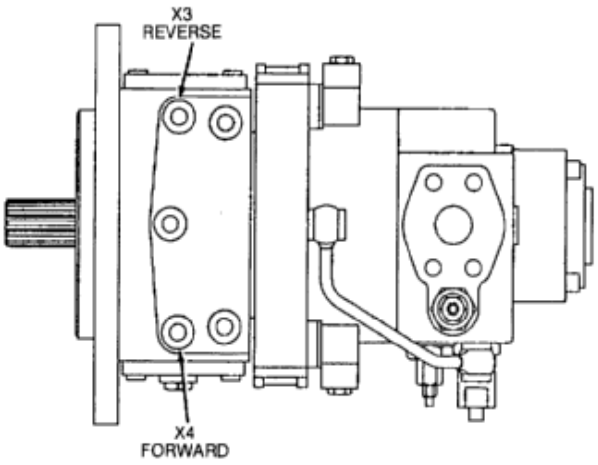
3. Install 600 psi gage, hose and adapter combination on charge pump mini-check test port and position gage in cab for observation.
4. Start engine and allow to run at low idle (800 RPM). Gage should indicate approximately 320 psi.



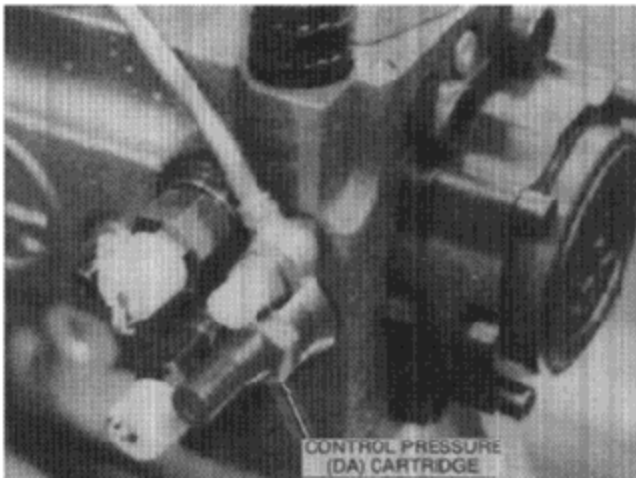
5. If necessary, loosen relief valve lock nut and turn adjusting screw clockwise to increase pressure or counterclockwise to decrease pressure.
6. Tighten lock nut to secure adjustment. Distributors must install a blue plastic cap to seal adjustment.

Testing Control Pressure

1. Position unit in a safe area for work to be performed, apply parking brake and move forward/reverse lever to neutral position.
2. Lower boom/attachment to ground and stop engine



3. Install 600 psi gage, hose and adapter combination in drive pump port X4 and position gage in cab for observation.
4. Install tachometer to monitor engine RPM. Start engine and operate at 1100 RPM.
5. Observe gage and move forward/reverse lever to forward position. Gage should indicate 100 psi. The same pressure should be seen with gage connected to port X3 and lever in reverse position.
6. If proper pressure is not indicated, check to be sure inching travel valve and forward/reverse solenoid valve are operating properly.



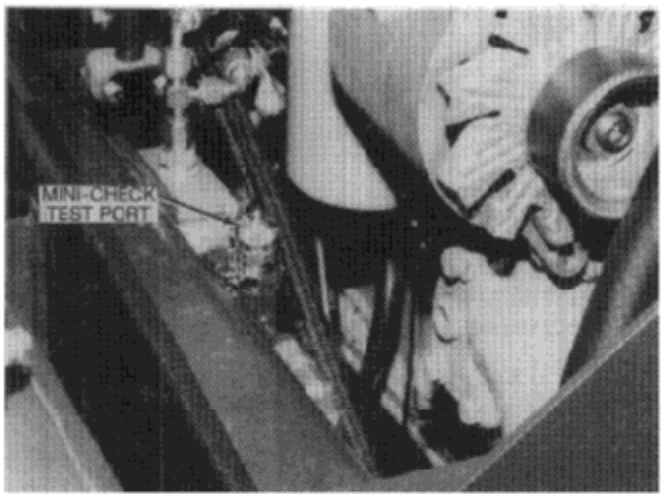
7. If inching travel valve and forward/reverse solenoid valve operate properly, replace control pressure (DA) cartridge.

Testing Drive Motors (front or rear)

NOTE: This procedure can be used as a field test to determine approximate efficiency of a motor and also as a check to isolate cause of a loss of charge pump pressure.

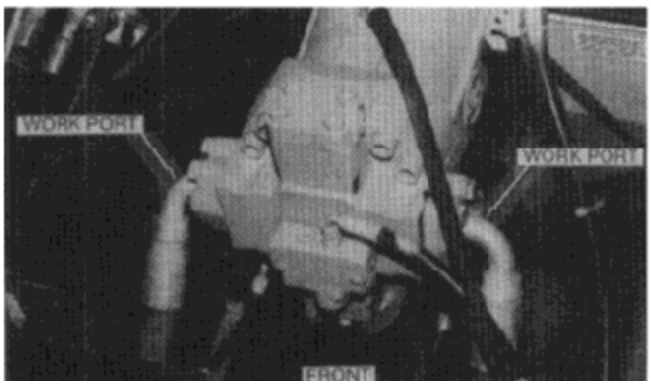
1. Position unit in a safe area for work to be performed, apply parking brake and move forward/reverse lever to neutral position. If a rear drive motor* is to be tested, be sure 2/4 wheel drive switch is positioned for four wheel drive.

2. Lower boom/attachment to rest on ground and stop engine.



3. Install 600 psi gage, hose and dapter combination on charge pump mini-check test port and position gage in cab for observation.

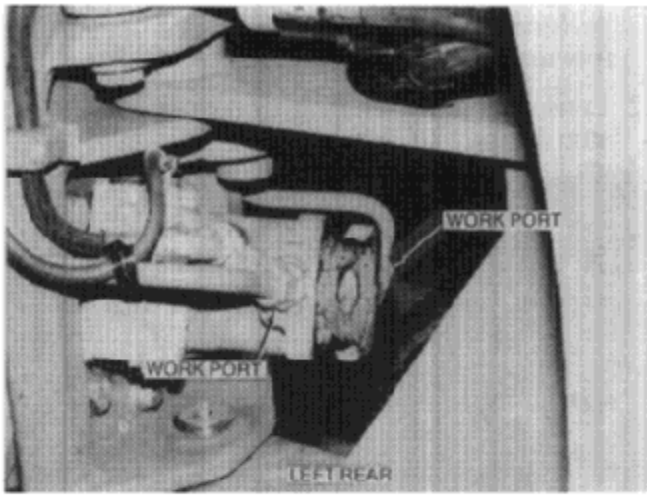
4. Start engine, operate at high idle and note gage indication. Stop engine.

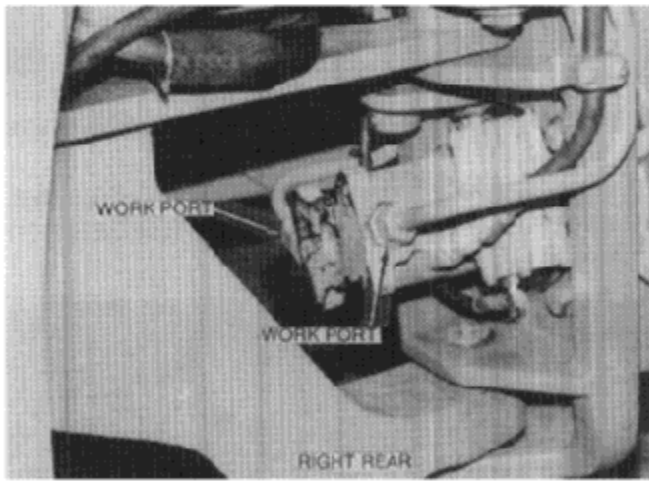


5. lc2 .5Disconnect hoses at work ports of motor to b e tested and plug/cap hoses and ports.

6. Start engine, operate at high idle and note gage indication. Stop engine.

   A significant pressure increase over that noted in step 4 is an indication that motor is excessively worn or defective.





7. If unit being tested is equipped for four-wheel-drive, repeat test for other two motors.

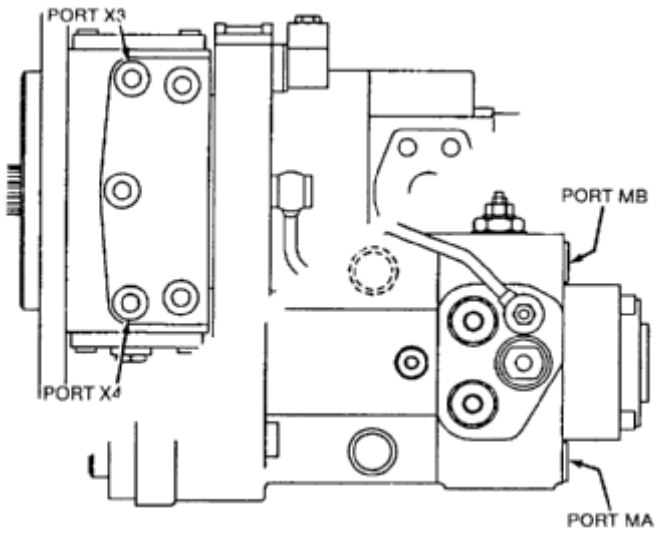
   If tests indicate moderate increase in pressure for two or more motors, the combination of wear (leakage) could prevent charge pump from building adequate charge pressure.

*If so equipped

Testing Drive Pump Stroking Piston Position

1. Position unit in a safe area for work to be performed, apply parking brake and move forward/reverse lever to neutral position.

2. Lower boom/attachment to rest on ground and stop engine.

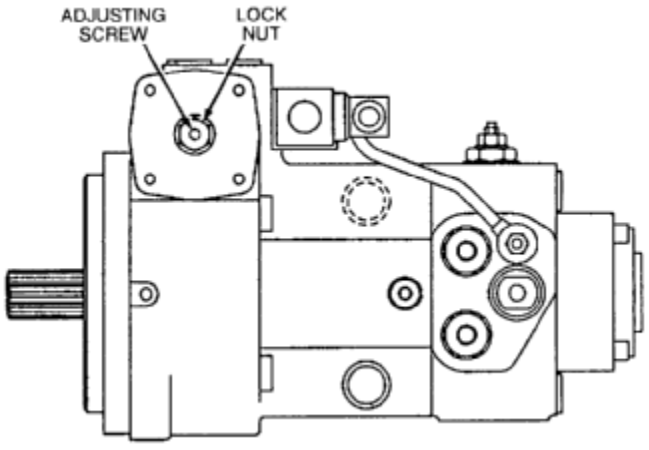


3. Remove plugs and install a **CLEAN** hose between drive pump ports **X3** and **X4.**

4. Install 7500 psi gage, hose and adapter combinations in drive pump ports **MA** and **MB.**

5. Start engine and operate at low idle.

6. Observe gages. Pressure at port **MA** must be equal to pressure at port **MB.**



7. If pressures are not equal, loosen lock nut and turn adjusting screw to equalize pressures. Tighten lock nut to secure adjustment.

8. Repeat 4, 5 and 6 using 600 psi gages.

Testing Charge Pump

⚠ CAUTION

Do not attempt to flow-test charge pump on machine. Test would be inconclusive and cause damage to drive pump and motor.

If adequate test facility is available, the following conditions must be observed:

- Supply oil must conform to hydraulic fluid specifications on page 11.
- Supply oil must be at normal operating temperature (160/180 F.).
- Rotation must be clockwise (viewed from spline end).
- A new pump should deliver approximately 12 gpm at rated engine speed (2500 RPM) against resistance of 480 psi.

Testing Drive Circuit Relief Valves

IMPORTANT NOTE: Though possible, it is very unlikely that both drive circuit relief valves would become faulty at the same time. Switch positions of these valves to see if malfunction follows the valve. If malfunction follows valve to other side of circuit, adjust, repair or replace valve.

⚠ CAUTION

These valves are set at 5000* psi (5500* psi). Any attempt to adjust these valve cartridges in place could damage or destroy other drive system components and void warranty on those components as well as drive pump.

If relief valve has an apparent defect (contamination or a broken spring) repair and readjust only if adequate test facilities are available to set valve at 5000*psi ***(5500* psi).*** Otherwise, replace cartridge.

Drive circuit relief valves provided by The Gradall Company are preset to proper pressure by the manufacturer and adjustment is sealed by a yellow or green gages. green plastic cap.

***Refer to page ii to determine proper pressure.**

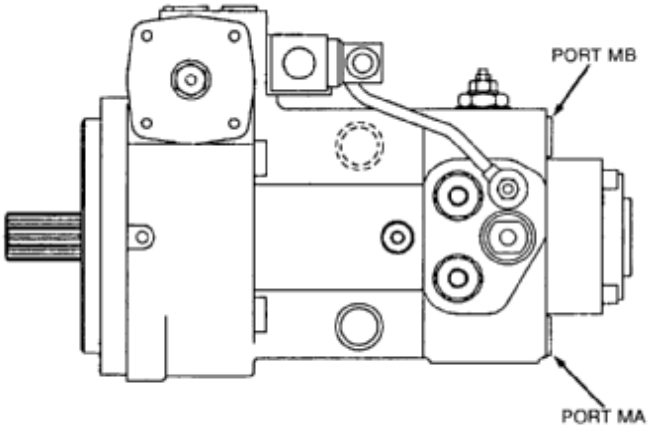
⚠ WARNING

Step 4. (below) requires that all drive motor work ports be plugged and that associated work hoses/tubes be capped. If your shop cannot procure fittings to cap work fines securely, *DO NOT PERFORM STEP 4*. Spray or flying fragments from a leaking or broken fitting could cause serious injury or death.

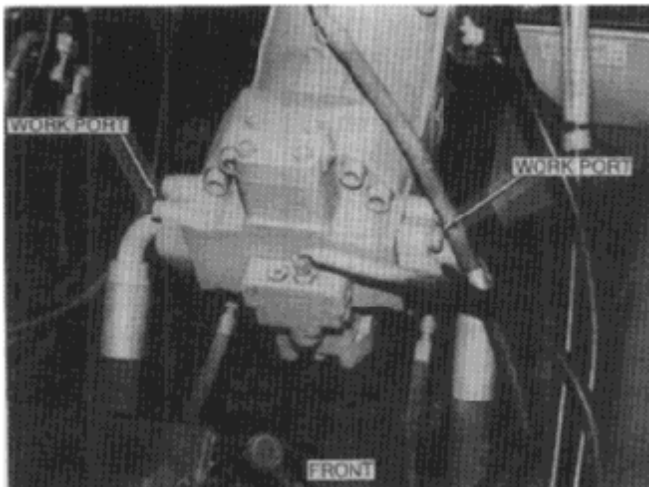
As an alternative, have pump tested on a test stand capable of handling pressures in the area of 5500 psi.

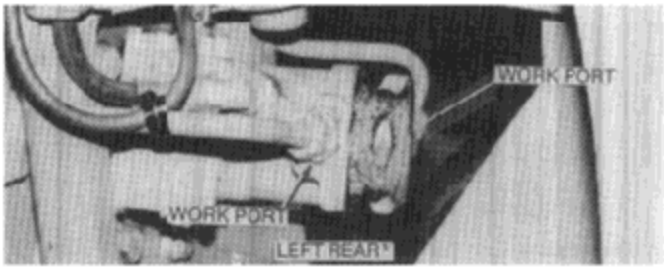
1. Position unit in a safe area for work to be performed, apply parking brake and move forward/reverse lever to neutral position.

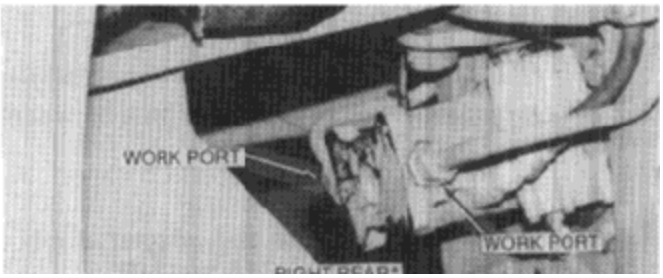
2. Lower boom/attachment to rest on ground and stop engine.



3. Install gage, hose and adapter combinations in drive pump ports MA and MB. Position gages in cab for observation.







4. Disconnect hoses/tubes at front and rear drive motor work ports and plug/cap ports and work lines. **Be certain to prevent contamination of system.**

5. Start engine and operate at high idle.

6. Observe gages while briefly engaging forward drive and reverse drive and record readings.

7. Readings should be approximately equal at *5000 psi (*55000 psi) for a new pump. Readings in the area of *4750 psi (*5250 psi) should provide nearly normal transmission operation Readings below this may indicate need to repair or replace pump, depending on performance required from machine.

8. If gage readings were not approximately equal, refer to Testing Drive Circuit Relief Valves heading.

***Refer to page ii to determine proper pressure.**

Servicing Hydrostatic Drive Loop

⚠ CAUTION

Whenever any portion of hydrostatic drive loop is to be opened, extreme care must be taken to prevent contamination of loop. Contamination will damage or destroy hydrostatic drive components.

Preliminary Precautions

- Before opening, disconnecting or removing any component, thoroughly **CLEAN** all affected components.
- Have an adequate supply of **CLEAN** caps and plugs in appropriate sizes to seal open ports and lines against contamination. Seal open ports and lines immediately.
- Be sure adapters and hoses to be used in testing are **CLEAN**
- Be sure any equipment to be used in adding oil to drive loop is **CLEAN**.
- Be sure any oil to be added to drive loop meets hydraulic oil speficications, including **FILTRATION LEVEL.**
- Be sure any necessary bench work is performed only under absolutely **CLEAN** conditions. Plan work carefully to minimize loss of oil from drive loop.

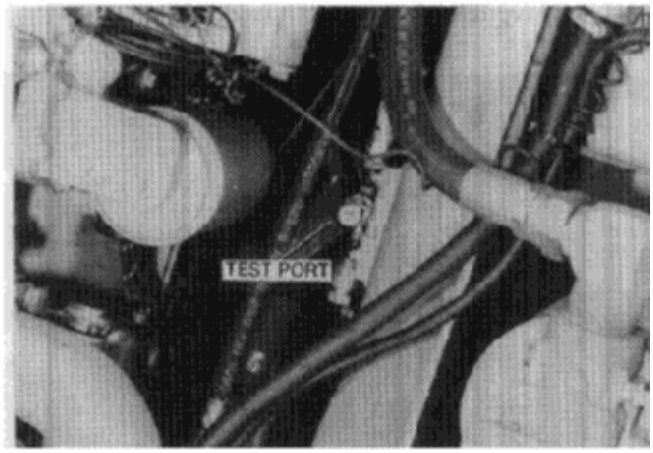
⚠ CAUTION

Whenever oil has been lost from certain areas of drive loop, it MUST be replaced before engine is started.

Consider the problem which caused loss of oil. Depending on problem it may be necessary to flush all or part of drive loop. If contaminates remain in drive loop, components will be damaged or destroyed.

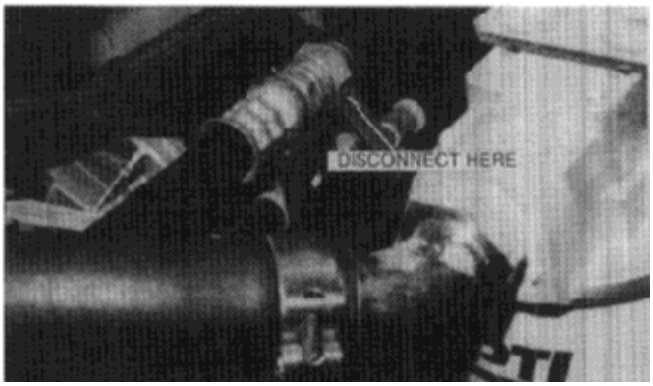
Adding Oil to Drive Loop

1. Flush any drive loop components which may have become contaminated.
2. Install new hydraulic filter elements.
3. Fill reservoir to proper level using oil which meets specification. Hydraulic oil specifications are shown on page 17. Be sure equipment is clean.



4. Install gage, hose and adapter combination on charge pressure test port and position gage in cab for observation.

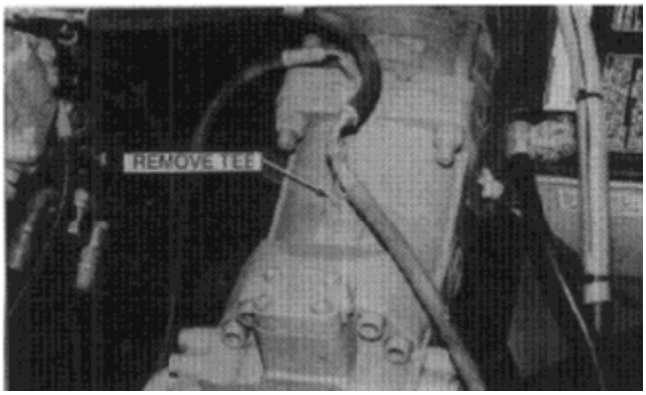
5. Clean area thoroughly and then disconnect hose at suction filter outlet port. Cap elbow imme - diately.
6. Using clean equipment (funnel etc.), fill hose using oil to specification.
7. Connect hose to filter elbow.



8. Clean area thoroughly and then disconnect drain hose at point shown and immediately install a tee between hose and tube port. Open port of tee should point upward.

9. Using clean equipment (funnel, etc.), fill hose using oil to specification.

10. Remove tee and connect hose immediately.



11. Clean area thoroughly and then remove tee (with hoses attached) from front drive motor case drain port. Plug tee immediately.

12. Using clean equipment (funnel, etc.), fill motor case. Install tee immediately.

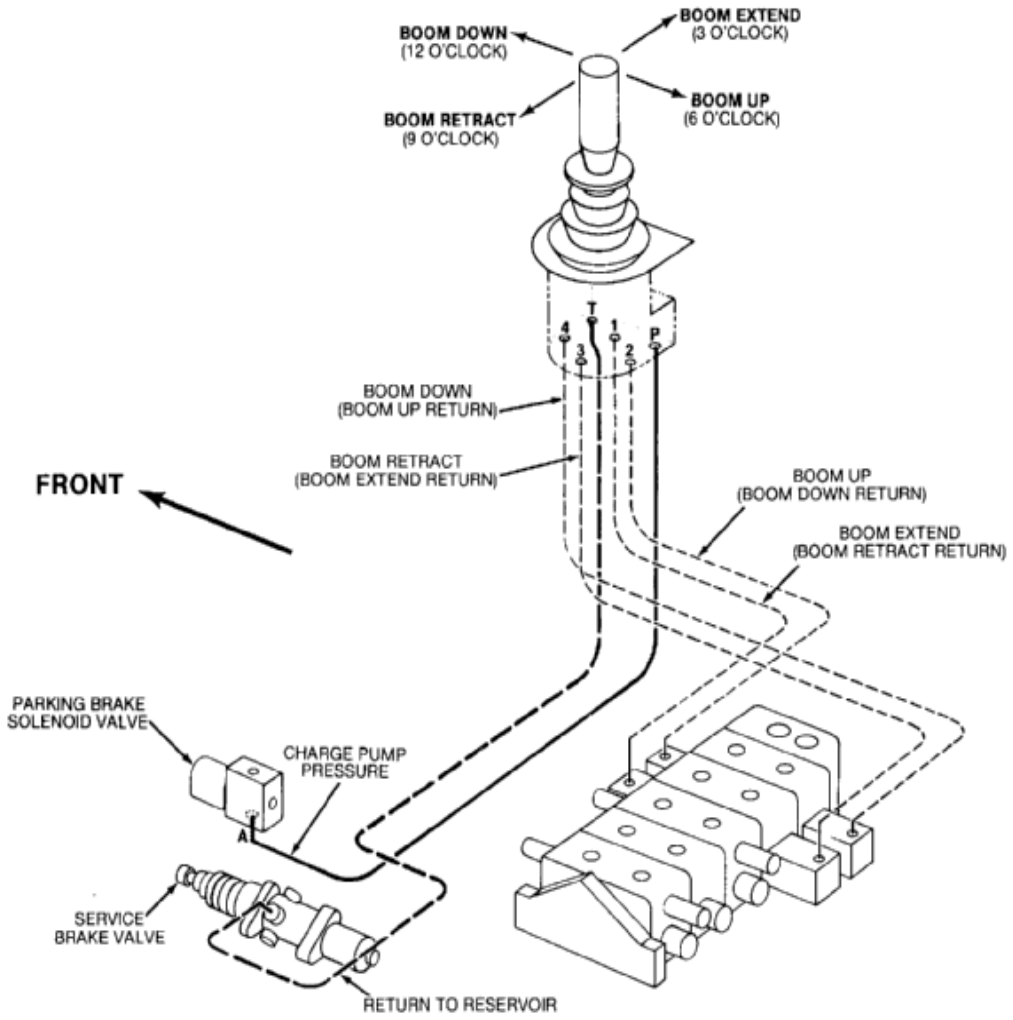
13. Disconnect wire 12B at fuel shut-off solenoid valve.

14. Crank engine for approximately 15 seconds while observing gage and then allow starting motor to cool for a few minutes. Repeat until gage indicates 50 psi.

15. Connect wire 12B at fuel shut-off solenoid valve.

16. Remove gage combination from test port.

17. With parking brake applied and forward/reverse lever in neutral position, operate engine at low idle for approximately 5 minutes.



CHARGE PRESSURE ——————————

RETURN — — — — — — — — — — — —

PILOT SIGNAL/RETURN — — — — — — — — —

NOTES

Only lines to and from joystick are shown Refer to appropriate boom and drive circuits for additional details.

Conditions: Engine running and joystick in neutral position.

The joystick actuates control valve sections hydraulically. When actuated, joystick modulates charge pump pressure/flow and directs a controlled pilot signal to proper end cap of appropriate control valve section. Signal at end cap causes control valve spool to shift.

Pilot signal to end cap is in proportion to joystick actuation and valve spool shift is in proportion to pilot signal.

Fluid displaced by spool shift returns thru Joystick to reservoir.

The joystick assembly includes four spring-centered ungers; a diagonally opposite pair for each function controlled by joystick.

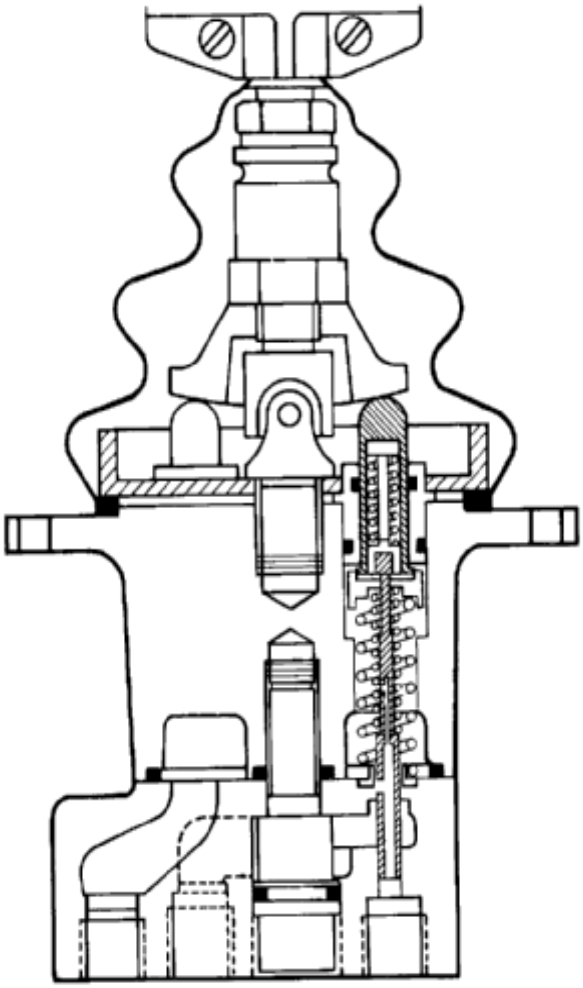
The joystick lever can be moved in any direction. Positions on a fine between 12 o'clock and 6 o'clock control one double-acting function and positions on a line between 9 o'clock and 3 o'clock control a second double acting function.

A pressure disk at base of lever depresses one or two plungers, depending on positioning of lever. Moving lever to positions between 12 & 3, 3 & 6, 6 & 9 and 9 & 12 o'clock will actuate both adjacent functions.

The greater the plunger depression, the greater the pilot signal to control valve end cap. A portion of controlled signal is diverted within joystick housing to "balance" control plunger. When signal pressure balances lever force control plunger shifts to block additional flow/pressure to control valve end cap and also blocks return flow from end cap.

When joystick is released it automatically returns to neutral position which permits return flow from end cap and allows spring-centered control valve spool to return to neutral position.

continued . . .



Relieving Trapped Pressure

⚠ WARNING

Back and forth movements of joystick will not relieve trapped pressure from associated circuit. Perform following procedure to relieve trapped pressure from a circuit controlled by a joystick.

1. Position unit in a safe area for work to be performed and lower boom/attachment to rest lightly on ground Do not apply excessive down pressure.
2. Apply parking brake, stop engine and chock wheels.
3. Carefully determine which portion of circuit is to be opened and locate the most accessible hose/tube fitting associated with that portion of circuit.
4. Position a container beneath fitting to catch oil.
5. Position a sturdy transparent shield between fitting and yourself.
6. Carefully loosen fitting just far enough to permit leakage and then wait until leakage stops before loosening fitting fully.
7. Repeat procedure for other side of circuit if necessary.

The following general information may be helpful when considering a control malfunction which seems to be related to joystick/s.

Check operation of all implement functions to determine the extent of problem.

If all implement circuits malfunction joysticks are probably not the cause:

- Refer to General Trouble Shooting Table heading and perform appropriate suggested trouble shooting checks.

If all four operations of a single joystick malfunction:

- Pressure disc loose-check to be sure joystick pressure disc is in light contact with all four spools and is secured with lock nut.
- Kinked or crushed pressure line to or return line from joystick-check and repair.
- Refer to Hydrostatic Drive Trouble Shooting Table heading and perform suggested trouble shooting checks for low charge pressure.

If a single, or a pair, of joystick operations malfunction:

- Refer to trouble shooting portion of appropriate circuit for additional information.
- Sticking joystick spool/s-remove one joy-stick spool and spring pack one at a time and check for contamination and damage-clean or replace as required.

Joystick testing procedures involve checking pilot signal pressure at control valve end caps. It also involves checking return flow pressure at opposite end cap.

Control valve spool should begin to shift at approximately 60 psi. Greater pressure is required to shift spool far enough to cause machine movement.

Valve spool should reach maximum stroke at approximately 300 psi. Maximum function speed may be achieved below this pressure.

Perform following procedure to test pilot pressure delivered from joystick:

1. Position unit in a safe area for work to be performed and apply parking brake. **Stop engine.**
2. Move appropriate Joystick back and forth to relieve any trapped pressure from pilot lines involved.
3. Remove fitting from appropriate end cap and install tee. Install a mini-check test port on open end of tee.
4. Install gage (600 psi), hose and adapter combination on mini-check test port and position gage in cab for observation.
5. Start engine and operate at full throttle.

   While observing gage, **GRADUALLY** move appropriate joystick in proper direction for function being tested. Note pressure indication at first machine movement while continuing **GRADUAL** joystick actuation.
6. Continue observation of gage while continuing **GRADUAL** actuation of joystick. Note pressure reading when machine response reaches maximum normal speed.

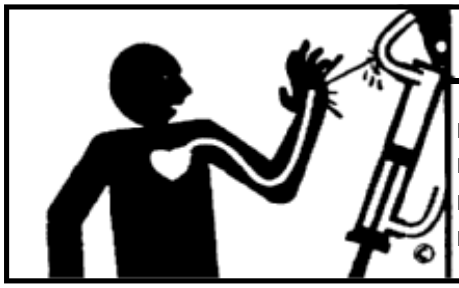
   NOTE:If hydraulic technician is not familiar with maximum normal response, refer to Preliminary Field Testing heading.
7. Evaluate pressure readings obtained in step 6 on basis of following information:

- If machine movement began a little above proper "Start Movement" pressure, continued to increase evenly, and reached maximum normal speed at or below proper "Full Movement" pressure, joystick and associated circuit components are working properly.
- If pressure increased erratically during test there are two possible causes:

  One or both associated joystick spools are sticking. Check for contamination or damage and clean or replace as required.

  Associated control valve spool is sticking. Check for contamination or damage and clean or replace as required.
- If pressure increased evenly but machine response was erratic, there are three possible causes:

  1. Associated control valve spool is sticking. Check for contamination or damage and clean or replace as required.
  2. Excessive mechanical friction or bind is restricting movement. Repair and/or lubricate as required.
  3. Excessive back pressure at opposite end cap is restricting control valve spool movement. Remove gage and tee (installed earlier) and install in opposite end cap. Observe gage while again moving joystick **GRADUALLY** in same direction as in step 6. Back pressure must remain **below** 45 psi. If pressure reaches 45 psi, check for sticking spool in joystick. Also check for kinked or crushed line which could increase back pressure. Be sure reservoir breather is clear.
- If test pressures in step 6 were significantly less than those listed for function, check for broken control valve spool centering.



⚠ WARNING

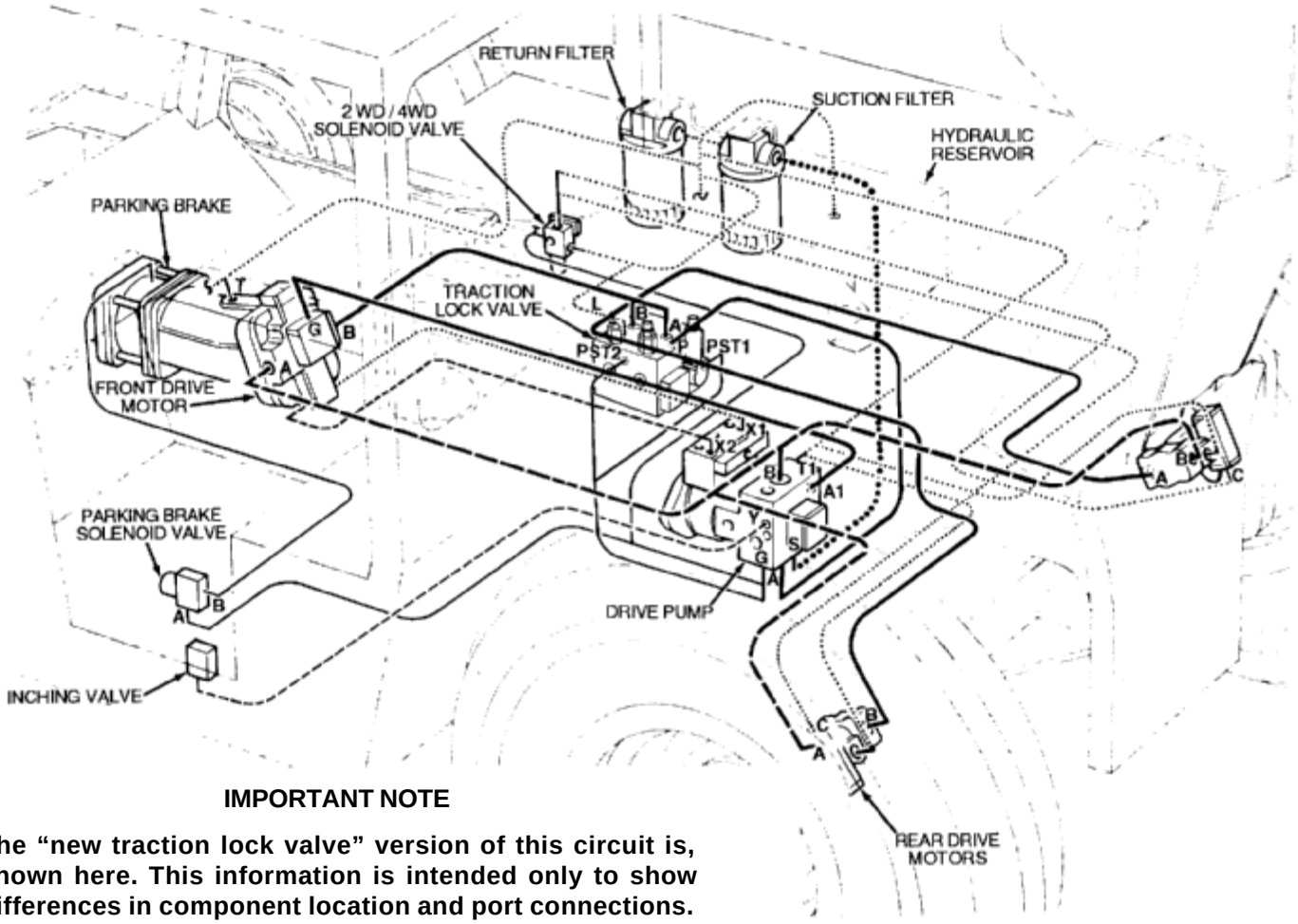
DO NOT GO NEAR LEAKS

High pressure oil easily punctures skin causing serious injury, gangrene or death. If injured, seek emergency medical help. Immediate surgery is required to remove oil. Do not use finger or skin to check for leaks. Lower load or relieve hydraulic pressure before fittings.

10614B

NEW TRACTION LOCK VALVE

For 524 units from S/N 0177074 and For 534C-6 units from S/N 0288251



IMPORTANT NOTE

The "new traction lock valve" version of this circuit is, shown here. This information is intended only to show differences in component location and port connections. Refer to information starting on page 55 for detailed description of this circuit.

SUCTION
CHARGE PUMP PRESSURE
CONTROL PRESSURE
DRIVE PUMP PRESSURE
DRIVE CIRCUIT RETURN
DRAIN

NOTES

FORWARD TRAVEL is shown.

Conditions: Parking brake released, inching travel valve closed, four wheel drive selected, traction lock switch OFF and engine running at 1100 RPM or higher.

The change from old to new style traction lock valves occurred at Serial Number **0177074** for **524** Handlers and at Serial Number **0288251** for **534C-6** Handlers.

Originally, the **traction lock solenoid valve** and the **anti-cavitation relief valves** were mounted separately from the traction lock valve as shown on pages 4 and 55.

The new style traction lock valve includes the solenoid and anti-cavitation reliefs within the traction lock valve body as shown here.

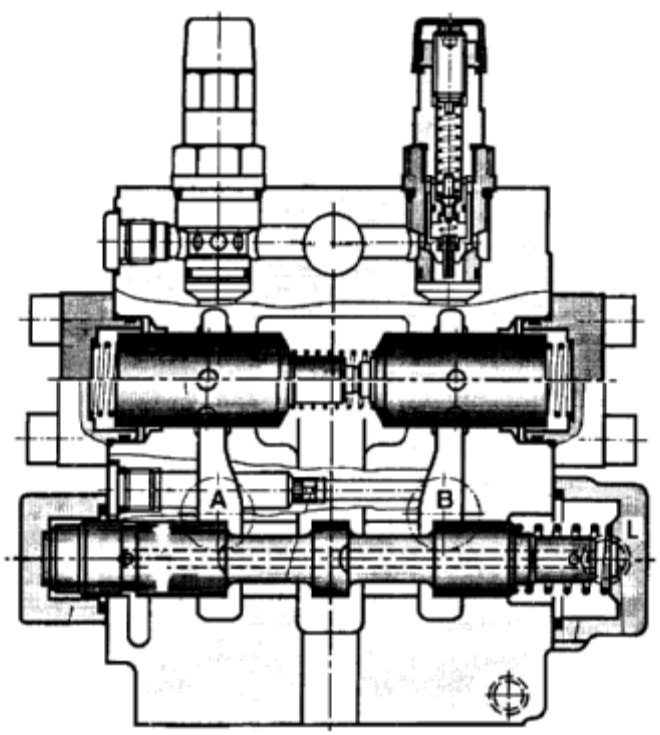
The illustration above is provided to show the differences between the old and new style traction lock valves (refer to page 55 for comparison).

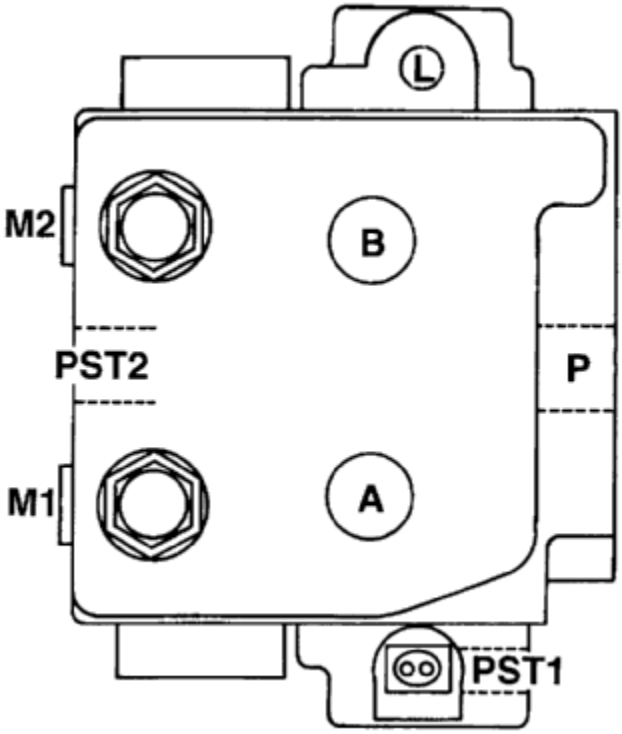
Material provided on pages 55 thru 67 provides a thorough description of the circuit, its components and their function, trouble shooting and testing. This material applies to the new style traction lock valve

The main difference involves the piping connections. Another difference involves porting changes between the old and new style valves.
Operating pressure changes **did not** occur at the same time as the change from old to new style traction lock valves.

KNOW YOUR SERIAL NUMBER

Refer to page ii for information regarding serial numbers involved in operating pressure change.





PORT IDENTIFICATION

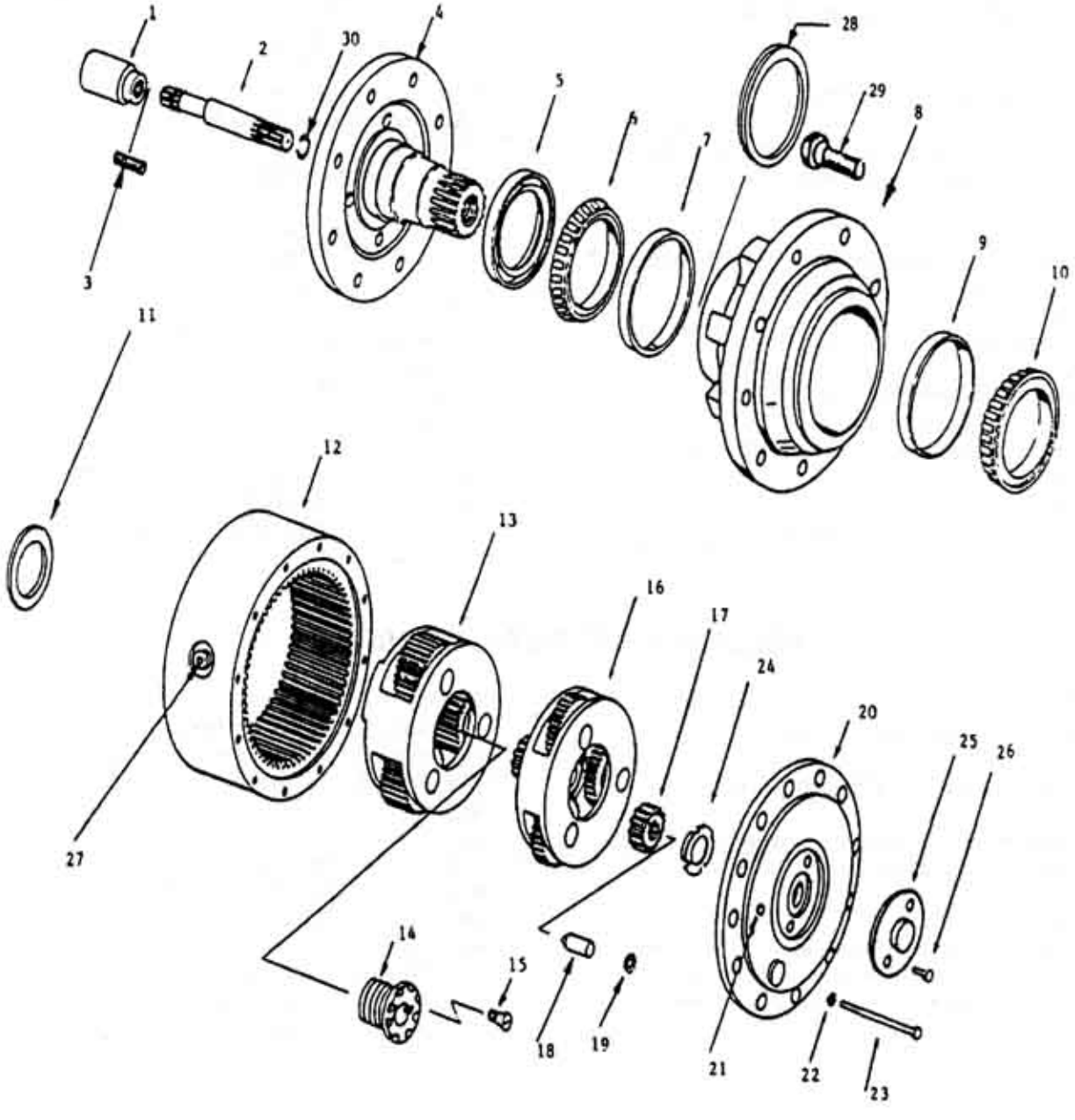
A Pump pressure to front drive motor (forward)
A Return from front drive motor (reverse)
B Pump pressure to rear drive motors (forward)
B Return from rear drive motors (reverse)
L Drain
M1 Front drive pressure test port (plugged)
M2 Rear drive pressure test port (plugged)
P Drive pump pressure/flow
Pst1 Pilot pressure to solenoid valve
Pst2 Pilot pressure to anti-cavitation relief valves

Note: For purpose of electrical testing, the solenoid valve coil is rated at 10.3 ohms.

Power Wheel Planetary Gear Drive Service Manual Model 8 Heavy Duty With Bearing Locknut

Auburn Gear
AUBURN, INDIANA 46706-3499

(219) 925-3200
TELEX: 888859
FAX: (219) 925-4725



IDENTIFICATION

IMPORTANT: When ordering parts the information stamped on the large cover is necessary to identify the model to obtain correct replacement parts. The 6xxxxx following the ❧ indicates the part number of the assembly. Please specify the model and assembly numbers when ordering replacement parts.

DISASSEMBLY OF POWER WHEEL

STEP 1
Slide the coupling (1) from splines on input shaft (2).
STEP 2
Position the assembly upright on face-of spindle (3).
STEP 3
Remove the disengage cover (25)
STEP 4
Remove bolts (23) and large cover (20). Disengage plunger (18) usually remains with cover. Remove plunger and "O" ring (19) from cover.
STEP 5
Thrustwasher (24) will usually remain in position on thrust face of cover.
STEP 6
Remove sun gear (17) from end of input shaft (2).
STEP 7
Remove primary carrier assembly (16).
STEP 8
Remove the input shaft (2) with snap ring (30) from the assembly.
STEP 9
Remove the bearing nut back screw (15).
STEP 10
Remove the secondary carrier assembly (13). Removal is accomplished by loosening bearing locknut (14) until the carrier assembly can be removed from spindle (4) splines. It may be necessary to remove the ring gear (12) first, if difficulty is encountered in removing the carrier. **Note: A special service tool is required for removal of the bearing locknut. Contact Auburn Gear for procurement of service tool.**
STEP 11
Remove the ring gear (12). It may be necessary to strike ring gear with a rubber mallet to loosen from hub.
STEP 12
Remove the large thrust washer (11) from in front of the tapered bearings and lift hub (8) from spindle (4). If bearings are not a loose fit, it may be necessary to press spindle from hub.
STEP 13
Remove the oil seal (5) and bearing cones (6,10) from hub (8). Inspect bearing cups (7,9) in position and remove only if replacement is required. Bearing cups and cones must be replaced in sets only.

ASSEMBLY OF POWER WHEEL

STEP 1
Position spindle (4) upright on bench.
STEP 2
Press bearing cups (7,9) into each side of hub (8).
STEP 3
Place bearing cone (6) in cup (7) at seal end of hub (8). Press a new oil seal (5) in until flush with face of hub.
STEP 4
Lubricate lips of oil seal (5) and lower hub (8) onto spindle (4). Keep hub centered over spindle to prevent seal damage as it is lowered over spindle.
STEP 5
Assemble bearing cone (10) over spindle (4) and into bearing cup (9). Replace large thrustwasher (11) over spindle end splines and on bearing cone (10).
STEP 6
Assemble secondary carrier assembly (13) splines over splined end of spindle (4). Install bearing locknut (14). Tighten locknut to 50 pound feet (67.8 Nm) while rotating the hub to seat bearings. Loosen the locknut 1/2 turn then retighten locknut to 45 pound feet (61 Nm) while rotating the hub. Loosen the locknut to nearest locking notch and secure with lockscrew (15). Tighten tockscrew to 10 pound feet (13.6 Nm).

STEP 7
Apply continuous 1/32 inch bead of RTV sealer to hub (8) face that mates with ring gear (12).

STEP 8
Assemble ring gear (12) to hub (8) being careful to align all bolt holes.

STEP 9
Place the input shaft (2) down into spindle (4) with the snap ring end of the shaft up.

STEP 10
Lower primary carrier assembly (16) into ring gear. (12). It may be necessary to rotate carrier and pinion to align sun gear teeth with secondary pinion and primary pinions with ring gear (12) teeth. Assemble the primary sun gear (17) over input shaft. Rotate primary sun gear to align shaft to gear splines and gear teeth.

STEP 11
Lubricate an "O" ring (19) and assemble into internal groove of cover (20). Assemble the thrustwasher (24) with tangs engaged with cover (20). Apply a continuous bead of RTV compound to end face of ring gear (12). Assemble cover (20) on end of ring gear. Install the twelve bolts (23) and flatwashers (22) which retain cover and ring gear to hub (8). Torque capscrews with dry threads to 60-65 pound feet (81.3-88.1 Nm) or with lubricated threads to 40-45 pound feet (54.2-61.0 Nm).

STEP 12
Insert disengage plunger (18) with tapered end inboard into cover (20). Assemble the disengage cover (25) with dimpled center protuding out if wheel is to be used to drive the vehicle. Assemble and torque the two hex head bolts (26). Torque bolts to 10-20 pound feet (13.6-27.1 Nm).

STEP 13
Invert the power wheel assembly and assemble the coupling (1) with counterbore outboard to the input shaft.

CARRIER ASSEMBLIES

Primary and secondary carriers (sub-assemblies) must be serviced in their entirety to protect the integrity of the powerwheel.

LUBRICATION RECOMMENDATIONS

Observe lubrication recommendations given by the original equipment manufacturer. When specific recommendations are not available, use mild extreme pressure lubricant API-GL-5, No. 80 or 90 for filling the Power Wheel under normal temperature ranges between 0-120 F (-18 to 49 C). Fill until oil just begins to flow from check plug in cover (20) with check plug on the horizontal axis. Fill and drain plug (27) is same.

SPECIFICATIONS

Approximate Weight .....232 lbs (105. Kg)
Approximate Oil Capacity.....47 oz. (1390 ml)

RTV SEALING COMPOUND

Silastic RTV 732 sealer and General Electric Silimate RTV No. 1473 are currently recommended for sealing gasket surfaces. The RTV should be applied in a continuous bead, which should be centered on the surface to be sealed but should move to the inside of the hole at each bolt hole location.

TOWING VEHICLE

CAUTION: The Power Wheel will not normally be damaged by towing; however the hydraulic drive components may be damaged unless the Power Wheel is disengaged from the drive motor. Road speed in excess to 25 MPH should be avoided unless clearly specified to be permissible by the equipment manufacturer.

TO DISENGAGE POWER WHEEL

To disconnect the wheel from the input shaft, assemble the disengage cover (25) with the dimpled cover protruding inward.

STORAGE

CAUTION: Finished surfaces must be protected to prevent rust when units are to be stored for extended periods.

*Reflects bead location in **"RTV sealing compound"** section.

ITEM NO.	DESCRIPTION (Refer to bill of materials for part. no.)	NO. USED IN ASS'Y	ITEM NO.	DESCRIPTION (Refer to bill of materials for part.no.)	NO. USED IN ASS'Y
1	Coupling	1	17	Pri. Sun Gear	1
2	Shaft, Input	1	18	Disengage Plunger	1
3	Spring	1	19	"O" Ring	1
4	Spindle	1	20	Cover	1
5	Oil Seal	1	21	Pipe Plug	1
6	Bearing Cone	1	22	Flat Washer	12
7	Bearing Cup	1	23	Bolt - Hex Head	12
8	Hub	1	24	Thrust Washer	1
9	Bearing Cup	1	25	Cover - Disengage	1
10	Bearing Cone	1	26	Bolt - Hex Head	2
11	Thrust Washer	1	27	Magnetic Plug	1
12	Ring gear	1	28	Seal, boot	1
13	Carrier Assembly - Sec.	1	29	Wheel Bolt	12
14	Lock [1,2]	1	30	Snap Ring	1
15	Lock Screw [1,3]	1	N.I.	Shipping Plug	1
16	Carrier Assembly - Pri.	1	**Notes:**	1 Serviced as part of secondary carrier assembly 2 Required service tool number AG03805 for removal and assembly. 3 Lock Screw should be replaced with each tear down.	

Auburn Gear
Auburn, Indiana 46706 (219)925-3200

MERITOR™

Revised 7-99
$2.50

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.

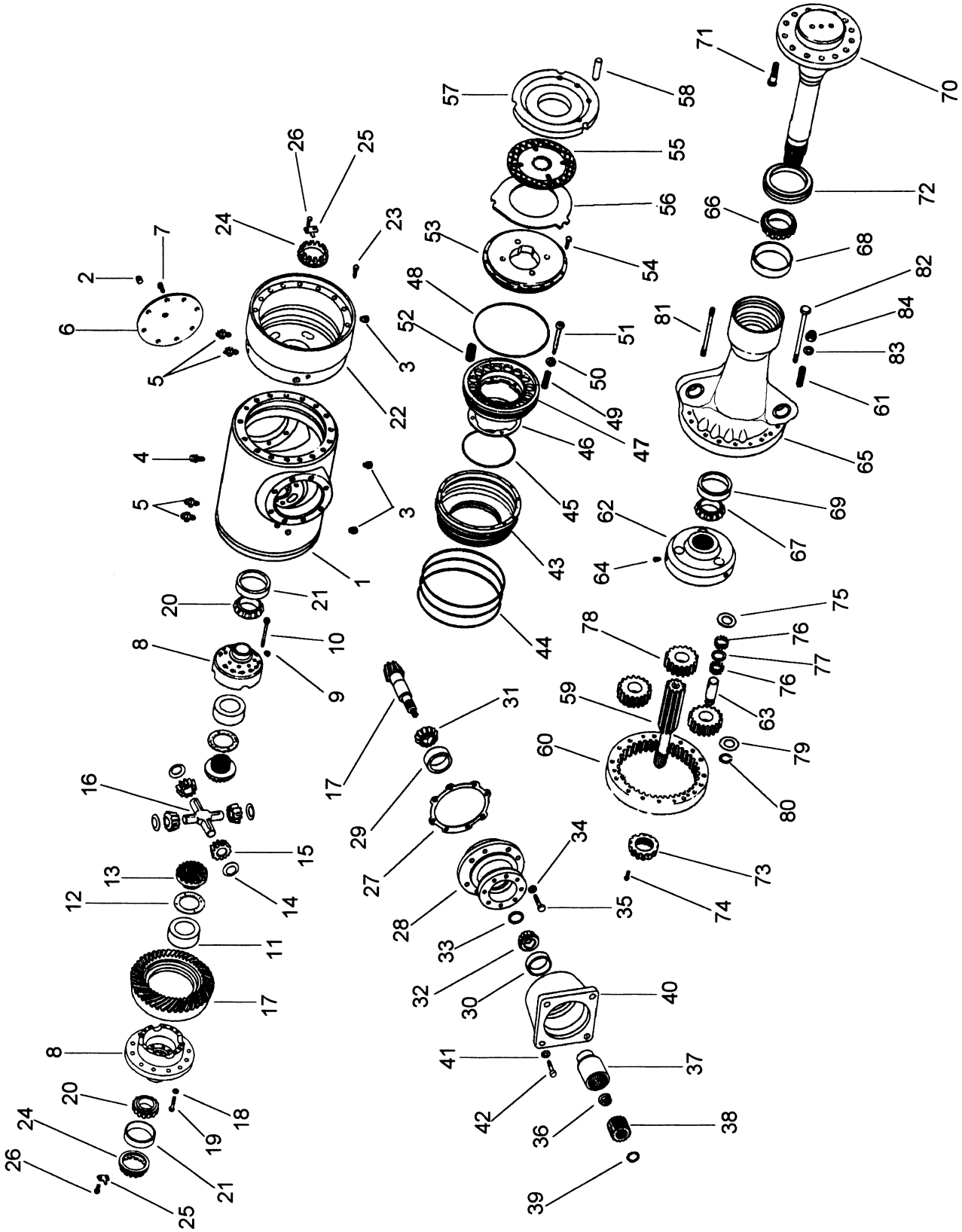
Drivetrain Plus™ *Technical Electronic Library (TEL)* on CD

The CD includes product and service information on Meritor's Drivetrain Plus™ component lineup. $20. Order TP-9853.

How to Order

Call Meritor's Customer Service Center at 800-535-5560.

PRA 352 – Trumpet Variation No. 1

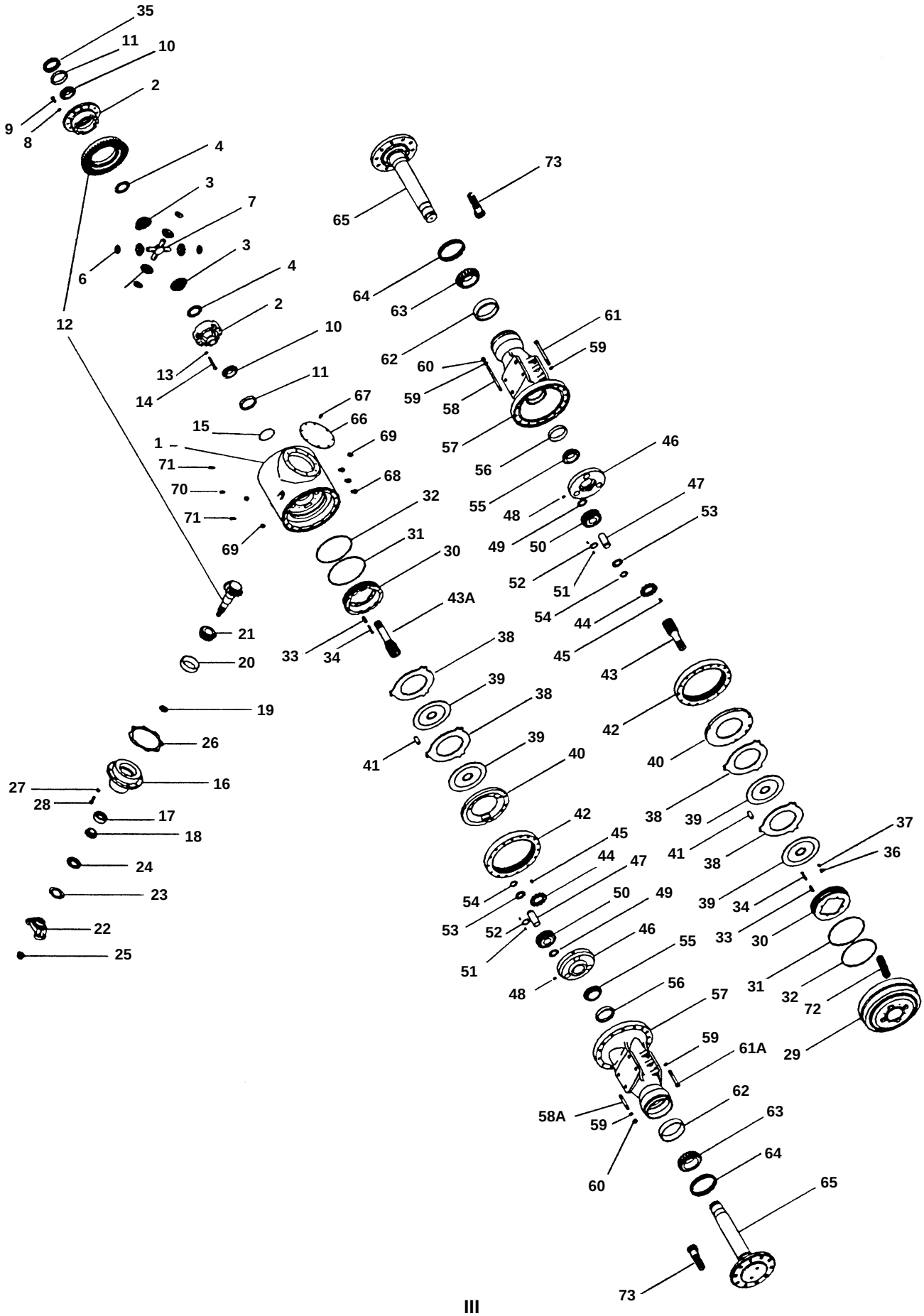


PRA 352 – Trumpet Variation No. 1

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

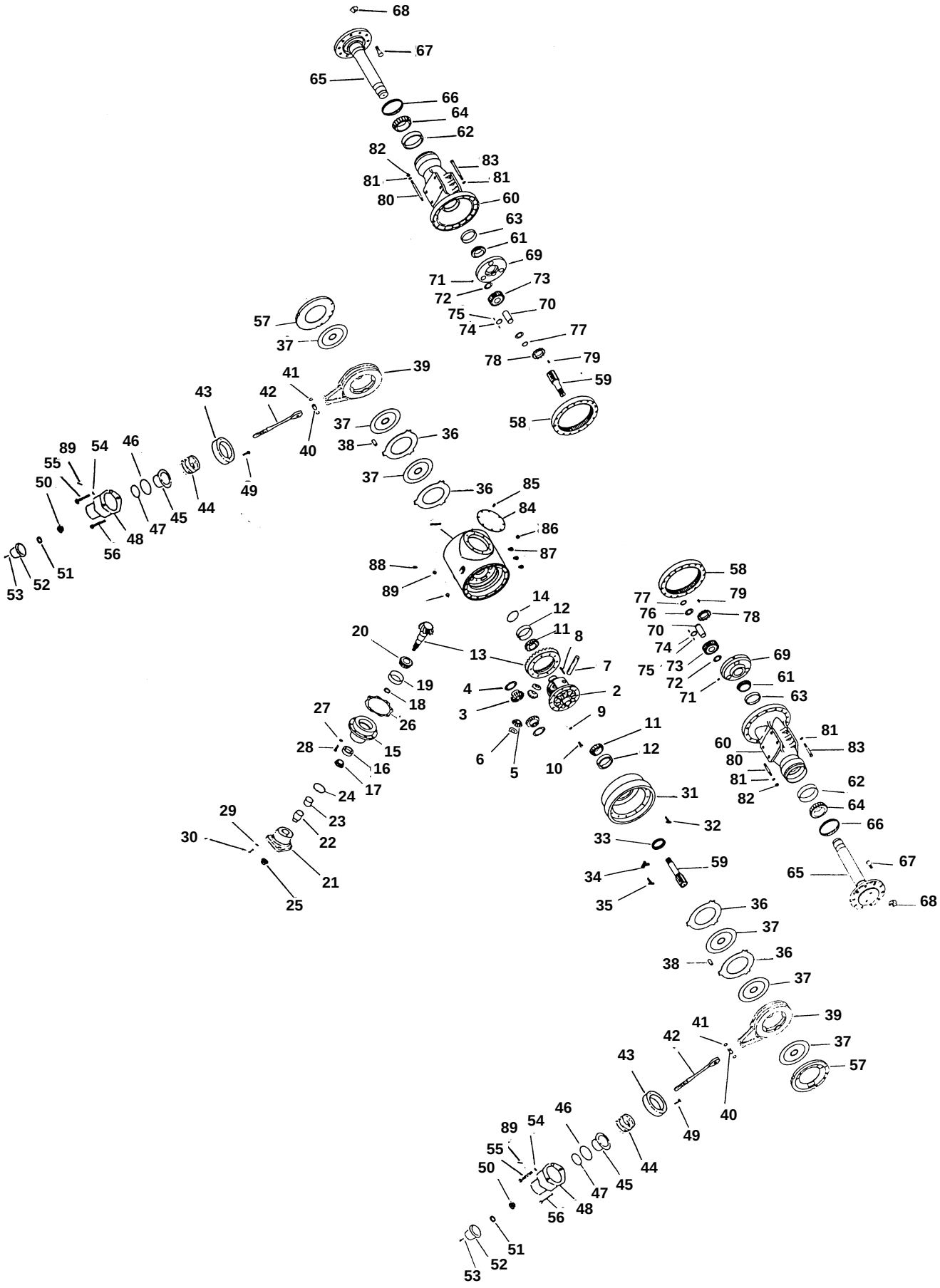


PRA 352 – Trumpet Variation No. 2

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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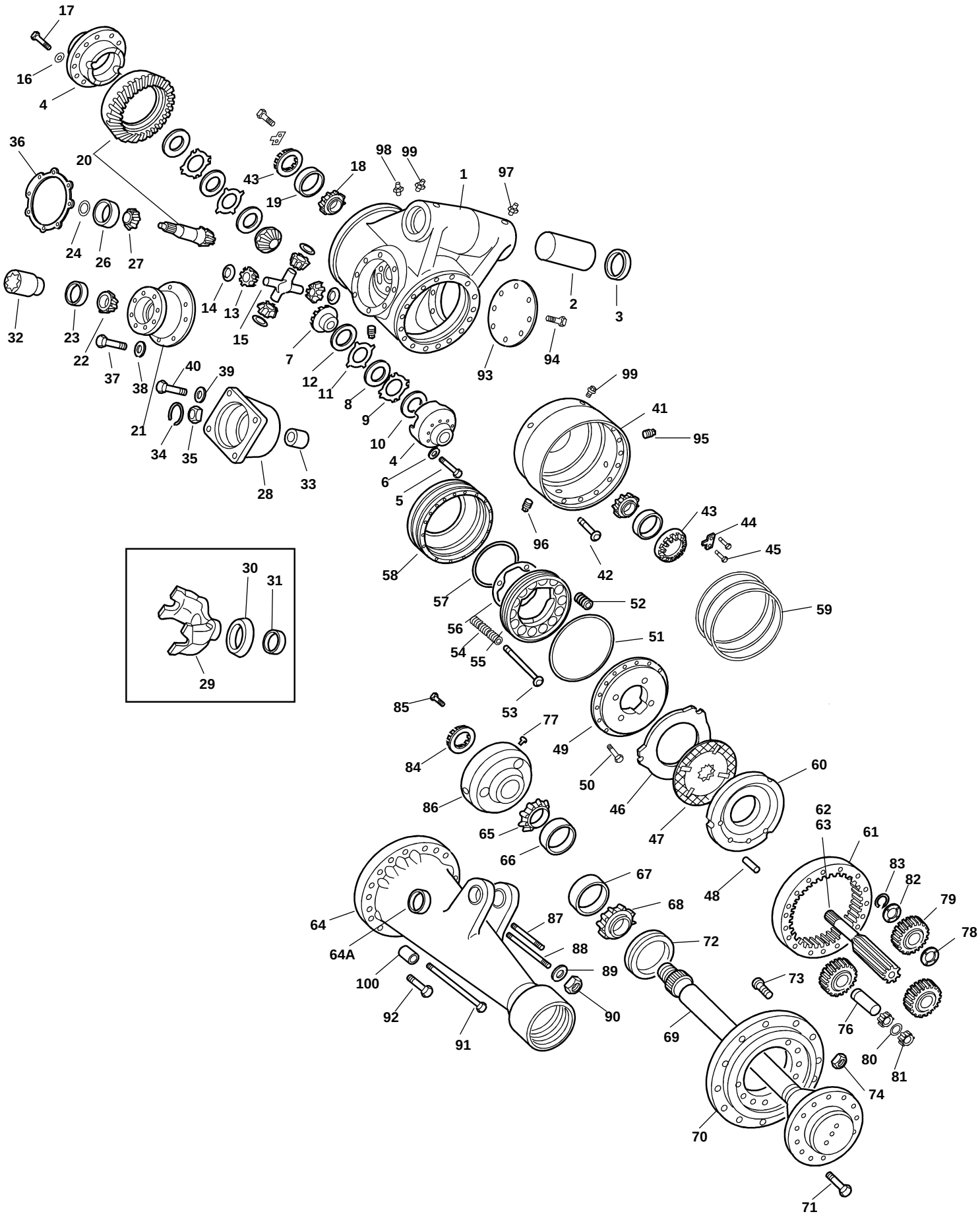
Item	Description
1	Center Housing
2	Differential Case
3	Side Gear
4	Thrust Washer
5	Pinion Gear
6	Thrust Washer
7	Differential Pinion Shaft
8	Pinion Shaft Lock Pin
9	Washer
10	Capscrew
11	Bearing Cone
12	Bearing Cup
13	Spiral Gear and Pinion
14	Differential Case Shim
15	Pinion Cage
16	Bearing Cup
17	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)

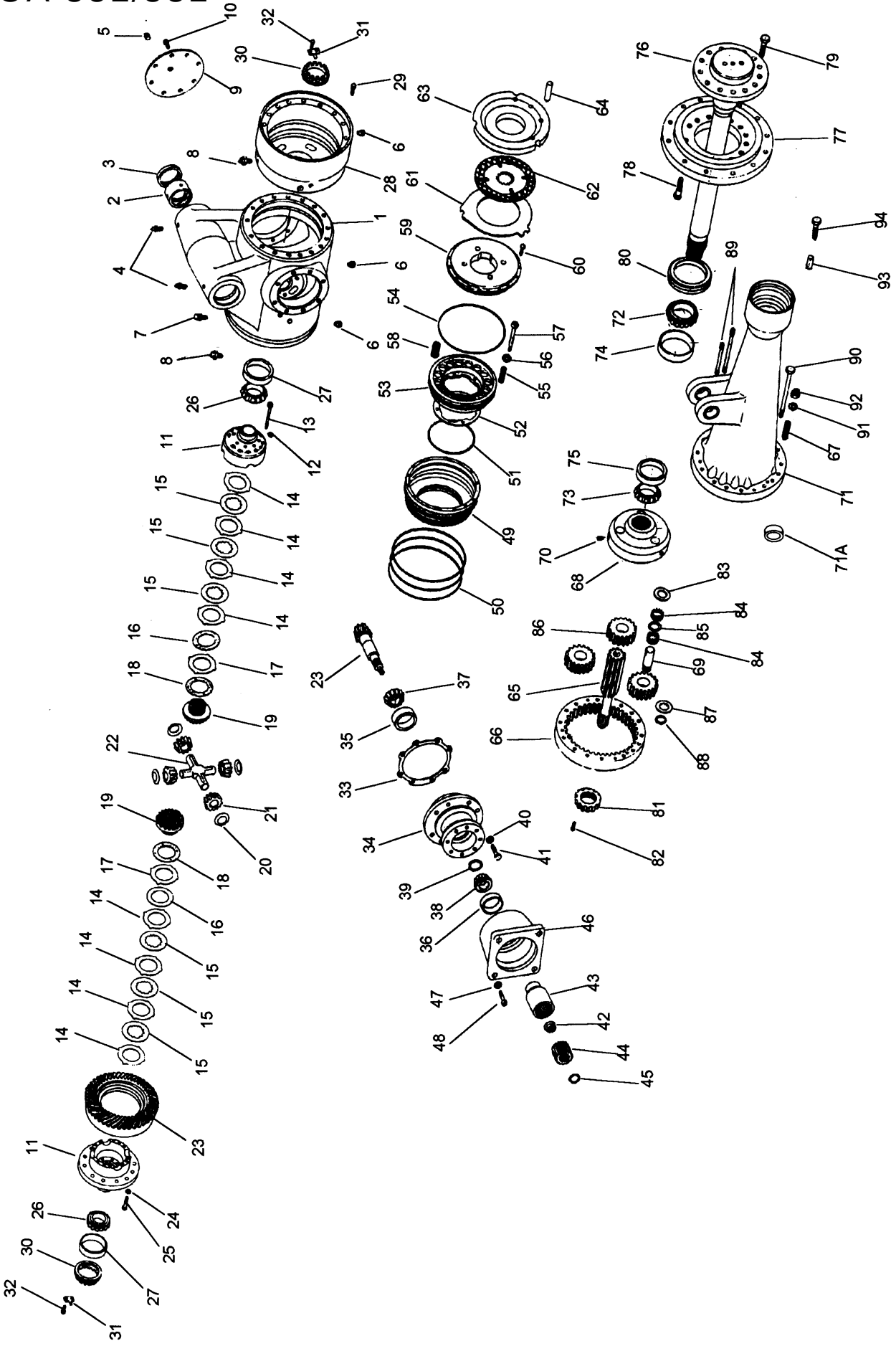


PROA 352/382 (With Mechanical Drive Option)

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

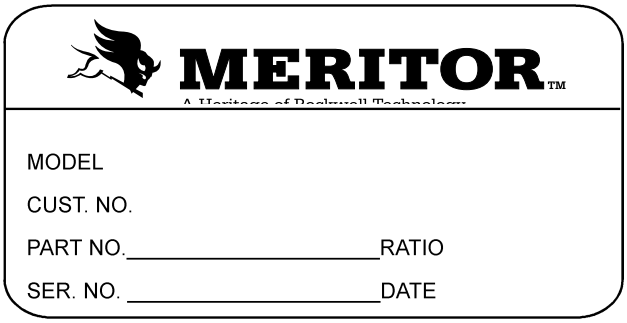
The Meritor PRA 352 Series Planetary Axle is a double reduction single speed unit that has:

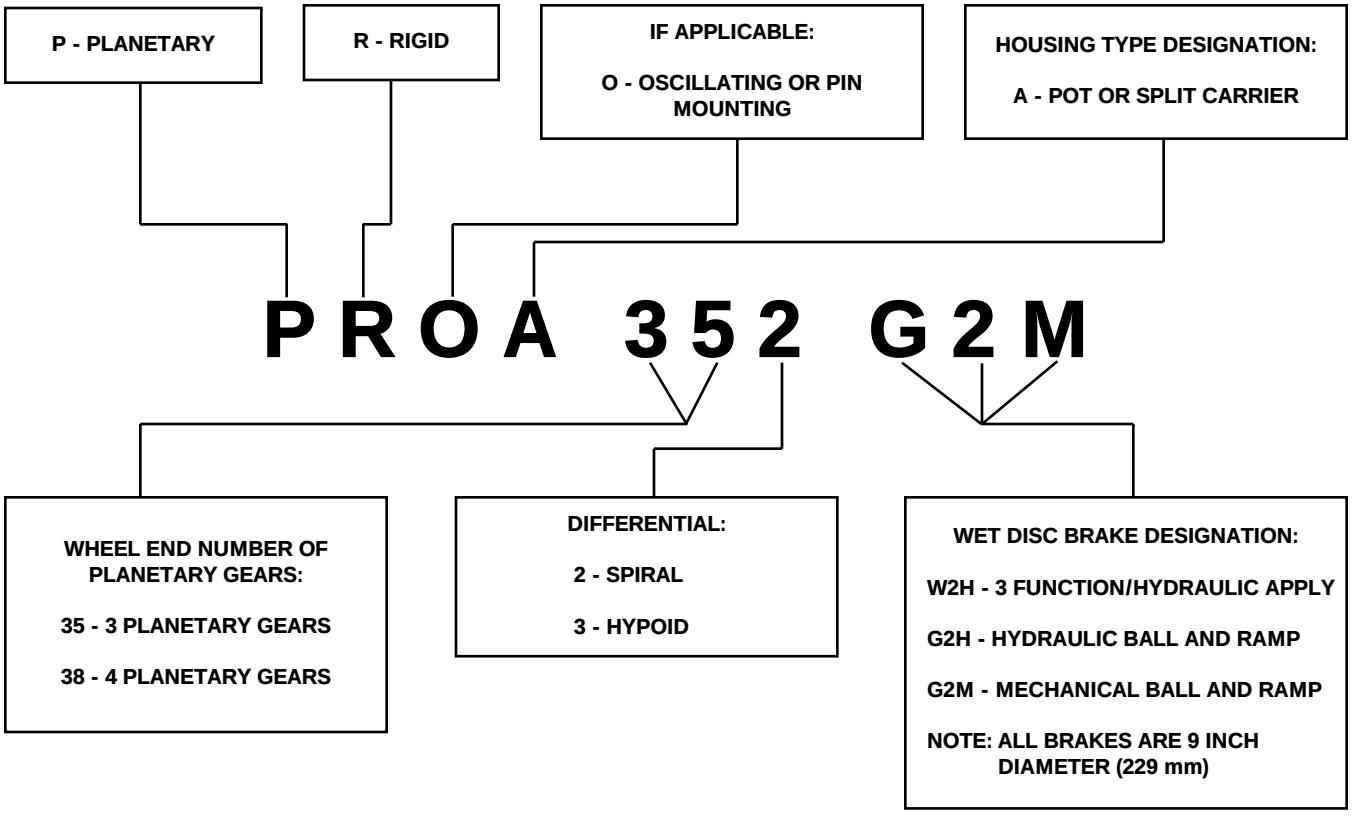
- A hypoid or spiral pinion and ring gear set
- Bevel gears in the differential assembly with 2 or 4 differential pinion gears
- A differential case assembly mounted on two tapered roller bearings
- A planetary system with 3 or 4 planetary pinion gears
- A trunnion mounting option
- An oil bath disc 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.





Remove Axle

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

WARNING

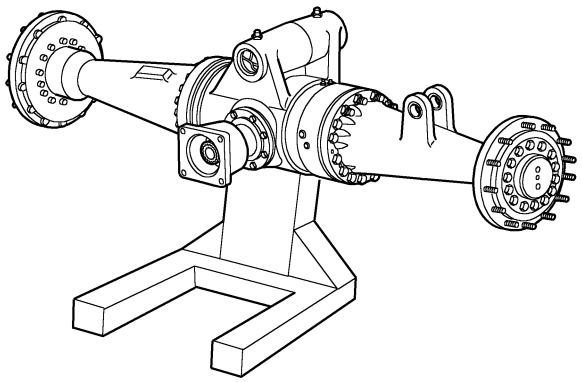
Support vehicle with safety stands. Do not work under a vehicle only supported by jacks. Jacks can slip or fall over and cause serious personal injury.

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

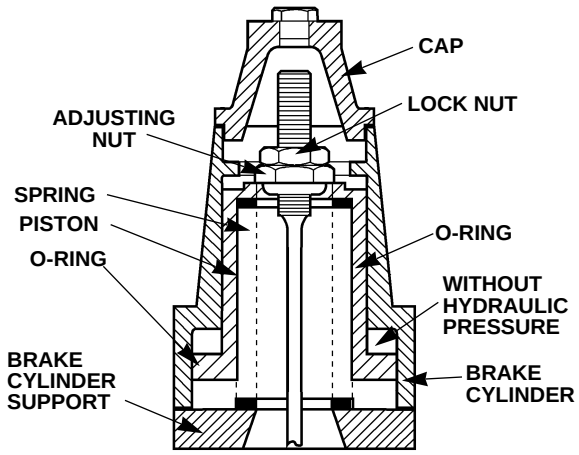
Disassemble Ball and Ramp Brake

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

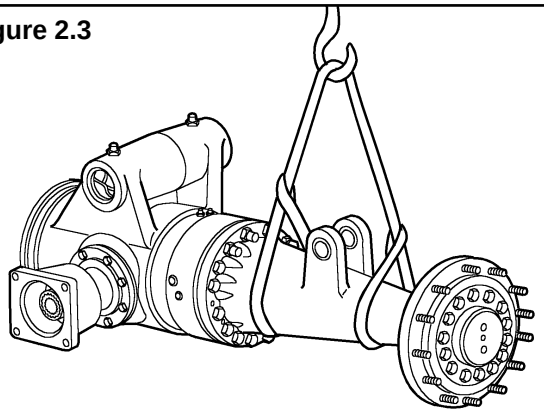
⚠ *WARNING*

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.

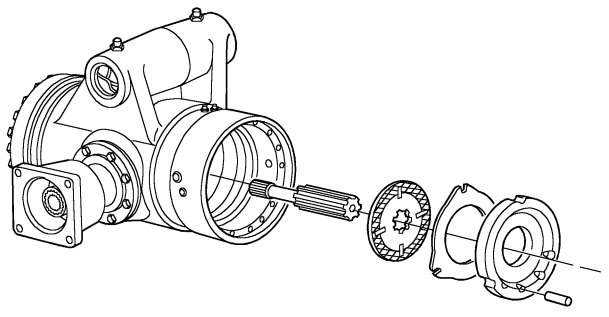
4. Remove ring gears from both sides through the two threaded puller holes. (Thread: M14 x 1.5 x 6 g).

⚠ *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



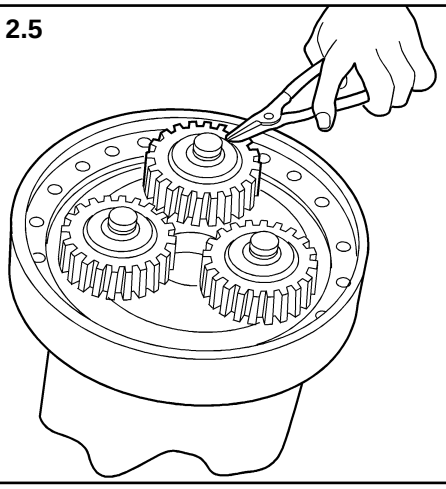
Disassemble Planetary System and Axle Shaft

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.

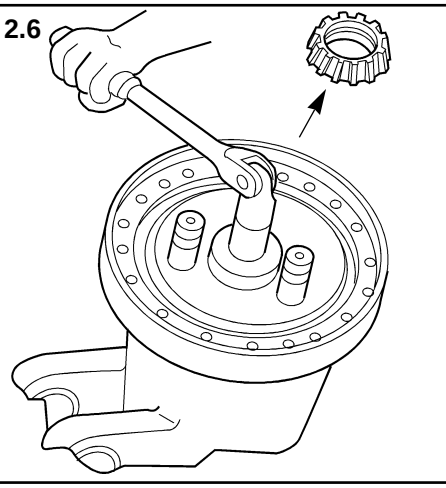
1. With pliers, remove snap rings. Disassemble planetary gears and rollers. **Figure 2.5.**

Figure 2.5



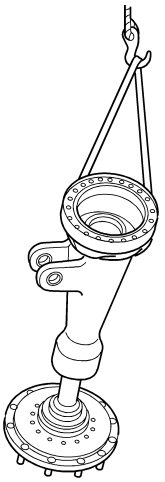
2. Remove axle shaft adjusting nut lock.
3. Remove axle shaft adjusting nut lock with special tool, illustrated in Section 6. **Figure 2.6.**

Figure 2.6



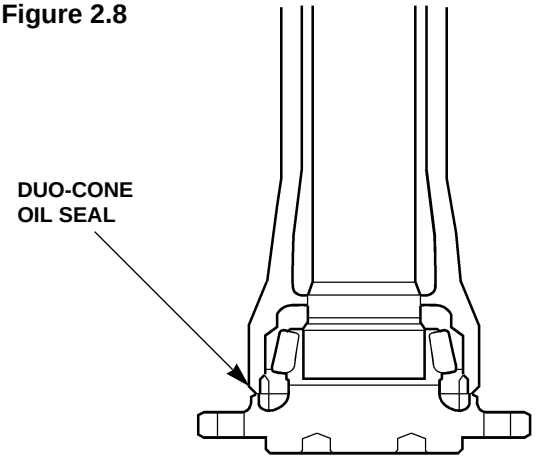
4. Remove pinion gear flange. Lift it through planetary gear pins.
5. Remove axle shaft assembly and cone bearing. If necessary, use press. **Figure 2.7.**

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.**

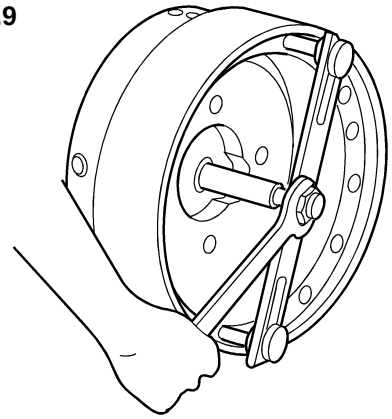
Figure 2.8



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

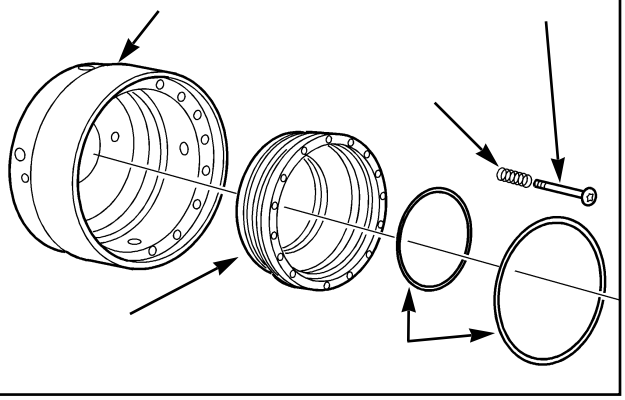


CAUTION

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.

