TORO

Service Manual

Reelmaster® 5200-D/5400-D

Preface

The purpose of this publication is to provide the service technician with information for troubleshooting, testing, and repair of major systems and components on the Reelmaster 5200-D/5400-D.

REFER TO THE TRACTION UNIT AND CUTTING UNIT OPERATOR'S MANUALS FOR OPERATING, MAINTENANCE AND ADJUSTMENT INSTRUCTIONS. Space is provided in Chapter 2 of this book 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 to:

The Toro Company
8111 Lyndale Avenue South
Bloomington, MN 55420-1196

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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General Safety Instructions

The REELMASTER 5200-D/5400-D was tested and certified by TORO for compliance with the B71.4-1990 specifications of the American National Standards Institute. 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. To reduce the potential for injury or death, comply with the following safety instructions.

WARNING

To reduce the potential for injury or death, comply with the following safety instructions.

Before Operating

1. Read and understand the contents of this manual before starting and operating the machine. Become familiar with the controls and know how to stop the machine and engine quickly. A free replacement manual is available by sending the complete model and serial number to:

   The Toro Company
   8111 Lyndale Avenue South
   Bloomington, Minnesota 55420-1196.

2. Never allow children to operate the machine. Do not allow adults to operate machine without proper instruction. Only trained operators who have read this manual should operate this machine.

3. Never operate the machine when 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, illegible or damaged, repair or replace it before operating the machine. Also tighten any loose nuts, bolts or screws to ensure machine is in safe operating condition.

5. Always wear substantial shoes. Do not operate machine while 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. Assure 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 highly 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 of 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 the ENABLE / DISABLE switch is in DISABLE.

    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. Therefore, 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. 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 and 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.

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. On 4-wheel drive models, always use the seat belt and ROPS together.

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

18. **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.

19. 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.

20. 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 reel may result.

21. Before getting off the seat:

    A. Move traction pedal to neutral.

    B. Set parking brake.

    C. Disengage cutting units and wait for reels to stop.

    D. Stop engine and remove key from switch.

    E. Toro recommends that anytime the machine is parked (short or long term) the cutting units should be lowered to the ground. This relieves pressure from the lift circuit and eliminates the risk of cutting units accidentally lowering to the ground.

    F. Do not park on slopes unless wheels are chocked or blocked.

Maintenance and Service

22. Before servicing or making adjustments, stop engine and remove key from the switch.

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

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

25. Keep body and hands away from pin hole leaks in hydraulic lines 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.

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

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

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

29. 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 everyone away.

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

31. Shut engine off before checking or adding oil to the crankcase.

32. Disconnect battery before servicing the machine. If battery voltage is required for troubleshooting or test procedures, temporarily connect the battery.

33. 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.

34. When changing attachments, tires, or performing other service, use correct blocks, hoists, and jacks. Make sure machine is parked on a solid level floor such as a concrete floor. Prior to raising the machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Used jack stands or solid wood blocks to support the raised machine. If the machine is not properly supported by blocks or jack stands, the machine may move or fall, which may result in personal injury (see Jacking Instructions).

Jacking Instructions

CAUTION

When changing attachments, tires, or performing other service, use correct blocks, hoists, and jacks. Make sure machine is parked on a solid level surface such as a concrete floor. Prior to raising machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use jack stands or solid wood blocks to support the raised machine. If the machine is not properly supported by blocks or jack stands, the machine may move or fall, which may result in personal injury.

Jacking the Front End (Fig. 1)

1. Set parking brake and chock both rear tires to prevent the machine from moving.

2. Position jack securely under the tie down rod that is welded to the square tube of the front frame.

3. Position jack stands or hardwood blocks under the square tube as close to the wheels as possible to support the machine.

Jacking the Rear End

1. The preferred method of lifting the rear end of the machine is (Fig. 3):

   A. Secure a chain fall or hoist to the tie down rod on the rear of the frame.

   B. Chock both front tires. Lift rear of the machine off the ground.

   C. On 2WD models, use jack stands or blocks under the axle as close to the wheels as possible to secure the machine.

   D. On 4WD models, use jack stands or blocks under the axle tube as close to the gear box housings as possible to secure the machine.

2. If the rear of the machine can not be lifted as above:

   A. On 2WD models, place jack securely under the pivot bracket for the steering cylinder (Fig. 2).

   B. On 4WD models, place jack securely under the differential casing (Fig. 3).

   C. Chock both front tires. Jack rear of machine off the ground.

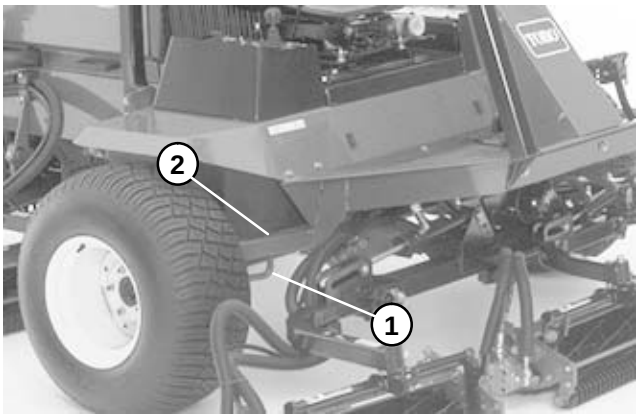

Figure 1

1. Tie down rod **2. Square tube (front frame)**

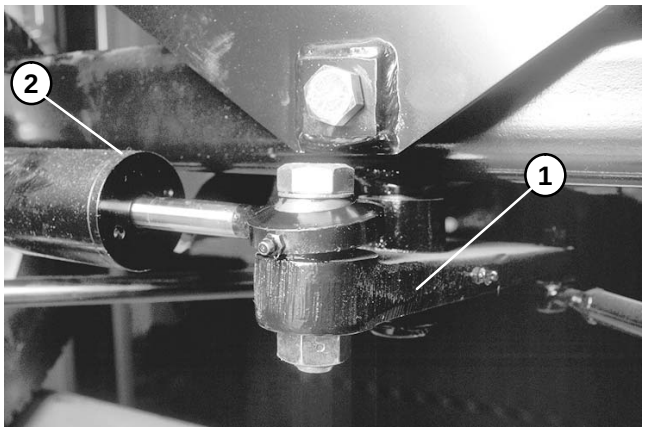

Figure 2

1. Pivot bracket **2. Steering Cylinder**

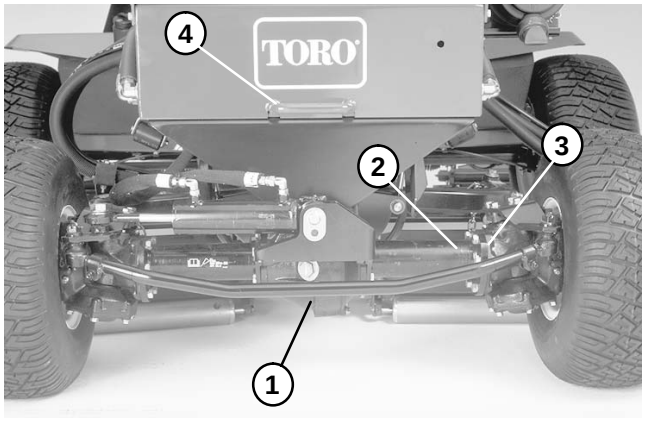

Figure 3

1. Differential case **3. Gearbox housing**
2. Axle tube **4. Tie down rod**

D. On 4WD models, use jack stands or blocks under the axle tube as close to the gear box housings as possible to secure the machine.

E. On 2WD models, use jack stands or blocks under the axle as close to the wheels as possible to secure the machine.

Chapter 2

Product Records and Maintenance

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Product Records

Insert Operator's Manual and Parts Catalog for your Reelmaster 5200-D and 5400-D at the end of this chapter. Additionally, if any optional equipment or accessories have been installed to your machine, insert the Installation Instructions, Operator's Manuals and Parts Catalogs for those options at the end of this chapter.

Maintenance

Maintenance procedures and recommended service intervals for your Reelmaster 5200-D and 5400-D are covered in the Operator's Manual. Refer to that publication when performing regular equipment maintenance.

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	0.09375	— 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	— 7.938	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
	Pounds/Sq. In.	Bar	0.069
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° 2. Multiply by 5/9

Torque Specifications

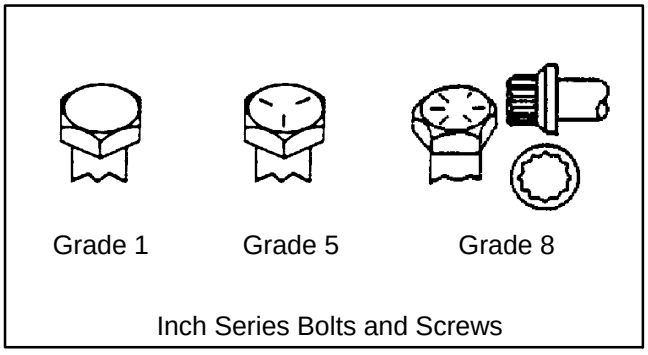
Recommended fastener torque values are listed in the following tables. For critical applications, as determined by Toro, either the recommended torque or a torque that is unique to the application is clearly identified and specified in this Service Manual.

These Torque Specifications for the installation and tightening of fasteners shall apply to all fasteners which do not have a specific requirement identified in this Service Manual. The following factors shall be considered when applying torque: cleanliness of the fastener, use of a thread sealant (Loctite), degree of lubrication on the fastener, presence of a prevailing torque feature, hardness of the surface underneath the fastener's head, or similar condition which affects the installation.

As noted in the following tables, torque values should be **reduced by 25% for lubricated fasteners** to achieve the similar stress as a dry fastener. Torque values may also have to be reduced when the fastener is threaded into aluminum or brass. The specific torque value should be determined based on the aluminum or brass material strength, fastener size, length of thread engagement, etc.

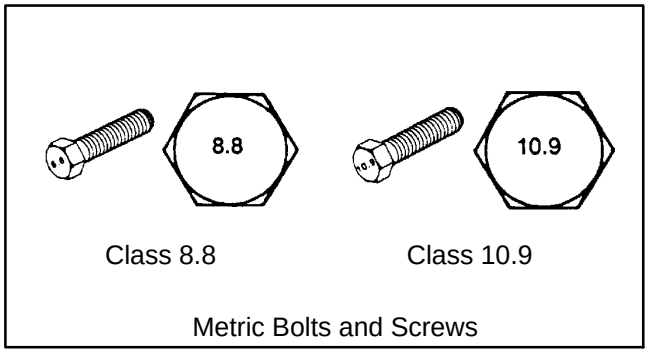
The standard method of verifying torque shall be performed by marking a line on the fastener (head or nut) and mating part, then back off fastener 1/4 of a turn. Measure the torque required to tighten the fastener until the lines match up.

Fastener Identification



Inch Series Bolts and Screws

Figure 1



Metric Bolts and Screws

Figure 2

Standard Torque for Dry, Zinc Plated, and Steel Fasteners (Inch Series)

Thread Size	Grade 1, 5, & 8 with Thin Height Nuts	SAE Grade 1 Bolts, Screws, Studs, & Sems with Regular Height Nuts (SAE J995 Grade 2 or Stronger Nuts)		SAE Grade 5 Bolts, Screws, Studs, & Sems with Regular Height Nuts (SAE J995 Grade 2 or Stronger Nuts)		SAE Grade 8 Bolts, Screws, Studs, & Sems with Regular Height Nuts (SAE J995 Grade 5 or Stronger Nuts)	
	in-lb	**in-lb**	**N-cm**	**in-lb**	**N-cm**	**in-lb**	**N-cm**
# 6 - 32 UNC	10 ± 2	13 ± 2	147 ± 23	15 ± 2	170 ± 20	23 ± 2	260 ± 20
# 6 - 40 UNF				17 ± 2	190 ± 20	25 ± 2	280 ± 20
# 8 - 32 UNC	13 ± 2	25 ± 5	282 ± 30	29 ± 3	330 ± 30	41 ± 4	460 ± 45
# 8 - 36 UNF				31 ± 3	350 ± 30	43 ± 4	485 ± 45
# 10 - 24 UNC	18 ± 2	30 ± 5	339 ± 56	42 ± 4	475 ± 45	60 ± 6	675 ± 70
# 10 - 32 UNF				48 ± 4	540 ± 45	68 ± 6	765 ± 70
1/4 - 20 UNC	48 ± 7	53 ± 7	599 ± 79	100 ± 10	1125 ± 100	140 ± 15	1580 ± 170
1/4 - 28 UNF	53 ± 7	65 ± 10	734 ± 113	115 ± 10	1300 ± 100	160 ± 15	1800 ± 170
5/16 - 18 UNC	115 ± 15	105 ± 7	1186 ± 169	200 ± 25	2250 ± 280	300 ± 30	3390 ± 340
5/16 - 24 UNF	138 ± 17	128 ± 17	1446 ± 192	225 ± 25	2540 ± 280	325 ± 30	3670 ± 340
	ft-lb	**ft-lb**	**N-m**	**ft-lb**	**N-m**	**ft-lb**	**N-m**
3/8 - 16 UNC	16 ± 2	16 ± 2	22 ± 3	30 ± 3	41 ± 4	43 ± 4	58 ± 5
3/8 - 24 UNF	17 ± 2	18 ± 2	24 ± 3	35 ± 3	47 ± 4	50 ± 4	68 ± 5
7/16 - 14 UNC	27 ± 3	27 ± 3	37 ± 4	50 ± 5	68 ± 7	70 ± 7	95 ± 9
7/16 - 20 UNF	29 ± 3	29 ± 3	39 ± 4	55 ± 5	75 ± 7	77 ± 7	104 ± 9
1/2 - 13 UNC	30 ± 3	48 ± 7	65 ± 9	75 ± 8	102 ± 11	105 ± 10	142 ± 14
1/2 - 20 UNF	32 ± 3	53 ± 7	72 ± 9	85 ± 8	115 ± 11	120 ± 10	163 ± 14
5/8 - 11 UNC	65 ± 10	88 ± 12	119 ± 16	150 ± 15	203 ± 20	210 ± 20	285 ± 27
5/8 - 18 UNF	75 ± 10	95 ± 15	129 ± 20	170 ± 15	230 ± 20	240 ± 20	325 ± 27
3/4 - 10 UNC	93 ± 12	140 ± 20	190 ± 27	265 ± 25	359 ± 34	375 ± 35	508 ± 47
3/4 - 16 UNF	115 ± 15	165 ± 25	224 ± 34	300 ± 25	407 ± 34	420 ± 35	569 ± 47
7/8 - 9 UNC	140 ± 20	225 ± 25	305 ± 34	430 ± 45	583 ± 61	600 ± 60	813 ± 81
7/8 - 14 UNF	155 ± 25	260 ± 30	353 ± 41	475 ± 45	644 ± 61	660 ± 60	895 ± 81

Note: Reduce torque values listed in the table above by 25% for lubricated fasteners. Lubricated fasteners are defined as threads coated with a lubricant such as oil, graphite, or thread sealant such as Loctite.

Note: Torque values may have to be reduced when installing fasteners into threaded aluminum or brass. The specific torque value should be determined based on the fastener size, the aluminum or base material strength, length of thread engagement, etc.

Note: The nominal torque values listed above for Grade 5 and 8 fasteners are based on 75% of the minimum proof load specified in SAE J429. The tolerance is approximately ± 10% of the nominal torque value. Thin height nuts include jam nuts.

Standard Torque for Dry, Zinc Plated, and Steel Fasteners (Metric Fasteners)

Thread Size	Class 8.8 Bolts, Screws, and Studs with Regular Height Nuts (Class 8 or Stronger Nuts)		Class 10.9 Bolts, Screws, and Studs with Regular Height Nuts (Class 10 or Stronger Nuts)	
M5 X 0.8	57 ± 5 in-lb	640 ± 60 N-cm	78 ± 7 in-lb	885 ± 80 N-cm
M6 X 1.0	96 ± 9 in-lb	1018 ± 100 N-cm	133 ± 13 in-lb	1500 ± 150 N-cm
M8 X 1.25	19 ± 2 ft-lb	26 ± 3 N-m	27 ± 2 ft-lb	36 ± 3 N-m
M10 X 1.5	38 ± 4 ft-lb	52 ± 5 N-m	53 ± 5 ft-lb	72 ± 7 N-m
M12 X 1.75	66 ± 7 ft-lb	90 ± 10 N-m	92 ± 9 ft-lb	125 ± 12 N-m
M16 X 2.0	166 ± 15 ft-lb	225 ± 20 N-m	229 ± 22 ft-lb	310 ± 30 N-m
M20 X 2.5	325 ± 33 ft-lb	440 ± 45 N-m	450 ± 37 ft-lb	610 ± 50 N-m

Note: Reduce torque values listed in the table above by 25% for lubricated fasteners. Lubricated fasteners are defined as threads coated with a lubricant such as oil, graphite, or thread sealant such as Loctite.

Note: Torque values may have to be reduced when installing fasteners into threaded aluminum or brass. The specific torque value should be determined based on the fastener size, the aluminum or base material strength, length of thread engagement, etc.

Note: The nominal torque values listed above are based on 75% of the minimum proof load specified in SAE J1199. The tolerance is approximately ± 10% of the nominal torque value.

Other Torque Specifications

SAE Grade 8 Steel Set Screws

Thread Size	Recommended Torque	
	Square Head	Hex Socket
1/4 - 20 UNC	140 ± 20 in-lb	73 ± 12 in-lb
5/16 - 18 UNC	215 ± 35 in-lb	145 ± 20 in-lb
3/8 - 16 UNC	35 ±10 ft-lb	18 ± 3 ft-lb
1/2 - 13 UNC	75 ± 15 ft-lb	50 ±10 ft-lb

Wheel Bolts and Lug Nuts

Thread Size	Recommended Torque**	
7/16 - 20 UNF Grade 5	65 ± 10 ft-lb	88 ± 14 N-m
1/2 - 20 UNF Grade 5	80 ± 10 ft-lb	108 ± 14 N-m
M12 X 1.25 Class 8.8	80 ± 10 ft-lb	108 ± 14 N-m
M12 X 1.5 Class 8.8	80 ± 10 ft-lb	108 ± 14 N-m

** For steel wheels and non-lubricated fasteners.

Thread Cutting Screws (Zinc Plated Steel)

Type 1, Type 23, or Type F	
Thread Size	**Baseline Torque***
No. 6 - 32 UNC	20 ± 5 in-lb
No. 8 - 32 UNC	30 ± 5 in-lb
No. 10 - 24 UNC	38 ± 7 in-lb
1/4 - 20 UNC	85 ± 15 in-lb
5/16 - 18 UNC	110 ± 20 in-lb
3/8 - 16 UNC	200 ± 100 in-lb

Thread Cutting Screws (Zinc Plated Steel)

Thread Size	Threads per Inch		Baseline Torque*
	Type A	Type B	
No. 6	18	20	20 ± 5 in-lb
No. 8	15	18	30 ± 5 in-lb
No. 10	12	16	38 ± 7 in-lb
No. 12	11	14	85 ± 15 in-lb

* Hole size, material strength, material thickness & finish must be considered when determining specific torque values. All torque values are based on non-lubricated fasteners.

Conversion Factors

in-lb X 11.2985 = N-cm
ft-lb X 1.3558 = N-m

N-cm X 0.08851 = in-lb
N-m X 0.7376 = ft-lb

Chapter 3

Kubota Diesel Engines

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Introduction

This Chapter gives information about specifications, maintenance, troubleshooting, testing, and repair of the diesel engine used in the Reelmaster 5200-D/5400-D.

Most repairs and adjustments require tools which are commonly available in many service shops. Special tools are described in the Kubota Workshop Manual, Diesel Engine, 05 Series. 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 an engine repair facility.

Service and repair parts for Kubota engines are supplied through your Authorized Toro Distributor. If no parts list is available, be sure to provide your distributor with the Toro model and serial number.

Specifications

Item	Description
Make / Designation	Kubota, 4-Cycle, 3 Cylinder, Water Cooled, Diesel Engine
Horse Power RM 5200-D RM 5400-D	 25.0 HP @ 3000 RPM 31.5 HP @ 3000 RPM
Bore mm (in.)	78.0 (3.07)
Stroke mm (in.)	78.4 (3.09)
Total Displacement cc (cu. in.)	1123 (68.53)
Torque N-m (ft-lb)	68.2 (50.3) @ 2000 RPM
Firing Order	1-2-3
Combustion Chamber	Spherical Type
Fuel	No. 2 Diesel Fuel (ASTM D975)
Fuel Capacity liters (gallons)	37.9 (10.0)
Fuel Injection Pump	Bosch MD Type Mini Pump
Governor	Centrifugal Mechanical
Low Idle (no load)	1150 $\pm$ 50 RPM
High Idle (no load)	3200 $\pm$ 50 RPM
Direction of Rotation	Counterclockwise (Viewed from Flywheel)
Compression Ratio	23.0:1
Injection Nozzles	Mini Nozzle (DNOPD)
Engine Oil	10W30 Detergent (API CD, or higher)
Oil Pump	Trochoid Type
Crankcase Oil Capacity liters (U.S. qt.)	3.8 (4.0) with Filter
Starter	12 VDC, 1.4 KW
Alternator/Regulator	12 VDC 40 AMP
Coolant Capacity liters (U.S. qt.)	7.1 (7.5) with 0.9 (1.0) Reservoir
Dry Weight kilograms (U.S. lbs) RM 5200-D RM 5400-D	 93.0 (205.0) 98.0 (215.0)

Check Engine Oil

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Remove, wipe clean, and reinstall dipstick. Remove dipstick, and check oil level on dipstick. Oil level should be up to FULL mark (Reelmaster 5200 - Fig. 1), (Reelmaster 5400 - Fig. 2).

3. If oil is below the FULL mark, remove fill cap and add SAE 10W-30 CD or higher classification oil until level reaches the FULL mark on the dipstick. **Do not overfill.** Crankcase capacity is 4.0 qt. (3.8 l) with filter.

4. Install oil fill cap and close hood.

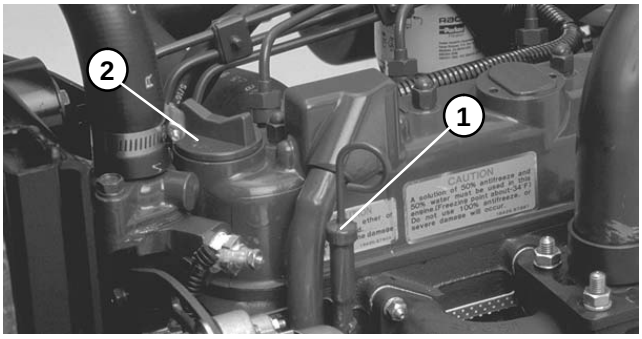


Figure 1

1. Dipstick **2. Oil fill cap**

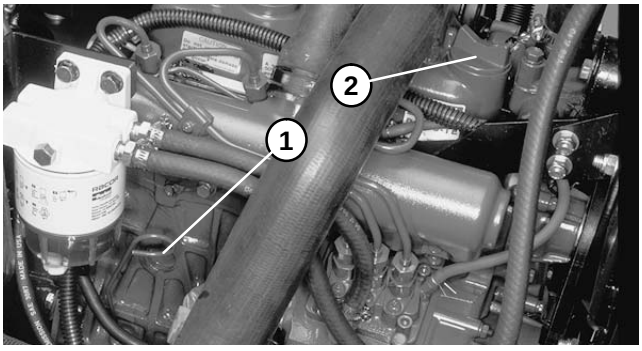


Figure 2

1. Dipstick **2. Oil fill cap**

Fill Fuel Tank

DANGER

Because diesel fuel is highly flammable, use caution when storing or handling it. Do not smoke while filling the fuel tank. Do not fill fuel tank while engine is running, hot, or when machine is in an enclosed area. Always fill fuel tank outside and wipe up any spilled diesel fuel before starting the engine. Store fuel in a clean, safety-approved container and keep cap in place. Use diesel fuel for the engine only; not for any other purpose.

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Clean area around the fuel tank cap. Remove cap from the tank.

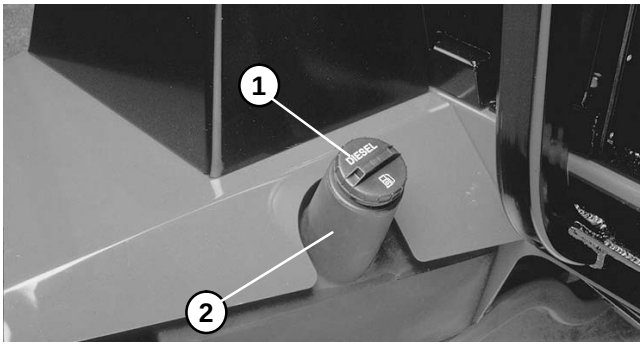


Figure 3

1. Fuel tank cap **2. Fuel tank filler neck**

3. Fill fuel tank to about one inch below the top of the tank (not the filler neck). **Do not overfill.** Install cap to the neck

Check Cooling System

The cooling system is filled with a 50/50 solution of water and permanent ethylene glycol anti-freeze. Check level of coolant at the beginning of each day before starting the engine. System capacity is about 9.6 quarts (9.1 l).

IMPORTANT: Clean debris off the screen, oil cooler, and front of the radiator daily, and more often if conditions are extremely dusty or dirty (see Engine Cooling System).

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

CAUTION

If engine has been running, pressurized hot coolant can escape when the radiator cap is removed and cause burns. Open radiator cap only when the radiator and engine are cold.

Figure 4

1. **Expansion tank**
2. **Cap**

2. Check level of coolant in the expansion tank. Coolant level should be between the marks on the side of tank.

3. If coolant level is low, remove expansion tank cap and replenish the system. **Do not overfill**.

4. Install expansion tank cap.

Adjustments

Adjust Throttle Cable

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Position throttle lever forward so it stops against the seat base slot.

3. At the fuel injection pump, loosen throttle cable connector on the control lever arm.

Note: Do not over tighten the cable connector. The connector must be free to swivel.

4. Hold fuel injection pump lever arm against the high idle stop screw and tighten the cable connector.

5. Torque lock nut used to set the friction device on the throttle lever from 40 to 55 in-lb (4.5 to 6.2 N-m) The maximum force required to operate the throttle lever should be 20 lb (89 N).

Figure 5

1. **Control panel**
2. **Throttle lever**

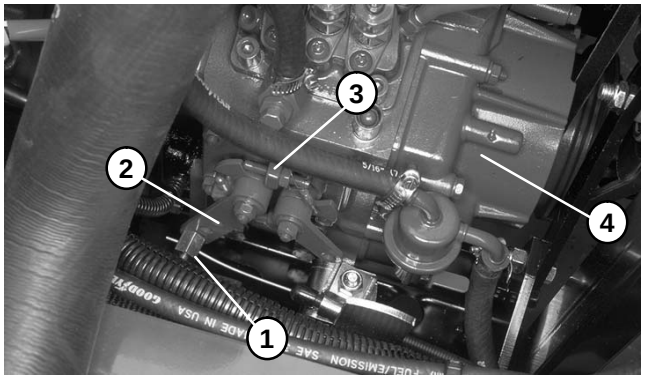


Figure 6

1. **Throttle cable connector**
2. **Control lever arm**
3. **High idle stop screw**
4. **Fuel injection pump**

Adjust Alternator/Fan Belt

The condition and tension of all belts should be checked periodically as recommended in the maintenance schedules in Chapter 2 - Product Records and Manuals.

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch. Open hood.

Alternator Belt (Fig. 7)

2. Check tension by depressing belt midway between alternator and crankshaft pulleys with 22 lb. (98 N) of force. Belt should deflect 7/16 in. (11 mm). If the deflection is incorrect, proceed to the next step. If the deflection is correct, continue operation of the machine.

3. Loosen bolt securing brace to engine and bolt securing alternator to brace.

4. Insert pry bar between alternator and engine and pry out on alternator.

5. When proper tension is achieved, tighten alternator and brace bolts to secure adjustment.

Cooling Fan Belt (Fig. 8)

IMPORTANT: Make sure both lock nuts are loosen before setting cooling fan belt tension. Not loosening the bottom nut may result in bending the belt tensioner lever.

6. Loosen upper and lower lock nuts on the belt tensioner lever.

7. Apply 5 to 10 lb. (22 to 44 N) of force at the end of the lever to set the proper tension on the fan belt.

8. Tighten both lock nuts to secure the adjustment.

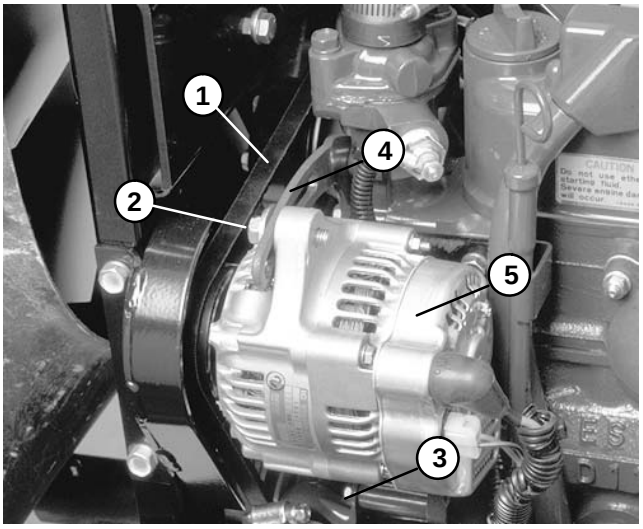


Figure 7

1. **Belt**
2. **Bolt**
3. **Bolt**
4. **Support bracket**
5. **Alternator**

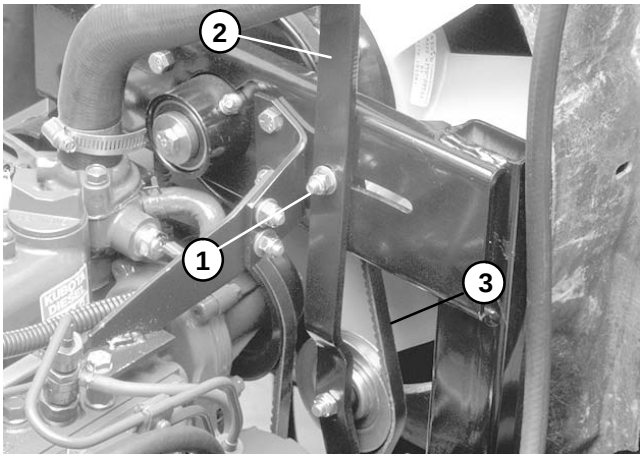


Figure 8

1. **Upper lock nut**
2. **Belt tensioner lever**
3. **Cooling fan belt**

Bleed Fuel System

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

2. Make sure fuel tank is at least half full. Gain access to the engine.

DANGER

Because diesel fuel is highly flammable, use caution when storing or handling it. Do not smoke while filling the fuel tank. Do not fill fuel tank while engine is running, hot, or when machine is in an enclosed area. Always fill fuel tank outside and wipe up any spilled diesel fuel before starting the engine. Store fuel in a clean, safety-approved container and keep cap in place. Use diesel fuel for the engine only; not for any other purpose.

3. Loosen air bleed screw on the top of the fuel filter/water separator (Fig. 9).

4. Pump lever on the fuel pump (Fig. 10) until a solid stream of fuel flows out around the bleed screw on the fuel filter/water separator. Tighten air bleed screw.

5. Open air bleed screw on the fuel injection pump with a 12 mm wrench (Fig. 11).

6. Pump lever on fuel pump (Fig. 10) until a solid stream of fuel flows out around screw on the fuel injection pump. Tighten air bleed screw.

IMPORTANT: The engine should normally start after the above bleeding procedures are followed. However, if the engine does not start, air may be trapped between injection pump and injectors (see Bleed Air from Fuel Injectors).

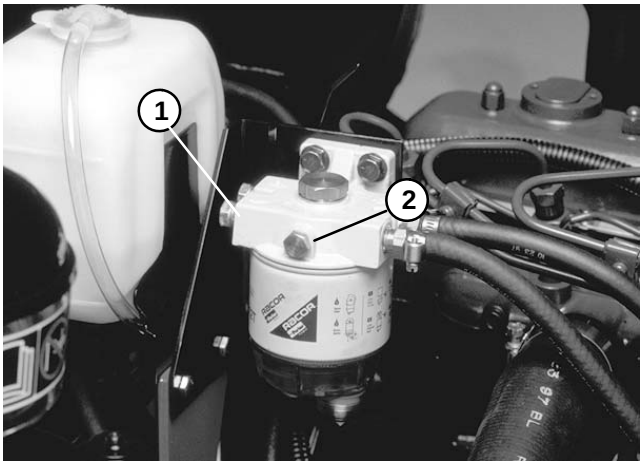


Figure 9

1. Fuel filter/water separator **2. Air bleed screw**

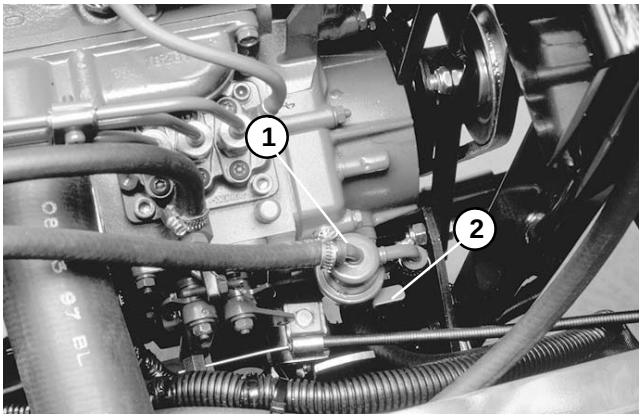


Figure 10

1. Fuel pump **2. Fuel pump lever**

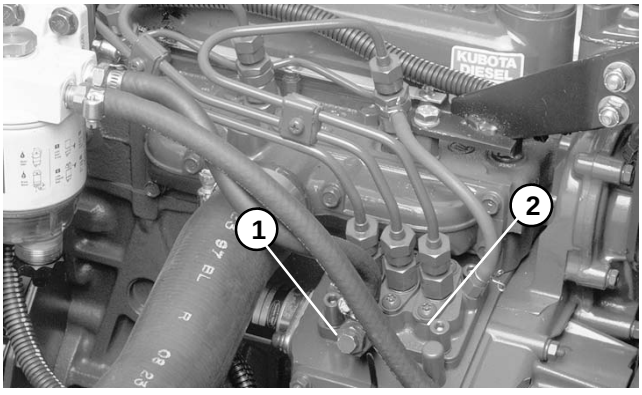


Figure 11

1. Bleed screw **2. Fuel injection pump**

Bleed Air from Fuel Injectors

IMPORTANT: This procedure should be used only if the fuel system has been purged of air through normal priming procedures (see Bleed Fuel System) and engine will not start.

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

DANGER

Because diesel fuel is highly flammable, use caution when storing or handling it. Do not smoke while filling the fuel tank. Do not fill fuel tank while engine is running, hot, or when machine is in an enclosed area. Always fill fuel tank outside and wipe up any spilled diesel fuel before starting the engine. Store fuel in a clean, safety-approved container and keep cap in place. Use diesel fuel for the engine only; not for any other purpose.

2. Loosen pipe connection to the No. 1 injector nozzle and holder assembly.

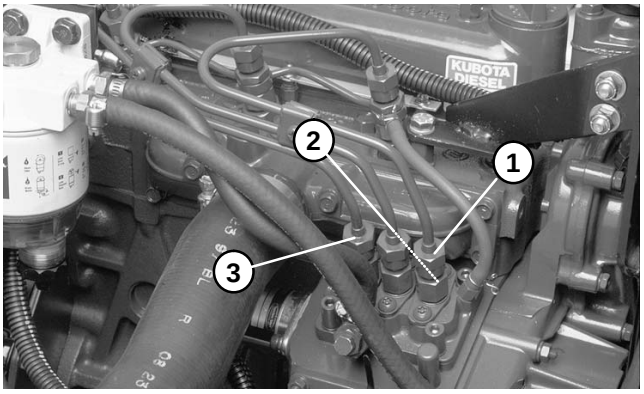


Figure 12

1. **No. 1 injector nozzle**
2. **No. 2 injector**
3. **No. 3 injector nozzle**

3. Move throttle to FAST position.

4. Turn ignition switch to START and watch fuel flow around connector. Turn key to OFF when solid flow is observed. Tighten pipe connector securely to the injector nozzle.

5. Repeat steps on the remaining injector nozzles.

Change Engine Oil and Filter

Change oil and filter periodically as recommended in the maintenance schedules in Chapter 2 - Product Records and Manuals.

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Remove either drain plug and let oil flow into drain pan. When oil stops flowing, install the drain plug.

3. Remove oil filter. Apply light coat of clean oil to the new filter seal before screwing filter on. **Do not overtighten filter.**

4. Add oil to the crankcase (see Check Engine Oil).

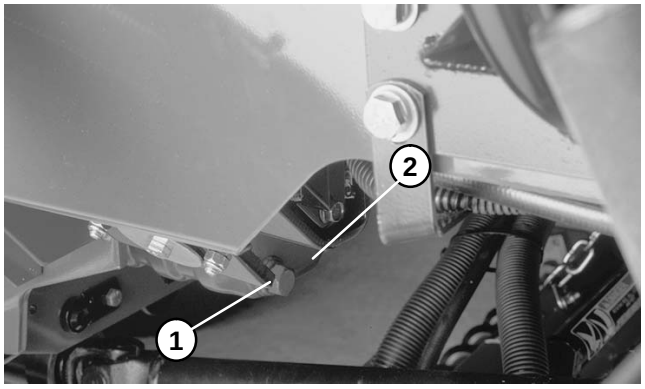


Figure 13

1. **Drain plug**
2. **Drain pan**

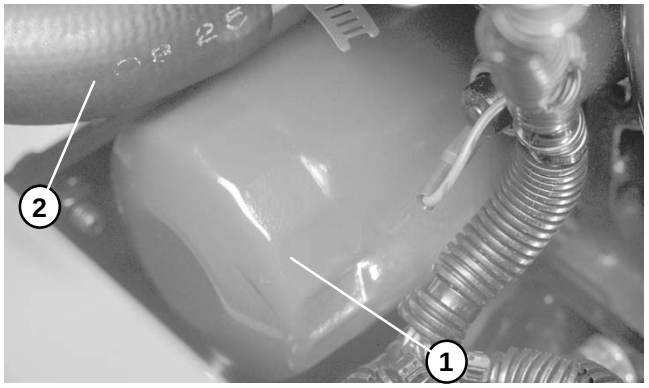


Figure 14

1. **Oil filter**
2. **Radiator hose**

Clean Radiator and Oil Coolers

The radiator and oil cooler should be checked for dirt and debris daily, and hourly if conditions are extremely dusty or dirty.

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

CAUTION

If engine has been running, the radiator may be hot and cause burns. Work on radiator only when the engine and radiator are cool.

2. Open engine hood.

3. Clean engine area thoroughly of all dirt and debris.

4. Release latches and pull up on the screen to slide it out of mounting tracks. Clean screen thoroughly with water or compressed air.

5. Slightly raise oil coolers and pivot forward. Clean both sides of oil coolers and radiator area thoroughly with water or compressed air. Pivot oil coolers back into position.

6. Install screen and close hood.

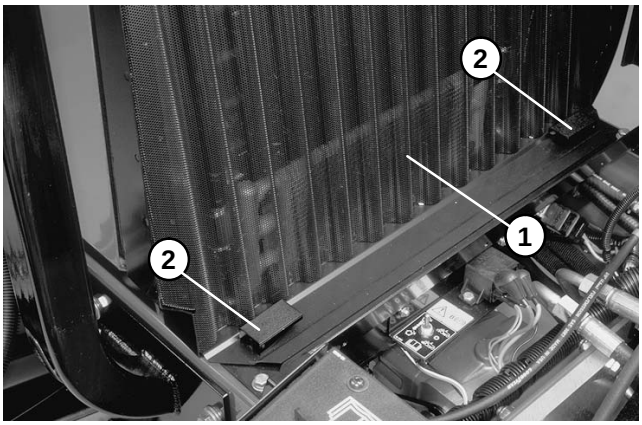


Figure 15

1. **Screen**
2. **Latch**

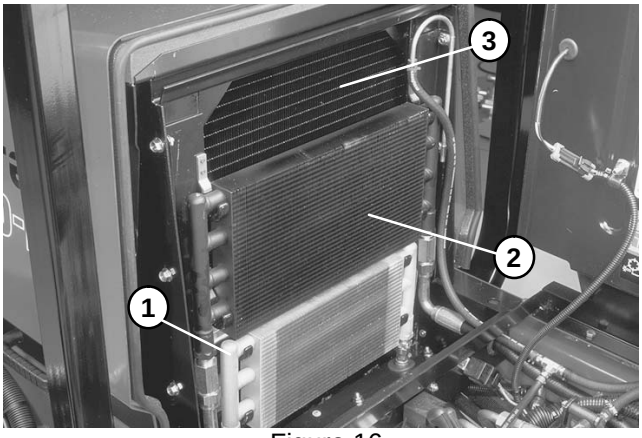


Figure 16

1. **Transmission oil cooler**
2. **Reel oil cooler**
3. **Radiator**

Replace Fuel Filter

Replace fuel prefilter periodically as recommended in the maintenance schedules in Chapter 2 - Product Records and Manuals.

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Clean area where filter bowl mounts to filter head.

3. Remove filter bowl and clean mounting surface.

4. Remove filter element from the bowl and replace with new filter.

5. Install filter bowl by hand until O-ring contacts mounting surface.

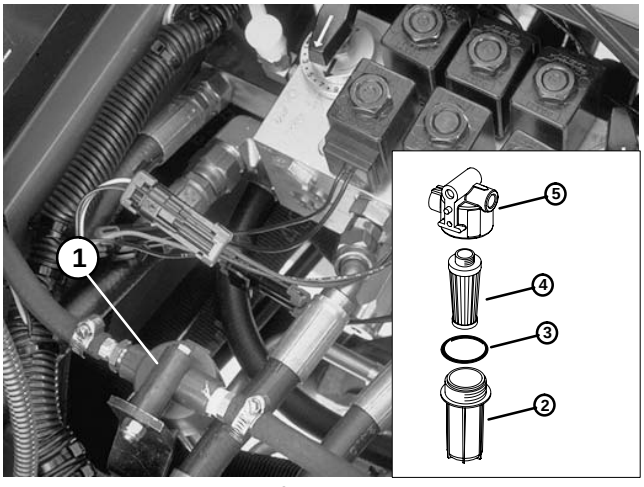


Figure 17

1. **Fuel filter assembly**
2. **Filter bowl**
3. **O-ring**
4. **Filter element**
5. **Filter head**

Muffler

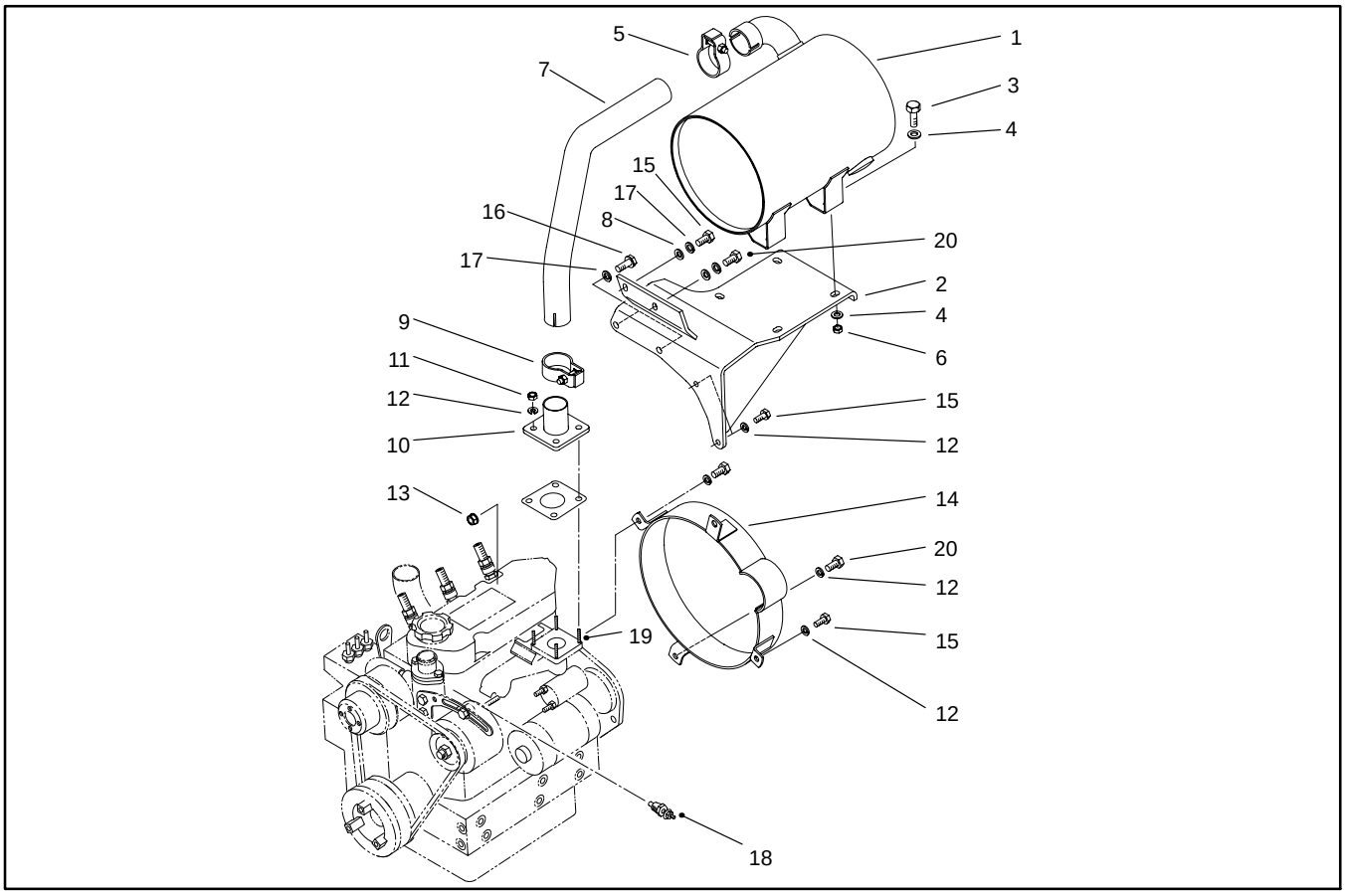


Figure 18

1. **Muffler**
2. **Muffler bracket**
3. **Cap screw**
4. **Flat washer**
5. **Muffler clamp**
6. **Lock nut**
7. **Exhaust tube**
8. **Flat washer**
9. **Muffler clamp**
10. **Exhaust pipe**
11. **Lock nut**
12. **Lock washer**
13. **Lock nut**
14. **Flywheel guard**
15. **Cap screw**
16. **Cap screw**
17. **Lock washer**
18. **Temperature sender**
19. **Stud**
20. **Cap screw**

Muffler Removal

CAUTION

The muffler and exhaust pipe may be hot. To avoid possible burns, allow the engine and exhaust system to cool before working on the muffler.

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Remove muffler and/or muffler bracket from the engine as necessary using Figure 18 as a guide.

Muffler Installation

Note: If a new gasket is to be installed, make sure muffler flange and exhaust manifold sealing surfaces are free of debris or damage that may prevent a tight seal.

1. Install **new** gasket if original gasket is damaged or torn.

2. Install muffler and/or muffler bracket to the engine using Figure 18 as a guide. Replace gasket if damaged or torn.

Fuel System

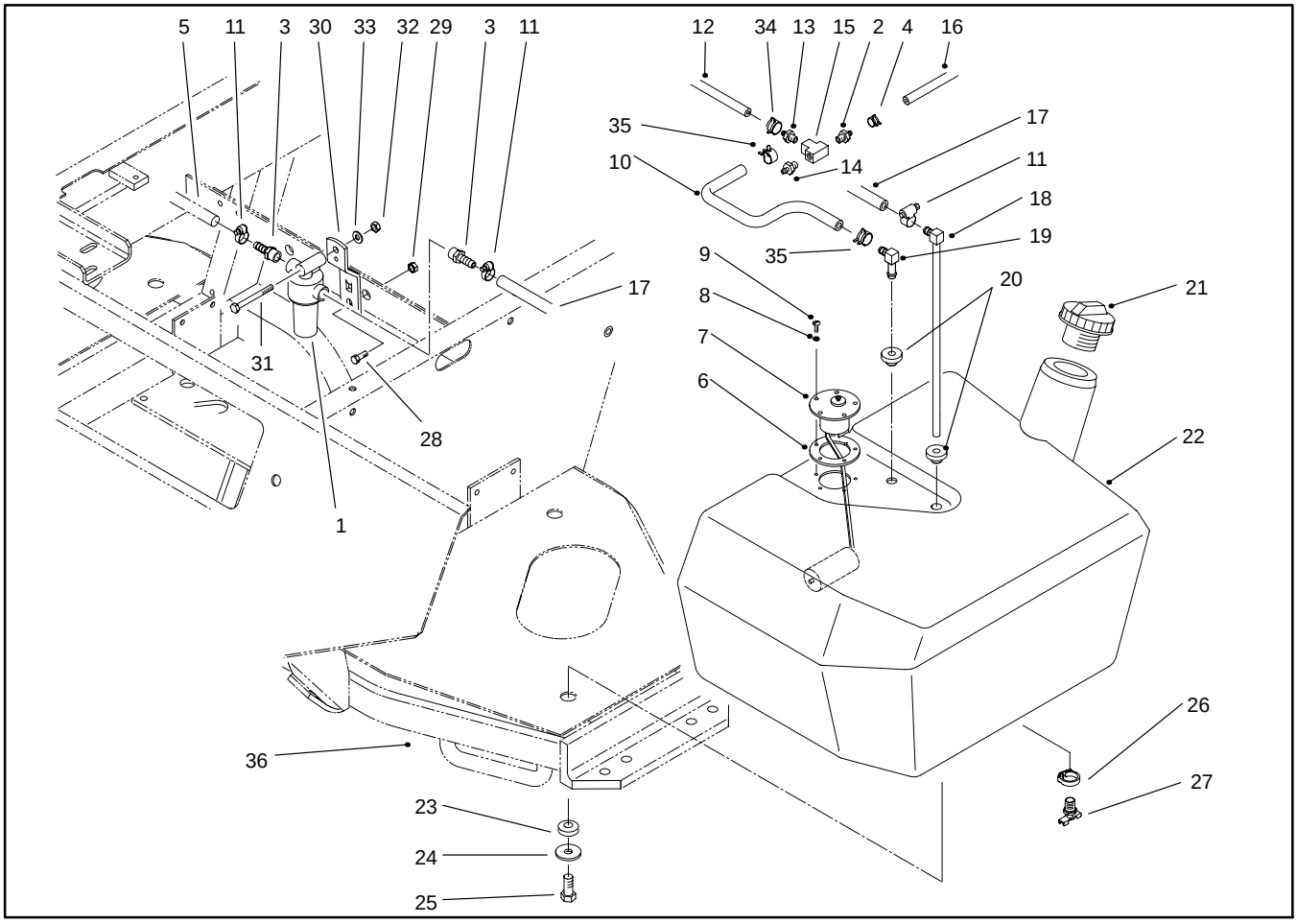


Figure 19

1. **Fuel filter**
2. **Barbed fitting**
3. **Fuel fitting**
4. **Hose clamp**
5. **Fuel hose**
6. **Gasket**
7. **Sending unit**
8. **Lock washer**
9. **Round head screw**
10. **Fuel hose**
11. **Hose clamp**
12. **Fuel hose**
13. **Fuel fitting (straight)**
14. **Fuel fitting (straight)**
15. **Fuel fitting (tee)**
16. **Fuel hose**
17. **Fuel hose**
18. **Stand pipe**
19. **Fuel elbow connector**
20. **Grommet**
21. **Tank cap**
22. **Fuel tank**
23. **Grommet**
24. **Flat washer**
25. **Cap screw**
26. **Drain clamp**
27. **Drain fitting**
28. **Cap screw**
29. **Lock nut**
30. **Filter support bracket**
31. **Cap screw**
32. **Lock nut**
33. **Flat washer**
34. **Spring clamp**
35. **Clamp**
36. **Frame**

DANGER

Because diesel fuel is highly flammable, use caution when storing or handling it. Do not smoke while filling the fuel tank. Do not fill fuel tank while engine is running, hot, or when machine is in an enclosed area. Always fill fuel tank outside and wipe up any spilled diesel fuel before starting the engine. Store fuel in a clean, safety-approved container and keep cap in place. Use diesel fuel for the engine only; not for any other purpose.

Check Fuel Lines and Connections

Check fuel lines and connections periodically as recommended in the maintenance schedules in Chapter 2 - Product Records.

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Check lines for deterioration, damage, leaking, or loose connections. Replace hoses, clamps, and connections as necessary.

Fuel Tank Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Remove left fender and tool box from the frame to gain access to the top of the fuel tank.

3. Drain fuel from the fuel tank into a suitable container by opening the drain fitting.

4. Disconnect electrical wiring from the sending unit. Disconnect both fuel hoses from the standpipe and fuel connector.

5. Remove fuel tank from the frame using Figure 19 as a guide.

Drain and Clean Fuel Tank

Drain and clean the fuel tank periodically as recommended in the maintenance schedules in Chapter 2 - Product Records. Also, drain and clean the fuel tank if the fuel system becomes contaminated or if the machine is to be stored of an extended period.

1. Remove fuel tank from the machine (see Fuel Tank Removal).

2. Flush fuel tank out with clean diesel fuel. Make sure tank is free of contaminates and debris.

3. Install fuel tank to the machine (see Fuel Tank Installation).

Fuel Tank Installation (Fig. 19)

1. Install fuel tank to the frame using Figure 19 as a guide.

   A. Apply antiseize lubricant to the threads of all three cap screws.

   B. Torque all three cap screws from 30 to 60 in-lb (3.4 to 6.8 N-m).

2. Connect both fuel hoses to the standpipe and fuel connector.

3. Connect electrical wiring to the sending unit.

   A. Connect blue/green wire to the center terminal and black wire to any of the screws on the sender.

   B. Apply skin-over grease to the terminal connections.

4. Install left fender and tool box to the frame.

5. Make sure drain fitting is closed. Fill fuel tank (see Fill Fuel Tank).

Air Filtering System

General Maintenance

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Check air cleaner body for damage which could cause an air leak. Replace damaged air cleaner body.

3. Service air cleaner filters whenever air cleaner indicator (Fig. 20) shows red or periodically as recommended in the maintenance schedules in Chapter 2 - Product Records and Manuals(more frequently in extreme dusty or dirty conditions). Do not over service air filter.

4. Make sure cover seals around the air cleaner body.

Service Precleaner Bowl

Inspect precleaner bowl daily. During extremely dusty or dirty conditions, inspect more frequently. Do not let dust or debris build up above level marks on bowl.

1. Remove thumb screw and separate cover from precleaner bowl. Empty precleaner bowl and wipe clean.

2. Assemble and install precleaner bowl, cover, and thumb screw.

Note: When operating in extremely dusty conditions, an optional extension tube (Toro Part No. 43-3810) raises the precleaner bowl above the hood; service intervals are increased.

Service Air Cleaner

1. Release latches securing air cleaner cover to the air cleaner body. Separate cover from the body. Clean inside of the air cleaner cover.

2. Carefully slide filter element out of the air cleaner body to prevent dislodging dust. Inspect filter element and discard if damaged.

Washing Method

A. Prepare a solution of filter cleaner and water. Soak filter element about 15 minutes. Follow directions on the cleaner carton.

B. Rinse filter with fresh water. Water pressure must not exceed 40 psi to prevent damage to the filter element. Rinse filter from clean side to dirty side.

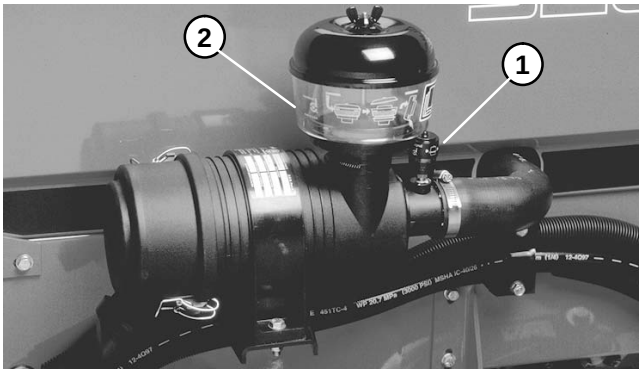


Figure 20

1. **Indicator** 2. **Precleaner bowl**

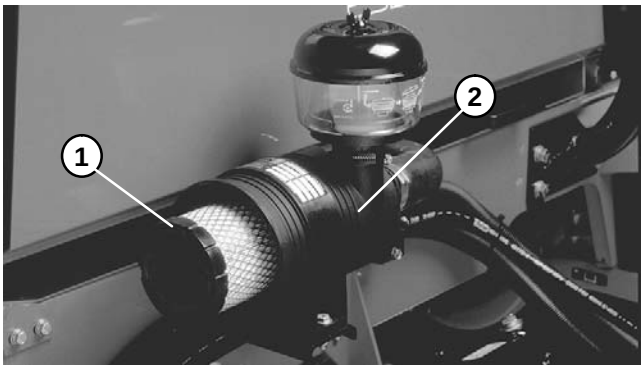


Figure 21

1. **Filter element** 2. **Body**

C. Dry filter element using warm, flowing air (160°F max.), or allow element to air-dry. Do not use a light bulb to dry the filter element; damage may result.

Compressed Air Method

A. Blow compressed air from inside to the outside of dry filter element. Do not exceed 100 psi to prevent damage to the element.

B. Keep air hose nozzle at least 2 inches (5 cm) from the filter. Move nozzle up and down while rotating the filter element. Inspect for holes and tears by looking through the filter toward a bright light.

3. Inspect new filter for shipping damage. Check sealing end of filter. Do not install a damaged filter

4. Insert new filter properly into air cleaner body. Make sure filter is sealed properly by applying pressure to outer rim of filter when installing. Do not press on flexible center of filter.

5. Reinstall cover and secure latches. Reset indicator if showing red (Fig. 20).

Water/Fuel Separator

DANGER

Because diesel fuel is highly flammable, use caution when storing or handling it. Do not smoke while filling the fuel tank. Do not fill fuel tank while engine is running, hot, or when machine is in an enclosed area. Always fill fuel tank outside and wipe up any spilled diesel fuel before starting the engine. Store fuel in a clean, safety-approved container and keep cap in place. Use diesel fuel for the engine only; not for any other purpose.

Draining

Drain water and other contaminants from the water/fuel separator daily.

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Place a suitable container under the fuel/water separator.

3. Loosen drain valve on the bottom of the separator base.

4. Allow all water and contaminants to drain from the separator. Tighten drain valve.

Filter Element Replacement

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Clean area where filter element mates with base and filter head.

3. Place a suitable container under the fuel/water separator.

4. Unscrew filter element from base and filter head. Discard element.

5. Lubricate gasket on new filter element and O-ring with clean diesel fuel.

6. Screw filter element onto base by hand until the gasket contacts the mounting surface. Rotate element an additional 1/2 turn.

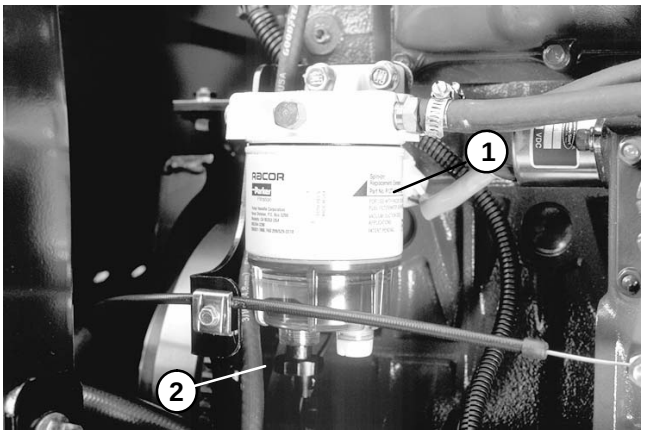


Figure 22

1. **Filter element**
2. **Drain valve**

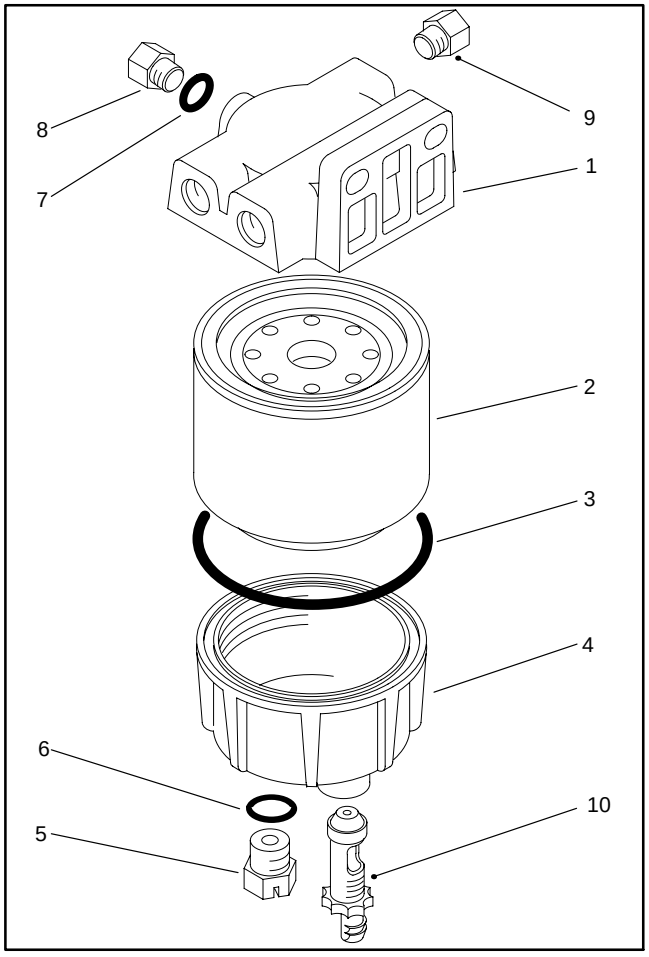


Figure 23

1. **Filter head**
2. **Filter element (spin on)**
3. **O-ring**
4. **Base**
5. **Plug**
6. **O-ring**
7. **O-ring**
8. **Plug**
9. **Pipe plug**
10. **Drain valve**

Radiator

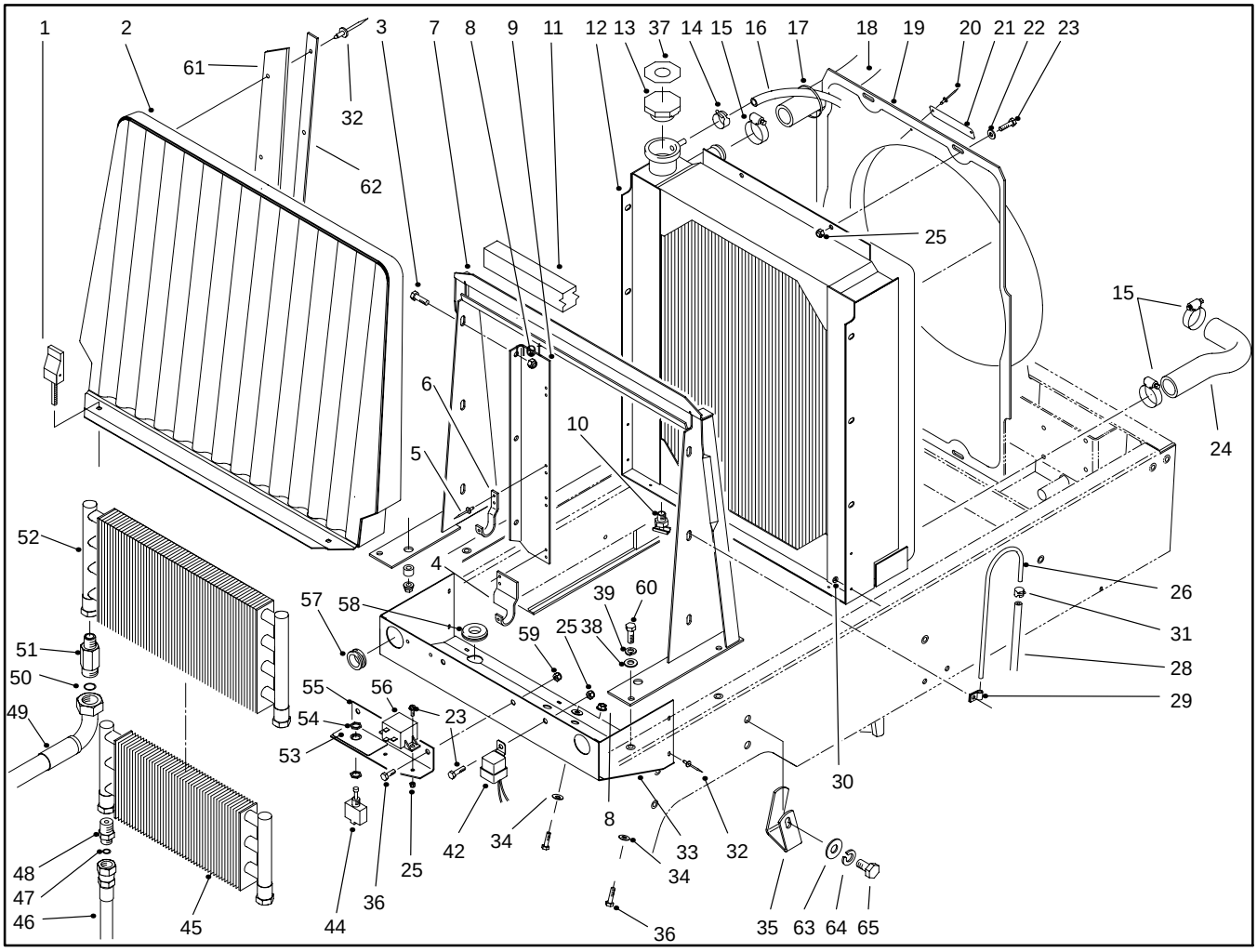


Figure 24

1. **Swell latch**
2. **Front screen housing**
3. **Whiz lock screw**
4. **Cooler bracket mount**
5. **Pop rivet**
6. **Oil cooler hook**
7. **Radiator support**
8. **Whiz nut**
9. **Cooler mount**
10. **Radiator drain**
11. **Foam strip**
12. **Radiator**
13. **Radiator cap**
14. **Hose clamp**
15. **Hose clamp**
16. **Expansion tank hose**
17. **Cable tie**
18. **Upper radiator hose**
19. **Fan shroud**
20. **Pop rivet**
21. **Caution plate**
22. **Flat washer**
23. **Cap screw**
24. **Lower radiator hose**
25. **Lock nut**
26. **Vent tube**
27. **Not used**
28. **Fuel vent hose**
29. **R-clamp**
30. **Back-up washer**
31. **Hose clamp**
32. **Pop rivet**
33. **Radiator shield**
34. **Flat washer**
35. **Hose clamp**
36. **Cap screw**
37. **Radiator cap decal**
38. **Flat washer**
39. **Lock washer**
40. **Not used**
41. **Not used**
42. **Starter relay**
43. **Not used**
44. **Backlap switch**
45. **Transmission oil cooler**
46. **Hydraulic hose**
47. **O-ring**
48. **Straight hydraulic fitting**
49. **Hydraulic hose**
50. **O-ring**
51. **90° hydraulic fitting**
52. **Reel motors oil cooler**
53. **Backlap decal**
54. **Lock nut**
55. **Backlap bracket**
56. **Glow plug relay**
57. **Grommet**
58. **Grommet**
59. **Lock nut**
60. **Cap screw**
61. **Radiator sealing strip**
62. **Retaining plate**
63. **Flat washer**
64. **Lock washer**
65. **Cap screw**

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Open engine hood on the machine.

CAUTION

Do not open radiator cap or drain coolant if the radiator or engine is hot. Pressurized, hot coolant can escape and cause burns. Ethylene-glycol antifreeze is poisonous. Dispose of coolant properly, or store it in a properly labeled container away from children and pets.

3. Drain radiator into a suitable container using the radiator drain. Disconnect hoses from the radiator.

4. Remove front housing screen from the radiator support. Disconnect hose from the vent tube.

5. Detach both oil coolers and fan shroud from the radiator.

6. Remove four cap screws, flat washers and lock washers securing the radiator support to the frame. Pull radiator and support from the frame.

7. Plug any openings to prevent contamination.

Installation

1. Remove any plugs used during the removal procedure.

2. Position radiator and support to the frame. Secure radiator support and radiator to the frame with four lock washers, flat washers, and cap screws.

3. Attach both oil coolers and fan shroud to the radiator.

4. Connect hose to the vent tube. Install front housing screen to the radiator support.

5. Connect hoses to the radiator.

6. Make sure radiator drain is closed. Fill radiator with fluid (see Check Cooling System).

7. Close engine hood to the machine.

Engine

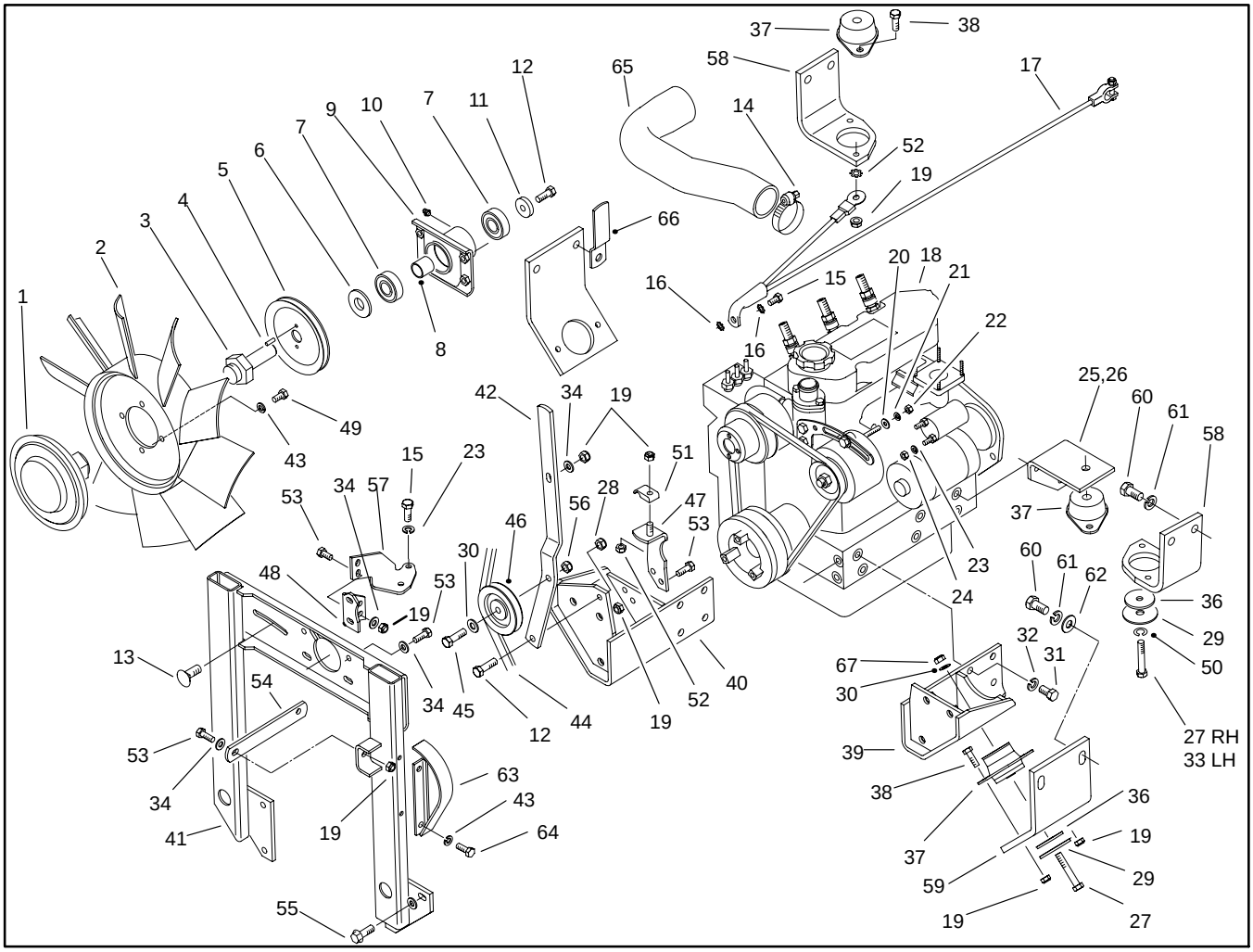


Figure 25

1. Fan clutch
2. Fan
3. Fan shaft
4. Roll pin
5. Fan pulley
6. Spindle spacer
7. Ball Bearing
8. Bearing spacer
9. Fan drive hub
10. 45° grease fitting
11. Fan spacer
12. Cap screw
13. Carriage bolt
14. Hose clamp
15. Cap screw
16. Lock washer
17. Battery ground cable
18. Engine assembly
19. Lock nut
20. Flat washer
21. Lock washer
22. Hex nut
23. Lock washer
24. Lock nut
25. Rear engine bracket (LH)
26. Rear engine bracket (RH)
27. Cap screw
28. Lock nut
29. Snubbing washer
30. Flat washer
31. Cap screw
32. Lock washer
33. Cap screw
34. Flat washer
35. Cap screw
36. Engine mount washer
37. Engine mount
38. Cap screw
39. Front engine bracket (LH)
40. Engine mounting bracket (RH)
41. Engine fan support
42. Fan idler bracket
43. Lock washer
44. V-belt
45. Cap screw
46. Idler pulley
47. Throttle mounting bracket
48. Fan support bracket
49. Cap screw
50. Lock washer
51. Cable clamp
52. Toothed lock washer
53. Cap screw
54. Fan mounting plate
55. Flange screw
56. Lock nut
57. Fan mounting bracket
58. Rear engine bracket (LH)
59. Front engine bracket
60. Cap screw
61. Lock washer
62. Flat washer
63. Alternator shield
64. Cap screw
65. Air cleaner hose
66. Retaining clamp
67. Flange nut

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Open engine hood.

3. Disconnect both battery cables at the battery (see Battery Service in Chapter 5 - Electrical system).

4. Disconnect yoke flange from the lower fan belt pulley (Fig. 26).

CAUTION

Do not open radiator cap or drain coolant if the radiator or engine is hot. Pressurized, hot coolant can escape and cause burns.

Ethylene-glycol antifreeze is poisonous. Dispose of coolant properly, or store it in a properly labeled container away from children and pets.

5. Drain radiator coolant from the radiator drain and engine block pet cock (LH) into a suitable container (see Radiator Removal). Disconnect coolant hoses from the water pump, radiator cap, and engine block.

CAUTION

The muffler and exhaust pipe may be hot. To avoid possible burns, allow the exhaust system to cool before working on or near the muffler.

6. Disconnect air filter hose from the engine.

7. Disconnect wires and/or electrical connections from the following electrical components:

   A. The oil low pressure switch, starter, and alternator (Fig 27). The temperature sender (Fig. 28).

   B. Battery, frame, and wire harness ground to the engine block and the ETR solenoid (Fig. 29).

   C. High temperature shutdown switch (Fig. 30). Glow plug bus (Fig. 31).

8. Disconnect fuel hose from the rear injector nozzle (Fig. 31).

9. Disconnect throttle cable from the cable clamp and swivel on the speed control lever. Disconnect fuel hoses from the water/fuel separator at the injector and fuel pumps. Disconnect fuel hose from the fuel tank at the fuel pump (Fig. 32).

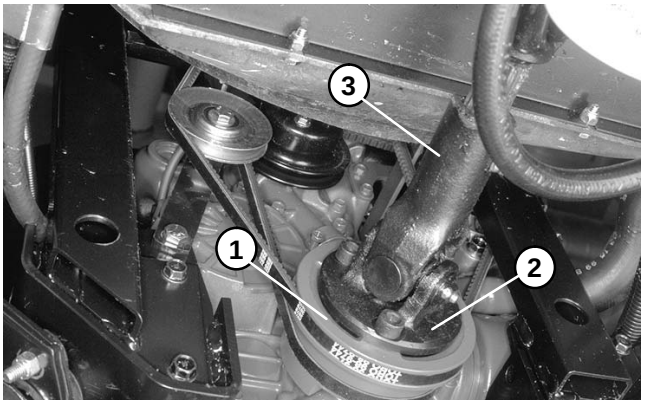


Figure 26

1. Lower fan belt pulley
2. Yoke flange
3. Yoke slip tube

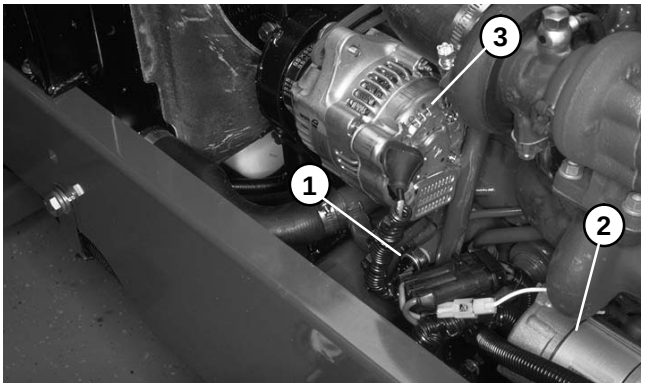


Figure 27

1. Oil low pressure switch
2. Alternator
3. Starter

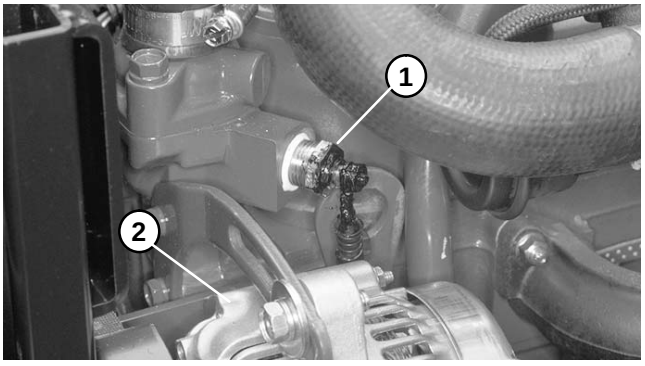


Figure 28

1. Temperature sender
2. Alternator

10. Remove four locknuts, cap screws, and flat washers securing the fan shroud to the radiator (Fig. 33).

11. Make sure all cable ties securing the wiring harness, fuel lines, or hydraulic hoses to the engine are removed.

12. Connect hoist or lift to the front and rear lift tabs.

Note: The rear left engine mount does not use a flange nut and flat washer to secure itself to the engine bracket. The cap screw is threaded into the engine bracket.

13. Remove flange head nuts, flat washers, cap screws, snubbing washers, and engine mount washers securing the engine mounts to the engine brackets.

CAUTION

One person should operate lift or hoist while the other person guides the engine out of the machine.

IMPORTANT: Make sure not to damage the engine, fuel and hydraulic lines, electrical harness, or other parts while removing the engine.

14. Remove engine slowly from the machine.

15. Remove muffler, muffler bracket, and/or flywheel guard as necessary (see Muffler Removal).

16. Remove engine fan support and engine brackets from the engine as necessary using Figure 25 as a guide.

Installation

1. Install muffler, muffler bracket, and/or flywheel guard if removed from the engine (see Muffler Installation).

2. Install engine and fan support brackets to the engine using Figure 25 as a guide.

3. Connect hoist or lift to the front and rear lift tabs.

CAUTION

One person should operate lift or hoist while the other person guides the engine into the machine.

IMPORTANT: Make sure not to damage the engine, fuel and hydraulic lines, electrical harness, or other parts while installing the engine.

4. Position fan shroud around the engine fan. Position engine slowly into the machine.

Note: The rear left engine mount does not use a flange nut and flat washer to secure itself to the engine bracket. The cap screw is threaded into the engine bracket.

5. Secure engine mounts to the engine brackets with engine mount washers, snubbing washers, cap screws, flat washers, and flange head nuts.

6. Secure fan shroud to the radiator with four cap screws, flat washers, and locknuts (Fig. 33).

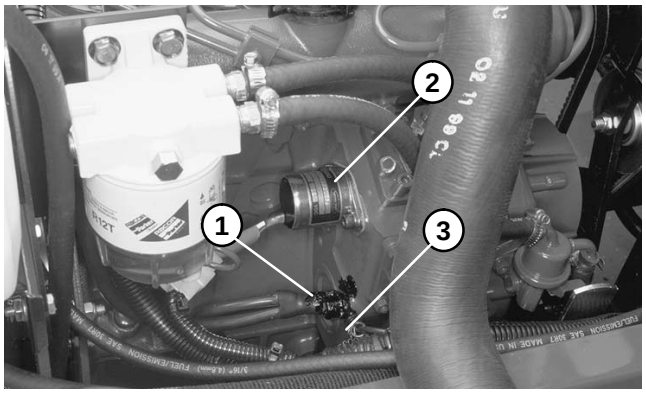


Figure 29

1. **Battery & frame ground**
2. **ETR solenoid**
3. **Wire harness ground**

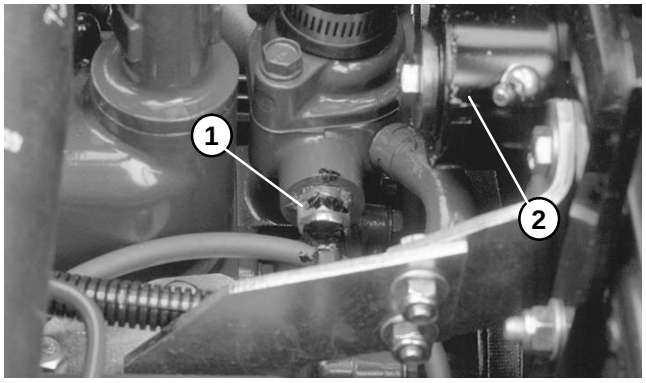


Figure 30

1. **High temperature shut-down switch**
2. **Engine fan drive hub**

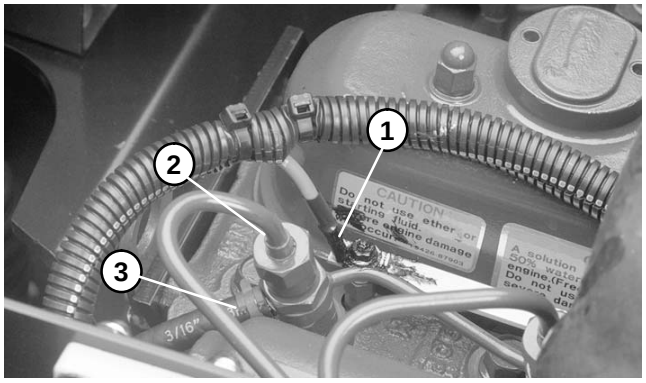


Figure 31

1. **Glow plug wire**
2. **Rear injection nozzle**
3. **Fuel hose**

7. Connect throttle cable to the cable clamp and swivel on the speed control lever. Connect both fuel hoses from the water/fuel separator to the injector and fuel pumps. Connect fuel hose from the fuel tank to the fuel pump (Fig. 32).

8. Connect fuel hose to the rear injector nozzle (Fig. 31).

9. Connect wires and/or electrical connections to the following electrical components:

   A. Glow plug bus (Fig. 31). High temperature shutdown switch (Fig. 30).

   B. Battery, frame, and wire harness ground to the engine block and the ETR solenoid (Fig. 29).

   C. The temperature sender (Fig. 28). The oil low pressure switch, starter, and alternator (Fig 27).

10. Connect air filter hose to the engine.

11. Connect coolant hoses to the water pump, radiator cap, and engine block. Make sure radiator drain is shut. Fill radiator with coolant (see Check Coolant System).

12. Secure yoke flange to the lower fan belt pulley with three socket head screws and lock washers (Fig. 26).

   A. Apply Loctite® thread locker 242 or equivalent to the threads of the screws.

   B. Torque screws from 30 to 35 ft-lb (41 to 47 N-m).

   C. Lubricate yoke slip tube (see Lubrication in Chapter 2 - Product Records and Maintenance).

13. Connect both battery cables to the battery (see Battery Service in Chapter 5 - Electrical System).

14. Close engine hood.

15. Adjust throttle cable (see Adjust Throttle Cable).

16. Bleed fuel system (see Bleed Fuel System).

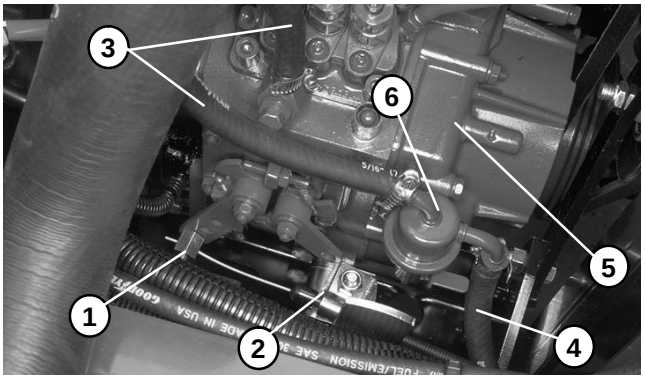


Figure 32

1. **Cable swivel**
2. **Cable clamp**
3. **Fuel hoses (separator)**
4. **Fuel hose (fuel tank)**
5. **Injection pump**
6. **Fuel pump**

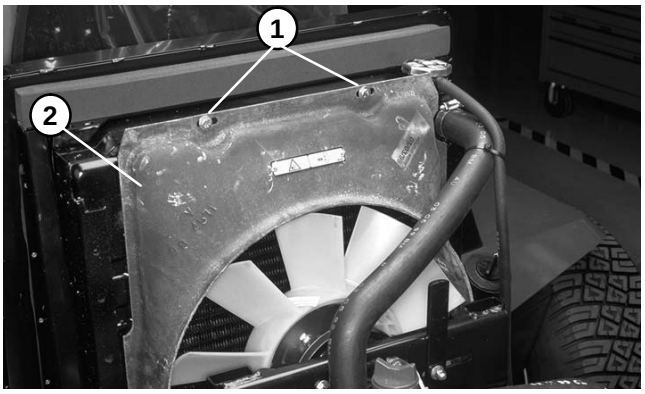


Figure 33

1. **Cap screws**
2. **Fan shroud**

Fan Drive Hub

Disassembly (Fig. 34)

1. Secure pulley and fan to prevent them from turning. Remove shaft screw and flat washer.

2. Press pulley and fan assembly from fan drive hub.

3. Remove bearings and bearing spacer from fan drive hub.

Note: The fan clutch and fan shaft have left hand threads.

4. If necessary, disassemble pulley and fan assembly using Figure 34 as a guide.

Assembly (Fig. 34)

1. If pulley and fan were disassembled, secure fan to fan clutch with cap screws and lock washers. Apply Loctite® thread locker 242 (or equivalent) to threads of fan shaft. Thread fan shaft into fan clutch and torque from 80 to 100 ft−lbs. (108 to 136 N−m).

2. Press first bearing into fan drive hub until it contacts shoulder in hub.

3. Place bearing spacer into fan drive hub.

4. Pressing equally on both inner and outer races of second bearing, install second bearing until it contacts shoulder in hub. Make sure that bearing spacer bore is aligned with bearing bores.

5. Make sure that pulley and thrust washer are installed on fan shaft.

6. While supporting inner bearing race, press pulley and fan assembly into bearing bores.

7. Apply Loctite® thread locker 242 (or equivalent) to threads of shaft screw. Secure assembly with flat washer and shaft screw.

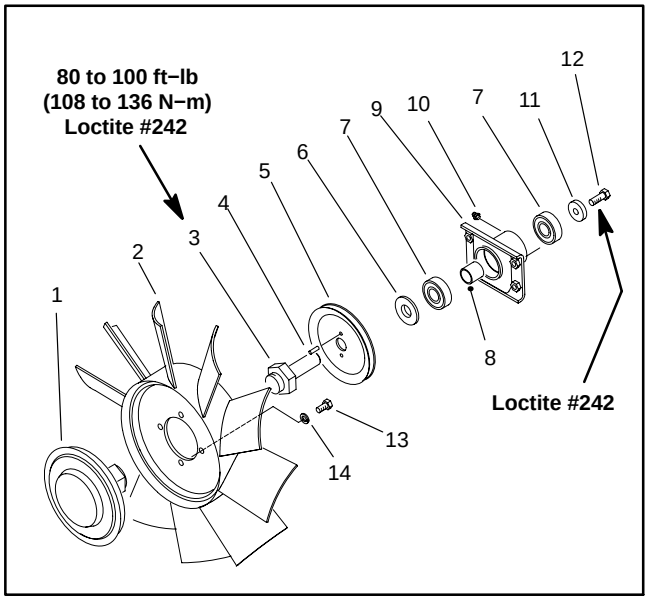


Figure 34

1. **Fan clutch**
2. **Fan**
3. **Fan shaft**
4. **Grooved pin (2 used)**
5. **Pulley**
6. **Thrust washer**
7. **Bearing**
8. **Bearing spacer**
9. **Fan drive hub**
10. **Grease fitting**
11. **Flat washer**
12. **Shaft screw**
13. **Cap screw (4 used)**
14. **Lock washer (4 used)**

Chapter 4

Hydraulic System

Table of Contents

Note: For hydraulic steering cylinder and valve information, see Chapter 7 “Steering and Brakes” in this manual.

Specifications

Item	Description
Hydraulic Transmission System Relief Pressure: Forward System Relief Pressure: Reverse Charge Pressure Cooler By-pass Pressure Filter By-pass Pressure Oil Filter In-line Strainer	Sauer-Sundstrand M25, U-type 3625 PSI (249.9 bar) 2755 PSI (190.0 bar) 150 PSI (10.3 bar) 70 PSI (4.8 bar) 70 PSI (4.8 bar) Screw-on type 260 micron, 8 GPM (30.3 LPM)
Gear Pump Maximum Operating Pressure Steering Relief Pressure	3 section, positive displacement gear type pumps 3000 PSI (207 bar) 1250 PSI (86.2 bar)
Hydraulic Manifold Block Front Reels Circuit Relief Pressure (R1) Rear Reels Circuit Relief Pressure (R2)	 3000 PSI (207 bar) 2000 PSI (138 bar)
Reel Motor s Maximum Operating Pressure	Gear motor 3000 PSI (207 bar)
Hydraulic Filter (Reels, Lift, and Steering Circuits)	5 Micron spin-on cartridge type
Hydraulic Reservoir (Reels, Lift, and Steering Circuits)	8.5 gal. U.S. (32.2 L)
Hydraulic Oil	See Check Hydraulic System Fluid in General Information section
Hydraulic Reservoir in Differential Housing (Transmission)	5.0 qts. U.S. (4.7 L)

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 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; hold the hose straight with one and tighten the hose swivel nut onto the fitting with the other.

WARNING

Before disconnecting or performing any work on hydraulic system, relieve all pressure in system. Stop engine; lower or support box and/or other attachment(s).

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 cause serious injury. 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. Gangrene may result from such an injury.

Hydraulic Fitting Installation

O-Ring Face Seal

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)	0.75 ± 0.25
6 (3/8 in.)	0.75 ± 0.25
8 (1/2 in.)	0.75 ± 0.25
10 (5/8 in.)	1.00 ± 0.25
12 (3/4 in.)	0.75 ± 0.25
16 (1 in.)	0.75 ± 0.25

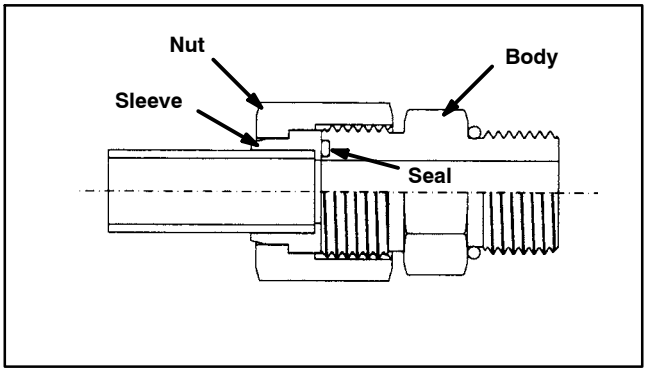


Figure 1

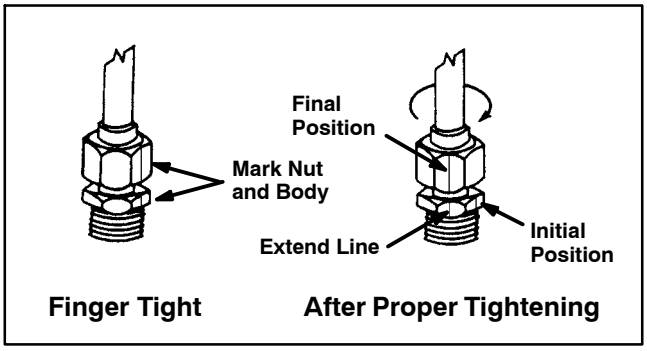


Figure 2

SAE Straight Thread O-Ring Port - Non-adjustable

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 ± 0.25
6 (3/8 in.)	1.50 ± 0.25
8 (1/2 in.)	1.50 ± 0.25
10 (5/8 in.)	1.50 ± 0.25
12 (3/4 in.)	1.50 ± 0.25
16 (1 in.)	1.50 ± 0.25

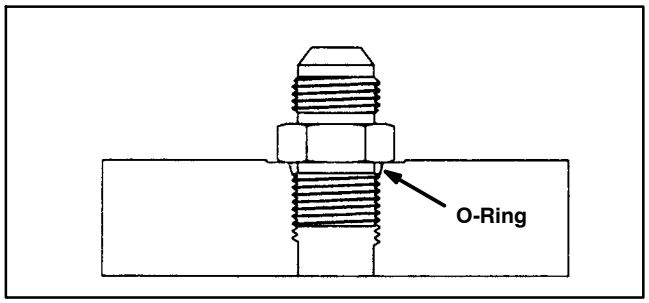


Figure 3

SAE Straight Thread O-Ring Port - Adjustable

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 ± 0.25
6 (3/8 in.)	1.50 ± 0.25
8 (1/2 in.)	1.50 ± 0.25
10 (5/8 in.)	1.50 ± 0.25
12 (3/4 in.)	1.50 ± 0.25
16 (1 in.)	1.50 ± 0.25

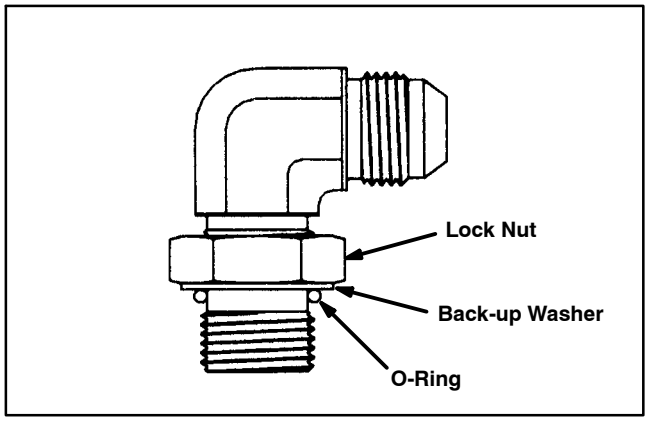


Figure 4

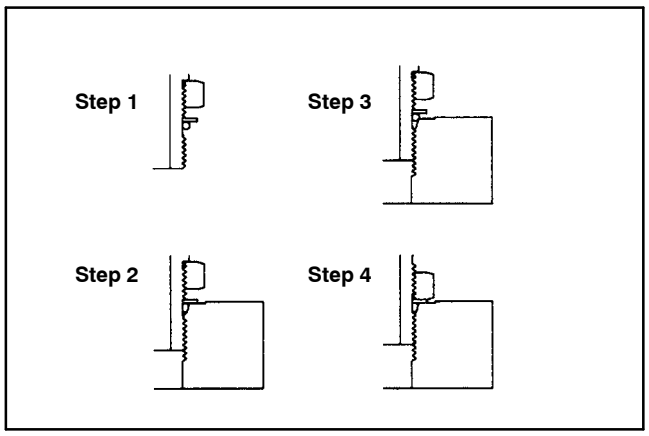


Figure 5

Towing Traction Unit

IMPORTANT: If towing limits are exceeded, severe damage to the hydrostatic transmission may occur.

If it becomes necessary to tow the machine, tow it **forward only** and at a speed **below 3 mph**.

IMPORTANT: If drive shaft is not removed before towing, the transmission input shaft will not be able to rotate, thus not allowing the transmission to maintain its internal lubrication. Severe damage to the hydrostatic transmission may occur.

1. Loosen and remove capscrews securing the drive shaft to the engine drive coupler. Loosen capscrews clamping drive shaft to transmission (Fig. 6). Remove drive shaft.

2. Attach a suitable chain, strap or cable to the center of the front frame member (Fig. 7).

IMPORTANT: Lock both brake pedals together before towing.

3. Attach the other end of the towing device to a vehicle that is capable of towing the machine safely and at speeds **below 3 mph**.

4. An operator must be on the machine to steer it and keep the traction pedal fully depressed in the forward position while towing.

5. When towing is completed, reinstall driveshaft. The splines are designed to allow assembly only when the two halves of the shaft are properly oriented (Fig. 6).

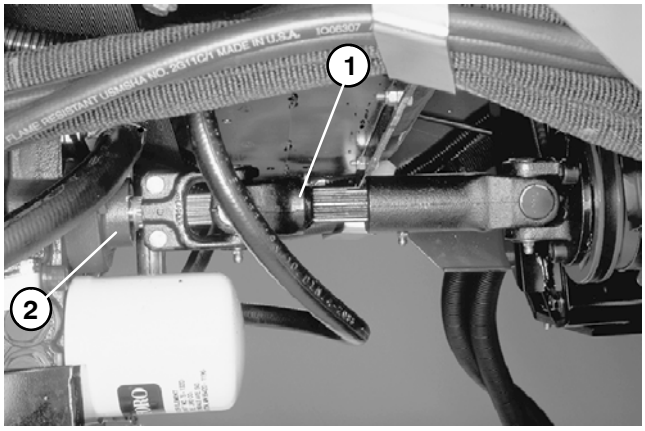


Figure 6

1. **Drive shaft**
2. **Hydraulic transmission**

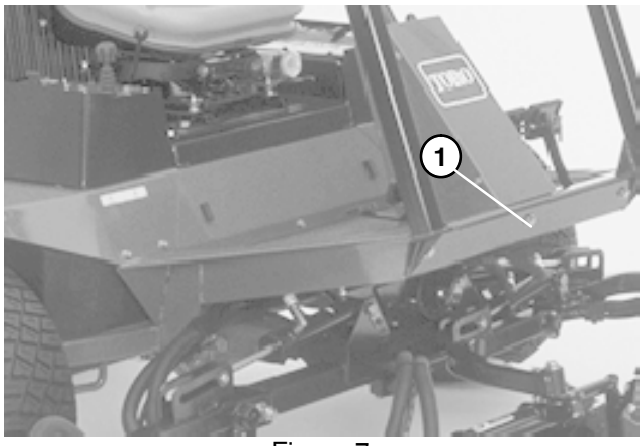


Figure 7

1. **Front frame member**

Check Transmission Fluid

The front axle housing acts as the reservoir for the transmission. The transmission and axle housing hold about 5 quarts (4.7 L) of Mobil 424 hydraulic fluid. Check level of transmission oil daily.

1. Position machine on a level surface, lower cutting units, and stop the engine.

2. Remove floor panel.

3. Unscrew dipstick cap from the transmission filler neck; wipe it with a clean rag. Screw dipstick into filler neck. Remove dipstick and check level of oil. If level is not within 1/2 inch (1.3 cm) from the groove in the dipstick, add enough oil to raise the level to the groove mark. **Do not overfill by more than 1/4 inch (0.6 cm) above the groove.**

4. Screw dipstick filler cap finger-tight onto filler neck. It is not necessary to tighten cap with a wrench.

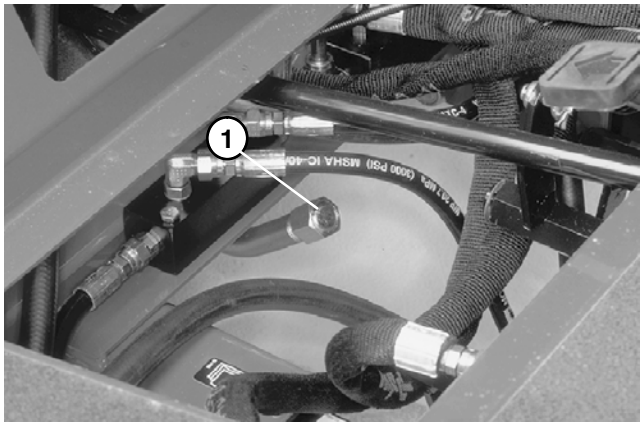


Figure 8

1. Transmission dipstick cap

Check Hydraulic Fluid

The hydraulic system driving the reels is designed to operate on anti-wear hydraulic fluid. The reservoir holds about 8.5 gallons (32 L) hydraulic fluid. **Check level of hydraulic fluid daily.**

Note: The fluids in this group are interchangeable.

Group 1 Hydraulic Fluid (Recommended for ambient temperatures consistently below 100° F.):

ISO type 46/68 anti-wear hydraulic fluid

Mobil	Mobil Fluid 424
Amoc	Amoco 1000
International Harvester	Hy-Tran
Texaco	TDH
Shell	Donax TD
Union OIl	Hydraulic/Tractor Fluid
Chevron	Tractor Hydraulic Fluid
BP Oil	BP HYD TF
Boron OIl	Eldoran UTH
Exxon	Torque Fluid
Conoco	Power-Tran 3
Kendall	Hyken 052
Phillips	HG Fluid

Note: The fluids in this group are interchangeable.

Group 2 Hydraulic Fluid (Recommended for ambient temperatures consistently above 70° F.):

ISO type 68 anti-wear hydraulic fluid

Mobil	DTE 26 or DTE 16
Shell	Tellus 68
Amoco	Rykon Oil 68
Arco	Duro AW S-315
Boron	Industron 53
BP Oil	Energol HLP68
Castrol	Hyspin AWS68
Chevron	Chevron EP68
Citgo	Citgo A/W68
Conoco	Super Hydraulic Oil 31
Exxon	Nuto H68
Gulf	68AW
Pennzoil	IAW Hyd Oil 68
Phillips	Magnus A315
Standard	Industron 53
Texaco	Rando HD68
Union	Unax AW 315

IMPORTANT: Two groups of hydraulic fluid are specified to allow optimal operation of the machine in a wide range of temperatures encountered. The Group 1 fluids are a multi-viscosity hydraulic fluids that allow operation at lower temperatures without increased viscosity, which is associated with straight viscosity fluids.

Using the Mobil 424 type fluids in the higher ambient temperatures may result in decreased efficiency in some of the hydraulic components compared to using the Mobil DTE 26 type fluids.

The Mobil DTE 26 type fluids are straight viscosity fluids which remain slightly more viscous at higher temperatures than the multi-viscosity fluids.

Using the Mobil DTE 26 type fluids in the lower ambient temperatures may result in harder starting, increased engine laboring while cold, sluggish or non-operating valve spools while cold and increase filter back pressure due to the higher fluid viscosity.

It is recommended that you select which set of conditions, either ambient temperatures above 70° F (21° C). or below 100° F (38° C), and use that type of fluid throughout the year, rather than changing fluid types several times per year.

Group 3 Hydraulic Fluid (Biodegradable):

ISO VG 32/46 anti-wear hydraulic fluid

Mobil	EAL 224 H

Note: This biodegradable hydraulic fluid in this group is not compatible with the fluids in Group 1 or 2.

Note: When changing from one type of hydraulic fluid to the other, be certain to remove all the old fluid from the system, because some brands of one type are not completely compatible with some brands of the other type of hydraulic fluid.

IMPORTANT: Use only types of hydraulic fluids specified. Other fluids could cause system damage.

Note: A red dye additive for the hydraulic system fluid is available in 2/3 oz. (20 cc) bottles. One bottle is sufficient for 4 to 6 gal. (15 to 23 L) of hydraulic fluid. Order Part No. 44-2500 from your Authorized Toro Distributor

1. Position machine on a level surface, lower the cutting units and stop the engine.

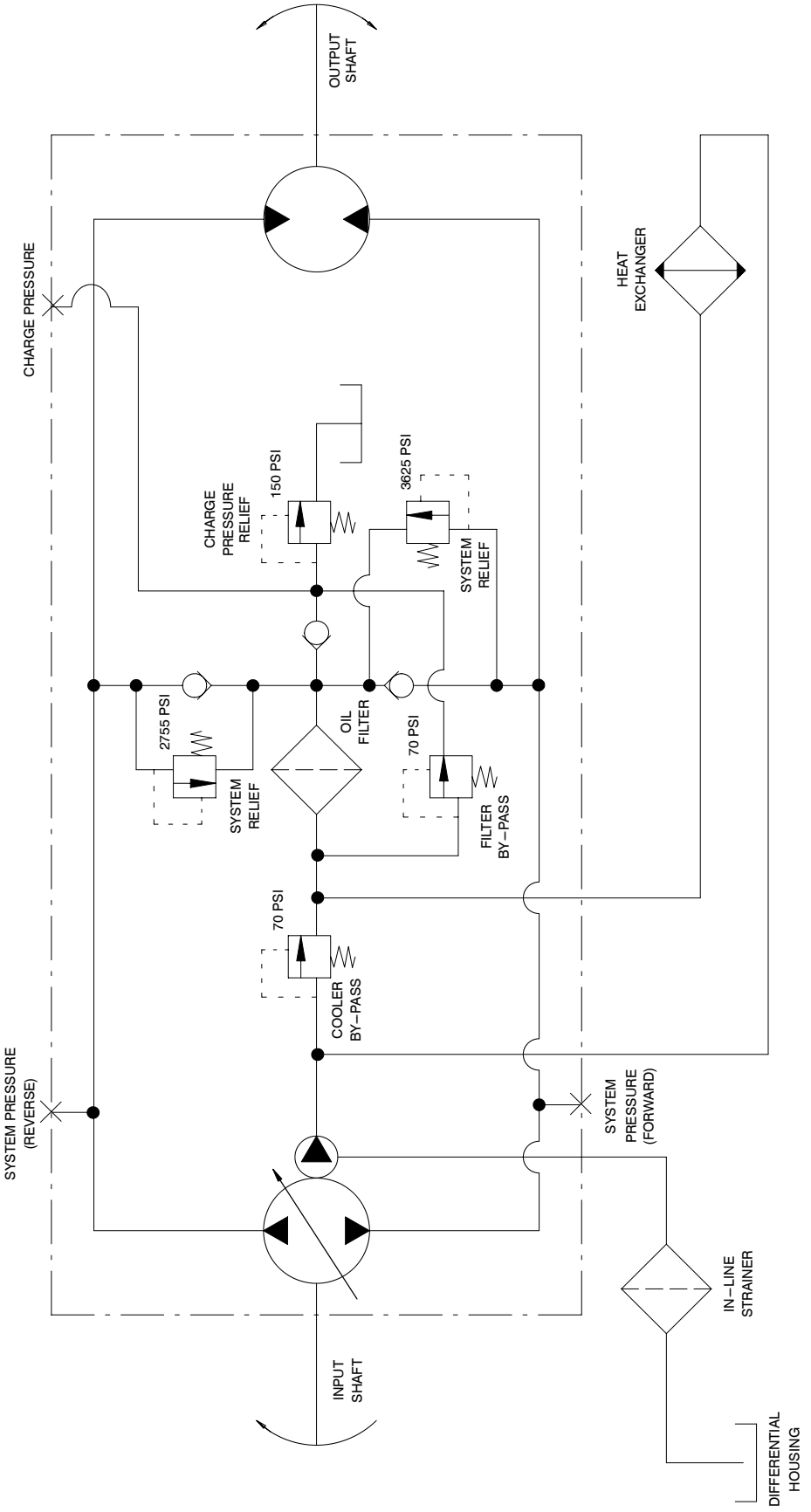
2. Clean area around filler neck and cap of hydraulic reservoir. Remove cap from filler neck.

3. Remove dipstick from filler neck and wipe it with a clean rag. Insert dipstick into filler neck; then remove it and check level of fluid. Fluid level should be within 1/4 inch (0.6 cm) of the mark on dipstick.

4. If level is low, add appropriate fluid to raise level to full mark

5. Install dipstick and cap onto filler neck.

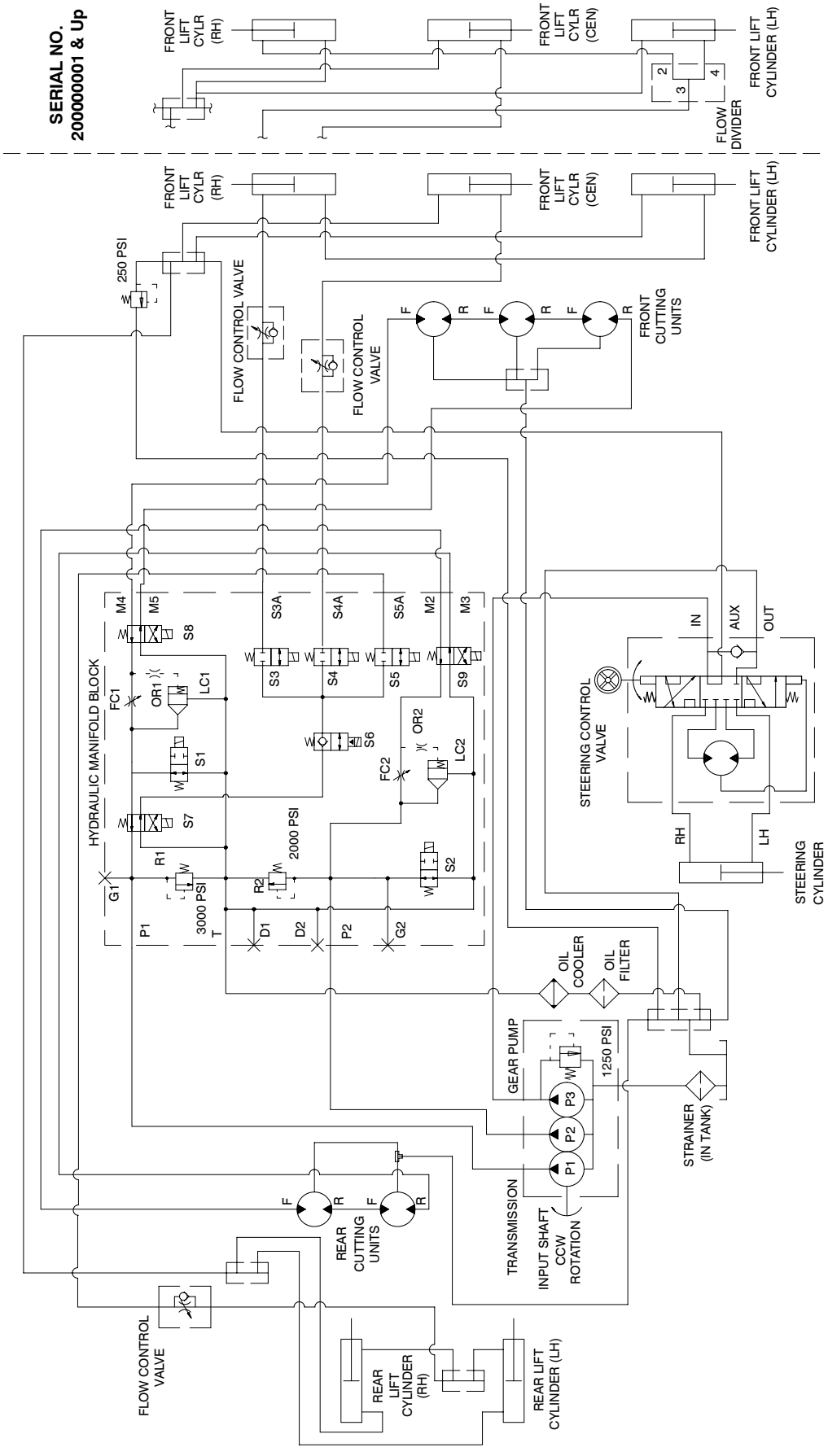
Hydraulic Schematics



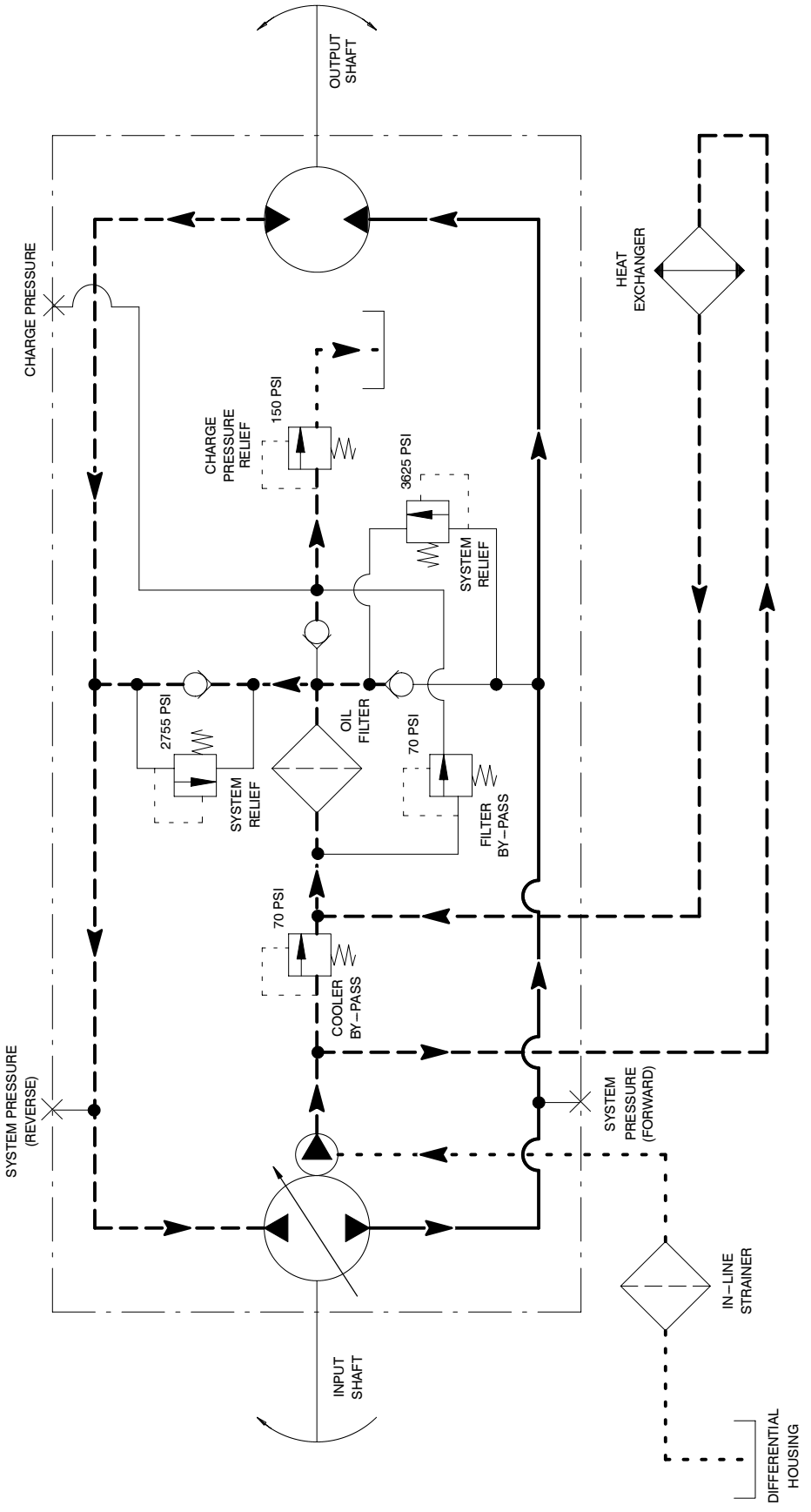
Reelmaster 5200-D/5400-D
Hydraulic Transmission Schematic

Reelmaster 5200-D/5400-D
Hydraulic System Schematic

All solenoids are shown as de-energized.



