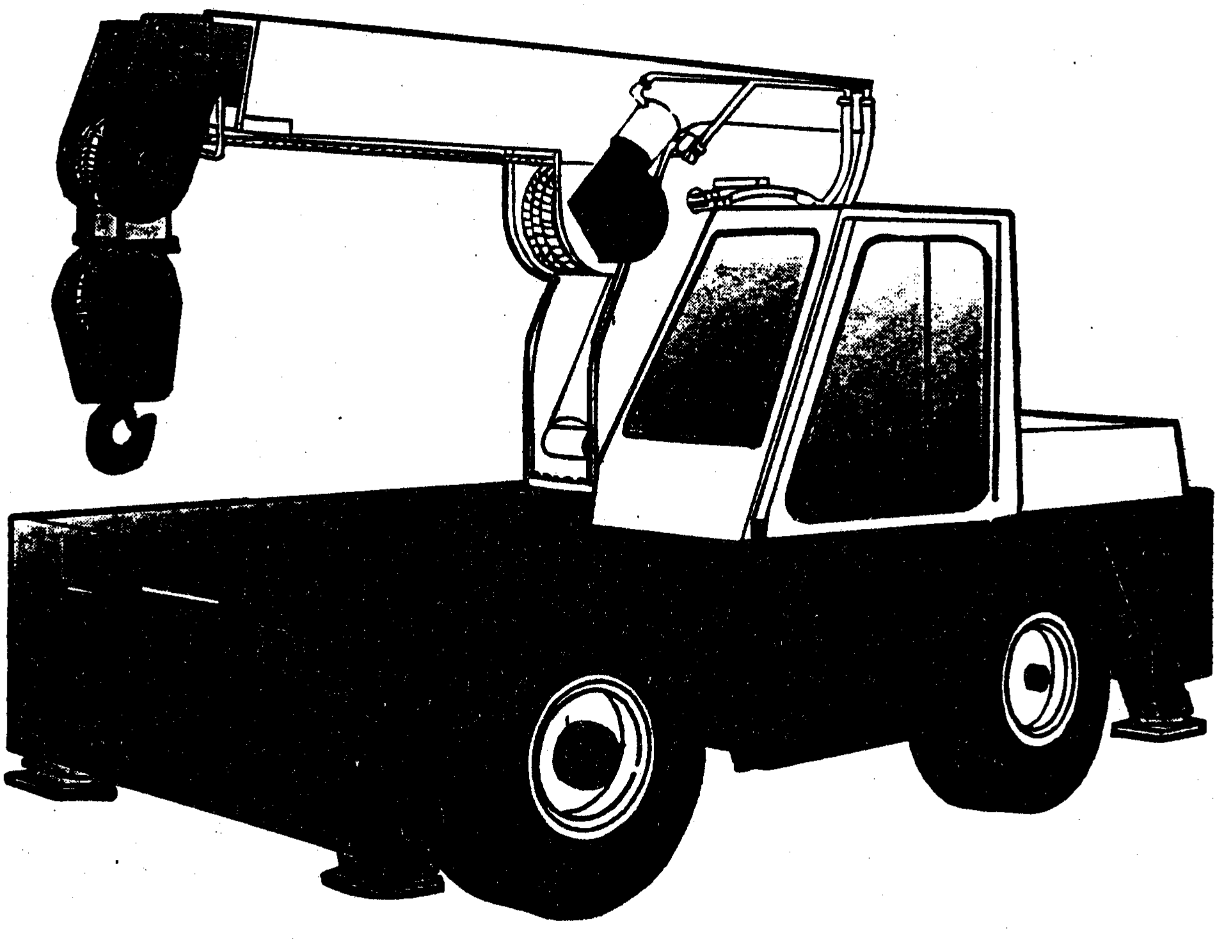
PETTIBONE

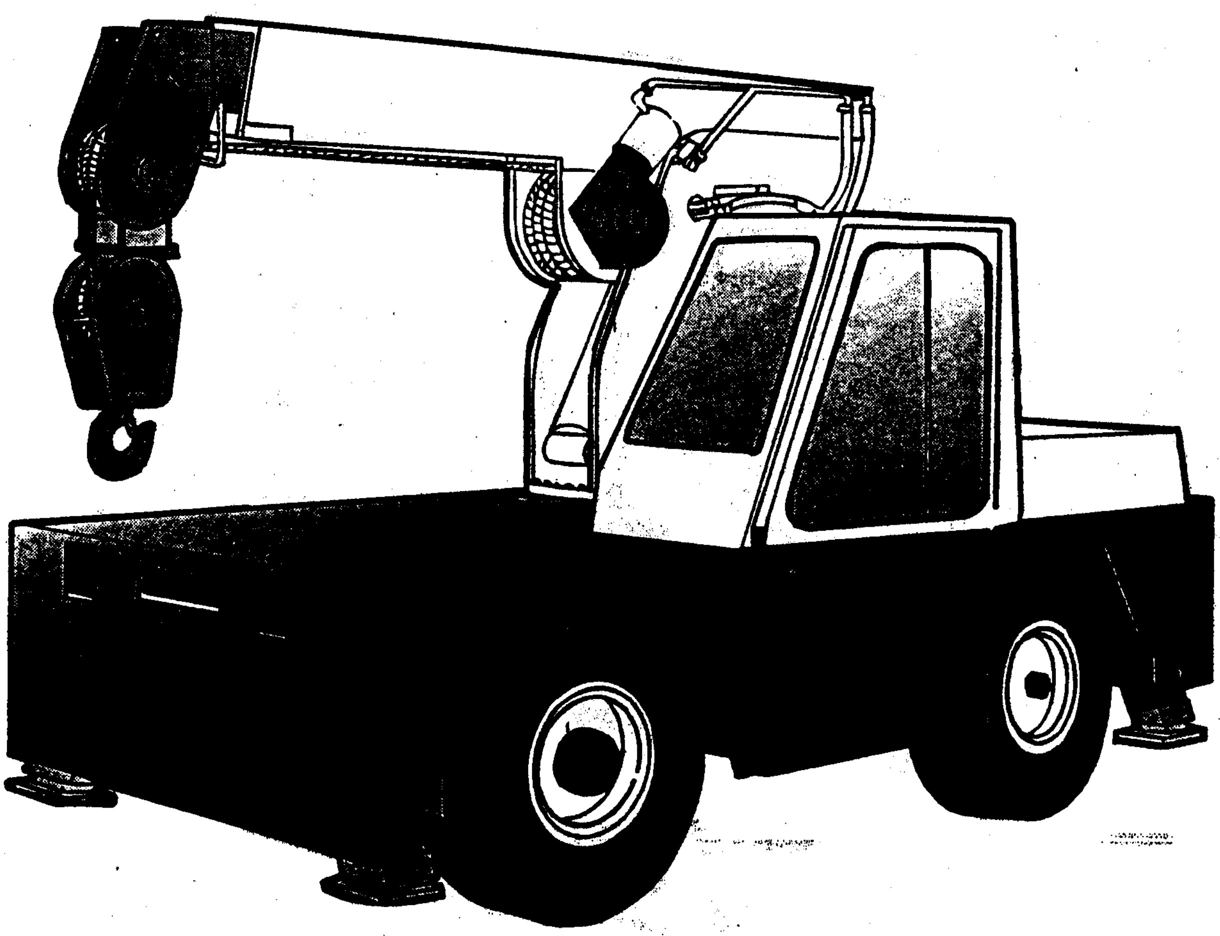
770 Multikrane
SERVICE MANUAL



P/N 1001828P

PETTIBONE

770 Multikrane SERVICE MANUAL



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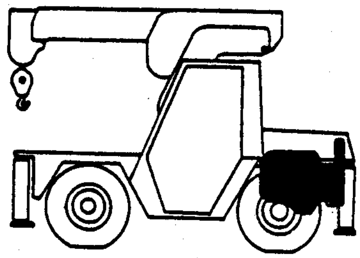
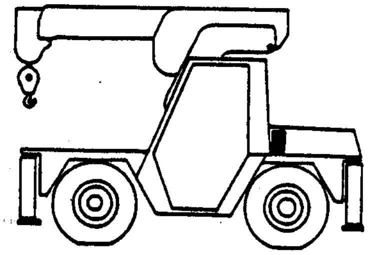
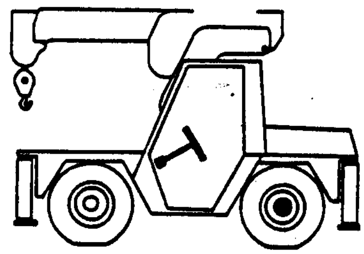
GENERAL 1



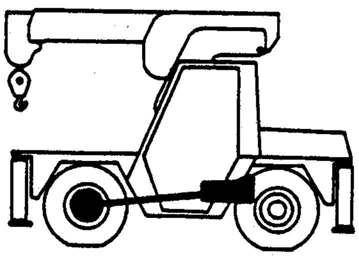
ENGINE 2



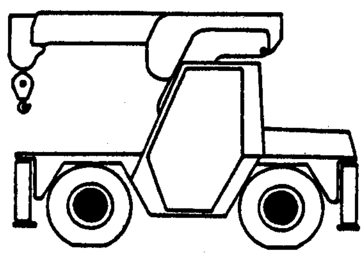
ELECTRICAL 4



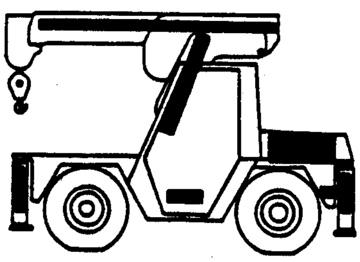
STEERING 5



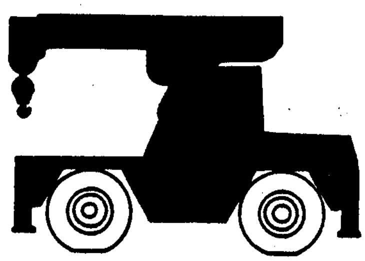
POWER TRAIN 6



BRAKES 7



HYDRAULIC 8



CHASSIS/
MOUNTED
EQUIPMENT 9

3330E CARRYDECK CRANE
TABLE OF CONTENTS

1

2

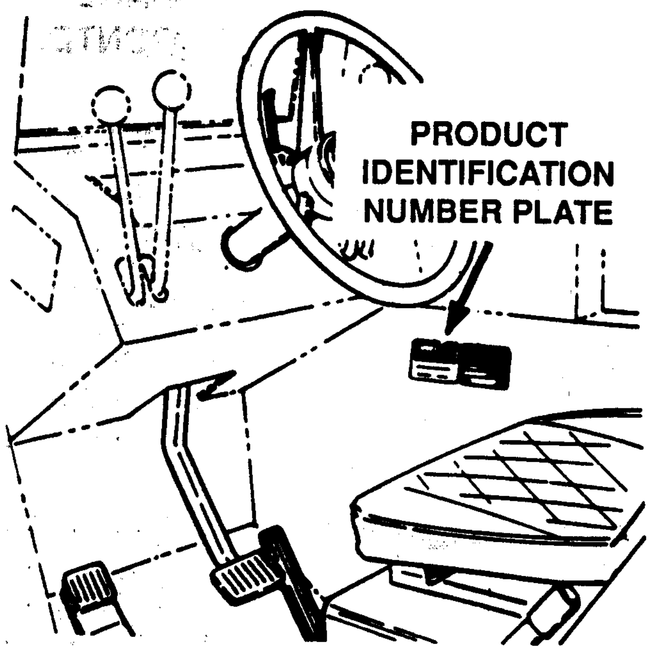
4

5

6

7

8



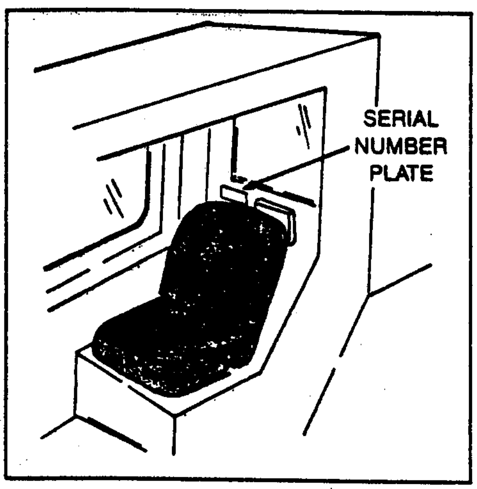


Figure 1. Machine Serial Number Plate

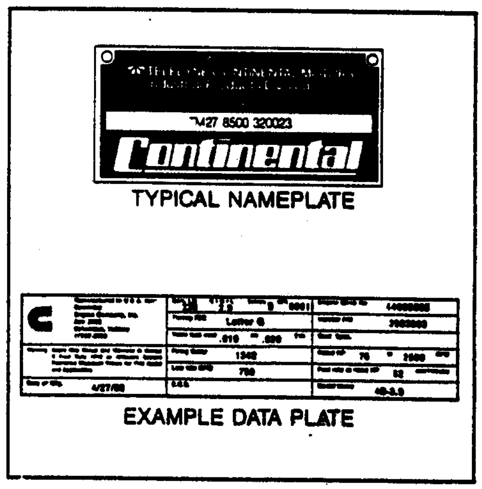


Figure 2. Engine Serial Number Plate

3330 CARRYDECK CRANE
TABLE OF CONTENTS (CONTD.)

8

9

Section 1010

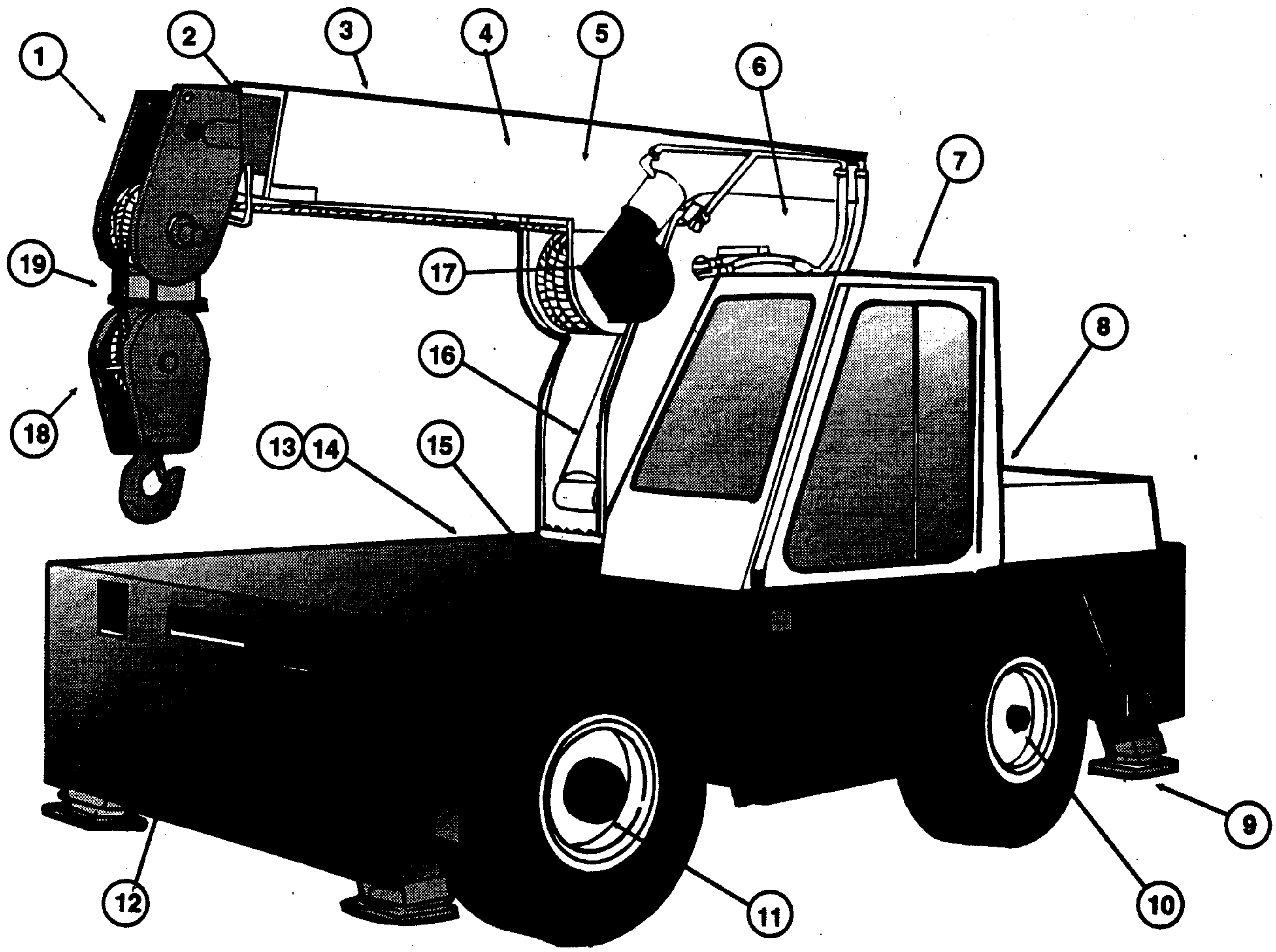
1

GENERAL SPECIFICATIONS

DIRECTIONS

All directions in this manual are given in relation to operatator's seat. Left is the opeator's left, right is the operator's right. Boom references are thesame as for the machine when the boom is over the front of the machine.

NOMENCLATURE



LEFT FRONT SIDE VIEW

1. Inner Boom
2. Intermediate Boom
3. Main boom
4. Sequencing Boom Location
5. Crowd Cylinder Location
6. Mast
7. Operator's Compartment
8. Engine Compartment
9. Outrigger
10. Steering Axle
11. Drive Axle
12. Recessed Mounted Winch Location (Optional)
13. Hydraulic Valve Location
14. Right Side - Fuel Tank Location
15. Swing Gearbox and Motor Location
16. Hoist Cylinder
17. Winch Gearbox, Brake and Motor
18. Drop Block
19. Double-Blocking Cutout

SPECIFICATIONS

ENGINE

Model	Continental TM2.7	Cummins 4B3.9
Type	Gas	Diesel
Number of Cylinders	4	4
Bore and Stroke	3.58" x 4.06" (91 mm x 103 mm)	4.02" x 4.72" (102 mm x 120 mm)
Displacement	104 CID (2.7 L)	2.38 CID (3.9 L)
Horsepower at Governed Speed	71	58
Governed Speed	2200 RPM	2200 RPM
Low Idle	400-600 RPM	750 RPM
High Idle	2380-2420 RPM	2500 RPM
Compression Ratio	8.2 : 1	8.2 : 1
Air Cleaner	Dry Type	Dry Type

1

BOOM

Construction . . . . Welded box sections
Number of Sections . . . . 3 standard*
Number of Sheaves 2
Sheave Diameter . . . . 10.75 in. (273 mm)
*4-Section Boom Optional

MAST ROTATION - 360°

Mast Bearing . . . . Single race. 22.62 in. (575 mm) diameter
Swing Drive Mechanism . . . . Hydraulic motor driven gear reducer
Swing Speed . . . . 2.05 RPM

ELECTRICAL SYSTEM

Type . . . . 12 volts, direct current
Alternator . . . . 530 CCA @ 0° F (-18° C) for 30 second rate

HYDRAULIC SYSTEM

Main Pump . . . . 2-section, gear pump
Main Control Valves . . . . Four-way, open-center, manually actuated
Swing Motor . . . . Single section, gerotor
Hydraulic Oil Filters . . . . (1) 1--micron filter in hydraulic line from valves
(1) 30-mesh diffuser inside hydraulic oil tank
Hydraulic Cylinders . . . . Double-acting cylinders for hoist, crowd,steering and outriggers
Hydraulic Oil Tank . . . . 23.5 gal. (89 L) capacity, steel construction with internal baffles

WIRE ROPE

Wire Rope -- Main Winch
1) Diameter . . . . 716 in. (11 mm)
2) Type . . . . 6 x 9 EIPS IWRC
3) Length . . . . Standard 3-section boom - 150 ft. 45.7 m)
Optional 4-section boom - 204 ft. (62.2 m)

Wire Rope -- Auxiliary Winch
1) Diameter . . . . 1/4" (6 mm)
2) Length . . . . 100 ft. (30.5 m)

SPECIFICATIONS (CONT'D)

TORQUE CONVERTER
Model . . . . Borg Warner S-11
Type . . . . Hydraulic

TRANSMISSION
Model PS-720
Type . . . . Powershift
Gear Ratio:
First 5.718:1
Second 3.225:1
Third 1.77:1
Fourth 1.0:1

AXLE, FRONT DRIVE (EARLIER UNITS)
Type . . . . Rockwell International
Ratio 6.8:1

AXLE FRONT DRIVE (LATER UNITS)
Type . . . . Clark-Hurth
Ratio 4.25:1

AXLE, FRONT DRIVE/STEER (Optional)
Type . . . . Clark-Hurth
Ratio . . . . 10.43:1 (Bevel Gear & Planetary)

AXLE, REAR STEERING
Type . . . . Shuttlelift

TIRES
12PR Pneumatic . . . . 10.5 x 15
Tire Pressure . . . . 100 psi (690 kPa)

WHEEL BRAKES, FRONT AXLE
Rockwell Axle:
Type . . . . Drum type, cam actuated
Brake Shoe Size . . . . 12.5 x 2.5 in. (318 x 64 mm)
Clark-Hurth Axle:
Type . . . . Internal wet disc brakes

WHEEL BRAKES, REAR AXLE
Type . . . . Caliper disc
Disc Diameter . . . . 11.0 in. (279 mm)
Location . . . . On each rear axle

OUTRIGGERS
Type . . . . Hydraulic
Construction . . . . Welded box

Section
1050

MAINTENANCE AND LUBRICATION

1

MAINTENANCE AND LUBRICATION

Introduction

Preventive maintenance and lubrication are the normal operations needed for safe and trouble free operation. Preventive maintenance is the easiest and best way to keep the machine down time to a minimum.

Hour intervals are specified according to the number of hours the engine has run. The hourmeter, which operates only when the engine is running, indicates the total hours of operation.

Run-In Period

The items given in the run-in section are to be done during the run-in period only.

Preventive Maintenance

The items in this section are separated into maximum hour intervals. These intervals are for "average" operating conditions. When operating under "severe" conditions, for example, severe heat, cold, dust mud or water, increase the interval (do the maintenance more frequently).

The following chart includes all components that need regular maintenance, the maintenance interval and the section where details can be found.

NOTE: See page 1050-6 for list of fluids and lubricants.

RUN-IN MAINTENANCE CHART

INTERVAL	MAINTENANCE	INSTRUCTION
Run-In Period after First 20 Hours	Change engine oil	See operator's manual
	Check brake fluid level	See operator's manual
	Change engine oil filter	See operator's manual
	Change hydraulic oil filter	See operator's manual
	Check hose clamps	
	Check tightness of swing gear box bolts	
	Lubricate swing gear and pinion	See operator's manual

PREVENTIVE MAINTENANCE CHART

INTERVAL	MAINTENANCE	INSTRUCTIONS
Daily or 10 Hour Intervals	Check engine crankcase oil	See operator's manual
	Check engine coolant	See operator's manual
	Drain fuel filters to remove water and sediment	See operator's manual
	Check control operation	Section 9206
	Check hydraulic oil level and for leaks in the system	Section 8201
	Check reeving, clamps and connections	Section 9213
	Check Tire Pressure	Section 6129

PREVENTIVE MAINTENANCE CHART (CONT'D.)

INTERVAL	MAINTENANCE	INSTRUCTIONS
Weekly or Every 50 Hours	Apply grease to all lube fittings	See page 1050-8
	Check transmission oil level	Section 6102
	Check planetary lubricant (Drive/Steer Axle - Hurth)	Section 6127
	Check differential lubricant levels	Sections 6126, and 6127
	Check brake fluid	See operator's manual
	Check oil level in winch gearbox	Section 9213
	Lubricate boom slides	See page 1050-9
	Lubricate parking brake linkage	Section 7127
Two Weeks or Every 100 Hours	Change engine oil (Gasoline engine only)	Section 2051
	Change engine oil filter	Section 2051
	Check tension on fan belts	See operator's manual
	Check engine air cleaner element	See operator's manual
Monthly or Every 250 Hours	Change engine oil (Diesel engine only)	Section 2051
	Change engine oil filter (Both gasoline and diesel engines	Section 2051
	Adjust engine spark plugs (Gasoline engine only)	See operator's manual
	Clean radiator fins and core	See operator's manual
	Change engine air cleaner element	See operator's manual
	Adjust parking brake	Section 7127
	Lubricate swing gear and pinion	See operator's manual
	Inspect and lubricate wire rope	Section 9213
Two Months or Every 500 Hours	Change hydraulic oil filter	Section 8201
	Change fuel filters (Diesel engine only)	See operator's manual

PREVENTIVE MAINTENANCE CHART (CONT'D.)

INTERVAL	MAINTENANCE	INSTRUCTION
Three Months or Every 750 Hours	Lubricate outrigger sliding surfaces	See page 1050-9
Six Months or Every 1500 Hours	Lubricate wheel bearings (Shuttlelift axle)	Section 5021
	Lubricate wheel bearings (Rockwell axle)	Section 6126
	Change planetary lubricant (Drive/Steer axle - Hurth)	See operator's manual
	Clean axle planetary breathers (Drive/Steer axle - Hurth)	See operator's manual
	Clean axle differential breather (Rockwell axle)	See operator's manual
	Change transmission oil filter	Section 6102
	Change hydraulic oil	Section 8201
	Change hydraulic oil tank breather	Section 8201
	Change winch gearbox lubricant	Section 9213
	Clean winch gearbox breather	Section 9213
	Clean batteries and battery posts	See operator's manual
12 Months or Every 3000 Hours	Check engine coolant	See operator's manual
	Check engine fan belts	See operator's manual
	Change transmission oil	Section 6102

IMPORTANT: Always install new decals whenever the old decals are destroyed, lost, painted over, illegible. When individual parts are replaced that have decals attached, be sure to install a new decal with the new part. Replacement decals are available from your local Carrydeck dealer.

ENGINE OIL SPECIFICATION

Diesel Engine

Oil Performance Recommendations

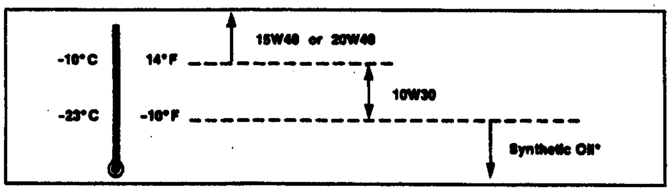
CC/SF for use in naturally aspired engines and in engines that operate in light duty service including standby and emergency operation (equivalent to MIL-L-2104B).

Sulfated Ash Limit of 1.85% by weight recommended. Oils with higher ash count may produce deposits on valves that can progress to guttering and valve burning.

Do not use "break-in" lubricating oils in new or rebuilt engines. Use lubrication oils specified for normal engine ***operation.***

Oil Viscosity Recommendations

The use of a multi-grade lubricating oil improves oil consumption control and improves engine cranking in cold temperatures while maintaining lubrication at high operating temperatures. A multi-grade oil is therefore recommended with the viscosity grades shown in the following chart. the use of single grade lubricating oils is not recommended, except for synthetic oils used in Artic conditions.



Arctic Operation

IMPORTANT: SAE 5W viscosity grade synthetic oil may be used when operating the engine in ambient temperatures below -10° F (-23° C) providing they meet the minimum viscosity at 212° F (100° C).

When there is no provision to keep the engine warm when operating in ambient temperatures consistently below -10° F (-23° C), use a lubricating oil that meets the following requirements:

Parameter (Test Method)	Specification
Performance	API Classification CC - Naturally Aspired API Classification CC/CD - Turbocharged
Viscosity	10,000 mPa's Maximum at -31° F (-35° C) 0.016 inch (4.1 mm) squared minimum at 212° f (100° C)
Pour Point (ASTM-97)	Maximum of 41° F (5° C) below the lowest expected ambient temperature
Sulfated Ash Content (ASTM-874	Maximum of 1.85% by weight

Gasoline Engine

The lubricating oil recommendation is based upon engine design, type of service and the atmospheric temperature prevailing. High quality oils are required to ensure maximum performance, long engine life, and minimum cost of operation

The recommended oil to be used in Continental gasoline engines must have the following classifications:

<u>API, SAEg, ASTM Classification</u>

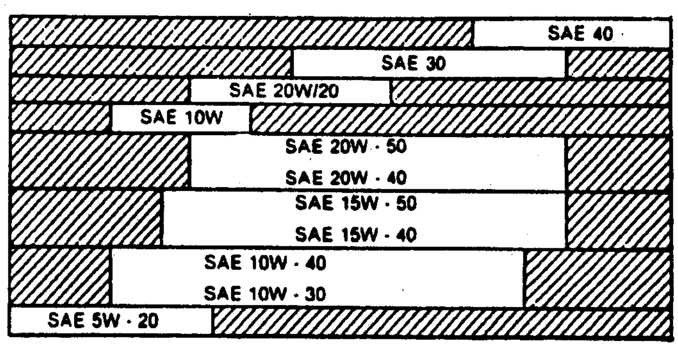
SE, SF, SE/CD, SF/CD

Do not use SD or SC API classification oils. These oils do not provide adequate protection against oil oxidation, high temperature oil deposits, rust and corrosion.

SAE Oil Body Grades

The following SAE grade are general recommendations for Continental gasoline engines during changing seasonal atmospheric temperatures.

AVERAGE AMBIENT TEMPERATURE AT WHICH ENGINE STARTING IS REQUIRED

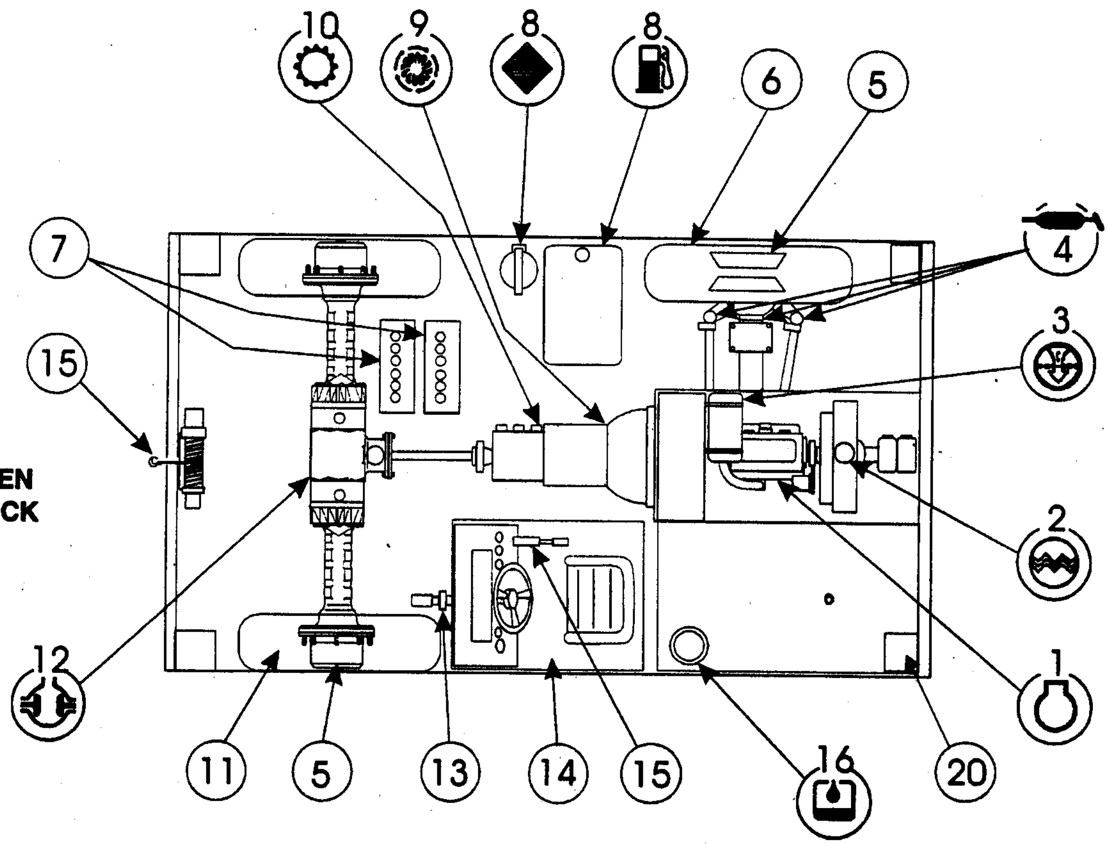


COMPONENT CAPACITIES

ITEM	CAPACITY	LUBRICANT/FLUID
Engine Crankcase: Gasoline	6 qts. (5.7 L) + 1 qt. (95 L) w/filter	See Engine Oil Specifications in Engine Manual
Diesel	10 qts (9.5 L) + 1.5 qt. (1.4 L) w/filter	
Cooling System	15 qts. (14 L)	1/2 ethylene glycol antifreeze, 1/2 water
Fuel Tank	18-1/2 gal. (70 L)	Continental TM 2.7 - Regular gasoline or unleaded gasoline with a 90 octane or higher rating Cummins 4B3.9 - Diesel fuel No. 2
Transmission	4 gal. (15.1 L)	Mobil ATF 210 or equivalent
Rockwell Axle Differential	3-1/2 pt. (1.7 L)	EP 80-90 gear lube . For cold weather lubricants, see Section 6126
Hurth Axle Differential	7-1/2 to 9-1/2 qts. (7 to 9 L)	MIL-L-2105, API GL 4, or SAE 85 W 90 with additives for oil immersed disc brakes
Hurth Axle Planetary Hubs	0.70 qts. (0.66 L) each	
Hydraulic Tank	23.5 gal (89 L)	Mobil Fluid #424 or equivalent (*ISO #46/48)
Hydraulic System - Complete	30 gal. (114 L)	
Brake Master Cylinder 2-Wheel Drive	1 pt. (0.5 L)	DOT 3 (Rockwell Axle) Dextron II ATF (Hurth Axle)
4- Wheel Steer		Dextron II ATF
Swing Gearbox	2 qt. (1.9 L)	Multi-purpose EP Lithium base grease
Winch Gearcase	4 qts. (3.8 L)	600 W cylinder oil
Swing Gear/Pinion		Open gear lube

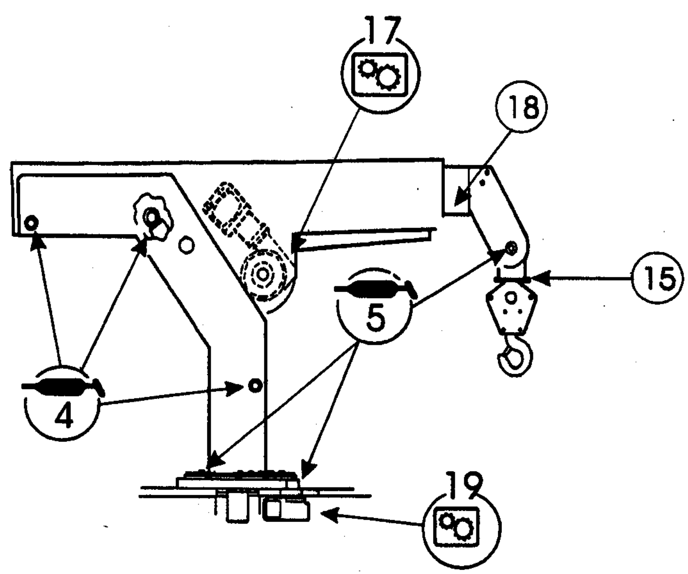
*International Standard Organization

MAINTENANCE POINTS ON LOWER STRUCTURE



NOTE:
DUAL BATTERIES WHEN OPTIONAL BELOW DECK WINCH IS INSTALLED

MAINTENANCE POINTS ON UPPER STRUCTURE



MAINTENANCE CHART

Ref.	Component/System	Daily - 10 Hour	Weekly - 50 Hours	2 Weeks - 100 Hours	Monthly - 250 Hours	2 Months - 500 Hours	3 Months - 750 Hours	6 Months - 1500 Hours	12 Months - 3000 Hours	Service Check
1	Engine	X								Check crankcase oil
				X						Change Oil -(Gasoline engine)
					X					Change Oil - (Diesel engine)
					X					Change oil filter - (Both engines)
					X					Adjust spark plugs
2.	Cooling System	X								Check coolant level
				X						Check fan belt tension and condition
					X					Clean radiator fins and core
									X	Change coolant, flush system, clean radiator
3.	Air Cleaner			X						Check engine air cleaner
					X					Clean or change air filter element
4.	Grease Fittings		X							Apply grease
5.	Wheel Bearings								X	Repack bearings
6.	Tires	X								Check tire pressure
7.	Batteries							X		Clean battery and connections
8.	Fuel System	X								Drain fuel filters to remove water
		X								Fill fuel tank
						X				Change fuel filters
9.	Parking Brake		X							Lubricate Linkage
					X					Adjust btake tension
10.	Transmission		X							Check oil level
								X		Change oil filter
									X	Change transmission oil
11.	Planetary (Hurth Axle)		X							Check lubricant
								X		Change lubricant
12.	Differential		X							Check lubricant
								X		Change lubricant, clean breather
13.	Brake Master Cylinder		X							Check fluid level
14.	Operator's Cab	X								Clean cab, check controls before operation
15.	Wire Rope System	X								Check reeving, clamps and connections
					X					Inspect and lubricate wire rope as necessary
16.	Hydraulic System	X								Check oil level in tank. Check system for leaks
					X					Change in-line hydraulic filter
17.	Winch Gearbox		X							Check oil level
								X		Change lubricant, clean breather
18.	Boom		X							Apply bronze anti-seize to slides
19.	Swing Gearbox and		X							Check lubricant level
	Swing Gear				X					Clean and lubricate swing gear
20.	Outriggers						X			Apply bronze anti-seize to slides

HYDRAULIC SYSTEM PRESSURES

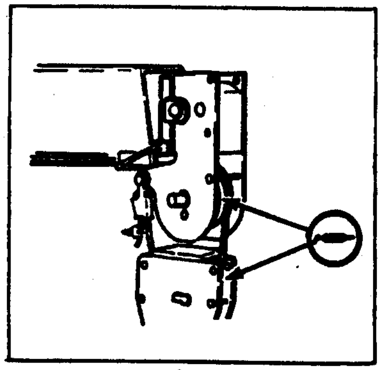
VALVE/CIRCUIT	LOCATION	PRESSURE SETTING
Main Relief - Pump Section 1	In Control Valve for Winch	2500 psi (14 130 kPa)
Main Relief - Pump Section 2	In Control Valve for Hoist Crowd and Swing	2500 psi (14 130 kPa)
Steering Relief	In Steering Section of Main Pump	1700 psi (11 720 kPa)

LIST OF GREASE FITTINGS

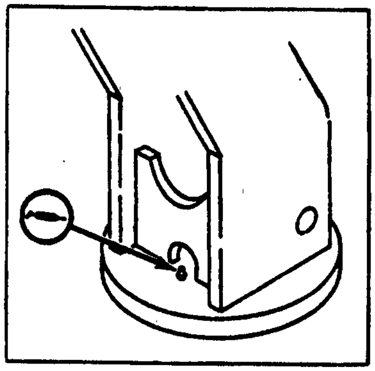
Grease Specification

Use a lithium base, E.P. No 2 bearing grease, moly-disulfide grease or functional equivalent. Apply enough grease to remove old grease.

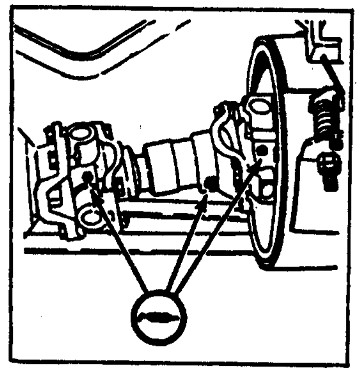
NOTE: If grease fitting will not receive grease, remove the fitting and check for restriction or install a new grease fitting.



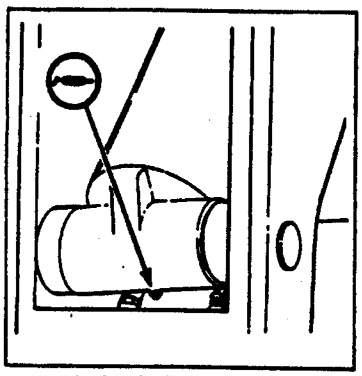
Sheaves



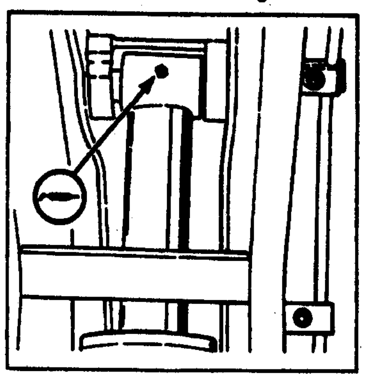
Mast Bearing



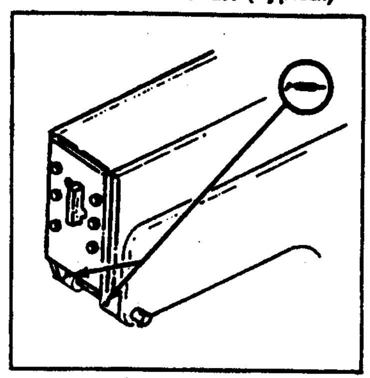
Drive Shaft (Typical)



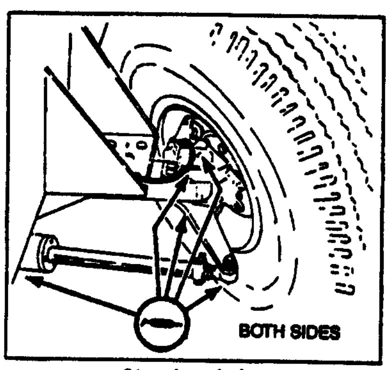
Hoist Cylinder (Base)



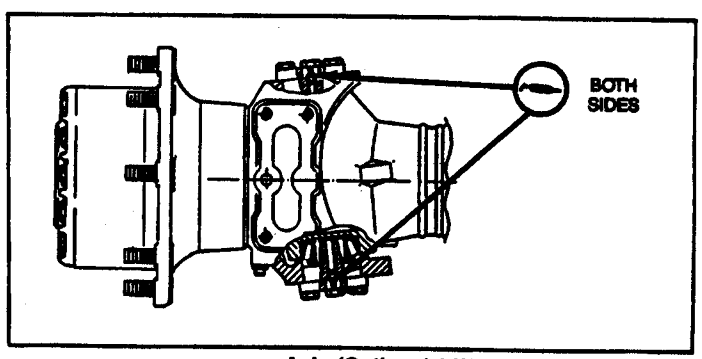
Hoist Cylinder (Rod)



Main Boom Pivot

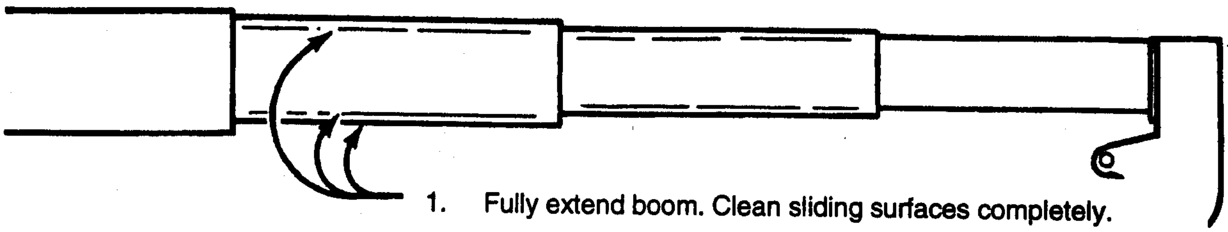


Steering Axle



Axle (Optional 4-Wheel Steer)

BOOM LUBRICATION

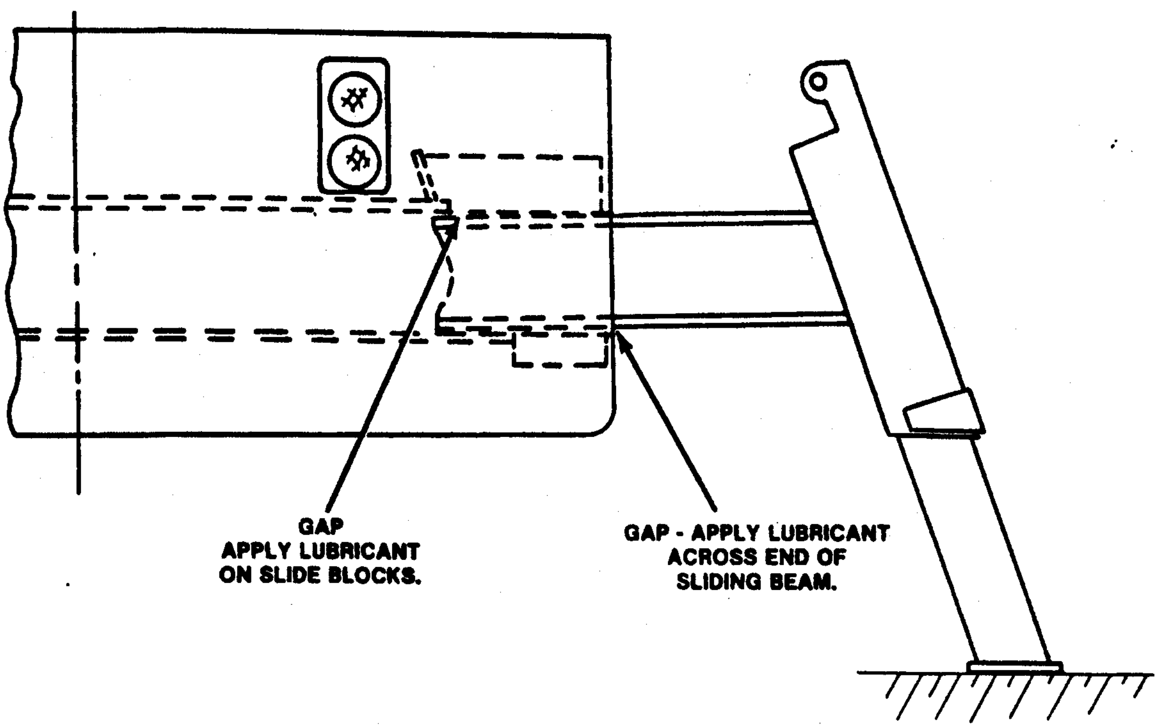


1. Fully extend boom. Clean sliding surfaces completely.
2. Lubricate sliding surfaces, sides and bottom of each section with a thin layer of bronze anti-seize.
3. Fully retract boom. Apply bronze anti-seize to wear bars on top of boom sections through four access holes in top of boom.
4. Extend and retract boom two or three times to make a distribution of the lubricant.

OUTRIGGER LUBRICATION

Clean and lubricate outriggers when sliding surfaces become dry. Apply bronze anti-seize, STP Oil Treatment, LUBAID NF, or equivalent.

1. Extend and set outriggers. Clean the sliding beams, top and bottom.
2. Apply lubricant in locations indicated. (Do not over lubricate by applying to complete outside of sliding beam). During extend and retract, the beam slides on only two surfaces.
3. Raise outriggers and retract horizontal beams to make a distribution of the lubricant.



Section 1051

TORQUE CHARTS

TORQUE CHARTS

SAE GRADE 5 or A325 Fine Thread				SAE GRADE 5 or A325 Coarse Thread			
SIZE	CLAMP LOAD	PLAIN/ LT. OIL	PLATED	SIZE	CLAMP LOAD	PLAIN/ LT. OIL	PLATED
1/4-28 (.250)	2,325	10 ft.lbs.	87 in. lbs.	1/4-20 (.250)	2,025	8 ft.lbs.	76 in. lbs.
5/16-24 (.3125)	3,675	19 ft.lbs.	14 ft.lbs.	5/16-18 (.3125)	3,338	17 ft.lbs.	13 ft.lbs.
3/8-24 (.375)	5,588	35 ft.lbs.	26 ft.lbs.	3/8-16 (.375)	4,950	31 ft.lbs.	23 ft.lbs.
7/16-20 (.4375)	7,575	55 ft.lbs.	41 ft.lbs.	7/16-14 (.4375)	6,788	50 ft.lbs.	37 ft.lbs.
1/2-20 (.500)	10,200	85 ft.lbs.	64 ft.lbs.	1/2-13 (.500)	9,075	76 ft.lbs.	57 ft.lbs.
9/16-18 (.5625)	12,975	122 ft.lbs.	91 ft.lbs.	9/16-12 (.5625)	11,625	109 ft.lbs.	82 ft.lbs.
5/8-18 (.625)	16,350	170 ft.lbs.	128 ft.lbs.	5/8-11 (.625)	14,400	150 ft.lbs.	112 ft.lbs.
3/4-16 (.750)	23,775	297 ft.lbs.	223 ft.lbs.	3/4-10 (.750)	21,300	266 ft.lbs.	200 ft.lbs.
7/8-14 (.875)	32,475	474 ft.lbs.	355 ft.lbs.	7/8-9 (.875)	29,475	430 ft.lbs.	322 ft.lbs.
1-12 (1.000)	42,300	705 ft.lbs.	529 ft.lbs.	1-8 (1.000)	38,625	644 ft.lbs.	483 ft.lbs.
1-14 (1.000)	32,275	721 ft.lbs.	541 ft.lbs.	1-1/8-7 (1.125)	42,375	794 ft.lbs.	596 ft.lbs.
1-1/8-12 (1.125)	47,475	890 ft.lbs.	668 ft.lbs.	1-1/4-7 (1.250)	53,775	1120 ft.lbs.	840 ft.lbs.
1-1/4-12 (1.250)	59,550	1241 ft.lbs.	930 ft.lbs.	1-3/8-6 (1.375)	64,125	1470 ft.lbs.	1102 ft.lbs.
1-3/8-12 (1.375)	72,975	1672 ft.lbs.	1254 ft.lbs.	1-1/2-6 (1.500)	78,000	1950 ft.lbs.	1462 ft.lbs.
1-1/2-12 (1.500)	87,750	2194 ft.lbs.	1645 ft.lbs.				

SAE GRADE 8 or A490 Fine Thread				SAE GRADE 8 or A490 Coarse Thread			
SIZE	CLAMP LOAD	PLAIN/ LT. OIL	PLATED	SIZE	CLAMP LOAD	PLAIN/ LT. OIL	PLATED
1/4-28 (.250)	3,263	14 ft.lbs.	10 ft. lbs.	1/4-20 (.250)	2,850	12 ft.lbs.	9 ft. lbs.
5/16-24 (.3125)	5,113	27 ft.lbs.	20 ft.lbs.	5/16-18 (.3125)	4,725	25 ft.lbs.	18 ft.lbs.
3/8-24 (.375)	7,875	49 ft.lbs.	37 ft.lbs.	3/8-16 (.375)	6,975	44 ft.lbs.	33 ft.lbs.
7/16-20 (.4375)	10,650	78 ft.lbs.	58 ft.lbs.	7/16-14 (.4375)	9,600	70 ft.lbs.	52 ft.lbs.
1/2-20 (.500)	14,400	120 ft.lbs.	90 ft.lbs.	1/2-13 (.500)	12,750	106 ft.lbs.	80 ft.lbs.
9/16-18 (.5625)	18,300	172 ft.lbs.	129 ft.lbs.	9/16-12 (.5625)	16,350	153 ft.lbs.	115 ft.lbs.
5/8-18 (.625)	23,025	240 ft.lbs.	180 ft.lbs.	5/8-11 (.625)	20,325	212 ft.lbs.	159 ft.lbs.
3/4-16 (.750)	33,600	420 ft.lbs.	315 ft.lbs.	3/4-10 (.750)	30,075	378 ft.lbs.	282 ft.lbs.
7/8-9 (.875)	45,825	668 ft.lbs.	501 ft.lbs.	7/8-9 (.875)	41,550	606 ft.lbs.	454 ft.lbs.
1-12 (1.000)	59,700	995 ft.lbs.	746 ft.lbs.	1-8 (1.000)	54,525	909 ft.lbs.	682 ft.lbs.
1-14 (1.000)	61,125	1019 ft.lbs.	764 ft.lbs.	1-1/8-7 (1.125)	68,700	1288 ft.lbs.	966 ft.lbs.
1-1/8-12 (1.125)	77,025	1444 ft.lbs.	1083 ft.lbs.	1-1/4-7 (1.250)	87,225	1817 ft.lbs.	1363 ft.lbs.
1-1/4-12 (1.250)	96,600	2012 ft.lbs.	1509 ft.lbs.	1-3/8-6 (1.375)	103,950	2382 ft.lbs.	1787 ft.lbs.
1-3/8-12 (1.375)	118,350	2712 ft.lbs.	2034 ft.lbs.	1-1/2-6 (1.500)	126,450	3161 ft.lbs.	2371 ft.lbs.
1-1/2-12 (1.500)	142,275	3557 ft.lbs.	2668 ft.lbs.				

Torque values for bolts listed above are with Engine Oil and/or Loctite applied to threads and under head. Applies to plated and non-plated capscrews.

GRADE 5    GRADE 8 

NOTE: Torque values specified are with residual oil remaining on bolts. If special lubricants of high stress ability such as never-seez compound, graphite and oil, molybdenum di-silfide, colloidal copper or white lead are used, multiply the torque figures in the chart by the factor .90.

MAXIMUM RECOMMENDED TORQUE VALUES FOR JIC SWIVEL NUT (37° SEAT)

THD. SIZE	SIZE	OD TUBE	LB-FT PRESSURE
7/16 - 20	4	1/4	9
1/2 - 20	5	5/16	17
9/16 - 18	6	3/8	20
3/4 - 16	8	1/2	30
7/8 - 14	10	5/8	40
1-1/16 -12	12	3/4	85
1-3/16 - 12	14	7/8	100
1-5/16 - 12	16	1	110
1-5/8 - 12	20	1-1/4	150
1-7/8 - 12	24	1-1/2	170
2-1/2 - 12	32	2	300
	40	2-1/2	400
	48	3	500

The torque required to seal swivel female fittings or hose couplings to a male connector depends on many variables such as fluid medium, surface finish, etc. The above values are intended only as a guide for the maximum values the fittings may be subjected to.

These values are the recommended torque values for JIC (37° Seat) Swivel nuts either swaged or brazed type. The swivel nuts will normally withstand this torque for a minimum of 15 repeated assemblies.

Conversion Factors:

Lb-Ft × 1.355 818 = Nm
Inch × 25.4 = mm

Section 1055

GENERAL CLEANING INSTRUCTIONS

GENERAL CLEANING INSTRUCTIONS

Complete Assemblies

Completely assembled components can be steam cleaned on the OUTSIDE only, before removal or disassembly. All openings and breathers must be closed before steam cleaning to prevent water or moisture entering the component.

Rough Parts

Rough parts, for example — housings, castings, etc., can be cleaned in hot solution tanks with mild alkali solutions ONLY IF these parts do not have ground or machined surfaces. Leave the parts in the hot solution tank long enough to be completely cleaned and heated. Flush the parts completely with clear water after cleaning to remove all residue of the cleaning solution.

Finished or Machined Parts

Parts which have ground or machined surfaces, for example — gears, bearings, shafts and collars, can be cleaned in a solvent that is not flammable.

IMPORTANT: DO NOT clean machined parts in hot solution tanks with water and alkaline solutions.

WARNING: To prevent injury from burns, always use a solvent that is not flammable for cleaning component parts. DO NOT use gasoline or other flammable substances.

Rubber Parts

Clean rubber parts by washing in clean denatured alcohol. DO NOT use cleaning solvents with a mineral base, for example — acetone or paint thinner. If a mineral base solvent is used, the rubber will start to wear away and continue to wear away after the part is put back into service. This rapid wearing away of the rubber part can cause failure of the component in service.

Drying

After cleaning, all parts must be dried immediately. Use compressed air free of moisture, and a soft cloth free of lint and abrasive materials.

Bearings can be dried with compressed air, but make sure the air is moved across the bearings in a direction which prevents spinning. DO NOT let bearings spin when drying. Bearings can be turned slowly by hand to shorten the drying time.

Corrosion Prevention

Parts that have been cleaned, dried, inspected and are to be immediately assembled into the component — Apply a light oil to prevent corrosion. If these parts are to be put in storage for any length of time, apply a good RUST PREVENTIVE then put the parts in special paper or other material to prevent corrosion.

Section 1056

SAFETY RULES

SAFETY RULES

General

The Safety Alert Symbol Indicates Important Safety Messages In This Manual. When You See This Symbol, Carefully Read The Message That Follows And Be Alert To The Possibility of Personal Injury Or Death.

WARNING: Stop the engine before doing any maintenance or adjustments. If necessary to make checks while the engine is running, have one person at the controls while the other person makes the check.

CAUTION: When doing any service on the machine, put a tag on the key switch or remove the key to prevent operation of the machine.

WARNING: To prevent injury from burns, always use a solvent that is not flammable for cleaning component parts. DO NOT use gasoline or other flammable substances.

Keep a fire extinguisher available and KNOW HOW TO USE IT. Check the fire extinguisher at regular intervals for correct operation.

WARNING: To prevent eye injury, wear eye protection when doing maintenance on this machine.

CAUTION: Clean any oil spills immediately and keep the work area as clean as possible. A clean area helps prevent accidents.

CAUTION: DO NOT wear loose clothing which may catch in moving parts.

CAUTION: Always lower the load or attachment to the ground before performing any service or adjustment.

Operation

WARNING: Read the Operator's Manual before operating the machine.

CAUTION: Before starting engine, make sure all operating controls are in NEUTRAL.

CAUTION: Before lifting a load, check the load chart on the machine. Make sure you will be in the safe load range [illegible] enough parts of line are used for the load.

WARNING: To prevent injury and possible death, keep hands, feet and clothing away from moving parts during operation.

DANGER: Engine exhaust can cause death. If necessary to start the engine in a closed area, make sure there is enough ventilation.

Maintenance

DANGER: The retaining ring and rim of the wheel and tire can come off with explosive force and can cause serious injury or death. Be extremely careful when working with them. Never try to disassemble the wheel until all the air is released from the tire. Always use a tire [illegible] adequate [illegible] inflating tires.

CAUTION: Decals provide operating instructions and safety information to the operator. To help prevent accidents or personal injury, clean or replace any decal that cannot be easily read.

CAUTION: When checking coolant, remove radiator cap slowly to relieve pressure in the system. To prevent burns, remove radiator cap only when engine is cool.

Inspect the machine daily for loose, worn or damaged parts. Have unsafe conditions corrected immediately.

CAUTION: To prevent accidents and possible personal injury from failure of wire rope, replace the wire rope immediately if any damage is found.

CAUTION: ENGINE FAN AND BELTS. [illegible]

WARNING: Never fill the fuel tank near an open flame or while the engine is running. Keep cigarettes away.

CAUTION: To prevent injury to your hands, always wear gloves when working with the wire rope.

WARNING: Use a pry bar or piece of wood to move the wire rope over the sheaves or around the winch drum. Never use your hands.

Service

CAUTION: The output shaft of the gearbox for the main winch is the carrier for the winch drum. To prevent possible injury or damage, make sure the drum is fastened in place before you remove the gearbox.

CAUTION: Use brake fluid to clean rubber parts. Acetone, paint thinner or other mineral base solvents must not be used on rubber parts. Mineral base solvents will cause damage and possible failure of the part.

CAUTION: If sequencing boom and crowd cylinder have been removed, do not permit the boom to be lowered below the horizontal position. Boom section will slide out if boom is not in horizontal position.

CAUTION: Hydraulic systems are highly pressurized. Escaping hydraulic oil, even an invisible pinhole leak, can penetrate body tissues causing serious injury. Use a piece of wood or cardboard when looking for leaks. Never use the hands or other parts of the body.

Release hydraulic pressure before disconnecting circuits. When reassembling make absolutely certain that all connections are tight.

If injured by hydraulic oil escaping under pressure, see a doctor immediately. Serious complications may arise if medical attention is not given at once.

WARNING: Never disconnect any hydraulic line unless the boom is fully lowered and hydraulic pressure is released. To relieve hydraulic pressure stop the engine and move the hydraulic controls forward and back several times.

CAUTION: Be very careful when working with tires. Tires can come apart with explosive force. Never try to disassemble the wheel until all air is released from the tire.

CAUTION: Do not attempt repairs you do not understand. There is no disgrace in asking for help.

CAUTION: Always wear asbestos gloves to prevent burning your hands when handling heated parts.

1

WARNING: When testing or adjusting fuel injectors, do not place your hands or arms in front of the injector nozzle.

In the event the skin is punctured from the discharge of an injector, apply the following first aid immediately, then have the injury examined by a physician as quickly as possible.

Wash the injured part with [illegible] support the injured finger [illegible] with a splint or sling so the injured part [illegible] absolutely at rest until [illegible]

CAUTION: When [illegible] air keep stream [illegible] Use only [illegible] air pressure.

CAUTION: [illegible] the [illegible]

WARNING: [illegible]

1. Maintain [illegible]
2. [illegible]
3. [illegible]
4. [illegible]
5. [illegible]
6. Another [illegible]

Electrical System

CAUTION: [illegible] must be well ventilated to prevent accumulation of [illegible] newly recharged batteries.

WARNING: Never operate the alternator on an open circuit. With no battery or other electrical load on the circuit, a voltage buildup will occur within the alternator. This voltage buildup [illegible] shock to anyone touching the alternator "BAT" terminal.

WARNING: Because of the danger of explosion [illegible] connecting [illegible] batteries. NEVER lean over batteries when connecting jumper cables.

CAUTION: [illegible] battery [illegible] negative ground cable first. When installing the battery [illegible] ground [illegible]

WARNING: [illegible] cigarettes away. Ventilate [illegible]

CAUTION: [illegible]

WARNING: Never check battery [illegible]

POISON DANGER: [illegible]

Antidote — EXTERNAL: Flush with water. INTERNAL: Drink large quantities of water or milk. Follow with Milk of Magnesia, beaten egg [illegible] EYES: Flush with [illegible] and get prompt medical attention. KEEP OUT OF REACH OF CHILDREN.

Section 2001

ENGINE DIAGNOSIS

GENERAL INFORMATION

Before making any repairs or adjustments on an engine, a mechanic or technician must properly diagnose the trouble.

Locating the trouble and repairing it is only part of the job, a technician must find and eliminate the cause of the trouble as well. Too many repairs are made with no thought to removing the causes that made the repair necessary.

For any engine to start or perform properly, three main requirements must be present:

1. FUEL
2. COMPRESSION
3. COMBUSTION

When any of these requirements are not present or limited by some mechanical reason, the engine will not start and will fail to operate properly throughout the power range.

FUEL. Fuel system problems can be present anywhere from the fuel tank, through the filters and injection pump as well as the injectors. Correct injection pump timing is important in the overall fuel system performance.

COMPRESSION. Compression on an engine is related to the "breathing function". Proper compression is affected by the air cleaner condition, muffler restriction, valve condition and operation including proper valve adjustment, cylinder head gaskets, condition of sleeves, rings, pistons, camshaft, and camshaft timing.

COMBUSTION. Combustion is the result of adequate compression to develop enough heat in the air charge on the compression stroke to fire the fuel being injected into the engine cylinders. Proper spray pattern and atomization of the fuel by the injector is very important. Timing the fuel injection pump to the engine to a precise degree BTDC is a vital requirement for proper combustion.

The engine diagnosis contained in the following pages covers many trouble symptoms, the causes, and what will be necessary to repair or eliminate the problem. Under each symptom are listed the most common and reoccuring problems progessing to the not so common problems. Locate your problem symptom in the diagnosis chart and refer to the pages listed for the probable causes and remedies.

REFER TO THE ENGINE MANUAL SUPPLIED WITH YOUR UNIT.

Section 2050

ENGINE AND POWER TRAIN REMOVAL AND INSTALLATION

2

SAFETY

DANGER: Engine exhaust can cause death. If necessary to start the engine in a closed area, make sure there is enough ventilation.

WARNING: To prevent eye injury, wear eye protection when doing maintenance on this machine.

WARNING: To prevent injury or death, do not work under raised machine unless:

1. Main frame is on firm support or blocks in a manner to prevent machine from falling or tipping
2. Engine is stopped
3. Transmission is in Neutral
4. Parking Brake is engaged and wheels stopped with blocks to prevent machine movements
5. Key is removed to prevent accidental starting
6. Another person is available to give assistance if needed

WARNING: To prevent injury from burns, always use a solvent that is not flammable for cleaning component parts. DO NOT use gasoline or other flammable substances.

Keep a fire extinguisher available and KNOW HOW TO USE IT. Check the fire extinguisher at regular intervals for correct operation.

CAUTION: When doing any service on the machine, put a tag on the key switch or remove the key to prevent operation of the machine.

WARNING: Stop the engine before doing any maintenance or adjustments. If necessary to make checks while the engine is running, have one person at the controls while the other person makes the check.

REMOVAL AND INSTALLATION

Removal

1. Remove engine hood.
2. Disconnect ground cable and battery cable from battery.
3. Disconnect main wiring harness plug from engine and outrigger wiring harness plugs.
4. Drain radiator. Disconnect upper and lower hoses from radiator. Also disconnect transmission cooling lines. Put plugs in the lines to keep dirt out of system.
5. Remove radiator, fan shroud and fan.
6. Remove air cleaner and intake hose.
7. Disconnect fuel lines from engine. Put plugs in the lines to prevent fuel leakage.
8. Make sure machine is secure on blocks to prevent machine movement. Release parking brake. Disconnect brake linkage at transmission.
9. Remove drive shaft from transmission.
10. Disconnect shifting linkage from transmission.
11. Remove throttle cable from engine.

12. Disconnect exhaust pipe from exhaust manifold on engine.

13. Remove Cold Start Kit from mounting bracket inside chassis (option - diesel engine only).

14. Disconnect engine ground cable from engine.

15. Install hook bolts in two holes with threads in top of engine flywheel housing and connect a hoist. Install another chain from front of engine to the hoist so front of engine will be tilted up approximately 30 degrees to permit removal of power train.

16. Remove mounting bolts from front engine mounts and rear engine/transmission mounts.

17. Slowly raise engine a small amount. Check that all lines and components which can possibly cause interference with engine removal have been removed. Carefully lift engine and transmission assembly from chassis.

Installation

1. Use a hoist to lift engine and transmission into place in chassis. Front of engine must be tilted up approximately 30 degrees to permit installation of power train into main frame. Install mounting bolts in front and rear mounts. Remove hoist.

2. Connect engine ground cable to engine.

3. Use new gasket and connect exhaust pipe to exhaust manifold.

4. Connect throttle cable, shifting linkage and parking brake linkage.

5. Connect drive shaft to transmission.

6. Fasten Cold Start Kit to mounting bracket inside chassis (diesel only) and connect to engine.

7. Connect fuel lines to engine.

8. Install air cleaner and intake hose.

9. Install radiator, fan shroud and fan. Install transmission cooling lines. Connect upper and lower radiator hoses.

10. Fill radiator with new coolant of specified type. See Section 1050.

11. Connect wiring harness plugs for engine wiring harness and outrigger wiring harness.

12. Make sure engine and transmission are filled with oil of the recommended type. See Section 1050.

13. Connect battery positive cable and ground cable to battery.

14. Check complete installation to be sure all components are installed and secure.

15. Start engine. Continue to add fluid to transmission as necessary until transmission cooling lines are filled. See Section 6102. Add coolant as needed to fill cooling system. See Section 2054.

16. Stop engine. Check for leaks. Check lubricant and fluid levels.

Section 2051

Changing Engine Oil

2

CHANGING ENGINE OIL

Continental TM 2.7L Gasoline & Dual Fuel Engine

Engine Specifications:*

Oil Capacity
- Crankcase - U.S. qt. (liters) 6 (5.7)
- Filter - U.S. qt. (liters) .... 1 (.95)
- Total - U.S. qt. (liters) 7 (6.65)

Engine Oil Pressure
- Max. Oil Pressure** - PSI (Bar) 40-60 (2.8-4.1)
- Min. Oil Pressure (Idling) - PSI (Bar) 7 (0.5)

*If additional information is required, see "Continental's Operator, Maintenance and Overhaul Manual" furnished with your machine.
**Higher oil pressure may be experienced during cold starts.

Oil Change:

Run-In Oil. After the engine has operated for 50 hours, remove the run-in oil. Replace with oil of the correct type per Specifications.*

Continuous Duty at Continuous Duty Rating		Light Duty Operation (25% Max. Continuous Rating) and Standby
CLEAN ENVIRONMENT	DIRTY ENVIRONMENT	
150 Hours Max.	50 Hours	100 Hours Max.

Suggested Oil and Oil Filter Change Intervals

a. For oil change only, add 6 measured U.S. quarts (5.7 L) of oil. Do NOT fill using only the dipstick as a guide.

b. For oil and filter change, use 7 U.S. quarts (6.65 L) of oil. Operate the engine for 2 or 3 minutes to fill the filter body. Stop the engine and check the level of oil with the dipstick. Check filter for leaks.

Filter Change:

Change the oil filter at the end of the run-in period (50 hours) and again per chart above.

a. Turn filter counterclockwise to loosen. Remove and discard the old filter.

b. Clean the mounting surface for the filter. See Figure 1.

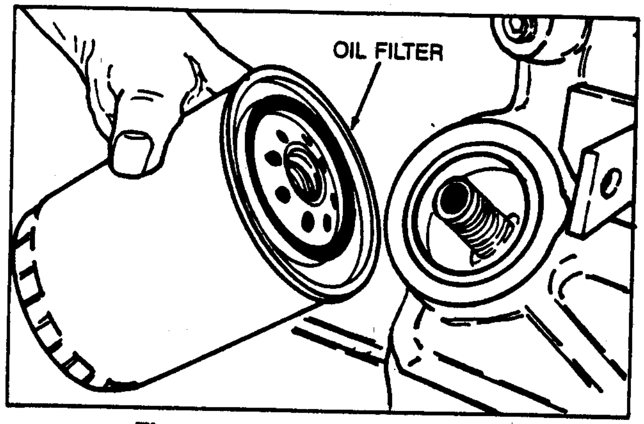


Figure 1. Removal of Oil Filter

c. Apply a small amount of engine oil to the gasket of the new filter. Install filter. Turn filter clockwise to tighten until gasket contact is made. Tighten the filter only 3/8 of a turn. Loosen the filter and tighten again until gasket contact is made. Then tighten filter ½ to ¾ turn more to get the correct seal.

Cummins 4B3.9 Diesel Engine

Engine Specifications:*

Oil Capacity	
Crankcase - U.S. qt. (liters)	10.0 (9.5)
Filter - U.S. qt. (liters)	1.5 (1.4)
Total - U.S. qt. (liters)	11.5 (10.9)
Engine Oil Pressure	
Max. Oil Pressure** - PSI (kPa)	30-65 (207-449)
Min. Oil Pressure (Idling) - PSI (kPa)	10 (69)

*If additional information is required, see "Cummins Operation and Maintenance Manual" furnished with your unit.

**Higher oil pressure may be experienced during cold starts.

Oil Change:

Run In Oil. Do not use special "break-in" lubricating oils for new or rebuilt engines. Use the lubricating oil specified for normal engine operation. Replace with oil of the correct type per Specifications.*

Regular Oil Change. Change oil after every three (3) months, 250 hours or 5,000 miles whichever occurs first.

Under difficult conditions, for example, frequent starting and stopping, high or low operating temperatures, change the oil more frequently. Remove the oil while the engine is still warm from operation.

a. For oil change only, add 10 measured U.S. quarts (9.5 L) of oil. Do NOT fill using only the dipstick as a guide.

b. For oil and filter change, use 11.5 U.S. quarts (10.9 L) of oil. Operate the engine for 2 or 3 minutes to fill the filter body. Stop the engine and check the level of oil with the dipstick. Check filter for leaks.

Filter Change:

Same schedule as regular oil changes.

a. Turn filter counterclockwise to loosen. See Figure 2. Remove and discard the old filter.

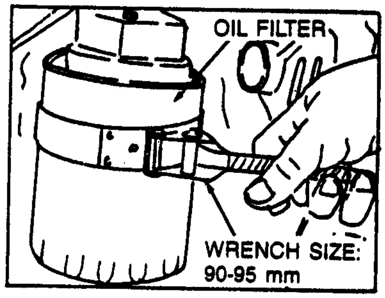


Figure 2. Removal of Oil Filter

b. Clean the mounting surface for the filter.

c. Apply a small amount of engine oil to the gasket of the new filter. Install filter. Turn filter clockwise to tighten until gasket contact is made. Tighten the filter only 3/8 of a turn. Loosen the filter and tighten again until gasket contact is made. Then tighten filter ½ to ¾ turn more to get the correct seal.

Section 4002

ELECTRICAL SYSTEM
DIAGNOSIS, TESTS AND CHECKS

TABLE OF CONTENTS

SPECIFICATIONS

General

Type of system	12 volt negative ground
Battery	12 volt 370 cca @ 0°F (-18°C) for 30 sec. rate
Alternator	Diesel - 12 volts, 63 amperes
	Gas - 12 volts, 37 amperes
Starter	12 volt, internal shift lever type

SAFETY RULES

WARNING: Never operate the alternator on an open circuit. With no battery or other electrical load on the circuit, a voltage buildup will occur within the alternator. This voltage buildup could cause electrical shock to anyone touching the alternator "BAT" terminal.

POISON DANGER: BATTERY ACID CAUSES SEVERE BURNS. BATTERIES CONTAIN SULFURIC ACID. Avoid contact with skin, eyes, or clothing.

Antidote - EXTERNAL. Flush with water. INTERNAL. Drink large quantities of water or milk. Follow with Milk of Magnesia, beaten egg or vegetable oil. Call physician immediately. EYES. Flush with water for 15 minutes and get prompt medical attention. KEEP OUT OF REACH OF CHILDREN.

WARNING: Never check battery charge by placing a metal object across the posts — the sparks could cause an explosion. Use a voltmeter or hydrometer.

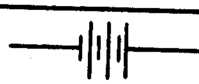
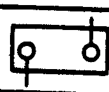
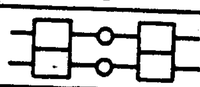
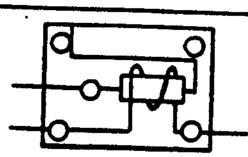
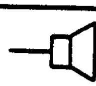
CAUTION: Think out the circuit before making or breaking a connection. A wrong connection can be painful and expensive.

CAUTION: Disconnect both leads from the batteries when working on the engine or electrical system. Always disconnect the ground lead first!

WARNING: Batteries produce explosive gases. Keep flames, sparks and cigarettes away. Ventilate when charging or using in enclosed space. Always shield eyes when working near batteries.

This Safety Alert Symbol Indicates Important Safety Messages In This Manual. When You See This Symbol, Carefully Read The Message That Follows And Be Alert To The Possibility of Personal Injury Or Death.

GRAPHIC SYMBOLS FOR ELECTRICAL DIAGRAMS

	GROUND
	FUSE
	SWITCH SINGLE POLE
	SWITCH PUSH BUTTON
	LAMP
	BATTERY
	CIRCUIT BREAKER
	MOTOR
	COLLECTOR RING
	SEPARABLE CONNECTOR
	RELAY
	SOLENOID
	HORN

FOR ELECTRICAL SCHEMATICS SEE REAR OF SECTION

WIRE NO. CODE (SAE)

SYSTEM POWER (0 - 9)
- -0- Ground
- -1- Power - Continuously Hot

POWER DISTRIBUTION (10 - 19)
- 12 Key Switch
- 14 Alternator Field Control
- 19 Circuit Breaker/Fuse

ENGINE CONTROLS (20 - 29)
- 21 Engine Cranking
- 23 Engine Shutoff
- 24 Transmission Control
- 25 Hi/Low Range Transmission
- 28 Cold Start (Ether)

INSTRUMENTS (30 - 39)
- 31 Warning Lights (Eng. & Torq. Conv.)
- 32 Warning Light (Torque Conv. Temp.)
- 33 Warning Light (Low Air)
- 35 Engine Hours
- 36 Gauges

LIGHTING (40 - 49)
- 41 Head and Tail Lights
- 44 Brake Light
- 45 Signal Light
- 49 Panel Light

CONTROLS (50 - 59)
- 56 Outriggers
- 58 Warning Systems - Control Functions

ACCESSORIES (60 - 69)
- 61 Heater
- 63 Wiper
- 64 Horn

INTRODUCTION

General

A few basic words and facts are given here to help in understanding and troubleshooting the electrical system.

Electrical Energy — energy caused by the flow of electrons. Electrons are particles with a negative charge which are pulled toward particles with a positive charge (protons).

Amperage — rate of flow of electrons, measured in Amps.

Voltage — the electromotive force which causes movement of electrons through an electrical circuit, measured in Volts.

Electrical Resistance — any resistance to the flow of electrons, measured in Ohms.

Important Facts: It is good to remember the following points when testing or troubleshooting an electrical circuit.

1. Current always moves from positive (+) to negative (−) or from the point of highest potential. (Conventional Theory)

2. All current that leaves the supply or battery returns to the supply or battery.

3. In a series circuit arrangement, the electromotive force (Volts) is completely used or discharged around the circuit (when current is flowing). In parallel circuit arrangements, the voltage is constant.

4. When voltage is constant, the electrical resistance (ohms) is the controlling factor for the current (amps) in the circuit. The basic formula is $E = IR$, where E represents voltage, I represents current or amps, and R is resistance (ohms).

Electrical Systems

An electrical system is in many ways similar to a hydraulic system. For example, a "pump" is needed to cause the flow which gives energy. A complete circuit is needed to return the flow to storage or supply. "Valves" are needed to direct and control the flow through the system.

Electrical System	Hydraulic System
Alternator	Pump
Battery	Reservoir
Switches	Valves
Wires or Cables	Tubes or Hoses
Diodes	Check Valves
Volts	PSI or kPa
Amps	GPM or l/m
Ohms	Resistance

Magnetic Forces in Electricity:

When current moves through a conductor, a magnetic field is caused around the conductor. This magnetic field can be used to cause movement of electrons in a second conductor. Practical applications of this magnetic field include generators, coils, relays and solenoids which are some of the basic components of the electrical system.

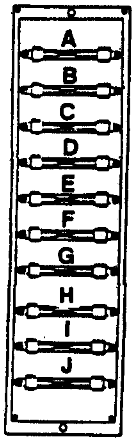
ELECTRICAL SYSTEM

The electrical system on this machine is a negative ground system and operates on 12 volts of direct current. The system uses one 12 volt battery for storage of the electrical energy. An alternator gives the power for operation of the electrical components and charging of the battery when the engine is running.

CAUTION: Disconnect both leads from the batteries when working on the engine or electrical system. Always disconnect the ground lead first.

Circuit Protection

There are ten fuses on a fuse block on the back side of the instrument panel. These fuses give protection to the components and circuits indicated in Figure 1.



FUSE	RATING	FUNCTION/CIRCUIT
A	15 Amp	Heater/Defroster, strobe light, gauges
B	15 Amp	Windshield wiper, parking brake, tachometer
C	15 Amp	Cold start, horn
D	15 Amp	Winch control, 4-wheel and crab steering control
E	20 Amp	Brake lights, mast lights, fuel shut-off (diesel engine), or spark ignition coil (gasoline engine)
F	20 Amp	Anti-double blocking, outrigger controls
G	20 Amp	Transmission warning light, transmission shift relays
H	20 Amp	Flashers, turn signals
I	20 Amp	Transmission shift control
J	20 Amp	Head lights, tail lights, work lights, gauge lights

Figure 1. Fuse Block on Back Side of Instrument Panel

ELECTRICAL TROUBLESHOOTING

Finding a problem in the electrical system is not difficult if you know basic electricity and understand the arrangement of the electrical system on this machine. Use the electrical schematic as your guide. A basic description of each circuit of the system is included on the following pages. For purposes of explanation, the system is separated into three parts:

The Charging Circuit
The Control Circuits
The Circuits for the Lights and Instruments

Accurate testing equipment is also necessary. The instruments normally used are the voltmeter, ammeter and ohmmeter.

Many times the problem can be found by visual inspection of the components in the circuit. Corrosion on terminals, loose connections or bad wiring are the causes of many problems.

Each circuit in the system has a fuse for protection against overloads. Remember that a burned fuse is an indication of an overload or **SHORT** circuit, not an **OPEN** circuit.

If you do not find the cause of the problem during the visual inspection, use voltmeter to check for voltage at several points in the circuit, or measure the voltage drop across each component. Normally, the best method is to start at the farthest component in the circuit and move backwards toward the power supply. An ohmmeter can be used to measure the resistance in any component. Remember to disconnect the component from the power supply before you connect the ohmmeter.

TROUBLESHOOTING CHART

PROBLEM	POSSIBLE CAUSE	REMEDY
Run Down Battery	Short circuit or ground in battery positive cable.	Inspect the cable from the battery positive post to the starting motor. Replace cable if insulation is worn.
	Loose battery cables or broken battery terminal.	Inspect, clean and tighten or replace if necessary.
	Fault in alternator or regulator causing low charging rate.	Any of reasons under Alternator Does Not Charge or Low Charging Rate
	Short circuit or ground in wiring in charging or starting circuits.	Check all wiring for indication of a ground, for example, sparks, heat, smoke or burned color.
	High use of starting motor or other electrical equipment.	Charge battery.
	Fault in starting circuit.	Inspect starting circuit wiring for ground.
	Dirty battery top causing continued drain on battery.	Check for leakage on dirty battery top, See Operator's Manual. Clean battery.
	Short circuit in cell of battery.	Replace battery.
Starter Not Operating Or Does Not Operate Correctly	Low charge on battery.	Test battery. If necessary, add slow charge. If battery continues to have a low charge, test regulator and alternator.
	Fault in battery ground wire.	Check for loose connections, corrosion or breaks.
	Fault in wiring or loose connections in starting circuit.	Use wiring diagram and check out starting circuit, looking for poor connections and broken or bad wires.
	Fault in key switch or neutral switch.	Replace switch.

TROUBLESHOOTING CHART (CON'T.)

PROBLEM	POSSIBLE CAUSE	REMEDY
Starter Not Operating Or Does Not Operate Correctly (Con't.)	Engine oil too heavy for outside temperature.	See Lubricants and Fluids Chart in Section 1050, Maintenance and Lubrication.
	High resistance in starter positive or ground circuits.	Test circuits. For procedure and specifications, see page 4002-13.
	Worn starter drive or flywheel ring gear teeth.	Remove starter and inspect teeth.
	Loose starter mounting.	Inspect and tighten.
	Worn brushes or bad armature or field coil or other defect in starter.	Disassemble starter, test and repair as necessary.
	Open circuit, short circuit or ground in windings in starter motor solenoid.	Replace solenoid as required.
Alternator Does Not Charge	Alternator belt loose or broken.	Tighten to specification or replace.
	Worn brushes or open brush leads or connections.	Replace alternator.
	Open circuit, short circuit or ground stator winding.	Replace alternator.
	Fault in voltage regulator.	Replace regulator.
	Short circuit or open circuit in rectifier diodes.	Replace alternator.
	Open circuit, short circuit or ground in rotor (field) winding.	Replace alternator.
	Wires wrongly connected after repairs.	See wiring diagram.
	Dirty slip rings or bad slip ring connections.	Inspect slip rings. Clean or repair as required.

TROUBLESHOOTING CHART (CON'T.)

PROBLEM	POSSIBLE CAUSE	REMEDY
Low Charging Rate	All of reasons under Alternator Does Not Charge.	
High Charging Rate. Lights Burning Out	Wrong or loose connections on alternator and regulator.	Check connections and tighten if necessary.
	Fault in voltage regulator.	Replace regulator.
Alternator Noise	Badly worn belt.	Replace belt.
	Pulleys out of alignment.	Align fan and alternator pulleys.
	Loose pulley.	Check for broken key or worn keyway, if used. Tighten pulley nut.
	Worn bearings.	Replace alternator.
	Short in rectifier diodes.	Replace alternator.
Continuity Test Shows No Voltage Through Wire Harness	Harness plugs not fully engaged.	Make sure plugs are fully engaged.
	One or more studs on plug broken.	Replace harness.
	Wrong wiring.	Check wiring harness diagram.
	Open circuit or short circuit in wire in harness.	Replace harness.

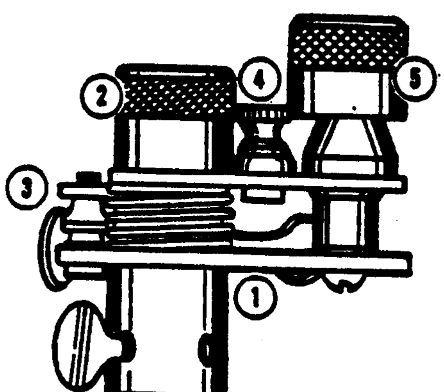
TROUBLESHOOTING THE CHARGING CIRCUIT

The following checks are given in the order of easiest performance and as near as possible in the order of malfunction.

CHECK	INSTRUCTIONS
Visual check	1. Check for damage to wiring, loose connections or corrosion on terminals and harness plug connections. Repair or replace as required. 2. Check fan belt condition and tension. Adjust or replace belt as required.
Check condition of battery	1. Clean battery top to prevent voltage loss. 2. Check for damage to battery case that can cause loss of fluid or let dirt into cell(s).
Check voltage at alternator	1. Connect voltmeter negative lead to the alternator frame. Connect voltmeter positive lead to the alternator "Bat" terminal. 2. Turn key switch on and check voltage at the alternator "Bat" and No. 1 and No. 2 terminals. a. Correct voltage at the "Bat" terminal is battery voltage to about 1/2 volt less than battery voltage. b. Correct voltage at terminal No. 1 is approximately 2-1/2 volts to 3 volts less than battery voltage. c. Correct voltage at terminal No. 2 is approximately 1/2 volt less than battery voltage.
Check alternator output	1. If necessary, remove alternator for repair. Continue troubleshooting procedure.

TROUBLESHOOTING THE CHARGING CIRCUIT (CON'T.)

CHECK	INSTRUCTIONS
Check wiring and terminals	1. Connect the positive lead of test ammeter to the alternator "Bat" terminal and the negative lead to the battery post adapter, Figure 2. 2. Connect a carbon pile to the battery terminals. Make sure carbon pile is OFF before making connections. 3. Start engine and run at 1/2 throttle. Adjust carbon pile to obtain a 10 amp charge rate on the test ammeter. 4. Connect voltmeter positive lead to alternator "Bat" terminal and negative lead to positive battery post. The voltage drop must not be more than .3 volt. If voltage drop is more than .3 volt, clean and tighten cable connections at battery and starter and check voltage drop again. If voltage drop is still high, the cable must be replaced. 5. Move voltmeter positive lead to negative battery post and negative lead to the alternator frame. The voltage drop must not be more than .1 volt. If voltage drop is more than .1 volt, clean and tighten all connections between the starter and battery and check voltage again. If voltage drop is still high, ground cable must be replaced.
Check voltage regulator	1. Remove battery post adapter after troubleshooting is complete.



1. Snap-On Battery Post Adapter. Install on Negative Battery Post.
2. Switch Nut.
3. Connect Ammeter Positive Lead Here.
4. Connect Ammeter Negative Lead Here.
5. Connect Negative Battery Cable Here.

Figure 2. Battery Post Adapter

TROUBLESHOOTING THE STARTING CIRCUIT

General Inspection

Many starting problems can be corrected by making the following checks:

1. Check battery condition. See Operator's Manual. Charge or replace battery as required. Clean battery post and cable connections.

2. Inspect wiring for bad insulation or other damage. Inspect all connections at the starter solenoid, key switch, and neutral start switch. Clean and tighten all connections and replace any bad wiring. Check to see that wiring harness plugs are fully engaged. Also check plugs for damage or corrosion.

3. If the starter still does not operate after correcting defects, do the Starting Circuit Check.

Starting Circuit Check

The following steps will show the location of defects in the starting circuit. The circuit can be checked with a 12 volt test lamp or a voltmeter.

1. Apply parking brake and make sure all controls are in neutral.

2. See Figure 3. Connect a jumper cable to the starter solenoid B and S terminals.

   a. If the starter operates, the starter and solenoid are good. The problem is somewhere between the solenoid and key switch. Go to step 3.

   b. If the starter did not operate, connect the jumper cable to the B and M terminals on the starter solenoid. If the starter operates correctly, the problem is in the starter solenoid. Replace. If the starter still does not operate, the starter is bad and must be repaired or replaced.

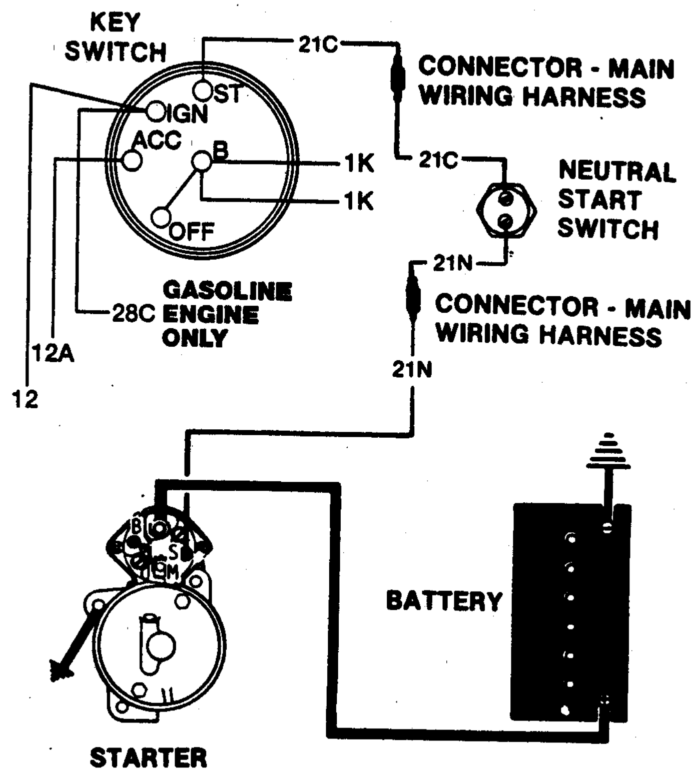


Figure 3. Starter Circuit

3. See Figure 4. Check for battery voltage at Bat terminal of key switch. No voltage indicates the circuit between the key switch and starter solenoid B terminal is at fault. Check harness connections and wiring and repair as required.

4. Turn key switch to Start position and check for voltage at Start terminal. Go to step 5 if voltage was indicated.

5. Have someone hold the key switch in Start position, check for voltage at neutral start switch and across the switch. (Make sure transmission shift is in neutral position.) If voltage is indicated at neutral start switch, go to step 6. Replace neutral start switch if no voltage is indicated across the switch.

6. With key switch in Start position, check for voltage at the switch terminal of the starter solenoid. If no voltage is indicated, the problem is in the wire from the neutral start switch to the starter solenoid. Repair or replace. If voltage is indicated, the problem is in the solenoid. Replace.

Checking the Insulated and Ground Circuits

For these tests, the starter is on the engine. A tester (for example, Sun Battery/Starter Tester) which has a voltmeter, ammeter, and a way of controlling the load will be needed.

Specifications

Minimum cranking voltage	9.6 volts
Maximum voltage drop	
Insulated circuit	.5 volt
Each cable	.4 volt
Starter solenoid	.1 volt
Each connection	.0 volt
Ground circuit	.5 volt
Test temperature	60° to 80° F (15.6° to 26.7° C)

Test 1 — Checking Cranking Voltage

1. Connect positive voltmeter lead to positive battery terminal. Connect negative voltmeter lead to negative battery terminal (ground).

2. Turn engine and check voltage reading. Make a record of the reading.

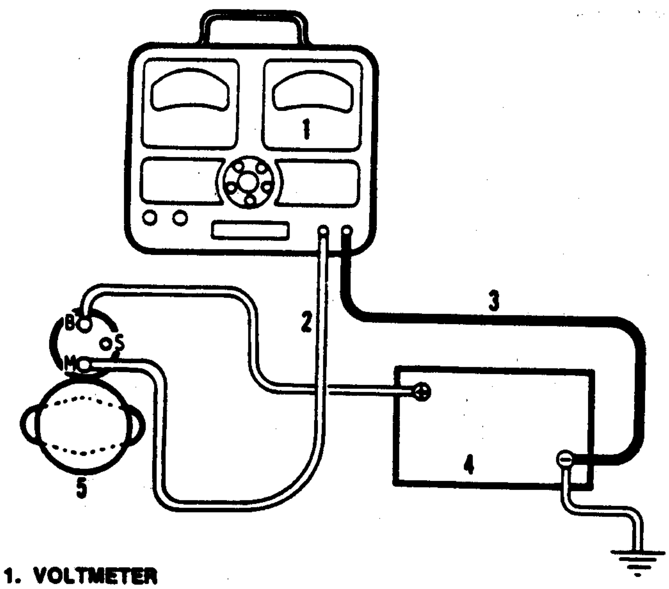
3. Voltmeter must read at least 9.6 volts. If above the minimum, continue testing. If below minimum, charge or replace battery.

Test 2 — Insulated Circuit Test

This test will show any high resistance in the circuit from the battery through the starter solenoid.

1. See Figure 4. Move positive voltmeter lead to the M terminal on starter. Leave negative voltmeter lead on battery negative terminal.

2. Turn engine and check voltage reading.



1. VOLTMETER
2. VOLTMETER POSITIVE LEAD
3. VOLTMETER NEGATIVE LEAD
4. BATTERY
5. STARTER

Figure 4. Insulated Circuit Test

3. Subtract this reading from the voltage reading received in Test 1. This is the voltage drop in the complete circuit. If voltage drop is .5 volt or less, do Test 4. If voltage drop is over .5 volt, do Test 3.

Test 3 — Finding Circuit Defects

These two tests will show the location of the defect in the insulated circuit indicated in Test 2.

1. CABLE, BATTERY TO SOLENOID TERMINAL. Connect positive voltmeter lead to positive battery post. Connect negative voltmeter lead to B terminal on solenoid. Turn engine. If voltage drop is .4 volt or less, go to step 2. If voltage drop is over .4 volt, replace the cable.

2. SOLENOID. Connect positive voltmeter lead to B terminal on solenoid. Connect negative voltmeter lead to M terminal on solenoid. Turn engine. If voltage drop is over .1 volt, repair or replace solenoid.

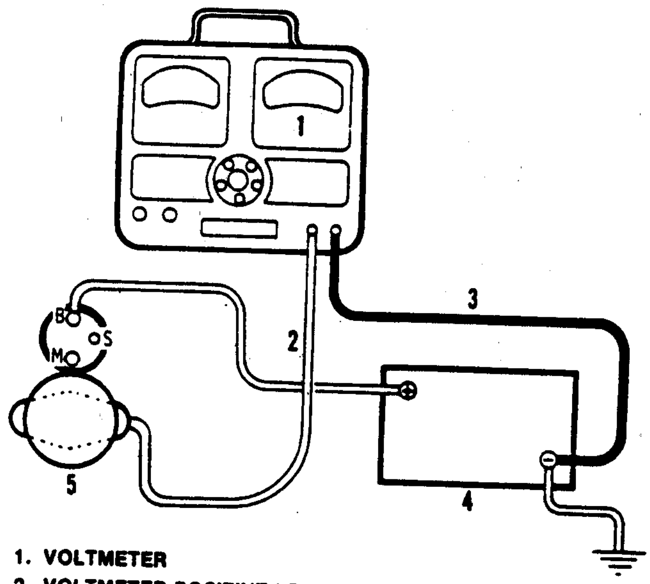
Test 4 — Ground Circuit Test

High resistance in the ground circuit can cause slow starter action or failure to turn and can also cause serious interference with the operation of the charging system.

1. See Figure 5. Connect the voltmeter positive lead to the ground end of the ground cable.

2. Turn engine. If voltage drop is over .5 volt, clean and tighten the ground cable connections.

3. Check the voltage drop again. If still over .5 volt, replace the ground cable.



1. VOLTMETER
2. VOLTMETER POSITIVE LEAD
3. VOLTMETER NEGATIVE LEAD
4. BATTERY
5. STARTER

Figure 5. Ground Circuit Test

PRECAUTIONS TO TAKE DURING SERVICE OF THE ALTERNATOR, REGULATOR AND BATTERIES

Do

1. Do connect booster batteries correctly if used as a starting aid. Connect (–) negative cable on unit battery. Connect the (+) positive cable of booster battery to the (+) positive terminal on the unit battery.

2. Do disconnect the battery ground cable before you start to work on the electrical system or when charging the batteries.

3. Do disconnect the regulator plug and wires at alternator terminals before you use an arc welder on the machine.

4. Do keep the drive belts at correct tension and in good condition.

Do Not

1. Do not make reverse connections between the batteries. Damage to the alternator diodes will occur. This machine has a negative (–) ground.

2. Do not cause a ground contact of the alternator positive output terminal.

4. Do not operate the machine with batteries disconnected.

5. Do not try to change the polarity of the alternator.

6. Do not use a steam cleaner or cleaning solvent to clean the alternator. Permanent damage can be caused if the alternator gets wet.

CONTROL CIRCUITS

Outriggers

For maximum lift and stability, fully extend and lower the outriggers. See Load Chart for maximum loads on tires.

You can operate all four outriggers at the same time, but do not operate any other hydraulic functions when operating the outriggers.

The outriggers are controlled by four switches on the instrument panel. Each switch controls a function of two outriggers (See Figure 6). When activating a switch it completes an electrical circuit to the dump valve solenoid. The dump valve energizes and makes oil available to operate the outrigger functions of the outrigger solenoid valve (See Figure 7). For outrigger functions see chart below.

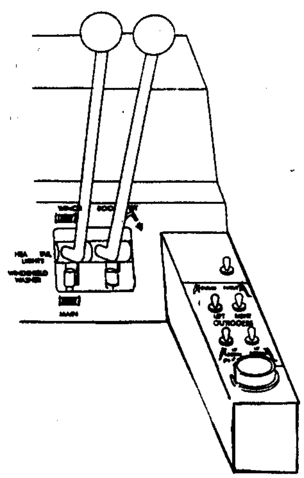


Figure 6. Outrigger Switches

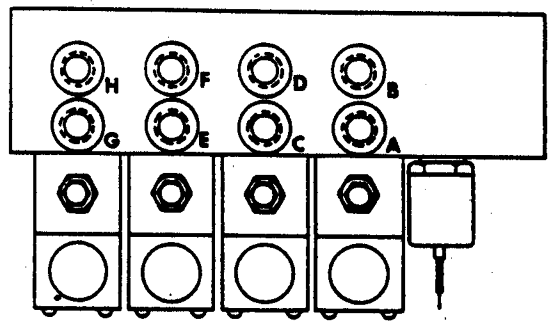


Figure 7. Outrigger Solenoid Valve Bank

Outrigger Functions

Top Left Switch - Left Outrigger In/Out

Switch Position	Dump Valve	Outrigger Valve
Center	De-energized	De-energized
Left	Energized	Sol(E) Energized
Right	Energized	Sol(F) Energized

Top Right Switch - Right Outrigger In/Out

Switch Position	Dump Valve	Outrigger Valve
Center	De-energized	De-energized
Left	Energized	Sol(H) Energized
Right	Energized	Sol(G) Energized

Bottom Left Switch - Left Outrigger Up/Down

Switch Position	Dump Valve	Outrigger Valve
Center	De-energized	De-energized
Up	Energized	Sol(C) Energized
Down	Energized	Sol(D) Energized

Bottom Right Switch - Right Outrigger Up/Down

Switch Position	Dump Valve	Outrigger Valve
Center	De-energized	De-energized
Up	Energized	Sol(A) Energized
Down	Energized	Sol(B) Energized

To Extend and Lower the Outriggers

CAUTION: Before you operate the outriggers or move the machine, make sure all persons are clear of the area.

NOTE: The left switches control the two outriggers on the left side of the machine. The switches on the right control the two outriggers on the right side of the machine.

1. To Extend: Run the engine at low rpm (accelerator pedal released). Push and hold the desired switch out as required (Figure 8, Item 1). Push the accelerator pedal to increase engine rpm and accelerate the outward movement of the outriggers. Release the accelerator pedal and the switch when the outriggers are fully extended.

2. To Lower: Hold the desired switch in the down position as required (Figure 8, Item 2). Push the accelerator pedal to increase engine rpm and accelerate the downward movement of the outriggers. Release the accelerator pedal and the switch when the outriggers are fully lowered.

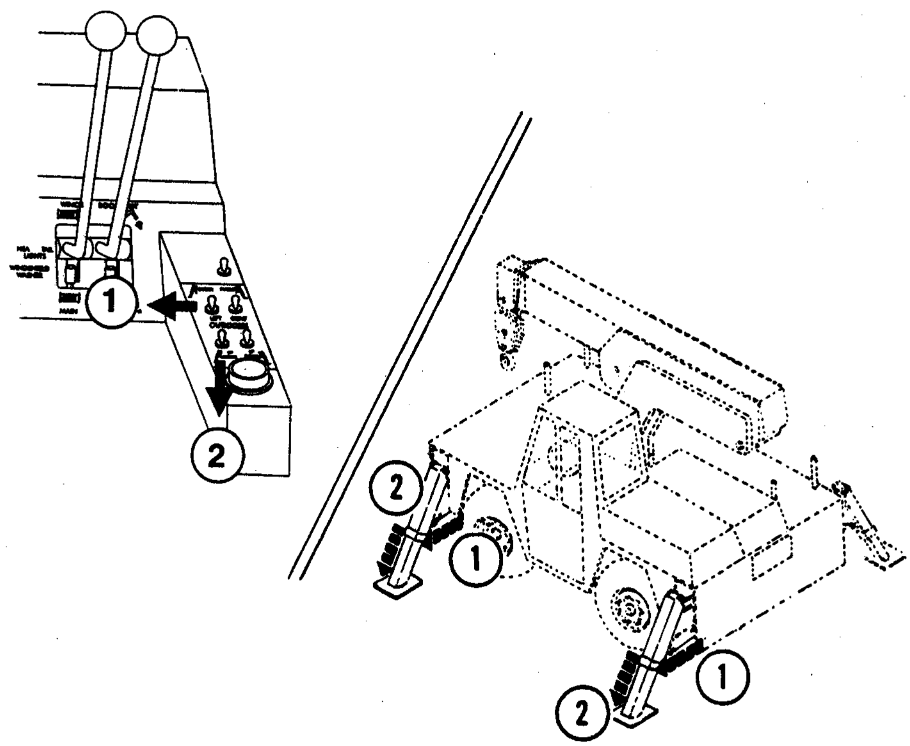


Figure 8. To Extend and Lower the Outriggers

To Raise and Retract the Outriggers

1. To Raise: Run the engine at low rpm (accelerator pedal released). Engage and hold the desired switch up as required (Figure 9, Item 1). Push the accelerator pedal to increase the engine rpm and accelerate the upward movement of the outriggers. Release the accelerator pedal and the switch when the outriggers are fully raised.

2. To Retract: Engage and hold the desired switch as required (Figure 9, Item 2). Push the accelerator pedal to increase the engine rpm and accelerate the retraction of the outriggers. Release the accelerator pedal and the switch when the outriggers are fully retracted.

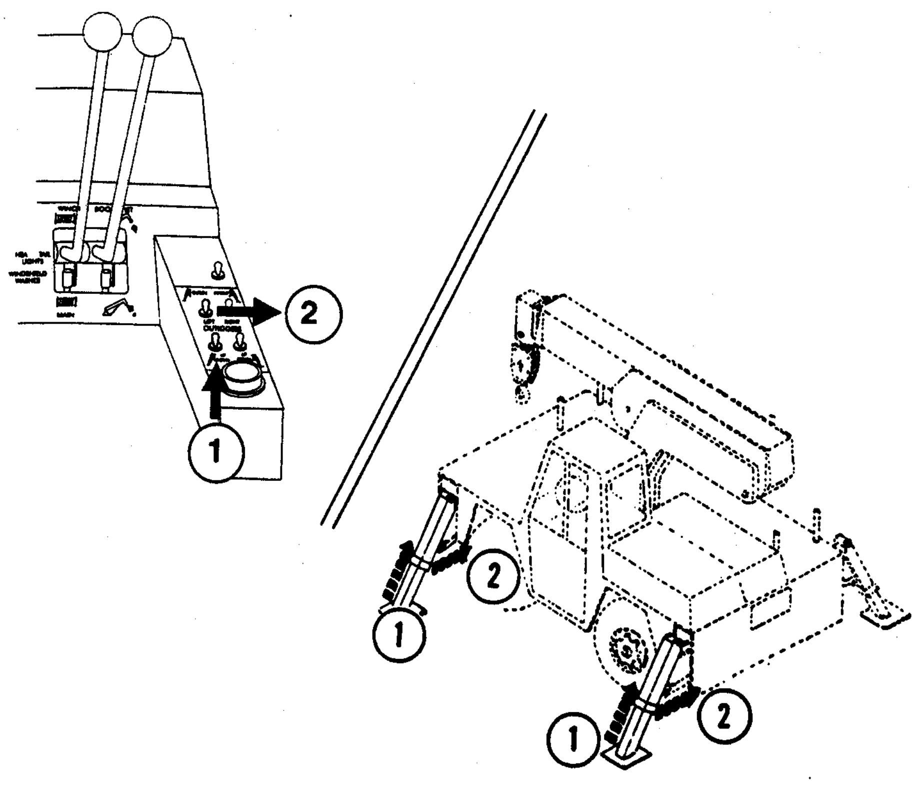


Figure 9. To Raise and Retract the Outriggers

Circuits for Lights and Instruments

Lights

Power is available to the main light switch from a 20 amp fuse on the fuse block. The light switch has four positions. Turning the switch counterclockwise from OFF position makes a complete circuit to the panel lights, tail lights and clearance lights. In the second position, the switch connects power to the head lights, in addition to the panel, tail and clearance lights. In the third position, the light switch connects power to the work lights, plus all the lights illuminated in the first and second positions. See Wiring Harness.

BULB REPLACEMENT GUIDE

Location	Part No.	Trade No.
Panel Lights	14553	#57
Head Lights	1000078	#6800
Tail Lights	S31861	#1157
Turn Signal	S31868	#1156

Gauges

The gauges are 12 volt components. Power is available to the gauges through a 15 amp fuse when the key switch is in the ON position.

Fuel Gauge: The fuel gauge connects to a sending unit in the fuel tank. The sending unit puts a variable resistance in the circuit and causes a corresponding indication on the fuel gauge, representing fuel level.

Engine Oil Pressure Gauge: This gauge connects to a sending unit in the engine lubrication system. The sending unit causes a variable resistance which gives a corresponding indication, representing oil pressure, on the gauge.

Engine Temperature Gauge: The gauge for engine temperature connects to a sending unit in the cooling system passage in the engine. The variable resistance caused by the sending unit gives an indication of the temperature of the engine coolant.

Hourmeter

Power is available to the hourmeter through a pressure switch on the engine. The hourmeter operates only when the engine is running.

Voltmeter

The voltmeter is installed in the instrument panel and connected in parallel with the charging circuit. The voltmeter gives indication of electric charging system problems that can not be seen with an ammeter.

Normally, when the engine is stopped (Key switch in the ON position) or when the engine is running at low idle, the voltmeter will indicate 10-14 volts. This is an indication that the battery charge is approximately 12 volts. When the engine is running above low idle, the voltmeter will normally indicate 14-16 volts. More than 16 volts indicates an overcharging condition. See chart 1. Chart 2 shows what to look for under the conditions shown. Column 5 "Ammeter Reading for Similar Condition" is given so you can make a comparison between the ammeter and voltmeter.

VOLTMETER

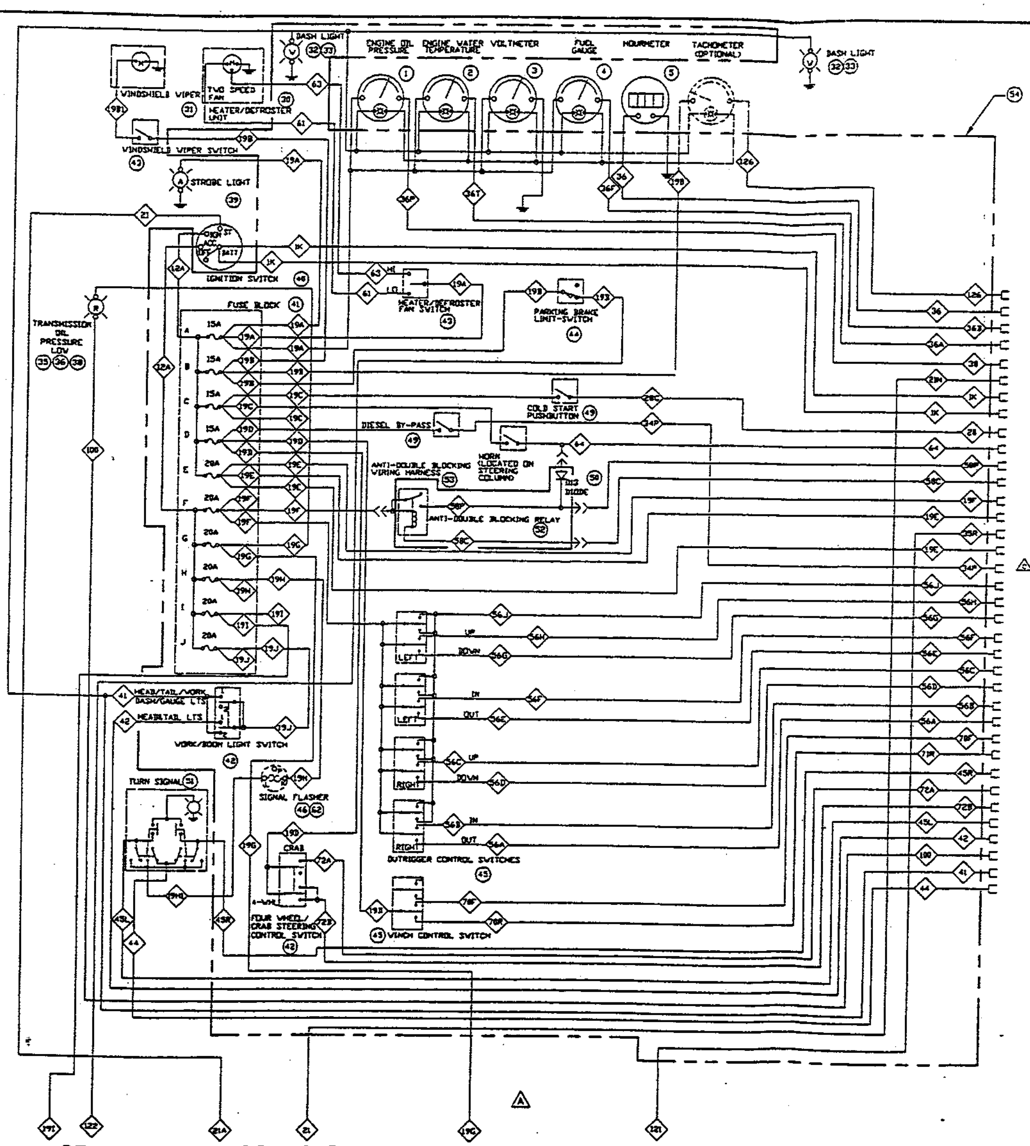
CHART 1

Voltage Measured	Engine Speed	Condition of Charging System
0-10 Volts	Stopped or Low Idle	Very low battery charge
11-12 Volts	Stopped or Low Idle	Low-to-normal battery charge
	Above Low Idle	Problem in charging system. See Troubleshooting — Charging System
12-14 Volts	Stopped or Low Idle	Normal battery charge
	Above Low Idle	Problem in charging system. See Troubleshooting — Charging System
14-16 Volts	Stopped or Low Idle	If needle is between 14 and 15 volts, the battery is newly charged
	Above Low Idle	Normal operation range
More than 16 Volts	Above Low Idle	Overcharge. See Troubleshooting — Charging System

CHART 2

Voltmeter Reading	Engine Speed	Load	Problem	Ammeter Reading for Similar Condition
Less than 14 Volts	Above Low Idle	No Load or Normal Load	1. Alternator Failure 2. Broken Drive Belt	No Reading
		More than Alternator Output	3. Low Alternator Output 4. Shorted or Open Diodes 5. Low Battery Charge	
		No Load or Normal Load	6. No Voltage Regulator Output	
		Overload	7. Too Much Accessory Draw	High Discharge
12-14 Volts	Above Low Idle	No Load or Normal Load	1. Voltage Regulator Setting too Low	No Reading
Over 16 Volts	Above Low Idle	No Load or Normal Load	1. Voltage Regulator Failure 2. Voltage Regulator Set too High	No Reading
	Low Idle	No Load or Normal Load	1. Uncontrolled Voltage Regulator Output	High Current Charge
Continued decrease in battery voltage	Engine Stopped	No Load	1. Slow Battery Failure	No Reading

REV	CHANGE	BY	DATE
B	CORRECTED PART NOS. ITEMS 18, 31, 46 AND 60.	KRM	02-14-94
C	ITEM 49 QTY 2 WAS 1; ADDED CIRCUIT 34P.	KRM	03-08-94



CONTINUED ON DRAWING 1300098, SHEET 3

CONTINUED ON DRAWING 1300098, SHEET 2

GENERAL NOTES:
1. WORK THIS DRAWING WITH SHEETS 2 AND 3.

