Form No. 12191SL Rev C

TORO

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Service Manual

Greensmaster® 3150

(Models 04358)

Original Instructions (EN)

Revision History

Revision	Date	Description
--	2012	Initial Issue.
A	02/2018	Added revision history.
B	04/2018	Revised bedknife installation procedure, added Universal Groomer chapter.
C	05/2020	added 2 schematics, 2 wire harnesses, reel restraining, universal groomer shaft repair

Reader Comments

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NOTES

Part No. 12191SL Rev. C

Service Manual

(Model 04358)

Greensmaster® 3150

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 Greensmaster 3150 (Model 04358).

REFER TO THE TRACTION UNIT AND CUTTING UNIT OPERATOR'S MANUALS FOR OPERATING, MAINTENANCE AND ADJUSTMENT INSTRUCTIONS. For reference, insert a copy of the Operator's Manuals and Parts Catalogs for your machine into Chapter 2 of this service manual. Additional copies of the Operator's Manuals and Parts Catalog are available on the internet at www.Toro.com.

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

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

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

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

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Chapter 1

Safety

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Safety Instructions

The Greensmaster 3150 was tested and certified by Toro for compliance with national and international standards as specified in the Operator's Manual. 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.

WARNING

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

Before Operating

1. Read and understand the contents of the Operator's Manual before starting and operating the machine. Become familiar with all controls and know how to stop quickly. Copies of the Operator's Manual are available on the internet at www.Toro.com.

2. Never allow children to operate the machine. Never allow adults to operate it without proper instructions.

3. Become familiar with the controls and know how to stop the engine quickly.

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.

5. Always wear substantial shoes. Do not operate machine while wearing sandals, tennis shoes or sneakers. Do not wear loose fitting clothing which could get caught in moving parts and cause personal injury.

6. Wearing safety glasses, safety shoes, long pants and a helmet is advisable and required by some local safety and insurance regulations.

7. Make sure work area is clear of objects which might be picked up and thrown by the reels.

8. Do not carry passengers on the machine. Keep everyone, especially children and pets, away from the areas of operation.

9. Gasoline (fuel) is highly flammable; handle it carefully.

   A. Store fuel in containers specifically designed for this purpose.

   B. Add fuel before starting the engine. Never remove the cap of the fuel tank or add fuel while the engine is running or when the engine is hot.

   C. Refuel outdoors only and do not smoke while refuelling.

   D. Fill fuel tank to a level no higher than to the bottom of fuel tank filler neck. **Do not overfill.**

   E. Replace all fuel tanks and container caps securely.

   F. If fuel is spilled, do not attempt to start the engine but move the machine away from the area of spillage and avoid creating any source of ignition until fuel vapors have dissipated.

   G. Wipe up any spilled fuel.

While Operating

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

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

3. Check the safety interlock switch daily for proper operation; see Verify Interlock System Operation in Chapter 5 – Electrical System. Replace any malfunctioning switches before operating the machine.

4. To start the engine:

   A. Sit on the seat, make sure cutting units are disengaged.

   B. Verify that functional control lever is in neutral.

   C. Verify that parking brake is set.

   D. Proceed to start engine.

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

   A. Mow only in daylight or when there is good artificial light.

   B. Watch for holes or other hidden hazards.

   C. Do not drive close to sand traps, ditches, creeks or other hazards.

   D. Reduce speed when making sharp turns. Avoid sudden stops and starts.

   E. Before backing up, look to the rear to be sure no one is behind the machine.

   F. Watch out for traffic when near or crossing roads. Always yield the right–of–way.

   G. Apply the service brakes when going downhill to keep forward speed slow and to maintain control of the machine.

6. Keep hands, feet and clothing away from moving parts and the reel discharge area. The grass baskets must be in place during operation of the reels or thatchers for maximum safety. Shut the engine off before emptying the baskets.

7. Wear appropriate clothing including substantial footwear, hard hat, safety glasses and ear protection.

8. Raise the cutting units when driving from one work area to another.

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

10. If a cutting unit strikes a solid object or vibrates abnormally, stop immediately, turn engine off, wait for all motion to stop and inspect for damage. A damaged reel or bedknife must be repaired or replaced before operation is continued.