Hydraulic Flow Diagrams



Reelmaster 5200-D/5400-D

Traction Circuit (Forward Direction Shown)

- High Pressure
- Low Pressure (Charge)
- Return or Suction
- Flow

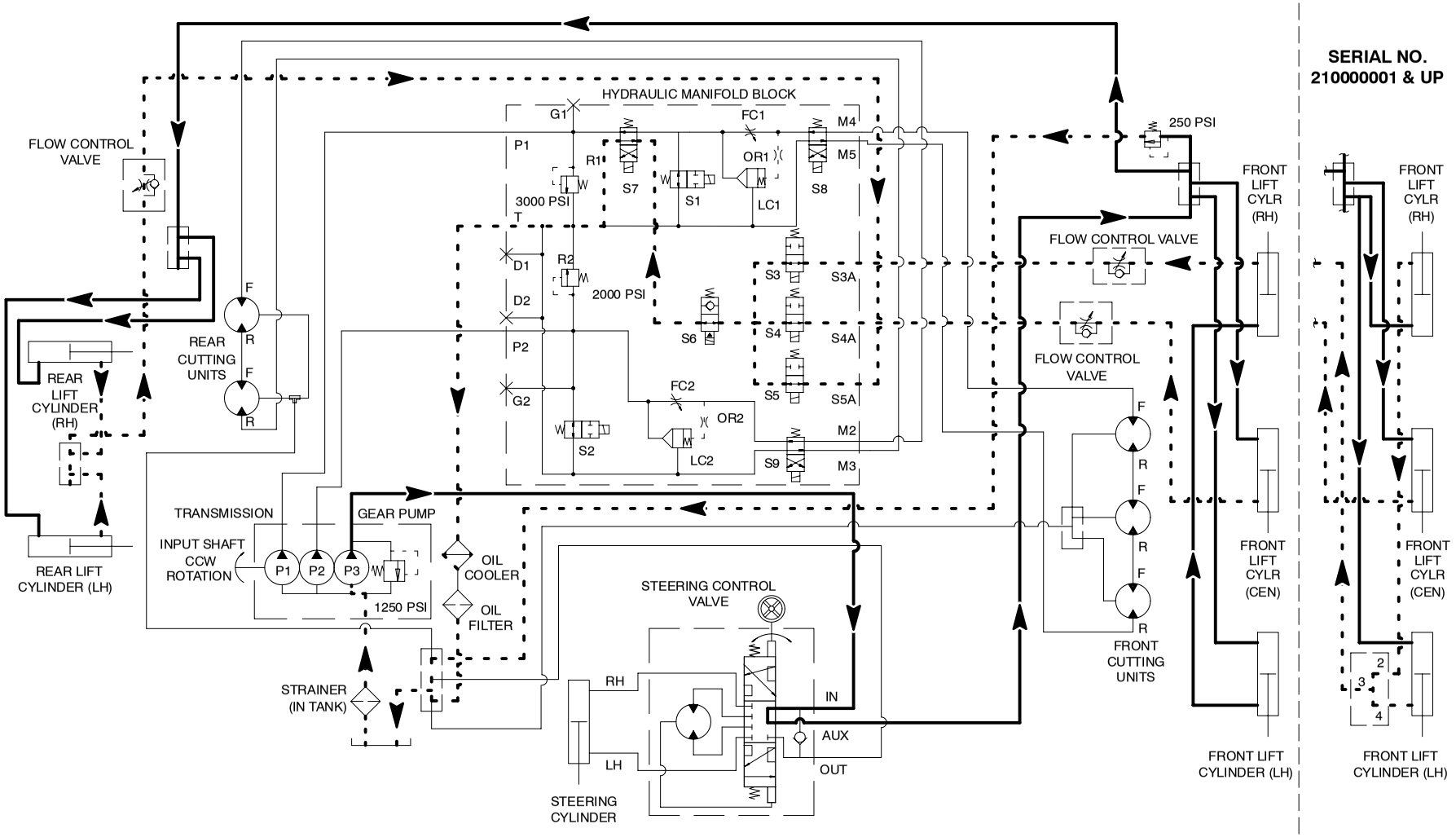
Traction Circuit

The hydrostatic transmission is driven by a drive shaft off the front of the engine crankshaft. Pushing the top of the traction pedal, rotates the variable displacement pump swash plate to create a flow of oil. This oil is directed to the fixed displacement motor which turns the differential input shaft to drive the front wheels in the forward direction. Operating pressure on the high pressure side of the closed loop is determined by the amount of load developed at the fixed displacement motor. As the load increases, pressure can increase to a maximum of 3625 PSI in the forward direction.

Pushing the bottom of the traction pedal rotates the variable displacement pump swash plate to create a flow of oil. This oil is directed to the fixed displacement motor which turns the differential input shaft to drive the front wheels in a reverse direction. Operating pressure on the high pressure side of the closed loop is determined by the amount of load developed at the fixed displacement motor. As the load increases, pressure can increase to a maximum of 2755 PSI in the reverse direction.

Main system pressure is limited by a high pressure relief valve on each side of the closed loop circuit. System pressure can be measured at test ports on the transmission. If pressure exceeds the relief setting, oil flows through the relief valve to the low pressure side of the closed loop circuit.

An integral charge pump provides a constant supply of charge oil to the variable displacement pump and closed loop circuit for lubrication and to make up for oil that is lost due to internal leakage in the pump and motor. Charge pump flow is directed through the oil cooler, then through the filter to the low pressure side of the closed loop circuit. A cooler bypass valve and filter bypass valve allow charge oil flow to the closed loop if the cooler or filter becomes plugged. Charge pressure is limited to 150 PSI by a relief valve. Charge pressure can be monitored at the charge pump test port.



Reelmaster 5200-D/5400-D

Lower Cutting Units

- High Pressure
- Low Pressure (Charge)
- Return or Suction
- Flow

Solenoids S6, S3, S4, and S5 are energized.

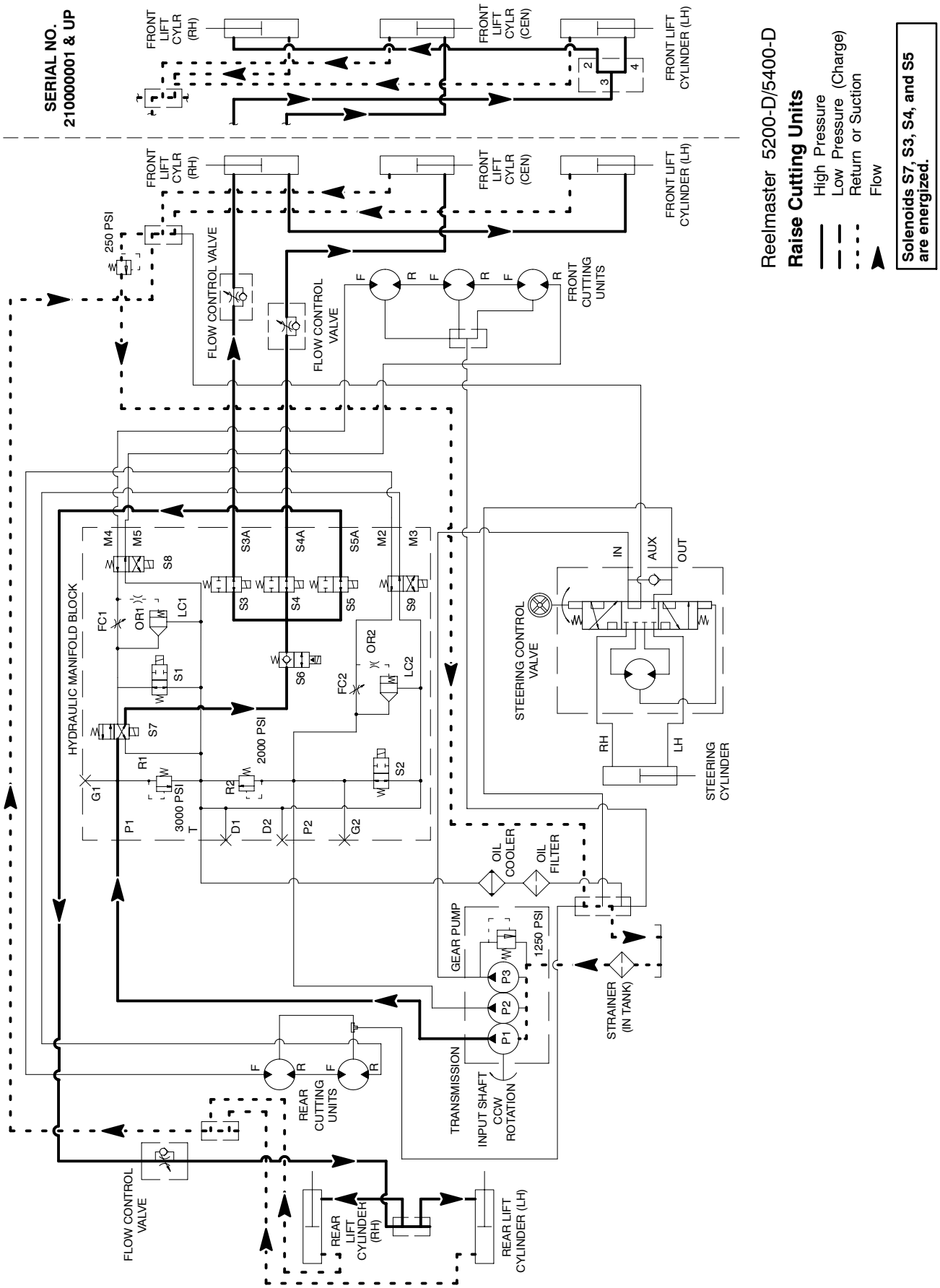
Lower Cuttings Units

A three section, gear pump is driven off the PTO output shaft of the hydrostatic transmission. Pump section (P3) provides oil flow through the steering control valve and hydraulic manifolds to all five cutting unit lift cylinders. Maximum circuit pressure (1250 PSI) is limited by a relief valve in the gear pump.

When the cutting units are in the raised position, flow from the gear pump (P3) is by-passed through the steering control valve, hydraulic manifold, 250 PSI relief valve, and to the hydraulic reservoir.

To lower the cutting units, solenoid valves (S3), (S4), and (S5) energize along with solenoid valve (S6). Valve (S6) is a load holding poppet-type valve. Solenoid valve (S7) is in its normally de-energized position, and allows oil from the rod end of the cylinders to return to the hydraulic reservoir. Hydraulic pressure against the piston side of the cylinder causes the shafts to extend, and lower the cutting units. When the solenoids are deenergized, the lift cylinders are locked in the lowered position.

The 250 PSI relief valve maintains a back pressure on the lift cylinders as they dump oil to the hydraulic reservoir.


SERIAL NO.
210000001 & UP
FRONT LIFT CYLR (RH)
FRONT LIFT CYLR (CEN)
FRONT LIFT CYLINDER (LH)
250 PSI
FLOW CONTROL VALVE
FRONT CUTTING UNITS
HYDRAULIC MANIFOLD BLOCK
STEERING CONTROL VALVE
IN
AUX
OUT
RH
LH
STEERING CYLINDER
2000 PSI
3000 PSI
OIL COOLER
OIL FILTER
GEAR PUMP
1250 PSI
STRAINER (IN TANK)
TRANSMISSION
INPUT SHAFT CCW ROTATION
REAR CUTTING UNITS
REAR LIFT CYLINDER (RH)
REAR LIFT CYLINDER (LH)
Reelmaster 5200-D/5400-D
Raise Cutting Units
High Pressure
Low Pressure (Charge)
Return or Suction
Flow
Solenoids S7, S3, S4, and S5 are energized.

Raise Cutting Units

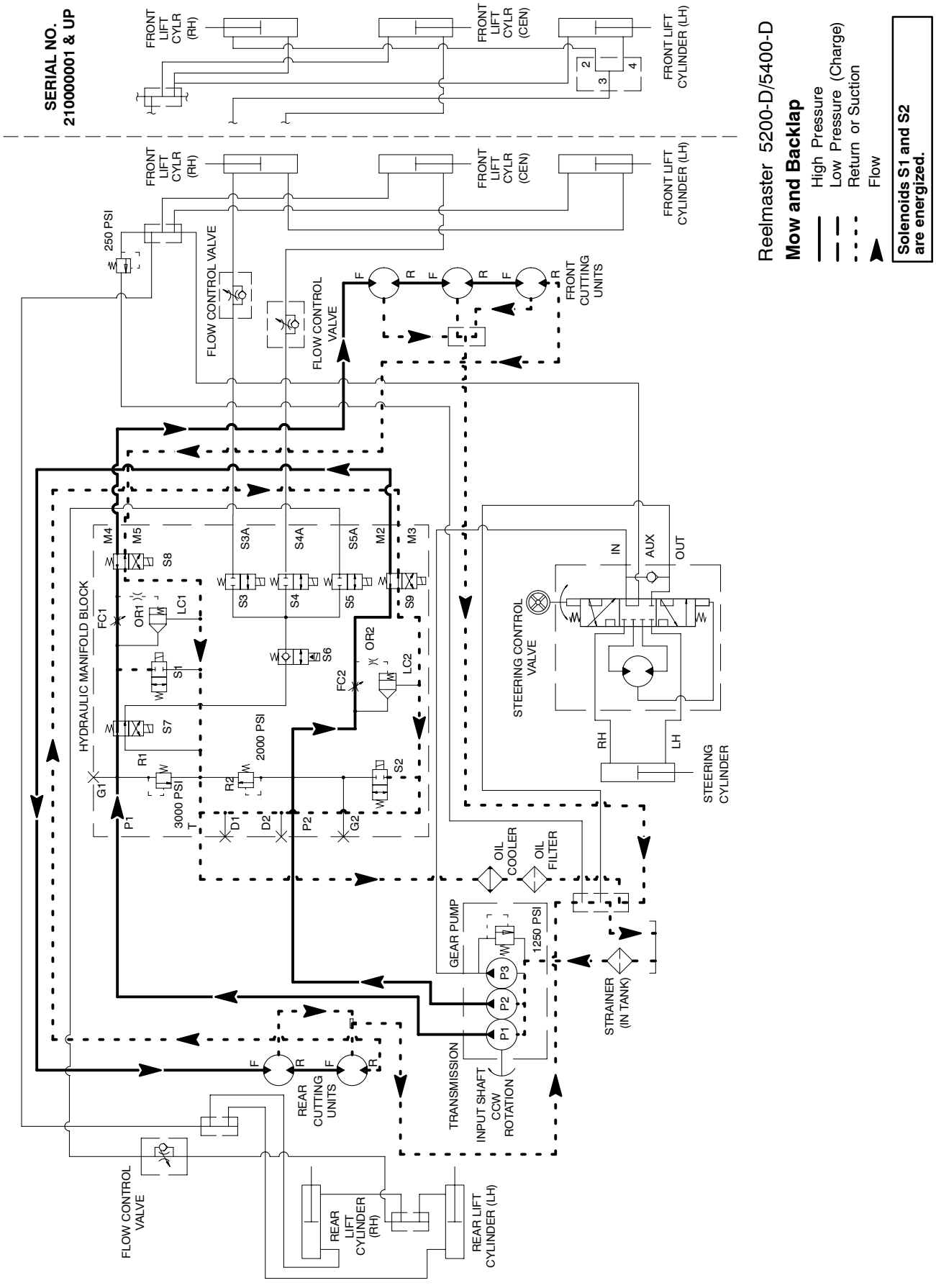
A three section, gear pump is driven off the PTO output shaft of the hydrostatic transmission. Pump section (P1) provides oil flow through the hydraulic manifold to all five cutting unit lift cylinders. Maximum circuit pressure (3000 PSI) is limited by a relief valve in the manifold block.

To raise the cutting units, solenoid valve (S7) is energized to direct pump flow through valve (S6) and valves (S3), (S4), and (S5). Solenoid valve (S6) a normally closed poppet-type valve, and the other three valves are normally closed solenoid valves that control raising the cutting units.

To hold the cutting units up in any position, all of the solenoid valves are de-energized. Valve (S6) is the load holding valve.

The lift speed of the cutting units is regulated by 3 flow control valves that are located in the hydraulic lines between the hydraulic manifold block and the lift cylinders.

The 250 PSI relief valve maintains a back pressure on the lift cylinders. Excess flow is routed to the hydraulic reservoir.


SERIAL NO.
210000001 & UP
FRONT LIFT CYLR (RH)
FRONT LIFT CYLR (CEN)
FRONT LIFT CYLINDER (LH)
250 PSI
FLOW CONTROL VALVE
FRONT CUTTING UNITS
HYDRAULIC MANIFOLD BLOCK
STEERING CONTROL VALVE
IN
AUX
OUT
RH
LH
STEERING CYLINDER
OIL COOLER
OIL FILTER
GEAR PUMP
1250 PSI
STRAINER (IN TANK)
TRANSMISSION
INPUT SHAFT CCW ROTATION
REAR CUTTING UNITS
REAR LIFT CYLINDER (RH)
REAR LIFT CYLINDER (LH)
3000 PSI
2000 PSI
Reelmaster 5200-D/5400-D
Mow and Backlap
High Pressure
Low Pressure (Charge)
Return or Suction
Flow
Solenoids S1 and S2 are energized.

Mow and Backlap

Mow

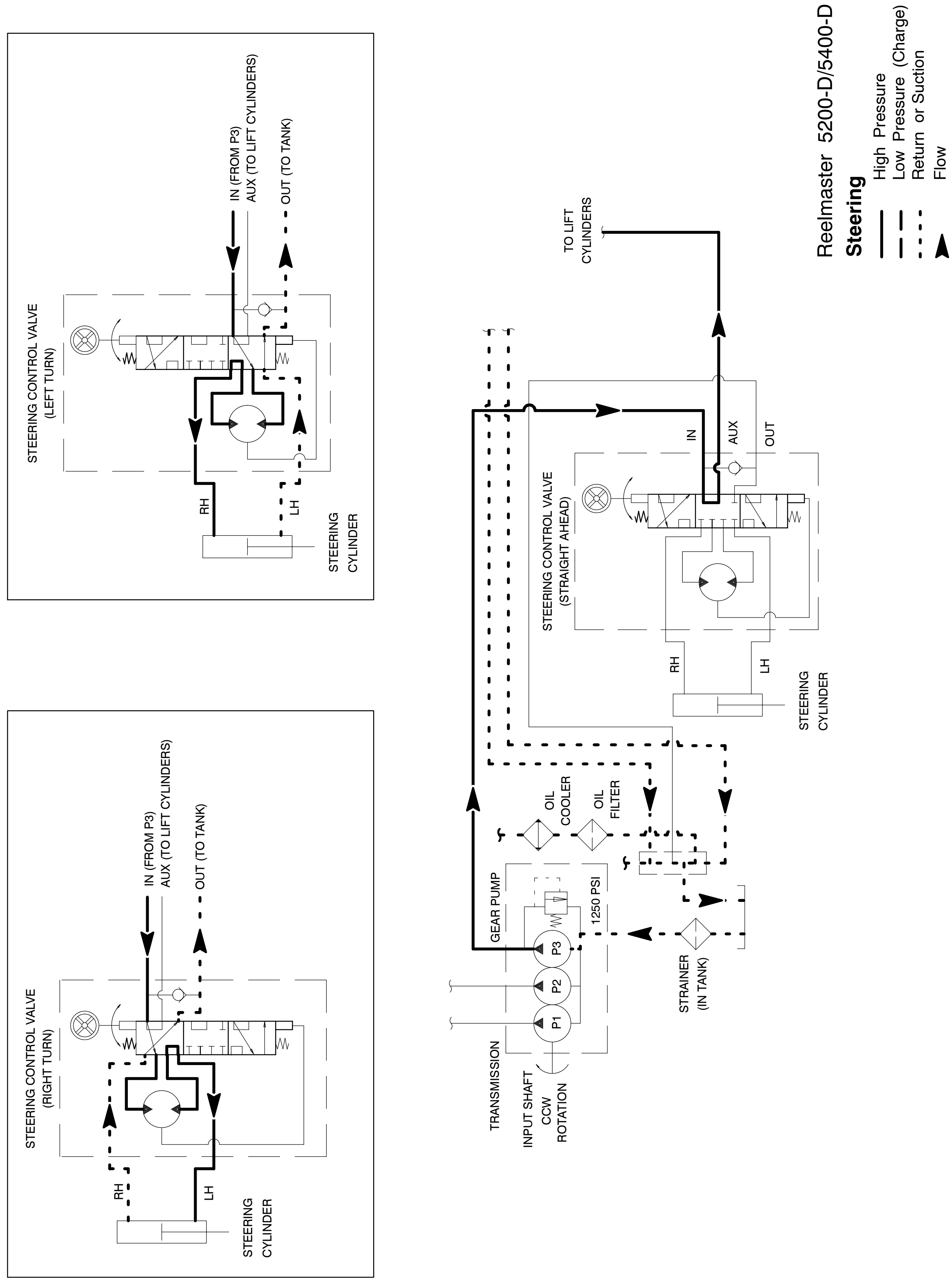
The hydraulic manifold block establishes of two independent control circuits for the front and rear cutting units. Each circuit is supplied by its own pump section. Pump section (P1) supplies hydraulic power to the front cutting units, while section (P2) supplies the the rear units. Both circuits share manifold port (T), which drains to the hydraulic reservoir.

On the circuit supplied by pump section (P1), maximum system pressure is limited by relief valve (R1), which is set at 3000 PSI. System pressure on the (P1) side can be measured at Port (G1). Total pump flow must go through solenoid valve (S7). In its normal deenergized position, valve (S7) directs pump flow to the front reel circuit. Solenoid valve (S1) must be energized to prevent hydraulic flow from by-passing the front reel circuit. When solenoid valve (S1) is energized, oil flow from port (P1) flows through reel speed control valve (FC1) and normally deenergized, solenoid valve (S8) and out to the front reel motors. Flow across the speed control valve is pressure compensated by logic cartridge valve (LC1). The logic cartridge valve maintains a pressure of 75 PSI (5.2 bar) across the speed control valve. Any excess flow above what the speed control valve is set for is by-passed to the hydraulic reservoir through the logic cartridge valve. Return oil from the motors is also directed to tank through valve (S8).

On the circuit supplied by pump section (P2), maximum system pressure is limited by relief valve (R2), which is set at 2000 PSI. This pressure can be monitored at port (G2). Total pump flow must go through solenoid valve (S9). In its normal deenergized position, valve (S9) directs pump flow to the rear reel circuit. Solenoid valve (S2) must be energized to prevent hydraulic flow from by-passing the rear reel circuit. When solenoid valve (S2) is energized, oil flow from port (P2) flows through reel speed control valve (FC2) and normally deenergized, solenoid valve (S9) and out to the rear reel motors. Flow across the speed control valve is pressure compensated by logic cartridge valve (LC2). The logic cartridge valve maintains a pressure of 75 PSI (5.2 bar) across the speed control valve. Any excess flow above what the speed control valve is set for is by-passed to the hydraulic reservoir through the logic cartridge valve. Return oil from the motors is directed to tank through valve (S9).

Backlap

During backlap mode of operation, the reel circuits operate the same as in the **"Mow"** mode, except for the operation of solenoid valves (S8) and (S9). When energized, these valves reverse the direction of hydraulic flow through the reel motors. The electrical system is designed using the backlap switch so that only one circuit (front cutting units or rear cutting units) can be operated when in the backlap mode.


Reelmaster 5200-D/5400-D
Steering
High Pressure
Low Pressure (Charge)
Return or Suction
Flow
STEERING CONTROL VALVE
(LEFT TURN)
IN (FROM P3)
AUX (TO LIFT CYLINDERS)
OUT (TO TANK)
RH
LH
STEERING
CYLINDER
STEERING CONTROL VALVE
(RIGHT TURN)
IN (FROM P3)
AUX (TO LIFT CYLINDERS)
OUT (TO TANK)
RH
LH
STEERING
CYLINDER
TO LIFT
CYLINDERS
IN
AUX
OUT
STEERING CONTROL VALVE
(STRAIGHT AHEAD)
RH
LH
STEERING
CYLINDER
OIL
COOLER
OIL
FILTER
GEAR PUMP
1250 PSI
P3
P2
P1
TRANSMISSION
INPUT SHAFT
CCW
ROTATION
STRAINER
(IN TANK)

Steering

The gear pump section (P3) supplies hydraulic flow to the steering control valve for turning the rear wheels and cutting lift circuit. The pump takes its suction from the hydraulic reservoir.

With the steering wheel in the neutral position (rear wheels positioned straight ahead), the engine running, and the spool valve is in the center position, flow enters the steering control valve at the IN port and goes through the spool valve by-passing the rotary meter (V1) and steering cylinder. Flow leaves the control valve through the AUX port to the 250 PSI relief valve and hydraulic reservoir.

Right Turn

When a right turn is made with the engine running, the turning of the steering wheel positions the spool valve so that flow goes through the top of the spool. Flow entering the steering control valve at the IN port goes through the spool and is routed to two places. First, most of the flow through the valve is by-passed out the AUX port back to the 250 PSI relief valve and hydraulic reservoir. Second, the remainder of the flow is drawn through the rotary meter (V1) and out the OUT port. Pressure retracts the piston for a right turn. The rotary meter ensures that the oil flow to the cylinder is proportional to the amount of the turning on the steering wheel. Fluid leaving the cylinder flows back through the spool valve then through the OUT port and to the hydraulic reservoir.

The steering control valve returns to the neutral position when turning is completed.

Left Turn

When a left turn is made with the engine running, the turning of the steering wheel positions the spool valve so that flow goes through the bottom of the spool. Flow entering the steering control valve at the IN port goes through the spool and is routed to two places. As in a right turn, most of the flow through the valve is by-passed out the AUX port back to the 250 PSI relief valve and hydraulic reservoir Also like a right turn, the remainder of the flow is drawn through rotary meter (V1) but goes out port (RH). Pressure extends the piston for a left turn. The rotary meter ensures that the oil flow to the cylinder is proportional to the amount of the turning on the steering wheel. Fluid leaving the cylinder flows back through the spool valve then through the OUT port and to the hydraulic reservoir.

The steering control valve returns to the neutral position when turning is complete.

Special Tools

Order these special tools from your Toro Distributor.

Hydraulic Pressure Test Kit - TOR47009

Use 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 PSI (70 Bar), 5000 PSI (350 Bar) and 10000 PSI (700 Bar) gauges. Use gauges as recommended in Testing section of this chapter.

Figure 9

Hydraulic Tester (Pressure and Flow) - TOR214678

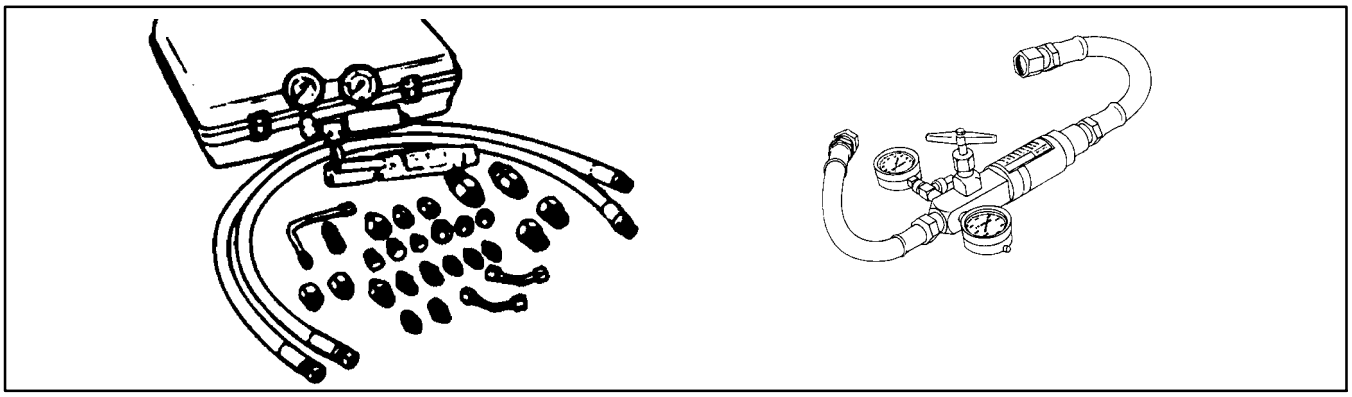


Figure 10

This tester requires O-ring face seal (ORFS) adapter fittings for use on this machine.

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

2. LOAD VALVE: A simulated working load is created in the circuit by turning the valve to restrict flow.

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

   A protector valve 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 which accommodates pressures beyond the capacity of the low pressure gauge, 0 to 5,000 PSI.

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

6. OUTLET HOSE: A hose from the outlet side of the hydraulic tester connects to the hydraulic system circuit.

Hydraulic Test Fitting Kit - TOR4079

This kit includes a variety of O-ring Face seal fittings to enable you to connect test gauges into the system.

The kit includes: tee's, unions, reducers, plugs, caps, and male test fittings.

Figure 11

Measuring Container - TOR4077

Use this container for doing hydraulic motor efficiency testing (motors with case drain lines only). Measure efficiency of a hydraulic motor by restricting the outlet flow from the motor and measuring leakage from the case drain line while the motor is pressurized by the hydraulic system.

Figure 12

Seal Protector - TOR491430

To protect the seal from damage, apply a light coating of clean hydraulic oil to the seal protector to ease the movement of the seal over the tool. Slide protector over the reel motor shaft before installing the shaft seal. Use this tool with the seal installer - TOR491450.

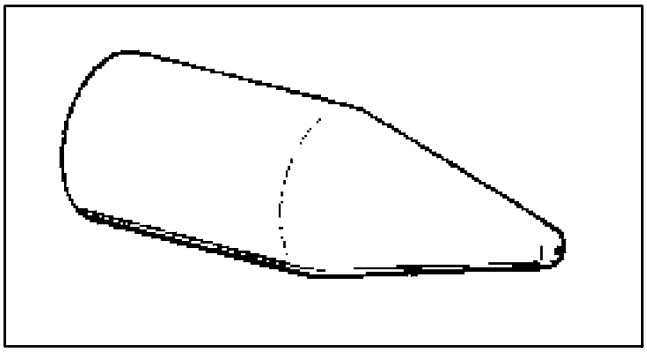


Figure 13

Seal Installer - TOR491450

Use installer and a small hammer to drive the reel motor shaft seal into position in the bore of the reel motor body. Use with seal protector - TOR491430.

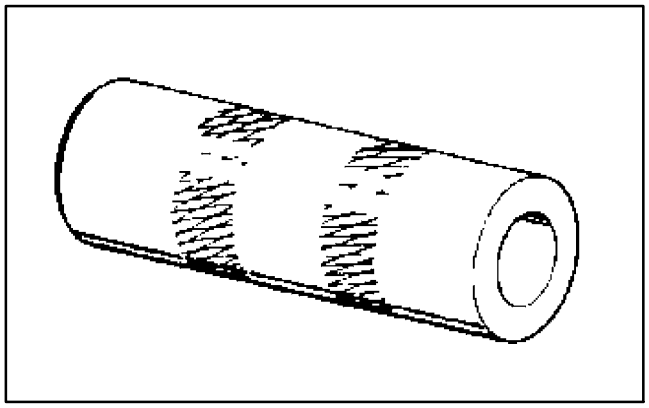


Figure 14

Troubleshooting

The charts that follow contain information to assist in troubleshooting. There may possibly be more than one cause for a machine malfunction.

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

Problem	Possible Cause
Transmission operates in one direction only.	Traction control linkage is faulty. Faulty relief valve for inoperative direction. Transmission charge check valve and/or system relief valve is defective.
Traction pedal does not return to neutral properly.	Incorrect charge check valve and/or system relief valve is installed in the reverse port of the transmission. Traction control linkage is faulty. Traction stud (eccentric) is not in the rear quadrant to provide maximum spring tension.
Transmission is jerky when starting.	Traction control linkage is faulty. Charge check valve and/or system relief valve is faulty.
Machine travels too far before stopping when the traction pedal is released.	Traction linkage is out of adjustment. Traction pedal does not return to neutral.
Transmission operates hot.	Engine RPM is too low. Transmission reservoir oil level is too low. Cooling system is not operating properly. Oil cooler bypass relief valve is faulty. Charge pressure is too low. Transmission load is too large. Traction pressure is too low.
Traction power is lost or unit will not operate in either direction.	Engine RPM is too low. Drive shaft is disconnected or damaged. Traction control linkage is damaged or disconnected. Transmission reservoir oil level is too low. Charge pressure is too low. Traction pressure is too low. Hydraulic filter is clogged.

Problem	Possible Causes
No cutting units will operate.	Lower-mow/raise lever was improperly used. Electrical problem exists (see Chapter 5 - Electrical System). Gear pump or its coupler is damaged (Steering and lift circuits are also affected).
Front (Rear) reels will not turn in either direction.	Solenoid valve S1 (S2) is not shifting. Relief valve R1 (R2) is by-passing. Solenoid valve S7 is partially shifted. Solenoid valve S7 energized (see Chapter 5 - Electrical System).
Front (Rear) reels turn too slowly.	Relief valve R1 (R2) is by-passing. Solenoid valve S7 is partially shifted. Solenoid valve S8 (S9) is partially shifted. Reel motor has internal leakage (by-passing oil). Gear pump section P1 (P2) is inefficient.
Front (Rear) reels turn only in one direction.	Solenoid valve S8 (S9) is not shifting.
Front (Rear) reels stop or won't start - during backlap only.	Reel motor has internal leakage (by-passing oil). Load too high for motor.
Front (Rear) reels stop under load.	Relief valve R1 (R2) is by-passing. Reel motor has internal leakage (by-passing oil). Gear pump section P1 (P2) is inefficient.
Cutting units will not raise.	Flow control valve is closed. Engine RPM is too low. Solenoid valve S7 is not shifting. Solenoid valve S3, S4, or S5 is not shifting. Relief valve R1 is by-passing. Lift cylinder(s) has(have) internal leakage. Lift arm pivots are binding. Gear pump section P3 is inefficient.
Cutting units raise, but will not stay up.	Solenoid valve S6 energized (See Chapter 5 - Electrical System). Solenoid valve S6 is not seating properly.
Cutting units raise too fast or slow.	Flow control(s) valve is(are) not adjusted properly.
Cutting units will not lower.	Solenoid valve S3, S4, or S5 is not shifting. Solenoid valve S6 is not shifting. Solenoid valve S7 is shifted (See Chapter 5 - Electrical System).

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.)

Before Performing Hydraulic Tests

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

Precautions for Hydraulic Testing

CAUTION

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

CAUTION

All testing should be performed by two (2) people. One person should be in the seat to operate the machine, and the other should read and record test results.

CAUTION

Operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil. Controls must be operated with the ignition switch in OFF. Remove key from the ignition switch.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved and all rotating machine parts must be stopped. Stop engine; lower or support attachments.

WARNING

Keep body and hands away from pin hole leaks or nozzles that eject hydraulic fluid under high pressure. Do not use hands to search for leaks; use paper or cardboard. Hydraulic fluid escaping under pressure can have sufficient force to penetrate the skin and cause serious injury. 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. Gangrene may result from such an injury.

1. Clean machine thoroughly before disconnecting or disassembling any hydraulic components. Always keep in mind the need for cleanliness when working on hydraulic equipment. Contamination will cause excessive wear of components.

2. Put metal 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 phototac when performing a hydraulic test. Engine speed can affect the accuracy of the tester readings. Check actual speed of the pump when performing flow testing.

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

5. When using tester with pressure and flow capabilities, open load valve completely in the hydraulic tester to minimize the possibility of damaging components.

6. Install fittings finger tight and far enough to make sure that they are not cross-threaded before tightening them with a wrench.

7. Position tester hoses to prevent **rotating** machine parts from contacting and damaging the hoses or tester.

8. Check oil level in the hydraulic reservoir. After connecting test equipment, make sure tank is full.

9. Check control linkages 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: Traction Circuit Charge Pressure

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

2. Make sure machine is parked on a level surface with the cutting units lowered and off. Make sure engine is off.

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS, and Precautions for Hydraulic Testing at the beginning of this section.

3. Connect a 1000 PSI gauge onto charge pressure test port (Fig. 15).

4. Start the engine and put throttle at full engine speed **(3200 RPM)** with no load on the system.

GAUGE READING TO BE **120 to 180 PSI**.

5. If there is no pressure, or pressure is low, check for restriction in pump intake line. Inspect charge relief valve and valve seat. Charge pressure can be adjusted by changing shim thickness behind the spring. Check for sheared charge pump key. Disassemble charge pump and check for internal damage or worn parts.

6. Also take a gauge reading while operating the machine in forward and reverse. Start the engine and put throttle at full engine speed **(3200 RPM)**. Apply the brakes and push the traction pedal forward, then reverse.

GAUGE READING TO BE **120 to 180 PSI**.

7. If pressure is good under no load, but drops below specification when under traction load, the piston pump and motor should be suspected of wear and inefficiency. When the pump and/or motor is worn or damaged the charge pump is not able to keep up with the internal leakage.

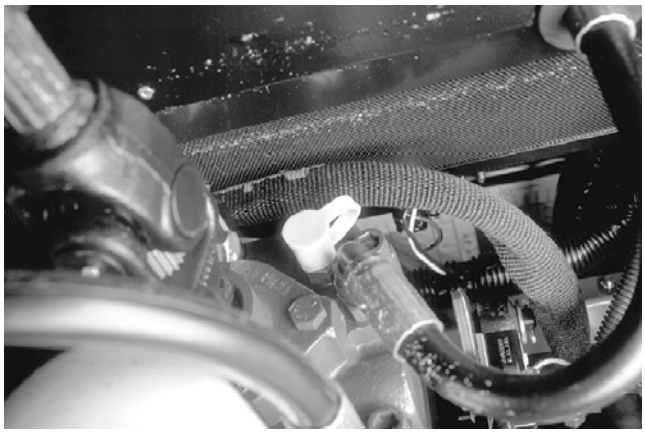


Figure 15

1. Charge pressure test port **2. Oil filter**

TEST NO. 2: Traction Circuit System Relief Pressure

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

2. Before doing traction pressure test:

   A. Drive machine to an open area, lower cutting units, turn the engine off and engage the parking brake.

   B. If testing forward function, connect a chain to the rear frame tie-down brackets. Connect the other end of the chain to an immovable object and remove all slack from the chain. If testing reverse function, attach chain to the center of the front frame member (Fig. 16).

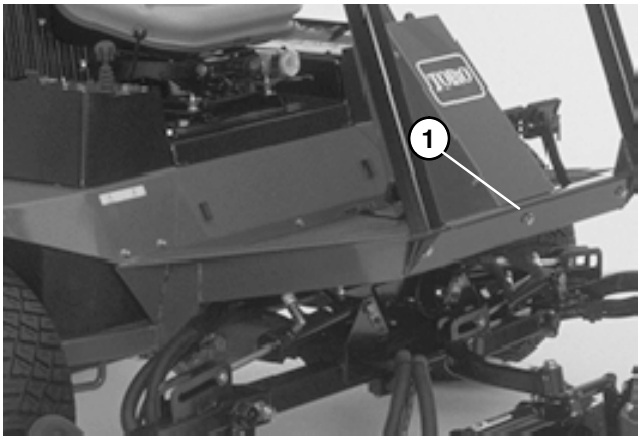


Figure 16
1. **Front frame member**

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS, and Precautions for Hydraulic Testing at the beginning of this section.

Note: Test ports are 7/16-20 SAE O-ring ports.

3. Connect a 5,000 PSI gauge to traction circuit test port for function to be checked (Fig. 17).

4. Start the engine and move throttle to full speed **(3200 RPM)**.

5. Sit on seat, and with brakes locked, slowly depress the top of traction pedal. While pushing top of traction pedal down, look at pressure reading on gauge.

   GAUGE READING:
   Forward: **3450 to 3750 PSI**
   Reverse: **2600 to 2900 PSI**

6. If traction pressure is too low, inspect check/high pressure relief valves. If problem occurs in one direction only, interchange the check/relief valves to see if the problem changes to the other direction.

Note: Clean or replace valves as necessary. These cartridge type valves are factory set, and are not adjustable. If check/relief valves are in good condition, replace or overhaul transmission.

Note: The forward and reverse check/high pressure relief valves are different. One valve cartridge has a machined groove on seating surface and must be installed in the ”reverse” port (see Check and High Pressure Relief Valves in Transmission Repairs section).

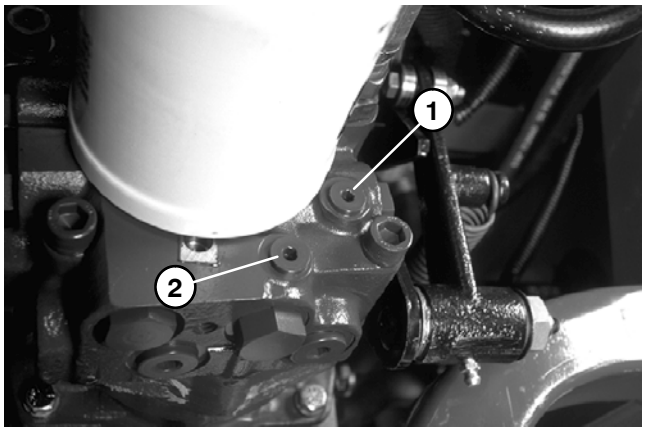


Figure 17
1. **Forward test port** 2. **Reverse test port**

TEST NO. 3: Relief Valve (R1) Pressure

Note: The front mowing circuit and cutting unit lift circuit share the same relief valve (R1). See Hydraulic Flow Diagrams at the beginning of this chapter.

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

2. Make sure machine is parked on a level surface with the cutting units lowered and off. Make sure engine is off.

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS, and Precautions for Hydraulic Testing at the beginning of this section.

3. Raise seat to get access to hydraulic test fittings. Remove access cover from in front of hydraulic valve block. Install a 5000 PSI gauge with extension hose onto quick disconnect fitting in port G1 (Fig. 18). Put gauge and hose through opening in front of hydraulic valve block as shown, then lower the seat (Fig. 19).

Note: It may be necessary to rotate 90° fitting in port G1 so seat can be lowered after pressure gauge with extension hose is connected. Loosen nut and rotate 90° fitting in port G1 1/4 turn so test fitting points to the right. Tighten nut to seat O-ring and secure fitting.

4. Set reel speed controls (FC1 and FC2) to position 5. Make sure backlap switch is OFF.

5. Sit on the seat and start the engine. Move throttle to full speed **(3200 RPM)**.

6. While sitting on the seat, pull "Lower-Mow/Raise" control lever back to the RAISE position to lift the cutting units. Hold the lever in the RAISE position while looking at the gauge.

GAUGE READING TO BE **2950 to 3050 PSI**.

7. Stop the engine. If pressure is too high, remove cap on relief valve R1 and adjust screw to get correct pressure (see Adjust Manifold Relief Valves). If pressure is too low, check for restriction in pump intake line. Remove cap from relief valve R1 and adjust screw to get correct pressure. If pressure is still too low, pump or lift cylinder(s) should be suspected of wear, damage or inefficiency.

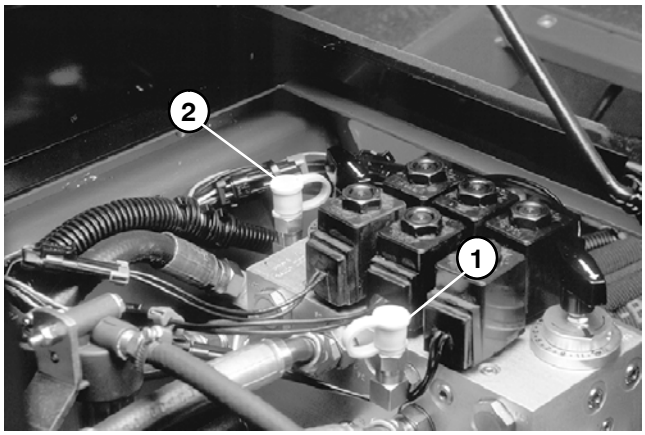


Figure 18

1. Test port G1
2. Test port G2

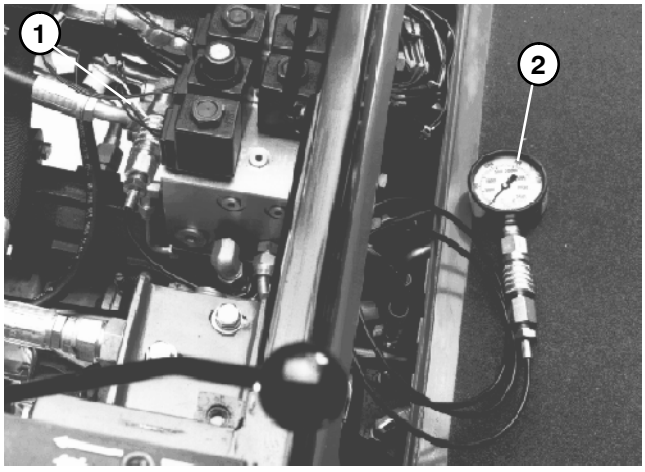


Figure 19

1. Test port G1
2. Test gauge

TEST NO. 4: Relief Valve (R2) Pressure

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

2. Make sure machine is parked on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS, and Precautions for Hydraulic Testing at the beginning of this section.

3. Set reel speed controls (FC1 and FC2) to full open (highest number). Make sure backlap switch is OFF.

4. Disconnect pressure hose from hydraulic fitting on **left-rear (No. 2)** reel motor (Fig. 20).

IMPORTANT: Make sure that the oil flow indicator arrow on the flow gauge is showing that the oil will flow from the pump, through the tester and into the reel motor.

5. Install tester with pressure gauges and flow meter in series with the hose and hydraulic fitting on reel motor. **Make sure the flow control valve on tester is fully open.**

6. Start engine and move throttle to full speed **(3200 RPM)**.

WARNING

Keep away from reels during test to prevent personal injury from rotating reel blades.

7. Have another person occupy seat, move "Enable/ Disable" switch to ENABLE. Move "Lower – Mow/Raise" lever forward to engage cutting units, then monitor the tester pressure gauge.

8. Watch pressure gauge carefully while slowly closing the tester flow control valve to fully closed.

9. System pressure should be from **1950 to 2050 PSI** as the relief valve (R2) lifts.

10. Open the tester flow control valve, disengage cutting units and stop the engine.

11. If pressure is too high, remove cap on relief valve R2 and adjust screw to get correct pressure (see Adjust Manifold Relief Valves). If pressure is too low, check for restriction in pump intake line. If intake line is not restricted, remove cap from relief valve R2 and adjust screw to get correct pressure. If pressure is still too low, pump or motor should be suspected of wear, damage or inefficiency.

12. Disconnect tester from reel motor fitting and hose. Reconnect hydraulic hose to reel motor fitting.

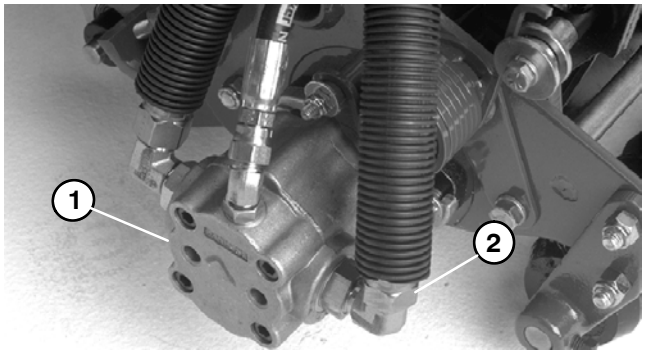


Figure 20

1. **Left rear (No. 2) motor**
2. **Pressure hose**

TEST NO. 5: Gear Pump Section (P1 & P2) Flow (Using Tester with Pressure and Flow Capabilities)

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

2. Make sure machine is parked on a level surface with the cutting units lowered and off. Make sure engine is off.

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS, and Precautions for Hydraulic Testing at the beginning of this section.

3. With the engine off and cutting units lowered, install tester in series between pressure hose and valve block fitting for suspected bad pump section (Fig. 21). Make sure the tester flow control valve is OPEN.

Front circuit - port P1

Rear circuit - port P2

IMPORTANT: Make sure that the oil flow indicator arrow on the flow gauge is showing that the oil will flow from the pump, through the tester and into the valve block.

IMPORTANT: The pump is a positive displacement type. If pump flow is completely restricted or stopped, damage to the pump, tester or other components could occur.

4. Make sure the parking brake is engaged. Start the engine and move throttle to full speed **(3200 RPM)**. DO NOT engage the cutting units.

5. While watching pressure gauges, slowly close flow control valve until **2000 PS**I is obtained on gauge. Verify pump speed at **3200 RPM** at the transmission input shaft from the engine.

TESTER READING: Flow not less than **5 GPM at 2000 PSI**.

6. Stop the engine. If flow was lower than **5 GPM** or a pressure of **2000 PSI** cannot be obtained, check for restriction in pump intake line. If not restricted, remove pump and repair or replace as necessary.

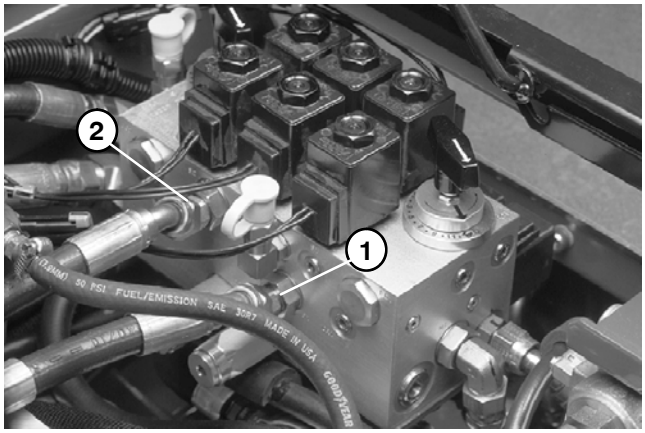


Figure 21

1. **Port P1**
2. **Port P2**

TEST NO. 6: Reel Motor Case Drain Leakage (Using Tester with Pressure Gauges and Flow Meter)

Note: Over a period of time, a reel motor can wear internally. A worn motor may by-pass oil to its case drain causing the motor to be less efficient. Eventually, enough oil loss will cause the reel motor to stall under heavy cutting conditions. continued operation with a worn, inefficient motor can generate a lot of heat, cause damage to seals and other components in the hydraulic system, and affect quality of cut.

Note: A way to find a possibly bad reel motor is to have another person observe the machine while mowing in dense turf. A bad motor will run slower, produce fewer clippings, and may cause marcelling (or a washboard appearance) on the turf.

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

2. Make sure machine is parked on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.

3. Read Precautions for Hydraulic Testing.

Note: The reel motors are connected in series. To isolate a faulty motor, you may have to test all three motors in the circuit by starting with the upstream motor first.

4. Disconnect the motor case drain hose (small diameter hose) where it connects to traction unit (not at the motor). Put a steel cap on the fitting at the traction unit; leave the case drain hose open (Fig. 23)

5. Disconnect hose from return of the motor to be tested. Install tester in series with the motor and disconnected return hose. Make sure the flow control valve on tester is fully open. (Fig. 23).

6. Set reel speed control to the full speed position. Make sure Backlap switch is OFF.

Note: Use a graduated container, special tool TOR4077, to measure case drain leakage (Fig. 23).

CAUTION

Cutting unit reels will rotate when lowered with Enable/Disable switch in ENABLE position. Keep away from cutting units during test to prevent personal injury from rotating reel blades. Do not stand in front of the machine.

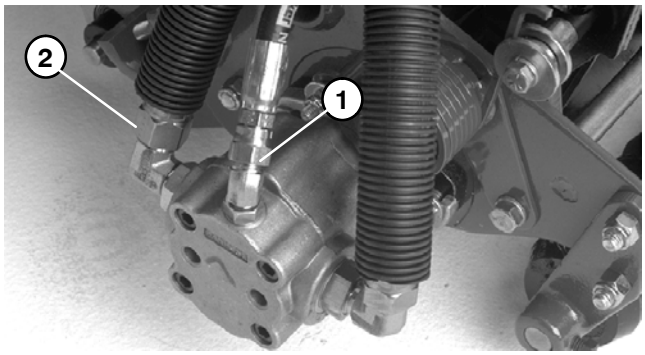


Figure 22

1. **Case drain hose**
2. **Return hose**

Figure 23

7. Sit on seat and start the engine. Move throttle to full speed **(3200 RPM)**. Move "Enable/Disable" switch to ENABLE. Move "Lower-Mow/Raise" lever forward to engage cutting units.

8. While watching pressure gauge, slowly close flow control valve on tester until a pressure of **1200 PSI** is obtained.

9. Have another person measure flow from the case drain line for **15 seconds**, then move the switch to DISABLE and stop the engine.

TEST RESULTS: Flow less than **0.5 GPM** (less than **473 milliliters** or **16 ounces** of hydraulic fluid)

10. Disconnect tester from motor and hose. Reconnect hose to the reel motor. Remove plug from machine. Reconnect case drain hose to the reel motor.

11. If flow is more than **0.5 GPM**, the motor is worn or damaged and should be repaired or replaced.

TEST NO. 7: Gear Pump Section (P3) Flow and Relief Valve Pressure (Using Tester with Pressure Gauges and Flow Meter)

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

2. Make sure machine is parked on a level surface with the cutting units lowered and off. Make sure engine is off.

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS, and Precautions for Hydraulic Testing at the beginning of this section.

3. With the engine off and cutting units lowered, install tester in series between pressure hose and the gear pump section P3 (Fig. 24). Make sure the tester flow control valve is OPEN.

IMPORTANT: Make sure that the oil flow indicator arrow on the flow gauge is showing that the oil will flow from the pump, through the tester and into the valve block.

IMPORTANT: The pump is a positive displacement type. If pump flow is completely restricted or stopped, damage to the pump, tester or other components could occur.

4. Make sure the parking brake is engaged. Start the engine and move throttle to full speed **(3200 RPM)**. DO NOT engage the cutting units.

5. While watching pressure gauges, slowly close flow control valve until **1000 PSI** is obtained on gauge. Verify pump speed at **3200 RPM** at the transmission input shaft from the engine.

TESTER READING: Flow not less than **3.5 GPM** at **1000 PSI**.

6. If flow was lower than **3.5 GPM** or a pressure of **1000 PSI** cannot be obtained, check for restriction in pump intake line. If not restricted, verify relief setting first, then remove pump and repair or replace as necessary.

7. While watching pressure gauges, slowly close flow control valve further until **1250 PSI** is maintained as the relief valve lifts.

TESTER READING: Relief valve setting of **1250 PSI.**

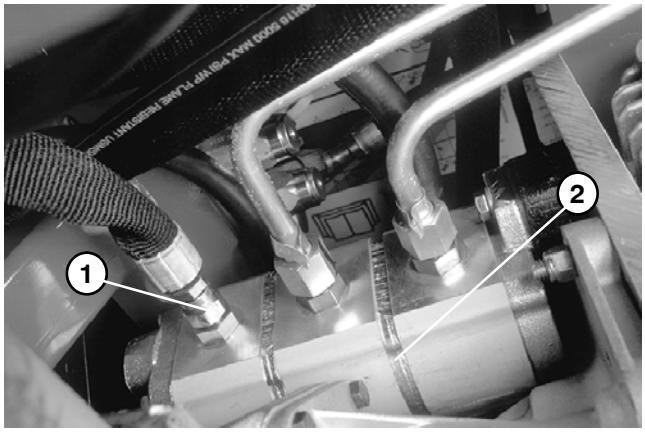


Figure 24

1. **Outlet to steering**
2. **Gear pump**

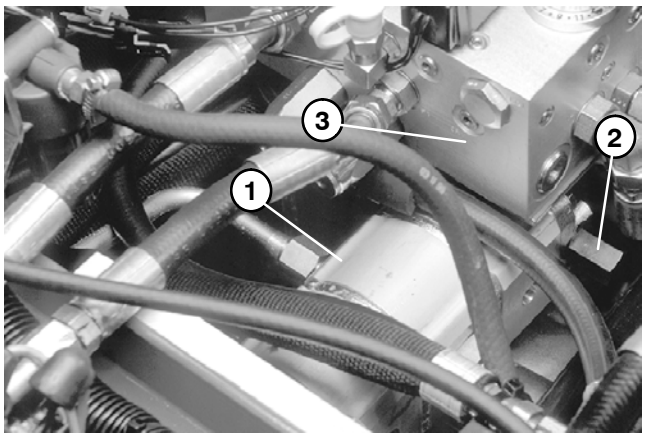


Figure 25

1. **Gear pump**
2. **Relief valve**
3. **Manifold block**

8. If pressure is maintained below **1250 PSI** or pressure goes beyond **1250 PSI**, adjust relief valve by removing the cap and turning the adjustment screw. Turn adjuster clockwise to increase pressure and counterclockwise to decrease pressure (Fig. 25).

9. Stop engine. Remove tester and reinstall hoses.

Adjust Manifold Relief Valve (R1 and R2)

The hydraulic reel circuit is equipped with a relief valve. Valve (R1) is preset at the factory to 3000 PSI and valve (R2) to 2000 PSI. However, an adjustment may be required if the setting proves to be off after testing (see TESTING). If an adjustment is required proceed as follows:

WARNING

Never adjust the relief valve with the hydraulic system pressurized. Hydraulic oil may spray out of the valve with the cap off. Personal injury may result. Always install the cap and tighten before pressurizing the system.

Note: Do not remove the relief valve from the hydraulic manifold for adjustment.

1. Remove cap from the relief valve with an allen wrench.

Note: An 1/8-turn of the adjustment socket is about 50 psi (3.5 bar), or 1 turn is about 400 psi (27.6 bar).

2. To **increase** pressure setting, turn the adjustment socket inside the valve 1/8 of a turn clockwise.

3. To **decrease** pressure setting, turn the adjustment socket inside the valve 1/8 of a turn counterclockwise.

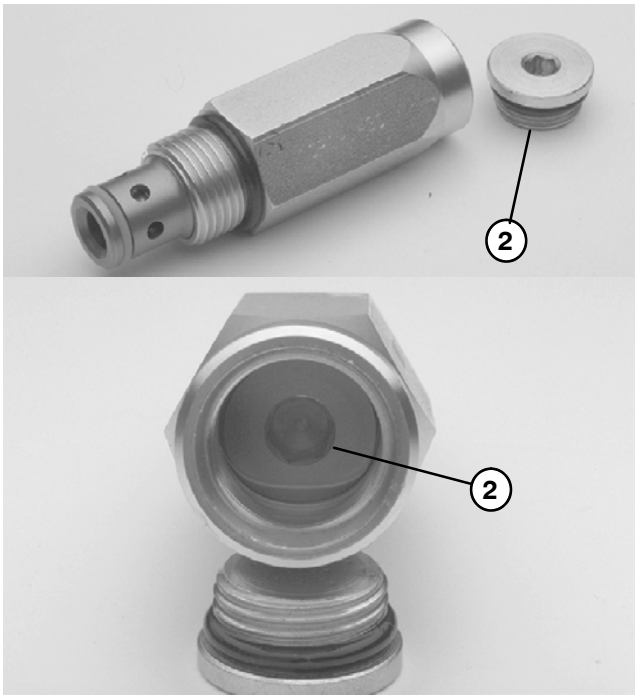


Figure 26

1. **Relief valve cap**
2. **Adjustment socket**

4. Install and tighten cap to valve. Retest pressure setting (see Testing).

Adjust Traction Drive for Neutral

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, shut engine off and lower cutting units to the floor. 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.

Note: On 4-wheel drive models, left rear tire must also be off the shop floor or 4-wheel drive driveshaft must be removed.

3. Under right side of machine, loosen locknut on traction adjustment cam.

WARNING

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

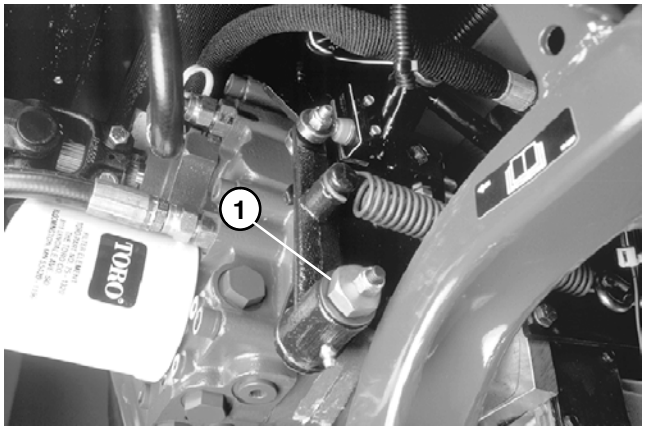


Figure 27

1. **Traction adjustment cam**

4. Start engine and set throttle to full speed. Rotate cam hex in either direction until wheel ceases rotation. Cam must remain in rear hemisphere of travel.

5. Tighten locknut securing adjustment.

6. Stop the engine and release the right brake. Remove jack stands and lower the machine to the shop floor. Test drive the machine to make sure it does not creep.

Adjust Cutting Unit Lift Rates

The cutting unit lift circuit is equipped with three (3) adjustable flow control valves used to ensure the cutting units do not raise too quickly and bang against lift stops. Adjust cutting units as follows:

Center Cutting Unit (Fig. 28)

1. Locate valve behind access panel above operator's platform.

2. Loosen setscrew on valve and rotate valve approximately 1/2 turn clockwise.

3. Verify lift rate adjustment by raising and lowering cutting unit several times. Readjust as required.

4. After desired lift rate is attained, tighten setscrew to lock adjustment.

Outside Front Cutting Units (Fig. 29)

1. Locate valve on left front lift cylinder (under foot rest).

2. Loosen setscrew on valve. Rotate valve 1/2 turn clockwise.

3. Verify lift rate adjustment by raising and lowering cutting units several times. Readjust as required.

4. After desired lift rate is attained, tighten set screw to lock adjustment.

Rear Cutting Units (Fig. 30)

1. Raise hood and locate valve on left rear side of machine.

2. Loosen setscrew on valve and rotate valve approximately 1/2 turn clockwise.

3. Verify lift rate adjustment by raising and lowering cutting units several times. Readjust as required.

4. After desired lift rate is attained, tighten setscrew to lock adjustment.

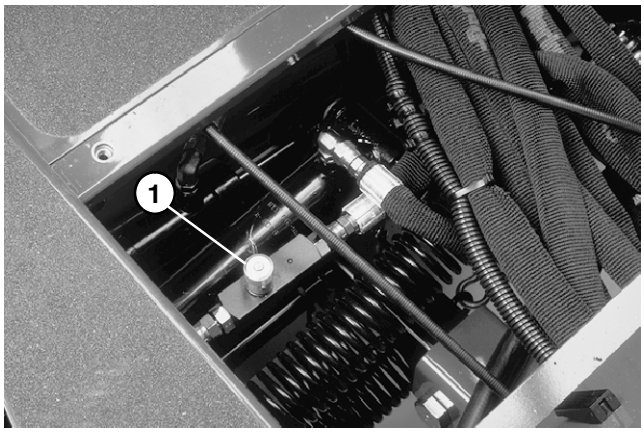


Figure 28

1. Center front cutting unit flow control valve

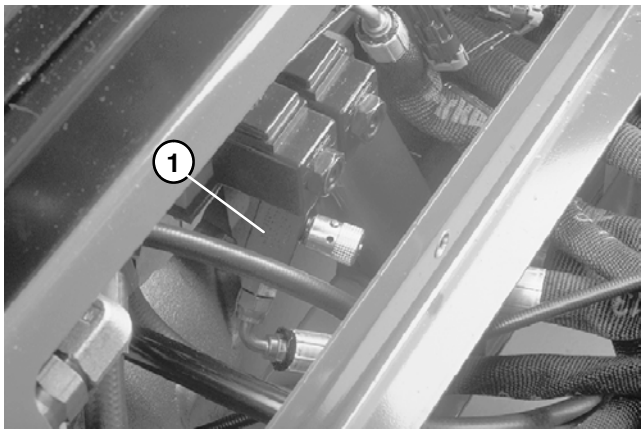


Figure 29

1. Outside front cutting units flow control valve

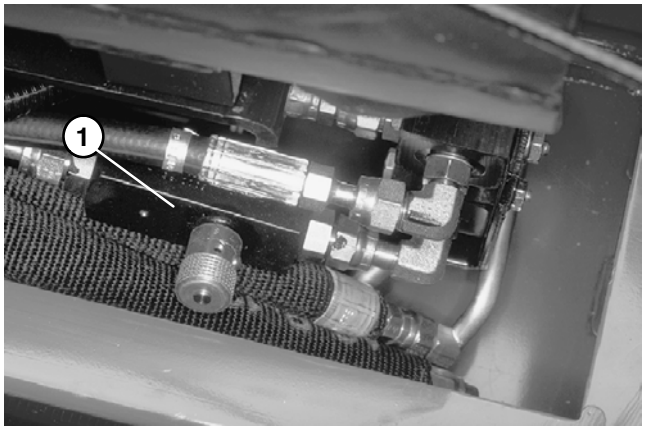


Figure 30

1. Rear cutting units flow control valve

Adjust Traction Control Linkage

The traction control linkage should not require routine maintenance or adjustment. The following information is provided if the control linkage assembly is disturbed to gain access to other components.

Adjust Traction Linkage

1. The machine should be parked on a level surface, cutting units lowered to the floor, and engine off.

2. Connect brake pedals together with locking pin, push both pedals down and pull parking brake latch out.

3. Adjust inner locknut until distance between inside of eye bolt loop and inside of spring anchor plate is 2.75” (70 mm) (Fig. 31). Tighten outer locknut.

4. Operate the machine and check for safe stopping distance.

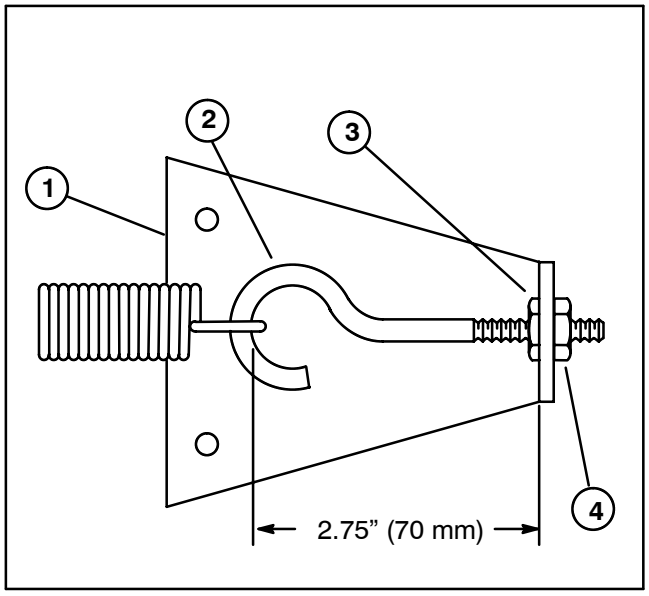


Figure 31

1. **Spring anchor plate**
2. **Eye bolt**
3. **Inner lock nut**
4. **Outer locknut**

General Precautions for Removing and Installing Hydraulic System Components

Before Repair or Replacement of Components

1. Before removing any parts from the hydraulic system, park machine on a level surface, engage parking brake, lower cutting units or attachments, and stop engine. Remove key from the ignition switch

2. Clean machine before disconnecting, removing, or disassembling any hydraulic components. Make sure hydraulic components, hoses connections, and fittings are cleaned thoroughly. Always keep in mind the need for cleanliness when working on hydraulic equipment.

CAUTION

Operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil. Controls must be operated with the ignition switch in RUN and the engine OFF. Make sure all electrically operated control valves are actuated. Return ignition switch to OFF when pressure has been relieved. Remove key from the ignition switch.

3. Put caps or plugs on any hydraulic lines, hydraulic fittings, and components left open or exposed to prevent contamination.

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

5. Note the position of hydraulic fittings (especially elbow fittings) on hydraulic components before removal. Mark parts if necessary to make sure they will be aligned properly when reinstalling hydraulic hoses and tubes.

After Repair or Replacement of Components

1. Check oil level in the 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 (see Flush Hydraulic System).

2. Lubricate O-rings and seals with clean hydraulic oil before installing hydraulic components.

3. Make sure caps or plugs are removed from the hydraulic tubes, hydraulic fittings, and components before reconnecting.

4. Use proper tightening methods when installing hydraulic hoses and fittings (see Hydraulic Fitting Installation).

5. Make sure caps or plugs are removed from the hydraulic tubes, hydraulic fittings, and components before reconnecting.

6. After repairs, check control linkages or cables for proper adjustment, binding, or broken parts.

7. After disconnecting or replacing any hydraulic components, operate machine functions slowly until air is out of system (see Charge Hydraulic System).

8. 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.

Check Hydraulic Lines and Hoses

WARNING

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 cause serious injury. 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. Gangrene may result from such an injury.

IMPORTANT: Check hydraulic lines and hoses daily for leaks, kinked lines, loose mounting supports, wear, loose fittings, weather deterioration and chemical deterioration. Make all necessary repairs before operating.

Flush Hydraulic System

IMPORTANT: Flush the hydraulic system any time there is a severe component failure or the system is contaminated (oil appears milky, black, or contains metal particles).

IMPORTANT: Flush hydraulic system when changing from petroleum base hydraulic fluid to a biodegradable fluid such as Mobil EAL 224H. Operate machine under normal operating conditions for at least four (4) hours before draining.

1. Park machine on a level surface. Lower cutting units, stop engine, and engage parking. Remove key from the ignition switch.

CAUTION

Operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil. Controls must be operated with the ignition switch in OFF. Remove key from the ignition switch.

IMPORTANT: Make sure to clean around any hydraulic connections that will be disconnected for draining.

2. Drain hydraulic reservoir (see Change Hydraulic Fluid).

3. Drain hydraulic system. Drain all hoses, tubes, and components while the system is warm.

4. Change and replace oil filter (see Change Hydraulic Oil Filter).

5. Inspect and clean hydraulic reservoir (see Hydraulic Reservoir Inspection).

6. Reconnect all hydraulic hoses, lines, and components that were disconnected while draining system.

NOTE: Use only hydraulic fluids specified in Check Hydraulic System Fluid. If changing to to biodegradable fluid, use Mobil EAL 224H for this step. Other fluids may cause system damage.

7. Fill hydraulic reservoir with **new** hydraulic fluid (see Change Hydraulic Fluid).

8. Disconnect electrical connector from ETR solenoid.

9. Turn ignition key switch; engage starter for 10 seconds to the prime pump. Repeat this step again.

10. Connect electrical connector on ETR solenoid.

11. Start engine and let it idle at low speed **(1150 RPM)** for a minimum of 2 minutes. Increase engine speed to high idle **(3200 RPM)** for minimum of 1 minute under no load.

12. Raise and lower cutting units several times. Turn steering wheel fully left and right several times.

13. Shut off engine and check for hydraulic oil leaks. Check oil level in hydraulic reservoir and add correct amount of oil if necessary.

14. Operate machine for 2 hours under normal operating conditions.

15. Check condition of hydraulic oil. If the new fluid shows any signs of contamination, repeat steps 1 through 15 again until oil is clean. If you are changing to biodegradable fluid, repeat steps 1 through 15 again at least once and until the oil is clean.

16. Assume normal operation and follow recommended maintenance intervals.

Charge Hydraulic System

NOTE: When initially starting the hydraulic system with new or rebuilt components such as motors, pumps, or lift cylinders, it is important that the hydraulic system be charged properly. Air must be purged from the system and its components to reduce the chance of damage.

IMPORTANT: Change hydraulic oil filter whenever hydraulic components are repaired or replaced.

1. Park machine on a level surface, and turn the engine off.

2. Make sure all hydraulic connections, lines, and components are secured tightly.

3. If component failure was severe or the system is contaminated, flush and refill hydraulic system and tank (see Flush Hydraulic System).

4. Make sure hydraulic reservoir is full. Add correct oil if necessary (see Check Hydraulic System Fluid).

5. Disconnect fuel cutoff solenoid lead to prevent the engine from starting.

6. Check control cable to the hydrostat for proper adjustment, binding, or broken parts.

7. Make sure traction pedal and the lift control lever are in the **neutral** position. Turn ignition key switch; engage starter for **fifteen (15) seconds** to prime the traction and charge pumps.

8. Reconnect fuel cutoff solenoid lead.

WARNING

Before jacking up the machine, review and follow Jacking Instructions in Chapter 1 - Safety.

9. Raise one front and rear wheel off the floor, and place support blocks under the frame. Chock remaining wheel to prevent movement of the machine.

10. Make sure traction pedal and lift control lever are in **neutral**. Start engine and run it at low idle of **1150 rpm**. The charge pump should pick up oil and fill the hydraulic system. If there is no indication of fill in 30 seconds, stop the engine and determine the cause.

11. After the hydraulic system starts to show signs of fill, actuate lift control lever until the lift cylinder rod moves in and out several times. If the cylinder rod does not move after 10 to 15 seconds, or the pump emits abnormal sounds, shut the engine off immediately and determine cause or problem. Inspect for the following:

    A. Loose filter or suction lines.

    B. Loose or faulty coupler on the pump.

    C. Blocked suction line.

    D. Faulty charge relief valve.

    E. Faulty charge pump.

12. If cylinder moves in **10 to 15 seconds**, proceed to step 13.

13. Operate the traction pedal in the forward and reverse directions. The wheel off the floor should rotate in the proper direction.

    A. If the wheel rotates in the wrong direction, stop engine, remove lines from rear of pump, and reverse the connections.

    B. If the wheel rotates in the proper direction, stop engine and adjust the spring adjusting pin lock nut.

14. Adjust traction pedal to the neutral position (see Adjust Traction Drive for Neutral).

15. Check operation of the traction interlock switch (see Check Interlock System in Chapter 5 – Electrical Systems).

16. Remove block from wheels and lower machine. Remove chocks from remaining wheel.

17. If the traction pump or a wheel motor was replaced or rebuilt, run the traction unit so all wheels turn slowly for 10 minutes.

18. Operate traction unit by gradually increasing its work load to full over a 10 minute period.

19. Stop the machine. Check tank and fill if necessary. Check hydraulic components for leaks and tighten any loose connections.

Change Hydraulic Fluid

Change hydraulic fluid after every 800 operating hours, in normal conditions. If fluid becomes contaminated, contact your local TORO distributor because the system must be flushed. Contaminated fluid looks milky or black when compared to clean oil.

1. Turn engine off and raise hood.

2. Remove drain plug from bottom of reservoir and let hydraulic fluid flow into drain pan. Reinstall and tighten plug when hydraulic fluid stops draining.

IMPORTANT: IMPORTANT: Use only hydraulic fluids specified. Other fluids could cause system damage.

3. Fill reservoir with approximately 8.5 gallons (32 L) of hydraulic fluid. Refer to Checking Hydraulic Fluid.

4. Install reservoir cap. Start engine and use all hydraulic controls to distribute hydraulic fluid throughout the system. Also, check for leaks. Then stop the engine.

5. Check level of fluid and add enough to raise level to FULL mark on dipstick. DO NOT OVER FILL.

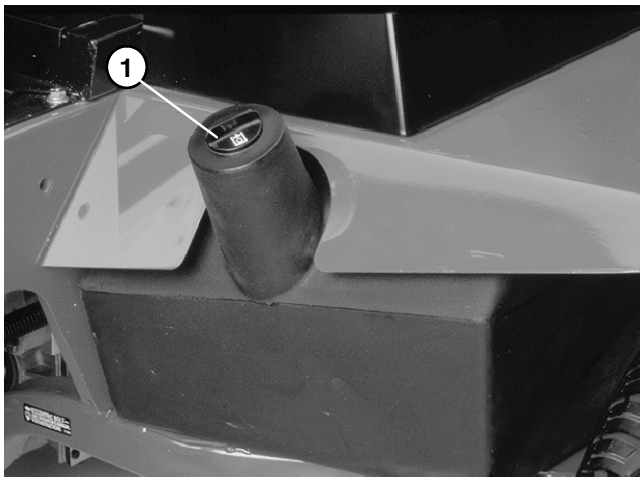


Figure 32

1. Hydraulic reservoir cap

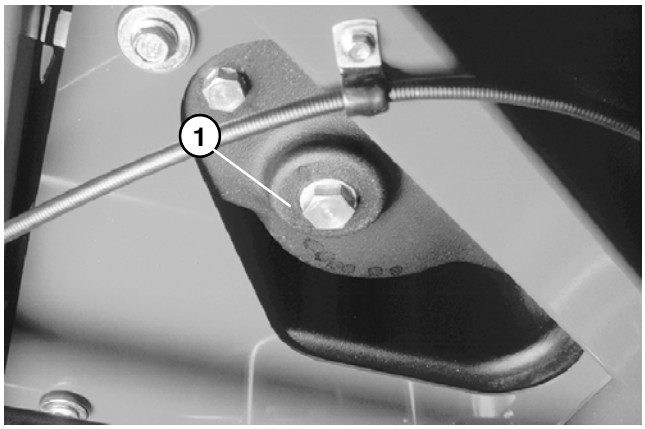


Figure 33

1. Drain plug

Replace Hydraulic Oil Filter

The hydraulic system filter head is equipped with a service interval indicator. With the engine running, view the indicator, it should be in the GREEN zone. When the indicator is in the RED zone, the filter element should be changed.

IMPORTANT: Use the Toro replacement filter (Part No. 75-1310). Use of any other filter may void the warranty on some components.

1. Position machine on a level surface, lower the cutting units, stop the engine, engage the parking brakes and remove key from ignition switch.

2. Clean area around filter mounting area. Place drain pan under filter and remove filter.

3. Lubricate new filter gasket and fill the filter with hydraulic fluid.

4. Assure filter mounting area is clean. Screw filter on until gasket contacts mounting plate. Then tighten filter one-half turn.

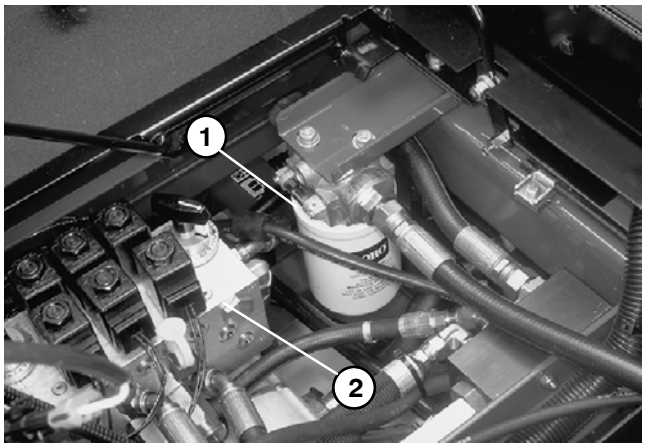


Figure 34

1. **Hydraulic filter**
2. **Hydraulic manifold block**

5. Start engine and let run for about two minutes to purge air from the system. Stop the engine and check for leaks.

Replace Transmission Fluid

Change the transmission fluid after every 800 hours of operation, in normal conditions.

1. Position machine on a level surface, lower the cutting units, stop the engine, engage the parking brakes and remove key from ignition switch.

2. Clean area around suction line on bottom of transmission. Place drain pan under line.

3. Remove line from transmission allowing fluid to drain into drain pan.

4. Reinstall suction line to transmission.

5. Fill with oil; see Check Transmission Fluid in this section if this manual.

6. Before starting the engine after changing transmission fluid, disconnect the run (ETR) solenoid on the engine, and crank the engine several times for 15 seconds. This allows the charge pump to fill the transmission with fluid before the engine is started.

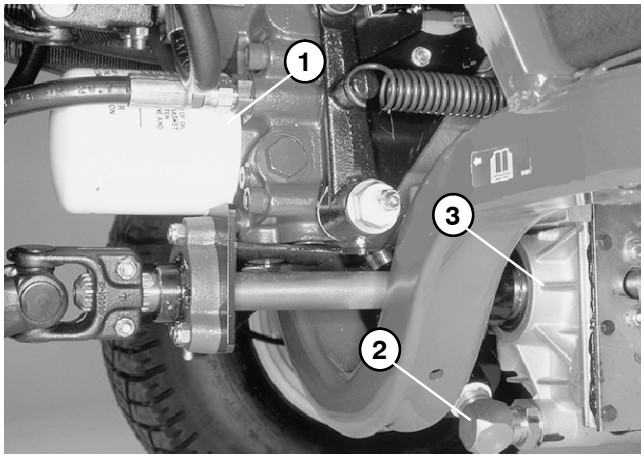


Figure 35

1. **Oil filter**
2. **Suction line**
3. **Hydraulic transmission**

Replace Transmission Filter (Fig. 35)

Change the transmission filter after the first 10 hours of operation and every 800 hours, thereafter.

IMPORTANT: Only the Toro replacement filter (Part No.75-1330) can be used in the hydraulic system. Use of any other filter may void the warranty on some components.

1. Position machine on a level surface, lower the cutting units, stop the engine, engage the parking brakes and remove key from ignition switch.

2. Clean area around filter mounting area. Place drain pan under filter and remove filter.

3. Lubricate new filter gasket and fill the filter with hydraulic oil.

4. Assure filter mounting area is clean. Screw filter on until gasket contacts mounting plate. Then tighten filter one-half turn.

5. Fill with oil; see Check Transmission Fluid in this section if this manual.

6. Start engine and let run for about two minutes to purge air from the system. Stop the engine and check for leaks. Check fluid level and replenish if necessary.

Transmission Control Linkage

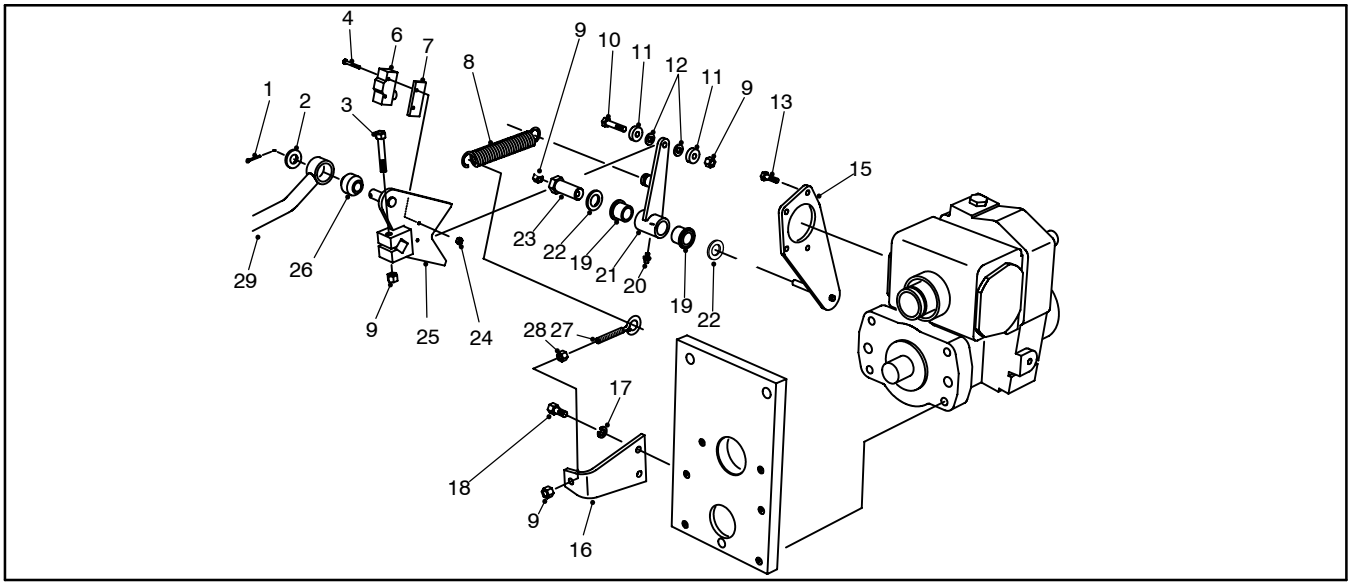


Figure 36

1. Cotter pin
2. Flat washer
3. Cap screw
4. Screw
5. Not used
6. Neutral switch
7. Switch plate
8. Extension spring
9. Lock nut
10. Cap screw
11. Ball bearing
12. Spacer
13. Cap screw
14. Not used
15. Traction plate
16. Spring anchor plate
17. Lock washer
18. Cap screw
19. Flanged bushing
20. Grease fitting
21. Switch arm
22. Thrust washer
23. Traction stud
24. Hex nut
25. Pump control
26. Rubber bushing
27. Eyebolt
28. Hex nut
29. Traction control rod

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Disconnect both wires from neutral switch.

CAUTION

The extension spring is under tension. Loosen lock nut from eye bolt to relieve spring tension.

3. Remove eyebolt from the spring anchor plate and extension spring from the switch arm.

4. Remove cotter pin and washer to disconnect traction control rod from pump control.

5. Loosen cap screw and lock nut securing pump control to swashplate control shaft.

Note: It is not necessary to disassemble transmission control assembly further.

6. Remove four cap screws securing traction plate to transmission housing. Remove transmission control assembly from transmission.

Installation

1. Position traction plate to the transmission. Secure traction plate to transmission housing with four cap screws.

2. Secure pump control to swash plate control shaft with cap screw and lock nut.

3. Reconnect traction control rod to pump control with washer and cotter pin.

4. Reinstall eyebolt and extension spring. Connect both wires to the neutral switch.

5. Adjust traction control neutral (see Adjust Traction Drive for Neutral).

Transmission

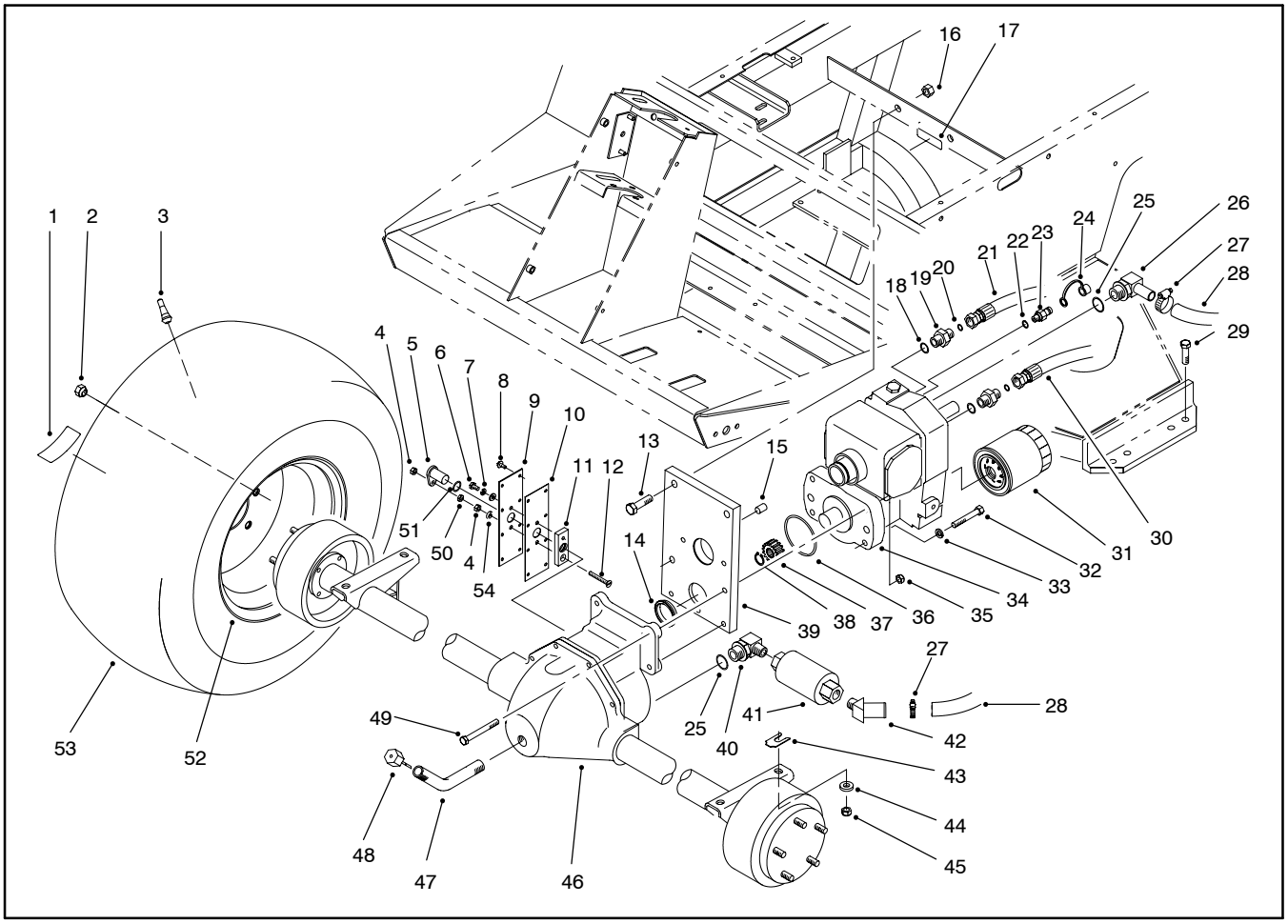


Figure 37

1. Bolt torque decal
2. Lug nut
3. Valve stem
4. Lock nut
5. Gear tooth sensor
6. Cap screw
7. Lock washer
8. Cap screw
9. Gear cover
10. Axle gasket
11. Sensor mounting plate
12. Machine screw
13. Cap screw
14. Transmission collar
15. Transmission pilot sleeve
16. Lock nut
17. Bolt decal
18. O-ring
19. Hydraulic straight fitting
20. O-ring
21. Hydraulic hose
22. O-ring
23. Hydraulic test port fitting
24. Test port cap
25. O-ring
26. 90° hydraulic fitting
27. Hose clamp
28. Hose
29. Cap screw
30. Hydraulic hose
31. Oil filter
32. Cap screw
33. Lock washer
34. Transmission
35. Lock nut
36. O-ring
37. Pinion gear
38. Retaining ring
39. Transmission support
40. 90° hydraulic fitting
41. In-lin strainer
42. 45° hydraulic fitting
43. Axle shim
44. Flat washer
45. Lock nut
46. Front axle
47. Oil fill tube
48. Axle dip stick
49. Cap screw
50. Jam nut
51. O-ring
52. Rim
53. Tire
54. Flat washer

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Remove two (2) rear cutting units (see Chapter 8 - Cutting Units).

3. To prevent contamination of hydraulic system during removal, thoroughly clean exterior of transmission and differential.

4. Put a drain pan below the transmission. Remove suction line from bottom of in-line filter to let oil drain out of differential (Fig. 38).

5. Remove transmission control linkage from the transmission (see Transmission Control Linkage Removal).

6. Remove hydraulic hoses and fittings connected to transmission. Put plugs or caps on disconnected hydraulic hoses to prevent contamination of the system. Put plugs in open ports of transmission.

7. Disconnect drive shaft from transmission (Fig. 38).

8. Support the transmission to prevent it from falling while carefully removing four (4) cap screws and locknuts retaining transmission to support plate. Carefully pull transmission off of support plate and lower it out of the machine (Fig. 39 and 40).

Note: If the machine is going to be stored until transmission is repaired or replaced, cover hole in support plate with weatherproof tape to prevent contamination of the reservoir.

9. Leave support plate installed and gear pump installed on the support plate.

10. Remove retaining ring and remove pinion gear from transmission output shaft.

11. Remove filter from the transmission.

Installation

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Before installing transmission, install new O-ring seal where transmission mates with support plate.

3. Install pinion gear and retaining ring to the transmission output shaft.

4. Uncover hole in support plate if necessary.

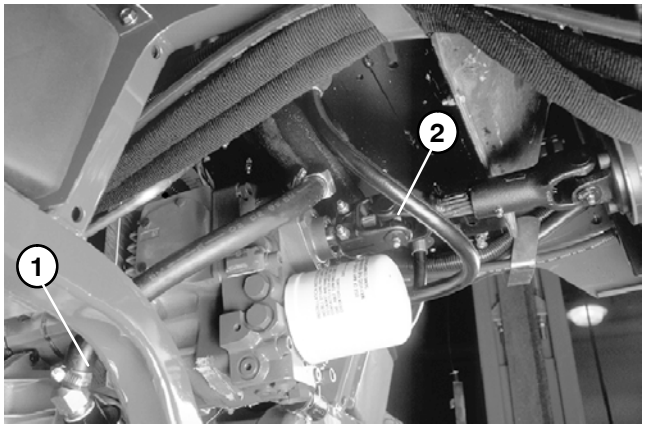


Figure 38

1. **Suction line** 2. **Drive shaft**

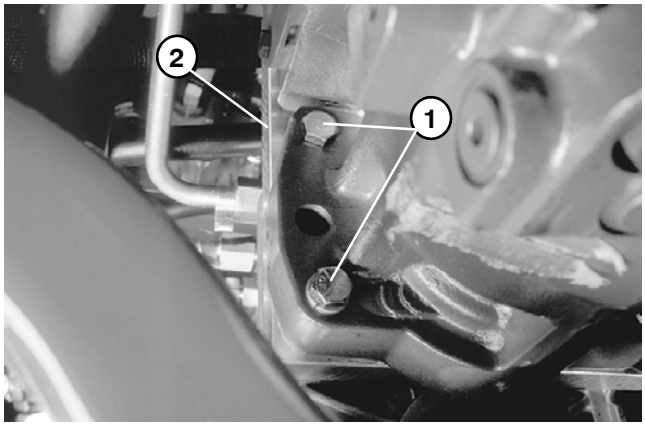


Figure 39

1. **Cap screw & lock nut** 2. **Support plate**

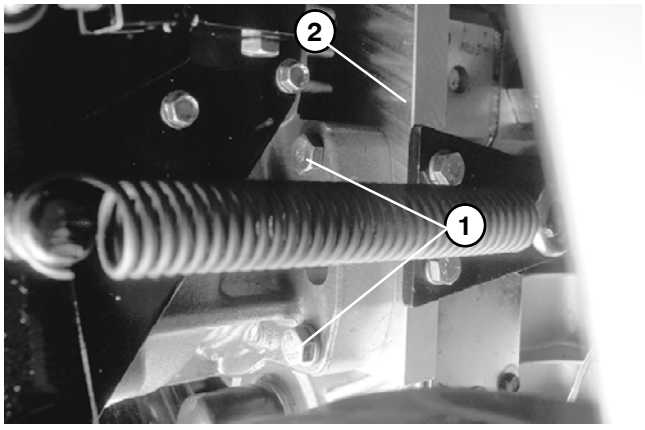


Figure 40

1. **Cap screw & lock nut** 2. **Support plate**

5. Carefully position transmission to the support plate while raising it into the machine. Support transmission to prevent it from falling while carefully installing four (4) cap screws and locknuts securing transmission to support plate. (Fig. 39 and 40).

6. Connect drive shaft to the transmission (Fig. 38).

7. Remove plugs or caps from disconnected hydraulic hoses and open ports of the transmission.

8. Install transmission control linkage to the transmission (see Transmission Control Linkage Installation).

9. Secure suction line to top of in-line filter (Fig. 38).

10. Install two (2) rear cutting units (see Chapter 8 - Cutting Units).

11. Install a new filter and fill differential with correct oil.

12. Disconnect fuel stop solenoid electrical connector on engine to prevent engine from starting. Prime transmission by turning ignition key switch to crank engine for 10 seconds. Repeat cranking procedure again.

13. Start the engine and let it idle for approximately two minutes. Operate machine slowly in forward and reverse. Stop engine and check differential oil level. Check transmission for leaks.

Transmission Service

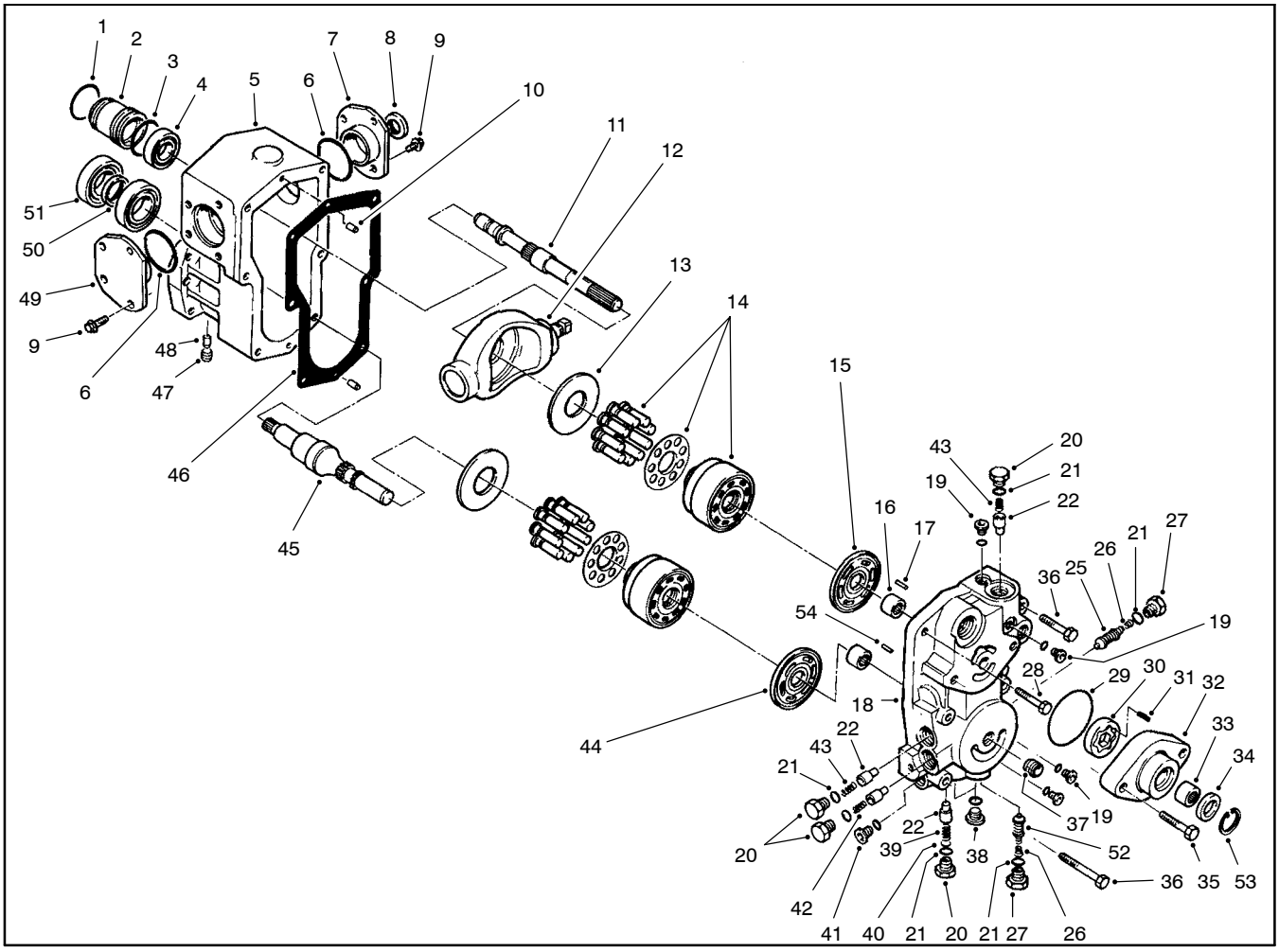


Figure 41

1. Retaining ring
2. Seal guide
3. O-ring
4. Ball bearing
5. Housing
6. O-ring
7. Trunnion cover (RH)
8. Lip seal
9. Cap screw
10. Pin
11. Pump shaft
12. Swash plate
13. Thrust plate
14. Cylinder block kit
15. Valve plate
16. Needle bearing
17. Pin
18. Center section
19. Straight thread plug
20. Plug
21. O-ring
22. Relief valve
23. Slotted pin
24. Cap screw
25. Check/pressure relief valve (forward)
26. Conical spring
27. Special plug
28. Cap screw
29. O-ring
30. Gerotor
31. Pin
32. Charge pump housing
33. Needle bearing
34. Lip seal
35. Cap screw
36. Cap screw
37. Nipple
38. Straight thread plug
39. Spring
40. Shim
41. Plug
42. Spring
43. Spring
44. Plate valve
45. Motor shaft
46. Housing gasket
47. Pipe plug
48. Pin
49. Trunnion cover (LH)
50. Collar
51. Ball bearing
52. Check/pressure relief valve (reverse)
53. Retaining ring

The procedures on the following pages are for the complete disassembly and reassembly of the transmission.

Cleanliness is a primary means of assuring 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.

Disassembly

1. Remove external components as described in the following sections:
   - Shaft Seal Replacement
   - Trunnion Seal Replacement
   - Check/High Pressure Relief Valve Replacement
   - Charge Pressure Relief Valve Replacement
   - Heat Exchanger By-Pass Valve Replacement
   - Filter By-Pass Valve Replacement
   - In-Line Filter Check Valve Replacement
   - Charge Pump Replacement

2. Remove six (6) screws securing the center section to the housing. Note position of longer and shorter screws. The cylinder block springs will cause the center section to separate from the housing (Fig. 42).

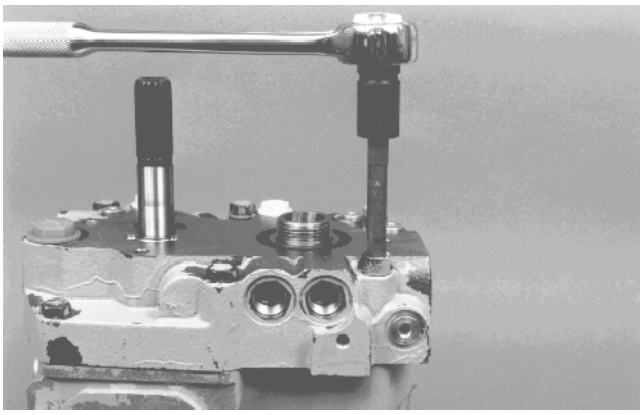


Figure 42

IMPORTANT: The pump and motor cylinder blocks may stick to the valve plates and center section. Be careful to prevent damage to the sealing surfaces.

3. Remove center section from housing (Fig. 43).

4. Remove gasket and two (2) alignment pins from housing.

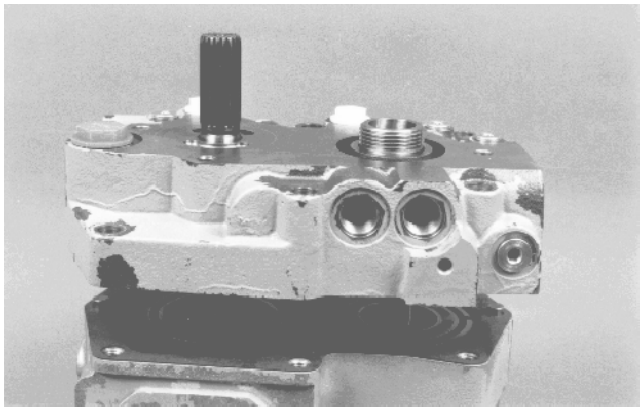


Figure 43

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 (Fig. 44).

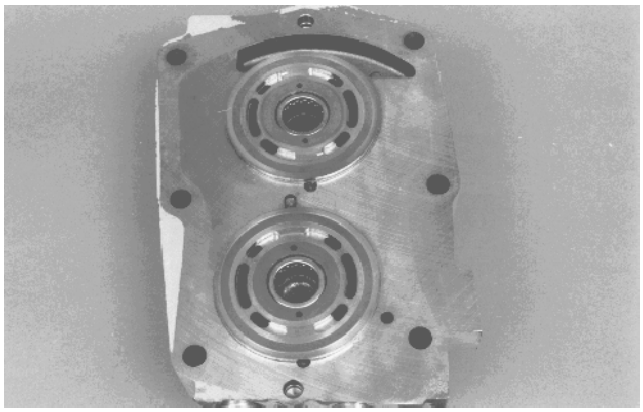


Figure 44

6. Remove valve plate pins from the center section (Fig. 45).

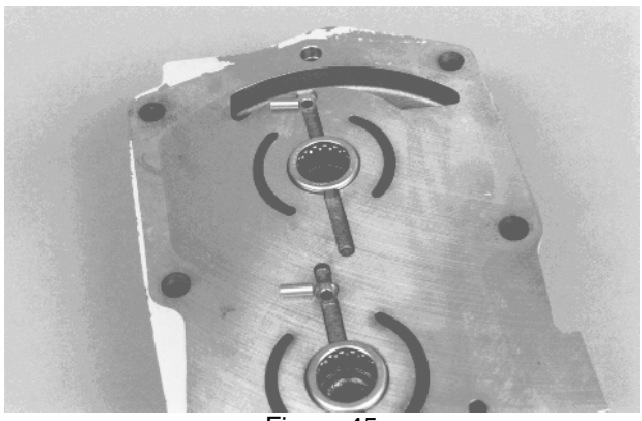


Figure 45

7. Lay transmission on its side and remove motor cylinder block assembly from the housing. Remove pump cylinder block assembly from pump shaft (Fig. 46).

Figure 46

IMPORTANT: Pump and motor cylinder block assemblies are identical. To avoid mixing wear patterns, do not mix parts between pump and motor cylinder block assemblies. Make sure each piston is returned to the bore it was taken from.

8. Remove slipper guide and piston assemblies from cylinder blocks (Fig. 47).

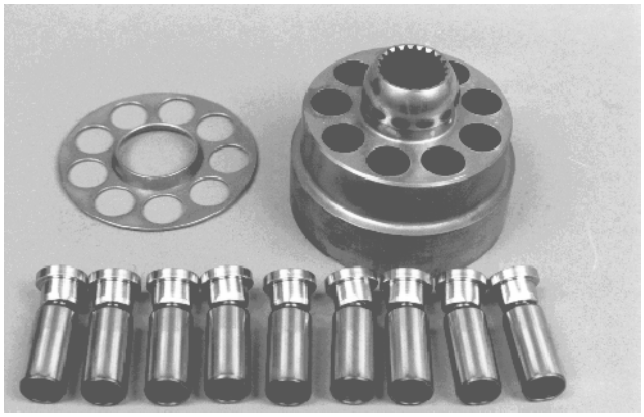


Figure 47

9. Use O-ring pick or wire to remove thrust plates from swashplate and housing (Fig. 48).

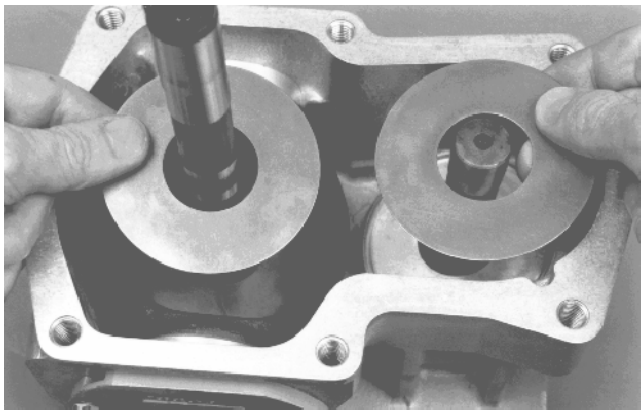


Figure 48

10. Use an internal hex wrench to remove pipe plug over motor shaft bearing retaining pin (Fig. 49).

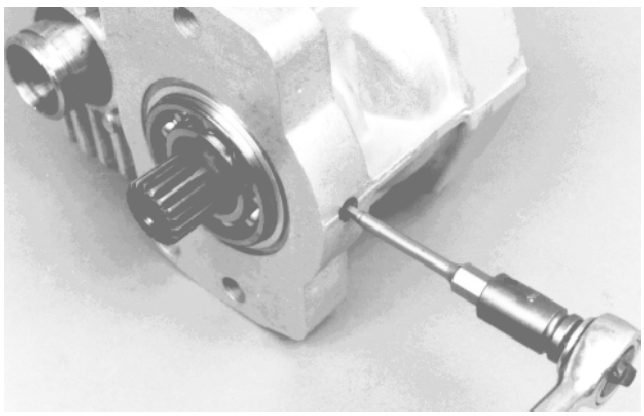


Figure 49

11. Use an 8-32 machine screw to remove motor shaft bearing retaining pin from housing (Fig. 50).

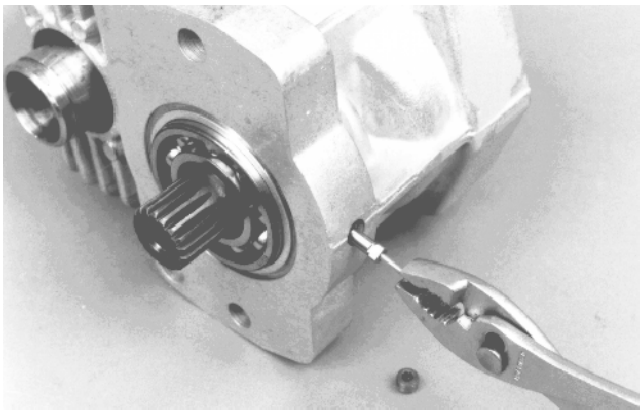


Figure 50

12. Remove motor shaft from housing (Fig. 51).

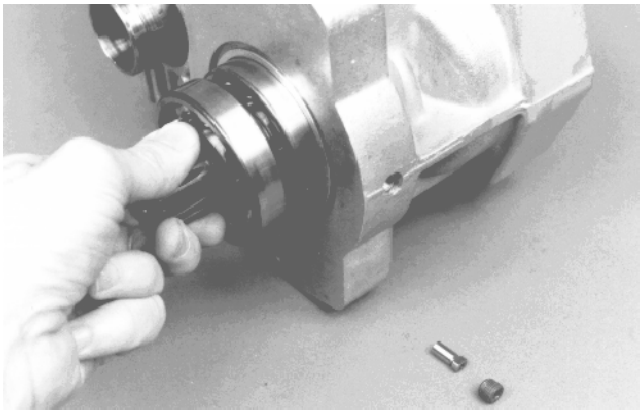


Figure 51

13. Press motor shaft out of the bearings and spacer (Fig. 52).

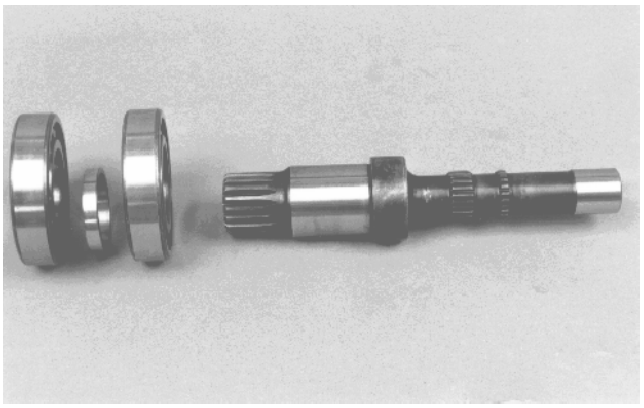


Figure 52

14. Remove spiral retaining ring and remove PTO seal guide (with O-ring) from the housing (Fig. 53).

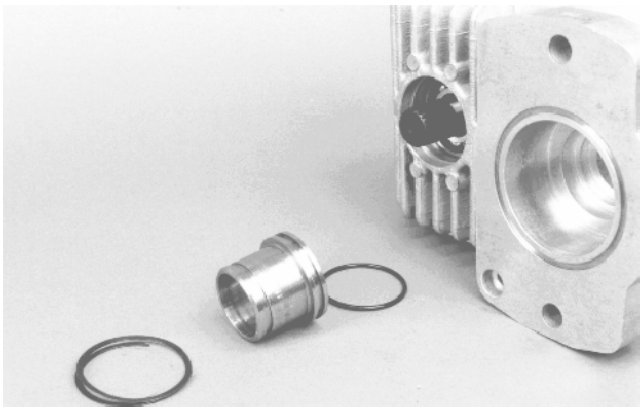


Figure 53

15. Slide pump shaft and bearing assembly from housing. Press shaft out of bearing (Fig. 54).

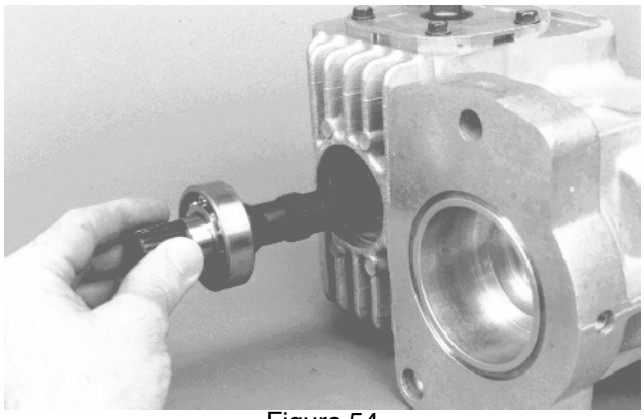


Figure 54

16. Remove hex tapping screws retaining the trunnion seal cover and trunnion cover to housing. Mark position of covers for reassembly. 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 (Fig. 55).

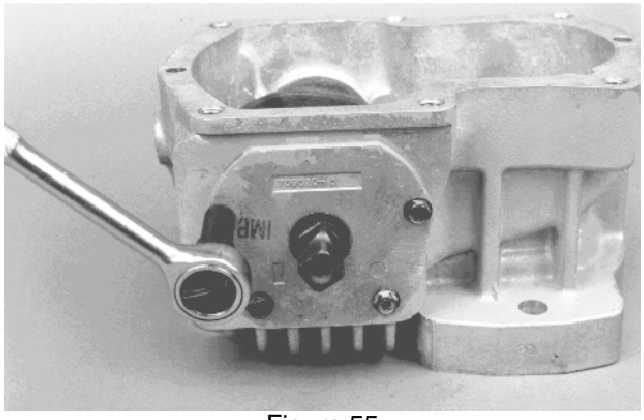


Figure 55

17. Tilt and lift swashplate from housing (Fig. 56).

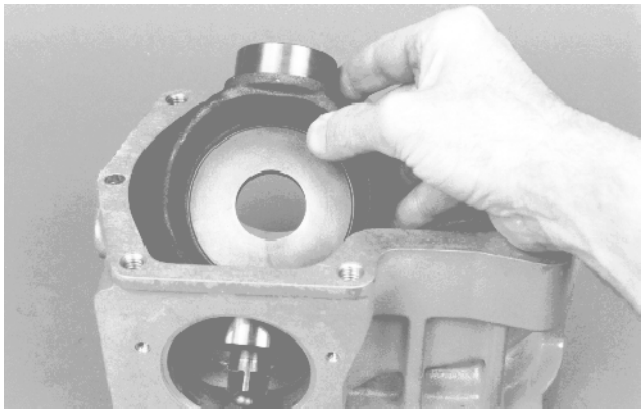


Figure 56

Inspection

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

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

3. 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.