ITEM	QTY	MATERIAL	DESCRIPTION
62	1	1000997	BRACKET, FLASHER
61	1	1100271	PANEL, MOUTING, RELAY
60	1	1300130	HARN., WIRE, TRANSMISSION
59	1	S240385	HARN., WIRE, BACK-UP ALARM
58	1	XXXXXXX	HARN., WIRE, GAS ENGINE
57	1	1300128	HARN., WIRE, DIESEL ENGINE
56	1	1200067	HARN., WIRE, SOL VALV BANK
55	1	1300127	HARN., WIRE, MAIN FRAME
54	1	1300126	HARN., WIRE, INST. PANEL
53	1	1100108	HARN., WIRE, ANTI-BLOCK
52	1	S513724	RELAY, ANTI-BLOCKING
51	1	S515141	SWITCH, TURN SIGNAL
50	5	1000384	DIODE, BLOCKING, IN5402
49	2	1001208	SWITCH, SPST, MOM.
48	1	1100189	LEVER, CONTROL
47	8	1001227	DIODE, BLOCKING, IN1199A
46	1	1000996	FLASHER, 80-120 FPM
45	5	S117471	SWITCH, DPDT, MOM.
44	1	1000374	SWITCH, MICRO
43	1	1001193	SWITCH, DPST, MAIN.
42	2	1000366	SWITCH, DPDT, MAIN.
41	1	1001189	BLOCK, FUSE, 10-POLE
40	1	S108413	SWITCH, IGNITION
39	1	1000051	LIGHT, STROBE, 12VDC
38	1	1001130	LENS, RED
37			NOT USED
36	1	1001131	BULB, 12VDC
35	1	1001129	HOLDER, LIGHT, IND.
34	9	1001188	RELAY, SPDT, 12VDC
33	2	71421	LAMP, 12VDC (USE W/ #32)
32	2	S28822	HOLDER, LIGHT, DASH
31	1	1000340	WIPER, WINDSHIELD
30	1	1001185	UNIT, HEATER/DEFROSTER
29	4	1000078	LIGHT, HD/WORK, 12VDC, 35W.
28	1	S49603	SWITCH, PRESS., BRAKE
27	1	1100097	VALVE, SOL., STEERING NO. 2
26	1	1100096	VALVE, SOL., STEERING NO. 1
25	2	S31861	LIGHT, TAIL/STOP, 12VDC
24	2	S31862	LIGHT, SIGNAL, 12VDC
23	1	S240090	BANK, VALVE, SOL., 12VDC
22	1	D121972	ALARM, BACKUP, 12VDC
21	1	S106375	SWIVEL, DOUBLE
20	1	S208459	SWIVEL, SINGLE
19	1	1100054	VALVE, ANTI-BLOCKING
18	1	S203189	HORN, 12VDC
17	1	1500217	REEL, CABLE
16	1	S100895	BATTERY, 12VDC, 90AH
15	1	1000913	STARTER, 12VDC
14	1	1000974	ALTERNATOR, 12VDC, 63A.
13	1	1000063	THERMOSTAT, COLD START
12	1	1000030	VALVE, ACT., COLD START
11	1	S82976	SWITCH, DOUBLE BLOCKING
10	1	F22316	RESISTOR,
9	1	S83884	SWITCH, PRESS., OIL
8	1	S108396	SENDER, TEMP., ENG. WATER
7	1	1200019	SENDER, LEVEL, FUEL
6	1	S108398	SENDER, PRES., ENG. OIL
5	1	1000782	METER, HOUR, 12VDC
4	1	1000784	GAUGE, FUEL LEVEL
3	1	1000785	METER, VOLT, 12VDC
2	1	1000786	GAUGE, TEMP., ENG. WATER
1	1	1000787	GAUGE, PRESS., ENG. OIL

ELEC WIRING DIAGRAM
INSTRUMENT PANEL

DRAWN BY: AFA — 01/12/94

1300098

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Figure 10. Electrical Schematic (1of 3)

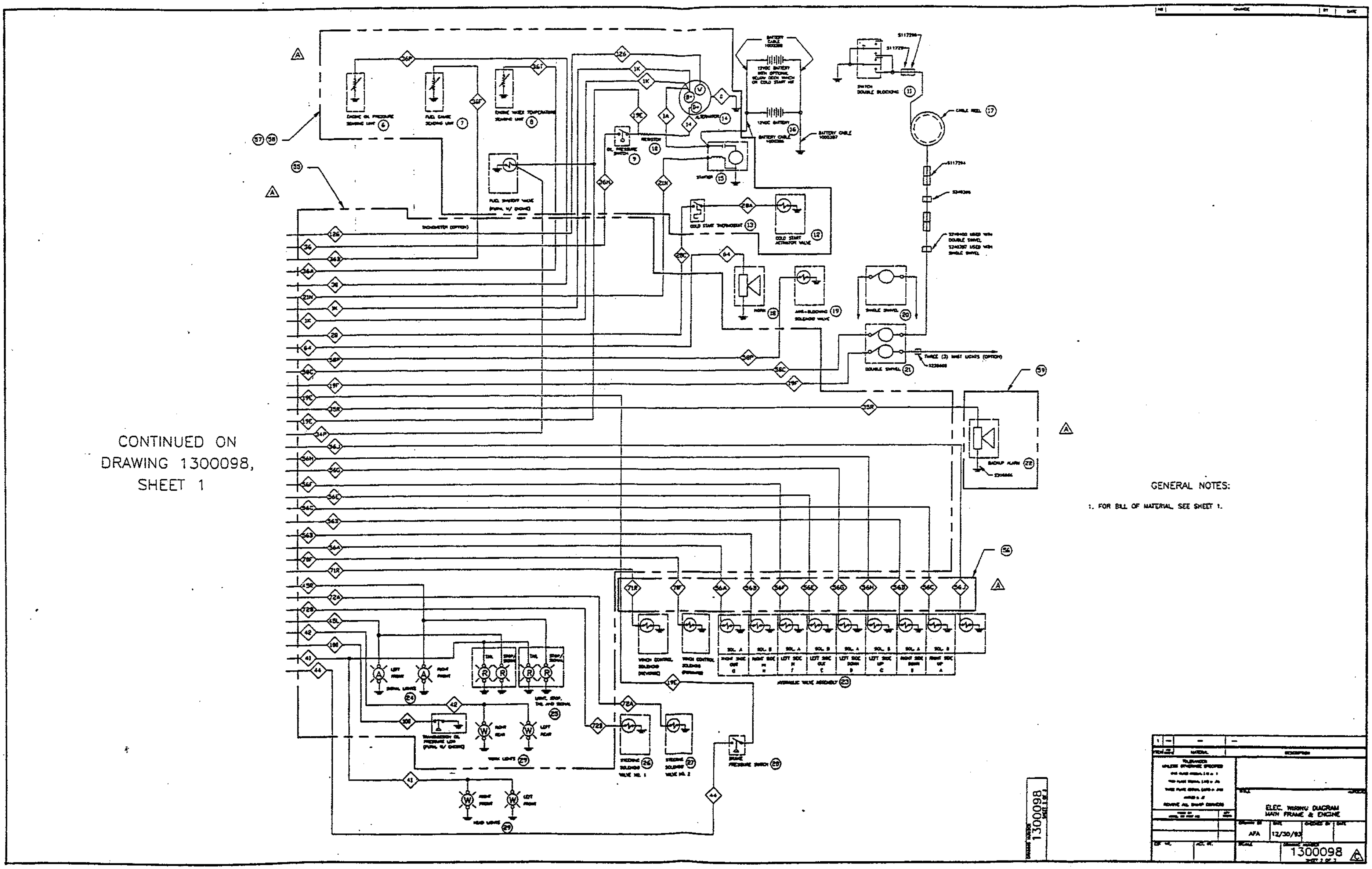


Figure 11. Electrical Schematic (2 of 3)

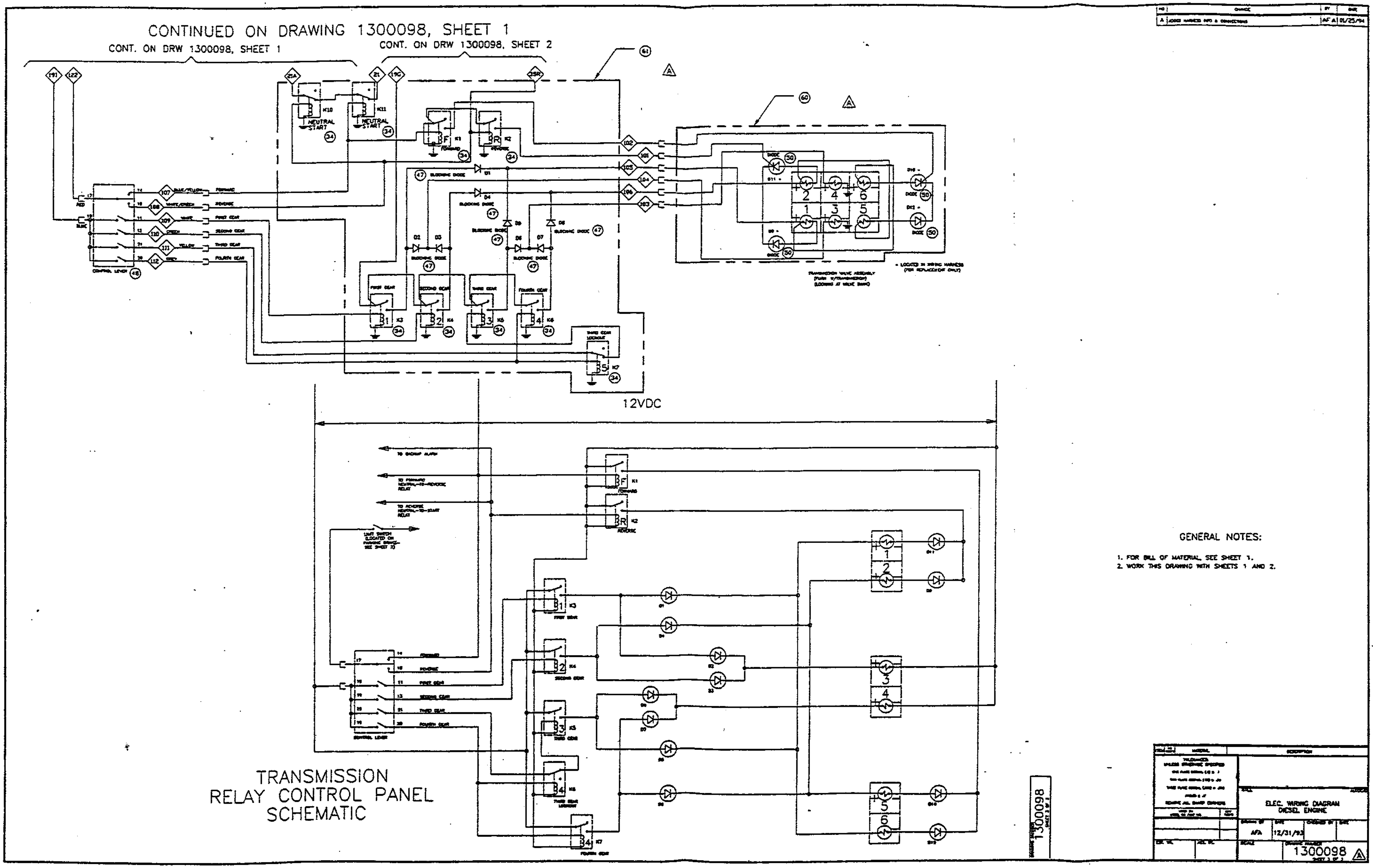


Figure 12. Electrical Schematic (3 of 3)

Section
4015

ELECTRICAL ACCESSORIES

4

ANTI-DOUBLE BLOCKING SYSTEM

General

This mechanism prevents the hook from being pulled into the boom head during extension of the boom (standard on all cranes) or during winch operation (optional). When the hook blocks actuates the limit switch on the boom head, oil flow to the crowd cylinder (and to winch motor optional) is stopped. A horn is activated to give warning to the operator in all cases. To move the hook block away from the boom head, the operator can operate the winch or retract the boom.

IMPORTANT: If the winch anti-blocking option is not installed, this mechanism only operates on the crowd circuit. The operator must use care to keep the hook block away from the boom head during winch operation.

Circuit Description

Power is made available through a 20 amp fuse to the cutout relay on the chassis and to the limit switch on the boom head. When the hook block reaches the upper limit, the limit switch closes, energizing the relay. The energized relay activates the solenoid valve in the crowd circuit and the warning horn.

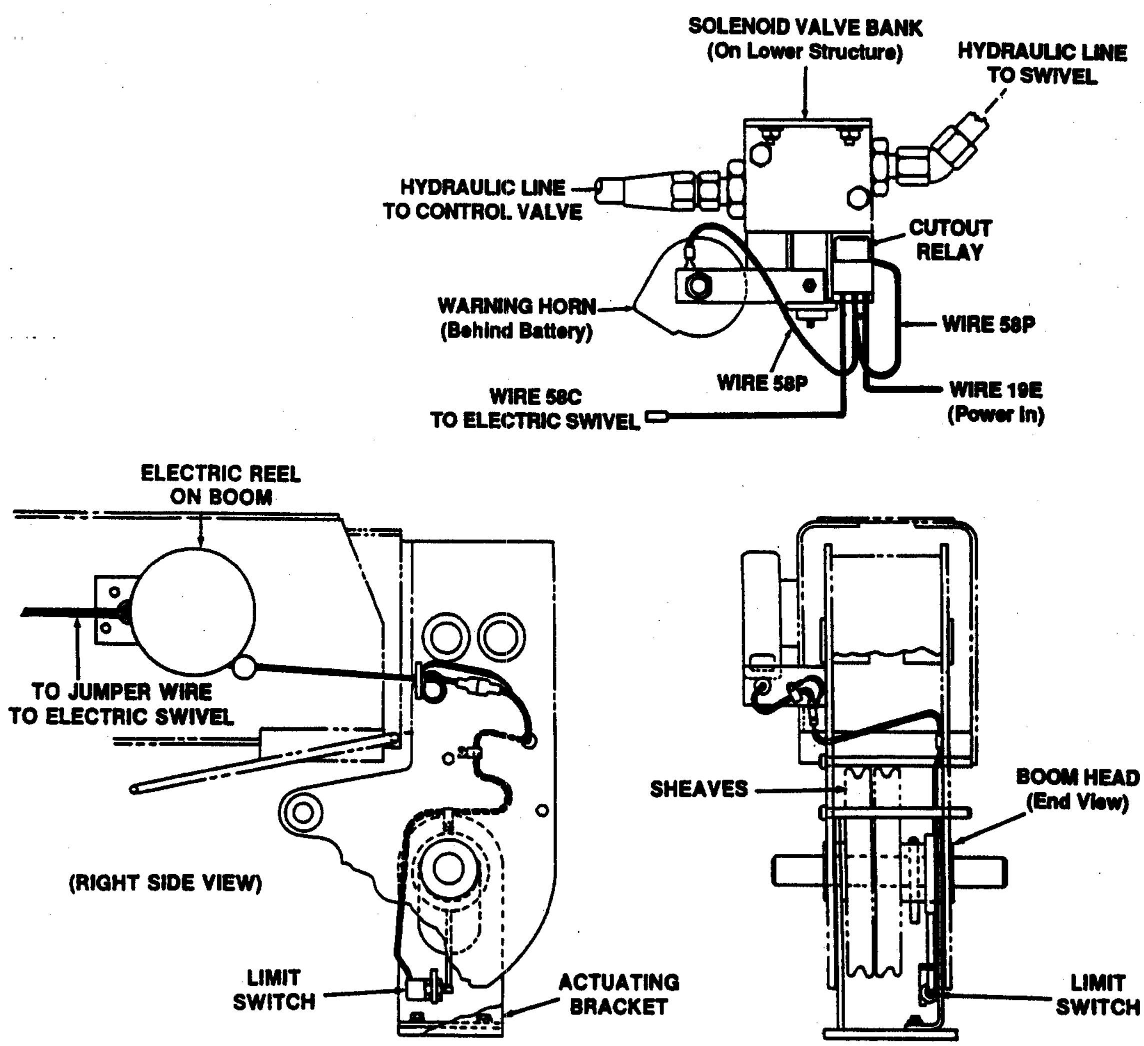


Figure 1. Anti-Double Blocking Arrangement

SERVICING THE ELECTRIC SWIVELS

General

On machines with load indicator or anti-double blocking system, an electrical swivel is installed at the center of the mast rotation. The swivel gives electrical circuit continuity through full rotation of the mast.

Maintenance

Check swivel periodically for accumulation of dirt or foreign material. the upper and lower swivel members must be parallel for full surface contact between the electrical contact sets. Dirt of foreign material can lift the electrical blocks of of position and cause loss of contact.

Pitting or oxidation of contact surfaces can also cause loss of contact and electrical circuit continuity. Normally rotating the mast through several cycles will correct the problem. If this procedure does not correct the problem, remove swivel for inspection and cleaning.

Disassembly and Cleaning

To disassemble swivel, remove the center bolt. Separate the swivel members and check electrical contacts for pitting, burned color or other damage. If the wear is not severe, the contact surfaces can be cleaned with extra fine sandpaper.

NOTE: Do not use emery cloth to clean contact sets.

1. Hold the sandpaper in position on the contact set. Put the two halves together, then rotate the swivel by hand. Make sure to keep the two halves parallel and apply equal force all around. Rotate in one direction only.
2. Turn the sandpaper over and repeat the procedure to clean the contacts in the opposite member.

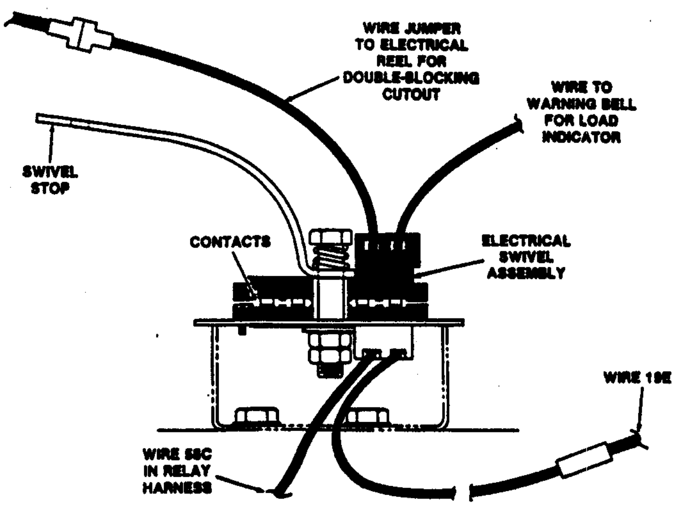


Figure 2. Electrical Swivel - Double

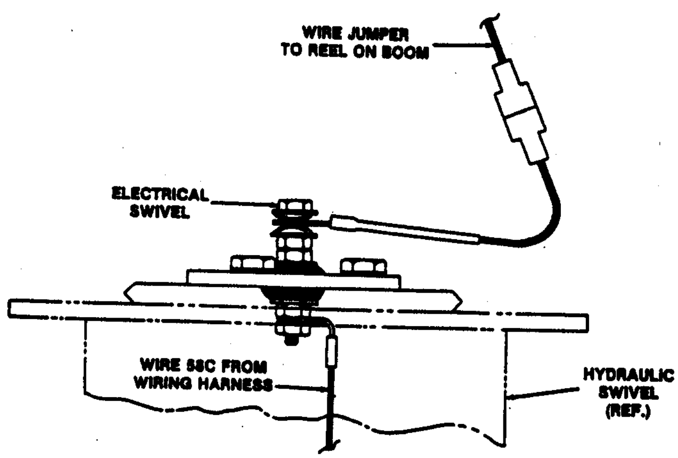


Figure 3. Electrical Swivel - Single

HEATER

General

The heater is a hot water heater and is connected into the cooling system of the engine. An electric blower pushes air through the heater core and into the cab and onto the windshield.

Electrical Circuit

See Electrical Schematics in Section 4002 for circuit. Power is available through a 15 amp to the heater/defroster switch in the instrument panel when the key switch is in the ON position. The switch is a three position switch (HI, LO and OFF).

Section 5002

STEERING SYSTEM
DIAGNOSIS, TESTS AND CHECKS

SPECIFICATIONS

Rated pump output . . . . 4.0 U.S. gpm at 2200 psi at full throttle
(15.1 L/min at 15 150 kPa at full throttle)

Relief valve pressure setting . . . . 1700 ± 100 psi at full throttle
(11 720 ± 689 kPa at full throttle)

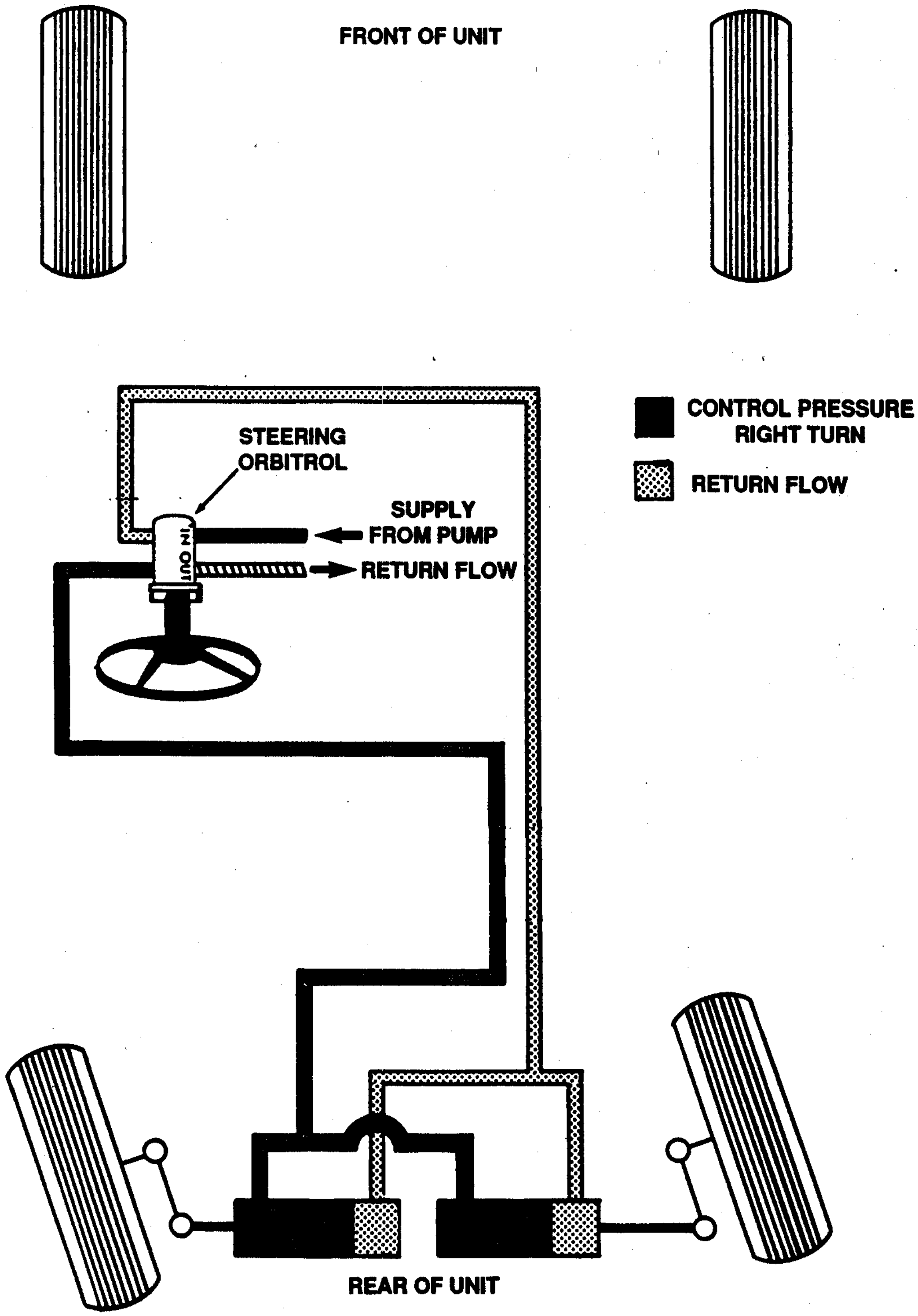


Figure 1. Standard Two Wheel Steer - Right

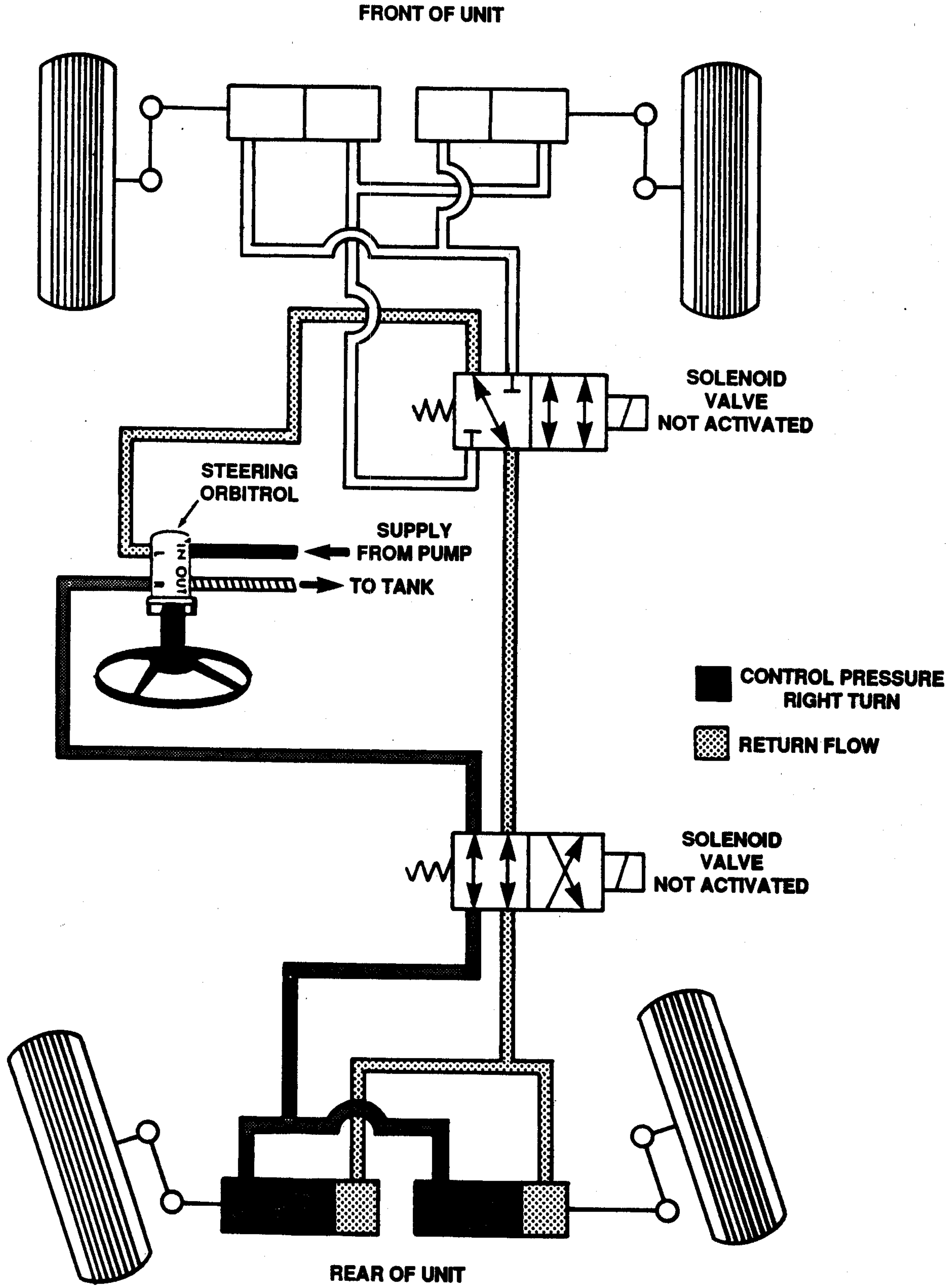


Figure 2.. Optional Four Wheel Steer - Two Wheel Steer Mode (Right)

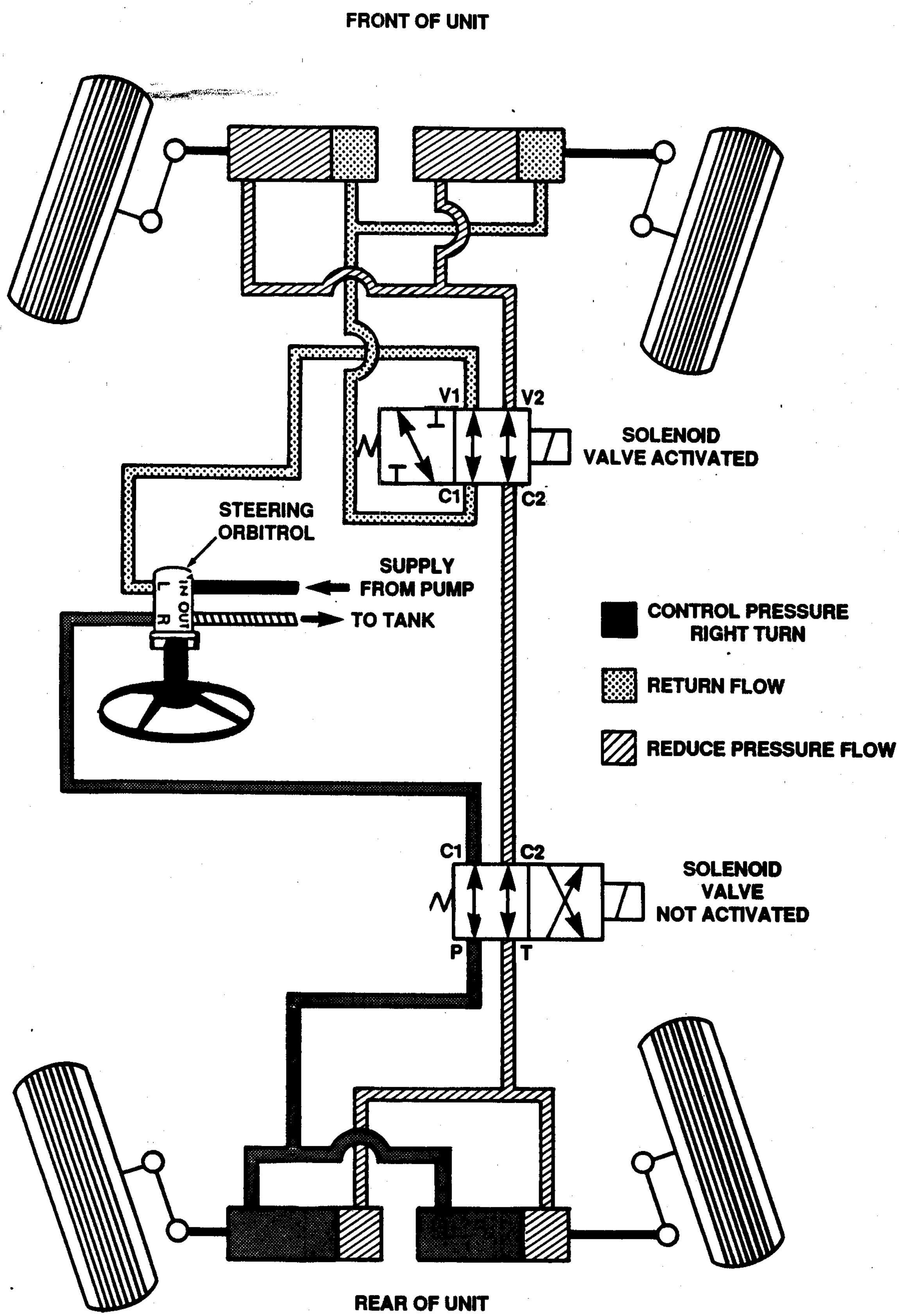


Figure 3. Optional Four Wheel Steer - Four Wheel Steer Mode (Right)

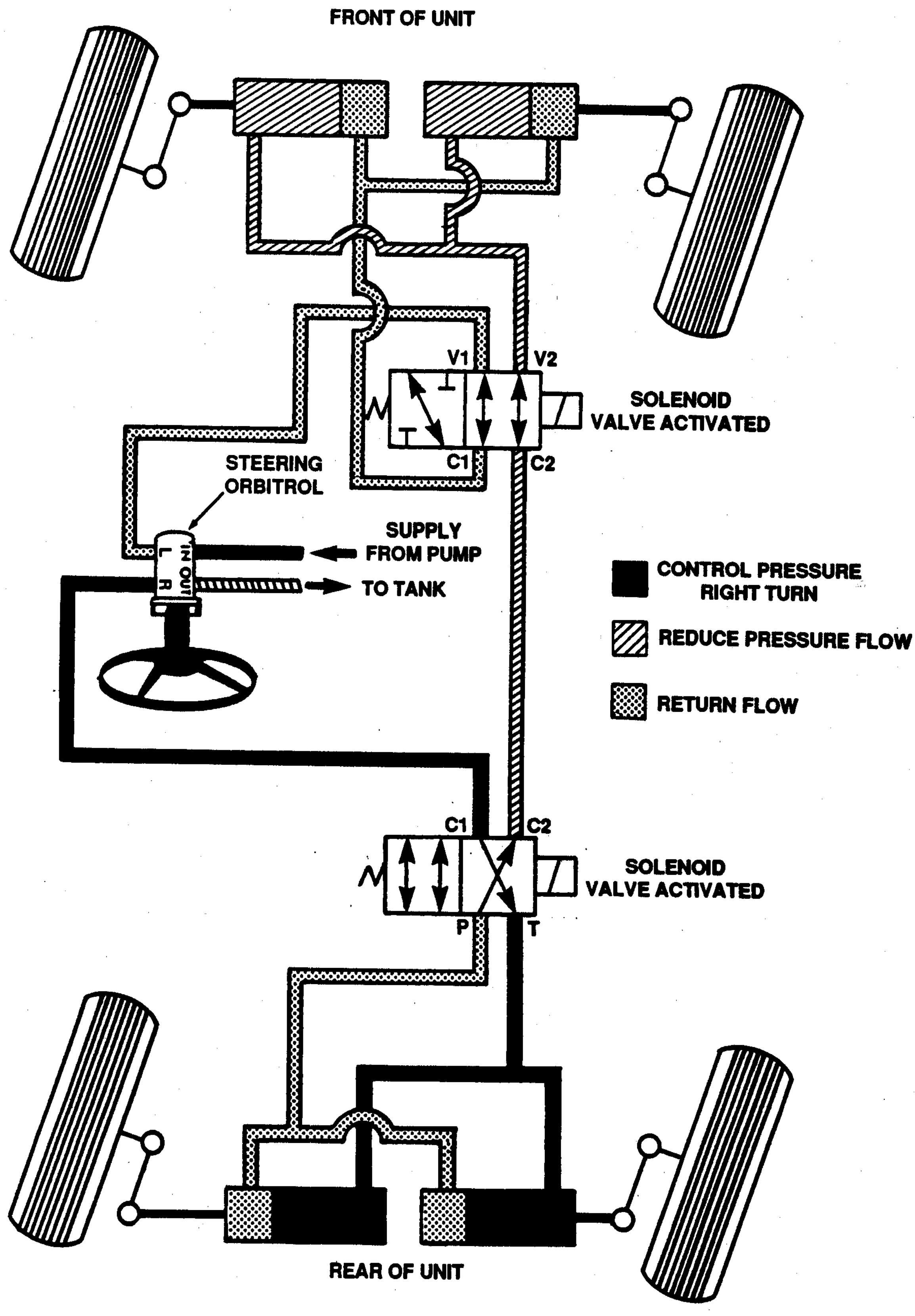


Figure 4. Optional Four Wheel Steer - Crab Steer Mode (Right)

RELIEF VALVE PRESSURE CHECK

1. Remove cap from tee and connect a 0-3000 psi pressure gauge on the tee as shown in Figure 5.

2. Start the engine. Turn the steering wheel and put the wheels at the maxium angle. Continue to turn the steering wheel after the steering cylinder has stopped. Read the pressure gauge. Release the steering wheel immediately.

3. The correct pressure is 1700 psi (11 720 kPa). Low pressure normally indicates a bad relief valve. The relief valve is inside the pump. See Section 5005 instructions on removal. If the relief valve is bad, replacement is necessary. No adjustment is possible.

NOTE: Pressure in the "OUT" line from the steering control valve must be less than 30 psi (200 kPa) during normal operation. High pressure indicates restriction between the steering control valve and the pump.

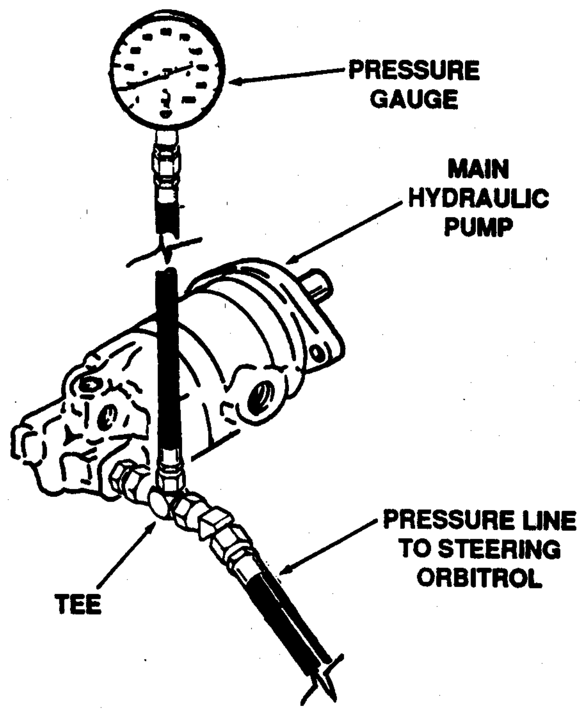


Figure 5. Arrangement to Check the Pressure in the Steering System.

TROUBLESHOOTING CHART

PROBLEM	POSSIBLE CAUSE	REMEDY
Steering wheel turns freely, no response	Leakage in ball check between IN and OUT ports in steering control valve.	Disassemble column from control valve, remove plug and steel ball. Check for damage or foreign material.
	Severe wear or damage to parts in steering control valve.	Replace valve.
	Leakage in piston seal in steering cylinder.	Check cylinder for leakage. Turn wheels all the way to right. Disconnect hose from rod port of cylinder. Start engine, hold steering wheel for full right turn and have someone check leakage from cylinder. Remove cylinder and repair as required.
Steering wheel turns hard, no response	Wrong connections at steering cylinder or control valve.	Check connections against diagram.
	Wear or damage to parts in steering control valve.	Replace valve.
Slow or hard steering	Wear or damage to parts in steering control valve.	Replace valve.
	Low system pressure.	Check pressure setting of relief valve. If setting is not as specified, replace relief valve.
	King pins tight.	Lubricate king pins according to maintenance schedule.
	Low tire pressure.	Inflate to specified pressure.
Slow steering response	Air in steering circuit.	Remove air from circuit.
	Dirt or foreign material in spool in steering valve.	Remove valve, disassemble and clean as required. See Section 5007. Check condition of system oil.

Section 5007

STEERING CONTROL VALVE

General

The steering valve includes three main assemblies: (1) steering column, (2) rotary type, open center valve and housing, (3) metering gear set. See Figure 1.

In neutral, the valve cylinder ports are closed. Oil is held in the lines to the steering cylinder. To cause movement of the cylinder the steering wheel must be turned.

The control section is similar in function to a standard spool type valve. The rotary spool, rather than being long like a cylinder with the lands in a series, is round with the lands outward like the hands of a clock. This spool is connected to the steering wheel.

The sleeve is similar in function to a standard valve body, but has a body that is a cylinder with galleries and passages on the inside diameter. The sleeve is connected to the metering gear. In addition, the sleeve is free to rotate within the steering valve housing.

The operation of the valve during a turn and with the steering wheel held stationary is shown in Figures 3 and 4.

Manual Pump

The design of the steering valve is such that the unit is also an auxiliary pump for steering. The machine can be steered (with some difficulty) by the action of the metering gear if, for any reason, the normal oil supply is lost. In this condition, the machine is without power steering but not without steering.

Check Valve

The pressure of the oil entering the control valve is usually enough to keep the check valve closed between the IN and OUT ports. The check valve does permit recirculation of the return oil when necessary to use the unit as a pump.

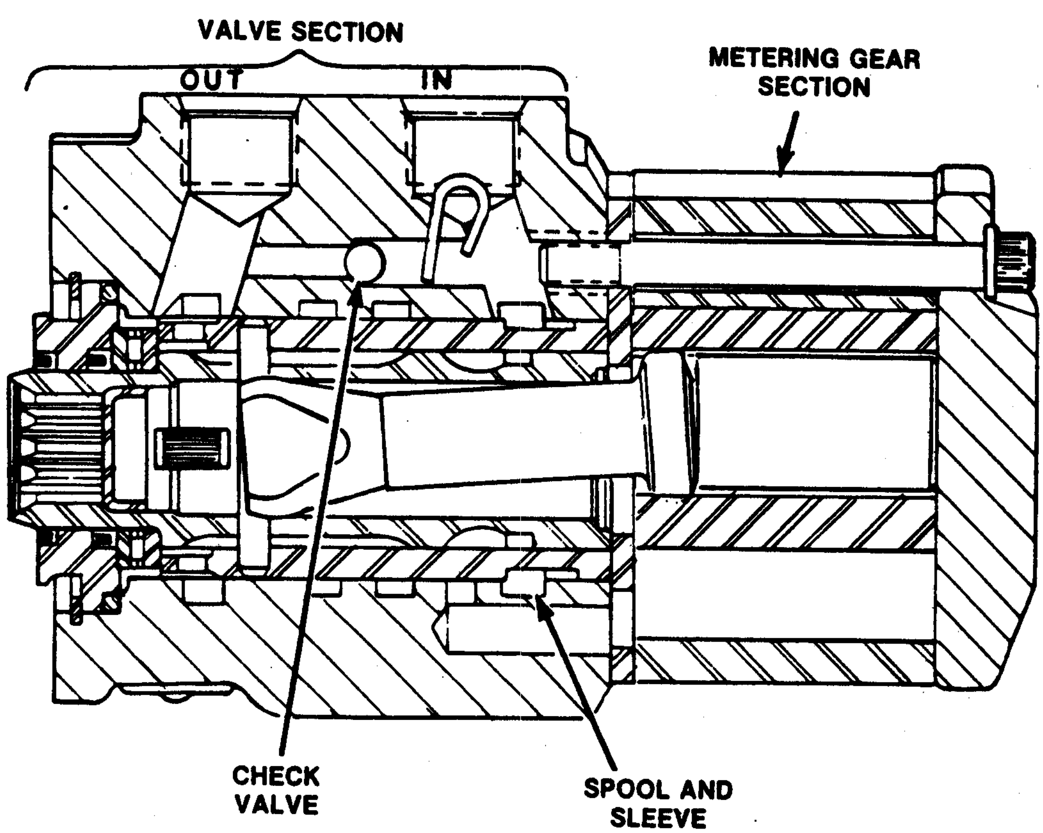


Figure 1. Steering Control Valve - Identification of Sections

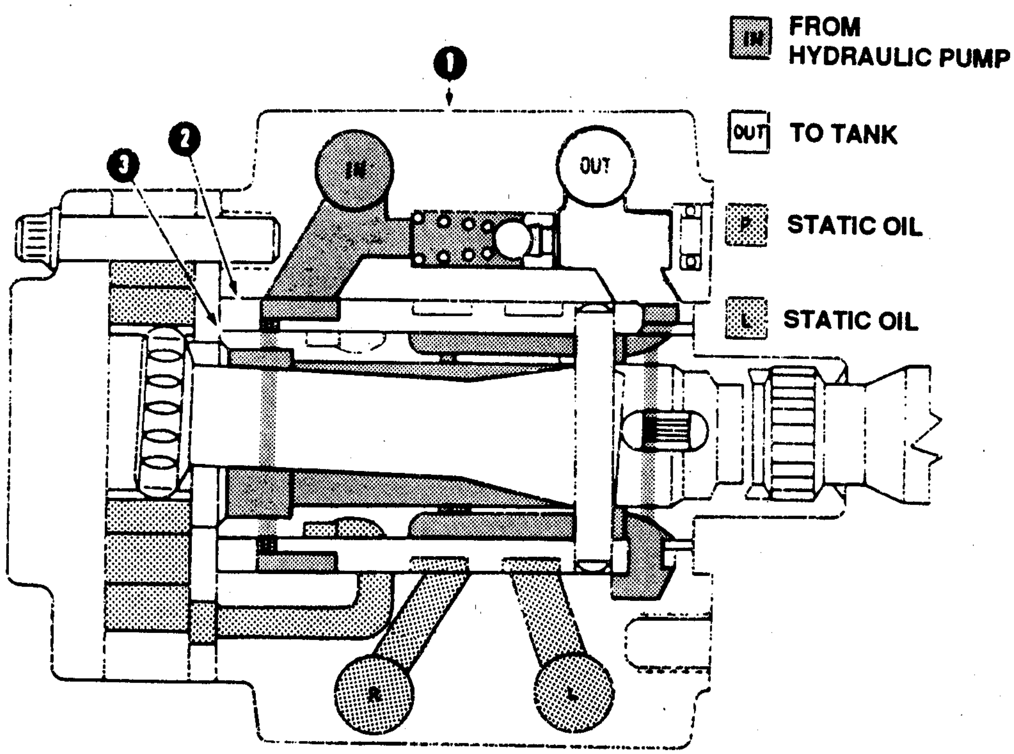


Figure 2. Oil Flow, Straight Ahead

Oil Flow — Straight Ahead

See Figure 2

The steering valve is normally in a centered position. The machine can be going straight or turning but the steering wheel is not being rotated. When the steering wheel is being held stationary, whatever position that is, the steering valve is in "neutral" In this position the cylinder ports "R" and "L" are both closed and the steering cylinder is held. The oil from the pump enters the "IN" port of the valve housing (1). From there the oil flows by a passage to the ports of the sleeve (2). In "neutral", these ports connect with through ports on the spool (3). The oil flows into the center chamber of the valve and toward the rear to where a second set of ports in the sleeve (2) and spool (3) direct the oil to the "OUT" port and to the reservoir.

Oil Flow — Right Turn

Refer to Figure 3.

In making a right turn, the steering wheel is rotated clockwise. As the wheel rotates, several porting changes take place at the same time. As the spool (3) rotates withing the sleeve (2), the spool closes the through ports to the steering supply. As the spool (3) rotates ports in the spool (3) and sleeve (2) are aligned and route the steering supply to the metering gear (4). The metering gear then starts to rotate clockwise in proportion to the oil directed to the metering gear. The sleeve (2) being mechanically connected to the metering gear (4) also rotates clockwise. As spool (3) and sleeve (2) rotate clockwise, the spool (3) leads the sleeve (2) by a small amount.

The steering supply flows through the metering gear (4) to ports in the sleeve (2). These ports align with ports in the spool (3) which route the steering supply back to a commutator slot on the sleeve (2). Here the oil flows out the "R" port of the housing. The oil is then routed to the cylinder.

At the same time, return ports in the spool (3) open to the commutator slot for the "L" port. Return oil is routed through the sleeve (2) into a passage on the spool (3), back through the sleeve (2) into the return commutator slot in the housing (1) and to the "OUT" port. From here the oil is sent back to the reservoir.

When steering wheel rotation is stopped, the sleeve returns to a balance with the spool and the valve returns to a "neutral" position. The valve has full metering function. The valve will route part of the supply oil to the steering cylinder and route the remainder of the oil back to the reservoir.

Oil Flow — Left Turn

The oil flow during a left turn is the same as a right turn except that the rotation of the spool and sleeve is counterclockwise. Oil is routed to the steering cylinder through "L" port and returns through the "R" port.

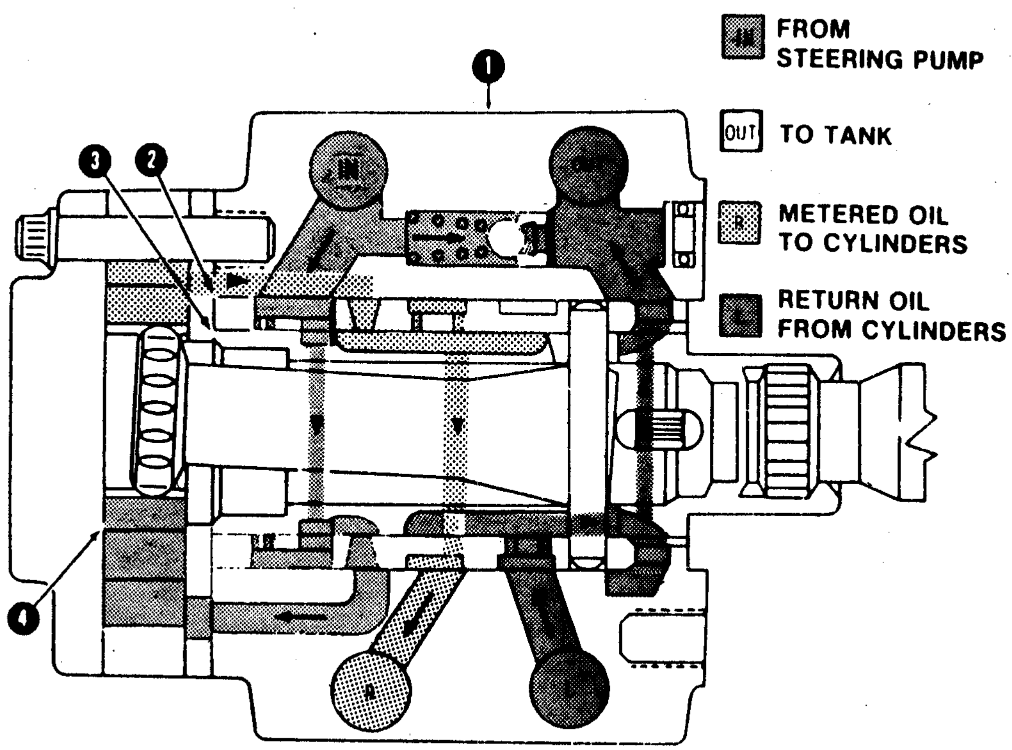


Figure 3. Oil Flow, Right Turn

SERVICING THE CONTROL VALVE

Removal

1. Remove cover plate in front of instrument panel.

2. Completely clean the area around the valve ports to keep dirt out of the system.

3. Put tags on the lines as necessary for identification at installation.

4. Rotate steering wheel a small amount in each direction then release to get a balance of pressure in the steering circuit. Slowly loosen hydraulic lines at "L" and "R" ports to release any remaining pressure. Disconnect hydraulic lines from IN and OUT ports. Put plugs in the hydraulic lines and caps on the port connectors of the control valve to keep dirt out of the system.

5. Remove four bolts which fasten steering column and steering control valve to the mounting bracket. Be sure to hold the control valve in position while the last bolt is being removed. Remove control valve.

Repair

Field repair of the control valve is not recommended. Check with your local distributor for service parts and repair.

Installation

Install in reverse order of removal. It is necessary to remove air from the steering lines after installation. See Section 5002.

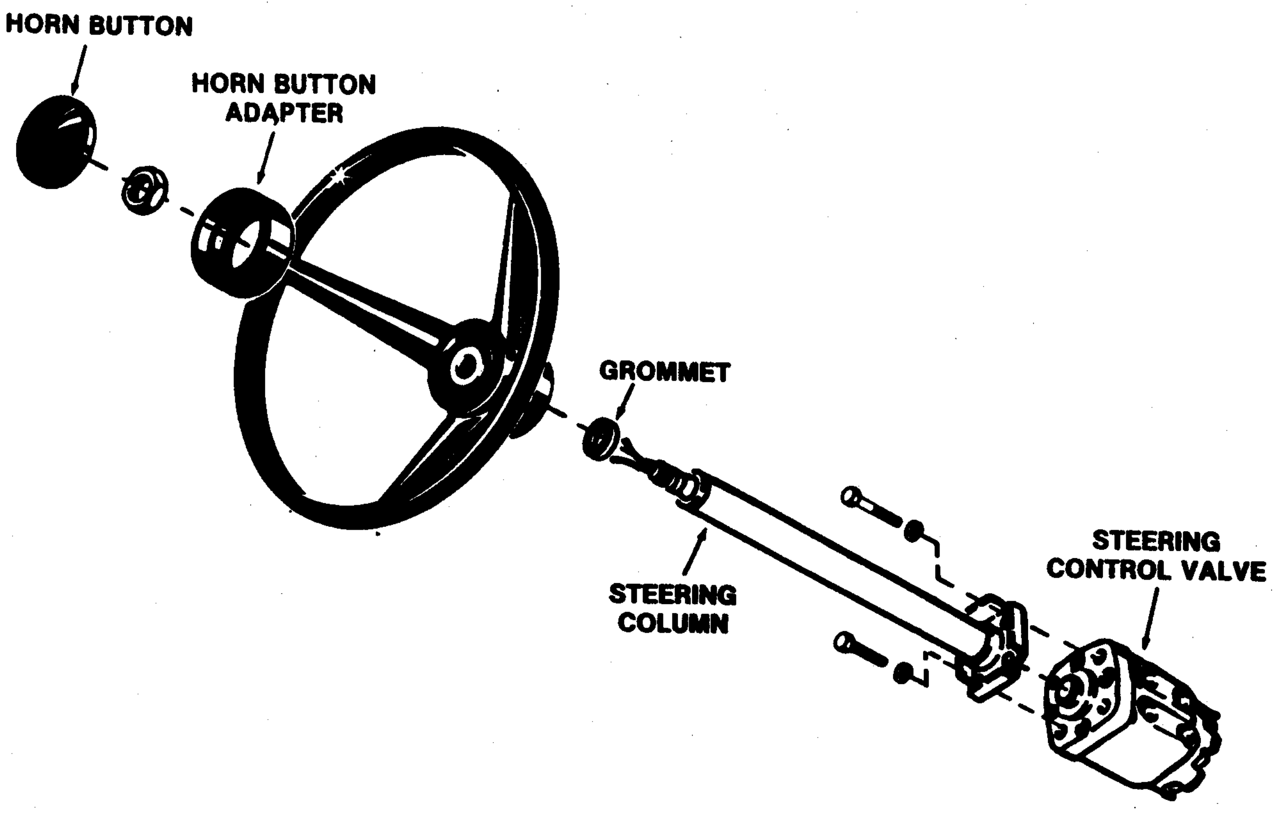


Figure 4. Steering Column and Control Valve

Section 5010

STEERING CYLINDER

SPECIFICATIONS

Cylinder bore . . . . 2.25" (57.2 mm)
Stroke . . . . 7.10" (180 mm)
Rod diameter . . . . 1.0" (2.54 mm)

SPECIAL TORQUES
Piston lock nut . . . . 225-250 lb-ft (305-339 Nm)

NOTE: Tighten cylinder head until contact is made between head flange and cylinder tube. Use spanner wrench and breaker bar. Then hit breaker bar with a soft hammer until all turning motion between head and cylinder tube stops.

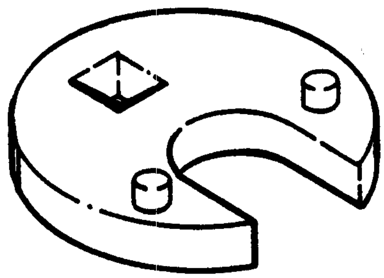


Figure 1. Spanner Wrench for Removal/Installation of Cylinder Head

WARNING: To prevent injury or death, do not work under raised machine unless:

1. Main frame is on firm support or blocks in a manner to prevent machine from falling or tipping.
2. Engine is stopped.
3. Transmission is in Neutral.
4. Parking Brake is engaged and wheels stopped with blocks to prevent machine movements.
5. Key is removed to prevent accidental starting.
6. Another person is available to give assistance if needed.

SERVICING THE STEERING CYLINDER

Removal

1. Use a service ramp or hoist to raise machine for access to steering cylinder.

2. Stop the engine. Turn steering wheel a small amount in each direction to release pressure in hydraulic lines to steering cylinder.

3. Be prepared to collect the oil as you remove the steering lines. Slowly loosen the hydraulic hoses to release any remaining pressure. Put a tag on the hoses for identification and correct assembly. Install plugs in end of hoses and caps on cylinder ports to keep dirt out of the system.

4. Measure the distance between centers of ball joints. Make a record of this measurement for assembly. Also, make a note of the position of the clamps on the adjustable ends. The clamps must be installed in same position at assembly.

5. Remove cotter pins, slotted nuts and washers from cylinder ends. Take cylinder to a clean work area for disassembly.

Disassembly

1. Remove caps from cylinder ports and drain oil from cylinder.

2. Fasten cylinder base in a vise; apply force only across the clamp on adjustable end. To prevent distortion or damage, do not apply force directly to cylinder tube. Use a chain wrench around solid end of cylinder tube if necessary to prevent rotation of cylinder tube during removal of head.

3. Use spanner wrench, Figure 1, and remove rod bearing.

4. Pull piston rod assembly straight out of cylinder tube. To help in removal, apply shop air to cylinder base port to push piston out of cylinder tube.

5. Fasten adjustable end of rod in a vise. Do not apply force to chrome part of rod.

6. Use a socket, wrench and a length of pipe to loosen and remove the self-locking nut from piston end of rod.

7. Remove piston assembly and rod bearing.

8. Remove and discard all o-rings, back-up rings, wiper, wear ring and packings.

Inspection

1. Clean all parts in a solvent that is not flammable. Dry with compressed air free of moisture.

2. Inspect cylinder rod for rust distortion, pitting or damage to the chrome. If there is damage, have the old chrome completely removed and finish with new chrome .001 inch (.0254 mm) thick. If rod is bent, the rod must be replaced. Do not try to straighten a bent rod.

3. Inspect cylinder bore for grooves, distortion or other damage. Use a light to illuminate cylinder bore for careful inspection. Replace cylinder tube if there is distortion or damage.

4. Inspect piston assembly for damage to lands.

5. Inspect rod bearing for wear or damage to bore or threads.

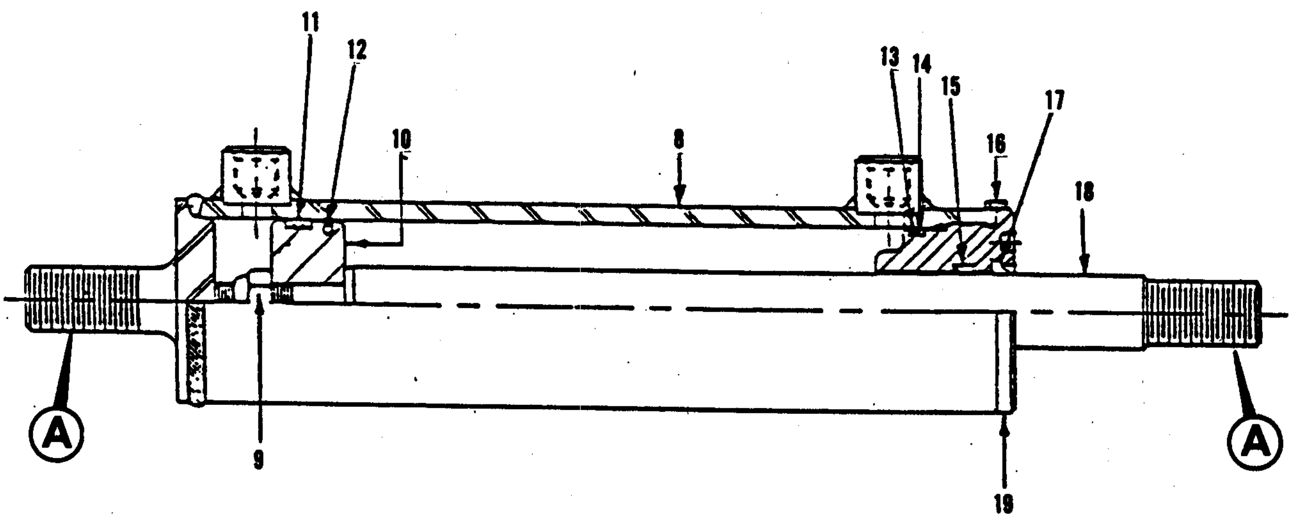
6. Replace all o-rings, back-up rings, rod wiper, piston wear ring, v-rings and all parts with wear or damage.

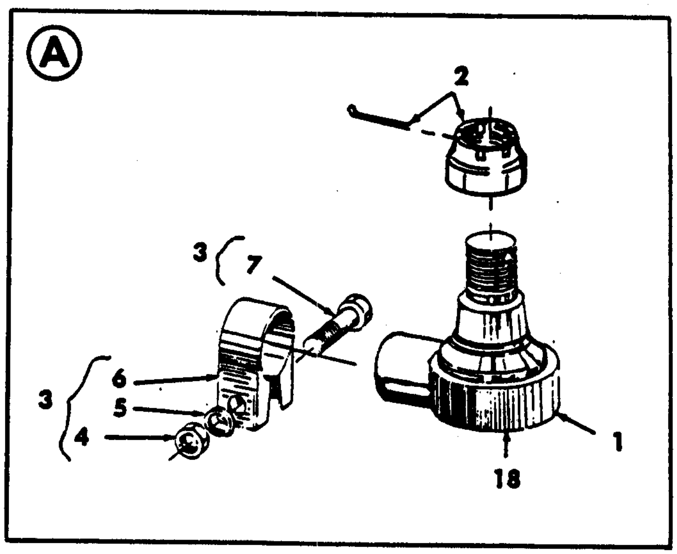
Assembly

1. Install rod seal in bore of rod bearing. Install wiper in front groove in bore of rod bearing. Lip of wiper must be toward outside of cylinder. Install o-ring and back-up ring in groove on outside of head. Back-up ring must be toward outside of cylinder.

5

1. Ball stud
2. Nut and cotter pin
3. Clamp assembly
4. Nut
5. Lockwasher
6. End clamp
7. Bolt
8. Cylinder tube
9. Nut
10. Piston
11. Wear ring
12. O-ring
13. O-ring
14. Back-up ring
15. Rod seal
16. Capscrew
17. Wiper
18. Cylinder rod
19. Rod bearing





2. Apply petroleum jelly to rod seal and wiper in bore of rod bearing. Carefully slide head assembly over piston end of rod. Do not try to install head over threaded end of rod. Damage can be caused by rough edges in the clamp thread area.

3. Install piston on rod, with wear ring groove toward rear.

4. Lubricate piston o-ring with petroleum jelly and install on rod next to piston. Use care not to roll the o-ring.

5. Install piston lock nut and tighten to specified torque, see page 5010-2.

6. Install split piston wear ring. Apply petroleum jelly to cylinder case threads and outside of piston v-rings. Carefully put assembled piston rod into cylinder tube. Use care to prevent damage to piston rings during installation. Work piston rod straight into cylinder.

7. Lubricate o-ring on outside of cylinder head. Slide head into cylinder tube and engage with cylinder case threads. Tighten with spanner wrench until contact is made between cylinder head flange and cylinder tube. Continue to tighten until all turning movement stops and head is secure.

8. Fill and test cylinder before installation.

Test

Cylinder rod must be retracted into the cylinder at the start of the test.

1. Move the cylinder rod through two complete cycles at 800 psi (5 516 kPa) to remove air from cylinder. Check for signs of external leakage. If pressure differential between cylinder ports during the second stroke is more than 50 psi (344 kPa), cylinder assembly is not acceptable.

2. Completely clean the cylinder rod to remove oil, grease and contamination. Move the cylinder through four complete cycles at a pressure of 800 psi (5 516 kPa). On each stroke, stop the cylinder stroke just before the piston reaches the cylinder head. After four cycles, extend the rod approximately half way. Check surface of rod for indication of amount of rod seal leakage. You will see a definite ring or part of a ring of oil around the rod, Figure 3.

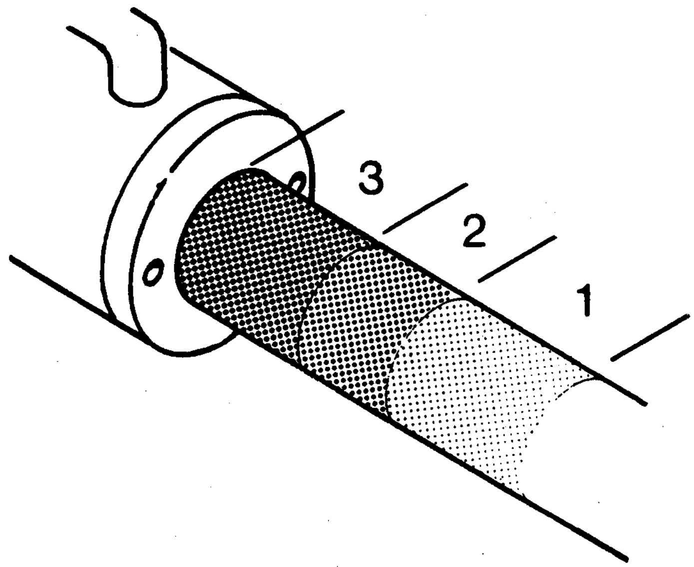


Figure 3. Rod Seal Leakage - Identification

3. Fully retract the cylinder rod. Then apply 2500 psi (17 237 kPa) of pressure to rod port and hold for a minimum of 10 seconds. Look for signs of internal (piston packing) and external leakage. No internal or external leakage is acceptable.

4. Fully extend the cylinder rod. Apply 2500 psi (17 237 kPa) of pressure to base port. Hold for a minimum of 10 seconds. Check for leakage. No internal or external leakage is acceptable.

5. If ball joints were removed, install and adjust to the original dimension.

Installation

It is best to fill the cylinder and remove air from the lines before fastening cylinder to mounting bracket. In this way, the cylinder ports will be at the top and will permit complete removal of the air.

1. Put the cylinder ports in a vertical position. Fill cylinder completely with clean hydraulic oil. Connect hydraulic hoses to cylinder ports. Leave hoses loosened a small amount until cylinder lines are filled with hydraulic oil.

2. Start the engine and turn the steering wheel to fill the steering lines. Tighten hoses when air is removed and lines are filled with hydraulic oil.

3. Extend cylinder rod to dimension measured at removal. Cylinder length, from center of ball joint to center of ball joint, when wheels are turned is 26.94 inches (684.3 mm) on rear steer axle. Lenght is 26.54 inches (674.1 mm) on optional front steer axle. Balance ball joints on opposite cylinder to fit with cylinder collapsed.

4. Fasten cylinder base to mounting bracket with washer, slotted nut and cotter pin. Fasten rod of cylinder to steering knuckle with flat washer, slotted nut and cotter pin.

Section 5021

STEERING AXLE AND TIE ROD

5

MAINTENANCE

Lubrication

Lubrication fittings are installed on the steering knuckles and tie rod ends. Lubricate according to schedule in Section 1050, Maintenance and Lubrication.

Steering Alignment

Correct alignment of the steering axle is important for correct steering and tire life. The wheels must be adjusted for zero toe-in or toe-out.

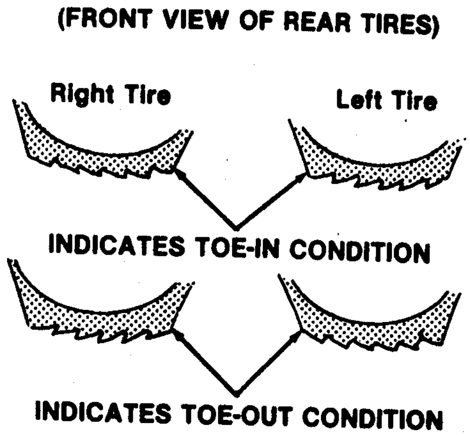


Figure 1. Tire Inspection

If the tread on the tires is wearing evenly, the alignment is correct. Indications of a toe-in or toe-out condition are shown in Figure 1. To correct a toe-in condition, increase the length of the tie rod. To correct a toe-out condition, decrease the length of the tie rod.

NOTE: If more than ¼ inch (6 mm) of adjustment is necessary, make the adjustment on both ends of the tie rod. Make sure both clamps on the tie rod are tight.

One method of checking the alignment is to measure from each wheel to the main frame. See Figure 2. When the wheels are in a straight forward position, dimensions A and B, C and D must be equal.

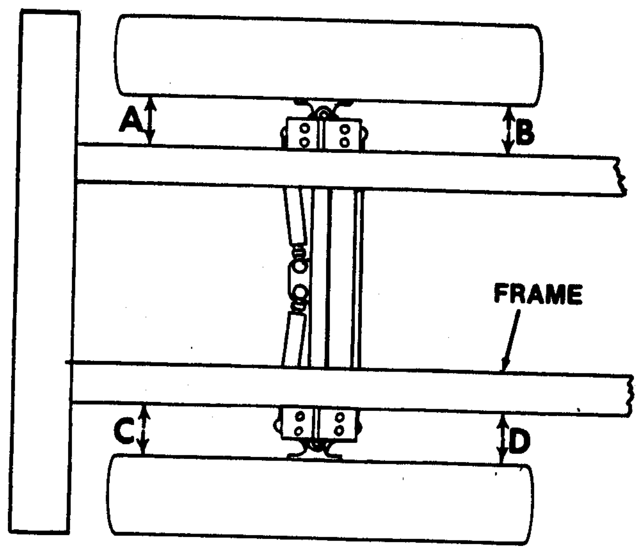


Figure 2. Wheel Alignment, Axle Installed on Machine

If the axle is removed from the machine, the wheels can be aligned according to the following procedure:

1. Measure the distance between the front and rear edges of the wheels on the wheel centerlines.

2. Both dimensions must be equal.

Steering Linkage

Before you remove any part of the steering linkage for repair or replacement, check the original installation carefully.

1. Measure the length of the tie rod, from center to center of the connections. Make a record of this measurement.

2. Measure the amount of threads showing on the ends of the steering cylinder, or measure the full retracted length of the cylinder. Make a record of these measurements.

Use these measurements to check the parts before installation. Adjust the parts as necessary to get the original dimensions. If you change the original dimensions, an adjustment of the alignment will be necessary.

SERVICING THE STEERING AXLE

WARNING: To prevent injury or death, do not work under raised machine unless:

1. Main frame is on firm support or blocks in a manner to prevent machine from falling or tipping.
2. Engine is stopped.
3. Transmission is in Neutral.
4. Parking Brake is engaged and wheels stopped with blocks to prevent machine movements.
5. Key is removed to prevent accidental starting.
6. Another person is available to give assistance if needed.

Removal of Complete Axle

1. Lower the outriggers to raise the axle. Put blocks under the rear of the frame. Remove the two rear tires.
2. Disconnect the brake lines from the axle.
3. Disconnect the hydraulic lines from the steering cylinder, or remove cylinder. See Section 5010.
4. Put a wheel jack under the axle beam. Remove axle mounting bolts. Carefully lower the axle and remove from under the machine.

NOTE: If dowels hold the axle beam against the frame, use a hammer and soft punch to remove the dowels from the frame brackets.

Disassembly — Axle Hub

1. If axle is on the machine, remove wheel.
2. Disassemble the disc brake from disc plate. See Section 7121.

NOTE: Do not disconnect the brake line from the disc brake. If brake line is disconnected, it is necessary to remove air from the brake line after installation.

3. Remove the hub cap (22). Then remove the cotter pin (21), slotted nut (23) and washer (24).
4. Pull hub (26) from spindle. The brake disc (31) will be removed with the hub.
5. Remove the outer bearing cone (20) from the hub.
6. Remove inner bearing cone (17).
7. Remove inner retainer (30) and felt seal (16). Do not remove outer retainer (29) or spacer (28) from the spindle unless replacement is necessary..
8. If the brake disc (31) needs replacement, remove twelve bolts (33) and washer (32). Then remove the brake disc.

Removal — Steering Knuckle

NOTE: Steering knuckle can be removed without disassembling the hub, but the wheel and disc brake must be removed. Do not disconnect the brake line.

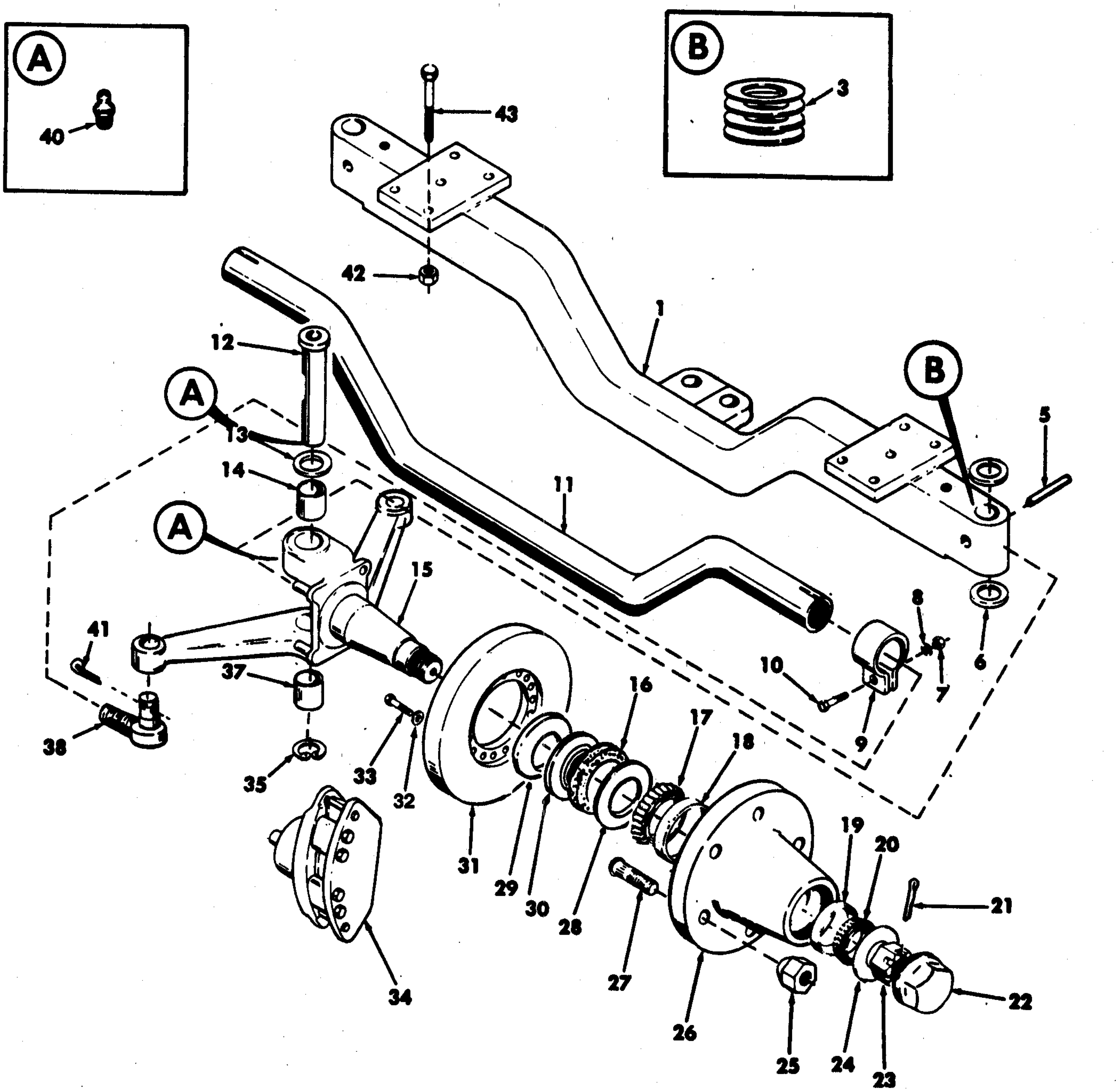
1. If the left steering knuckle is being removed, disconnect the steering cylinder from the knuckle.
2. Remove cotter pin (41), nut (39) and washer (32). Disconnect ball joint (38) from steering knuckle.
3. With a hammer and soft punch, remove retainer pin (5).
4. Remove kingpin (12), then remove the steering knuckle. Use care not to cause damage to the shims (3) when removing the knuckle. Keep the shims together for assembly.

Inspection

Clean all parts completely. See Section 1055.

Make a careful inspection of all bearings, cups and cones, including those not removed. Replace bearings if rollers or cups are worn or show indication of damage or distortion. Bearing cups and cones must be replaced as a set.

Replace all parts which have damage. Also replace any bolts with round corners, all lockwashers and seals at the time of overhaul.



1. Axle beam	15. Steering knuckle	27. Wheel stud (6)	40. Grease fitting
3. Shims	16. Felt seal	28. Spacer	41. Cotter pin
5. Retaining pin	17. Inner bearing cone	29. Outer retainer	42. Nut
6. Thrust washer	18. Inner bearing cup	30. Inner retainer	43. Bolt
7. Nut	19. Outer bearing cup	31. Disc plate	44. Tap bolt
8. Lockwasher	20. Outer bearing cone	32. Washer (12)	45. Jam nut
9. Clamp	21. Cotter pin	33. Bolt (12)	
10. Bolt	22. Hub cap	34. Disc brake (caliper)	
11. Tie rod	23. Slotted nut	35. Retaining ring	
12. Kingpin	24. Washer	37. Bearing	
13. Thrust washer	25. Wheel nut (6)	38. Ball stud joint	
14. Bearing	26. Hub	39. Slotted nut	

Figure 3. Steering Axle

Assembly — Steering Axle

1. If bearings were removed, press new bearings into kingpin bores in knuckle. Top of bearings must be even with top of kingpin bore as shown in Figure 4.

2. Apply petroleum jelly to thrust washers (4 and 6) and install thrust washers on the axle beam (1).

3. Put the steering knuckle into position on axle beam. By hand, lift the steering knuckle and install shims (3) until the steering knuckle fits tightly against the axle beam (minimum vertical movement). Shims are available in four sizes from .005 to .025 inch (.127 to .635 mm).

4. Align the holes in the axle beam, thrust washers, shims and steering knuckle. Install the thrust washer (13) and kingpin (12). When installing the kingpin, make sure the machine flat for the retainer pin is toward the axle center. Install the retainer pin (5). Use a hammer and soft punch.

5. Connect ball joint (38) to the steering knuckle with flat washer (32), slotted nut (39) and cotter pin (41).

6. If the steering cylinder was disconnected from the steering knuckle, connect the steering cylinder at this time.

7. Apply grease to the fittings for the steering knuckle bearings. See List of Grease Fittings.

Assembly — Axle Hub

1. Fill inner bearing cone (17) and outer bearing cone (20) with wheel bearing grease. Install bearing cones into the hub.

2. Install felt seal (16) on outer retainer which is already installed on the spindle. Then install inner retainer (30).

3. Install the assembled hub on the spindle of the steering knuckle.

4. Install washer (24) and slotted nut (23).

5. Rotate the hub while tightening the slotted nut. The slotted nut must be tightened until there is resistance in the rotation of the hub. Then loosen the nut until the nearest groove in the nut aligns with the hole in the threaded end of the spindle. Install the cotter pin (21).

6. Install the hub cap (22).

NOTE: If the axle is on the machine frame, do steps 7 and 8. If the axle is removed continue with "Installation of Steering Axle."

7. Install the disc brake (34). See Section 7121 for assembly procedures.

8. Install wheel. See Section 6129.

Installation of Steering Axle

1. Use a wheel jack to move the steering axle into position under the machine. Raise the axle and align the two dowel pins with the holes in the brackets on the frame.

2. Fasten the axle to the frame with eight bolts and nuts. Tighten the bolts to the correct torque. See Section 1051.

3. Connect the hydraulic lines to the steering cylinder.

4. Connect the lines to the disc brake and remove the air from the brake lines. See Section 7121.

5. Install the wheels, remove blocks from under frame and lower the outriggers.

6. Check wheel alignment, page 5021-3.

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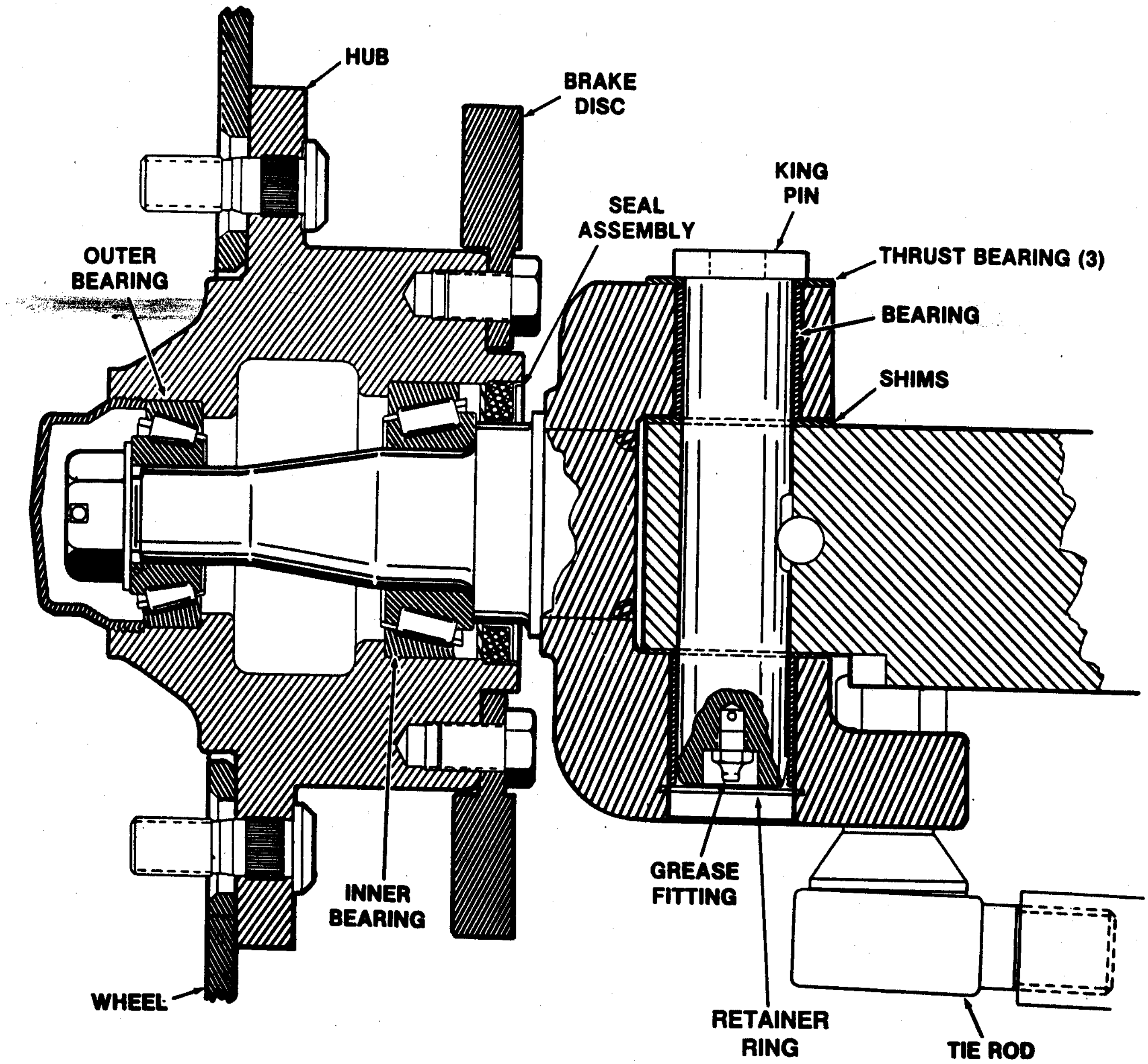


Figure 4. Axle Hub — Cross Section View

Section 6102

TRANSMISSION
GENERAL INFORMATION AND TROUBLESHOOTING

6

SPECIFICATIONS

Description	Full electro-hydraulic transmission unit with input, reverse, layshaft and mainshaft clutch packs. Torque converter and parking brake integral.	
Designation	PS720 (2 wheel drive)	
Weight(dry)	236 lb. (107 kg)	
Number of Teeth		
Transfer Gear	46	
Layshaft	16	
Gear Ratios		
1st	5.72:1	
2nd	3.23:1	
3rd	1.77:1	
4th	1.00:1	
Torque Converter Dia.	11 in. (279 mm)	
Torque Multiplication at Stall	2.45:1	
Torque Converter Color Code Identification		
Color Coded Dots	One Blue One Green	
Minimum Engine Rev/Min at Converter Stall*	**2.45:1 Ratio**	
-2nd Gear (Forward & Reverse)	2150 rpm	
-3rd Gear (Forward & Reverse)	2200 rpm	
Converter Pressures (in neutral)	**PSI**	**kPa**
Converter In at 122° F (50° C) 1000 rpm	40-60	272-410
2000 rpm	70-90	476-612
Converter Out at 122° F (50° C) 1000 rpm	27-33	184-224
2000 rpm	33-39	224-265
Converter Inlet Relief Valve Pressure (max.)	95	646
Lubrication Pressures(in neutral)	**PSI**	**kPa**
At 122° F (50° C) 1000 rpm	2.0-4.0	14-27
2000 rpm	.0-8.0	27-54

***Note:** Using 2nd and 3rd gears in forward and reverse drive will ensure that ALL clutches are energized during the stall test - refer to "Torque Converter Stall Test" on page 6102-15.

Mainline Pressure(in neutral)	**PSI**	**kPa**
Cooler at 122° F (50° C) 1000 rpm	85.5-104.5	581-711
2000 rpm	108-132	734-898

SPECIFICATIONS (CONT'D)

Flow Rates(In neutral)		GPM	L/PM
Cooler at 122° F (50° C)	1000 rpm	2.8-3.6	10.4-13.6
	2000 rpm	3.8-5.3	14.5-20.0
Pump at 122° F (50° C)	1000 rpm	2.9-4.0	11.0-15.0
	2000 rpm	6.0-7.8	22.5-29.5

The following clutch pressures should be the same as Mainline Pressure to within 10 PSI (69 kPa):

Input Clutch Pressure (high and low ratio)

Reverse Clutch Pressure (high and low ratio)

Layshaft Clutch Pressure

Mainshaft Clutch Pressure

MAINTENANCE

Check Oil Level - (See Figure 1)

A Dipstick/Filler

Weekly or every 50 hours the oil level should be checked. Oil level should be to the full mark on the dipstick when the oil is cold, i.e., before starting machine operation. DO NOT OVERFILL.

Change Oil & Clean Strainer - (See Figure 1)

Every 12 months or 3000 hours replace the transmission oil and clean the strainer.

Drain oil by removing drain plug **B**.

1. Engage parking brake and shut off engine.
2. Unlatch and lift the engine compartment cover.
3. Put a suitable container under transmission drain port.
4. Remove drain plug **B**, Figure 1 and drain oil.
5. Remove capscrews **D**, strainer **G** and gasket **C**. Clean strainer in a suitable solvent. Discard gasket **C**.
6. Install clean strainer **G** and new gasket **C**. Tighten capscrews **D** to a torque of 7.4 lb.-ft. (10 Nm).
7. Fill transmission with Mobil ATF210, or equivalent, to dipstick **A** full mark. Capacity of transmission is approximately four gallons (15.1 liters). Start engine and run for a period not exceeding five minutes. Stop engine, wait approximately one minute. Check oil on dipstick **A**. Add oil to fill mark if required.
10. Close engine cover and latch in place.

Filter Replacement (See Figure 1)

1. Level crane, engage parking brake and shut off engine.
2. Unscrew and discard filter **F**.
3. Coat seal of new filter with clean transmission oil. Install filter **F** and hand tighten only.
4. Fill transmission with Mobil ATF210, or equivalent transmission oil to full mark on dipstick **A**.
5. Start engine and run for period not exceeding five minutes. Stop engine, wait approximately one minute and check oil level. Add oil to full mark on dipstick if required.

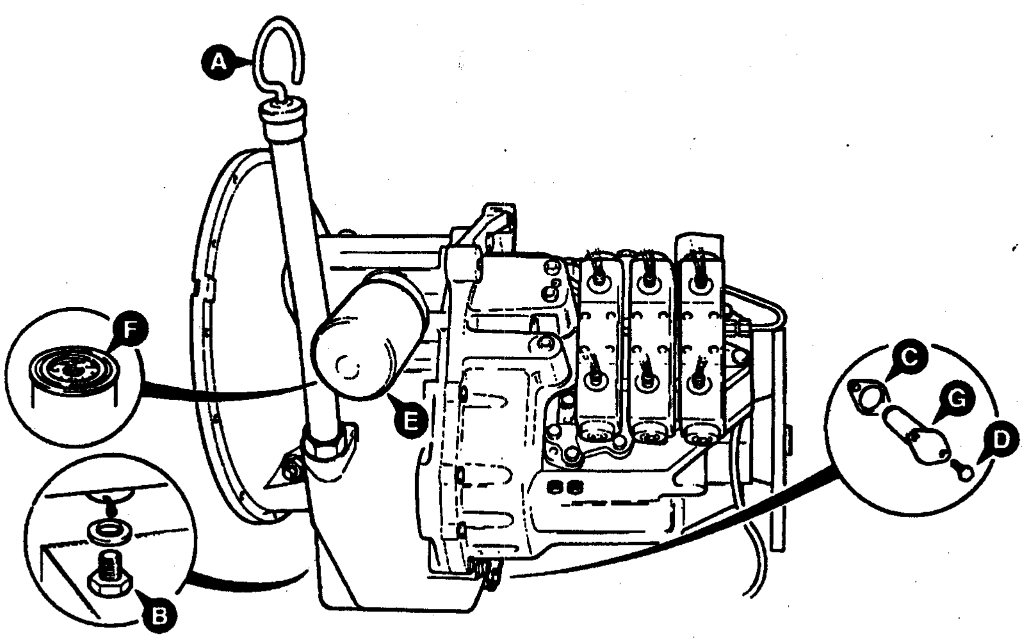


Figure 1. Maintenance Points

DESCRIPTION OF OPERATION

TORQUE CONVERTER (SEE FIGURE 2)

The torque converter is the hydraulic link between the engine and the drive train. There are three main components in the torque converter:

1. A turbiner
2. An impeller (or pump)
3. A Stator and One-Way Clutch

The **Impeller** is the pump for the torque converter. This component starts the movement of the oil to the other components. The impeller is connected to the engine flywheel through the torque converter and a drive plate. The impeller rotates at engine speed. Similar to a centrifugal pump, the impeller takes oil at the inner diameter and releases the oil at the outer diameter.

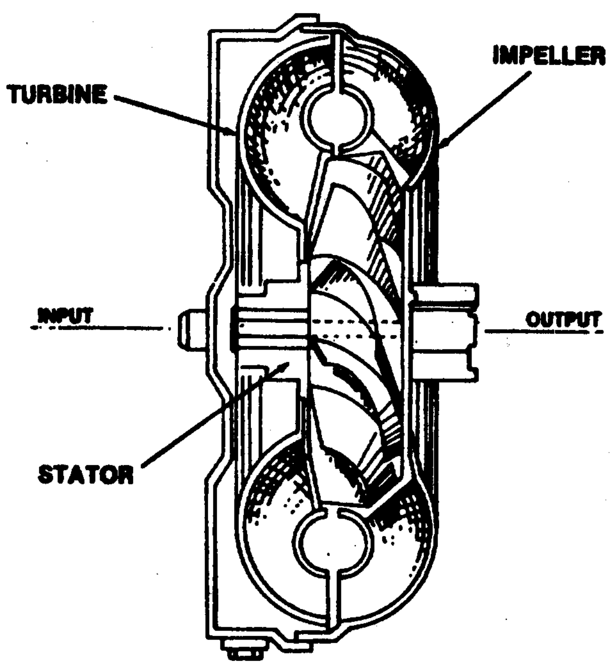


Figure 2. Cross Section of Torque Converter

The **turbine** is opposite the impeller and is connected by splines to the input shaft of the Powershift -Transmission. The turbine receives oil at the outer diameter and releases the oil to the stator at the inner diameter. The movement of oil from the impeller to the turbine makes a multiplication of torque possible. The torque converter gives maximum torque when the turbine is at zero rpm.

The stator is between and at the center of the impeller and the turbine. The stator changes the direction of the oil which leaves the turbine so the oil will enter correctly again into the impeller.

The torque converter and the transmission have a common hydraulic system. Figure 3 shows the arrangement of the system.

NOTE: Normal operating temperature is 180-190° F (82-88° C). High temperatures will cause damage and leakage in the seals and gaskets of the torque converter. Do not continue operation if the temperature increases above 190° F (88° C). Put the transmission in "neutral" position and let the engine run at low rpm until the temperature returns to normal. If the temperature does not return to normal, check for restriction in the lubrication and cooling lines of the torque converter.

POWERSHIFT TRANSMISSION - (SEE FIGURE 3)

The Powershift is an electro-hydraulic transmission unit. Gear shifting and direction selection are controlled using multi-disc clutch packs.

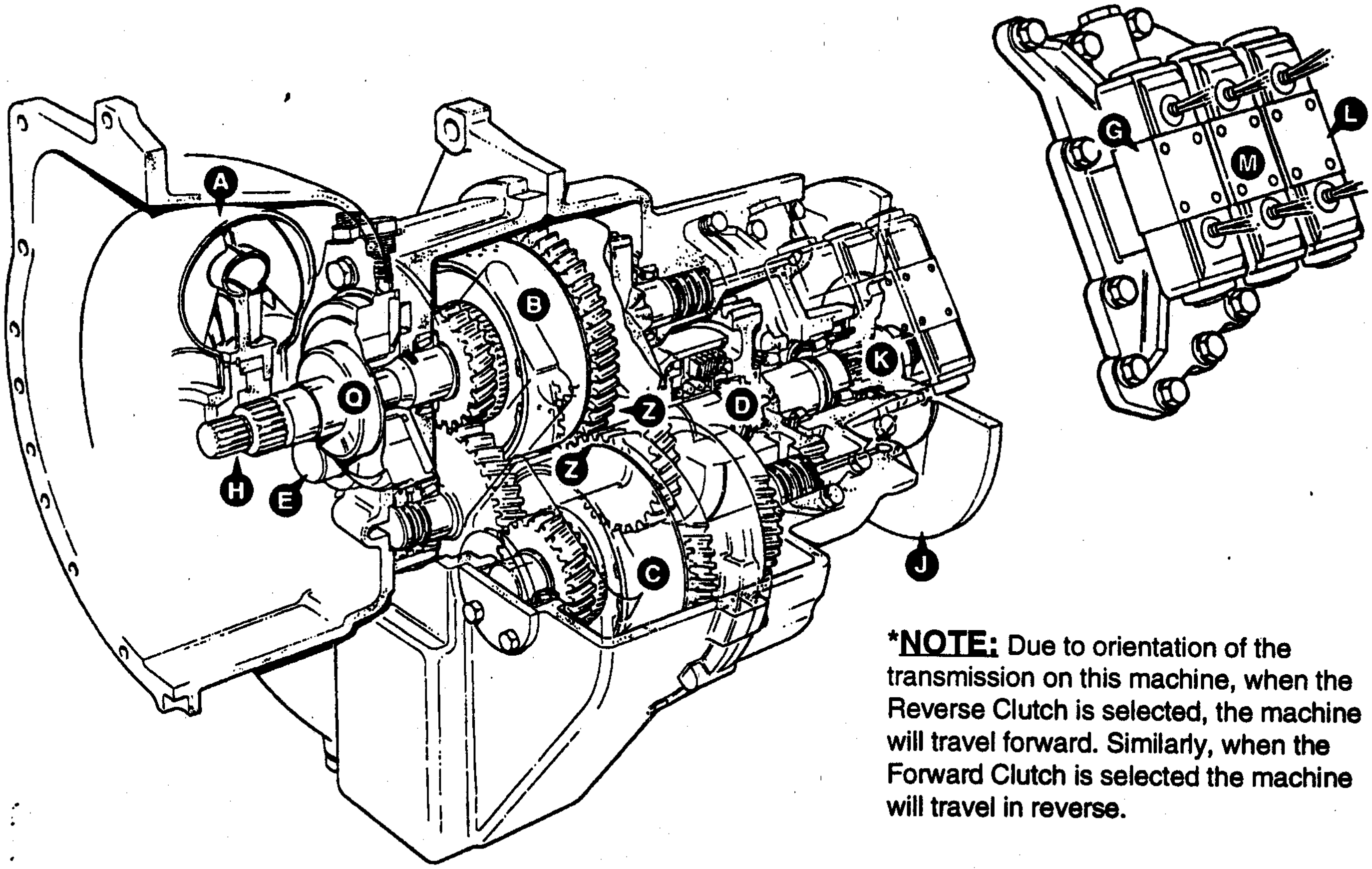
Electrically operated solenoid valves divert pressurized oil (provided by pump **Q**) to the selected clutch packs.

A combined lever/swivel switch (Travel Select Lever) on the steering column actuates both gear ratio and direction solenoids.

IMPORTANT: Due to the orientation of the transmission unit in this machine, when the Reverse Clutch is selected, the machine will travel forwards. Similarly, when the Forward Clutch is selected, the machine will travel in reverse.

The Powershift unit consists of a torque converter **A**, input clutch assembly **B**, reverse clutch assembly **C**, layshaft assembly **E**, mainshaft assembly **D** and a parking brake disc **J** mounted on splined output shaft **K**.

The torque converter is a fluid coupling bolted to a drive plate which in turn is bolted to the engine flywheel. As the engine starts to rotate, the converter gives smooth power take-off gradually increasing the torque transmitted. This torque is transferred from the converter assembly to the clutch/gear assemblies via input shaft **H**.



*NOTE: Due to orientation of the transmission on this machine, when the Reverse Clutch is selected, the machine will travel forward. Similarly, when the Forward Clutch is selected the machine will travel in reverse.

A - Torque Converter
B - Input Shaft Assembly
C - Reverse Clutch Assembly
D - Mainshaft Assembly
E - Layshaft Assembly
G - *3-Position Solenoid Valve (Forward)
H - Input Shaft
J - Parking Brake Disc
K - Splined Output Shaft
L - *3-Position Solenoid Valve (Reverse)
M - 3-Position Solenoid Valve (Mainshaft/Layshaft)
P - Solenoid Valve Adapter Block
Q - Pump
R - Spur Gears

Figure 3. Transmission Operation

Input clutch assembly **B** contains two hydraulically operated clutches; one clutch provides a forward low ratio drive and the other a forward high ratio drive. 3-position solenoid valve **G**, when energized,directs pressurized oil to either the forward low or forward high clutch.

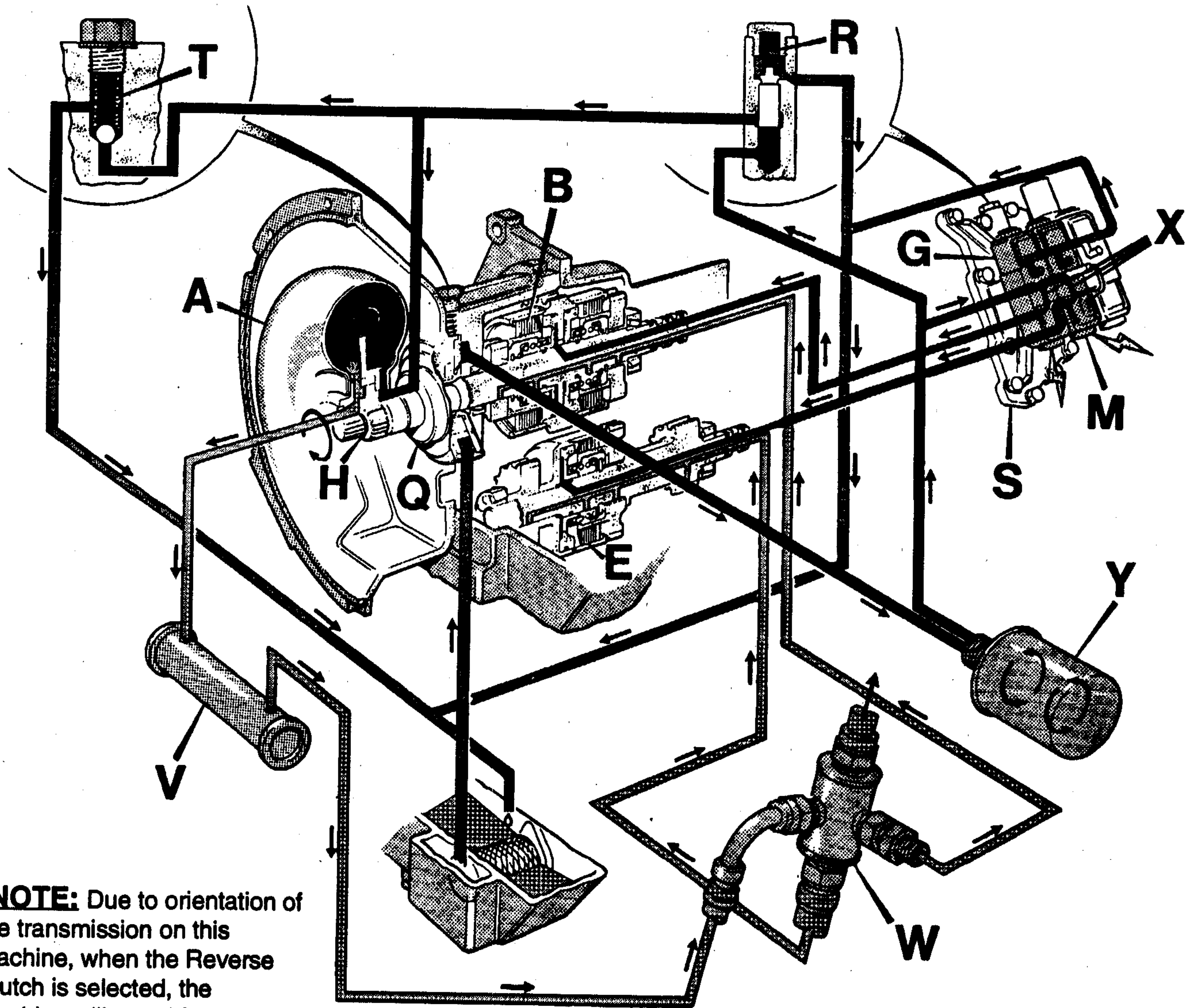
The reverse clutch assembly **C** is similar to the input clutch assembly. It contains two hydraulically operated clutches; one clutch provides a reverse low ratio drive and the other a reverse high ratio drive. 3-position solenoid valve **L**, when energzsed, directs pressurized oil to either the reverse low or reverse high clutch.

Forward drive is transmitted via constant meshing of spur gears **Z**.

Both the mainshaft and the layshaft assemblies have a single clutch each. 3-position solenoid valve **M**, when energized, directs pressurized oil to either the mainshaft clutch or the layshaft clutch.

Hydraulic Operation (See Figure 4)

When the Powershift is operated, multi-disc clutch packs are pressurized and engaged. The engaged clutch packs then transfer drive from the engine to the road wheels (via the torque converter **A**, input shaft **H** and drive shafts).



***NOTE:** Due to orientation of the transmission on this machine, when the Reverse Clutch is selected, the machine will travel forward. Similarly, when the Forward Clutch is selected the machine will travel in reverse.

A - Torque Converter
B - *Forward Low Ratio Clutch
E - Layshaft Drive Clutch
G - *Forward Solenoid Valve

M - Mainshaft/Layshaft Solenoid Valve.
R - Pressure Maintenance Valve
S - Solenoid Valve Adapter Block
T - Relief Valve

W - Manifold
X - Restrictor Orifices
Y - Filter

Figure 4.

Different combinations of engaged clutches give four gear ratios in forward and reverse drive. There must always be two clutches engaged before the machine will drive: 1) a direction ratio clutch (for instance forward low) and 2) a drive clutch (layshaft or mainshaft).

NOTE: Due to the orientation of the transmission unit in this machine, when the Reverse Clutch is selected, the machine will travel forward. Similarly, when the Forward Clutch is selected, the machine will travel in reverse.

The illustration shows 1st gear reverse selected, therefore, the two engaged clutches will be forward low ratio clutch **B** and layshaft drive clutch **E**.

For the purpose of this description, clutches not used when 1st gear reverse is selected are not shown.

Oil from the pump **Q** is fed through an internal passage via the filter **Y** to the pressure maintenance valve **R,** which maintains a constant pressure to the solenoid valve adapter block **S**.

The solenoid adapter block houses the solenoid valves which are used to divert oil to the clutch packs.

Excess oil from the maintenance valve flows through the casing to the torque converter. Oil enters the converter between the converter hub and the stator support, and leaves between the stator and the input shaft. Pressure in the converter is controlled by relief valve **T** which dumps oil from the converter line back to the sump.

Oil from the torque converter flows out of the transmission unit to the external oil cooler **V**. From the cooler, the oil flows to manifold W which distributes the oil to pass through the center of all the clutches for lubrication purposes.

In neutral, the flow of pressurized oil is blocked at the solenoid valves.

With 1st gear reverse, selected solenoid valves **G** and **M** are energized. The energized valves cause internal spools to move, which then divert pressurized oil to clutch packs **B** and **E** via internal galleries.

The drive from the engine is then transferred via the engaged clutches and gears to the output flange (and finally to the road wheels).

Figures 5 through 9 illustrate drive paths and which clutches are engaged.

Restrictor orifices **X** in the feed lines to the solenoid valves modulate the pressure to the clutches, this ensures a smooth clutch engagement. Pressure from clutches not engaged will vent back to the sump via galleries and the solenoid spools.

Powershift-Drive Paths

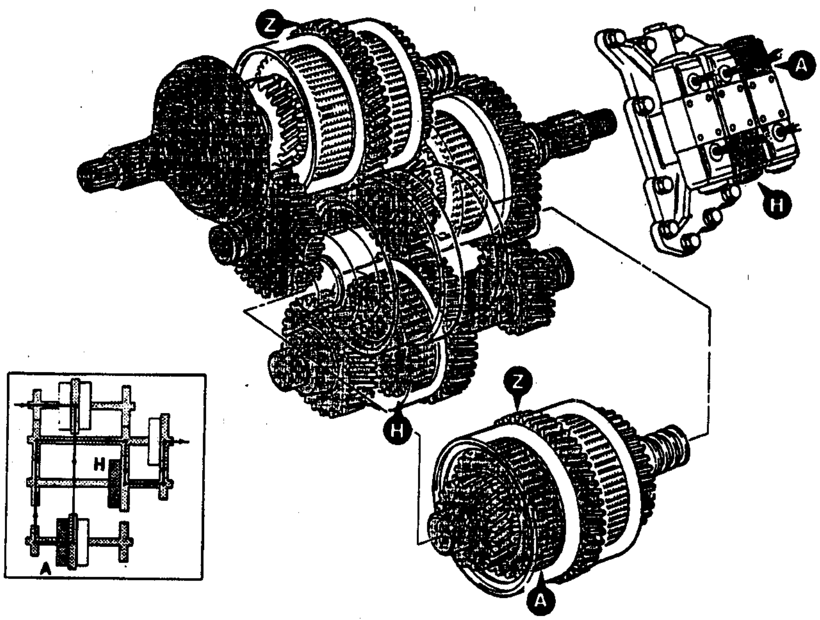


Figure 5.

Figure 5 -1st GEAR FORWARD

Clutches Engaged	Solenoids Active
A - Reverse Low Ratio	**A** - Reverse low
H - Layshaft	**H** - Layshaft

Note that forward drive is achieved through the meshing of spur gears **Z**.

