Part No. 91772SL, Rev. C

Service Manual

Reelmaster® 335-D/3500-D

Preface

This publication provides the service technician with information for troubleshooting, testing, and repair of major systems and components on the Reelmaster 335-D/3500-D

REFER TO THE TRACTION UNIT AND CUTTING UNIT OPERATOR'S MANUALS FOR OPERATING, MAINTENANCE AND ADJUSTMENT INSTRUCTIONS. Space is provided at the end of Chapter 2 in this publication to insert the Operator's Manuals and Parts Catalogs for your machine. Replacement Operator's Manuals are available by sending complete Model and Serial Number of traction unit and cutting unit to:

The Toro Company
8111 Lyndale Avenue South
Minneapolis, MN 55420

The Toro Company reserves the right to change product specifications or this publication without notice.

This safety symbol means DANGER, WARNING, or CAUTION, PERSONAL SAFETY INSTRUCTION. When you see this symbol, carefully read the instructions that follow. Failure to obey the instructions may result in personal injury.

NOTE: A NOTE will give general information about the correct operation, maintenance, service, testing or repair of the machine.

IMPORTANT: The IMPORTANT notice will give important instructions which must be followed to prevent damage to systems or components on the machine.

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Chapter 1

Safety

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Safety Instructions

The Reelmaster 335-D has been tested and verified for compliance with the B71.4-1984 specifications of the American National Standards Institute (ANSI) for riding mowers. Although hazard control and accident prevention partially are dependent upon the design and configuration of the machine, these factors are also dependent upon the awareness, concern, and proper training of the personnel involved in the operation, transport maintenance, and storage of the machine. Improper use or maintenance of the machine can result in injury or death.

CAUTION

Obey the following safety instructions. Read and understand these instructions before operating the Reelmaster 335-D or doing maintenance, troubleshooting, testing, adjustments or repairs. Failure to comply with the safety instructions may result in personal injury.

Before Operating

1. Read and understand the Operator's Manual before starting, operating, maintaining or repairing the machine. Become familiar with the controls and know how to stop the machine and engine quickly. Replacement Operator's Manuals are available by sending complete Model and Serial Number of traction unit and cutting units to:

The Toro Company
8111 Lyndale Avenue South
Minneapolis, MN 55420

Use the Model and Serial Number when referring to your machine. If you have questions about this Service Information, please contact:

The Toro Company
Commercial Service Department
8111 Lyndale Avenue South
Minneapolis, MN 55420

2. Never allow children to operate the machine or adults to operate it without proper instruction. Only trained operators who have read this manual should operate this machine.

3. Never operate the machine while under the influence of drugs or alcohol.

4. Keep all shields, safety devices and decals in place. If a shield, safety device or decal is defective or damaged, repair or replace it before operating the machine.

5. Always wear substantial shoes. Do not operate machine wearing sandals, tennis shoes, sneakers or when barefoot. Do not wear loose fitting clothing that could get caught in moving parts and possibly cause personal injury. Wearing safety glasses, safety shoes, long pants and a helmet is advisable and required by some local ordinances and insurance regulations.

6. Make sure interlock switches are adjusted correctly so engine cannot be started unless traction pedal is in NEUTRAL and cutting units are DISENGAGED.

7. Remove all debris or other objects that might be picked up and thrown by the reels or fast moving components from other attached implements. Keep all bystanders away from operating area.

8. Since diesel fuel is flammable, handle it carefully:

A. Use an approved fuel container.
B. Do not remove fuel tank cap while engine is hot or running.
C. Do not smoke while handling fuel.
D. Fill fuel tank outdoors and only to within an inch (25 mm) from the top of the tank, not the filler neck. Do not overfill.
E. Wipe up any spilled fuel.

While Operating

9. Sit on the seat when starting and operating the machine.

10. Before starting the engine:

A. Engage the parking brake.
B. Make sure traction pedal is in NEUTRAL and cutting units are DISENGAGED. Move axle shift to HI or LO position.
C. After engine is started, release parking brake and keep foot off traction pedal. Machine must not move. If movement is evident, the neutral return mechanism is adjusted incorrectly; therefore, shut engine off and adjust until machine does not move when traction pedal is released.

11. Seating capacity is one person. Never carry passengers.

12. Do not run engine in a confined area without adequate ventilation. Exhaust fumes are hazardous and could possibly be deadly.

13. Check interlock switches daily for proper operation. Do not rely entirely on safety switches - use common sense. If a switch fails, replace it before operating the machine. The interlock system is for your protection, so do not bypass it. Replace all interlock switches every two years.

14. Using the machine demands attention. To prevent loss of control:

A. Operate only in daylight, or when there is good artificial light.
B. Drive slowly.
C. Watch for holes or other hidden hazards.
D. Look behind machine before backing up.
E. Do not drive close to a sand trap, ditch, creek or other hazard.
F. Reduce speed when making sharp turns and turning on a hillside.
G. Avoid sudden stops and starts.

15. Traverse slopes carefully. Do not start or stop suddenly when traveling uphill or downhill. Never shift axle when moving. Machine must be on a flat surface and / or brakes must be engaged to prevent free-wheeling.

16. Operator must be skilled and trained in how to drive on hillsides. Failure to use caution on slopes or hills may cause loss of control and vehicle to tip or roll, possibly resulting in personal injury or death.

17. When operating 4 wheel drive machine, always use the seat belt and ROPS together and have seat pivot retaining pin installed.

18. If engine stalls or loses headway and cannot make it to the top of a slope, do not turn machine around. Always back slowly straight down the slope.

19. Raise cutting units and latch them securely in transport position before driving from one work area to another.

20. DON'T TAKE AN INJURY RISK! When a person or pet appears unexpectedly in or near the mowing area, STOP MOWING. Careless operation, combined with terrain angles, ricochets, or improperly positioned guards can lead to thrown object injuries. Do not resume mowing until area is cleared.

21. Do not touch engine, muffler or exhaust pipe while engine is running or soon after it is stopped. These areas could be hot enough to cause burns.

22. If cutting unit strikes a solid object or vibrates abnormally, stop immediately, turn engine off, set parking brake and wait for all motion to stop. Inspect for damage. If reel or bedknife is damaged, repair or replace it before operating. Do not attempt to free blocked cutting unit by reversing reel direction. Damage to hydraulic system and / or reel may result.

23. Before getting off of the seat:

A. Set parking brake.
B. Move traction pedal to neutral and wait for reels to stop.
C. Disengage cutting units and wait for reels to stop.
D. Stop engine and remove key from switch.
E. Do not park on slopes unless wheels are chocked or blocked.

24. Use only a rigid tow bar if it becomes necessary to tow machine. Use trailer for normal transport.

While Doing Maintenance, Troubleshooting, Testing, Adjustments or Repairs

25. Before servicing or making any adjustments, stop engine and remove key from switch.

26. Make sure machine is in safe operating condition by keeping all nuts, bolts and screws tight.

27. Make sure all hydraulic line connections are tight, and all hydraulic hoses and lines are in good condition before applying pressure to the system.

28. Keep body and hands away from pin hole leaks or nozzles that eject high pressure hydraulic fluid. Use cardboard or paper to find hydraulic leaks. Hydraulic fluid escaping under pressure can penetrate skin and cause injury. Fluid accidentally injected into the skin must be surgically removed within a few hours by a doctor familiar with this form of injury or gangrene may result.

29. Before disconnecting or performing any work on the hydraulic system, all pressure in system must be relieved by lowering cutting units to the ground and stopping the engine.

30. If major repairs are ever need or assistance is desired, contact an Authorized Toro Distributor.

31. To reduce potential fire hazard, keep engine area free of excessive grease, grass, leaves and dirt. Clean protective screen on back of machine frequently.

32. If engine must be running to perform maintenance or an adjustment, keep hands, feet, clothing and other parts of the body away from cutting units and other moving parts. Keep all bystanders away.

33. Do not overspeed engine by changing governor setting. To assure safety and accuracy, have an Authorized Toro Distributor check maximum engine speed.

34. Shut engine off before checking or adding oil to engine crankcase.

35. Disconnect battery before checking or adding oil to the crankcase.

36. Toro recommends that two people be used to backlap reels. Each person has specific duties and must communicate with one another. Refer to Cutting Unit Operator's Manual for specific backlapping instructions.

37. At the time of manufacture, the machine conformed to the safety standards for riding mowers. To assure optimum performance and continued safety certification of the machine, use genuine Toro replacement parts and accessories. Replacement parts and accessories made by other manufacturers may result in non-conformance with the safety standards, and the warranty may be voided.

Chapter 2

Product Records and Manuals

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Product Records

Record information about your machine on the Product Record Form. Use this information when referring to your machine.

Insert the Operator's Manuals and Parts Catalogs for your Reelmaster 335-D or 3500-D at the end of this section.

Equivalents and Conversions

Decimal and Millimeter Equivalents

Fractions	Decimals	mm	Fractions	Decimals	mm
1/64	0.015625	— 0.397	33/64	0.515625	— 13.097
1/32	0.03125	— 0.794	17/32	0.53125	— 13.494
3/64	0.046875	— 1.191	35/64	0.546875	— 13.891
1/16	0.0625	— 1.588	9/16	0.5625	— 14.288
5/64	0.078125	— 1.984	37/64	0.578125	— 14.684
3/32	0.9375	— 2.381	19/32	0.59375	— 15.081
7/64	0.109275	— 2.778	39/64	0.609375	— 15.478
1/8	0.1250	— 3.175	**5/8**	0.6250	— 15.875
9/64	0.140625	— 3.572	41/64	0.640625	— 16.272
5/32	0.15625	— 3.969	21/32	0.65625	— 16.669
11/64	0.171875	— 4.366	43/64	0.671875	— 17.066
3/16	0.1875	— 4.762	11/16	0.6875	— 17.462
13/64	0.203125	— 5.159	45/64	0.703125	— 17.859
7/32	0.21875	— 5.556	23/32	0.71875	— 18.256
15/64	0.234375	— 5.953	47/64	0.734375	— 18.653
1/4	0.2500	— 6.350	**3/4**	0.7500	— 19.050
17/64	0.265625	— 6.747	49/64	0.765625	— 19.447
9/32	0.28125	— 7.144	25/32	0.78125	— 19.844
19/64	0.296875	— 7.541	51/64	0.796875	— 20.241
5/16	0.3125	— 7.541	13/16	0.8125	— 20.638
21/64	0.328125	— 8.334	53/64	0.828125	— 21.034
11/32	0.34375	— 8.731	27/32	0.84375	— 21.431
23/64	0.359375	— 9.128	55/64	0.859375	— 21.828
3/8	0.3750	— 9.525	**7/8**	0.8750	— 22.225
25/64	0.390625	— 9.922	57/64	0.890625	— 22.622
13/32	0.40625	— 10.319	29/32	0.90625	— 23.019
27/64	0.421875	— 10.716	59/64	0.921875	— 23.416
7/16	0.4375	— 11.112	15/16	0.9375	— 23.812
29/64	0.453125	— 11.509	61/64	0.953125	— 24.209
15/32	0.46875	— 11.906	31/32	0.96875	— 24.606
31/64	0.484375	— 12.303	63/64	0.984375	— 25.003
1/2	0.5000	— 12.700	**1**	1.000	— 25.400

1 mm = 0.03937 in. **0.001 in. = 0.0254 mm**

U.S to Metric Conversions

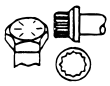
	To Convert	Into	Multiply By
Linear Measurement	Miles	Kilometers	1.609
	Yards	Meters	0.9144
	Feet	Meters	0.3048
	Feet	Centimeters	30.48
	Inches	Meters	0.0254
	Inches	Centimeters	2.54
	Inches	Millimeters	25.4
Area	Square Miles	Square Kilometers	2.59
	Square Feet	Square Meters	0.0929
	Square Inches	Square Centimeters	6.452
	Acre	Hectare	0.4047
Volume	Cubic Yards	Cubic Meters	0.7646
	Cubic Feet	Cubic Meters	0.02832
	Cubic Inches	Cubic Centimeters	16.39
Weight	Tons (Short)	Metric Tons	0.9078
	Pounds	Kilograms	0.4536
	Ounces (Avdp.)	Grams	28.3495
Pressure	Pounds/Sq. In.	Kilopascal	6.895
Work	Foot-pounds	Newton-Meters	1.356
	Foot-pounds	Kilogram-Meters	0.1383
	Inch-pounds	Kilogram-Centimeters	1.152144
Liquid Volume	Quarts	Liters	0.9463
	Gallons	Liters	3.785
Liquid Flow	Gallons/Minute	Liters/Minute	3.785
Temperature	Fahrenheit	Celsius	1. Subract 32^{o} 2. Multiply by 5/9

Torque Specifications

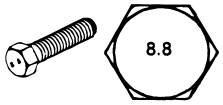
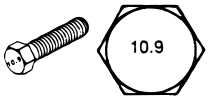
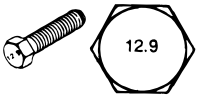
Use these torque values when specific torque values are not given. DO NOT use these values in place of specified values.

The torque values listed below are for lubricated threads. Plated threads are considered to be lubricated.

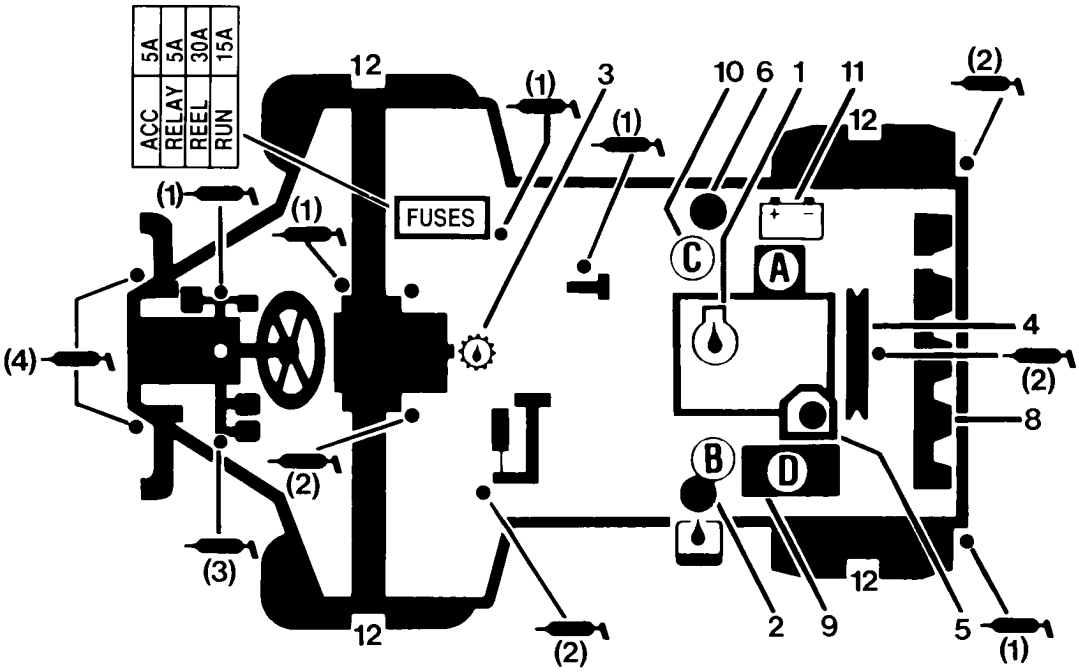
Capscrew Markings and Torque Values - U.S. Customary

SAE Grade Number	5				8			
Capscrew Head Markings								
Capscrew Body Size	Capscrew Torque - Grade 5				Capscrew Torque - Grade 8			
	Cast Iron		Aluminum		Cast Iron		Aluminum	
	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm
1/4-20	7	9	6	8	11	15	9	12
-28	9	12	7	9	13	18	10	14
5/16-18	15	20	12	16	22	30	18	24
-24	17	23	14	19	24	33	19	25
3/8-16	30	40	20	25	40	55	30	40
-24	30	40	25	35	45	60	35	45
7/16-14	45	60	35	45	65	90	50	65
-20	50	65	40	55	70	95	55	75
1/2-13	70	95	55	75	95	130	75	100
-20	75	100	60	80	110	150	90	120
9/16-12	100	135	80	110	140	190	110	150
-18	110	150	85	115	155	210	125	170
5/8-11	135	180	110	150	190	255	150	205
-18	155	210	120	160	215	290	170	230
3/4-10	240	325	190	255	340	460	270	365
-16	270	365	210	285	380	515	300	410
7/8-9	360	490	280	380	550	745	440	600
-14	390	530	310	420	610	825	490	660
1-8	530	720	420	570	820	1100	660	890
-14	590	800	480	650	890	1200	710	960

Capscrew Markings and Torque Values – Metric

Commercial Steel Class	8.8				10.9				12.9			
Capscrew Head Markings												
Thread Diameter mm	Capscrew Torque - Class 8.8				Capscrew Torque - Class 10.9				Capscrew Torque - Class 12.9			
	Cast Iron		Aluminum		Cast Iron		Aluminum		Cast Iron		Aluminum	
	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm
6	5	9	4	7	9	14	7	11	9	14	7	11
7	9	14	7	11	14	18	11	14	18	23	14	18
8	18	25	14	18	23	32	18	25	27	36	21	28
10	30	40	25	30	45	60	35	45	50	70	40	55
12	55	70	40	55	75	105	60	80	95	125	75	100
14	85	115	65	90	120	160	95	125	145	195	110	150
16	130	180	100	140	175	240	135	190	210	290	165	220
18	170	230	135	180	240	320	185	250	290	400	230	310

RM 335-D 2WD
QUICK REFERENCE AID



CHECK/SERVICE

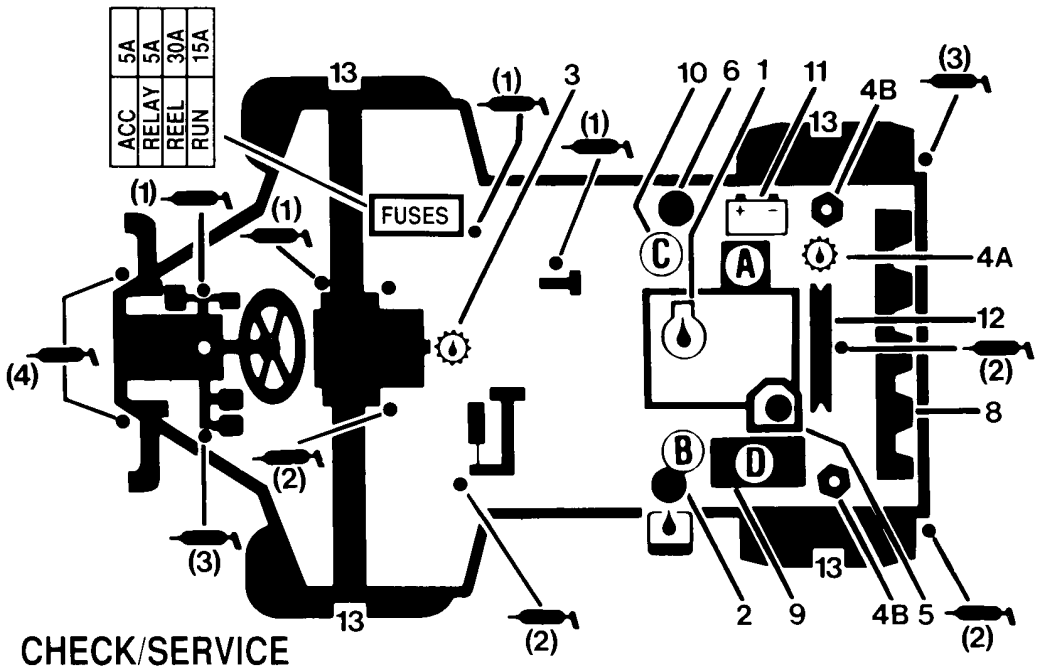
1. ENGINE OIL LEVEL/FILL
2. HYDRAULIC OIL LEVEL/FILL
3. FRONT AXLE OIL LEVEL/FILL
4. FAN BELT
5. COOLANT LEVEL/FILL
6. FUEL-DIESEL ONLY
7. GREASE POINTS (20)
8. RADIATOR SCREEN
9. AIR CLEANER
10. WATER SEPARATOR/FUEL FILTER
11. BATTERY
12. TIRE PRESSURE (1-1.5 BAR/15-20 PSI)

FLUID SPECIFICATIONS/CHANGE INTERVALS

*See operator's manual for initial changes.		FLUID TYPE	CAPACITY		CHANGE INTERVAL		FILTER PART NO.
		-	L	USA	FLUID	FILTER	
ENGINE OIL		SAE 10W-30 CD	5	5.3QT	50 HRS	100 HRS	74 - 7970 (A)
HYD. CIRCUIT OIL		Mobil DTE 26	24.6	6.5G	500 HRS	500 HRS	76 - 6490 (B)
AXLE OIL		SAE 80-90 E.P.	-		750 HRS	-	-
FUEL FILTER		-				400 HRS	76 - 8790 (C)
AIR CLEANER		Clean @ 50 hrs.				250 HRS	27 - 7110 (D)
FUEL	>32° F 0° C	NO.2-D	53	14 GAL.	Drain and flush, 2 yrs.		
	<32° F 0° C	NO. 1-D					
COOLANT		50/50 Peugeot recommended anti-freeze	13.25	3.5 GAL.			

82-4870

RM 335-D 4WD
QUICK REFERENCE AID



CHECK/SERVICE

1. ENGINE OIL LEVEL/FILL
2. HYDRAULIC OIL LEVEL/FILL
3. FRONT AXLE OIL LEVEL/FILL
4. REAR AXLE OIL
   - A. FILL
   - B. CHECK (2)
5. COOLANT LEVEL/FILL
6. FUEL - DIESEL ONLY
7. GREASE POINTS (22)
8. RADIATOR SCREEN
9. AIR CLEANER
10. WATER SEPARATOR/FUEL FILTER
11. BATTERY
12. FAN BELT
13. TIRE PRESSURE (1-1.5 BAR/15-20 PSI)

FLUID SPECIFICATIONS/CHANGE INTERVALS

*See operator's manual for initial changes.		FLUID TYPE	CAPACITY		CHANGE INTERVAL		FILTER PART NO.
		-	L	USA	FLUID	FILTER	
ENGINE OIL		SAE 10W-30 CD	5	5.3QT	50 HRS	100 HRS	74 - 7970 (A)
HYD. CIRCUIT OIL		Mobil DTE 26	24.6	6.5G	500 HRS	500 HRS	76 - 6490 (B)
AXLE OIL		SAE 80-90 E.P.	-		750 HRS	-	-
FUEL FILTER		-				400 HRS	76 - 8790 (C)
AIR CLEANER		Clean @ 50 hrs.				250 HRS	27 - 7110 (D)
FUEL	>32°F 0° C	NO.2-D	53	14 GAL.			
	<32°F 0° C	NO. 1-D					
COOLANT		50/50 Peugeot recommended anti-freeze	13.25	3.5 GAL.	Drain and flush, 2 yrs.		

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EQUIPMENT OPERATION AND SERVICE HISTORY REPORT
for
REELMASTER® 335-D and 3500-D

TORO Model and Serial Number:_____-_____

Engine Numbers: _____

Transaxle Numbers: _____

Cutting Unit Numbers: _____ _____

_____ _____

Date Purchased: _____ Warranty Expires_____

Purchased From: _____

_____

_____

Contacts: Parts _____ Phone_____

Service _____ Phone_____

Sales _____ Phone_____

See your TORO *Distributor/Dealer for other Publications, Manuals, and Videos from* The TORO Company.

REELMASTER® 335-D and 3500-D Maintenance Schedule

Minimum Recommended Maintenance Intervals:

Maintenance Procedure	Maintenance Interval & Service Type:				
	Every 50hrs	Every 100hrs	Every 200hrs	Every 400hrs	Every 800hrs
Inspect Air Filter, Dust Cup, and Baffle Lubricate All Grease Fittings	*A Level Service*				
‡ Change Engine Oil & Filter Check Battery Level and Connections Inspect Cooling System Hoses		*B Level Service*			
Service Air Cleaner Filter Element Inspect Cutting Unit Reel Drive Belts † Torque Wheel Lug Nuts			*C Level Service*		
Replace Fuel Filter Check Front Transaxle Oil level Check Rear Axle Oil level (4WD) Inspect Fuel Lines and Connections ‡ Check Engine RPM (idle and full throttle)				*D Level Service*	
Inspect Engine Fan Belt Inspect Engine Timing Belt(see note below) Drain and Clean Fuel Tank Change Hydraulic Oil ‡ Replace Hydraulic Oil Filter Change Front Transaxle Oil Pack Rear Axle Bearings (2WD) Change Rear Axle Oil (4WD) Check Rear Wheel Toe-in					*E Level Service*

† Initial break in at 10 hours

‡ Initial break in at 50 hours

Replace Moving Hydraulic Hoses
Replace Safety Switches
Cooling System - Flush/Replace Fluid

Annual Recommendations:
Items listed are recommended every 1500 hours or 2 years whichever occurs first.

See Operator's and Service Manual for specifications and procedures)

NOTE: Replace Timing Belt if worn, cracked or oil soaked. A new Timing Belt should be installed any time the Belt is removed or loosened.

REELMASTER® 335-D and 3500-D Daily Maintenance Check List

Unit Designation:_____

Daily Maintenance:(duplicate this page for routine use) TORO ID#:_____-_____

Maintenance Check Item	Daily Maintenance Check For Week Of _____						
	MON _____HRS	TUES _____HRS	WED _____HRS	THURS _____HRS	FRI _____HRS	SAT _____HRS	SUN _____HRS
✓ Safety Interlock Operation							
✓ Brake Operation							
✓ Engine Oil Level							
✓ Fuel Level							
✓ Cooling System Fluid Level							
Drain Water/Fuel Separator							
✓ Optional Air Filter Precleaner							
✓ Radiator & Screen for Debris[1]							
✓ Unusual Engine Noises[2]							
✓ Unusual Operating Noises							
✓ Hydraulic System Oil Level							
✓ Hydraulic Hoses for Damage							
✓ Fluid Leaks							
✓ Tire Pressure							
✓ Instrument Operation							
✓ Reel-to-Bedknife Adjustment							
✓ Height-of-Cut Adjustment							
Lubricate All Grease Fittings[3]							
Touch-up damaged paint							

[1] = Use only low pressure compressed air for debris removal. **Do not use water**.

[2] = Check Glow Plugs and Injector Nozzles, if hard starting, excess smoke, or rough running is noted.

[3] = Immediately after every washing, regardless of the interval listed.

Notation for areas of concern: Inspection performed by:_____

Item	Date	Information
1		
2		
3		
4		
5		
6		
7		

(See Operator's and Service Manual for specifications and procedures)

REELMASTER® 335-D and 3500-D Supervisor Maintenance Work Order

Date:_____

(duplicate this page for routine use)

Unit Designation:	TORO I.D. #: _____-_____
Hours:	Service to perform (circle):
Technician:	**A B C D E Other**

Remarks:

A -Service (every 50 hours)

- ☐ Inspect Air Filter, Dust Cup, and Baffle
- ☐ Lubricate All Grease Fittings
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____

B -Service (every 100 hours)

- ☐ Change Engine Oil and Filter
- ☐ Check Battery Level and Connections
- ☐ Inspect Cooling System Hoses
- ☐ **A-Service** required
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____

C -Service (every 200 hours)

- ☐ Service Air Cleaner Filter Element
- ☐ Inspect Cutting Unit Reel Drive Belts
- ☐ Torque Wheel Lug Nuts
- ☐ **A** and **B Service** required
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____

D -Service (every 400 hours)

- ☐ Replace Fuel Filter
- ☐ Check Front Transaxle Oil level
- ☐ Check Rear Axle Oil level (4WD)
- ☐ Inspect Fuel Lines and Connections
- ☐ Check Engine RPM (Idle/Full Throttle)
- ☐ **A**, **B**, and **C Service** required
- ☐ _____
- ☐ _____
- ☐ _____

E -Service (every 800 hours)

- ☐ Inspect Engine Fan Belt
- ☐ Inspect Engine Timing Belt
- ☐ Drain and Clean Fuel Tank
- ☐ Change Hydraulic Oil & Filter
- ☐ Change Front Transaxle Oil
- ☐ Pack Rear Axle Bearings (2WD)
- ☐ Change Rear Axle Oil (4WD)
- ☐ Check Rear Wheel Toe-in
- ☐ **A**, **B**, **C**, and **D Service** required

Other - Annual Service and Specials

- ☐ Replace Moving Hoses
- ☐ Replace Safety Switches
- ☐ Coolant System - Flush/Replace Fluid
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____

(See Operator's and Service Manual for specifications and procedures)

Chapter 3

Engine

Table of Contents

Introduction

The following pages give information about specifications, maintenance, troubleshooting, testing and repair of the diesel engine used in the Reelmaster® 335-D and 3500-D mowers.

Most repairs and adjustments require tools which are commonly available in many service shops. Special tools are described in the Special Tools section. The use of some specialized test equipment is explained, however, the cost of the test equipment and the specialized nature of some repairs may dictate that the work be done at a qualified diesel engine repair facility.

Service and repair parts for the Peugeot engine used in the Reelmaster 335-D and 3500-D are supplied through TORO Distributors. Repair parts may be ordered by TORO Part Number. If no parts list is available be sure to provide your dealer or distributor with the TORO Model Number and Serial Number.

A plate, riveted to the left-hand side of the engine block carries the Engine Serial Number. Always include the engine serial number with parts orders and warranty claims.

Identification and Specifications

General Specifications

Item	Specification
Engine Type	Peugeot XUD9AI, 4 cycle, water cooled, 4 cylinder, vertical in-line cylinders, single overhead cam, indirect injection, naturally aspirated.
Compression ratio	23.5 : 1
Governor:	Mechanical centrifugal type integral with fuel injection pump.
Governor Adjustment	2500 ± 50 RPM no load 1600 +100/–0 RPM idle speed
Engine Rotation	Counterclockwise when facing flywheel.
Crankshaft	Forged steel, induction hardened bearing surfaces, 5 main bearing supports.
Cylinder Block	Cast iron with integral cylinder liners.
Cylinder Head	Cast aluminum material with single overhead camshaft.
Timing Drive	The camshaft, water pump and fuel injection pump are driven from the front end of the crankshaft through belt drive.
Piston and Piston Rings	Pistons are aluminum alloy castings with free-floating wrist pin.
Lubrication	Full pressure feed by gear type pump.
Oil Filter	Full flow, cartridge type, paper element with bypass.
Oil Capacity	5 liters (5.3 qt.), including oil filter.
Lubricating Oil	API class CD SAE 15W-40
Oil Pressure	0.5 Bar (7 PSI) minimum
Fuel Requirements	No. 2 diesel fuel (ASTM No. 2-D).
Fuel Filter	Replaceable paper element.
Crankcase Ventilation	Connected to intake manifold with PCV valve.
Cooling System	Water is circulated through the cylinder block and head by a centrifugal water pump mounted at the front of the cylinder block. The water pump operates at 1.05 times engine speed. Water flow is 92 liters/min. at 2500 engine RPM.
Firing Order (NO. 1 CYL. IS ON FLYWHEEL END)	1 - 3 - 4 - 2
Electrical System	12 volt, negative ground, 55 AMP alternator with integral regulator. 12 volt - 1.4 Kw starter motor with integral solenoid, pinion shaft type.

Cylinder Head

Cylinder head height **h** is measured with the camshaft in place fitted with two bearing caps.

h is measured on the oil seal lip contact diameter (the largest diameter).

h nominal: 157.40 to 157.75 mm

Maximum permissible bow on bottom of cylinder head: 0.07 mm (camshaft must turn freely).

Maximum permissible gasket face machining: 1.4 mm in relation to the measured **h** nominal.

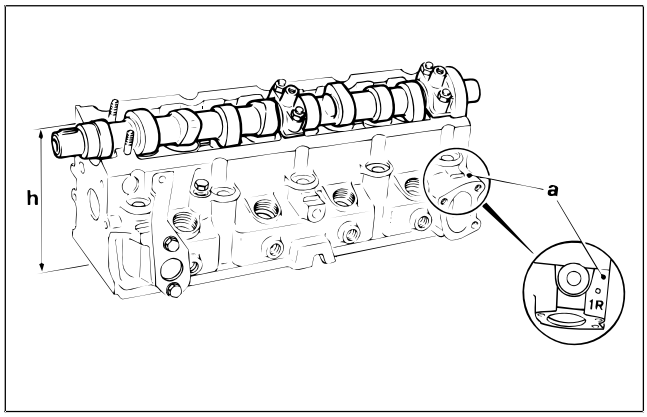


Figure 2

Cylinder heads machined undersize are stamped **R** in the area (**a**):

After machining gasket face, the following operations must be done:

1. Valve seat machining to re-establish correct recess (see Valve Recess in this section).

2. Replacement of swirl chambers by repair dimension and correction of their protrusion (see Swirl Chambers in this section).

3. Fitting of 0.4 mm thick compensation washers under the valve springs (to match cylinder head machining.

Cylinder heads manufactured with oversize camshaft bearings (+0.5) are stamped **1** in the area (**a**)

Cylinder Head Gasket

Thickness identification:

Units: mm

Identification (**c**)	Identification (**b**)	Thickness
No notch	2 notches	1.48
	3 notches	1.52
	4 notches	1.58
	5 notches	1.62

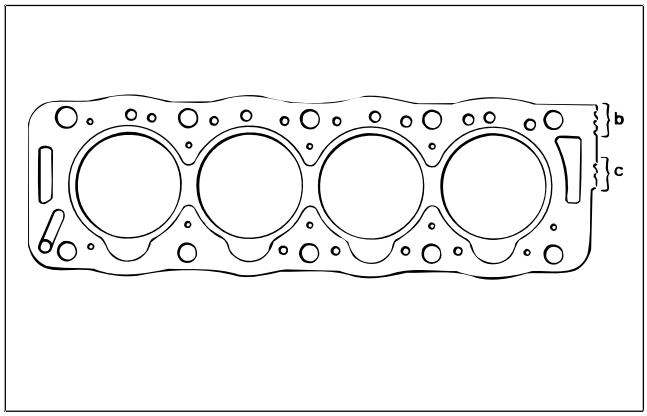


Figure 3

Camshaft

Camshafts with 0.5 mm oversize bearings* are identified by a yellow paint ring (**d**) between the cams of No. 1 cylinder.

* NOTE: These camshafts are installed only on exchange engines, and can be obtained on special order.

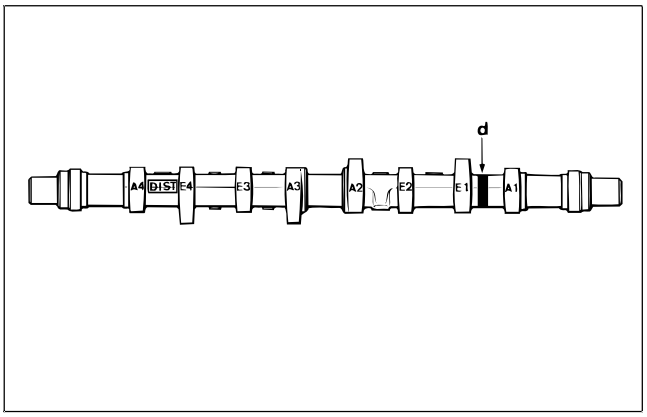


Figure 4

Valves

Units: mm

	Intake	Exhaust
Min. Length **l**	112.2	
ø**a** $^{+0}_{-0.015}$	8.005	7.985
ø**b** ± 0.1	38.5	33
a	90°	90°

Intake: Faces **x** and **y** can machined a maximum of 0.2 mm

Exhaust: No machining is permissible.

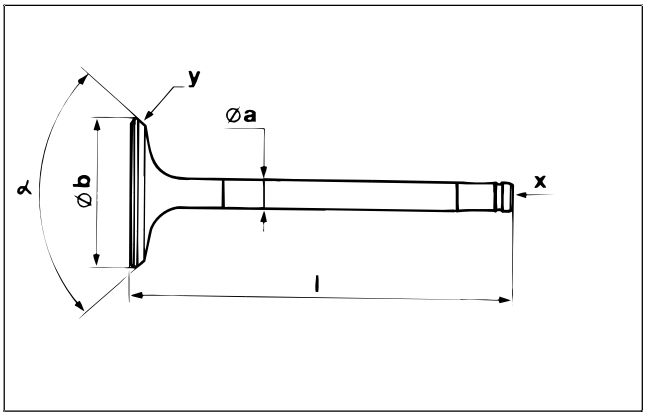


Figure 5

Valve Recess

Units: mm

	Intake	Exhaust
c	0.5 to 1.05	0.9 to 1.45

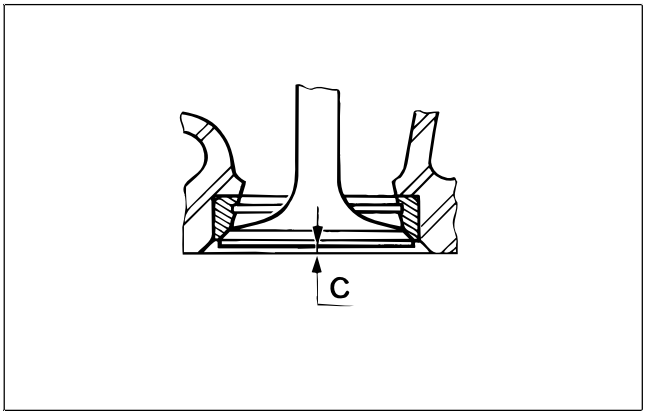


Figure 6

Valve Springs

Units: mm

	Spring
ød	29
P1: daN **e1**	18 42.4

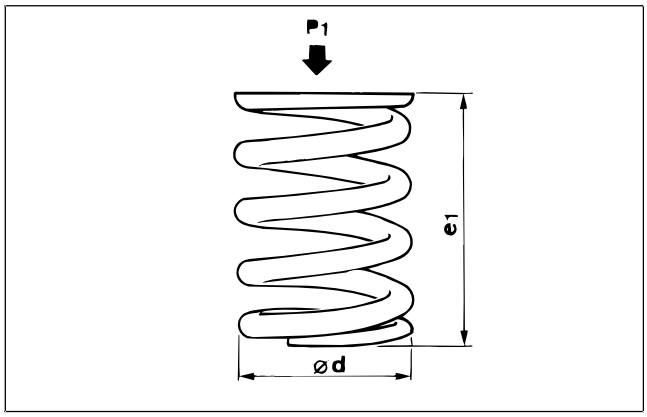


Figure 7

Valve Guides

Units: mm

	øf	**øg**	**h**	**j**	**øk**
Tolerance	0 – 0.011	+ 0.032 0	± 0.25	± 0.50	0 + 0.2
Production	14.02 14.13	13.981 14.051			
Repair 1	14.29	14.211	52.00	36.50	8.02
Repair 2	14.59	14.511			

øk is obtained by machining after fitting in the cylinder head

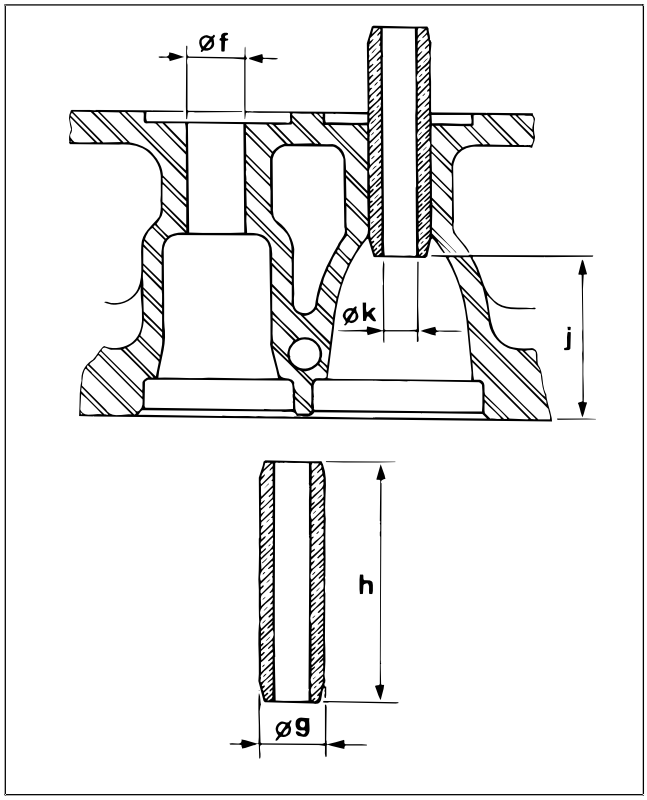


Figure 8

Valve Seats

Units: mm

Intake				
	øa	**øb**	**c**	**d**
Tolerance	0 – 0.025	± 0.025	0 – 0.1	± 0.15
Production	40.161 40.361	40 40.2	6.25 6.45	8.267 8.467
Repair 1	40.461	40.3	6.45	8.467
Repair 2	40.661	40.5	6.45	8.467

Units: mm

Exhaust				
	øa	**øb**	**c**	**d**
Tolerance	0 – 0.025	± 0.025	0 – 0.1	± 0.15
Production	34.137 34.337	34 34.2	6.05 6.25	8.15 8.35
Repair 1	34.437	34.3	6.25	8.35
Repair 2	34.637	34.5	6.25	8.35

After fitting valve seats into the cylinder head, machine them according to drawings (Fig. 9).

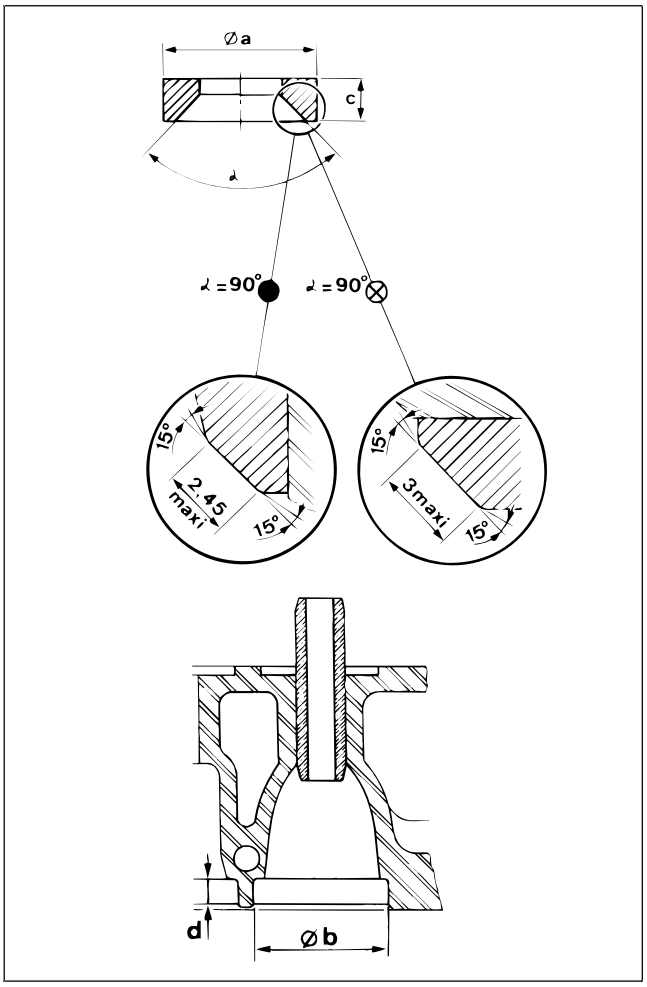


Figure 9

Swirl Chambers

Units: mm

	øe	**øf**	**g**	**h**
Tolerance	+ 0.099 – 0.060	+ 0.039 + 0	+ 0.020 – 0.025	+ 0.02 – 0.04
Production	32.05 32.25	32 32.2	4 4.1	3.9 4
Repair 1	32.45	32.4	4.2	4.1
Repair 2	32.65	32.6	4.3	4.2

The protrusion **j** must be between **0** and **0.03 mm**
Dimension **j** is obtained by machining faces (**x**) and (**y**)

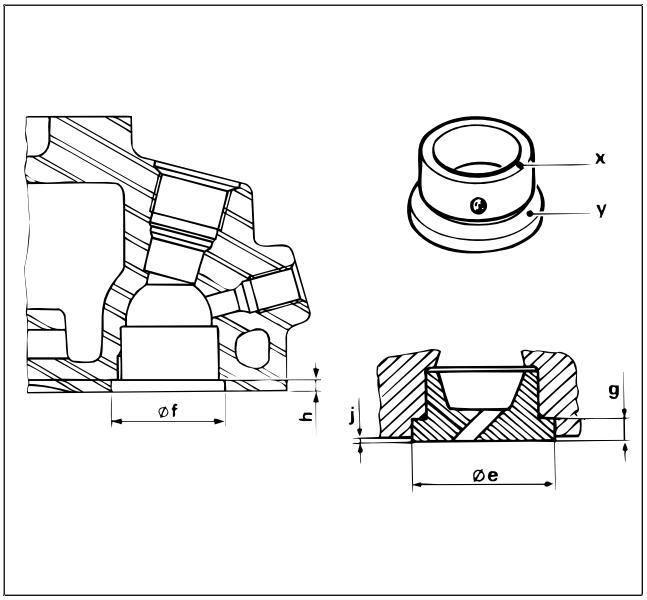


Figure 10

Cylinder / Piston Matching

Units: mm

	Identification (**x**)	CYLINDER ø**a** Tolerance: + 0.018 – 0	PISTON ø**b** Tolerance: ± 0.009
Production	None	83	82.93
	A1	83.03	82.96
Repair 1	R1	83.20	83.13
Repair 2	R2	83.50	83.43
Repair 3	R3	83.80	83.73

NOTE: The piston ø**b** must be measured at dimension **c.**

C	25.00

NOTE: The repair dimension (**x**) is stamped on the cylinder block and pistons.

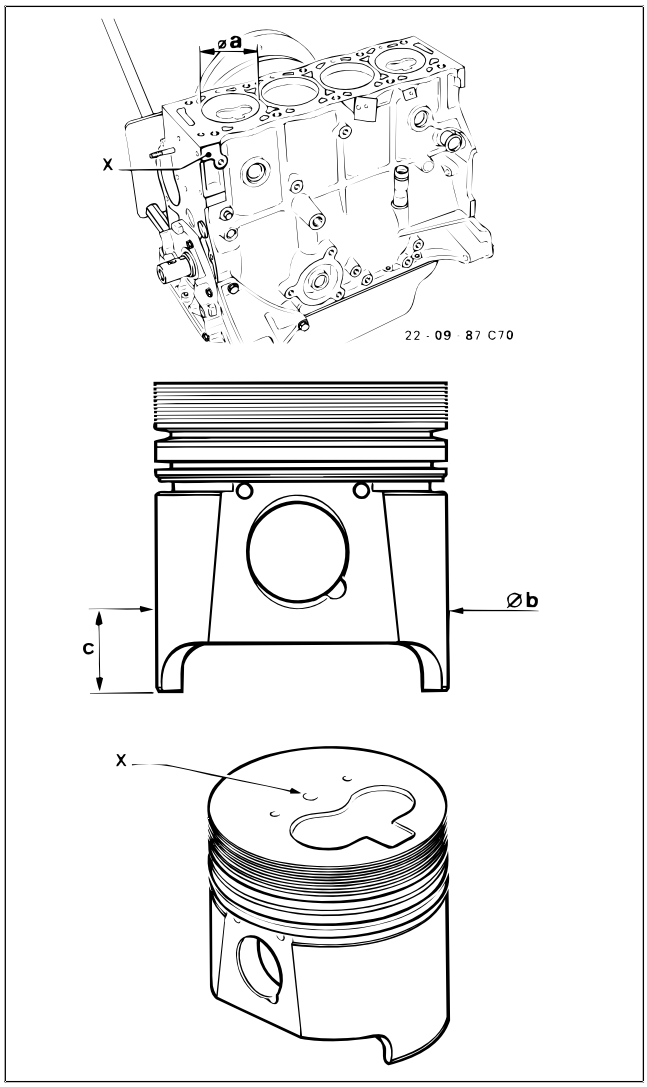


Figure 11

Piston Pin

Units: mm

Ø external	24.994 to 25
Ø internal	13.8 to 14.1

Crankshaft

Units: mm

Crank Pins and Journals				
	øa	**b**	**øc**	**d**
Tolerance	– 0 – 0.016	± 0.003	– 0 – 0.019	± 0.003
Production	50.00	1.827	60.00	1.842
Repair 1	49.70	1.977	59.70	1.992

NOTE: Repair 1 size connecting rod and main bearing shells can be identified by white paint (**1**) on the edge of the shell.

Units: mm

End Float		
	No. 2 Journal	Half Shell Thickness
	e	**f**
Tolerance	+ 0.05 0	± 0.025
Production	26.60	2.305
Repair 1	26.80	2.405
Repair 2	26.90	2.455
Repair 3	27.00	2.505

Units: mm

Oil Seal Contact Surface	
	øg
Tolerance	– 0 – 0.087
Production	90.00
Repair 1	89.80

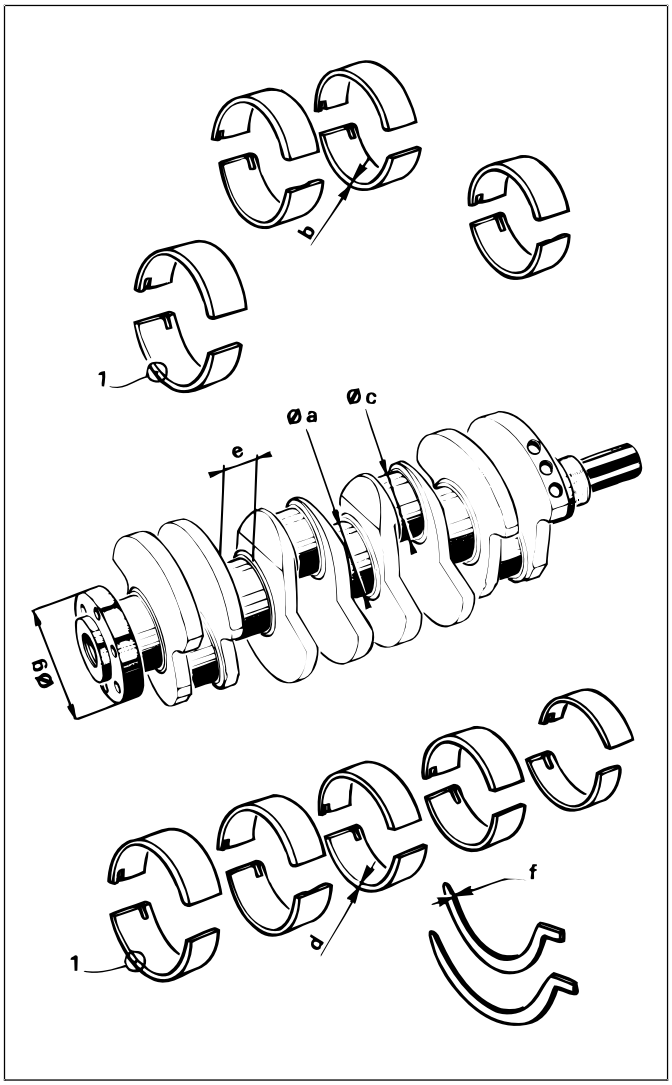


Figure 13

Tightening Torques

Part	Nm	Kgm	ft-lb
Connecting rod end caps	50	5	37
Camshaft bearing caps	17.5	1.8	13
Camshaft gear	40	4	30
Coolant pump	15	1.5	11
* Crankshaft pulley	40 + 60°	4 + 60°	30 + 60°
Cylinder head bolts pre-tightening * tightening	 30 70 +120°	 3 7 + 120°	 22 52 + 120°
Cylinder head cover	10	1	7
Flywheel	50	5	36
Glow plugs	22	2.2	16
Injector pump gear	47	4.7	33
Injector into Cylinder Head	90	9	66
Main bearing caps	70	7	52
Oil pump	20	2	15
Oil seal carrier, timing gear end	15	1.5	11
Sump to block	20	2	15
Timing belt tensioner	15	1.5	11
Water drain plug	25	2.5	18
Oil drain plug	37	3.7	27
Tension roller pin nut	17	1.7	12
Manifold screws	22	2.2	16
Alternator bracket	17	1.7	12

* NOTE: 40 + 60° is tighten to 40 Nm then an additional 60° (60 degrees) of rotation (one flat of bolt head)

Special Tools

NOTE: Order special tools from the *TORO SPECIAL TOOLS AND APPLICATIONS GUIDE (COMMERCIAL PRODUCTS)*. Some tools may be listed in the Reelmaster 335-D or 3500-D Parts Catalog. Some tools may also be available from a local supplier.

TOR4033 Overhaul Tool Set

This tool kit includes tools required for overhauling the engine. TOR4035 Tune-Up Set will also be required if overhauling the engine.

TOR80504A1 Extension (Fig. 24)
TOR80110H Indicator Holder (Fig. 25)
TOR80110DZ 2mm Shim Cutoff Gauge (Fig. 23)
TOR80504A2 Indicator Holder (Fig. 30)
TOR80110GY Extension Rod Adapter (Fig. 24)
TOR70153A1 Main Seal Installer (Fig. 18)
TOR70153A2 Main Seal Installer Shims (Fig. 19)
TOR70153C Rear Main Seal Installer (Fig. 20)
TOR70153D Front Cover Seal Installer (Fig. 21)

TOR4035 Tune-Up Set

This tool kit includes tools required for doing timing belt replacement, injection pump timing, injector removal and camshaft seal replacement.

TOR976697 Camshaft Seal Installer (Fig. 31)
TOR2437T Dial Indicator (Fig. 16)
TOR70153N Flywheel TDC Locator Pin (Fig. 22)
TOR80117AM Injector Pump
Timing Tool Kit (Fig. 26)
TOR80117EZ Crankshaft Rotating Wrench (Fig.27)
TOR80149 Injector Socket (Fig. 28)

TOR2437T Dial Indicator

This dial indicator may be used with TOR80110H, TOR80117AM and TOR80504A2 to accomplish any of the following tasks: for checking the protrusion of the swirl chambers, valve recess and measurement for cylinder head gasket selection, adjusting the timing of the injection pump and for checking the crankshaft and float.

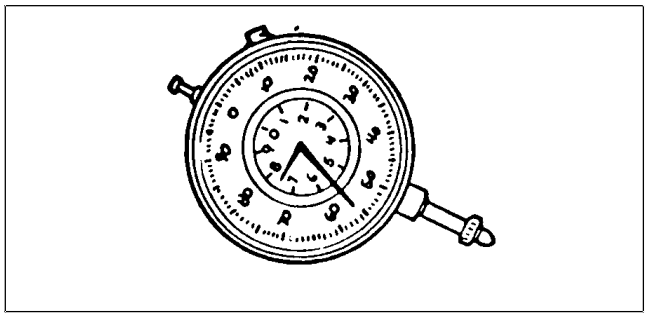


Figure 16

TOR4024T Valve Spring Compressor

This tool is used to compress valves for removal.

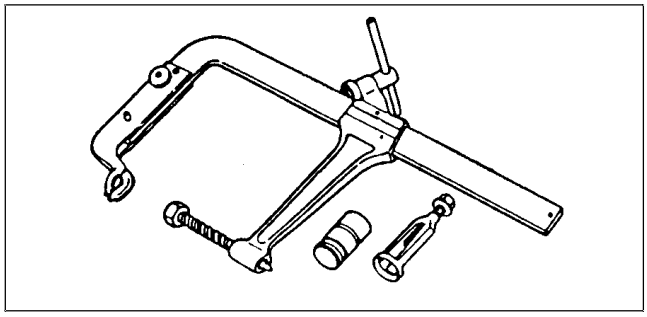


Figure 17

TOR70153A1 Main Seal Installer

Used to install the two side seals to the no. 1 main bearing cap.

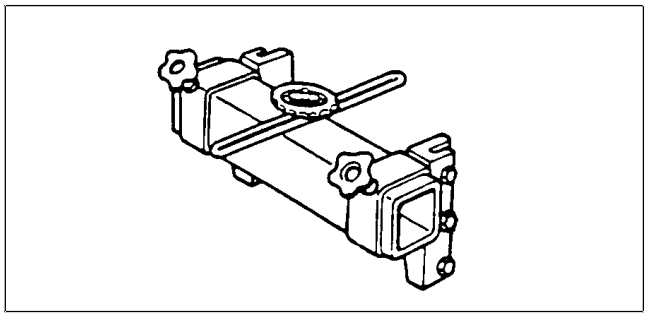


Figure 18

TOR70153A2 Shim Set

Used with main seal installer TOR70153A1.

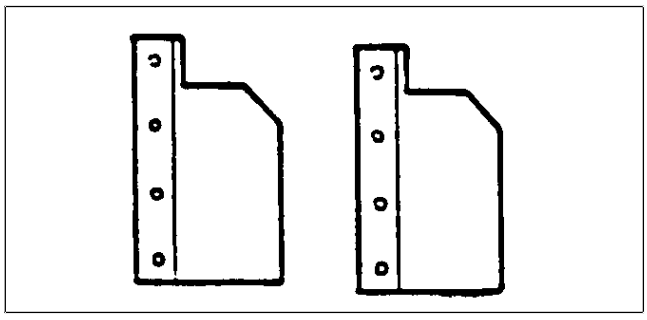


Figure 19

TOR70153C Rear Main Seal Installer

Used with a small hammer to install new rear main oil seal.

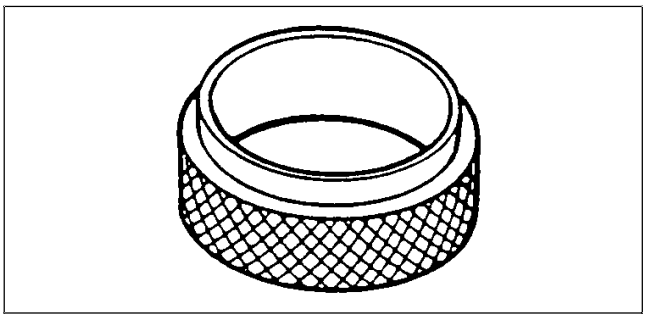


Figure 20

TOR70153D Front Cover Seal Installer

Used with a small hammer to install new front crankshaft seal.

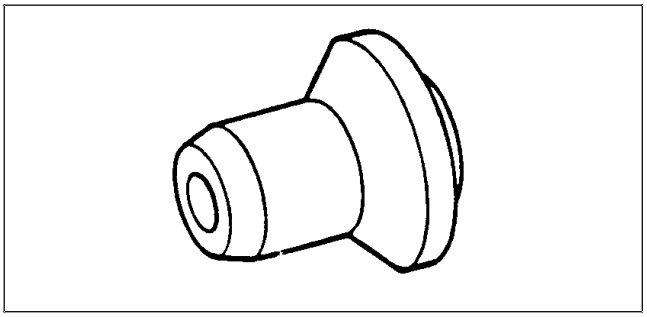


Figure 21

TOR70153N Flywheel T.D.C. Locator Pin

Used to set injection pump timing.

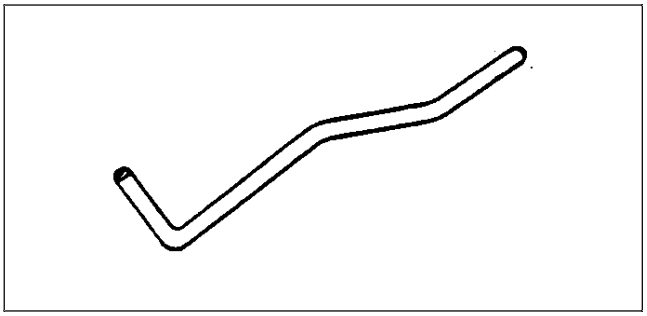


Figure 22

TOR80110DZ 2mm Shim Cut Off Gauge With Cut Off Shim

Used to gage and gut off new side seals to 2mm height.

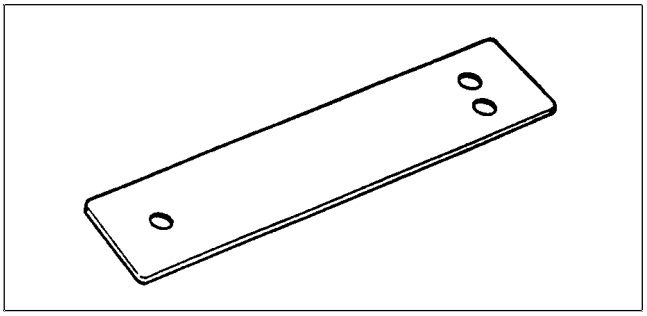


Figure 23

TOR80110GY Extension Rod and Adapter

Used with TOR 80504A1 and TOR80504A2 to check crankshaft end float.

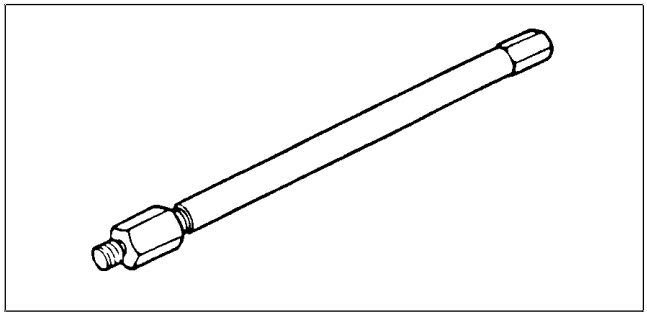


Figure 24

TOR80110H Indicator Holder

Block used to hold dial indicator to check protrusion of swirl chambers, valve recess and measurement for cylinder head gasket selection.

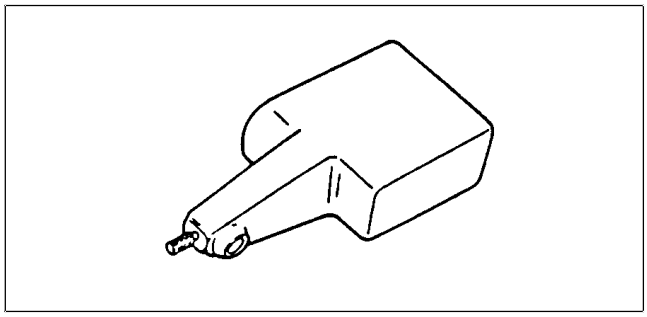


Figure 25

TOR80117AM Timing Tool Kit For Roto Diesel DPC Pump

Used with dial indicator to adjust timing of injection pump.

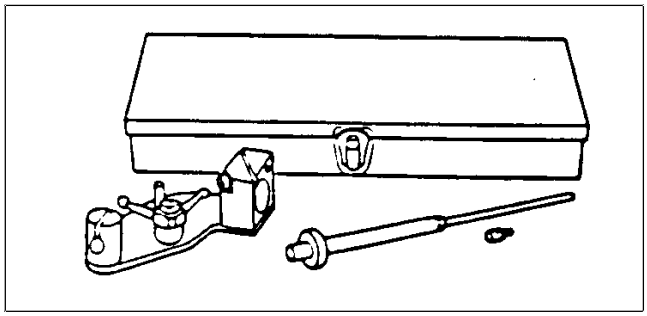


Figure 26

TOR80117EZ Crankshaft Rotating Wrench

Used with a 1/2" drive ratchet wrench to turn the crankshaft.

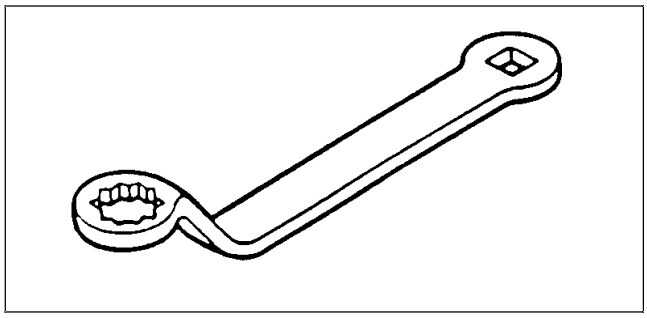


Figure 27

TOR80149 Injector Socket

Used to remove and install fuel injectors.

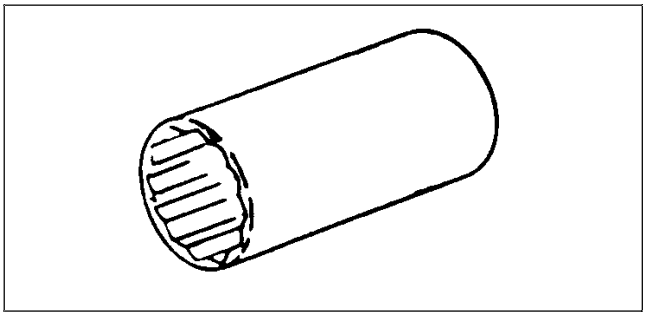


Figure 28

TOR80504A1 Extension

Used with TOR 80110GY and TOR 80504A2 to check crankshaft end float.

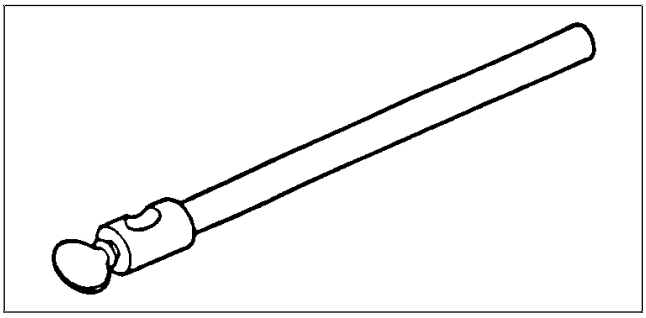


Figure 29

TOR 80504A2 Indicator Holder

Used with TOR80110GY and TOR 80504A1 to check crankshaft end float.

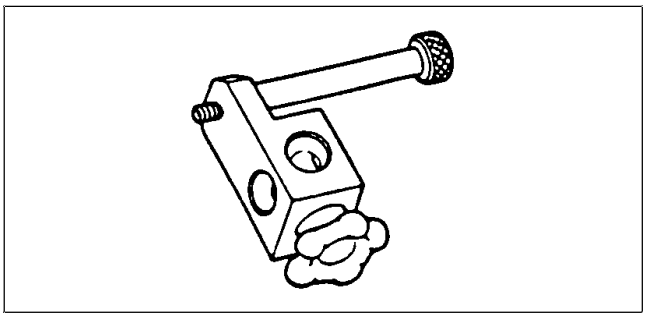


Figure 30

TOR976697 Camshaft Seal Installer

Used to install camshaft seal.

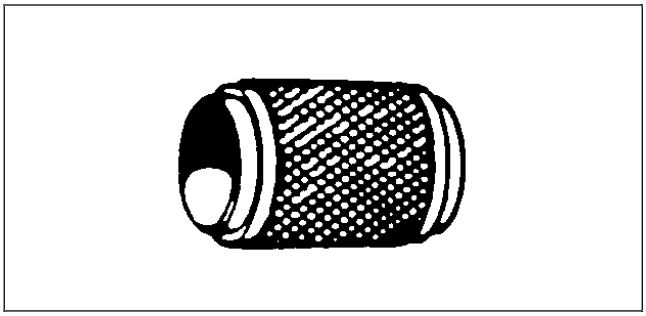


Figure 31

.0149 - Cylinder Head Separating Levers (Make Locally)

Used to remove cylinder head (qty. 2 required).

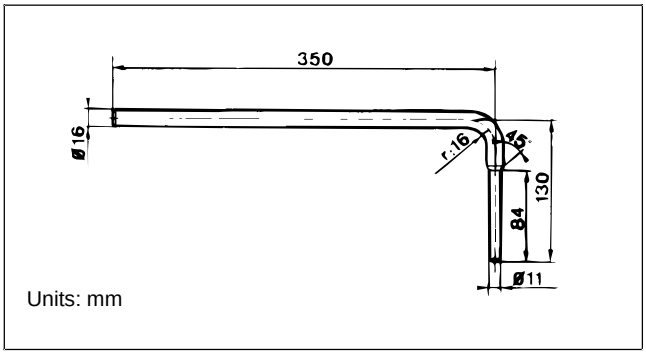


Figure 32

TOR70153H Injector Pump Gear Puller

Loosen the nut on the injector pump gear, then use this tool to loosen the pulley from the tapered shaft on the injector pump.

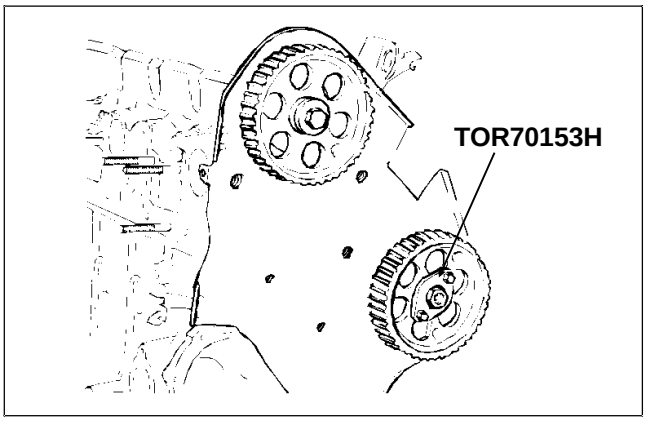


Figure 33

Adjustments

Valve Clearance Adjustment

(See Valve Clearance Adjustment in the Engine Overhaul Section.)

Engine Speed Adjustments

Maximum fuel flow and speed adjustments are sealed and should only be unsealed by a CAV Lucas ROTO-DIESEL service dealer.

Throttle Cable Adjustments

The throttle control lever at the operator's station must not touch the end of the slot during full range of motion from idle (SLOW) to full engine RPM (FAST).

Adjust throttle cable at injection pump so throttle lever on injection pump operates at full range of motion without throttle control lever at operator's station touching end of slot at either FAST or SLOW position.

Alternator

Problem	Possible Causes
Alternator is not charging.	Alternator belt loose. Charging circuit defective. Energizing circuit defective. Brushes worn or seized. Rotor winding defective. Stator winding defective. Regulator defective.
Output low or irregular.	Alternator belt loose. Charging circuit defective. Energizing circuit defective. Brushes worn or seized. Rotor winding defective. Stator winding defective. Regulator defective. Rotor partially short-circuited. Stator partially short-circuited. Rectifier diode defective. Rectifier diode short-circuited.
Battery voltage too high.	In-line diode defective. Regulator defective. Poor connections.
Alternator noisy.	Rectifier diode short-circuited. Belt worn. Alternator mounting loose. Alternator pulley loose. Worn bearings.

Fuel Injectors

Problem	Possible Cause	Correction
Bad spray pattern	Carbon deposit around the orifice	Clean
	Scored nozzle seat	Replace injector
	Needle damaged	Replace injector
Leaking injector	Foreign matter jammed between nozzle seat and needle	Clean
	Nozzle seat out-of-true	Replace injector
Needle seized or showing seizing marks	Water in fuel	Drain water and flush fuel feed system (1)
	Copper gasket not replaced	Replace gasket at each repair
	Injector nut too tight on injector body	Tighten injector nut (1)
Leakage collector fills too quickly	Leak between upper bearing face of nozzle and bearing face of injector body:	
	Foreign matter between bearing faces	Clean
	Unevenness	Replace injector
Blue needle point	Incorrect injection pump timing	Replace injector and adjust pump timing again
End of injector body corroded	Running temperature of engine too low	Check thermostat
	Intermittent operation	Run machine longer. Do not start and stop engine.

(1) In these cases, replace the injector

Fuel Injection Pump

Problem	Possible Cause	Correction
Engine has no power	Defective fuel supply	Check filter cartridge and pipes
	Incorrect pump timing	Correct timing
	Incorrect spray, or injector pressure out of adjustment	Check, clean and adjust injectors
	Air intake restriction	Check hoses and air cleaner
	Insufficient automatic advance	Have pump repaired
	Discharge rates too low	Have pump repaired
Idling too fast	Idling stop out of adjustment	Adjust stop and fast idling control
	Throttle cable out of adjustment	Adjust throttle cable
	Governor out of adjustment	Have pump repaired
Maximum speed too high	Max. speed stop out of adjustment	Have pump repaired
	Jammed discharged valve	Have pump repaired
	Blocked pump governor	Have pump repaired
Engine will not accelerate	Defective fuel supply	Check filter cartridge and pipes
	Seized pump plunger	Have pump repaired
	Broken pump plunger spring	Have pump repaired
	Hard discharge valve	Have pump repaired
	Seized feed pump	Drain water from tank, pipes and filter – have pump repaired
	Accelerator linkage defective	Repair linkage
Engine emits smoke	Air getting into feed system	Check gaskets and pipes
	Defective fuel supply	Check filter cartridge
	Incorrect pump timing	Correct timing
	Incorrect spray, or injectors out of adjustment	Check, clean and adjust injectors
	Insufficient automatic advance	Have pump repaired
	Discharge rates too high	Have pump repaired
	Air intake restriction	Check hoses and air cleaner

Problem	Possible Cause	Correction
Engine will not start	No preheating	Check glow plugs and relay
	No fuel supply	Make sure tank is not empty
		Check filter element and pipes
		Check system bleeding
	Defective solenoid valve	Check electric stop solenoid
	Seized pump plunger	Have pump repaired
	Discharge valve blocked in “stop” position	Have pump repaired
	Seized feed pump	Drain water from tank, pipes and filter – repair pump
Irregular engine speed	Defective fuel supply	Check filter cartridge and pipes
	Carbon fouled injectors	Check, clean and adjust injectors
	Unequal discharge rates	Have pump repaired
	Faulty governor	Have pump repaired
Noisy engine	Incorrect pump timing	Correct timing
	Blocked automatic advance	Have pump repaired
	Automatic advance to far advanced	Have pump repaired
Engine stalls at idling	Air getting into fuel system	Check gaskets and pipes
	Idling stop out of adjustment	Adjust idling stop
	Jammed discharge rate	Have pump repaired
Vibrating engine	Unequal discharge rate	Have pump repaired
	Air in fuel system	Check fuel lines and clamps
	Defective fuel injector	Check injectors
	Jammed discharge valve	Have pump repaired
Engine will not stop	Key switch defective	Replace key switch
	Defective electric stop solenoid	Check electric stop solenoid

Low Power

Problem	Possible Causes
Engine does not give full power	Injection pump timing Seized piston rings Defective injector(s) Air intake restricted Valve leaks Clogged fuel filter Injection pipe restriction due to excessive tightening of unions Defective injection pump
Irregular idling	Defective injection pump Air getting into fuel system Idling stop out of adjustment Leaky injection pipe unions
Speed fall-Off	Clogged fuel filter Defective injection pump
Engine speed rises to maximum	Defective injection pump Throttle cable jammed

Noisy Engine

Problem	Possible Causes
Knocking	Loose main bearings Broken part Leakage return collector clogged Lifters out of adjustment Foreign matter in a cylinder Seized injector Injection pump timing Sheared glow plug Timing out of adjustment
Whistling, blowing	Leaking cylinder head gasket Leaky glow plug Valve seats Leaky injector

Pre-heating

Problem	Possible Causes
Glow plug does not glow red hot	Faulty glow plug Faulty glow plug relay Damaged wiring or connector All four glow plugs burnt out / ends melted – injection pump timing out of adjustment (engine overheating) See Chapter 5 - Electrical System

Smoke During Operation

Problem	Possible Causes
Black	Defective injector Injection pump out of adjustment Injection pump timing Air intake restricted Inlet chambers clogged Not enough advance
Grey	Defective injector Injection pump timing Air intake restricted Not enough advance
Blue-Grey	Defective injector Injection pump timing Too much oil
Blue	Too much oil Wear
White	Injection pump timing Cylinder head gasket Cold engine

Starting Problems

Problem	Possible Causes
Engine will not start and emits black smoke	Air intake obstructed Defective injectors Lack of compression (seized rings, damaged or worn valve seats, or general wear) Injection pump timing
Engine will not start and emits white smoke	Leaking cylinder head gasket
Engine will not start and does not emit any smoke	Frozen fuel Injection pump does not work Leaking injection pipe unions Injection valve blocked No preheating Empty fuel tank Feed pipe obstructed Air getting in pipes Tank vent plugged Injection pump needs re-priming Shutdown control jammed in “stop” position
Starter does not crank or cranks slowly	Battery discharged Oil too thick Engine seized Faulty starter Faulty wiring

Injection Pump Timing

(See Timing of Injection Pump in the Engine Overhaul section.)

Glow Plug Test

CAUTION

Be careful while handling or testing glow plugs. Glow plugs become extremely hot. Accidental contact with the heated plug tip could cause personal injury.

1. Disconnect the wire lead(s) to the glow plug.

2. Remove the glow plug.

3. Inspect the glow plug for signs of a burnt glow plug end tube.

NOTE: If the metal of the glow plug end is melted, it is a sign of cylinder overheating.

4. Connect the positive (+) battery terminal to the glow plug terminal, and the negative (–) battery terminal to the plug body (Fig. 34). If the glow plug glows red-hot in 9 to 12 seconds, the glow plug is operating correctly. DO NOT leave on more than 20 seconds.

5. Replace any glow plugs that do not operate correctly.

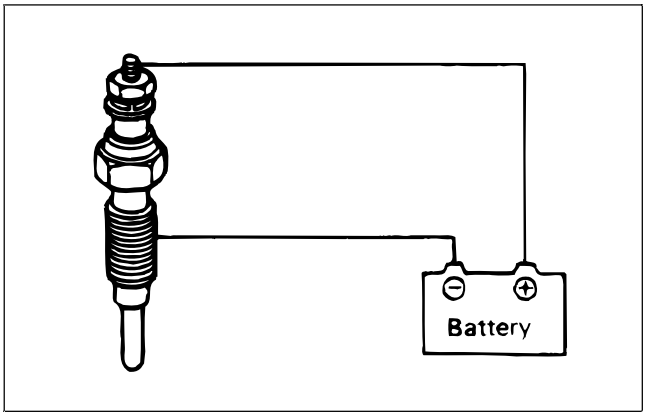


Figure 34

Compression Test

Minimum cylinder compression is 20 bar (290 psi) at 200 rpm (normal cranking speed). The engine should be warm - coolant temperature of 50^{o} C (120^{o} F).

IMPORTANT: DO NOT put oil into the combustion chamber before performing a compression test. Damage may result because of "hydraulic" forces acting upon the piston and connecting rod.

1. Remove the glow plug lead wires and glow plugs from all four cylinders.

2. Insert a compression gauge adapter into the glow plug hole.

3. Connect a high pressure compression gauge to the adapter.

4. Disconnect the fuel stop solenoid electrical connector or hold the fuel stop lever in the stop position to prevent fuel delivery during the compression test. This will prevent wash-down of the cylinders and inaccurate readings.

5. Crank the engine with the starter motor until you get a stable gauge reading.

6. If the pressure is less than 20 bar (290 psi) it will be necessary to find the cause of low compression.

7. Repeat the test for the other three cylinders. Difference between cylinders should be no more than 5 bar (70 psi).

8. Connect the fuel stop solenoid electrical connector.

9. Install the glow plugs.

Injector Tests

There are several tests to examine the condition of the injection nozzles. These tests require the use of a nozzle tester and nozzle tester adapter.

CAUTION

The nozzle tester forces fuel from the nozzle under extremely high pressure. Always point the nozzle tip away from yourself and any other personnel. Contact with the fuel stream, even though it appears to be a mist can cause fuel to penetrate clothing and skin. If fuel is injected into the skin get proper medical attention from a doctor immediately. A serious infection or other reaction can develop if the injury is not properly treated. Tighten all adapter fittings to prevent leaks. If a leak is suspected, use a piece of cardboard, not your hands to search for a leak.

To prevent possible injury, wear eye protection when operating the nozzle tester.

IMPORTANT: Always use fresh filtered fuel in the nozzle tester. Use of dirty fuel can damage the precision parts of the injector nozzle. It is a good practice to:

1. Bolt the tester securely to the test bench.

2. Use a drain pan to catch fuel.

3. Flush the adapter by pumping the handle of the tester slowly several times before attaching the nozzle to be tested.

Injection Pressure Test

The diesel engine requires that fuel be sprayed into the combustion chamber at a precise point in the compression stroke. The point at which this fuel injection occurs is determined by the injection timing. If the nozzle is defective, damaged or adjusted incorrectly, starting failures, low power output, or engine knocking can occur.

1. Securely fasten the nozzle to the adapter.

2. Pump the handle several times to purge air from the nozzle mechanism.

3. Allow pressure to dissipate before performing the test.

4. Operate the pump handle slowly and observe the gauge to determine the pressure at which the nozzle opens and the fuel is sprayed.

5. Verify that starting pressure is within the following limits:

"C" injectors 115 $\pm$ 5 bar or kg/cm^2 (1668 $\pm$ 70 psi)
"D" injectors 130 $\pm$ 5 bar or kg/cm^2 (1885 $\pm$ 70 psi)

6. Starting pressure can be adjusted by adding or removing shims from the nozzle. A 0.10 mm shim thickness will cause a 10 bar or kg/cm^2 (140 psi) starting pressure difference.

7. Repeat the test after installing shim to verify that a correct opening pressure has been obtained.

Chattering Test

Proper and free operation of the nozzle valve can be determined by the chattering test.

1. Securely fasten the nozzle to be tested to the adapter.

2. Operate the pump handle slowly (1 - 2 strokes per second). As the pump pressure reaches the starting pressure the nozzle valve will chatter or buzz as it opens and closes rapidly. A nozzle which does not chatter or buzz may be the result of a binding or bent nozzle valve.

Nozzle Leakage Test

A nozzle that leaks fuel from the nozzle orifice must be replaced.

1. Securely fasten the nozzle to the adapter.

2. Wipe all fuel from the nozzle.

3. Operate the pump until the pressure is approximately 20 bar or kg/cm^2 (280 psi) below opening pressure. Maintain this pressure to the nozzle.

4. Watch for leaks where the threaded nozzle body threads into the retaining nut. Leaks in this area would indicate a bad seat between the distance piece and/or the body or nozzle assembly.

5. If leakage occurs, verify that the body is tightly fastened in the retaining nut. If the leak continues, replace the nozzle.

6. While pressure is being applied, watch for an accumulation of fuel at the tip of the nozzle (Fig. 35). A small amount of fuel may be present due to a previous chattering test - this would be normal. If the fuel accumulates and drips down during the test (about ten seconds) the nozzle assembly is defective and must be replaced.

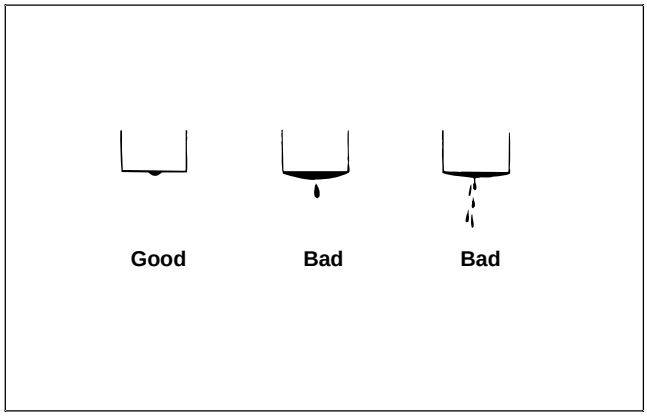


Figure 35

Spray Test

For proper combustion, the nozzle must effectively atomize the injected fuel.

1. Operate the pump handle quickly (4 - 6 strokes per second).

2. Observe the injector nozzle spray. The spray pattern should be finely atomized in a broad, straight stream (Fig. 36).

3. If the nozzle fails to spray properly, it must be cleaned, repaired or replaced.

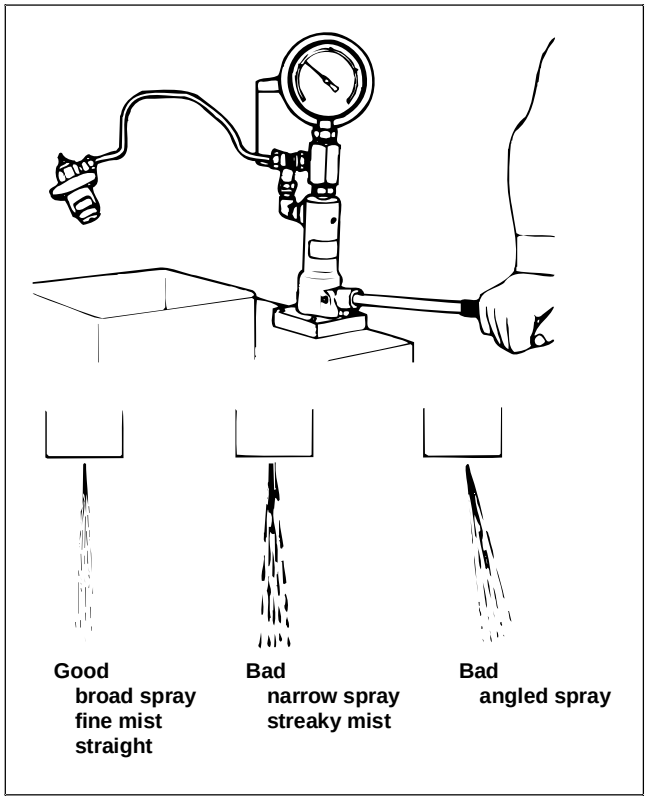


Figure 36

Injection Pump Testing

Calibration of fuel delivery volumes, pressure and distribution between pump barrels should be performed by a professional diesel engine service shop. Special test fixtures and equipment are required.

It is possible to determine if the fuel injection pump requires service through a process of elimination using other fuel system tests. The following test procedure will help isolate fuel system difficulties.

1. Make sure that fuel is being supplied to the injector pump.

2. Check the operating condition of the injection nozzles to make sure that the injection pressure is correct.

3. Make sure that the injection pump is providing sufficient fuel pressure to operate the nozzle by performing the following procedures:

A. Loosen the fuel delivery pipe from the number one nozzle.

B. Remove the nozzle from the cylinder head.

C. Connect the fuel delivery pipe to the nozzle assembly so the tip of the nozzle is pointed away from the engine. Tighten the fitting securely.

D. Put the throttle control in the FAST position. Turn the ignition key to the START position to crank the engine. Observe the nozzle.