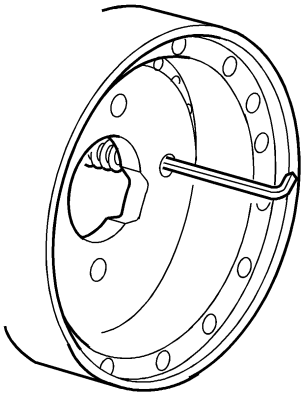
Disassemble Three Function Wet Disc Brake

NOTE

Do not disassemble brake piston unless necessary.

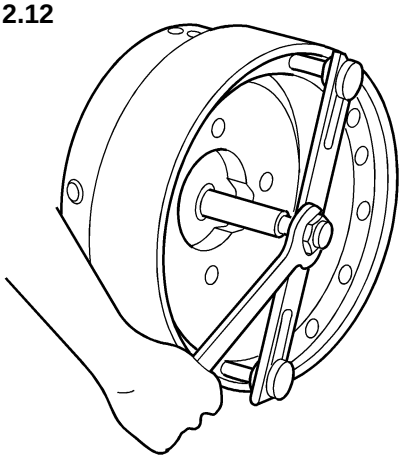
1. Remove return spring capscrews with 4 mm Allen wrench. Remove return springs and washers. **Figure 2.11.**

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



⚠ *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

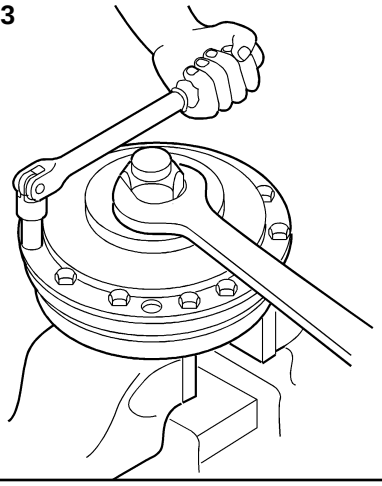
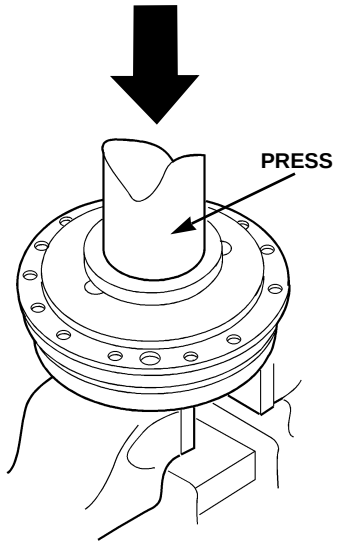


Figure 2.14

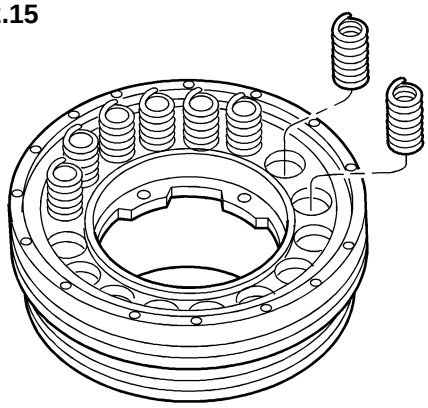


⚠ *CAUTION*

Before removing action plate and other parts, mark the original assembly positions of all brake piston assembly parts. This procedure will make reassembly easier.

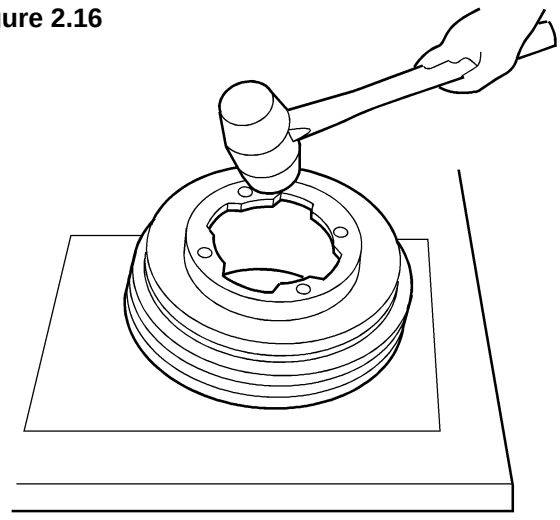
6. Remove action plate and springs. **Figure 2.15.**

Figure 2.15



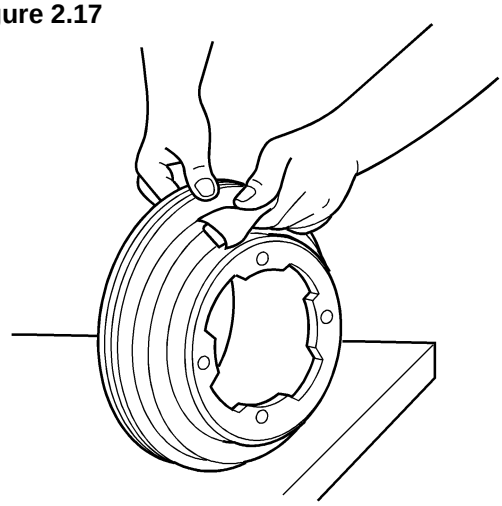
7. Remove internal piston by placing brake piston assembly on bench with action plate support surface turned down. Tap internal piston with rubber mallet. **Figure 2.16.**

Figure 2.16



8. Use sand paper on piston surfaces if they have nicks or hits. **Figure 2.17.**

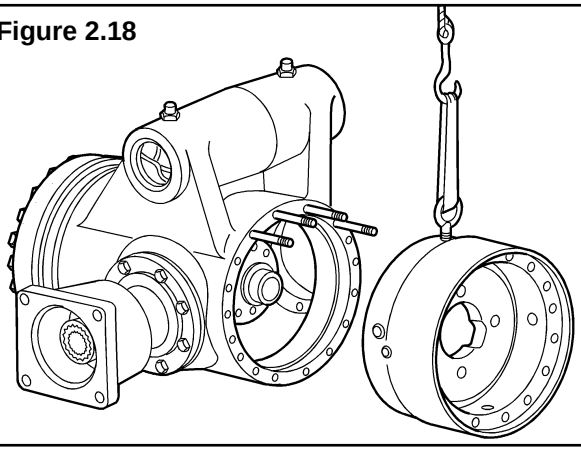
Figure 2.17



Disassemble Main Housing

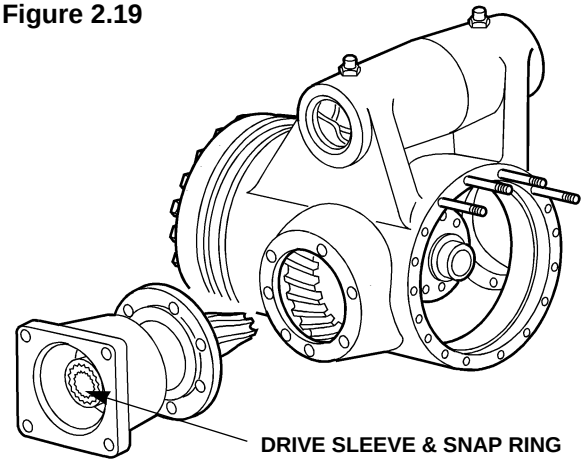
1. Remove adjusting nut capscrew lock.
2. Remove adjusting nut capscrew and adjusting nut.
3. Remove brake housing capscrews that are set deep in brake housing flange. Use long 6mm Allen wrench.
4. Remove brake housing from main housing. Hit brake housing with brass hammer or use two slots to remove it from main housing. Be careful not to hit ring gear. **Figure 2.18.**

Figure 2.18



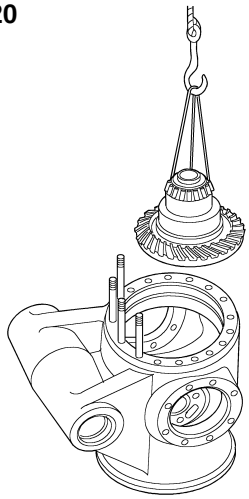
5. Depending on ring gear position, remove pinion bearing cage capscrews.
6. Remove pinion bearing cage assembly from main housing. **Figure 2.19.**
7. Remove drive sleeve and snap ring. **Figure 2.19.**

Figure 2.19



8. Remove differential case assembly. **Figure 2.20.**

Figure 2.20

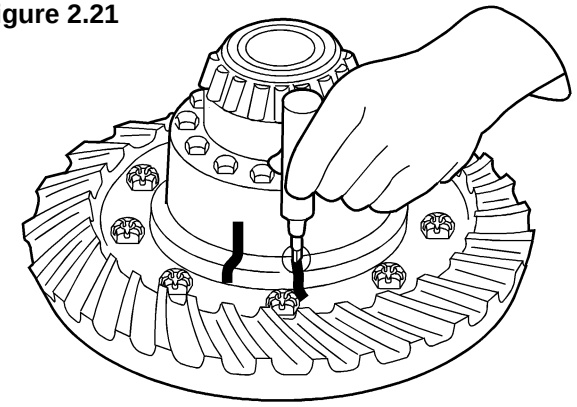


9. Remove main housing cover.

Disassemble Differential Case

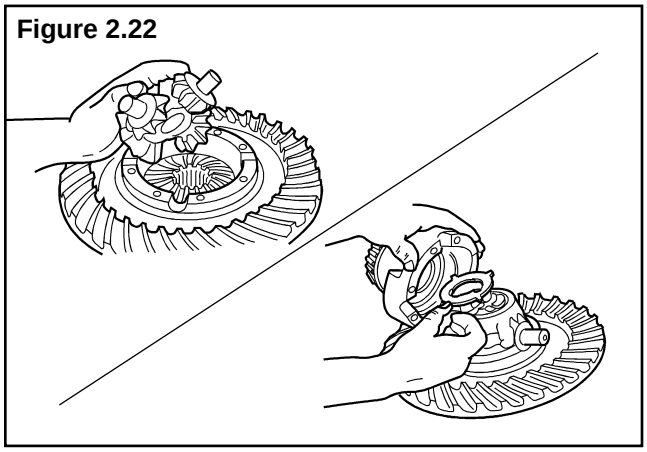
1. Before disassembling differential case, mark position of both halves and spider cross for easier reassembly. **Figure 2.21.**

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

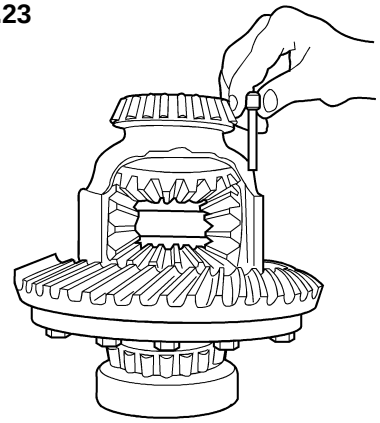


Figure 2.24

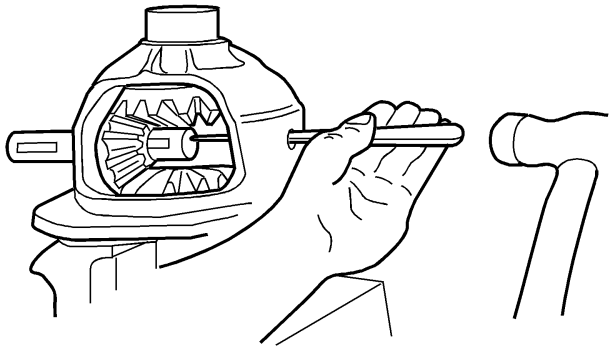
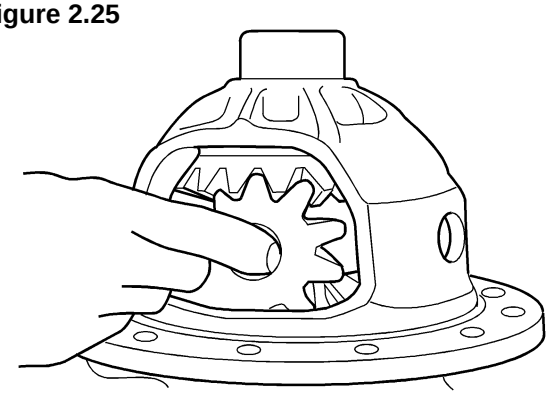


Figure 2.25



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

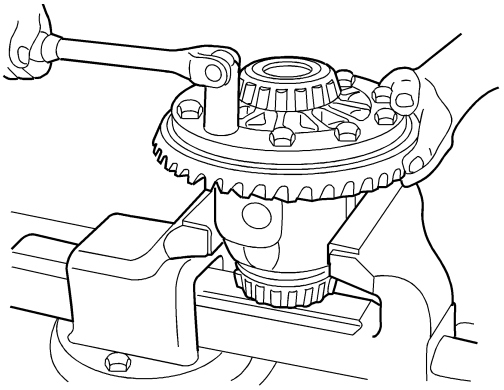
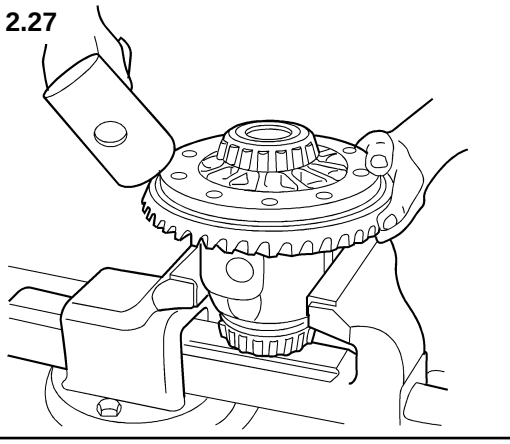


Figure 2.27

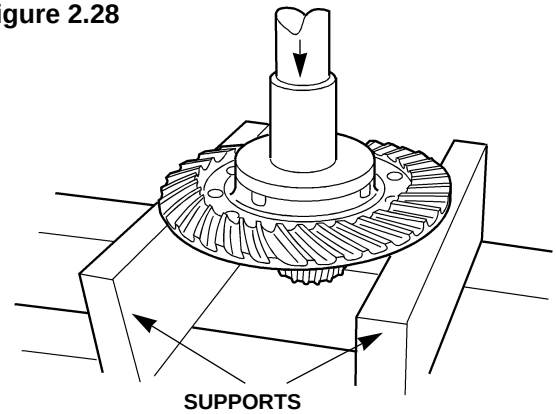


WARNING

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

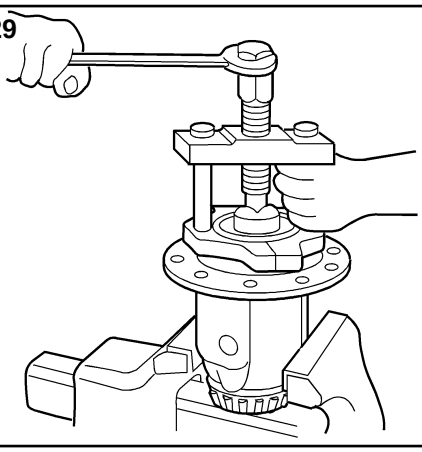


Figure 2.30

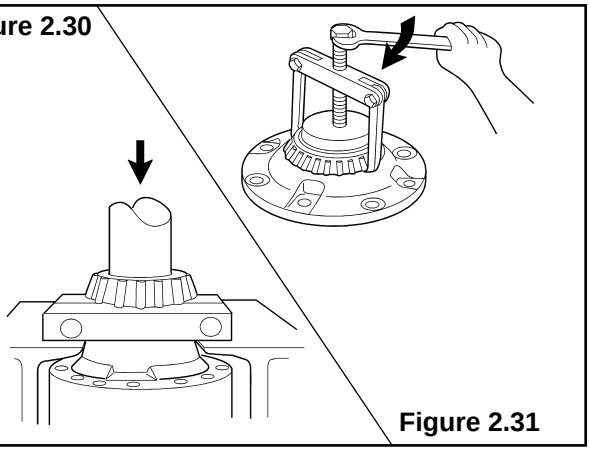


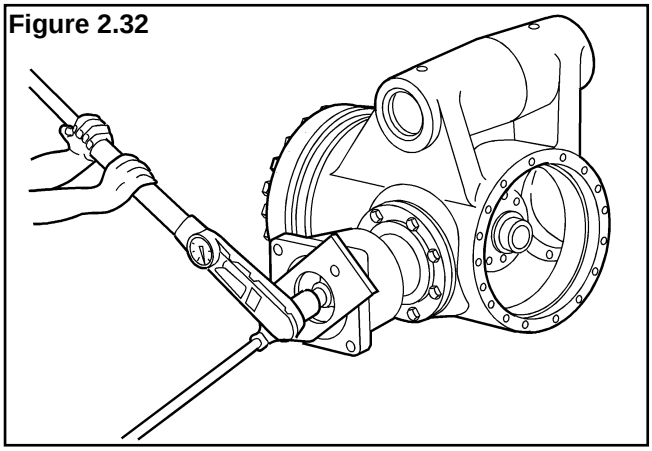
Figure 2.31

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

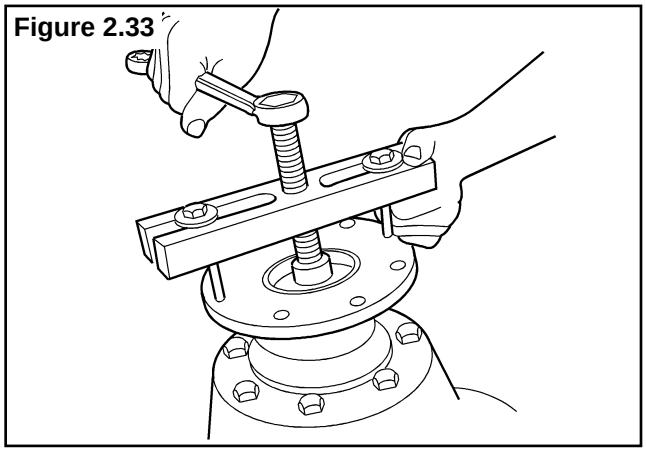


CAUTION

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

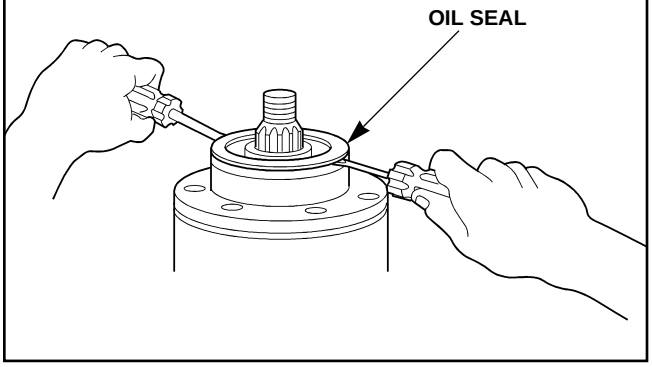


CAUTION

To avoid oil leaks, be careful not to damage the mounting surface of the bearing cage.

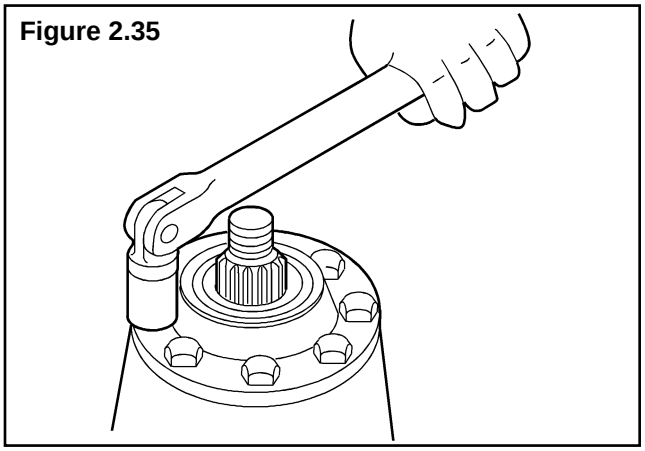
3. Remove pinion oil seal. Pry at several points around circumference between seal, flange and bearing cage. **Figure 2.34.**

Figure 2.34



4. Remove capscrews and washers that fasten pinion bearing cage on main housing. **Figure 2.35.**

Figure 2.35

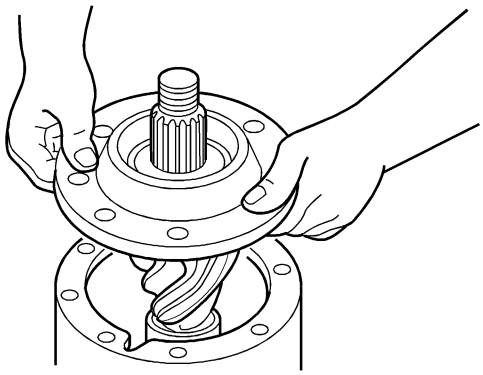


⚠ CAUTION

Do not use pry bar to remove bearing cage from carrier. A pry bar can damage bearing cage, shims and main housing.

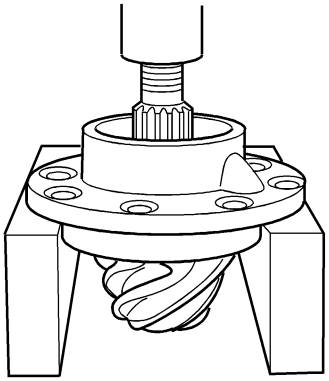
5. Remove pinion bearing cage and shims from main housing. If bearing cage is tight within the main housing, hit bearing cage at several points around flange area with leather, plastic or rubber mallet. **Figure 2.36.**

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

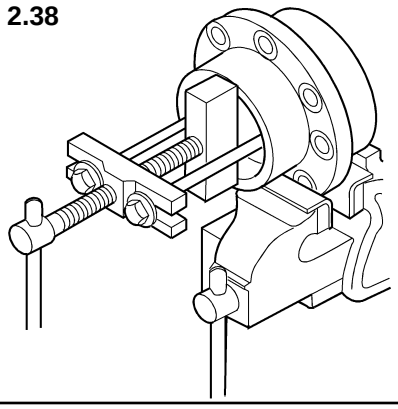
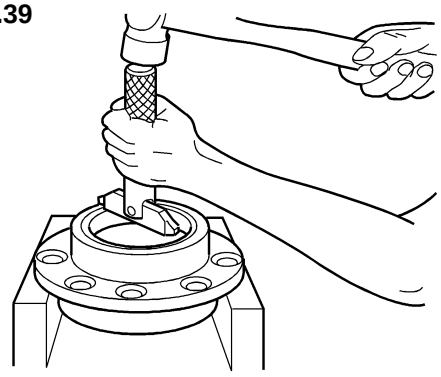
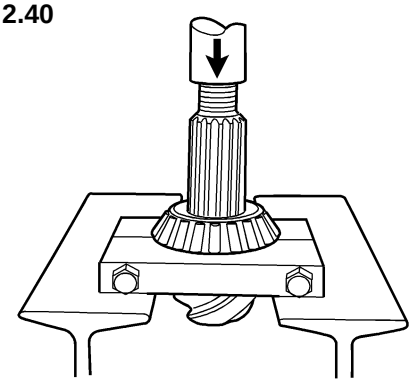


Figure 2.39



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.**

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

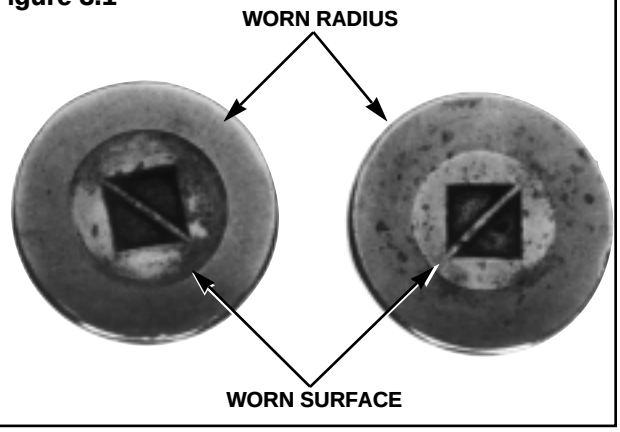
It is very important to inspect all parts carefully and completely before the axle or carrier is assembled. Check all parts for wear and replace damaged parts. Replacement of damaged or worn parts will prevent breakdown of assembly later.

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:

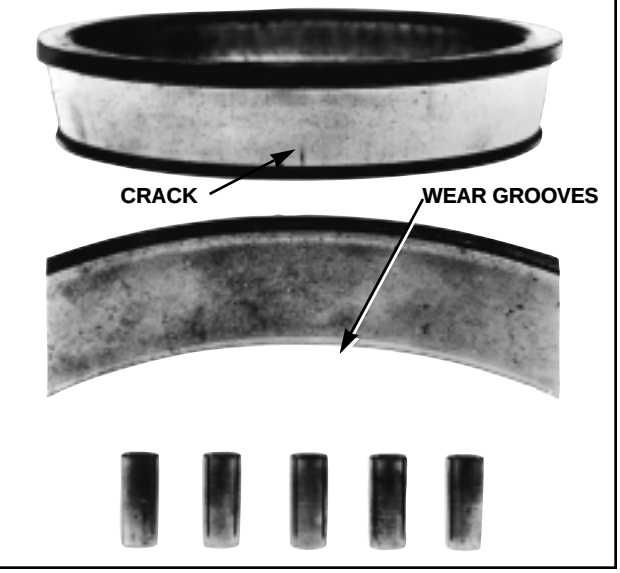
- The center of the large diameter end of the rollers are worn level with, or below the surface.
- The center of the large diameter end of the rollers are worn to a sharp edge. **Figure 3.1.**

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.**

Figure 3.2

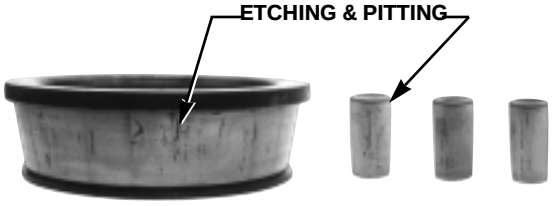


- Deep cracks or breaks in the cup, cone inner race or roller surfaces.
- Bright wear marks on the outer surface of the roller cage. **Figure 3.3.**

Figure 3.3

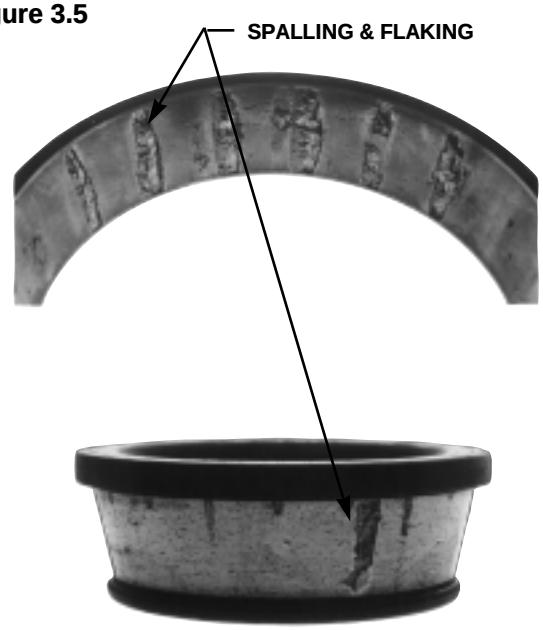
- Damage on rollers and on surfaces of the cup and cone inner race that touch the rollers. **Figure 3.4.**

Figure 3.4



- Damage on the cup and cone inner race surfaces that touch the rollers.**Figure 3.5.**

Figure 3.5



Inspect Hypoid Pinion and Ring Gear Sets

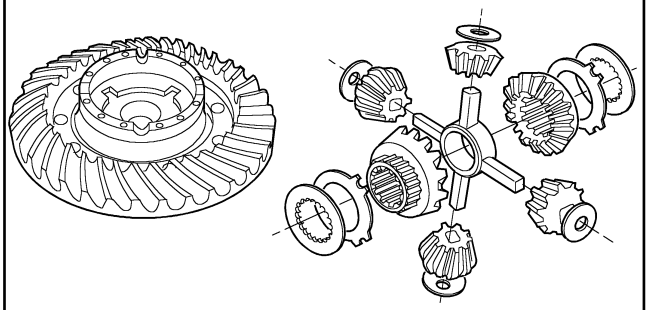
CAUTION

- ***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.**

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.

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

CAUTION

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

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).

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.

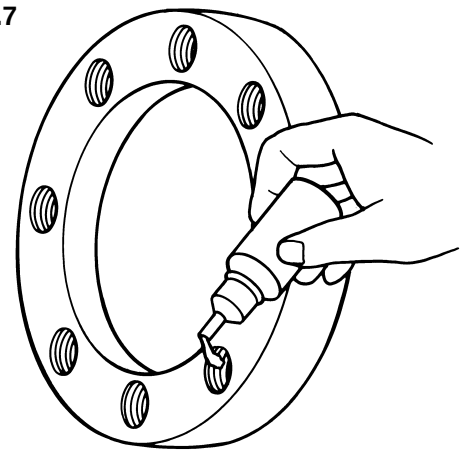
Reassembly

- 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)

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.

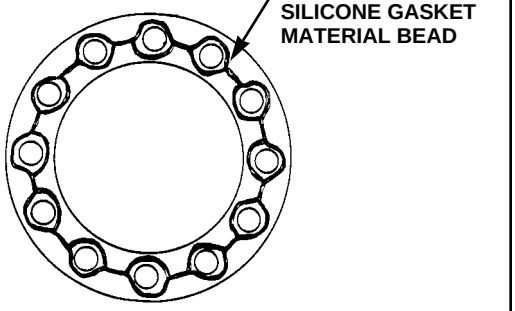
1. Remove all old gasket material from both surfaces.
2. Clean the surfaces where liquid gasket material will be applied. Remove all oil, grease, dirt and moisture.
3. Thoroughly dry both surfaces.
4. Apply according to the following procedures:

- **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. T

DUO-CONE Oil Seal: Mount and Install

NOTE

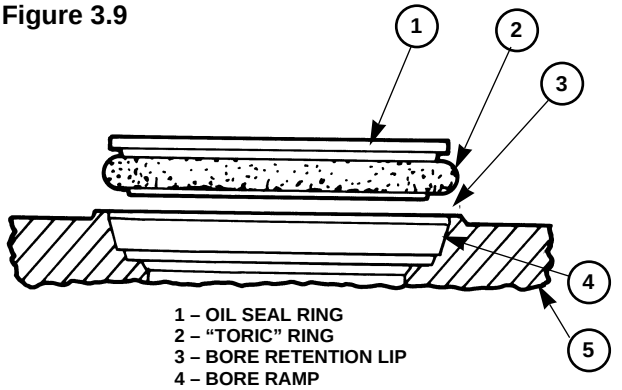
- ***Always follow correct procedures when mounting and installing DUO-CONE oil seals. Many DUO-CONE oil seal leaks result from errors made during mounting or installation of oil seal components.***
- ***Never let oil touch Toric ring or lodging ramps before both oil seal rings are installed in their 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).

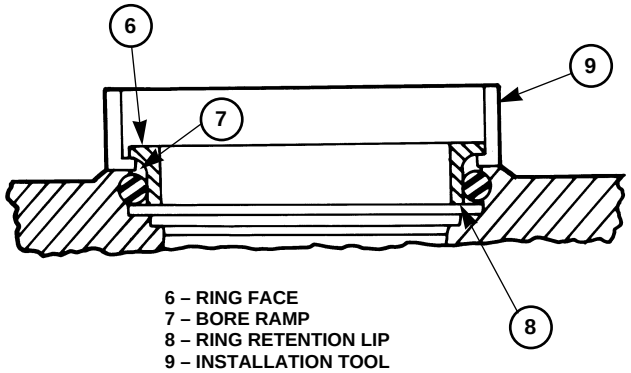
1. Remove any dust, oil or foreign material from Toric ring (2), lodging ramps (4, 7), ring retention lips (3, 8), oil seal ring (1) and ring bore (5). Clean components with trichloroethylene and a clean cotton cloth or a paper towel. **Figures 3.9 and 3.10.**

Figure 3.9



1 – OIL SEAL RING
2 – "TORIC" RING
3 – BORE RETENTION LIP
4 – BORE RAMP
5 – RING BORE

Figure 3.10

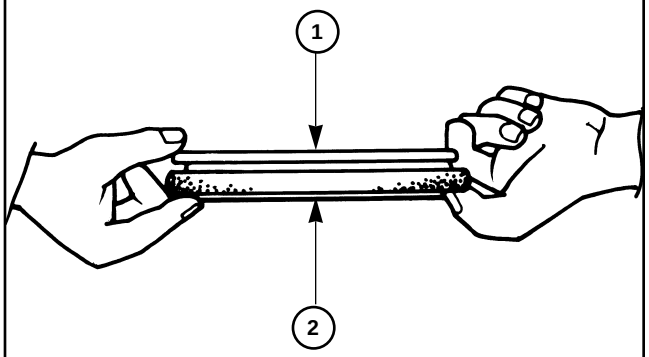


6 – RING FACE
7 – BORE RAMP
8 – RING RETENTION LIP
9 – INSTALLATION TOOL

⚠ *CAUTION*

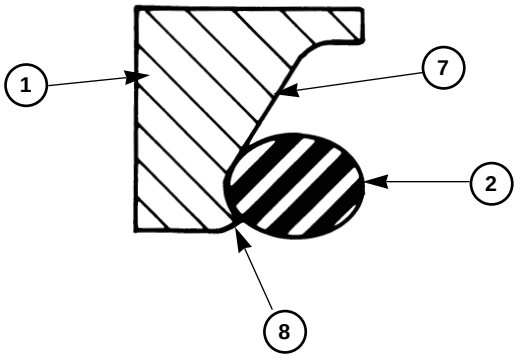
Make sure that Toric ring (2) is seated in oil seal ring (1). Be careful when you work with Toric ring. Cuts and scratches in Toric ring may cause leaks. **Figure 3.11.**

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

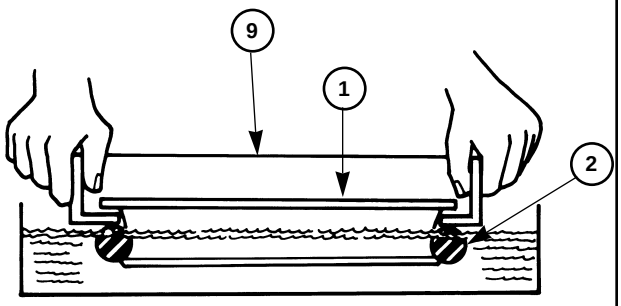


NOTE

Do not use any liquid that leaves a film of oil or does not evaporate quickly.

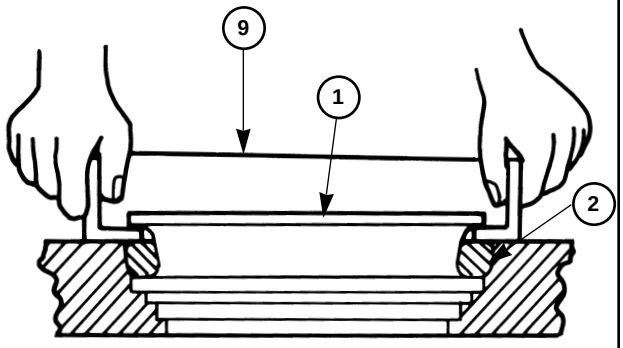
3. Place installation tool (9) under oil seal ring with Toric ring (2). Submerge ring in receptacle filled with trichloroethylene until entire surface of Toric ring is wet. **Figure 3.13.**

Figure 3.13



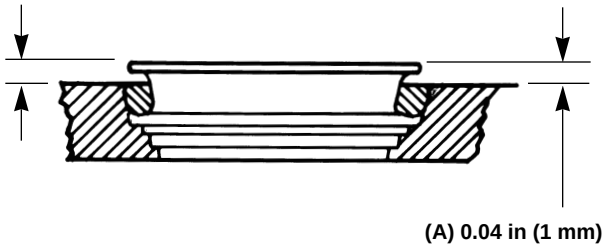
4. With Toric ring surface wet (2), use installation tool (9) to install oil seal ring and Toric ring perpendicular to ring bore. Use a rapid and uniform pressure to push Toric ring under ring retention lip. **Figure 3.14.**

Figure 3.14



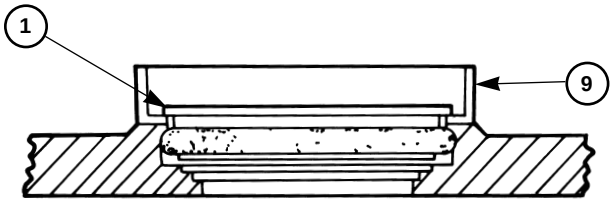
5. Verify mounting distance (A) in at least four places spaced 90 degrees apart. The difference in the mounting distance (A) around ring cannot be more than 0.04 inches (1 mm). **Figure 3.15.**

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

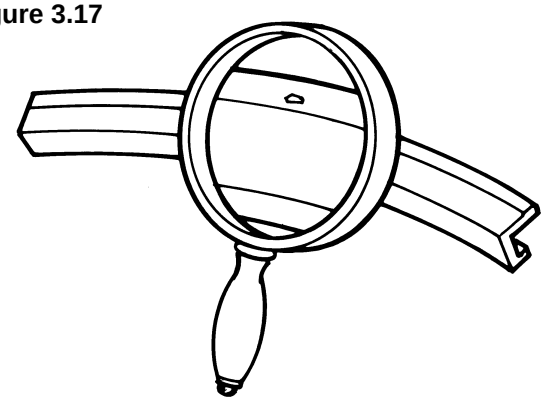


7. Toric ring may become distorted if not entirely wet or if there is a sharp edge on the retention lip and bore.

⚠ CAUTION

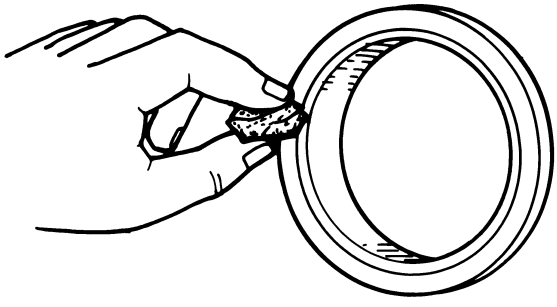
- ***Misalignment or a twisted Toric ring may cause leakage in the DUO-CONE oil seal. If installation was not correct, remove oil seal from bore and repeat steps 3-6.***
- ***A Toric ring must never slide on any ramp of oil seal ring or bore. To prevent sliding, wait at least two minutes for trichloroethylene 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



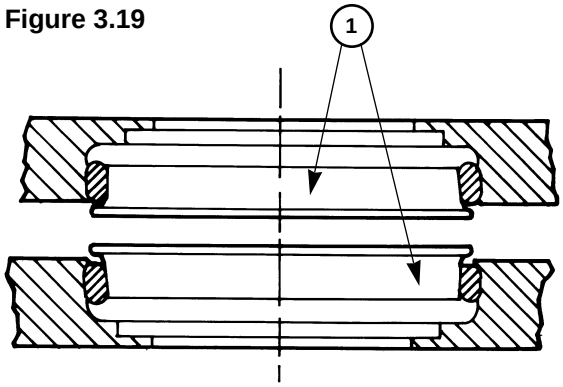
8. Clean oil seal surfaces with lint-free cloth or paper.
9. Apply a thin, uniform film of clean oil on oil seal surfaces with cloth or clean finger. Do not get oil on Toric ring. **Figure 3.18.**

Figure 3.18



10. Make sure both bores are correctly aligned and concentric. Move slowly and carefully. **Figure 3.19.**

Figure 3.19



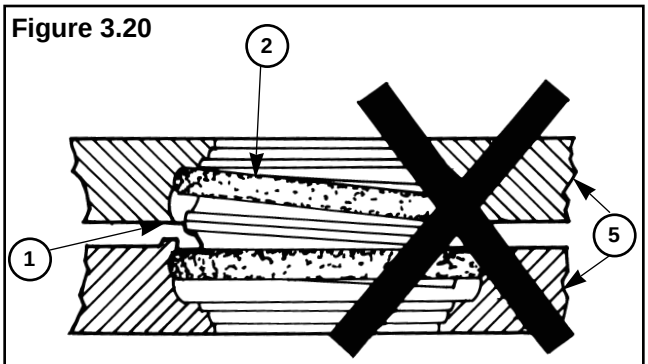
⚠ CAUTION

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



- 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 3.21

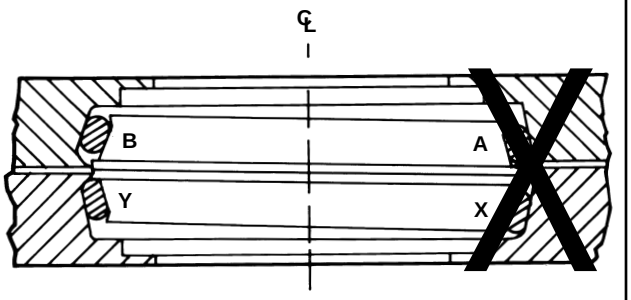
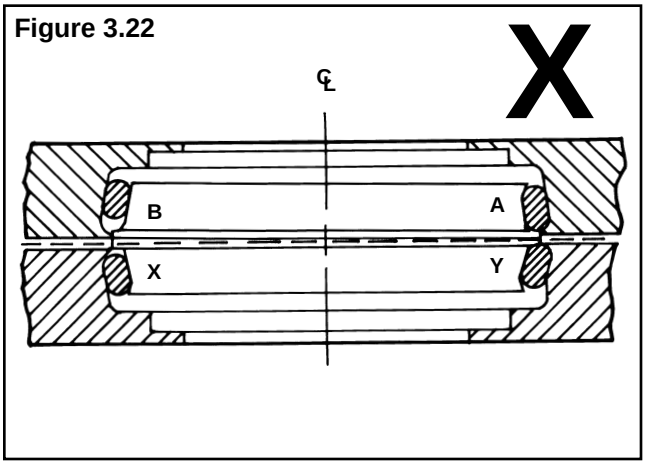


Figure 3.22 shows the same lower bore after rotation of 180 degrees. In this position, high pressure occurs on points “A” and “Y”. This high pressure variation may damage rings. Points “B” and “X” will develop low pressure and possible leakage.

Figure 3.22



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.

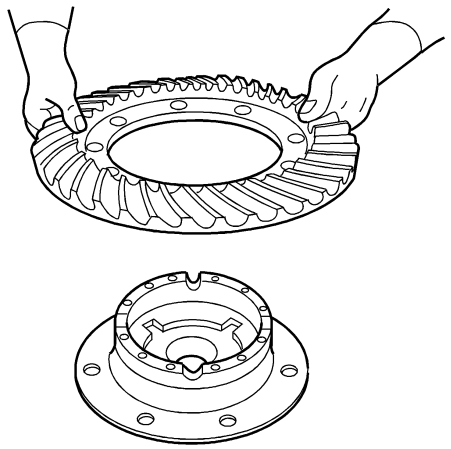
2. Expand ring gear bore by heating ring gear in tank of water heated 160°F to 180°F (71°C to 82°C) for 10 to 15 minutes. DO NOT USE AN OPEN FLAME SUCH AS A TORCH FOR THIS PROCEDURE.
3. Install ring gear on case half or in the integral differential case.

⚠ 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.

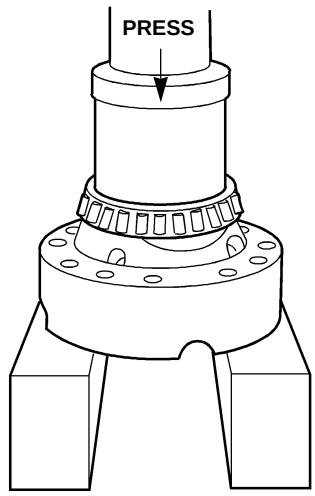
4. Apply Loctite 271 or Three Bond 1305 adhesive to ring gear fasteners. See Section 3, "Liquid Adhesive." Install ring gear fasteners and fasten with the specified torque, 66-75 lb-ft (90-100 N•m). **Figure 4.1.** T

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

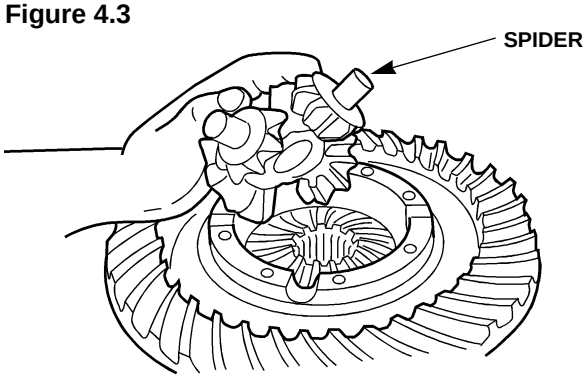


NOTE

For limited slip differential, go to step 12.

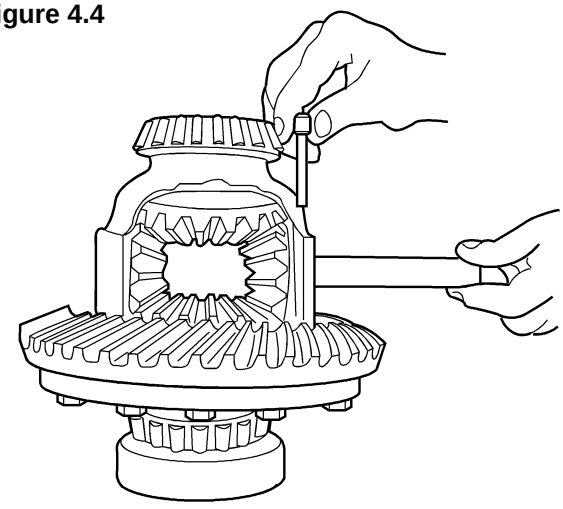
7. Install spider cross, differential pinions and washers on original assembly position. **Figure 4.3.**

Figure 4.3



   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.

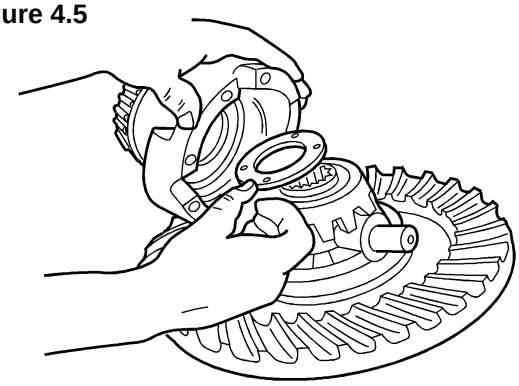
Figure 4.4



   d. Install differential pinion axle and lock capscrew. Fasten capscrew to specified torque 17-23 lb-ft (23-31 N•m).

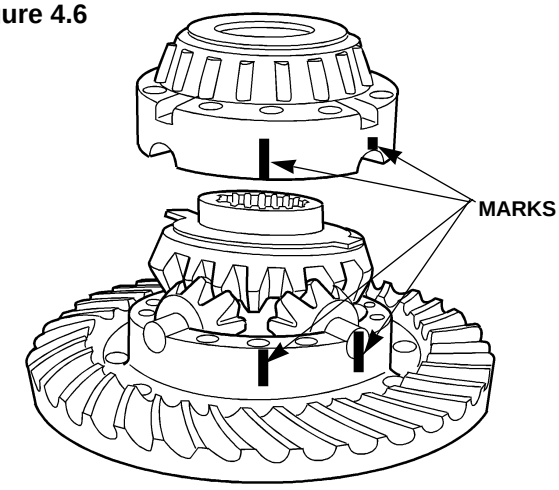
8. Install other side gear over spider and differential pinions. **Figure 4.5.**

Figure 4.5



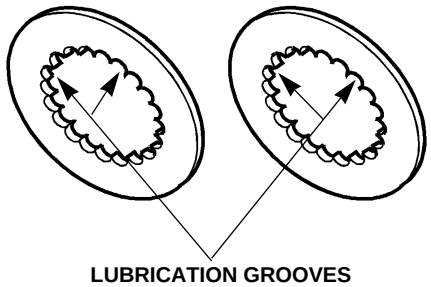
9. Place plain half of differential over flanged half. Rotate plain half as needed to align match marks. **Figure 4.6.**

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.**

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

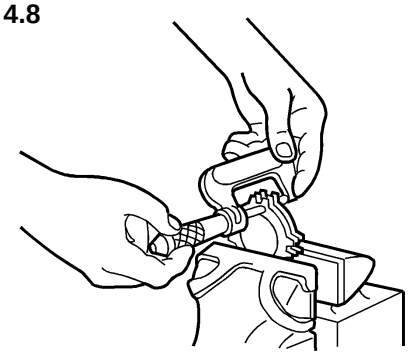
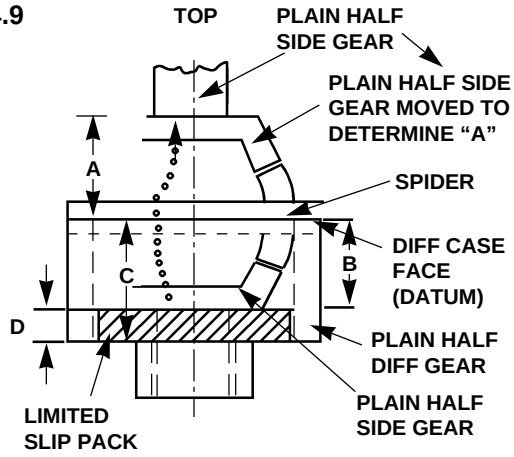


Figure 4.9



A: Differential case half flange to back of differential side gear distance.

B: Differential case face to side gear seat.

C: Differential case half depth.

D: Stack height (thickness).

    e. Use depth gauge to determine “C”, depth of differential case half. Take four readings. Average readings for result. **Figure 4.9.**

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.

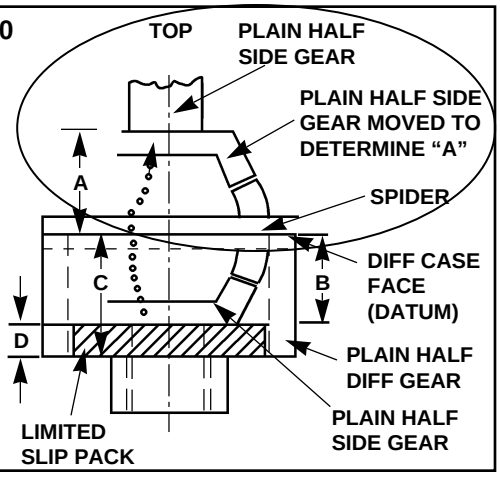
i. Assemble friction discs in differential case using sequence in step C including shims. Make sure discs are lubricated.

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.

Figure 4.10

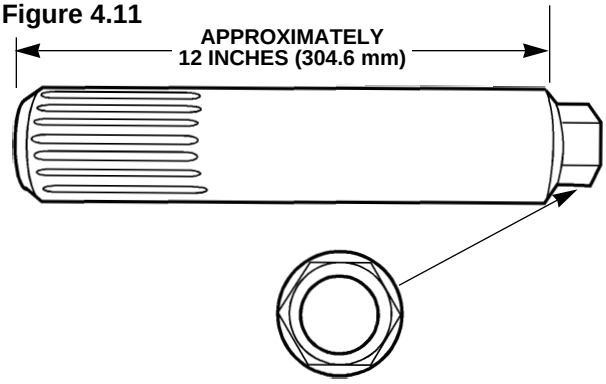


Check Rotating Resistance of Differential Gears (Not Limited Slip)

NOTE

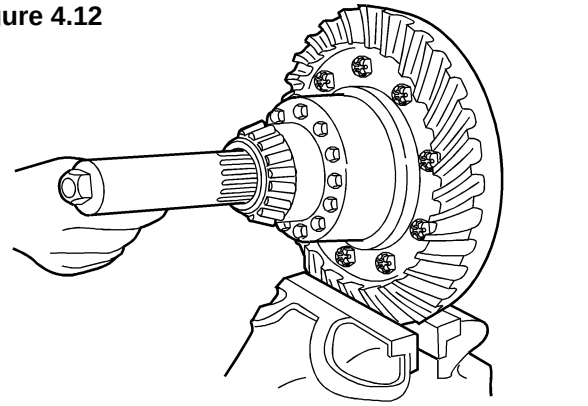
Make tool to check rotating resistance of the differential gears, 50 lb-ft (68 N•m). The tool can be made from a sun gear that matches the spline of the differential side gear. **Figure 4.11.**

Figure 4.11



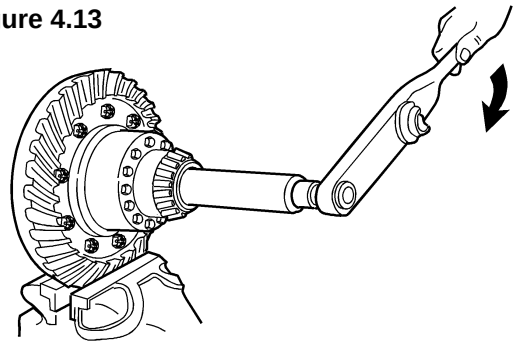
1. Place differential case assembly in a vise with soft metal covers on the vise jaws. Install the tool into differential until splines of tool and one side gear are engaged. **Figure 4.12.**

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.** T

Figure 4.13



3. If torque value exceeds specification of 50 lb-ft (68 N•m), disassemble gears from differential case. T
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.

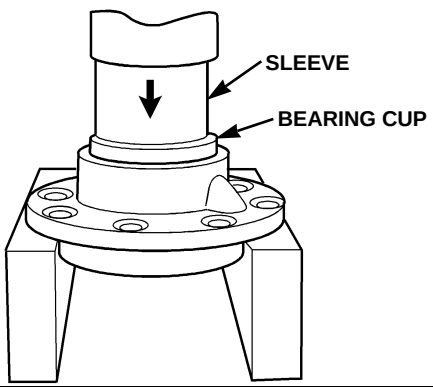
Assemble Drive Pinion and Bearing Cage

⚠ *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.



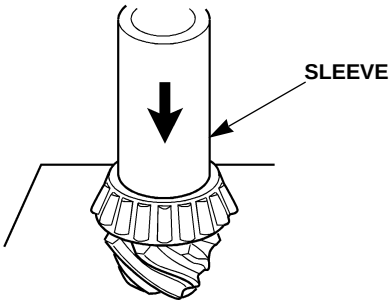
2. Support bearing cage with metal or wood blocks.
3. Press the bearing cup into bore of bearing cage until cup is flat against bottom of bore. Use correct size sleeve to install bearing cup.

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

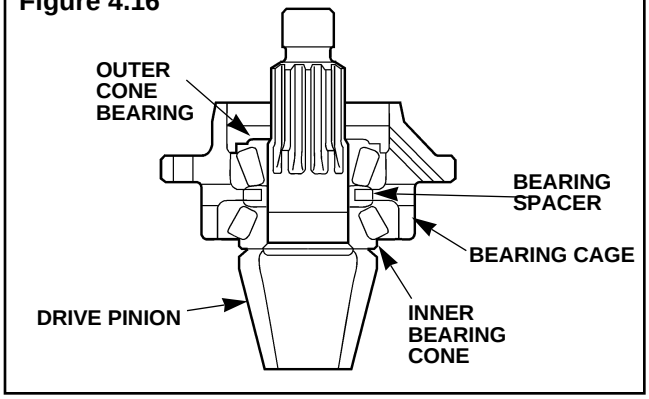


6. Apply axle lubricant on bearing cups in cage and bearing cones.
7. Install drive pinion into bearing cage.
8. Install bearing spacer(s) in pinion shaft against inner bearing cone. **Figure 4.16.**

NOTE

Spacer(s) controls preload adjustment of drive pinion bearings.

Figure 4.16



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 Kg x 9.3 cm = 21.4 Kg-cm
5.0 lb x 3.65 in = 18.25 lb-in.

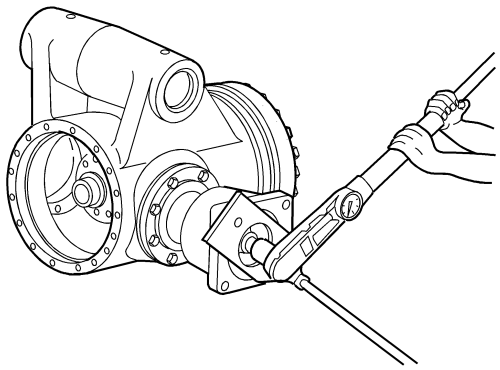
Conversion to N•m:
21.4 x 0.098 = 2.1 N•m
18.25 x 0.113 = 2.1 N•m

NOTE

- ***To convert lb-in to N•m: multiply by 0.113***
- ***Kg-cm to N•m: multiply by 0.098***

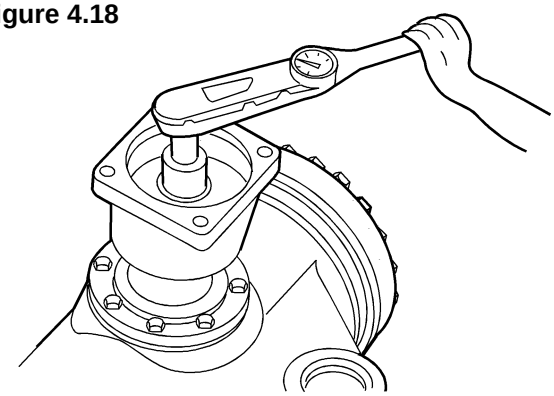
1. Lubricate bearing cups and cones with specified oil.
2. Install yoke or flange without pinion oil seal.
3. Install pinion bearing cage assembly on main housing without bearing cage shims.
4. Fasten bearing cage assembly on main housing with two capscrews. Apply minimum specified torque of 67 lb-ft (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.

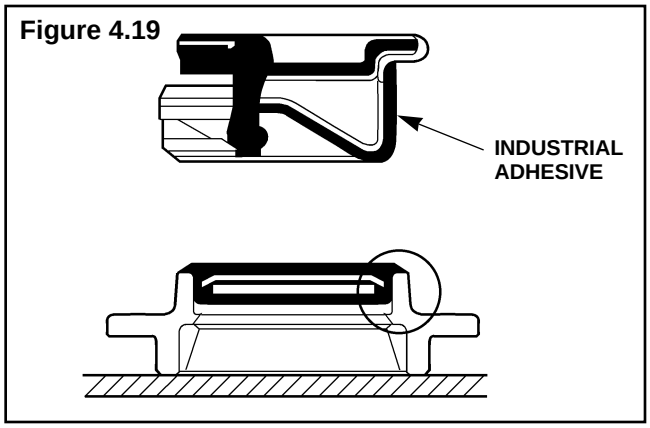
⚠ CAUTION

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.**

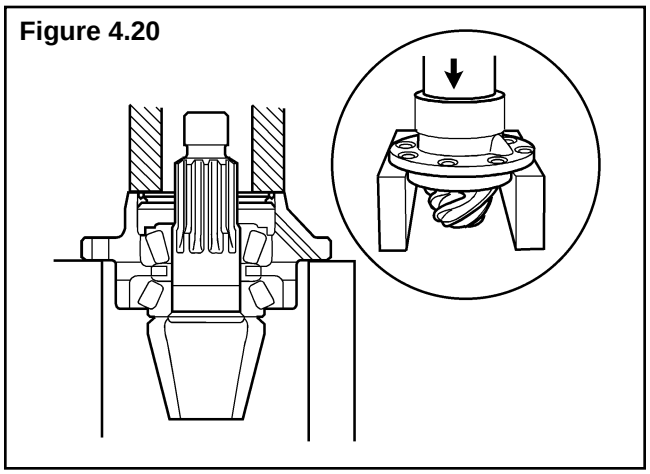
Figure 4.19



    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.**

Figure 4.20



    d. Install yoke or flange and pinion nut into pinion.

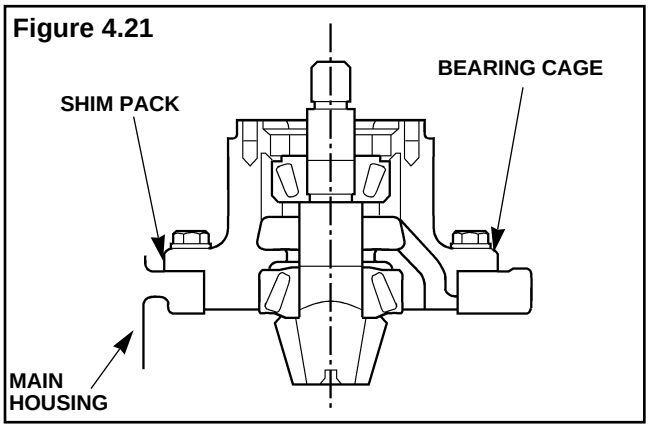
    e. Tighten pinion nut to specified torque after installing pinion bearing cage into main housing of 465-570 lb-ft (630-775 N•m). (T)

Adjust Thickness of Pinion Bearing Cage Shim Pack (Depth of Pinion)

NOTE

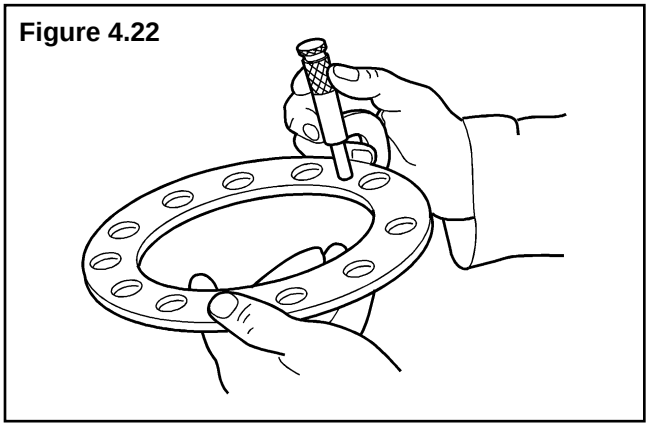
Use this procedure if a new drive pinion and ring gear set is installed or if the depth of the drive pinion has to be adjusted. **Figure 4.21.**

Figure 4.21



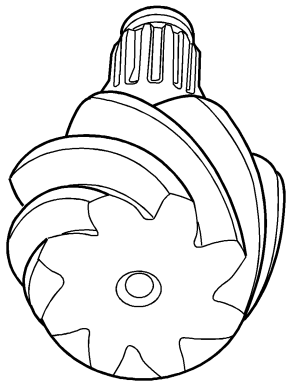
1. Use a micrometer to measure the thickness of the old shim pack that was removed from under the pinion cage. Record the measurement for later use. **Figure 4.22.**

Figure 4.22



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)	–0.002	–0.05
Standard shim pack thickness	0.028	0.71
New PC number, PC+5 (+0.13mm)	+0.005	+0.13
New shim pack thickness	0.033	0.84
2.		
Old shim pack thickness	0.030	0.76
Old PC number, PC–2 (–0.05mm)	+0.002	+0.05
Standard shim pack thickness	0.032	0.81
New PC number, PC+5 (+0.13mm)	+0.005	+0.13
New shim pack thickness	0.037	0.94
3.		
Old shim pack thickness	0.030	0.76
Old PC number, PC+2 (+0.05mm)	–0.002	–0.05
Standard shim pack thickness	0.028	0.71
New PC number, PC–5 (–0.13mm)	–0.005	–0.13
New shim thickness	0.023	0.58
4.		
Old shim pack thickness	0.030	0.76
Old PC number, PC–2 (–0.05mm)	+0.002	+0.05
Standard shim pack thickness	0.032	0.81
New PC number, PC–5 (–0.13mm)	–0.005	–0.13
New shim pack thickness	0.027	0.68

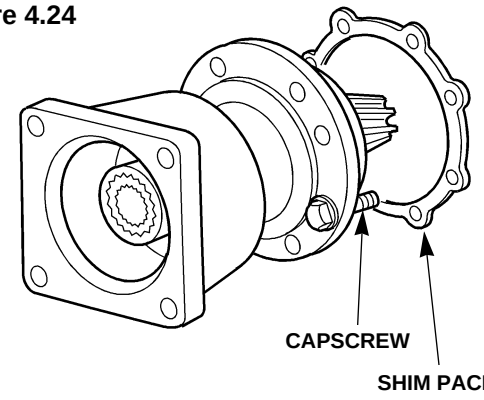
Install Pinion Bearing Cage Assembly on Main Housing

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

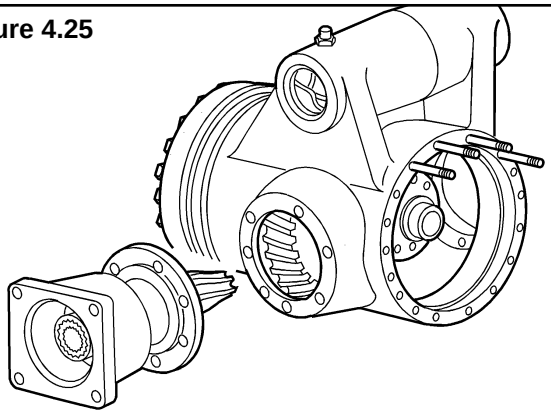


WARNING

Do not hit steel parts with a steel hammer during assembly and installation procedures. Parts can break and cause serious personal injury.

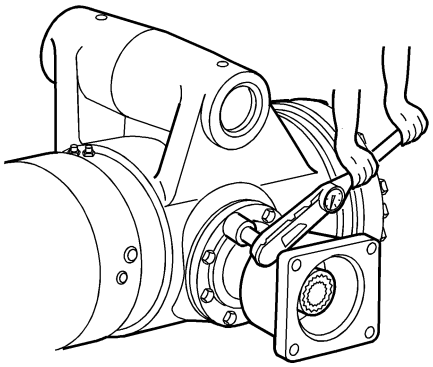
2. Install drive pinion and bearing cage into carrier. If necessary, use rubber, plastic or leather mallet to tap assembly into position. **Figure 4.25.**

Figure 4.25



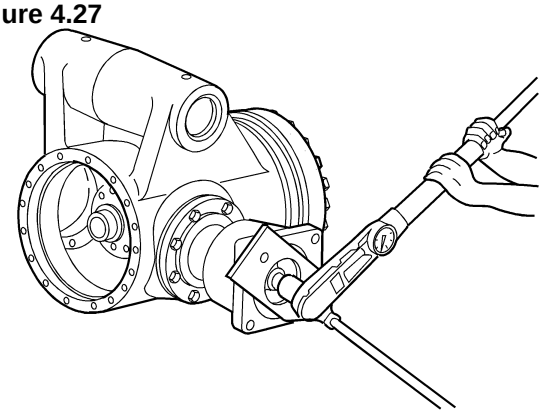
3. Install two capscrews and washers that fasten bearing cage. Tighten to minimum torque of 67 lb-ft (90 N•m). **Figure 4.26.** T

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.** T

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.

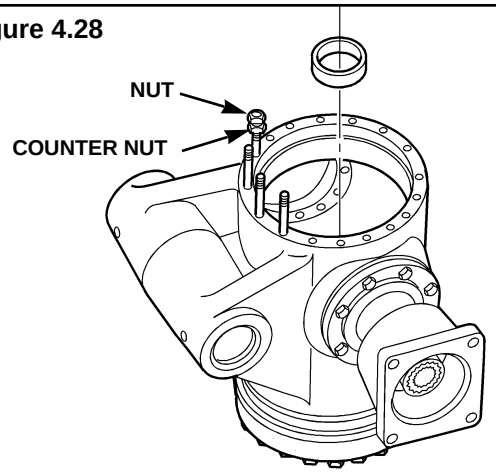
5. If ring gear is mounted on opposite brake housing side, loosen two capscrews that fasten pinion bearing cage. Remove cage and mount it after differential case is assembled.

   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.**

Figure 4.28

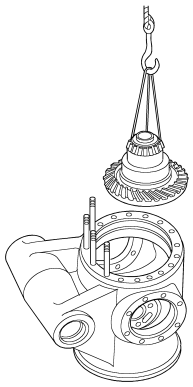


NOTE

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.

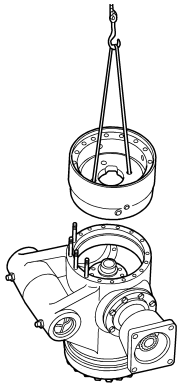
3. Install differential case bearing cup, axle shaft housing and brake housing studs into main housing until the thread is completely attached. Apply Three Bond 1134 liquid gasket material on stud threads. **Figure 4.28.**
4. Install differential case assembly. **Figure 4.29.**

Figure 4.29



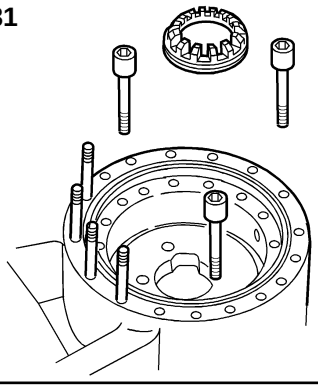
5. Install brake housing and other differential case bearing cup. **Figure 4.30.**

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



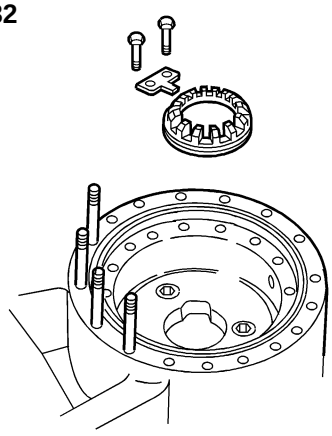
7. Install differential case bearing adjusting nut on brake housing. **Figure 4.31.**
8. Install pinion bearing cage assembly and shim pack.
9. Check backlash, differential preload and teeth contact. See Section 5, “Adjustments.”

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

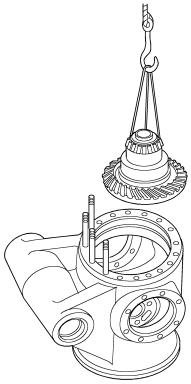
Figure 4.32



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.**

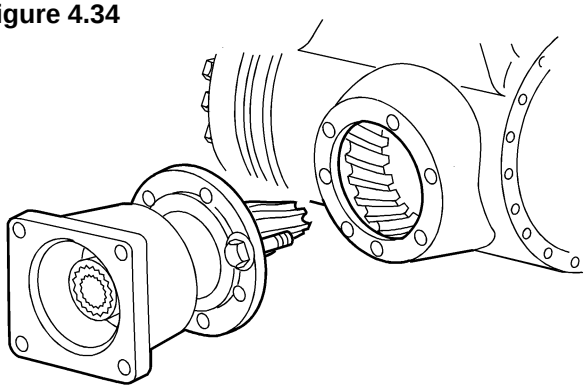
Figure 4.33



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.**

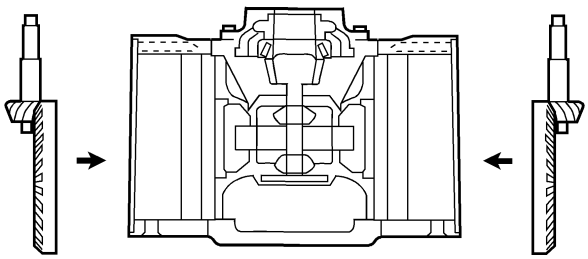
7. Install pinion bearing cage assembly and shim pack. **Figure 4.34.** See “Install Pinion Bearing Cage Assembly on Main Housing,” page 31.

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.

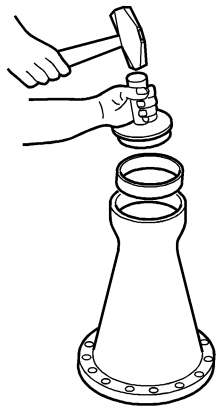
14. Install 3 bolts into the brake housing to adjust differential. Tighten them to 19-26 lb-ft (26-36 N•m). **Figure 4.31.** T

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

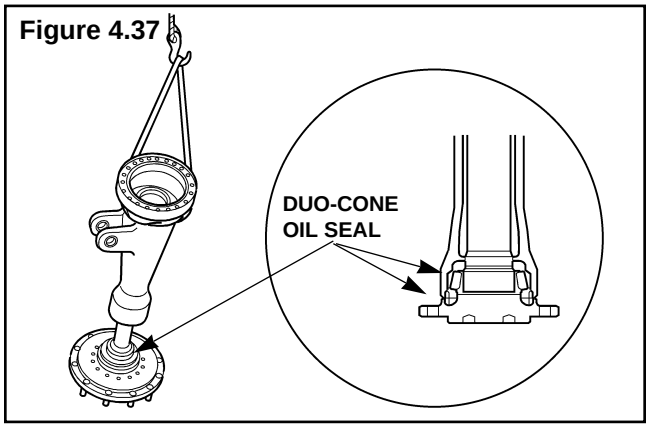
1. Use correct size sleeves to install cups into bores in axle shaft housing until cups are flat against bottom of bores. **Figure 4.36.**

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.**

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 4.38

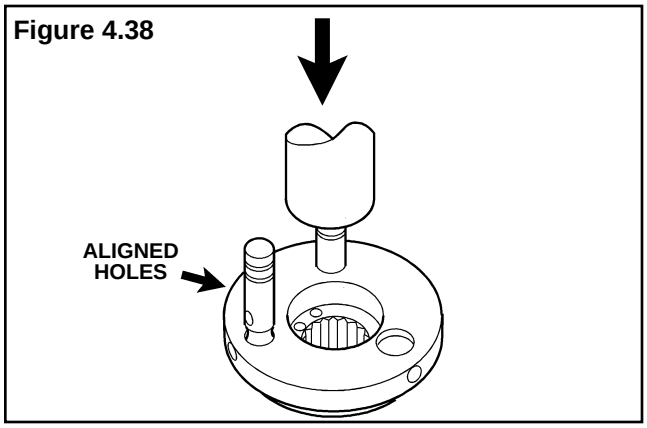
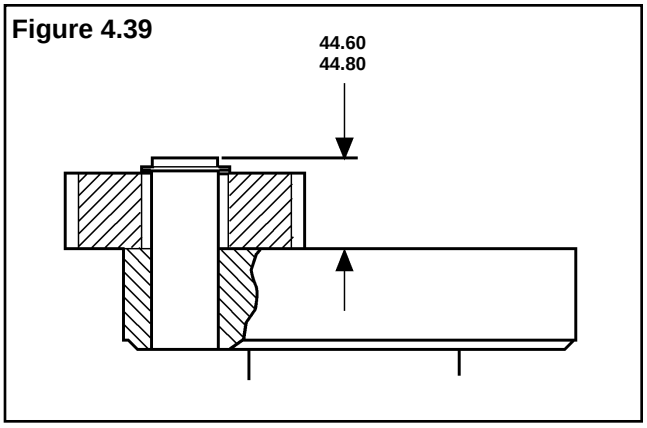


Figure 4.39



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.

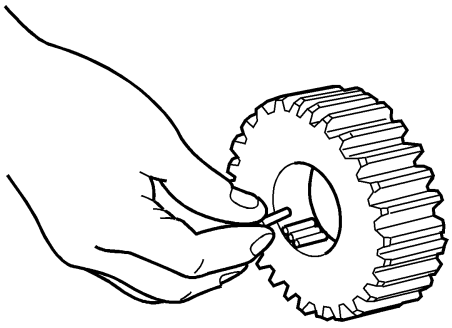
2. Apply Medium Torque liquid adhesive, Loctite 241 or Three Bond 1334, to threads of planetary gear axle lock capscrews. Install and tighten to 17-23 lb-ft (23-31 N•m). T

CAUTION

Rollers must come from the same manufacturer and have the same tolerance range. Replace spacers and washers when a new roller is used.

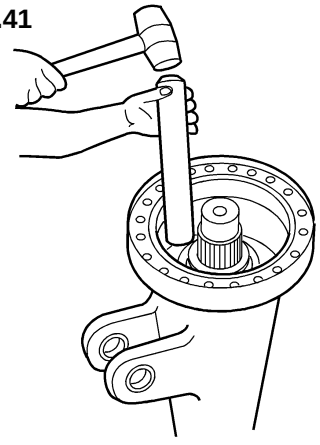
3. Apply grease, Shell-71032 Alvania EP-2 or Texaco - 995 Multifak EP-2, on each gear hole. Install rollers and spacers into planetary gears. **Figure 4.40.**

Figure 4.40



4. Install bearing cone. **Figure 4.41.**

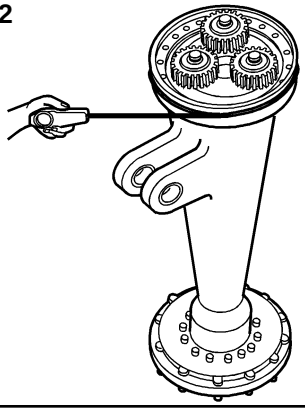
Figure 4.41



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.

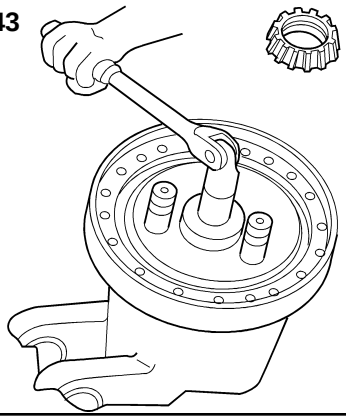
   The value will be obtained by multiplying the number read on the spring scale dial by the flange radius. Make note of the value. **Figure 4.42.**

Figure 4.42



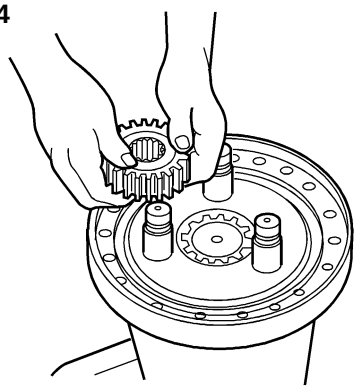
7. Tighten adjusting nut with special tool shown on page 60. At the same time, manually rotate the trumpet to assure a correct fit between bearing cups and cones and get desired preload. **Figure 4.43.**

Figure 4.43



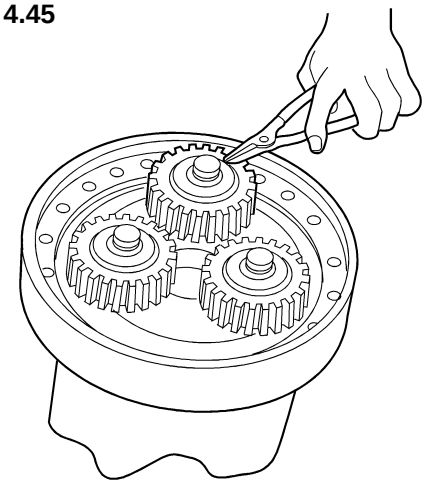
8. Check trumpet assembly preload and subtract value obtained before tightening adjusting nut. Value must be 15-35 lb-in (1.7-4 N•m). T
9. Apply Medium Torque liquid adhesive, Loctite 241 or Three Bond 1334, on adjusting nut lock capscrew threads. Install adjusting nut lock capscrew. Tighten to 17-23 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



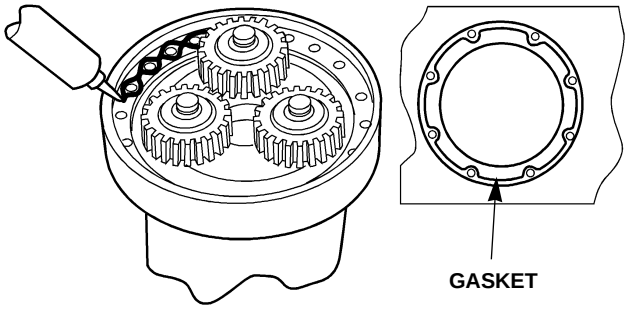
11. Install outer washers.
12. With correct pliers, install snap rings. **Figure 4.45.**

Figure 4.45



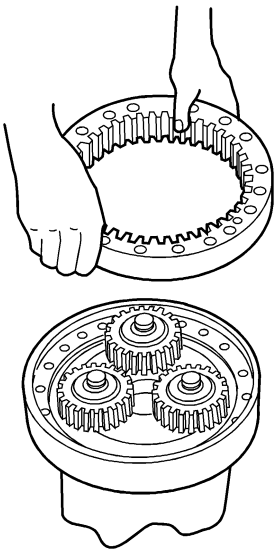
13. Apply liquid gasket material on contact surfaces of trumpet and ring. **Figure 4.46.**

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



Assemble Hydraulic Apply Brake Housing Assembly

NOTE

- ***To assemble three function brake, see page 39.***
- ***To assemble ball and ramp brake, see page 43.***

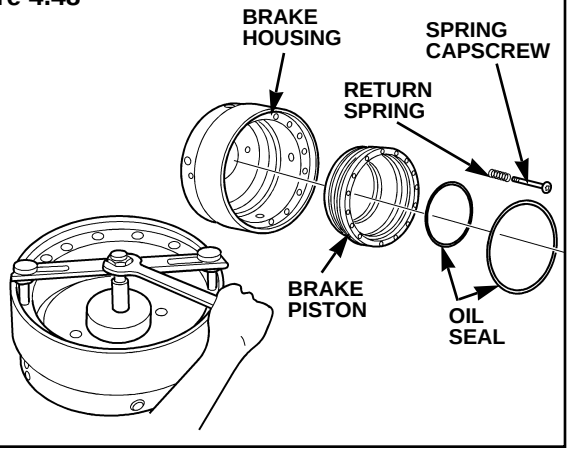
1. Check to see if the piston lodging surfaces on brake housing is free of sharp edges, nicks and burrs. Repair any damage if possible or replace the part.
2. Repeat Step 1 on outer surfaces of brake piston.
3. Apply a thin film of oil, SAE W140 or SAE 90, to piston and bore. Apply a dense layer of oil 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.