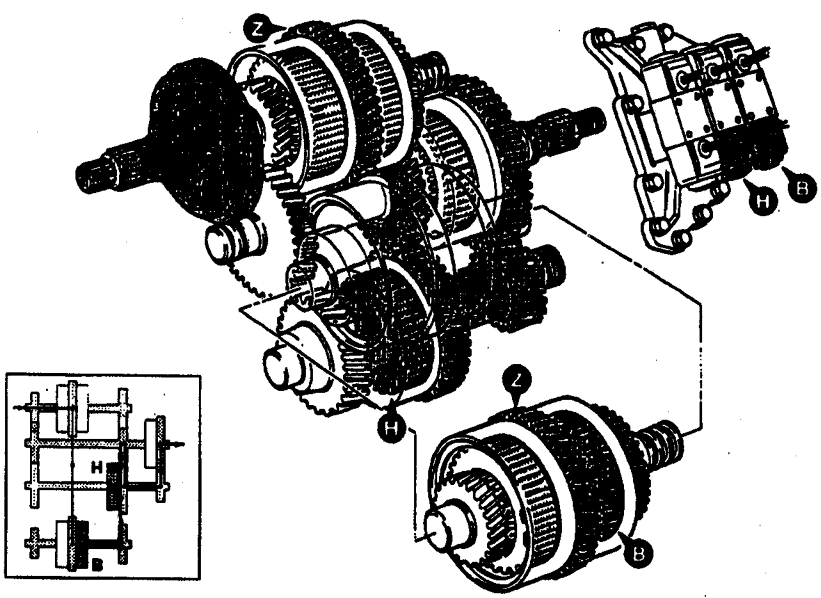


Figure 6.

Figure 6 - 2nd GEAR FORWARD

Clutches Engaged	Solenoids Active
B - Reverse High Ratio	**B** - Reverse High
H - Layshaft	**H** - Layshaft

Note that forward drive is achieved through the meshing of spur gears **Z**.

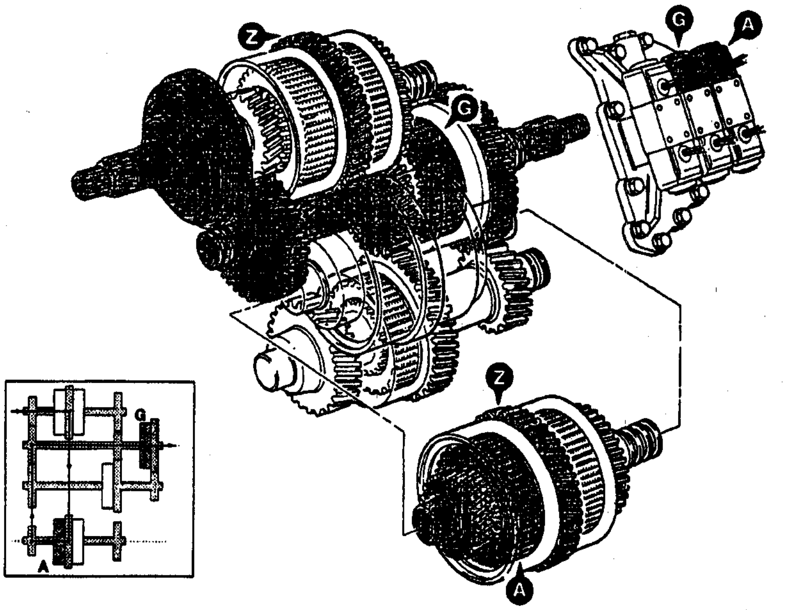


Figure 7.

Figure 7 - 3rd GEAR FORWARD

Clutches Engaged	Solenoids Active
A - Reverse Low Ratio	**A** - Reverse low
G - Mainshaft	**G** - Mainshaft

Note that forward drive is achieved through the meshing of spur gears **Z**.

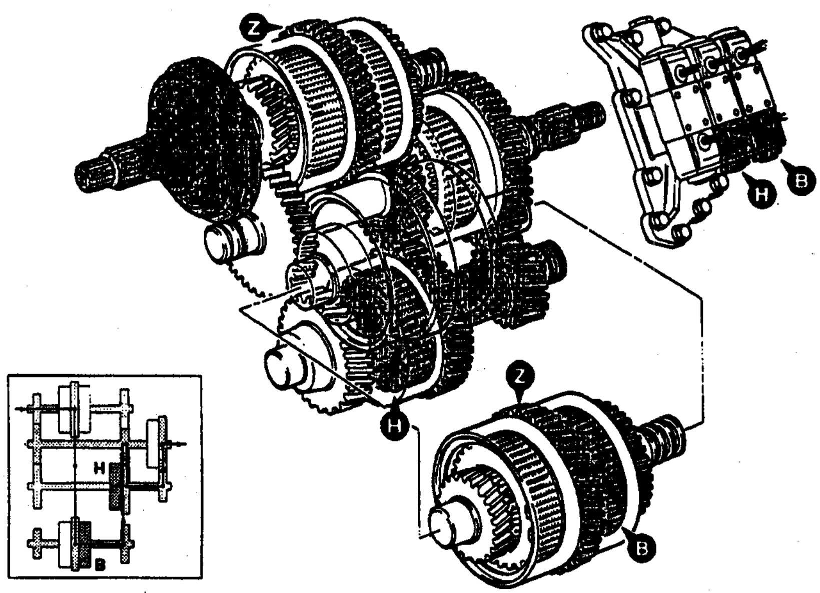


Figure 8.

Figure 8 - 4th GEAR FORWARD

Clutches Engaged	Solenoids Active
B - Reverse High Ratio	**B** - Reverse High
G - Mainshaft	**G** - Mainshaft

Note that forward drive is achieved through the meshing of spur gears **Z**.

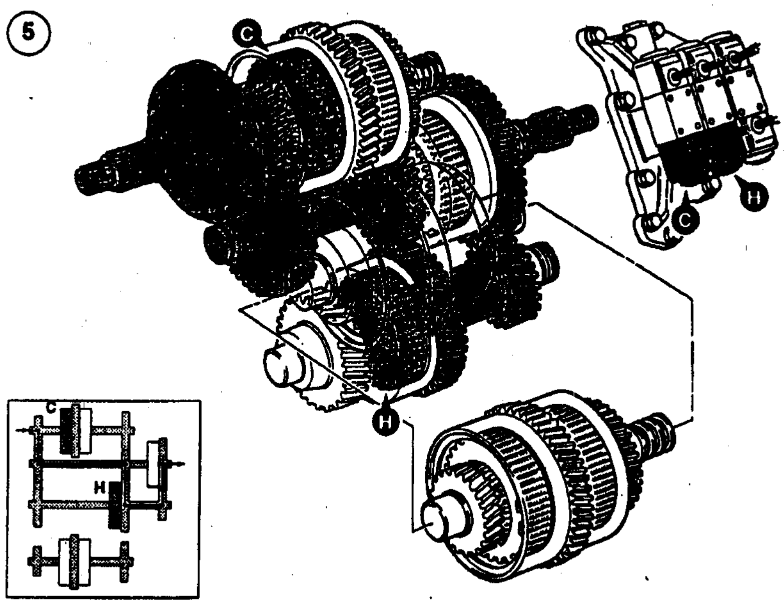


Figure 9.

Figure 9 - 1st GEAR REVERSE

Clutches Engaged	Solenoids Active
C - Forward Low Ratio	C - Forward Low
H - Layshaft	H - Layshaft

TROUBLESHOOTING

The Powershift fault finding procedures concern themselves with general problems normally associated with this type of transmission system, and so the layout is a "Possible Cause and Remedy" type.

Full flows, pressure and stall testing procedures for the Powershift transmission start on page 6201-14.

Before commencing with the fault finding procedure, make sure that the correct type of transmission fluid has been used (Mobil ATF210, or equivalent).

NOTE: Due to the orientation of the transmission unit in this machine, when the Reverse Clutch is selected, the machine will travel forwards. Similarly, when the Forward Clutch is selected, the machine will travel in reverse.

Troubleshooting Guide

LACK OF POWER

Possible Cause	Remedy
1. Poor engine condition	1. Check and if necessary repair engine
2. Low oil level	2. Top up system
3. Worn pump.	3. Check and if necessary repair or replace pump
4. Torque converter damage	4. Check and if necessary repair or replace torque converter
5. Low mainline pressure	5. See fault "Low Mainline Pressure"
6. Clutches slipping	6. Check clutch pressures, check clutch piston rings
7. Internal leakage	7. Check internal cored galleries and their casting for porosity.
8. High stall speeds	8. See fault "High Speeds (on ALL clutches)"
9. Low stall speeds	9. See fault "Low Speeds (on ALL clutches)"
10. Overheating	10. See fault "Overheating"

LOW MAINLINE PRESSURE

Possible Cause	Remedy
1. Worn pump	1. Check and if necessary repair or replace pump
2. Blocked suction strainer	2. Clean suction strainer
3. Pressure maintaining valve sticking/leaking	3. Free sticking valve or replace valve
4. Oil aerated (foaming)	4. a) Internal leakage(cored galleries) -inspect/repair transmission b) Dirty suction strainer-clean strainer c) High oil level-drain to proper level d) Incorrect grade of oil-drain then refill with correct oil

Troubleshooting Guide Cont'd)

HIGH STALL SPEEDS (ON ALL CLUTCHES)

Possible Cause	Remedy
1. Damaged converter blades	1. Check and if necessary repair or replace converter
2. Clutches slipping	2. Strip, inspect and install new clutch friction/counter plates
3. Internal leakage	3. Check internal cored galleries and the casting for porosity

LOW STALL SPEEDS (ON ALL CLUTCHES)

Possible Cause	Remedy
1. Poor engine condition	1. Check and if necessary repair engine
2. Torque converter reaction member clutch slipping	2. Check and if necessary repair torque converter

LOW CONVERTER OUT PRESSURE

Possible Cause	Remedy
1. Low Mainline Pressure	1. See fault heading "Low Mainline Pressure"
2. Converter internal leakage	2. Check and if necessary replace converter
3. Converter relief valve faulty	3. Check and if necessary repair relief valve

LOW PUMP FLOW

Possible Cause	Remedy
1. Low oil level	1. Add hydraulic oil
2. Blocked suction strainer	2. Clean suction strainer

HIGH CONVERTER OUT PRESSURE

Possible Cause	Remedy
1. Oil cooler/lines blockage.	1. Clean cooler, free blockage.

LOW LUBRICATION PRESSURE

Possible Cause	Remedy
1. Low mainline pressure	1. See fault "Low Mainline Pressure"
2. Oil cooler/lines blockage.	2. Clean cooler, free blockage
3. Ruptured lubrication line	3. Repair line
4. Converter internal leakag	4. Check, and if necessary replace converter
5. Converter relief valve faulty	5. Check, and if necessary repair or replace relief valve

Troubleshooting Guide (Cont'd)

OVERHEATING

Possible Cause	Remedy
1. Low oil level	1. Top up system
2. High oil level	2. Drain oil to correct leve
3. Trapped or kinked hoses in cooler system	3. Renew & or repair hoses
4. Low converter out pressure and flow rate	4. Repair or replace the converter relief valve.
5. Oil cooler blockage	5. Clean cooler
6. Operating in wrong gear range usage	6. Select correct gears to suit working conditions
7. Water system overheating	7. Rectify water system problems; example, radiator, cooler lines, low water level, etc.
8. Oil aerated (foaming)	8. See fault "Low Mainline Pressure", item 4
9. Clutch piston(s) sticking on return stroke	9. Check and repair clutch piston(s) and seal(s.
10.Cored galleries on front housing pump mounting face wrong depth (minimum 0.2 inches [5 mm]). Indicated with an excessively low pressure and flow on the converter out cooling line. See Figure 10.	10.Replace front housing (or rectify existing housing)
11.Leakage across pump mounting face and front case.	11.Check for damaged surface on both components and loose pump mounting bolts.

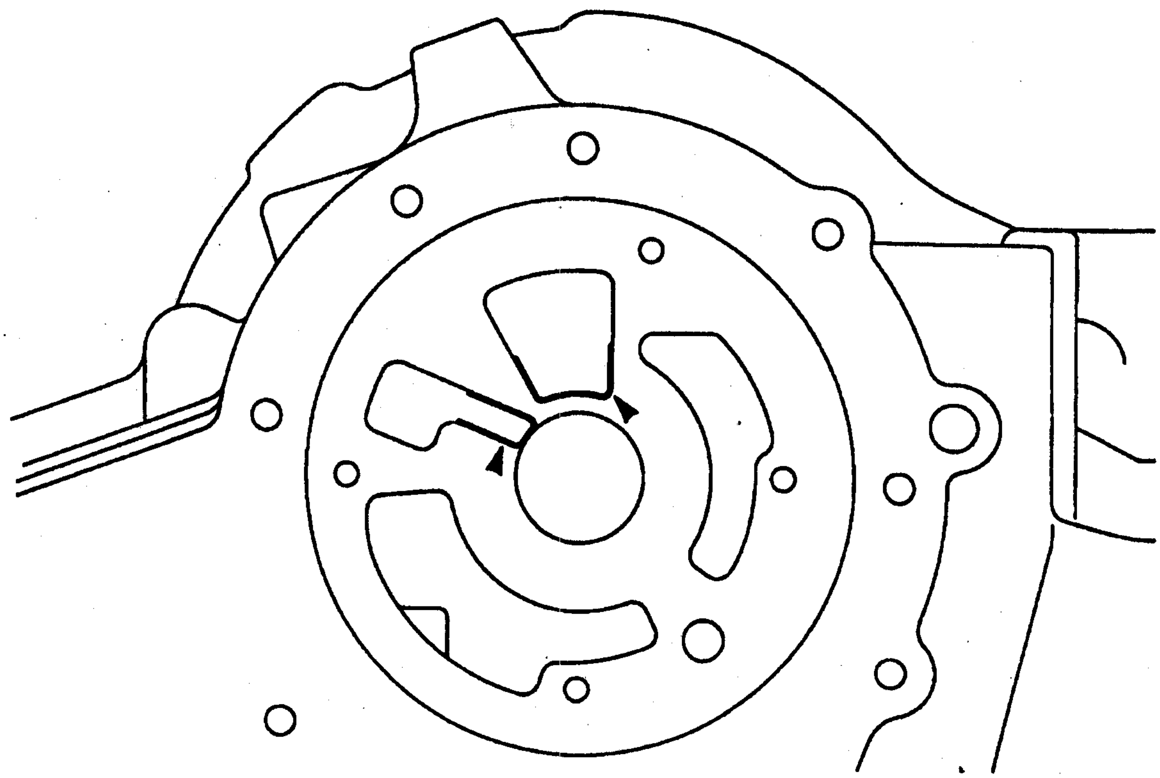


Figure 10.

SOLENOID IDENTIFICATION

When testing individual clutch pressures (see page 6102-15), it is necessary to isolate the clutch being tested. So, for instance, to check the layshaft clutch, we could select 1st gear forward. This would energize the layshaft and reverse low clutches. Because we only want to check the layshaft clutch pressure and not the reverse low clutch pressure, remove the electrical connector to the reverse low clutch BEFORE selecting 1st gear.

Use the tables below to determine which solenoid electrical connectors should be removed when pressure testing individual clutches. Table 1 identifies the solenoid connectors (refer to Figure 11), and Table 2 identifies which clutches are engaged when the various gears are selected.

Note that the identifying annotations (items E, F etc.) are the same as those found on the machine wiring harness.

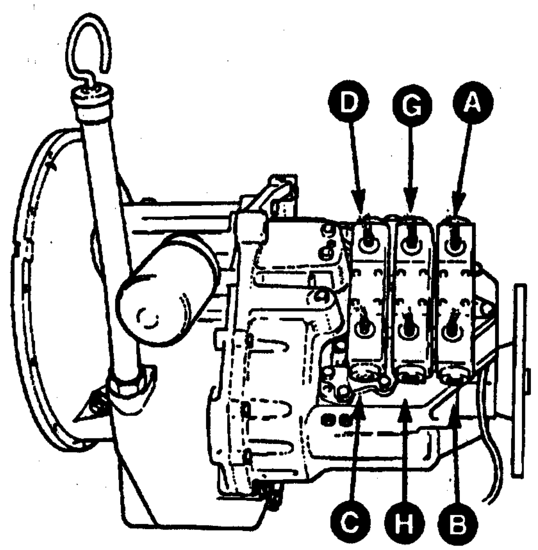


Figure 11.

Table 1

Item	Solenoid Description
D	Forward High
C	Forward Low
G	Mainshaft
H	Layshaft
A	Reverse Low
B	Reverse High

Table 2

Gear Selected	Clutches Engaged
1st Forward	Reverse Low & Layshaft (items A & H)
2nd Forward	Reverse High & Layshaft (items B & H)
3rd Forward	Reverse Low & Mainshaft (items A & G)
4th Forward	Reverse High & Mainshaft (items B & G)
1st Reverse	Forward Low & Layshaft (items C & H)
2nd Reverse	Forward High & Layshaft (items D & H)
3rd Reverse	Forward Low & Mainshaft (items C & G)
4th Reverse	Forward High & Mainshaft (items D & G)

TEST FOR CLUTCH LEAKAGE

WARNING: DO NOT go underneath the machine with the engine running. Turn off the engine, apply parking brake, chock wheels and remove ignition key before going underneath the machine.

Isolating a Suspect Clutch

1. Stop engine, connect a 0-300 psi (0-2040 kPa) pressure gauge to test connector A, Figure 13 (mainline pressure test point).
2. Make sure that both sides of all four wheels are chocked. Apply foot brake and parking brake.
3. Start engine and run at 1000 rpm, engage 1st gear forward. Record the pressure reading. Repeat the test for all gear ratios in forward drive and record the pressure readings as shown below:

Example Only

Gear Select	Ratio Clutch	Mainshaft or Layshaft Clutch	PSI	kPa
1st	Reverse Low	Layshaft	140	952
2nd	Reverse High	Layshaft	125	850
3rd	Reverse Low	Mainshaft	140	952
4th	Reverse High	Mainshaft	125	850

NOTE: Due to orientation of the transmission unit in this machine, when the reverse clutch is selected, the machine will travel forward. Similarly, when the forward clutch is selected, the machine will travel in reverse.

Readings should not vary between clutches by more than 10 psi (69 kPa). In the example shown, we can see that pressure is low when 2nd and 4th gear forward is selected, indicating clutch leakage.

From the table we can see that the reverse high clutch is used for selection of both 2nd and 4th gear forward. We know from the table that the mainshaft and layshaft clutches are working normally (1st and 3rd gear selection show normal operating pressure). So we can assume that the reverse high clutch is leaking.

We can now confirm the reverse high clutch is leaking by completing an "Individual Clutch Leakage Test."

NOTE: Repeat above procedure using reverse ratios if necessary.

Individual Clutch Leakage Test

In the following procedures the reverse clutch is tested, therefore, in step 2 a pressure gauge is connected to the reverse high clutch test point.

When testing other suspect clutches, connect a gauge to the relevant suspect clutch test point. See Figure 13 for the position of individual clutch pressure test points. Because the reverse clutch high clutch is suspect, a gear must be selected that will use the reverse high clutch, in this instance 2nd gear forward.

1. Stop engine, connect a 0-300 psi (0-2040 kPa) pressure gauge to test connector **A**, Figure 13 (mainline pressure test point).
2. Remove the layshaft clutch solenoid feed connector **H**, Figure 12. This ensures that only the reverse high clutch is energized when 2nd gear forward is selected.

NOTE: See page 6102-1 for identification and position of solenoid feed connectors when testing other suspect clutches.

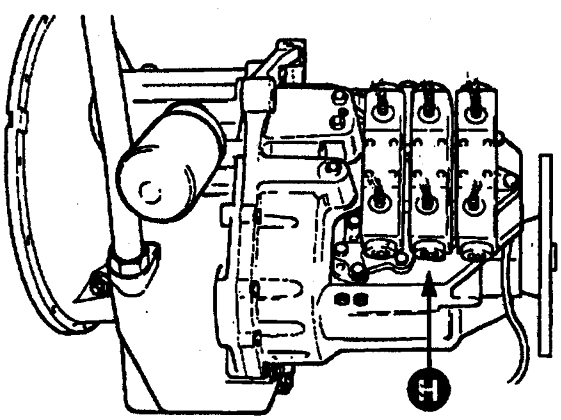


Figure 12.

3. Make sure that both sides of all four wheels are chocked. Apply foot brake and parking brake.
4. Start engine and run at 1000 rpm, select 2nd gear forward. Note the pressure readings on both gauges, which should not vary more than 10 psi (60 kPa). If the difference on the gauges is greater than 10 psi (69 kPa) do the following:
   a. Stop the engine and interchange the gauges.
   b. Start the engine and run at 1000 rpm, select 2nd gear forward. If the difference on the gauges is still greater than 10 psi (69 kPa), service the reverse high clutch.
   c. If after interchanging the gauges, the readings are different than in step 5, have the gauges calibrated and repeat the test procedure.

TORQUE CONVERTER STALL TEST

NOTE: Engine speed must be recorded during this test. This machine is not equipped with a tachometer. One must be temporarily installed to perform this test.

NOTE: DO NOT stall the converter for longer than 10 seconds or the transmission fluid will overheat. Make sure that the oil level is correct and at normal operating temperature.

Before completing the following test, remove the transmission dipstick. If there is any sign of smoke emitting from the dipstick tube, **STOP THE TEST IMMEDIATELY** and dismantle the transmission for servicing.

1. Ensure that the engine and transmission are at normal working temperature. Run engine at maximum speed and check the **No Load Speed.** See engine Technical Data in Engine Operator's Manual.
2. Apply parking brake and foot brake firmly. If necessary, set the machine against a fixed obstruction.
3. Select 2nd speed forward drive and open throttle fully. Record the engine speed from the tachometer. Repeat the test for 3rd speed forward and record the speed reading.
4. Repeat step 3, except this time select 2nd and 3rd gear reverse drive respectively. Record the speed readings.

NOTE: Using 2nd and 3rd gears in forward and reverse drive will ensure that ALL clutches are energized during the test.

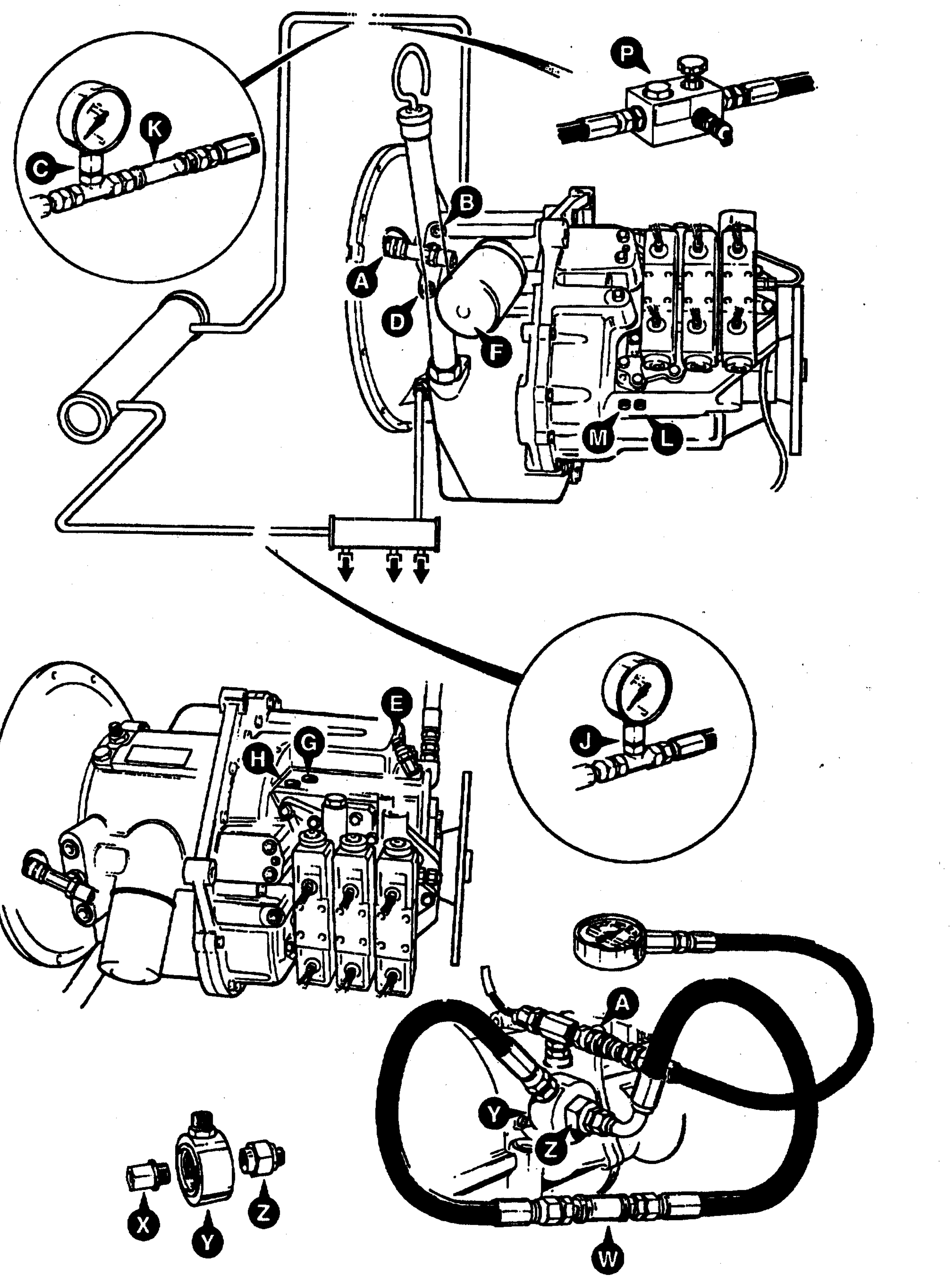


Figure 13.

5. All recorded readings should be as specified at Torque Converter Stall in technical data on page 6102-1.

If engine speeds are below the stated figures, either the engine is losing power and should be serviced/overhauled or the torque converter reaction member clutch is slipping. To check the engine, select Neutral, open throttle fully and raise the booms fully to bring the main relief over relief. Engine speed should fall to slightly above the Maximum Governed Speed. If engine speed is correct, the torque converter reaction member is slipping.

If engine speeds are higher than Maximum Governed Speed, check the transmission for clutch slippage or internal leakage. To isolate a suspect clutch, tabulate the recorded readings as shown in the example below:

Gear Select	Direction Clutch	Mainshaft or Layshaft Clutch	RPM
2nd	Forward High	Layshaft	2060
3rd	Forward Low	Mainshaft	1990
2nd	Reverse High	Layshaft	1985
3rd	Reverse Low	Mainshaft	1980

In the example shown, the engine speed is abnormally high when 2nd speed forward drive is selected, indicating a slipping clutch.

From the table, we can see that the layshaft clutch is working normally (2nd speed reverse indicates 1985 rpm). Therefore, it follows that the suspect clutch is the forward high. Assuming all other possible faults have been eliminated (see Troubleshooting) this clutch would be disassembled for servicing.

PRESSURE AND FLOW TESTING

WARNING: Fine jets of hydraulic oil at high pressure can penetrate the skin. Do not use your hand to check for hydraulic leaks. Do not put your face close to suspected leaks. Hold a piece of cardboard close to suspected leaks and inspect the cardboard for signs of hydraulic oil. If hydraulic oil penetrates your skin, get medical help immediately.

WARNING: Take care when disconnecting hydraulic hoses and fittings. The oil will be hot and could cause burns.

WARNING: DO NOT go underneath the machine with the engine running. Turn engine off, apply parking brake and remove ignition key before going underneath the machine.

Before completing any transmission pressure/flow tests, make sure that the oil level is correct and normal operating temperature.

TEST POINTS

A - Mainline pressure

B - Converter inlet/converter relief valve pressure

C - Converter outlet pressure

D - Mainshaft clutch pressure

E - Layshaft clutch pressure

F - Pump flow (remove filter and fit adapters)

G - Forward high ratio clutch pressure

H - Forward low ratio clutch pressure

J - Lubrication pressure

K - Cooler flow (flowmeter in-line from cooler to transmission

L - Reverse high ratio clutch pressure

M - Reverse low ratio clutch pressure

N - (Not applicable)

P - Load valve

Pump Flow

NOTE: Special adapters are required to perform the following test. Contact Shuttlelift, Inc.

Refer to Figure 13.

NOTE: The installation is typical Powershift transmission; it may vary in detail from the actual transmission.

1. Stop engine, remove transmission filter and screw special adapter **X** onto the threaded spigot. Install special test adapter **Y** and secure with adapter **Z**. Connect flowmeter **W**.

2. Start engine and run at 1000 rpm. With the transmission in neutral, the flowmeter will show the pump flow which is shown in specifications on page 6102-1. A low reading indicates a worn pump or blocked suction strainer.

3. Repeat step 2 and note gauge readings with engine running at 2000 rpm.

4. Stop engine and remove test adapters. Install filter.

Mainline Pressure

Refer to Figure 13.

1. Stop engine, connect a 0-300 psi (0-2040 kPa) pressure gauge to test connector **A**.
2. Start engine and run at 1000 rpm. With the transmission in neutral the pressure gauge will show the mainline pressure, which should be as shown in specifications on page 6102-1. A low reading can be caused by either a faulty pressure maintenance valve or a worn pump. A high reading may indicate a faulty pressure maintenance valve.
3. Repeat step 2 and note gauge readings with engine running at 2000 rpm.
4. Stop engine and remove test gauge.

Converter Out Pressure/Oil Cooler Flow Rate

Refer to Figure 13.

1. Stop engine, connect a 0-300 psi (0-2040 kPa) pressure gauge and flowmeter into the converter out line as shown at **C** and **K** respectively.
2. Run the engine at 1000 rpm with transmission in neutral. The pressure gauge indicates the converter out pressure and the flowmeter indicates the oil cooler flow rate. Both readings are found in the specifications on page 6102-1. A high pressure together with a low flow could be caused by a blocked oil cooler.
3. Repeat step 2 and note gauge reading with engine running at 2000 rpm.
4. Stop engine, remove test gauge and flowmeter and install hoses to original position.

Converter In Pressure

Refer to Figure 13.

1. Connect a 0-300 psi (0-2040 kPa) pressure gauge to test point **B**.
2. Install a load valve **P** into the converter out line.

IMPORTANT: DO NOT allow the pressure to exceed 150 psi (1020 kPa) or damage to the converter seals will occur.

3. Start the engine and run at 1000 rpm. With the transmission in neutral, slowly screw down the load valve **P** while observing the gauge reading which should rise to the converter relief (safety) valve setting specified on page 6102-1.
4. If the reading is higher than specified then the converter relief valve is faulty. A low reading indicates a leaking pump seal or faulty converter relief valve.
5. Stop engine, remove test gauges and install hoses to original position.

Lubricating Pressure

Refer to Figure 13.

1. Stop engine, connect a suitable pressure gauge into the return line from the oil cooler to the transmission as shown in **J**.
2. Start engine and run at 1000 rpm. With the transmission in neutral, the pressure gauge will indicate the lubrication pressure which is specified on page 6102-1.
3. Repeat step 2 and note pressure with engine running at 2000 rpm.
4. Stop engine and remove pressure gauge.

Section 6108

TRANSMISSION HYDRAULIC LINES

6

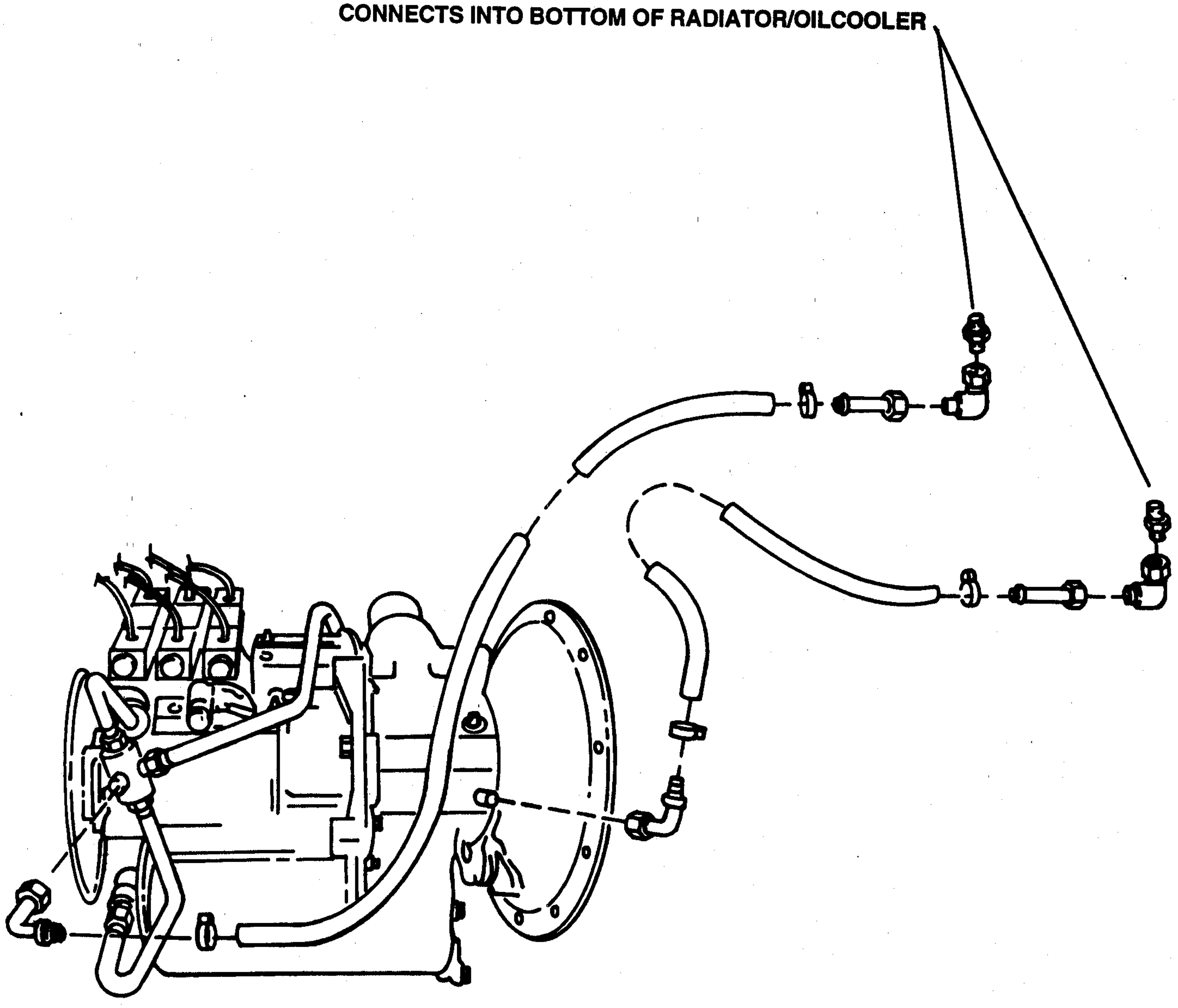


Figure 1

Section 6110

TORQUE CONVERTER
AND
POWERSHIFT TRANSMISSION

SERVICING THE TORQUE CONVERTER

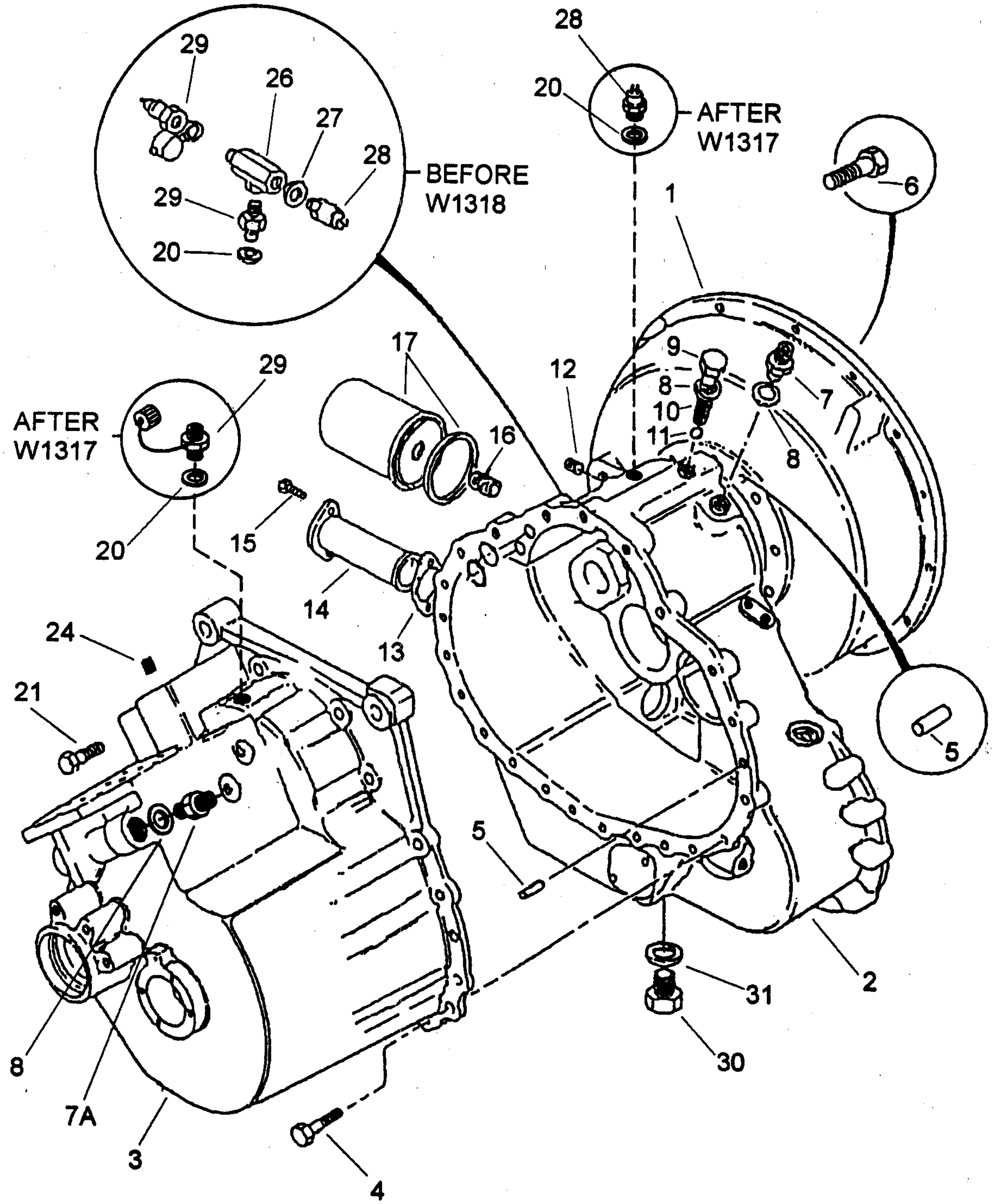
Removal

1. Remove complete power unit. See Section 2050.
2. Fasten front engine mount to work bench and put blocks under rear of engine in a way that will prevent engine from tilting. Use a hoist to hold the weight of the transmission.
3. Remove 12 bolts and lockwashers which fasten torque converter housing to engine flywheel housing. (see Figure 6).
4. The converter is fastened through a drive plate to the engine flywheel. Remove six mounting bolts to remove converter and drive plate. Then remove six bolts and lockwashers which fasten converter and reinforcement to drive plate.
5. Replace complete converter. The parts are not serviced separately. Replace drive plate if there is distortion or damage.

NOTE: It is recommended that the converter be replaced each time system contamination occurs. It is not possible to completely clean the converter by flushing to remove the contamination. Replacement of the complete assembly is necessary to prevent early failure of other components in the system.

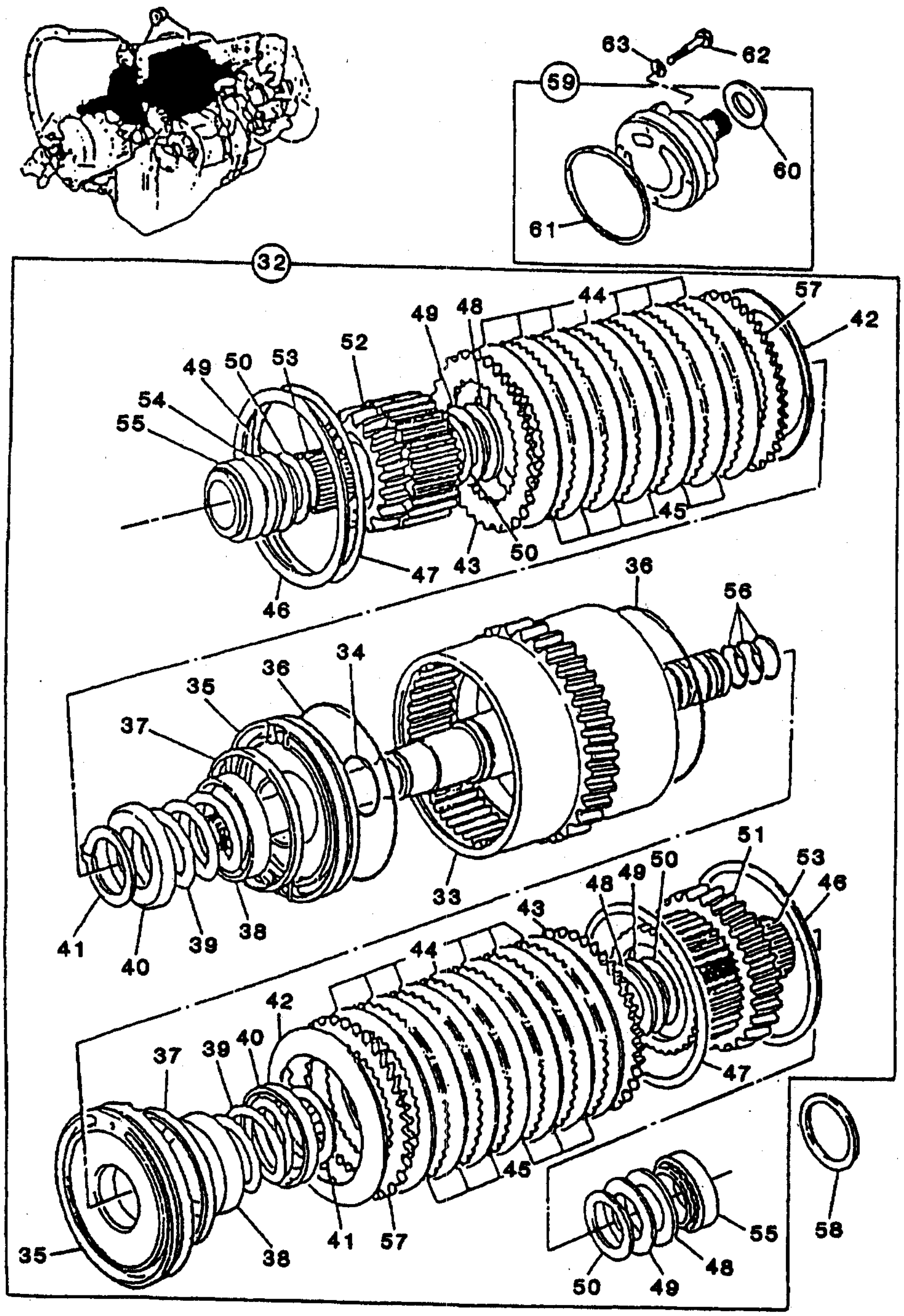
Installation

1. Assemble the drive plate and reinforcing plate to the torque converter. Tighten bolts to specified torque, Section 1051.
2. Clean the pilot bore of the engine flywheel.
3. Install the torque converter and drive plate to the engine flywheel. Check alignment of the torque converter to the flywheel. The torque converter must be centered on the flywheel within .004 inch (.102 mm). To check, use a dial indicator held in position against the converter hub.
4. Tighten the mounting bolts for the drive path to specified torque, Section 1051.
5. Clean and lubricate the splines on the input shaft.
6. Assemble torque converter housing to the engine housing. Align the splines on transmission input shaft with the splines for the torque converter impeller. Install the mounting bolts for the torque converter housing and tighten to specified torque, Section 1051.
7. Install power unit into machine. See Section 2050.
8. Connect transmission cooling lines. Fill transmission sump and lines. See Maintenance, Powershift Transmission, Section 6102.



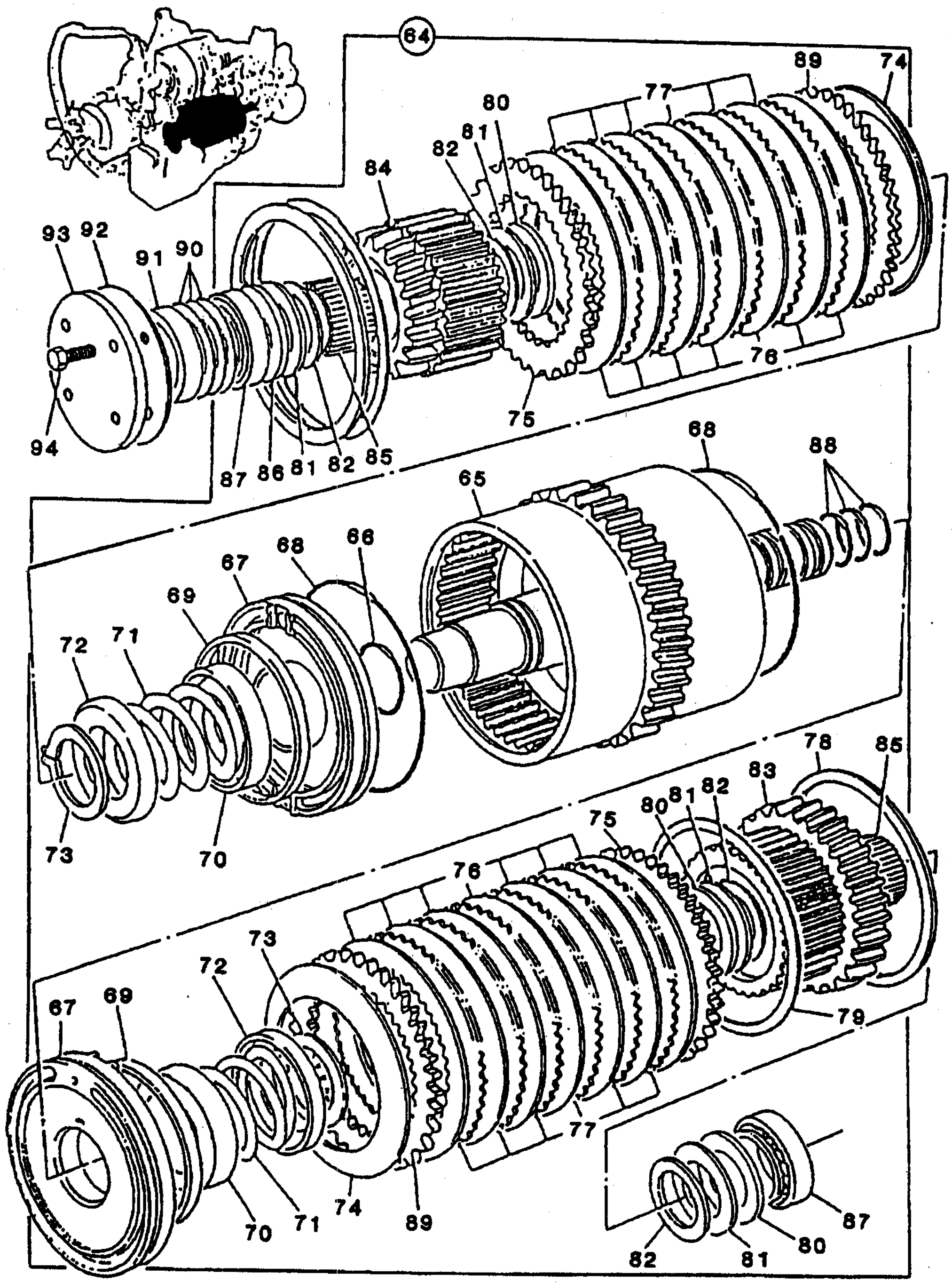
1. Flywheel Housing
2. Front Casing
3. Rear Casing
4. Bolt (19)
5. Dowel (6)
6. Screw (11)
7A. Adapter (2)
8. Seal Washer (3)
9. Plug
10. Spring
11. Ball
12. Plug (8)
13. Gasket
14. Suction Strainer
15. Capscrew (2)
16. Filter Adapter
17. Oil Filter Element
18. O-Ring (3)
20. Seal Washer (2)
21. Bolt (2)
24. Plug (7)
25. Adapter
26. Adapter
27. Washer Seal
28. Oil Pressure Switch
29. Test Adapter
30. Plug
31. Seal Washer

Figure 1. Transmission - External Components



32. Input Clutch Assembly
33. Clutch Housing
34. O-Ring (2)
35. Piston Assembly (2)
36. O-Ring (2)
37. Piston Liner (2)
38. Oil Baffle (2)
39. Spring (2)
40. Spring Retainer (2)
41. Circlip (2)
42. Spring Disc (2)
43. Pressure Plate (2)
44. Friction Plate (12)
45. Counter Plate (10)
46. Circlip (2)
47. Shim Plate (A/R)
48. Thrust Washer (2)
49. Thrust Bearing (4)
50. Thrust Washer (4)
51. Gear/Clutch Housing (High)
52. Gear/Clutch Housing (Low)
53. Bearing (2)
54. Thrust Washer (2)
55. Bearing (2)
56. Ring Seal (4)
57. Pressure Plate (2)
58. Shim Kit
59. Oil Pump
60. Shaft Seal
61. Seal
62. Bolt (4)
63. Washer (4)

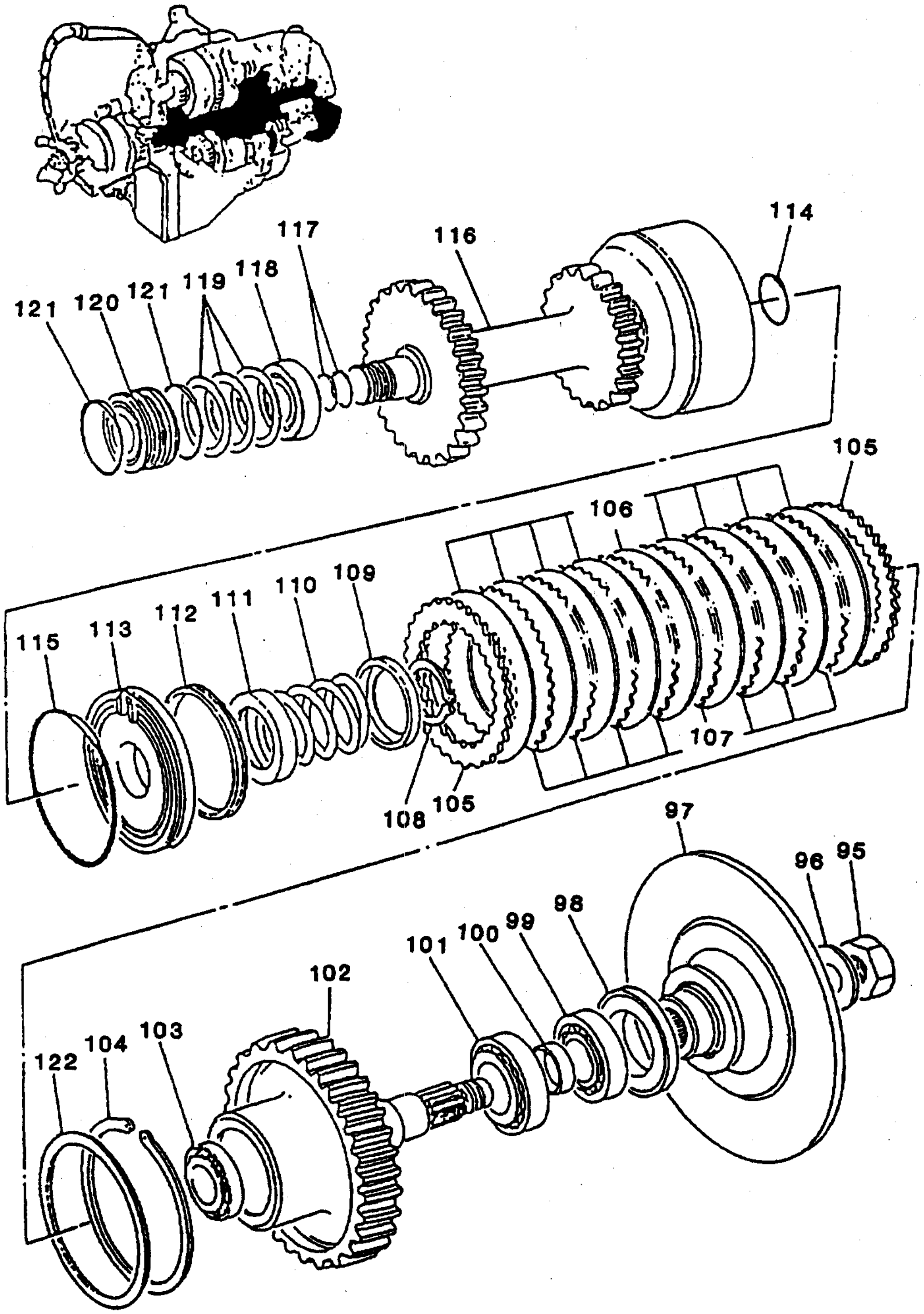
Figure 2. Transmission - Input Clutch



64. Output Clutch Assembly
65. Clutch Housing
66. O-Ring (2)
67. Piston Assembly (2)
68. O-Ring (2)
69. Piston Liner (2)
70. Oil Baffle (2)
71. Spring (2)
72. Spring Retainer (2)
73. Circlip (2)
74. Spring Disc (2)
75. Pressure Plate (2)
76. Friction Plate (12)
77. Counter Plate (10)
78. Circlip (2)
79. Shim Plate (A/R)
80. Thrust Washer (3)
81. Thrust Bearing (4)
82. Thrust Washer (4)
83. Gear/Clutch Housing (High)
84. Gear/Clutch Housing (Low)
85. Bearing (2)
86. Thrust Washer (2)
87. Bearing (2)
88. Ring Seal (4)
89. Pressure Plate (2)
90. Shim Kit
91. Spacer
92. Gasket
93. Cover
94. Bolt (4)

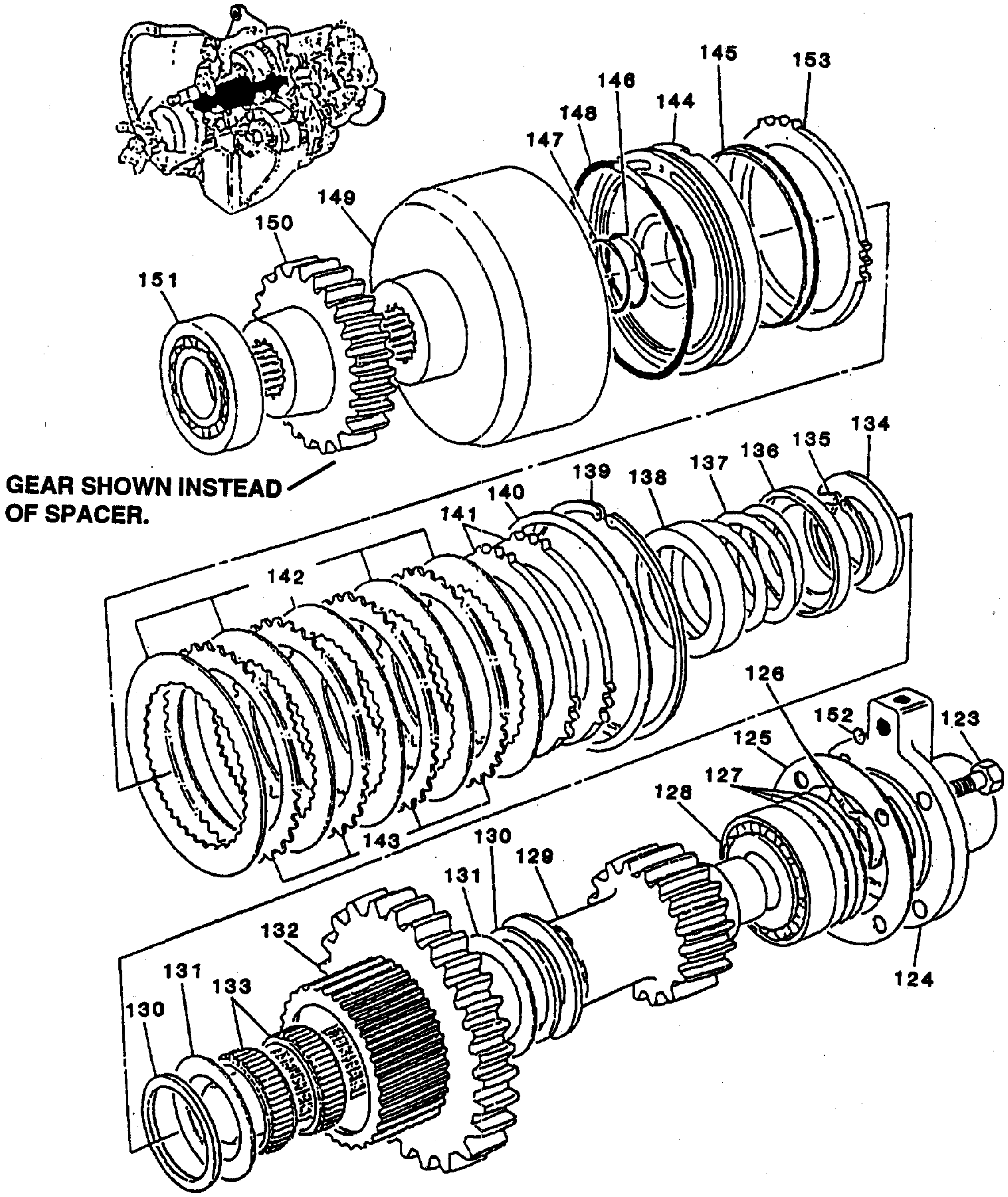
Figure 3. Transmission - Reverse Clutch

6



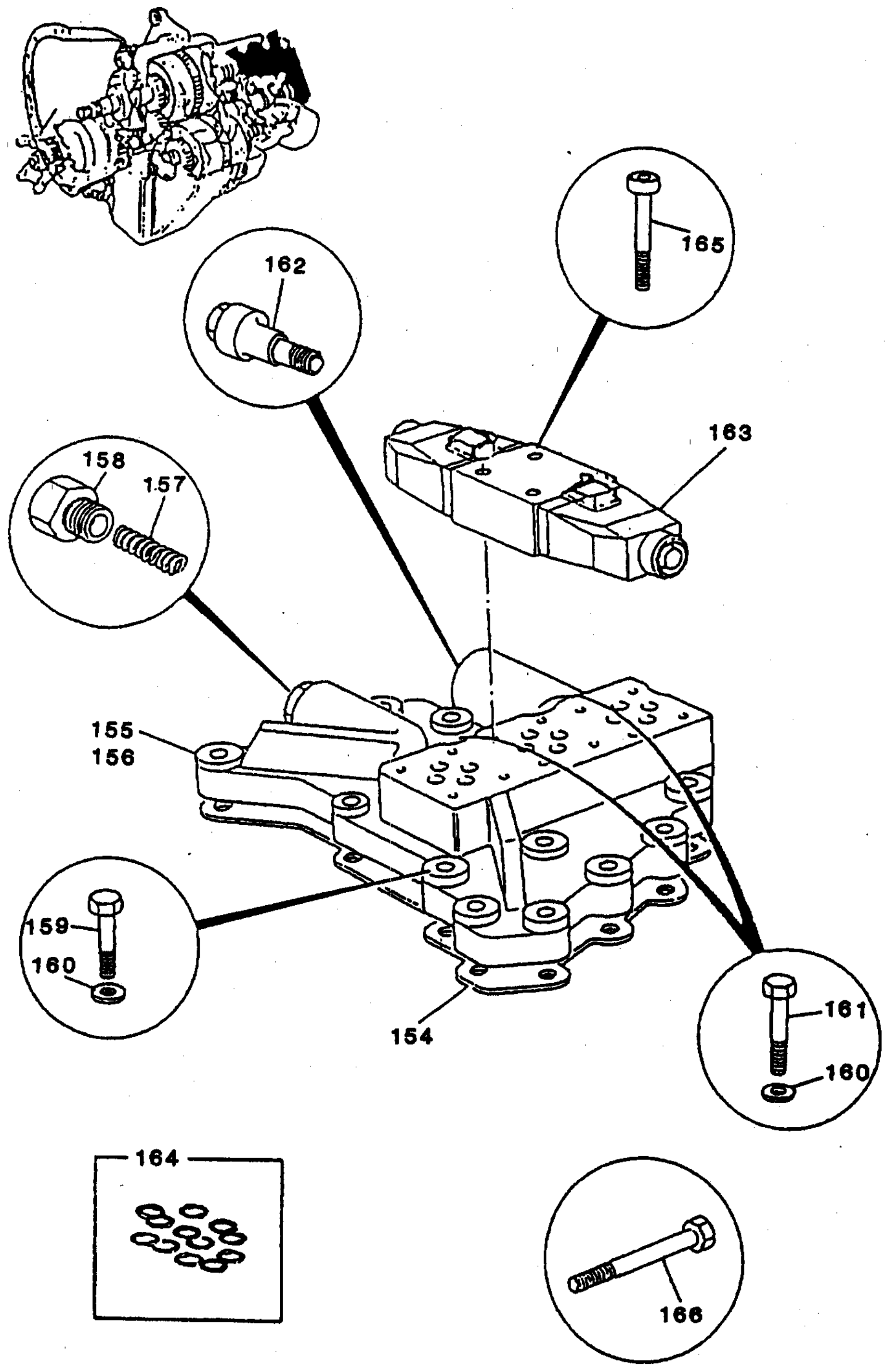
95. Nut
96. Washer
97. Output Flange
98. Seal
99. Bearing
100. Collapsible Spacer
101. Bearing
102. Transfer Gear
103. Bearing
104. Circlip
105. Pressure Plate (2)
106. Friction Plate (9)
107. Counter Plate (8)
108. Circlip
109. Spring Retainer
110. Spring
111. Oil Baffle
112. Piston Liner
113. Piston Assembly
114. O-Ring
115. O-Ring
116. Mainshaft Gear
117. Ring Seal
118. Taper Roller Bearing
119. Shim Kit
120. Mainshaft Spacer
121. O-Ring
122. Shim (A/R)

Figure 4. Transmission - Mainshaft



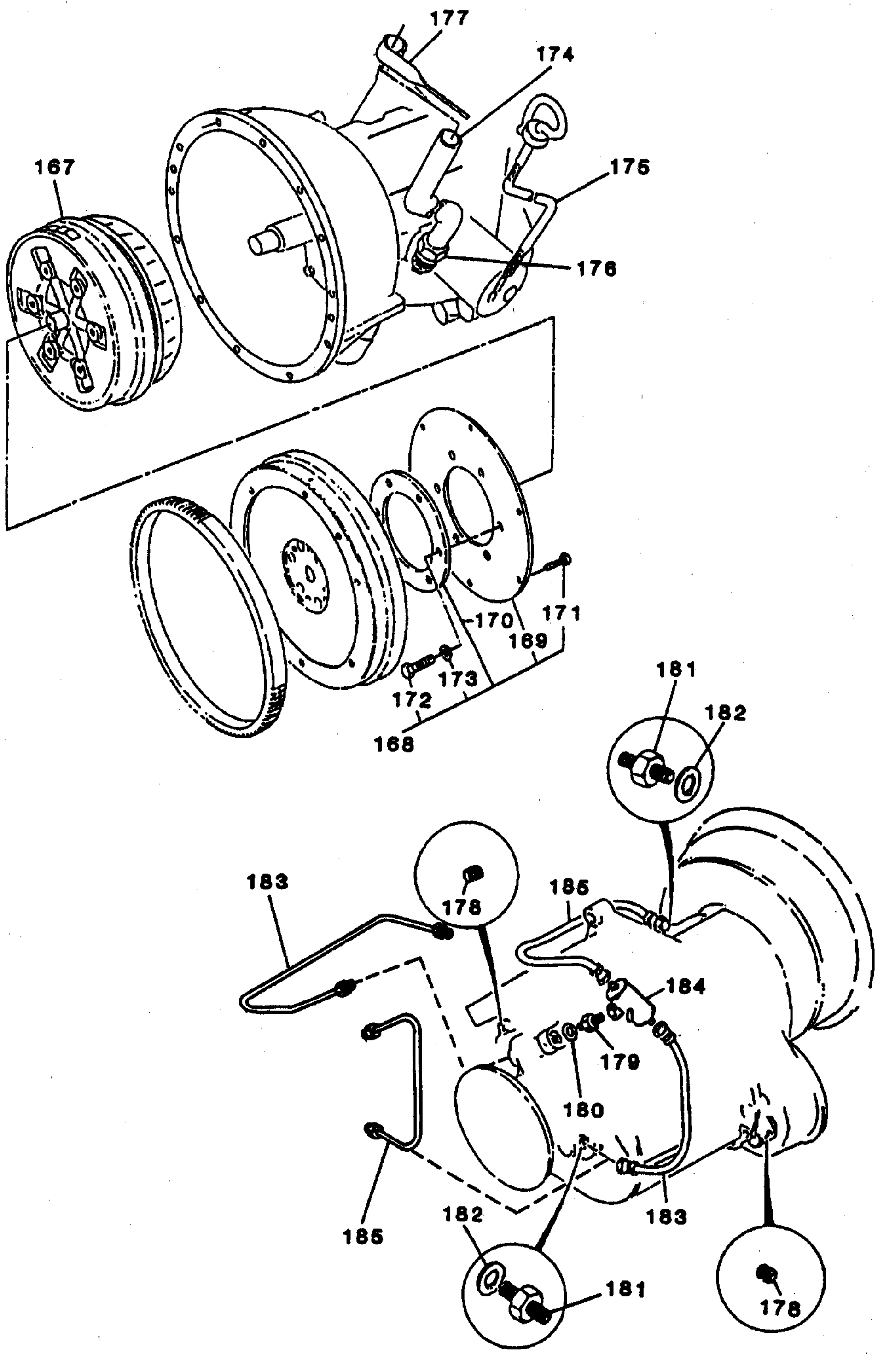
123. Coated Bolt (4)
124. End Cover
125. Gasket
126. Ring Seal
127. Shim Kit
128. Bearing
129. Layshaft Gear
130. Needle Bearing (2)
131. Thrust Washer (2)
132. Gear
133. Needle Roller Bearing (2)
134. Washer
135. Circlip
136. Spring Retainer
137. Spring
138. Oil Baffle
139. Circlip
140. Plate Shim (A/R)
141. Pressure Plate (2)
142. Friction Plate (6)
143. Counter Plate (5)
144. Piston Assembly
145. Piston Liner
146. O-Ring
147. O-Ring
148. O-Ring
149. Housing
150. Spacer
151. Bearing
152. O-Ring
153. Pressure Plate

Figure 5. Transmission - Layshaft



154. Gasket
155. Adapter Block Assembly
156. Spool
157. Spring
158. Plug
159. Bolt (14)
160. Flat Washer (16)
161. Bolt (2)
162. Plug
163. Solenoid Valve
164. Seal Kit
165. Capscrew (12)
166. Bolt

Figure 6. Transmission - Solenoid Valves



167. Torque Converter	172. Bolt (6)	177. Gearbox Filler Tube Bracket	182. Seal Washer (2)
168. Drive Plate Kit	173. Washer (6)	178. Plug (2)	183. Pipe
169. Drive Plate	174. Filler Tube	179. Adapter (2)	184. Manifold
170. Reinforcing Plate	175. Dipstick	180. Seal Washer (2)	185. Pipe
171. Bolt (6)	176. Nut	181. Adapter (2)	

Figure 7. Transmission - Drive Components and Piping

SERVICING THE POWERSHIFT TRANSMISSION

IMPORTANT: To properly service this transmission, special tools are required. DO NOT attempt to perform service without the tools. See page 6110-28.

Removal:

1. Follow removal instructions for the torque converter and remove the torque converter.

Disassembly:

1. Remove drain plug (30, Figure 1). Drain lubricant from transmission into a suitable container.
2. Remove and discard oil filter (17). Remove filter adapter (16).
3. Unscrew bolts (A, Figure 8) and remove the torque converter pump assembly.

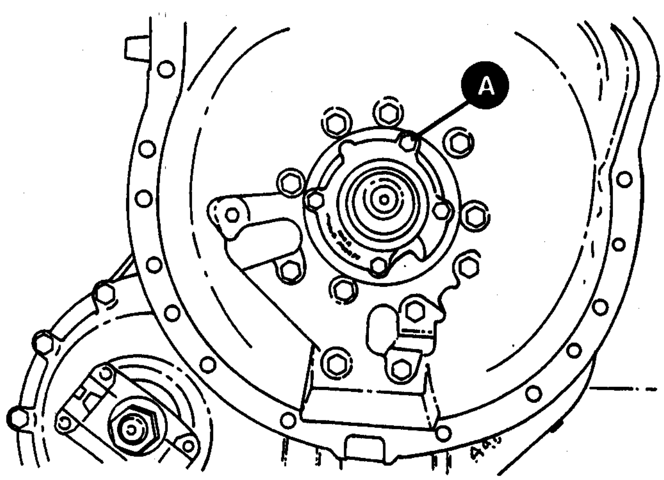


Figure 8.

4. Remove and discard pump sealing ring (61, Figure 2).
5. Separate the torque converter pump components. Remove and discard oil seal (60) from pump housing.
6. Remove twelve capscrews (B, Figure 9). Remove the three solenoid valves (C).
7. Unscrew sixteen bolts (D, Figure 10) and remove the solenoid adapter block. Remove and discard the solenoid adapter block gasket.
8. Unscrew plug and withdraw pressure maintenance valve spool and spring.

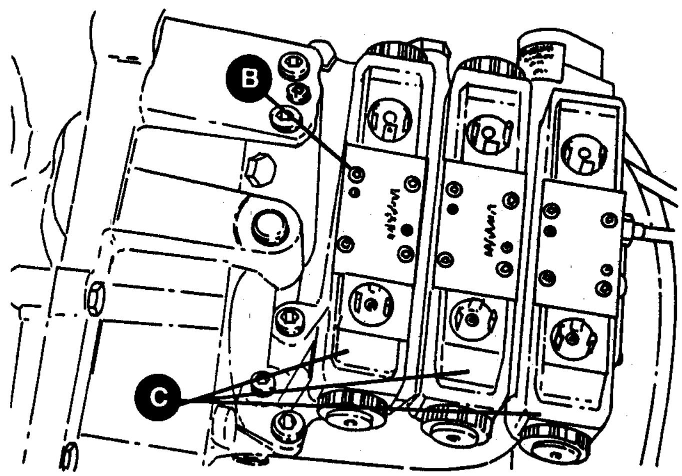


Figure 9.

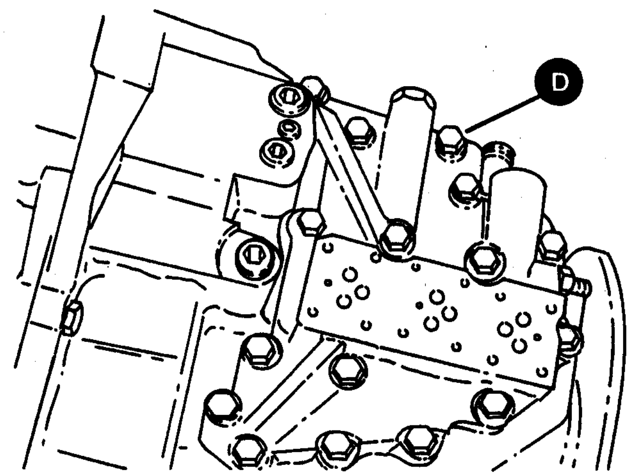


Figure 10.

9. Position transmission vertically, standing on face of flywheel housing.

> **CAUTION:** The transmission weighs approximately 236 lb. (107 kg). A crane must be used to move the transmission into a vertical position.

10. Remove plug (9, Figure 1), relief valve ball (11), spring (10), and seal (8) from front casing (2).
11. Remove four bolts (123, Figure 5) and remove layshaft end cap (124). Remove gasket (125), shims (127), ring seal (126) and o-ring (152).

NOTE: The brake mounting bracket must be removed to allow access.

12. Unscrew nineteen bolts (4, Figure 1) and lift off rear casing (3).

NOTE: Make sure that the internal components remain seated in the front casing. If necessary, rotate the brake disc back and forth slightly to dislodge the internal components.

13. Note the three o-rings fitted next to the input and reverse clutch assemblies. See Figure 11.

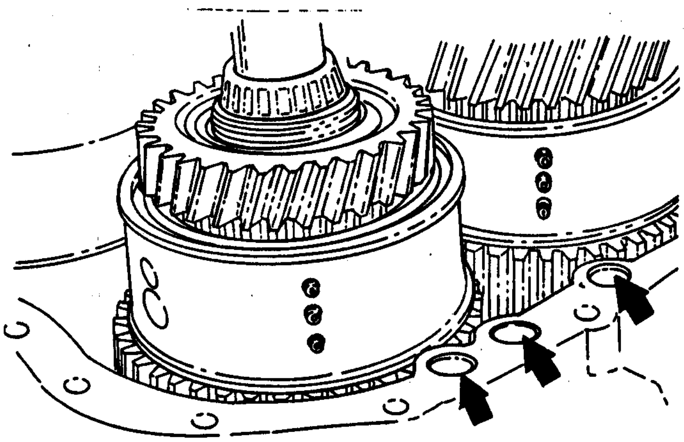


Figure 11.

14. Tilt and lift out the layshaft assembly (**E**, Figure 12).

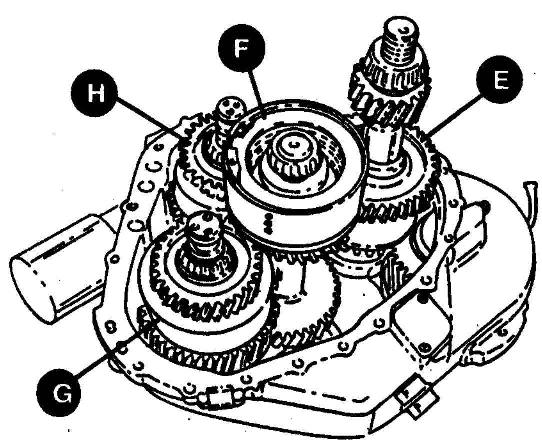


Figure 12.

NOTE: For reference, the clutch assemblies are identified as follows:

E = Layshaft

F = Mainshaft

G = Reverse Clutch

H = Input Clutch

15. With the help of an assistant, lift and tilt both mainshaft and input clutches as shown in Figure 13; then tilt and lift out the reverse clutch (**G**).

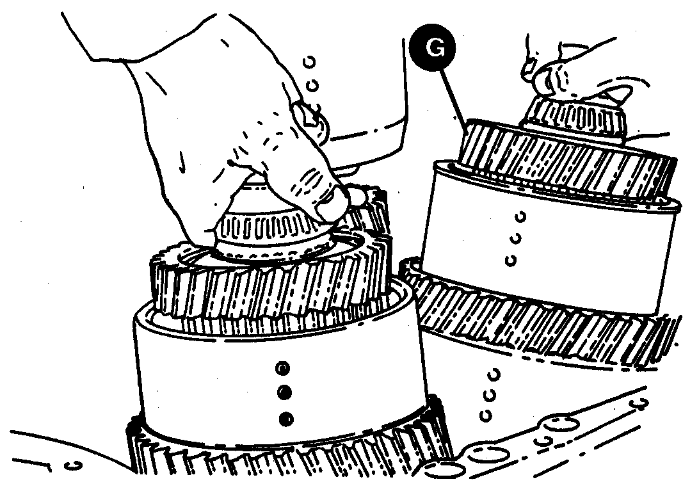


Figure 13.

16. Slightly lift the input clutch and at the same time tilt and lift out mainshaft (**F**, Figure 14).

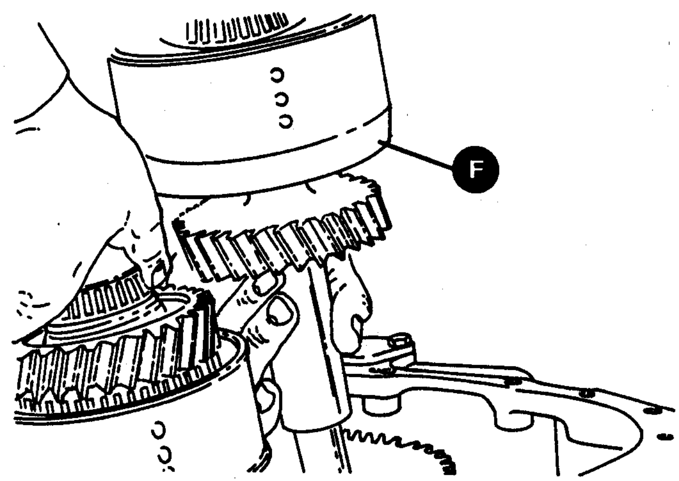


Figure 14.

6

17. Lift out the input clutch (**H**, Figure 13).

18. Unscrew eleven bolts (6, Figure 1) and remove flywheel housing (1).

19. Secure the brake disc using tool P/N 1001835 as shown in Figure 15. Unscrew output shaft nut. Support output shaft from beneath and lift off brake disc. Remove the output shaft assembly from the rear casing.

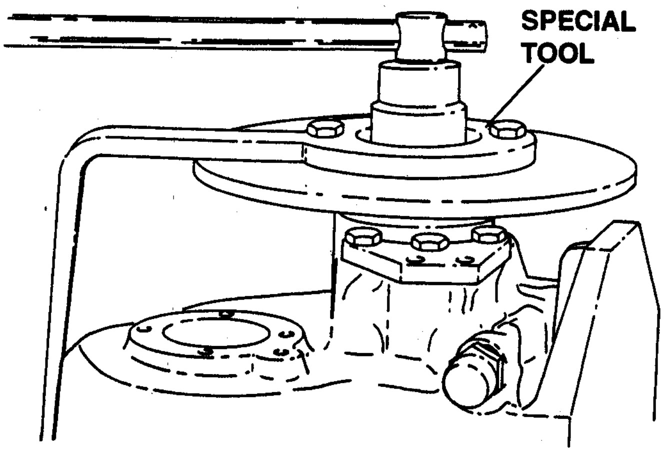


Figure 15.

20. Pry out oil seal (98, Figure 4) from the rear casing. Remove outer taper bearing (99). Remove and discard collapsible spacer (100).

21. Using a suitable puller, remove output shaft inner bearing (101).

22. Remove two capscrews (15, Figure 1) and remove strainer (14). Discard strainer gasket (13).

Assembly

NOTE: After repair and replacement of parts, make sure casings and parts have been thoroughly cleaned using suitable solvents before starting assembly procedures.

When assembling, coat bearings with a good grade high pressure grease. Replace all o-rings, seals and gaskets.

Remember that dirt in the transmission system will cause damage to the transmission and its associated parts.

1. Install suction strainer (14, Figure 1), new gasket (13). Apply Loctite #270 to capscrews (15) and tighten to 7 lb-ft. (10 Nm).

2. Remove the mainshaft end spacer (Figure 16). Remove and discard the two o-rings. DO NOT install new o-rings at this time. Install the spacer.

   This is a preparatory step for setting the mainshaft end float. At a later time, it will be necessary to remove the end spacer so the shims can be installed to correct end float tolerances. If the o-rings are left on at this stage, the seal prevents the spacer from being removed. New o-rings are installed once the correct mainshaft end float has been established.

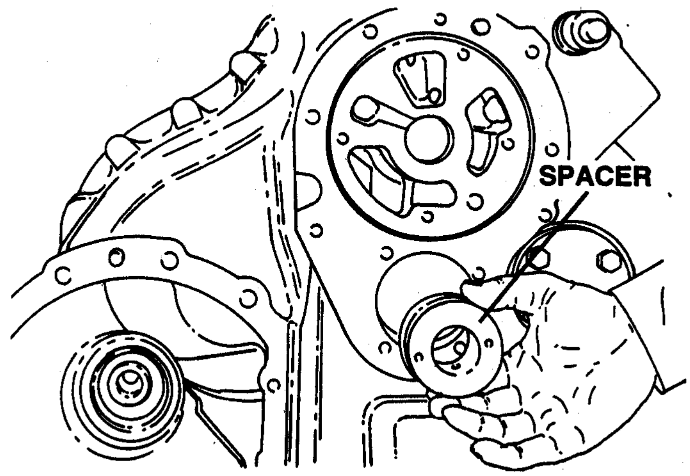


Figure 16.

3. Position flywheel housing (1, Figure 1) to front casing (2). Install eleven screws (6) and tighten to a torque of 42 lb-ft. (56 Nm).

4. Coat output shaft inner bearing (101, Figure 4) with high pressure grease before installing. Install bearing onto output shaft. Install a new collapsible spacer (100) over output shaft. Insert assembled output shaft into rear casing.

5. Coat outer bearing (99) with high pressure grease and install into rear casing. Coat oil seal (98) with grease and install in rear casing. Be sure grease is applied between the seal lips.

6. Install brake disc and NEW retaining nut. Tighten retaining nut to achieve a rolling torque of 1.1 to 2.1 lb-ft. (1.5 to 2.8 Nm), inclusive of seal drag.

IMPORTANT: If this torque is accidentally exceedes the output shaft must be disassembled and the collapsible spacer replaced.

7. Stake retaining nut into the slot on the output shaft.

8. Position transmission vertically, standing on face of the flywheel housing. Coat piston ring seal and pump end bearing with high pressure grease. Carefully lower input clutch into front casing.

9. Assemble the rear casing to the front casing. Tighten bolts (4, Figure 1) to torque of 42 lb-ft. (56 Nm).

   Assembling the case halves at this stage is a temporary arrangement to enable measurement of the input shaft end float.

NOTE: To prevent damaging input shaft piston ring seals (56, Figure 2), it is permissible to remove the seals prior to assembling case halves. However, this is applicable only while measuring input shaft end float. INSTALL THE SEALS BEFORE FINAL ASSEMBLY.

10. Position transmission horizontally and measure the end float of the input clutch shaft (Figure 17), which should be 0.001-0.003 inches (0.03 to 0.08 mm). Rotate the shaft while measuring to fullyseat bearings.

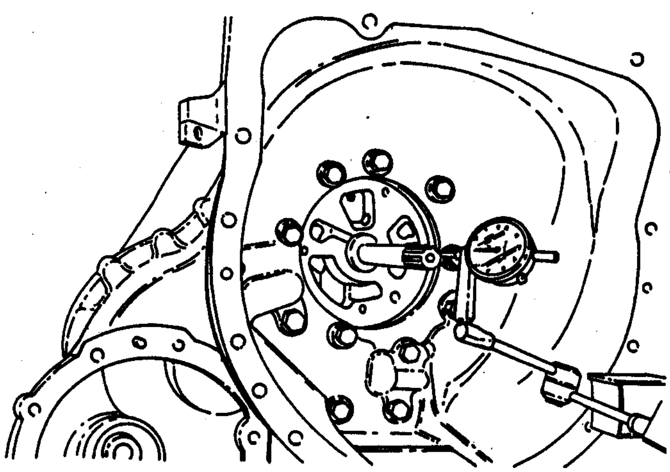


Figure 17.

11. Separate the two casing halves and add or subtract shims (Figure 18) beneath the bearing outer race in the rear casing to correct input clutch shaft end float. Repeat steps 9 and 10 to recheck the end float.

    When correct end float is obtained, remove the input clutch and install piston ring seals removed in step 9.

NOTE: Production machines have the shims filled in the front casing; however, when servicing the transmission, it is permissible to install shims in rear casing.

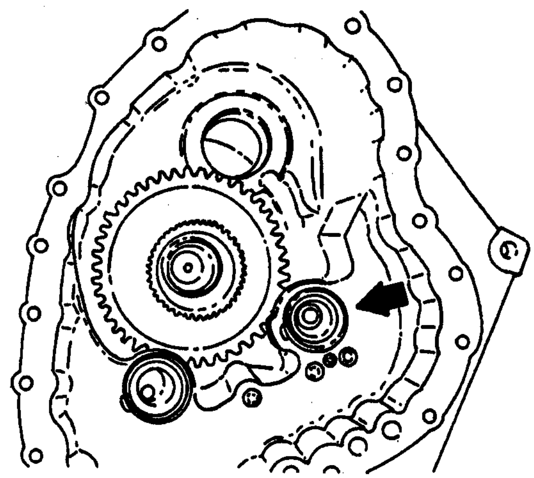


Figure 18.

12. Install the input clutch and the mainshaft (**F**, Figure 19) simultaneously into the front case as shown. Before fitting make sure that piston ring seals have been lightly greased, and both the input clutch and mainshaft taper roller bearings have been coated with high pressure grease.

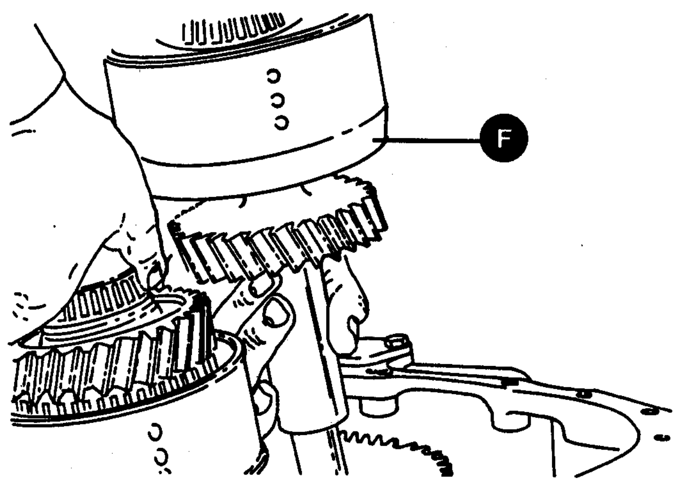


Figure 19.

6

13. This step requires the help of an assistant. Have the assistant SLIGHTLY raise and tilt the input clutch and mainshaft, while the assistant is holding the two units, fit the reverse clutch (**G**, Figure 20).

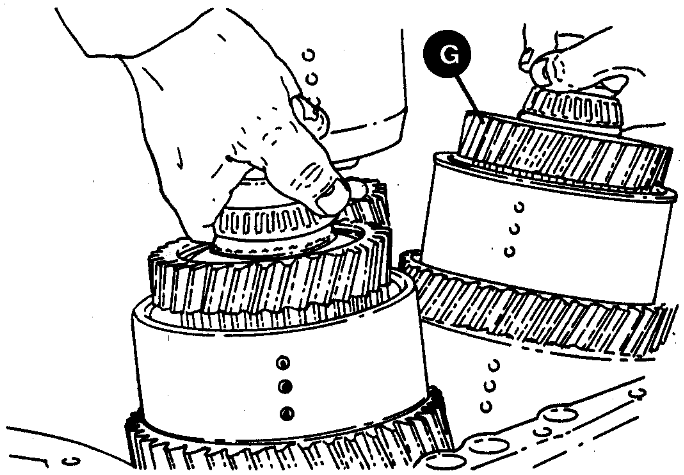


Figure 20.

14. Coat the layshaft taper roller bearing with clean oil and fit the layshaft assembly (**E**, Figure 21).

    The clutch assemblies should now be installed in front case as shown in the photograph. Make sure that all bearings are fully seated, and that the relevant gears have meshed correctly.

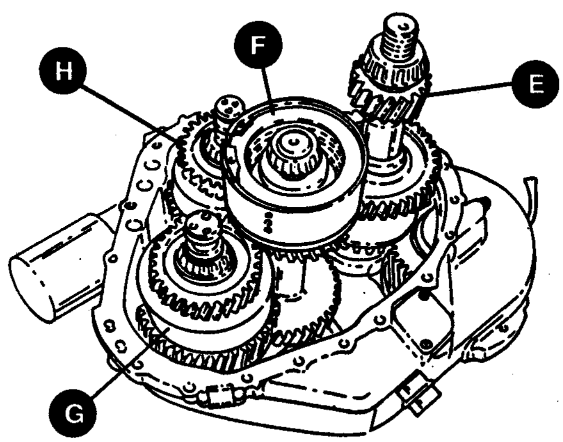


Figure 21.

15. Using two small screwdrivers (Figure 22) align the friction/counter plates of the mainshaft clutch.

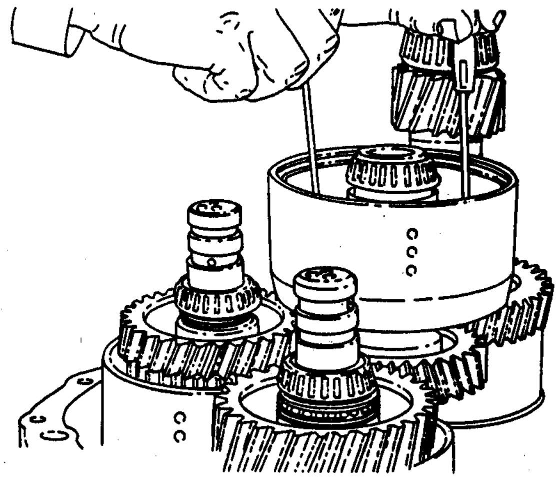


Figure 22.

16. Install three new o-rings (Figure 23) in the front case. Smear the o-rings with grease to hold in position.

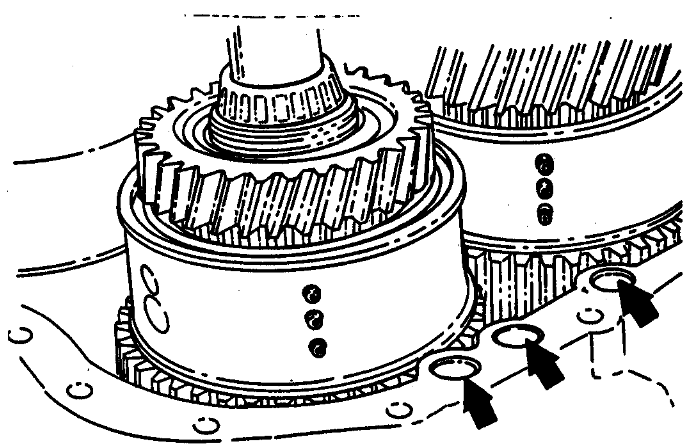


Figure 23.

17. Apply a good grade liquid gasket in front case mating face (Figure 24). Prior to fitting the rear (output) case, make sure all bearings have been coated with high pressure grease. Make sure all piston rings seals are in good condition and have been coated with grease.

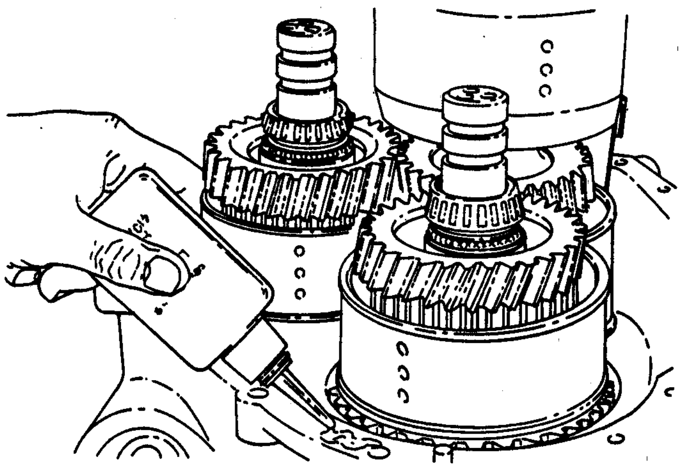


Figure 24.

NOTE: Do not apply an excessive amount of liquid gasket around o-rings (see step 16); too much can dislodge the o-rings.

18. Make sure the friction/counter plates in the mainshaft clutch are aligned (see step 15).

    Carefully lower rear (output) case into position, taking care to align output gear splines with the mainshaft clutch friction/counter plates. Apply Loctite 270 to bolts and torque to 42 lb-ft. (56 Nm).

19. Using a new gasket (125, Figure 5) install the layshaft end cap (124) and shims (127), tighten retaining bolts (123) a torque of 42 lb-ft. (56 Nm).

    Fitting the layshaft end cap at this stage is a temporary arrangement to enable measurement of the layshaft end float.

NOTE: Take care not to damage the gasket as it must be used for final assembly.

20. Position the transmission horizontally. Unscrew screws (6, Figure 1) and remove the flywheel housing (1).

21. Measure layshaft end float, which should be 0.001 to 0.003 inches (0.03 to 0.08 mm). (See Figure 25).

    See page 6110-27 for the correct end float checking procedure.

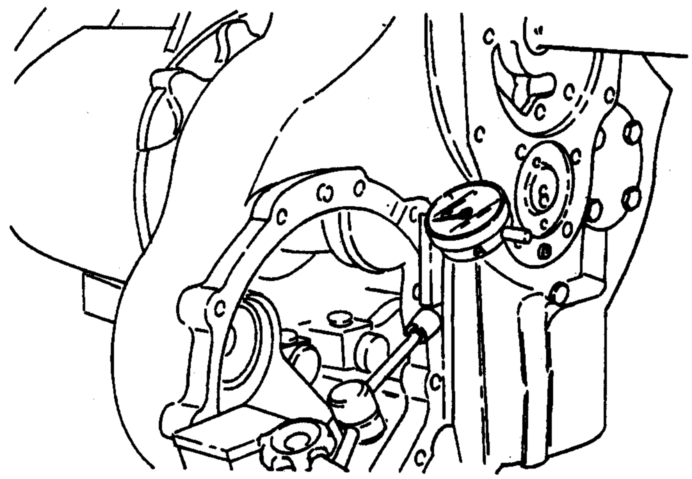


Figure 25.

NOTE: Turn the layshaft using the brake disc.

22. Remove the layshaft end cap (124, Figure 5) and add or subtract shims (127) to give correct end float. Fit shims between outer race and layshaft end cap (124).

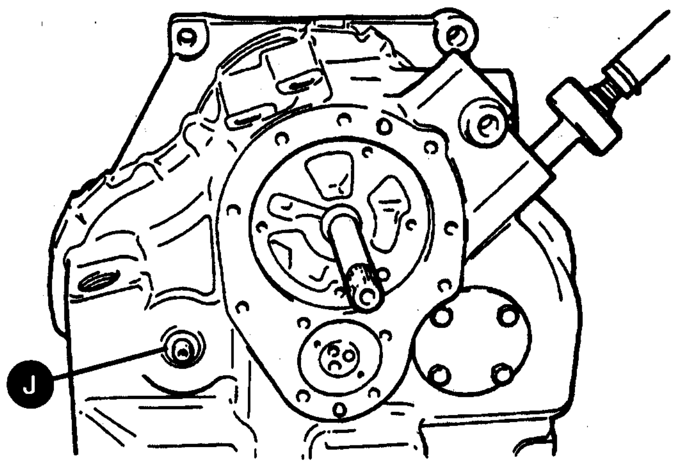


Figure 26.

    Install blanking plug (J, Figure 26).

23. Prior to final fitting of the layshaft end cap (124, Figure 5), fit a new o-ring (152) in the rear case. Coat the o-ring with grease to hold in position.

24. Coat the layshaft outer bearing (128) with high pressure grease. Install the layshaft endcap with its new gasket. Apply Loctite 270 to bolts and tighten a torque of 42 lb-ft. (56 Nm).

    Install brake mounting bracket removed in step 11 (Disassembly). Tighten mounting bolts to a torque of 63 lb-ft. (85 Nm).

25. Install mainshaft end float tool **K** (P/N 1001836) over the mainshaft end bearing and spacer, as shown in Figure 27. Tighten securing bolts to a torque of 42 lb-ft. (56 Nm.)

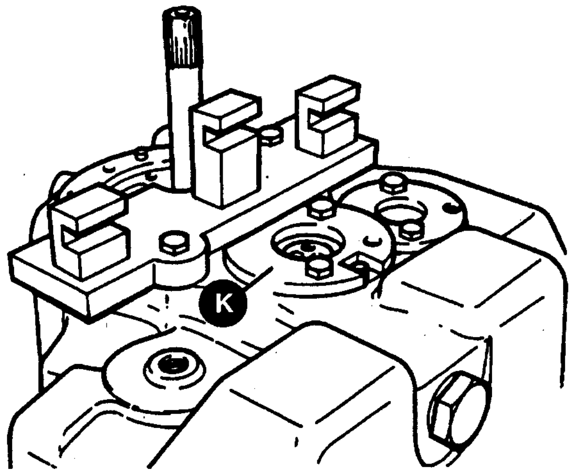


Figure 27.

26. Measure mainshaft end float which should be 0.001 to 0.003 inches (0.03 to 0.08 mm).

    See page 6110-27 for the correct end float checking procedure.

NOTE: Turn the main shaft using the brake disc.

NOTE: The main shaft clutch must be engaged to carry out this check. To engage the clutch, install airline adapter **L**, as shown in Figure 28 and apply low pressure compressed air.

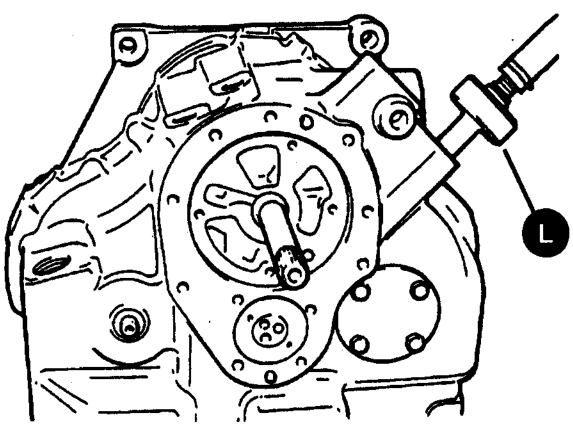


Figure 28.

27. Add or subtract shims (119, Figure 4) to correct the end float. The shims must only be fitted between the bearing outer race (118) and spacer (120). When the correct end float has been established - INSTALL NEW O-RINGS (121) ON SPACER.

NOTE: In step 2 the mainshaft end spacer was fitted without its o-rings so that it could be readily removed.

NOTE: Install the spacer with the extraction holes facing towards you.

28. Unscrew reverse clutch cover bolts (94, Figure 3) and remove cover.

29. Install special tool, P/N 1001833 (Figure 29) together with a new gasket in place of reverse clutch cover cap. Tighten bolts to a torque of 42 lb-ft. (56 Nm).

NOTE: Take care not to damage the gasket as it must be used for final assembly.

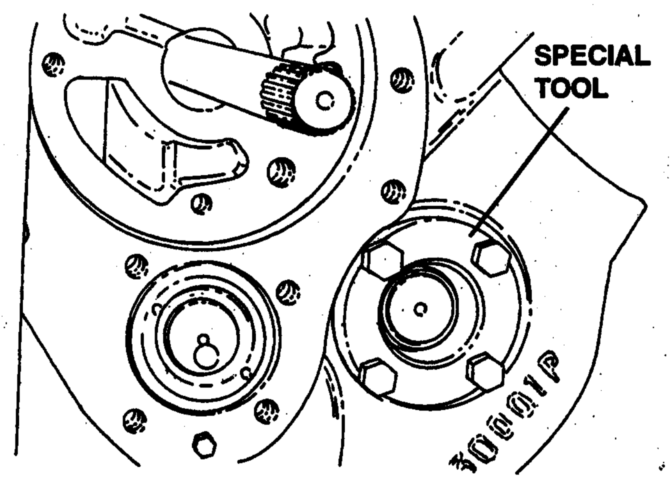


Figure 29.

30. Measure reverse clutch shaft end float which should be 0.001 to 0.003 inches (0.03 to 0.08 mm).

    See page 6110-27 for the correct end float checking procedure.

NOTE: Turn the reverse clutch shaft using the input shaft.

31. Add or subtract shims to correct the end float. The shims must only be fitted between the bearing outer race (87) and spacer (91).

32. Coat the reverse clutch bearing (87) with high pressure grease. Fit the reverse clutch end cover (93) and gasket (92). Apply Loctite #270 to bolts (94) and tighten to a torque of 42 lb-ft. (56 Nm).

33. Make sure all bearings have been lubricated with high pressure grease. Apply a good grade of liquid gasket to mating face of flywheel housing. Install the flywheel housing. Apply Loctite #270 to screws (6, Figure 1) and tighten to a torque of 42 lb-ft. (56 Nm). Install a new pump sealing ring (61, Figure 2).

34. Assemble pump (if disassembled). Install pump taking care to align mounting holes. Apply Loctite #270 to bolts (A, Figure 30) and, using a new sealing washers, tighten to a torque of 21 lb-ft.(28 Nm).

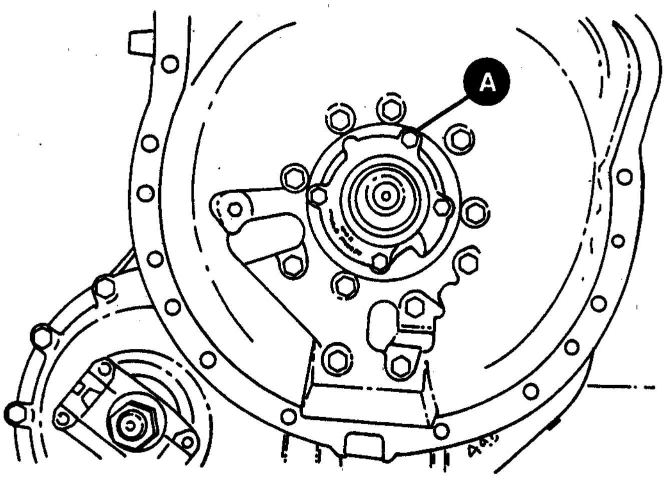


Figure 30.

35. Install torque converter relief valve ball (11, Figure 1) and spring (10). Make sure that the larger diameter of the spring is located securely over the spigot on the plug. Use a new sealing washer (8) then install and tighten plug (9).

36. Using a new gasket, fit the solenoid adapter block to the casing (Figure 31). Apply Loctite #270 to bolts (**D**) and tighten to torque of 21 lb-ft. (28 Nm).

37. Assemble pressure maintenance valve spool and spring into adapter block (Figure 31). Fit and tighten plug. Do not over-tighten as damage to the aluminum housing could result.

38. Mount the input (forward) high/low clutch solenoid (Figure 32) onto adapter block. Install capscrews (**B**) and tighten to a torque of 4 lb-ft. (5 Nm).

    Fit seal caps over capscrews (**B**).

NOTE: The mounting holes will only align when the solenoid valve has been positioned correctly on the adapter block.

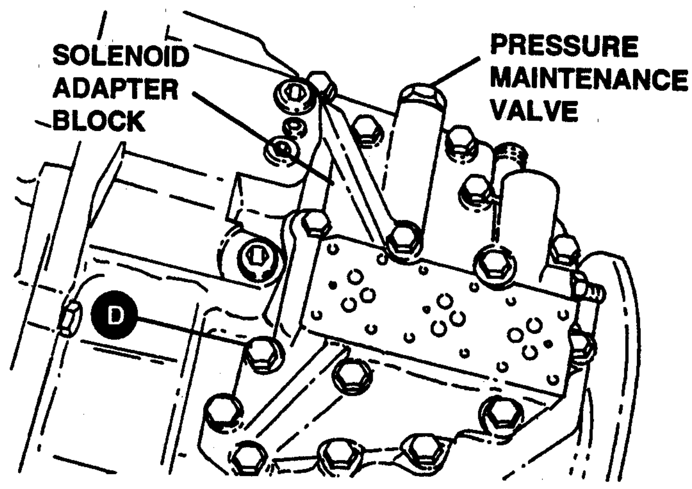


Figure 31.

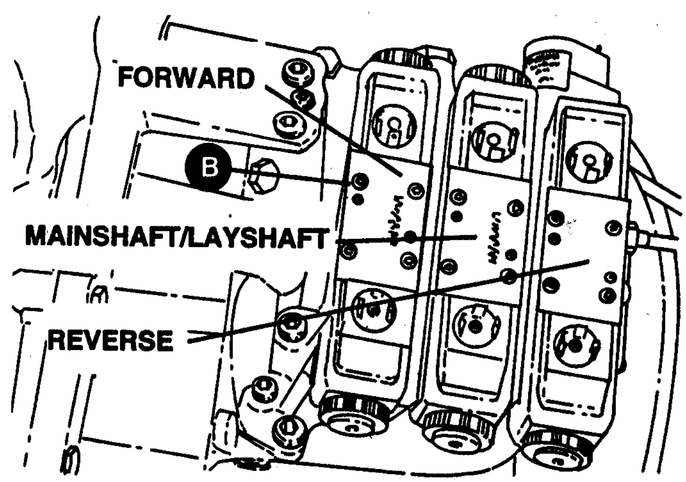


Figure 32.

39. Mount the mainshaft/layshaft clutch solenoid valve onto adapter block. Install capscrews (**B**) and tighten to a torque of 4 lb-ft. (5 Nm).

    Fit sealing caps over capscrew (**B**).

40. Mount the reverse high/low clutch solenoid valve onto adapter block. Fit capscrews (**B**), and tighten to a torque of 4 lb-ft. (5 Nm).

    Fit sealing caps over capscews (**B**).

NOTE: The mounting holes will only align when the solenoid valve has been positioned correctly on the adapter block.

41. Coat seal of new filter (17, Figure 1) with oil and install hand tight only. Fit the drain plug (30) with a new sealing washer (31), tighten to a torque of 150 lb-ft. (203 Nm). Install a new sealing washer (8) to mainline pressure test adapter (7A).

INPUT CLUTCH

Disassembly (See Figure 2)

1. Carefully remove piston ring seals (56, Figure 2).

NOTE: If piston ring seals are excessively worn then check for burrs or damage on shaft grooves. If necessary, remove burrs with a fine grade abrasive paper and oil.

2. Loosen the high clutch end bearing by tapping the assembly on a piece of aluminum as shown in Figure 33.

NOTE: If aluminum is not available then tap the assembly on wood, but make sure that the oil feed holes do not become blocked.

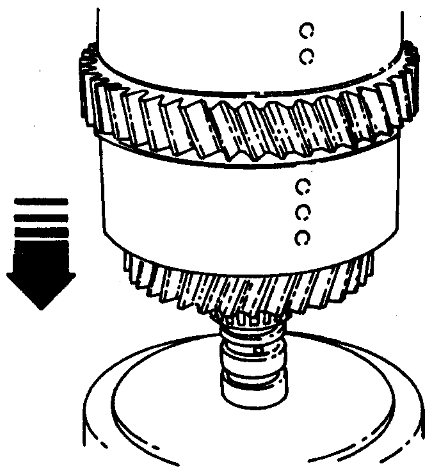


Figure 33.

3. Remove bearing (55, Figure 2), one thick thrust washer (54), one thrust washer bearing (49) and one thin thrust washer (50).
4. Remove the high gear/clutch housing (51) with the needle roller bearing (53).
5. Remove one thin washer (50), one thrust bearing (49) and one thick thrust washer (48).
6. Remove circlip (46). Remove pressure (end) plate (43). Remove the clutch friction/counter plates (44 and 45). Keep them together in sets. DO NOT mix the plates with those from other clutches.
7. Remove pressure (end) plate (57). Remove disc spring assembly (42). The disc spring is assembled within a liner to protect the hub support spline.
8. Position clutch assembly in press to compress piston spring (39) and remove circlip (41). See Figure 34. Lift off spring retaining plate (40, Figure 2).

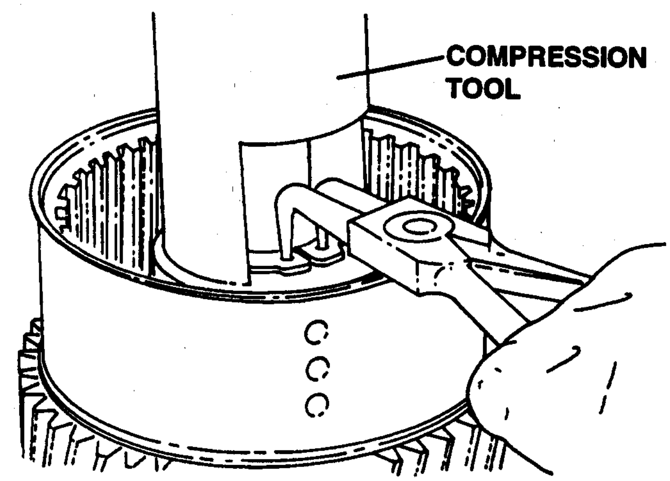


Figure 34.

9. Knock the clutch shaft on a piece of aluminum (or wood) to remove the piston (See Figure 35). If the piston does not loosen when the clutch shaft is knocked on aluminum, then hand pump air down the shaft oil inlet hole.

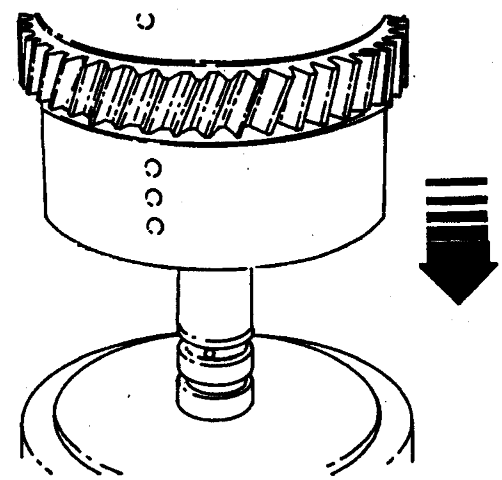


Figure 35.

10. Remove piston assembly (35, Figure 2). Remove and discard piston o-rings (34). Make sure the piston liner (37) is secure. The liner must be a tight fit on the piston.

11. Loosen the low clutch end bearing (53) by tapping the assembly on a piece of aluminum. See Figure 36. Remove bearing using pullers.

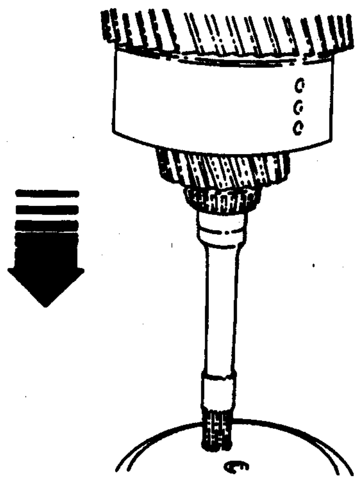


Figure 36.

12. Repeat step 3 through 11 to disassembly the input low clutch assembly.

Assembly (See Figure 2)

1. Install new o-rings (34 and 36, Figure 2) onto piston and shaft (35), lubricate with oil then press piston fully into bore of clutch housing (33).
2. Install the oil baffle (38) and piston spring (39). Make sure that oil baffle (38) seats on piston (35).

   Install spring retainer plate (40).

   Compress spring (39) and secure with circlip (41). See Figure 37.