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

5. Press new needle bearings into center section using a suitable press pin. When installed correctly, bearing cage will protrude from 0.09 to 0.11 inch (2.3 to 2.8 mm) from the surface of the center section to serve as pilots for the valve plates (Fig. 57).

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

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

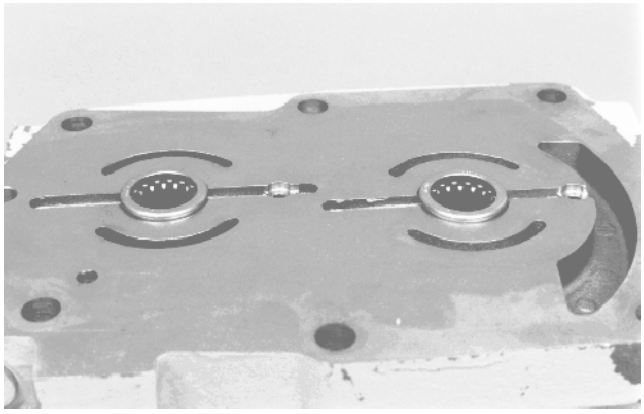


Figure 57

Assembly

Note: During assembly of the transmission, 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.

Note: Replace all gaskets, O-rings and seals. Lightly lubricate all O-rings with clean petroleum jelly before assembly. All gasket sealing surfaces must be cleaned before installing new gaskets.

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) (Fig. 58).

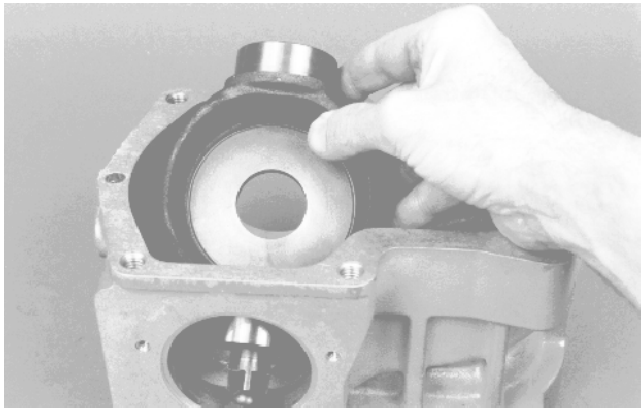


Figure 58

Note: The trunnion bearings are pressed into the cover assemblies so the split in each bearing will be located closest to the center section.

3. Install trunnion cover (with O-ring and trunnion bearing) into housing and over swashplate trunnion (Fig. 59).

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.

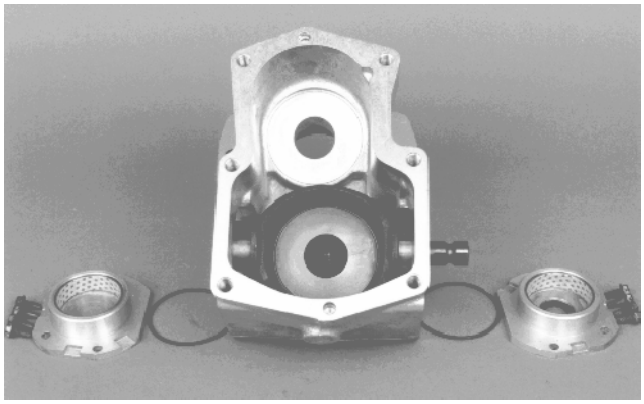


Figure 59

Note: Wrap end of swashplate control shaft with thin plastic to prevent damage to seal lip during installation.

5. Install trunnion seal cover with O-ring, seal and trunnion bearing into housing and over swashplate trunnion (see Trunnion Seal Replacement) (Fig. 60).

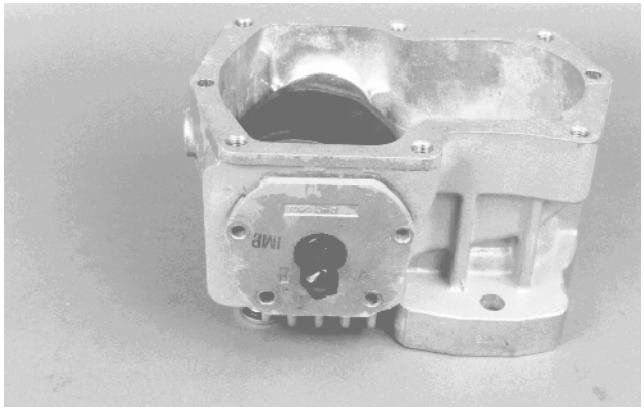


Figure 60

6. Install hex tapping screws and tighten to a torque of 6 to 9 ft-lb (8 to 12 N-m) (Fig. 61).

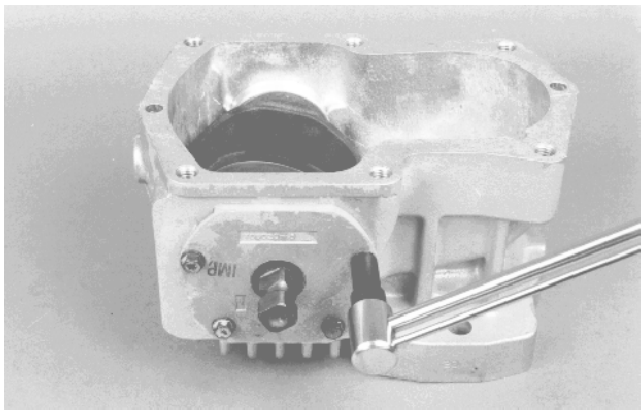


Figure 61

7. Press ball bearing onto pump shaft. Install pump shaft and bearing assembly into housing (Fig. 62).

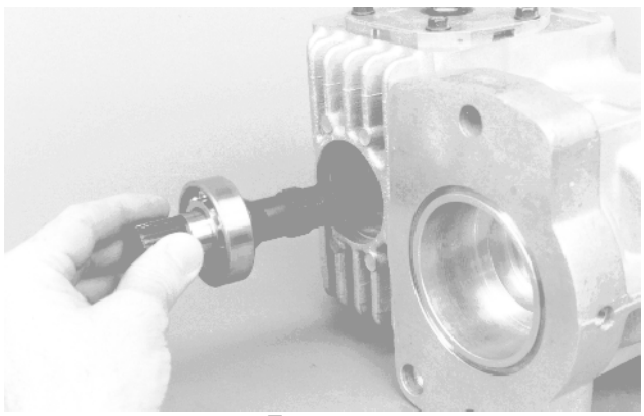


Figure 62

8. Install PTO seal guide and O-ring into housing. Install spiral retaining ring (Fig. 63).

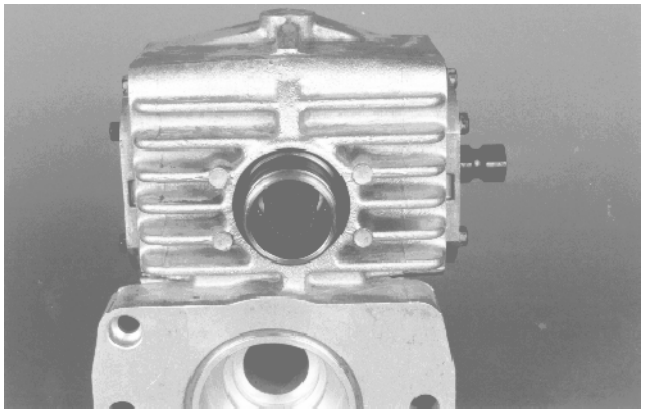


Figure 63

9. Press inner bearing, spacer and outer bearing onto motor shaft (Fig. 64).

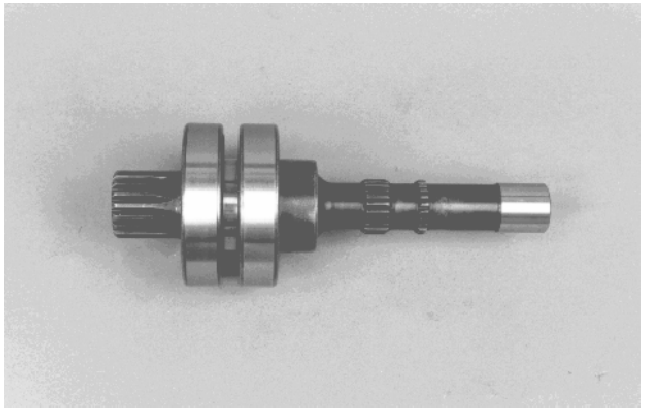


Figure 64

10. Install motor shaft assembly into housing (Fig. 65).

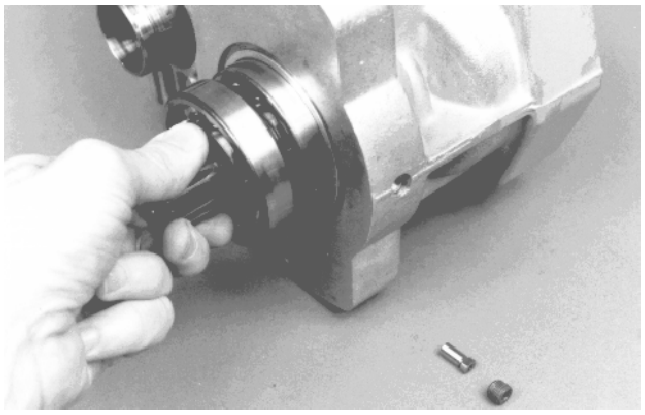


Figure 65

11. Install motor shaft bearing retaining pin into housing (Fig. 66).

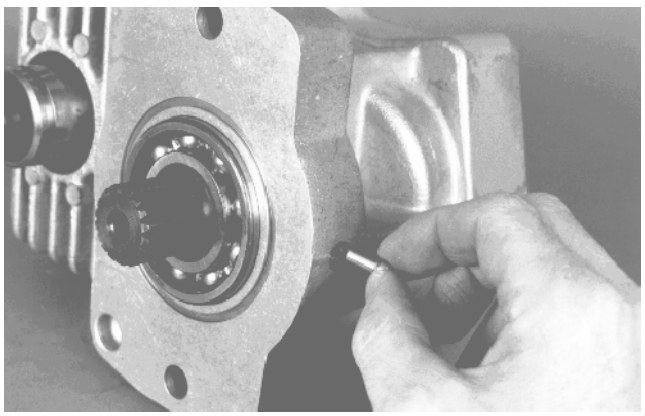


Figure 66

12. Install pipe plug over motor shaft bearing retaining pin and tighten to a torque of 6 to 9 ft-lb (8 to 12 N-m) (Fig. 67).

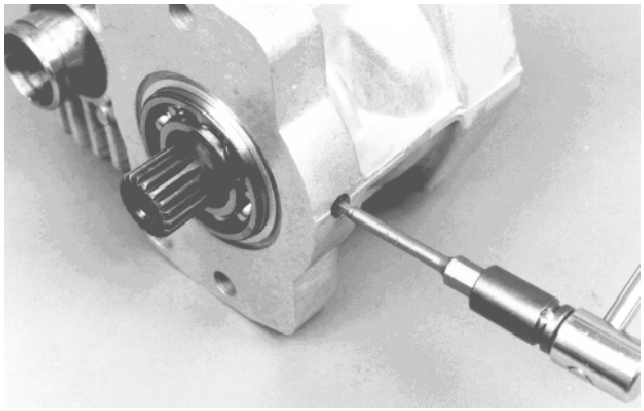


Figure 67

13. Coat thrust plates with petroleum jelly and install into housing and swashplate (Fig. 68). The thrust plates are reversible.

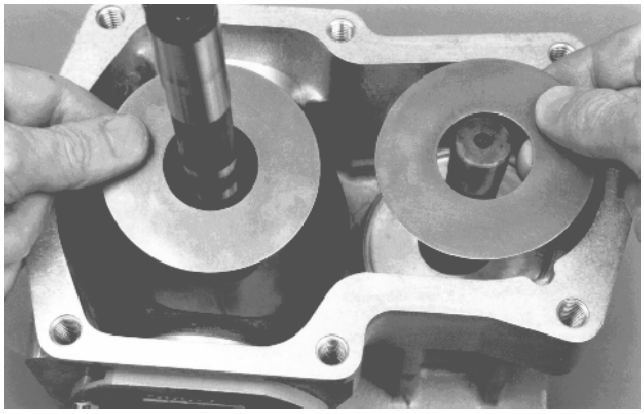


Figure 68

14. 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 (Fig. 69).

Figure 69

15. Lay the transmission on its side and install cylinder block kits into the housing (Fig. 70).

16. Put the transmission housing on a work surface with the center section opening facing up.

Figure 70

17. Install valve plate locating pins into center section (Fig. 71).

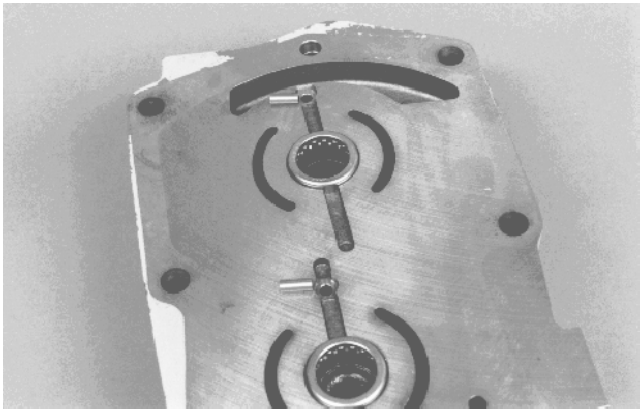


Figure 71

18. 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 (Fig. 72). The notch on each valve plate must engage its locating pin.

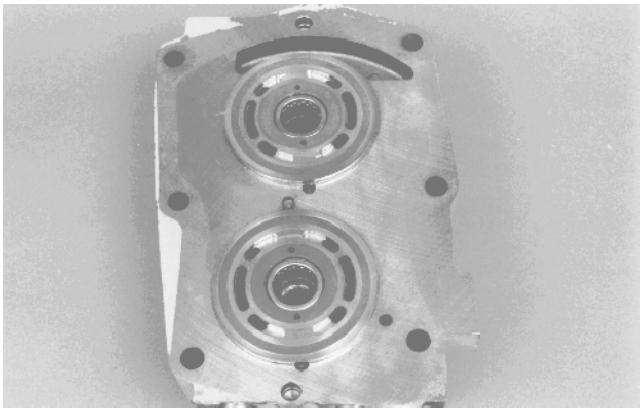


Figure 72

Note: Do not interchange pump and motor valve plates when assembling transmission. The motor valve plate has either no grooves, or grooves on both sides of the ports. The pump plate has grooves on one side of the ports (Fig. 73).

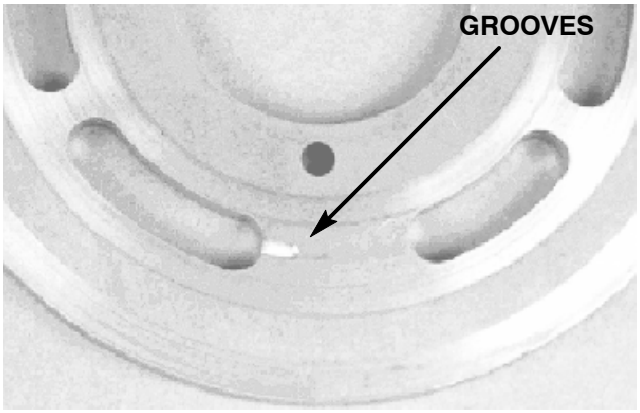


Figure 73

19. Install the two (2) alignment pins and install a new center section gasket onto the housing (Fig. 74).

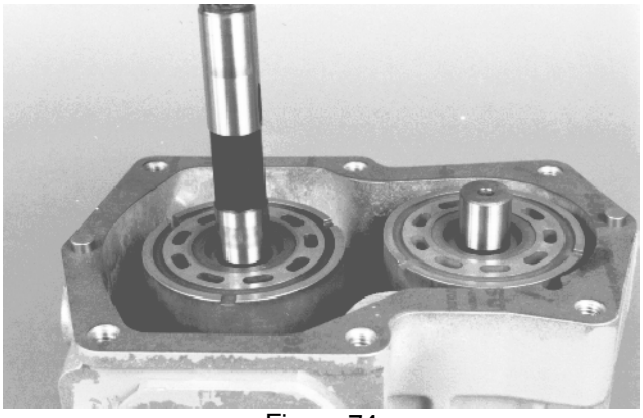


Figure 74

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

20. Install center section with valve plates onto transmission housing (Fig. 75).

Note: When the center section is properly installed, the cylinder block springs will hold the end center section away from the housing about 1/8 inch (3.1 mm).

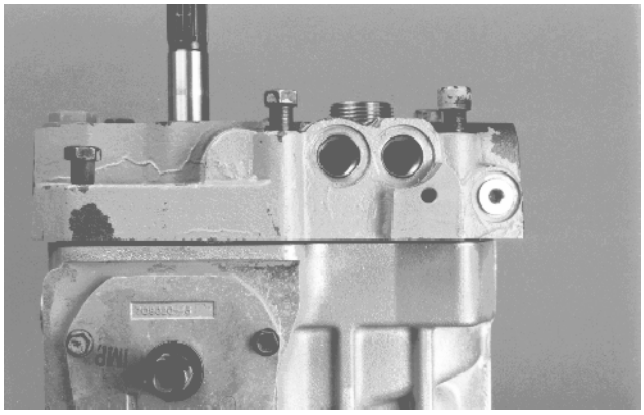


Figure 75

21. Install six (6) screws that retain the center section to the housing and torque evenly to 33 to 41 ft-lb (45 to 56 N-m) (Fig. 76).

22. Rotate pump and motor shafts to make sure transmission is assembled correctly. When properly assembled, a maximum torque of 3.5 ft-lb (4.7 N-m) should be required to turn either shaft.

23. Assemble following components as described in the procedures:
    - Charge Pump Replacement
    - In-Line Filter Check Valve Replacement
    - Filter By-Pass Valve Replacement
    - Heat Exchanger By-Pass Valve Replacement
    - Charge Pressure Relief Valve Replacement
    - Check/High Pressure Relief Valve Replacement
    - Trunnion Seal Replacement
    - Shaft Seal Replacement

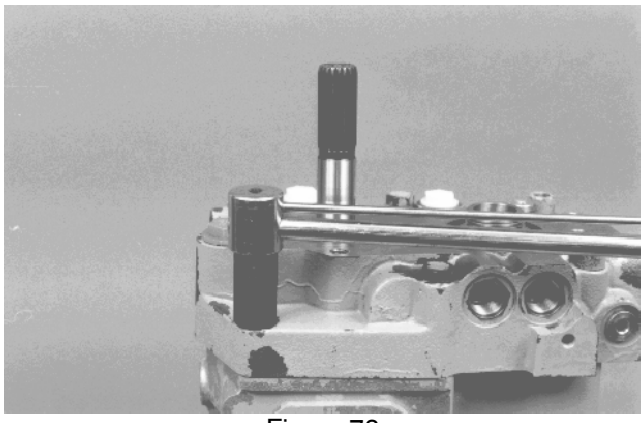


Figure 76

Shaft Seal Replacement

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Disconnect drive shaft from the transmission (Fig 77).

Note: The face of the seal may be punctured with a sharp instrument (such as a screwdriver) to aid in prying the seal out, or a slide hammer type puller may be used to remove the seal. Be careful to not damage the charge pump cover or shaft. Once removed the seal is not reusable.

3. Remove retaining ring, then carefully remove seal from bore in charge pump cover (Fig. 78).

4. Inspect the charge pump cover, new seal, and shaft for damage. Inspect sealing area on shaft for rust, wear or contamination. Polish seal area on shaft if necessary.

5. Use a seal installer tool or wrap spline end of shaft with thin plastic to prevent damage to seal lip during installation. Lubricate inside diameter of new seal with petroleum jelly.

6. Press new seal into charge pump cover, being certain the seal is perpendicular to the shaft. Be careful not to damage the seal. The outer face of the seal should be located between 0.056 to 0.096 inch (1.42 to 2.44 mm) below the outer surface of the charge pump cover. Install the retaining ring.

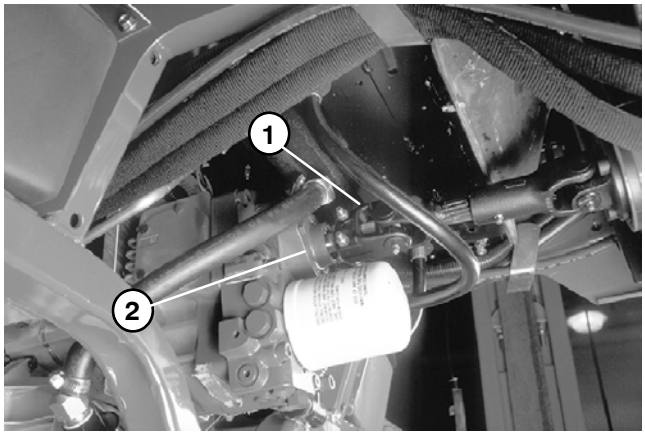


Figure 77

1. **Drive shaft**
2. **Charge pump**

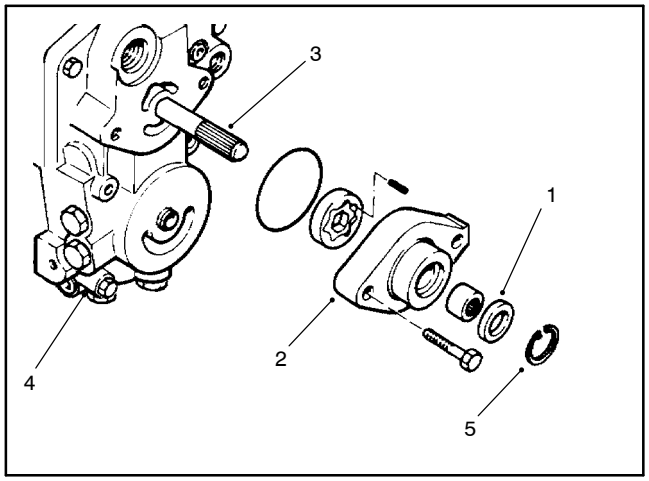


Figure 78

1. **Shaft seal**
2. **Charge pump cover**
3. **Shaft**
4. **Transmission**
5. **Retaining ring**

Trunnion Seal Replacement

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Remove pump control from the swashplate control shaft on transmission (see Hydraulic Transmission Control Linkage Removal).

3. Remove hex tapping screws retaining trunnion seal cover to transmission housing.

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 (8 to 12 N-m).

11. Install pump control onto transmission swashplate control shaft. Check machine for ”creeping” when engine is running with foot pedal in neutral position (see Adjust Traction Drive for Neutral).

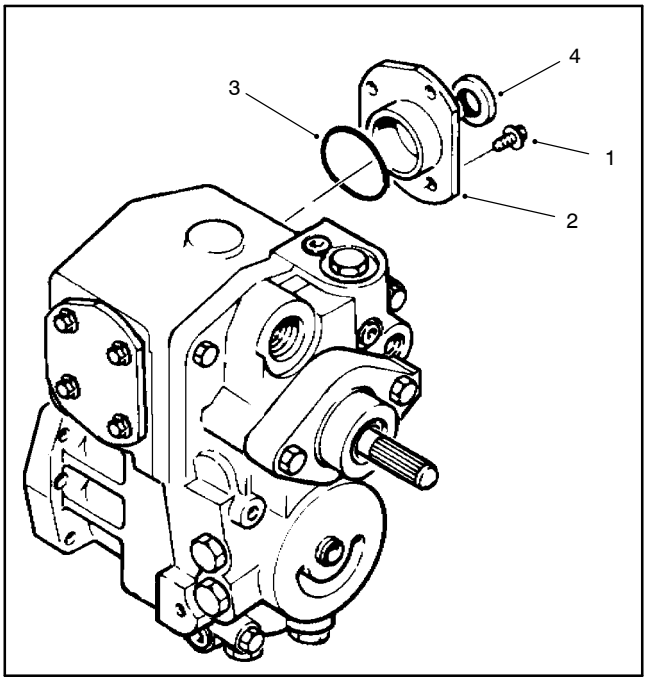


Figure 79

1. **Hex tapping screw**
2. **Trunnion seal cover**
3. **O-ring**
4. **Lip seal**

Check/High Pressure Relief Valve Replacement

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Remove check/high pressure relief valve hex plug.

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.

Note: The forward and reverse valves are different. The seating surface of the ”reverse” check/high pressure relief valve has a machined groove in it. Installing the ”reverse” check/high pressure relief valve in the wrong port may cause performance problems.

5. Reinstall the valve cartridges with O-rings into the housing and tighten the plugs to a torque of 30 to 70 ft-lb (41 to 95 N-m).

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 transmission for leaks.

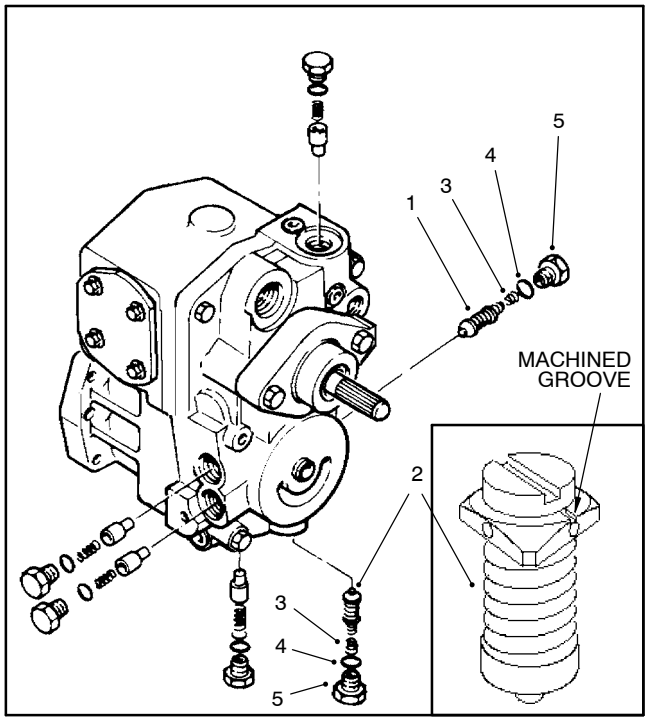


Figure 80

1. Forward check/high pressure relief valve
2. Reverse check/high pressure relief valve
3. Spring
4. O-ring
5. Plug

Charge Pressure Relief Valve Replacement

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Remove the charge relief valve plug.

3. Remove the spring and poppet from the housing.

4. Do not interchange parts with another valve.

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

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.

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 (41 to 95 N-m).

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.

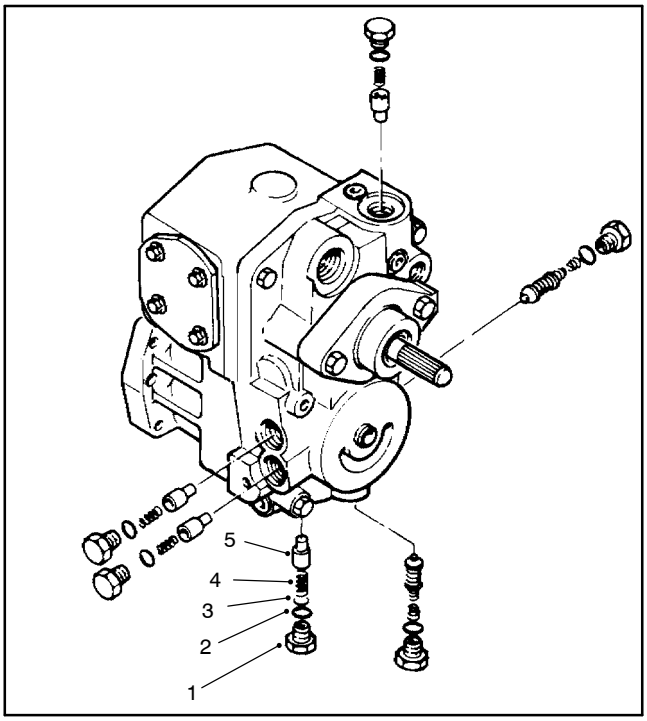


Figure 81

1. **Plug**
2. **O-ring**
3. **Shim**
4. **Spring**
5. **Relief valve**

Heat Exchanger By-Pass Valve Replacement

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Remove the heat exchanger bypass valve hex plug.

3. Remove the spring and poppet from the housing.

4. Do not interchange parts with another valve. The spring used in the heat exchanger bypass valve is identified by a yellow dye mark, and requires a force of approximately 5.5 lb (24.5 N) to compress it to a length of 1.28 inch (3.25 cm).

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 (41 to 95 N-m).

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.

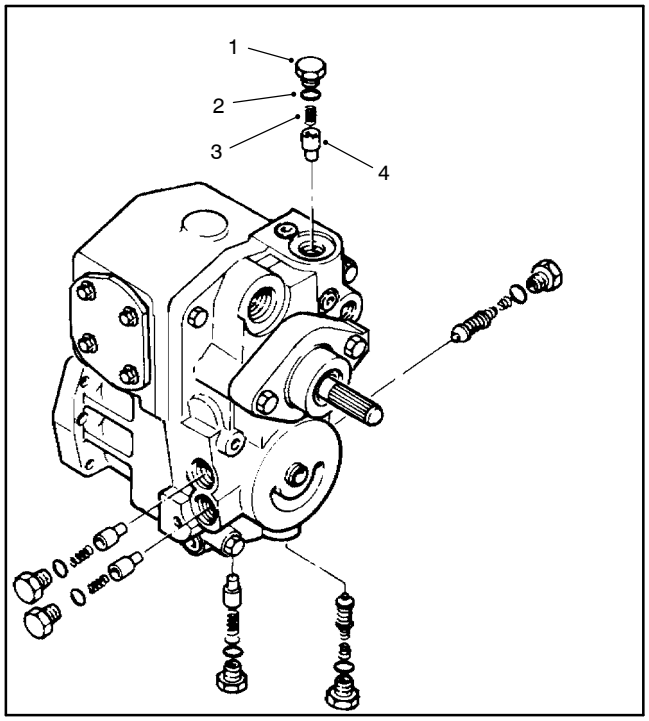


Figure 82

1. **Plug**
2. **O-ring**
3. **Spring**
4. **Relief valve**

Filter By-Pass Valve Replacement (Fig. 83)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Remove the filter bypass valve hex plug.

3. Remove the spring and poppet from the housing.

4. Do not interchange parts with another valve. The spring used in the filter bypass valve is identified by a red dye mark, and requires a force of approximately 2.2 lb (9.8 N) to compress it to a length of 1.28 inch (3.25 cm).

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 (41 to 95 N-m).

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.

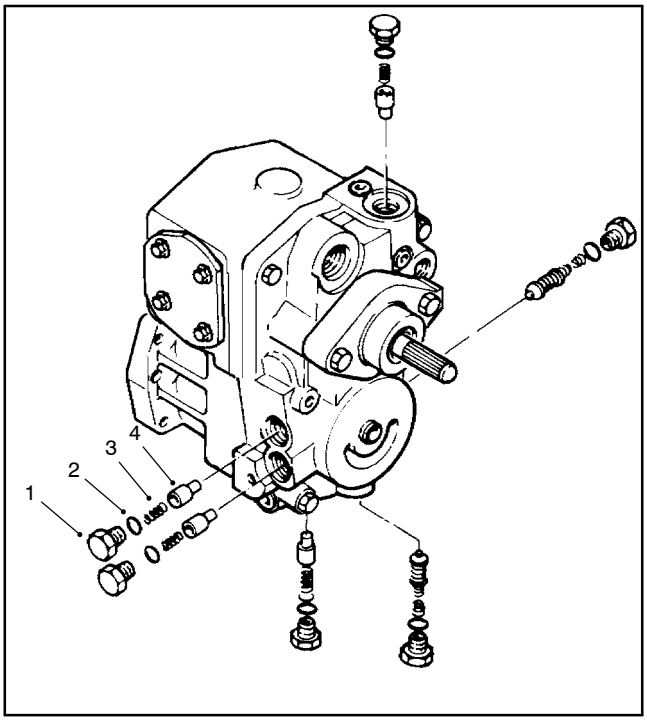


Figure 83

1. **Plug**
2. **O-ring**
3. **Spring**
4. **Relief valve**

In-line Filter Check Valve Replacement (Fig. 84)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Remove the in−line filter check valve hex plug.

3. Remove the spring and poppet from the housing.

4. Do not interchange parts with another valve. The spring used in the in−line filter check valve is identified by a blue dye mark, and requires a force of approximately 0.3 lb (1.3 N) to compress it to a length of 1.28 inch (3.25 cm).

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 (41 to 95 N-m).

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.

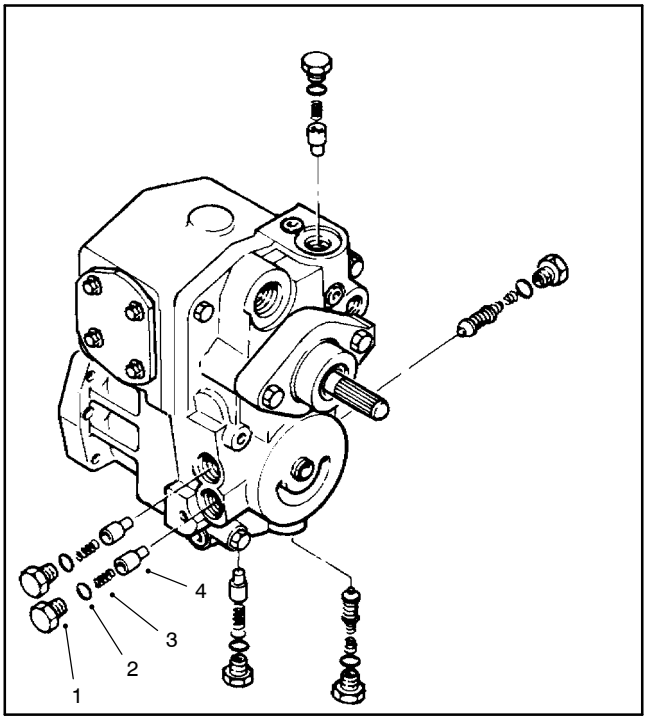


Figure 84

1. **Plug**
2. **O-ring**
3. **Spring**
4. **Relief valve**

Charge Pump Replacement

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Remove the two (2) cap screws retaining the charge pump cover. Remove the charge pump (Fig. 37, 38).

3. Remove geroter drive pin from the groove in the shaft.

4. Remove the geroter assembly from the charge pump cover. Remove the shaft seal from the cover.

5. Each part should be inspected separately if they are to be reused. If either of the geroter assembly parts needs to be replaced, they should both be replaced. Always replace the O-ring.

6. Inspect the shaft bearing in the charge pump cover for wear or damage. If replacement is necessary, remove the needle bearing from the cover using a suitable puller. Press a new needle bearing into the cover using a suitable press pin. When installed correctly, the bearing cage will be flush to 0.020 inch (51 mm) below the surface of the seal counterbore in the front of the cover.

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

7. Install the geroter drive pin in the groove in the drive shaft, and retain with petroleum jelly.

8. Before assembly, lubricate the geroter assembly with clean hydraulic oil. Install the geroter assembly into the charge pump cover. Install the O-ring and retain with petroleum jelly.

IMPORTANT: Correct charge pump installation to match engine rotation is determined by the position of the charge pump cover on the transmission housing. To prevent damage to transmission from lack of replenishing oil from charge pump, the flat on the charge pump cover must be on the right (toward the heat exchanger ports).

9. With the flat on the charge pump cover to the right, install the charge pump assembly over the drive shaft and onto the transmission housing. Make sure the geroter engages the drive pin in the shaft.

10. Tighten the charge pump cover cap screws to a torque of 27 to 37 ft-lb (37 to 50 N-m).

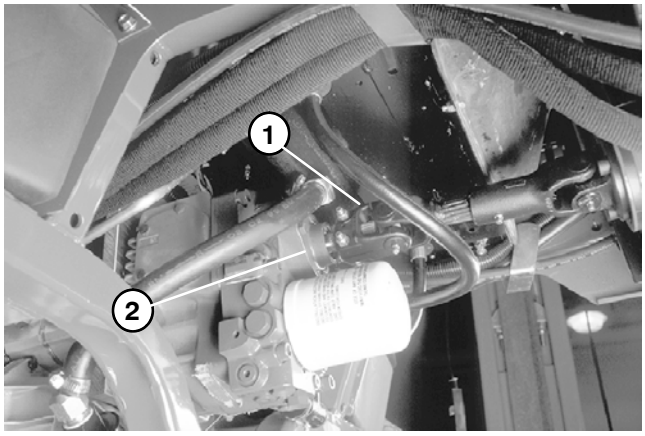


Figure 85

1. **Drive shaft**
2. **Charge pump**

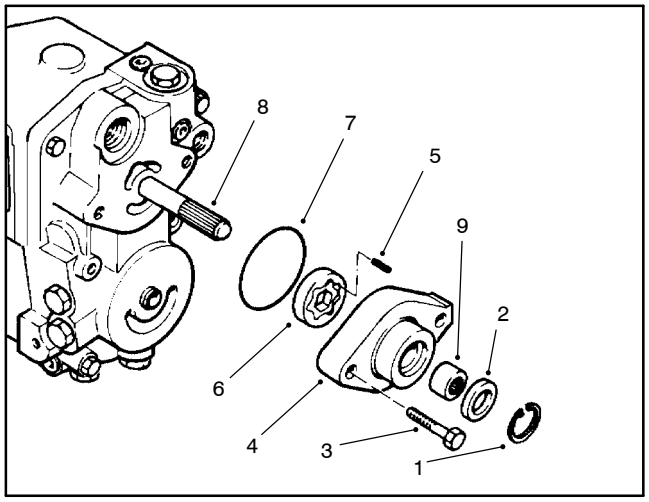


Figure 86

1. **Retaining ring**
2. **Lip seal**
3. **Cap screw**
4. **Bearing**
5. **Housing**
6. **Gerotor**
7. **O-ring**
8. **Drive shaft**
9. **Needle bearing**

11. Install a new shaft seal (see Shaft Seal Replacement).

12. Before starting the engine, check the oil level in 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.

Gear Pump

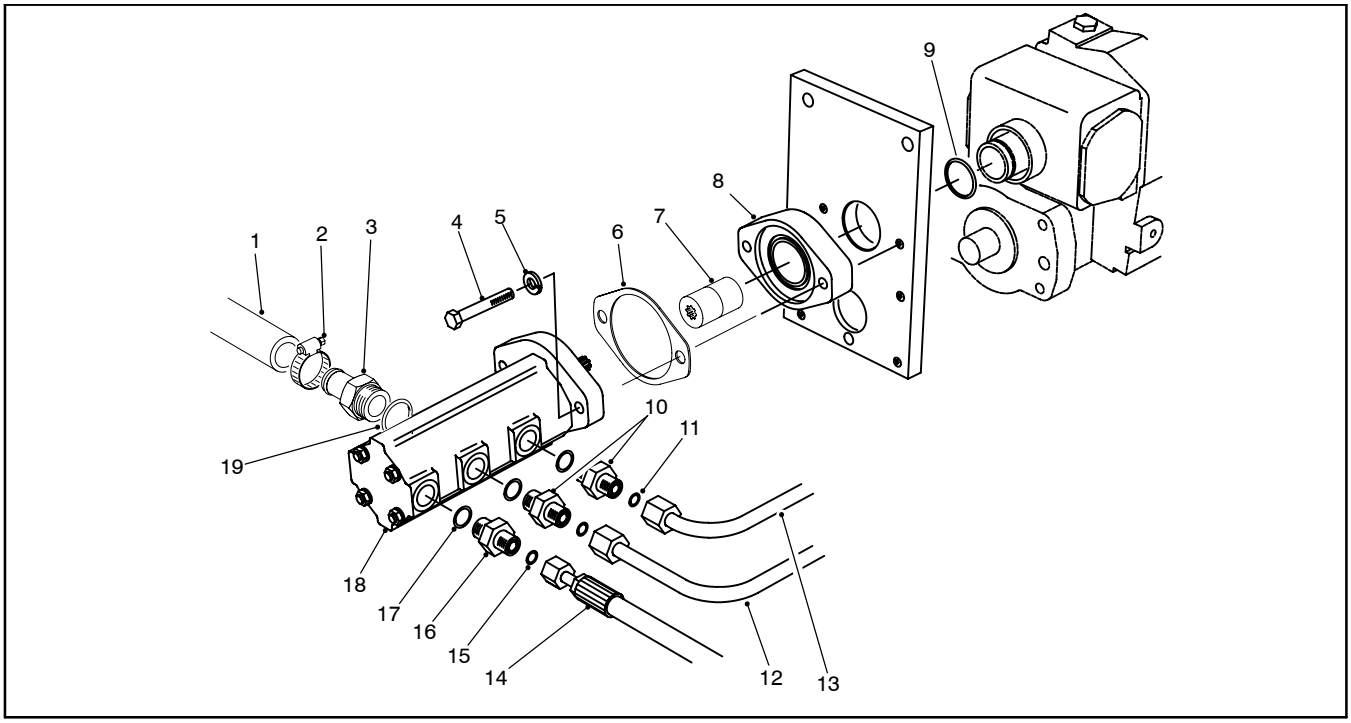


Figure 87

1. **Suction hose**
2. **Hose clamp**
3. **Hydraulic fitting**
4. **Cap screw**
5. **Lock washer**
6. **Gasket**
7. **Transmission coupler**
8. **Transmission adapter**
9. **O-ring**
10. **Hydraulic straight fitting**
11. **O-ring**
12. **Hydraulic tube**
13. **Hydraulic tube**
14. **Hydraulic hose**
15. **O-ring**
16. **Hydraulic straight fitting**
17. **O-ring**
18. **Gear pump**
19. **O-ring**

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Raise seat and secure it with prop rod to get access to pump.

3. Drain the hydraulic reservoir.

4. To prevent contamination of hydraulic system during removal, thoroughly clean exterior of pump and fittings.

5. Disconnect hydraulic lines from pump and put caps or plugs on open hydraulic lines and fittings. Label disconnected hydraulic lines for proper reassembly.

6. Remove two (2) cap screws and washers securing pump to support plate. Remove pump, transmission coupler, and transmission adapter.

Installation

1. Lubricate a new O-ring with clean hydraulic oil and install on pump.

2. Install transmission coupler on the transmission output shaft.

3. Install pump shaft with transmission adapter onto the transmission coupler and support plate. Secure pump and transmission adapter to support plate with two (2) cap screws and lock washers.

4. Replace hydraulic filter and fill hydraulic reservoir with new hydraulic oil.

5. Disconnect fuel stop solenoid electrical connector on engine to prevent engine from starting. Prime the hydraulic pump by turning the ignition key switch to crank the engine for 10 seconds. Repeat cranking procedure again.

6. Connect fuel stop solenoid electrical connector, start the engine and check for proper operation.

7. Stop engine and check for hydraulic oil leaks. Check hydraulic reservoir oil level.

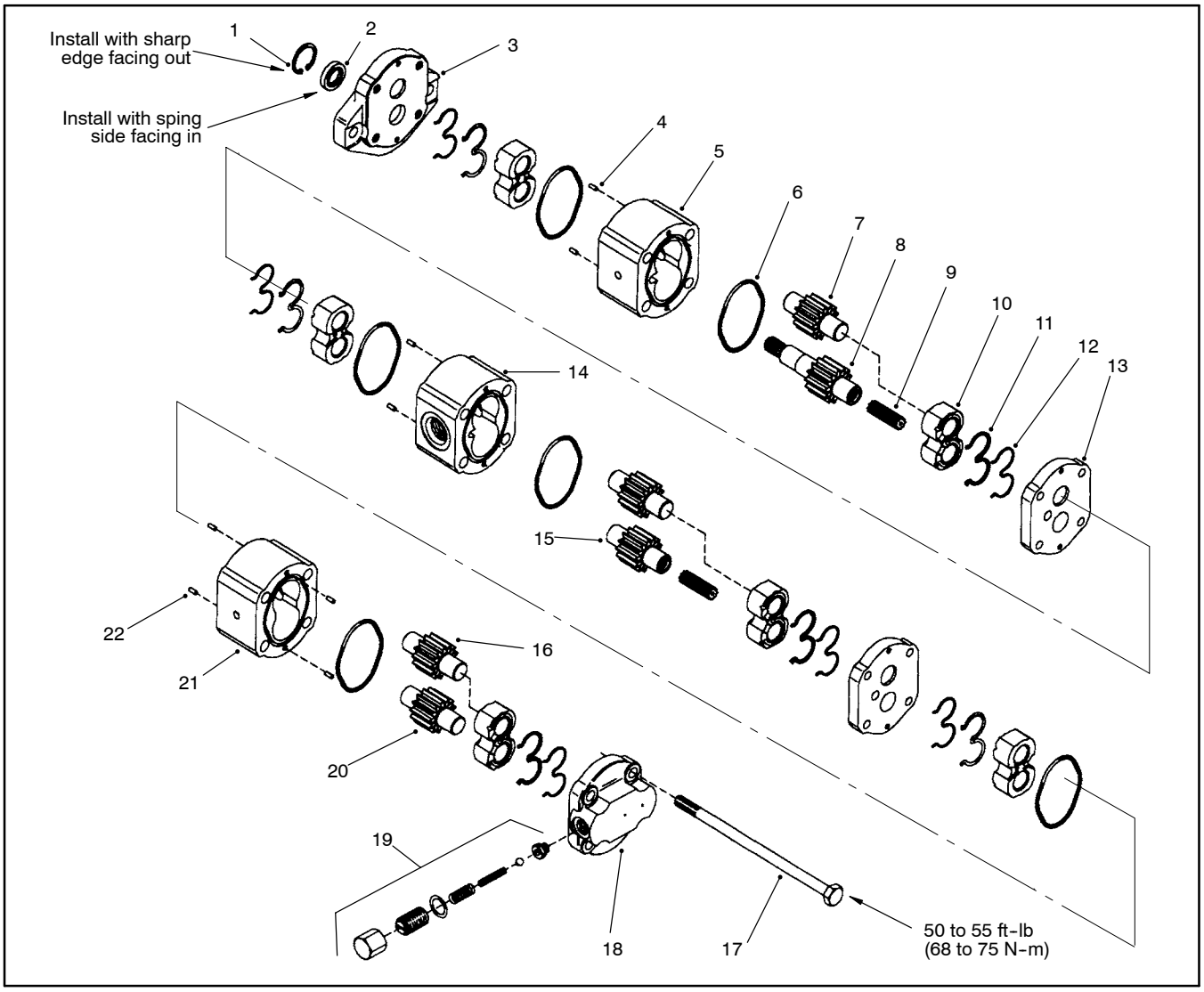


Figure 88

1. **Retaining ring**
2. **Shaft seal**
3. **Flange**
4. **Dowel pin**
5. **Housing**
6. **O-ring**
7. **Idler gear**
8. **Drive gear**
9. **Coupling**
10. **Bearing**
11. **E-seal**
12. **Backup ring**
13. **Distance plate**
14. **Housing**
15. **Idler gear**
16. **Idler gear**
17. **Bolt**
18. **Valve block**
19. **Valve kit**
20. **Idler gear**
21. **Housing**
22. **Dowel pin**

Relief Valve Service

Note: The relief valve (Item 19) must be replaced as a complete assembly. Disassemble parts for cleaning and inspection only.

1. Disassemble relief valve parts. **Do not** attempt to remove the valve seat. It is installed with thread locking compound at the factory. Count number of revolutions it takes to unscrew the relief valve adjusting screw so it can be installed at the same pressure setting.

2. Inspect ball for burrs or roughness. Inspect relief valve bore and seat in valve block.

3. Inspect spring for damage.

4. Clean and air dry all parts. Apply hydraulic oil to parts and install in the same order they were removed.

5. Before operating the machine, check steering relief pressure and adjust to 1250 PSI. To adjust, remove cap, turn adjuster clockwise to increase pressure and counterclockwise to decrease pressure. (See Test No. 7: Gear Pump Section (P3) Flow and Relief Valve Pressure).

Shaft Seal Replacement

1. Remove pump (see Pump Removal and Installation).

2. Plug ports and wash exterior of pump with cleaning solvent. Make sure parts and work area are clean.

3. Remove retaining ring (Fig. 93, Item 1).

4. Remove and dispose of the seal.

Note: Seal can be removed by punching two holes in face of seal 180° apart, installing metal screws and pulling seal out by grasping the screws.

IMPORTANT: Do not try to pry the seal out of the pump. This usually damages the shaft seal bore and mounting hub area so oil will leak past the seal.

5. Clean seal bore and shaft on pump so it is free of any foreign material.

6. Put a seal protector tool on pump shaft or apply thin plastic or tape on the shaft to protect the seal from damage.

7. Apply grease or petroleum jelly to inside diameter of new shaft seal.

8. Use a seal installation tool to install new shaft seal. Install seal with spring side facing in. Make sure seal is installed square with the seal bore.

9. Install retaining ring with sharp edge facing **out**.

Pump Service

Note: Parts within each pump section must be replaced as a kit. Gears, housings and bearings cannot be serviced separately.

IMPORTANT: Keep housings, gears and bearings for each pump section together; do not mix parts between sections.

IMPORTANT: The pump is ”run-in” at the factory to obtain precise parts tolerances. Keep housing, gears and bearings for each section together. DO NOT mix parts between different sections.

1. Plug ports and wash exterior of pump with cleaning solvent.

2. Draw a line across seam areas on pump case with a scribe or marker to ensure proper reassembly

IMPORTANT: Use caution when clamping in a vise to avoid distorting any parts.

3. Secure the flange end of the pump (Fig. 93, Item 3) in a vise with the drive shaft pointing down.

4. Remove the four (4) bolts.

5. Put your hand on the pump case and gently tap the pump case with a soft face hammer to loosen the pump sections. Be careful not to drop parts or disengage gear mesh.

6. Remove the bearings and seals from each pump section. Before removing each gear set, apply marking dye to mating teeth to retain ”timing”. Pump efficiency may be affected if the teeth are not installed in the same position during reassembly. Keep the parts for each pump section together; do not mix parts between sections.

7. Remove the retaining ring (Item 1) and shaft seal (Item 2).

8. Clean all parts. Check all parts for burrs, scoring, nicks and other damage.

9. Replace pump section if parts are excessively worn or scored.

10. Apply clean hydraulic oil to all parts before assembling.

11. Assemble pump sections starting at flange end. Apply grease or petroleum jelly to new O-rings (Item 6) to hold them in position during assembly of pump.

12. After pump has been assembled, tighten cap screws by hand. Rotate the drive shaft to check for binding. Protect the shaft if using a pliers.

13. Tighten the cap screws evenly in a crossing pattern to a torque of 50 to 55 ft-lb (68 to 75 N-m).

14. Install shaft seal (see Shaft Seal Replacement above).

Reel Motor (Serial Number Under 230000000)

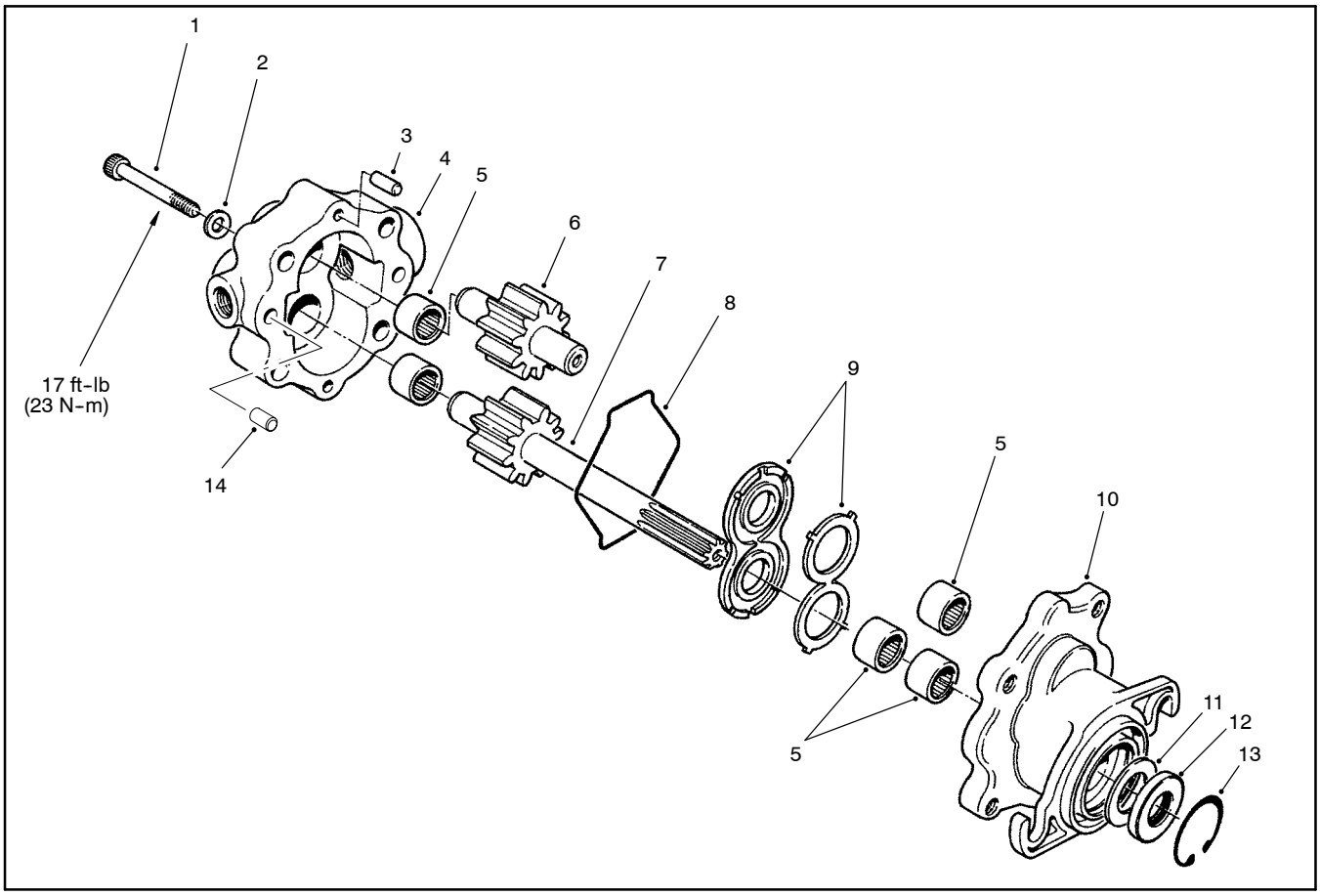


Figure 89

1. **Socket head screw**
2. **Washer**
3. **Dowel pin**
4. **Cover**
5. **Needle bearing**
6. **Idler gear**
7. **Drive shaft**
8. **Ring seal**
9. **Load plate**
10. **Body**
11. **Spacer**
12. **Shaft seal**
13. **Retaining ring**
14. **Dowel pin**

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Disconnect hydraulic lines. Put caps or plugs on fittings and hoses to prevent contamination. Tag hydraulic lines for proper reassembly.

3. Loosen motor mounting nuts (Fig. 90).

4. Rotate motor clockwise so motor flanges clear studs and pull motor out.

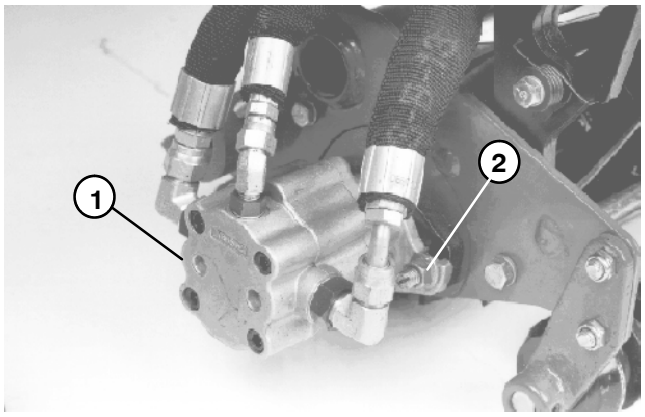


Figure 90

1. **Reel motor**
2. **Motor mounting nut**

Installation

1. Place motor into position on mounting studs. Rotate motor counterclockwise so motor flanges lock to studs.

2. Tighten motor mounting nuts.

3. Remove caps or plugs from fittings and hoses. Connect hydraulic lines lines to the motor.

Shaft Seal Removal

1. Remove reel motor (see Reel Motor Removal and Installation).

2. Plug ports and wash exterior of motor with cleaning solvent. Make sure parts and work area are clean.

3. Remove retaining ring from motor (Fig. 89).

IMPORTANT: Do not try to pry the seal out of the motor. This usually damages the shaft seal bore and mounting hub area so oil will leak past the seal.

Note: Seal may also be removed by punching two holes in face of seal 180° apart, installing metal screws and pulling seal out by grasping the screws.

4. Install threaded metal O-ring seal plugs in the two (2) pressure ports on the motor or put metal threaded caps on the fittings in these ports.

5. With motor shaft pointed away from you into a clean five (5) gallon container, attach a hydraulic load (hand pump) or compressed air to the case drain port.

6. With the motor shaft pointed away from you into a clean five (5) gallon container, gradually apply pressure to the case drain port. The seal should come out of the motor seal cavity.

7. Remove and discard shaft seal and spacer.

Shaft Seal Installation

1. Clean seal bore and shaft on motor so it is free of any foreign material.

2. Install a new spacer on motor shaft.

3. Put seal protector tool on motor shaft (Fig. 91) or apply thin plastic or tape on the shaft to protect the seal from damage.

4. Apply ”Permatex No. 2” or equivalent to outside diameter of new seal.

5. Apply grease or petroleum jelly to inside diameter of new shaft seal.

6. Use seal installation tool to install new shaft seal. Make sure seal is installed square with the seal bore (Fig. 91).

Disassembly

1. Plug ports and wash exterior of motor with cleaning solvent. Make sure parts and work area are clean.

IMPORTANT: Extreme caution must be used when using a vise to avoid distorting any parts.

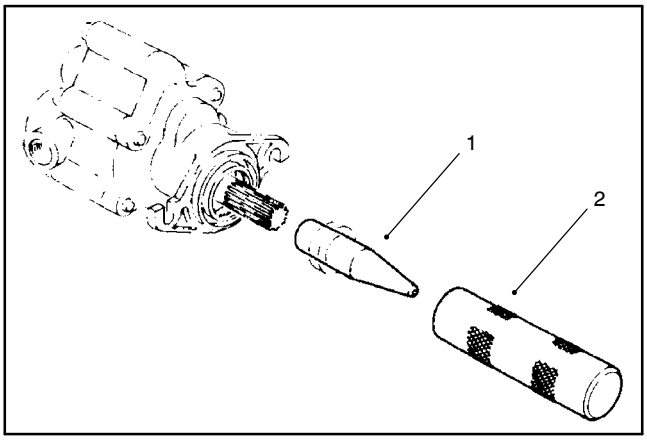


Figure 91

1. **Seal protector** 2. **Seal installation tool**

2. Remove shaft seal (see Shaft Seal Removal).

3. Draw a line across the seam areas on the motor case with a scribe or marker to ensure proper reassembly.

4. Remove four socket head cap screws (Fig. 96).

5. Put your hand on the cover assembly and gently tap the drive shaft with a soft face hammer to separate the body from the cover. Be careful not to drop parts or disengage gear mesh.

6. Before removing gear set, apply marking dye to mating teeth to retain ”timing”. Pump efficiency may be affected if the teeth are not installed in the same position during reassembly.

IMPORTANT: To prevent damage to load plates during motor operation, do not mark gears with a punch or scribe.

7. Be careful when disassembling. The needle bearings may be of the loose grease retained type. Pack these with general purpose grease to retain them for reassembly It is recommended NOT to remove the bearing races from the cover and body.

8. Remove and discard the seal ring, retaining ring, shaft seal, and spacer (Items 8, 13, 12 and 11). These items are available in a repair kit.

Inspection

1. Clean and air dry all parts. Check for burrs, scoring, nicks, etc.

2. Replace gears as a set if excessively scored or worn. Replace load plate if worn or scored.

Assembly

1. Apply grease or petroleum jelly to load plate assembly and install in body. Insert gear set into body, maintaining the original timing and locations.

2. Apply grease or petroleum jelly to ring seal and install on body.

3. Apply hydraulic oil to inside of cover and assemble the cover to the body, making sure none of the parts become displaced. Insert the cap screws and washers and hand tighten.

4. Before tightening the cap screws, rotate the drive shaft in the direction of normal rotation (counterclockwise) to check for binding. You may not be able to rotate the drive shaft by hand. Protect the shaft if using a pliers.

5. Tighten the cap screws evenly in a crossing pattern to a torque of 17 ft-lb (23 N-m).

6. Carefully install a new spacer, shaft seal and snap ring (see Shaft Seal Installation).

Reel Motor (Serial Number Above 230000000)

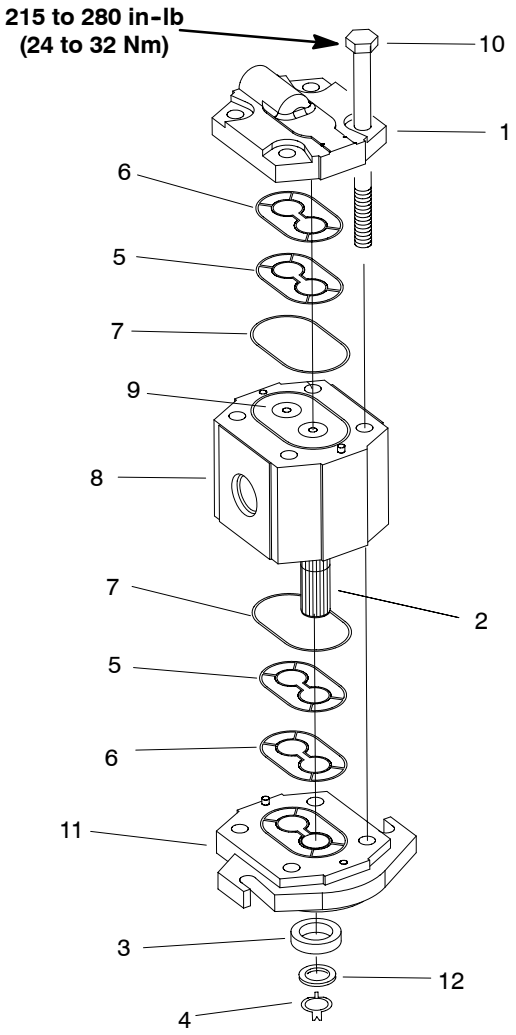


Figure 92

1. Rear cover
2. Drive gear
3. Seal
4. Tab washer
5. Pressure seal
6. Back-up ring
7. O-ring
8. Body
9. Idler gear
10. Cap screw
11. Front flange
12. Washer (if equipped)

Disassembly (Fig. 92)

1. Plug motor ports and clean the outside of the motor thoroughly. After cleaning, remove plugs and drain any oil out of the motor.

2. Use a marker or scribe to make a **diagonal** mark across the front flange, body, and rear cover for reassembly purposes (Fig. 93).

IMPORTANT: Avoid using excessive clamping pressure on the motor flange to prevent distorting the casting.

3. Clamp mounting flange of motor in a vise with the shaft end down.

4. Loosen cap screws on the rear cover.

5. Take motor from the vise and remove cap screws.

6. Remove front flange from the body, then remove rear cover. Locate and remove dowel pins from body.

IMPORTANT: Mark the relative positions of the gear teeth and the bearing blocks so they can be reassembled in the same position. Do not touch the gear surfaces as residue on hands may be corrosive to gear finish.

7. Place the motor on its side and push on the rear bearing block to remove the bearing block and gear set (Fig. 94).

8. Carefully remove and discard o−rings, pressure seals, and back−up rings (Fig. 95) from motor. Do not cause any damage to the machined grooves during the removal process.

IMPORTANT: Make sure not to damage the counter bore when removing the shaft seal from the front plate.

9. Position front flange with seal side up. Remove shaft seal.

Inspection

1. Remove any nicks and burrs from all motor components with emery cloth.

CAUTION

Use eye protection such as goggles when using compressed air.

2. Clean all motor components with solvent. Dry all parts with compressed air.

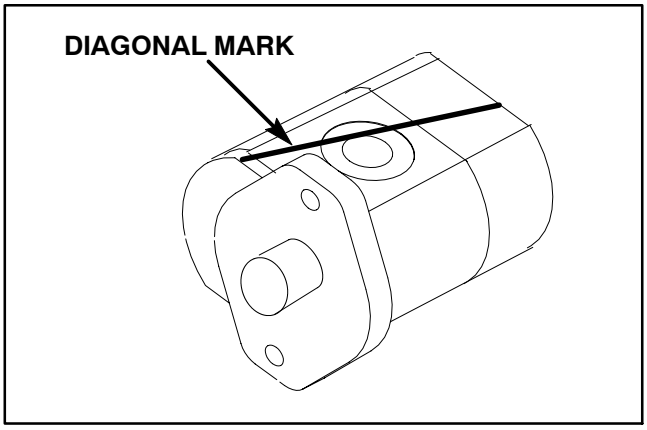


Figure 93

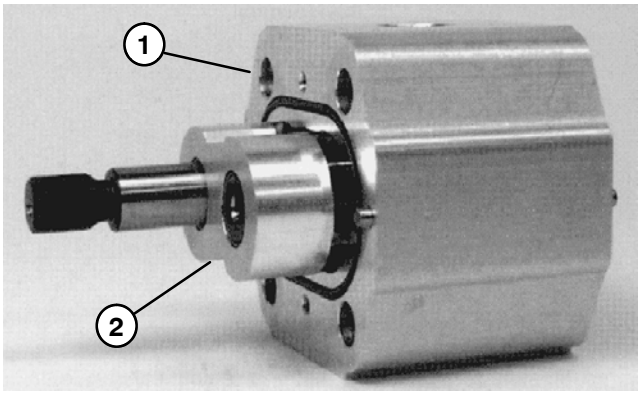


Figure 94

1. **Motor body**
2. **Bearing block & gear set**

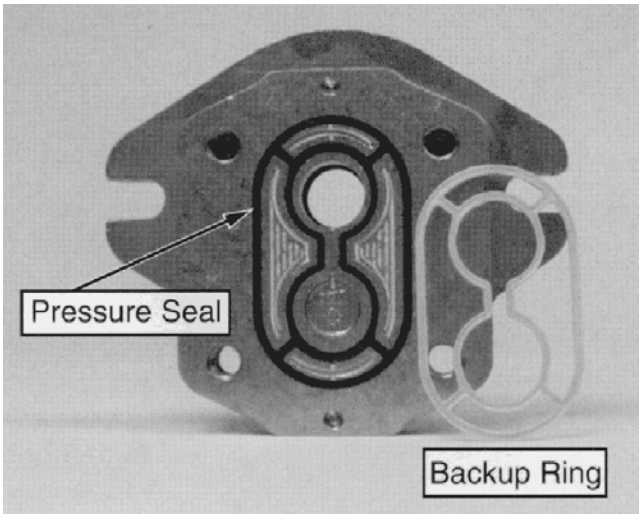


Figure 95

3. Inspect drive gear, idler gear and bearing blocks (Fig. 96) for the following:

A. Gear shafts should be free of rough surfaces and excessive wear at bushing points and sealing areas. Scoring, rough surfaces, or wear on gear shafts indicates need for replacement.

B. Gear teeth should be free of excessive scoring and wear. Any broken or nicked gear teeth must be replaced.

C. Inspect gear face edge for sharpness. Sharp edges of gears will mill into bearing blocks and, thus, must be replaced.

D. Bearing areas of bearing blocks should not have excessive wear or scoring.

E. Face of bearing blocks that are in contact with gears should be free of wear, roughness or scoring.

4. Inspect front flange and rear cover for damage or wear.

Reassembly (Fig. 92)

NOTE: When reassembling the motor, check the identification marks made during disassembly to make sure the parts are properly aligned during reassembly.

1. Lubricate o-rings, pressure seals, back-up gaskets, and seal grooves with a thin coat of petroleum jelly. Lubricate all other internal parts freely with clean hydraulic oil.

2. Install new shaft seal into front flange.

3. Install lubricated pressure seals into the grooves in the front flange and rear cover. Follow by carefully placing the back-up rings into the grooves.

4. Install new o-rings to the body.

5. Lubricate gear faces and bearing surfaces of drive gear, idler gear, and bearing blocks. Carefully assemble bearing blocks and gears noting identification marks made during disassembly.

6. Position the motor body on its side. Carefully slide bearing block and gear assembly into the body cavity using identification marks made during disassembly.

7. Remove any excess lubrication from mating surfaces of body, rear cover, and front flange. Make sure that these surfaces are clean and dry.

8. Install dowel pins in body.

IMPORTANT: Do not dislodge o-rings, pressure seals, or back-up rings during final assembly.

9. Gently slide the rear cover onto the assembly using marker or scribe mark for proper location. Firm hand pressure should be sufficient to engage the dowel pins.

10. Position the motor with rear cover downwards. Carefully slide the front flange onto the assembly using marker or scribe mark for proper location.

11. Install the four cap screws and hand tighten.

IMPORTANT: Avoid using excessive clamping pressure on the motor housing to prevent distorting the housing.

12. Place motor front flange in a vise and alternately torque the cap screws from **215 to 280 ft-lb (24 to 32 Nm)**.

13. Put a small amount of hydraulic oil in port on motor and rotate driveshaft one revolution. Protect the shaft if using a pliers. If drive shaft binds, disassemble motor and repeat assembly process.

14. Remove motor from vise.

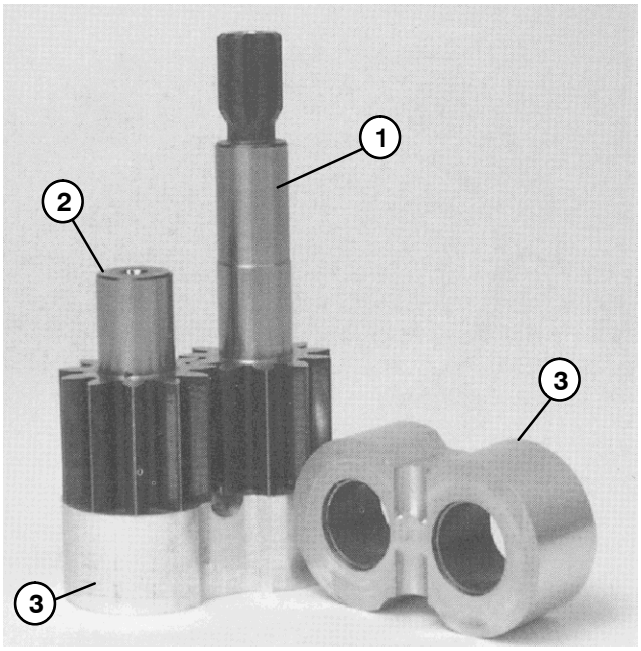


Figure 96

1. **Drive gear**
2. **Idler gear**
3. **Bearing block**

Hydraulic Control Manifold

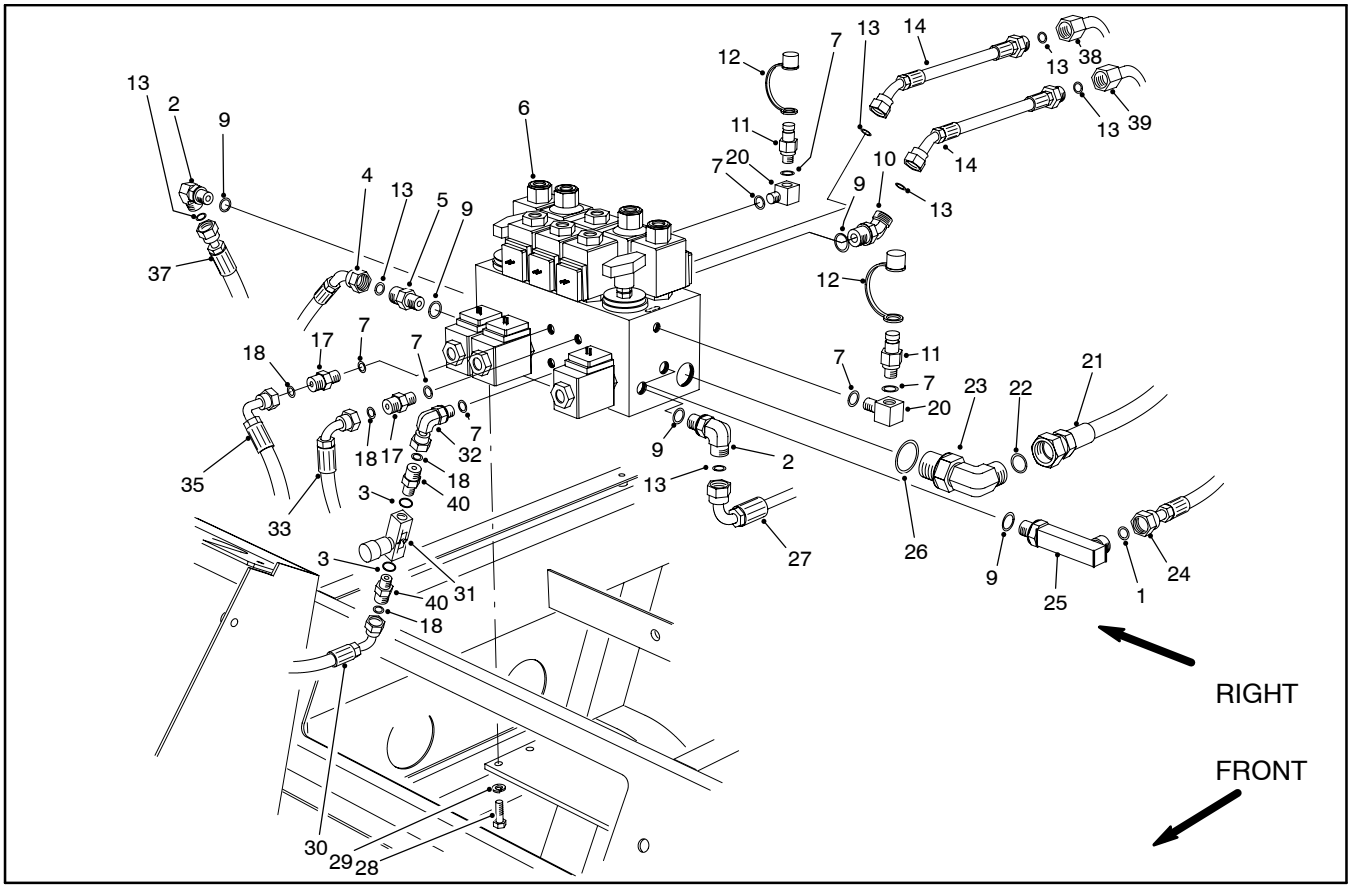


Figure 97

1. O-ring
2. 90° hydraulic fitting
3. O-ring
4. Hydraulic hose
5. Straight hydraulic fitting
6. Control manifold
7. O-ring
8. Not used
9. O-ring
10. 45° hydraulic fitting
11. Test port fitting
12. Test port cap
13. O-ring
14. Hydraulic hose
15. Not used
16. Not used
17. Straight hydraulic fitting
18. O-ring
19. Not used
20. 90° hydraulic fitting
21. Hydraulic fitting
22. O-ring
23. 90° hydraulic fitting
24. Hydraulic hose
25. 90° hydraulic fitting
26. O-ring
27. Hydraulic hose
28. Cap screw
29. Lock washer
30. Hydraulic hose
31. Flow control valve
32. 90° hydraulic fitting
33. Hydraulic hose
34. Not used
35. Hydraulic hose
36. Not used
37. Hydraulic hose
38. Hydraulic tube
39. Hydraulic tube
40. Straight hydraulic fitting

Removal

Note: The ports on the manifold are marked for easy identification of components. Example: R1 is the reel circuit relief valve and P1 is a gear pump connection port. (See Hydraulic Schematics to identify the function of the hydraulic lines and cartridge valves at each port).

1. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

2. Disconnect electrical connectors from the solenoid valves.

3. Remove hydraulic manifold from the frame (Fig. 97).

Installation (Fig. 97)

1. Install manifold to the frame (Fig. 97).

2. Connect electrical connectors to the solenoid valves (see Hydraulic Valve Solenoids in Chapter 5 - Electrical System).

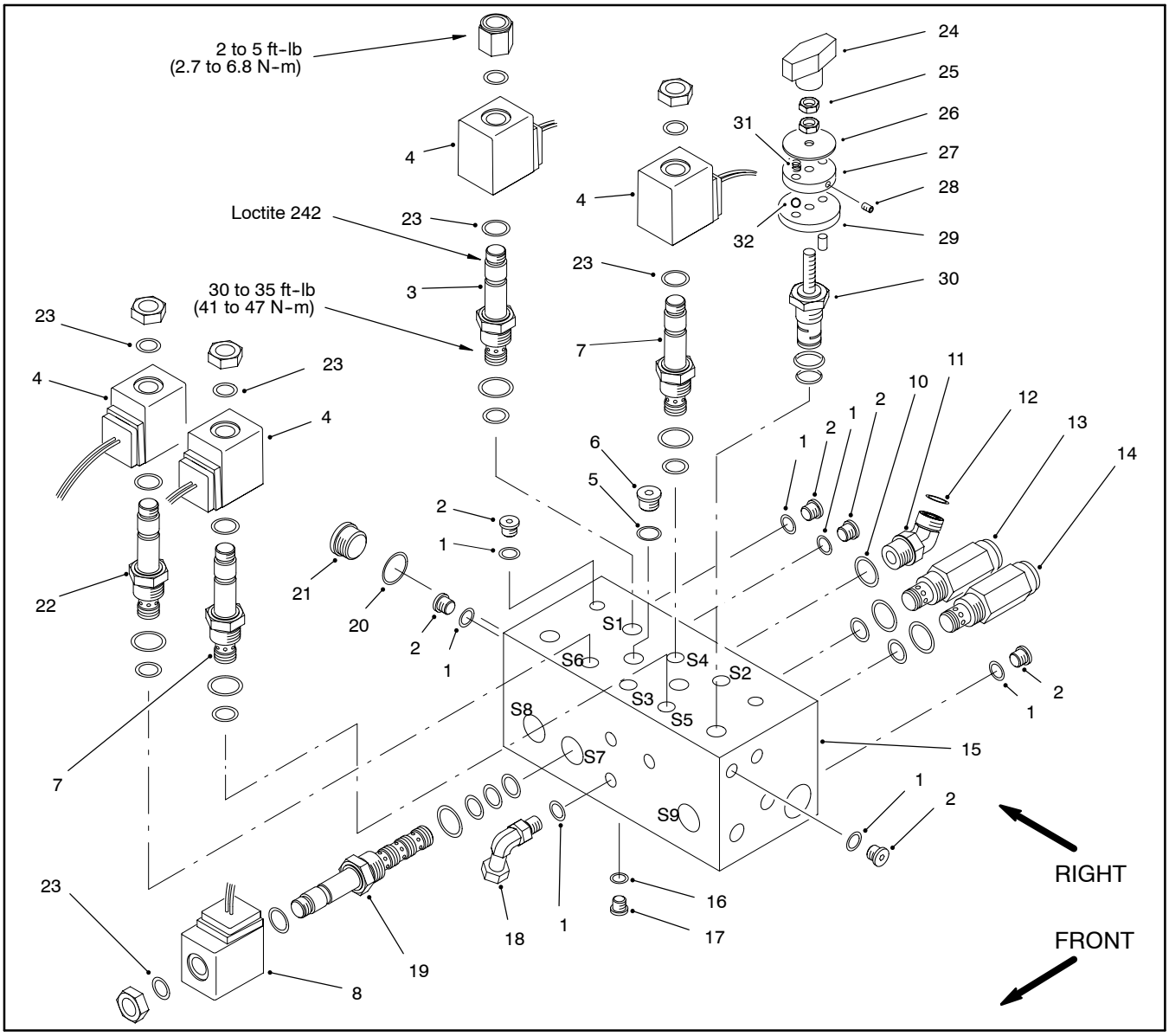


Figure 98

1. O-ring
2. Plug
3. Cartridge valve (N.O.)
4. Solenoid (20 watt)
5. O-ring
6. Plug
7. Cartridge valve (N.C.)
8. Solenoid (28 watt)
9. Not used
10. O-ring
11. 45° hydraulic fitting
12. O-ring
13. Relief valve cartridge (3000 psi)
14. Relief valve cartridge (2000 psi)
15. Manifold body
16. O-ring
17. Plug
18. 90° hydraulic fitting
19. Cartridge valve (4 way - 2 position)
20. O-ring
21. Plug
22. Cartridge valve (N.C.)
23. Solenoid seal
24. Knob
25. Jam nut
26. Indicator plate
27. Detent plate
28. Set screw
29. Locating plate
30. Rotary cartridge valve (flow control)
31. Detent spring
32. Detent ball

Note: The ports on the manifold are marked for easy identification of components (see Hydraulic Schematics to identify the function of the hydraulic lines and cartridge valves at each port location).

Solenoid Operated Valve Cartridge

1. Make sure the manifold is clean before removing the valve.

2. Remove nut securing solenoid to the cartridge valve. Slide solenoid and both O-rings off the valve.

Note: Use care when handling the cartridge valve. Slight bending or distortion of the stem tube can cause binding and malfunction.

3. Remove cartridge valve with a deep socket wrench. Remove seal kit.

4. Visually inspect the port in the manifold for damage to the sealing surfaces, damaged threads, and contamination.

5. Visually inspect cartridge valve for damaged sealing surfaces and contamination.

   A. Contamination may cause valves to stick or hang up. Contamination can become lodged in small valve orifices or seal areas causing malfunction.

   B. If valve sealing surfaces appear pitted or damaged, the hydraulic system may be overheating or there may be water in the system.

CAUTION

Use eye protection such as goggles when using compressed air.

6. Cleaning cartridge valves:

   A. Remove all o-rings from the cartridge valve.

   B. Submerge valve in clean mineral spirits to flush out contamination. Use a probe to push the internal spool in and out 20 to 30 times to flush out contamination. Particles as fine as talcum powder can affect the operation of high pressure hydraulic valves. Clean and dry with compressed air.

7. Reinstall the cartridge valve:

   A. Lubricate new O-rings and backup rings of seal kit with clean hydraulic oil and install. The O-ring and backup ring must be arranged properly on the cartridge valve for proper operation and sealing.

   B. Thread spool valve carefully into port. The valve should go in easily without binding.

IMPORTANT: Use care when handling the cartridge valve. slight bending or distortion of the stem tube can cause binding and malfunction.

   C. Torque cartridge valve using a deep socket to 30 to 35 ft-lb (41 to 47 N-m).

   D. Make sure a new O-ring is at each end of the solenoid coil. Install solenoid coil to the cartridge valve. Apply "Loctite 242" or equivalent to the threads of the valve. Torque nut from 2 to 5 ft-lb (2.7 to 6.8 N-m).

   E. If problems still exist, remove valve and clean again or replace valve.

Relief Cartridge Valves

1. Make sure manifold is clean before removing the cartridge valve and seal kit.

2. Remove relief valve cartridge.

3. Visually inspect port in the manifold for damage to the sealing surfaces, damaged threads, and contamination.

4. Visually inspect relief valve cartridge for damaged sealing surfaces and contamination.

   A. Contamination may cause valves to stick or hang up. Contamination can become lodged in small valve orifices or seal areas causing malfunction.

   B. If sealing surfaces appear pitted or damaged, the hydraulic system may be overheating or there may be water in the system.

CAUTION

Use eye protection such as goggles when using compressed air.

5. Clean relief valve cartridge using clean mineral spirits. Submerge valve in clean mineral spirits to flush out contamination. Particles as fine as talcum powder can affect the operation of high pressure hydraulic valves. Use compressed air for cleaning.

6. Reinstall relief valve cartridge:

   A. Lubricate new O-ring and backup ring of seal kit with clean hydraulic oil and install. The O-ring and backup ring must be arranged properly on the cartridge valve for proper operation and sealing.

   B. Thread relief valve cartridge carefully into the applicable port. The valve should go in easily without binding. Torque valve to 30 to 35 ft-lb (41 to 47 N-m).

Rotary Cartridge Valves

1. Remove knob assembly:

   A. Unscrew and remove knob. Remove both jam nuts.

   B. Slide off applicable indicator plate being careful not to lose springs. Remove spring.

   C. Loosen set screw and slide detent plate off the applicable cartridge valve stem.

   D. Remove applicable locating plate with pin from the cartridge valve stem and manifold.

2. Make sure manifold is clean before removing the cartridge valve. Remove the valve and seal kit.

3. Visually inspect port in the manifold for damage to the sealing surfaces, damaged threads, and contamination.

4. Visually inspect cartridge valve for damaged sealing surfaces and contamination.

   A. Contamination may cause valves to stick or hang up, it can become lodged in small valve orifices or seal areas causing malfunction.

   B. If sealing surfaces appear pitted or damaged, the hydraulic system may be overheating or there may be water in the system.

CAUTION

Use eye protection such as goggles when using compressed air.

5. If necessary, clean cartridge valve using clean mineral spirits. Submerge valve in clean mineral spirits to flush out contamination. Particles as fine as talcum powder can affect the operation of high pressure hydraulic valves. Use compressed air for cleaning.

6. Reinstall the cartridge valve:

   A. Lubricate new O-ring and backup ring of seal kit with clean hydraulic oil and install. The O-ring and backup ring of seal kit must be arranged properly on the cartridge valve for proper operation and sealing.

   B. Thread valve carefully into the applicable port (MD1 or FC1). The valve should go in easily without binding. Torque valve from 30 to 35 ft-lb (41 to 47 N-m).

7. Reinstall knob assembly:

   A. Install applicable locating plate so that the pin seats into the locating hole.

   B. Turn the threaded cartridge valve stem carefully clockwise until it stops.

   C. Face detent plate counterbore down. Thread detent plate down onto the valve stem until it is stopped by the locating plate. Turn detent plate back counterclockwise 1/4 turn.

   D. Center one detent plate hole over a locating plate indentation. Drop a ball into each hole, then drop a spring into each hole.

   E. On the 2-position directional valve cartridge, place indicator plate over the detent plate. Make sure the arrow points directly at the number 1 on the locating plate.

   F. On flow control cartridge valve cartridge, place indicator plate over the detent plate. Make sure the arrow points to the right at 45°.

   G. While pushing down on the indicator plate and compressing the springs, thread down a jam nut. While tightening the set screw, tighten jam nut at the same time using a 7/16 - inch wrench.

   H. Thread second jam nut all the way down the valve stem. Apply ”Loctite 242” or equivalent to the valve stem threads. Screw knob all the way down until it hits the upper jam nut.

   I. On 2-position directional cartridge valve cartridge, turn knob counterclockwise so the arrow is 90° with the back of the manifold. Simultaneously tighten upper jam nut and turn knob so it is tight and the arrow is pointing 45° to the right in line with the indicator plate.

   J. On flow control valve cartridge, turn knob counterclockwise until the arrow points at the number ”5”. Simultaneously tighten upper jam nut and turn knob so it is tight and the arrow is pointing at the number ”1” on the locating plate.

Logic Cartridge

1. Make sure the manifold is clean before removing logic cartridge valve and seal kit. Remove cartridge valve.

2. Visually inspect the port in the manifold for damage to the sealing surfaces, damaged threads, and contamination.

3. Visually inspect logic cartridge valve for damaged sealing surfaces and contamination.

   A. Contamination may cause valves to stick or hang up, it can become lodged in small valve orifices or seal areas causing malfunction.

   B. If sealing surfaces appear pitted or damaged, the hydraulic system may be overheating or there may be water in the system.

CAUTION

Use eye protection such as goggles when using compressed air.

4. Clean logic cartridge valve using clean mineral spirits. Submerge valve in clean mineral spirits to flush out contamination. Particles as fine as talcum powder can affect the operation of high pressure hydraulic valves. Use compressed air for cleaning.

5. Reinstall logic cartridge valve:

   A. Lubricate new O-ring and backup ring of seal kit with clean hydraulic oil and install. The O-ring and backup ring must be arranged properly on the cartridge valve for proper operation and sealing.

   B. Thread cartridge valve carefully into the port (LC1). The valve should go in easily without binding. Torque the valve 30 to 35 ft-lb (41 to 47 N-m).

Flow Divider

On machines with serial numbers above 200000001, the lift circuit for the front, outer lift cylinders includes a flow divider to provide for even lifting of those cutting units. Lift speed of the front, outer cutting units should be similar when the flow divider is functioning correctly. The flow divider assembly mounts to the front of the frame (Fig. 99).

The flow divider on machines with serial numbers from 200000001 to 210000400 consists of a three (3) port manifold and a flow divider cartridge. The flow divider on machines with serial numbers above 210000400 includes a solenoid cartridge valve and two (2) flow regulator cartridges (Fig. 100).

If necessary, the cartridges can be carefully removed from the manifold for cleaning.

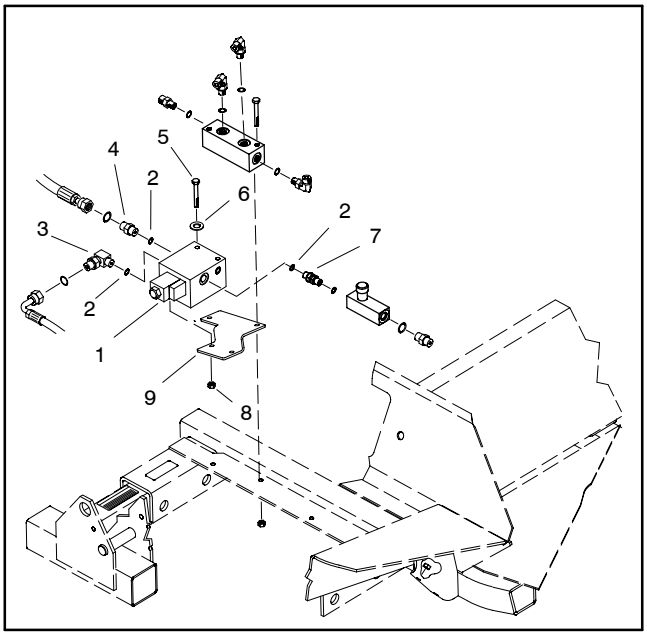


Figure 99

1. **Flow divider**
2. **O-ring**
3. **Hydraulic fitting**
4. **Hydraulic fitting**
5. **Cap screw (2 used)**
6. **Flat washer (2 used)**
7. **Hydraulic fitting**
8. **Lock nut (2 used)**
9. **Mounting bracket**

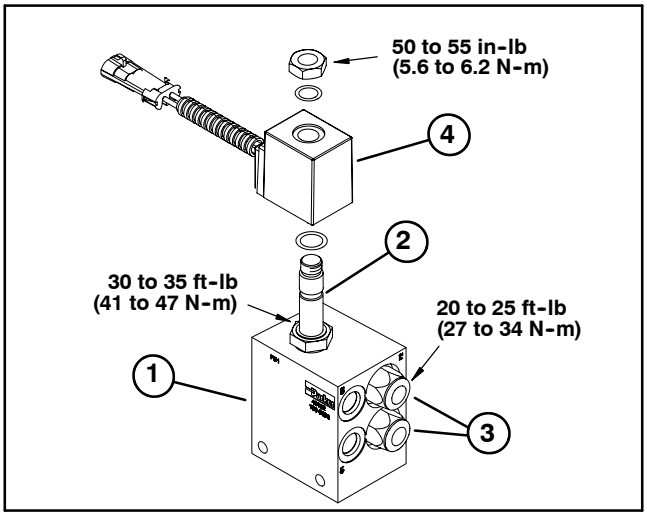


Figure 100

1. **Manifold**
2. **Solenoid cartridge valve**
3. **Flow regulator cartridge**

Lift Cylinders

Removal

1. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

2. Disconnect hydraulic hoses from lift cylinder.

3. Remove front right or left lift cylinder.

   A. Remove retaining ring from the cylinder rod end pin. Remove cylinder pin with remaining retaining ring and thrust washers from the lift arm and cylinder clevis (Fig. 102 and 101).

   B. Remove self tapping screw from cylinder pin and carrier frame. Pull cylinder pin from carrier frame and cylinder clevis (Fig. 102).

4. Remove front center lift cylinder (Fig. 103).

   A. Remove retaining ring from the cylinder rod end pin. Remove cylinder pin with remaining retaining ring and thrust washers from the lift arm and cylinder clevis.

   B. Remove self tapping screw from cylinder pin and carrier frame. Pull cylinder pin from carrier frame and cylinder clevis.

5. Remove rear lift cylinder (Fig. 104).

   A. Remove retaining ring from the cylinder rod end pin. Remove cylinder pin with remaining retaining ring and thrust washers from the lift arm and cylinder clevis.

   B. Remove retaining ring from the cylinder cap end pin. Remove cylinder pin with remaining retaining ring from the frame and cylinder clevis.

Installation

1. Install rear lift cylinder (Fig. 104).

   A. Insert cylinder pin with ratcheted retaining ring through the frame and cylinder clevis. Secure retaining ring to the cylinder cap end pin.

   B. Insert cylinder pin with attached retaining ring and thrust washer through the lift arm and cylinder clevis. Secure thrust washer and retaining ring to the cylinder rod end pin.

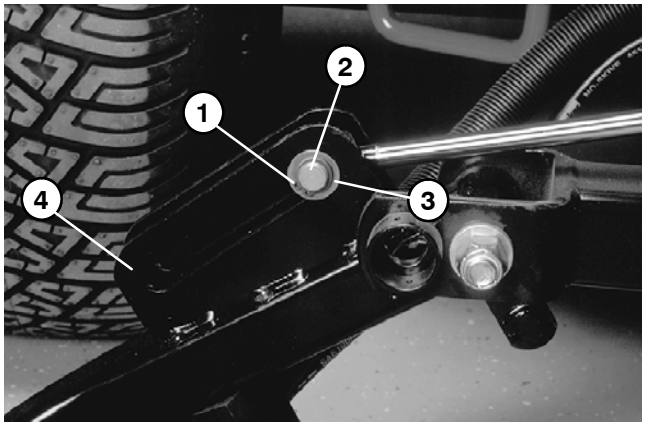


Figure 101

1. **Retaining ring**
2. **Cylinder rod end pin**
3. **Thrust washer**
4. **Lift arm**

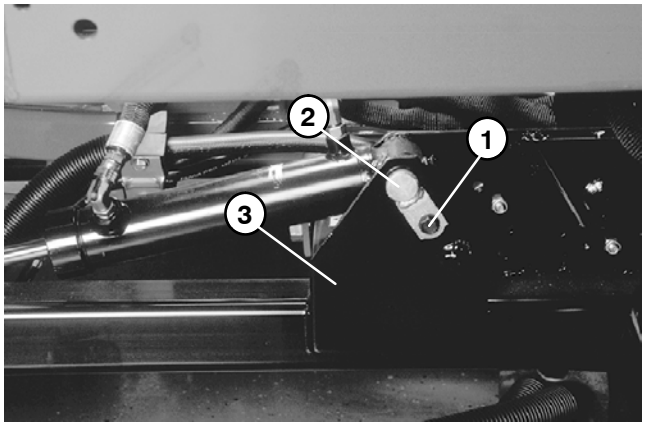


Figure 102

1. **Self tapping screw**
2. **Cylinder pin (long)**
3. **Carrier frame**

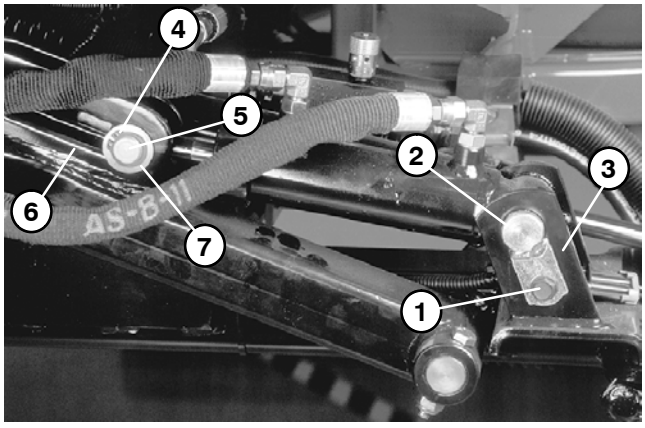


Figure 103

1. **Self tapping screw**
2. **Cylinder pin (short)**
3. **Carrier frame**
4. **Retaining ring**
5. **Cylinder rod end pin**
6. **Thrust washer**
7. **Lift arm**

2. Install front center lift cylinder (Fig. 103).

   A. Insert cylinder pin through the carrier frame and cylinder clevis. Secure self tapping screw to the cylinder pin and carrier frame.

   B. Insert cylinder pin with attached retaining ring and thrust washer through the lift arm and cylinder clevis. Secure thrust washer and retaining ring to the cylinder rod end pin.

3. Install front right or left lift cylinder.

   A. Insert cylinder pin through carrier frame and cylinder clevis. Secure self tapping screw to cylinder pin and carrier frame (Fig. 102).

   B. Insert cylinder pin with attached retaining ring and thrust washer through the lift arm and cylinder clevis. Secure thrust washer and retaining ring to the cylinder rod end pin (Fig. 102 and 101).

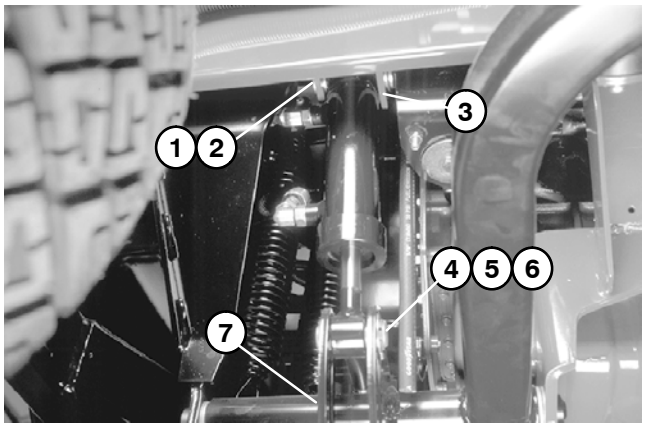


Figure 104

1. **Retaining ring**
2. **Cylinder cap end pin**
3. **Frame**
4. **Retaining ring**
5. **Cylinder rod end pin**
6. **thrust washer**
7. **Lift arm**

Lift Cylinder Service

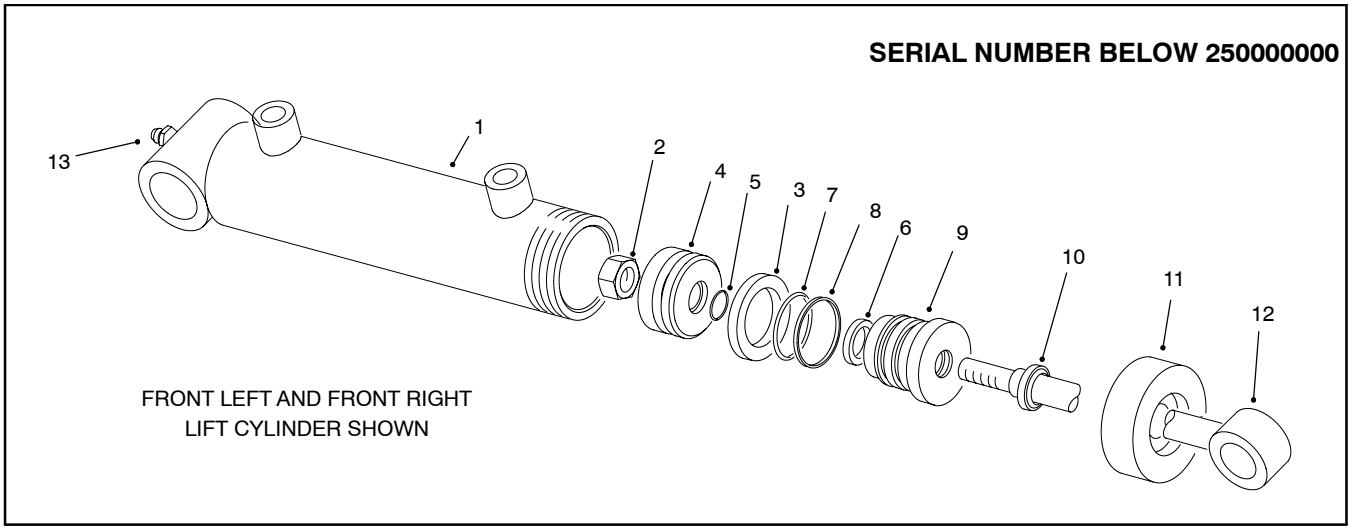


Figure 105

1. **Barrel with clevis**
2. **Nut**
3. **Uni-ring**
4. **Piston**
5. **O-ring**
6. **Rod seal**
7. **O-ring**
8. **Back-up ring**
9. **Head**
10. **Dust seal**
11. **Collar**
12. **Shaft with clevis**
13. **Grease fitting**

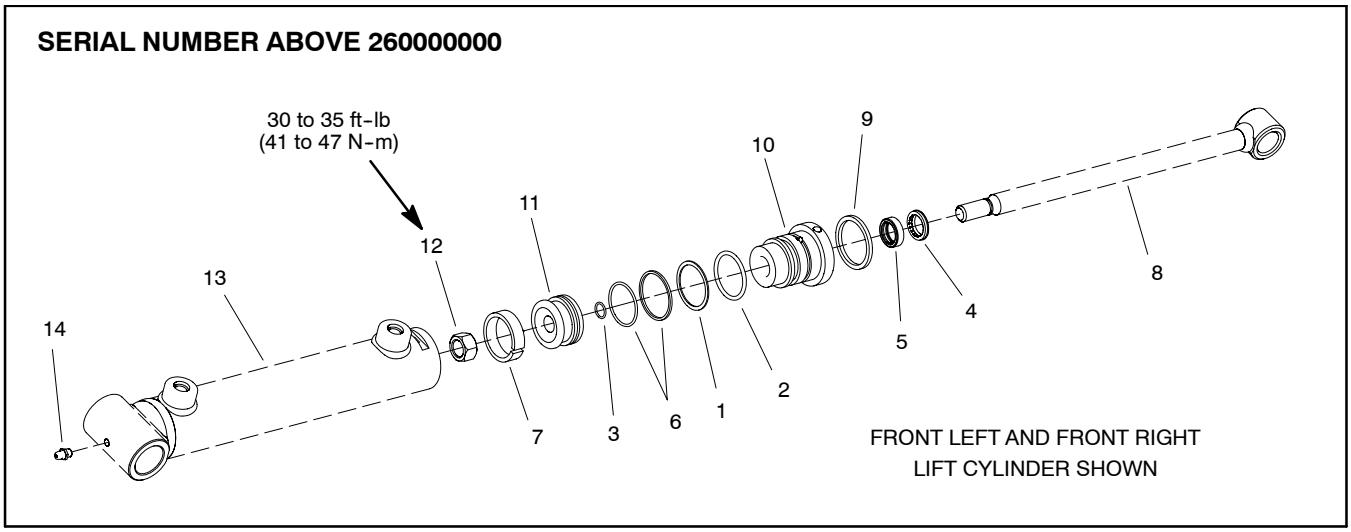


Figure 106

1. **O-ring**
2. **Back-up ring**
3. **O-ring**
4. **Wiper**
5. **Rod seal**
6. **Loaded cap seal**
7. **Wear ring**
8. **Shaft with clevis**
9. **Retaining ring**
10. **Head**
11. **Piston**
12. **Lock nut**
13. **Barrel with clevis**
14. **Grease fitting**

Disassembly

1. Remove oil from lift cylinder into a drain pan by slowly pumping the cylinder shaft. Plug both ports and clean the outside of the cylinder.

IMPORTANT: Prevent damage when clamping the cylinder's barrel into a vise; clamp on the clevis only. Do not close vise enough to distort the barrel.

2. Mount lift cylinder into a vise.

3. Remove shaft assembly from barrel:

   A. For serial numbers below 250999999, remove collar with a spanner wrench.

   B. For serial numbers above 260000000, use a spanner wrench to rotate head clockwise until the edge of the retaining ring appears in the barrel opening. Insert a screwdriver under the beveled edge of the retaining ring to start the retaining ring through the opening. Rotate the head counter−clockwise to remove retaining ring from barrel and head.

   C. Extract shaft, head, and piston by carefully twisting and pulling on the shaft.

IMPORTANT: Do not clamp vise jaws against the shaft surface. Protect shaft surface before mounting in a vise.

4. Mount shaft securely in a vise by clamping on the clevis of the shaft. Remove lock nut and piston from the shaft. Slide head off the shaft.

5. Remove seal kit components from the piston and head.

6. Carefully inspect internal surface of barrel for damage (deep scratches, out−of−round, etc.). Replace entire cylinder if barrel is damaged. Inspect shaft, head, and piston for evidence of excessive scoring, pitting, or wear. Replace any damaged parts.

Reassembly

1. Make sure all cylinder parts are clean before reassembly.

2. Coat new O-rings, Uni-rings, rod seal, back-up ring, and dust seal with clean hydraulic oil. Install new seal kit components to piston and head.

IMPORTANT: Do not clamp vise jaws against the shaft surface. Protect shaft surface before mounting in a vise.

3. Mount shaft securely in a vise by clamping on the clevis of the shaft.

   A. Coat shaft with with clean hydraulic oil.

   B. For serial numbers below 250999999, install collar onto shaft if it was removed.

   C. Slide head and piston onto the shaft. Secure piston to shaft with lock nut.

4. Lubricate head and piston with clean hydraulic oil. Carefully slide shaft assembly into cylinder barrel.

IMPORTANT: Prevent damage when clamping the cylinder's barrel into a vise; clamp on the clevis only. Do not close vise enough to distort the barrel.

5. Mount lift cylinder into a vise. Secure shaft assembly in barrel:

   A. For serial numbers below 250999999, install collar with a spanner wrench.

   B. For serial numbers above 260000000, align retaining ring hole in the head with the access slot in the barrel. Insert the retaining ring hook into the hole and rotate head clockwise until the retaining ring is completely pulled into the barrel and the ring ends are covered.

Hydraulic Reservoir

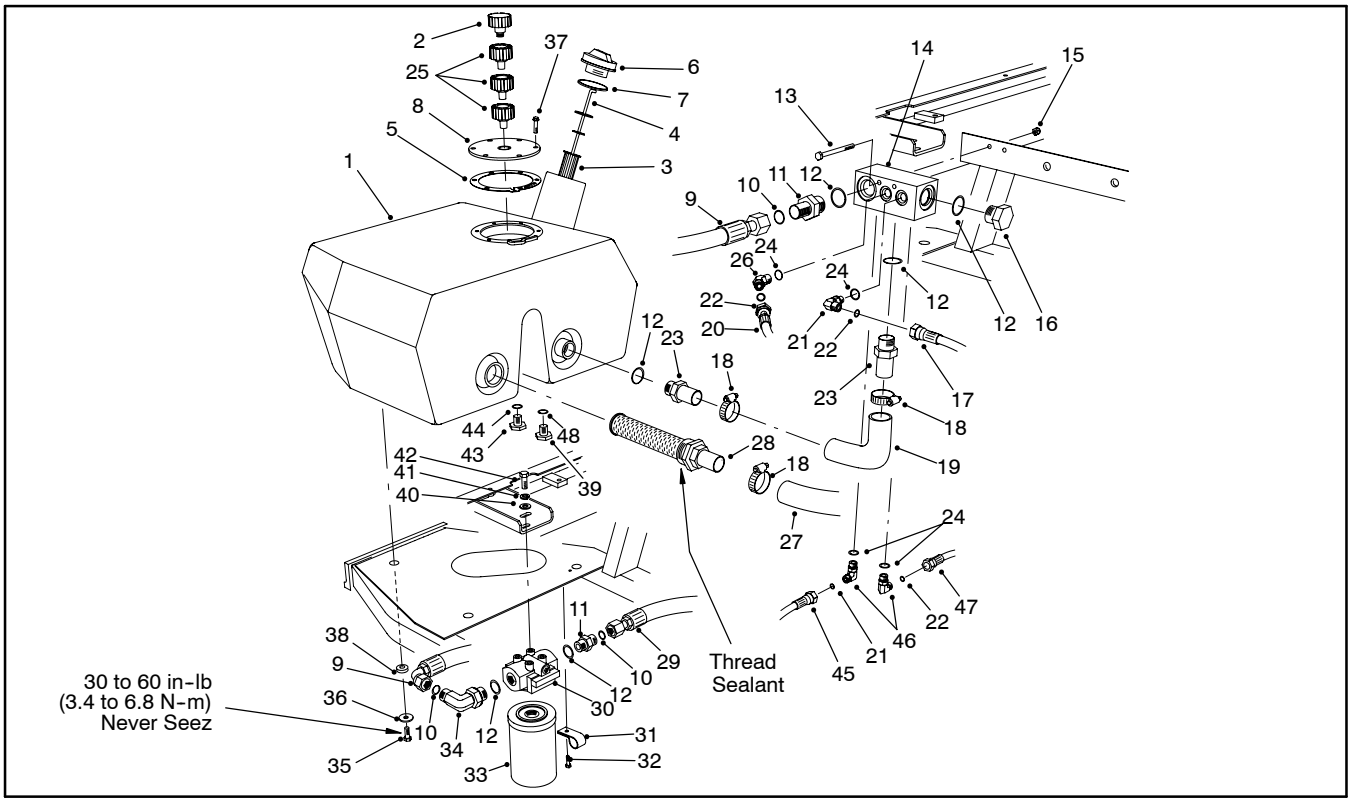


Figure 107

1. **Hydraulic reservoir**
2. **Tank breather**
3. **Filler screen**
4. **Dipstick**
5. **Flange gasket**
6. **Plastic plug**
7. **O-ring**
8. **Tank cover**
9. **Hydraulic hose**
10. **O-ring**
11. **Hydraulic straight fitting**
12. **O-ring**
13. **Cap screw**
14. **Tank manifold**
15. **Lock nut**
16. **Hydraulic plug fitting**
17. **Hydraulic hose**
18. **Hose clamp**
19. **Hydraulic hose**
20. **Hydraulic hose**
21. **90° hydraulic fitting**
22. **O-ring**
23. **Hydraulic straight fitting**
24. **O-ring**
25. **Breather adapter**
26. **45° hydraulic fitting**
27. **Hydraulic suction hose**
28. **Suction strainer**
29. **Hydraulic hose**
30. **Hydraulic filter head assembly**
31. **R-clamp**
32. **Washer head screw**
33. **Hydraulic filter element**
34. **90° hydraulic filter**
35. **Cap screw**
36. **Flat washer**
37. **Flange head screw**
38. **Grommet**
39. **Hydraulic plug**
40. **Flat washer**
41. **Lock washer**
42. **Cap screw**
43. **Drain plug**
44. **O-ring**
45. **Hydraulic hose**
46. **90° hydraulic fitting**
47. **Drain hose**
48. **O-ring**

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

Note: The electrical harness does not have to be disconnected to remove the right fender and control console from the frame.

2. Remove right fender with control console attached enough to allow removal of the hydraulic reservoir.

3. Drain reservoir into a suitable container (see Change Hydraulic Fluid).

4. Remove oil tank using Figure 107 as a guide.

Hydraulic Reservoir Inspection

1. Clean hydraulic reservoir and suction strainer with solvent.

2. Inspect hydraulic reservoir for leaks, cracks, or other damage.

Hydraulic Reservoir Installation

1. Install reservoir using Figure 107 as a guide.

Note: When applying Permabond LH150 or equivalent to the threads of the suction strainer, do not apply sealant to the first thread.

2. Apply Permabond LH150 or equivalent to the threads of the hydraulic straight fitting (suction). Secure fitting to the suction strainer.

3. Apply Permabond LH150 or equivalent to the threads of the suction strainer.

4. Using a wrench, turn strainer into port at least 1-1/2 to 2 full turns beyond finger tight.

5. Apply an anti-seize compound to three cap screws that secure the reservoir to the frame. Install and torque screws 30 to 60 in−lb (3.4 to 6.8 N−m).

6. Fill reservoir with hydraulic fluid (see Change Hydraulic Fluid).

Hydraulic Oil Cooler and Transmission Heat Exchanger

Removal

CAUTION

The radiator and oil cooler may be hot. To avoid possible burns, allow the engine and cooling systems to cool before working on the oil cooler.

1. Remove oil cooler using Figures 108 and 109 as guides.

Inspection

CAUTION

Use eye protection such as goggles when using compressed air.

1. Back flush oil cooler with cleaning solvent. After cooler is clean, make sure all solvent is drained from the cooler.

2. Dry inside of oil cooler using compressed air in the opposite direction of the oil flow.

3. Plug both ends of oil cooler. Clean exterior of cooler. Make sure fins are clear of dirt and debris.

4. The oil cooler should be free of corrosion, cracked tubes, and excessive pitting of tubes.

Installation

1. Install oil cooler using Figures 108 and 109 as guides.

2. If removed, apply Permabond LH150 or equivalent to the hydraulic straight fitting threads before installing into cooler.