CAUTION

The injection pump forces fuel from the nozzle under extremely high pressure. Always point the nozzle tip away from yourself and any other personnel. Contact with the fuel stream, even though it appears to be a mist can cause fuel to penetrate clothing and skin. If fuel is injected into the skin get proper medical attention from a doctor immediately. A serious infection or other reaction can develop if the injury is not properly treated. Tighten all adapter fittings to prevent leaks. If a leak is suspected, use a piece of cardboard, not your hands to search for a leak.

If the nozzle produces an atomized mist of fuel the injector pump for that cylinder is operating properly. Failure of the nozzle to inject fuel can indicate a injection pump cylinder that is not operating correctly.

5. Repeat the test for the other cylinders.

Thermostat Test

If the engine overheats or runs too cool, and a faulty thermostat is suspected, the thermostat should be tested.

1. Remove the thermostat.

2. Put the thermostat in a container of water with a thermometer and heat the water.

Starts to open at: 81° C (178° F)
7 mm (0.28 in.) full open at 88° C (190° F)

3. If the thermostat fails to open, only partially opens, or sticks, it should be replaced.

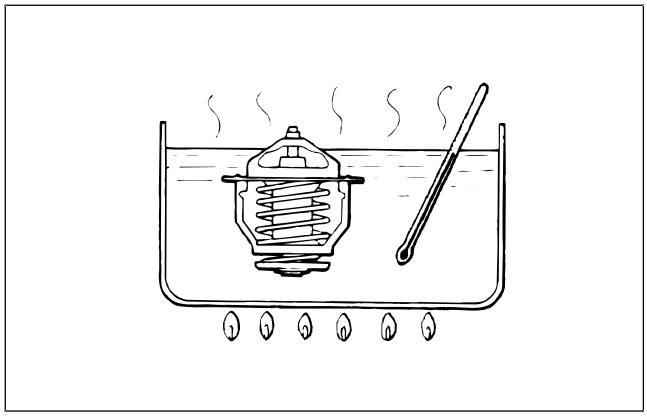


Figure 37

Fuel System Service

Priming Fuel System

1. Stop the engine. Unlatch and raise the hood

2. Fill the fuel tank.

3. Install a 3/16" hose over bleed screw. Put other end of hose into a container to catch fuel (Fig. 38).

4. Pump priming plunger until resistance is felt. Try to start engine. If engine does not start, go to step 5.

5.Loosen bleed screw a few turns. Pump priming plunger until a steady stream of fuel comes out of hole in bleed screw. When fuel stops foaming, tighten bleed screw during down stroke of priming plunger. Wipe up any spilled fuel.

NOTE: It may be necessary to bleed air out of the fuel line, between the fuel filter/water separator and the injection pump. To do this, loosen the fitting on the injection pump (Fig. 39) and pump priming plunger until a steady stream of fuel comes out of fitting. When fuel stops foaming, tighten the fitting during the down stroke of the priming plunger. Wipe up any spilled fuel.

NOTE: The high pressure fuel system is self-bleeding. It is not necessary to open the high pressure lines.

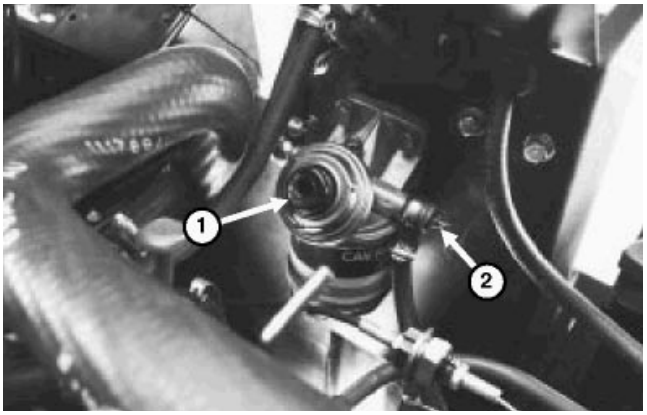


Figure 38

1. Primer plunger **2. Bleed screw**

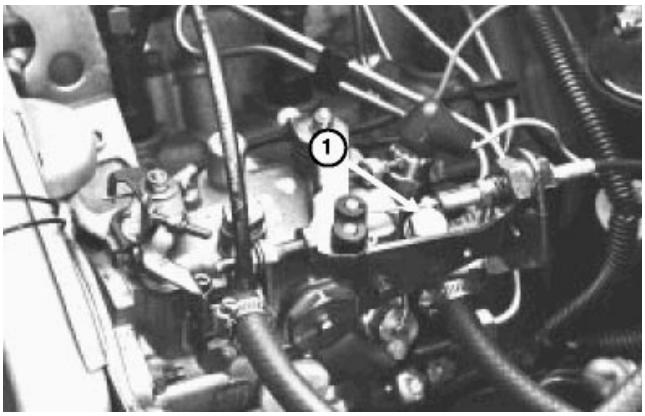


Figure 39

1. Injection pump fitting

Injection Pump Removal

(See Injection Pump Removal in the Engine Overhaul section.)

Injection Pump Repair

NOTE: If the pump needs to be inspected or repaired it is recommended that it be done by an authorized CAV Lucas ROTO DIESEL service dealer - especially during the warranty period. Repairs by non-authorized dealers WILL void the pump warranty.

IMPORTANT: Clean the injection pump and the area around the injection pump before removing or servicing it. DO NOT spray water onto a hot injection pump.

Injector Service

NOTE: If injectors need to be inspected or repaired it is recommended that it be done by an authorized CAV Lucas ROTO DIESEL service dealer - especially during the warranty period. Repairs by non-authorized dealers WILL void the warranty on the injectors.

Removal

1. Clean top of cylinder head and injection pipes.

2. Remove injection pipes (Fig. 57, Item 12).

3. Disconnect injector leakage pipe.

4. Remove the injectors (Fig. 58, Item 19) and retrieve the copper washer (Item 20) and flame trap washer (Item 21).

NOTE: Never disassemble injector before checking its operation.

Disassembly and Cleaning

1. Secure the injector body in a “V” type injector holder.

2. Remove the injector holder nut.

3. Remove the injector, spacer, push rod, pressure setting spring, adjusting shims and body.

4. Dip all parts in clean diesel fuel.

5. Clean nozzle and needle in clean diesel fuel.

6. De-carbon injector nozzle using a wooden spatula. Never use metallic objects, emery cloth or rags. Do not attempt to grind the needle on its seat. Clean each injector separately to matched parts are not mixed up. The needle should slide freely and fall in the nozzle by its own weight.

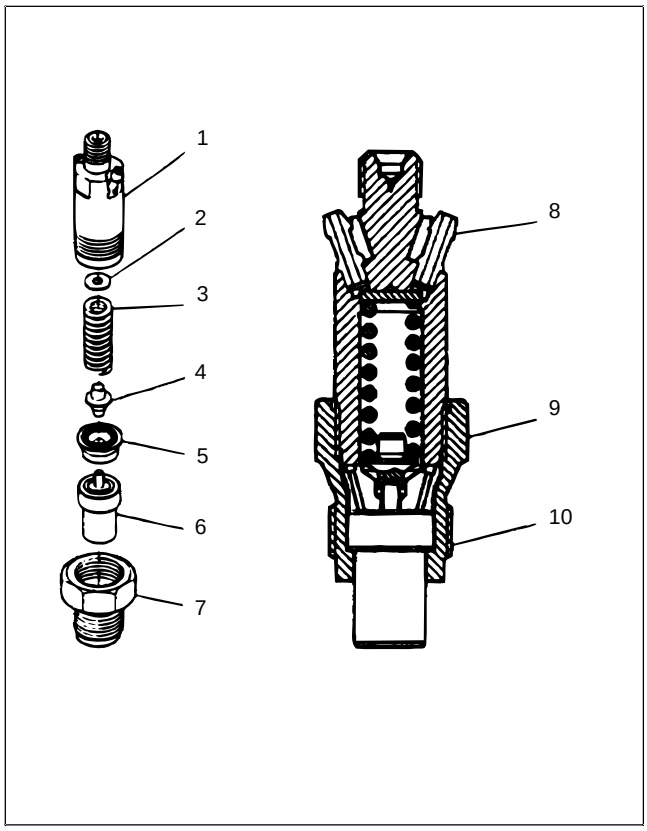


Figure 40

1. Body
2. Adjusting shim
3. Pressure setting spring
4. Push rod
5. 2-sealing face spacer
6. Injector
7. Injector nut
8. Leak return connectors
9. Injector holder nut
10. Thread

Assembly

1. Check all parts for condition and cleanliness. Oil parts before reassembly.

2. Secure the injector body in a “V” type injector holder.

3. Install the adjusting shims, spring, push rod, spacer and injector (Fig. 40, Items 2, 3, 4, 5, 6).

4. Install the injector holder nut (Fig. 28, Item 7) and tighten by hand.

5. Tighten injector nut to a torque of 10 Nm. Tighten the nut an additional 22° of rotation.

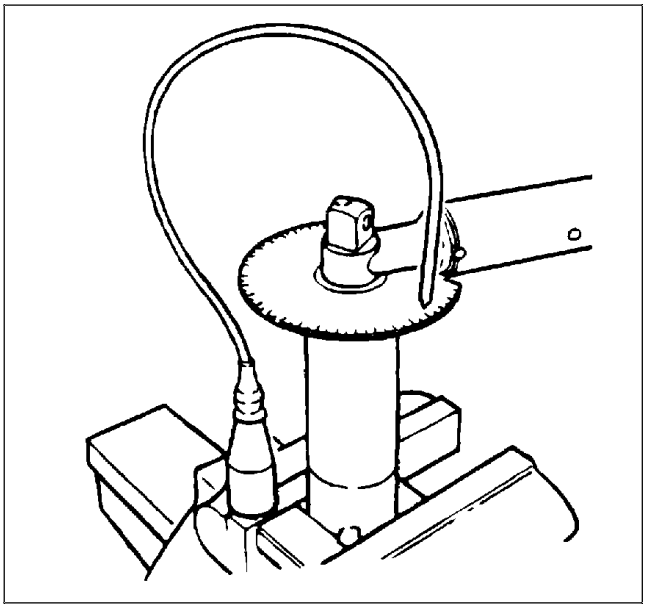


Figure 41

Installation

NOTE: Each time an injector is removed from the engine, new washers must be installed. Fire ring washer is installed with convex surface up.

1. Install new fire ring washers (Fig. 58, Item 21), convex surface facing up.

2. Install new copper washers (Fig. 58, Item 20).

3. Install the injectors and tighten to a torque of 90 Nm (66 ft-lb).

1. Install new flame arrestor steel washer and copper gasket.

2. Install injector in cylinder head.

3. Install injection pipe unions on pump and injectors and tighten by hand.

4. Moderately tighten each union, 25 Nm (18 ft-lb) max., on pump and injector. Over-tightening will distort the end of the injector line.

5. Connect fuel return pipe.

Timing Belt Replacement

Timing Belt Removal

IMPORTANT: Never install a used belt. When the timing belt is removed a NEW timing belt must be installed.

SPECIAL TOOLS REQUIRED:
Tune-Up Tool Set TOR 4035
1 ea. M8 x 125 x 40 Metric Bolt
2 ea. M8 x 125 x 35 Metric Bolt

1. Slowly turn the crankshaft in the operating direction (clockwise as viewed from the timing belt end) until the TDC Lock Pin tool (TOR 70153N) goes into the hole in the flywheel (Fig. 42).

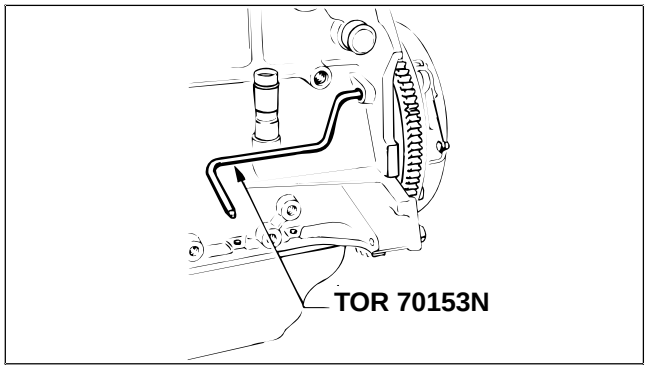


Figure 42

2. Remove the crankshaft pulley bolt (Fig. 43, Item 1) and the pulley. Note: The bolt is secured with thread locking compound and will be difficult to remove.

3. Remove cover attachment nut (Item 5), cover clips and timing belt covers (Item 2, 3 and 4) in the numbered order.

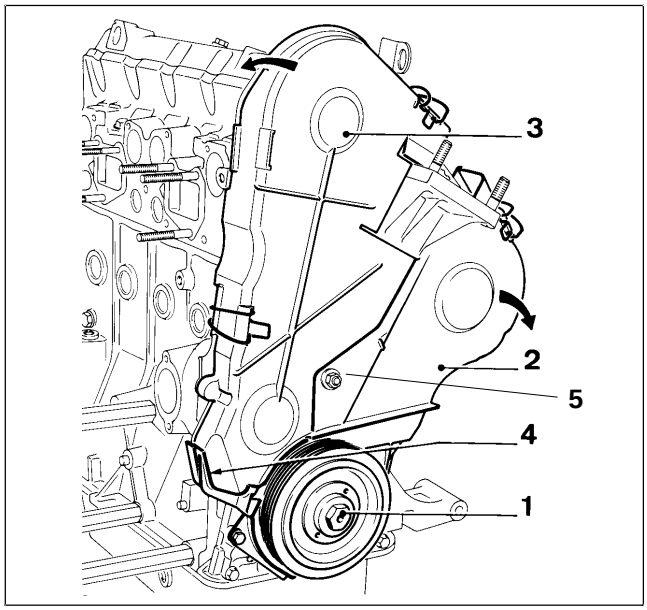


Figure 43

4. Re-install the crankshaft bolt (Fig. 44, Item 1) and the washer.

5. Lock the camshaft gear (Item 6) in position by installing an M8 x 125 x 40 bolt. Tighten finger tight.

6. Lock the injection pump gear (Item 7) in position with two M8 x 125 x 35 bolts. Tighten finger tight.

IMPORTANT: To prevent damage to the face of the injector pump housing and future timing problems, the camshaft gear and injection pump gear locking bolts must be tightened ONLY FINGER TIGHT.

NOTE: If the bolts in steps 5 and 6 cannot be installed because the holes in the gears and engine block do not align, remove the TDC Lock Pin tool and rotate the engine (clockwise) one revolution. Install the TDC Lock Pin, then install the bolts as instructed in steps 5 and 6.

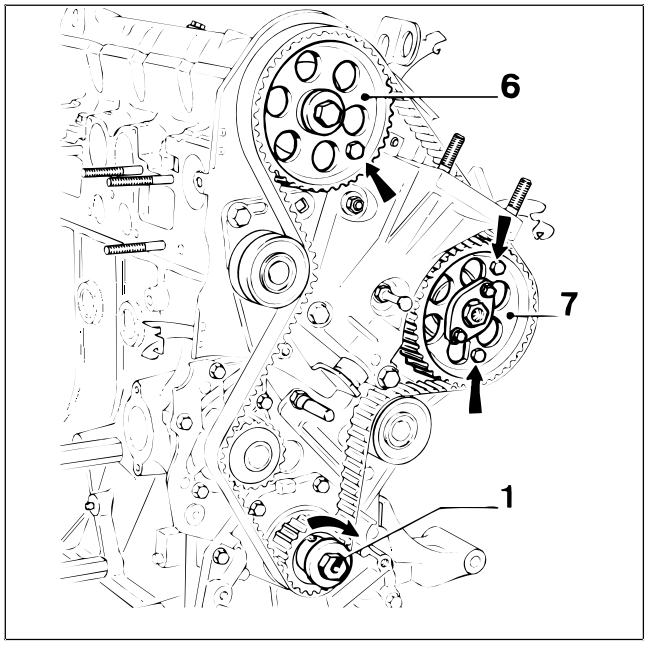


Figure 44

7. Loosen the nut (Fig. 45, Item 8) and the bolt (Item 9), securing the roller tensioner bracket (Item 10).

8. Rotate the roller tensioner bracket square (Item A) to compress the spring (Item 11).

9. Re-tighten the bolt (Item 9).

10. Remove the timing belt.

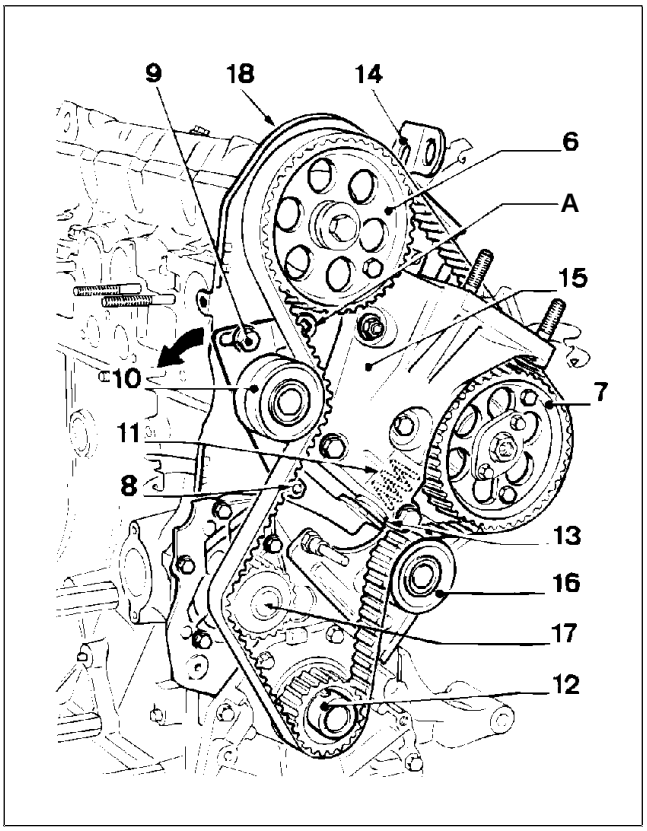


Figure 45

Timing Belt Installation

IMPORTANT: Never install a used belt. When the timing belt is removed a NEW timing belt must be installed.

1. Install the new timing belt, with the runs taut, in the following order (Fig. 46):

   Crankshaft gear (Item 13)
   Fixed roller (Item 11)
   Injection pump gear (Item B)
   Camshaft gear (Item C)
   Tensioner roller (Item 17)
   Coolant pump gear (Item 10).

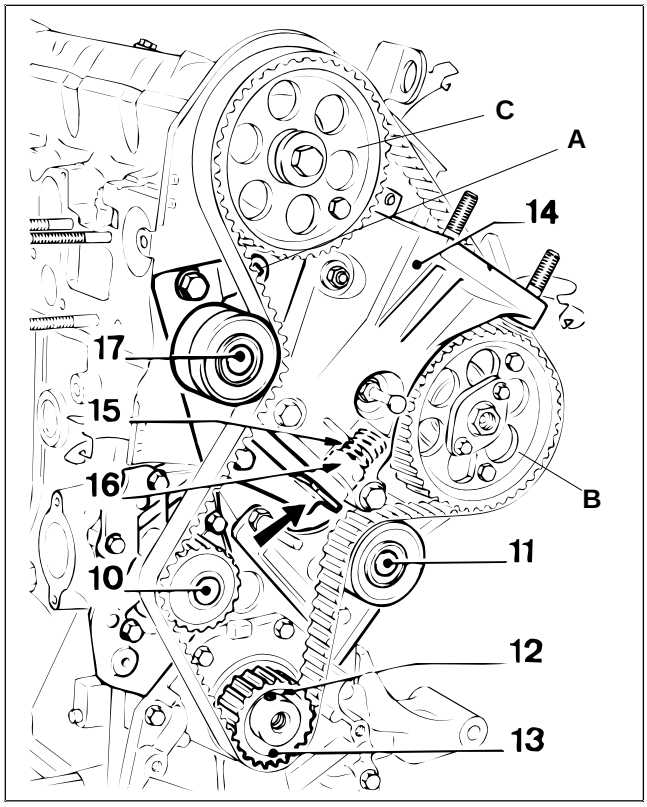


Figure 46

2. Loosen the bolt (Fig. 47, Item 18) and nut (Item 19) to release the tensioner roller. DO NOT use Item **A** to set tension. Tension on belt is only to be set by the spring (Fig. 46, Item 15) when tensioner plate is free to rotate.

3. Re-tighten the bolt (Item 18), then the nut (Item 19), when the belt is tensioned.

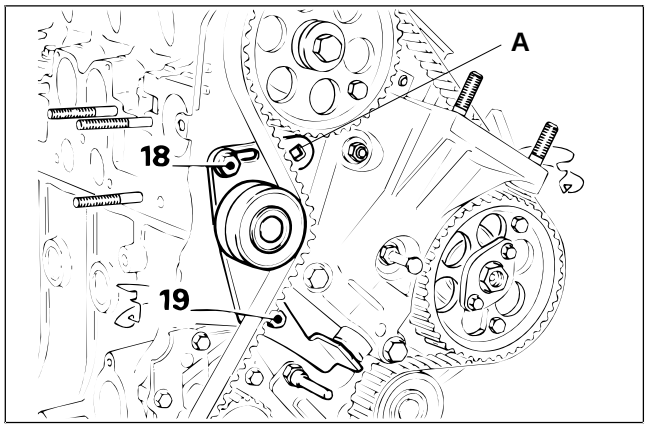


Figure 47

4. Remove the three gear locking bolts and TDC Lock Pin tool.

5. Turn the crankshaft two revolutions (clockwise).

6. Re-install the TDC Lock Pin tool TOR 70153 N and the three gear locking bolts.

IMPORTANT: If you can not install any one of the locking devices, repeat the Timing Belt Installation procedures from the beginning.

7. Loosen the bolt (Fig. 48, Item 18) and nut (Item 19) to release the tensioner roller.

8. Re-tighten the bolt (Item 18) then the nut (Item 19) to a torque of 17.5 Nm (13 ft-lb).

9. Remove the three gear locking bolts.

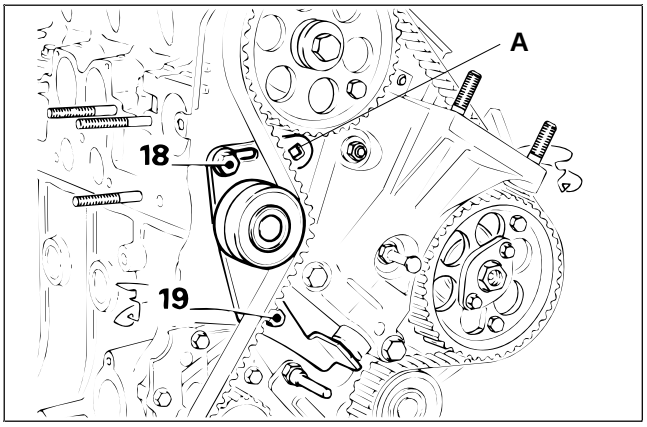


Figure 48

10. Install the covers (Fig. 49, Item 2, 3 and 4), cover clips and cover attachment nut (Item 5).

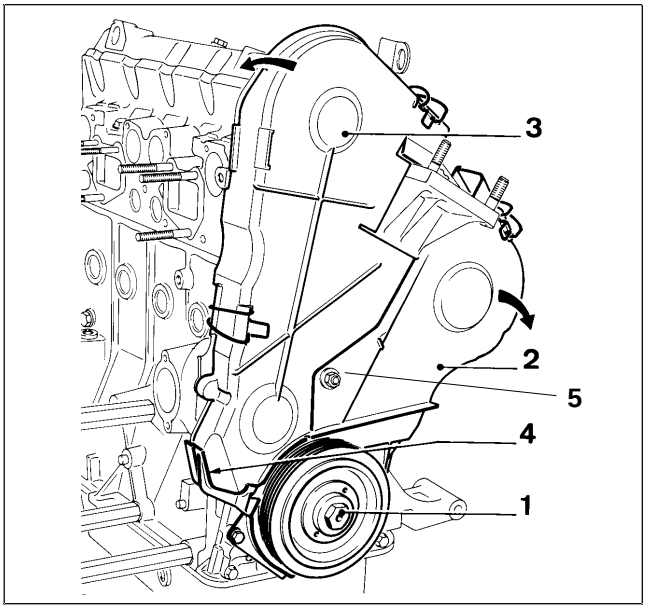


Figure 49

11. Install the pulley.

A. Clean with a brush and de-grease the threads of the bolt (Fig. 50, Item 1), the bearing faces of the washer (Item 2) and the head of the bolt (Item 1).

B. Coat the threads of the bolt (Item 1) with thread lock LOCTITE. Install the bolt (Item 1) and washer (Item 2) and tighten to a torque of 40 Nm (30 ft-lb).

C. Tighten the bolt 60° further (one flat).

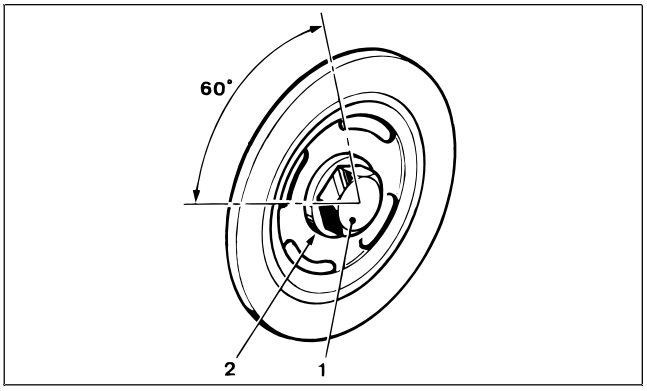


Figure 50

Injection Pump Timing

Timing of Injection Pump (Pump Mounted on Engine)

The adjustment position for start of injection varies on each pump (manufacturing tolerances). The adjustment position is given by measurement “X.XX” in one of three places on the pump (Fig. 51):

a. Tag on pump lever.
b. Bar code label
c. Inspection cap

NOTE: “PMH” in French = “TDC” in English.

1. Remove the cover attachment nut, cover clips and timing belt covers.

2. Slowly turn the crankshaft in the operating direction (clockwise as viewed from the timing belt end) until the TDC Lock Pin tool (TOR 70153N) goes into the hole in the flywheel (Fig. 52).

3. Verify that the camshaft and injection pump gears are properly timed:

A. Lock the camshaft gear (Fig. 53, Item 6) in position with a M8 x 125 x 40 bolt. Tighten finger tight.

B. Lock the injection pump gear (Item 7) in position with two M8 x 125 x 35 bolts. Tighten finger tight.

NOTE: If the locking bolts cannot be installed because the holes in the gears and engine block do not align, remove the TDC Lock Pin tool and rotate the engine (clockwise) one revolution. Install the TDC Lock Pin, then install the bolts as instructed.

IMPORTANT: To prevent damage to the face of the injector pump housing and future timing problems, the camshaft gear and injection pump gear locking bolts must be tightened ONLY FINGER TIGHT.

4. Remove the three locking bolts (Fig. 53).

5. Remove the TDC Lock Pin tool TOR 70153N, then turn the crankshaft 1/4 to 1/3 turn in the opposite direction of running (counterclockwise as viewed from the timing belt end).

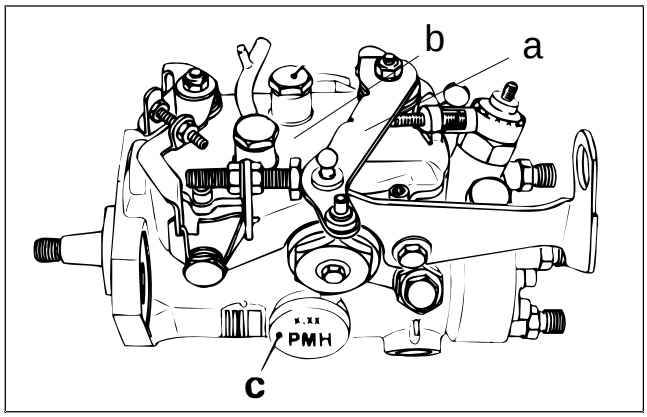


Figure 51

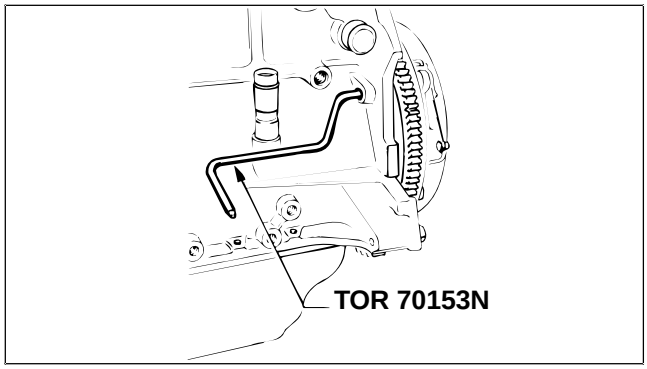


Figure 52

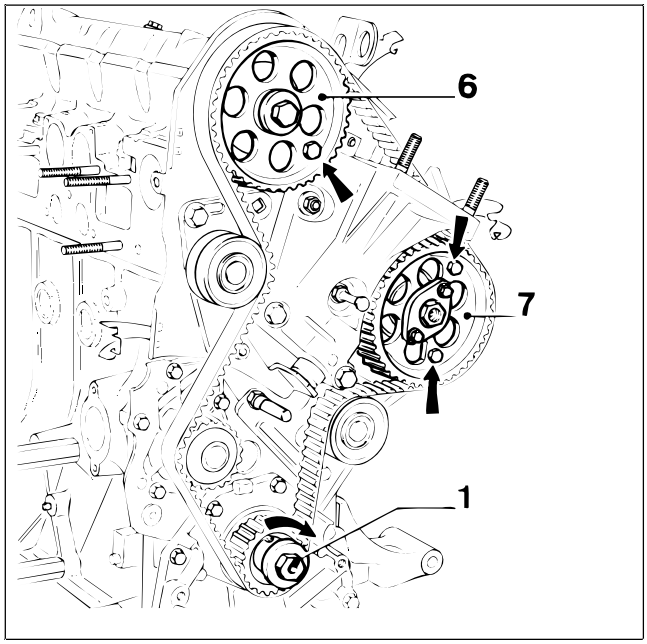


Figure 53

6. Clean the area around the pump timing plug (Fig. 54, Item d). Remove the pump timing plug.

7. Use Timing Tool Assembly TOR 80117 AM. Lubricate the timing rod (Fig. 55, Item 1) with Diesel fuel, then install the timing rod in the pump timing hole (Item d). Check to see that the rod moves freely in the bore.

8. Install the dial indicator (metric) on the indicator bracket (Item 2).

9. Install the indicator bracket with dial indicator on the plug boss. Set the dial indicator to “0.00 mm”.

10. Slowly turn the crankshaft in the operating direction (clockwise as viewed from the timing belt end) until the TDC Lock Pin tool (TOR 70153N) goes into the hole in the flywheel (Fig. 56).

11. The dial indicator should show the reading “X.XX” ±0.04 mm engraved on the injection pump. If adjustment is required, loosen the three bolts at the pump flange, one bolt at the rear, and the injection lines. Rotate the pump away from the engine, then slowly rotate the pump toward the engine in one smooth motion to obtain the reading “X.XX”. If you go to far and the reading is passed, stop. Again, rotate the pump away from the engine, then rotate the pump toward the engine in one smooth motion.

12. After obtaining the correct reading, be careful to keep the pump in position and tighten the pump bolts.

13. Remove the TDC Lock Pin tool TOR 70153 N.

14. Turn the crankshaft 1/4 to 1/3 turn in the opposite direction of running (counterclockwise as viewed from timing belt end). Check that the indicator reads 0.00.

15. Slowly turn the crankshaft in the operating direction (clockwise as viewed from the timing belt end) until the TDC Lock Pin tool (TOR 70153N) goes into the hole in the flywheel (Fig. 56).

16. In this position the dial indicator mounted on the pump should read the value “X.XX” shown on the pump ±0.04 mm.

17. Check to make sure the three lock bolts fit in the cam pulley and injection pump pulley (Fig. 53).

18. Repeat steps 11 and 12 if necessary.

19. Remove TDC Lock Pin tool, three lock bolts, indicator and indicator bracket. Install pump cover plug.

20. Tighten injector lines.

21. Install timing belt covers, clips and attachment nut.

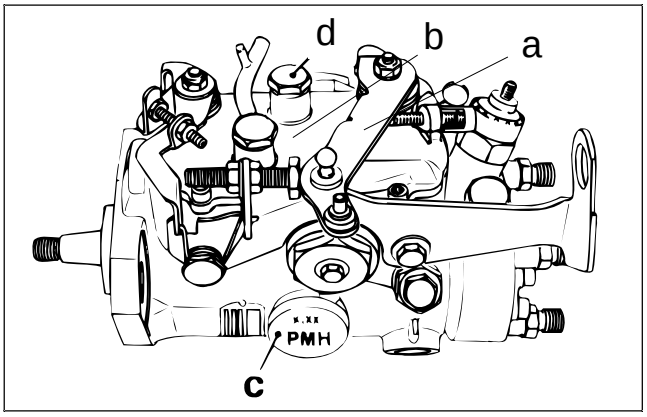


Figure 54

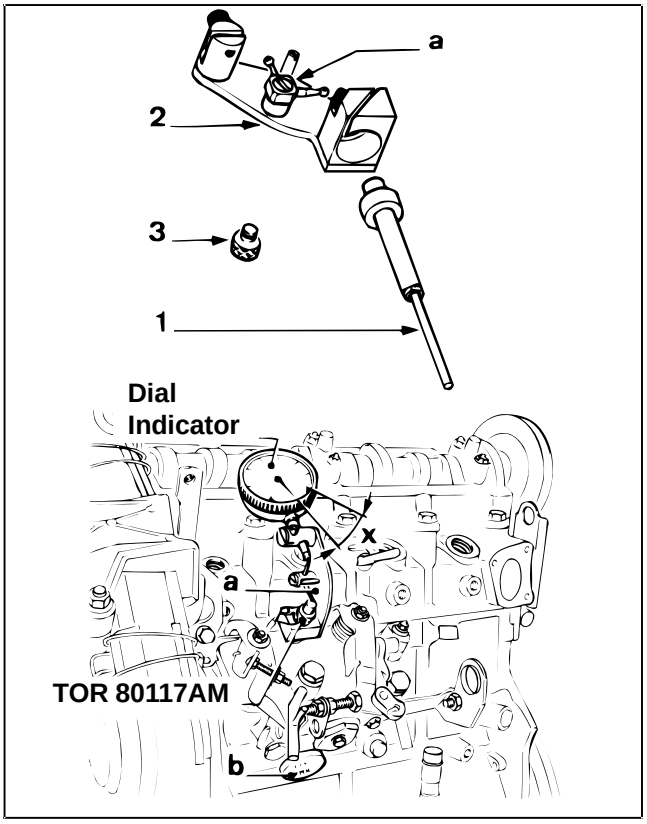


Figure 55

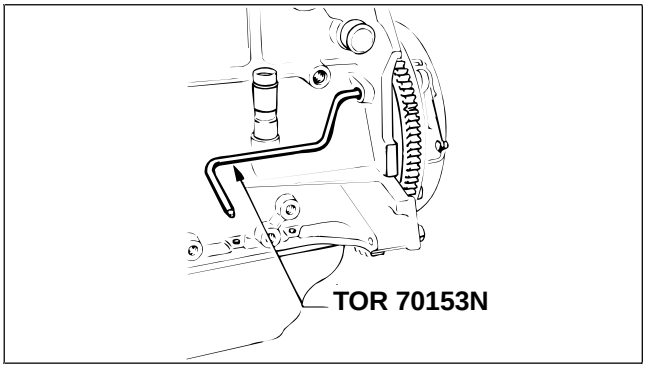


Figure 56

Preparation For Engine Repair

1. Before cleaning and disassembly, carefully check for problems that cannot be found after the engine has been cleaned or disassembled (e.g. oil leaks from cracked components, gaskets or loose fittings, damaged air cleaner or breather hoses that could cause cylinder wear, etc.). Make a note of any problems that you find.

2. Clean or wash the engine exterior thoroughly before disassembly.

IMPORTANT: Do not spray water on a hot engine. Injection pump seizure or other failures could result.

3. Do not disassemble or remove parts that do not require disassembly.

4. Disassemble the engine in proper order, arranging the parts the disassembled parts neatly. Apply clean engine oil to all disassembled parts to prevent rust.

5. Keep the work area clean; dirt causes engine failures.

6. Be very careful when working on fuel system components. Cover the work area with clean paper. Store components of the nozzles or injector pump in clean fuel oil. Do not allow components to strike each other or other objects. Wet hands with clean diesel fuel before handling these parts.

IMPORTANT: Apply clean engine oil to all surfaces when engine is assembled to prevent marking when engine is first started.

Cylinder and Cylinder Block Overhaul

Before removing any parts, disassembly or overhaul of the Peugeot engine, it is very important to understand the nature and probable cause of the problem that made an overhaul necessary.

When the engine trouble is caused by worn cylinders, rings or valves, one or more of the following symptoms will occur:

1. Low engine power, and a decrease in compression pressure.

2. Increased fuel consumption.

3. Increased lubricating oil consumption.

4. Poor engine starting.

5. Loud noises in the engine.

It is important to find the cause of the engine failure before beginning repair. Symptoms 2 and 4 in the above list can be a result of excessive fuel injection, improper injection timing, or nozzle and injection pump wear. Poor starting may be a result of electrical problems. Noises may be associated with a mechanical part outside the engine. Excess fuel or oil consumption may be the result of leaks. (See the Troubleshooting section.)

Another indicator of the need for an overhaul is oil consumption. Make sure the engine does not leak oil. when the oil consumption between the oil change maintenance interval is approximately 1-1/2 times normal (150%), engine overhaul should be considered.

With a good knowledge of how the engine operates, access to maintenance and compression test records, and information in the Troubleshooting section of this chapter, unnecessary disassembly and inspection can be eliminated.

Engine Removal and Installation

1. Put machine on a level surface and engage parking brake. Turn engine OFF and remove key from ignition switch. Allow engine and radiator to cool.

2. Open the hood. Disconnect hood stop cable from engine. Lower the hood. Remove left and right hinge plates. Lift hood off chassis.

3. Disconnect positive (+) and negative (–) battery cables from battery. Loosen battery securing bolt and remove battery.

4. Open the radiator cap. Open radiator drain valve or remove lower radiator hose and allow coolant to drain into a pan.

CAUTION

DO NOT open radiator cap or drain coolant if engine or radiator is hot. Pressurized, hot coolant can escape and cause burns.

5. Loosen hose clamps and disconnect upper and lower radiator hoses from engine and radiator.

6. Loosen hose clamp and remove fuel hose from injector pump. Plug end of fuel line to prevent fuel leakage. Disconnect injector return hose.

7. Loosen hose clamp and disconnect PCV hose from engine.8. Disconnect and tag electrical wires that attach to the engine or engine components: alternator, starter motor and solenoid, ground cable, oil pressure switch, tem-perature gauge sender, thermoswitch, fuel stop (ETR) solenoid, glow plugs.

9. Disconnect hydraulic piston pump assembly from flywheel end of engine.

10. Remove upper fan shroud from radiator.

11. Disconnect throttle cable from speed control lever on fuel injection pump. Loosen clamp and remove throttle cable and from engine bracket.

12. Remove fasteners securing engine to engine mounts.

13. Attach a short section of chain between the two lifting brackets on the engine. Connect hoist, or block and tackle chain at center of the short section of chain. One person should operate hoist or block and tackle and other person should help guide engine out of chassis. Remove engine from chassis. Be careful when removing engine to prevent damage to engine, radiator or other parts. Mount engine in an engine rebuilding stand.

14. Remove muffler, brackets, coolant expansion tank and accessories from engine as necessary. Drain oil from engine and remove engine oil filter.

Installing the Engine

1. To install the engine, perform steps 2- 14 of Removing the Engine in reverse order.

2. After disassembling or overhauling the engine, install a new oil filter. Replace this filter after the first 20 to 50 hours of operation.

3. Fill the engine with the correct oil. Fill the cooling system with a 50/50 solution of ethylene glycol anti-freeze, and clean, soft water. Check for oil and coolant leaks and repair as necessary.

Peugeot recommended Coolant/Antifreeze is available in 1 U.S. Gallon containers under Toro Part No. 93-7213.

IMPORTANT: The anti-freeze should contain no Borate and have a Ph of 7 to 8.5.

4. Adjust the throttle linkage.

Disassembly of External Components

1. Remove TDC sensor and clutch housing centering pin.

2. Mount the engine on a stand.

3. Lock the flywheel with TOR FD86 tool.

4. Remove exhaust manifold and inlet manifold.

5. Remove the coolant manifold.

6. Remove the alternator and belt.

7. Remove the oil filter (Fig. 57, Item 10).

8. Remove the injector pipes (Item 12).

9. Remove the glow plug leads.

10. Remove the crankcase breather pipes/oil filter/filter pipe assembly (Item 13).

11. Remove the oil pressure switch (Item 14).

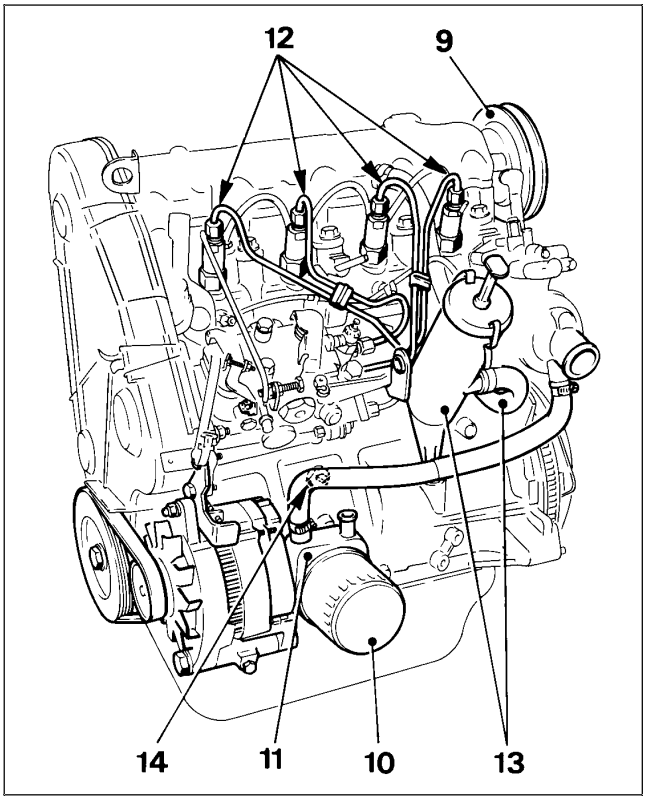


Figure 57

12. Remove the thermostat housing cover (Fig. 58, Item 17).

13. Remove the thermostat housing (Item 18).

14. Remove the injectors (Item 19) and retrieve the copper washer (Item 20), and flame trap washer (Item 21).

15. Remove the glow plugs (Item 22).

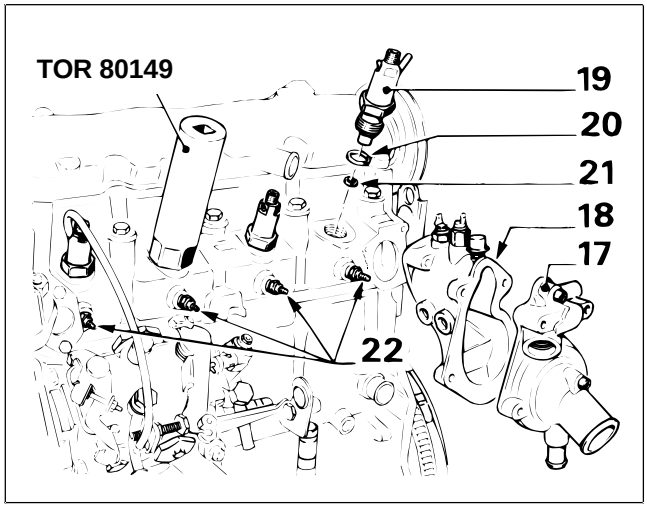


Figure 58

Injection Pump Removal

1. Remove the timing belt.

2. Use injector pump gear puller TOR70153H, to remove injector pump gear (Fig. 58a, Item 5).

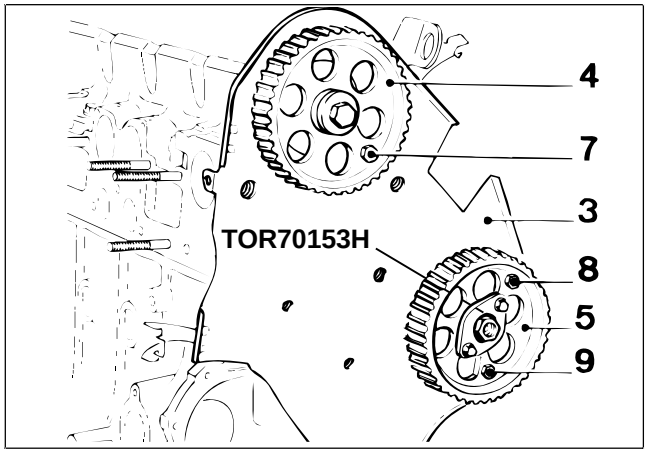


Figure 58a

3. Remove the injection pump (Fig. 58b, Item 19).

4. Remove bracket (Item 20).

NOTE: If the pump needs to be inspected or repaired it is recommended that is be done by an authorized CAV Lucas ROTO DIESEL service dealer - especially during the warranty period. Repairs by non-authorized dealers WILL void the pump warranty.

IMPORTANT: Clean the injection pump and the area around the injection pump before removing or servicing it. DO NOT spray water onto a hot injection pump.

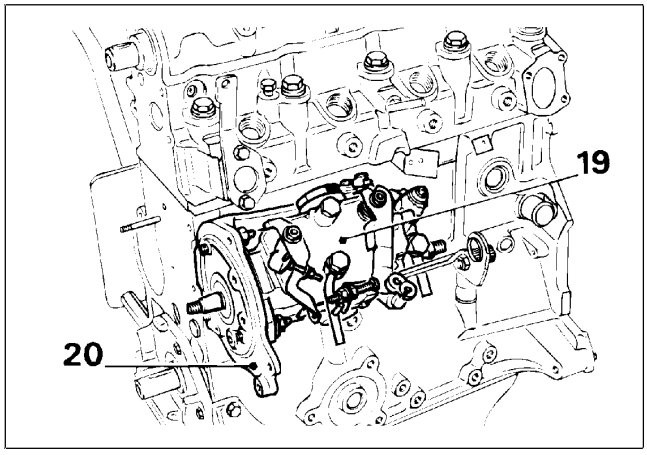


Figure 58b

Cylinder Head Removal

1. Remove the cylinder head cover.

2. Use a Torx head T55 tool to loosen the cylinder head bolts, working in a spiral from the outside. Remove the cylinder head bolts.

IMPORTANT: DO NOT pry at gasket surface to loosen cylinder head from block.

3. Use levers (0.0149) to release the cylinder head from the block.

4. Remove the cylinder head and gasket.

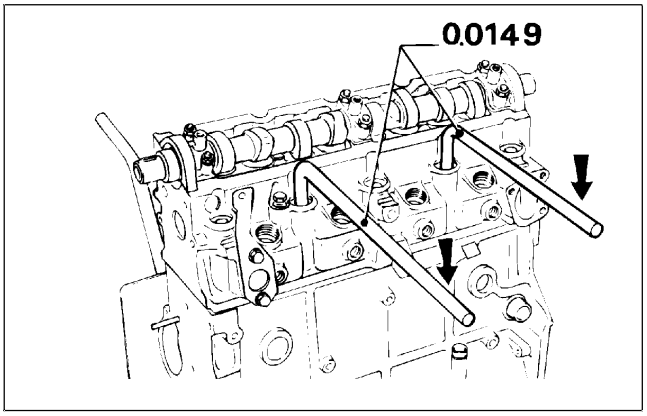


Figure 59

Oil Pump Removal

1. Remove the oil pan and gasket

IMPORTANT: Use solvent and a wood or plastic scraper to remove the silicone gasket material. Be careful not to damage the sealing face of the block.

2. Remove the bolts (Fig. 60, Item 1, 2, and 3).

3. Remove the seal carrier plate (Item 4).

IMPORTANT: The bolt (Item 1) is a special bolt that centers the pump in the correct location.

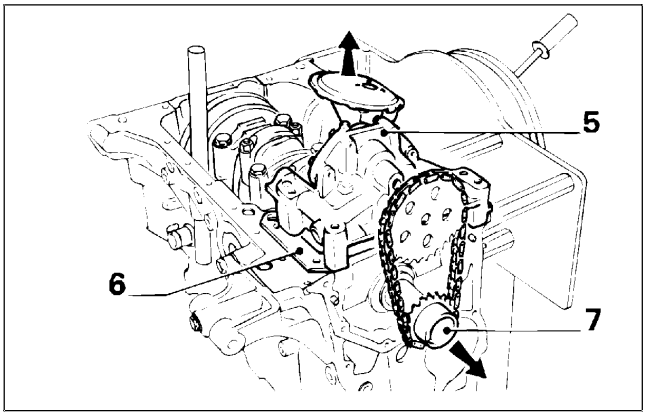


Figure 60

4. Remove the pump (Fig. 61, Item 5) / drive chain / crankshaft sprocket (Item 7) assembly. NOTE: Item 6 - spacer is not used on engines used in TORO machines.

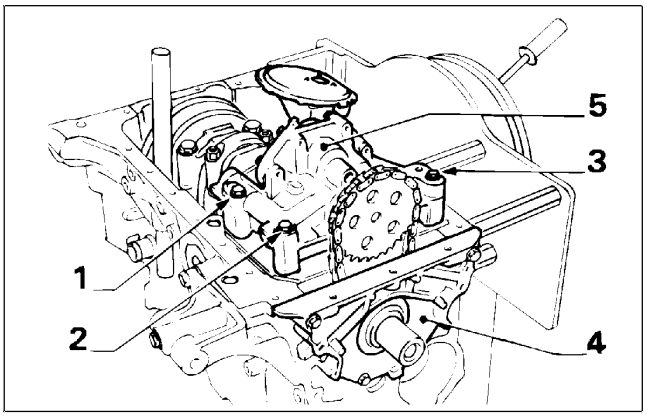


Figure 61

Crankshaft and Piston Removal

1. Remove flywheel locking tool.

2. Remove the connecting rod end caps (Fig. 62, Item 8), marking each cap for re-installation in the same location.

NOTE: Connecting rods and end caps are not numbered. Once they are removed there is no way of knowing the correct location for installation unless you mark them for re-installation.

3. Remove the flywheel.

4. Remove the main bearing caps (Item 9) (marks are cast-in).

5. Retrieve end float washers with No. 2 cap.

5. Remove the oil seal (Fig. 63, Item 10).

6. Remove the end float washers (Item 11).

7. Remove the crankshaft.

8. Remove the main bearing shells.

9. Remove the piston/connecting rod assemblies, marking each piston and connecting rod for re-installation in the same location.

NOTE: Connecting rods and end caps are not numbered. Once they are removed there is no way of knowing the correct location for installation unless you mark them for re-installation.

10. Remove the piston pin circlips and separate the pistons from the connecting rods.

11. Remove the plugs (Fig. 63 and 64, Item 12) from the oil galleries.

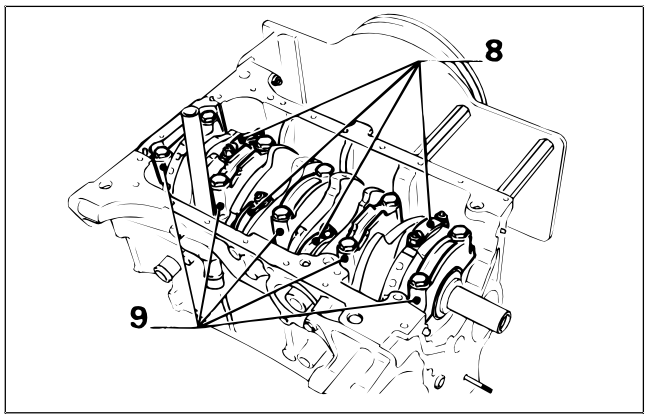


Figure 62

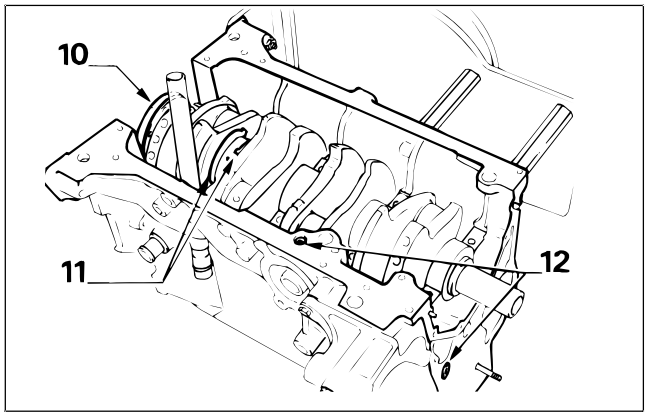


Figure 63

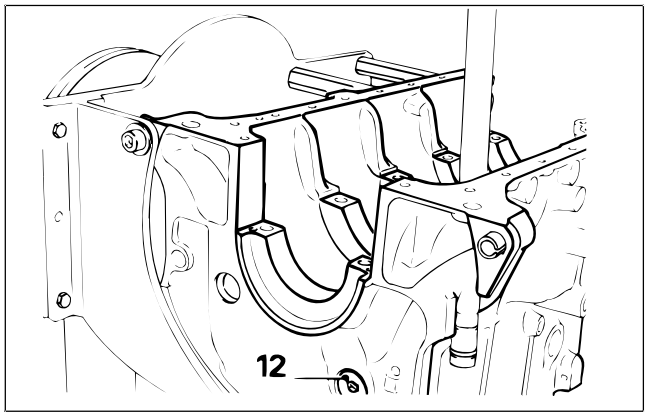


Figure 64

Cylinder Head Overhaul

1. Progressively slacken the camshaft bearing caps (Fig. 65, Item 1).

2. Remove the bearing caps (Item 1), oil seals (Item 2), camshaft (Item 3), tappets (Item 4) and adjustment shims (Item 5). Mark adjustment shims and tappets so they will be re-installed in the same location – #1 intake, #1 exhaust, #2 intake, #2 exhaust, etc.

NOTE: The shims are small and can stick to the tappets.

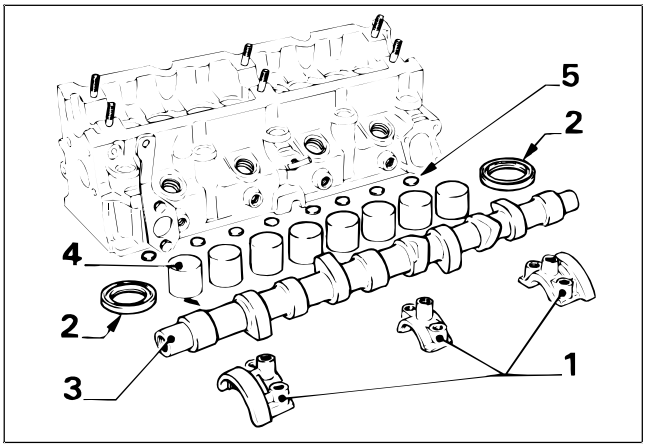


Figure 65

3. Use a valve compressor to remove the eight valves (Fig. 66).

4. Use a hammer and drift to remove the swirl chambers from the injector orifices, if necessary.

NOTE: Swirl chambers do not need to be removed unless cylinder head is to be machined or replaced.

5. Clean the cylinder head. Use a wooden scraper and gasket stripping solvent to clean the gasket face. DO NOT use a metal scraper.

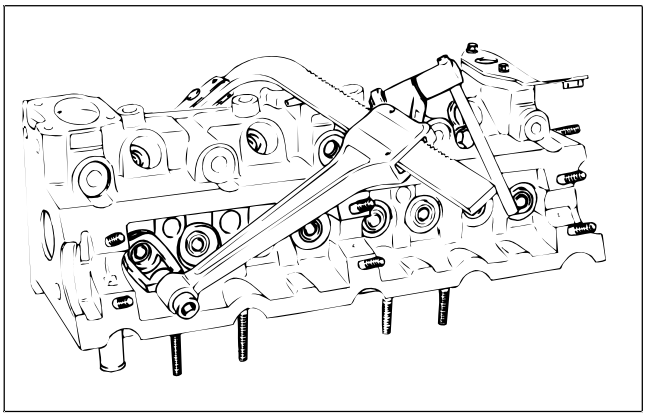


Figure 66

6. Check the gasket face for bow (flatness). Check corner to corner and side to side (Fig. 67).

Maximum bow: 0.7 mm.

7. Check the condition of the valve seats and guides, valve, valve springs, swirl chambers, camshaft, camshaft bearings and all tapped holes. (See Identification and Specifications section.)

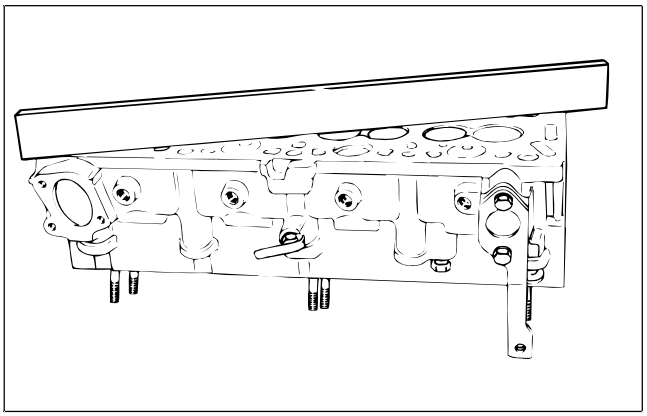


Figure 67

8. Check the protrusion of the swirl chambers (Fig. 68, A).

Protrusion: 0 to 0.03 mm

Achieve this dimension by machining faces (a) and (b).

9. Check the valve recess (B).

Exhaust: 0.9 to 1.45 mm
Inlet: 0.5 to 1.05 mm

Achieve this dimension by machining the valve seats.

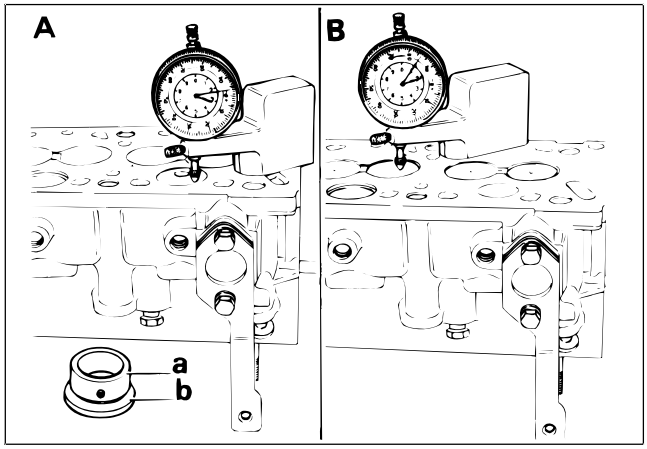


Figure 68

10. Lap in the valves.

11. Re-install the valves.

IMPORTANT: If the cylinder head has been machined, fit compensating washers under the valve springs. (See Identification and Specifications section.)

12. Install the shims as removed in step 2. If replacing cylinder head or if cylinder head has been machined, install a basic shim (Fig. 69, Item 6) (2.425 mm thick) to each valve stem and check that each shim is higher than the spring cup (Item c). If a shim is not higher than the cup, grind the top of the cup (Item c).

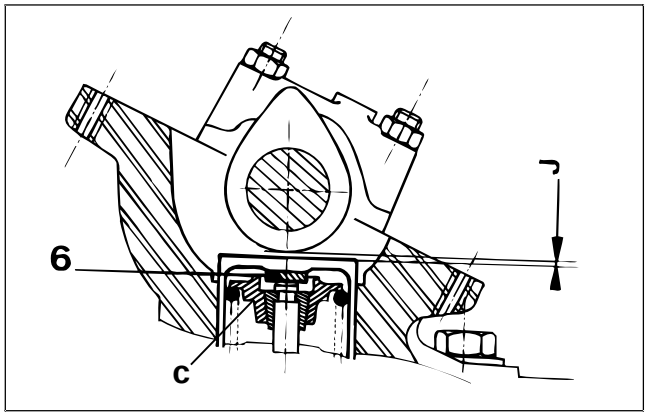


Figure 69

13. Re-install the tappets.

14. Oil the camshaft bearings.

15. Install the camshaft, with the **DIST** mark at the timing gear end.

16. Progressively tighten the bearing caps to a torque of 17.5 Nm (13 ft-lb). The bearing caps have cast-in markings for correct installation.

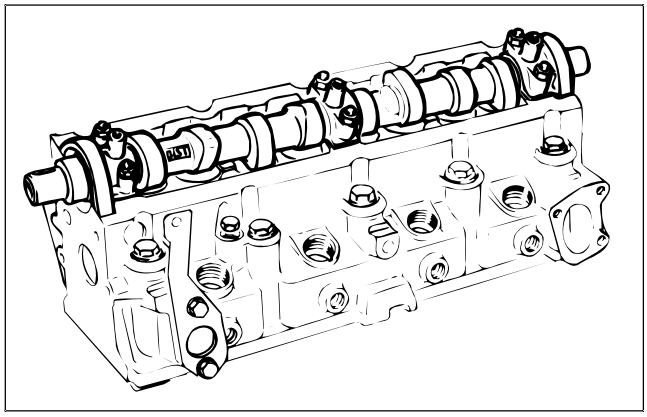


Figure 70

Crankshaft Installation

1. Put thread lock Loctite on the oil gallery plugs and install them in the cylinder block.

2. Install the grooved main bearing shells. (See Crankshaft in the Inspection and Specifications section for main bearing shell thickness.)

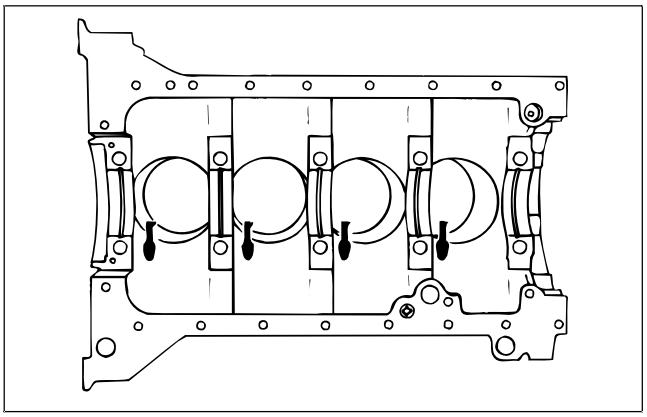


Figure 71

3. Install the crankshaft.

4. Install the no. 3, 4 and 5 main bearing caps.

5. Install the two end float half-washers (Fig. 72, Item 1), with the anti-friction faces towards the crankshaft.

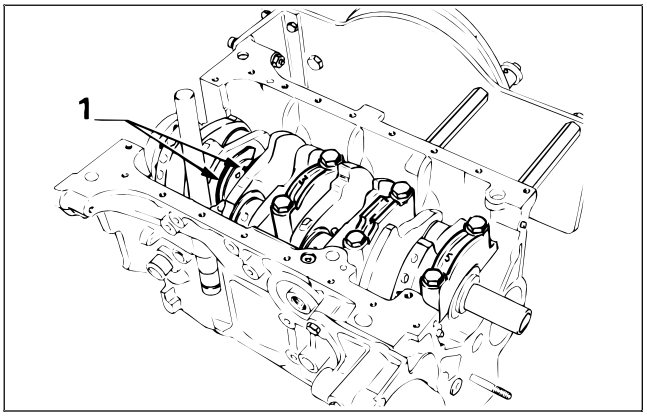


Figure 72

6. Install the no. 2 main bearing cap (Fig. 73, Item 2) with its two end float half-washers, with the anti-friction faces towards the crankshaft.

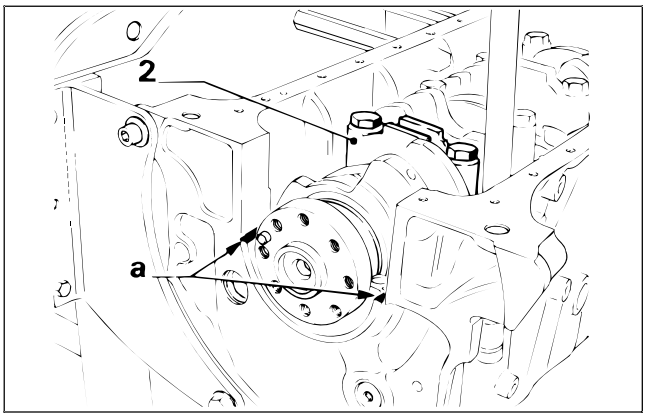


Figure 73

7. Check crankshaft end float (Fig. 74):

A. Install the dial indicator, using tools TOR 80110G1, TOR 80504 A1 and A2.

B. End float must be between 0.07 and 0.32 mm.

NOTE: For choice of half-washer thickness see Crankshaft in the Identification and Specifications section.

8. Apply a thin coat of Formetanch or Permatex No. 2 sealant to surface of block where bearing cap will mate (Fig. 73, Item a).

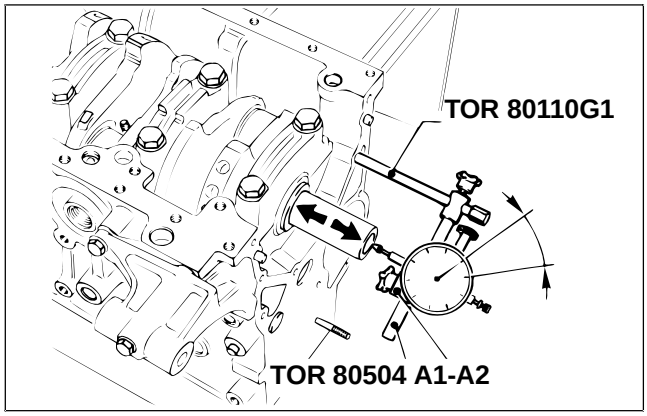


Figure 74

9. Install the two new side seals (Fig. 75, Item 3) to no. 1 main bearing cap.

10. Using a bolt and washer (Item 5), attach tool 80153 fitted with shims A2 to no. 1 main bearing cap (Item 4).

11. Adjust the height (**x**) of the shims.

x = 0.5 mm above flat on side of rear main cap

12. Oil the shims and the housing.

IMPORTANT: To avoid stretching the side seals, fit the cap as follows:

A. Engage it in its housing at 45°.

B. Straighten it.

C. Lower it slowly.

D. Tighten the two bearing cap bolts (Item 6) finger tight.

E. Remove the capscrew securing the tool to the main bearing cap and withdraw the tool horizontally.

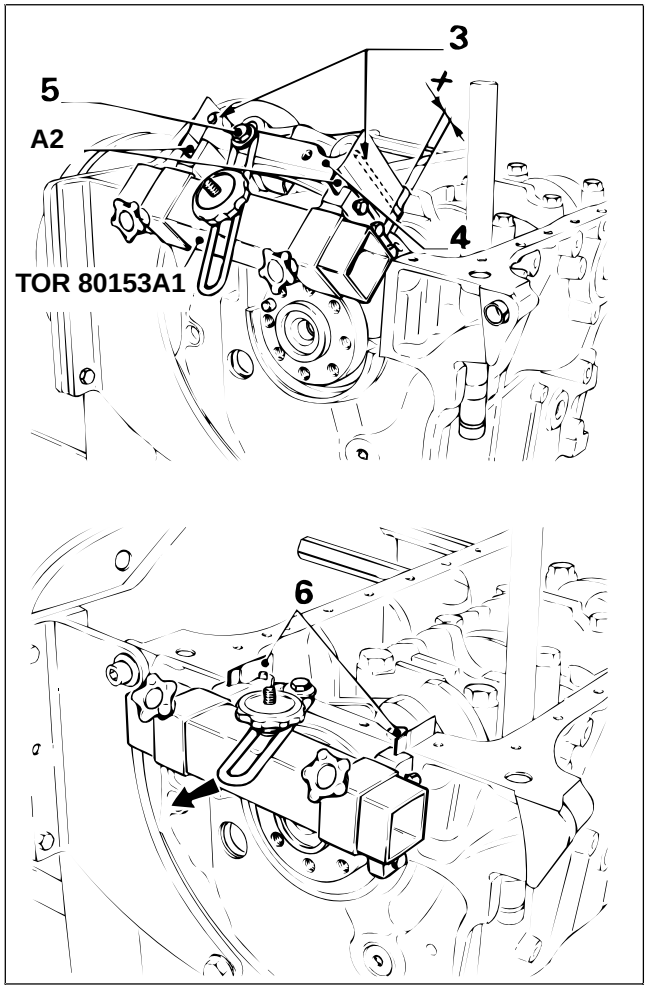


Figure 75

13. Tighten the bearing cap bolts to a torque of 70 Nm (52 ft-lb).

14. Using shim TOR 80110DZ, cut off the side seals so that they protrude 2 mm.

15. Check that the crankshaft rotates without tight spots.

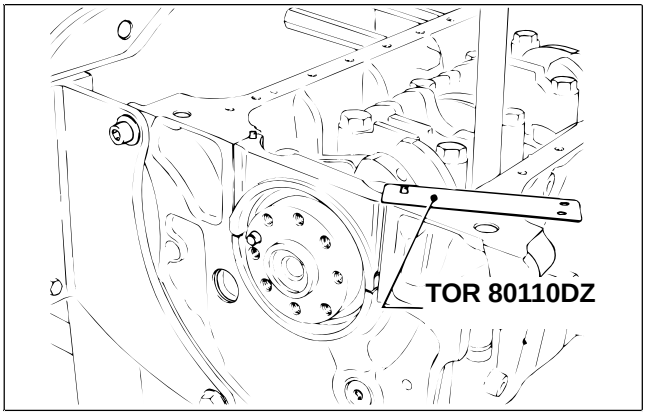


Figure 76

Pistons and Connecting Rod Assembly

1. Assemble the connecting rods and pistons with the bearing shell tab recess (Fig. 77, Item a) on the same side as the piston crown recess (Item b).

2. Use a piston rings pliers to install the piston rings:

NOTE: The marked face of the tapered ring must be towards the combustion chamber.

(1) – scraper ring
(2) – tapered ring
(3) – domed chrome ring

Space the ring gaps at 120° in relation to the scraper ring gap (Item c).

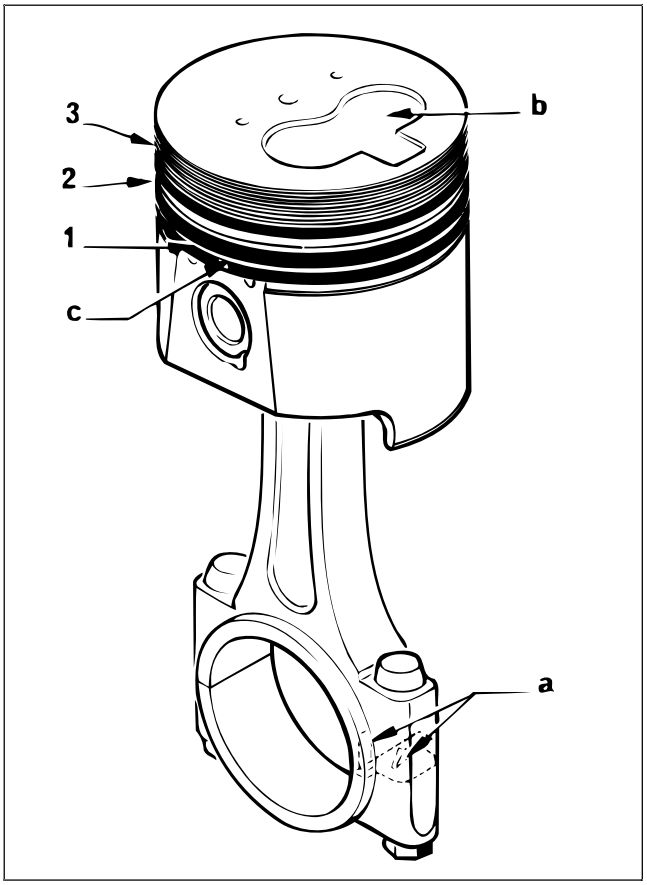


Figure 77

3. Oil the piston and tighten the piston ring clamp (Fig. 78, Item 4).

4. Remove the connecting rod end caps.

5. Install the pistons in the bores, matching the markings made when removed, and aligning the crown recess (Item a) on the oil filter side of the block.

6. Install the connecting rod end caps. Tighten the nuts to a torque of 50 Nm (37 ft-lb).

NOTE: For choice of bearing shell thickness, see Crankcase in Identification and Specifications section.

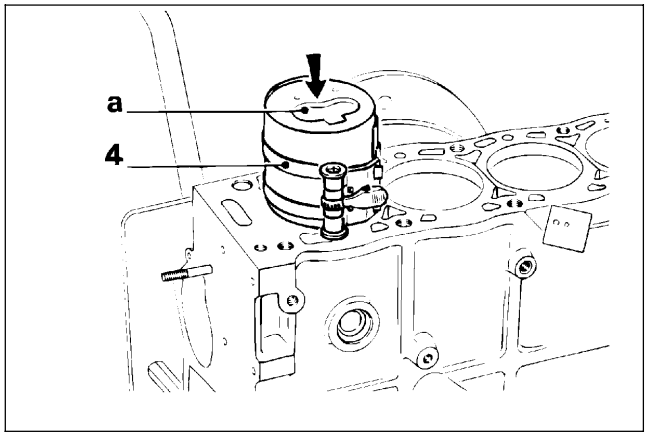


Figure 78

Oil Seal Installation

1. Put a new oil seal on tool TOR 70153 C.

2. Install seal with lip toward the inside of the engine block to keep the oil in. Fit the seal by tapping fully home with a mallet.

3. Withdraw the tool with a twisting movement.

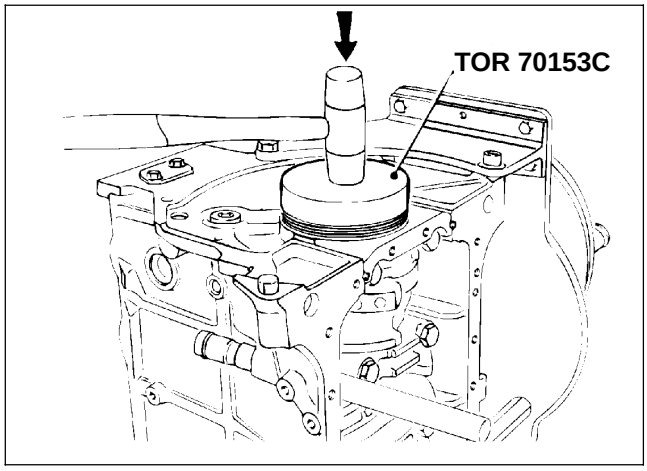


Figure 79

Oil Pump Installation

1. Install the key (Fig. 80, Item 6).

2. Install the pump (Item 7), drive chain and sprocket (Item 8) assembly.

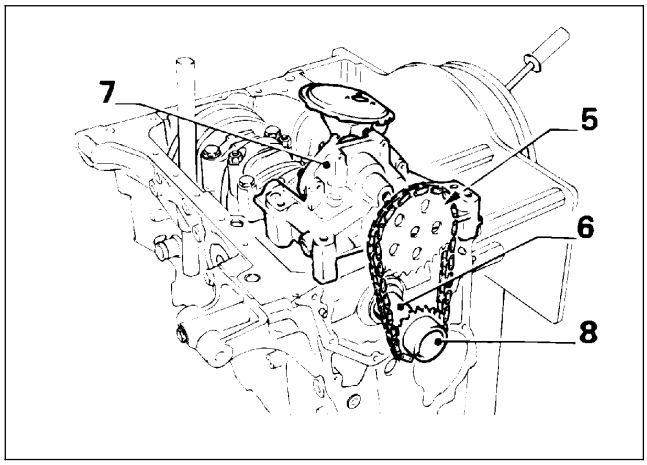


Figure 80

3. Install the special shoulder bolt (Fig. 81, Item 1) to center the pump in the proper location.

4. Install the other bolts and tighten the bolts (Item 1, 2, 3) to a torque of 20 Nm (15 ft-lb).

5. Install the seal carrier plate and a new gasket (Item 4) and tighten the bolts to a torque of 15 Nm (11 ft-lb).

6. Put a new oil seal on tool TOR 70153 D.

7. Install the seal by tapping it fully home with a mallet.

8. Apply Formetanch or Permatex No. 2 sealant as shown (Item a).

9. Install oil pan gasket:

XUD9A Engine: Install the oil pan gasket.

XUD9AI Engine: Apply silicone sealant to the oil pan using the pattern shown in Figure 81a. Wait 10 minutes before installing the oil pan to allow partial hardening of the gasket material.

10. Install the oil pan (Item 5).

11. Install the bolts (Item b).

NOTE: The two shorter bolts are installed into the main bearing cap.

12. Tighten the bolts (Item b) to a torque of 20 Nm (15 ft-lb).

13. Wait a minimum of 1 hour for the oil pan gasket to harden before filling with oil.

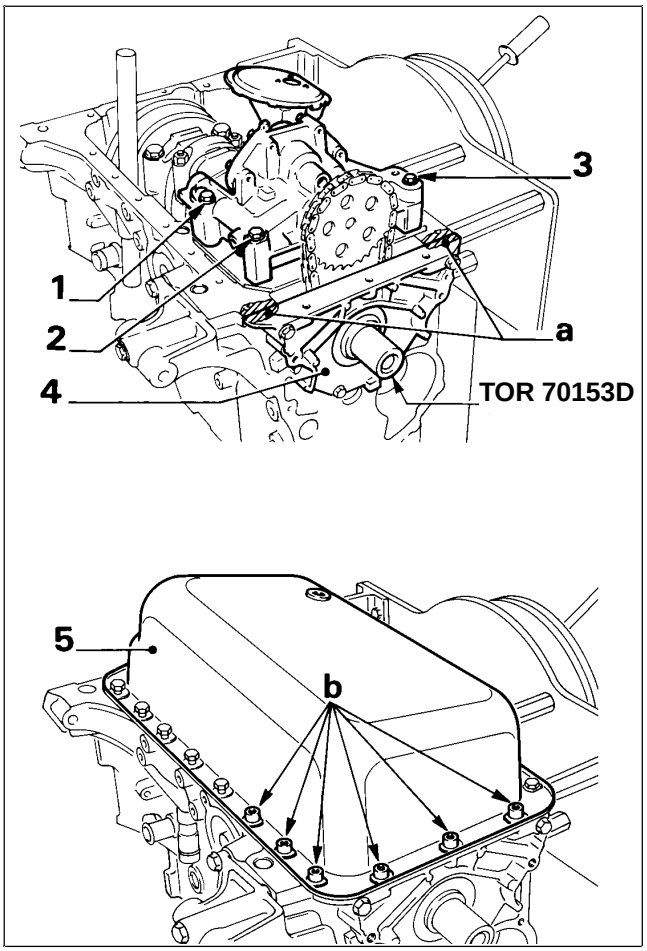


Figure 81

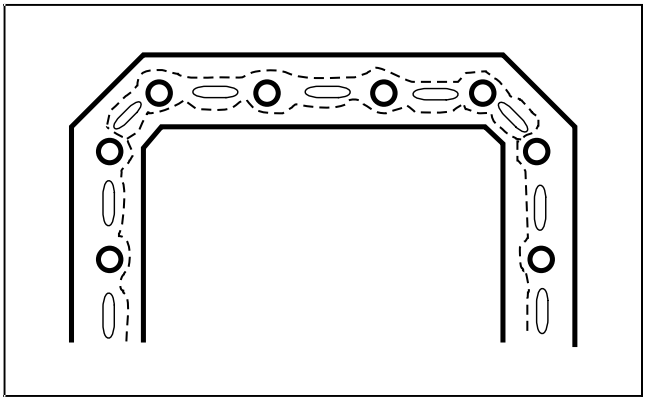


Figure 81a

Flywheel Installation

1. Install the flywheel. Put Locket thread lock on the flywheel mounting bolts.

2. Install a TORFD86 flywheel locking tool.

3. Tighten the flywheel bolts to a torque of 50 Nm (37 ft-lb).

4. Remove the flywheel locking tool.

Cylinder Head Gasket Selection

1. Install the dial indicator on support TOR 80110 H and zero it on a surface plate.

2. Turn the crankshaft and measure the protrusion of each piston at TDC.

3. Note the maximum protrusion (Fig. 82, Item d).

4. Select a cylinder head gasket of suitable thickness.

Units: mm

Piston protrusion (**d**)	Thickness identification
0.56 to 0.71	2 notches
0.71 to 0.75	3 notches
0.75 to 0.79	4 notches
0.79 to 0.83	5 notches

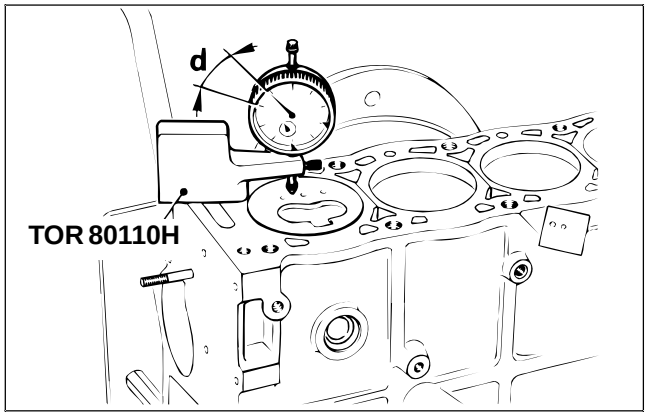


Figure 82

Cylinder Head Installation

1. Turn the crankshaft to put the pistons at mid-stroke with damper pulley key (Fig. 83, Item 6) at the 9 o'clock position.

2. Clean the tapped holes in the cylinder block (12 x 150 thread).

3. Install the centralizing dowel (Item 7).

4. Install a new head gasket (dry).

5. Install the cylinder head.

6. Carefully clean the threads of the cylinder head bolts with a brush.

7. Coat the bolt threads and washer contact faces with MOLYKOTE G RAPID.

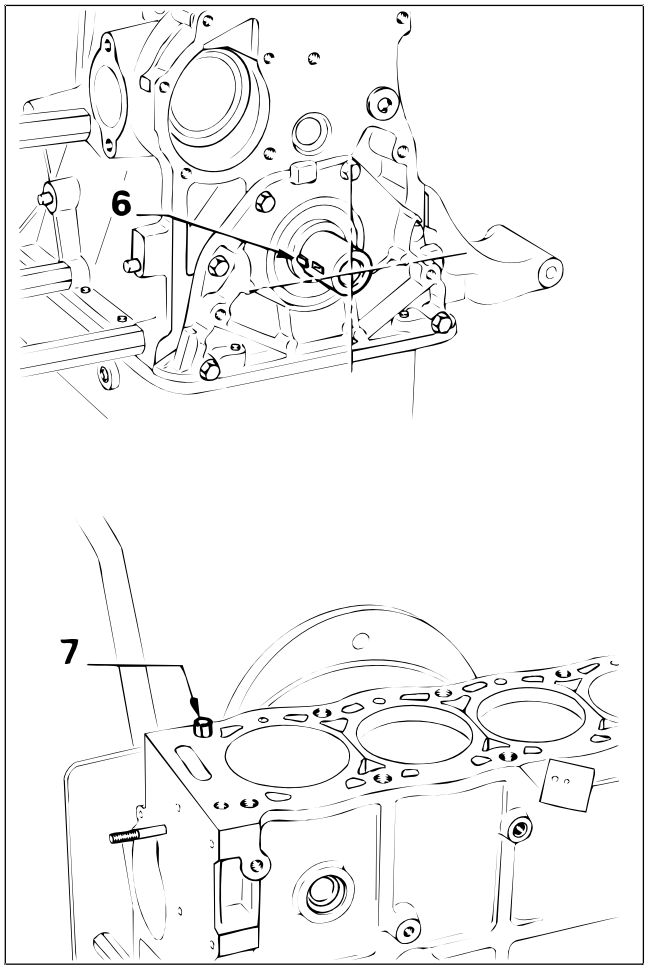


Figure 83

Cylinder Head Tightening

1. Install new washers on the bolts.

2. Pre-tighten the bolts in the order shown (Fig. 84) to a torque of 30 Nm (22 ft-lb).

3. Tighten the bolts in the order shown to a torque of 70 Nm 52 ft-lb).

4. Tighten each bolt in the order shown an additional 120° ± 2°.

NOTE: The special cylinder head bolts (Item B) do not require re-tightening. The bolts can be removed and re-installed 5 times before replacing with new bolts.

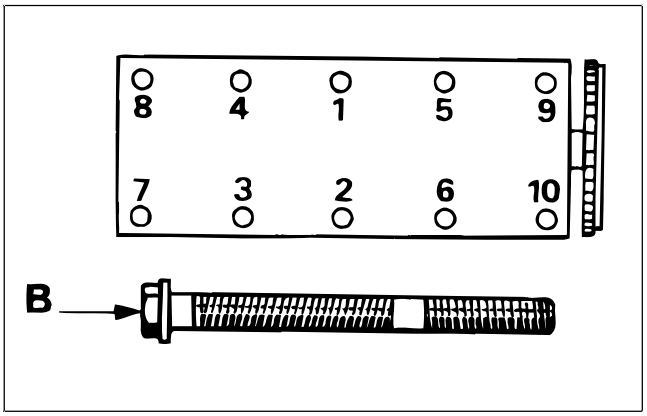


Figure 84

Valve Clearance Adjustment

NOTE: If all valve parts are re-installed in their original location it should not be necessary to adjust valve clearance, unless the head has been machined or valves ground.