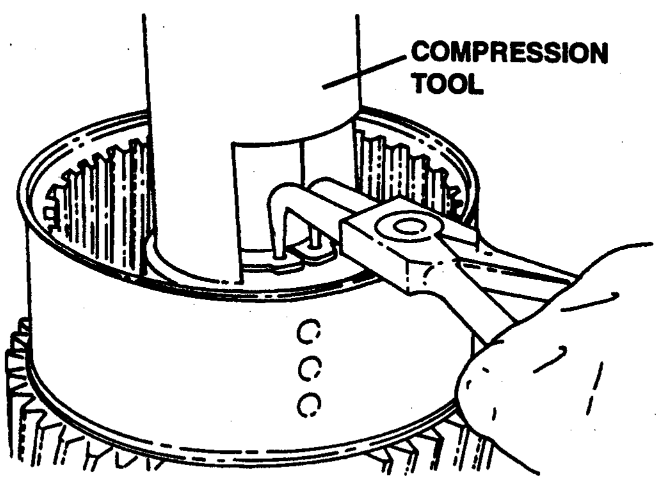


Figure 37.

3. Install disc spring assembly (40, Figure 2). Install the assembly so that the outer diameter curves away from the clutch piston.

NOTE: The disc spring is assembled with a liner to protect the hub support spline.

4. Install pressure (end) end plate (57). Make sure that the prongs on the pressure plate DO NOT locate in the large grooves in the hub (the ones with drilled holes).

   First, fit one friction plate (44) followed by one steel counter plate (45).

   Continue fitting alternate friction and steel counter plates, finishing with a friction plate.

5. Install pressure (end) plate (43). Make sure that the prongs on the pressure plate DO NOT locate in the large grooves in the hub (the ones with drilled holes). Install circlip (46).
6. Using a dial test indicator as shown in Figure 38, measure the end float of the pressure (end) plate, which should be 0.075 to 0.126 inches (1.90 to 3.20 mm). If necessary, fit shims (47, Figure 2) between the retaining circlip (46) and pressure (end) plate (43) to correct end float inaccuracies.

NOTE: Later type shim has teeth on the outside diameter; the teeth inhibit it from spinning during operation. If the shim removed from the clutch does not have teeth, then discard it and use the new type shim.

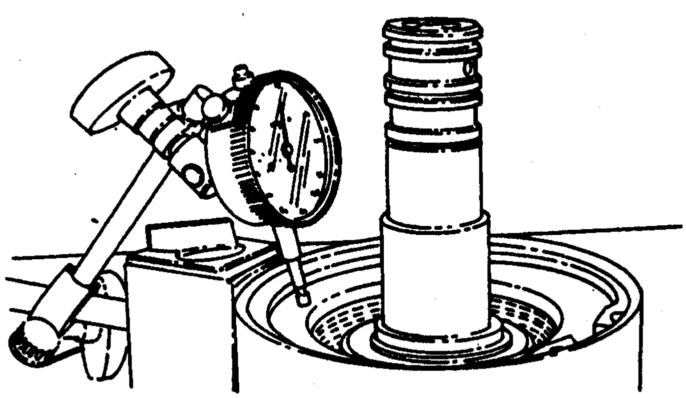


Figure 38.

7. Install one thick washer (48, Figure 2), one thrust bearing (49) followed by one thin thrust washer (50).
8. Install High Gear/Clutch Housing (51).

9. Install needle roller bearing (53). Install one thin thrust washer (50), one thrust bearing (49) followed by one thick thrust washer (54).

10. Coat the high clutch end bearing (55) with high pressure grade grease and press bearing (55) onto shaft.

11. Install piston ring seals (56).

NOTE: If the piston ring seals are the polytetraflouroethene (PTFE) type, then see page 6110-26 for correct fitting procedure.

12. Repeat steps 1 through 11 for the opposite clutch, make sure that the low clutch and taper roller bearing are coated with grease. Fit the bearing using a hollow tube as shown in Figure 39 and then fit the piston ring seal.

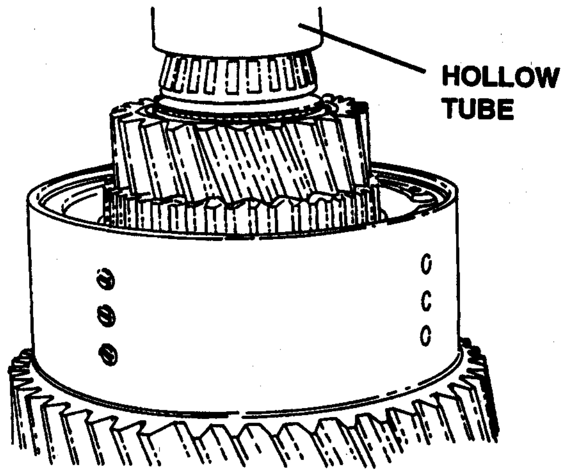


Figure 39.

REVERSE CLUTCH

Disassembly (See Figure 3)

1. Carefully remove piston ring seals (88, Figure 3).

NOTE: If the piston ring seals are excessively worn then check for burrs or damage on shaft grooves. If necessary, remove burrs with a fine grade abrasion paper and oil.

2. Loosen the high clutch end bearing by tapping the assembly on a piece of aluminum as shown in Figure 40.

NOTE: If aluminum is not available, then tap the assembly on wood, but make sure that the oil feed holes do not become blocked.

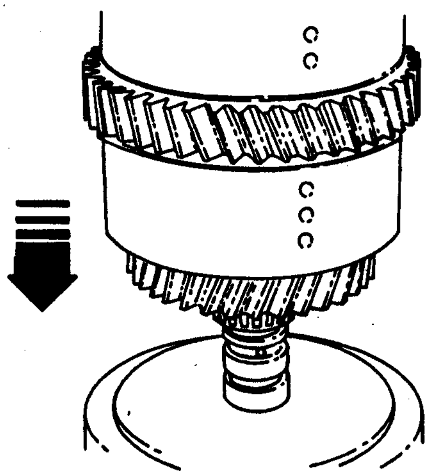


Figure 40.

3. Remove bearing (87, Figure 3), one thick thrust washer (80), one thrust bearing (81) and one thin thrust washer (82).
4. Withdraw the high gear/clutch housing (83), with the needle roller bearing (85).
5. Remove one thin thrust washer (82), one thrust bearing (81) and one thick thrust washer (80).
6. Remove circlip (78).

   Remove pressure (end) plate (75).

   Remove the clutch friction/counter plates (76 and 77). Keep them together in sets, DO NOT mix the plates with those from other clutches.
7. Remove pressure (end) plate (89). Remove the disc spring assembly (74). The disc spring is assembled within a liner to protect the hub support spline.
8. Position clutch assembly in press to compress piston spring then remove circlip (73). See Figure 41.

   Lift off spring retaining plate (72).

   Remove spring (71) and oil baffle plate (70).

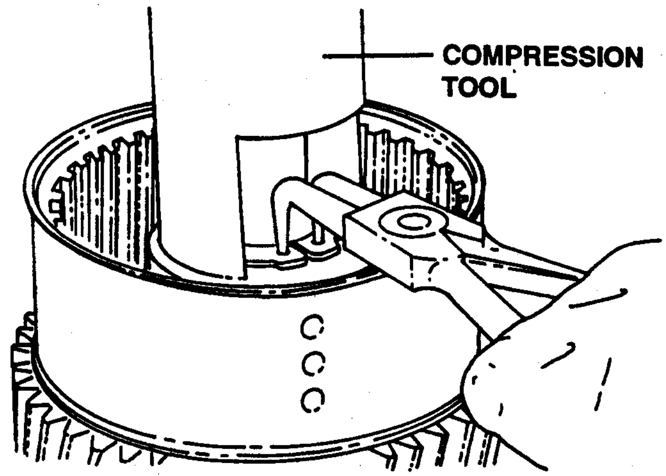


Figure 41.

9. Knock the clutch shaft on a piece of aluminum (or wood) to remove the piston (See Figure 40). If the piston does not loosen when the clutch shaft is knocked on aluminum, then hand pump air down the shaft oil inlet hole.
10. Remove piston assembly (67). Remove and discard piston o-ring (68) and shaft o-rings (66). Make sure the piston liner (69) is secure. The liner must be a tight fit on the piston.

11. Loosen the low clutch end bearing (87) by tapping the assembly on a piece of aluminum. Remove bearing using pullers.

12. Repeat step 3 through 11 to disassemble the input low clutch assembly.

Assembly (See Figure 3)

1. Install new o-rings (66 and 68, Figure 3) onto piston and shaft (67), lubricate with oil, then press piston fully into bore of clutch housing (65).

2. Install the oil baffle (70) and piston spring (71). Make sure that oil baffle (70) seats on piston (67).

   Install spring retainer plate (40).

   Compress spring (71) and secure with circlip (73). See Figure 42.

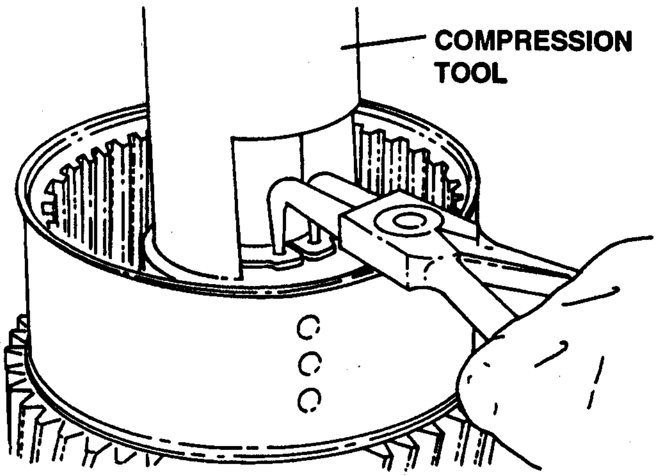


Figure 42.

3. Install disc spring assembly (74, Figure 3). Install the assembly so that the outer diameter curves away from the clutch piston.

NOTE: The disc spring is assembled with a liner to protect the hub support spline.

4. Install pressure (end) end plate (89). Make sure that the prongs on the pressure plate DO NOT locate in the large grooves in the hub (the ones with drilled holes).

   First, fit one friction plate (76) followed by one steel counter plate (77).

   Continue fitting alternate friction and steel counter plates, finishing with a friction plate.

5. Install pressure (end) plate (75). Make sure that the prongs on the pressure plate DO NOT locate in the large grooves in the hub (the ones with drilled holes). Install circlip (78).

6. Using a dial test indicator as shown in Figure 43, measure the end float of the pressure (end) plate, which should be 0.075 to 0.126 inches (1.90 to 3.20 mm). If necessary, fit shims (79, Figure 2) between the retaining circlip (78) and pressure (end) plate (75) to correct end float inaccuracies.

NOTE: Later type shim has teeth on the outside diameter; the teeth inhibit it from spinning during operation. If the shim removed from the clutch does not have teeth, then discard it and use the new type shim.

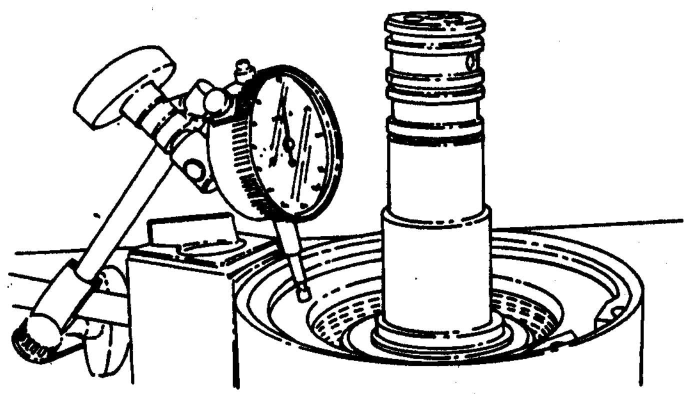


Figure 43.

7. Install one thick thrust washer (80), one thrust bearing (81) followed by one thin thrust washer (82).

8. Install high gear clutch housing (83).

9. Install needle roller bearing (85). Install one thin thrust washer (82), one thrust bearing (81) followed by one thick thrust washer (80).

10. Coat the high clutch end bearing (87) with high pressure grade grease and press bearing (87) onto shaft.

11. Install piston ring seals (88).

NOTE: If the piston ring seals are the polytetraflouroethene (PTFE) type, then see page 6110-26 for correct fitting procedure.

12. Repeat steps 1 through 11 for the opposite clutch, make sure that the low clutch and taper roller bearing are coated with grease.

MAINSHAFT

Disassembly (See Figure 4)

1. Carefully remove piston ring seals (117, Figure 5).

NOTE: If piston ring seals are excessively worn then check for burrs or damage on shaft grooves. If necessary, remove burrs with a fine grade abrasive paper and oil.

2. Remove taper roller bearing (118) using collet tool and press as shown in Figure 44.

NOTE: This bearing would not normally be removed unless it was damaged. If the collet tool shown is not available, then it is permissible to use a standard bearing puller, although damage to the bearing cage may result.

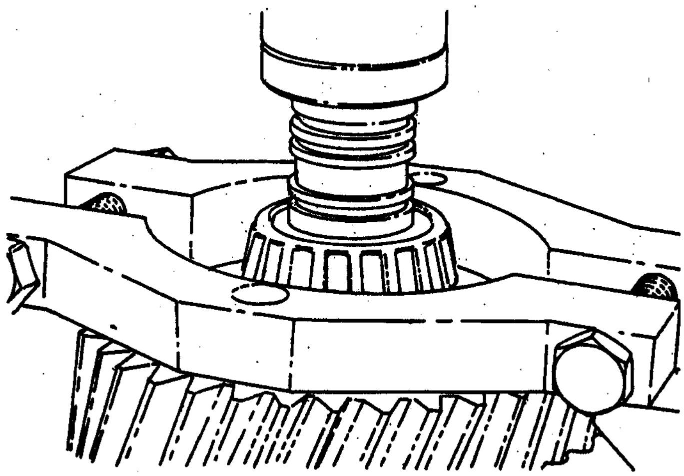


Figure 44.

3. Remove internal circlip (104, Figure 4). Remove pressure (end) plate (105). Remove the clutch friction/counter plates (106 and 107). Keep them together in sets, DO NOT mix the plates with those from other clutches. Remove pressure (end) plate (105).
4. Remove taper roller bearing (103) using a suitable puller.
5. Position clutch on press and compress piston spring (110). Remove circlip (108). See Figure 45.

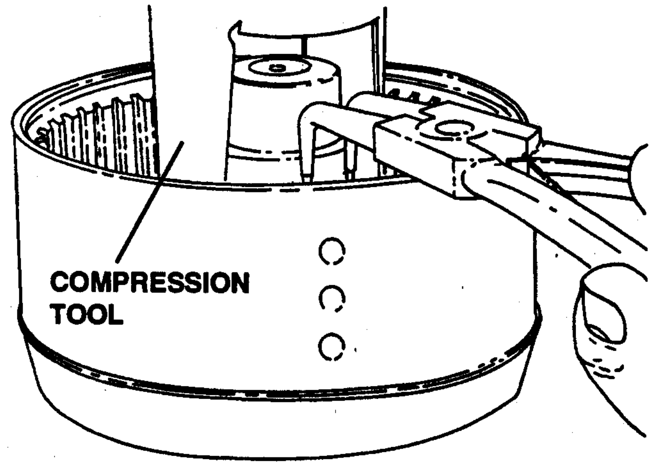


Figure 45.

6. Remove spring retaining plate (109, Figure 4). Remove spring (110). Remove oil baffle (111).
7. Knock the clutch on a piece of aluminum (or wood) to remove the piston. See Figure 46.

NOTE: If the piston does not loosen when the clutch is knocked on aluminum, then hand pump air down the shaft oil inlet hole.

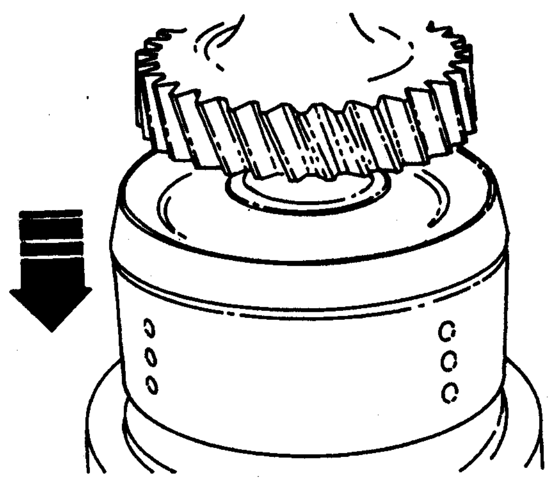


Figure 46.

8. Remove piston (113). Remove and discard o-ring (115) and o-ring (114).

NOTE: Make sure the piston is secure. The liner must be a tight fit on the piston.

Assembly (See Figure 4)

1. Fit new o-rings (114 and 115, Figure 4) onto the piston and shaft, lubricate with oil then press piston (113) fully onto mainshaft gear (116).

2. Install oil baffle (111). Make sure that the oil baffle (111) seats on piston (113). Install piston spring (110). Install spring retaining plate (109).

3. Using a press, compress piston spring (110) and install circlip (108). See Figure 47. Also, use the press to fit taper roller bearing (103).

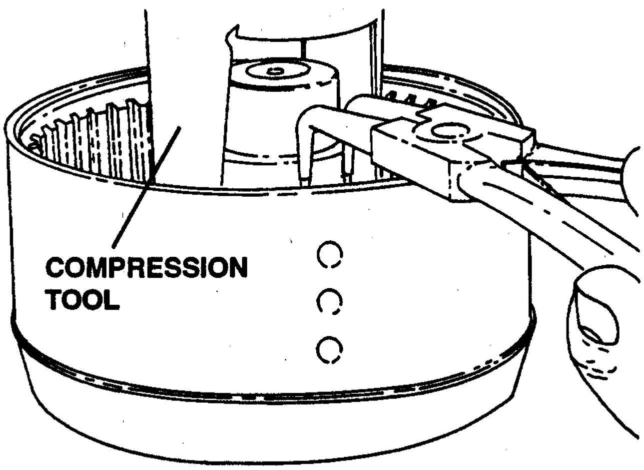


Figure 47.

4. Install pressure (end) plate (105, Figure 4). Make sure that the prongs on the pressure plate DO NOT locate in the large grooves in the hub (the ones with drilled holes).

   First, install one friction plate (106) followed by one steel outer plate (107).

   Continue fitting alternate friction and plain steel plates, finishing with a friction plate. Install pressure plate (105). Make sure that the prongs on the pressure plate DO NOT locate in the large grooves in the hub (the ones with drilled holes). Install circlip (104).

5. Using a dial indicator as shown in Figure 48, measure the end float of the pressure (end) plate, which should be 0.087 to 0.138 inches (2.2 to 3.5 mm). If necessary, install shim (122) between circlip (104) and pressure (end) plate (105) to correct end float inaccuracies.

NOTE: Later type shim has teeth on the outside diameter; the teeth inhibit shim spinning during operation. If the shim removed does not have teeth, then discard it and use the new type shim.

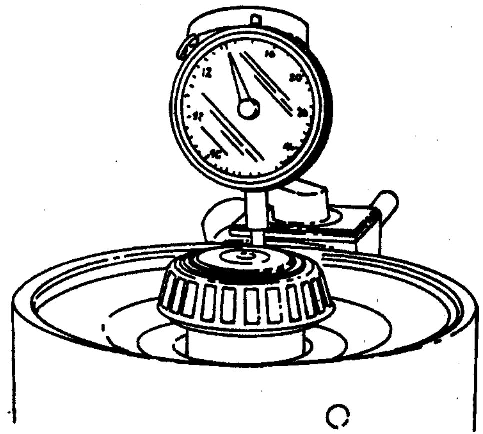


Figure 48.

6. Using a press, install a new taper bearing (118, Figure 4). Install piston tin seals (117).

NOTE: If the piston ring seals are polytetrafluoroethene (PTFE) type then see page 6110-26 for the correct fitting procedure.

LAYSHAFT

Disassembly (See Figure 5)

1. Carefully remove piston ring seals (126, Figure 6).

NOTE: If the piston ring seals are excessively worn, then check for burrs or damage on shaft grooves. If necessary, remove burrs with a fine grade abrasion paper and oil.

2. Remove taper roller bearing (128) using a collet tool and press as shown in Figure 49).

NOTE: This bearing would not normally be removed unless it was damaged. If the collet tool shown is not available, then it is permissible to use standard bearing pullers to remove it. Although, damage to the bearing cage may result.

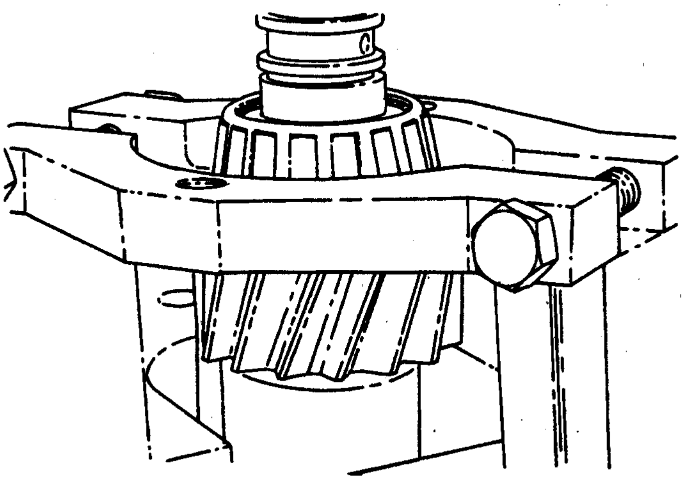


Figure 49.

3. Use a suitable puller to remove both spacer (150, Figure 5) and taper roller bearing (151).

4. Lift off full clutch assembly.

5. Remove oil baffle plate (138) and spring (137).

   Remove and discard two o-rings (147 and 148) located on the layshaft (129).

   Remove spring retaining plate (136).

6. Remove external circlip (135).

   Remove gear and splined hub (132) together with one thick thrust washer (134), one bearing (130) and one thin thrust washer (131).

   Remove two needle bearings (133) and bearing (130).

7. Remove retaining circlip (139).

   Remove two pressure (end) plates (141).

   Remove friction/counter plates (142 and 143) together in sets. DO NOT mix the plates with those from other clutches.

8. Remove piston and discard o-ring (148).

NOTE: Make sure the piston liner is secure. The liner (145) must be a tight fit on the piston.

Assembly (See Figure 5)

1. Install a new o-ring (148, Figure 5) onto piston (144). Lubricate with oil then press piston (144) fully into bore of hub (149).

2. Install pressure plate (141). Make sure that the prongs on the pressure plate DO NOT locate in the large grooves in the hub (the ones with drilled holes).

   First, install one friction plate (142) followed by one steel counter plate (143).

   Continue installing alternate friction and plain steel plates finishing with a friction plate. Install two pressure (end) plates (141). Make sure the prongs on the pressure plate DO NOT locate in the large grooves in the hub (the ones with drilled holes). Install retaining circlip (139).

3. Using a dial test indicator as shown in Figure 50, measure the end float of the pressure (end) plate, which should be 0.075 to 0.126 inches (1.90 to 3.20 mm). If necessary, install shim (140) to correct the end float between retaining circlip (139) and pressure plate (141).

NOTE: Later type shim has teeth on the outside diameter; the teeth inhibit shim spinning during operation. If the shim removed does not have teeth, then discard it and use the new type shim.

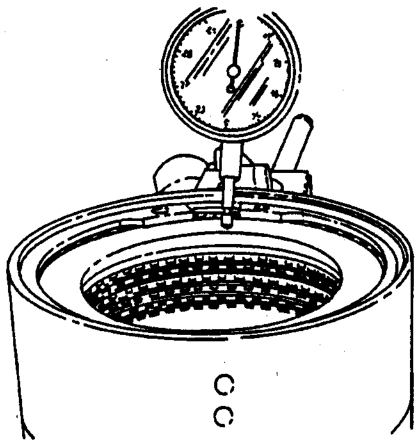


Figure 50.

4. Install bearing (130) and two needle roller bearing (133) onto layshaft (129).
5. Install gear (132) onto layshaft 129). Install one thin thrust washer (131), one bearing (130) followed by one thick thrust washer (134). Install external circlip (135).
6. Install spring retaining plate (136). Install two new o-rings (147 and 148) to layshaft (129).
7. Position the clutch housing (149) on the layshaft (129) splined hub to align the clutch friction/counter plates (142 and 143).

   Wedge the plates together by inserting two blunt tools (small rounded screwdrivers) through the bottom holes at the side of the clutch housing as shown in Figure 51.

   Remove the wedged clutch housing (149).

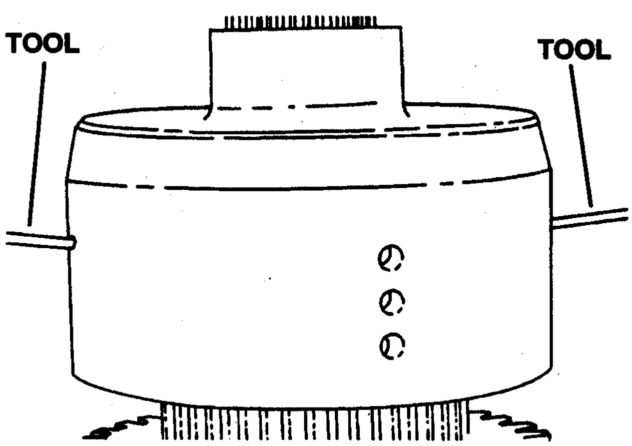


Figure 51.

8. Install spring (137) and oil baffle (138). Install wedged clutch housing (149).
9. Position spacer (150) on layshaft gear (129).

   Position taper roller bearing (151) on top of spacer (150). Press taper roller bearing (151) and spacer (150) using a bench press.

   When the taper roller bearings and the spacer have been fully installed on the layshaft, remove the two blunt tools (small rounded screwdrivers) used to wedge the clutch plates. Finally, rotate the gear to make sure that the clutch has been correctly installed.
10. Using a press, install a new taper roller bearing (128). Install piston ring seals (126).

NOTE: If the piston ring seals are polytetrafluoroethene (PTFE) type then see page 6110-26 for the correct fitting procedure.

POLYTETRAFLUOROETHENE (PTFE) PISTON RING SEALS INSTALLATION

1. Wind the PTFE piston ring around your finger as shown in Figure 52 so that the seal forms a "coil."

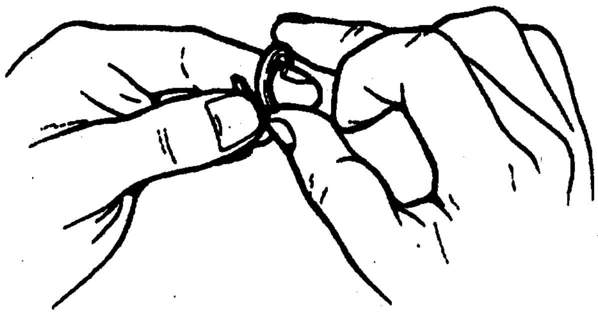


Figure 52.

2. Coat the seal with grease and install the seal to the shaft (Figure 53).

   Make sure that the seal sits below or flush with the outer diameter of the shaft. If necessary, use finger pressure as shown to make the seal flush with the shaft.

IMPORTANT: If the seal is not set below or flush with the outer diameter of the shaft, then the seal will "cut" when the shaft is fitted to its mating component.

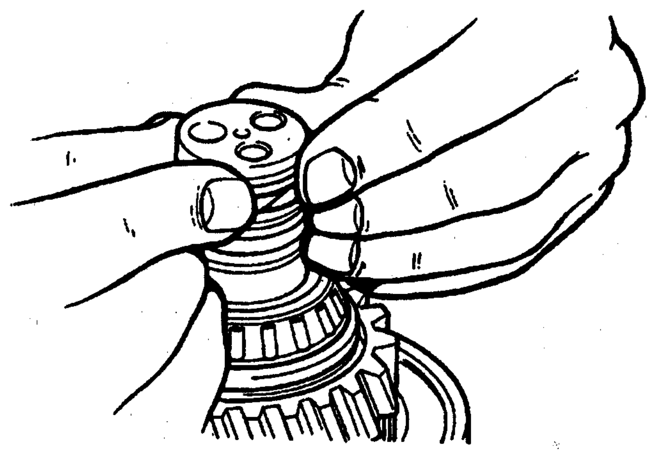


Figure 53.

END FLAT CHECKING PROCEDURE

NOTE: Special tools are required to check the float A kit is available under P/N 1001837.

1. Install bar A as shown in Figure 55. Install the adapters B, C and D as necessary.

NOTE: Adapter B and D are similar; adapter B with the long thread is used for the layshaft; adapter D is used for the reverse shaft.

Set up the dial test indicator.

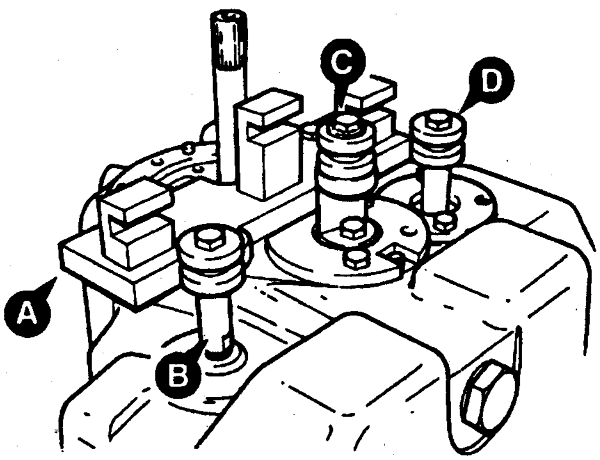


Figure 55.

2. Install the torque handle E as shown in Figure 56. Make sure that the torque direction arrow is pointing down, push down on the handle applying the torque of 22 lb-ft. (30 Nm). Turn the shaft being checked to seat the bearings.

   Maintaining the downward pressure, zero the dial test indicator.

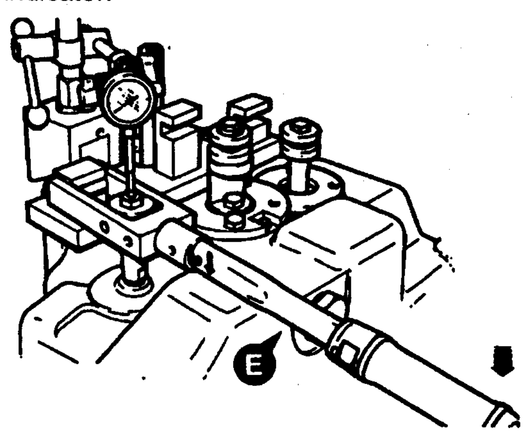


Figure 56.

3. Rotate the torque handle E as shown in Figure 57. Make sure that the torque direction arrow is now pointing up. Lift the handle applying the torque of 22 lb-ft. (30 Nm). Turn the shaft being checked to seat the bearings.

   Maintaining the upward pressure, note the dial test indicator reading.

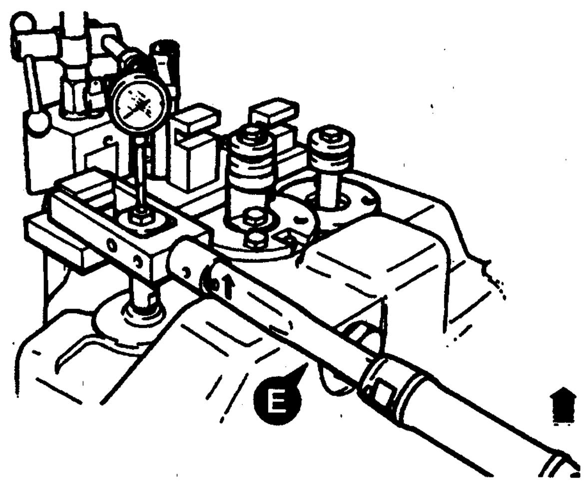
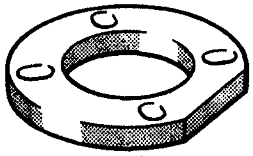


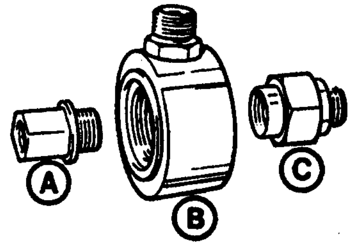
Figure 57.

SPECIAL TOOL

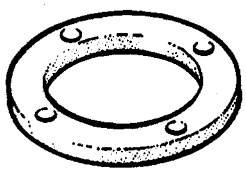
These tools must be used to service the Powershift transmission.



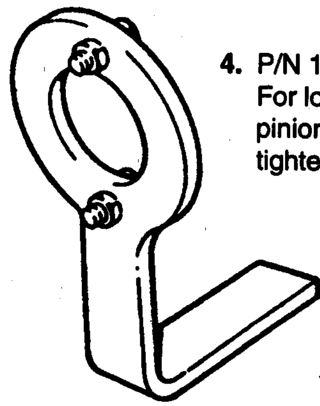
1. P/N 1001833 End Float Setting Tool



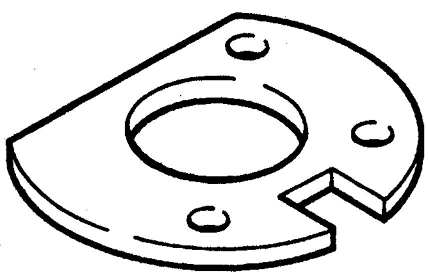
2. P/N 1001340 Test Kit (Includes A - C)



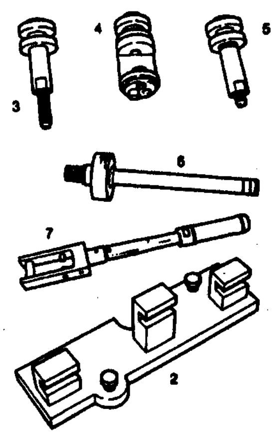
3. P/N 1001834 Reverse Clutch End Float Setting Tool



4. P/N 1001835 Flange Spanner - For locking pinion flange while pinion nut is loosened or, tightened.



5. P/N 1001836 - Mainshaft End Float Setting Tool



P/N 1001837- EndFloat Checking Kit (includes items 2 thru 7)

6

Section 6122

DRIVE SHAFTS

6

SERVICING THE DRIVE SHAFT

Removal

1. Remove nuts and bolts from flange yoke on parking brake.
2. Remove U-bolts or end bolt flange from the companion yoke on the axle differential. Remove drive shaft.

Disassembly

1. Put the flange yoke in a vise. With a pliers, remove the two snap rings from the bearing caps on the flange yoke.
2. Apply force on the drive shaft in the direction of the bearings to push the bearings out of the flange yoke. When both bearings are removed, tilt the journal cross to permit removal of the universal joint.
3. Disassemble the journal crosses from the drive shaft in the same way. After the snap rings are removed, use a soft drift with a flat face slightly smaller than the diameter of the bearing to remove the bearings.
4. To disassemble the yoke sleeve from the shaft, turn the dust cap in a counterclockwise direction. When the dust cap is free, pull the shaft, dust cap and washers from the yoke sleeve.

Inspection

Clean all parts in a solvent that is not flammable. Remove all rough areas from any finished surfaces. Make sure the bearing surfaces on the journal crosses are smooth. Do not disassemble the needle bearings. Clean with a brush and compressed air. Apply a small quantity of SAE 140 oil into each bearing cap and rotate the bearing on the trunnion to check for wear. If there is any indication of wear or damage to the needle bearing, bearing cap or journal crosses, replace the journal and bearings as an assembly. Repair kits are available. See Parts Catalog.

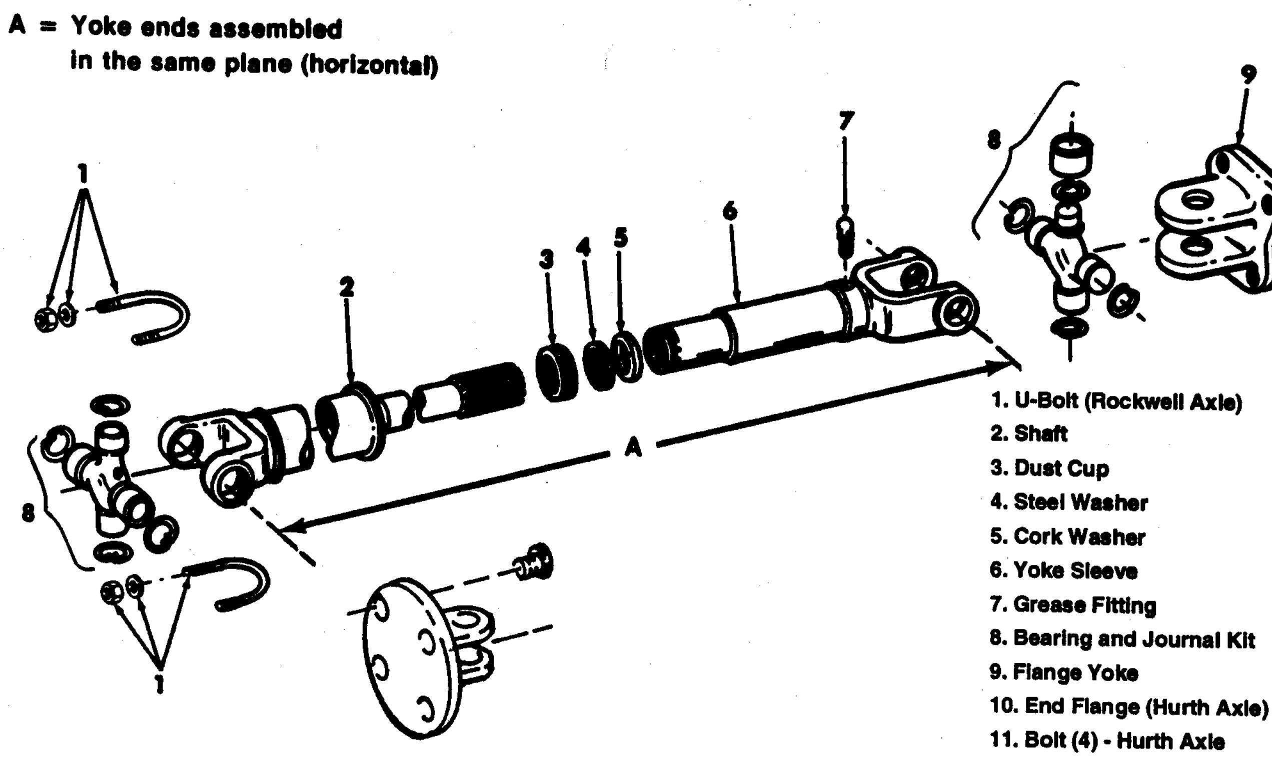


Figure 1. Drive Shaft (Transmission to Axle)

Check for damage to the splines of the slip joint. Make sure the splines are clean and smooth. Look for damage or distortion of the tube. Damage can cause failure of the drive shaft under high torque loads. The drive shaft must be straight to prevent vibration during operation. Replace the drive shaft if there is damage.

Assembly

1. If new journal and bearing kits are not being installed, install new seals in the journal retainers.

2. Install the journal cross into the yoke of the yoke sleeve. The relief must be towards flange yoke.

3. Apply a small amount of SAE 140 oil to trunnions on journal cross. Press the bearing and cap assemblies into place. Use care not to cause damage to bearings or caps. Install snap rings. Make sure the snap rings are fully engaged in the groove.

4. Repeat the procedure on the opposite end of the drive shaft.

5. Repeat the procedure to install the flange yoke to the drive shaft.

6. Apply SAE 140 oil to splines on the shaft and sleeve. Assemble the dust cap, steel washer and cork washer on the shaft. Assemble the shaft into the sleeve. Make sure both ends of the drive shaft are in the same plane as shown in Figure 1. Tighten the dust cap.

Installation

1. Install the drive shaft on the machine. Fasten the flange yoke to the companion flange on the parking brake with nuts and bolts. Fasten the other end of the drive shaft to the differential with U-bolts, washers and nuts, or end flange bolts.

2. Apply grease to the slip joint and journal crosses until each joint is filled. It will be necessary to close the hole in the end plug on the slip joint to get full lubrication of the joint. Grease will show through the seal when the joint is full.

3. Check the drive shaft for correct balance before the machine is put into operation. Lower the outriggers to lift the wheels off the ground. Operate the drive train and check for vibration. If vibration is indicated, stop the machine and check the drive shaft again. Make sure the yoke ends are in the same plane.

Lubrication Procedure

The drive shaft is an important part of the drive train and needs regular maintenance. There is a grease fitting on the slip joint and on each journal cross. Apply grease to these fittings every week or 50 hours. Use E.P. No. 2 bearing grease. Always apply enough grease to remove the old grease. On the slip joint, apply grease to the fitting until the grease comes through the hole in the end of the shaft. Put your finger over the hole and continue to apply grease until the grease shows at the seal on the slip joint.

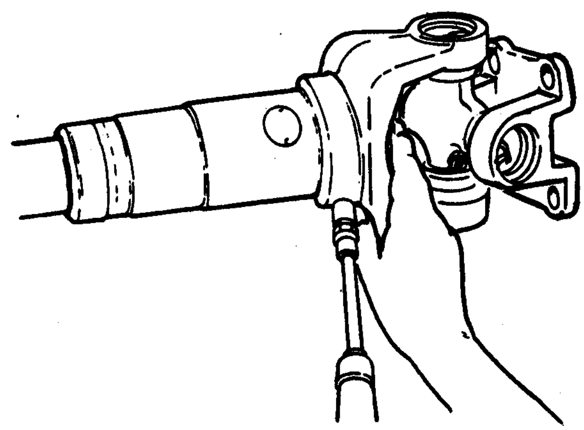


Figure 2. Lubrication of Drive Shaft

At each lubrication, check the drive shaft for side movement. As the wear in the bearings increases, the side movement will increase. Movement must be minimum to prevent vibration during operation.

Section 6126

DRIVE AXLE (ROCKWELL)

TABLE OF CONTENTS

WARNING: To prevent injury or death, do not work under raised machine unless:

1. Main frame is on firm support or blocks in a manner to prevent machine from falling or tipping.
2. Engine is stopped.
3. Transmission is in Neutral.
4. Parking Brake is engaged and wheels stopped with blocks to prevent machine movements.
5. Key is removed to prevent accidental starting.
6. Another person is available to give assistance if needed.

MAINTENANCE

Differential

Keep the oil at the level of the plug on the rear of the housing. For oil recommendation, see Section 1050. Change the oil every 6 months or 1500 hours of operation. Look for particles of metal in the oil which give indication of broken gears or parts with damage. Remove and clean the breather. Use a solvent that is not flammable.

Install the breather. Clean and install the magnetic plug. Fill the differential housing with new oil to the level of the plug on the rear of the housing.

Cold Weather Lubricant Recommendations

	MINIMUM	MAXIMUM
Hatcol 2601	−70° F (−56° C)	+30° F (0° C)
Conoco Polar Start DN-600	−60° F (−50° C)	+40° F (5° C)

The above lubricants must not be used when outside temperatures are above the maximum range.

Wheel Bearings

Pack wheel bearings with a good quality of wheel bearing grease every 6 months or 1500 hours of operation.

DESCRIPTION AND TROUBLESHOOTING

General

The drive axle has a NoSPIN differential. A differential is necessary in an axle to prevent damage to the tires when the machine is turning a corner. During a turn, the outside wheel must turn faster to move a greater distance than the inside wheel. The NoSPIN differential gives positive drive to both wheels over all surfaces. The clutches in the NoSPIN will let one wheel rotate faster than the ring gear (when making a turn), but will never let either wheel turn slower than the ring gear.

Troubleshooting — NoSPIN

It is important to remember that the performance of the NoSPIN will be different than a standard differential. For example:

1. During a turn, the clutch for the outside wheel disengages automatically to let the wheel rotate freely when necessary. A sound can be heard in the differential when the clutch engages and disengages. This sound is normal.
2. During straight travel, you will hear a regular click in the differential if the radius of the two tires is not equal. This radius is the radius of the tire under load and is measured from the ground to the center of the tire. It is important that both tires are the same size and have equal pressures.
3. If there is a heavy load on one side of the machine, the machine will pull to that side during travel. The heavy load changes the radius of the tire.
4. If too much power is applied during a turn, the differential will have a possible effect on steering. Decreasing the engine speed will decrease the torque to the wheels and make steering easier.
5. The NoSPIN will have more backlash or free movement than a standard differential. This movement is necessry to permit the clutches to engage and disengage automatically during a turn. The amount of backlash in the NoSPIN normally does not increase with use. There will be an increase in the total backlash in the drive train as the wear in the components increases.

6. During a turn, it is normal to hear a loud noise in the differential if you rapidly increase, then decrease the engine speed. This noise is caused when the torque changes between driving torque to the inside wheel and braking torque to the outside wheel.

7. During a turn on loose ground or other conditions of bad traction, there can be loss of torque to both wheels for a short time. This condition occurs when the clutch for the outside wheel is disengaged and full torque is applied to the inside wheel. The inside wheel will turn, but movement of the machine will stop until the clutch for the outside wheel engages.

To check the performance of the differential:

1. On a concrete surface, move the machine several times around a circle with the steering wheels turned at the maximum angle.

2. Check the drive wheels while the turn is being made. The outside wheel must rotate faster than the inside wheel. There must be no loss of traction to the inside wheel.

3. Turn the machine in the opposite direction and check the drive wheels again. If there is no differential action, or if there is slippage in the wheels, repair or replacement of the differential is necessary.

If noise in the differential during straight travel is the problem, check the radius of the drive wheels. Use the following procedure:

1. Put a mark with chalk on both wheels in the same location.

2. Move the machine a short distance in a straight line. If the radius of the two tires is not equal, the marks on the two wheels will be in a different location.

3. Adjust the pressures in the two tires and repeat the check until the marks are in the same location when the machine is stopped.

Before you remove the differential, make a final check to see if the problem is in the differential. Two persons are needed for the check.

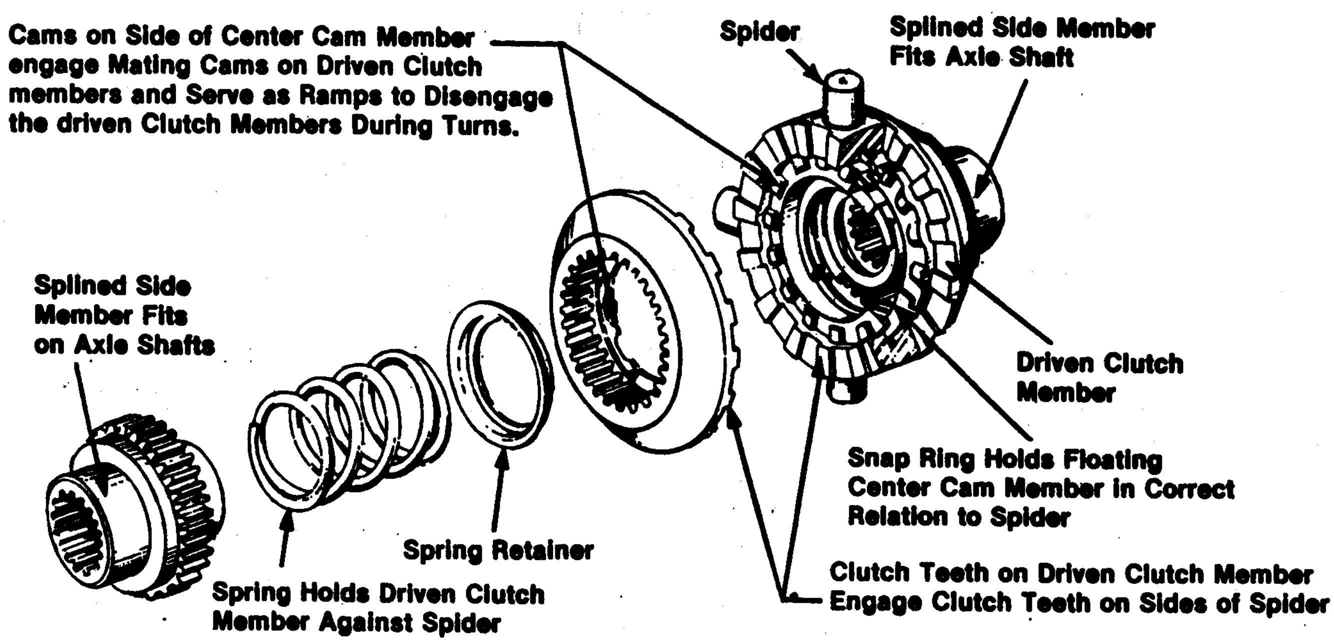


Figure 1. NoSPIN Differential

1. Lower the outriggers and lift the wheels off the ground. Stop the engine.

2. Disengage the park brake and put the transmission in "Neutral" position.

3. While one person holds the left wheel, rotate the right wheel forward. Now hold the right wheel and turn the left wheel forward. Repeat this procedure for each wheel in the reverse direction. If the differential is working correctly, you will hear a regular series of clicks while each wheel is being rotated. If the wheels do not turn smoothly and easily, remove and make an inspection of the differential.

SERVICING THE DIFFERENTIAL

Removal

1. Remove the drain plug from the axle housing to remove the lubricant.

NOTE: Before the differential carrier can be removed, the axle shafts must be pulled from the differential side gears.

2. Pull the axle shafts from the differential side gears. See disassembly instructions for axle hubs.

3. Disconnect the drive shaft from the differential pinion flange. See removal instruction for drive shafts.

4. Loosen two top bolts which fasten the carrier to the axle housing. Remove the remainder of the bolts and washers.

5. Loosen differential carrier from axle housing with a block of wood and a hammer.

6. Put a roller jack under the carrier and remove the two top bolts and washers. Carefully, remove the carrier from the axle housing.

Disassembly

1. Put the differential carrier in a holding fixture.

Remove Differential and Gear Assembly:

NOTE: If inspection indicates that the bevel pinion (24) is not to be replaced, measure the bevel gear clearance and make a record of the clearance. See Figure 2.

Figure 2. Checking Clearance

2. Use a hammer and center punch to put a mark on one differential case half (10 or 14) and the bearing cap (3).

3. Loosen bolts (1) on bearing caps (3). Remove the bearing caps and adjusting rings (7, 17).

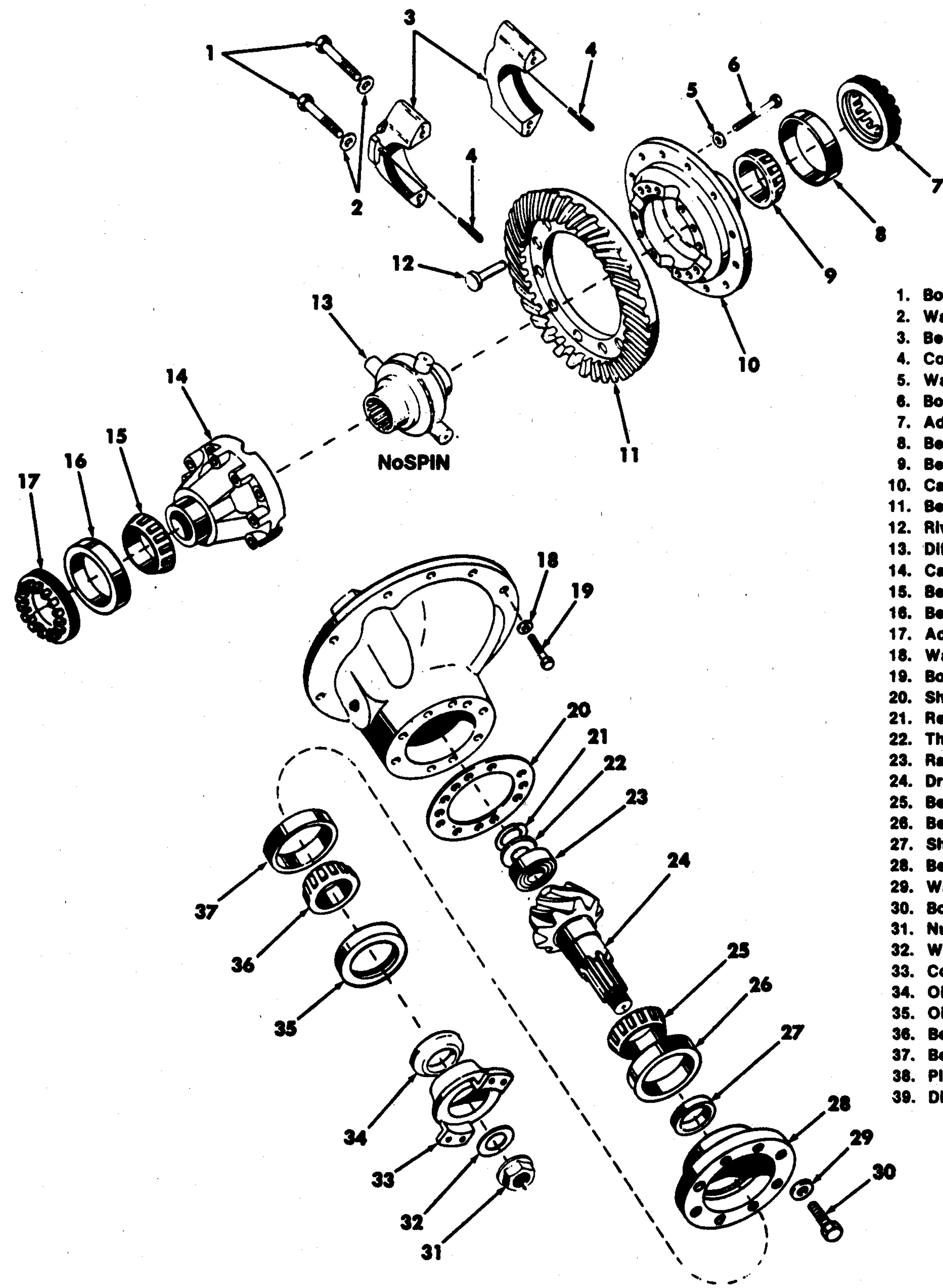
4. Lift differential and gear assembly out of the differential carrier (39).

Disassemble Differential Case and Gear Assembly:

5. If the identification marks on the differential case are not clear, put new marks on the differential case halves with a punch or chisel for correct alignment at assembly.

6. Remove bolts (6) and separate the case halves (10, 14).

7. Remove differential assembly (13).



1. Bolt
2. Washer
3. Bearing cap
4. Cotter pin
5. Washer
6. Bolt (quantity of 4)
7. Adjusting ring
8. Bearing cup
9. Bearing cone
10. Case half for differential
11. Bevel gear
12. Rivet
13. Differential Assembly
14. Case half for differential
15. Bearing cone
16. Bearing cup
17. Adjusting ring
18. Washer
19. Bolt (quantity of 16)
20. Shims (as needed)
21. Retainer
22. Thrust washer
23. Radial bearing
24. Drive pinion
25. Bearing cone (inner)
26. Bearing cup (inner)
27. Shim
28. Bearing cage
29. Washer
30. Bolt (quantity of 8)
31. Nut
32. Washer
33. Companion yoke
34. Oil slinger
35. Oil seal
36. Bearing cone (outer)
37. Bearing cup (outer)
38. Plug
39. Differential carrier

Figure 3. Axle Differential

8. If necessary, remove rivets (12) and separate the bevel gear (11) and case half (10). To remove the rivets, use a center punch to put a mark on rivets in center of head. Then use a drill 1/32 in. smaller than body of rivet to drill through head.

9. If necessary to replace differential bearings, remove the bearing cones (9, 15) with a bearing puller.

Remove Pinion and Cage Assembly:

10. Hold companion flange (33) and remove nut and washer (31, 32).

11. Use a gear puller to remove the companion flange (33).

12. Remove bolts (30) from bearing cage.

13. Remove oil slinger (34).

14. Remove bearing cage (28).

IMPORTANT: Use bolts in puller holes to loosen the bearing cage from the differential carrier. The use of a pry bar will cause damage to the shims. Hitting the drive pinion from inner end can cause damage to the lock ring groove on the bearing.

15. Keep the shims (14) together to get correct adjustment at assembly.

Disassemble Pinion and Cage Assembly:

16. Hit the drive pinion (24) out of bearing cage with soft hammer.

17. Remove oil seal (35) from bearing cage (28).

18. Remove outer bearing (36) from cage.

19. Remove shim (27) from bevel pinion.

20. If necessary to replace rear bearing cone (25), pull the bearing off the drive pinion. Use a bearing puller.

21. Remove retainer (21) and thrust washer (22). Press the radial bearing (23) off the drive pinion.

Inspection

Clean all parts thoroughly. Use a solvent that is not flammable. See Section 1055.

Make a careful inspection of all bearings, cups and cones, including those not removed from the drive unit. Replace bearings if rollers or cups are worn or show an indication of damage or distortion.

Replace all parts which have damage. Also replace any bolts with round corners, all lock washers, oil seals and gaskets at the time of assembly.

Clean all finished surfaces thoroughly and make sure these surfaces are smooth. Threads of bolts, nuts, etc. must be clean and in good condition to get accurate adjustment and correct torque.

When you assemble the parts, use a press where possible. Tighten all nuts to the specified torque, Section 1051.

Assembly

Assemble Pinion and Cage Assembly:

1. If new bearing cups (26, 37) are being installed, press the cups tight against shoulders in bearing cage (28).

2. Apply light machine oil to bearing and cups. Press inner bearing cone (25) and radial bearing (23) firmly against the pinion shoulders. Use a sleeve that will fit on the inner race of the bearing. See Figure 4.

3. Install the thrust washer (22) and retainer (24) on drive pinion.

4. Put the assembled drive pinion into the bearing cage (28). Install the shim (27) on the drive pinion next to the bearing cone.

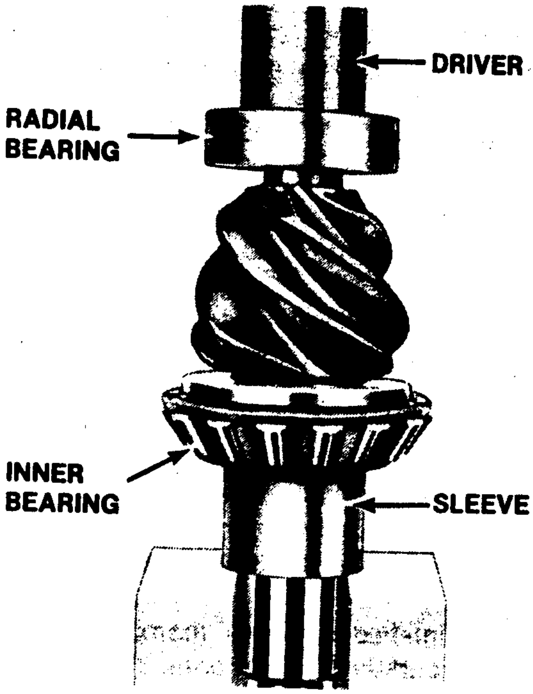


Figure 4. Assembly of Drive Pinion

5. Press outer bearing cone (36) tight against the shim.

6. Rotate cage several times to get normal bearing contact.

7. While in press under pressure (12,000 lbs [5 440 kg]), check bearing preload. Wind a soft wire around cage and pull on horizontal line with pound scale. If a press is not available, install the companion flange and nut (31). The nut can be tightened to 300-400 lb-ft (406-542 Nm) and preload checked. Use rotating torque, not starting torque.

   If rotating torque is not within 5 to 15 pound-inches (.57-1.69 Nm), use thinner spacer to increase or thicker spacer to decrease preload.

   Example: If the diameter of the pinion cage is 6 inches, the radius is 3 inches. With 5 pounds pull you will have 15 pound-inches of preload torque.

8. Install companion flange, washer and nut (items 31-33) on the drive pinion.

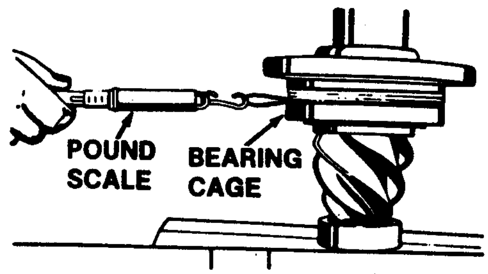


Figure 5. Checking Preload of Pinion

9. Install pinion and cage assembly in differential carrier. Tighten nut on pinion shaft to 300-400 lb-ft (406-542 Nm).

10. Check the preload torque on the pinion bearings again. If rotating torque is not within 5 to 15 pound-inches (.57-1.69 Nm), repeat the above procedure.

11. Remove nut and companion flange from drive pinion.

12. Apply oil to the lips of the oil seal (35). Apply a non-hardening sealing compound to outer edge of the oil seal. Press seal against shoulder inside the bearing cage. Use a seal driver.

13. Install oil slinger. Install companion flange, washer and nut.

14. Tighten nut to a torque of 300-400 lb-ft (406-542 Nm). Install cotter pin.

15. Install correct shim pack (20).

16. Install pinion and cage assembly into the differential carrier. Install bolts (30) and tighten to a torque of 50-65 lb-ft (68-88 Nm).

Assemble and Install Differential and Bevel Gear:

17. If bevel gear (11) was removed in disassembly, assemble the gear to the differential case (flange half). Install new rivets.

18. Apply EP 80-90 gear lubricant to inside surface of differential case and to all component parts of the differential assembly.

19. Put the differential (13) in bevel gear and case half assembly.

20. Align punch marks, and put the case halves together. Pull the assembly together with four bolts installed at equal spaces around the case.

21. Check the assembly for free rotation of the differential gears. Disassemble and correct if necessary.

22. Install the remainder of the bolts. Tighten the bolts to a torque of 90-120 lb-ft (122-163 Nm).

23. If bearings were removed, press new bearings on differential case halves.

24. Install the bearing cups (8, 16), adjusting rings (7, 17) and bearing caps (3). Tighten the bolts on the bearing caps to a torque of 160-190 lb-ft (217-257 Nm).

25. By hand, push the bearing cups (8, 16) into the bores. If the cups can not be pushed in by hand, use a scraper or emery cloth to clean the bores. When the cups fit correctly, remove the bearing caps.

26. Apply EP 80-90 gear lubricant to bearing cups and cones. Put the bearing cups over the assembled differential bearing cones, then install the differential assembly in the carrier.

27. Install bearing adjusting rings (7, 17) again and turn hand tight against bearing cups.

28. Install bearing caps (3) again.

NOTE: If bearing caps do not install correctly, it is possible that the threads of the adjusting rings are not correctly engaged. Remove caps and move the adjusting rings. Do not use force in the installation of the bearing caps, you can cause damage to the bearing housing or bearing caps.

29. Install washers (2) and bolts (1). Tighten bolts to a torque of 160-180 lb-ft (217-244 Nm).

Adjust the Preload on Differential Bearing:

30. Use a dial indicator against back face of the bevel gear. Loosen the bearing adjusting ring on the side opposite the gear only enough to get an indication on the indicator.

31. Tighten the same adjusting ring only enough to get .000 movement or indication on the indicator.

32. Check the bevel gear for run-out. If run-out is more than .008 inch (.2 mm) remove differential and check for the cause.

33. Tighten the adjusting rings one notch each from .000 movement to get the correct preload on the differential bearings. Install cotter pins (4) to hold the adjusting rings in place.

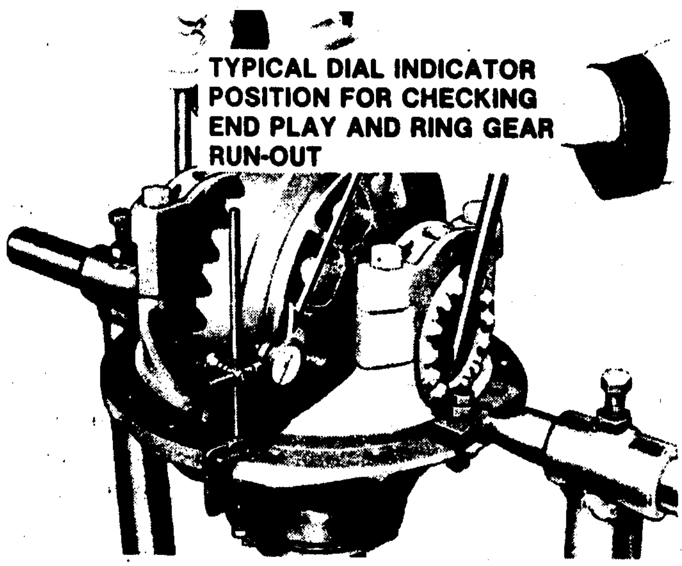


Figure 6. Adjusting Preload on Differential Bearing

Adjust Clearance between Drive Pinion and Bevel Gear

1. The backlash must be checked with a dial indicator. The dial indicator must be put in the position shown in Figure 7.

2. The clearance for a new bevel gear and pinion is .010" (.025 mm). If using original gears, use clearance reading taken before disassembly.

6

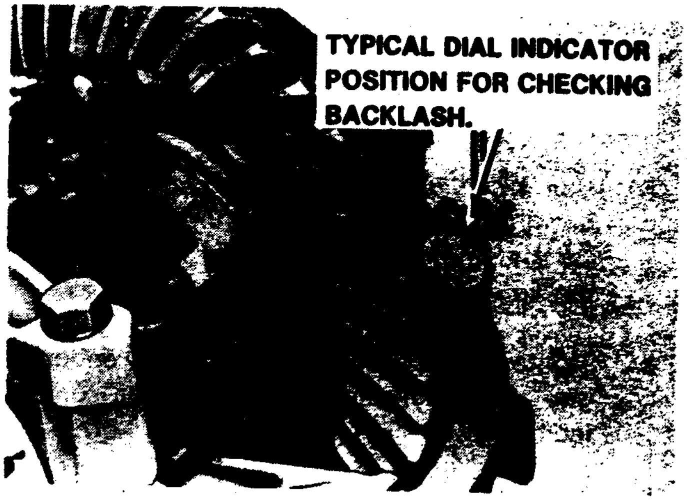


Figure 7. Checking Clearance

3. Prevent the pinion from turning and move the bevel gear. Make a record of reading on the dial indicator.

4. If the reading is not correct for old gears or new gears, move the bevel gear away from the drive pinion to increase clearance or move ring gear toward drive pinion to decrease clearance. When you loosen or tighten the adjusting nuts, move each nut the same distance.

5. Hold the adjustment by installing cotter pins between grooves on adjusting nuts.

Installation

1. Before you install the differential carrier in the axle housing, remove any dirt or residue from housing and sleeves. Clean the housing thoroughly with solvent and compressed air.

2. Check the axle housing for cracks, loose studs or damage. Make all necessary repairs or parts replacement before you install the differential carrier into the axle housing.

3. Install new gasket on differential carrier. Move the differential carrier into position on roller jack. Start carrier into housing with four bolts and plain washers at equal spaces.

IMPORTANT: Do not hit the differential carrier with a hammer at the carrier bolt flange. You can cause damage or distortion on the flange, which will cause leakage.

4. Tighten the four bolts equally to pull the carrier straight into the axle housing.

5. If necessary, remove bolts and plain washers and install taper dowels, lock washers and bolts. Tighten nuts to correct torque.

6. Install the drive shaft.

7. Install axle shafts.

8. Check magnetic drain plugs. These plugs have an important function. The plugs remove the small metal particles from the lubricant. The magnet must be strong enough to hold the particles under all operating conditions. Add a new magnetic charge or replace the plugs if necessary. The magnetic plugs must have a minimum holding capacity of 2 pounds (.9 kg) of low carbon steel in plate or flat bar form.

9. Fill axle housing to the correct level with specified lubricant, Section 1050.

10. Apply grease to the drive shaft.

11. Lower the outriggers to raise the wheels off the ground. Operate the drive train with transmission in high gear at approximately 1/4 to 1/2 throttle for five minutes, so lubrication reaches all parts of the carrier assembly.

SERVICING THE AXLE HUBS

Removal of Complete Axle

NOTE: Removal of axle is necessary when there is damage to the axle housing. Axle can be disassembled with axle housing fastened to the frame.

1. Lower the outriggers to lift the wheels. Put blocks under the front of the frame. Remove the two front tires.

2. Disconnect the brake lines from the axle.

3. Disconnect the drive shaft from the axle differential. See Section 6122.

4. Put a support under the axle housing and remove the eight nuts from the bolts that fasten the axle housing to the frame. Remove the two mounting plates.

5. Two dowels hold the axle housing against the frame. The axle housing can be removed by hitting the dowels with a hammer and soft punch.

Axle Hubs — Disassembly

See Figure 8.

1. Remove drain plug (10) and remove the lubricant from the axle housing.

2. If axle is on the machine, remove the tire.

3. Remove the brake drum (23) from the hub and stud unit (14).

4. Remove the nuts (32), washers (31) and dowels (30). Pull axle shaft out of axle housing.

5. Remove the outer bearing nut (22), the lockwasher (21) and inner bearing nut (20).

6. Remove the hub and stud unit (14). The outer bearing cone (19) will be removed with the hub and stud unit.

7. Remove the inner bearing cone (13) and the oil seal (12).

8. Remove nuts (26) and washers (27). Then remove the oil slinger (11).

9. Remove the brake unit (8) from the axle housing.

Inspection

It is important that an inspection be made of all axle hub parts before assembly. Make an inspection for parts that are worn or have damage.

Make an inspection of all bearing cones and bearing cups, including those bearing cups not removed from the hub and stud unit. Replace if rollers or cups have damage. Remove bearing cups with a puller or in an arbor press with sleeves. Do not use a hammer and punch.

Make an inspection of the axle shaft. Check for bends and other damage.

Replace all parts that are not in good condition. Lockwashers, oil seals and gaskets must be replaced at assembly.

Tighten all nuts to specified torque. See Section 1051.

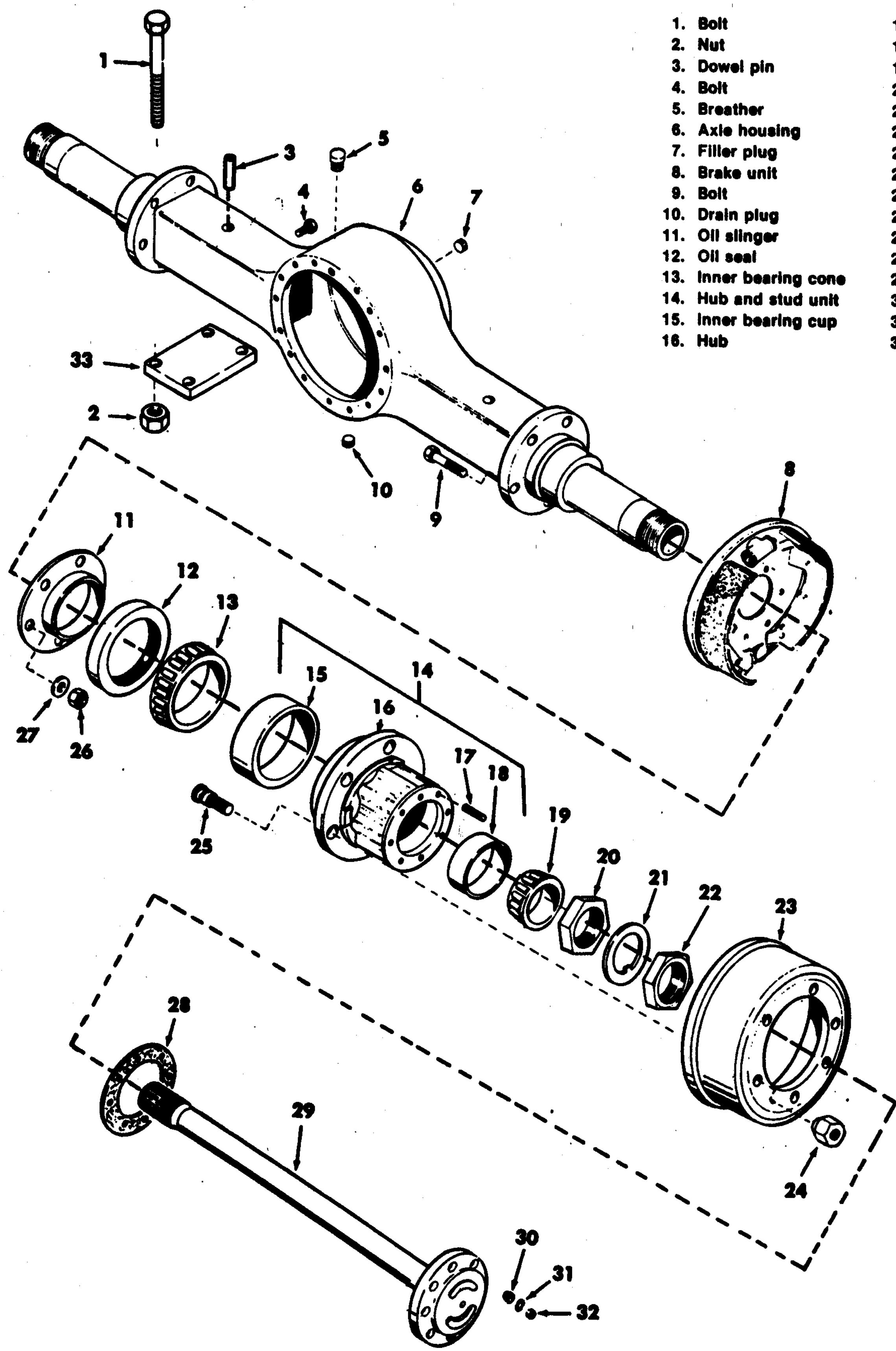
Assembly

1. Install the brake unit (8) on the axle housing (6).

2. Install the oil slinger (11) in front of the brake unit. Fasten the brake unit and oil slinger to the axle housing with bolts (9), washers (27) and nuts (26).

3. Install the oil seal (12) on the oil slinger.

4. Apply a light machine oil to inner and outer bearing cones (13 and 19).



1. Bolt
2. Nut
3. Dowel pin
4. Bolt
5. Breather
6. Axle housing
7. Filler plug
8. Brake unit
9. Bolt
10. Drain plug
11. Oil slinger
12. Oil seal
13. Inner bearing cone
14. Hub and stud unit
15. Inner bearing cup
16. Hub
17. Stud
18. Outer bearing cup
19. Outer bearing cone
20. Inner bearing nut
21. Lockwasher
22. Outer bearing nut
23. Brake drum
24. Wheel stud nut
25. Wheel stud
26. Nut
27. Plain washer
28. Gasket
29. Axle Shaft
30. Dowel
31. Lockwasher
32. Nut

Figure 8. Drive Axle

5. Assemble the inner bearing cone (13) and the outer bearing cone (19) in the hub and stud unit (14). Install the hub and stud unit on the spindle of the axle housing.

6. Tighten the inner bearing nut (20) and at the same time rotate the hub and stud assembly (14). The inner bearing nut must be tightened until there is a small amount of resistance to the rotation of the hub. Then loosen the inner bearing nut ¼ of a turn.

7. Install the lockwasher (21) and outer bearing nut (22).

8. Install a new gasket (28) on the axle shaft (29). Install the axle shaft into the axle housing. Fasten the axle shaft with dowels (30), lockwashers (31) and nut (32).

9. Install the brake drum (23) and tire.

10. Fill the axle housing with the specified lubricant. See Section 1050.

6

Section
6126A

DRIVE AXLE
(HURTH)

MAINTENANCE

Level check (Weekly or Every 50 Hour Interval)

1. Level crane, engage parking brake and shut off engine. Tag or remove ignition key.
2. Clean area around the differential check/fill plug (Figure 1). Remove plug from axle housing and check oil level. Oil must be level with bottom of fill plug hole. If low, add recommended oil, see Section 1050.
3. Install plug.
4. Move the machine until the plug is lined up as shown in Figure 2. Clean area around the axle hub drain/fill plug. Remove the plug and check oil level. Oil level must be level with the bottom of the fill plug hole. If low add recommended oil, see Section 1050.
5. Install plug and repeat for other axle hub.

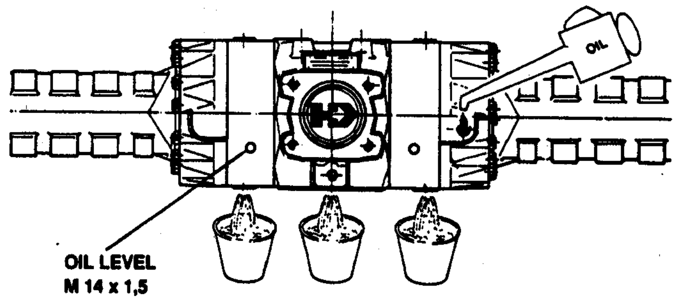


Figure 1.

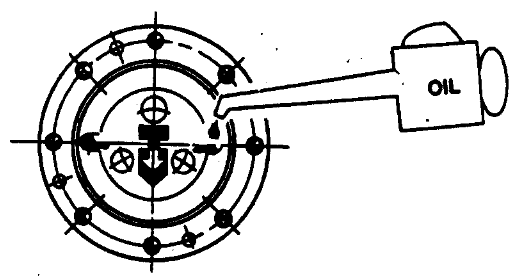


Figure 2.

Oil Change (Every six months or 1500 Hour Intervals)

1. Level crane, engage parking brake, and shut off engine.
2. Clean around the differential fill/check plug and drain plugs (See Figure 1).
3. Remove the fill/check plug. Place a container under the axle housing and remove the drain plugs. Drain all oil.
4. Clean the drain plug and install it in the axle housing.
5. Fill differential with recommended oil, see Section 1050.
6. Remove breather and clean in a suitable solvent.
7. Move the machine until the plug is lined up as shown in Figure 3. Clean area around the axle hub drain/fill plug. Remove the plug and drain oil into a suitable container.
8. Move machine to place axle in position shown in Figure 2. Fill axle hub to level with bottom of fill hole with recommended lubricant. See Section 1050. Install plug.
9. Repeat steps 7 and 8 for the other axle hub.

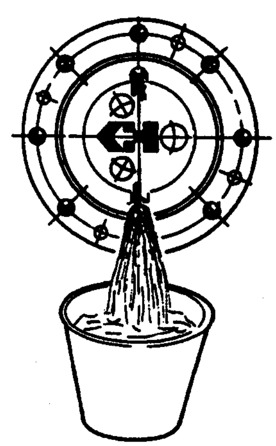


Figure 3.

DESCRIPTION AND TROUBLESHOOTING

General

The drive axle has a NoSpin differential. A differential is necessary in an axle to prevent damage to the tires when the machine is turning a corner. During a turn, the outside wheel must turn faster to move a greater distance than the inside wheel. The differential gives positive drive to both wheels over all surfaces. The clutches in the NoSpin will let one wheel rotate faster than the ring gear (when making a turn), but will never let either wheel turn slower than the ring gear.

Troubleshooting

It is important to remember that the performance of the NoSpin differential will be different than a standard differential. For example:

1. During a turn, the clutch for the outside wheel disengages automatically to let the wheel rotate freely when necessary. A sound can be heard in the differential when the clutch engages and disengages. This sound is normal.
2. During straight travel, you will hear a regular click in the differential if the radius of the two tires is not equal. This radius is the radius of the tire under load and is measured from the ground to the center of the tire. It is important that both tires are the same size and have equal pressures.
3. If there is a heavy load on one side of the machine, the machine will pull to that side during travel. The heavy load changes the radius of the tire.
4. If too much power is applied during a turn, the differential will have a possible effect on steering. Decreasing the engine speed will decrease the torque to the wheels and make steering easier.
5. The NoSpin will have more backlash or free movement than a standard differential. This movement is necessary to permit the clutches to engage and disengage automatically during a turn. The amount of backlash in the NoSpin normally does not increase with use. There will be an increase in the total backlash in the drive train as the wear in the components increases.
6. During a turn, it is normal to hear a loud noise in the differential if you rapidly increase, then decrease the engine speed. This noise is caused when the torque changes between driving torque to the inside wheel and braking torque to the outside wheel.
7. During a turn on loose ground or other conditions of bad traction, there can be loss of torque to both wheels for a short time. This condition occurs when the clutch for the outside wheel is disengaged and full torque is applied to the inside wheel. The inside wheel will turn, but movement of the machine will stop until the clutch for the outside wheel engages.

To check the performance of the differential:

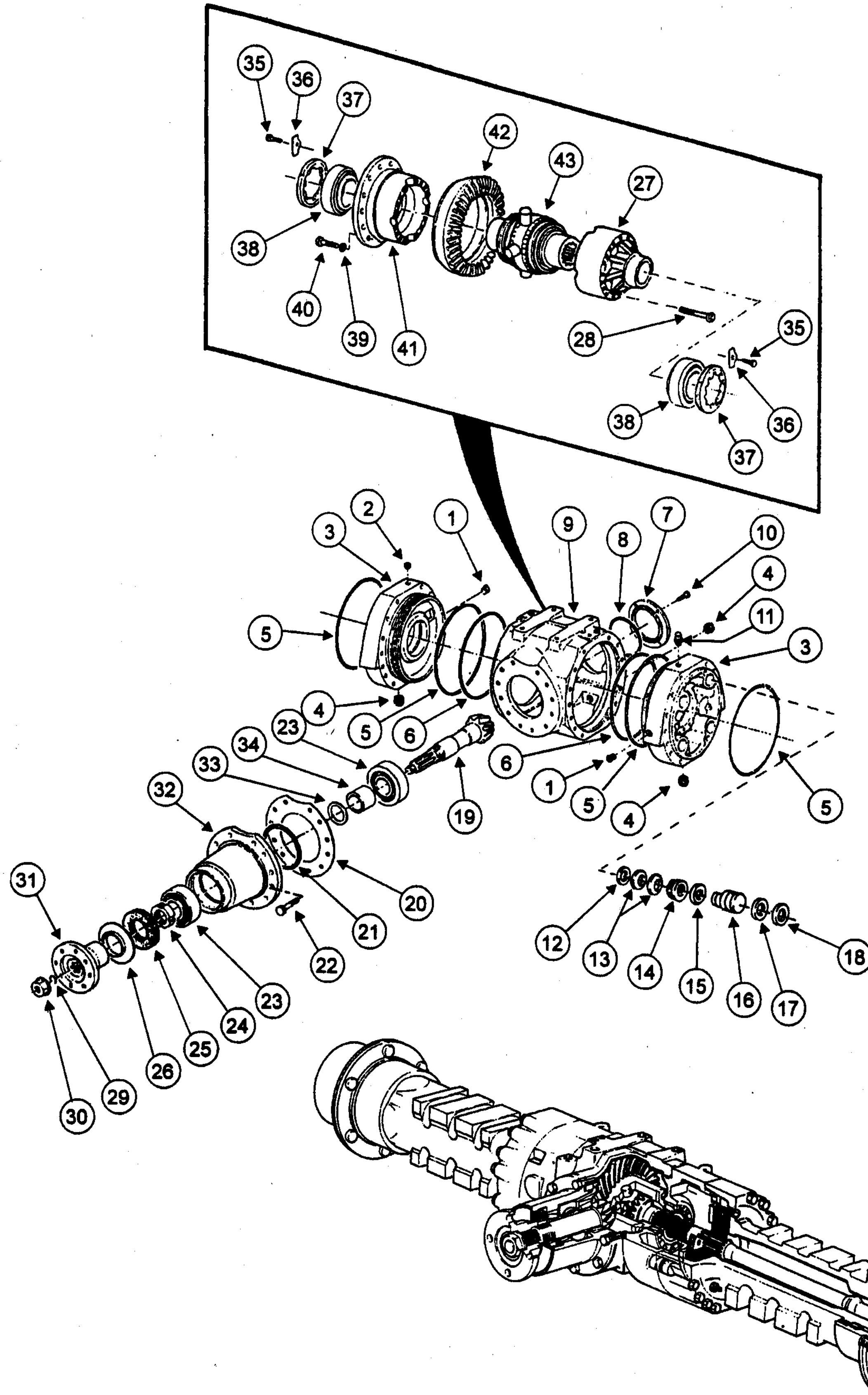
1. On a concrete surface, move the machine several times around a circle with the steering wheels turned at the maximum angle.
2. Check the drive wheels while the turn is being made. The outside wheel must rotate faster than the inside wheel. There must be no loss of traction to the inside wheel.
3. Turn the machine in the opposite direction and check the drive wheels again. If there is no differential action, or if there is slippage in the wheels, repair or replacement of the differential is necessary.

If noise in the differential during straight travel is the problem, check the radius of the drive wheels. Use the following procedure:

1. Put a mark with chalk on both wheels in the same location.
2. Move the machine a short distance in a straight line. If the radius of the two tires is not equal, the marks on the two wheels will be in a different location.
3. Adjust the pressure in the two tires and repeat the check until the marks are in the same location when the machine is stopped.

Before you remove the differential, make a final check to see if the problem is in the differential. Two persons are needed for the check.

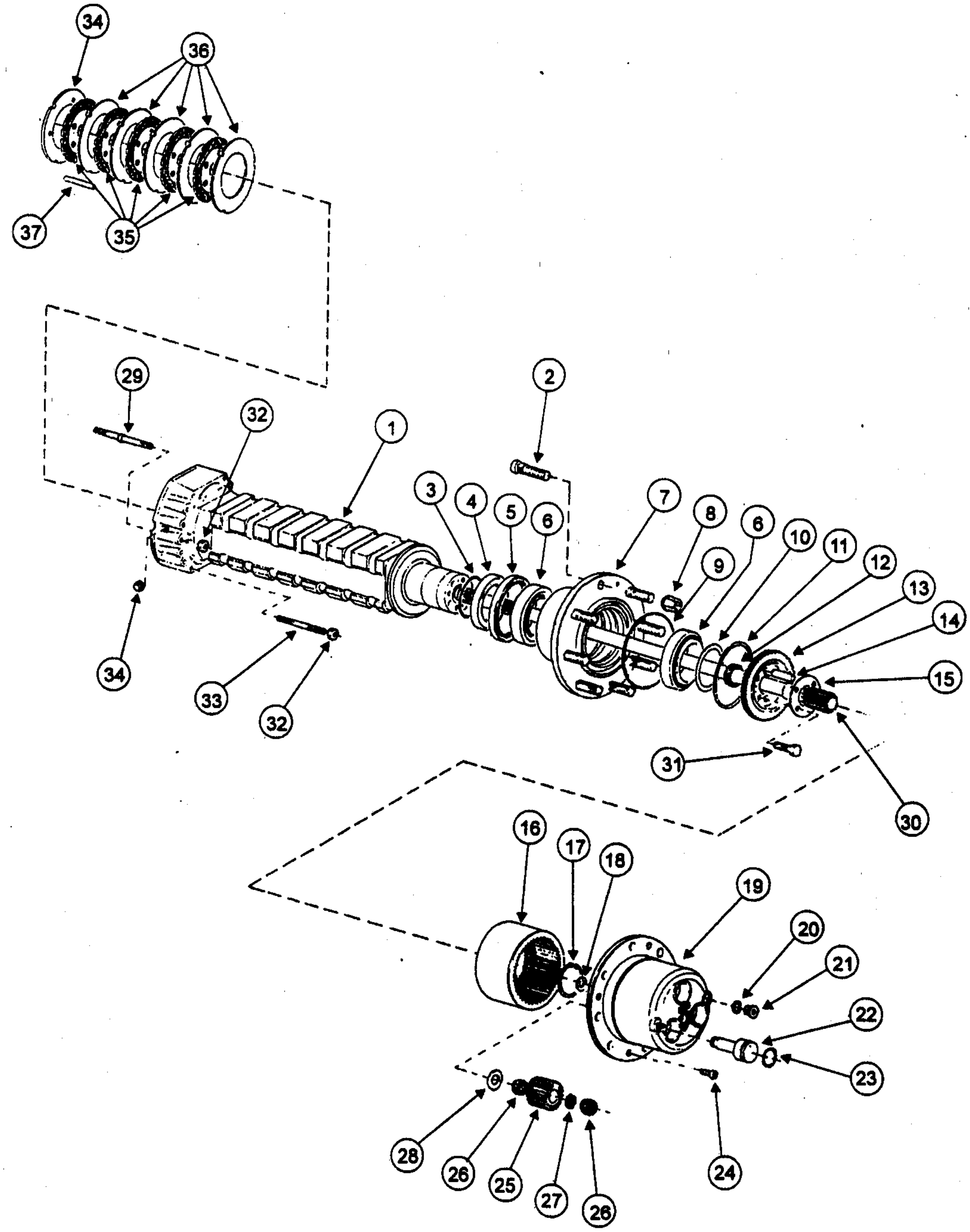
1. Lower the outriggers and lift the wheels off the ground. Stop the engine.
2. Disengage the park brake and put the transmission in "Neutral" position.
3. While one person holds the left wheel, rotate the right wheel forward. Now hold the right wheel and turn the left wheel forward. Repeat this procedure for each wheel in the reverse direction. If the differential is working correctly, you will hear a regular series of clicks while each wheel is being rotated. If the wheels do not turn smoothly and easily, remove and make and make an inspection of the differential.



1. Plug
2. Plug
3. Intermediate Cover (2)
4. Magnetic Plug (3)
5. O-Ring (4)
6. O-Ring (2)
7. Cover
8. O-ring
9. Housing
10. Bolt (4)
11. Vent
12. Circlip (8)
13. Cup Spring (16)
14. Spring (8)
15. Spacer (8)
16. Piston (8)
17. O-Ring (8)
18. Back-up Ring
19. Bevel Pinion*
20. Shim
21. O-Ring
22. Bolt
23. Taper Roller Bearing
24. Ring Nut
25. Seal
26. Cover Plate
27. Differential Carrier
28. Bolt (16)
29. O-Ring
30. Nut
31. Flange
32. Cover
33. Shim
34. Spacer
35. Bolt (2)
36. Retainer (2)
37. Ring Nut (2)
38. Taper Roller Bearing
39. Lock Washer (16)
40. Bolt (16)
41. Differential Carrier
42. Bevel Gear*
43. NoSpin Differential

* Comes as a set.

Figure 4.



1. Lateral Axle Housing (2)
2. Wheel Stud (16)
3. O-Ring (2)
4.Spacer (2)
5. Seal (2)
6. Taper Roller Bearing (2)
7. Wheel Hub (2)
8. Wheel Nut (16)
9. O-Ring (2)
10. Shim (2)
11. Snap Ring (2)
12. Seal (2)
13. Ring Gear Support (2)
14. Dowel (8)
15. Locking Plate (2)
16. Ring Gear (2)
17. Circlip (2)
18. Thrust Washer (2)
19. Planet Gear Carrier (2)
20. Seal Washer (2)
21. Plug (2)
22. Pin (6)
23. O-Ring (6)
24. Bolt (8)
25. Planet Gear (6)
26. Needle Bearing (12)
27. Spacer (6)
28. Thrust Washer (6)
29. Stud (4)
30. Half-Shaft (2)
31. Bolt (8)
32. Nut (28)
33. Stud (24)
34. Plug (2)
35. Disc (2)
36. Brake Disc (10)
37. Intermediate Brake Disc (10)
38. Pin (6)

Figure 5.

SERVICING THE AXLE

Disassembly

NOTE: Apart from replacement of the hub and piston shaft oil seals, it is recommended that the axle be removed for all other disassembly operations.

1. Remove plug (4, Figure 4) and drain oil into a suitable container.
2. Remove fourteen nuts (32, Figure 5) from casing studs (33).
3. Separate lateral axle housing (1, Figure 5) from intermediate housing (3, Figure 2). Repeat on opposite side.
4. Stand lateral axle housing (1, Figure 3) on the planet gear carrier. Remove disc (35), five brake discs (36) and five intermediate discs (37). Remove three pins (38).
5. Drain oil from the planet gear carrier (19, Figure 5).
6. Remove three bolts (24). Lift off planet gear carrier (19) and remove half shaft (30). If the axle is on the machine, leave the half shaft in position.
7. Remove circlip (17) securing the plant gears.
8. Using a deft and hammer (Figure 4), remove the planet pins (22, Figure 5). Be careful not to damage thrust washers (28). They may be removed once there is clearance.

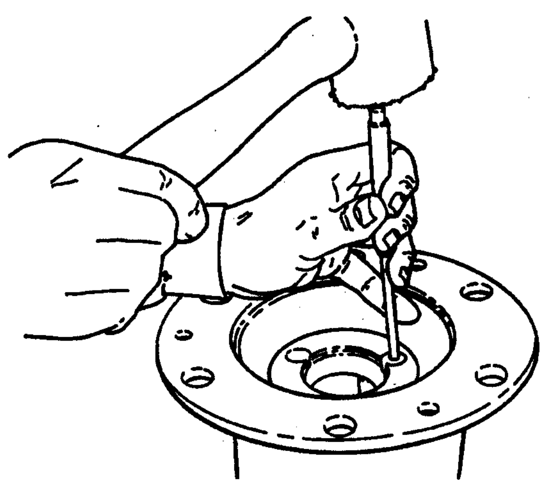


Figure 6.

9. Remove planet gears (25), (28), and bearings (26).
10. Remove ring gear (16). Unscrew and remove four bolts (31), retaining ring (15), and ring gear support (13).
11. Using a suitable puller and center pad (Figure 7), remove the hub carrier (7, Figure 5), from lateral axle housing (1). If the axle is still on the machine, the half shaft may be used in place of the center pad.

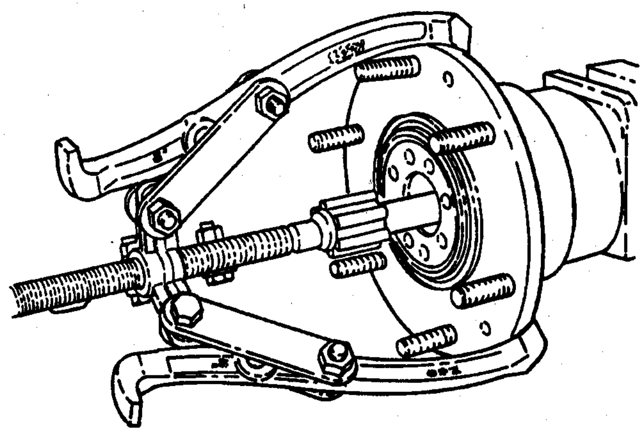


Figure 7.

12. Stand center assembly (Figure 8) on end, and apply 40-70 psi (270 - 483 kPa) to the brake line part to release brake pistons (16, Figure 4). Remove brake pistons (16). Note o-ring (17) and back-up ring (18).

WARNING: Perform this operation only with assembly in position shown in Figure 8. Treat compressed air with caution.

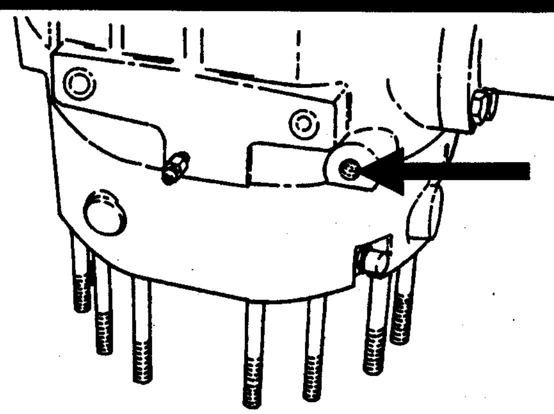


Figure 8.

13. Unscrew eight bolts (22, Figure 4), and remove pinion housing (32) by reinserting two bolts into the unused tapped holes in the pinion housing to jack it away from the differential casing (9).
14. Withdraw pinion housing (32), retain shim (20).
15. Uscrew flange nut (30) and remove flange (31).
16. Press out pinion shaft (19). Remove outer taper roller bearing (23), spacer (34) and shim (33).
17. Lift out spacer (26) and remove oil seal (25).
18. Remove the two shouldered studs (29, Figure 5) (black in color), placed diametrically opposite each other, which retain the intermediate casing.
19. With the housings (3 and 9, Figure 4) in the vertical(3) upward, assisting by lifting from the inside to release it from the brake system o-rings (5 and 6).

NOTE: Never dismantle intermediate housing (3) from center casing (9) in the horizontal position, as this will cause the bevel gear (7) to drop, possibly causing damage.

20. Lift out differential assembly. Mark casing externally to indicate side.
21. Disassemble the differential assembly using Figure 4 as a guide. Assembly (43) is not serviceable.

Assembly

1. Using Figure 4 as a guide, assemble the differential assembly. Coat threads of bolts (40) with Loctite #270 before installation.
2. Measure and record dimension X (Figure 9), between the pinion housing mounting face of the center (differential) casing and the nearest point of the adjacent intermediate housing counterbore, for later use in setting pinion depth.

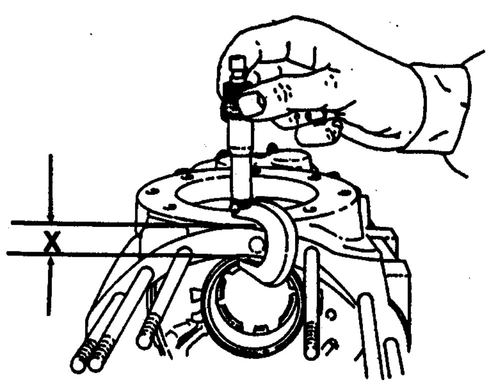


Figure 9.

3. Assemble outer races of pinion bearing (Figure 4) into pinion housing (32).
4. Install bearing (23) onto pinion (19).
5. Lower pinion (19) into pinion housing (32) and invert assembly.
6. Assemble shims (33) and spacer (34). Assemble outer bearing (23). Tap new oil seal (25) into position and grease lips with grease. Install outer spacer (24).
7. Install flange (31). Install new o-ring (29). Install nut (30). Tighten to a torque of 192-206 lb.-ft. (260-280 (Nm).
8. Check rolling torque of pinion shaft, which should be 8.8 to 13 lb-in. (100-150 Nem). If torque is improper, disassemble pinion and pinion housing. Increase shim thickness by 0.01 mm to decrease preloading torque by approximately 4.4 to 5.3 lb-in. (50-60 Nem) conversely to increase preloading the shim, thickness should be reduced. Assemble pinion and pinion housing. Check o-ring (29) for damage. If damaged, replace it. Tighten nut (30) to a torque of 192-206 lb-ft. (260-280 Nm).
9. Assemble side intermediate housing (3, Figure 4) to center casing (9) after lubricating o-rings (5 and 8) and checking their security and position. Install two shouldered studs (29, Figure 5) to intermediate housing (3).
10. Invert assembly in order to place NoSpin differential unit into position in center casing as originally marked.
11. Install other intermediate housing (3, Figure 4) after lubricating o-rings (5 and 8) and checking their security. Install two shouldered studs (29, Figure 5).
12. Clamp three sections together by using four tubes and nuts each side (Figure 10) and torque tighten to 18 lb-ft. (25 Nm).

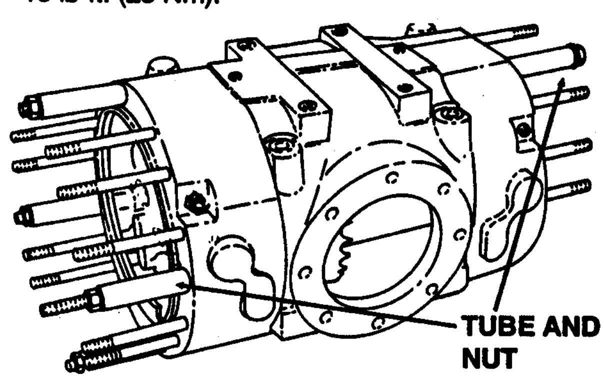


Figure 10.

13. Wrap a cord around the differential housing and note the pull required to maintain rotation to the differential assembly (Figure 11), which should be 6.7 to 7.8 lb. (30-35 N).

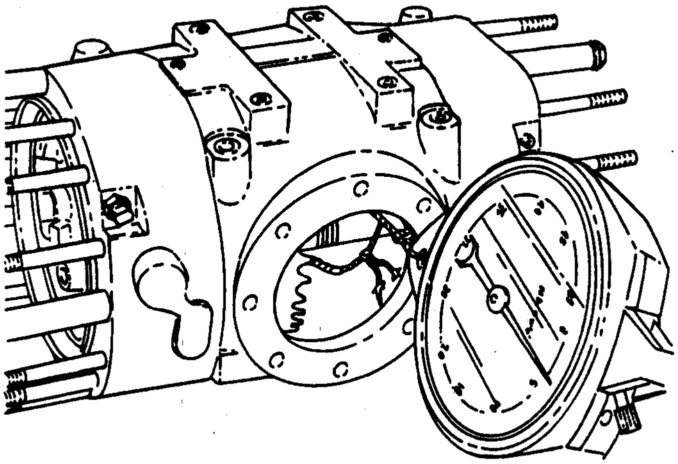


Figure 11.

14. Adjust bearing rings to alter bearing preload, but do not lock them at this stage (Figure 12).

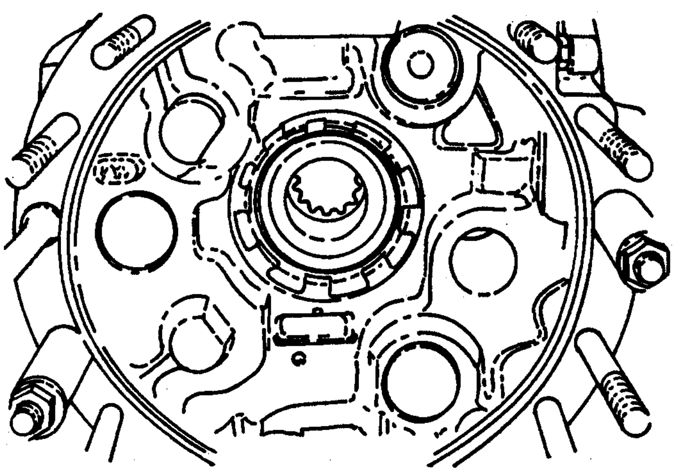


Figure 12.

15. Note measurement **Y** etched on end of pinion face (e.g.) 97.9 (any other marking, such as B22, is the bevel gear and pinion pairing number), and measurement **Z** stamped on inner face of pinion housing (Figure 13).

16. Oil scoop **A**, Figure 14, must be located at the top when installing pinion housing to center casing. Select thickness of pinion housing shim **B** by completing the calculation below.

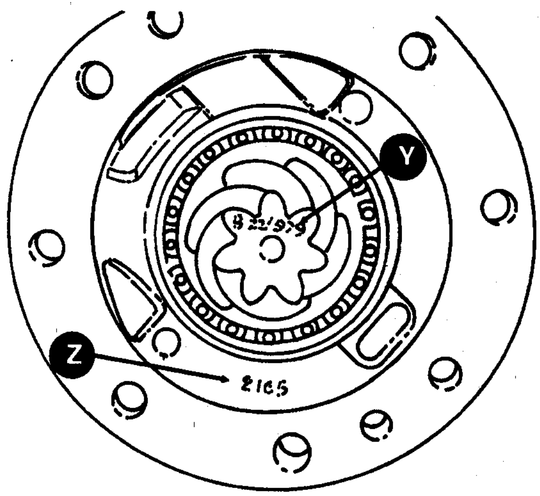


Figure 13.

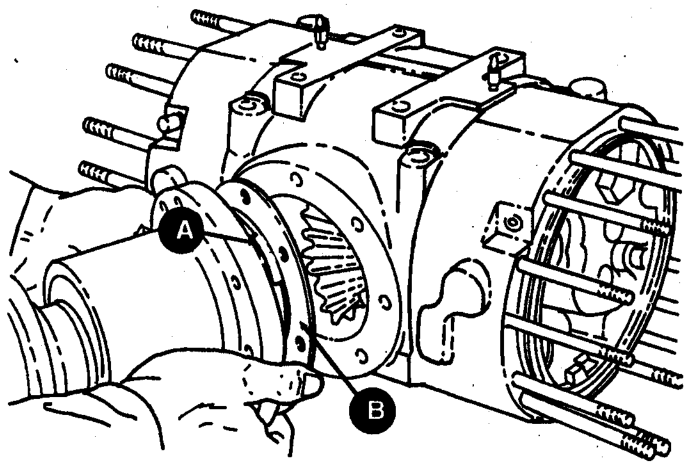


Figure 14.

Explanation of Formula for Calculating Pinion Housing Shim Requirement

A. Dimension X:

Formula: Standard Value minus Measured Value = Correction Value

Example: 24.00mm minus 24.28mm = -0.28mm

Because the measured value is greater than the standard value the result is a negative value.

B. Dimension Y:

Formula: Standard Value minus Measured Value = Correction Value

Example: 98.00mm minus 97.90mm = 0.10mm

C. Dimension Z:

Formula: Measured Value minus Standard Value = Corrective Value

Example: 21.65mm minus 21.00mm = 0.65mm

D. *Calculation of Shim Thickness:*

Formula: Correction X plus Correction Y plus Correction Z						= Shim t thickness
Example:	-0.28	plus	0.1	plus	0.65	= 0.47mm

NOTE: When new bearings have been installed, subtract an additional 0.05 mm to 0.08 mm from the above result for initial bedding of the bearings.

17. Assemble pinion housing to center casing using the selected shim, and temporally secure it using four fixing bolts (22, Figure 4). Tighten to a torque of 18 lb-ft. (25 Nm).

18. Bevel gear (42, Figure 4) and pinion (19) backlash should be 0.15 mm to 0.20 mm. Adjust by screwing ring nut (37) in or out to alter position of bevel gear assembly.

NOTE: It is important to turn each ring by equal amounts in either direction to void losing bearing preload.

19. Check meshing of bevel gear (42) and pinion (19) by marking teeth with engineers blue and rotating gears. Refer to page 9 for correct marking. When meshing is correct, install locking tab (36) to ring nuts (37).

20. Remove the four fixing bolts and remove pinion housing (32). Install new o-ring (21) to pinion housing (32), and assemble to center casing (9), ensuring that oil scoop faces top and drain faces bottom of differential center casing. Coat threads of bolts (22) with Loctite #270 and tighten to a torque of 18.5 lb-ft. (25 Nm). Remove nuts and tubes from assembly.

21. Install new o-rings (17) and back-up rings (18) onto pistons (16). Install pistons.

22. Insert new half shaft oil seal (18, Figure 5) into axle arm (1) to a depth of 3.75 inches (95 mm) below hub mounting surface. See Figure 15.

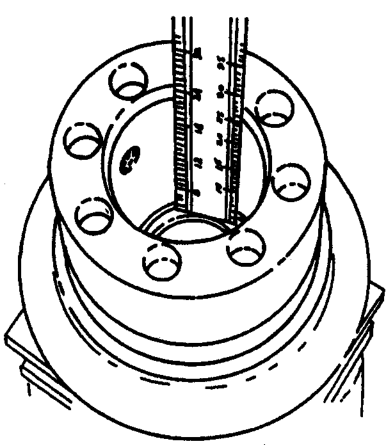


Figure 15.

23. Press new oil seal (5) into hub carrier (7).

24. Assemble hub carrier (7) to axle arm (1). Install outer bearing (6).

25. Install ring gear support (13), locking plate (15). Coat threads of bolts (31) with Loctite #270 and tighten to a torque of 88 lb-ft. (120 Nm). Install ring gear (16) onto ring gear support (13).

26. Replace half shaft thrust washer (18) if worn.

27. Invert hub unit and place on blocks. Using a suitable mandrel or oil pin, locate gears (25) and thrust washes (28) in place, after coating thrust washers with grease (Figure16).

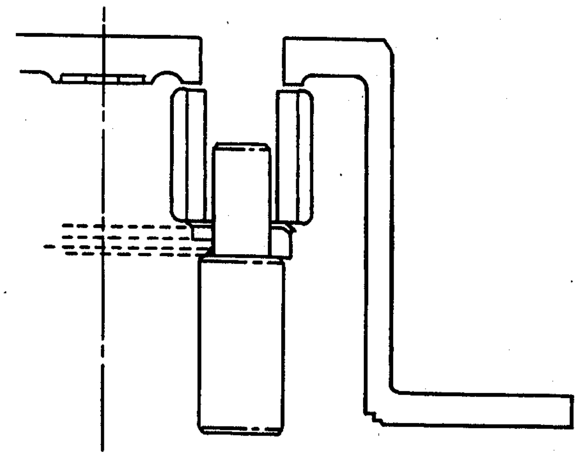


Figure 16.

28. Install needle roller bearings (26, Figure 5) in planet gears (25) and position planet gears in hub. Locate lock tab of thrust washers (28) in slots in hub unit.

NOTE: The last two gears must be in position before inserting second pin.

29. Install new o-rings (23) onto pins (22). Tap pins into hub reduction unit (19) while supporting mandrel. Upon reaching last 1/4 inch (6 mm) check to ensure thrust washers (28) are securely located on pin, concentric with bore and thrust washer lock tab is located in slot, before tapping all the way in.

30. Install circlip (17).

31. If axle is off the machine, insert half shaft (30) in axle arm (1). Install new o-ring (9) to hub carrier (7). Install hub reduction unit (19) to hub carrier (7).

If axle is still on the machine, proceed as follows:

a. Remove half shaft (30) slightly and install hub reduction unit to axle to engage sun gears with gear on half shaft.

b. Insert reduction unit over wheel studs on carrier, pushing half shaft back into axle casing.

32. Install capscrews (24).

33. Install brake discs. First install an intermediate brake disc (37), then a brake disc (36). Alternate discs until five of each are installed. End with disc (35).

NOTE: Brake discs (36) are 4.9 mm thick and must be replaced in complete sets, together with intermediate brake discs (37), when worn to 4.5 mm or less. Soak brake discs for twelve hours in oil (See axle lubricant specifications in Section 1050) prior to installation.