11. Before getting off the seat:

   A. Make sure cutting units are disengaged.

   B. Verify that functional control lever is in neutral.

   C. Set the parking brake.

   D. Stop the engine and remove key from ignition switch.

12. Traverse slopes carefully. Do not start or stop suddenly when traveling uphill or downhill.

13. Operator must be skilled and trained in how to drive on hillsides. Avoid wet slopes. 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.

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

15. **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.

16. Whenever machine is left unattended, make sure cutting units are fully raised and reels are not spinning, key is removed from ignition switch and parking brake is set.

Maintenance and Service

1. Before servicing or making adjustments to the machine, stop the engine, remove key from switch to prevent accidental starting of the engine.

2. Be sure entire machine is in good operating condition. Keep all nuts, bolts, screws and hydraulic fittings tight.

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

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

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

6. To reduce potential fire hazard, keep the engine area free of excessive grease, grass, leaves and accumulation of dirt. Never wash a warm engine or electrical connections with water.

7. Check all fuel lines for tightness and wear on a regular basis. Tighten or repair fuel lines as needed.

8. If the engine must be running to perform a maintenance adjustment, keep hands, feet, clothing and any other parts of the body away from the cutting units, attachments and any moving parts. Keep everyone away.

9. Do not overspeed the engine by changing governor settings. To assure safety and accuracy, have an Authorized Toro Distributor check maximum engine speed with a tachometer. Maximum governed engine speed should be 2850 $\pm$ 50 RPM.

10. Engine must be shut off before checking oil or adding oil to the crankcase.

11. If major repairs are ever needed or if assistance is desired, contact your Authorized Toro Distributor.

12. 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.

13. 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 the machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use appropriate jack stands to support the raised machine. If the machine is not properly supported by jack stands, the machine may move or fall, which may result in personal injury.

Jacking Instructions

CAUTION

When changing attachments, tires or performing other service, use correct jacks and supports. 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 to support the raised machine. If the machine is not properly supported by jack stands, the machine may move or fall, which may result in personal injury.

Front End Jacking

1. Apply parking brake and chock rear tire to prevent the machine from moving. Make sure that cutting units are fully lowered.

2. Position jack securely under the frame jacking point:

   A. The left side jacking point is the frame channel under the step behind the LH front wheel.

   B. The right side jacking point is the ROPS support bracket behind the RH front wheel (Fig. 1).

3. Jack front of machine off the ground.

4. Position appropriate jack stands under the frame as close to the wheel as possible to support the machine.

Rear End Jacking

1. Apply parking brake and chock both front tires to prevent the machine from moving. Make sure that cutting units are fully lowered.

2. Place jack securely below the rear castor fork.

3. Jack rear of machine off the ground.

4. Position appropriate jack stands under the frame to support the machine.

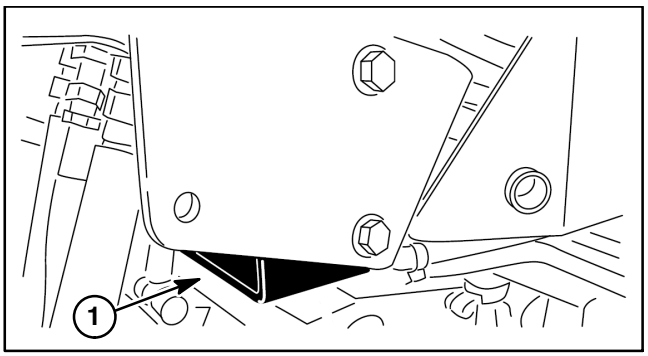

Figure 1

1. ROPS support bracket

Safety and Instruction Decals

Numerous safety and instruction decals are affixed to the traction unit and the cutting units of the Greensmaster 3150. If any decal becomes illegible or damaged, install a new decal. Part numbers are listed in your Parts Catalog and Operator's Manual. Order replacement decals from your Authorized Toro Distributor.