1. Install the camshaft gear. (Fig. 85, Item 1).

2. Check the valve clearance:

Units: mm

	Running Clearance
Inlet	0.15
Exhaust	0.30
Tolerance	± 0.04

Set “on the rock”	Inlet 4, Exhaust 4	Inlet 1, Exhaust 1
Check	Inlet 1, Exhaust 1	Inlet 4, Exhaust 4
	Inlet 2, Exhaust 3	Inlet 3, Exhaust 2

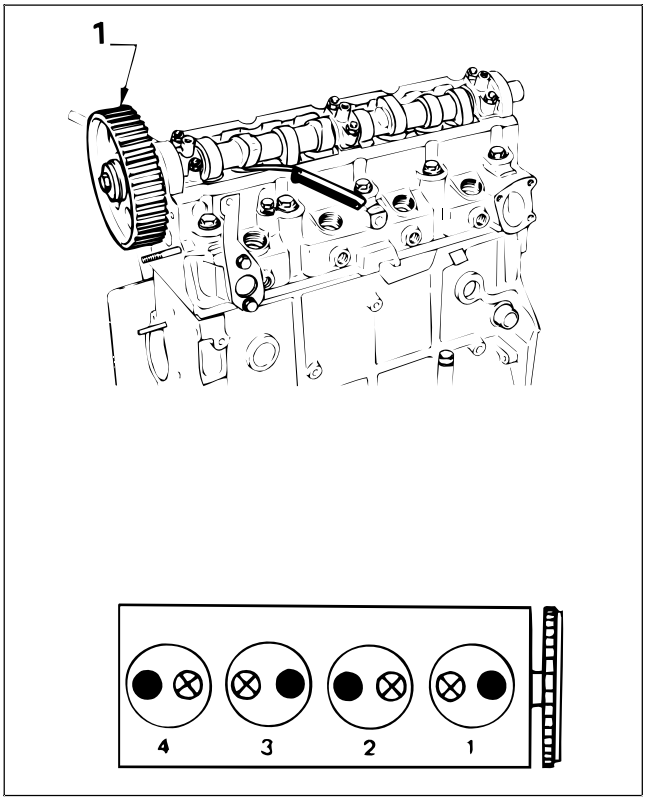


Figure 85

3. Remove the camshaft gear (Fig. 86, Item 1).

4. Remove the camshaft bearing caps (Item 2).

5. Remove the camshaft (Item 3).

6. Remove the tappets (Item 4).

7. Remove the basic shims (Item 5).

8. Determine the shim thickness to be fitted for each valve. Example:

Units: mm

	No. 1 Intake valve
Specified clearance	0.15
Clearance measured	0.25
Difference	+ 0.10
Shim installed	2.425 *
Shim to be installed	2.50
Clearance obtained	0.175

* Basic shim

9. Install the shims as determined in step 8.

10. Install the tappets.

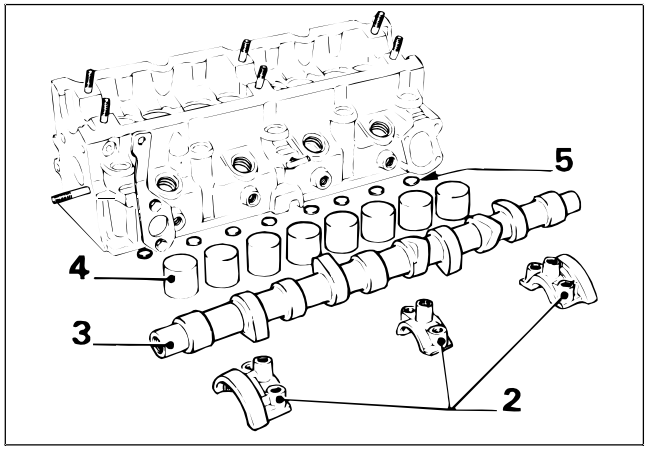


Figure 86

11. Apply a thin coat of Formetanch or Permatex No. 2 sealant to each end of the bearing housing at (Fig. 87, Item a).

12. Apply MOLYKOTE G RAPID to the bearing surfaces on the camshaft.

13. Install the camshaft (Item 3) with the DIST marking at the timing gear end.

14. Install the camshaft bearing caps (Item 2) as shown by cast-in markings.

15. Progressively tighten the bearing caps to 17.5 Nm (13 ft-lb).

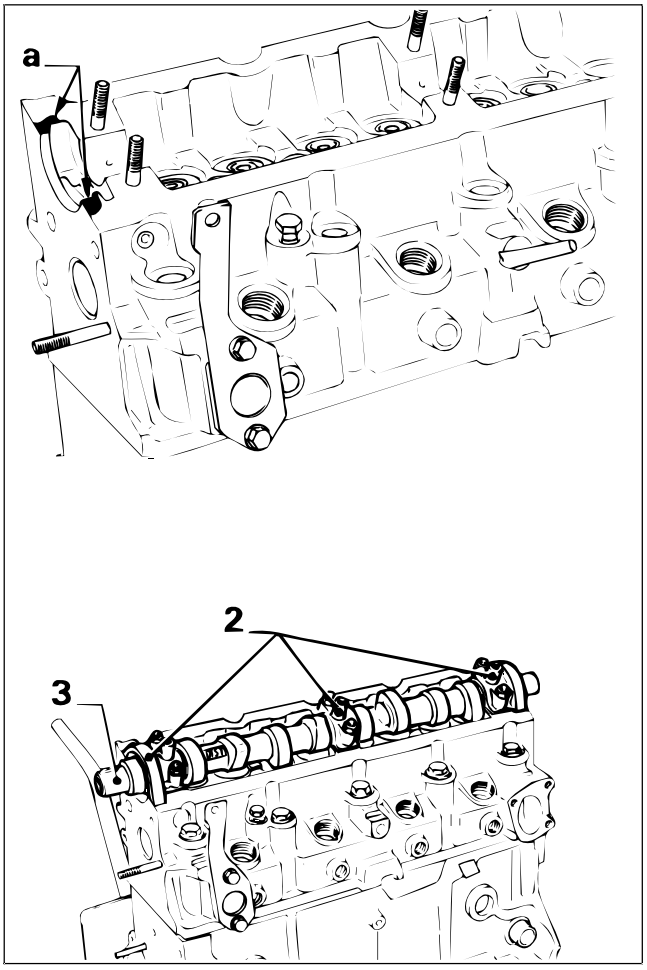


Figure 87

16. Install a new oil seal on tool TOR 976697 on the side where the inner flange is the farthest away (Fig. 88).

17. Use a camshaft gear or pulley bolt to install the two camshaft oil seals.

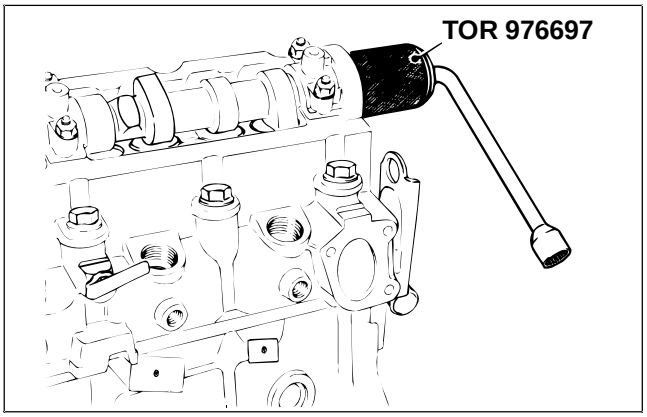


Figure 88

Assembly of External Components

1. Install new fire ring washers (Fig. 89, Item 1), convex surface facing up.

2. Install new copper washers (Item 2).

3. Install the injectors and tighten to a torque of 90 Nm (66 ft-lb).

4. Install the pre-heat plugs (Item 4) and tighten to a torque of 22 Nm (16 ft-lb).

5. Install the thermostat housing (Item 5) and cover (Item 6), fitted with a new thermostat and gasket.

6. Install the cylinder head cover (Item 7), and tighten to a torque of 10 Nm (7 ft-lb).

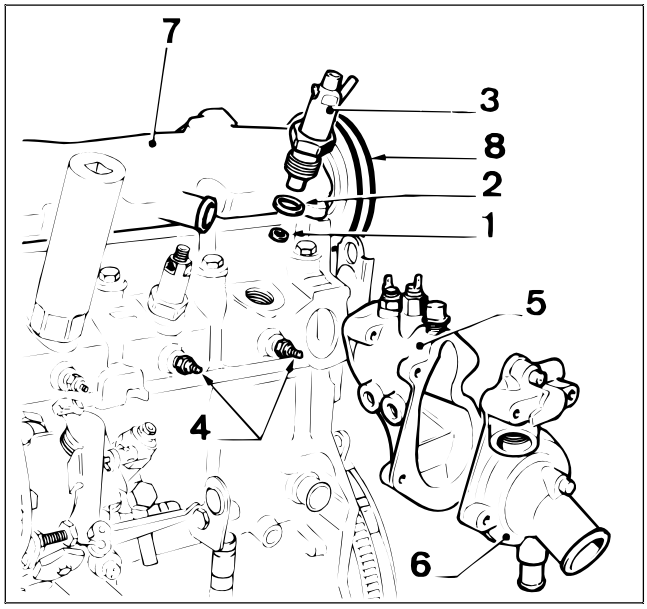


Figure 89

7. Install the pre-heat plug wires.

8. Install the breather pipe assembly, with oil filler pipes and filler orifice (Fig. 90, Item 13).

9. Install the injector pipes (Item 12).

10. Install the oil pressure switch (Item 14) and tighten to a torque of 27.5 Nm (20 ft-lb).

11. Install a new oil filter (Item 10). (See Break-in Engine After Overhaul.)

12. Install the alternator and alternator belt.

13. Install the water inlet housing.

14. Install the exhaust manifold with new seals.

15. Install the intake manifold.

16. Remove the engine from the stand.

17. Install the clutch housing centering pin.

18. Install the TDC sensor.

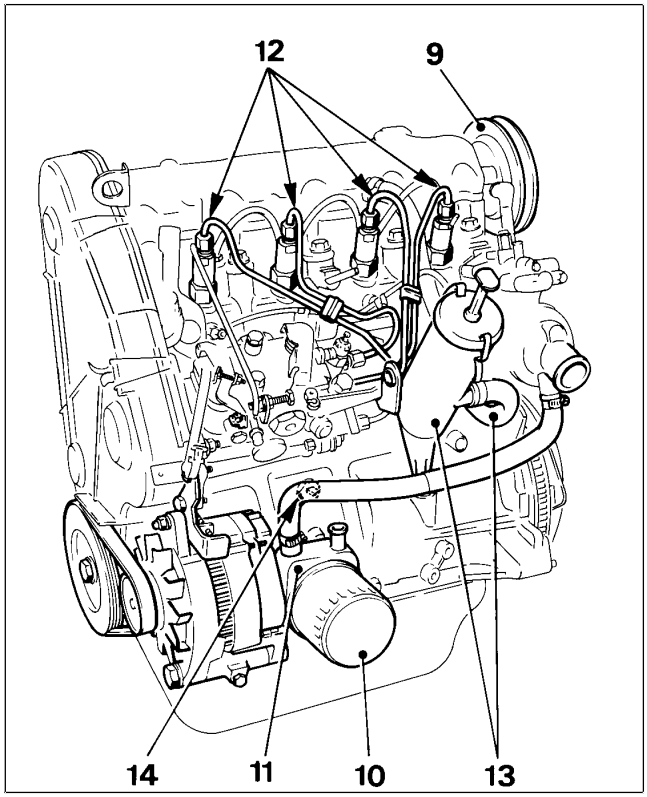


Figure 90

Break-in Engine After Overhaul

After disassembling or overhauling the engine, install the a new oil filter. Replace this filter with a new filter after the first 20 to 50 hours of operation.

Chapter 4

Hydraulic System

Table of Contents

Specifications

Item	Description
Traction/Reel Drive Pump (Sundstrand-Sauer) Traction relief pressure Mow relief pressure Charge pressure (remote charge relief valve)	Sundstrand-Sauer, tandem in-line variable axial piston pump 5000 ± 100 PSI 2540 ± 100 PSI 100 ± 25 PSI
Traction/Reel Drive Pump (Eaton) Forward relief pressure Mow relief pressure Charge pressure	Eaton tandem in-line variable axial piston pump 5500 ± 100 PSI 2750 ± 100 PSI 75 ± 25 PSI
Charge/Auxiliary Pump Steering pressure	Eaton gear pump with flow divider 1200 ± 100 PSI
Traction Motor (front)	Sundstrand-Sauer fixed axial piston motor
Traction Motor (rear w/4WD)	Eaton fixed axial piston pump
Reel motor	Eaton gear motor with elec./hyd. solenoid control valve
Lift Control Valve Lift relief pressure Counterbalance pressure (remote mounted)	Cessna spool type directional control valve 1850 - 2000 PSI 300 - 400 PSI (hot oil)
Hydraulic Filter	Spin-on cartridge type
Hydraulic Oil	***** Mobil DTE 26 or equivalent
Reservoir	Approximately 6.5 gal. U.S.

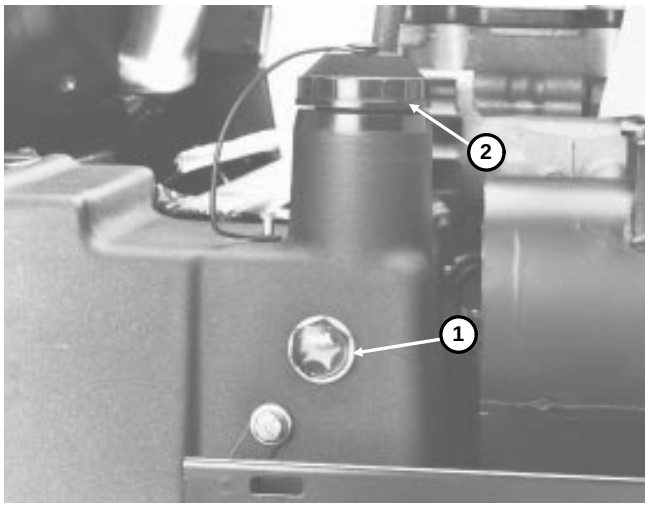


Figure 1

1. Sight gauge **2. Hydraulic reservoir cap**

*** Equivalent Hydraulic Oils (interchangeable):**

Shell Tellus 68
Amoco Rykon Oil 68
Conoco Super Hydraulic Oil 68
Exxon Nuto H 68
Kendall Kenoil R & O AW 68
Pennzoil Penreco 68
Phillips Magnus A 68
Standard Energol HLP 68
Sun Sunvis 831 WR
Union Unax AW 68
Chevron AW Hydraulic Oil 68

General Information

Hydraulic Hoses

Hydraulic hoses are subject to extreme conditions such as, pressure differentials during operation and exposure to weather, sun, chemicals, very warm storage conditions or mishandling during operation or maintenance. These conditions can cause damage or premature deterioration. Some hoses, such as reel motor hoses, are more susceptible to these conditions than others. Inspect the hoses frequently for signs of deterioration or damage.

When replacing a hydraulic hose, be sure that the hose is straight (not twisted) before tightening the fittings. This can be done by observing the imprint on the hose. Use two wrenches; one to hold the hose straight and one to tighten the hose swivel nut onto the fitting.

CAUTION

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved by stopping the engine and opening the bypass valve.

Keep body and hands away from pin hole leaks or nozzles that eject hydraulic fluid under high pressure. Use paper or cardboard, not hands, to search for leaks. Hydraulic fluid escaping under pressure can have sufficient force to penetrate the skin and do serious damage. If fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type of injury or gangrene may result.

Hydraulic Fitting Installation

O-Ring Face Seal (Fig. 2, 3)

1. Make sure both threads and sealing surfaces are free of burrs, nicks, scratches, or any foreign material.

2. Make sure the O-ring is installed and properly seated in the groove. It is recommended that the O-ring be replaced any time the connection is opened.

3. Lubricate the O-ring with a light coating of oil.

4. Put the tube and nut squarely into position on the face seal end of the fitting and tighten the nut until finger tight.

5. Mark the nut and fitting body. Hold the body with a wrench. Use another wrench to tighten the nut to the correct flats from finger tight (F.F.F.T.). The markings on the nut and fitting body will verify that the connection has been tightened.

Size	F.F.F.T.
4 (1/4 in. nominal hose or tubing)	.75 ± .25
6 (3/8 in.)	.75 ± .25
8 (1/2 in.)	.75 ± .25
10 (5/8 in.)	1.00 ± .25
12 (3/4 in.)	.75 ± .25
16 (1 in.)	.75 ± .25

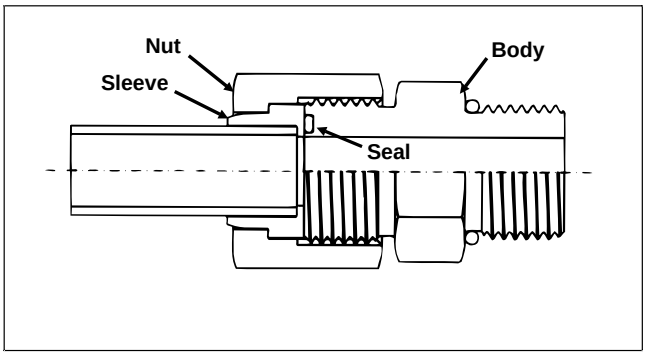


Figure 2

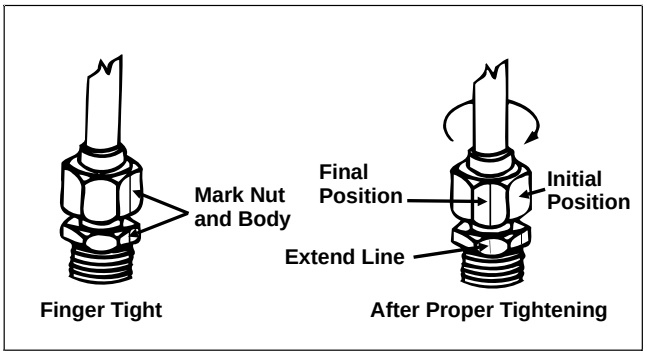


Figure 3

SAE Straight Thread O-Ring Port - Non-adjustable (Fig. 4)

1. Make sure both threads and sealing surfaces are free of burrs, nicks, scratches, or any foreign material.

2. Always replace the O-ring seal when this type of fitting shows signs of leakage.

3. Lubricate the O-ring with a light coating of oil.

4. Install the fitting into the port and tighten it down full length until finger tight.

5. Tighten the fitting to the correct flats from finger tight (F.F.F.T.).

Size	F.F.F.T.
4 (1/4 in. nominal hose or tubing)	1.00 ± .25
6 (3/8 in.)	1.50 ± .25
8 (1/2 in.)	1.50 ± .25
10 (5/8 in.)	1.50 ± .25
12 (3/4 in.)	1.50 ± .25
16 (1 in.)	1.50 ± .25

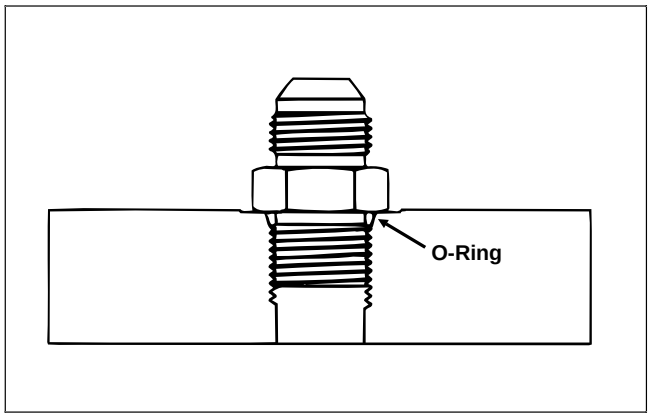


Figure 4

SAE Straight Thread O-Ring Port - Adjustable (Fig. 5, 6)

1. Make sure both threads and sealing surfaces are free of burrs, nicks, scratches, or any foreign material.

2. Always replace the O-ring seal when this type of fitting shows signs of leakage.

3. Lubricate the O-ring with a light coating of oil.

4. Turn back the jam nut as far as possible. Make sure the back up washer is not loose and is pushed up as far as possible (Step 1).

5. Install the fitting into the port and tighten finger tight until the washer contacts the face of the port (Step 2).

6. To put the fitting in the desired position, unscrew it by the required amount, but no more than one full turn (Step 3).

7. Hold the fitting in the desired position with a wrench and turn the jam nut with another wrench to the correct flats from finger tight (F.F.F.T.) (Step 4)

Size	F.F.F.T.
4 (1/4 in. nominal hose or tubing)	1.00 ± .25
6 (3/8 in.)	1.50 ± .25
8 (1/2 in.)	1.50 ± .25
10 (5/8 in.)	1.50 ± .25
12 (3/4 in.)	1.50 ± .25
16 (1 in.)	1.50 ± .25

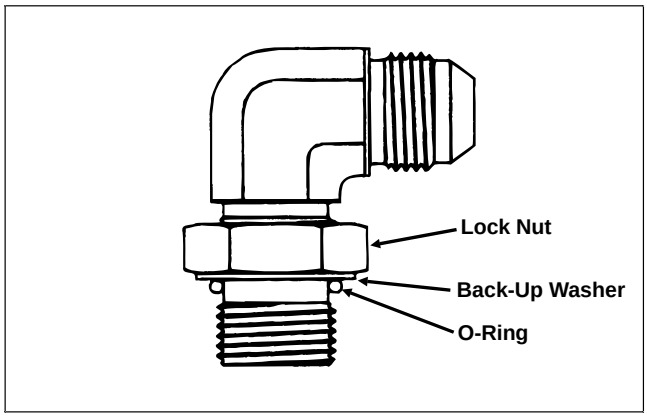


Figure 5

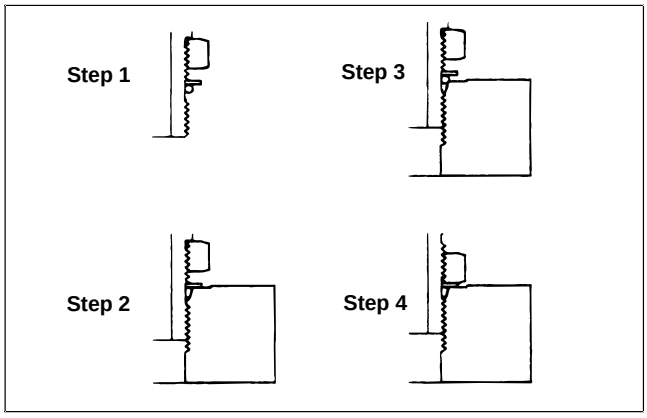
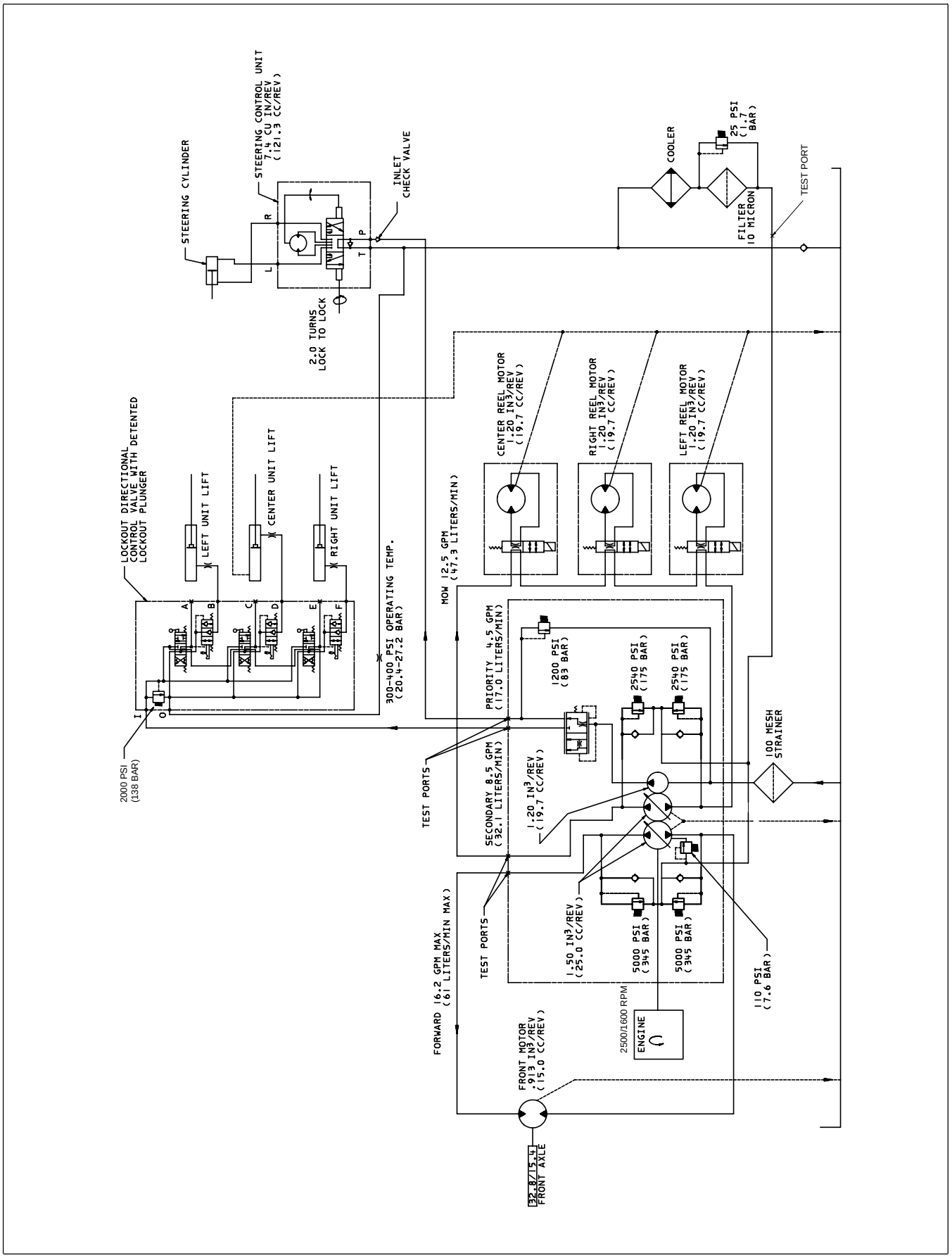
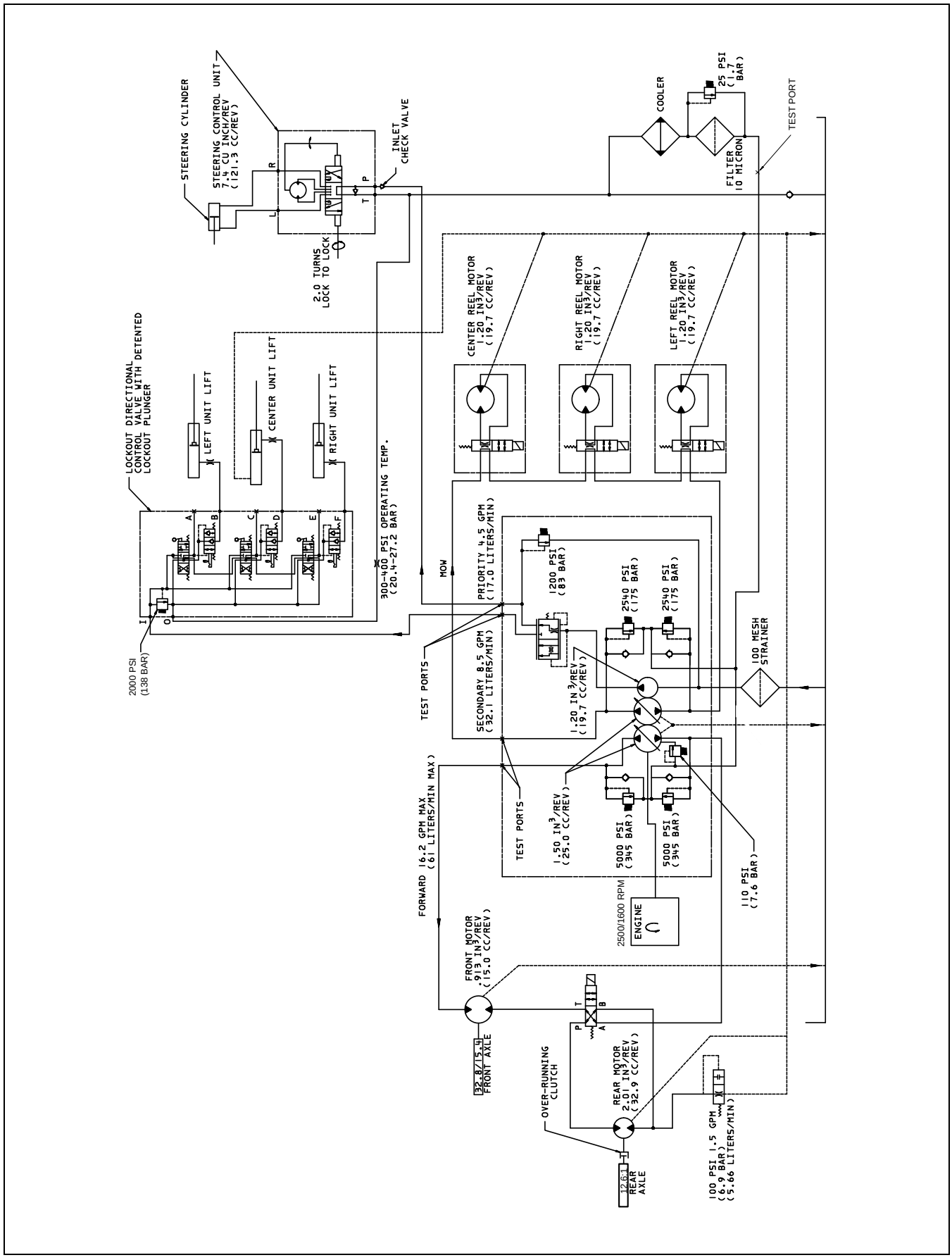


Figure 6

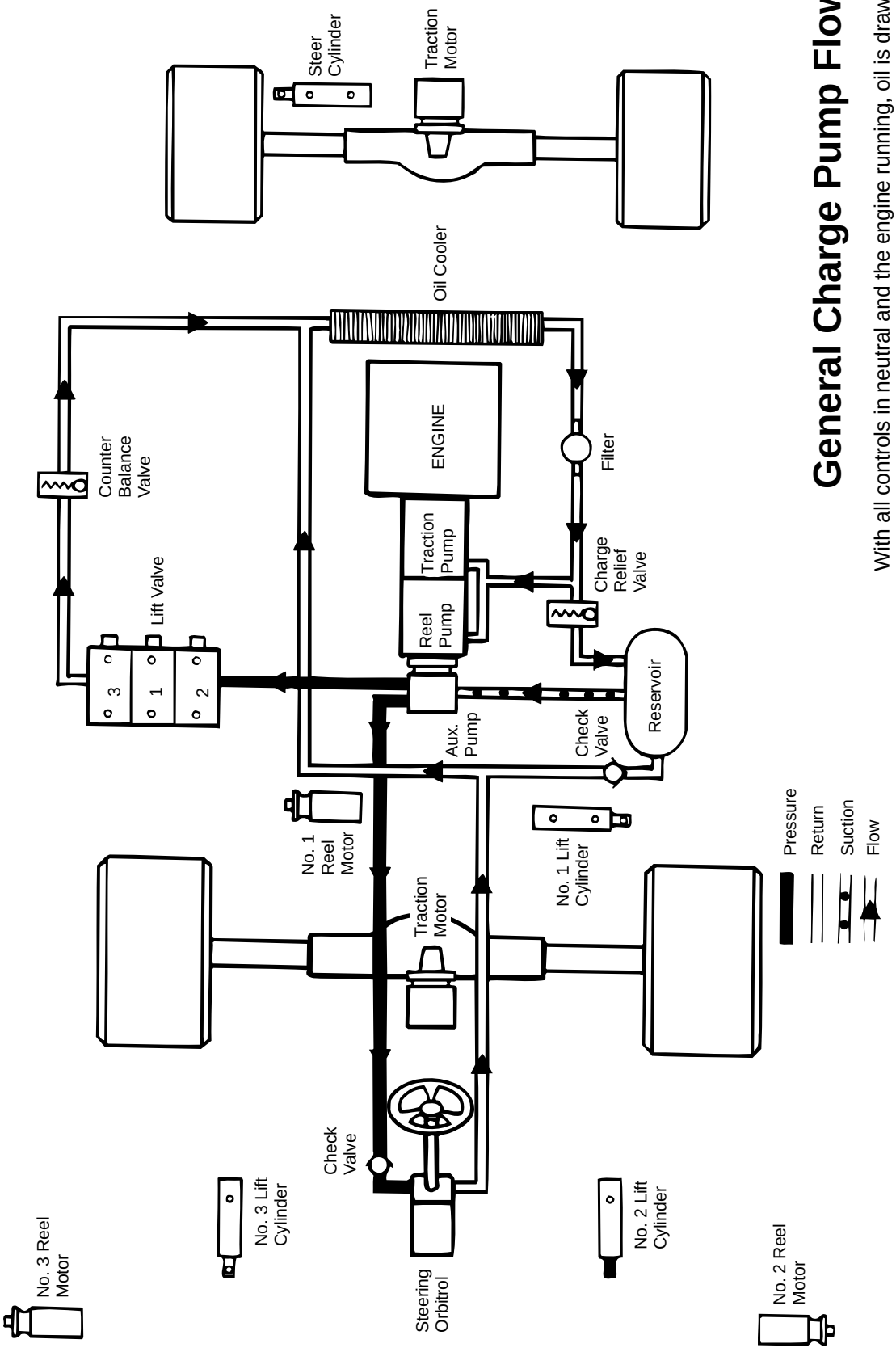
Hydraulic Schematic - Two (2) Wheel Drive



Hydraulic Schematic - Four (4) Wheel Drive

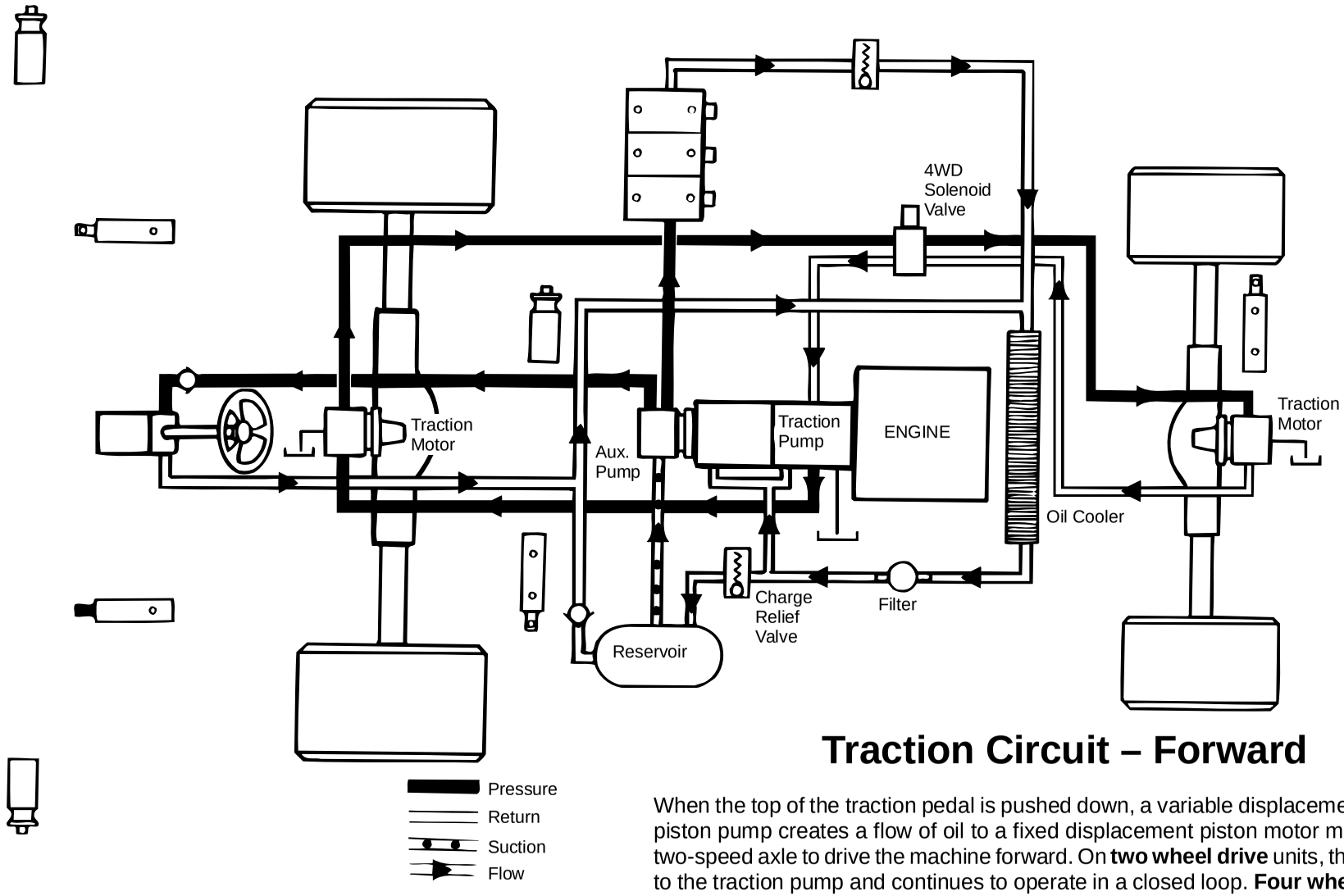


Hydraulic Flow Diagrams



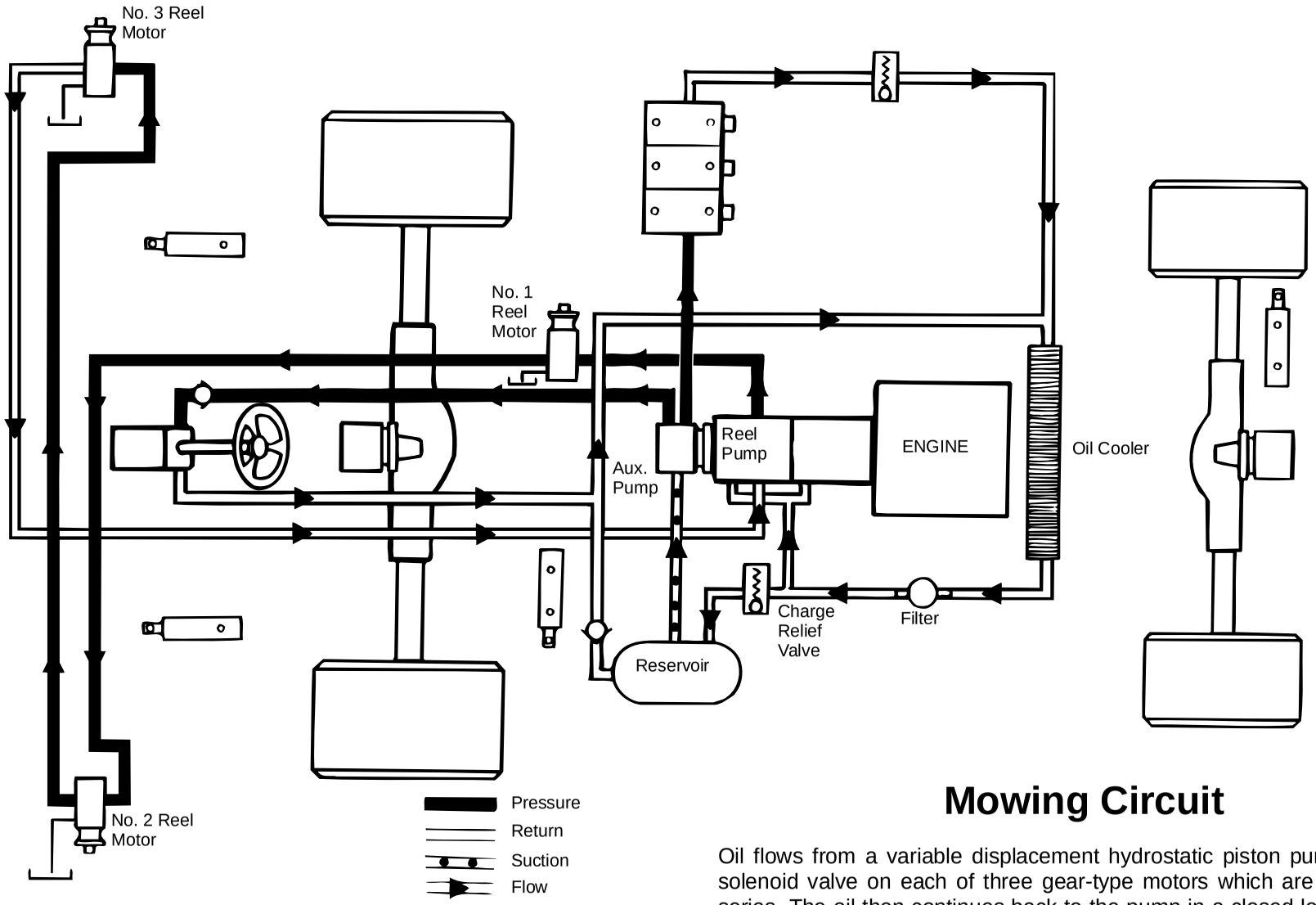
General Charge Pump Flow

With all controls in neutral and the engine running, oil is drawn from the reservoir by the auxiliary pump. This gear-type pump has a flow divider cover. Priority flow goes to the steering valve, then through the oil cooler, filter, and back to reservoir. Secondary flow goes to the lift valve, then through the counterbalance valve, oil cooler and back to reservoir. The charge relief valve keeps the return flow under pressure so charge oil is always available to the traction and mowing circuits.



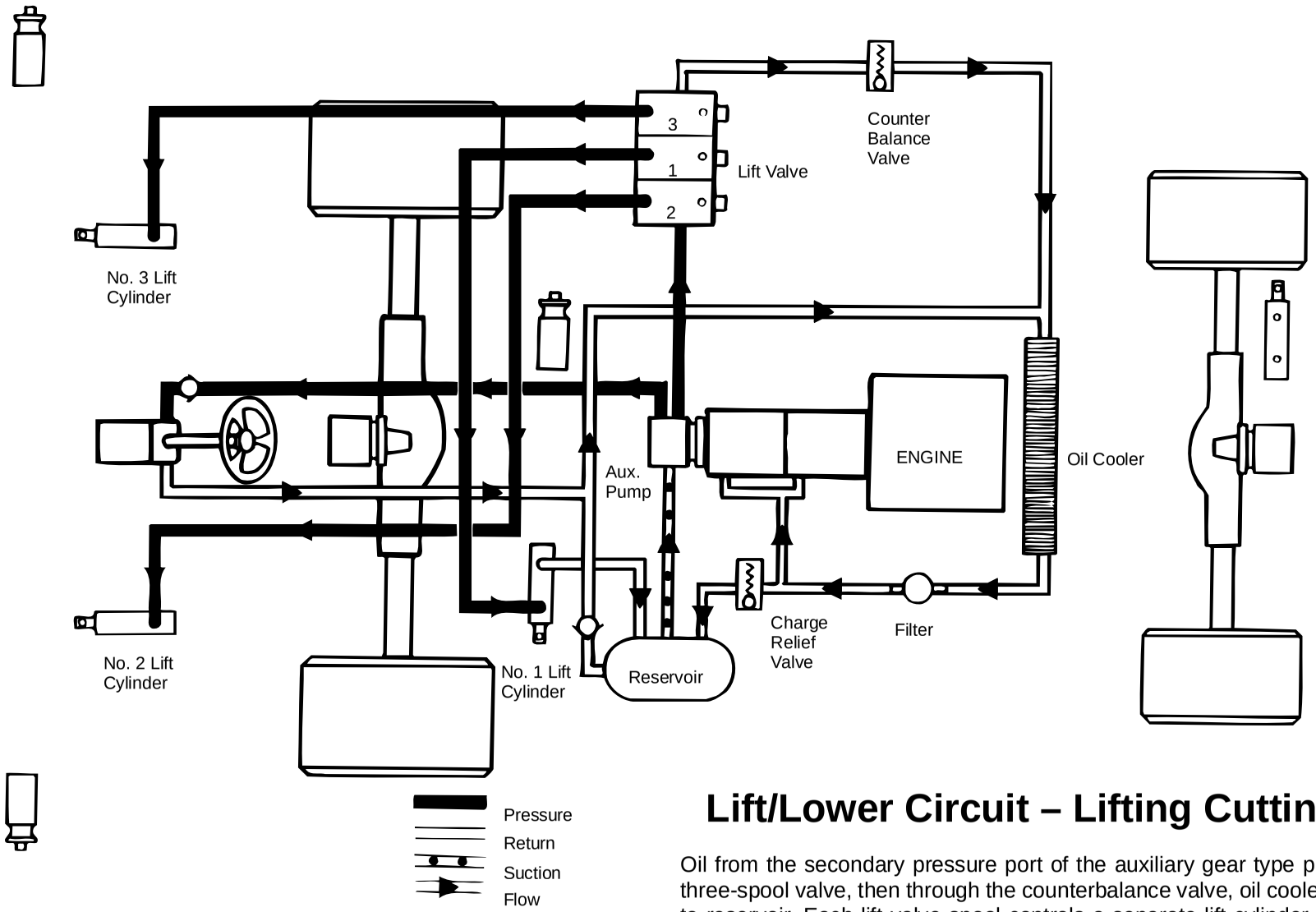
Traction Circuit – Forward

When the top of the traction pedal is pushed down, a variable displacement hydrostatic piston pump creates a flow of oil to a fixed displacement piston motor mounted on the two-speed axle to drive the machine forward. On **two wheel drive** units, this flow returns to the traction pump and continues to operate in a closed loop. **Four wheel drive** units have another piston motor connected in series with the front motor and mounted to the steerable rear axle. On these units, flow is from the pump to the front motor, through a solenoid valve, then to the rear motor and back to the pump, continuing in a closed loop. An interlock switch on the front axle controls the 4wd solenoid valve to engage four wheel drive only when the transmission is in low gear. When in four wheel drive, an over-running clutch between the motor and rear axle automatically engages the rear axle only when the front wheels begin to slip.



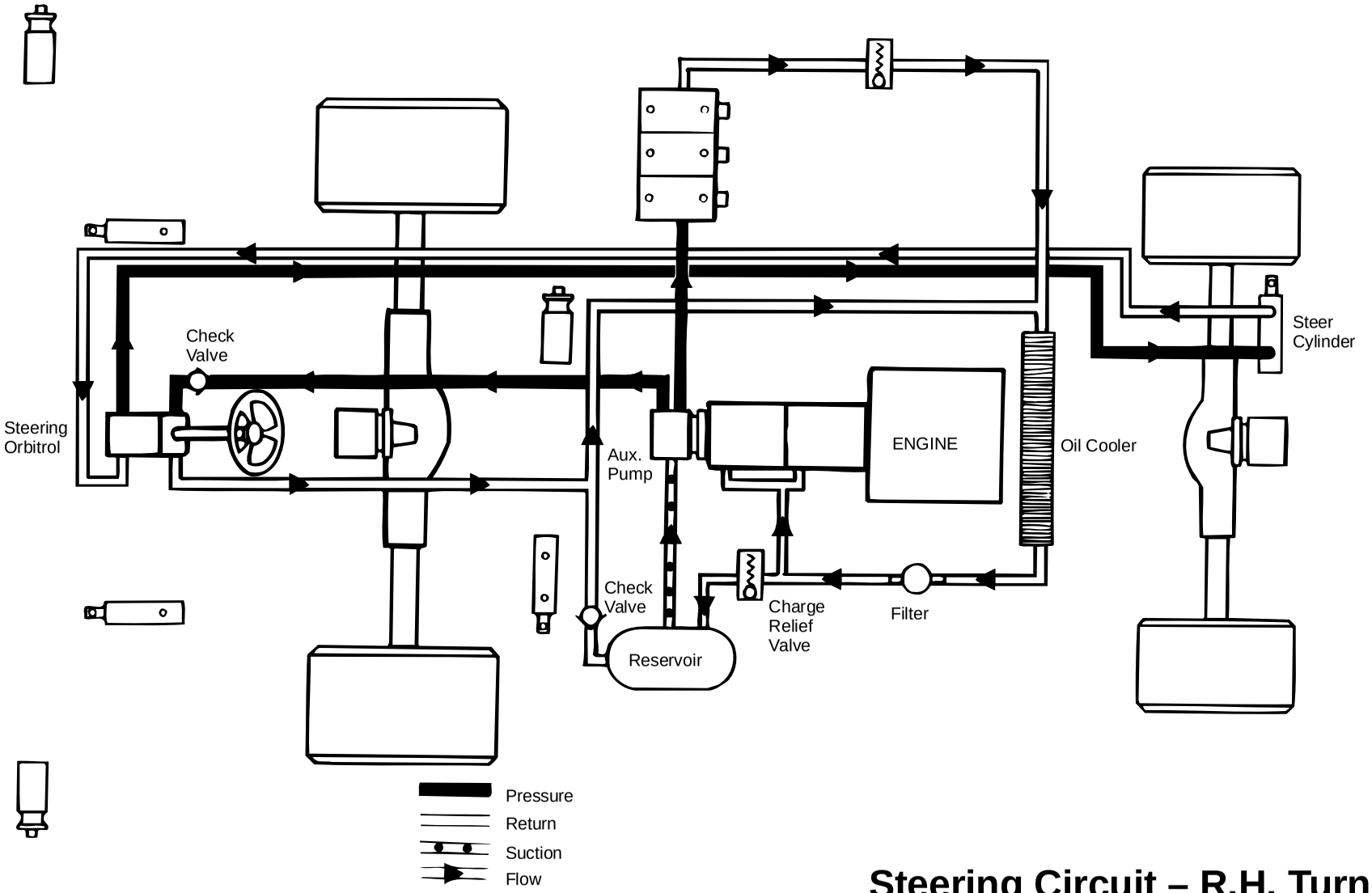
Mowing Circuit

Oil flows from a variable displacement hydrostatic piston pump through a solenoid valve on each of three gear-type motors which are connected in series. The oil then continues back to the pump in a closed loop. When the cutting unit engagement switch is on, with the front axle in low gear, and cutting units lowered, the solenoid valve on each cutting unit motor will allow oil to flow through the motor to turn the reel. An interlock switch on the front axle allows the electric solenoid valves to engage the reel motors only when the axle is in low gear. An interlock switch in each lift arm causes the electrical solenoid valve on each motor to automatically stop the reel as the cutting unit is lifted. Reel speed is controlled by turning a knob to change the displacement of the pump thus increasing flow to the reel motors.



Lift/Lower Circuit – Lifting Cutting Units

Oil from the secondary pressure port of the auxiliary gear type pump goes to the three-spool valve, then through the counterbalance valve, oil cooler, filter, and back to reservoir. Each lift valve spool controls a separate lift cylinder. Check valves in each spool section hold the cutting units in the raised position. When a lift lever is moved to the lift position, the valve spool moves to direct oil flow to the lift cylinder, lifting the cutting unit. An orifice in the lift port of each cylinder limits the speed of cutting unit lifting and lowering. A counterbalance relief valve in the return line creates a constant back pressure in the lift circuit to transfer some of the cutting unit weight to the traction unit.



Steering Circuit – R.H. Turn

Oil flows from the priority pressure port of the gear type auxiliary pump to the power steering valve, then through the oil cooler, filter, and back to reservoir. Turning the steering wheel to the right (clockwise) moves the control spool in the steering valve to meter oil to the steering cylinder for a right turn. Turning the steering wheel to the left (counterclockwise) has the opposite effect. Cylinder movement forces oil out the other end of the cylinder, back to the steering valve which directs it back to reservoir.

Special Tools

NOTE: Order special tools from the *TORO SPECIAL TOOLS AND APPLICATIONS GUIDE (COMMERCIAL PRODUCTS)*. Some tools may be listed in the Reelmaster 335-D Parts Catalog. Some tools may also be available from a local supplier.

Hydraulic Pressure Test Kit

Used to take various pressure readings for diagnostic tests. Quick disconnect fittings provided attach directly to mating fittings on machine test ports without tools. A high pressure hose is provided for remote readings. Contains one each, 1000, 5000 and 10000 PSI gauges. Use gauges as recommended in Testing section of this chapter.

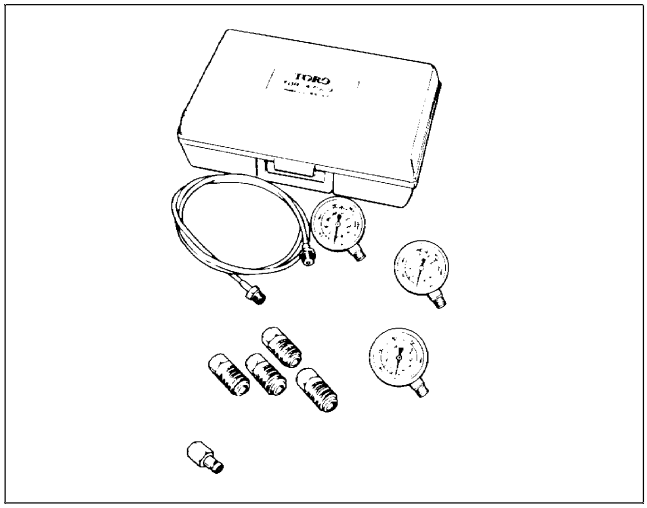


Figure 7

Hydraulic Tester - With Pressure and Flow Capabilities

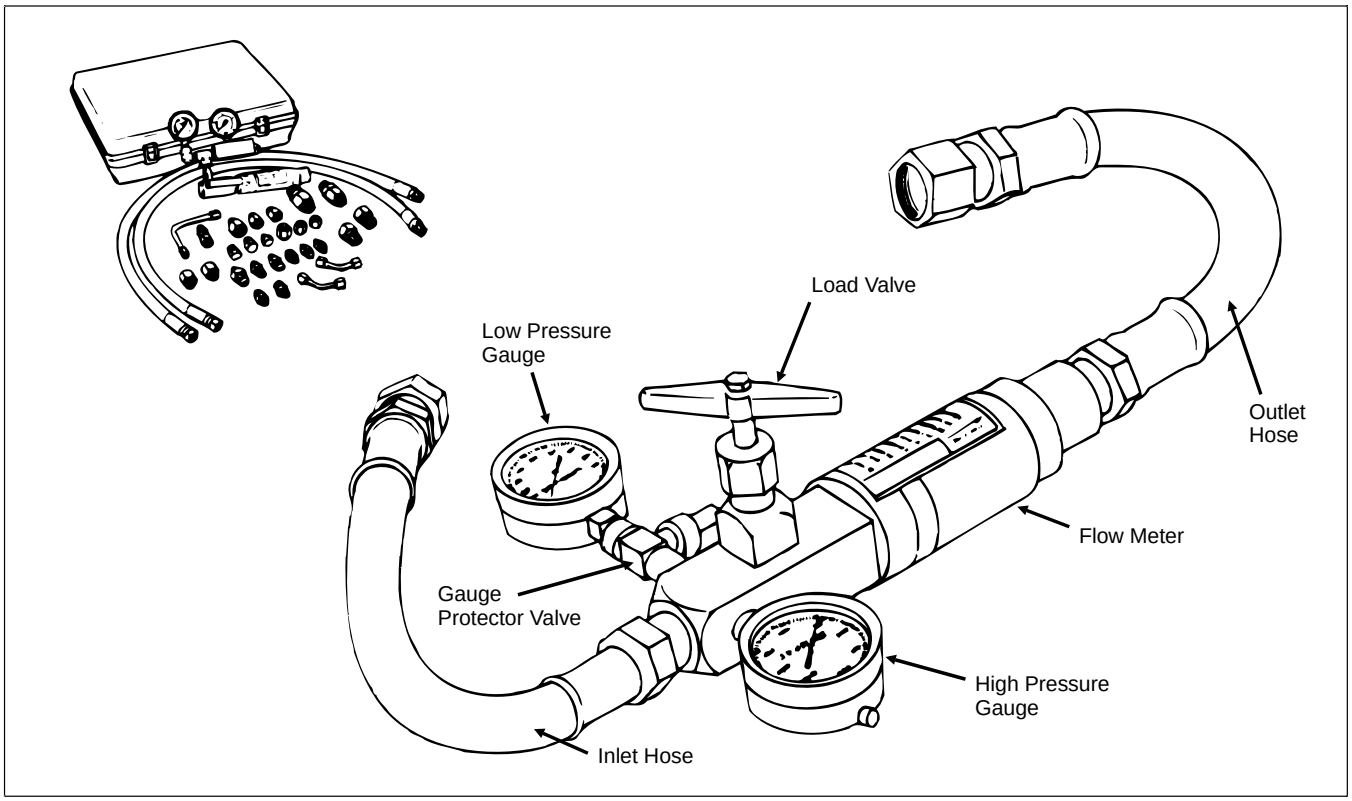


Figure 8

You must have o-ring face seal (ORFS) adapter fittings for this tester to use it on the Reelmaster 335-D.

1. INLET HOSE: Hose connected from the system circuit to the inlet side of the hydraulic tester.

2. LOAD VALVE: If required, upon turning the valve to restrict flow, a simulated working load is created in the circuit.

3. LOW PRESSURE GAUGE: Low range gauge to provide accurate reading at low pressure, 0 - 1000 PSI.

   This gauge has a protector valve which cuts out when pressure is about to exceed the normal range for the gauge. The cutout pressure is adjustable.

4. HIGH PRESSURE GAUGE: High range gauge to accommodate pressure beyond the capacity of the low pressure gauge, 0 - 5000 PSI.

5. FLOW METER: This meter measures actual oil flow in the operation circuit, with a gauge rated at 15 GPM.

6. OUTLET HOSE: Hose from the outlet side of the hydraulic tester to be connected to the hydraulic system circuit.

Troubleshooting

The cause of an improperly functioning hydraulic system is best diagnosed with the use of proper testing equipment and a thorough understanding of the complete hydraulic system.

A hydraulic system with an excessive increase in heat or noise is a potential failure. Should either of these conditions be noticed, immediately stop the machine, turn off the engine, locate the cause of the trouble, and correct it before allowing the machine to be used again. Continued use of an improperly functioning hydraulic system could lead to extensive internal component damage.

The charts that follow contain detailed information to assist in troubleshooting. There may possibly be more than one cause for a machine malfunction. All causes should be checked in the order in which they are listed on the charts.

Refer to the Testing section of this Chapter for precautions and specific test procedures.

System Operates Hot

Cause	Correction
Cooling system not operating properly.	Clean screen, oil cooler & radiator. Repair fan or belt. Check coolant level and add coolant if necessary.
Low engine RPM.	Adjust - use tachometer.
Hydraulic oil level too low.	Fill to proper level.
Kinked or severely bent hose or tubing.	Replace kinked or bent hose or tubing.
Traction circuit working pressure too high - TEST NO. 1.	Inspect brakes for binding and adjust or repair if necessary. Check for other cause of excessive machine load and correct.
Damaged pump or motor(s).	Repair or replace pump or motor(s).

Machine Travels In One Direction Only

Cause	Correction
Traction control linkage damaged or out of adjustment.	Repair control linkage.
Pump charge check/relief valves defective.	Inspect and clean or replace pump check/relief valves.

Traction Response Is Sluggish

Cause	Correction
Brakes dragging.	Inspect brakes and adjust or repair if necessary.
Charge pressure low - TEST NO. 8. NOTE: Counterbalance pressure will also be affected.	Inspect charge relief valve and adjust or repair if necessary. Inspect auxiliary pump and repair or replace if necessary NOTE: Steering and lift will also be affected if auxiliary pump is damaged.
Pump or motor damaged.	Inspect and repair or replace traction pump or motor if necessary.

Machine Will Not Travel In Either Direction

Cause	Correction
Front axle shift lever in neutral (middle) position.	Move shift lever to engage transmission.
Damaged front axle or rear 4wd axle.	Repair axle.
Brakes engaged.	Inspect brakes and adjust or repair if necessary.
Hydraulic oil level too low.	Fill to proper level.
Control linkage damaged or out of adjustment.	Repair control linkage.
Charge pressure low - TEST NO. 8. NOTE: Counterbalance pressure will also be affected.	Inspect charge relief valve and adjust or repair if necessary. Inspect auxiliary pump and repair or replace if necessary NOTE: Steering and lift will also be affected if auxiliary pump is damaged.
Traction pressure too low - TEST NO. 1.	Inspect traction pump check/relief valves and repair or replace if necessary. Check for damaged pump or motor(s) and repair or replace if necessary.

Four Wheel Drive Does Not Engage

Cause	Correction
Front axle shift lever in “HI” (forward) position.	Front axle shift lever must be in “LOW” (rear) position for four wheel drive to engage.
Electrical problem.	Check for faulty front axle HI/LOW switch, four wheel drive solenoid or wiring and repair if necessary.
Faulty four wheel drive solenoid valve.	Inspect and clean solenoid valve and repair or replace if necessary.
Faulty roller clutch.	Replace roller clutch.
Faulty rear axle hydraulic motor.	Repair or replace motor.

Four Wheel Drive Does Not Disengage

Cause	Correction
Electrical problem.	Check for faulty front axle HI/LOW switch, or wiring and repair if necessary.
Four wheel drive solenoid valve sticking.	Inspect solenoid valve for damage or sticking in on position and clean or replace valve if necessary.
Faulty roller clutch.	Replace roller clutch.

No Cutting Units Operate

Cause	Correction
Front axle shift lever in “HI” (forward) position.	Front axle shift lever must be in “LOW” (rear) position for cutting units to engage.
Hydraulic oil level too low.	Fill to proper level.
Reel speed control linkage damaged or out of adjustment.	Repair control linkage.
Electrical problem.	Check for faulty front axle HI/LOW switch, cutting unit engage switch, cutting unit relay, reel speed neutral switch, or wiring and repair if necessary.
Charge pressure low in with machine moving and cutting units engaged - TEST NO. 8. NOTE: Traction circuit will also be affected.	Inspect charge relief valve and adjust or repair if necessary. Inspect auxiliary pump and repair or replace if necessary NOTE: Steering and lift will also be affected if auxiliary pump is damaged.
Mowing circuit pressure too low - TEST NO. 3.	Inspect mowing circuit pump check/relief valves and repair or replace if necessary. Check for damaged pump and repair or replace if necessary.

All Cutting Units Operate Slowly

Cause	Correction
Low engine RPM.	Adjust engine rpm - use tachometer.
Hydraulic oil level too low.	Fill to proper level.
Bedknife to reel contact too tight.	Adjust bedknife to reel contact.
Reel speed control linkage damaged or out of adjustment.	Repair or adjust control linkage as necessary.
Charge pressure low in with machine moving and cutting units engaged - TEST NO. 8. NOTE: Traction circuit will also be affected.	Inspect charge relief valve and adjust or repair if necessary. Inspect auxiliary pump and repair or replace if necessary NOTE: Steering and lift will also be affected if auxiliary pump is damaged.
Mowing circuit pressure too low - TEST NO. 3.	Inspect mowing circuit pump check/relief valves and repair or replace if necessary. Check for damaged pump and repair or replace if necessary.
Mowing circuit flow too low - TEST NO. 4.	Check for damaged pump and repair or replace if necessary.

One Cutting Unit Does Not Operate

Cause	Correction
Reel drive belt damaged or loose.	Inspect and adjust or replace belt.
Key on reel motor shaft sheared.	Replace key. Inspect for damaged pulley or motor shaft.
Bedknife to reel contact too tight.	Adjust bedknife to reel contact.
Electrical problem.	Check for faulty reel switch on lift arm, solenoid on reel motor or wiring and repair if necessary.
Faulty solenoid valve on reel motor.	Inspect and clean solenoid valve and repair or replace if necessary.
Damaged reel drive motor.	Check for damaged reel motor and repair or replace if necessary.

One Cutting Unit Operates Slowly and/or Loses Power in Heavy Cutting

Cause	Correction
Cutting unit drive belt slipping.	Inspect belt and adjust or replace belt.
Bedknife to reel contact too tight.	Adjust bedknife to reel contact.
Inefficient cutting unit drive motor - TEST NO. 5.	Repair or replace motor.

One Cutting Unit Will Not Stop Operating

Cause	Correction
Electrical problem.	Check for faulty reel switch on lift arm, or wiring and repair if necessary.
Solenoid valve sticking.	Inspect solenoid valve for damage or sticking in on position and clean or replace valve if necessary.

NOTE: Disconnect affected reel motor solenoid electrical connector and observe results. If cutting unit stops, problem is electrical. If cutting unit continues to operate, problem is in reel motor valve spool.

Cutting Unit(s) Do Not Lift or Lift Too Slowly

Cause	Correction
Hydraulic oil level too low.	Fill to proper level.
Low engine RPM.	Adjust engine rpm - use tachometer.
Lift arm or cylinder pivots binding.	Lubricate bushings. Inspect for damage. Repair or replace damaged parts.
Lift cylinder damaged.	Check lift cylinder(s). Repair or replace if necessary.
Low counterbalance pressure - TEST NO. 2.	Adjust counterbalance pressure or replace counterbalance relief valve if necessary.
Low lift pressure - TEST NO. 7.	Check for restriction in pump intake line or strainer and repair if necessary. Check lift cylinder(s) for internal leakage and repair or replace if necessary. Clean relief valve in lift control valve and adjust if necessary by adding required shims. Inspect lift valve for internal leakage or improper operation and repair or replace if necessary. Inspect steering/lift pump and priority flow valve for wear or damage and repair or replace if necessary.

Cutting Units Will Not Drop or Follow Ground Contours

Cause	Correction
Low engine RPM.	Adjust engine rpm - use tachometer.
Lift arm or cylinder pivots binding.	Lubricate bushings. Inspect for damage. Repair or replace damaged parts.
Lift cylinder damaged.	Check lift cylinder(s) and repair or replace if necessary.
Counterbalance pressure to high - TEST NO. 2.	Adjust counterbalance pressure or replace counterbalance relief valve if necessary.
Cylinder port orifice plugged.	Clean orifice.
Worn or damaged spool detent in lift valve.	Repair or replace.
Faulty lift valve.	Repair or replace lift valve.

Cutting Unit(s) Drop From Raised Position With Lift Valve in Centered Position

Cause	Correction
Internal leakage of lift cylinder(s)	Check lift cylinder(s) and repair or replace if necessary.
Lift cylinder hydraulic lines or fittings leaking.	Check for leaks. Correct any leaks by replacing o-rings and tightening connection properly. Replace lines or fittings if necessary.
Faulty lift valve lockout assembly.	Check for damaged o-rings on lockout plugs or seats and repair if necessary. Check for damaged or worn lockout poppet assembly and replace if necessary. Check for broken lockout spring and replace if necessary.

Cutting Unit(s) Lower or Raise Too Quickly

Cause	Correction
Missing or improperly installed cylinder port orifice.	Properly install orifice between fitting and lift port of hydraulic lift cylinder(s). NOTE: Orifice must be installed at least 10 - 12 revolutions to avoid interference with adapter fitting.

Steering Loss

Cause	Correction
Steering linkage or cylinder pivots damaged, worn, or binding.	Lubricate bushings. Inspect for damage. Repair or replace damaged parts.
Low steering pressure - TEST NO. 6.	Check for restriction in pump intake line or strainer and repair if necessary. Check steering cylinder for internal leakage and repair or replace if necessary. Clean relief valve in steering pump and adjust or replace if necessary. Inspect steering/lift pump for wear or damage and repair or replace if necessary.
Steering control unit faulty.	Repair or replace steering control unit.

NOTE: Steering loss after washing machine can be the result of “thermal shock”. Normal functions will return after steering control unit temperature stabilizes. To prevent damage to steering control unit, DO NOT attempt to turn steering wheel until temperature stabilizes when thermal shock is noted.

Testing

The most effective method for isolating problems in the hydraulic system is by using hydraulic test equipment such as pressure gauges and flow meters in the circuits during various operational checks. (See the Special Tools section in this Chapter.)

CAUTION

Failure to use gauges with the recommended pressure (psi) rating as listed in the test procedures could result in damage to the gauge and possible personal injury from leaking hot oil.

Before Performing Hydraulic Tests

All obvious areas such as oil supply, filter, binding linkage, loose fasteners, or improper adjustments must be checked before assuming that a hydraulic component is the source of the problem being experienced.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved by stopping the engine and lowering the cutting units.

Keep body and hands away from pin hole leaks or nozzles that eject hydraulic fluid under high pressure. Use paper or cardboard, not hands, to search for leaks. Hydraulic fluid escaping under pressure can have sufficient force to penetrate skin and do serious damage. If fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type of injury or gangrene may result.

1. Thoroughly clean the machine before disconnecting or disassembling any hydraulic components. Always keep in mind the need for cleanliness when working on hydraulic equipment.

2. Put caps or plugs on any hydraulic lines left open or exposed during testing or removal of components.

3. The engine must be in good operating condition. Use a tachometer when making a hydraulic test. Engine speed can affect the accuracy of the tester readings.

4. To prevent damage to tester or components, the inlet and the outlet hoses must be properly connected, and not reversed (tester with pressure and flow capabilities).

5. To minimize the possibility of damaging components, completely open the load valve by turning it counterclockwise (tester with pressure and flow capabilities).

6. Install fittings finger tight, far enough to insure that they are not cross-threaded, before tightening with a wrench.

7. Position the tester hoses so that rotating machine parts will not make contact with them and result in hose or tester damage.

8. Check the oil level in the reservoir.

9. Check the control linkage for improper adjustment, binding or broken parts.

10. All hydraulic tests should be made with the hydraulic oil at normal operating temperature.

TEST NO. 1: Checking Traction Circuit Working Pressure or Relief Pressure

WORKING Pressure Check:

1. Make sure hydraulic oil is at normal operating temperature by operating machine for approximately 10 mines.

2. Lower cutting units, engage parking brake and stop the engine.

3. Raise seat to get access to hydraulic test fittings. Remove access cover from in front of auxiliary pump.

4. Install a 10,000 PSI gauge with extension hose onto the traction circuit quick disconnect fitting for the function to be checked. Put gauge and hose through opening below seat in front of auxiliary pump so gauge can be observed while sitting on seat.

5. Operate machine while monitoring gauge.

RANGE OF TESTER READINGS: 100 - 5100 PSI

RELIEF Pressure Check

CAUTION

Move machine to an open area away from people and obstructions.

6. Set traction pedal stop for minimum ground speed (1 mph).

7. Start the engine and move throttle to full speed (2500 rpm).

8. Release parking brake.

9. Engage the traction pedal to start machine in motion.

10. Maintain traction pedal engagement while momentarily engaging the brakes to bring the unit to a halt and read gauge.

TESTER READING TO BE 5000 ± 100 PSI.

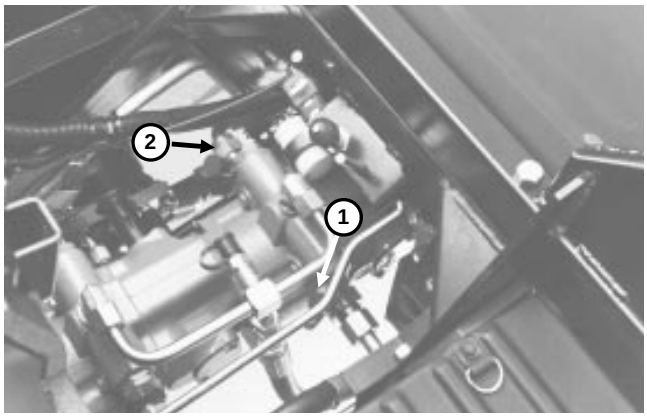


Figure 9
(Eaton pump)

1. Traction FORWARD test port
2. Traction REVERSE test port

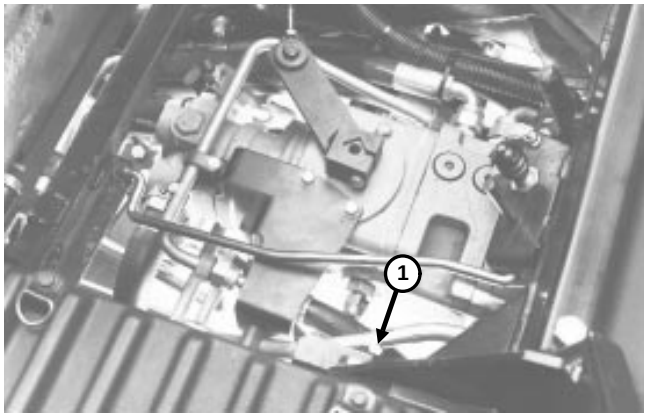


Figure 10
(Sundstrand pump)

1. Traction FORWARD test port

TEST NO. 2: Checking Counterbalance Pressure

1. Make sure hydraulic oil is at normal operating temperature by operating machine for approximately 10 minutes.

2. Lower cutting units, engage parking brake and stop the engine.

3. Remove access cover from in front of auxiliary pump.

4. Install a 1000 PSI gauge into the counterbalance quick disconnect fitting.

5. Start the engine, move throttle to full speed (2500 rpm) and observe gauge.

TESTER READING: 300 - 400 PSI (oil at normal operating temperature)

Counterbalance Relief Valve Adjustment
(If equipped with adjustable valve)

6. Remove access cover from in front of lift control valve.

NORMAL SETTING:
300 - 400 PSI (oil at normal operating temperature)

MAXIMUM QUALITY OF CUT:
300 PSI (oil at normal operating temperature)

CAUTION

When adjusting counterbalance relief valve, do not unscrew relief valve adjuster too far. Watch pressure gauge while adjusting valve. Stop unscrewing valve adjuster when pressure no longer decreases.

7. If necessary, adjust the relief valve screw until the desired pressure is attained. Adjust nearer the high end of the range for improved hill climbing or nearer the low end for improved quality-of-cut.

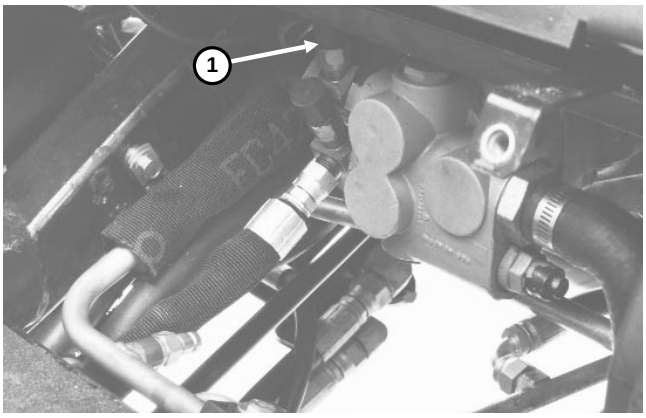


Figure 11

1. Counterbalance/lift circuit test port (S/N 39999 & below)

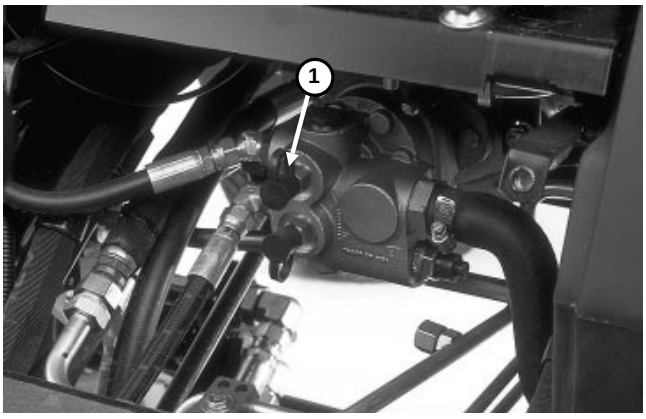


Figure 11A

1. Counterbalance/lift circuit test port (S/N 40001 & UP)

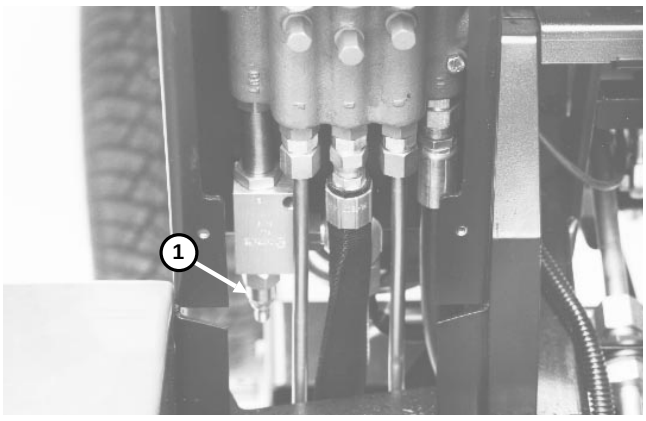


Figure 12

1. Adjustable counterbalance relief valve

TEST NO. 3: Checking Mowing Circuit Working Pressure or Relief Pressure

WORKING Pressure Check:

1. Make sure hydraulic oil is at normal operating temperature by operating machine for approximately 10 minutes.

2. Lower cutting units, engage parking brake and stop the engine.

3. Raise seat to get access to hydraulic test fittings. Remove access cover from in front of auxiliary pump.

4. Install a 5000 PSI gauge onto mow circuit quick disconnect fitting. Put gauge and hose through opening below seat in front of auxiliary pump so gauge can be observed while sitting on seat.

NOTE: Front axle shift lever must be in LO position for cutting units to operate.

5. Operate machine while monitoring gauge.

RANGE OF TESTER READINGS 100 - 2640 PSI.

NOTE: Normal pressure during operation is 1500 - 2000 PSI. Gauge may spike higher during initial engagement of cutting units.

RELIEF Pressure Check:

6. Lower center cutting unit to the ground.

7. Turn the engine OFF.

8. Use a substantial hardwood block inserted between reel blades of center cutting unit to prevent rotation. Center cutting unit motor is first in series from pump.

CAUTION

Stand clear of the reels during the following procedures:

9. Place reel speed control knob at minimum speed.

10. Start engine and position throttle at idle.

11. Move cutting unit engagement switch into “MOW” while monitoring gauge.

NOTE: It may be necessary to increase throttle slightly to prevent engine from stalling.

TESTER READING TO BE 2540 ± 100 PSI.

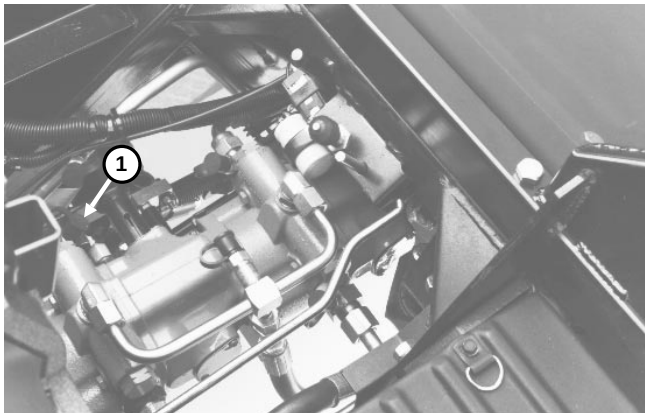


Figure 13
(Eaton pump)

1. Mow circuit test port

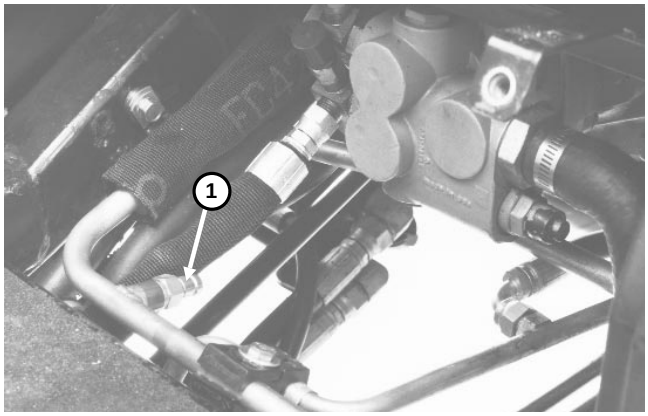


Figure 14
(Sundstrand pump)

1. Mow circuit test port (S/N 39999 & below)

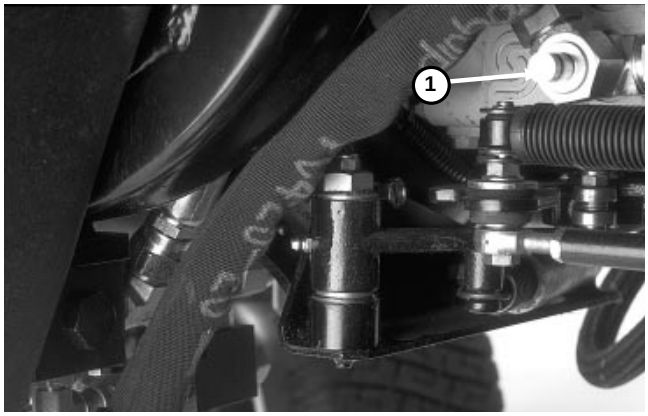


Figure 14A
(Sundstrand pump)

1. Mow circuit test port (S/N 40001 & UP)

TEST NO. 4: Checking Mowing Circuit Flow

1. Make sure hydraulic oil is at normal operating temperature by operating machine for approximately 10 minutes.

2. Start the engine and lower the center cutting unit to the ground.

3. Turn the engine OFF.

4. Disconnect inlet hose at reel motor of center cutting unit.

5. Install tester in series between disconnected hose and reel motor (flow direction is from hose to motor). Make sure gate valve of tester is OPEN.

6. Position reel speed control knob at neutral (N) position. Make sure cutting unit engagement switch is OFF.

7. Start engine and move throttle to full speed (2500 rpm).

8. Gradually move reel speed control knob to maximum speed position while monitoring tester flow gauge.

NOTE: It is not necessary to engage the cutting units to measure flow in the circuit.

CAUTION

Keep clear of reels. DO NOT exceed maximum flow rating of tester flow gauge.

TESTER READING TO BE APPROXIMATELY 13 GPM.

Figure 15

TEST NO. 5: Checking Reel Motor Efficiency

1. Make sure hydraulic oil is at normal operating temperature by operating machine for approximately 10 minutes.

2. Start the engine and lower the cutting unit to be checked.

3. Turn the engine OFF and engage the parking brake.

4. Use a substantial hardwood block inserted between the reel blades of reel to be checked to prevent rotation.

5. Disconnect inlet hose at reel motor.

6. Install tester in series between disconnected hose and reel motor (flow direction is from hose to motor). Make sure gate valve of tester is OPEN.

7. Position reel speed control knob at MINIMUM speed.

8. Start engine and move throttle to idle speed (1500 rpm).

NOTE: Front axle shift lever must be in LO position for cutting units to operate.

CAUTION

Stand clear of the reels during the following procedures:

9. Move the cutting unit engagement switch to “MOW” while monitoring the tester.

NOTE: It may be necessary to raise the throttle slightly to prevent the engine from stalling.

TESTER READING NOT TO EXCEED 1.5 GPM at 2640 PSI.

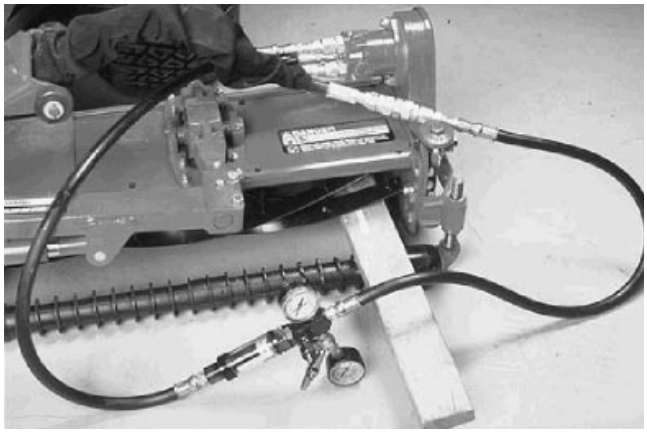


Figure 16

TEST NO. 6: Checking Steering Circuit Working Pressure or Relief Pressure

WORKING Pressure Check:

1. Make sure hydraulic oil is at normal operating temperature by operating machine for approximately 10 mines.

2. Lower cutting units, engage parking brake and stop the engine.

3. Remove access cover from in front of auxiliary pump.

4. Install a 5000 PSI gauge onto steering quick disconnect fitting.

5. Operate machine while monitoring gauge.

RANGE OF TESTER READINGS 0 - 1300 PSI.

RELIEF Pressure Check:

6. With engine running, turn the steering wheel until heavy resistance is felt indicating that the cylinder has reached maximum stroke.

7. Momentarily hold steering wheel against resistance and read gauge.

TESTER READING TO BE 1200 ± 100 PSI.

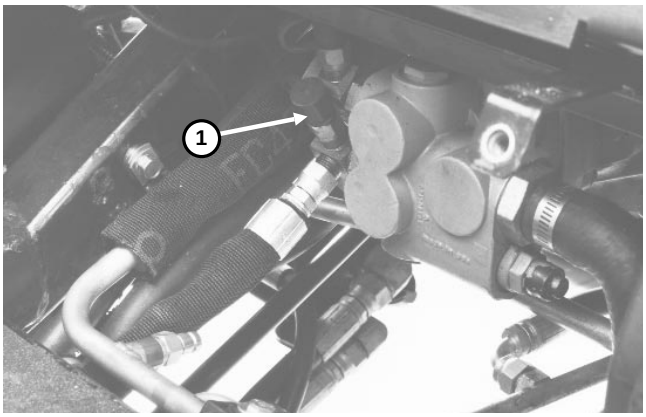


Figure 17

1. Steering circuit test port (S/N 39999 & below)

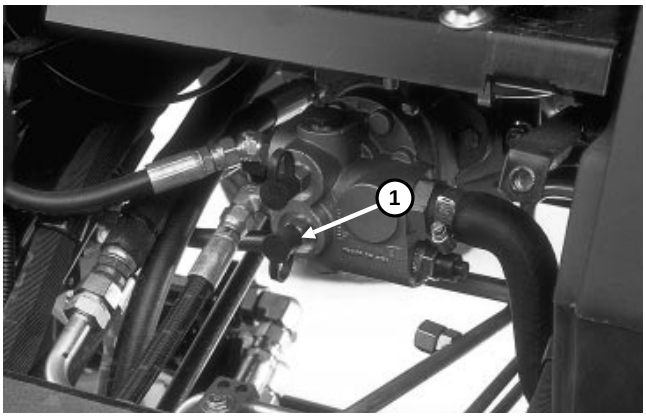


Figure 17A

1. Steering circuit test port (S/N 40001 & UP)

TEST NO. 7: Checking Lift Circuit Working Pressure or Relief Pressure

WORKING Pressure Check:

1. Make sure hydraulic oil is at normal operating temperature by operating machine for approximately 10 minutes.

2. Lower cutting units, engage parking brake and stop the engine.

3. Raise seat to get access to hydraulic test fittings. Remove access cover from in front of auxiliary pump.

4. Install a 5000 PSI gauge onto lift circuit quick disconnect fitting. Put gauge and hose through opening below seat in front of auxiliary pump so gauge can be observed while sitting on seat.