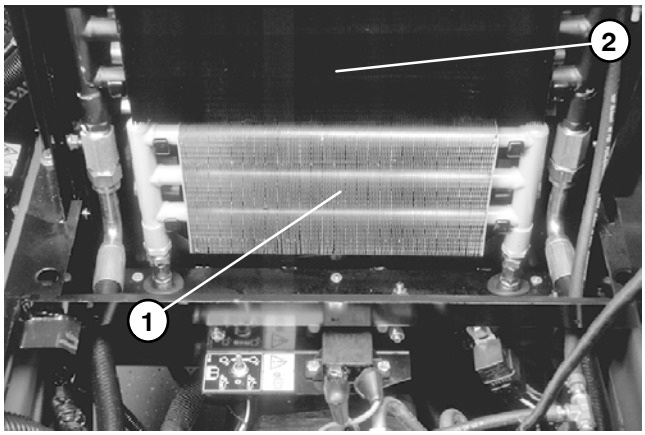


Figure 108

1. **Oil cooler**
2. **Heat exchanger**

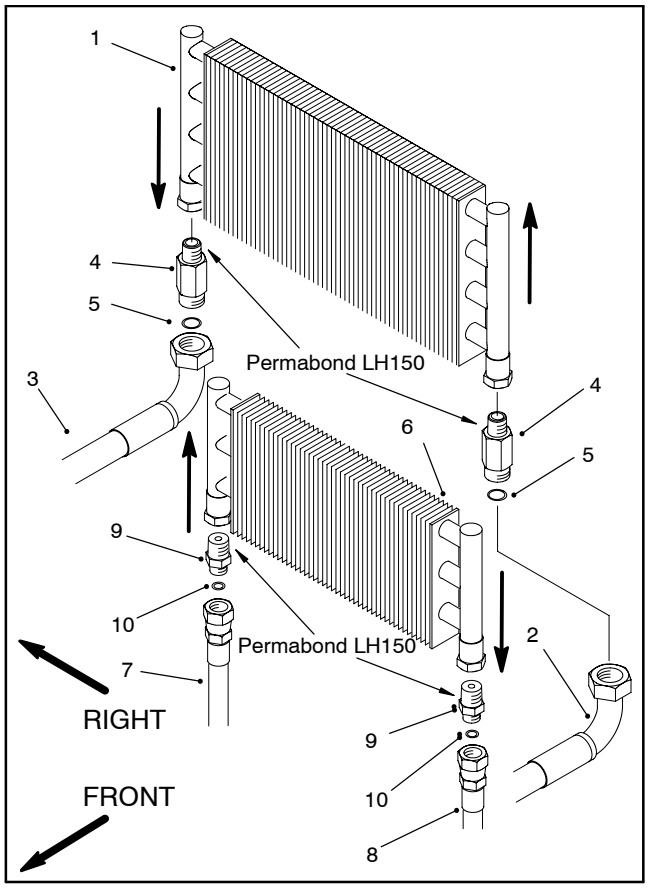


Figure 109

1. **Oil cooler**
2. **Hydraulic hose (IN)**
3. **Hydraulic hose (OUT)**
4. **Hydraulic straight fitting**
5. **O-ring**
6. **Heat exchanger**
7. **Hydraulic hose (IN)**
8. **Hydraulic hose (OUT)**
9. **Hydraulic straight fitting**
10. **O-ring**

Chapter 5

Electrical System

Table of Contents

Note: For Electrical Schematics, and Electrical Harness and Connectors Drawings, see Chapter 10 “Electrical Diagrams” in this manual.

Special Tools

Order special tools from your Toro Distributor. Some tools may also be available from a local supplier.

Multimeter

The meter can test electrical components and circuits for current, resistance, or voltage.

NOTE: Toro recommends the use of a DIGITAL Volt-Ohm-Amp multimeter when testing electrical circuits. The high impedance (internal resistance) of a digital meter in the voltage mode will make sure that excess current is not allowed through the meter. This excess current can cause damage to circuits not designed to carry it.

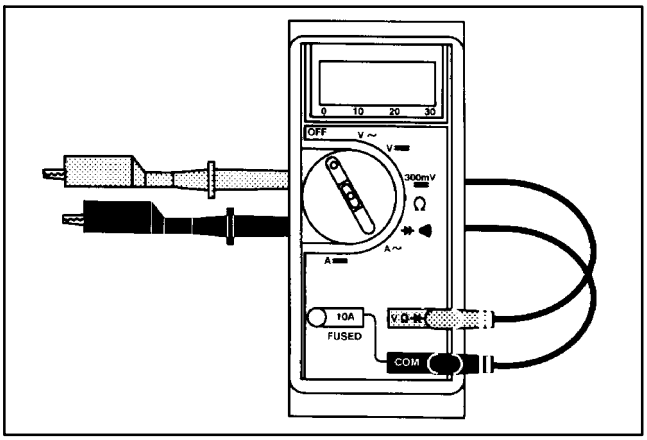


Figure 1

Skin-Over Grease

Special non-conductive grease (Toro Part No. 505-165) which forms a light protective skin which helps waterproof electrical switches and contacts.

Figure 2

Toro Automated Control Electronics™ Diagnostic Tool

Diagnostic ACE™ Display

The diagnostic display is connected to the wiring harness connector located inside the control console to help the user verfiy correct electrical functions of the machine (Fig. 3 and 4).

ACE Display (Toro Part No. 85-4750)
Overlays for RM 5200/5400:
Unit Serial No. 80001 -209999999
(Toro Part No. 100-3700)
Unit Serial No. 210000001 & Up
(Toro Part No. 104-9270)

Note: Overlays in Dutch, Finish, Italian, German, French, Danish, Japanese, Norwegian, Polish, Spanish, and Swedish are available. Refer to Reelmaster 5200-D/5400-D Parts Catalog.

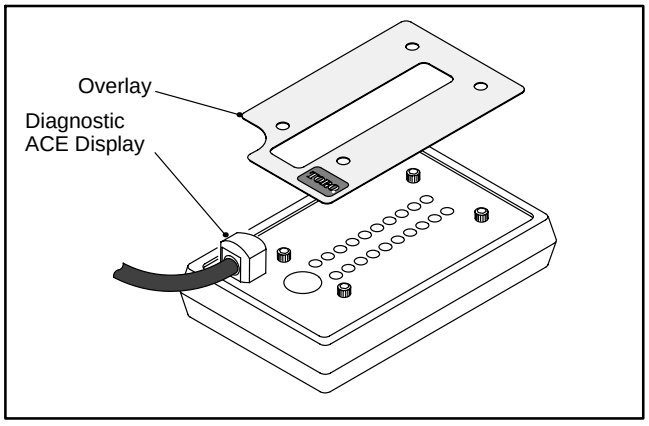


Figure 3

Figure 4

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 Electrical Harness and Connectors Drawing section of this manual).

If the machine has any interlock switches by-passed, they must be reconnected for proper troubleshooting and safety.

Quick Reference Troubleshooting Guide

Diagnostic Light

The RM 5200-D/5400-D is equipped with a diagnostic light and red fault lamp located on the steering tower that indicate if the electronic controller is functioning correctly. The green diagnostic light is located under the control panel, next to the fuse block. When the electronic controller is functioning correctly and the key switch is moved to the ON position, the controller diagnostic light will be illuminated and the fault lamp will be off. The lights will blink if the controller detects a malfunction in the electrical system. The lights will stop blinking and automatically reset when the key switch is turned to the OFF position. The fault will be retained in memory.

When the controller diagnostic light blinks, one of the following problems has been detected by the controller:

1. One of the **outputs** has been shorted.
2. One of the **outputs** is open circuited.

Using the diagnostic display, determine which output is malfunctioning (see Verify Output Functions and Retrieving Stored Faults).

If the diagnostic light is not illuminated when the key switch is in the ON position, this indicates that the electronic controller is not operating. Possible causes are:

1. Loopback is not connected.
2. The light is burned out.
3. Fuses are blown.
4. Not functioning correctly.

Check electrical connections, input fuses, and diagnostic light bulb to determine malfunction. Make sure loopback connector is secured to wire harness connector.

Diagnostic Ace Display

The RM 5200-D/5400-D is equipped with an electronic controller which controls most machine functions. The controller determines what function is required for various input switches (i.e. seat sensor, key switch, etc.) and turns on the outputs to actuate solenoids or relays for the requested machine function.

For the electronic controller to control the machine as desired, each of the input switches, output solenoids and relays must be connected and functioning properly.

The Diagnostic ACE display is a tool to help the user verify correct electrical functions of the machine.

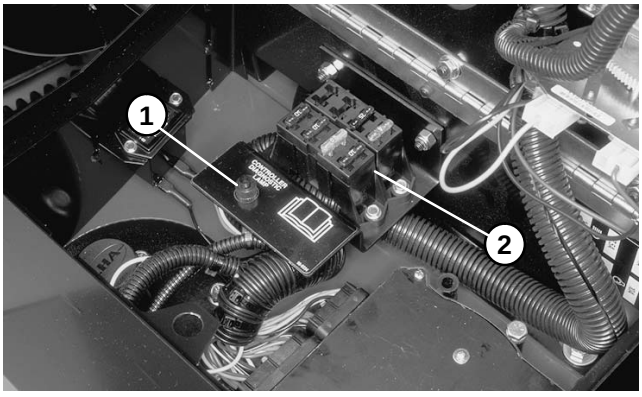


Figure 5

1. Diagnostic light **2. Fuse block**

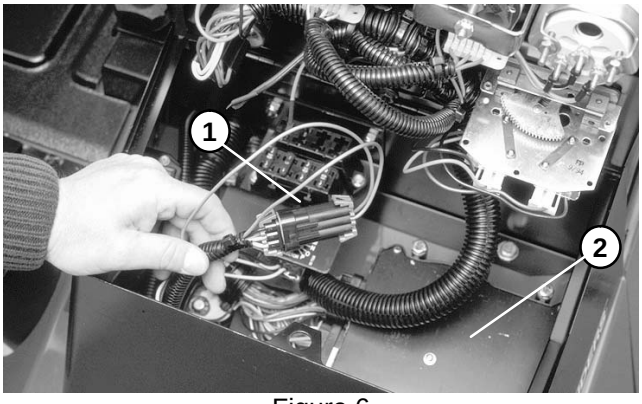


Figure 6

1. Loopback connector **2. ECU**

Check Interlock Switches

The purpose of the interlock switches is to prevent the engine from cranking or starting unless the traction pedal is in NEUTRAL, the Enable / Disable switch is in DISABLE and the Lower Mow / Raise control is in the neutral position. The engine will stop when the traction pedal is depressed with operator off the seat. In addition, the engine will stop if the traction pedal is depressed and the parking brake is engaged.

CAUTION

The interlock switches are for the protection of the operator and bystanders and to ensure correct operation of the machine. Do not bypass or disconnect switches. Check operation of the switches daily to make sure the interlock system is operating properly. If a switch is defective, replace it before operating. Do not rely on safety switches entirely - use common sense!

Verify Interlock Switch Function

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

2. Open control panel cover. Locate wire harness and connectors near controller. Carefully unplug loop back connector from harness connector.

3. Connect the Diagnostic ACE display connector to the harness connector. Make sure correct overlay decal is positioned on Diagnostic ACE display.

4. Turn the key switch to the ON position, but do not start machine.

Note: The **red** text on the overlay decal refers to input switches and the **green** text refers to outputs.

5. The "inputs displayed" LED, on lower right column of the Diagnostic ACE, should be illuminated. If "outputs displayed" LED is illuminated, press the toggle button on Diagnostic ACE to change to "inputs displayed" LED.

6. The Diagnostic ACE will illuminate the LED associated with each of the inputs when that input switch is closed. Individually, change each of the switches from open to closed (i.e., sit on seat, engage traction pedal, etc.), and note that the appropriate LED on Diagnostic ACE will blink on and off when corresponding switch is closed. Repeat on each switch that is possible to be changed by hand.

7. If switch is closed and appropriate LED does not turn on, check all wiring and connections to switch and/or check switches with an ohm meter. Replace any defective switches and repair any defective wiring.

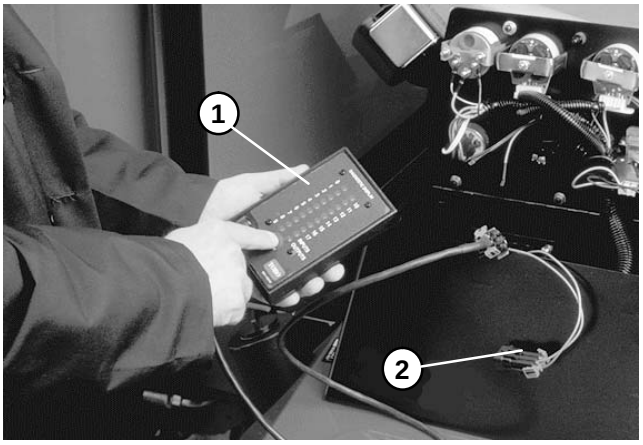


Figure 7

1. **Diagnostic ACE**
2. **Loopback connector**

The Diagnostic ACE also has the ability to detect which output solenoids or relays are turned on. This is a quick way to determine if a machine malfunction is electrical or hydraulic.

Verify Output Functions

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

2. Open control panel cover. Locate wire harness and connectors near controller. Carefully unplug loopback connector from harness connector.

3. Connect the Diagnostic ACE connector to the harness connector. Make sure correct overlay decal is positioned on Diagnostic ACE.

4. Turn the key switch to the ON position, but do not start machine.

5. The "outputs displayed" LED, on lower right column of Diagnostic ACE, should be illuminated. If "inputs displayed" LED is illuminated, press the toggle button on the Diagnostic ACE to change to "outputs displayed" LED.

Note: It may be necessary to toggle between "inputs displayed" and "outputs displayed" several times to do the following step. To toggle back and forth, press toggle button once. This may be done as often as required. **Do not hold button**.

6. Sit on seat and attempt to operate the desired function of the machine. If you need help verifying the correct input settings for each function. The appropriate output LED's should illuminate to indicate that the ECU is turning on that function.

Note: If any output LED is blinking, this indicates an electrical problem with that OUTPUT. Repair and/or replace defective electrical parts immediately. To reset a blinking LED, turn the key switch "OFF", then back "ON" and retest. Memory must be cleared.

If no output LED's are blinking, but the correct output LED's do not illuminate, verify that the required input switches are in the necessary positions to allow that function to occur. Verify correct switch function.

If the output LED's are on as specified, but the machine does not function properly, this indicates a non-electrical problem. Repair as necessary.

Note: Due to electrical system constraints, the output LED's for "START", "PREHEAT" and "ETR/ALT" may not blink even though an electrical problem may exist for those functions. If the machine problem appears to be with one of these functions, be certain to check the electrical circuit with a volt/ohm meter to verify that no electrical problem exists to these functions.

If each output switch is in the correct position and functioning correctly, but the output LED's are not correctly illuminated, this indicates an ECU problem. If this occurs, contact your Toro Distributor for assistance.

Retrieving Stored Faults

1. Turn ignition key switch to OFF. Unplug loopback connector and connect Diagnostic ACE to the ECU harness connector.

2. Move Lower-Mow/Raise lever to the RAISE position and hold.

3. Turn Ignition key switch to ON while continuing to hold the lever in the RAISE position until the top left light on the Diagnostic ACE comes on (approximately 2 seconds).

4. Make sure Diagnostic ACE is set to OUTPUTS.

5. Release the RAISE lever to the center position.

   There will be 8 records displayed. The fault is displayed on the 8th record and will appear a flashing output light. Each record will be displayed for 10 seconds. Records will repeat until the Ignition switch is turned to OFF. The machine will not start in this mode.

6. Observe Diagnostic ACE for the playback of the retained fault in the ECU memory. The problem circuit will be flashing.

Clearing Fault Memory

Once a fault is repaired, it must be must be cleared from the ECU memory so any future fault can then be stored.

Note: If the faults have been cleared or there are no faults stored, ALL used input and output lights will be on for each record displayed.

1. Turn Ignition key switch to OFF.

2. Move Backlap switch to the FRONT or REAR position.

3. Move Enable/Disable switch to the ENABLE position.

4. Move Lower-Mow/Raise lever to the RAISE position and hold.

5. Turn Ignition key switch to ON while continuing to hold the lever in the RAISE position until the Reel Control Lamp on the steering column starts to flash (approximately 2 seconds).

6. Release RAISE lever and turn Ignition switch to OFF. Move the Backlap switch to OFF and the Enable/Disable switch to DISABLE. **Fault memory is now cleared.**

IMPORTANT: The Diagnostic ACE display must not be left connected to the machine. It is not designed to withstand the environment of the machine's every day use. When done using Diagnostic ACE, disconnect it from the machine and reconnect loopback connector to harness connector. Machine will not operate without loopback connector installed on harness. Store Diagnostic ACE in dry, secure location in shop, not on machine.

Starting Problems

Problem	Possible Causes
All electrical power is dead, including gauges.	The battery charge is low. The ignition switch or circuit wiring is faulty. The fusible link from the battery is faulty. The 20 ampere fuse to the ignition switch is open.
Starter solenoid clicks, but starter will not crank. **Note:** If the solenoid clicks, the problem is not in the interlock circuit wiring or the ECU.	Low battery charge. Loose or corroded battery cables. Loose or corroded ground. Faulty wiring at the starter. Faulty starter solenoid.
Nothing happens when start attempt is made. Control panel lights and gauges operate with the ignition switch in ON.	The traction pedal is not in neutral position or the neutral switch or circuit wiring is faulty. The cutting units are engaged. Faulty joystick switch (raise position). Faulty ignition switch or circuit wiring. Faulty circuit between controller and start relay. Start relay or circuit wiring is faulty. Start solenoid or starter is faulty.
Engine starts, but stops when the ignition switch is released from the START position.	The run (ETR) solenoid or circuit wiring is faulty. High temperature shutdown switch or circuit wiring is faulty.
Engine cranks, but does not start.	Engine is not cranking fast enough. Glow plugs not used or not functioning. Engine run (ETR) solenoid, circuit wiring, or fuel pump is faulty. The problem is not electrical (see Chapter 3 - Kubota Engines).
Starter cranks, but should not when the traction is depressed.	The traction neutral switch is out of adjustment. The traction neutral switch or circuit wiring is faulty.

General Run and Transport Problems

Engine continues to run, but should not, when the ignition switch is turned off.	The engine run (ETR) solenoid is stuck open. Ignition switch or circuit wiring is faulty.
Engine continues to run, but should not, when the traction pedal is engaged with no operator in the seat.	The seat sensor or circuit wiring is faulty. Traction neutral switch or circuit wiring is faulty.
The engine stops during operation, but is able to restart.	The parking brake is engaged. The seat sensor actuator is lifting off the seat switch. The seat sensor or circuit wiring is faulty. The ignition switch or circuit wiring is faulty. Not an electrical issue, check fuel delivery system.
The engine kills when the traction pedal is depressed.	The parking brake is engaged. The seat sensor actuator is lifting off the seat switch. The seat sensor or circuit wiring is faulty.
Battery does not charge.	Loose or broken wire(s). The fusible link to the battery is faulty. Faulty alternator or dead battery. Alternator warning lamp is faulty or burned out. Alternator warning lamp wiring loose, corroded, or damaged.

Cutting Unit Operating Problems

The cutting units remain engaged, but should not, with no operator in the seat.	The seat sensor or circuit wiring is faulty.
Cutting units run, but should not, when raised. Units shut off with enable disable switch.	The front reels down sensor or circuit wiring is faulty.
Cutting units run, but should not, when raised. Units do not shut off with the enable disable switch.	Both the front reels down sensor or circuit wiring, and enable/disable switch or circuit wiring are faulty. A hydraulic problem exists (see Troubleshooting section of Chapter 4 - Hydraulic System).
Cutting units run, but should not, when lowered with enable/disable switch in the disable position.	The enable/disable switch or circuit wiring is faulty.
The front cutting units do not operate in either direction. Units are able to raise and lower.	Solenoid S1 or circuit wiring is faulty. A hydraulic problem exists (see Troubleshooting section of Chapter 4 - Hydraulic System).

Cutting Unit Operating Problems (Cont.)

None of the cutting units operate in either direction. Units are able to raise and lower.	The seat sensor actuator is lifting off the seat switch. The seat sensor or circuit wiring is faulty. The enable/disable switch or circuit wiring is faulty. The front reels down sensor or circuit wiring is faulty. Ground circuit wiring to solenoids may be open. A hydraulic problem exists (see Troubleshooting section of Chapter 4 - Hydraulic System).
The rear cutting units do not operate in either direction. Units are able to raise and lower.	Solenoid S2 or circuit wiring is faulty. A hydraulic problem exists (see Troubleshooting section of Chapter 4 - Hydraulic System).
None of the cutting units will lower.	Lower/mow switch on joystick or circuit wiring is faulty. Solenoid S6 or circuit wiring is faulty. A hydraulic problem exists (see Troubleshooting section of Chapter 4 - Hydraulic System).
None of the cutting units will raise.	Raise switch on joystick or circuit wiring is faulty. Solenoid S7 or circuit wiring is faulty. A hydraulic problem exists (see Troubleshooting section of Chapter 4 - Hydraulic System).
Left and right front cutting units will not raise or lower, but the other cutting units will raise and lower.	Solenoid S3 or circuit wiring is faulty. A hydraulic problem exists (see Troubleshooting section of Chapter 4 - Hydraulic System).
The center front cutting unit will not raise or lower, but the other cutting units will raise and lower.	Solenoid S4 or circuit wiring is faulty. A hydraulic problem exists (see Troubleshooting section of Chapter 4 - Hydraulic System).
The rear cutting units will not raise or lower, but the other cutting units will raise and lower.	Solenoid S5 or circuit wiring is faulty. A hydraulic problem exists (see Troubleshooting section of Chapter 4 - Hydraulic System).
The front cutting units do not backlap, but run in the forward direction instead.	Solenoid S8 or circuit wiring is faulty. A hydraulic problem exists (see Troubleshooting section of Chapter 4 - Hydraulic System).
The front cutting units do not backlap, but all cutting units run in the forward direction.	The front backlap switch or circuit wiring is faulty.
The rear cutting units do not backlap, but run in the forward direction instead.	Solenoid S9 or circuit wiring is faulty. A hydraulic problem exists (see Troubleshooting section of Chapter 4 - Hydraulic System).
The rear cutting units do not backlap, but all cutting units run in the forward direction.	The rear backlap switch or circuit wiring is faulty.

TurfDefender Leak Detector

The TurfDefender™ is an electronic hydraulic fluid leak detection device that fits inside the hydraulic tank of your machine. It is a pressure based system which requires a sealed hydraulic tank to function properly. Very small changes to the oil level in the sealed tank result in a large movement of the leak detector's internal float. The Turfdefender's internal microprocessor analyzes the float movement and determines if there is a leak in the system.

- Turn ignition key to "ON" position start the system. The system will reset itself whenever the ignition key is moved to "OFF" position. Wait 5 seconds, then move key to "ON" position to restart the system.
- When the machine is started, the alarm will give one short beep to indicate that everything is operating properly. No noise from the alarm indicates a boot sequence or faulty alarm, and should be corrected immediately.
- If the alarm gives 4 short beeps it means a system problem has been detected. The 4 beep pattern will continue for approximately 1-1/2 minutes, then stop, unless the ignition key is moved to "OFF" position.

  Note: The 4 beep signal may occur if machine is started on a slope. Move machine to a level surface, move ignition key to "OFF" position, wait 5 seconds, then move key to "ON" position to restart the system.
- If the alarm gives a loud continuous beep while mowing and shuts off the cutting units, it means that a leak has been detected. On the traction unit, the red light on the steering console will also blink indicating the ECU has shut off the cutting units.

Checking Leak Detector Operation

When any of the following conditions occur, the operation of the TurfDefender™ should be checked :

a. No beeps are heard when ignition switch is turned "ON".

b. Any time the machine gives a series of 4 short beeps.

c. False alarms are observed.

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

2. Open control panel cover. Locate leak detector harness loopback connector with a green hydraulic symbol tag. Carefully unplug loopback connector from harness connector.

3. Connect the Diagnostic ACE display connector to the correct harness loopback connector. Install TurfDefender overlay decal (supplied with leak detector kit) onto Diagnostic ACE (Fig. 8).

4. Turn the key switch to the ON position, but do not start machine.

Note: Red text on the overlay decal refers to inputs and green text refers to outputs.

5. The red "Inputs displayed" LED (Light Emitting Diode), on lower right column of the Diagnostic ACE, should be illuminated. If green "Outputs displayed" LED is illuminated, press and release the toggle button, on Diagnostic ACE, to change LED to "Inputs displayed". Do not hold button down (Fig. 8).

If TurfDefender is functioning normally:

1. When the "Inputs displayed" LED is lit (Fig. 9),

- The actual Float position should register as the 3rd and 4th, or 4th LED down.
- The "Oil level OK" LED should be displayed.

2. Press toggle button until green "Outputs displayed" LED is lit (Fig. 10).

- "Valve ON", "data line" and "self diagnostic"LED's should be lit steadily.
- "Alarm ON" LED may be displayed temporarily (about 5 seconds).

Note: If "data line" or "self diagnostic" LED's are blinking, there is a problem in the system.

If No beeps are heard:

1. Check alarm wires to make sure they are not disconnected, broken, or "+" and "-" reversed.

2. Toggle "outputs displayed" on Diagnostic ACE display (Fig. 10).

- Alarm open circuit (LED blinking): Check TurfDefender alarm or wires. Replace if necessary.
- Alarm short circuit (LED blinking): Check TurfDefender alarm or wires. Replace if necessary.

If 4 beeps are heard:

The most common cause for a 4 beep signal is from an improper oil level reading. Make sure machine is on a level surface when checking oil level. Since oil level will vary with temperature, it is best to check when cool.

1. When toggling “input”, a LED should display (Fig. 9) any of the following problems diagnosed by the TurfDefender:

- Oil level low: Position machine on a level surface and fill to proper level.
- Oil level high: Position machine on a level surface and remove excess oil until proper level is attained.
- Oil too hot: Allow machine to cool and clean any debris from oil cooler.
- Air leak in system: Assure tank cap is tight or check for leak in tank.

  Note: Only large air leaks can be detected by TurfDefender.

2. When toggling “output” a LED should display (Fig. 10) any of the following problems diagnosed by the TurfDefender:

- Valve open circuit (LED blinking): Check / replace TurfDefender electric solenoid valve or wires.
- Valve short circuit (LED blinking): Check / replace TurfDefender electric solenoid valve or wires.
- Self diagnostic LED Blinking: Internal circuit failure in TurfDefender.
- Data Line LED Blinking: Problem with communications between machine and leak detector; or problem with wires.

  Note: If machine must be operated with leak detector disabled, unplug leak detector 4-pin connector from 4-pin connector of main harness. Do not unplug leak detector alarm.

If false alarms are observed:

1. Oil level may be low causing air to be drawn into the system. Check oil level.

2. Extremely hard left turns can cause oil to slosh to the right, exposing suction line and purging air out of system. Normal maneuvering should not cause this condition.

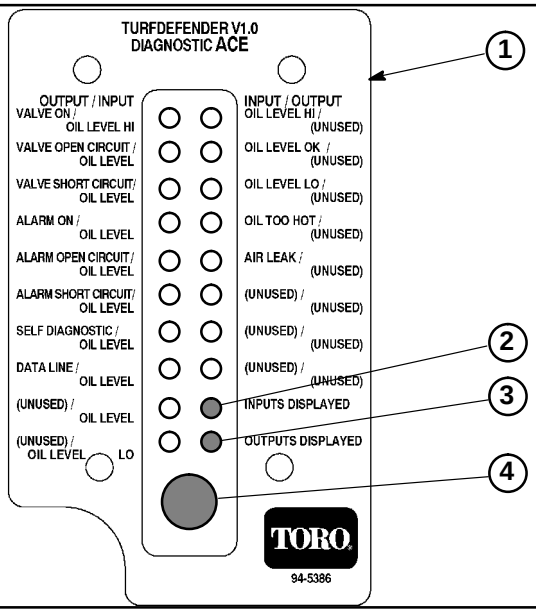
3. Air leak in system. Check to make sure cap is securely on tank.

Note: The system will reset itself whenever the ignition key is turned to “OFF” position. The hand held Diagnostic ACE must be connected and observed during a false alarm. Once the ignition key is turned to “OFF” position, the TurfDefender will reset itself.

4. To check for a system problem, install hand held Diagnostic ACE, toggle input/output and check for any problems previously discussed.

5. Your Authorized Toro Distributor has equipment to analyze system problems.

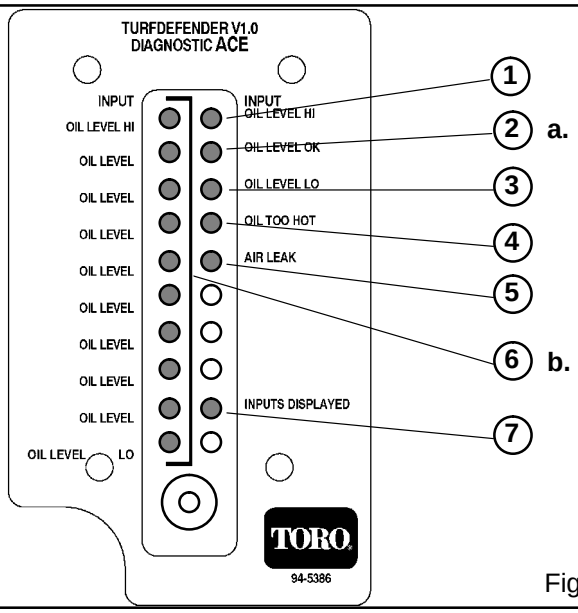
IMPORTANT: The Diagnostic ACE displays must not be left connected to the machine. It is not designed to withstand the environment of the machine’s every day use. When done using Diagnostic ACE, disconnect them from the machine and reconnect loopback connectors to harness connectors. Machine will not operate without loopback connectors installed on harness. Store Diagnostic ACE in dry, secure location in shop, not on machine.



Diagnostic ACE Display Functions

1. **Overlay decal (English shown)**
2. **“Inputs Displayed” LED (Red)**
3. **“Outputs Displayed” LED (Green)**
4. **Toggle button**

Figure 8



Using “Inputs Displayed” (Red Text)

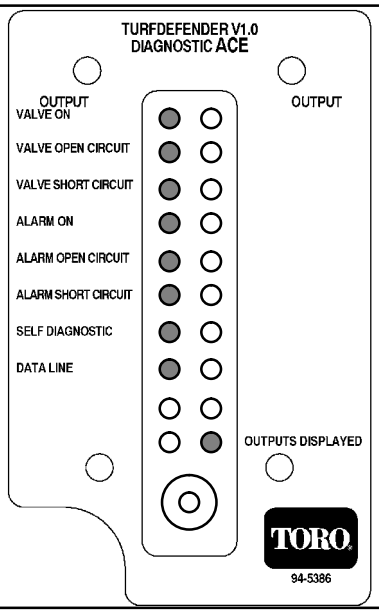
1. **LED lit if oil level is too high**
2. **LED lit if oil level is OK**
3. **LED lit if oil level is too low**
4. **LED lit if oil is too hot**
5. **LED lit if system air leak has been detected**
6. **One or two LED’s lit displaying relative position of the Turfdefender’s internal float.**
7. **“Inputs Displayed” LED “ON” (Red)**

Normal Operation:

a. “Oil Level OK” LED lit

b. 1 or 2 LED’s lit on left column

Figure 9



Using “Outputs Displayed” (Green Text)

Normal Operation:

a. “Valve ON” LED lit steadily

b. “Self Diagnostic” LED lit steadily

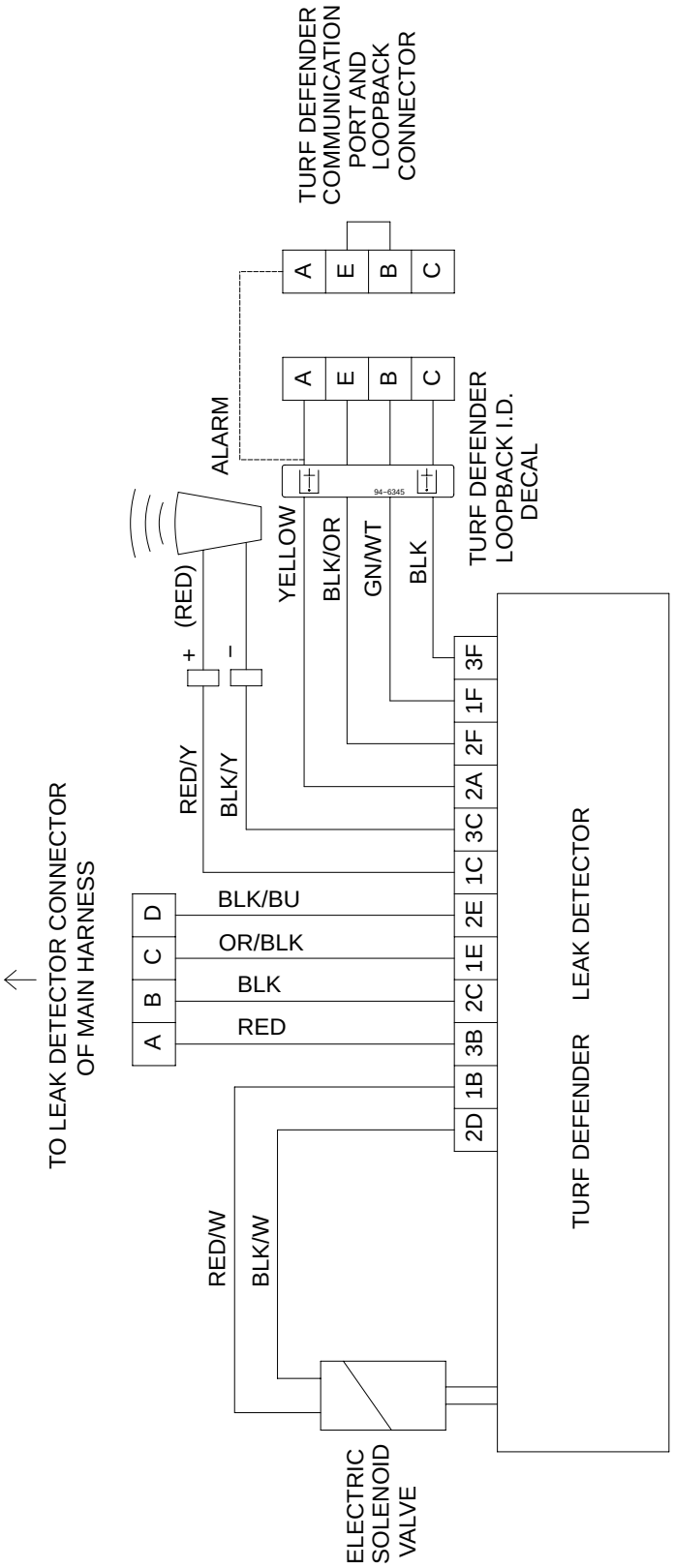
c. “DATA LINE” LED lit steadily

d. “Alarm ON” LED lit temporarily

Problem Diagnosed:

The appropriate LED will blink to identify the problem

Figure 10


TURF DEFENDER COMMUNICATION PORT AND LOOPBACK CONNECTOR
A E B C
A E B C
TURF DEFENDER LOOPBACK I.D. DECAL
ALARM
94-6345
YELLOW
BLK/OR
GN/WT
BLK
(RED)
+
–
RED/Y
BLK/Y
3F 1F 2F 2A 3C 1C 2E 1E 2C 3B 1B 2D
TURF DEFENDER LEAK DETECTOR
TO LEAK DETECTOR CONNECTOR OF MAIN HARNESS
A B C D
BLK/BU
OR/BLK
BLK
RED
RED/W
BLK/W
ELECTRIC SOLENOID VALVE

Electrical System Quick Check

Battery Test (Open Circuit Test)

Use a multimeter to measure the voltage between the battery terminals.

Set multimeter to the DC volts setting. The battery should be at a temperature of 60 to 100°F (16 to 38°C). The ignition key should be off and all accessories turned off. Connect the positive (+) meter lead to the positive battery post and the negative (-) meter lead the the negative battery post.

NOTE: This test provides a relative condition of the battery. Load testing of the battery will provide additional and more accurate information.

Voltage Measured	Battery Charge Level
12.68 V (or higher)	Fully charged (100%)
12.45 V	75% charged
12.24 V	50% charged
12.06 V	25% charged
11.89 V	0% charged

Component Testing

For accurate resistance and/or continuity checks, electrically disconnect the component being tested from the circuit (e.g. unplug the ignition switch connector before doing a continuity check).

NOTE: For more component testing information, see the Kubota Workshop Manual, Diesel Engine, 05 Series at the end of Chapter 3 - Kubota Diesel Engines.

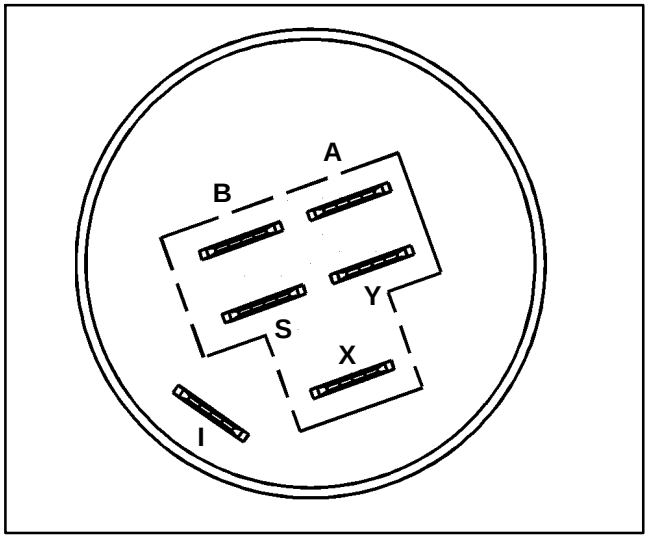
CAUTION

When testing electrical components for continuity with a multimeter (ohms setting), make sure that power to the circuit has been disconnected.

Ignition Switch

The ignition (key) switch has three positions (OFF, RUN, and START). The terminals are marked as shown. The circuit wiring of the ignition switch is shown in the chart. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each position. Verify continuity between switch terminals.

POSITION	CIRCUIT
OFF	NONE
RUN	B + I + A, X + Y
START	B + I + S



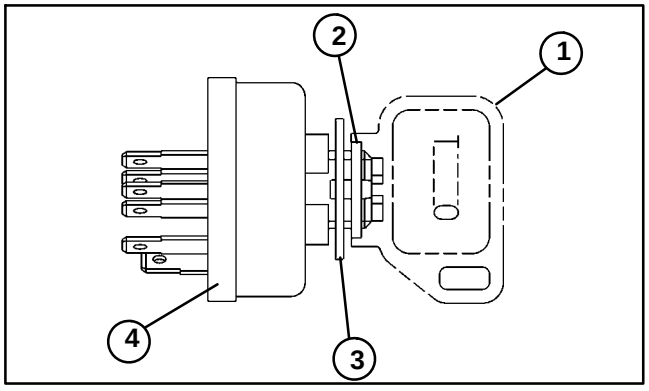


Figure 11

1. **Key**
2. **Hex nut**
3. **Lock washer**
4. **Ignition switch**

Glow and Start Relays

These relays are attached to the radiator shield that is located below the seat.

Note: The start relay may be manufactured by one of three different manufacturers. Verify manufacturer name and part number before performing the resistance check on the relay coil.

Note: Prior to taking small resistance readings with a digital multi meter, short the test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from from the measured value of the component you are testing.

1. Verify coil resistance between terminals 86 and 85 with a multimeter (ohms setting).

   A. For the **glow** relay (Bosch #0 332 002 150), resistance should be from 41 to 51 ohms (Fig. 13).

   B. For the **start** relay (Bosch #0 332 204 174), resistance should be from 60 to 70 ohms (Fig. 14).

   C. For the **start** relay (Potter & Brumfield #VF4-55F11), resistance should be from 85 to 95 ohms (Fig. 14).

   D. For the **start** relay (Hella Electronics #66214), resistance should be from 70 to 80 ohms (Fig. 14).

2. Ground terminal 86 and apply +12 VDC to terminal 85. The relay should pick up making the sound of a sharp click.

   A. Resistance between terminals 30 and 87 should be 1 ohm or less.

   B. On the **start** relay, resistance between terminals 30 and 87A should read as an open circuit.

3. Remove +12 VDC from terminal 85. The relay should drop out making the sound of a sharp click.

   A. Resistance between terminals 30 and 87 should read as an open circuit.

   B. On the **start** relay, resistance between terminals 30 and 87A should be 1 ohm or less.

4. Disconnect voltage and leads from all terminals.

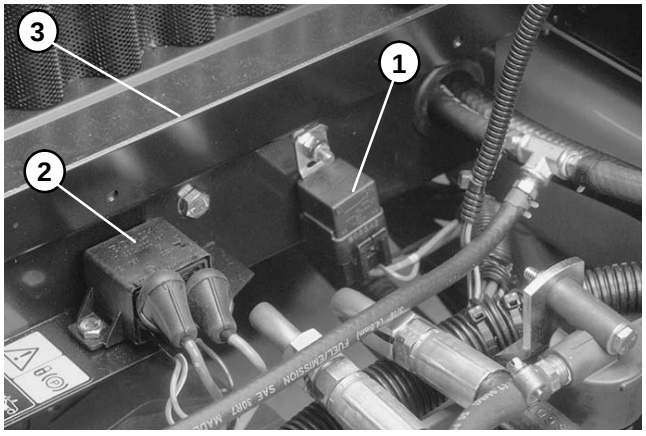


Figure 12

1. **Start relay**
2. **Glow relay**
3. **Radiator shield**

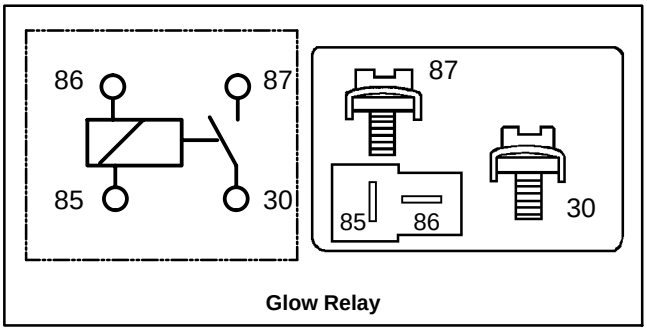


Figure 13

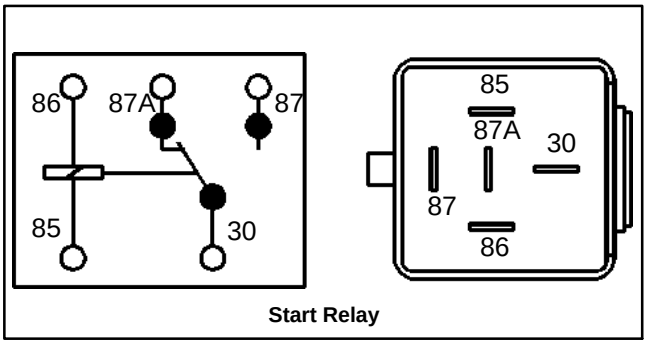


Figure 14

Fuses

The fuse blocks are located under the control panel and inside the control console.

Identification, Function, and Wiring

The fuses are held in two fuse blocks. Use Figure 16 to identify each individual fuse and its correct amperage. Each fuse holder has the following functions and wire connected to it.

Fuse A1

A. Supplies power to Electronic Control Unit (ECU) terminals 1L and 1M.

B. Has blue/white wire (1L), green/black wire (1M) and red wire (battery).

Fuse A2

A. Supplies power to ignition switch terminal B.

B. Has red/blue wire (B) and red wire (battery).

Fuse A3

A. Supplies power to ECU terminal 1J.

B. Has pink/black wire (1J) and red wire (battery).

Fuse A4

A. Supplies power to ECU terminal 1K.

B. Has red/black wire (1K) and red wire (battery).

Fuse B1

A. Supplies power to harness splice N that feeds ECU terminal 1A, diagnostic indicator light, warning light cluster, and ECU communications port and loopback connector.

B. Has two yellow wires.

Fuse B2

A. Supplies power to harness splice K that feeds the hour meter, temperature gauge, fuel gauge, speedometer, gear tooth sensor, and light switch (optional).

B. Has two orange wires.

Fuse B3 (When Optional Lighting is Installed)

A. Supplies power to light relay terminal 30.

B. Has two red wires.

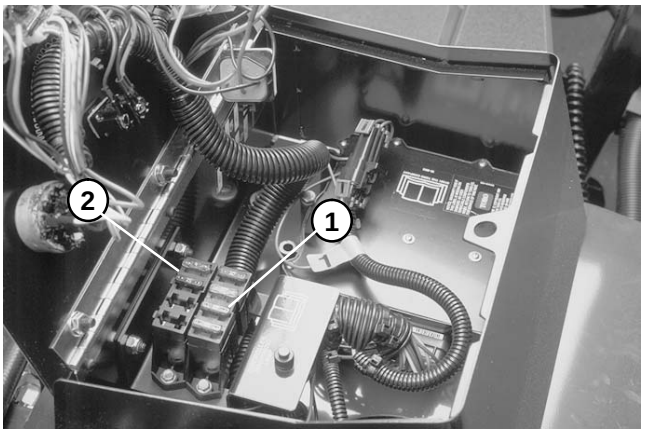


Figure 15

1. Fuse block A **2. Fuse block B**

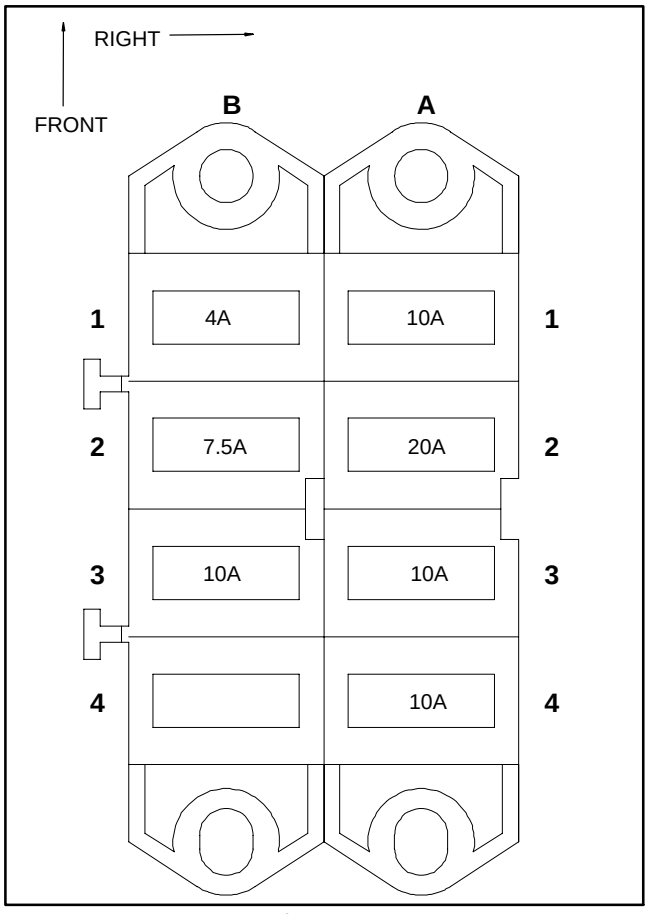


Figure 16

Hydraulic Valve Solenoids

Note: Prior to taking small resistance readings with a digital multimeter, short the test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from from the measured value of the component you are testing.

1. Make sure engine is off. Disconnect solenoid valve electrical connector.

2. Apply 12VDC source directly to the solenoid. Listen for solenoid to switch on.

3. Remove 12VDC source from the solenoid. Listen for solenoid to switch off.

4. Measure resistance between the two connector terminals.

   A. The resistance for a 20 watt coil should be about 7.2 ohms.

   B. The resistance for a 28 watt coil should be about 5.1 ohms.

5. Install **new** solenoid if necessary.

   A. Make sure o-ring is installed at each end of the coil. Apply ”Loctite 242” or equivalent to threads on end of valve stem before installing nut.

   B. Tighten nut to a torque of 15 in-lb (17.3 kg-cm). Over-tightening may damage the solenoid or cause the valve to malfunction.

Note: Each electrical harness connection for the valve solenoids has a colored power and a black ground wire attached to it.

Solenoid	Wire Color
S1	Pink/Blue
S2	Brown/White
S3	Orange/Blue
S4	Yellow/Black
S5	Yellow/White
S6	Orange/Red
S7	Yellow/Blue
S8	Black/Red
S9	Brown/White

6. Reconnect electrical connector to the solenoid.

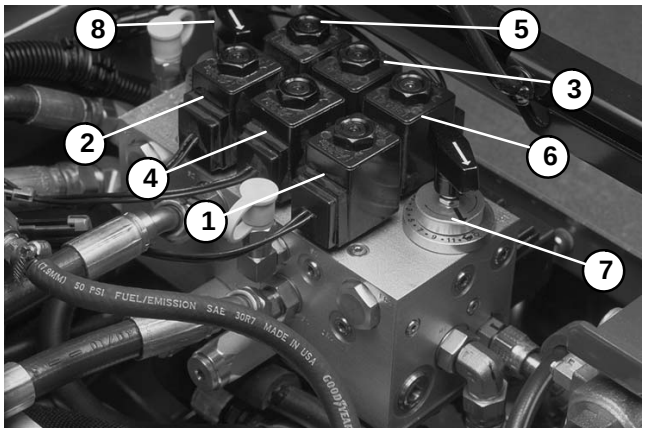


Figure 17

1. **20 watt solenoid (S1)**
2. **20 watt solenoid (S2)**
3. **20 watt solenoid (S3)**
4. **20 watt solenoid (S4)**
5. **20 watt solenoid (S5)**
6. **20 watt solenoid (S6)**
7. **Front reel speed control**
8. **Rear reel speed control**

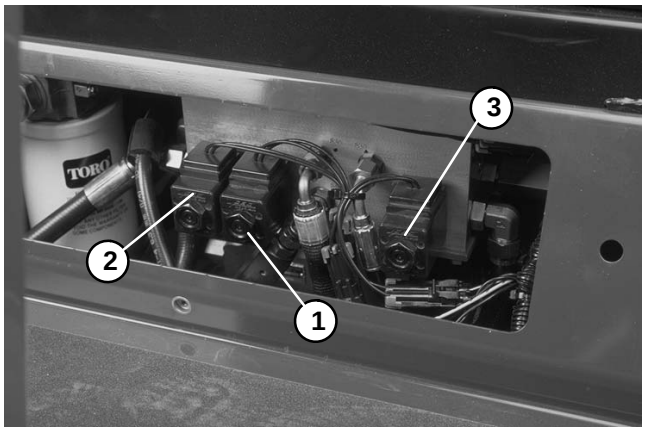


Figure 18

1. **28 watt solenoid (S7)**
2. **28 watt solenoid (S8)**
3. **28 watt solenoid (S9)**

Hydraulic Valve Solenoid Functions

The list below identifies and describes the function of each valve solenoid on the hydraulic manifold. Each solenoid functions when energized.

Solenoid	Function
S1	Front reel circuit
S2	Rear reel circuit
S3	Lift/lower left and right front cutting units
S4	Lift/lower front, center cutting unit
S5	Lift/lower rear cutting units
S6	Lower any cutting units
S7	Lift any cutting units
S8	Backlap front cutting units
S9	Backlap rear cutting units

High Temperature Warning and Shutdown Switch

The high temperature warning and shut down switch is located on the right side of the water flange that is attached to the front of the engine cylinder head. There is a green/white wire attached to the switch (Fig. 19).

CAUTION

Make sure engine is cool before removing the temperature switch.

1. Lower coolant level in the engine and remove the temperature switch.

2. Put switch in a container of oil with a thermometer and slowly heat the oil (Fig. 20).

CAUTION

Handle the hot oil with extreme care to prevent personal injury or fire.

3. Check continuity of the switch with a multimeter (ohms setting). The temperature switch is normally open and should close between 216 to 226°F (102 to 108°C).

4. Allow oil to cool while observing temperature. The temperature switch should open at about 208°F (98°C).

5. Replace switch if necessary.

6. Install sender to the water flange.

   A. Clean threads of water flange and sender thoroughly. Apply Permabond #LH150 sealant or equivalent to the threads of the water flange.

   B. Screw sender into the water flange and tighten.

   C. Connect green/white wire to sender. Apply skinover grease to sender terminal.

7. Fill engine cooling system (see Check Cooling System in Chapter 3 - Kubota Diesel Engine).

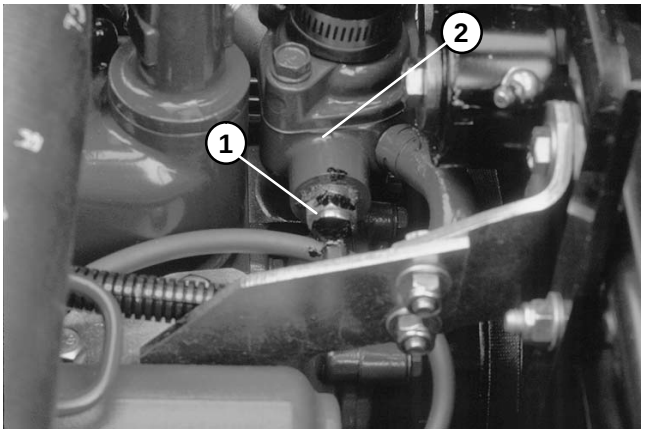


Figure 19

1. Temp. warning and shutdown switch **2. Water flange**

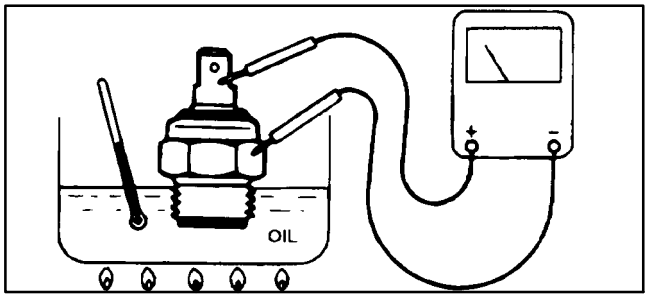


Figure 20

Warning Light Cluster

Note: Individual light bulbs can be tested by removing them from the lighting cluster and applying 14 VDC to their wiring terminals.

Testing Cluster Removed from Connector.

1. Apply 14 VDC to pin D.
2. Ground pins F, A, and E.
3. Lamps 1, 2, and 3 should light.
4. Apply 14 VDC to pin B.
5. Ground pin C.
6. Lamp 4 should light.

Oil Pressure Light

The oil pressure light should come on when the ignition switch is in the ON position with the engine not running. Also, it should light with the engine running when the oil pressure drops below 4 PSI (0.3 kg/cm^2).

1. Disconnect green/blue wire from the oil pressure switch.
2. Ground green/blue wire to the engine block.
3. Turn ignition switch to ON; the light should come on.
4. Turn ignition switch to OFF. Connect green/blue wire to the oil pressure switch.

High Temperature (Water) Shutdown Light

When the coolant temperature is above 221°F (105°C), the temperature light comes on as the high temperature shutdown switch and Electronic Control Unit (ECU) stop the engine.

Glow Light

The glow light comes on when the ignition switch is placed in RUN prior to placing the ignition switch in START, and stays light for 10 seconds while left in RUN.

Battery Light

The battery light should come on when the ignition switch is in ON with the engine not running, or with an improperly operating charging circuit while the engine is running.

1. Turn ignition switch to ON; the light should come on.
2. Turn ignition switch to OFF: the light should go off.

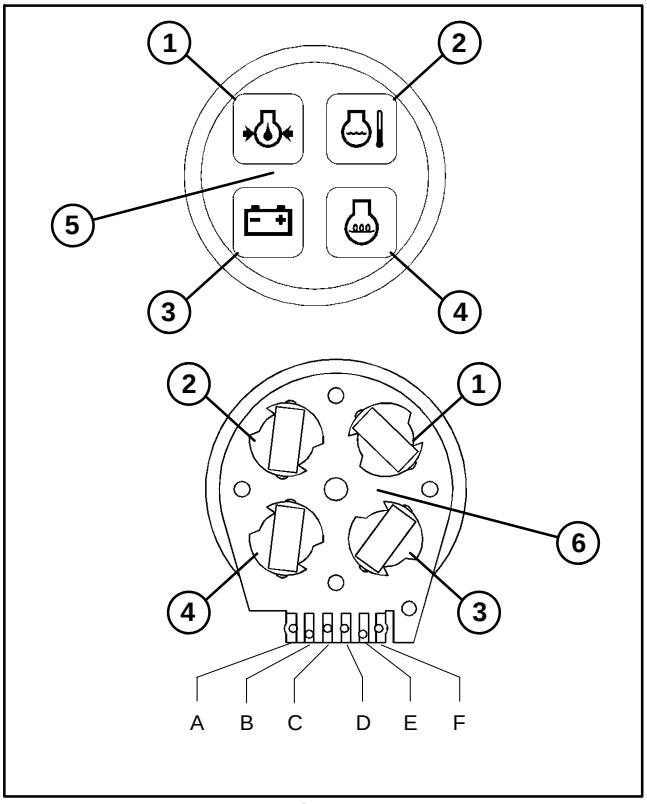


Figure 21

1. **Oil pressure (red)**
2. **Water temperature (red)**
3. **Battery (amber)**
4. **Glow plugs (amber)**
5. **Gauge front**
6. **Gauge back**

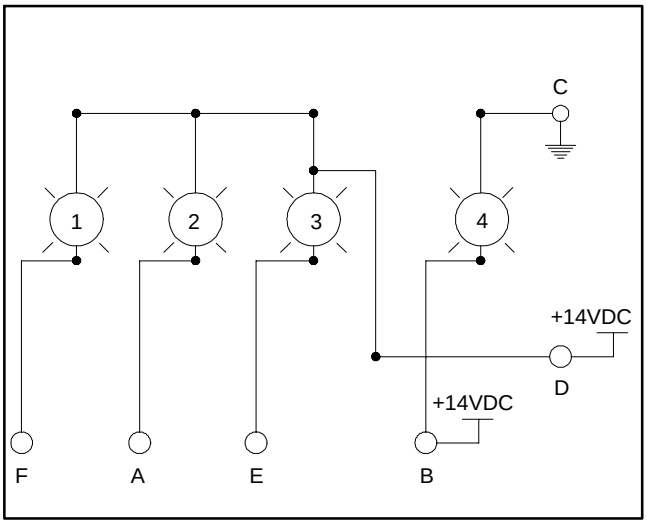


Figure 22

Fuel Stop Solenoid (Solenoid With 3 Wire Connector)

The solenoid must be energized for the engine to run. It is mounted on the engine block near the injection pump.

In Place Testing

Note: Prior to taking small resistance readings with a digital multimeter, short the test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from from the measured value of the component you are testing.

1. Disconnect the connector from the solenoid.

2. Using a digital multimeter, touch one lead to the pin of the **black** wire and the other lead to the pin of the **white** wire. The resistance of the **pull coil** should be about 0.33 ohms.

3. Using a digital multimeter, touch one lead to the pin of the **black** wire and the other lead to the pin of the **red** wire. The resistance of the **hold coil** should be about 12.2 ohms.

4. Connect solenoid to the wiring harness.

Live testing

1. Disconnect connector from the solenoid.

Note: The solenoid may be removed from the engine or tested in place.

2. If the solenoid is removed from the engine, make sure that the solenoid plunger moves freely and is free of dirt, debris, and corrosion.

3. Connect a positive (+) test lead from a 12 VDC source to the pins of the **red** and **white** wires.

4. Touch a negative (-) test lead from the 12 VDC source to the pin of the **black** wire. The solenoid should engage making an audible ”click”.

5. Remove positive (+) voltage from the pin of the **white** wire. The solenoid should stay engaged.

6. Remove positive (+) voltage from the pin of the **red** wire. The solenoid should release.

7. Reconnect the wires to the solenoid.

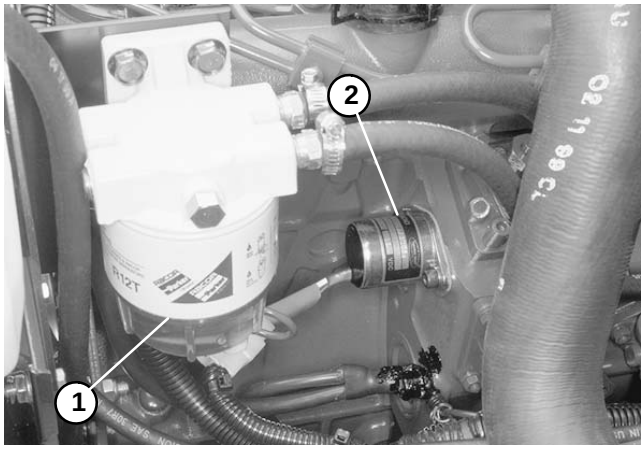


Figure 23

1. **Fuel/water separator**
2. **Fuel stop solenoid**

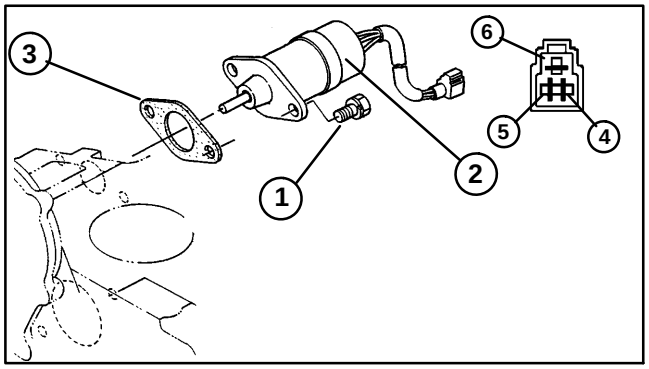


Figure 24

1. **Cap screw**
2. **Fuel stop solenoid**
3. **Gasket**
4. **Common (Black wire)**
5. **Hold coil (Red wire)**
6. **Pull coil (White wire)**

Run (ETR) Solenoid (Solenoid With 2 Wire Connector)

The run (ETR) solenoid must be energized for the engine to run. It is mounted on the engine block near the injection pump.

In Place Testing

Note: Prior to taking small resistance readings with a digital multimeter, short the test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from from the measured value of the component you are testing.

1. Disconnect wire harness connector from solenoid.

2. Using a digital multimeter, touch one test lead to the pull coil terminal and the other test lead to the fuel stop solenoid frame (ground) (Fig. 25). The resistance of the pull coil should be less than 1 ohm (but not zero).

3. Using a digital multimeter, touch one test lead to the hold coil terminal and the other test lead to the fuel stop solenoid frame (ground) (Fig. 25). The resistance of the hold coil should be approximately 15 ohms.

4. Connect solenoid to the wiring harness.

Live testing

1. Disconnect wire harness connector from solenoid.

Note: The solenoid may be removed from the engine or tested in place.

2. If the solenoid is removed from the engine, make sure that the solenoid plunger moves freely and is free of dirt, debris and corrosion.

Note: When testing run solenoid, use test leads with at least 14 gauge wire.

3. Connect a positive (+) test lead from a 12 VDC source to the pull coil and hold coil terminals.

4. Touch a negative (−) test lead from the 12 VDC source to the fuel stop solenoid frame (ground) (Fig. 25). The solenoid should engage, making an audible “click,” and the plunger should retract.

5. Remove positive (+) voltage from the pull coil terminal. The solenoid should stay engaged.

6. Remove positive (+) voltage from the hold coil terminal. The solenoid should release.

7. Reconnect the wires to the solenoid.

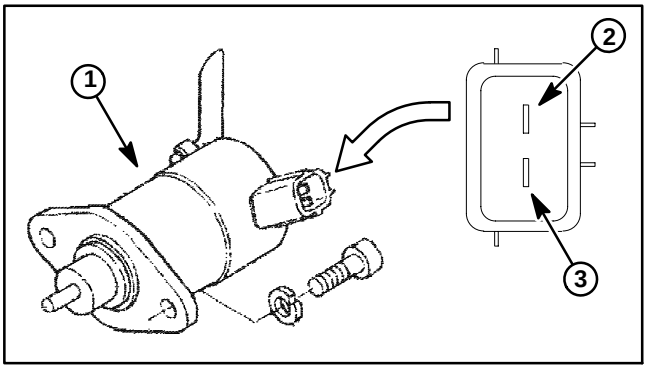


Figure 25

1. **Fuel stop solenoid**
2. **Pull coil terminal**
3. **Hold coil terminal**

Fuel Sender

The sender is located on top of the fuel tank under the right, front fender.

1. Remove blue/green wire and black ground wire from the sender.

2. Remove round head screws and lock washers from the sender and fuel tank.

3. Remove sender and gasket from the fuel tank. Clean any fuel from the sender.

Note: Before taking small resistance readings with a digital multimeter, short test leads together. The meter will display a small resistance value. This internal resistance of the meter and test leads should be subtract from the measured value of the component.

CAUTION

Make sure sending unit is completely dry (no fuel on it) before testing. Perform test away from the tank to prevent an explosion or fire from sparks.

4. Check resistance of the sender with a multimeter.

   A. Resistance with the float in the **full** position should be **27.5 to 39.5 ohms**.

   B. Resistance with the float in the **empty** position should be **240 to 260 ohms**.

5. Replace sender as necessary. Reinstall sender into fuel tank. Connect wires.

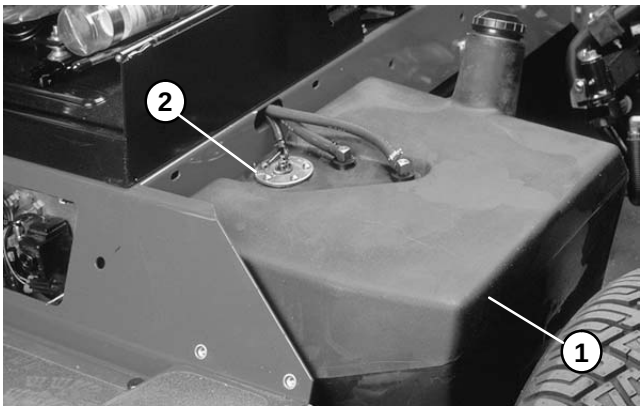


Figure 26

1. Tank **2. Fuel sender**

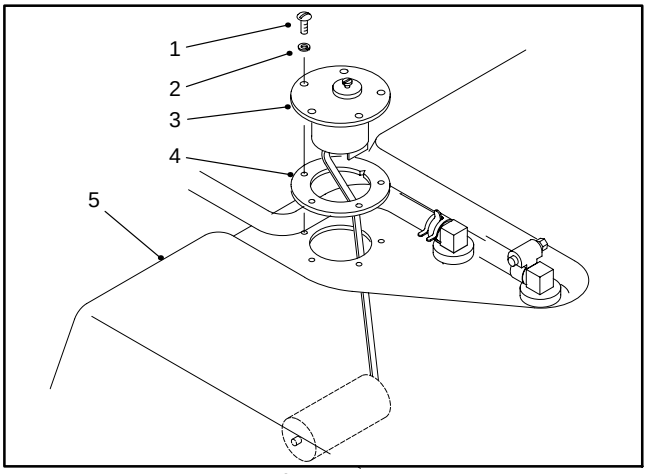


Figure 27

1. Round head screw **4. Gasket**
2. Lock washer **5. Fuel tank**
3. Fuel sender

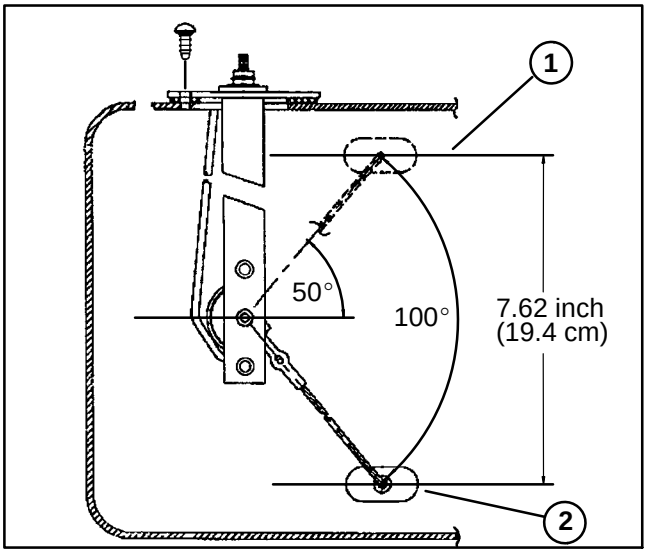


Figure 28

1. Full position **2. Empty position**

Fuel Gauge

The fuel gauge can be tested using a new gauge as a substitute or by the use of a DC voltage source and a variable resistance box.

CAUTION

Make sure the voltage source is turned OFF before connecting it to the electrical circuit to avoid electrical shock and prevent damaging the gauge.

1. Connect fuel gauge to the variable resistance and DC voltage source (Fig. 29).

Note: When reading the gauge test point, there are two white dots on the gauge face below the edge of the glass cover for the each test point. For each variable resistance setting, the needle must be pointed between the two white dots.

2. Take test point readings (Fig. 30).

IMPORTANT: Allow circuit to warm up for at least 5 minutes before taking test readings.

A. Set variable resistance to 240 ohms. Apply a 14 ± 0.01 VDC to the circuit. The needle should point to the **left** edge of the **red area (empty)**.

B. Set variable resistance to 33 ohms. The needle should point to the **right** edge of the **green area (full)**.

3. Turn off the voltage source. Disconnect voltage source, gauge, and variable resistance.

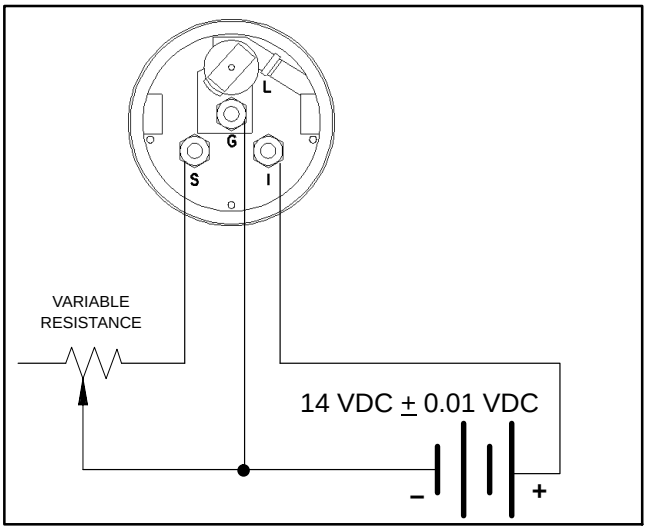


Figure 29

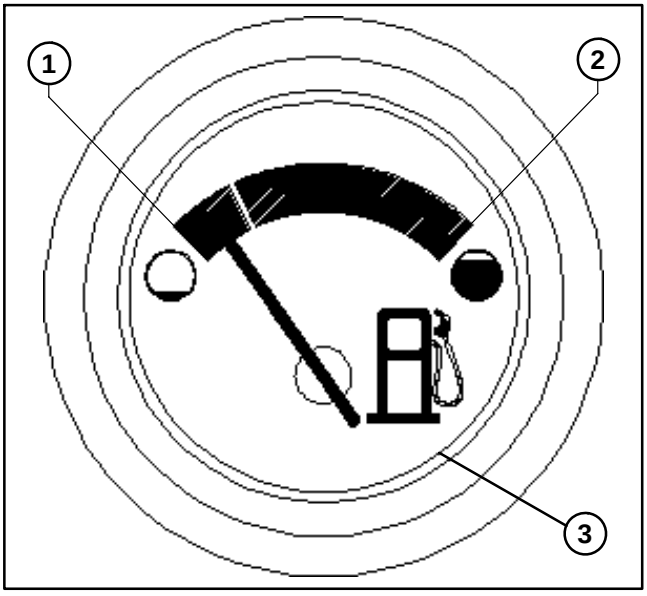


Figure 30

1. **Empty position**
2. **Full position**
3. **Glass face edge**

Temperature Sender

The sender is located on the left side of the water flange that is attached to the front of the engine cylinder head. There is a blue/white wire attached to the terminal of the switch (Fig. 31).

1. Lower coolant level in the engine and remove the high temperature sender.

2. Put switch in a container of oil with a thermometer and slowly heat the oil (Fig. 32).

CAUTION

Handle the hot oil with extreme care to prevent personal injury or fire.

Note: Prior to taking resistance readings with a digital multi meter, short the test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from from the measured value of the component you are testing.

3. Check resistance of the sender with a multimeter (ohms setting) as the temperature increases.

   A. The meter should indicate from **54 to 78 ohms** at **200°F (93.3°C)**.

   B. Replace sender if specification is not met.

4. Install sender to the water flange.

   A. Clean threads of water flange and sender thoroughly. Apply Permabond #LH150 sealant or equivalent to the threads of the water flange.

   B. Screw sender into the water flange and tighten.

   C. Connect blue/white wire to sender. Apply skin-over grease to sender terminal.

5. Fill engine cooling system (see Check Cooling System in Chapter 3 - Kubota Diesel Engine).

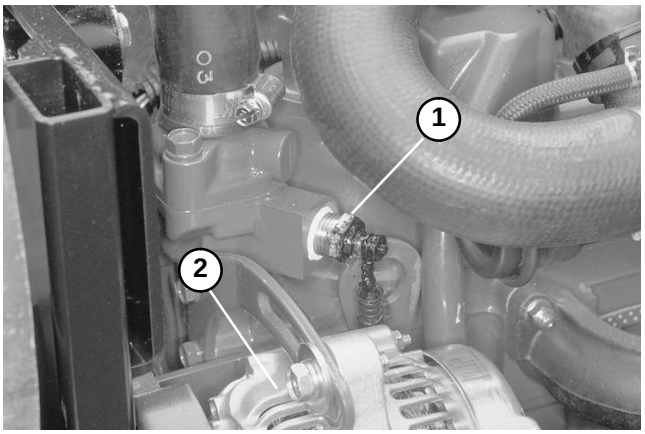


Figure 31

1. Temperature sender **2. Alternator**

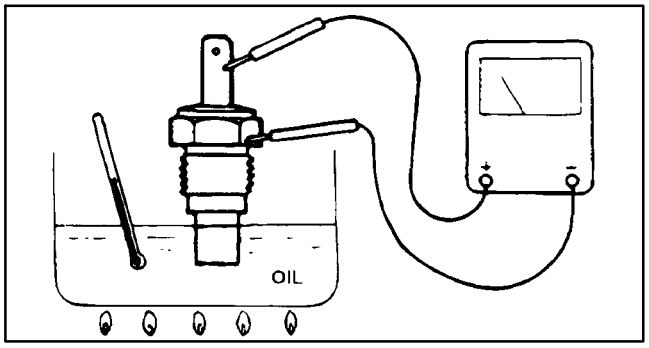


Figure 32

Electrical System

Temperature Gauge

The temperature gauge can be tested using a new gauge as a substitute or by the use of a DC voltage source and a variable resistance box.

CAUTION

Make sure the voltage source is turned OFF before connecting it to the electrical circuit to avoid electrical shock and prevent damaging the gauge.

1. Connect temperature gauge to the variable resistance and DC voltage source (Fig. 29).

Note: When reading the gauge test point, there are two white dots on the gauge face below the edge of the glass cover for the each test point. For each variable resistance setting, the needle must be pointed between the two white dots.

2. Take test point readings (Fig. 30).

IMPORTANT: Allow circuit to warm up for at least 5 minutes before taking test readings.

A. Set variable resistance to **71 ohms**. Apply a 14 ± 0.01 VDC to the circuit. The needle should point to the **middle of the green area** (80°C).

B. Set variable resistance to **38 ohms**. The needle should point **between the green and red area** (105°C).

3. Turn off the voltage source. Disconnect voltage source, gauge, and variable resistance.

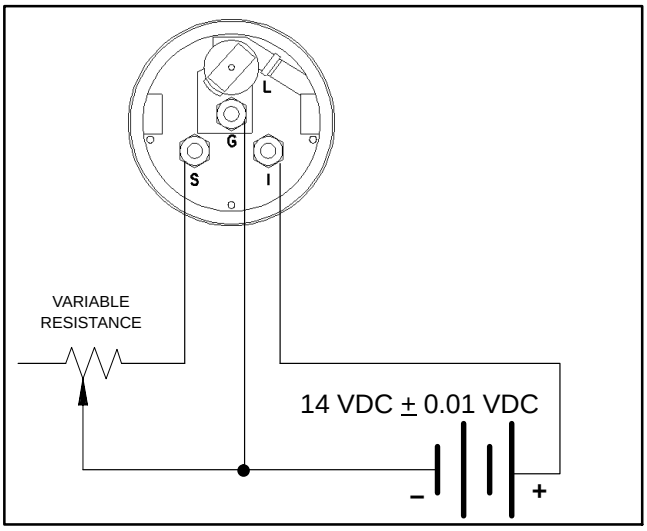


Figure 33

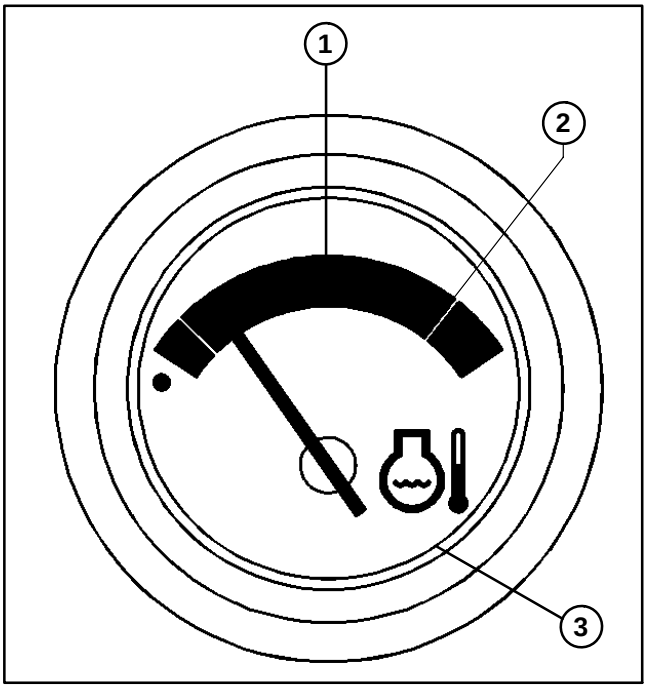


Figure 34

1. **Middle position**
2. **High temp position**
3. **Edge of glass cover**

Hour Meter

The meter is located under the control panel and inside the control console.

1. Connect the positive (+) terminal of a 12 VDC source to the positive terminal of the hour meter.

2. Connect the negative (-) terminal of the voltage source to the other terminal of the hour meter.

3. The hour meter should move a 1/10 of an hour in six minutes.

4. Disconnect voltage source from the hour meter.

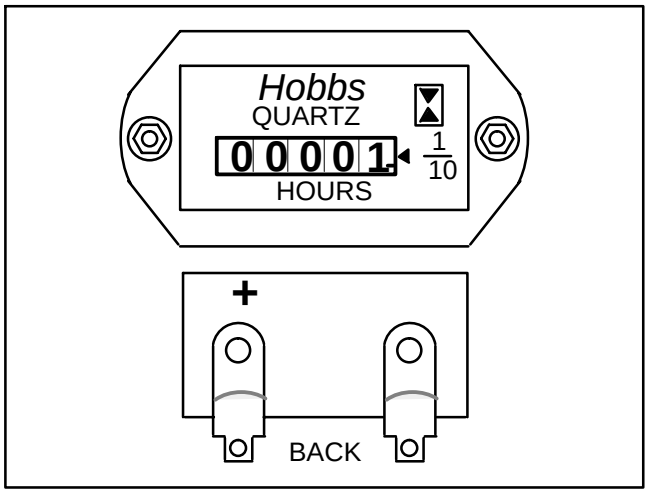


Figure 35

Electronic Control Unit (ECU)

The Toro electronic control unit (ECU) senses the condition of various switches, such as the seat sensor, cutting unit down switches, traction neutral switch, etc., and directs power output to allow certain machine functions, such as engine run, cutting units engage, etc.

To test the controller, make sure it can check, verify, retrieve, and clear information as described in the “Diagnostic Ace Display” section of this chapter. The controller may be damaged if an attempt is made to test it with an electrical test device, such as a volt-ohm meter.

IMPORTANT: Before performing welding on the machine, disconnect both battery cables from the battery, disconnect both wire harness connectors from the electronic control unit and disconnect the terminal connector from the alternator to prevent damage to the electrical system.

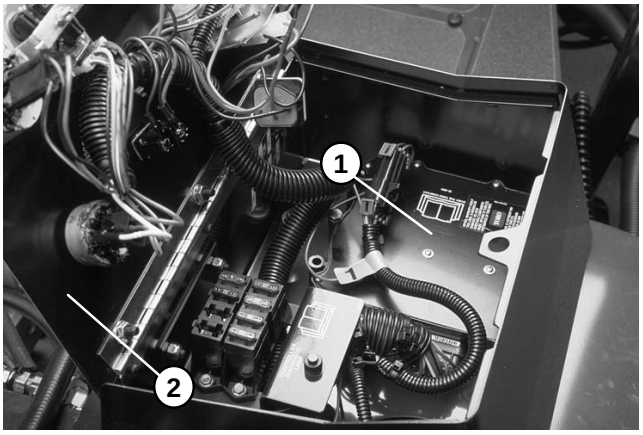


Figure 36

1. Electronic control unit (ECU) **2. Control panel**

Parking Brake Switch

The parking brake switch is a proximity switch located inside the steering tower. When functioning properly, this feature kills the engine when the forward/reverse pedal is depressed and the parking brake is **On**.

For unit serial number 80001-209999999 the switch is closed to ground (orange/brown wire to black wire) when the parking brake is **On**.

For units serial number 210000001 and Up, the switch is closed to ground (orange/brown wire to black wire) when the parking brake is **Off**.

1. With the parking brake engaged, separate the terminal connector and measure resistance between the switch connector pins. Resistance should read as a closed circuit (80001-209999999) or as an open circuit (210000001 and Up).

2. Release the parking brake and measure resistance between the switch connector pins. Resistance should read as an open circuit (80001-209999999) or as an closed circuit (210000001 and Up).

3. Adjust the position of the proximity switch as necessary to obtain the above results.

Traction Speed Sensor

The sensor is located on the right side of differential gear box that is part the front axle. It uses a magnetically biased Hall Effect integrated circuit. As the spur gear turns in the differential, the sensor accurately senses the movement of the gear teeth passing by the sensor. The red connector wire is the positive lead, the black wire is the ground lead, and the gray wire is the signal output.

The sensor is tested as part of the output checks with the Diagnostic ACE tool.

IMPORTANT: When replacing the sensor, see Traction Speed Sensor Replacement in this section of the manual.

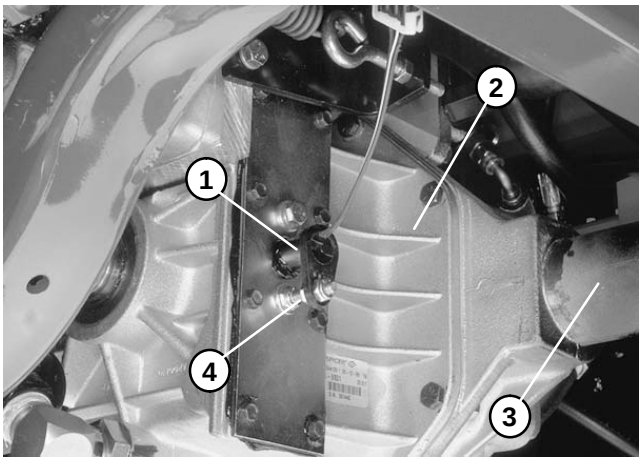


Figure 37

1. **Traction speed sensor**
2. **Differential gear box**
3. **Front right axle**
4. **Jam nut**

Speedometer

The speedometer can be tested using a DC pulse generator, or by verifying the gear tooth sensor is operating properly and operating the machine with the wheels off the ground.

CAUTION

Make sure the voltage source is turned OFF before connecting it to the electrical circuit to avoid electrical shock and prevent damaging the gauge.

Using Pulse Generator

1. Connect speedometer to the pulse generator and DC voltage source (Fig. 38).

2. Take test point readings (Fig. 39).

   A. Set generator to **325.2 Hertz**. Apply signal to circuit. The needle should point to **4 MPH**.

   B. Set generator to **650.4 Hertz**. Apply signal to circuit. The needle should point to **8 MPH**.

   C. Set generator to **975.6 Hertz**. Apply signal to circuit. The needle should point to **12 MPH**.

3. Turn off the voltage source. Disconnect voltage source, gauge, and variable resistance.

Using Traction Speed Sensor

CAUTION

When testing the speedometer using the gear tooth sensor, make sure all moving wheels are properly lifted and secured off the ground to prevent the machine from moving and causing personal injury. All wheels must be off the ground with 4WD units

1. Verify with Ace Diagnostic tool that the traction speed sensor is operating properly.

2. Lift all wheels that will be moving off the ground.

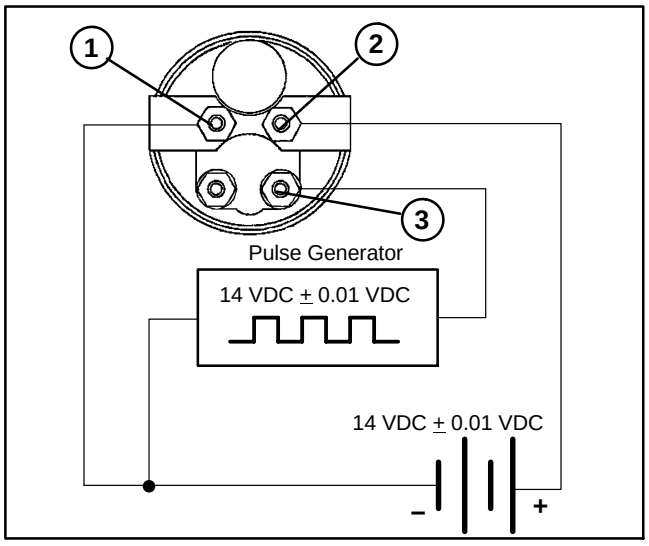


Figure 38

1. Ground terminal
2. Ignition switch terminal
3. Temp sender terminal

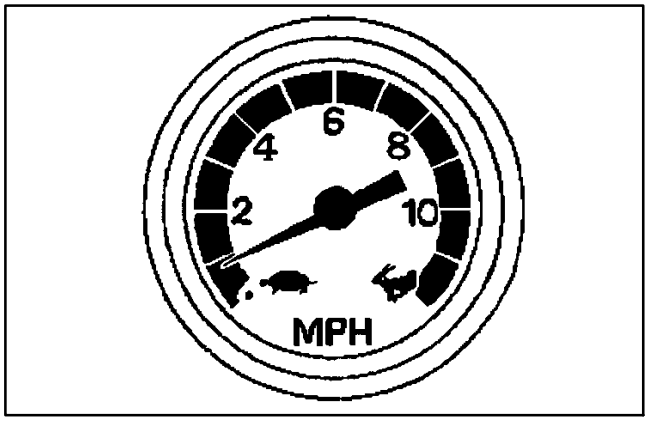


Figure 39

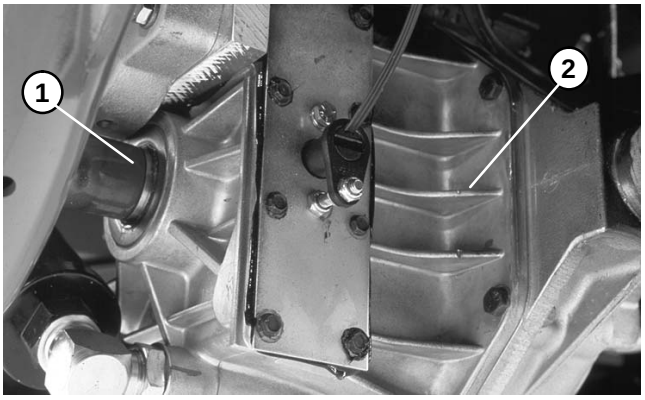


Figure 40

1. Pinion shaft (2WD)
2. Differential housing

3. Start engine. Verify pinion shaft or traction shaft (4WD units) speed (RPM) with phototac. Check corresponding speed on the speedometer (Fig. 40 and 41)

4. Turn off engine. Replace meter as necessary.

Pinion Speed (RPM)	Speedometer (MPH)
291.2	4
582.4	8
873.6	12

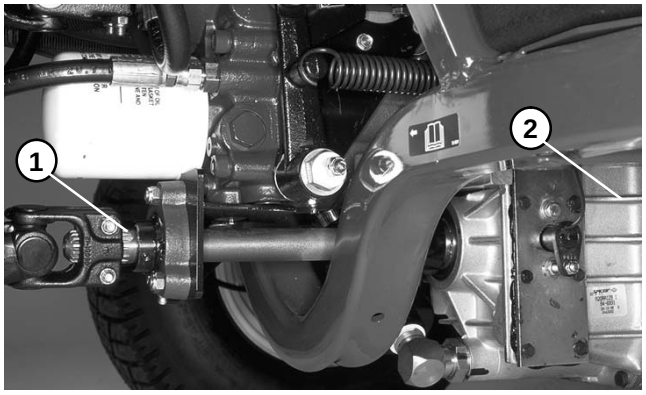


Figure 41

1. Traction shaft (4WD) **2. Differential housing**

Reels Enable/Disable and Backlap Switches

The reels enable/disable switch is attached to the instrument panel. It is a three position switch that is maintained in any of its three positions. Positioning the toggle back closes the switch between the back (brown wire) and center (black wire) terminals. Positioning the toggle forward closes the switch between the front (orange wire) and center terminals (Fig. 42).

The backlap switch is under the seat. It is a three position switch that is maintained in any of its three positions. Positioning the toggle to the right closes the switch between the right (white wire) and center (black wire) terminals. Positioning the toggle to the left closes the switch between left (blue wire) and center terminals (Fig. 43).

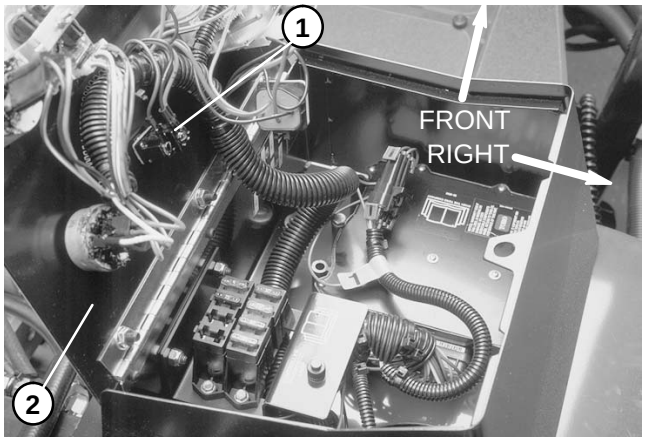


Figure 42

1. Reel enable/disable switch **2. Instrument panel**

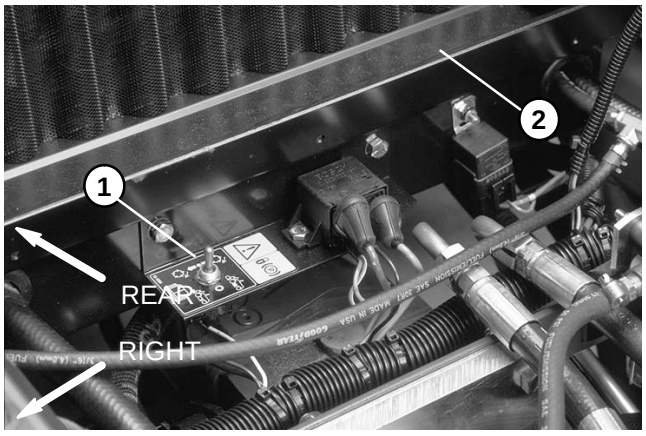


Figure 43

1. Backlap switch **2. Radiator shield**

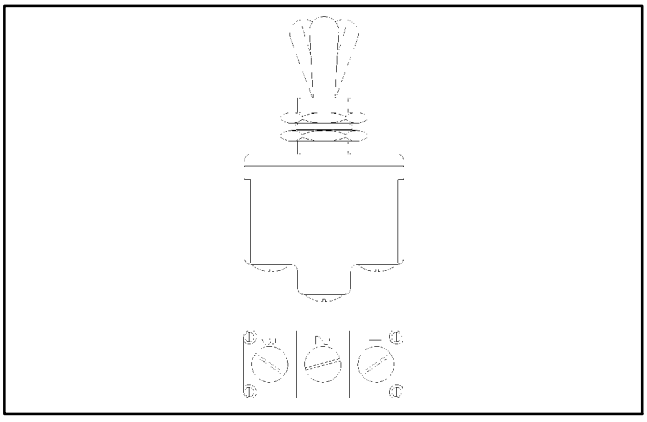


Figure 44

Traction Neutral Switch

The switch is located on the right side of the transmission. It uses its normally open contact that is closed by the switch arm depressing the plunger when the traction pedal is in the neutral position. When the traction pedal is depressed in either the forward or reverse direction, the switch arm releases the plunger on the switch and its normally open contact opens.

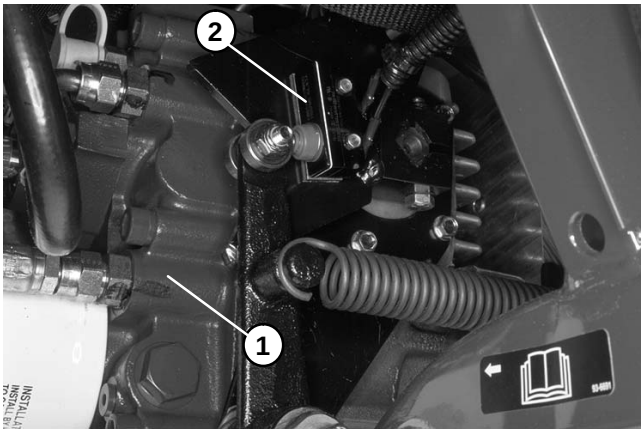


Figure 45

1. **Transmission**
2. **Neutral switch**
3. **Switch arm**

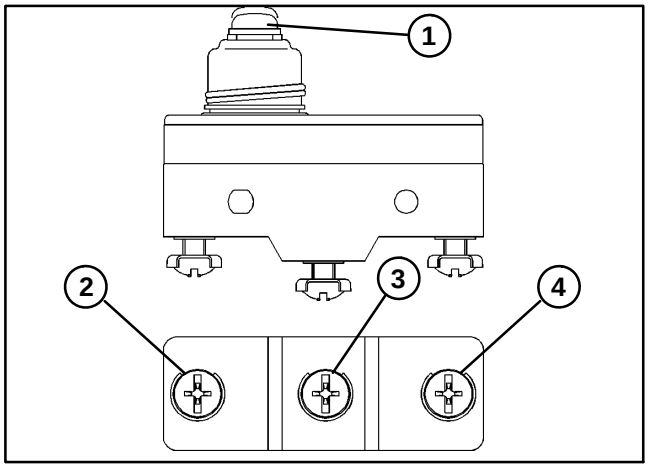


Figure 46

1. **Plunger**
2. **Ground**
3. **Normally open**
4. **Normal closed**

Seat Sensor

The sensor consists of two parts. The reed switch is located on the lower bracket of the seat suspension mechanism and has a normally open contact. The switch actuator is located on the upper plate of the seat suspension mechanism and is made of a magnetic material. When the operator sits in the seat, the magnetic field of the actuator is positioned near the reed switch and the contact in the switch closes. The switch has a electrical connector that can be accessed when the seat is raised.

1. Raise the seat to get access to the seat sensor wiring connector.

2. Disconnect the seat sensor wiring connector and install a continuity tester or ohm meter between the two leads of the seat sensor.

3. Lower the seat. The continuity tester should show no continuity.

Note: Make sure the compression spring holds the seat up off the seat sensor when there is no operator on the seat.

4. Have the operator sit on the seat, slowly depressing the seat sensor magnet. The continuity tester should show continuity as the seat approaches the bottom of its travel.

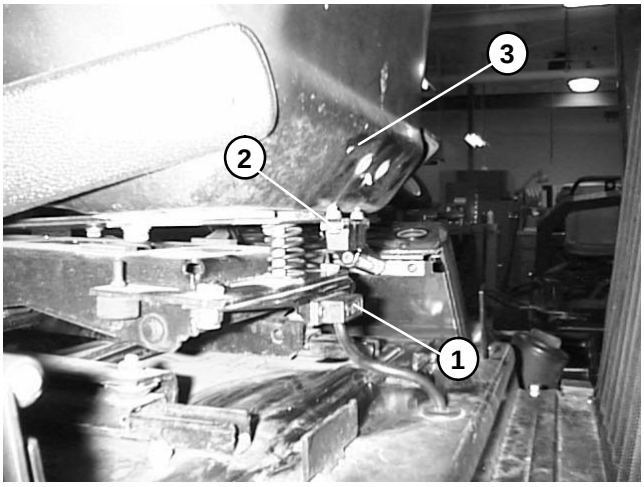


Figure 47

1. **Reed switch**
2. **Switch actuator**
3. **Seat back**

Joystick Raise and Lower/Mow Switches

Two micro switches for the joy stick are located on the lift control mechanism that is inside the control console. The rear switch on the mechanism is used to lower the reels and the front switch to raise them. A normally open contact closes when the joy stick is positioned to either to lower or raise the reels. Each switch has a electrical connector to make sure the normally closed contact on the switch is not used. The raise switch has violet and black wires connected to it and the lower switch has pink and black wires.

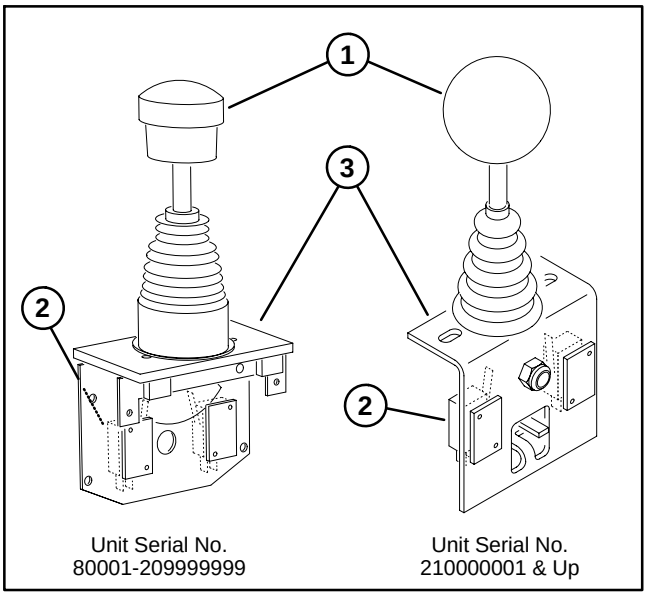


Figure 48

1. **Joy stick**
2. **Micro switch**
3. **Lift control mechanism**

Front Reels Down Sensor

The sensor consists of two parts. The reed switch is located on the left end of the carrier frame and has a normally open contact. The switch actuator is located on the left lift arm and is made of a magnetic material. When the front reels are lowered, the magnetic field of the actuator is positioned near the reed switch, and the contact in the switch closes. The switch has a electrical connector attached to the carrier frame.

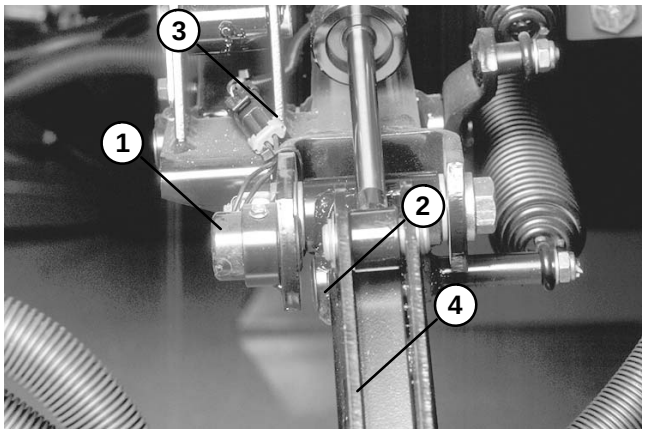


Figure 49

1. **Reed switch**
2. **Switch actuator**
3. **Carrier frame**
4. **Lift arm (LH)**

Service and Repairs

NOTE: For more component repair information, see the Kubota Workshop Manual, Diesel Engine, 05 Series at the end of Chapter 3 - Kubota Diesel Engines.

Battery Storage

If the machine will be stored for more than 30 days

1. Remove the battery and charge it fully (see Battery Service).

2. Either store battery on a shelf or on the machine.

3. Leave cables disconnected if the battery is stored on the machine.

4. Store battery in a cool atmosphere to avoid quick deterioration of the battery charge.

5. To help prevent the battery from freezing, make sure it is fully charged (see Battery Service).

Battery Care

1. Battery electrolyte level must be properly maintained. The top of the battery must be kept clean. If the machine is stored in a location where temperatures are extremely high, the battery will run down more rapidly than if the machine is stored in a location where temperatures are cool.

WARNING

Wear safety goggles and rubber gloves when working with electrolyte. Charge battery in a well ventilated place so gasses produced while charging can dissipate. Since the gases are explosive, keep open flames and electrical sparks away from the battery; do not smoke. Nausea may result if the gases are inhaled. Unplug charger from electrical outlet before connecting or disconnecting charger leads to or from battery posts.

IMPORTANT: Do not remove fill caps while cleaning.

2. Check battery condition weekly or after every 50 hours of operation. Keep terminals and entire battery case clean because a dirty battery will discharge slowly.

   A. Clean battery by washing entire case with a solution of baking soda and water. Rinse with clear water.

   B. Coat battery posts and cable connectors with Grafo 112X (skin-over) grease (Toro Part No. 505-47) or petroleum jelly to prevent corrosion.

3. Battery cables must be tight on terminals to provide good electrical contact.

WARNING

Connecting cables to the wrong post could result in personal injury and/or damage to the electrical system.

4. If corrosion occurs at terminals, disconnect cables. Always disconnect negative (-) cable first. Scrape clamps and terminals separately. Reconnect cables with positive (+) cable first. Coat battery posts and cable connectors with Grafo 112X (skin-over) grease (Toro Part No. 505-47) or petroleum jelly to prevent corrosion.

5. Check electrolyte level every 25 operating hours, and every 30 days if machine is in storage.

6. Maintain cell level with distilled or demineralized water. Do not fill cells above the fill line.

Battery Service

The battery is the heart of the electrical system. With regular and proper service, battery life can be extend. Additionally, battery and electrical component failure can be prevented.

CAUTION

When working with batteries, use extreme caution to avoid slashing or spilling electrolyte. Electrolyte can destroy clothing and burn skin or eyes. Always wear safety goggles and a face shield when working with batteries.

Electrolyte Specific Gravity
Fully charged: 1.265 corrected to 80°F (26.7°C)
Discharged: less than 1.240

Battery Specifications
BCI Group Size 26:
550 CCA at 0° F (-17.8° C)
Reserve Capacity of 85 minutes at 80°F (26.7°C)

Dimensions (including terminal posts and caps)

Length	8.50 inches (21.59 cm)
Width	6.80 inches (17.27 cm)
Height	7.96 inches (20.22 cm)

Removal (Fig. 50)

IMPORTANT: Be careful not to damage terminal posts or cable connectors when removing the battery cables.

1. Open engine hood. Loosen battery retainer securing the battery to the frame.

2. Loosen nut on ground cable (-) post first and remove cable from battery. This should prevent short circuiting the battery, other components, or the operators hands.

3. Loosen nut on positive (+) cable post and remove cable from battery.

4. Make sure battery vent caps are on tightly.

5. Remove battery from the battery compartment to a service area to allow better access for service.

Inspection, Maintenance, and Testing

1. Perform following inspections and maintenance:

   A. Check for cracks. Replace battery if cracked or leaking.

   B. Check battery terminal posts for corrosion. Use wire brush to clean corrosion from posts.

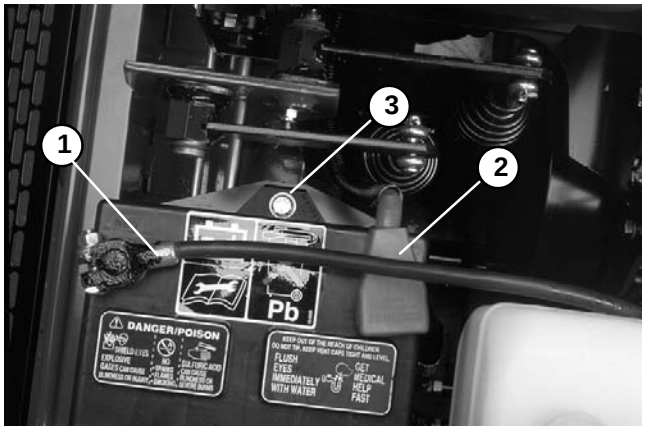


Figure 50

1. **Ground cable**
2. **Positive cable**
3. **Battery retainer**

IMPORTANT: Before cleaning the battery, tape or block vent holes to the filler caps and make sure the caps are on tightly.

C. Check for signs of wetness or leakage on the top of the battery which might indicate a loose or missing filler cap, overcharging, loose terminal post, or overfilling. Also, check battery case for dirt and oil. Clean the battery with a solution of baking soda and water, then rinse it with clean water.

D. Check that the cover seal is not broken away. Replace the battery if the seal is broken or leaking.

E. Check the electrolyte level in each cell. If the level is below the tops of the plates in any cell, fill all cells with **distilled** water between the minimum and maximum fill lines. Charge at 15 to 25 amps for 15 minutes to allow sufficient mixing of the electrolyte.

2. Conduct a hydrometer test of the battery electrolyte.

IMPORTANT: Make sure the area around the cells is clean before opening the battery caps.

A. Measure the specific gravity of each cell with a hydrometer. Draw electrolyte in and out of the hydrometer barrel prior to taking a reading to warm-up the hydrometer. At the same time take the temperature of the cell.

B. Temperature correct each cell reading. For each 10°F (5.5°C) above 80°F (26.7°C) add 0.004 to the specific gravity reading. For each 10°F (5.5°C) below 80°F (26.7°C) subtract 0.004 from the specific gravity reading.

Example: Cell Temperature 100°F
Cell Gravity 1.245
100°F minus 80°F equals 20°F
(37.7°C minus 26.7°C equals 11.0°C)
20°F multiply by 0.004/10°F equals 0.008
(11°C multiply by 0.004/5.5°C equals 0.008)
ADD (conversion above) 0.008
Correction to 80°F (26.7°C) 1.253

C. If the difference between the highest and lowest cell specific gravity is 0.050 or greater or the lowest cell specific gravity is less than 1.225, charge the battery. Charge at the recommended rate and time given in **Charging** or until all cells specific gravity is 1.225 or greater with the difference in specific gravity between the highest and lowest cell less than 0.050. If these charging conditions can not be met, replace the battery.

3. Perform a high-discharge test with an adjustable load tester.

This is one of the most reliable means of testing a battery as it simulates the cold-cranking test. A commercial battery load tester is **required** to perform this test.

CAUTION

Follow the manufacturer's instructions when using a battery tester.

A. Check the voltage across the battery terminals prior to testing the battery. If the voltage is less than 12.4 VDC, recharge the battery.

B. If the battery has been charged, apply a 150 amp load for 15 seconds to remove the surface charge. Use a battery load tester following the manufacturer's instructions.

C. Make sure battery terminals are free of corrosion.

D. Measure the temperature of the center cell.

E. Connect a battery load tester to the battery terminals **following the manufacturer's instruction**s. Connect a digital multimeter to the battery terminals.

F. Apply a test load of one half the Cranking Performance (see Battery Specifications) rating of the battery for 15 seconds.

G. Take a voltage reading at 15 seconds, then remove the load.

H. Using the table below, determine the minimum voltage for the cell temperature reading.

Minimum Voltage	Battery Electrolyte Temperature	
9.6	70°F (and up)	21.1°C (and up)
9.5	60°F	15.6°C
9.4	50°F	10.0°C
9.3	40°F	4.4°C
9.1	30°F	-1.1°C
8.9	20°F	-6.7°C
8.7	10°F	-12.2°C
8.5	0°F	-17.8°C

I. If the test voltage is below the minimum, replace the battery. If the test voltage is at or above the minimum, return the battery to service.

Installation

IMPORTANT: To prevent possible electrical problems, install only a fully charged battery.

1. Make sure ignition and all accessories are **off**.

2. Make sure battery compartment is clean and repainted if necessary.

3. Make sure all battery cables and connections are in good condition and battery retainer has been repaired or replaced.

4. Place battery in its compartment. Make sure battery is level and flat. Connect positive cable connector onto positive battery post. Tighten cap screw and lock nut with two wrenches.

5. Secure battery retainer. Do not overtighten to prevent cracking or distorting the battery case.

6. Apply a light coat of skin-over grease on all battery posts and cable connectors to reduce corrosion after connections are made.

7. Connect a digital multimeter (set to amps) between the negative battery post and the negative (ground) cable connector. The reading should be less than 0.1 amp. If the reading is 0.1 amp or more, the unit's electrical system should be tested and repaired.

8. Connect negative (ground) cable connector to the negative battery post. Tighten cap screw and lock nut with two wrenches.

Charging

To minimize possible damage to the battery and allow the battery to be fully charged, the slow charging method is presented here. This charging method can be accomplished with a constant current battery charger which is available in most shops.

CAUTION

Follow the manufacturer's instructions when using a battery charger.

NOTE: Using specific gravity of the battery cells is the most accurate method of determining battery condition.

1. Determine the battery charge level from either its open specific gravity or circuit voltage.

Battery Charge Level	Specific Gravity	Open Circuit Voltage
100%	1.265	12.68
75%	1.225	12.45
50%	1.190	12.24
25%	1.155	12.06
0%	1.120	11.89

2. Determine the charging time and rate **using the manufacturer's battery charger instructions** or the following table.

Battery Reserve Capacity (Minutes)	Battery Charge Level (Percent of Fully Charged)			
	75%	50%	25%	0%
80 or less	3.8 hrs @ 3 amps	7.5 hrs @ 3 amps	11.3 hrs @ 3 amps	15 hrs @ 3 amps
81 to 125	5.3 hrs @ 4 amps	10.5 hrs @ 4 amps	15.8 hrs @ 4 amps	21 hrs @ 4 amps
126 to 170	5.5 hrs @ 5 amps	11 hrs @ 5 amps	16.5 hrs @ 5 amps	22 hrs @ 5 amps
171 to 250	5.8 hrs @ 6 amps	11.5 hrs @ 6 amps	17.3 hrs @ 6 amps	23 hrs @ 6 amps
above 250	6 hrs @ 10 amps	12 hrs @ 10 amps	18 hrs @ 10 amps	24 hrs @ 10 amps

CAUTION

Do not charge a frozen battery because it can explode and cause injury. Let the battery warm to 60°F (15.5° C) before connecting to a charger.

Charge the battery in a well-ventilated place to dissipate gases produced from charging. These 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.

3. **Following the manufacturer's instructions**, connect the charger cables to the battery. Make sure a good connection is made.

4. Charge the battery **following the manufacturer's instructions**.

5. Occasionally check the temperature of the battery electrolyte. If the temperature exceeds 125°F (51.6°C) or the electrolyte is violently gassing or spewing, the charging rate must be lowered or temporarily stopped.

6. Three hours prior to the end of the charging, measure the specific gravity of a battery cell once per hour. The battery is fully charged when the cells are gassing freely at a low charging rate and there is less than a 0.003 change in specific gravity for three consecutive readings.

Traction Speed Sensor Replacement

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Jack up the front end of the machine about 1 ft (30 cm) to prevent transmission fluid from leaking from the gear box when the sensor is removed (see Jacking Instructions in Chapter 1 - Safety).

3. Disconnect electrical connector from the harness.

IMPORTANT: The position of the sensor within the gear box is very critical for proper operation. When removing the sensor, do not change the position of the jam nut. A new sensor must be replaced in the same position as the old sensor (Fig. 51).

4. Remove lock nut, sensor and O-ring from the machine screw and gear cover. Inspect O-ring for damage.

Installation

1. Lubricate O-ring and bore of the mounting plate with grease. Install O-ring into groove of the mounting plate.

2. Install sensor opening in gear plate so the machine screw goes through the hole in the sensor ear.

IMPORTANT: Do not change the position of the jam nut when tightening the lock nut to the machine screw.

3. Secure sensor to the machine screw with lock nut.

4. If the position of the jam nut is changed,

   A. Run jam nut down the machine screw until it contacts the mounting plate.

   B. Insert sensor into hole in cover so hole in sensor goes over the long machine screw.

   C. Make sure sensor contacts the axle gear.

   D. Thread jam nut out until it contacts the sensor.

   E. turn jam nut one more complete turn to pull the sensor out from the gear.

   F. Secure sensor to the machine screw with lock nut.

5. Lower the machine to the ground.

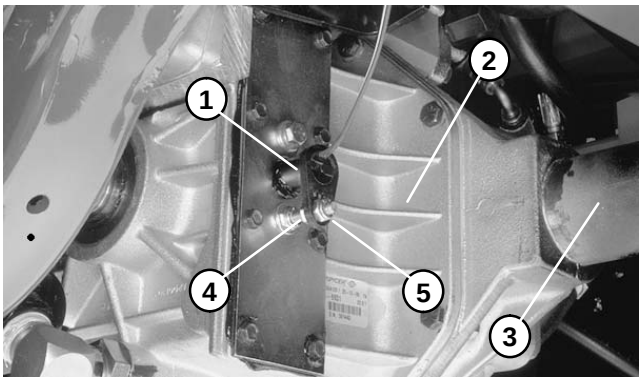


Figure 51

1. Traction speed sensor
2. Differential gear box
3. Front right axle
4. Jam nut
5. Lock nut

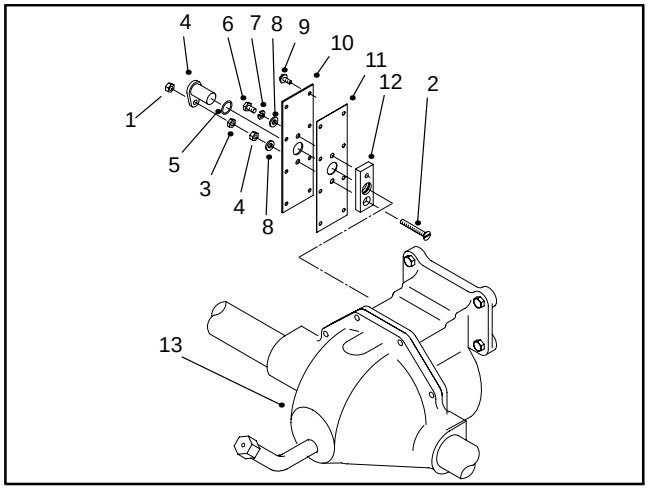


Figure 52

1. Lock nut
2. Machine screw
3. Jam nut
4. Traction speed sensor
5. O-ring
6. Cap screw
7. Lock washer
8. Flat washer
9. Cap screw
10. Gear cover
11. Axle gasket
12. Sensor mounting plate
13. Differential gear box

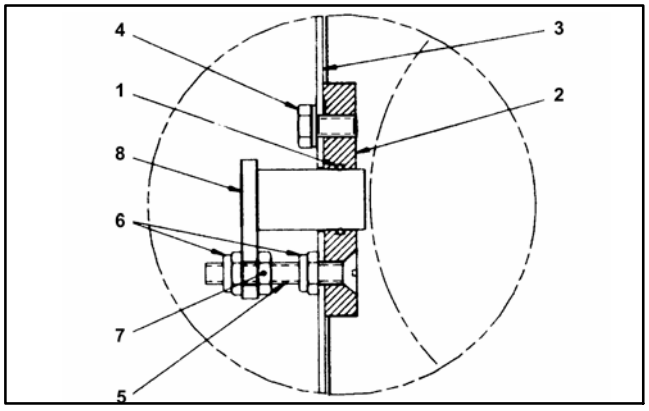


Figure 53

1. O-ring
2. Mounting plate
3. Cover
4. Cap screw & lock washer
5. Machine screw
6. Lock nut
7. Jam nut
8. Sensor

Chapter 6

Differential Axle

Table of Contents

Introduction

The Reelmaster® 5200-D/5400-D uses a Dana® Hydrostatic Axle, model GT-20. The differential and axle form the final drive of the power train (Fig. 1).