34. Install three pins (38).

35. Install new o-rings (5, Figure 4) to intermediate housings (3) and install axle arms. Coat threads of studs (29 and 33, Figure 5) with Loctite #270 and tighten nuts to a torque of 18 lb-ft. (25 Nm)

36. Fill differential with recommended lubricant to bottom of oil level plug opening. See Figure 1.

37. Fill each wheel hub with recommended lubricant to bottom of fill plug opening. See Figure 2.

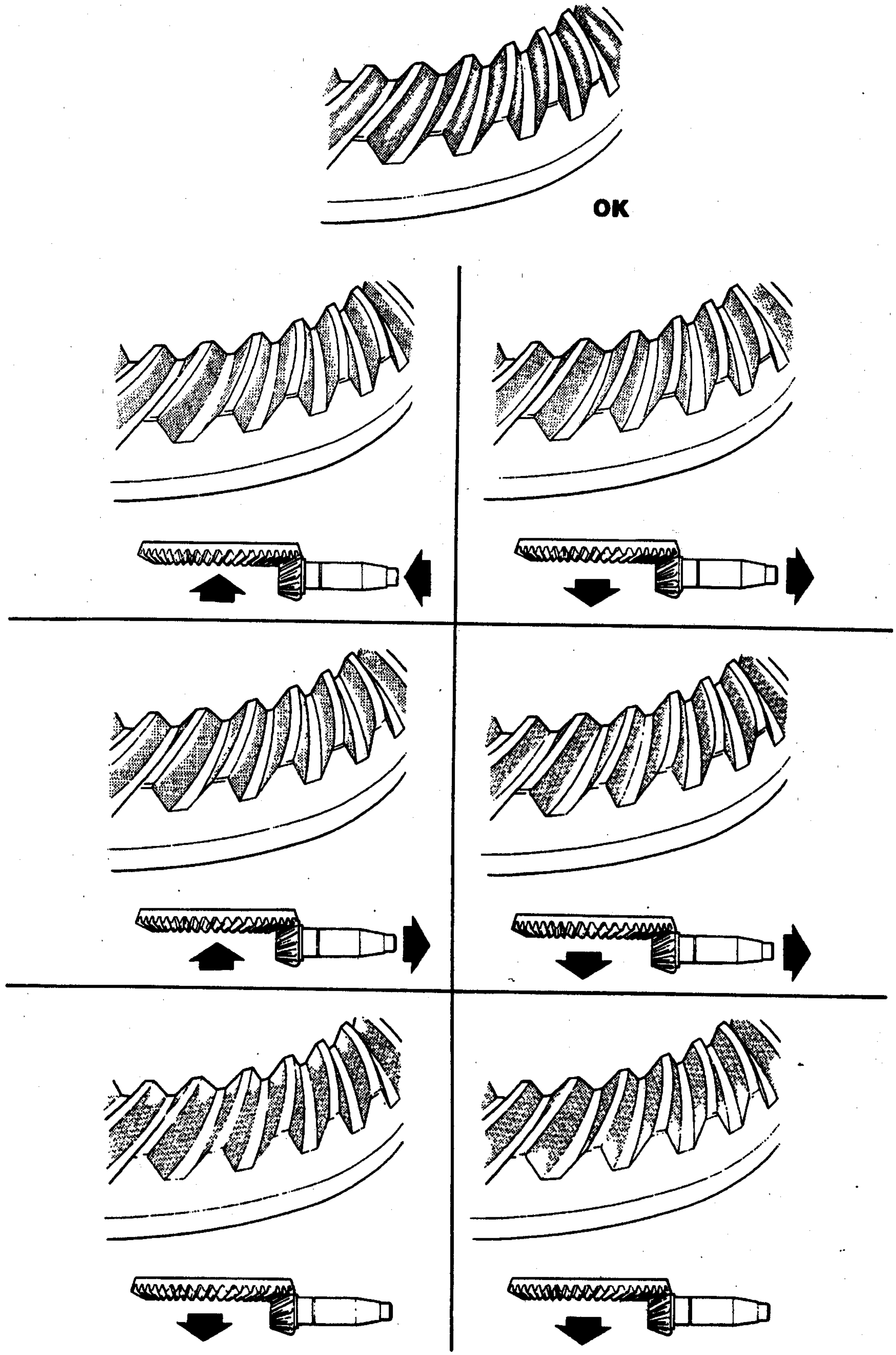


Figure 17.

Section 6127

FRONT STEERING AND DRIVE AXLE (OPTIONAL - HURTH)

6

MAINTENANCE

Level check (Weekly or Every 50 Hour Interval)

1. Level crane, engage parking brake and shut off engine. Tag or remove ignition key.
2. Clean area around the differential check/fill plug (Figure 1). Remove plug from axle housing and check oil level. Oil must be level with bottom of fill plug hole. If low, add recommended oil, see Section 1050.
3. Install plug.
4. Move the machine until the plug is lined up as shown in Figure 2. Clean area around the axle hub drain/fill plug. Remove the plug and check oil level. Oil level must be level with the bottom of the fill plug hole. If low add recommended oil, see Section 1050.
5. Install plug and repeat for other axle hub.

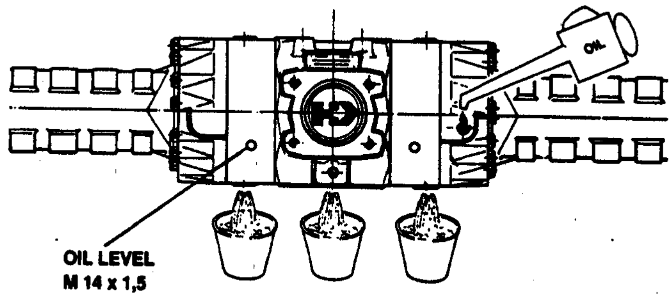


Figure 1.

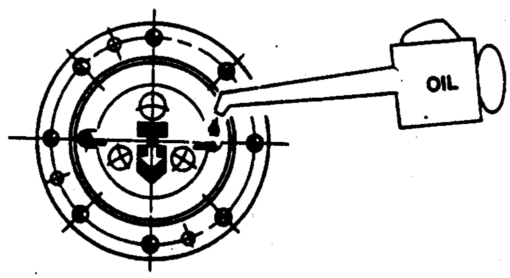


Figure 2.

Oil Change (Every six months or 1500 Hour Intervals)

1. Level crane, engage parking brake, and shut off engine.
2. Clean around the differential fill/check plug and drain plugs (See Figure 1).
3. Remove the fill/check plug. Place a container under the axle housing and remove the drain plugs. Drain all oil.
4. Clean the drain plug and install it in the axle housing.
5. Fill differential with recommended oil, see Section 1050.
6. Remove breather and clean in a suitable solvent.
7. Move the machine until the plug is lined up as shown in Figure 3. Clean area around the axle hub drain/fill plug. Remove the plug and drain oil into a suitable container.
8. Move machine to place axle in position shown in Figure 2. Fill axle hub to level with bottom of fill hole with recommended lubricant. See Section 1050. Install plug.
9. Repeat steps 7 and 8 for the other axle hub.

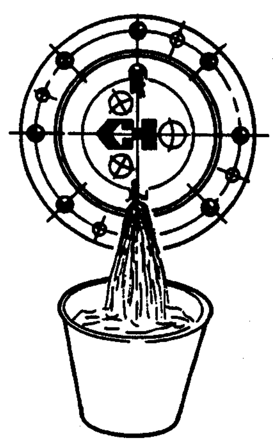


Figure 3.

DESCRIPTION AND TROUBLESHOOTING

General

The steering drive axle has a NoSpin differential. A differential is necessary in an axle to prevent damage to the tires when the machine is turning a corner. During a turn, the outside wheel must turn faster to move a greater distance than the inside wheel. The differential gives positive drive to both wheels over all surfaces. The clutches in the NoSpin will let one wheel rotate faster than the ring gear (when making a turn), but will never let either wheel turn slower than the ring gear.

Troubleshooting

It is important to remember that the performance of the NoSpin differential will be different than a standard differential. For example:

1. During a turn, the clutch for the outside wheel disengages automatically to let the wheel rotate freely when necessary. A sound can be heard in the differential when the clutch engages and disengages. This sound is normal.
2. During straight travel, you will hear a regular click in the differential if the radius of the two tires is not equal. This radius is the radius of the tire under load and is measured from the ground to the center of the tire. It is important that both tires are the same size and have equal pressures.
3. If there is a heavy load on one side of the machine, the machine will pull to that side during travel. The heavy load changes the radius of the tire.
4. If too much power is applied during a turn, the differential will have a possible effect on steering. Decreasing the engine speed will decrease the torque to the wheels and make steering easier.
5. The NoSpin will have more backlash or free movement than a standard differential. This movement is necessary to permit the clutches to engage and disengage automatically during a turn. The amount of backlash in the NoSpin normally does not increase with use. There will be an increase in the total backlash in the drive train as the wear in the components increases.
6. During a turn, it is normal to hear a loud noise in the differential if you rapidly increase, then decrease the engine speed. This noise is caused when the torque changes between driving torque to the inside wheel and braking torque to the outside wheel.
7. During a turn on loose ground or other conditions of bad traction, there can be loss of torque to both wheels for a short time. This condition occurs when the clutch for the outside wheel is disengaged and full torque is applied to the inside wheel. The inside wheel will turn, but movement of the machine will stop until the clutch for the outside wheel engages.

To check the performance of the differential:

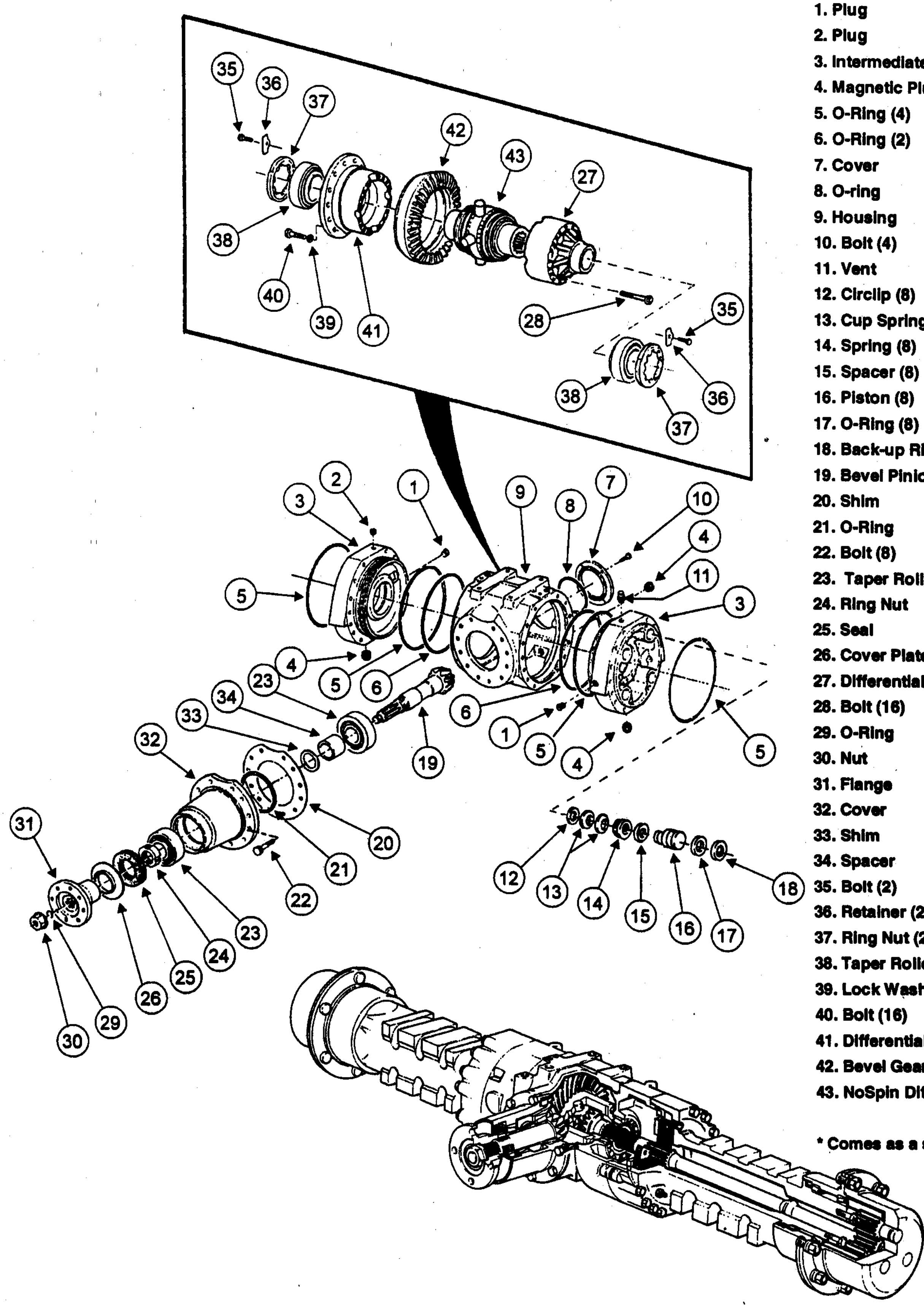
1. On a concrete surface, move the machine several times around a circle with the steering wheels turned at the maximum angle.
2. Check the drive wheels while the turn is being made. The outside wheel must rotate faster than the inside wheel. There must be no loss of traction to the inside wheel.
3. Turn the machine in the opposite direction and check the drive wheels again. If there is no differential action, or if there is slippage in the wheels, repair or replacement of the differential is necessary.

If noise in the differential during straight travel is the problem, check the radius of the drive wheels. Use the following procedure:

1. Put a mark with chalk on both wheels in the same location.
2. Move the machine a short distance in a straight line. If the radius of the two tires is not equal, the marks on the two wheels will be in a different location.
3. Adjust the pressure in the two tires and repeat the check until the marks are in the same location when the machine is stopped.

Before you remove the differential, make a final check to see if the problem is in the differential. Two persons are needed for the check.

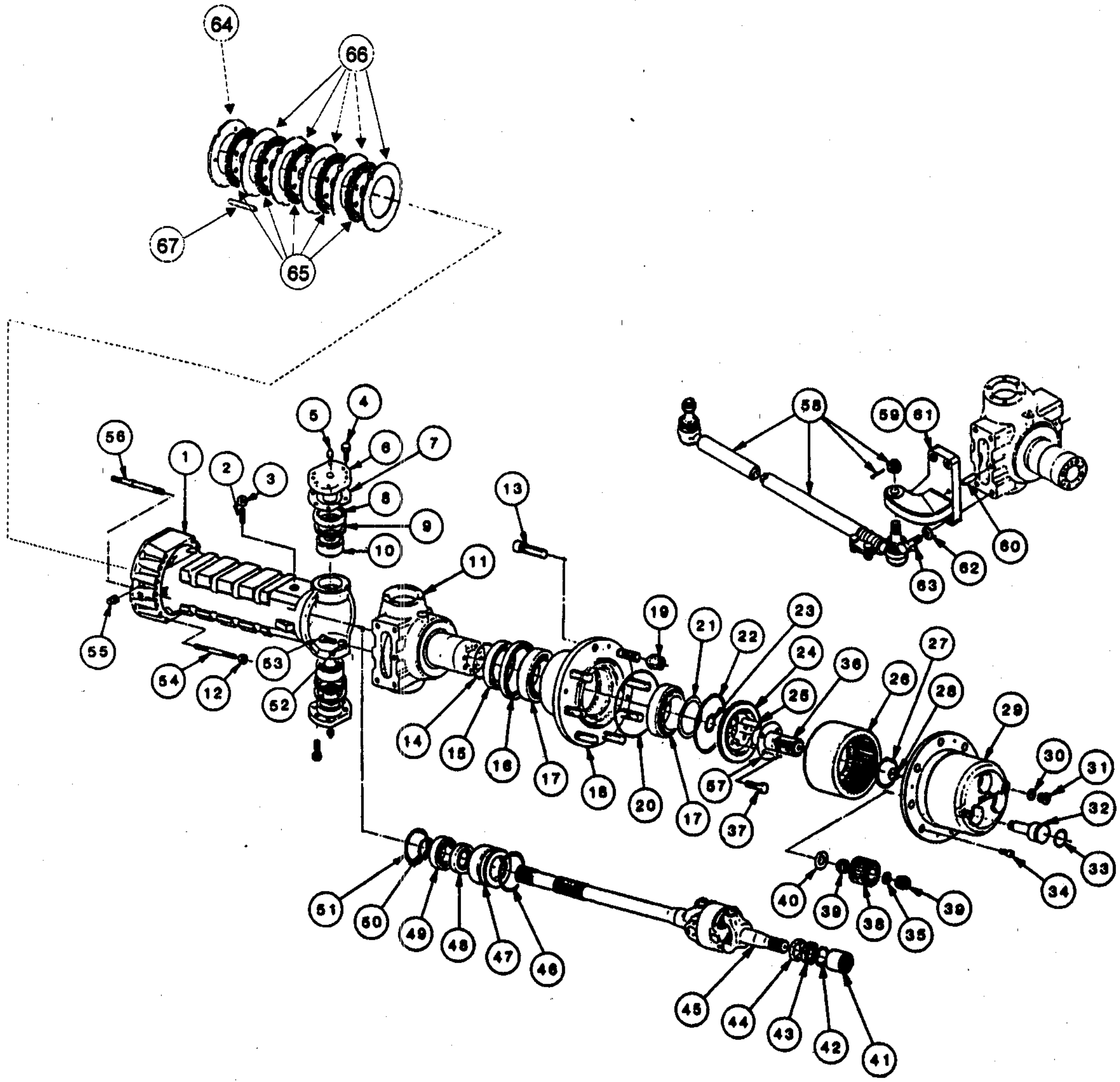
1. Lower the outriggers and lift the wheels off the ground. Stop the engine.
2. Disengage the park brake and put the transmission in "Neutral" position.
3. While one person holds the left wheel, rotate the right wheel forward. Now hold the right wheel and turn the left wheel forward. Repeat this procedure for each wheel in the reverse direction. If the differential is working correctly, you will hear a regular series of clicks while each wheel is being rotated. If the wheels do not turn smoothly and easily, remove and make and make an inspection of the differential.



1. Plug
2. Plug
3. Intermediate Cover (2)
4. Magnetic Plug (3)
5. O-Ring (4)
6. O-Ring (2)
7. Cover
8. O-ring
9. Housing
10. Bolt (4)
11. Vent
12. Circlip (8)
13. Cup Spring (16)
14. Spring (8)
15. Spacer (8)
16. Piston (8)
17. O-Ring (8)
18. Back-up Ring
19. Bevel Pinion*
20. Shim
21. O-Ring
22. Bolt (8)
23. Taper Roller Bearing
24. Ring Nut
25. Seal
26. Cover Plate
27. Differential Carrier
28. Bolt (16)
29. O-Ring
30. Nut
31. Flange
32. Cover
33. Shim
34. Spacer
35. Bolt (2)
36. Retainer (2)
37. Ring Nut (2)
38. Taper Roller Bearing
39. Lock Washer (16)
40. Bolt (16)
41. Differential Carrier
42. Bevel Gear*
43. NoSpin Differential

* Comes as a set.

Figure 4.



1. Lateral Axle Housing (2)
2. Grub Bolt (2)
3. Nut (3)
4. Bolt (24)
5. Grease Fitting (4)
6. Pivot Pin (4)
7. Shim (4)
8. Dust Excluder (5)
9. Ring (4)
10. Taper Roller Bearing ((4)
11. Steering Case (2)
12. Nut (28)
13. Wheel Stud (16)
14. O-Ring (2)
15. Spacer (2)
16. Seal (2)
17. Taper Roller Bearing (4)
18. Wheel Hub (2)
19. Wheel Nut (16)
20. O-Ring (2)
21. Shim (AR)
22. Snap Ring (2)
23. Friction Washer (2)
24. Ring Gear Support
25. Dowel (8)
26. Ring Gear (2)
27. Circlip (2)
28. Friction Washer (2)
29. Planet Gear Carrier (2)
30. Seal Washer (2)
31. Plug (2)
32. Pin (6)
33. O-Ring (6)
34. Cylinder Bolt (8)
35. Spacer (6)
36. Pinion (2)
37. Bolt (8)
38. Planetary Gear (6)
39. Needle Bearing (12)
40. Friction Washer (6)
41. Needle Bearing (2)
42. Snap Ring (2)
43. Seal (2)
44. Dust Excluder (2)
45. Double Universal Joint (2)
46. O-Ring (2)
47. Reduction Bushing (2)
48. Seal (2)
49. Ball Bearing (2)
50. Circlip (2)
51. Circlip (2)
52. Nut (2)
53. Steering Adjust Bolt (2)
54. Stud (24)
55. Plug (4)
56. Stud (4)
57. Locking Plate (2)
58. Tie Rod
59. Track Rod Arm
60. Dowel (2)
61. Track Rod Arm
62. Spring Washer (8)
63. Bolt (8)
64. Disc (2)
65. Brake Disc (10)
66. Intermediate Disc (10)
67. Pin (6)

Figure 5.

SERVICING THE AXLE

Disassembly

NOTE: Apart from replacement of the hub and piston shaft oil seals, it is recommended that the axle be removed for all other disassembly operations.

1. Remove plug (4, Figure 4) and drain oil into a suitable container.
2. Disconnect tie rod (63, Figure 5) from brackets (59 and 61).
3. Remove fourteen nuts (12, Figure 5) from casing studs (54).
4. Separate lateral axle housing (1, Figure 5) from intermediate housing (3, Figure 2). Repeat on opposite side.
5. Remove disc (64), five brake discs (65) and five intermediate discs (66). Remove three pins (67).
6. Drain oil from the planet gear carrier (29, Figure 5).
7. Remove three bolts (24). Lift off planet gear carrier (29).
8. Remove circlip (27) securing the plant gears.
9. Using a deft and hammer (Figure 4), remove the planet pins (32, Figure 5). Be careful not to damage thrust washers (40). They may be removed once there is clearance.

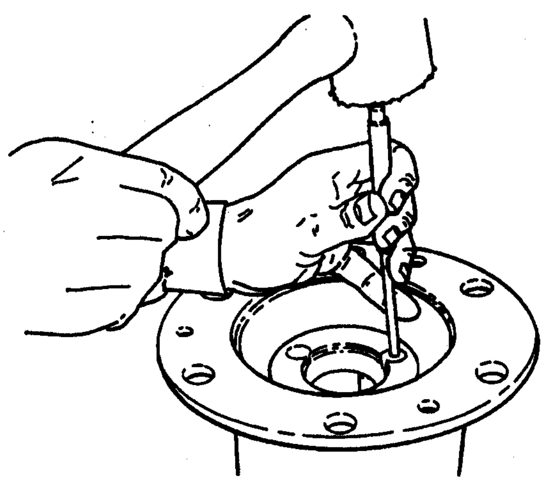


Figure 6.

10. Remove planet gears (38), thrust washer (40), and bearings (39).
11. Remove ring gear (26). Unscrew and remove four bolts (37), retaining ring (57), and ring gear support (24).
12. Using a suitable puller and center pad (Figure 7), remove the hub carrier (18, Figure 5), from lateral axle housing (1). If the axle is still on the machine, the half shaft may be used in place of the center pad.

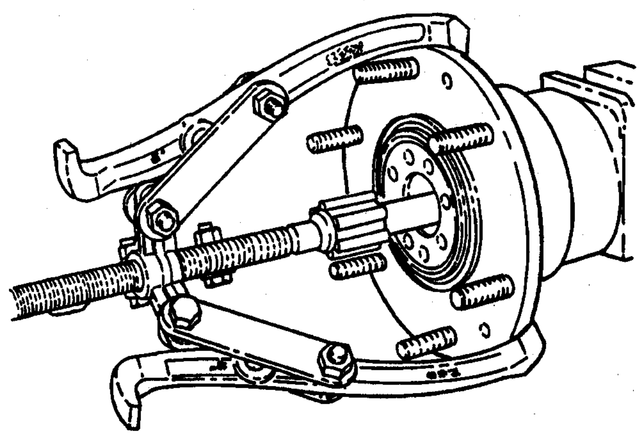


Figure 7.

13. Remove bolts (4, Figure 5) and both pivot pins (6). Save shims (7). Remove taper roller bearing (10) and seals (9).
14. Separte steering case (11) from lateral axle housing (1). Save the dust exluder (44).
15. Remove seal (43), retaining ring (42) and needle bearing (41).
16. Remove outer races of taper roller bearings (10) from lateral axle housing (1).

NOTE: When extracting the double universal joint on the differential lock side and the and the steering case will not be disassembled, install the differential lock mechanism in its engaged position so that the box coupling does not fall. Lock the brakes in order to keep the discs in position.

17. Remove nut (3) and grub bolt (2) and slide out the double universal joint (45). Remove retainer rings (50 and 51). Pull out bushing (47) and remove ball bearing (49), seal (48) and o-ring (46).

18. Stand center assembly (Figure 8) on end, and apply 40-70 psi (270 - 483 kPa) to the brake line part to release brake pistons (16, Figure 4). Remove brake pistons (16). Note o-ring (17) and back-up ring (18).

WARNING: Perform this operation only with assembly in position shown in Figure 8. Treat compressed air with caution.

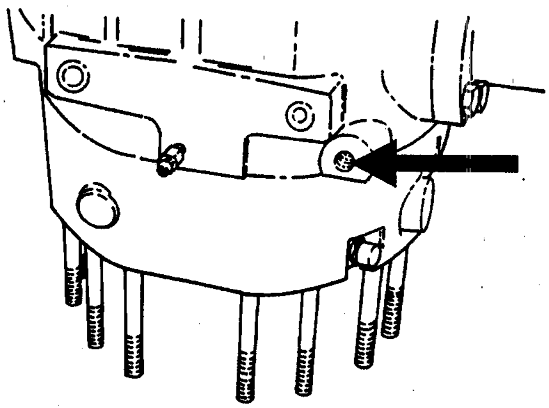


Figure 8.

19. Unscrew eight bolts (22, Figure 4), and remove pinion housing (32) by reinserting two bolts into the unused tapped holes in the pinion housing to jack it away from the differential casing (9).
20. Withdraw pinion housing (32), retain shim (20).
21. Uscrew flange nut (30) and remove flange (31).
22. Press out pinion shaft (19). Remove outer taper roller bearing (23), spacer (34) and shim (33).
23. Lift out spacer (26) and remove oil seal (25).
24. Remove the two shouldered studs (29, Figure 5) (black in color), placed diametrically opposite each other, which retain the intermediate casing.
25. With the housings (3 and 9, Figure 4) in the vertical(3) upward, assisting by lifting from the inside to release it from the brake system o-rings (5 and 6).

NOTE: Never dismantle intermediate housing (3) from center casing (9) in the horizontal position, as this will cause the bevel gear (7) to drop, possibly causing damage.

26. Lift out differential assembly. Mark casing externally to indicate side.
27. Disassemble the differential assembly using Figure 4 as a guide. Assembly (43) is not serviceable.

Assembly

1. Using Figure 4 as a guide, assemble the differential assembly. Coat threads of bolts (40) with Loctite #270 before installation.
2. Measure and record dimension X (Figure 9), between the pinion housing mounting face of the center (differential) casing and the nearest point of the adjacent intermediate housing counterbore, for later use in setting pinion depth.

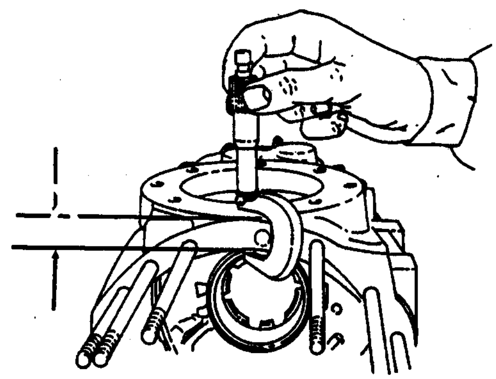


Figure 9.

3. Assemble outer races of pinion bearing (Figure 4) into pinion housing (32).
4. Install bearing (23) onto pinion (19).
5. Lower pinion (19) into pinion housing (32) and invert assembly.
6. Assemble shims (33) and spacer (34). Assemble outer bearing (23). Tap new oil seal (25) into position and grease lips with grease. Install outer spacer (24).
7. Install flange (31). Install new o-ring (29). Install nut (30). Tighten to a torque of 192-206 lb.-ft. (260-280 (Nm).
8. Check rolling torque of pinion shaft, which should be 8.8 to 13 lb-in. (100-150 Nem). If torque is improper, disassemble pinion and pinion housing. Increase shim thickness by 0.01 mm to decrease preloading torque by approximately 4.4 to 5.3 lb-in. (50-60 Nem) conversely to increase preloading the shim, thickness should be reduced. Assemble pinion and pinion housing. Check o-ring (29) for damage. If damaged, replace it. Tighten nut (30) to a torque of 192-206 lb-ft. (260-280 Nm).

6

9. Assemble side intermediate housing (3, Figure 4) to center casing (9) after lubricating o-rings (5 and 8) and checking their security and position. Install two shouldered studs (29, Figure 5) to intermediate housing (3).

10. Invert assembly in order to place NoSpin differential unit into position in center casing as originally marked.

11. Install other intermediate housing (3, Figure 4) after lubricating o-rings (5 and 8) and checking their security. Install two shouldered studs (29, Figure 5).

12. Clamp three sections together by using four tubes and nuts each side (Figure 10) and torque tighten to 18 lb-ft. (25 Nm).

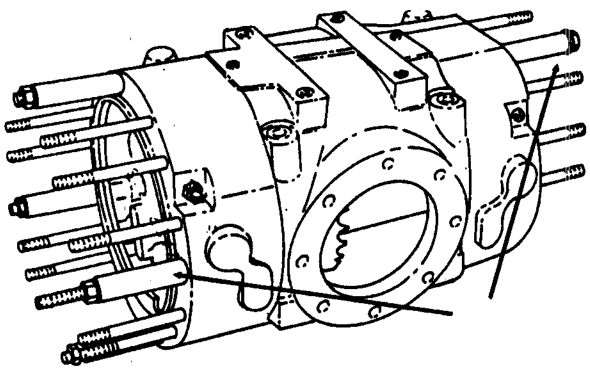


Figure 10.

13. Wrap a cord around the differential housing and note the pull required to maintain rotation to the differential assembly (Figure 11), which should be 6.7 to 7.8 lb. (30-35 N).

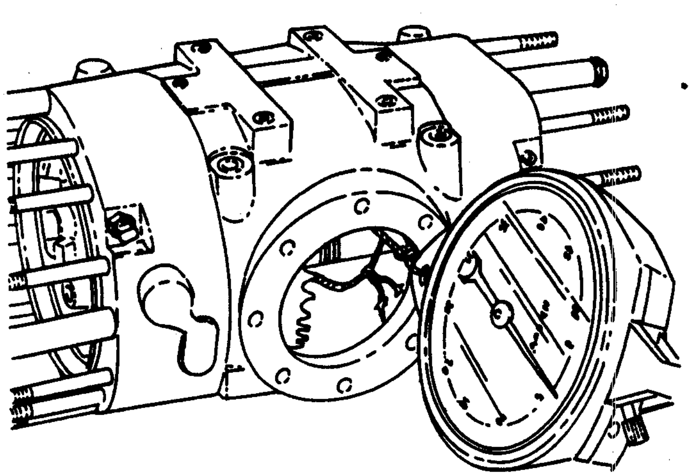


Figure 11.

14. Adjust bearing rings to alter bearing preload, but do not lock them at this stage (Figure 12).

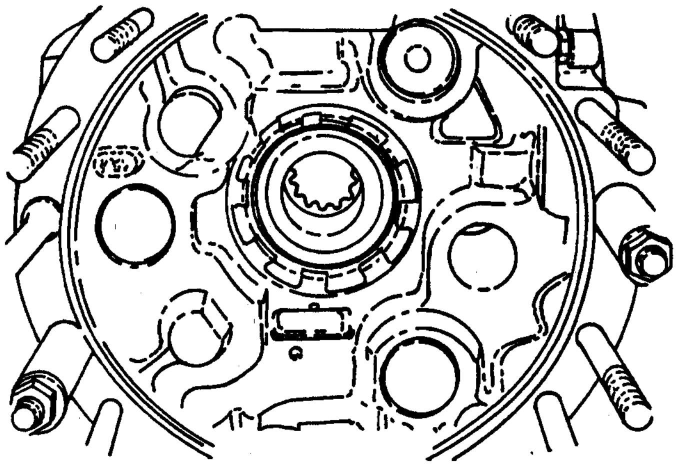


Figure 12.

15. Note measurement **Y** etched on end of pinion face (e.g.) 97.9 (any other marking, such as B22, is the bevel gear and pinion pairing number), and measurement **Z** stamped on inner face of pinion housing (Figure 13).

16. Oil scoop **A**, Figure 14, must be located at the top when installing pinion housing to center casing. Select thickness of pinion housing shim **B** by completing the calculation below.

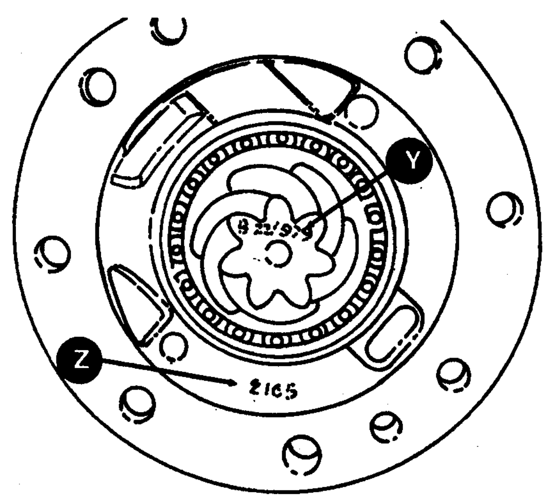


Figure 13.

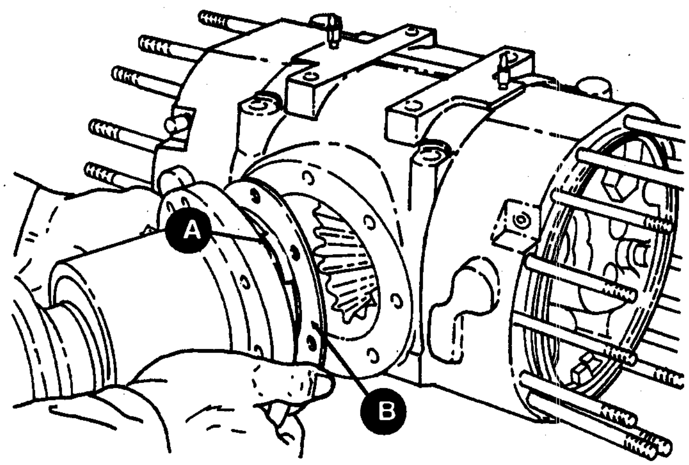


Figure 14.

Explanation of Formula for Calculating Pinion Housing Shim Requirement

A. Dimension X:

Formula: Standard Value minus Measured Value = Correction Value

Example: 24.00mm minus 24.28mm = -0.28mm

Because the measured value is greater than the standard value the result is a negative value.

B. Dimension Y:

Formula: Standard Value minus Measured Value = Correction Value

Example: 98.00mm minus 97.90mm = 0.10mm

C. Dimension Z:

Formula: Measured Value minus Standard Value = Corrective Value

Example: 21.65mm minus 21.00mm = 0.65mm

D. Calculation of Shim Thickness:

Formula: Correction X plus Correction Y plus Correction Z = Shim t thickness

Example: -0.28 plus 0.1 plus 0.65 = 0.47mm

NOTE: When new bearings have been installed, subtract an additional 0.05 mm to 0.08 mm from the above result for initial bedding of the bearings.

17. Assemble pinion housing to center casing using the selected shim, and temporally secure it using four fixing bolts (22, Figure 4). Tighten to a torque of 18 lb-ft. (25 Nm).

18. Bevel gear (42, Figure 4) and pinion (19) backlash should be 0.15 mm to 0.20 mm. Adjust by screwing ring nut (37) in or out to alter position of bevel gear assembly.

NOTE: It is important to turn each ring by equal amounts in either direction to void losing bearing preload.

19. Check meshing of bevel gear (42) and pinion (19) by marking teeth with engineers blue and rotating gears. Refer to page 9 for correct marking. When meshing is correct, install locking tab (36) to ring nuts (37).

20. Remove the four fixing bolts and remove pinion housing (32). Install new o-ring (21) to pinion housing (32), and assemble to center casing (9), ensuring that oil scoop faces top and drain faces bottom of differential center casing. Coat threads of bolts (22) with Loctite #270 and tighten to a torque of 18.5 lb-ft. (25 Nm). Remove nuts and tubes from assembly.

21. Install new o-rings (17) and back-up rings (18) onto pistons (16). Install pistons.

22. Insert new half shaft oil seal (18, Figure 5) into steering case (11) to a depth of 3.75 inches (95 mm) below hub mounting surface. See Figure 15.

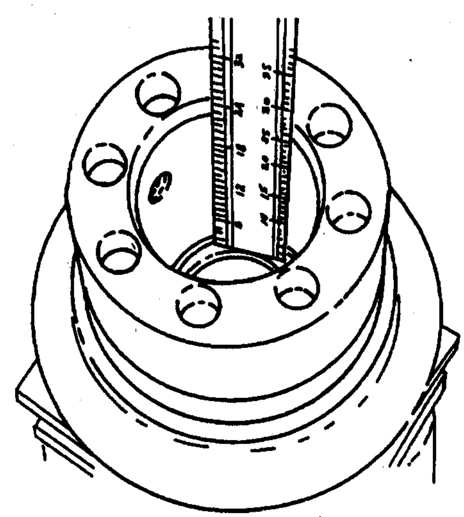


Figure 15.

23. Press new oil seal (16) into hub carrier (18).

24. Assemble hub carrier (18) to steering housing (11). Install outer bearing (17).

25. Install ring gear support (24), locking plate (25). Coat threads of bolts (37) with Loctite #270 and tighten to a torque of 88 lb-ft. (120 Nm). Install ring gear (26) onto ring gear support (24).

26. Replace half shaft thrust washer (28) if worn.

6

27. Invert hub unit and place on blocks. Using a suitable mandrel or oil pin, locate gears (38) and thrust washes (40) in place, after coating thrust washers with grease (Figure16).

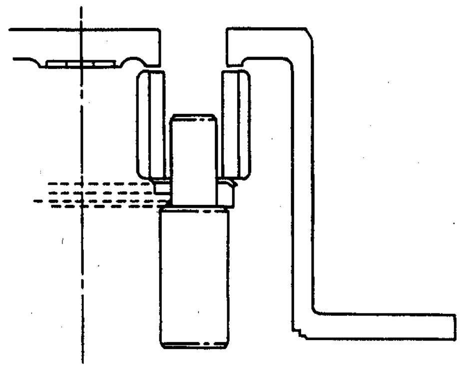


Figure 16.

28. Install needle roller bearings (39, Figure 5) in planet gears (38) and position planet gears in hub. Locate lock tab of thrust washers (40) in slots in hub unit.

NOTE: The last two gears must be in position before inserting second pin.

29. Install new o-rings (33) onto pins (32). Tap pins into hub reduction unit (29) while supporting mandrel. Upon reaching last 1/4 inch (6 mm) check to ensure thrust washers (40) are securely located on pin, concentric with bore and thrust washer lock tab is located in slot, before tapping all the way in.

30. Install circlip (27).

31. Install new o-ring (46) onto bushing (47). Install seal (48) and bearing (49) into bushing 47). Secure with retaining ring (51).

32. Install assembled bushing onto double universal joint (45). Install double universal joint into lateral axle housing (1). install grub bolt (2) and nut (3).

33. Install outer races of taper roller bearings (10) into lateral axle housing (1).

34. Install needle bearing (41), retaining ring (42) and seal (43) into planet gear carrier (29).

35. Place steering case (11) over knuckle end of lateral axle housing (1).

36. Install dust extruders (8), rings (9) and taper roller bearings (10) onto pivot pin (6). Install shims (7) onto upper pivot pin.

37. Install both assembled pivot arm pins into steering case. Besure shims are on the top pivot pin. Secure pivot pins with twelve bolts (4) each.

NOTE: If shims were damaged or lost during disassembly, shims must be installed for steering to function properly. Install top pivot pin with only four bolts (4). Tighten the bolts until there is zero end float on the taper roller bearings. Measure distance between the upper pivot pin (6) and the steering case (11) in two opposite positions. Average the two mesurements and then subtract 0.70 mm for preload. This is the thickness of shims to istall. Install proper thickness of shims between pivot pin and steering case.

38. Use an approximate 39" (1 m) log wrench and a force gauge (Figure 17) to check rotating torque on the lower pivot pin. The force set tangentally to the wrench must be 3.4 - 3.8 lb. (15-17 N). I force needed to rotate the articulation is higher than 3.8 lb. (17 N) put in thicker shims; if the force is lower, take away shims until the correct preload is obtained.

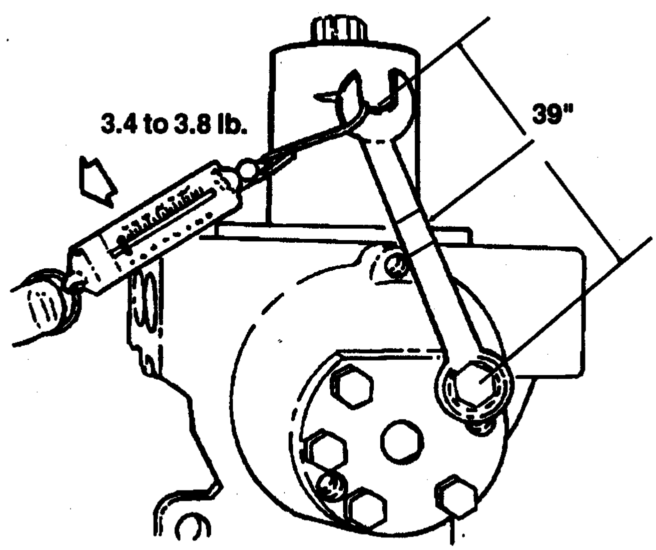


Figure 17.

39. Install remaining bolts (4) and tighten all bolts. Check preload again.

40. Install hub reduction unit (29) to wheel hub (18).

41. Install capscrews (34).

42. Install brake discs. First install an intermediate brake disc (66), then a brake disc (65). Alternate discs until five of each are installed. End with disc (64).

NOTE: Brake discs (65) are 4.9 mm thick and must be replaced in complete sets, together with intermediate brake discs (66), when worn to 4.5 mm or less. Soak brake discs for twelve hours in oil (See axle lubricant specifications in Section 1050) prior to installation.

43. Install three pins (67).

44. Install new o-rings (5, Figure 4) to intermediate housings (3) and install axle arms. Coat threads of studs (54 and 56, Figure 5) with Loctite #270 and tighten nuts to a torque of 18 lb-ft. (25 Nm)

45. Connect steering tie rod (58) to brackets (59 and 61).

46. Lubricate steering knuckle through grease fittings (5, Figure 5).

47. Fill differential with recommended lubricant to bottom of oil level plug opening. See Figure 1.

48. Fill each wheel hub with recommended lubricant to bottom of fill plug opening. See Figure 2.

49. Check steering alignment and adjust if required. See Section 5021.

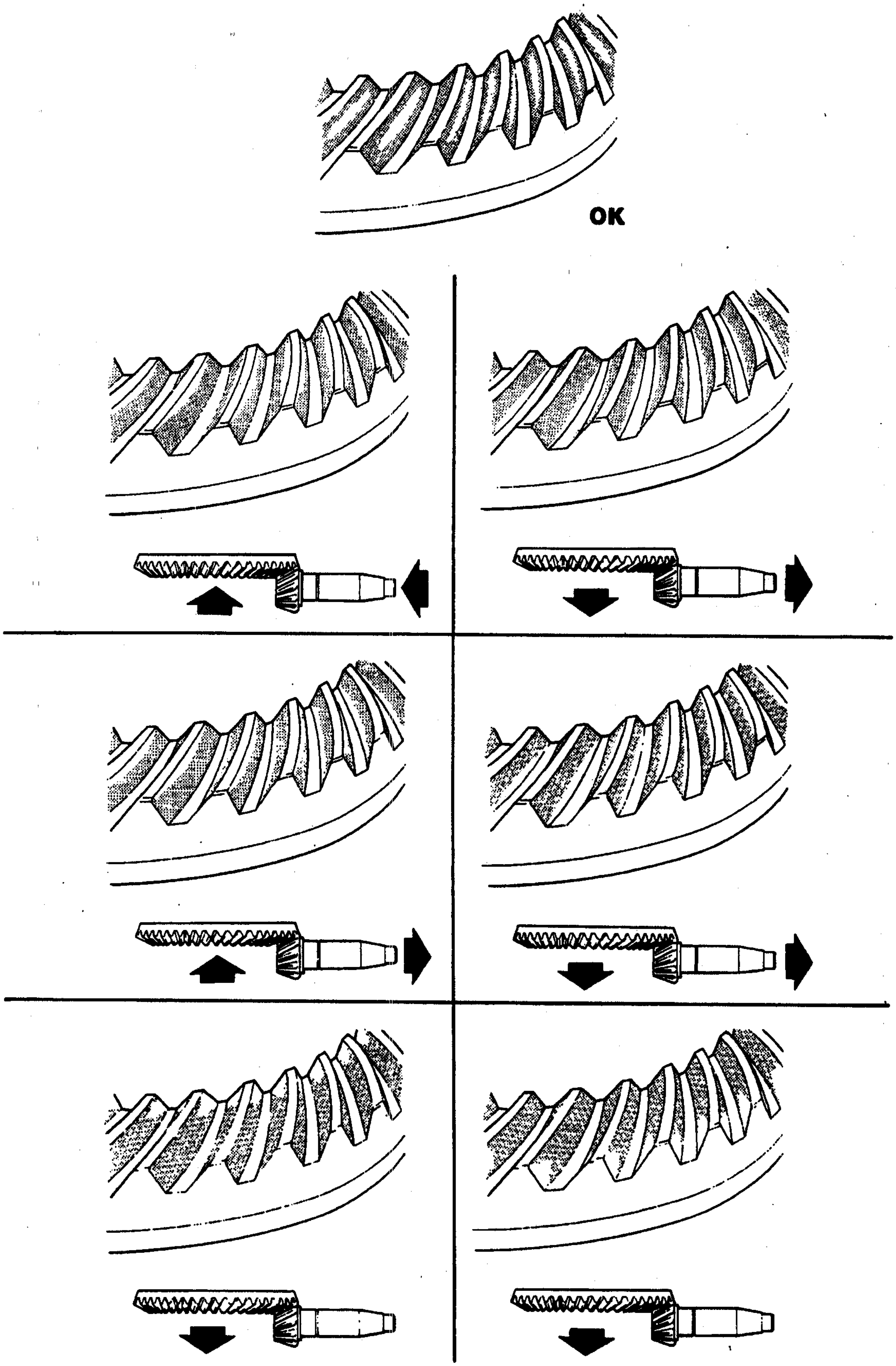


Figure 18.

Section 7102

BRAKES
DIAGNOSIS, TEST AND CHECKS

SPECIFICATIONS

2-Wheel Steering (Rockwell Axle)
Fluid Type . . . . Brake Fluid, SAE Spec J1703f or equivalent
Capacity, Master Cylinder . . . . 1 pint (.5 L)
Relief Valve . . . . 90 psi (620 kPa)

2 and 4 Wheel Steering (Hurth Axle)
Fluid Type . . . . Dexron II ATF
Capacity, Master Cylinder . . . . 1 pint (.5 L)
Relief Valve . . . . 90 psi (620 kPa)

MAINTENANCE

Fluid Level

Keep the fluid level in the master cylinder at approximately 3/4 inch (19 mm) from top of the reservoir.

IMPORTANT: Keep dirt and foreign material out of the brake system. Clean the filler plug before removal. Use clean brake fluid and containers.

Removal of Air from System

Air in the brake system will decrease the braking force and can cause possible loss of brakes. When there is loss of fluid or air in the system, the amount of travel on the brake pedal will increase.

Air can enter the system:

a. Through a leak in the cylinders or lines.

b. If the level of the fluid in the master cylinder is too low.

c. When any lines or components are disconnected.

To remove air from the system, you can use the brake pedal or an external source of pressure. When only one wheel cylinder has been disconnected, it is necessary to remove the air from that line only.

The following procedure is for removal of air from the complete system.

1. Fill the master cylinder with clean brake fluid of the specified type. During the procedure, check the fluid frequently. If the level of fluid in the master cylinder gets too low, more air will enter the system and it will be necessary to start the procedure again.

2. Start at the wheel cylinder nearest the master cylinder.

   a. Clean the air removal screw. Install a hose made of clear plastic on the air removal screw. Put the other end of the hose into a container with a small amount of brake fluid.

   b. While one person pushes and holds the brake pedal, loosen the air removal screw. Look for air bubbles in the hose. Continue to apply pressure to the system until fluid which is free of bubbles comes from the air removal screw. Tighten the air removal screw.

NOTE: The disc brakes have two air removal screws. Loosen both screws, one at a time, to release air.

   c. Move clockwise around the machine and repeat the procedure on the next wheel. Repeat the entire procedure until all air is removed from the system.

DESCRIPTION OF OPERATION

General

The braking system on this machine is similar to the braking system on a car. The system includes a master cylinder, wheel cylinders, disc brake and hydraulic lines which connect the master cylinder to the wheel cylinders and disc brakes. See Figure 1 and 1A.

The front wheels have drum brakes (Rockwell Axle) or oil submerged disc brakes (Hurth Axle). The rear wheels have disc brakes.

Brake Master Cylinder

The brake master cylinder is inside the front fender directly in front of the cab. A mechanical linkage connects the master cylinder to the brake pedal.

The housing of the master cylinder is also the reservoir for the system. The lower part of the housing is the low pressure chamber and the housing for the brake pistons. Internal ports in the housing connect the reservoir to the low pressure chamber.

A relief valve is installed in the reservoir and is in communication with the low pressure chamber. The relief valve is connected by an external line to the brake lines.

The filler plug on the reservoir has a vent to prevent a vacuum in the reservoir.

Operation

When the operator pushes the brake pedal, force is applied to the low pressure piston of the master cylinder. See Figure 2. The piston moves forward and closes the reservoir ports in the low pressure chamber and the relief valve. The oil which is pushed ahead of the piston flows through the primary piston and enters the brake lines. The wheel cylinders extend and move the brake shoes into contact with the brake drums or discs.

When pressure reaches 90 psi (620 kPa), the low pressure chamber is closed to the brake lines. Further movement of the brake pedal applies full force to the oil in the high pressure chamber between the pistons. This force gives approximately 1000 psi (6 895 kPa) of pressure for full brake application.

When the operator releases the brake pedal, spring force moves the primary piston to the original position and opens the brake line to the reservoir.

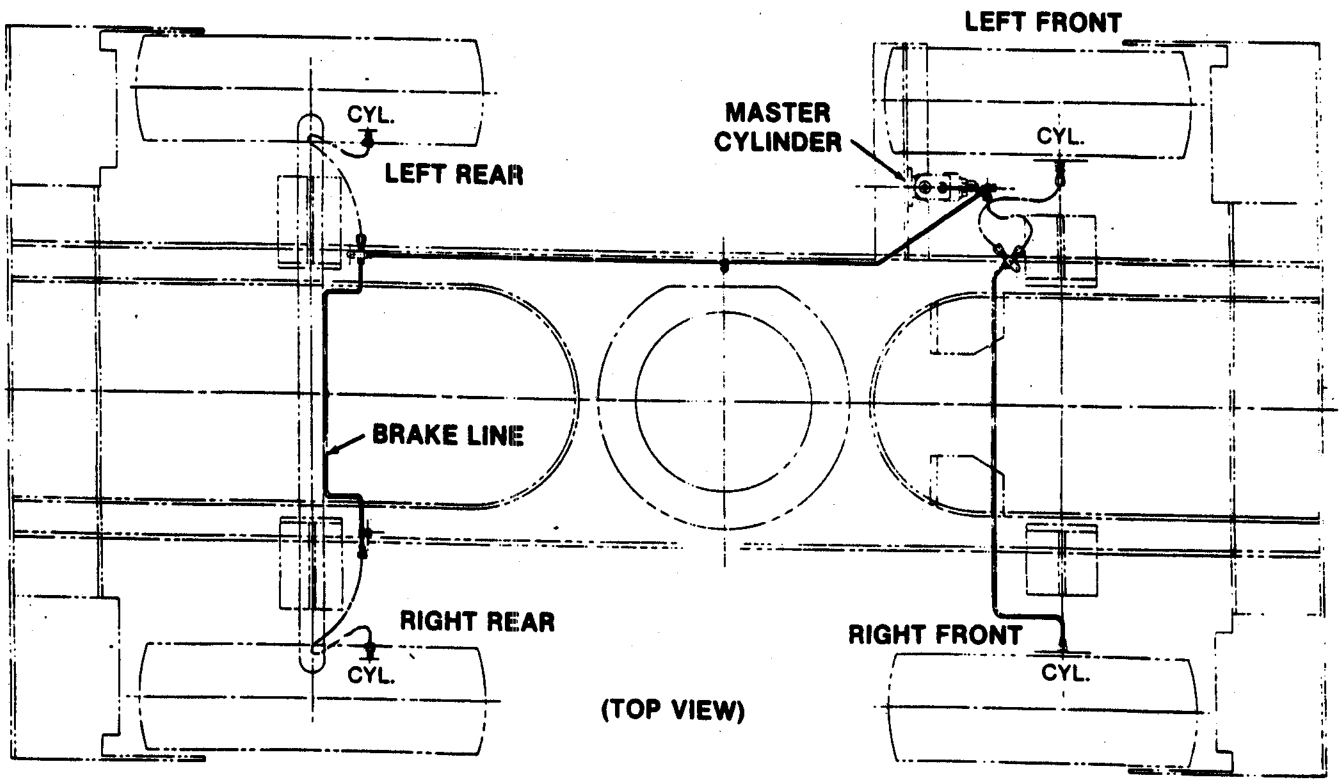


Figure 1. Wheel Brake System (2-Wheel Steer - Rockwell Axle)

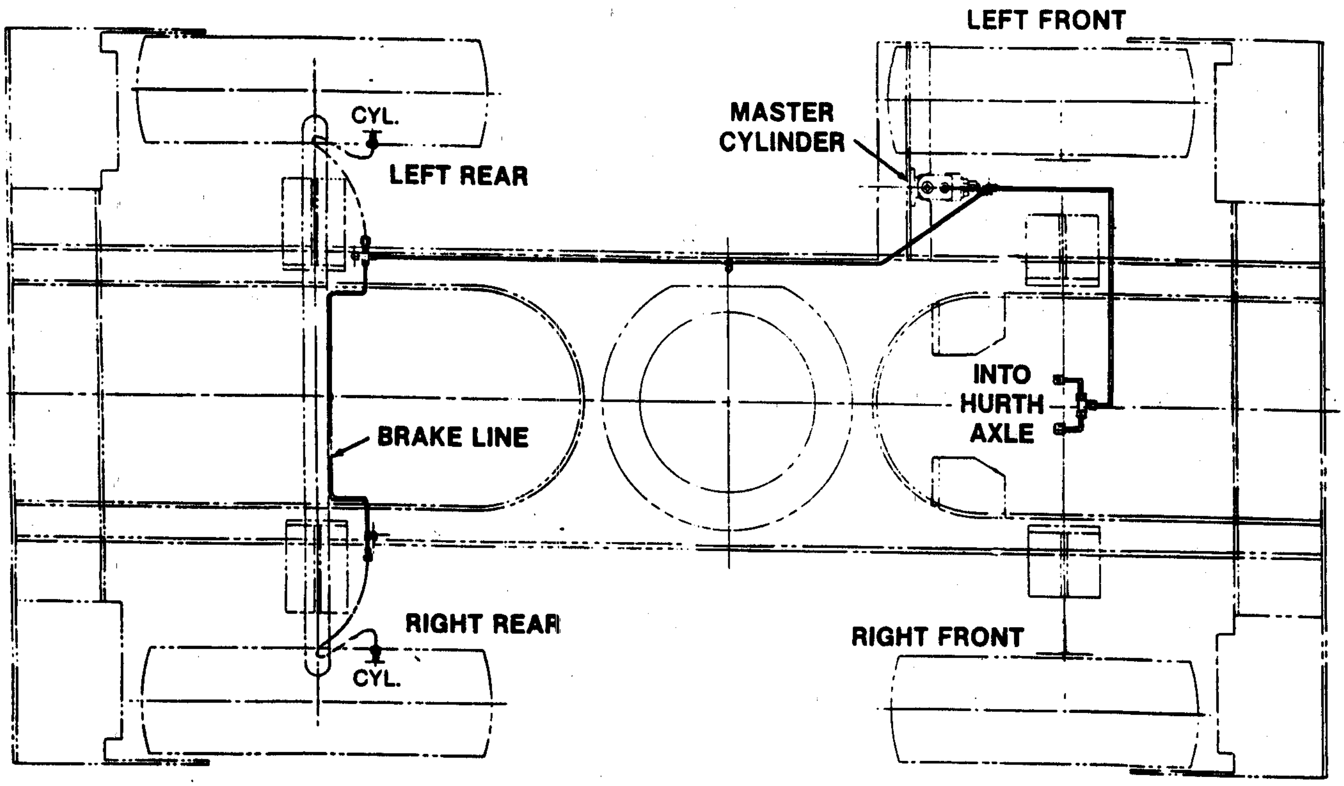


Figure 1a. Wheel Brake System (2 and 4-Wheel Steer - Hurth Axle)

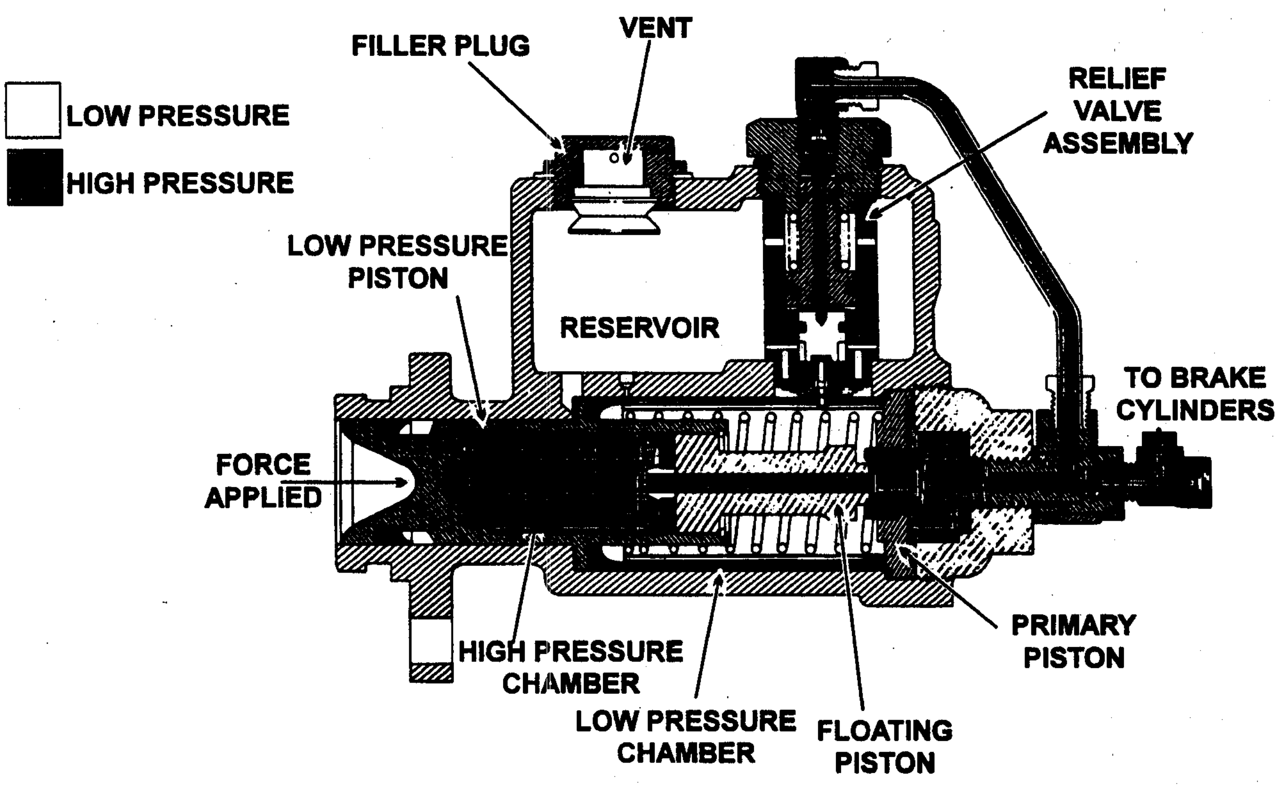


Figure 2. Master Cylinder – Cross Section View

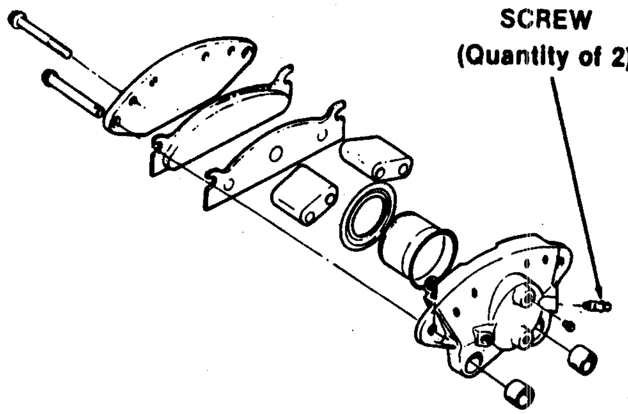


Figure 3. Disc Brake on Rear Axle

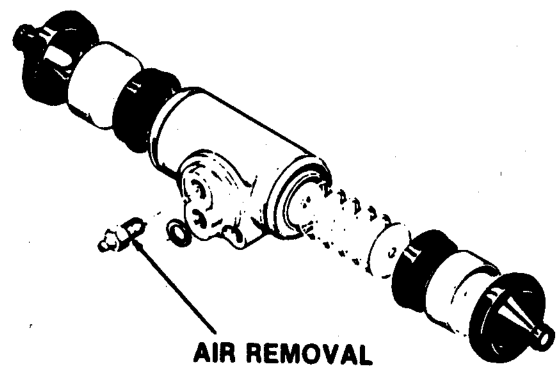


Figure 4. Wheel Cylinder on Front Axle (Rockwell Axle)

ADJUSTMENT

Brake Shoe Adjustment (Rockwell Axle)

A minor adjustment as compensation for the wear in the brakes can be made on the adjusting bolts shown in Figure 5. This adjustment is for the drum brakes only. The disc brakes have no adjustment.

1. Lower the outriggers until the wheels are off the ground. Stop the engine.

2. Put the transmission in "Neutral" position and disengage the park brake.

3. Turn the adjusting bolts in the direction shown in Figure 5. Move each brake shoe into contact with the brake drum until the wheel can no longer be turned by hand. Now turn the adjusting bolt in the opposite direction until the wheel can be turned freely.

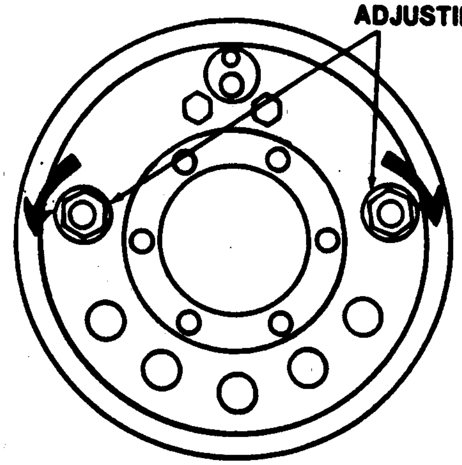


Figure 5. Brake Shoe Adjustment – Drum Brakes

TROUBLESHOOTING – HYDRAULIC BRAKE

PROBLEM	POSSIBLE CAUSE	REMEDY
Brakes pull to right or left	Wheel cylinder frozen or bad. (Rockwell Axle)	Repair or replace wheel cylinder, Section 7121.
	Severe wear or glaze on brake linings.	Replace brake linings.
Brakes do not release fully	Not enough brake free pedal.	Check brake pedal travel. Pedal must be ¾ to 1 inch of free travel before pressure stroke starts.

TROUBLESHOOTING - HYDRAULIC BRAKE (CON'T.)

PROBLEM	POSSIBLE CAUSE	REMEDY
No brakes, pedal moves easily to floor	Low fluid level.	Add fluid to brake master cylinder, remove air from brake lines.
	Loss of fluid from broken line, loose fitting or hose.	Check all lines and fittings.
	Leakage in wheel cylinder. (Rockwell Axle)	Repair or replace wheel cylinder. Section 7121.
	Fault in master cylinder.	Repair or replace master cylinder. Section 7106.
Bad brakes (pedal fully applied, machine stops gradually)	Any of the causes under "No brakes".	Same as above.
	Moisture or fluid on brake disc, shoes or drum. (Rockwell Axle)	Disasemble and inspect wheel brakes. Section 7121.
	Severe wear in brake pads or shoes.	Adjust brake lining clearance, page 7102-5. Replace brake linings or pads. Section 7121.
Soft pedal	Air in system.	Remove air from brake lines per instructions in this section.
	High pressure leaks - external.	Apply full pressure, inspect for leakage in lines, hoses or connections.
	Wrong adjustment of brake lining clearance. (Rockwell Axle)	Adjust lining clearance per instructions in this section.
	Crack in brake drum. (Rockwell Axle)	Replace brake drum.
Slow pedal return	Restriction in return ports in relief valve.	Remove and clean relief valve. Section 7106.
	Wrong type brake fluid, causing swelling of rubber cups in master cylinder.	Replace fluid in system with specified fluid.
	Return spring weak, broken or disconnected.	Check return spring. Section 7106.
	Restriction in air vent of filler cap.	Clean vent opening in filler cap.
	Dry bearings in brake pedal.	Disassemble pedal and lubricate bearings.

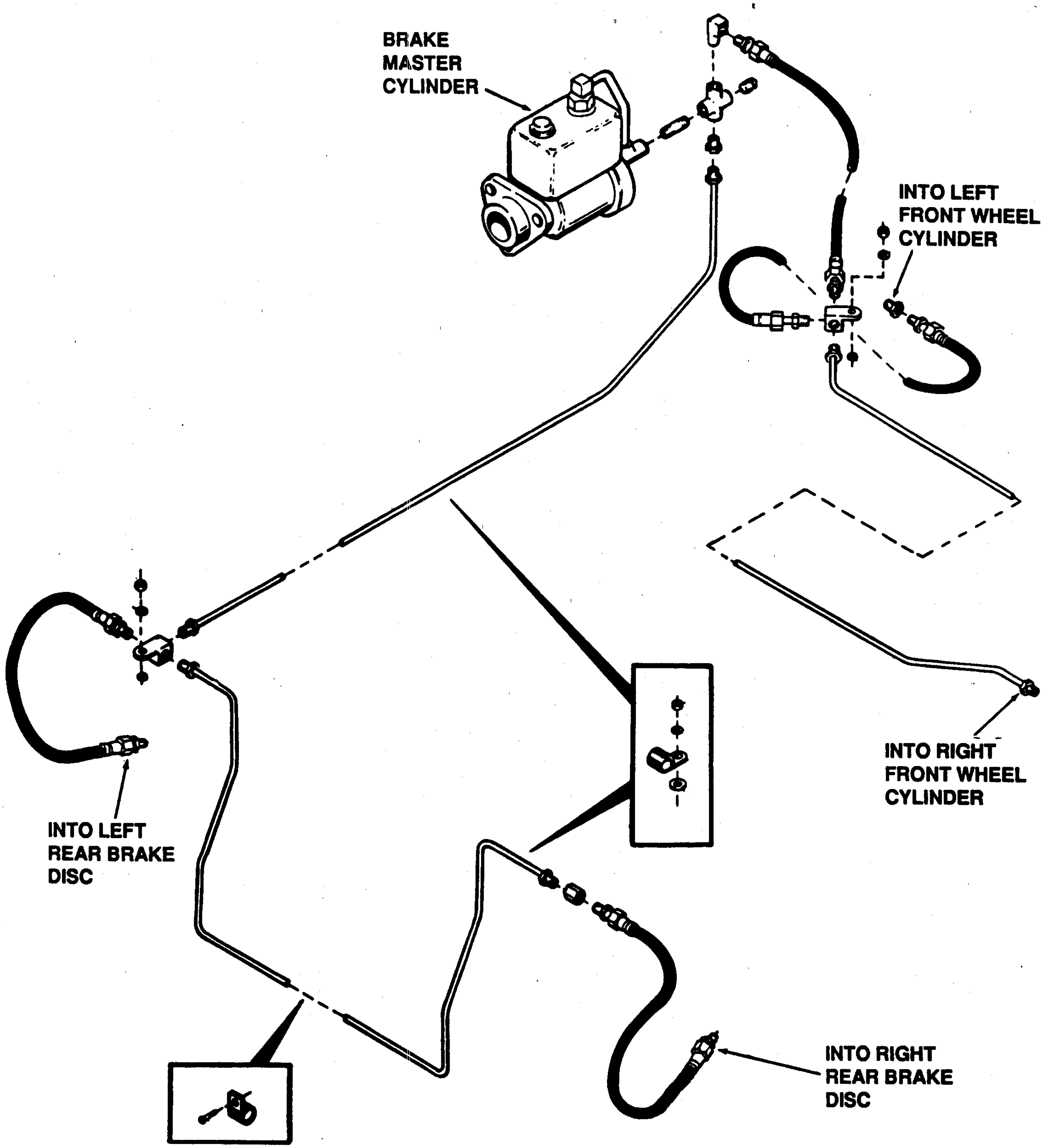


Figure 6. Brake Hydraulic Lines
2-Wheel Steering (Rockwell Axle)

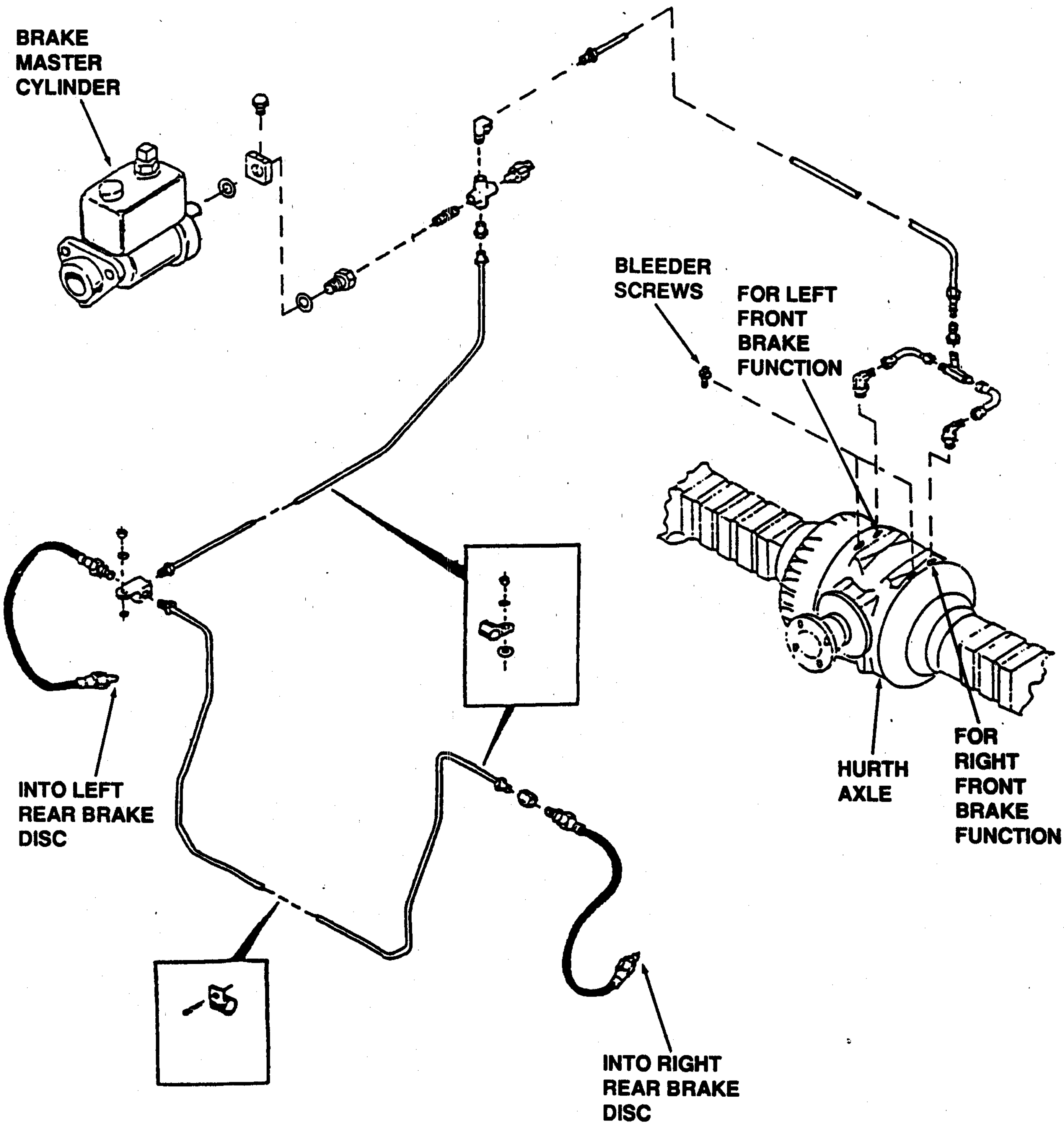


Figure 7. Brake Hydraulic Lines (2 or 4-Wheel Steer - Hurth Axle)

Section 7106

BRAKE MASTER CYLINDER

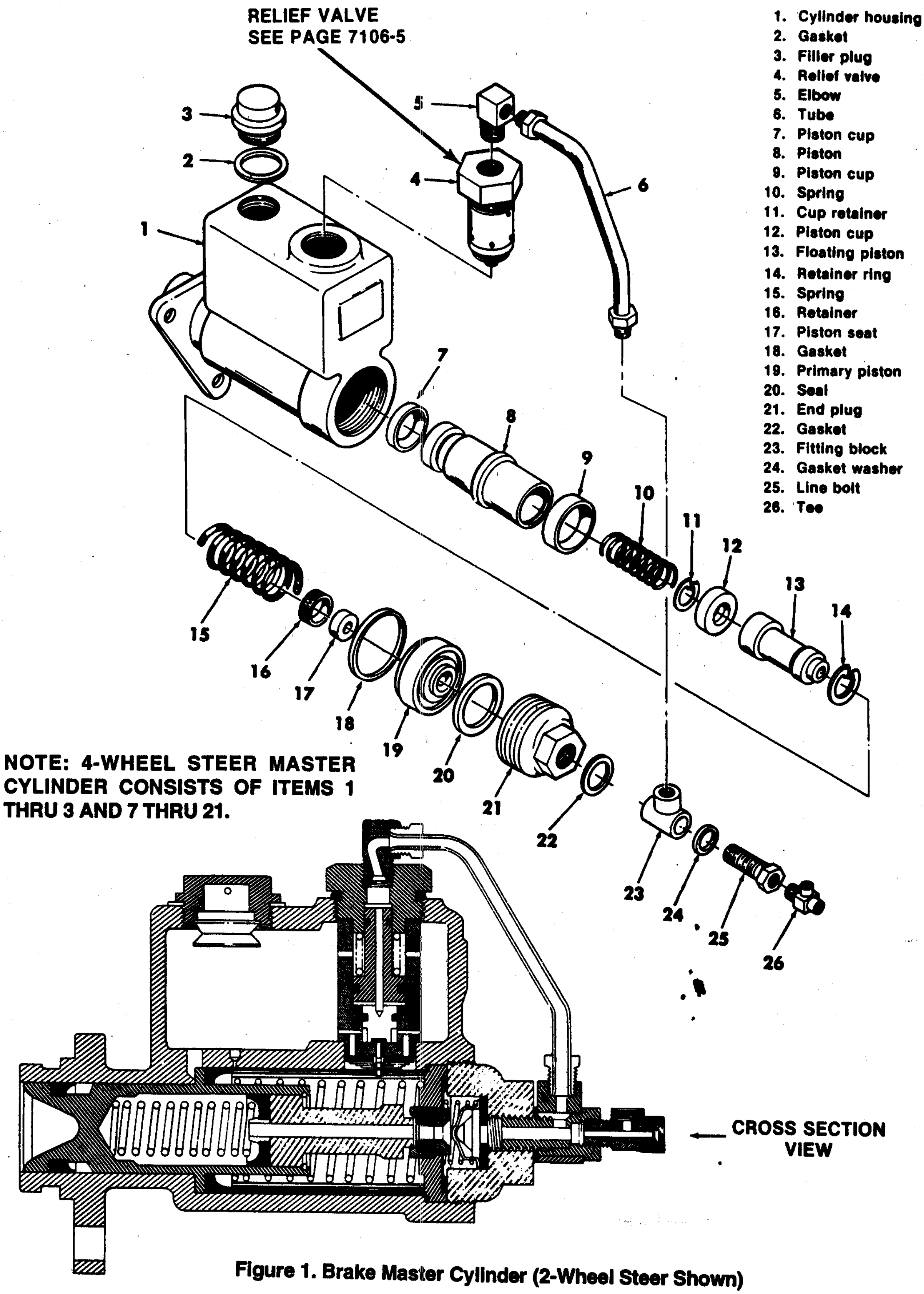


Figure 1. Brake Master Cylinder (2-Wheel Steer Shown)

SERVICING THE MASTER CYLINDER

Removal

1. Disconnect the brake line from the master cylinder. Install caps and plugs on the fittings.

2. Loosen the three bolts that fasten the master cylinder to the frame.

3. Pull the master cylinder to the rear to remove the cylinder from the push rod.

Disassembly

1. Remove the brake fluid from the master cylinder.

2. Disconnect the tube (6) from the elbow (5) and the fitting block (23). See Figure 1.

3. Remove the relief valve (4).

4. Loosen the line bolt (25). Remove the line bolt (25), gasket washer (24), fitting block (23) and gasket (22).

5. Remove the end plug (21) from the cylinder housing.

6. Remove the primary piston (19). Disassemble the primary piston:

    a. Remove the gasket (18) and then remove the seal (20).

    b. Remove the retainer (16) and the piston seat (17).

7. Remove the spring (15) from the cylinder housing.

8. The piston (8) and floating piston (13) are fastened together by a retainer ring (14). Remove piston and floating piston assembly.

9. Remove the retainer ring (14) from the piston to permit the removal of the floating piston (13) and spring (10).

10. Remove the cup retainer (11) from the floating piston (13). Remove the piston cup (12).

11. Remove the piston cups (7 and 9) from the piston.

Inspection

Wash all parts thoroughly. Use clean brake fluid.

Make an inspection for wear and damage of all parts, especially springs and pistons. Check the boot for damage. Replace if necessary. Replace all piston cups, back-up rings, o-rings and seals. Two repair kits are available. See Parts Catalog. One is for the master cylinder, the other is for the relief valve.

Use a soft copper wire as a probe to clean the compensating and return ports in the master cylinder. These ports can be seen through the filler opening. Also clean the vent opening in the filler cap.

Inspect cylinder bore for scoring or other damage. Replace cylinder if there is damage.

Assembly

1. Install new piston cups (7 and 9) on the piston (8). Install new piston cup (12) on the floating piston (13). Fasten the piston cup with the retainer (11).

2. Put the spring (10) into the piston (8). Install the floating piston over the spring.

3. By hand, push the floating piston (13), into the bore of the piston (8) until the groove for the retainer can be seen. Install the retainer ring (14) into the groove.

4. Install the piston and floating piston assembly into the cylinder housing (1).

5. Assemble the primary piston by installing a new gasket (18), a new seal (20), the piston seat (17) and the retainer (16).

6. Install the spring (15) and the assembled primary piston into the cylinder body.

7. Install the end plug (21).

8. Assemble the gasket washer (24), the fitting block (23) and the gasket (22) on the line bolt (25). Install these parts on the end plug by tightening the line bolt.

9. Install the relief valve (4) in the cylinder body.

10. Connect the tube (6) to the elbow (5) and the fitting block (24).

Installation

1. Align the master cylinder with the push rod on the control linkage. Push the master cylinder on the push rod.

2. Fasten the master cylinder to the frame with three bolts and lock nuts.

3. Connect the brake line to the master cylinder.

4. Remove the air from the brake system. See Section 7102.

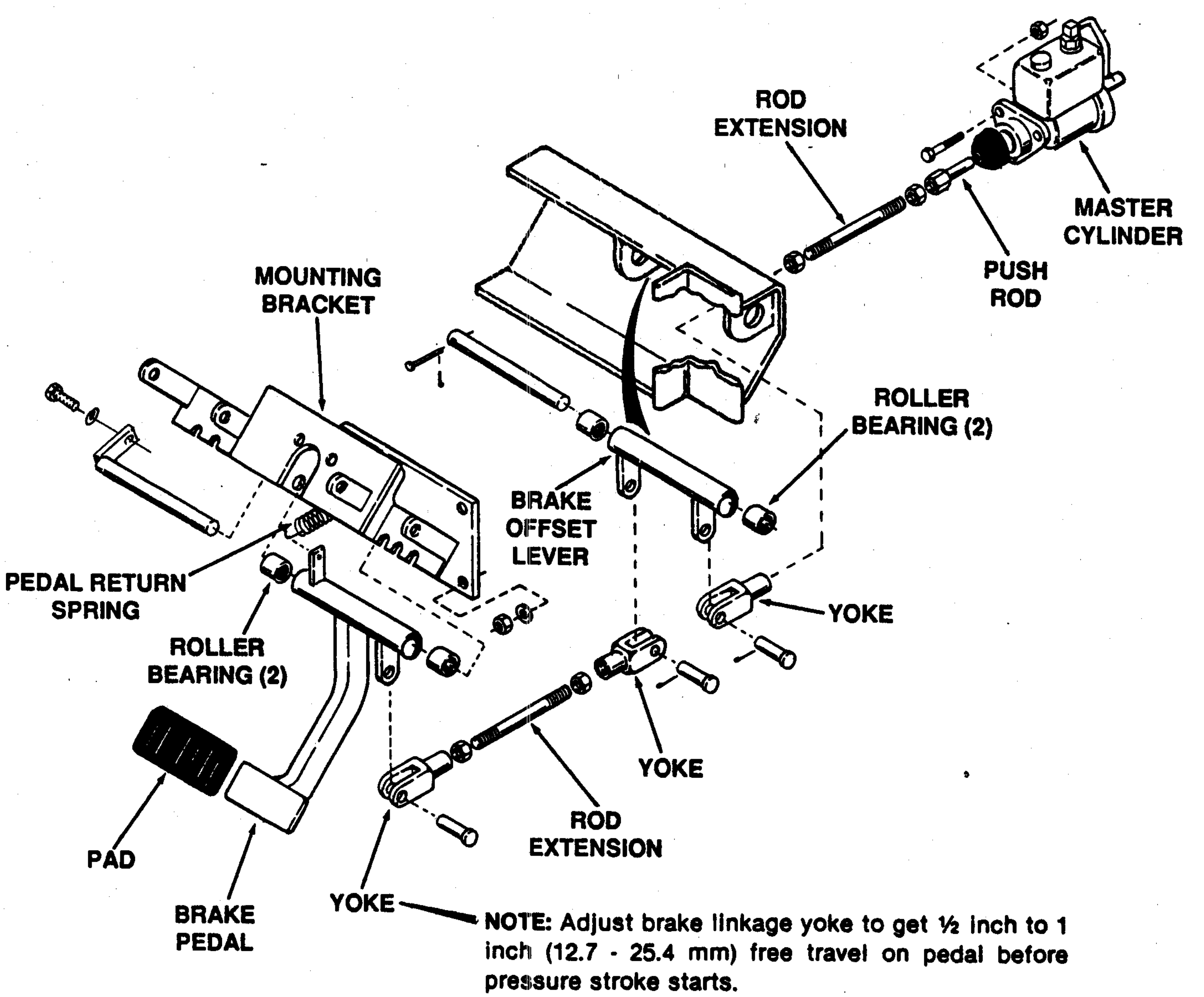


Figure 2. Brake Linkage and Master Cylinder

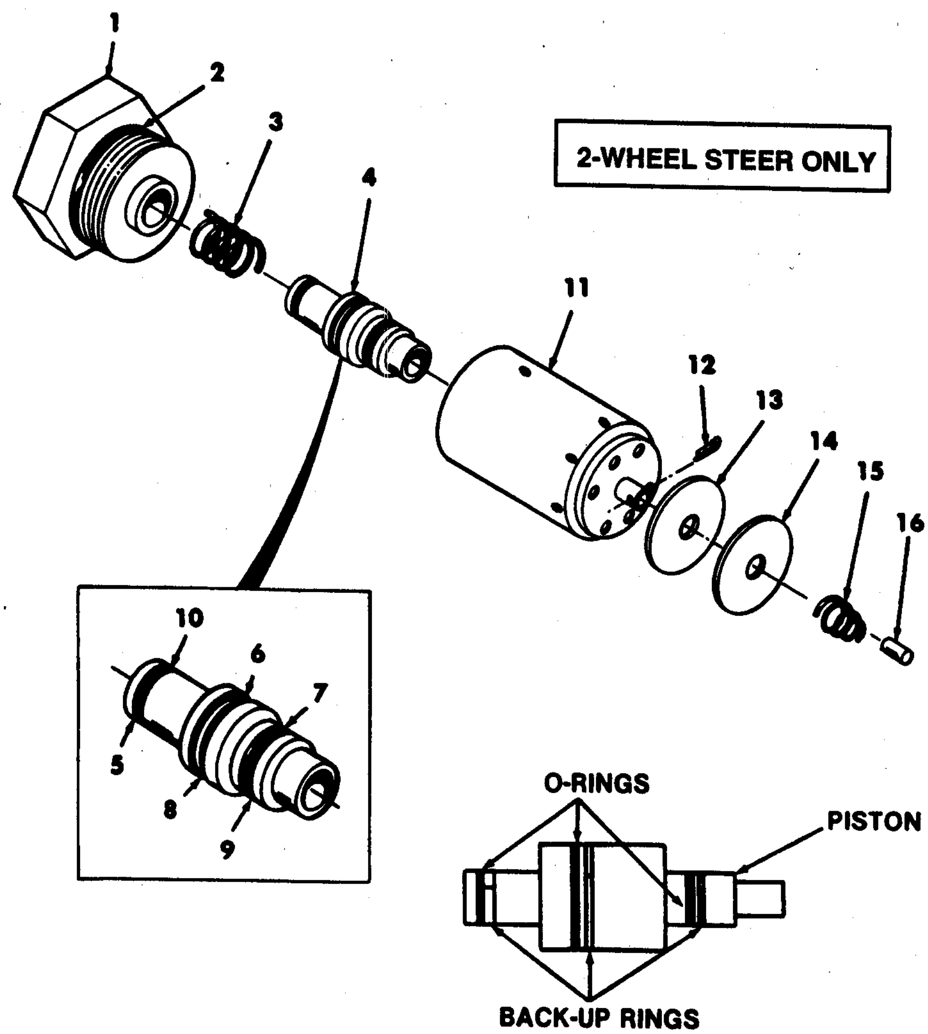
SERVICING THE RELIEF VALVE

Disassembly

1. Remove the spring (3) and piston assembly (4) from the valve body (11).
2. Remove the o-rings (5, 6 and 7) and back-up rings (8, 9 and 10) from the piston assembly (4).
3. Remove the cotter pin (12) to permit the removal of the seal (13), washer (14), spring (15) and metering pin (16).

Assembly

1. Install the seal (13), washer (14) and spring (15) on the valve body. Fasten the parts by installing the cotter pin (12).
2. Install new o-rings (5, 6 and 7) and new back-up rings (8, 9 and 10) on the piston. Make sure the back-up rings and o-rings are installed correctly. See Figure 3.
3. Install the metering pin (16) into the valve body.
4. Install the piston assembly (4) and spring (3) into the valve housing.

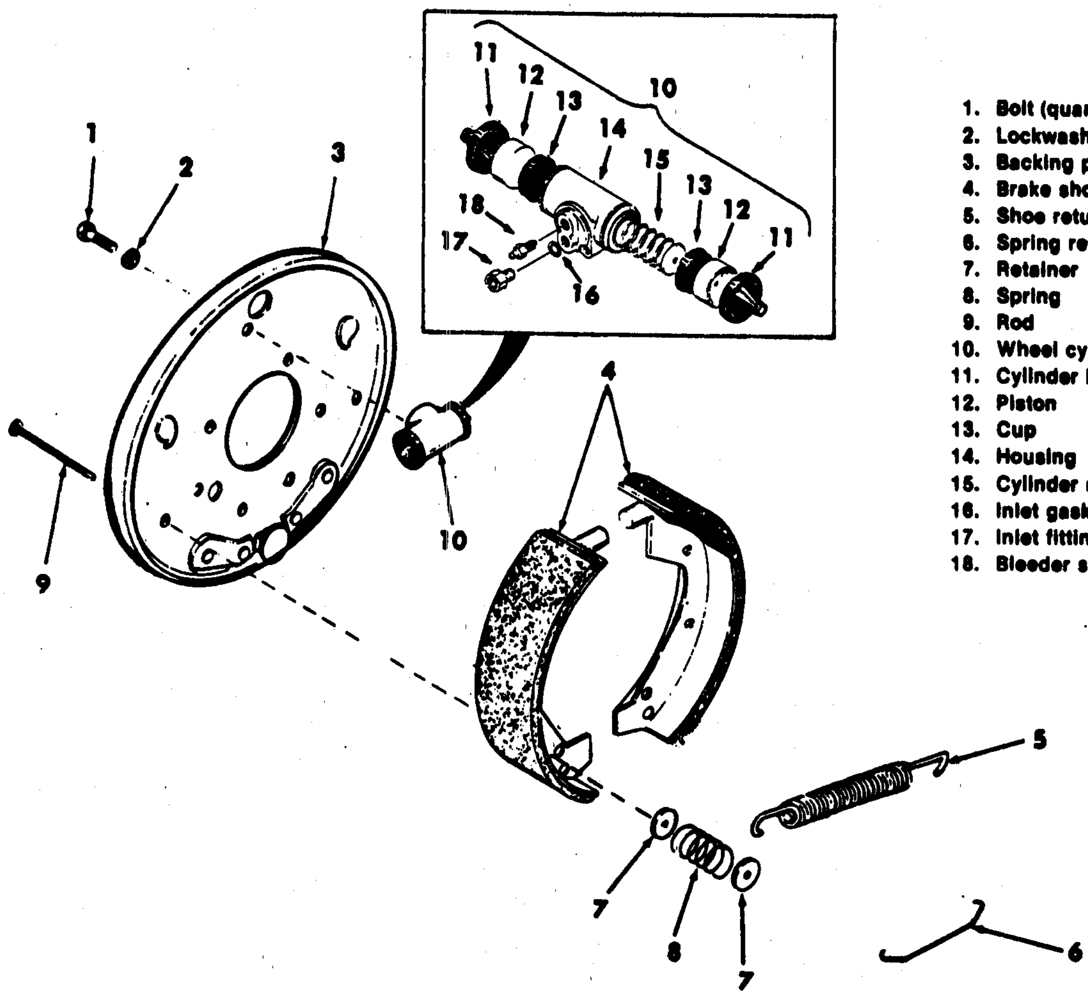


1. Filler plug
2. O-ring
3. Spring
4. Piston Assembly
5. O-ring
6. O-ring
7. O-ring
8. Back-up ring
9. Back-up ring
10. Back-up ring
11. Valve body
12. Cotter pin
13. Seal
14. Washer
15. Spring
16. Metering pin

Figure 3. Relief Valve for the Brake Cylinder

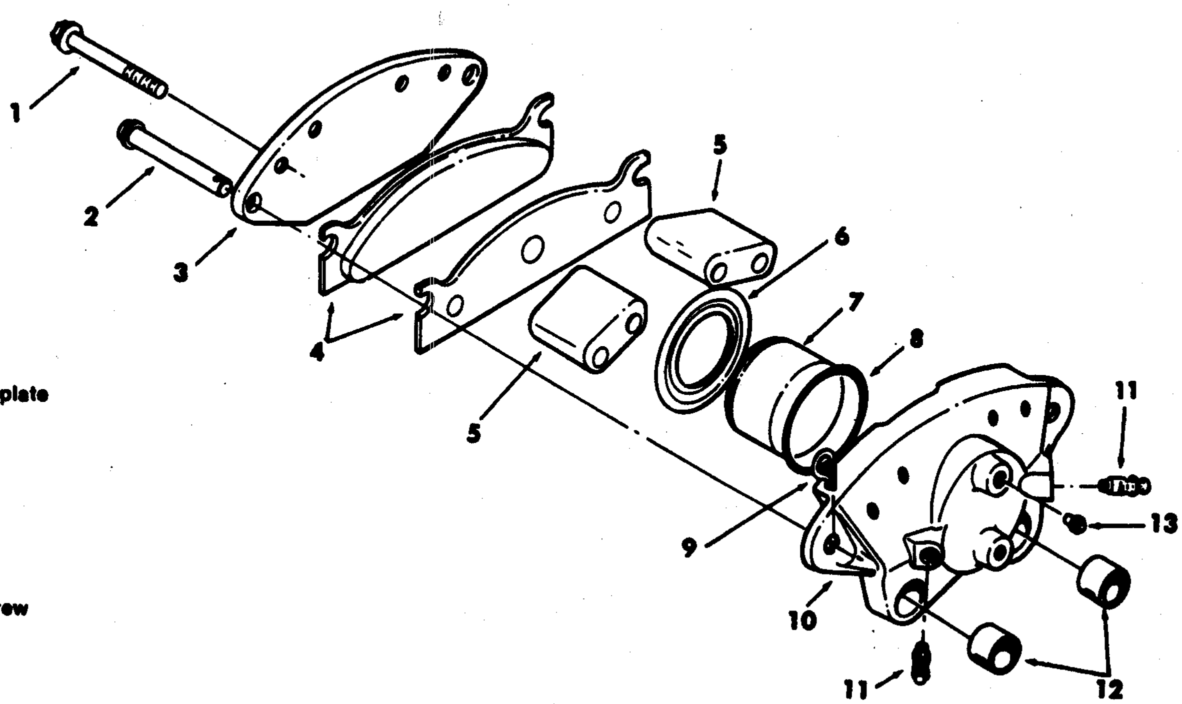
Section 7121

WHEEL BRAKES



1. Bolt (quantity of 2)
2. Lockwasher
3. Backing plate
4. Brake shoes
5. Shoe return spring
6. Spring retainer
7. Retainer
8. Spring
9. Rod
10. Wheel cylinder
11. Cylinder boot
12. Piston
13. Cup
14. Housing
15. Cylinder spring
16. Inlet gasket
17. Inlet fitting
18. Bleeder screw

Figure 1. Drum Brake (Front Axle)
Rockwell



1. Bolt
2. Clevis pin
3. Secondary plate
4. Brake pads
5. Spacers
6. Boot
7. Piston
8. O-ring
9. Clip pin
10. Housing
11. Bleeder screw
12. Bushings
13. Plug

Figure 2. Disc Brake (Rear Axle)

SERVICING THE WHEEL BRAKES

DRUM BRAKES (FRONT AXLE) (Rockwell - Used with 2-Wheel Steer)

Disassembly

See Figure 1.

1. Remove wheels and brake drum.

2. Remove the spring retainer from the brake shoes.

3. Remove the shoe return spring from the brake shoes.

4. Remove the rod, spring and retainers which fasten the brake shoes to the backing plate. Remove the brake shoes.

5. If it is necessary to remove the wheel cylinder, disconnect the hydraulic line. Then remove the bolts and lockwashers which fasten the wheel cylinder to the backing plate.

Inspection and Repair

The following parts must be carefully checked and replaced as necessary.

1. Check backing plates for distortion and loose rivets.

2. Check brake shoes for wear.

3. Check shoe return springs for corrosion or distortion.

4. Check the wear on the brake linings. If the linings show severe wear especially on the leading edge, replacement is necessary. Make sure the lining surface is clean and dry, without glaze.

5. Check the drums for cracks, grooves or other damage. The drum bore can be machined if the procedure will not increase the original diameter of the bore by more than .080 inch (2.03 mm). Original bore diameter is 12.50 inch (317.5 mm).

6. Check the wheel cylinder for leaks. Boots that have damage must be replaced.

7. If new brake shoe and lining assemblies are being installed, or if brake drum has been machined, check lining against brake drum. For efficient braking, there must be a minimum 80% contact between lining and drum. If necessary, circle grind the lining to get 80% contact.

Assembly

1. Fasten the wheel cylinder to backing plate with two bolts and lockwashers. Connect the hydraulic line.

2. Put the rod end of the brake shoe into the wheel cylinder. Align brake shoe to install the rod. Install the retainers and spring to the rod.

3. Install other brake shoe. See instructions in step 2.

4. Install the shoe return spring. Put hook in one brake shoe and pull the spring until the other hook can be installed in other shoe.

5. Install the spring retainer.

DISC BRAKES (REAR AXLE)

Disassembly

NOTE: It is not necessary to disassemble the disc brake to replace the two brake pads. See "Replacement of Brake Pads".

See Figure 2.

1. Remove the wheel and tire.

2. Disconnect the brake line at the disc brake. Put a cap on the brake line.

3. Remove the two clip pins (9) and the two clevis pins (2). Then remove the four bolts (1).

4. Remove the secondary plate (3), the brake pads (4) and the spacers (5).

5. Remove the housing (10) from the steering knuckle of the axle.

6. Remove the boot (6) and piston (7) from the housing.

7. Remove and discard the o-ring (8).

Assembly

1. Replace o-ring (8) in housing (10).

2. Install the piston (7) and new boot (6) in the housing.

3. Install the housing on the two studs on the steering knuckle of the axle.

4. Install the spacers (5) and the secondary plate with the four bolts (1). Tighten the bolts to a torque of 45-50 lb-ft (62-68 Nm).

5. Install the brake pads (4) on both sides of the disc. Install the clevis pins (2) and clip pins (9).

6. Connect the brake line and remove the air in the brake line. See instructions, Section 6102.

7. Install tire and wheel.

Replacement of Brake Pads

1. Remove the wheel and tire.

2. Remove the two clips (9) and the two clevis pins (2). The brake pads can now be removed from both sides of the brake disc.

SERVICING THE WHEEL CYLINDERS

Disassembly

1. It is not necessary to remove cylinder body unless replacement is necessary.

2. Remove brake shoe and lining assemblies. See page 7121-3.

3. Remove rubber boot.

4. Apply brake pedal to push piston(s) out of cylinder bore.

5. Remove and discard cup from piston.

Inspection

1. Check piston for pitting or damage to chrome plate. Replace piston if there is pitting or damage.

2. Inspect cylinder bore for scoring, grooves, pitting, corrosion or damage. Replace as necessary.

Assembly

1. Install new seal cup on piston. Lubricate with clean hydraulic brake fluid and install piston assembly into cylinder.

2. Install rubber boot.

3. Install brake shoes. See page 7121-3.

4. Remove air from brake line and cylinder. See Section 7102.

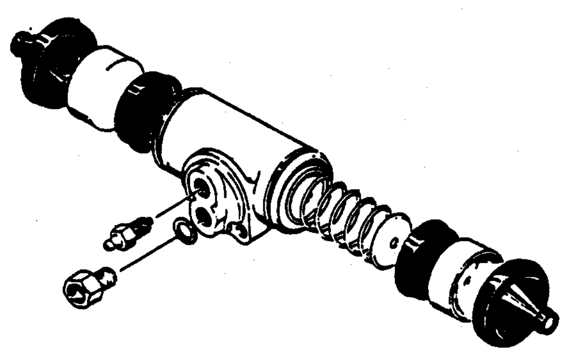


Figure 3. Wheel Cylinder

Section 7127

PARKING BRAKE

7

LUBRICATION/ADJUSTMENT

General

The parking brake is a mechanical brake which includes a brake lever in the cab, connected to disc brake on the transmission.

IMPORTANT: Do not apply the parking brake when the machine is moving. The parking brake has a high holding capacity, but low energy absorption capacity. The brake linings will heat rapidly under rotating friction.

The parking brake is not made to be an emergency brake, but only to hold the machine in a park condition. When applied, the brake stops the drive shaft. Using this brake to stop the crane while moving can become dangerous, because the applied force will not be equal on each wheel.

Lubrication

Weekly or every 50 hour interval, oil the clevis at the brake end of the cable and at the base of the lever. See Figure 1.

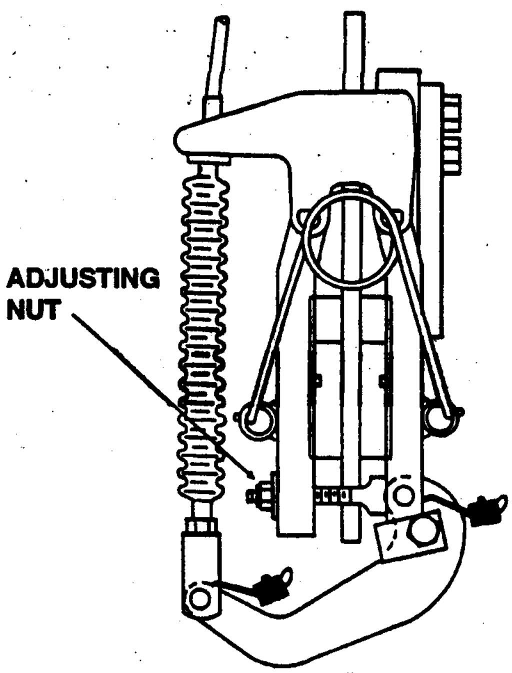


Figure 1.

Adjustment

It is important that the parking brake is correctly adjusted to prevent movement of the machine. Two adjustments are possible:

Parking Brake Lever Adjustment

In the cab, turn the knob on the brake lever (Figure 2) clockwise to increase tension on the brake linkage. Correctly, adjusted, approximately 50 pounds (23 kg) of force will be be needed to engage the brake handle.

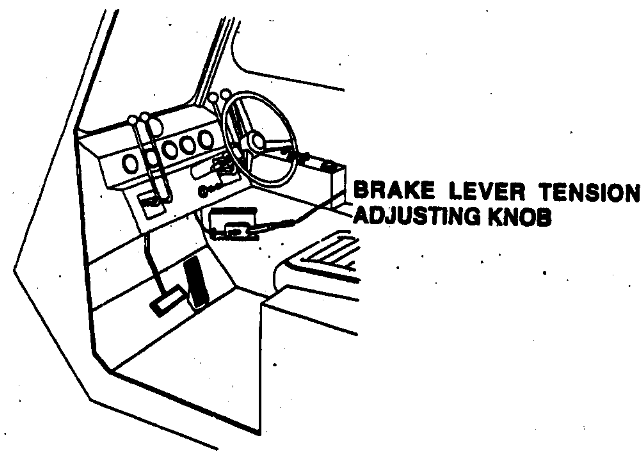


Figure 2.

Disc Brake Adjustment

> **WARNING:** Before [illegible] the parking [illegible] on level ground. Put chocks each side of all four wheels. Remove the ignition key. If these precautions are not taken the machine could could run over you.

If brake lever can not be adjusted to hold the crane, it may be necessary to adjust the parking brake disc pads.

NOTE: Before you adjust the disc brake, inspect the transmission brake disc for rough areas or scoring. Replace the disc if damage is found. Inspect the brake disc pads and replace if the disc thickness is 0.125 inch (3 mm) or less.

NOTE: If the parking brake is used to stop the machine in an emergency situation, inspect the brake for wear and if necessary replace or repair.

1. Engage parking brake lever in the cab. Check that the pads just touch the disc, shown in **A**, Figure 3.
2. If necessary, adjust the pad position by turning nut (**B**) until the disc is clamped, then back off nut (**B**) until the pads just touch the disc.
3. Apply the parking brake firmly three times and repeat step 1.

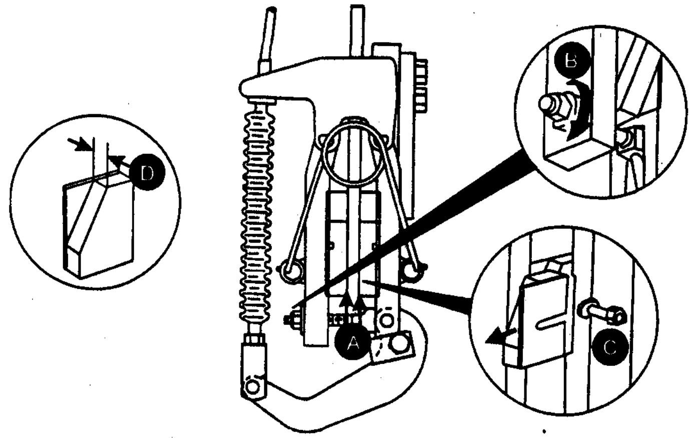


Figure 3.

SERVICING THE PARKING BRAKE

Removal/Installation

1. Disconnect the brake control cable from parking brake lever 74, Figure 4).
2. Loosen adjusting nut (3).
3. Remove bolts (1). Remove the brake assembly and shims (21 and 22).
4. Install in reverse order. Fit shims (21 & 22, Figure 4) between mounting bracket (17) and caliper bracket (16) as necessary to align the parking brake caliper assembly centerline to within .020 inches (0.5 mm) of the brake disc centerline. Tighten bolts (1) to 87 lb-ft. (118 Nm).

Replacing Brake Disc Pads

1. Loosen adjusting nut (**B**, Figure 3) far enough to remove brake disc pads.
2. Loosen nuts (**C**) and slide brake disc pads out between arms and transmission brake disc.
3. Install new brake disc pads. Tighten nut (**C**) to 4.4 lb-ft. (6 Nm).
4. Adjust the pads as described under "Disc Brake Adjustment," page 7127-1.
5. Adjust brake lever knob in cab. See "Adjustment", on page 7127-1.

Disassembly/Assembly

Use Figure 4 as a guide in disassembling the brake.

For assembly the sequence is reversed.

When Disassembling

To disassemble the parking brake caliper assembly, the tension spring (14, Figure 4) must be released; apply and keep pressure to item 3, remove items 10 and 11. Allow the spring to open out to its full travel by slowly releasing hand pressure on item 3.

When Assembling

Replace pads if thickness of lining material is less than 0.125 inches (3.00 mm).

Lightly grease all pivots and working surfaces, taking care not to allow grease to contact the brake pads.

Tighten nut (23) sufficiently to permit lever (4) free movement with minimum side clearance.

1. Brake Assembly
2. Adjusting Arm
3. Seal Pivot
4. Lever
5. Brake Pad Kit (Includes items 6 and 7)
6. Bolt (2)
7. Nut (2)
8. Pivot Pin
9. Adjusting Pull Rod
10. Spherical Washer
11. Nut (4)
12. Bolt
13. Safety Clip (2)
14. Torsion Spring
15. Retaining Pin (2)
16. Body
17. Mounting Bracket
18. Dowl Bolt (2)
19. Transmission Brake Disc
20. Bolt (3)
21. Shim - 0.5 mm (2)
22. Shim - 1.5 mm (2)
23. Nut

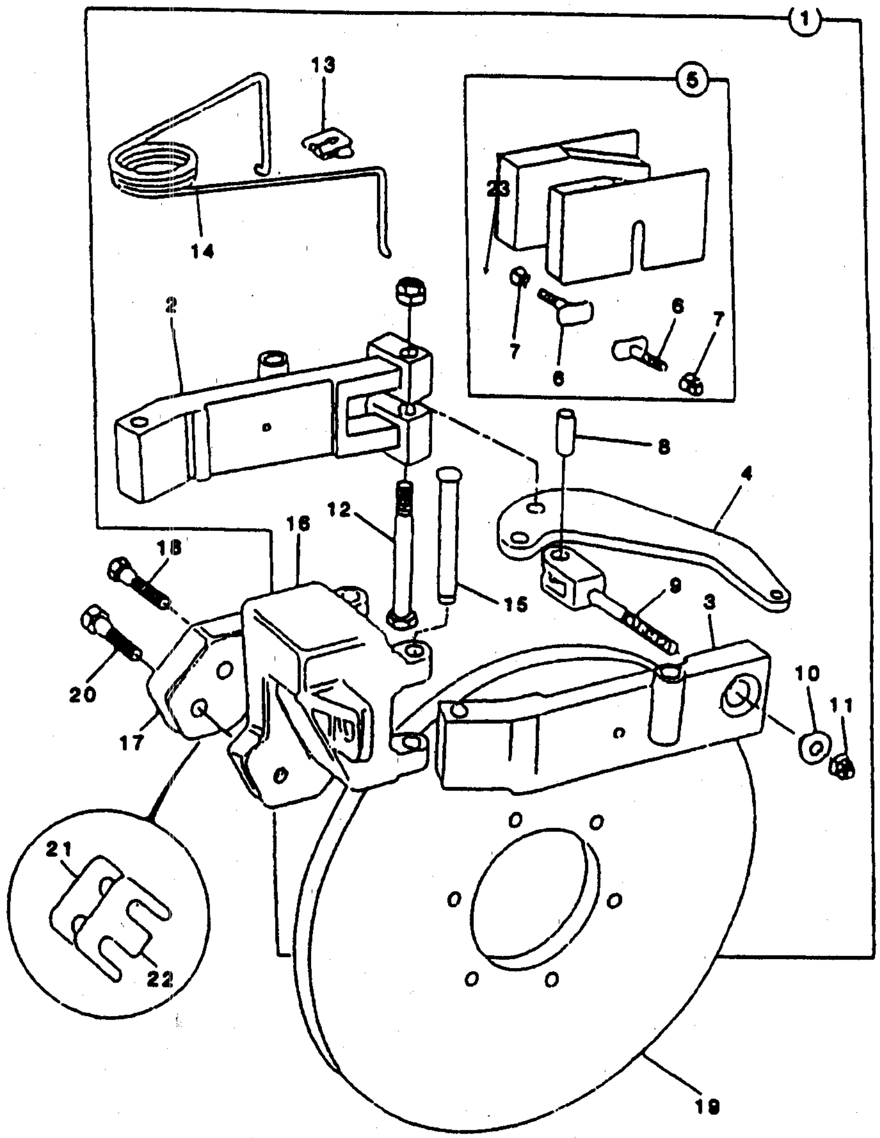


Figure 3. Parking Brake Assembly

Section 8201

HYDRAULIC SYSTEM MAINTENANCE AND SERVICE

MAINTENANCE

General

The components of the hydraulic system are precision mechanisms. Damage can easily be caused by particles of dirt or foreign material in the oil. Overheating of the oil, loss of oil or air in the oil will also cause problems. Regular maintenance of the system is important to prevent permanent damage to the hydraulic components.

Oil Level

Check the oil before each period of operation. For correct indication of the level of the oil in the hydraulic oil tank:

1. The machine must be level.
2. Boom must be fully retracted and lowered.
3. The outriggers must be retracted.

The oil in the hydraulic oil tank must be at the bottom of the filler screen. For oil recommendation, see Section 1050.

NOTE: If the oil level is low, check for leaks in the system. Look for oil on the ground and for dark areas around fittings and connections.

IMPORTANT: Never use cloth as a filter for the hydraulic oil. The oil will remove particles of the cloth. These particles will enter the system and cause possible restriction of the valves.

Oil Filter

The hydraulic oil filter is near the fuel tank. For access to the hydraulic oil filter, remove the side cover in the fuel tank area. See Figure 1.

After the first 20 hours of operation, replace the hydraulic oil filter. Then replace the hydraulic oil filter every two months or 500 hours of operation.