5. Raise each cutting unit while monitoring gauge.

   RANGE OF TESTER READINGS 300 - 1800 PSI when counterbalance setting is 300 PSI.

   NOTE: Changes in counterbalance setting will affect the lift circuit relief pressure.

RELIEF Pressure Check:

6. With engine running at full speed, engage control lever into the “LIFT” position.

7. Momentarily hold the lever in the engaged position after full cylinder extension and read gauge.

   TESTER READING TO BE APPROXIMATELY 1800 PSI when counterbalance setting is 300 PSI.

NOTE: Changes in counterbalance setting will affect the lift circuit relief pressure.

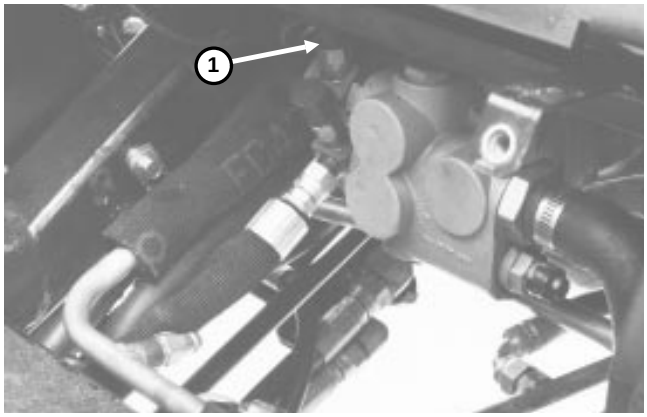


Figure 18

1. Lift circuit test port

TEST NO. 8: Checking Charge Pressure for Traction and Mowing Circuits

1. Make sure hydraulic oil is at normal operating temperature by operating machine for approximately 10 mines.

2. Lower cutting units, engage parking brake and stop the engine.

3. Raise seat to get access to hydraulic test fittings. Remove access cover from in front of auxiliary pump.

4. Install a 1,000 PSI gauge with extension hose onto the charge pressure quick disconnect fitting. Put gauge and hose through opening below seat in front of auxiliary pump so gauge can be observed while sitting on seat.

5. Start the engine and position throttle at idle (1500 rpm).

TESTER READING TO BE 100 ± 25 PSI.

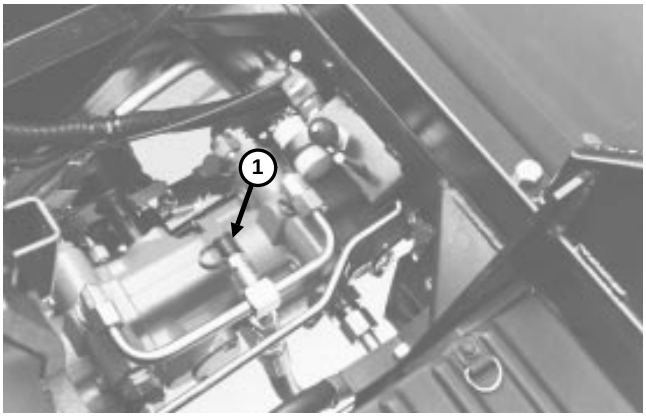


Figure 19
(Eaton pump)

1. Charge pressure test port

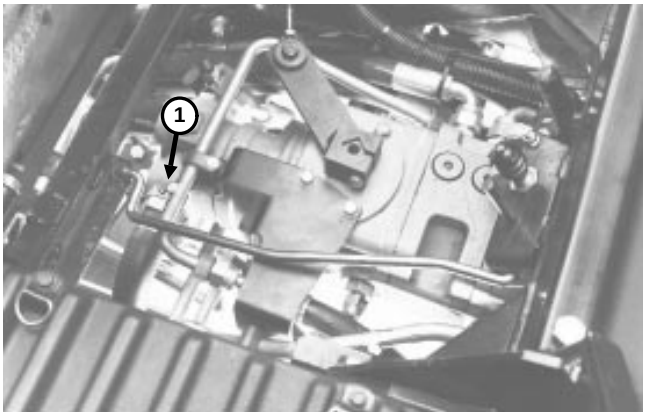


Figure 20
(Sundstrand pump)

1. Charge pressure test port

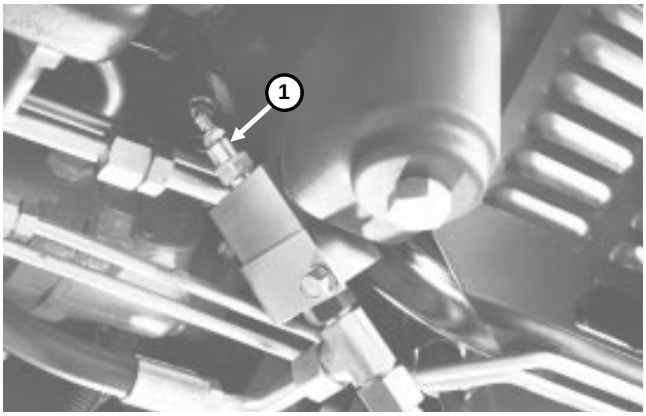


Figure 21

1. Charge relief valve

TEST NO. 9: Checking Traction Circuit Rear Motor Pressure (4WD Only)

WORKING Pressure Check:

1. Make sure hydraulic oil is at normal operating temperature by operating machine for approximately 10 mines.

2. Lower cutting units, engage parking brake and stop the engine.

3. Raise seat to get access to hydraulic test fittings. Remove access cover from in front of auxiliary pump.

4. Install a 10,000 PSI gauge with extension hose onto the rear drive motor quick disconnect fitting. Put gauge and hose through opening below seat in front of auxiliary pump so gauge can be observed while sitting on seat.

5. Operate machine while monitoring gauge.

NOTE: Front axle must be in LO position for 4wd to engage.

6. When operating in conditions that would cause the front wheels to begin to slip, pressure should increase as four wheel drive automatically engages.

RANGE OF TESTER READINGS: 100 - 5100 PSI.

NOTE: When operating on level ground, pressure reading should be approximately 100 - 300 PSI.

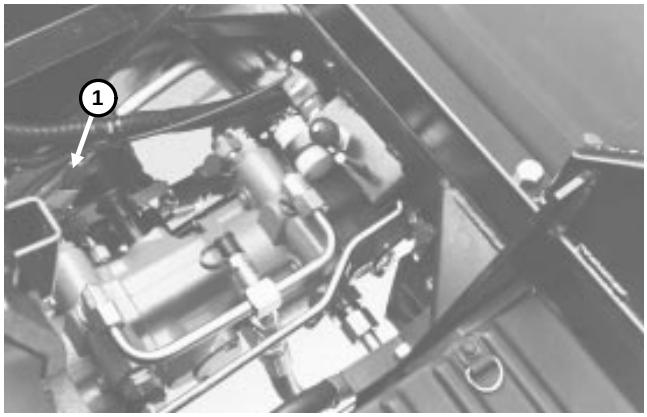


Figure 22
(Eaton pump)

1. Rear drive motor test port

Adjustments

Traction Pump Neutral Adjustment

The machine must not “creep” when traction pedal is released. If it does creep, an adjustment is required.

1. Park machine on a level surface and shut engine off. Make sure transaxle is engaged in HI position. Depress only the right brake pedal and engage the parking brake.

2. Jack up left side of machine until front tire is off the shop floor. Support machine with jack stands to prevent it from falling accidentally.

3. Loose locknut on traction adjustment cam (Fig. 22 or 23).

CAUTION

Engine must be running so final adjustment of traction adjustment cam can be performed. To guard against possible personal injury, keep hands, feet, face and other parts of body away from rotating parts.

4. Start engine and run at low idle.

5. Rotate cam hex in either direction until raised wheel is not rotating.

6. Tighten locknut to secure adjustment.

7. Stop the engine. Remove jack stands and lower machine to ground. Release parking brake and test drive machine to make sure it does not creep in neutral.

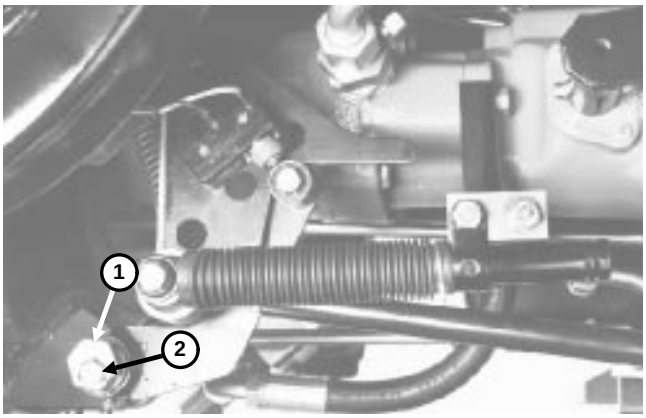


Figure 23
(Eaton pump)

1. Traction adjustment cam
2. Locknut

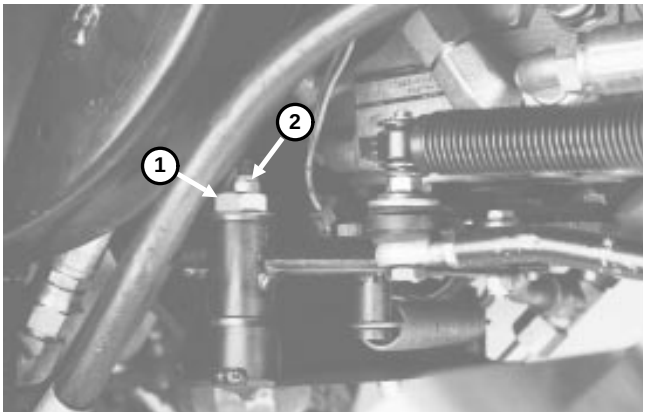


Figure 24
(Sundstrand pump)

1. Traction adjustment cam
2. Locknut

Reel Speed Control Adjustment

1. Operate machine with cutting units engaged to make sure hydraulic oil is at normal operating temperature.

2. Park machine on a level surface and engage parking brake. Raise center and left-hand cutting units, then lock in position with transport latches. Lower right-hand cutting unit.

CAUTION

Engine must be running and cutting unit engaged so final adjustment of reel speed can be performed. To guard against possible personal injury, keep hands, feet and other parts of body away from reel blades and other rotating parts.

3. Start engine and run at maximum speed.

4. Rotate reel speed control knob clockwise until reel on right-hand cutting unit just starts to rotate.

5. Measure RPM of right-hand cutting unit. If necessary, adjust pump lever linkage so reel speed is 450 - 550 RPM.

6. Rotate reel speed knob clockwise until reel speed reaches 1100 - 1200 RPM. Set maximum stop bolt.

7. Check RPM at minimum and maximum speed again (steps 5 and 6).

8. Slow engine to low idle speed. Rotate reel speed knob counterclockwise to backlap position. Reel speed in back-lap should be 200 - 500 RPM.

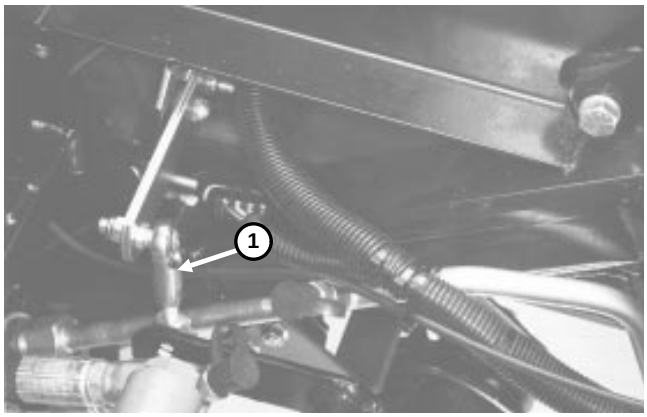


Figure 25
(Eaton pump)

1. Pump lever linkage

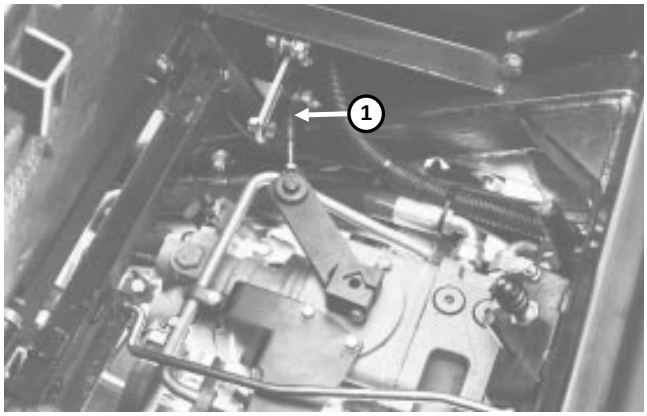


Figure 26
(Sundstrand pump)

1. Pump lever linkage

Removing Hydraulic System Components

1. Thoroughly clean the machine before disconnecting, removing or disassembling any hydraulic components. Always keep in mind the need for cleanliness when working on hydraulic equipment.

2. Put caps or plugs on any hydraulic lines or fittings left open or exposed.

3. Put labels on disconnected hydraulic lines and hoses for proper installation after repairs are completed.

After Repair or Replacement of Components

1. Check oil level in hydraulic reservoir and add correct oil if necessary. Drain and refill hydraulic system reservoir and change oil filter if component failure was severe or system is contaminated.

2. After repairs, check control linkage for proper adjustment, binding or broken parts.

3. If a pump was disconnected or removed, prime system before operating. Disconnect fuel stop solenoid electrical connector on engine to prevent fuel delivery to engine cylinders. Turn ignition switch to engage starter for ten (10) seconds to prime pumps. Repeat cranking procedure again. Connect injection pump fuel stop solenoid electrical connector. Start engine and run at idle speed for a minimum of two (2) minutes.

4. After disconnecting or replacing any hydraulic components, operate machine functions slowly until air is out of system.

5. Check for hydraulic oil leaks. Shut off engine and correct leaks if necessary. Check oil level in hydraulic reservoir and add correct oil if necessary.

Shaft Seal Replacement

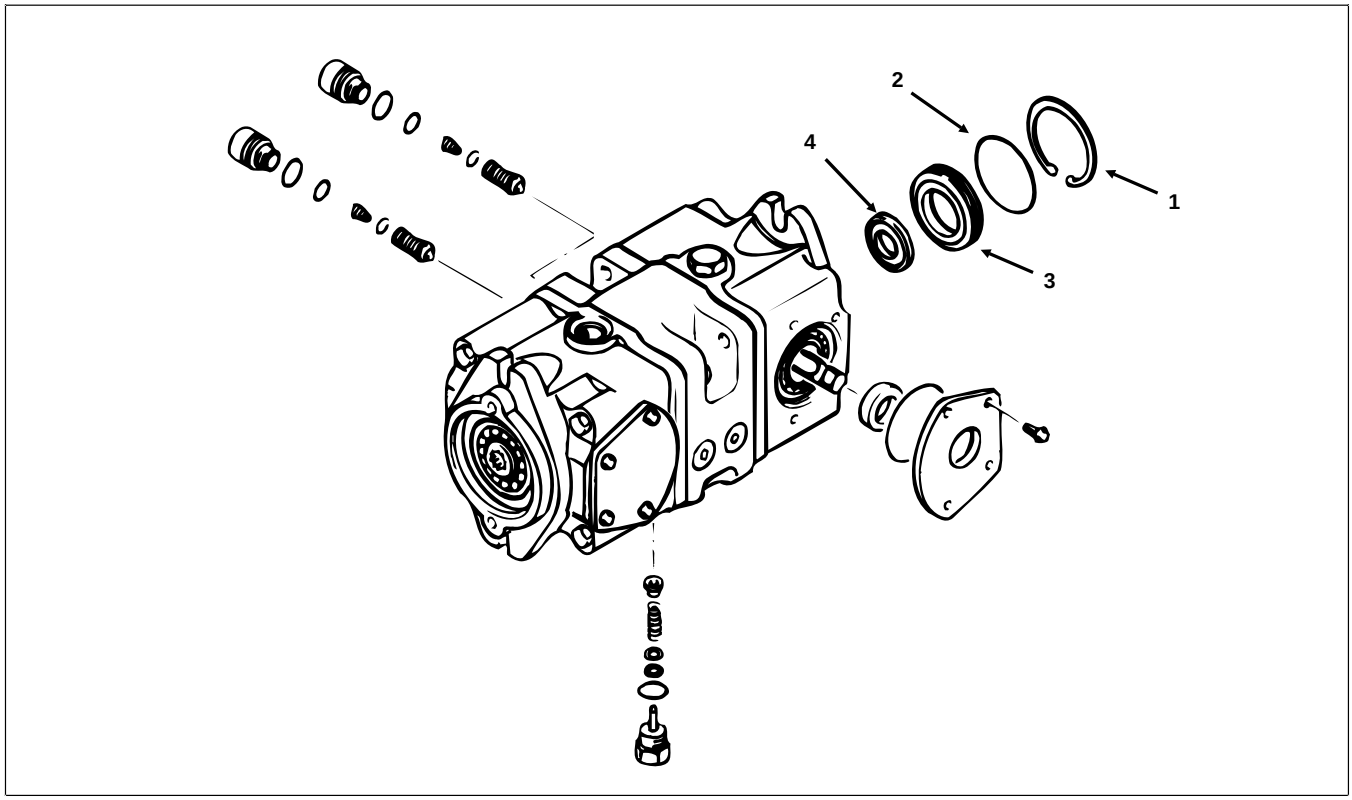


Figure 28

1. Retaining ring
2. O-ring
3. Seal carrier
4. Lip seal

1. Park machine on a level surface, lower cutting units, engage parking brake and stop the engine.

2. Remove pump assembly from machine.

3. Remove retaining ring from pump housing.

NOTE: It may be necessary to hold inward pressure against shaft to compress cylinder block spring while removing retaining ring.

4. After removing retaining ring, seal carrier will move out approximately 1/4 in. due to cylinder block spring force on shaft. Lightly tap end of shaft with a soft mallet until seal carrier can be removed from housing.

NOTE: After seal carrier is removed, the shaft and bearing assembly are free in the housing. Do not remove shaft unless unit is positioned with mounting flange UP. If unit is positioned horizontally when shaft is removed, the cylinder block could move out of place, making shaft installation difficult.

5. Remove o-ring from seal carrier.

6. Put seal carrier in an arbor press and press out old seal. Use a properly sized pipe spacer or socket wrench for a press tool. The seal cannot be used again.

7. Inspect seal carrier, new seal and o-ring for damage. Inspect sealing surface on shaft for rust, wear, or contamination. Polish sealing area on shaft if necessary.

8. Use an arbor press to press new seal into seal carrier. Be careful not to damage seal.

NOTE: New seals are lubricated with an assembly grease.

9. Use a seal protector tool or wrap end of shaft with thin plastic to prevent damage to seal lip during installation.

10. Install o-ring into seal carrier and lubricate with petroleum jelly.

11. Slide seal carrier assembly over shaft and into housing bore. Hold inward pressure against shaft to compress cylinder block spring while pressing seal carrier into position. Install retaining ring.

Trunnion Seal Replacement

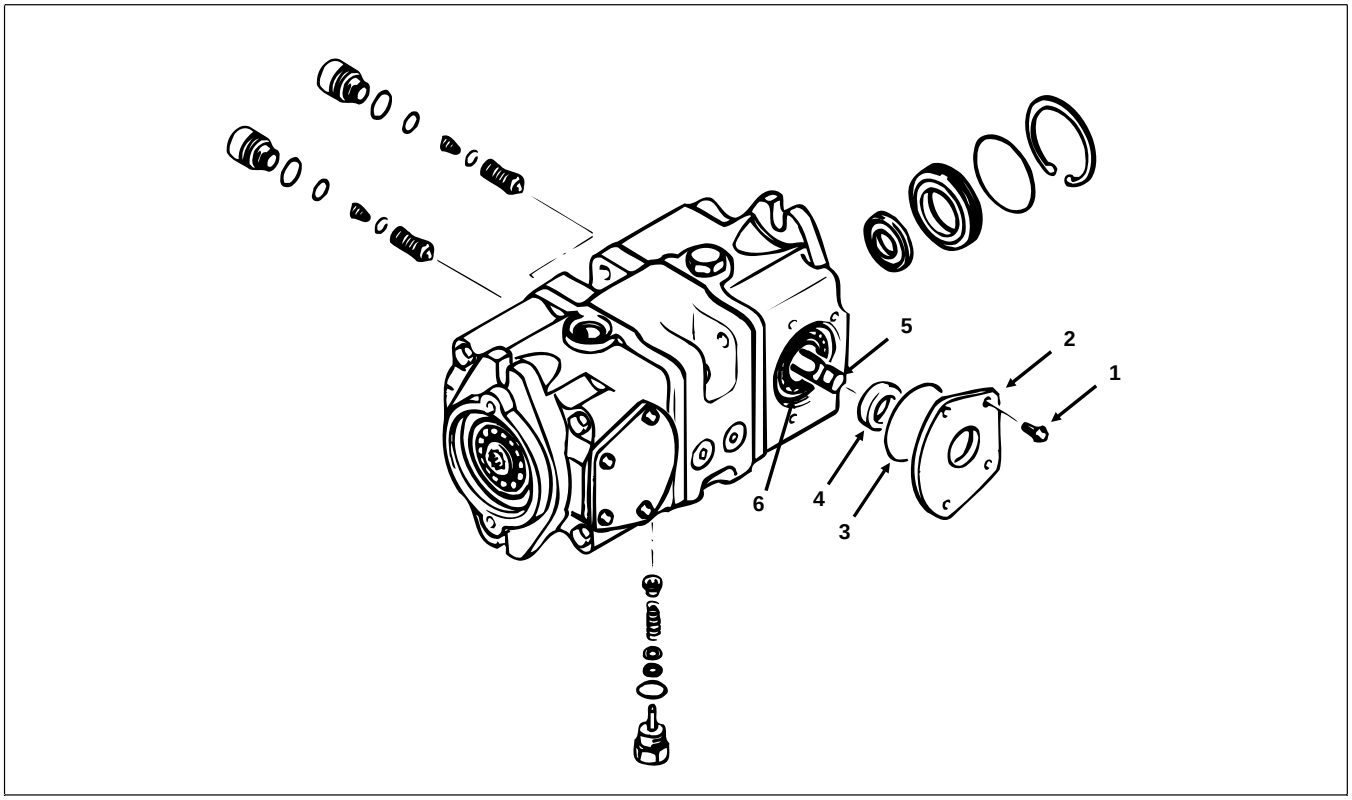


Figure 29

1. Hex tapping screw (4)
2. Trunnion seal cover
3. O-ring
4. Seal
5. Swashplate control shaft
6. Spacer, shim & bearing

1. Park the machine on a level surface, lower cutting units, engage parking brake and stop the engine.

2. Remove control linkage from swashplate control shaft on transmission (see Transmission Control Removal).

3. Remove hex tapping screws retaining trunnion seal cover to transmission housing (Fig. 29).

4. Remove trunnion seal cover with lip seal and o-ring.

5. Put seal cover in an arbor press and press out old seal. Once removed, the seal is not reusable.

6. Inspect seal cover for damage. Inspect sealing area on shaft for rust, wear, or contamination. Polish sealing area on shaft if necessary.

7. Using an arbor press, press seal into position from inside of seal cover until it bottoms out in its bore. Be careful not to damage the seal.

8. Install o-ring onto seal cover and retain with petroleum jelly.

9. Use a seal installer tool or wrap end of swashplate control shaft with thin plastic to prevent damage to seal during installation.

10. Slide seal cover assembly over swashplate control shaft onto housing. Install hex tapping screws and tighten to a torque of 6 to 9 ft-lbs.

11. Install control linkage onto transmission. Check machine for “creeping” when engine is running with foot pedal in neutral position. Do Traction Control Neutral Adjustment if necessary.

Check and High Pressure Relief Valves

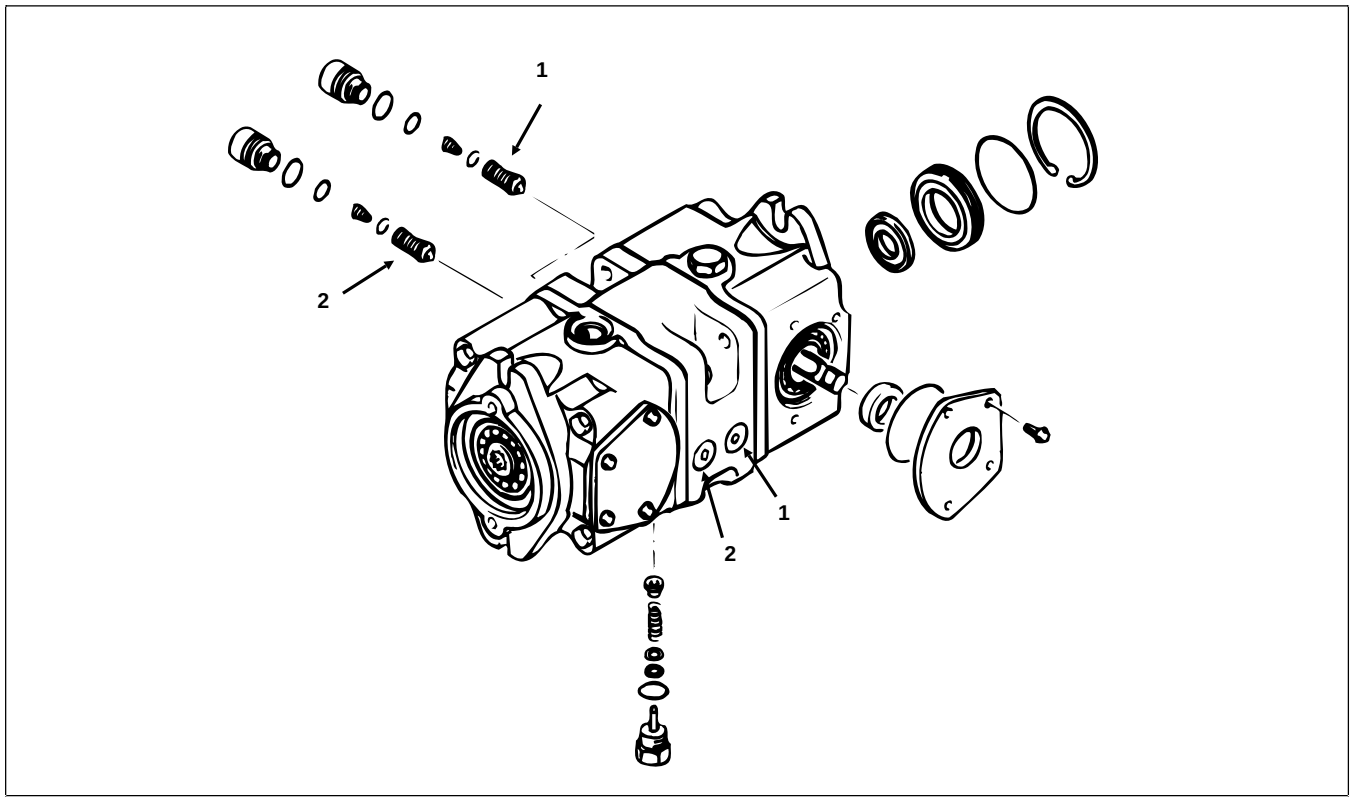


Figure 30

1. Traction check/high pressure relief valve **2. Reel check/high pressure relief valve**

1. Park the machine on a level surface, lower cutting units, engage parking brake and stop the engine.

2. Remove the check/high pressure relief valve hex plug (Fig 30).

3. Remove the valve cartridge assembly. Inspect the valve and mating seat in the housing for damage or foreign material. It will be necessary to replace the center section if the seat is damaged.

IMPORTANT: The relief valves are factory set and should not be tampered with, except to replace the entire valve cartridge.

4. The valve cartridge is retained in the special plug by a circlip. The check valve spring may be removed from the special plug by pulling out at a slight angle. When reassembling, install the check valve spring into the special plug with its larger diameter toward the plug, and snap the valve cartridge into position in the plug.

5. Reinstall the valve cartridges with o-rings into the housing and tighten the plugs to a torque of 30 to 50 ft-lb.

6. Before starting the engine check the oil level in the differential housing and add the correct oil as necessary. Start the engine and let it run for one to two minutes, then turn the engine off and check the oil level again. Check the transmission for leaks.

Charge Pressure Relief Valve

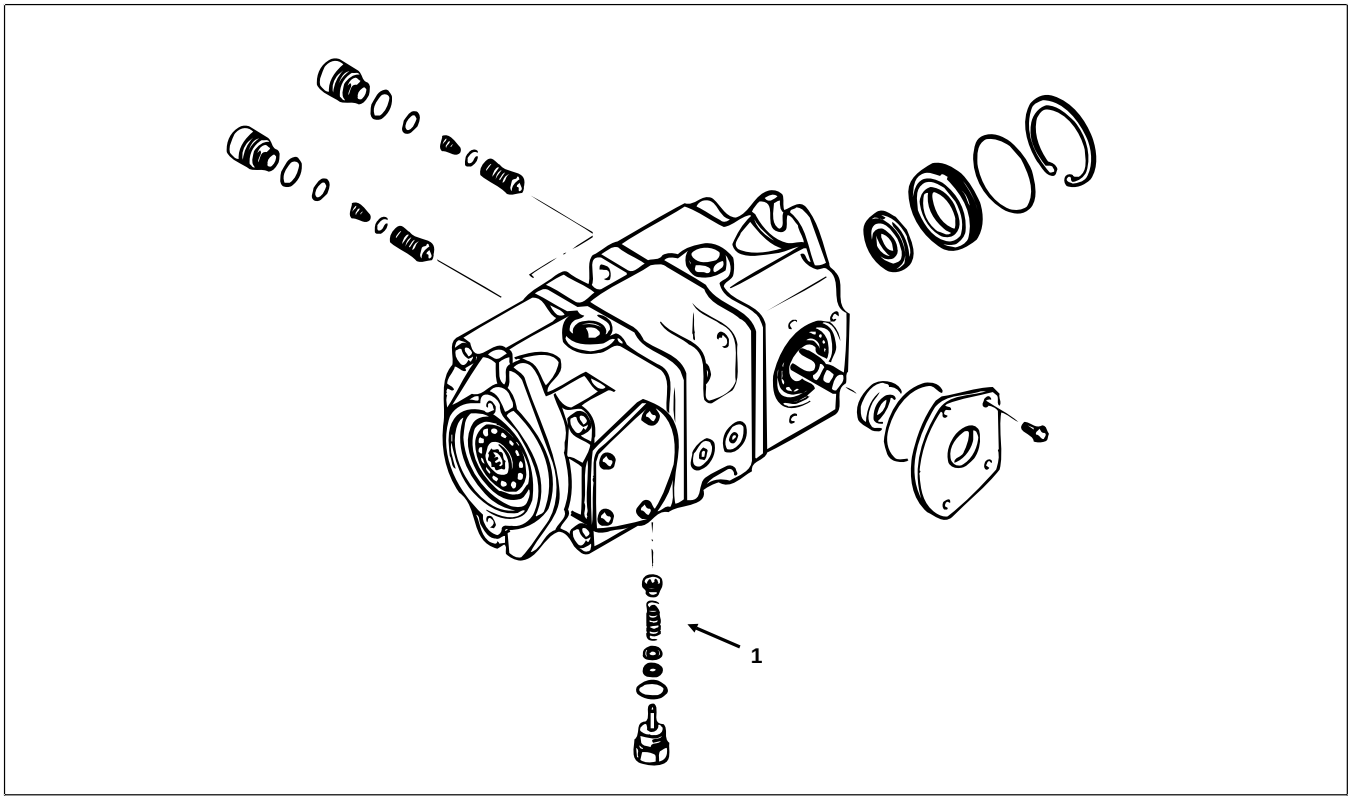


Figure 31

1. Charge pressure relief valve

1. Park the machine on a level surface, lower cutting units, engage parking brake and stop the engine.

2. Remove the charge relief valve hex plug (Fig. 31).

3. Remove the spring and poppet from the housing.

4. Do not interchange parts with another valve.

NOTE: The shim(s) which may be installed between the spring and plug may remain inside the plug, being held by an oil film. Make sure the same number and thickness of shims is installed when reassembling the parts unless shims need to be added or removed to adjust the pressure setting.

5. Inspect the poppet and mating seat in the end cap for damage or foreign material.

6. Reinstall the poppet, spring and plug (with shims and o-ring) into the housing. Tighten the plug to a torque of 30 to 70 ft-lb.

7. Before starting the engine check the oil level in the differential housing and add the correct oil as necessary. Start the engine and let it run for one to two minutes, then turn the engine off and check the oil level again. Check the transmission for leaks.

Disassembly of Sundstrand Tandem Pump

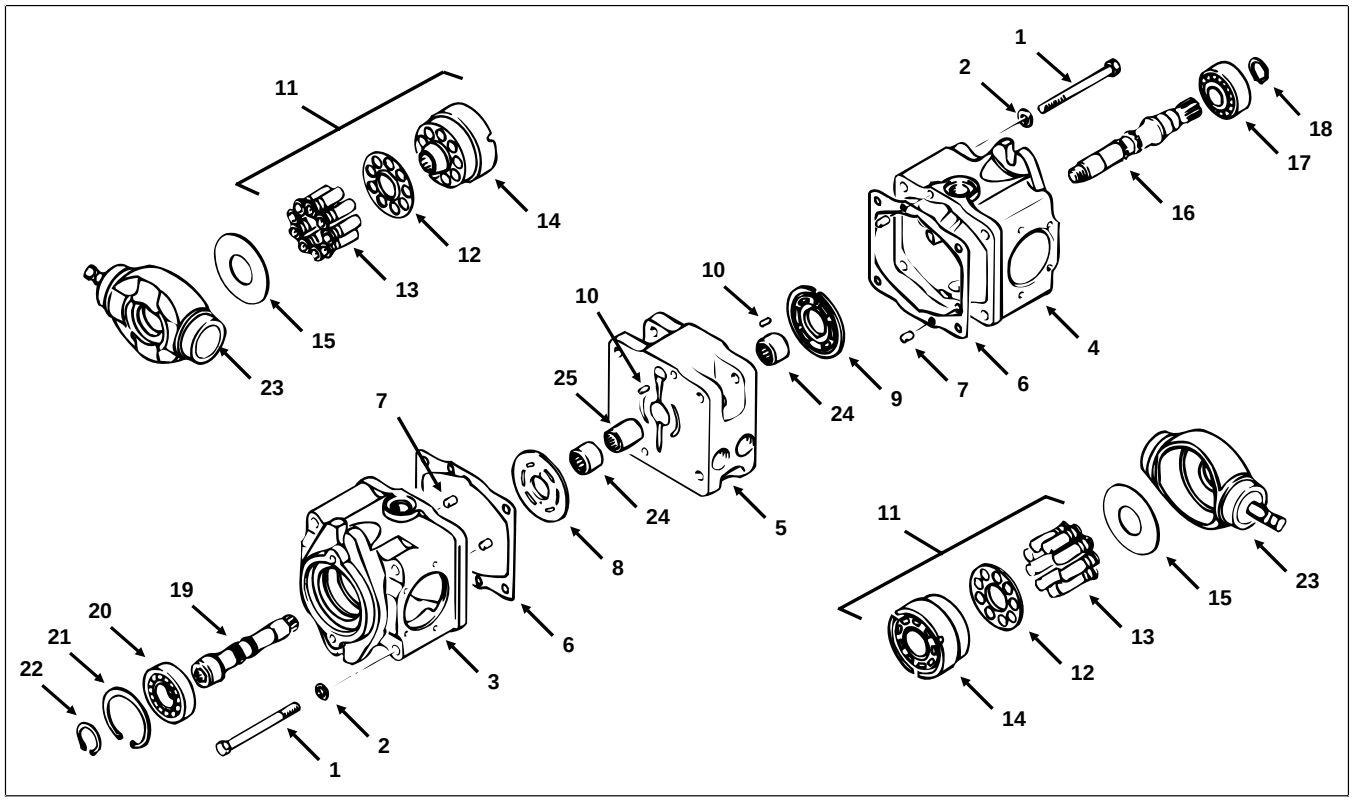


Figure 32

1. Capscrew
2. Washer
3. Pump housing
4. Pump housing
5. Center section
6. Gasket
7. Alignment pin
8. Valve plate (L.H.)
9. Valve plate (R.H.)
10. Valve plate pin
11. Cylinder block assembly
12. Pistons
13. Slipper guide
14. Piston block
15. Thrust plate
16. Drive shaft
17. Bearing
18. Retaining ring
19. Drive shaft
20. Bearing
21. Retaining ring
22. Retaining ring
23. Swash plate
24. Needle bearing
25. Drive coupling

Cleanliness is a primary way of getting satisfactory transmission life, on either new or repair units. Cleaning parts by using a clean solvent wash and air drying is usually adequate. As with any precision equipment, all parts must be kept free of foreign materials and chemicals. Protect all sealing surfaces and open cavities from damage and foreign material.

During assembly of the pump, all surfaces which have relative motion between two parts should be coated with a film of clean hydraulic oil. This will assure that these surfaces will be lubricated during start-up.

It is recommended that all gaskets, o-rings and seals be replaced. Lightly lubricate all o-rings with clean petroleum jelly before assembly. All gasket sealing surfaces must be cleaned before installing new gaskets.

1. Before performing major repairs on the pump, remove external components as described in previous procedures. These include the Charge Check / High Pressure Relief Valves and Charge Relief Valve.

2. Remove four (4) screws which retain each pump section to center section.

3. Remove housings from center section.

IMPORTANT: The valve plates may stick to the center section. Do not allow valve plates to fall from center section.

4. Remove gaskets and alignment pins from center section.

NOTE: Since the tandem pump sections are mounted “back-to-back”, each section will have a different valve plate installed. Note the position of each valve plate for proper installation during assembly of the tandem pump.

IMPORTANT: Be careful not to damage valve plate and center section surfaces.

5. Carefully remove valve plates from center section. It may be necessary to pry valve plates off with a small screwdriver.

6. Remove valve plate pins from center section.

7. Lay each pump section on its side and remove cylinder block assembly from housing.

8. Remove the slipper guide and piston assemblies from cylinder blocks.

9. Use an o-ring pick or wire to remove thrust plates from swashplate and housing.

10. Remove shaft seal carrier. (See Tandem Pump Shaft Seal Replacement.)

11. Slide drive shaft and bearing assembly from housing.

12. Remove retaining ring and press shaft out of bearing.

13. Remove hex tapping screws retaining trunnion seal cover and trunnion cover to housing. Mark position of covers for reassembly.

14. The trunnion seal cover assembly includes an o-ring, lip seal and trunnion bearing on the control side. The trunnion cover assembly includes an o-ring and trunnion bearing on the side opposite the control. Remove these parts from the housing. (See Trunnion Seal Replacement).

15. Remove swashplate bearings, spacers and shims from housing and swashplate. The bearing assemblies are a slip fit in the housing.

16. Tilt and lift swashplate from housing.

Inspection and Replacement of Parts

17. After disassembly, thoroughly clean all parts in a suitable solvent. Replace all o-rings, gaskets and seals.

18. Inspect all parts for damage, nicks or unusual wear patterns. Replace all parts having unusual or excessive wear or discoloration.

19. If scratches, which can be felt with a pencil lead, can be found on bronze surface of valve plates or running surface of cylinder blocks, polish or replace the parts.

20. Inspect needle bearings and drive coupling in center section. If replacement is necessary, remove shaft needle bearings using a suitable puller. Do not damage valve plate surface of center section.

21. Press new needle bearings into center section using a suitable press pin. When installed correctly, bearing cage will protrude from 0.08 to 0.10 in. from surface of center section to serve as pilots for valve plates.

IMPORTANT: When installing the needle bearing, the printed (numbered) end of the bearing cage must face the press pin.

22. Install drive coupling into center section. Install second needle bearing into center section, following procedure outlined above in step 21.

23. Install a new cylinder block kit if brass slippers on pistons are scored or excessively rounded at edges.

Assembly of Sundstrand Tandem Pump

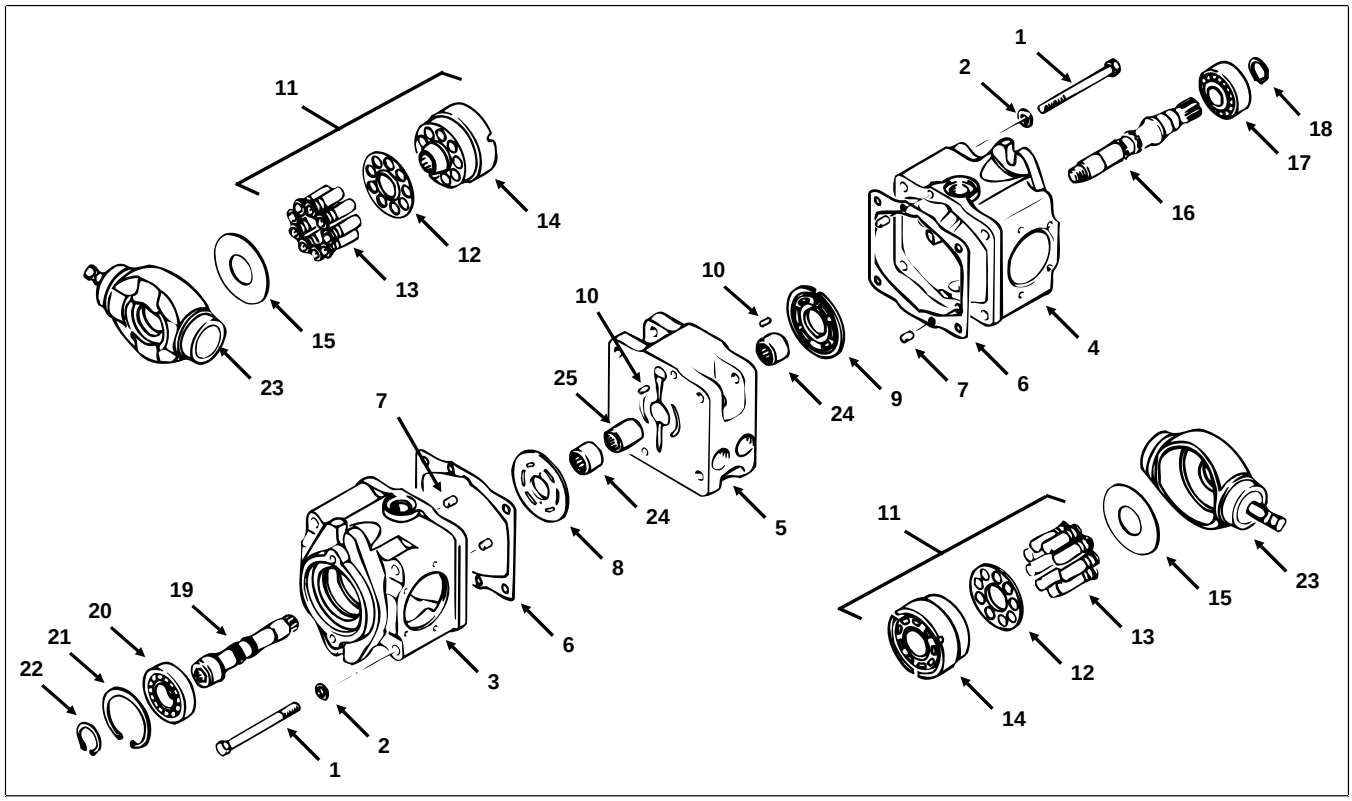


Figure 33

1. Capscrew
2. Washer
3. Pump housing
4. Pump housing
5. Center section
6. Gasket
7. Alignment pin
8. Valve plate (R.H.)
9. Valve plate (L.H.)
10. Valve plate pin
11. Cylinder block assembly
12. Pistons
13. Slipper guide
14. Piston block
15. Thrust plate
16. Drive shaft
17. Bearing
18. Retaining ring
19. Drive shaft
20. Bearing
21. Retaining ring
22. Retaining ring
23. Swash plate
24. Needle bearing
25. Drive coupling

1. Clean and lightly oil parts before assembly. Tighten all threaded parts to recommended torque value.

IMPORTANT: Most parts have critical, high tolerance surfaces. Use caution to prevent damage to these surfaces during assembly. Protect exposed surfaces, openings and ports from damage and foreign material.

2. Install swashplate into housing. Make sure swashplate control shaft is located on correct side of housing (note marks made during disassembly). Install swashplate bearings into housing and onto swashplate trunnions.

3. Install trunnion cover (with o-ring and trunnion bearing) into housing and over swashplate trunnion.

4. Use an arbor press to press a new seal into trunnion seal cover. Outer face of seal should be pressed flush with outer surface of seal cover. Be careful not to damage the seal.

5. Install trunnion seal cover with o-ring, seal and trunnion bearing into housing and over swashplate trunnion (see Trunnion Seal Replacement). Wrap end of swashplate control shaft with thin plastic to prevent damage to seal lip during installation.

6. Install hex tapping screws and tighten to a torque of 6 to 9 ft-lb.

7. Using caution to not damage the sealing surface, press ball bearing onto drive shaft. Install bearing retaining ring onto shaft.

8. Install drive shaft and bearing into housing.

9. Install input shaft seal, seal cover and o-ring as described in Tandem Pump Shaft Seal Replacement. Coat thrust plate with petroleum jelly and install onto swashplate. The thrust plate is reversible.

10. Assemble each cylinder block kit by installing piston assemblies into the slipper guide. Lubricate pistons and cylinder block bores. Install assembled guide and pistons into cylinder block by inserting pistons into cylinder block bores. The pistons and bores are not selectively fitted, so no specific piston and bore orientation is required.

11. Lay the pump on its side and install cylinder block kits into the housing.

12. Install valve plate locating pins into center section.

13. Coat back (steel side) of valve plates with petroleum jelly to hold them in position and install valve plates onto center section, with their bronze faces visible. The notch on each valve plate must engage its locating pin.

NOTE: Since the tandem pump sections are mounted “back-to-back”, each section will have a different valve plate installed.

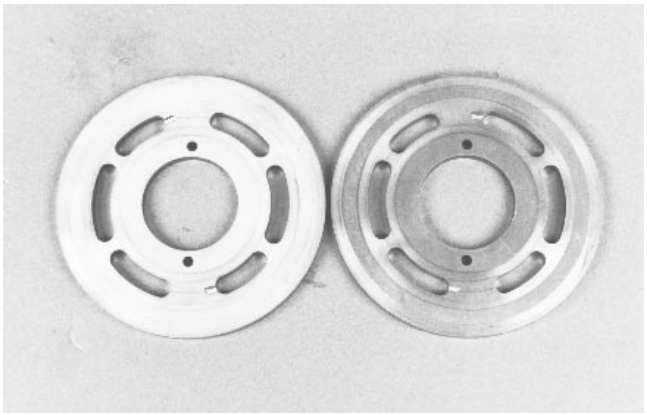


Figure 34

L.H. plate **R.H. plate**

14. Install the four (4) alignment pins and install new gaskets onto center section.

15. Assemble rear pump section onto center section (with valve plate installed). Align drive coupling splines while assembling. When the sections are properly assembled, cylinder block spring will hold center section away from housing approximately 1/8 in.

16. Install the four (4) screws and washers that retain rear housing to center section and evenly tighten to a torque of 45 to 54 ft-lb.

IMPORTANT: Be sure all parts are properly aligned. Do not force center section into position on housing.

17. Assemble front pump section onto assembled center and rear section. Align drive coupling splines while assembling.

18. When the sections are properly assembled, cylinder block spring will hold center section away from housing approximately 1/8 in.

IMPORTANT: Be sure all parts are properly aligned. Do not force center section into position on housing.

19. Install the four (4) screws and washers that retain rear housing to center section and evenly tighten to a torque of 45 to 54 ft-lb.

20. Rotate the pump motor shaft to make sure pump is assembled correctly. When properly assembled, a maximum torque of 7 ft-lb should be required to turn shaft.

21. Assemble the following components as described in previous procedures:

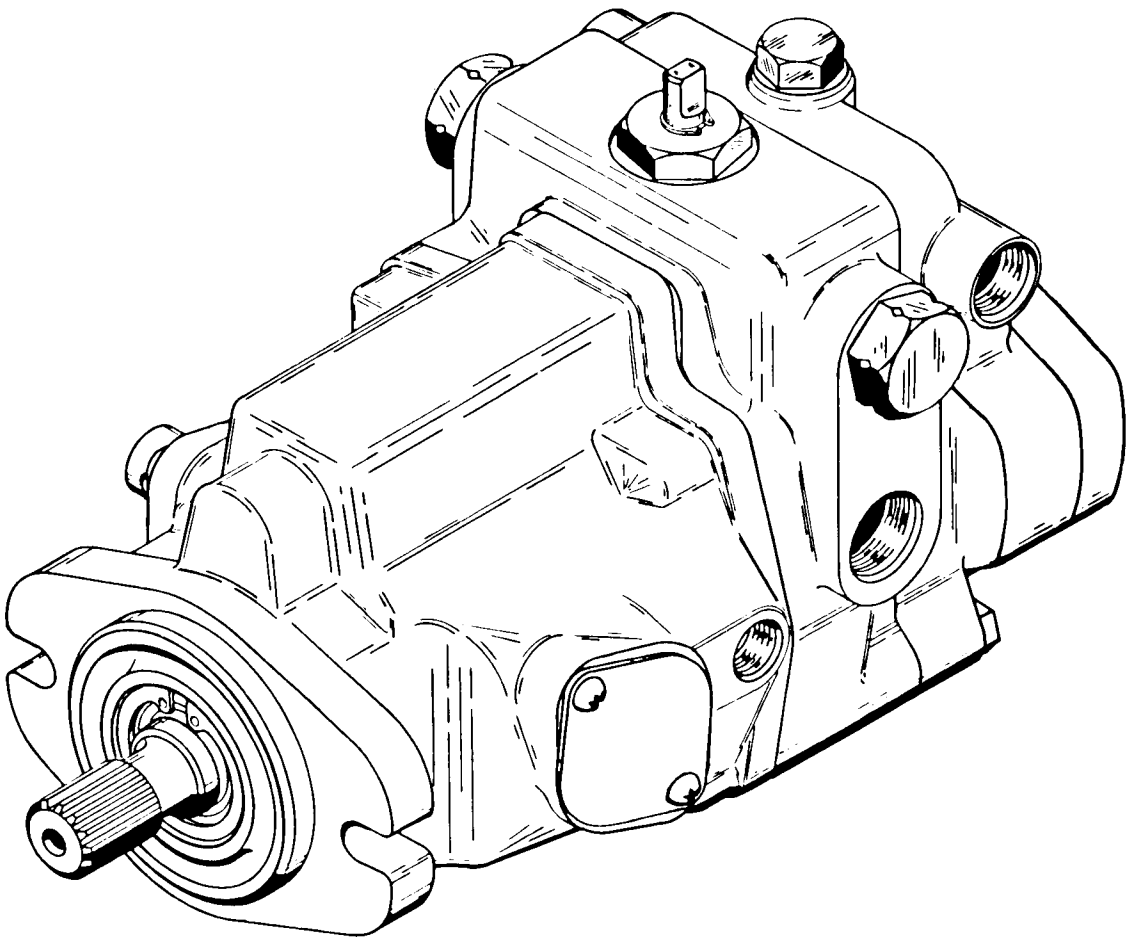
Charge Check / High Pressure Relief Valves
Charge Relief Valve

NO. 7-618

Eaton
Hydraulics
Division

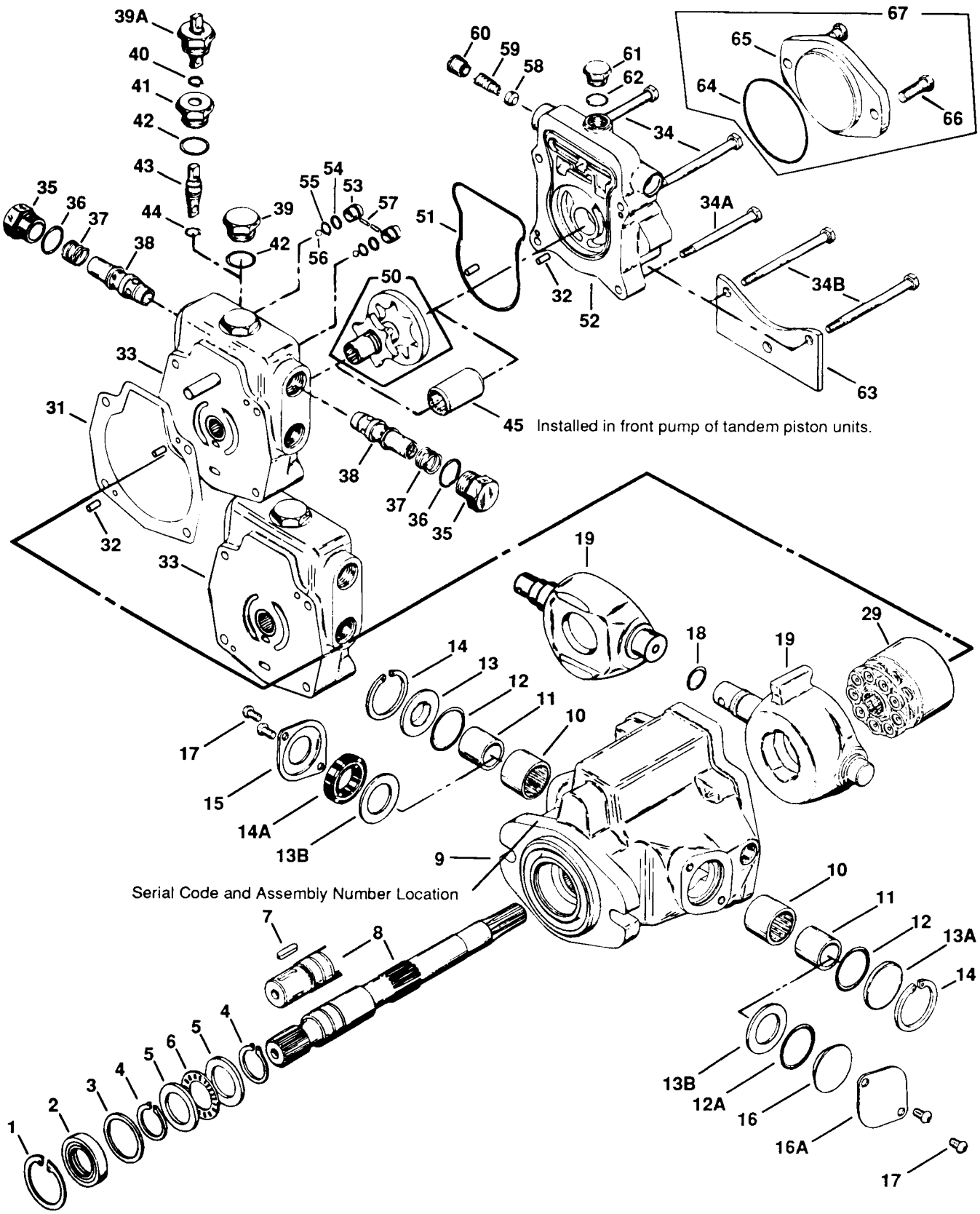
Repair Information

Model 70142 Propulsion Piston Pumps



EATON

Parts Drawing



	Item No.	Description	Model 70142 -DAJ,-RAT,-LAH, -RAR,-RAZ,-LAF,-LAT Quantity	Model 70142 -DBK,-RFD,-LBP, -RER,-RFC,-LBL,-LBK Quantity
++	1	Retaining Ring	1	1
++	2	Shaft Seal	1	1
	3	Washer	1	1
++	4	Retaining Ring	2	2
	5	Bearing Race	2	2
	6	Bearing	1	1
	7	Key	1	1
	8	Drive Shaft	1	1
	9	Housing Assembly	1	1
	10	Bearing	2	2
	11	Inner Race	2	–
	11	Inner Race	–	1
+o	12	O-ring, 3/32 x 1-5/16 I.D. [2,38mm x 33,34mm I.D.]	2	–
+n	12A	O-ring, 3/32 x 1-5/16 I.D. [2,38mm x 33,34mm I.D.]	–	1
	13	Sleeve Cover	1	–
	13A	Trunnion Cover	1	–
	13B	Washer	–	2
	14	Retaining Ring	2	–
+n	14A	Shaft Seal	–	1
	15	Seal Cover	–	1
	16	O-ring Cover	–	1
	16A	Trunnion Cover	–	1
	17	Screw	–	4
+o	18	O-ring,1/16 x 5/8 I.D. [1,59 mm x 15,88mm I.D.]	1	–
	19	Camplate	1	1
	29	Rotating Kit Assembly	1	1
++	31	Housing Gasket	1	1
	32	Dowel Pin	–	4
	33	Backplate Assembly	1	1
	34	Cap Screws	2	2
	34A	Cap Screws	2	2
	34B	Cap Screws (used w/mounting bracket)	2	2
	35	Plug Assembly	2	2
++	36	O-ring, 3/32 x 7/8 I.D. [2,38mm x 22,23mm I.D.]	2	2
	37	Spring	2	2
	38	Relief Valve Assembly, 5000 P.S.I. [345 bar]	2	2
	39	Plug Assembly	1	1
	39A	Tow Valve Assembly	1	1
++	40	Retaining Ring	1	1
	41	Separator Plug	1	1
++	42	O-ring, 3/32 x 3/4 I.D. [2,38mm x 19,05mm I.D.]	1	1
	43	Spreader	1	1
++	44	O-ring, 1/16 x 3/8 I.D. [1,59mm x 9,53mm I.D.]	1	1

++ *Common to both seal repair kits
+o *Included in seal repair kit 70142-908
+n *Included in seal repair kit 70142-938

(continue)

Parts List (continued)

	Item No.	Description	Model 70142 -DAJ,-RAT,-LAH, -RAR,-RAZ,-LAF,-LAT Quantity	Model 70142 -DBK,-RFD,-LBP, -RER,-RFC,-LBL,-LBK Quantity
	45	Coupler	1	1
	50	Gerotor and Coupler Assembly	1	1
++	51	O-ring,Molded	1	1
	52	Adaptor Assembly	1	1
	53	Check Valve Assembly	2	–
+o	54	Back-up Washer	2	–
+o	55	O-ring,1/16 x 7/16 I.D. [1,59mm x 11,11mm I.D.]	2	–
	56	Steel Ball	2	–
	57	Pin	2	–
	58	Poppet Filter Relief	1	1
	59	Spring	1	1
	60	Spring Retainer	1	1
	61	Plug Assembly	1	1
++	62	O-ring, 3/32 x 41/64 I.D. [2,38mm x 16,27mm I.D.]	1	1
	63	Mounting Support Bracket	1	1
++	64	O-ring, 1/16 x 3-1/4 I.D. [1,59mm x 82,55mm I.D.]	1	1
	65	Cover Plate	1	1
	66	Cap Screw	2	2
	67	Cover Plate Kit	1	1
	*S	Seal Repair Kit	1	–
	*S	Seal Repair Kit	–	1

Tools Required for Disassembly and Reassembly

- 1/2 in. Socket
- 1 in. Socket
- 1 1/8 in. Socket
- Ratchet Wrench
- Torque Wrench (100 lb-ft)
- 7/16 in. Hex Key
- 9/16 End Wrench
- T-25 Torx Screwdriver
- Soft Face Hammer
- Internal Retaining Pliers (straight .090 Tip)
- External Retaining Pliers (straight .070 Tip)
- Regular or Locking Pliers
- Seal Driver or Similar Tool
- Arbor Press
- Petroleum Jelly (Such as Vaseline)

Repair Infomation - Model 70142

Cleanliness is extremely important when repairing these pumps. Work in a clean area. Before disconnecting the lines, clean port area of pump. Disconnect hydraulic lines. Remove pump assembly from vehicle and plug ports. Thoroughly clean the outside of pump. After cleaning, remove port plugs and drain oil.

Disassembly

1 Clamp the end of the drive shaft in a protected jaw vise with the body of the pump up and remove the four cap screws (34) from the pump assembly.

2 Use a plastic mallet and tap the adapter assembly (52) to loosen it, then pull the adapter straight up until it Is free.

3 Remove retainer (60), spring (59), and poppet (58) from adapter assembly.

Skip step four if Check Valve Assemblies are not included in unit.

4 Remove the two check valve assemblies (53) from backplate (33). Pin (57) is a loose fit. Caution must be taken when removing check valve assembly so that pin (57) and ball (56) are not lost.

5 Remove gerotor and coupler assembly (50) from backplate (33). Further disassembly of gerotor and coupler assembly is not required. See Figure 1.

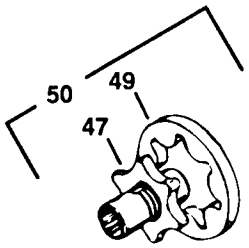


Figure 1

6 Use screw driver slots in housing and pry up on backplate (33) or tap with plastic mallet to loosen, then pull the backplate straight up to remove. Remove gasket (31).

7 Remove tow valve assembly (39A) or plug (39) from backplate. Remove retaining ring (40) from spreader (43), and pull spreader from spreader plug (41).

8 Remove plug assembly (35), spring (37), and relief valve assembly (38).

9 Remove pump from vise and remove rotating assembly (29) from pump housing.

10 If pistons (20) did not come with piston block, you may remove them, spider (21), and spider pivot (22).

11 The disassembly of the piston block assembly (23) is not required unless the pins (25) or spring (27) are possibly damaged. See Figure 2.

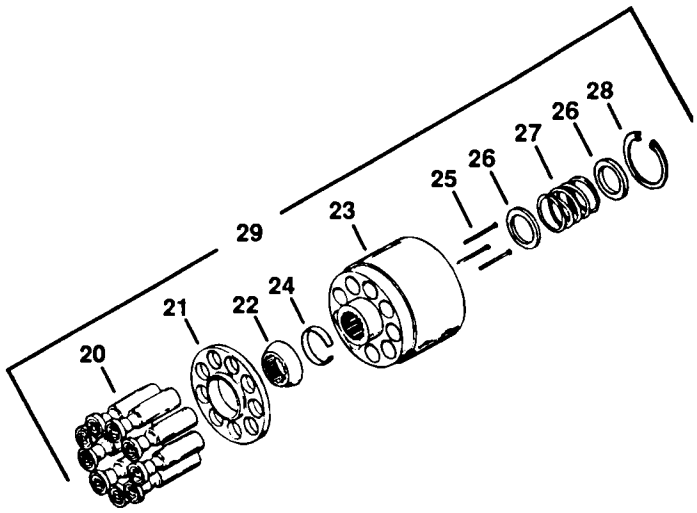


Figure 2

Caution

The following procedure should be used if the spring is to be removed from the piston block. The spring (27) is highly compressed and the retaining ring (28) should not be removed without compressing the spring (27).

The following parts will be needed to disassemble the piston block:

2ea.	5/16 in. I.D. X 15/16 in. O.D. flat washers. [7,9mm I.D. x 23,8mm O.D.]
1ea.	5/16 in. X 2-7/8 in. N.C. cap screw, and [7,9mm x 73mm N.C.]
1ea.	5/16 in. N.C. nut [7.9mm]

Place one of the flat washers over the 5/16 X 2-7/8 cap screw and place this through the center of the piston block. Place the other washer over the cap screw and let it rest on the three pins. Screw the nut on and compress the spring inside the piston block. Use a pair of retaining ring pliers and remove the internal retaining ring. Remove the nut, bolt, and the two washers. Remove the washer (26), spring (27), washer (26), and three pins (25), and the pin keeper (23).

12 Remove retaining ring (1) from housing. Press shaft (8) from housing (9) and remove shaft seal (2), and washer (3).

13 Remove retaining ring (4) from shaft and remove thrust washers (5) and thrust bearing (6).

14 To remove the camplate (19) from housing, remove either the two retaining rings (14) or the four screws (17)

from the sides of the housing. Remove two covers (13 and 13A) or (15 or 16A), o-ring cover (16), o-ring (12), seal (14A), and washer (13B). Now remove the inner race (11) and needle bearings (10).Slide the camplate to one side and remove. The two camplate pivot bearings are a loose fit into the housing; do not be concerned if they are not tight.

15 Replace the shaft seal, gasket, backup washers and all o-rings with new items upon reassembly.

Inspection

1 Inspect the charge pump relief valve seat inside the charge pump adapter. Check to insure that the seat is smooth and free of burrs or other defects.

2 Inspect the charge pump relief valve spring (59).

3 Inspect the gerotor pocket inside the charge pump adapter housing (52). It should not be scored excessively.

4 Inspect the needle bearing inside the charge pump adapter housing, making sure that needles remain in the bearing cage.

5 Inspect the check valve assembly (53), make sure the ball seat is in good condition and the ball is free to move.

6 Inspect the flat surface of the backplate (33), the finish on the gerotor side should show no galling. The finish on the piston block side should be smooth and free of grooves. Replace the backplate if it shows any of the wear characteristics outlined above. Insure that the cam stop is tight in the specific backplate (33)design.

7 Inspect the piston block (23). Insure the surface that contacts the backplate is smooth and free of grooves.

8 The pistons (20) should move freely in the piston block bore. If they are sticky in the bore, examine the bore for scoring or contamination.

9 Examine the O.D. of the pistons for finish condition. They should not show wear or deep scratches. Inspect the shoes for a snug fit on the ball end of the pistons and a flat smooth surface that comes in contact with the camplate. DO NOT LAP PISTON SHOES.

10 Examine the spider (21) for wear in the pivot area.

11 Examine the pivot (22).to insure smoothness and no signs of wear.

12 The finish on polished shoe surface of the camplate (19) should show no signs of scoring.

13 Inspect the shaft (8) for fretting in the bearing and spline areas.

14 Inspect thrust bearing (6) and washers (5) for wear.

15 Inspect the needle bearings in the housing assembly, making sure needles remain in bearing cage.

Reassembly

1 Clean all parts in suitable solvent, lubricate all critical moving parts before reassembly.

2 Place the camplate (19) into the housing with the long trunnion down and to the appropriate side of linkage on the machine. Follow step 3 or 4 for retaining the specific design of unit.

3 Installing the camplate with the retaining ring design. Install new o-ring (18) on camplate trunnion. Insert the needle bearings (10) and the bearing inner race (11) over the shaft and slide into the housing. The numbered end of the race and bearing should face outward and the chamfered I.D. of the race inward. Install new o-ring (12) around O.D. of trunnion bearings. Install trunnion cover (13A) and sleeve cover (13) and secure with retaining ring (14).

4 Installing the camplate with cover and screw design. Install needle bearing (10) and the bearing inner race (11) over the trunnion opposite the linkage side of the camplate and into housing.The numbered end of the race and bearing should face outward and the chamfered I.D. of the race inward.Now install washer (13B) to both trunnion areas. Insert new o-ring (12), o-ring cover (16) and retain with trunnion cover (16A) and screws (17). On the linkage side of the camplate install needle bearing (10), washer (13B), seal (14A) and retain with seal cover (15) and screws (17).Torque screws (17) 36 to 48 lbs. in. [4 to 5 N·m].

5 Install retaining ring (4) on shaft (8). Install thrust washer (5), thrust bearing (6), and second thrust washer (5). Secure with second retaining ring (4).

6 Install shaft in housing. Install washer (3), new shaft seal (2), and retain with retaining ring (1).

7 If piston block assembly was disassembled complete the following: Compress the pin keeper (24) and install in the spline of piston block. Install the three pins (25) with head end to the inside of the block and install in the special grooves of the piston block spline.

8 Install the washer (26), spring (27), and second washer (26) in the piston block. Use the two 5/16 I.D. washers and the 5/16 x 2-7/8 cap screw to compress the spring and retain with retaining ring (28). Remove the 5/16 x 2-7/8 cap screw and the two washers. See Figure 3.

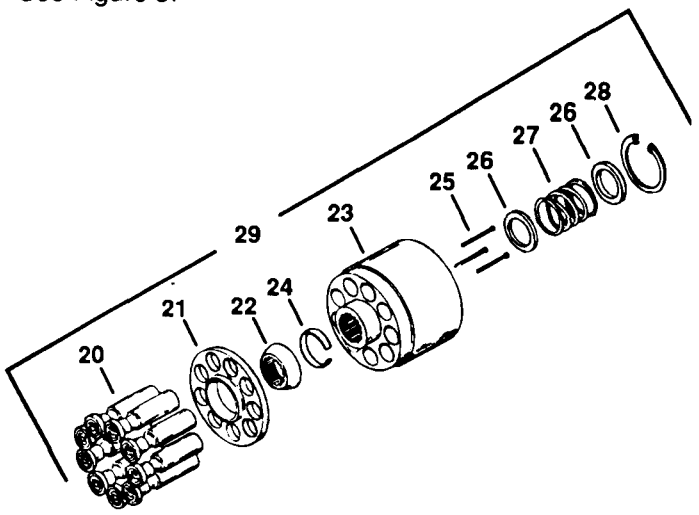


Figure 3

9 Install the pivot (22), spider (21), and the piston assemblies (20) in the piston block assembly (23). Install rotating assembly (29) in to housing assembly over shaft. The piston shoes must make contact with the camplate. Be sure all parts are in their proper position before proceeding.

10 Clamp pump assembly in a protected jaw vise with the open end of the housing up.

11 Install new gasket (31) over dowel pins(32) installed in housing.

12 Place backplate (33) over shaft and on housing with gasket in place.

If the backplate has check valves complete step 13. If not go on to step 14.

13 Place ball (56) into check valve housing and secure with pin (57). Install new o-ring (55) and back-up washer (54) on check valve assembly (53).O-ring is nearest pin in check valve. Check valve is installed with the pin end into backplate.

14 If backplate does not have check valves make sure dowel pins (32) are in place.

15 Install outer gerotor ring (49) into adapter assembly (52). Lubricate ring to hold in place.See Figure 4.

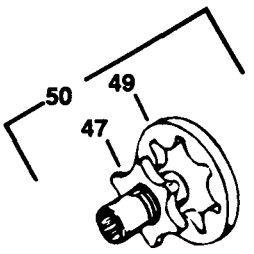


Figure 4

16 Install inner gerotor and coupler assembly (47) onto shaft (8) and backplate (33). Lubricate inner gerotor. See Figure 4.

17 Install new o-ring (51) in groove, hold in place with clean clear grease. Place adapter plate assembly (52) on pump backplate. Install four cap screws (34 & 34A) and torque to 17 to 20 lbs. ft.[23 to 27 N·m] (If bracket (63) is used, cap screws (34B) are used.)

18 Install new o-rings (42 & 44). Insert spreader (43) into separator plug (41) and retain with retaining ring (40).

19 Install tow valve assembly (38) or plug (39) in backplate (33). Torque 27 to 30 lbs. ft. [37 to 40 N·m].

20 Install relief valve assembly (38) and spring (37) into backplate. Place new o-ring (36) on plug (35) and retain spring and relief valve.Torque plug (35) 95-105 lbs ft. [129 to 142 N·m].

21 Remove pump from vise and install poppet (58), spring (59), and spring retainer (60) Torque spring retainer (60) 5 to 7 lbs ft. [7 to 10 N·m].

Start-up Procedure

When initially starting a new or a rebuilt propulsion system, it is extremely important that the start-up procedure be followed. It prevents the chance of damaging the unit which might occur if the system was not properly purged with oil before start-up.

1 After the propulsion components have been properly installed, fill the pump housing at least half full with filtered system oil. Connect all hydraulic lines and check to be sure they are tight.

2 Install and adjust all control linkage.

3 Fill the reservoir with an approved oil that has been filtered through a 10 micron filter.

4 Gasoline or L.P. engines: remove the coil wire and turn the engine over for 15 seconds. Diesel engines: shut off the fuel flow to the injector and turn the engine over for 15 seconds.

5 Replace the coil wire or return the fuel flow to the injectors. Place the propulsion unit in the neutral position, start the engine and run it at a low idle. The charge pump should immediately pick up oil and fill the system. If there is no indication of fill in 30 seconds, stop engine and determine the cause.

6 After the system starts to show signs of fill, slowly move pump camplate to a slight cam angle. Continue to operate system slowly with no load on motors until system responds fully.

7 Check fluid level in the reservoir and refill if necessary to the proper level with an approved filtered oil.

8 Check all line connections for leaks and tighten if necessary.

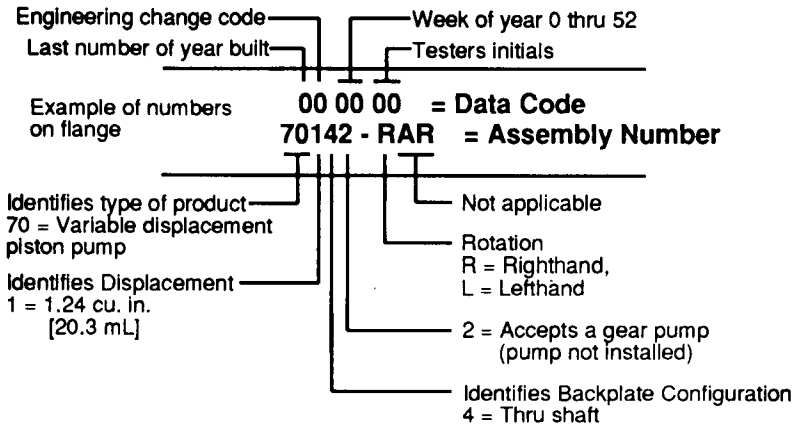
9 The machine is now ready to be put into operation.

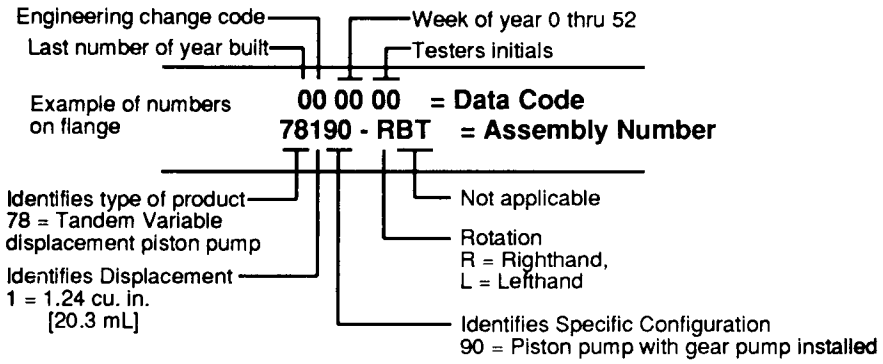
10 Short hour filter changes are recommended for the first two changes after placing the machine back into operation. The first filter would be changed in 3-5 hours and the second at approximately 50 hours. Routine scheduled filter changes are recommended for maximum life of the hydraulic system.

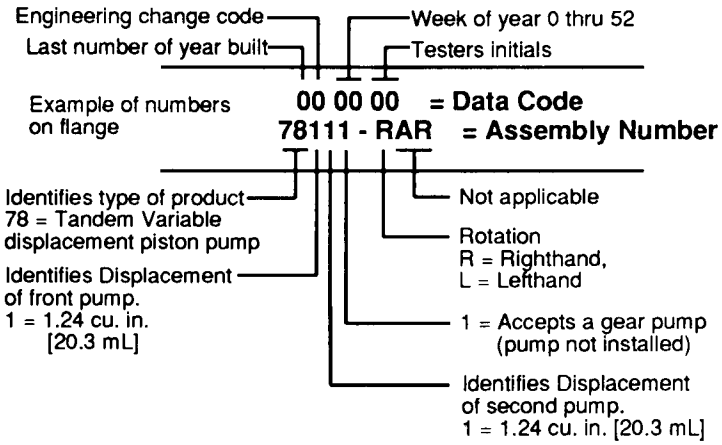
Trouble Shooting

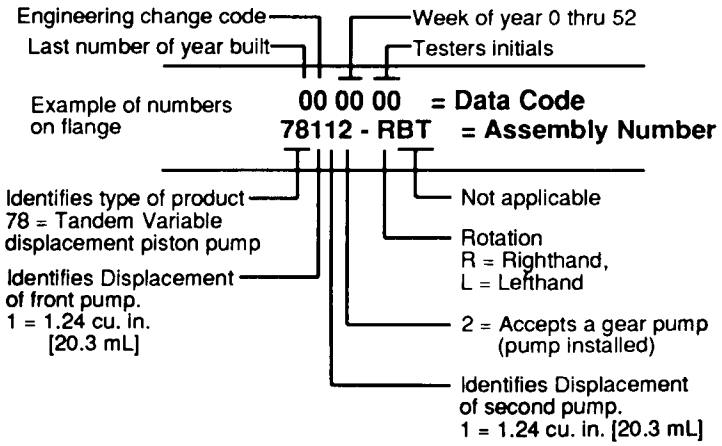
Problem	Possible Causes	Correction
1 System will not operate in either direction.	**A** Oil supply low.	**A** Check oil level, fill.
	B Oil filter clogged.	**B** Replace filter element.
	C Oil too heavy.	**C** Use proper viscosity oil.
	D Control linkage misadjusted. or unfastened.	**D** Check to see if control linkage is binding
	E Low charge pressure. should be 60-100 P.S.I.	**E** See below: F, G, H, & I. Pressure
	F Charge pump key sheared.	**F** Inspect charge pump for damage.
	G Charge pump relief valve damaged.	**G** Remove relief valve parts, examine parts and seat. Replace necessary parts.
	H Charge pump gears worn or scored.	**H** Remove parts and examine. Replace defective parts. If severe scoring is indicated, remove complete pump disassemble, clean, and inspect for damage.
	I Internal charge pump damage.	**I** Disassemble pump, inspect for damage.
	J Drive coupling broken.	**J** Inspect coupling for sheared spline, key or broken chain.
	L Relief valve stuck open.	**L** Remove relief valve, clean or replace.
	M Damaged check valve.	**M** Disassemble and check if check valve is faulty or damaged.
2 System Noisy	**A** Air in system.	**A** Low oil level in reservoir.
	B Loose suction line.	**B** Tighten fittings.
	C Clogged suction filter.	**C** Replace filter element.
	D Internal pump or motor damage.	**D** Disassemble, inspect and repair.
3 Sluggish response to acceleration or deceleration.	**A** Air in system.	**A** See step 1-A, 1-B, 1-C, 2-B.
	B Low charge pressure.	**B** See step 1-F 1-6, 1-I.
	C Internal pump or motor wear or damage.	**C** Disassemble, inspect and repair.
	D Relief valve dirty or damaged.	**D** Remove, clean or replace.

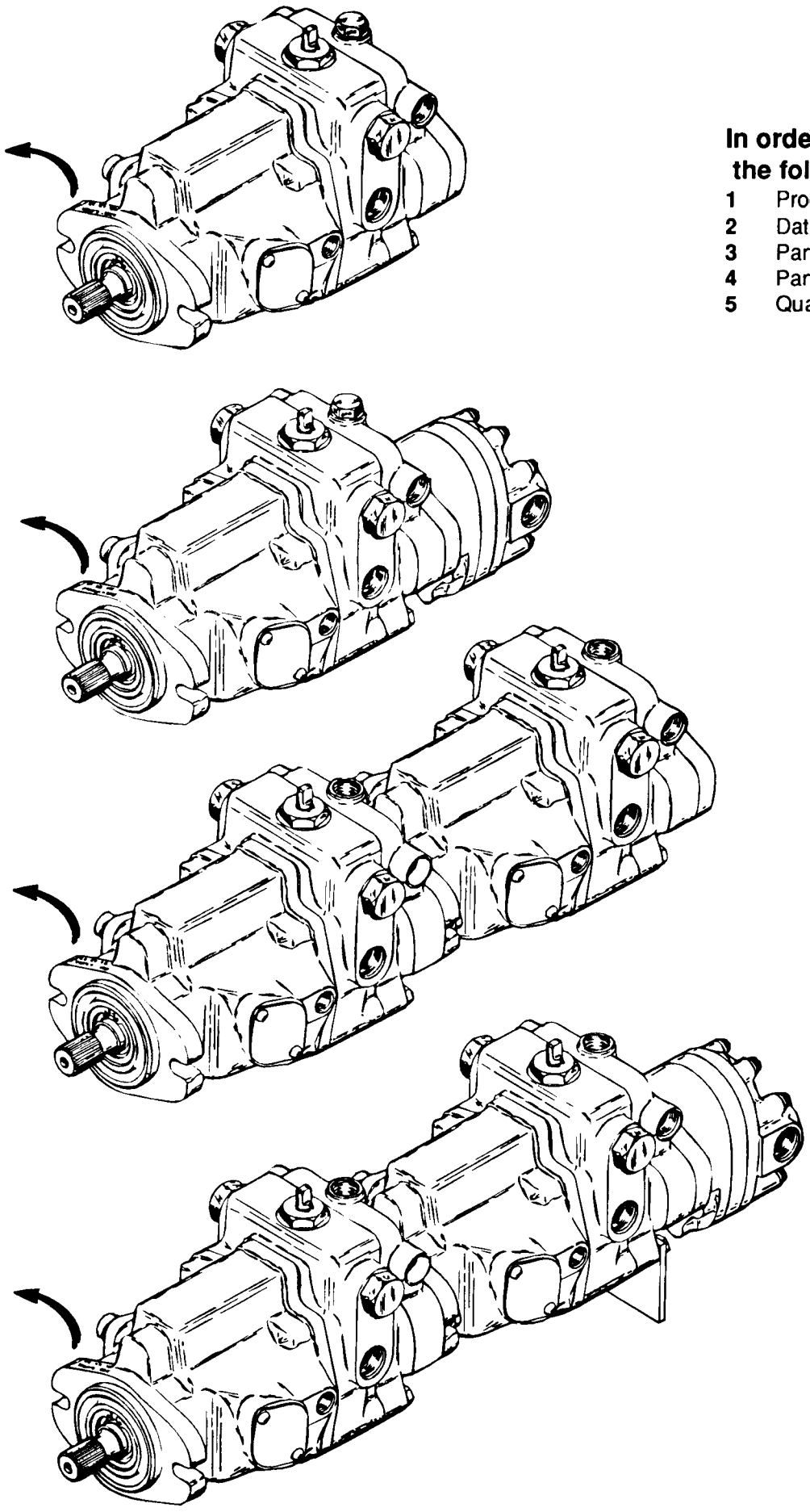
Identification Numbers











In ordering spare parts include the following information:

1. Product Number
2. Date Code
3. Part Name
4. Part Number
5. Quantity of Parts

Eaton Corporation **Hydraulics Division,** 15151 Highway 5, Eden Prairie, MN 55344 Telephone (612) 937-9800

Eaton G.m.b.H. **Hydraulics Division** ✉ 100 410 • D-5620 Velbert 1 West Germany ☎ 49-2051-20745

Printed in U.S.A.

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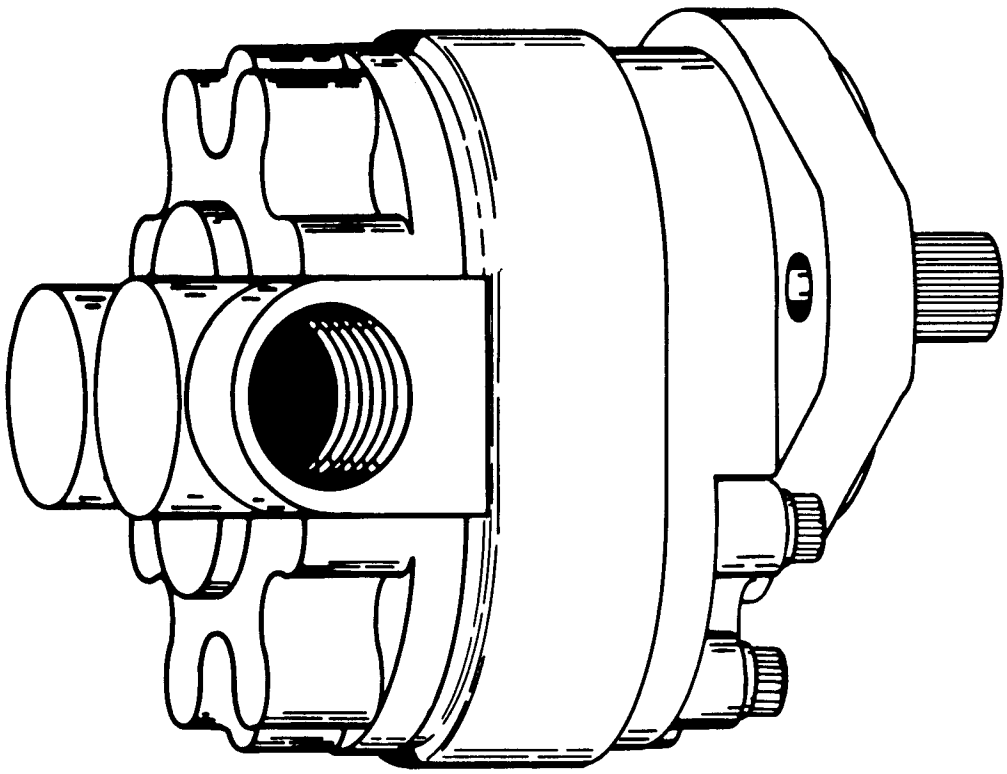
September, 1989

NO. 7-615

Eaton
Hydraulics
Division

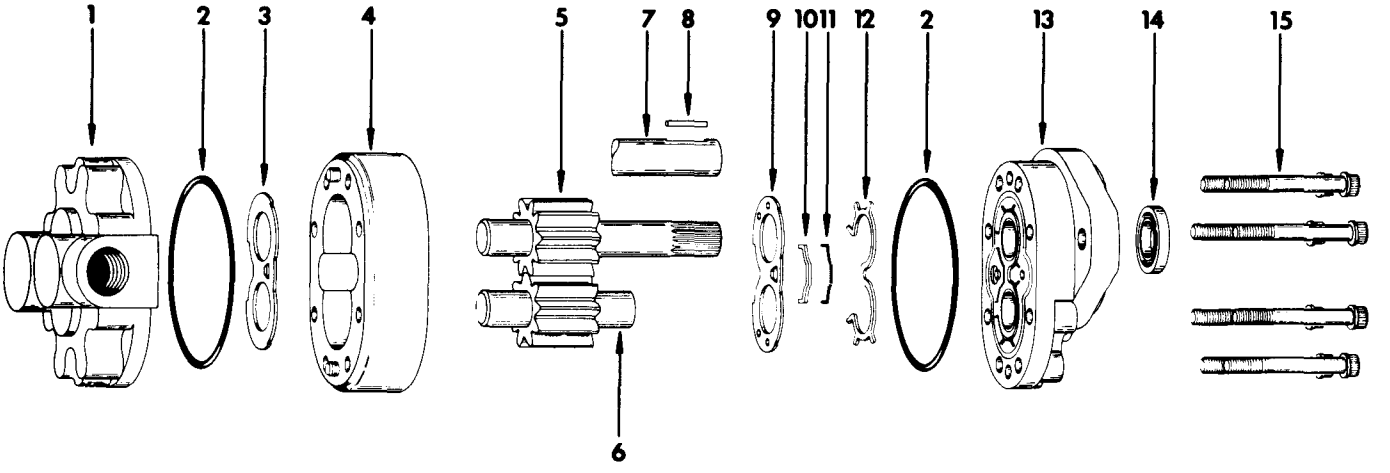
Repair Information

Model 25300 Gear Pump — B2 Series



EATON

SINGLE PUMP



PARTS LIST

REF. NO.	DESCRIPTION	REQ'D. PER ASSY.	REF. NO.	DESCRIPTION	REQ'D. PER ASSY.
1	Back plate assembly	1	9	Wear plate	1
2	O-ring	2	10	Bearing seal	1
3	Optional thrust plate	1	11	Molded o-ring	1
4	Body	1	12	Back-up gasket	1
5	Spline drive gear assy.	1	13	Front plate assy.	1
6	Idler gear assy.	1	14	Shaft seal	1
7	Keyed drive gear assy.	1	15	Cap screw	8
8	Key	1			

Note: For pumps with Flow Divider, Flow Control or Relief Valve backplates refer to page 7.