The differential has a heavy duty case with automotive type, cut gears that rotate on tapered roller bearings. Single-row, pre-set, tapered roller bearings are used on the outside ends of the axle shafts.

The entire drive line of the axle assembly is made of alloy steel. The axle has a die-cast aluminum housing that also serves as the hydraulic oil reservoir.

Power is transmitted from the transmission output gear to the pinion spur gear. The pinion spur gear transmits power directly to the differential drive gears, to turn the axles and the wheels.

The differential axle has a one-piece axle shaft with the flange being part of the axle stem (Fig. 2).

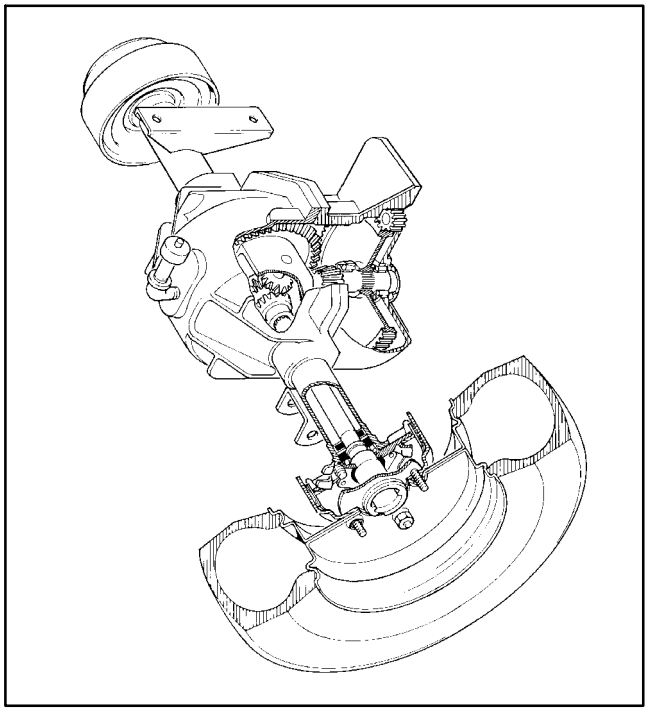


Figure 1

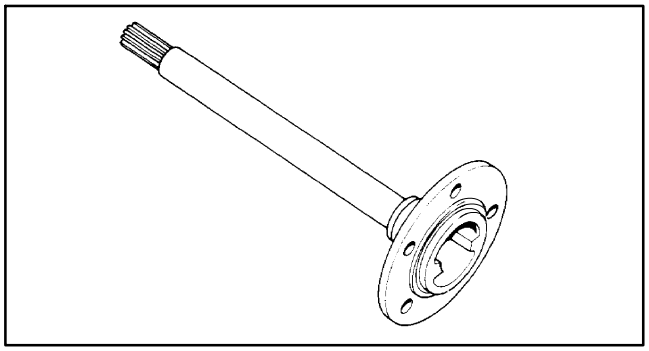


Figure 2

Specifications

Item	Specification
Front wheel lug nut torque	45 to 55 ft-lbs (61 to 75 Nm)
Front to rear housing torque	18 to 28 ft-lbs. (24 to 38 Nm)
Transmission to axle torque	25 to 30 ft-lbs. (34 to 41 Nm)
Differential bearing cap torque	30 to 45 ft-lbs. (41 to 61 Nm)
Pinion coupler nut torque	75 to 90 ft-lbs. (100 to 122 Nm)
Ring gear to differential case torque	45 to 65 ft-lbs. (61 to 89 Nm)
Fill pipe torque	20 to 30 ft-lbs. (27 to 41 Nm)
Side plate (gear cover) torque	25 to 40 ft-lbs. (34 to 54 Nm)
Axle bearing retainer/seal plate (screw) torque (Serial No. 80001 - 200000200)	16 to 20 ft-lbs. (22 to 27 Nm)
Axle bearing cap (screw) torque (Serial No. 200000201 & Up)	32 to 35 ft-lbs. (43 to 47 Nm)
Ring gear to pinion gear backlash	0.003 to 0.007 in. (0.076 to 0.178 mm)
Pinion gear end play	0.000 to 0.005 in. (0.000 to 0.127 mm)

Special Tools

Order special tools from your Toro Distributor.

Differential Gear Holder (TOR4027)

Remove gear cover from right hand side of differential and bolt this tool in place to lock spur gear in position when removing nut that secures pinion coupler to differential pinion shaft.

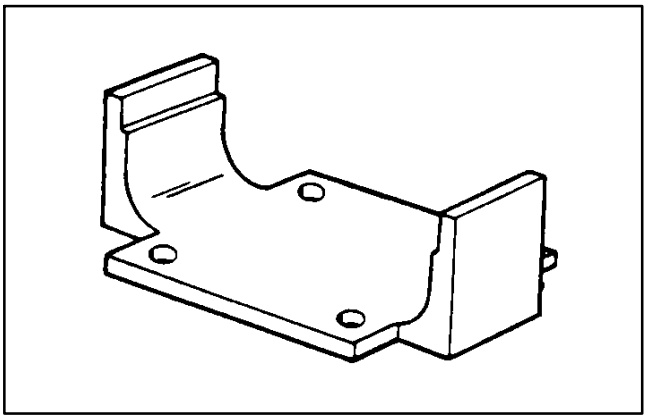


Figure 3

Axle Assembly Removal and Installation

1. Put machine on a level surface, lower cutting units, stop the engine and remove key from ignition switch. Block rear wheels to prevent machine from moving.

2. Remove the cutting units (See the Repairs section of Chapter 8 - Cutting Units).

3. If unit is equipped with 4WD, remove rear axle drive shaft (see Chapter 9 - 4WD Rear Axle). Remove nut, pinion spacer and pinion coupler.

4. Remove hydrostatic transmission. (See Repairs section of Chapter 4 - Hydraulic System.) Keep transmission support attached to frame and gear pump attached to transmission support.

5. Slightly loosen all front wheel lug nuts. Jack both front wheels off the ground and install jackstands or blocks under traction unit frame (not axle tubes) to prevent machine from falling. Remove both front wheels.

6. Remove the cotter pin and clevis pin to disconnect the brake cable from brake actuating lever on each brake. Loosen jam nut to remove brake cable from each end of axle bracket. Disconnect speedometer sensor wire connector.

7. Put a jack or block under differential to hold it in place. Remove cap screws and lock nuts securing axle mounting pads to frame. Carefully lower differential axle and pull it out from under traction unit.

8. To install axle, reverse steps 1 - 9. Apply silicone sealant between axle housing and transmission support. Leave axle mounting pad nuts loose. Install shims (P/N 42-6080) between axle mounting pads and frame to align differential with transmission support, then tighten axle mounting nuts.

9. Before installing pinion coupler, apply Permatex® No. 2 to external splines of pinion and internal splines of pinion coupler. Tighten nut securing pinion coupler to 75 to 90 ft-lbs (100 to 122 Nm).

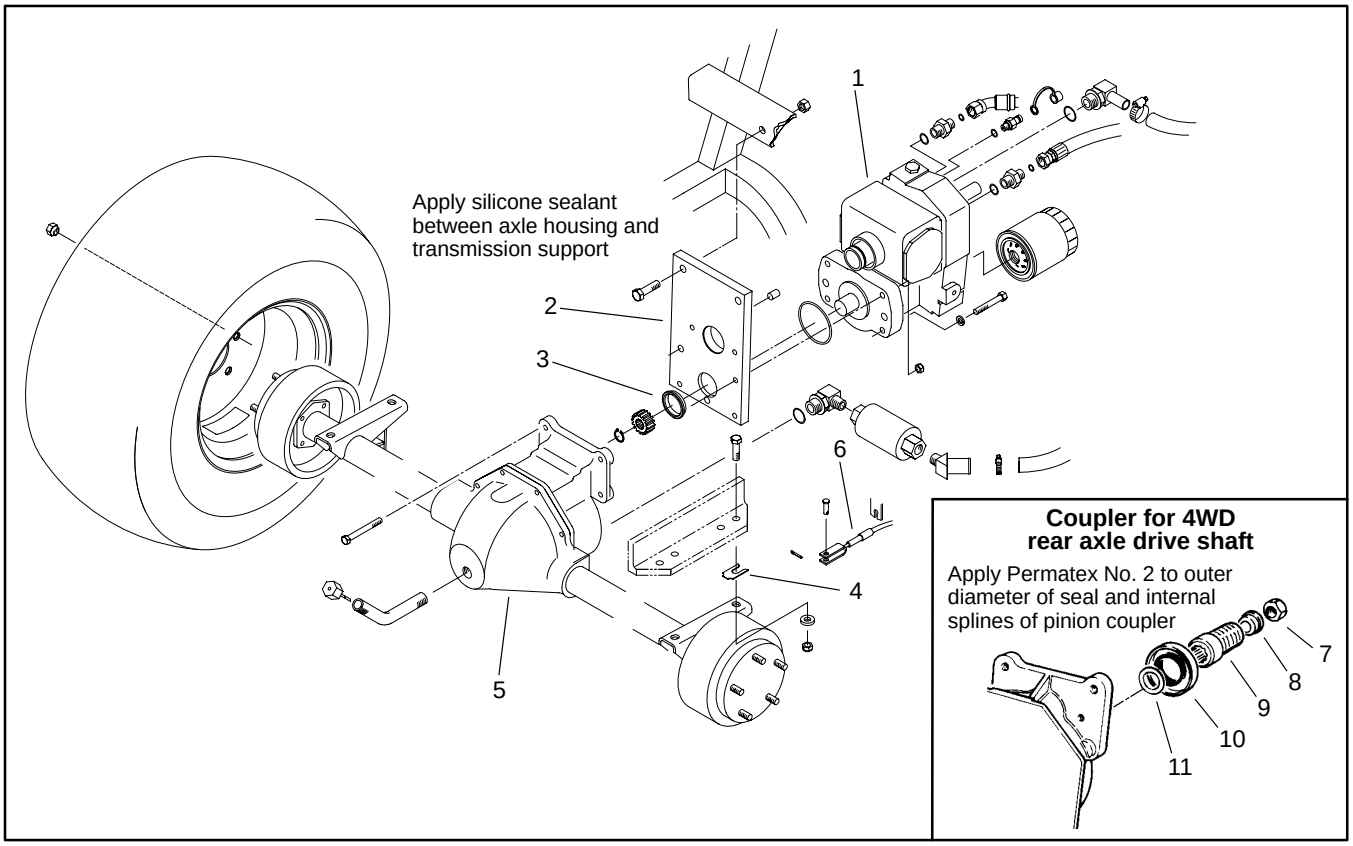


Figure 4

1. **Hydrostatic transmission**
2. **Transmission support**
3. **Transmission collar**
4. **Axle shim**
5. **Differential axle**
6. **Brake cable**
7. **Nut**
8. **Spacer**
9. **Pinion coupler**
10. **Seal**
11. **Shim**

Axle Shafts and Wheel Bearings (Serial No. 80001 - 200000200)

Disassembly

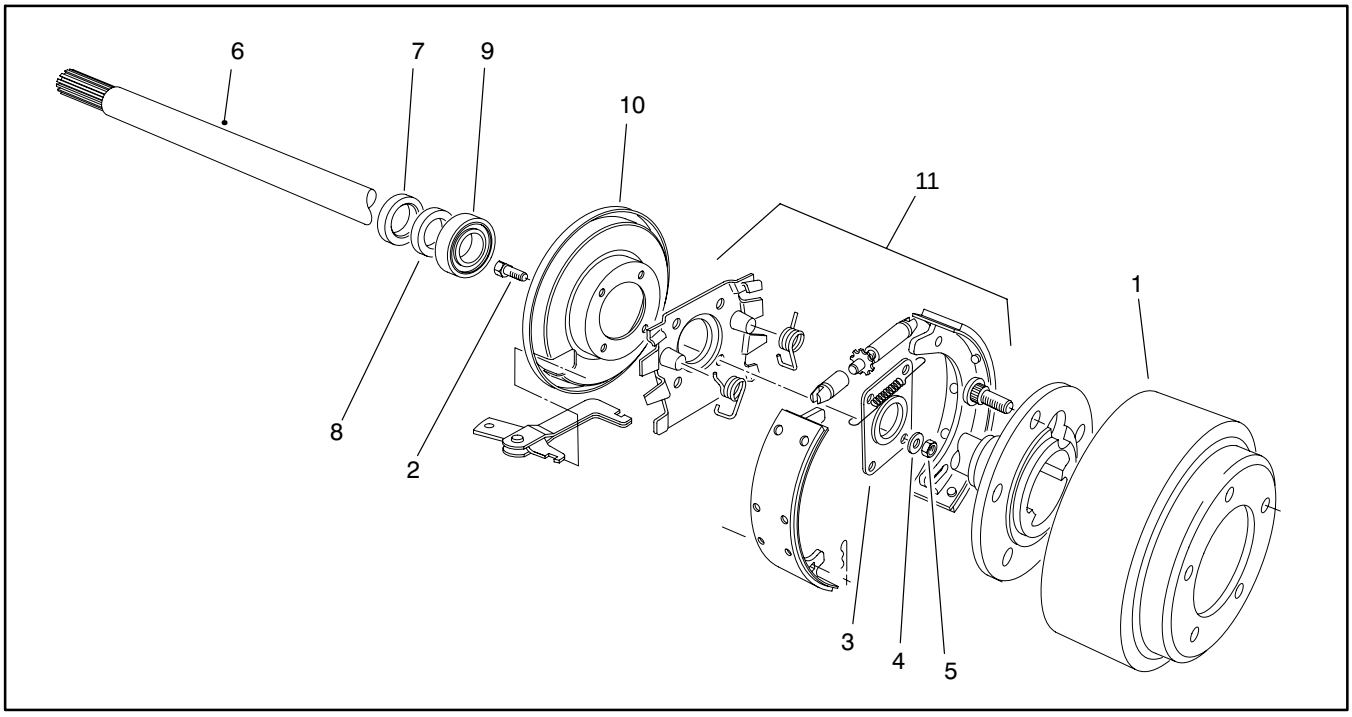


Figure 5

1. **Brake drum**
2. **Bearing retainer/seal plate screw**
3. **Outer seal plate**
4. **Washer**
5. **Locknut**
6. **Axle shaft**
7. **Axle shaft inner seal**
8. **Bearing retainer**
9. **Bearing**
10. **Brake backplate**
11. **Brake assembly**

1. Remove axle from traction unit.

2. Slide the brake drum off of the axle flange (Fig. 6).

NOTE: If the brake drum is severely worn, it may be necessary to loosen the brake shoes before removing the brake drum. Loosen the brake shoes by turning the star wheel inside the brake drum assembly (See Chapter 7 - Steering and Brakes).

Figure 6

3. Align the holes in the axle shaft flange with the backing plate/bearing retainer nuts. Remove and discard the nuts, washers, and bearing retaining bolts (Fig. 7).

IMPORTANT: Hold the socket head screws with a hex wrench to prevent the screw head from damaging the axle tube.

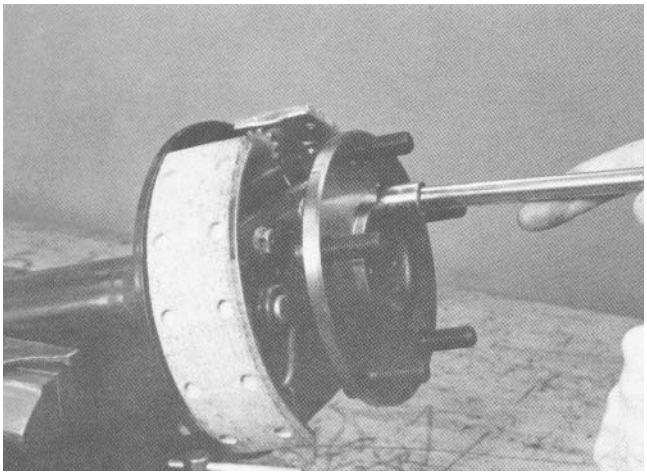


Figure 7

4. Pull the axle shaft and brake assembly out of the axle housing (Fig 8).

NOTE: Remove the bearing race from the axle housing with a bearing puller if necessary.

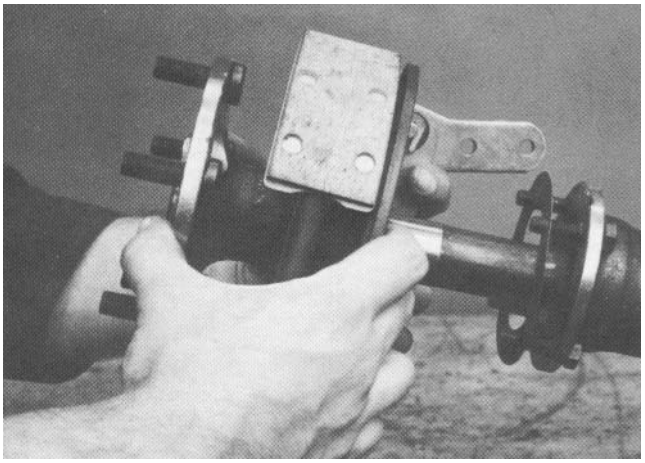


Figure 8

5. Remove and discard the inner axle shaft seal (Fig. 9).

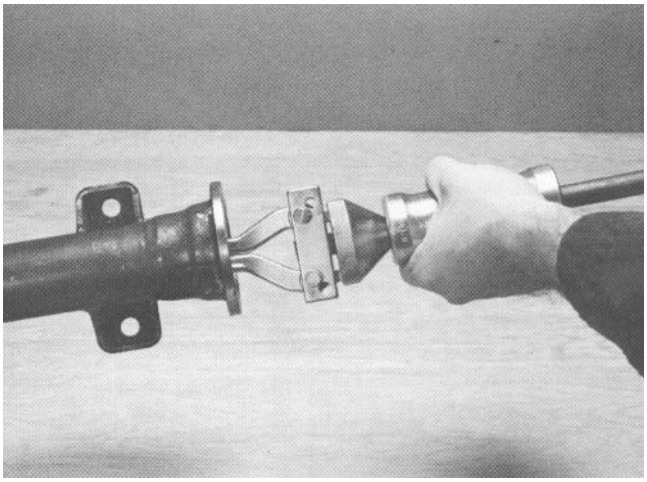


Figure 9

6. Center punch and drill a 1/4 inch hole (approximate) into the outside of the bearing retainer to a depth of about 3/4 the thickness of the retainer (Fig. 10).

IMPORTANT: Drilling completely through the retainer ring will damage the axle shaft.

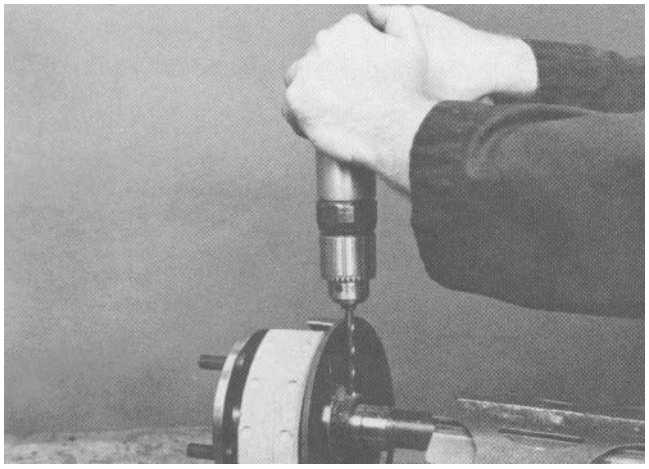


Figure 10

7. Place a chisel in position across the drilled hole and strike sharply to break the retainer (Fig. 11). Remove and discard the retainer.

WARNING

Wear protective safety goggles when breaking the retaining ring. Personal injury could result from flying metal particles. Keep all personnel away during this procedure.

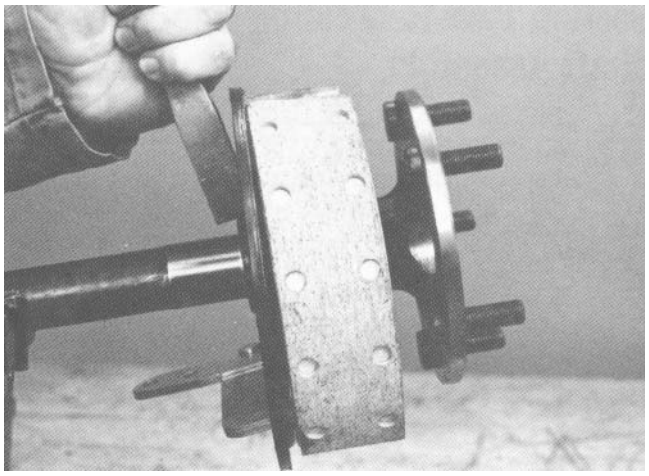


Figure 11

8. Remove the bearing.

9. Remove and discard the outer seal plate.

10. Inspect all components for wear and damage (Fig. 12). Replace the hub and shaft if the seal has grooved the axle surface more that 1/64 inch (0.4 mm).

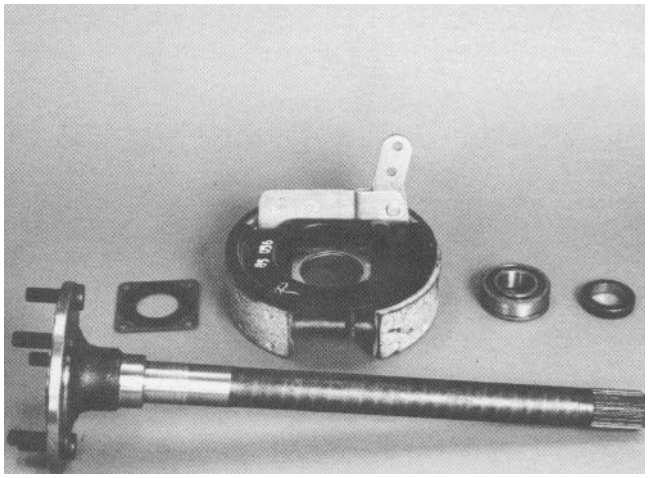


Figure 12

Assembly

1. Coat a new outer seal plate with a thin film of oil and place the seal plate and brake assembly in position on the axle shaft.

2. Pack the bearing with grease and press it onto the axle shaft (Fig. 13).

IMPORTANT: Drive the bearing onto the axle shaft by pressing on the inner race of the bearing only.

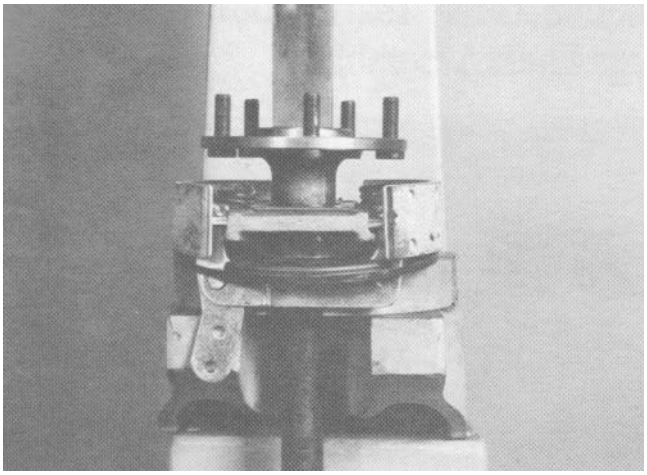


Figure 13

3. Slide a new bearing retainer on the axle shaft. Support the shaft and retainer in a suitable press and push the bearing retainer firmly against the bearing (Fig. 14).

IMPORTANT: Do not heat the bearing retainer to install. Heat will destroy the close tolerance press fit.

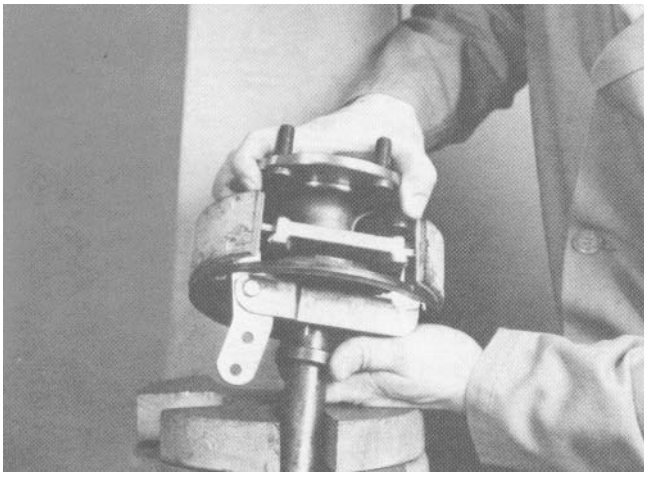


Figure 14

4. Prepare a new inner shaft seal for assembly. Put a light coat of No. 1 Permatex or equivalent on the outside diameter (surface that contacts the axle housing), and a thin film of oil on the inside diameter (surface that contacts the axle shaft. Install the new seal to a depth of 1.218 in. (30.9 mm) into the housing (Fig. 15).

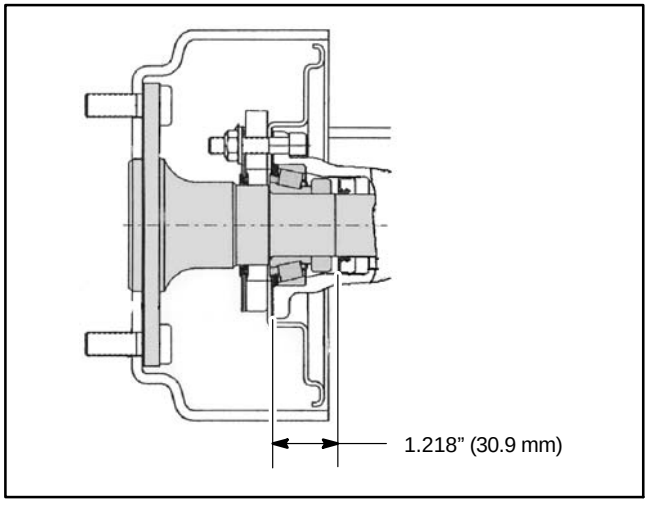


Figure 15

5. Apply a 0.0625” (16 mm) bead of gasket material to the axle housing flange. Align the brake backplate and brake assembly with axle housing flange and push the axle shaft assembly all the way into the axle housing. Be careful not to damage the oil seal and bearing (Fig. 16).

NOTE: Liquid Gasket Kit (Toro P/N 92-8775) includes Loctite® Ultra Gray, gasket eliminator, and instructions.

Figure 16

6. Use medium strength Loctite thread locker and install new bearing retaining bolts, washers, and nuts. Start the nuts onto the bolts by hand. Tighten the nuts in an alternating pattern so the bearing is drawn into the axle housing evenly (Fig. 17). Tighten the nuts to 16 to 20 ft-lbs. (22 to 27 Nm).

IMPORTANT: Hold the socket head screws with a hex wrench to prevent the screw head from damaging the axle tube.

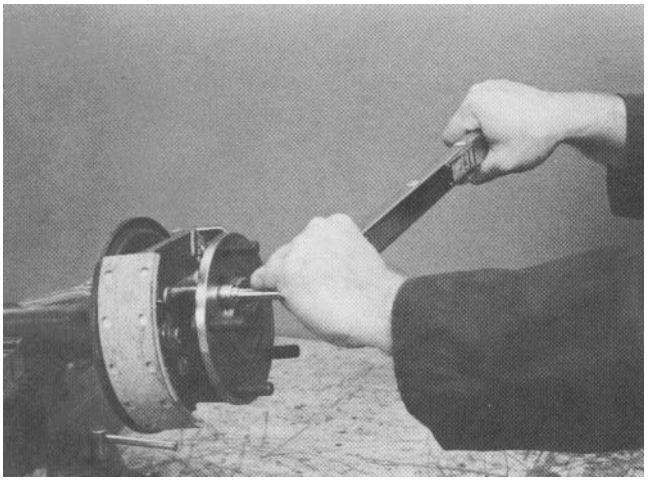


Figure 17

Axle Shafts and Wheel Bearings (Serial No. 200000201 & Up)

Lubrication

NOTE: It is not necessary to remove the axle assembly to lubricate the axle bearings.

1. Put machine on a level surface, lower cutting units, stop the engine and remove key from ignition switch. Block rear wheels to prevent machine from moving.

2. Slightly loosen all front wheel lug nuts. Jack both front wheels off the ground and install jackstands or blocks under traction unit frame (not axle tubes) to prevent machine from falling. Remove both front wheels.

3. Slide the brake drum off of the axle flange (Fig. 18).

NOTE: If the brake drum is severely worn, it may be necessary to loosen the brake shoes before removing the brake drum. Loosen the brake shoes by turning the star wheel inside the brake drum assembly (See Chapter 7 - Steering and Brakes).

4. Lubricate the wheel bearings through the grease fittings (one each wheel) with No. 2 general purpose lithium base grease (Fig 19).

WARNING

Do not to overfill bearing cavity with grease. Do not get grease on brake linings or inside brake drum. Greasy brake linings and drums increase vehicle stopping distance. Wipe brake linings and drums with brake cleaner or lacquer thinner and a clean rag if necessary.

5. Install brake drums and wheels. Tighten wheel lug nuts to 45-55 ft-lbs. (61-75 Nm).

Figure 18

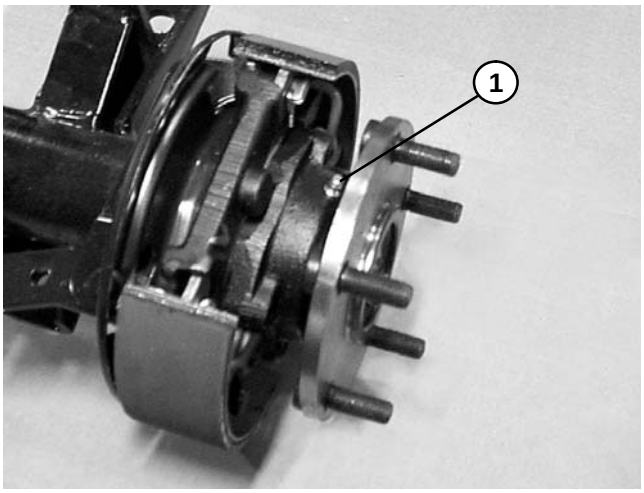


Figure 19

1. **Grease fitting**

Disassembly

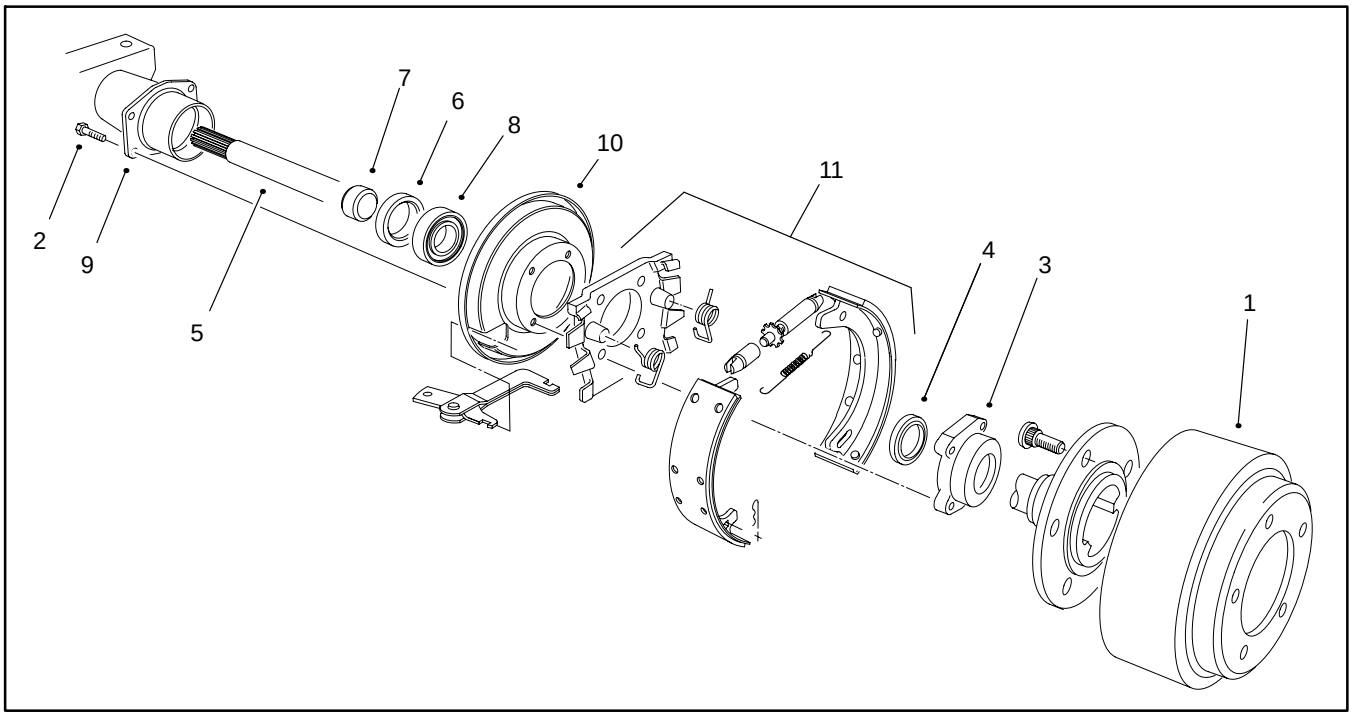


Figure 20

1. **Brake drum**
2. **Cap screw**
3. **Bearing cap**
4. **Bearing cap seal**
5. **Axle shaft**
6. **Inner axle shaft seal**
7. **Bearing retainer**
8. **Bearing**
9. **Axle housing**
10. **Brake assembly**
11. **Brake backplate**

1. Remove axle from traction unit.

2. Slide the brake drum off of the axle flange.

3. Remove cap screws securing bearing cap (Fig. 20).

4. Pull the axle shaft and bearing assembly out of the axle housing.

5. Remove and discard the inner axle shaft seal (Fig. 20).

6. Center punch and drill a 1/4 inch hole (approximate) into the outside of the bearing retainer to a depth of about 3/4 the thickness of the retainer.

IMPORTANT: Drilling completely through the retainer ring will damage the axle shaft.

7. Place a chisel in position across the drilled hole and strike sharply to break the retainer. Remove and discard the retainer.

WARNING

Wear protective safety goggles when breaking the retaining ring. Personal injury could result from flying metal particles. Keep all personnel away during this procedure.

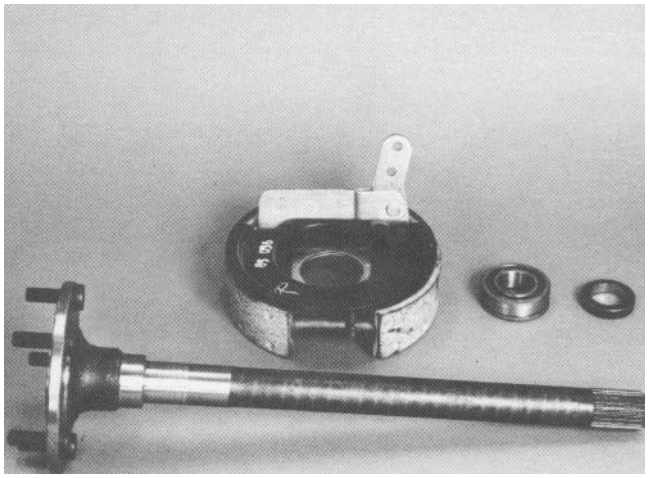


Figure 21

8. Remove the bearing.

9. Remove the bearing cap and discard the bearing cap seal (Fig. 20).

10. Inspect all components for wear and damage (Fig. 21). Replace the hub and shaft if the seal has grooved the axle surface more that 1/64 inch (0.4 mm).

Assembly

1. Coat a new bearing cap seal with a thin film of oil and install it in the bearing cap. Place the bearing cap and seal in position on the axle shaft.

2. Pack the bearing with grease and press it onto the axle shaft.

IMPORTANT: Drive the bearing onto the axle shaft by pressing on the inner race of the bearing only.

3. Slide a new bearing retainer on the axle shaft. Support the shaft and retainer in a suitable press and push the bearing retainer firmly against the bearing.

IMPORTANT: Do not heat the bearing retainer to install. Heat will destroy the close tolerance press fit.

4. Coat a new inner shaft seal with a thin film of oil. Install the new seal to a depth of 0.75 in. (19 mm) into the housing (Fig. 22).

5. Align the brake backplate and brake assembly with axle housing flange.

6. Push the axle shaft assembly all the way into the axle housing. Be careful not to damage the oil seal and bearing.

7. Use medium strength Loctite® thread locker and install the cap screws securing the bearing cap. Tighten the screws to 32 to 35 ft-lbs. (43 to 47 Nm).

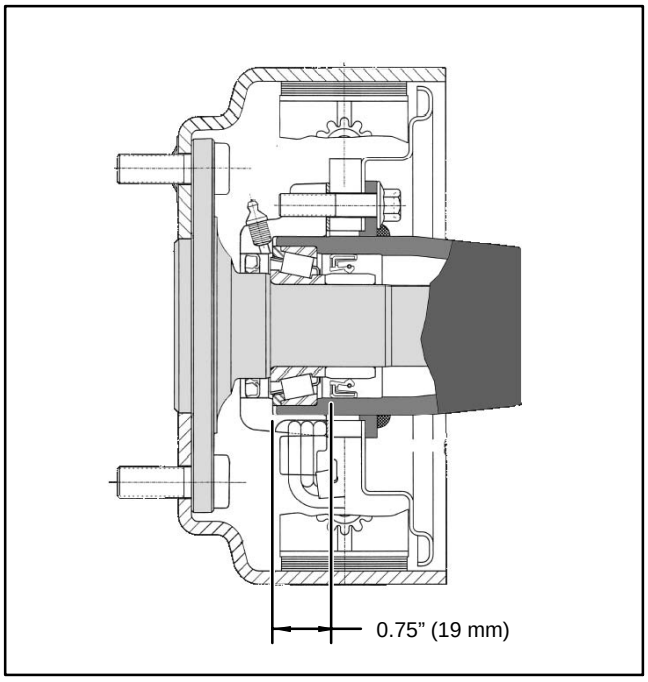


Figure 22

8. Install the brake drum.

9. Install the axle assembly on the traction unit.

10. Check and adjust the brakes if necessary (see Steering and Brakes chapter in this manual).

Differential and Housing (All Units)

Disassembly

1. Remove the right and left-hand axle assemblies (See Axle Shafts and Wheel Bearings Disassembly in this section of the book).

2. Remove the eight (8) housing cap screws and separate the upper and lower axle housings (Fig. 23). Clean the gasket material from the mating surfaces.

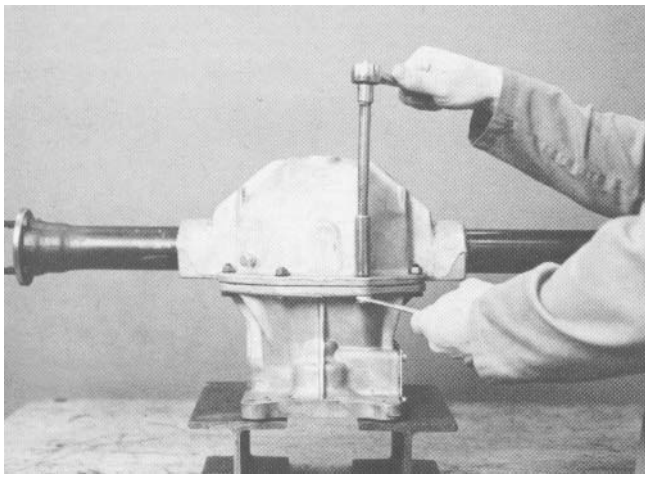


Figure 23

3. Remove the four bearing cap screws and remove the caps. Place the caps in a safe place to avoid damaging their machined surfaces (Fig. 24).

IMPORTANT: The bearing caps are marked for identification. The letters or numbers are in horizontal and vertical positions. Record them for reference during assembly. Always reinstall them in the same position.

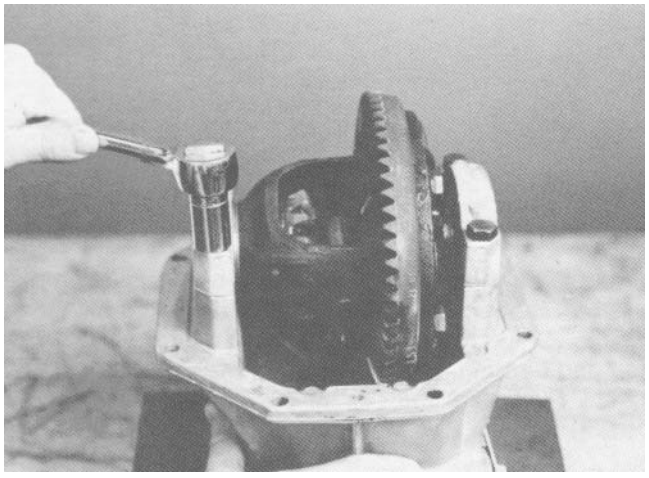


Figure 24

4. To remove the differential assembly, place two wooden devices (i.e. hammer handles) under the differential case and pry firmly upward. Mark the bearing cups and cones, they must be reinstalled in matched sets (Fig. 25).

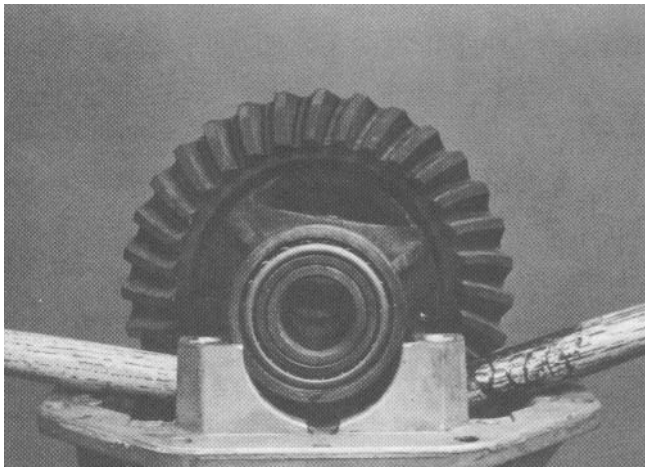


Figure 25

5. Remove the ring gear cap screws. Using a hard wooden block and a hammer, drive the ring gear off of the differential case. Be prepared to protect the ring gear when removing it from the differential case; this will avoid damage of the ring gear teeth (Fig. 26).

NOTE: It is recommended that whenever the ring gear screws are removed, they are to be replaced with new screws.

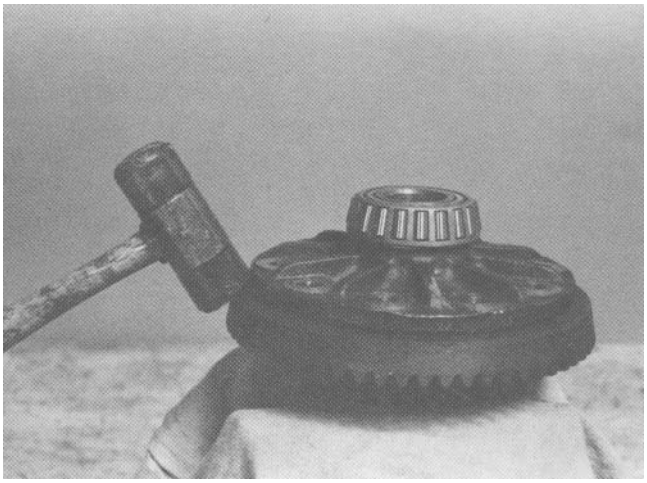


Figure 26

6. Do not remove the bearings from the differential case unless bearing failure is evident. It is recommended that whenever bearings are removed (regardless of usage) they must be replaced with new ones. Remove the case side bearing with a puller as shown (Fig. 27).

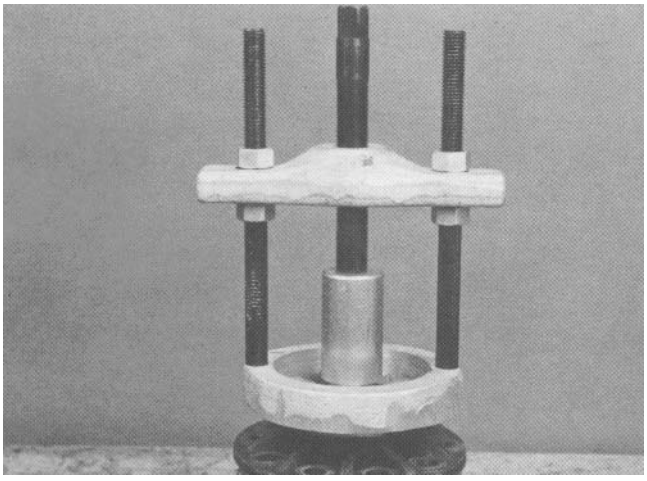


Figure 27

7. Put the case in a vise. Drive the lock pin out of the pinion shaft (Fig. 28). Use a small drift punch as shown.

WARNING

To prevent personal injury, always wear a face shield or safety goggles when striking a drift punch with a hammer.

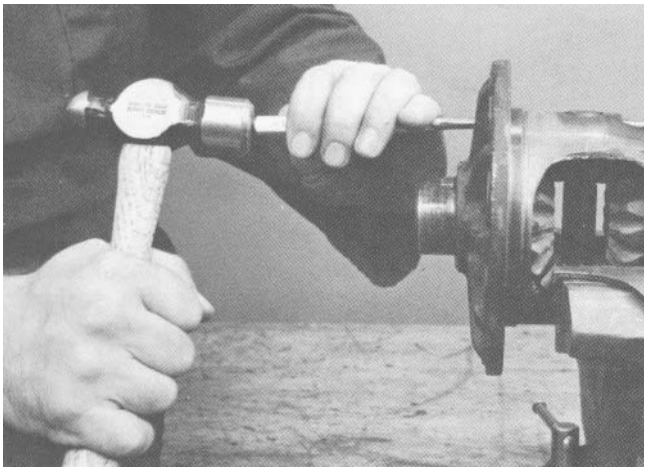


Figure 28

8. While supporting the differential in a vise, drive the pinion mate shaft from the differential with a long drift punch (Fig. 29).

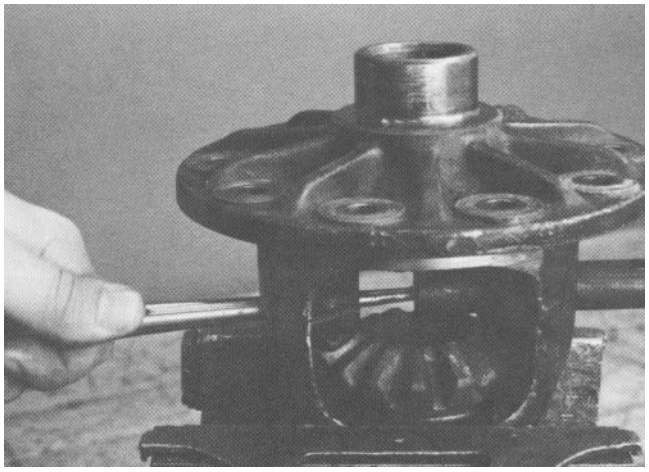


Figure 29

9. To remove the side gears and pinion mate gears, rotate the side gears. This will allow the pinion mate gears to turn to the opening of the case (Fig. 30). Remove the pinion mate gears and the spherical washers behind the gears.

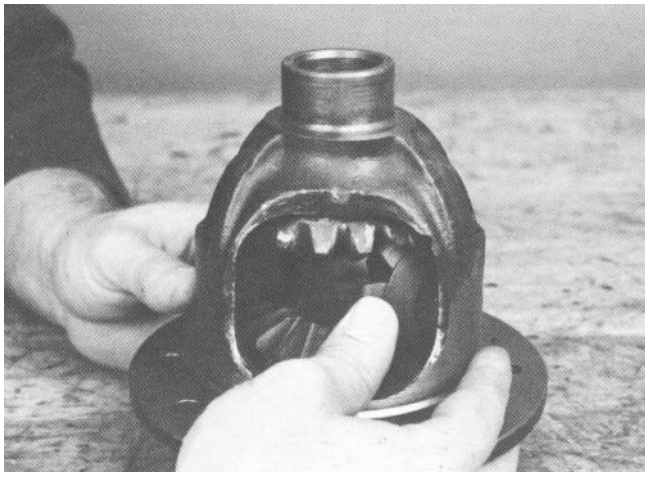


Figure 30

10. Remove the eight side cover capscrews. Remove the side cover from the carrier assembly (Fig. 31). Clean the gasket material from the mating surfaces before reassembly.

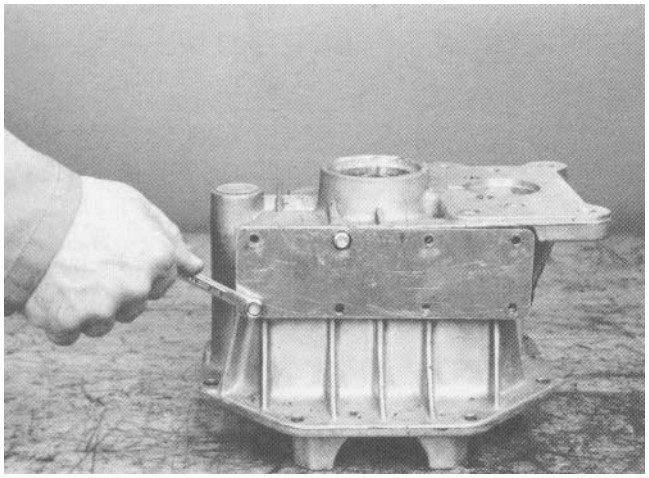


Figure 31

11. Install differential gear holder to carrier to retain spur gear (see Special Tools). Remove the nut, spacer, pinion coupler, and shim from the pinion shaft (Fig. 32). Remove differential gear holder from carrier.

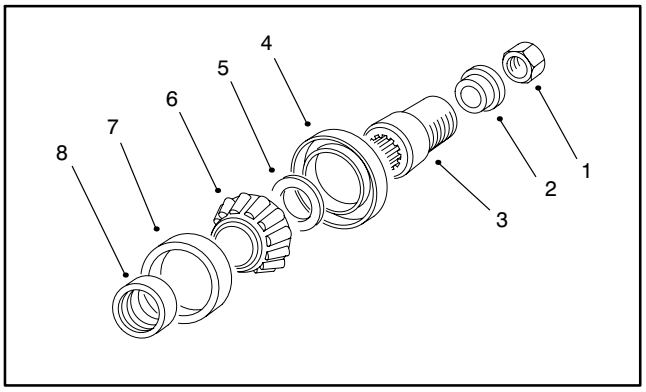


Figure 32

1. **Nut**
2. **Spacer**
3. **Pinion coupler**
4. **Seal**
5. **Shim**
6. **Outer bearing cone**
7. **Outer bearing cup**
8. **Bearing spacer**

12. Position the housing assembly on a suitable press. Place a 1/8 inch (3 mm) piece of steel or a screwdriver blade under the edge of the spur gear. This will prevent the spur gear from cocking and possibly cracking the housing (Fig. 33).

When the pinion is close to being pressed completely out of the bearing, reach under the housing and catch the pinion in your hand to prevent any damage to the pinion.

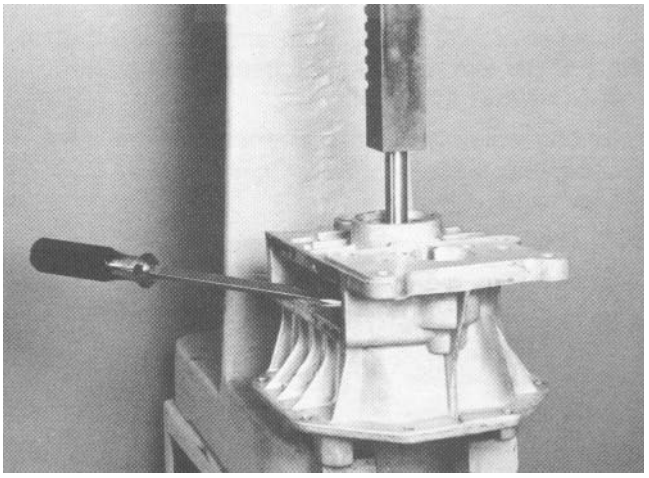


Figure 33

13. Removing the drive pinion releases the spur gear, bearing spacer, and outer pinion bearing for removal (Figs. 32 and 34).

14. Remove oil seal from housing (Fig. 32).

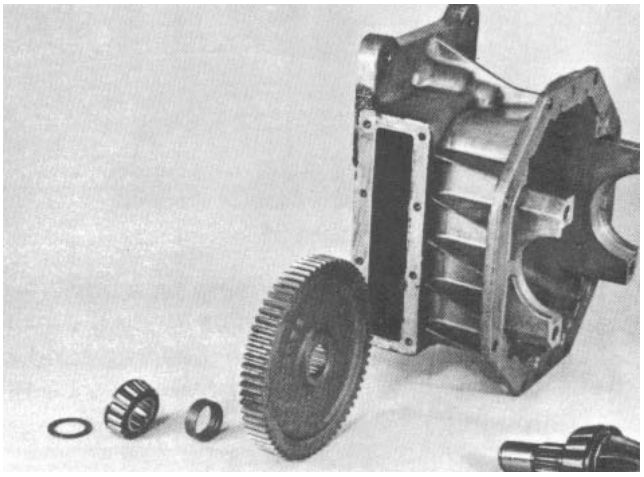


Figure 34

15. Clamp the inner pinion bearing with a universal bearing remover (Fig. 35). Position the unit in a press and carefully push the drive pinion out of the bearing.

IMPORTANT: DO NOT allow the pinion to drop on the floor - damage will result.

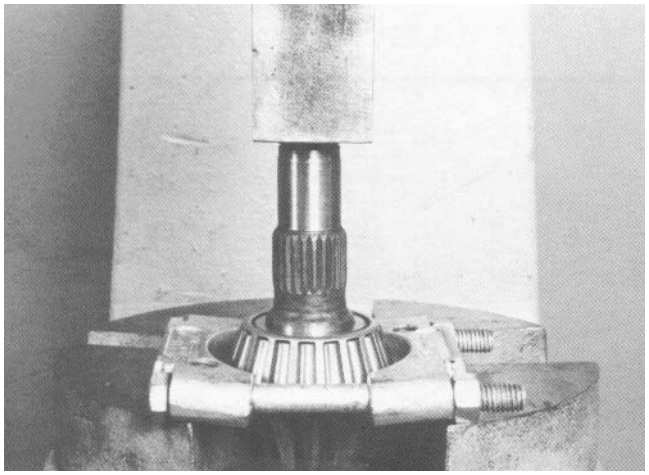


Figure 35

16. To remove the outer pinion bearing cup, position the housing in a press. Place a press plate of the proper size against the cup. Press the cup out of the housing (Fig. 36).

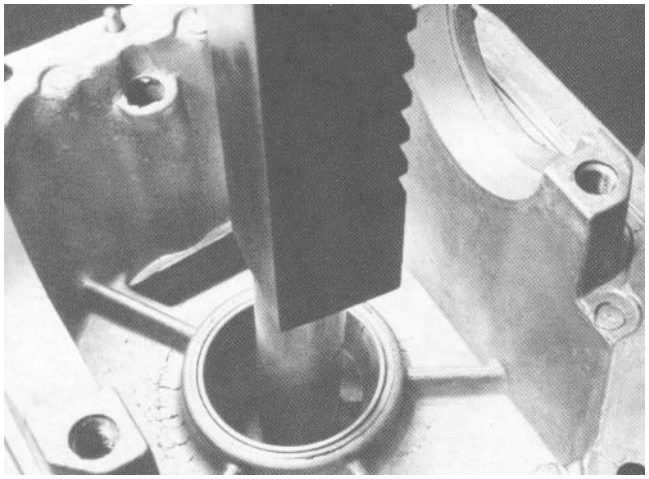


Figure 36

17. Position the front housing on a press bed with the bearing saddles resting on the press bed. Protect the bearing saddles with a strip of wood if the press bed is rough.

Insert a press plate of the proper size and press the bearing cup toward the inside of the housing. Retain the shims located under the bearing cup (Fig. 37). If the shims are damaged, replace with new shims of the same thickness.

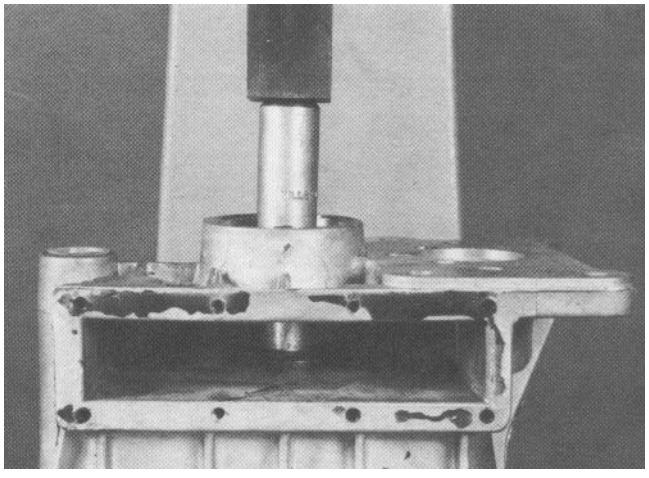


Figure 37

Assembly

1. Inspect the differential parts for damage before assembling.

   A. If any bearings are damaged they must be replaced with new ones.

   B. Check the ring, pinion, and spur gear for abnormal wear and damage; replace worn components.

   C. Inspect the housings for cracks and external damage that could affect the operation of the axle assembly.

   D. Inspect the differential case for wear in the side gear and pinion mate area. Replace the case if its machined areas are scored or if the pinion mate shaft fits loosely in the bore.

2. Press the pinion inner bearing onto the pinion drive gear. Support the bearing on the inner cup of the bearing ONLY WHEN INSTALLING (Fig. 38).

3. Put the front housing on a press. Using a press plate, push the pinion outer bearing cup into the housing until it bottoms in the housing (Fig. 39).

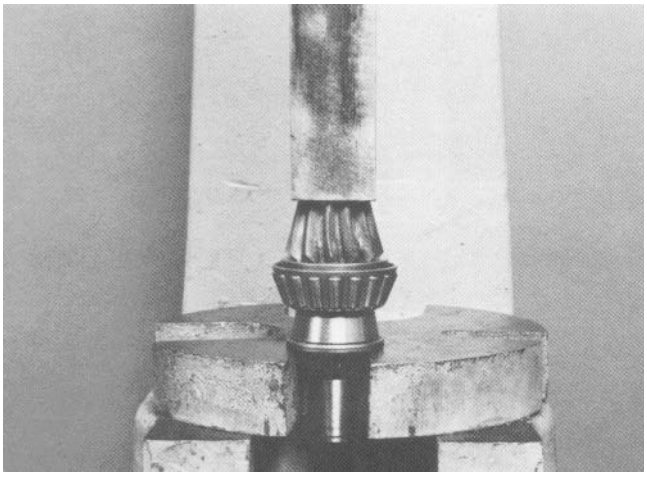


Figure 38

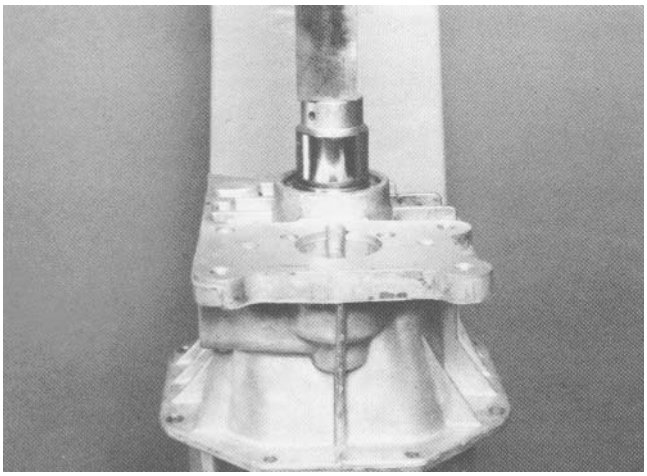


Figure 39

IMPORTANT: Correct engagement between ring gear and pinion gear is critical to axle performance and durability.

NOTE: A complete Upper Housing Assembly for Differential repairs is available. Using this assembly eliminates the need for shimming to establish the correct contact pattern between the ring and pinion gears.

4. Determine the correct inner bearing shims for use with ring and pinion gear sets:

A. When reinstalling the ORIGINAL ring and pinion gears, the original bearing shims or new shims of the same thickness should be used. In this case, proceed directly to step 5.

B. When installing NEW ring and pinion gears (supplied in matched sets only) make sure the numbers etched on both the pinion and ring gear match (Fig. 40).

Compare the +, -, or 0 markings of the old and new pinions. Adjust the thickness of a new shim pack to compensate for the difference in these two numbers.

For example: If the old pinion reads +2 and the new pinion reads -2, add 0.004 in. of bearing shims to the original shim pack thickness.

NOTE: The following information is provided to help you understand the adjustment required for proper engagement of NEW ring and pinion gears.

To ensure proper engagement, an additional number is etched into the button end of each pinion gear. This number indicates modifications that must be made to the “pinion to ring gear distance” for each particular gear set. This distance is controlled by adding or removing shims behind the inner bearing cup.

A pinion gear etched 0 is considered standard, and has a 1.210 in. pinion to ring gear distance.

A pinion gear etched +3 requires a pinion to ring gear distance of 1.213 in. (+0.003 in. from standard). Removing 0.003 in. of bearing shims moves the pinion gear away from the ring gear, increasing the pinion to ring gear distance.

A pinion gear etched -3 requires a pinion to ring gear distance of 1.207 in. (-0.003 in. from standard). Adding 0.003 in. of bearing shims moves the pinion gear closer to the ring gear, decreasing the pinion to ring gear distance.

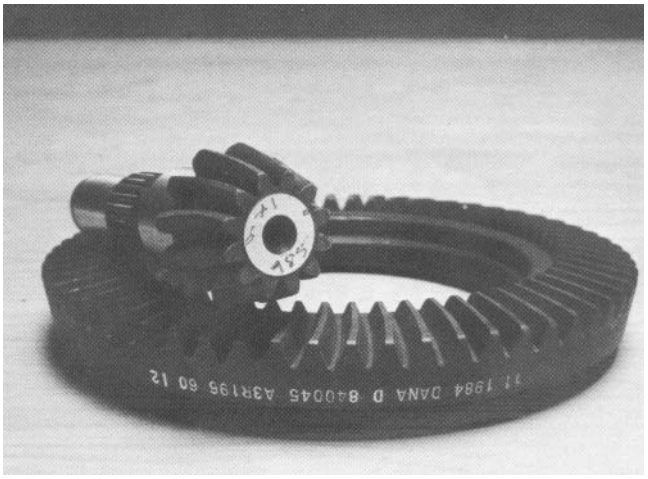


Figure 40

5. Install the correct bearing shims and a new inner bearing cup using a press plate of proper diameter. Push the bearing into the housing until it bottoms out against the shims (Fig. 41).

Note: Pinion bearing shims are available in 0.003 in. (0.08 mm), 0.005 in. (0.13 mm), 0.010 in. (0.25 mm), and 0.030 in. (0.76 mm) thickness.

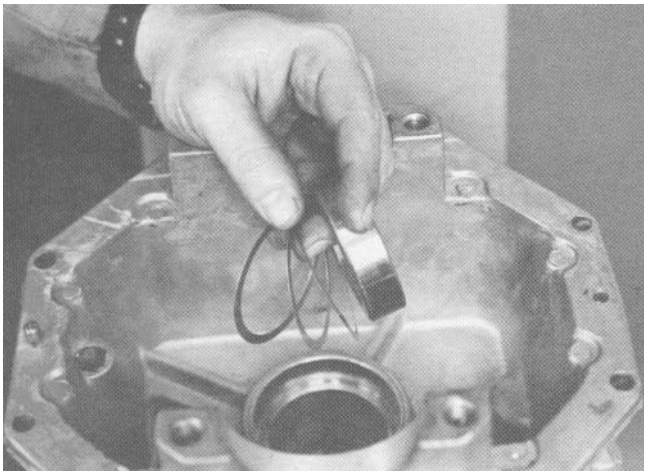


Figure 41

6. Insert the spur gear into the front housing with the chamfered area of the center spline toward the pinion gear. Tap the pinion gear with a soft mallet to engage the splines in the spur gear (Fig. 42).

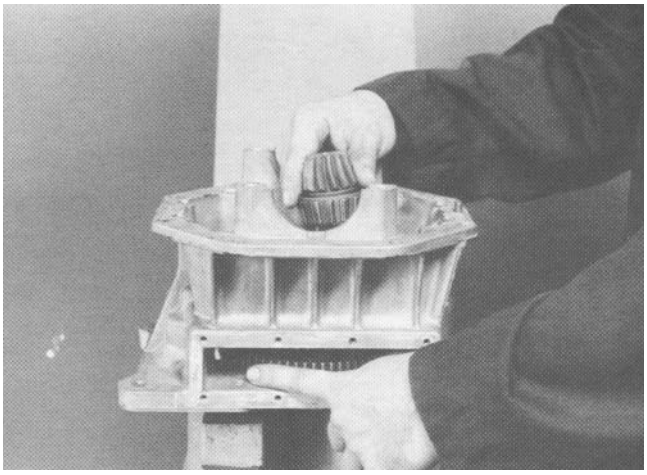


Figure 42

7. Support the drive pinion in a suitable press (Fig. 43).

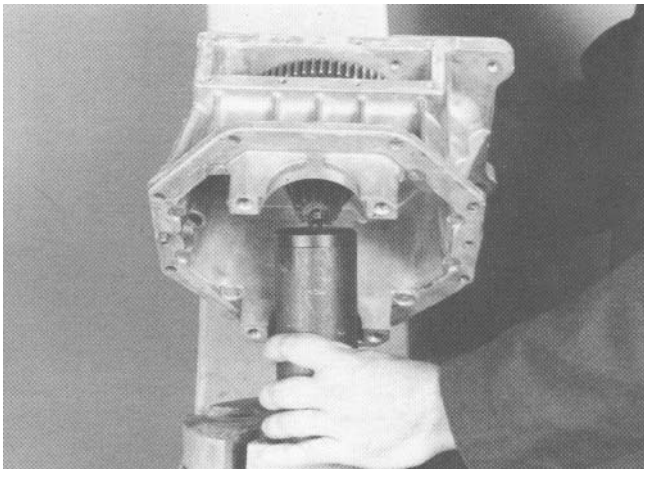


Figure 43

8. Install the outer pinion spacer with the chamfer towards the pinion splines and position the new outer bearing cone on the pinion shaft (Fig. 44).

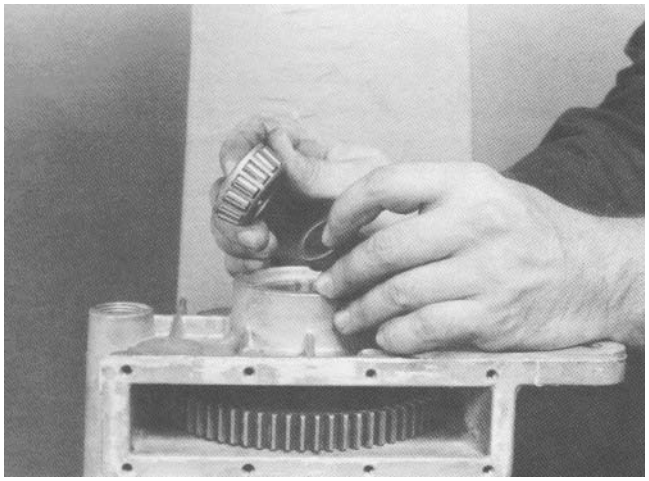


Figure 44

9. With a hollow press sleeve of proper diameter, press on the outer bearing cone race until the drive pinion seats in the carrier and a slight drag is felt when the gear is rotated by hand (Fig. 45). If more than 2−13 in-lbs. (.2−1.5 Nm) torque is required to rotate the pinion and spur gear, tap the pinion shaft with a soft mallet until the drag is reduced.

10. Install differential gear holder to carrier to retain spur gear (see Special Tools). Apply Permatex No. 2 (or equivalent) to outer diameter of seal, external splines of pinion shaft and internal splines of pinion coupler.

11. Install seal into housing. Install the shim, pinion coupler, spacer, and nut onto the end of the pinion shaft (Fig. 32). Tighten pinion coupler nut to a torque of 75−90 ft-lbs (100−122 Nm). Remove differential gear holder and check pinion shaft endplay. If necessary, change shim to adjust pinion shaft endplay.

PINION SHAFT END PLAY:
0.000 to 0.005 in. (0.00 to 0.13 mm)

Note: Pinion shaft shims are available in 0.094 in. (2.39 mm) to 0.120 in. (3.05 mm) thickness, and in 0.125 in. (3.18 mm) to 0.151 in. (3.84 mm) thickness in 0.002 in. (0.05 mm) increments.

12. Install the spur gear cover. Use Permatex No. 2 or silicone sealant when installing the cover. Tighten the capscrews to a torque of 25−40 in-lbs (3−4.5 Nm) (Fig. 46).

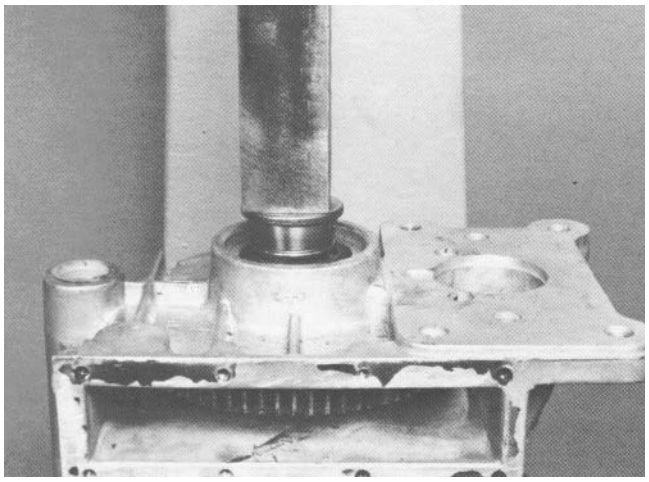


Figure 45

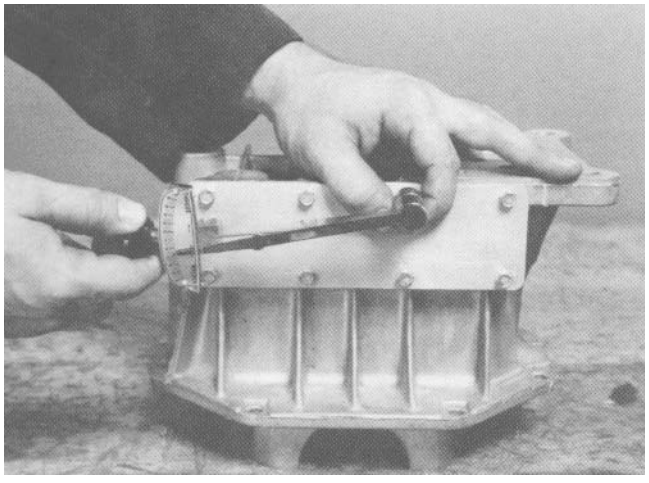


Figure 46

13.Place the differential case in a vise as shown (Fig. 47). Apply grease to new side gear thrust washers and hubs of the side gears. Apply grease to new pinion mate spherical washers and pinion mate gears. Place the side gears and thrust washers in the case. Install the pinion gears while holding the side gears in place.

Rotate the side gears until the holes of the washers and pinion gears line up with the holes of the case. If the gears cannot be rotated by hand, install one of the axle shafts into the side gear spline and use a pipe wrench to turn the shafts.

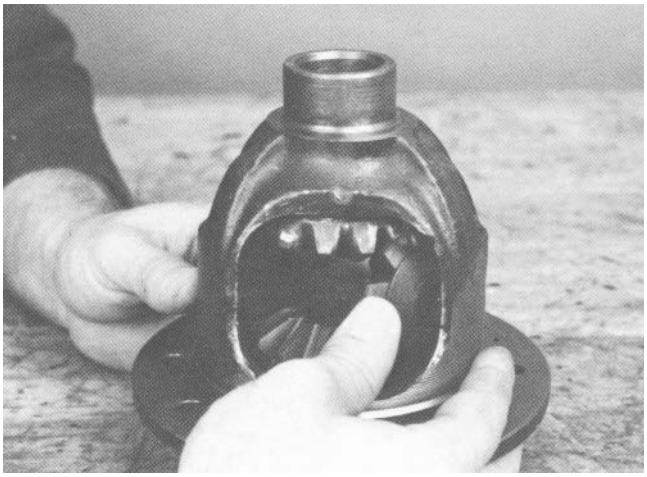


Figure 47

14.Install the pinion shaft. Grease the shaft to aid assembly. Be sure the hole in the pinion shaft lines up with the hole in the differential case (Fig. 48).

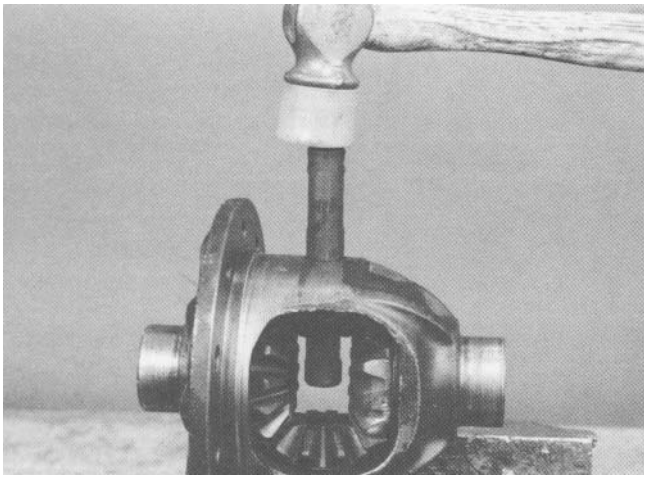


Figure 48

15.Assemble the lock pin. Drive the pin to the approximate center location of the pinion mate shaft. Peen the metal of the case to lock the pin in place (Fig. 49).

Figure 49

16. Put the ring gear onto the differential case and start the new capscrews into the gear with your fingers. Tighten the screws, alternating back and forth across the gear to allow the gear to be pulled evenly into place. Tighten the cap screws to a torque of 45-65 ft-lbs. (61-88 Nm) (Fig. 50).

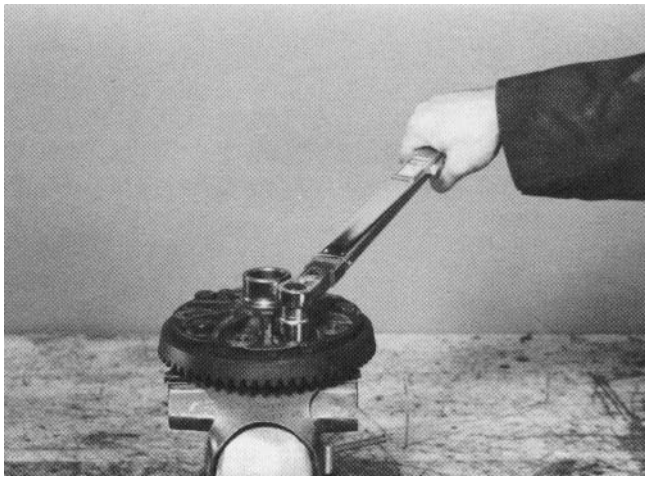


Figure 50

17. When installing new differential bearings, reuse the original shims or use new shims of the same thickness. Press the bearing onto the differential case. If a new differential case is being installed, start with a .020 inch pack of shims under each differential bearing (Fig. 51).

Note: Shims are available in 0.003 in. (0.08 mm), 0.005 in. (0.13 mm), 0.010 in. (0.25 mm), and 0.030 in. (0.76 mm) thickness.

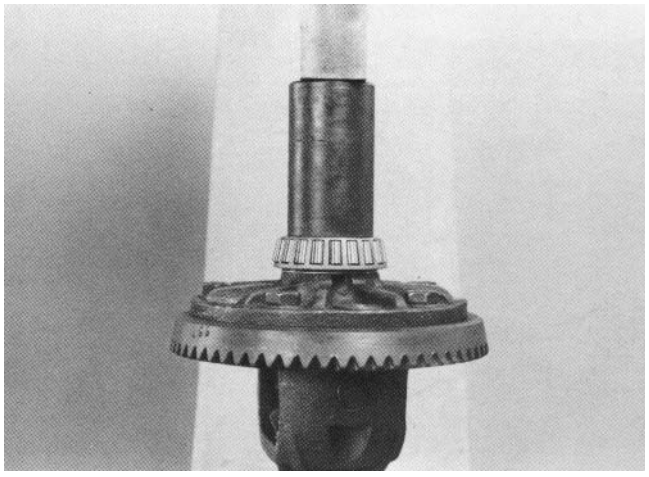


Figure 51

18. Assemble new differential bearing cups onto differential bearing cones. Seat differential assembly with drive gear on proper side of carrier into carrier bearing cradles.

NOTE: This application requires that the ring gear teeth face toward the spur gear cover.

19. The bearing cradles are designed to apply a slight preload to the bearings. It is important to push both of the bearing assemblies simultaneously into their saddles.

Install the bearing caps into their original position as previously marked. Tighten the cap screws to a torque of 30-45 ft-lbs. (41-61 Nm) (Fig. 52).

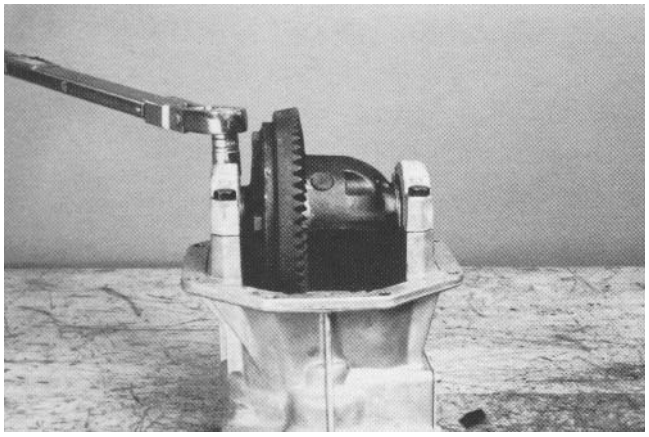


Figure 52

20. Using a dial indicator, check the ring gear backlash in three equally spaced points. Ring gear backlash should be .003-.007 inch (.076-.178 mm) and must not vary more than .002 in. between points checked (Fig. 53).

If the backlash is not in this range, move the shims which are located beneath the differential bearings, from one side to the other until the correct backlash is attained.

21. Check ring to pinion gear engagement (see Ring and Pinion Gear Engagement in this chapter of the manual).

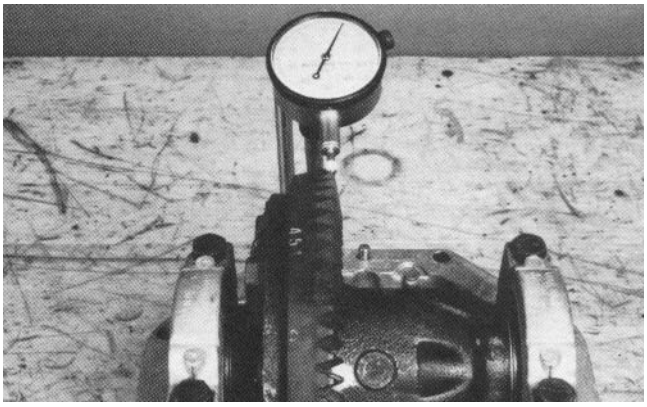


Figure 53

22. Apply silicone sealant between the front and rear axle housings and install the eight housing cap screws. Tighten the cap screws to a torque of 18-23 ft-lbs. (24-31 Nm) (Fig. 54).

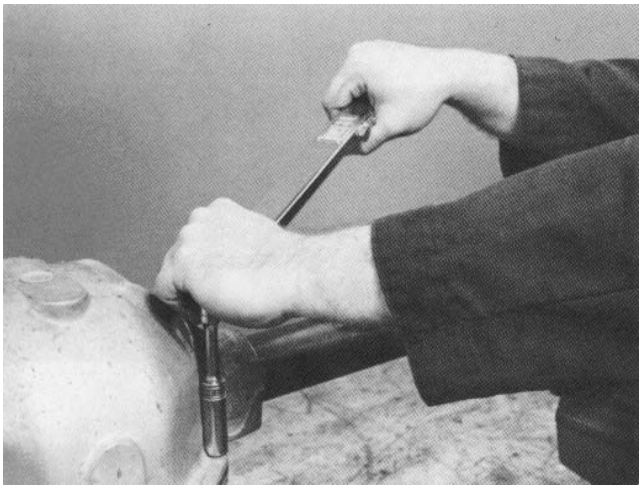


Figure 54

Ring to Pinion Gear Engagement

Final position of pinion is verified by using the gear contact pattern method as described in the following procedure.

GEAR TOOTH DEFINITIONS (Fig. 55):

Toe-the portion of the tooth surface at the end towards the center.

Heel-the portion of the gear tooth at the outer end.

Top Land-top surface of tooth.

1. Paint the teeth of the ring gear, both drive and coast side, with a gear marking compound, such as DyKem® Steel Blue.

2. While applying a light load to the ring gear, rotate the pinion gear until the ring gear has made one complete revolution. The drive side pattern should be located at the toe portion of the tooth. The coast pattern should also be at the toe portion of the tooth (Fig. 56).

Study the patterns in the following illustrations and correct engagement as necessary.

NOTE: When making changes, note that two variables are involved. Example: If you have the backlash set correctly to specifications and you change the pinion position shim, you may have to readjust backlash to the correct specification before checking the pattern.

Every gear has a characteristic pattern. The illustrations show typical patterns only and explain how patterns shift as gear location is changed. When making pinion position changes, shims should be changed in the range of .002 inch to .004 inch until a correct pattern has been obtained.

When a change in backlash is required, backlash shims should be changed in the range of 1-1/2 times the amount of backlash required to bring the gears into specification. For example, if the backlash needed to be changed by .004 inch, the shim pack should be changed by .006 inch as a starting point.

High backlash is corrected by moving the ring gear closer to the pinion. Low backlash is corrected by moving the ring gear away from the pinion. These corrections are made by switching shims from one side of the differential case to the other.

Example 1: Backlash correct. Thicker pinion position shims required (Fig. 57).

Example 2: Backlash correct. Thinner pinion position shims required (Fig. 58).

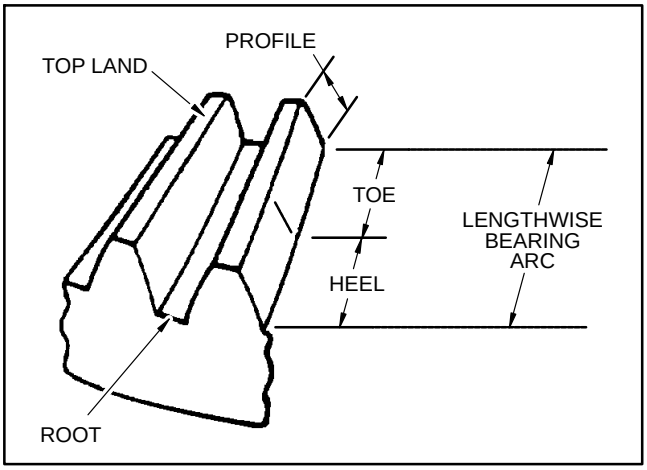


Figure 55

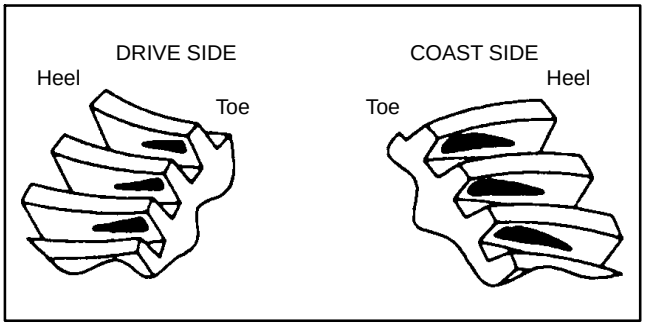


Figure 56

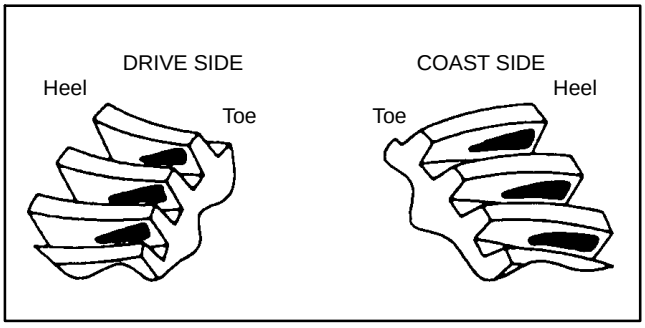


Figure 57

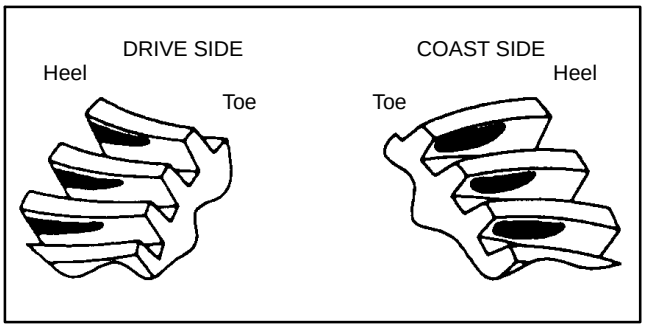


Figure 58

Example 3: Backlash incorrect. Thinner pinion position shim required. Adjust backlash to match (Fig. 59).

GEAR PATTERN MOVEMENT SUMMARY:

A. Decreasing backlash moves the ring gear closer to the pinion.

Drive pattern (convex side of gear) moves lower and toward the toe.

Coast pattern (concave side of gear) moves slightly higher and toward the heel.

B. Increasing backlash moves the ring gear away from the pinion.

Drive pattern (convex side of gear) moves higher and toward the heel.

Coast pattern (concave side of gear) moves slightly lower and toward the toe.

C. Thicker pinion position shim with the backlash constant moves the pinion closer to the ring gear.

Drive pattern (convex side of gear) moves deeper on the tooth (flank contact) and slightly toward the toe.

Coast pattern (concave side of gear) moves deeper on the tooth and toward the heel.

D. Thinner pinion position shim with backlash constant moves the pinion further from the ring gear.

Drive pattern (convex side of gear) moves toward the top of the tooth (face contact) and toward the heel.

Coast pattern (concave side of gear) moves toward the top of the tooth (face contact) and toward the heel.

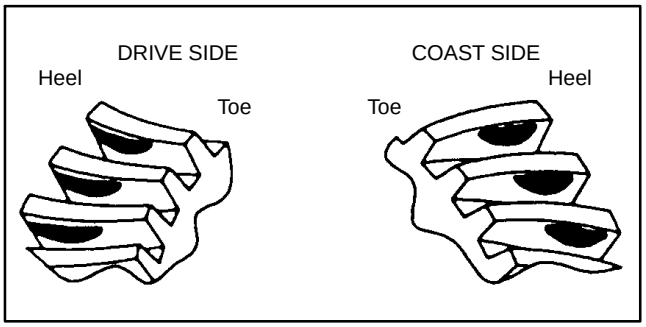


Figure 59

Chapter 7

Steering and Brakes

Table of Contents

Introduction

Power Steering

The Reelmaster® 5200-D/5400-D is equipped with power steering. The power steering valve is enclosed in the steering tower at the front of the traction unit. As the steering wheel is turned, the steering valve meters hydraulic fluid to the double-acting steering cylinder on the rear axle and turns the wheels. Hydraulic fluid flow for power steering is supplied by section P3 of the hydraulic pump. Hydraulic pump section P3 has a built−in relief valve.

Note: Because the steering cylinder has different displacements when extended and retracted, the steering wheel will not return to its original position after making a turn.

Note: The steering system will operate with the engine off if necessary (with increased effort).

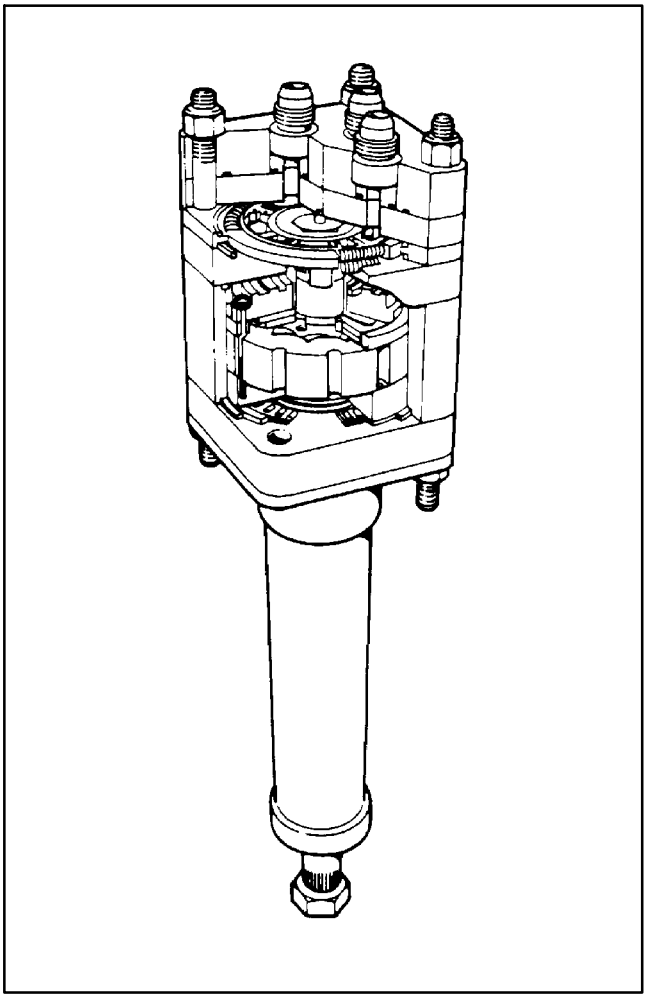


Figure 1

Brakes

The Reelmaster® 5200-D/5400-D is equipped with 7 inch diameter, 1-3/4 inch wide mechanical drum brakes on the front wheels (Fig. 2).

Two pedals are used to control the brakes. When used separately, the pedals can control each wheel brake to assist steering or traction on side hills. The two pedals may be locked together with the brake lock arm. When the lock arm is engaged both wheels will brake equally and act as a service brake or parking brake.

The brake pedals operate the brakes through a cable system to a strut and lever on the brake shoes.

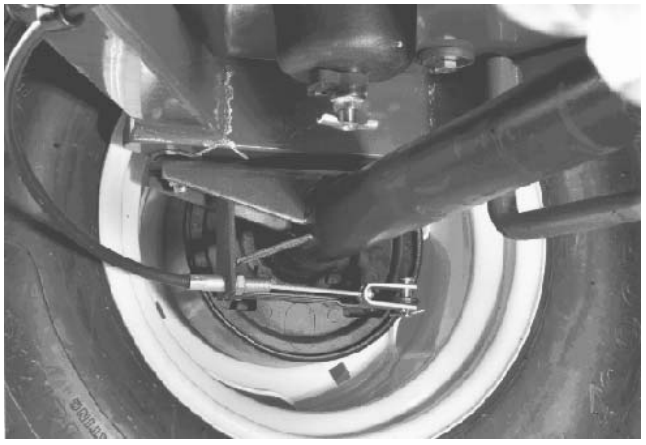


Figure 2

Power Steering Schematics

Right Turn

With the engine running, and the steering wheel turned to the right, the flow travels through the top of the steering control spool. Flow enters the steering control valve at the IN port and is divided into two paths. Most of the flow through the valve is directed out the AUX port back to the lift manifold, and on to the hydraulic reservoir. The remainder of the flow is sent through the rotary meter (V1) and out the (LH) port to the rod end of the steering cylinder. The rotary meter ensures that the oil flow to the cylinder is proportional to the amount of steering wheel rotation. The steering cylinder retracts, pivoting the rear wheels to the left. This results in a turn to the operator's right when the vehicle is moving forward. Fluid leaving the steering cylinder flows back through the steering control valve, exits through the OUT port, travels to the lift manifold, and returns to the hydraulic reservoir.

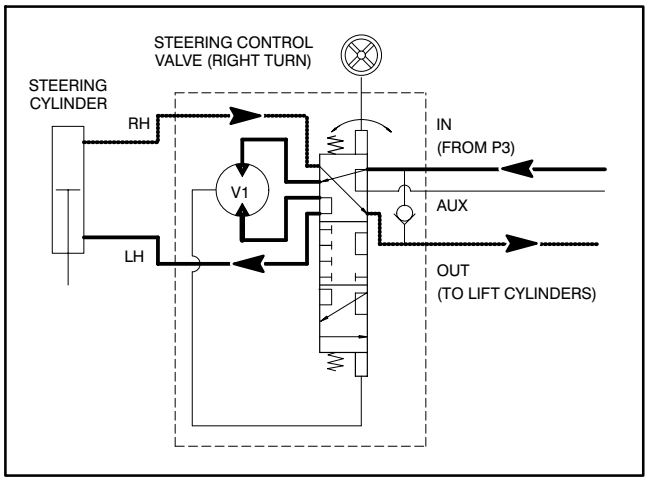


Figure 3

Neutral (Straight Ahead)

With the the engine running and the steering wheel in the neutral position (rear wheels positioned straight ahead), the spool of the steering control valve is in the center position. Hydraulic flow enters the steering control valve at the IN port, by-passes the rotary meter (V1) and steering cylinder, and exits through the control valve through the AUX port. The flow continues on to the lift manifold and returns to the hydraulic reservoir.

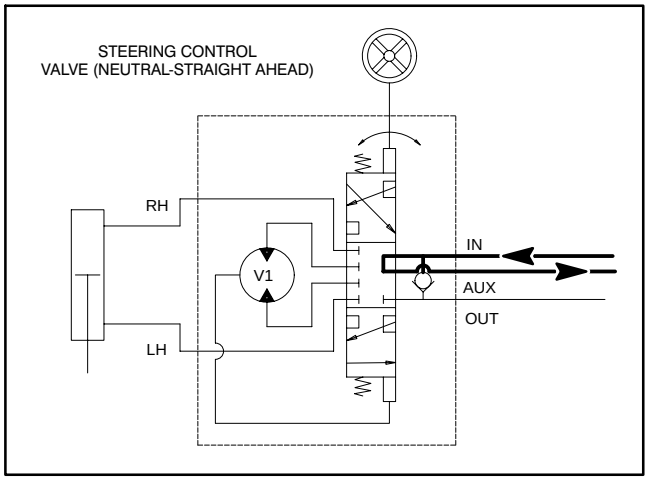


Figure 4

Left Turn

With the engine running, and the steering wheel turned to the left, the flow travels through the bottom of the steering control spool. Flow enters the steering control valve at the IN port and is divided into two paths. Most of the flow through the valve is directed out the AUX port back to the lift manifold, and on to the hydraulic reservoir. The remainder of the flow is sent through the rotary meter (V1) and out the (RH) port to the piston end of the steering cylinder. The rotary meter ensures that the oil flow to the cylinder is proportional to the amount of steering wheel rotation. The steering cylinder extends, pivoting the rear wheels to the right. This results in a turn to the operator's left when the vehicle is moving forward. Fluid leaving the steering cylinder flows back through the steering control valve, exits through the OUT port, travels to the lift manifold, and returns to the hydraulic reservoir.

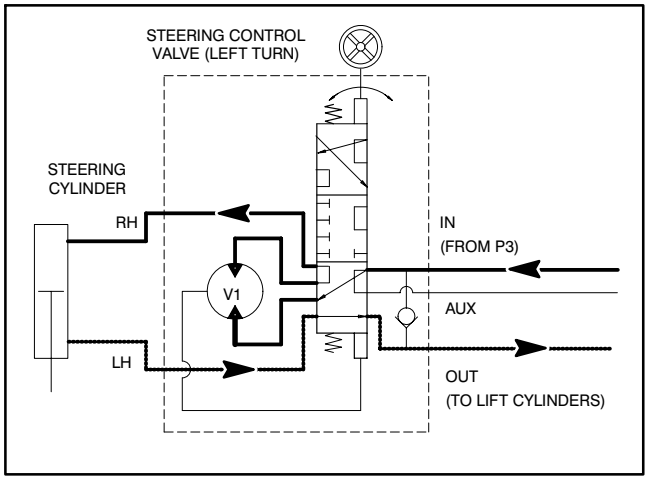


Figure 5

Specifications

Item	Specification
Front wheel lug nut torque	45 to 55 ft-lbs (61 to 75 Nm)
Rear wheel lug nut torque	30 to 35 ft-lbs. (41 to 47 Nm)
Steering cylinder bolt torque	130 to 150 ft-lbs. (176 to 203 Nm)
Rear wheel toe-in	0.000 to 0.125 in. (0.0 to 3.0 mm)
Tire pressure (front and rear)	10 to 15 psi. (0.69 to 1.03 Bar)
Brake pedal free travel	0.5 to 1.0 in. (6.0 to 25.0 mm)

Special Tools

Order special tools from your Toro Distributor.

Steering Valve Service Fixture

To avoid distorting or damaging the steering valve when repairing, do not clamp it directly into a vise. Fabricate a service fixture (Fig. 6) and use it as instructed (See Steering Valve Service in this section of this manual).

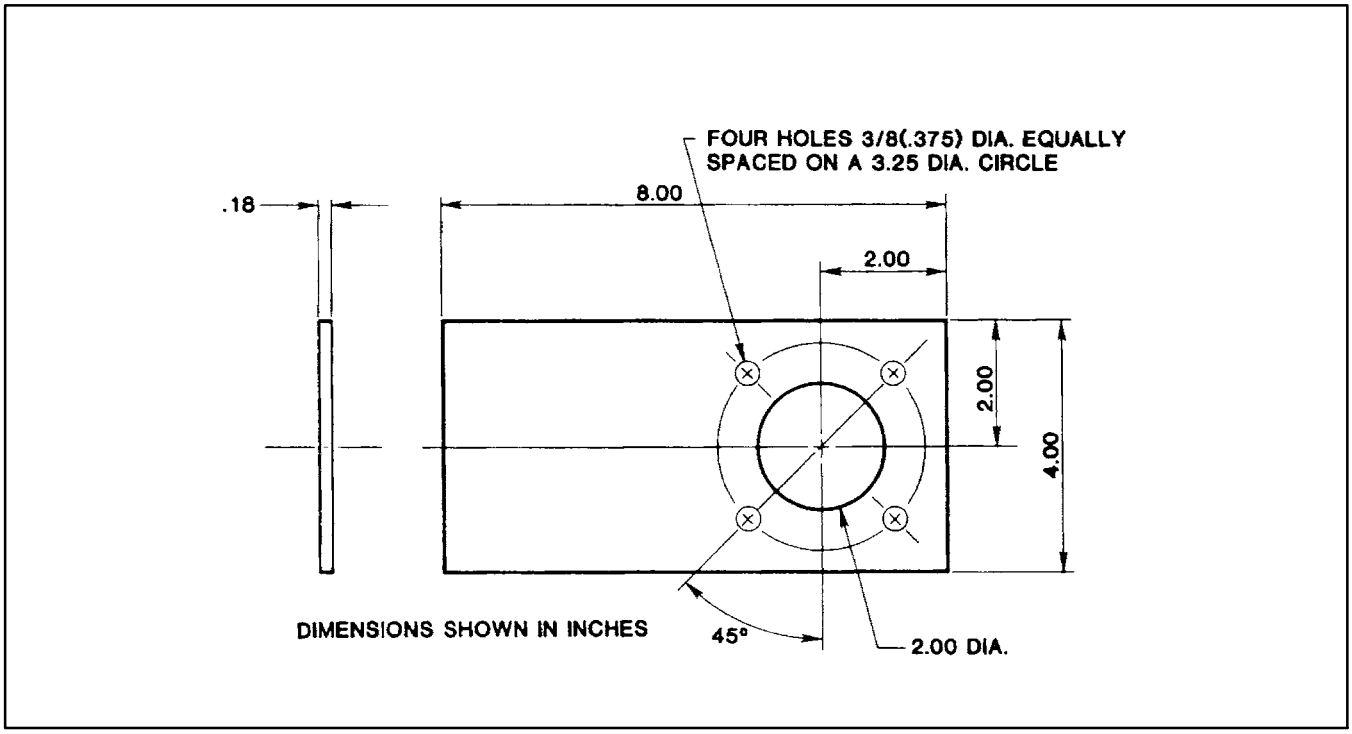


Figure 6

Hydraulic Tester (Pressure and Flow) - TOR214678

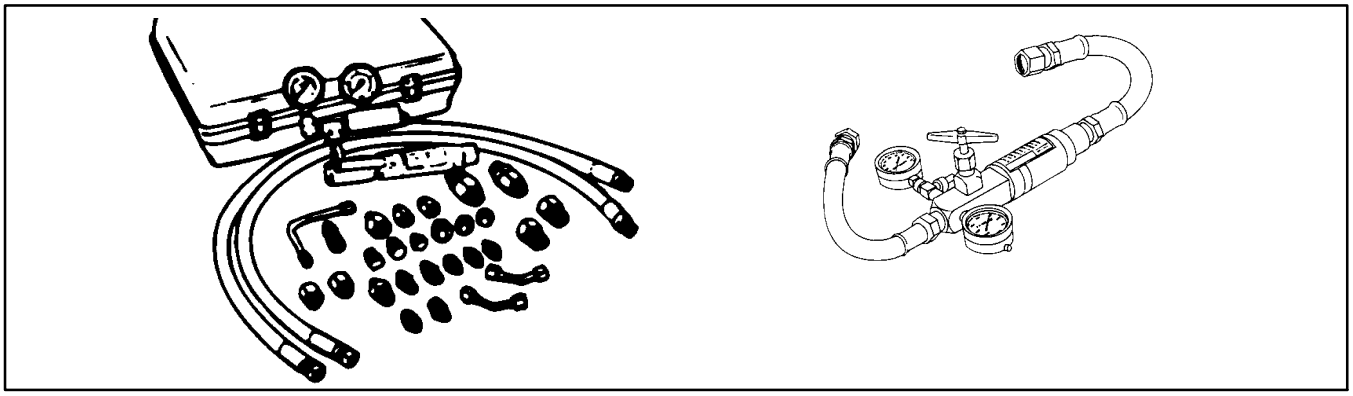


Figure 7

This tester requires O-ring face seal (ORFS) adapter fittings for use on this machine.

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

2. LOAD VALVE: A simulated working load is created in the circuit by turning the valve to restrict flow.

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

   A protector valve 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 which accommodates pressures beyond the capacity of the low pressure gauge, 0 to 5,000 PSI.

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

6. OUTLET HOSE: A hose from the outlet side of the hydraulic tester connects to the hydraulic system circuit.

Troubleshooting

The charts that follow contain information to assist in troubleshooting. There may possibly be more than one cause for a machine malfunction.

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

Problem	Possible Cause
Steering wander	Tire pressure incorrect or unequal left to right.
	Loose or worn steering linkage.
	Improperly adjusted or worn rear wheel bearings.
	Rear wheels out of alignment; toe−in/toe−out.
	Low hydraulic system pressure (steering circuit).
	Internal leakage of steering cylinder.
Poor or no return (recovery)	Improper rear wheel alignment; toe−in.
	Steering linkage binding.
	Low tire pressure.
	Steering column binding or out of alignment.
	Low hydraulic system pressure (steering circuit).
Shimmy	Steering linkage loose, worn or out of adjustment.
	Wheel bearings out of adjustment.
	Air in hydraulic system.
	Internal leakage of steering cylinder.
High steering effort in one direction	Low hydraulic system pressure.
	Excessive heat causing steering valve plate valve to stick (See Excessive Heat in this section).
High steering effort in both directions	Low hydraulic fluid level.
	Low flow or pressure from hydraulic pump.
	Steering linkage binding.
	Restriction in hydraulic return line.
Steering wheel lash (free movement)	Steering wheel loose on column.
	Steering linkage loose or worn.
	Steering valve loose at mounting.
	Air in hydraulic system.
	Internal leakage in hydraulic cylinder.
Excessive heat in hydraulic system	Undersized replacement hose or tube line.
	Kinked or severely bent hose or tube line.
	Restricted oil cooler.
	Restricted re-centering of steering valve control valve plate.

Testing

Note: For testing the gear pump section that supplies the steering circuit, see Test No. 8 in Chapter 4−Hydraulic System of this manual.

Steering Cylinder Internal Leakage Test

1. Engage the parking brake, and lower the cutting units to the floor.

2. Turn the steering wheel all the way to the left (counterclockwise) so the steering cylinder rod is extended all the way.

3. Turn the engine OFF

4. Disconnect the hydraulic hose from the fitting on the rod end of the cylinder (Fig. 8). Put a plug in the end of the hose to prevent contamination.

5. With the engine OFF, continue turning the steering wheel to the left (counterclockwise) with the cylinder rod completely extended and observe the open fitting on the steering cylinder. If oil comes out of the fitting while turning the steering wheel to the left, the steering cylinder has internal leakage and must be repaired or replaced.

Note: DO NOT turn the steering wheel to the right (clockwise) or the steering valve will meter oil out the disconnected hydraulic hose.

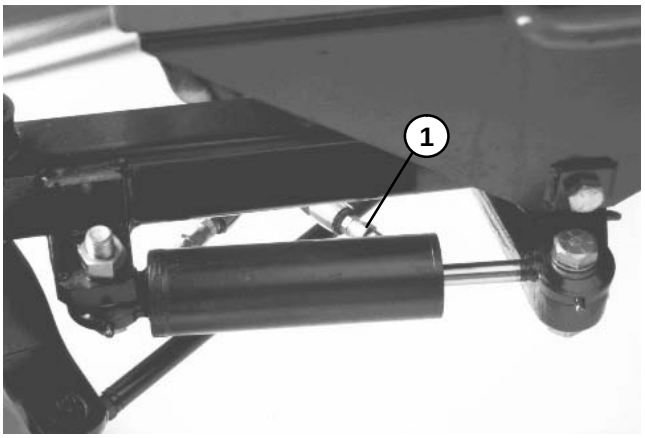


Figure 8

1. Hydraulic hose and fitting (2WD shown)

Rear Wheel Toe-in Adjustment

The rear wheels should have 0 to 1/8 of an inch toe-in when they are pointed straight ahead. To check toe-in, measure the center-to-center distance, at axle height, in front and rear of steering tires. If toe-in is not within specifications, an adjustment is required.

2WD Traction Units

1. Rotate the steering wheel so the rear wheels are straight ahead.

2. Loosen the jam nuts on both tie rods. Adjust both tie rods equally until center-to-center distance at front of rear wheels is 0−0.125 in. (0.0−3.0 mm) less than at the rear of the wheels (Fig. 9).

3. When toe−in is correct, tighten jam nuts against tie rods.

4WD Traction Units

1. Rotate the steering wheel so the rear wheels are straight ahead.

2. Remove the cotter pin and slotted hex nut from either tie rod ball joint. Use a ball joint fork and remove the tie rod ball joint from the axle case support (Fig. 10).

3. Loosen clamps on both ends of tie rod.

4. Rotate the detached ball joint inward or outward one (1) complete revolution. Tighten the clamp at the loose end of the tie rod.

5. Rotate the entire tie rod assembly the same direction (inward or outward) one (1) complete revolution. Tighten the clamp at the connected end of the tie rod.

6. Install the ball joint in the axle case support and tighten the slotted hex nut finger tight.

7. Measure the distance at the front and the rear of the rear wheels at axle height. The distance at the front of the rear wheels should be 0−0.125 in. (0.0−3.0 mm) less than the distance measured at the rear of the wheels.

8. Repeat steps 3. through 7. if necessary.

9. Tighten ball joint hex nut and install a new cotter pin.

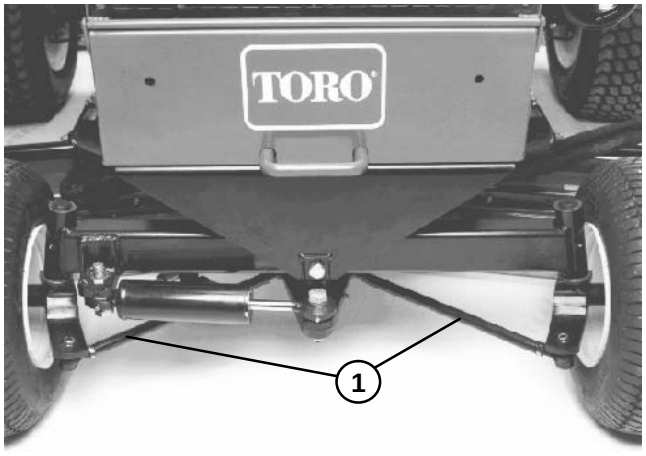


Figure 9

1. Tie rods (2WD shown)

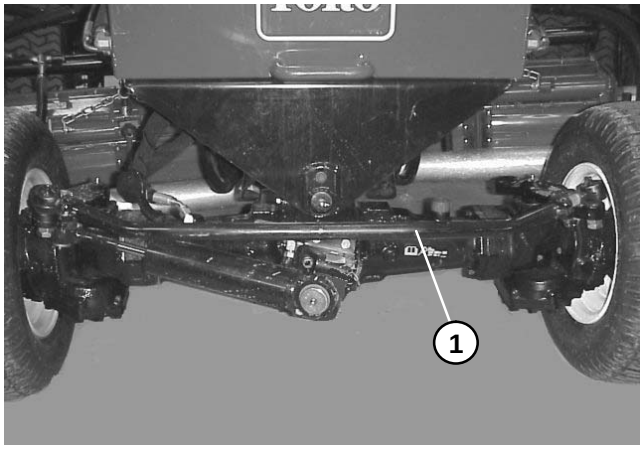


Figure 10

1. Tie rod

Brake Adjustment

Adjust the service brakes when there is more that 1.0 in. (25.4 mm) of “free travel” of the brake pedals. Free travel is the distance the brake pedal moves before braking resistance is felt (Fig. 11).

Adjust where brake cables connect to bottom of brake pedals. When cable is no longer adjustable, star nut on inside of the brake drum must be adjusted to move brake shoes outward. Brake pedals must be adjusted again after star nut is adjusted.

1. Disengage lock arm from left brake pedal so both pedals work independently of each other.

2. To reduce free travel of brake pedals:

   A. Loosen front nut on threaded end of brake cable (Fig. 12).

   B. Tighten rear nut to move cable toward the rear until brake pedals have 0.5 to 1 in. (13 to 25 mm) of free travel.

   C. Tighten front nut after adjusting.

3. When brake cables cannot be adjusted to get free travel within specification, star nut inside brake drum must be adjusted. Before adjusting the star nut, loosen brake cable nuts to prevent unnecessary strain on the cables.

4. Loosen (do not remove) the five (5) wheel lug nuts.

5. Jack up machine until front wheel is off the floor. Use jack stands or block machine to prevent it from falling accidentally. Remove wheel.

6. Remove brake drum. Rotate star nut until there is contact between brake shoes and drum when drum is installed (Fig. 13).

7. Remove brake drum and loosen star nut approximately 12 to 15 notches or until brake drum rotates freely.

8. Install wheel and lug nuts.

9. Remove jack stands or blocking and lower machine to floor. Tighten wheel lug nuts to a torque of 45 to 55 ft-lbs. (61 to 75 Nm).

10. Adjust brake cables (see step 2. of this procedure)

Figure 11

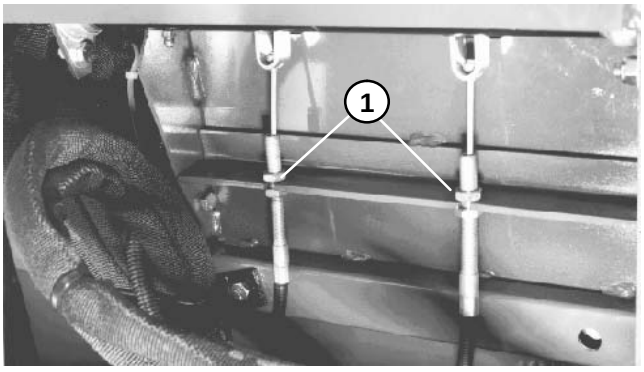


Figure 12

1. Jam nuts

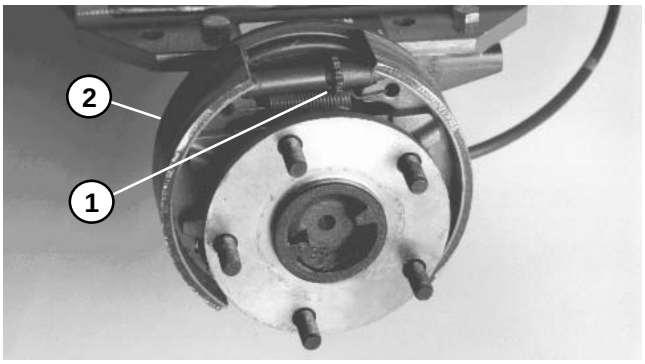


Figure 13

1. Star nut **2. Brake shoe**

Steering Wheel

Removal

1. Remove cover from center of steering wheel.

2. Remove the lock nut that secures the steering wheel to the shaft. Pull the steering wheel and foam seal off the steering valve shaft (Fig. 14).

Note: It may be necessary to use a jaw-type puller to remove the steering wheel from the steering shaft.

IMPORTANT: DO NOT hit the steering shaft with a hammer. This could damage the steering valve components.

Installation

1. Use the steering wheel to put the rear wheels in the straight ahead position.

2. Slide the foam seal and the steering wheel onto the steering shaft and secure the steering wheel in place with the lock nut (Fig. 14). Tighten the nut from 20 to 26 ft-lbs. (28 to 35 Nm).

3. Install steering wheel cover.

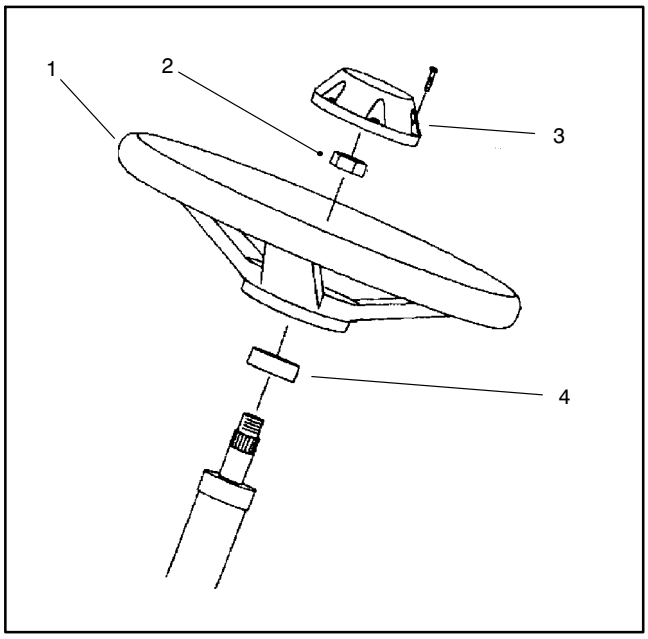


Figure 14

1. **Steering wheel**
2. **Lock nut**
3. **Cover**
4. **Foam seal**

2WD Rear Axle

Note: For information on 4WD rear axle service and repairs, see Chapter 9−4WD Axle in this manual.