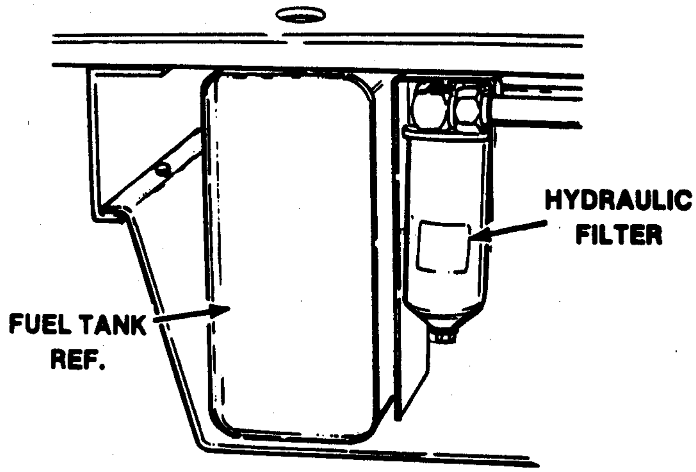


Figure 1. Location of Hydraulic Filter

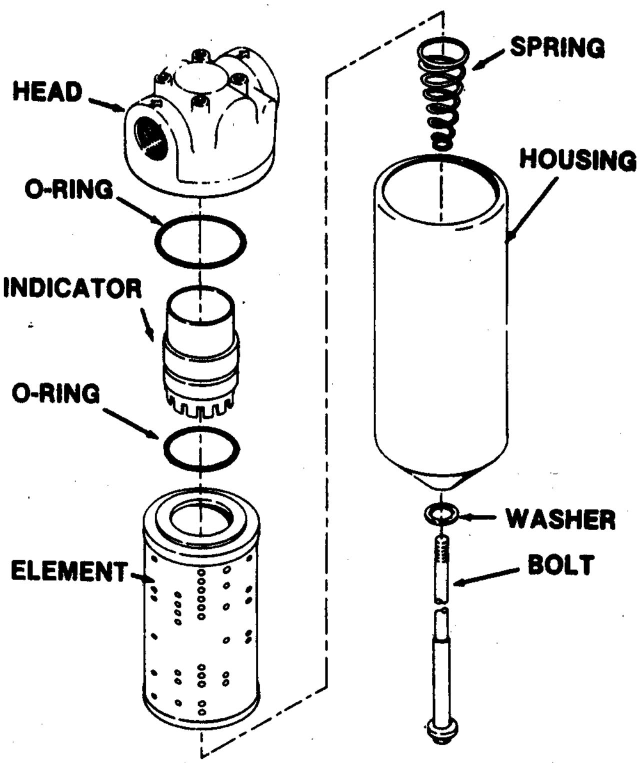


Figure 2. Hydraulic Oil Filter

To replace the hydraulic oil filter:

1. Apply a vacuum (10 inches of mercury max.) to the hydraulic oil tank through tank cap filler/breather opening or remove the hydraulic oil from the tank before opening the filter.

2. Loosen the center bolt. Remove the filter housing and filter element.

3. Install new filter element.

4. Check the o-ring in the filter head and the seal washer on the center bolt. Replace if damage is found.

5. Assemble filter element and filter housing to filter head. Tighten the center bolt to a torque of 20 lb-ft (30 Nm).

Procedure to Change Hydraulic Oil

Change hydraulic oil in the hydraulic system every 6 months or 1500 hours of operation.

1. Operate the hydraulic system until the hydraulic oil is at operating temperature (170° F, 77° C).

2. Fully retract and lower the boom. Retract the outriggers. Stop the engine.

3. Remove the drain plug from bottom of the hydraulic oil tank.

4. When the tank is empty, disconnect the hydraulic lines from the bottom of the hydraulic oil tank. Clean inside the tank to remove dirt and other sediment.

5. Connect the hydraulic lines to the bottom of the hydraulic tank. Install the drain plug.

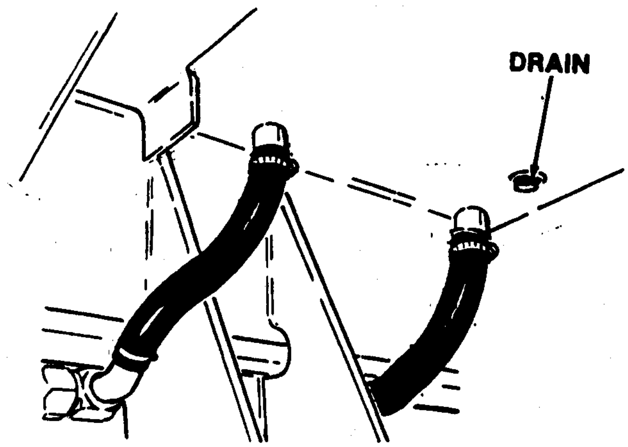


Figure 3. Location of Drain Plug on Hydraulic Oil Tank

6. Replace the hydraulic oil filter in the hydraulic lines. See page 8201-2.

7. Fill the hydraulic oil tank with new hydraulic oil of the correct type. See Hydraulic Oil Recommendations, Section 1050.

8. After the tank is filled, start the engine and engage the accelerator for approximately 1000 rpm. Operate each hydraulic function until all cylinders and lines are filled. Add oil to the hydraulic oil tank as necessary. Check for leaks in the filter mountings.

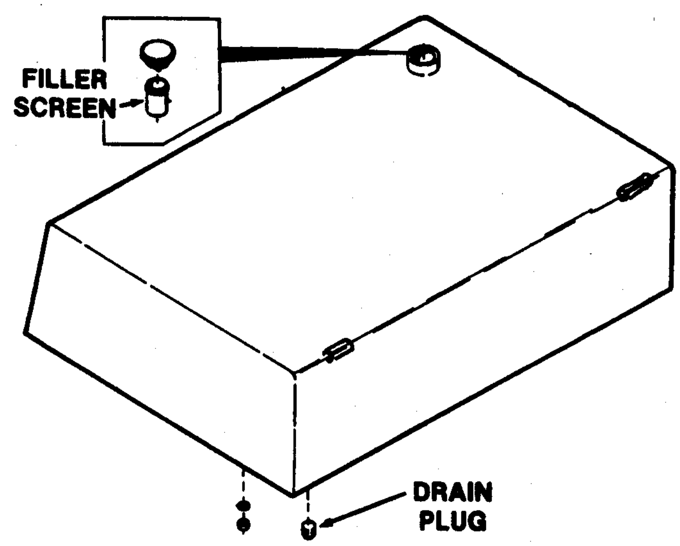


Figure 4. Hydraulic Oil Tank

SERVICING THE HYDRAULIC SYSTEM

Procedure to Flush the System

If foreign material, metal particles or dirt are found in the hydraulic oil, flush the hydraulic system to remove these particles to prevent damage to the hydraulic components.

1. Completely remove the oil from the hydraulic system. Remove and clean the hydraulic oil tank with steam or solvent. Clean the screen. MAKE SURE THE HYDRAULIC TANK IS CLEAN.

2. Replace the hydraulic filter in the hydraulic line.

3. Remove, disassemble and clean the motors and cylinders. Replace any parts with damage. Install new seals during assembly.

4. Install the hydraulic oil tank and the pump. Fill the hydraulic oil tank with a mixture of ½ No. 1 diesel fuel and ½ motor oil. The oil must be added as a lubricant for the pumps during flushing. Fill the pump with motor oil and diesel fuel mixture before you connect the high pressure lines.

5. Do not connect the motors or cylinders into the hydraulic system at this time. Use hoses to join the hydraulic lines at the motors and cylinders so the oil will flow around the motors and cylinders.

6. When all circuits are connected for flushing, start the engine and push the accelerator pedal until engine speed is approximately 1500 rpm and no higher than 1800 rpm. If a new or rebuilt pump is installed follow the run-in procedure for the pump. See Section 8205.

7. Flush each circuit in the hydraulic system separately. Operate each control for two minutes in each direction. Operate all controls, one at a time, until the system has been thoroughly flushed. Repeat this cycle for a minimum of 1 hour.

8. When the hydraulic system has been thoroughly flushed, clean the hydraulic system completely. Make sure the mixture used for flushing is completely removed from all circuits.

9. Remove, disassemble and clean the hydraulic swivel and all hydraulic control valves. Make any necessary repairs and install new seals during assembly.

10. Change the hydraulic oil filter. Make sure the filter housing and filter head are clean before you install the new element.

11. Install all components into the hydraulic system. Remove the hoses used for flushing.

12. Fill the hydraulic oil tank with new hydraulic oil. See Hydraulic Oil Recommendations, Section 1050.

IMPORTANT: Use a screen (200 mesh or finer) as a filter when you fill the hydraulic oil tank. All foreign material must be kept out of the system.

13. Start the engine and push the accelerator pedal until engine speed is approximately 1000 rpm. Slowly actuate each hydraulic control to fill the hydraulic lines and cylinders with hydraulic oil. Add hydraulic oil to the tank as necessary during this procedure to be sure there is enough hydraulic oil to the pumps. Operate the control for each circuit several times in each direction.

14. Stop the engine. Check for leaks in the system. Check the hydraulic oil level in the hydraulic tank and add hydraulic oil as necessary. The system is ready for operation.

Hydraulic Fittings

All hydraulic fittings must be tight to prevent loss of oil and keep air and dirt out of the system. When you connect any hydraulic lines, make sure the connections are clean and tight. To prevent leakage of straight thread fittings 1.062"-12 (.7500 tube) or larger, use Loctite or pipe compound on the threads of the fittings. Do not let any compound get into the system.

Procedure to Remove Air from the Hydraulic System

Air in the hydraulic system will cause corrosion and other damage to the precision components of the system. Air can enter the system when hydraulic lines or components are disconnected, when the hydraulic oil is changed, or through loose connections or bad seals.

Large amounts of air in the system will cause slow movement, noise and loss of hydraulic power to the actuators. For smooth operation of the hydraulic system, air must be kept out of the hydraulic system. Foaming oil in the hydraulic oil tank is normally an indication that air is entering the system.

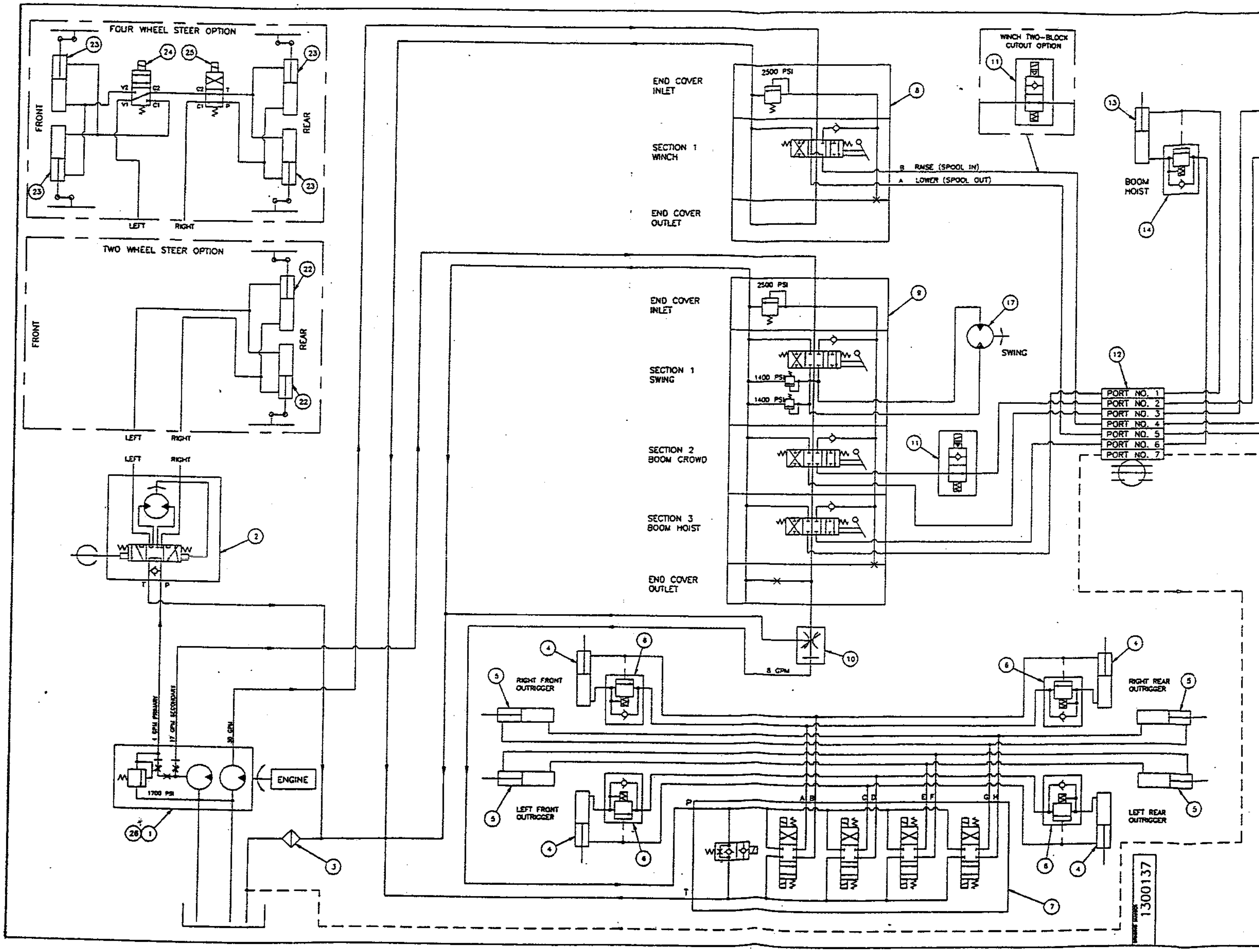
1. Start the engine and push the accelerator pedal until engine speed is approximately 1000 rpm or lower. Slow engine speeds will remove the air more rapidly than faster speeds.

2. Extend and retract the boom fully several times. Check for foam in the hydraulic oil tank.

3. Repeat this procedure for the hoist and outrigger cylinders.

4. Repeat the entire procedure for a minimum of ½ hour or until the hydraulic oil does not have foam.

If the movement of the oil continues to cause foam, either the wrong type of oil is being used, or there is a leak in the system. Check for bad o-ring or loose connection at the pump inlet. Change oil if necessary and repeat the procedure to see if the problem is corrected. Check for leaks in each circuit.



26	1	1100230	PUMP W/GAS OR DUAL FUEL ENGINE
25	1	1100097	SOLENOID VALVE
24	1	1100096	SOLENOID VALVE
23	4	1200165	HYDRAULIC CYLINDER
22	2	1200165	HYDRAULIC CYLINDER
21	1	S232846	LOAD HOLDING VALVE
20	1	1000372	HYDRAULIC MOTOR
19	1	1000373	BRAKE
18	1	1100091	SHUTTLE VALVE
17	1	1000209	HYDRAULIC MOTOR
16	1	S107689	LOAD HOLDING VALVE
15	1	S610101	HYDRAULIC CYLINDER
14	1	S238873	LOAD HOLDING VALVE
13	1	1300076	HYDRAULIC CYLINDER
12	1	1300109	HYDRAULIC SWIVEL
11	1	1100054	DOUBLE BLOCKING VALVE
10	1	1100092	FLOW REGULATOR
9	1	1100098	CONTROL VALVE – 3 SPOOL
8	1	1100099	CONTROL VALVE – 1 SPOOL
7	1	S240090	SOLENOID VALVE
6	4	1001354	LOAD HOLDING VALVE
5	4	1200166	HYDRAULIC CYLINDER
4	4	1300134	HYDRAULIC CYLINDER
3	1	S227285	FILTER
2	1	S237326	ORBITROL
1	1	1100051	PUMP W/ DIESEL ENGINE

HYDRAULIC SCHEMATIC

RAL

NONE

1300137

Hydraulic Schematic

Section 8202

DIAGNOSIS, TESTS AND CHECKS

TABLE OF CONTENTS

SPECIFICATIONS

Hydraulic Pressures
- Main Relief No. 1 .... 2500 psi (17 230 kPa)
- Main Relief No. 1 .... 2500 psi (17 230 kPa)
- Steering Relief .... See Section 5002
- Hoist Holding Valve .... Do not adjust
- Crowd Holding Valve .... Do not adjust
- Winch Holding Valve .... Do not adjust

Rated Pump Output at 2200 rpm
- Section No. 1 (front) .... 30 gpm (113.6 L/min)
- Section No. 2 (rear) .... 21 gpm (79.5 L/min)

GENERAL DESCRIPTION

General

A hydraulic system uses liquid to make a transfer of force. Any force on a confined liquid is applied to any point in the system that the liquid reaches. Oil is normally used as the liquid for the system because the liquid must also be a lubricant for the components of the system.

There are several main components in a hydraulic system. Each component has a specific function in the system.

The **pump** moves the oil through the system. It is important to remember that the pump causes the flow, not the pressure in the system. Pressure is caused by any resistance to the flow. This resistance can be **external** (for example, a load on the cylinder or motor), or **internal** (the resistance of the components of the system). Pressure increases as the resistance to the flow increases. The pump will continue to push more oil into the system until the resistance is overcome or the relief valve opens.

Valves are used to control the flow, pressure, direction and volume of oil in the system. There are many different types of valves. An explanation of the different valves used on this machine is given in the description of each circuit.

Filters remove the dirt and particles of foreign material from the oil in the system. The oil in the system must be kept clean to prevent damage to the pump, cylinders, valves and other precision components of the system.

Motors and Cylinders are the actuators or working tools of the system. In the motors and cylinders, hydraulic energy is changed into mechanical force (rotary or straight line movement).

The **Hydraulic Oil Tank** has three important functions: Storage, Cooling, and Supply of oil to the pumps. Because piston rods take space in the cylinders, the level of the oil in the tank will be higher when all cylinders are retracted that when all cylinders are extended.

To understand how a hydraulic system works, it is important to understand the following words.

The **Flow** of fluid through the system is caused by the pump. The amount of fluid which is sent to a circuit or actuator generally controls the speed of that function. The flow is measured in gpm (gallons per minute) or L/min (litres per minute).

Pressure is caused by any resistance to the flow of the oil. Pressure is normally measured in psi (pounds per square inch) or kPa (kiloPascals). There are four general types of pressure:

1. **High Pressure,** which is normally the result of an external load on the system.
2. **Low Pressure,** normally the result of the internal resistance of the components in the system.
3. **Static Pressure,** where the oil is closed in a circuit between two components. There is no movement of the oil, but there is pressure on the oil, normally because there is an external load on the circuit.
4. **Series Pressure,** which is found where oil is confined between components in a series arrangement, for example when the rod port of one cylinder is connected to the base port of another cylinder. Movement of either cylinder will cause movement of the other cylinder.

Hydraulic System

There are three hydraulic systems on this machine. Information on the hydraulic systems for the transmission and steering is found in Sections 6102 and 5002. Only the main hydraulic system is included in this section. The main hydraulic system is a closed system, except for the hydraulic oil tank, which is under atmospheric pressure. The main hydraulic system gives hydraulic power to:

1. The swing motor
2. The main winch motor
3. The auxiliary winch motor
4. The boom cylinders
5. The front and rear outrigger cylinders

The hydraulic components on the boom and mast are connected to the hydraulic components on the lower structure through the hydraulic swivel. The hydraulic swivel is at the center of rotation of the mast. The design of the hydraulic swivel permits operation of the hydraulic functions through full rotation of the mast.

TROUBLESHOOTING

To find a problem in the hydraulic system with minimum loss of time, use the following aids and procedures.

Troubleshooting Aids

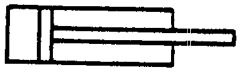
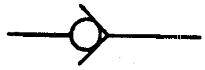
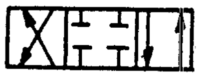
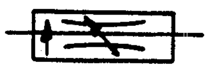
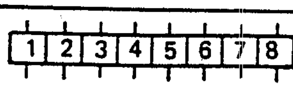
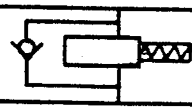
1. **Hydraulic schematic** – an exact illustration of the arrangement of the system. The schematic shows all of the components in relation to the system. The ability to understand the schematic is important to good troubleshooting.
2. **Flow meter** – an instrument that can be connected into the system to measure the flow of oil in the system. The flow is measured in gallons per minute (gpm) or litres per minute (L/m). Normally, the flow meter is used to check the output of the pump. The flow meter can also be used to find the location of leakage or restriction in the system. Instructions for installation and the use of the flow meter are normally included with the flow meter.
3. **Pressure Gauge** – an instrument for measurement of the pressure in the system. This indication is normally given in pounds per square inch (psi) or kiloPascals (kPa). On this machine, quick couplers are installed in the pressure lines from the pumps. Pressures taken at these locations will give indication of operating pressure or relief pressure.

Troubleshooting Procedures

For good troubleshooting, a step by step analysis of the problem and the possible causes is necessary. First, find the symptoms.

1. Check with the operator. Learn if there was a loss of power (machine did not move the load) or a loss of speed (slow cycle time).
2. Learn if the problem is common to all circuits or if found in one or two circuits.

GRAPHIC SYMBOLS FOR FLUID POWER DIAGRAMS

	CYLINDER
	RELIEF VALVE
	CHECK VALVE
	MOTOR
	PUMP
	DIRECTIONAL VALVE
	FLOW REGULATOR
	FILTER
	SHUT-OFF VALVE
	SWIVEL
	MANUAL OPERATED SELF CENTERING
	FLOW DIVIDER
	OVERCENTER VALVE
	SPRING

Troubleshooting (Con't.)

3. Make a visual inspection. Look for restriction in the linkages, low level of oil in the hydraulic oil tank, bent tubes or hoses, leakage around the hydraulic components, etc.

Second, make an analysis of symptoms. The function of each component in the system must be known before a correct analysis can be made. An explanation of the function and operation of each component can be found in the remaining pages of this section.

Remember:

1. If a problem is common to all circuits, the component which is causing the problem must also be common to all circuits. Examples are: the engine, pump, hydraulic oil tank and filters.

2. If the problem is common to only two or three circuits, the component which is causing the problem must be common to those two or three circuits. Examples are: pump section, relief valve, hydraulic swivel, etc.

3. If a problem is in only one circuit, then the component which is causing the problem must be in that circuit. Examples are: valve section, cylinder or motor.

Again, use the schematic. Find which components are in the circuit or circuits. What component can cause a problem with these symptoms? Make a list of the possible causes. Start at the source of the flow in that circuit. If the problem is in all circuits, start at the pump. Know the direction of the oil flow through each circuit.

Use the flowmeter and the pressure gauge to check your diagnosis of the problem. Start at the source of the flow and check each component in sequence until the exact location of the problem is found.

If the problem is in two or three circuits, check each circuit separately. After a circuit is checked, use caps or plugs to remove that circuit from the system. Continue to the next circuit down the line until the problem is found.

IMPORTANT: Do not remove the main relief valve from the circuit. The relief must be kept in the circuit to prevent damage to the pump and other components.

TROUBLESHOOTING GUIDE — HYDRAULIC SYSTEM

PROBLEM	POSSIBLE CAUSE	REMEDY
Noise (above normal)	Air in system.	With engine at low rpm, operate all functions several times to return air to atmosphere through the tank breather.
	Low oil supply.	Add oil. Section 8201.
	Restriction in pump inlet line.	Remove and clean inlet line to pump.
	Dirty oil.	Change oil and filters. Section 8201.
	Loose clamps, vibration of hydraulic lines.	Check and tighten.
	Dirt or foreign material in relief valve.	Clean or replace relief valve.
	Broken control spool.	Replace valve. Section 8207.
	Pump bearings worn.	Replace. Section 8205.
Slow operating speeds	Low engine rpm.	Increase engine rpm.
	Air leak in pump inlet line.	Tighten pump inlet line. Replace o-ring in inlet flange.
	Air in the oil (foam in tank).	Check oil level, look for leaks in the system.
	Leakage in relief valve.	Remove and clean or replace relief valve.
	Leakage in hydraulic swivel.	Replace seals on swivel shaft. Section 8218.
	Control valve not fully actuated.	Check spool travel. Section 8207.
	Bad pump.	Overhaul or replacement. Section 8205.
No movement when system is first started	Low oil level.	Check oil supply.
	Air or restriction in inlet line to pump.	Check and tighten inlet line.
	Cold oil or wrong weight of oil.	Use correct oil, follow normal warming procedure.
Loss of movement during operation	Low oil level.	Check and add oil.
	Vacuum in hydraulic tank.	Clean tank cap filler/breather
	Restriction or leakage in relief valve.	Clean or replace relief valve.
	Broken hydrualic line.	Replace.
	Bad seal in hydraulic swivel.	Replace seals. Section 8218.
	Broken gear or shaft in pump.	Replace. Section 8205.
Overheating of hydraulic oil	Wrong operation (running over relief pressure for long periods).	Change procedure of operation.
	Dirty filters.	Change filter. Section 8201.

TROUBLESHOOTING GUIDE — HYDRAULIC SYSTEM (CON'T.)

PROBLEM	POSSIBLE CAUSE	REMEDY
Overheating of hydraulic oil (Con't.)	Oil too light.	Use correct oil.
	Low oil level.	Check and add oil.
	Dirty oil.	Change oil and filters. Section 8201.
Foam in hydraulic oil tank	Leak in system.	Check o-ring on pump inlet.
	Wrong type of oil.	Use correct oil.
	Low oil level.	Check and add oil.
	Bad seal on pump, motor or cylinder.	Overhaul.
Short life of pump bearings, shafts, etc.	Dirty oil.	Change oil and filter more frequently.
	Wrong type of oil.	Use correct oil.
Pump leakage (external)	Bad seal on pump shaft.	Replace shaft seal. Section 8205.
	Bad o-ring between pump sections.	Replace o-ring. Section 8205.
Difficult to engage valve spools.	Restriction in control linkages.	Check and correct.
	Dirt or foreign material between valve spool and valve bore.	Remove and clean valve spool and bore.
	Loose mounting bolts.	Tighten bolts to correct torque. Section 8207.
	Broken spring (spool return).	Replace spring.
	Distortion or damage to valve spool.	Replace complete valve.

TROUBLESHOOTING GUIDE — HOIST CIRCUIT

PROBLEM	POSSIBLE CAUSE	REMEDY
Hoist cylinder does not extend or retract	Control valve not actuated.	Check linkage to the control valve.
	Not enough oil from pump to operate cylinder.	See "Loss of Movement during Operation".
	Bad leak in hydraulic swivel.	Replace seals in hydraulic swivel. Section 8218.
	Main relief held open by dirt on valve seat.	Disassemble and clean main relief. Section 8207.
Cylinder extends, but does not retract	Restriction in linkage to control valve.	Check and correct.
	Malfunction of holding valve.	Replace holding valve, DO NOT ADJUST.

TROUBLESHOOTING GUIDE — HOIST CIRCUIT (CON'T.)

PROBLEM	POSSIBLE CAUSE	REMEDY
Boom moves slowly downward when control valve is in NEUTRAL position	Internal leakage in cylinder.	Replace seals on piston. Section 8290.
	Leakage in holding valve.	Replace holding valve. DO NOT ADJUST.
	Spool not in neutral position.	Linkage binding or centering spring broken.
Cylinders retract in a jerking movement	Low engine rpm.	Increase engine speed.
	Not enough oil from pump to fill rod of cylinder.	Check pump output and for leakage in the center swivel.
	Air in cylinder.	Remove air from rod end of cylinder.

TROUBLESHOOTING GUIDE — CROWD CIRCUIT

PROBLEM	POSSIBLE CAUSE	REMEDY
Cylinders will not extend boom under load	Restriction in boom sections.	Clean and apply lubrication to boom slides.
	Load too heavy.	Reduce load.
	Bad pump.	Overhaul or replacement.
	Leakage in center swivel.	Replace seals in center swivel.
	Main relief malfunction.	Check main relief pressure.
	Dirt or restriction in main relief.	Disassemble and clean.
Boom extends, but will not retract	Restriction in linkage to the control valve.	Check and correct.
	Malfunction in holding valve.	Replace holding valve. DO NOT ADJUST.
Boom constantly gets out-of-sequence	Restriction in boom sections.	Clean and lubricate boom slides. Section 1050.
	Packing bad in cylinders.	Repair cylinder. Section 8290.

TROUBLESHOOTING GUIDE — OUTRIGGER HYDRAULIC CIRCUITS

PROBLEM	POSSIBLE CAUSE	REMEDY
No movement, all outriggers	Electrical problem (fuse, bad solenoid, etc.).	See Electrical System, Section 4002.
	Dirt or restriction in dump valve in outrigger valve.	Clean or replace solenoid valve.
	If this problem also is found in the crowd and swing circuits, the cause is probably dirt in the relief valve or a bad pump (broken drive shaft, etc.).	Disassemble and clean the relief valve. Replace or make repairs to pump.

TROUBLESHOOTING GUIDE — OUTRIGGER HYDRAULIC CIRCUITS (CON'D.)

PROBLEM	POSSIBLE CAUSE	REMEDY
Slow movement, all outriggers	Low engine rpm.	Increase engine speed.
	Solenoid valve on outrigger valve section not fully actuated.	Check for restriction or binding in solenoid valve.
	Leakage in relief valve.	Clean or replace relief valve. Section 8207.
	Bad pump.	Replacement or overhaul. Section 8205.
Outriggers extend, but do not retract, or vice versa	Problem in electrical circuit.	See Electrical System, Section 4002.

TROUBLESHOOTING GUIDE — MAIN WINCH CIRCUIT

PROBLEM	POSSIBLE CAUSE	REMEDY
Winch will not lift maximum (rated) load, considerable reduction in line speed	Main relief malfunction.	Check main relief pressure, page 8202-15.
	Dirt in main relief, keeping the valve off the valve seat.	Remove and clean the relief valve. Section 8207.
	Not enough oil from pump.	See "Main Hydraulic System".
	Malfunction or damage to winch components.	Overhaul of winch. Section 9213.
	Internal leakage in winch motor.	Replace or repair winch motor. Section 8213.
Reverse speed is slower than forward speed	Restriction in linkage to control valve.	Check the travel on the valve spool. The travel must be the same in both directions.
	Malfunction of holding valve.	Replace cartridge of holding valve.
Motor will not hold the load when the control lever is in neutral - load drops rapidly	Overload condition.	Decrease the load.
	Holding valve setting too low.	Check holding valve setting, Section 8213.
	Malfunction of holding valve.	Replace cartridge of holding valve.
Motor will not hold the load when the control lever is in neutral - load drifts down slowly	Overload condition.	Check brake condition, pressure setting.
	Brake pressure set to high (not holding).	
Winch does not move	Brake not releasing.	Check brake condition, pressure setting.

TROUBLESHOOTING GUIDE — OUTRIGGER HYDRAULIC CIRCUITS (CON'T.)

PROBLEM	POSSIBLE CAUSE	REMEDY
Outriggers on only one side do not operate	Bad solenoid or open circuit to solenoid (loose wire, etc.).	See Electrical System, Section 4002.
	Restriction or dirt between valve spool and housing.	Remove and clean valve spool.
	Internal leakage in cylinder.	Replace piston seals. Section 8290.
Outrigger jack cylinder extends, but will not retract	Bad lock valve in base of cylinder.	Replace lock valve.
	Bad solenoid or open electrical circuit to solenoid.	See Electrical System, Section 4002.
Outrigger jack cylinder does not hold under load	Leakage in lock valve on base of cylinder.	Clean or replace lock valve.
	Internal leakage in cylinder.	Replace piston seals.

TROUBLESHOOTING GUIDE — SWING CIRCUIT

PROBLEM	POSSIBLE CAUSE	REMEDY
Mast will not rotate when swing control is engaged	Shaft between motor and gearbox broken.	Replace.
	Broken drive gear.	Overhaul or replacement of gearbox. Section 9210.
	No oil to swing control valve, caused by: a. Bad pump. b. Relief valve held open by dirt or foreign material.	Check amount of oil available at control valve: a. Overhaul or replacement. b. Clean or replace relief valve, check and adjust pressure.
Difficult or slow swing	Restriction in linkage to valve, preventing full travel of the valve spool.	Check travel on valve spool. The distance must be the same in both directions.
	Friction or restriction in mast bearing.	See Section 9216.
	Leakage in circuit or components.	Check and correct.

TESTS AND CHECKS

General

Oil is available to the inlet of both sections of the pump from the hydraulic oil tank. The first pump (nearest to the engine) moves the oil to the inlet of the single spool valve near the fuel tank. Here the oil is available to operate the main winch. Hydraulic oil which returns from this control valve is sent through a manifold to the hydraulic oil filter. From the hydraulic oil filter, the hydraulic oil returns to the hydraulic oil tank.

The second section of the hydraulic pump pushes oil to the multiple spool valve farthest from the fuel tank.At this valve, the oil is available to operate the functions of the hoist, crowd, swing and, via a priority flow divider, to the steering orbitrol. Hydraulic oil which returns from these functions is sent through the manifold to the hydraulic filter, then back to tank.

The outlet of the multiple spool valve has an additional port which makes oil under pressure available to the outrigger solenoid valve bank. Oil from the outrigger valve returns through the manifold and the hydraulic filter to tank.

Hydraulic Pump

The main hydraulic pump is a gear pump with two sections. The drive gears of both gear sets turn the drive shaft. When the gears turn, oil from the inlet side of the hydraulic pump is moved around the outside of the gears to the outlet side.

The inlet side of the hydraulic pump is under low pressure. The outlet side is normally under high pressure. Pressure from the outlet side of the pump pushes the pressure plates against the gears to prevent internal leakage or bypass in the hydraulic pump.

Lubrication of internal components is given through passages in the hydraulic pump body and grooves in the pressure plates. A lip seal on the drive shaft and o-rings between the sections prevent external leakage in the hydraulic pump.

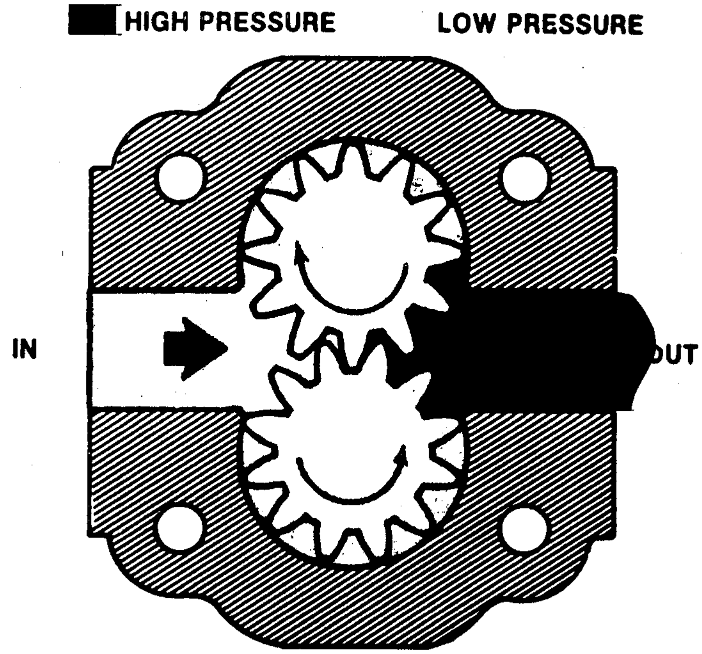


Figure 1. Typical Gear Pump — Cross Section View

Test — Pump Output

To check the output of the hydraulic pump, use a 100 gpm flowmeter. Follow the instructions in the manual for the flowmeter. For rated output, see page 8202-3.

NOTE: All flow tests must be taken when the temperature of the hydraulic oil is 130-150° F (54-65° C).

To check the efficiency of the pump, use the following procedure:

1. Connect a flowmeter between the pump and the control valve according to the instructions in the flowmeter manual. Make sure the needle valve of the flowmeter is fully open.

2. Start the engine and push the accelerator pedal until engine is at maximum rpm. Wait until the temperature of the hydraulic oil is 130° F (54° C) minimum.

3. Slowly close the needle valve of the flowmeter until the pressure is 2500 psi (17 230 kPa).

4. Read the amount of the flow on the flowmeter. Make a record of the flow and the engine rpm.

5. Fully open the needle valve of the flowmeter.

6. Push the accelerator pedal until engine is at the same speed on the engine tachometer as in step 4. Read the amount of flow on the flowmeter. Make a record of the flow.

7. Compare the results to find the efficiency of the pump.

$$\text{PERCENT OF PUMP EFFICIENCY} = \frac{\text{Flow at 2000 psi (13 800 kPa)} \times 100}{\text{Flow at 0 psi (0 kPa)}}$$

8. If the pump is less than 80% efficient, repair or replacement is necessary.

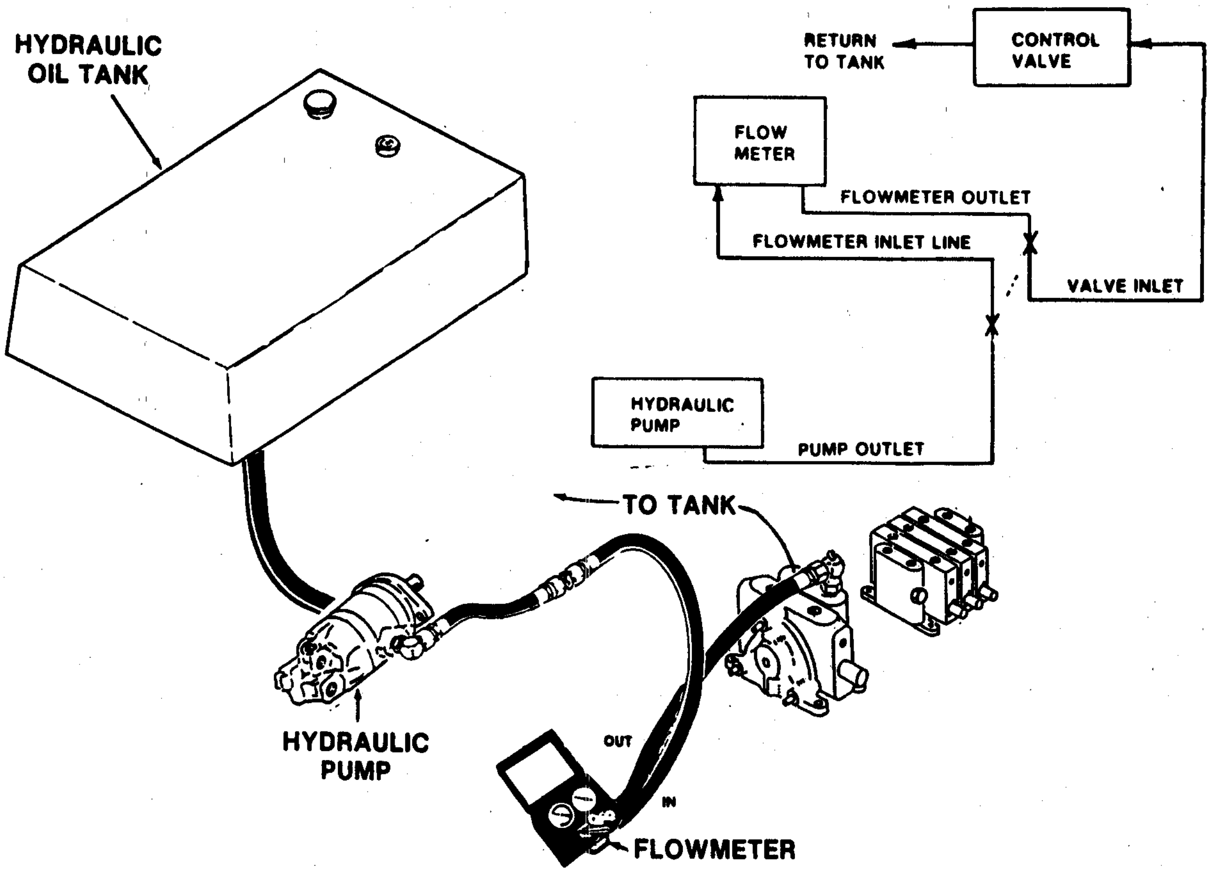


Figure 2. Typical Connection for Flowmeter

Main Relief Valves

Each pump circuit has a main relief valve. The location of the main relief valves is in the inlet of the main control valves, Figure 3. The relief valve is between the center or pump passage and the tank passage in the control valve.

The purpose of the main relief valve is to control the maximum pressure in the hydraulic pump circuit. Pressure in the system increases as the resistance to the flow of hydraulic oil increases. The hydraulic pump operates constantly and will continue to push more hydraulic oil into the system. When this flow of hydraulic oil is stopped at any point in the system, pressure increases very rapidly. The relief valve opens and lets the hydraulic oil from the hydraulic pump return to the hydraulic oil tank when pressure reaches the maximum limit.

Remember, pressure in a hydraulic system is applied to every component in contact with the hydraulic oil. For example, pressure will increase when a cylinder rod reaches the end of the cylinder. This pressure will have an effect on every component between that cylinder and the hydraulic pump. Without a relief valve in the circuit, the high pressure can easily break the hydraulic pump, a hydraulic line or other component in that circuit.

The main relief valve for pump circuit No. 1 is in the control valve for MAIN WINCH, Figure 3. The main relief valve for pump circuit No. 2 is in the control valve for HOIST, CROWD, SWING and OPTIONAL WINCH. Both relief valves are set at 2500 psi (17 230 kPa).

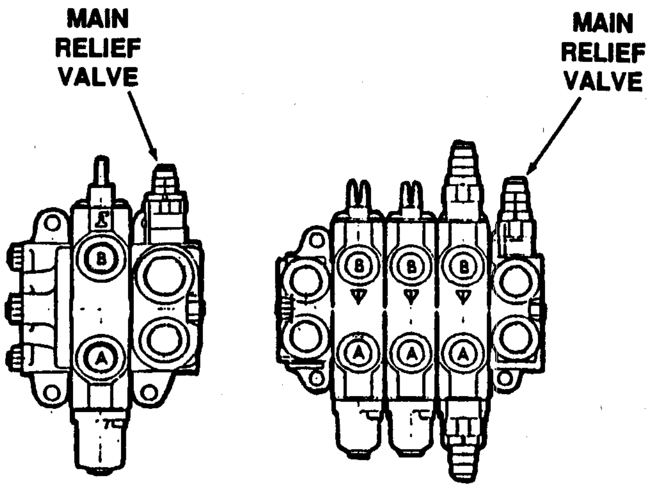


Figure 3. Location of Main Relief Valves

Procedure to Test the Main Relief Valves

1. IMPORTANT: The oil must be at operating temperature (120 - 130° F, 49 - 55° C).

2. Install a 0-5000 psi pressure gauge on the quick coupler in the pump circuit being tested. See Figure 3.

3. Operate the engine at maximum rpm.

4. Use the hoist or crowd cylinder to put pump circuit No. 2 over relief pressure.

   a. Fully retract the cylinder. Continue to hold the control in position after the cylinder has stopped.

   b. Read the pressure on the pressure gauge when the relief valve opens.

   c. Release the control.

5. To test relief pressure in pump circuit No. 1, it is necessary to remove two hydraulic lines from "A" and "B" port adapters. Put steel caps on the adapters. Then test the pressure.

Adjustment: The correct pressure is 2500 ± 50 psi (17 230 ± 340 kPa).

1. If the reading on the pressure gauge is higher or lower than 2500 ± 50 psi (17 230 kPa), remove the relief valve cartridge and check for foreign material and wear. Check that the relief valve cartridge is aligned with the seat for the relief valve cartridge. See Section 8207.

2. Again follow the procedure to check the relief valve. If the reading on the pressure gauge is not 2500 ± 50 psi (17 230 kPa), replace the relief valve cartridge.

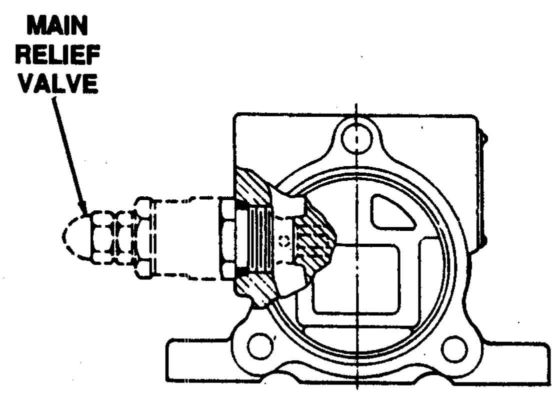


Figure 4. Installation of Main Relief Valve

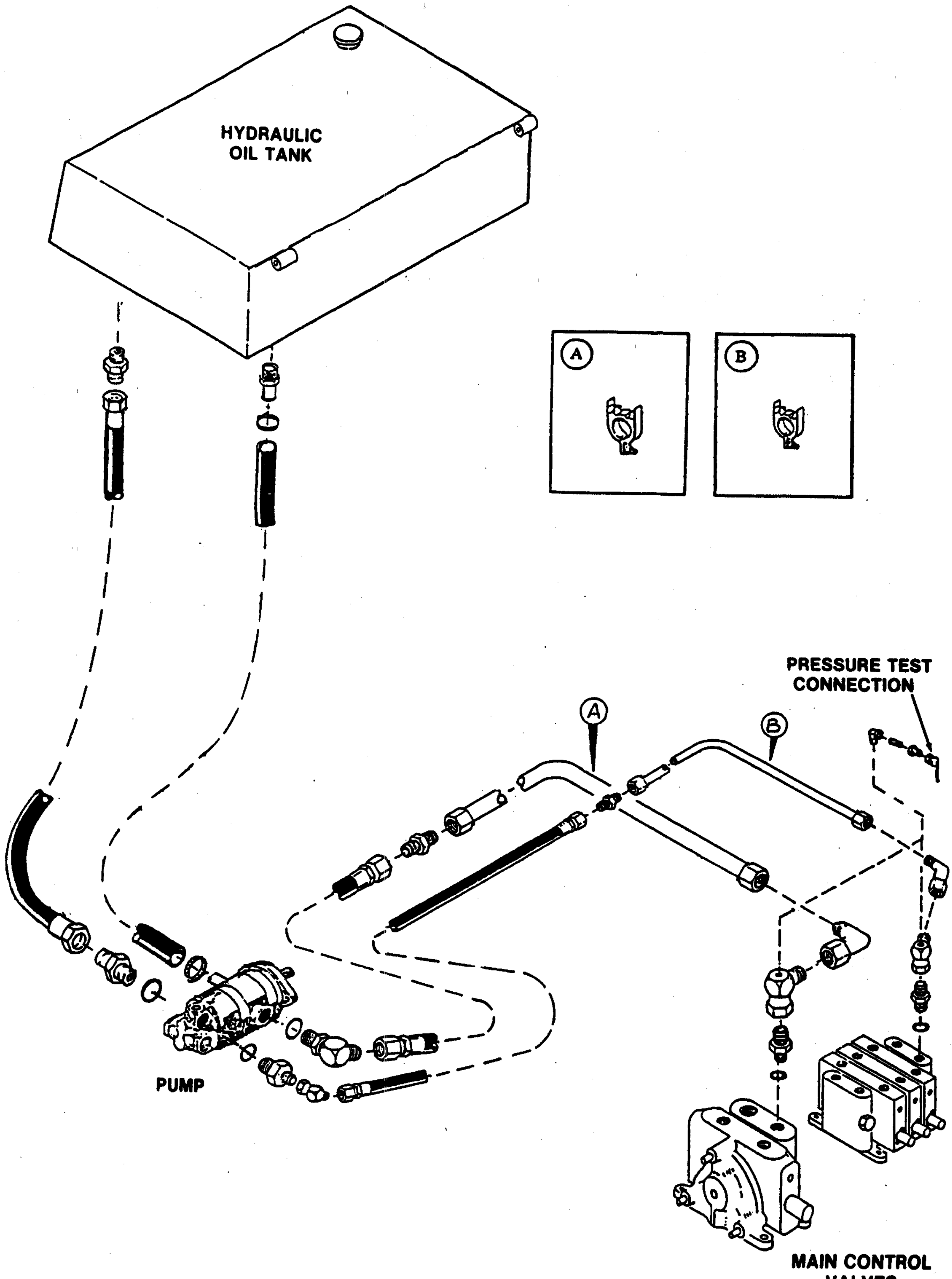


Figure 5. Supply Lines – Pump to Control Valves

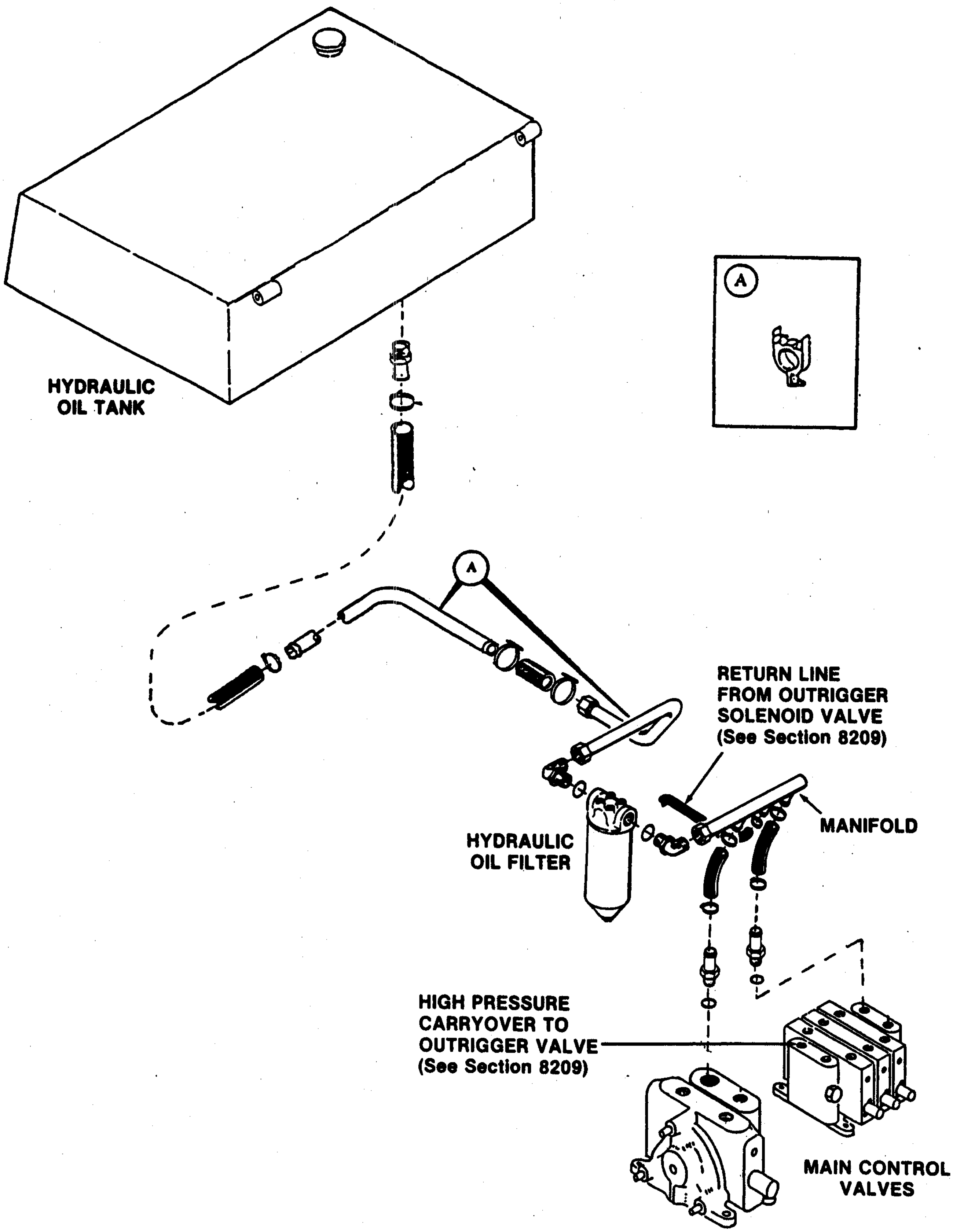


Figure 6. Return Lines – Control Valves to Tank

Section 8205

MAIN HYDRAULIC PUMP

8

SPECIFICATIONS

Pump rotation (as seen from shaft end) .... counterclockwise
Gear size and displacement per revolution
Front set .... 2.94 in^3/rev
Rear set .... 1.41 in^3/rev
Special Torques
Stud nuts - front section .... 55-65 lb-ft (74-88 Nm)
Bolts - rear section .... 55-65 lb-ft (74-88 Nm)
Taper-lock studs .... 25-35 lb-ft (34-47 Nm)

SERVICING THE PUMP

Removal

1. Drain hydraulic oil from tank.
2. Disconnect inlet and outlet lines from pump. Put caps on the lines and plugs in the open ports to keep dirt out of the system.
3. The pump is heavy. Use a sling or support to hold the pump in position.
4. Remove pump mounting bolts, lock washers and flat washers. Remove pump from spline coupling on engine.
5. Take pump to a clean work area for disassembly.

General

The pump has two gear sections, each with a matched set of gears. The gears rotate in bushings in the end covers, and in the adapter section and center port section. The gear ends are sealed by wear plates with a bronze face on the gear side. Seal glands behind the wear plates seal the high pressure side of the pump and prevent oil bypass within the pump.

The center port section includes an inlet port which is common to both gear sections, plus an outlet port for the front pump section. The outlet port for the rear pump section is in the rear cover.

During final assembly, care must be taken that the external notches on the wear plates and sections are in line.

PARTS LIST FOR FIGURE 1

1. Body Assembly
2. Bearing Plate Assembly
3. Poppet
4. Ilder Gear
5. Cover Assembly
6. Drive Shaft Gear - 323K
7. Idler Gear
8. Drive Shaft Gear - 151K
9. Gear Plate
10. Dowel Pin
11. Coupling
12. Spring
13. Guide Spring
14. Gear Plate
15. Set Screw
16. O-ring
17. Dowel Pin
18. Wear Plate
19. Preload Seal
20. Load Seal
21. Ring Seal
22. Washer
23. Bolt
24. Oil Seal
25. Bolt
26. Plug
27. O-ring
28. Plug
29. Cap
30. Gasket
31. Spring
32. Orifice Disc
33. Piston

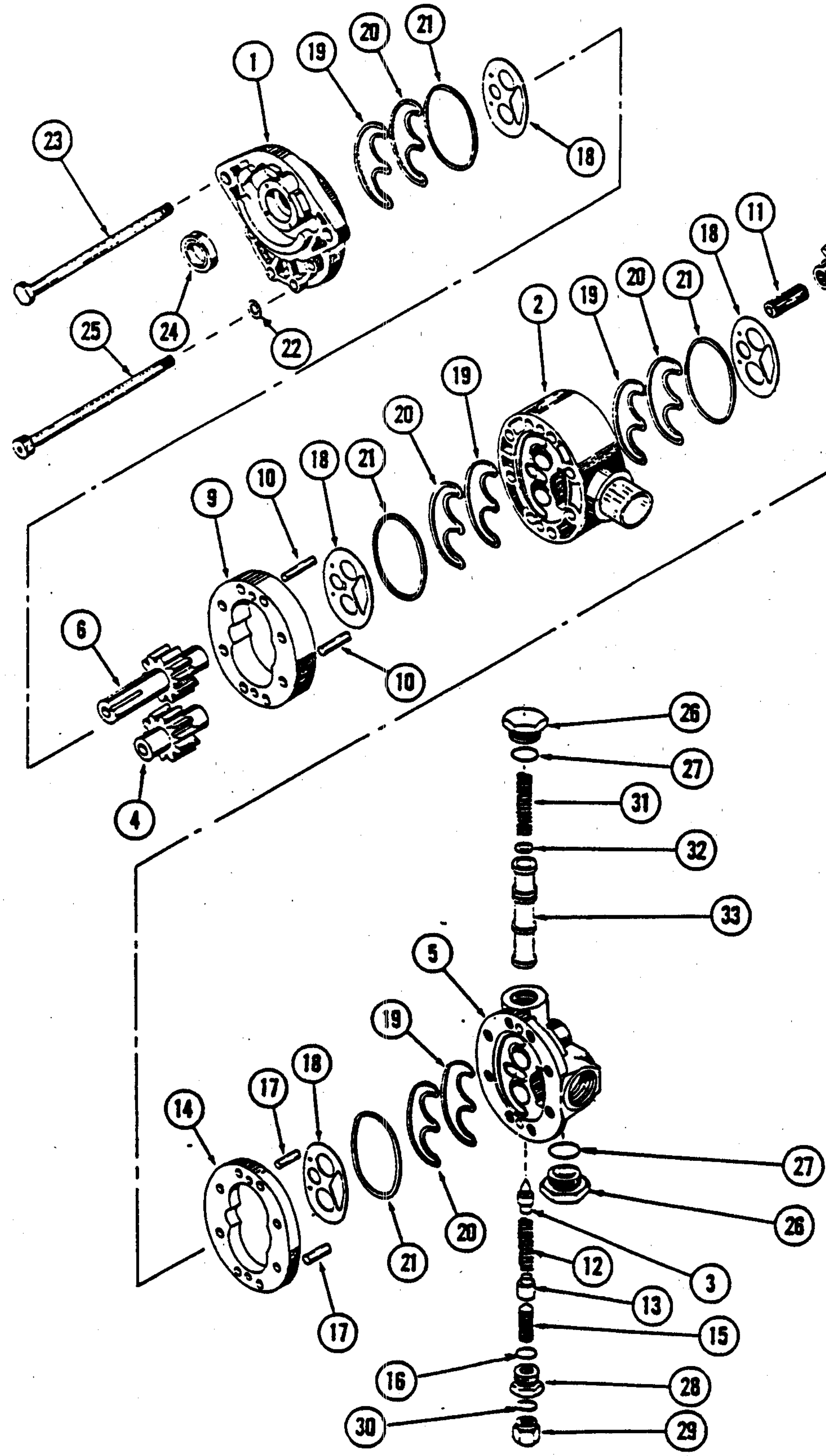


Figure 1. Main Hydraulic Pump

Service Instructions

1. Plug ports and wash exterior with mineral spirits or solvent. Clean parts and work area.
2. Extreme caution must be used when using a vise to avoid distorting any parts.
3. Never pry components apart. Light tapping with plastic hammer on drive shaft will separate body from cover without burring. **Caution:** Place hand over cover assembly while tapping drive shaft to prevent dropping parts or disengaging gear mesh when separation occurs.
4. All parts must be free from burrs, scores, nicks, etc.
5. Before removing gear set, apply marking dye to mating teeth to retain "timing" when reassembling. Gears should be replaced in sets unless other components can be restored to a like new condition.
6. Use complete **Minor Repair Kit** with each unit you rebuild.
7. Extreme care must be used when replacing shaft seal. It must be installed square with seal bore and with metal case to the outside of the pump/motor. Great care must be taken to prevent the drive shaft keyway or spline from cutting the new seal. Use a "bullet" type sleeve or tape over the keyway and generously grease the lips of the seal before installing the shaft.
8. Generously lubricate lips of seal with general purpose bearing grease before installing shaft.
9. Rotate drive shaft before tightening bolts.
10. Hand start all screws or studs to prevent stipping. Torque all bolts and cap screws evenly to avoid distortion. Use the following specifications:
    3/8 Cap Screw, 41-45 ft.lbs.
    3/8 Stud & Nut, 31-35 ft. lbs.
11. Generously lubricate pump - break in slowly.

Specifications

Displacement:	Approx. Gear Width
194K . . . . .1.94 cubic inches per revolution	.9
237K . . . . 2.37 cubic inches per revolution	1.1
280K . . . . 2.80 cubic inches per revolution	1.3
323K . . . . 3.23 cubic inches per revolution	1.5
388K . . . . 3.88 cubic inches per revolution	1.8

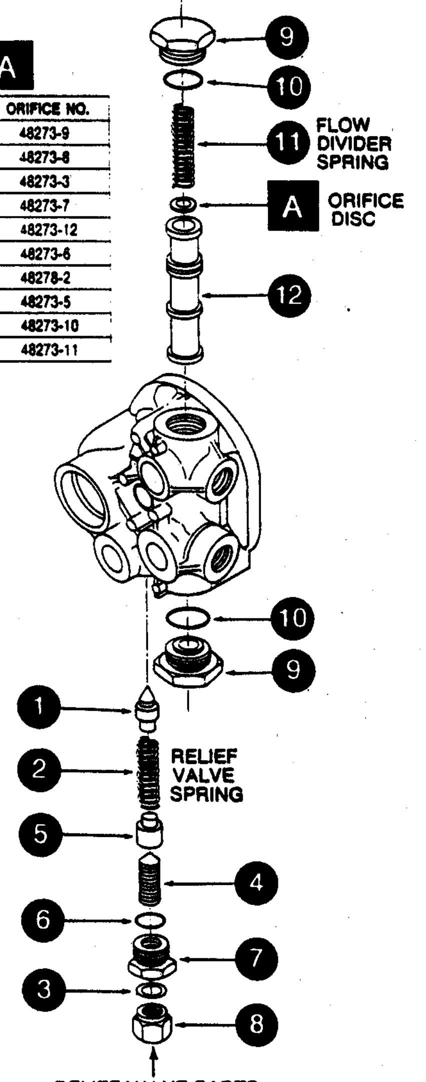
Operating Pressure: to 2500 PSI with peaks permissible to 3250 PSI. (Model 388K to 2250 PSI only)

Operating Speed: to 3000 RPM. (Model 388K to 2750 RPM only)

H1 FLOW DIVIDER COVER ASSEMBLY

A

	GPM	ORIFICE NO.
1	2	48273-9
2	4	48273-8
3	6	48273-3
4	8	48273-7
5	10	48273-12
6	12	48273-6
7	14	48278-2
8	16	48273-5
12	3	48273-10
13	5	48273-11



RELIEF VALVE PARTS

FLOW DIVIDER PARTS		
Item	Description	Part No.
1	Poppet	43451
2	Spring	43114-2 (500-1000 psi) 43114 (1000-2000 psi)
3	Gasket	24829
4	Set Screw	29547-6 (500-1000 psi) 29547-7 (1000-2000 psi)
5	Spring Guide	44095
6	"O" Ring	29791-910
7	Plug	43115
8	Cap	23413
9	Plug	(2) 43112-3
10	"O" Ring	(2) 29791-914
11	Spring	48046
12	Piston	48272

Section 8207

MAIN CONTROL VALVES

8

SPECIFICATIONS

Spool Type - "D"	Sliding, double action, cylinder
Relief valve, main	See Section 8202
Spool travel (from neutral position)	5/16 inch (7.87 mm)
Port pressurized	
Spool Out	8-port
Spool In	4-port
Tie Bolt Torque	15 lb-ft (20 Nm)

VALVE IDENTIFICATION

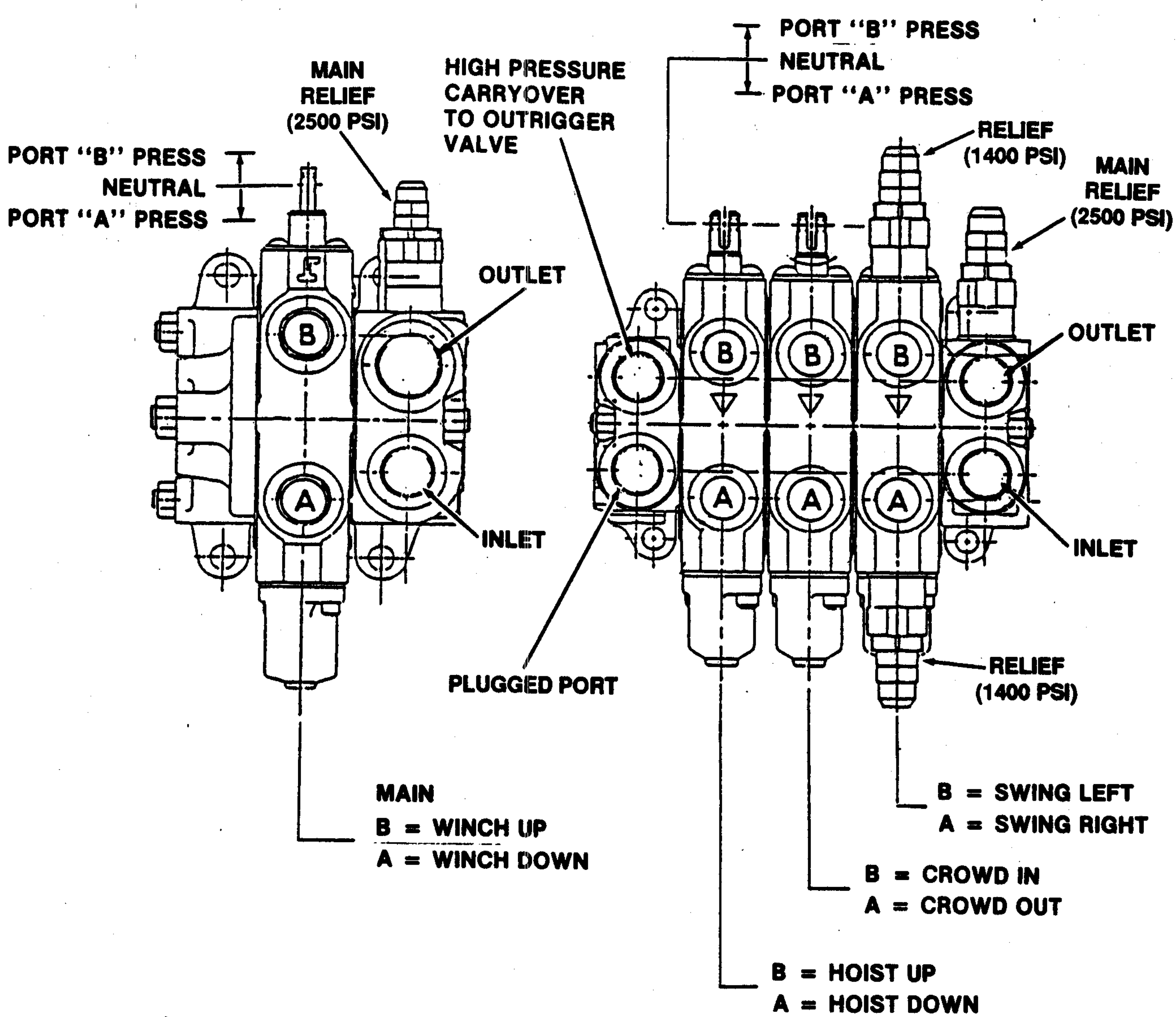


Figure 1. Main Control Valves – Identification

Section 8209

OUTRIGGER HYDRAULIC CIRCUIT

OUTRIGGER SYSTEM

General

Oil is made available to the outrigger control valve from the pressure carryover port of the control valve for hoist, crowd, swing and auxiliary winch (optional).

Outrigger Valve

The outrigger valve includes a dump valve and four working valve sections. The valve bank has a closed center passage. Oil from the valve inlet flows directly to the valve outlet through the dump valve when the valve is de-energized.

The dump valve is controlled by the outrigger main switches on right side of the instrument panel. See Section 4002. When energized, the dump valve stops the free flow of oil between the valve inlet and outlet.

Oil under pressure is then available to the outrigger functions.

Outrigger Valve Ports

For easy identification, the ports of the outrigger valve are given an alphabetical sequence from A to H, starting at the cylinder port nearest the dump valve.

Port	Function (Under High Pressure)	Sol.	Wire No.
A	Right outriggers up	B	56C
B	Right outriggers down	A	56D
C	Left outriggers up	B	56H
D	Left outriggers down	A	56G
E	Left outriggers out	B	56E
F	Left outriggers in	A	56F
G	Right outriggers out	B	56A
H	Right outriggers in	A	56B

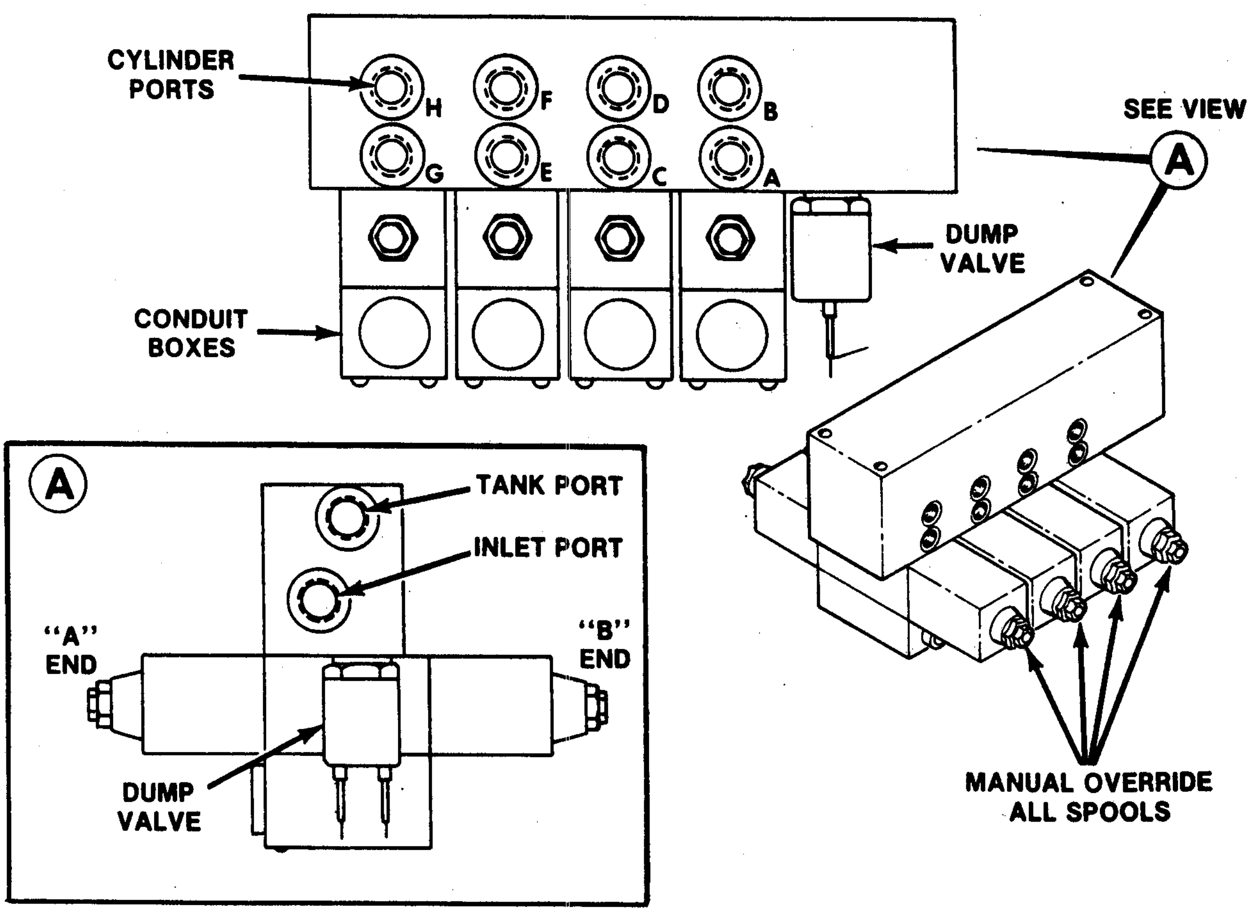


Figure 1. Outrigger Valve - Port Identification

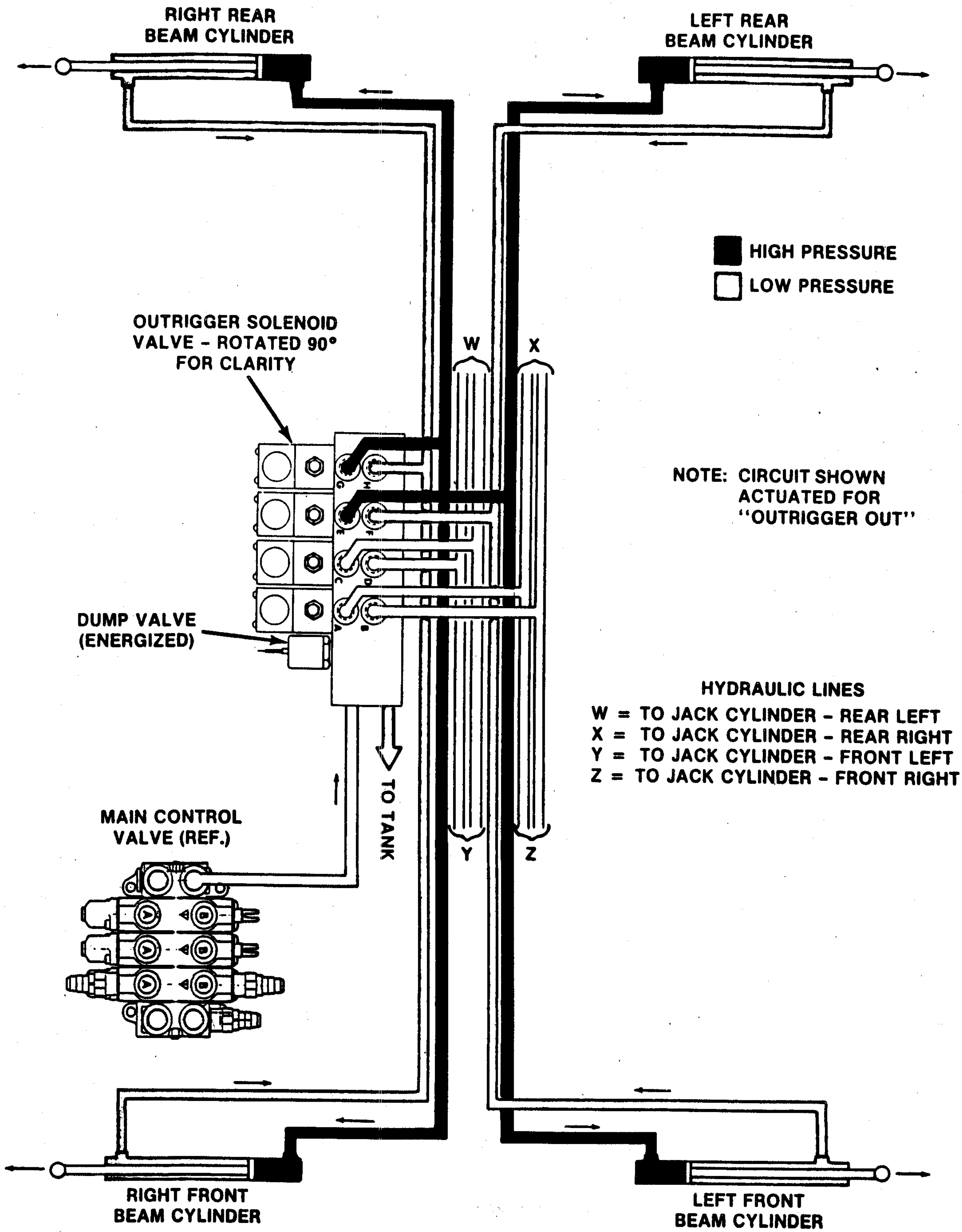


Figure 2. Outrigger Hydraulic Diagram — Beam Cylinder Circuits

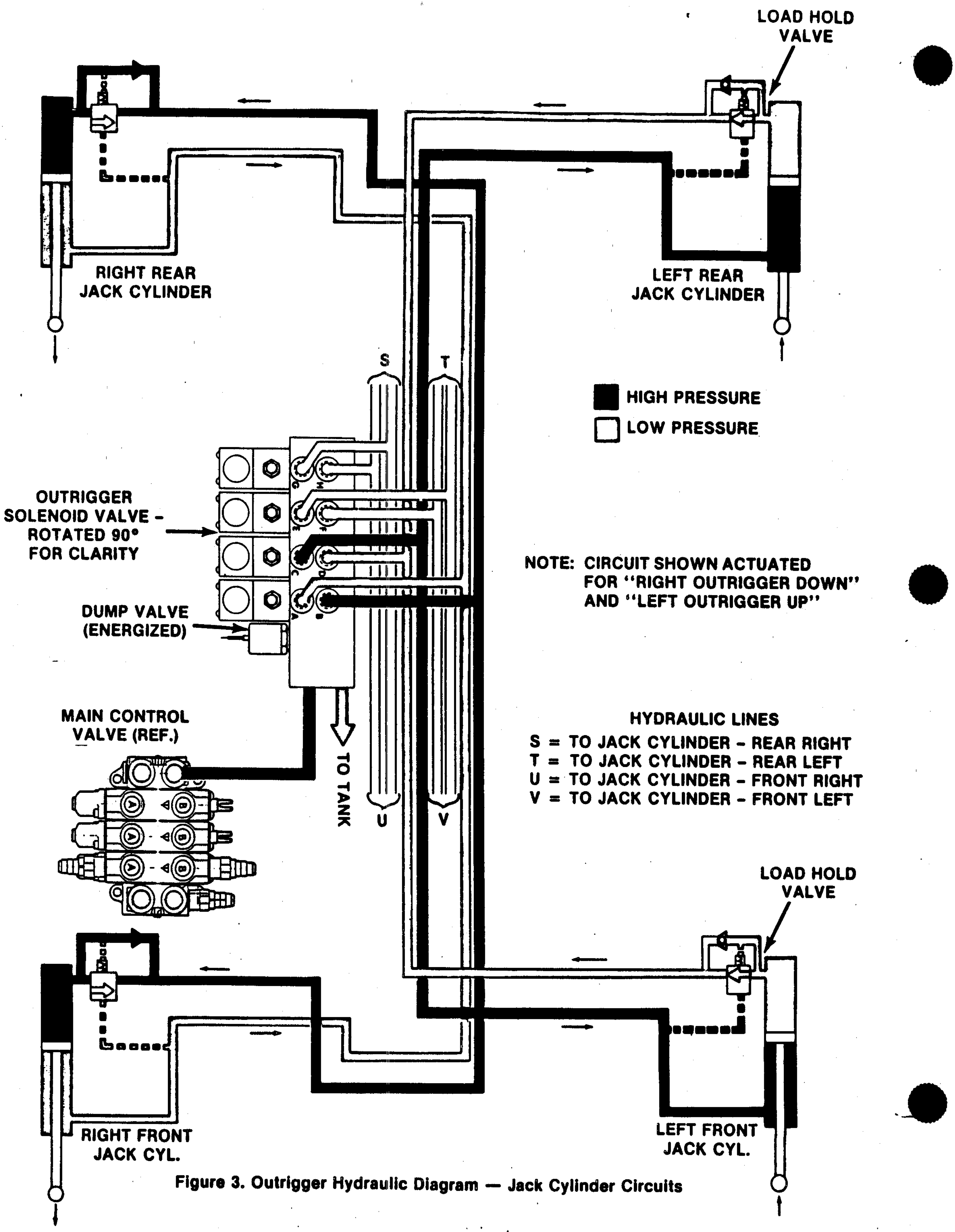


Figure 3. Outrigger Hydraulic Diagram — Jack Cylinder Circuits

8209-5

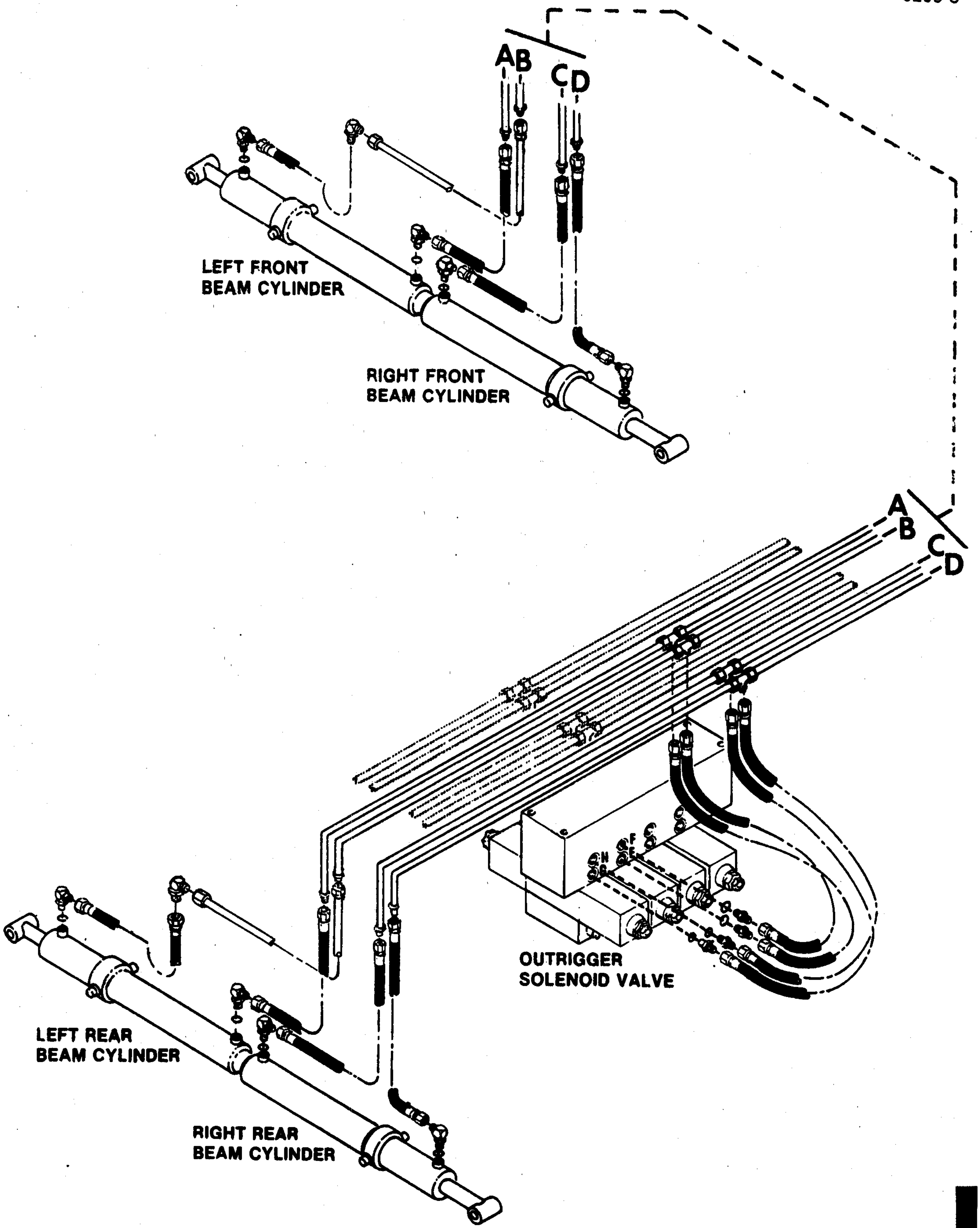


Figure 4. Outrigger Hydraulic Lines — Out/In — Outrigger Valve to Beam Cylinders

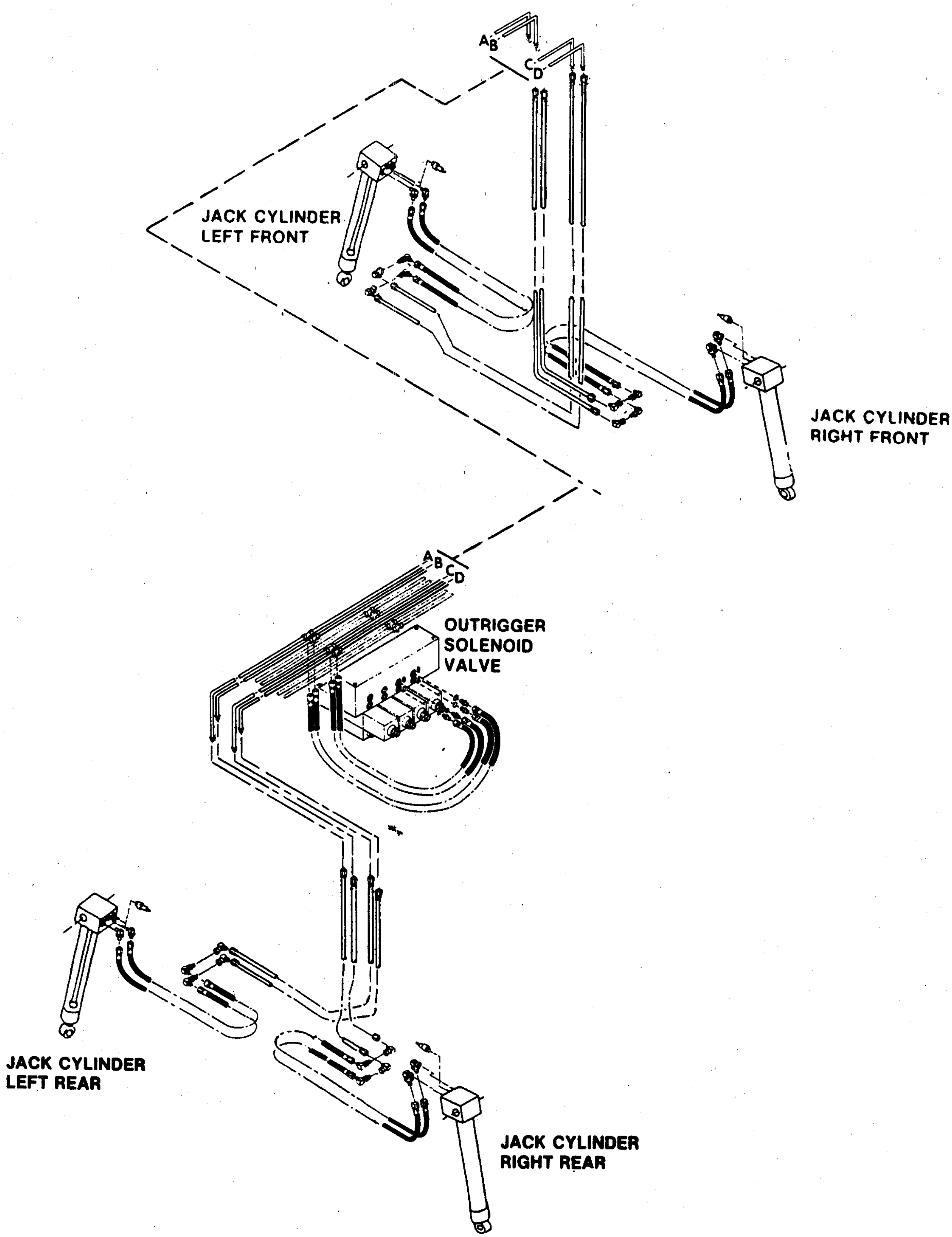


Figure 5. Outrigger Hydraulic Lines — Down/Up — Outrigger Valve to Jack Cylinders

Load-Holding Valves

The outrigger jack cylinders have load-holding valves installed in the cylinder base. The purpose of these valves is to prevent the cylinder from retracting if a hydraulic line or hose breaks. The load-holding valves will hold oil in the cylinder base until there is oil from the pump available to the rod side of the cylinder.

Oil flows freely through the load-holding valve and into the cylinder base when cylinder is being extended. To retract the cylinder, oil is sent to the rod port of the cylinder. As the cylinder starts to retract, the piston meets the resistance of the oil held in the cylinder base by the holding valve. Pressure increases as the pump tries to overcome the resistance.

When pressure on the oil from the pump is high enough to overcome the spring in the load-holding valve plus the pressure of the oil in the cylinder base, the load-holding valve opens and the cylinder retracts.

If the cylinder starts to retract too rapidly, for example, because of a heavy load on the cylinder, pilot pressure from the rod side decreases and the load-holding valve closes. The cylinder stops retracting temporarily until enough oil is again available to the rod side of the cylinder. In this way, cylinder cavitation is prevented and the load is held.

NOTE: The engine must be running to retract the outrigger cylinders. The load-holding valves prevent retracting the outrigger jacks simply from the weight of the machine.

Outrigger Cylinders

If one of the jack cylinders will not hold under load, the problem is either in the holding valve or the cylinder piston packings. To check for internal leakage in the cylinder:

1. Fully extend cylinder.
2. Remove hydraulic line from ROD port of jack cylinder being checked.
3. Actuate the control switch in a direction to extend the cylinder. Check the amount of leakage from the open rod port. If the leakage is more than a couple of drops per minute, the cylinder needs an overhaul. See Section 8290.

SERVICING THE OUTRIGGER VALVE

Removal

1. Stop engine. Engage parking brake and put blocks under the wheels.
2. Disconnect battery cables from battery. Make sure you disconnect the (–) negative lead first.
3. Remove valve access cover on right side of machine.
4. Disconnect valve leads from outrigger wiring harness. Disconnect ground lead for the dump valve.
5. Put labels on the hydraulic lines for correct assembly. Clean the valve and connecting lines. Disconnect hydraulic lines from valve ports. Put caps on the lines to keep dirt out of the system.
6. Individual valve sections can be removed from the valve block without removing the complete valve.

Installation

1. Put valve section in position on valve block and install mounting bolts.
2. Connect hydraulic lines to valve ports.
3. Connect electrical leads to outrigger wiring harness. Install ground connection for dump valve solenoid. Make sure all connections are clean and tight.
4. Connect battery cables to battery.
5. Operate outriggers to check for correct function. Stop engine. Check for leakage, and add hydraulic fluid as necessary.

Section 8210

SWING CIRCUIT
AND
SWING MOTOR

8

SWING CIRCUIT

General

The swing motor is controlled by the first section of the multiple spool valve. In the neutral position, oil is held in the circuit and the motor is prevented from turning. The gear/pinion is protected by relief valves (set at 1400 psi) for both swing directions.

Pulling the valve spool out sends oil through B-port to the swing motor. The motor rotates clockwise and causes the mast to rotate to the right. Oil from the downstream side of the motor returns through the A-port and is sent back through a filter to the hydraulic oil tank.

Pushing the valve spool in sends the oil through the circuit in the opposite direction and causes the mast to rotate to the left.

SERVICING THE SWING MOTOR

Specifications

Rotation (from shaft end) .... Clockwise when pressure is applied at lower port in diagram below
Displacement .... 6.8 cu in/rev

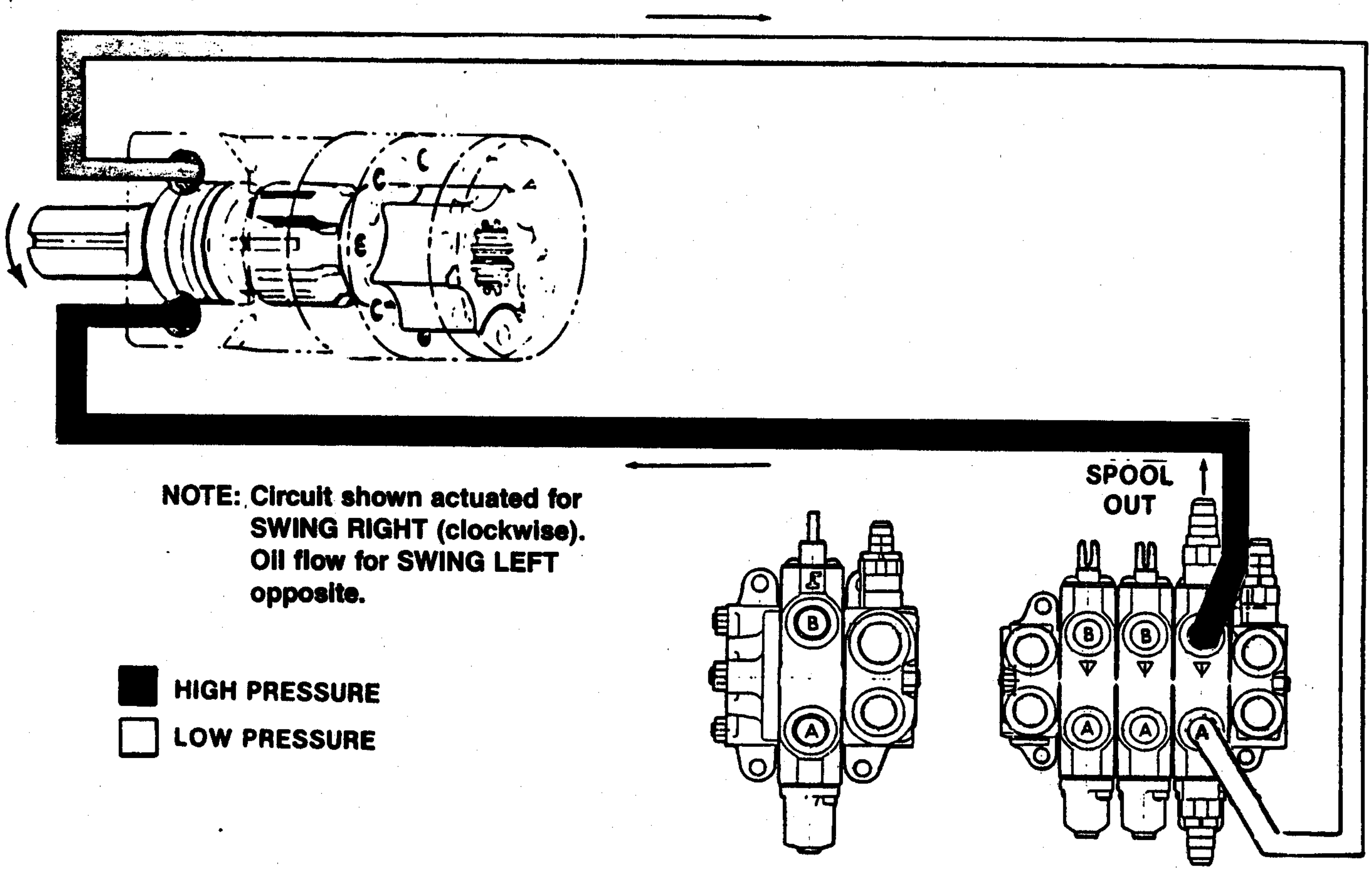
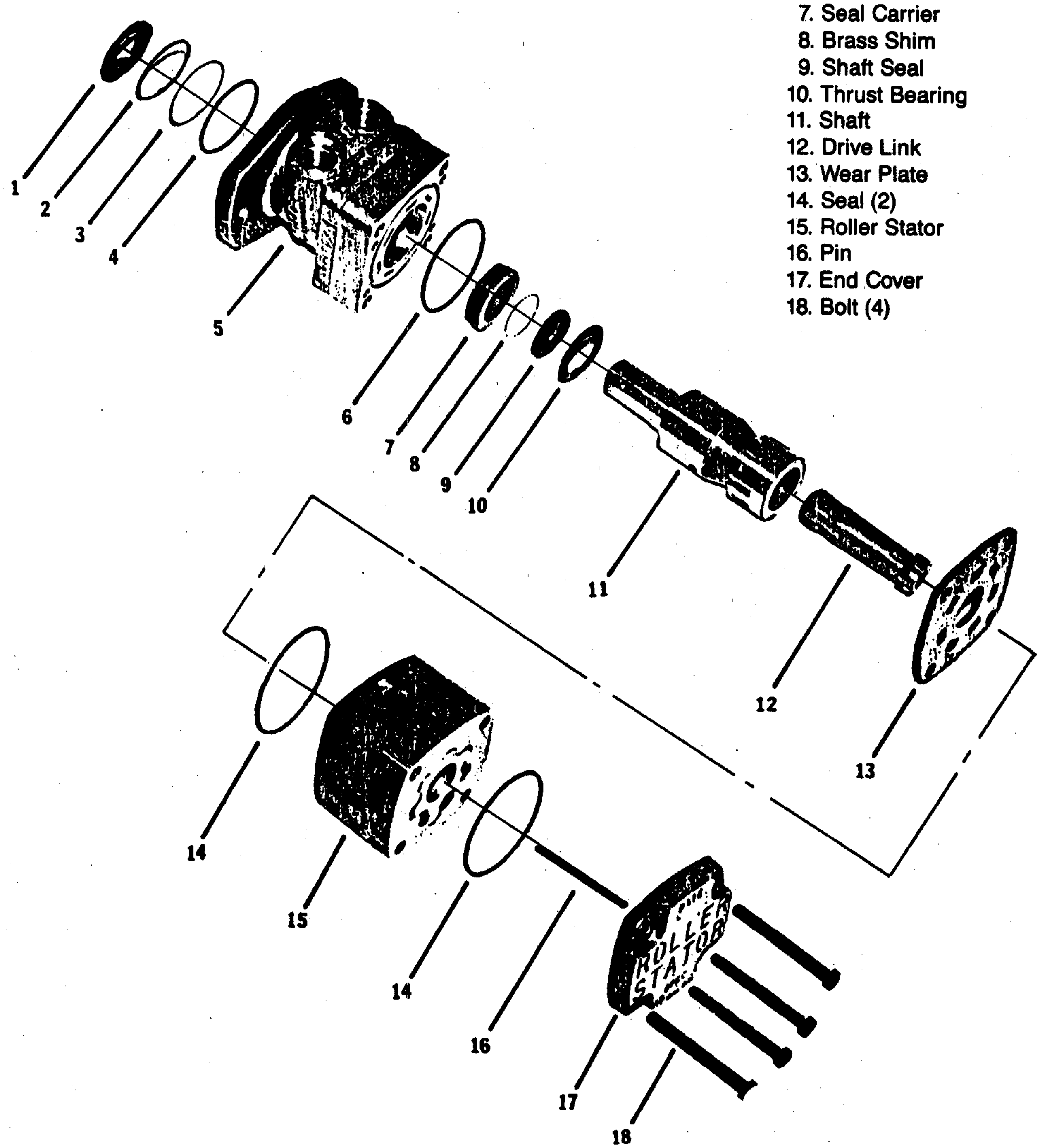


Figure 1. Swing Hydraulic Circuit



1. Dust Seal
2. Wire Ring
3. Shim
4. Seal
5. Housing
6. Seal
7. Seal Carrier
8. Brass Shim
9. Shaft Seal
10. Thrust Bearing
11. Shaft
12. Drive Link
13. Wear Plate
14. Seal (2)
15. Roller Stator
16. Pin
17. End Cover
18. Bolt (4)

Figure 1A. Swing Motor

Removal

CAUTION: Make sure crane is parked on level surface and avoid any swing motion of mast while swing motor is removed (bearings in swing gearcase will become dislodged).

1. Release the hydraulic pressure in the swing circuit, by moving the swing control in both directions with engine stopped.
2. Put labels on the hydraulic hoses for correct assembly. Disconnect the hydraulic hoses and install plugs and caps on the hydraulic hoses and fittings.
3. Remove the two bolts that fasten motor to the gearbox. Remove the motor.

Disassembly

The roller stator assembly should have the ports plugged and all of the excess dirt on the outside of the motor washed off. After this is accomplished place the motor in vise as shown in Fig. 2 and clamp at port area on housing (Fig. 1). Newspapers should be placed on top of bench to allow a clean area on which to work.

Disassembly of Roller Stator (Reference Fig. 1)

1. Remove four bolts (18) (9/16 boxed end).
2. Shift wear plate to clear end of drive link and lift group [end cover (17), rotor assembly (15) and wear plate] from housing assembly (5).
3. Remove woodruff key from shaft (11); then lift shaft from housing by rapping shaft end. Item 7, 8, 9, 10, 11, 12 and 16 usually will come out from assembly.
4. With fingers place through dust seal (10) of housing (5), push seal carrier (7) out the opposite end from the dust seal. Care should be taken not to have the seal carrier turn and mar the I.D. of the housing. This procedure will remove items 7, 8, 9 and 10 from housing.
5. Mount housing assembly (5) in vise. Use large screwdriver to remove dust seal (1).
6. Take a screwdriver and remove wire ring (2).
7. Take a screwdriver and pry in behind item 3 deforming it and removing it.
8. With small screwdriver remove seal (4).

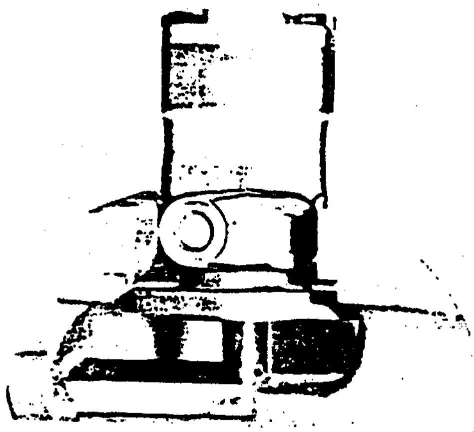


Fig. 2

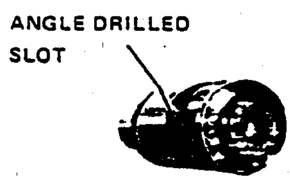


Fig. 3

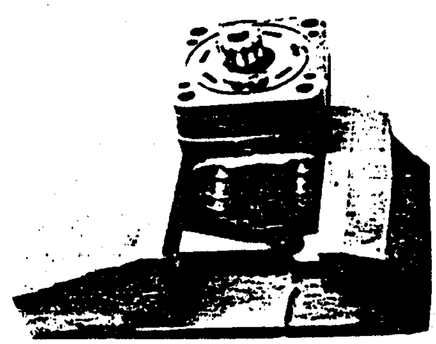


Fig. 4

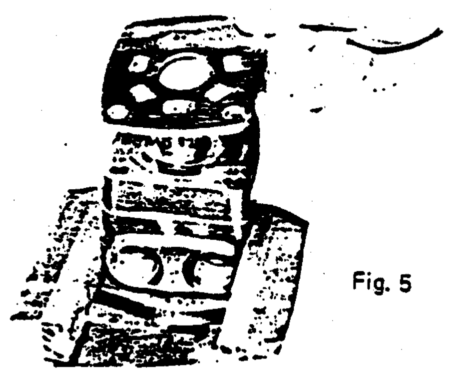


Fig. 5

Assembly

Important: Before assembling, wash all parts off in clean solvent. Also it is best to have a new seal kit including items 1, 3, 4, 6, 8, 9 and 14. (2 parts).

1. Place housing with groove side down on newspaper, install shim (3).

2. Install seal (4) underneath shim.

3. Place wire ring (2) in position.

4. Place housing (5) in vise as shown in Fig. 4 with groove side up.

5. Seal (6) [lightly oiled] is placed in groove in housing top (6).

6. Seal carrier (7) has the brass shim (8) placed in I.D. groove, followed by the shaft seal (9) with lip side away from brass shim.

7. Place thrust bearing (10) on shaft (11), followed by the seal carrier assembly (7, 8 and 9) with seal lip towards bearing (10).

8. Assemble the shaft (11) with drive link (12). This is done with dot on cupped end of shaft aligned with marking at root of tooth on drive link (12). If spline is tight, this assembly can be made by rapping the end of the drive link with a hammer. See Fig. 3. Fill drive link end with grease.

   Note: If markings are indistinguishable, the mark on the root of the drive link should be placed with the angle drilled slot of output shaft to the right and 1/4" through hole to the left.

9. Place the output shaft assembly (7, 8, 9, 10, 11 & 12) into housing. Fig. 4.

10. Place wear place (13) on top of grooved side of housing, insuring alignment of seven feed holes. See Fig. 5.

11. Install lightly oiled seal (14) into grooved end roller stator (15). Place this assembly over drive link with mark on drive link root in line with rotor lobe. See Fig. 6. Observe rotor face so that undercut of the rotor is up. Observe rotor face so that undercut of the rotor is up, if applicable. See Fig. 7. Note alignment of seven feed holes with manifold and wear plate. See Fig. 6. Align the four bolt holes with housing.

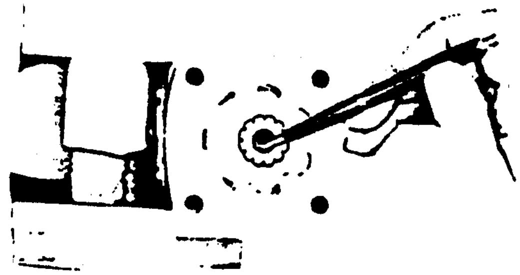


Fig. 6

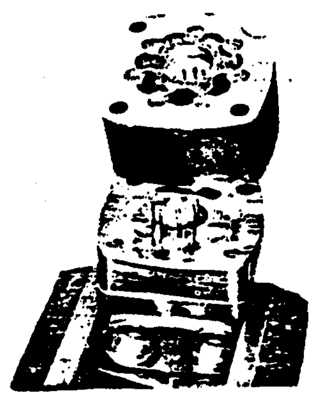


Fig. 7

12. Place lightly oiled seal (14) into end cover (17).

13. Place grease in recessed center of end cover (17) face. Place pin (16) into this greased recess. If recess is filled with oil, wipe clean before loading with grease.

14. Place the end cover assembly on top on the roller stator assembly. Be very careful not to dislodge seal or pin from the end cover.

15. Check side for any possible seals out of place.

16. Insert four bolts and torque to 30 foot pounds.

17. Place assembly on side in vise and rotate shaft with key in place. Check to insure the suction port is in the same direction of turning.

Installation

1. Install the motor on the gearbox.

2. Connect the hydraulic lines to the motor.

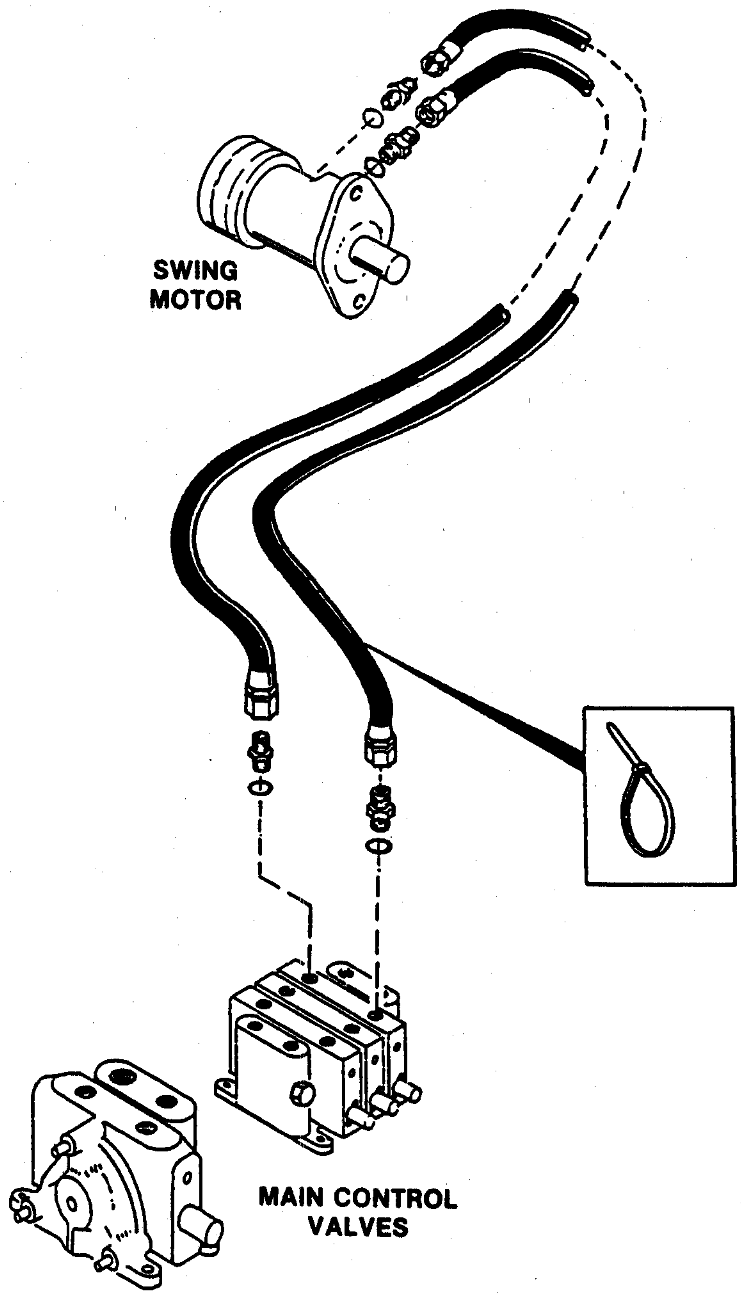


Figure 8. Swing Hydraulic Lines

Section 8211

HOIST CIRCUIT

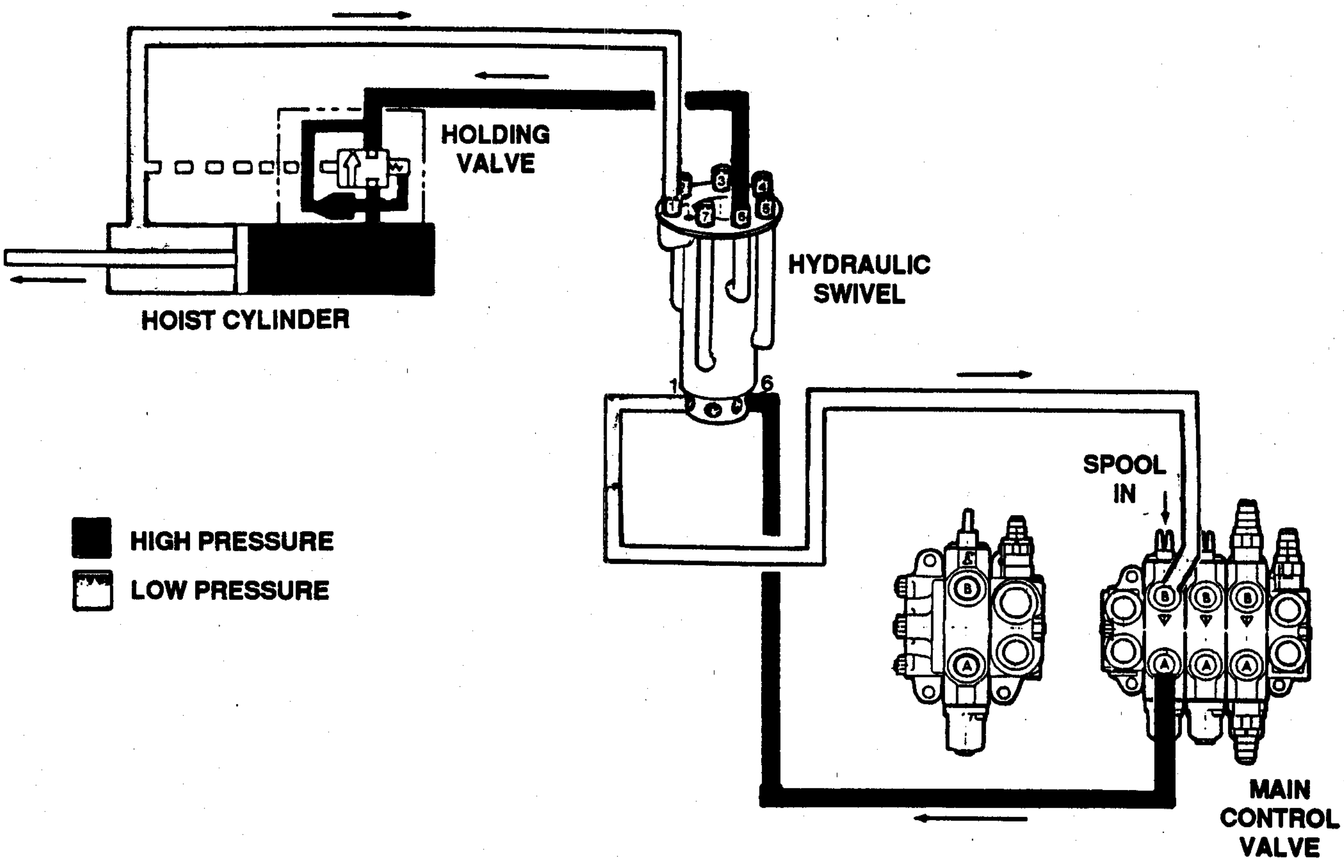


Figure 1. Oil Flow – Hoist Up

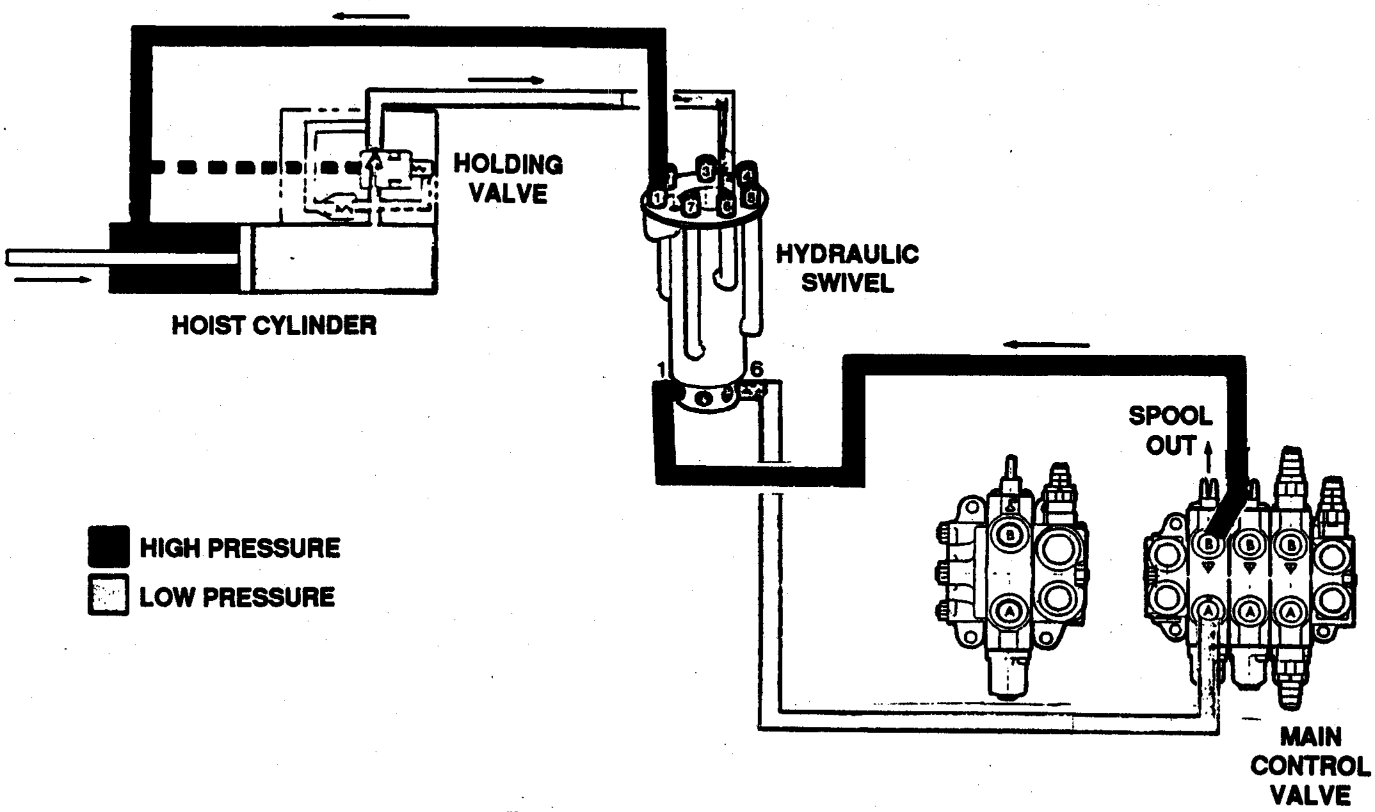


Figure 2. Oil Flow - Hoist Down

HOIST CIRCUIT

General

The hoist circuit includes the hoist cylinder, a holding valve, Port 1 and Port 6 in the hydraulic swivel, the first spool in the multiple spool valve and hydraulic lines.