DISASSEMBLY

1. Remove key (8) from drive shaft if keyed drive gear assembly (7) is used.
2. Thoroughly clean outside of pump.
3. Use sharp tool to mark across front plate, body and backplate. This will assure proper reassembly.
4. Clamp pump in vise, shaft up.
5. Remove cap screws (15) eight each.
6. Remove pump from vise, hold pump in hands and bump shaft against wooden block to separate front plate (13) from back plate (1). Body (4) will remain with either front plate or backplate.
7. If backplate was removed first, remove optional thrust plate (3) from body gear pockets (4). If the front plate was removed first, remove wear plate (9) from body gear pockets (4).
8. Remove drive gear assembly (5) or (7) and idler gear assembly (6) from body (4).
9. To separate body (4) from the plate it remains with, place drive gear assembly (5) or (7) in bushing and tap protruding end with plastic hammer or rawhide mallet.
10. Remove o-ring (2) from front plate (13) and backplate (1).
11. Remove back-up gasket (12) from front plate (13) by prying with a sharp tool.
12. Remove bearing seal (10) from front plate (13) by prying with a sharp tool.
13. Remove molded o-ring (11) from front plate (13).
14. Remove shaft seal (14) from front plate (13) by prying with a screwdriver.

INSPECT PARTS FOR WEAR

GENERAL

1. Clean and dry all parts.
2. Remove all nicks and burrs from all parts with emery cloth.

GEAR ASSEMBLY

1. Check drive shaft spline for twisted or broken teeth or check keyed drive shaft for broken or chipped keyway.
2. Inspect both the drive gear and idler gear shafts at bushing points and seal area for rough surfaces and excessive wear.
3. If shaft measures less than .748 in bushing area, the gear assembly should be replaced. (one gear assembly may be replaced separately; shafts and gears are available as assemblies only.)
4. Inspect gear face for scoring and excessive wear.
5. If gear width is below the following figures — the gear assembly should be replaced.

Pump Disp.	.50	.66	.84	1.02	1.20	1.37	1.54	1.69	1.87
Gear Width	.384	.510	.636	.762	.888	1.014	1.140	1.266	1.392

6. Be sure snap rings are in grooves on either side of drive and idler gears.
7. If edge of gear teeth are sharp, break edge with emery cloth.

FRONT AND BACKPLATE

1. Oil groove in bushings in both front plate and backplate should be in line with dowel pin holes and 180° apart. This positions the oil grooves closest to respective dowel pin holes.
2. If I.D. of bushings in front plate or backplate exceed .755 front or backplate should be replaced. (Bushings are not available as separate items.)
3. Bushings in front plate should be flush with face of front plate.
4. If optional thrust plate is not used, check for scoring on face of backplate. If wear exceeds .0015, backplate should be replaced.

BODY

1. Check inside gear pockets for excessive scoring or wear.
2. Body should be replaced if I.D. of gear pockets exceeds 1.713.

GENERAL INFORMATION

It is important that the relationship of the backplate, thrust plate, body, wear plate and front plate is correct. You will note two half moon cavities in the body which must face away from the front plate. Note: The smaller half moon port cavity must be on the pressure side of the pump. Side of thrust plate and wear plate with mid section cut out must be on suction side of pump. Suction side of backplate is always side with larger port boss.

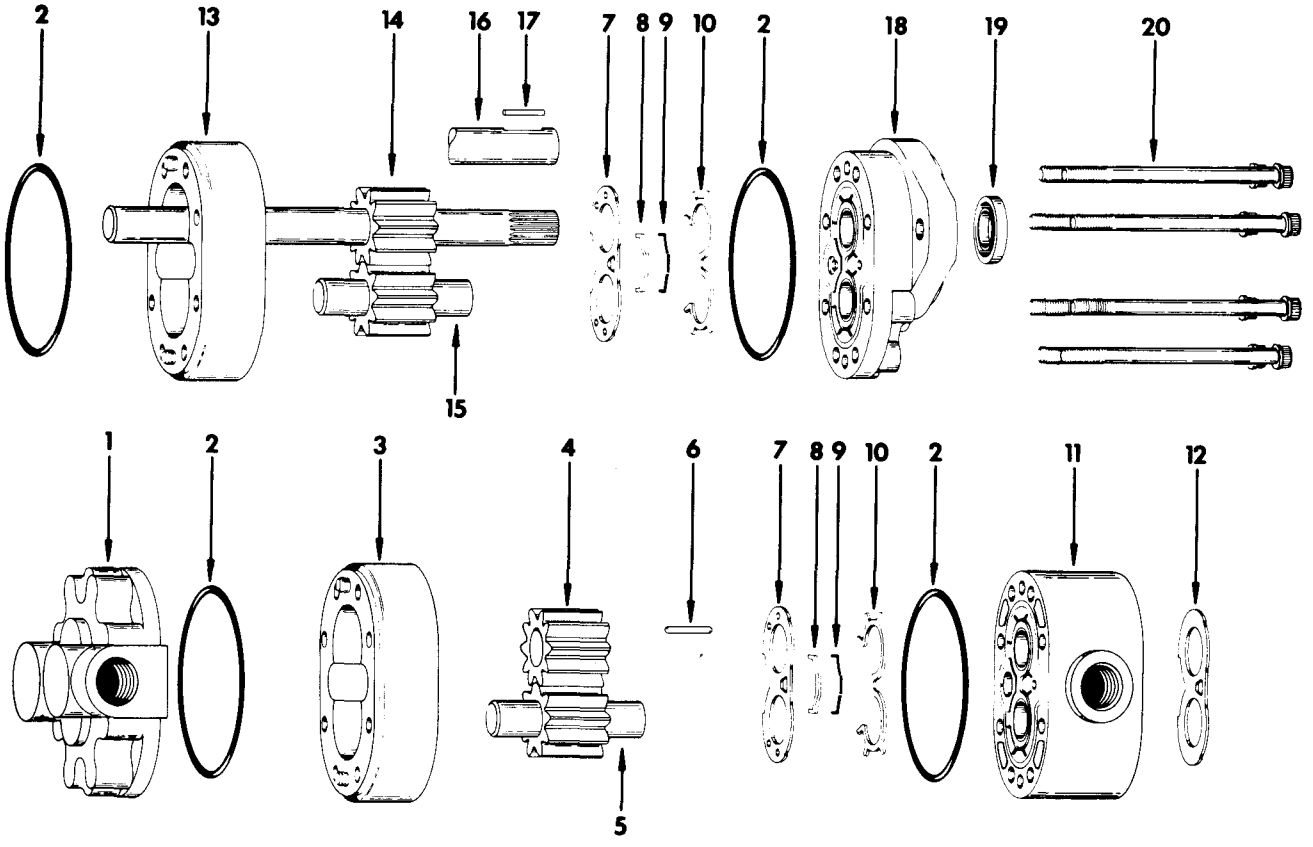
REASSEMBLY

1. The optional thrust plate, wear plate, bearing seal, molded o-ring, back-up gasket, shaft seal and o-rings should be replaced as new parts.
2. Install o-ring (2) in groove of front plate (13).
3. Tuck back-up gasket (12) into groove in front plate (13) with open part of "V" section down.
4. Place molded o-ring (11) in groove in front plate. Place bearing seal (10) over molded o-ring — groove side down.
5. Apply a thin coat of heavy grease to both milled faces of body. Slip body onto front plate — half moon port cavities in body must face away from front plate.

   Note: The small half moon port cavity must be on the pressure side of pump.
6. Place wear plate (9) on top of back-up gasket with bronze face up. The side with the mid section cut away must be on suction side of pump. (Be sure to note difference between wear plate (9) and optional thrust plate (3).
7. Dip gear assemblies into oil and slip into front plate bushings.
8. Install optional thrust plate (3) — bronze face toward gears. The side with mid section cut out must be on suction side of pump. Thrust plate must fit inside gear pockets.
9. Install o-ring (2) in groove in backplate (1).
10. Slide backplate (1) over gear shafts until dowel pins are engaged.
11. Install bolts (15). Tighten evenly to 25/28 ft. lbs. torque.
12. Liberally oil shaft seal (14) and carefully work over drive shaft being careful not to cut rubber sealing lip.
13. Place 1-5/16" O.D. sleeve over shaft and press in shaft seal (14) until flush with front surface of front plate.
14. Install key (8) on keyed shaft (7).

Note: Refer to Trouble Shooting and Start-up Procedure on page 6.

DOUBLE PUMP



PARTS LIST

REF. NO.	DESCRIPTION	REQ'D. PER ASSY.	REF. NO.	DESCRIPTION	REQ'D. PER ASSY.
1	Back plate assembly	1	11	Adapter plate	1
2	O-ring	4	12	Optional thrust plate	1
3	Rear body	1	13	Front body	1
4	Gear (slip fit)	1	14	Spline drive gear assy.	1
5	Idler gear assy. (rear)	1	15	Idler gear assy. (front)	1
6	Round key	1	16	Keyed drive gear assy.	1
7	Wear plate	2	17	Key	1
8	Bearing seal	2	18	Front plate assy.	1
9	Molded o-ring	2	19	Shaft seal	1
10	Back-up gasket	2	20	Cap screw	8

Note: For pumps with Flow Divider, Flow Control or Relief Valve backplates refer to page 7.

DISASSEMBLY

1. Remove key (17) if keyed drive gear assembly (16) is used.
2. Clean outside of pump thoroughly.
3. Use sharp tool to scribe a mark across all sections of the pump. This will assure proper reassembly.
4. Clamp pump in vise, shaft up and remove cap screws (20) eight each.
5. Remove pump from vise, hold pump in hands and bump shaft against wooden block to separate front pump sections. Body (13) will remain with either front plate (18) or adapter plate (11).
6. Remove idler gear (15) from either front plate or adapter plate.
7. Remove backplate (1) from body (3) by tapping on backplate with plastic hammer or rawhide mallet.
8. Remove idler gear (5), slip fit gear (4) and key (6). Remove drive gear assembly (14 or 16) from adapter plate. Remove optional thrust plate (12) from adaptor plate (11).
9. Place drive gear assembly in bushing and tap protruding end with plastic hammer or rawhide mallet to remove bodies (3) or (13) from plates they remained with.
10. Remove wear plate (7) from front plate (18).
11. Remove wear plate (7) from adapter plate (11).
12. Remove o-rings (2) from front plate (18), adapter plate (11), and backplate (1).
13. Remove back-up gasket (10), bearing seal (8) and molded o-ring (9) from front plate (18) and adapter plate (11) by prying out with a sharp tool.
14. Remove shaft seal (19) from front plate (18) by prying with a screwdriver.

INSPECT PARTS FOR WEAR

GENERAL

1. Clean and dry all parts.
2. Remove nicks and burrs from all parts with emery cloth.

GEAR ASSEMBLY

1. Check drive shaft spline (14) for twisted or broken teeth or check keyed drive shaft (16) for broken or chipped keyway. Check for broken keyway in shaft where slip fit gear is installed for double pump.
2. Inspect both the drive gear and idler gear shafts at bushing points and seal area for rough surfaces and excessive wear.
3. If shaft measures less than .748 in bushing area, the gear assembly should be replaced. (One gear assembly may be replaced separately; shafts and gears are available as assemblies only. The slip fit gear is available separately).
4. Inspect gear face for scoring and excessive wear.
5. If gear widths are below the following figures the gear assembly should be replaced.

Pump Disp.	.50	.66	.84	1.02	1.20	1.37	1.54	1.69	1.87
Gear Width	.384	.510	.636	.762	.888	1.014	1.140	1.266	1.392

6. Be sure retaining rings are in grooves on either side of drive and idler gears.
7. If edge of gear teeth are sharp, break edge with emery cloth.

FRONT PLATE, BACKPLATE & ADAPTER PLATE

1. Oil gooves in bushing in both front plate, backplate and adapter plate should be in line with dowel pin holes and 180° apart. This positions the oil grooves closest to the respective dowel pin holes.
2. If I.D. of bushings in front plate, backplate or adapter plate exceed .755 the front plate, backplate, or adapter plate should be replaced. (Bushings are not available as separate items).
3. Bushings in front plate and back-up gasket side of adapter plate should be flush with face.
4. If optional thrust plates are not used check for scoring on face of backplate and adapter plate. If wear exceeds .0015 backplate or adapter plate should be replaced.

BODY

1. Check inside gear pockets for excessive scoring or wear.
2. Body should be replaced if I.D. of gear pockets exceed 1.713.

GENERAL INFORMATION

It is important that relationship of the backplate, body, wear plate and front plate is correct. You will note two half moon cavities in the body which must face away from the front plate. Note: The smaller half moon port cavity must be on the pressure side of the pump. Side of thrust plate and wear plate with mid section cut out must be on suction side of pump. Suction side of backplate is always side with larger port boss.

REASSEMBLY

1. Optional thrust plate, wear plates, bearing seals, molded o-rings, back-up gaskets, shaft seal and o-rings should be replaced as new parts.
2. Install o-rings (2) in groove of front plate (18), adapter plate (11), and backplate (1) with a small amount of grease to hold in place.
3. Tuck back-up gasket (10) in front plate (18) and adapter plate (11) with open part of "V" section down.
4. Place molded o-ring (9) in groove in front plate and adapter plate. Place bearing seal (8) over molded o-ring, groove side down.
5. Apply a thin coat of heavy grease to both milled faces of body. Slip body onto front plate-half moon port cavities in body must face away from front plate. Note: The small half moon port cavity must be on the pressure side of pump.
6. Place wear plate (7) on top of back-up gasket with bronze face up. The side with the mid section cut away must be on suction side of pump.
7. Dip drive gear assembly (14 or 16) and idler gear assembly (15) into oil. Slip both gear assemblies into gear pocket of body and into front plate bushings.
8. Install optional thrust plate (12) into body (13) bronze face toward gears with mid section cut away towards suction side of pump.
9. Install adapter plate (11) in place on front body (13). Check positioning mark on all sections of pump.
10. Install second body (3) onto adapter plate (11) and install wear plate (7).
11. Install key (6) in slot of drive gear assembly shaft (14 or 16). Dip slip fit gear (4) in oil and slip on shaft and into gear pocket of body. Check key for proper location.
12. Dip idler gear (5) in oil and install in gear pocket of body (3).
13. Position backplate (1) over shafts until dowel pins in body are engaged.
14. Install cap screws (20). Tighten evenly to 25/28 ft. lbs. torque.
15. Work shaft seal (19) over drive gear shaft, being careful to not cut rubber sealing lip. (Oil seal liberally before installing). Place 1-5/16 O.D. sleeve over shaft and press in shaft seal (19) until flush with front surface of front plate.
16. Install key (17) on keyed shaft (16).

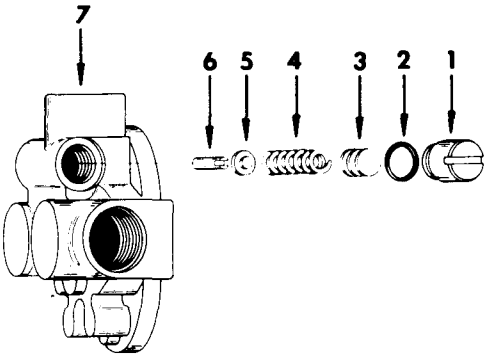
PLACING PUMP BACK INTO SERVICE

1. If shop test stand is available, the following procedure for testing rebuilt pumps is recommended:
   - A. Mount pump on test stand making sure that the proper level of clean oil is available in the reservoir. Check suction line for leaks and obstructions.
   - B. Start pump and run for three minutes at zero pressure.
   - C. Intermittently load pump to 500 P.S.I. for three minutes.
   - D. Intermittently load pump to 1000 P.S.I. for three minutes.
   - E. Intermittently load pump to 2000 P.S.I. for three minutes.
   - F. Remove pump from test stand and check for freeness of drive shaft. Check for leaks.
2. If shop test stand is not available, the following procedure for testing rebuilt pumps is recommended:
   - A. Mount pump on equipment and run pump at 1/2 engine speed at zero pressure.
   - B. By operating control valve build pressure intermittently for three minutes.
   - C. Increase engine speed to full throttle and build pressure intermittently for three minutes.
   - D. Idle engine and check for leaks.

SINGLE OR DOUBLE PUMP TROUBLE SHOOTING

PUMP TROUBLE	PROBABLE CAUSE	REMEDY
1. Noisy pump caused by cavitation.	a. Oil too heavy. b. Oil filter plugged. c. Suction line plugged or too small.	a. Change to proper viscosity. b. Clean filters. c. Clean line and check for size.
2. Oil heating	a. Oil supply low. b. Contaminated oil. c. Setting of relief valve too high or too low. d. Oil in system too light.	a. Fill reservoir. b. Drain reservoir and refill with clean oil. c. Set to correct pressure. d. Drain reservoir and refill with proper viscosity oil.
3. Shaft seal leakage	a. Worn shaft seal. b. Worn shaft in seal area c. Broken bearing seal or back-up gasket d. Bushings out of position. e. Excessive internal wear.	a. Replace shaft seal. b. Replace drive shaft c. If replacing the shaft and shaft seal does not stop seal leakage, the pump should be disassembled and checked for items 3, c. & d. d. Disassemble pump and replace front plate. e. Disassemble pump inspect parts and replace as needed.
4. Foaming oil	a. Low oil level. b. Air leaking into suction line. c. Wrong kind of oil.	a. Fill reservoir. b. Tighten fittings. c. Drain and fill reservoir with non-foaming oil.

RELIEF VALVE BACKPLATE



PARTS LIST

REF. NO.	DESCRIPTION	REQ'D. PER ASSY.
1	Slotted plug	1
2	O-ring	1
3	Shims	As Reqd.
4	Spring, Relief Valve	1
5	Plug Seat	1
6	Seat	1
7	Backplate	1

DISASSEMBLY

1. Use slotted socket and remove relief valve plug (1), shims (3), spring (4), plug seat (5) and seat (6) from backplate (7).

Note: Do not remove internal relief valve cartridge assembly. Cartridge assembly has been set to a predetermined depth with locktite applied.

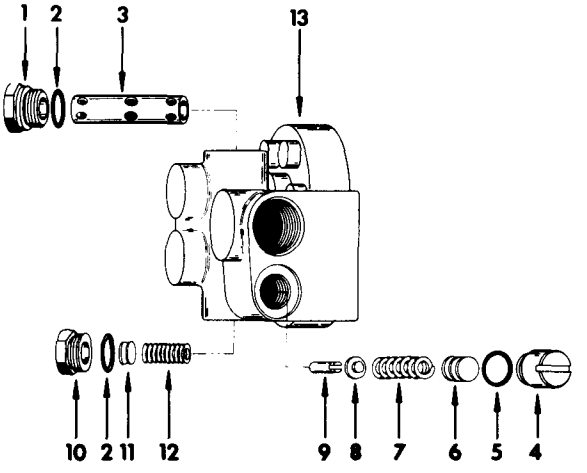
INSPECTION

1. Clean and dry all parts.
2. The o-rings need not be inspected as they should be replaced as new items.
3. Remove all nicks and burrs from all parts with emery cloth.
4. Oil grooves in bushings should be in line with dowel pin holes and 180 degrees apart. This positions the oil grooves closest to the respective pin holes.
5. If I.D. of bushings in backplate exceed .755, the backplate should be replaced. (Bushings are not available as separate items).
6. If optional thrust plate is not used, check for scoring on face of backplate. If wear exceeds .0015, backplate should be replaced.
7. Check shims (3) for wear.
8. Check spring (4) for weakness or breakage.
9. Wash backplate in clean solvent, direct compressed air into relief valve cavity in backplate to dry relief valve cartridge assembly. The procedure removes any trapped contamination.

REASSEMBLY

1. Install relief valve parts in backplate (7), seat (6), plug seat (5), spring (4), same number of shims (3), new o-ring (2) on plug (1) and torque plug to 21 to 24 ft. lbs.

FLOW DIVIDER/FLOW CONTROL BACKPLATE



PARTS LIST

REF. NO.	DESCRIPTION	REQ'D. PER ASSY.
1	Hex Plug	1
2	O-ring	2
3	Flow Divider Spool	1
4	Slotted Plug	1
5	O-ring	1
6	Shims	As Req'd
7	Spring, Relief Valve	1
8	Plug Seat	1
9	Seat	1
10	Hex Plug	1
11	Shims	As Req'd
12	Spring, Flow Divider	1
13	Backplate	1

EATON
REPAIR INFORMATION
GEAR PUMP
MODEL 25300
NO. 7-615

DISASSEMBLY

1. Use slotted socket and remove relief valve plug (4), shims (6), spring (7), plug seat (8) and seat (9) from backplate (13).
   Note: Do not remove internal relief valve cartridge assembly. Cartridge assembly has been set to a predetermined depth with locktite applied.
2. Remove plug (1), spool (3), plug (10), shims (11) and spring (12) from backplate (13).

INSPECTION

1. Clean and dry all parts.
2. The o-rings need not be inspected as they should be replaced as new items.
3. Remove all nicks and burrs from all parts with emery cloth.
4. Oil grooves in bushings should be in line with dowel pin holes and 180 degrees apart. This positions the oil grooves closest to the respective pin holes.
5. If I.D. of bushings in backplate exceed .755 the backplate should be replaced. (Bushings are not available as separate items).
6. If optional thrust plate is not used, check for scoring on face of backplate. If wear exceeds .0015, backplate should be replaced.
7. Inspect backplate spool bore for scoring or contamination.
8. Inspect spool O.D. for scratches, it should be smooth and free of nicks and burrs. Spool should slide freely inside backplate bore.
9. Check shims (6) and (11) for wear.
10. Check springs (7) and (12) for weakness or breakage.
11. Wash backplate in clean solvent, direct compressed air into relief valve cavity in backplate to dry relief valve cartridge assembly. The procedure removes any trapped contamination.

REASSEMBLY

1. Install relief valve parts in backplate (13), seat (9), plug seat (8), spring (7), same number of shims (6), new o-ring (5) on plug (4) and torque plug (4) to 21 to 24 ft. lbs.
2. Install flow divider parts in backplate (13) spool (3), spring (12), same number of shims (11), new o-rings (2) on plugs (1) and (10) and torque plugs (1) and (10) to 27 to 30 ft. lbs.

FLOW DIVIDER/FLOW CONTROL TROUBLE SHOOTING

FLOW DIVIDER TROUBLE	PROBABLE CAUSE	REMEDY
1. External leakage.	a. Spool plug o-ring. b. Relief valve plug o-ring.	a. Remove spool plug and replace o-ring. b. Remove relief valve plug and replace o-ring.
2. Low priority pressure.	a. Low relief valve setting.	a. Replace weak or broken spring. b. Shim as required. c. Replace backplate assy.
3. Low priority flow.	a. Relief valve open or leaking. b. Scratched machined sealing surface in relief valve. (Either in seat or poppet within cartridge) c. Contaminant lodged in relief valve. d. Missing spring shims. e. Weak Spool spring.	a. Replace weak or broken spring. b. Replace parts as required. c. Clean relief valve cavity. d. Add shims as required. e. Replace spool spring.
4. No priority flow.	a. Broken spool spring. b. Orifice inside spool plugged.	a. Replace spool spring. b. Check for contaminant lodged in orifice.
5. No secondary flow.	a. Spool sticking.	a. Remove and clean spool bore.
6. Low secondary flow.	a. Pump flow degradation due to wear.	a. Check pump for worn parts and replace.

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FORM NO. 7-615
June, 1989

Printed in U.S.A.

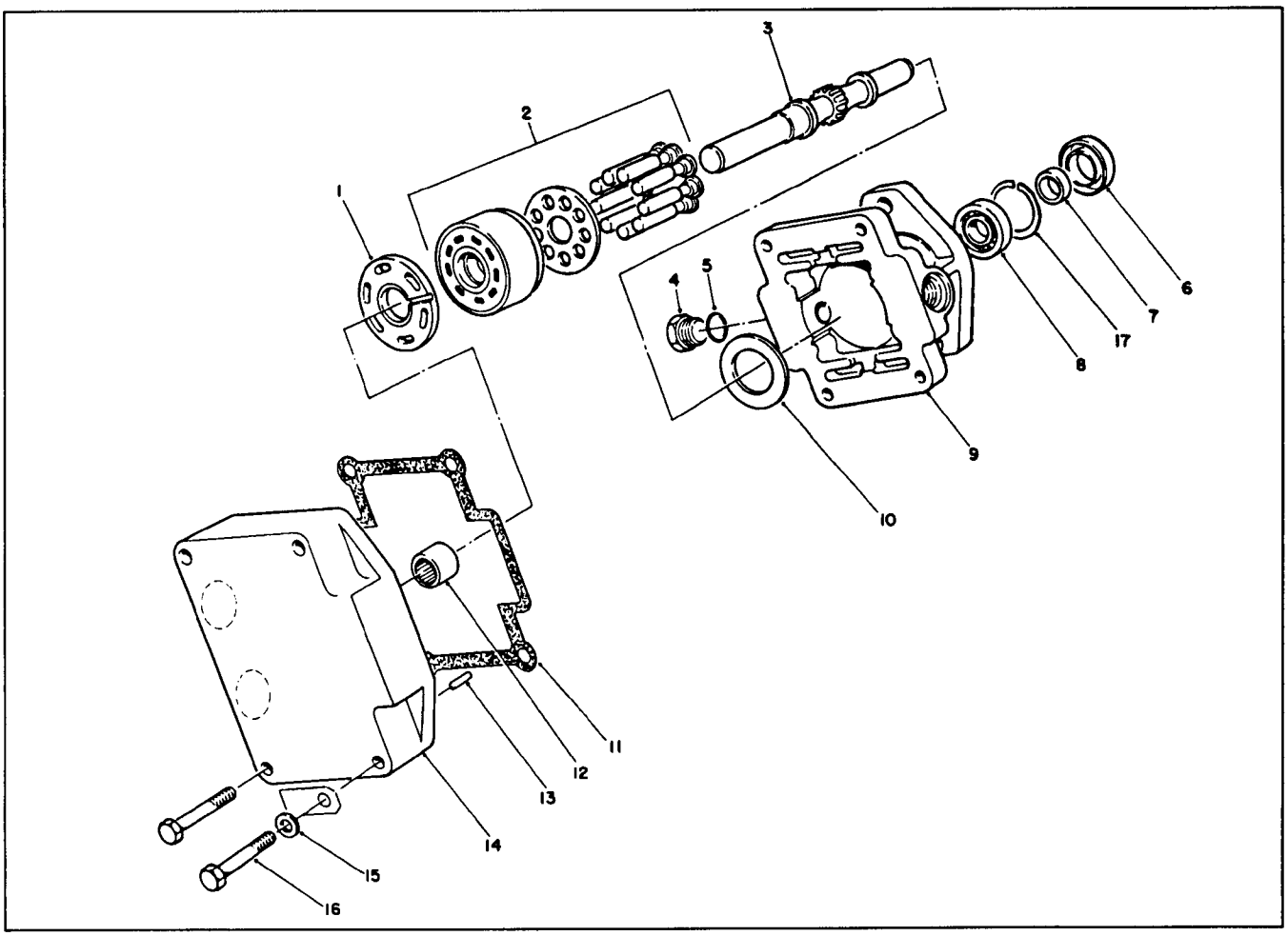
Service Manual

Sundstrand Sauer
15 Series Axial Piston Motor

Reelmaster® 335-D

TORO®

Parts Identification



1. Plate - Valve
2. Cylinder Block Kit
3. Shaft Assembly (Incl. Ref. #7 & 8)
4. Plug
5. Seal - O-Ring Seal - Lip Sleeve
6. Bearing - Roller
7.
8.
9. Housing - Fixed
10. Plate - Thrust
11. Gasket
12. Bearing
13. Pin - Straight
14. Cap - End
15. Washer - Flat
16. Screw - Cap Hex. Hd.
17. Ring - Retaining

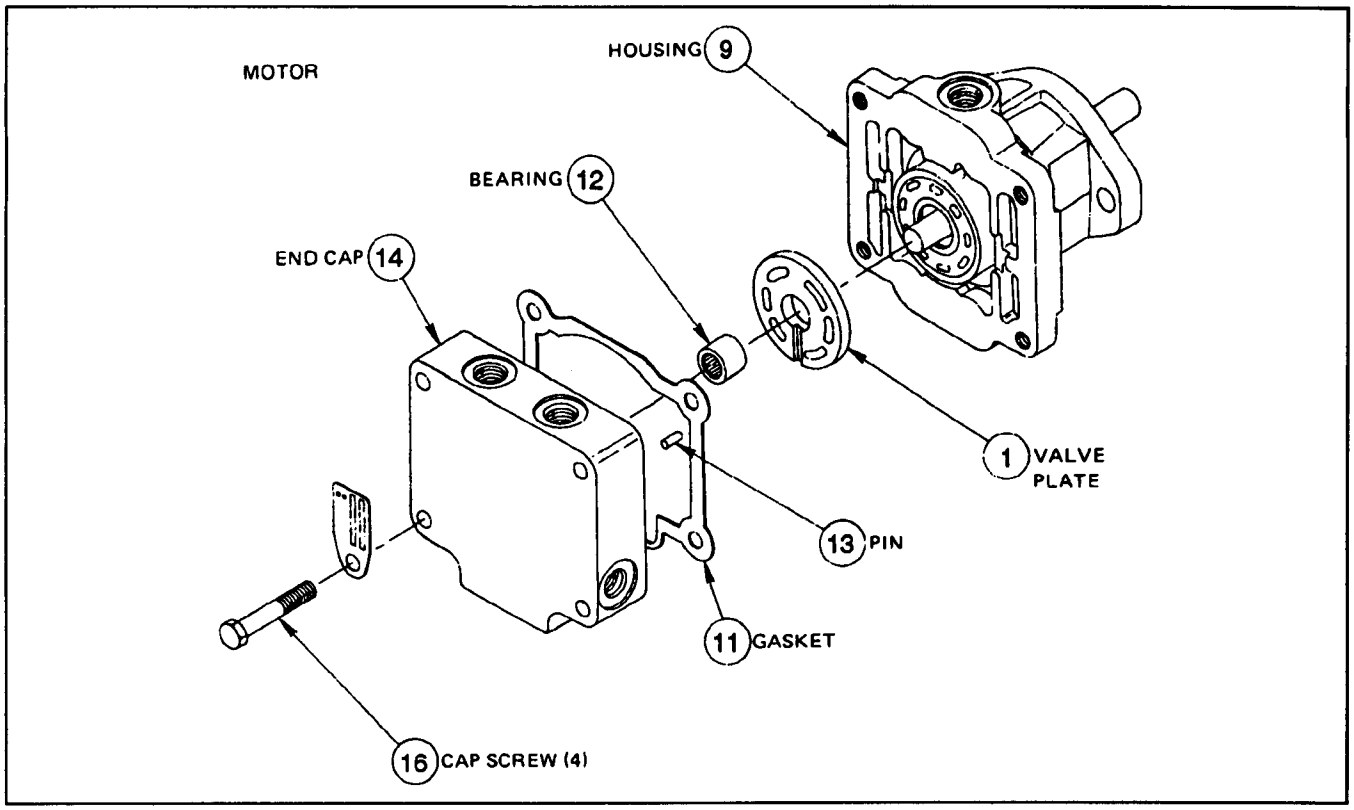
Shaft Seal Replacement

The lip type shaft seal (6) can be replaced without disassembly of the motor; however, replacement of the seal requires removal of the motor from the transaxle.

Pry the seal carefully out of the housing bore, using care not to distort the housing or damage the bore or shaft. Once removed, the seal is not reusable.

Prior to installing the new seal, polish the shaft extension, wrap it in thin plastic and lubricate with hydraulic oil to insure that the seal is not damaged during assembly. Slide the seal over the shaft and press it into the housing bore.

Major Repair



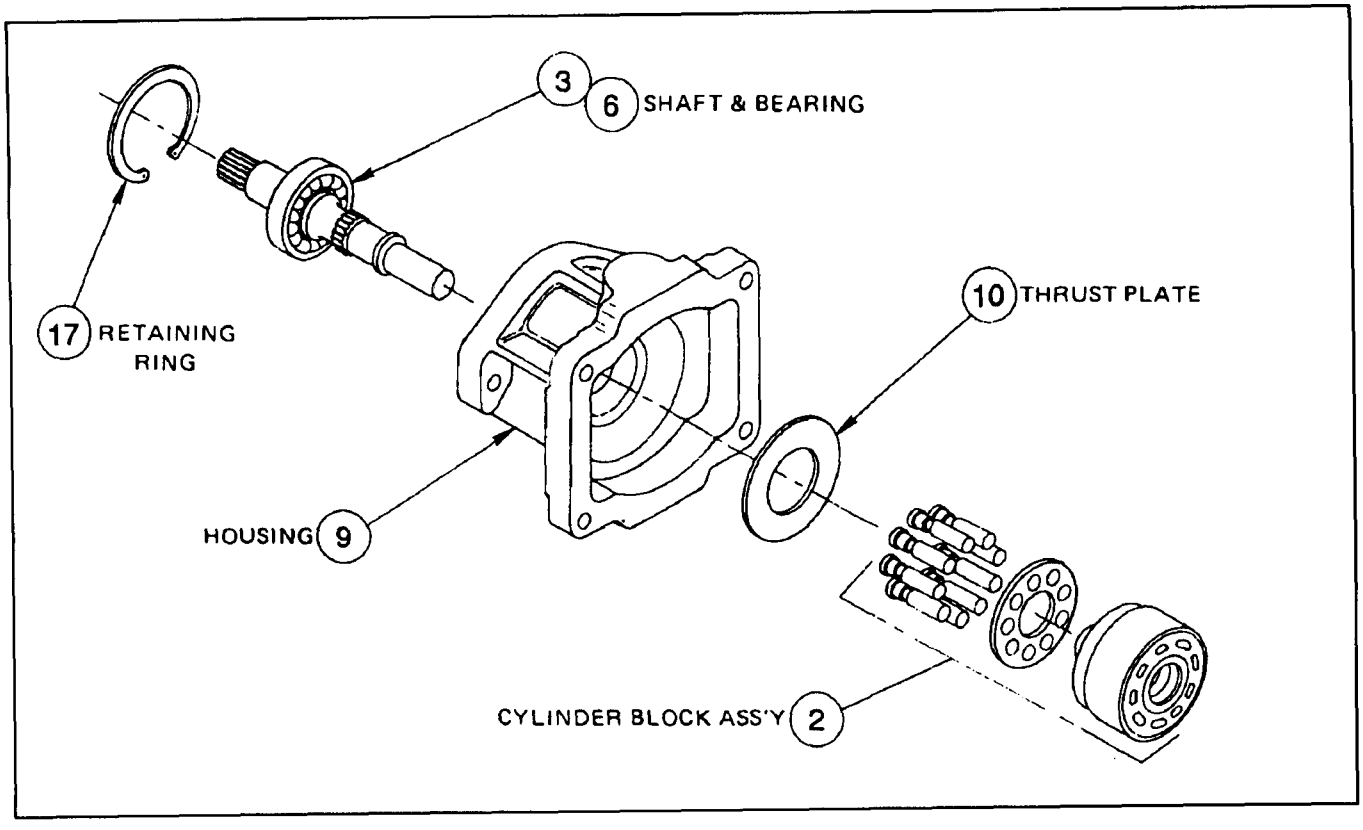
When the four (4) cap screws (16) are loosened, the internal spring loading will cause the end cap (14) to separate slightly. Loosen these screws evenly to prevent distortion of parts. If separation does not occur as screws are loosened, tap end cap with soft hammer until parts separate.

IMPORTANT: All surfaces exposed are critical and caution must be used to avoid damage.

Note the orientation of housing (9) to end cap (14). To insure proper assembly scribe a line across housing and end cap for an assembly guide.

The end cap (14) can now be removed from the motor, however, be certain that the valve plate (1) does not fall and become damaged. If the valve plate tends to lift off with the end cap (14), hold it in place on the end cap and remove both parts together. If the valve plate remains on the cylinder block, remove it at this time.

The end cap is actually an assembly consisting of a needle bearing which is a press fit in the end cap and the valve plate locating pin (13). Inspect the bearing (12) and remove if replacement is required.



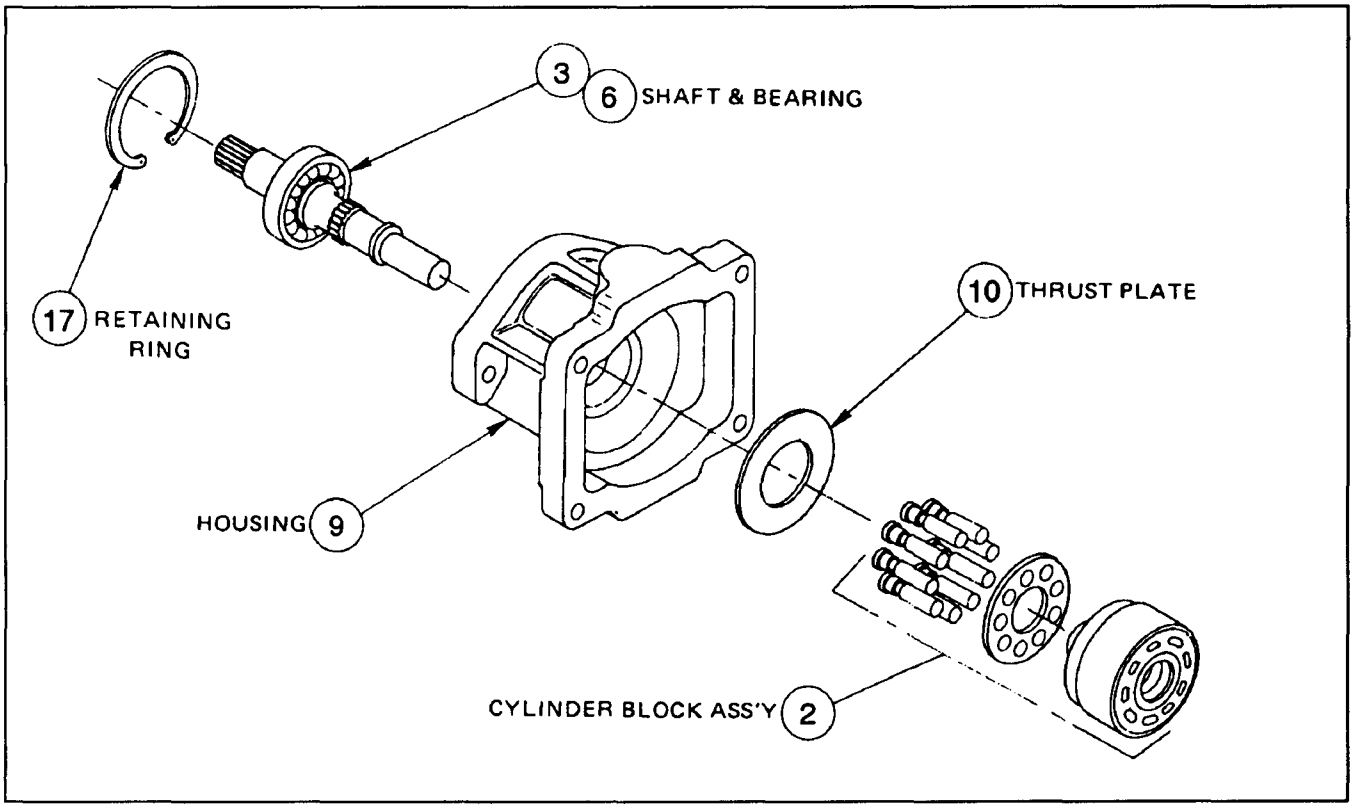
Lift out the cylinder block assembly (2). The pistons may come out of cylinder block bores. There is no special orientation of piston to bore that needs to be maintained.

Do not attempt to disassemble the spring and other parts from the center bore of the cylinder block. The entire cylinder block assembly (2) should be replaced if any of its components are damaged.

Visually inspect wear surfaces of valve plate, cylinder block and slippers for damage. Check to be sure pistons are free in bores.

Remove thrust plate (10) from counter bore in motor housing (9). Visually inspect both sides for damage and flatness.

The retaining ring (17) must be removed prior to removal of shaft and bearing. The output shaft seal must be removed to expose the retaining ring (See Shaft Seal Replacement). The motor shaft (3) and bearing (8) can be pressed out of the motor housing.



Press shaft (3) and bearing (8) together, then press into housing (9). Install retaining ring (17) if used.

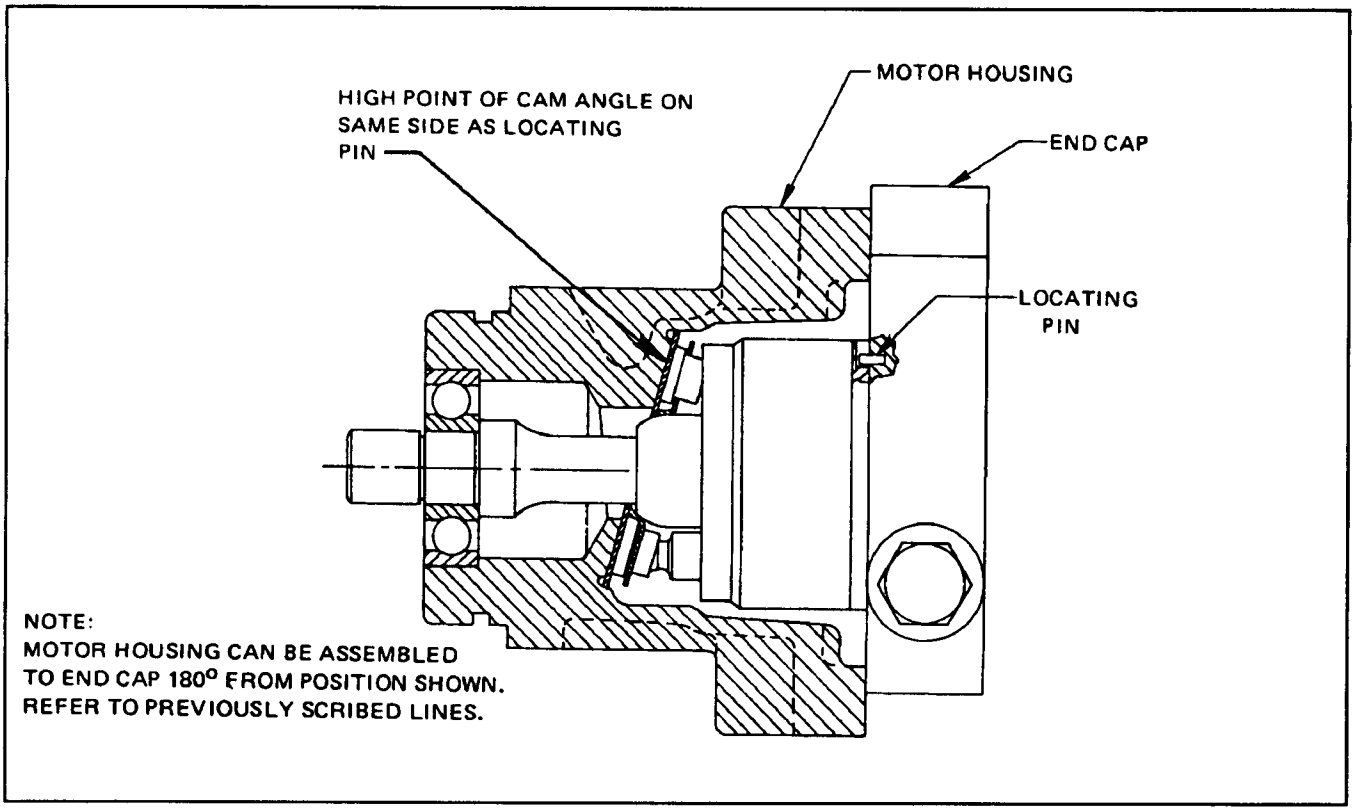
Lubricate thrust plate (10) and insert in counterbore of housing (9).

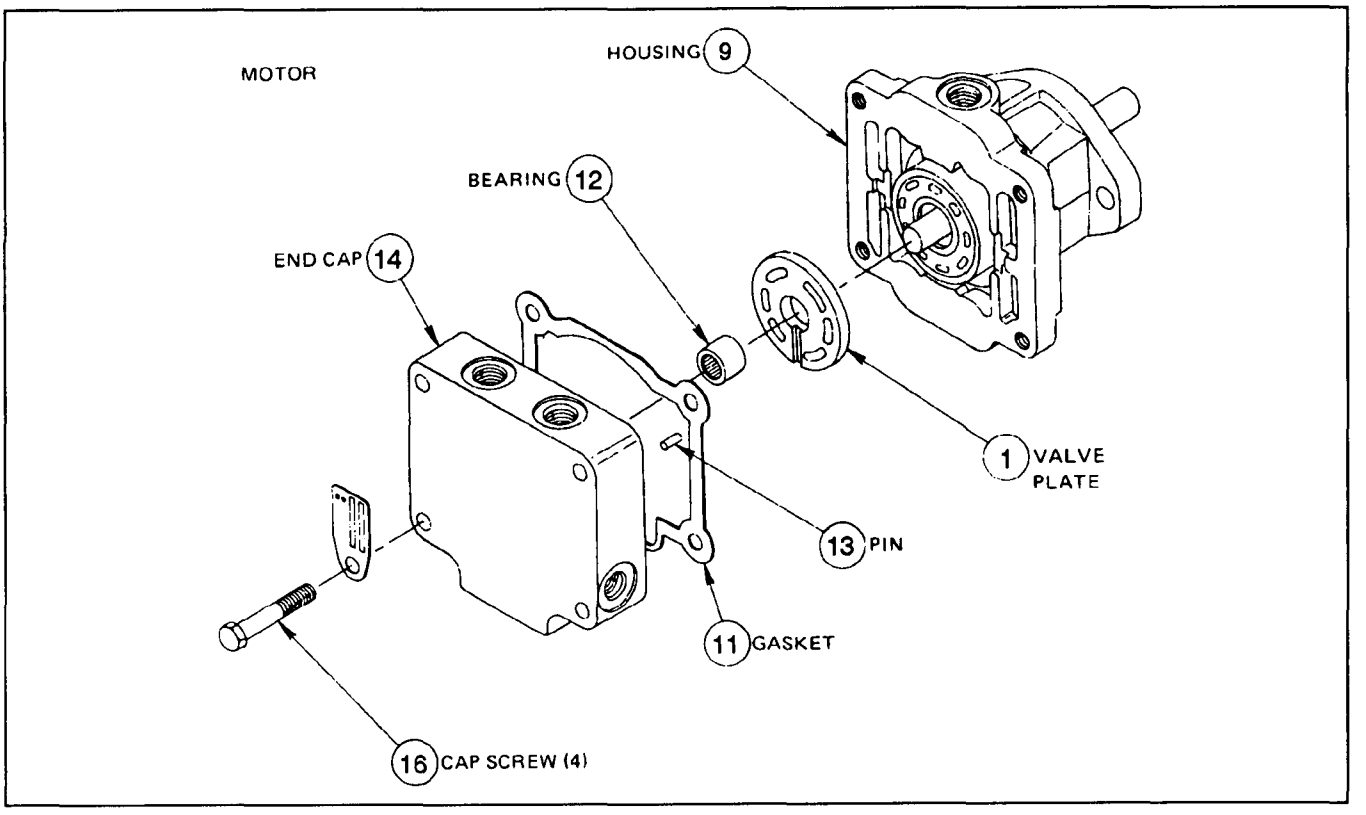
Assemble cylinder block parts if necessary and lubricate with clean hydraulic oil. There is no special orientation of piston to bore that needs to be maintained.

Place the housing assembly in a horizontal position.

Slide cylinder block assembly (2) over shaft and engage spline. Be certain that pistons and thrust plate remain in place. When properly installed a slight spring tension can be felt when pushing on cylinder block.

Lubricate exposed surface of cylinder block with clean hydraulic oil.


HIGH POINT OF CAM ANGLE ON SAME SIDE AS LOCATING PIN
MOTOR HOUSING
END CAP
LOCATING PIN
NOTE:
MOTOR HOUSING CAN BE ASSEMBLED TO END CAP 180° FROM POSITION SHOWN. REFER TO PREVIOUSLY SCRIBED LINES.



Properly orient the end cap (14) and housing (9). Refer to previously scribed lines for assembly guide.

Press the bearing (11) into end cap (14) leaving 3/32 to 1/8 inch of bearing protruding beyond face. The valve plate (1) pilots on this bearing.

Insert locating pin (13) into end cap. Lubricate the slotted side of the motor valve plate (1) and slip it over the locating pin and protruding bearing.

Place gasket (11) on housing (9), then install end cap and valve plate. Hold the valve plate so it does not drop off during assembly.

Install four (4) screws (16) and tighten alternately until the end cap and housing are pulled completely together. Torque to 27-37 ft. lbs. Check for proper internal assembly by slowly rotating motors shaft while tightening these screws.

Commercial Products Division

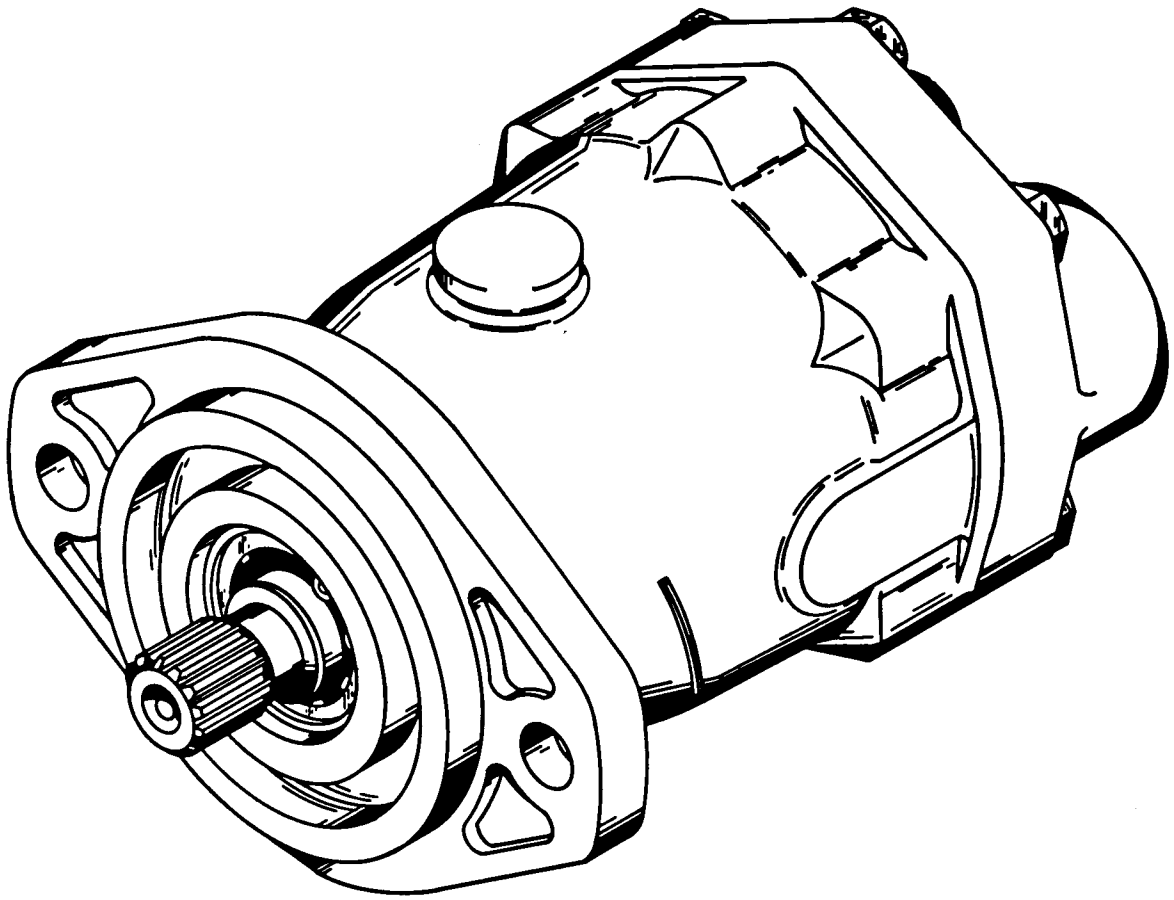
Printed in U.S.A.

NO. 7-138

Eaton
Hydraulics
Division

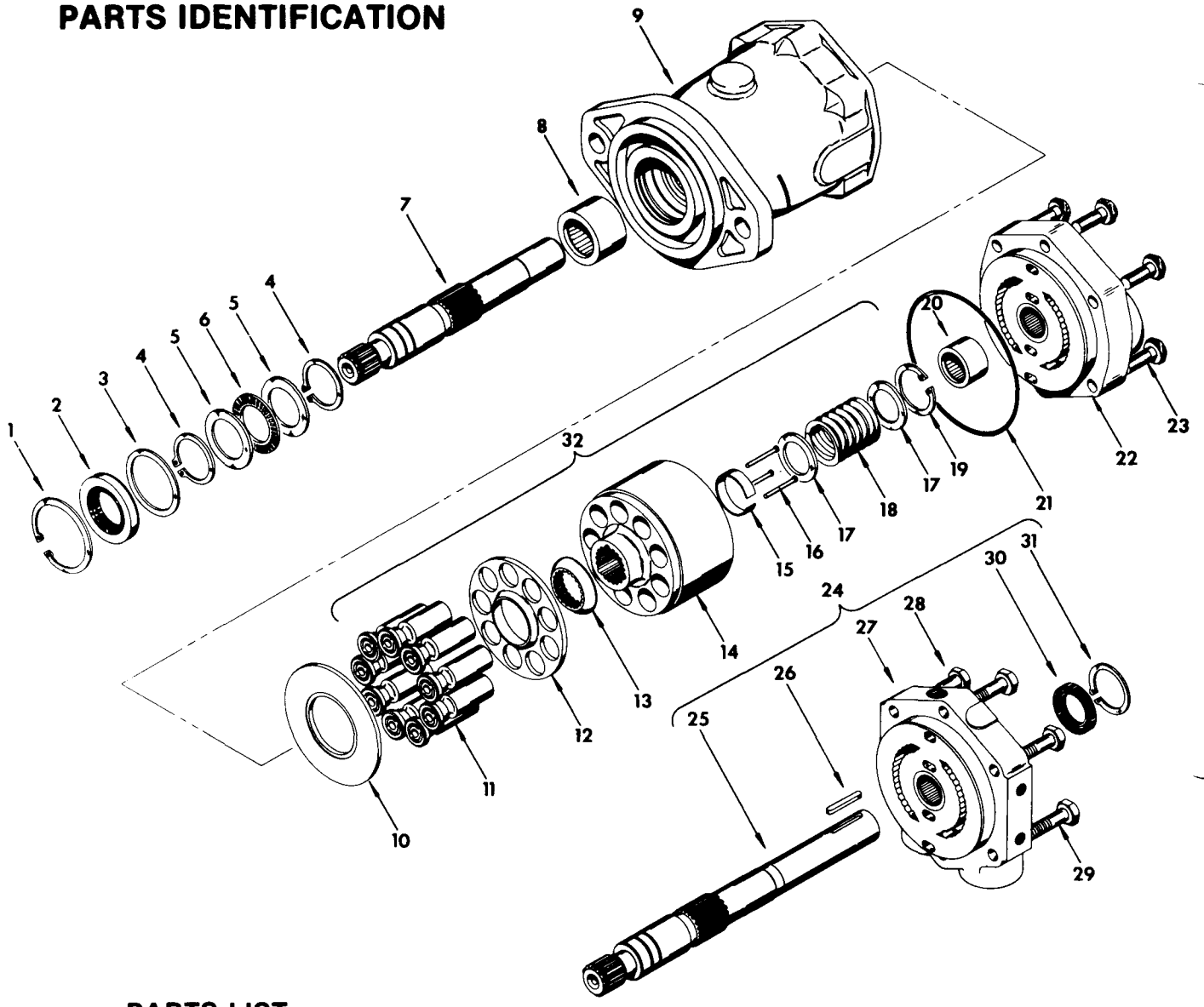
Repair Information

Model 74418 & 74448 Fixed Axial Piston Motor



EATON

PARTS IDENTIFICATION



PARTS LIST

REF. NO.	DESCRIPTION	REF. NO.	DESCRIPTION	REF. NO.	DESCRIPTION
1	Snap ring	12	Spider	23	Capscrew
2	Shaft seal	13	Pivot	24	Through shaft optional assembly
3	Washer	14	Piston block	25	Drive shaft
4	Snap ring	15	Pin keeper	26	Key
5	Thrust washer	16	Pin	27	Backplate
6	Thrust bearing	17	Washer	28	Capscrew
7	Drive shaft	18	Spring	29	Capscrew
8	Needle bearing	19	Snap ring	30	Shaft seal
9	Housing assembly	20	Needle bearing	31	Snap ring
10	Thrust race	21	O-ring, 3/32 × 4 I.D.	32	Rotating kit assembly
11	Piston assembly	22	Backplate assembly		

DISASSEMBLY

1. Clean outside of unit thoroughly.
2. Clamp shaft in a protected jaw vise with backplate end up.
3. Remove six cap screws (23 or 28 & 29) from backplate (22 or 27).
4. Use a plastic mallet and tap the backplate (22 or 27) to loosen it.
5. Remove o-ring (21) from backplate.
6. Remove the complete piston block assembly from the housing assembly.
7. Remove piston assemblies (11), spider (12), and pivot (13) from piston block assembly.
8. The piston block assembly need not be disassembled unless the pins (16) or spring (18) is damaged.

CAUTION

The following procedure should be used if the spring (18) is to be removed from the piston block. The spring is highly compressed and the snap ring (19) should not be removed without compressing the spring.

The following parts will be needed to disassemble the piston block:

2 ea. 3/8 I.D., × 1-1/8 O.D. flat washers
1 ea. 3/8 × 3-1/4 N.C. capscrew
1 ea. 3/8 N.C. nut

Place on of the flat washers over the 3/8 × 3-1/4 capscrew and place this through the center of the piston block. Place the other washer over the capscrew and let it rest on the three pins (16). Screw nut on and compress the spring inside the piston block. Use a pair of snap ring pliers and remove the internal snap ring (19). Remove the bolt and two washers. Remove the two washers (17), spring (18), three pins (16), and pin keeper (15).

9. Remove thrust race (10) from housing.
10. Remove snap ring (1) from housing.
11. Remove shaft seal (2) from housing.
12. Remove washer (3) from housing.
13. Remove drive shaft (7 or 25) from housing.
14. Remove the two snap rings (4), thrust washers (5), and thrust bearing (6), from drive shaft.
15. On through shaft type assembly, remove snap ring (31) and shaft seal (30) from backplate (27).

INSPECTION

1. Wash all parts thoroughly in a suitable solvent.
2. Examine needle bearings (8) and (20) in housing (9) and backplate (22 or 27). If the needles are free of excessive play and remain in the bearing cage, there is no need to replace the bearing.
3. Inspect thrust washers (5) and thrust bearing (6). All surfaces should be free of any signs of wear or fretting.
4. Inspect spider (12) and pivot (13); conical surfaces should be free of wear and score marks.
5. Inspect the pistons (11); the O.D. surface should be smooth and free of scoring. The shoes should be snug fit to the piston. The face of the shoes should be flat and free of scoring and flaking. **Do not lap piston shoes.**
6. Inspect the piston block (14); the bores should be free of scoring. The surface that contacts the backplate should be smooth and free of grooves or metal build-up. **Do not lap piston block.**
7. Inspect the thrust race (10); the surface should show no signs of scoring or grooves.
8. Inspect the flat surface on the backplate (22 or 27); it should be free of excessive scoring or metal build-up. **Do not lap back plate.**
9. Inspect the drive shaft (7 or 25) for fretting in the bearing areas. Check spline area for twisted or broken teeth. If keyed shaft, check for cracked or chipped keyway.

REASSEMBLY

1. Use filtered system oil to lubricate all critical moving parts before assembly.
2. Install one snap ring (4) in rear groove of drive shaft (7 or 25). Install one thrust washer (5), thrust bearing (6), and second thrust washer (5) on drive shaft (7 or 25). Install second snap ring (4) in front groove on drive shaft.
3. Replace needle bearing (8) in housing (9) if necessary. Install shaft in housing assembly (9) and install washer (3). Oil I.D. of new shaft seal (2) and press into position. Retain with snap ring (1).
4. Compress pin keeper (15) and install in the spline area of the piston block (14).
5. Install the three pins (16) in the special grooves of the spline and with head end of pin toward inside of block.
6. Install one washer (17), spring (18), and second washer (17). Use the two 3/8 I.D. washers and the 3/8 × 3-1/4 capscrew to compress the spring and retain with snap ring (19). Remove the 3/8 × 3-1/4 capscrew and two washers.
7. Install the pivot (13), spider (12), and the piston assemblies (11) in the piston block assembly.
8. Lubricate thrust race (10) and install in housing assembly.
9. Install piston block assembly in housing assembly. The piston shoes must contact the thrust race (10). Be sure all parts are in their proper position.
10. Install new needle bearing (20) in backplate (22 or 27) if necessary.
11. Install new o-ring (21) on backplate (22 or 27).
12. Install backplate (22 or 27) on housing.
13. Install six capscrews (23 or 28 & 29) and torque 15-18 ft. lbs.
14. On through shaft type assembly, install shaft seal (30) and snap ring (31) in backplate (27). Install key (26) in drive shaft (25).

MOTOR TROUBLE SHOOTING

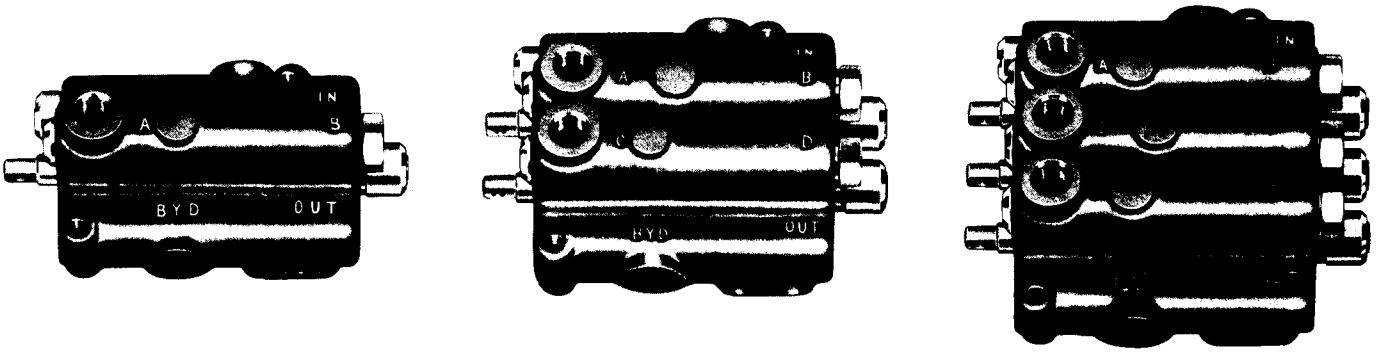
In trouble shooting a pump-motor system it is necessary to isolate the pump from the motor to determine which unit is actually malfunctioning. A worn pump or worn motor will both give the same system indication. Therefore, it is advisable to first run a pressure and flow check on the pump to make sure it is performing within its operating specifications. The following trouble shooting suggestions are based on the assumption that the pump has been flow and pressure checked and has been found within operating specifications.

POSSIBLE TROUBLE	CAUSES	REMEDIES
1. Motor turns while unloaded but slows down or stops when load is applied.	A. Scored back plate.	A. Remove back plate and examine surface condition of flat area; if scored, replace back plate. **Do not lap.**
	B. Scored or worn piston shoes.	B. Disassemble motor, examine condition of shoes on pistons; replace pistons as a complete set if necessary. **Do not lap.**
	C. Low relief valve pressure.	C. Check relief valve for proper pressure setting; adjust or replace relief valve.
2. Motor will not turn.	A. Severely scored back plate.	A. Disassemble motor completely. Inspect all parts, clean all parts, replace all worn parts and flush hydraulic system.
3. Motor free wheels.	A. Oil flow and pressure shut off going to motor.	A. When the hydraulic system is shut off, either by shutting off the engine on a closed loop system or returning the control valve spool to neutral on an open center system, the motor will free wheel after it has leaked off. This is inherent in the design. On a closed loop or propulsion system, the motor will not free wheel as long as charge pressure is maintained to and from the motor.
4. Excessive case drain flow.	A. Excessive internal wear in motor.	A. Disassemble motor, inspect parts and replace as necessary. Case drain flow should not exceed 1.5 GPM at full pressure.

Cessna

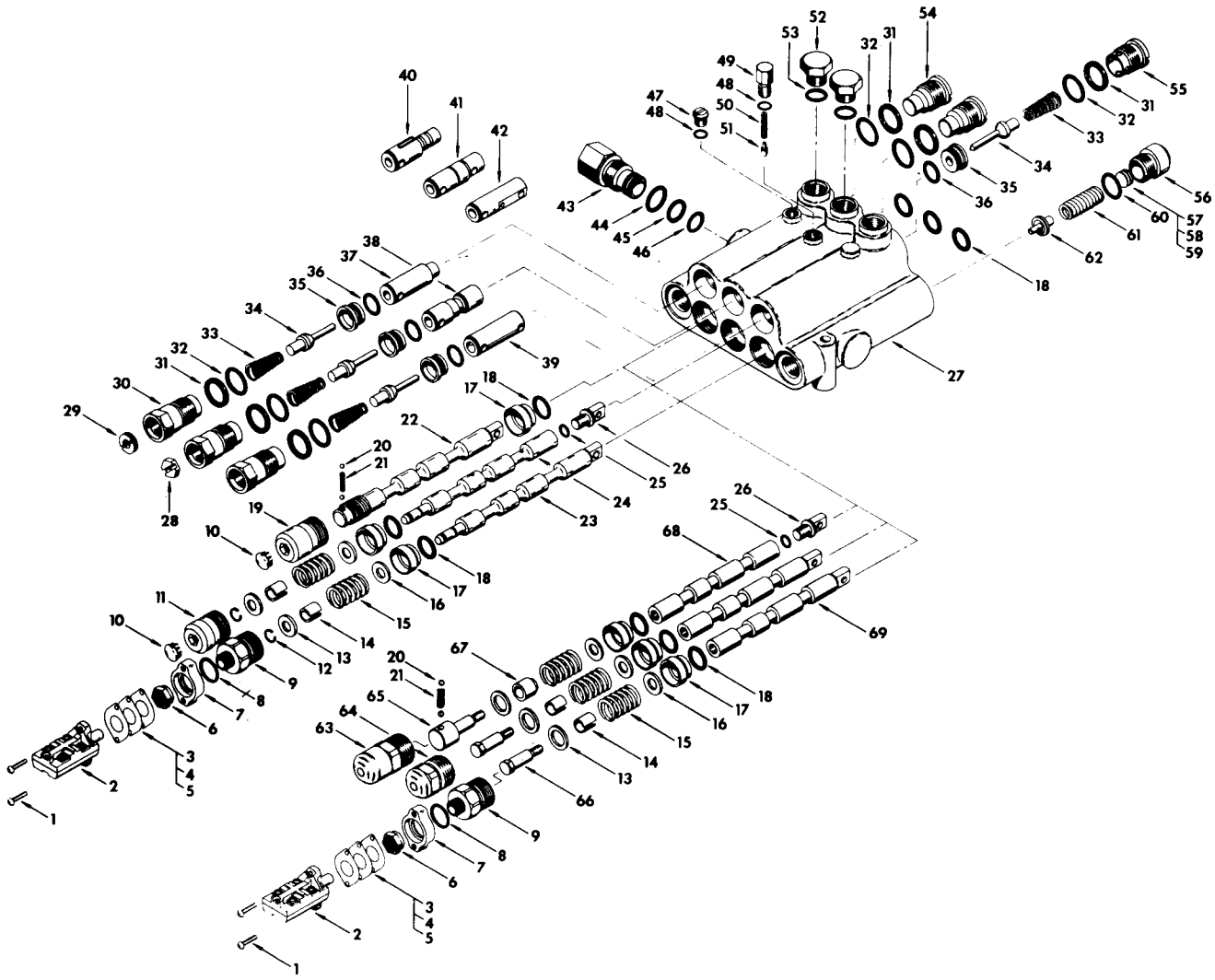
FLUID POWER DIVISION
HUTCHINSON, KANSAS

SERVICE MANUAL



MODEL 31920, 31930
DIRECTIONAL CONTROL VALVE

PARTS IDENTIFICATION



PARTS LIST

REF. NO.	DESCRIPTION
1	Mach. scw. RD rec HD #4-40 × 3/8
2	Micro switch
3	Shim .003 thk. green
4	Shim .005 thk. blue
5	Shim .010 thk. brown
6	Nut
7	Micro switch mounting plate
8	O-ring, 1/16 × 9/16 I.D., 90 Dur.
9	Micro switch base cap
10	Button insert
11	Spool cap
12	Ret. ring, lg. ext. 5/16 closed
13	Washer, misc. stl., .670 O.D. × .065
14	Spacer, spool
15	Spring, spool center
16	Washer, misc. std., .670 O.D. × .046
17	Bushing
18	O-ring, 3/32 × 1/2 I.D.
19	Cap, detent
20	Ball, chrome alloy 5/32 D.
21	Spring, detent
22	Spool, detent

REF. NO.	DESCRIPTION
23	Spool, motor
24	Spool, D.A.
25	O-ring, 1/16 × 7/32 I.D.
26	Clevis, spool
27	Body
28	Orifice plate, unidirectional
29	Orifice plate threaded
30	Plug assembly
31	Back-up washer, 3/32 × 5/8 I.D.
32	O-ring, 3/32 × 5/8 I.D.
33	Spring, lockout
34	Poppet, lockout
35	Seat, lockout
36	O-ring, 1/16 × 1/2 I.D.
37	Plunger, unloading
38	Plunger, detent
39	Plunger, double acting lockout
40	Plunger, special unloading
41	Plunger, circuit relief
42	Plunger, double acting with drain
43	Plug, pressure beyond
44	O-ring, 3/32 × 5/8 I.D.
45	Back-up washer, 1/16 × 1/2 I.D.
46	O-ring, 1/16 × 1/2 I.D.

REF. NO.	DESCRIPTION
47	Plug
48	O-ring, 1/16 × 7/32 I.D. 90 Dur.
49	Plug, plunger detent
50	Spring, detent
51	Plunger, detent
52	Plug
53	O-ring, 5/64 × 15/32
54	Plug, lockout
55	Plug, seat retainer
56	Plug, relief
57	Shims, relief valve .010
58	Shims, relief valve .015
59	Shims, relief valve .035
60	O-ring, 3/32 × 9/16 I.D.
61	Spring, relief valve
62	Poppet, relief valve
	PREVIOUS STYLE
63	Cap, detent
64	Cap, spool
65	Screw, detent
66	Screw, spool
67	Spacer, special spool
68	Spool, detent
69	Spool, motor

INSTRUCTIONS

DISASSEMBLY

1. Plug all ports and clean outside of valve thoroughly.
2. Remove two screws (1) and remove micro switch (2) and shim(s) (3, 4, & 5).
3. Remove nut (6) and micro switch mounting plate (7).
4. Remove o-ring (8) and micro switch base cap (9).
5. Remove button inserts (10) from spool caps (11 & 19).
6. Remove spool caps (11 & 19) with 3/8" allen wrench, being careful not to lose balls (20) and spring (21) from inside detent spool cap (19).
7. Remove spool caps (63 & 64) if the previous style spool caps are used, being careful not to lose balls (20) and spring (21) from inside detent cap (63).
8. Do not remove retaining ring (12) from spools (23 & 24) or spool screws (65 & 66) from spool assemblies (68 & 69) unless spool spring (15) is broken. Washers and spool spring on detent spool assembly (22) cannot be removed.
9. Remove spools (22, 23, & 24) or spools (68 & 69) from valve body (27). NOTE: Spools and spool bores are matched sets. Be sure each spool is identified with the correct body spool bore.
10. Remove bushings (17) and o-rings (18) from spools.
11. Remove clevis (26) and o-ring (25) from spool (24 or 68). (Clevis need not be removed unless spool is leaking.)
12. Remove orifice plates (28 & 29). CAUTION: Check position and location of orifice plates when removed to assure proper assembly.
13. Remove lockout plugs (54), lockout seat retainer plug (55), and port adapter plugs (30) from valve body (27). Remove springs (33), nylon poppets (34), and lockout seats (35).
14. Remove plungers (37, 38, 39, 40, 41 or 42) depending on which styles are used. CAUTION: Check location and positioning of plungers when removing from body to assure proper assembly.
15. Remove relief valve plug (56), shim(s) (57, 58 & 59), spring (61), and poppet (62) from body. NOTE: Do not remove poppet seat. Seat has been set to a predetermined depth and locked in place.
16. Remove o-rings (18) from body spool bores.
17. Remove plugs (47 & 52).
18. Remove detent plunger plug (49), detent spring (50) and detent plunger (51).
19. Remove pressure beyond plug (43).
20. Remove all o-rings and back-up washers from all plugs and seats.

INSPECTION

1. Remove all nicks and burrs from parts and inspect for excessive wear.
2. Inspect all plungers and poppet seats for burrs or roughness.
3. Inspect spool springs (15), relief valve spring (61), lockout springs (33), detent spring (50) and spool spring on valve spool (22) for breakage.
4. If spools have excessive wear, the valve becomes non-serviceable as the spools and spool bores are matched and damaged spools cannot be replaced. A broken spool spring on detent spool assembly (22) results in a non-serviceable valve, as the spring cannot be replaced.
5. Inspect relief valve poppet (62) for breakage or wear.
6. Inspection of o-rings, back-up washers and nylon poppets is not necessary. It is recommended that they be replaced as new parts when the valve is serviced.

SERVICE OF RELIEF VALVE

The pin type relief valve is serviced when disassembly of the valve is accomplished. If a higher or lower system pressure is required, shim(s) (57, 58 & 59) may be added or taken out as needed. The thickness of the shims are .010, .015 and .035.

REASSEMBLY

1. Thoroughly clean and dry all parts. Metal parts should be lightly oiled prior to assembly. NOTE: All o-rings, back-up washers and nylon poppets should be replaced as new items.
2. Position new o-rings (18) in proper grooves in spool bores.
3. Install relief valve components (62, 61, 57, 58 & 59) and new o-ring (60) on plug (56).
4. Install new back-up washers (31) and o-rings (32) on lockout plugs (54), seat retainer plug (55), port adapters (30) and new o-rings (36) on seats (35).
5. Install plungers (37, 38, 39, 40, 41 or 42) depending on which styles are used. NOTE: Check location and positioning of plungers during installation.

REASSEMBLY (Cont.)

6. Install seats (35), poppets (34), springs (33), port adapter plugs (30), lockout seat retainer plugs (55) and lockout plug (54).
7. Install plug (47) with new o-ring (48).
8. Install plugs (52) with new o-rings (53).
9. Install detent plunger (51), detent spring (50) and detent plunger plug (49) with new o-ring (48) and torque to 20-30 in. lbs.
10. Install pressure beyond plug (43) with new o-ring (44), back-up washer (45) and new o-ring (46).
11. If retainer ring (12) has been removed to replace spool spring (15) install washer (16), spacer (14), spring (15), washer (13), and secure with retainer ring (12).
12. If spool screws (65 & 66) have been removed to replace spool spring (15), they should be installed and torqued 5-8 ft. lbs.
13. If clevis (26) had been removed, install with new o-ring (25) in spools (24 or 68).
14. Slide bushings (17) over spools, slide new o-ring (18) over spool and position next to bushing (17.)

    Dip spools in oil and install spool assemblies (23 & 24) or (69) in proper location.
16. Install spring (21) and balls (20) by placing index finger over bottom hole in detent spool (22) or screw (65). Place one ball, then spring and other ball into the hole. with the cap (19 or 63) in the other hand, assemble the two parts with the bottom hole entering the cap first and at the same time sliding index finger away from the hole. Press other ball down with thumb, and slide cap on and back into detent position. Dip detent spool assembly (22 or 68) in oil. Install detent assembly with cap (19 or 63) into proper location in valve body and torque to 20-25 ft. lbs.
17. Install spool caps (11 or 64) into proper location in valve body and torque to 20-25 ft. lbs.
18. Install button inserts (10) in spool caps (11 & 19).
19. Install micro switch base cap (9) and torque to 20-25 ft. lbs.
20. Install new o-ring (8) and micro switch mounting plate (7) and retain with nut (6) and torque to 5-8 ft. lbs.
21. Install micro switch (2), shim(s) (3, 4 & 5) and retain with screws (1). NOTE: Shim micro switch to make contact within .020-.060 spool travel in both directions. Spool travel in both directions must be within .010 at point where the micro switch makes contact. The thickness of the shims are .003 green, .005 blue and .010 brown. To obtain an accurate setting while shimming, a test light and dial indicator are used to check spool travel and micro switch electrical connection. If a dial indicator and test light are not available, shim micro switch until the desired performance of the system is achieved.

TROUBLE SHOOTING

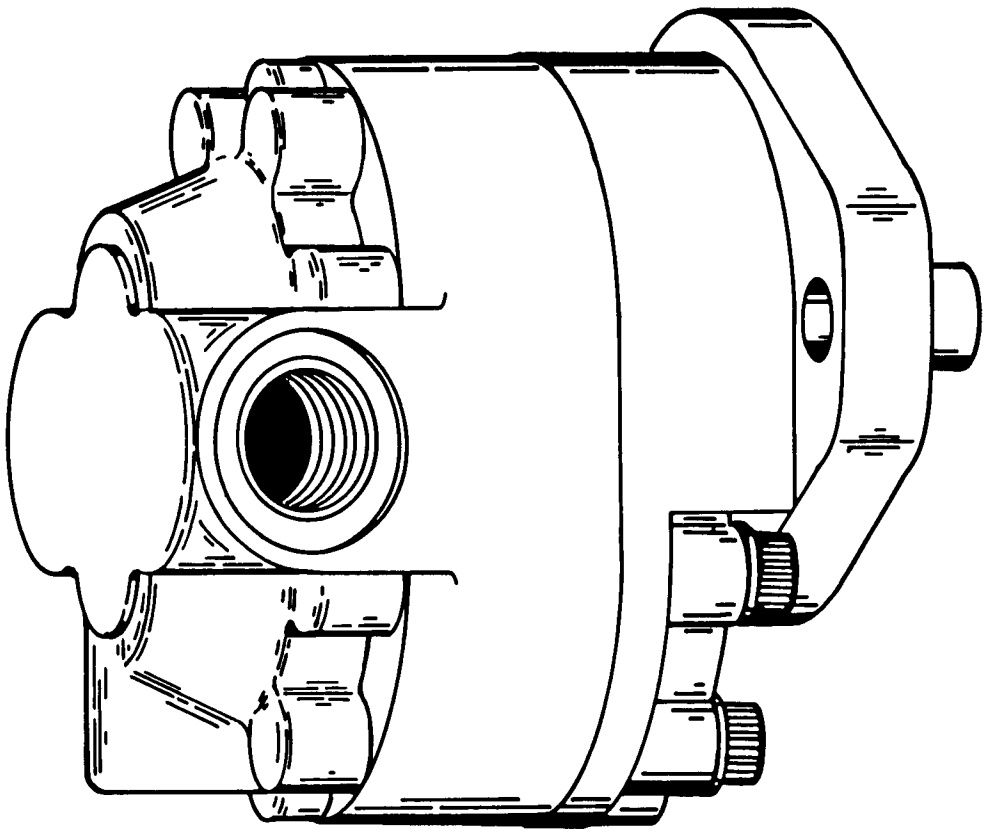
TROUBLE	PROBABLE CAUSE	REMEDY
1. Low system pressure.	A. Worn poppet. B. Weak or broken spring.	A. Replace worn poppet. B. Add shims or replace spring.
2. Sticky valve spool.	A. Misaligned control linkage. B. Foreign matter in spool bore. C. Incorrect mounting bolt torque.	A. Correct alignment. B. Remove spool and clean bore. C. Retorque mounting bolts to 12-15 ft. lbs.
3. External leakage.	A. Damaged o-rings.	A. Disassemble valve and replace o-rings.
4. Load drops with spool in centered position.	A. Damaged cylinder packing. B. Line to cylinder leaking. C. Damaged o-rings on lockout plugs or seats. D. Damaged or worn lockout poppet assembly. E. Broken lockout spring.	A. Replace cylinder packing. B. Tighten fittings or replace line. C. Remove lockout plugs or seat and replace o-rings. D. Replace lockout poppet assembly. E. Replace lockout spring.
5. Electrical function does not operate when spool with micro switch is operated.	A. Damaged micro switch. B. Broken or lose electrical connection. C. Micro switch out of adjustment.	A. Replace micro switch. B. Check all electrical connections. C. Readjust micro switch.

NO. 7-133

Eaton
Hydraulics
Division

Repair Information

Model 21300 Gear Motor—"B1" Series



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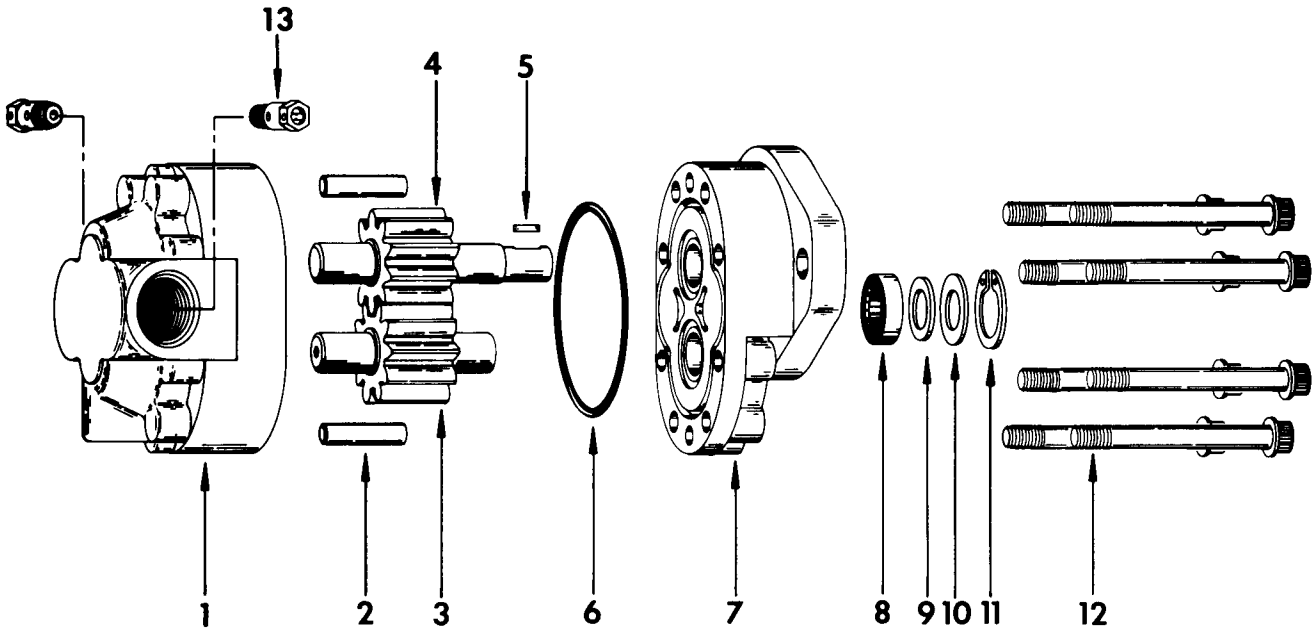

PARTS LIST

REF. NO.	DESCRIPTION	REQ'D. PER ASSY.
1	Housing assembly	1
2	Dowel pin	2
3	Idler gear assembly	1
4	Drive gear assembly	1
5	Key	1
6	O-ring	1
7	Front plate assembly	1
8	Shaft seal	1
9	Back-up washer	1
10	Washer	1
11	Snap ring	1
12	Cap screw	8
13	Check valve assembly	2

DISASSEMBLY

1. Remove key (5) from drive shaft.
2. Clean outside of motor thoroughly. Scribe a line along front plate and housing assembly to assure proper reassembly.
3. Clamp motor in vise, shaft up.
4. Remove eight cap screws (12).
5. Remove motor from vise. Hold motor in hands and bump shaft against wooden block to separate housing assembly (1) from front plate assembly (7).
6. Remove drive gear assembly (4) and idler gear assembly (3).
7. Remove snap ring (11), washer (10), back-up washer (9), shaft seal (8) and o-ring (6) from front plate (7).
8. Remove two check valves (13) from housing assembly (check valves are optional in side porting). Do not disassemble check valves.