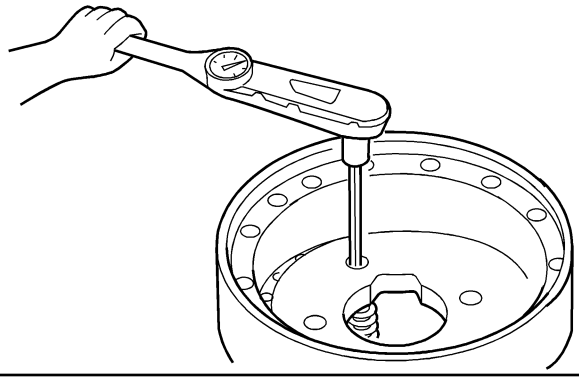
5. With a manual press, carefully install piston into brake housing. Do not damage oil seals. If there is resistance in installing the piston, do not proceed. **Figure 4.48.**

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). T **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 4.50

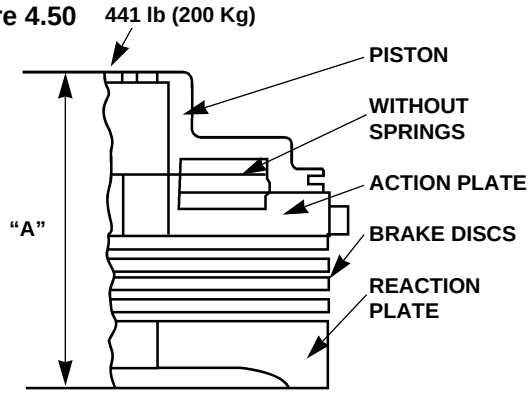
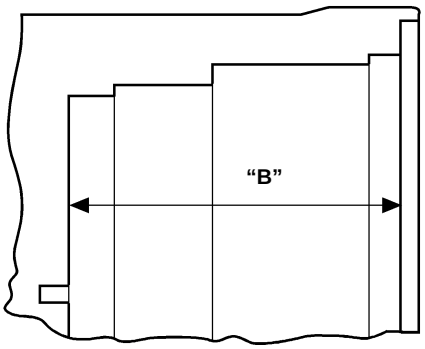


Figure 4.51



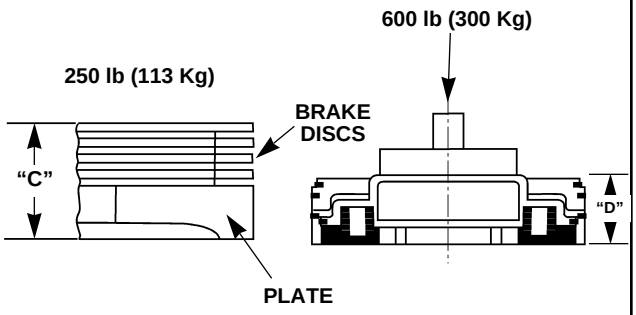
   c. The shim pack thickness is the difference between dimension “B” and dimension “A” minus 0.06 in. (1.5 mm):

      B-A-0.06 in. (1.5 mm) = 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):

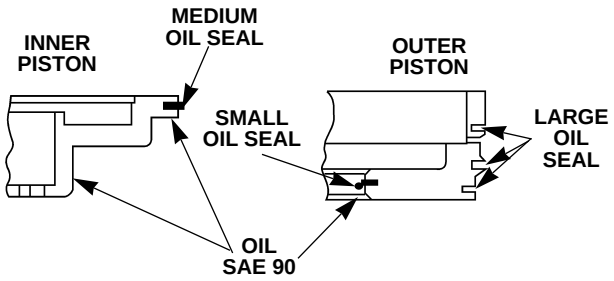
      B-(C+D) -0.06 (0.15) = shim pack thickness. **Figure 4.52.**

Figure 4.52



2. Lubricate internal brake housing surfaces, inner and outer piston surfaces and oil seal bores with SAE 90 oil. **Figure 4.53.**

Figure 4.53

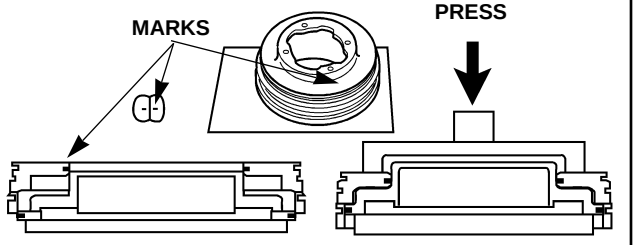


NOTE

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.**

Figure 4.54

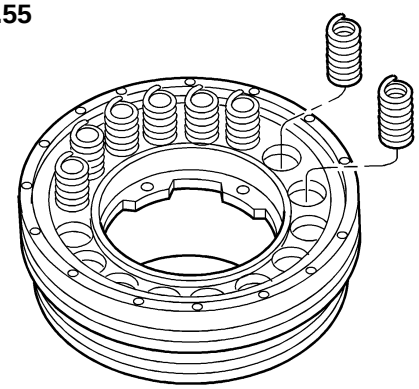


NOTE

Rotate pistons until marks are aligned. If inner piston does not rotate easily, disassemble it and find the cause. **Figure 4.54.**

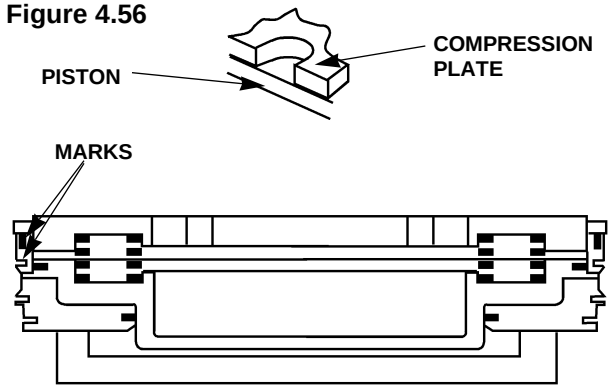
5. Install springs into bores in inner piston. **Figure 4.55.** For brake with 12 springs, jump one bore each three. **Figure 4.55.**

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.**

Figure 4.56



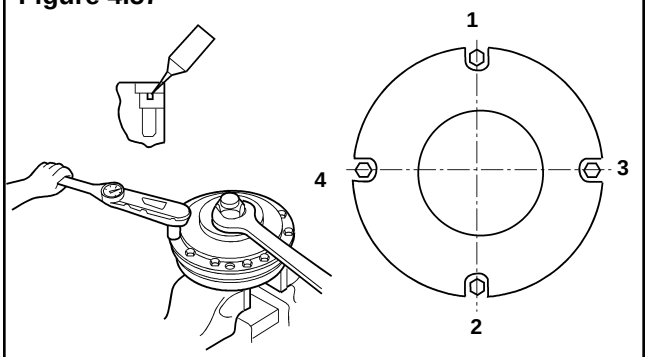
7. Apply pressure to the compression plate until it is flat against the piston.

⚠ 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.

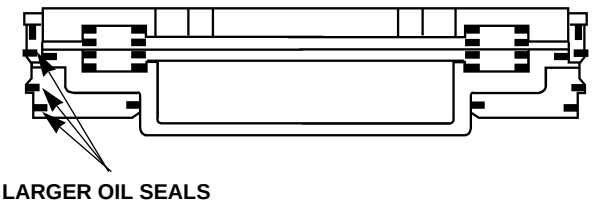
8. Apply medium torque liquid adhesive, Loctite 241 or Three Bond 1334 in threaded external piston bolt holes. Install action plate bolts as shown in **Figure 4.57** and apply a pretorque of 30 lb-in (3.3 N•m). Tighten to specified torque of 120-140 lb-in (13.5-16 N•m).

Figure 4.57



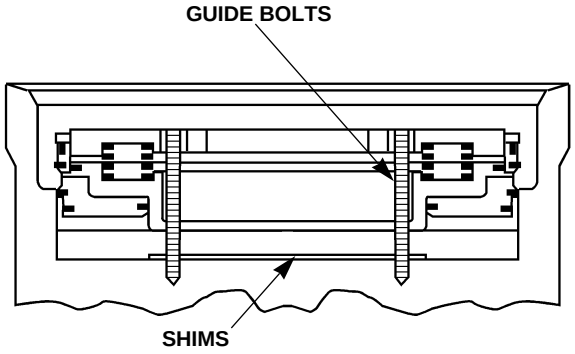
9. Install three larger oil seals into outer piston. Make sure the oil seals fit in the bores. **Figure 4.58.**

Figure 4.58



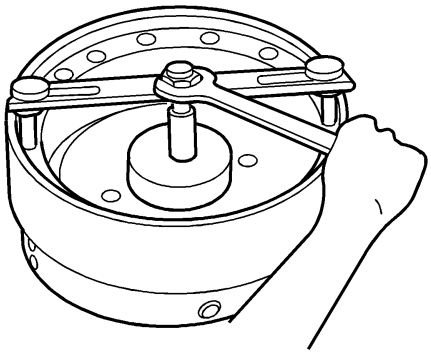
10. Install shim pack into brake housing. Use bolts to align holes. **Figure 4.59.**

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.**

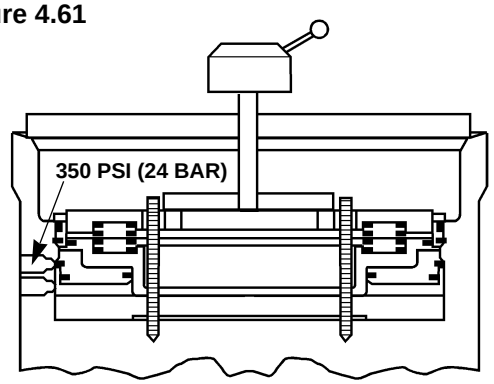
Figure 4.60



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.**

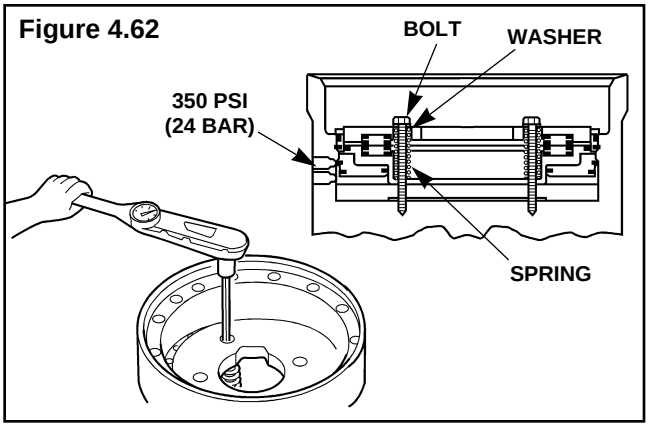
14. With piston still compressed, apply 350 psi (24 bar) into parking brake to make sure oil seals fit in bores. **Figure 4.61.**

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.** T

Figure 4.62



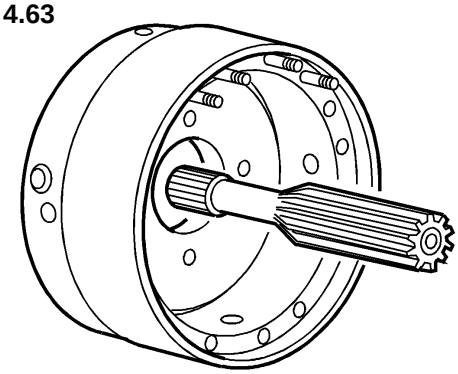
NOTE

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

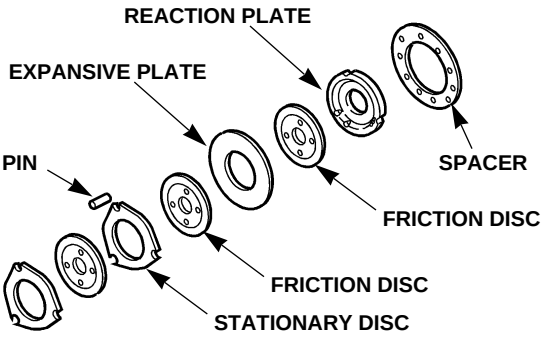


NOTE

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

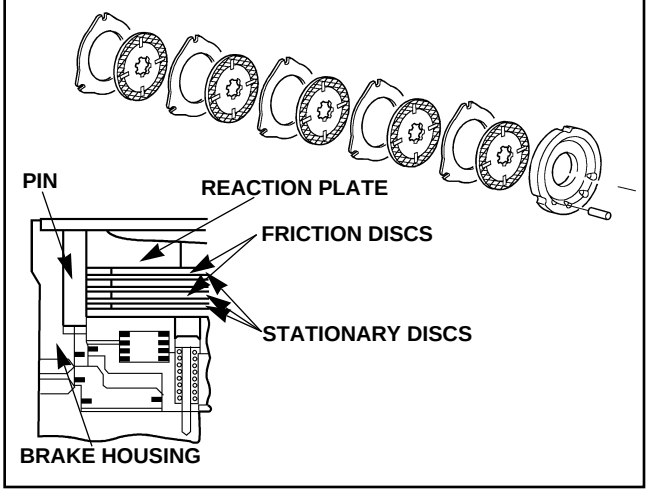


4. Install stationary disc lock pins.
5. Install reaction plate with lubrication hole on down side of axle.
6. If there is an outer spacer, install it on brake housing surface. Use liquid gasket material.

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.**

Figure 4.65



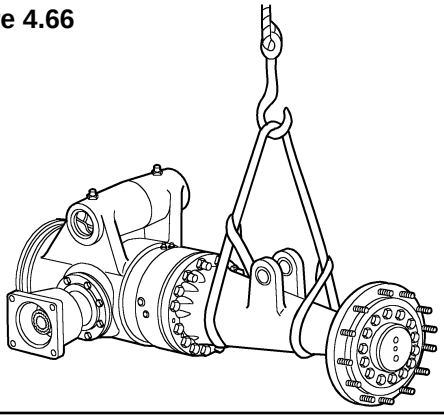
Install Housing Assembly into Main Housing

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.**

Figure 4.66

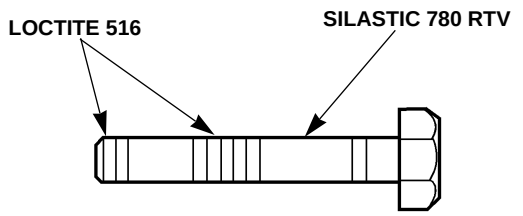


2. Install capscrews and nuts that fasten housing to main housing.
   - Tighten grade 12.9 capscrew 170-200 lb-ft (230-271 N•m). T
   - Tighten grade 10.9 capscrew 135-170 lb-ft (183-230 N•m). T
   - Tighten stud nuts 120-150 lb-ft (160-205 N•m). T
3. Release pressure from parking brake.
4. Apply liquid 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

Assemble Three Function Brake Release Bolts and Sleeves

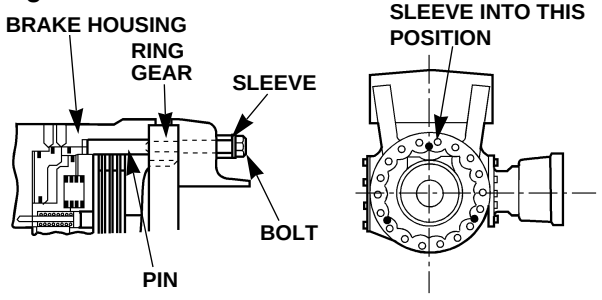
1. Apply Loctite 516 on bolt threads. **Figure 4.67.**

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.** T
   - 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).

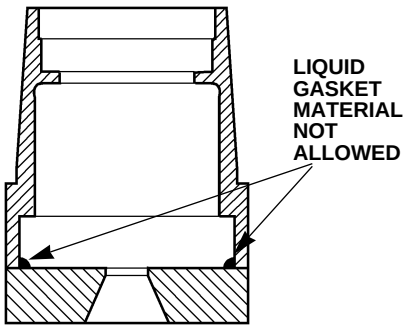
Figure 4.68



Assemble Ball and Ramp Brake Cylinder Assembly and Install on Main Housing

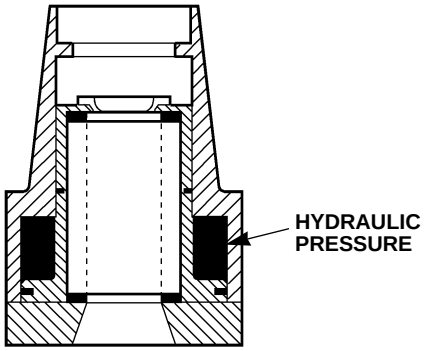
1. Apply liquid gasket material FAG-3 on brake cylinder surface that fastens to brake cylinder support. Assemble brake cylinder, oil seals, piston and brake cylinder support. Tighten capscrews that fasten brake cylinder support 19-26 lb-ft (26-36 N•m). **Figure 4.69.** T

Figure 4.69



2. 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.**

Figure 4.70

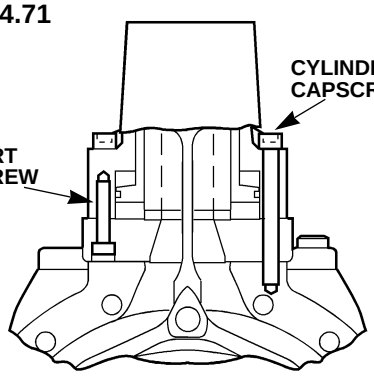


CAUTION

Do not use brake fluid in the hydraulic system. Use Shell Donax TD or Shell Tellus 32 or equivalent.

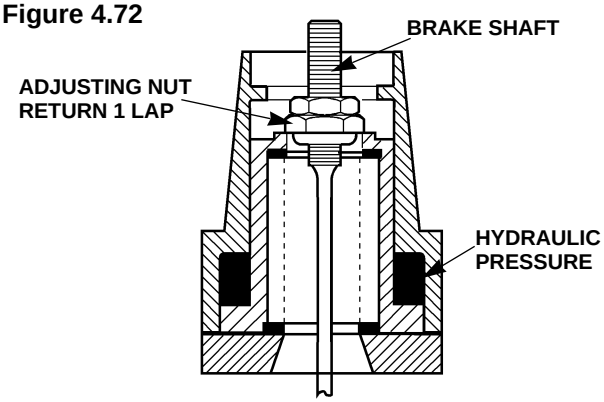
3. Install brake cylinder assembly onto main housing. **Figure 4.71.**

Figure 4.71



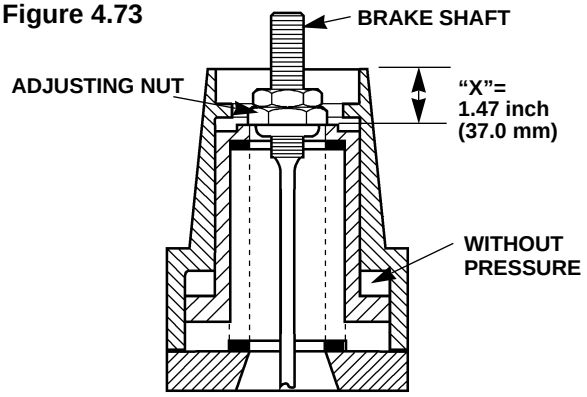
4. While the cylinder is pressurized with 400 psi (27.6 bar), apply liquid adhesive, Loctite 221 or Three Bond 1341, on threads of brake shaft. Install adjusting nut until it rests against piston. DO NOT TIGHTEN ADJUSTING NUT. Loosen the adjusting nut one full turn. **Figure 4.72.**

Figure 4.72



5. Release cylinder pressure to ZERO so piston returns back against adjusting nut. Check dimension “X” as shown in **Figure 4.73.**

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.

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.

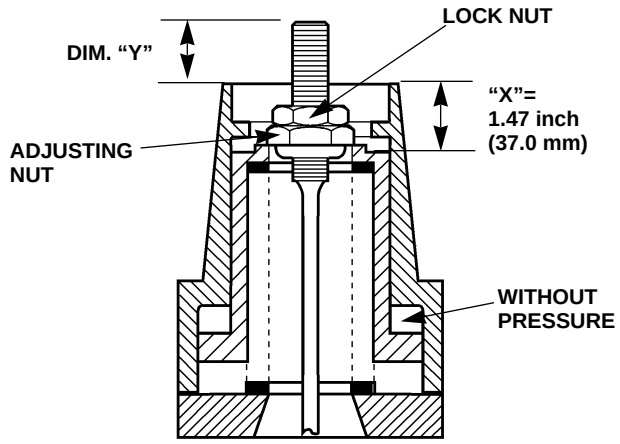
Torque Reduction	Disc No.	Pressure	Torque
PRA-382 17.08:1	06	275 psi min (19 bar min)	950-1200 lb-ft (1288.0-1559.0 N•m)
PRA-353 46.00:1	06	275 psi min (19 bar min)	350-500 (474.5-678.0 N•m)

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%.

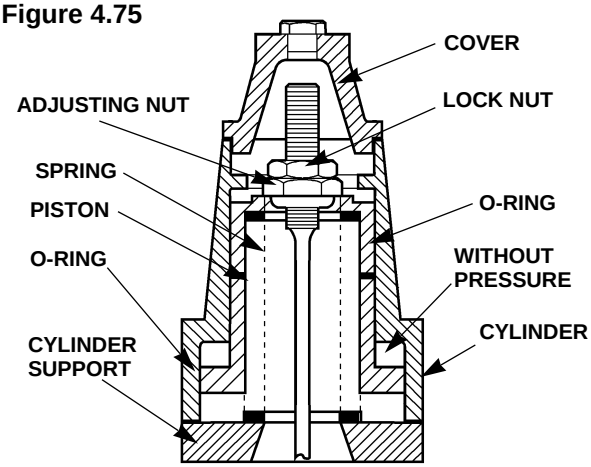
7. After obtaining the desired brake torque, install nut lock as shown in **Figure 4.74.** Tighten to 60-90 lb-in (80-120 N•m).

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.

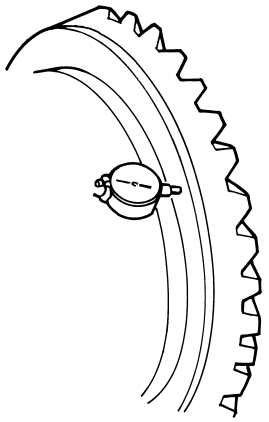
Check Ring Gear Runout Specification: 0.008 inch (0.20 mm)

⚠ *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.**

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*

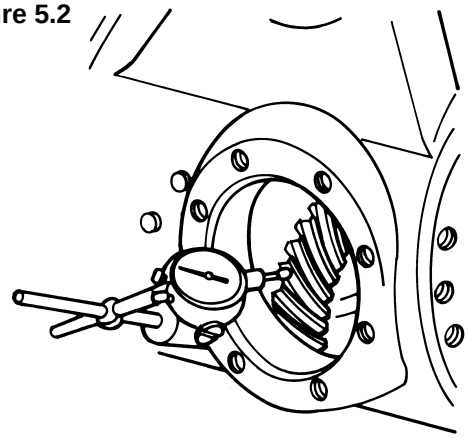
Shock load failure will distort the differential case flange and transfer damage to ring gear. In this case, differential carrier must be discarded.

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**.

Figure 5.2



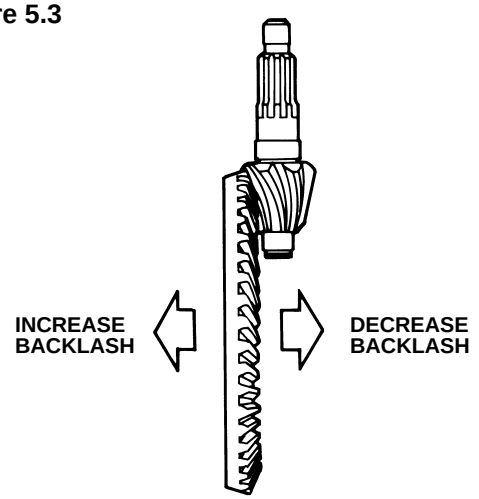
NOTE

- ***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.

6. Loosen one bearing adjusting ring one notch, then tighten opposite ring the same amount to keep differential roller bearing preload. **Figure 5.3.**

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.***

7. Repeat steps two to six until backlash is within specifications. Record setting for use when you adjust pinion bearing preload.

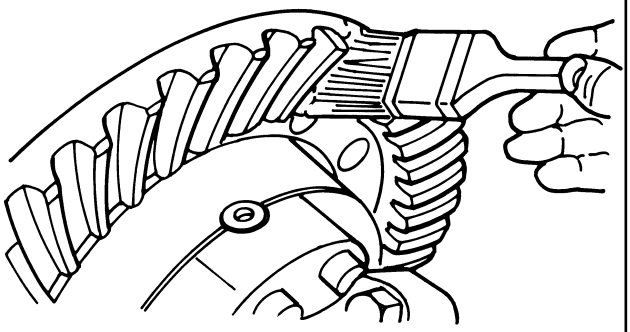
Teeth Contact Patterns

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

1. 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



2. 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

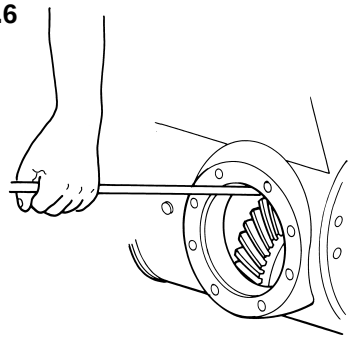
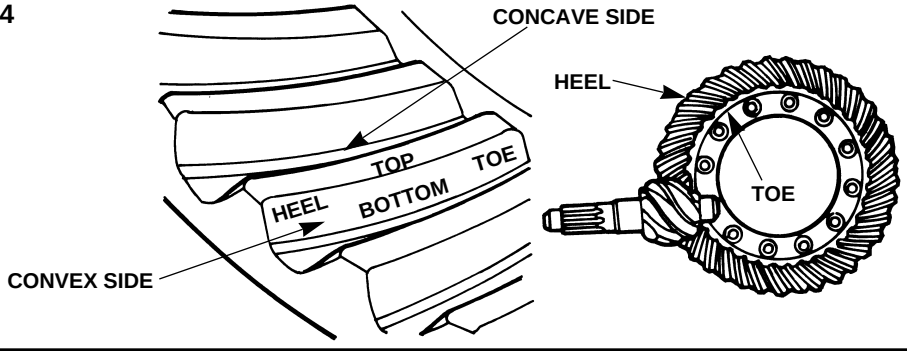
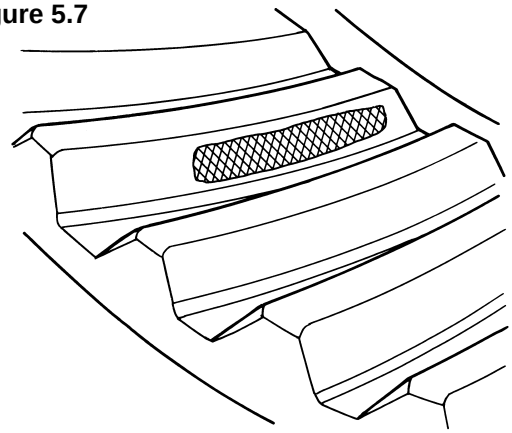


Figure 5.4



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.

Figure 5.7

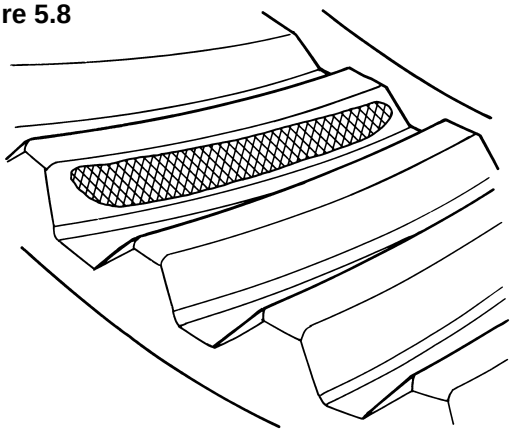


Correct Contact Patterns

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.**

Figure 5.8



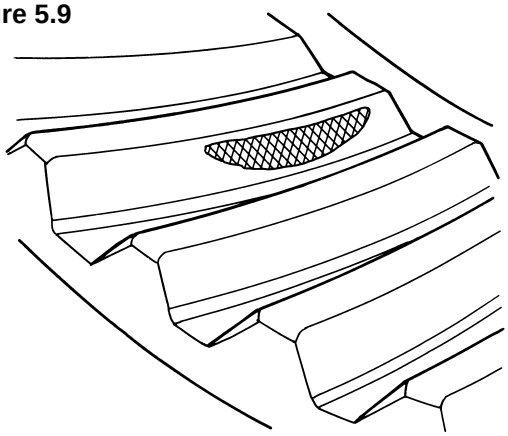
The location of a good hand-rolled pattern for a used gears set must match wear pattern in ring gear. The contact pattern will be smaller in area than the wear pattern.

Incorrect Contact Patterns

High Contact Pattern:

A high contact pattern indicated that drive pinion was not installed deep enough into carrier. **Figure 5.9.**

Figure 5.9



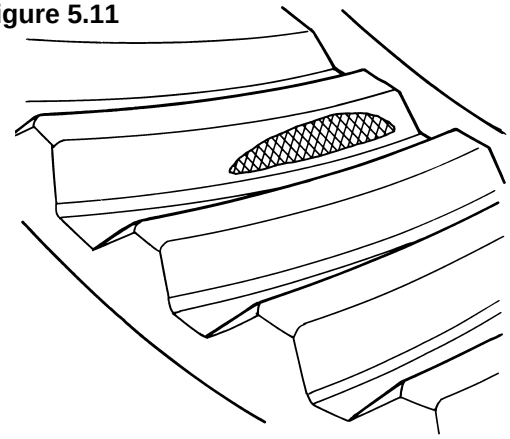
- To correct a high-contact pattern, decrease thickness of shim pack under bearing cage. This will move drive pinion toward ring gear. **Figure 5.10.**

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.

Figure 5.11



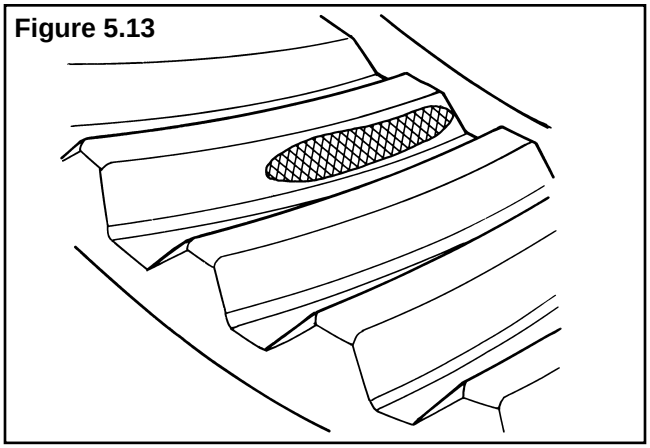
- To correct a deep contact pattern, increase thickness of shim pack under bearing cage. This will move the drive pinion away from the ring gear. **Figure 5.12.**

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.**

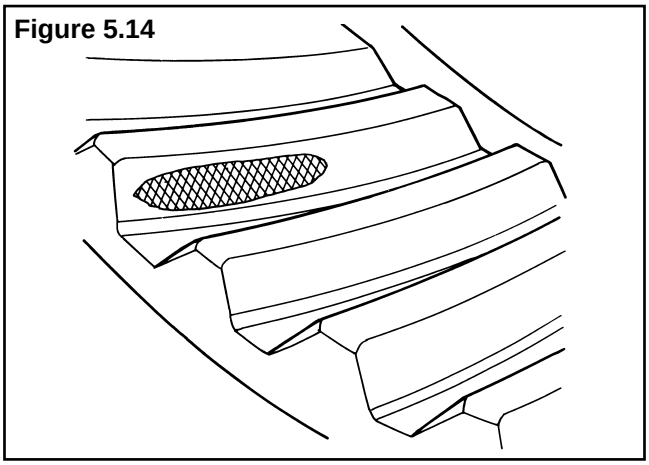
Figure 5.13



- 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.**

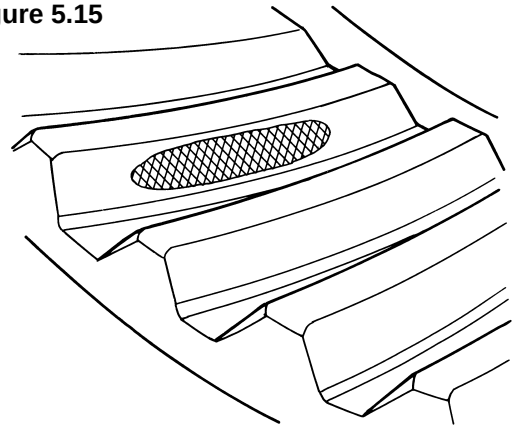
Figure 5.14



- 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.**

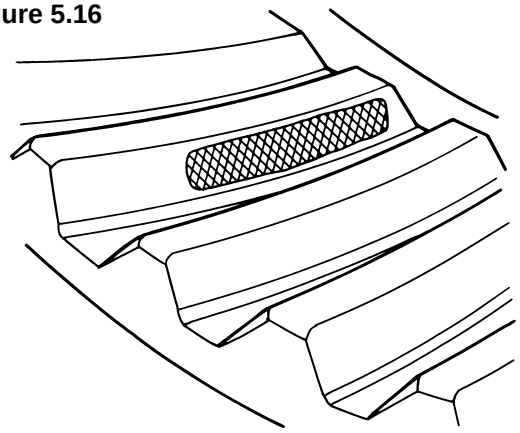
Figure 5.15



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.

Figure 5.16



Replace Lubricant

1. Install and tighten drain plug in central housing and brake housing. (T)
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. (T)
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 (whichever comes first)	—	0-84	—	Petroleum Base SAE 10W, 20W or 10W/30 ②

NOTES:

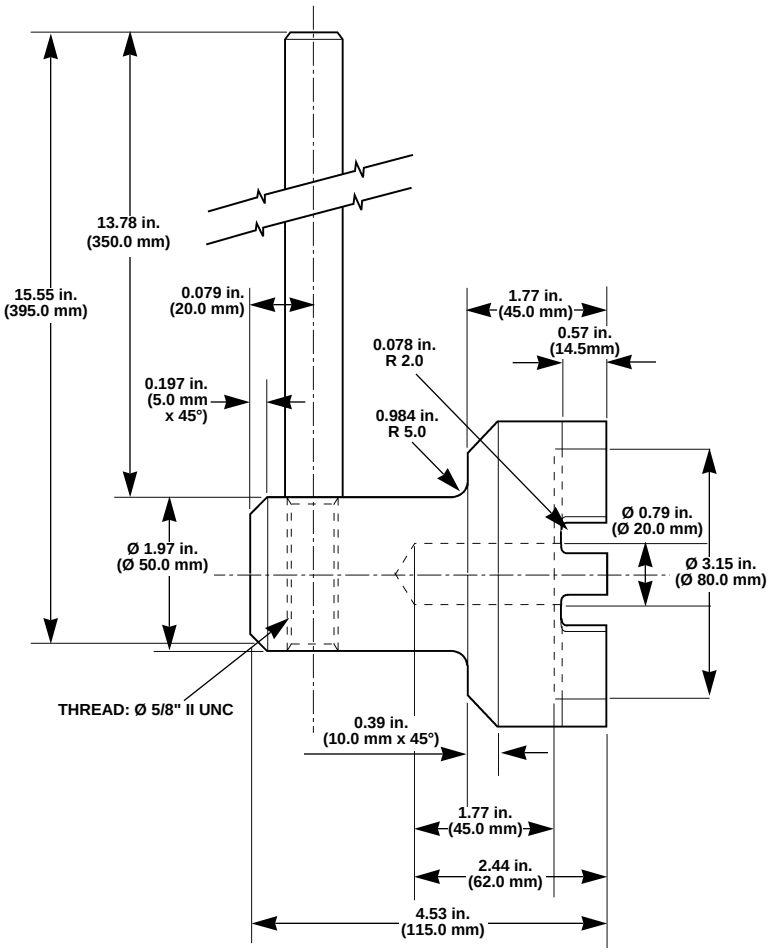
① The checking interval depends on the individual operating conditions, speeds and loads. Severe operating conditions may require more frequent intervals.

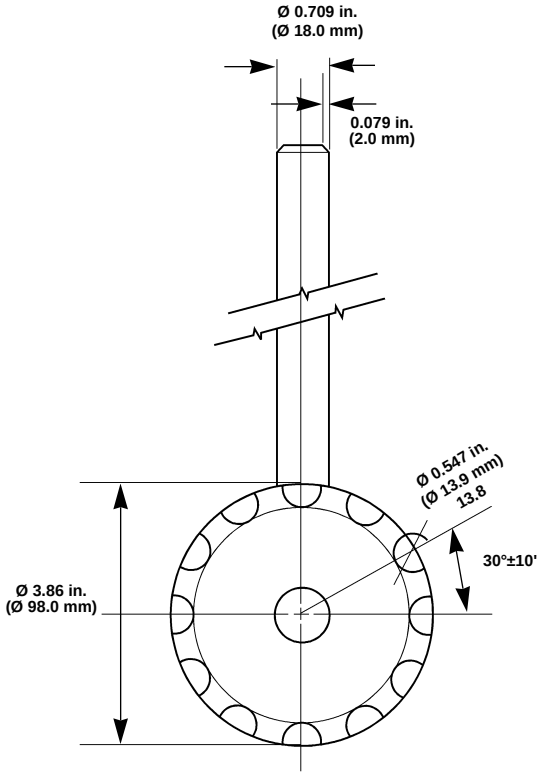
② Tractor oil universal fluid, 'TOU' types formulated for wet disc brakes, is recommended for use in the wet disc brake housing. Make sure that the specifications of the tractor fluid are the same as the recommended specifications of the vehicle manufacturer.

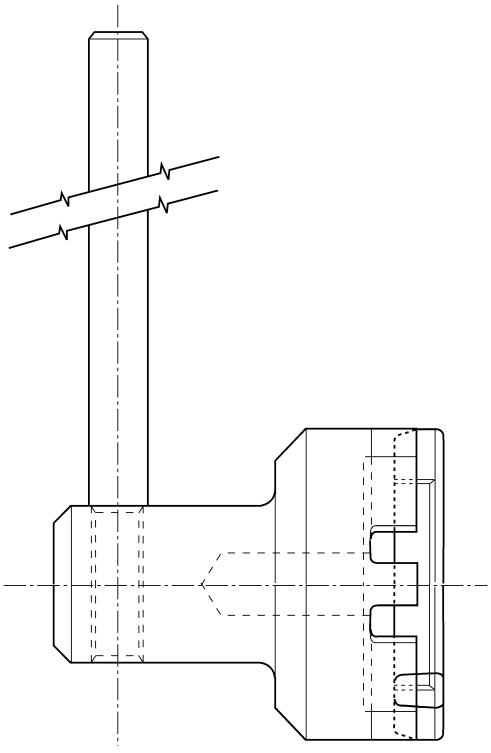
CAUTION

- ***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.***

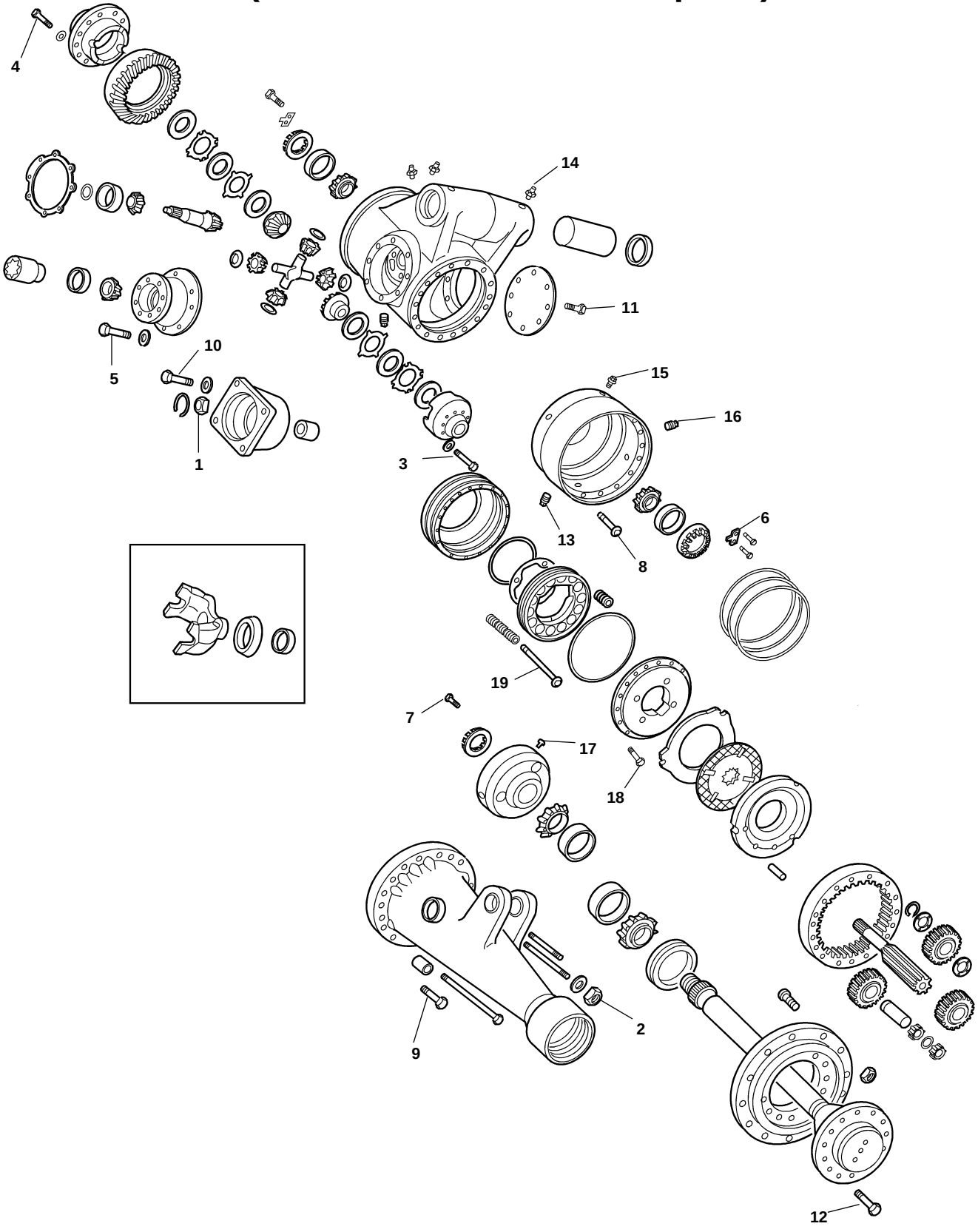
Nut Lock Special Tool







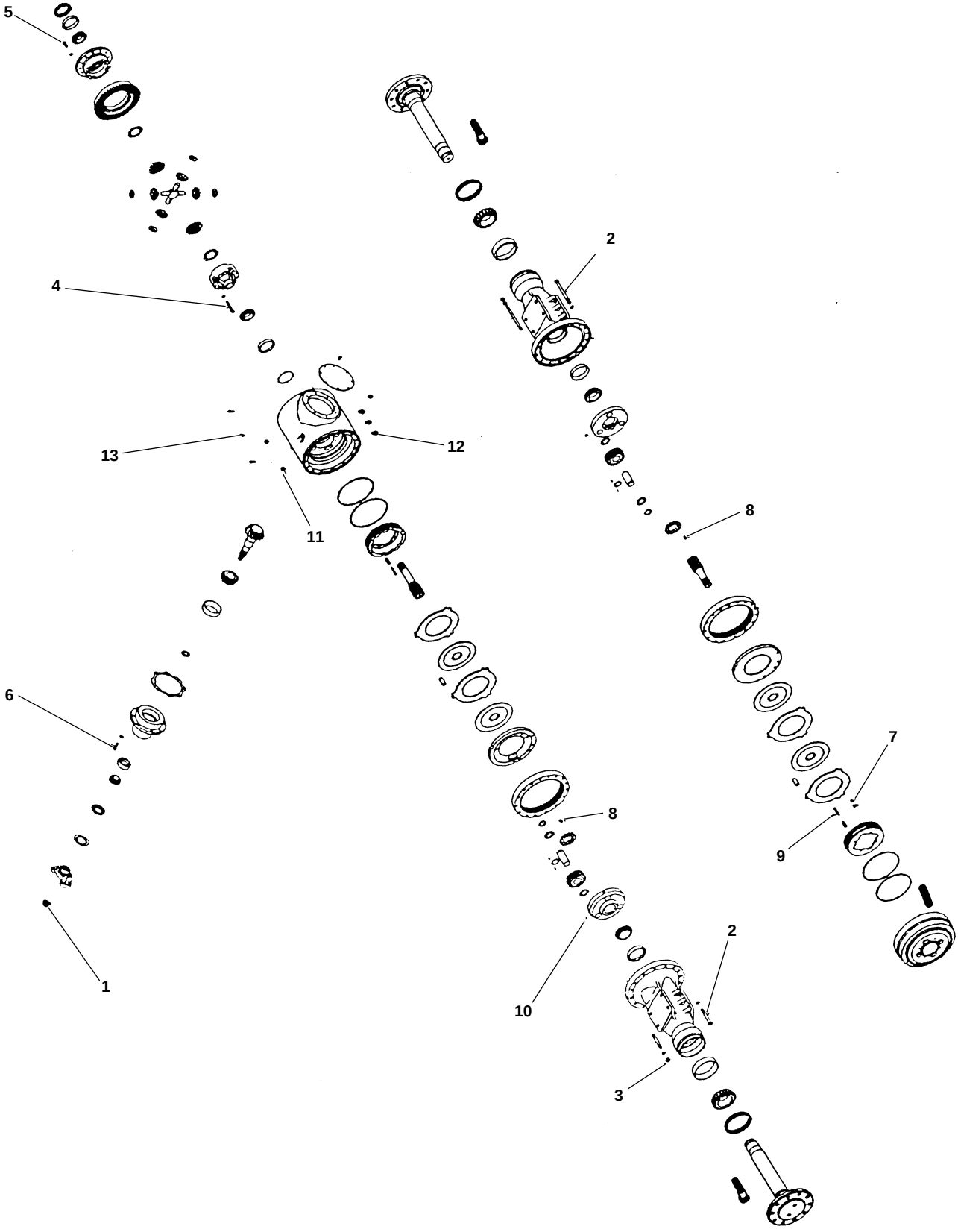
PROA 352/382 (With Mechanical Drive Option)



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)

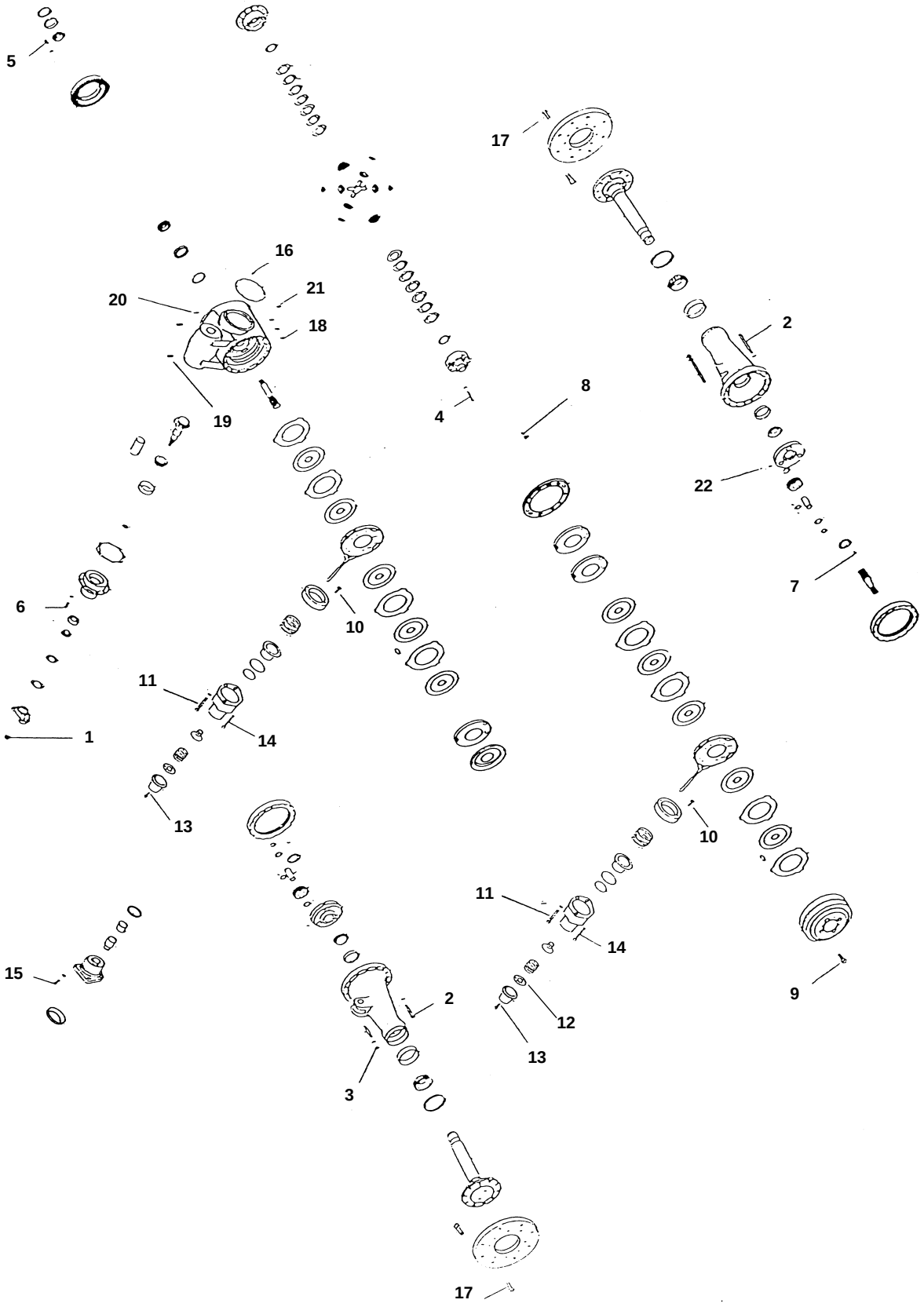
PRA 352 – Trumpet Variation No. 2



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)

Information contained in this publication was in effect at the time the publication was approved for printing and is subject to change without notice or liability. Meritor Heavy Vehicle Systems, LLC, reserves the right to revise the information presented or discontinue the production of parts described at any time.

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GRADALL®

MATERIAL HANDLERS

522, 524, 532C-6 & 534C-6 HYDROSTATIC DRIVE PERFORMANCE CHECKS MANUAL (VERSION 1)

COVERS MATERIAL HANDLERS
522 & 524 STARTING SERIAL NO. 0177005 THROUGH 0177188
532C-6 & 534C-6 STARTING SERIAL NO. 0188002 THROUGH 0388348

Form No. 29504 Rev. 9/97

DISCLAIMER!

There are two versions of this **HYDROSTATIC DRIVE PERFORMANCE CHECKS MANUAL**; ***Version 1 and Version 2***.
This is to accommodate major component changes which have taken place during the production history of these Material Handler models.

The component changes involve:

(i) Hydrostatic Transmission
Universal change, from *Version 1* to *Version 2*:

- **ALL** Handlers covered in *Version 1* have a *Rexroth* Series 1 Hydrostatic Transmission
- **ALL** Handlers covered in *Version 2* have a *Rexroth* Series 3.2 Hydrostatic Transmission

(ii) Front Axle
Staggered introduction; some overlap between *Version 1* and *Version 2*:

- **MOST** Handlers covered in *Version 1* have a *Rockwell* Front Axle. However, starting Serial Number 0288247, Handlers have a *Rockwell/Braseixos* Front Axle.
- **ALL** Handlers covered in *Version 2* have a *Rockwell/Braseixos* Front Axle.

GRADALL 522, 524, 532C-6 & 534C-6 HYDROSTATIC DRIVE PERFORMANCE CHECKS MANUAL (VERSION 1)

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* "4WD" machines only

NOTE! "High-pressure" denotes 10,000 PSI gauge
"Low-pressure" denotes 1,000 PSI gauge

COVERS MATERIAL HANDLERS
522 AND 524 STARTING SERIAL NO. 0177005 THROUGH 0177188
532C-6 AND 534C-6 STARTING SERIAL NO. 0188002 THROUGH 0388348

Introduction

These tests ensure that the MATERIAL HANDLER HYDROSTATIC DRIVE SYSTEM operates to the proper specifications. All tests should be done in a safe, open area. Apply the park brake, chock the wheels and leave the shifter in "Neutral" unless otherwise advised. The boom attachment must rest on the ground unless the machine is being driven. Safe working habits must be used for these checks. Refer to ***Operation and Lubrication Manual, Hydraulic System Manual*** and/or ***Service Manual*** for further information.

Important Safety Notice

Read and understand this Manual, along with **Operation and Lubrication Manual, EMI Rough Terrain Forklift Safety Manual, GRADALL Material Handler Safety Manual** and all instructional decals and plates before starting, operating or performing mechanical adjustments and maintenance procedures on this material handler. **Keep operator and safety manuals in cab. If this machine does not have the above listed manuals, contact your GRADALL distributor and obtain the manuals before proceeding with performance checks.**

Safe operation depends on reliable equipment and proper operating procedures. Performing the adjustments and repairs described in this Manual will help to keep your material handler in reliable condition. Use of the recommended operating procedures can help you avoid accidents. Because some procedures may be new to even the experienced technician, this Manual must be read, understood and followed by all who service this Material Handler.

! DANGER, ! WARNING, ! CAUTION notes in this Manual will help you avoid injury and damage to the material handler. These notes are not intended to cover all eventualities. It is impossible to anticipate and evaluate all possible applications and methods of operation for this equipment.

Any procedure not specifically recommended by GRADALL must be thoroughly evaluated from the standpoint of safety before it is placed in practice. If you are not sure, contact your GRADALL Distributor before operating. Do not modify this machine without written permission from GRADALL.

The following symbols are used to call your attention to safety notices.

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

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

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

Required Tools

Color-coded plastic caps seal the adjustments on components in the hydraulic system. If a GRADALL Distributor makes an adjustment, the component should be sealed with a blue cap.

The tools needed to make these checks are:

- Tachometer
- GRADALL pressure testing kit; P/N 7713-4197
- Mechanic's hand tools (Metric included)
- Blue plastic caps; P/N 8093-4459 (small) and P/N 8093-4460 (large)
- ORS #12 plugs; P/N 8471-4002 (2)
- ORS #12 caps; P/N 8471-4006 (2)
- Blocking plates; P/N 9108-1667 (2)

General Warning Information

This Manual provides important information for those responsible for understanding, troubleshooting, testing, repairing and/or performing maintenance on the mechanical systems of 522, 524, 532C-6, 534C-6 MATERIAL HANDLERS.

NOTE! Although this Manual does not cover any of the hydraulic implement systems of the machine, hydraulic system pressures are tabulated in ***Section XII, "Hydraulic System Pressures".***

Accidents involving injury or serious machine damage

Immediately notify your GRADALL Distributor of the incident so he may assist in your investigation of the problem. If he is unavailable, contact the GRADALL Service Department at (330) 339-2211.

Related manuals and decals

Separate publications are furnished with your material handler to provide information concerning safety, replacement parts, operation, maintenance procedures and vendor components. Replacement manuals and decals may be ordered through your GRADALL Distributor.

Orientation

When used to describe the location of components on the machine, the directions "front", "rear", "left", and "right" indicate the point of view of a person sitting in the operator's seat in the cab.

Special Note: Welding

! CAUTION GRADALL advises against conducting welding repairs. If you determine that welding on the machine is necessary, first contact the GRADALL Service Department for instructions and advice.

Fasteners

1. Grade 8 bolts are used whenever two machined surfaces or major assemblies are bolted together. Grade 5 bolts are used to fasten non-machined areas such as sheet metal. Refer to ***"Torque Chart"*** in ***Operation and Lubrication Manual.***
2. Dowel pins are used in assemblies to absorb the shear load to these components and assist in correct positioning for bolt insertion.

Testing and adjustment precautions

1. Read and understand the manuals listed under ***"Important Safety Notice", page ii.*** Be sure you are familiar with the machine's response to controls.
2. Read and understand all material concerning the area to be checked, adjusted or repaired.
3. This Manual covers hydraulic testing and adjustments. Read and understand material related to hydraulics before proceeding with service of any kind on the hydraulic system. Prior to performing maintenance, be sure there is no residual, trapped hydraulic pressure. Do not remove hoses with the engine running.
4. If you are working with a helper, be sure they understand the procedure. Be certain each of you knows what to expect from the other and when to expect it. Be certain each of you knows where the other is at all times.
5. Understand all steps of the procedure before testing, adjusting or repairing any component or mechanical assembly. Follow the procedure carefully.
6. Always wear safety glasses, hard hat and any other locally-required, safety-related protective apparel when performing the tests and adjustments outlined in this Manual.

7. Always mechanically secure machine components that could suddenly start in motion and cause injury or damage.

8. Remove key from ignition. Place a sign in the operator's cab advising that the machine is being worked on and that personnel are on the machine.

Do not move any function without first checking that all personnel, equipment and structures are clear of the machine.

9. Double-check bolt torques.

10. Check that all fluids are at the correct level.

11. Remove mechanical restraints before restarting and operating the machine following repairs.

12. Clear all personnel from area adjacent to machine when first operating after a repair or adjustment. This reduces the risk of injuries to personnel if repairs or adjustments are performed incorrectly and/or if the machine acts unpredictably.

13. Clean machine before returning it to work.

I. Hydraulic Oil Reservoir

Make sure the machine is level before retracting all cylinders. Proper level is to "FULL" mark ± 1/4" in the sight gauge located on the outside of the reservoir. ***See Figure 2 and Figure 2A.*** The system contains approximately 45 gallons of hydraulic oil. Refer to the ***"Lubrication Specifications Chart"*** in the ***Operation and Lubrication Manual.*** Oil should be in good condition. If oil has been used for more than 1,500 hours, change oil. ***See Figure 1.***

NOTE! In 1996, GRADALL issued a *G-Tech Report* (#HE96-7) recommending the use of *Mobilfluid 424* in machines built *after* 8/10/96. It is further recommended that *Mobilfluid 424* also be used in machines built *prior to* 8/10/96, after the oil is drained from the hydraulic system.

FIGURE 1
HYDRAULIC RESERVOIR ASSEMBLY

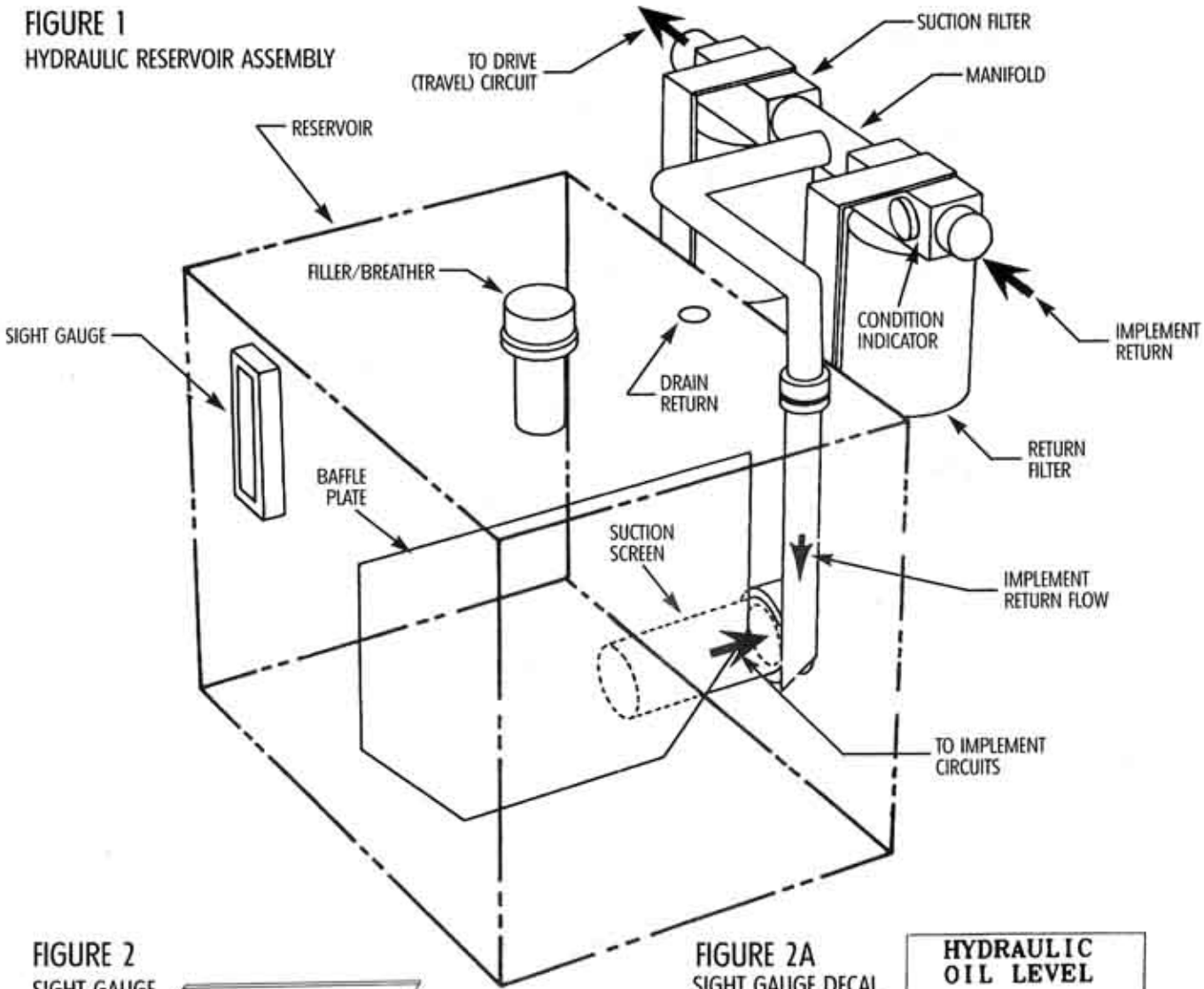


FIGURE 2
SIGHT GAUGE

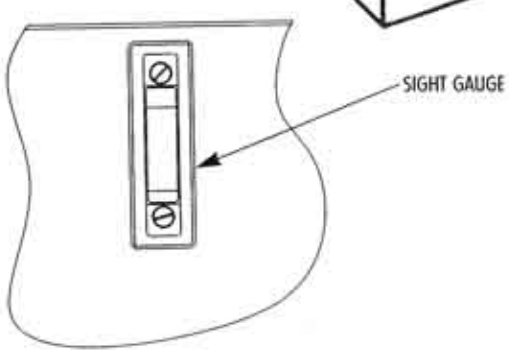
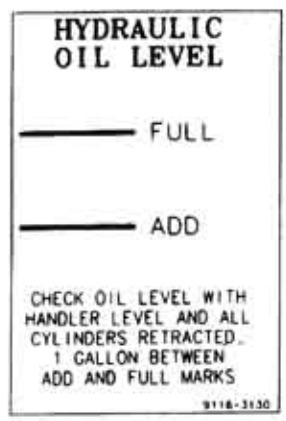


FIGURE 2A
SIGHT GAUGE DECAL



II. Park Brake

Reason for Park Brake check:
Park brake wear can reduce braking effectiveness.

With the park brake engaged, start the engine. Position the 2WD/4WD switch in "2WD". With the rear wheels aligned straight ahead, move the shift lever to the forward position and run the engine full throttle (2,500 +150/-0 RPM). If the brakes are working properly, the machine will not drive through the brakes.

High backpressure in the actuation line can affect the brake holding power. To determine whether the brake is at fault, remove and plug brake actuation line. ***See Figure 4.*** Check park brake operation again. If the machine does not move, the brake is working properly. Backpressure should be less than 20 PSI with oil at operating temperature. To check this pressure, tee a low-pressure (1,000 PSI) gauge, hose and adapter in the brake actuation line. If it is higher than 20 PSI, check for proper operation of the park brake solenoid valve. ***See Figure 3.*** Disconnect the park brake actuation line and tank return line at the valve and plug them. There should be no oil flowing from the open port on the park brake solenoid valve. The brake actuation line should not be kinked. There should be no restriction back to the reservoir. ***See Figure 5.***

There is a 10% wear factor on original rotor discs in the park brake assembly. Applying this 10% wear factor, the park brake assembly's two (2) .150-inch (thick) discs have a minimum allowable thickness of .135 inches and the six (6) .062-inch (thin) discs have a minimum allowable thickness of .056".

To remove park brake assembly, remove four (4) drive motor nuts and slide motor out of the way. Take snap ring off and remove coupler. This will allow access to pinion nut. Take pinion nut off and remove park brake assembly.

Park Brake Assembly Rotor Discs

Original Thickness	No. of Discs	10% Allowable Wear Thickness
.150"	2	.135"
.062"	6	.056"

Spring free length is one inch. Anything less reduces brake holding power. Any combination of the above circumstances reduces brake holding capability. ***See Figures 6 and Figure 7.*** Also refer to ***GRADALL Parts Manual*** for breakdown of park brake assembly.

FIGURE 3
PARK BRAKE SOLENOID VALVE

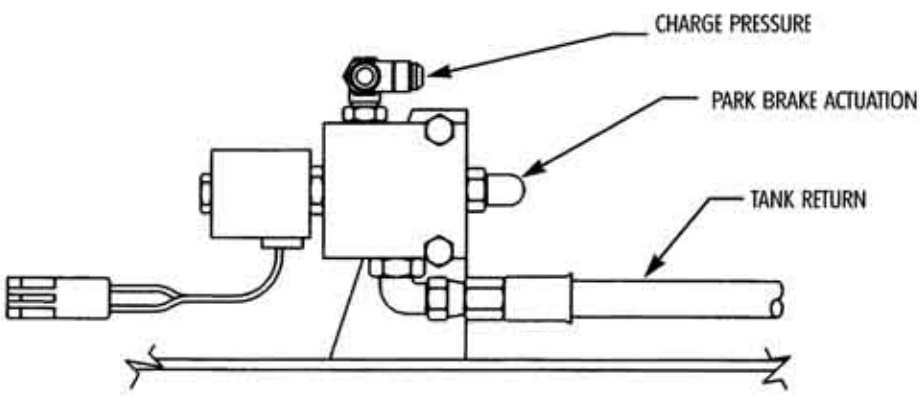
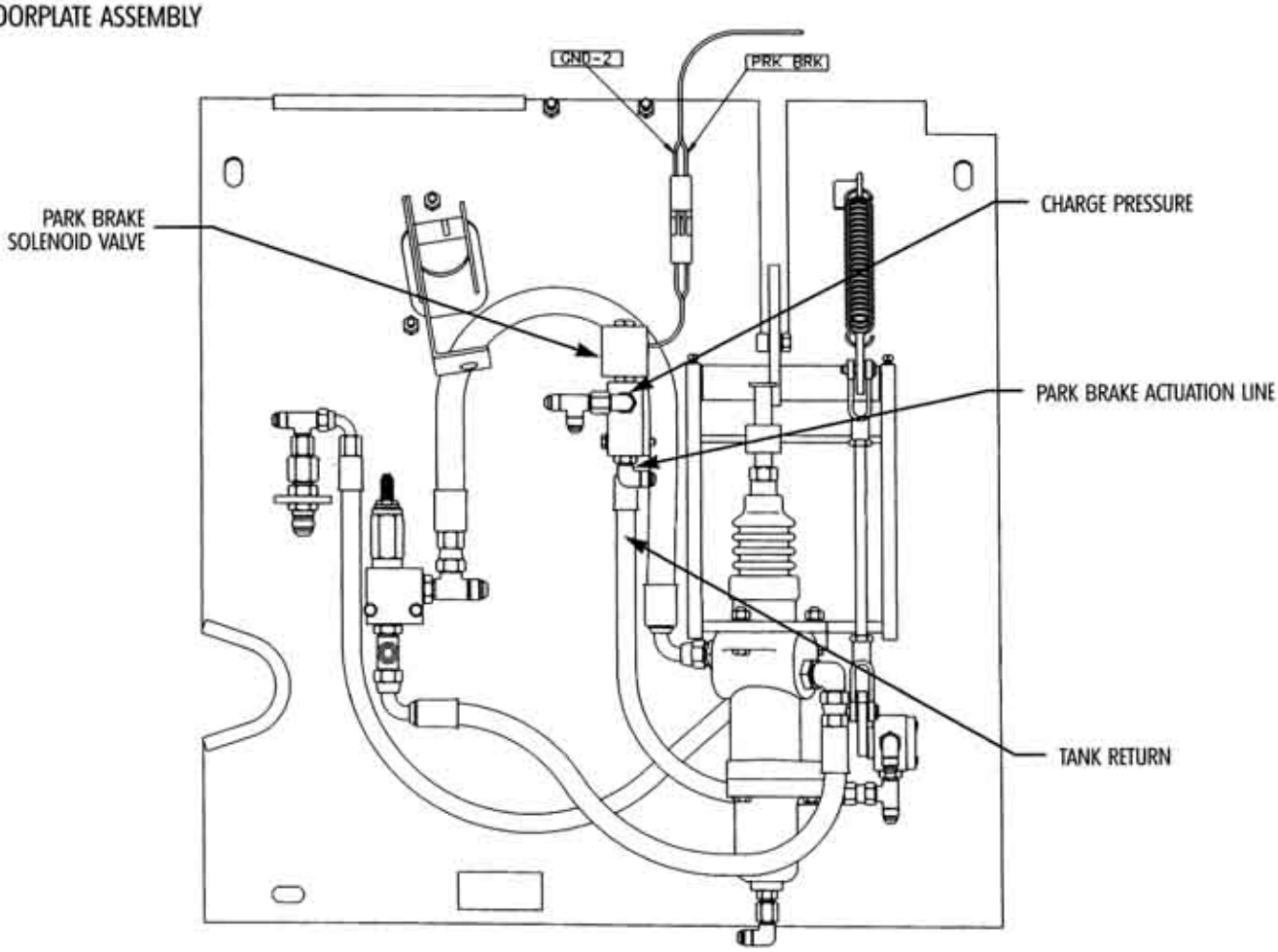


FIGURE 4
FLOORPLATE ASSEMBLY

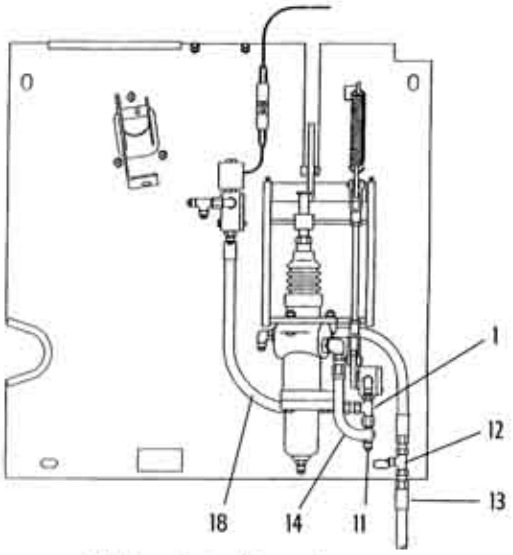


IMPORTANT! As noted in a 1996 *G-Tech Report,* the park brake on certain older machines, with the engine running and the hydraulic oil still cold, could develop sufficient "back pressure" to allow the brake to partially release, even *with* the park brake switch "On". To eliminate this problem, GRADALL modified the brake circuit by re-routing the dump/return line. ***See Figure 5.***

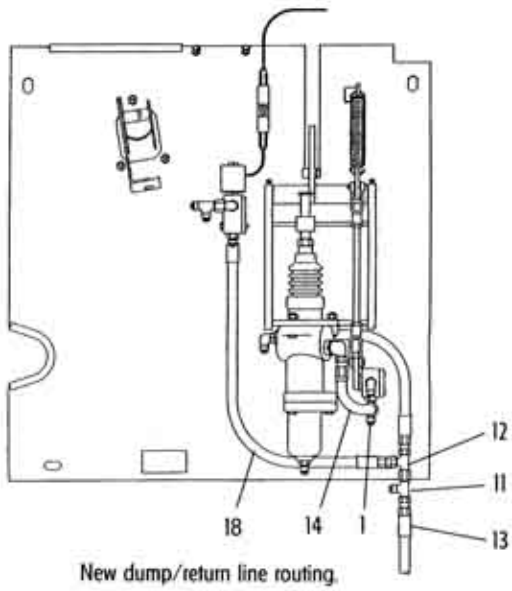
NOTE! For a fuller account, see the original Technical Bulletin, *G-Tech Report* #MH96-3.

FIGURE 5
FLOORPLATE ASSEMBLY
BRAKE CIRCUIT MODIFICATION

STANDARD MACHINES



Old dump/return line routing.

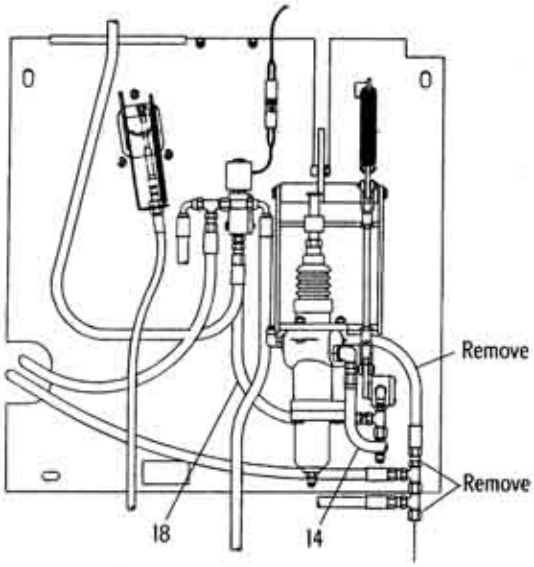


New dump/return line routing.

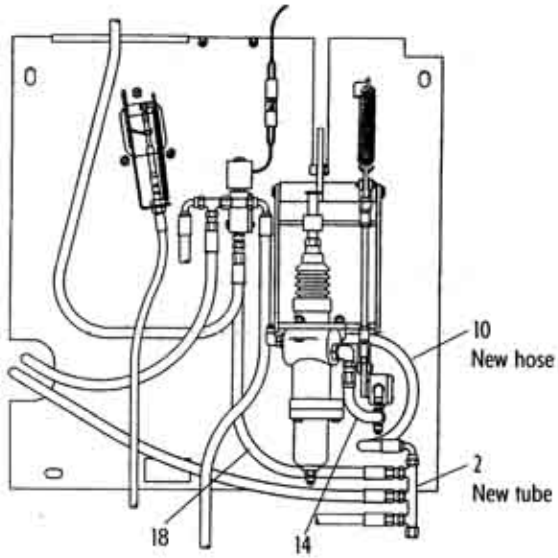
No new parts are required. Relocation of existing parts is as follows:

1. Remove hose item #14 from run tee item #11.
2. Remove item #11 from item #1 and install onto item #12 between items #12 and 13.
3. Remove end of hose item #18 from item #1, run tee.
4. Attach hose end item #18 onto item #11, run tee.
5. Rotate item #1, run tee down 90° and attach hose end #14 onto item #1

MACHINES EQUIPPED WITH "TILT-ON-JOYSTICK"



Old dump/return line routing.



New dump/return line routing.

Item #10, hose #8471-7893, is a new hose. Item #2, tube assembly #9108-3534 is a new part also. The new tube assembly replaces the union tee and the run tee to accept the dump hoses as shown. Relocation of the dump hose is the same as the standard machines using the new parts referenced.

FIGURE 6
FRONT AXLE ASSEMBLY

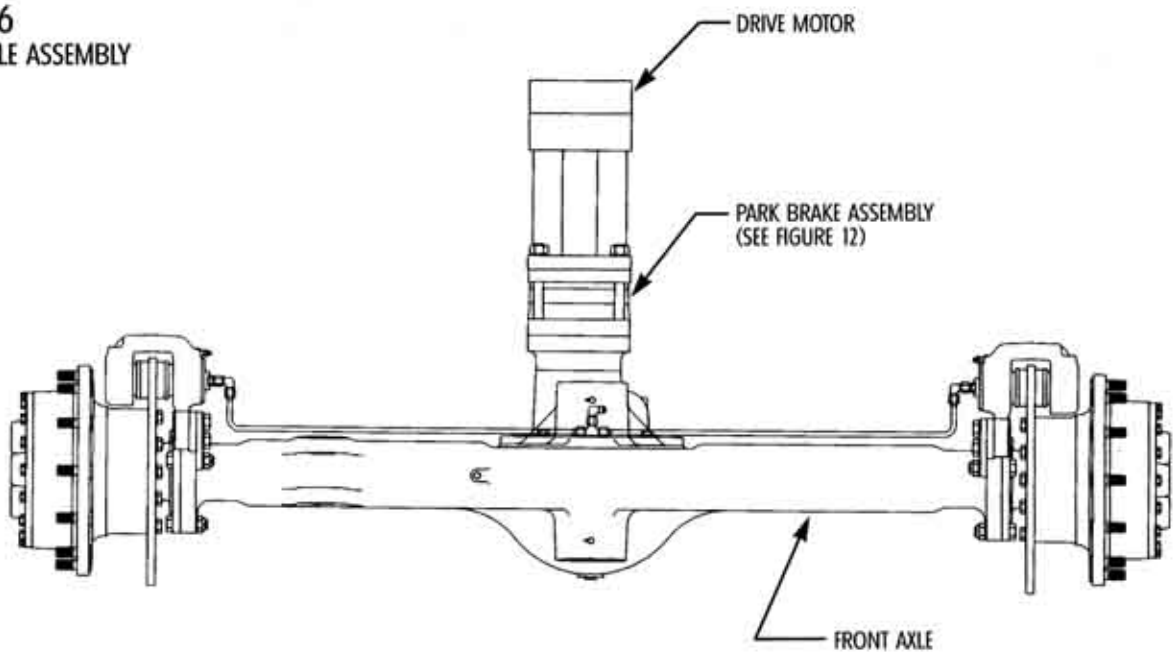
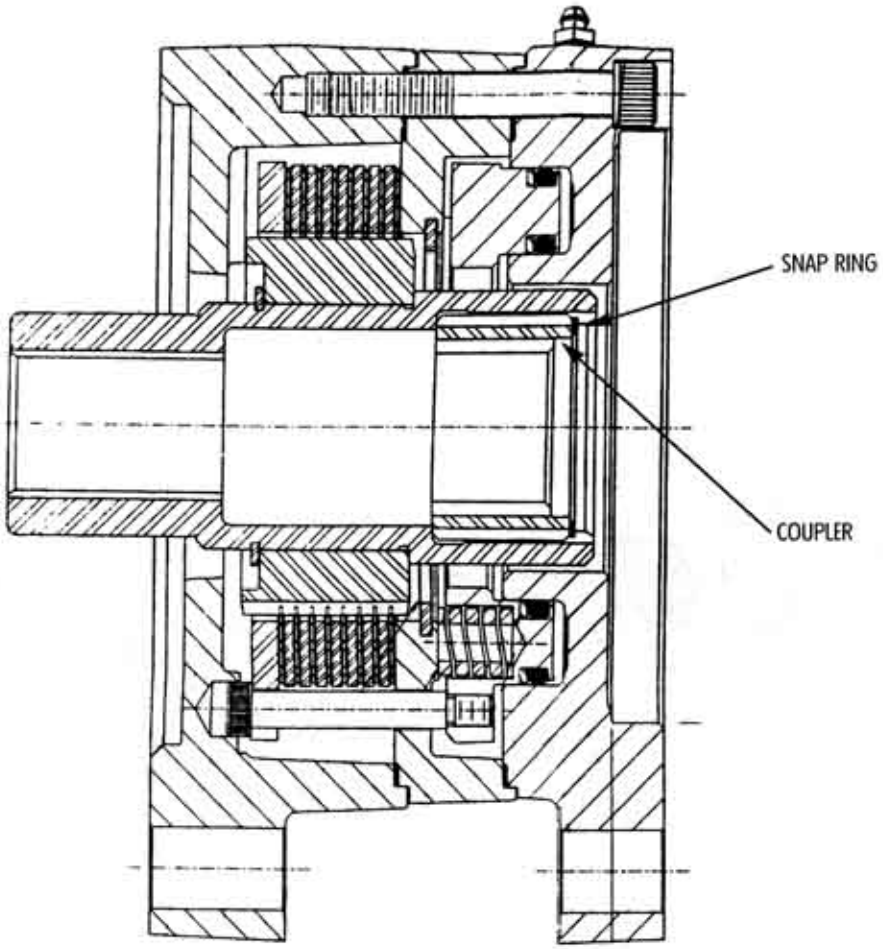


FIGURE 7
PARK BRAKE ASSEMBLY



A new front axle went into production on the 534C-6 starting Serial Number 02882870 and on the 524 starting Serial Number 0177165. The park brake is internal in the front axle assembly. To check for friction disc wear, the axle must be dissassembled and reassembled according to ***Rockwell Maintenance Manual No 9D.*** The brake disc thickness is 0.1245". There is an 8-10% maximum wear factor allowed on the discs. The minimum disc thickness allowed is 0.1120". ***See Figure 8 and Figure 9.***

FIGURE 8
FRONT AXLE ASSEMBLY

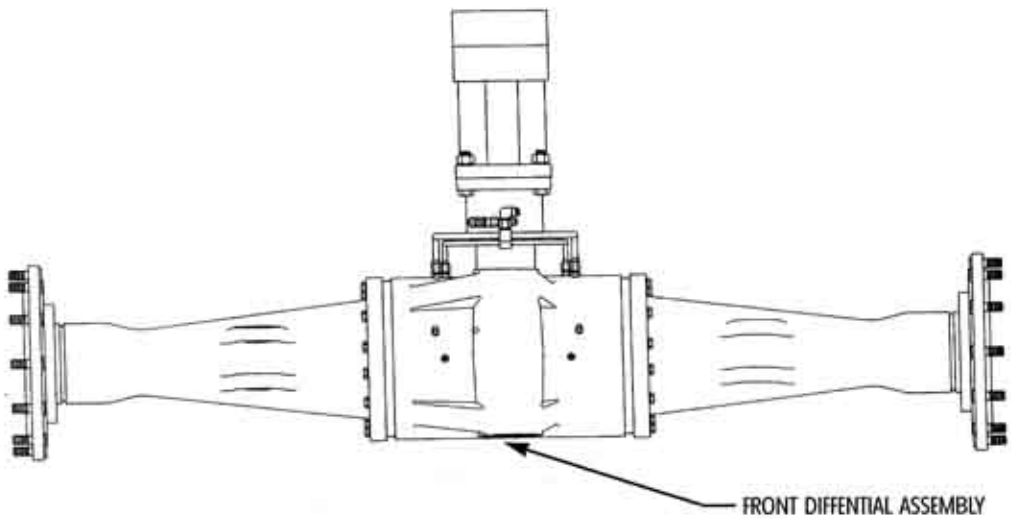
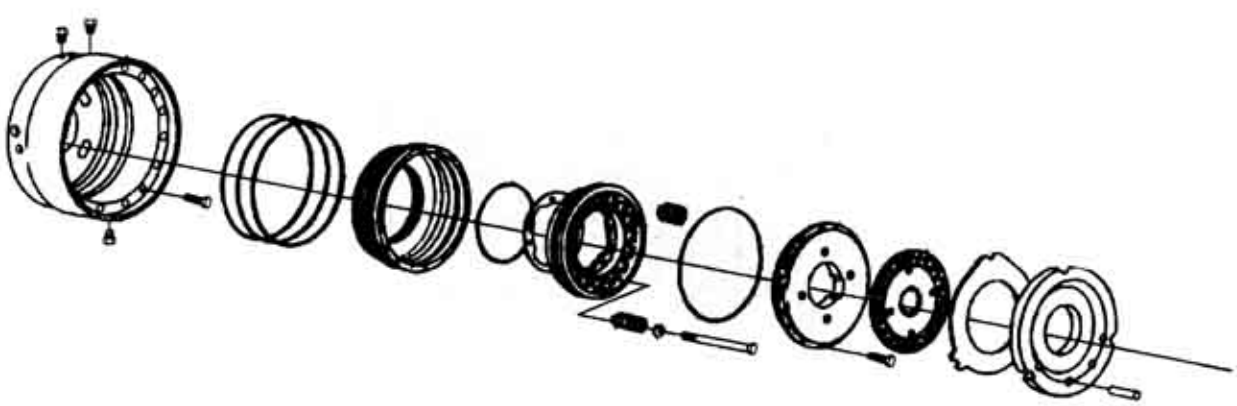


FIGURE 9
PARK BRAKE ASSEMBLY



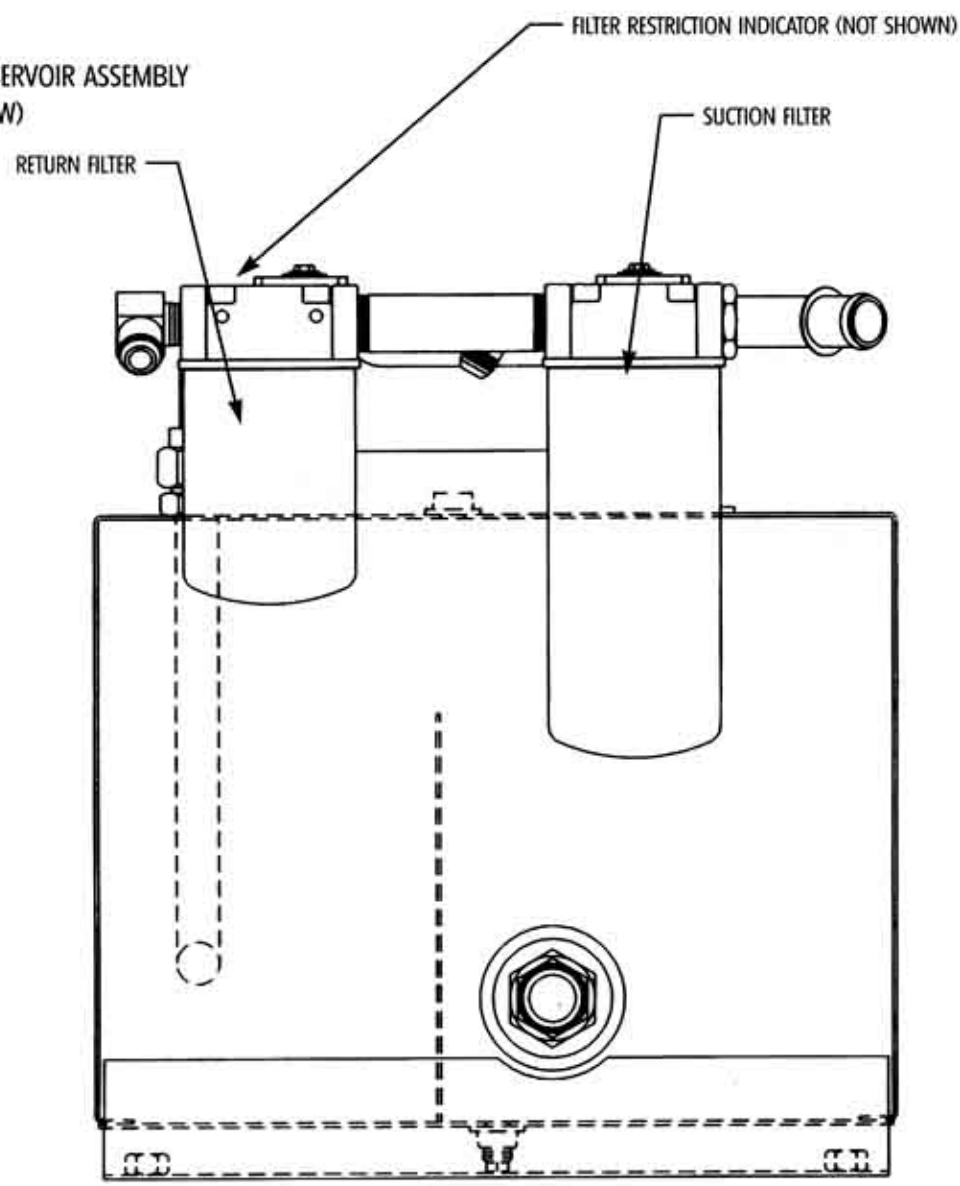
III. Hydraulic Filter Condition

Reason for Hydraulic Filter Condition check:
Dirty suction filters can restrict oil flow to the charge pump. This can lower control pressure which can affect the machine's mobility, especially when ambient temperature is below 32°F.