Oil Flow

When valve spool is in neutral position, both A and B ports are closed and oil is held in the circuit to prevent movement of the hoist cylinder.

Pushing the valve spool IN connects the pump passage to cylinder port "A" in the control valve. Oil leaves the A-port, goes through Port 6 of the hydraulic swivel, then enters the base of the hoist cylinder through the holding valve. In this direction, the oil flows freely through the holding valve and into the base of the cylinder. The cylinder starts to extend, pushing the oil ahead of the piston out through the rod port. This oil returns through Port 1 of the hydraulic swivel to Port "B" of the control valve. From here, the oil is routed to the tank passage of the control valve and returns through the filter to the hydraulic oil tank.

Pulling the valve spool OUT sends oil through the circuit in the opposite direction and causes the cylinder to retract. The holding valve lets the cylinder retract only as there is oil under pressure available to the rod port of the cylinder. See Holding Valve.

Holding Valve

The holding vale has three main functions:

a) Prevent cavitation of the cylinder,
b) Give full control of the lowering of the boom
c) Hold load in the event of a hydraulic failure.

Pilot pressure from the rod side of the piston opens the holding valve. If the cylinder starts to retract faster than the pump can fill the cylinder, there will be a decrease in the pilot pressure. The holding valve will close and interrupt the flow of oil from the cylinder. The holding valve will interrupt the flow as often as necessary to keep the cylinder filled. Also if there is a failure of the pump or a hydraulic line, the holding valve will hold the boom in position.

Engine speed is important for good lowering of the boom. At low engine speed, normally there will not be enough oil from the pump to keep the cylinder filled. As a result, the boom will move down in a movement that is not regular.

IMPORTANT: Do not adjust the holding valve. The valve is adjusted by the manufacturer. A seal kit is available for replacement of the seals on the cartridges. These seals can be replaced without changing the adjustment of the valve.

Procedure to Check for Leakage in the Hoist Cylinder

If the cylinder does not hold the load, the problem is normally internal leakage in the cylinder. This problem can also be caused by leakage in the control valve or the holding valve. To check for leakage in the cylinder:

1. Fully extend the hoist cylinder to raise the boom. Use a chain hoist to hold boom in position.

2. Stop the engine. Move the hoist control lever several times in each direction to release pressure in the circuit.

3. Disconnect the hydraulic line which connects to the rod port of the hoist cylinder. A little oil will drain from the rod port of the cylinder.

4. Start the engine. Activate the control lever in a direction to raise the boom. Check the amount of leakage from the rod port of the cylinder. If this leakage is more than a few drops, replacement of the piston seals is necessary.

5. For cylinder repair, see Section 8290.

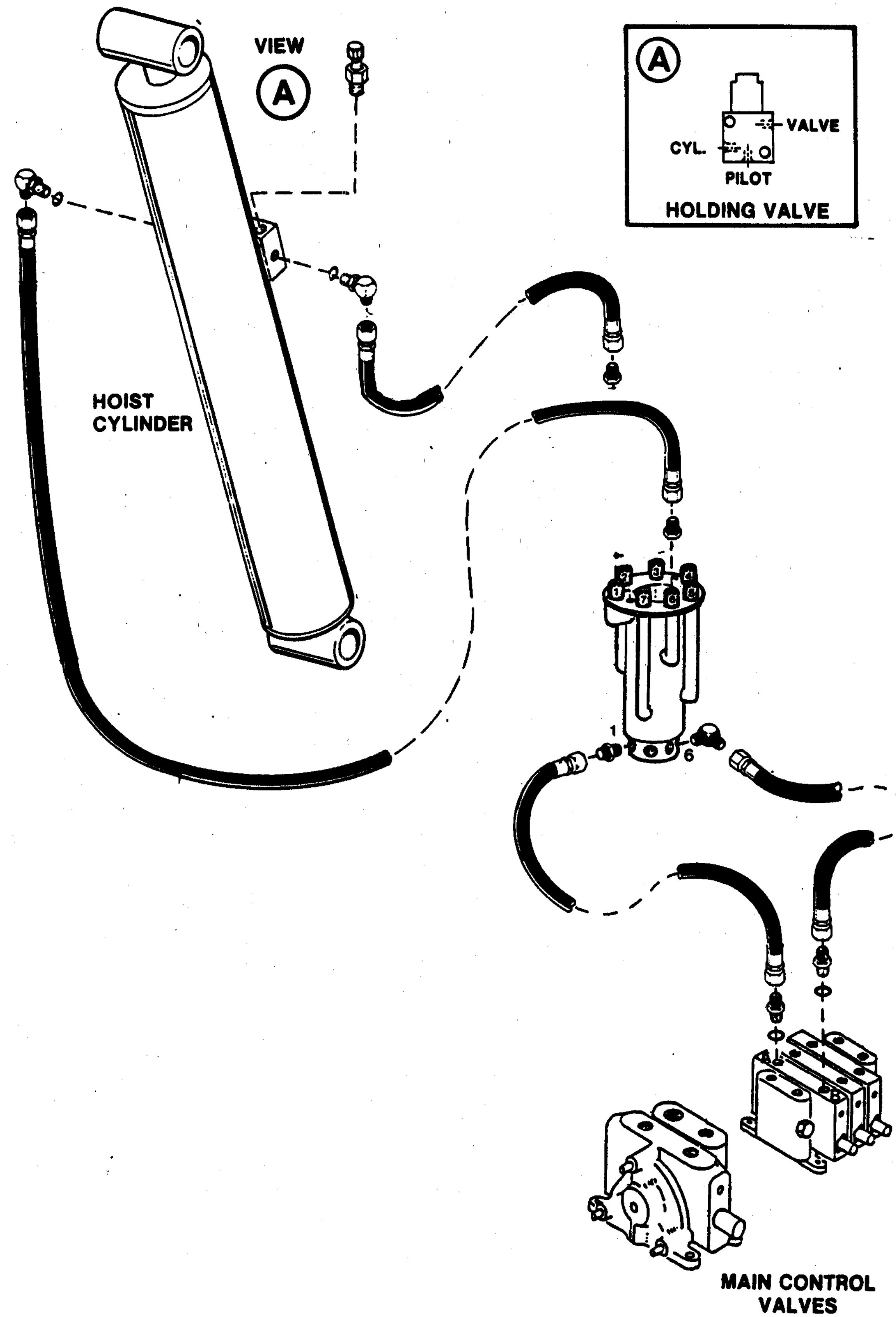


Figure 3. Hoist Hydraulic Lines

Section 8212

CROWD HYDRAULIC CIRCUIT

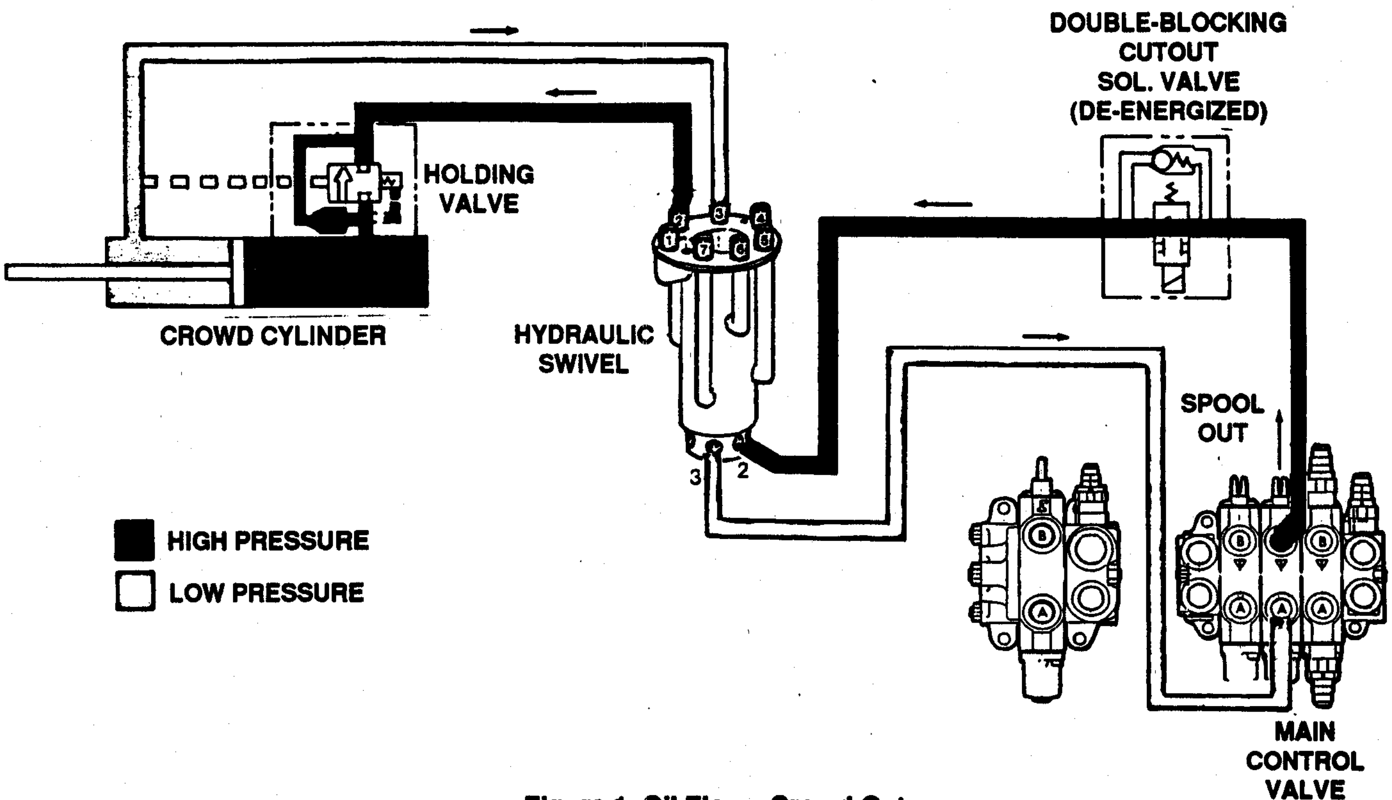


Figure 1. Oil Flow - Crowd Out

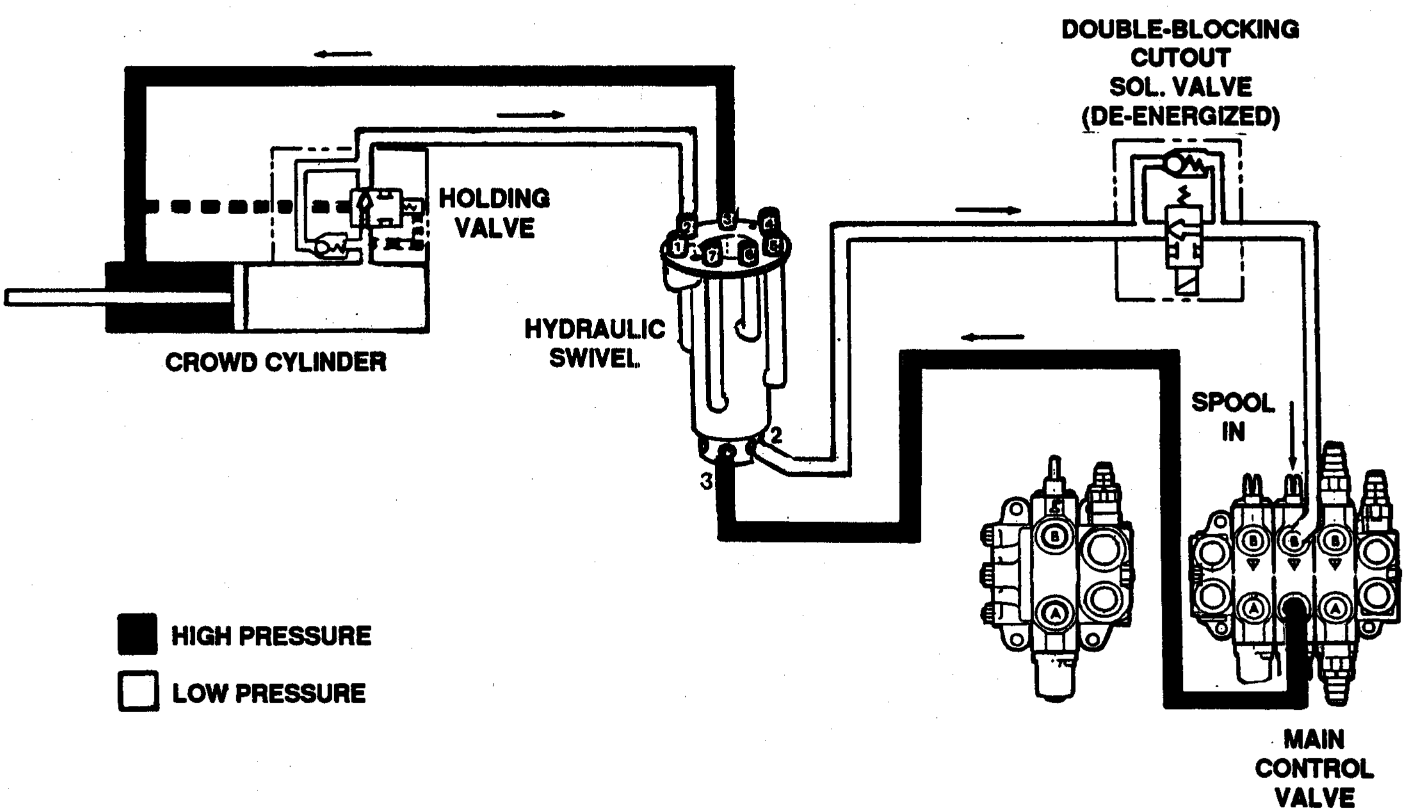


Figure 2. Oil Flow - Crowd In

CROWD CIRCUIT

General

The crowd circuit includes the crowd cylinder, a holding valve, Port 2 and Port 3 of the hydraulic swivel, the second spool in the multiple spool valve and hydraulic lines. A solenoid valve is installed between the control valve and the hydraulic swivel to prevent double-blocking when extending the boom.

Oil Flow

When the valve spool is in neutral position, oil is held in the circuit and the cylinder is prevented from extending or retracting.

Crowd Out:

Pulling the valve spool OUT connects the supply from the pump to cylinder port "B" of the control valve. Oil leaves the B-port and is routed through the solenoid valve and the hydraulic swivel to the base of the crowd cylinder.

In the extending direction, oil flows freely through the holding valve and into the base of the cylinder. The cylinder extends and pushes oil ahead of the piston and through the rod port. This oil returns through the hydraulic swivel to port "A" of the control valve. From here, the oil is routed into the tank passage and returns through the oil filter to the hydraulic oil tank.

With the Double-Blocking Cutout, when the hook block is in contact with the boom head, oil is stopped at the solenoid valve. In this case the operator must let out more wire rope on the main winch before he can extend the boom.

Crowd In:

Pushing the valve spool IN routes oil out of valve port "A" and through the hydraulic swivel to the rod port of the cylinder. The cylinder starts to retract but meets resistance from the oil held in the cylinder base by the holding valve. This restriction causes an increase in pressure as the pump continues to push more oil into the rod port of the cylinder. When the pressure is high enough to open the holding valve, the cylinder retracts. See Holding Valve.

Oil from the cylinder base returns through the hydraulic swivel to the control valve. From here, the oil is routed through the filter to the hydraulic oil tank.

Holding Valve

The holding valve has two main functions:

a) Prevent cavitation of the cylinder,
b) Give full control of the retracting of the boom

Pilot pressure from the rod side of the piston opens the holding valve. If the cylinder starts to retract faster than the pump can fill the cylinder, there will be a decrease in the pilot pressure. The holding valve will close and interrupt the flow of oil from the cylinder. The holding valve will interrupt the flow as often as necessary to keep the cylinder filled. Also if there is a failure of the pump or a hydraulic line, the holding valve will hold the boom in position.

Engine speed is important for smooth operation. At low engine speeds, normally there will not be enough oil from the pump to keep the cylinder filled. As a result, the boom will move down in a movement that is not regular.

IMPORTANT: Do not adjust the holding valve. The valve is adjusted by the manufacturer. A seal kit is available for replacement of the seals on the cartridges. These seals can be replaced without changing the adjustment of the valve.

Procedure to Check for Leakage in the Crowd Cylinder

If the cylinder does not hold the load, the problem is normally internal leakage in the cylinder. This problem can also be caused by leakage in the control valve or the holding valve. To check for leakage in the cylinder:

1. Raise the boom a little above the horizontal position.

2. Fully extend the boom.

3. Stop the engine. Move the control lever several times in each direction to release pressure in the circuit.

4. Disconnect the hydraulic hose from the hydraulic line which connects to the rod port of the crowd cylinder. A little oil will drain from the hydraulic line.

5. Start the engine. Activate the control lever in a direction to extend the boom. Check the amount of leakage from the rod port of the cylinder. If this leakage is more than a few drops, replacement of the piston seals is necessary.

6. For cylinder repair, see Section 8290.

Double-Blocking Cutout

For description of the double-blocking cutout, see Section 4015.

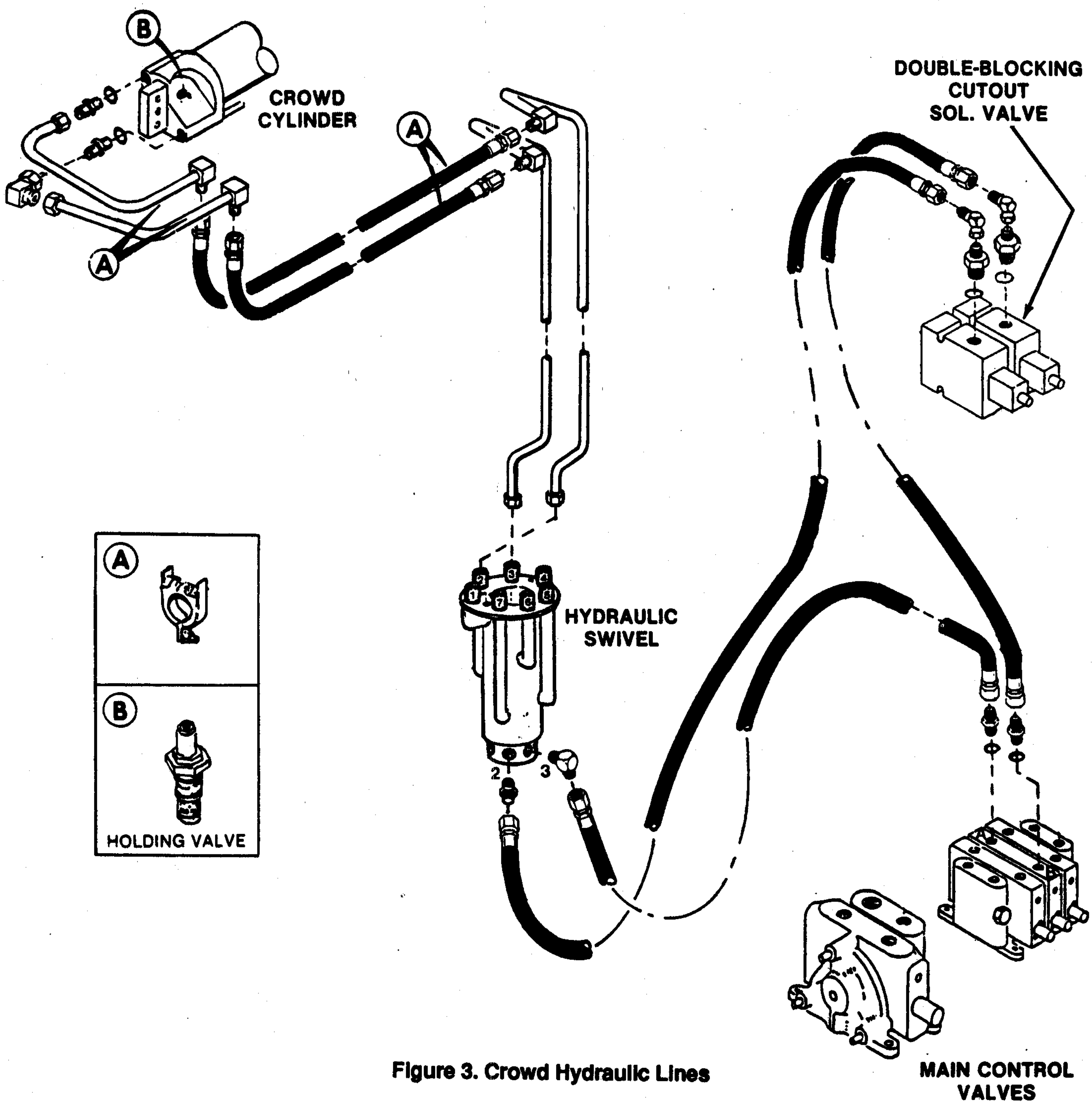


Figure 3. Crowd Hydraulic Lines

Section 8213

MAIN WINCH CIRCUIT

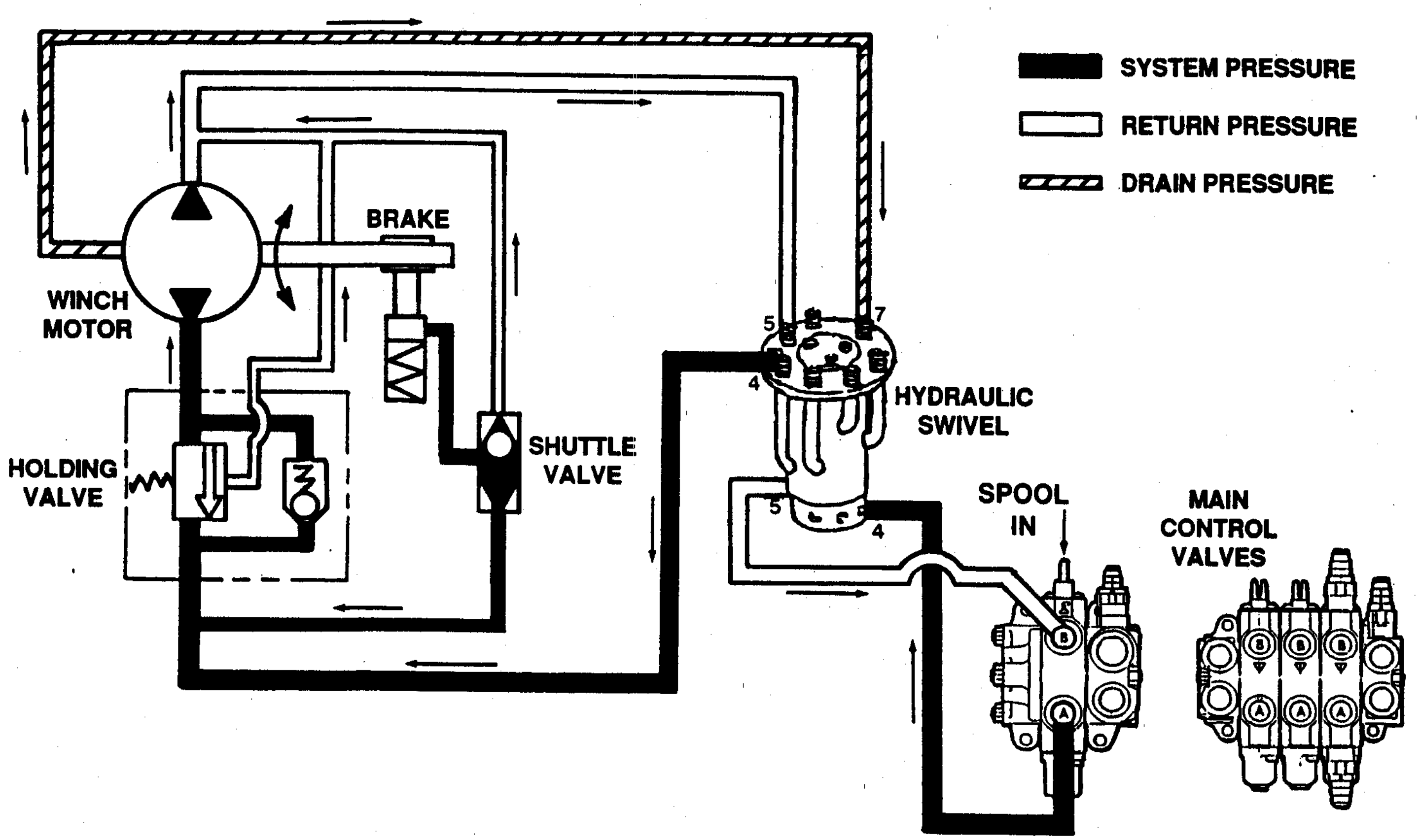


Figure 1. Hoist Circuit - Raise Load

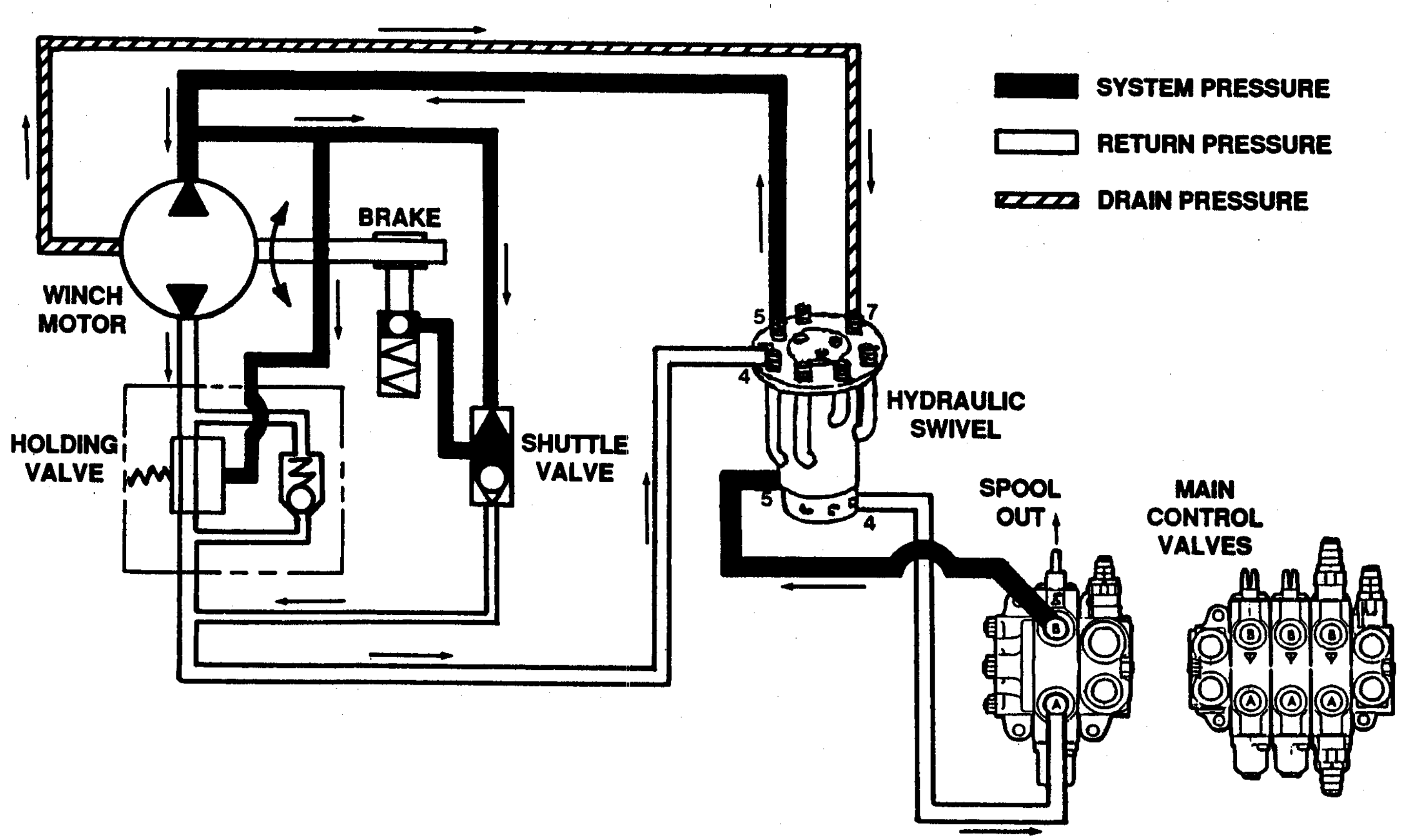


Figure 2. Hoist Circuit - Lower Load

MAIN WINCH CIRCUIT

General

The winch circuit includes the winch motor, brake, a holding valve, swivel ports 4 and 5, the single spool valve and hydraulic lines.

Oil Flow

When valve spool is in neutral position, both A and B ports are closed. Oil is held in the winch circuit, preventing movement of the winch motor.

Winch Up:

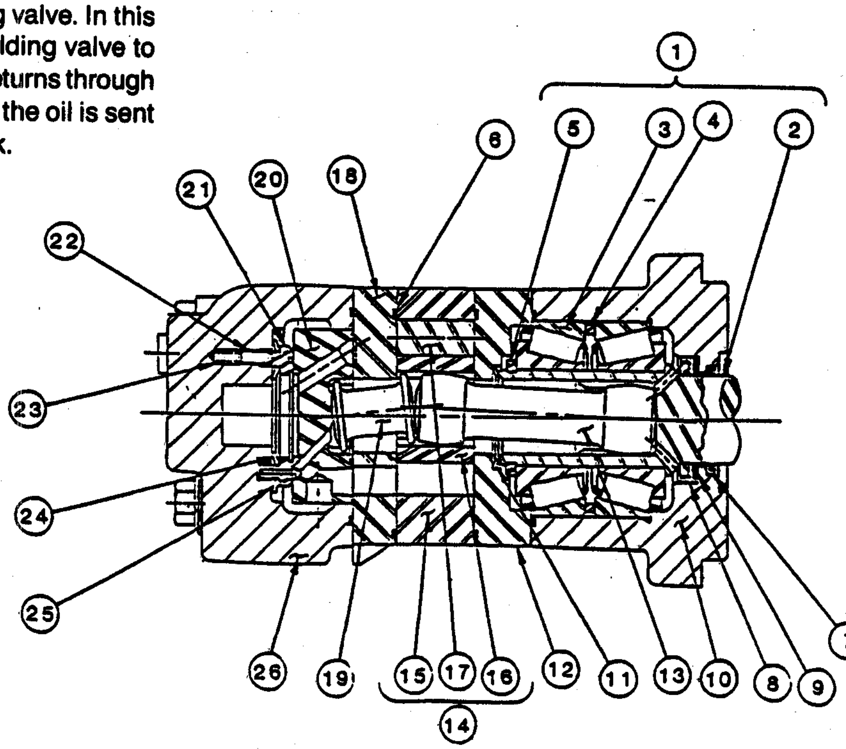
Pushing the valve spool IN routes oil from the front pump to cylinder port "A" of the control valve. From here the oil is routed through swivel port A to the holding valve. In this direction, the oil flows freely through the holding valve to the winch motor. The oil turns the motor and returns through swivel port 5 to the control valve. From here, the oil is sent back through the filter to the hydraulic tank.

Winch Down:

Pulling the valve spool OUT sends oil out of part "B" and through swivel port 5 to the winch motor. The motor starts to turn in a direction to lower the winch. The increase in pressure on the downstream side of the motor causes the holding valve to open. The oil then returns through swivel port 4 to the control valve.

Holding Valve

The function of the holding valve is to generate a back pressure of 200 psi (1 380 kPa) against the winch motor. This back pressure prevents a heavy load from turning the winch motor when the control lever is in neutral position.



1. **Shaft sub-assembly (Includes items 2 thru 5)**
2. **Output shaft**
3. **Bearing**
4. **Bearing spacer**
5. **Retaining ring**
6. **Seal**
7. **Shaft exclusion seal**
8. **Shaft seal**
9. **Back-up ring**
10. **Bearing housing**
11. **Shaft face seal**
12. **Wear plate**
13. **Drive**
14. **Geroler sub-assembly (Includes items 15 thru 17)**
15. **Geroler ring**
16. **Geroler star**
17. **Geroler roller**
18. **Valve plate**
19. **Valve drive**
20. **Valve**
21. **Balancing plate**
22. **Pin**
23. **Spring**
24. **Inner face seal**
25. **Outer face seal**
26. **Valve housing**
27. **Plug**
28. **Bolt**
29. **Nameplate**
30. **Rivet**

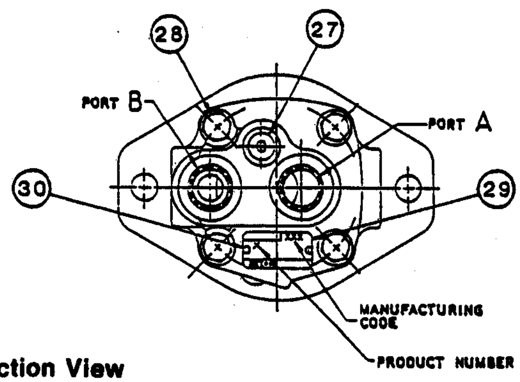


Figure 3. Winch Motor – Cross Section View

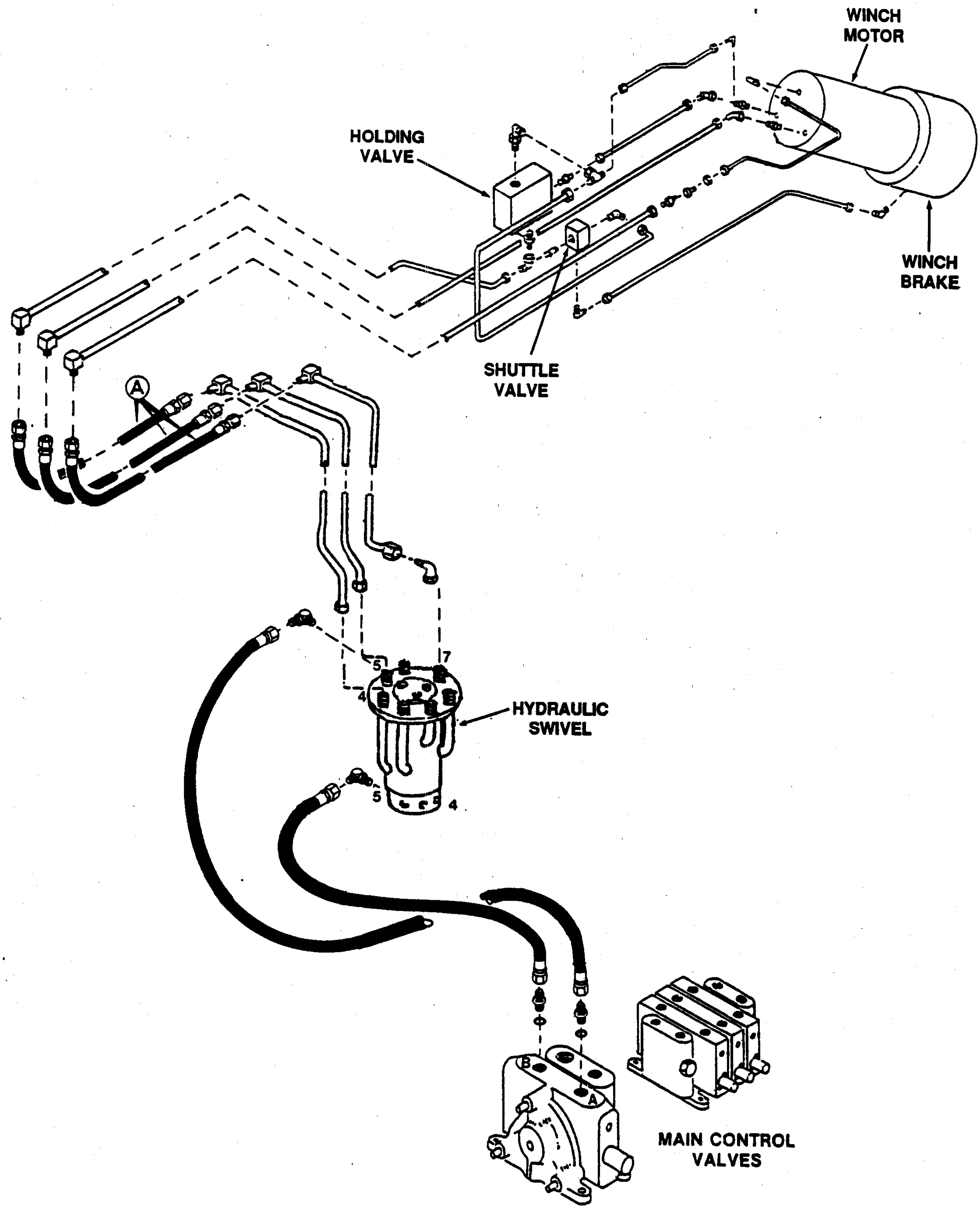
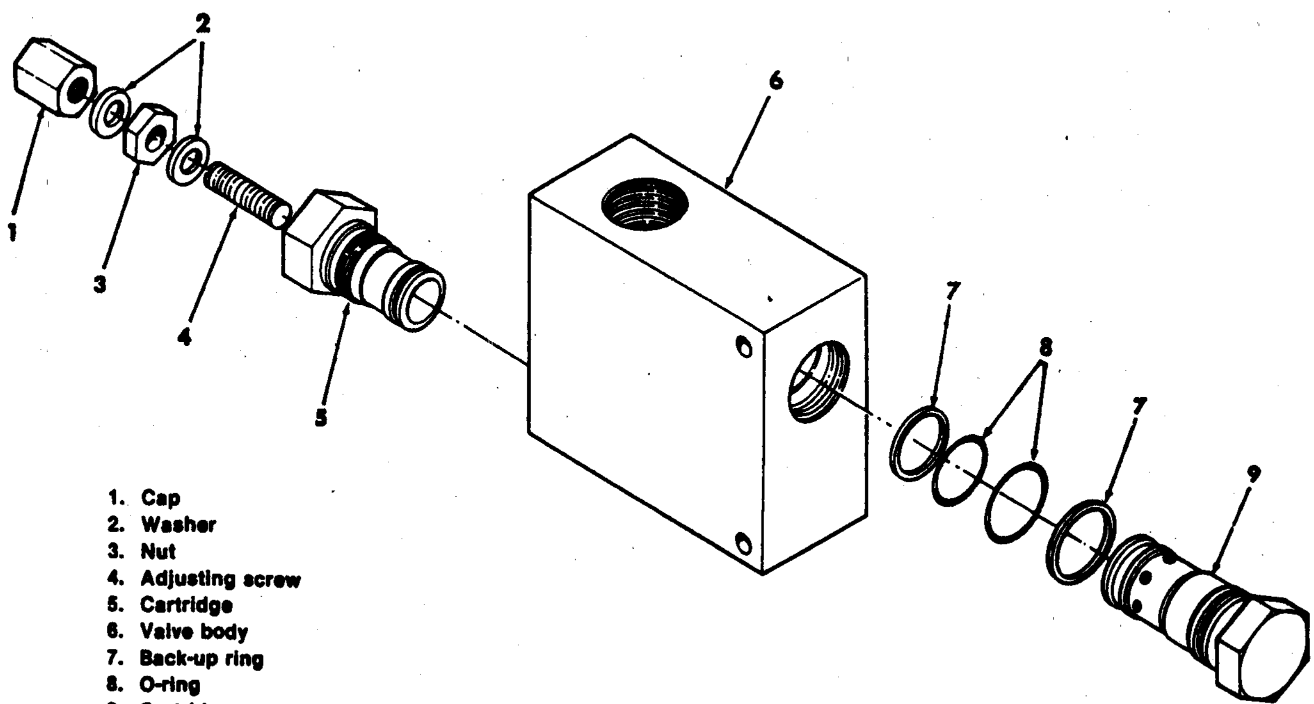


Figure 5. Hydraulic Lines - Main Winch and Brake Installation

SERVICING THE HOLDING VALVE

Normally, a malfunction of the valve will be caused by internal leakage or restriction in the valve. Leakage can be caused by a bad o-ring or a part with damage.

The valve parts can be easily disassembled for cleaning and inspection (See Illustration). Make careful inspection of the valve parts to find the cause of the malfunction. Replace any parts that have damage. Make sure the parts are clean and dry. Apply clean hydraulic oil to the parts before assembly.



1. Cap
2. Washer
3. Nut
4. Adjusting screw
5. Cartridge
6. Valve body
7. Back-up ring
8. O-ring
9. Cartridge

Figure 4. Holding Valve

SERVICING THE WINCH MOTOR

Removal

1. With engine stopped, move winch control lever in both directions to release the hydraulic pressure from the winch circuit.

2. Disconnect the hydraulic lines from the winch motor and holding valve. Put caps or plugs on the lines to keep dirt out of the system.

3. Remove two mounting bolts from the winch motor. Remove the winch motor.

Installation

1. Install the key in the key slot on the output shaft.

2. Install the winch motor on the winch brake.

3. Connect the hydraulic hoses to the winch motor.

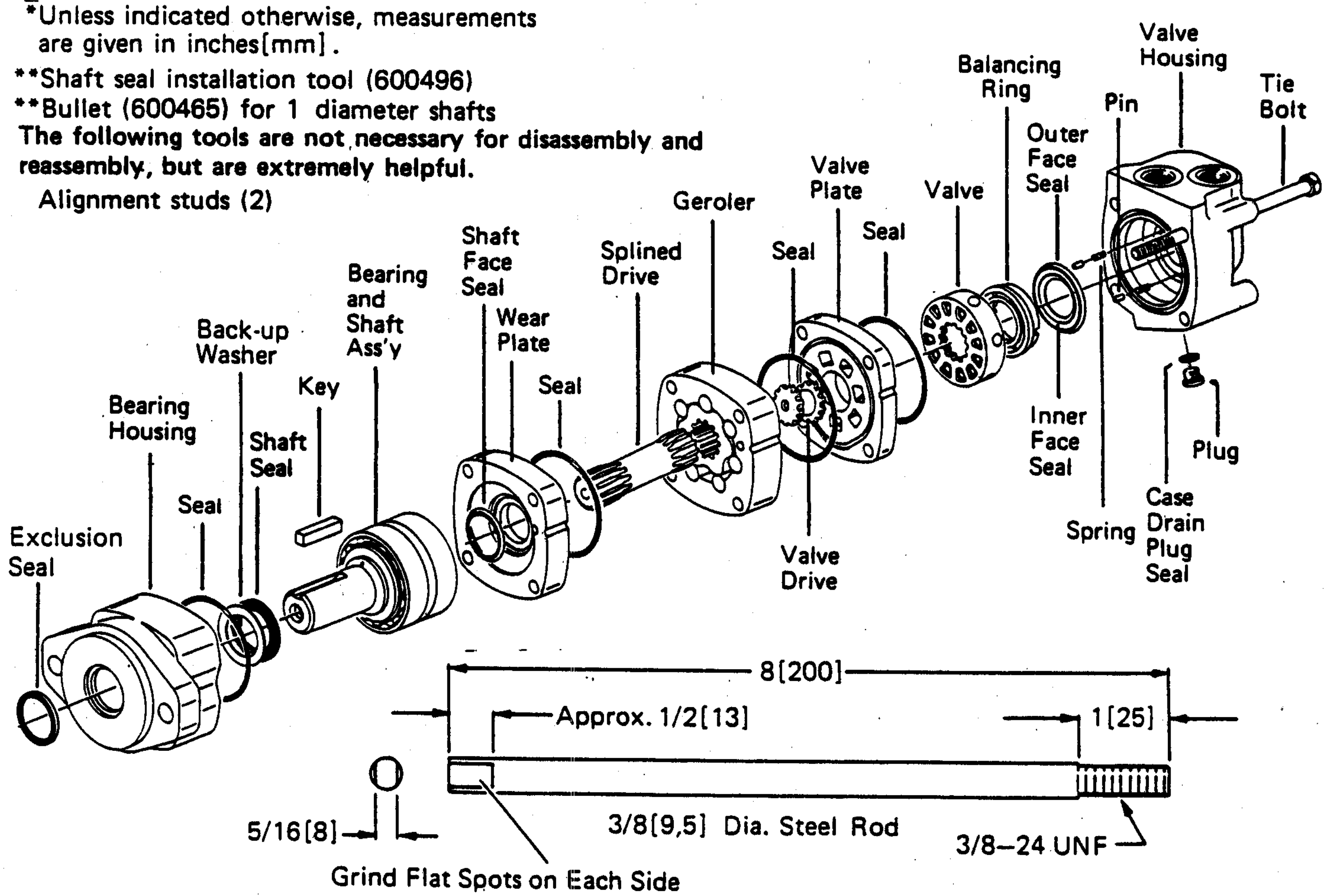
Winch Motor Service Information

Tools required for disassembly and reassembly.

Torque wrench 500 lb-in[57Nm] capacity
12-16[300-450]* breaker bar
9/16 socket
Small screwdriver 6-8x1/4[150-200x6,5] blade
3/16 allen wrench
Press
*Unless indicated otherwise, measurements are given in inches[mm].
**Shaft seal installation tool (600496)
**Bullet (600465) for 1 diameter shafts

The following tools are not necessary for disassembly and reassembly, but are extremely helpful.

Alignment studs (2)



**Available--by special order

Figure 5.

Disassembly

Cleanliness is extremely important when repairing a hydraulic motor. Work in a clean area. Before disconnecting the lines, clean the port area of the motor thoroughly. Use a wire brush to remove foreign material and debris from around the exterior joints of the motor. Check the shaft and keyslot, remove all nicks, burrs or sharp edges that might damage the bearing housing seals when installing the shaft and bearing assembly. Before starting the disassembly procedures, drain the oil from inside the motor.

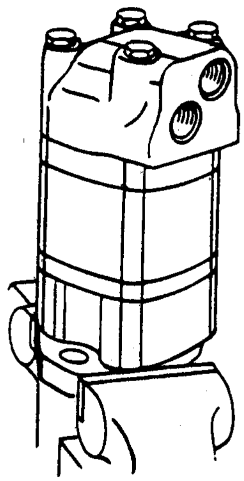


Figure 6.

1 Place the motor in a vise with the output shaft down. Clamp across the mounting flange of the motor not the housing. Excessive clamping pressure will cause distortion. When clamping, use some protective device on the vise, such as special soft jaws, pieces of hard rubber or board.

> Although not all drawings show the motor in a vise, we recommend that you keep the motor in the vise during disassembly and reassembly. Follow the clamping procedures explained throughout the manual.

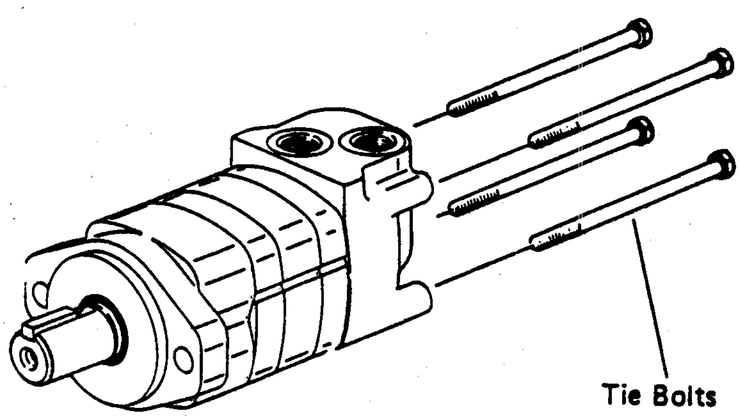


Figure 7.

2 Remove 4 bolts from motor.

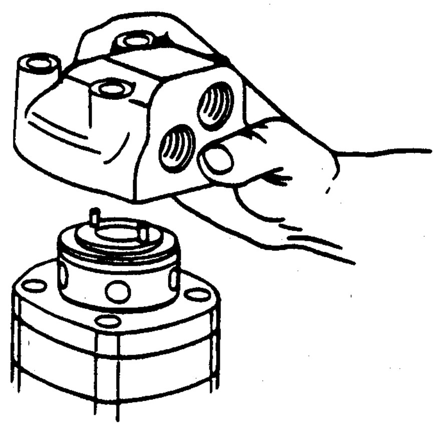


Figure 8.

3 Lift valve housing straight up. If done carefully the pins, springs, balance ring assembly, and valve will remain on the valve plate.

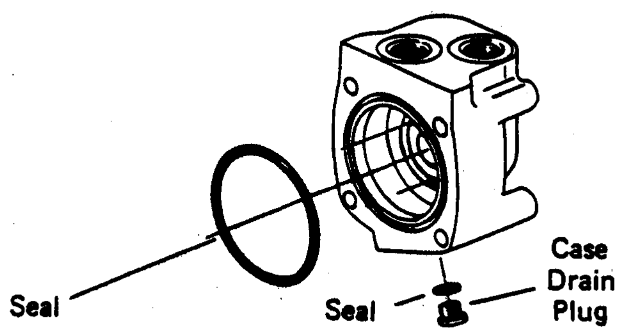


Figure 9.

4 Carefully remove 3[76] diameter seal from valve housing.

5 Remove case drain plug—with seal, from valve housing.

6 Remove 2 pins and 2 springs from balance ring assembly, see Fig. 10.

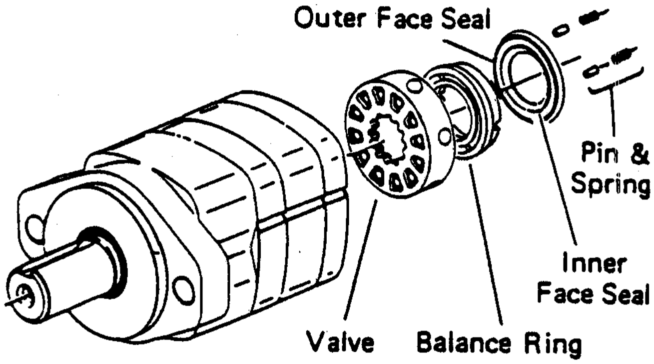


Figure 10.

7 Remove balance ring assembly.

8 Remove inner and outer face seals from balance ring.

9 Remove the valve.

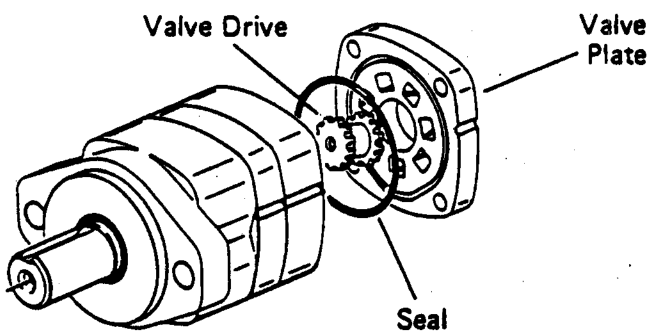


Figure 11.

10 Remove the valve plate.

11 Remove the 3[76] diameter seal from valve plate.

12 Remove the valve drive.

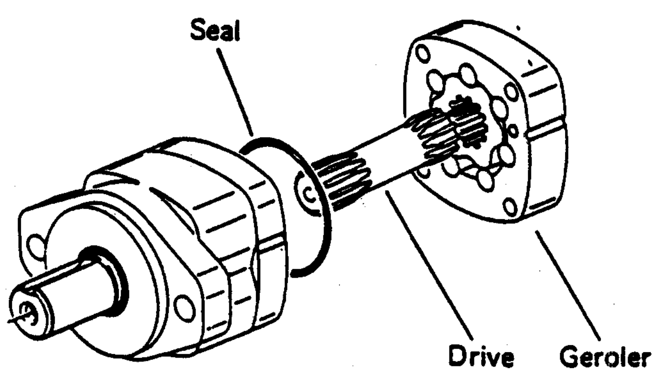


Figure 12.

13 Remove the Geroler. Be sure to retain the rollers in the outer ring if they are loose.

14 Remove the drive.

15 Remove the 3[76] diameter seal from wear plate, see Fig. 12.

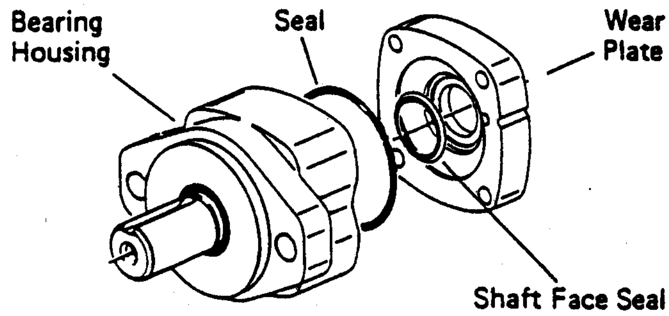


Figure 13.

16 Remove the wear plate.

17 Remove the shaft face seal from the wear plate.

18 Remove the 3[76] diameter seal from bearing housing.

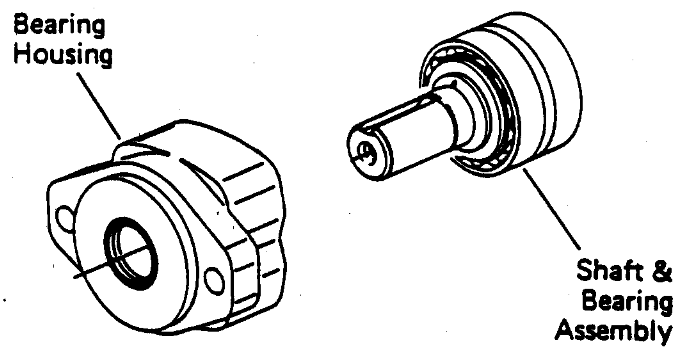


Figure 14.

19 You may need a press to remove shaft and bearing assembly from bearing housing. (Key must be removed before removing shaft.)

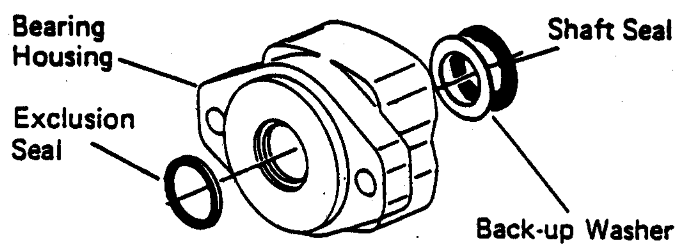


Figure 15.

20 Use a small screwdriver to remove shaft seal, back-up washer and exclusion seal from bearing housing, see Fig. 15. Do not damage bore of housing.

Note: Individual parts of shaft and bearing assembly are not sold separately. Replace as a unit.

Check all mating surfaces. Replace any parts that have scratches or burrs that could cause leakage. Clean all metal parts in clean solvent. Blow dry with air. Do not wipe dry with cloth or paper towel because lint or other matter can get in the hydraulic system and cause damage. Do not use a coarse grit or try to file or grind these parts. Check around the keyway and chamfered area of the shaft for burrs, nicks or sharp edges that can damage the seals when reassembling the bearing housing.

Note: Lubricate all seals (prior to installation) with petroleum jelly such as Vaseline. Use new seals when reassembling this motor. Refer to parts list (6-129) for proper seal kit number.

21 Use a press to install exclusion seal in outer bore of bearing housing. Lip of seal must face outward. See Fig. 16.. If a press is not available use a plastic or rubber hammer, being careful not to damage or cock seal in the bore.

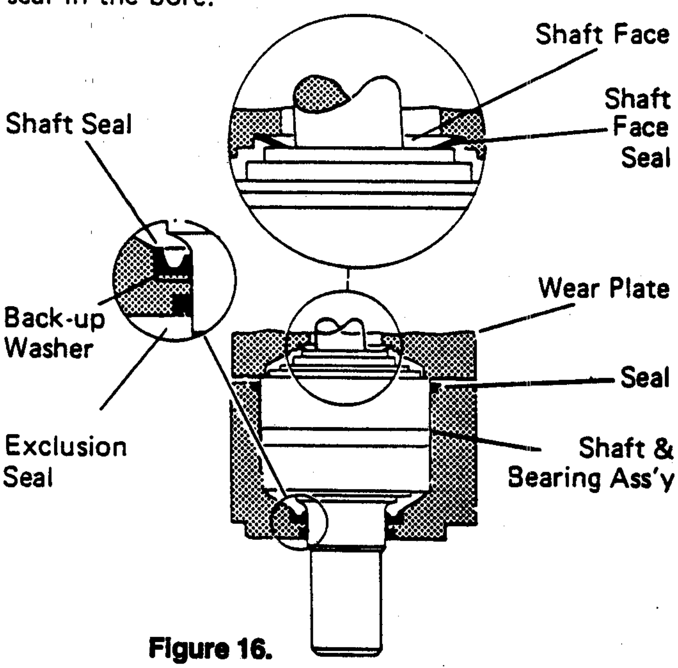


Figure 16.

22 Place back-up washer into seal bore. Place shaft seal onto installation tool (600496) and press seal into seal bore of the housing.

23 Clamp housing in vise, see Fig. 6.

24 Place protective bullet (see note below) over shaft. Apply petroleum jelly to inside diameter of dust and shaft seal. You may need a press to install shaft and bearing assembly. Do not distort shaft seal. Damage to this seal will cause leakage.

Note: Bullet (600465), for 1" shafts, available-- by special order. Use tape over other shafts to prevent cutting the seals.

25 Apply petroleum jelly to the 3[76] diameter seal. Install seal into the bearing housing.

26 Alignment studs can be very helpful in reassembly of the motor. See special tool listing page 2. If you use studs, install 2 studs diagonally opposed in the bearing housing.

27 Install the shaft face seal in the wear plate as shown in Fig. 16. Do not distort seal.

28 Install the wear plate, see Fig. 16.

29 Apply a light film of petroleum jelly to the 3[76] diameter seal and install seal in the wear plate.

30 Install the drive into the output shaft.

31 Align the notch on the outside of the Geroler with the notch on the wear plate. Install the Geroler against the wear plate. Be sure to retain the rollers in the outer ring if they are loose.

32 Install the valve drive in the Geroler.

Note: Installation at this time involves 3 steps in the timing of the motor. Timing determines the direction of rotation of the output shaft. Timing parts include:

1. Geroler
2. Valve Drive
3. Valve Plate
4. Valve

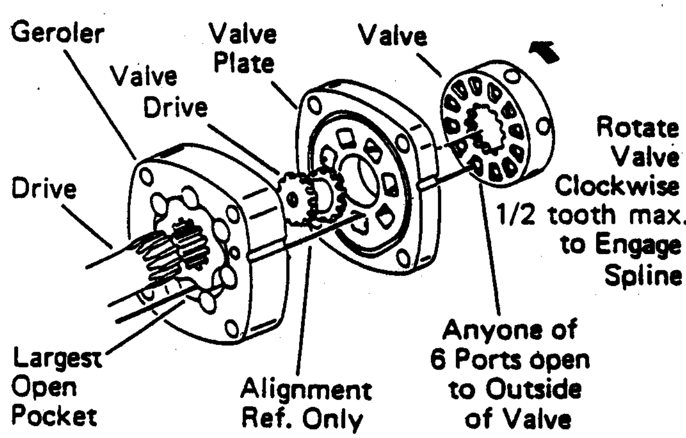


Figure 17. Timing Alignment

Timing Step # 1—Locate the largest open pocket in the Geroler and mark it on the outside edge of the Geroler.

33 Apply a light film of petroleum jelly to the 3[76] diameter seal. Install seal in groove of valve plate.

34 Align the notch on the outside of the valve plate with the notch on the Geroler as shown in Fig. 17.

Timing Step #2– Locate the slot opening in the valve plate which is in line with the largest open pocket of the Geroler.
Timing Step #3– Locate any one of the side openings of the valve and align this opening with the open slot of the valve plate that is in line with the largest open pocket of the Geroler. Install the valve by rotating it clockwise until the spline teeth engage (1/2 spline tooth max.). This will provide the proper rotation when pressurized as shown in Fig. 18.

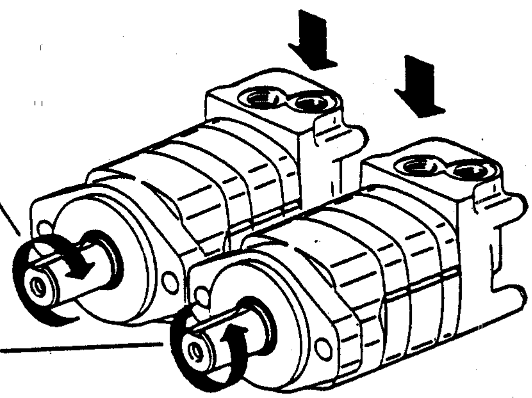


Figure 18.

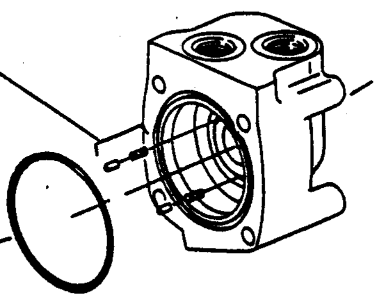


Figure 19.

35 Install 2 springs and 2 pins in the holes located in the bore of the valve housing, as shown in Fig. 19

36 Apply a light film of petroleum jelly to the 3[76] diameter seal. Install seal in the valve housing.

37 Apply petroleum jelly to inner and outer face seals. Install seals on balance ring as shown in Fig. 20.

Important: Install face seals in the positions shown in Fig. 20. or the motor will not operate properly. Do not force or bend the face seals. Any damage to these seals will affect the operation of the motor.

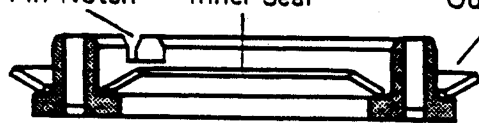


Figure 20.

38 Align pin notches in balance ring with pins in bore of valve housing. Install balance ring assembly in valve housing.

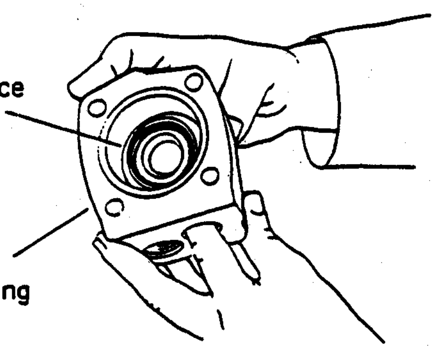


Figure 21.

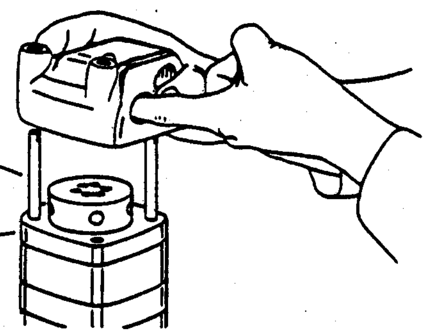


Figure 22.

39 Insert your finger through port of valve housing. Apply pressure to side of balance ring as shown in Fig. 21. Hold ring in position until valve housing is in place against valve plate. See Fig. 22

Note: After installing the valve housing on the valve plate check for proper placement. Push down on the valve housing. You should get a slight spring action.

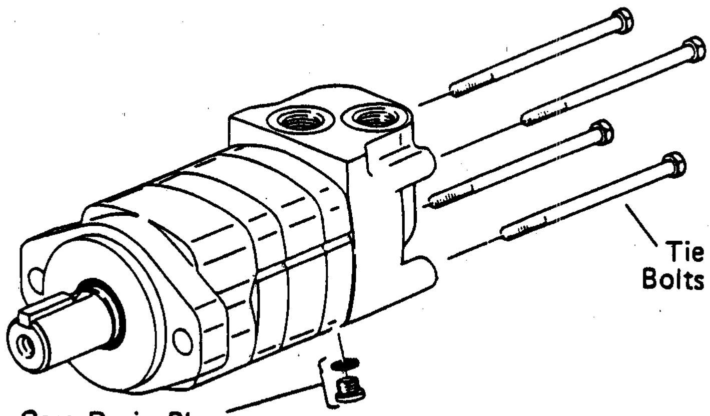


Figure 23

40 Install the tie bolts. If you use alignment studs, install 2 bolts opposite the studs. Finger tighten the bolts. Remove the alignment studs and replace with the 2 remaining bolts. Torque all 4 bolts alternately to 450 lb-in[50Nm].

41 Install seal on case drain plug then install in valve housing. Torque to 50 lb-in[6Nm].

Wheel Motor

On wheel motors, a different bearing housing is used, see Fig. 24. Other than this the parts are the same as the standard motor and the same disassembly and reassembly procedures apply.

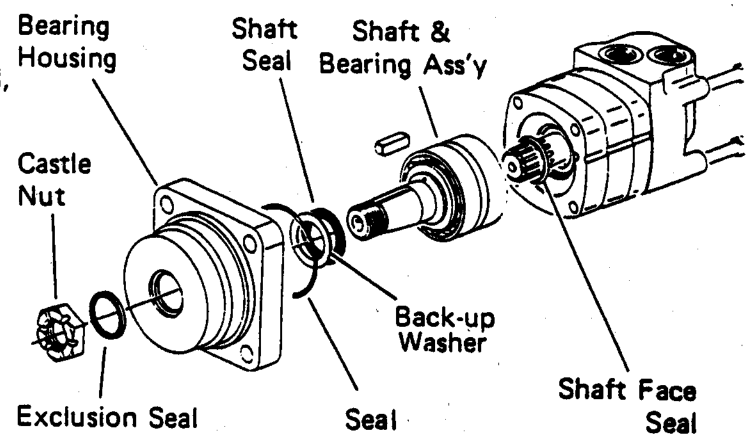


Figure 24.

Bearingless Motor

This motor is the same as the standard motor without the shaft/bearing assembly, and bearing housing. The mounting flange replaces the bearina housing, see Fig. 25. Follow same disassembly and reassembly procedures as rear section of standard motor.

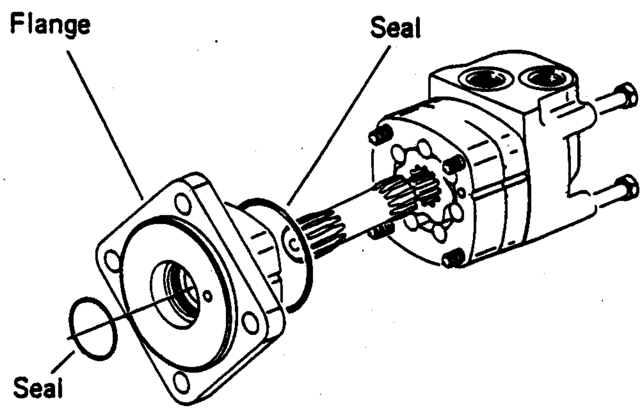


Figure 25.

SERVICING THE WINCH FAILSAFE BRAKE

BRAKE FUNCTION

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

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

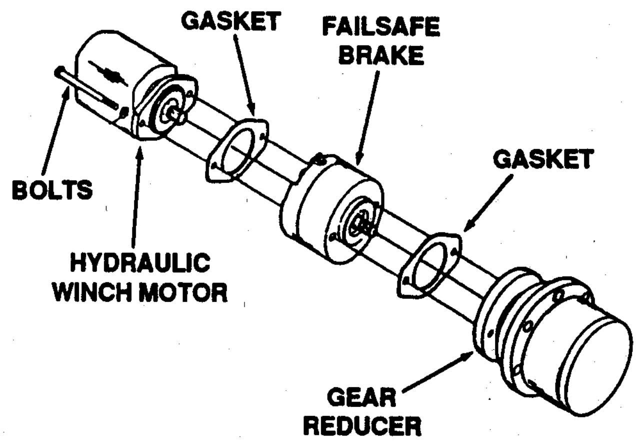


Figure 26. Installation of Motor, Brake Gear Reducer

INSTALLATION INSTRUCTIONS

See Figure 26.

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

BRAKE DISASSEMBLY PROCEDURE

See Figure 27.

1. With shaft protrusion downward, disassemble in the following order:
2. Bolts (21) alternately, Power Plate (20), Gasket (2), Bearing (18) is pressed onto Shaft (7) and must be removed before removal of Rotating Disc (11) and Stationary Discs (12).
3. Further disassembly is not recommended and should not be attempted unless necessary for the replacement of specific parts, i.e. , Bearing (3), Seal (4) and Shaft (7) from Housing (1), if necessary proceed as follows:

   A) Remove shaft and stack sub-assembly from housing by lightly or pressing on the small external spline end of the shaft and removing the shaft, bearings and stack from the Housing (1).

B) Remove Bearing (18), Stationary Disc (12), Rotating Disc (11), Springs (10) and Primary Disc (9).

C) Remove Bearing (3) from shaft. Use care not to damage the Seal (4). Remove Seal (4) and inspect sealing lip and O.D. for damage. If damaged, replace per reassembly instructions.

D) Remove Springs (6) and Spring Retainer (5) from Housing (1).

4. Remove the Piston (13) from the Power Plate (20) by introducing **low** pressure air - 15 psi - into the hydraulic inlet. Make sure piston is directed away from the operator. Remove O-rings (15 & 17), and Back-up Rings (14 & 16) from the piston O.D. and I.D. grooves. Back-up Rings will be damaged and should not be removed if replacement is not planned.

5. Pressure Relief Valve (22) can be removed and inspected to assure spring-loaded ball moves freely and is free of contamination.

1. Houshing
2. Gasket
3. Ball bearing
4. Oil seal
5. Spring retainer
6. Compression spring
7. Splined shaft
8. Torque pin
9. Primary disc
10. Compression spring
11. Rotating disc
12. Stationary disc
13. Piston
14. Back-up ring
15. O-ring
16. Back-up ring
17. O-ring
18. Ball bearing
19. Bleeder screw
20. Power plate
21. Hex flanged screw
22. Pressure relief valve
23. Protective plug
24. Gasket

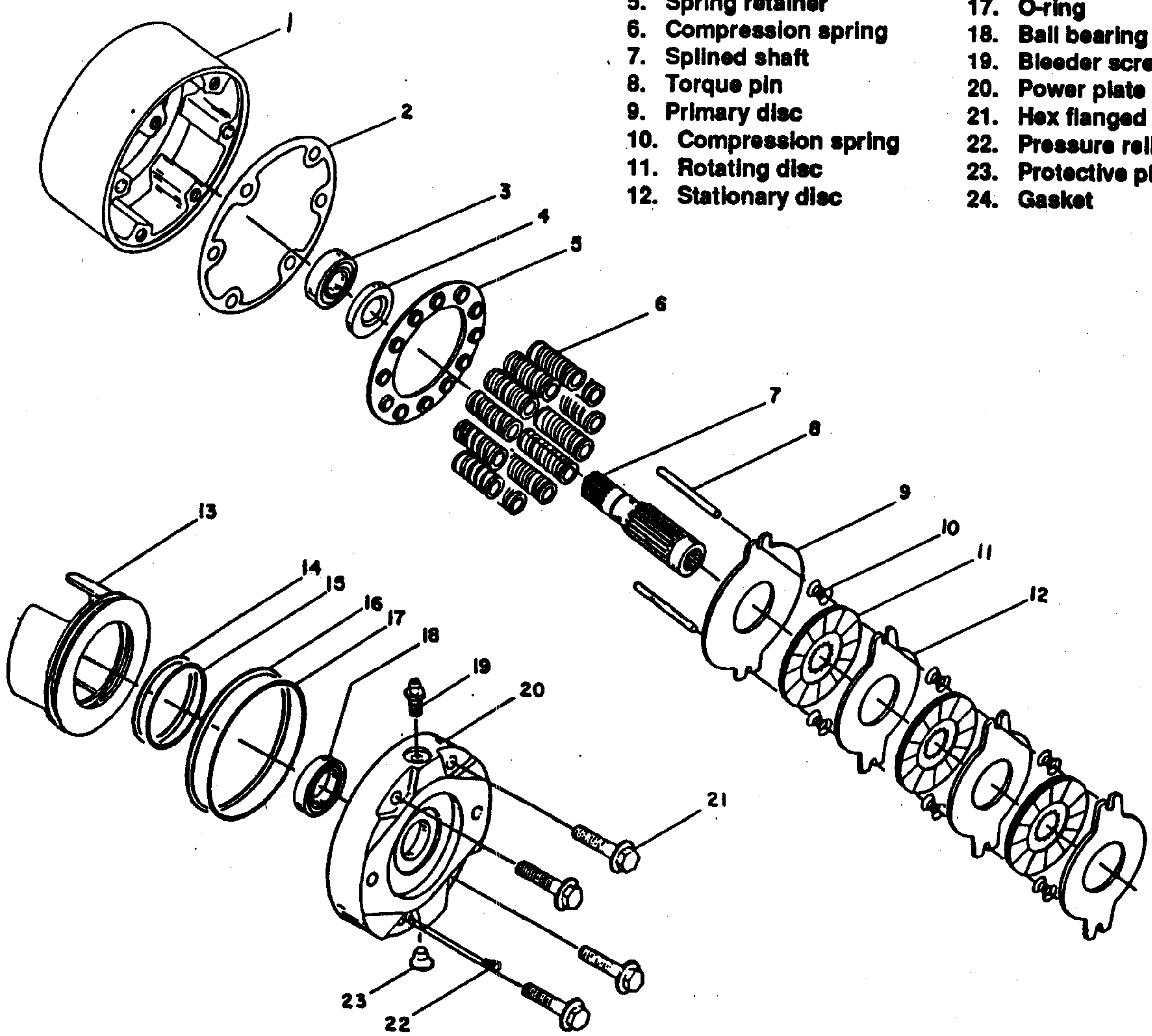


Figure 27. Failsafe Brake Assembly

BRAKE RE-ASSEMBLY PROCEDURE

1. All parts must be thoroughly clean prior to re-assembly.

2. **IMPORTANT:** There may be more parts in a service kit than your brake requires. Check parts list carefully for the exact quantity. In the case of springs, space the required quantity equally. See Figure 27.

3. Generally use the reverse of the disassembly procedure to re-assemble the brake.

4. Cylinder of the power plate, piston and O-ring must be clean prior to assembly, and pre-lubed with system hydraulic fluid.

5. Assemble Piston (13) into Power Plate (20) using a shop press, being careful not to damage the O-rings or the Teflon backup rings. Visually align the center of the cutouts in Piston (13) with Torque Pin (8) holes in Power Plate (20). Avoid pushing the piston all the way to the bottom of the cylinder in the power plate. Generally, try to keep the top surface of the piston flush to 1/8" below the machined surface of the power plate.

6. When pressing the bearing onto the shaft, press on the inner race of the bearing and support the shaft properly.

7. Rotating discs must be clean and dry. There should be no pressence of oil on any lining material or mating surfaces of the stationary discs. Worn or heavily scored rotating discs must be replaced.

8. Press Bearing (3) into Housing (1). Bearing must be seated against shoulder in housing.

9. Before installing Seal (4), lubricate the lip of the seal with system hydraulic fluid or other suitable lubricant. Use a shop press to install Seal (4). Face the lip of the seal toward the outside of the brake in order to keep the gear box oil or other external contaminants out of the brake.

10. Install Seal (4) into housing by pressing evenly around O.D. of the seal. Use care to avoid cocking. The back of the seal must be installed flush to surface of housing. See Figure 28.

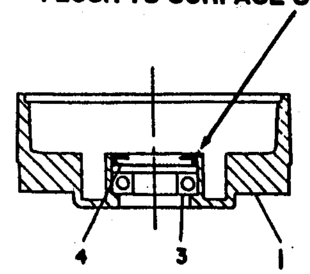


Figure 28. Installation of Seal In Housing

11. Install Shaft (7) into housing. Support the inner race of Bearing (3) when pressing shaft into bearing.

12. Install Gasket (2). Be sure to properly align. After installing all the remaining internal components of the brake, install Bearing (18). Properly support the shaft when pressing the bearing onto shaft.

13. Install the power plate sub-assembly. Use a shop press to evenly lower plate into position. There should be no gap at the O.D. when the power plate is properly seated against housing. If a shop press is not available, use the Assembly Bolts (21). Tighten sequentially one turn at a time until the power plate is properly seated. Torque to 50-60 lb-ft.

14. If replacement of Pressure Relief Valve (22) is necessary, install 1/2 to 3/4 turns beyond finger tight.

SERVICE KITS

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

O-ring Kit - Consists of items 2,14,15,16,17
Stack Kit - Consists of Items 6,8,9,10,11,12
Bearing Kit - Consists of Items 3,4,18
Gasket Kit - Consists of Item 24

Section 8218

HYDRAULIC SWIVEL

HYDRAULIC SWIVEL

General

The hydraulic swivel is at the center of rotation of the mast. The purpose of the hydraulic swivel is to permit the flow of hydraulic oil between the hydraulic components on the mast and boom and the components on the lower structure during a full rotation of the mast.

The hydraulic swivel has seven passages. Grooves and ports in the shaft align with ports in the housing. Seals between the grooves of the shaft prevent leakage between the passages. The seals fit tightly against the housing. The housing rotates with the mast. The shaft is stationary.

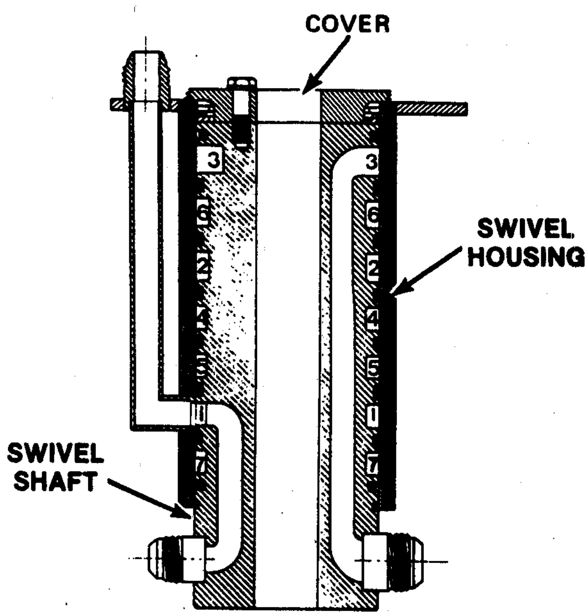


Figure 1. Cross Section of the Hydraulic Swivel

Functions

The number of each port is on the upper flange of the housing.

Port Number 1.

Hydraulic oil under high pressure flows through this port when the boom is being lowered. When raising the boom, hydraulic oil under low pressure flows through this port.

Port Number 2.

Hydraulic oil under high pressure flows through this port when the boom is being extended. When retracting the boom, hydraulic oil under low pressure flows through this port.

Port Number 3.

Hydraulic oil under high pressure flows through this port when the boom is being retracted. When extending the boom, the hydraulic oil is under low pressure.

Port Number 4.

Hydraulic oil under high pressure flows through this port when the winch is being raised. When the winch is being lowered, hydraulic oil under low pressure flows through this port.

Port Number 5.

Hydraulic oil under high pressure flows through this port when the winch is being lowered. When the winch is being raised, hydraulic oil under low pressure flows through this port.

Port Number 6.

Hydraulic oil under high pressure flows through this port when the boom is being raised. When lowering the boom, hydraulic oil under low pressure flows through this port.

Port Number 7.

Hydraulic oil under low pressure flows through this port from the winch motor drain.

Maintenance

Normally, the hydraulic swivel needs no maintenance except regular maintenance of the hydraulic oil in the system. Dirt or foreign material in the oil can cause damage to the seals or the chrome surface of the housing. Failure of the seals will cause internal leakage between the passages.

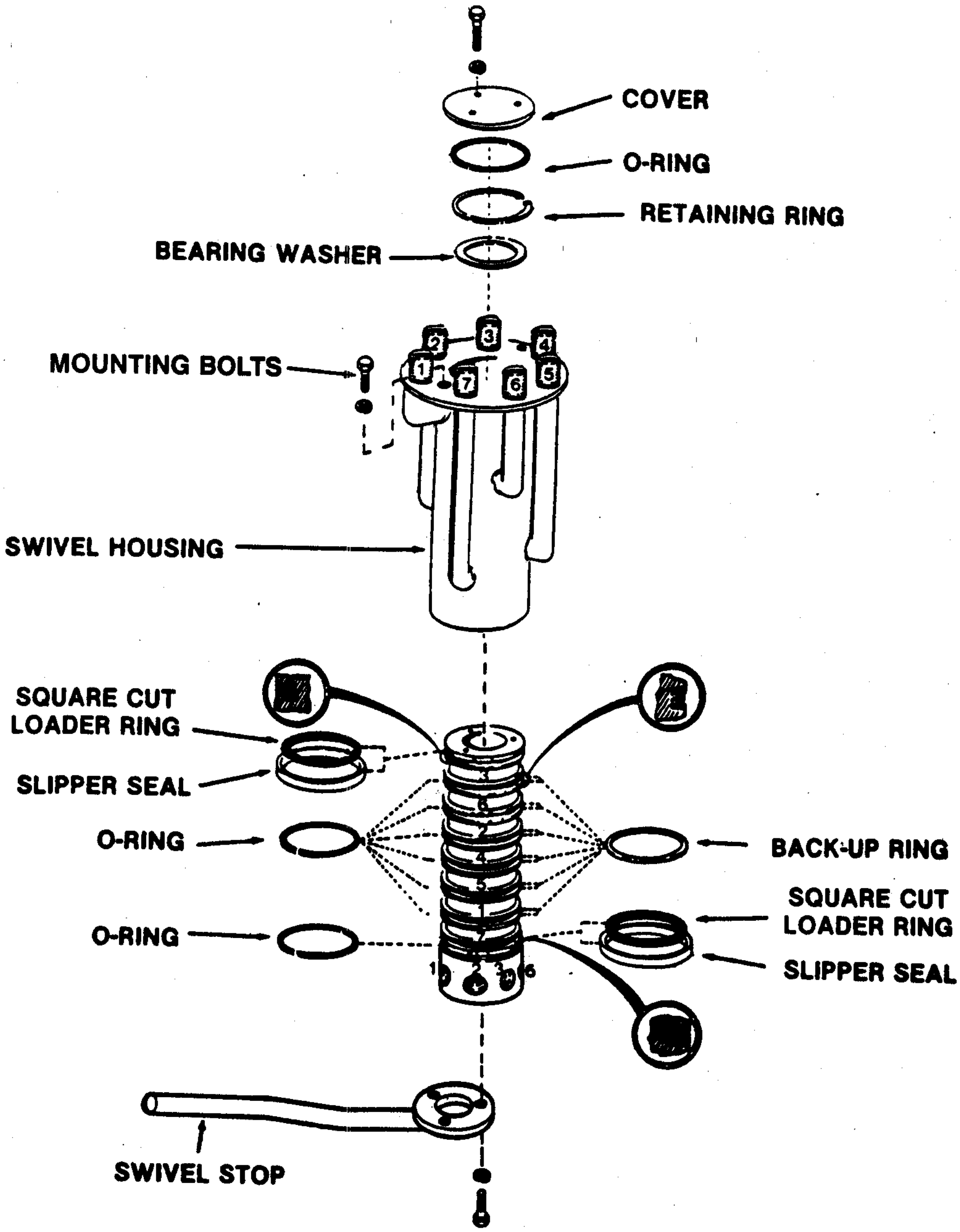


Figure 2. Hydraulic Swivel

Troubleshooting

Leakage between the passages of the hydraulic swivel will cause loss of power or possible wrong operation of one of the circuits. It is important to know the arrangement of the passages in the hydraulic swivel. Remember that the oil will always follow the path of least resistance.

SERVICING THE HYDRAULIC SWIVEL

NOTE: The area around the swivel and the swivel must be completely cleaned before removing the swivel from the machine.

Removal

1. Stop engine and move the controls in both directions to release pressure in hydraulic circuits.
2. Put tags on the hydraulic lines with the number of the hydraulic swivel port to which the hydraulic lines connect.
3. Disconnect the hydraulic tubes from the upper and lower swivel ports. Be prepared to collect the hydraulic oil in the lines. Put caps or plugs on the fittings and hydraulic lines.
4. Remove the stop from bottom of the swivel.
5. Put a support under the swivel. Remove the two brackets from top of swivel.
6. Remove the hydraulic swivel.

Disassembly

1. Remove three bolts and lock washers (1, 2) from the top cover. Remove the top cover (3) and the o-ring (4). Discard the o-ring (4).
2. Remove the retaining ring (5) and bearing washer (6) from the hydraulic swivel.
3. Carefully pull the swivel shaft from the swivel housing. If the swivel shaft can not be pulled from the swivel housing, hit the top of the swivel shaft with a soft hammer.
4. Remove and discard all o-rings, back-up rings and seals.

Inspection

Wash the housing and the shaft in a solvent that is not flammable.

Check the housing for damage. If there is scoring or deep grooves, the housing must be replaced.

Use compressed air to remove foreign material from the passages in the shaft. Check the shaft for rough edges that can cause damage to the seals during installation.

Install new seals, o-rings and back-up rings. A seal kit is available for repair of the hydraulic swivel. See Parts Catalog. The new seals must be installed dry.

Installation

IMPORTANT: The hard rubber, slipper seals (10 and 14) must be warm before installation. Heat the seals with a trouble lamp. Do not apply lubrication to the seals before installation.

1. Install one o-ring (12) in lowest groove on the shaft.
2. Install one square cut loader ring (9) in the next groove of the shaft, followed by the slipper seal (10) which has been heated.
3. Install two back-up rings (8) and one o-ring (13) in each of the next six grooves on the shaft. The o-ring must be between the two back-up rings. Use a soft tool to fit each o-ring over the top of the shaft and into position in the groove. Use care not to cause damage or distortion to the o-rings and back-up rings.
4. Install the other square cut loader ring (15) and heated slipper seal (14) in top groove on the shaft.

1. Bolt
2. Lock washer
3. Top cover
4. O-ring
5. Retainer ring
6. Bearing washer
7. Housing
8. Back-up washer (Teflon)
9. Loader ring (square cut)
10. Slipper seal
11. Shaft
12. O-ring
13. O-ring
14. Slipper seal
15. Loader ring (square cut)

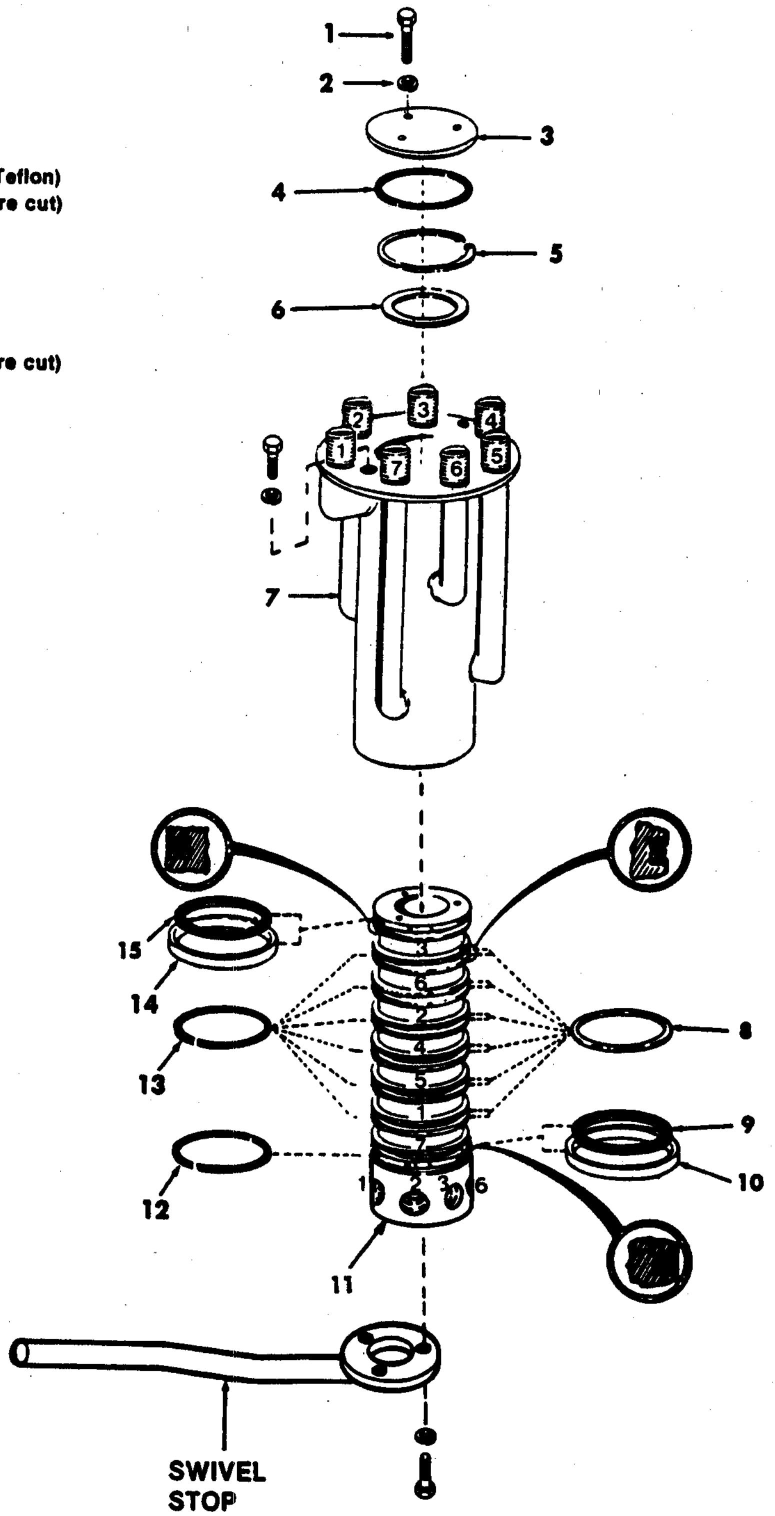


Figure 3. Hydraulic Swivel

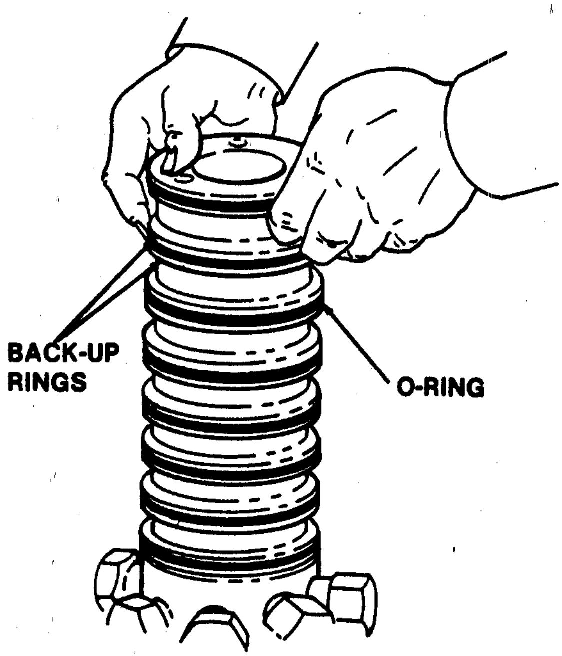


Figure 4. Installation of Rings and Seals

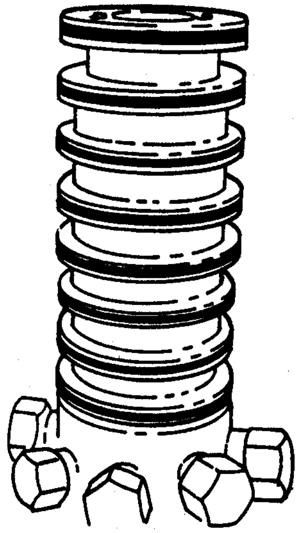


Figure 5. Shaft Complete with Seals

Assembly

1. Apply clean hydraulic oil to the outside of the shaft and inside of the housing.

2. CAREFULLY install the shaft into the housing. Make sure that the o-rings and seals are not cut during installation. Turn the shaft slowly by hand while you push the shaft into the housing.

3. Install the bearing washer (6) and snap ring (5). Then install the new o-ring (4) and top cover (3). Fasten top cover with three bolts and lock washers (1 and 2).

Test

Pressure test using oil at 100 S.S.U. while rotating the swivel. Test all ports at 3000 psi (20 685 kPa).

Installation

1. Put the hydraulic swivel in place on the machine. Fasten the hydraulic swivel to the two brackets on the mast.

2. Install the swivel stop to the bottom of the hydraulic swivel.

3. Connect the hydraulic lines to the lower ports of the hydraulic swivel.

4. Fill the lower hydraulic system by adding hydraulic oil through the upper ports of the hydraulic swivel.

5. Connect the hydraulic lines to the upper ports.

6. Start the machine to move the hydraulic oil through the hydraulic swivel.

NOTE: Do not rotate the mast until the oil has moved through the hydraulic swivel for several minutes.

Section 8290

HYDRAULIC CYLINDERS

SERVICING THE HYDRAULIC CYLINDERS

Removal

1. Put a support under the component to which the cylinder is fastened. Make sure the component can not fall after the cylinder is removed.

2. Stop the engine. Release the pressure in the cylinder circuit by moving the control back and forth several times.

3. Disconnect the hydraulic lines from the cylinder. Put caps on the hydraulic lines to keep dirt out of the system.

4. Connect a hoist to lift the weight of the cylinder. On the crowd cylinder, make sure the cylinder has support on both ends to prevent bending.

5. Remove cylinder mounting pins. Remove cylinder.

NOTE: For instructions on removal and repair of the crowd cylinder, see page 8290-11.

Disassembly

The following procedure gives general instructions for repair of the hydraulic cylinders. See illustrations for relation of the component parts.

1. Put the ports of the cylinder down and drain the oil from the cylinder.

2. Fasten the base of the cylinder in a vise with soft jaws. Put a support under the rod so the cylinder is level.

3. Use a spanner wrench to loosen and remove the head gland. Slide the head gland forward on the rod.

4. Pull the rod and piston straight out of the cylinder tube. If necessary, air or hydraulic pressure can be applied to the base port of the cylinder to push the piston and rod out of the cylinder tube.

5. The piston is fastened to the rod either by internal threads or with a bolt or locking nut. To remove the piston:

   a. Fasten the eye of the rod in a vise with soft jaws. Put a support under the opposite end of the rod so the rod is held in a level position. Use care not to cause damage to the chrome surface of the rod.

   b. On pistons which have internal threads, remove the set screw or clevis pin. Use a spanner wrench to loosen and remove the piston.

   c. On pistons which are fastened with a bolt or locking nut, use a socket and an extension to loosen.

6. Remove and discard the o-rings, back-up rings, wear rings, rod wiper and seals.

Inspection

Wash the parts in a solvent that is not flammable. Use compressed air to remove all residue.

Check the bore of the cylinder tube for damage or distortion. Move the piston through the full length of the cylinder and check the clearance between the piston and the bore of the cylinder. If there is damage or distortion, replace the cylinder tube.

Look for damage to the chrome surface of the rod. The rod must be smooth and straight. A bent rod indicates possible loss of strength in the rod and replacement is necessary. If the chrome surface has damage, completely remove the old chrome and apply new chrome .001 inch (.03 mm) thick.

Remove any rough edges on the piston to prevent damage to new rings during installation.

Assembly

1. Install new rings, rod wiper and seals on head gland. See illustrations for location and correct installation.

2. Apply hydraulic oil to the rod and slide the assembled head gland on the rod.

3. Assemble the rings and seals on the piston.

4. Fasten the piston to the rod and tighten to specified torque. See illustrations. On pistons with internal threads, install the set screw or clevis pin and cotter pin.

5. Apply hydraulic oil to the bore of the cylinder and the rings on the piston. Carefully slide the piston and rod into the cylinder. Keep the rod straight during installation. Use care not to cause damage to the piston rings when you install the piston through the threads in the bore of the cylinder tube.

6. Slide the head gland into the cylinder tube and tighten to specified torque. See illustrations. Install the locking screw or bolts.

Test

1. Fill cylinder with clean hydraulic oil. To test piston sealing rings, continue to push oil into rod end after cylinder has hit bottom. Test to 3500 psi (24 130 kPa) static, in both directions, Steps 2 through 5.

2. Move the cylinder rod through two complete strokes at 800 psi (5 510 kPa) to remove air from the cylinder. Look for external leaks. If the pressure difference between cylinder ports is more than 100 psi (689 kPa) during the second stroke, the cylinder assembly is not acceptable. Disassemble and inspect for foreign material or wrong assembly.

3. Wipe cylinder rod clean, then move the cylinder through four complete strokes at 800 psi (5 510 kPa), but do not permit cylinder to hit bottom on each retract stroke. After four strokes, extend cylinder rod just enough to see how much oil has collected during the first four strokes. Inspect the rod for indication of rod seal leakage. A thin layer of oil on the rod is normal.

4. Fully retract cylinder. Keep base port open. Apply 3500 psi (24 130 kPa) of pressure to rod port. Hold this pressure for a minimum of 10 seconds. Visually check for internal and external leakage. No internal or external leakage is permitted.

5. Fully extend cylinder. Keep rod port open. Apply 3500 psi (24 130 kPa) of pressure to base port and hold for minimum of 10 seconds. Visually check for internal and external leakage. No internal or external leakage is permitted.

6. Put plugs in cylinder ports to keep out dirt during installation.

Installation

1. Install cylinder on machine using the correct mounting hardware.

2. Connect hoses and tubes.

3. Lubricate cylinder grease fittings with moly-disulfide grease.

4. Check hydraulic oil level and add Case TCH Fluid as required.

5. Start the engine and operate the cylinder(s) through several complete cycles to remove air. Check for leaks. Operate cylinders slowly and do not let the cylinders hit bottom until movement is positive in both directions. After the circuit is filled with oil, the cylinders can be operated normally.

NOTE: If the cylinder(s) does not move in correct direction when the control lever is actuated, check for wrong hose connections.