INSPECT PARTS FOR WEAR

GENERAL

1. Clean and dry all parts.
2. Remove nicks and burrs from all parts with emery cloth.

GEAR ASSEMBLY

1. Inspect drive gear assembly (4) for broken or cracked keyway.
2. Inspect both the drive gear (4) and idler gear (3) shafts at bearing points for rough surfaces and excessive wear.
3. If shaft measures less than .686 in bearing area, the gear assembly should be replaced. (One gear assembly may be replaced separately.) (Shafts and gears are available as assemblies only.)
4. If gear width is below the following figures, gear assembly should be replaced.

Motor Disp.	.40	.49	.58	.70	.84	1.02	1.24	1.48	1.77
Gear Width	.310	.371	.441	.535	.636	.767	.924	1.107	1.327

5. Inspect gear face for scoring and excessive wear.
6. Snap rings on shaft assemblies should be in groove.
7. If edge of gear teeth are sharp, break edge with emery cloth.

HOUSING AND FRONT PLATE

1. Inspect I.D. of bushings in housing (1) and front plate (7). If I.D. exceeds .693, housing (1) or front plate (7) should be replaced. (Bushings are not available as separate items.)
2. Housing assembly should be replaced if I.D. of gear pocket exceeds 1.719.
3. Check for scoring on face of housing assembly and front plate, if wear exceeds .0015, housing assembly or front plate should be replaced.
4. Visually inspect check valves (13) for broken spring, proper placement of roll pin and to assure that the ball moves freely. If check valves show any of these discrepancies, they should be replaced as new parts.

REASSEMBLY

1. Snap ring (11), washer (10), back-up washer (9), shaft seal (8) and o-ring (6) should be replaced as new parts.
2. Install o-ring (6) in groove of front plate (7).
3. Apply thread sealant on the check valve threads (13) and install check valves (13) into housing assembly (1).
4. Dip gear assemblies (3 and 4) into oil and slip into front plate bushing.
5. Install housing assembly (1) noting position of scribe line. Install cap screws (12), draw up bolts evenly and torque to 22-25 ft. lbs.
6. Oil shaft seal (8) liberally. Work shaft seal (8) over drive shaft taking care not to cut rubber sealing lip.
7. Seat shaft seal (8) by tapping with plastic hammer. Install new back-up washer (9), washer (10) and snap ring (11).
8. Replace key (5) in drive shaft (4).

EATON
REPAIR INFORMATION
GEAR MOTOR
MODEL 21300
NO. 7-133

PLACING MOTOR BACK INTO OPERATION

When placing a rebuilt motor back into operation, it is important to follow the break-in procedure to prevent damaging the motor. If at all possible, run the motor at operating R.P.M. for 10 minutes with the motor disconnected from the machine. If the motor cannot be run without being connected to the machine, make all the necessary connections and run motor at operating R.P.M. for 10 minutes at minimal load. Increase the load on the motor and run for 3 minutes at operating R.P.M. Place full load on motor and run for 3 minutes at operating R.P.M. Idle engine and inspect for external leaks and check to be sure that all connections are tight. NOTE: If dual rotation motor, run in both directions during break in procedure. The motor is now ready to be placed back into service.

TROUBLE SHOOTING

POSSIBLE MOTOR TROUBLE	CAUSES	REMEDIES
1. Erratic motor R.P.M.	a. Oil supply low. b. Oil too heavy. c. Oil filter plugged.	a. Fill reservoir. b. Change to proper viscosity. c. Clean filters.
2. Oil heating	a. Oil supply low. b. Contaminated oil. c. Setting of relief valve too high or too low. d. Oil in system too light.	a. Fill reservoir. b. Drain reservoir and refill with clean oil. c. Set to correct pressure. d. Drain reservoir and refill with proper viscosity oil.
3. Shaft seal leakage.	a. Worn shaft seal. b. Bushings out of position. c. Excessive internal wear.	a. Replace shaft seal. b. and c. If replacing the shaft seal does not stop leakage, the motor should be disassembled and checked for items b., c.
4. Foaming oil.	a. Low oil level. b. Air leaking into suction line of pump. c. Wrong kind of oil.	a. Fill reservoir. b. Tighten fittings. c. Drain and fill reservoir with non-foaming oil.

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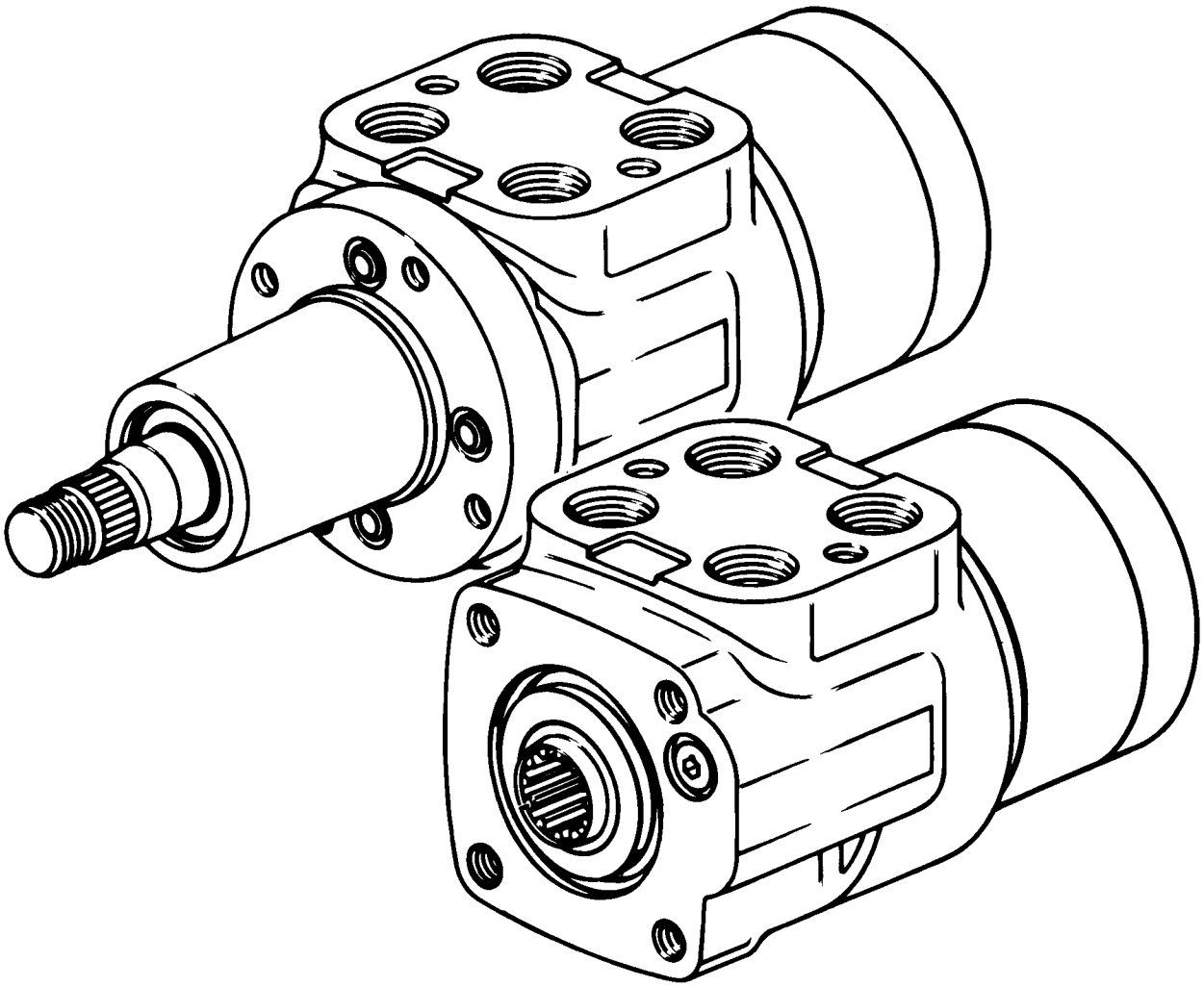
Eaton
Hydraulics
Division

Repair Information

Steering Control Units, Char-Lynn® 001



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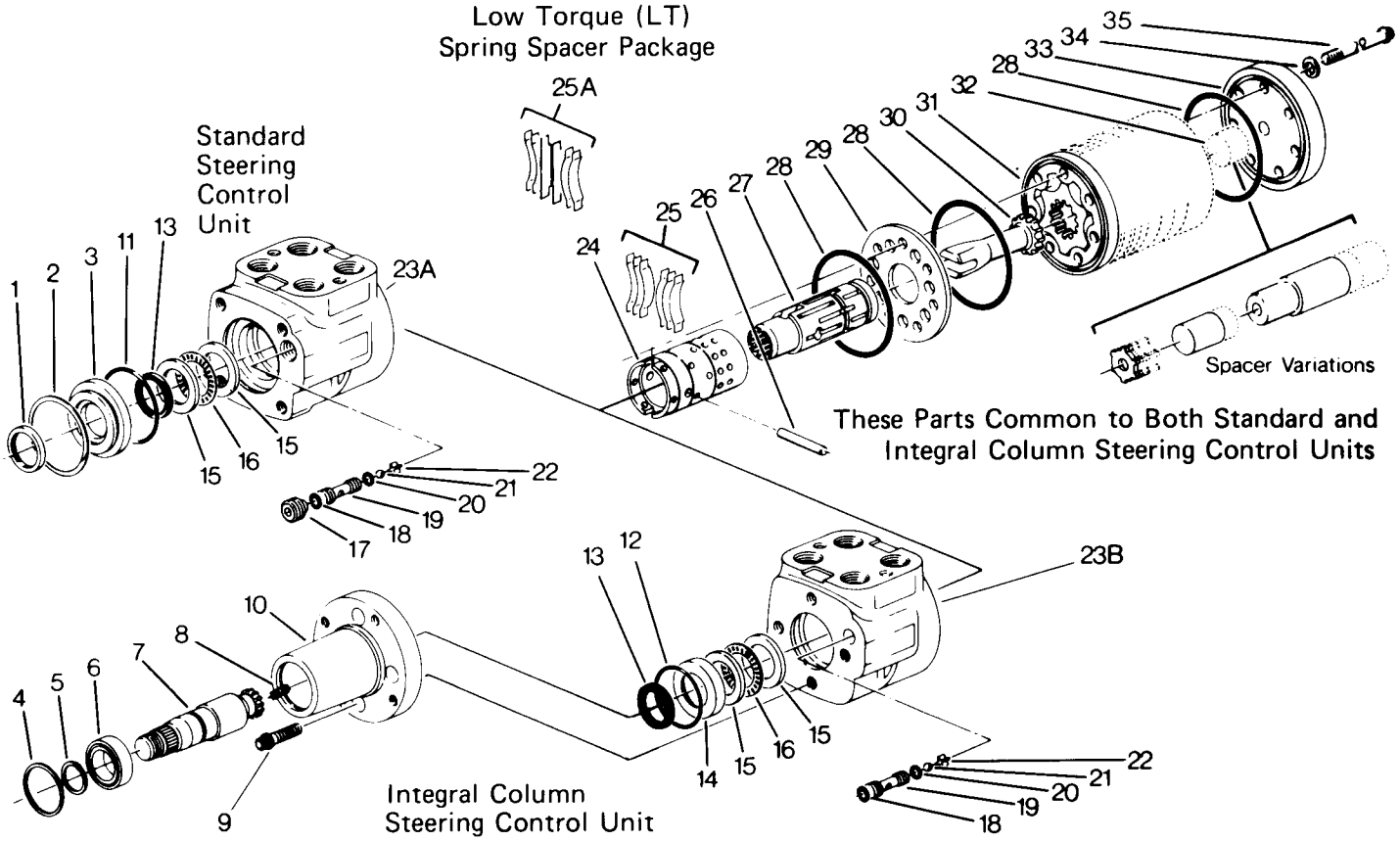
3



1. Dust Seal
2. Retaining Ring
3. Seal Gland Bushing
4. Retaining Ring
5. Retaining Ring
6. Control Column Bearing Ass'y
7. Control Shaft
8. Spring
9. Cap Screw
10. Steering Control Column
11. Seal, 2-1/8"OD
12. Seal, 1-15/16" OD
13. Quad Ring Seal
14. Bearing Locator
15. Bearing Race
16. Needle Thrust Bearing
17. Set Screw
18. Seal, 5/8" OD
19. Check Ball Seat
20. Seal, 7/16" OD
21. Check Ball
22. Check Ball Retainer
23A. Standard Housing
23B. Housing w/integral control column
24. Control Sleeve
25. Centering Springs
25A. Centering Springs and Spacers (LT)
26. Pin
27. Control Spool
28. Seal, 3" OD
29. Spacer Plate
30. Drive
31. Meter (Gerotor)
32. Spacer(s)
33. End Cap
34. Seal Washer
35. Cap Screw

See pages 10 thru 12 for disassembly and reassembly instructions covering the power steering integral control column.

Tools required for disassembly and reassembly.

- Screwdriver (4"–6" long, 1/8" flat blade)
* 5/16" – 12 pt. socket 5422
- Breaker bar wrench
- Torque wrench (275 inch pound capacity)
- Plastic hammer or rubber hammer
- 1/4" Allen wrench
- #10-24 machine screw, 1-1/2" long.
- Needle nose pliers

The following tool isn't necessary for disassembly and reassembly, but is extremely helpful.

*Spring installation tool 600057

* Tools available--by special order--through our service department.

Disassembly

Cleanliness is extremely important when repairing a steering control unit. Work in a clean area. Before disconnecting lines, clean port area of unit thoroughly. Use a wire brush to remove foreign material and debris from around exterior joints of the unit.

Note: Trouble shooting information on pages 13, 14, and 15 defines terms and problems, possible causes for problems, and recommends procedures for correcting problems.

> Although not all drawings show the unit in a vise, we recommend that you keep the unit in the vise during disassembly. Follow the clamping procedures explained throughout the manual.

Meter (Gerotor) End

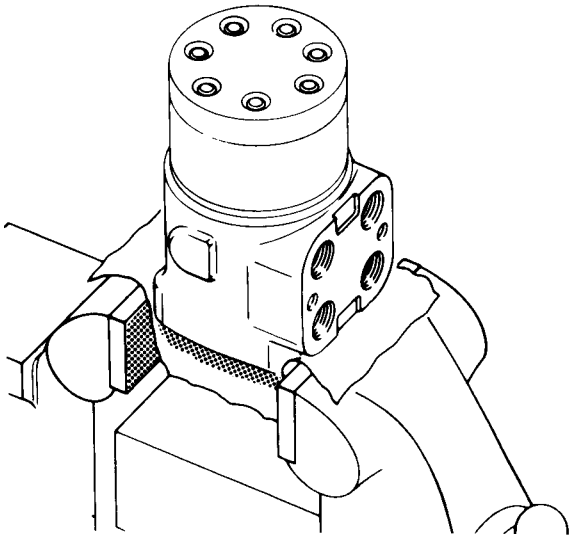


Figure 1

1 Clamp unit in vise, meter end up. Clamp lightly on edges of mounting area, see Fig. 1. Use protective material on vise jaws. Housing distortion could result if jaws are overtightened.

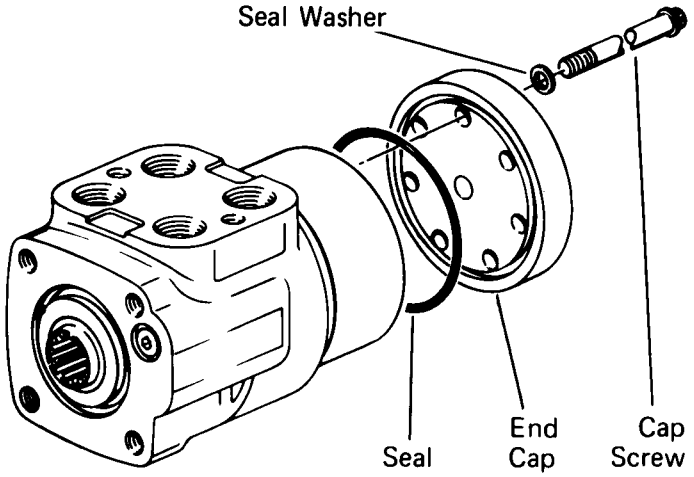


Figure 2

4

2 Remove 5/16" cap screws.

3 Remove end cap.

4 Remove seal from end cap.

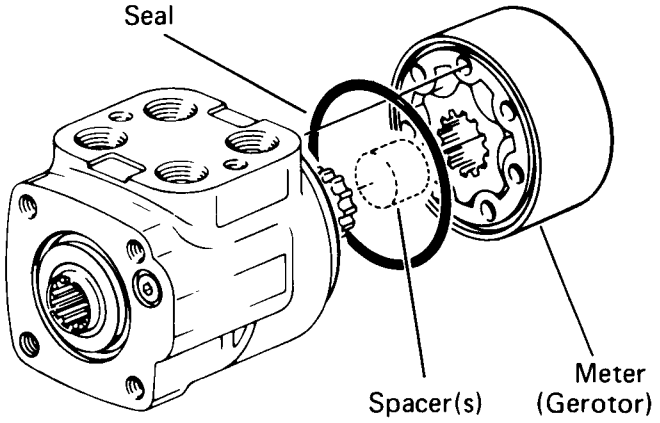


Figure 3

5 Remove meter. Be careful not to drop star.

6 Remove seal from meter.

7 Remove drive spacer(s) (not used on 4.5 cu. in displacement units).

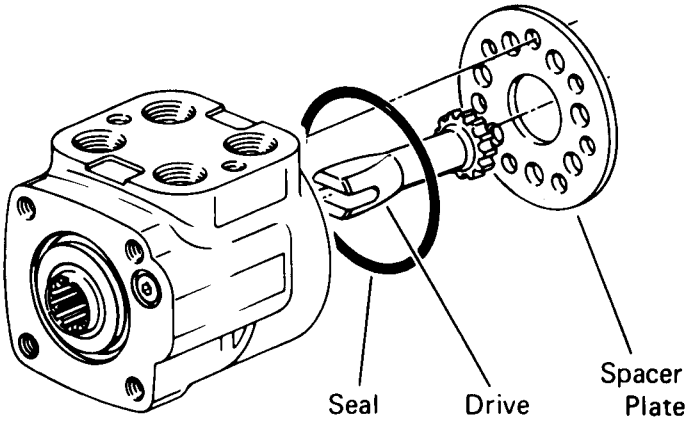


Figure 4

8 Remove drive.

9 Remove spacer plate.

10 Remove seal from housing.

Control End

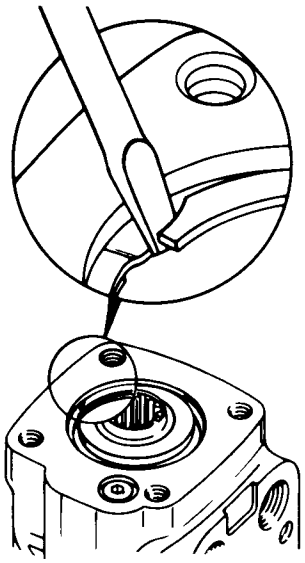


Figure 5

11 Remove housing from vise. Place housing on a clean soft cloth to protect surface finish. Use a thin bladed screwdriver to pry retaining ring from housing, as shown in Fig. 5.

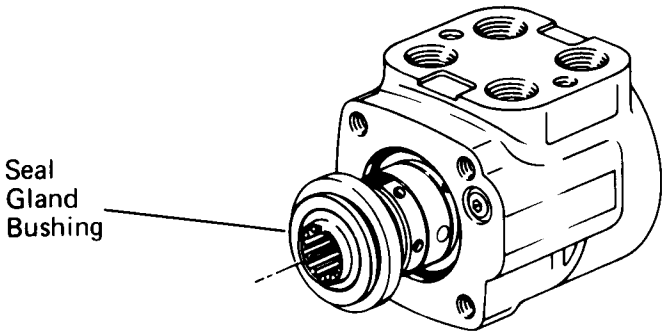


Figure 6

12 Rotate spool and sleeve until pin is horizontal. Push spool and sleeve assembly forward with your thumbs just far enough to free gland bushing from housing, see Fig. 6. Remove bushing

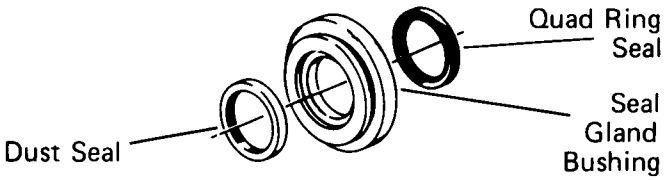


Figure 7

13 Remove quad ring seal from seal gland bushing.

14 Use a thin bladed screwdriver to pry dust seal from seal gland bushing. Do not damage bushing.

Note: If the unit you are repairing is a low input torque steering control unit, see page 12 for disassembly and reassembly procedures.

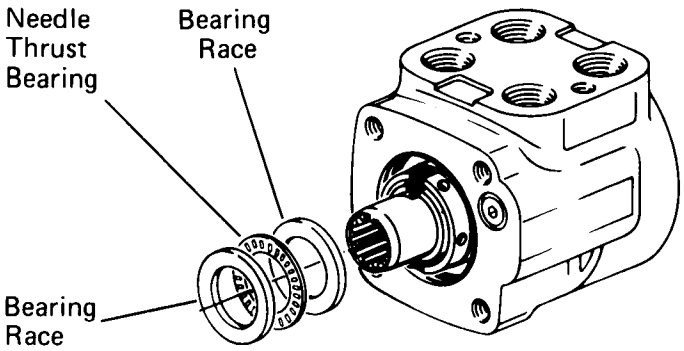


Figure 8

15 Remove 2 bearing races and the needle thrust bearing from spool and sleeve assembly.

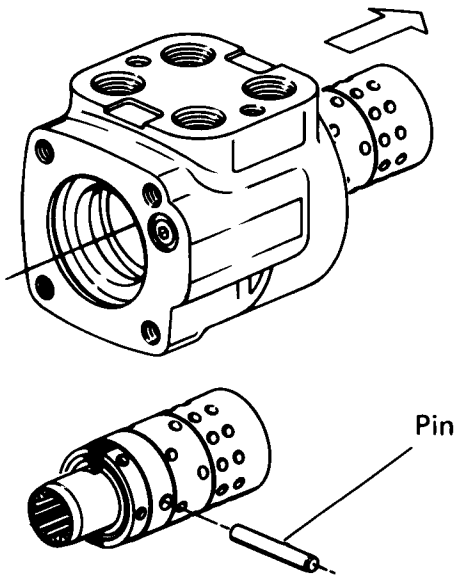


Figure 9

16 Remove spool and sleeve assembly from 14 hole end of housing, see Fig. 9.

Attention: **Do not bind spool and sleeve in housing. Rotate spool and sleeve assembly slowly when removing from housing.**

17 Push pin from spool and sleeve assembly.

Disassembly

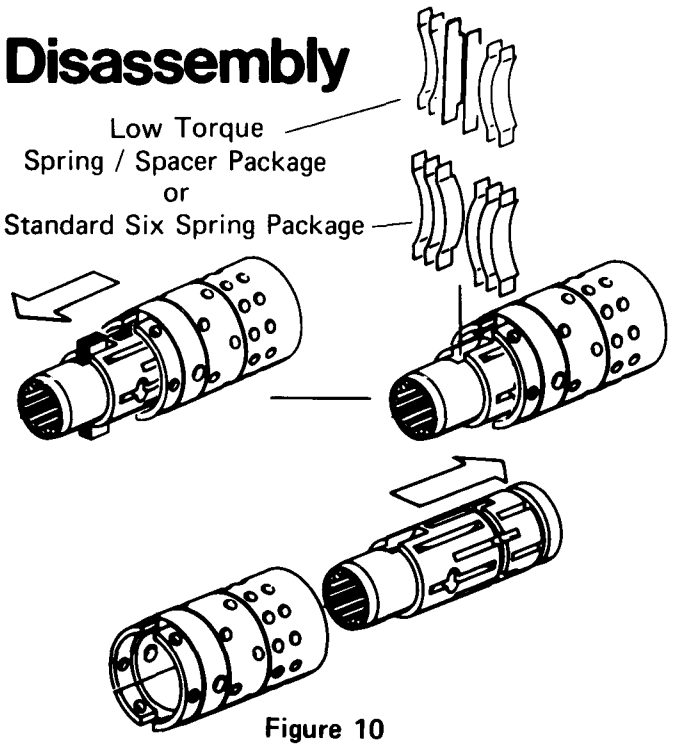


Figure 10

18 Push spool partially from control end of sleeve, then remove 6 centering springs from spool carefully by hand, see Fig. 10.

19 Push spool back through and out of sleeve, see Fig. 10. Rotate spool slowly when removing from sleeve.

20 Remove seal from housing, see Fig. 11.

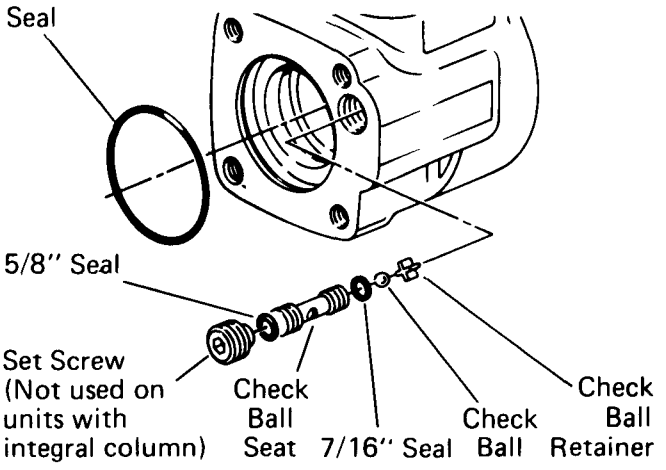


Figure 11

21 Remove set screw (not used on units with integral column) from housing, see Fig. 11.

22 Screw a #10-24 machine screw into end of check ball seat. Then by pulling on screw, with a pliers, lift seat out of housing.

23 Remove 2 seals from check valve seat.

24 Tip housing to remove check ball and check ball retainer.

Reassembly

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 into the hydraulic system and cause damage. Do not use a coarse grit or try to file or grind these parts.

Note: Lubricate all seals with clean petroleum jelly such as Vaseline.

Do not use excessive lubricant on seals for meter section.

Refer to parts listings covering your steering control unit when ordering replacement parts. A good service policy is to replace all old seals with new seals.

Control End

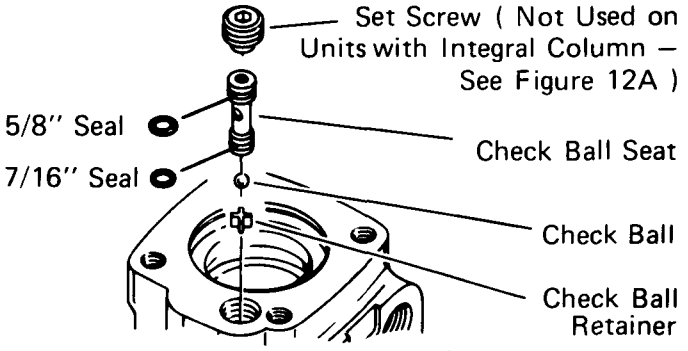


Figure 12 (Standard Steering Control Unit)

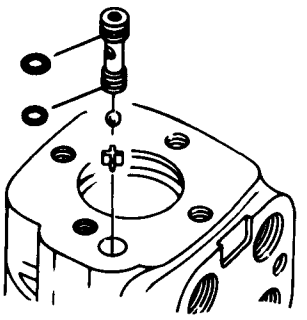


Figure 12A (Integral Column Steering Control Unit)

1 Use a needle nose pliers to lower check ball retainer into check valve hole of housing. Make sure retainer is straight (not tilted on edge) in housing, see Fig. 12.

2 Install check ball in housing.

3 Lubricate 5/8" diameter seal and 7/16" diameter seal. Install seals on check ball seat as shown in Fig. 12.

4 Lubricate check ball seat and seals thoroughly before installing seat in housing. When installing seat do not twist or damage seals. Install check ball seat in housing, insert open end of seat first, see Fig. 12. Push check ball seat to shoulder of hole.

5 Install set screw (not used on units with integral column, see Fig. 12A). Use a 1/4" allen wrench to torque set screw to 100 inch pounds. To prevent interference, make sure top of set screw is slightly below housing mounting surface.

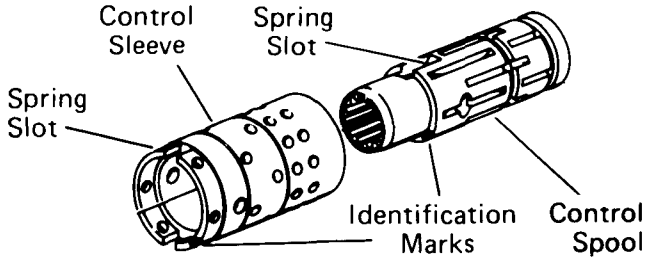


Figure 13

6 Assemble spool and sleeve carefully so that the spring slots line up at the same end. Rotate spool while sliding parts together. Some spool and sleeve sets have identification marks, align these marks as shown in Fig. 13. Test for free rotation. Spool should rotate smoothly in sleeve with finger tip force applied at splined end.

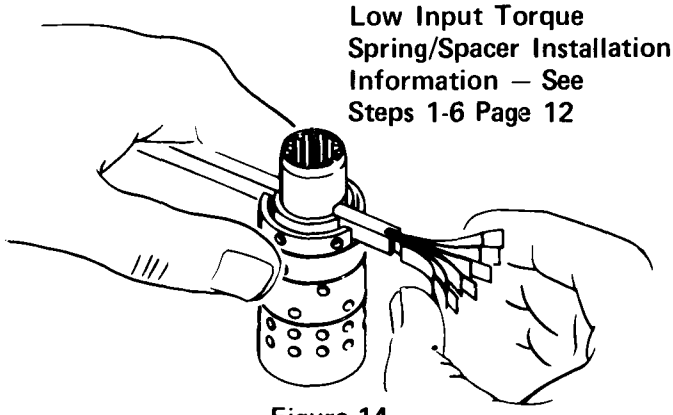


Figure 14

7 Bring spring slots of both parts in line and stand parts on end of bench. Insert spring installation tool through spring slots of both parts. Tool is available as part no. 600057. Position 3 pairs of centering springs (or 2 sets of 3 each) on bench so that extended edge is down and arched center section is together. In this position, insert one end of entire spring set into spring installation tool, as shown in Fig. 14, with spring notches facing sleeve.

8 Compress extended end of centering spring set and push into spool sleeve assembly withdrawing installation tool at the same time.

9 Center the spring set in the parts so that they push down evenly and flush with the upper surface of the spool and sleeve.

10 Install pin through spool and sleeve assembly until pin becomes flush at both sides of sleeve.

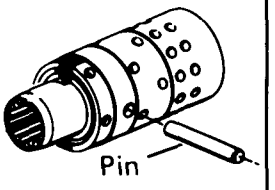


Figure 15

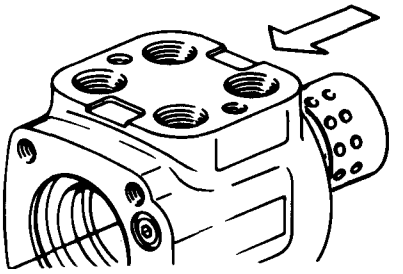


Figure 16

11 Position the spool and sleeve assembly so that the splined end of the spool enters the 14 hole end of housing first, see Fig. 16.

Attention: **Be extremely careful that the parts do not tilt out of position while inserting. Push parts gently into place with slight rotating action, keep pin nearly horizontal. Bring the spool assembly entirely within the housing bore until the parts are flush at the meter end or 14 hole end of housing. Do not pull the spool assembly beyond this point to prevent the cross pin from dropping into the discharge groove of the housing. With the spool assembly in this flush position, check for free rotation within the housing by turning with light finger tip force at the splined end.**

Reassembly

12 Place housing on clean, lint free cloth. Install 2-1/8" diameter seal in housing, see Fig. 17.

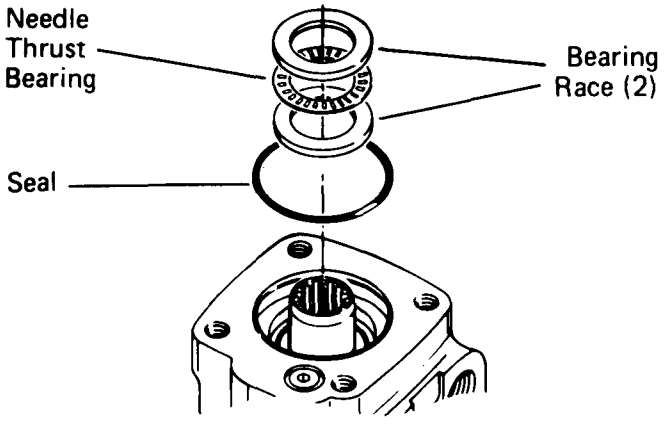


Figure 17

13 Install 2 bearing races and the needle thrust bearing in the order shown in Fig. 17.

14 Install 1-1/4" diameter dust seal in seal gland bushing, flat or smooth side of dust seal must face down towards bushing, see Fig. 19.

15 Install the quad ring seal in seal gland bushing. Smooth seal in place with your finger. Do not use any seal that falls freely into pocket of bushing, see Fig. 19.

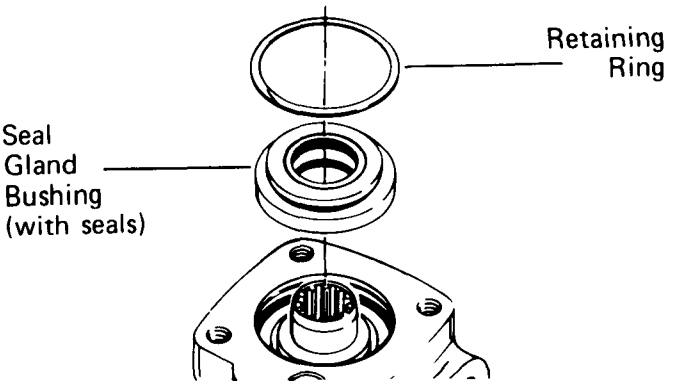


Figure 18

16 Install seal gland bushing over the spool end with a twisting motion. Tap the bushing in place with a rubber hammer. Make sure the bushing is flush against the bearing race.

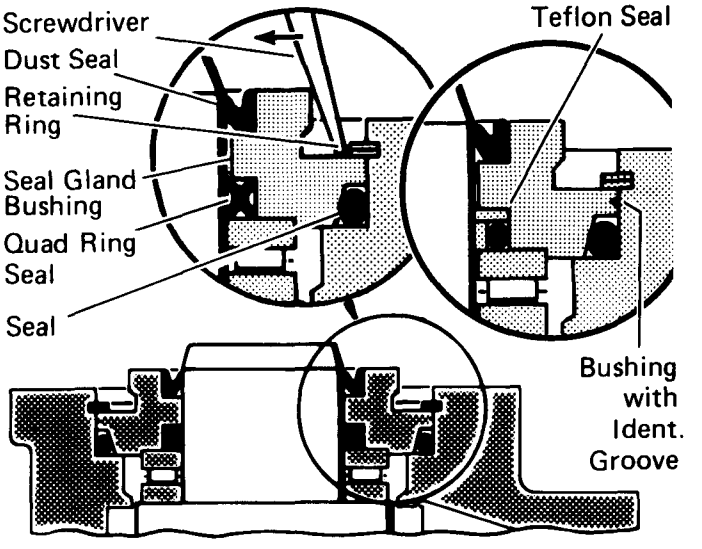


Figure 19

17 Install retaining ring (see Fig. 18-19) in housing. After installing ring, tap on ring end or pry with screwdriver around entire circumference of ring to properly seat ring in groove.

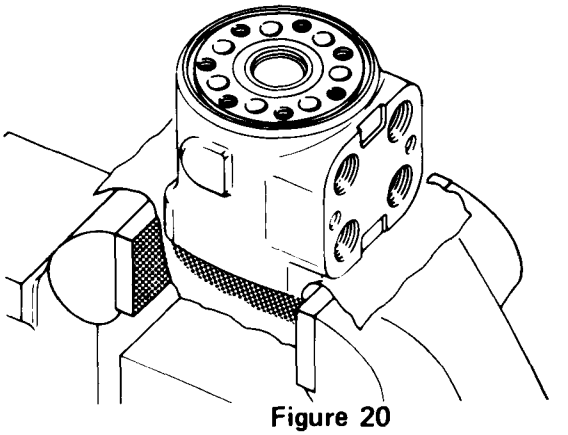


Figure 20

18 Clamp housing in vise, as shown in Fig. 20. Clamp lightly on edges of mounting area. Do not over tighten jaws.

Note: Check to insure that the spool and sleeve are flush or slightly below the 14 hole surface of the housing.

Attention: Clean the upper surface of the housing by wiping with the palm of clean hand. Clean each of the flat surfaces of the meter section parts in a similar way when ready for reassembly. Do not use cloth or paper to clean surfaces.

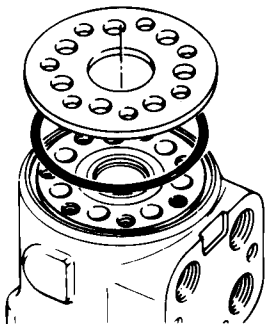


Figure 21

19 Install 3" diameter seal in housing, see Fig. 21.

20 Install spacer plate. Align bolt holes in spacer plate with tapped holes in housing.

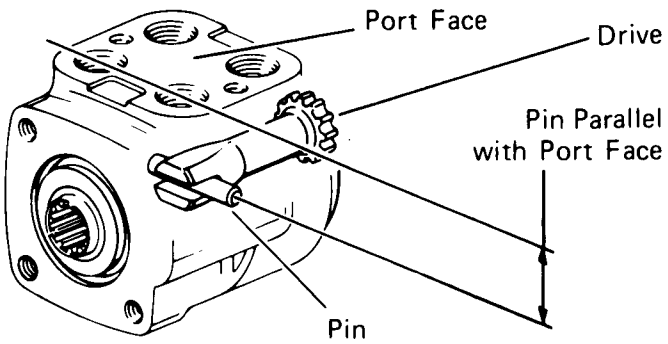


Figure 22

21 Rotate spool and sleeve assembly until pin is parrallel with port face, see Fig. 22. Install drive, make sure you engage drive with pin, To assure proper alignment, mark drive as shown in Fig. 24 (ref. B). Note relationship between slotted end of drive to splined end of drive when marking.

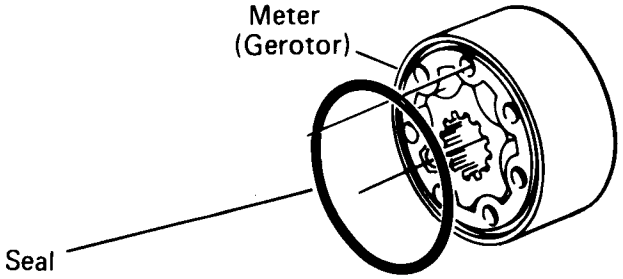


Figure 23

22 Install 3" diameter seal in meter.

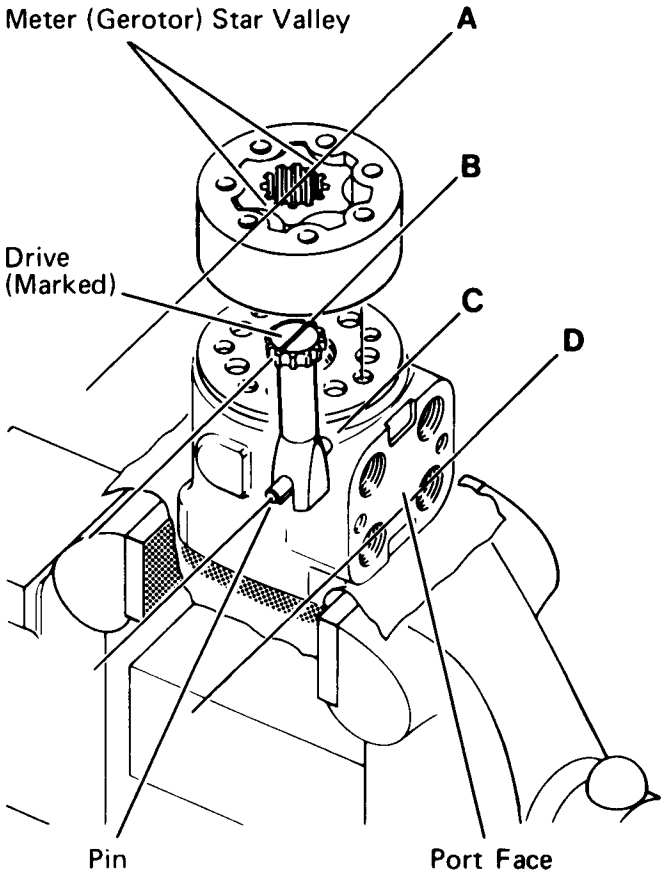
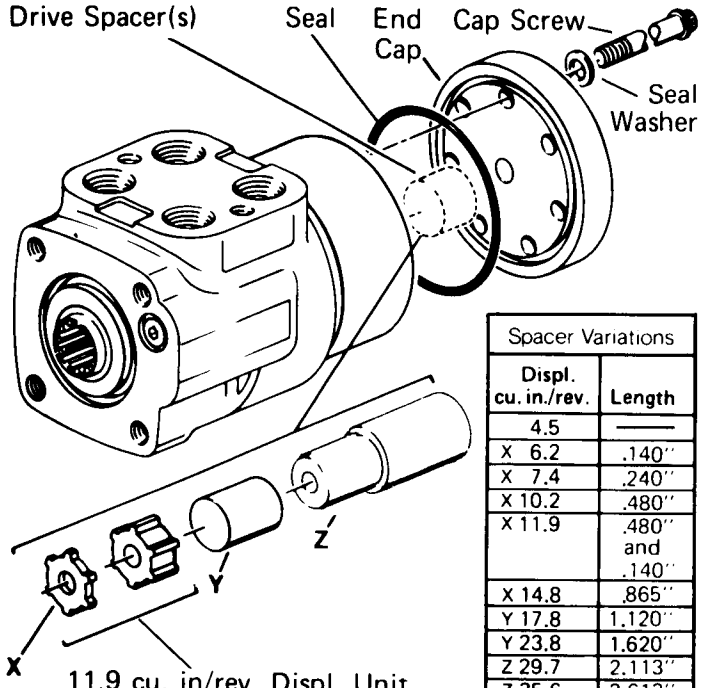


Figure 24

23 With seal side of meter toward spacer plate, align star valleys (ref. A) on drive (ref. B). Note the parallel relationship of reference lines A, B, C, and D– Fig. 24. Align bolt holes without disengaging meter from drive.

Reassembly



Spacer Variations	
Displ. cu. in./rev.	Length
4.5	——
X 6.2	.140"
X 7.4	.240"
X 10.2	.480"
X 11.9	.480" and .140"
X 14.8	.865"
Y 17.8	1.120"
Y 23.8	1.620"
Z 29.7	2.113"
Z 35.6	2.613"
Z 47.5	3.613"

Figure 25

24 Install drive spacer(s) when used, in meter, see Fig. 25.

25 Install 3" diameter seal in end cap.

26 Install end cap on gerotor, align holes.

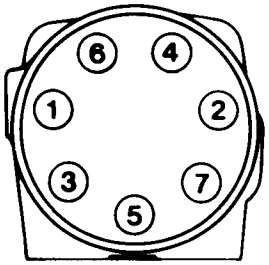


Figure 26

27 Install 7 dry cap screws with new seal washers in end cap. Pretighten screws to 150 inch pounds, then torque screws to 275 inch pounds in sequence shown in Fig. 26.

Disassembly

Disassembly of Integral Column Sub Assembly

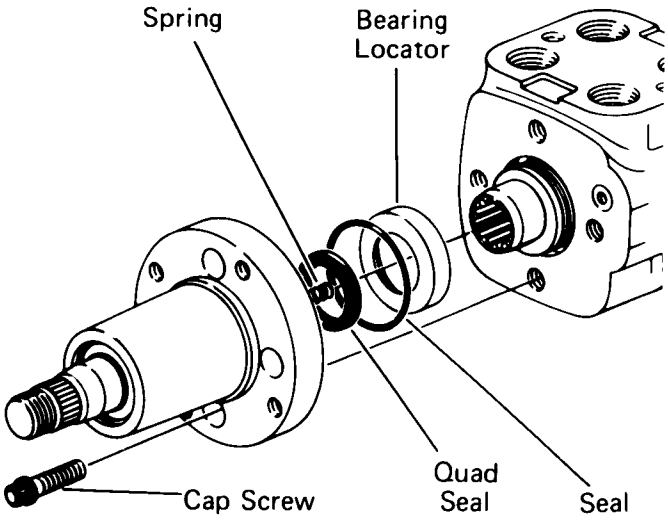


Figure 27

1 Remove 4 cap screws from column.

2 Remove column and spring, see Fig. 27.

3 Remove bearing locator.

4 Remove quad ring seal, and 1-15/16" diameter seal from column.

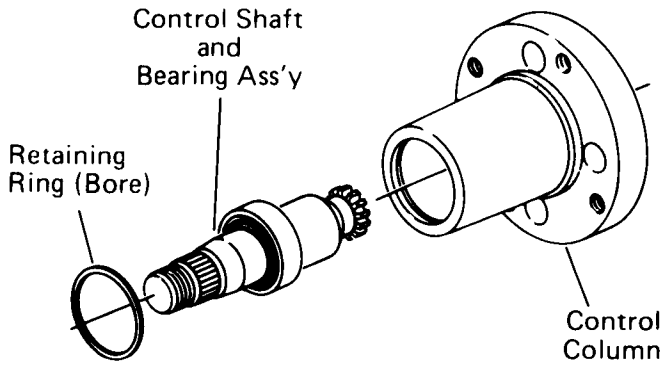


Figure 28

5 Use a thin bladed screwdriver to pry retaining ring from bore of control column.

6 Remove control shaft and bearing assembly from column, see Fig. 28. If tight, tap lightly with a plastic hammer or rubber hammer) on splined end of control shaft until the shaft breaks loose from the column.

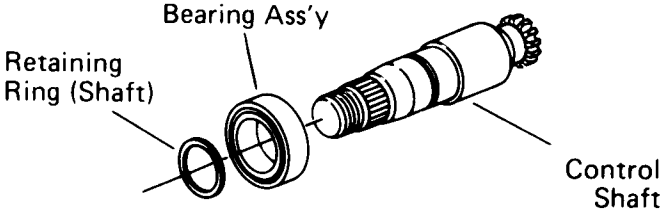


Figure 29

Disassembly

7 Use a thin bladed screwdriver to pry retaining ring from shaft. The retaining ring fits very tight, be careful not to distort it. Remove this ring only if it's necessary to remove bearing assembly from shaft, see Fig. 29.

8 Press bearing assembly from control shaft. Remove bearing assembly from threaded end of shaft, see Fig. 29. Remove this bearing assembly only if necessary.

Reassembly

Reassembly of Integral Column Sub Assembly

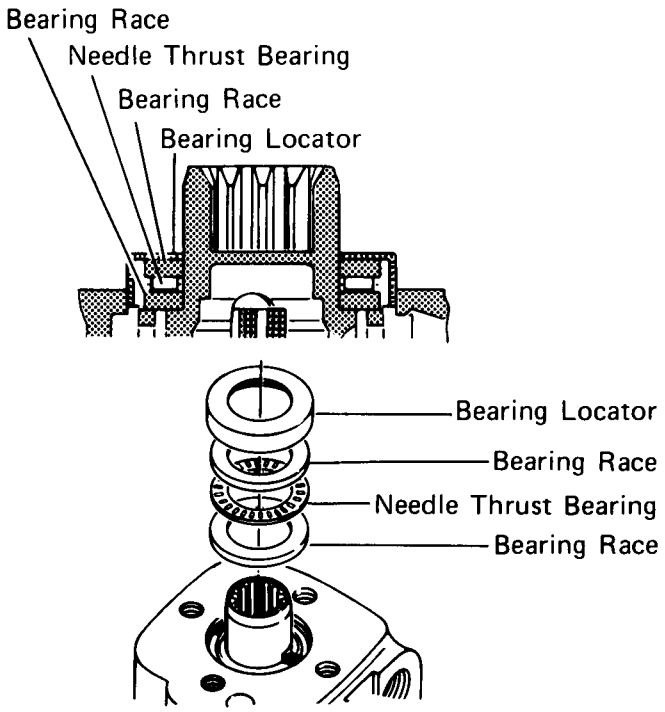


Figure 30

1 Install bearing locator over 2 bearing races and the needle thrust bearing, see Fig. 30. Use a soft plastic hammer or rubber hammer to lightly tap bearing locator in housing.

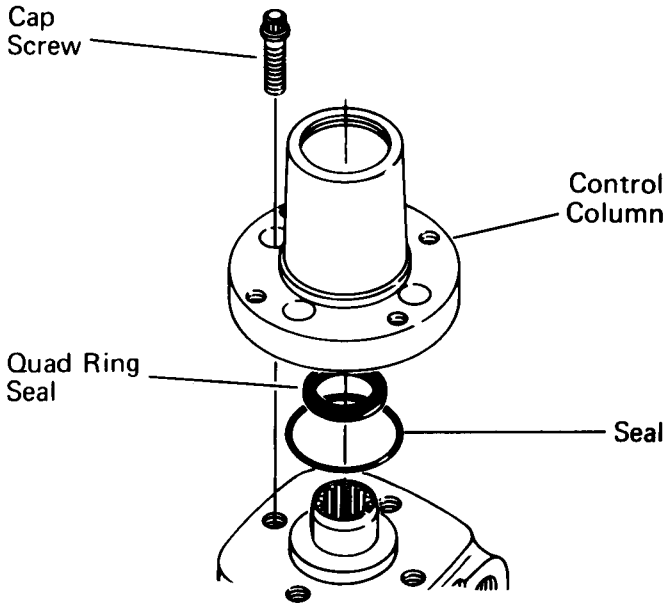


Figure 31

2 Install dry quad ring seal, and lubricated 1-15/16" diameter seal in column, see Fig. 31.

3 Install column on housing. Align bolt holes.

4 Install 4 dry cap screws. Torque screws in a criss-cross pattern to 200 inch pounds.

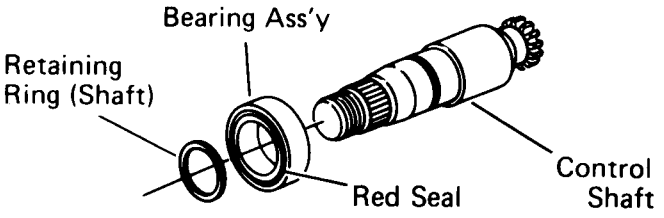


Figure 32

5 Press bearing assembly on control shaft with seal (red) side of bearing assembly facing toward threaded end of shaft. Make sure the bearing assembly seats against shoulder of shaft.

6 Install retaining ring on control shaft, see Fig. 32. Make sure ring seats properly in ring slot above bearing assembly.

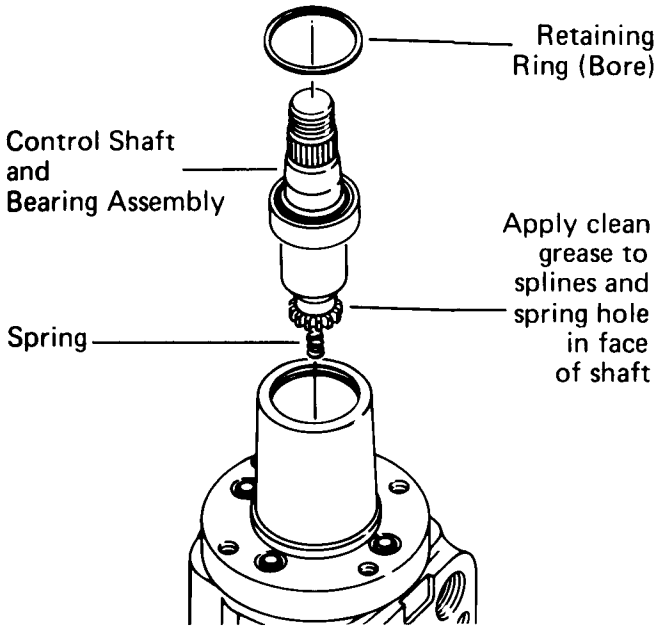


Figure 33

7 Apply clean grease to splines and spring hole located in face of control shaft, see Fig. 33. Install spring in hole. The grease should hold the spring in place until you install control shaft in column.

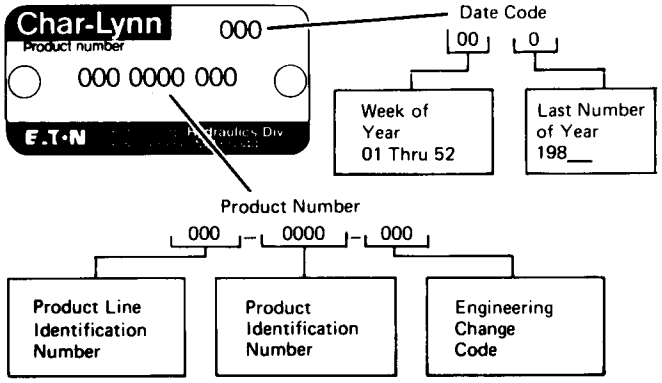
8 Install control shaft and bearing assembly in column (insert splined end of control shaft in column first), see Fig 33. Turn shaft to engage with spool. Push bearing assembly in far enough so you can in stall retaining ring in bore of column.

9 Install retaining ring in bore of column. Make sure you fully seat this retaining ring in ring groove.

How to order replacement parts.

Each order must include the following information:

1. Product Number
2. Date Code
3. Part Name
4. Part Number
5. Quantity of Parts



Low Input Torque Steering Control Unit

1 After disassembling steering control unit, discard quad-ring seal, seal gland bushing and two centering springs. Seal gland bushings for Teflon seal and quad-ring seal are not interchangeable.

2 Low torque steering control unit has one pair of spring spacers and two pairs of centering springs. Install spring spacers between two sets of centering springs. The installation procedure is the same as that used on the standard units.

3 Install Teflon seal, o-ring and back-up ring on the spool, see Figure X.

Note: Apply a light coat of hydraulic oil to all seals before installation.

4 Install dust seal in seal gland bushing, flat or smooth side down. This bushing has identification groove in outer diameter. Non-grooved bushing cannot be used with Teflon seal.

5 Install seal gland bushing over spool end with a twisting motion. Tap bushing in place with a rubber hammer. Make sure bushing is flush against bearing race.

6 Install retaining ring (see Figure X) in housing. After installing ring , tap on ring end or pry with screwdriver around entire circumference of ring to properly seat ring in groove.

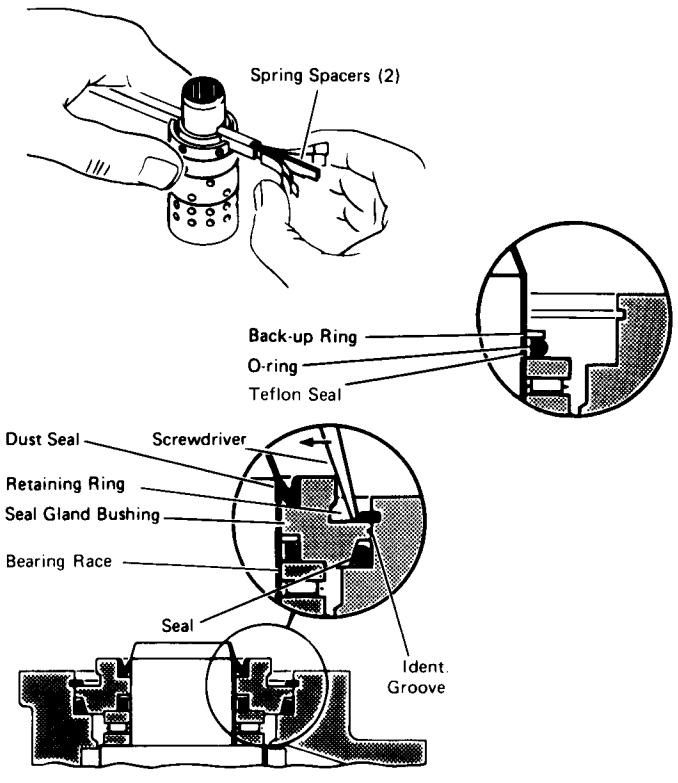


Figure X

13 Trouble Shooting

Most steering problems can be corrected if the problem is properly defined. The entire steering system should be evaluated before removing any components. The steering control unit is generally not the cause of most steering problems. The following is a list of steering problems along with possible causes and suggested corrections.

Problem	Possible Cause	Correction
1. Slow steering, hard steering, or loss of power assist.	Worn or malfunctioning pump.	Replace pump.
	Stuck flow divider piston.	Replace flow divider.
	Worn pump compensator allowing the system pressure to be less than specified.	Replace pump and compensator.
	Malfunctioning relief valve allowing the system pressure to be less than specified.	Replace the relief valve.
	Overloaded steer axle.	Reduce load.
	If load sensing system 1. Leaking or kinked load sensing signal line. 2. Malfunctioning priority valve.	Correct Check spring and sticking spool. Check damping orifices in both ends of main bore for debris. Check system pressure at SCU inlet for proper system pressure. If not correct replace priority valve relief cartridge.
2. Wander—Tendency of vehicle path to deviate from course defined by operator input.	Air in the system due to low level of oil, cavitating pump, leaky fitting, pinched hose, etc.	Correct condition and add fluid.
	Worn mechanical linkage.	Repair or replace.
	Bending of linkage or cylinder rod.	Repair or replace.
	Loose cylinder piston.	Repair or replace.
	Leaky crossover relief or anti-cavitation valve in cylinder lines.	Repair or replace the accessory valve.
	Severe wear in steering control unit.	Replace the steering control unit.
3. Drift—Diviation of vehicle path, without operator input, from normally expected continuing course.	Single rod end cylinder slowly extends without turning the steering wheel.	A small rate of extension may be normal on a closed center system.
	Worn or damaged steering linkage.	Replace linkage and align front end.
4. Slip—A slow movement of steering wheel fails to cause any movement of steered wheels.	Leakage of cylinder piston seals or accessory valve between cylinder lines or ports.	Replace seals or accessory valve.
	Worn steering control unit meter.	Replace steering control unit.
5. Temporary hard steering or hang-up—A momentary increase in steering wheel torque during steering reversal or initial input.	Thermal Shock*	Check unit for proper operation and cause of thermal shock.

*Thermal shock definition bottom of page 14.

Trouble Shooting 14

Problem	Possible Cause	Correction
6. Erratic steering.	Air in system due to low level of oil, cavitating pump, leaky fitting, pinched hose, etc.	Correct condition and add fluid.
	Loose cylinder piston.	Replace cylinder.
	*Thermal shock damage.	Replace steering control unit.
	Sticking flow control spool.	Replace flow control valve.
7. "Spongy" or soft steering.	Air in hydraulic system. Most likely air trapped in cylinders or lines.	Bleed air out of system. Placing ports on top of the cylinder will help prevent air trapping.
	Low fluid level.	Add fluid and check for leaks.
8. Free Wheeling—Steering wheel turns freely with no feeling of of pressure and no action on steered wheels.	Steering column upper shaft is loose or damaged.	Tighten steering wheel nut.
	Lower splines of column may be disengaged or broken.	Repair or replace column.
	Steering control unit meter has a lack of oil. This can happen on start-up, after repair, or long periods of non use.	Usually starting engine will cure problem.
	No flow to steering unit can be caused by: 1. Low fluid level. 2. Ruptured hose. 3. Internal steering control unit damage due to thermal shock*.	 Add fluid and check for leaks. Replace hose. Replace the unit.
9. Free Wheeling—Steering wheel turns with slight resistance but results in little or no steered wheel action.	Leaking crossover relief or anti-cavitation valve in cylinder lines.	Repair or replace the accessory valve.
	Piston seal blown out.	Determine cause. Correct and replace seal.
10. Excessive free play at steering wheel.	Loose steering wheel nut. Steering column shaft worn or damaged. There should be very little free play in the unit itself.	Repair or replace steering wheel connection or column.
11. Excessive free play at steered wheels.	Broken or worn linkage between cylinder and steered wheels.	Check for loose fitting bearings and anchor points in steering linkage between cylinder and steered wheels.
	Leaky cylinder seals.	Replace cylinder seals.

*Thermal shock—A condition caused when the hydraulic system is operated for some time without turning the steering wheel so that fluid in the reservoir and system is hot and the steering control unit is relatively cool (more than 50° F temperature differential). When the steering wheel is turned quickly the result is temporary seizure and possible damage to internal parts of the steering control unit. The temperary seizure may be followed by total free wheeling. This applies to closed center and load sensing units only.

Problem	Possible Cause	Correction
12. Binding or poor centering of steering wheel.	Binding or misalignment in steering column or splined input connection.	Align column pilot and spline to steering control unit.
	High back pressure in tank line can cause slow return to center. Should not exceed 300 psi.	Revise circuit return line.
	Large particles can cause binding between the spool and sleeve.	Clean the unit and filter the oil. If another component has failed generating contaminents, flush the system while bypassing the steering control unit.
13. Steering unit locks up.	Large particles in meter section.	Clean the unit.
	Insufficient hydraulic power (units over 15 cu. in./rev.)	Check hydraulic power supply.
	Severe wear and/or broken pin.	Replace the unit.
	*Thermal shock.	Replace the unit.
14. Steering wheel oscillates or turns by itself, either side of neutral, after operator has removed input.	Parts assembled wrong. Steering unit improperly timed.	Correct timing.
	Lines connected to wrong ports.	Reconnect lines correctly.
15. Steered wheels turn in wrong direction when operator activates steering wheel	Lines connected to wrong cylinder ports.	Reconnect lines correctly.
16. Kick—Momentary kick back of steering wheel at start of steering.	No inlet check valve on steering control unit.	Install a check valve.
17. Instability—Fluid-born oscillation.	Air in lines	Check pump inlet. Bleed sensing lines.
	Harmonic system	Add hose or an accumulator.
	Plumbing	Bleed all lines. Pilot lines should be tubing. lines to cylinder should be tubing. If 2 pilot lines are used go to 1.
	Relief Setting	Pump relief should be 300 PSI above priority relief.
	Priority Valve	Bleed by holding against stop for 30 seconds on models w/built in relief only.
		Decrease damping orifice by adding small wire.
		Increase spring rate (this will raise the standby pressure).
	Load Sensing Pump	Compensator sticky. Increase standby pressure.

*Thermal shock definition bottom of page 14.

Selection Data

3 Series

System	Load Circuit	Rated Flow ★ GPM [LPM]	Port Size	External Configuration	Product Number						
					Displacement-cu. in. rev. [cu. cm. rev.]						
					4.5 [75]	6.2 [100]	7.4 [120]	10.2 [165]	11.9 [195]	14.8 [240]	17.8 [290]
Open Center	Non-Load Reaction	2-4 [7,5-15]	9/16-18	Standard	211-1001	211-1002	211-1003	-	-	-	-
				Integral Column	211-1004	211-1005	211-1006	-	-	-	-
Closed Center	Non-Load Reaction	2-4 [7,5-15]	9/16-18	Standard	212-1009	212-1010	212-1011	212-1012	-	-	-
	Load Reaction	2-4 [7,5-15]	9/16-18	Standard	212-1021	212-1022	212-1023	212-1024	-	-	-
				Integral Column	212-1025	212-1026	212-1027	212-1028	-	-	-

6 Series

					Displacement-cu. in. rev. [cu. cm. rev.]						
					4.5 [75]	6.2 [100]	7.4 [120]	10.2 [165]	11.9 [195]	14.8 [240]	17.8 [290]
Open Center	Non-Load Reaction	4-8 [15-30]	3/4-16	Standard	211-1007	211-1008	211-1009	211-1010	211-1011	211-1012	211-1013
				Integral Column	211-1014	211-1015	211-1016	211-1017	211-1018	211-1019	211-1020
	Load Reaction	4-8 [15-30]	3/4-16	Standard	211-1047	211-1048	211-1049	211-1050	211-1051	211-1052	211-1053
Closed Center	Non-Load Reaction	12 [45]	3/4-16	Standard	212-1001	212-1002	212-1003	212-1004	212-1005	212-1006	212-1007
	Load Reaction	8 [30]	3/4-16	Standard	-	-	-	212-1018	212-1019	212-1020	
Load Sensing	Non-Load Reaction	6 [23]	3/4-16	Standard	213-1001	213-1002	213-1003	213-1004	213-1005	213-1006	213-1007

12 Series

					Displacement-cu. in. rev. [cu. cm. rev.]						
					17.8 [290]	23.8 [390]	29.7 [490]	35.6 [585]	47.5 [780]		
Open Center	Non-Load Reaction	8-16 [30-60]	3/4-16	Standard	211-1037	211-1038	211-1039	211-1040	211-1041	-	-
				Integral Column	211-1042	211-1043	211-1044	211-1045	211-1046	-	-
Closed Center	Non-Load Reaction	16 [60]	3/4-16	Standard	-	212-1014	212-1015	212-1016	212-1017	-	-
Load Sensing	Non-Load Reaction	12 [45]	3/4-16	Standard	213-1012	213-1013	213-1014	213-1015	213-1016	-	-

Other combinations of the above standard features available on special order—consult factory

★For closed center unit, rated flow is measured at 1000 PSI pressure drop at full valve deflection.
For load sensing unit, rated flow is designed for 65 PSI pressure drop between inlet (P) and load sensing (LS) port at full valve deflection.

Eaton Corporation **Hydraulics Division** 15151 Highway 5 Eden Prairie. MN 55344 Telephone (612) 937-9800

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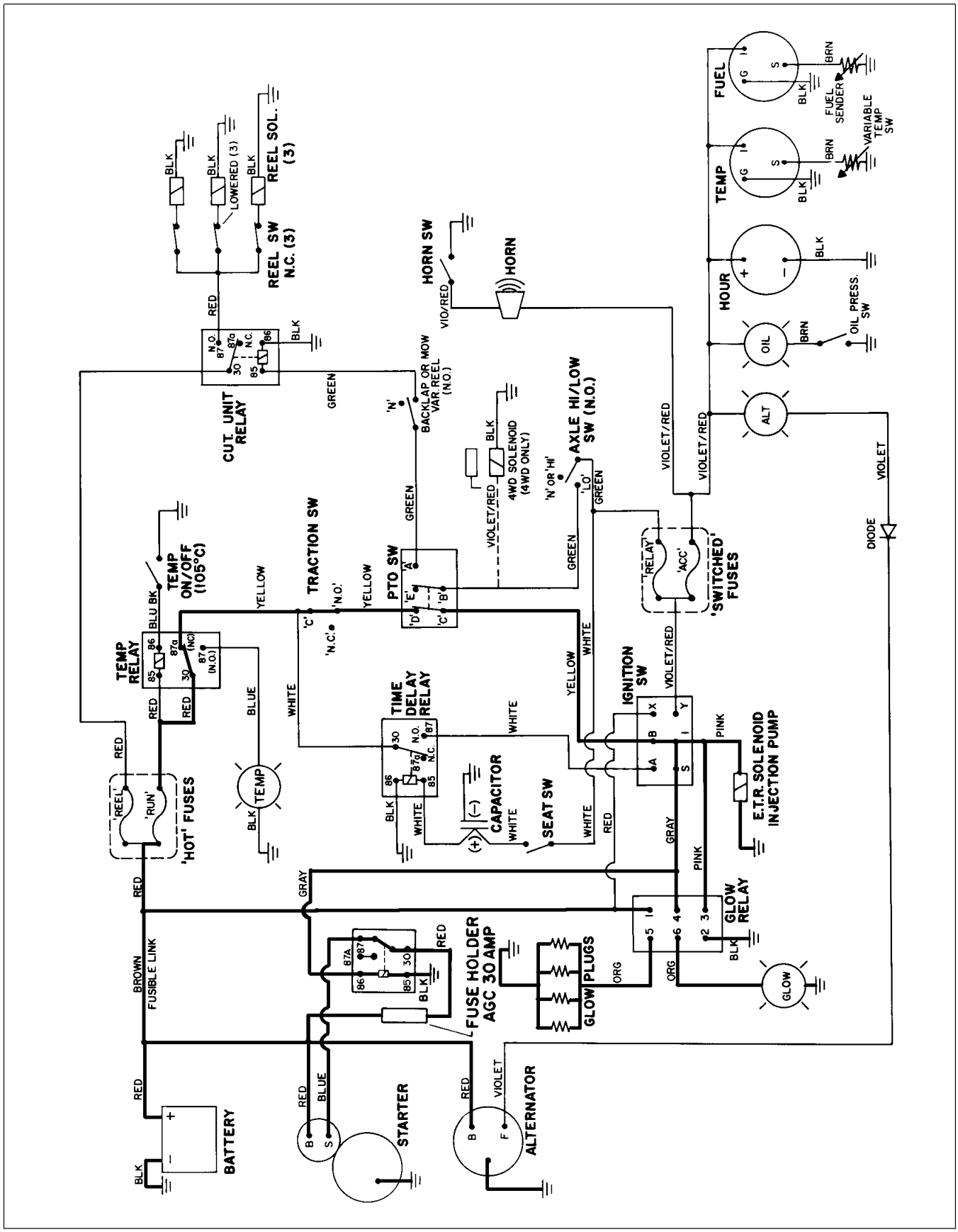
Chapter 5

Electrical System

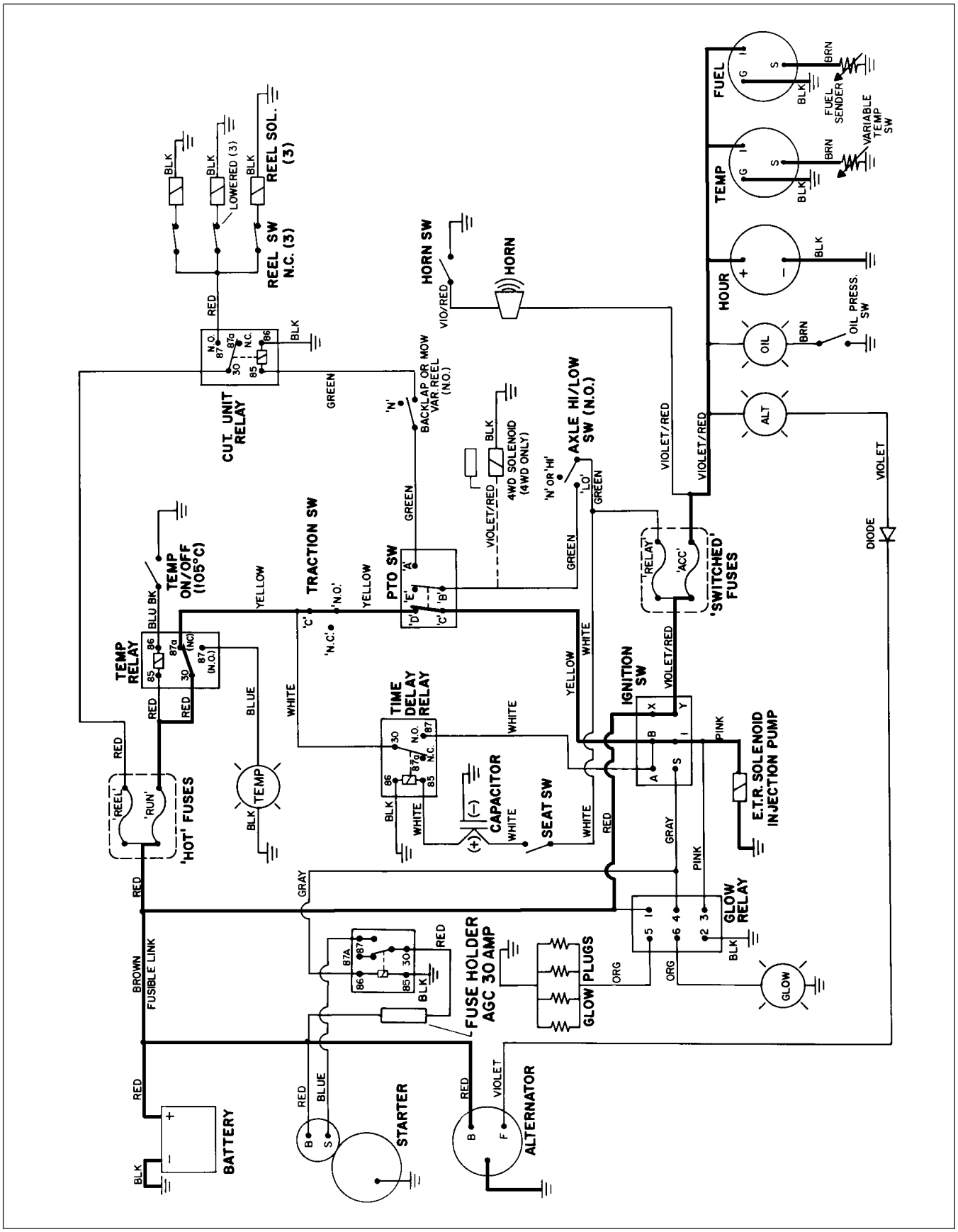
Table of Contents

Wiring Schematics

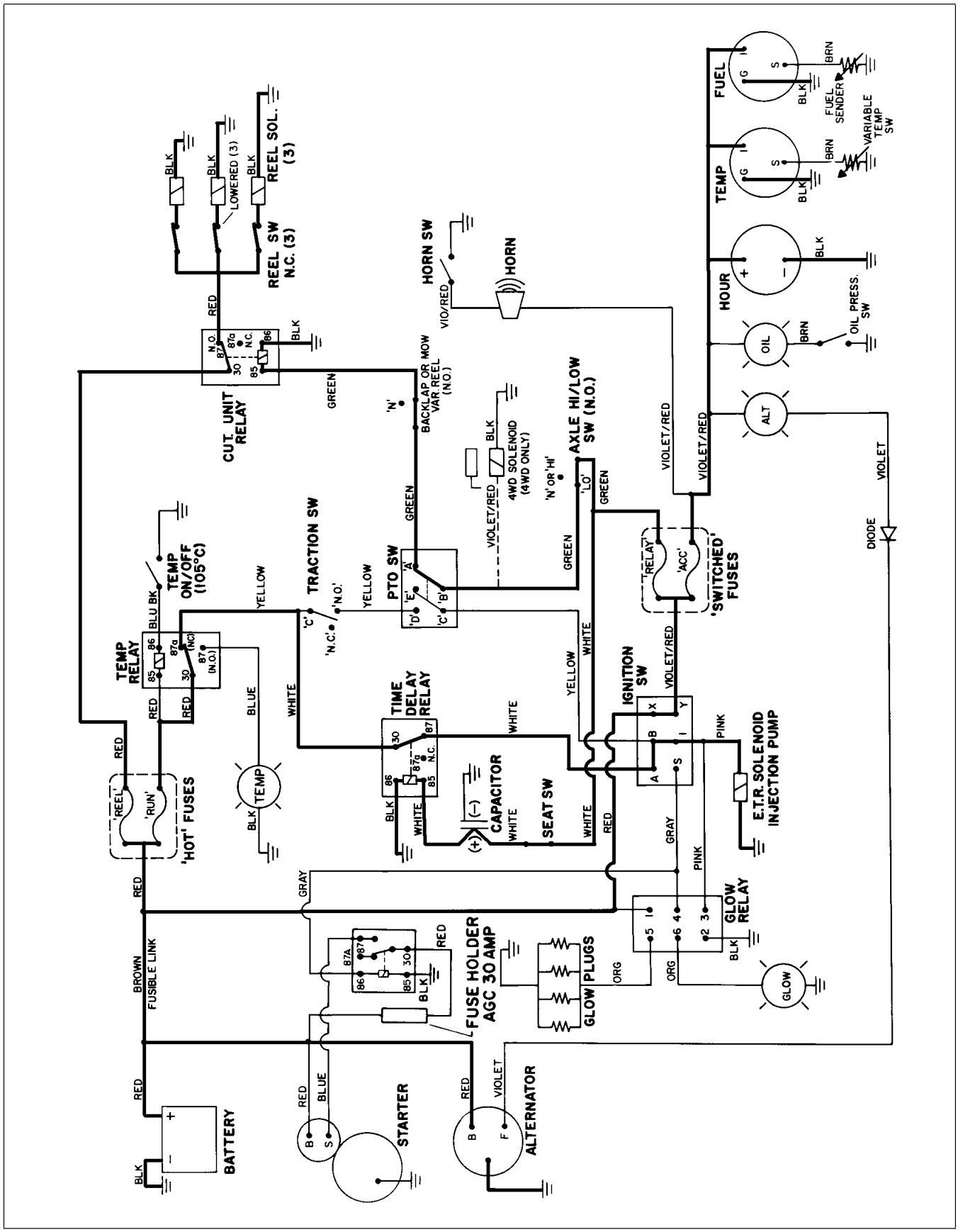
Engine Crank and Start Circuit



Engine Run Circuit



Engine Run and Mow Circuits



Special Tools

NOTE: Order special tools from the *TORO SPECIAL TOOLS AND APPLICATIONS GUIDE (COMMERCIAL PRODUCTS)*. Some tools may be available from a local supplier.

Continuity Tester

Battery powered test lamp which is helpful in testing for continuity of circuits and electrical components when the current is off.

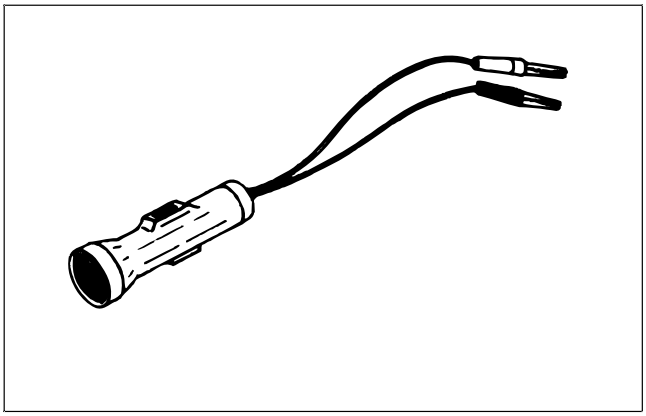


Figure 1

Volt - Ohm - Amp Meter

The meter can test electrical components and circuits for current, resistance, or voltage draw.

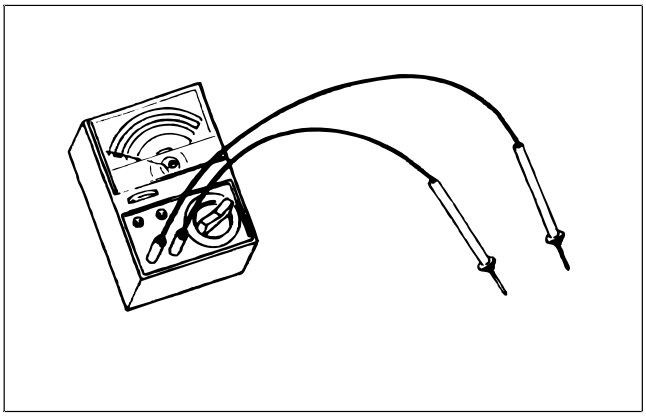


Figure 2

Skin-Over Grease

Special non-conductive grease which forms a light protective skin to help waterproof electrical switches and contacts.

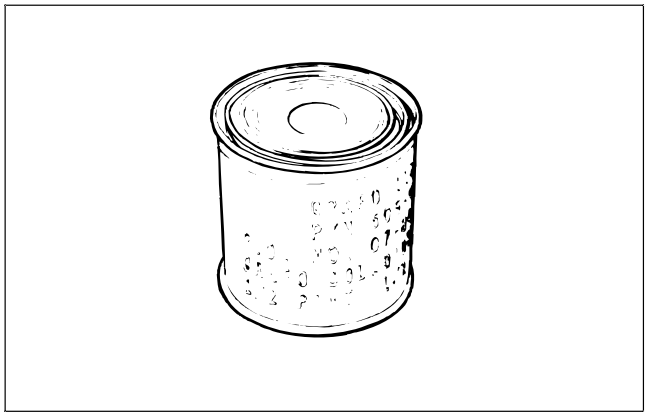


Figure 3

Troubleshooting

CAUTION

Remove all jewelry, especially rings and watches, before doing any electrical troubleshooting or testing. Disconnect the battery cables unless the test requires battery voltage.

For effective troubleshooting and repairs, you MUST have a good understanding of the electrical circuits and components used on this machine. (See Electrical Schematics and Diagrams section of this chapter.)

Study the operating characteristics preceding the electrical failure to help identify the area of difficulty. Try to isolate the failure to a specific functional system; then check that area, repairing one component at a time. Attempting to repair more than one system at one time will lead to confusion.

Possible Causes and Corrections in the troubleshooting charts should be checked in the order in which they are listed.

If the machine being repaired has any interlock switches by-passed, they must be reconnected for proper troubleshooting and safety.

Starting Problems

Condition	Possible Cause	Correction
Starter solenoid clicks, but starter will not crank. (If solenoid clicks, problem is not in interlock system.)	Low battery charge	Charge battery. Replace battery if it will not hold a charge.
	Loose or corroded battery cables. Loose or corroded ground.	Clean and tighten, or repair as necessary.
	Faulty wiring at starter.	Repair wiring.
	Loose starter mounting bolts.	Clean mounting surface and tighten bolts.
	Faulty starter.	Repair or replace starter.
	Faulty starter solenoid.	Replace starter solenoid.

Starting Problems (continued)

Condition	Possible Cause	Correction
Nothing happens when start attempt is made.	Battery is dead.	Charge battery. Replace battery if it will not hold a charge.
	Loose or corroded battery cables. Loose or corroded ground.	Clean and tighten or repair as necessary.
	“Run” fuse open.	Check fuse and replace if fuse is open. If fuse burns out often, find and correct cause.
	Fusible link open.	Replace fusible link.
	Temp. switch or relay faulty.	Test temp. switch and relay. Replace if faulty.
	Temp relay wiring loose, corroded or damaged.	Repair wiring.
	Traction switch out of adjustment or faulty.	Test traction switch. Adjust or replace traction switch if faulty.
	Traction switch wiring loose, corroded or damaged.	Repair wiring.
	PTO switch engaged or faulty.	Make sure PTO switch is OFF. Test switch and replace if faulty.
	PTO switch wiring loose, corroded or damaged.	Repair wiring.
	Ignition switch faulty.	Test ignition switch. Replace if faulty.
	Ignition switch wiring loose, corroded or damaged.	Repair wiring.
	Start relay faulty.	Test start relay. Replace if faulty.
	Start relay wires loose, corroded or damaged.	Clean and tighten or repair as necessary.
	In-line 30 amp starter solenoid fuse open.	Check fuse and replace if fuse is open. If fuse burns out often, find and correct cause.
	Starter solenoid wiring loose, corroded or damaged.	Clean and tighten or repair as necessary.
	Starter solenoid faulty.	Replace starter.

Starting Problems (continued)

Condition	Possible Cause	Correction
Engine cranks, but does not start (if engine cranks, cause of problem is not in interlock system).	Injection pump ETR solenoid wiring loose or corroded.	Clean and tighten or repair as necessary.
	Injection pump ETR solenoid faulty.	Test solenoid. Replace if faulty.
	Glow relay faulty.	Test glow relay. Replace if faulty.
	Glow relay/glow plug wiring loose, corroded or damaged.	Check wiring and connections. Clean, tighten or repair as necessary.
	Glow plugs faulty.	Test glow plugs and replace if faulty.
	Engine or fuel system problem.	See Troubleshooting section of Chapter 3 - Engine.
Engine cranks (but should not) with traction pedal out of neutral.	Traction switch out of adjustment or faulty.	Adjust or replace traction switch.
Engine cranks (but should not) with PTO switch ON.	PTO switch faulty.	Replace PTO switch.

General Run and Transport Problems

Condition	Possible Cause	Correction
Engine continues to run (but should not) when traction pedal is depressed with no operator on seat.	Seat switch plunger depressed with no operator on seat.	Check for seat support spring that is broken, missing or stuck in down position. Check for binding seat pivot hinge. Check for waterlogged seat.
	Seat switch faulty or out of adjustment.	Test seat switch. Adjust or replace if faulty.
	Time delay relay faulty.	Test relay. Replace if faulty.
Engine kills when traction pedal is depressed or PTO switch is turned ON.	Operator sitting too far forward on seat (seat switch not depressed).	Instruct operator.
	Seat hinge, support pin or spring binding, preventing seat switch from closing.	Repair seat pivot and support.
	Seat switch is faulty or out of adjustment.	Test seat switch. Adjust or replace if faulty.
	Seat switch wiring loose, corroded or damaged.	Repair wiring.
	Time delay relay faulty.	Test relay. Replace if faulty.
	Time delay wiring loose, corroded or damaged.	Repair wiring.
	“Relay” fuse open.	Check fuse and replace if fuse is open. If fuse burns out often, find and correct cause.
	Ignition switch faulty.	Test ignition switch. Replace if faulty.
	Ignition switch or fuse wiring loose, corroded or damaged.	Repair wiring.
4WD is engaged (but should not be) with axle in “HI” range.	Axle HI/Low switch faulty.	Test HI/Low switch. Replace switch if faulty.
	4WD solenoid valve faulty.	Test 4WD solenoid valve. Replace if faulty.

General Run and Transport Problems (continued)

Condition	Possible Cause	Correction
4WD does not engage.	Axle in Hi range.	Axle must be in Low range for 4WD to engage.
	Axle HI/Low switch faulty.	Test HI/Low switch. Replace switch if faulty. Make sure switch is screwed all the way in.
	Axle Hi/Low switch wiring loose, corroded or damaged.	Repair wiring.
	4WD solenoid valve faulty.	Test 4WD solenoid valve. Replace if faulty.
	4WD solenoid wiring loose, corroded or damaged.	Repair wiring.
	Problem is not electrical.	See Troubleshooting section of Chapter 4 - Hydraulic System.
Battery does not charge.	Loose or broken wire(s).	Repair wiring.
	Faulty alternator.	Check alternator belt tension. Test alternator and replace if faulty.
	Dead battery.	Charge battery. Replace battery if it will not hold a charge.