Hydraulic filters should be changed if they have more than 1,000 hours on them. To check hydraulic filter condition, warm the hydraulic system oil to operating temperature (minimum 100°F). Check the filter restriction indicator on the return filter. The indicator should not show filter bypass with the engine at full throttle, all machine functions in "Neutral" and the park brake engaged. If it shows "Bypass", replace the suction and return filters. The long filter for suction (P/N 9114-3144) can also be used in place of the short return filter (P/N 9108-4021). ***See Figure 10.***

Only GRADALL-supplied filters meet or exceed the filtration requirements of the drive system. If any other type of filter is installed, change to a GRADALL filter and sample oil for condition. **Failure to use GRADALL filters could cause hydraulic component failures and may void warranty.**

FIGURE 10
HYDRAULIC RESERVOIR ASSEMBLY
(BACK SIDE VIEW)



IV. Engine Speed

Reason for Engine Speed check:
Low engine RPM will reduce oil flow to motors. Flow and motor displacement determines machine speed. Therefore, low oil flow will reduce machine speed at full RPM.

Check engine speed with an adequate tachometer. At low idle, it should be 800-900 RPM. Adjust low-idle engine speed using the screw on the injection pump. ***See Figure 11.*** At full throttle with no load, it should be 2,500 +150/-0 RPM. Engine RPM under load will drop to 2,400 RPM. When testing engine speed, make sure the injection pump lever is contacting the stop. If it is not, adjust the stop bolt on the floorplate. The accelerator pedal should just barely contact the stop bolt as the lever touches the stop on the injection pump. ***See Figure 12.*** The sealed adjustment screw on the stop is not adjustable. The accelerator pedal changed design after April 1995. Please note the initial adjustment on current accelerator pedals. Again, the pump lever should contact the stop on the pump. ***See Figure 13, Figure 14, and Figure 15.***

FIGURE 11
ENGINE ASSEMBLY
(LEFT SIDE)

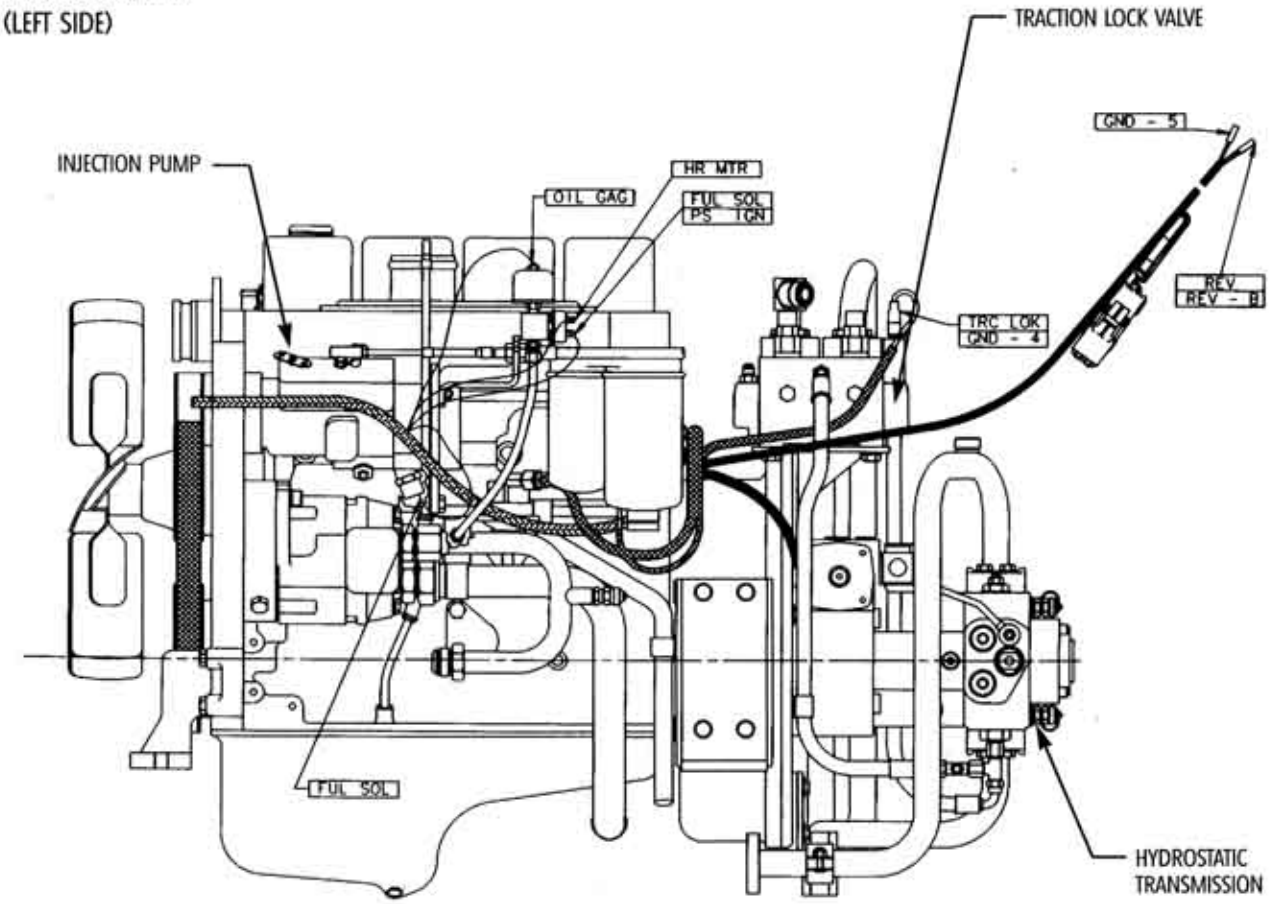


FIGURE 12
BOTTOM OF FLOORPLATE ASSEMBLY
(ORIGINAL)

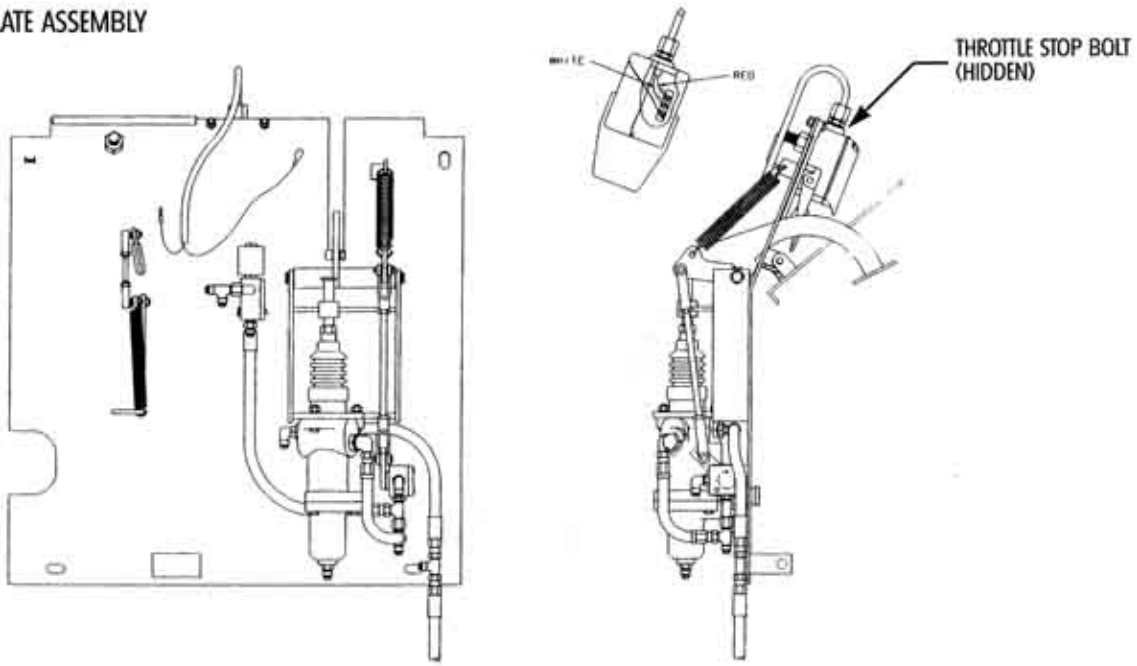


FIGURE 13
BOTTOM OF FLOORPLATE ASSEMBLY
(STARTING 4/95)

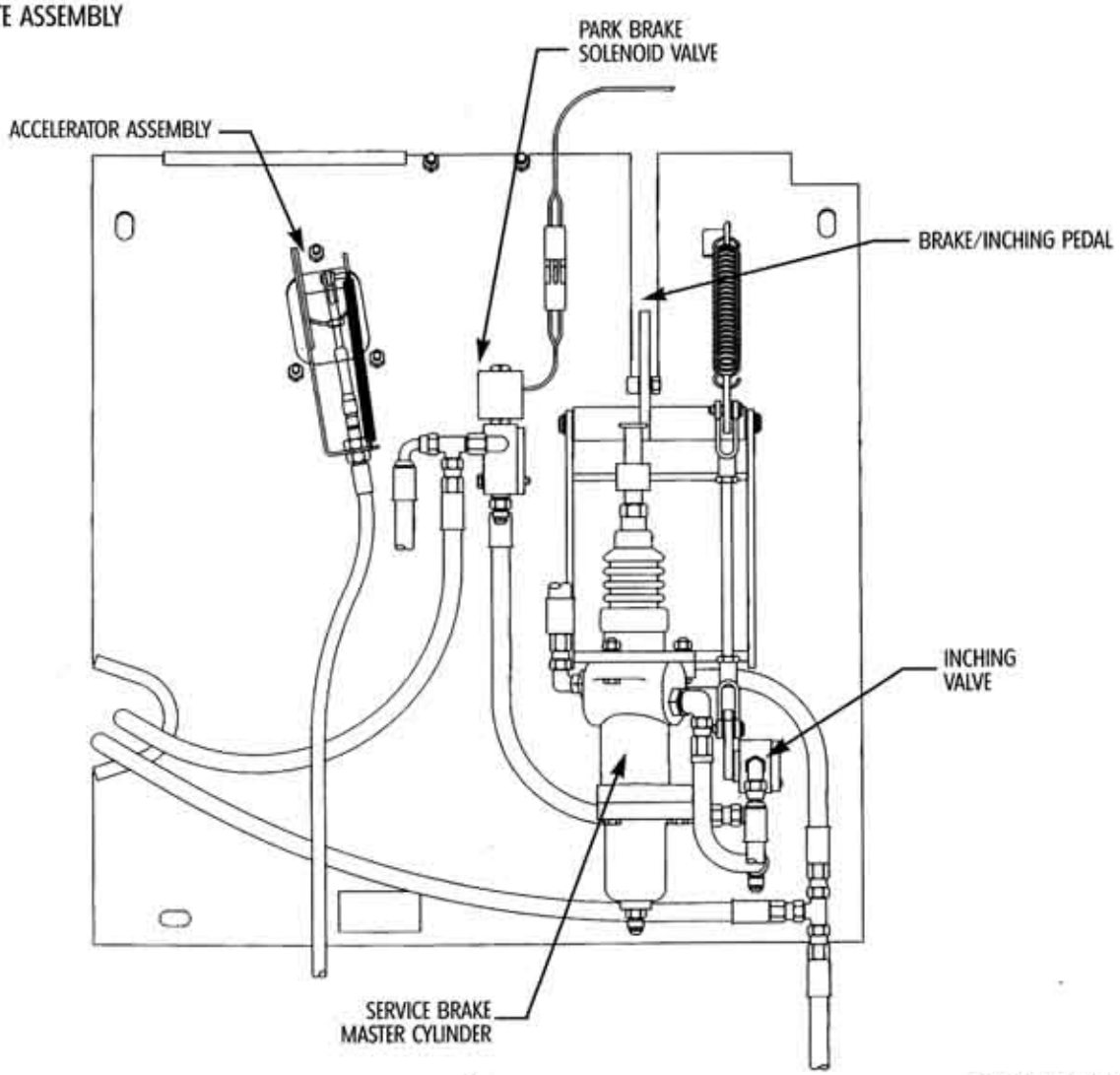


FIGURE 14
ACCELERATOR PEDAL
(STARTING 4/95)

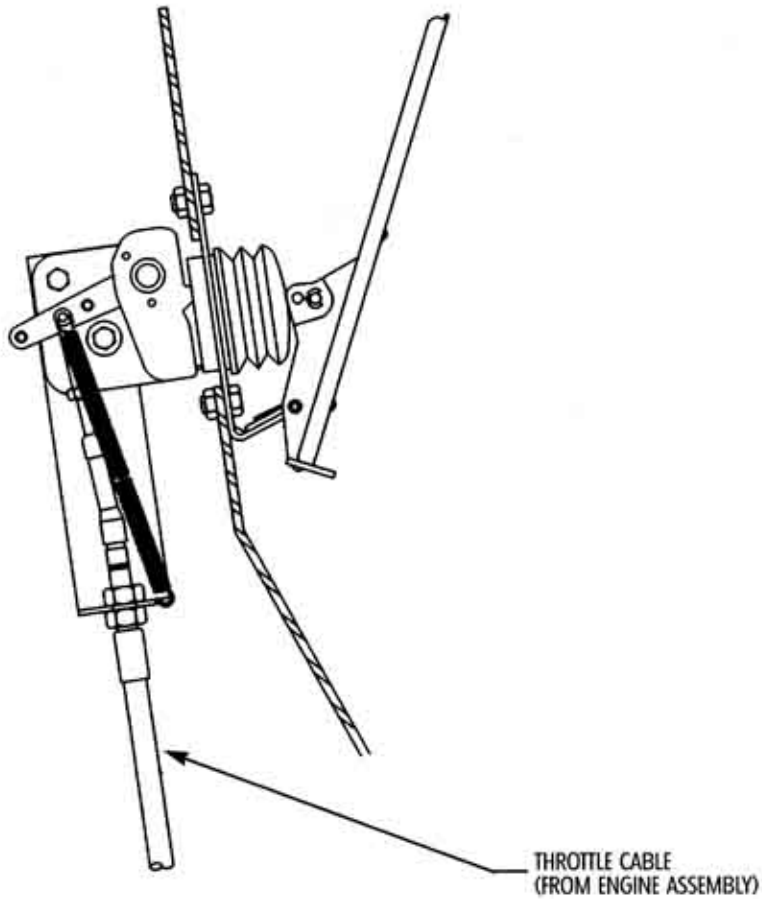
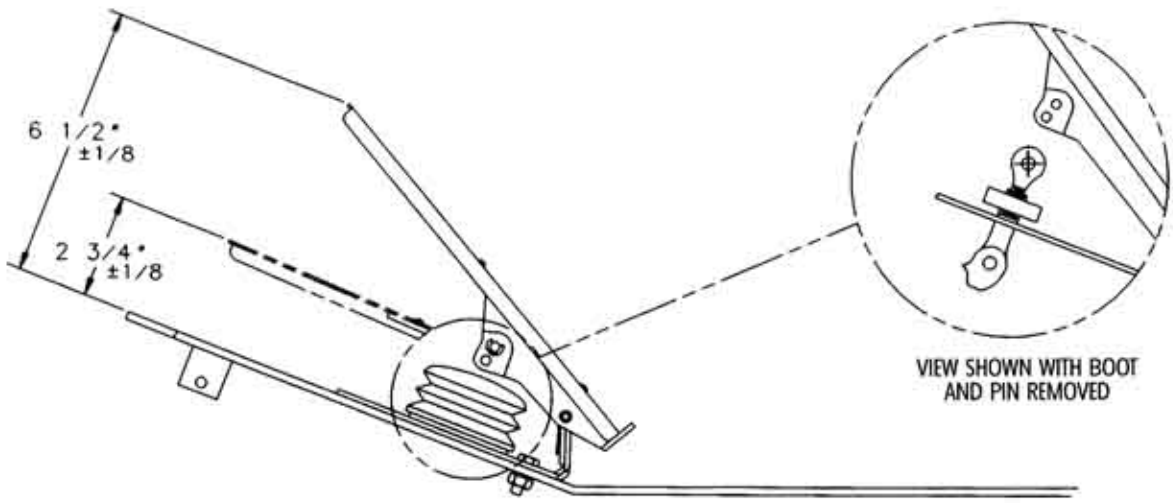


FIGURE 15
ACCELERATOR PEDAL
(STARTING 4/95)
(INITIAL ADJUSTMENT)



V. Charge Pressure

Reason for Charge Pressure check

To ensure proper park brake operation, charge pressure needs to be at proper specification. Control pressure is modified charge pressure. If charge pressure is low, control pressure may be low and machine performance will be adversely affected.

Install a low-pressure (1,000 PSI) gauge, hose and adapter on the charge pump pressure test port that is located on the right side of the engine compartment. ***See Figure 16.*** For more details, see the ***Hydraulic System Manual.***

NOTE! Before starting, make sure the gauge can be observed in the operator's cab.

Start the engine and run at low idle (800-900 RPM) where the gauge should read approximately 320 PSI. At full throttle the gauge should read a maximum of 480 PSI and never be less than 320 PSI.

The charge pump relief, located at the top, left rear of the hydrostatic transmission, can be adjusted as is necessary. ***See Figure 17.*** For more details, see the ***Hydraulic System Manual.*** To adjust the charge pump relief, loosen the locknut and turn the adjusting screw clockwise to increase charge pressure; turn counter-clockwise to decrease charge pressure. When finished, tighten the locknut and install a blue plastic cap.

FIGURE 16
CHARGE PRESSURE TEST PORT

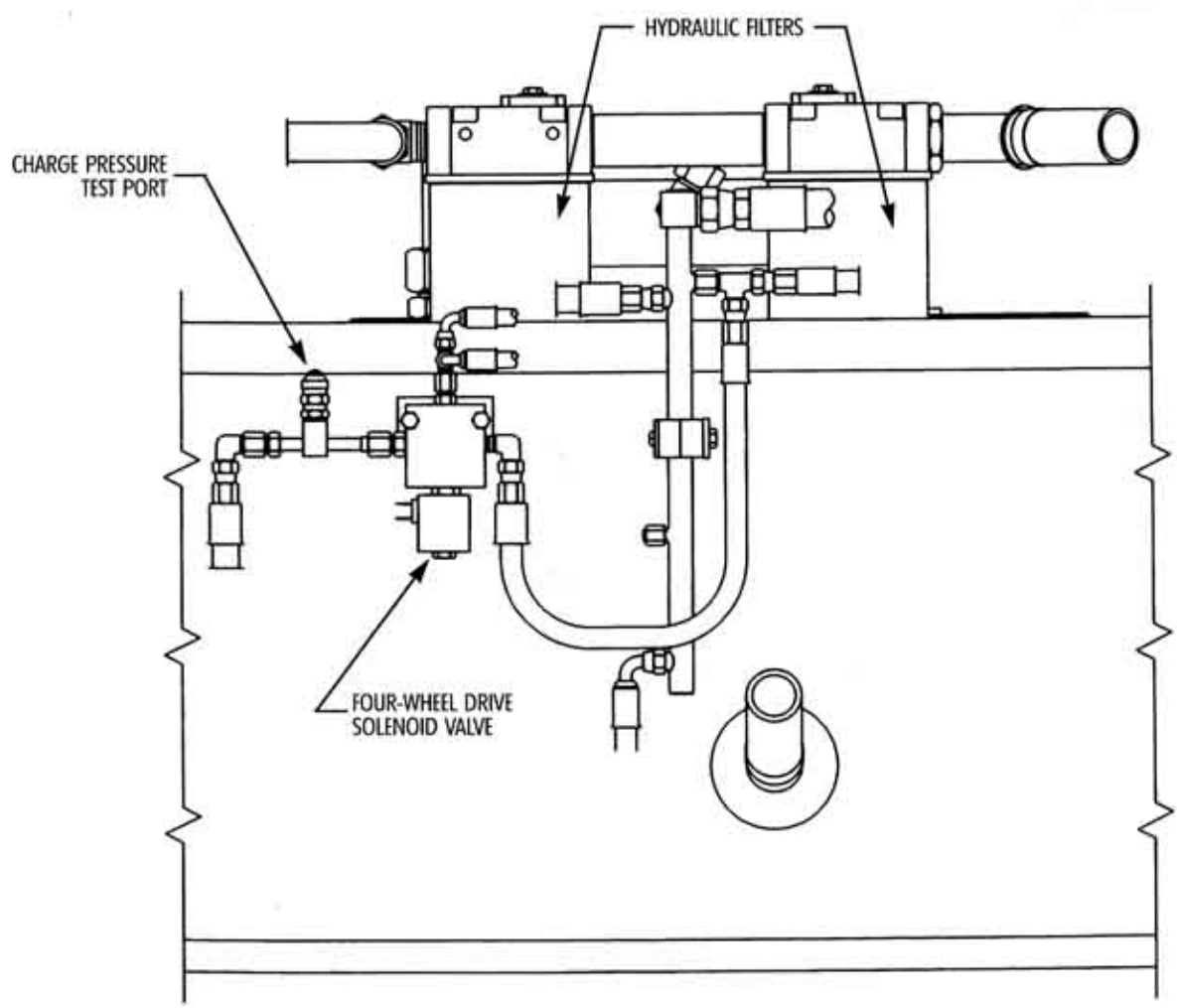
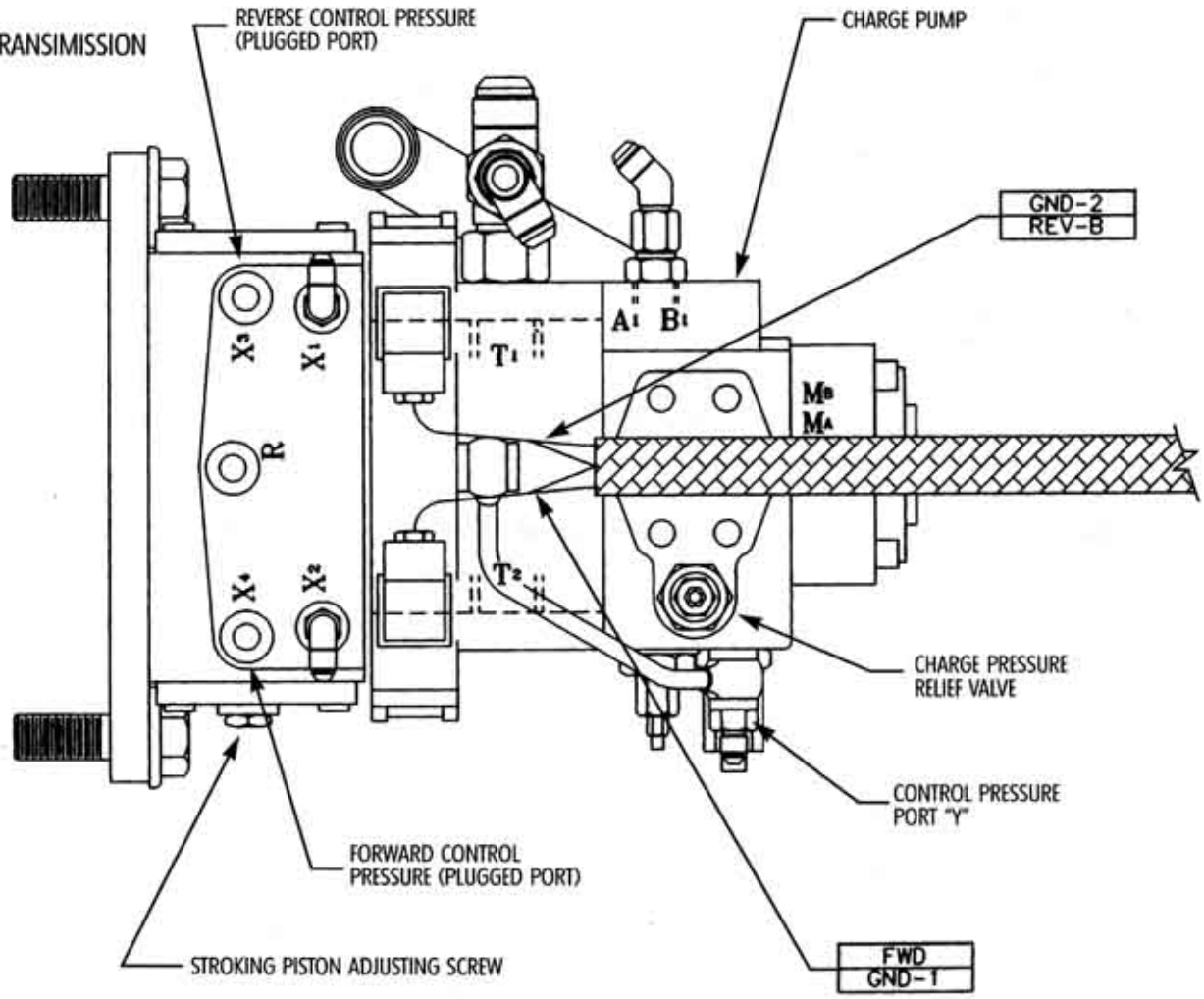


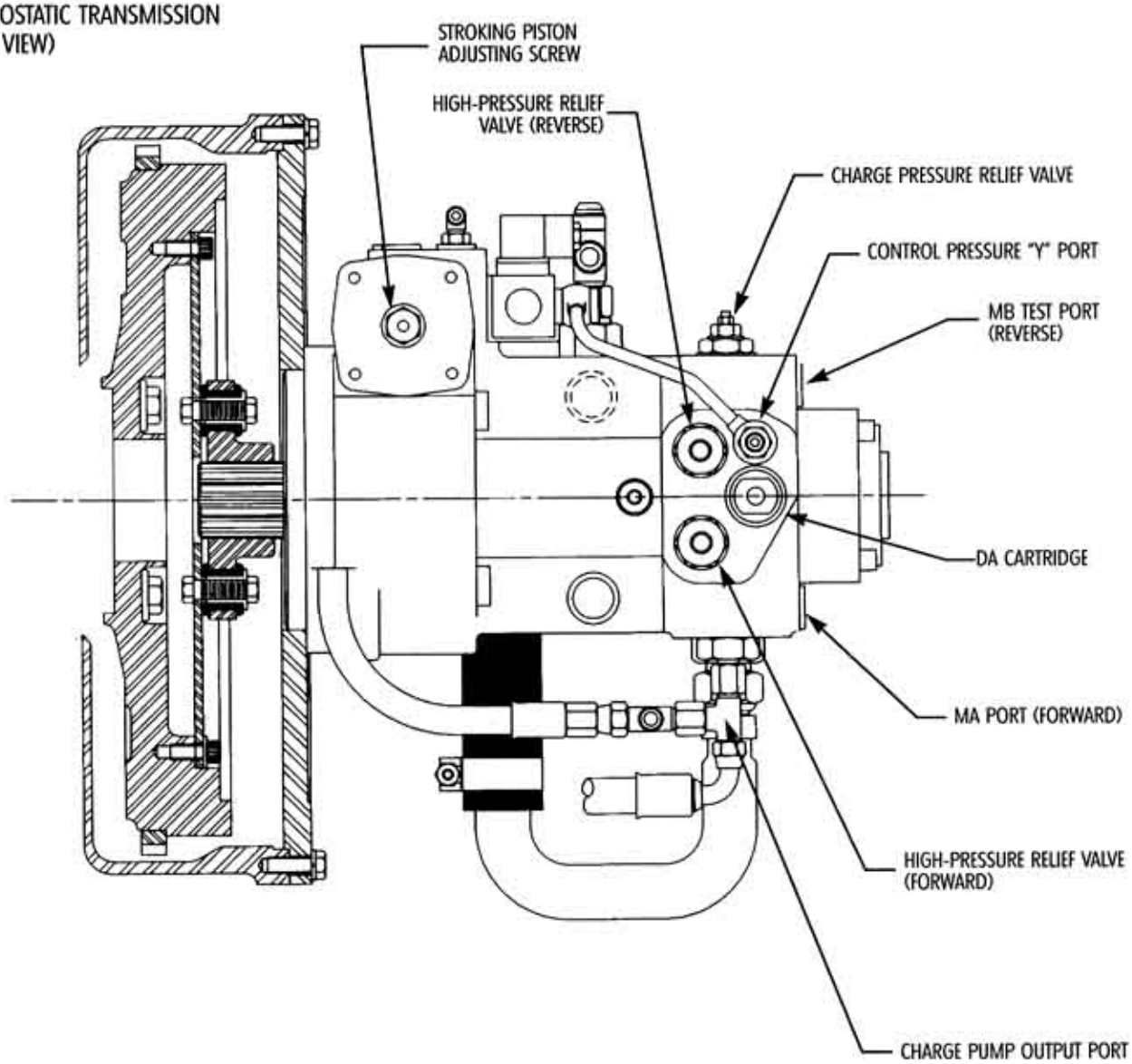
FIGURE 17
HYDROSTATIC TRANSIMISSION
(TOP VIEW)



To pinpoint the loss of charge pressure, start at the pump. Remove the run tee from the elbow on charge pump output port on the hydrostatic transmission, install a low-pressure (1,000 PSI) gauge on the elbow fitting and plug the tee. ***See Figure 17A.*** Check the charge pressure again and observe the gauge. If the charge pressure comes back to specifications, the loss of pressure is in one of the auxiliary valves. These valves include the 2WD/4WD valve, traction lock valve, park brake solenoid valve and the joystick. Isolate each of these valves to check for the loss of charge pressure.

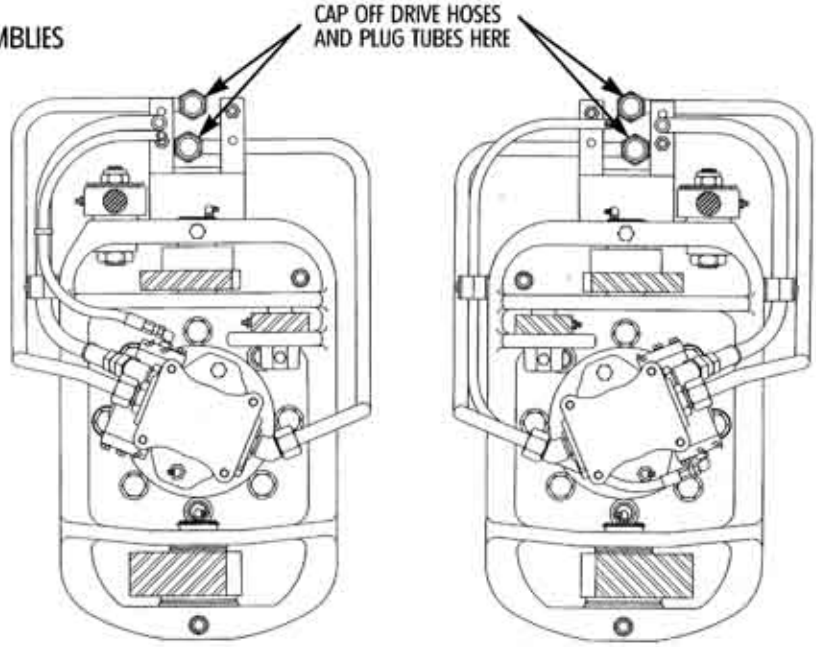
The charge pump relief is located at the left side of the hydrostatic transmission. ***See Figure 17.*** To adjust the charge pump relief, loosen the locknut and turn the adjusting screw clockwise to increase charge pressure; counter-clockwise to decrease charge pressure. Be sure to note the amount that the relief turns in either direction. When finished, tighten the locknut and install a blue plastic cap.

FIGURE 17A
HYDROSTATIC TRANSMISSION
(SIDE VIEW)



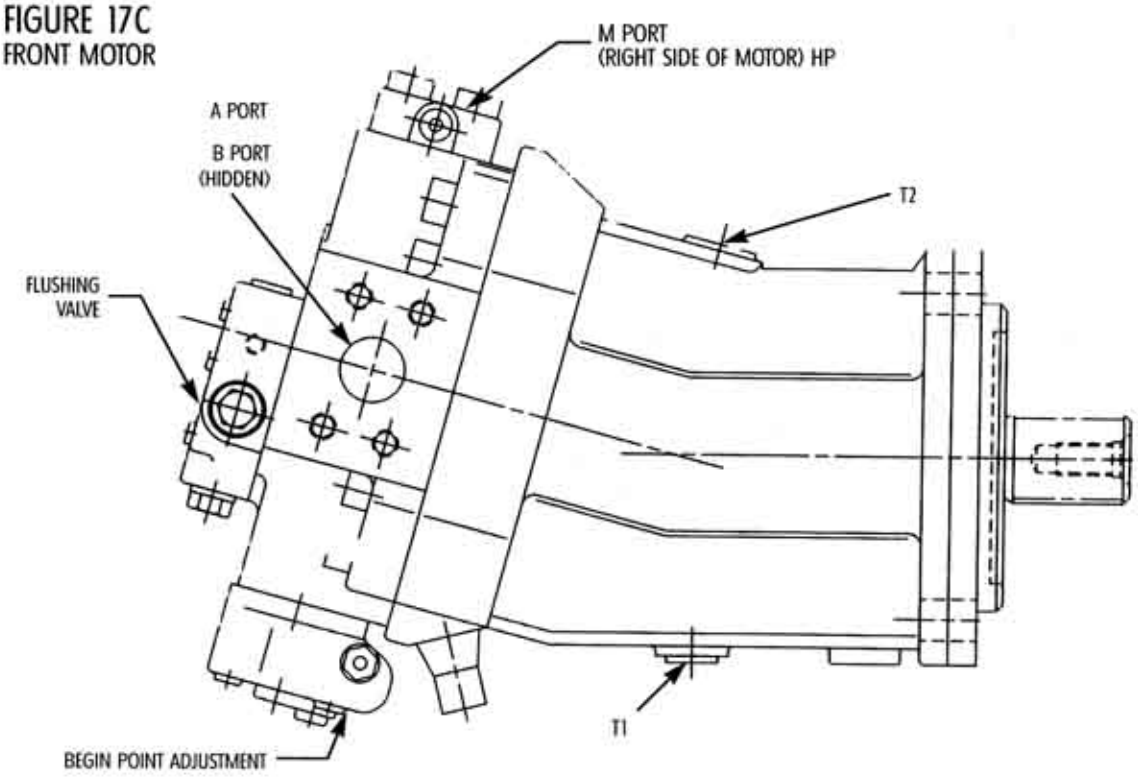
Another test to determine loss of charge pressure is to cap off drive hoses to the rear drive motors. Reinstall hoses from previous test. Install low-pressure (1,000 PSI) gauge on the charge pressure test port. ***See Figure 16.*** Check each motor separately. Start at the left rear motor. Remove the hoses to the motor at the tubes and plug with ORS #12 plugs (P/N 8471-4002). Also cap off tubes (with ORS #12 caps, P/N 8471-4006) to prevent dirt from entering the motor. ***See Figure 17B.*** Start the machine and observe the gauge for charge pressure. Engage drive forward and reverse against the park brake and observe gauge for charge pressure simultaneously. Record the findings. If charge pressure recovers, the motor is defective. If charge pressure does not recover, repeat test for right rear motor.

FIGURE 17B
REAR DRIVE MOTOR ASSEMBLIES



Isolate the front drive motor from the circuit if the rear motors are not defective. Isolating it will require two blocking plates (P/N 9108-1667). Install these plates between the front drive motor work ports and the drive hoses. ***See Figure 17C.*** Remove the flange halves and place the blocking plates on the ports, reinstalling the hoses and flange halves. Again, start the machine and observe the pressure gauge for charge pressure. If charge pressure recovers, the motor is defective. To confirm, check charge pressure with drive against park brake. Charge pressure should remain between 380-480 PSI.

FIGURE 17C
FRONT MOTOR



VI. Control Pressure

Reason for Control Pressure check:
To ensure control pressure is correct for proper machine speed. For the machine to move at proper engine performance, control pressure should match engine RPM.

Install a low-pressure (1,000 PSI) gauge, hose and adapter on the hydrostatic transmission control pressure port "Y". Remove and plug hose from port. For more details, ***see Hydraulic System Manual.***

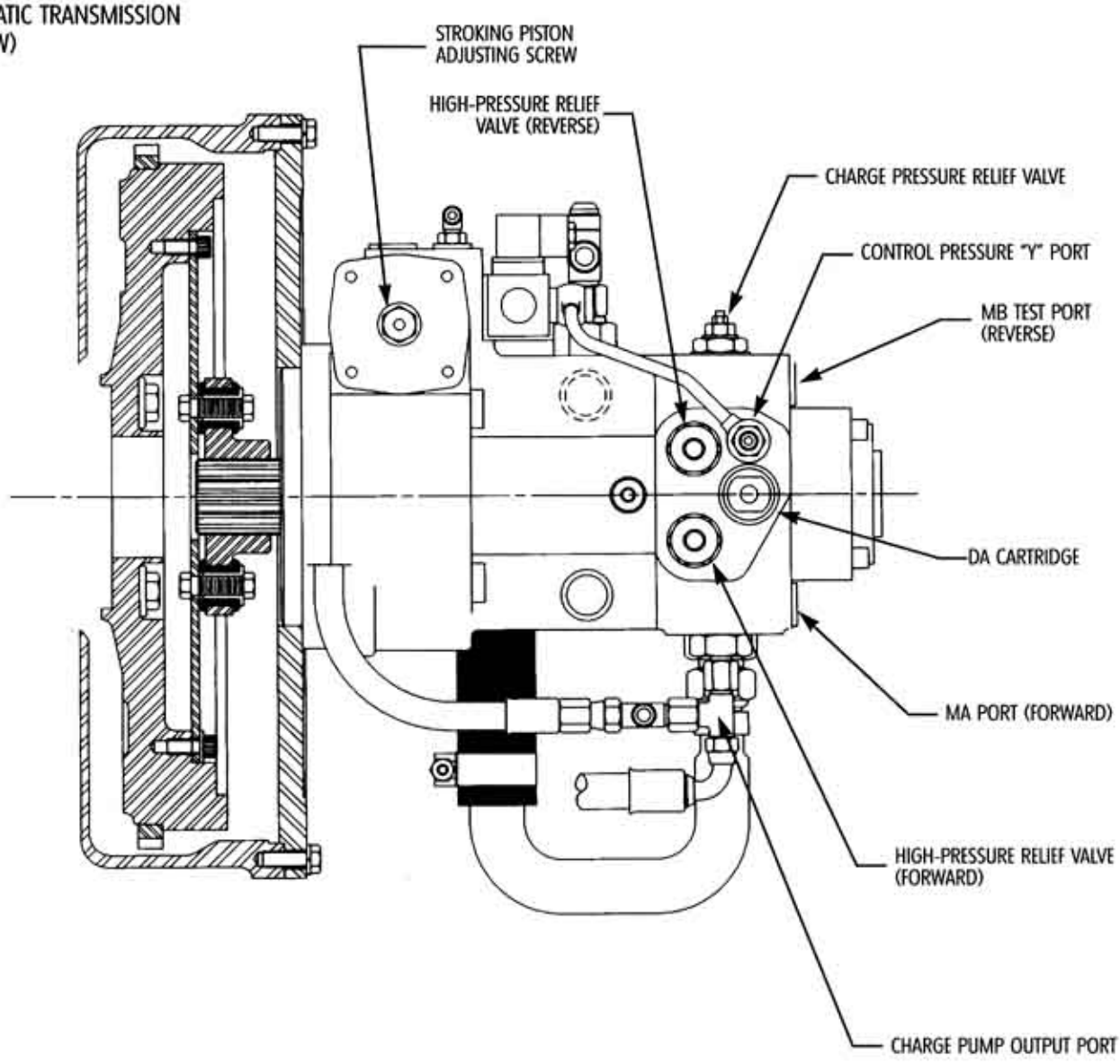
NOTE: Before starting, make sure the gauge can be observed in the operator's cab and apply the park brake.

Start the engine and run at full throttle speed. With the hydrostatic transmission in "Neutral", the gauge should read 325 PSI. This may vary ±15 PSI.

Use a tachometer to monitor engine speed. Install the pressure gauge in the "X4" port on top of the pump. Start the engine and run at 1,100 RPM. While watching the pressure gauge, move the shift lever to the forward position. The gauge should read 100 PSI. Next move the gauge to the "X3" port and repeat the test for reverse. If the inching valve and forward/reverse valve work correctly, but adjustment does not produce the desired pressure change, replace the control pressure (DA) cartridge.

If the machine does not start to move at 1,100 RPM engine speed in both directions equally at 100 PSI control pressure, the stroking piston may need to be mechanically centered. To check adjustment, remove plugs from ports "X3" and "X4." ***See Figure 17.*** Install a clean hose between the ports. They are located on the top of the hydrostatic transmission. Install two HP (10,000 PSI) gauges, hoses and adapters in hydrostatic transmission ports "MA" and "MB." Start the engine and operate at low idle. Observe the gauges. Pressure at "MA" port must be equal to pressure at "MB" port. If pressures are not equal, loosen locknut on stroking piston adjustment and turn adjusting screw to equalize pressures. ***See Figure 18.*** Tighten locknut to secure adjustment. Repeat this procedure with two low-pressure (1,000 PSI) gauges to fine tune. For more information, ***see Hydraulic System Manual.***

FIGURE 18
HYDROSTATIC TRANSMISSION
(SIDE VIEW)



VII. Inching

Reason for Inching check:
A loss of control pressure can affect machine performance.

Tee the low-pressure (1,000 PSI) gauge, hose and adapter into the "Y" port on the hydrostatic transmission. ***See Figure 18.*** Apply the park brake and run the engine at full throttle. The gauge reading should be the same as in the previous control pressure test. Depress the brake pedal. The control pressure should start to fall after 1/2" of pedal travel. This pressure should drop as the pedal travels further and the service brakes are applied. For correct inching adjustment. ***See Figure 19.*** The lever arm position on the inching valve should be set 1/8" off the pin as a starting point.

FIGURE 19
FLOORPLATE ASSEMBLY

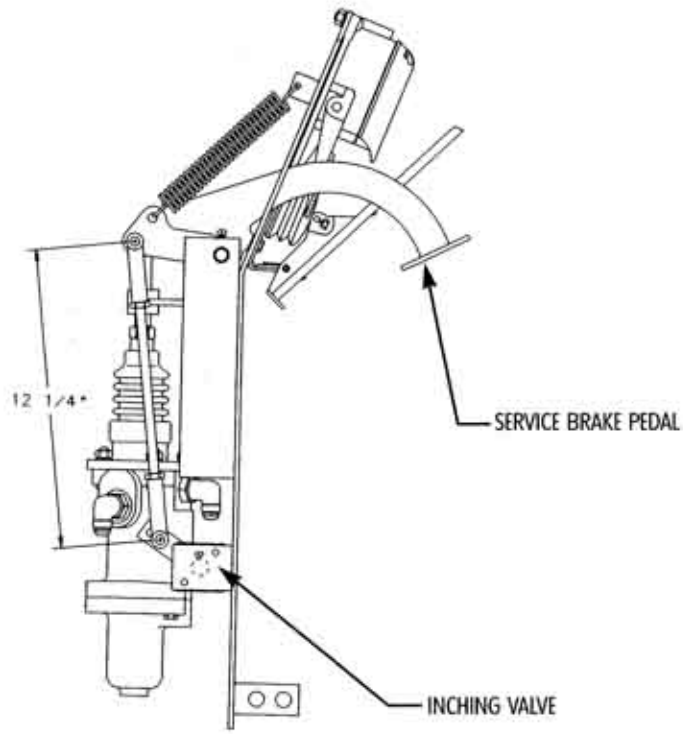
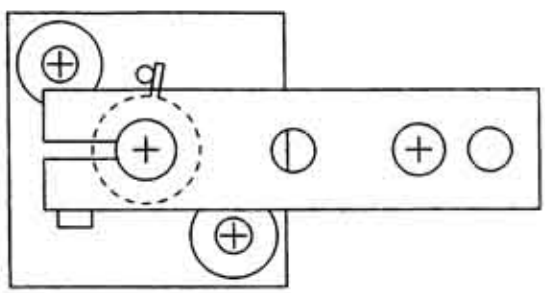


FIGURE 19A
INCHING VALVE

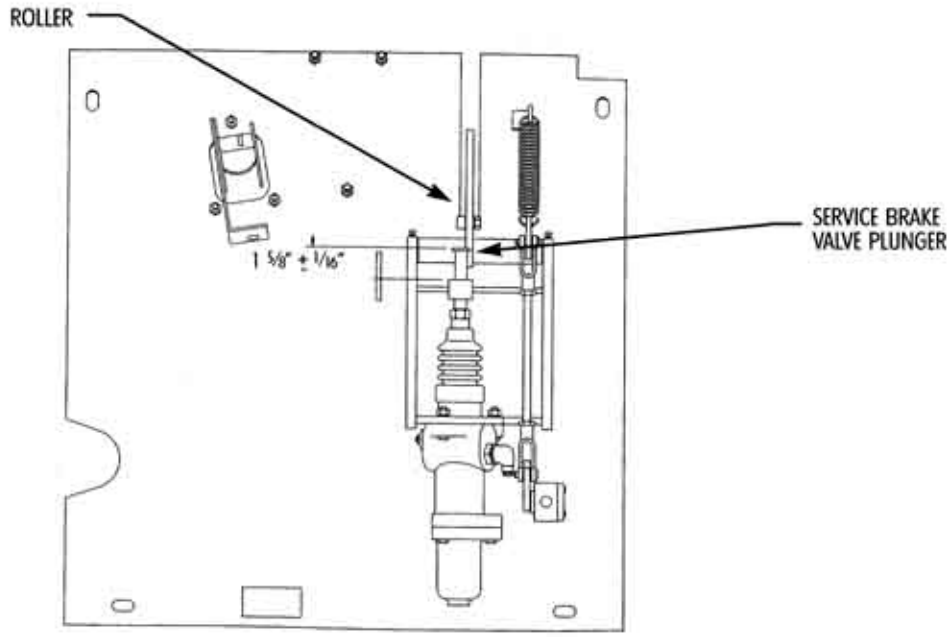


NOTE! INCHING VALVES CANNOT BE INTERCHANGED DUE TO FLOW CHARACTERISTICS. EACH VINTAGE OF MACHINE (DENOTED BY SERIAL NUMBER) HAS A SPECIAL INCHING VALVE.

VII. Inching (continued)

Another check for the inching adjustment is to install a high-pressure (10,000 PSI) gauge, hose and adapter on "MA" port on the hydrostatic transmission. ***See Figure 18.*** With the park brake on and the wheels chocked, move the shift lever to the forward position. At full throttle, depress the inching/brake pedal slowly. When the roller on the pedal just touches the service brake valve plunger, the gauge should read 2,300 PSI ± 100. Service brake valve plunger length should be 1 5/8" ± 1/16". ***See Figure 19B.***

FIGURE 19B
FLOOR PLATE ASSEMBLY
(BOTTOM VIEW)



VIII. Hydrostatic Transmission Pressure

Reason for Hydrostatic Transmission Pressure check:
Hydrostatic tansmission pressure determines the drive power of the machine. Low drive pressure will result in less power.

Install an high-pressure (10,000 PSI) gauge, hose and adapter on the "MA" port (located below charge pump) of the hydrostatic transmission using mini-check test port P/N 9108-3475. Apply the park brake. Move the shift lever to the forward position and run the engine at full throttle. The gauge reading should be 5,000 PSI. As is necessary, adjust the bottom relief valve located on the left side of the hydrostatic transmission. On 534C-6 (starting serial number 0288587) and 524 (starting serial number 0177107) models, the drive pressure was increased to 5,500 PSI. Adjust same as above using an high-pressure (10,000 PSI) gauge).

To adjust this relief valve, loosen the locknut and turn the adjusting screw clockwise to increase pressure; counter-clockwise to decrease pressure.

Move the gauge to the "MB" port of the hydrostatic transmission to repeat the procedure with the shift lever in the reverse position. As is necessary, adjust the top relief on the left side of the hydrostatic transmission. ***See Figure 18.***

524 and 534C-6 ("4WD" machines) only
There are also two (2) high-pressure/anti-cavitation relief valves on the traction lock valve. ***See Figure 20, Figure 21, and Figure 22.*** These could influence drive system pressure with a low setting or missing O-ring. On machines with 5,500 PSI drive pressure, these valves are set at 5,800 PSI. ***See Figure 23.*** Normally, these relief valves are not checked. However, if there is a drive power problem and adjustment of the relief valves on the hydrostatic transmission does not change the pressure, these need to be checked.

To check these reliefs, both relief valves on the hydrostatic transmission have to be raised and then reset.

FIGURE 20
HIGH-PRESSURE RELIEF BLOCK

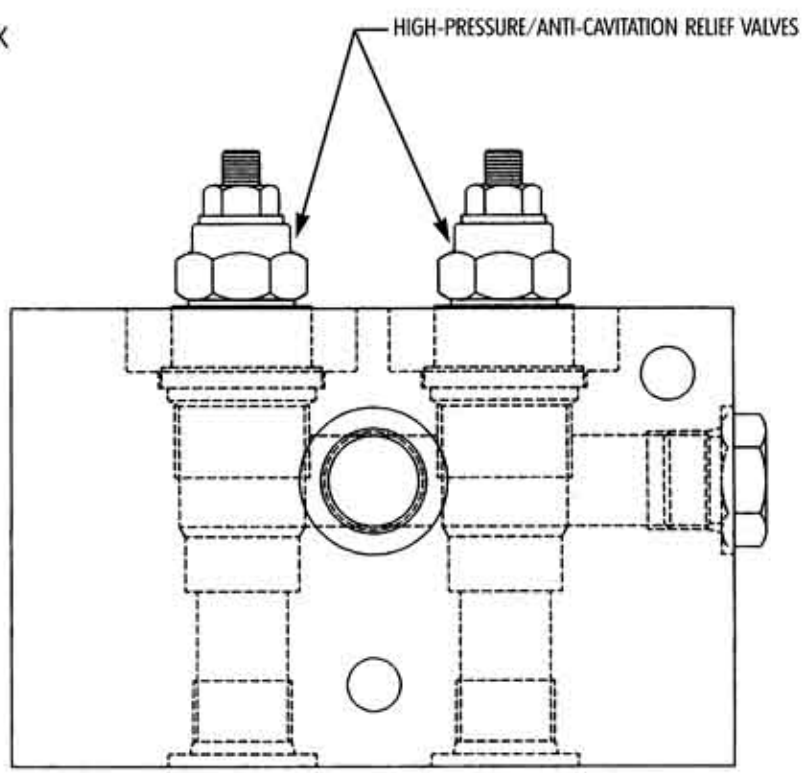
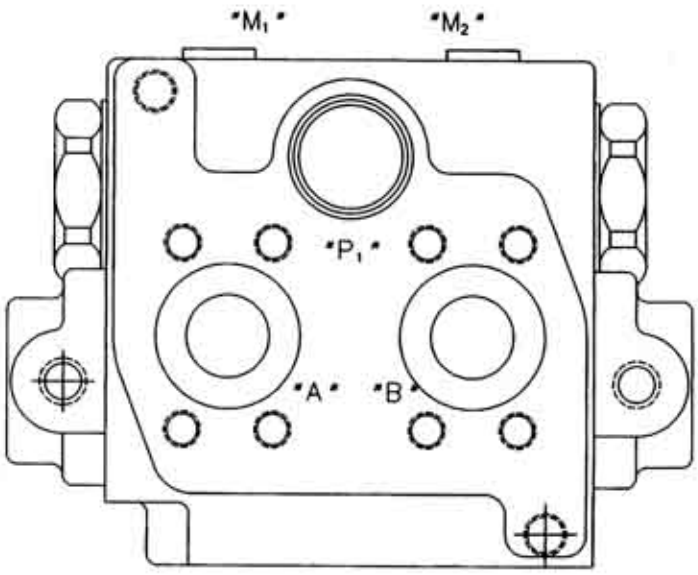


FIGURE 21
TRACTION LOCK VALVE
543C-6 STARTING SERIAL NO. 0188002
524 STARTING SERIAL NO. 0177005



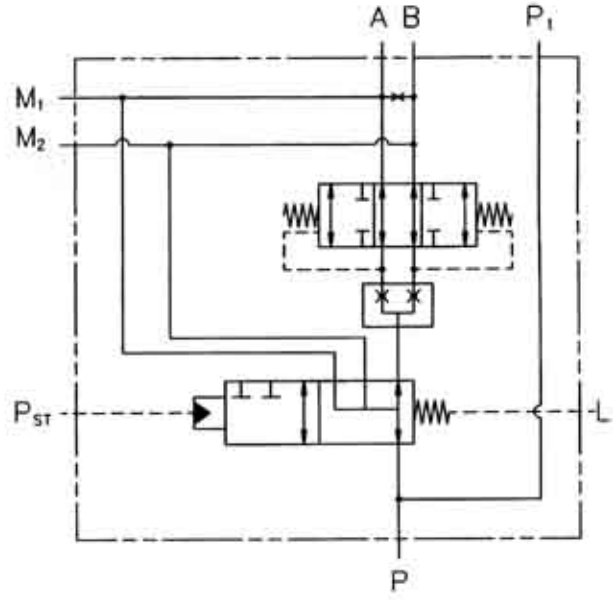
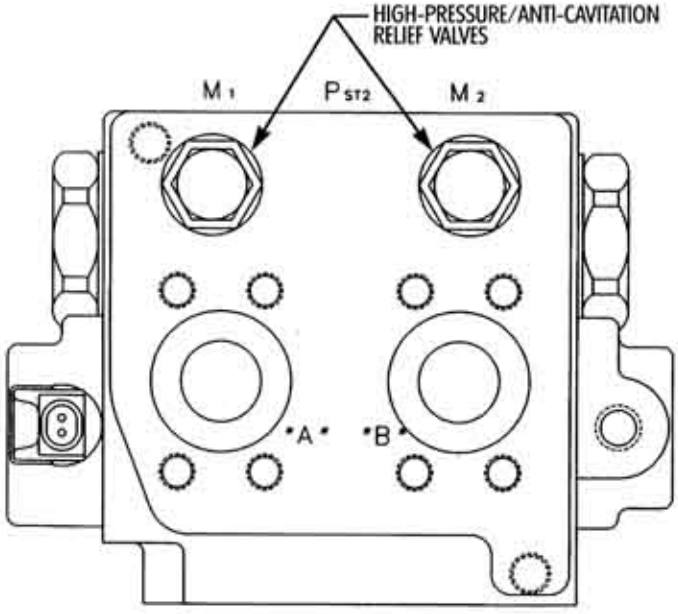


FIGURE 22
TRACTION LOCK VALVE
543C-6 STARTING SERIAL NO. 0188251
524 STARTING SERIAL NO. 0177074



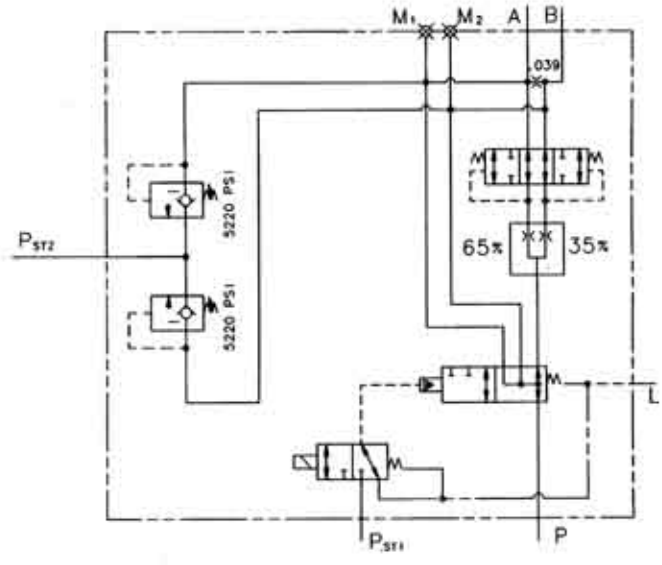
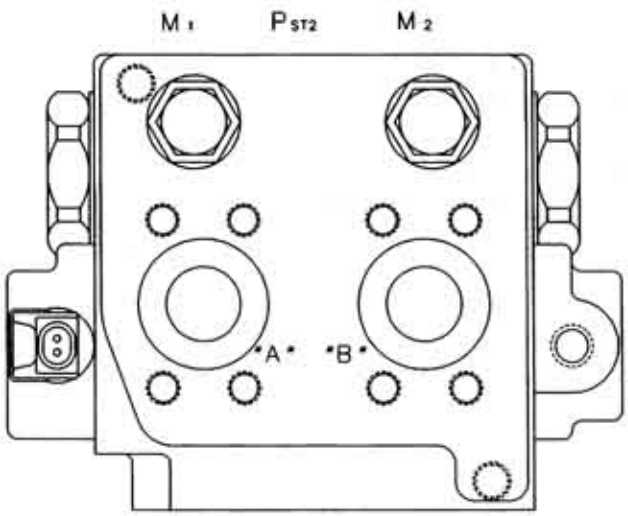
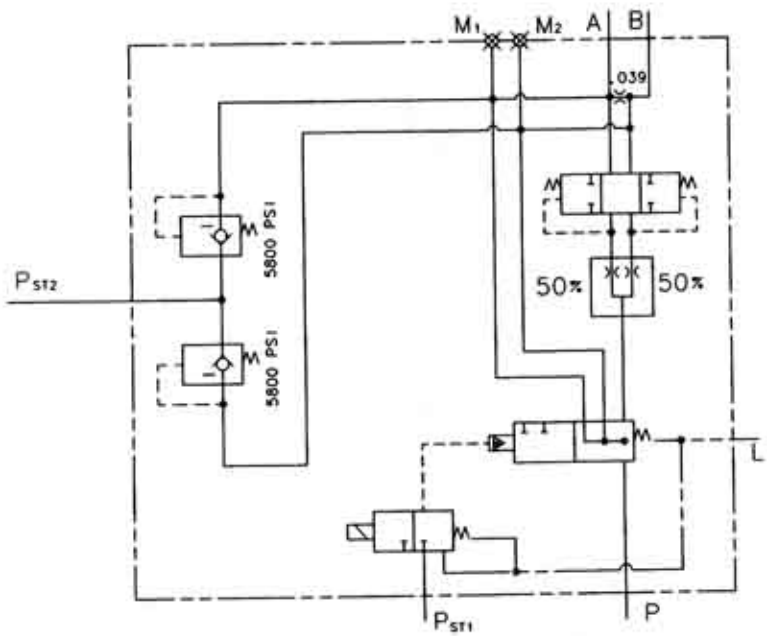


FIGURE 23
TRACTION LOCK VALVE
543C-6 STARTING SERIAL NO. 0288587
524 STARTING SERIAL NO. 0177107





IX. Front Motor Begin Point

Defined as the point at which the front motor begins to stroke toward minimum displacement.

Reason for Front Motor Begin Point check:
Without proper adjustment, machine speed and/or acceleration on a flat, smooth surface will not meet specifications. The motor may not be shifting to a maximum speed position. It may also shift to maximum too soon, losing torque and gradeablility.

Install an high pressure (10,000 PSI) gauge, hose and adapter on the "M" port of the front motor. ***See Figure 24.*** Apply the park brake and move the 2WD/4WD switch to the "2WD" position. Chock the wheels or raise the front of the machine off the ground and block. Start the engine and shift to the forward position. Run the engine at full throttle. The gauge reading should be 0 PSI plus case pressure (very slight). Turn the small adjustment screw on the motor clockwise until pressure on the gauge reads one-half full system pressure. ***See Figure 25.*** Back the adjustment screw off until the gauge drops to 0 PSI pressure. Then turn an additional 1/8 - 1/4 turn. When finished, tighten the locknut and install a (small) blue plastic cap.

Wrench sizes required: 4mm Allen and 10mm Box.

FIGURE 24
FRONT MOTOR

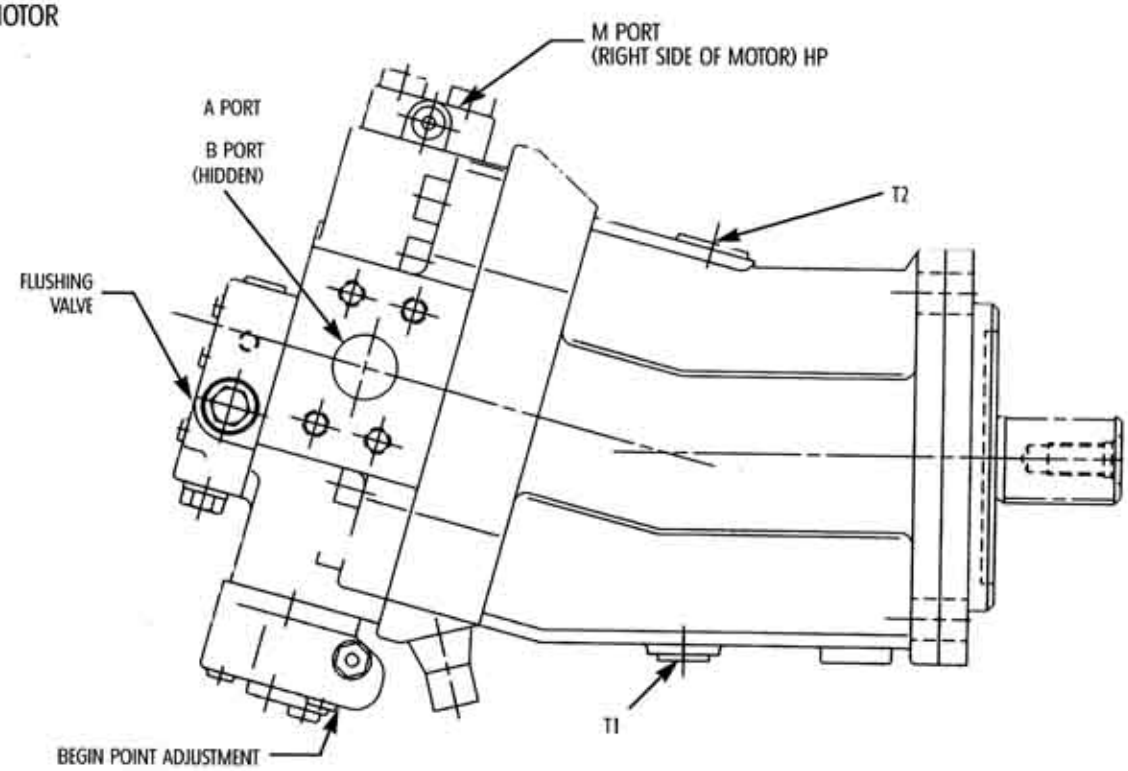
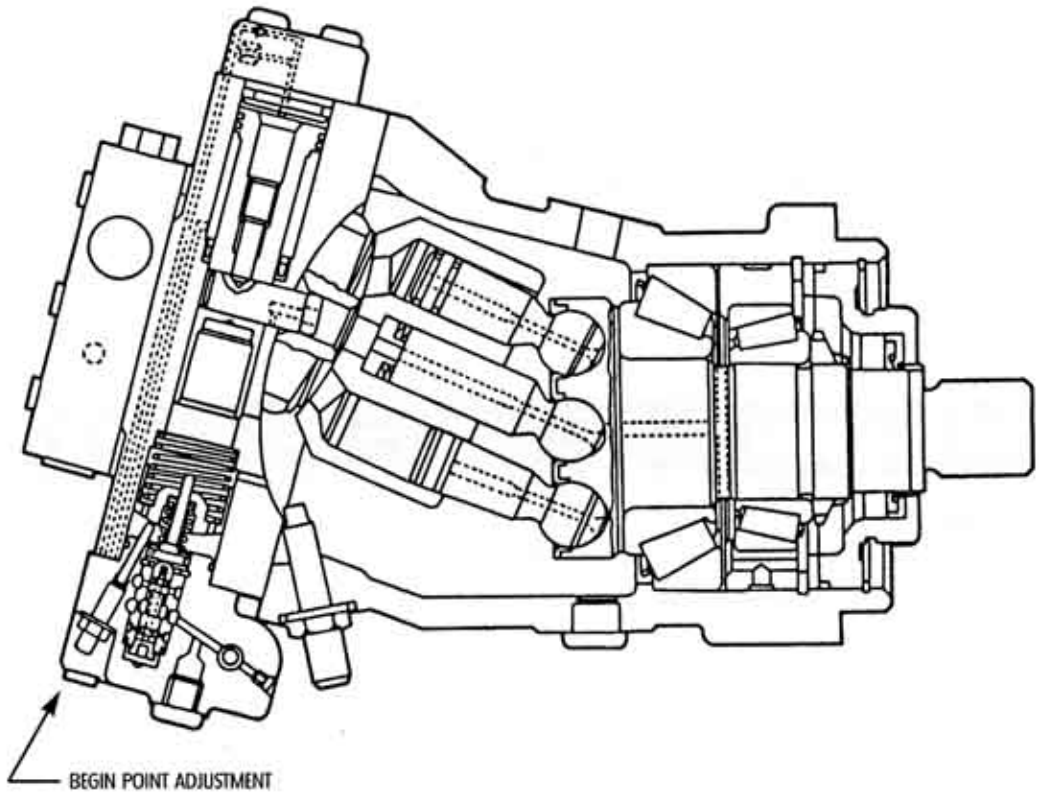


FIGURE 25
FRONT MOTOR
(CUTAWAY)



X. Front Motor Flushing Valve

Reason for Front Motor Flushing Valve check:
Loss of pressure can occur in the drive circuit if the flushing valve is not ported correctly. The result could be low drive circuit power.

When the flushing valve on the front motor needs to be checked, remove the valve and check for a plug. It is located in the left port of the valve (looking at the hidden face). If the plug is not in place, it will affect operation of the machine when using the traction lock valve. If no plug is found, install a "4WD" flushing valve (P/N 9109-4020). This is a one-time-only performance check. ***See Figure 24.***

XI. Machine Operation

Reason for Machine Operation check:
To ensure that the traction lock valve is operating correctly. Also to check for proper operation of the 2WD/4WD solenoid valve and proper begin point adjustment on the front motor.

After completion of these checks, operate the machine in a flat, smooth open area. Set the machine for "4WD" drive operation. Depress the traction lock switch. Drive the machine at full speed. Let off the traction lock switch. The machine should accelerate. After the speed stablizes (i.e. the machine is traveling at full speed, but no longer accelerating), shift the handler into "2WD". Again, the handler will surge, gradually accelerating up to a new top speed. At full speed in two-wheel drive, the handler should cover an 88-foot distance in 3.5 -3.7 seconds.

XII. Hydraulic System Pressures

FUNCTION	MODEL	PRESSURE (PSI)	IDLE
Main Control Relief	All	3,000 ± 100	High
Drive Circuit	All	5,000 or 5,500 ± 100*	High
Aux. Circuit Reliefs	All	2,000 ± 100	Low
Tilt Circuit Relief	All	2,800 ± 100	Low
Steering	All	2,500 ± 100	Low
Charge Pressure	All	320-480	Low & High
Max. Service Brake Pressure	All	1,300 $^{+100}_{-200}$	Low

* ***See section VIII, "Hydrostatic Transmission Pressure", page 19.***

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CALIFORNIA

Proposition 65 Warning

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

Wash hands after handling.

CALIFORNIA

Proposition 65 Warning

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

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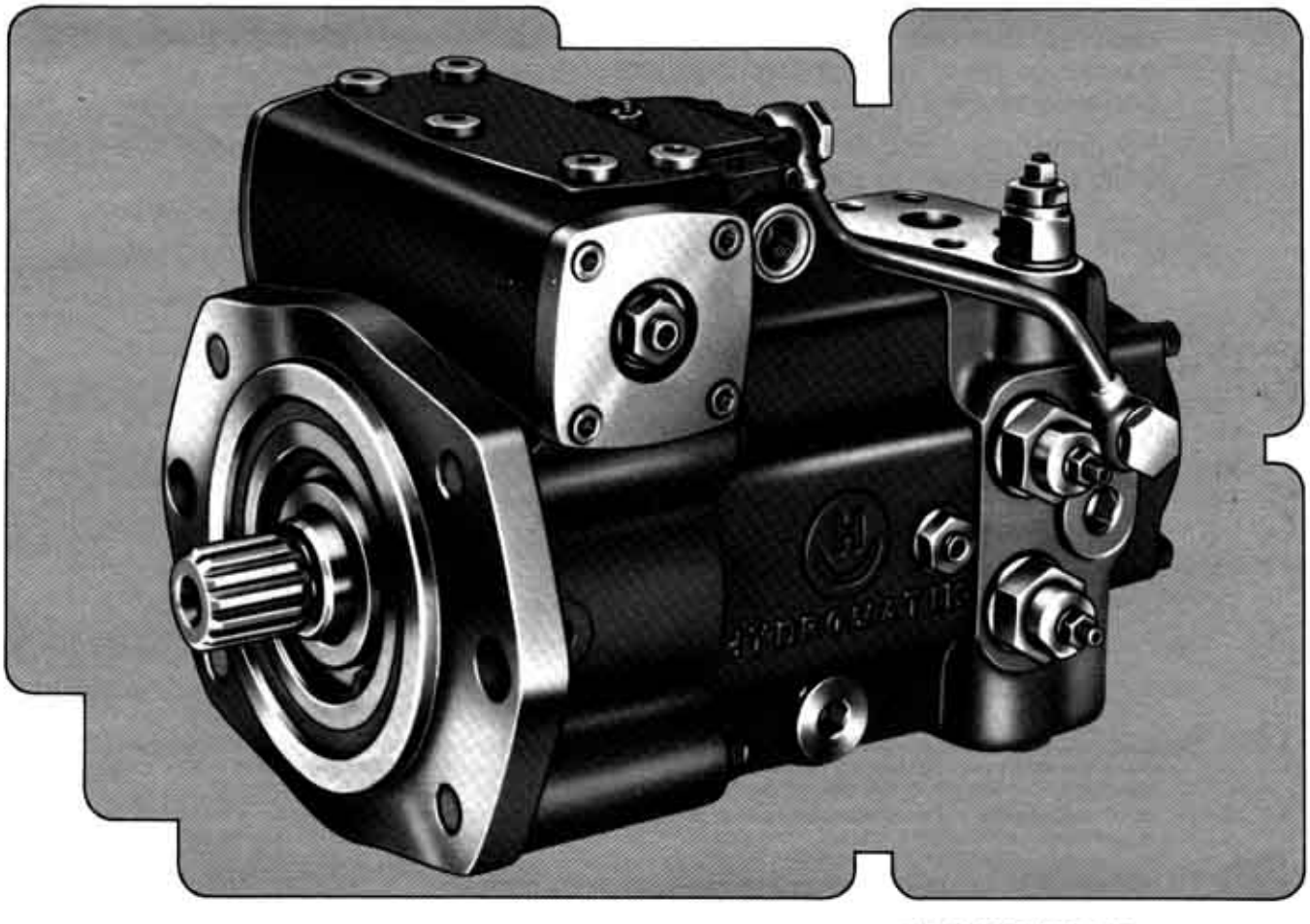
REXROTH
WORLDWIDE HYDRAULICS

Applications and Service Manual

AA4V SERIES 1
Hydrostatic Transmission Pump



RA 06710/09.90
Replaces: 06.89

INTRODUCTION

This manual is intended to provide the information required to successfully start up, adjust, troubleshoot and service the Rexroth hydrostatic transmission pump, type AA4V Series 1.

The adjustment and disassembly procedures described herein may be performed in clean conditions without affecting the warranty. Dismantling the units beyond the stages described in the manual without the express permission of Rexroth may void the warranty.

When performing any type of service or conversion to these pumps, the utmost cleanliness of work area, tools, cleaning rags, and the components is required. Dirt and contamination introduced during assembly and service is a major cause of failure in high pressure piston equipment. Therefore, the importance of cleanliness cannot be over emphasized.

For dimensions and detailed descriptions of the function of the various controls, please refer to the relevant "RA" engineering data sheet.

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Specifications, descriptions and illustrative material shown herein were as accurate as known at the time this publication was approved for printing. 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 additional 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 sheets for the basic unit and the desired option.

Information contained herein should be confirmed before placing orders.

Type Code

AA4V	56	EL	1	R	3	0	2	0	1	0	/12VDC-TP-CV

Model

Axial Piston, Variable Displacement Pump — AA4V

Size

2.44 in³/rev 40 cm³/rev	40
3.42 in³/rev 56 cm³/rev	56
5.49 in³/rev 90 cm³/rev	90
7.63 in³/rev 125 cm³/rev	125

Controls

Remote hydraulic pilot	HD
Manual rotary servo	HW
Proportional electric	EL
Non-proportional electric	EL/NP
Without control module	OV
Without control module with P.O.R.	HM

Design Series No.

Sizes, 40, 56, 90, & 125	1

Direction of Rotation

Right hand (clockwise)	R
Left hand (counter-clockwise)	L

(As viewed at shaft end)

Mounting Configuration

Sizes 40 and 56, SAE 'C' 2-bolt Flange, 14T, 12/24 Pitch, 30° Involute, Tol. CL.5, Spline Shaft. ANSI B92.1a	3
Size 90 SAE 'D' 2-bolt Flange, 14T, 12/24 Pitch, 30° Involute, Tol. CL.5, Spline Shaft. ANSI B92.1a	3
Size 125, SAE 'D' 2-bolt Flange, 13T, 8/16 Pitch, 30° Involute, Tol, CL.5, Spline Shaft. ANSI B92.1a	3

**Refer to the relevent data sheet for torque limitations and dimensional details of through drive

Model Number Example—AA4V56EL 1R302010/12VDC-TP-CV

Variable displacement hydrostatic transmission pump, type AA4V, size 56, remote proprotional electric control (12VDC), series 1, right-hand rotation, SAE 'C' mounting flange, 14 teeth—12/24 pitch, spline shaft, porting for external charge flow filter, relief valve adjustment range of 2600 to 6000 psi, without pressure override, tamper-proof caps on adjustment screws and with high pressure shuttle checks.

Through Drive For Auxiliary Pump**

Without through drive for auxiliary pump	0
Without charge pump & without through drive	E
With charge pump & SAE A, 2-bolt through drive	C
With charge pump & SAE B, 2-bolt through drive	G
With charge pump & SAE B-B, 2-bolt through drive	J
With charge pump & SAE C, 2-bolt through drive. Size 90 & 125 only.	M

Filter Port Options

With porting for suction filter only (standard)	1
With porting for external charge flow filter (If external charge flow filtration is required with S.S.H.L., contact Rexroth for details)	2
With direct mounted filter (supplied with AA4V) Contact Rexroth for details and availability	5

Speed Sensing Horsepower Limiter

For use with diesel or gasoline engines only. Not available with OV control.

Without S.S.H.L. control cartridge (standard design)	0

For S.S.H.L. see brochure RA06202

High Pressure Relief Valves

With pilot-operated relief valves adjustable in range of 2600 to 6000 psi (standard design)	1
With pilot-operated relief valves adjustable in range of 1160 to 2600 psi.	2

Pressure Override (P.O.R.) Option

Without pressure override	0
With pressure override (pressure override is standard with HM control)	1

Additional Information

(In clear text)

1) For EL control, advise required control voltage. Standard = 24 VDC Volts DC Optional = 12 VDC Volts DC
2) For tamper-proof caps on adjustment screws show TP.
3) For P.O.R. checks but without the P.O.R. show CV.
4) For neutral start switch (HW control only) show NSS.
5) For larger charge pump (size 40 only) show LCP.
6) For viton shaft seal show V.
7) For auxiliary Y-Port for remote inching show Y.

General Specifications AA4V Pump

SPECIFICATION	Unit	AA4V40	AA4V56	AA4V90	AA4V125
Displacement	in³/rev	2.44	3.42	5.49	7.63
	cm³/rev	40	56	90	125
Nominal flow at 1000 rpm	gpm	10.56	14.80	23.77	33.00
	l/min	40	56	90	125
Maximum pressure	psi	6000	6000	6000	6000
	bar	414	414	414	414
Torque constant	lb ft/100 psi	3.23	4.53	7.28	10.12
	Nm/bar	0.636	0.89	1.44	1.98
Maximum allowable shaft torque	lb ft	305	381	473	1007
	Nm	414	517	641	1367
Maximum drive speed	rpm	3700	3400	2900	2600
Minimum drive speed	rpm	500	500	500	500
Weight (approx. varies with control type)	lbs	64	77	112	154
	Kg	29	35	51	70
Moment of Inertia	lb-in²	16.72	29.01	59.73	102.4
	Kgm²	0.0049	0.0085	0.0175	0.03
Maximum case pressure	psi	29	29	29	29
	bar	2	2	2	2
Maximum permissable external loading of the drive shaft	F_A lbs	337	494	786	1078
	N	1500	2200	3500	4800
	F_B lbs	809	1124	1798	2472
	N	3600	5000	8000	11,000

Charge Pump

Displacement	in³/rev	0.51	0.70	1.16	1.61
	cm³/rev	8.4	11.4	19.0	26.4
Nominal flow at 1000 rpm	gpm	2.20	3.03	5.02	6.97
	l/min.	8.4	11.4	19.0	26.4
Nominal pressure	psi	320	320	320	320
	bar	22	22	22	22
Maximum pressure	psi	580	580	580	580
	bar	40	40	40	40
Minimum inlet pressure (at normal operating temp.)	psig	−3.2	−3.2	−3.2	−3.2
	bar(absolute)	0.8	0.8	0.8	0.8

Installation....the AA4V pump may be mounted in any position around the horizontal axis. The horizontal axis (drive shaft) may be tilted to 15° in either direction from the horizontal.

The AA4V transmission pump is usually face-mounted to a drive gear box with the shaft engaging a mating female splined gear hub, or spline adapter. The large drive shaft bearings permit the pump to be driven by vee or toothed belt drives. 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 return piping, or hose, should be sized to accept the full flow of the charge pump at the maximum anticipated drive speed.

For mobile applications, the oil reservoir capacity required (in US gallons) is generally .75 to 1 times the charge pump flow (in US gallons per minute) for a one pump, one motor transmission. The heat exchanger should be located between the pump case drain and the reservoir, and sized to accept the full flow of the charge pump at the maximum anticipated drive speed.

To accommodate slight shaft misalignment and to dampen vibration, use of a flexible coupling is recommended. The pump user should work closely with the coupling manufacturer in selecting and applying a suitable coupling. When flexible couplings, gear, Vee-belts or toothed timing belts are to be used, the coupling half, gear, or pulley, should be secured to the drive shaft using a spacer between the coupling and the shoulder on the drive shaft, and locking the coupling to the shaft by using a set screw in the threaded hole in the end of the shaft. If this is not possible, as when mounting the motor to a drive gearbox, Optimoly Paste White T multi-purpose lubricating paste or equivalent MUST be applied to the shaft to avoid fretting corrosion of the spline.

Flushing Circuit....When one variable pump and one motor is used, a flushing valve is not normally required unless continuous high speed and/or high pressure is anticipated. In this case, flushing may be required through the motor case as well as the pump case (see note below).

Whenever any type of valves, such as directional control valves or flow divider valves, are used in the closed loop circuit, a system flushing valve is recommended.

NOTE: All charge pump flow must pass through the pump case when the transmission is in neutral and the pump is rotating. If a circuit flushing valve (hot oil shuttle valve) is used, the outlet port of this valve must be connected to the lower case drain port of the pump.

Filtration....There are three options available for the filtration of the hydraulic fluid used in the AA4V pump.

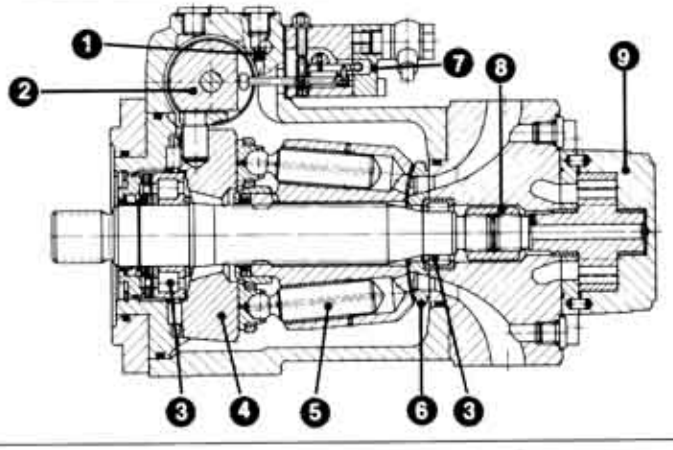
See Page 9 for detailed descriptions.

Fluid Recommendations....the AA4V pumps are supplied as standard for use with good quality, petroleum-based, hydraulic fluids.

See Page 23 for fluid characteristics and fluid viscosity ranges.

Operating Temperature.... −13°F to +195°F (−25°C to 90°C). The temperature level of a particular system is normally measured at the pump or motor case drain. This temperature is then used to establish the cooling requirements for the system.

Design Features AA4V Pump



1. Stroking time orifice (2 per pump)
2. Control piston
3. Heavy-duty roller bearings
4. Rocker cam swashplate
5. Inclined pistons
6. Spherical control plate
7. Control module
8. Spline coupling
9. Internal gear charge pump

REXROTH
WORLDWIDE HYDRAULICS

Remote Hydraulic Pilot Control, Type HD

The flow output of the pump is infinitely varied in the range of 0 to 100%, proportional to a low pressure pilot signal, in the range of 85 to 260 psi, applied at port Y_1 or Y_2.

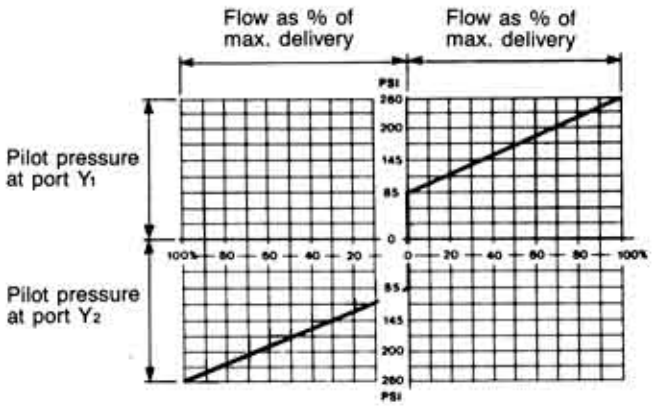
The pilot signal, which originates from an external, remote source, is pressure only. Flow is negligible as the pilot signal is only acting on the spool of the control valve.

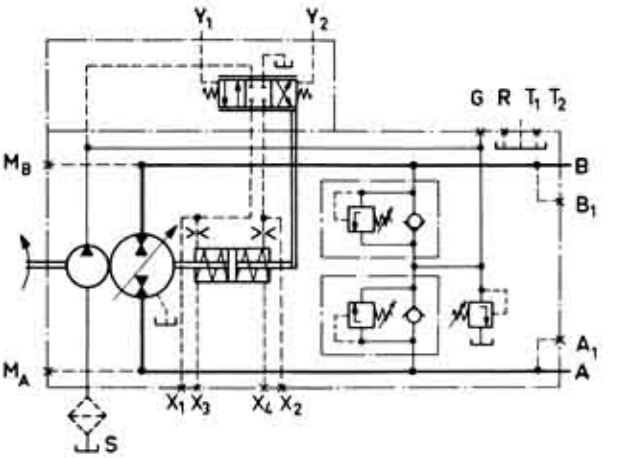
This spool then directs control oil in and out of the control cylinder to stroke the pump as required.

A feedback lever connected to the control piston maintains the pump flow for any given pilot signal.

With no command signal at Y_1 or Y_2, the control is in the neutral (zero flow) position preventing transmission output.

The Rexroth TH7 remote control, lever, and foot pedal-operated pilot valves, may be used directly with this pump control.





STANDARD STROKING TIMES		40	56	90	125
Zero to max. displ.	(sec)	1.0	1.0	1.2	1.2
Max. displ. to zero	(sec)	1.0	1.0	1.2	1.2
Orifice size	(mm)	0.8	0.8	1.0	1.0

Faster or slower stroking times are possible by changing the size of the stroking time orifices.

Manual Rotary Servo Control, Type HW

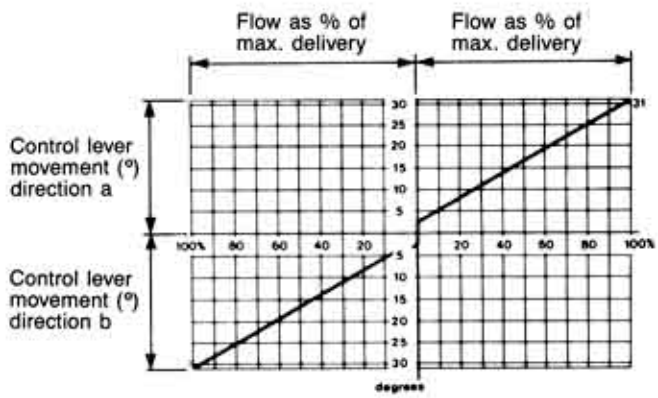
The flow output of the pump is infinitely varied in the range of 0 to 100%, proportional to the control lever between 0° and 31°.

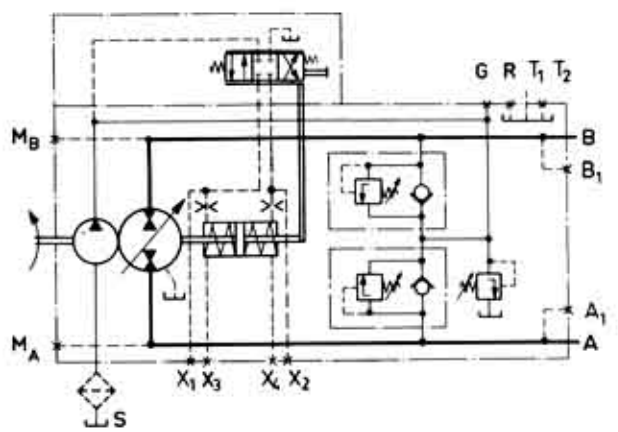
Flow from the pump is reversed by moving the lever from position 'a' to position 'b'.