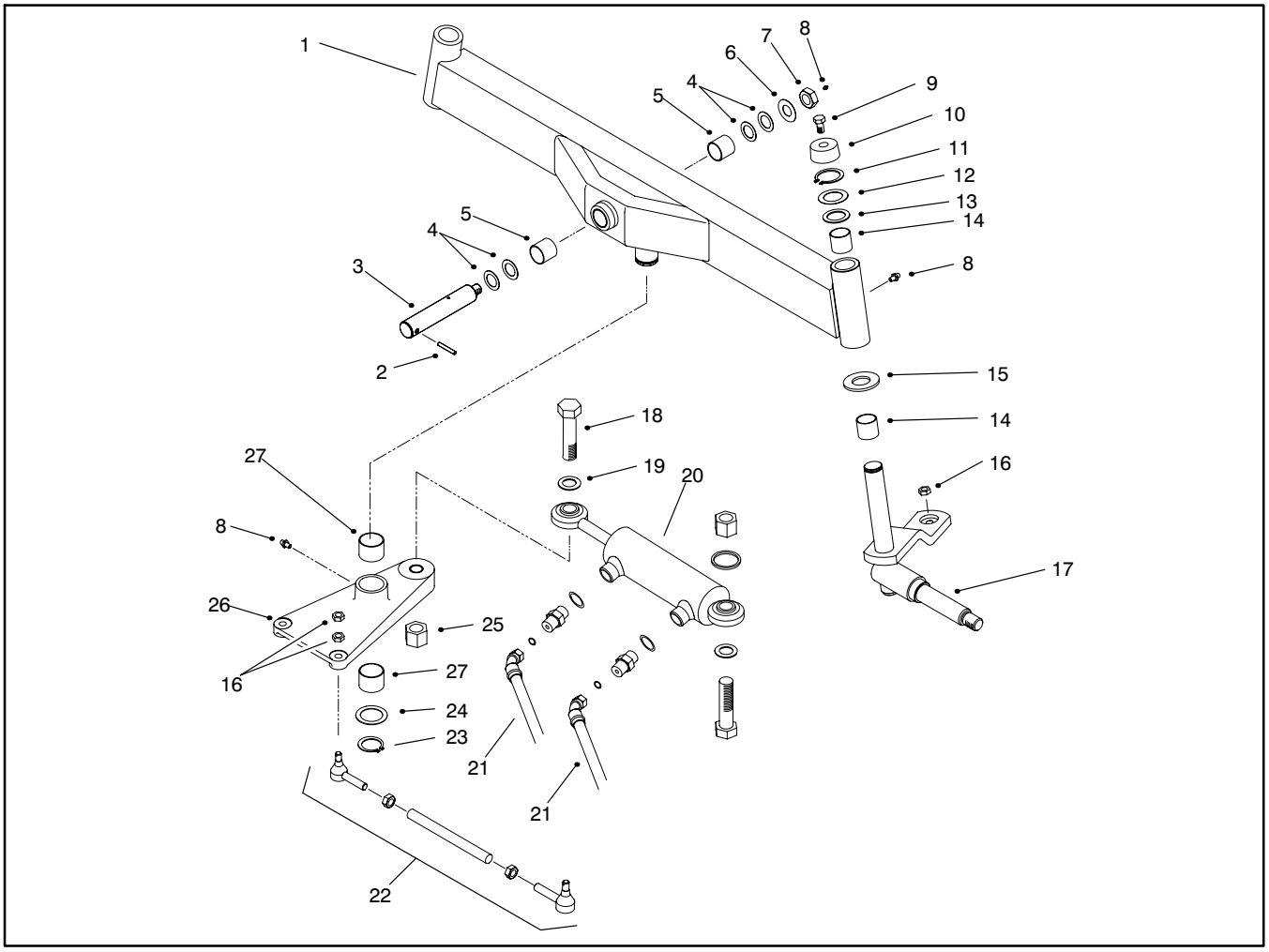


Figure 15

1. **Rear axle**
2. **Roll pin**
3. **Axle pivot pin**
4. **Thrust washer**
5. **Axle bushing**
6. **Thrust washer**
7. **Jamnut**
8. **Grease fitting**
9. **Capscrew**
10. **Spindle cap**
11. **Retaining ring**
12. **Thrust washer**
13. **Thrust washer**
14. **Steering pivot bushing**
15. **Thrust washer**
16. **Jamnut**
17. **Spindle**
18. **Capscrew**
19. **Washer**
20. **Steering cylinder**
21. **Hydraulic hose**
22. **Tie rod**
23. **Retaining ring**
24. **Thrust washer**
25. **Locknut**
26. **Steering pivot plate**
27. **Steering pivot bushing**

Axle Pivot Bushings

The rear axle must be held in place snugly by the axle pin. Excessive movement of the axle, which is characterized by erratic steering, usually indicates worn bushings. To correct the problem, replace the bushings.

1. Disconnect the hydraulic hoses from the steering cylinder. Put caps or plugs on all the fittings and hoses to prevent contamination.

Note: To ease reassembly, tag each of the hoses to show their correct position on the steering cylinder.

2. Remove the jamnut and thrust washer (or capscrew) securing the end of the axle pivot pin to the chassis (Fig. 15).

3. Jack up the frame (just ahead of the rear wheels) until pressure is taken off the axle pivot pin. Support the machine with jack stands to prevent it from falling.

4. Pull the axle pivot pin out. This will release the rear axle and washer(s) from the frame. Carefully pull the entire axle and wheel assembly out from under the machine.

Note: Several washers may have been installed between the axle pivot tube and frame during manufacture. Make sure the same number of washers are installed during reassembly.

5. Use a drift punch and hammer to drive both bushings out of the axle. Clean the inside of the axle pivot tube to remove dirt and foreign material.

6. Apply grease to the inside and outside of the new bushing. Use an arbor press to install the bushings into the top and bottom of the axle pivot tube. Bushings must be flush with the axle tube.

7. Wipe the rear axle pivot pin with a rag to remove dirt and grease. Inspect the pin for wear or damage and replace as necessary.

8. Mount the axle to the frame with the axle pin. Install washer(s) and axle pivot pin. Secure the axle pivot pin in place with the thrust washer and jamnut (or capscrew).

9. Remove the jackstands and lower the machine to the floor.

10. Lubricate the rear axle pivot bushings through the grease fitting on the pivot pin (or axle body).

11. Install the hydraulic hoses to the steering cylinder.

12. Check steering cylinder hydraulic connections for leaks.

Steering Pivot Bushings

The steering pivot must fit snugly onto the mounting pin. Excessive movement of the steering pivot may indicate worn bushings or tie rod ball joints.

1. Remove the lock nut, cap screw, and thrust washer securing the steering cylinder rod end to the steering pivot plate (Fig. 15).

2. Remove four (4) jamnuts to disconnect both tie rod ends from the pivot plate. Inspect all tie rod end ball joints for wear or damage and replace as necessary.

3. Remove the retaining ring and thrust washer. Slide the steering pivot plate off of the mounting pin on the bottom of the axle.

4. Use a drift punch and hammer to drive both bushings out of the steering pivot. Clean the inside of the steering pivot to remove dirt and foreign material. Also clean the mounting pin on the bottom of the rear axle.

5. Apply grease to the inside and outside of the new bushings. Use an arbor press to install the bushings into the top and bottom of the steering pivot tube. Bushings must be flush with the end of the tube.

6. Slide the steering pivot onto the mounting pin. Secure the plate in place with the thrust washer and retaining ring.

7. Connect each tie rod end to the pivot plate with two (2) jamnuts. For each tie rod, tighten the first nut to a torque of 25 to33 ft-lbs. (34 to 45 Nm). Install the second jamnut and tighten against the other nut to secure tie rod end.

8. Install the thrust washer, cap screw, and locknut to secure the steering cylinder rod end to the steering pivot plate. Tighten the nut to 130 to 150 ft-lbs. (176 to 203 Nm).

9. Lubricate the bushings through the grease fitting on the pivot plate.

Rear Wheel Spindle Bushings

The rear wheel spindles must fit snugly in the rear axle. Excessive movement of the spindle in the axle indicates that the bushings are probably worn and must be replaced.

1. Disconnect the hydraulic hoses from the steering cylinder. Put caps or plugs on the fittings and hoses to prevent contamination.

Note: To ease reassembly, tag each of the hoses to show their correct position on the steering cylinder.

2. Remove the jamnut and thrust washer securing the end of the axle pivot pin to the chassis (Fig. 15).

3. Jack up the frame (just ahead of the rear wheels) until pressure is taken off the axle pivot pin. Support the machine with jackstands to prevent it from falling.

4. Pull the axle pivot pin out. This will release the rear axle and washer(s) from the frame. Carefully pull the entire axle and wheel assembly out from under the machine.

Note: Several washers may have been installed between the axle pivot tube and frame during manufacture. Make sure the same number of washers are installed during reassembly.

5. Remove one (1) jamnut to disconnect the tie rod end from the spindle arm.

6. Remove the capscrew, spindle cap, retaining ring, and washers that secure the wheel spindle into the axle tube. Slide the spindle, washer, and wheel assembly out of the axle tube to expose the bushings.

7. Use a punch and hammer to drive both bushings out of the axle tube. Clean the inside of the axle tube to remove any dirt and foreign material.

8. Apply grease to the inside and outside of the new bushings. Use an arbor press to install the bushings into the top and bottom of the axle tube. The bushings must be flush with the axle tube.

9. Wipe the spindle shaft with a rag to remove any dirt and grease. Inspect the spindles for wear and replace as necessary.

10. Install a washer onto the spindle shaft and push the shaft through the axle tube. Hold the wheel and spindle shaft assembly in place and install the thrust washer flat washer and retaining ring onto the end of the spindle shaft. Install the spindle cap and capscrew.

11. Connect the tie rod end to the spindle bracket with two (2) jamnuts. Tighten the first nut to a torque of 25 to33 ft-lbs. (34 to 45 Nm). Install the second jamnut and tighten against the other nut to secure tie rod end.

12. Mount the axle to the frame with the axle pin. Install washer(s) and axle pivot pin. Secure the axle pivot pin in place with the thrust washer and jamnut.

13. Remove the jackstands and lower the machine to the floor.

14. Lubricate the steering spindles through the grease fittings on the rear axle.

15. Install the hydraulic hoses to the steering cylinder.

16. Check steering cylinder hydraulic connections for leaks.

Wheel Bearings

Front Wheel Bearings

See Chapter 6−Differential Axle “Axle Shafts and Wheel Bearings” in this manual.

Rear Wheel Bearings

Rear wheel bearing buddies should be lubricated every 50 operating hours. Disassemble, clean, repack and adjust the rear wheel bearings after 800 hours of operation or once a year. Use No. 2 general purpose lithium grease containing E.P. additive. If operating conditions are extremely dusty and dirty, it may be necessary to perform this maintenance more often.

1. Jack up the rear of the machine until the tire is off the floor. Support the machine with jack stands or blocks to prevent it from falling.

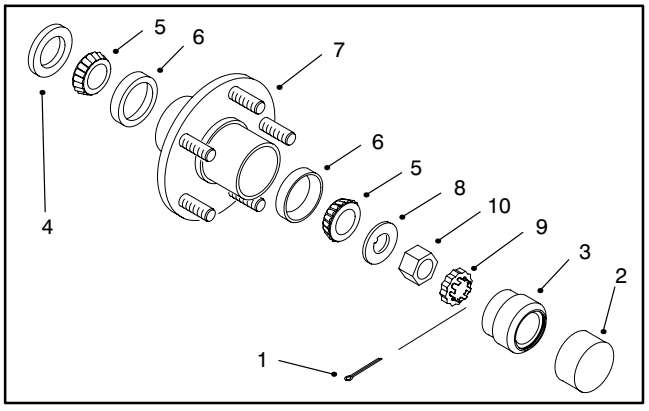


Figure 16

1. **Cotter pin**
2. **Dust cap**
3. **Bearing buddy**
4. **Seal**
5. **Bearing cone**
6. **Bearing race**
7. **Wheel hub**
8. **Washer**
9. **Retainer**
10. **Locknut**

2. Remove the dust cap and bearing buddy from the end of the wheel spindle (Fig. 16).

3. Remove the cotter pin, retainer, slotted nut, and washer. Slide the wheel off the spindle shaft.

4. Pull the seal out of the wheel hub.

5. Remove the bearings from both sides of the 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. Pack both bearings with grease. Install one bearing into the cup on inboard side of the 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 the 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. Rotate the wheel by hand and tighten the slotted nut (Fig. 16) to 75 - 100 in-lb (8.5 - 11.3 Nm) to set the bearing. Then, loosen the nut until the hub has endplay.

11. Rotate the wheel by hand and re-tighten the slotted nut to 15 - 20 in-lb (1.7 - 2.3 Nm).

12. If necessary rotate the slotted nut counterclockwise to align slot with cotter pin hole in spindle, and install retainer and cotter pin.

13. Remove jack stands or blocks and lower machine to floor.

14. Fill the inside of the bearing with grease. Install bearing buddy and dust cap.

Steering Cylinder

Removal

1. Engage the parking brakes, lower the cutting units to the ground, turn the engine OFF and remove the key from the ignition switch.

2. Disconnect the hydraulic hoses from the steering cylinder. Put caps or plugs on all the fittings and hoses to prevent contamination.

Note: To ease reassembly, tag each of the hoses to show their correct position on the steering cylinder.

3. Remove the steering cylinder as follows:

   A. (2WD) Remove the lock nut and capscrew securing the rod end of the cylinder to the steering pivot (Fig. 17).

   B. Remove the lock nut and capscrew securing the barrel end of the cylinder to the rear axle. Remove the steering cylinder.

   A. (4WD Unit Serial No. 80001 - 99999) Remove the lock nut, capscrew, and thrust washers securing the rod end of the cylinder to the steering arm. (Fig. 18).

   B. Remove the capscrew securing the pivot pin to the cylinder support, and remove the pivot pin and thrust washers. Remove the steering cylinder.

   A. (4WD Unit Serial No. 200000001 & Up) Remove the retaining ring securing the rod end of the cylinder to the bevel gear case (Fig. 19).

   B. Remove the retaining ring securing the barrel end of the cylinder to the cylinder mounting bracket. Remove the steering cylinder.

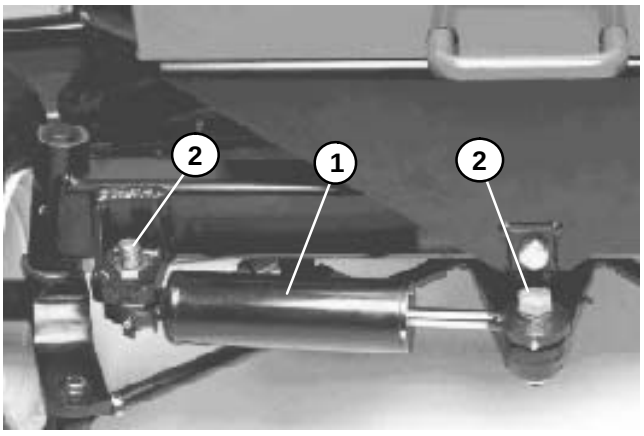


Figure 17

1. **Steering cylinder**
2. **Locknut and capscrew**

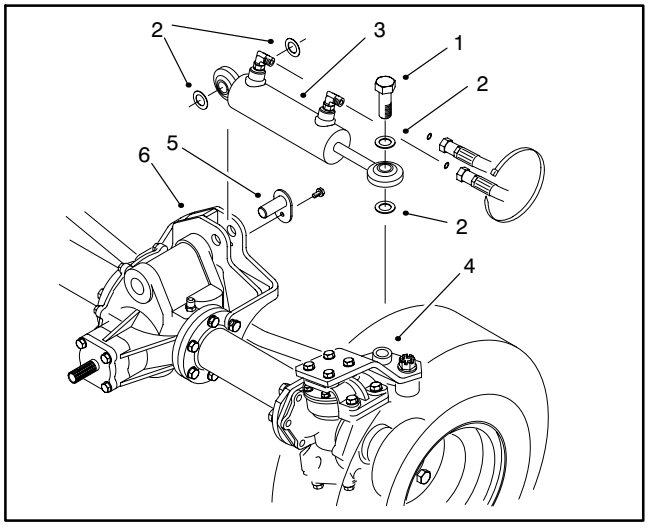


Figure 18

1. **Capscrew**
2. **Thrust washer**
3. **Steering cylinder**
4. **Steering Arm**
5. **Pivot Pin**
6. **Cylinder support**

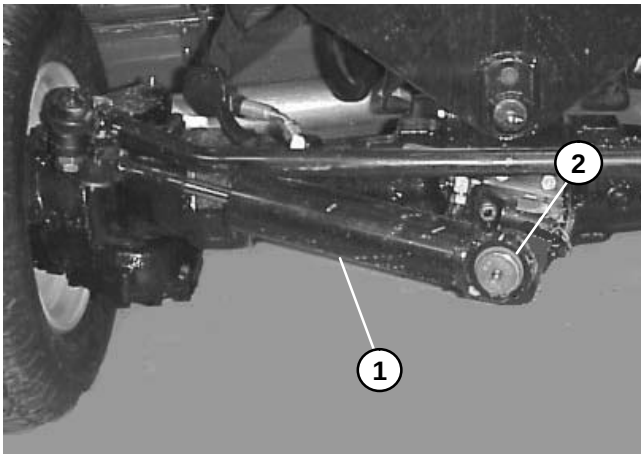


Figure 19

1. **Steering cylinder**
2. **Retaining ring**

Installation

1. Install the steering cylinder as follows:

   A. (2WD) Hold the steering cylinder in position and install the lock nut and cap screw securing the barrel end of the cylinder to the rear axle (Fig. 17).

   B. Install the lock nut and cap screw securing the rod end of the cylinder to the steering pivot.

   C. Tighten the cylinder mounting cap screws and nuts to 130 to150 ft-lbs. (176 to 203 Nm).

   A. (4WD Unit Serial No. 80001 - 99999) Hold the steering cylinder in position and install the pivot pin and thrust washers (Fig. 18). Use medium strength Loctite® thread locker and tighten the capscrew to 70 to 80 in-lbs. (8 to 9 Nm).

   B. Install the lock nut, capscrew, and thrust washers securing the rod end of the cylinder to the steering arm. Tighten the cylinder capscrew and nut to 130 to150 ft-lbs. (176 to 203 Nm)

   A. (4WD Unit Serial No. 200000001 & Up) Hold the steering cylinder in position and install the retaining ring securing the barrel end of the cylinder to the cylinder mounting bracket (Fig. 19).

   B. Install the retaining ring securing the rod end of the cylinder to the bevel gear case.

2. Connect hydraulic hoses. Bleed the hydraulic system and check hydraulic connections for leaks (see Chapter 4−Hydraulic System “Bleeding the Hydraulic System” in this manual).

Steering Cylinder Service

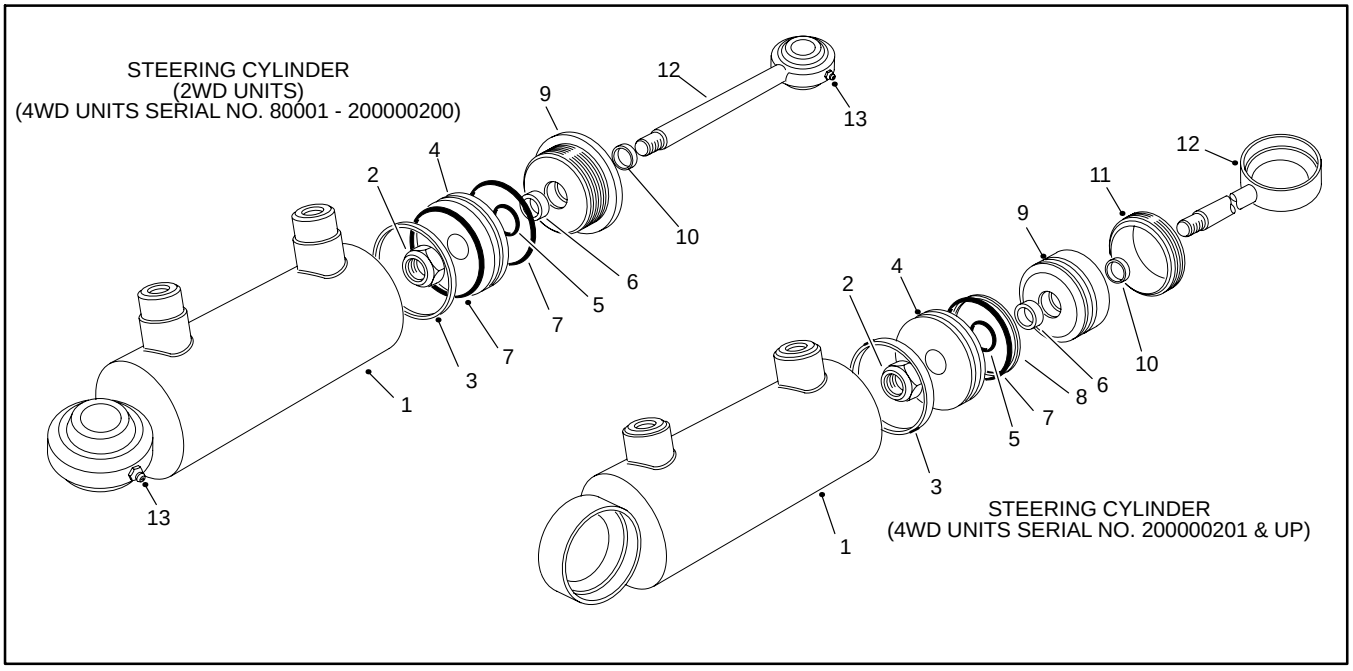


Figure 20

1. **Barrel with clevis**
2. **Nut**
3. **Uni-ring**
4. **Piston**
5. **O-ring**
6. **Rod seal**
7. **O-ring**
8. **Back-up ring**
9. **Head**
10. **Dust seal**
11. **Collar**
12. **Shaft with clevis**
13. **Grease fitting**

IMPORTANT: To prevent damage to rod or barrel, clamp vise on pivot ends only. DO NOT clamp against smooth rod surface.

1. After removing the cylinder, pump oil out of cylinder into a drain pan by SLOWLY moving piston in and out of cylinder bore.

2. Plug the ports and clean the outside of the cylinder.

3. Mount cylinder in a vise so rod end of cylinder is tilted up slightly. Do not close the vise so firmly that the cylinder barrel could become distorted.

4. Use a spanner wrench to unscrew (counterclockwise) head from barrel (Fig. 20).

5. Grasp large end of piston rod and use a twisting and pulling motion to carefully extract piston, rod, and head from cylinder tube.

6. Securely mount piston, rod, and head into vise so large nut is easily accessible for removal. Remove nut by turning it counterclockwise.

7. Remove piston. Slide head off of piston rod.

8. Remove all seals and O−rings.

9. Wash parts in a safe solvent. Dry parts with compressed air. DO NOT wipe them dry with a cloth or paper as lint and dirt may remain.

10. Carefully inspect internal surface of barrel for damage (deep scratches, out−of−round, etc.). Replace entire cylinder if barrel is damaged. Inspect head, rod, and piston for evidence of excessive scoring, pitting, or wear. Replace any damaged parts.

11. Put a light coating of oil on all new seals, and O−rings. Install new seals and O−rings.

12. Install head onto piston rod.

13. Install piston onto rod and tighten hex nut to 30 to 34 ft-lbs. (40 to 46 Nm).

14. Put a light coating of oil on all cylinder parts.

15. Slide piston rod assembly into cylinder tube.

16. Install head into tube and tighten by hand to properly engage threads. Tighten head with a spanner wrench.

Brake Shoe Replacement

WARNING

Older brake linings may contain asbestos fibers. Breathing dust containing asbestos fibers may be hazardous to your health and may cause serious respiratory or other bodily harm. When servicing wheel brake parts, do not create dust by grinding, sanding or filing brake linings or by cleaning wheel brake parts with a dry brush or compressed air. (Use a water dampened cloth.) Use proper protective equipment when working with asbestos materials.

1. Loosen wheel lug nuts. Jack up machine until front wheel is off of floor. Use jackstands to prevent machine from falling accidentally. Remove wheel lug nuts and slide wheel and tire assembly off of studs.

2. Remove brake drum.

NOTE: If the brake drum is severely worn, it may be necessary to loosen the brake shoes before removing the brake drum. Loosen the brake shoes by turning the star wheel inside the brake drum assembly.

3. Remove adjusting screw spring.

4. Remove brake lever retainers (cotter pins) with a slip joint pliers.

5. Pull strut and lever from brake shoes. Remove brake shoes by sliding them both on one motion straight down off cast−iron spider.

6. Remove star wheel assembly.

7. Remove brake shoe return spring (Fig. 21) by prying the end of the spring up and out of the brake shoe. Use a brake spring pliers or flat blade screwdriver.

CAUTION

Wear a face shield when removing brake return spring (Fig. 21). The spring is under tension and could possibly slip during removal.

8. Install new brake shoes (reverse steps 2 thru 7) Install new brake drum if it is severely scored.

9. Install wheel and tire assembly on studs with five (5) wheel nuts. Tighten wheel lug nuts to 45 to 55 ft-lbs. (61 to 75 Nm). Remove jack stands or blocking and lower machine to the floor.

10. Adjust brakes (see Brake Adjustment in this section of this manual).

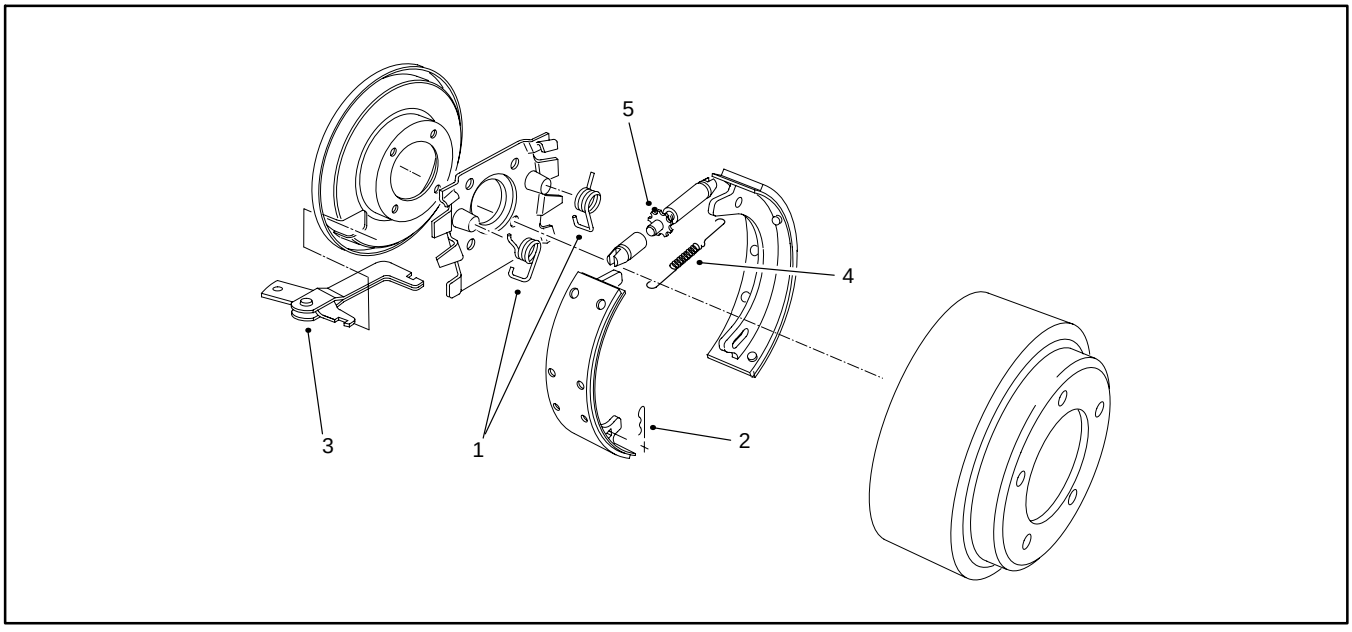


Figure 21

1. **Return spring**
2. **Cotter pins**
3. **Strut and lever**
4. **Adjusting screw spring**
5. **Star wheel assembly**

Steering Valve

Removal

1. Engage the parking brakes, lower the cutting units to the ground, turn the engine OFF and remove the key from the ignition switch.

2. Remove the front center cutting unit (see Chapter 8−Cutting Units in this manual).

3. Remove cap screws and cover from steering tower.

4. Clean outside of the steering valve and the area around the hydraulic fittings. Disconnect hydraulic lines from steering valve (Fig. 22). Put caps or plugs on all fittings and lines to prevent contamination.

Note: To ease reassembly, tag each of the lines to show their correct position on the steering cylinder.

5. Remove the steering wheel (see Steering Wheel Removal in this section of this manual).

6. Remove the clamp securing the steering column to the steering tower.

7. Remove four (4) nuts and washers securing steering valve to steering tower.

8. Carefully move hydraulic lines to the side and pull steering valve and column out through bottom of steering tower.

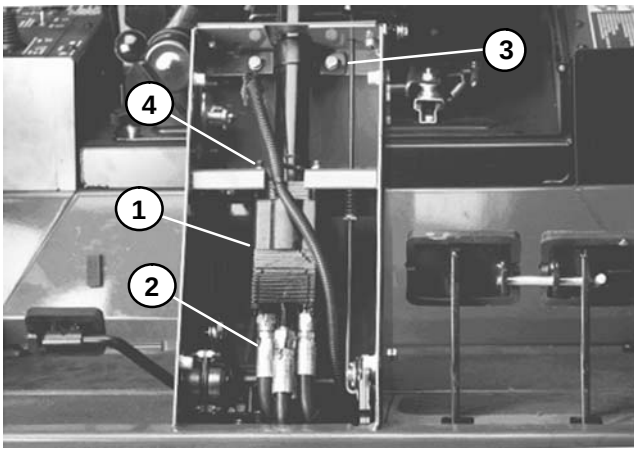


Figure 22

1. **Steering valve**
2. **Hydraulic line**
3. **Clamp**
4. **Nut and washer**

Installation

1. Carefully feed the steering valve and column into the steering tower through the bottom.

2. Install four (4) nuts and washers securing steering valve to steering tower.

3. Install the clamp securing the steering column to the steering tower.

4. Install the steering wheel (see Steering Wheel Installation in this section of this manual).

5. Connect hydraulic lines. Bleed the hydraulic system and check hydraulic connections for leaks (see Chapter 4−Hydraulic System “Bleeding the Hydraulic System” in this manual).

6. Check hydraulic connections for leaks.

7. Install cap screws and cover to steering tower.

8. Install the front center cutting unit (see Chapter 8−Cutting Units in this manual).

Steering Valve Service

Note: For repair of the steering valve, see the Ross Hydraguide™ Hydrostatic Steering System HGF Series Service Procedure at the end of this chapter.

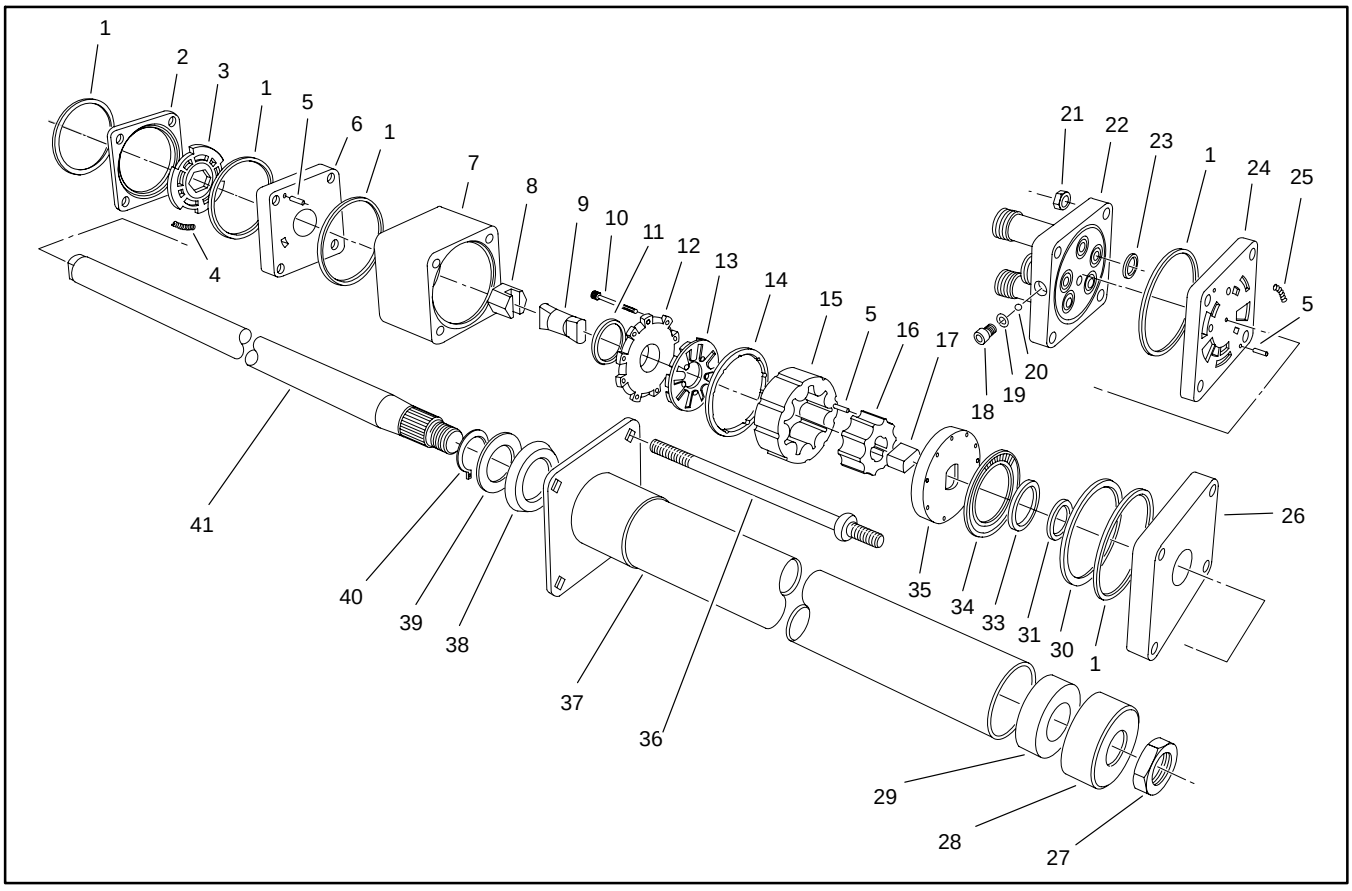


Figure 23

1. **Seal ring**
2. **Valve ring**
3. **Valve plate**
4. **Spring**
5. **Alignment pin**
6. **Isolation manifold**
7. **Metering ring**
8. **Hex drive**
9. **Drive link**
10. **Socket head screw**
11. **Commutator seal**
12. **Commutator cover**
13. **Commutator**
14. **Commutator ring**
15. **Stator**
16. **Rotor**
17. **Drive link spacer**
18. **Plug**
19. **O−ring**
20. **Ball**
21. **Nut**
22. **Port cover**
23. **O−ring**
24. **Port manifold**
25. **Spring**
26. **Upper cover plate**
27. **Nut**
28. **Seal**
29. **Bushing**
30. **Thrust bearing spacer**
31. **Seal spacer**
32. **Not used**
33. **Face seal**
34. **Thrust bearing**
35. **Drive plate**
36. **Special bolt**
37. **Upper cover and jacket**
38. **Retaining plate**
39. **Retaining plate washer**
40. **Retaining ring**
41. **Input shaft**

Table of Contents

Note: For cutting unit **Models 03527 & 03528**, see Chapter 8.1 “Cutting Units” in this manual.

Specifications

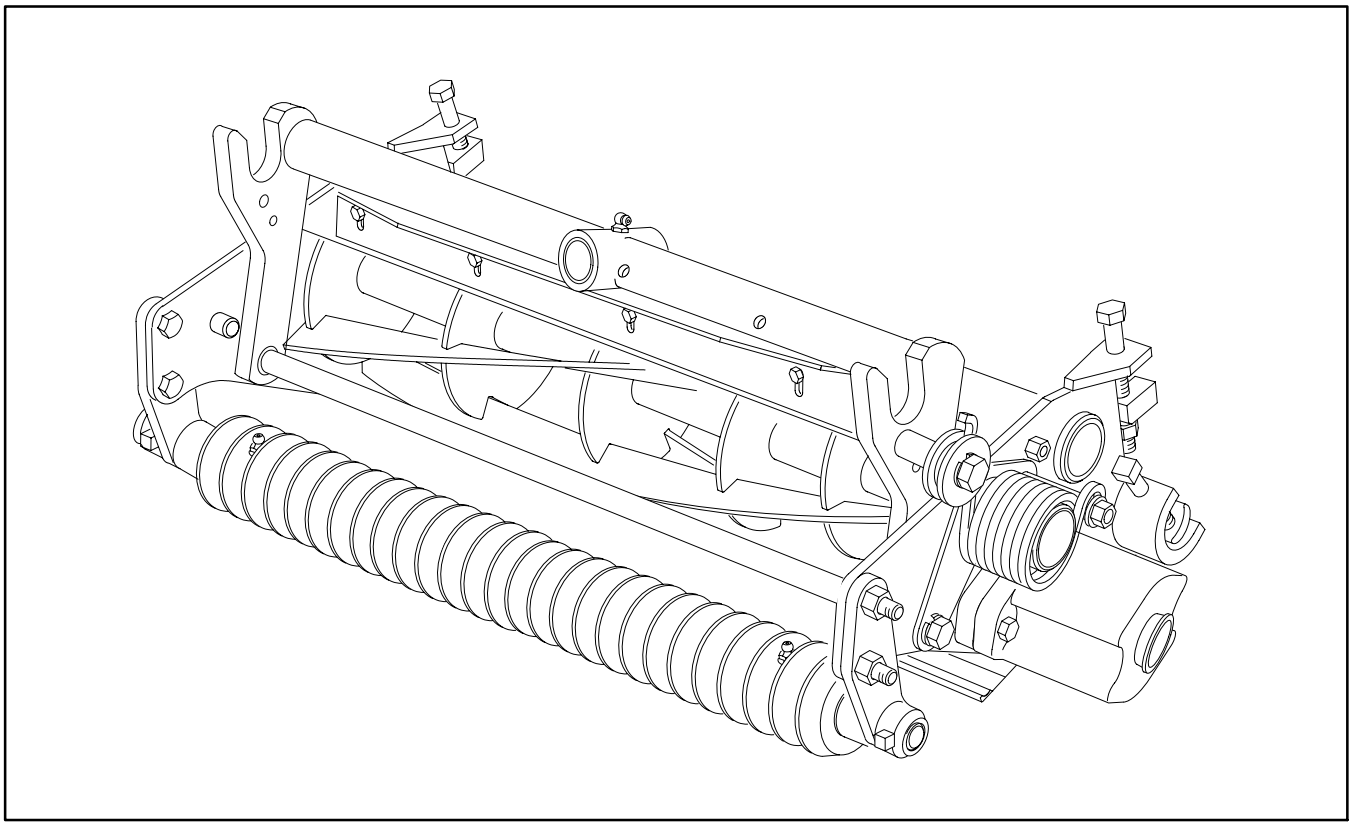


Figure 1

Reel Construction

5 or 8 blade welded construction with 5 inch diameter.

Height-of-Cut

5-blade: 1/2 to 3/4 inch (1.27 to 1.91cm)

8-blade: 1/4 to 5/8 inch (0.64 to 1.59 cm) using Standard Rear Roller Kit (2 inch dia.) Model 03525
5/16 to 5/8 inch (0.79 to 1.59 cm) using Premium Rear roller Kit (2.5 inch dia.) Model 0323

Roller Adjustment

Front: Fixed

Rear: Screw adjustable with bolt clamp lock

Bedknife-to-Reel Adjustment

Bedknife adjusts against the reel with opposing screw adjustment on each end of the bedbar.

Bedknife Screw Torque

180 to 200 in-lb (20.3 to 22.6 N-m)

Reel Spline Drive Nut Torque

40 to 60 ft-lb (54 to 81 N-m)

Reel Bearing Roller Torque

4 to 7 in-lb (0.45 to 0.79 N-m) with no end play

Special Tools

Order special tools from the *TORO SPECIAL TOOLS AND APPLICATIONS GUIDE (COMMERCIAL PRODUCTS)*.

Some tools may have been supplied with your machine or available as TORO parts. Some tools may also be available from a local supplier.

Handle Assembly - TOR299100

For applying lapping compound to cutting units while keeping hands a safe distance from the rotating reel.

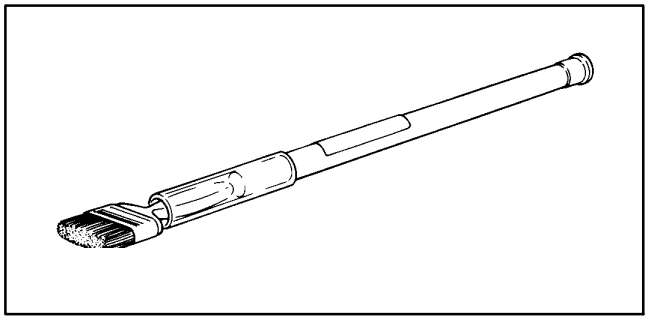


Figure 2

Bedknife Screw Tool - TOR510880

This screwdriver type bit is made to fit Toro bedknife attaching screws. Use this bit with a torque wrench to secure the bedknife to the bedbar.

IMPORTANT: Do not use an air or manual impact wrench with this tool.

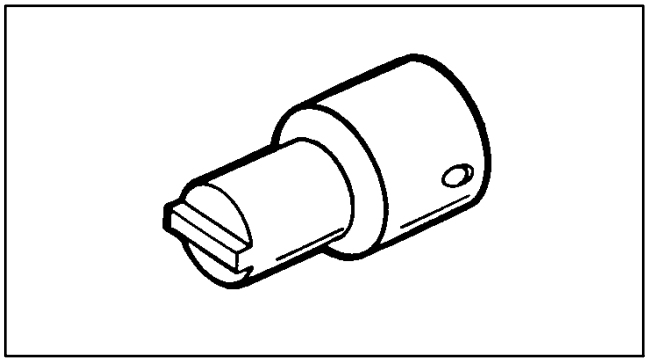


Figure 3

Turf Evaluator Tool - Toro Model No. 04399

Many turf discrepancies are subtle and require closer examination. In these instances, the TurfEvaluatort grass viewing tool is helpful. It can assist turf managers and service technicians in determining causes for poor reel mower performance and comparing the effective height of cut of one mowed surface to another. This tool should be used with the Toro Guide to Evaluation Reel Mower Performance and Using the TurfEvaluator (Toro Part No. 97931SL)

Figure 4

Troubleshooting

Turf Condition

Turf conditions play a dramatic role in the aftercut appearance. Turf conditions must always be considered before attempting to remedy a problem with adjustments to your turf equipment. Equipment used strictly for mowing cannot remedy turf conditions but can often times be adjusted to adapt to a given turf condition.

The goal of a turf equipment service person is to help address concerns by matching the equipment to the current conditions. This is a partnership between you and the person or persons responsible for the turf. The ultimate solution is usually a combination of turf remedies and machine adjustments.

It is important to remember that the same ”fix” will not work for every turf condition and it may not work every time in what seems to be identical conditions. Requirements are different between warm season grasses and cool season grasses and the cutting unit needs to be setup for the grass type and seasonal differences.

Cutting Units

A cutting unit that is set up incorrectly or improperly maintained can cause many problems. The items listed below must be checked, corrected if necessary, and be the same on all cutting units:

- Adjusters, Pivots, Bushings and Compensating Springs− lubricated if necessary, tight and in good working order.
- Bedknife: Correct for the application with sharp, flat and straight cutting edge .
- Bedknife Attitude: Set to manufacturer recommendations.
- Bedknife Contact: Set properly according to manufacturer recommendations.
- Reel: Sharp cutting edge (relief or backgrind recommended) with less than .002 (.05mm) run out as a general rule, always refer to manufacturers recommendations.
- Reel Bearings: In good condition, no end−play and adjusted properly.
- Reel Diameter: Meets or exceeds the manufacturer recommended minimum diameter.
- Rollers: Parallel to the reel (see operators manual).
- Roller condition: Bearings (no end−play), surface run out as a general rule should be less than .015 (.38mm) (but always refer to manufacturers recommendations), and centered in the frame.
- H.O.C. set to obtain the correct effective height of cut.
- The wear factors must be equal. (a new part on one unit and the same part being worn on another unit can cause differences).

Problem Solving

- Define the issue (ask enough questions and see the issue for yourself) the issue must be clearly defined before you can begin to address it correctly.
- Evaluate turf conditions for their part in the outcome (including weather trends such as extreme wet or dry, recent turf maintenance performed such as top dressing etc.).
- Verify the traction unit is operating properly and in good condition (no switches jumped, proper engine RPM, maintenance up to date etc.).
- Check and recheck the cutting units for accurate and proper setup.
- Understand and be able to duplicate the complaint or condition.

While attempting to resolve aftercut appearance issues it will be necessary to make physical changes to components of the cutting unit or traction unit. All adjustment, changes, and modifications from a current condition should be made singularly using a scientific process. Make only one change at a time and take careful notes of the conditions resulting from each change before additional changes or adjustments are made. A systematic approach to troubleshooting will assist in resolving issues timely and effectively.

Record information about the machine and turf conditions below to assist with your problem solving.

Machine:

Model _____ Serial Number _____ Engine @ _____ RPM

Cutting Units:

Model _____ Serial Number _____

Number of Blades _____ Serial Number _____

Use: (describe − i.e. Fairways, Outfields, Greens, etc.)

_____

_____

HOC _____ **Number of Blades** _____ **Type of Grass** _____

Over-seeded? ____ **Last Turf Maintenance Performed** _____ **Date** _____

Current Weather Pattern (i.e. Drought, Hot, Wet, etc.) _____

Condition Found: _____

_____

_____

_____

Condition Environment (when it happens, what needs to be done to duplicate the condition):

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Note: For additional information see Toro Commercial Products Aftercut Appearance Troubleshooting Aid. Part No. 00076SL.

Adjustments

Adjustment Summary and Check List

DETAILED ADJUSTMENT INSTRUCTIONS FOLLOW THIS SUMMARY AND CHECK LIST. Study this information and refer to it often to get maximum life and performance from the cutting units.

CAUTION

Never install or work on the cutting units or lift arms with the engine running. Always stop engine and remove key first.

Daily Performance Checks

NOTE: It is not necessary to remove cutting units from traction unit to perform these daily checks. It is recommended that mowers be washed after each use. Always remove key from ignition switch when working on the machine.

1. Purge water and debris from all bearings by greasing them. Use No. 2 multi-purpose lithium base grease.

2. Visually check for sharp reel and bedknife. **Remove burrs, nicks, and rounded edges.**

3. Lower cutting units to the ground (setting on both rollers). Remove reel motor and rotate the reel backwards by hand. Light contact between the bedknife and reel should be felt and heard.

- It should be possible to pinch newspaper when inserted from the front, and cut paper when inserted at a right angle (along entire length of bedknife).
- It should be possible to cut paper with minimum bedknife to reel contact. Should excessive reel drag be evident you must backlap or grind the cutting unit.
- Excessive clearance greater than 0.003 inch (0.076 mm) will dull the cutting edges.
- Excessive contact accelerates wear, and quality of cut may be adversely affected.

4. Check reel speed controls. If necessary, adjust reel speed to settings shown on REEL SPEED SETTINGS graph for number of reel blades (5 or 8) and desired ground speed (see Operator's Manual and decal on machine under seat plate).

NOTE: Reel speed settings may require "fine tuning" from initial adjustment for optimum cutting performance.

Weekly Checks

1. Check reel bearing adjustment and bearing condition.

2. Make sure bed bar pivot bolts are securely seated to a maximum of 40 ft-lb (54 N-m).

3. Using a gauge bar, verify correct height-of-cut setting and adjust as necessary.

4. Check lift arm down pressure springs. Make sure all springs have same down pressure setting.

Monthly Adjustments

NOTE: Remove cutting unit from traction unit before doing these checks and adjustments (See Cutting Unit Removal and Installation in the Repairs section of this chapter.)

1. Visually check for sharp reel and bedknife. Backlap or grind reel and bedknife if necessary (see Prepare Reel for Grinding).

2. Check reel to bedknife contact (see Adjust Bedknife to Reel).

3. Check front roller level to to reel (see Level Front Roller to Reel).

4. Check height-of-cut (see Adjust Height-of Cut).

5. Check rear roller scraper (if equipped) to be 1/32 inch (0.79 mm) from roller. Adjust if necessary.

6. Check grass shield adjustment (see Adjust Shield Height).

7. Check cutoff bar adjustment (see Adjust Cutoff Bar).

Special Notes

1. A "rifled" reel and/or bedknife must be corrected by grinding.

2. If reel bearings will not hold adjustment during operation, loosen adjustment nut, tap on head of bolt at end of reel shaft with a small hammer until end play of reel shaft can be felt, tighten reel shaft spline nut to a torque of 40 to 60 ft-lb (54 to 81 N-m), then adjust reel bearings.

Reel Bearing Adjustment and Service

IMPORTANT: Before removing cutting unit, remove reel motors to prevent damaging hydraulic hoses.

It is recommended that a check be made periodically of the drag on the reel bearings. Proper adjustment of the reel bearings insures that no end play of reel exists and there is minimum rolling torque of reel assembly. All measurements and adjustments of reel rolling torque must be done with a completely assembled cutting unit. The reel bearings can be checked and adjusted in the following manner:

1. First, adjust the bedknife so it is not in contact with the reel.

2. The rolling torque required to turn the reel should be 4 to 7 in-lb (0.45 to 0.79 N-m). This should be measured with a torque wrench (Fig. 5).

If the rolling torque of the reel is not per specification or end play of reel exists, adjust the reel bearing as follows:

A. Remove the mounting nuts from the counterbalance end cap, and remove end cap from the mounting studs (Fig. 6).

B. Using a large socket wrench, remove the reel bearing adjustment nut (Fig. 7). Tap on the head of the hex head bolt on the end of the reel shaft, with a small hammer, until end play of the reel can be felt.

CAUTION

Do not use your hand to prevent reel from turning while servicing; this can result in personal injury. Use a 1/2 inch thick x 3 inch wide x 8 inch long piece of hardwood inserted into front of cutting unit between reel blades.

C. Hold the reel from turning and slowly tighten the reel bearing adjustment nut until no end play of the reel exists.

D. Using an appropriate dial torque wrench, check the rolling torque of the reel. The rolling torque of the reel should be 4 to 7 in-lb (0.45 to 0.79 N-m). Check to make sure no end play exists and reel spins freely.

E. Reinstall counterbalance end cap.

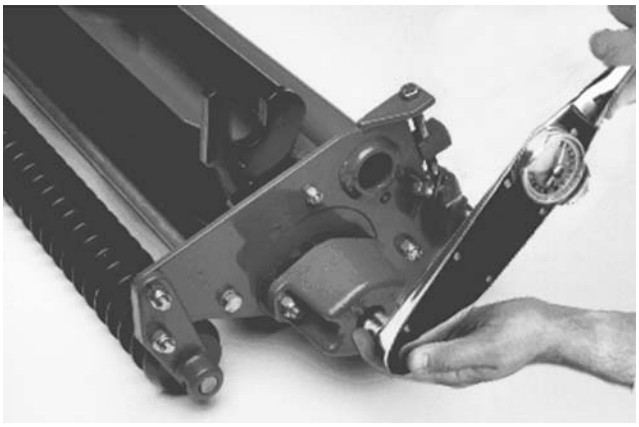


Figure 5

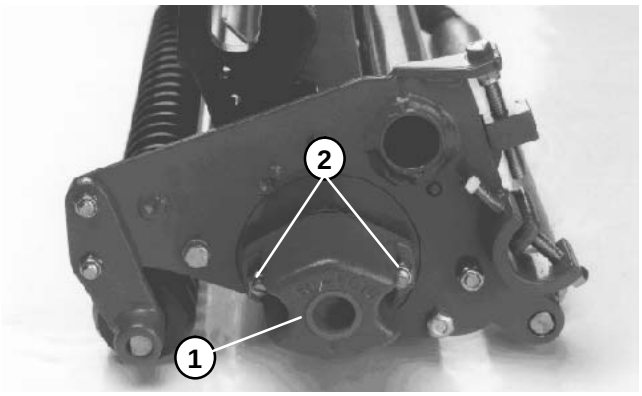


Figure 6

1. Counterbalance end cap **2. Mounting nuts**

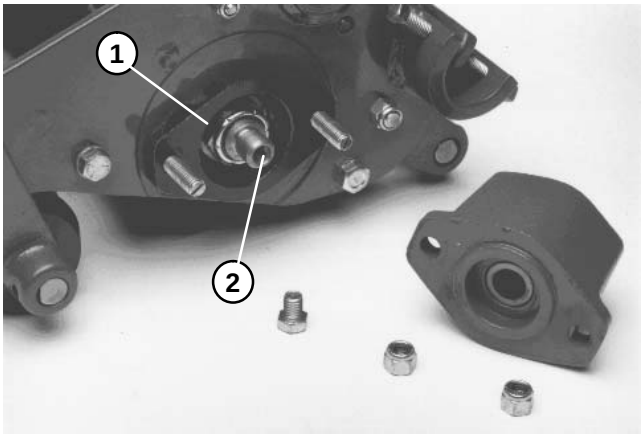


Figure 7

1. Reel bearing adj. nut **2. Reel shaft**

Adjust Bedknife to Reel

IMPORTANT: The reel and bedknife must be parallel to insure the cutting unit cuts grass across the bedknife, and the reel and bedknife wear evenly.

1. Rotate cutting unit backward to gain access to the reel and bedknife.

2. Adjustment of bedknife to reel is accomplished by loosening bottom screw on each side of cutting unit (Fig. 8), and tightening the top adjustment screw (Fig. 9) on each side of cutting unit. This adjustment will position the bedknife closer to the reel blades. Adjust until light contact is heard on both ends of the reels.

Note: Correct reel to bedknife contact should not increase the reel rolling torque more than 3 in−lbs. over the reel bearing rolling torque setting (see Servicing and Adjusting the reel bearings for checking reel rolling torque).

IMPORTANT: Use only a 3/8 open end wrench 3" to 6" (76−152 mm) in length for adjusting bedknife to reel. A longer wrench will provide too much leverage and may cause distortion of the mounting plate for the adjustment screw.

3. After adjusting bedknife to reel, make sure that both the top and the bottom adjustment screws are secured on both ends of the cutting unit (Fig. 8 & 9).

4. Insert 1" (25 mm) wide piece of newspaper perpendicular to the bedknife, and then rotate the reel slowly in the mowing direction to see if the reel cuts the paper − do this on both ends of the bedknife (Fig. 10).

5. If paper is cut on both ends, the bedknife is parallel to the reel. If not, go back to step 2.

Note: If reel makes contact on both sides of bedknife but still does not cut paper, cutting unit may need to be backlapped (refer to backlapping) or reel and/or bedknife may need to be reground (refer to Toro manual for Sharpening Reel and rotary Mowers, Form No. 80−300PT).

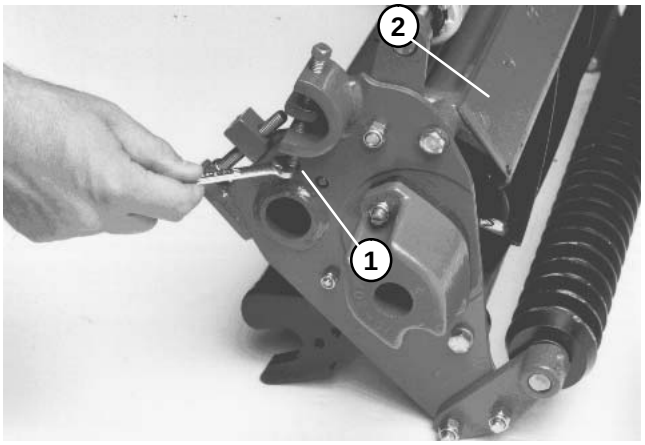


Figure 8

1. Bottom adj. screw **2. Bedknife**

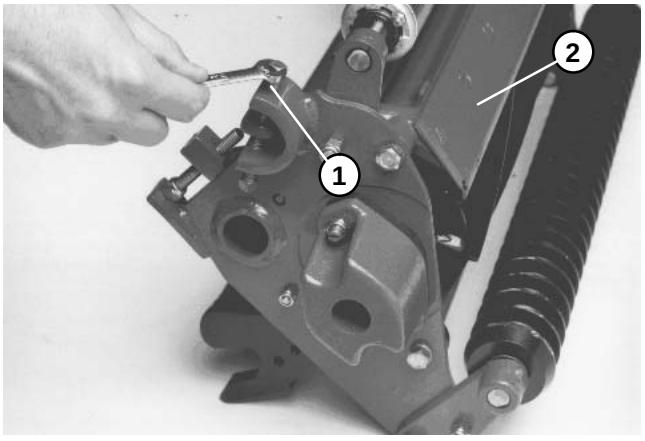


Figure 9

1. Top adj, screw **2. Bedknife**

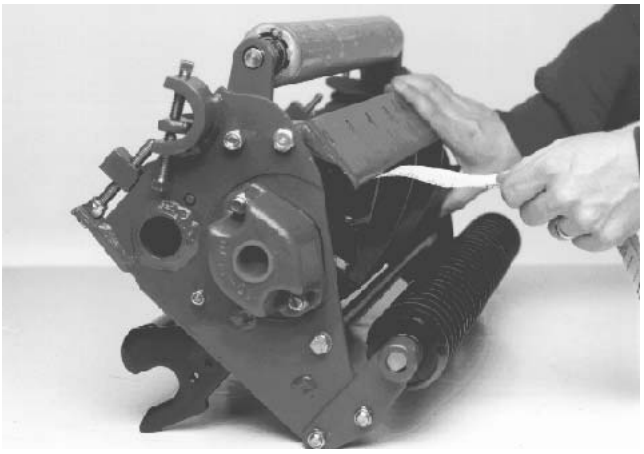


Figure 10

Level Front Roller to Reel

1. Adjust rear roller assembly to the lowest height-of-cut (see Adjust Height-of-Cut). Do not tighten lock nuts securing rear roller brackets at this time.

NOTE: Be sure the plate covers the full length of reel blades.

2. Place a 1/4 inch (6.4 mm) or thicker plate under the reel blades and against the cutting edge of the bedknife. Rear roller should not contact surface.

NOTE: When securing the front roller brackets, tighten fastener on inside of cutting unit frame so position of roller bracket does not change.

3. Level front roller to reel by loosening both cap screws holding each front roller bracket and rotating front roller until it contacts surface that plate is on. Tighten cap screws and make sure roller has not changed position. To prevent moving the front roller bracket when tightening, hold nut and tighten cap screw.

NOTE: This adjustment should be made on a flat working surface.

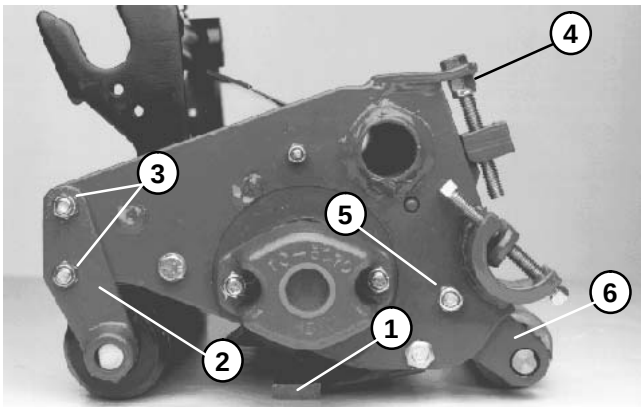


Figure 11

1. **Steel plate**
2. **Front roller bracket**
3. **Cap screws**
4. **H.O.C. adj. bolt**
5. **Lock nut**
6. **Rear roller bracket**

Adjust Height-of-Cut

NOTE: Effective height-of-cut (H.O.C.) in the turf can be affected by lift arm down pressure adjustment and turf conditions, such as grass type, grass density, and amount of thatch.

1. Perform Adjust Bedknife to Reel and Level Front Roller to Reel before adjusting the height-of-cut.

2. To adjust height-of-cut, the cutting unit should be turned over.

3. Loosen locknut securing rear roller bracket to the side plate on each end of cutting unit. Loosen locknut on each height-of-cut adjusting bolt.

IMPORTANT: Perform steps 4 and 5 at each end of the bedknife.

4. Set head of screw on gauge bar to desired height-of-cut. Height of cut measurement is from face of bar to under side of screw head.

5. Put bar across front and rear rollers. Turn height-of-cut adjustment bolt until underside of screw head engages bedknife cutting edge.

6. Tighten height-of-cut adjustment bolt locknut and rear roller bracket locknut at both ends of cutting unit. Check adjustment and readjust if necessary.

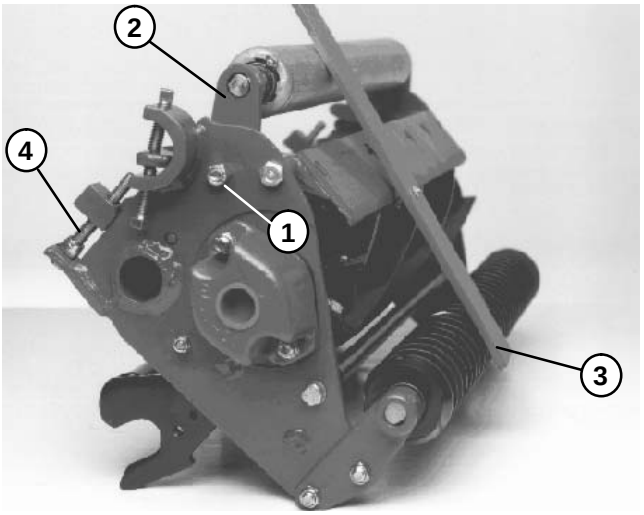


Figure 12

1. **Lock nut**
2. **Rear roller bracket**
3. **Gauge bar**
4. **'H.O.C. adj. bolt**

Adjust Front Shield Height

Adjust shield to get proper grass clipping discharge into the basket or the desired front discharge when not using baskets.

NOTE: Shield can be lowered in dry grass conditions (clippings fly over top of baskets) or raised to allow for heavy wet grass conditions (clippings build up on rear edge of basket.

1. Set cutting unit in normal cutting position.

2. Loosen cap screws and nuts securing shield to each side-plate, adjust shield to correct height and tighten fasteners (Fig. 13).

3. Repeat adjustment on remaining cutting units and adjust top bar. (See Adjust Cutoff Bar).

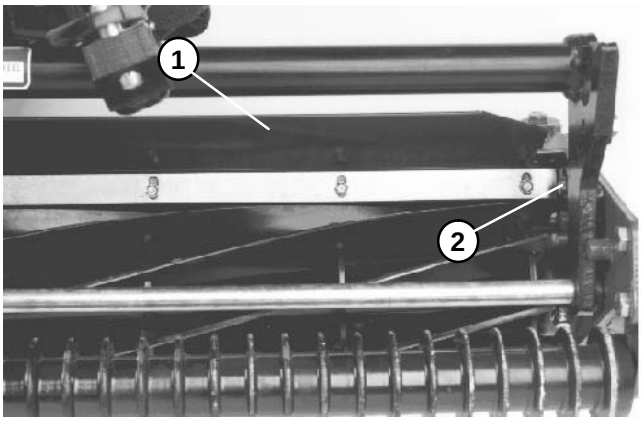


Figure 13

1. Shield **2. Cap screw & nut**

Opening Rear Shield

When mowing in wet conditions or conditions in which an excessive amount of clippings is being removed, rear discharge may be desirable. Opening the rear shield will allow direct discharge of clippings, to prevent cutting the clippings again.

1. Loosen locking bolt on side of cutting unit (Fig. 14).

2. Open rear shield to desired operating position.

3. Tighten locking bolt on each side of cutting unit.

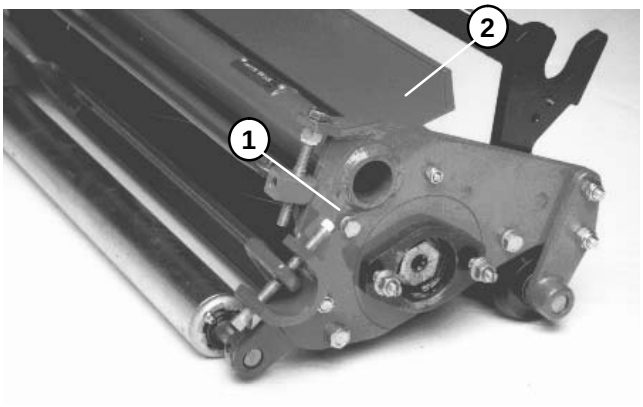


Figure 14

1. Locking bolt **2. Rear shield**

Adjust Cutoff Bar

Adjust top bar to make sure clippings are cleanly discharged from reel area:

NOTE: Bar should be parallel to reel for optimum performance and should be adjusted whenever shield height is adjusted or whenever reel is sharpened on a reel grinder.

1. Loosen screws securing top bar. Insert 0.060 inch (1.52 mm) feeler gauge between the top of the reel and bar; tighten screws. Make sure bar and reel are an equal distance apart across the entire reel.

2. Do adjustment on remaining cutting units.

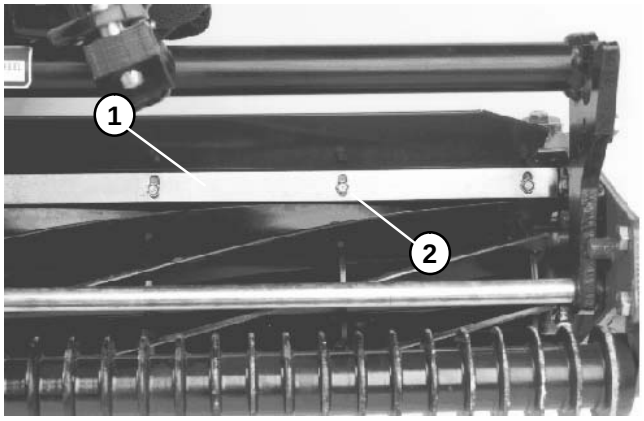


Figure 15

1. **Cutoff bar**
2. **Mounting screw**

Adjust Lock-up Roller

Adjust lock-up rollers so they contact the lock-up lever on each rear lift arm and support the cutting units when fully raised. The cutting units should have approximately 3/8 to 5/8 inch (9.5 to 15.9 mm) vertical travel when measured at the rear roller.

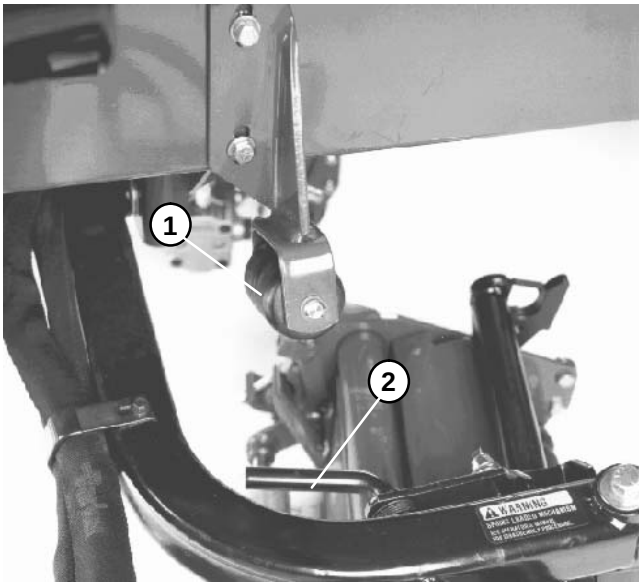


Figure 16

1. **Lock-up roller**
2. **Lock-up lever**

Adjust Lift Arm Down Pressure

The down pressure spring on each cutting unit lift arm can be adjusted to compensate for different turf conditions. Increased down pressure will help keep the cutting units on the ground when mowing at higher speeds and helps maintain a uniform height-of-cut in rough conditions or in areas of thatch build up.

Each down pressure spring may be adjusted to one of four (4) settings. Each increment increases or decreases down pressure on cutting unit by 8 lbs (37 N).

1. Put machine on a level surface, lower the cutting units, stop the engine, engage the parking brakes and remove key from ignition switch.

2. Remove floor plate in front of seat and open the hood to get access to all five (5) springs.

CAUTION

Springs are under tension. Use caution when adjusting.

3. Put an open end wrench on hex shaft of spring bracket.

NOTE: Because wrench can be moved only a limited distance, it may be necessary to use a second wrench to hold hex shaft while re-positioning other wrench for further rotation of hex shaft.

4. Remove cap screw and locknut securing retaining bracket, while rotating hex shaft to relieve spring tension.

5. Move spring bracket to desired position and install cap screw and locknut, while rotating hex shaft to relieve spring tension.

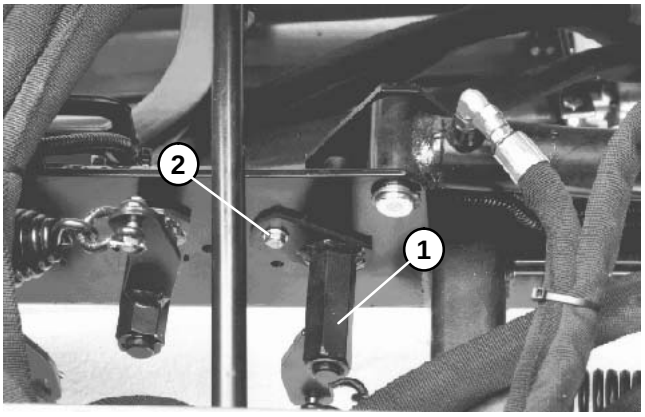


Figure 17

1. Spring bracket hex shaft **2. Retaining bracket**

Cutting Unit Removal and Installation

Removal

Remove cutting unit from traction unit before doing adjustments or repairs.

1. Remove basket from cutting unit.

2. Disconnect chain from cross tube on each rear cutting unit (Fig. 18).

3. Loosen reel motor mounting nuts. Rotate motor clockwise so motor flanges clear studs. Pull motor off of cutting unit (Fig. 19).

4. Remove cap screw, lock washer, flat washer and thrust washer from cutting unit mounting shaft (Fig. 20).

5. Pull cutting unit off mounting shaft (Fig. 20).

Installation

1. Position cutting unit onto the mounting shaft (Fig. 20).

2. Secure thrust washer, flat washer, lock washer, and cap screw to the cutting unit mounting shaft (Fig. 20).

3. Install motor onto the cutting. Rotate motor counterclockwise so motor flanges engages studs (Fig. 19).

4. Connect chain to the cross tube on each rear cutting unit (Fig. 18).

5. Install basket to the cutting.

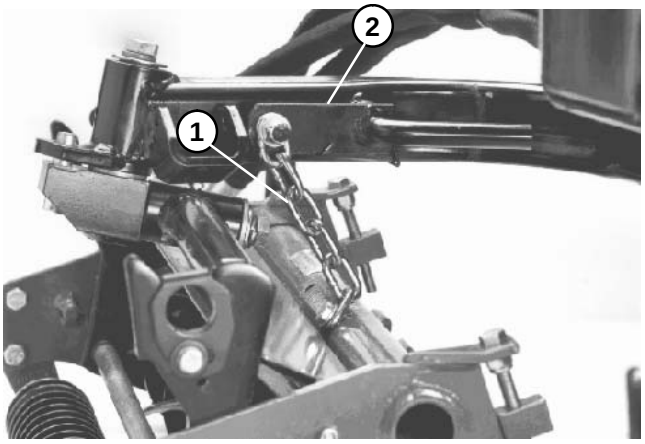


Figure 18

1. Lock-up chain **2. Cross tube**

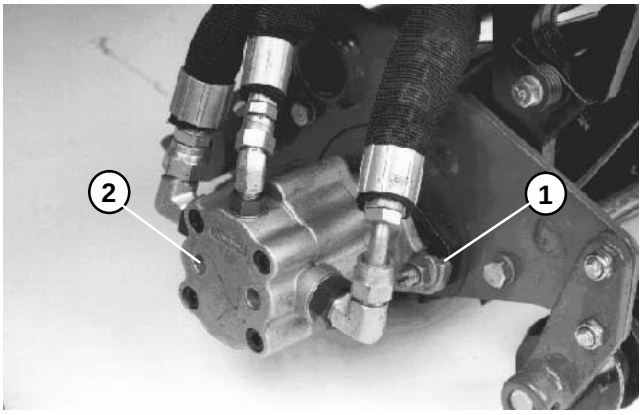


Figure 19

1. Reel motor **2. Mounting nut**

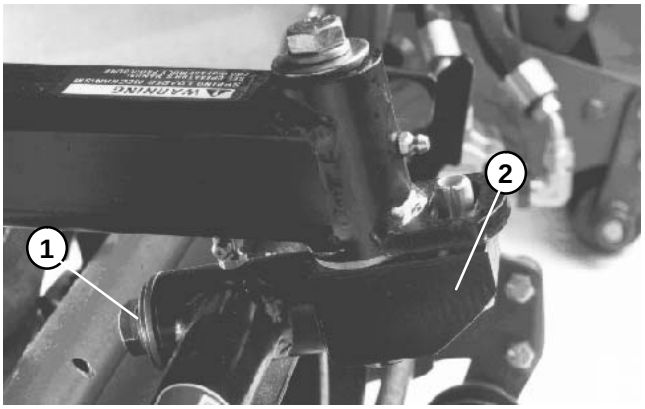


Figure 20

1. Cap screw, lock washer, flat washer, & thrust washer **2. Cutting unit mounting shaft**

Backlapping

DANGER

Reels may stall while backlapping. Do not attempt to restart reels by hand or adjust while backlapping. Stop engine and set speed control to position 11 to the start reels; set to position 1 for backlapping.

NOTE: Backlap either the front cutting units together or the rear ones together.

1. Park machine on a clean, level surface. Lower cutting units, stop engine, engage parking brake, move enable/disable switch to disable position, and remove key from the ignition switch.

2. Unlock and raise seat to expose controls.

3. Make initial reel to bedknife adjustments appropriate for backlapping on all cutting units. Start engine and set engine at idle speed.

4. Set both reel speed controls to position 11 (Fig. 21).

5. Select either front or rear on backlap switch to determine which units to backlap (Fig. 22).

6. Move enable/disable switch to enable position. Move lower mow/raise lever forward to start backlapping operation on designated reels (Fig. 23).

7. For the cutting units being backlapped, move the reel speed control to position 1.

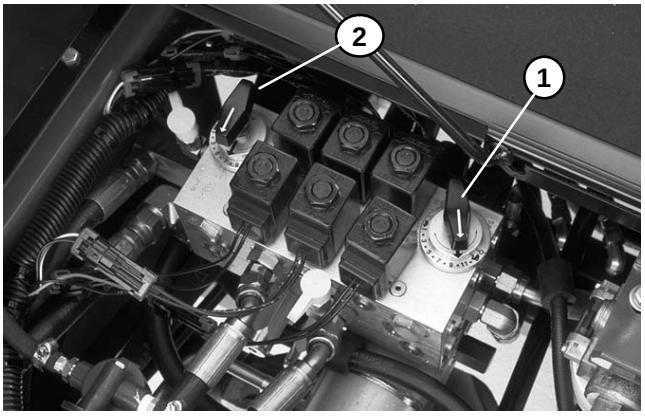


Figure 21

1. Front reel speed control **2. Rear reel speed control**

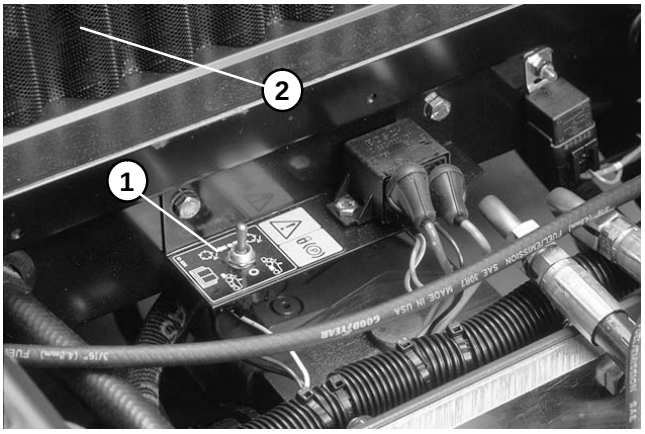


Figure 22

1. Backlap switch **2. Radiator screen**

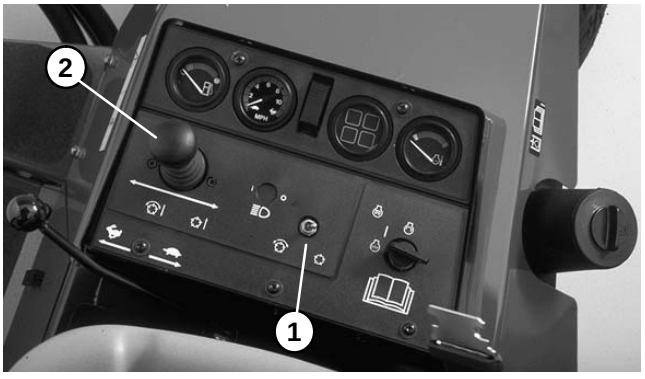


Figure 23

1. Enable/Disable switch **2. Lower Mow/Raise lever**

DANGER

Be careful when lapping the reel because contact with the reel or other moving parts can result in personal injury.

8. Apply lapping compound with long handled brush supplied with machine (Fig. 24).

9. To make an adjustment to the cutting units while backlapping, turn reels OFF by moving Lower Mow/Raise lever REARWARD, Move Enable/Disable switch to DISABLE and turn engine OFF (Fig. 23).

10. After adjustments have been completed, repeat steps 3 thru 8.

11. Repeat procedure for remaining cutting units.

12. When backlap operation is completed, return backlap switch to OFF (Fig. 22).

13. Set reel speed controls to desired mowing setting (Fig. 21).

14. Wash all lapping compound off cutting units.

NOTE: For additional instructions and procedures on backlapping, see the Toro Sharpening Reel & Rotary Mowers Book, Part No. 80300SL.

NOTE: For a better cutting edge, run a file across the front face of the bedknife when the lapping operation is completed. This will remove any burrs or rough edges that may have built up on the cutting edge (Fig 25).

Figure 24

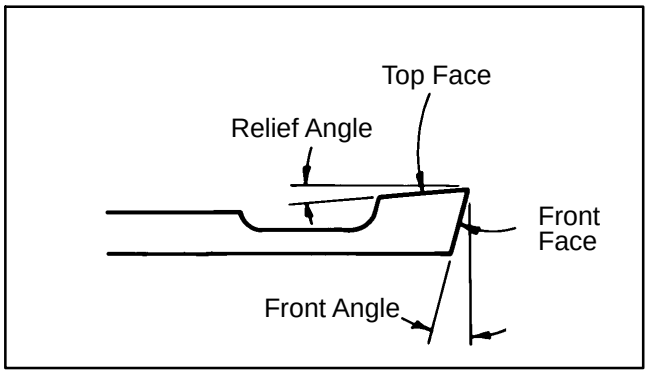


Figure 25

Bedbar Removal and Installation

The rear roller assembly must be removed so the bedbar can be removed for bedknife sharpening.

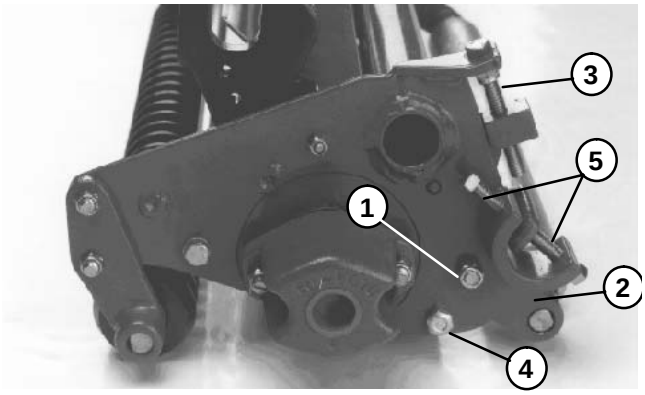


Figure 26

1. Lock nut & cap screw
2. Rear roller bracket
3. H.O.C. adjustment screw
4. Mounting bolt
5. Bedknife adj. screws

Removal

1. Remove locknut and cap screw securing the rear roller bracket to side plate at both ends of cutting unit.

2. Loosen set screws securing the rear roller shaft to rear roller brackets.

3. Note position, and unthread and remove height-of-cut (H.O.C.) adjustment bolts from both side plates.

4. Remove bedbar mounting bolts from each end of the cutting unit. Loosen bedknife adjusting screws at each end of cutting unit. Remove bedbar by rotating it away from the reel.

NOTE: For proper grinding of bedknife follow procedures in the Toro Sharpening Reel and Rotary Mowers Book, Part No. 80300SL.

Installation

IMPORTANT: When installing bedbar, be sure to assemble rear roller brackets UNDER arms of bedbar.

1. Position bedbar into the cutting unit by rotating it towards the reel. Tighten bedknife adjusting screws at each end of cutting unit. Secure bedbar to each end of the cutting unit with mounting bolts to a maximum of 40 ft-lb (54 N-m).

2. Install H.O.C. adjustment bolts to their original position on both side plates.

3. Secure rear roller shaft to rear roller brackets brackets with set screws. Torque set screws from 25 to 30 ft-lb (34 to 41 N-m).

4. Securing rear roller bracket to side plate at both ends of cutting unit with cap screw and lock nut.

Bedknife Replacement and Grinding

Replacement

1. Remove bedbar (see Bedbar Removal and Installation).

2. Remove bedknife screws and remove bedknife.

3. Remove all rust, scale and corrosion from bedbar surface before installing the new bedknife.

4. Install **new** bedknife as follows:

   A. Make sure bedbar threads are clean.

   B. Use new bedknife screws (Toro Part No. 57-4910). Apply anti-seize lubricant to the screw threads before installing.

IMPORTANT: Do not use an air or manual impact wrench.

   C. Bedknife screws must bottom out on the bedknife, not the bedbar. Tighten screws to a torque of 180 to 200 in-lb (20.3 to 22.6 N-m); work from the center toward each end of the bedbar (Fig. 27)

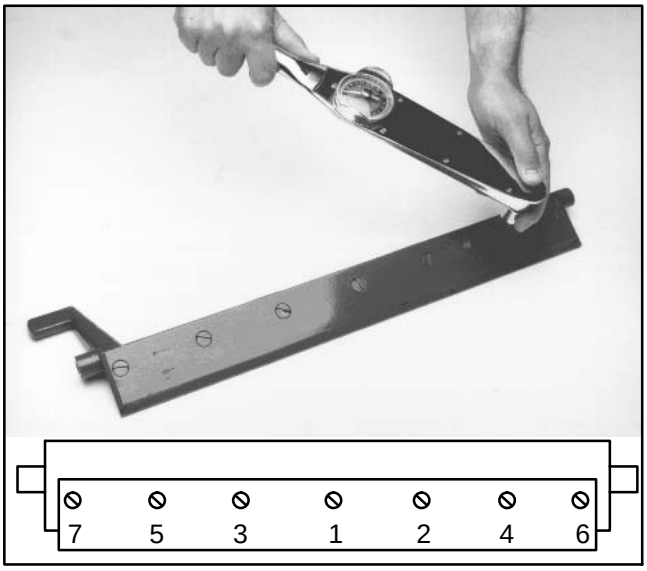


Figure 27

NOTE: Since there can be variations in the mounting surface of the bedbar, a new bedknife will not be perfectly flat after it is installed. Because of this, it is necessary to backlap or grind a new bedknife after installing it to the bedbar. Follow the existing angle that was ground into the bedknife and grind only enough to make sure the top surface is true.

NOTE: For proper grinding of bedknife, follow procedures in the Toro Sharpening Reel and Rotary Mowers Book, Part No. 80300SL.

Note: When grinding, be careful to not overheat the bedknife. Remove small amounts of material with each pass of the grinder.

Note: If the height of cut is a 1/2 inch or lower on the cutting unit, the front angle can be increased to 30° for improved performance.

Bedknife Regrinding Specifications	
Relief Angle	5°
Relief Angle Range	3° to 6°
Front Angle	15° (see Note above)
Front Angle Range	13° to 17°

5. Grind bedknife.

6. Install bedbar (see Bedbar Removal and Installation).

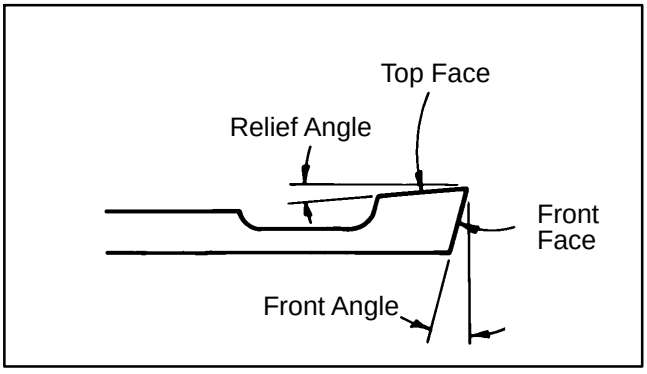


Figure 28

Prepare Reel for Grinding

The front roller may have to be removed so that the reel can be sharpened.

Note: Check to make sure reel bearings are in good condition and properly adjusted before grinding reel.

IMPORTANT: Some reel grinders may require that the rear roller assembly be mounted to the cutting unit for proper support in the reel grinder.

1. Remove locknuts and cap screws securing the front roller brackets to the sideplates at both ends of the cutting unit (Fig. 11).

2. Remove front roller assembly from the cutting unit by pulling evenly on both sides.

3. For proper grinding of reel, grind in accordance with procedures in the Toro Sharpening Reel and Rotary Mowers Book, Part No. 80300SL.

Note: Most reel grinders require that the rear roller assembly be mounted to the cutting unit for proper support in the reel grinder. The rear roller must be parallel to the reel shaft to remove taper when grinding, or the cutting unit must be aligned so the grinding wheel will travel parallel to the reel shaft. This will result in the the reel being ground to the desired cylinder shape.

IMPORTANT: After grinding operation is complete, reassemble cutting unit, check bearing adjustment and adjust top shield and bar; refer to sections on Adjusting Shield Height and Adjust Top Bar. Back lap the cutting unit to complete sharpening operation. To assure proper alignment of the rear roller in the roller brackets, make sure roller moves freely within brackets before tightening set screws on bearing shafts. Apply medium strength Locktite #242 or equivalent to set screws before tightening.

Reel Grinding Specifications	
Nominal Reel Diameter	5 inches (126 mm)
Service Limit Reel Diameter	4.5 inches (114 mm)
Blade Relief Angle	30°
Relief Angle Range	20° to 40°
Blade Land Width	0.040 inch (1.0 mm)
Land Width Range	0.030 to 0.060 inch (0.7 to 1.5 mm)
Max. Reel Taper	0.040 inch (1.0 mm)

4. Install front roller and brackets. Complete cutting unit set-up and adjustment sequence (see Adjustments section).

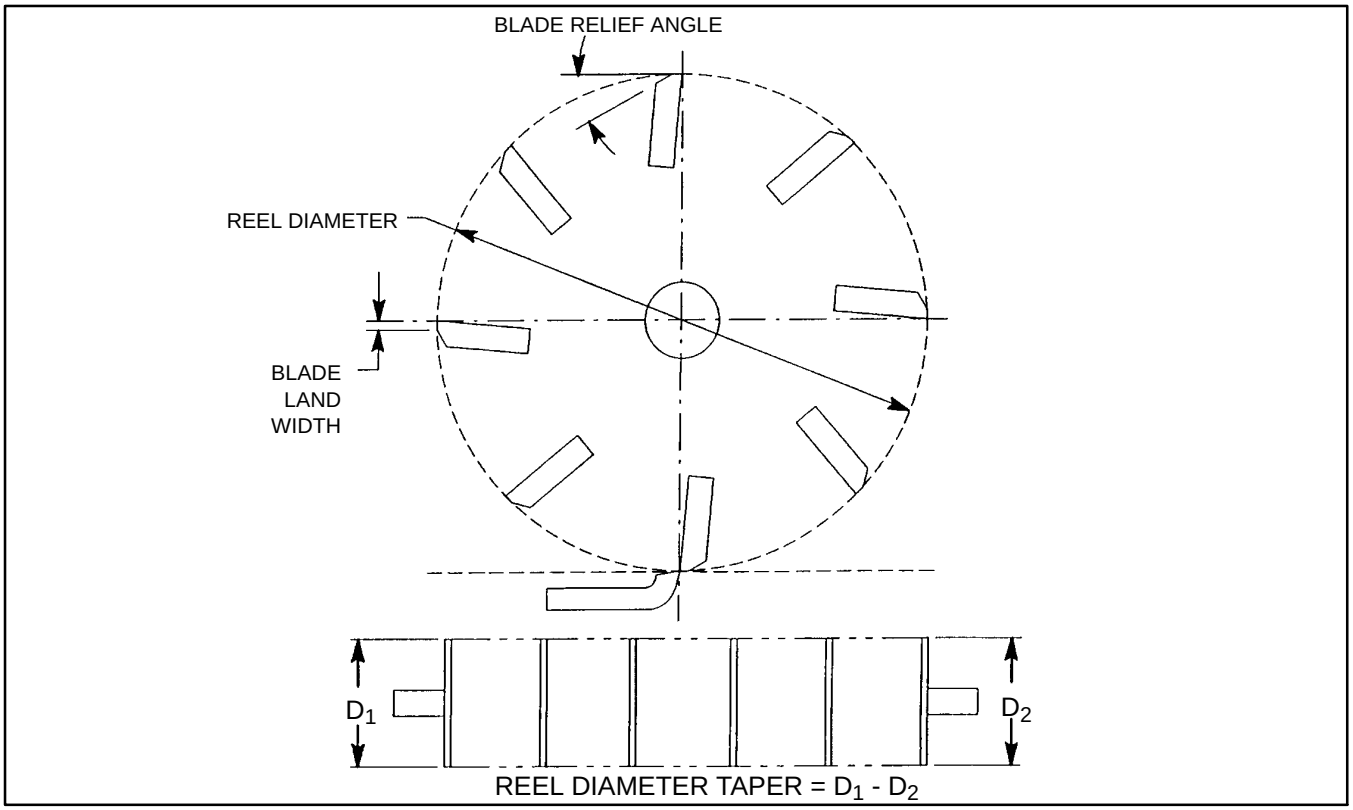


Figure 29

Reel Removal and Bearing Replacement

Removal

1. Remove the front roller assembly by removing lock nuts and cap screws securing the brackets to each side plate. Remove counterbalance end cap (Fig. 30)

2. Remove large bearing adjustment nut from the counterbalance end of the reel shaft and the special spline nut at the opposite end of the reel shaft (Fig. 30).

3. Remove mounting bolts from the bearing housing on both ends of cutting unit.

IMPORTANT: Remove grease fittings from bearing housing at each end of cutting unit. Note that 45° fitting is on right end and 90° fitting is at left end (when viewed in the direction of travel).

4. Using a plastic headed hammer, rotate bearing housing slightly, install bearing housing bolts from outside housing, turn bolts alternately against side plate. Use this method to remove bearing housing (Fig. 31).

5. The bearing housing will slip out of the side plates and the reel assembly can be removed as soon as the bearing housings are removed from the side plates.

6. If necessary, install new bearings and seals:

   A. Remove outer seal (in counterbalance weight), bearing cup, bearing cone and inner seal.

   B. Bearing housing must be completely free of paint and foreign material before installing bearing cup. If necessary, remove any ”flash” from bearing housing that may interfere with accurate seating of bearing. Install new inner seal. Install bearing cup.

   C. Install bearing housing to frame. Pack bearing cone with grease and install over reel shaft into bearing cup. Install outer seal (in counterbalance weight).

Installation

1. Position reel assembly into the cutting unit.

2. Tighten spline nut to 40 to 60 ft-lb (54 to 81 N-m), then adjust bearings (See Reel Bearing Service and Adjustment.)

3. Install bearing housing to reel shaft ends and side plate. Secure bearing housing to side plate with mounting bolts.

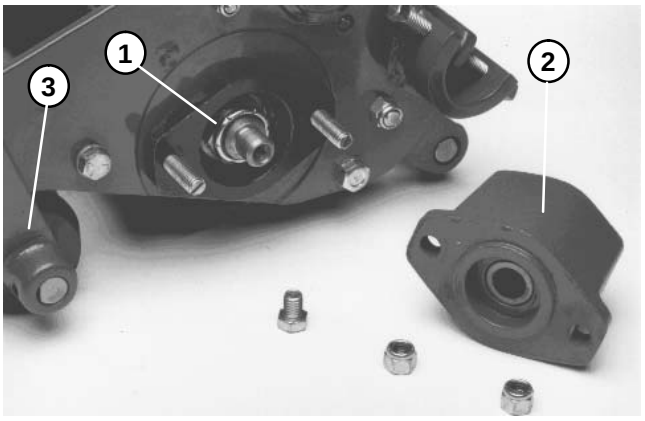


Figure 30

1. Reel bearing adj. nut
2. Counterbalance end cap
3. Front roller bracket

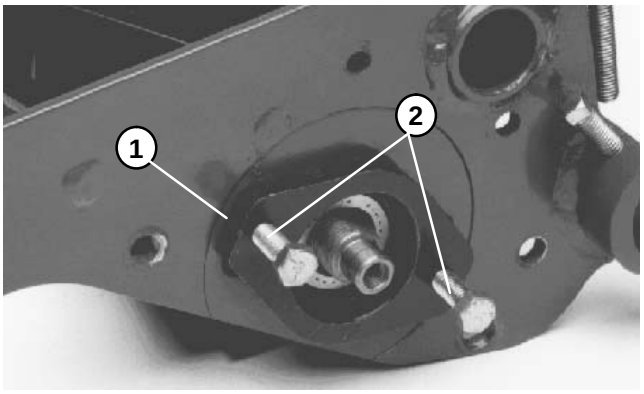


Figure 31

1. Bearing housing
2. Mounting bolts

IMPORTANT: Install grease fittings to bearing housing at each end of cutting unit. The 45° fitting goes on right end and 90° fitting goes on the left end (when viewed in the direction of travel).

4. Install large bearing adjustment nut to the counterbalance end of the reel shaft and the special spline nut at the opposite end of the reel shaft (Fig. 30).

5. Install counterbalance end cap. Install front roller assembly by securing the brackets to each side plate with lock nuts and cap screws (Fig. 30).

Traction Unit Lift Arm Spring Replacement

1. Put machine on a level surface, lower cutting units, stop engine, engage parking brakes, and remove key from the ignition switch.

2. Remove floor plate in the front of the seat to get access to the front springs, or open hood to get access to the rear springs.

CAUTION

Springs are under tension. Use caution when removing or adjusting.

3. Put an open end wrench on the hex shaft of the spring bracket.

NOTE: Because the wrench can be moved only a limited distance, it may be necessary to use a second wrench to hold the hex shaft while repositioning the other wrench for further rotation of the hex shaft.

4. Remove cap screw and locknut securing the retaining bracket while rotating hex shaft to relieve spring tension, then rotate hex shaft to completely relieve spring tension.

5. Remove spring.

6. Install new spring.

7. Use an open end wrench to move spring bracket to the desired position. Install cap screw and locknut while rotating the hex shaft to relieve spring tension.

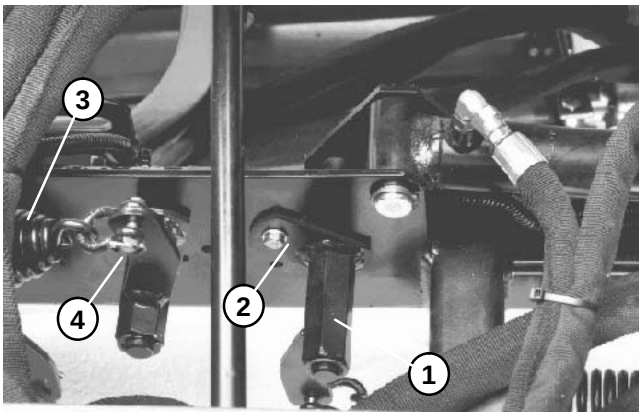


Figure 32

1. **Spring bracket hex shaft**
2. **Retaining bracket**
3. **Spring**
4. **Cotter pin, clevis pin, & clevis**

Model 03527, S/N 210000001 & Up
Model 03528, S/N 210000001 & Up

Cutting Units

Table of Contents

Note: For cutting unit **Models 03506 & 03509**, see Chapter 8 “Cutting Units” in this manual.

Specifications

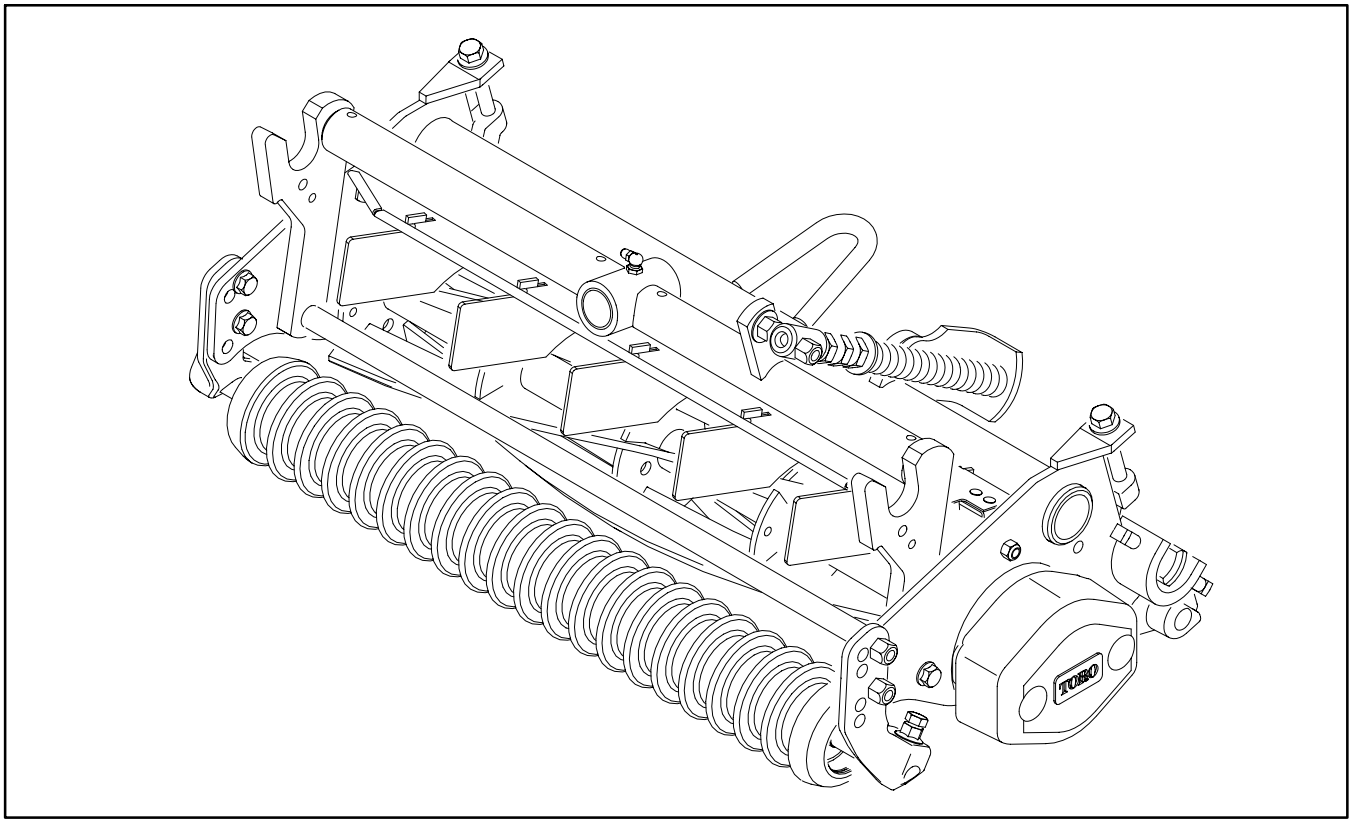


Figure 1

REEL CONSTRUCTION: Fairway reels. All welded. 5 or 8 blades.

HEIGHT OF CUT RANGE:
5 Blade - 5/8” to 1” (13-25 mm)
8 Blade - 1/4” to 5/8” (6-16 mm)

Note: Heavy duty bedknife Part No. 100-3350 available for height-of-cuts over 1/2” (13 mm).

REEL DIAMETER: 5 in. (127 mm)

REEL BEARINGS: Taper roller bearings

POWER: Hydraulic motor splined to reel shaft. Reel motors feature quick disconnect for removal or installation onto cutting unit.

BEDKNIFE AND BEDBAR ADJUSTMENT: Opposing fine thread screws

HEIGHT−OF−CUT & ROLLER ADJUSTMENT:

Front: 3 fixed positions for setting cutting unit attitude. Optional Adjustable Front Height Of Cut kit, part no. 104−8205, allows for variable adjustment to cutting unit attitude with adjustable height of cut rods, within the height of cut range of 1/4” to 1 3/8”.

Rear: Screw adjustable with bolt clamp lock used for setting height of cut.

Selected Clip Control: The Reelmaster 5200/5400 is equipped with manually adjustable reel speeds (275 rpm to 2000 rpm) which control selected clip.

Rollers: Front roller is a 3” (76 mm) diameter cast Wiehle roller. Rear roller is a 2.5” (64 mm) diameter steel full roller. Both rollers use heavy duty ball bearings with two conventional single lip seals and a Toro labyrinth seal to provide four sealing surfaces to protect the bearings.

OPTIONS & KITS:

Basket Kit (3 baskets)	Model 03532
Rear Roller Brush Kit	Model 03533
Wiehle Roller Scraper	Part No. 104-3380-03
Rear Roller Scraper Kit	Part No. 104-3395
Shoulder Wiehle Roller	Part No. 104-3369
Shoulder Wiehle Scraper	Part No. 104-8208-03
Comb Kit	Part No. 104-3385
Adjustable Front H.O.C. kit	Part No. 104-8205

Special Tools

Order special tools from your Toro Distributor.

Some tools may have been supplied with your machine or be available as TORO parts. Some tools may also be available from a local supplier.

Gauge Bar Assembly

Use gauge bar to verify height of cut and bedknife attitude.

Toro P/N **98-1852**

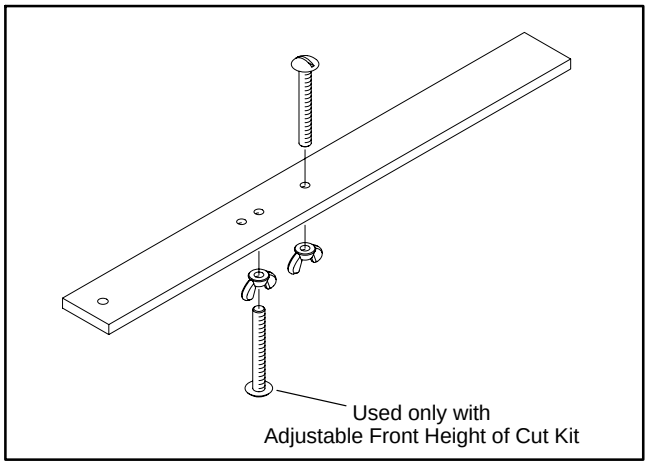


Figure 2

Angle Indicator

Use with Gauge Bar Assembly to verify bedknife attitude.

Toro P/N **99-3503**

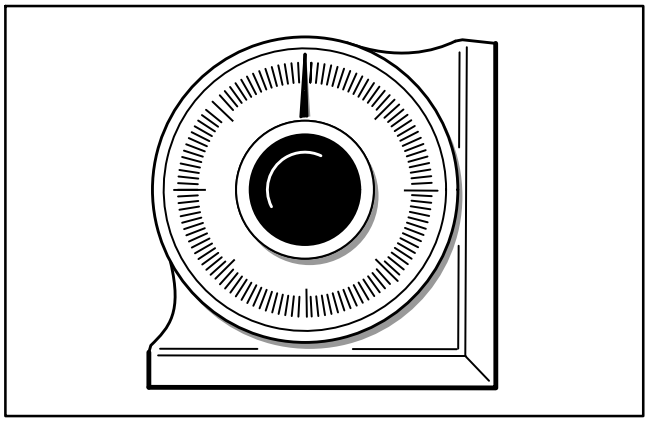


Figure 3

Bedknife Screw Tool - TOR510880

This screwdriver-type bit is made to fit Toro bedknife attaching screws. Use this bit with a torque wrench to secure the bedknife to the bedbar. Make sure bedbar threads are clean and use new screws. Tighten screws to a torque of 250 - 300 in.lb. (28 - 34 Nm) starting in the middle of the bedknife (Fig. 34).

NOTE: Remove all rust, scale and corrosion from bedbar surface before installing bedknife.

DO NOT use and air impact wrench with this tool.

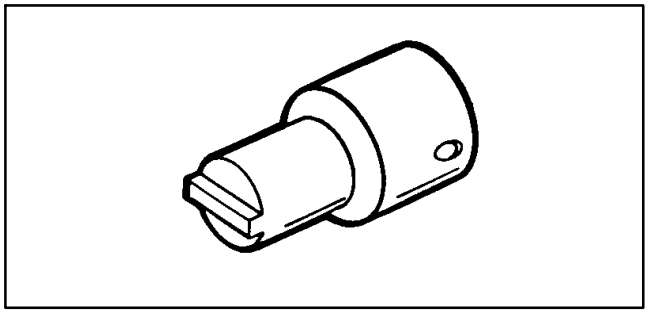


Figure 4

Handle Assembly - TOR299100

For applying lapping compound to cutting units while keep hands a safe distance from the rotating reel.

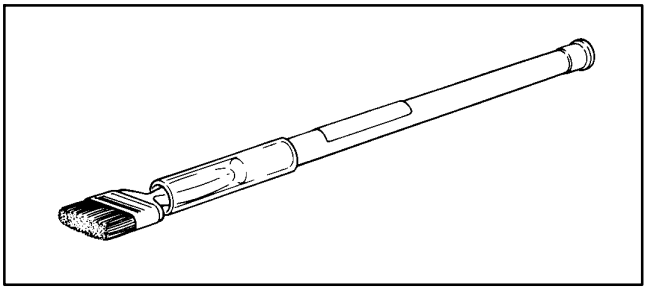


Figure 5

Cutting Unit Tool Kit - TOR4070

This tool kit includes special tools required for rebuilding the cutting units on the Reelmaster 5200-D/5400-D.

TOR4064	Spanner Wrench
TOR4065	Inner Oil Seal Installer
TOR4066	Bearing Installer
TOR4067	Shaft Support Tool
TOR4068	Inner Seal Installer
TOR4869	Outer Seal Installer
TOR4071	Outer Oil Seal Installer
TOR4072	Reel Motor Shaft Seal Protector
TOR4073	Handle
TOR4074	Spline Insert Tool

Figure 6

Turf Evaluator Tool − Toro Model No. 04399

Many turf discrepancies are subtle and require closer examination. In these instances, the TurfEvaluator grass viewing tool is helpful. It can assist turf managers and service technicians in determining causes for poor reel mower performance and comparing the effective height of cut of one mowed surface to another. This tool should be used with the Toro Guide to Evaluation Reel Mower Performance and Using the TurfEvaluator (Toro Part No. 97931SL)

Figure 7

Troubleshooting

Turf Condition

Turf conditions play a dramatic role in the aftercut appearance. Turf conditions must always be considered before attempting to remedy a problem with adjustments to your turf equipment. Equipment used strictly for mowing cannot remedy turf conditions but can often times be adjusted to adapt to a given turf condition.

The goal of a turf equipment service person is to help address concerns by matching the equipment to the current conditions. This is a partnership between you and the person or persons responsible for the turf. The ultimate solution is usually a combination of turf remedies and machine adjustments.

It is important to remember that the same ”fix” will not work for every turf condition and it may not work every time in what seems to be identical conditions. Requirements are different between warm season grasses and cool season grasses and the cutting unit needs to be setup for the grass type and seasonal differences.

Cutting Units

A cutting unit that is set up incorrectly or improperly maintained can cause many problems. The items listed below must be checked, corrected if necessary, and be the same on all cutting units:

- Adjusters, Pivots, Bushings and Compensating Springs− lubricated if necessary, tight and in good working order.
- Bedknife: Correct for the application with sharp, flat and straight cutting edge .
- Bedknife Attitude: Set to manufacturer recommendations.
- Bedknife Contact: Set properly according to manufacturer recommendations.
- Reel: Sharp cutting edge (relief or backgrind recommended) with less than .002 (.05mm) run out as a general rule, always refer to manufacturers recommendations.
- Reel Bearings: In good condition, no end−play and adjusted properly.
- Reel Diameter: Meets or exceeds the manufacturer recommended minimum diameter.
- Rollers: Parallel to the reel (see operators manual).
- Roller condition: Bearings (no end−play), surface run out as a general rule should be less than .015 (.38mm) (but always refer to manufacturers recommendations), and centered in the frame.
- H.O.C. set to obtain the correct effective height of cut.
- The wear factors must be equal. (a new part on one unit and the same part being worn on another unit can cause differences).

Problem Solving

- Define the issue (ask enough questions and see the issue for yourself) the issue must be clearly defined before you can begin to address it correctly.
- Evaluate turf conditions for their part in the outcome (including weather trends such as extreme wet or dry, recent turf maintenance performed such as top dressing etc.).
- Verify the traction unit is operating properly and in good condition (no switches jumped, proper engine RPM, maintenance up to date etc.).
- Check and recheck the cutting units for accurate and proper setup.
- Understand and be able to duplicate the complaint or condition.

While attempting to resolve aftercut appearance issues it will be necessary to make physical changes to components of the cutting unit or traction unit. All adjustment, changes, and modifications from a current condition should be made singularly using a scientific process. Make only one change at a time and take careful notes of the conditions resulting from each change before additional changes or adjustments are made. A systematic approach to troubleshooting will assist in resolving issues timely and effectively.

Record information about the machine and turf conditions below to assist with your problem solving.

Machine:

Model _____ Serial Number _____ Engine @ _____ RPM

Cutting Units:

Model _____ Serial Number _____

Number of Blades _____ Serial Number _____

Use: (describe − i.e. Fairways, Outfields, Greens, etc.)

_____

_____

HOC _____ **Number of Blades** _____ **Type of Grass** _____

Over-seeded? _____ **Last Turf Maintenance Performed** _____ **Date** _____

Current Weather Pattern (i.e. Drought, Hot, Wet, etc.) _____

Condition Found: _____

_____

_____

_____

Condition Environment (when it happens, what needs to be done to duplicate the condition):

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Note: For additional information see Toro Commercial Products Aftercut Appearance Troubleshooting Aid. Part No. 00076SL.

Initial Set-up and Adjustments

IMPORTANT: Toro strongly recommends the use of a leveling plate when setting-up or adjusting any reel type cutting unit. The leveling plate will help to ensure accurate and consistent adjustments.

Note: Right and left ends of cutting unit is determined by standing in the operator's position (Fig. 8).

After the cutting unit is unboxed, use the following procedures to assure the cutting units are adjusted properly.

1. Check each end of the reel for grease. Grease should be visibly evident in the reel bearings and internal splines of reel shaft.

2. Insure that all nuts and bolts are securely fastened.

3. Make sure carrier frame suspension operates freely and does not bind when moved back and forth.

IMPORTANT: Set height of cut by completing the following steps in order:

A. Adjust bedknife to reel.

B. Set cutting unit attitude.

C. Level front roller.

D. Set height-of-cut.

E. Adjust turf compensation spring.

IMPORTANT: Each cutting unit must be set consistently. Minor differences in either height-of-cut, attitude, bedknife wear, or reel blade wear, among cutting units, may result in negative after cut appearance.

Note: The cutting unit has been set at the factory at 1/2" (13 mm) height-of-cut and the front roller set in the normal attitude position (middle hole in front brackets). Also, the bedknife has been backed off from the reel to prevent shipping damage.

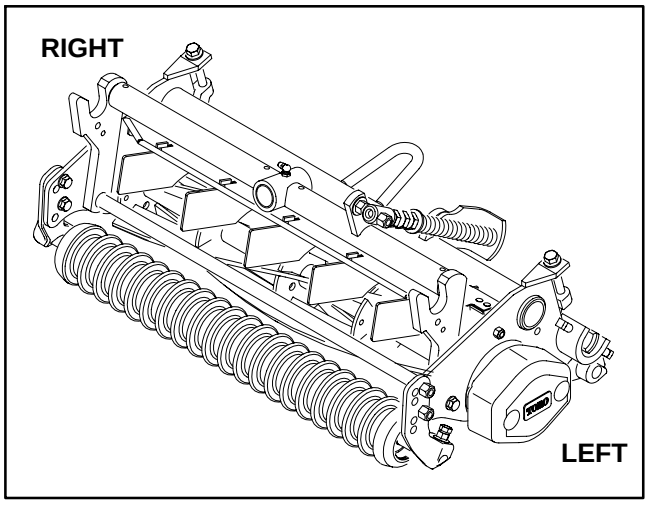


Figure 8

Bedknife to Reel Adjustment

IMPORTANT: The reel and bedknife must be parallel to insure the cutting unit cuts grass across the bedknife, and the reel and bedknife wear evenly.

1. Rotate cutting unit backward to gain access to the reel and bedknife (Fig. 10).

2. Adjustment of bedknife to reel is accomplished by first, loosening bottom screw on each side of cutting unit (Fig. 9), then tightening the top adjustment screw on each side of cutting unit. This adjustment will position the bedknife closer to the reel blades. Adjust until light contact is heard on both ends of the reels.

Note: Correct reel to bedknife contact should not increase the reel rolling torque more than 3 in−lbs. over the reel bearing rolling torque setting (see Servicing and Adjusting the reel bearings for checking reel rolling torque).

IMPORTANT: Use only a 3/8 open end wrench 3" to 6" (76−152 mm) in length for adjusting bedknife to reel. A longer wrench will provide too much leverage and may cause distortion of the mounting plate for the adjustment screw.

3. After adjusting bedknife to reel, make sure that both the top and the bottom adjustment screws are secured on both ends of the cutting unit (Fig. 9).