1. Grease Fitting (2)
2. Bushing (4)
3. Holding Valve
4. Back-up Ring
5. O-Ring
6. Rod
7. O-Ring
8. Piston
9. Seal
10. Wear Ring
11. Nut
12. Head
13. Seal
14. Wiper
15. Barrel

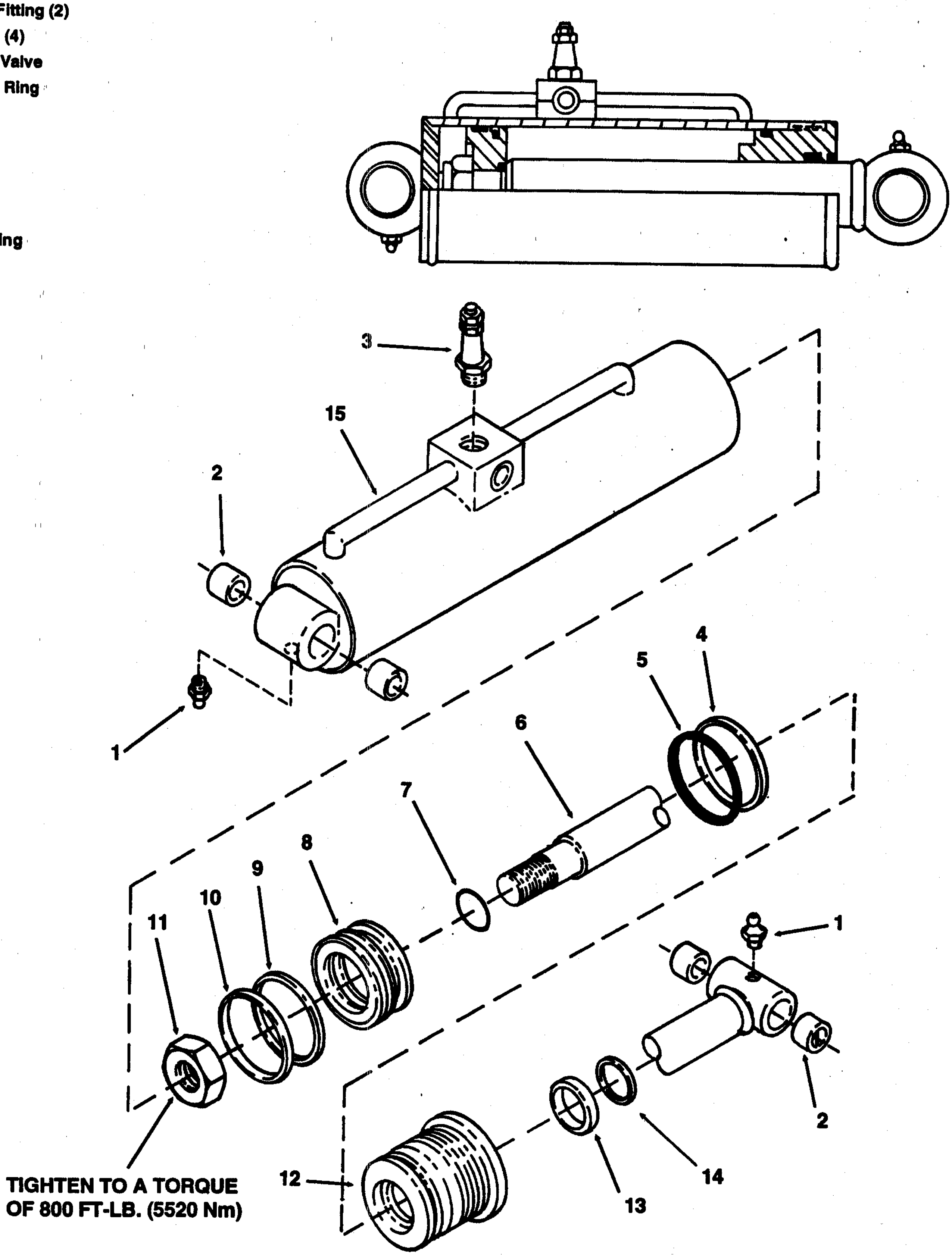


Figure 1. Hoist Cylinder

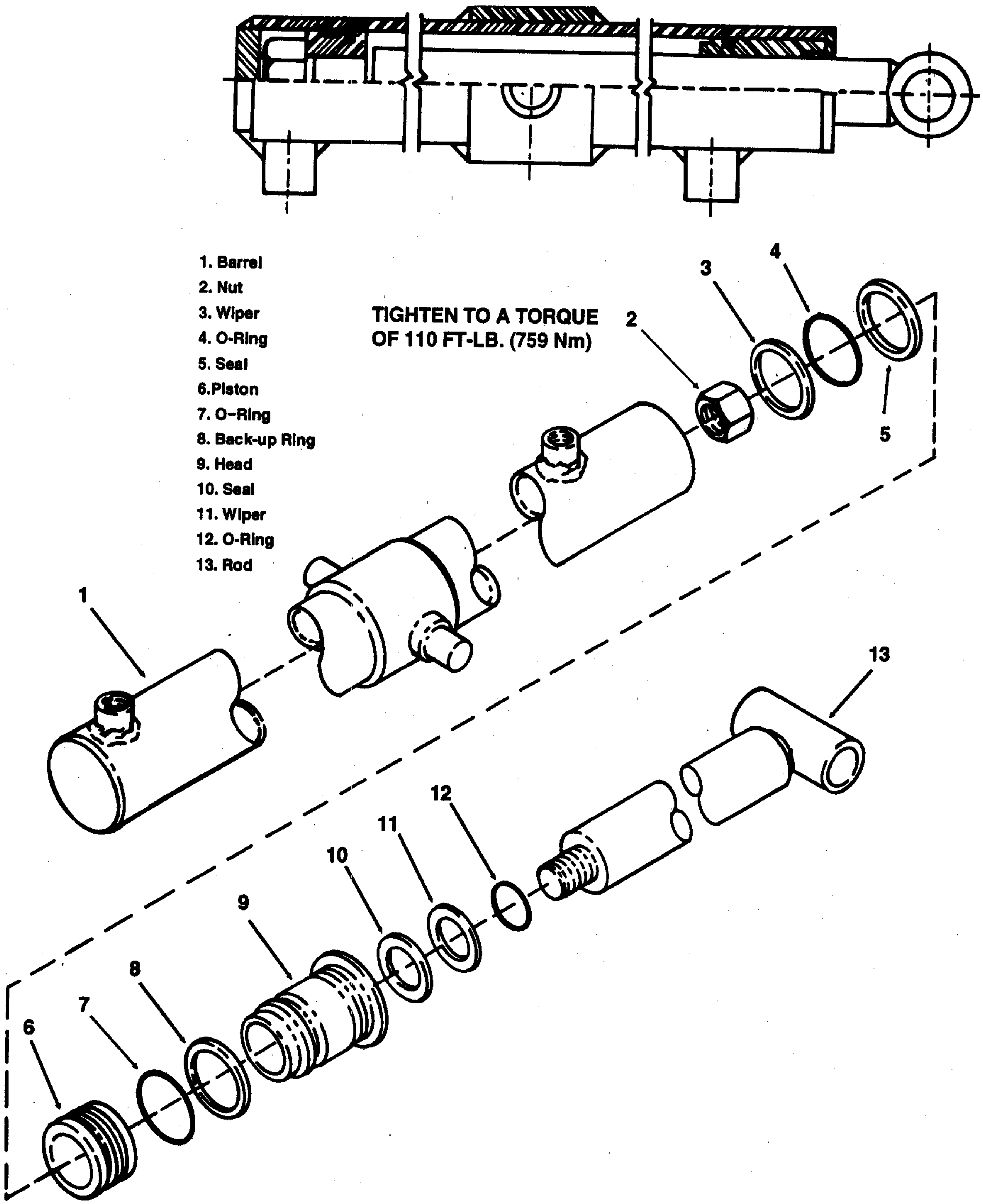


Figure 2. Outrigger Horizontal Cylinder

1. Rod Assemly
2. Wiper Seal
3. Seal
4. Head
5. Back-up Ring
6. O-Ring
7. O-Ring
8. Barrel
9. Nut
10. Back-up Ring
11. O-Ring
12. Wear Ring(2)
13. Piston
14. Plug
15. Plug

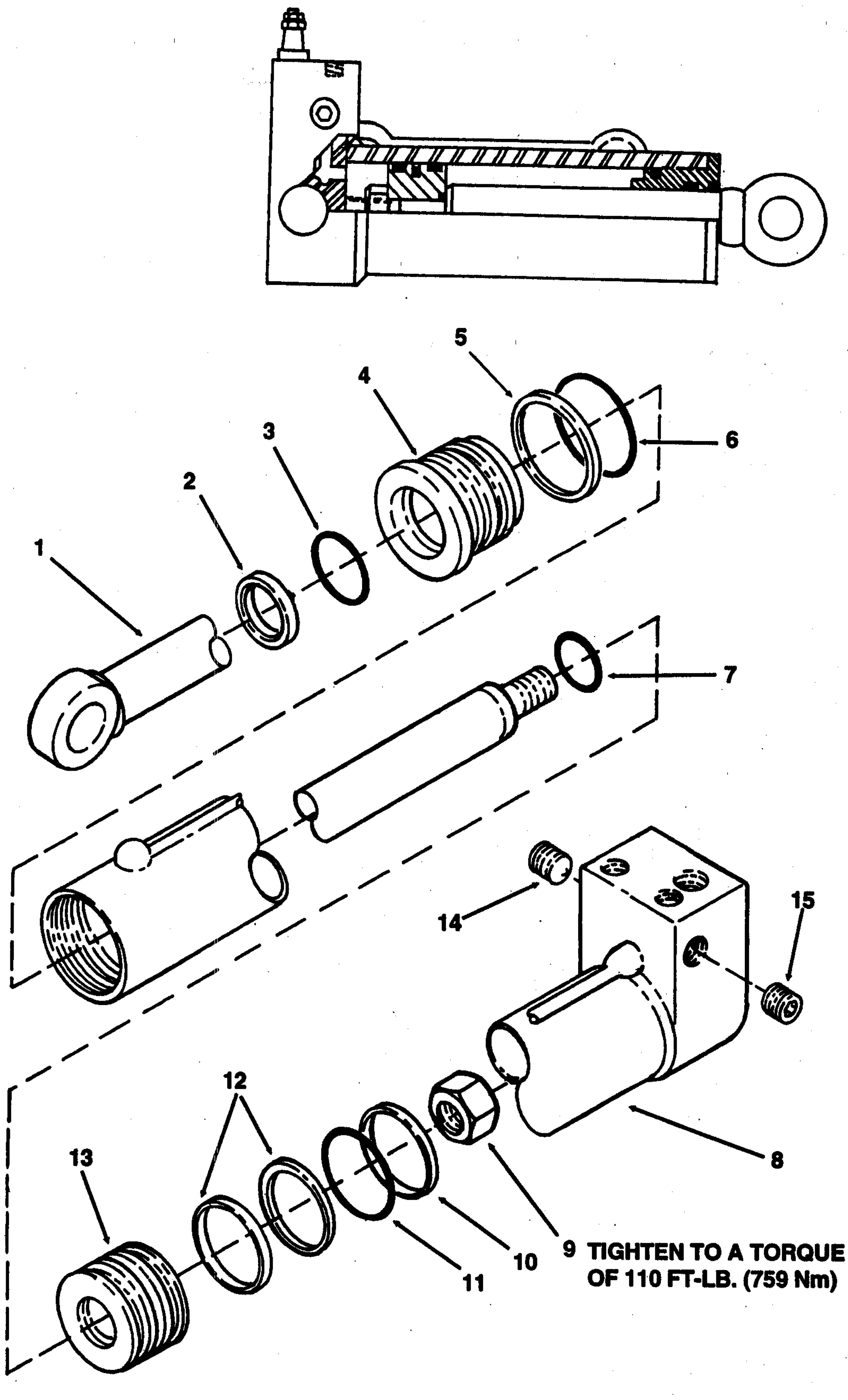


Figure 3. Outrigger Jack Cylinder

1. Holding valve
2. Cylinder tube
3. Wear ring
4. Seal
5. O-ring
6. Intermediate tube
7. Back-up ring
8. O-ring
9. Cylinder head
10. O-ring
11. Screw (Qty. of 2)
12. Spacer
13. Wiper ring
14. Seal
15. Cylinder head
16. O-ring
17. Screw
18. Piston
19. Wear ring
20. O-ring
21. Seal
22. Bearing guide
23. Retaining ring
24. Rod seal
25. Wiper ring
26. Piston rod

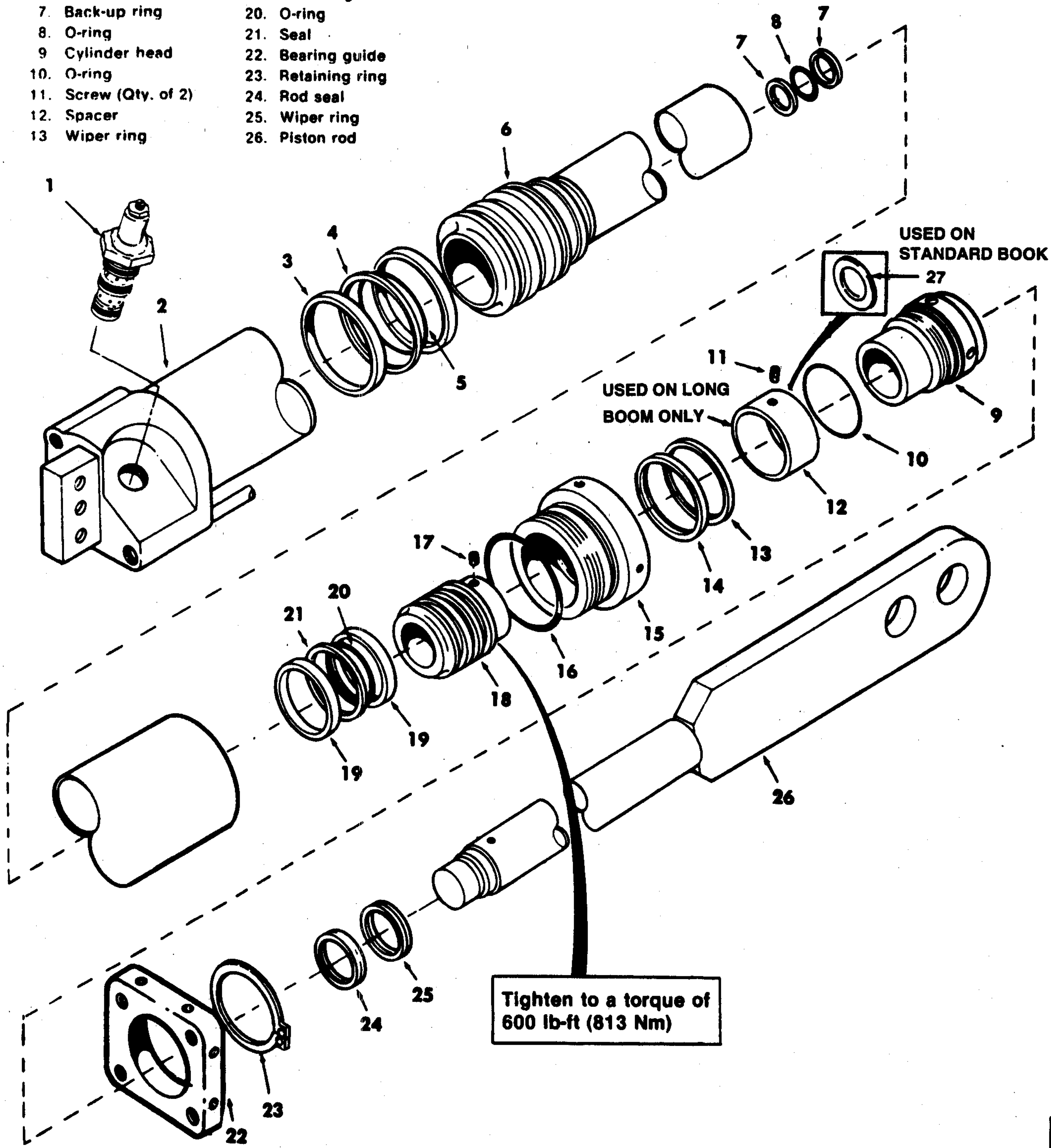


Figure 4. Crowd Cylinder

CROWD CYLINDER

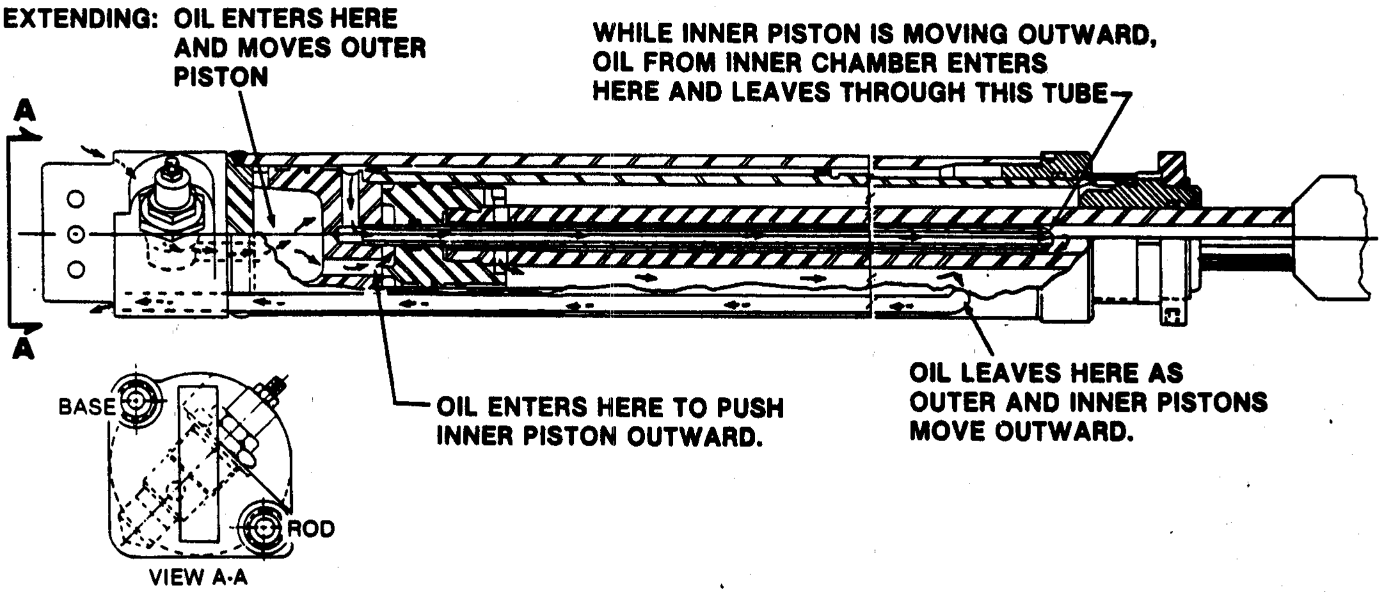


Figure 3. Cross Section of Crowd Cylinder
Shows Oil Flow Through Cylinder in a Direction to Extend the Cylinder

General

The crowd cylinder is telescopic and includes an inner and outer cylinder. The intermediate tube is both the rod for the outer cylinder and the cylinder tube for the inner cylinder.

Removal

See Disassembly of Boom, Section 9211.

Disassembly

1. Leave retaining ring and bearing guide on inner cylinder head unless replacement is necessary.

2. With a spanner wrench, loosen and remove the head from the outer cylinder.

3. Pull inner cylinder assembly straight out of cylinder tube. Apply shop air to base port if necessary to help in removing the inner cylinder.

4. Loosen and remove head of inner cylinder. Use a spanner wrench. It will be necessary to hold the outer cylinder piston with a pipe wrench in the area that is not machined.

IMPORTANT: Use care not to cause damage to machined surfaces.

5. Pull inner cylinder rod from intermediate tube.

6. Loosen piston set screw and remove piston from inner cylinder rod.

7. Replace all o-rings, back-up rings, wear rings, wipers and seals.

Inspection

See Inspection, page 8290-2.

Assembly

1. Make sure all parts are clean and dry.

2. Install rod wiper and seal in head of inner cylinder. See cross section views for correct installation. Install o-ring carefully over threads and into position against flange on head. Use care that the o-ring is not rolled or cut.

3. Lubricate and install inner head assembly on cylinder rod.

4. Install wear rings and seal on outer diameter of the inner cylinder piston. Install o-ring between two back-up rings in bore of piston.

5. Install piston assembly on inner cylinder rod. Tighten to a torque of 600 lb-ft (813 Nm). Install piston set screw.

6. Install rod wiper and seal in bore of outer cylinder head. See illustration for correct installation. Install o-ring on outside of head. Use care that the o-ring is not rolled or cut. Lubricate and install the head assembly on the intermediate tube. Slide spacer on intermediate tube. Do not tighten the set screw at this time.

7. Lubricate piston seals, guide tube and bore of intermediate tube with clean hydraulic oil. Slide inner piston and rod assembly straight into intermediate tube.

8. Tighten inner cylinder head until flange on head is in contact with lip of intermediate tube. Continue to tighten the head by hitting the spanner wrench with a soft hammer until all turning movement stops.

9. Install wear rings and piston loading seal on outer cylinder piston.

10. Slide the external spacer into position tight against inner cylinder head and tighten the set screw until secure.

11. Lubricate piston seals and bore of outer cylinder tube. Slide intermediate tube and inner cylinder assembly into outer cylinder tube.

12. Tighten outer cylinder head until contact is made between head flange and lip of cylinder tube. Continue to tighten by hitting the spanner wrench with a soft hammer until all turning movement stops.

13. Fill and test cylinder per instructions on page 8290-3.

Section 9206

CONTROLS AND LINKAGES

CONTROL LINKAGES

General

The control cables have a teflon lining and do not normally need lubrication.

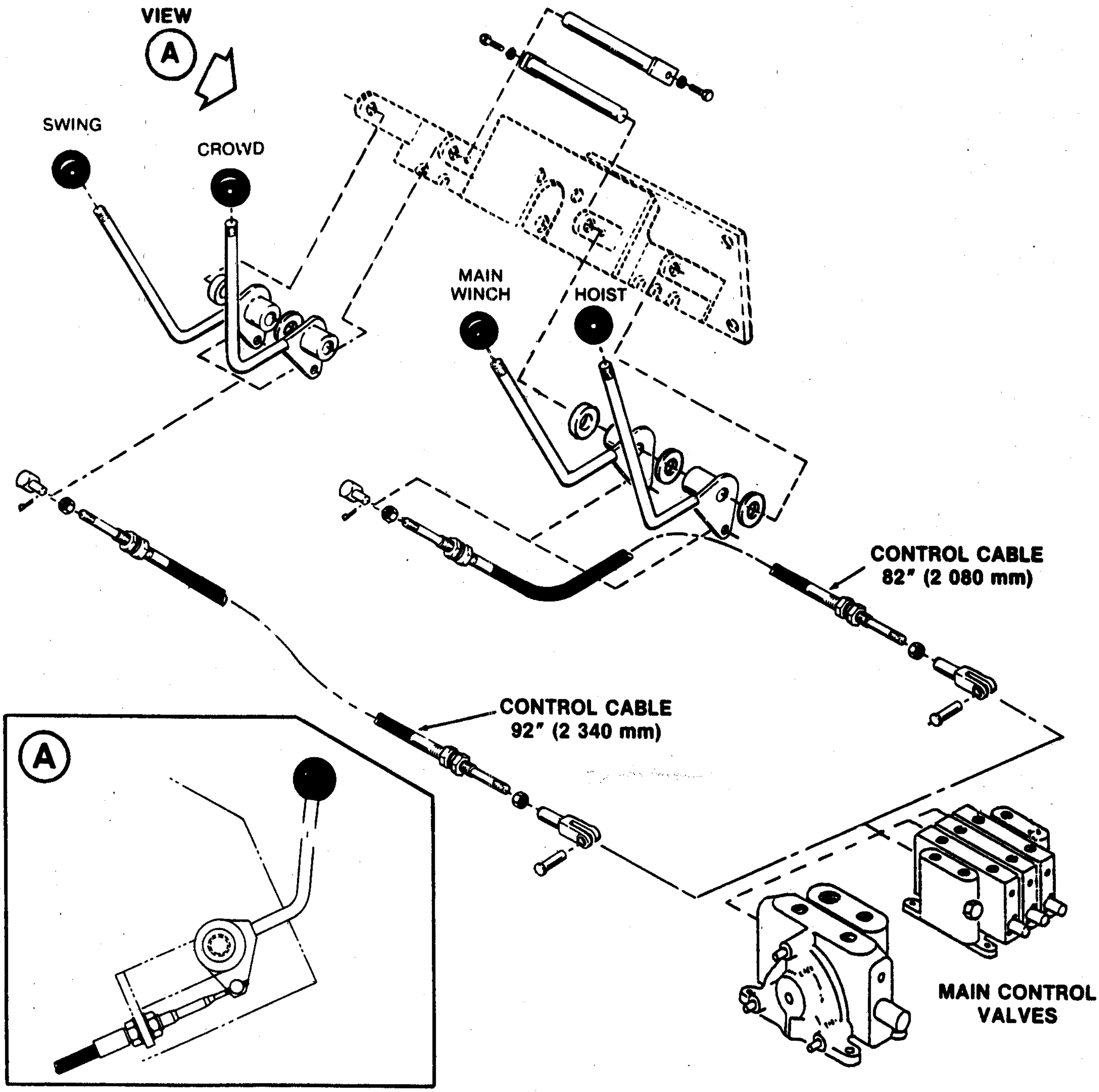


Figure 1. Control Linkages — Hydraulic Valves

Section 9209

OUTRIGGERS

SERVICING THE OUTRIGGERS

WARNING: To prevent injury or death, do not work under raised machine unless:

1. Main frame is on firm support or blocks in a manner to prevent machine from falling or tipping.
2. Engine is stopped.
3. Transmission is in Neutral.
4. Parking Brake is engaged and wheels stopped with blocks to prevent machine movements.
5. Key is removed to prevent accidental starting.
6. Another person is available to give assistance if needed.

Removal

1. Engage parking brake and put blocks under wheels to prevent machine movement.
2. Extend outrigger. Disconnect rod of beam cylinder from outrigger. Retract the beam cylinder.
3. Lower the outrigger jack just enough to remove load on the outrigger beam.
4. Stop engine. With key switch in ON position, actuate outrigger switches in both directions to release pressure in the hydraulic circuit. Turn key switch to OFF position.
5. Disconnect two hydraulic lines for the jack cylinder from bulkhead fittings, location "A", Figure 1. There is an access slot in the inner frame member.
6. Use a hoist to remove outrigger assembly from the machine.

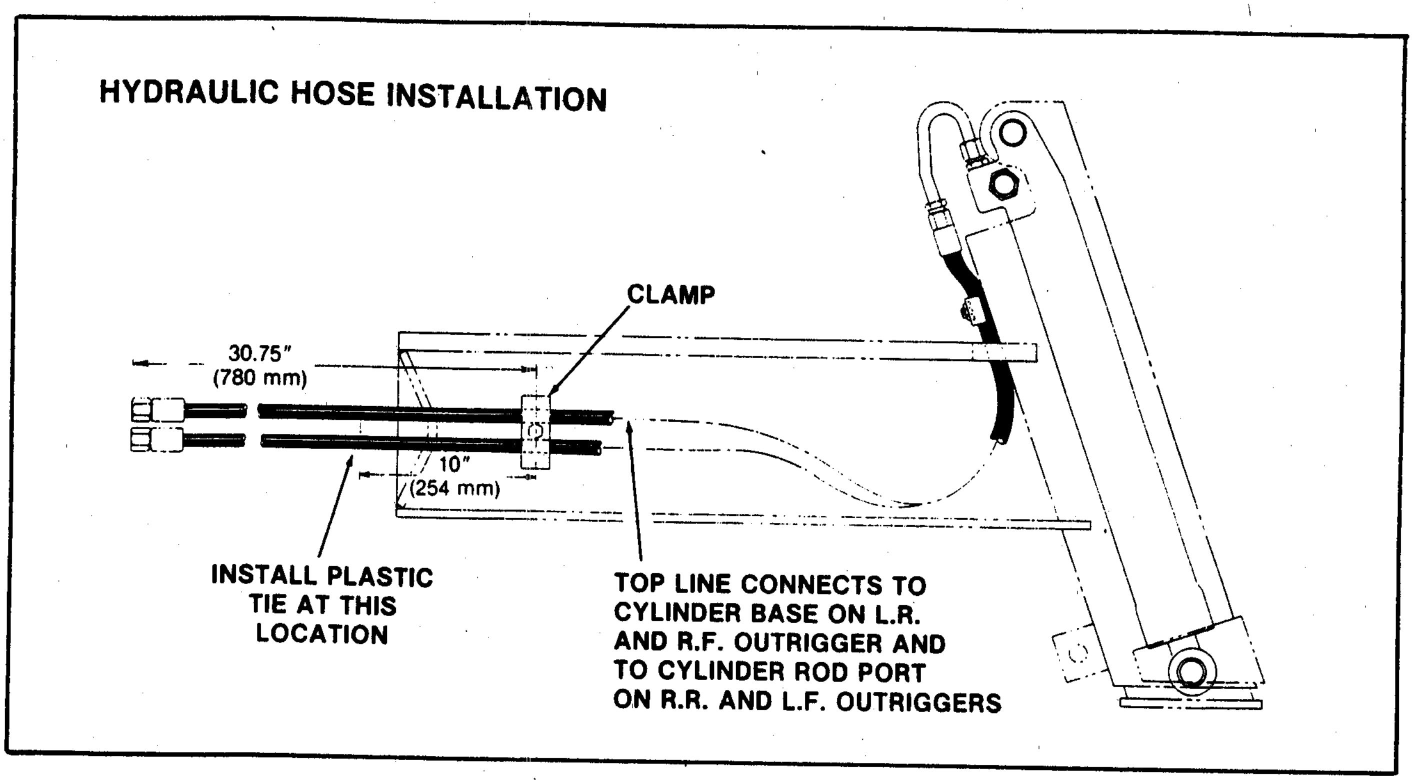
Disassembly

See Figure 2.

1. Remove retainer ring (4) from either side of mounting pin (5). Drive out the mounting pin.
2. Pull inner box (6) from outrigger assembly.
3. Disconnect hydraulic lines from cylinder ports.
4. Remove retainer ring (3) from either end of mounting pin (2) for the cylinder base. Hold the cylinder in position and drive out the mounting pin.
5. The hydraulic hoses are held in position inside the beam by a clamp. Loosen clamp mounting bolt and remove hoses.

Assembly

1. Completely clean the sliding beams and inner box. Use steam or a solvent that is not flammable. Also clean the slide contact surfaces on the main frame.
2. Install inner box over rod of jack cylinder. Align cylinder rod with mounting hole in inner box. Lubricate and install pin (5) and retainer ring (4).
3. Lubricate inside of outrigger box and outside of the inner box with STP Oil Treatment or equivalent.
4. Align and install the cylinder assembly into outrigger. Lubricate and install cylinder base pin and retainer ring (2, 3).
5. Install hydraulic lines and connect to cylinder ports. Tighten hose clamp to hold hoses in position inside the beam.
6. Route the hoses around the V-groove in end of sliding beam and along outside of beam. Use a rope to hold the hoses in this position for installation.
7. For identification of the hoses after assembly into the main frame, put a tag on the hose which connects to the cylinder base port.



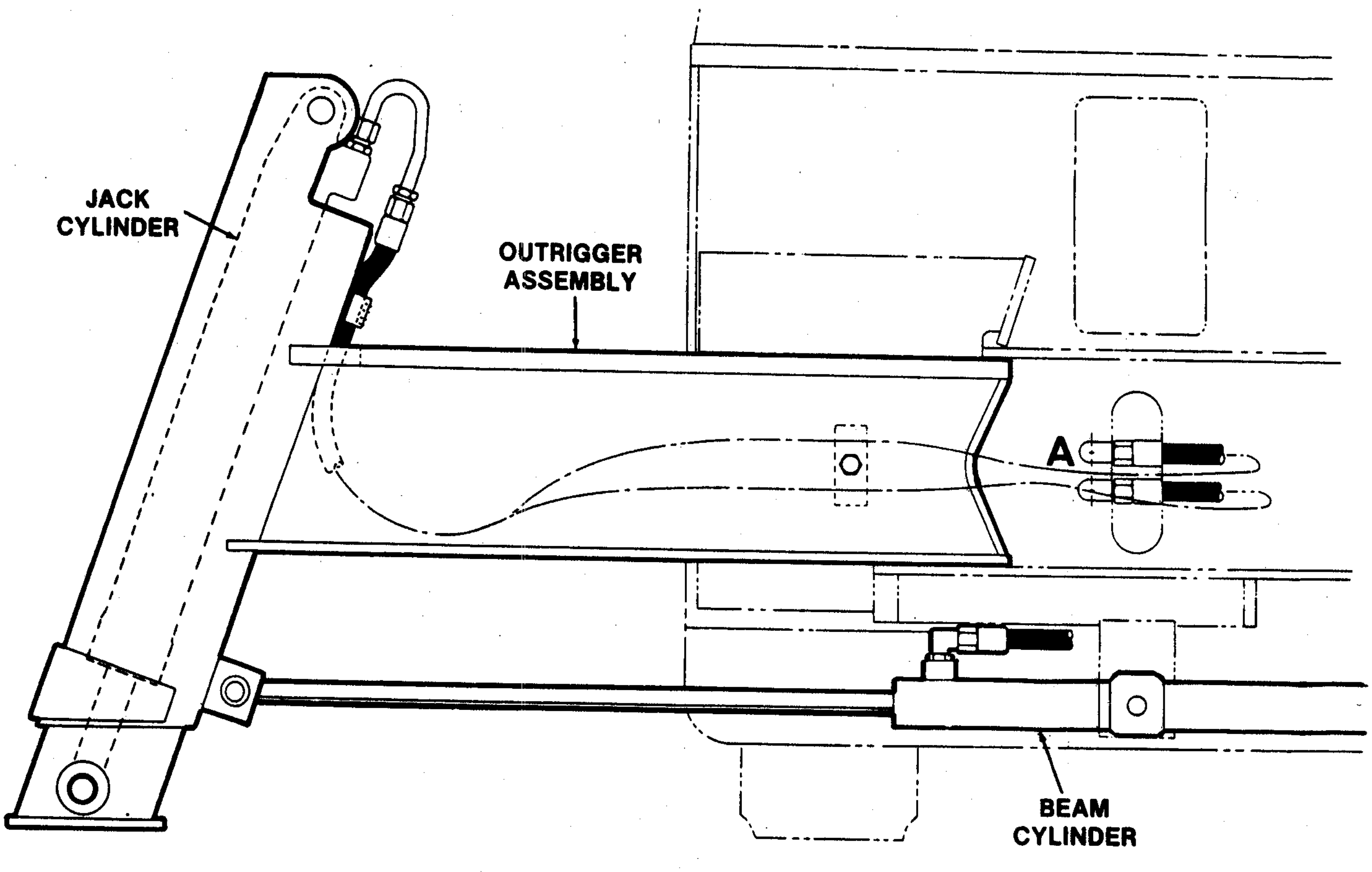


Figure 1. Outrigger Installation

Installation

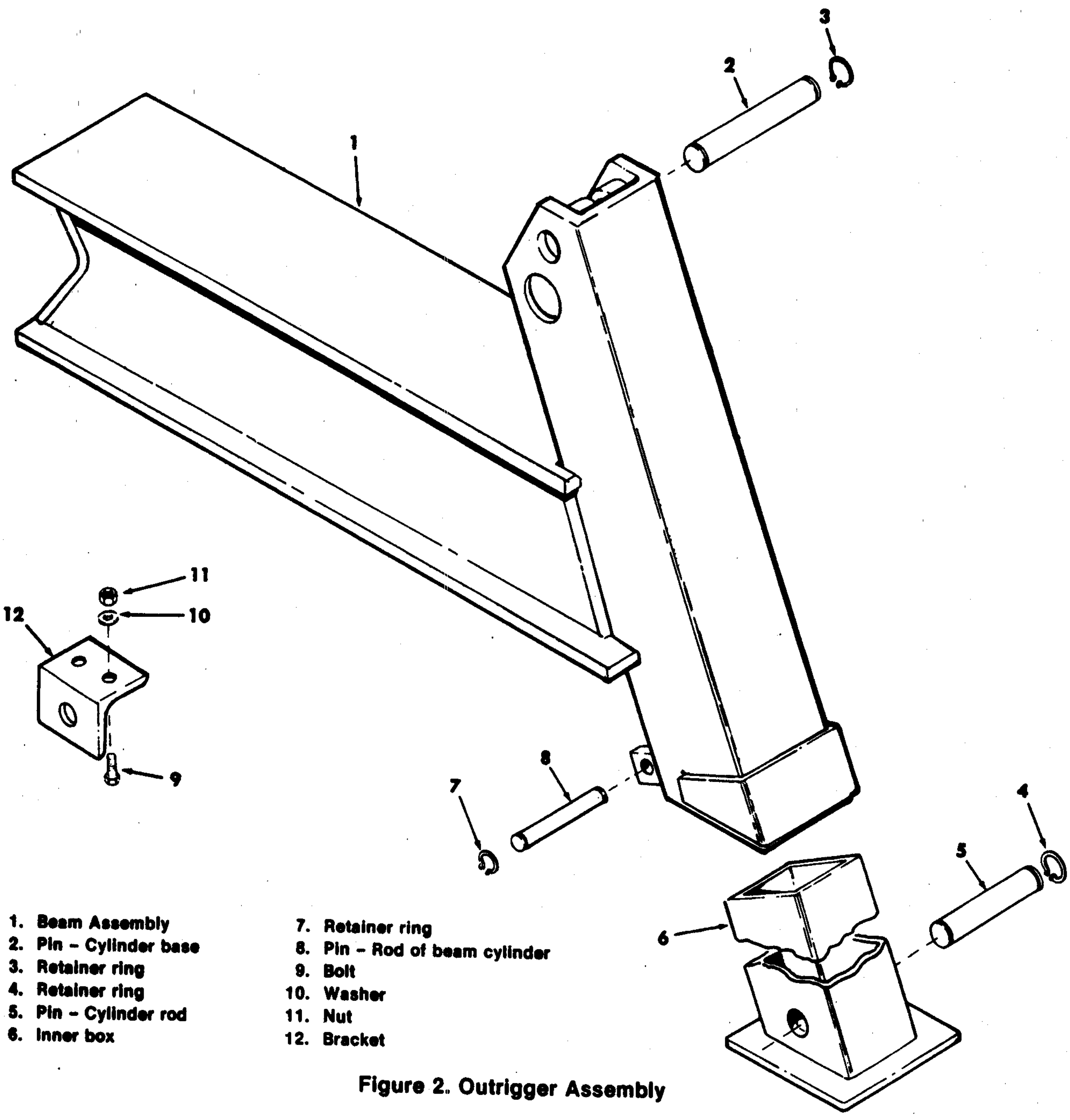
1. Lubricate the slide blocks inside the main frame with STP Oil Treatment or equivalent. Use a hoist and install the outrigger assembly into the main frame.

2. Connect hydraulic lines to bulkhead fittings. Make sure that the hoses are routed closely along the side of the beam and will not be damaged when outrigger is retracted.

3. Connect rod of beam cylinder to outrigger box. Install rod mounting pin and retaining ring.

4. Apply a thin, even layer or STP Oil Treatment to slide contact surfaces on sliding beams.

5. Operate outrigger to check for correct installation. Stop the engine. Check for leakage at hose connections.



1. Beam Assembly
2. Pin - Cylinder base
3. Retainer ring
4. Retainer ring
5. Pin - Cylinder rod
6. Inner box
7. Retainer ring
8. Pin - Rod of beam cylinder
9. Bolt
10. Washer
11. Nut
12. Bracket

Figure 2. Outrigger Assembly

Section 9210

SWING GEAR AND PINION

MAINTENANCE AND ADJUSTMENT

Maintenance

Swing Gearbox

The gearbox has a worm gear set which rotates on taper roller bearings. The gears and bearings are given lubrication by the grease in the gearbox. Gaskets prevent external leakage in the gearbox.

Keep gearcase filled with grease. If low, add multipurpose EP Lithium base grease (See Figure 1).

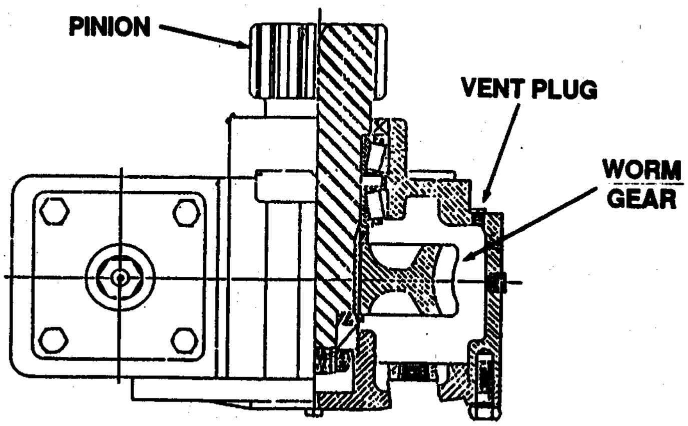


Figure 1. Swing Gearbox

Swing Gear/Pinion

Clean, adjust, then lubricate swing gear/pinion monthly or every 250 hours. Using brush, apply open gear lube to pinion/gear. Keep hands clear of rotating pinion and gear (See Figure 2).

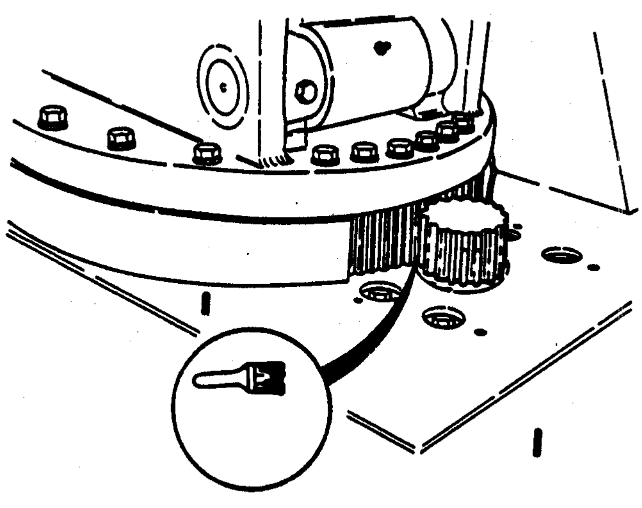


Figure 2. Swing Gear/Pinion

Adjustment of Swing Gear/Pinion Lash

Swing Gear/Pinion Lash

1. Remove swing pinion cover.
2. Start machine and rotate mast until high point on gear is in alignment with pinion (See Figure 3). (**NOTE:** Hight point is punch-marked on edge of mast base plate after factory assembly). Lash at this position between gear and pinion should be between 0.005 and 0.015.
3. Loosen slightly the four bolts securing the rotationgear reducer.
4. With spanner wrench, turn eccentric ring at pinion to set correct lash.
5. Retighten bolts to appropriate torque.
6. Replace swing pinion cover.

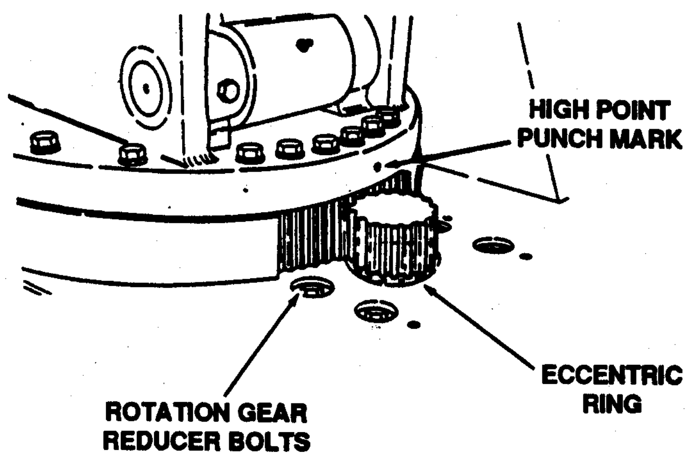


Figure 3. Adjustment of Gear/Pinion Lash

WARNING: Before removing swing chain or swing gearbox, make sure machine is level and mast is stopped to prevent rotation.

SERVICING THE SWING GEARBOX

Removal

1. Use a hoist or blocks to hold boom in position and prevent rotation of mast.

2. Remove swing motor from gearbox. IMPORTANT: Do not rotate mast after hydraulic motor has been removed from swing gearbox. Internal bearings will become dislodged. Make a note of the position of the swing motor for installation.

3. Provide support and remove the four bolts which fasten the gearbox to the frame. Remove the gearbox from under the unit.

Disassembly

1. Clean outside of gearbox before disassembly.

2. Loosen bolts (34) from bottom cover (1). Remove bottom cover (1) from the gear housing.

3. Keep the shims (25 and 26) together.

4. Pull the gear and shaft assembly out of the gear housing.

5. Used a bearing puller to remove the bearing cone.

Procedure to Disassemble the Worm Gear

6. Loosen the bolts (3) and remove bearing retainer (8).

7. Remove the worm gear shaft (16) from the gear case.

8. Use a bearing puller to remove the bearing cones (13 and 28) from the worm gear.

Inspection

Clean all parts. See Section 1055. Make sure the breather is clean. Make a careful inspection of all parts, including gears, shafts and bearings.

Replace all parts that have wear or damage. Make sure all finished parts are clean and smooth.

Replace all seals and gaskets.

1. **Housing cover**
2. **Gear Worm**
3. **Bearing container**
4. **Worm**
5. **Gasket**
6. **O-ring**
7. **Spacer**
8. **Bearing retainer**
9. **Worm gear housing**
10. **Spacer**
11. **Output pinion shaft**
12. **Castel nut**
13. **Cone bearing**
14. **Cup bearing**
15. **O-ring**
16. **Pipe plug**
17. **Cone bearing**
18. **Cup bearing**
19. **Ball bearing**
20. **Nation seal**
21. **Nation seal**
22. **Vent plug**
23. **Cotter key**
24. **Hydraulic motor gasket**
25. **Metal shim (1/64)**
26. **Metal shim (1/32)**
27. **Drive screw**
28. **Cone bearing**
29. **Cup bearing**
30. **O-ring**
31. **Alemite plug**
32. **Label plate**
33. **Capscrew**
34. **Capscrew**
35. **Capscrew**
36. **Lock washer**
37. **Flat washer**

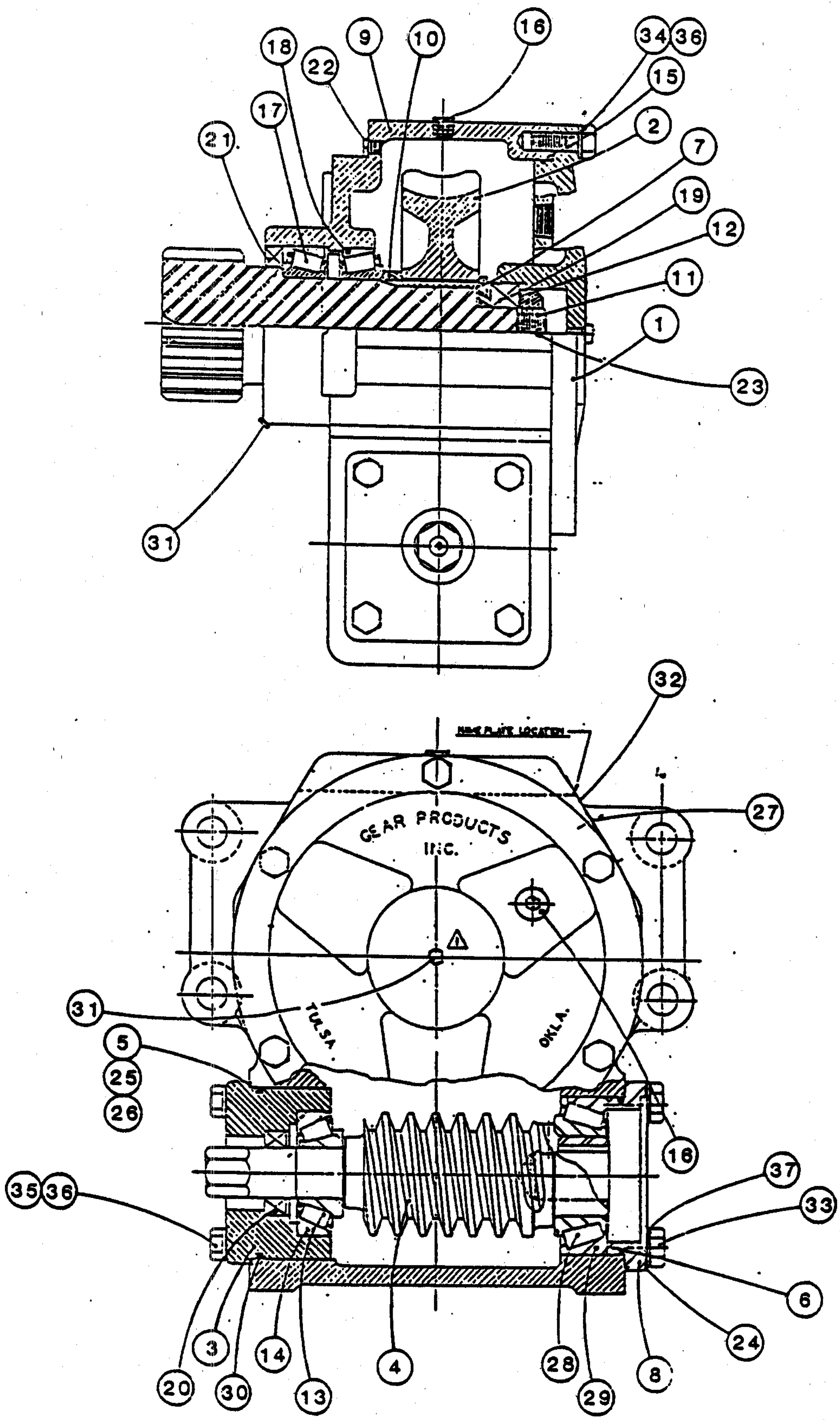


Figure 4. Swing Gearbox

Section 9211

BOOM AND JIB

9

MAINTENANCE

General

The telescopic boom with three sections is standard equipment. The fourth section is optional (standard height units only). See Operator's Manual for adjustment of the fourth section.

Wear bars are installed between the box sections to keep friction and side movement to a minimum.

Location	Quantity
Top rear of Sections 2, 3, 4	2/section
Bottom front of sections 1, 2, 3	2/section
Sides of sections 2, 3, 4	2/section
Head of crowd cylinder	4
Rod of crowd cylinder	1

The boom is hydraulically extended and retracted by a cylinder inside the boom. Holding valves on the boom cylinders prevent lowering or retracting of the boom unless the engine is running. For information on the cylinders and the hydraulic circuit to the cylinders, see Sections 8211 and 8212.

Boom Lubrication

Clean and apply lubrication to all areas of contact between the boom sections every 50 hours or when boom slide becomes dry. Use bronze anti-seize, STP Oil Treatment, or equivalent.

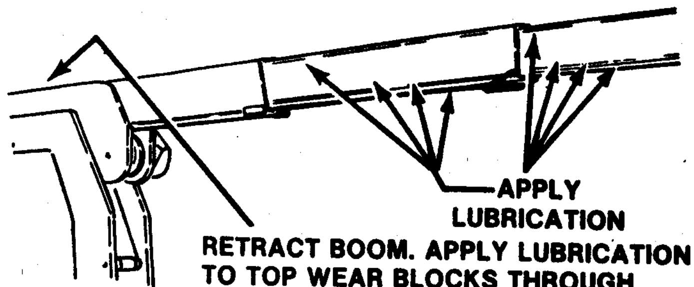


Figure 1. Boom Lubrication

There are grease fittings on the sheaves in the boom head, on the hoist cylinder and on the boom pivot. Apply grease to these areas at intervals shown on Maintenance Chart, Section 1050.

SERVICING THE BOOM

Removal of Sequencing Boom and Crowd Cylinder

NOTE: It is not necessary to remove the boom from the mast.

1. Retract the boom. If the crowd cylinder can not be retracted, it is possible to use the winch to pull the boom sections together:

   a. The holding valve must be removed to permit crowd cylinder to retract. See Section 8212.

   b. Engage and hold the crowd control lever in a position to retract the boom.

   c. Raise the hook block until there is contact between the boom sheave and the hook block.

   d. Slowly pull boom sections together with the winch. Stop immediately if boom does not retract easily. Damage can be caused to crowd cylinder or boom components.

   e. Return both control levers to the Neutral position.

2. Disconnect the hydraulic lines from the fittings at the rear of the crowd cylinder. Install caps and plugs on the fittings and the hydraulic lines.

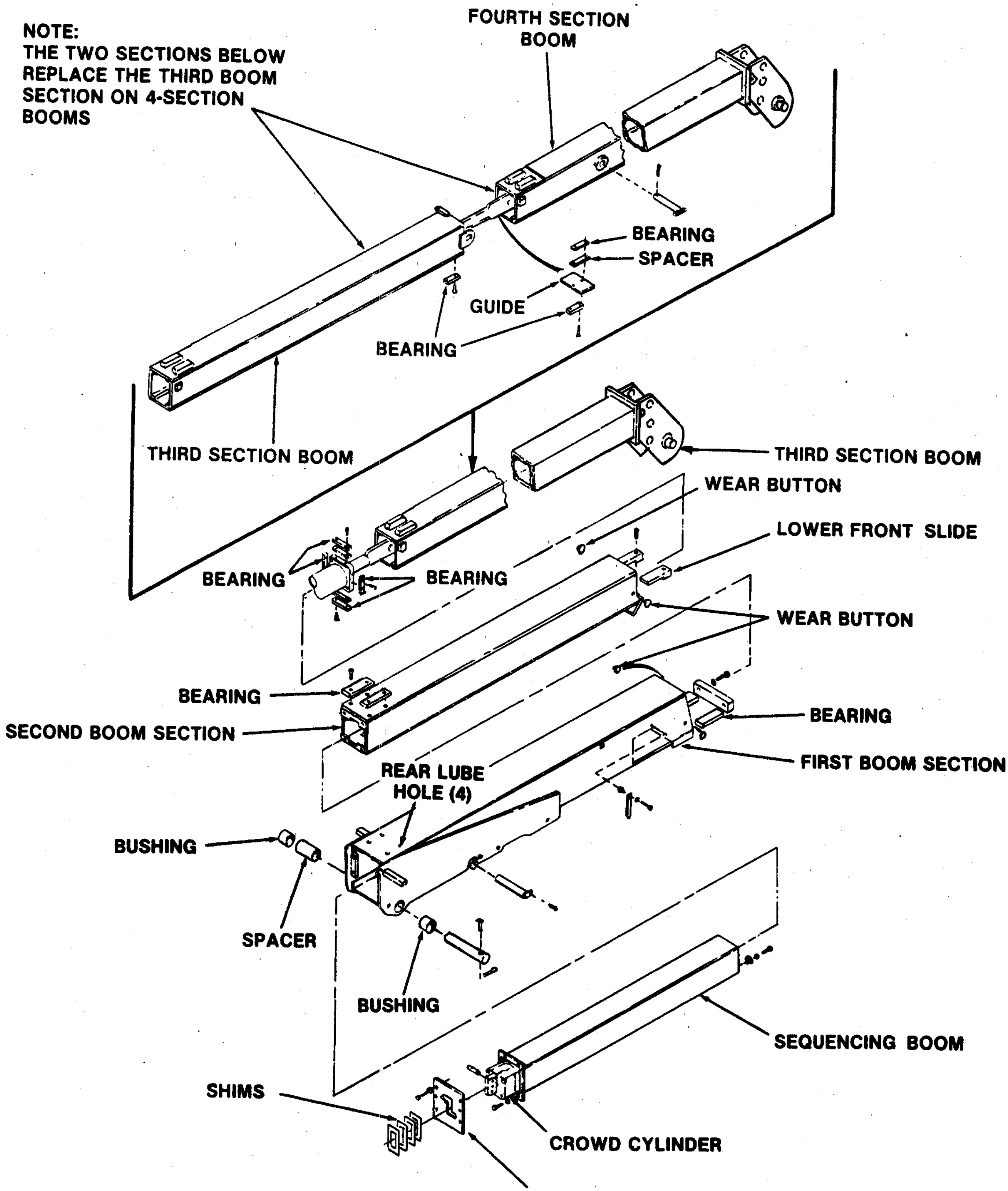


Figure 2. Boom Assembly

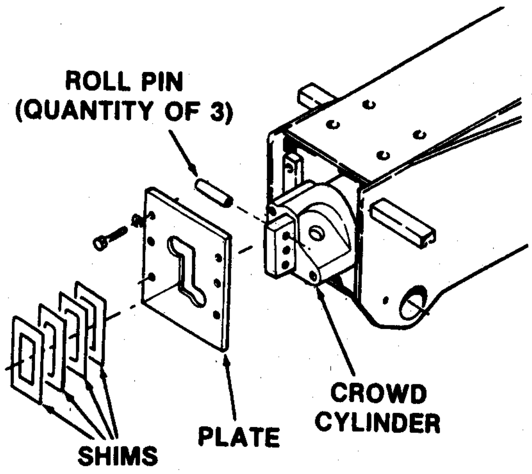


Figure 3. Rear of Main Boom

3. Three roll pins fasten the crowd cylinder to the end plate of the first section. Remove the roll pins.

4. Remove the bolts which fasten the end plate to the first section. Remove the end plate and shims.

5. Remove the four bolts which fasten the flange on the rear of the sequencing boom to the rear of the second section.

6. Remove the pin from the rod end of the crowd cylinder. After the pin is removed, the sequencing boom and crowd cylinder can be removed out the rear of the first section boom. Use a hoist to lift the sequencing boom and crowd cylinder away from the machine.

7. Remove the crowd cylinder from the sequencing boom.

   a. Remove the bolts which fasten the front of the sequencing boom to the flange on the outer rod of the crowd cylinder.

   b. Pull the crowd cylinder out through the front of the sequencing boom. Be careful not to cause damage to the hydraulic tube on the crowd cylinder.

8. Make an inspection of the bearing blocks on the flange of the crowd cylinder. Look for damage or wear. If the bearing blocks are badly worn, replacement is necessary.

Removal of Boom from Machine

1. Remove hook block and wire rope.

2. Retract boom.

3. Remove the jib boom, if installed.

4. Raise the boom until the pin in the rod of the hoist cylinder can be seen.

5. Connect a hoist to the boom that will lift more than 2000 lb (906 kg).

6. Release the hydraulic pressure in the winch and crowd circuits. Disconnect the hydraulic tubes on the boom from the hydraulic hoses on the mast. Put caps and plugs on the hydraulic tubes and hydraulic hoses.

7. Remove the pin from the rod of the hoist cylinder. Retract the rod of the hoist cylinder. Put a support under the cylinder to prevent damage to the cylinder.

8. Remove the boom pivot pin and remove the boom. Put the boom on blocks or steel horses.

> **CAUTION:** If sequencing boom and crowd cylinder have been removed, do not permit the boom to be lowered below the horizontal position. Boom section will slide out if boom is not in horizontal position.

Disassembly

1. If sequencing boom and crowd cylinder have not been removed, remove the sequencing boom and crowd cylinder at this time.

2. Four Section Boom: Using a hoist, slide the fourth section from the third section. Then, slide the third section from the second section. Next, slide the second section from the first section.

Three Section Boom: Using a hoist, slide the third section from the second section. Then, slide the second section from the first section.

3. Replace any wear blocks that are worn. Replace any boom sections and parts that have damage.

Assembly

NOTE: Use Loctite (blue) on all retaining screws for the wear plates.

1. Clean new boom section:

   a. Remove all paint from threads of bolt holes.

   b. Remove all residue from inside of the boom section with compressed air.

2. Install all wear blocks that were removed.

3. Four Section Boom: Apply lubrication to top and bottom of the inside surfaces of the third boom section. Apply lubrication to the sides (outside surface) of the fourth section. Using a hoist, slide the fourth section into the third section.

   Apply lubrication to the top and bottom of inside surfaces of the second boom section. Apply lubrication to sides (outside surface) of the third boom section. Using a hoist, slide the assembled third and fourth boom sections into the second boom section.

   Three Section Boom: Apply lubrication to top and bottom of the inside surfaces of the second boom section. Apply lubrication to the sides (outside surface) of the third section. Using a hoist, slide the fourth section into the second section.

4. Apply lubrication to the top and bottom of the inside surfaces of the first boom section. Apply lubrication to the sides (outside surface) of the second boom section. Using a hoist, slide the assembled second boom section into the first boom section.

5. At this time, install the sequencing boom and crowd cylinder.

Installation of Sequencing Boom and Crowd Cylinder

1. Install the crowd cylinder into the sequencing boom. Fasten the flange on the crowd cylinder to the sequencing boom with four bolts and washers.

2. Use a hoist to install the sequencing boom into the boom assembly. Fasten the sequencing boom to the second section with four bolts and lock washers.

3. Install the pin in the rod of the crowd cylinder.

4. Fasten the end plate to the first section with six bolts and lock washers.

5. Install the shims and fasten the crowd cylinder to the end plate with three roll pins.

6. Connect the hydraulic tubes to the fittings on the crowd cylinder.

7. Operate boom and remove air from the crowd cylinder. Also, check that the boom extends and retracts smoothly. Adjust the wear blocks and apply lubrication as necessary.

Installation of Boom

1. Connect a hoist to the boom that will lift more than 2000 lb (906 kg).

2. Lift the boom into position on the mast and install the pivot pin. Connect the rod of the hoist cylinder to the boom.

3. Connect the hydraulic lines to the boom.

4. Operate boom and remove air from the crowd cylinder. Also check that boom extends and retracts smoothly. Adjust the wear blocks and apply lubrication as necessary.

Section 9213

WINCHES, SHEAVES AND WIRE ROPE

MAINTENANCE

Main Winch

The main winch is fastened to the boom through a mounting bracket. The winch has a hydraulic drive with a worm gear reduction, similar to the swing gearbox.

Check oil in gearbox weekly or every 10 hours. For correct indication, the boom must be in the horizontal position. The correct oil level is indicated in Figure 1. If low, add 600 W cylinder oil or equivalent. Every 6 months or 1500 hours, change the oil and clean the breather. Use a solvent that is not flammable to clean the breather. It is important that the breather is kept clean.

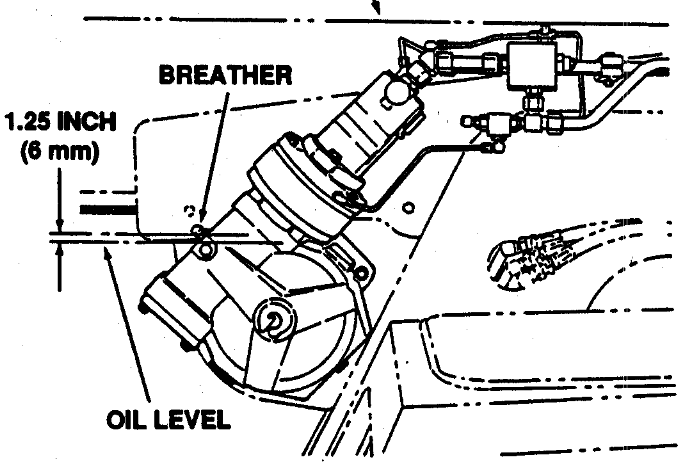


Figure 1. Winch Gearbox

Winch Motor

For information on the winch motor and the hydraulic circuit to the motor, see Section 8213.

Auxiliary Winch

The auxiliary winch is optional equipment. When installed, the winch will be under the deck at the front of the machine. See Figure 2. This winch is electric and is intended for intermittent use. Prolonged operation may cause excessive discharge to batteries.

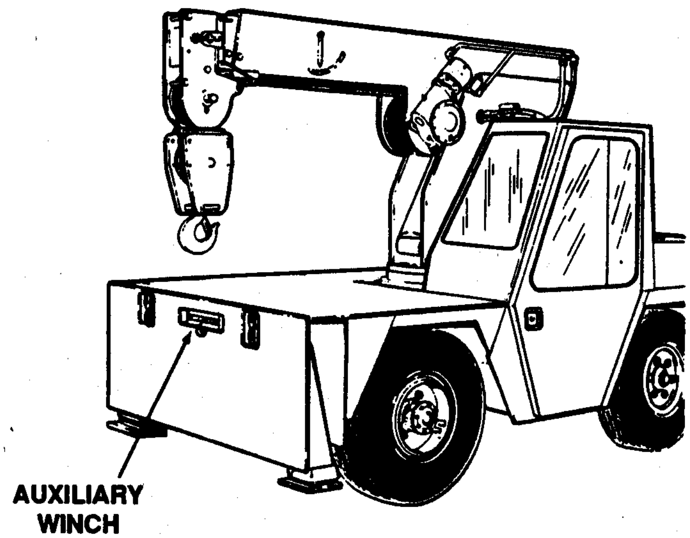


Figure 2. Auxiliary Recessed Winch

All moving parts in the winch are permanently lubricated with high temperature lithium grease at the time of assembly.

Wire Rope

The wire rope has many moving parts and needs regular maintenance. Make a careful inspection of the wire rope at least once a month or every 250 hours. Look for damage, rust and general condition. Keep a record of these inspections. Replace the wire rope immediately if there is wear or damage.

NOTE: It is recommended that a short section of the wire rope be removed from the socket end of the wire rope at regular intervals. This procedure removes the section with possible damage near the neck of the socket and puts the wear points into a new location in the wire rope system.

> ⚠ **CAUTION:** To prevent injury to your hands, always wear gloves when working with the wire rope.

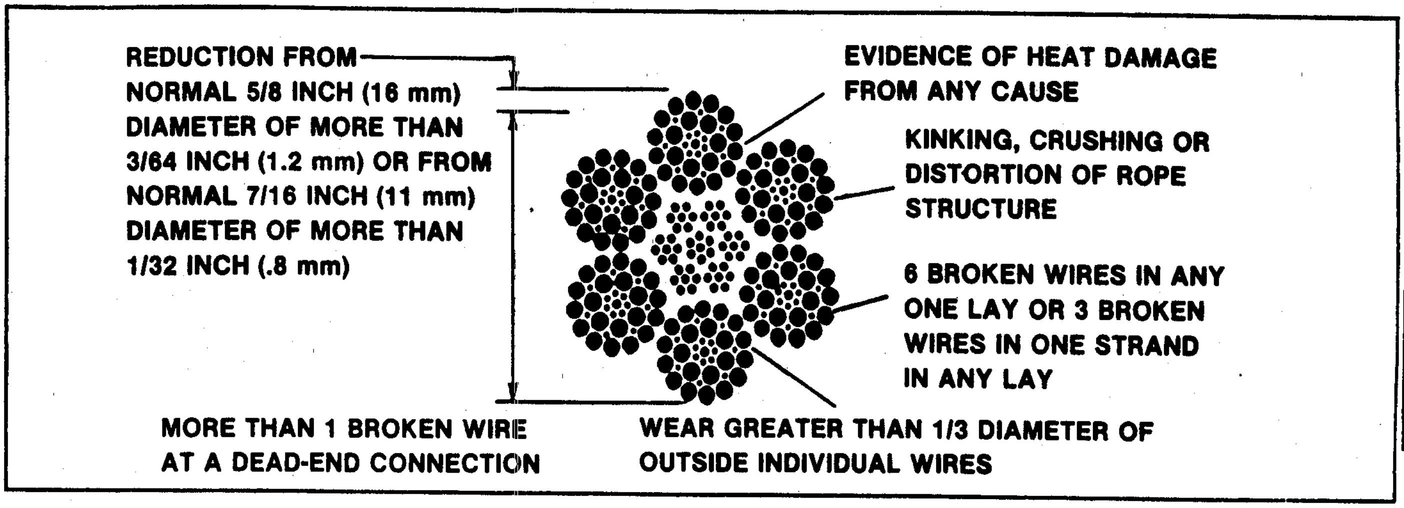


Figure 3. Inspection of Wire Rope

Lubrication of Wire Rope

For maximum life, corrosion of the wire rope must be kept to a minimum. Often corrosion starts at the core of the wire rope and is not easily seen. Regular application of a wire rope lubricant or heavy crankcase oil is necessary to control corrosion.

One method of lubrication is shown in Figure 4. The wire rope must be clean and dry before the lubricant is applied. Move the wire rope slowly through the lubricant. Remove the extra lubricant with a cloth. For smoother application, heat the lubricant first.

Frequent applications of the lubricant will give better results than a heavy application less frequently applied.

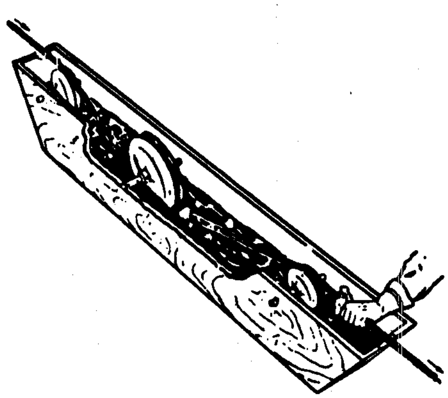


Figure 4. Lubrication

Socket and Wedge

Correct installation of the socket is important. Always install the socket so the load line is pulled straight in line with the eye of the socket, as shown in Figure 5.

When you install the wedge, hit the wedge several times with a hammer to make sure the wedge is fully engaged with the socket. If there are tracks in the goove of the wedge which prevent full contact with the wire rope, reconditioning or replacement of the wedge is necessary.

Wire Rope Clamps

Always install the wire rope clamp so the U-bolt part of the clamp is on the loose end of the wire rope. For extra protection, always keep a clamp on the loose end of the wire rope near the socket, as shown in Figure 5.

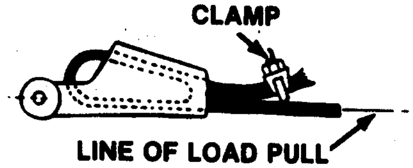


Figure 5. Socket for the Wire Rope

Storage of Wire Rope

Use extra care in handling and storage of wire rope. Permanent damage to the wire rope can be caused if you hit the wire rope against any hard or sharp object.

Keep the wire rope in a tight coil until ready for installation. The storage area must be dry, with enough ventilation to prevent moisture and rust.

Installation of New Wire Rope

The wire rope is given a natural bend or winding from the coil. If the wire rope is on a reel, unwind the wire rope from the reel as shown in Figure 6. Use care to prevent reverse bend in the wire rope.

1. Make sure that the equipment (winches, sheaves, etc.) is in good condition.

2. Unwind enough wire rope from the reel to connect the wire rope to the winch drum. Use care to prevent twists or sharp bends.

3. Operate the winch slowly to move the wire directly from the reel to the winch. Make sure the wire rope winds correctly on the drum. Loose winding will increase the wear on the wire rope and cause bad performance.

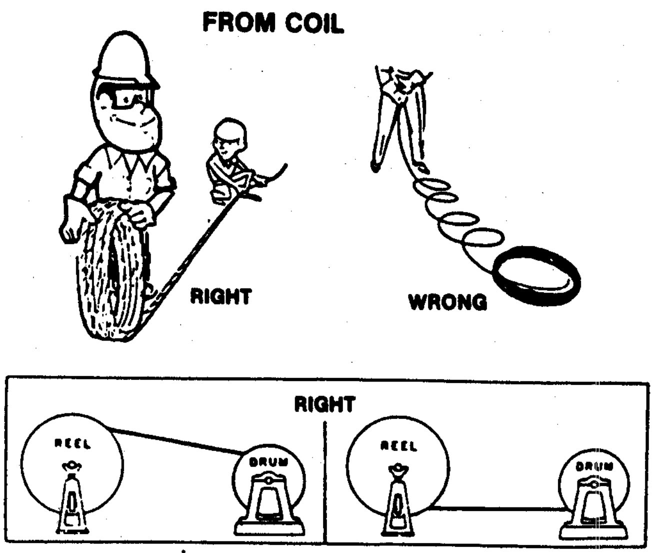


Figure 6. Installation of Wire Rope

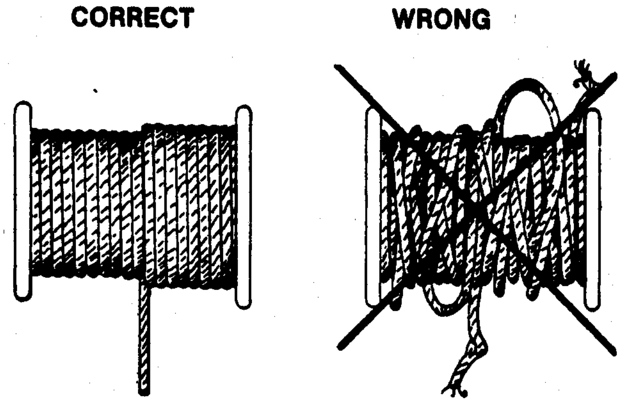


Figure 7. Correct Winding of Wire Rope

4. After installation, operate the winch with a minimum load until you see the wire rope is moving easily over the sheaves and winding correctly on the drum.

5. Gradually increase the speed and load until the wire rope is moving at normal load and speed. This run-in period adjusts the moving parts to each other.

> **WARNING:** Use a pry bar or piece of wood to move the wire rope over the sheaves or around the winch drum. Never use your hands.

Sheave Maintenance

Each sheave has a grease fitting for lubrication of the sheave bearing. The location of the fitting is either in the sheave groove or on the hub of the sheave. Apply lubrication to each sheave weekly or after every 50 hours of operation. See List of Grease Fittings, Section 1050.

Make an inspection of the sheaves monthly or every 250 hours to make sure the sheaves are not causing damage to the wire rope. The sheave groove must be smooth and a little larger in diameter than the wire rope. The sheave must turn freely and without deflection. Check the entire groove of each sheave. Remove any rough areas or sharp edges.

NOTE: As wear in the sheave increases, the sheave groove gets smaller, not larger. Tracks in the sheave grooves are caused by the wire rope, but the wire rope will not continue to engage these tracks, as for example, a chain engages a sprocket. A twist in the wire rope or a small change of lay will prevent the wire rope from engaging the track and will increase the wear on the wire rope.

When the tracks in the sheave grooves are deep enough to cause damage to the wire rope, reconditioning or replacement of the sheaves is necessary.

SERVICING THE MAIN WINCH

Removal

1. Remove the wire rope from the winch drum.

2. Release the hydraulic pressure in the winch circuit and disconnect the hydraulic lines from the winch motor. Use plugs and caps on the ends of the fittings and lines.

3. Connect a hoist to the main winch and remove the four bolts that fasten the main winch to the boom. Remove the main winch.

Disassembly

1. Remove the pipe plug from the bottom of the winch gearbox and remove the lubricant. Install the pipe plug after lubricant is removed.

2. Loosen the three bolts that fasten the gearbox to the mounting bracket. Remove the gearbox, brake and motor from the winch drum.

Disassembly — Winch Gearbox

See Figure 8.

1. Remove the winch brake and motor from the gearbox.

2. Loosen the twelve bolts (29) from the bottom cover (27). Remove the bottom cover (27).

3. Keep the shims (30) together.

4. Pull the gear and shaft assembly out of the gearbox.

5. Remove the six bolts (33) to remove the top cover.

6. With a bearing puller, remove the bottom bearing cone (25).

7. Remove the spacer (24) from the shaft.

8. Remove the gear (23) from the shaft.

9. With a bearing puller, remove the top bearing cone (5). Remove the spacer (6) from the shaft.

10. Loosen the bolts (20) and remove the adapter (16).

11. Remove shims (15). Keep the shims together.

12. Remove the worm gear shaft (11) from the gearbox.

13. With a bearing puller, remove the bearing cones (10 and 13) from the worm gear.

Inspection

Clean all parts thoroughly, including the breather. See Cleaning Instructions, Section 1055. Make a careful inspection of all parts, especially gears, shafts and bearings.

Replace all parts that are worn or have damage. Make sure all finished parts are clean and smooth.

Replace all seals and gaskets.

Assembly

1. To assemble the winch gearbox, follow the basic procedure given for assembly of swing gearbox. See Section 9210.

2. Fill the gearbox with the correct lubricant. See Section 1050.

3. Assemble the gearbox key and winch drum to the mounting bracket. Fasten the gearbox to the mounting bracket with the three bolts and washers. See Figure 8.

Installation of Main Winch

1. Connect a hoist to the main winch and lift the main winch into place under the boom.

2. Fasten the main winch to the boom with four bolts, eight flat washers, four lock washers and nuts.

3. Connect the hydraulic lines to the winch motor.

4. Install the wire rope on the winch drum.

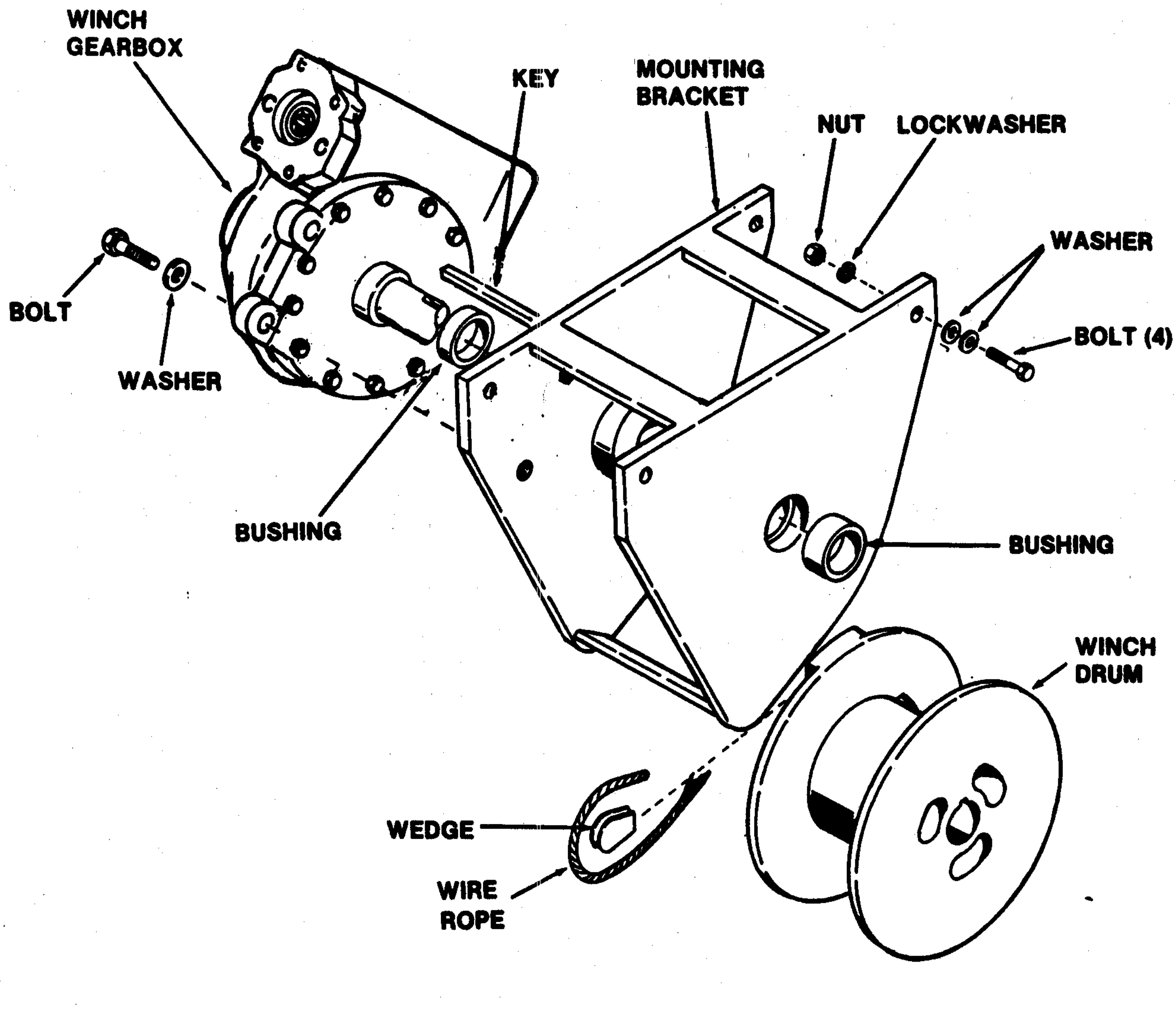
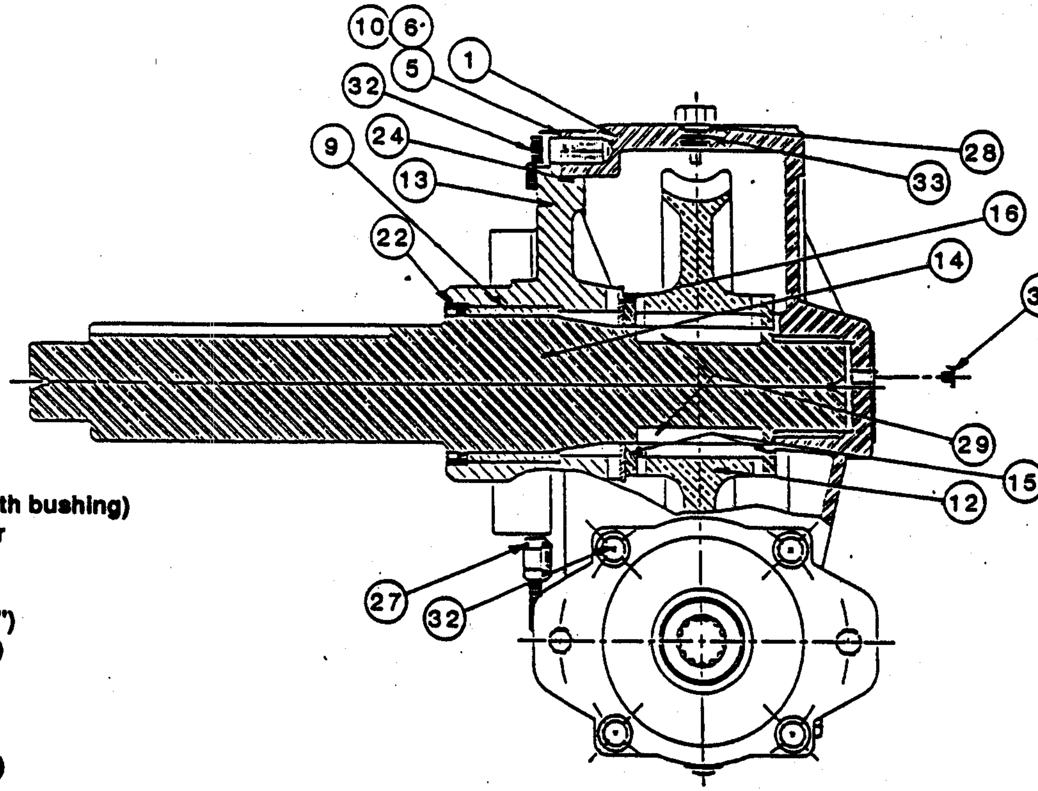


Figure 8. Main Winch

1. Main housing (with bushing)
2. Mounting adapter
3. Shim (.oo5")
4. Shim (.015")
5. Cover shim (.005")
6. Cover shim (1/64)
7. Gasket
8. Bearing retainer
9. Bronze bushing
10. Cover shim (1/32)
11. Input worm
12. Worm gear
13. Main housing cover
14. Output key shaft
15. Thrust ring
16. Spacer
17. Drive screw
18. Shim (.030")
19. Cone bearing
20. Cup bearing
21. Plug
22. Seal
23. O-ring
24. O-ring
25. Reducer bushing
26. Vent plug
27. Plug
28. O-ring
29. Key
30. Alemite plug
31. Label plate
32. Capscrew
33. Magnetic plug
34. Capscrew



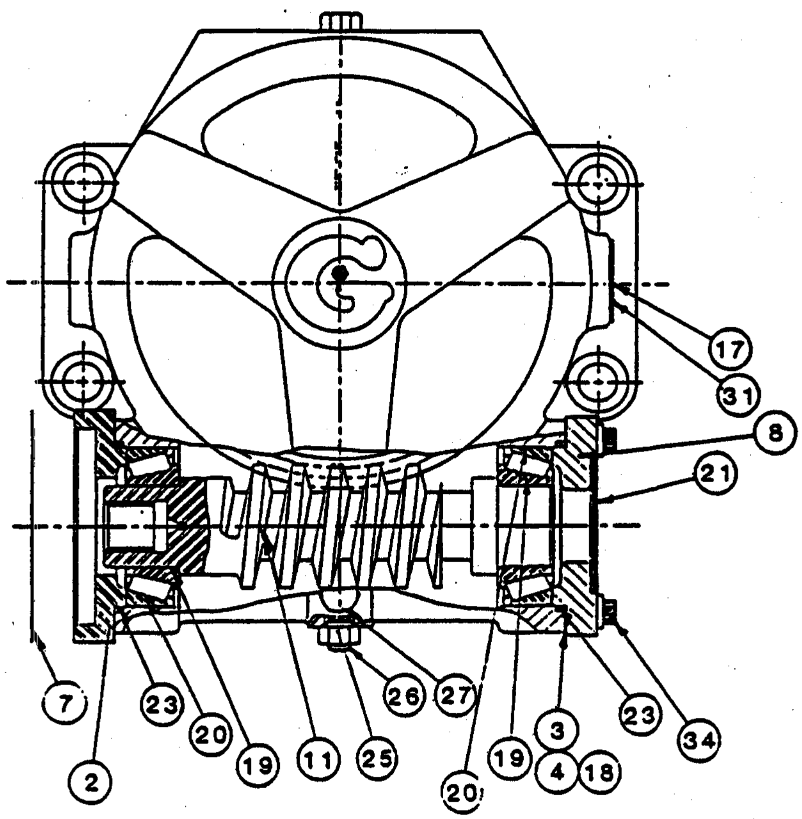


Figure 9. Winch Gearbox

SERVICING THE AUXILIARY WINCH

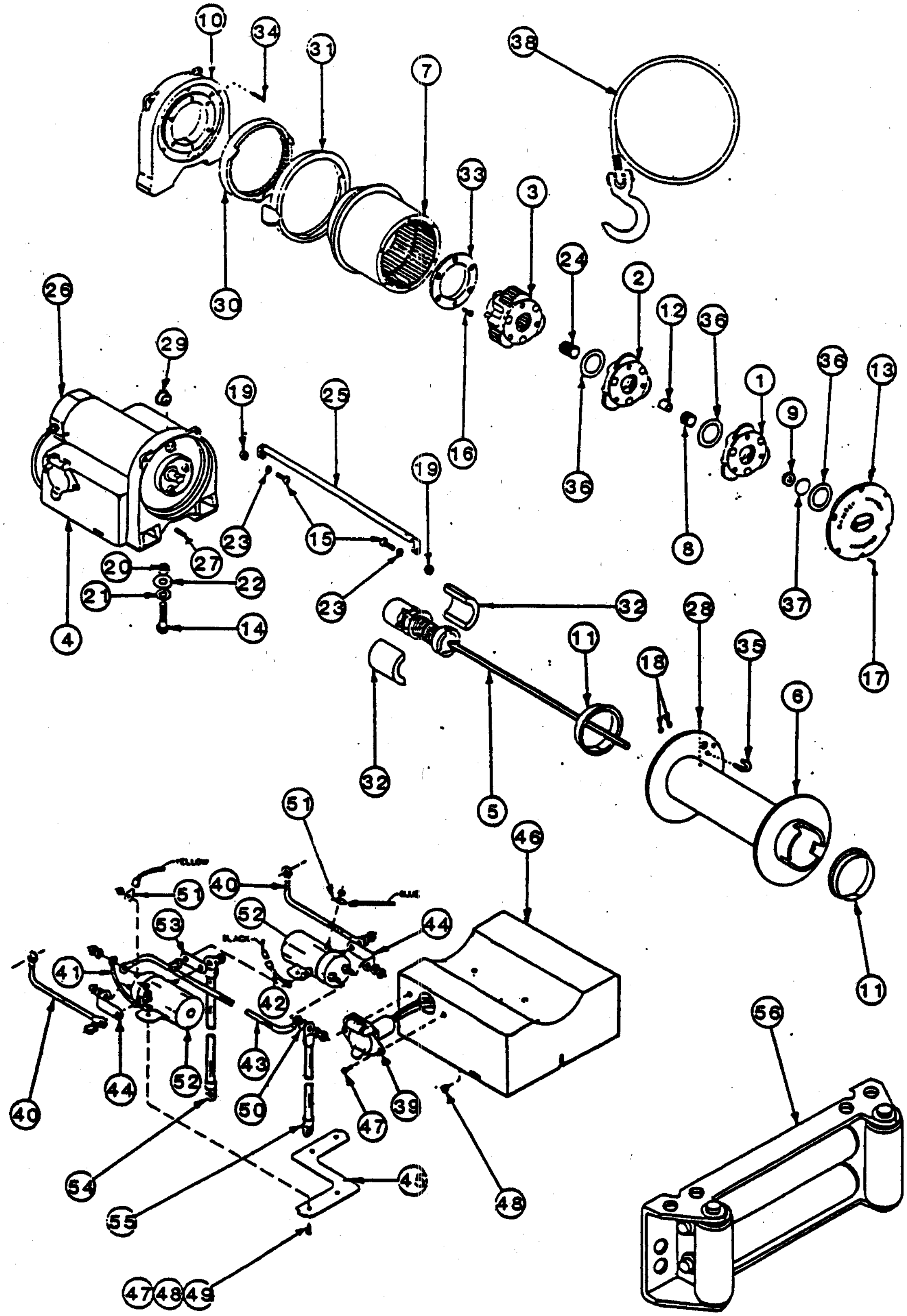


Figure 10. Below Deck Electric Winch

1. Input gear carrier assembly
2. Intermediate gear carrier assembly
3. Output gear carrier assembly
4. Solenoid assembly - 12V
5. Brake/Shaft assembly
6. Cable drum
7. Ring gear
8. Sun intermediate gear - 12V
9. Sun input gear
10. End bearing
11. Drum bushing
12. Bushing
13. Gear housing cover
14. Capscrew
15. Capscrew
16. Capscrew
17. Screw
18. Nut
19. Nut
20. Nut
21. Lockwasher
22. Flat washer
23. Spacer
24. Sun output gear
25. Tie bar
26. Motor/End bearing
27. Roll pin
28. Roll pin
29. Plug
30. Locking ring
31. Cam ring
32. Half ring
33. Ring gear retainer
34. Spring
35. U-bolt
36. Thrust washer
37. Thrust disc
38. Cable assembly
39. Female connector assembly
40. Black wire assembly
41. Black wire assembly
42. Black wire assembly
43. Black wire assembly
44. Copper strap
45. Bracket
47. Screw
48. Nut
49. Flat washer
50. External tooth washer
51. Terminal tab
52. Solenoid - 12V
53. Copper strap
54. Red wire assembly - battery
55. Black wire assembly - battery
56. Fairlead Roller assembly - (See Figure 10)

HOOK BLOCKS

HOOK REPLACEMENT

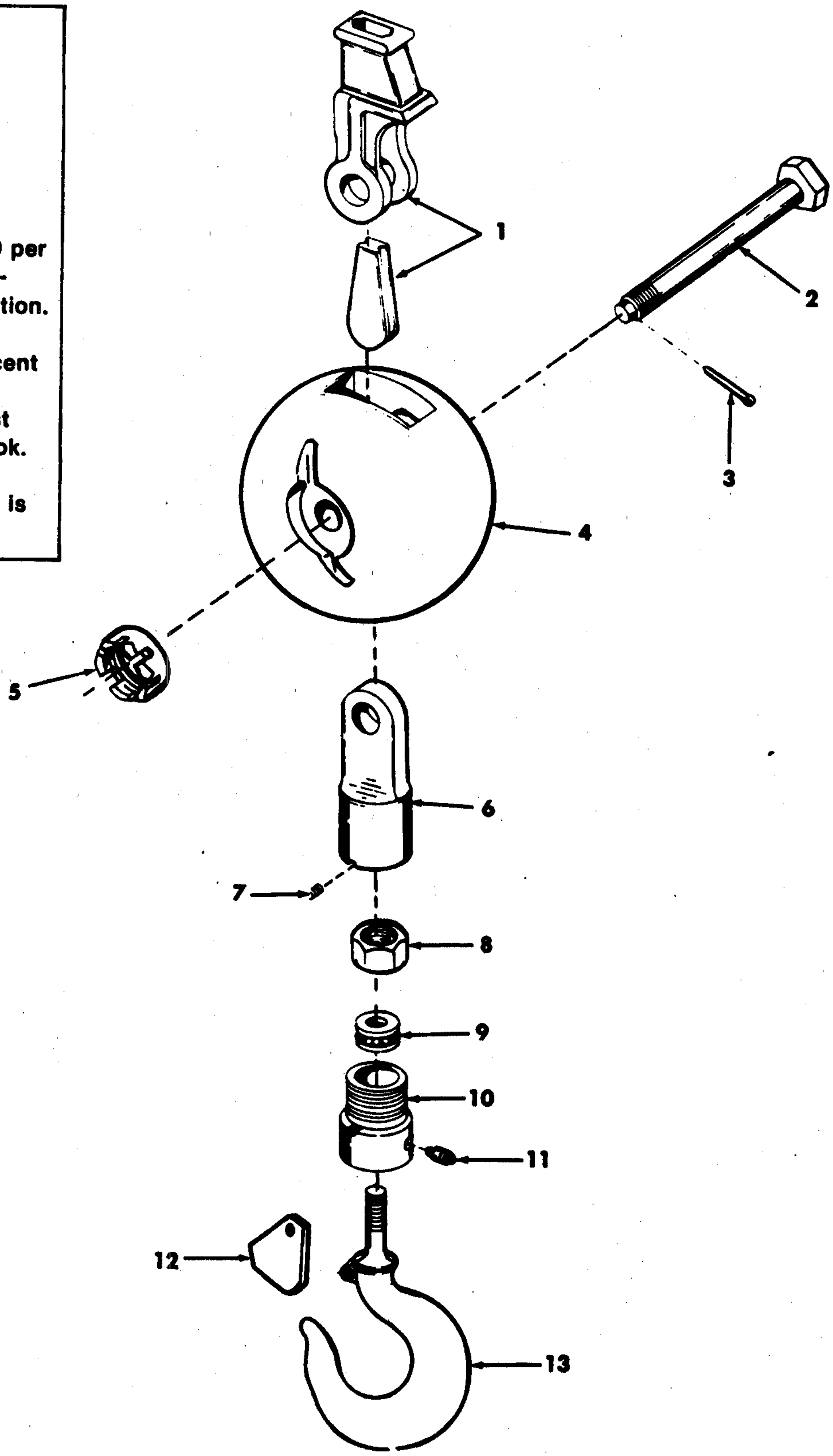
Replace hook if any of the following conditions is found:

1 – Cracks or other defects.

2 – Wear reduction more than 10 per cent in width or depth dimensions at the load bearing section.

3 – Distortion more than 15 per cent of original throat opening or more than 10 degrees of twist from plane of the straight hook.

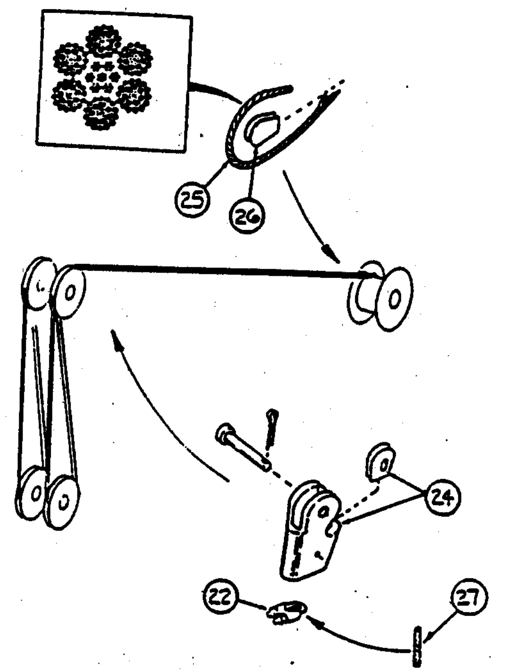
NOTE: Repair of hook by welding is not recommended.



1. Socket and wedge
2. Bolt
3. Cotter pin
4. Ball
5. Nut
6. Housing, top half
7. Set screw
8. Nut
9. Trust bearing
10. Housing, bottom half
11. Grease fitting
12. Safety latch
13. Hook

Figure 11. Hook and Ball - 10000 Lb (4500 Kg) Cap.

1. Block side plate
2. Plate
3. Hook shank
4. Bronze washer
5. Slotted nut
6. Roll pin
7. Clevis pin
8. Hair pin
9. Spacer
10. Bolt
11. Nut
12. Lock washer
13. Sheave pin
14. Keeper plate
15. Bolt
16. Lock washer
17. Bolt
18. Lock nut
20. Sheave assembly
21. Nylatron spacer washer
22. Wire rope clamp
23. Load decal
24. Wedge & socket assembly
25. Wire rope
26. Wedge
27. Wire rope pigtail



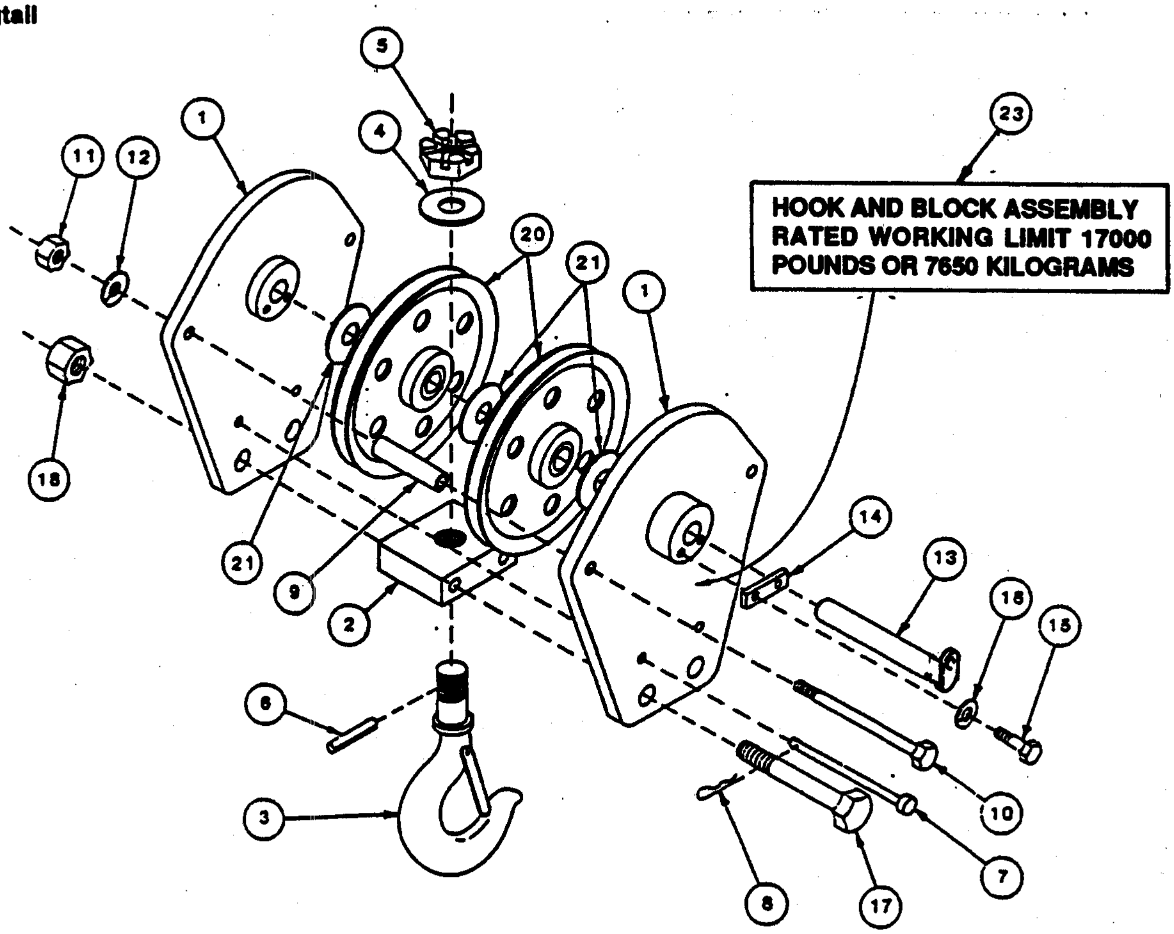


Figure 12. Hook and Block - 17000 Lb (7650 Kg) Cap.

Section 9216

MAST, BEARING AND RELATED PARTS

MAST BEARING AND DRIVE

General

The mast is fastened to the main frame of the Crane through a bearing. The inner race of the bearing is fastened to the mast. The outer race of the bearing is fastened to the frame. See Figure 1 and 2.

The rotation of the mast is done by a gearbox which is mounted below the deck. A hydraulic motor connected to the gearbox gives hydraulic power for rotation of the mast.

The bearing cavity is filled with grease through a grease fitting on the inner race of the bearing. A slotted hole in the mast plate allows access to inner race bolts and grease fitting. An o-ring is installed between the bearing and the mast as a grease and dust seal.

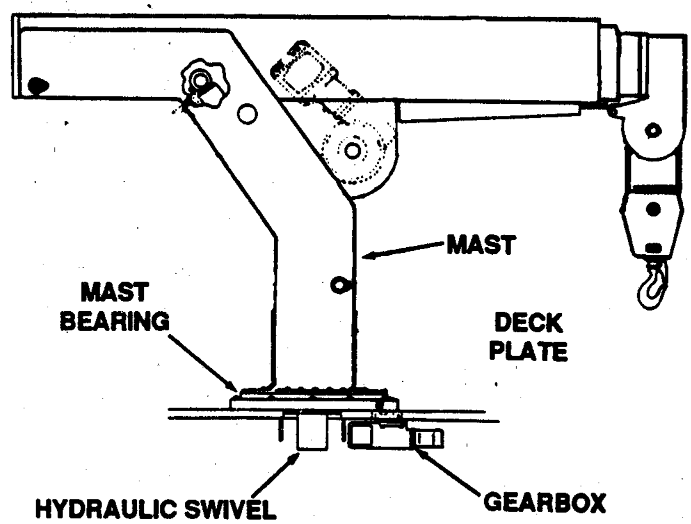


Figure 1. Swing Mechanism

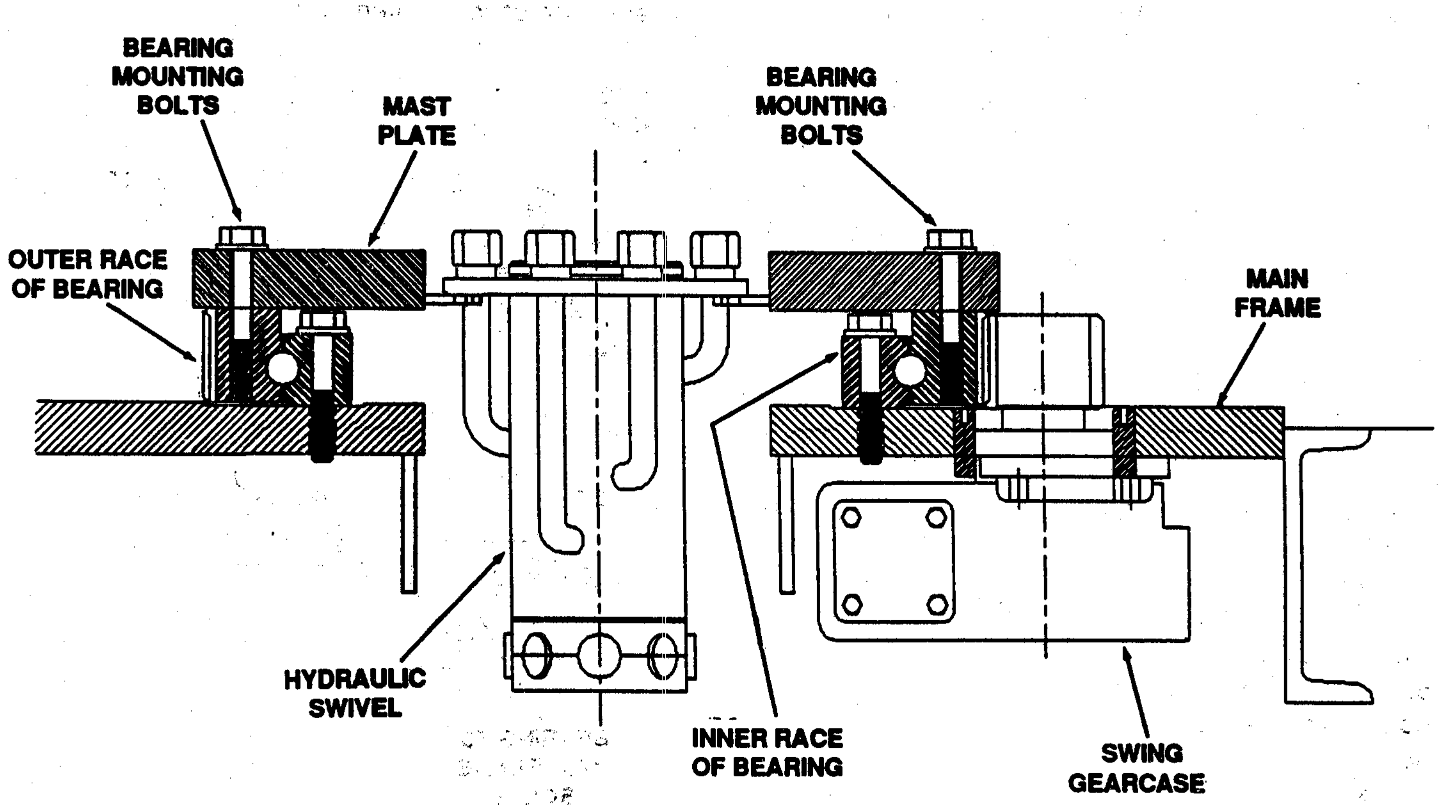


Figure 2. Cross Section of Mast Bearing

Mast Bearing

The bearing is a ball thrust bearing. The inner race rotates inside the outer race on a row of steel balls. The balls are in groups which are separated by helical springs.

Apply grease to the bearing weekly or every 50 hours of operation. Use a lithium grease, E.P. No. 2 or equivalent.

There are two grease fitting to grease the bearing and are directly across from each other. Rotate the mast untill the access hole on the mast plate lines up with the grease fitting. See Figure 3. Then apply grease to the bearing. Rotate the mast through several rotations and then repeat procedure for the other grease fitting. The old grease will be removed at the bottom of the bearing.

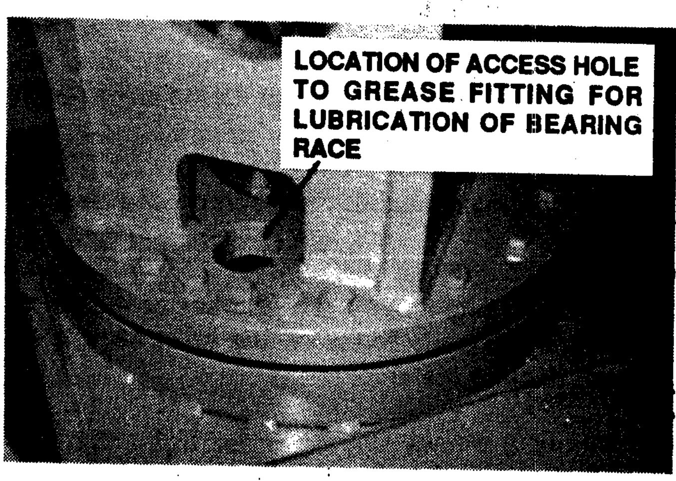


Figure 3. Mast Bearing

Bolts for Mast Bearing

Very high stress is put on the mast bolts during crane operation. It is important that these bolts be checked at regular intervals.

Check the torque on the bolts after the first week or 50 hours of operation, and then every month or 250 hours. Make a record of any loose bolt. If any bolt does not hold the correct torque after the second check, remove and replace the bolt. A loose bolt indicates possible failure of the bolt.

IMPORTANT: Use only special hardened bolts for replacement of the mast bolts. See Parts Catalog. If any bolts are removed, apply blue Loctite to the threads of the bolt before installation.

The tools needed for the torque check are shown in Figure 4. Tighten each bolt in the order shown in Figure 5. Use a smooth, firm movement of the torque wrench to get the final torque. Correct torque on the bolts is 200 lb-ft (270 Nm).

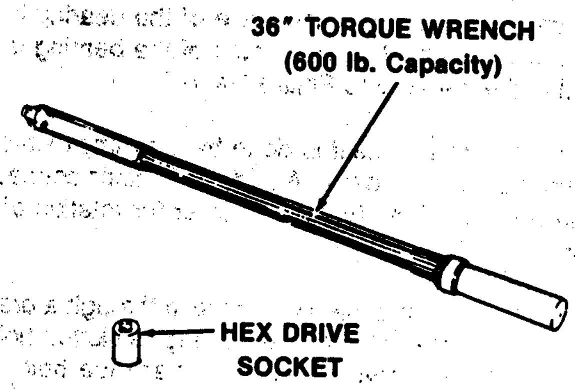


Figure 4. Tools Needed for the Torque Check

NOTE: If a broken bolt is found, also replace the bolt on each side of the broken bolt.

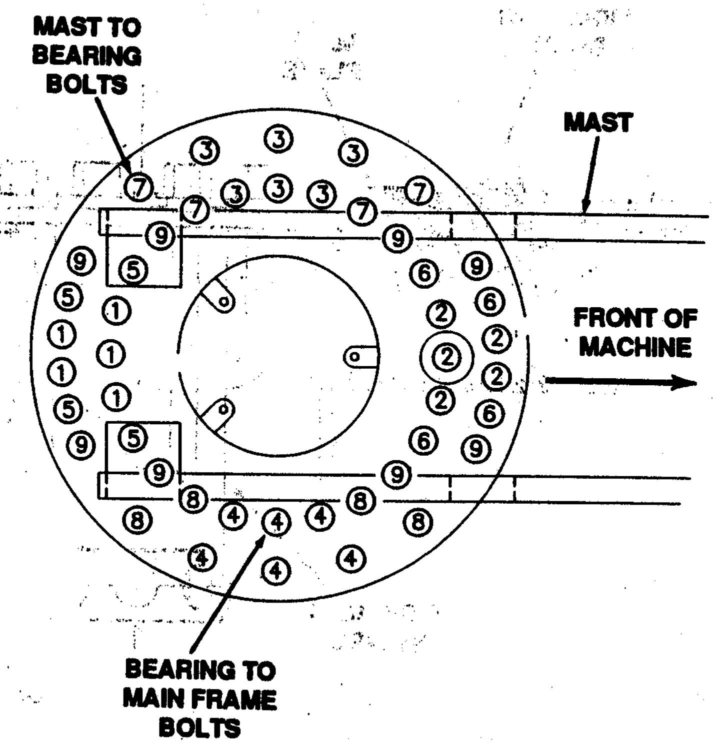


Figure 5. Tightening Order for the Mast Bolts

REPLACEMENT OF MAST BEARING

Removal

1. Raise the boom until the pin in the rod of the hoist cylinder can be seen.

2. Connect a hoist that will lift more than 2000 lbs (906 kg) to the boom.

3. Release the hydraulic pressure in the winch and crowd circuits. Disconnect the hydraulic tubes on the boom from the hydraulic hoses on the mast. Put caps and plugs on the hydraulic tubes and hydraulic hoses.

4. Remove the pin from the rod of the hoist cylinder. Retract the rod of the cylinder. Put a support under the cylinder to prevent damage to the cylinder.

5. Remove the boom pivot pin and remove the boom. Put the boom on blocks or steel horses.

6. Remove the swivel stop from bottom of the hydraulic swivel, Figure 6.

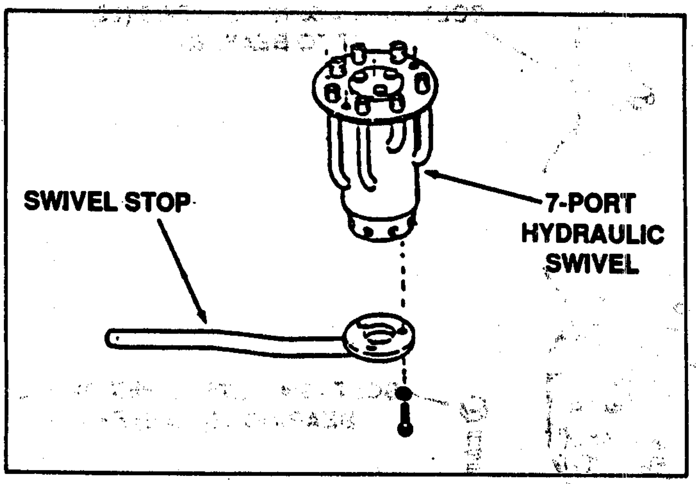


Figure 6.

7. Put tags on the hydraulic tubes with the number of the hydraulic swivel port to which the hydraulic tube connects.

8. Disconnect the hydraulic tubes from the lower swivel ports. Put caps and plugs on the fittings and hydraulic tubes.

9. Connect a hoist to the mast. Remove the twenty two bolts which fasten the mast to the mast bearing.

10. Remove the mast and put on blocks.

11. Remove the 24 bolts which fasten the mast bearing to the frame.

12. Use a hoist to remove the mast bearing.

Installation

1. Use a solvent to clean the holes for the bolts in the bearing plate on the frame. Remove the residue with compressed air. Clean all dirt from the bearing plate.

2. Put the mast bearing in place on the bearing plate.

3. Apply Loctite (blue) to the threads of the bolts. Install the bolts to fasten the mast bearing to the bearing plate.

4. Figure 5 shows the order for tightening the bolts. Each bolt must first be tightened to a torque of 200 lb-ft (271 Nm) and then loosened a small amount. Next, tighten the bolts again to a torque of 200 lb-ft (271 Nm).

5. Make sure the top surface of the mast bearing and the bottom surface of the mast base are clean.

6. With a hoist, lower the mast into position over the mast bearing.

7. Align the holes for bolts in the mast bearing and the mast base plate.

8. Do not use Loctite on the bolts. By hand, tighten each bolt.

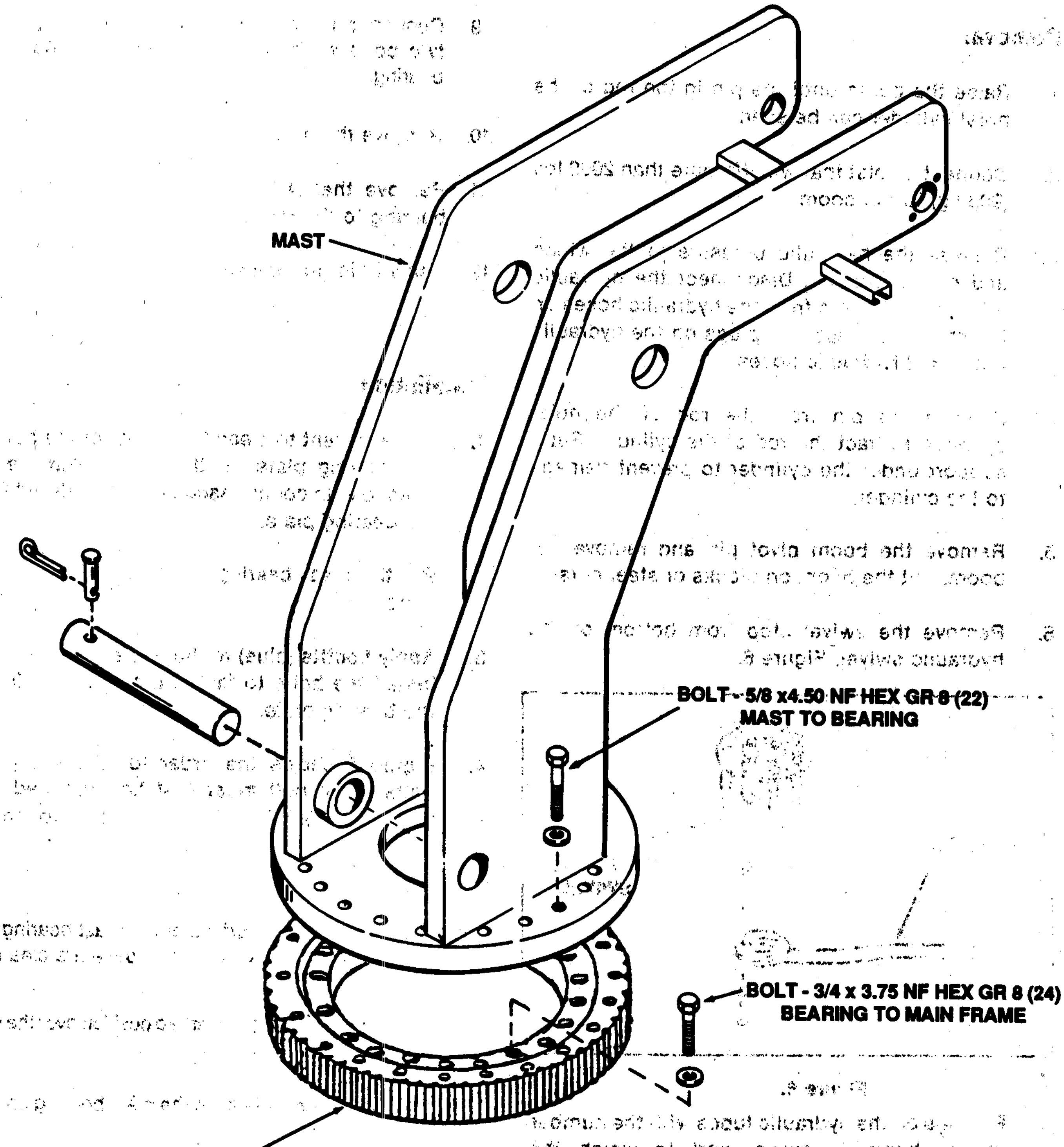


Figure 7. Mast and Bearing Assembly

9. Figure 5 shows the order for tightening the bolts. Each bolt must first be tightened to a torque of 200 lb-ft (271 Nm) and then loosened a small amount. Next, tighten the bolts to a torque of 200 lb-ft (271 Nm).

10. Install the swivel stop to the hydraulic swivel.

11. Connect the hydraulic tubes to the correct ports on the hydraulic swivel.

12. With a hoist, lift the boom into position over the mast. Align the holes for the boom pivot pin in the mast with the holes in the boom. Install the boom pivot pin.

13. Raise the boom with the hoist. Lift the hoist cylinder into the vertical position and extend the rod of cylinder. Align the pin hole in the rod with the pin hole in the boom and install the pin.

14. Connect the hydraulic tubes on the boom to the hydraulic hoses on the mast.

15. Apply grease to the boom pivot pin and pin in the rod end of the hoist cylinder. Apply grease to the mast bearing.

16. Operate the boom to remove air from the hydraulic lines.