A feedback lever connected to the control piston maintains the pump flow for any given position of the control lever between 0° and 31°.

The 'HW' control is suitable for use with push-pull cables and mechanical linkages; however, lever movement must be mechanically limited to prevent control damage.

The torque required to activate the control is 1.95 in lbs. (22 Ncm).





STANDARD STROKING TIMES		40	56	90	125
Zero to max. displ.	(sec)	1.0	1.0	1.2	1.2
Max. displ. to zero	(sec)	1.0	1.0	1.2	1.2
Orifice size	(mm)	0.8	0.8	1.0	1.0

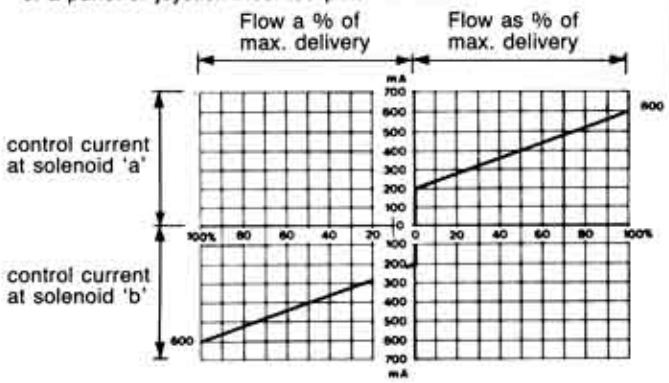
Faster or slower stroking times are possible by changing the size of the stroking time orifices.

Proportional Electric Control, Type EL

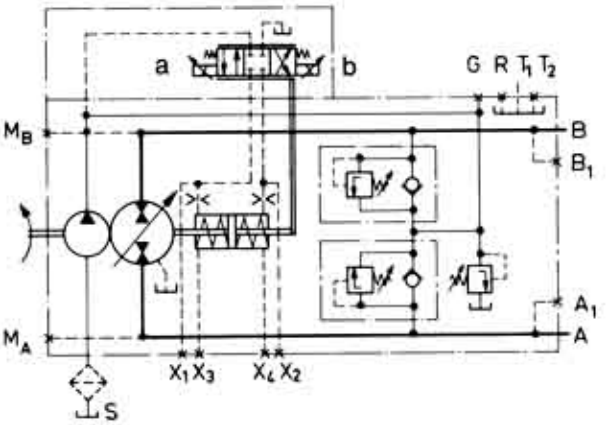
The flow output of the pump is infinitely varied in the range of 0 to 100%, proportional to an electrical current, in the range of 200 ± 10% to 600 ± 10% milliamps at 24 VDC, supplied to solenoid a or b. (A current of 400 ± 10% to 1200 ± 10% mA is required for the 12-volt solenoids)

The electrical energy is converted to a force acting on the control spool. The spool then directs control oil in and out of the control cylinder to stroke the pump as required. A feedback lever connected to the control piston maintains the pump flow for any given current within the control range. Even though this is a proportional control, the filtration requirement is the same as the total pump assembly.

Several Rexroth amplifiers may be used to provide the control current to solenoid a or b. The amplifier requires an external power supply of 12 or 24 VDC and can be remotely operated by means of a panel or joystick-mounted potentiometer.



24 VDC



STANDARD STROKING TIMES		40	56	90	125
Zero to max. displ.	(sec)	1.0	1.0	1.2	1.2
Max. displ. to zero	(sec)	1.0	1.0	1.2	1.2
Orifice size	(mm)	0.8	0.8	1.0	1.0

Faster or slower stroking times are possible by changing the size of the stroking time orifices. Also, stroking times may be varied by adjusting the ramp times on the amplifier.

Coil Resistance

Pump Size	Voltage	@ 20°C
40, 56, 90 & 125	12 VDC	6.2
	24 VDC	24.6

Coils require a 100 Hz. dither frequency with an amplitude of ± 300 mA for 12 VDC or ± 150 mA for 24 VDC.

Pump Without Control Module, Type OV

Pumps with ordering code OV have no control module. The module is replaced by a cover plate.

When a hydraulic pressure which is typically supplied by a remote hydraulic pilot control or pressure reducing valve is applied to the X_1 or X_2 port, the pump will come on stroke to produce a flow of oil out of either the A or B port. Pump displacment is determined by the resistance of the centering springs in the pump, the hydraulic pressure supplied at port X_1 or X_2, and the hydrostatic centering force of the rotary pump which is proportional to system pressure. This pump control is not a positive displacement control, since there is no feedback between the stroking piston and the control module.

Typical applications for an OV control are: a drive transmission in a vehicle where speed is continuously controlled by the operator and smooth acceleration and deceleration is a necessity, or for a swing control on a crane or excavator. Some examples of these applications are skidsteer loaders, industrial sweepers, municipal sweepers, railroad equipment, tow tractors, and lift trucks.

Control Characteristics

1. Control piston displacement from neutral to maximum swash angle of 15° in either direction.

Pump Size	40	56	90	125
Displacement in³ (cm³)	0.685 (11.23)	0.987 (16.18)	1.585 (25.97)	2.227 (36.5)

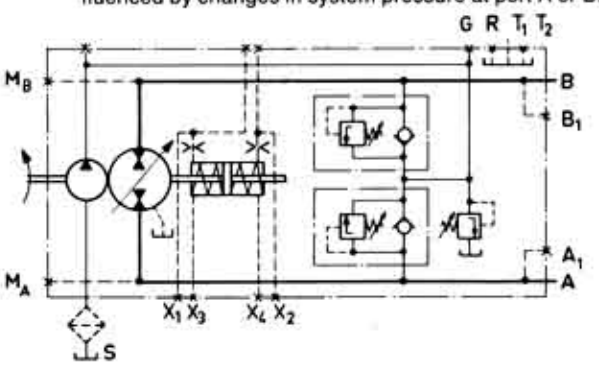
2. Standard stroking times when using ports X_1 and X_2.

Pump Size	40	56	90	125
Neutral to 15° swash angle	1.0	1.0	1.2	1.2
15° swash angle to neutral	1.0	1.0	1.2	1.2
Orifice size (mm)	0.8	0.8	1.0	1.0

Faster or slower stroking times are possible by changing the size of the stroking time orifices in ports X_1 and X_2.

3. Control pressure required at port X_3 or X_4 to begin stroking the pump against the centering springs with only charge pressure at port A and B = 87 psi (6 bar).
4. Control pressure required at port X_3 to X_4 to fully stroke the pump against the centering springs and hydrostatic centering forces at 5800 psi (400 bars) will be in the 320 psi (22 bar) to 400 psi (28 bar) range depending on pump size and drive speed.

NOTE: The pump swash angle for any given control pressure between 87 psi (6 bar) and 350 psi (24 bar) will be influenced by changes in system pressure at port A or B.



REXROTH
WORLDWIDE HYDRAULICS

Control Descriptions

Pump Without Control Module With P.O.R., Type HM

CONTROL DESCRIPTION

The HM pump control provides the same type of displacement control as an OV, but also incorporates a pressure override valve. When a hydraulic pressure, which is typically supplied by a remote hydraulic pilot control or pressure reducing valve, is applied to the Y_1 or Y_2 port, the pump will come on stroke to produce a flow of oil out of either the A or B port. Pump displacement is determined by the resistance of the centering springs in the pump, the hydraulic pressure supplied at port Y_1 or Y_2, and the hydrostatic centering force of the rotary group which is proportional to system pressure. The pressure override valve (P.O.R.) varies the swashplate angle, as required, to limit the maximum system 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 pump control is not a positive displacement control since there is no feedback between the stroking piston and the control module.

Typical applications for an HM control are: a drive transmission in a vehicle where speed is continuously controlled by the operator and smooth acceleration and deceleration is a necessity, or for a swing control on a crane or excavator. Some examples of these applications are skidsteer loaders, industrial sweepers, municipal sweepers, railroad equipment, tow tractors, and lift trucks.

Control Characteristics

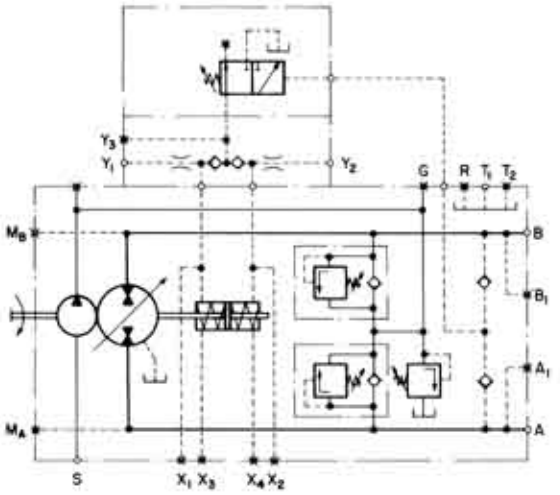
1. Standard stroking times when using ports X_1 or X_2

Pump Size	40	56	90	125
Neutral to 15° swash angle	1.0	1.0	1.2	1.2
15° swash angle to neutral	1.0	1.0	1.2	1.2
Orifice size (mm)	0.8	0.8	1.0	1.0

Faster or slower stroking times are possible by changing the size of the stroking time orifices in ports X_1 and X_2.

2. Control pressure required at port X_2 or X_4 to begin stroking the pump against the centering springs with only charge pressure at port A and B = 87 psi (6 bar).
3. Control pressure required at port X_3 or X_4 to fully stroke the pump against the centering springs and hydrostatic centering forces at 5800 psi (400 bar) will be in the 320 psi (22 bar) to 400 psi (28 bar) range depending on pump size and drive speed.

NOTE: The pump swash angle for any given control pressure between 87 psi (6 bar) and 350 psi (24 bar) will be influenced by changes in system pressure at port A or B.



Optional Features

Through Drive for Auxiliary Pump

- Standard SAE A, B, B-B, and C 2-bolt mounting flanges
- Convenient location for additional pump
- Compact dimensions
- Rexroth steering pumps can be mounted to provide complete drive and steering package
- Through drive can be retrofitted in the field

Length of through drive adapter: ("b" dimension)

Through drive	Size	40	56	90	125
SAE A (Code C)		1.99	2.24	2.17	3.31
SAE B (Code G)		3.76	4.02	3.94	2.83
SAE B-B (Code J)		3.76	4.02	3.94	3.07
SAE C (Code M)				4.96	5.24

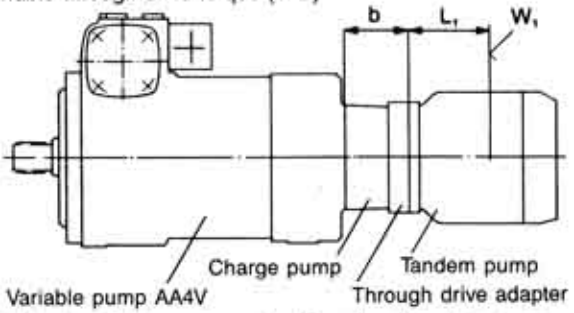
Maximum Allowable Through Drive Torque: T_{max} (lb-ft)

Through drive	Size	40	56	90	125
SAE A (Code C)		74	74	74	74
SAE B (Code G)		118	118	118	162
SAE B-B (Code J)		118	118	118	244
SAE C (Code M)				162	162

Refer to RA06204 for more information.

Charge Pump and Through Drive

Allowable moment of force (M_{max})
Allowable through drive torque (T_{max})



L_1 (inches) Distance to center of gravity of tandem pump

b (inches) Length of through drive adapter

W_1 (pounds) Weight of tandem pump

$$M = W_1 (L_1 + b) \frac{1}{12} \text{ (lb-ft.)}$$

Allowable Moment of Force: M_{max} (lb-ft)

Through drive	Size	40	56	90	125
SAE A (Code C)		38	38	38	76
SAE B (Code G)		37	37	37	76
SAE B-B (Code J)		37	37	37	76
SAE C (Code M)				162	120

FILTRATION

The fluid should be filtered prior to system start-up and continuously during operation to achieve and maintain a cleanliness level of ISO 18/15. (This corresponds approximately to NAS 1638 Class 9, or SAE [1963] Class 6.) This recommendation should be considered a minimum, as better cleanliness levels will significantly increase component life.

Each application should be analyzed to determine the proper method of filtration needed to maintain the required cleanliness levels, as contaminant generation and ingression can vary greatly, depending on the configuration and complexity of the system.

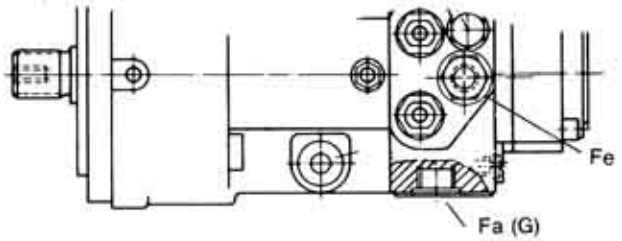
For particular system requirements, or for application outside these parameters, a Rexroth Applications Engineer should be consulted.

Ordering Code Option Number 1
With porting for suction filter only (standard design).

Fluid cleanliness level ..... ISO code 18/15
Pressure drop at filter element
at V = 141 SSU (30 cSt) and pump max speed ..... 1.5 psi (0.1 bar)
at V = 4600 SSU (1000 cSt) and 1000 rpm ..... 4.4 psi (0.3 bar)
Pressure at inlet port of charge pump
at V = 141 SSU (30 cSt) ..... –3 psig (0.8 bar)
on cold start ..... –7 psig (0.5 bar)

A suction filter without bypass and with clogging indicator is recommended.

Ordering Code Option Number 2*
With porting for external charge flow filter, this option is achieved by removing the plug in port Fe and replacing it with an adapter sleeve. This adapter sleeve allows all of the fluid from the charge pump to be passed through a customer-supplied, external, low pressure filter prior to being delivered into the closed loop circuit via port Fa (G).

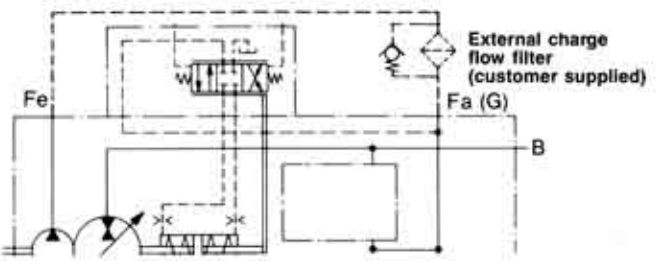


Filter Connection Port Sizes

Pump Size	40 & 56	90	125
Port Fe	7/8"-14 UNF	7/8"-14 UNF	1-1/16"-12 UNF
Port Fa (G)	7/8"-14 UNF	1-1/16"-12 UNF	1-1/16"-12 UNF

IMPORTANT

Never plug port Fe when the adapter sleeve is fitted as there will be no internal pressure protection for the charge pump.



CIRCUIT SCHEMATIC, OPTION NUMBER 2

Recommendations For External Charge Flow Filter
Fluid cleanliness level ..... ISO code 18/15
Pressure drop at filter element
at V = 141 SSU (30 cSt) ..... 14.5 psi (1.0 bar)
on cold start ..... 45 psi (3 bar)
(Valid for speed range Nmin. to Nmax.)

A charge flow filter with bypass and with clogging indicator is recommended. FILTER ELEMENT MUST BE CAPABLE OF WITHSTANDING FULL CHARGE PRESSURE WITHOUT COLLAPSING.

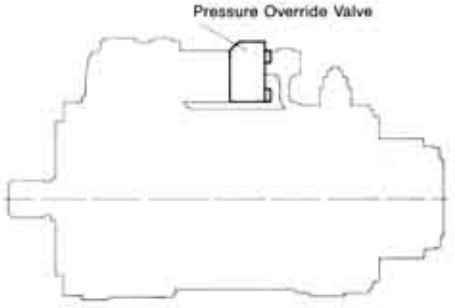
***NOTE:** Ordering code option 2 is not available on pumps fitted with the Speed Sensing Horsepower Limiter. If option 2 is required along with horsepower limiting, an external limiting valve is needed. Contact Rexroth for details.

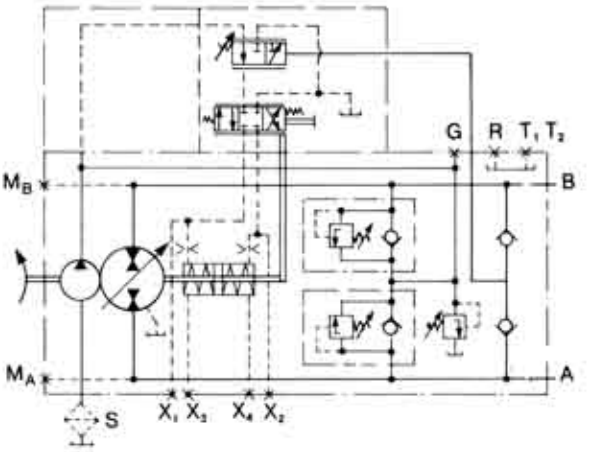
Ordering Code Option Number 5
Filter in charge pressure loop of AA4V. Filter direct mounted to AA4V pump.

Contact Rexroth for details and availability of this option.

PRESSURE OVERRIDE

With porting for a pressure override valve (P.O.R.). The pressure override valve varies the swashplate angle as required to limit the maximum pressure of 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 500 psi (34 bar) less than the setting of the main relief valves and have an adjustment range of 1160-6100 psi (80-420 bar).



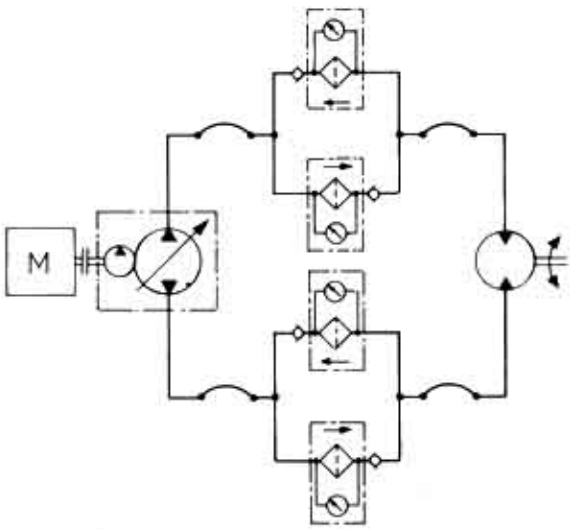


Variable pump AA4V with hydraulic manual servo control, HW with pressure override valve (P.O.R.)

Pre-Start Procedure

This should be performed prior to start-up of a new installation, or for a system in which new or overhauled components have been fitted.

1. Ensure that hydraulic reservoir piping and pressure hoses are cleaned and flushed.
2. Fill the reservoir through fill pump and filter.
3. If there is any doubt regarding the absolute cleanliness of the system, fit high pressure bi-direction filters in high pressure lines as shown in following diagram. These filters are in addition to the installed suction and return filters.



4. Check that all filters have elements of the correct rating and the filter housings are filled with the hydraulic fluid to be used in the system.
5. Where possible, fill the high pressure lines.
6. Open suction line valves.
7. Fill pump and motor cases to the highest case drain or vent port (marked T or R).
8. Check that all pressure connections are secure.
9. Ensure all mechanical gearboxes have the correct oil type and are filled to the prescribed level.
10. Fully back off all high pressure relief valves and then reset one half turn against the spring.
11. Fully back off the charge and pilot pressure relief valves, and reset two full turns against the spring.
12. Fit 10,000 psi pressure gauges to each high pressure line.
13. Fit 500 psi pressure gauges to charge and pilot circuits (ports M_1, X_3, X_4, Y_1, Y_2).
14. Fit 100 psi pressure gauge to pump case drain port R.
15. Fit vacuum gauge to the charge pump suction line as close as possible to suction port.
16. Release brakes and jack up the driving wheels. Winches should be started without the cable fitted.
17. Ensure that the fluid temperature in the reservoir is 45°F. or higher.

Start-Up Procedure

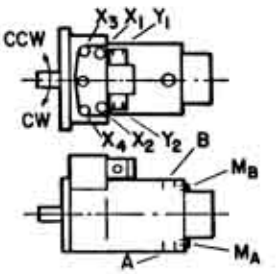
The following procedure has been developed based on experience with most types of applications, however, certain applications may require a departure from, or variations to, this procedure.

For the start-up of new or overhauled installations.

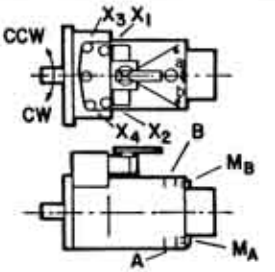
1. If the prime mover is:
   Internal combustion engine: (diesel, gasoline or LP)—Remove the coil wire, close the injector rack or leave the gas turned off and turn the engine over until the charge pressure reaches 50 psi or more.
   Electric Motor: Jog the starting circuit until the charge pressure 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 Y_1 and Y_2 and then actuate the remote control unit in both directions until oil seeps from the connections.
8. Retighten all connections.
9. Operate 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 on Pages 17 and 18.
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. See Pages 19 and 20.
17. Check security of high pressure connections.
18. Check oil level and temperature.
19. Remove and inspect high pressure filter elements. 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 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 there is no foam on the surface of the oil in the reservoir (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 troubleshooting procedures on Pages 14, 15, and 16.

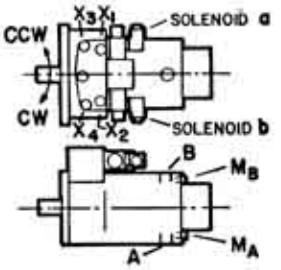
HD Control				
DIRECTION OF ROTATION	CLOCKWISE		COUNTERCLOCKWISE	
PILOT PRESSURE AT	Y_1	Y_2	Y_1	Y_2
POSITIONING PRESSURE AT	X_1, X_3	X_2, X_4	X_1, X_3	X_2, X_4
OUTPUT FLOW FROM PORT	B	A	A	B
WORKING PRESSURE AT	M_B	M_A	M_A	M_B



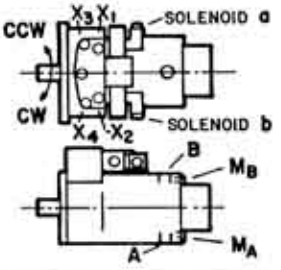
HW Control				
DIRECTION OF ROTATION	CLOCKWISE		COUNTERCLOCKWISE	
LEVER MOVEMENT DIRECTION	a	b	a	b
POSITIONING PRESSURE AT	X_2, X_4	X_1, X_3	X_2, X_4	X_1, X_3
OUTPUT FLOW FROM PORT	A	B	B	A
WORKING PRESSURE AT	M_A	M_B	M_B	M_A



EL Control				
DIRECTION OF ROTATION	CLOCKWISE		COUNTERCLOCKWISE	
SOLENOID OPERATION	a	b	a	b
POSITIONING PRESSURE AT	X_1, X_3	X_2, X_4	X_1, X_3	X_2, X_4
OUTPUT FLOW FROM PORT	B	A	A	B
WORKING PRESSURE AT	M_B	M_A	M_A	M_B



DA or EL/NP Control				
DIRECTION OF ROTATION	CLOCKWISE		COUNTERCLOCKWISE	
SOLENOID OPERATION	a	b	a	b
POSITIONING PRESSURE AT	X_2, X_4	X_1, X_3	X_2, X_4	X_1, X_3
OUTPUT FLOW FROM PORT	A	B	B	A
WORKING PRESSURE AT	M_A	M_B	M_B	M_A



HM Control				
DIRECTION OF ROTATION	CLOCKWISE		COUNTERCLOCKWISE	
PILOT PRESSURE AT	Y_1	Y_2	Y_1	Y_2
POSITIONING PRESSURE AT	X_1, X_3	X_2, X_4	X_1, X_3	X_2, X_4
OUTPUT FLOW FROM PORT	B	A	A	B
WORKING PRESSURE AT	M_B	M_A	M_A	M_B

NOTE: Pressure gauge connections should be located as close as possible to the pump port being gauged.

Port Designations Pressure Limits

PORT	PRESSURE LIMITS
R Case Vent	30 psig
X_1 (X_3) Control Pressure	580 psig
X_2 (X_4) Control Pressure	580 psig
G Charge Pump Access Port	580 psig
S Charge Pump Suction Port	14 in. Hg (at start-up)
M_A High Pressure at A	6000 psig
M_B High Pressure at B	6000 psig

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Diagnostic Ports

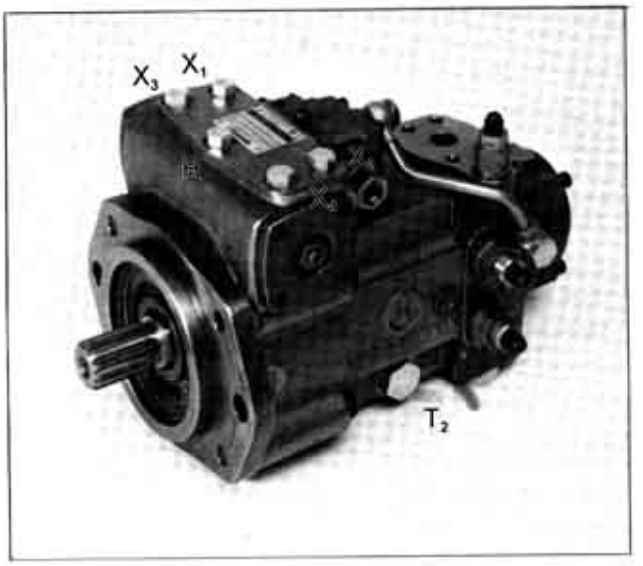
R —Case vent port
All sizes 7/16"-20 UNF

X_1, X_2 —Control pressure gauge port (before control orifices). All sizes 7/16"-20 UNF

X_3, X_4 —Control pressure gauge ports (after control orifices). All sizes 7/16"-20 UNF

T_1, T_2 —Case drain ports
Sizes 40, 56 7/8"-14 UNF
Size 90 1 1/16"-12 UNF
Size 125 1 5/16"-12 UNF

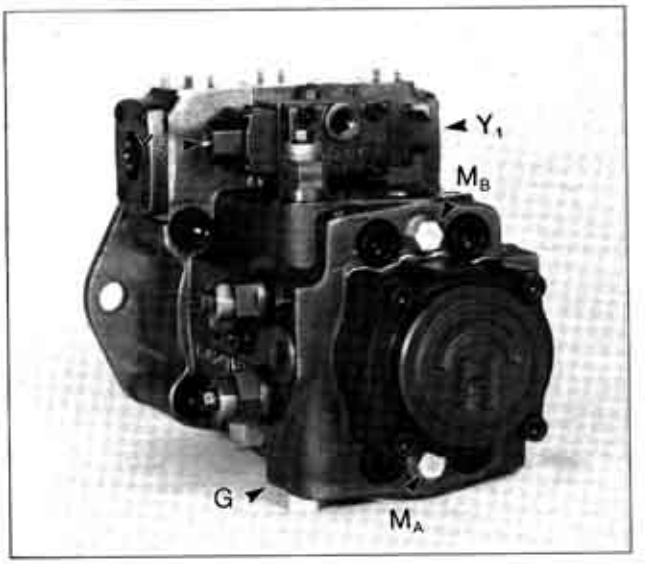
A, B —Service ports
Sizes 40, 56 SAE 3/4" - 6000 psi
Size 90 SAE 1" - 6000 psi
Size 125 SAE 1 1/4" - 6000 psi



M_A, M_B—High pressure gauge ports
All sizes 7/16"-20 UNF

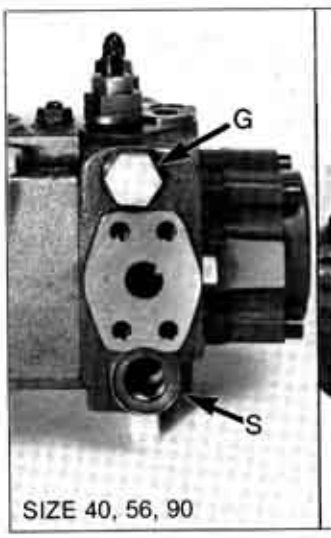
Y_1, Y_2 —Remote hydraulic pilot control ports (HD and HM control only.) All sizes 9/16"-18 UNF

A_1, B_1 —Auxiliary service ports
All sizes 3/4"-16 UNF



G —Charge pump access port
Sizes 40, 56 7/8"-14 UNF
Sizes 90, 125 1 1/16"-12 UNF

S —Charge pump suction port
Sizes 40, 56 7/8"-14 UNF
Sizes 90 1 3/16"-12 UNF
Sizes 125 1 5/8"-12 UNF



SIZE 40, 56, 90

SIZE 125

To aid in troubleshooting, refer 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 and 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 specification while the pump is running at normal operating speed?
No Proceed to step 1.9.
Yes Proceed to step 1.19.

1.9 Can the charge pressure be adjusted at the charge pressure relief valve? (Refer to relief valve adjustment.)
No Proceed to step 1.10.
Yes Adjust charge pressure to specification and proceed to step 1.19.

Note: If flushing valve is used in circuit, it should be set at 50 psi less than charge pump relief. Refer to data sheet on flushing valve for information and setting procedure.

1.10 Is suction line shut-off valve open?
No Open valve.
Yes Proceed to step 1.11.

1.11 Is the charge pump suction pressure within recommended limits? (−3.2 psig or 6.5 in. Hg vacuum.)
No Proceed to step 1.12.
Yes Proceed to step 1.16.

1.12 Is 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. Note: replace charge pump as complete unit.

1.18 Is the charge pump installed for correct direction of rotation?
No Refit charge pump by rotating pump housing 180°. 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
EL 12 or 24 volts dc electrical current
No Connect appropriate medium and check that control signal is actually being applied to the 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?
No Proceed to step 1.22.
Yes Operate the transmission.

1.22 Stroke the pump in both directions. Do the pressures at X_3 and X_4 alternate between 30 and 250 psi during cycle?
No Remove control module and replace with new unit. Repeat step 1.21.
Yes Proceed to step 1.23.

1.23 Is the pressure at port R less than 21 psi?
No Repipe pump case drain line so that case pressure at port R is less than 21 psi. Return to step 1.21.
Yes Proceed to step 1.24.

1.24 Stroke pump in both directions. Does any pressure greater than 350 psi alternate between ports 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.
Yes Proceed to step 1.25.

1.25 Is it possible to adjust high pressure relief valves using the 0-10,000 psi gauges at M_A and M_B to monitor pressure? (Refer to relief valve adjustment.)
No Replace high pressure relief valve cartridges and return to step 1.21.
Yes Adjust high pressure relief valves to required or design pressure. Proceed to step 1.26.

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 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 EL control—fluctuating control current.	No Rectify the control fault. HD—bleed pilot lines HW—lubricate or free the cable or linkage EL—check control current Yes Proceed to step 2.2
2.2	Are the brakes fully released?	No Check brake release circuit or mechanism. Yes Proceed to step 2.3.
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 wtih screwdriver. Try various sizes until desired pump stroking rate is attained. Yes Proceed to step 2.4.
2.4	With HD control, is the control curve of remote pilot valve correctly matched to the pump?	No Change spring to suit. AA4V pump—curve 05 or 06 of 4TH7 pilot operator. Yes Proceed to step 2.5.
2.5	Does the charge pressure fluctuate more than 30 psi when stroking the pump?	No Proceed to 2.9. Yes Proceed to step 2.6.
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 2.7.
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 Operate transmission and return to step 2.1.
2.8	Are there system pressure fluctuations which are synchronous with the charge pressure fluctuations?	No Proceed to step 2.9. Yes Determine the cause of system pressure fluctuations.
2.9	If variable displacement motor is used, is motor stroking time correct for the application?	No Add motor stroking time adjustment valve to the variable motor or modify the control circuit to provide desired stroking time.

3. TRANSMISSION DRIVES IN ONE DIRECTION ONLY

3.1	With control lines switched, does pump drive in the opposite direction only?	No Proceed to step 3.2. Yes Control signal from one side does not work properly. Repair as necessary.
3.2	With control lines still switched, does pump drive in initial direction only?	No Proceed to step 3.3. Yes Problem is in one side of control module or the pump. Proceed to step 3.3.
3.3	Is there control pressure or current from both control lines?	No Correct control signal problem. Yes Proceed to step 3.4.
3.4	Check flushing valve (if installed). Is shuttle spool stuck in one position?	No (Not installed.) Proceed to step 3.5. Yes Remove flushing valve and clean or replace.
3.5	Switch relief valves. Does transmission drive in the other direction only?	No Proceed to step 3.6. Yes Repair or replace relief valve on non-driving side.
3.6	Replace control module and reconnect control lines. Does pump operate properly?	No Replace or repair pump. Yes Operate transmission

4. TRANSMISSION DRIVES IN THE WRONG DIRECTION

4.1	Pump with HD control.	Switch control lines on ports Y_1 & Y_2.	
4.2	Pump with EL control.	Switch electrical connectors on solenoids A & B.	
4.3	Pump with HW control.	Rework linkage or cable to give correct drive direction.	

5. PUMP DOES NOT FIND OR HOLD NEUTRAL (Also refer to Pages 16 and 17.)

5.1	Does pump return to neutral with control lines removed?	No Proceed to step 5.2. Yes Check control for electrical signal problem (EL control), or back pressure in the pilot lines (HD control).
5.2	Check mechanical centering of pump and control per Pages 16 and 17. Does pump return to neutral with control lines removed?	No Repair or replace pump. Yes Replace control module if needed. Operate transmission.

6. TRANSMISSION DRIVES AT A HIGH NOISE LEVEL

6.1 Are the drive gearboxes filled with correct grade of oil?
- No Fill gearbox with correct grade of oil to the prescribed level.
- Yes Proceed to step 6.2.

6.2 Is the drive coupling correctly installed and aligned?
- No Install coupling per manufacturer's instructions and tolerances.
- Yes Proceed to step 6.3.

6.3 Is rigid piping connected to the pump?
- No Proceed to step 6.4.
- Yes Install short length of hose between pressure ports of the pump and the system piping.

6.4 Is the suction pressure at the charge pump inlet within recommended limits?
- No Return to step 1.7.
- Yes Proceed to step 6.5.

6.5 Is there air in the hydraulic oil? This may be indicated by foaming or milky colored oil.
- No Proceed to step 6.6.
- Yes Deaerate the oil and inspect system for cause of air induction.

6.6 Is the hydraulic motor operating at excessive speed?
- Yes Check motor sizing in relation to available oil flow from the pump.

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 temp. is close to 195°F, the oil cooler may need to be cleaned.
- Yes Proceed to step 7.2.

7.2 Is the hydraulic motor stalling intermittently?
- No Proceed to 7.3.
- 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.
- Yes Proceed to step 7.4.

7.4 Check differential pressure across oil cooler as compared to the manufacturer's specs at charge pump flow.
- No Proceed to step 7.5.
- Yes Check piping from oil cooler to the reservoir.

Is △ P higher than it should be?
- Check for plugged or damaged cooler.

NOTE: Max. case pressure is 30 psi.

7.5 Disconnect pump case drain from oil cooler and check flow from charge pump. Is flow normal?
- No Refer to charge pump remove and inspection procedure.
- Yes Check oil cooler location.

8. PUMP DOES NOT DEVELOP MAXIMUM HORSEPOWER (FLOW & PRESSURE)

8.1 Does the charge pressure meet specifications as measured at port G?
- No Return to 1.9.
- Yes Proceed to 8.2.

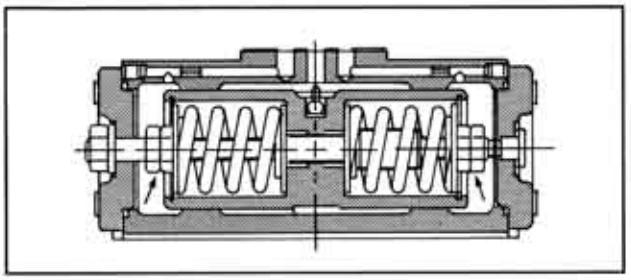
8.2 Is the case pressure less than 30 psi?
- No Check sizing of return lines from T port of pump and the cooler sizing related to flow.
- Yes Proceed to 8.3.

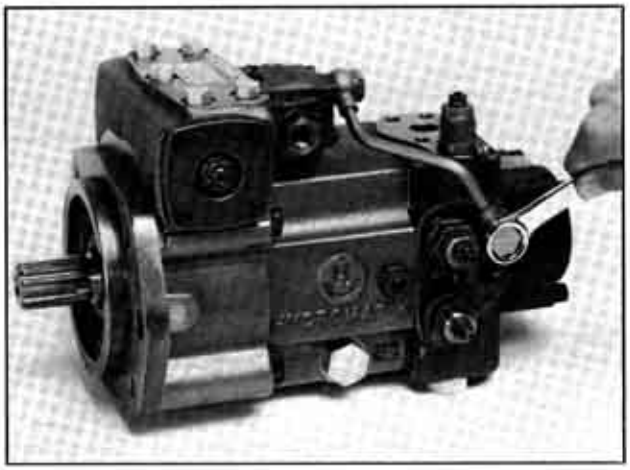
8.3 Are the high pressure relief valves adjusted to the required pressure so that they do not by-pass?
- No Adjust or replace relief valve cartridge.
- Yes Replace the pump.

NOTE: If pressure override valve is fitted to pump, check that pressure setting is sufficient for the application.

Mechanical Centering of Pump

The control piston has strong centering springs to ensure that once the pump is adjusted for neutral position it will always return to neutral. If an adjustment is necessary follow the steps listed below.



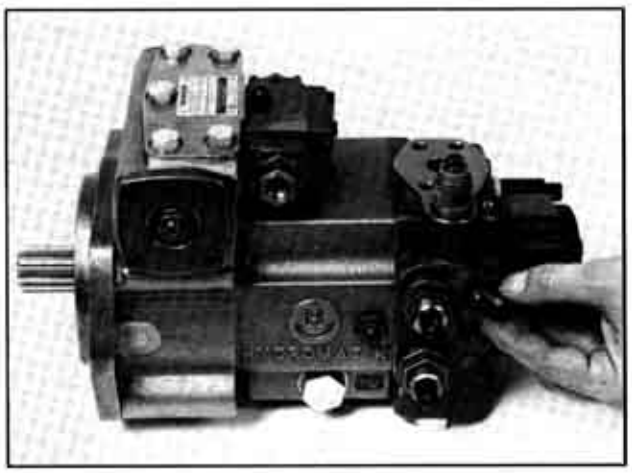


To ensure there will be no control pressure at the control module during the centering operation, remove the piping assembly. All sizes require 19mm box wrench.

Plug the control pressure outlet port before running the pump. Block pump ports A & B, or install a hydraulic motor.

NOTE:
The control pressure outlet port has an M14×1.5 thread. Use a M14×1.5 plug (Part Nbr 76116-001), or combination of M14×1.5 to 9/16—18UNF adapter (Part Nbr 5974-101-002) and 9/16—18UNF plug, to plug this port during the mechanical centering operation.

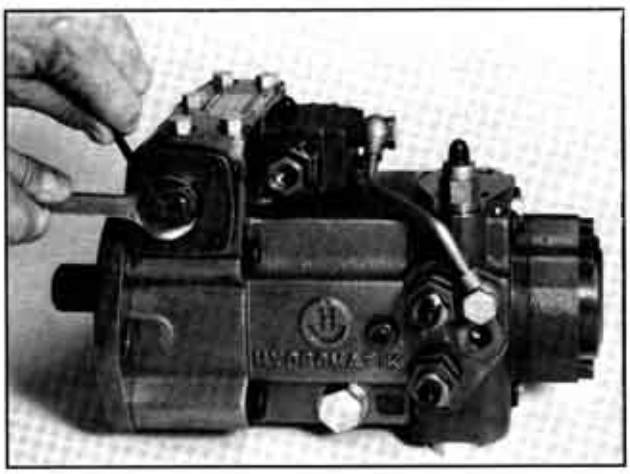
Alternate method to neutralize control: Instead of removing control pipe, connect ports X_3 & X_4 by means or a low pressure hose.



With pressure gauges installed at M_A and M_B as per Page 12, and with the pump running, loosen the jam nut and turn the adjusting screw until equal pressure (charge pressure) is registered on the two gauges. Alternatively, if a hydraulic motor is connected to the pump, turn the adjusting screw until the motor shaft does not rotate.

Tighten the jam nut, stop the pump drive, remove the plug in the control pressure port, open ports A & B, and reinstall the control pressure pipe.

Alternate method: Remove the low pressure hose connecting ports X_3 & X_4 and plug ports X_3 & X_4.



Pump Size	Allen Wrench	Wrench
40	5mm	17mm
56	5mm	17mm
90	6mm	19mm
125	6mm	22mm

Hydraulic Centering of Control Modules HD, HW, EL

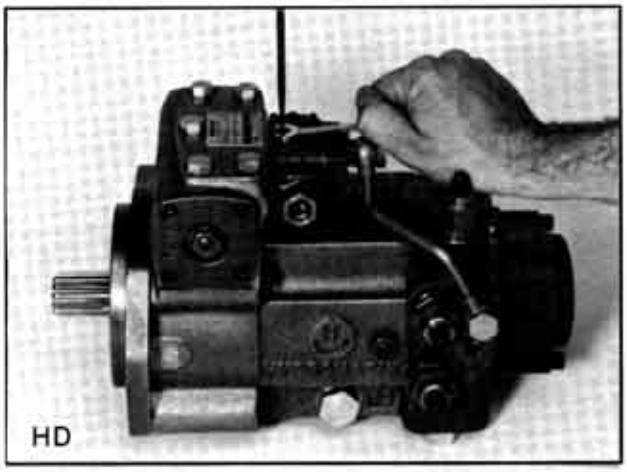
When control modules are exchanged or replaced, it is generally necessary to center the new module. This is done by running the pump with gauges installed at ports X_3 and X_4, and M_A and M_B as shown on Page 12. Then release the jam nut and turn the adjustment screw on top of the control module valve body.

NOTE:
The adjustment screw is eccentric, therefore, turning more than 90° in either direction will have no further centering effect and may cause the control to bind. FOR ALL PUMP SIZES, A SMALL SCREWDRIVER AND 10mm WRENCH ARE REQUIRED TO PERFORM THIS ADJUSTMENT.

Centering the HD Control Module

With zero pilot pressure at both pilot ports Y_1 and Y_2, neutral position of the HD control is correctly adjusted when any or all of the following conditions exist:

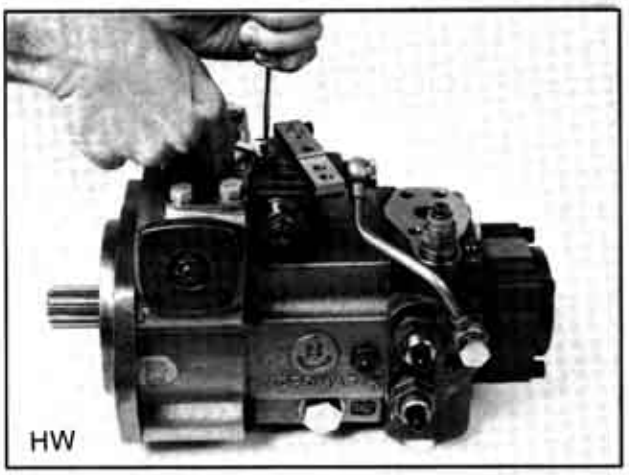
1. The hydraulic motor does not turn when the brake is released.
2. Charge pressure is registerd equally at ports M_A and M_B when flow output of the pump is deadheaded against a locked motor or a valve.
3. Approximately equal control pressures are obtained at control pressure ports X_3 and X_4.



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. The hydraulic motor does not turn when the brake is released.
2. 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.
3. Approximately equal control pressures are obtained at control pressure ports X_3 and X_4.

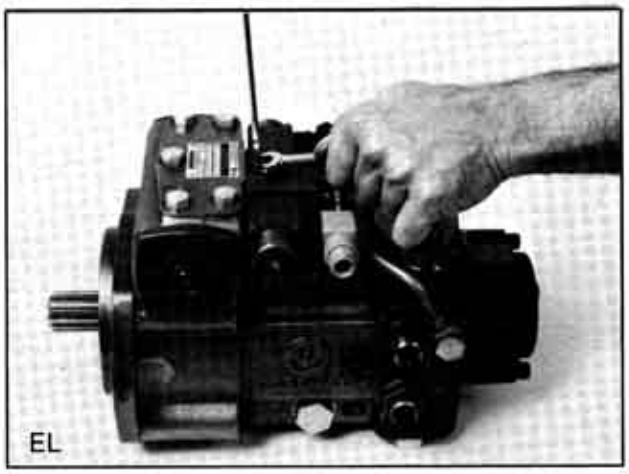


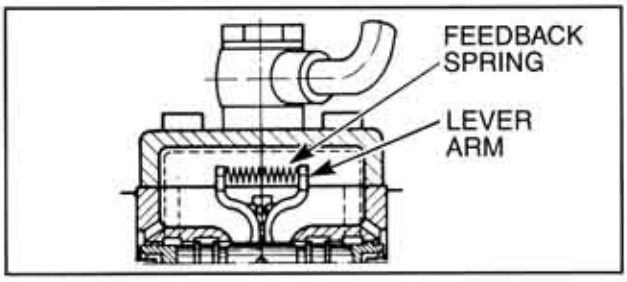
Centering the EL Control Module

With no electrical signal to solenoids A and B (remove both plug-in connectors), the EL control module is correctly adjusted when any or all of the following conditions exist:

1. The hydraulic motor does not turn when the brake is released.
2. 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.
3. Approximately equal control pressures are obtained at control pressure ports X_3 and X_4.

If difficulties are encountered in obtaining neutral position of the HD or EL control modules, check that the ends of the control spring are correctly located in the grooves near the end of the feedback lever arms.





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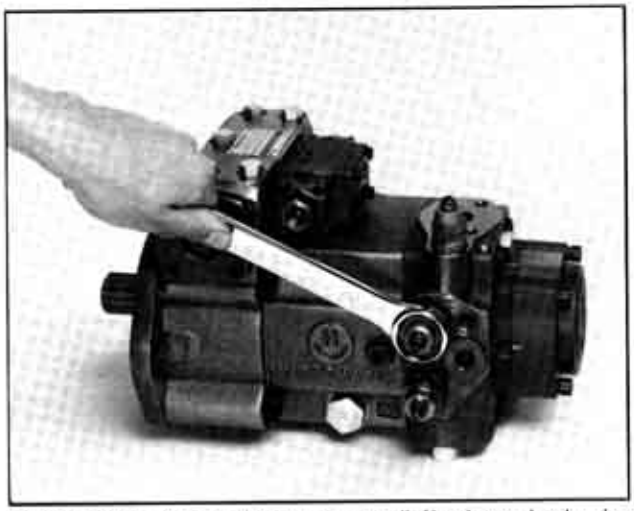
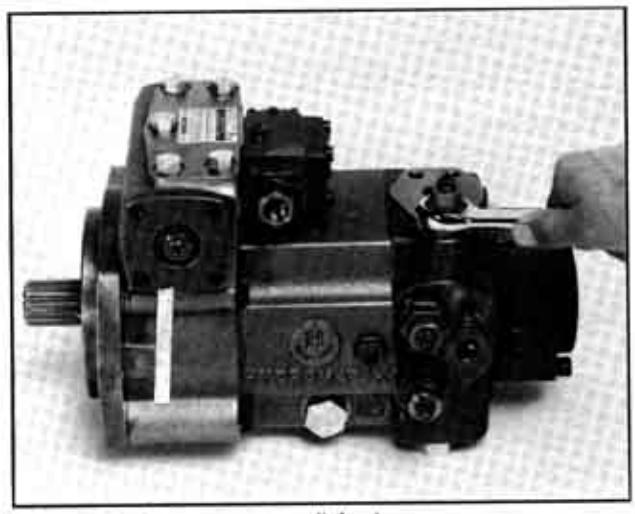
Removal and Adjustment of Relief Valves

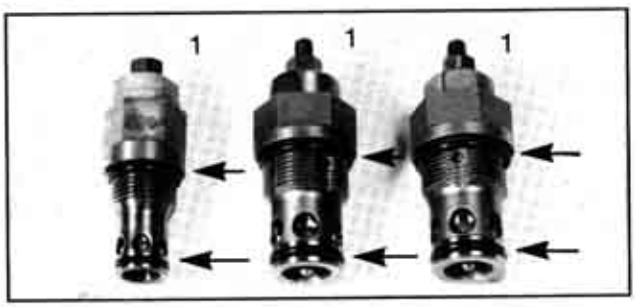
Pump Size	System Relief		Charge Relief Wrench Size
	Wrench Size	Assembly Torque	
40	27mm	100 Ft.-lb.	22mm
56	27mm	100 Ft.-lb.	22mm
90	36mm	125 Ft.-lb.	27mm
125	30mm	180 Ft.-lb.	36mm



Removal of combination high pressure relief/makeup check valve cartridge.



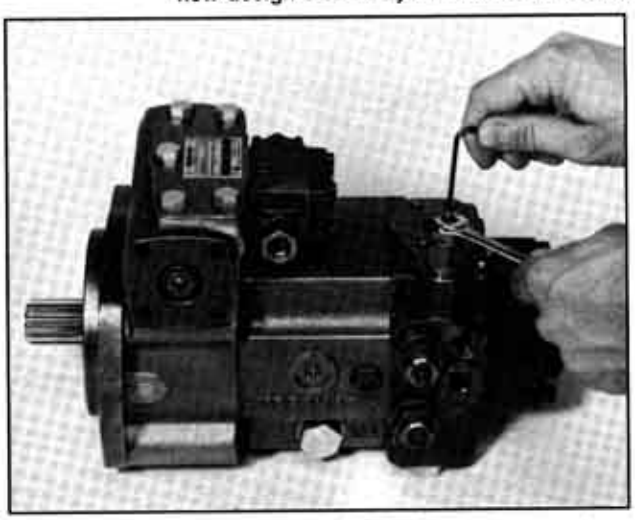
Removal of charge pressure relief valve.



Inspect valves and seals for wear or damage. Replace seal-lock nut (1) and O-rings if there are signs of wear or damage. Seal-lock nuts are included in the seal kit.

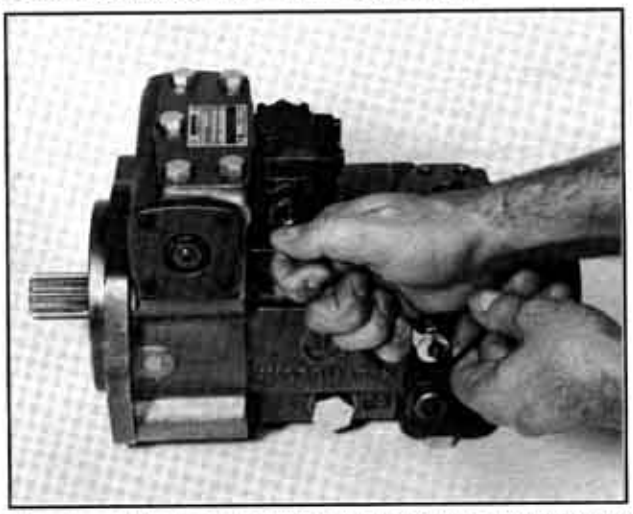
NOTE:
Certain relief valves have limited adjustment ranges. Refer to the ordering code on Page 4 for the relief valve pressure range of your pump.

All relief valve adjustments to be done with 3mm allen wrench and 10mm box wrench, except for new design size 90 system reliefs which use a 5mm allen wrench and a 17mm box wrench.



Adjustment of charge pressure relief valve. Pressure gauge at port G as shown on Page 12. Run pump at normal operating speed in neutral and adjust pressure to specification.

NOTE: If pump is equipped with P.O.R. (Pressure Override) valve, see Page 19 for proper adjustment procedure.



Adjustment of high pressure relief valves. Pressure gauges at ports M_A and M_B as shown on Page 12. Run the pump at normal operating speed. Stroke the pump to approx. 20% of maximum displacement and adjust pressure as required.

NOTE: Flow must not spill over high pressure relief valves for more than 10 seconds.

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 500 psi less than the setting of the main relief valves.

Adjustment Procedure

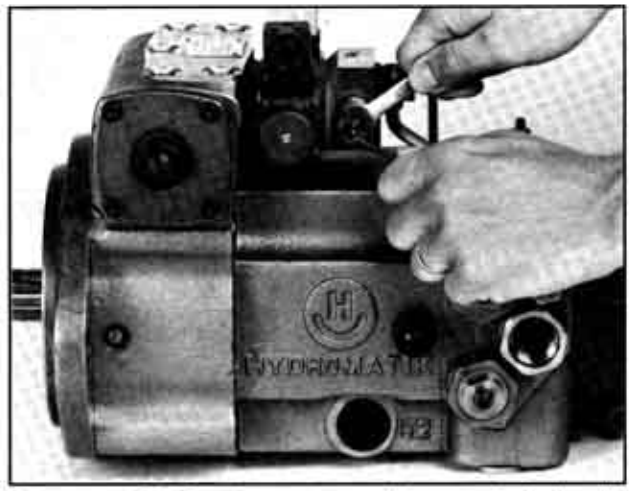
Following is a suggested procedure for adjusting the P.O.R. It is assumed that high pressure gauges are connected to ports M_A and M_B as shown on Page 12. Some applications may require a slight departure from the procedure.

1. Block the output flow from the high pressure ports A & B, or lock the hydraulic motor by applying the brake.
2. Using a 3mm allen wrench, 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 valve for that flow direction to a pressure which is 500 psi higher than the required P.O.R. pressure setting.
5. Repeat step 4 for the opposite direction of flow.

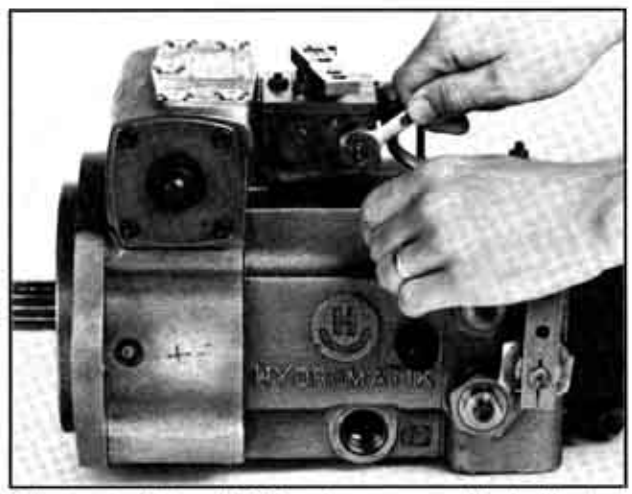
NOTE:
Perform steps 4 & 5 as quickly as possible to prevent overheating of the pump. Flow must not be permitted to spill over the high pressure relief valves for longer than 10 seconds, especially at higher pressures.

6. Neutralize the pump control and turn P.O.R. adjusting screw counterclockwise, all the way out.
7. Stroke the pump fully in either direction, then turn the P.O.R. adjusting screw in (clockwise) until the desired pressure setting is achieved.
8. Stroke the pump for opposite flow direction to that used in step 7 and check the operation of the P.O.R. Equal maximum pressures should be seen both sides of center.

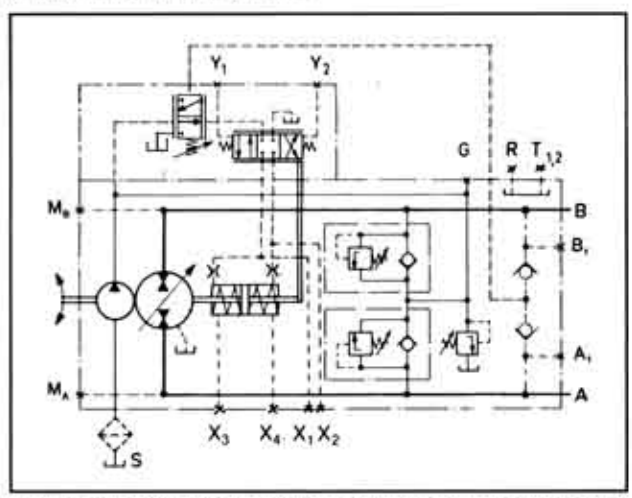
NOTE: All adjustments require a 3mm allen wrench and 10mm box wrench except for new design size 90 system reliefs which use a 5mm allen wrench and 17mm box wrench



Adjustment of P.O.R. valve on pumps with remote hydraulic pilot control, type HD, and proportional electric control, type EL. (Illustrated).

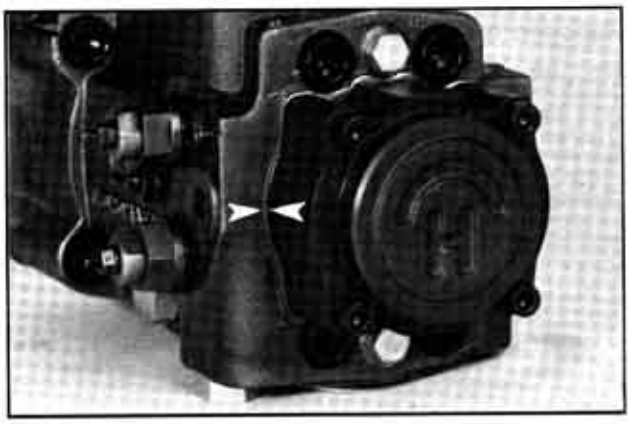


Adjustment of integral P.O.R. valve on pumps fitted with rotary manual servo control, type HW.



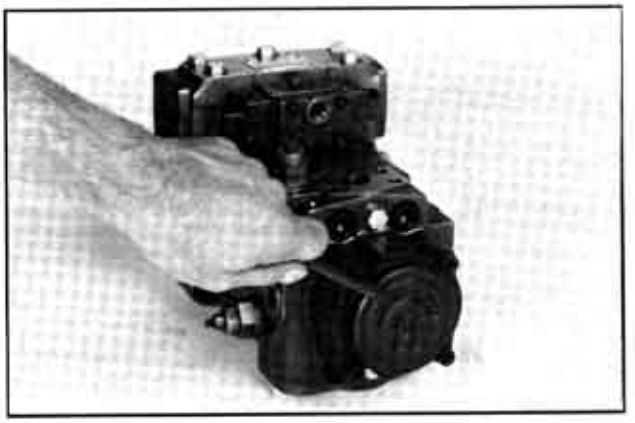
Circuit schematic of AA4V hydrostatic transmission pump with P.O.R. HD control is shown. Other control types use same P.O.R. schematic.

Removal and Inspection of Charge Pump



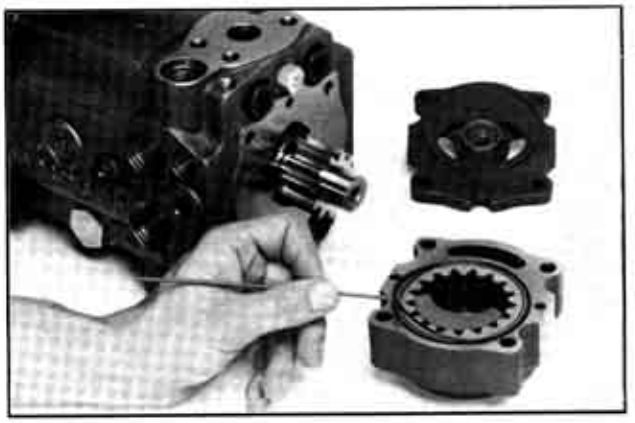
Before removing cap screws, mark the position of the charge pump housing and separator plate in relation to the port block.

NOTE:
Charge pumps are the same for right and left hand rotation pumps. However, charge pump must be mounted with correct orientation or charge pump will not supply oil into closed loop.



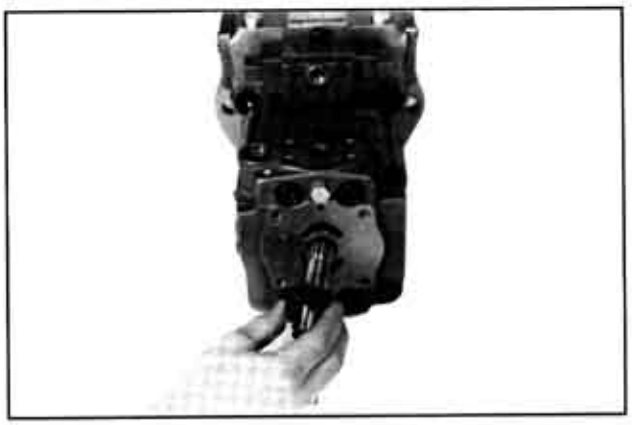
Loosen screws with metric allen wrench.

Pump Size	Wrench Size
40	6mm allen
56	6mm allen
90	6mm allen
125	8mm allen



Remove charge pump housing and inspect for wear or damage to gear set and O-ring seal. Grease O-ring prior to reassembly.

Be sure O-ring is completely seated in groove.



Withdraw pinion shaft and inspect gear teeth and bearing surfaces for abnormal wear.

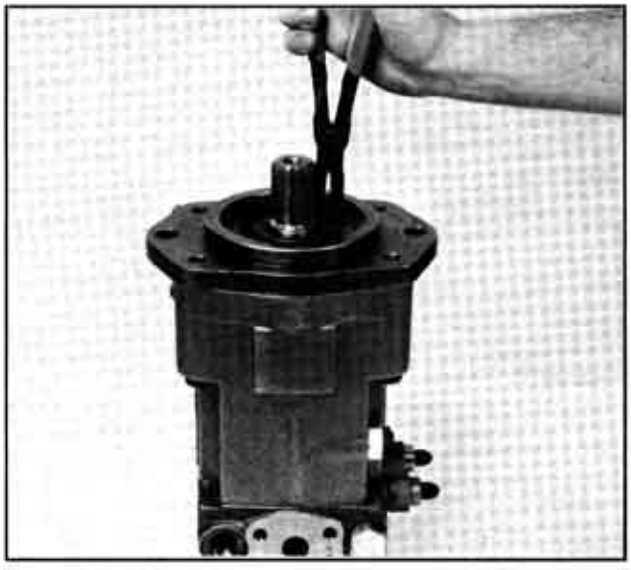
When reassembling, make sure chamfer (on outer edge of driven gear) goes down into charge pump housing.

Torque values for bolts when replacing charge pump.

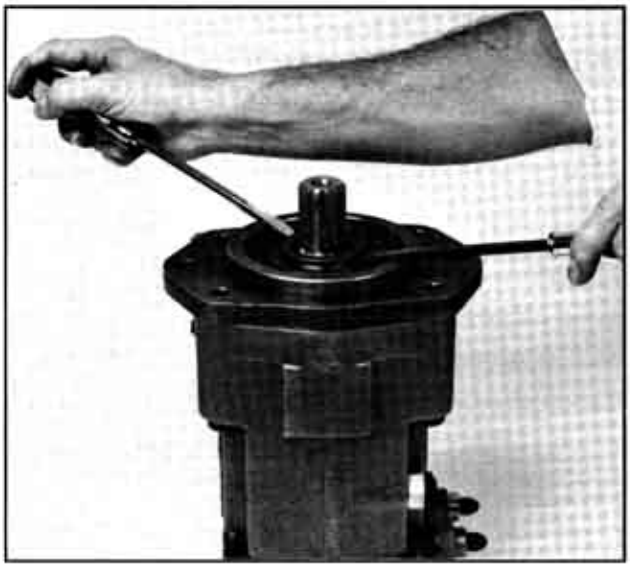
Pump Size	Torque (In-lb)
40	220
56	220
90	220
125	440

NOTE:
If serious wear or damge has occured to one component, the complete charge pump assembly must be replaced because they are matched components.

Replacement of Shaft Seal



Remove the retaining ring with snap ring pliers.



With two screw drivers, carefully pry up on shaft seal housing to remove.

Replace O-ring and radial seal. Lubricate parts before assembly.

Re-install retaining ring.

NOTE:
On the size 125 pump, use care when replacing the shaft seal. The O.D. of the pump drive shaft is approximately the same diameter as the seal I.D., and therefore, the seal could be damaged when sliding over the spline surfaces.

Routine Maintenance

The AA4V 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

a. After commissioning
b. After 500 operating hours
c. Thereafter during an oil change
d. With suction filtration, the filter element should be renewed as soon as a charge pump inlet pressure of less than −3.2 psig (0.8 bar absolute) becomes evident with the transmission in warm running condition (indicates contiamination).
e. 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 requirement (ref. p. 9) should be used.
Note: Paper inserts cannot be cleaned; use throw-away cartridge (maintain a stock).

2. Hydraulic Oil Change

a. After 500 operating hours (1st oil change)
b. After 2000 operating hours (2nd oil change)
c. 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 oil 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:
a. Use of an unsuitable hydraulic oil
b. Use of oil contaminated due to faulty storage
c. Failure to clean reservoir
d. Inadequate cleanliness when filling (dirty drums or containers)

3. Leakage Inspection

1. After commissioning
2. 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 pressureless 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 Fluids

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 degredation
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 viscocity-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. These 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).

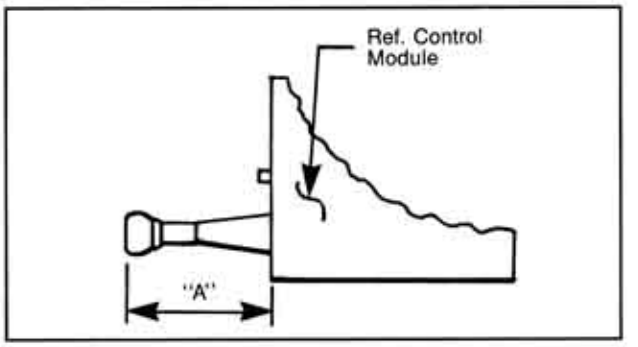
For applications that will operate near the extremes of viscosity and/or temperature, the fluid manufacturer should be consulted for assistance in selection of the most suitable type and grade of fluid for your application.

Rexroth strongly recommends the selection and use of fluids from reputable and established suppliers.

Control Module Size

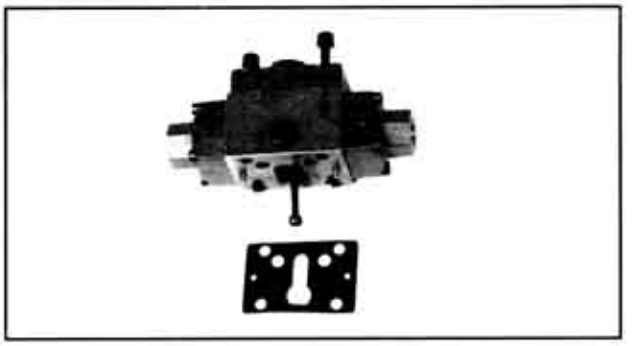
The servo feedback lever length (dimension "A") varies with pump size. The dimension can be checked to determine the control module size.

Pump Size	"A" Dimension (In.)
40	.85
56	1.03
90	1.25
125	1.43



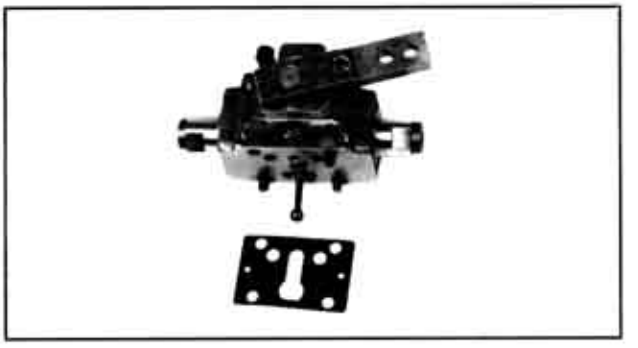
Remote Hydraulic Pilot Control Module, Type HD*

Pump Size	Part No.
40	5411-552-001
56	5421-552-001
90	5441-552-001
125	5451-552-001



Manual Rotary Servo Control Module, Type HW*

Pump Size	Part No.
40	5412-552-001
56	5422-552-001
90	5442-552-001
125	5452-552-001

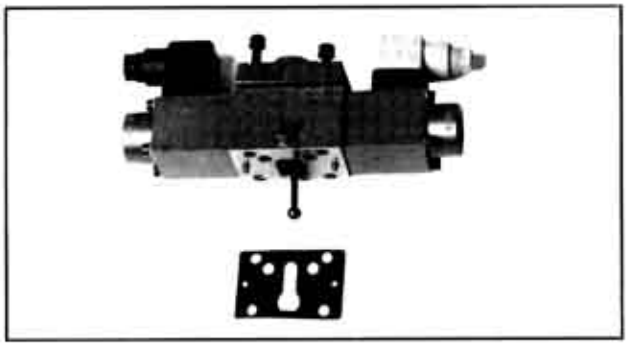


Proportional Electric Control Module, Type EL*

Pump Size	24 Volt DC Part No.	12 Volt DC Part No.
40	5413-552-001	5413-552-002
56	5423-552-001	5423-552-002
90	5443-552-001	5443-552-002
125	5453-552-001	5453-552-002

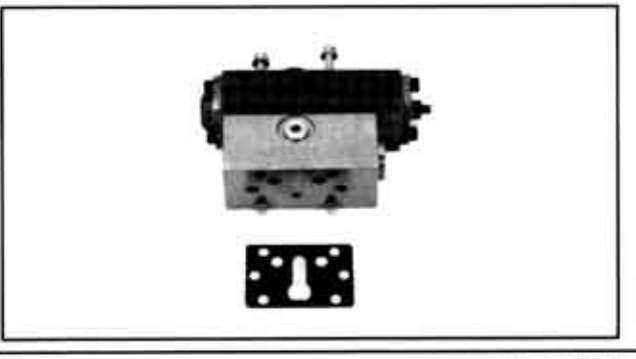
Non-Proportional Electric Control*

Pump Size	24 Volt DC Part No.	12 Volt DC Part No.
With P.O.R.	5406-552-003	5406-552-004
Without P.O.R.	5406-552-001	5406-552-002



Without Control Module With P.O.R., Type HM*

Pump Size	Part No.
All	5407-552-001

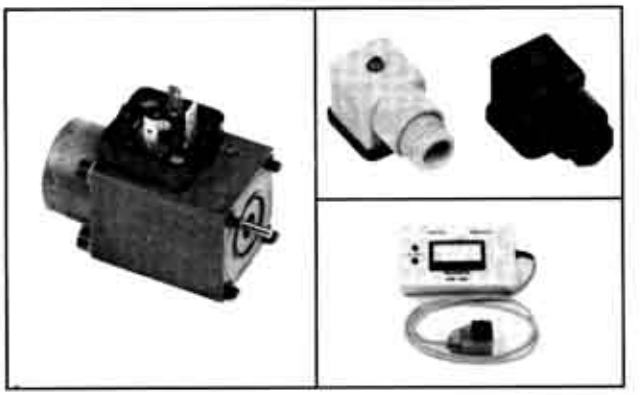


*All control module mounting bolts require a 5mm allen wrench and a torque of 90 in-lbs.

REXROTH
WORLDWIDE HYDRAULICS

Proportional Solenoids

Pump Size	24 Volt DC Part No.	12 Volt DC Part No.
All	5403-580-001	5403-580-002

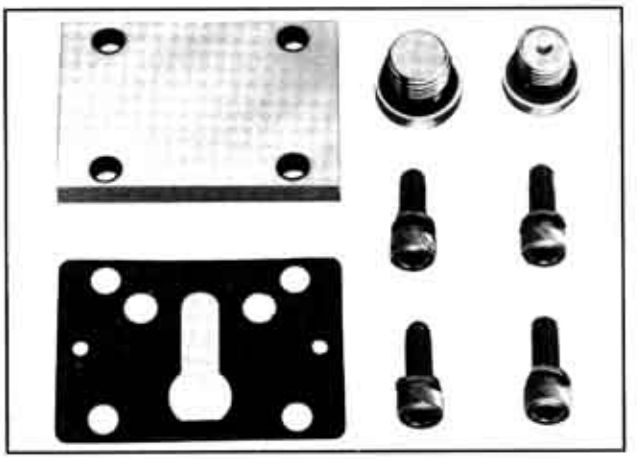


Non-Proportional Solenoids

Pump Size	24 Volt DC Part No.	12 Volt DC Part No.
All	5406-580-001	5406-580-002

Plug-In Connectors

Pump Size	Solenoid A Gray Color	Solenoid B Black Color
All	5400-085-001	5400-085-002



Ammeter With Sandwich Plug

Pump Size	Part No.
All EL Controls	5956-001-018

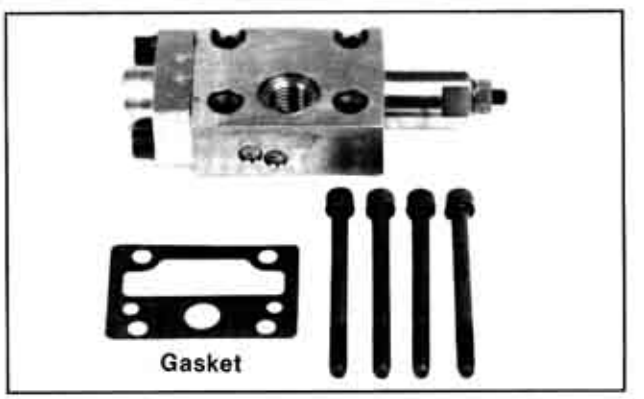
Conversion Kit OV Control

Pump Size	Part No.
All	5404-635-001

Pressure Override Valve (P.O.R.) For HD & EL Controls (includes gasket & bolts)

Pump Size	Part No.
All	5400-552-002

NOTE: A new control pipe and a high pressure pipe is required with the P.O.R. These can be found on Page 25.



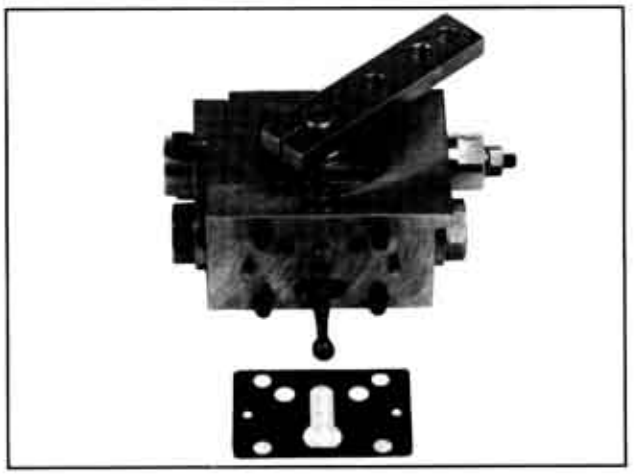
Gasket Only (for P.O.R.)

Pump Size	Part No.
All	5400-082-002

NOTE: This is not the same gasket used on other control module kits. Control module gasket can be ordered from Page 26.

Manual Rotary Servo Control (HW) Module With Integral P.O.R.

Pump Size	Part No.
40	5412-552-002
56	5422-552-002
90	5442-552-002
125	5452-552-002



Control Pipe With Fittings

Pump Size	P.O.R.	HD & EL Controls	HW Control
40	WITHOUT	5410-635-001	5412-635-001
	WITH	5410-635-004	5410-635-004
56	WITHOUT	5420-635-001	5422-635-001
	WITH	5420-635-004	5420-635-004
90	WITHOUT	5440-635-001	5442-635-001
	WITH	5440-635-004	5440-635-004
125	WITHOUT	5450-635-001	5452-635-001
	WITH	5450-635-004	5450-635-004

High Pressure Pipe With Fittings P.O.R. To Check Valves

Pump Size	Part No.
40	5410-635-005
56	5420-635-005
90	5440-635-007
125	5450-635-005

Sizes 40, 56, & 90

Size 125

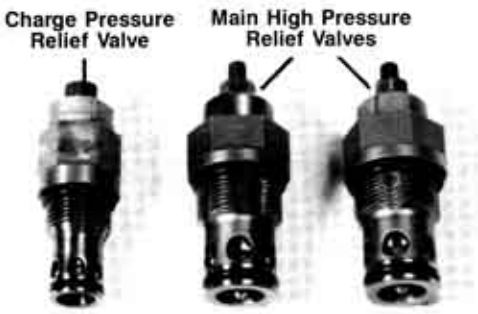
Charge Pump

Pump Size	Part No.
40	5410-430-001
56	5420-430-001
90	5440-430-001
125	5450-430-001

Relief Valve Cartridge

Pump Size	Main Relief		Charge Relief Part No.
	Pressure Range	Part No.	
40	2600-6000 psi	5400-566-011	5400-566-004
	1160-4640 psi	5400-566-013	
56	2600-6000 psi	5400-566-011	5400-566-004
	1160-4640 psi	5400-566-013	
90	2600-6000 psi	5400-566-012	5440-566-007
	1160-4640 psi	5400-566-012	
125	2600-6000 psi	5450-566-006	5450-566-007
	1160-4640 psi	5450-566-008	

NOTE: Maximum setting on charge relief is 580 psi.

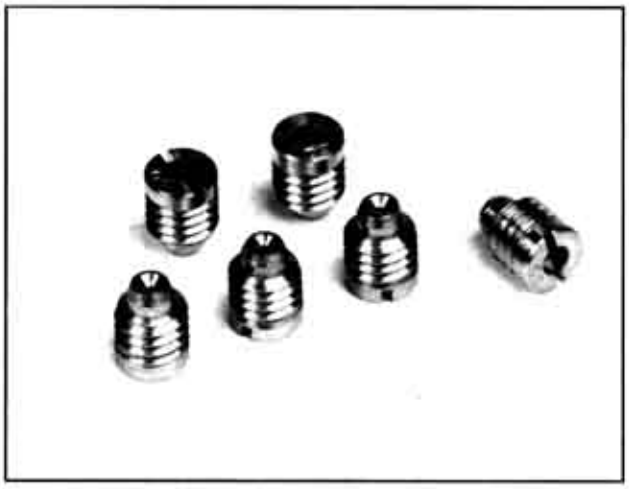


Sleeve Adapter For External Charge Flow Filtering

Pump Size	Part No.
40	5400-083-001
56	5400-083-001
90	5440-083-001
125	5450-083-001

Stroking Time Orifices

Size	Part No.
0.7	H156491
0.8	H156492
1.0	H156493
1.2	H156494
1.4	H156495



Seal Kits

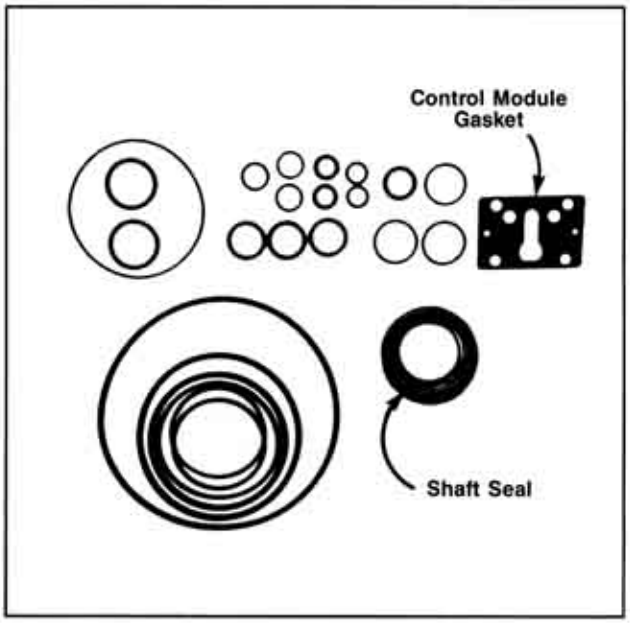
Pump Size	Part No.
40	5410-635-002
56	5420-635-002
90	5440-635-002
125	5450-635-002

Shaft Seal Only

Pump Size	Part No.
40	5000-076-023
56	5000-076-021
90	5000-076-015
125	5000-076-004

Control Module Gasket Only

Pump Size	Part No.
All	5400-082-001



Through Drive Conversion Kits

Through drive	Pump Size			
	40	56	90	125
SAE A (Code C)	5410-635-003	5420-635-003	5440-635-003	5450-635-010
SAE B (Code G)	5410-635-010	5420-635-010	5440-635-005	5450-635-003
SAE B-B (Code J)	5410-635-011	5420-635-011	5440-635-012	5450-635-012
SAE C (Code M)			5440-635-015	5450-635-014

Through Drive Charge Pump

Through drive	Pump Size			
	40	56	90	125
SAE A (Code C)	5410-430-003	5420-430-003	5440-430-003	5450-430-005
SAE B (Code G)	5410-430-004	5420-430-004	5440-430-004	5450-430-003
SAE B-B (Code J)	5410-430-004	5420-430-004	5440-430-004	5450-430-006
SAE C (Code M)			5440-430-005	5450-430-007

Adapter Flange Kit

Through drive	Pump Size			
	40	56	90	125
SAE A (Code C)	5410-635-008	5420-635-008	5440-635-010	5450-635-008
SAE B (Code G)	5410-635-009	5420-635-009	5440-635-011	5450-635-009
SAE B-B (Code J)	5410-635-012	5420-635-012	5440-635-013	5450-635-013
SAE C (Code M)			5440-635-014	5450-635-015

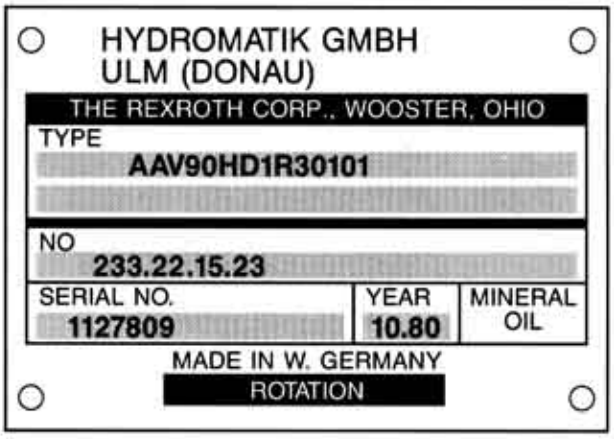
NOTE:
Kit includes bolts, O-rings and spline adapter (if required) to mount flange to through drive charge pump.

Ordering of AA4V Subassemblies

For Rexroth to supply the correct parts for your unit, please include all of the following information with your parts order.

TYPE CODE
TYPE NUMBER
SERIAL NUMBER
PART NUMBER
PART NAME

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 charge pump for an AA4V hydrostatic transmission pump having the above nameplate, the following information would be required.

+	Type Code	AA4V90HD1R30101
+	Type Number	233.22.15.23
+	Serial Number	1127809
*	Part Number	5440-430-001
*	Part Name	Charge pump

+ This information is taken from the nameplate on the pump.
*This information is taken from Pages 23 through 27 of this publication.

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GRADALL®

material handlers

532/534 Boom Maintenance

Form No. 29906

Issued 11/99

REVISIONS

- This page is provided so you may determine that this Manual is complete and current with respect to Gradall Engineering Specifications.

Page	Date	Revision

532/534 Boom Maintenance
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Safety	
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Bearing Pad Installation	4
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Hose Fitting Torque Chart	Appendix B
Boom Drawings	Appendix C

Covers Material Handlers:
532C-6/534C-6 Starting Serial No. 0188002 Through 0488378
534C-9 Starting Serial No. 0344004 Through 0444189
534C-10 Starting Serial No. 0266001 Through 0266139
534D-6 Starting Serial No. 0588001
534D-9 Starting Serial No. 0544001
534D-10 Starting Serial No. 0366001

Read and understand this Manual along with the appropriate *Owner/Operator Manual*, the *Gradall Material Handler Safety Manual*, the *EMI Rough Terrain Forklift Safety Manual* and all instructional decals and plates before starting, operating or performing mechanical adjustments and maintenance procedures on this equipment. Keep Operator and Safety Manuals in the operator's cab.

Orientation

When used to describe the location of components on the machine, the directions "front","rear","left", and "right" indicate the point of view of a person sitting in the operator's seat in the cab.

Fastener and Fitting Torque

Torque values for mechanical fasteners and hydraulic fittings are given in "Appendix A" and "Appendix B". They must be adhered to at all times. **LOCTITE 242** (P/N 1440-3364) must be used on all bolt threads. **LOCTITE 545** (P/N 1440-4043) must be used on all hydraulic fittings. Whenever a hydraulic hose is tightened, two wrenches must be used; one to tighten the hose, the other to hold it from twisting. Hoses must lie and roll free of twist.

Preparing The Material Handler For Service

1. Before performing any maintenance or service, position the material handler in a safe, open, level area, well away from traffic lanes, buildings, other equipment or personnel.
2. Set the park brake and shift the transmission to "Neutral."
3. Lower the forks to the ground.
4. Place the controls in "Neutral," idle the engine 3 minutes for gradual cooling then shut the engine off.
5. Cycle the hydraulic controls, remove the ignition key and fasten a "Do Not Operate" tag to the steering wheel.
6. Dismount from the material handler facing the machine using the proper hand rails, grab irons and/or ladders provided. Always maintain 3-point contact with the handler while dismounting or mounting.
7. If you must park on a slope or incline, position the material handler at right angles to the slope and chock the wheels.