4. Insert 1" (25 mm) wide piece of newspaper perpendicular to the bedknife, and then rotate the reel slowly in the mowing direction to see if the reel cuts the paper – do this on both ends of the bedknife (Fig. 10).

5. If paper is cut on both ends, the bedknife is parallel to the reel. If not, go back to step 2.

Note: If reel makes contact on both sides of bedknife but still does not cut paper, cutting unit may need to be backlapped (refer to backlapping) or reel and/or bedknife may need to be reground (refer to Toro manual for Sharpening Reel and rotary Mowers, Form No. 80−300PT).

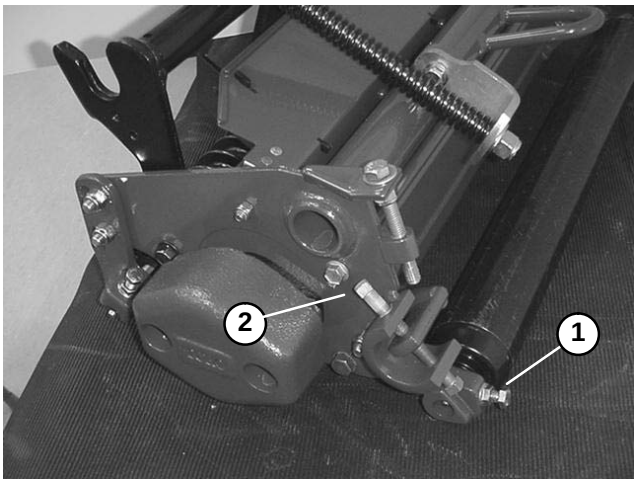


Figure 9

1. **Bottom bedknife adjusting screw**
2. **Top bedknife adjusting screw**

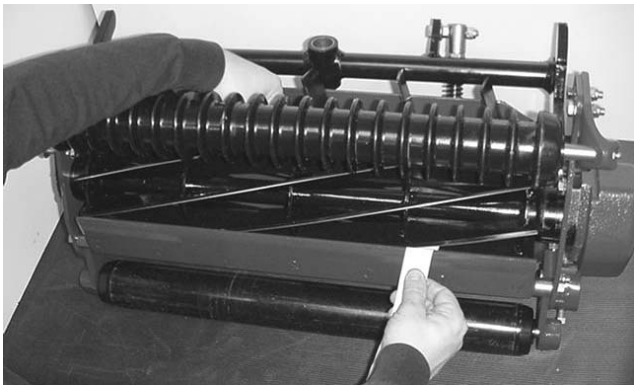


Figure 10

Setting Cutting Unit Attitude

Cutting unit “attitude” has a significant impact on the performance of the cutting unit. Attitude refers to the angle of the bedknife relative to the ground (Fig.11).

Adjustable front and rear brackets allow for variable adjustment of cutting unit attitude within the height-of-cut range. All cutting units on a given machine must be set to the same attitude, otherwise after-cut appearance could be negatively affected.

The best cutting unit attitude is dependent on your turf conditions and desired results. Experience with the cutting unit on your turf will determine the best setting to use. Cutting unit attitude can be adjusted throughout the cutting season to allow for various turf conditions.

In general, less aggressive attitudes (example: 2 degrees) are more appropriate for warm season grasses (Bermuda, Zoysia) while cool season grasses (Bluegrass, Rye) may require more aggressive attitudes (example: 6 degrees). More aggressive attitudes cut more grass off by allowing the spinning reel to pull more grass up into the bedknife. An angle that is too flat (attitude less than 1 degree) may allow the bedbar or other parts of the cutting unit to drag in the turf causing tufting. Therefore, minimum recommended attitude is 1 degree.

For setting consistent cutting unit attitude, Toro strongly recommends using a two-screw gauge bar, Toro part no. 98-1852 (Fig.12). The Height of Cut Screw is set for height-of-cut, and the Attitude Screw is set for cutting unit attitude. The Attitude Screw is only used when the Adjustable Front Height of Cut Kit (Part No. 104-8205) is installed on the cutting unit.

Note: The Attitude screw setting is an easy method of transferring cutting unit attitude to all cutting units on a machine.

Note: The Attitude Screw setting will change throughout the life of the bedknife and reel due to wear, **even if the height-of-cut is not changed.** Therefore, after initial set up use **Checking and Adjusting Attitude for Used Cutting Unit** procedure.

Table 1 lists starting dimensions for setting up a new cutting unit with attitudes of 2, 4, 6 and 8 degrees.

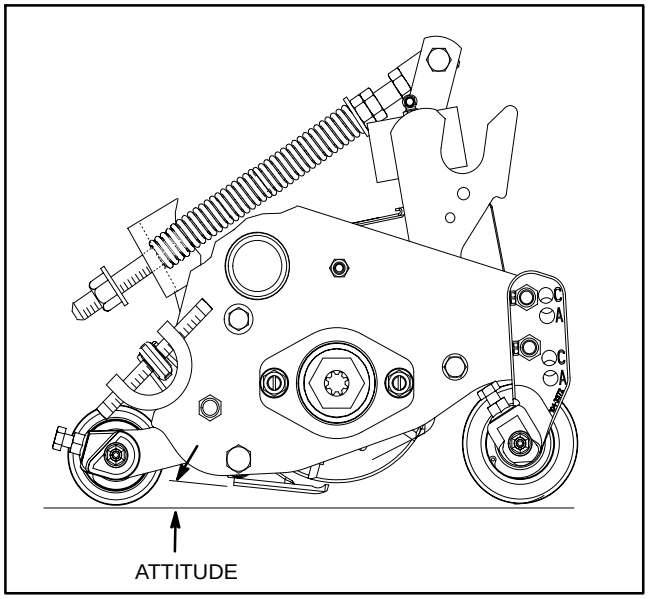


Figure 11

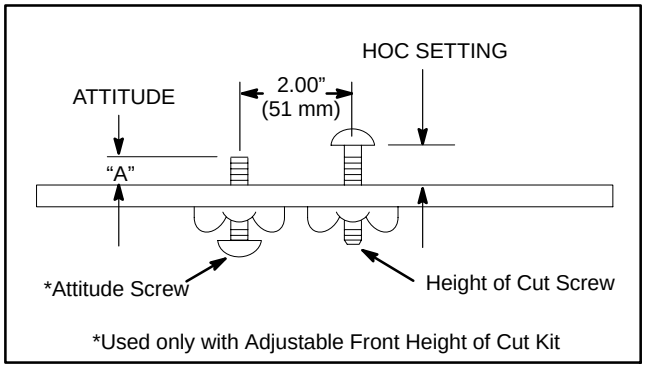


Figure 12

Adjusting Attitude (New Cutting Units)
Table 1—New Cutting Unit Set Up Guide

Desired Height of Cut (HOC)		Front Fixed Bracket			Optional Adjustable Front Height of Cut Kit
		Position A	Position B	Position C	Attitude Range (min. to max.)
Inches	(mm)	(Degrees)	(Degrees)	(Degrees)	(Degrees)
.250	(6)	6	3	Not Recommended	1 to 10
.375	(10)	7	4	1	1 to 11
.500	(13)	9	6	3	1 to 13
.625	(16)	10	7	4	1 to 14
.750	(19)	11	8	5	1 to 15
.875	(22)	Not Recommended	10	7	1 to 11
1.000	(25)	Not Recommended	Not Recommended	8	1 to 10
1.125	(29)	Not Recommended	Not Recommended	Not Recommended	1 to 8
1.250	(32)	Not Recommended	Not Recommended	Not Recommended	1 to 7
1.375	(35)	Not Recommended	Not Recommended	Not Recommended	1 to 6

Note: Due to wear on the bedknife and reel, over time the attitude of the cutting unit will decrease.

1. Rotate the cutting unit backward to gain access to reel and bedknife.

2. Place an angle indicator, Toro Part No. 99-3503, on the bedknife and record the bedknife angle (Fig. 13).

3. Using a two-screw gauge bar, Toro Part No. 98-1852, set Height of Cut screw to desired height-of-cut.

4. Place the gauge bar across the front and rear rollers. The height of cut screw head needs to fit snugly over the edge of the bedknife while the gauge bar contacts the rollers (Fig. 14).

5. Place an angle indicator on the gauge bar and record the gauge bar angle (Fig. 14).

6. Bedknife Angle (step 2) − Gauge Bar Angle (step 5) = Cutting Unit Attitude (degrees)

7. For adjusting the cutting unit attitude, change the position of the roller (A, B or C) (Fig. 14).

Note: If Front Height of Cut kit, Part No. 104−8205 is installed on cutting unit (Fig. 15), adjust front roller to desired attitude and reset attitude screw. Gauge bar can now be utilized to set remaining cutting units on machine.

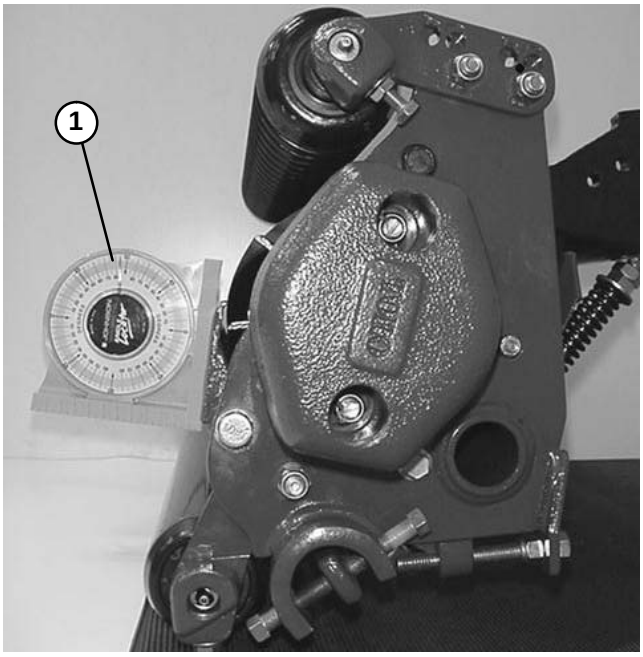


Figure 13
1. **Bedknife angle**

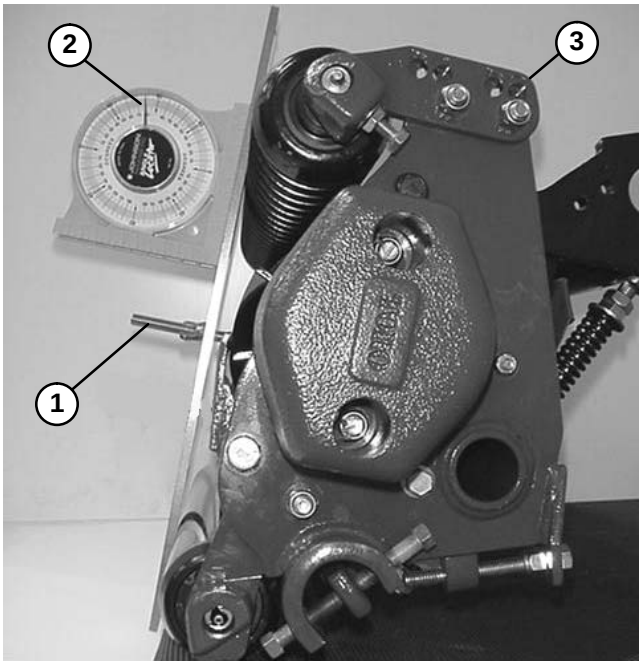


Figure 14

1. Height of cut screw
2. Gauge bar angle
3. Roller bracket (A, B, C)

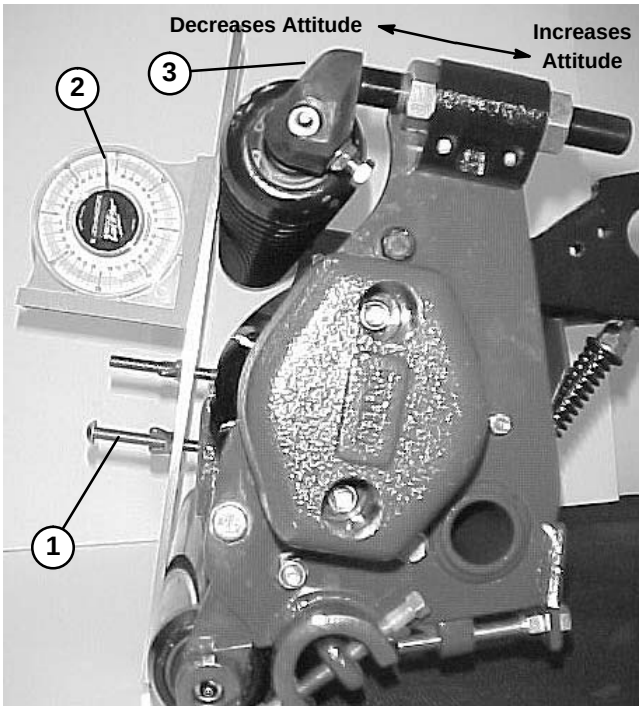


Figure 15

1. Attitude screw
2. Gauge bar angle
3. Front height of cut kit

Leveling Front Roller

1. Place a 1/2 in. or thicker plate under the reel blades and against the cutting edge of the bedknife (Fig. 16). The rear roller should not contact surface.

Note: Be sure the plate covers the full length of reel blades.

2. Level front roller to reel by loosening the 4 capscrews holding the front roller brackets and rotating the front roller until it contacts the surface that the plate is on. Tighten the capscrews and make sure that the roller has not changed position. To prevent moving the roller bracket when tightening (Fig. 17), hold the nut while tightening capscrew.

Note: Try to slide a piece of paper under each end of roller to make sure there is contact (Fig. 17).

Note: If Front Height of Cut kit, Part No. 104−8205 is installed on cutting unit (Fig. 15), adjust front roller to contact leveling plate.

Note: If cutting unit attitude changes by more than 1° from side to side, reel and/or bedknife may need to be reground to remove uneven wear.

Note: If rollers are parallel to reel before changing bedknife attitude, you can change one roller at a time and still maintain parallelism.

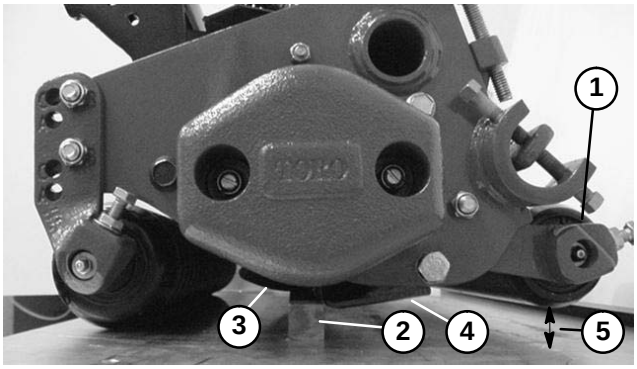


Figure 16

1. Rear roller
2. 1/2” steel plate
3. Reel blades
4. Bedknife
5. Gap

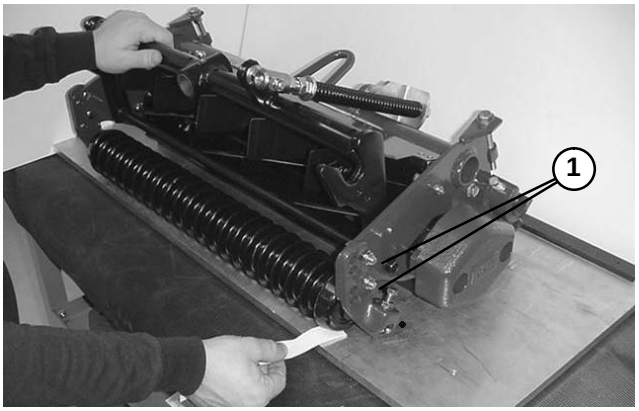


Figure 17

1. Capscrews

Adjusting Height of Cut

1. Rotate the cutting unit vertical and place the gauge bar across front and rear rollers (Fig. 18).

2. Loosen the locknuts securing the height-of-cut brackets to each end of the cutting unit (Fig. 18).

3. Set the head of the height of cut screw on the gauge bar to the desired height of cut, making this measurement from the bar face to the underside of the screw head.

4. Place the bar across the front and rear rollers and adjust the tap bolt until the underside of the screw head engages the bedknife cutting edge (Fig. 18).

IMPORTANT: Do step 3 on each end of the bedknife. Tighten the height-of-cut adjustment locknuts on both ends. Recheck the adjustment.

Note: Same procedure is used when Front Height of Cut kit, Part No. 104−8205 is installed on cutting unit.

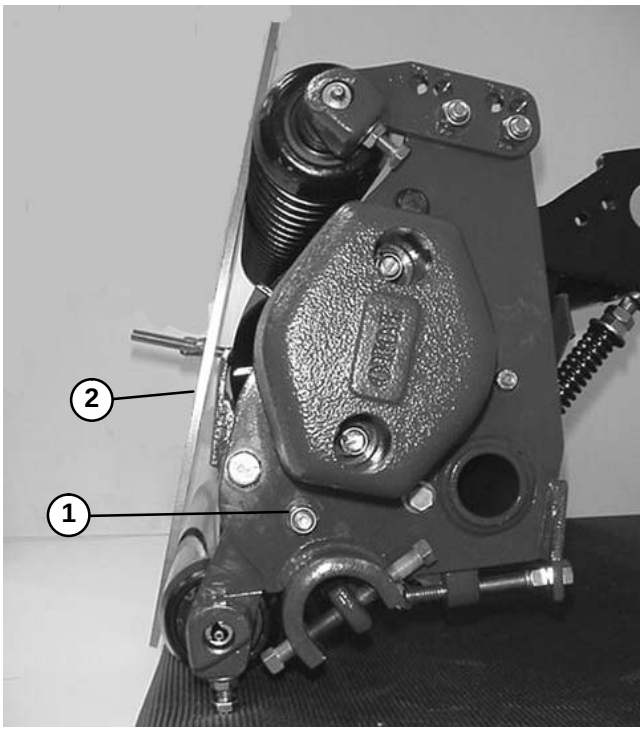


Figure 18

1. Locknut **2. Gauge bar**

Adjusting Turf Compensation Spring

The Turf Compensation Spring, connecting carrier frame to cutting unit, controls the amount of fore-aft rotation available for the cutting unit.

The Turf Compensation Spring also transfers weight from the front to rear roller. This helps to reduce a wave pattern in the turf, also known as bobbing.

IMPORTANT: Make spring adjustments with cutting unit mounted to traction unit and lowered to shop floor. Refer to Traction Unit Operator's Manual for mounting instructions.

1. Tighten lock nut on rear of spring rod until the gap (C) between rear of spring bracket and front of washer is 1.25" (32 mm) (Fig. 19).

2. Tighten hex nuts on front end of spring rod until the compressed length (A) of spring is 6.25" (159 mm) (Fig. 19).

NOTE: As compressed spring length (A) **decreases**, weight transfer from front roller to rear roller **increases** and carrier frame/cutting unit rotation angle (B) **decreases**.

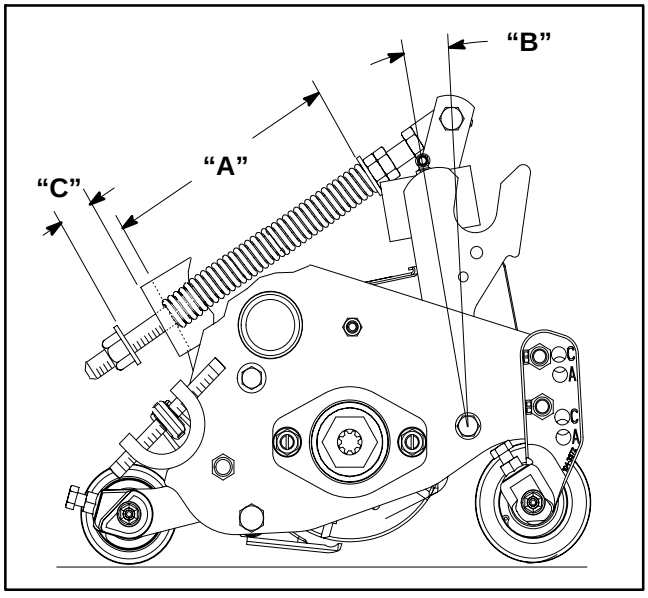


Figure 19

NOTE: As gap (C) between spring bracket and washer **increases**, cutting unit ground clearance **decreases** and carrier frame/cutting unit rotation angle (B) **increases**.

Front Grass Shield Adjustment

Adjust front grass shield for desired grass clippings dispersion.

1. Position cutting unit on a flat level surface.

2. Loosen capscrews and nuts securing shield to each side plate. Move shield to desired angle and tighten fasteners (Fig. 20).

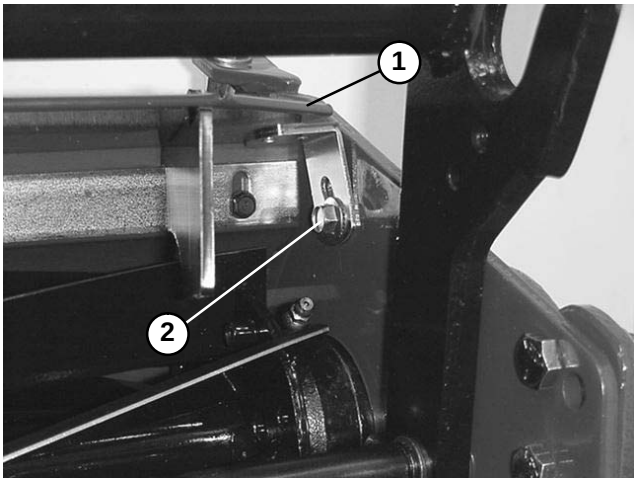


Figure 20

1. **Front grass shield**
3. **Capscrew & nut**

Rear Shield Adjustment

Under most conditions, best dispersion is attained when rear shield is closed (front discharge). When conditions are heavy or wet, rear shield may be opened.

1. To open rear shield, loosen flange head capscrew securing shield to right side plate, rotate shield to open position and tighten screw (Fig. 21).

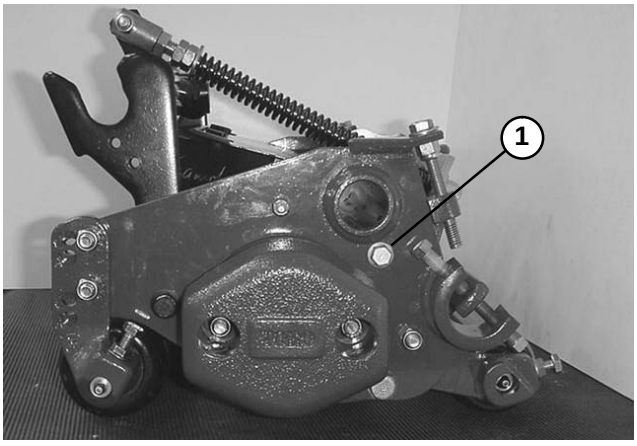


Figure 21

1. **Rear grass shield mounting screw**

Cut-Off Bar Adjustment

The Cut−Off bar is designed to keep the gap between the reel and the Cut−Off minimal to insure grass clippings discharge cleanly from reel area.

Note: The gap between the Cut−Off bar and reel will increase as: 1) the reel wears, 2) reel is sharpened by grinding, or 3) if the front grass shield is adjusted.

1. Loosen screws securing Cut−Off bar (Fig. 22). Insert 0.060” (2 mm) feeler gauge between top of reel and Cut−Off bar.

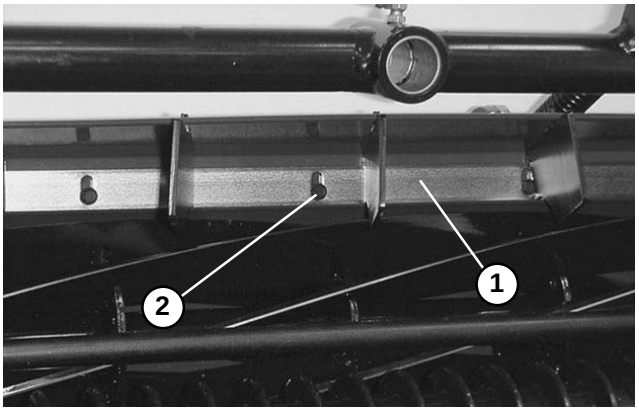


Figure 22

1. **Cut-off bar**
3. **Screw (4)**

Adjust Lock-up Roller

Adjust lock-up rollers so they contact the lock-up lever on each rear lift arm and support the cutting units when fully raised. The cutting units should have approximately 3/8 to 5/8 inch (9.5 to 15.9 mm) vertical travel when measured at the rear roller.

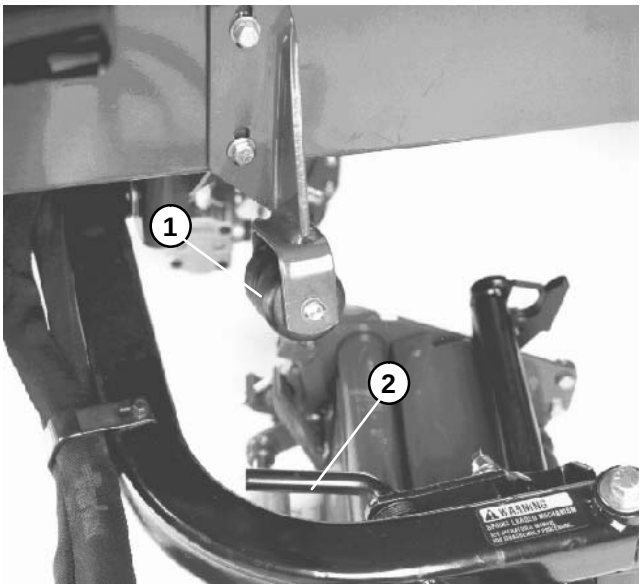


Figure 23

1. **Lock-up roller** 2. **Lock-up lever**

Adjust Lift Arm Down Pressure

The down pressure spring on each cutting unit lift arm can be adjusted to compensate for different turf conditions. Increased down pressure will help keep the cutting units on the ground when mowing at higher speeds and helps maintain a uniform height-of-cut in rough conditions or in areas of thatch build up.

Each down pressure spring may be adjusted to one of four (4) settings. Each increment increases or decreases down pressure on cutting unit by 8 lbs (37 N).

1. Put machine on a level surface, lower the cutting units, stop the engine, engage the parking brakes and remove key from ignition switch.

2. Remove floor plate in front of seat and open the hood to get access to all five (5) springs.

CAUTION

Springs are under tension. Use caution when adjusting.

3. Put an open end wrench on hex shaft of spring bracket.

NOTE: Because wrench can be moved only a limited distance, it may be necessary to use a second wrench to hold hex shaft while re-positioning other wrench for further rotation of hex shaft.

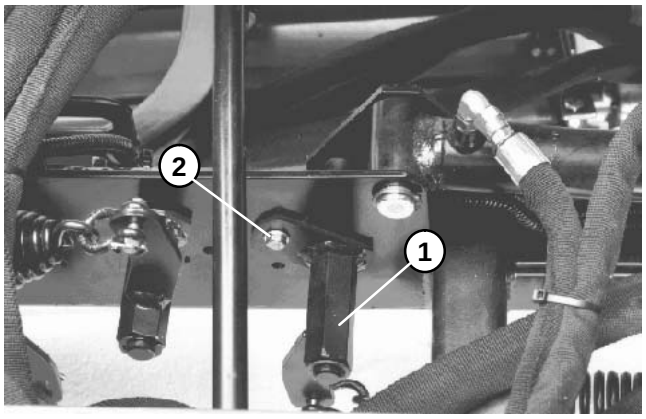


Figure 24

1. **Spring bracket hex shaft** 2. **Retaining bracket**

4. Remove cap screw and locknut securing retaining bracket, while rotating hex shaft to relieve spring tension.

5. Move spring bracket to desired position and install cap screw and locknut, while rotating hex shaft to relieve spring tension.

Daily Adjustments

Prior to each day's mowing, or as required, each cutting unit must be checked to verify proper bedknife-to-reel contact. **This must be performed even though quality of cut is acceptable.**

1. Lower cutting units onto a hard surface, shut off engine and remove key from ignition.

2. Slowly rotate reel in reverse direction listening for reel−to−bedknife contact. If no contact is evident, turn bedknife adjusting knob clockwise, one click at a time, until light contact is felt and heard.

IMPORTANT: Light contact is preferred at all times. If light contact is not maintained, bedknife/reel edges will not sufficiently self−sharpen and dull cutting edges will result after a period of operation. If excessive contact is maintained, bedknife/reel wear will be accelerated, uneven wear can result, and quality of cut may be adversely affected.

Note: As the reel blades continue to run against the bedknife a slight burr will appear on the front cutting edge surface the full length of the bedknife. If a file (or a light face grind) is occasionally run across the front edge to remove this burr, improved cutting can be obtained.

After extended running, a ridge will eventually develop at both ends of the bedknife. These notches must be rounded off or filed flush with cutting edge of bedknife. Also, maintaining a lead−in chamfer (Fig. 25), on right end of bedknife, will ensure smooth operation of the bedknife and reel.

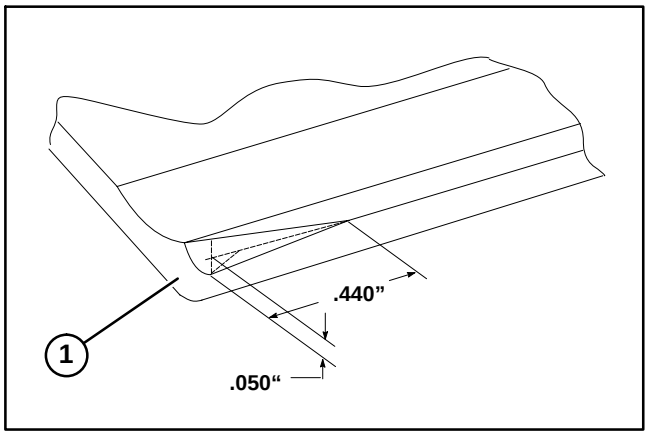


Figure 25

1. **Lead-in chamfer on right end of bedknife**

Note: The chamfer from the factory should last approximately half the life of the bedknife.

Note: Do not make lead−in chamfer too large as it may cause turf tufting.

Lubrication

Each cutting unit has six (6) grease fittings that must be lubricated regularly with No. 2 General Purpose Lithium Base Grease (Fig. 26).

IMPORTANT: Lubricating cutting units immediately after washing helps purge water out of bearings and increases bearing life.

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.

2. Grease the (2) reel bearings until grease comes out the weep hole.

3. Apply grease to the (2) front and (2) rear roller bearings until clean grease comes out seals.

4. Wipe excess grease away.

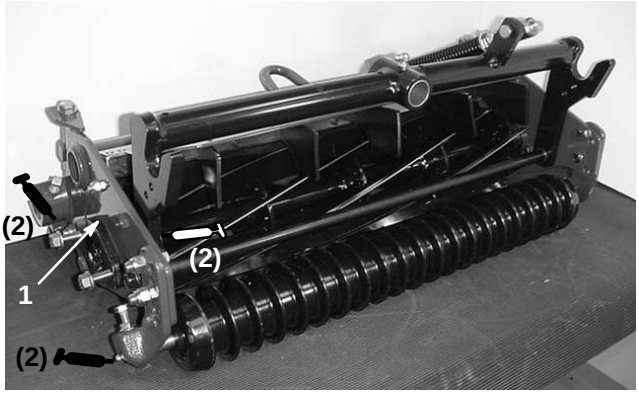


Figure 26

1. **Weep Hole**

Cutting Unit Removal and Installation

IMPORTANT: The reel motors must be removed before removing the cutting units to prevent hose damage due to twisting, bending, and kinking.

Removal

Remove cutting unit from traction unit before doing adjustments or repairs.

1. Remove basket from cutting unit.

2. Disconnect chain from each rear cutting unit cross tube (Fig. 27).

3. Loosen reel motor mounting nuts. Rotate motor clockwise so motor flanges clear studs. Pull motor off of cutting unit (Fig. 28).

4. Remove cap screw, lock washer, flat washer and thrust washer from cutting unit mounting shaft (Fig. 29).

5. Pull cutting unit off mounting shaft (Fig. 29).

Installation

1. Assemble and adjust per Cutting Unit Operator's Manual.

2. Thoroughly grease the cutting unit reel bearings prior to installation on the traction unit. Grease should be evident at the weep holes (see "Lubrication" in this section of this manual).

3. Position cutting unit onto the lift arm mounting shaft.

4. Secure thrust washer, flat washer, lock washer, and cap screw to the cutting unit mounting shaft (Fig. 29).

Note: Lubricate internal splines of cutting unit reels shafts with grease before installing cutting unit motors.

5. Mount the hydraulic motor to the drive end of the cutting unit and secure with two capscrews provided. Rotate motor counterclockwise so motor flanges engages studs (Fig. 28).

6. Connect chain to the cross tube on each rear cutting unit (Fig. 27).

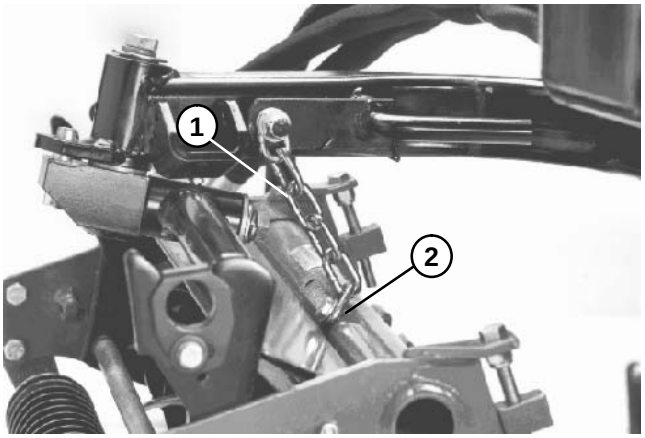


Figure 27

1. Lock-up chain **2. Cross tube**

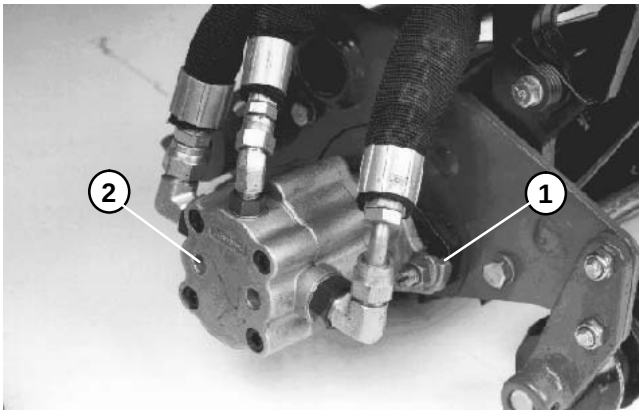


Figure 28

1. Reel motor **2. Mounting nut**

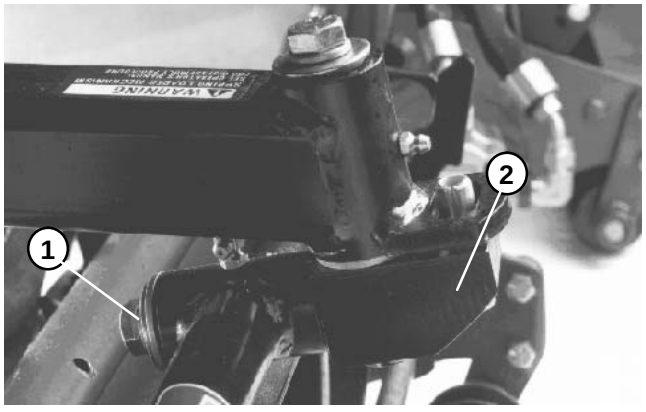


Figure 29

1. Cap screw, lock washer, flat washer, & thrust washer **2. Cutting unit mounting shaft**

Backlaping

DANGER

REELS MAY STALL WHILE BACKLAPPING. DO NOT ATTEMPT TO RESTART REELS BY HAND OR TOUCH REELS WHILE BACKLAPPING. STOP ENGINE AND TURN H.O.C. KNOB ONE POSITION TOWARD ”1”.

Note: When backlapping, the front units operate together, and the rear units operate together.

1. Position the machine on a level surface, lower the cutting units, stop the engine, engage the parking brake, and move the Enable/Disable switch to disable position. Remove the key from the ignition switch.

2. Unlock and raise the seat to expose the controls.

3. Make the initial reel to bedknife adjustments appropriate for backlapping on all cutting units. Start the engine and set the engine at idle speed.

4. Set both reel speed controls to position 11 (Fig. 30).

5. Select either the front or rear on the backlap switch to determine which units to backlap (Fig. 31).

6. Move the enable/disable switch to the enable position. Move the lower mow/raise lever forward to start the backlapping operation on the designated reels (Fig. 32).

7. For the cutting units being backlapped, move the reel speed control to position 1.

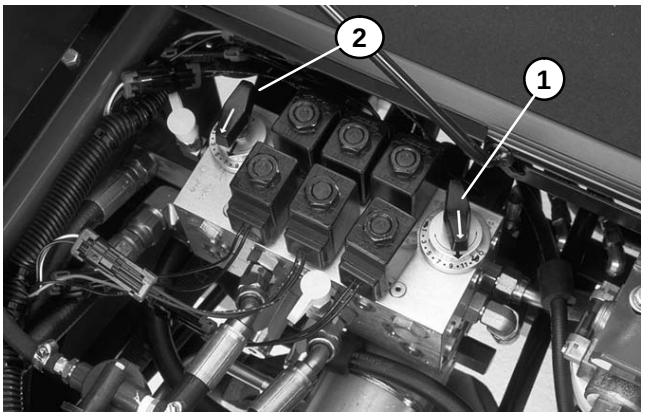


Figure 30

1. Front reel speed control **2. Rear reel speed control**

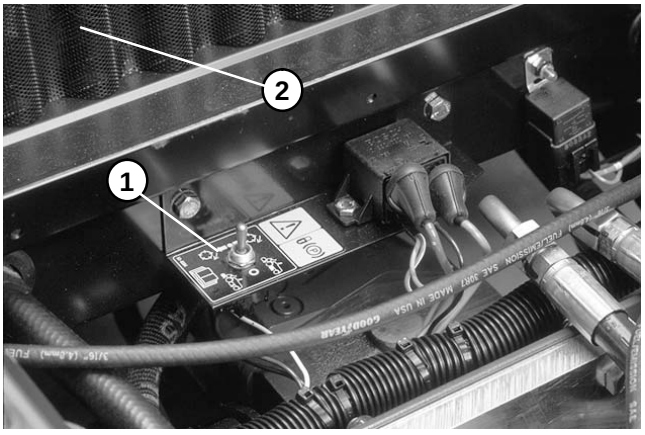


Figure 31

1. Backlap switch **2. Radiator screen**

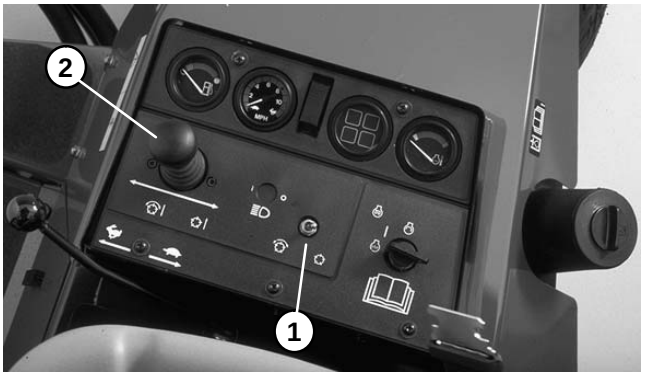


Figure 32

1. Enable/Disable switch **2. Lower Mow/Raise lever**

8. Apply lapping compound with the long handled brush supplied with machine (Fig. 33).

CAUTION

Contact with the reel or other moving parts can result in personal injury.

Stay away from the reel and other moving parts while backlapping.

9. To make an adjustment to the cutting units while backlapping, turn the reels Off by moving the lower mow/raise lever rearward, move the enable/disable switch to Disable, and turn the engine off. After adjustments have been completed, repeat steps 3-7.

10. Repeat the procedure for the remaining cutting units.

11. When the backlap operation is completed, return the backlap switch to Off, set the reel speed controls to the desired mowing setting, and wash all lapping compound off of the cutting units.

Note: Additional instructions and procedures on backlapping are available in the Toro Sharpening Reel and Rotary Mowers Manual, Form No. 80-300PT.

Note: For a better cutting edge, run a file across the front face of the bedknife when the lapping operation is completed. This will remove any burrs or rough edges that may have built up on the cutting edge.

Figure 33

Bedknife Replacement and Grinding

Replacement

1. Remove bedbar.

2. Remove bedknife screws and remove bedknife.

3. Remove all rust, scale and corrosion from bedbar surface before installing the new bedknife.

4. Install **new** bedknife as follows:

   A. Make sure bedbar threads are clean.

   B. Use new bedknife screws (Toro Part No. 57-4910). Apply anti-seize lubricant to the screw threads before installing.

IMPORTANT: Do not use an air or manual impact wrench.

   C. Bedknife screws must bottom out on the bedknife, not the bedbar. Tighten screws to a torque of 180 to 200 in-lb (20.3 to 22.6 N-m); work from the center toward each end of the bedbar (Fig. 34)

NOTE: Since there can be variations in the mounting surface of the bedbar, a new bedknife will not be perfectly flat after it is installed. Because of this, it is necessary to backlap or grind a new bedknife after installing it to the bedbar. Follow the existing angle that was ground into the bedknife and grind only enough to make sure the top surface is true.

NOTE: For proper grinding of bedknife, follow procedures in the Toro Sharpening Reel and Rotary Mowers Book, Part No. 80300SL.

Note: When grinding, be careful to not overheat the bedknife. Remove small amounts of material with each pass of the grinder.

Note: If the height of cut is a 1/2 inch or lower on the cutting unit, the front angle can be increased to 30° for improved performance.

5. Grind bedknife.

6. Install bedbar and tighten bedbar mounting bolts to 35 to 40 ft-lbs (47 to 54 Nm).

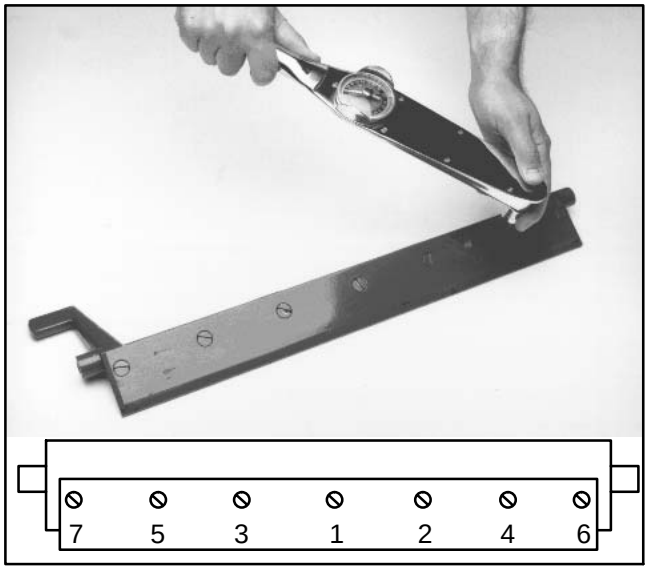


Figure 34

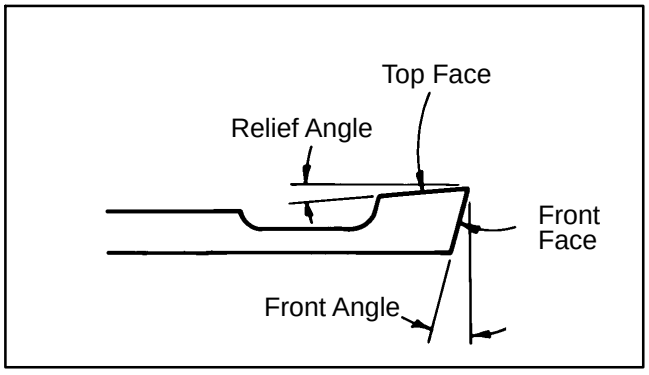


Figure 35

Bedknife Regrinding Specifications	
Relief Angle	10° ± 2°
Front Angle	15° ± 2° (If the height of cut is a 1/2 inch or lower on the cutting unit, the front angle can be increased to 30° for improved performance)

Preparing Reel for Grinding

The front roller may have to be removed so that the reel can be sharpened.

Note: Check to make sure reel bearings are in good condition and properly adjusted before grinding reel.

IMPORTANT: Some reel grinders may require that the rear roller assembly be mounted to the cutting unit for proper support in the reel grinder.

1. Remove locknuts and cap screws securing the front roller brackets to the sideplates at both ends of the cutting unit.

2. Remove front roller assembly from the cutting unit by pulling evenly on both sides.

3. For proper grinding of reel, grind in accordance with procedures in the Toro Sharpening Reel and Rotary Mowers Book, Part No. 80300SL.

Note: Most reel grinders require that the rear roller assembly be mounted to the cutting unit for proper support in the reel grinder. The rear roller must be parallel to the reel shaft to remove taper when grinding, or the cutting unit must be aligned so the grinding wheel will travel parallel to the reel shaft. This will result in the the reel being ground to the desired cylinder shape.

IMPORTANT: After grinding operation is complete, reassemble cutting unit, check bearing adjustment and adjust top shield and bar; refer to sections on Adjusting Shield Height and Adjust Top Bar. Back lap the cutting unit to complete sharpening operation. To assure proper alignment of the rear roller in the roller brackets, make sure roller moves freely within brackets before tightening set screws on bearing shafts. Apply medium strength Locktite #242 or equivalent to set screws before tightening.

Reel Grinding Specifications	
Nominal Reel Diameter	5 inches (126 mm)
Service Limit Reel Diameter	4.5 inches (114 mm)
Blade Relief Angle	30°
Relief Angle Range	20° to 40°
Blade Land Width	0.040 inch (1.0 mm)
Land Width Range	0.030 to 0.060 inch (0.7 to 1.5 mm)
Max. Reel Taper	0.040 inch (1.0 mm)

4. Install front roller and brackets. Complete cutting unit set-up and adjustment sequence (see Adjustments section).

Note: When grinding, be careful to not overheat the reel blades. Remove small amounts of material with each pass of the grinder.

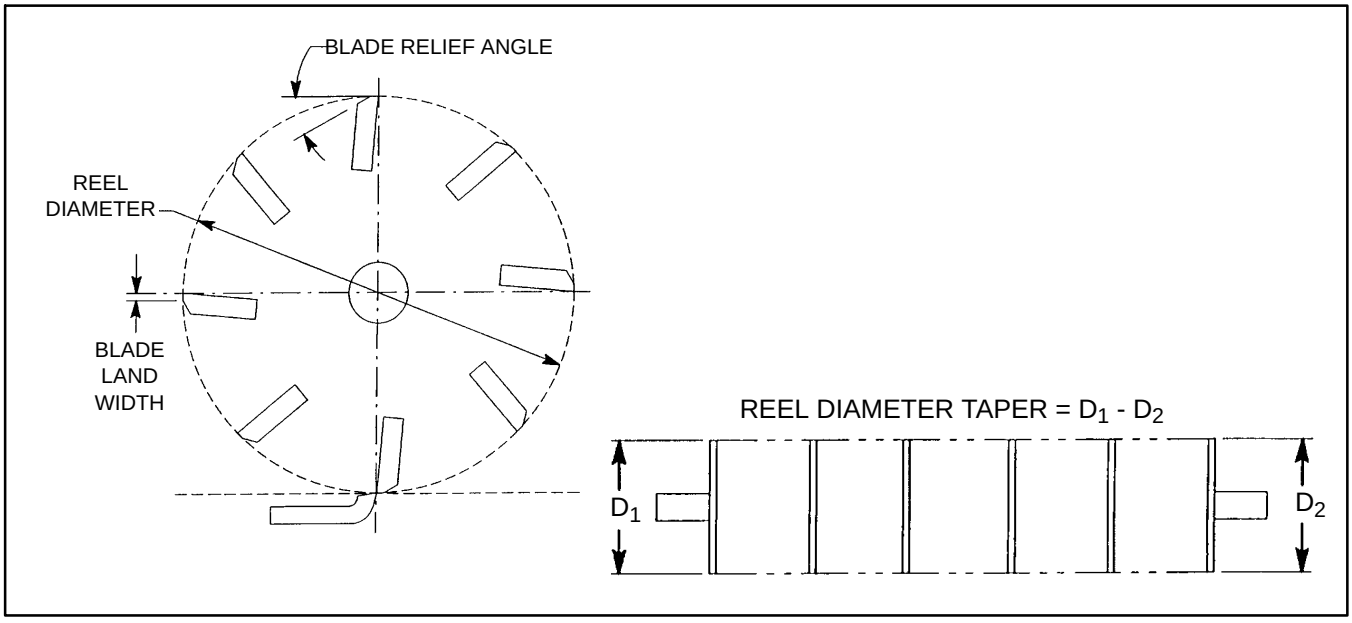


Figure 36

Reel and Reel Bearings

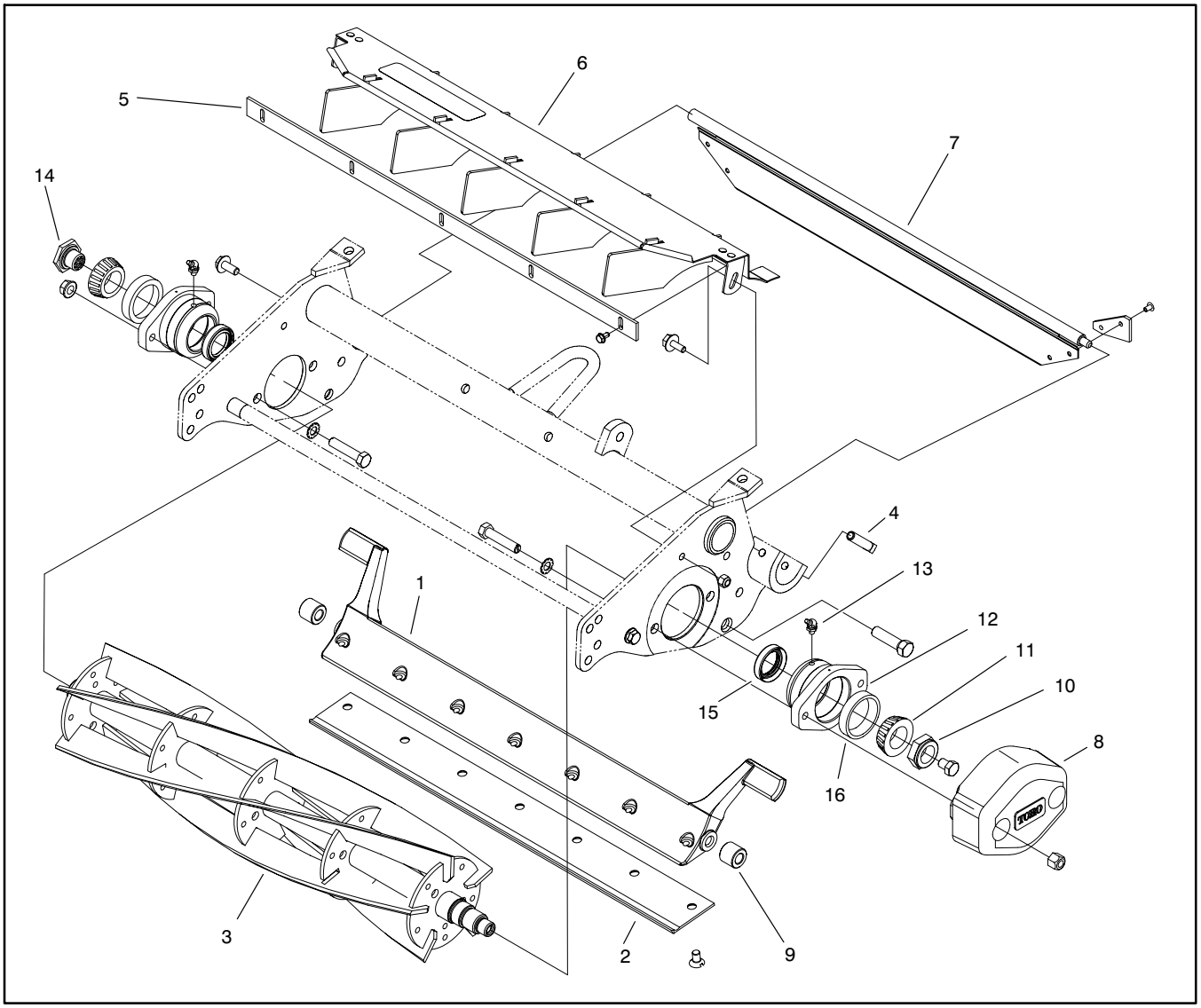


Figure 37

1. **Bedbar**
2. **Bedknife**
3. **Reel**
4. **Bedknife adjustment screw**
5. **Cut-off bar**
6. **Front grass shield**
7. **Rear grass shield**
8. **Counterbalance end weight**
9. **Spacer**
10. **Reel adjustment nut**
11. **Bearing Cone**
12. **Bearing housing**
13. **Grease fitting**
14. **Spline nut**
15. **Seal**
16. **Bearing cup**

Bearing Adjustment

IMPORTANT: Before removing the cutting unit, remove the reel motors to prevent damage to the hydraulic hoses.

Periodically check the drag on the reel bearings. Proper adjustment of the reel bearings ensures that no end play of the reel exists and there is minimum rolling torque of the reel assembly. All measurements and adjustments of the reel rolling torque must be done with a completely assembled cutting unit. Check and adjust the reel bearings in the following manner:

1. Adjust the bedknife so it is not in contact with the reel.

2. Measure the rolling torque with a torque wrench. The measurement should be 5 to 7 in.-lbs. If it is not, or if end play exists, adjust the reel bearing as follows:

   A. Remove the mounting nuts from the counterbalance end weight (Fig. 38).

B. Using a large socket wrench, remove the reel bearing adjustment nut (Fig. 39). Tap on the head of the hex head bolt on the end of the reel shaft, with a small hammer, until end play of the reel can be felt.

C. Hold the reel to keep it from turning and slowly tighten the reel bearing adjustment nut until no end play of the reel exists.

D. Using an appropriate torque wrench, check the rolling torque of the reel. The rolling torque of the reel should be 5 to 7 in.-lbs. Check to make sure no end play exists and the reel spins freely.

E. Install the counterbalance end weight.

Reel Removal

1. Remove counterbalance end weight (Fig. 38).

2. Remove large bearing adjustment nut from the counterbalance end of the reel shaft and the special spline nut at the opposite end of the reel shaft.

3. Remove mounting bolts from the bearing housing on both ends of cutting unit.

IMPORTANT: Remove grease fittings from bearing housing at each end of cutting unit.

4. Using a plastic headed hammer, rotate bearing housing slightly, install bearing housing bolts from outside housing, turn bolts alternately against side plate. Use this method to remove bearing housing (Fig. 39).

5. The bearing housing will slip out of the side plates and the reel assembly can be removed as soon as the bearing housings are removed from the side plates.

6. If necessary, install new bearings and seals:

A. Remove bearing cup, bearing cone and inner seal.

B. Bearing housing must be completely free of paint and foreign material before installing bearing cup. If necessary, remove any ”flash” from bearing housing that may interfere with accurate seating of bearing. Apply a thin film of grease to lip of new inner seal, and install seal with face toward reel. Install bearing cup.

C. Install bearing housing to frame. Pack bearing cone with grease and install over reel shaft into bearing cup.

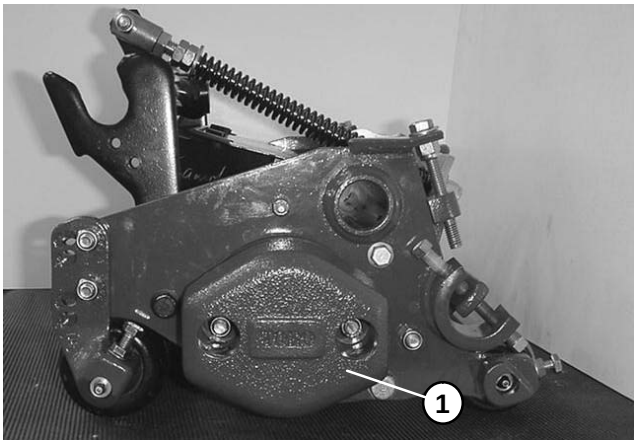


Figure 38

1. Counterbalance end weight

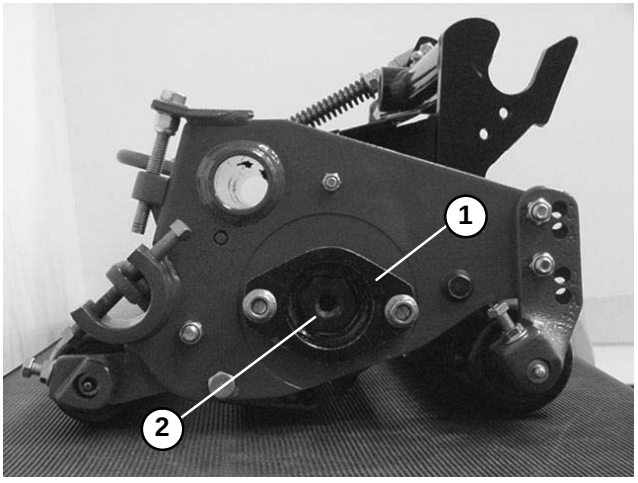


Figure 39

1. Reel bearing housing **3. Reel adjustment nut**

7. Lubricate the (2) reel bearings until grease comes out the bearing housing weep hole.

Inspection

1. Replace reel if diameter has decreased to the service limit (see Reel Grinding Specifications).

2. Replace reel if blades are bent or cracked.

3. Inspect bearings and seals.

Roller Bearing and Seal Replacement

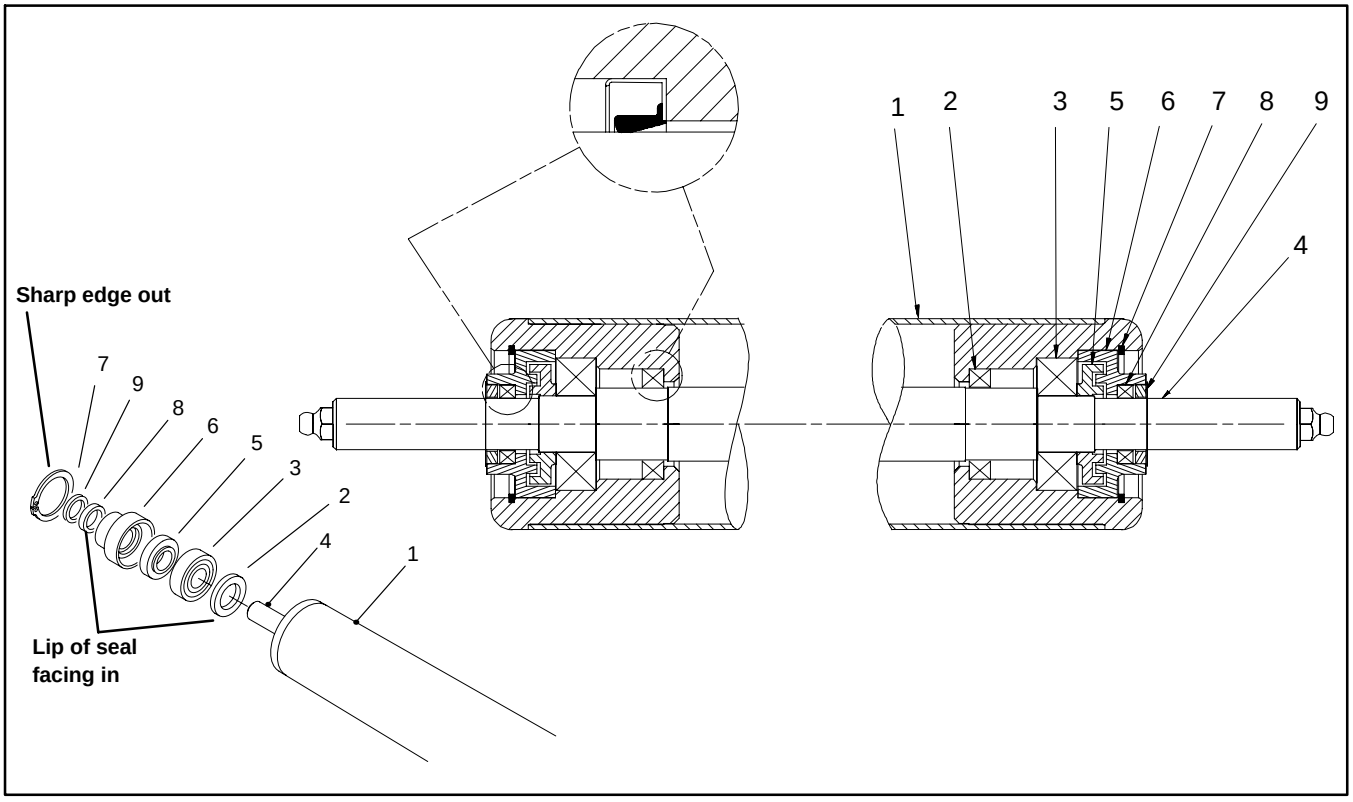


Figure 40

1. Roller
2. Inner oil seal
3. Bearing
4. Roller shaft
5. Inner seal
6. Outer seal
7. Retaining ring
8. Outer oil seal
9. Washer

NOTE: Bearing and seal configurations are the same for both the front and rear rollers.

Removal

1. Remove retaining ring from both ends of roller.

2. Hit end of roller shaft with a soft face hammer to remove seals and bearing from one end of roller. Hit other end of roller shaft to remove seals and bearing from other end of roller. Be careful not to drop roller shaft.

3. Discard seals and bearings.

Installation

NOTE: A soft face hammer can be used with the special tools to assemble the roller, however use of a press is recommended.

1. Use installation tool TOR4065 and handle TOR4073 to install inner oil seal into each end of roller.

2. Install bearings:

   A. Use tool TOR4066, handle TOR4073 to install bearing into one end of roller.

   B. Install roller shaft from opposite end of roller. Be careful not to damage the inner oil seals.

   C. Put roller in a vertical position and support shaft and bearing with tool TOR4067.

   D. Use tool TOR4067 to install second bearing.

3. Use tool TOR4068 to install inner seal.

4. Use tool TOR4069 to install outer seal

5. Install retaining ring.

6. Use tool TOR4071 to install outer oil seal.

7. Use tool TOR4067 to install washer.

8. Put opposite end of roller facing up and support bottom end with tool TOR4067. Repeat steps 3 - 7.

9. Use a hand operated grease grease gun and No. 2 general purpose lithium base grease to lubricate bearings until grease appears at washer. Wipe off excess grease.

Traction Unit Lift Arm Spring Replacement

1. Put machine on a level surface, lower cutting units, stop engine, engage parking brakes, and remove key from the ignition switch.

2. Remove floor plate in the front of the seat to get access to the front springs, or open hood to get access to the rear springs.

CAUTION

Springs are under tension. Use caution when removing or adjusting.

3. Put an open end wrench on the hex shaft of the spring bracket.

NOTE: Because the wrench can be moved only a limited distance, it may be necessary to use a second wrench to hold the hex shaft while repositioning the other wrench for further rotation of the hex shaft.

4. Remove cap screw and locknut securing the retaining bracket while rotating hex shaft to relieve spring tension, then rotate hex shaft to completely relieve spring tension.

5. Remove spring.

6. Install new spring.

7. Use an open end wrench to move spring bracket to the desired position. Install cap screw and locknut while rotating the hex shaft to relieve spring tension.

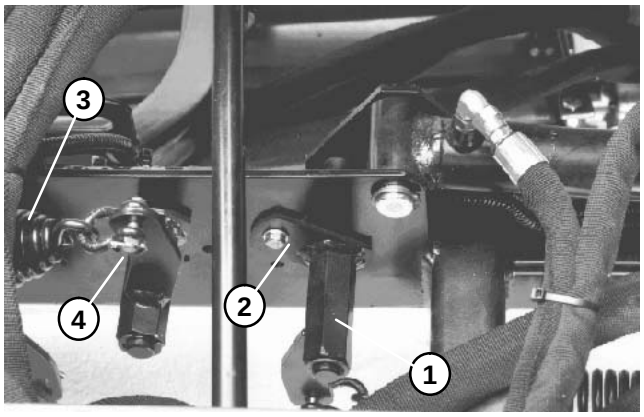


Figure 41

1. **Spring bracket hex shaft**
2. **Retaining bracket**
3. **Spring**
4. **Cotter pin, clevis pin, & clevis**

Chapter 9
Unit Serial No. 80001 - 99999
4WD Rear Axle

Table of Contents

Note: For Unit Serial No. 200000001 & Up, see Chapter 9.1 “4WD Rear Axle” in this manual.

Rear Axle and Overrunning Clutch Operation

The following explanation is intended to clarify the operation of the 4WD rear axle and overrunning clutch used with this TORO product.

A drive shaft connected to the front axle provides power to the rear 4WD axle. The drive shaft incorporates an overrunning clutch that transfers power in the forward direction only (Fig. 1).

Front and rear axle gear ratios and tire sizes were carefully selected so during normal operation, the rear axle input shaft turns slightly faster than the rear axle drive shaft.

Note: The Four-Matic overrunning clutch may not operate properly if different size tires are used, or if correct tire pressure is not maintained.

Any time the front wheels begin to slip (climbing a steep hill), the forward movement of the traction unit slows. In this condition the rear axle input shaft speed also slows. As soon as the rear axle input shaft turns at the same speed as the drive shaft, the clutch will engage and power is transferred to the rear axle (Fig. 2). The result is automatic four wheel drive.

When the traction unit is turning, the rear wheels swing at a larger arc and must travel faster than the front wheels (Fig. 3). In this condition, the rear axle input shaft is turning faster than the rear axle drive shaft and the clutch in disengaged (overrunning).

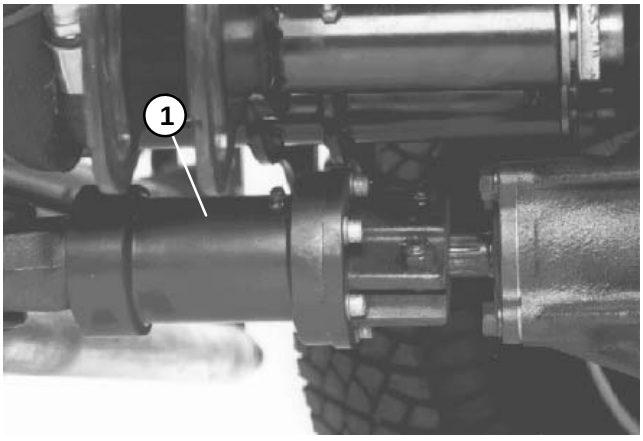


Figure 1

1. Four-Matic overrunning clutch

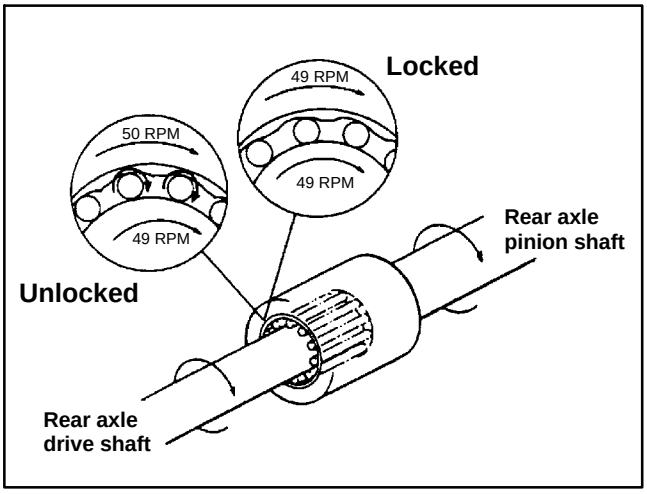


Figure 2

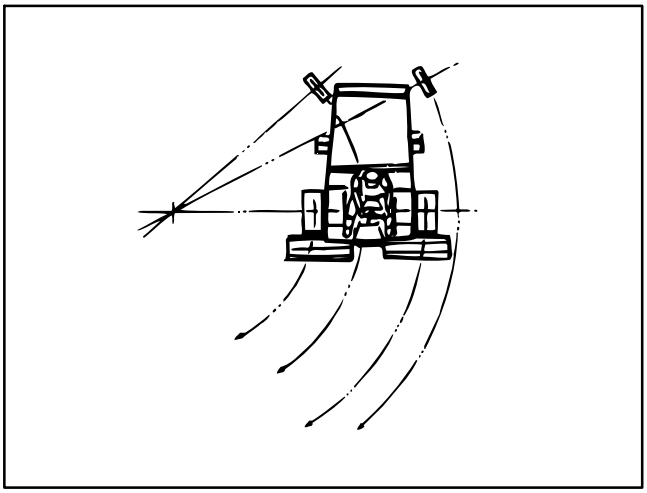


Figure 3

Specifications

Item	Specification
Rear wheel lug bolt torque	30 to 35 ft-lbs. (41 to 47 Nm)
Rear wheel toe-in	0.000 to 0.125 in. (0.0 to 3.0 mm)
Tire pressure (front and rear)	10 to 15 psi. (0.69 to 1.03 Bar)
Axle lubricant	SAE GL-5 80W90 gear lube
Four-Matic™ overrunning clutch lubricant	No. 2 general purpose lithium grease

Changing Rear Axle Lubricant

Rear axle lubricant should be changed every 800 hours of operation. There are 3 separate oil reservoirs (axle support, right gear case, and left gear case) that require draining and refilling with SAE GL-5 80W90 gear lube.

1. Position machine on a level surface.

2. Clean area around the drain plugs.

3. Remove plugs allowing oil to drain into drain pans (Fig. 4).

4. After oil is drained, apply thread locking compound to all drain plug threads and reinstall.

5. Remove axle support check/fill plug. Add enough lubricant to bring the level up to the bottom of the plug hole (Fig. 5).

6. Remove the gear case check plug and one of the knuckle arm bolts from each gear case. Add enough lubricant through knuckle arm hole to bring the oil level up to the bottom of the plug hole (Fig. 6).

7. Install all plugs and bolts.

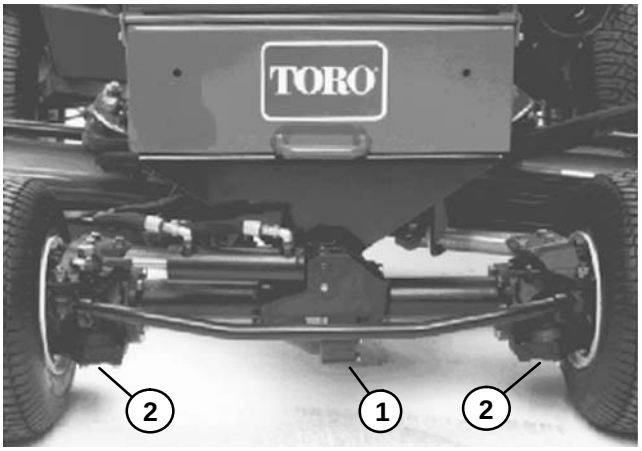


Figure 4

1. Axle support drain plug **2. Gear case drain plug**

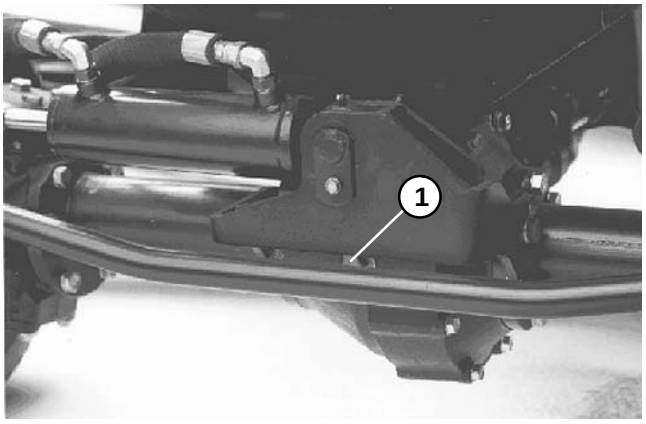


Figure 5

1. Check/fill plug

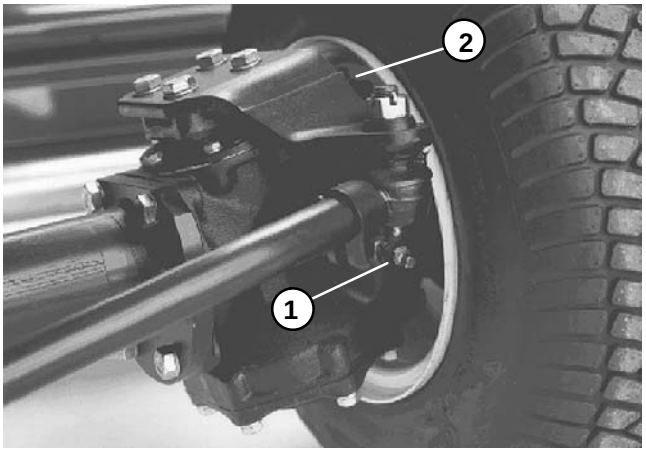


Figure 6

1. Check plug **2. Knuckle arm bolt**

Drive Shaft

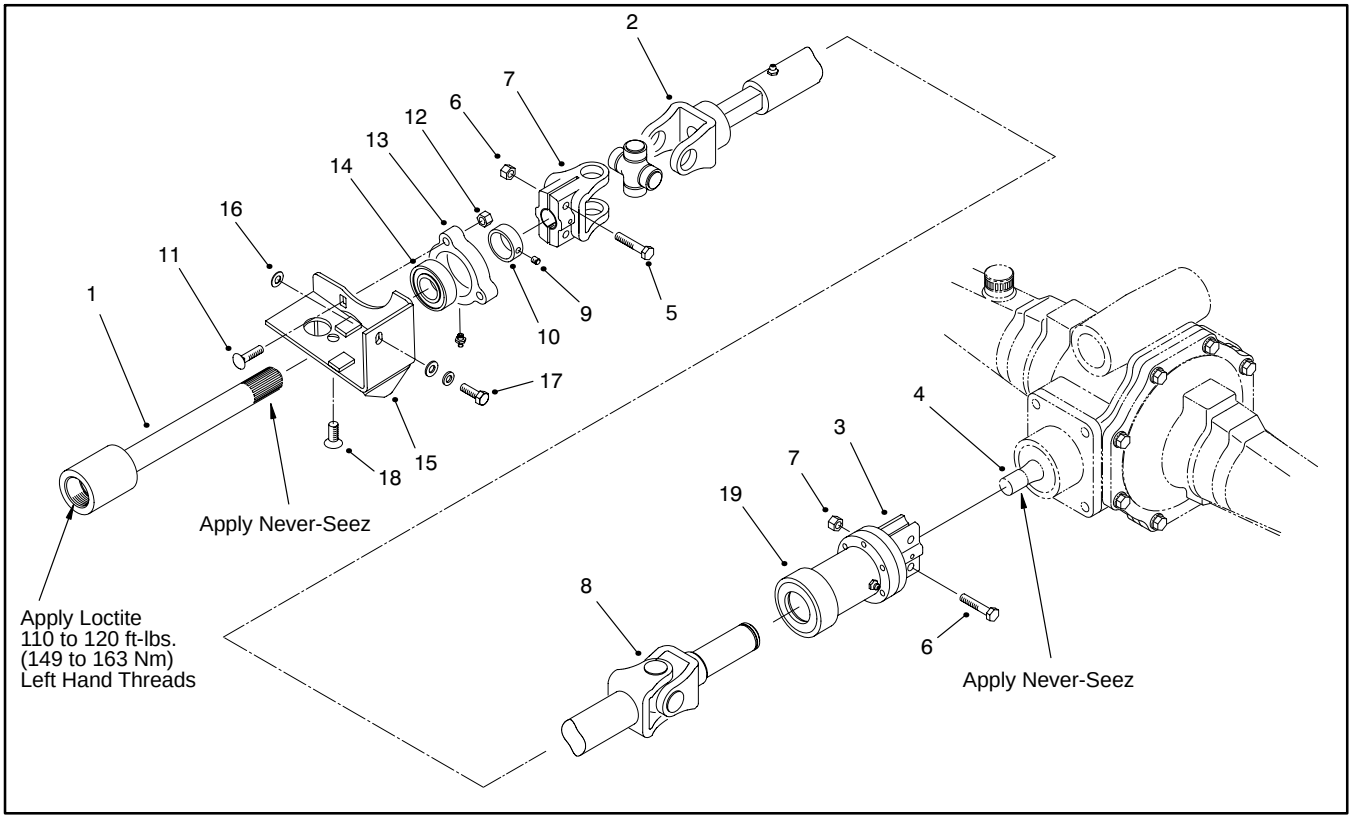


Figure 7

1. **Traction shaft**
2. **Slip yoke**
3. **Axle coupling**
4. **Rear axle input shaft**
5. **Capscrew**
6. **Locknut**
7. **End yoke**
8. **Drive shaft assembly**
9. **Set screw**
10. **Bearing collar**
11. **Carriage bolt**
12. **Locknut**
13. **Bearing support**
14. **Bearing**
15. **Bearing bracket**
16. **Shim**
17. **Capscrew**
18. **Socket head screw**
19. **Four-Matic clutch**

Removal

1. Position machine on a level surface, lower cutting units, stop engine and remove ignition key from switch. Block front wheels to prevent the machine from moving.

2. If front axle or traction shaft will be removed for repairs, loosen traction shaft before removing the drive shaft. Use an open end wrench on the square slip yoke shaft and turn the shaft in a clockwise (left hand threads) direction (Fig. 7).

3. Raise the rear axle off the ground.

4. Loosen capscrews and locknuts securing axle coupling to rear axle input shaft, and slide coupling off shaft.

5. Loosen capscrews and locknuts securing end yoke to traction shaft, and slide drive shaft assembly off traction shaft (Fig. 7).

6. If front axle or traction shaft will be removed for repairs:

A. Loosen the set screws in the bearing locking collar. Use a hammer and punch to loosen the collar by rotating it in a counterclockwise direction (Fig. 7).

B. Remove the carriage bolts and locknuts securing the bearing support to the bracket. Remove the bearing and bearing support (Fig. 7).

C. Remove the traction shaft from the front axle by continuing to turn it in a clockwise (left hand threads) direction.

D. Remove bearing bracket (Fig. 7). Record number of shims used between side of bracket and transmission.

Installation

1. If front axle or traction shaft was removed:

   A. Apply medium strength Loctite to coupler output shaft on rear of hydrostatic.

   B. Slide traction shaft through bearing bracket, aligning the (2) bearing bracket mounting holes with the holes in side and bottom of hydrostatic (Fig. 8).

   C. Mount side of bracket to hydrostat with a capscrew, lock washer, flat washer and 1 or 2 shims (Fig. 8).

   D. Place top carriage bolt in bearing bracket and mount bottom of bearing bracket to hydrostat with socket head screw.

   Note: Determine whether 1 or 2 shims are required between bracket and hydrostat before tightening any fasteners. After shim(s) are in position on capscrew, tighten socket head bolt and capscrew.

   E. Thread traction shaft (left hand thread) all the way onto coupler output shaft.

   F. Mount bearing assembly to bearing bracket with carriage bolts and locknuts. Tighten lock nuts.

   G. Slide locking collar onto traction shaft.

2. Apply never-seize to splines of traction shaft and rear axle input shaft.

3. Slide clutch end of drive shaft assembly onto shaft. Tighten axle coupling capscrews and locknuts (Fig. 7).

4. Slide end yoke of drive shaft assembly onto traction shaft and tighten end yoke capscrews and locknuts (Fig. 7).

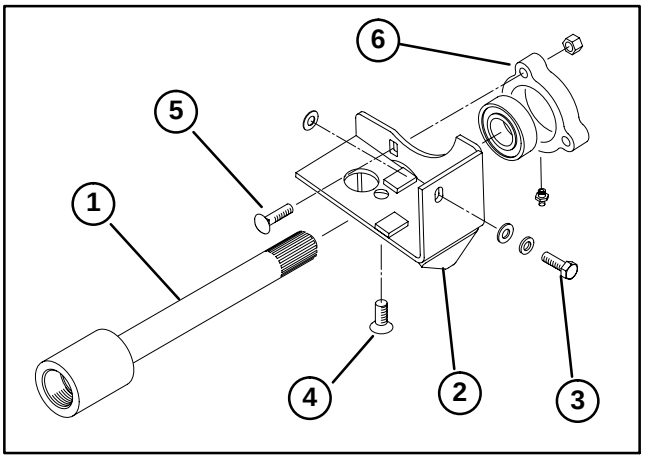


Figure 8

1. **Traction shaft**
2. **Bearing bracket**
3. **Capscrew**
4. **Socket head screw**
5. **Carriage bolt**
6. **Bearing assembly**

5. If front axle or traction shaft was removed:

   A. Block front wheels to prevent the machine from moving.

   B. Jack up the rear of the machine until there is about 1 in. (25 mm) clearance between the rear tires and the ground. SECURELY SUPPORT THE VEHICLE FRAME.

   C. Use an open end wrench on the square slip yoke shaft and turn the shaft in a counterclockwise (left hand threads) direction. Tighten shaft to 110 to 120 ft-lbs. (149 to 163 Nm).

   D. Tighten locking collar to traction shaft by carefully rotating it in a clockwise direction with a hammer and punch. Tighten collar set screws (Fig. 7).

Overrunning Clutch

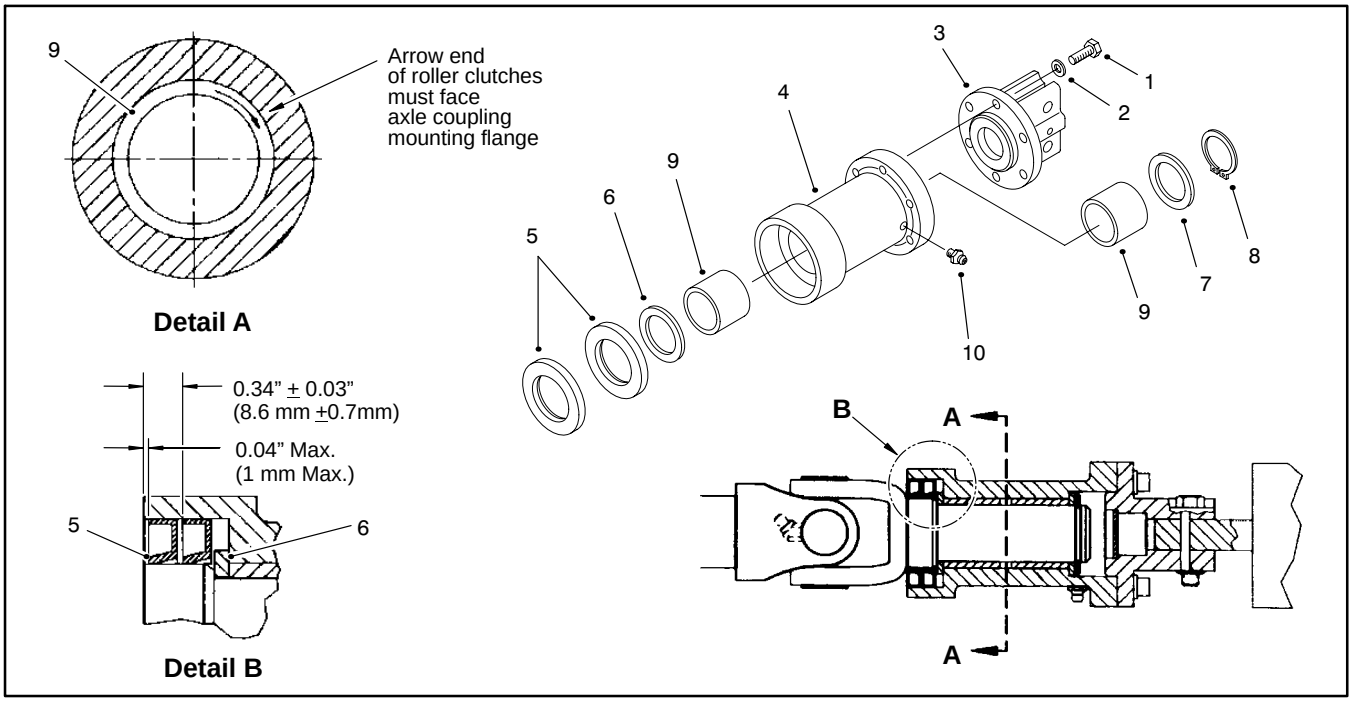


Figure 9

1. **Capscrew**
2. **Lock washer**
3. **Axle coupling**
4. **Clutch housing**
5. **Shaft seal**
6. **Inner thrust washer**
7. **Outer thrust washer**
8. **Retaining ring**
9. **Roller clutch**
10. **Grease fitting**

Removal

1. Remove drive shaft (see Drive Shaft Service in this section of this manual).

2. Remove the capscrews and lock washers securing the axle coupling to the clutch and remove the coupling (Fig. 9).

3. Remove the retaining ring from the yoke shaft and slide the clutch assembly off the yoke shaft (Fig. 9).

4. Remove and discard shaft seals.

5. Clean and inspect all clutch components for damage and wear. Replace parts as necessary.

Installation

1. Install roller clutches in clutch housing.

   A. Each roller clutch must be .000 to .040 in. (0.00 to 1.00 mm) below the shoulder at each end of clutch housing bore.

   B. Each roller clutch must be installed with arrow stamped end toward axle coupling mounting flange (Fig. 9 Detail A).

2. Install inner thrust washer.

3. Press both seals into clutch housing to dimensions shown (Fig. 9 Detail B). Seals must be installed with lip facing out.

4. Slide clutch assembly onto yoke shaft and install outer thrust washer and retaining ring (Fig. 9).

5. Secure axle coupling to clutch housing with capscrews and lock washers. Tighten capscrews evenly.

6. Lubricate clutch through grease fitting with No.2 general purpose lithium grease.

7. Install drive shaft (see Drive Shaft Service in this section of this manual).

4WD Rear Axle

Note: For information on 2WD rear axle service and repairs, see Chapter 7−Steering and Brakes in this manual.

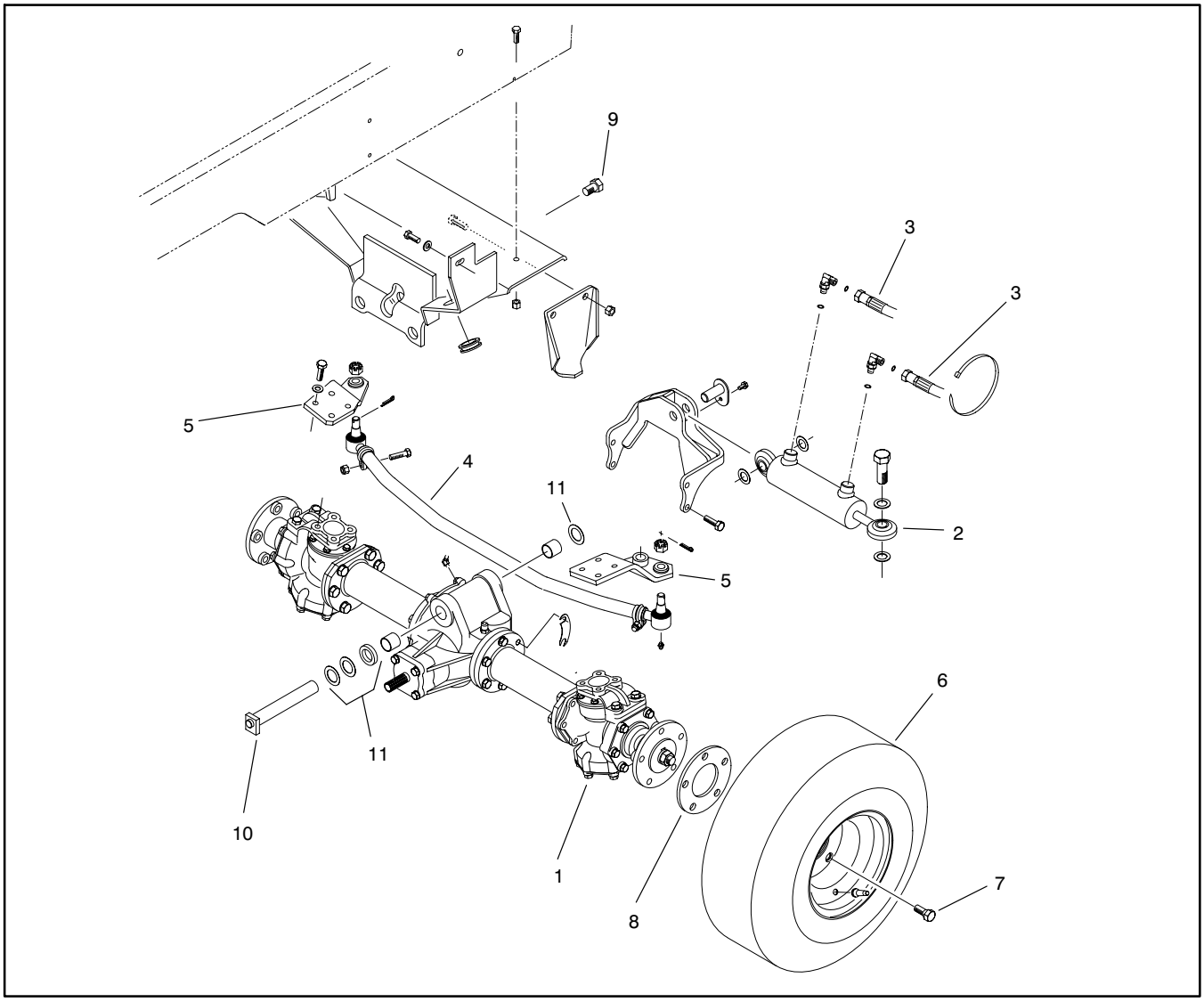


Figure 10

1. **Rear axle assembly**
2. **Steering cylinder**
3. **Hydraulic hose**
4. **Tie rod**
5. **Steering plate**
6. **Rear wheel**
7. **Lug bolt**
8. **Rear wheel spacers**
9. **Pivot pin screw**
10. **Pivot pin**
11. **Washer**

Removal

1. Remove rear axle drive shaft (see Drive Shaft in this section of this manual).

2. Drain rear axle lubricant (see Changing Rear Axle Lubricant in this section of this manual).

3. Thoroughly clean the steering cylinder hydraulic hose connections. Disconnect the hydraulic hoses from the steering cylinder. Put caps or plugs on all the fittings and hoses to prevent contamination.

Note: To ease reassembly, tag each of the hoses to show their correct position on the steering cylinder.

4. Remove steering cylinder (see Chapter 7−Brakes and Steering in this manual).

5. Remove the cotter pins and slotted hex nuts from the tie rod ball joints. Use a ball joint fork and remove the ball joints from the steering arms.

6. Loosen the rear wheel lug bolts.

7. Remove the capscrew securing the end of the axle pivot pin to the chassis (Fig. 10).

8. Block the front wheels and jack up the frame (just ahead of the rear wheels) until the rear tire is about 1 in. (25 mm) above the floor. Support the machine with jack stands to prevent it from falling.

9. Remove rear wheels and wheel spacers.

10. Support the rear axle from underneath and remove the axle pivot pin. This will release the rear axle and washer(s) from the frame, allowing the axle to be lowered and removed.

Note: Several washers may have been installed between the axle pivot tube and frame during manufacture. Make sure the same thickness and quantity of washers are installed in the same location during reassembly.

11. Wipe the rear axle pivot pin and pivot bushings with a rag to remove dirt and grease. Inspect the pin and bushings for wear or damage. Replace components as necessary.

Installation

1. Apply a thin coat of grease to the inside of the rear axle pivot bushings and move the rear axle assembly into position under machine frame.

2. Install washer(s) and axle pivot pin. Use medium strength Loctite® thread locker on the capscrew and secure the axle pivot pin in place (Fig. 10).

1. Install the tie rod ball joints. Tighten ball joint hex nuts and install new cotter pins.

2. Install steering cylinder (see Chapter 7−Brakes and Steering in this manual).

3. Install rear wheel spacers, rear wheels, and lug bolts.

4. Remove the jackstands and lower the machine to the floor.

5. Tighten rear wheel lug bolts to 30 to 35 ft-lbs. (41 to 47 Nm).

6. Lubricate the rear axle pivot bushings through the grease fitting on axle assembly.

7. Fill rear axle with lubricant (see Changing Rear Axle Lubricant in this section of this manual).

8. Install rear axle drive shaft (see Drive Shaft in this section of this manual).

9. Install the hydraulic hoses to the steering cylinder.

10. Check steering cylinder hydraulic connections for leaks.

Disassembly

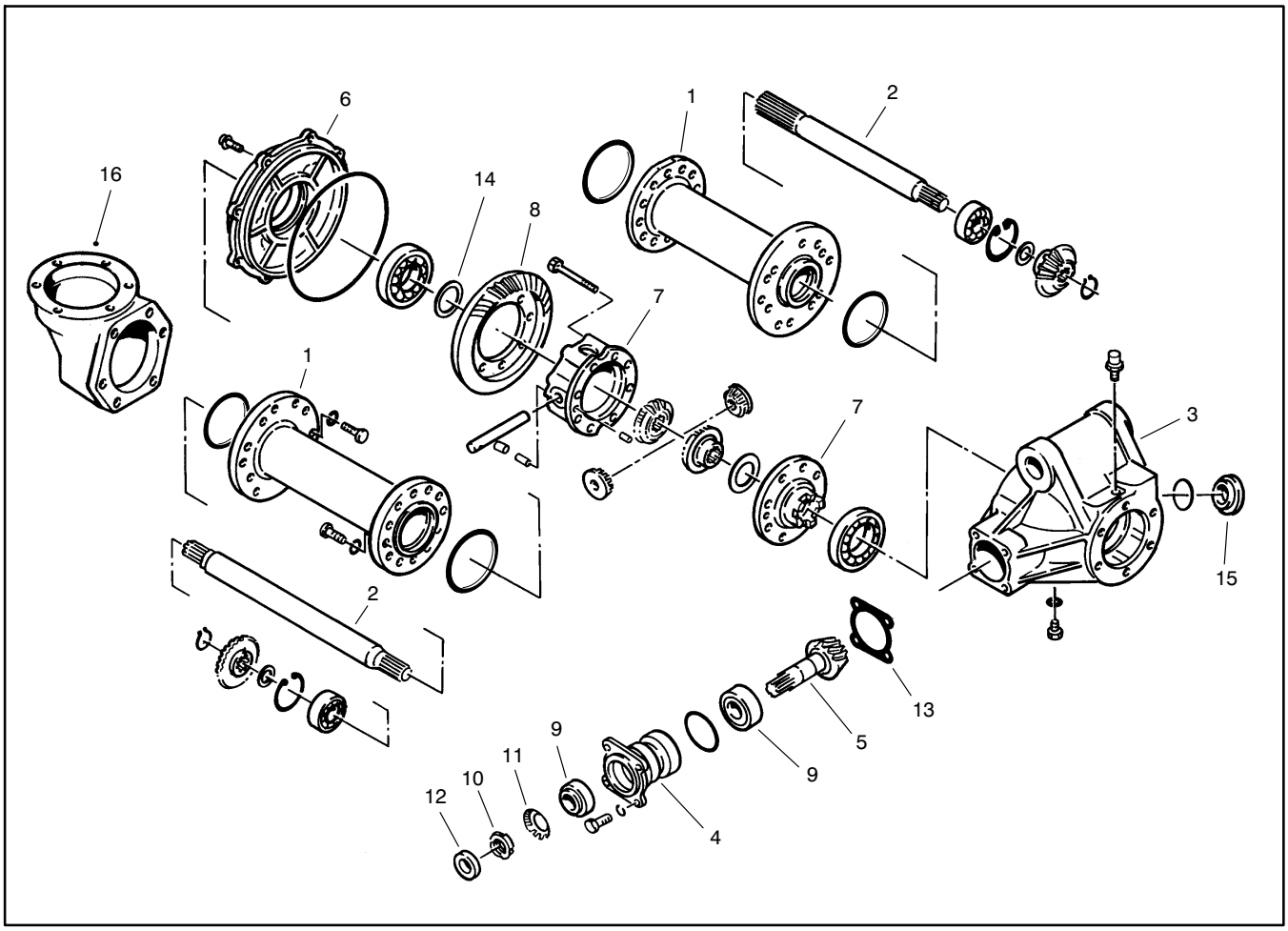


Figure 11

1. **Axle tube**
2. **Axle**
3. **Differential housing**
4. **Pinion gear case**
5. **Pinion gear**
6. **Housing cover**
7. **Differential gear case**
8. **Ring gear**
9. **Pinion bearing**
10. **Pinion nut**
11. **Lock washer**
12. **Oil seal**
13. **Bearing case shim**
14. **Differential bearing shim**
15. **Inspection cover**
16. **Gearbox housing**

The following procedures assume the rear axle assembly has been removed from the machine.

1. Remove axle tube bolts. Separate axle tubes and axles from differential housing (Fig. 11).

2. Remove gearbox housing bolts. Separate tubes and axles from gearbox housings.

IMPORTANT: Do not interchange right and left components or assemblies.

3. Remove pinion gear case bolts. Separate pinion gear case from differential housing.

4. Remove differential housing cover bolts. Separate housing cover from differential housing.

5. Remove differential gear case from differential housing (Fig. 11).

6. Remove differential gear case bolts. Separate gear case halves and disassemble gear case.

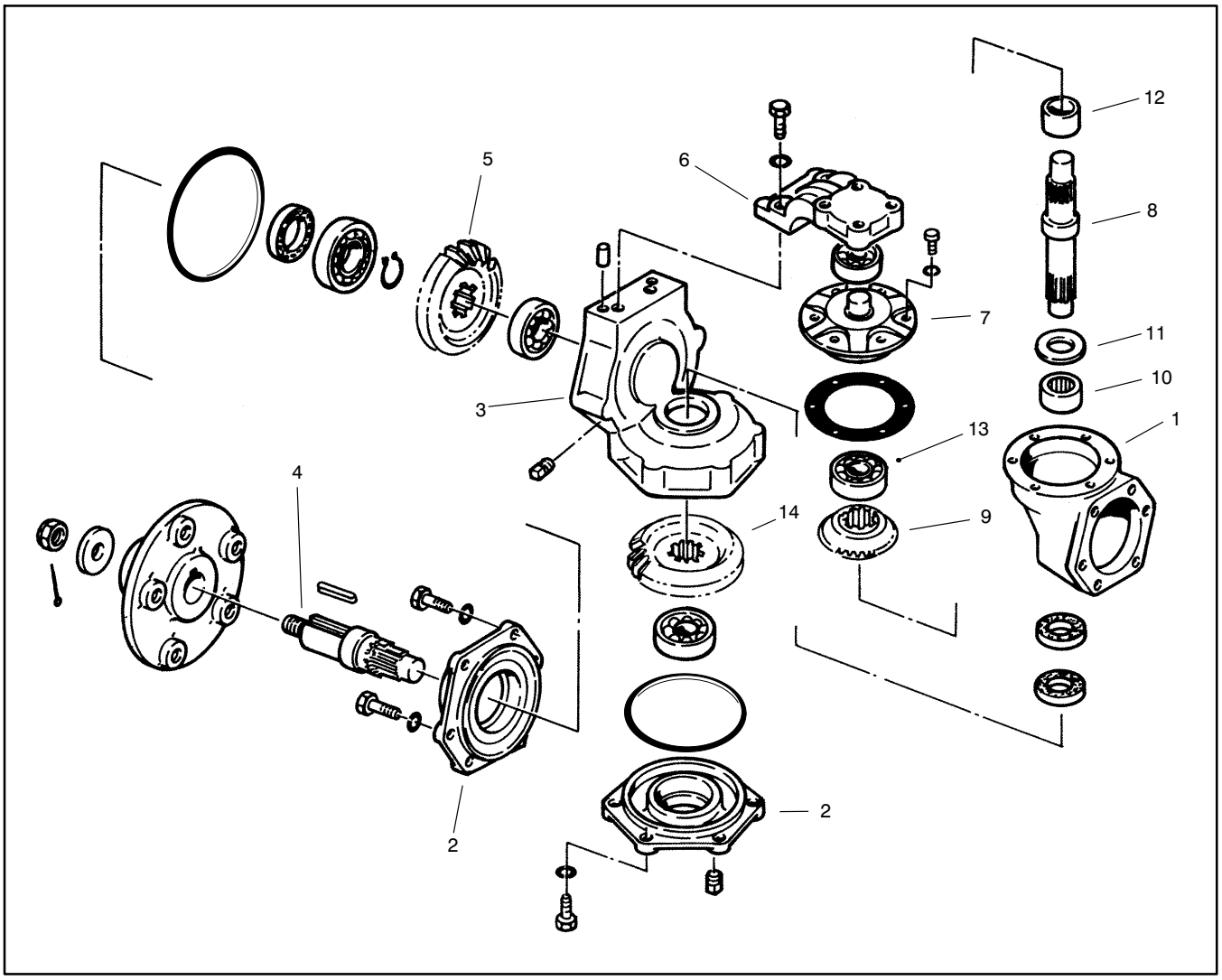


Figure 12

1. **Gearbox housing**
2. **Knuckle cover**
3. **Knuckle housing**
4. **Outer axle shaft**
5. **Outer axle bevel gear**
6. **Knuckle arm**
7. **Bearing retainer**
8. **Knuckle pin**
9. **Inner bevel gear**
10. **Needle bearing**
11. **Washer**
12. **Spacer**
13. **Bearing**
14. **Outer bevel gear**

7. Remove knuckle cover bolts. Separate knuckle covers from knuckle housing. Remove outer bevel gear (Fig. 12).

8. Remove outer axle shaft and bevel gear from knuckle housing.

9. Remove the steering arms (Fig. 10).

10. Remove knuckle arm capscrews. Pull the knuckle arm from the gearbox housing.

11. Pull the knuckle housing from the gearbox housing.

12. Remove the bearing retainer screws. Separate the bearing retainer from the gearbox housing.

13. Remove the knuckle pin and the inner bevel gear.

Inspection

1. Inspect all gears, shafts, bearings, cases, and covers for damage and wear. Replace components as necessary.

Note: Differential ring and pinion gears are a matched set, and must be replaced as a set.

Assembly

Note: Always use new gaskets and Seals when assembling the rear axle.

1. Assemble differential gear case (Fig. 11). Use medium Loctite thread locker on gear case bolts and tighten evenly to 20 to 24 ft-lbs (27 to 33 Nm).

2. Assemble pinion gear and pinion gear case (Fig. 11). Tighten pinion nut to pre-load bearings. Pinion gear should require 2 to 5.5 in-lbs (0.23 to 0.62 Nm) torque to rotate. Once correct pre-load is set, bend tabs of lock washer and install oil seal.

3. Adjust pinion gear to ring gear engagement (see "Pinion Gear to Ring Gear Engagement" in this section of this manual).

4. Adjust pinion gear to ring gear backlash (see "Pinion Gear to Ring Gear Engagement" in this section of this manual). Backlash can be checked by removing the differential inspection cover (Fig. 11).

PINION GEAR TO RING GEAR BACKLASH:
0.003 to 0.010 in. (0.08 to 0.25 mm)

5. Tighten pinion gear case bolts to 16 to 20 ft-lbs (22 to 27 Nm).

6. Install knuckle pin, needle bearing, washer, spacer, and inner bevel gear in gearbox housing (Fig. 12). Install bearing and bearing retainer to gearbox housing and tighten bolts evenly to 6 to 8 ft-lbs (8 to 11 Nm).

7. Align gearbox housing, knuckle housing, and knuckle arm. Install knuckle arm bolts (Fig. 12).

8. Install outer bevel gear and knuckle cover to knuckle housing (Fig. 12). Use medium strength Loctite thread locker and evenly tighten the cover bolts to 12 to 20 ft-lbs (16 to 27 Nm).

9. Assemble outer axle shaft and bevel gear to knuckle cover (Fig. 12). Use medium strength Loctite thread locker and evenly tighten the cover bolts to 12 to 20 ft-lbs (16 to 27 Nm).

Note: The top two (2) bolts used to attach the outer axle shaft knuckle cover are shorter than the remainder of the cover bolts.

10. Assemble axles and axle tubes to gearbox housings.

11. Install axles and axle tubes to differential housing.

12. Install axle assembly (see 4WD Rear Axle Installation in this section of this manual).

Pinion Gear to Ring Gear Engagement

Final position of pinion is verified by using the gear contact pattern method as described in the following procedure.

GEAR TOOTH DEFINITIONS (Fig. 13):

Toe−the portion of the tooth surface at the end towards the center.

Heel−the portion of the gear tooth at the outer end.

Top Land−top surface of tooth.

1. Paint the teeth of the ring gear, both drive and coast side, with a gear marking compound, such as DyKem® Steel Blue.

2. Install the pinion gear assembly.

3. While applying a light load to the ring gear, rotate the pinion gear until the ring gear has made one complete revolution. The drive side pattern should be located at the toe portion of the tooth. The coast pattern should also be at the toe portion of the tooth (Fig. 14).

Ideal tooth contact should cover more than 35% of each tooth surface. The contact area should be in the center of each tooth and extent 1/3 to 1/2 way across each tooth from the toe end.

Adjustments to the gear engagement are made by moving the input shaft/pinion gear (bearing case shims) or by moving the differential gear case (differential bearing shims) (Fig. 15).

Note: Bearing case shims are available in 0.004 in. (0.1 mm), 0.006 in. (0.15 mm), 0.032 in. (0.8 mm), 0.040 in. (1.0 mm), and 0.048 in. (1.2 mm) thickness

Note: Differential bearing shims are available in 0.004 in. (0.1 mm), 0.006 in. (0.15 mm), 0.032 in. (0.8 mm), 0.040 in. (1.0 mm), and 0.048 in. (1.2 mm) thickness.

Study the different contact patterns (Fig. 16 − 18) and correct engagement as necessary.

NOTE: When making changes, note that two variables are involved (see Gear Pattern Movement Summary in this section of this manual).

Example: If you have the backlash set correctly to specifications and you change the pinion position shim, you may have to readjust backlash to the correct specification before checking the pattern.

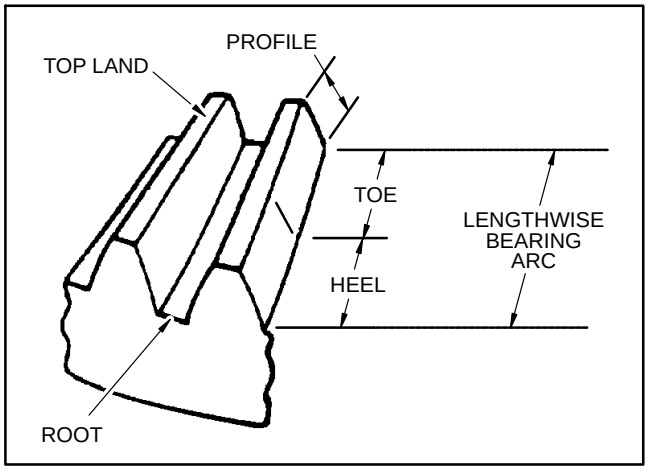


Figure 13

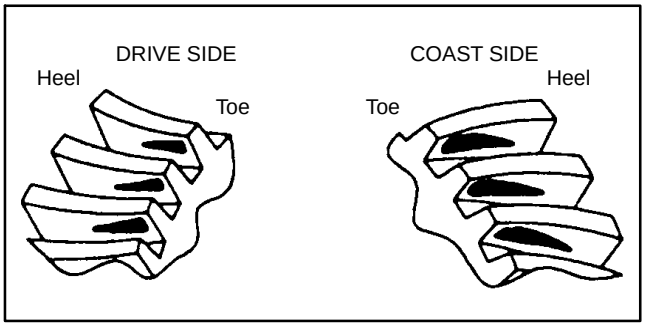


Figure 14

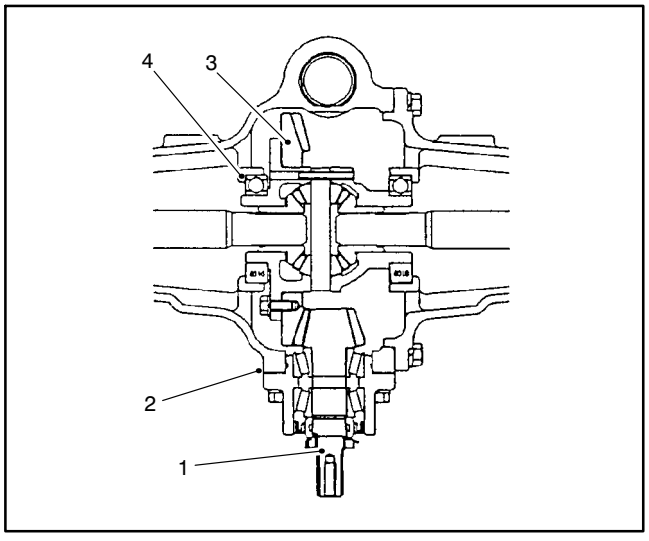


Figure 15

1. **Input shaft/pinion gear**
2. **Bearing case shims**
3. **Differential gear case**
4. **Differential bearing shims**

Every gear has a characteristic pattern. The illustrations show typical patterns only and explain how patterns shift as gear location is changed. When making pinion position changes, shims should be changed in the range of .002 inch to .004 inch until a correct pattern has been obtained.

When a change in backlash is required, backlash shims should be changed in the range of 1-1/2 times the amount of backlash required to bring the gears into specification. For example, if the backlash needed to be changed by .004 inch, the shim pack should be changed by .006 inch as a starting point.

High backlash is corrected by moving the ring gear closer to the pinion. Low backlash is corrected by moving the ring gear away from the pinion. These corrections are made by switching shims from one side of the differential case to the other.

Example 1: Backlash correct. Thicker pinion position shims required (Fig. 16).

Example 2: Backlash correct. Thinner pinion position shims required (Fig. 17).

Example 3: Backlash incorrect. Thinner pinion position shim required. Adjust backlash to match (Fig. 18).

Gear Pattern Movement Summary

A. Decreasing backlash moves the ring gear closer to the pinion.

Drive pattern (convex side of gear) moves lower and toward toe.

Coast pattern (concave side of gear) moves slightly higher and toward heel.

B. Increasing backlash moves the ring gear away from the pinion.

Drive pattern (convex side of gear) moves higher and toward heel.

Coast pattern (concave side of gear) moves slightly lower and toward toe.

C. Thicker pinion position shim with the backlash constant moves the pinion closer to the ring gear.

Coast pattern (concave side of gear) moves deeper on the tooth and toward heel.

D. Thinner pinion position shim with backlash constant moves the pinion further from the ring gear.

Drive pattern (convex side of gear) moves toward the top of the tooth (face contact) and toward heel.

Coast pattern (concave side of gear) moves toward the top of the tooth (face contact) and toward heel.

Drive pattern (convex side of gear) moves deeper on the tooth (flank contact) and slightly toward toe.

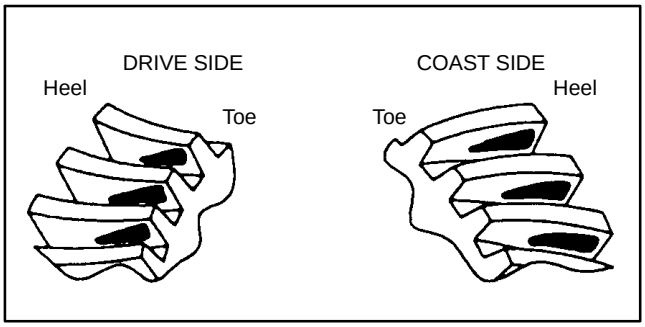


Figure 16

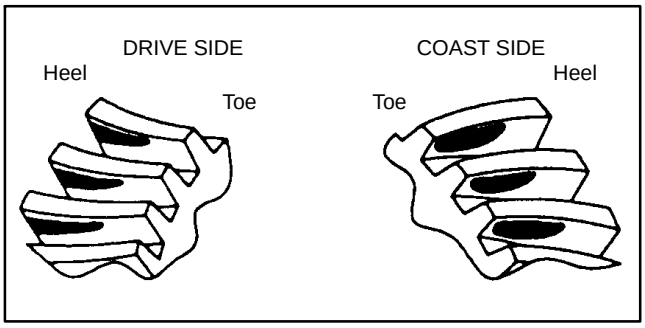


Figure 17

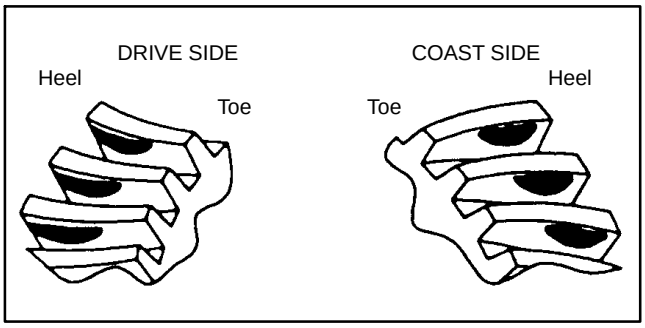


Figure 18

Chapter 9.1
Unit Serial No. 200000001 & Up

4WD Rear Axle

Table of Contents

Note: For Unit Serial No. 80001 - 9999, see Chapter 9 “4WD Rear Axle” in this manual.

Rear Axle and Overrunning Clutch Operation

The following explanation is intended to clarify the operation of the 4WD rear axle and overrunning clutch used with this TORO product.

A drive shaft connected to the front axle provides power to the rear 4WD axle. The drive shaft incorporates an overrunning clutch that transfers power in the forward direction only (Fig. 1).

Front and rear axle gear ratios and tire sizes were carefully selected so during normal operation, the rear axle input shaft turns slightly faster than the rear axle drive shaft.

Note: The Four-Matic overrunning clutch may not operate properly if different size tires are used, or if correct tire pressure is not maintained.

Any time the front wheels begin to slip (climbing a steep hill), the forward movement of the traction unit slows. In this condition the rear axle input shaft speed also slows. As soon as the rear axle input shaft turns at the same speed as the drive shaft, the clutch will engage and power is transferred to the rear axle (Fig. 2). The result is automatic four wheel drive.

When the traction unit is turning, the rear wheels swing at a larger arc and must travel faster than the front wheels (Fig. 3). In this condition, the rear axle input shaft is turning faster than the rear axle drive shaft and the clutch in disengaged (overrunning).