Cutting Unit Operation Problems

Condition	Possible Cause	Correction
Engine continues to run (but should not) when PTO switch is ON with no operator on the seat.	Seat switch plunger depressed with no operator on seat.	Check for seat support spring that is broken, missing or stuck in down position. Check for binding seat pivot hinge. Check for waterlogged seat.
	Seat switch faulty or out of adjustment.	Test seat switch. Adjust or replace if faulty.
	Time delay relay faulty.	Test relay. Replace if faulty.
Cutting unit runs (but should not) when raised, but shuts off with PTO switch.	Lift arm (Reel) switch faulty.	Test reel switch. Replace if faulty. Make sure switch is screwed in all the way. Check for damaged pivot shaft or bushings and repair if damaged.
	Reel solenoid valve sticking.	Inspect valve and clean or repair valve if necessary.
Cutting units shut off when raised, but do not shut off with PTO switch.	Cutting unit relay faulty.	Test relay. Replace if faulty.
	PTO switch faulty.	Test switch. Replace if faulty.
Cutting units run (but should not) with axle in “HI” range.	Axle HI/Low switch faulty.	Test HI/Low switch. Replace switch if faulty.
	Cutting unit relay faulty.	Test cutting unit relay. Replace if faulty.
One cutting unit does not operate.	Lift arm (Reel) switch faulty.	Test reel switch. Replace if faulty.
	Lift arm (Reel) switch wiring loose, corroded or damaged.	Repair wiring.
	Reel solenoid valve faulty.	Test reel solenoid valve. Repair or replace if faulty.
	Reel solenoid wiring loose, corroded or damaged.	Repair wiring.
	Problem is not electrical.	See Troubleshooting section of Chapter 4 - Hydraulic System.

Cutting Unit Operation Problems (continued)

Condition	Possible Cause	Correction
No cutting units engage.	Axle in Hi range.	Axle must be in Low range for cutting units to operate.
	“Reel” fuse open.	Check fuse and replace if fuse is open. If fuse burns out often, find and correct cause.
	Cutting unit relay faulty.	Test relay. Replace relay if faulty.
	Cutting unit relay wiring loose, corroded or damaged.	Repair wiring.
	Transaxle shift linkage out of adjustment (not closing Hi/Low switch in Low range).	Check linkage and adjust if necessary.
	Axle Hi/Low switch faulty.	Test switch. Replace if faulty. Make sure switch is screwed all the way in.
	Axle Hi/Low switch wiring loose, corroded or damaged.	Repair wiring.
	PTO switch faulty.	Test switch. Replace if faulty.
	PTO switch wiring loose, corroded or damaged.	Repair wiring.
	Variable reel control in neutral (N) position or linkage out of adjustment..	Check control and linkage. Adjust linkage if necessary.
	Variable reel control switch faulty.	Test switch. Replace if faulty. Make sure switch is screwed all the way in.
	Variable reel control switch wiring loose, corroded or damaged.	Repair wiring.
	Problem not electrical.	See Troubleshooting section in Chapter 4 - Hydraulic System.

Verify Interlock System Operation

The purpose of the interlock system is to prevent the engine from cranking or starting unless the traction pedal is in NEUTRAL and the cutting unit engagement switch is DISENGAGED. In addition, the engine will stop when the cutting unit engagement switch is engaged or traction pedal is depressed with the operator off the seat.

CAUTION

The interlock switches are for the operator's protection, so do not disconnect them. Check operation of the switches daily to assure interlock system is operating. If a switch is defective, replace it before operating. Regardless if switches are operating properly or not, replace them every two years to assure maximum safety. do not rely entirely on safety switches - use common sense!

To check interlock system operation:

1. Move machine to a wide open area free of debris and bystanders. Raise cutting units and stop engine. Engage parking brake.

2. Sit on seat. Move cutting unit engagement (PTO) switch to ON position. Try to start engine. If engine cranks, there may be a malfunction in interlock system. Repair immediately. If engine does not crank, cutting unit engagement (PTO) switch is operating correctly. Proceed to step 3.

3. Sit on seat. Depress traction pedal in forward and reverse directions while trying to start engine. If engine cranks while pedal is in forward or reverse position, there may be a malfunction in interlock system. Repair immediately. If engine does not crank, traction neutral switch is operating correctly. Proceed to step 4.

4. With cutting units in raised position, sit on seat and start engine. Move cutting unit engagement (PTO) switch to ON position. Lower cutting units to ground. Cutting unit reels should start turning when cutting units are lowered. Raise cutting units and verify that they stop. If they do not stop, there may be a malfunction in interlock system. Repair immediately. If cutting units stop, lift arm (reel) switches are operating correctly. Proceed to step 5.

5. While sitting on seat with cutting units in raised position and engine running, move cutting unit engagement (PTO) switch to ON position. Hold on to steering wheel and raise up off of seat. Engine should stop within 2 seconds. If engine does not stop, there is a malfunction in interlock system. Repair immediately. If engine stops, seat switch is operating correctly.

Testing

This section will define components, and the tests that can be performed on those components, when those parts are disconnected from the electrical system.

For accurate resistance and/or continuity checks, electrically disconnect the component being tested from the circuit (e.g. unplug the seat switch connector before doing a continuity check).

NOTE: Electrical troubleshooting of any 12 Volt power connection can also be performed through voltage drop tests without disconnection of the component.

CAUTION

When testing electrical components for continuity with a volt-ohm meter or continuity tester, make sure that power to the circuit has been disconnected.

Ignition Key Switch

The ignition (key) switch has three positions (OFF, RUN and START). The terminals are marked as shown.

The circuitry of the ignition switch is shown in the chart. With the use of a continuity tester, the switch functions may be tested to determine whether all circuits are being completed while the key is moved to each position.

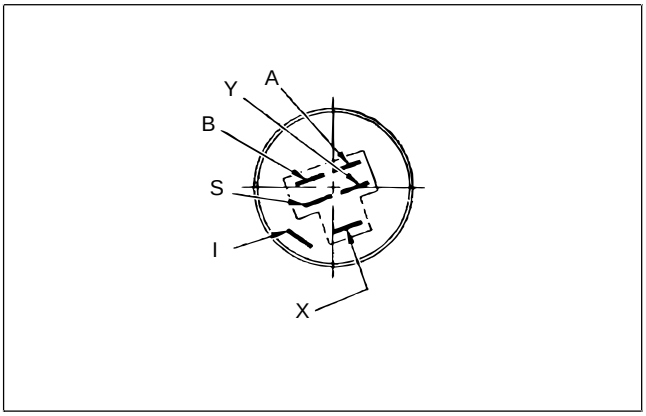


Figure 4

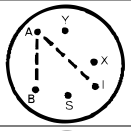
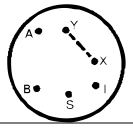
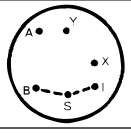
POSITION	CONTINUITY AMONG TERMINALS	OTHER CIRCUITS MADE
1. OFF	NONE	NONE
2. RUN	 B + I + A	 X + Y
3. START	 B + I + S	NONE

Figure 5

Seat Switch, Relay and Time Delay Capacitor

The seat switch is a normally open (N.O.) switch that closes when the operator is on the seat. With no operator on the seat, there is an open circuit to the time delay capacitor and relay coil. If the PTO switch or traction switch is open and the operator raises off the seat, the engine will stop after a delay of 1 to 2 seconds.

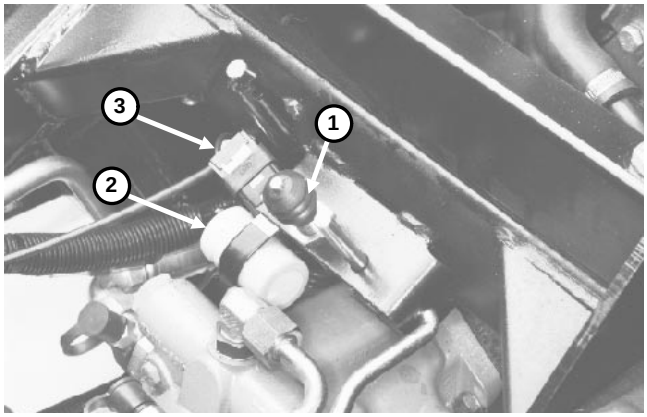


Figure 6

1. Seat switch
2. Time delay capacitor
3. Seat switch relay

Seat Switch Test

1. Raise the seat to get access to the seat switch wiring connector.

2. Disconnect the seat switch wiring connector and install a continuity tester or ohm meter between the two leads of the seat switch.

3. Lower the seat. The continuity tester should show no continuity.

NOTE: Make sure the compression spring and pin holds the seat up off the seat switch when there is no operator on the seat.

4. Have the operator sit on the seat, slowly depressing the seat switch. The continuity tester should show continuity as the seat approaches the bottom of its travel.

Relay Test

To test the relay, disconnect the relay wire connector and install a continuity tester between the relay terminals (terminals 30 and 87). The relay should make and break continuity at terminals 30 and 87 as 12 V.D.C. is connected and disconnected to terminal 85 with terminal 86 connected to ground.

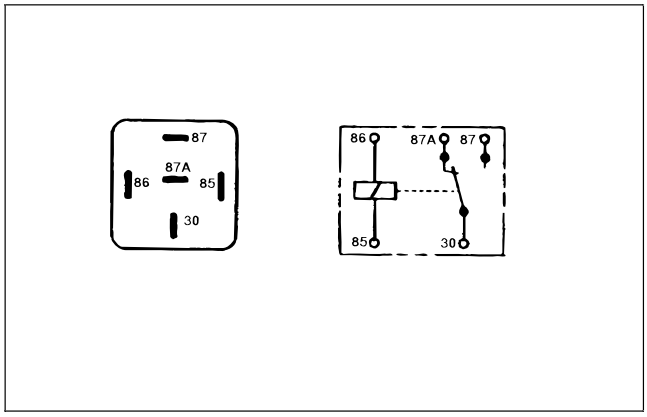


Figure 7

Relay

Traction (Neutral) Switch

The traction switch is a normally closed and opens when traction pedal is depressed in either direction.

IMPORTANT: The traction switch has three (3) terminals. Make sure the wires are connected to the "COMMON" and "N.O." terminals.

Test the switch by disconnecting the wires from the switch terminals and connecting a continuity tester across the COMMON and N.O. terminals. With the engine turned off, slowly push the traction pedal in a forward and reverse direction while watching the continuity tester. There should be indications that the traction switch is opening and closing. Allow the traction pedal to return to neutral. There should be continuity across the terminals. (See Replacing the Traction Switch in the Repairs section of this chapter for replacement and adjustment procedures.)

NOTE: Apply "Loctite 271" or equivalent to threads of switch screws before installing.

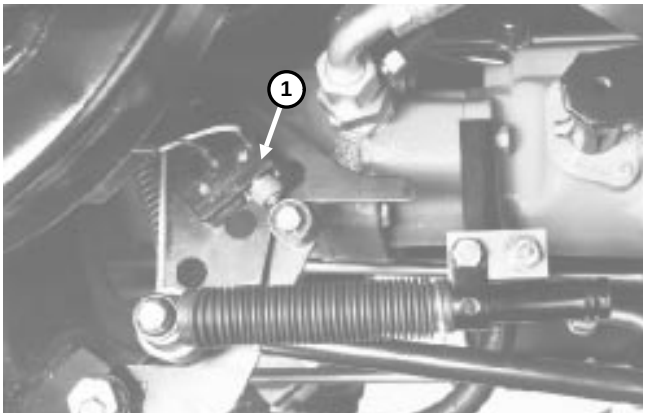


Figure 8

1. Traction (neutral) switch (Eaton pump)

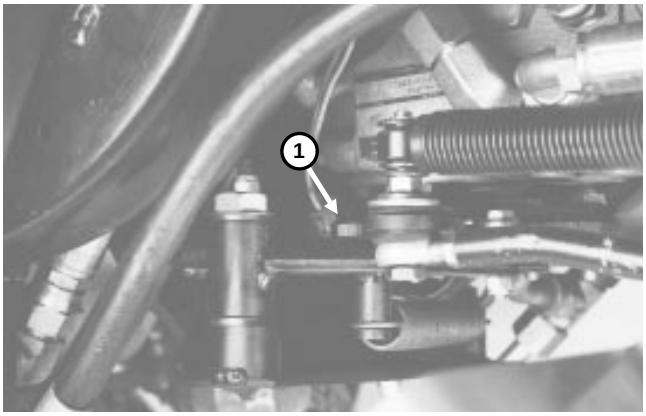


Figure 9

1. Traction (neutral) switch (Sundstrand pump)

Reel Switches

The reel switches are normally closed (N.C.) switches that open when the lift arm is raised, which pushes the switch ball in.

1. Disconnect the switch wire connector and install a continuity tester or ohm meter between the two leads of the switch.

2. With the lift arm in the lowered position the tester should show continuity. With the lift arm in the raised position, the tester should show no continuity.

NOTE: For proper operation, the switch must be screwed all the in. A damaged pivot shaft or bushings could cause the switch to not open and close properly. Also, debris in the switch could cause the switch to not open and close properly.

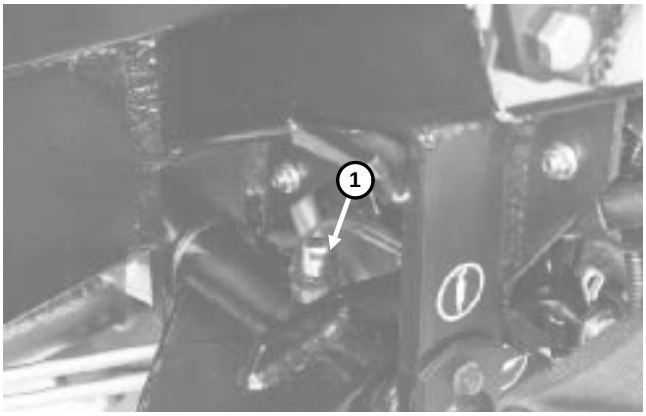


Figure 10
(Right front lift arm pivot shown)

1. Reel switch

Axle Hi/Low Switch

The axle hi/low switch is normally open (N.O.) when the transaxle is in neutral or hi range. This prevents the cutting units or 4WD from engaging while the transaxle is neutral or hi range. The switch closes when the axle shift rod is moved to low range, which pushes the switch button in.

1. Disconnect the switch wire connector and install a continuity tester or ohm meter between the two leads of the switch.

2. With the axle in neutral or hi range, the switch should show no continuity. With the axle in low range the switch should show continuity.

NOTE: For proper operation, the switch must be screwed all the way in. Debris in the switch could cause the switch to not open and close properly. Shift linkage that is out of adjustment can also cause improper switch operation.

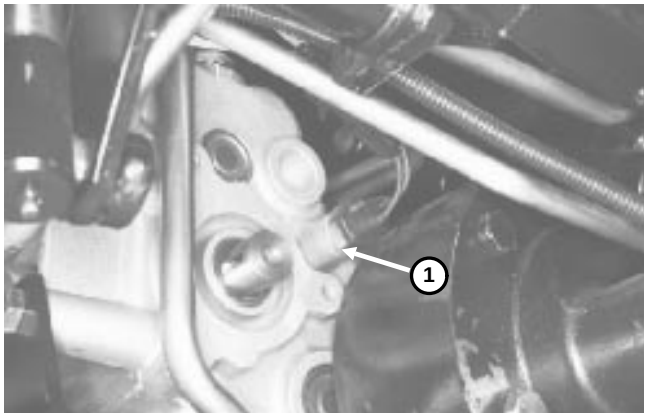


Figure 11

1. Axle Hi/Low switch

Backlap/Mow Variable Control Switch

The backlap/mow variable reel speed control switch is normally open (N.O.) with the variable reel speed control in neutral position. This prevents the cutting units from engaging with the variable speed control set to neutral. The switch closes when the variable reel speed control is moved to the mow or backlap position, which pushes the switch button in.

1. Disconnect the switch wire connector and install a continuity tester or ohm meter between the two leads of the switch.

2. With the variable reel speed control in the neutral position, the switch should show no continuity. When the variable reel speed control is moved into the mow or backlap position, the switch should show continuity.

NOTE: For proper operation, the switch must be screwed all the in. Debris in the switch could cause the switch to not open and close properly.

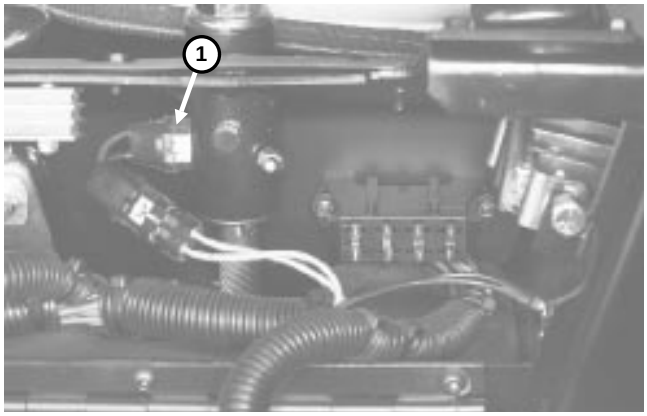


Figure 12

1. Backlap/mow variable control switch

PTO Switch

To test the PTO switch independent of wiring harness, disconnect wire connector from the switch terminals. When the switch is ON, there should be continuity between terminals A – B only. When the switch is OFF, terminals C – D and B – E should show continuity.

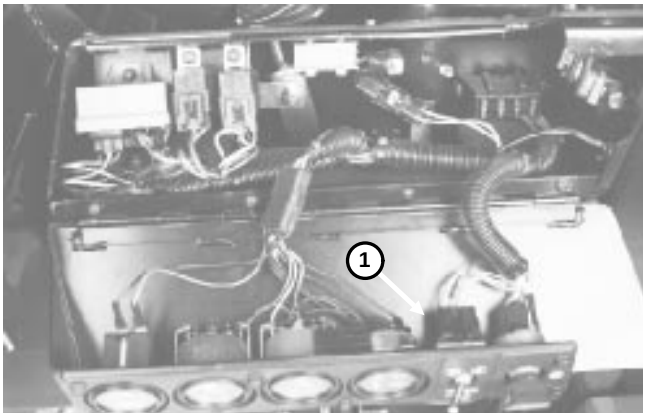


Figure 13

1. PTO switch

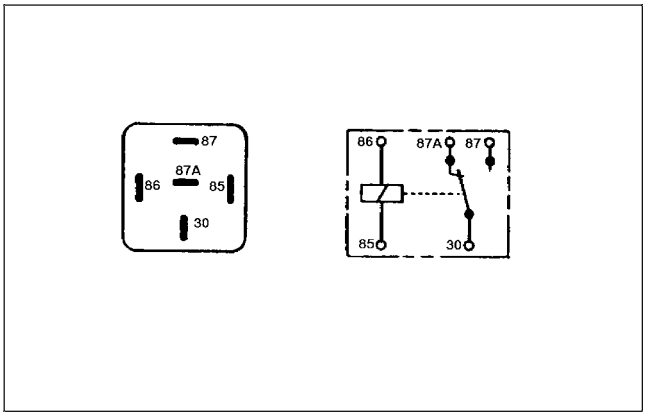


Figure 14

1. PTO switch terminals

Start, Cutting Unit and High Temp. Relays

To test the relay, disconnect the relay wire connector and install a continuity tester between the relay terminals (terminals 30 and 87). The relay should make and break continuity at terminals 30 and 87 as 12 V.D.C. is connected and disconnected to terminal 85 with terminal 86 connected to ground.

Figure 15

1. Start relay

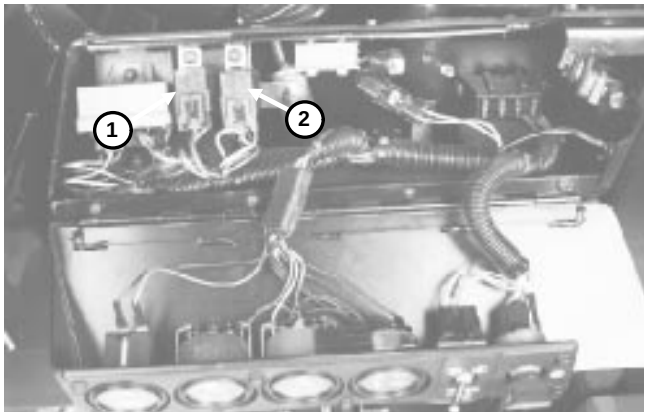


Figure 16

1. Cutting unit relay **2. High temp. relay**

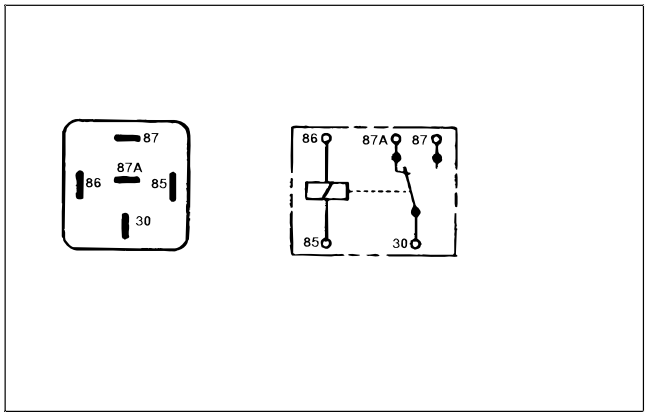


Figure 17

Glow Relay and Glow Plugs

1. Attach an amp meter to glow plug circuit. Turn ignition switch to ON. Meter may have an initial reading as high as 100 amps.

   A. If amp meter shows a reading for 5 to 12 seconds, the glow relay is operating. If there is no reading, go to step 2.

   B. Turn ignition switch OFF, then ON again. A reading of 48 amps should be observed. Go to step 3.

2. To test the circuit:

   A. Check with a test light at buss bar connection for glow plugs at cylinder head. Turn the ignition switch ON. If the light glows, power is being supplied from glow relay. If light does not glow check wiring or relay.

   B. Check relay with a test light connected at terminal#5 on relay (glow plugs connection).Turn ignition switch ON. If the light glows, the power relay is working. If the light does not glow, check for power to relay by moving to terminal #1 (power from battery). If the light glows, check for power from ignition switch by moving to terminal #3.

4. Glow plug test:

   A. Warm up the glow plugs, then check for total draw of all four (4) glow plugs:

   if draw is 48 amps all four (4) are OK.
   if draw is 36 amps, then one (1) is faulty.
   if draw is 24 amps, then two (2) are faulty.
   if draw is 12 amps, then three (3) are faulty.
   if draw is 0 amps, then all are faulty.
   if draw is more than 48 amps (60 to 100 amps) there is a short in one or more of the glow plugs (see Glow Plugs in Testing section of Chapter 3 - Engine.

NOTE: The glow relay has a built in temperature sensor and timer. Battery voltage is always available at terminal #1. When voltage is sensed at terminal 3 (ignition switch turned to ON) power is directed to terminals #5 (glow plugs) and #6 (glow indicator light). At 68°F (20°C) the glow indicator light will turn off after 5 seconds, then the glow plugs will turn off after 12 seconds. At 32°F (0°C) the glow indicator light will turn off after 10 seconds, then the glow plugs will turn off after 18 seconds.

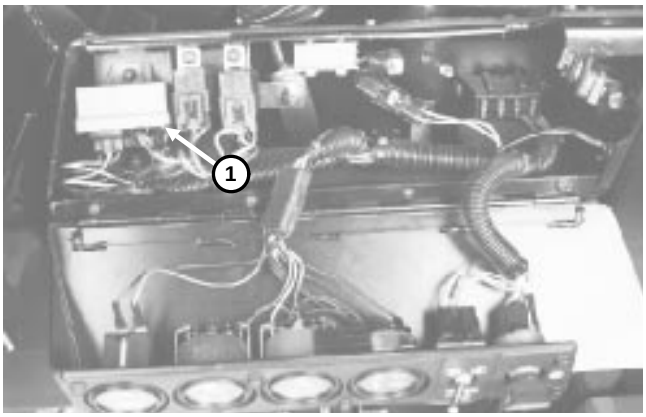


Figure 19

1. Glow relay

Battery

Use a hydrometer to test the battery. Charge the battery if necessary (see Battery Service).

Electrolyte specific gravity

Fully charged: 1.250 - 1.280
Discharged: less than 1.240

Figure 20

Injection Pump (ETR) Solenoid

The Reelmaster® 335-D has an energize-to-run (ETR) fuel stop solenoid. The solenoid will stop injector pump fuel delivery with any electrical failure in the RUN circuit.

1. Disconnect the wire from the solenoid.

2. Remove the solenoid from the injector pump.

3. Connect a 12 volt battery so that a wire from positive (+) battery terminal is connected to switch terminal. Touch a wire from the negative (–) battery terminal to solenoid body. The plunger should retract.

NOTE: You can also test operation without removing the solenoid from the injector pump. Listen for an audible “click” as the solenoid extends and retracts while doing step 3 of the above procedure. This will not show if the solenoid is fully extending and retracting.

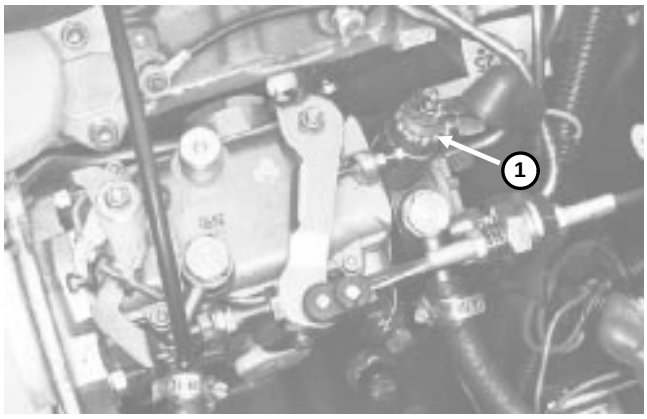


Figure 21

1. Injection pump (ETR) solenoid

Gauges and Indicator Lights

Oil Pressure Light

Oil pressure lamp should come on when the ignition key switch is in the RUN position with the engine not running or if the oil pressure switch closes during operation - oil pressure below 7 psi (0.5 kg/cm^2).

Test the lamp by disconnecting the wire from oil pressure switch and grounding it against the engine. The light should come on when the wire is grounded with the ignition switch in the ON position.

Amp Light

The amp light should come on when the ignition key switch is in the RUN position with the engine not running or if the charging circuit is not operating properly during operation.

Test the lamp by disconnecting the wires and applying 12 V.D.C. between the lamp wiring terminals.

Glow Light

The glow light should come on for 5 to 12 seconds after the ignition key switch is turned ON.

Test the lamp by disconnecting the wires and applying 12 V.D.C. between the lamp wiring terminals.

Temperature Light

The temperature light should come on only if the high temperature shut-down switch and relay has stopped the engine - coolant temperature above 221^o F (105^{o}C).

Test the lamp and relay by disconnecting the wire from high temperature shut-down switch and grounding it against the engine. The light should come on when the wire is grounded with the ignition switch in the ON position.

Hourmeter

Test the hourmeter by connecting a 12 volt battery so the positive (+) battery terminal is connected to the positive terminal on the hourmeter. Connect the negative (–) battery terminal to the negative (–) terminal on the alternator. The hourmeter should operate as 12 V.D.C. is applied between the terminals.

Temperature Gauge and Fuel Level Gauge

To test a gauge, use a commercial gauge tester. If a commercial gauge tester is not available, substitute a new gauge or test the sending unit.

High Temperature Shut-Down Switch

1. Lower the coolant level in the engine and remove the high temperature shut-down switch.

2. Put the switch in a container of oil with a thermometer and heat the oil.

3. The switch is normally open (N.O.) and should close at approximately 221° F (105° C).

CAUTION

Handle hot oil with special care to prevent personal injury or fire.

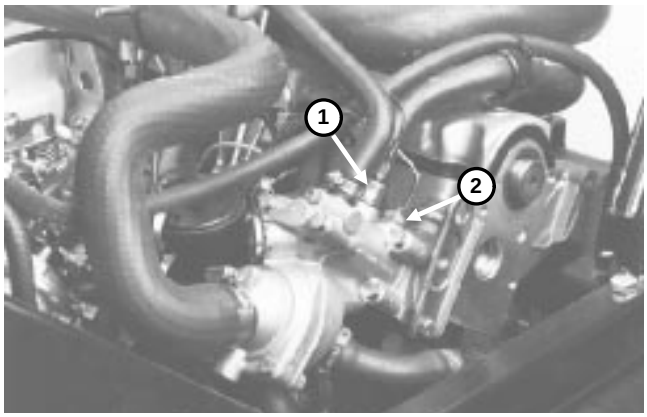


Figure 22

1. High temperature shut-down switch
2. Temperature gauge sender

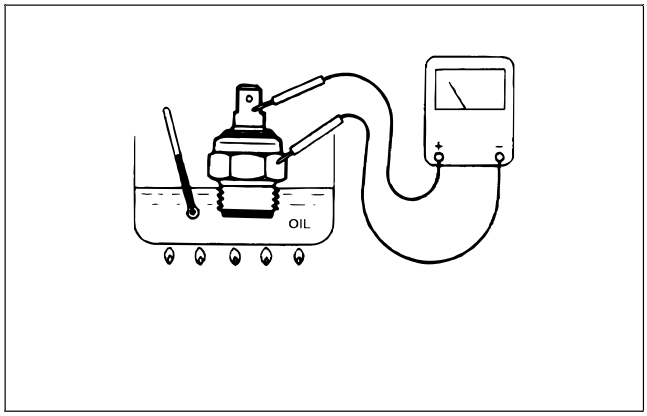


Figure 23

Temperature Gauge Sender

1. Lower the coolant level in the engine and remove the temperature gauge sender.

2. Put the switch in a container of oil with a thermometer and heat the oil.

3. With an Ohm meter connected as shown, the following resistance readings should be indicated.

90.5 - 117.5 ohm at 160° F (70° C)
21.3 - 26.3 ohm at 207° F (115° C)

CAUTION

Handle hot oil with special care to prevent personal injury or fire.

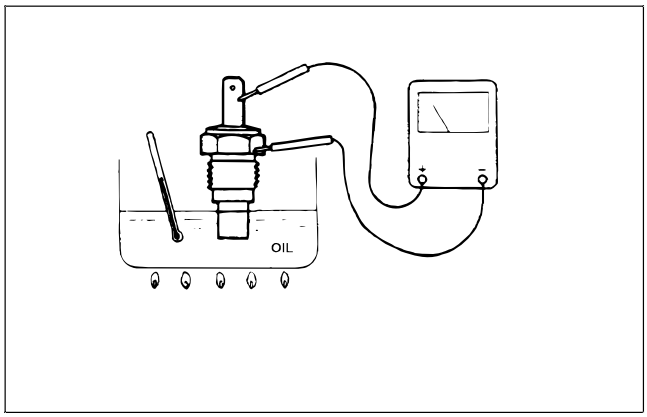


Figure 24

Engine Oil Pressure Switch

The switch is normally closed (NC) and opens with pressure.

The switch opens at approximately 8 psi.

1. Turn ignition key switch ON. Oil pressure lamp should be on.

If bulb is not on:

1. Disconnect wire from switch and touch wire to a good ground, such as the engine block.

2. If lamp comes on, replace switch.

3. If lamp does not come on check wiring between lamp and switch for continuity.

If lamp is on with engine running:

1. Shut off engine immediately.

2. Check switch by disconnecting wire with ignition switch in ON position. Light should go out.

3. If light is still on, check for short circuit in wiring.

4. Install test gauge in engine oil pressure switch port. Start engine and check for 30 psi minimum at 1500 rpm. If engine pressure is good, replace switch. If engine pressure is low, DO NOT operate the engine.

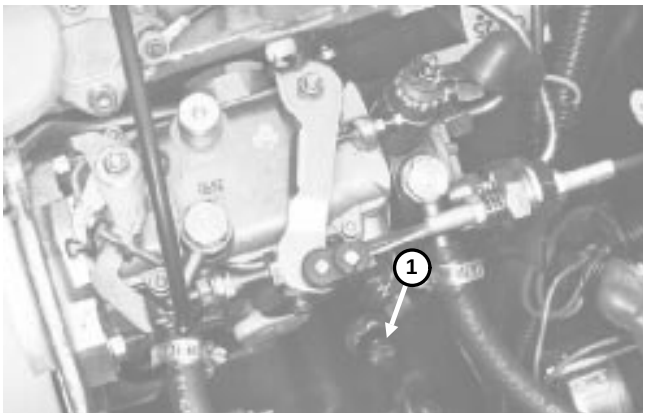


Figure 25

1. Engine oil pressure switch

Fuel Gauge Sender

1. Disconnect wire and remove the fuel gauge sender from the fuel tank.

2. Install an ohm meter between the terminal and base.

3. With arm completely down (empty position), resistance should be 240 - 260 ohms.

4. With arm completely up (full position), resistance should be 29 - 34 ohms.

NOTE: Bend float arm, if necessary, to get proper gauge reading for a 1/2 full tank.

CAUTION

Make sure the sending unit is completely dry (no fuel on it) before testing. Perform test away from fuel tank to prevent an explosion or fire from sparks.

Reel Motor Solenoids

1. Disconnect the wire connector.

2. Connect a 12 volt battery so the positive (+) battery terminal is connected to lead of the wiring connector and the negative (–) battery terminal to the other lead. The valve spool should retract completely as 12 V.D.C is applied between leads.

3. If valve spool does not retract check for binding or damage in valve.

4. If valve operates smoothly, but does not retract when 12 V.D.C is applied to solenoid leads, replace solenoid coil.

5. If valve still does not retract after replacing solenoid coil, replace the valve.

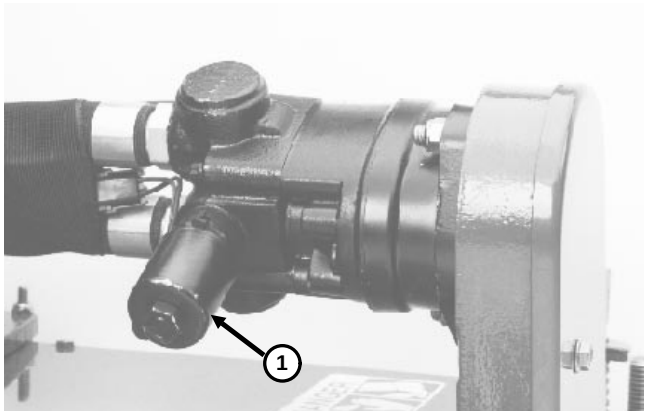


Figure 27

1. Reel motor solenoid

4WD Solenoid

1. Disconnect the wire connector.

2. Connect a 12 volt battery so the positive (+) battery terminal is connected to colored solenoid lead. Connect the negative (–) battery terminal to black lead. The valve spool should retract completely as 12 V.D.C is applied between leads.

3. If valve spool does not operate properly check for binding or damage to valve.

4. If valve moves smoothly, but does not engage when 12 V.D.C is applied to solenoid leads, replace solenoid coil.

5. If valve still does not operate after replacing solenoid coil, replace the valve.

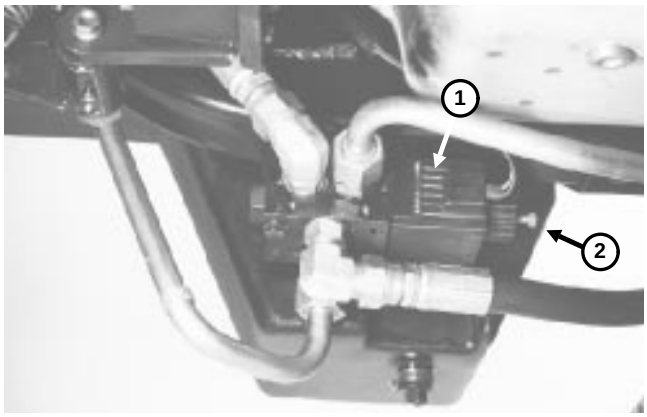


Figure 28

1. 4WD solenoid
2. Indicator

Repairs

IMPORTANT: Before welding on the machine, disconnect both battery cables from the battery and disconnect the terminal connector from the alternator to prevent damage to the electrical system.

Battery Service

IMPORTANT: To prevent damage to electrical components, do not operate the engine with the battery cables disconnected.

Keep the terminals and entire battery case clean. To clean the battery, wash the entire case with a solution of baking soda and water. Rinse with clear water. Do not get the soda solution into the battery because damage to the battery will result. Coat the battery posts and cable connectors with skin-over grease, or petroleum jelly to prevent corrosion.

Check for loose battery hold-downs. A loose battery may crack or cause the container to wear and leak acid.

Check the electrolyte solution to make sure the level is above the plates. If the level is low (but above the plates inside the battery), add water so the level is to the bottom of the cap tubes. If the level is below the plates, add water only until the plates are covered and then charge the battery. After charging, fill the battery to the proper level.

CAUTION

Do not charge a frozen battery because it can explode and cause injury. Let the battery warm to 60^{O} F (16^{O} C) before connecting to a charger.

Charge the battery in a well-ventilated place so that gases produced while charging can dissipate. Since the gases are explosive, keep open flame and electrical spark away from the battery; do not smoke. Nausea may result if the gases are inhaled. Unplug the charger from the electrical outlet before connecting or disconnecting the charger leads from the battery posts.

Electrolyte Specific Gravity

Fully charged: 1.250 - 1.280
Discharged: less than 1.240

Battery Specifications

BCI Group 26 SMF–5 Battery:
530 Amp Cranking Performance at 0^{O} F (–17 ^{O} C)
85 min. Reserve Capacity at 80^{O} F (27 ^{O} C)

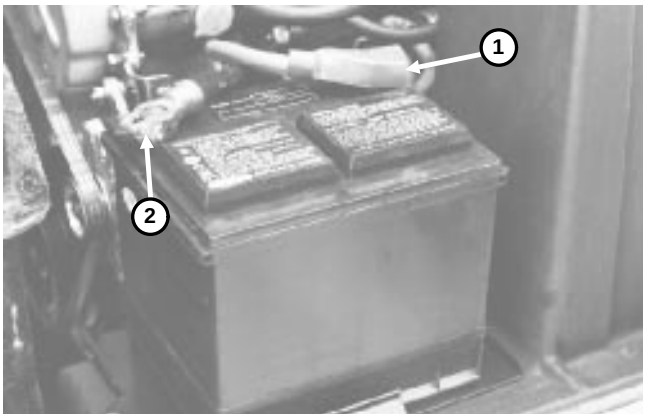


Figure 29

1. Positive (+) terminal
2. Negative (–) terminal

Figure 30

Fuses

The electrical system is protected by twelve (4) fuses located under the control panel to the operator's right.

NOTE: It is not always possible to see if a fuse is faulty. It is recommended that you check for faulty fuses with a continuity tester, not visually.

The starter circuit is also protected by a 30 amp in-line fuse between the start relay and starter solenoid.

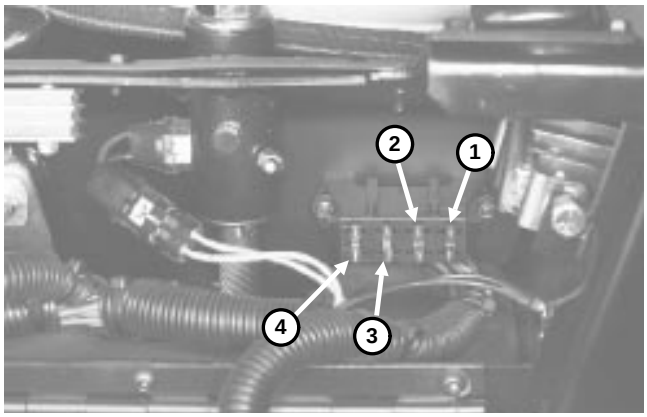


Figure 31

1. ACC fuse
2. RELAY fuse
3. REEL fuse
4. RUN fuse

FUSES	
1. ACC	5A
2. RELAY	5A
3. REEL	30A
4. RUN	15A

Traction (Neutral) Switch Replacement

1. Remove the two wires that are connected to the traction switch.

2. Have a helper push the traction pedal down into either the FORWARD or REVERSE position; this will take the switch arm tension off of the switch. Loosen two (2) screws and remove the switch.

3. Install new switch. DO NOT over-tighten screws as the switch case could break.

NOTE: Have a helper hold the traction pedal down while installing the switch.

4. Reconnect the two wires to the new switch. Make sure that one wire is connected to the “COMMON” terminal, and one wire is connected to the “NORMALLY OPEN” (N.O.) terminal.

IMPORTANT: The traction switch has three (3) terminals. If the two (2) wires are not connected to the “COMMON” and “NORMALLY OPEN” (N.O.) terminals, the engine will be unable to start and the safety interlock circuit will not function properly.

NOTE: Apply “Loctite 271” or equivalent to threads of switch screws before installing.

CAUTION

If the wires are not correctly installed to the switch, the engine could start with the traction pedal in forward or reverse.

5. Coat the switch terminals and wires with skin-over grease.

6. Check traction control neutral adjustment. (See Traction Control Neutral Adjustment in the Adjustments section of Chapter 4 - HYDRAULIC SYSTEM.

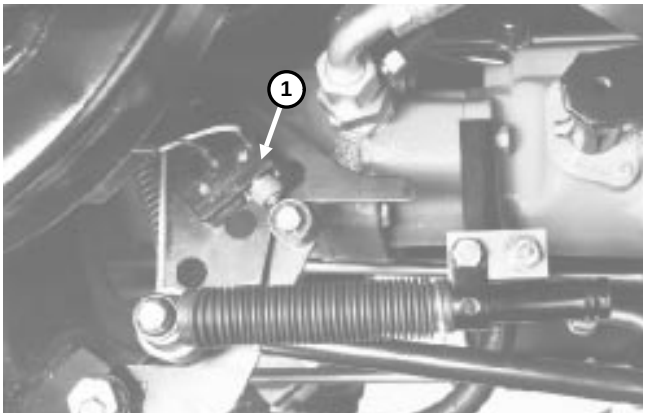


Figure 33

1. Traction (neutral) switch (Eaton pump)

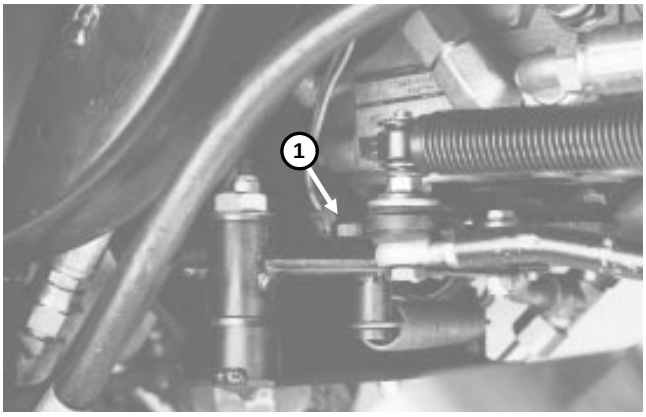


Figure 34

1. Traction (neutral) switch (Sundstrand pump)

Reel Motor Solenoid Coil Replacement

1. Park machine on a level surface, engage parking brake, lower the cutting units and turn engine OFF.

2. Disconnect solenoid electrical connector.

3. Remove nut from solenoid.

4. Remove cover and solenoid coil.

5. Install new solenoid coil and secure with nut. Apply “Locktite 242" or equivalent to threads on end of stem tube before installing nut. Tighten nut to a torque of 15 in-lb. Over-tightening may cause the solenoid valve to malfunction.

6. Connect electrical connector.

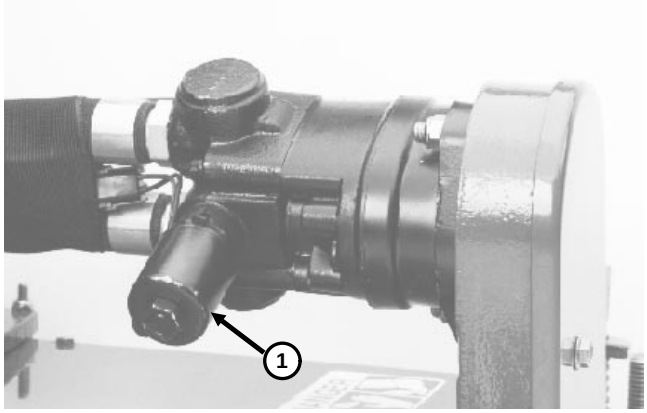


Figure 35

1. Reel motor solenoid

4WD Solenoid Coil Replacement

1. Park machine on a level surface, engage parking brake, lower the cutting units and turn engine OFF.

2. Disconnect solenoid electrical connector.

3. Remove coil nut.

4. Remove coil assembly.

5. Install new coil assembly and secure with coil nut. Apply “Locktite 242" or equivalent to threads on end of stem tube before installing nut. Tighten nut to a torque of 15 in-lb. Over-tightening may damage coil nut or cause solenoid valve to malfunction.

6. Connect electrical connector.

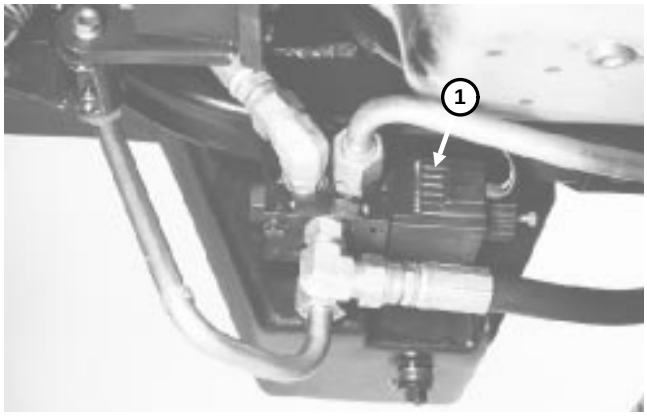


Figure 36

1. 4WD solenoid

Chapter 6

Axles and Brakes

Table of Contents

Specifications

Item	Specification
Tire pressure	15 - 20 PSI front and rear
Wheel bolt torque	45 - 55 ft-lb
Front axle hub nut torque	300 - 350 ft-lb
Transaxle adapter plate screw torque	65 ft-lb
Front axle housing cap screw torque	100 ft-lb
Rear wheel toe-in	0.25 in.
Service brake adjustment	1.5 in. “free travel” in pedal
Front axle lubricant	SAE 80-90W EP gear lube 144 oz. (4.5 U.S. qt.) capacity
Rear 4WD axle lubricant	SAE 80-90W EP gear lube 80 oz. (2.5 U.S. qt.) capacity

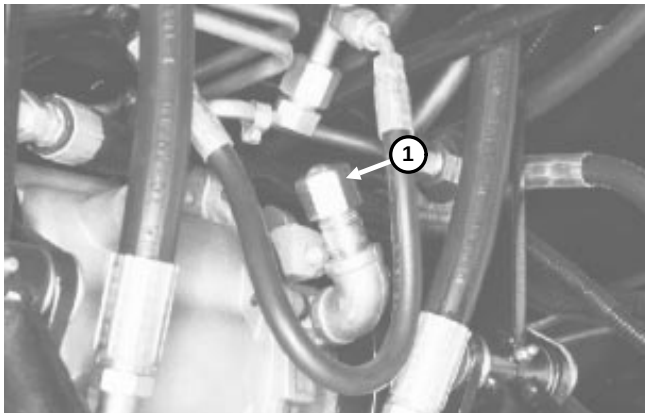


Figure 1

1. Front axle dipstick cap

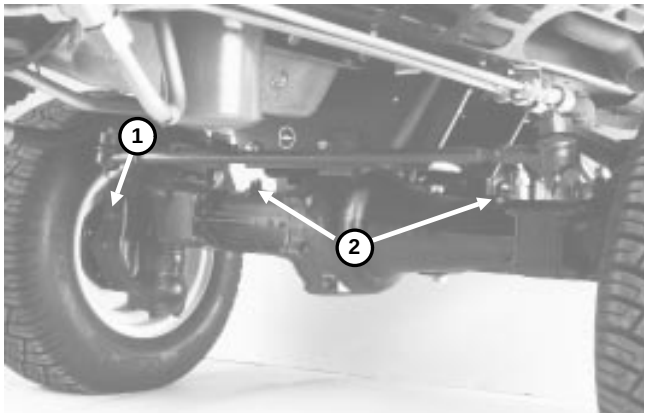


Figure 2

1. Rear axle check plug **2. Rear axle fill plug**

Four-Matic™ 4WD Over-Running Clutch Operation

There are two hydraulic drive motors on the Reelmaster 335-D, 4WD; one for the front axle and one for the rear axle. The drive for the rear axle incorporates an OVER-RUNNING (ROLLER) CLUTCH THAT TRANSMITS POWER ONLY IN THE FORWARD DIRECTION (Fig. 3A).

Front and rear axle gear ratios and tire sizes were carefully selected so that during normal operation, the REAR AXLE SHAFT TURNS SLIGHTLY FASTER THAN THE REAR AXLE MOTOR.

Any time the front wheels begin to slip (such as when climbing a steep hill), the forward movement of the traction unit slows. This causes the rear axle shaft speed to slow down. As soon as the rear axle shaft is turning the same speed as the rear motor, the roller clutch will engage and power will be transmitted from the rear motor to the rear wheels – four wheel drive (Fig. 3A).

When the traction unit is turning, the rear wheels swing out in a larger arc and must travel faster than the front wheels. In this condition, the rear wheels and axle shaft are turning faster than the rear motor and the roller clutch is disengaged (Fig. 3B).

NOTE: The Four-Matic four wheel drive system may not operate properly if the tires are replaced by different size tires, or if proper tire pressure is not maintained.

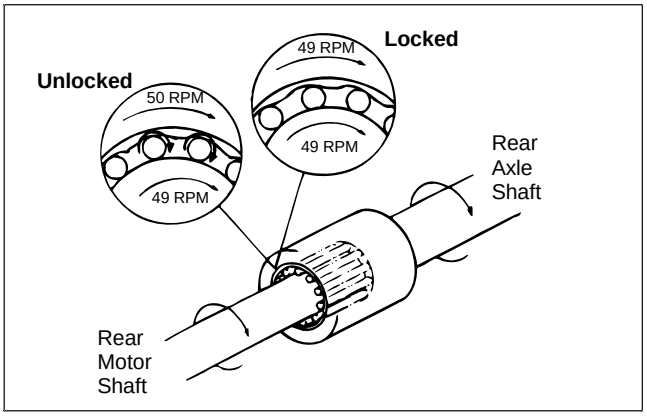


Figure 3A

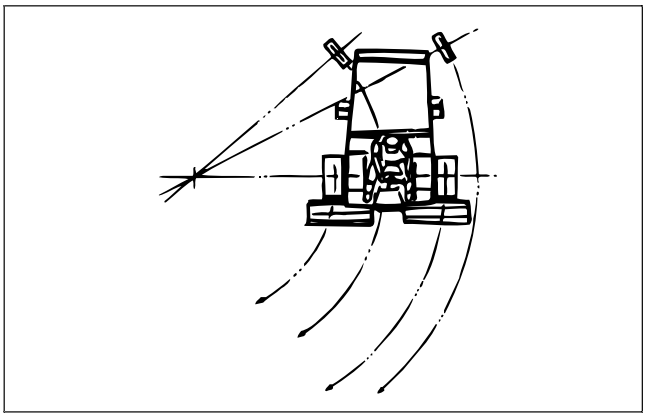


Figure 3B

Adjustments

Brake Adjustment

Adjust service brakes when there is more than 1.5 in. “free travel” of brake pedal, or when brakes do not work effectively. Free travel is the distance the brake pedal moves before braking resistance is felt.

To reduce free travel of brake pedals, tighten nut on brake rod adjuster, 1/2 turn at a time, until you get desired “free travel” in pedal.

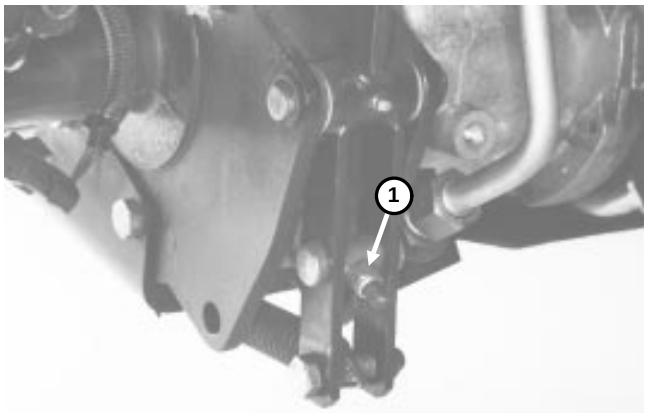


Figure 5

1. Brake rod adjuster

Rear Axle Toe-in Adjustment

1. Measure center-to-center distance (at axle height) at front and rear of steering tires. Front measurement must be 1/4 in. less than rear measurement.

2. To adjust, loosen clamps at both ends of tie rods.

3. Rotate tie rod to move front of tire inward or outward.

4. Tighten tie rod clamps when adjustment is correct.

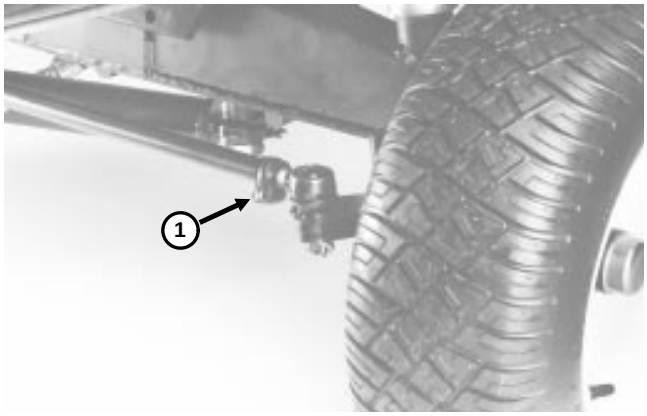


Figure 6

1. Tie rod clamps

Transaxle Shift Linkage Adjustment

1. Remove steering tower cover. Raise and securely lock the front cutting unit in raised transport position.

2. Move axle shift lever forward to transport (high speed) position. Measure shaft dimension from side of transaxle case to end of shaft (Fig. 7). Adjust upper linkage length at top eye rod if necessary to get proper dimension (Fig. 8).

3. Move axle shift lever rearward to mow (low speed) position. Measure shaft dimension from side of transaxle case to end of shaft. Adjust linkage length at top eye rod if necessary to get proper dimension.

4. Move axle shift lever forward to transport (high speed) position and verify that the dimension is correct.

5. Move axle shift lever rearward to mow (low speed) position. Start the engine and lower one cutting unit. Turn on reel speed control and cutting unit engagement switch. The cutting unit should engage. When axle shift lever is moved to N or transport position, the cutting unit should disengage. If the cutting unit does not disengage there is a problem in the axle hi-low switch circuit (see Chapter 5 - Electrical System).

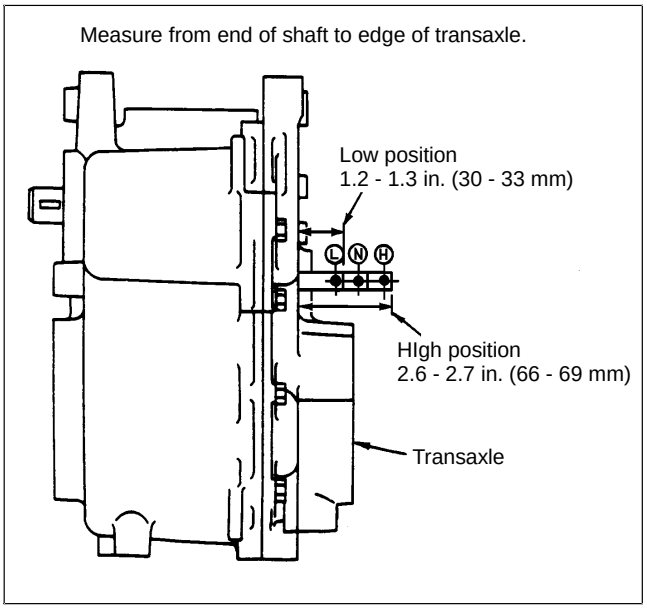


Figure 7

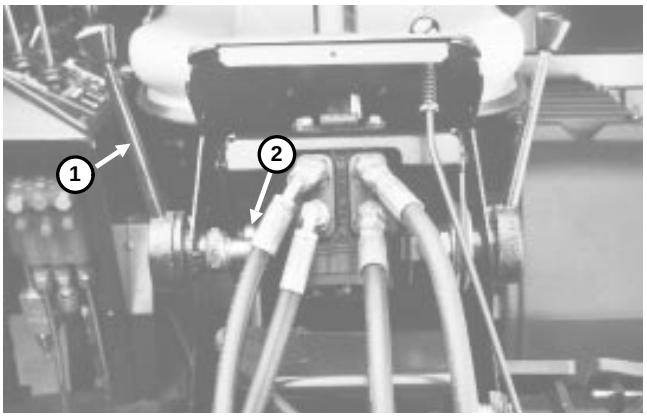


Figure 8

1. Axle shift lever **2. Upper linkage**

Wheel Bearing Service (2WD Rear Axle)

1. Jack up rear of machine until tire is off the floor. Support machine with jack stands or blocks to prevent it from falling.

2. Remove dust cap from end of wheel spindle.

3. Remove cotter pin, slotted nut and washer. Slide wheel off of spindle shaft.

4. Pull seal out of wheel hub.

5. Remove bearings from both sides of wheel hub. Clean the bearings in solvent. Make sure the bearings are in good operating condition. Clean the inside of the wheel hub. Check the bearing cups for wear, pitting or other noticeable damage. Replace worn or damaged parts.

6. If bearing cups were removed from the wheel hub, press them into the hub until they seat against the shoulder.

7. Use No. 2 general purpose lithium base grease containing E.P. additive. Pack both bearings with grease. Install one bearing into the cup on inboard side of wheel hub. Lubricate the inside of the new lip seal and press it into the wheel hub.

IMPORTANT: The lip seal must be pressed in so it is flush with the end of the hub. The lip of the seal must be toward the bearing.

8. Pack inside of wheel hub with some grease (not full). Install remaining bearing into bearing cup.

9. Slide the wheel onto the spindle shaft and secure it in place with the flat washer and slotted nut. DO NOT tighten the nut or install the cotter pin.

10. Adjust preload on the wheel bearings (see Adjusting Rear Wheel Bearings).

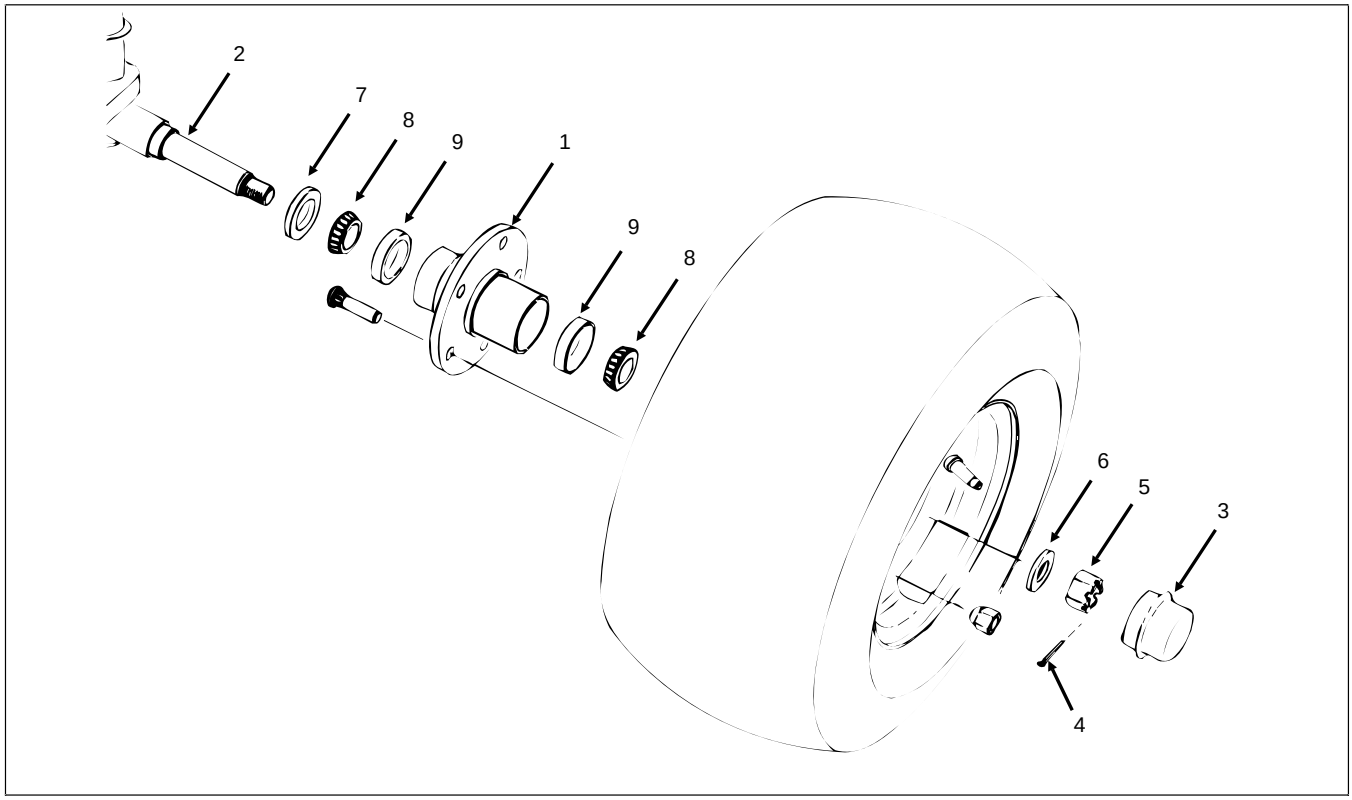


Figure 9

1. Wheel hub
2. Wheel spindle
3. Dust cap
4. Cotter pin
5. Slotted nut
6. Washer
7. Seal
8. Bearing cone
9. Bearing cup

Adjusting Rear Wheel Bearings

1. Remove dust cap from end of wheel spindle. Remove cotter pin retaining slotted nut in place.

2. Rotate the wheel by hand and tighten the slotted nut until the bearing binds SLIGHTLY. Then, loosen the nut until the nearest slot and hole in the spindle line up. Reinstall the cotter pin to retain the slotted nut in place. NOTE: The correct end play of the adjusted assembly is 0.002 - 0.005 inches.

3. Remove jack stands or blocks and lower machine to floor.

4. Put a coating of grease on the inside of the dust cap. Install dust cap on end of wheel spindle.

Figure 10

1. Cotter pin and slotted nut

Front Axle Removal and Disassembly

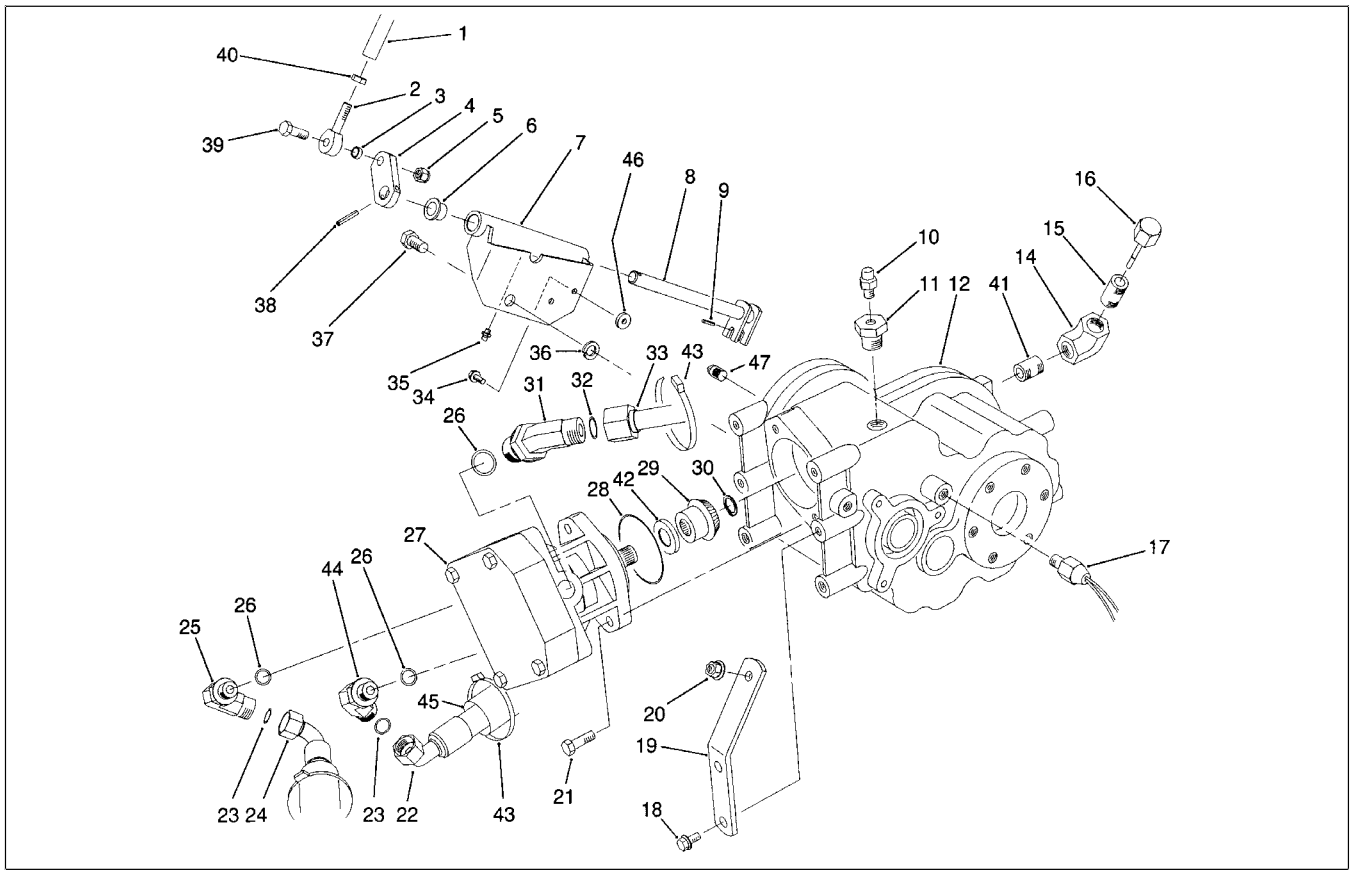


Figure 11

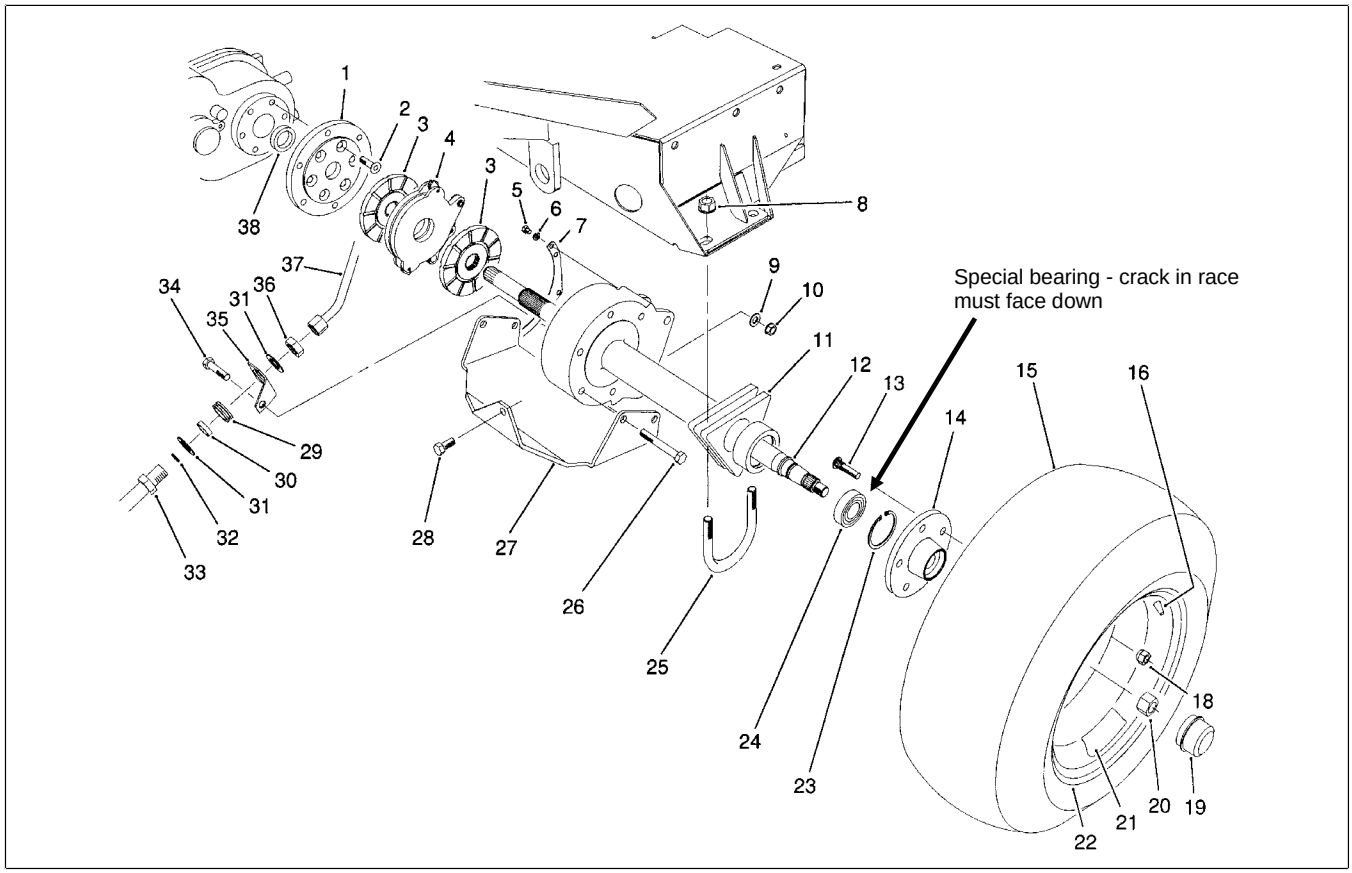


Figure 12

Front Axle Removal

1. Drain oil from transaxle.

2. Jack up front of machine and support chassis frame with jack stands.

3. Remove front wheels. Remove nuts (Fig. 12, Item 20). Use a puller to pull wheel hubs (Item 14) off of shaft.

4. Clean all exterior surfaces of axle and transaxle.

5. Disconnect hydraulic motor (Fig. 11, Item 27) from transaxle. DO NOT disconnect hoses from hydraulic motor.

6. Disconnect brake linkage rod eyes from brake linkage arms.

7. Disconnect and put covers on hydraulic lines that run under axle assembly or that go through bulkhead brackets connected to axle assembly. Mark hydraulic lines for proper reassembly.

8. Support axle assembly, then remove U-bolts (Fig. 12, Item 25) securing axle to frame.

9. Carefully lower and pull axle assembly out from under machine.

Front Axle Disassembly

1. Remove skid plate (Fig. 12, Item 27).

NOTE: Before removing axle housings, scribe alignment marks across transaxle housing, adapter plate and axle housing for proper reassembly.

2. Remove remaining capscrews securing axle housing (Item 11) to transaxle and carefully pull axle housing and shaft (Item 12) away from transaxle.

3. Remove axle housing cover (Item 7).

4. Remove cotter pin and clevis pin to disconnect brake clevis from brake actuator.

5. Remove brake disks (Item 3) and brake actuator (Item 4).

6. Remove adapter plate (Item 1) and transaxle spacer (Item 38).

7. To remove axle from housing, remove retaining ring (Item 23) from outboard end of housing, then tap lightly with a mallet from inside out. A pressed on, sealed ball bearing (Item 24) will be on end of axle.

8. Do steps 2 - 7 for axle housing on other side.

Front Axle Assembly

Reverse steps 1 - 8 under Front Axle Disassembly.

IMPORTANT: Outboard axle support bearings (Fig. 12, Item 24) are a special design with a "cracked race". When bearing is installed, it is important that this crack points down. Improper installation will result in rapid bearing wear. Apply Loctite 680 or equivalent to outer race of bearing before installing in axle housing.

To install axle assemblies into transaxle case, grease axle spline ends heavily. Push axle through seal. Use caution to prevent damage to seal when axle splines are going through seal.

Front Axle Installation

Reverse steps 1 - 9 under Front Axle Removal.

If a new transaxle is installed, determine correct shim to use behind spiral bevel gear on hydraulic motor by subtracting actual motor flange face to sleeve dimension from dimension stamped on transaxle or attached to tag.

Dimensional Range	Pinion Shim
2.6000 - 2.6155	0.038 (82-5390)
2.6156 - 2.6225	0.045 (82-5380)
2.6226 - 2.6400	0.052 (82-5400)

After Assembly

1. Fill transaxle with approximately 144 oz. (4.5 U.S. qt.) of SAE 80-90W EP gear lube.

2. Check for hydraulic oil leaks.

3. Check adjustment of transaxle shift linkage.

4. Check brake "free play" adjustment.

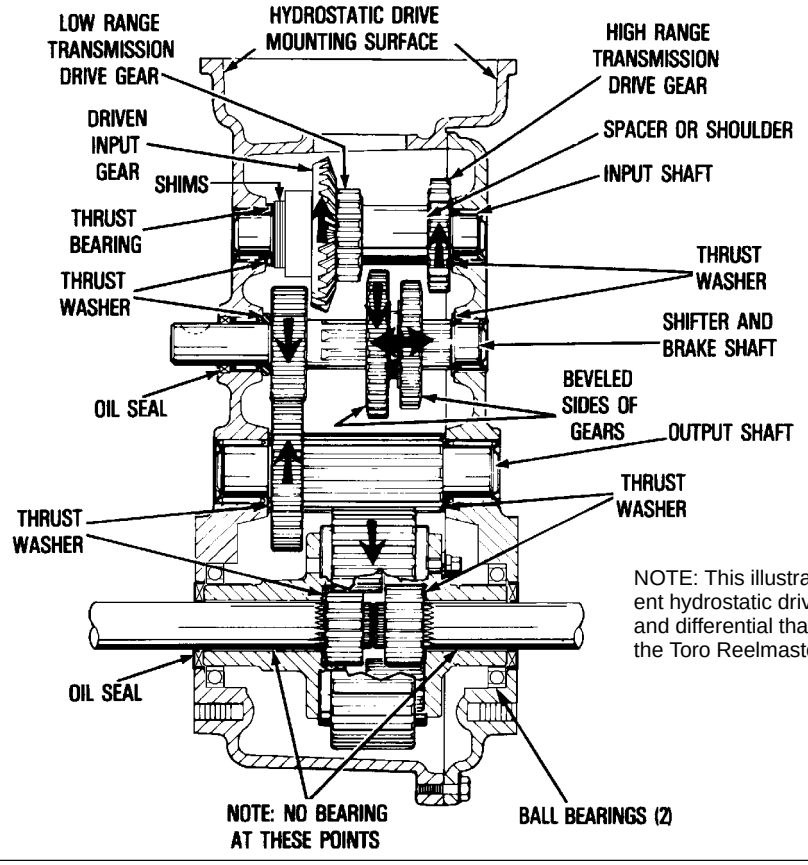


Figure 13

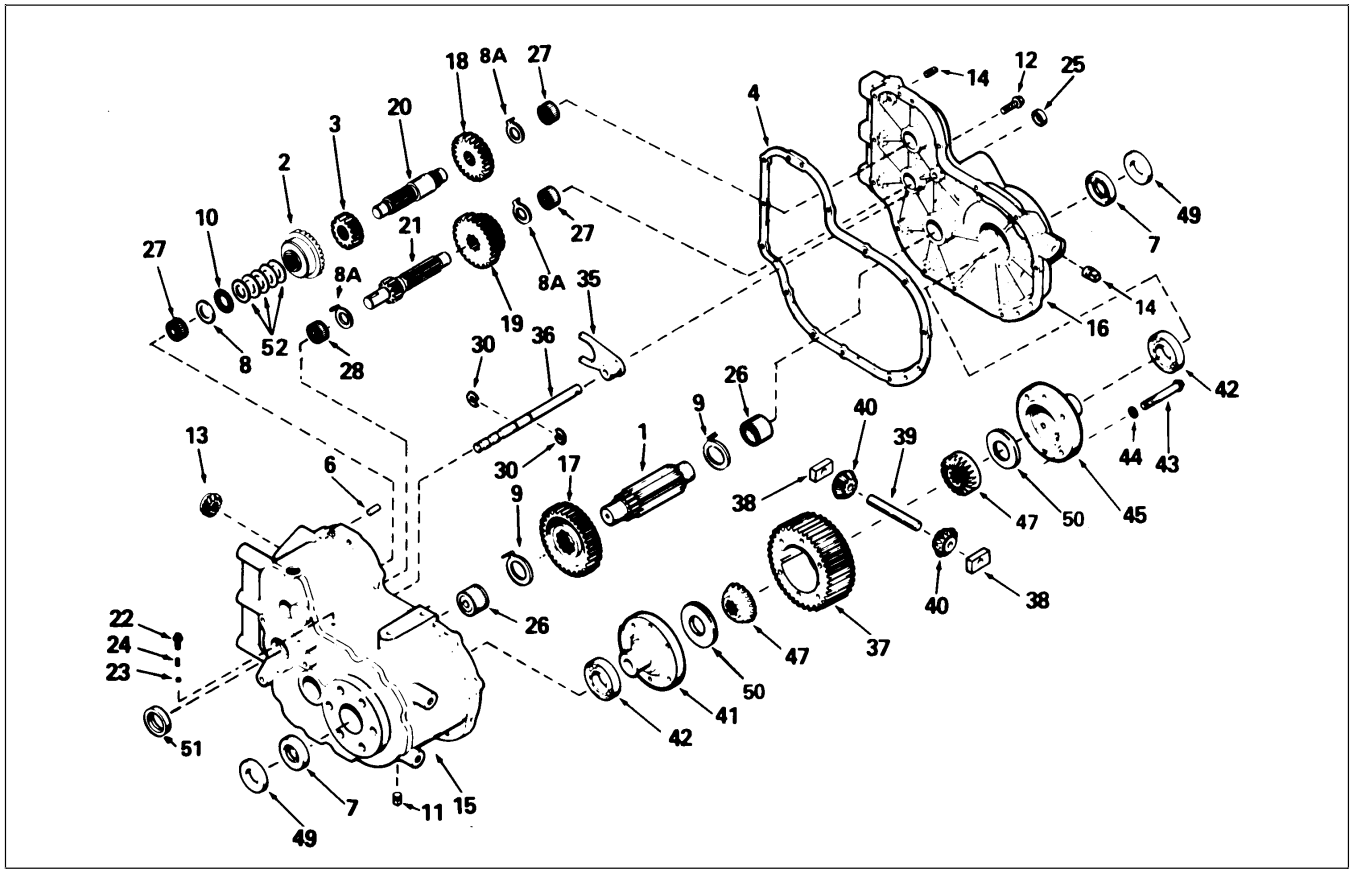


Figure 14

Transaxle Disassembly

1. Clean all exterior surfaces of transaxle.

2. Put the transaxle on a work bench with cover side up. Remove screws. Lift cover (Fig. 14, Item 16) off and discard gasket (Item 4).

3. Remove differential assembly and thrust washers (Item 8A and 9).

4. Remove large drive gear (Item 18) from input shaft bevel gear assembly.

5. Before removing shifter rod and fork, the bolt (Item 22), spring (Item 24) and ball (Item 23) should be removed at the outside of the case.

6. Remove shifting rod (Item 36), fork (Item 35) and shifter gears (Item 19).

7. Remove output shaft assembly.

8. Remove shifter / brake shaft assembly.

Inspection

1. Check case and cover for leaks or cracks.

2. Remove and discard all oil seals. Do not replace seals until unit is reassembled.

3. Inspect needle bearings and replace if necessary.

   Use an arbor press and properly sized tool to remove and install needle bearings. When installing bearings, apply pressure to bearing from stamped side. Bearings should be pressed in 0.015 to 0.020 in. below the thrust surface.

4. Check gear teeth for wear, pitting or breakage.

5. Inspect bearing surfaces for smoothness.

6. Inspect gears and shafts for out of round.

7. Splines should allow a smooth fit. Rotate meshing parts for a better fit if binding seems excessive.

8. Check shift detent spring for tension and ball for wear.

9. Check shifter rod grooves for wear. Be sure snap ring sharp edges go away from shifter fork.

10. Inspect shifter fork for straightness and wear.

11. Check differential for loose or damaged parts.

12. Check differential carrier ball bearings for wear and smoothness of rotation and replace if necessary.

Transaxle Assembly

Reverse steps 1 - 8 under Transaxle Disassembly, watching out for the following:

1. After shift rod is in position, install ball, then spring and bolt. Turn bolt in until head of bolt contacts case.

2. Be sure that thrust washers and spacers are between every shaft and case and cover.

3. Threads of differential bolts must be coated with standard stud Loctite. Install differential assembly so bolt heads are facing away from gear on output shaft.

4. Install new gasket. It may be helpful to dampen gasket with oil to get it to lie flat.

5. After installing cover, install new brake shaft oil seal (Item 51), shifter rod oil seal (Item 25) and axle shaft oil seals (Item 7).

6. To install axle assemblies into transaxle case, grease axle spline ends heavily. Push axle through seal. Use caution to prevent damage to seal when axle splines are going through seal.

6. Install hi/low interlock switch (Fig. 11, Item 17) into transaxle case if removed.

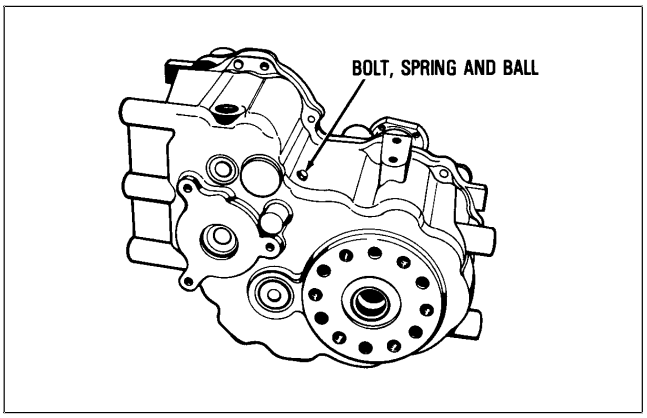


Figure 15

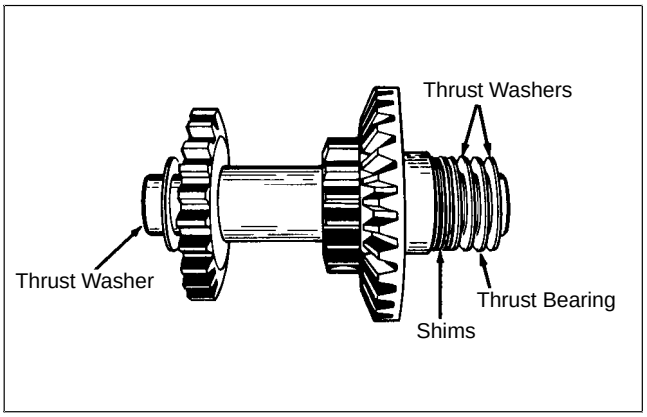


Figure 16

Rear 4WD Axle Service

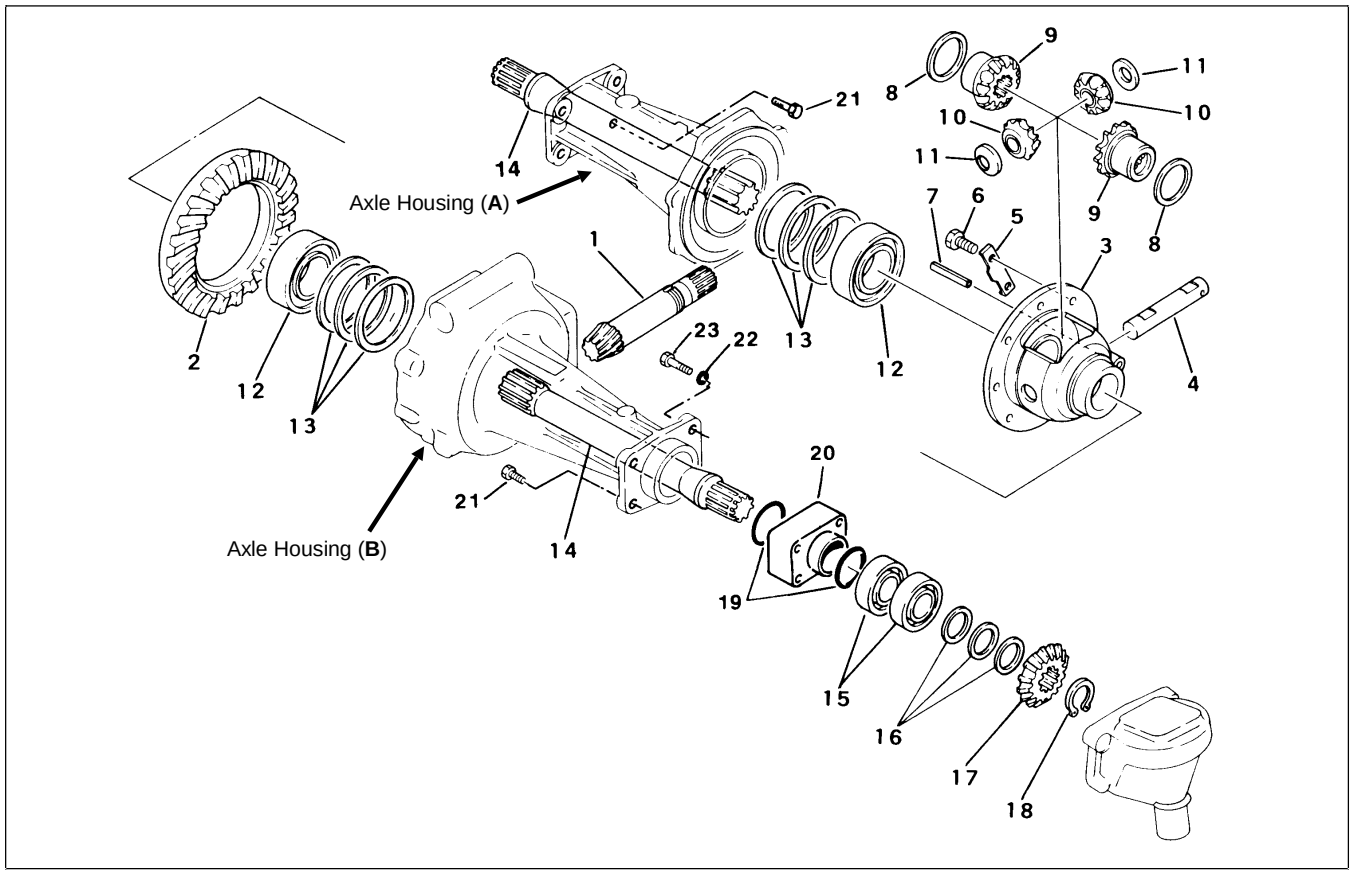


Figure 17

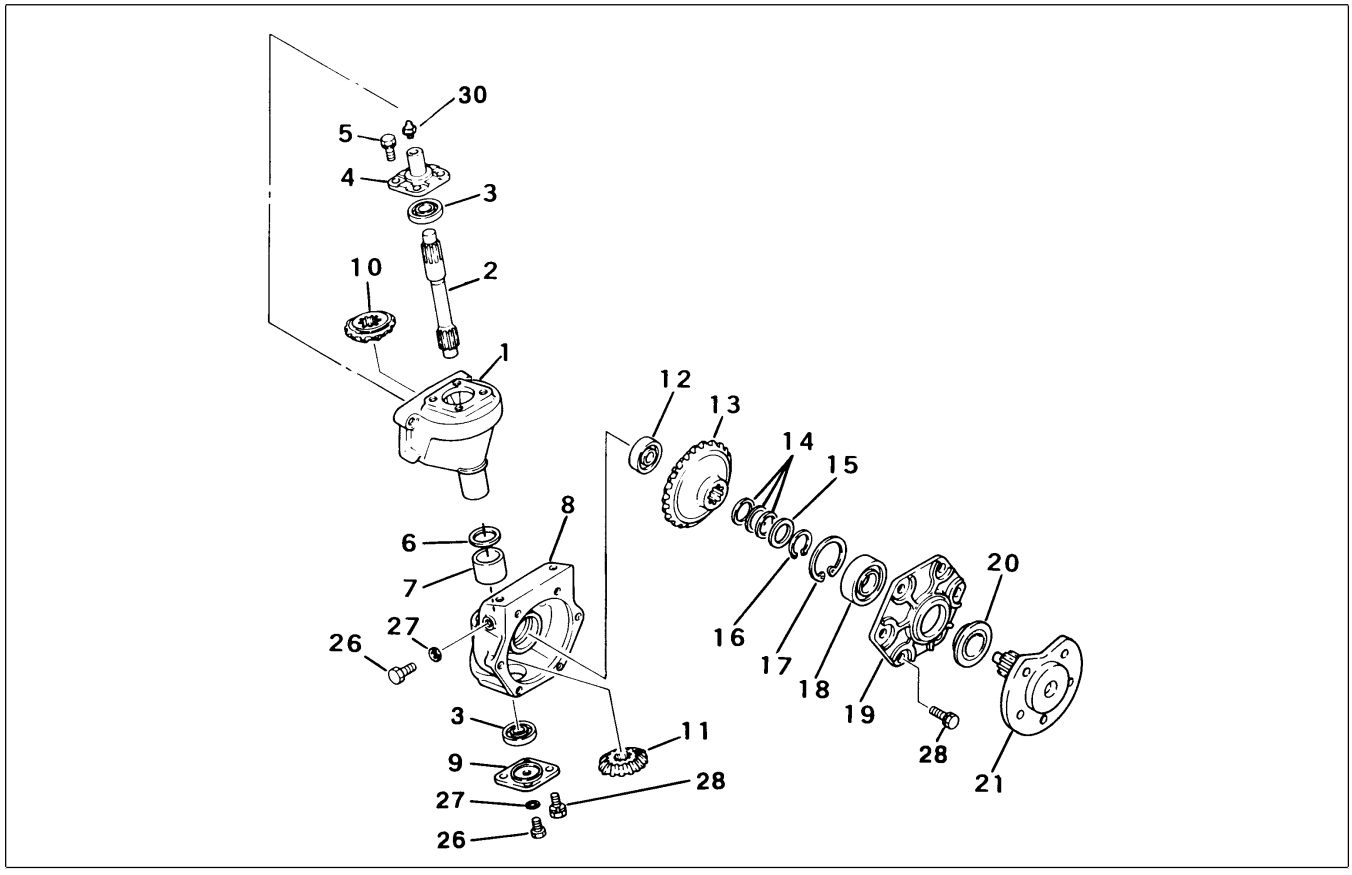


Figure 18

Disassembly

The two gear cases, right and left can be removed from the housing without requiring the entire axle to be disassembled.