DANGER

Since you will occasionally have to perform service/maintenance procedures with the material handler running, you must take extra precautions to avoid being injured, perhaps fatally. At a minimum this means:

- Set the park brake.
- Chock the wheels.
- Avoid all exposed moving parts.
- Post a warning in the operator's cab that you are working on the machine.
- Work with an assistant.
- Maintain vision to assistant allowing you to know where he is and what he is doing.

Additional Maintenance/Service Precautions

- Refer to the safety decals on the machine and in the relevant *Owner/Operator Manual* before attempting any repair or adjustment.
- If you are working with someone else, make sure they understand the procedure. Make sure each of you knows what to expect and when to expect it. Make sure each of you knows where the other is at all times.
- Make sure you wear all the protective clothing and personal safety gear necessary to perform the service safely.
- Make sure there is adequate light and ventilation in the work area.
- Remove oil, grease, mud, snow, water or any other substance that might cause slippery surfaces from all climbing, walking and working areas.

Note!

Steps 4 and 5 clearly relate to maintenance and service procedures performed with the machine shut down. Although ideal, this may not be possible. Some procedures can only be performed with the machine running. Therefore, this list of precautions headed "Preparing the Material Handler for Service" should be modified according to the specific circumstances of a particular service/maintenance procedure.

- Clean around the area to be serviced to minimize any possibility of contamination.
- Use only the correct tools to perform any check, service or repair.
- Make sure any lifting and supporting devices you use are stable and strong enough to handle the weight of the material handler or component.
- Remove only the guards/covers on the area being serviced. Replace all guards/covers immediately upon completion of the task.
- If the material handler has special optional equipment, make sure that the appropriate maintenance and operational requirements are understood by everyone who operates and services the machine.

What This Manual Covers

This Manual covers maintenance and repair procedures for the three-section boom assembly of all 532 and 534 Series Gradall Material Handlers. Specifically this includes; 532C-6, 534C-6/T, 534C-9/C-10, 534D-6/T & 534D-9/D-10. Mechanical adjustments, replacement, removal and reinstallation of major components are covered. Hydraulic system operations are not discussed. Refer to appropriate manuals for this information. Areas requiring special attention are so indicated.

Illustrations and pictures used are taken from various models. They are typical with regards to assembly and component location and should be used for reference only.

Information in the various charts, tables and illustrations is correct at the time of printing. Refer to the appropriate current *Gradall Parts Manual* to verify correct component Part Numbers.

Special Note on Boom Cables

The extension/retraction boom cables used on all Gradall 532 and 534 Series Material Handlers are made of wire rope. All wire ropes in service should be inspected regularly for damage and evidence of wear. Refer to the *Wire Rope Users' Manual* and *OSHA Wire Rope Excerpts*, both published by the American Iron and Steel Institute Committee of Wire Rope Producers.

Users of Gradall Material Handlers equipped with wire rope should conduct a thorough inspection of all wire rope boom cables at least once a month, keeping full and accurate records as to the condition of the ropes. Any deterioration will lead to the depletion of original rope strength which is sufficient cause to replace the rope.

Listed below are some conditions that warrant wire rope replacement:

- Corrosion of wire rope.
- More than one broken wire in any one strand. Breaks in valleys between strands indicate problems (fatigue, breakage) in wires not necessarily visible on the surface.
- More than one broken wire near attached fittings.
- Heavy wear and/or broken wires in rope sections under sheaves where rope travel is limited.
- Evidence of reduction in original rope diameter, allowing for normal stretch factors.
- Excessive abrasion, scrubbing and cleaning of outside wires.
- Pitting, kink damage or evidence of other kinds of mechanical trauma.

In addition to inspecting wire rope boom cables regularly, inspect all sheaves, guards, guides and other surfaces which are in contact with the rope during boom operation. Any defect/damage to the above listed components poses a risk to the integrity of the rope.

DO NOT reach into the Boom until you are CERTAIN the keys have been removed from the ignition.

A fully comprehensive set of inspection procedures and guidelines (including replacement recommendations) is practically unattainable because of the many variables involved. In the final analysis, SAFETY depends largely on the good judgment of competent service personnel in determining:

(i) Damage to wire ropes
(ii) The remaining service life expectancy of the wire rope. If there is **any doubt**, the rope **must** be replaced
(iii) The proper procedures to replace worn or damaged rope

If you have any questions, including inquiries about the American Iron and Steel Institute publications mentioned above, please call your Authorized Gradall Distributor or Gradall Product Support at (330) 339-2211.

THE FOLLOWING SYMBOLS CALL YOUR ATTENTION TO IMPORTANT SAFETY NOTICES:

DANGER	This symbol indicates an extreme hazard which would result in high probability of death or serious injury if proper precautions are not taken.
WARNING	This symbol indicates a hazard which could result in death or serious injury if proper precautions are not taken.
CAUTION	This symbol indicates a hazard which could result in injury or damage to equipment or property if proper precautions are not taken.

DANGER, WARNING and CAUTION notes in this Manual will help you avoid injury and damage to the equipment.

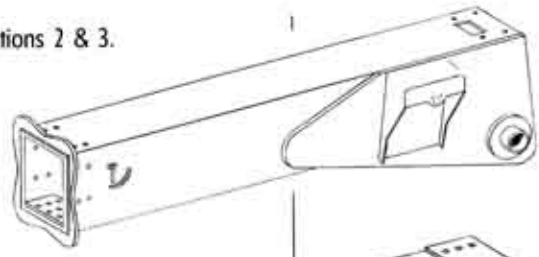
Any procedure not specifically recommended by Gradall must be thoroughly evaluated from the standpoint of SAFETY before it is placed in practice. If you are not sure, contact your Authorized Gradall Distributor.

Do not modify this machine without written permission from Gradall.

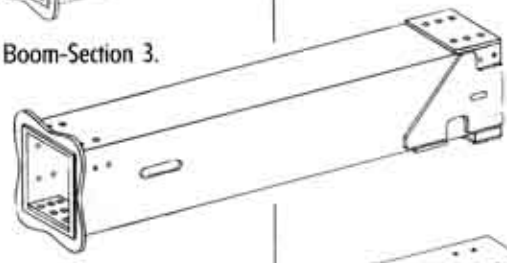
Note on Using the Manual

This Manual contains a series of maintenance and repair procedures for the Boom Assembly of all 532 and 534 Series Material Handlers. In every instance—unless otherwise noted—there are certain basic precautions and steps you should take before working on the machine. These precautions are outlined in the "Introduction" under the heading "Preparing the Material Handler for Service." You must read, understand and comply with these instructions in every instance before working on the machine. You must also observe the general warnings listed under the heading, "Additional Maintenance/Service Precautions," also in the "Introduction."

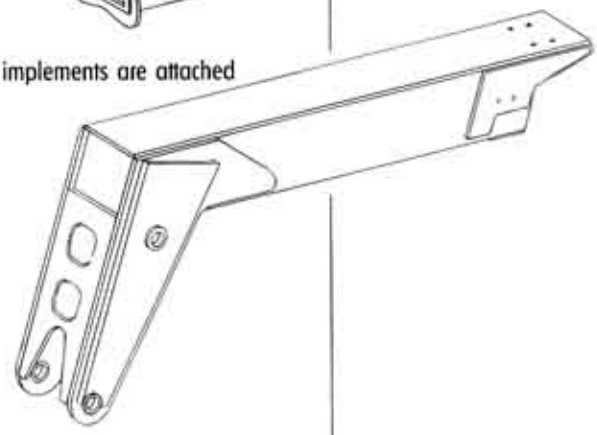
BOOM-SECTION 1
Base boom connected to the carrier frame that houses Boom-Sections 2 & 3.



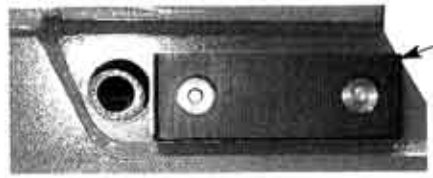
BOOM-SECTION 2
Intermediate Boom-Section, located inside Boom-Section 1, houses Boom-Section 3.



BOOM-SECTION 3
Outer Boom-Section located inside Boom-Section 2. Working implements are attached to the boom head end of this section.



BEARING PAD
Also known as a "Slider Pad" or a "Wear Pad". Mounts to the boom and contacts mating boom surface. Reduces friction during boom extension and retraction. Keeps Boom-Sections centered with each other.

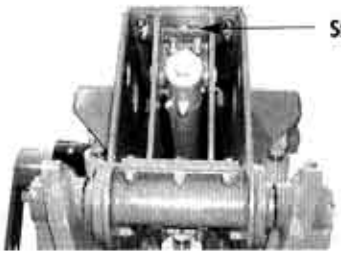


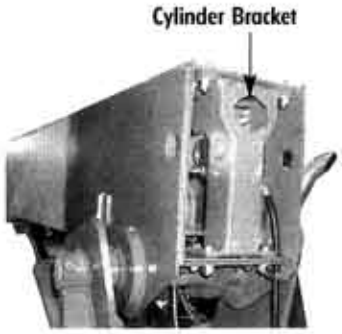
BEARING PAD SPACER
Mounts on the inside of a bearing pad, facing the boom surface. Provides a solid surface for boom bearing pad shims. Gradall Part Number and thickness is stamped on each spacer.

SHIM
Metal plate used to fill the space between components, allowing the component to be properly placed against a solid surface, (bearing pad, strongback, etc). Gradall Part Number and thickness are stamped on each shim.

Push Beam (534C-9/C-10 & D-9/D-10 only)
Weldment that houses the crowd cylinder and the extension cable sheave assembly. Mounts to the rear of Boom-Section 2.

Strongback
Also known as the Cylinder Bracket on the 532C-6, 534C-6 & 534D-6. Located at the inside rear of Boom-Section 1. Extension cables and the base end of the crowd cylinder are mounted to this weldment.





Crowd Cylinder
Extends and retracts the complete Boom Assembly.
534C-9/C-10: Located inside the push beam. Rod eye pinned to the push beam; base end pinned to the strongback.
532C-6, 534C-6 & 534D-6: Rod eye pinned to the cylinder bracket and barrel-mounted to the rear of Boom-Section 2.

Tilt Cylinder
Tilts the boom attachments forward or backward. Located in the boom head of Boom-Section 3.

Boom Cable
Wire Rope that mechanically extends and retracts Boom-Section 3.

Boom Cable Sheave
Grooved rollers that the boom cables ride on. As the sheave rotates, the cable is extended or retracted from its anchor point. There are extension and retraction sheaves used in the boom assembly. They are located at the front end of the push beam and the rear of Boom-Section 2.

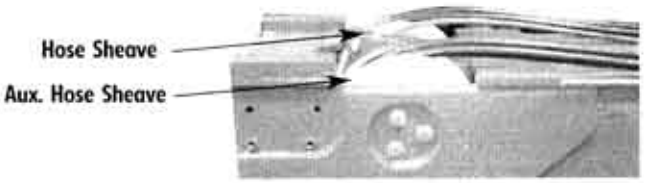
534D-6 Extend Cable Sheave
Front View

Hydraulic Hoses

Located inside boom assemblies. Used to carry fluid to the attachment; fastened to the end of Boom-Section 3.

Hose Sheave

Located at the inside left of Boom-Section 2. The plastic roller is designed with lips on the outer edge of the OD. As the booms extend and retract, the roller rotates against the hoses, maintaining the proper radius point of the hose. The lips keep the hose captive on the roller.

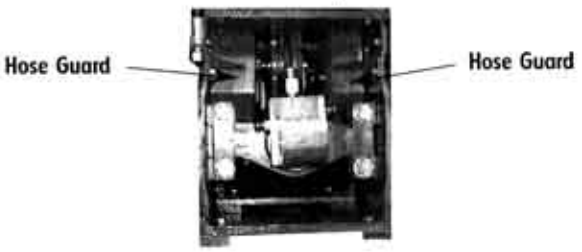


Note!

Boom-Section inverted 180° (upside-down)

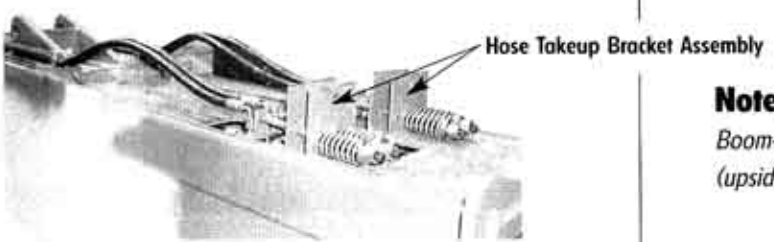
Hose Guard Plate

Located in the back of the hose sheave, the hose guard plate protects the hoses from contamination and prevents them from jumping the lips of the hose sheave.



Hose Take-Up Assembly

Located at the outside bottom of Boom-Section 1, the Hose Take-Up Assembly weldment absorbs sudden shocks which impact the tilt circuit and auxiliary circuit hydraulic hoses, minimizing the possibility of hose failure.

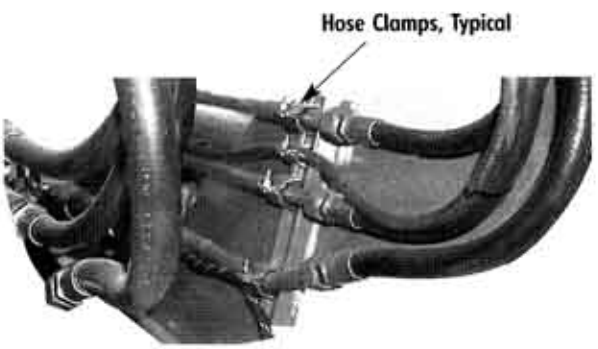


Note!

Boom-Section Inverted 180° (upside-down)

Hose Clamp Sets

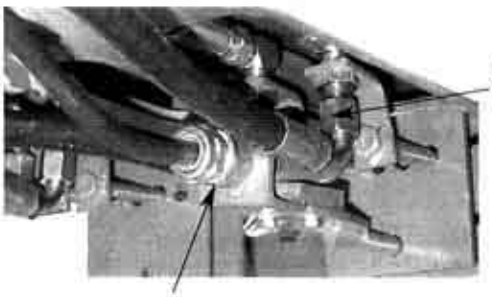
Keep hydraulic hoses located in a fixed position. Hose movement and damage is minimized when hoses are properly clamped.



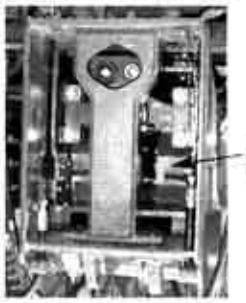
Auxiliary Circuits

Special attachments may require additional hydraulic and electric circuits. These circuits are fed to the attachments through the right side of the boom assembly. They are similar to the standard circuits in the left side of the boom.

Front Bottom, Boom-Section 1:
Cable Take-Up Bracket



Rear View Boom Assembly



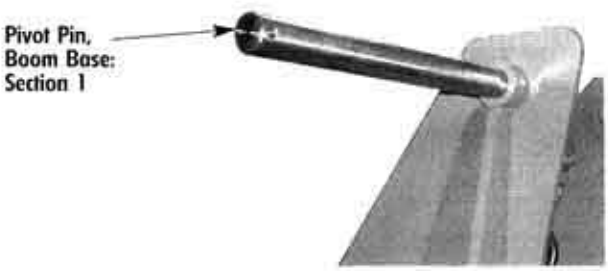
Fasteners

Refer to Appendix "A" at the rear of this Manual for correct torque values.
***LOCTITE* 242** (P/N 1440-3364) must be used on all fasteners when setting the torque.

Bearing Pad Mounting Bolt
and Washer

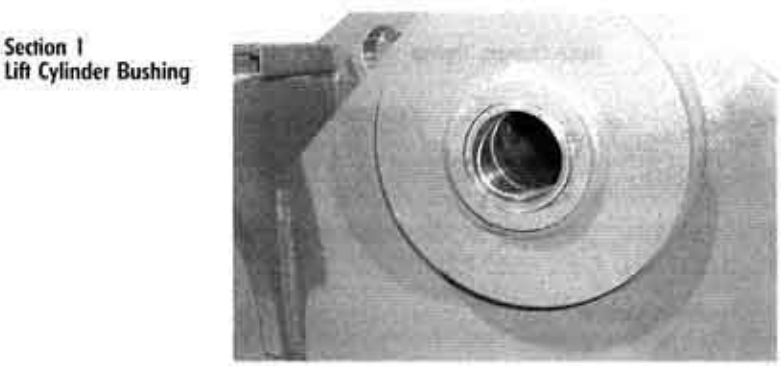
Pins

Special dimensioned pins are used in some locations to fasten components together. During installation and removal, care must be taken to protect the outside surface and any lubrication passages.



Bushings

Bushings equipped with lubrication grooves are used in conjunction with pins. Lubricate ID and OD of bushings before installation in parent bore and pin installation.



Optimum Boom Assembly Performance and Service Life depend on proper adjustment and alignment of components. A boom is considered in proper adjustment as long as the following criteria are met:

- Boom-Sections centered to each other.
- Extension/Retraction cables are adjusted properly, resulting in simultaneous extension and retraction of Boom-Section 3, proportional to the crowd cylinder, throughout partial and/or full boom travel.
- Hydraulic circuit hoses (including Auxiliary Hydraulic and Electric) are properly installed, resulting in stress-free movement during boom extension/retraction cycle.

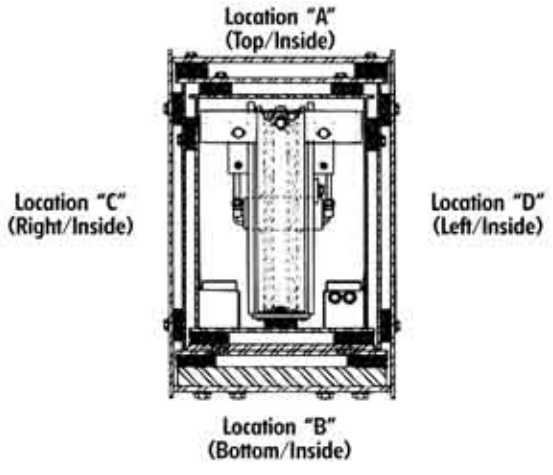
BOOM ADJUSTMENT PROCEDURE:

CENTERING OF BOOM-SECTIONS TO EACH OTHER

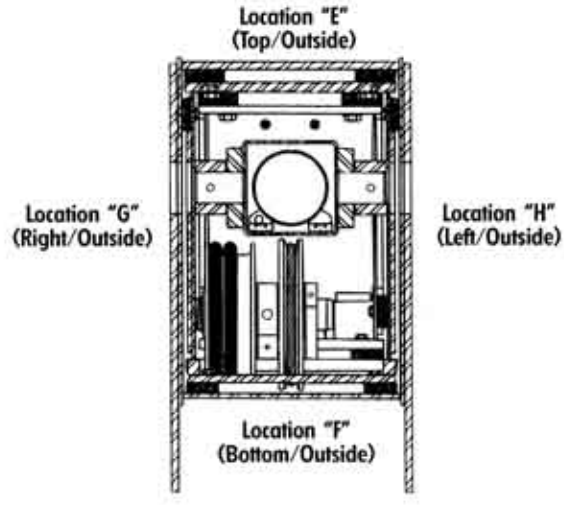
BEARING PAD PACKAGE

Boom bearing pads (sometimes called slider pads or wear pads), spacers and shims are used as a package to achieve proper centering of Boom-Sections to each other. For the purpose of clarification, the area and location of bearing pad packages are referenced below.

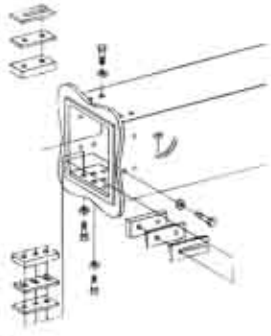
END VIEW AREA 1 & 2



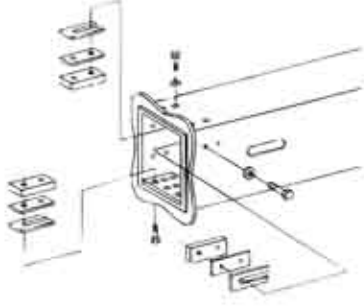
END VIEW AREA 3 & 4



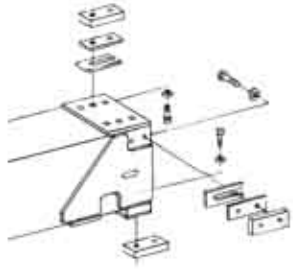
BOOM-SECTION 1:
AREA 1, FRONT INSIDE



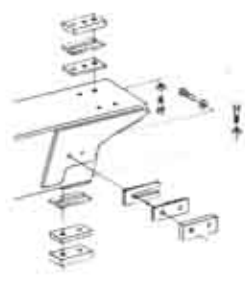
BOOM-SECTION 2:
AREA 2, FRONT INSIDE



BOOM-SECTION 2:
AREA 3, REAR OUTSIDE



BOOM-SECTION 3:
AREA 4, REAR OUTSIDE



Note

The 534C9/10 and 534D9/10 booms require 3 bolts on the bottom front bearing pads on section one. They also require 3 bolts on the boom bearing pads on the bottom front and top rear of section two and the top rear of section three. All other boom bearing pads as well as all the boom bearing pads on the 532/534C6 and 534D6 require two bolts.

Boom Wear Pad Adjustments

To maximize boom service life, wear pads must be carefully adjusted at all times. The following Service Notes are a general guide for properly adjusting boom wear pads:

General Service Notes

- Familiarize yourself with all bearing pad package components.
- Add bearing pad spacers (backing plates) and shims as required to fit boom within 1/16" of tight fit to mating outer boom.
- Boom-Sections 2 and 3 should be evenly centered to outer Boom-Section 1. Spacer and shim packs should be equal (within 1 shim) side to side and top to bottom.
- It may be possible on new booms for bearing pads only to be installed. There may not be room for spacers and shims.
- Insert spacers between pad and shim.
- Be sure no pad sits directly on the slotted surface of a shim.
- Bolts must not extend beyond the chamfer on the bearing pad. The length of pad bolts depends on the number of shims used.
- If no shim is used with the bearing pad, two washers are installed under the head of the bolt against the boom. Remove one washer if a shim is installed at a later date, otherwise the bearing pad will not be securely held in place by the bolt.
- Grease bearing pads and pad slide area on the boom with *Mystik Tetrimoly* grease (or equivalent) (Gradall P/N 1440-4595).
- Apply **LOCTITE 242** (Gradall P/N 1440-3364) to all bolt threads.
- Bearing pad bolt torques are:
  3/8" bolt: 32-37 ft-lb
  1/2" bolt: 76-86 ft-lb
- Do not overtorque pad mounting bolts. Overtorqueing will pull the pad nut through the pad. The pad will then fall out of the boom.
- Booms should not be adjusted so tight that the lube is wiped off the sliding path.
- Visual checking of the witness lines left on the bearing slide path may assist in determining which side of the boom is not making proper contact with the bearing pad.
- If a wedge is used to assist in shifting a Boom-Section for adjustment, be certain it is removed before activating the boom circuit. Damage to the boom structure will occur if the boom is retracted with a wedge left installed. Do not use more than one wedge at a time during the adjustment operation.
- You can use .060" thick shim stock as a feeler gauge to check boom clearance to bearing pad.
- Shims and spacers are stamped with their part number and thickness for quick reference. Check the ones you are installing against the ones installed in the same area. Make sure you install the right ones.

Boom Adjustment Procedure:
Area 1 and Area 2 (Pad location "A" & "B")

→ Inspection

1. Extend the boom three-quarters of total travel. (Extend at least 1 ft. beyond access holes.)
2. Lower the boom using slight down-pressure to remove Boom-Section weight from the bottom.
3. Using a feeler gauge, measure the gap between the bearing pad and the boom at Area "2", location "B".

.060" Shim (used as feeler gauge)

4. If the gap is more than $^{1}/_{16}$", shims must be added to bring the boom into tolerance.

Note!

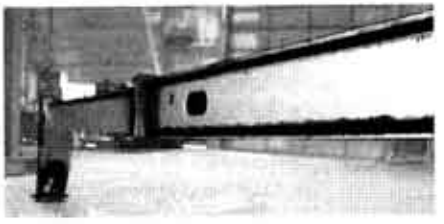
Shim packs should be equal top to bottom (within 1 shim), location "A" and "B". If an unequal amount of shim must be added, first add the shims to location "A" then equalize the shim pack at the next adjustment. Do not use more than 3 levels of shims. The bottom of the boom, Location "B", is most critical. Shim pack levels must ***always*** *be equal (within 1 shim) at this location.*

→ Adjustment

1. Loosen the bearing pad mounting bolts at locations "A" or "B" (or both) and add required shims.
2. Shims are stamped with the Gradall Part Number and thickness. Check the part number on the shim in the area you are installing additional ones and make sure they are the same.
3. Apply ***LOCTITE* 242** to the threads on the pad mounting bolts.
4. Re-torque the bearing pad mounting bolts.
5. Repeat "Inspection" Steps 3 & 4 and "Adjustment" Steps 1 & 2 for Area 1, Location "B".

Area 1 & 2

Extend the Boom, Slight Down-Pressure



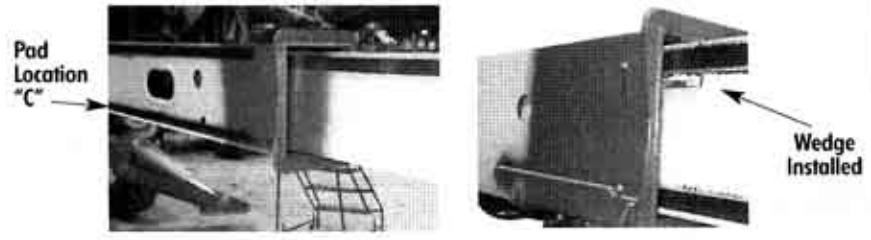
Area 1, Location B

ADJUSTMENT PROCEDURE:

AREA 1 AND AREA 2 (PAD LOCATION "C" & "D")

→ **Inspection**

1. Extend the boom three-quarters of total travel. (Extend at least 1 ft. beyond access holes)
2. Lower the boom to 1ft. of ground clearance.
3. Install a wedge between Boom-Section 2 and 3 at Area 2, Location "C".



4. Hammer a wedge into the area between Boom-Section 3 and 2 at Location "C", forcing it against the opposite side (Location "D").

CAUTION **Do not distort the side plates of the boom sections.**

5. Using a feeler gauge, measure the gap between the bearing pad and the boom at Area 2, Location "C".
6. If the gap is more than 1/16", shims must be added to bring the boom into tolerance.

Note!

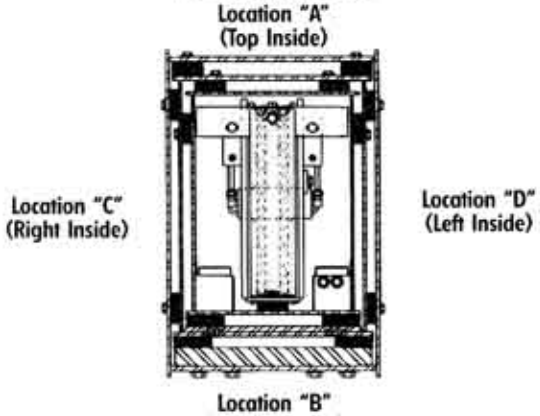
Shim packs should be equal side to side (within 1 shim), Location "C" & "D". If an unequal amount of shim must be added, equalize the shim pack at the next adjustment.

→ **Adjustment**

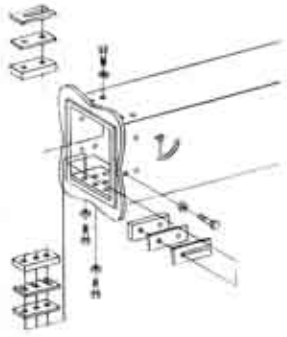
1. Loosen the bearing pad mounting bolts at locations "C" or "D" (or both) and add the required shims.
2. Shims are stamped with their Gradall Part Number and thickness. Check the shims already in place and make sure you are installing the right ones.
3. Apply ***LOCTITE* 242** to the threads on the pad mounting bolts.
4. Re-torque the bearing pad mounting bolts.
5. Remove wedge installed in Step 3.
6. Repeat "Inspection" Steps 3-6 and "Adjustment" Steps 1-5 for Area 1, Location "C".

CAUTION If a wedge was used to move the Boom-Sections for checking, **be certain it is removed** before activating the boom circuit. Failure to do so will damage the boom structure. Do not use more than one wedge at a time for the adjustment operation.

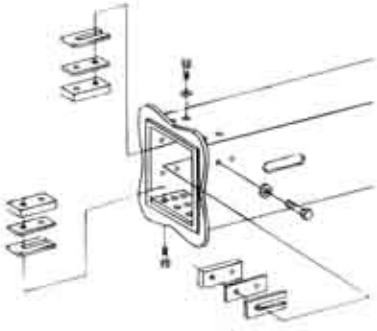
END VIEW AREA 1 & 2



BOOM-SECTION 1: AREA 1, FRONT INSIDE



BOOM-SECTION 2: AREA 2, FRONT INSIDE



SEE NOTE ON PAGE 2.0 FOR BOOM BEARING PAD BOLT QUANTITIES

Note!

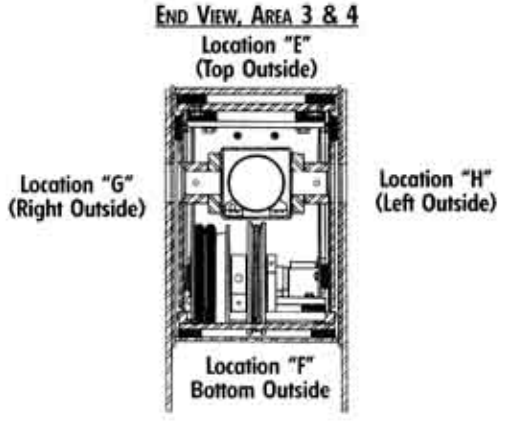
If two washers were installed under the head of the pad mounting bolts and a shim was added, it is imperative that one washer be removed. Otherwise the bolt will not secure the pad nut properly.

ADJUSTMENT PROCEDURE:

AREA 3 & 4 (PAD LOCATION "E" & "F")

→ **Inspection**

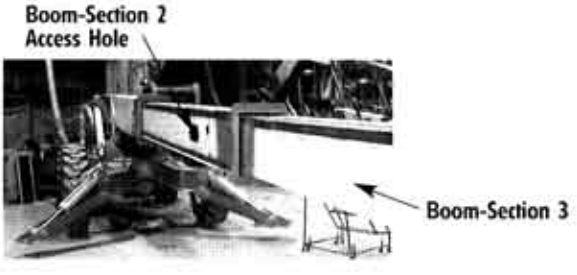
1. Retract the boom assembly within 1 ft. of full retraction.
2. Raise the boom assembly approximately 30° so that the weight of the assembly will force the boom package to rest against the bottom plate at the rear.
3. At the rear of the boom, use a feeler gauge to check the bearing pad clearance between Boom-Sections 1 & 2 and Boom-Sections 2 & 3 at Area 3 and the top of Area 4, Pad Location "E". Visually check pad location "F" at this time.



4. Lower and extend the boom until Boom-Section 3, Area 4, and all pad locations clear the access holes in Boom-Section 2 by at least 1 ft.
5. Using a feeler gauge, check the pad clearance for Area 4, Pad location "F". It may be possible for a boom to show the pad clearance when fully retracted and no pad clearance when extended. If no pad clearance is evident when extended, do not add shims at this time.
6. If there is more than $^{1}/_{16}$", shims must be installed to bring the boom into tolerance.

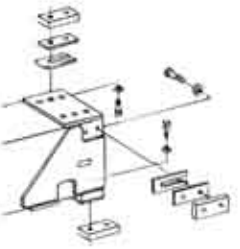
Note!

Shim pack levels should be equal top to bottom (within 1 shim) pad locations "E" and "F". If the shim pack level is unequal after this adjustment, equalize at the next adjustment.

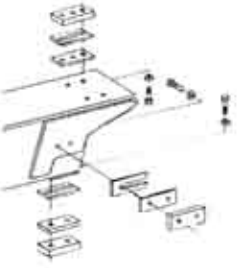


Boom Bearing Pads are now fully adjusted.

BOOM-SECTION 2:
AREA 3, REAR OUTSIDE



BOOM-SECTION 3:
AREA 4, REAR OUTSIDE



SEE NOTE ON PAGE 2.0 FOR BOOM BEARING PAD BOLT QUANTITIES

Adjustment Procedure:

Area 4, (Pad Location "G" & "H")

→ **Inspection**

1. With the engine off, reach through the access hole, install a wedge between Boom-Sections 2 and 3 at Area 4, Pad Location "G". Force Boom-Section 3, Area 4 against the opposite side Pad Location "H" to check the clearance.
2. Using a feeler gauge, check the clearance between the boom and the bearing pad at Area 4, Pad Location "G".
3. If there is more than .060" clearance present, shims must be installed to bring the boom into tolerance.

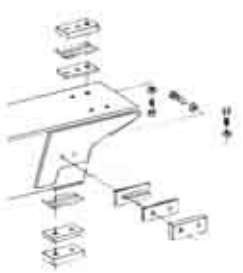
Note!

Shim pack levels should be equal side to side (within 1 shim), pad locations "G" and "H". If the shim pack level is unequal after this adjustment, equalize at the next adjustment.

→ **Adjustment**

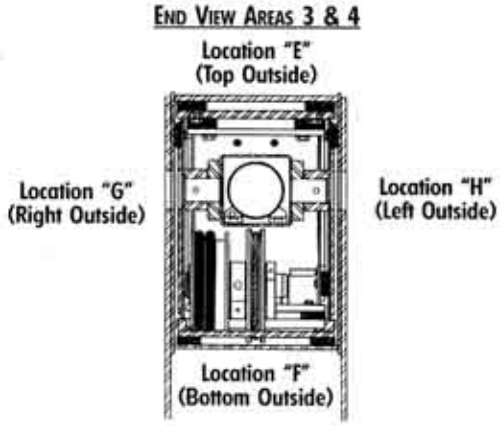
1. Loosen the bearing pad mounting bolts at location "G" or "H" (or both) and add required shims.
2. Shims are stamped with the Gradall Part Number and thickness. Check the part number on the shim being installed against the one previously installed to be certain they are the same.
3. Apply **LOCTITE 242** to the threads on the bearing pad mounting bolts.
4. Re-torque the bearing pad mounting bolts.
5. Remove the wedge installed under "Inspection", Step 1.

Boom-Section 3:
Area 4, Rear Outside



See note on page 2.0 for boom bearing pad bolt quantities

End View Areas 3 & 4



Boom-Section 2
Access Hole

Boom-Section 3
- Right side Location "G"
- Left side Location "H"

Inside View Location "G"
(From Opposite Side Access Hole)

ADJUSTMENT PROCEDURE:

AREA 3 & AREA 4 (PAD LOCATION "E", "F", "G" & "H")

→ **INSPECTION**

1. Raise the boom assembly to approximately 30° and retract to approximately 1ft. of full retraction. Shims for Area 3, Pad Locations "E", "F", "G" & "H" and Area 4, Pad Location "E" are added at the rear of the boom assembly.
2. Using a feeler gauge, measure the clearance between the boom and the bearing pad at all the above locations.
3. If there is clearance of more than 1/16" at Area 3 and/or Area 4 pad Location "E" and "F", shims are normally first added to Pad Location "E" at the rear of the boom assembly.

NOTE!

Shim packs should be equal (within 1 shim). Do not have more than one extra shim level at any bearing point.

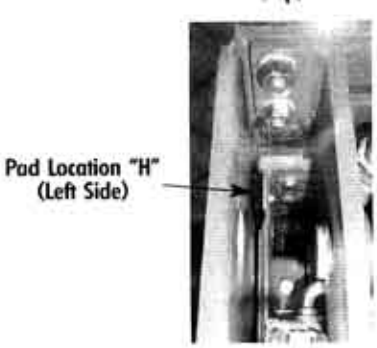
→ **Adjustment**

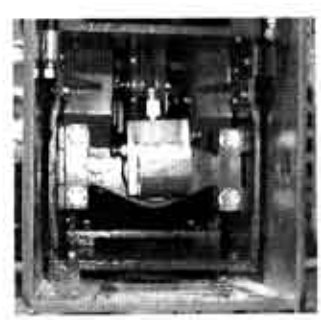
(Pad Location "F")

1. To add shims to Pad Location "F", wedge up the Boom-Section for clearance.
2. Shims are stamped with their Gradall Part Number and thickness. Check the part number on the shim being installed against the part number of the one previously installed to be certain they are the same.
3. Loosen bearing pad mounting bolt and install shims as required.
4. Apply ***LOCTITE* 242** to the mounting bolt threads.
5. Re-torque the bearing pad mounting bolts.
6. Remove any wedges you installed.

REAR VIEW

AREA 3





→ **Adjustment**
(Pad Locations "G" & "H")

1. To add shims to Area 3 or 4, Pad Location "G" or "H", install a wedge to Pad Location "G" to force the boom to the opposite side Pad Location "H".
2. Install a shim, remove the wedge and repeat step 29 on opposite side, Pad Location "H".
3. Apply **LOCTITE 242** to the bearing pad mounting bolt threads.
4. Re-torque the bearing pad mounting bolts.
5. Remove any wedges you installed.

REAR VIEW, TYPICAL

Pad Location "H" (Left Side)

Pad Location "G" (Right Side)

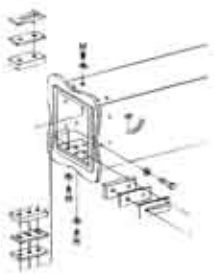
The Boom Bearing Pads are now fully adjusted.

AREA 1 AND AREA 2

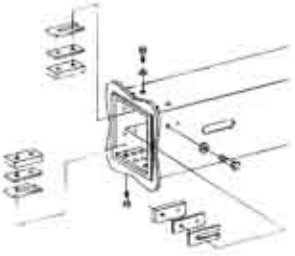
Bearing pad removal from Area 1 and Area 2 is accomplished with the boom extended approximately three fourths of the total stroke. If the pinch point is tight, you may have to remove shims and spacers from the opposite bearing pad.

Record quantities and Part Numbers of the spacers and shims removed from each location. This will assist you in reinstalling the bearing pad, spacer and shim package.

BOOM-SECTION 1:
AREA 1, FRONT INSIDE

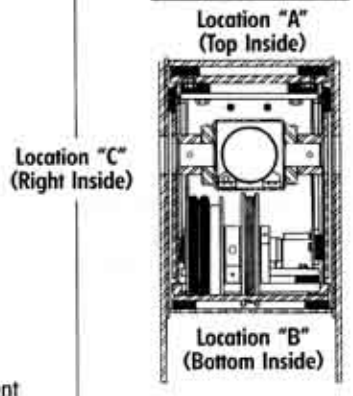


BOOM-SECTION 2:
AREA 2, FRONT INSIDE



SEE NOTE ON PAGE 2.0 FOR BOOM BEARING PAD BOLT QUANTITIES

END VIEW AREA 1 & 2



→ **Removal**

Pad Location "A"

1. Raise the boom assembly approximately 1 ft. off the ground.
2. Remove the key from the ignition and fasten a "do not operate" tag to the steering wheel.
3. Remove the bearing pad mounting bolts and washers.
4. Remove the shims, spacers and the bearing pad.

→ **Removal**

Pad Location "B"

1. Lower the boom assembly to ground and apply minimal down-pressure, sufficient to provide clearance at Location "B".
2. Remove the key from the ignition and fasten a "do not operate" tag to the steering wheel.
3. Remove the bearing pad mounting bolts and washers.
4. Remove shims, spacers and bearing pads.

→ **Removal**

Pad Location "C" & "D"

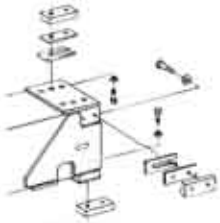
1. If the boom is tight, install a wedge to the side and force the boom to the opposite side.
2. Remove the key from the ignition and fasten a "do not operate" tag to the steering wheel.
3. Remove the bearing pad mounting bolts.
4. Remove shims, spacers and bearing pads.
5. Remove the wedge installed in Step 1.

Area 3 and Area 4, Pad Location "E"

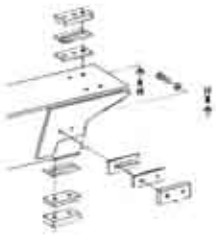
→ **Removal**

1. Steam-clean or pressure-wash the rear of the boom assembly.
2. Retract the boom fully, then extend 1 ft.
3. Remove the key from the ignition and fasten a "do not operate" tag to the steering wheel.
4. If necessary, use a wedge to shift the Boom-Section to the opposite side to create clearance for bolt removal. If additional clearance is required, remove the shim pack from the side opposite the bearing pad being removed.
5. Remove the bearing pad mounting bolts.
6. Remove shims, spacers and bearing pads.
7. Remove the wedge installed in Step 4.

Boom-Section 2:
Area 3; Rear Outside



Boom-Section 3:
Area 4; Rear Outside



See note on page 2.0 for boom bearing pad bolt quantities

Area 4

→ **Removal**

Pad Location "F"

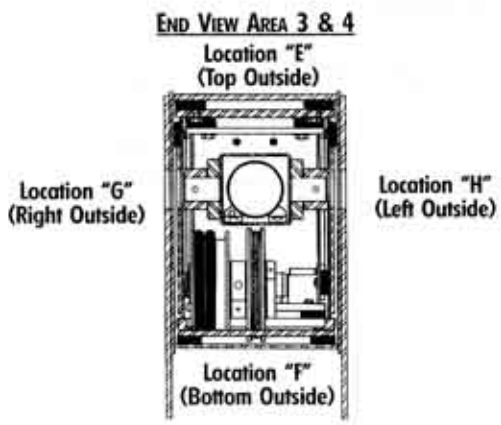
1. Extend Boom-Section 3 past the access holes in Boom-Section 2.
2. Lower the boom to 1 ft. off ground. The front of the boom will pivot down, creating clearance at Pad Location "F".
3. Remove the key from the ignition and fasten a "do not operate" tag to the steering wheel.
4. Through the access hole, remove the bearing pad mounting bolts at Pad Location "F".
5. Remove the shims, spacers and bearing pads.

→ **Removal**

Pad Location "G" & "H"

1. Extend Boom-Section 3 past the access holes in Boom-Section 2.
2. Remove the key from the ignition and fasten a "do not operate" tag to the steering wheel.
3. Install a wedge at pad location "G" or "H" and force the Boom-Section to the opposite side.
4. Remove the bearing pad mounting bolts.
5. Remove shims, spacers and bearing pads.
6. Remove the wedge installed in Step 3.
7. Repeat Steps 2 thru 5 for opposite side bearing pad removal.

End View Area 3 & 4



GENERAL

- It may be possible for a bearing pad only to be installed if there is insufficient clearance for spacers or shims.
- If no spacer or shim is installed, or if only the spacer is installed with the bearing pad, use two (2) flat washers under the head of the bearing pad mounting bolt. This will ensure the bolt will not protrude past the chamfer on the pad.
- **Do Not** install a shim against a bearing pad. This will ruin the integrity of the fastener system.
- If there is not room for a spacer and a shim, use only the spacer.
- Use ***LOCTITE* 242** (Gradall P/N 1440-3364) on all bearing pad mounting bolts.
- Bearing pad mounting bolt torques are:
  $^3/_8$" bolt: 32-37 ft-lb
  $^1/_2$" bolt: 76-86 ft-lb
- **Do Not** overtorque mounting bolts. This could pull the bearing pad nut through the bearing, causing the bearing pad to fall out of the boom.
- Lube bearing pad slide paths.
- Shims and spacers are stamped with the Gradall Part Number and thickness. Check replacement parts against the original to be certain the correct parts are being used.

DANGER **Remove the key from the ignition and fasten a "do not operate" tag to the steering wheel before working on or inside the boom.**

BEARING PAD INSTALLATION

1. Refer to bearing pad removal instructions for boom area and bearing pad placement, Sections 2 & 3.
2. Refer to the Part Numbers of shims and spacers removed.
3. Refer to the quantity of shims removed.
4. Place the new package (bearing pad, spacer and shims) to installation area using the same quantity that was removed.
5. **Do Not** install a shim directly against the bearing pad.
6. Install the bearing pad mounting bolts. Determine whether one or two flat washers must be used under the bolt head at this time.
7. Apply ***LOCTITE* 242** to the mounting bolt threads.
8. Torque the mounting bolts to 32-37 ft-lb ($^3/_8$" bolt) or 76-86 ft-lb ($^1/_2$" bolt).

Note!

After new bearing pads are installed, you will have to check the boom for correct adjustment. Readjust if necessary.

534C-9/C-10/& 534 D-9/D-10 Bearing Pad, Spacer, Shim Data: 40' & 45' Boom

Part Number	Pad	Shim	Spacer	Dimension	Boom-Section	Area	Location
9112-3018	X				3	4	B
9112-3019	X				2, 3	2, 3, 4	A, F
9114-3168	X				1, 2, 3	1, 2, 3, 4	A, C, G, H
9103-3186	X				1, 3	4, 1	A, C, D
9112-3021	X				2	2	C, D, G, H
9103-3185	X				1	1	A
9103-3187	X				1		Push Beam
9114-3083	X				1		Crowd Cylinder
9103-1236			X	.060"	1, 2, 3	1, 3, 4	A, C, D, G, H
9112-1083			X	.060"	2,3	2, 3, 4	A, F, C, D
9114-1302		X		.060"	1, 2, 3	1, 2, 3, 4	A, B, E
9114-1303		X		.060"	1, 2, 3	4	A, B, E
9020-5870		X		.060"	1, 2, 3	1, 2, 3, 4	A, C, D, G, H
9112-1082		X		.060"	2, 3	2, 3, 4	A, B, C, D, F
9112-1157		X		.134"			Strong Back
9112-1023		X		.060"			Strong Back
9112-1024		X		.036"			Strong Back

534C-6, & 534D-6 Bearing Pad, Spacer, Shim Data: 42' Boom

Part Number	Pad	Shim	Spacer	Dimension	Boom-Section	Area	Location
9112-3019	X				2, 3	3, 4	F
9108-3297	X				2, 3	3, 4	E
9103-3186	X				1, 2, 3	1, 3, 4	C, D, G, H
9112-3021	X				2	2	C, D
9108-3063	X				1, 2	2	B
9103-3185	X				1	1	A
9103-3187	X				**	**	**
9112-1081		X		.06	3	3, 4	A E
9020-5870		X		.06	1, 3	1, 3, 4	C, D, G, H
9112-1082		X		.06	2	2	C, D
9108-1171		X		.06	1	1	B
9112-1023		X		.0598	1		*
9112-1024		X		.0359	1		*
9112-1157		X		.1340	1		*
9108-1447			X	.132	3, 2	3, 4	E
9103-1236			X	.06	2, 3	3, 4	C, D, G, H
9112-1083			X	.06	2	2	A, C, D
9108-1172			X	.132	1, 2		B

* Rear of Boom, Crowd Cylinder Bracket

** Extension Cable Bracket

532C-6 & 534C-6 Bearing Pad, Spacer, Shim Data: 36' Boom

Part Number	Pad	Spacer	Shim	Dimension	Boom-Section	Area	Location
9112-3019	X				2, 3	2, 3, 4	A, F
9108-3297	X				2, 3	3, 4	E
9103-3186	X				1, 2, 3	1, 3, 4	C, D, G, H
9103-3185	X				1	1	A
9112-3021	X				3	4	G, H
9108-3063	X				1, 2, 3	1, 2	B, F
9103-3187	X						*
9108-1447		X		.132	3, 2	3, 4	E
9103-1236		X		.060	1, 2, 3	1, 3	A, C, D, G, H
9108-1172		X		.132	1, 2	1, 2	B
9112-1083		X		.060	2	2	A
9112-1081			X	.060	3, 2	3, 4	E
9112-1024			X	.0359	1		**
9112-1023			X	.0598	1		**
9020-5870			X	.060	2, 3	1, 2, 4	A, C, D, G, H
9112-1082			X	.060	1, 2	1, 2	C, D
9112-1157			X	.134	1		**
9108-1171			X		2	2	B

* Extension Cable Bracket
** Crowd Cylinder Mounting Bracket

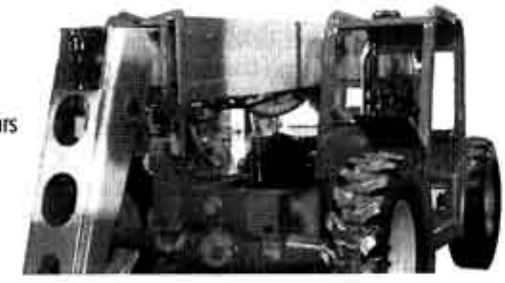
While the booms can be separated from each other on the machine, Gradall recommends against this procedure. It is much safer, more efficient and more cost-effective to remove the complete boom assembly from the machine and place it on stanchions (horses) for separation. Work can then progress at a normal working height.

(5A) REMOVAL OF THE COMPLETE BOOM ASSEMBLY FROM THE MACHINE

→ Preparation

1. Position the handler in a safe, level, open area away from personnel and equipment.
2. Apply the parking brake, shift the Forward/Reverse lever to "Neutral" and turn the rear wheels straight forward.
3. Level the boom assembly.
4. Turn off the ignition switch, remove the key and fasten a "do not operate" tag to the steering wheel.
5. Chock the wheels to prevent machine movement during removal operation.

MACHINE READY FOR BOOM REMOVAL: WHEELS STRAIGHT, BOOM LIFTED INTO PLACE, SLING AT BALANCE POINT



→ Stage 1

1. Procure a crane and lifting tackle capable of safely lifting 5000 lb.
2. Install a tag line to the front of the boom to help guide the boom once it clears the machine.
3. Fasten slings to Boom-Section 1 at the balance point.
4. Take the weight off the boom assembly.

→ Stage 2

1. Identify and tag all hydraulic hoses and electrical cables.
2. Separate, plug and cap all hoses and electrical cables. With the crowd cylinder hoses blocked off, the Boom-Sections will be locked in position, preventing run-out.
3. Carefully remove pins from the compensation and lift cylinders. Do not let the cylinders fall uncontrolled. Carefully place them in a position of rest. Block the lift cylinder in place to ensure it does not fall against the engine. Do not install blocking over the engine valve cover.

4. Confirm the crane still has the weight of the boom in a balanced position.
5. Carefully remove the boom base pivot pin.
6. Lift the boom assembly free of the machine and place in the designated work area.

BOOM BASE PIVOT PIN

(5B) Reinstalling the Complete Boom Assembly to the Machine

→ Preparation

- Select a work area with sufficient space to work safely and efficiently.
- Clean the work area.
- Procure tools required for this operation.
- Procure a crane or hoist and slings capable of lifting 5000 lb.
- If working with a helper, be certain each of you know your individual assignments.
- Mechanically fasten the Boom-Sections together to prevent unexpected uncontrolled movement if the crowd cylinder is removed or the crowd cylinder hydraulic line is opened or removed.
- Procure hydraulic fluid for topping off the hydraulic system. Use only Gradall–approved fluids.

Machine Ready for Boom Reinstallation: Wheels Straight, Boom Lifted into Place, Sling at Balance Point

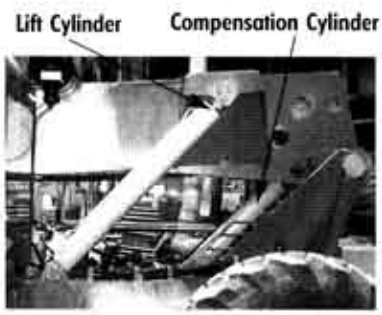
→ Stage 1

1. Install slings around the boom assembly at the balance point.
2. Make a trial lift to be certain the balance point is correct.
3. Connect a tag line to the front of the boom assembly to aid placement of the assembly.
4. Lubricate all cylinder and boom assembly mounting wear bushings and pins.
5. Lift the assembly and position the mounting base for pivot pin installation.
6. Install the mounting base pin and lock in position using a stover nut.
7. Position the boom assembly bores correctly to install the cylinder pins.

Note!

Using the sway circuit will aid Steps 5, 6, and 7.

8. Install the cylinder pins and lock in position using **LOCTITE 242** (Gradall P/N 1440-3364) on the pin keeper threads.



Boom Base Pivot Pin Location

→ **Stage 2**

1. Apply **LOCTITE 545** (Gradall P/N 1440-4043) to all hydraulic fittings.
2. Connect all hydraulic hoses to the proper circuits and torque. Refer to identification tags applied during removal operation.
3. Connect auxiliary electrics if the machine is so equipped.
4. Check the torque on all mounting and cylinder locking pins.
5. Refill the hydraulic system (if necessary).

→ **Stage 3**

1. Remove lifting tackle and tag line.
2. Drive the machine to an area with sufficient space for full boom circuit operation.
3. Start up the machine and cycle all boom functions a sufficient length of time to warm up the hydraulic system to at least 120°F.
4. After completion of Step 3, check all circuits for hydraulic leaks, correcting where necessary.
5. Re-check the hydraulic system capacity level; fill up if necessary.

→ **Stage 4**

1. Inspect boom bearing pads for correct adjustment. If adjustment is required see Section 2, "Boom Adjustment".
2. Inspect retraction and extension cable for proper installation and adjustment. If adjustment is required, see Section 7.
3. Inspect hydraulic hose installations to ensure they are not rolling under twist. If they are under twist, readjust by loosening fittings and clamps to relieve the twist. Re-torque using two wrenches at the fittings. Tighten all hose clamps.
4. Inspect auxiliary circuit electric cable for proper installation. It should be tight and roll simultaneous with the auxiliary hydraulic hoses. Correct if necessary.

The Boom should now be properly installed and ready to return to service.

(5C) Separating Boom-Sections 2 and 3 From Boom-Section 1

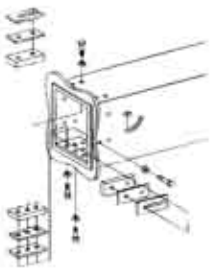
→ Preparation

- Review all Safety issues before commencing.
- Select a safe, clean area with sufficient space to work on the assembly.
- Procure lifting tackle and a crane capable of lifting 5000 lb.
- Place the boom assembly upside down (inverted 180°) on stanchions.
- If working with a helper, be certain each of you know your individual assignments.
- Procure tags for identification of hoses and components removed.
- Designate area placement of removed components.

Stage 1

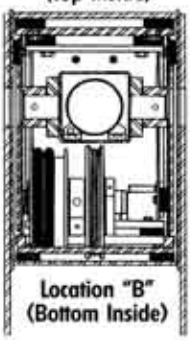
→ **1.** Remove all bearing pads at the front inside of Boom-Section 1, Area 1, Pad Locations A, B, C, D.

Boom-Section 1
Area 1: Front Inside

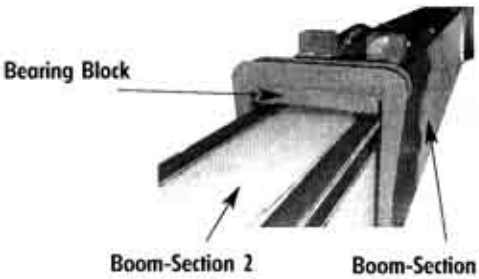


See note on page 2.0 for boom bearing pad bolt quantities

End View Area 1 & 2



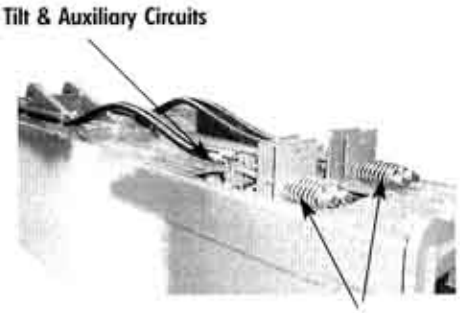
2. Remove the bearing block from the front inside of Boom-Section 1, Area 1.



Note! *Boom-Sections Upside-Down*

3. Loosen the hose take-up brackets.

4. Separate, plug and cap tilt circuit (and auxiliary) hydraulic hoses inside the boom at the hose take-up bracket.



Note! *Boom Upside-Down*

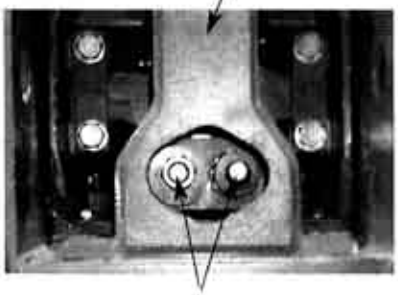
5. If auxiliary electrics are present, separate the electric plug at the hose take-up area.

→ **Stage 2**

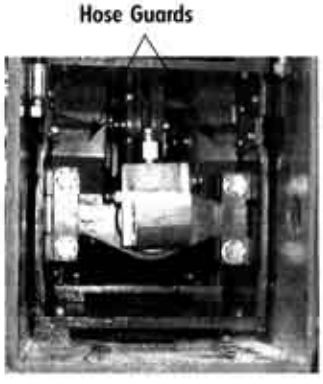
1. Loosen the retraction cable and remove all fasteners from the retraction cable adjusting block, located at the front of Boom-Section 1.

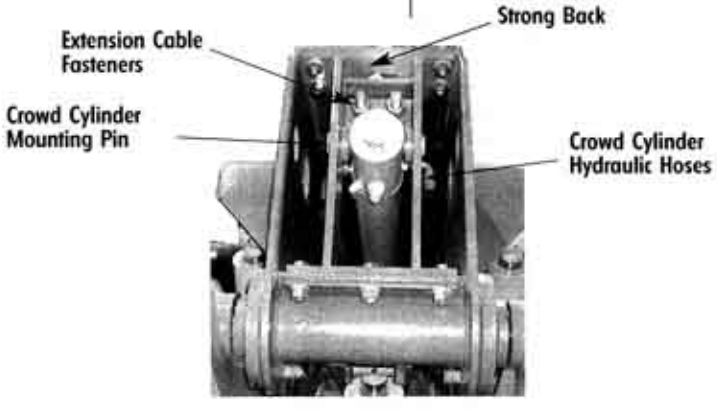
Retraction Cable Adjusting Block

Block and Fasteners



2. At the rear of the boom assembly (strong back/cylinder bracket), remove all fasteners from the extension cables, using one wrench to hold and one to turn.
3. Separate, cap and plug the crowd cylinder hydraulic hoses.
4. Remove the crowd cylinder mounting pins and fasteners.
5. At the rear of the boom assembly, remove the hose guards.
6. Remove the strong back (cable bracket) from the rear of the boom assembly.





→ **Stage 3**

1. Fasten lifting tackle to Boom Sections 2 and 3, lift and partially pull out of Boom Section 1.
2. Place stanchions under Boom Sections 2 and 3 and take off the weight, letting them rest on stanchions.
3. Reinstall lifting tackle at the balance point of Boom Sections 2 and 3 and slowly extract them from Boom Section 1, protecting all hydraulic hoses and cables.
4. Place Boom Sections 2 and 3 in the designated work area for the next operation.

(5D) Separating Boom-Section 3 from Boom-Section 2

The procedures listed in this section are complete for separating Boom-Sections from each other. Reassembly procedures are given in Section 6, *"Assembling Boom-Sections 1, 2 & 3"*. These procedures are given using shop conditions only, with the Boom-Sections inverted 180° (upside down).

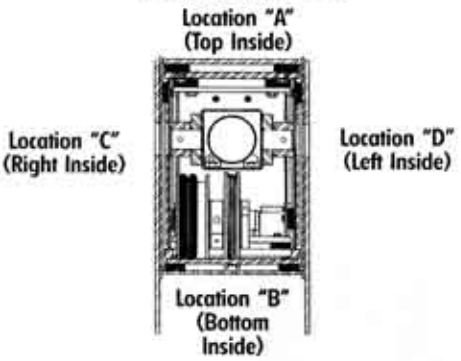
→ Preparation

- Review preparation parameters from Section 5C.
- Review all Safety Issues.
- Select an appropriate place to store Boom-Section 3 after removal from Boom-Section 2

→ Stage 1

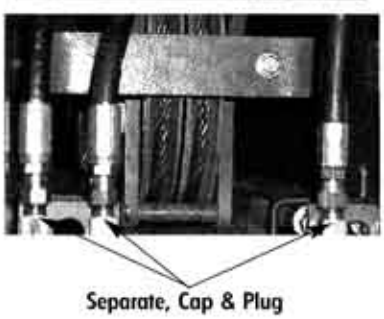
1. Remove all bearing pads from the inside front of Boom-Section 2, Area 2, Pad Locations A, B, C, D.

End View Area 1 & 2



2. Separate, plug and cap tilt circuit hydraulic hoses (and auxiliary circuits) at the inside front of Boom-Section 3 at the boom head section.

Tilt & Auxiliary Circuit Hoses - Step 2

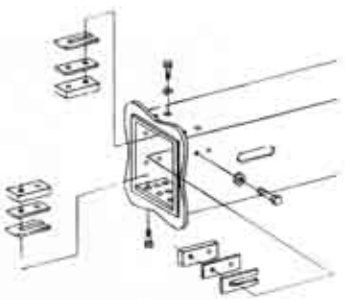


3. **534C-9/C-10 & 534D-9/D-10:**
   Remove all extension cable sheave components from the pivot beam front.
4. **532C-6, 534C-6 & 534D-6:**
   Remove extension cable sheave bracket fasteners from the front of the crowd cylinder.

Extend Cable Sheave Front Section #3

5. **532C-6, 534C-6 & 534D-6:**
   Pull extension cable sheave bracket free of Boom-Section 3 and set aside for repair or reinstall.

Boom-Section 2:
Area 2, Front Inside

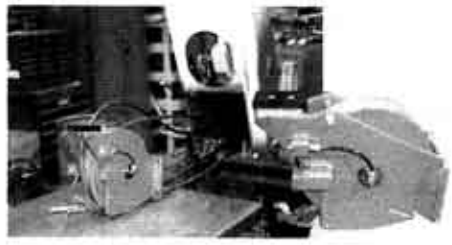


See note on page 2.0 for boom bearing pad bolt quantities

534C-9/C-10 & 534D-9/D10:
Extend Cable Sheave & Push Beam

5. **532C-6, 534C-6 & 534D-6:**
Pull extension cable sheave bracket free of Boom-Section 3 and set aside for repair or reinstall.

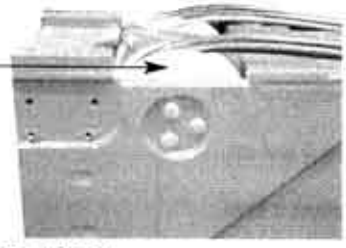
532C-6, 543C & D-6
EXTENSION CABLE BRACKET



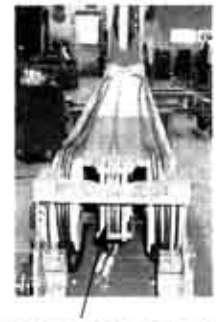
6. Pull the extension cables free of the sheave brackets and lay them on the boom.

→ **Stage 2**

1. At the rear of the boom, remove all retraction cable sheave components.
2. Remove hydraulic hose rollers and components.



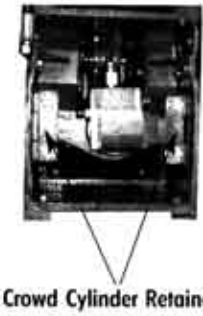
REAR SECTION 2 & 3:
HOSES AND RETRACTION CABLE



Retraction Cable Sheave, Step 1

3. **532C-6, 534C-6 & 534D-6:**
Remove crowd cylinder retainers.

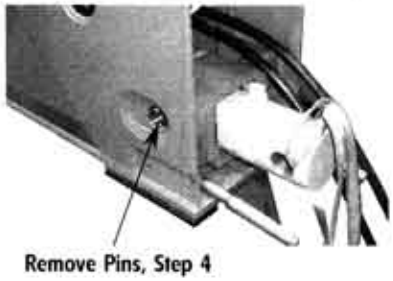
532C-6, 534C-6 & 534D-6



Crowd Cylinder Retainers

4. **534C-9/C-10 & 534D-9/D-10:**
Remove all push beam pins and fasteners.

PUSH BEAM MOUNTING PIN AREA



Remove Pins, Step 4

534C-9/C-10 & 534D-9/D-10

Push Beam

→ **Stage 3**

1. **534C-9/C-10 & 534D-9/D-10:** From the front of Boom-Section 3, pull the push beam free of the boom assemblies.

2. **532C-6, 534C-6 & 534D-6:** From rear of Boom-Section 2 pull the crowd cylinder free of the boom assembly.

3. Place hydraulic hoses and cables inside Boom-Section 3 for protection.

Boom-Section 3, Front Inside: Cable & Hoses Inside Boom

532C-6, 534C-6 & 534D-6

→ **Stage 4**

1. Install lifting tackle to Boom-Section 3.
2. Take the weight and pull Boom-Section 3 from Boom-Section 2 far enough to rest at the balance point.
3. Place stanchions under Boom-Section 3 and release the weight, letting it rest on the stanchions.
4. Reinstall lifting tackle at Boom-Section 3 balance point and slowly extract it from Boom-Section 2.
5. Place Boom-Section 3 in the designated work area for the next operation.

The Boom-Sections are now separated. No special instructions are required for component removal and/or replacement. Refer to "Section 6" for reassembly of Boom-Sections.

The procedures listed in this section are complete for assembling the bare boom weldment to final assembly of the boom. Assembly procedures start with Boom-Section 3, followed in order by Boom-Sections 2 and 1. They also are given using shop conditions only, with the Boom-Sections inverted 180° (upside-down).

The instructions cover all 532 and 534 "C" and "D" series booms of any length. Deviations from standard procedures that cover all models are indicated with appropriate notations.

It would not be practical to attempt to cover every repair situation that might occur in the field. Therefore, these instructions cover the complete boom assembly and individual components. You may have to adapt these procedures to fit specific field situations.

⚠ CAUTION!

- Use **LOCTITE 242** (Gradall P/N 1440-3364) on all bolt threads.
- Use **LOCTITE 545** (Gradall P/N 1440-4043) on all hydraulic tube fittings.
- Torque fasteners and hydraulic fittings to the values given in Appendix "A" & Appendix "B".
- Shim bearing pads to 1/16" of tight fit. You may have to final adjust the bearing pads after the boom is installed on the machine and hydraulic power is available.
- Follow instructions given in Section 2 for bearing pad adjustment.
- Coat the interior of all bushings and sheaves with *Mystik Tetrimoly* grease (Gradall P/N 1440-4595) prior to installation of pins and bushings.
- Bearing pads and slide areas must be lubricated with *Mystik Tetrimoly* grease or equivalent.

Note!

Assembly of the Boom-Sections is quite complex. Close attention to the instructions is extremely important. Normal mechanic's tools are required, as well as a hoist capable of lifting 5000 lb. to handle the weight of the complete boom assembly.

(6A) Boom-Section 3 Assembly

→ Preparation

- Select an area with sufficient space to work safely and efficiently.
- Clean the work area.
- Procure all tools and lifting devices required for this operation.
- Use crane capable of lifting 5000 lbs.
- Gather and identify parts to be used.
- If working with a helper, be certain each of you know your individual assignments.
- Use stanchions (work horses) of sufficient capacity to hold boom assemblies safely.

→ Stage 1, Boom Weldment, Bearing Pads

1. Place Boom-Section 3 upside-down on stanchions.

Boom-Section 3, Upside-Down

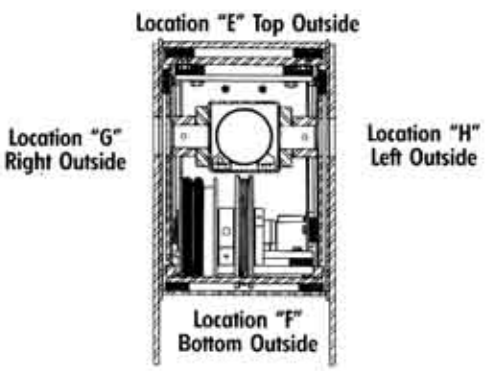
2. Clean the inside and outside boom surfaces.
3. Inspect tilt carriage bushings in the boom head section for damage or excessive wear. Bushing ID when new is 2.511-2.512". Replace if worn more than 1/16" or damaged.

4. Install bearing pads, spacers and shims to the rear of the boom, Area 4, at the following locations:
   534C-6/534D-6; All pad locations.
   534C-9/C10, 534D-9/D10; Locations "B", "C", & "D".

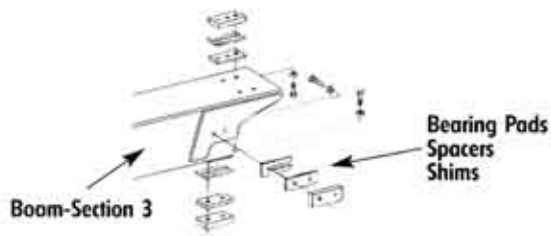
Note!

Do Not install spacers and shims to bearing pads at Location "E" at this time. This will make insertion into Boom-Section 2 easier.

END VIEW AREA 3 & 4



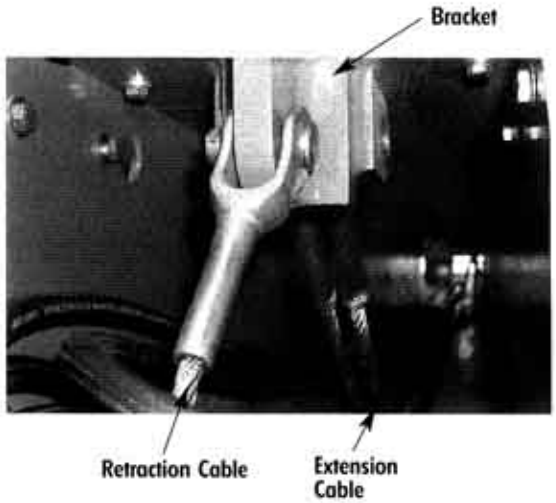
BOOM-SECTION 3
AREA 4, - REAR OUTSIDE



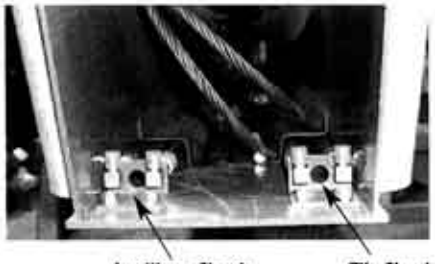
SEE NOTE ON PAGE 2.0 FOR BOOM BEARING PAD BOLT QUANTITIES

→ **Stage 2, Cables and Hoses**

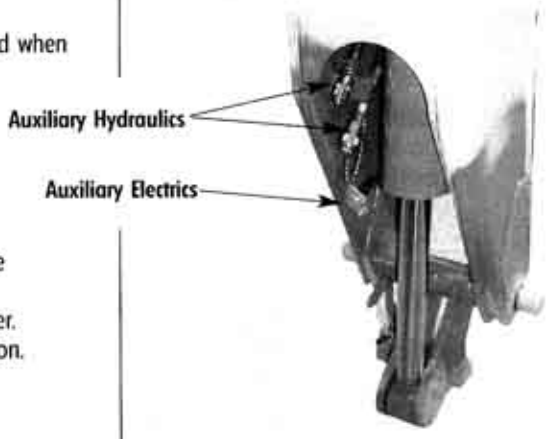
1. Install single retraction cable and double extension cable to the bracket at the inside rear of the boom.



2. Install tilt circuit hoses and auxiliary circuit hoses and electric cables and brackets inside protected areas.
3. Bolt hose brackets in place at the front of the boom.

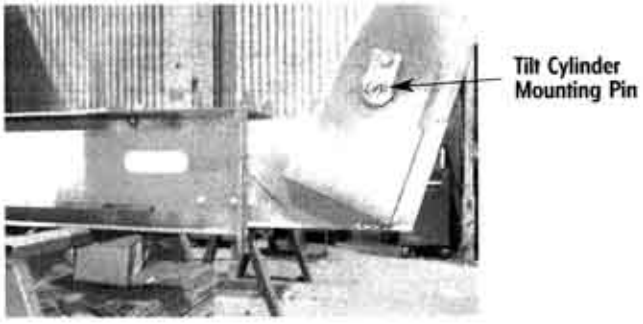


4. Lubricate Bearing pad paths.
5. Lay cable and hose inside Boom-Section 3 to protect against being pinched when installed into Boom-Section 2.



→ **Stage 3, Tilt Cylinder and Auxiliary Circuits**

1. Install hoses for the tilt cylinder.
2. Install hoses and electric cables for any auxiliary circuits.
3. Lift the tilt cylinder and place it inside the boom head section, lining up the mounting pin bores.
4. Install the mounting pin through the boom head section and the tilt cylinder.
5. Apply ***LOCTITE* 242** to the keeper bolt and lock the mounting pin in position.



Boom-Section 3 is now ready for insertion into Boom-Section 2.

(6B) Boom-Section 2 Assembly

→ Preparation

- Clean the work area.
- Gather and identify parts to be used.
- If working with a helper, be certain each of you knows your individual assignments.
- Procure proper lifting tackle to safely lift and install components to each other.
- Use stanchions of sufficient capacity to hold Boom-Sections 1 & 2.
- Be certain the work area has sufficient space to work safely.

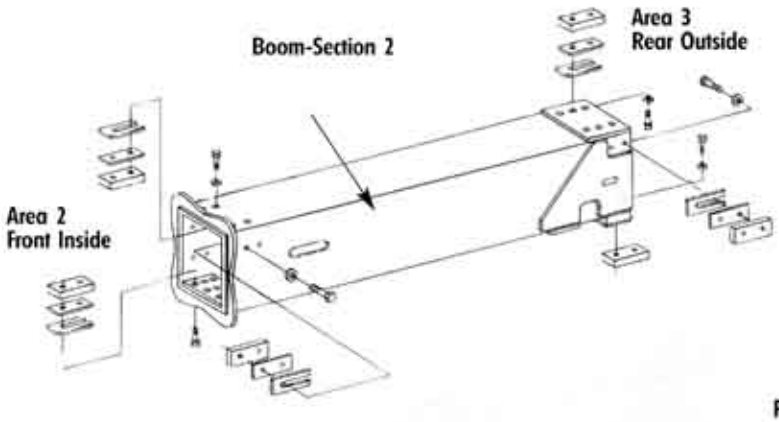
Assembly

→ Stage 1, Boom Weldment, Bearing Pads

1. Place Boom-Section 2 upside-down on stanchions.
2. Clean the inside and outside of Boom-Section 2 thoroughly.
3. Lubricate the inside of the boom at the bearing slide path area.
4. Install Boom-Section 3 into Boom-Section 2. Install through the front of Boom-Section 2.

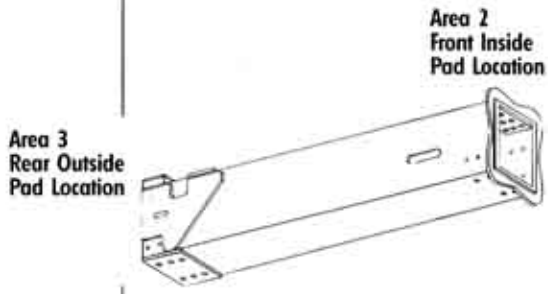
Typical Installation

5. Install bearing pads, spacers and shims to the rear boom Area 3 and front boom Area 2. **Do Not install pads to locations "F" and "H" yet.** This will make insertion into Boom-Section 1 easier.
6. Install bearing pads, spacers and shims at Pad Location "E" (See Section 6A, "Boom-Section 3 Assembly," Stage 1, Step 4 on page 6.1).



See note on page 2.0 for boom bearing pad bolt quantities

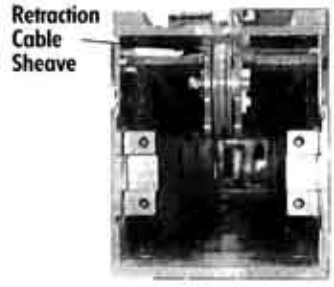
Boom-Section 2 (Upside-Down)



→ **Stage 2, Retract Cable and Hose Sheaves**

532C-6, 534C-6 & 534D-6 ONLY!

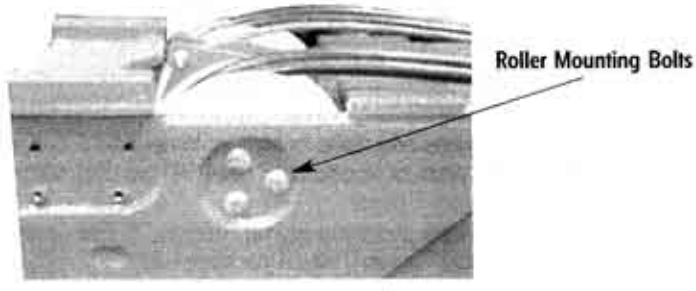
1. Install the retraction cable sheave to the bracket at rear of Area 3.
2. Install the cable around the sheave and lock it in place using ***LOCTITE* 242** on threads.
3. Install the cable adjustment block to the cable at the other end.



RETRACTION CABLE ADJUSTMENT BLOCK

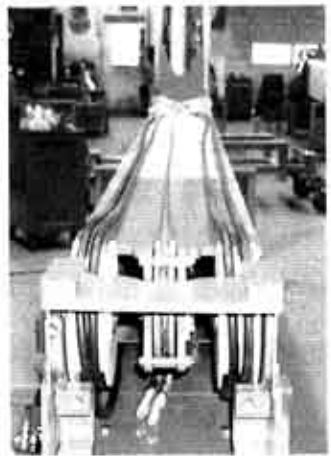
4. Install the tilt (and auxiliary electric/hydraulic) circuit hose rollers and hoses to the rear of the boom at Area 3.

HOSE ROLLERS AND HOSES



5. Lay out hoses and cable to the top of the boom in preparation for installation into Boom-Section 1.
6. Lubricate all bearing pad slide surfaces.

BOOM-SECTIONS 2 & 3 UPSIDE-DOWN:
STANDARD & AUXILIARY CIRCUITS INSTALLED



→ **Stage 3, Crowd Cylinder**

532C-6, 534C-6 & 534D-6 ONLY!

Install the crowd cylinder into the boom assembly. The crowd cylinder is installed through the rear of the boom assembly.

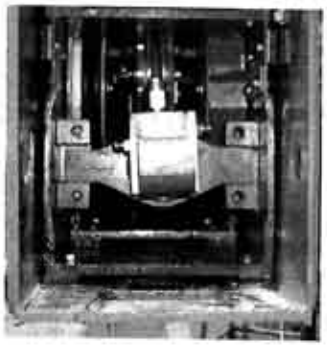
1. Clean the threads at the extension cable sheave mounting area.
2. Feed the cylinder into the boom until the base anchor area is secured into the bracket at the rear of Boom-Section 2.
3. Install the crowd cylinder retainers and torque the bolts to 340-365 ft-lb.

Crowd Cylinder Mounting Bolts Extension Cable Sheave

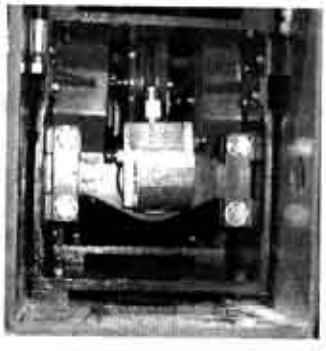
Crowd Cylinder

534D-6 Crowd Cylinder Base End

Rear of Booms: Crowd Cylinder Installed into Brackets



Retainer Plates Installed & Torqued

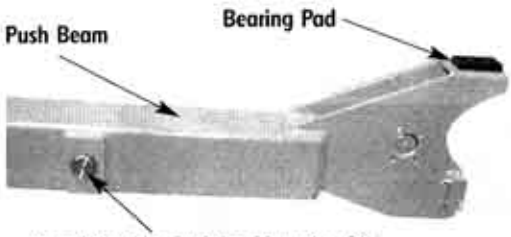


→ Stage 3, Crowd Cylinder & Push Beam Assembly

534C-9/C-10 & 534D-9/D-10 ONLY!

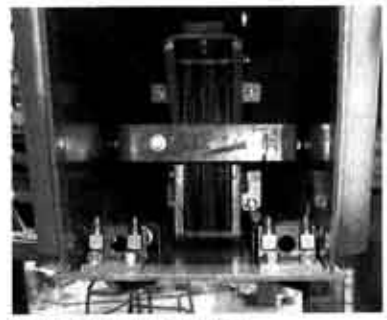
Part One

1. Clean the push beam weldment and all parts for the extension sheave assembly.
2. Install the crowd cylinder into the push beam.
3. Install the mounting pin and hardware at the crowd cylinder rod eye.

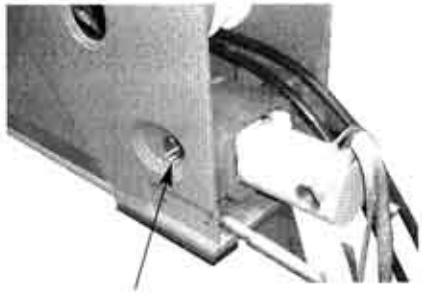


4. Through the front of Boom-Section 3, partially insert the push beam leaving the sheave bracket extended for accessibility.
5. Install the extension cables and feed the threaded end through the sheave bracket. The cable end will not feed through the sheave bracket with the sheave installed.
6. Lay out the cables over boom head toward the rear of boom assembly.
7. Install the extension cable sheave assembly complete; ie. sheaves, pins, lube system, bearing pads.
8. Feed the cables around the sheave.
9. Install the cable guide and guide bar.
10. Install the push beam mounting pins and locking hardware at the rear of Boom-Section 2.

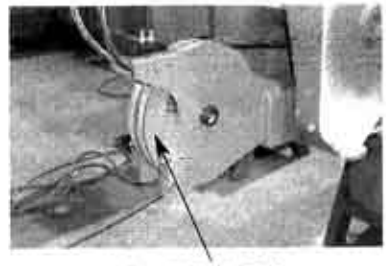
EXTENSION SHEAVE BRACKET: FRONT CROWD CYLINDER



Cable Guide & Guide Bar



Install Mounting Pins Here



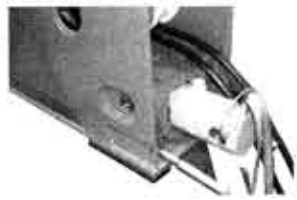
Install Cable Before Sheave Components

Part Two

1. Install the push beam fully into Boom-Section 2, lining up the mounting pin bores.
2. Install the push beam mounting pins and locking hardware at the rear of Boom-Section 2.

Mounting Pin Area

PUSH BEAM MOUNTING PIN AREA



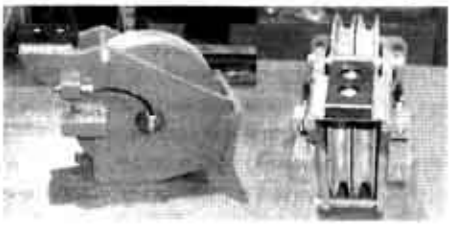
Boom-Sections 3 & 2 are now ready for insertion into Boom-Section 1.

→ Stage 4, Extension Cable Sheave

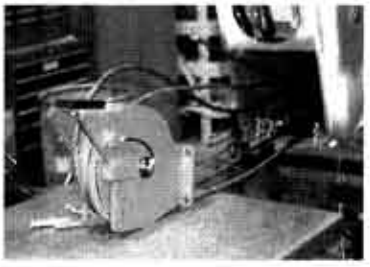
532C-6, 534C-6 & 534D-6

1. Gather and clean parts to assemble the cable extension sheave.
2. Assemble the extension cable sheave bracket assembly. See the appropriate current *Gradall Parts Manual* for applicable parts.
3. Place the cable extension sheave bracket on the work table, in front of Boom-Section 3.
4. Feed the extension cable around the sheaves in the bracket.
5. Install the cable guards on the sheave assembly.

Extension Cable Sheave Bracket Assembly



Extension Cable (Steps 3 & 4)

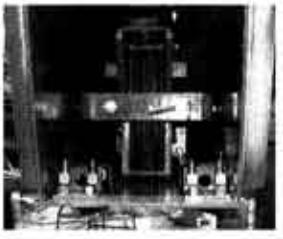


6. Pulling the cables to the rear of the boom assembly, install the sheave bracket on the crowd cylinder mounting bolts.
7. Install and torque the nuts at the crowd cylinder and the cable extension bracket.
8. Install the guide bar to the cable extension sheave bracket.

Crowd Cylinder Mounting Bolts

Extension Cable Installed on Sheave

Guide Bar



(6C) Boom-Section 1 Assembly

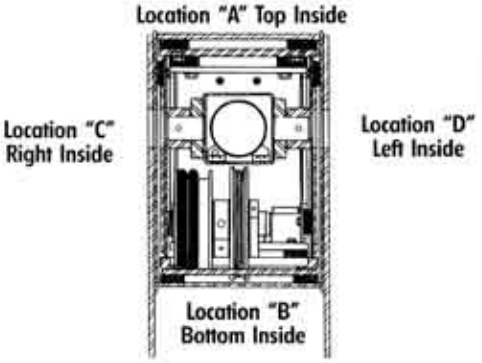
→ Preparation

- Clean the work area.
- Gather and identify all the parts to be used.
- Use stanchions of sufficient capacity to hold Boom-Sections 1, 2 & 3.
- Be certain the work area has sufficient space to work safely.
- If working with a helper, be certain each of you knows your individual assignments.
- Review the assembly operation for this Boom-Section.