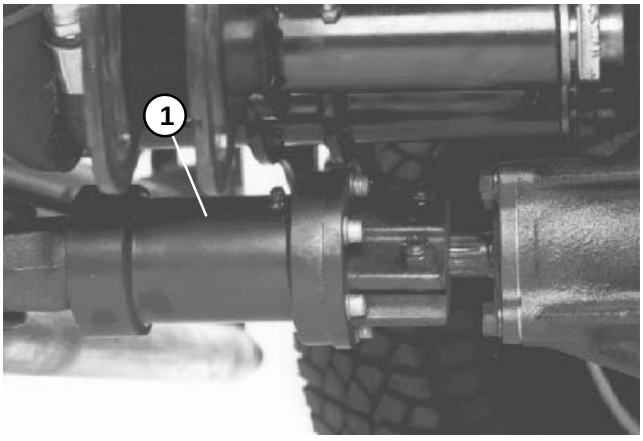


Figure 1

1. Four-Matic overrunning clutch

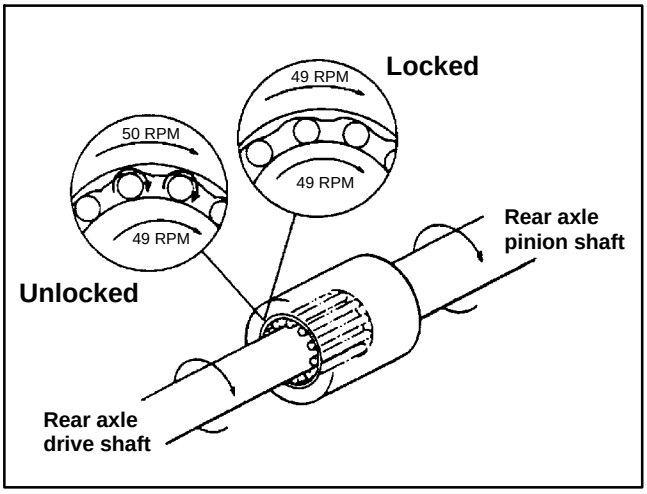


Figure 2

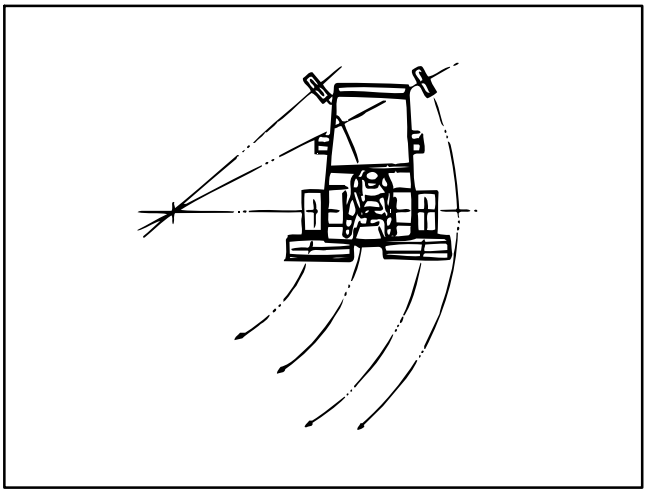


Figure 3

Specifications

Item	Specification
Rear wheel lug nut torque	30 to 35 ft-lbs. (41 to 47 Nm)
Rear wheel toe-in	0.000 to 0.125 in. (0.0 to 3.0 mm)
Tire pressure (front and rear)	10 to 15 psi. (0.69 to 1.03 Bar)
Axle lubricant	SAE GL-5 80W90 gear lube
Four-Matic™ overrunning clutch lubricant	No. 2 general purpose lithium grease

Changing Rear Axle Lubricant

Rear axle lubricant should be changed every 800 hours of operation. There are 3 separate oil reservoirs (axle support, right gear case, and left gear case) that require draining and refilling with SAE GL-5 80W90 gear lube.

1. Position machine on a level surface.

2. Clean area around the drain plugs.

3. Remove plugs allowing oil to drain into drain pans (Fig. 4).

4. After oil is drained, apply thread locking compound to all drain plug threads and reinstall.

5. Remove axle support check plug and fill plug. Add enough lubricant to bring the level up to the bottom of the center check plug hole (Fig. 5).

6. Remove each gear case check plug. Add enough lubricant to bring the level up to the bottom of each check plug hole (Fig. 6).

7. Install all plugs.

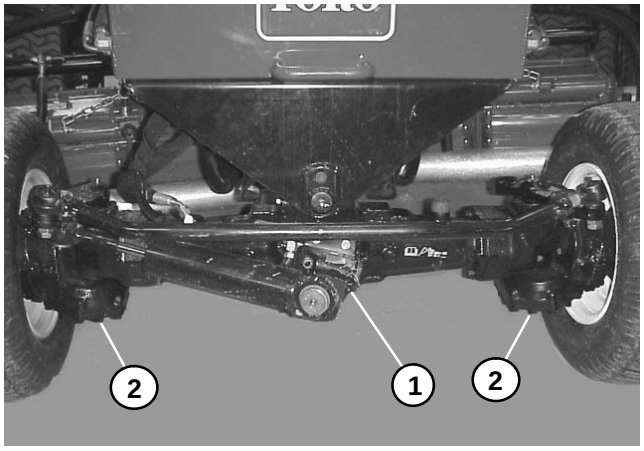


Figure 4

1. Axle support drain plug **2. Gear case drain plug**

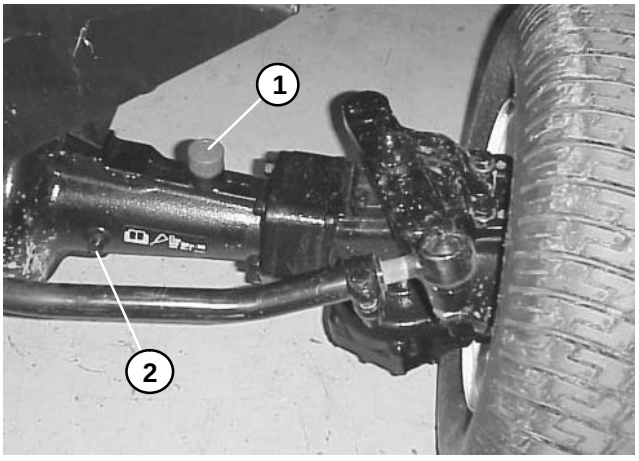


Figure 5

1. Check plug **2. Fill plug**

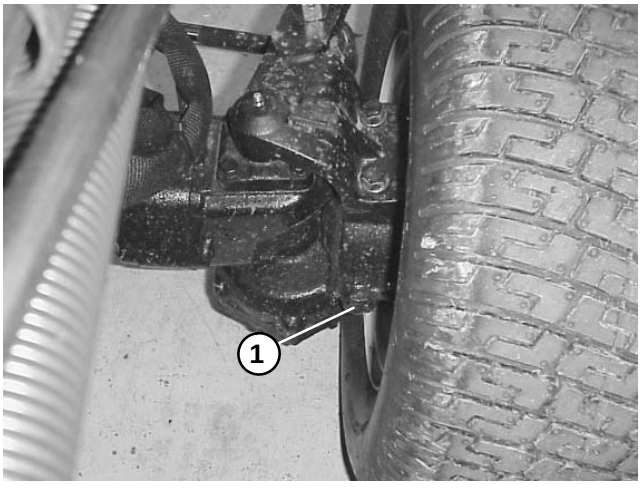


Figure 6

1. Check plug

Drive Shaft

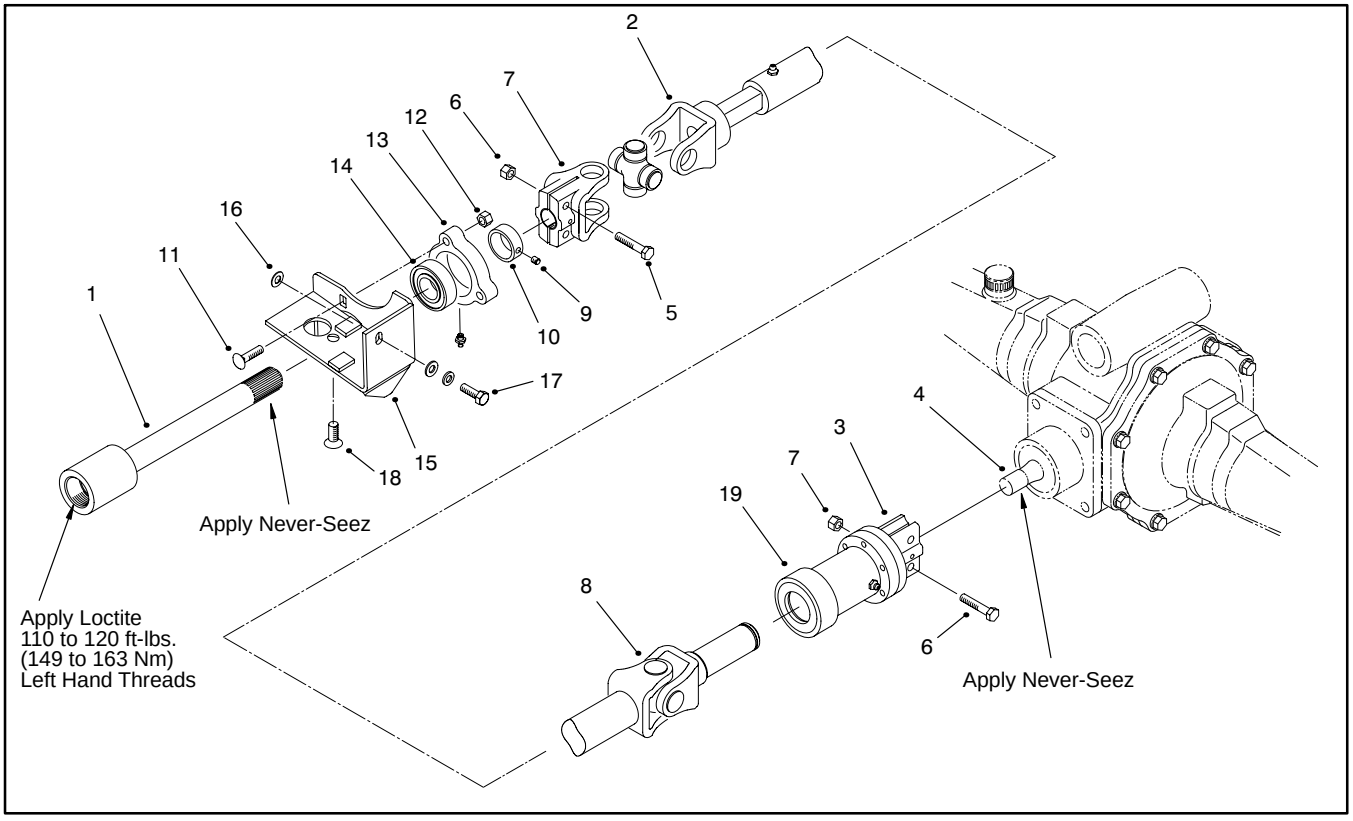


Figure 7

1. **Traction shaft**
2. **Slip yoke**
3. **Axle coupling**
4. **Rear axle input shaft**
5. **Capscrew**
6. **Locknut**
7. **End yoke**
8. **Drive shaft assembly**
9. **Set screw**
10. **Bearing collar**
11. **Carriage bolt**
12. **Locknut**
13. **Bearing support**
14. **Bearing**
15. **Bearing bracket**
16. **Shim**
17. **Capscrew**
18. **Socket head screw**
19. **Four-Matic clutch**

Removal

1. Position machine on a level surface, lower cutting units, stop engine and remove ignition key from switch. Block front wheels to prevent the machine from moving.

2. If front axle or traction shaft will be removed for repairs, loosen traction shaft before removing the drive shaft. Use an open end wrench on the square slip yoke shaft and turn the shaft in a clockwise (left hand threads) direction (Fig. 7).

3. Raise the rear axle off the ground.

4. Loosen capscrews and locknuts securing axle coupling to rear axle input shaft, and slide coupling off shaft.

5. Loosen capscrews and locknuts securing end yoke to traction shaft, and slide drive shaft assembly off traction shaft (Fig. 7).

6. If front axle or traction shaft will be removed for repairs:

   A. Loosen the set screws in the bearing locking collar. Use a hammer and punch to loosen the collar by rotating it in a counterclockwise direction (Fig. 7).

   B. Remove the carriage bolts and locknuts securing the bearing support to the bracket. Remove the bearing and bearing support (Fig. 7).

   C. Remove the traction shaft from the front axle by continuing to turn it in a clockwise (left hand threads) direction.

   D. Remove bearing bracket (Fig. 7). Record number of shims used between side of bracket and transmission.

Installation

1. If front axle or traction shaft was removed:

   A. Apply medium strength Loctite to coupler output shaft on rear of hydrostatic.

   B. Slide traction shaft through bearing bracket, aligning the (2) bearing bracket mounting holes with the holes in side and bottom of hydrostatic (Fig. 8).

   C. Mount side of bracket to hydrostat with a capscrew, lockwasher, flat washer and 1 or 2 shims (Fig. 8).

   D. Place top carriage bolt in bearing bracket and mount bottom of bearing bracket to hydrostat with socket head screw.

   Note: Determine whether 1 or 2 shims are required between bracket and hydrostat before tightening any fasteners. After shim(s) are in position on capscrew, tighten socket head bolt and capscrew.

   E. Thread traction shaft (left hand thread) all the way onto coupler output shaft.

   F. Mount bearing assembly to bearing bracket with carriage bolts and locknuts. Tighten lock nuts.

   G. Slide locking collar onto traction shaft.

2. Apply never-seize to splines of traction shaft and rear axle input shaft.

3. Slide clutch end of drive shaft assembly onto shaft. Tighten axle coupling capscrews and locknuts (Fig. 7).

4. Slide end yoke of drive shaft assembly onto traction shaft and tighten end yoke capscrews and locknuts (Fig. 7).

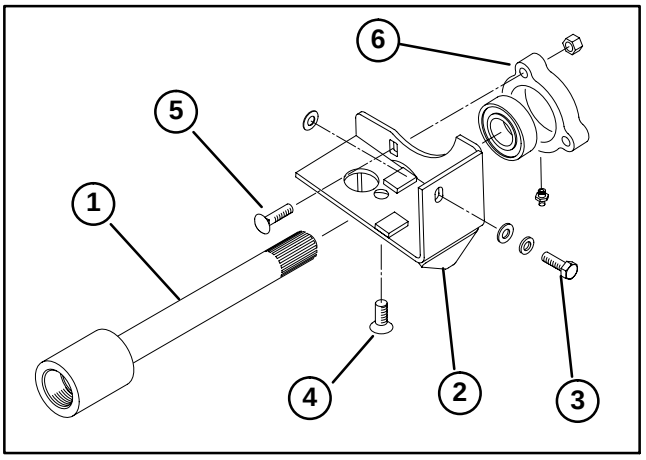


Figure 8

1. **Traction shaft**
2. **Bearing bracket**
3. **Capscrew**
4. **Socket head screw**
5. **Carriage bolt**
6. **Bearing assembly**

5. If front axle or traction shaft was removed:

   A. Block front wheels to prevent the machine from moving.

   B. Jack up the rear of the machine until there is about 1 in. (25 mm) clearance between the rear tires and the ground. SECURELY SUPPORT THE VEHICLE FRAME.

   C. Use an open end wrench on the square slip yoke shaft and turn the shaft in a counterclockwise (left hand threads) direction. Tighten shaft to 110 to 120 ft-lbs. (149 to 163 Nm).

   D. Tighten locking collar to traction shaft by carefully rotating it in a clockwise direction with a hammer and punch. Tighten collar set screws (Fig. 7).

Overrunning Clutch

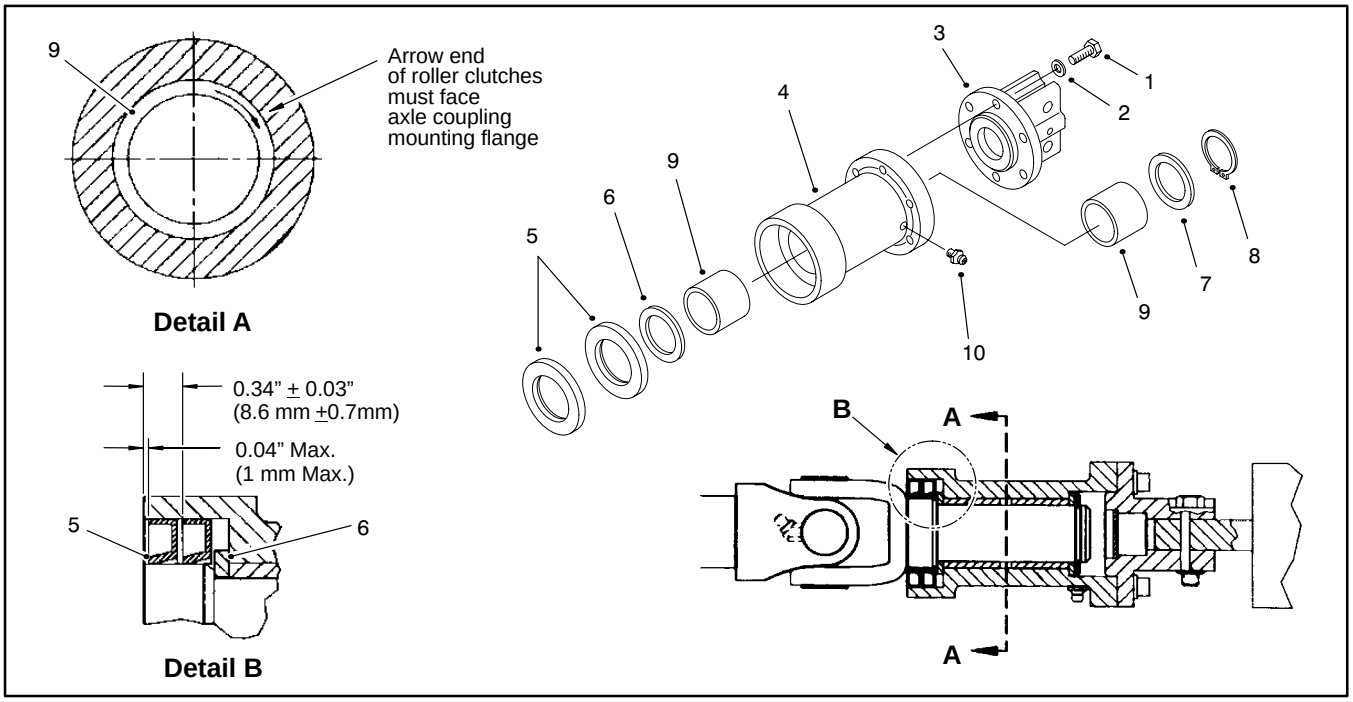


Figure 9

1. **Capscrew**
2. **Lock washer**
3. **Axle coupling**
4. **Clutch housing**
5. **Shaft seal**
6. **Inner thrust washer**
7. **Outer thrust washer**
8. **Retaining ring**
9. **Roller clutch**
10. **Grease fitting**

Removal

1. Remove drive shaft (see Drive Shaft Service in this section of this manual).

2. Remove the capscrews and lock washers securing the axle coupling to the clutch and remove the coupling (Fig. 9).

3. Remove the retaining ring from the yoke shaft and slide the clutch assembly off the yoke shaft (Fig. 9).

4. Remove and discard shaft seals.

5. Clean and inspect all clutch components for damage and wear. Replace parts as necessary.

Installation

1. Install roller clutches in clutch housing.

   A. Each roller clutch must be .000 to .040 in. (0.00 to 1.00 mm) below the shoulder at each end of clutch housing bore.

   B. Each roller clutch must be installed with arrow stamped end toward axle coupling mounting flange (Fig. 9 Detail A).

2. Install inner thrust washer.

3. Press both seals into clutch housing to dimensions shown (Fig. 9 Detail B). Seals must be installed with lip facing out.

4. Slide clutch assembly onto yoke shaft and install outer thrust washer and retaining ring (Fig. 9).

5. Secure axle coupling to clutch housing with capscrews and lock washers. Tighten capscrews evenly.

6. Lubricate clutch through grease fitting with No.2 general purpose lithium grease.

7. Install drive shaft (see Drive Shaft Service in this section of this manual).

4WD Rear Axle

Note: For information on 2WD rear axle service and repairs, see Chapter 7−Steering and Brakes in this manual.

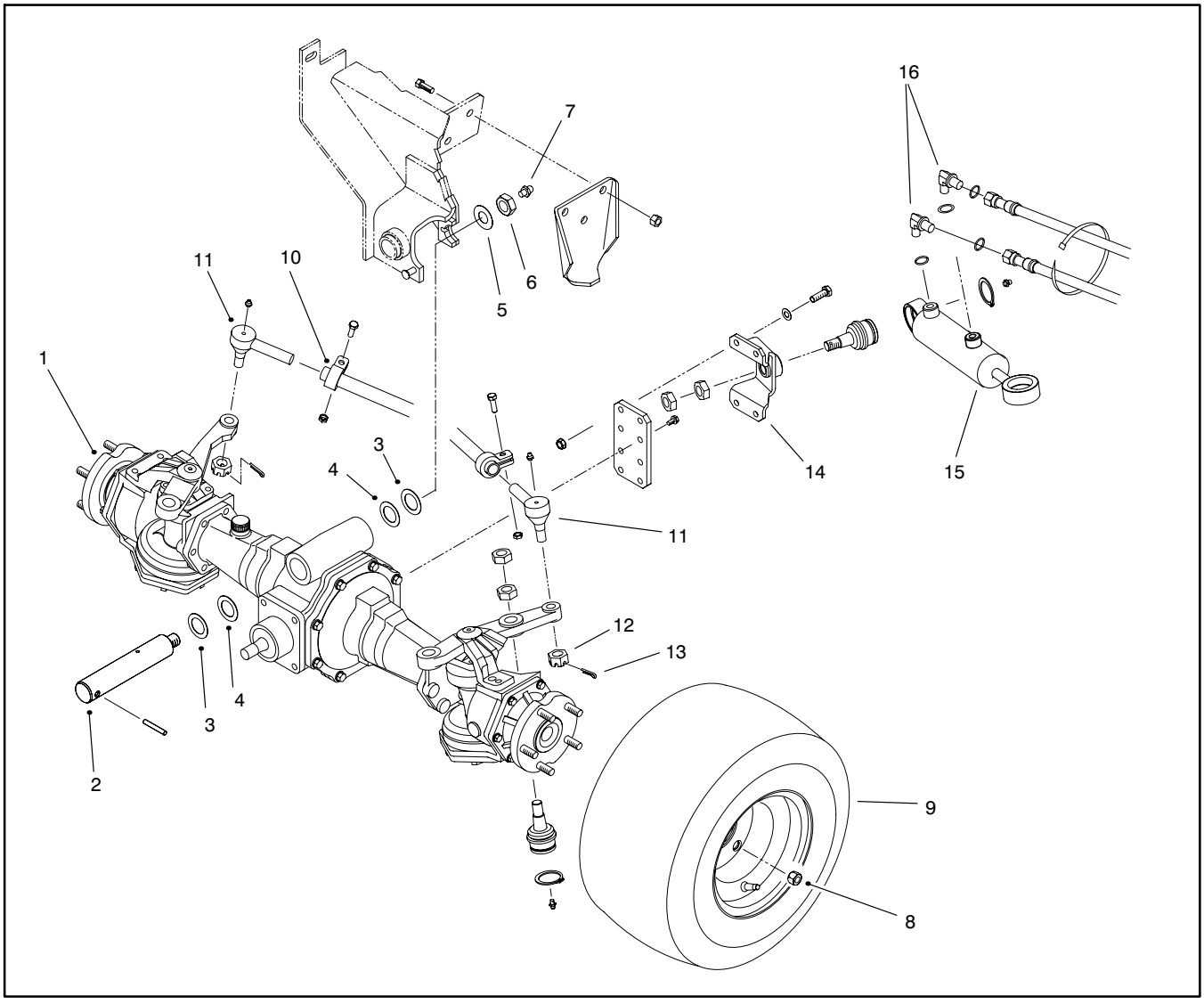


Figure 10

1. **Rear axle assembly**
2. **Pivot pin**
3. **Thrust washer**
4. **Thrust washer**
5. **Thrust washer**
6. **Jam nut**
7. **Grease fitting**
8. **Lug nut**
9. **Rear wheel & tire**
10. **Tie rod assembly**
11. **Tie rod ball joints**
12. **Slotted hex nut**
13. **Cotter pin**
14. **Cylinder mounting bracket**
15. **Steering cylinder**
16. **Hydraulic hoses**

Removal

1. Remove rear axle drive shaft (see Drive Shaft in this section of this manual).

2. Drain rear axle lubricant (see Changing Rear Axle Lubricant in this section of this manual).

3. Thoroughly clean the steering cylinder hydraulic hose connections. Disconnect the hydraulic hoses from the steering cylinder. Put caps or plugs on all the fittings and hoses to prevent contamination.

Note: To ease reassembly, tag each of the hoses to show their correct position on the steering cylinder.

4. Remove steering cylinder (see Chapter 7−Brakes and Steering in this manual).

5. Remove the cotter pins and slotted hex nuts from the tie rod ball joints. Use a ball joint fork and remove the ball joints from the axle case supports.

6. Loosen the rear wheel lug nuts.

7. Remove the jamnut and thrust washer securing the end of the axle pivot pin to the chassis (Fig. 10).

8. Block the front wheels and jack up the frame (just ahead of the rear wheels) until the rear tire is about 1 in. (25 mm) above the floor. Support the machine with jack stands to prevent it from falling.

9. Remove rear wheels.

10. Support the rear axle from underneath and remove the axle pivot pin. This will release the rear axle and washer(s) from the frame, allowing the axle to be lowered and removed.

Note: Several washers may have been installed between the axle pivot tube and frame during manufacture. Make sure the same number of washers are installed in the same location during reassembly.

11. Wipe the rear axle pivot pin and pivot bushings with a rag to remove dirt and grease. Inspect the pin and bushings for wear or damage. Replace components as necessary.

Installation

1. Apply a thin coat of grease to the inside of the rear axle pivot bushings and move the rear axle assembly into position under machine frame.

2. Install washer(s) and axle pivot pin. Secure the axle pivot pin in place with the thrust washer and jamnut (Fig. 10).

1. Install the tie rod ball joints. Tighten ball joint hex nuts and install new cotter pins.

2. Install steering cylinder (see Chapter 7−Brakes and Steering in this manual).

3. Install rear wheels and lug nuts.

4. Remove the jackstands and lower the machine to the floor.

5. Tighten rear wheel lug nuts to 30 to 35 ft-lbs. (41 to 47 Nm).

6. Lubricate the rear axle pivot bushings through the grease fitting on the pivot pin.

7. Fill rear axle with lubricant (see Changing Rear Axle Lubricant in this section of this manual).

8. Install rear axle drive shaft (see Drive Shaft in this section of this manual).

9. Install the hydraulic hoses to the steering cylinder.

10. Check steering cylinder hydraulic connections for leaks.

11. Check steering stop bolt adjustment. When the steering cylinder is fully extended in either direction, a gap of 1/16” (1.6 mm) should exist between bevel gear case casting and stop bolt on left axle case. Figure 11 shows stop bolt location.

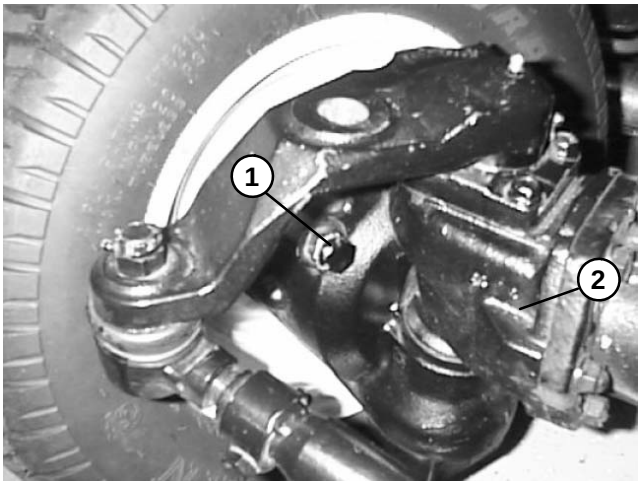


Figure 11

1. Steering stop bolt
2. Bevel gear case (LH)

Bevel Gear Case and Axle Case

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

1. Remove the mounting screws, nuts, and lock washers. Remove the bevel gear case/axle case assembly and O-ring from the axle support (Fig. 12).

2. Mark both right and left bevel gear case/axle case assemblies.

IMPORTANT: Do not interchange right and left bevel gear case/axle case assemblies.

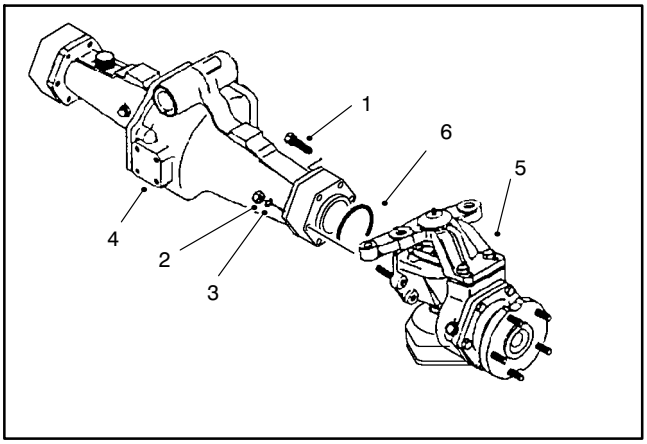


Figure 12

1. **Cap screw**
2. **Lock nut**
3. **Lock washer**
4. **Axle support**
5. **Bevel gear case/axle case assembly**
6. **O-ring**

3. Remove the axle cover mounting screws. Remove the axle cover from the axle case as an assembly (Fig. 13).

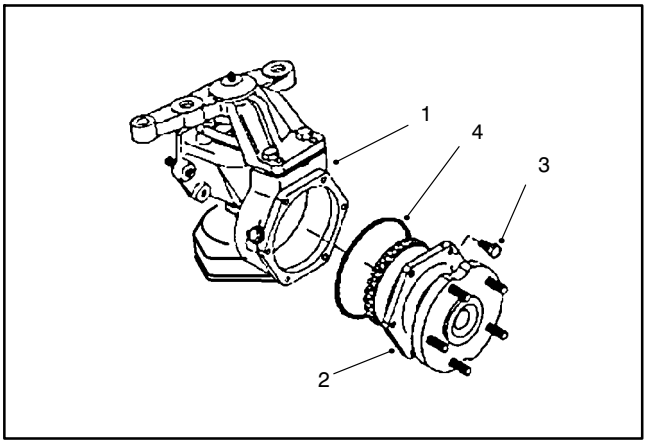


Figure 13

1. **Axle case**
2. **Axle cover assembly**
3. **Mounting screw**
4. **O-ring**

4. Remove the axle case support mounting screws, the axle case support, and the support shims (Fig. 14).

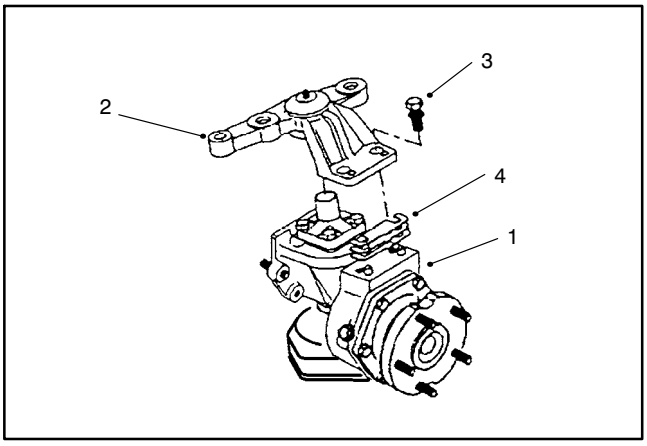


Figure 14

1. **Axle case**
2. **Axle case support**
3. **Mounting screw**
4. **Support shim**

5. Remove the knuckle pin mounting screws and the knuckle pin. Remove the gasket and any remaining gasket material from either mating surface (Fig. 15).

6. While holding the bevel gear case, lightly tap the upper end of the bevel gear shaft out of the upper bearing and upper bevel gear.

7. Pull the bevel gear case from the axle case and remove the upper bevel gear, collar, spacer, and thrust washer from the gear case.

8. Remove the axle case cover screws, cover, and the O-ring from the axle case.

9. Remove the plug and sealing washer from the center of the axle case cover. While holding the axle case cover, lightly tap the lower end of the bevel gear shaft out of the lower bearing and lower bevel gear.

10. Remove and discard bevel gear shaft seals from bevel gear case and axle case (Fig. 15).

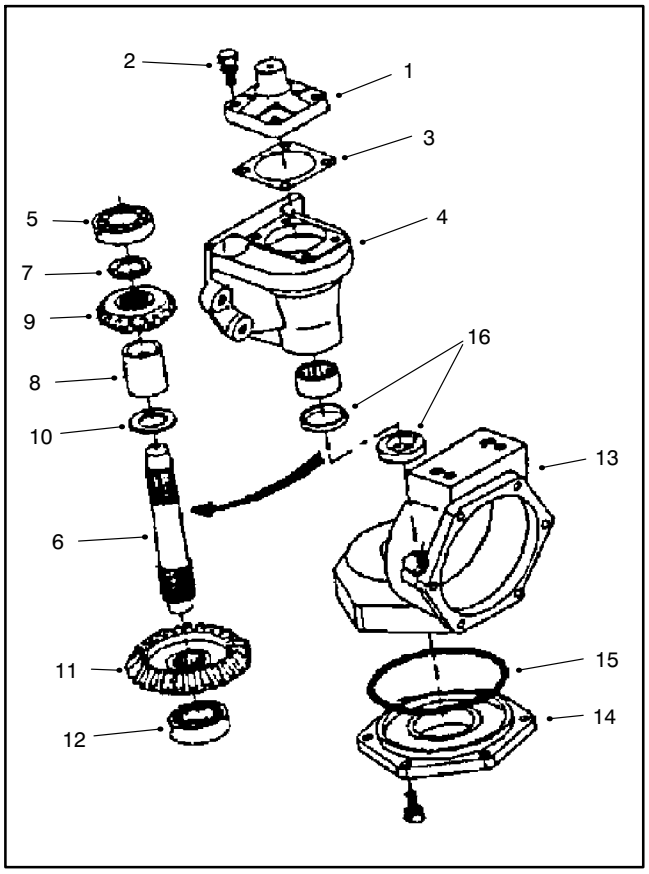


Figure 15

1. **Knuckle pin**
2. **Mounting screw**
3. **Gasket**
4. **Bevel gear case**
5. **Upper bearing**
6. **Bevel gear shaft**
7. **Collar**
8. **Spacer**
9. **Upper bevel gear**
10. **Thrust washer**
11. **Lower bevel gear**
12. **Lower bearing**
13. **Axle case**
14. **Axle case cover**
15. **O-ring**
16. **Shaft seals**

Inspection

1. Measure the knuckle pin O.D. and the axle case support bushing I.D. to determine the bushing to pin clearance (Fig. 16). Replace components as necessary.

BUSHING TO PIN CLEARANCE:
0.002 to 0.016 in. (0.05 to 0.40 mm)

KNUCKLE PIN O.D. (Factory Spec.):
0.982 to 0.983 in. (24.95 to 24.98 mm)

AXLE CASE SUPPORT BUSHING I.D.
(Factory Spec.):
0.984 to 0.987 in. (25.00 to 25.08 mm)

2. Inspect all gears, shafts, bearings, cases, and covers for damage and wear. Replace components as necessary.

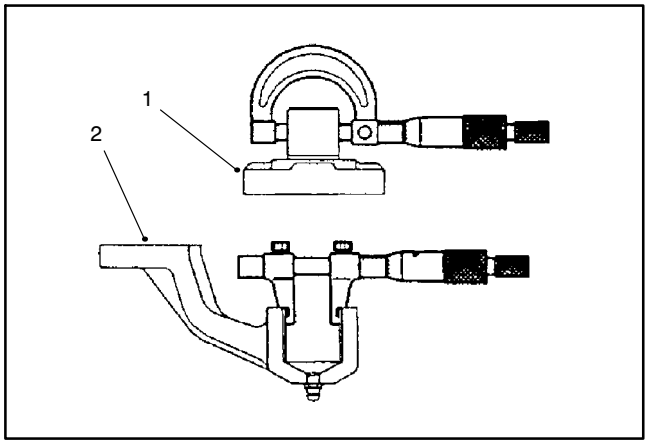


Figure 16

1. **Knuckle pin**
2. **Axle case support**

Installation

1. Coat new shaft seals with grease and install in axle case and bevel gear case as shown (Fig. 17).

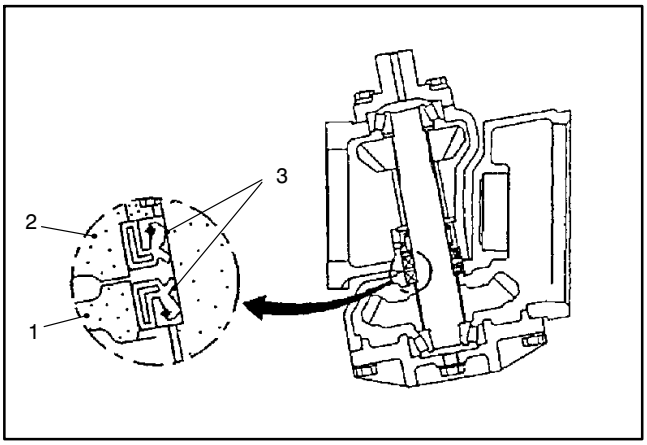


Figure 17

1. **Axle case**
2. **Bevel gear case**
3. **Shaft seal**

2. Install the lower bevel gear, and bevel gear shaft in the axle case cover. Coat a new O-ring with grease and install the axle case cover (Fig. 18). Tighten cover screws to 17 to 20 ft-lbs. (23 to 27 Nm).

3. Slide the bevel gear case over the bevel gear shaft and install the thrust washer, spacer, bevel gear, and collar. Make sure the bevel gear shaft is completely seated in the upper and lower bearings (Fig. 18).

4. Install the knuckle pin. Use medium strength Loctite thread locker and tighten the knuckle pin mounting screws to 17 to 20 ft-lbs. (23 to 27 Nm).

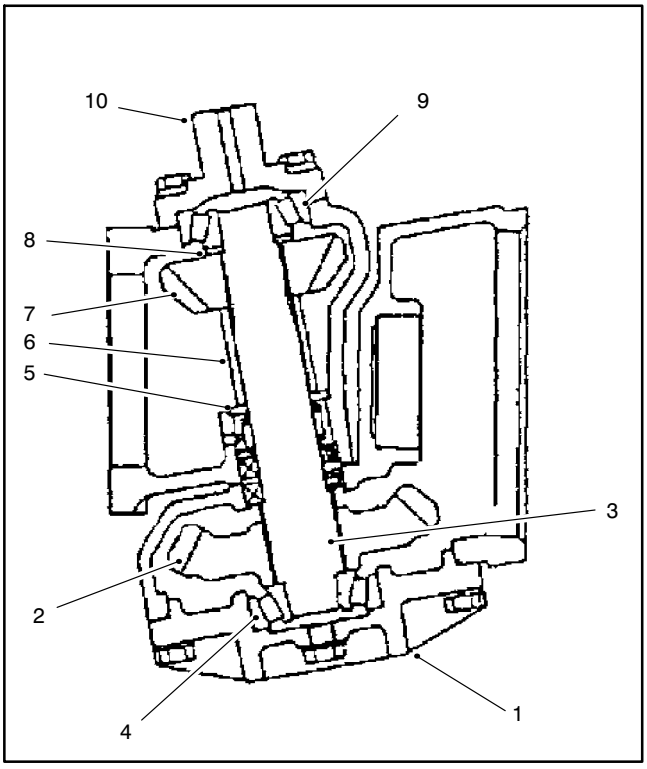


Figure 18

1. **Axle case cover**
2. **Lower bevel gear**
3. **Bevel gear shaft**
4. **Lower bearing**
5. **Thrust washer**
6. **Spacer**
7. **Upper bevel gear**
8. **Collar**
9. **Upper bearing**
10. **Knuckle pin**

5. Determine necessary quantity of support shims.

A. Lubricate the axle case support bushing with a thin coat of grease and slide axle case support onto knuckle pin.

B. Position support shims that were removed during disassembly between axle case support and axle case. Install mounting screws into axle case. Slowly tighten screws while frequently checking for clearance (vertical endplay) between axle case support and knuckle pin. If binding of components is noted before screws are fully tightened, add additional support shims. Torque screws from 57 to 67 ft−lb (77 to 91 N−m).

C. Use dial indicator to measure vertical endplay of axle case (Fig. 19).

AXLE CASE ASSEMBLY ENDPLAY:
0.001 to 0.008 in. (0.02 to 0.20 mm)

D. Adjust endplay by increasing or reducing number of axle case support shims.

NOTE: Axle case support shims are available in 0.004 in. (0.1 mm), 0.008 in. (0.2 mm), and 0.016 in. (0.4 mm) thickness.

6. After correct support shims have been determined, remove mounting screws, apply heavy strength thread−locking compound to screw threads, reinstall screws, and torque from 57 to 67 ft−lb (77 to 91 N−m).

IMPORTANT: Correct engagement between bevel gears is critical to axle performance and durability.

7. Temporarily install the bevel gear case/axle case assembly on the axle support. Position a dial indicator at the tooths center. Prevent the axle from turning and measure the upper bevel gear to differential shaft gear backlash (Fig. 20).

UPPER BEVEL GEAR BACKLASH:
0.004 to 0.016 in. (0.10 to 0.40 mm)

8. Adjust backlash by increasing or reducing axle bearing shim thickness (see Differential Shafts in this section of this manual).

NOTE: Axle bearing shims are available in 0.004 in. (0.1 mm), 0.008 in. (0.2 mm), and 0.020 in. (0.5 mm) thickness.

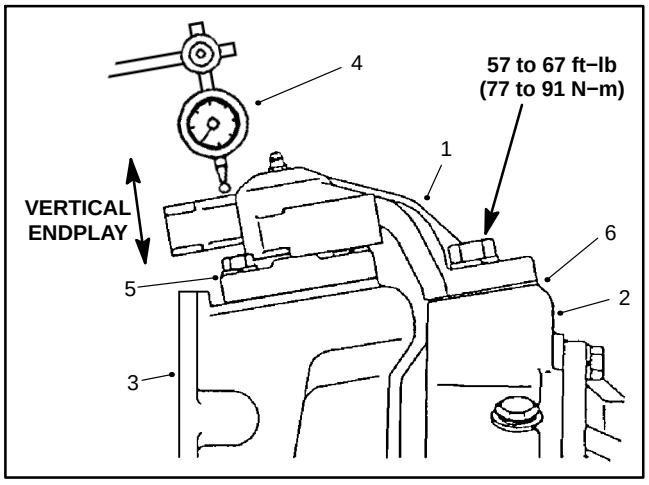


Figure 19

1. **Axle case support**
2. **Axle case**
3. **Bevel gearcase**
4. **Dial indicator**
5. **Knuckle pin**
6. **Support shim location**

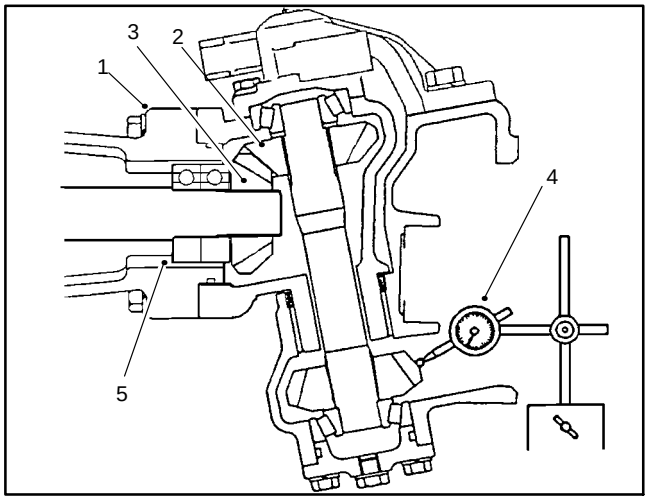


Figure 20

1. **Axle support**
2. **Upper bevel gear**
3. **Differential shaft gear**
4. **Dial indicator**
5. **Axle bearing shims**

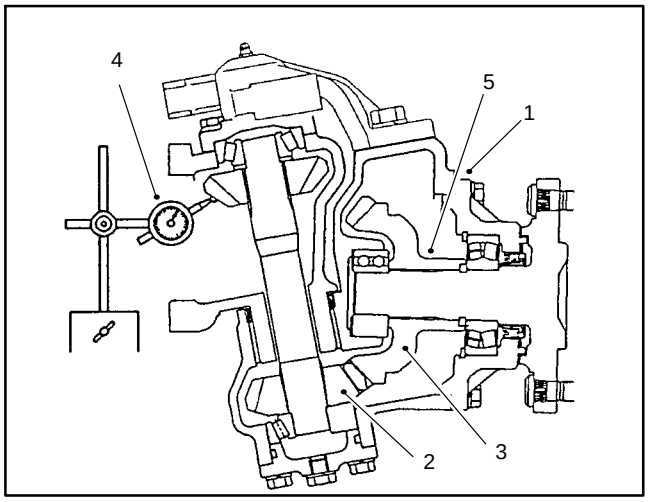


Figure 21

1. **Axle cover assembly**
2. **Lower bevel gear**
3. **Axle gear**
4. **Dial indicator**
5. **Axle bearing shims**

9. Remove the bevel gear case/axle case assembly from the axle support. Coat a new O-ring with grease and temporarily install the axle cover assembly. Position a dial indicator at the tooths center. Prevent the axle from turning and measure the lower bevel gear to axle gear backlash (Fig. 21).

LOWER BEVEL GEAR BACKLASH:
0.004 to 0.016 in. (0.10 to 0.40 mm)

10. Adjust backlash by increasing or reducing axle bearing shim thickness (see Axle Shafts in this section of this manual).

NOTE: Axle bearing shims are available in 0.008 in. (0.2 mm), 0.012 in. (0.3 mm), and 0.020 in. (0.5 mm) thickness.

11. Tighten axle cover screws from 17 to 20 ft-lb (23 to 27 N−m).

12. Coat a new O-ring with grease and install the bevel gear case/axle case assembly on the axle support. Tighten mounting screws and nuts from 35 to 41 ft-lb (47 to 56 N−m) (Fig. 12).

Differential Shafts

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

IMPORTANT: Do not interchange right and left differential shafts assemblies.

1. Remove the mounting screws, nuts, and lock washers. Remove the bevel gear case/axle case assembly and O-ring from the axle support (Fig. NO TAG).

2. Mark and pull the differential shaft assembly from the axle support.

3. Remove the retaining ring and bevel gear (Fig NO TAG).

4. Drive the differential shaft out of the bearings. Remove the bearings and bearing shims.

5. Inspect all gears, shafts, bearings, and cases for damage and wear. Replace components as necessary.

Installation

1. Press bearings onto differential shaft. Place correct combination of bearing shims in axle support and drive differential shaft and bearing assembly into axle support.

2. Install bevel gear and retaining ring.

3. Coat new O-ring with grease. Align differential shaft splines with differential gear assembly and slide differential shaft assembly onto axle support.

4. Install bevel gear case/axle case assembly (see Bevel Gear Case/Axle Case Assembly in this section of this manual).

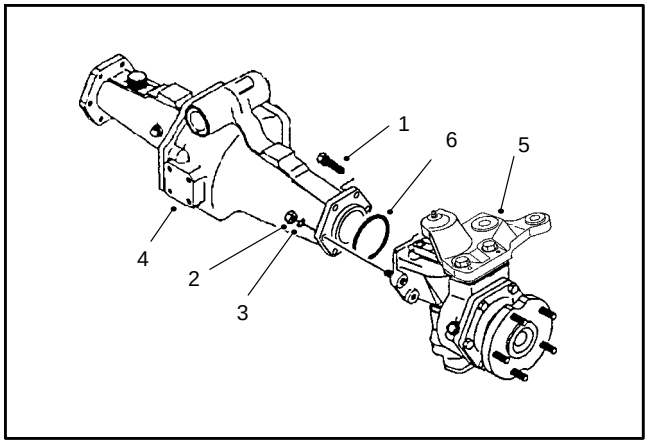


Figure 22

1. **Cap screw**
2. **Lock nut**
3. **Lock washer**
4. **Axle support**
5. **Bevel gear case/axle case assembly**
6. **O-ring**

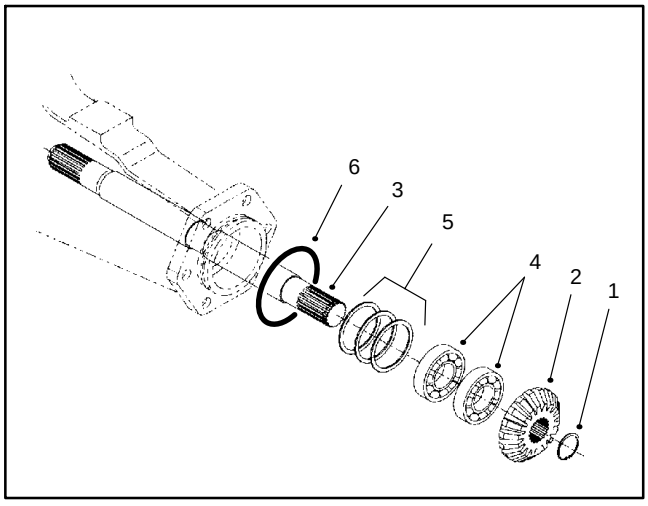


Figure 23

1. **Retaining ring**
2. **Bevel gear**
3. **Differential shaft**
4. **Bearing**
5. **Bearing shims**
6. **O-ring**

Axle Shafts

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

1. Remove the axle cover mounting screws. Remove the axle cover from the axle case as an assembly (Fig. 24).

2. Use a bearing puller to remove the bearing and bevel gear as shown (Fig. 25).

3. Remove the shims, spacer, and retaining ring. Drive the axle out of the bearing and cover. Remove and discard the axle shaft seal.

4. Inspect all gears, shafts, bearings, spacers, and cases for damage and wear. Replace components as necessary.

Installation

1. Coat new axle shaft seal with grease and install in axle cover as shown (Fig. 26).

2. Press the axle cover and bearing assembly onto the axle shaft. Press only on the inner race of the cover bearing (Fig. 26).

3. Install retaining ring, spacer, and correct combination of bearing shims. Install bevel gear and bearing.

4. Coat a new O-ring with grease and install the axle cover assembly. Tighten axle cover screws to 17 to 20 ft-lbs. (23 to 27 Nm).

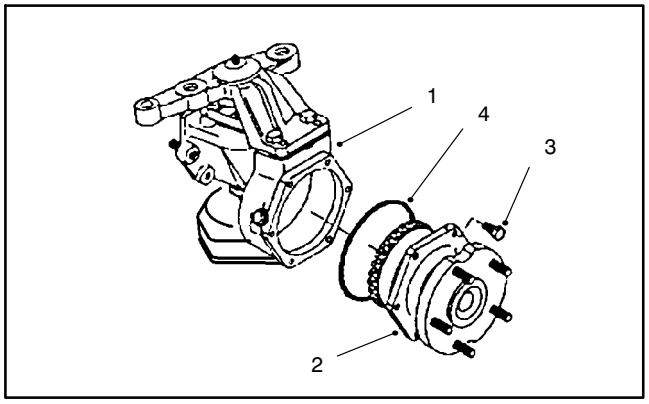


Figure 24

1. **Axle case**
2. **Axle cover assembly**
3. **Mounting screw**
4. **O-ring**

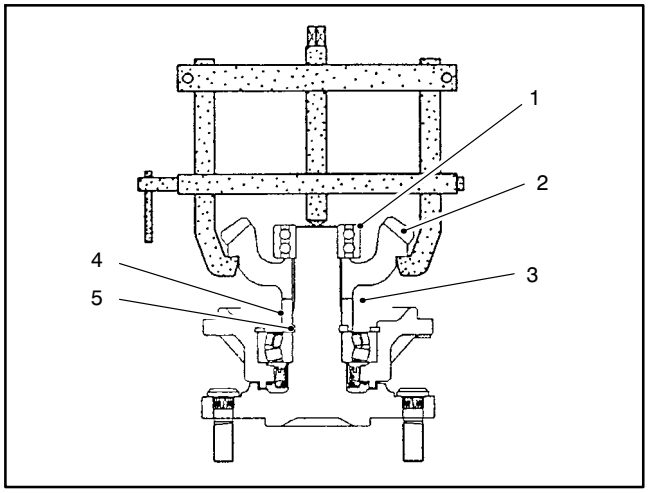


Figure 25

1. **Bearing**
2. **Bevel gear**
3. **Shims**
4. **Spacer**
5. **Retaining ring**

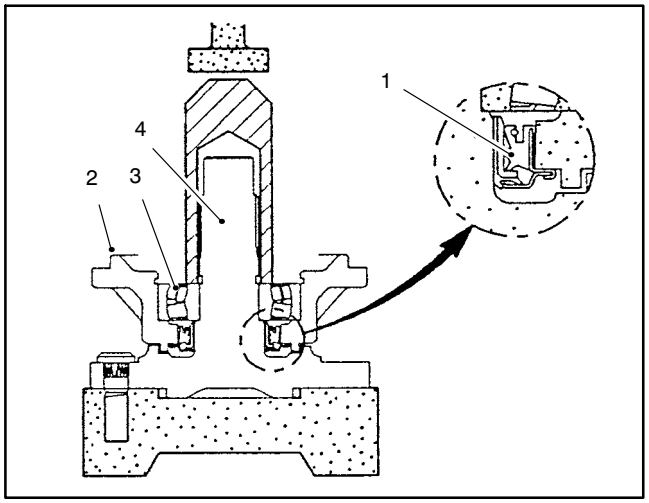


Figure 26

1. **Axle shaft seal**
2. **Axle cover**
3. **Bearing**
4. **Axle shaft**

Input Shaft/Pinion Gear

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

1. Remove input shaft/pinion gear assembly from the axle support. Remove the shims and bearing case O-ring.

2. Release the stake washer and remove the locknut. Remove and discard the stake washer (Fig. 27).

3. Drive the input shaft/pinion gear out from the outer bearing cone and bearing case. Remove and discard the oil seal and O-ring.

4. Inspect all gears, shafts, bearings, spacers, and cases for damage and wear. Replace components as necessary.

NOTE: Replacement input shaft/pinion gears are only available in matched ring and pinion sets.

Installation

NOTE: When installing new bearing cones, press only on the inner race of the bearing cone.

1. If the inner bearing cone was removed, press a new bearing cone all the way onto the input shaft/pinion gear.

2. Place the shaft and bearing assembly in the bearing case and install the outer bearing cone.

NOTE: The bearings must be completely seated. There should be no input shaft/pinion gear end play.

3. Coat a new oil seal with grease and install as shown (Fig. 28).

4. Coat a new O-ring with grease. Install O-ring in the oil seal collar, and install the collar.

5. Install a new stake washer. Install the lock nut finger tight.

6. Set the bearing preload be securing the bearing case in a vise. Thread a M12 x 1.5 hex. hd. capscrew into the splined end of the input shaft/pinion gear.

7. Slowly tighten the locknut until 4.0 to 6.0 in-lbs. (0.4 to 0.7 Nm) of force is required to rotate the input shaft/pinion gear in the bearing case.

8. Secure the lock nut with the stake washer.

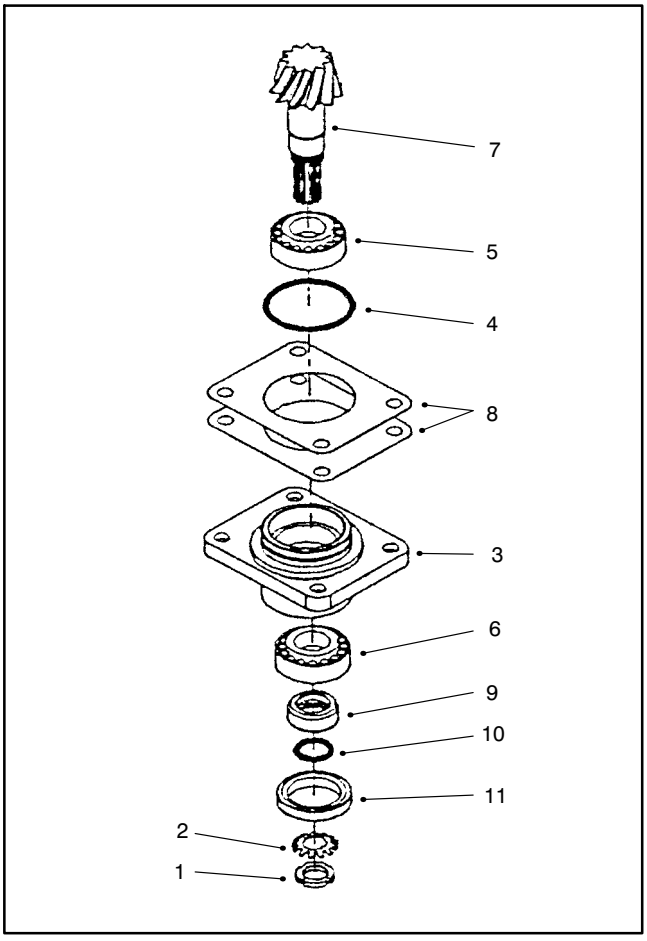


Figure 27

1. **Lock nut**
2. **Stake washer**
3. **Bearing case**
4. **Bearing case O-ring**
5. **Inner bearing**
6. **Outer bearing**
7. **Input shaft/pinion gear**
8. **Bearing case shims**
9. **Seal collar**
10. **O-ring**
11. **Oil seal**

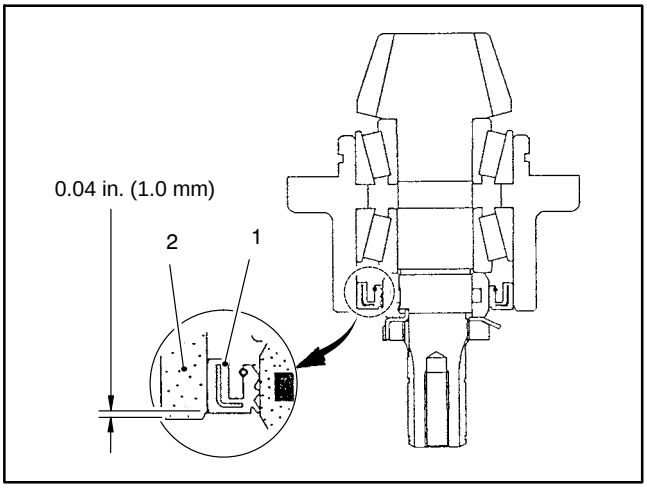


Figure 28

1. **Oil seal**
2. **Bearing case**

9. Use a depth gauge to measure the distance from the end face of the input shaft/pinion gear to the mating surface of the bearing case. Subtract the “Design Cone Center Distance” from this distance to determine initial shim thickness (Fig. 29).

DESIGN CONE CENTER DISTANCE
(distance from mating surface of axle support to end face of pinion gear):
1.870 ± 0.002 in. (47.5 ± 0.05 mm)

Note: Bearing case shims are available in 0.004 in. (0.1 mm) and 0.008 in. (0.2 mm) thickness.

10. Coat a new O-ring with grease. Place shims on the bearing case and temporarily install input shaft/pinion gear assembly into axle case. Tighten mounting screws to 35 to 41 ft-lbs. (47 to 56 Nm).

11. Insert a screwdriver through the drain plug hole to hold ring gear and measure the pinion gear to ring gear backlash (Fig. 30).

PINION GEAR TO RING GEAR BACKLASH:
0.004 to 0.016 in. (0.10 to 0.40 mm)

12. Adjust backlash by increasing or reducing bearing case shim thickness.

13. Check pinion gear to ring gear engagement (see Pinion Gear to Ring Gear Engagement in this section of this manual.

14. Place the correct combination of shims on the bearing case. Tighten mounting screws to 35 to 41 ft-lbs. (47 to 56 Nm).

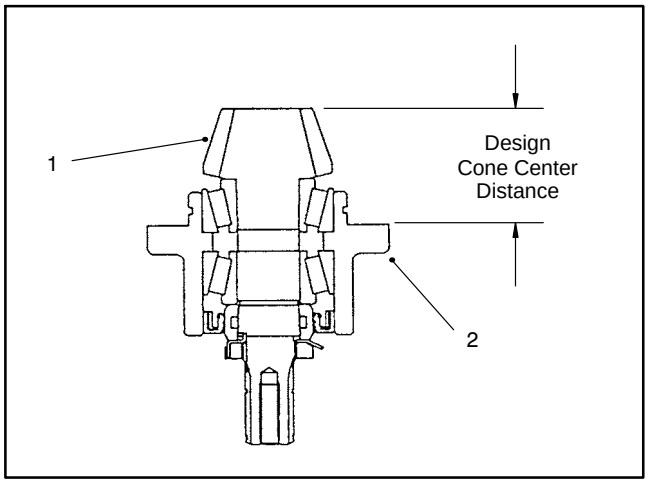


Figure 29

1. Input shaft/pinion gear **2. Bearing case**

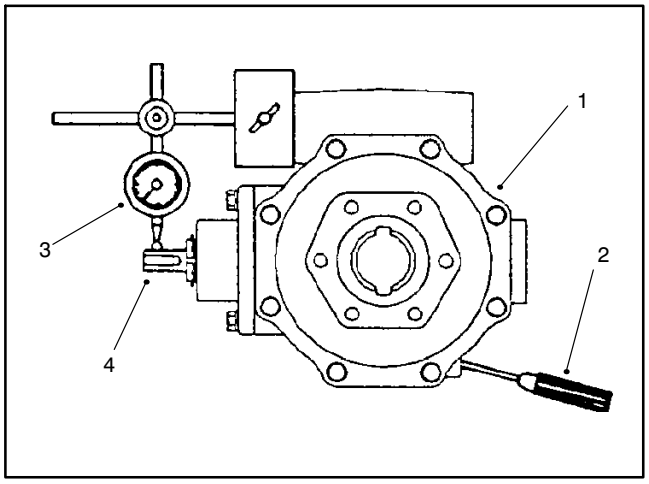


Figure 30

1. Axle case **3. Dial indicator**
2. Screwdriver **4. Input shaft/pinion gear**

Differential Gear

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

1. Remove bevel gear case/axle case assemblies (see Bevel Gear Case/Axle Case Assembly in this section of this manual).

IMPORTANT: Do not interchange right and left differential shafts assemblies.

2. Mark and pull the differential shaft assemblies from the axle support.

3. Remove input shaft/pinion gear assembly, shims, and O-ring from the axle support (Fig. 31).

4. Remove the axle support case screws. Separate the axle support halves and remove the O-ring.

5. Remove the differential gear assembly, bearings, and adjusting shims from the axle case.

6. Drive the spring pin from the differential case with a punch and hammer. Discard the spring pin (Fig. 32).

NOTE: Mark and arrange all components so they can be reassembled in their original position.

7. Remove the differential pinion shaft, pinion gears, and pinion washers. Remove the differential side gears and side gear shims. Remove the ring gear only if it will be replaced (Fig. 33).

NOTE: Replacement ring gears are only available in matched ring and pinion sets.

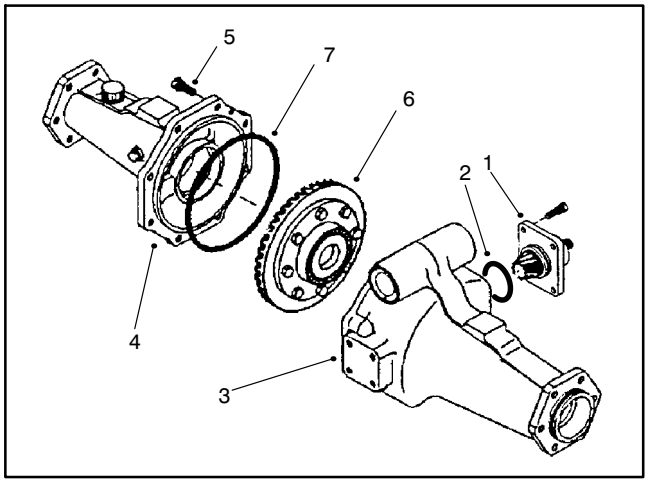


Figure 31

1. **Pinion gear**
2. **O-ring**
3. **Axle support (right)**
4. **Axle support (left)**
5. **Case screws**
6. **Differential gear**
7. **O-ring**

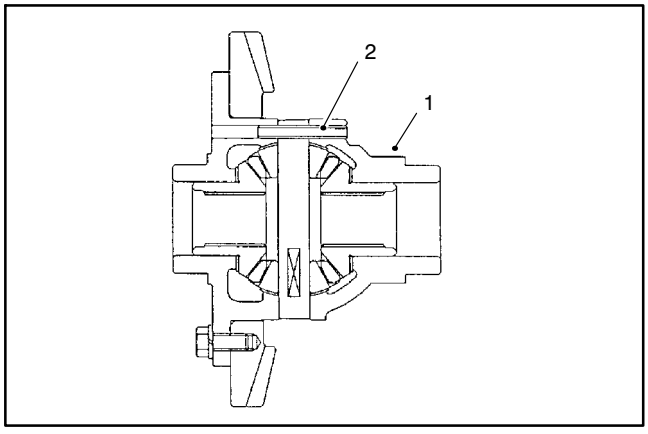


Figure 32

1. **Differential case**
2. **Spring pin**

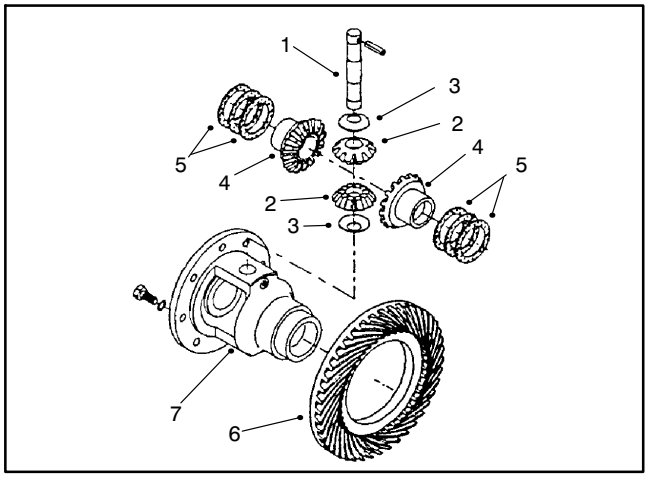


Figure 33

1. **Differential pinion shaft**
2. **Pinion gear**
3. **Pinion washer**
4. **Side gear**
5. **Side gear shims**
6. **Ring gear**
7. **Differential case**

Inspection

1. Measure the differential side gear O.D. and the differential case I.D. to determine the side gear to case clearance (Fig. 34). Replace components as necessary.

SIDE GEAR TO CASE CLEARANCE:
0.002 to 0.012 in. (0.05 to 0.30 mm)

SIDE GEAR O.D. (Factory Spec.):
1.335 to 1.337 in. (33.91 to 33.95 mm)

DIFFERENTIAL CASE I.D. (Factory Spec.):
1.339 to 1.341 in. (34.00 to 34.06 mm)

2. Measure the differential pinion shaft O.D. and the pinion gear I.D. to determine the pinion shaft to pinion gear clearance (Fig. 35). Replace components as necessary.

PINION SHAFT TO PINION GEAR CLEARANCE:
0.001 to 0.010 in. (0.03 to 0.25 mm)

PINION SHAFT O.D. (Factory Spec.):
0.550 to 0.551 in. (13.97 to 13.10 mm)

PINION GEAR I.D. (Factory Spec.):
0.551 to 0.552 in. (13.10 to 14.02 mm)

3. Inspect all gears, shafts, bearings, cases, and covers for damage and wear. Replace components as necessary.

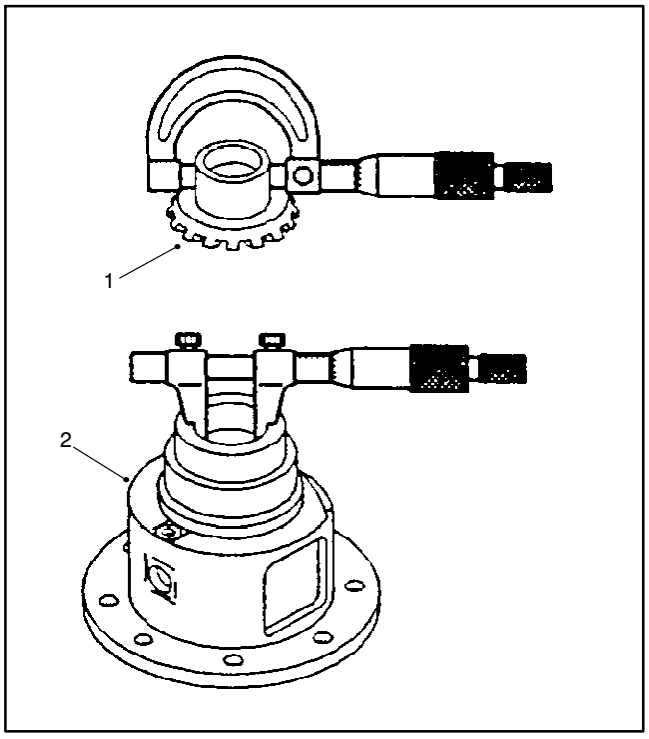


Figure 34

1. Side gear **2. Differential case**

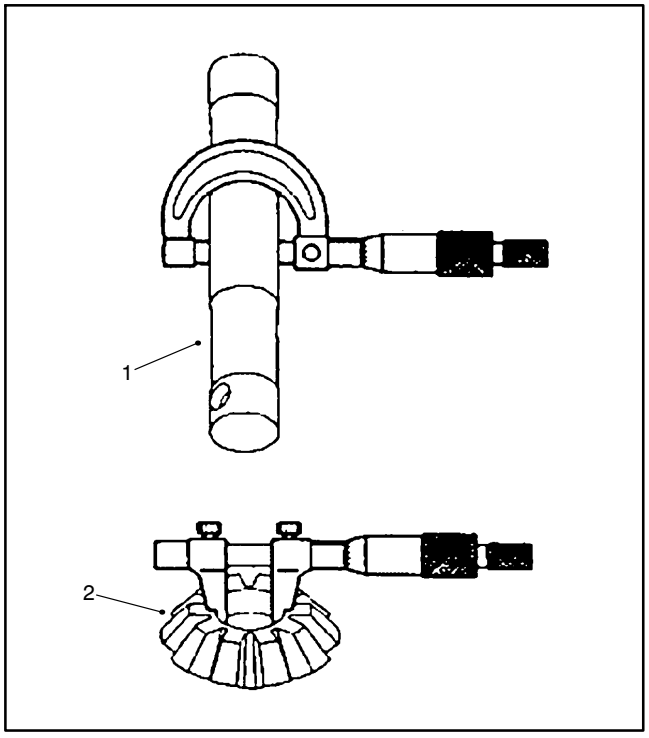


Figure 35

1. Pinion shaft **2. Pinion gear**

Installation

1. If the ring gear was removed, use medium strength Loctite thread locker and tighten the mounting screws to 22 to 25 ft-lbs. (30 to 34 Nm).

2. Apply molybdenum disulfide to the splines and bearing surfaces of the differential pinion gears, pinion washers, and side gears.

3. Install the side gear shims and side gears in their original location in the differential case.

4. Place the differential pinion gears and pinion washers in their original location in the differential case. Temporarily install the differential pinion shaft.

5. Secure the differential case in a vise. Position a dial indicator on a tooth of the differential pinion gear. Press the pinion and side gear against the differential case and measure the pinion gear to side gear backlash (Fig. 36).

PINION GEAR TO SIDE GEAR BACKLASH:
0.004 to 0.016 in. (0.10 to 0.40 mm)

6. Adjust backlash by increasing or reducing side gear shim thickness.

Note: Side gear shims are available in 0.043 in. (1.1 mm), 0.047 in. (1.2 mm), and 0.051 in. (1.3 mm) thickness.

7. Paint the teeth of the differential pinion gears and side gears with a gear marking compound, such as Dy-Kem® Steel Blue.

8. While applying a light load to either side gear, rotate either pinion gear until the side gears have made one complete revolution.

9. Ideal tooth contact should cover more than 35% of each tooth surface. The contact area should be in the center of each tooth and extent 1/3 to 1/2 way across each tooth from the toe (small) end (Fig. 37).

10. Adjust side gear shims if necessary to correct tooth contact. Recheck differential pinion gear to side gear backlash if any changes are made.

11. After backlash and tooth contact have been adjusted, align the hole in the differential pinion shaft with the hole in the differential case and install a new spring pin.

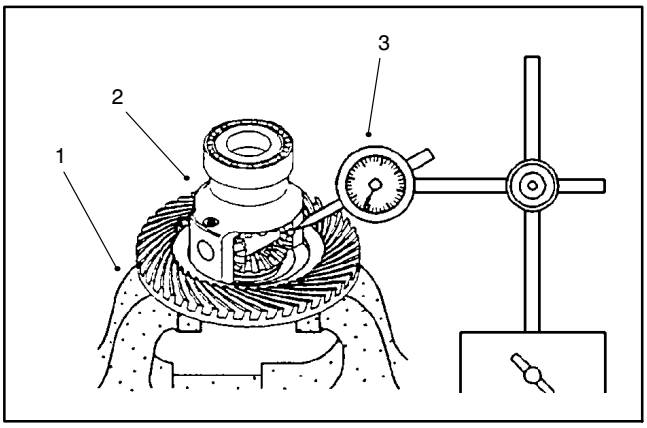


Figure 36

1. **Vise**
2. **Differential gear case**
3. **Dial indicator**

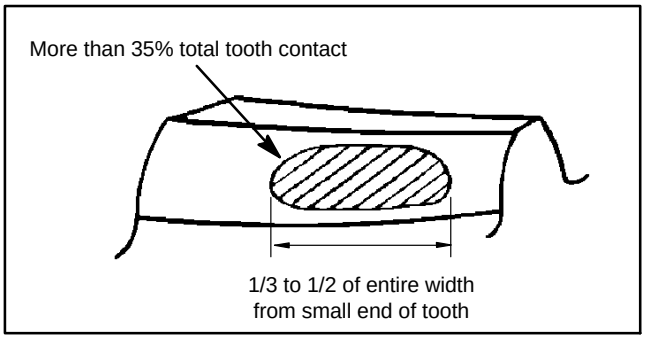


Figure 37

12. Install differential gear assembly in right side axle support half.

13. Coat a new O-ring with grease and install left side axle support half. Tighten axle support case screws to 35 to 41 ft-lbs. (47 to 56 Nm).

14. Install input shaft/pinion gear assembly (see Input shaft/Pinion in this section of this manual).

15. Coat new O-rings with grease, align differential shaft splines with differential gear assembly, and slide differential shaft assemblies onto axle support.

16. Install bevel gear case/axle case assemblies (see Bevel Gear Case/Axle Case Assembly in this section of this manual).

Pinion Gear to Ring Gear Engagement

Final position of pinion is verified by using the gear contact pattern method as described in the following procedure.

GEAR TOOTH DEFINITIONS (Fig. 38):

Toe − the portion of the tooth surface at the end towards the center.

Heel − the portion of the gear tooth at the outer end.

Top Land − top surface of tooth.

1. Paint the teeth of the ring gear, both drive and coast side, with a gear marking compound, such as DyKem® Steel Blue.

2. Install the input shaft/pinion gear assembly into axle case.

3. While applying a light load to the ring gear, rotate the pinion gear in the direction of forward travel until the ring gear has made one complete revolution.

Ideal tooth contact observed on the ring gear should cover more than 35% of each tooth surface. The contact area should be in the center of each tooth and extend 1/3 to 1/2 way across each tooth from the toe end (Fig. 39).

Adjustments to the gear contact position are made by moving the input shaft/pinion gear (bearing case shims) or by moving the differential gear case (differential bearing shims) (Fig. 40).

Note: Bearing case shims are available in 0.004 in. (0.1 mm) and 0.008 in. (0.2 mm) thickness.

Note: Differential bearing shims are available in 0.004 in. (0.1 mm), 0.008 in. (0.2 mm), and 0.016 in. (0.4 mm) thickness.

Study the different contact patterns (Fig. NO TAG and NO TAG) and correct engagement as necessary.

NOTE: When making changes, note that two variables are involved (see Gear Pattern Movement Summary in this section of this manual).

Example: If the pinion gear to ring gear backlash is set correctly to specifications and the bearing case shim is changed to adjust tooth contact, it may be necessary to readjust backlash to the correct specification before checking the contact pattern.

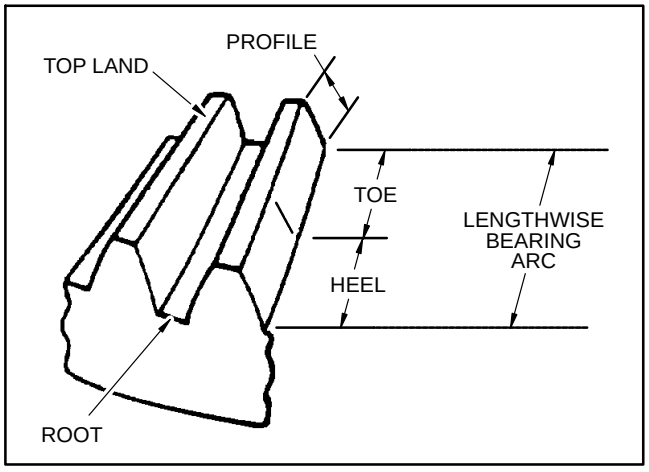


Figure 38

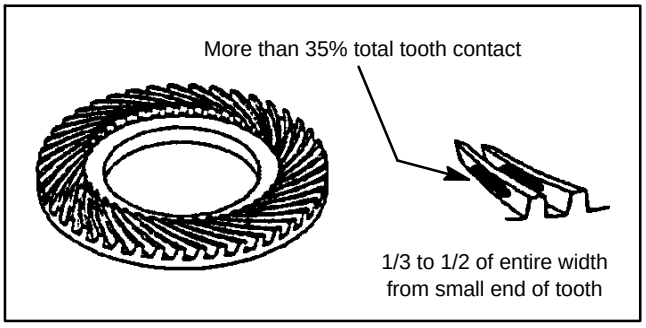


Figure 39

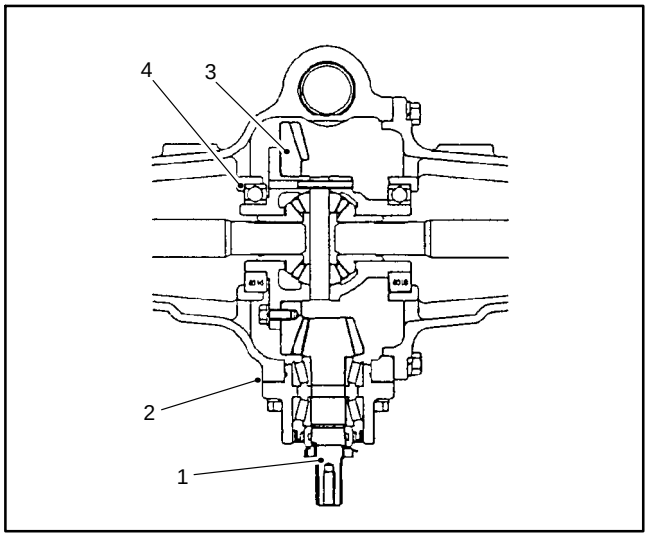


Figure 40

1. **Input shaft/pinion gear**
2. **Bearing case shims**
3. **Differential gear case**
4. **Differential bearing shims**

Gear Pattern Movement Summary

Every gear has a characteristic pattern. The illustrations show typical patterns only and explain how patterns shift as gear location is changed.

1. If contact is toward the heel or base of the gear (Fig. 41):

   A. Install thicker or additional bearing case shim(s) to move pinion shaft toward ring gear.

   B. Install thinner or remove differential bearing shim(s) to move ring gear backward.

   C. Repeat until proper tooth contact and pinion gear to ring gear backlash are correct.

2. If contact is toward the toe or tip of the gear (Fig. 42):

   A. Install thinner or remove bearing case shim(s) to move pinion shaft away from ring gear.

   B. Install thicker or additional differential bearing shim(s) to move ring gear forward.

   C. Repeat until proper tooth contact and pinion gear to ring gear backlash are correct.

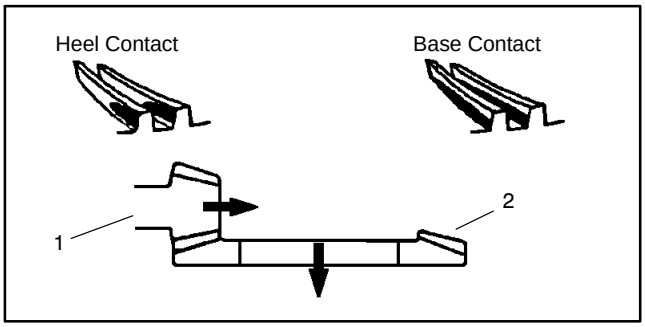


Figure 41

1. Pinion shaft **2. Ring gear**

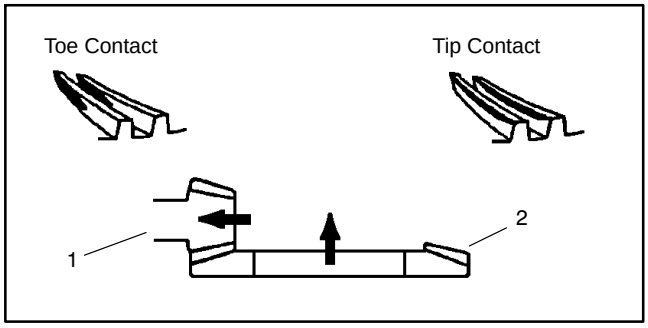


Figure 42

1. Pinion shaft **2. Ring gear**

Chapter 10

Electrical Diagrams

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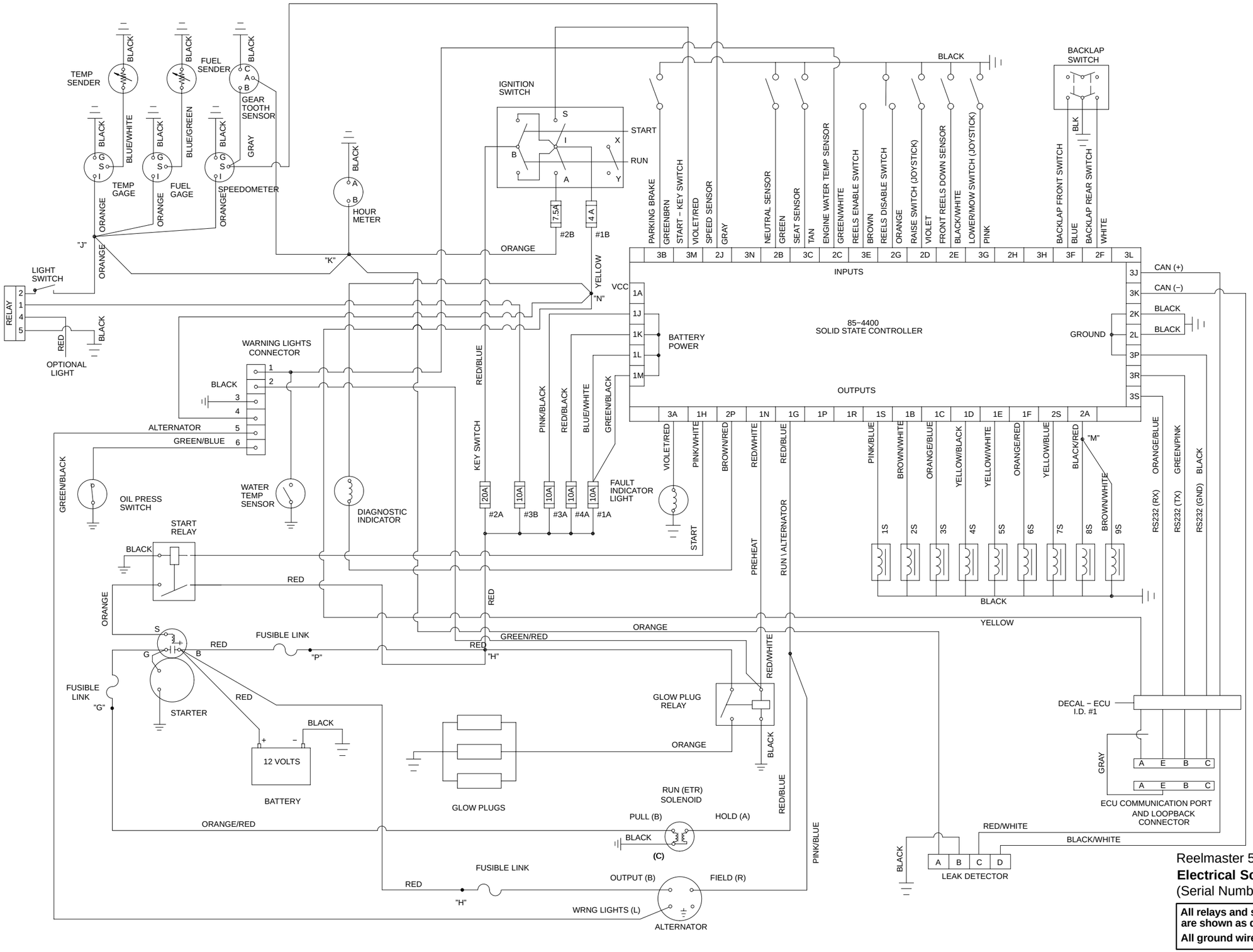


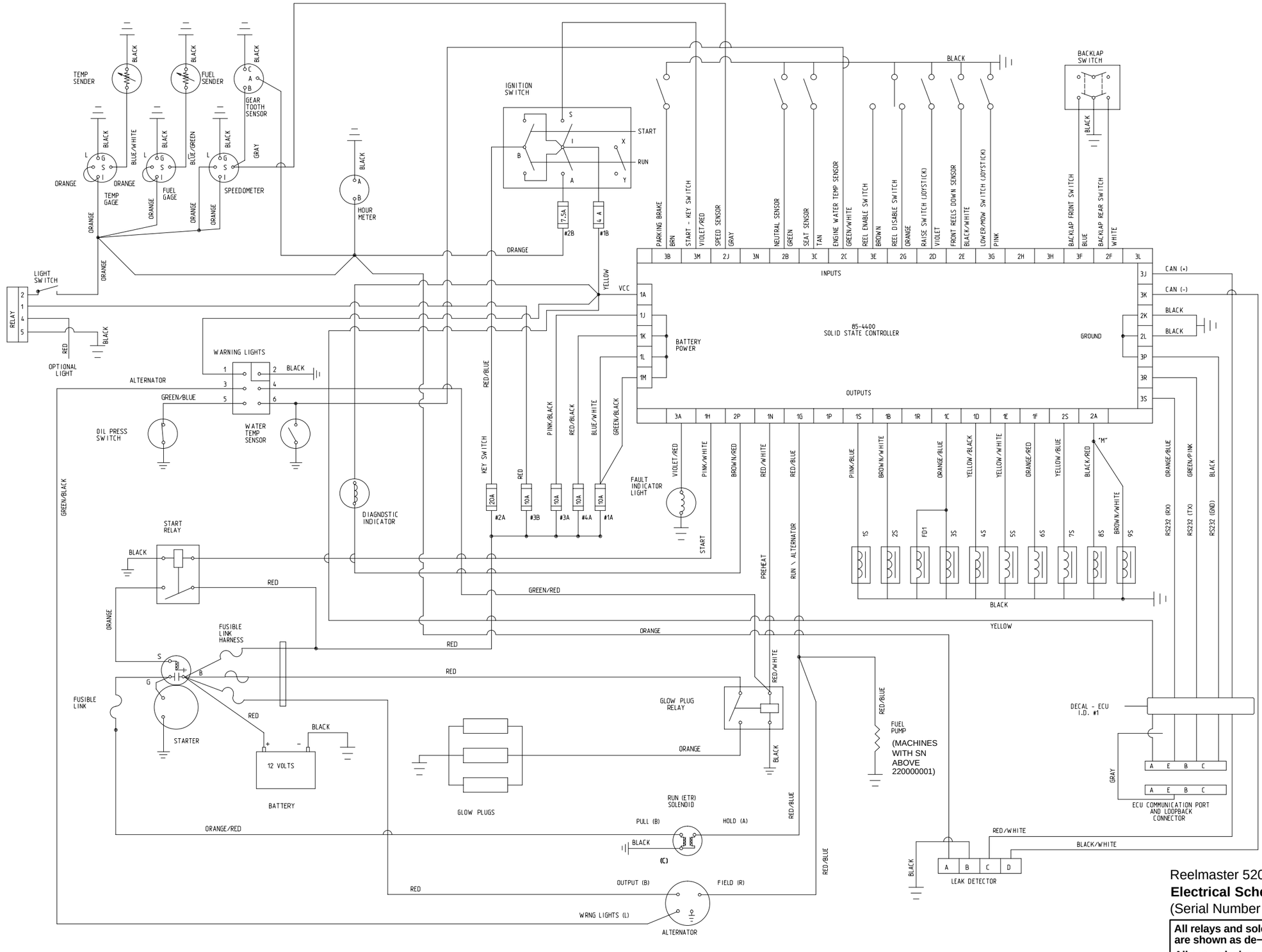
Reelmaster 5200-D/5400-D

Electrical Schematic

(Serial Number Below 210000400)

All relays and solenoids are shown as de−energized.

All ground wires are black.



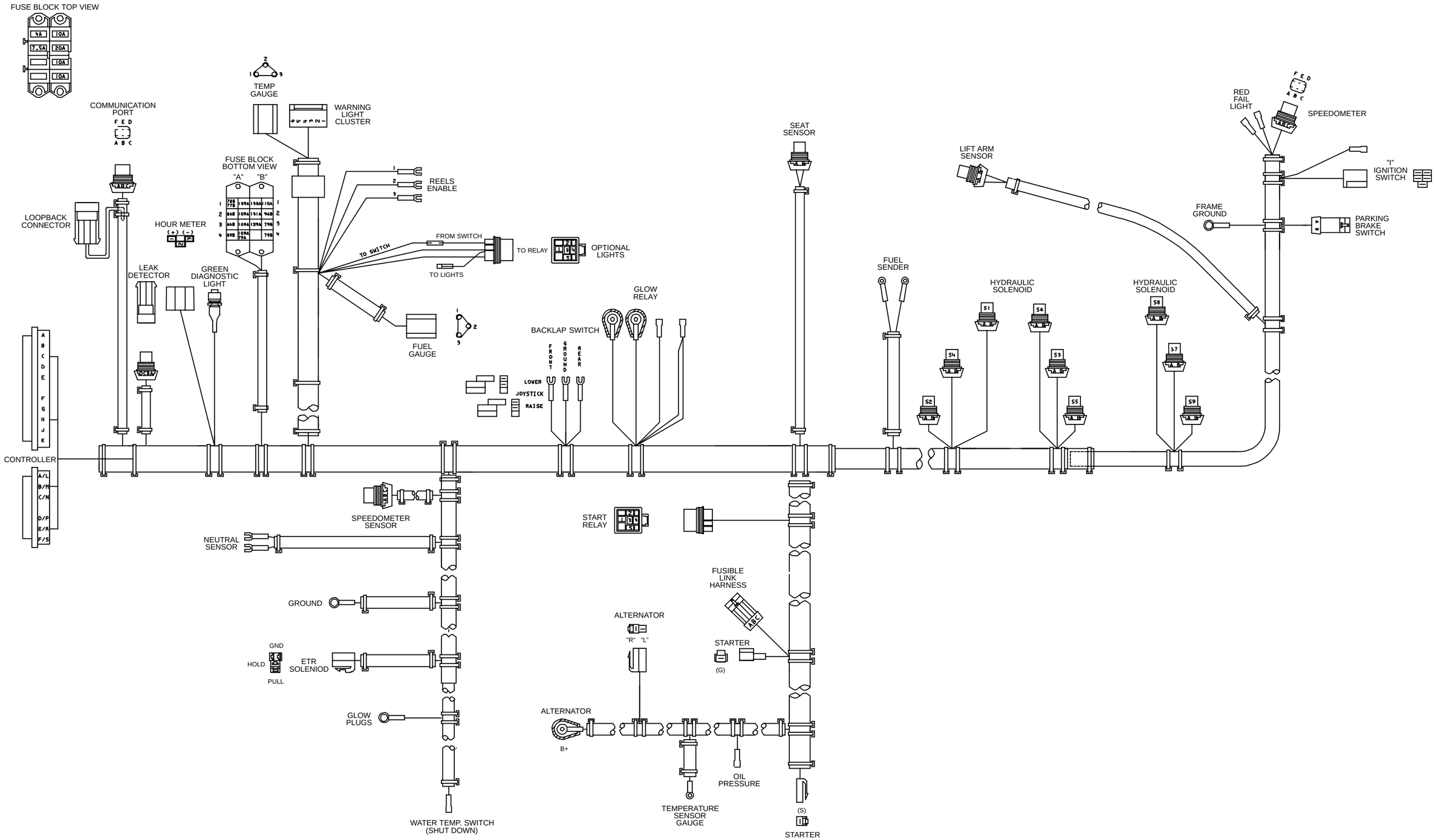
Reelmaster 5200-D/5400-D

Electrical Schematic

(Serial Number Above 210000400)

All relays and solenoids are shown as de−energized.

All ground wires are black.



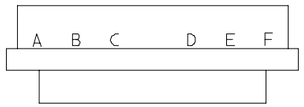
Reelmaster 5200-D/5400-D
Electrical Harness Drawing
(Serial Number Below 210000400)

A3	B3	C3	D3	E3		F3	G3	H3	J3	K3
A2	B2	C2	D2	E2		F2	G2	H2	J2	K2
A1	B1	C1	D1	E1		F1	G1	H1	J1	K1

30 Pin Connector

Located under the control console
Plugged into the ACE control module

Cavity	Wire
A1	Yellow
A2	Black/Red
A3	Violet/Red
B1	Brown/White
B2	Green
B3	Brown
C1	Orange/Blue
C2	Green/White
C3	Tan
D1	Yellow/Black
D2	Violet
D3	Open
E1	Yellow/White
E2	Black/White
E3	Brown
F1	Orange/Red
F2	White
F3	Blue
G1	Red/Blue
G2	Orange
G3	Pink
H1	Pink/White
H2	Open
H3	Open
J1	Pink/Black
J2	Gray
J3	Red/White
K1	Red/Black
K2	Black
K3	Black/White



A3	B3	C3		D3	E3	F3
A2	B2	C2		D2	E2	F2
A1	B1	C1		D1	E1	F1

18 Pin Connector

Located under the control console
Plugged into the ACE control module

Cavity	Wire
A1	Blue/White
A2	Black
A3	Open
B1	Green/Black
B2	Open
B3	Violet/Red
C1	Red/White
C2	Open
C3	Open
D1	Open
D2	Brown/Red
D3	Black
E1	Open
E2	Open
E3	Green/Pink
F1	Pink/Blue
F2	Yellow/Blue
F3	Orange/Blue

Communications Port

Located in the control console

Cavity	Wire
A	Yellow
B	Green/Pink
C	Black
D	Open
E	Orange/Blue
F	Open

Loop−Back connector

Located in the control console

Wire Color
Gray

Leak Detector

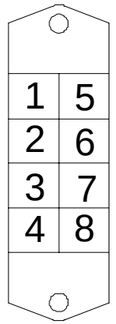
Located in the control console

Cavity	Wire
A	Orange
B	Black
C	Red/White
D	Black/White

Diagnostic Light

Located in the control console

Wire Color
Brown/red
Yellow



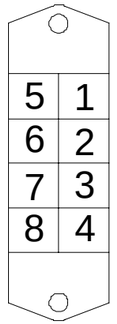
10 AMP
20 AMP
10 AMP
10 AMP

Fuse Holder A

(Bottom View)

Located in the control console

Cavity	Wire
1	Green/Black
	Blue/White
2	Red/Blue
3	Pink/Black
4	Black
5	Red
6	Red
7	Red
8	Red



4 AMP

7.5 AMP

Fuse Holder B

(Bottom View)

Located in the control console

Cavity	Wire
1	Yellow
2	Orange
3	Red
4	Red
5	Yellow
6	Orange
7	Red
8	Open

Warning light cluster

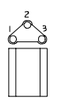
Located under the control console

Cavity	Wire
1	Green/Blue
2	Green/Black
3	Yellow
4	Black
5	Orange/Red
6	Green/White

Optional Light Relay

Located under the control console

Cavity	Wire
1	Red
2	Orange
3	Open
4	Red
5	Black



Fuel Gauge

Located under the control console

Cavity	Wire
1	Orange
2	Black
3	Blue/Green

Joystick Lower

Located under the control console

Cavity	Wire
1	Black
2	Pink
3	Open

Joystick Raise

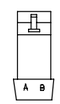
Located under the control console.

Cavity	Wire
1	Black
2	Violet
3	Open

Lift Arm Sensor

Located on left hand front lift arm

Cavity	Wire
A	Black/White
B	Black



Parking Brake Switch

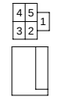
Located in steering tower

Cavity	Wire
A	Brown
B	Black

Starter

Located on "S" terminal of the starter

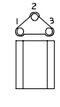
Wire Color
Orange



Ignition Switch

Located in the control console or steering tower

Cavity	Wire
1	Open
2	Open
3	Orange
4	Red/Blue
5	Violet/Red



Temp Gauge

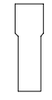
Located in the control console

Cavity	Wire
1	Orange
2	Black
3	Blue/White

Alternator

Located on the RH front side of the engine

Wire Color
Red



Water Temp Switch

Located on the RH side of the engine

Wire Color
Green/White
Green/White

Glow Plugs

Located on the RH rear of the engine

Wire Color
Orange

Ground

Located on the LH side of the engine

Wire Color
Black

Alternator

Located on the LH front of the engine

Cavity	Wire
1	Pink/Blue
2	Green/Black

Starter

Located on Starter ground terminal

Wire Color
Fusible Link

Start Relay

Located under the operators seat

Cavity	Wire
1	Red
2	Pink/White
3	Open
4	Orange
5	Black

Run (ETR) Solenoid

Located on LH side of engine

Cavity	Wire
1	Orange/Red
2	Black
3	Red/Blue

Speedometer Sensor

Located on RH side of the axle housing

Cavity	Wire
A	Orange
B	Gray
C	Black

Hour Meter

Located in the control console

Cavity	Wire
1	Orange
2	Open
3	Black

S1 Solenoid

Located on lift manifold

Cavity	Wire
A	Pink/Blue
B	Red

S2 Solenoid

Located on lift manifold

Cavity	Wire
A	Brown/White
B	Black

S4 Solenoid

Located on lift manifold

Cavity	Wire
A	Yellow?Black
B	Black

S5 Solenoid

Located on lift manifold

Cavity	Wire
A	Yellow?White
B	Black

S6 Solenoid

Located on lift manifold

Cavity	Wire
A	Orange/White
B	Black

S7 Solenoid

Located on lift manifold

Cavity	Wire
A	Yellow/Black
B	Black

S8 Solenoid

Located on lift manifold

Cavity	Wire
A	Black/Red
B	Black

S9 Solenoid

Located on lift manifold

Cavity	Wire
A	Brown/White
B	Black

Battery Cable

Located on the RH side of the engine, By the starter

Cavity	Wire
A	Red
B	Red
C	Red

Temperature Sensor

Located on the LH side of the engine

Wire Color
Blue/White

Seat Switch

Located under operators seat

Cavity	Wire
A	Tan
B	Black

Ignition Switch "I"

Located in the control console or steering tower

Wire Color
Yellow

Reels Enable

Located under the control console

Wire Color
Orange

Reels Enable

Located under the control console

Wire Color
Black

Reels Enable

Located under the control console

Wire Color
Brown

Speedometer

Located in steering column

Cavity	Wire
A	Black
B	Black
C	Gray
D	Orange
E	Black
F	Open

Glow Plug Relay

Located under the operators seat

Wire Color
Orange

Glow Plug Relay

Located under the operators seat

Wire Color
Red

Fuel Sender

Located on Fuel tank. LH side of machine

Wire color
Blue/Green

Fuel Sender

Located on Fuel tank. LH side of machine

Wire color
Black

Neutral Sensor

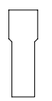
Located on the hydrostatic pump

Wire Color
Green

Neutral Sensor

Located on the hydrostatic pump

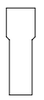
Wire Color
Black



Fault Light

Located in steering column

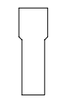
Wire Color
Violet/Red



Fault Light

Located in steering column

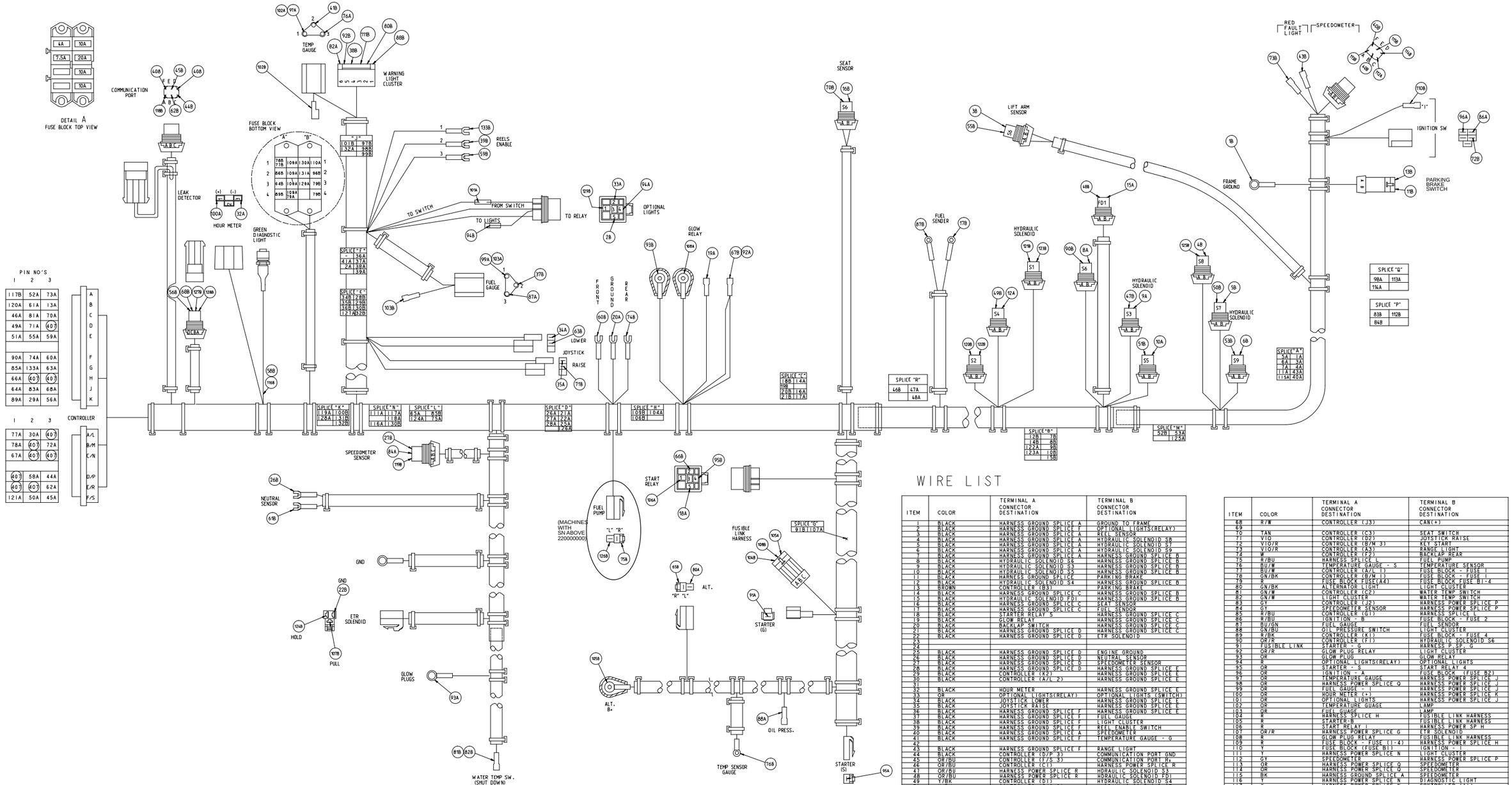
Wire Color
Black



Engine Oil Pressure

Located on LH side of engine

Wire Color
Green/Blue



WIRE LIST

ITEM	COLOR	TERMINAL A CONNECTOR DESTINATION	TERMINAL B CONNECTOR DESTINATION
1	BLACK	HARNESS GROUND SPLICE A	GROUND TO FRAME
2	BLACK	HARNESS GROUND SPLICE F	OPTIONAL LIGHTS(RELAY)
3	BLACK	HARNESS GROUND SPLICE A	REEL SENSOR
4	BLACK	HARNESS GROUND SPLICE A	HYDRAULIC SOLENOID S8
5	BLACK	HARNESS GROUND SPLICE A	HYDRAULIC SOLENOID S7
6	BLACK	HARNESS GROUND SPLICE A	HYDRAULIC SOLENOID S9
7	BLACK	HARNESS GROUND SPLICE A	HARNESS GROUND SPLICE B
8	BLACK	HYDRAULIC SOLENOID S6	HARNESS GROUND SPLICE B
9	BLACK	HYDRAULIC SOLENOID S3	HARNESS GROUND SPLICE B
10	BLACK	HYDRAULIC SOLENOID S5	HARNESS GROUND SPLICE B
11	BLACK	HARNESS GROUND SPLICE	PARKING BRAKE
12	BLACK	HYDRAULIC SOLENOID S4	HARNESS GROUND SPLICE B
13	BROWN	CONTROLLER (B3)	PARKING BRAKE
14	BLACK	HARNESS GROUND SPLICE C	HARNESS GROUND SPLICE B
15	BLACK	HYDRAULIC SOLENOID FD1	HARNESS GROUND SPLICE B
16	BLACK	HARNESS GROUND SPLICE C	SEAT SENSOR
17	BLACK	HARNESS GROUND SPLICE C	FUEL SENDOR
18	BLACK	STARTER RELAY S	HARNESS GROUND SPLICE C
19	BLACK	GLOW RELAY	HARNESS GROUND SPLICE C
20	BLACK	BACKLAP SWITCH	HARNESS GROUND SPLICE C
21	BLACK	HARNESS GROUND SPLICE D	HARNESS GROUND SPLICE C
22	BLACK	HARNESS GROUND SPLICE D	ETR SOLENOID
23			
24			
25	BLACK	HARNESS GROUND SPLICE D	ENGINE GROUND
26	BLACK	HARNESS GROUND SPLICE D	NEUTRAL SENSOR
27	BLACK	HARNESS GROUND SPLICE D	SPEEDOMETER SENSOR
28	BLACK	HARNESS GROUND SPLICE D	HARNESS GROUND SPLICE E
29	BLACK	CONTROLLER (K2)	HARNESS GROUND SPLICE E
30	BLACK	CONTROLLER (A/L 2)	HARNESS GROUND SPLICE E
31			
32	BLACK	HOUR METER	HARNESS GROUND SPLICE E
33	OR	OPTIONAL LIGHTS(RELAY)	OPTIONAL LIGHTS (SWITCH)
34	BLACK	JOYSTICK LOWER	HARNESS GROUND SPLICE E
35	BLACK	JOYSTICK RAISE	HARNESS GROUND SPLICE E
36	BLACK	HARNESS GROUND SPLICE F	HARNESS GROUND SPLICE E
37	BLACK	HARNESS GROUND SPLICE F	FUEL GAUGE
38	BLACK	HARNESS GROUND SPLICE F	LIGHT CLUSTER
39	BLACK	HARNESS GROUND SPLICE F	REEL ENABLE SWITCH
40	BLACK	HARNESS GROUND SPLICE A	SPEEDOMETER
41	BLACK	HARNESS GROUND SPLICE F	TEMPERATURE GAUGE - G
42			
43	BLACK	HARNESS GROUND SPLICE F	RANGE LIGHT
44	BLACK	CONTROLLER (D/P 3)	COMMUNICATION PORT GND
45	OR/BU	CONTROLLER (F/S 3)	COMMUNICATION PORT R+
46	OR/BU	CONTROLLER (C1)	HARNESS POWER SPLICE R
47	OR/BU	HARNESS POWER SPLICE R	HDRAULIC SOLENOID S3
48	OR/BU	HARNESS POWER SPLICE R	HYDRAULIC SOLENOID FD1
49	Y/BK	CONTROLLER (D1)	HYDRAULIC SOLENOID S4
50	Y/BU	CONTROLLER (F/S 2)	HYDRAULIC SOLENOID S7
51	Y/W	CONTROLLER (E1)	HYDRAULIC SOLENOID S5
52	BK/R	CONTROLLER (A2)	HARNESS SPLICE M
53	BN/W	HARNESS SPLICE M	HYDRAULIC SOLENOID S9
54			
55	BK/W	CONTROLLER (E2)	LIFT ARM SENSOR
56	BK/W	CONTROLLER (K3)	CAN(-)
57			
58	BN/R	CONTROLLER (D/P 2)	DIAGNOSTIC LIGHT
59	BN	CONTROLLER (E3)	REELS ENABLE SWITCH
60	BU	CONTROLLER (F3)	BACKLAP FRONT
61	GN	CONTROLLER (B2)	NEUTRAL SENSOR
62	GN/PK	CONTROLLER (E/R 3)	COMMUNICATION PORT T+
63	PK	CONTROLLER (G3)	JOYSTICK LOWER
64	PK/BK	CONTROLLER (J1)	FUSE BLOCK - FUSE 3
65	PK/BU	HARNESS SPLICE L	ALTERNATOR RUN
66	PK/W	CONTROLLER (H1)	STARTER RELAY 2
67	R/W	CONTROLLER (C/N 1)	GLOW PLUG RELAY

ITEM	COLOR	TERMINAL A CONNECTOR DESTINATION	TERMINAL B CONNECTOR DESTINATION
68	R/W	CONTROLLER (J3)	CAN(+)
69			
70	TAN	CONTROLLER (C3)	SEAT SWITCH
71	V1O	CONTROLLER (D2)	JOYSTICK RAISE
72	V1O/R	CONTROLLER (B/M 3)	KEY START
73	V1O/R	CONTROLLER (A3)	RANGE LIGHT
74	W	CONTROLLER (F2)	BACKLAP REAR
75	R/BU	HARNESS SPLICE L	FUEL PUMP
76	BU/W	TEMPERATURE GAUGE - S	TEMPERATURE SENSOR
77	BU/W	CONTROLLER (A/L 1)	FUSE BLOCK - FUSE 1
78	GN/BK	CONTROLLER (B/M 1)	FUSE BLOCK - FUSE 1
79	R	FUSE BLOCK FUSE(A4)	FUSE BLOCK FUSE B1-4
80	GN/BK	ALTERNATOR LIGHT	LIGHT CLUSTER
81	GN/W	CONTROLLER (C2)	WATER TEMP SWITCH
82	GN/W	LIGHT CLUSTER	WATER TEMP SWITCH
83	GY	CONTROLLER (J2)	HARNESS POWER SPLICE P
84	GY	SPEEDOMETER SENSOR	HARNESS POWER SPLICE P
85	R/BU	CONTROLLER (G1)	HARNESS SPLICE L
86	R/BU	IGNITION - B	FUSE BLOCK - FUSE 2
87	BU/GN	FUEL GAUGE	FUEL SENDOR
88	GN/BU	OIL PRESSURE SWITCH	LIGHT CLUSTER
89	R/BK	CONTROLLER (K1)	FUSE BLOCK - FUSE 4
90	OR/R	CONTROLLER (F1)	HYDRAULIC SOLENOID S6
91	FUSIBLE LINK	STARTER - G	HARNESS P SP G
92	OR/R	GLOW PLUG RELAY	LIGHT CLUSTER
93	OR	GLOW PLUG	GLOW RELAY
94	R	OPTIONAL LIGHTS(RELAY)	OPTIONAL LIGHTS
95	OR	STARTER - S	START RELAY A
96	OR	IGNITION - A	FUSE BLOCK - (FUSE B2)
97	OR	TEMPERATURE GAUGE	HARNESS POWER SPLICE J
98	OR	HARNESS POWER SPLICE Q	HARNESS POWER SPLICE J
99	OR	FUEL GAUGE - I	HARNESS POWER SPLICE J
100	OR	HOUR METER (+)	HARNESS POWER SPLICE K
101	OR	OPTIONAL LIGHTS	HARNESS POWER SPLICE J
102	OR	TEMPERATURE GUAGE	LAMP
103	OR	FUEL GUAGE	LAMP
104	R	HARNESS SPLICE H	FUSIBLE LINK HARNESS
105	R	STARTER-B	FUSIBLE LINK HARNESS
106	R	START RELAY 1	HARNESS POWER SP H
107	OR/R	HARNESS POWER SPLICE G	ETR SOLENOID
108	R	GLOW PLUG RELAY	FUSIBLE LINK HARNESS
109	R	FUSE BLOCK - FUSE (1-4)	HARNESS POWER SPLICE H
110	Y	FUSE BLOCK (FUSE B1)	IGNITION - I
111	Y	HARNESS POWER SPLICE N	LIGHT CLUSTER
112	GY	SPEEDOMETER	HARNESS POWER SPLICE P
113	OR	HARNESS POWER SPLICE Q	SPEEDOMETER
114	OR	HARNESS POWER SPLICE Q	SPEEDOMETER
115	BK	HARNESS GROUND SPLICE A	SPEEDOMETER
116	Y	HARNESS POWER SPLICE N	DIAGNOSTIC LIGHT
117	Y	HARNESS POWER SPLICE N	CONTROLLER (A1)
118	Y	HARNESS POWER SPLICE N	COMMUNICATION PORT
119	OR	HARNESS POWER SPLICE K	SPEEDOMETER SENSOR
120	BN/W	CONTROLLER (B1)	HYDRAULIC SOLENOID S2
121	PK/BU	CONTROLLER (F/S 1)	HYDRAULIC SOLENOID S1
122	BLACK	HARNESS GROUND SPLICE B	HYDRAULIC SOLENOID S2
123	BLACK	HARNESS GROUND SPLICE B	HYDRAULIC SOLENOID S1
124	R/BU	HARNESS SPLICE L	ETR SOLENOID
125	BK/R	HARNESS SPLICE M	HYDRAULIC SOLENOID S8
126	BK	HARNESS GROUND SPLICE L	FUEL PUMP
127	BLACK	HARNESS GROUND SPLICE(E1)	LEAK DETECTOR
128	OR	HARNESS POWER SPLICE K	LEAK DETECTOR
129	R	FUSE BLOCK FUSE(B3)	OPTIONAL LIGHTS
130	Y	FUSE BLOCK (B1)	HARNESS PWR SPLICE N
131	OR	FUSE BLOCK (B2)	HARNESS PWR SPLICE K
132	OR	HARNESS PSW SPLICE J	HARNESS PWR SPLICE K
133	OR	CONTROLLER 2G	ENABLE SWITCH-1

Reelmaster 5200-D/5400-D
Electrical Harness Drawing
(Serial Number Above 210000400)