1. Remove tie rod by disconnecting rod end ball joint on each end. Disconnect hydraulic cylinder rod end from drag link arm.

2. Remove bolts (Fig. 17, Item 23 and 21) securing gear case to axle housing and pull gear case complete with final drive case.

NOTE: Of four (4) bolts securing the gear case, the one on the bottom right side (viewed from center of axle) is a reamer bolt (Item 21).

Disassembling Final Drive Case

1. Remove bearing holder (Fig. 18, Item 19) from final drive case. The holder will come out together with the wheel shaft (Item 21).

2. Pull draglink arm or tie rod arm off final drive case. Be sure to recover the thrust washer.

3. Remove the bolts securing top cover (Item 4) to gear case and remove the cover to expose the top end of final drive shaft (Item 2). Drive lightly on the exposed shaft end so that the final drive case will slide off the gear case.

4. Remove bottom cover (Item 9) from final drive case to expose bottom end of shaft. Drive the shaft out and take out the 15T bevel pinion (Item 11)).

Disassembling Wheel Shaft

1. Use a gear puller to draw the bevel gear (Item 13) and ball bearing (Item 12) off wheel shaft.

2. Remove shaft from bearing holder by lightly tapping on the shaft.

3. Remove retaining ring (Item 17) from holder and remove bearing outer race and oil seal (Item 20).

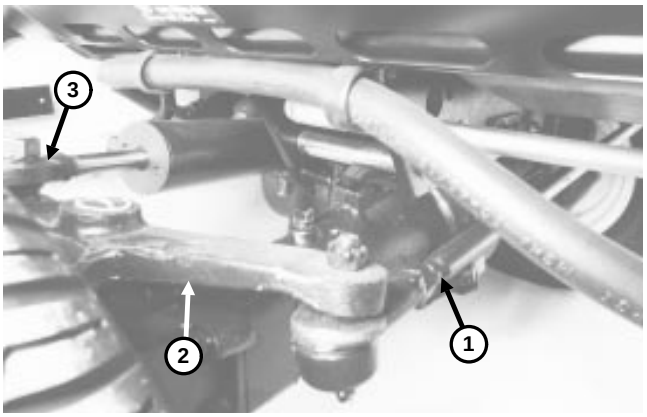


Figure 19

1. Tie rod **2. Drag link** **3. Hydraulic cylinder**

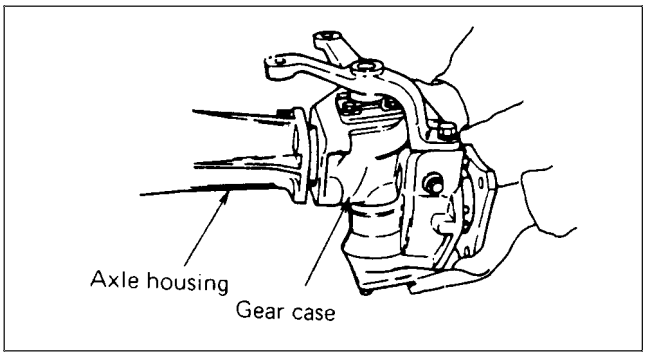


Figure 20

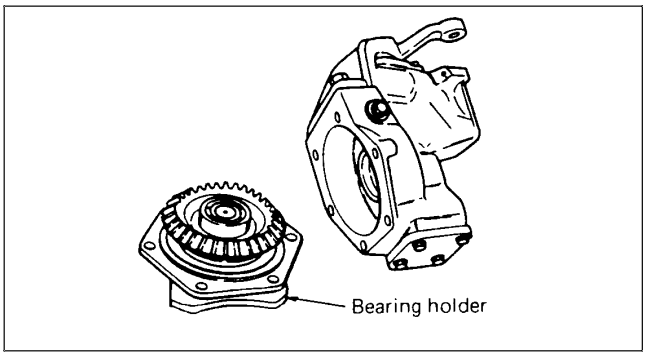


Figure 21

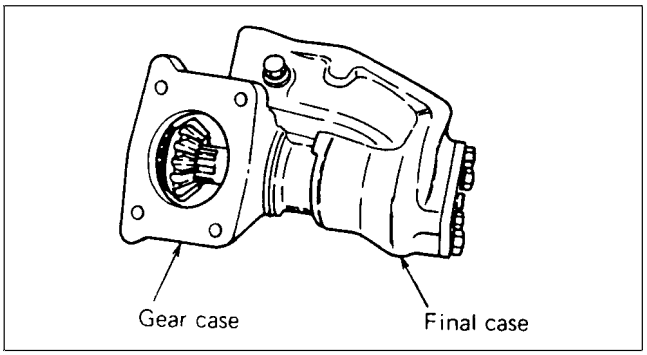


Figure 22

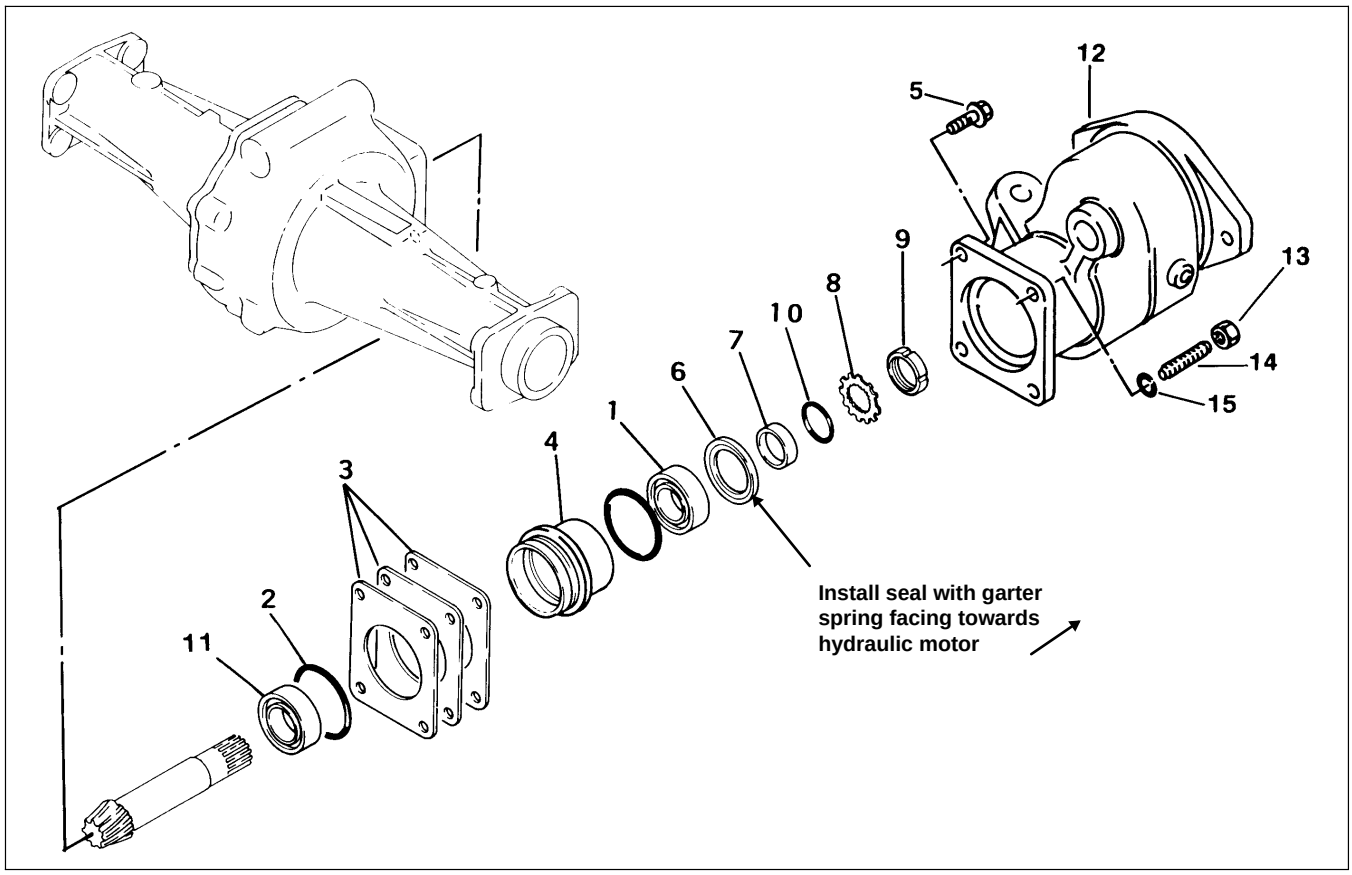


Figure 23

Disassembling Axle Housing

1. Remove axle from machine before disassembling:

   A. Jack up rear of machine and support from frame with jack stands.
   B. Remove wheels from axle.
   C. Remove hydraulic motor. Do not disconnect hydraulic lines from motor.
   D. Support axle with a jack, then remove axle pivot pin to separate axle from frame.
   E. Pull axle out from under machine and put on a work bench.
   F. Be sure to account for thrust washers between axle pivot and frame.

2. Remove bolts (Fig. 23, Item 5) securing adapter to axle housing and remove adapter.

3. Separate axle housing by removing bolts.

4. Pull out differential shaft (Fig. 17, Item 14) from housing (B).

5. Remove differential gear assembly (Fig. 17, Items 3 - 11) from axle housing (A).

6. Pull out differential shaft from housing (A).

Disassembling Sleeve Assembly

1. Remove sleeve (Item 4) from adaptor case. Straighten tab washer (Fig. 23, Item 8) and remove sleeve (lock) nut (Item 9).

2. Use a press or tap lightly on shaft end to force pinion shaft out of case.

3. Remove oil seal (Item 6) and bearings (Item 1 and 11) as necessary.

Inspection

Clean the disassembled parts by washing in cleaning solvent. Inspect gears and pinions to be sure their teeth are in good condition. Check to be sure that each bearing rotates smoothly. Examine housings for cracks.

Reassembly

Replace damaged or worn parts as necessary. Oil or grease the surfaces of rotating or sliding parts before assembling. Grease oil seals and o-rings before installing.

Assembling Pinion Shaft

1. Fit two outer races of tapered roller bearings into sleeve, positioning each race as shown.

2. Fit inner race of tapered roller bearing to gear side of pinion shaft, pushing it all the way against the pinion shoulder.

3. Insert pinion shaft into sleeve. Fit other inner race to shaft and install oil seal bushing. Pinion shaft is now securely installed inside the sleeve.

4. Grease oil seal and install it between sleeve and bushing, with garter spring facing toward hydraulic motor. Make outer end face flush with mating face of sleeve.

5. Grease o-ring. Install o-ring, tab washer and lock nut. Tighten lock nut to specified preload on bearings.

Pinion shaft bearing preload	0.04 ~ 0.06 kg-m (0.29 ~ 0.43 ft-lb)

NOTE: Make sure pinion shaft has no end play when checking bearing preload.

6. After obtaining specified preload, secure lock nut by bending tab washer.

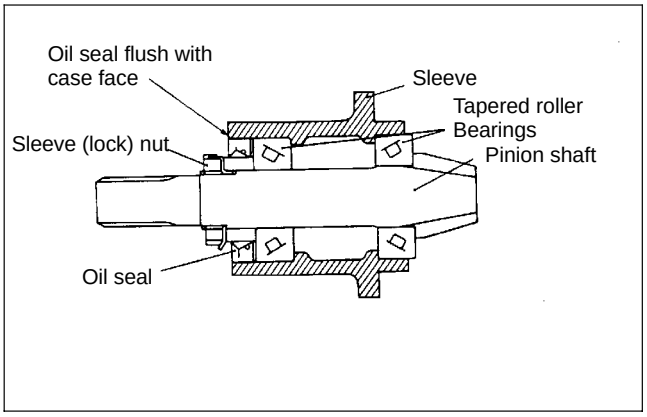


Figure 24

Adjusting Pinion Shaft Cone Center

"Cone Center" is the distance from the mating face of axle housing to end face of pinion (Fig. 25A). This distance can be increased or decreased by installing removing shims.

Cone center specification	43 ± 0.05mm (1.69 ± 0.002 in.)

Shim stock for this adjustment is available in the following thicknesses:

Thickness	**Part No.**
Shim set	77-4010
0.1 mm (0.004 in.)	76-7410
0.2 mm (0.008 in.)	76-7420
0.4 mm (0.016 in.)	77-7430

Determine the required thickness of shim by proceeding as follows:

1. Apply grease to o-rings. Install o-rings to sleeve, then install sleeve assembly into adapter case.

2. Put a straightedge on end of pinion shaft and measure distance between bottom of straightedge and face of adaptor case (Fig. 25B). Subract 43 mm (1.69 in.) from measured distance. Select shim(s) closest to result.

Example: 43.18 mm (measured distance) – 43 = 0.18 mm.
Use 0.02 mm shim.

Apply grease to o-ring and fit to mating face of sleeve. Attach adapter case to axle housing (A) and secure by tightening bolts to proper torque.

Adapter bolt torque	2.5 ~ 3.0 kg-m (18 ~ 22 ft-lb)

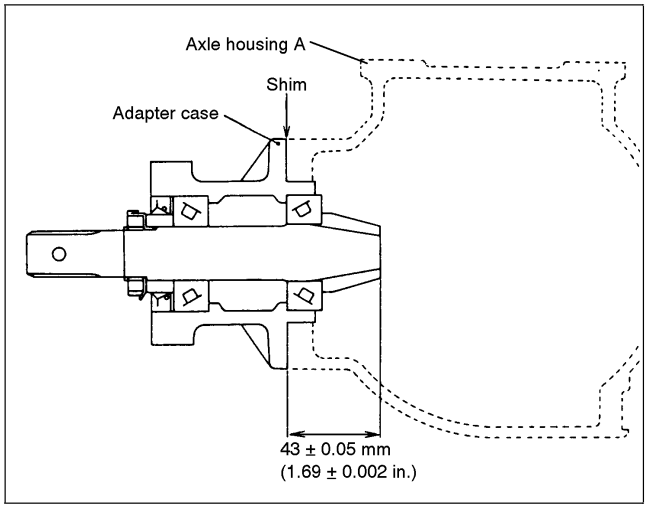


Figure 25A

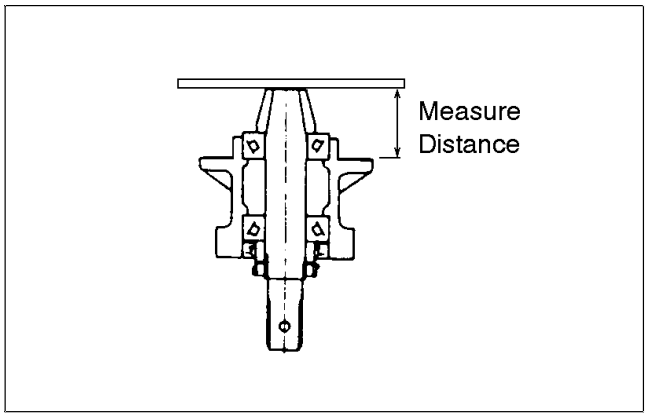


Figure 25B

Adjusting Backlash

Backlash specification	0.25 ~ 0.35 mm (0.010 ~ 0.014 in.)

Adjust shim thickness (between bearing housing of axle housing (A) and bearing) to get specified backlash. Shim stock for this adjustment is available in these thicknesses:

Thickness	**Part No.**
Shim set	77-4000
0.1 mm (0.004 in.)	76-7290
0.2 mm (0.008 in.)	76-7300
0.4 mm (0.016 in.)	76-7310

Shim Between Differential and Axle Housing (B)

After obtaining specified backlash, determine amount of shims needed:

1. Put the straightedge flat on the ball bearing (Fig. 28A).

2. Read clearance A between axle housing (A) and straightedge.

3. Put straightedge on axle housing (B) and read clearances C and D. Subtract D from C. The difference between D and C is clearance B (Fig. 28B).

4. Select from the shim shock to obtain:

A – B = 0 to 0.1 mm (0. to 0.004 in.).

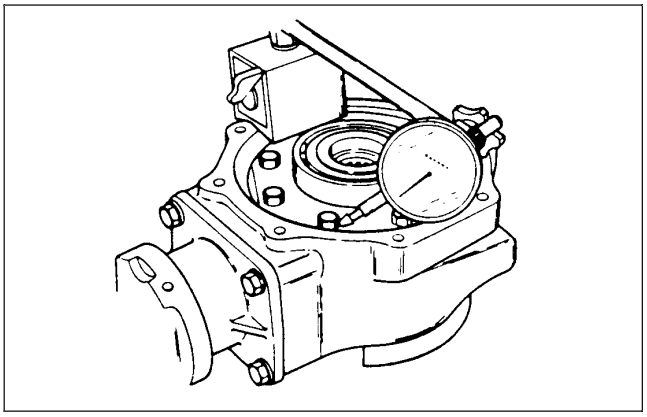


Figure 27

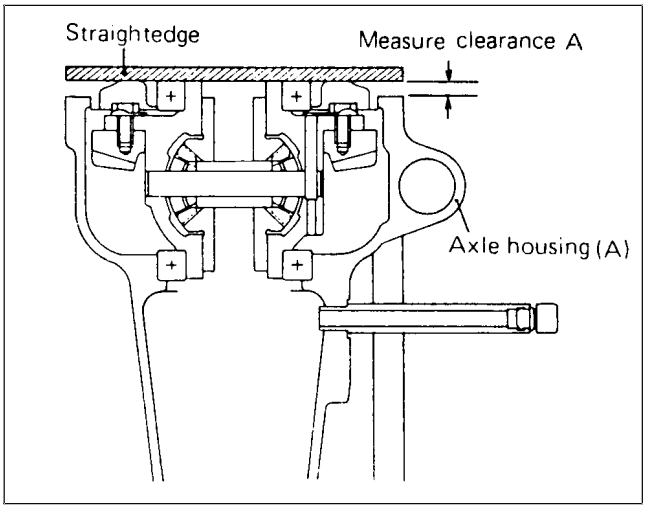


Figure 28A

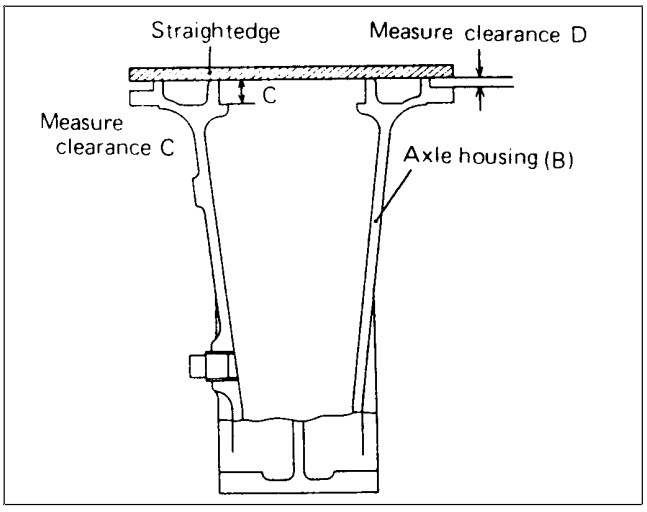


Figure 28B

Assembling Axle Housing

1. Coat mating faces of two housings (A) and (B) with sealant and attach selected shim to face of housing (B). Put the two housings together and fasten them by tightening bolts to following torque value:

Torque specification	2.5 ~ 3.0 kg-m (18 ~ 22 ft-lb)

2. Fit ball bearings to out end of each differential shaft, then mount pinion (14T) and retain pinion by installing circlip. The ball bearings have a groove cut in the end faces of the inner and outer races. Be sure to position the bearing to its grooved end is on inner side as shown.

3. Install o-rings to spacers. Insert differential shafts through spacers then install differential shaft and spacer to each axle housings.

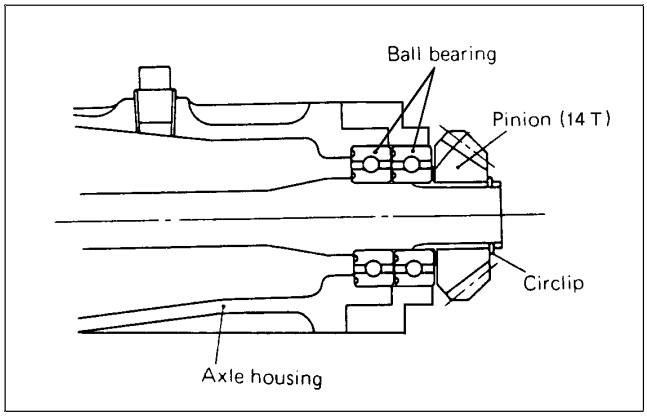


Figure 29

Assembling Gear Case and Final Case

1. Install bushing into final case.

2.Grease oil seal and carefully fit it to final case, making sure the seal is properly aligned.

NOTE: The steel part of this oil seal is so thin that the seal can distort at the time of installation.

3. Insert final drive shaft into gear case, bringing its large diameter end to top side and fitting pinion (14T) onto splined end. Install inner race of upper tapered roller bearing as shown.

4. Fit bearing out race into gear case. Apply sealant to mating face of holder and secure to case by tightening bolts to following torque value:

Torque specification	2.5 ~ 3.0 kg-m (18 ~ 22 ft-lb)

NOTE: Be sure to wrap each bolt with sealing tape before installation.

5. Attach final case to gear case while fitting pinion (15T) onto splined end of shaft.

6. Install tapered roller bearing. Apply sealant to mating face of cover and secure cover to final case. Tighten bolts to above listed torque value:

7. Wrap drain plug with sealing tape and install in bottom cover.

8. Turn final case around gear case by hand and check for smooth rotation.

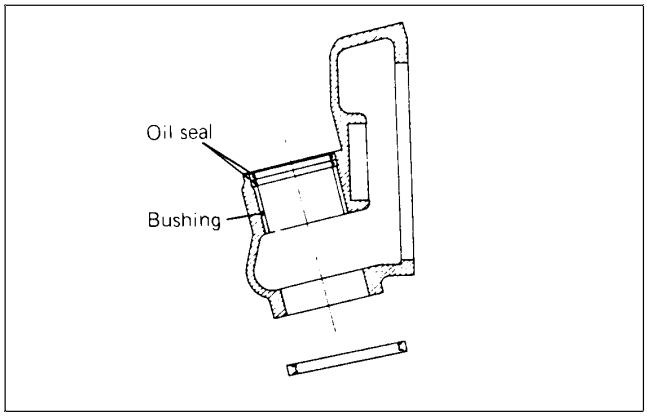


Figure 30

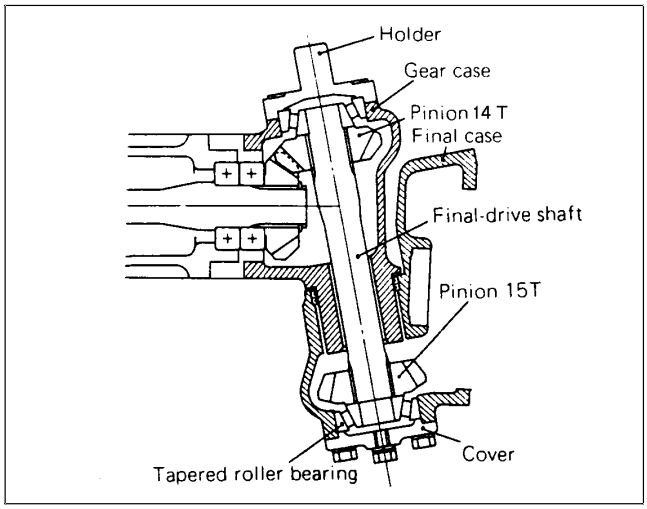


Figure 31

Installing Drag Link and Tie Rod Arm

1. Carefully insert bushing into arm.

2. Put arm into position over holder, fitting it to final case and secure to case with bolts.

3. Check thrust clearance. Proper thrust clearance is 0 to 0.2 mm (0.008in.). If necessary reduce clearance to specification by shimming. Shim stock for this adjustment is available in the following thicknesses:

Thickness	**Shim Part No.** TIE ROD ARM	**Shim Part No.** DRAG LINK ARM
Shim set	77-4050	77-4040
0.8 mm (0.03 in.)	76-7820	76-7700
1.0 mm (0.04 in.)	76-7970	76-7760
1.2 mm (0.05 in.)	76-7980	76-7780
1.4 mm (0.055 in.)	76-7990	76-7790

4. After selecting required shim, remove the arm. Apply multi-purpose lithium base grease to OD part of holder. Install holder on arm with shim and secure to final case by tighten reamer bolts to following torque value:

Torque specification	8.5 ~ 9.5 kg-m (61 ~ 69 ft-lb)

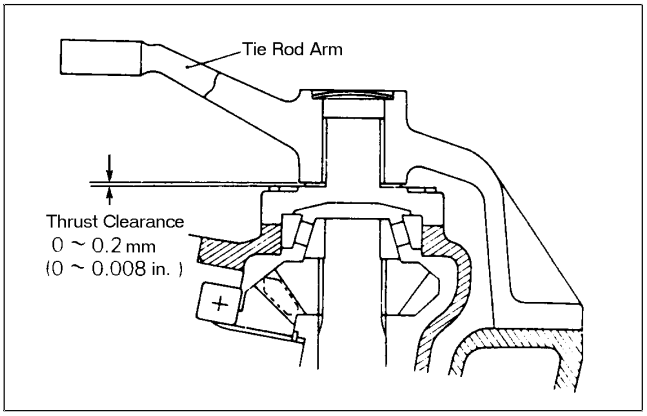


Figure 32

Installing Gear Case Assembly to Axle Housing

1. To check backlash between pinions (14T) — one on final drive shaft and one on differential shaft — temporarily fit gear case to axle housing and tighten two bolts diametrically opposite. DO NOT use black reamer bolt for this temporary assembly.

2. Install a dial indicator to final case, putting gauge spindle to tooth on pinion (15T pinion on bottom end of final drive shaft). Take a backlash reading.

Pinion (14T) backlash	0.2 ~ 0.4 mm (0.008 ~ 0.016 in.)

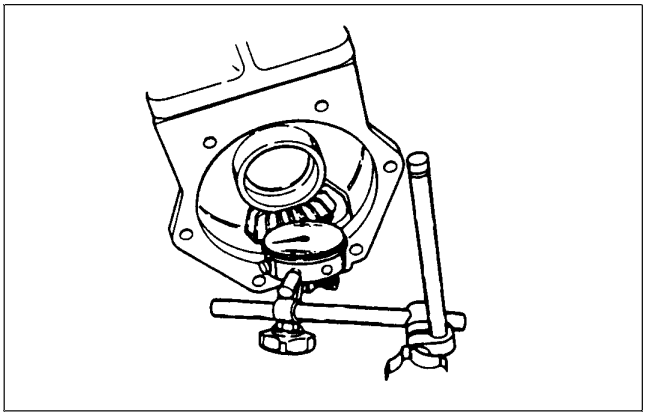


Figure 33

3. If reading is outside of specified range, remove gear case and adjust shim between pinion (14T) on differential shaft and ball bearing. Shim stock for this adjustment is available in the following thicknesses:

Thickness	**Part No.**
Shim set	77-4020
0.1 mm (0.004 in.)	76-7520
0.2 mm (0.008 in.)	76-7530
0.4 mm (0.016 in.)	76-7540

4. After obtaining proper pinion backlash, grease o-ring and fit it to mating face of axle housing. Secure gear case to housing by tightening bolts to the following torque value:

Torque specification	5.0 ~ 6.0 kg-m (36 ~ 43 ft-lb)

Reassembling Wheel Shaft

1. Grease oil seal and fit it to bearing holder.

2. Insert shaft into holder. Install ball bearing and retain bearing by installing circlip.

3. Mount bevel gear (29T) on splined end of shaft.

4. Fit bearing holder (complete with shaft and bevel gear) to final case and temporarily secure it bolting. Leave bolts lightly tightened.

NOTE: Inner ball bearing is left out at this time.

5. Check backlash between bevel gear (29T) and pinion (15T) by installing dial indicator on tip of wheel shaft. Adjust shim between bevel gear (29T) and ball bearing if reading is outside of specification:

Bevel gear (29T) backlash	0.2 ~ 0.4 mm (0.008 ~ 0.016 in.)

Shim stock for this adjustment is available in the following thicknesses:

Thickness	**Part no.**
Shim set	77-4030
0.1 mm (0.004 in.)	76-7890
0.2 mm (0.008 in.)	76-7900
0.4 mm (0.016 in.)	76-7910

6. After obtaining proper backlash, remove bearing holder and install inner ball bearing on shaft. Apply sealant to mating face of final case and attach holder. Tighten bolts to following torque value:

Torque specification	2.5 ~ 3.0 kg-m (18 ~ 22 ft-lb)

7. Use a torque wrench as shown to check final case for torque required to turn it around gear case and make sure that no more than 0.03 kg-m (0.22 ft-lb) is required.

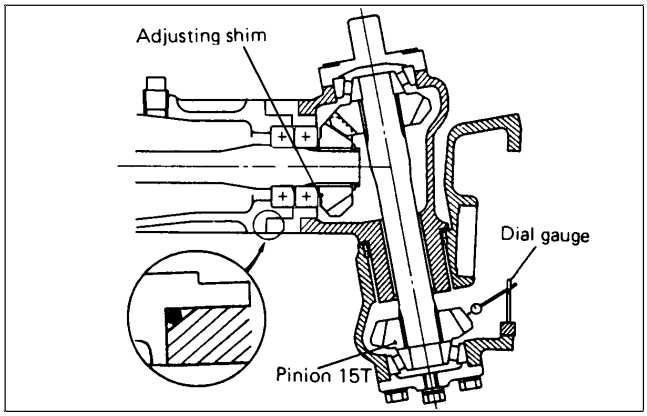


Figure 34

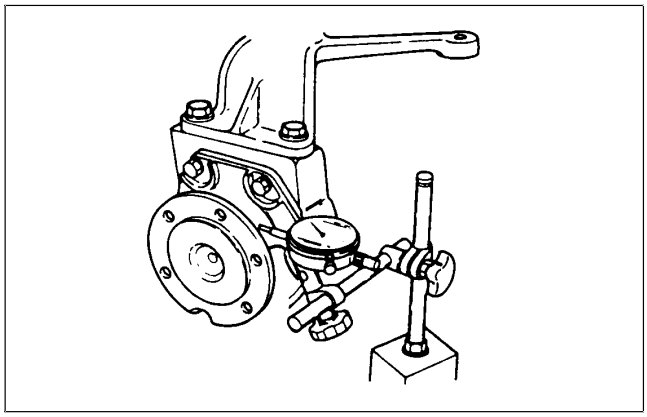


Figure 35

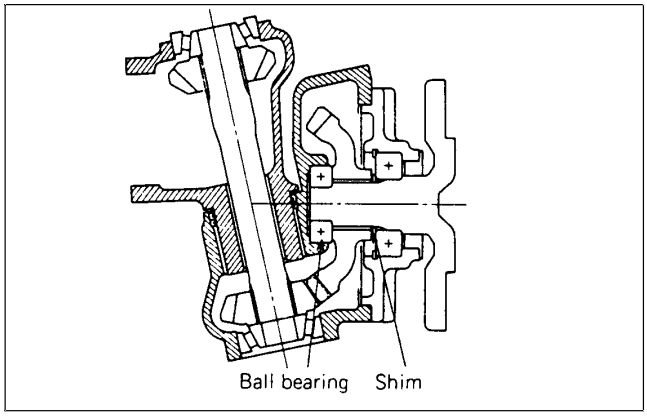


Figure 36

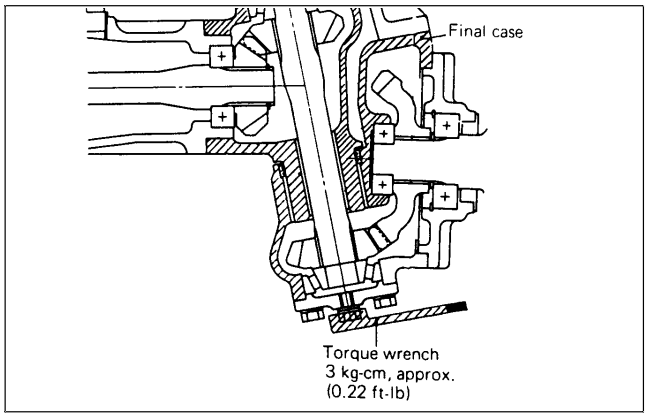


Figure 37

Installing Axle on Machine

1. Support axle under machine with a jack.

2. Install axle pivot pin to secure axle to frame. Make sure to install thrust washers between axle pivot and frame.

3. Install hydraulic motor to adaptor housing.

4. Install wheels to axle. Tighten lug nuts to a torque of 45 - 55 ft-lb.

5. Fill axle with SAE 80-90W EP gear lube. Lubricant capacity is approximately 80 oz. (2.5 U.S. qt.).

6. Check rear wheel toe-in and adjust if necessary.

Rear wheel toe-in	0.25 in.

Chapter 7

Cutting Units

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Specifications

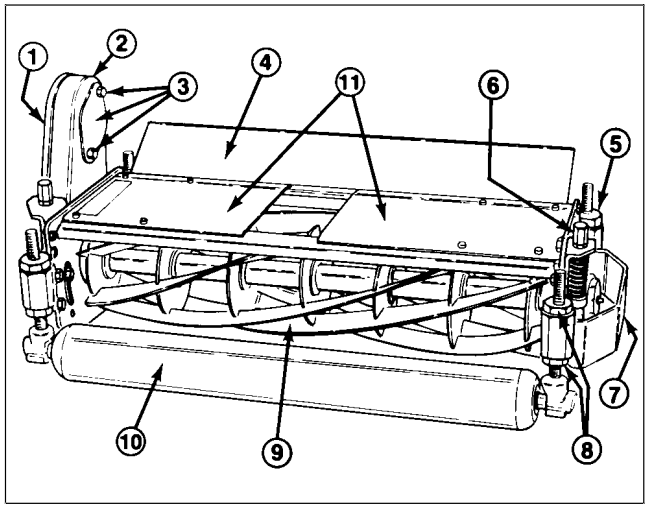

Figure 1

1. **Drive housing cover**
2. **Drive housing**
3. **Reel motor fasteners, drive plate shield and shipping cover**
4. **Grass deflector**
5. **Rear roller adjusting assembly**
6. **Reel to bedknife adjusting assembly**
7. **Guard**
8. **Cone nut**
9. **Reel assembly**
10. **Front roller (optional)**
11. **Top covers**

Construction: Welded steel frame and reel with heavy duty, self-aligning ball bearings. Heavy duty steel rear roller with tapered roller bearings. Rear roller and bedbar are isolated and mounted in rubber bushings for quiet, vibration-free operation. Adjustable deflector shields are standard. Stainless steel components are used at key points for added durability.

Reel Configuration: The 5, 7 and 11 blade heavy duty welded reels all have 8 in. (20.3 cm) diameters and are 29-3/4 in. (75.5 cm) wide.

Bedknife/Bedbar Assembly: A replaceable, single edged, alloy steel bedbar is induction hardened. It's fastened with steel screws to a precision ground surface on the high strength, fabricated steel bedbar. The stress-relieved machined bedbar is mounted with four (4) vibration isolation bushings.

Bedknife to Reel Adjustment: Two lockable lead screw adjusters at each side of the frame adjust the reel to bedknife contact.

Rear Roller: 3-1/2 in. (89 mm) diameter steel roller has greaseable tapered roller bearings. A double lip oil seal and wear sleeve isolates grit and moisture from the bearings.

Height-of-Cut: 5 Blade - 1 to 3 in. (25 to 76 mm). 7 Blade - 1/2 to 1-3/4 in. (9.5 to 45 mm). 1 1 Blade - 3/8 to 3/4 in. (9.5 to 19 mm).

Height-of-Cut Adjustment: Quick adjustment and positive locking is provided by locking type cone nuts. Gauge marks of 1/4 in. (6.3 mm) are provided as a reference for easy changes of height-of-cut.

Clip (variable to match cutting conditions):

5 Blade Cutting Unit: .176 in. per mph
(.352 in. at 2 mph - 1.32 in. at 7.5 mph)

7 Blade Cutting Unit: .1 26 in. per
(.252 in. at 2 mph - .945 in. at 7.5 mph)

11 Blade Cutting Unit: .080 in. per mph
(.16 in. at 2 mph - .600 in. at 7.5 mph)

Lubrication: Easily accessible grease fittings for bearings and all major pivot points.

Drive: The reel drive motor turns a maintenance-free cog belt which drives the reel. Drive pulley and cog belt are encased in a drive housing for safety and protection from contamination.

Grass Deflector Shields: Fully Adjustable.

Special Tools

Order special tools from the *TORO SPECIAL TOOLS AND APPLICATIONS GUIDE (COMMERCIAL PRODUCTS)*. Some tools may be listed in the Reelmaster 335-D Parts Catalog. Some tools may also be available from a local supplier.

Gauge Bar Assembly

Use gauge bar to set final height of cut (floating cutting unit with front roller only).

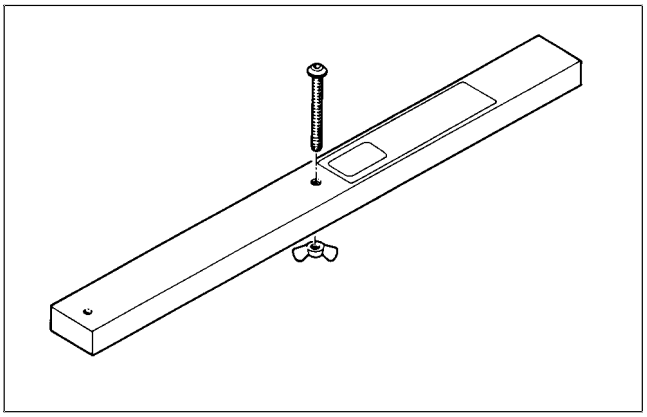

Figure 2

Handle Assembly

For applying lapping compound to cutting units while keep hands a safe distance from the rotating reel.

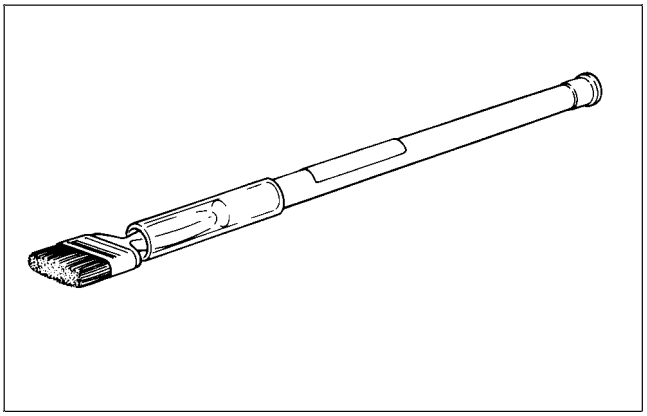

Figure 3

Bedknife Screw Tool

Fits Toro bedknife attaching screws. Use with torque wrench to secure bedknife to bedbar. With clean bedbar threads and new screws, tighten to a torque of 250 in-lb.

NOTE: Remove all rust, scale and corrosion from bedbar surface before installing bedknife.

DO NOT use and air impact wrench with this tool.

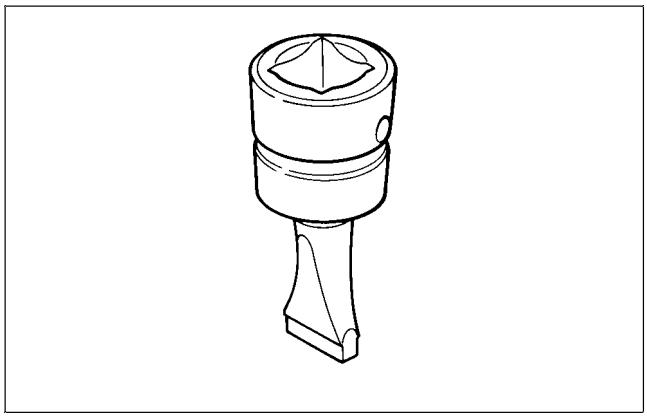

Figure 4

Adjustments

CAUTION

Never install or work on the cutting units or lift arms with the traction unit engine running. Always stop the engine and remove the key first.

Adjusting Reel to Bedknife Contact

Before adjusting height-of-cut and each day before operating, check reel to bedknife contact, regardless if quality of cut had previously been acceptable.

NOTE: A 3/4" wrench is required for making the reel to bedknife adjustment.

A. Slowly and carefully rotate reel,listening for light contact across the full length of the reel and bedknife.

CAUTION

Before adjusting reel to bedknife, raise and fully latch cutting units. Remove key from the ignition switch. Keep others off machine while adjusting cutting units.

B. If no contact - loosen the adjuster locking nut on each adjuster (Fig. 5). Then, equally turn each adjuster knob clockwise until light contact is felt and heard.

C. If excessive contact - Turn the adjusting knobs counter-clockwise until no contact is noticed. Then equally turn both adjusting knobs clockwise, until light contact is felt and heard between the reel and bedknife. Final adjustment should always be in the tightening (clockwise) direction.

D. Tighten adjuster locking nuts when completed making adjustments.

AUTION

When adjusting the cutting units, wear heavy gloves and use care when turning reels by hand. Sharp edges can cut or pinch hands or fingers.

IMPORTANT: Adjusted correctly, the reel will cut paper (approx. .003" thick) across its entire length.

The Reelmaster 335-D cutting units will provide optimum mowing performance when adjusted and maintained correctly. Keeping a precise reel to bedknife adjustment (light contact), at each end of the cutting unit will produce a continual self-sharpening action. Therefore, sharp cutting edges are maintained, good quality of cut assured, and the need for corrective re-sharpening reduced.

IMPORTANT: Cutting units with excessive contact between the reel and bedknife are noisy, consume excessive power, shorten component life and result in overall poor performance. Light contact between the reel and bedknife, once the cutting unit is warmed up, provides optimum mowing performance and component life.

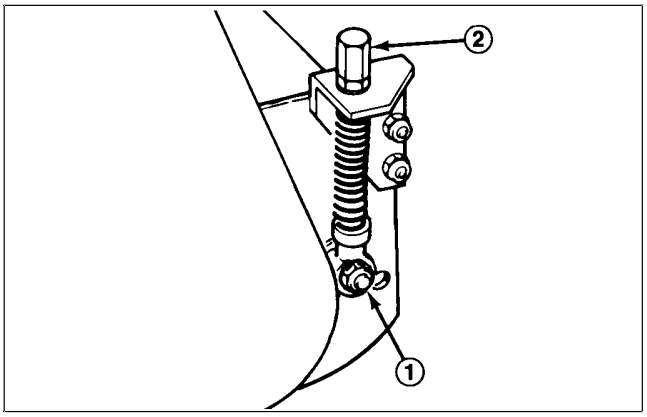

Figure 5

1. Adjuster locking nut
2. Adjustment knob

Height-of-Cut Adjustment (Floating Cutting Unit)

Overview of Procedure:

1. Adjust reel to bedknife contact
2. Level rear roller to reel
3. Final height-of-cut adjustment using gauge bar.

STEP 1 - Adjust Reel to Bedknife Contact

A. Adjust reel to bedknife contact on all cutting units. (Refer to Adjusting Reel To Bedknife Contact).

STEP 2 - Level Rear Roller to Reel

B. Start engine and lower the cutting units onto a flat surface such as a piece of 3/4" or 1 " plywood (at least 20" x 30" in size). Stop engine and remove key from switch. Lock cutting units in the fixed position, by loosening the jam nut on lockout pin (Fig. 6) and screwing pin into hole in pivot arm (Fig. 7). Tighten nut to secure lockout. Raise the front rollers up so they do not contact the flat surface.

C. Insert a piece of bar stock 25" - 28" (70 cm) long (Fig. 8), and approximately 1/8" (3 mm) thicker than the desired height-of-cut, under the reel and up against the bedknife cutting edge (Fig. 8). The reel (not bedknife) must contact the bar stock along its full length.

NOTE: Using a bar 1 /8" (3 mm) thicker than height-of-cut provides proper bedknife attitude (heeled “up” in back) required for excellent low height-of-cut performance.

D. Loosen rear roller jam nuts and adjusting knobs and push roller down against flat surface. At this point the reel should contacting the bar stock and the rear roll contacting the flat surface. Contact should exist along the entire length of the reel a rear roller. Tighten rear roller adjustme knobs and jam nuts. Recheck to be sure roller and reel are both still making contact after jam nuts have been tightened. Check roll contact by trying to slide paper between the roller and the flat surface.

E. Rear roller is now leveled to the reel.

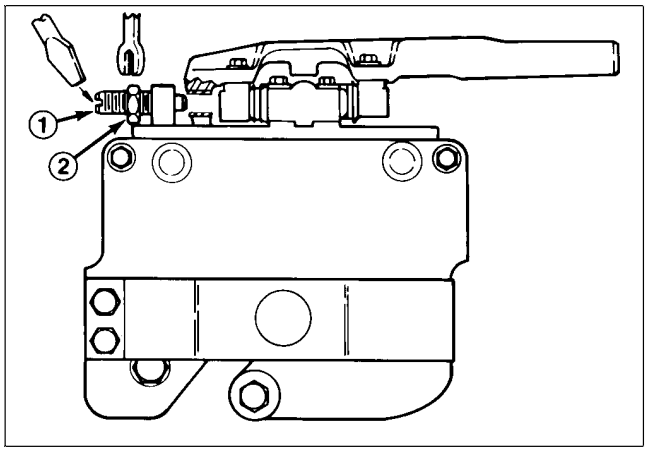

Figure 6
Cutting Unit Float Position

1. Lockouts **2. Jam nut**

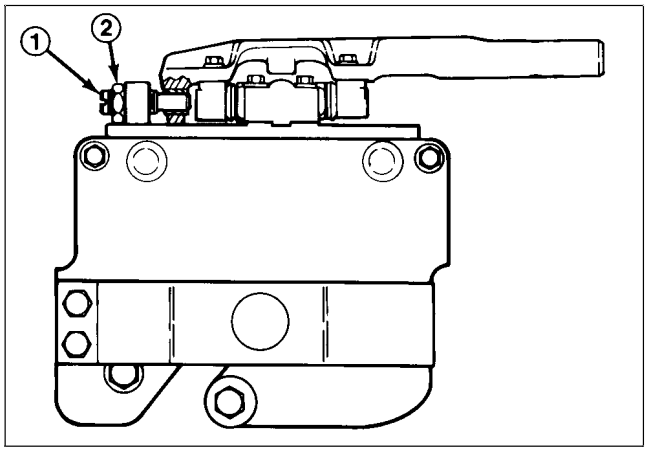

Figure 7
Cutting Unit Fixed Position

1. Lockout pin **2. Jam nut**

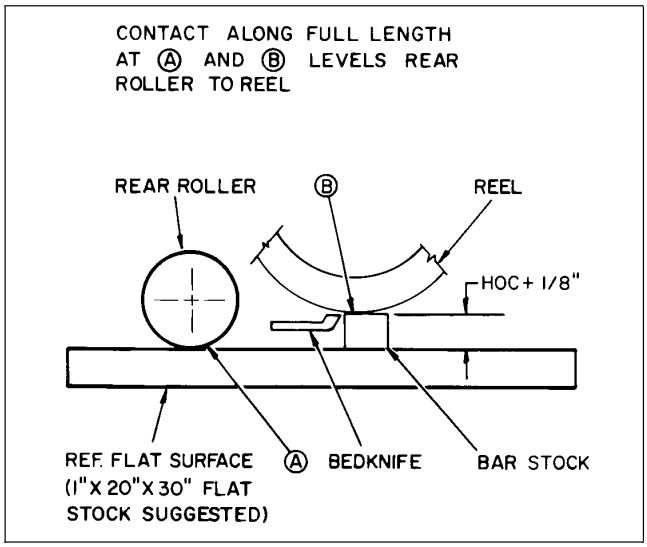

Figure 8
Leveling Rear Roller to Reel

STEP 3 - Final Height-of-Cut Adjustment Using Gauge Bar

F. Raise cutting units and lock in the transport position. Shut off the engine and remove the key.

G. Use gauge bar (Toro Part No. 59-7900) to set final height-of-cut by adjusting front roller only.

H. Loosen the gauge bar jam nut and adjust the screw to set dimension between underside of screw head and gauge bar for desired height-of-cut. (Fig. 9). Tighten the jam nut to secure the adjustment. Hook screw head over cutting edge of bedknife and position bar against bottom of front roller (Fig. 10).

I. Loosen front roller nuts and adjust both ends of the front roller until it contacts gauge bar at both ends. With the gauge bar held firmly against the bottom of the rollers adjust the front roller so the screw head just slips over the lip of the bedknife (Fig. 10). Tighten front roller nuts.

IMPORTANT: Set properly, front and rear rollers will contact gauge bar and screw head will be snug over bedknife cutting edge when checked at both ends of the reel.

J. Loosen lockout pin so cutting unit can float freely (Fig. 6).

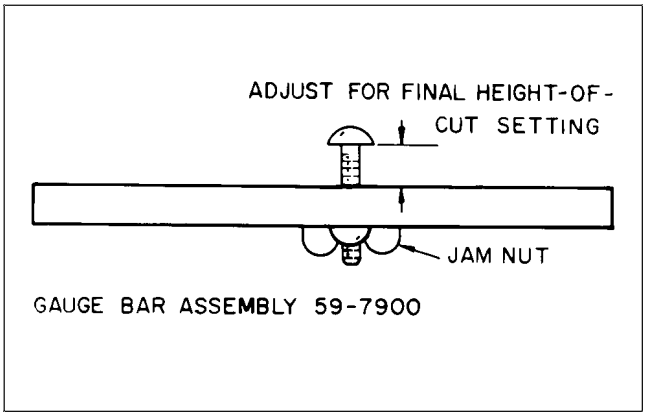

Figure 9
Gauge Bar Assembly

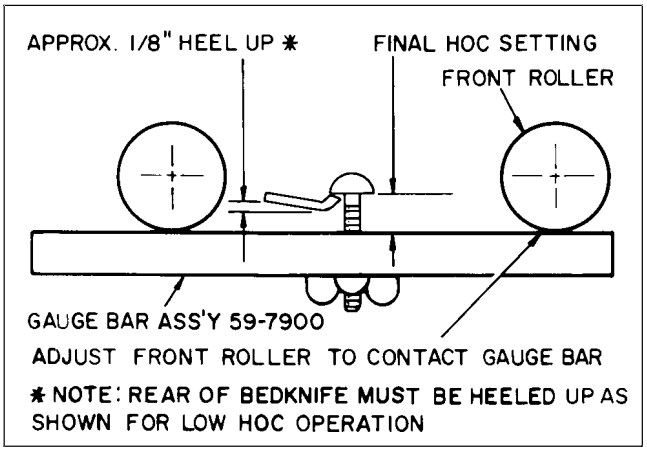

Figure 10
Final Height-of-Cut Adjustment Using Gauge Bar

Quick Method For Changing Height-of-Cut After Initial Set Up of a Floating Cutting Unit

If the reel to bedknife adjustment has been set (STEP 1) and the rear roller leveled to the reel (STEP 2), the 335-D cutting unit may be quickly changed from one height-of-cut to another by using the gauge bar (Part #59-7900) and adjusting the front roller only. In many cases, an entire machine can be done quickly by using the gauge bar to set the front roller of one cutting unit. The remaining cutting units can then be set by loosening their front roller jam nuts and turning each front roller adjustment knob the same number of turns and in the same direction as the first unit.

Height-of-Cut Adjustment (Fixed Cutting Unit)

1. Adjust reel to bedknife contact.

2. Loosen nuts securing skids or front roller and raise to highest position.

3. Loosen jam nuts securing rear roller. Lower roller beyond desired height-of-cut (assures proper bedknife attitude).

4. Lower cutting unit onto a flat surface, such as a 1 " x 20" x 30" piece of plywood. Shut off engine and remove the key.

5. Insert piece of bar stock (Fig. 11) 25"-28" (70 cm) long with thickness equal to desired height-of-cut, under entire length of the reel, next to bedknife.

6. Adjust rear roller adjustment knobs and jam nuts until full length of the rear roller contacts the flat surface and the full length of the reel (not bedknife) contacts the bar stock. Tighten rear roller knobs and jam nuts.

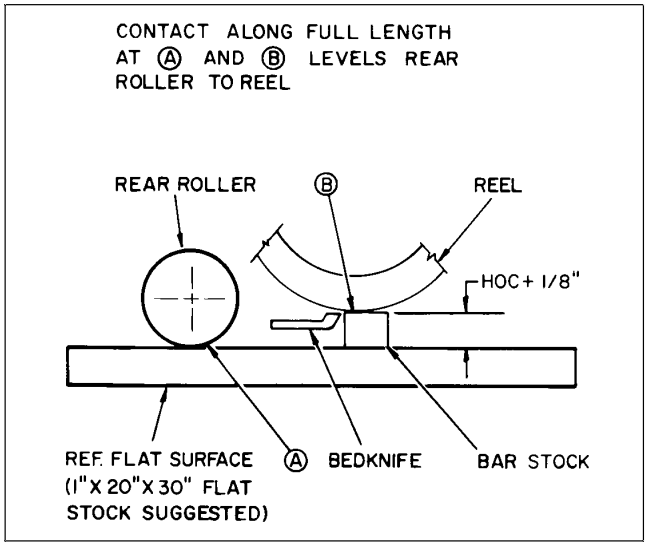

Figure 11

Adjusting Skids and Front Roller (Fixed Head Cutting Unit)

After skid kit or front rollers are installed (installation instructions are included with each option) make the following adjustments to prevent them from pushing down uncut grass or scalping on undulating terrain:

1. Lock each cutting unit in the fixed position (Refer to Cutting Unit Orientation, Fig. 15. Set the reel to bedknife adjustment and height-of-cut adjustment.

2. Position the cutting units on a flat,level surface (a 1" inch (25 mm) thick piece of plywood is ideal).

3. Skids and front rollers used to prevent scalping should not ride on the ground. Adjust each skid or front roller so it is 1/8 - 1/4 in. (3 - 6 mm) or higher above the level surface. Allow greater clearance at the higher height-of-cut settings.

4. Proper adjustment is achieved when the cutting unit does not scalp the grass in normal mowing conditions and yet is set high enough not to mar the turf and create undue wear on the skids or rollers.

NOTE: Skids are used only with the cutting unit in the fixed position. Front rollers may be used with the cutting unit in either the fixed or floating position.

Repairs

CAUTION

Never install or work on the cutting units or lift arms with the traction unit engine running. Always stop the engine and remove the key first.

Backlapping

DANGER

DURING BACKLAP OPERATION REELS ARE UNDER POWER. CONTACT WITH ROTATING REELS CAN RESULT IN PERSONAL INJURY. DO NOT ADJUST CUTTING UNITS WHILE ENGINE AND REELS ARE OPERATING. INSTRUCT OPERATOR TO STOP THE REELS AND SHUT THE ENGINE OFF WHEN ADJUSTMENT IS NECESSARY.

Use a good grade of medium grit (80 courseness) lapping compound with a water soluble carrier so the compound will be easily washed away after completion of the operation. Dry lapping compound should be mixed with liquid detergent until it has a free-flowing consistency.

Two people are required to perform backlapping. Good communication between one another is necessary and caution should be used when making each move. With one person on the seat to operate the controls (operator) the other performs the backlapping operation.

NOTE: Before starting the engine raise the grass deflector on the #1 cutting unit (center) and tighten fasteners to retain the deflector in the raised position.

1st persons duties (Operator):

A. Sit on the seat and engage parking brake.

B. Start the engine and run at minimum throttle. Lower either:
1.) the center cutting unit (#1) or
2.) the left hand (#2) cutting unit or
3.) the right hand (#3) cutting unit.

With the #2 & # 3 cutting units up and latched (automatically shut off) and the #1 cutting unit down, backlap the center (#1) cutting unit from the rear of the machine with the long handled brush. Backlap the #2 and #3 cutting units from the front of the machine.

C. Wait for 2nd person's instruction to engage reels in BACKLAP mode, then pull up on reel switch and move it to ENGAGE position.

D. Turn REEL SPEED KNOB counterclockwise to the BACKLAP position.

E. Follow 2nd person's instructions. Be prepared to stop reels and engine quickly in case of an emergency.

2nd persons duties:

A. Instruct operator when to start and stop reels.

DANGER

UNDER NO CIRCUMSTANCES USE A SHORT-HANDLED PAINT BRUSH TO APPLY BACK-LAPPING COMPOUND. A ROTATING REEL CAN ACTUALLY PULL A SHORT HANDLED PAINT BRUSH AND THE USERS HAND INTO THE REEL CAUSING SERIOUS PERSONAL INJURY.

B. Dip 3 in. (76 mm) paint brush attached to Toro Part No. 29-9200 Handle Assembly into lapping compound. Stand clear and instruct operator to engage reel into backlap mode.

C. Apply lapping compound evenly over full length of the reel, assuring that all reel blades are covered. Whenever noise of reel against the bedknife begins to disappear or, an uneven concentration of material appears on the reel, redistribute the compound with the brush.

D. When it becomes necessary to adjust the reel to the bedknife, instruct the operator to disengage the reel, stop the engine and remove the key from the ignition switch. Then proceed with the adjustment only after the reels have stopped rotating.

E. Backlap each reel until the cutting edges are sharp, even, and consistent on all blades. Achieve a minimum of 1/32 in. (0.79 mm) land area on newly sharpened reel assemblies. Normally, a reel need only be backlapped for approximately 3 minutes.

F. Upon completion, stop the reel and turn off the engine. Remove the key from the ignition switch. Wash the unit thoroughly with a low pressure stream of water to remove all lapping material. Allow the reel to dry and lubricate the grease fittings.

G. Check sharpness of the reel and bedknife with strips of newspaper. With light reel to bedknife contact, the paper should be cleanly sheared across the entire width of the reel. If the paper is not sheared acceptably, continue backlapping.

H. After backlapping the first cutting unit, raise and latch this unit and proceed with the #2 and #3 cutting units.

NOTE: See the Toro Sharpening Manual (Part #80-300) for additional backlapping/sharpening information.

Hydraulic Motor Installation

NOTE: Adjust reel to bedknife contact before installing hydraulic motor to prevent possible bearing failure from to excessive belt tension.

1. Install the drive plate shield onto the reel drive motor flange (Fig. 12). Be sure the widest portion of the shield is at the top.

NOTE: Check to see that motor pulley set screws are tight on motor shaft before installing motor onto cutting unit (Fig. 13).

2. Insert the reel drive motor pulley through the housing and slip the cutting unit drive belt over the pulley (Fig. 13).

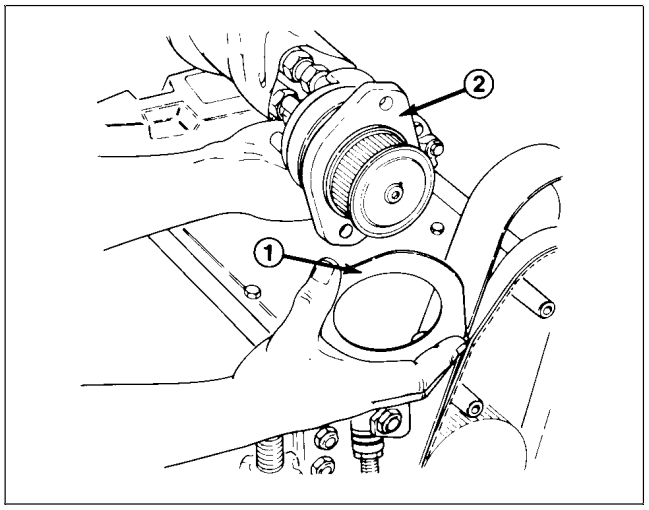

Figure 12

1. Drive plate shield **2. Reel drive motor flange**

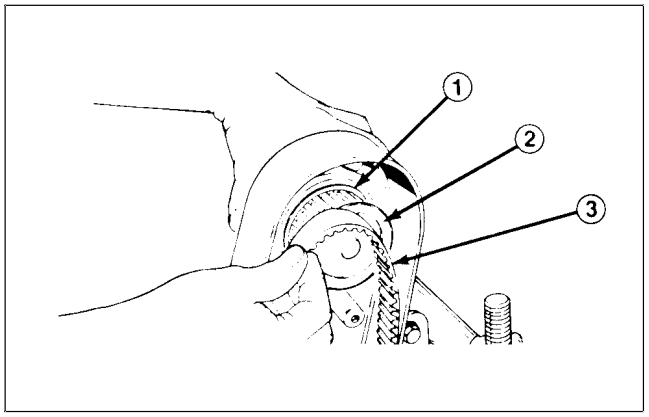

Figure 13

1. Hydraulic motor **2. Motor pulley**
3. Drive belt

3. Insert the two (2) reel drive motor mounting bolts (heads on inside of the drive housing - flat washer on top bolt) through the reel motor flange holes. Thread the locknuts onto the bolts. Rotate reel motor upward in the slotted hole in the housing to tension the drive belt and tighten the fasteners (Fig. 14) to approx. 25 ft-lbs (34 Nm). NOTE: Proper belt tension is achieved when belt deflects approximately 1/8" (3 mm) at mid-point when 7 lbs. force is applied. (Fig. 14).

IMPORTANT: Rotate motors by hand only. Never place a bar between hose fittings on hydraulic motors - motor damage may result.

4. Install the gasket and drive housing cover after making sure the ends of the gasket are at the bottom of the housing to allow for drainage.

IMPORTANT: When hydraulic motors have been mounted to the cutting units make sure hydraulic hoses lay flat and do not contact the frame of the machine when the cutting units are in the raised position. There should also be sufficient slack SO hoses are above and not in contact with the floatation kit. If hoses appear twisted once the hydraulic motors have been mounted and the belts tightened, loosen swivel nuts at the motor and reposition hoses. This can greatly increase the life of the hoses. With cutting units down, all cutting unit hoses should have a flat natural lay and be free from twist.

5. Using one of the rear “U” bolts and nuts securing mounting kits to cutting units #2 and #3, mount a hose bracket to each cutting unit as shown in Fig. 15.

NOTE: Refer to the Traction Unit Operator’s Manual for instructions on setting the adjustable hydraulic counterbalance.

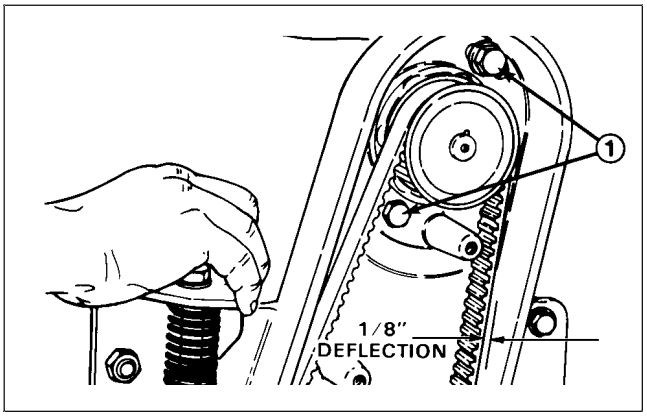

Figure 14

1. Reel motor fasteners

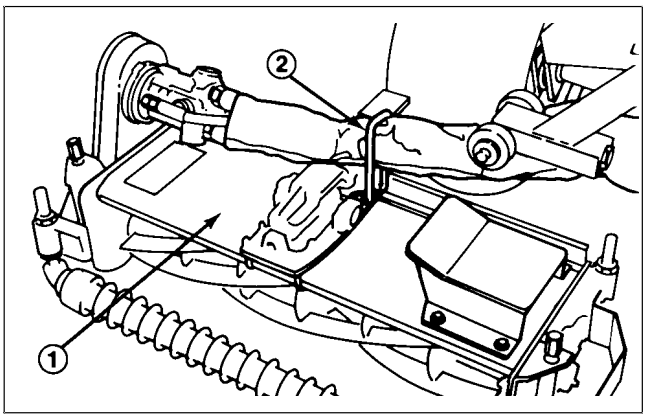

Figure 15

1. #3 Cutting unit
2. Hose bracket

Servicing the Bedknife/Bedbar Assembly

NOTE: The bedbar on each 335-D cutting unit has a precision ground mounting surface to provide an excellent fit with a bedknife. Backlapping of replacement bedknives is often sufficient to achieve an excellent cutting edge with minimum material removed.

Bedknife/Bedbar Removal:

1. Remove the shoulder bolts,bushings and spacers from each end of the unit and remove the bedbar/bedknife assembly (Fig. 16).

2. Remove the mounting screws for the bedknife and separate the bedknife from the bar (Fig. 17). Discard the screws.

Assembly:

1. Thoroughly clean the bedknife mounting face on the bedbar of all rust and scale. Remove any material on the mounting face of the bedbar that will affect a good match-up with the bedknife.

2. Before installation, apply a coating of “Never Seez”, or any material that will ease future disassembly of the bedknife mounting screws, to the threads before installation.

3. Use a torque wrench and special bedknife screw tool to complete tightening of the screws (Fig. 18). Tighten the screws to a torque of 250 in.-lb (28 Kgm) beginning with the center screw and tightening alternate screws toward each end to insure the bedknife will be flat against the bedbar.

4. Install the bedbar/bedknife assembly to the cutting unit.

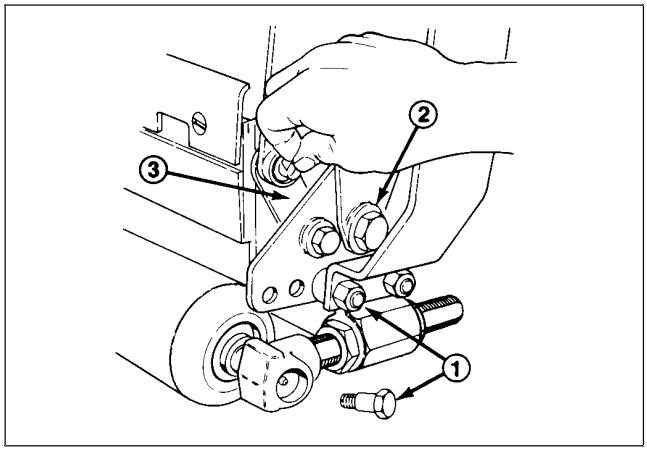

Figure 16

1. Shoulder bolts (2 each side) **2. Bushing** **3. Spacer**

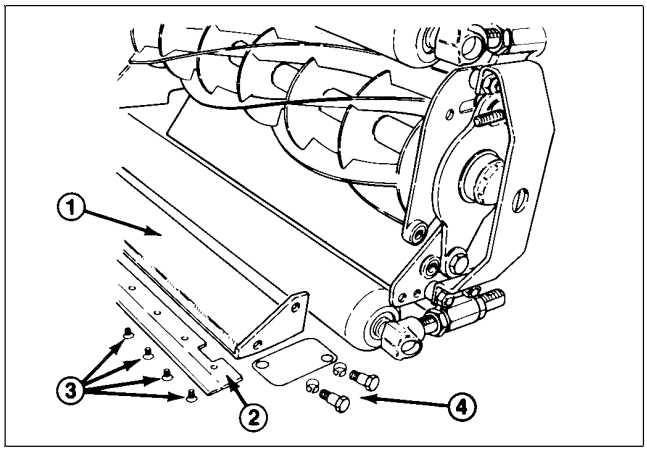

Figure 17

1. Bedbar
2. Bedknife
3. Bedknife mounting screws
4. Bedbar mounting components

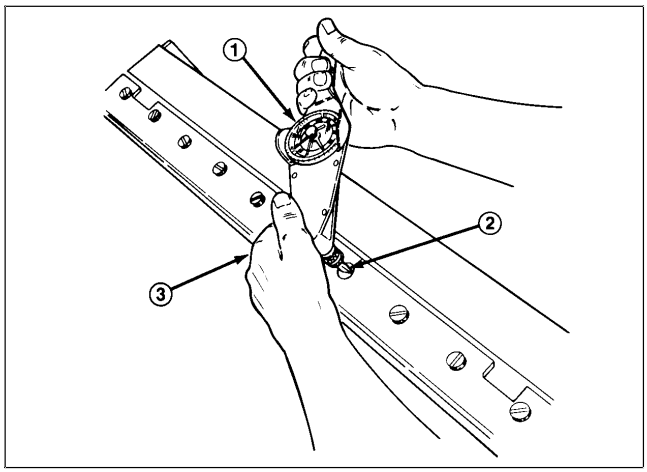

Figure 18

1. Torque wrench
2. Part No. 51-0880 Tool
3. Torque from the center out

Servicing the Reel Assembly

Disassembly:

1. Remove the guards from each end of the cutting unit and the front and rear roller assemblies (Fig. 19).

2. Remove the shoulder bolts, bushings and spacers from each end of the unit and remove the bedbar/bedknife assembly (Fig. 20).

3. Remove the inboard locknut from the adjuster pin, the fasteners for the bracket and remove the adjusting handle assembly from the side plate (Fig. 20).

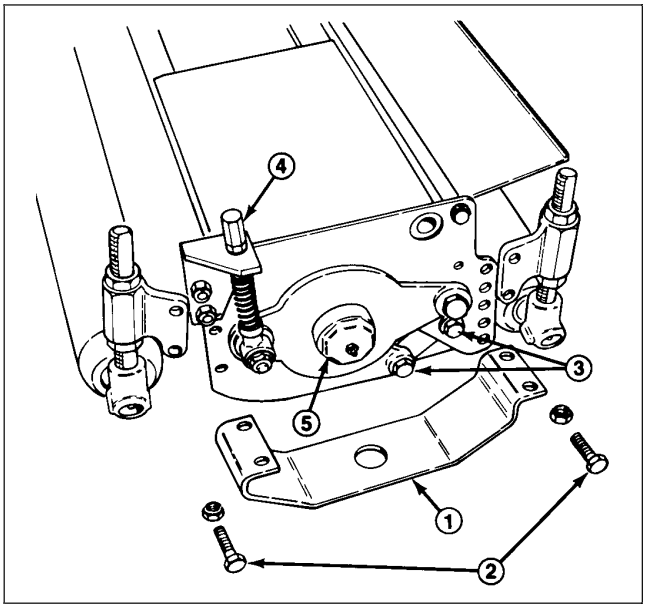

Figure 19

1. Guard
2. Mounting fasteners
3. Bedbar mounting assembly
4. Adjusting assembly
5. Dust cap

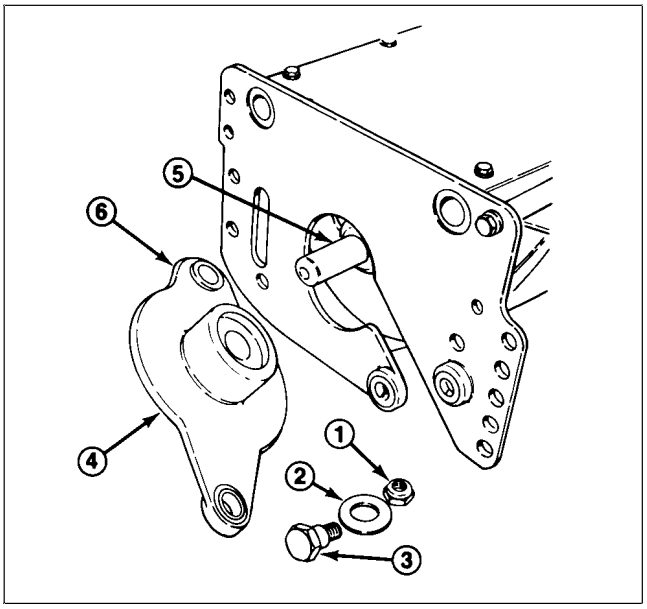

Figure 20

1. Locknut
2. Belleville washer
3. Shoulder bolt
4. Bearing housing
5. Reel shaft
6. Flange bushing

4. Disassemble the cone nut from the shoulder bolt securing the bearing housing to the side plate, remove the belleville washer and bolt and slide the bearing housing off the reel shaft (Fig. 21).

5. Disassemble the cover from the drive housing and remove the drive belt from the housing (Fig. 22).

6. Remove the reel capscrew, toothed washer and pulley washer from the reel shaft (Fig. 22). (Note: Capscrew is assembled with a thread locking compound).

7. Using a puller,remove the driven pulley from the reel shaft (Fig. 22). Remove the woodruff key from the reel shaft.

8. Remove the adjustment assembly and cone nut, belleville washer and shoulder bolt securing the housing to the side plate (Fig. 22). Remove the housing.

9. Slide the reel assembly out of the slots in the side plates.

10. To remove the bearing and seals from the drive housing, remove the retaining ring from inside the housing. Pry the outer seal out of the belt drive case side. Press the bearing and rear seal out from the outer side of the housing.

11. To remove the bearing and seal from the bearing housing, remove the dust cap (Fig. 19) and press the bearing and seal out of the housing.

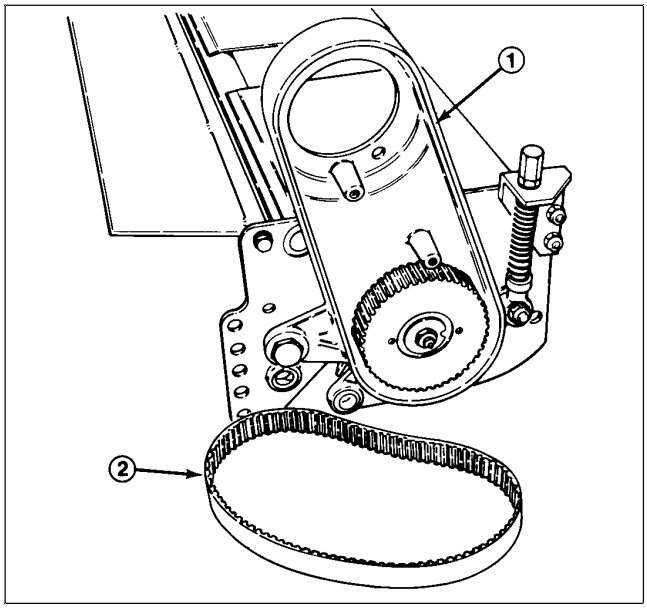

Figure 21

1. Drive housing (cover removed)
2. Drive belt

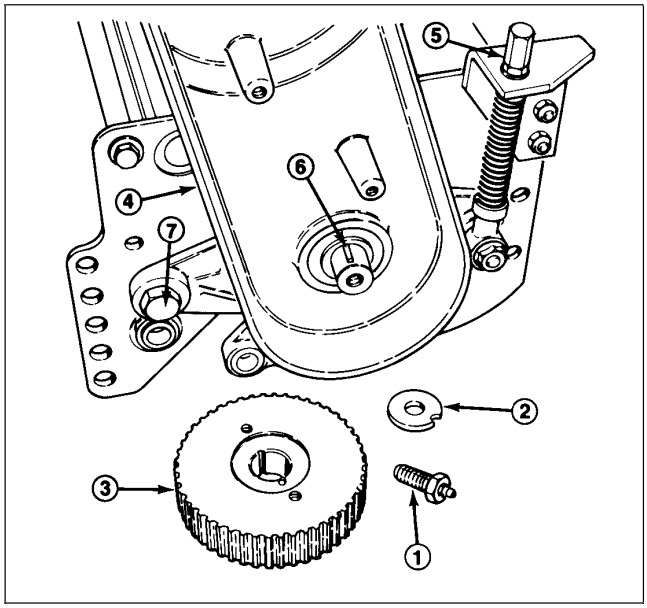

Figure 22

1. Reel capscrew
2. Pulley washer
3. Driven pulley
4. Drive housing
5. Adjustment handle assembly
6. Woodruff key
7. Drive housing fasteners

Assembly:

1. Inspect the flange bushings in the mounting holes for the drive housing and bearing housing for wear (Fig. 20). Replace, if necessary.

2. Assemble the outer seal (lip facing in to retain grease) into the drive housing using Loctite 242 retaining compound on the outer diameter. Apply a light coat of oil to the seal lips and insert the bearing assembly through the seal from the opposite side (Fig 23).

3. Apply a light coating of oil to the inner seal lips and install (lip facing away from the bearing and toward the reel) in the housing. Install the retaining ring to secure the assembly in the housing (Fig. 23).

4. Apply a light coat of oil to the seal lips of the seal for the bearing housing and install (lip facing away from the bearing) over the bearing assembly (Fig. 23).

5. Insert the bearing and seal in the housing and install the dust cap into the housing.

6. Assemble the reel assembly to the frame. Ensure the shield washer is installed on the drive housing end of the reel shaft. Align drive pin on reel shaft with slot in bearing and slide the drive housing onto the shaft.

7. Insert the shoulder bolt through the Belleville washer and rear housing mounting hole. Slide the bolt through the side plate mounting hole (Fig. 20). Install the cone nut locknut onto the bolt. Tighten the cone nut to 45 - 55 ft.-lbs.

8. Align the drive pinon the reel shaft with the notch in the bearing inner race and slide the bearing housing over the opposite end of the reel shaft. Insert the shoulder bolt and belleville washer through the rear bearing housing mounting hole. Slide the bolt through the side plate mounting hole. Install the cone onto the bolt. Tighten the cone nut to 45 - 55 ft.-lbs.

9. Install the woodruff key in the drive housing end of the reel shaft and install the driven pulley onto the shaft.

10. Ensure the slot in the pulley washer is aligned with the roll pin in the pulley and install the washer, toothed washer and reel capscrew (Fig. 21). Apply a medium strength thread locking compound to the reel capscrew during assembly. Torque the capscrew to 45 - 55 ft.-lbs.

11. Install the reel adjustment assemblies to each side plate. Install roll pins before tightening fasteners.

12. Install the bedbar/bedknife assembly.

13. Install the front and rear roller assemblies or skids.

14. To adjust the reel to the bedknife; refer to Reel to Bedknife Adjustment. To adjust the height-of-cut; refer to Height-of-Cut Adjustment section.

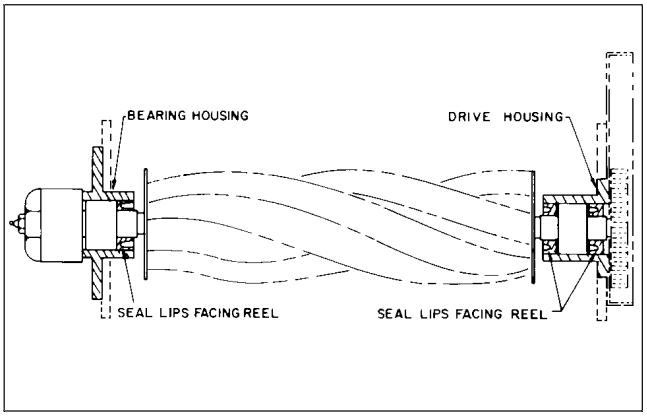

Figure 23

Roller Removal and Installation

1. Remove the fasteners securing the guard and roller adjustment housing to the side plate (Fig. 24) or unscrew the upper cone nut and drop the threaded rod out of the adjustment housing (Fig. 25).

2. The threaded rod and collar assembly can be removed from the roller by sliding it off the shaft at both ends (Fig. 25).

IMPORTANT: When assembling a new roller to the cutting unit mount the roller so that the roller shaft "locknut" is on the right side of the cutting unit (Fig. 25). (As viewed by the operator sitting on seat of machine). This prevents the lock nut from loosening during operation.

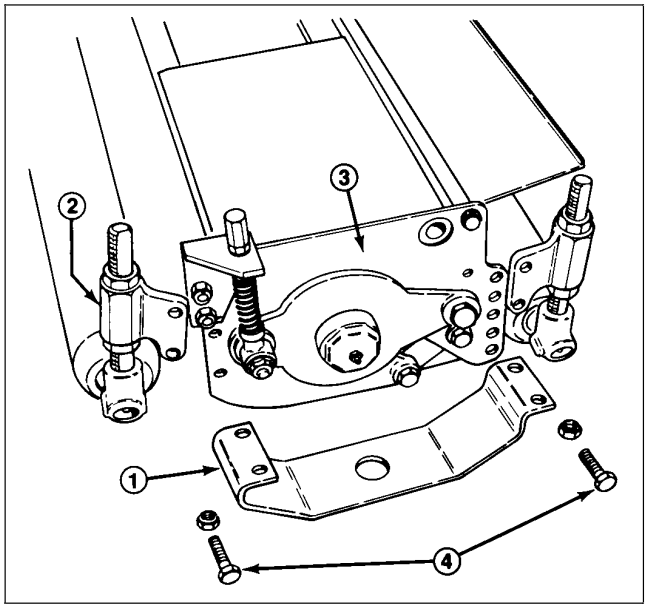

Figure 24

1. Guard
2. Roller adjustment housing
3. Side plate
4. Mounting fasteners

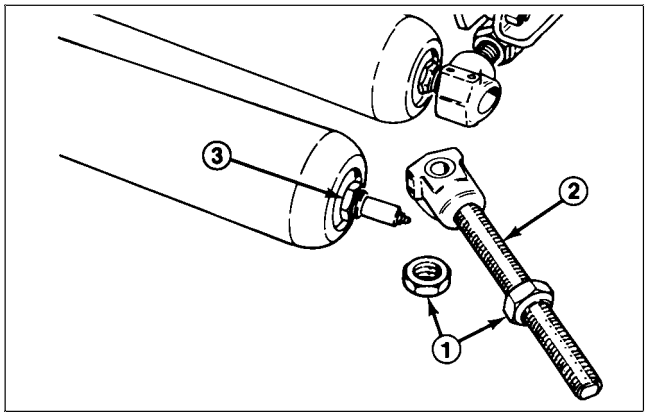

Figure 25

1. Cone nut
2. Rod and collar assembly
3. Flex locknut

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