→ Stage 1, Boom Weldment

1. Place Boom-Section 1 upside-down on stanchions.
2. Clean the inside and outside of Boom-Section 1 thoroughly.
3. Lubricate the inside of the boom at the bearing slide path area.

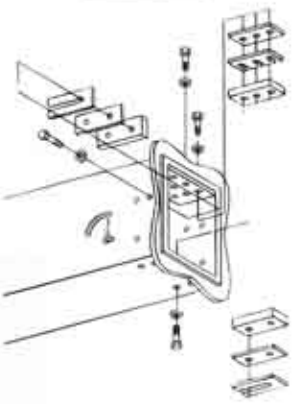
End View Area 1 & 2



4. Through the front of Boom-Section 1, install Boom-Sections 2 & 3.

Typical Installation

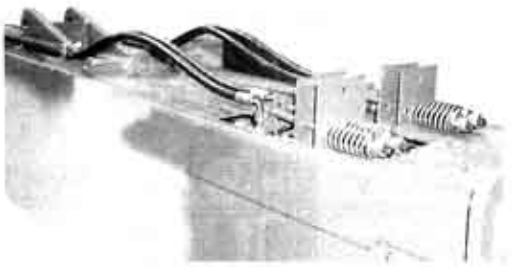
View with Boom-Section 1: Upside-Down



See note on page 2.0 for boom bearing pad bolt quantities

→ Stage 2, Bearing Pads & Hose Take-Up Assembly

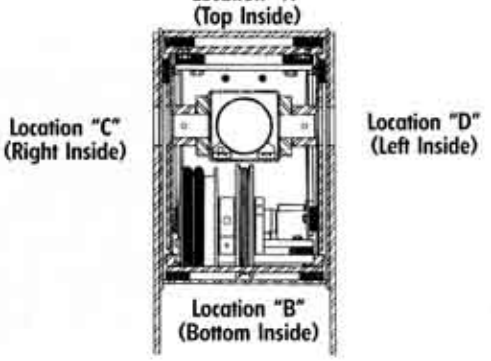
1. Install hose take-up assembly components to the front of the boom. Tighten components and fasten all hoses.
2. Install the retraction cable adjusting block. **Do Not tighten the cable yet!**

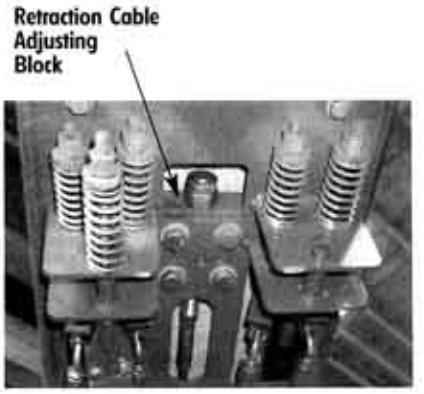


3. Install bearing block to the front inside of Boom-Section 1. This is the block on which the boom bearing pads mount at Area 1, Pad Location "B".

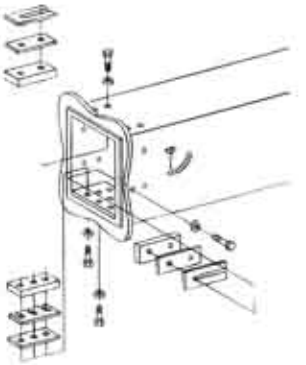
4. Install bearing pads, spacers and shims at Area 1, Pad Location A, B, C, D.
5. Torque the bearing block bolts 265-290 ft-lb and bearing pad mounting bolts to 68-78 ft-lb using ***LOCTITE* 242** on threads.

END VIEW AREA 1 & 2





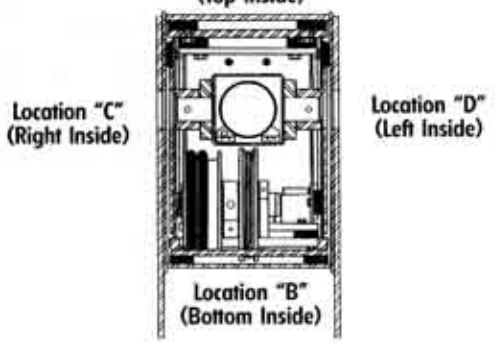
AREA 1 FRONT INSIDE - BOOM-SECTION 1



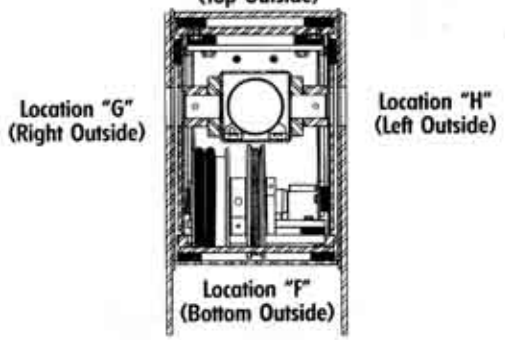
SEE NOTE ON PAGE 2.0 FOR BOOM BEARING PAD BOLT QUANTITIES

6. Install and adjust bearing pads at Pad Location "F" & "H" (See 6B, Boom Section 2 Assembly. Stage 1, Step 5 on page 6.4).
7. Adjust the front inside pads at Area 1 and 2 Pad Locations A, B, C, D.
8. If necessary, at the rear of the boom assembly, readjust the bearing pads at Areas 3 and 4.

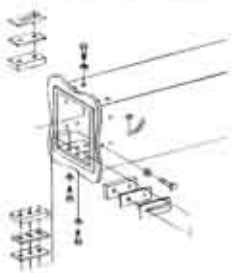
END VIEW AREA 1 & 2



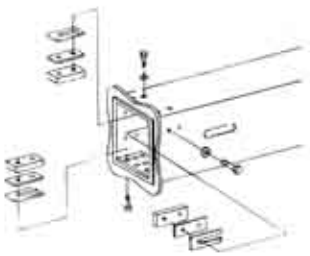
END VIEW AREA 3 & 4



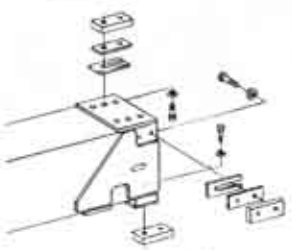
BOOM-SECTION 1
AREA 1, FRONT INSIDE



BOOM-SECTION 2
AREA 2, FRONT INSIDE



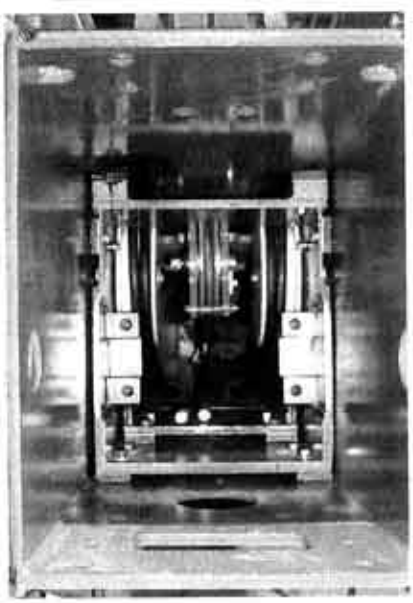
BOOM-SECTION 2
AREA 3, REAR OUTSIDE



BOOM-SECTION 3
AREA 4, REAR OUTSIDE

SEE NOTE ON PAGE 2.0 FOR BOOM BEARING PAD BOLT QUANTITIES

BOOM ASSEMBLY REAR AREA 3 & 4

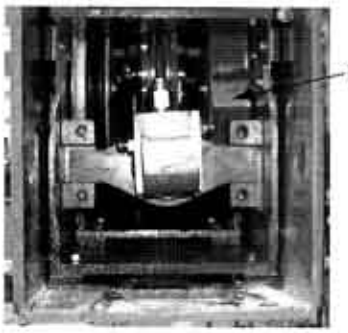


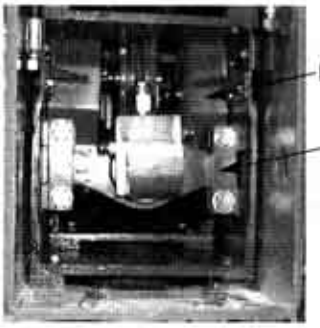
→ **Stage 3**

Boom Assembly Rear, Crowd Cylinder and Mounting Bracket, Extension & Retraction Cables

532C-6, 534C-6 & 534D-6 ONLY!

1. Install the standard and auxiliary circuit hose guards at the sheave area located in the rear of the Boom.

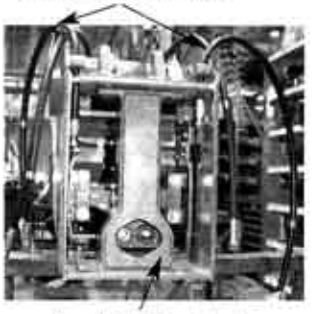


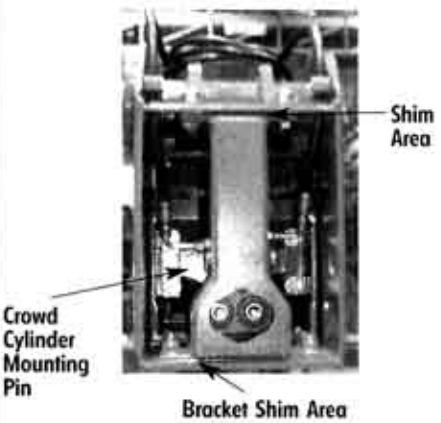


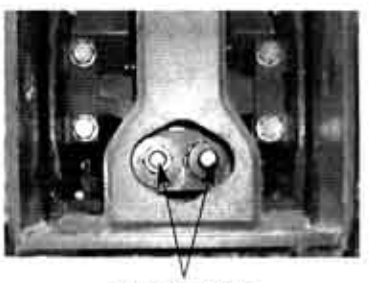
2. Place the crowd cylinder bracket inside the rear of Boom-Section 1. **Do not bolt in place yet!**
3. Insert the extension cables through the adjustment holes in the crowd cylinder mounting bracket. Make sure the cables are not crossed.
4. Install the crowd cylinder rod eye in the bracket. Lock it in place with the pin and snap rings.
5. Install the crowd cylinder bracket fasteners.
6. Measure the top and bottom clearance between Boom-Section 1 and the crowd cylinder bracket.
7. Install shims as required between the crowd cylinder and Boom-Section 1.
8. Torque the crowd cylinder bracket mounting bolts (see Appendix A), and apply ***LOCTITE* 242** to threads.
9. Install springs and nuts on the extension cables.
10. Tighten the retraction cable at the adjusting block.
11. Tighten the cable until its end lines up with the front of the cable adjustment access hole. When tightening, make sure that the wire rope is not turning.
12. **534C-9/C-10 & 534D-9/D-10:**
    The cable is tightened until the third thread from the end lines up with the cable adjustment access hole. When tightening, make sure that the wire rope is not turning.
13. Tighten the extension cables' adjusting nut until gap between cable flat washer and strong back is 1/32 to 1/16 inch. Gap for both washers should be equal. When tightening, make sure that the cable is not turning.
14. Install and torque the cable jam nuts to 100 ft-lb.
15. Install all hydraulic circuit hoses to the crowd cylinder.

Note!

See Stage 4 for 534C-9/C-10 & 534D-9/D-10 Strong Back Installation.



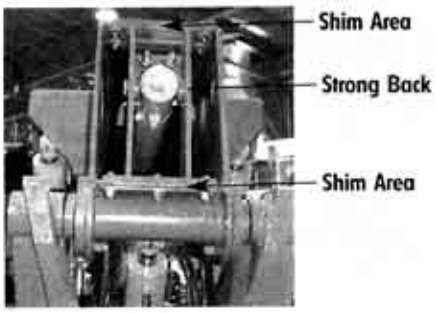




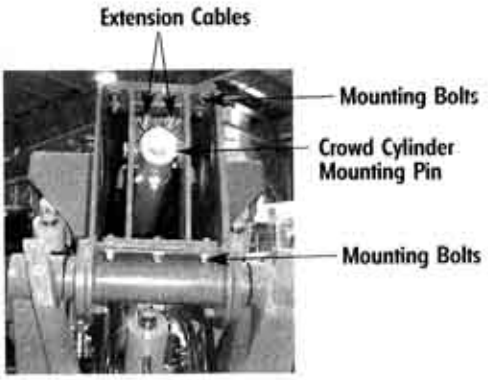
→ Stage 4, Strong Back Installation

534C-9/C-10 & 534D-9/D-10 ONLY!

1. Place the strong back in place at the rear of Boom-Section 1.
2. Install and lock the crowd cylinder mounting pin.
3. Measure the clearance between the top and bottom of the strong back to Boom-Section 1.
4. Install shims as required at the top and bottom of the strong back.

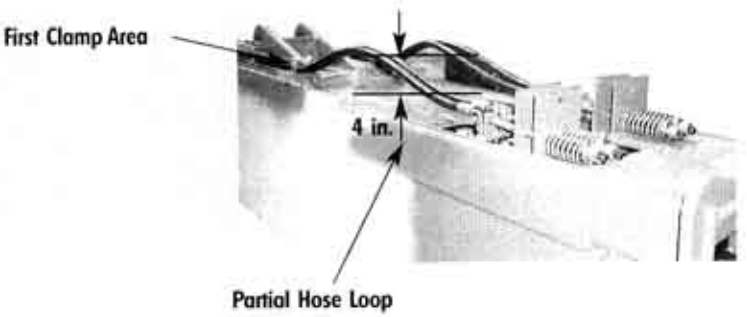


5. Install and torque the strong back mounting bolts.
6. Install extension cables and hardware into the strong back.
7. Tighten the extension cables' adjusting nut until gap between cable flat washer and strong back is 1/32 to 1/16 inch. Gap for both washers should be equal. When tightening, make sure that the cable is not turning.
8. Torque cable jam nuts to 100 ft-lb.
9. Install the crowd cylinder hoses.

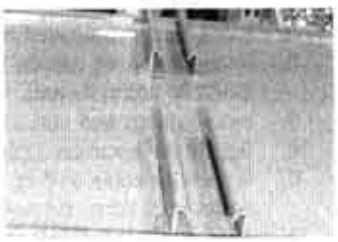


→ Stage 5, Hose Take-Up Assembly, Hydraulic Hoses & Clamps

1. Install the hose clamps for the tilt and auxiliary circuit hoses. **Do Not tighten them yet!**
2. At the area between the hose take-up bracket to the first hose clamp, adjust the hoses to form a 4" partial loop from the bottom of the boom to the hoses.
3. Tighten all hose clamps.



CHANNEL USED FOR HOSE CLAMPS; TYPICAL

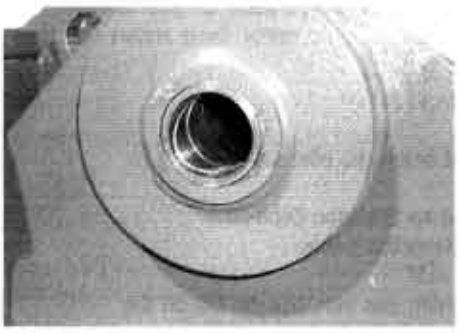


HOSE CLAMP; TYPICAL

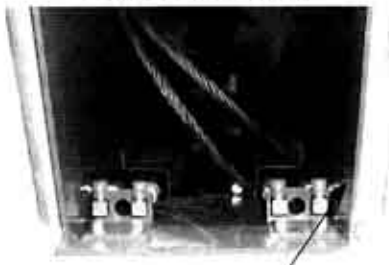
4. Connect Quick-Disconnect tilt circuit hoses (and auxiliary circuits) located at the boom head area of Boom-Section 3 to the fittings at the front of Boom-Section 3.
5. Install the lift cylinder bushings.

Boom-Section 3, Head

Lift Cylinder Bushing



Boom-Section 3, Front



Auxiliary Hydraulic and Electric Connection

7.0 Boom Cables

The extension/retraction cables are made from wire rope. Review the reference to Boom Cables in the "Safety" section of this Manual for safety related parameters. The boom cables are an important component of your Gradall Material Handler. They mechanically provide the extension/retraction force of Boom-Section 3.

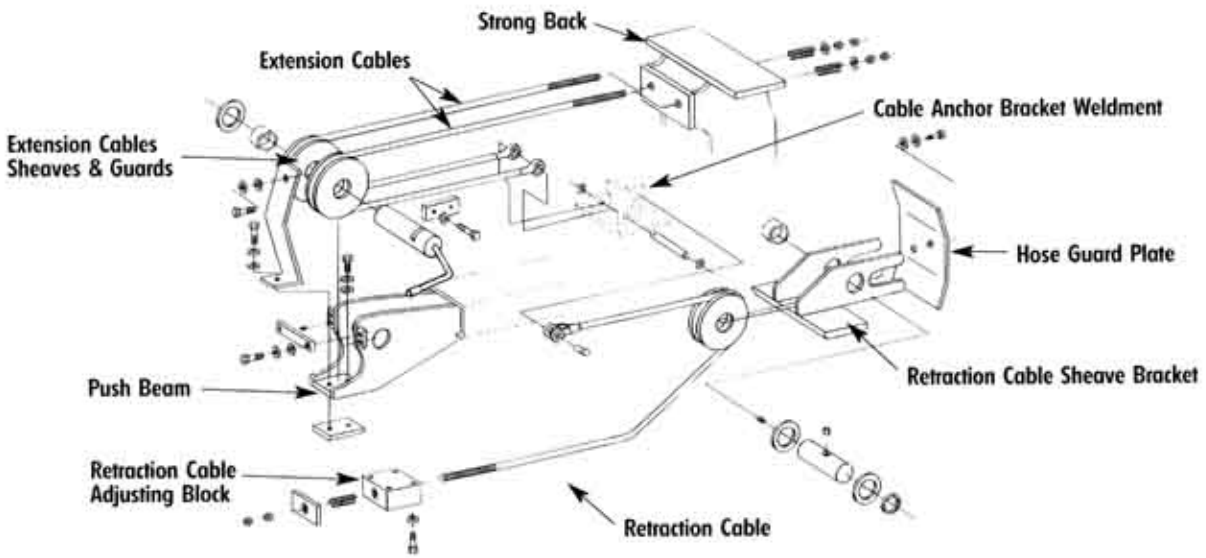
"Boom Cable Data" (see below) covers part numbers used, length, and key specifications. Please review this table to be certain you are using the correct cable for your operation. **Do Not** use cable other than that supplied by Gradall for replacement. These cables are specifically designed for Gradall Material Handlers.

General Cable Information

- Cables are pre-stretched; lengths cited below are after pre-stretching.
- Threaded stud, Galvanized Plating.
- Safe Lock Closed Socket Terminal used on Extension Cable.
- Safe Lock or Spelter Socket used on Retraction Cable.
- Boom Cable length tolerances: +0.5" -1.0".
- Use 2 wrenches when torqueing adjusting jam nuts. Use the flat on the threaded cable end to hold the cable straight, eliminating twist.

Boom Cable Data

Model	Boom Length	Boom Cable Part Number	Cable Length	Cable Diameter	Thread Size	Socket Style
Retraction Cable						
534C & D-10	45'	9113-3356	198 1/2"	1/2"	7/8 - 14	Open
534C-6	42'	9112-3147	191 1/2"	3/8"	3/4 - 10	Open
532C-6, 534D-6	36'	9112-2013	161 1/2"	3/8"	3/4 - 10	Open
534C & D-9 & 10	40'	9114-3027	177 1/2"	1/2"	7/8 - 14	Open
Extension Cable						
534C & D-10	45'	9114-3355	386"	9/16"	1" - 8	Closed
534C & D-9 & 10	40'	9114-3026	344"	9/16"	1" - 8	Closed
534C-6	42'	9112-3146	383"	1/2"	7/8 - 14	Closed
532C-6, 534D-6	36'	9112-3012	323"	1/2"	7/8 - 14	Closed

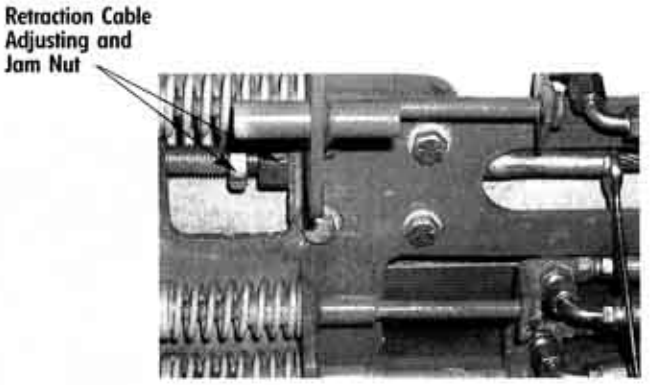


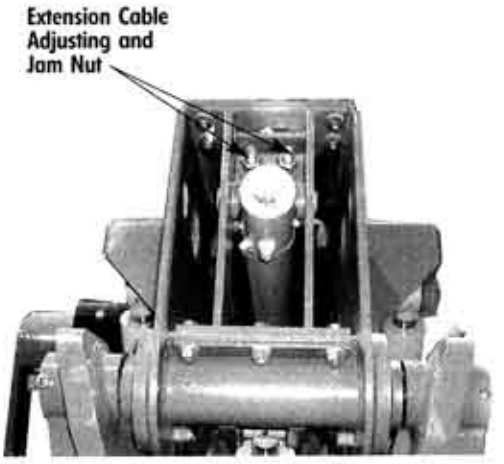
(7A) Cable Adjustments

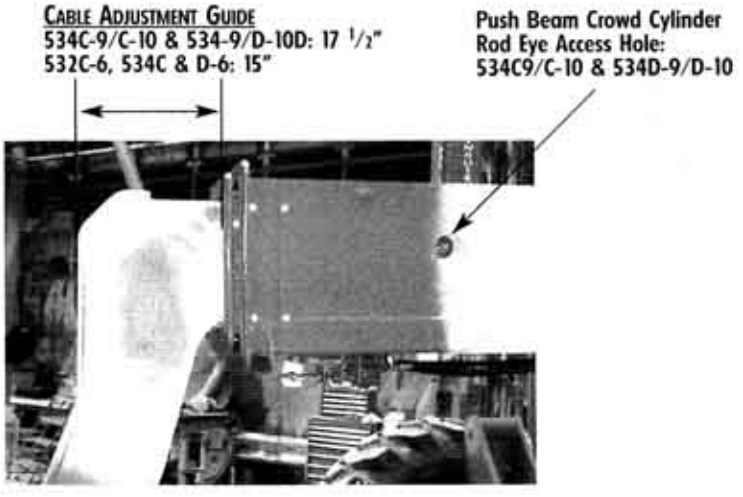
The cables are adjusted by tightening and/or backing off the adjusting nuts at the threaded end of the cable. Tightening the retraction cable adjusting nut pulls Boom-Section 3 in, to the rear. Tightening the extension cable adjusting nut pulls the boom out, to the front. The opposite cable adjusting nut usually must be loosened whenever this procedure is performed. The cables are properly adjusted whenever the following parameters are met:

534C9/C-10 & 534D-9/D-10:
Crowd cylinder rod eye pin is centered in the side access hole of the push beam and/or 17 1/2" dimension from Boom-Section 3 boom head front to the front of Boom-Section 2.

532C-6, 534C6 & 534D-6:
15" dimension from Boom-Section 3 boom head front to the front of Boom-Section 2.







(7B) Retraction Cable Removal

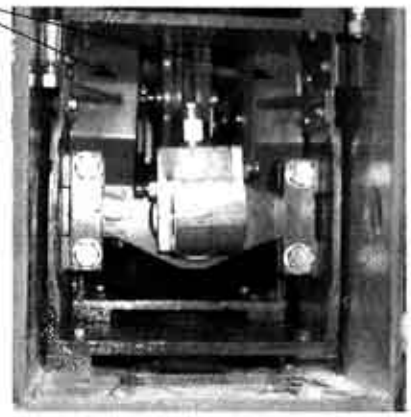
Removal of the retraction cable is a difficult operation; but it can be accomplished. You must be able to reach into the rear of the boom assembly to unfasten the retraction cable socket from the cable anchor bracket weldment. If you can't reach this bracket, the booms must be separated.

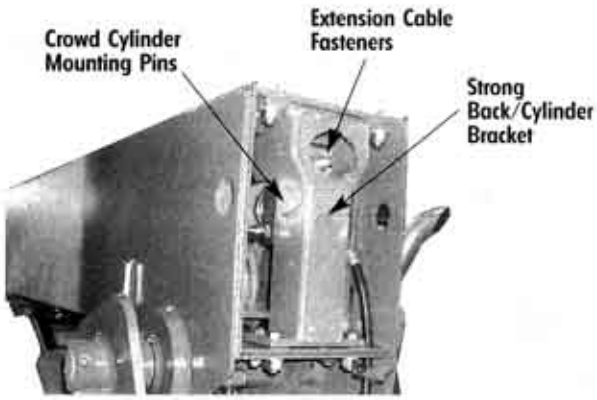
→ Preparation

- Retract the boom assembly fully.
- Remove the keys from the ignition and fasten a "do not operate" tag to the steering wheel. **DO NOT** reach into the boom until you are **CERTAIN** that keys have been removed from the ignition.
- Place the machine in a level, open area with sufficient space to work safely.
- Procure tools and platforms required for this operation.
- Procure a rope to tie to the cable end. This rope must be of sufficient length to allow accessibility whenever the cable is removed. This will assist in reinstallation.
- If working with a helper, be certain each of you know your individual assignments.

→ Stage 1

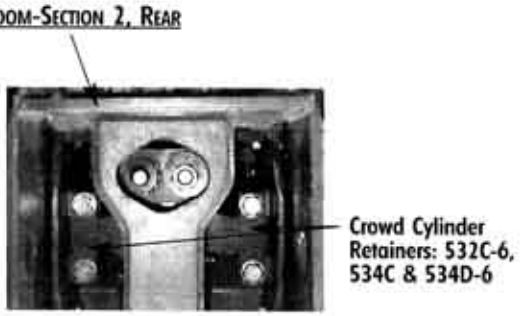
1. Remove the hose guards from the rear of Boom-Section 1.
2. Remove the crowd cylinder mounting pins from the strong back/cylinder bracket.
3. Remove the extension cable fastener hardware from the strong back/cylinder bracket.
4. Pull the cable free of strong back/cylinder bracket. Fasten a rope to the cable end to aid in reinstallation.
5. Remove the strong back/cylinder bracket mounting hardware.
6. Remove the strong back/cylinder bracket from the rear of the machine.

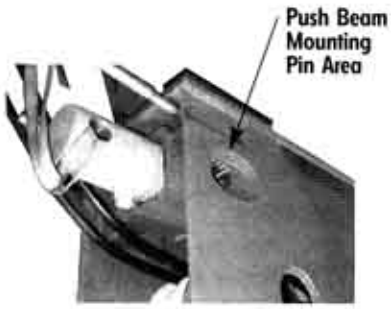




→ **Stage 2**

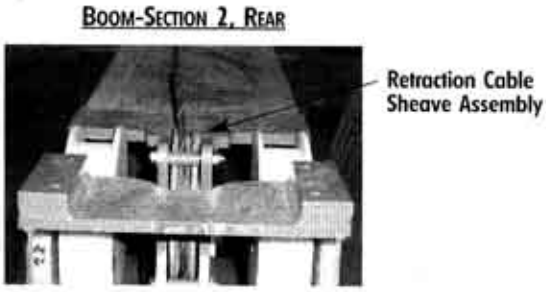
1. **534C & D-9 & 10:**
   Remove the push beam mounting pins.
2. At the front of Boom-Section 3, pull the push beam clear of Boom-Section 3.
3. Separate, plug and cap the crowd cylinder hoses.
4. **532C-6, 534C-6 & 534D-6:**
   At the rear of Boom-Section 2, remove the crowd cylinder retainers.
5. Drop the crowd cylinder to the bottom of the boom to give more clearance for access to the inside of the booms in the second section. The cylinder must be removed from the retainer area.

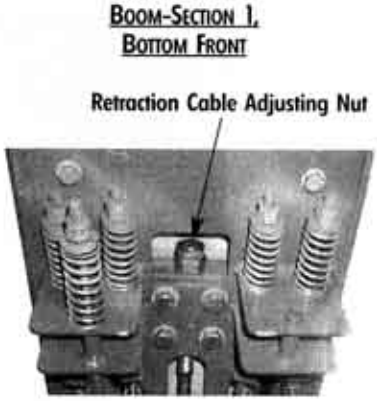




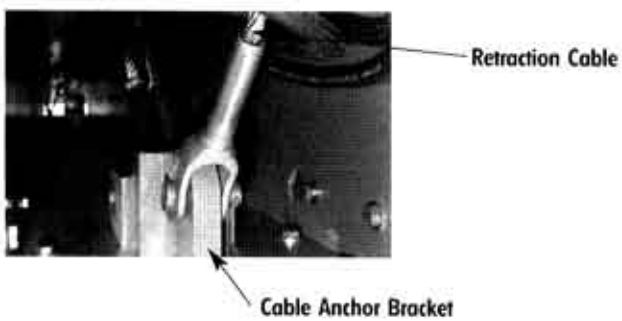
→ **Stage 3**

1. At the bottom front of Boom-Section 3, loosen the retraction cable adjustment fasteners.
2. Remove all the retraction cable sheave components.





3. Reaching inside the boom rear, at the cable anchor bracket weldment, remove the cotter pin from the retraction cable pin.
4. Remove the retraction cable pin. The retraction cable should now be free.
5. Pull the cable from the boom assembly through the rear. Remove the ropes, and leave them in place to aid in reinstallation.



(7C) Retraction Cable Reinstallation

To reinstall the retraction cable, you must be able to reach into the rear of the boom assembly to the cable anchor bracket weldment. The anchor bracket is welded to the bottom rear boom plate of Boom-Section 3. If you can't reach the bracket, the booms will have to be separated. Be certain that the keys have been removed from the ignition and fasten a "do not operate" tag to the steering wheel before you reach into the boom.

→ Preparation

- Place the machine in a level, open area with sufficient space to work safely.
- Procure the tools and platforms required for this operation.
- If working with a helper, review each of your duties.
- Be certain that the boom assembly is still retracted fully. If not, mechanically push the boom into the correct position before commencing reinstallation. **DO NOT** reach into the beam assembly while sections are being mechanically retracted/extended.

→ Stage 1

1. Fasten a rope to the retraction cable and pull the cable through the Boom-Sections to the approximate final position. Remove the rope.
2. Install the retraction cable socket end with mounting hardware to the cable anchor bracket weldment.

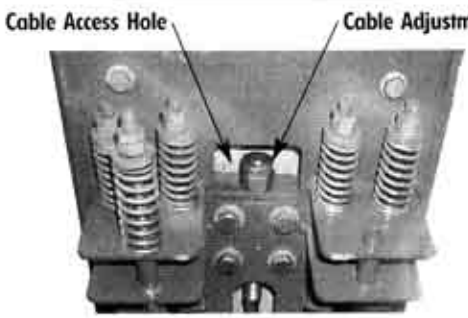
Cable Anchor Bracket

3. Install the retraction cable threaded end through the rear cable sheave bracket and cable adjusting block, bolted to the bottom front of Boom-Section 1.

Retraction Cable Sheave Assembly

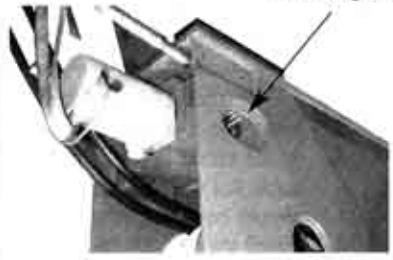
4. Feed the cable into the inside bottom front of Boom-Section 1 to the cable adjustment access hole.

Boom-Section 1, Bottom Front



5. **534C-9/C-10 & 534D-9/D-10:**
   At the front of Boom-Section 3, feed the push beam toward the rear of the boom assemblies to line up the push beam mounting pins.
6. Install the push beam mounting pins and fasteners.
7. **532C-6, 534C-6 & 534D-6:**
   Reinstall the crowd cylinder into the retainers at the rear of Boom-Section 2.
8. Reinstall and torque the crowd cylinder retainer fasteners.

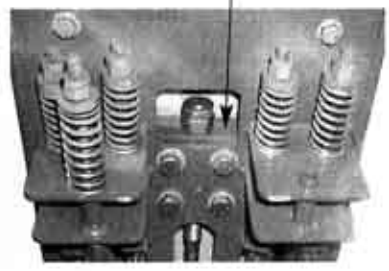
Push Beam Mounting Area



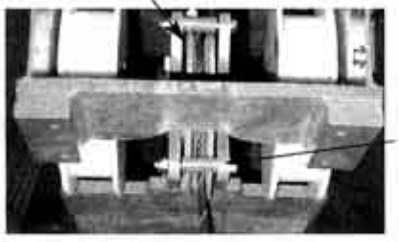
→ **Stage 2**

1. Install the retraction cable to the cable adjustment block at the bottom front of Boom-Section 1.
2. Install the retraction cable sheave and all the related components. Be certain the cable guards are installed.

Cable Adjustment Block



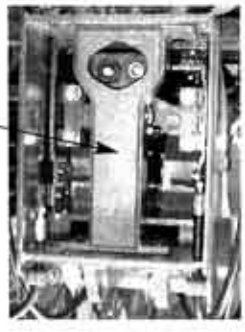
Retraction Cable Sheave



Cable Guard

3. Install the hose guards to the rear of the boom.
4. Place the strong back/cylinder bracket in place at the rear of Boom-Section 1.

Cylinder Bracket



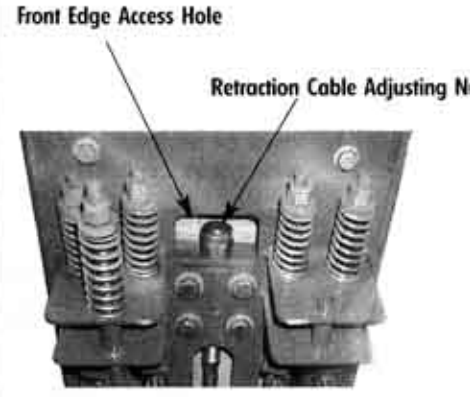
→ **Stage 3**

1. Install the crowd cylinder into the strong back/cylinder bracket.
2. Install previously removed shims to the top and bottom of the strong back/cylinder bracket.
3. Torque the strong back/cylinder bracket fasteners and apply ***LOCTITE* 242** to threads.
4. Reconnect the crowd cylinder hydraulic hoses.
5. Reinstall fasteners and springs to the extension cable threads at the strong back/cylinder bracket.

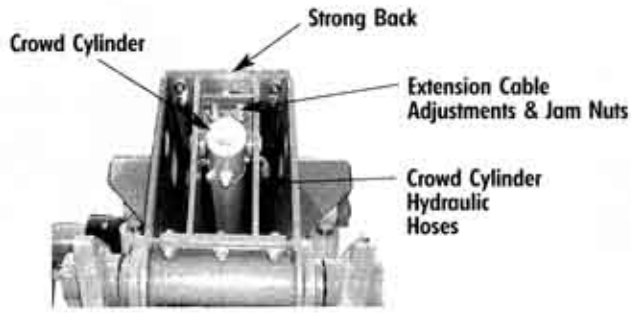
→ **Stage 4**

534C-9/C-10 & 534D-9/D-10 ONLY!

1. At the retraction cable adjusting block, located at the inside bottom front of Boom-Section 1, tighten the cable adjusting nut until the third thread lines up with the front edge of the access hole.
2. Install the jam nut to the adjusting nut and torque to 100 ft-lb.
3. At the strong back, tighten the extension cable adjusting nut until gap between cable flat washer and strong back is 1/32 to 1/16 inch. Gap for both washers should be equal. When tightening, make sure that the cable is not twisting.
4. Install the jam nut and torque to 100 ft-lb.
5. Adjust the cables to specifications given on page 7.1.



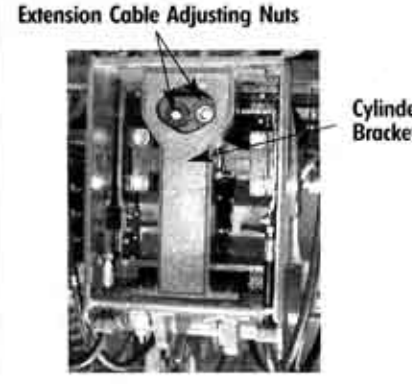
BOOM REAR 534C-9/C-10 & 534D-9/D-10



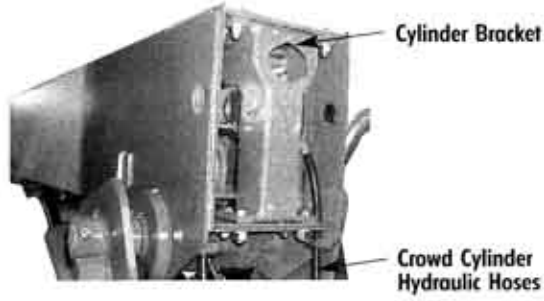
→ **Stage 4**

532C-6, 534C-6 & 534D-6 ONLY!

1. At the retraction cable adjusting block located at the inside front bottom of Boom-Section 1, tighten the cable adjusting nut until the front of the threaded end lines up with the front edge of the access hole.
2. Install the jam nut against the adjusting nut and torque to 100 ft-lb.
3. At the cable adjusting bracket, tighten the extension cable adjusting nuts until gap between cable flat washer and strong back is 1/32 to 1/16 inch. Gap for both washers should be equal. When tightening, make sure that the wire rope is not twisting.
4. Install the jam nut against the adjusting nuts and torque to 100 ft-lb.
5. Adjust the cables to specifications given on page 7.1.



532C-6, 534C-6 & 534D-6



The Retraction Cable should now be correctly installed.

(7D) Extension Cable Removal

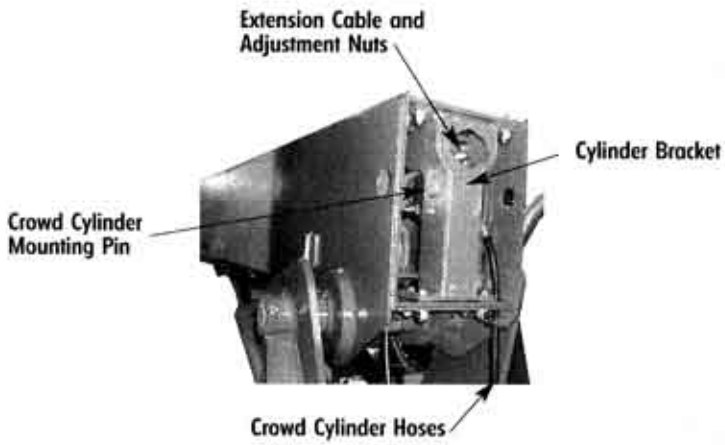
Removal of the extension cable is a difficult operation, but it can be accomplished. You must be able to reach into the rear of the boom assembly to unfasten the extension cable socket from the cable anchor bracket weldment. The bracket is welded to the rear bottom plate of Boom-Section 3. If you can't reach this bracket, the booms must be separated. Make sure that the keys have been removed from the ignition and fasten a "do not operate" tag to the steering wheel before you reach into the boom.

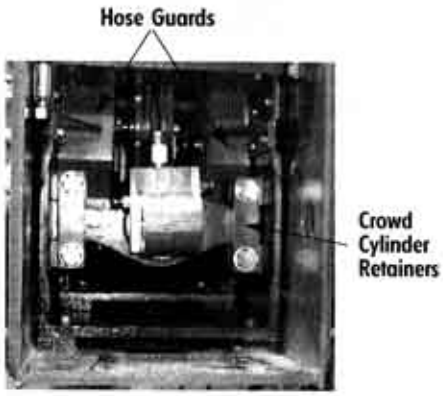
→ Preparation

- Retract the boom assembly fully.
- Remove the keys from the ignition and fasten a "do not operate" tag to the steering wheel. **DO NOT** reach into the boom until you are **CERTAIN** that keys have been removed from the ignition.
- Place the machine in a level, open area with sufficient space to work safely.
- Procure the tools and platforms required for this operation.
- Procure a rope to tie to the cable. This rope must be of sufficient length to allow access to each end whenever it is pulled through the boom assemblies with the cable.
- If working with a helper, review each of your duties.

→ Stage 1

1. Remove the hose guards from the rear of Boom-Section 1.
2. Separate, plug and cap the crowd cylinder hoses.
3. Remove the crowd cylinder mounting pins from the strong back/cable bracket.
4. Remove the extension cable mounting hardware from the strong back/cylinder bracket at the rear of boom.
5. Pull the cable free of the strong back/cylinder bracket. Fasten a rope to the cable end to aid in reinstallation.
6. Remove the strong back/cylinder bracket from the ear of the boom assembly. Keep the top and bottom shim packs together and identified. This will make assembly easier.

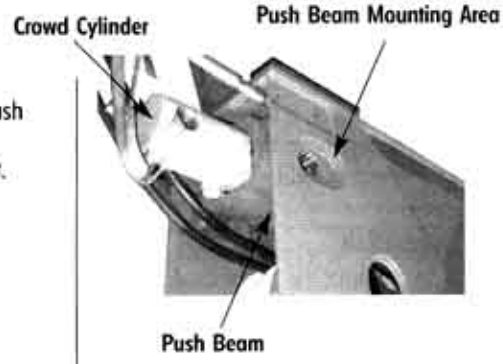




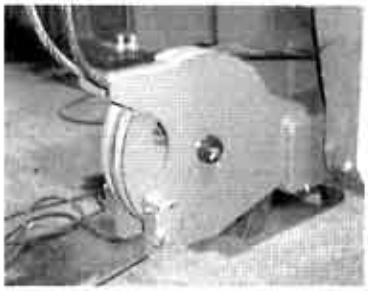
→ **Stage 2**

534C-9/C-10 & 534D-9/D-10 ONLY!

1. Remove the push beam mounting hardware.
2. Pull the push beam extension cable sheave bracket free of Boom-Section 3.
3. Remove all extension cable sheave bracket components from the front of the push beam.
4. Pull the extension cable through the push beam extension cable sheave bracket.



PUSH BEAM SHEAVE BRACKET

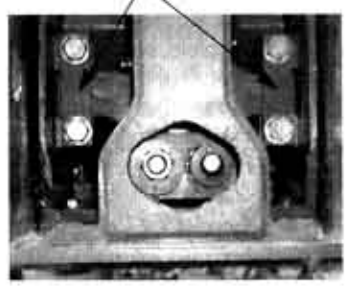


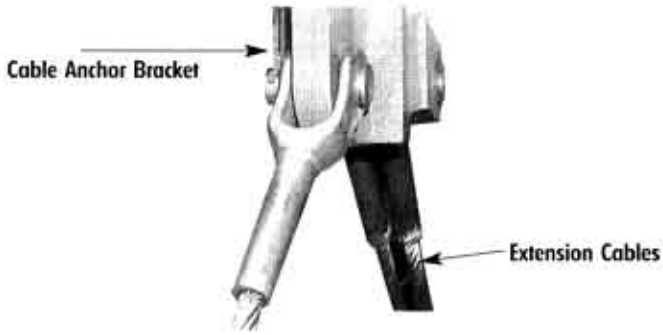
→ **Stage 2**

532C-6, 534C-6 & 534D-6 ONLY!

1. Remove the crowd cylinder retainers from the rear of Boom-Section 2.
2. Drop the crowd cylinder to the bottom of the boom. This will give more clearance for access to the cable anchor bracket welded to the bottom rear of Boom-Section 3.
3. At Boom-Section 3, front boom head, remove the extension cable sheave bracket assembly components. This will allow the passage of the threaded end of the cable through the sheave bracket.

Crowd Cylinder Retainers





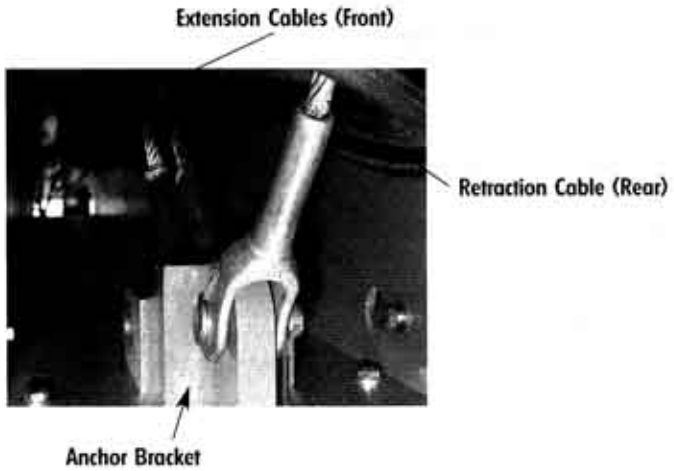
4. Pull the extension cable free of the sheave bracket.

EXTENSION CABLE SHEAVE BRACKET

→ **Stage 3**

532C-6, 534C-6 & 534D-6

1. If required for clearance access, pull the crowd cylinder free of the boom through the back of the boom assembly. To do this, you will have to remove the extension cable sheave bracket from the front of the crowd cylinder.
2. Reach inside the rear of Boom-Section 3, and remove the extension cable retaining ring (snap ring) and the extension cable pin. This pin is located at the front of the cable anchor bracket weldment which is welded to the bottom rear of Boom-Section 3.
3. The extension cable is now free and can be removed from the boom.
4. Tie a rope to the extension cable socket end to aid in reinstallation.



(7E) Extension Cable Reinstallation

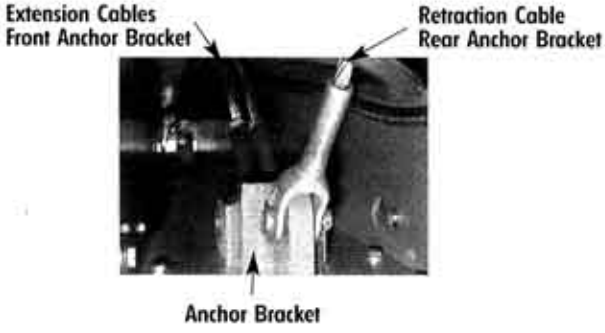
To reinstall the extension cable, you must be able to reach into the rear of the boom assembly to the cable anchor bracket weldment. The anchor bracket is welded to the bottom rear boom plate of Boom-Section 3. If you can't reach the bracket, the booms must be separated. Make sure the keys have been removed from the ignition and fasten a "do not operate" tag to the steering wheel before you reach into the boom.

→ Preparation

- Place the machine in a level, open area with sufficient space to work safely.
- Procure the tools and platforms required for this operation.
- If working with a helper, review each of your duties.
- Be certain the boom assembly is still retracted fully. If not, mechanically push the boom into the correct position. **DO NOT reach into the boom assembly while sections are being mechanically retracted/extended.**

→ Stage 1

1. Tie a rope to the extension cable threaded end and pull the cable to the anchor bracket weldment area.
2. Install the extension cable socket end and the mounting hardware to the cable anchor bracket weldment.

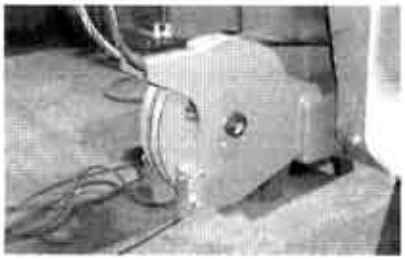


3. **532C-6, 534C-6 & 536D-6:**
   If it has been removed, install the crowd cylinder into the boom assembly from the rear.
4. If it has been removed, install the extension cable sheave bracket to the front of the crowd cylinder.

532C-6, 534C-6 & 534D-6
Extension Cable Sheave Bracket

5. Install the extension cable threaded end through the sheave bracket and feed to the rear of the boom.
6. **534C-9/C10 & 534D-9/D-10:**
   Assemble all extension cable sheave bracket components to the front of the push beam. Be certain that the cable threaded end is inserted through the sheave bracket before the sheave components are installed.

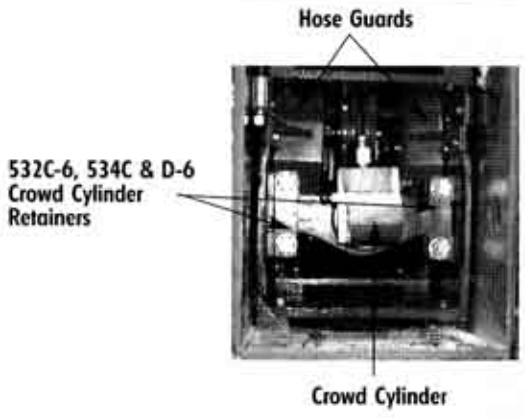
534C-9/C-10 & 534D-9/D-10
Push Beam Front,
Extension Cable Sheave Bracket



→ **Stage 2**

1. **534C-9/C-10 & 534D-9/D-10:**
   Insert the push beam fully into Boom-Section 2.
2. **532C-6, 534C-6 & 534D-6:**
   Insert the crowd cylinder fully into Boom-Section 2.

532C-6, 534C-6 & 534D-6

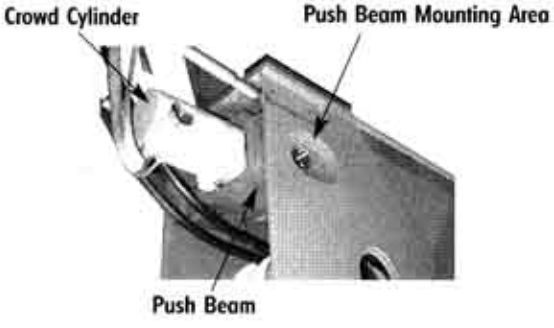


3. Install the push beam mounting hardware or crowd cylinder retainers.
4. Install the tilt and auxiliary circuit hose guards at the rear of Boom-Section 1.

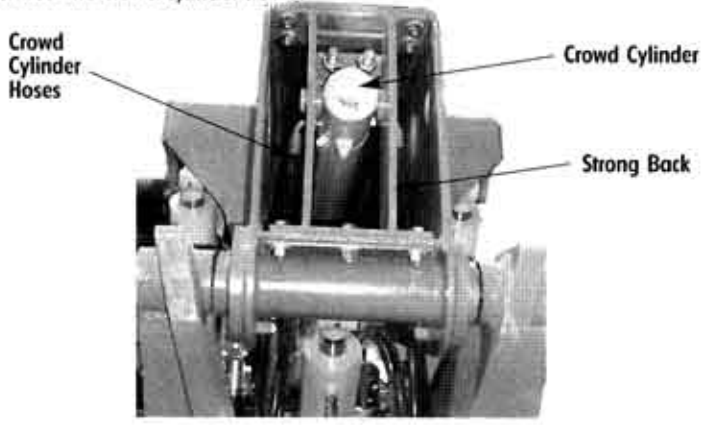
→ **Stage 3**

1. Place the strong back/cable bracket in place at the rear of Boom-Section 1.

534C/C-10 & 534D-9/D-10



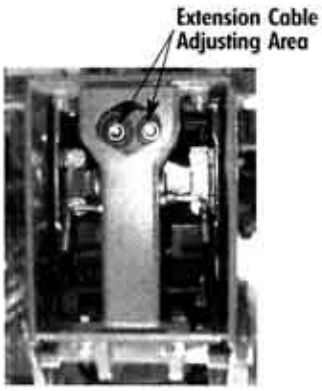
2. Install the crowd cylinder and mounting hardware into the strong back/cable bracket.
3. Replace the removed shim packs to the strong back/cable bracket.
4. Install and torque the strong back/cable bracket fasteners by applying ***LOCTITE* 242** to threads.
5. Reconnect the crowd cylinder hoses.



→ **Stage 4**

1. Feed the extension cables into the strong back/cable bracket mounting area. Be certain that the cables are stress-free and not twisted. Remove the rope.
2. Install the cable adjusting hardware. Tighten the extension cables' adjusting nuts until gap between cable flat washer and strong back is 1/32 to 1/16 inch. Gap for both washers should be equal. When tightening, make sure that the wire rope is not turning.

532C-6, 534C-6 & 534D-6
CYLINDER BRACKET



534C-9/C-10 & 534D-9/D-10
STRONG BACK

3. Install the jam nut against the adjusting nut and torque to 100 ft-lb. Make sure that the cable is not twisting.
4. Adjust the boom cables to the parameters given on page 7.1.

The Extension Cable is now installed.

Hydraulic hoses are used to carry fluid to the tilt cylinder and/or auxiliary circuits. At the boom, the hoses are fastened to the hose take-up weldment at the front outside/inside bottom of Boom-Section 1. They are then fed around a roller, through a protective channel at the top left and right of Boom-Section 3, to the front head of Boom-Section 3. At that point, another connection is made to carry fluid to the tilt or auxiliary circuit. Tilt circuit hoses are fed through the left side of the boom. Auxiliary circuit hoses are fed through the right side of the boom.

Hoses must be of correct length, laying straight and flat, rolling free of twist and torqued per values in "Appendix B". **LOCTITE 545** (Gradall P/N 1440-4043) must be used on all connections. Two wrenches should be used when tightening hoses to prevent twisting. Use one wrench on the swivel hose fitting; the other on the fixed hose fitting.

Gradall strongly recommends against using generic hoses as replacements. Hoses for Gradall Material Handlers are specifically designed for use in this application. There is no way to ensure that generic hoses will meet Gradall's strict application performance requirements.

TILT AND AUXILIARY CIRCUIT HOSE REMOVAL/REINSTALLATION

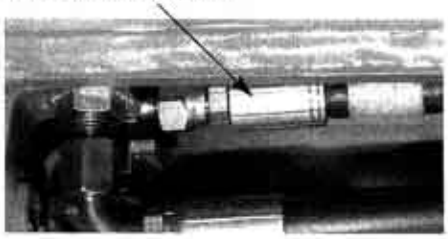
Hoses normally can be removed and reinstalled simply by connecting a union to the fittings on the hose (joining them together) then pulling them through the boom assembly until they are free. You may have to remove the hose guard at the roller assembly. If this doesn't work, follow the procedures listed below.

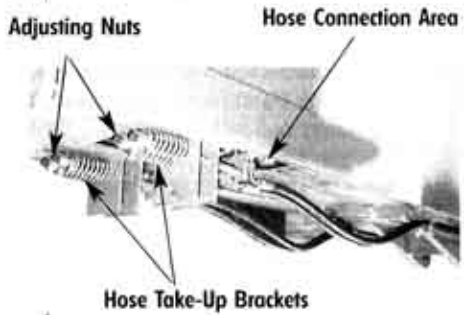
→ Preparation

- Retract the boom fully level.
- Remove the keys from the ignition and fasten a "do not operate" tag to the steering wheel.
- Procure the tools and work platforms to allow the work to progress safely.
- Procure a rope to assist pulling the hose to the correct location during reinstall.
- If working with a helper, be certain each of you know your assigned duties.
- Review the removal/reinstallation procedure.

→ Removal, Stage 1

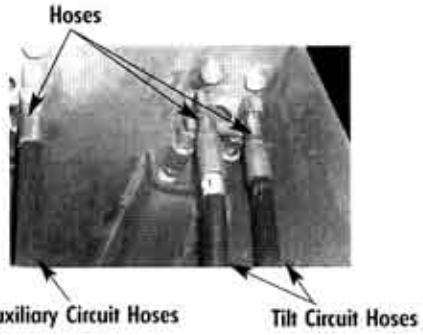
1. Loosen the adjusting nuts at the hose take-up bracket to relieve the tension on the hose assemblies.
2. At the inside of the hose take-up brackets, separate, plug, and cap all hoses to be removed.

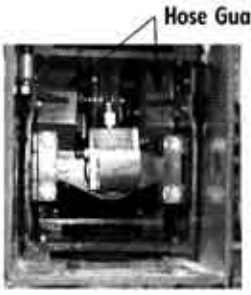




→ Removal, Stage 2

1. At the rear of the boom, remove the hose guard for the hose being removed.
2. At the front of Boom-Section 3, separate, cap, and plug the hose to be removed. Tie a rope to the hose end.
3. Through the rear, pull the separated hose free of the boom assembly.
4. At the hose take-up bracket area, pull the hose free of the boom assembly.

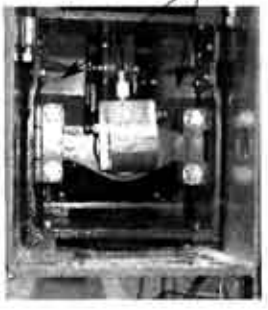




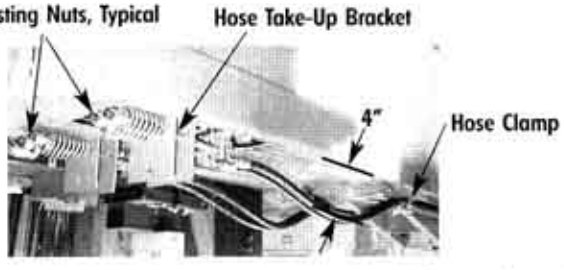
→ Reinstallation

1. Tie the rope to the hose end.
2. Installing the hose at the hose bracket take-up area, pull the hose to the rear of the boom.

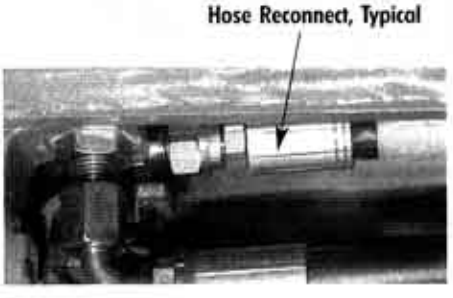
Steps 1 & 3



3. Feed the hose around the roller and pull it through the protective channels in Boom-Section 3 to the boom head at the front.
4. At the boom head, apply LOCTITE 545 to the fittings, connect and torque the hoses and install clamps.
5. Install the hose guard at the rear boom roller.
6. Apply LOCTITE 545 to the hose fittings at the hose take-up bracket area; connect and torque the hose.



7. Tighten the hose take-up bracket adjusting nuts. Ensure 4" dimension (boom bottom to hose) is held at the hose area between the take-up bracket and the first hose clamp.



The Hose is now correctly installed.

ELECTRIC BOOM CABLE

The electric cable is fed through the right side of the boom assembly in a fashion similar to the auxiliary hydraulic hoses. The electric cable lies adjacent to the hydraulic hoses and moves in unison with them, whenever the booms are extended and retracted. The receptacle and socket connector are equipped with a strain relief fitting to prevent wires from pulling loose. This strain relief is tie-wrapped to the cable. **DO NOT** install a cable without the strain relief connected.

The socket end of the electric cable is fastened to the front boom head of Boom-Section 3. It is secured with a bracket at this location. A strain relief fitting is installed at the cable take-up weldment and support. These assemblies are located in the area adjacent to the hydraulic hose take-up weldment.

The receptical and socket are equipped with six contact points. One contact point is usually extra and is plugged using Gradall Part No. 8348-1301. Refer to the following chart for identification in the socket (as viewed from the wire insertion end).

ELECTRICAL WIRE DATA

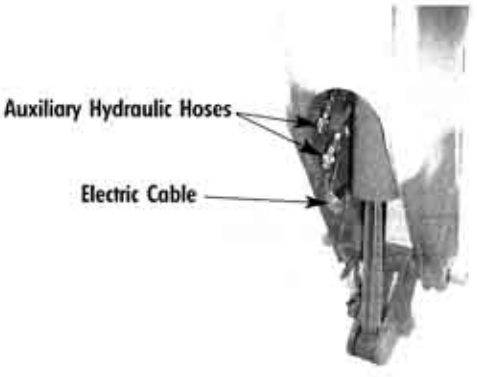
Socket Body Letter	Wire Color	Wire Function
"TM"	Orange	Panel
"A"	Blue	Open/Extra
"S"	Black	Mast
"RT"	Green	Swing
"LT"	Red	Side Shift
"C"	Green/Yellow	Ground

Electric Cable Removal

→ **Stage 1**

1. Retract the boom fully level.
2. At the front of Boom-Section 3 boom head, unfasten the electrical socket and clamps.
3. Remove the socket from the electrical cable.
4. Remove the strain relief fitting and the tube at the boom head from the boom and cable.
5. Tie a rope to the cable end; this will aid in reinstallation.

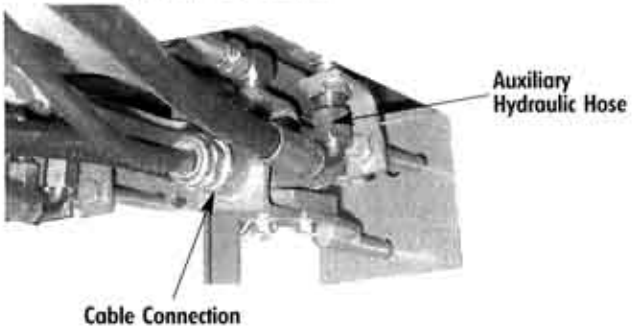
Boom Head



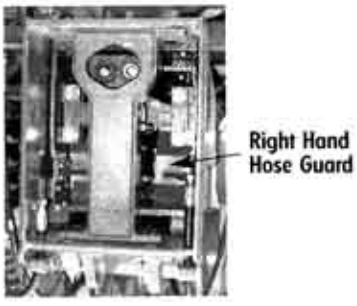
→ **Stage 2**

1. At the rear of the boom, remove the hose guard from the right side roller.
2. Pull the electric cable to the rear, free of the boom assembly.
3. At the bottom front of Boom-Section 1, remove the cable take-up weldment and support.
4. Pull the electric cable free of the boom through the cable take-up weldment.
5. Remove the remaining cable clamps and unplug the receptacle.

Boom-Section 1, Bottom Front, Cable Take-Up Bracket



Rear View Boom Assembly



The Electric Cable is now free of the Boom assembly.

Electric Cable Installation

It is assumed the electric cable has been removed and related parts are still left off the boom assembly. The electric socket must not be installed at this time. The cable must be well tensioned in the area between the strain reliefs at the boom head and Boom-Section cable take-up brackets.

→ Stage 1

1. Tie the rope to the cable and feed it through the strain relief fitting and cable take-up weldment tube, then feed to the rear through the cable take-up weldment located at the bottom front of Boom-Section 1. The cable lies in the bottom plate area between Boom-Sections 1 and 2.
2. Feed electric cable around right side hose roller, through top protection channel, then to the boom head at the front of Boom-Section 3.
3. Install the hose guard at right side hose roller located at the rear of Boom-Section 2.

Boom Head

→ Stage 2

1. At front boom head of Boom-Section 3, feed the cable through the tube weldment, and install the strain relief fittings on cable. Do not tighten at this time.
2. Pull the electric cable through the boom to correct position at boom head
3. Install cable wires into the socket. See "Electrical Wire Data" on page 9.0 for wire locations.
4. Install the socket into the bracket at the boom head. Tighten the strain relief fitting at the socket and tube. Install and tighten the cable clamps at the boom head.

→ Stage 3

1. Install the cable take-up weldment and support at the bottom front of Boom-Section 1.
2. Tighten the strain relief fittings at the cable take-up weldment area.
3. Install the cable clamps to the bottom front of Boom-Section 1.
4. Plug the receptacle connector into the frame cable wiring harness.

Front Bottom Boom Section 1
Cable Take-Up Bracket

The Electric Cable is now correctly installed.

10.0 Crowd Cylinder Removal and Installation

The crowd cylinder hydraulically extends and retracts Boom-Section 2. A cable sheave arrangement is designed into the system to extend and retract Boom-Section 3 proportional to Boom-Section 2. While similar in operation, there are slight differences in cylinder design for 532C-6, 534C-6 & 534D-6 machines verses 534C-9/C-10 & 534D-9/D-10 machines.

The 534C-9/C-10 & 534D-9/D-10 cylinder is installed in a push beam. The base end of the cylinder mounts into a structure at the rear of Boom-Section 1 called a strong back. The rod eye end of the cylinder mounts into the push beam. The push beam is fastened to the rear of Boom-Section 2. As the cylinder rod extends or retracts, the push beam moves Boom-Section 2 proportional.

The 532C-6 and 534C-6 & 534D-6 cylinder rod end is fastened to a cable bracket mounted to the rear of Boom-Section 1 (similar to the strong back of the 534C-9/C-10 & 534D-9/D-10). The rear of the cylinder barrel is designed with a mount that fits into a retainer bracket at the rear of Boom-Section 2. The front of the cylinder barrel is equipped with mounting bolts to hold the cable sheave assembly. As the cylinder rod extends and retracts the barrel movement moves Boom-Section 2 proportional.

Re-pack kits for the crowd cylinders are available from your Authorized Gradall Distributor.

Removing and Reinstalling the Crowd Cylinder:

534C-9/C-10 & 534D-9/D-1 ONLY!

→ **Preparation**

- Review all safety issues before commencing work.
- Place the machine in a safe, level, uncongested working area.
- Apply the brakes and chock the wheels.
- Procure a crane and lifting tackle capable of lifting 1000 lb.
- If working with a helper, be certain each of you know your assigned duties.
- Select a location to place the cylinder once it has been removed.
- Pressure-wash or steam-clean the machine so that you have a clean safe working surface.

→ **Removal**

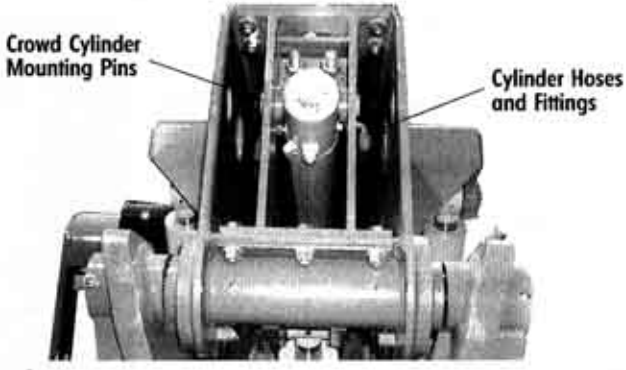
1. Retract the boom and line up the push beam crowd cylinder rod eye access holes in all Boom-Sections.
2. Remove the keys from the ignition and fasten a "do not operate" tag to the steering wheel.
3. Remove the cylinder rod eye mounting pin.
4. Separate, plug and cap the crowd cylinder hoses at the rear of the boom assembly.
5. Remove the crowd cylinder fittings from the rear of the cylinder barrel.
6. Attach lifting tackle to the cylinder, remove the mounting pins and carefully pull the crowd cylinder free of the machine through the strong back.
7. Place the crowd cylinder in the designated area for the next operation.

→ **Reinstallation:**

1. Feed the crowd cylinder into the push beam and line up the rod eye to the access holes. Be certain that the bearing pad is installed at the rod end of the cylinder.
2. Install the rod eye mounting pin and secure.

3. Install the crowd cylinder base mounting pin into the strong back and secure.

REAR BOOM ASSEMBLY STRONG BACK



4. Apply **LOCTITE 545** (Gradall P/N 1440-4043) to cylinder fittings and install into the barrel.
5. Apply **LOCTITE 545** to fittings and reconnect the hydraulic hoses.

The Crowd Cylinder is now installed.

Removing and Reinstalling the Crowd Cylinder:
532C-6 & 534C-6 & 534D-6 ONLY!

→ Preparation

- Review all safety issues before commencing work.
- Place the machine in a safe, level, uncongested working area.
- Apply the brakes and chock the wheels.
- Procure a crane and lifting tackle capable of lifting 1000 lb.
- If working with a helper, be certain each of you knows your assigned duties.
- Select a location to place the cylinder once it has been removed.
- Pressure-wash or steam-clean the machine so that you have a clean safe working surface.

→ Removal

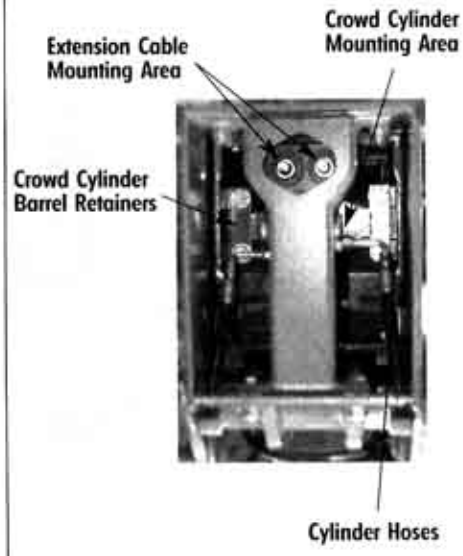
1. Level and retract the boom within approximately 1 ft. of full retraction. The boom sections should be positioned to allow the top rear cable access holes to line up.
2. Remove the keys from the ignition and fasten a "do not operate" tag to the steering wheel.
3. Remove the extension cable adjusting hardware from the rear cable bracket. Reaching through the top rear access hole, install a wrench to cable end flat. This will keep the cable from twisting during removal.
4. At the boom head of Boom-Section 3, remove the four extension cable sheave bracket mounting nuts.
5. At the boom rear cable bracket, remove the crowd cylinder mounting pins and hardware.
6. Remove the cable bracket from Boom-Section 1. Identify top and bottom shim packs to aid in reinstallation.
7. Disconnect the hydraulic hoses from the crowd cylinder.
8. Fasten lifting tackle to the crowd cylinder and take the weight off the cylinder.
9. Remove the crowd cylinder retainers from the rear of Boom-Section 2.
10. Through the back of the boom, carefully pull the crowd cylinder free.
11. Pull the extension cables free of the boom while extracting the crowd cylinder. Keep tension against the sheave bracket. This will pull the sheave bracket toward the rear to the inside cable anchor bracket.
12. Place the crowd cylinder in the designated area for the next operation.

→ Reinstallation

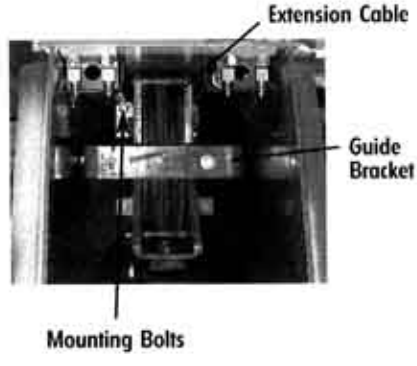
1. Lift and feed the cylinder into the boom assembly, through the rear.
2. Carefully install the cylinder into the extension cable sheave assembly bracket. The sheave bracket will be located at the cable anchor bracket area, inside Boom-Section 3. Be careful not to damage the sheave bracket mounting bolts while installing the cylinder into the bracket.
3. Keep tension on the extension cable sheave while the crowd cylinder is being fully inserted.
4. Install the crowd cylinder retainers at the rear of Boom-Section 2 rear. Apply **LOCTITE 242** (Gradall P/N 1440-3364) to the threads and torque as required.
5. Place the cylinder bracket in place at the rear of Boom-Section 1.
6. Install the crowd cylinder mounting pins into the cylinder bracket.
7. Install and torque the cylinder bracket fasteners. Use **LOCTITE 242** on the threads.
8. Apply **LOCTITE 545** (Gradall P/N 1440-4043) to the hydraulic fittings and reconnect the crowd cylinder hoses.
9. Reinstall the extension cables and the hardware. Adjust as required.

The Crowd Cylinder is now installed.

Cylinder Bracket - Rear



Boom Head, Front Extension Cable Sheave Bracket (Hoses removed for clarity)



Appendix A: Fastener Torque Chart

The following bolt torque charts covering English and Metric fasteners are the ones used by Gradall Engineering. Gradall ratings are for lubricated fasteners. Do not exceed the allowable rating. **Remember!** An over-torqued bolt in most cases will fail as rapidly as an under-torqued one.

Lubricated English Bolts

BOLT SIZE	GRADE 5 BOLTS			GRADE 8 BOLTS		
	Torque (ft-lb.)	Tolerance + or - (ft-lb.)	Clamp Load (lb.)	Torque + or - (ft-lb.)	Tolerance + or - (ft-lb.)	Clamp Load (lb.)
1/4 - 20	9	+3 -0	2,700	10	+3 -0	3,000
1/4 - 28	11	+3 -0	3,300	12	+3 -0	3,600
5/16 - 18	17	+5 -0	4,080	20	+5 -0	4,800
5/16 - 24	19	+5 -0	4,560	24	+5 -0	5,760
3/8 - 16	30	+5 -0	6,000	40	+5 -0	8,000
3/8 - 24	32	+5 -0	6,400	48	+5 -0	9,600
7/16 - 14	44	+10 -0	7,540	68	+10 -0	11,660
7/16 - 20	48	+10 -0	8,230	76	+10 -0	13,030
1/2 - 13	68	+10 -0	10,200	100	+10 -0	15,000
1/2 - 20	76	+10 -0	11,400	115	+10 -0	17,250
9/16 - 12	100	+10 -0	13,330	140	+10 -0	18,670
9/16 - 18	112	+10 -0	14,930	160	+10 -0	21,330
5/8 - 11	140	+15 -0	16,800	200	+15 -0	24,000
5/8 - 18	168	+15 -0	20,160	215	+15 -0	25,800
3/4 - 10	240	+25 -0	24,000	340	+25 -0	34,000
3/4 - 16	265	+25 -0	26,500	370	+25 -0	37,000
7/8 - 9	360	+35 -0	30,860	530	+35 -0	45,430
7/8 - 14	390	+35 -0	33,430	560	+35 -0	48,000
1 - 8	545	+50 -0	40,875	795	+50 -0	59,625
1 - 14	570	+50 -0	42,750	840	+50 -0	63,000
1 1/8 - 7	710	+50 -0	47,330	1175	+50 -0	78,330
1 1/8 - 12	795	+50 -0	53,000	1325	+50 -0	88,330
1 1/4 - 7	1005	+75 -0	60,300	1680	+75 -0	100,800
1 1/4 - 12	1105	+75 -0	66,300	1850	+75 -0	111,000
3/8 - 6	1310	+75 -0	71,450	2200	+75 -0	120,000
1 3/8 - 12	1500	+75 -0	81,820	2490	+75 -0	135,820
1 1/2 - 6	1745	+75 -0	87,250	2910	+75 -0	145,500
1 1/2 - 12	1945	+75 -0	97,250	3280	+75 -0	164,000

Appendix A: Fastener Torque Chart

Metric Fasteners

Nominal Size	Stress Area (mm^2)	CLASS 4.6		CLASS 8.8		CLASS 9.8		CLASS 10.9		CLASS 12.9	
		400 Megapascals Min. Tensile Str.		830 Megapascals Min. Tensile Str.		900 Megapascals Min. Tensile Str.		1040 Megapascals Min. Tensile Str.		1220 Megapascals Min. Tensile Str.	
		(Nm)	(ft-lb.)	(Nm)	(ft-lb.)	(Nm)	(ft-lb.)	(Nm)	(ft-lb.)	(Nm)	(ft-lb.)
M 2.0	2.1	0.14	0.10	0.37	0.27	0.40	0.30	0.52	0.38	0.61	0.45
M 2.5	3.4	0.28	0.21	0.76	0.56	0.82	0.61	1.06	0.78	1.24	0.92
M 3.0	5.0	0.51	0.37	1.35	1.00	1.47	1.08	1.88	1.39	2.21	1.63
M 3.5	6.8	0.80	0.59	2.13	1.57	2.31	1.70	2.96	2.18	3.47	2.56
M 4.0	8.8	1.18	0.87	3.15	2.32	3.41	2.52	4.38	3.23	5.14	3.79
M 5.0	14.2	2.39	1.76	6.36	4.69	6.90	5.09	8.86	6.54	10.59	7.67
M 6.0	20.1	4.05	2.99	10.81	7.97	11.72	8.65	15.05	11.10	17.66	13.02
M 6.3	22.6	4.78	3.53	12.76	9.41	13.84	10.21	17.77	13.11	20.84	15.37
M 8.0	36.6	9.84	7.26	26.25	19.36	28.46	20.99	36.54	26.95	42.87	31.62
M 10.0	58.0	19.49	14.37	51.99	38.35	56.38	41.58	72.38	53.39	84.91	62.63
M 12.0	84.3	33.99	25.07	90.68	66.88	98.33	72.52	126.25	93.12	148.10	109.23
M 14.0	115.0	54.10	39.90	144.32	106.45	156.49	115.42	200.93	148.20	235.70	173.85
M 16.0	157.0	84.40	62.25	255.18	166.08	244.17	180.09	313.50	231.22	367.76	271.24
M 20.0	245.0	164.64	121.43	439.24	323.96	476.28	351.29	611.52	451.03	717.36	529.10
M 24.0	353.0	284.66	209.95	759.43	560.13	823.48	607.37	1057.31	779.83	1240.30	914.80
M 30.0	561.0	565.49	417.08	1508.64	1112.72	1635.88	1206.56	2100.38	1549.16	2463.91	1817.29
M 36.0	817.0	988.24	728.89	2636.49	1944.58	2858.85	2108.58	3670.62	2707.31	4305.92	3175.88
M 42.0	1120.0	1580.54	1165.75	4216.66	3110.05	4572.29	3372.35	5870.59	4329.93	6886.66	5079.34

Note!

To check Gradall torque values, set the torque wrench at 95% of rated torque value and check the fastener. If the torque wrench releases before the fastener moves, assume that fastener torque is correct. When setting Gradall torque values, use values given on the chart, not exceeding allowances.

CODE 61 4-BOLT SPLIT FLANGE BOLT TORQUE

SAE DASH SIZE	FLANGE SIZE	BOLT SIZE	BOLT TORQUE ft-lb.
-12	3/4	3/8-16	25+/-4.5
-16	1	3/8-16	31+/-4.5
-20	1 1/4	7/16-14	41+/-5
-24	1 1/2	1/2-13	52+/-6
-32	2	1/2-13	60+/-6

CODE 62 4-BOLT SPLIT FLANGE BOLT TORQUE

SAE DASH SIZE	FLANGE SIZE	BOLT SIZE	BOLT TORQUE ft-lb.
-12	3/4	3/8-16	30+/-4.5
-16	1	7/16-14	46+/-4.5
-20	1 1/4	1/2-13	69+/-6
-24	1 1/2	5/8-11	125+/-8

ORS FACE SEAL; TUBE/HOSE TO FITTING

SAE DASH SIZE	THREAD SIZE	TUBE SIDE ASSEMBLY TORQUE ft-lb.
-4	9/16-18	18+/-1
-6	11/16-16	27+/-2
-8	13/16-16	40+/-2
-10	1-14	63+/-3
-12	1 3/16-12	90+/-4
-16	1 7/16-12	120+/-8
-20	1 11/16-12	140+/-8
-24	2 1/2-12	165+/-8

Note!

Aluminum material ports use 50% of the steel torque value.

SAE FITTINGS; STRAIGHT & ADJUSTABLE

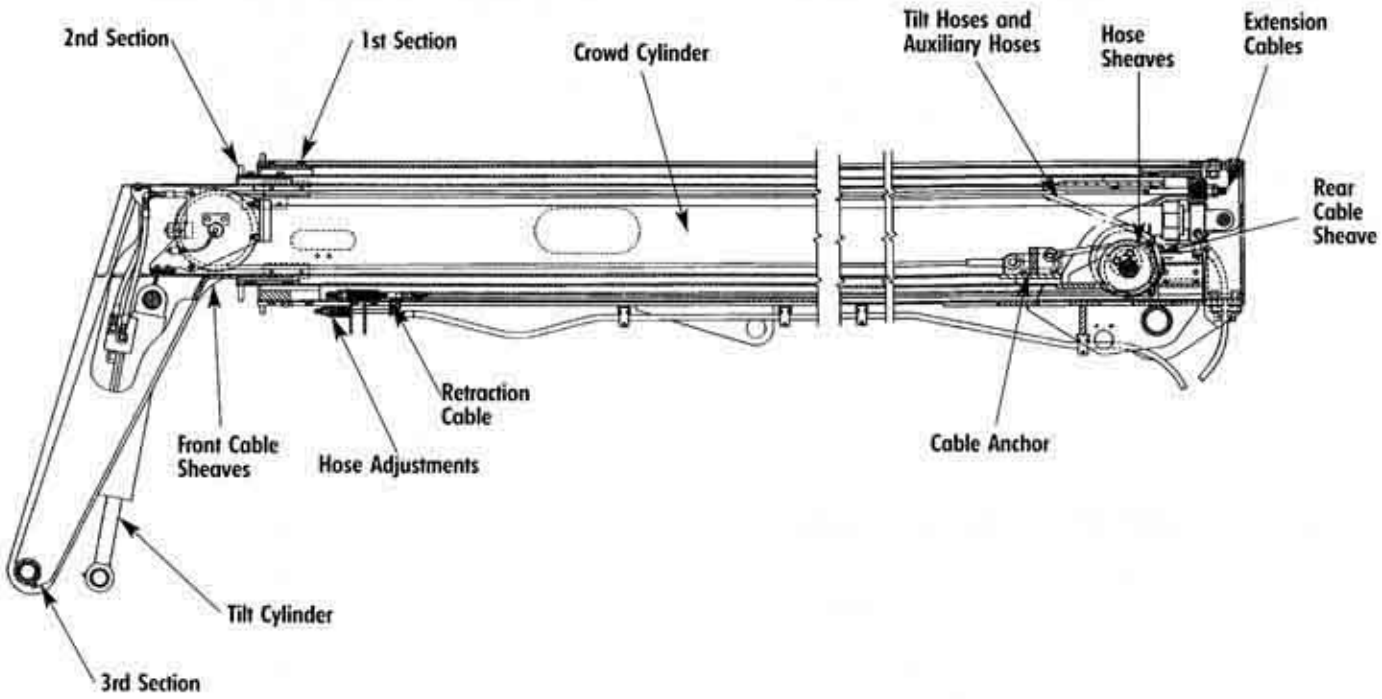
SAE DASH SIZE	THREAD SIZE	PORT SIDE ASSEMBLY TORQUE ft-lb.
-2	5/16-24	7.5+/-.5*
-3	3/8-24	14+/-1*
-4	7/16-20	16+/-1
-5	1/2-20	22+/-1*
-6	9/16-18	35+/-1
-8	3/4-16	60+/-2
-10	7/8-14	105+/-5
-12	1 1/16-12	140+/-6
-14	1 3/16-12	145+/-6*
-16	1 5/16-12	210+/-8
-20	1 5/8-12	260+/-12
-24	1 7/8-12	315+/-12
-32	2 1/2-12	325+/-15*

* TORQUE VALUES WITH AN ASTERISK ARE FROM JIC FITTING TORQUE CHART

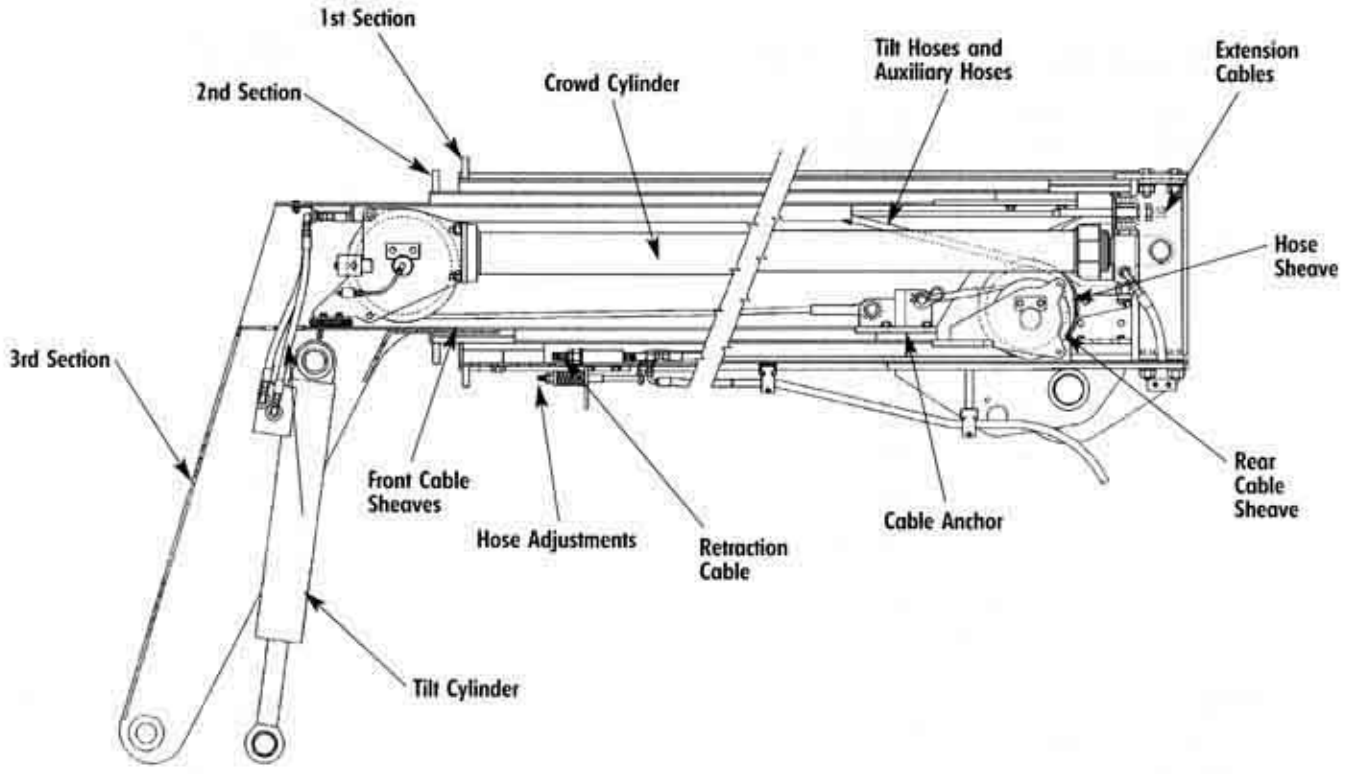
JIC 37° TUBE/HOSE TO FITTING

SAE DASH SIZE	THREAD SIZE	TUBE SIDE ASSEMBLY TORQUE ft-lb.
-2	5/16-24	3+/-1
-3	3/8-24	6+/-1
-4	7/16-20	12+/-1
-5	1/2-20	15+/-1
-6	9/16-18	21+/-1
-8	3/4-16	45+/-2
-10	7/8-14	60+/-5
-12	1 1/16-12	85+/-5
-14	1 5/16-12	105+/-5
-16	1 5/16-12	120+/-5
-20	1 5/8-12	170+/-10
-24	1 7/8-12	200+/-15
-32	2 1/2-12	270+/-20

APPENDIX C: 534C-6 AND D-6



APPENDIX C: 534C-9/C-10 AND 534D-9/D-10



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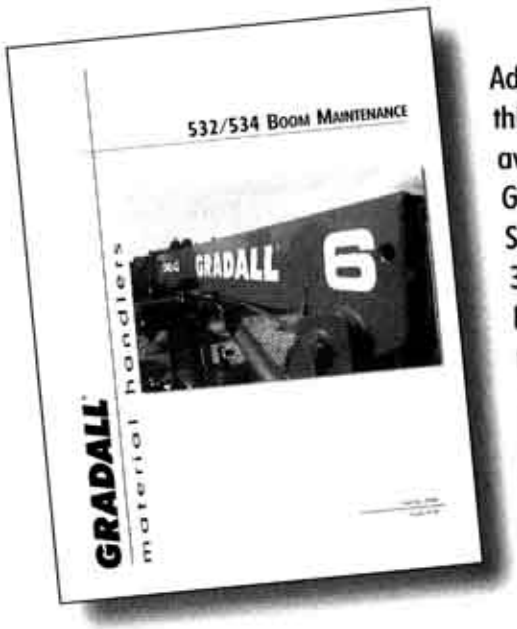

Additional copies of this Manual are available from Gradall Product Support. Call 330-339-2211, Ext. 385. Ask for the complete list of available Technical Manuals for Gradall Material Handlers.

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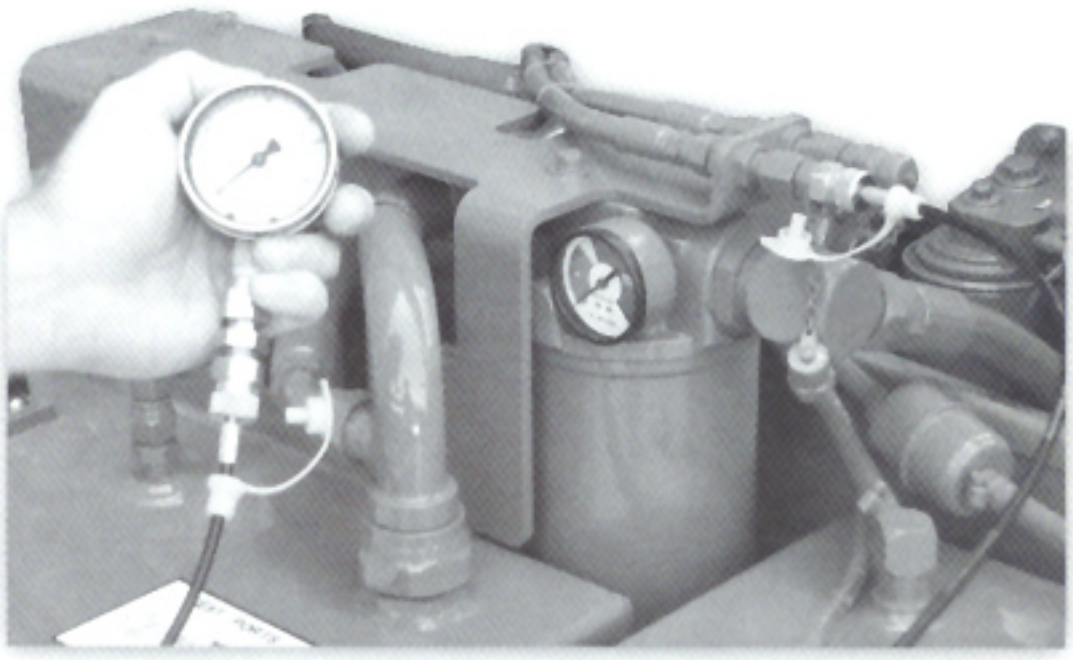
IMPLEMENT CIRCUIT PERFORMANCE CHECKS

Covers all C & D Series Material Handlers



GRADALL®

material handler

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Form No. 29813
Issue Date 4/99 Rev. B

REVISIONS

This page is provided so you may determine that this Manual is complete and current with respect to Gradall Engineering Specifications.

Page	Date	Revision
N/A	Jan/01	Updated original manual to include all C and D-Series Implement Functions.

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INTRODUCTION

This Manual details Implement Circuit Performance Checks and Adjustments for all Gradall C & D Series Material Handlers. Use the Manual in conjunction with the appropriate *Owner/Operator Manual* and the appropriate *Hydrostatic Drive Performance Checks Manual*. Make sure you read the entire Manual before testing, adjusting, or troubleshooting on any Gradall Material Handler. Make sure you understand and comply with all procedures as outlined in the Manual. Make sure you understand and comply with all safety precautions noted in this Manual, the *Owner/Operator Manual* and the *Gradall Material Handler Safety Manual*.

ORIENTATION

The directions "front", "rear", "left", and "right" indicate the point of view of a person sitting in the seat in the operator's cab.

PREPARING THE MATERIAL HANDLER FOR SERVICE

1. Before performing any maintenance or service, position the material handler in a safe, open, level area, well away from traffic lanes, buildings, other equipment or personnel.
2. Set the park brake and shift the transmission to "Neutral".
3. Lower the forks to the ground.
4. Place the controls in "Neutral", idle the engine 3 minutes for gradual cooling then shut the engine off.
5. Cycle the hydraulic controls, remove the ignition key and fasten a "Do Not Operate" tag to the steering wheel.
6. Dismount from the material handler facing the machine using the proper hand rails, grab irons and/or ladders provided. Always maintain 3-point contact with the handler while dismounting or mounting.
7. If you must park on a slope or incline, position the material handler at right angles to the slope and chock the wheels.

ADDITIONAL MAINTENANCE/SERVICE PRECAUTIONS

- If you are working with someone else, make sure they understand the procedure. Make sure each of you knows what to expect and when to expect it. Make sure each of you knows where the other is at all times.
- Make sure you wear all the protective clothing and personal safety gear necessary to perform the service safely.
- Make sure there is adequate light and ventilation in the work area.
- Remove oil, grease, mud, snow, water or any other substance that might cause slippery surfaces from all climbing, walking, and working areas.
- Clean around the area to be serviced to minimize any possibility of contamination.
- Use only the correct tools to perform any check, service or repair.
- Make sure any lifting and supporting devices you use are stable and strong enough to handle the weight of the material handler or component.
- Remove only the guards/covers on the area being serviced. Replace all guards/covers immediately upon completion of the task.
- If the Material Handler has special optional equipment, make sure that the appropriate maintenance and operational requirements are understood by everyone who operates and services the machine.

⚠ WARNING

Since you will occasionally have to perform service/maintenance procedures with the material handler running, you must take extra precautions to avoid being injured, perhaps fatally. At a minimum this means:

- *Set the park brake.*
- *Chock the wheels*
- *Avoid all exposed moving parts.*
- *Post a warning in the operator's cab that you are working on the machine.*
- *Work with an assistant.*

NOTE!

Steps 4 and 5 clearly relate to maintenance and service procedures performed with the machine shut down. Although ideal, this may not be possible. Some procedures can only be performed with the machine running. Therefore, this list of precautions headed "Preparing the Material Handler for Service" should be modified according to the specific circumstances of a particular service/maintenance procedure.

HYDRAULIC SYSTEM PRECAUTIONS

- Make sure the hydraulic fluid level in the reservoir is maintained at the proper level. If the fluid level drops unduly, the pumps will be starved and will be destroyed almost immediately.
- Hydraulic fluid must be completely free of contamination at all times. Contaminated hydraulic fluid can severely damage hydraulic components. It may even destroy the entire hydraulic system. Contaminants include dust, sand, water, and minute particles of packing or metal from worn/damaged system components. CHECK THE HYDRAULIC FLUID INDICATOR DAILY, with the fluid at the correct operating temperature. Replace filters as soon as the Indicator warns you. Always clean the reservoir cap and the surrounding area thoroughly before removing the cap. Any fluid you add to the system must conform with the specification outlined in the "Recommended Lubricants and Capacities" Chart posted on the machine and in the relevant *Owner/ Operator Manual*. Add only clean fluid using a clean funnel or hose.
- If you have a reason to suspect hydraulic fluid contamination, send a sample for analysis IMMEDIATELY! If the system is contaminated, all related components must be drained, flushed and cleaned before the system is refilled.
- Watch for leaks or seepage of hydraulic fluid, especially between the reservoir and the pump. Any leakage point may draw air into the system and trapped air can do just as much damage to a hydraulic system as sand!
- Use a piece of cardboard or paper to search for leaks. DO NOT use your bare hands! When tightening hydraulic hoses, always use two wrenches: one to tighten the hose, the other to hold the hose and prevent it from twisting. All hydraulic hoses must lie and roll free of stress.
- If you have to open or disconnect a hydraulic circuit, be very careful!

REQUIRED TOOLS FOR TESTING/ADJUSTING

- Hydraulic Pressure Testing Gauge Kit (7,500 PSI/10,000 PSI Gauge and 1,000 PSI Gauge)
- SAE Combination Wrench Set (up to 1¼")
- Metric Combination Wrench Set (up to 19 mm)
- SAE Allen Key Set
- Metric Allen Key Set
- Large Blue Plastic Caps (Gradall P/N 8093-4460)
- Small Blue Plastic Caps (Gradall P/N 8093-4459)

⚠ WARNING

Always relieve trapped pressure before opening or disconnecting any portion of a hydraulic circuit. Oil at operating temperature can cause serious burns. Oil released under pressure can cause serious injury or death.

NOTE!

You do not have to relieve trapped pressure in order to install the mini-check/hose/gauge combination. Always make sure the gauge and adapter are securely tightened on the hose. Also make sure the seating surfaces and threads of the mini-check and adapter are clean and undamaged.

SAFETY

THE FOLLOWING SYMBOLS CALL YOUR ATTENTION TO IMPORTANT SAFETY NOTICES:

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

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

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

DANGER, WARNING, and CAUTION notes in this Manual will help you avoid injury and damage to the equipment.

Any procedure not specifically recommended by Gradall must be thoroughly evaluated from the standpoint of safety before it is placed in practice. If you are not sure, contact your Authorized Gradall Distributor.

Do not modify this machine without written permission from Gradall.

NOTE ON USING THE MANUAL

This Manual contains a series of tests designed to assess the performance of various implement circuits on the Material Handler. In every instance, there are certain basic precautions and steps you should take before conducting the test. These precautions are outlined in the "Introduction" under the heading, "Preparing the Material Handler for Service". You must read, understand and comply with these instructions in every instance before attempting any check or adjustment on the machine. You must also observe the general warnings listed under the heading, "Additional Maintenance Service Precautions".

HYDRAULIC OIL RESERVOIR

- **CHECK**
  1. The hydraulic oil level gauge is on the outside of the reservoir.
  2. Proper level is to "Full" mark in the sight gauge.
  3. Do not operate the machine if below "Add" line.
  4. Check level with boom fully retracted and forks on the ground.

HYDRAULIC OIL LEVEL SIGHT GAUGE

- **ADJUST**
  1. Refer to the "Lubrication Chart" in the appropriate *Owner/ Operator Manual* for oil specifications.

NOTE!

The system contains approximately 45 gallons of hydraulic oil.

SAMPLE LUBRICATION CHART

NOTE!

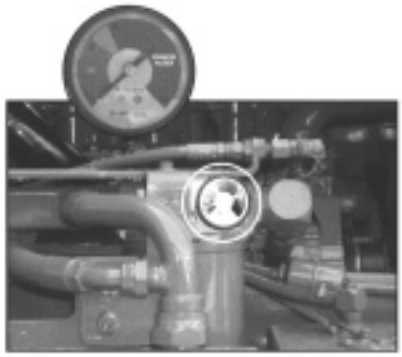
Oil should be changed every 1000 hours, unless you are analyzing oil on a regular basis.

HYDRAULIC FILTER CONDITION

- **SET UP**
  1. With the park brake engaged and the transmission in "Neutral", start the material handler.
  2. Warm the hydraulic oil to 100°F by stalling the "Crowd-In" function at full engine speed.

- **CHECK**
  1. After the hydraulic oil reaches operating temperature (minimum 100°F), check the condition of the hydraulic filter. You will need an assistant.
  2. While one of you sits in the cab running the engine at full throttle (2500 RPM), the other one must check the Filter Restriction Indicator. The indicator is located on the right side of the machine, on the Filter Manifold.
  3. Make sure the indicator does not show "Bypass" with the engine running at full throttle.

- **ADJUST**
  1. If the Indicator shows filter bypass, replace the suction and return filters.



FILTER RESTRICTION INDICATOR

NOTE!

If the hydraulic filters have more than 1000 hours on them, change them.

⚠ WARNING

***Only** Gradall Hydraulic Filters meet or exceed the filtration requirements of the Gradall Material Handler Hydrostatic Drive and Hydraulic Implement Systems. If any other type of filter is installed on the machine, change it immediately and sample the oil. Have the sample analyzed by a reputable test lab.*
***Remember!** Failure to use Gradall Filters may void warranty!*

NOTE!

The long filter for suction (Gradall P/N 9114-3144) also fits in place of the short return filter (Gradall P/N 9108-4021).

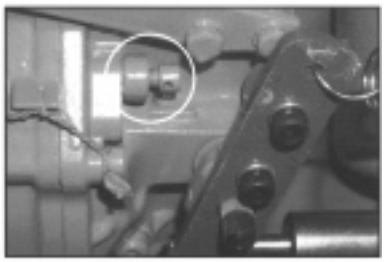
ENGINE SPEED

- **SET UP**
  1. With the park brake engaged and the transmission in "Neutral", start the material handler.
  2. Raise the boom high enough to gain access to the engine compartment.

- **CHECK**
  1. Install an adequate tachometer and check the engine speed (RPM).
  2. At low idle, engine speed should be 800-900 RPM.
  3. At full throttle, engine speed should be 2500 +150/-0 RPM.

- **ADJUST**
  1. Adjust low idle engine speed using the screw on the injection pump.
  2. When testing engine speed, make sure the injection pump lever is contacting the stop.
  3. The full-throttle adjustment screw is pre-set at the factory to prevent "Overspeed". The screw is not adjustable in the field.

RAISE THE BOOM HIGH ENOUGH TO GAIN ACCESS TO THE ENGINE COMPARTMENT



LOW IDLE ADJUSTMENT SCREW

NOTE!

Please note the initial adjustment on current accelerator pedals.

CHARGE PRESSURE (Also used as Pilot Pressure on Joystick Machines)

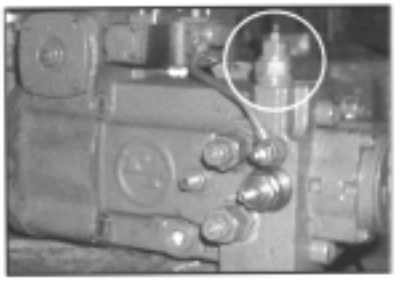
- **SET UP**
  1. Install a 1,000 PSI pressure gauge, hose and adapter on the charge pump test port.
  2. Make sure the gauge can be observed in the operator's cab.

C SERIES: CHARGE PUMP TEST PORT

D SERIES: CHARGE PUMP TEST PORT (HOSE ATTACHED)

- **CHECK**
  1. With the park brake engaged and the transmission in "Neutral", start the engine and run at low idle (800-900 RPM). The gauge should read no less than 320 PSI.
  2. At full throttle (2500 +150/-0 RPM), the gauge should read a maximum of 480 PSI and never less than 320 PSI.

- **ADJUST**
  1. Before attempting any adjustment, you *must* switch the engine off! Also, make sure the park brake is still engaged.



522, 524, 532C-6, 534C-6 and 534C-6T CHARGE PUMP RELIEF VALVE

ALL OTHER MODELS CHARGE PUMP RELIEF VALVE

  2. To adjust the charge pump relief valve, remove the cap and loosen the locknut.
  3. Turn the adjusting screw clockwise to increase charge pressure.
  4. Turn the adjusting screw counter-clockwise to reduce charge pressure.
  5. Be sure to note the amount that the relief turns in either direction.
  6. When finished, tighten the locknut and install a blue plastic cap.
  7. To locate the loss of charge pressure, refer to the appropriate *Hydrostatic Drive Performance Checks Manual* under the "Charge Pressure" section.

NOTE!

*For more details, see page 73 of the **Material Handler Hydraulic System Manual** (Form No. 29101).*

NOTE!

The location of the charge pump test port varies by machine vintage.

NOTE!

The location of the charge pump relief valve varies by machine vintage.

STEERING CIRCUIT

- **SET UP**
  1. Install a 10,000 PSI gauge, hose and adapter to the test port in the outlet tube of the main implement pump. Make sure you can see the gauge from the operator's cab.

522, 524, 532C-6, 534C-6 and 534C-6T MAIN IMPLEMENT TEST PORT

ALL OTHER MODELS MAIN IMPLEMENT TEST PORT

  2. With the park brake engaged and the transmission in "Neutral", start the material handler. Retract all cylinders and bring the boom level.
  3. Make sure there is no one behind the machine and turn the steering wheel fully in one direction until the steering bottoms.

NOTE!

The location of the main implement test port varies by machine vintage.

⚠ CAUTION

Do not hold the steering fully turned any longer than necessary.

- **CHECK**
  1. With the engine running at low idle (800-900 RPM), observe the pressure gauge while holding the steering fully turned.
  2. The gauge should read 2500 ± 100 PSI for all Models except the 544C-10 and 544D-10 which should read 3000 ± 100PSI.

- **ADJUST**
  1. If adjustment is necessary, turn the steering slightly in the opposite direction, make sure the park brake is still engaged and the transmission in "Neutral" and stop the engine.
  2. Locate the steering flow divider valve.
  3. Remove the hose and the straight adapter fitting from the reservoir port of the valve to allow access to the relief valve socket head adjusting screw.
  4. Turn the screw clockwise to increase pressure; counter-clockwise to reduce pressure.
  5. Re-connect the hose and adapter fitting to the flow divider valve and re-test.

STEERING FLOW DIVIDER VALVE

MAIN CONTROL VALVE PUMP RELIEF

- **SET UP**
  1. Install a 10,000 PSI gauge, hose and adapter to the test port in the outlet tube of the main implement pump. Make sure you can see the gauge from the operator's cab.

522, 524, 532C-6, 534C-6 and 534C-6T MAIN IMPLEMENT TEST PORT

ALL OTHER MODELS MAIN IMPLEMENT TEST PORT

  2. With the park brake engaged and the transmission in "Neutral", start the material handler. Move the Boom In/Out lever fully right to extend the boom to the end of its stroke.

- **CHECK**
  1. With the engine running at full throttle (2500 RPM), observe the pressure gauge.
  2. The gauge should read:
     522, 524, 532C-6, 534C-6, 522D, 524D, 534D-6 ..... 3000 ± 100 PSI
     534C-9, 534C-10, 534D-9, 534D-10 ..... 3200 ± 100 PSI
     544C-10, 544D-10 ..... 3600 ± 100 PSI

- **ADJUST**
  1. Before attempting any adjustment, you *must* switch the engine off! Also, make sure the park brake is still engaged.
  2. The main pump relief is located in the inlet side of the main control valve, located under the operator's seat.
  3. If necessary, loosen the pump relief valve locknut.
  4. Turn the adjusting screw clockwise to increase pressure; counter-clockwise to reduce pressure.
  5. Tighten the locknut and re-test for proper pressure.

NOTE!

The location of the main implement test port varies by machine vintage.

MAIN PUMP RELIEF VALVE

TILT CIRCUIT RELIEF VALVES

- **SET UP**
  1. Install a 10,000 PSI gauge, hose and adapter to the test port on the outlet tube of the main implement pump. Make sure you can see the gauge from the operator's cab.

522, 524, 532C-6, 534C-6 and 534C-6T MAIN IMPLEMENT TEST PORT

ALL OTHER MODELS MAIN IMPLEMENT TEST PORT

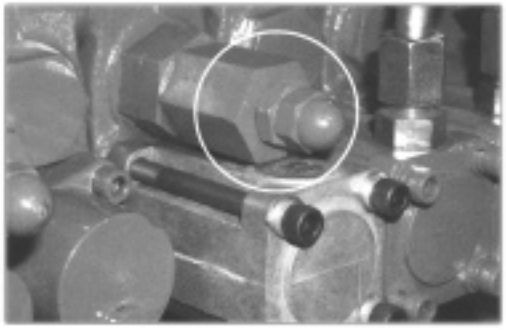
  2. With the park brake engaged and the transmission in "Neutral", start the material handler.

- **CHECK**
  1. With the engine running at low idle (800-900 RPM) and holding the Attachment Tilt Lever fully **forward**, observe the gauge.
  2. The gauge should read 2800 ± 100 PSI for all Models except the 544C-10 and 544D-10 which should read 3000 ± 100 PSI.
  3. Raise the forks (or other attachment) until the cylinder bottoms.
  4. Observe the gauge while holding the Attachment Tilt Lever fully **backward**.
     Again, the gauge should read 2800 ± 100 PSI for all Models except the 544C-10 and 544D-10 which should read 3000 ± 100 PSI.

- **ADJUST**
  1. Before attempting any adjustment, you *must* switch the engine off! Also, make sure the park brake is still engaged.
  2. If necessary, loosen the locknut and turn the adjusting screw clockwise to increase pressure; counter-clockwise to reduce pressure.

NOTE!

The location of the main implement test port varies by machine vintage.



TILT CIRCUIT RELIEF VALVE

CROWD CIRCUIT EXTEND RELIEF VALVE

- **SET UP**
  1. Install a 10,000 PSI gauge, hose and adapter to the test port on the outlet tube of the main implement pump. Make sure you can see the gauge from the operator's cab.

MAIN IMPLEMENT TEST PORT

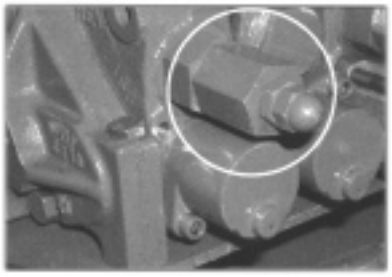
  2. With the park brake engaged and the transmission in "Neutral", start the material handler.

- **CHECK**
  1. With the engine running at low idle (800-900 RPM), extend the boom fully and hold over relief.
  2. The gauge should read 2700 ± 100 PSI.

- **ADJUST**
  1. Before attempting any adjustment, you *must* switch the engine off! Also, make sure the park brake is still engaged.
  2. If necessary, loosen the locknut and turn the adjusting screw clockwise to increase pressure; counter-clockwise to reduce pressure.

NOTE!

The 534C-9, 534C-10, 534D-9 and 534D-10 are the only C or D Series Material Handlers with a Crowd Circuit Extend Relief Valve.



CROWD CIRCUIT EXTEND RELIEF VALVE

AUXILIARY CIRCUIT RELIEF VALVES

- **CHECK # 1**
  1. Inspect the quick-disconnect fittings at the boom head for signs of leakage.
  2. Replace any leaking fittings.

BOOM-HEAD QUICK-DISCONNECT FITTINGS

- **CHECK # 2**
  1. Install a 10,000 PSI gauge, hose and adapter to the test port on the outlet tube of the main implement pump. Make sure you can see the gauge from the operator's cab.

522, 524, 532C-6, 534C-6 and 534C-6T MAIN IMPLEMENT TEST PORT

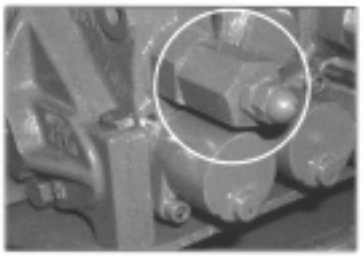
ALL OTHER MODELS MAIN IMPLEMENT TEST PORT

NOTE!

The location of the main implement test port varies by machine vintage.

  2. With the park brake engaged and the transmission in "Neutral", start the material handler.
  3. With the engine running at low idle (800-900 RPM) and holding the Auxiliary Control Lever fully **forward** to pressurize Work Port A, observe the gauge. The gauge should read 2000 ± 100 PSI.
  4. Release the lever.
  5. Observe the gauge while holding the Auxiliary Control Lever fully **backward** to pressurize Work Port B. The gauge should read 2000 ± 100 PSI.
  6. Release the lever.

- **ADJUST**
  1. Before attempting any adjustment, you *must* switch the engine off! Also, make sure the park brake is still engaged.
  2. If necessary, loosen the locknut on the given circuit's relief valve.
  3. Turn the adjusting screw clockwise to increase pressure; counter-clockwise to reduce pressure.



AUXILIARY RELIEF

SERVICE BRAKE VALVE

- **SET UP**
  1. Install a 10,000 PSI gauge, hose and adapter to the test port on the service brake system. Make sure you can see the gauge from the operator's cab.

D-SERIES SERVICE BRAKE TEST PORT

  2. With the park brake engaged and the transmission in "Neutral", start the material handler.

- **CHECK**
  1. With the engine running at low idle (800-900 RPM) and while depressing the service brake pedal fully, observe the gauge.
  2. The gauge should read:
     522, 524, 532C-6, 534C-6, 522D, 524D, 534D-6 ..... 1250 ± 150 PSI
     534C-9, 534C-10 ..... 1400 ± 100 PSI
     534D-9, 534D-10 ..... 1650 ± 150 PSI
     544C-10, 544D-10 ..... 1675 ± 75 PSI
  3. If the gauge does not read correctly, check the following components:

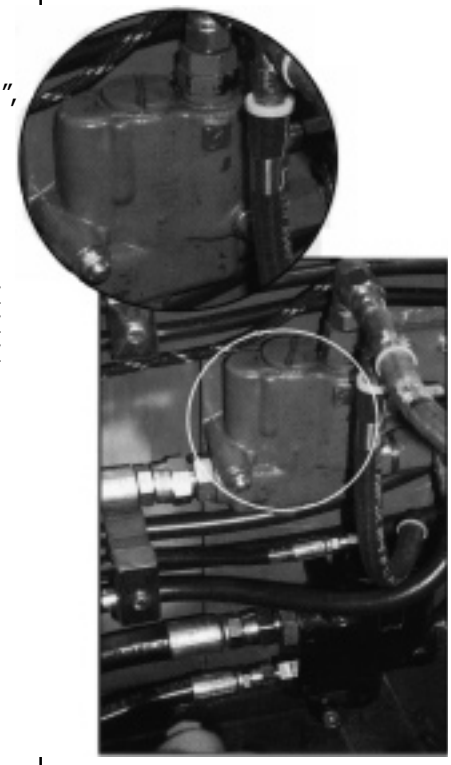
     522, 524, 532C-6, 534C-6, 544C-10 and all D-Series Material Handlers
     1. Brake pedal is misadjusted or bent.
     2. Brake Valve is not functioning correctly.
     3. Brake Flow Divider Valve is not adjusted properly or is malfunctioning.
     4. Air is trapped in the hydraulic lines.
     5. Leaking hydraulic fittings, tubes and hoses.
     6. Leaking or bypassing Axle Pistons or Calipers.

     534C-9 and 534C-10 Material Handlers
     1. Brake pedal is misadjusted or bent.
     2. Brake Valve is not functioning correctly.
     3. Service Brake Relief Valve is malfunctioning.
     4. Service Brake Pump is faulty.
     5. Air is trapped in the hydraulic lines.
     6. Leaking hydraulic fittings, tubes and hoses.
     7. Leaking or bypassing Axle Pistons or Calipers.

- **ADJUSTMENT OF THE BRAKE FLOW DIVIDER VALVE**
  1. The Relief Valve is located below the return line elbow. If adjustment is required, the elbow must be removed to gain access to the relief valve.
  2. Loosen and remove the top hex-head nut to gain access to the shims (available in .021" and .005" thickness - install thinner shims against the spring).
  3. If adjustment is required, *stop the engine* and remove the elbow from the relief valve.
  4. Open the valve between the hex-head nuts to gain access to the shims.
  5. Add or remove shims as required and assemble.

NOTE!

The Service Brake Test Port may be in one of three different locations:
1. *Under the cab by the Brake Valve.*
2. *Along the left-hand frame rail in the Battery Compartment.*
3. *In the Battery Compartment behind the differential (see picture).*



BRAKE FLOW DIVIDER VALVE

NOTE!

Only the 522, 524, 532C-6, 534C-6, 522D, 524D and 534D-6 Brake Flow Divider Valves are adjustable. The 544C-10, 534D-9, 534D-10 and 544D-10 Brake Flow Divider is not adjustable and is mounted on the frame rail along the left-hand side of the engine. The 534C-9 and 534C-10 do not have a Brake Flow Divider Valve.

NOTE!

Make sure you install the elbow before testing.

APPENDIX A: CYCLE TIMES FOR FUNCTIONS

1. Position the handler safely, in a level, open area, well away from traffic lanes, buildings, other equipment or personnel.
2. Position the handler so that all cylinders may bottom out in both directions.
3. Run the engine at full throttle (2500 RPM) during testing.

C-Series Cycle Times

FUNCTION	TIME (seconds)		
	522 & 524	532C-6 & 534C-6	534C-9 & 53
Boom Up (fully retracted)	10.00	14.00	12.00
Boom Down (fully retracted)	7.00	10.25	10.00
Boom Extend (level)	7.00	10.75	12.50
Boom Retract (level)	10.00	14.00	13.50
Attachment Tilt Up	3.00	3.25	3.00
Attachment Tilt Down	3.50	3.75	3.50

D-Series Cycle Times

FUNCTION	TIME (seconds)				
	522D & 524D	534D-6	534D9-42	534D-9 & 534D-10	534D
Boom Up (fully retracted)	10.00	14.00	14.00	12.00	
Boom Down (fully retracted)	7.00	10.25	11.50	10.00	
Boom Extend (level)	7.00	10.75	13.50	12.50	
Boom Retract (level)	10.00	14.00	15.00	13.50	
Attachment Tilt Up	3.00	3.25	3.25	3.00	
Attachment Tilt Down	3.50	3.75	3.75	3.50	

NOTE!
Use these charts to help determine the condition of the Main Implement Pump.

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Additional copies of this Manual are available from Gradall Product Support. Call 330-684-2604, Ext. 4146. Ask for the complete list of available Technical Manuals for Gradall Material Handlers.

GRADALL®

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Important rim and wheel safety precautions

NOTICE!

An inflated tire and rim can be very dangerous if misused or worn-out. Many accidents, some fatal, have resulted from improper handling and operation of truck rims and wheels. It is, therefore, of the utmost importance that the precautions outlined on this page be carefully followed by all persons servicing truck rims and wheels to avoid personal injuries and costly damage.

How to prevent rim accidents during tire mounting

Always inflate tire in safety cage or use a portable lock ring guard. This is a safeguard against improper assembly, inadvertently mismatched parts, and other assembly errors. Remember, an inflated tire contains potentially explosive energy that can blow improperly assembled rings loose. In emergency situations, where a safety cage or portable safety device is not available, use a clip-on type air chuck so that the operator can stand clear during tire inflation. **Important,** when clip-on air chuck is used, line pressure must be restricted to maximum inflation capacity of tire.

Use properly matched parts only. Rim base and rings must be matched according to size and type. This information is stamped on each Firestone part.

Replace damaged parts. Abuse during road operations or in mounting the tire can cause dents, cracks, or distortions which weaken the parts. Inspect for and replace damaged parts.

Periodically inspect and remove rust and other foreign matter. Accumulation of such material in the rim gutter can prevent the proper fitting of rings. Parts that are excessively corroded are weakened and should be replaced. Use of a rust preventative compound (not containing water) during mounting will minimize rusting.

Do not use over-size or over-inflated tires. Use only recommended size rims for tires and do not exceed maximum inflation pressure for the rim.

Follow manufacturer's recommended mounting procedures.

ADDED PRECAUTION: **Re-check assemblies just prior to inflation, particularly if they have been rolled across the floor or have received rough handling between mounting and inflation.**

During tire demounting

Completely deflate tire prior to demounting. The tire should be deflated prior to removal of the tire and rim assembly from the vehicle. Remove the valve core to insure complete deflation.

DO NOT STAND IN FRONT OF RIM/TIRE DURING DEFLATION.

Follow recommended demounting procedures.

Check for damaged or worn parts. Mark defective parts for destruction to preclude their future use.

During vehicle operation

Before putting new vehicles into service, clamps and wheel nuts should be checked for proper torque.

Do not overload rims or wheels. Insure that the combination of load and vehicle weight does not exceed the rated load of the rims or wheels used. Rims and wheels are designed to sustain their rated load using the maximum tire size recommended for that rim width by the Tire & Rim Association.

Inspect rims and wheels for damage during tire checks and at periodic maintenance intervals. Remove and replace defective parts.

Do not exceed maximum inflation pressures. This is determined by the size and ply rating of the tire, but is not to exceed the maximum inflation listed for the rim or wheel. It is also important to maintain uniform inflation in both tires of a dual assembly so that weight is equally sustained.

Do not run vehicle on one tire of dual assembly. When there is loss of air in a dual tire the carrying capability is reduced and the load must be sustained by the other tire and rim. Both tires should be inflated to balanced, recommended pressures before further operation.

Never re-inflate a tire that has been run flat or seriously underinflated without first breaking rim down and reassembling rim. It is especially important to make sure the lock ring is secure in the gutter and has not been damaged prior to re-inflation.

After first 50 to 100 miles of service re-check clamp and wheel nut torque. Loose wheel nuts can cause excessive wear around bolt holes, dangerous wheel vibration, and metal fatigue failure. Excessive torque is also dangerous in that it can cause stud or wheel breakage.

THE GRADALL COMPANY
406 Mill Ave., S.W. New Philadelphia, Ohio 44663

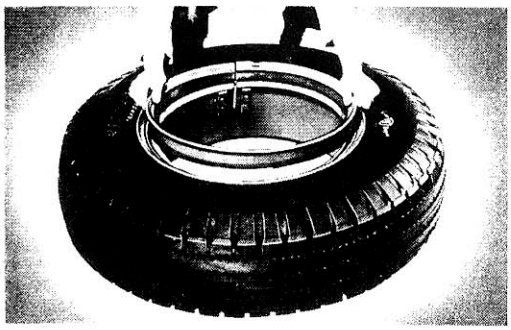
Form No. 0009

How to mount and demount ACCU-RIDE 5° Commander and 3-piece convertible rims

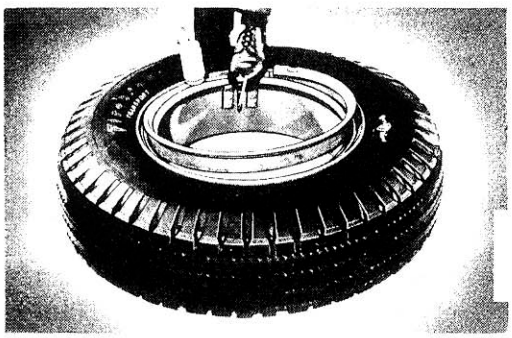
(Procedure applies to tires on both demountable rims and disc wheels)

Tools required: 1 rim mallet / 1 rim tool

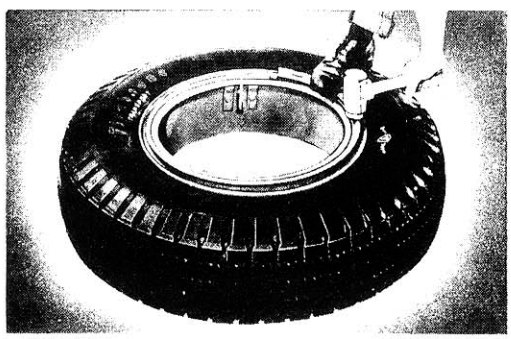
MOUNTING



After applying tire and tube in usual manner, place removable side ring (flange) on bead of tire. Then insert tapered toe of lock ring between side ring and rim base.

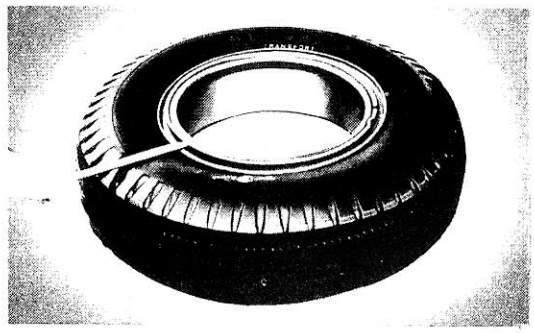


To fasten lock ring, hold with foot at one end of split and hammer end of ring into place with rim mallet.

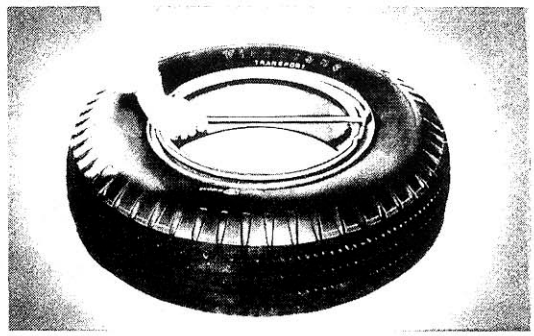


Continue progressively around the rim, holding ring with foot and hammering until entire ring is seated. Check seating of rings and inflate tire to recommended pressure.

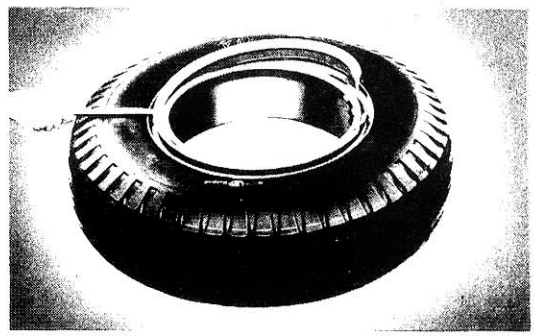
DEMOUNTING



Standing clear of rim, completely deflate tire by removing valve core or using deflator cap. Place tapered end of rim tool in depression in lock ring, or between rings, and press down on side ring to free bead. Continue downward pressure on side ring progressively around the tire until the bead is completely freed from the bead seat.



To disengage lock ring from the gutter, insert rim tool in removing notch, near split in the ring, and push downward. If desired, a second similar tool may be used to facilitate removal.



Insert the rim tool between the lock ring and side ring and press downward to pry ring up. Move progressively around the rim until lock ring is free, then lift off lock and side rings. Turn assembly over, unseat tire bead, stand tire up and remove rim base.

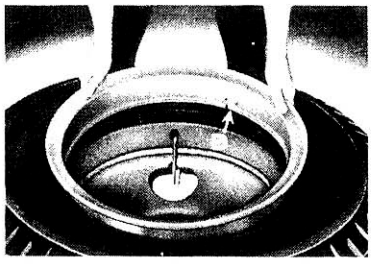
SAFETY PRECAUTIONS

1. **Use only parts free from damage or heavy rust.**
2. **Insure that lock ring is completely installed before inflating tire. Inflate tire in safety cage or use a lock ring guard. In emergency situations where a safety cage or portable safety device is not available, use clip-on type air chuck so that operator may stand clear during inflation.**
3. **Insure that tire is completely deflated prior to removal of rings.**
4. **Split lock rings used with continuous side rings must not butt.**
5. **Do not inflate a flat or seriously underinflated tire while tire is on vehicle. Remove and make sure all parts are serviceable and fully reassemble before reinflating tire.**

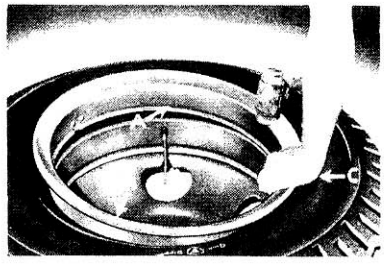
How to mount and demount ACCU-RIDE RH5° rims

Tools Required: 1 Rim Mallet
1 Rim Tool

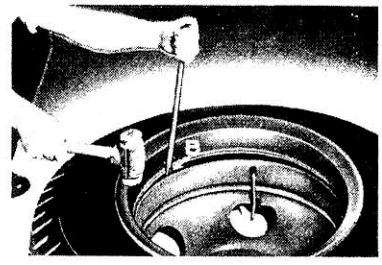
MOUNTING



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.

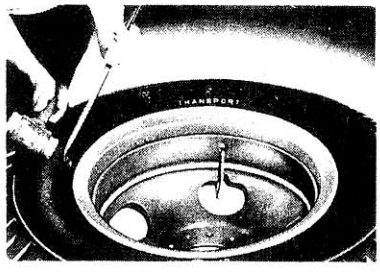


The two cutaway portions opposite each other in the inner diameter of the ring (points A) are placed so as to span the rim gutter. At point C, opposite valve, force half of ring into the gutter as far as possible using hand and rim mallet.

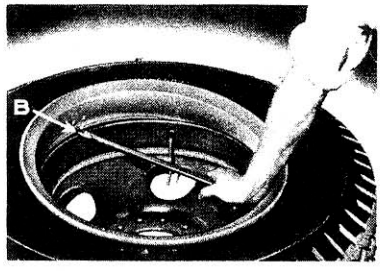


Insert straight end of rim tool in operating notch (point B), then pull in direction indicated by arrow. Retain pressure with tool and strike ring downward with mallet at point between tool slot and cutaway portion, thereby engaging ring over rim gutter at that point. Remove tool and strike additional 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.

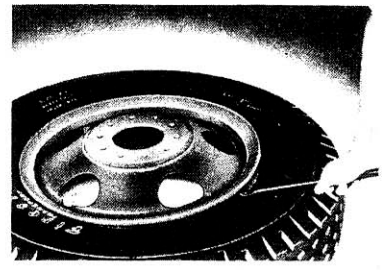
DEMOUNTING



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.



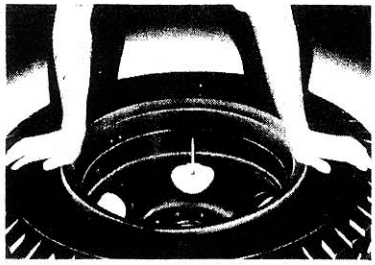
Remove ring by putting straight end of rim tool into notch in ring located between embossings (point B). Push ring downward at point opposite operating notch. Force tool handle downward as illustrated, causing ring to disengage from rim gutter. Continue operation, prying away from rim gutter with flat 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.



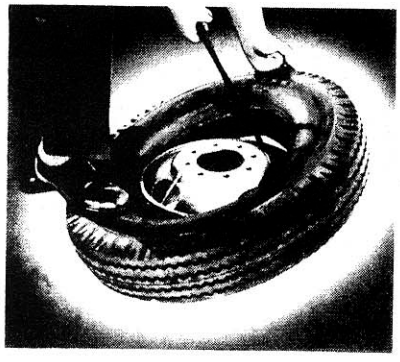
SAFETY PRECAUTIONS:

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.**

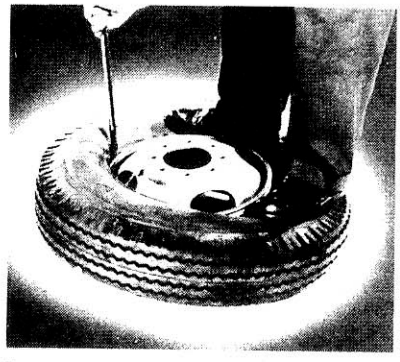
How to mount and demount ACCU-RIDE RHP rims

Tools required: 2 rim tools
1 rim mallet
1 tire tool (thin end)

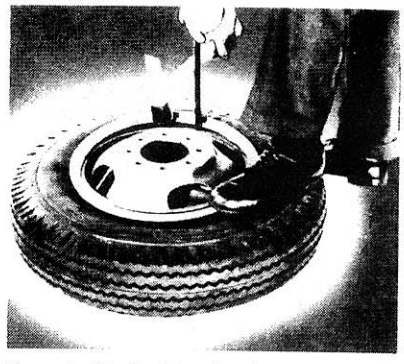
MOUNTING



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.

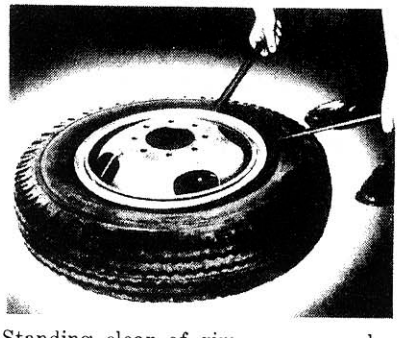


To apply second bead, start at point opposite valve and press bead toe over rim gutter and into rim well with foot pressure. Mount remainder of bead over rim gutter by means of thin tire tool, being careful not to pinch tube.

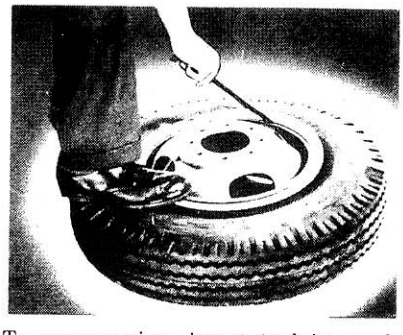


Place half of side ring in rim gutter with cutaway portions in position as shown. Insert thin end of rim tool or heavy screw driver and pull ring outward toward centered position. Strike with mallet, forcing rim into gutter.

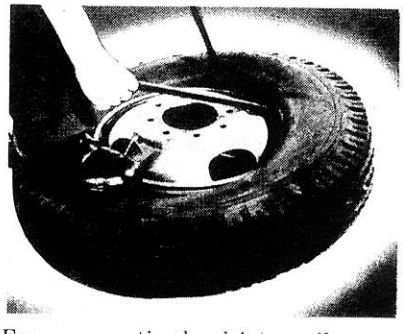
DEMOUNTING



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.



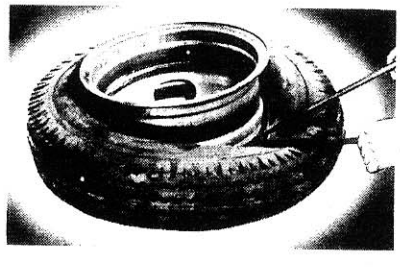
To remove ring, insert tool in notch and force ring opposite of notch into gutter, then pry off. Pry out and up on side ring, carefully but firmly. (Be careful not to bend side ring.)



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:

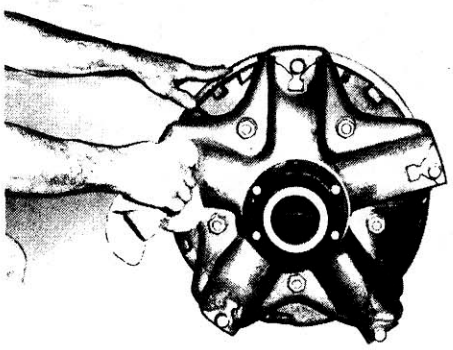
1. **Use only parts free from damage or heavy rust.**
2. **Insure that side ring is completely seated before inflating tire.**
3. **Inflate tire in safety cage or use a lock ring guard. In emergency situations where a safety cage or portable safety device is not available, use clip-on type air chuck 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.

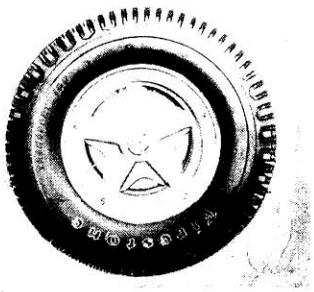
RECOMMENDED INSTALLATION PROCEDURE

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.

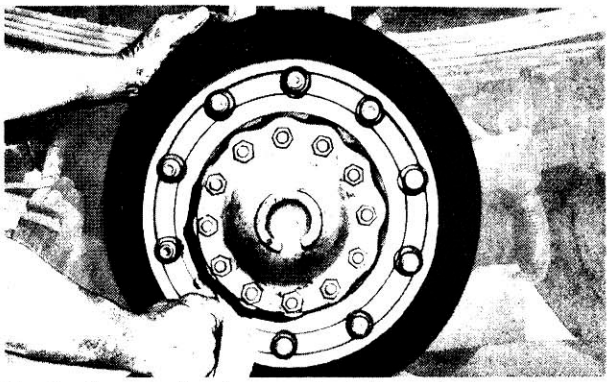
SPOKE WHEELS*	
Thread Size	Torque Ft.-Lbs. (Dry)
5/8 - 11	150 - 175
3/4 - 10	200 - 250
1 - 8	400 - 450
1 - 14	400 - 450

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.

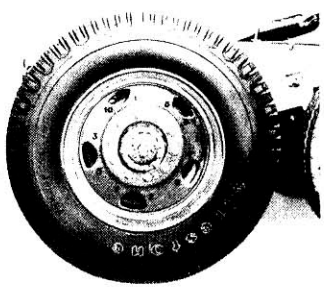
Wrenches for Demountable Rims and Disc Wheels: Double-end socket wrenches for rims and disc wheels normally are adequate to install and remove Accu-Ride rims and wheels, when used with a 3-foot bar. A 150-pound man, exerting his entire weight, 2.5 feet out on a bar, can apply 375 foot-pounds of torque 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, nuts and mounting faces of hub and wheels are clean and free from grease. Replace any defective parts.



Mount single wheel or inner dual wheel (also, outer dual wheel for hub - type mounting) over studs, being careful not to damage stud threads. Draw up nuts alternately in the sequence shown at left. Do **not** tighten them fully, however. This procedure will permit the uniform seating of nuts and insure the even, face-to-face contact of wheels and hub.

Tighten nuts fully, using the same alternate sequence. Mount the outer wheel (for double cap mounting) and repeat the entire procedure. In each case, be sure to tighten wheel nuts only to the torque level recommended in the table below and to maintain them at that level through planned, periodic checks.

Note: When inner cap nuts are re-tightened, be sure first to loosen outer cap nuts several turns; then, re-tighten them.

DISC WHEELS*		
Application	Thread Size	Torque Ft.-Lbs. (Dry)
Passenger Type Mtg.	7/16-20	80-90
	1/2-20	80-90
	9/16-18	110-120
	5/8-18	125-140
In-Out Coined Mtg.	9/16-18	175-200
	5/8-18	175-200
		1-pc. nut / 2-pc. nut
Piloted Mtg.	11/16-16	300-350 / 200-250
	3/4-16	450-500 / 300-350
	7/8-14	..... / 350-400
Ball Seat Mtg.	3/4-16	450-500
	1-1/8-16	450-500
Heavy Duty Ball Seat Mtg.	15/16-12	750-800
	1-5/16-12	750-800

CAUTION: *Insufficient* mounting torque can cause wheel shimmy, resulting in damage to parts and extreme tire tread wear. *Excessive* mounting torque can cause studs to break and discs to crack in the stud hole area.

Proper maintenance of ACCU-RIDE rims and wheels

Accu-Ride rims and wheels are thoroughly tested in Firestone laboratories, on Firestone test tracks and by both small and large fleets on the highways of America. All these tests, plus a rigid quality-control program, insure maximum performance of all Accu-Ride rims and wheels. In order, however, to maintain their built-in quality and to insure maximum service and safety a continuous maintenance program is advisable. Maintenance procedures should be carried out during all tire inspections and changes and at periodic maintenance intervals depending upon road and environmental conditions of operation.

RIM AND WHEEL MAINTENANCE DURING TIRE INSPECTIONS

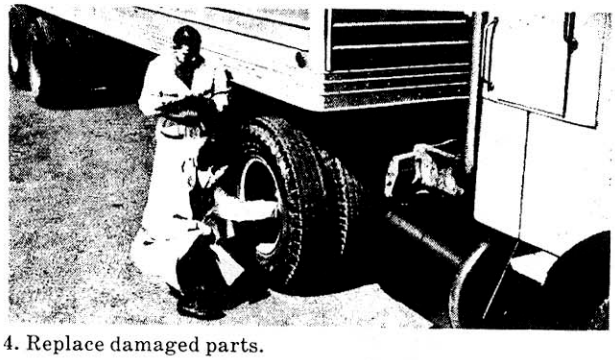
1. Check all metal surfaces thoroughly while making tire inspections, including areas between duals and on inboard side of wheel. Watch for:

excessive rust or corrosion build-up
cracks in metal
bent flanges, resulting from road obstructions
deep rim tool marks on rings or in gutter areas
loose, missing or damaged nuts or clamps
bent or stripped studs
damaged or missing rim drive plates
matched rim parts

2. Pull damaged rims or wheels.

CAUTION: Excessively corroded or cracked rims or rings can be dangerous. Deflate tires prior to the removal of rims or wheels from the vehicle.

3. Mark damaged or hazardous areas with chalk so that part will be removed from service.



4. Replace damaged parts.

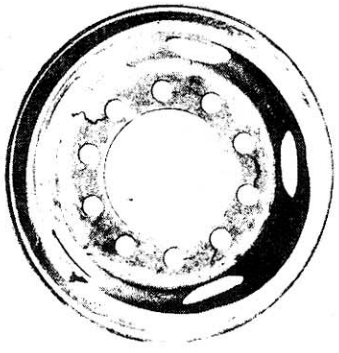
CAUTION: Insure that replacements are made with the proper sizes and types of rims and rings.

5. Inflate tires only to recommended air pressures.

RIM AND WHEEL MAINTENANCE DURING TIRE CHANGES

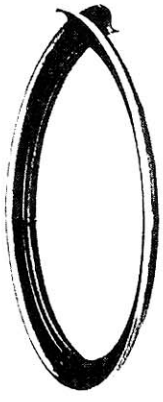
1. Check all metal surfaces as in No. 1, above. A more thorough check may be made, however, after the tire has been demounted. Watch particularly for the damages illustrated below and refer to recommendations in this section of the catalog if corrective measures are required.

Cracks in the rim base, in the back flange and gutter areas. These are caused by deep rim tool marks, overloading and overinflating tires and using larger than recommended tire sizes.



Cracks in the wheel disc, between stud holes or hand holes. These are caused by loose wheel nuts, improper installation procedures and use of incorrect sizes or types of attaching parts.

Cracks through side ring, spreading laterally through the entire section. These are caused by improper mounting and demounting techniques, impact with road obstructions, and excessive clamping torques.



Sprung side ring, resulting from improper mounting procedures.

Erosion and chipping of bead seat of lock ring, resulting from excessive corrosion. This may occur with this part as well as others if protective measures described on following page are not taken.

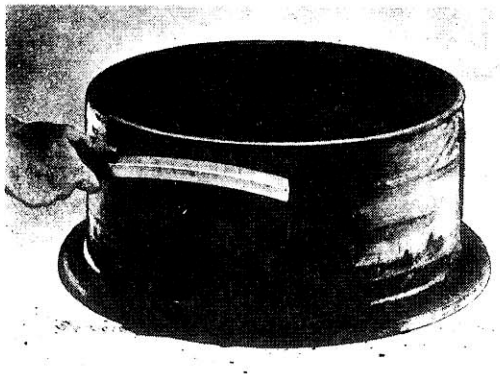
2. Replace damaged parts.

CAUTION: Insure that replacements are made with the proper sizes and types of rims and rings.

NOTE: Openings between ends of split side rings must not be less than 3/32" except where the ring design calls for an abutting condition, or more than 5/16" after ring is seated-in during operation. Split lock rings used with endless side rings must not butt.

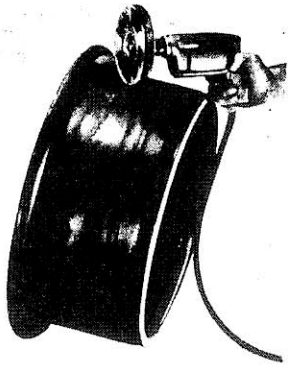
(Continued)

Proper maintenance of ACCU-RIDE rims and wheels
(continued)

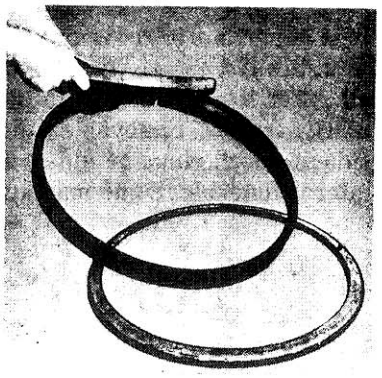


3. Thoroughly remove rust, dirt and other foreign materials from all surfaces. Hand or electric wire brushes, sand blasting or chemical baths may be used.

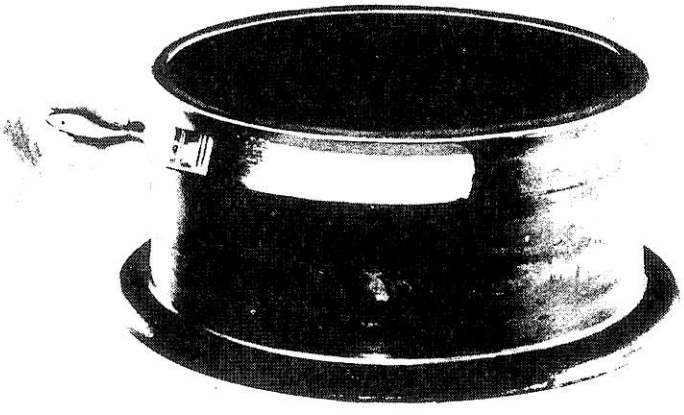
Gutter of rim base should be cleared of rust and other materials obstructing safe, positive seating of rings.



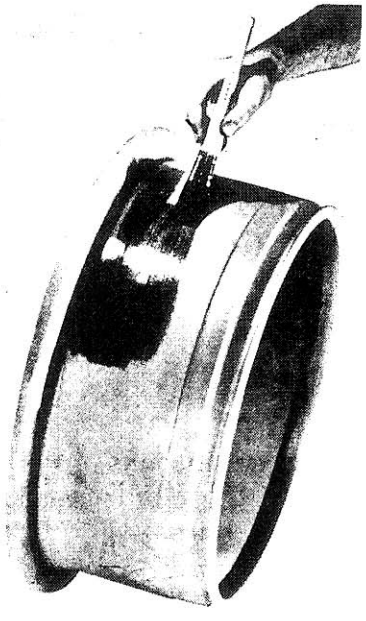
Bead seat areas of rim should be free of rust and rubber deposits. This is especially important for drop-center tubeless rims, because the 15° bead seat is the air-sealing element.



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.

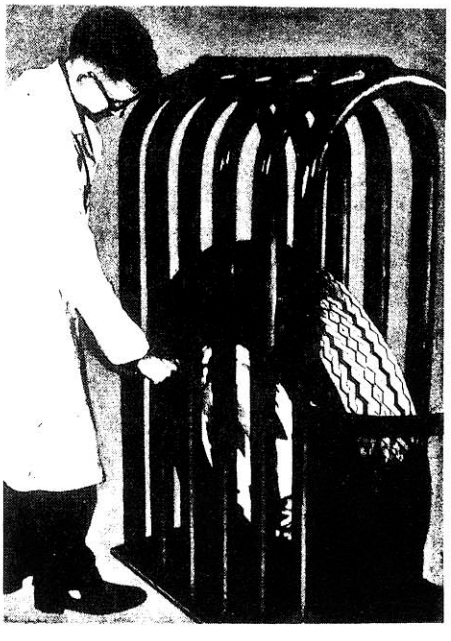


5. Lubricate tire side of rim base just prior to mounting tire. Avoid the use of any lubricant which contains water or solvent that is injurious to rubber. A combination lubricant and rust-preventive compound is preferable. This protective measure is of particular importance with drop-center tubeless 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.**



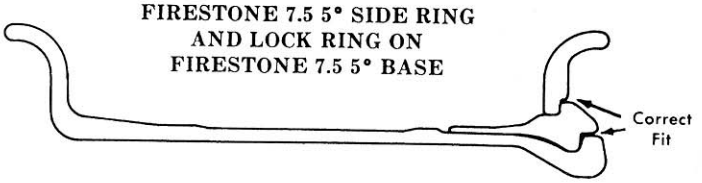
How to Insure Greater Safety and Service by Properly Matching Side and Lock Rings

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.

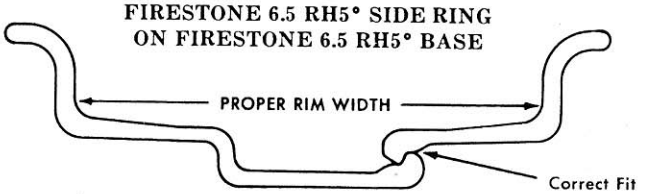
The drawings below illustrate a few of the potentially dangerous conditions which can result from the mismatching of rings and bases.

CORRECT

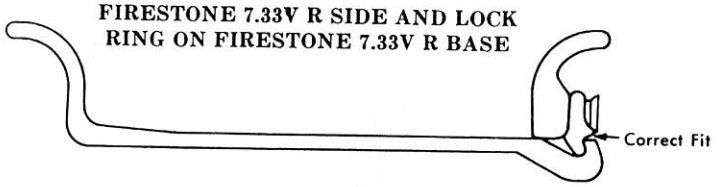
FIRESTONE 7.5 5° SIDE RING AND LOCK RING ON FIRESTONE 7.5 5° BASE



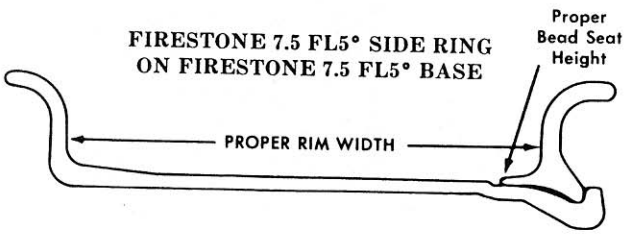
FIRESTONE 6.5 RH5° SIDE RING ON FIRESTONE 6.5 RH5° BASE



FIRESTONE 7.33V R SIDE AND LOCK RING ON FIRESTONE 7.33V R BASE

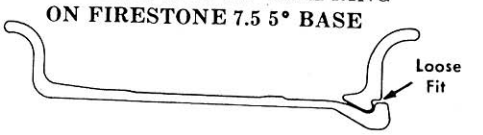


FIRESTONE 7.5 FL5° SIDE RING ON FIRESTONE 7.5 FL5° BASE

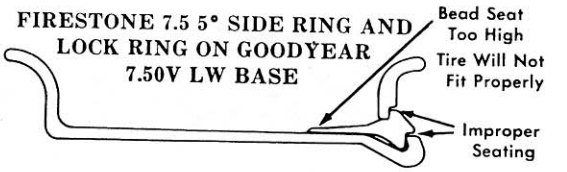


INCORRECT

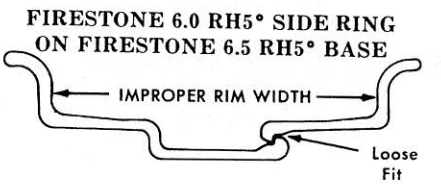
GOODYEAR 7.50V LW SIDE RING ON FIRESTONE 7.5 5° BASE



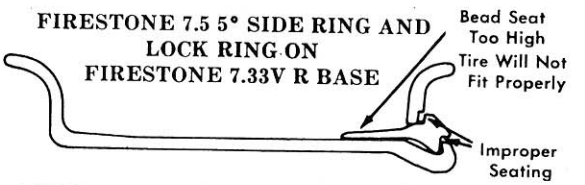
FIRESTONE 7.5 5° SIDE RING AND LOCK RING ON GOODYEAR 7.50V LW BASE



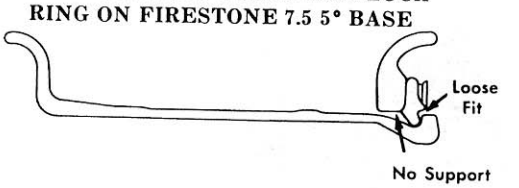
FIRESTONE 6.0 RH5° SIDE RING ON FIRESTONE 6.5 RH5° BASE



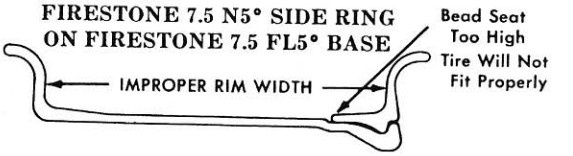
FIRESTONE 7.5 5° SIDE RING AND LOCK RING ON FIRESTONE 7.33V R BASE



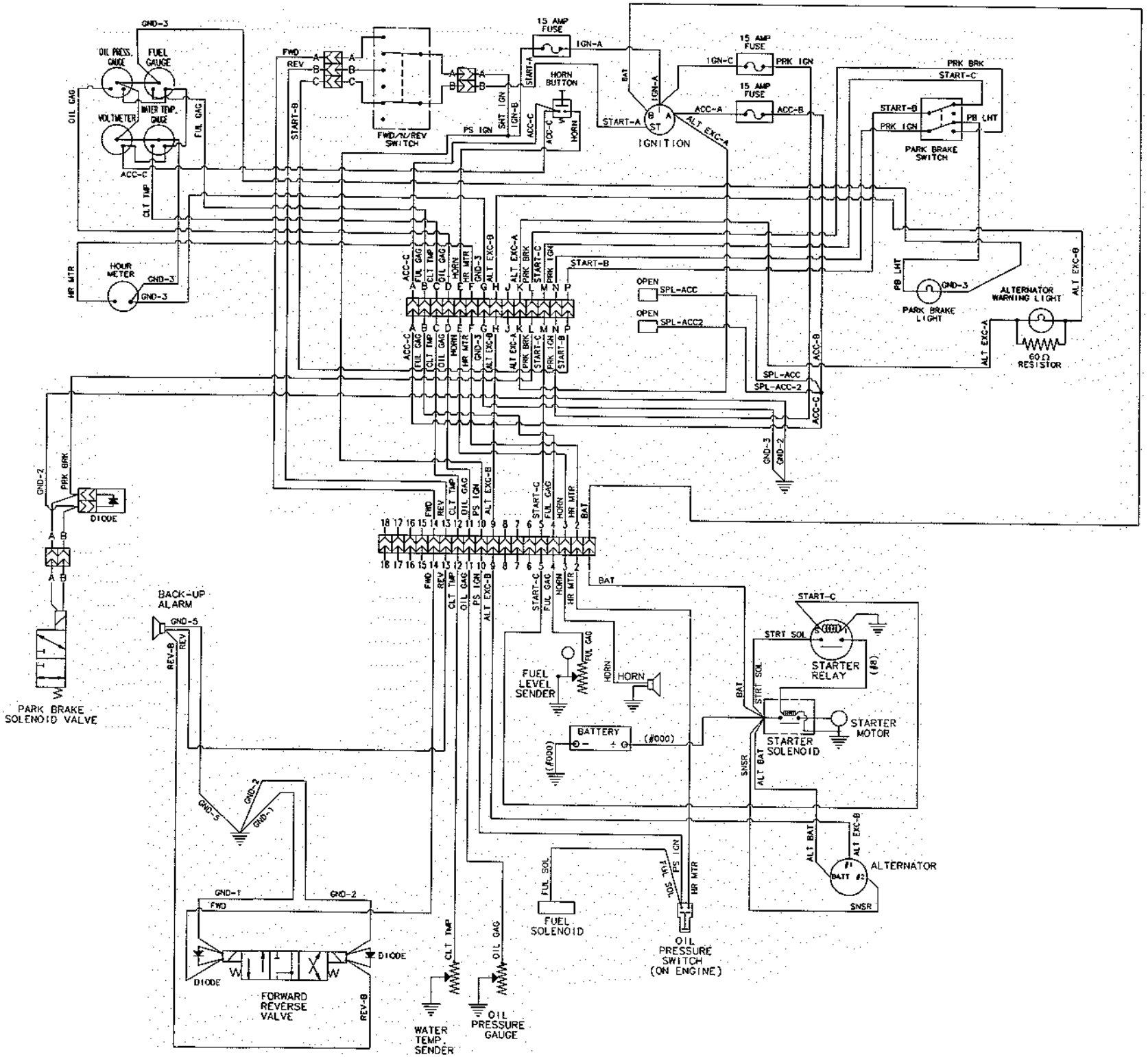
FIRESTONE 7.33V R SIDE AND LOCK RING ON FIRESTONE 7.5 5° BASE



FIRESTONE 7.5 N5° SIDE RING ON FIRESTONE 7.5 FL5° BASE



NOTE: When in doubt of component compatibility, refer to the U.S. Department of Transportation, National Highway Traffic Safety Administration's Multipiece Rim / Wheel Matching Chart. Chart is available from D.O.T. NHTSA Office of Defect Investigation, all rim and wheel distributors and all Firestone Sales Offices.

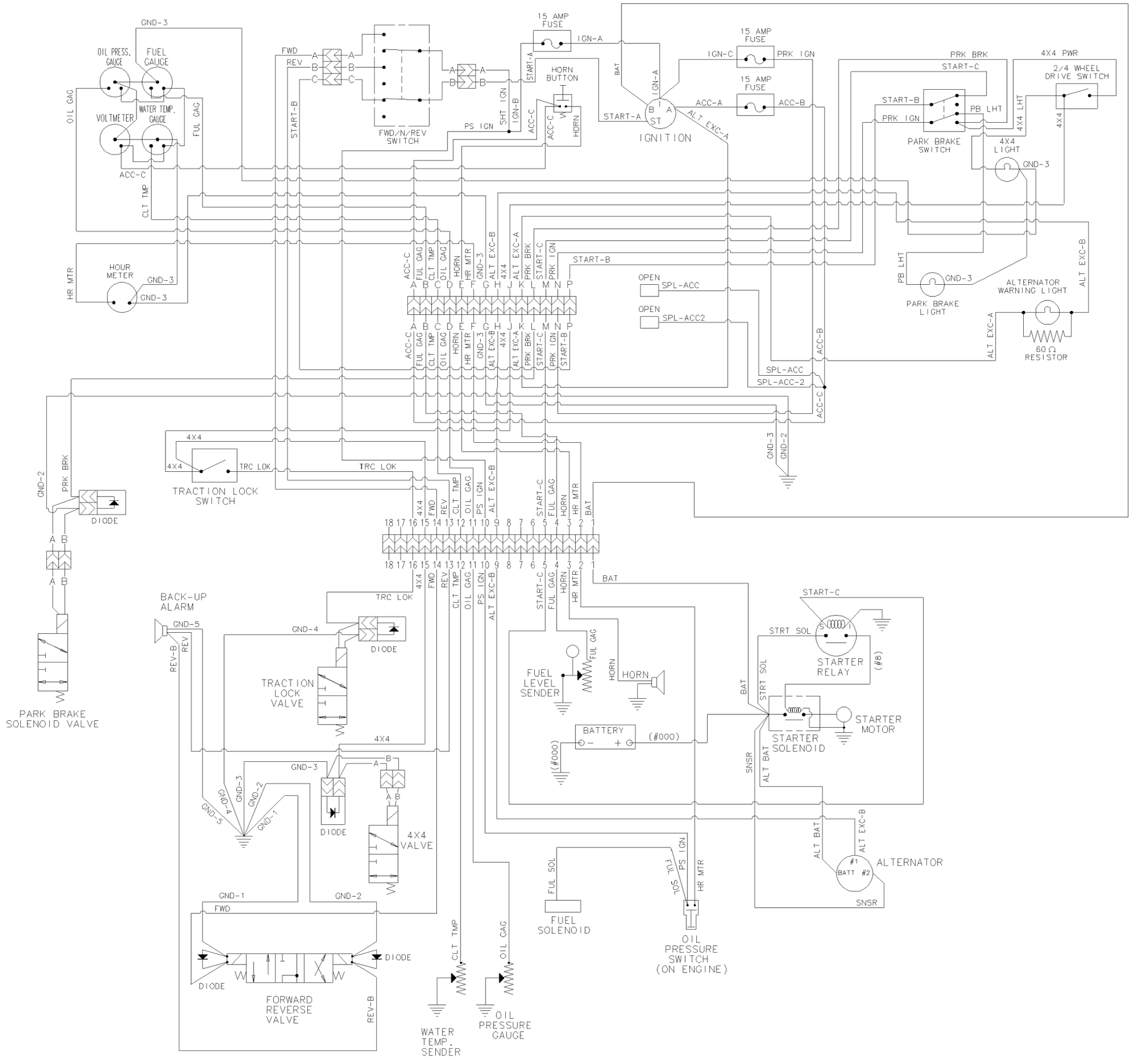


KEY		
WIRE DESIGNATION	WIRE COLOR/STRIPE	WIRE GAGE
ACC-A	ORANGE/TAN	16
ACC-B	ORANGE/BLUE	16
ACC-C	ORANGE/RED	16
ALT BAT	RED/WHITE	6
ALT EXC-A	VIOLET/RED	16
ALT EXC-B	VIOLET/RED	16
BAT	RED	8
CLT TMP	BLUE/VIOLET	16
FUL GAG	BLUE/BLACK	16
FUL SOL	VIOLET	16
FWD	BROWN/WHITE	16
GAG ACC	ORANGE/RED	16
GND-1	BLACK	16
GND-2	BLACK	16
GND-3	BLACK	16
GND-5	BLACK	16
HORN	VIOLET/YELLOW	16
HR MTR	BLUE/RED	16
IGN-A	ORANGE/GRAY	16
IGN-B	ORANGE/LT GREEN	16
IGN-C	ORANGE/DK GREEN	16
OIL GAG	BLUE/BROWN	16
PB LHT	BLUE/YELLOW	16
PRK BRK	VIOLET	16
PRK IGN	ORANGE/BLACK	16
PS IGN	ORANGE/YELLOW	16
REV	BROWN/YELLOW	16
REV-B	BLUE	16
SHT IGN	ORANGE/BROWN	16
SNSR	RED/BLACK	16
SPL ACC	ORANGE	16
SPL-ACC2	ORANGE/VIOLET	16
START-A	VIOLET/BROWN	16
START-B	VIOLET/BROWN	16
START-C	VIOLET/BROWN	16
STRT SOL	RED/VIOLET	10
TL SW	BROWN/RED	16

ELECTRICAL SCHEMATIC

LPR-60 (2WD)

9131-9011



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BAT	RED	8
CLT TMP	BLUE/VIOLET	16
FUL GAG	BLUE/BLACK	16
FUL SOL	VIOLET	16
FWD	BROWN/WHITE	16
GND-1	BLACK	16
GND-2	BLACK	16
GND-3	BLACK	16
GND-4	BLACK	16
GND-5	BLACK	16
HORN	VIOLET/YELLOW	16
HR MTR	BLUE/RED	16
IGN-A	ORANGE/GRAY	16
IGN-B	ORANGE/LT GREEN	16
IGN-C	ORANGE/DK GREEN	16
OIL GAG	BLUE/BROWN	16
PB LHT	BLUE/YELLOW	16
PRK BRK	VIOLET	16
PRK IGN	ORANGE/BLACK	16
PS IGN	ORANGE/YELLOW	16
REV	BROWN/YELLOW	16
REV-B	BLUE	16
SHT IGN	ORANGE/BROWN	16
SNSR	RED/BLACK	16
SPL ACC	ORANGE	16
SPL ACC2	ORANGE/VIOLET	16
START-A	VIOLET/BROWN	16
START-B	VIOLET/BROWN	16
START-C	VIOLET/BROWN	16
STRT SOL	RED/VIOLET	10
TRC LOK	BROWN/GRAY	16
4X4	BROWN	16
4X4 LHT	BLUE/VIOLET	16
4X4 PWR	VIOLET	16

ELECTRICAL SCHEMATIC

524 534C-6 534C-9 534C-10 LPR-60

9114-9012

Trouble Shooting Information

Steering Control Units, Char-Lynn

Most steering problems can be corrected if the problem is properly defined. The entire steering system should be evaluated before removing any components. The steering control unit is generally not the cause of most steering problems. The following is a list of steering problems along with possible causes and suggested corrections.

Problem	Possible Cause	Correction
1. Slow steering, hard steering, or loss of power assist.	Worn or malfunctioning pump. Stuck flow divider piston. Malfunctioning relief valve allowing the system pressure to be less than specified. Overloaded steer axle.	Replace pump. Replace flow divider. Adjust or replace relief valve. Reduce load,
2. Wander-Vehicle will not stay in a straight line.	Air in the system due to low level of oil, cavitating pump, leaky fitting, pinched hose, etc. Worn mechanical linkage. Bending of linkage or cylinder rod. Loose cylinder piston. Severe wear in steering control unit.	Correct Repair or replace. Repair or replace. Repair or replace. Replace the steering control unit.
3. Drift-Vehicle veers slowly in one direction.	Worn or damaged steering linkage.	Replace linkage and align front end.
4. Slip-A slow movement of steering wheel fails to cause any movement of steered wheels.	Leakage of cylinder piston seals. Worn steering control unit meter.	Replace seals. Replace steering control unit.
5. Temporary hard steering or hang-up.	Thermal Shock*	Check unit for proper operation and cause of thermal shock.
6. Erratic steering.	Air in system due to low level of oil, cavitating pump, leaky fitting, pinched hose, etc. Loose cylinder piston. *Thermal shock damage. Sticking flow control spool.	Correct condition and add fluid. Replace cylinder. Replace steering control unit. Replace flow control valve.
7. “Spongy” or soft steering.	Air in hydraulic system. Most likely air trapped in cylinders or lines.	Bleed air out of system. Placing ports on top of the cylinder will help prevent air trapping. Add fluid and check for leaks.
8. Free Wheeling-Steering wheel turns freely with no feeling of of pressure and no action on steered wheels.	Low fluid level Steering column upper shaft is loose or damaged. Lower splines of column may be disengaged or broken.	Tighten steering wheel nut. Repair or replace column.

*Thermal shock definition bottom of back page.

continued . . .

Problem	Possible Cause	Correction
	Steering control unit meter has a lack of oil. This can happen on problem. start-up, after repair, or long periods of non use.	Usually starting engine will cure problem.
	No flow to steering unit can be caused by:	
	1. Low fluid level.	Add fluid and check for leaks.
	2. Ruptured hose.	Replace hose.
	3. Internal steering control unit damage due to thermal shock*.	Replace the unit.
9. Free Wheeling-Steering wheel turns with slight resistance but results in little or no steered wheel action.	Piston seal blown out.	Determine cause. Correct and replace seal.
10. Excessive free play at steering wheel.	Loose steering wheel nut. Steering column shaft worn or damaged. There should be very little free play in the unit itself.	Repair or replace steering wheel connection or column.
11. Excessive free play at steered wheels.	Broken or worn linkage between cylinder and steered wheels.	Check for loose fitting bearings and anchor points in steering linkage between cylinder and steered wheels.
12. Binding or poor centering of steering wheel.	Leaky cylinder seals.	Replace cylinder seals.
	Binding or misalignment in steering column or splined input connection.	Align column pilot and spline to steering control unit.
	High back pressure in tank line can cause slow return to center. Should not exceed 300 psi.	Check for restriction.
	Large particles can cause binding between the spool and sleeve (in Orbitrol).	Clean the unit and filter the oil. If another component has failed generating contaminents, flush the system while bypassing the steering control unit.
13. Steering unit locks up.	Large particles in meter section.	Clean the unit.
	Severe wear and/or broken pin.	Replace the unit.
	*Thermal shock.	Replace the unit.
14. Steering wheel oscillates or turns by itself.	Parts assembled wrong. Steering unit improperly timed.	Correct timing.
	Lines connected to wrong ports.	Reconnect lines correctly.
15. Steered wheels turn in wrong direction when operator activates steering wheel	Lines connected to wrong cylinder ports.	Reconnect lines correctly.
16.Steering wheel kicks at start of steering.	Sticking check valve on steering control unit.	Clean or replace check valve.

***Thermal shock-A condition caused when the hydraulic system is operated for some time without turning the steering wheel so that fluid in the reservoir and system is hot and the steering control unit is relatively cool (more than 50°F temperature differential). When the steering wheel is turned quickly the result is temp orary seizure and possible damage to internal parts of the steering control unit. The temperary seizure may be followed by total free wheeling.**

Cyclopac® Service Procedures

Proper air cleaner servicing results in maximum engine protection against the ravages of dust. Proper servicing can also save time and money by maximizing filter life and dust cleaning efficiency.

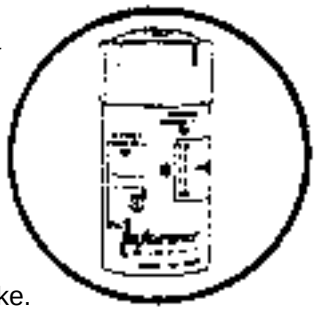
Two of the most common problems:

A) Over Servicing. New filter elements increase in dust cleaning efficiency as dust builds up on the media. Don't be fooled by filter appearance.... the filter should look dirty. By using proper filter measurement tools you will use the full life of the filter at maximum efficiency.

B) Improper Servicing. Your engine is vulnerable to abrasive dust contaminants during servicing. The most common cause of engine damage is careless servicing procedures. By following the steps shown, you can avoid unnecessary risk to the engine.

Measure Restriction

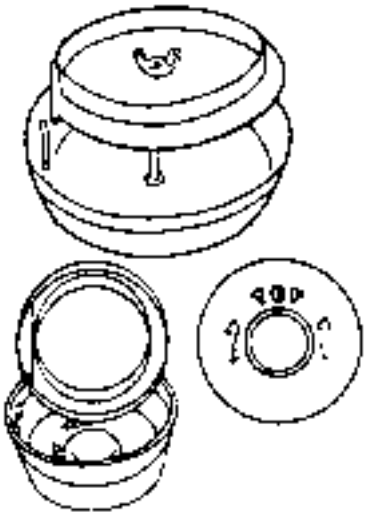
Measure the restriction of the air cleaner with a Donaldson restriction indicator, such as The Informer, a service gauge, or water manometer at the restriction tap provided in the air cleaner, the transfer pipe, or the blower intake.



One of two conditions will exist
(1) If the reading indicates the maximum restriction (per engine manufacturer's recommendations), change out the filter.
(2) If the reading shows below the maximum, the filter still has life left and should not be touched.

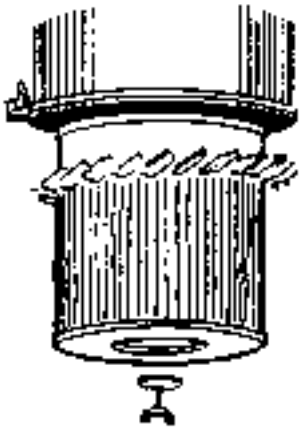
Empty the Dust Cup

Dust should not be allowed to build up closer than one inch from the baffle. On models equipped with a Donaldson Vacuator valve, dust cup service is cut to a minimum; all that is necessary is a quick check to see that the Vacuator valve is not inverted, damaged, or plugged.



Filter Servicing

When restriction indicates that filter servicing is required, loosen the wingnut and remove the primary filter. Before installing new filter, inspect the filter and gasket for shipping or storage damage. (See service tips on reverse side of this document.) Carefully install new element and wingnut.



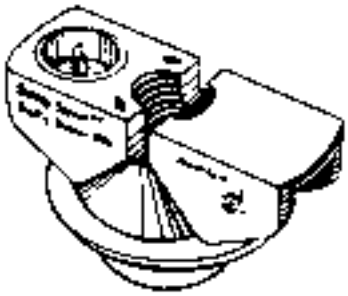
Always use authentic replacement Donaldson filters, which have been engineered to fit the air cleaner and engine intake system exactly.

Cover the Inlet

Don't leave the air inlet exposed! If the new filter won't be installed immediately, cover the opening to prevent stray contaminant from entering the induction system.

Safety Element Service

For Maximum engine protection and air cleaner service life, replace the safety filter **every third** primary filter change or cleaning, or as indicated by the Donaldson Safety Signal service indicator. Note that the safety element is not intended to be cleaned.



Reinstall the Dust Cup

Be sure the dust cup is sealed 360° around the air cleaner body. Reset the restriction indicator to green.

Check Connections

Ensure that all connections between the air cleaner and the engine are tight and leak-free.

Donaldson®

Air Filter Service Tips

7 Important Steps to Follow

(1) Remove the old element gently to prevent knocking dust off of it.

2) Always clean the inside of the housing carefully

3) Always clean the gasket sealing surfaces of the housing

4) Check for uneven dirt patterns in your old filter that indicate gasket leakage

5) Press your fresh gasket to see that it springs back

6) Make sure the gasket seats evenly

7) Ensure an airtight fit on all connections and ducts

T

The Important "Don't"

<u>Don't</u> remove filter for inspection.

Never rap a filter to clean it. Rapping only damages the filter.

<u>Never</u> judge the filter's life by looking at it. Measure how restricted its airflow is.

<u>Never</u> leave an air cleaner open longer than necessary.

<u>Don't</u> ignore a worn or damaged gasket in the housing....replace it!

Don't use a damaged or bunched filter.

Never use a warped cover on a housing.

Never substitute an incorrect filter model number.

Brochure No. F114004 (4/96) Replaces 1400-23

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