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Product Records and Maintenance

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Product Records

Insert a copy of the Operator's Manual and Parts Catalog for your Greensmaster 3150 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 the Greensmaster 3150 are covered in the Traction Unit Operator's Manual. Maintenance procedures and recommended service intervals for the Greensmaster Cutting Units are covered in the Cutting Unit Operator's Manual. Refer to these publications when performing regular equipment maintenance. Refer to the Engine Operator's Manual for additional engine specific maintenance procedures.

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 (e.g. 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

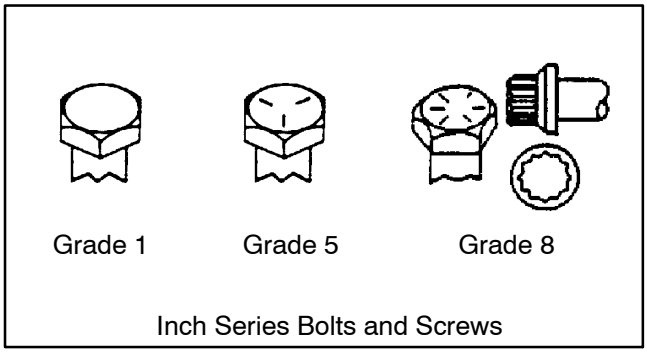

Figure 1

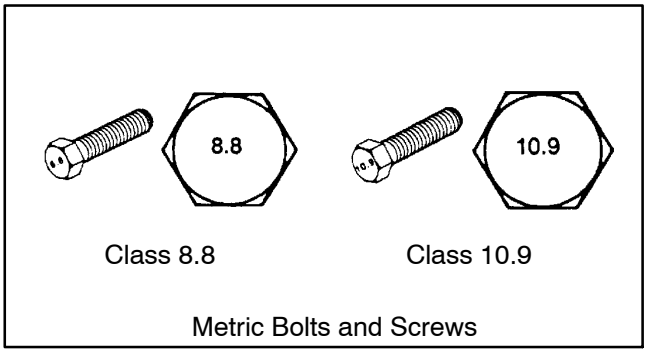

Figure 2

Using a Torque Wrench with an Offset Wrench

Use of an offset wrench (e.g. crowfoot wrench) will affect torque wrench calibration due to the effective change of torque wrench length. When using a torque wrench with an offset wrench, multiply the listed torque recommendation by the calculated torque conversion factor (Fig. 3) to determine proper tightening torque. Tightening torque when using a torque wrench with an offset wrench will be lower than the listed torque recommendation.

Example: The measured effective length of the torque wrench (distance from the center of the handle to the center of the square drive) is 18".

The measured effective length of the torque wrench with the offset wrench installed (distance from the center of the handle to the center of the offset wrench) is 19".

The calculated torque conversion factor for this torque wrench with this offset wrench would be 18 / 19 = 0.947.

If the listed torque recommendation for a fastener is from 76 to 94 ft–lb, the proper torque when using this torque wrench with an offset wrench would be from 72 to 89 ft–lb.

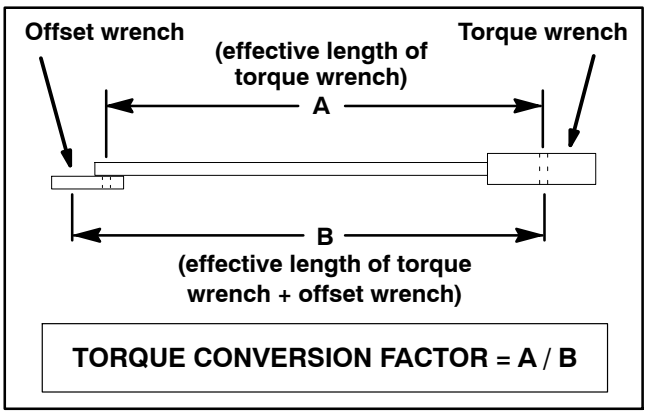

Figure 3

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 ± 17	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

Engine

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General Information

This Chapter gives information about specifications, maintenance, troubleshooting, testing and repair of the engine used in the Greensmaster 3150.

Most repairs and adjustments require tools which are commonly available in many service shops. Special tools are described in the Briggs & Stratton Vanguard V-Twin OHV Repair Manual. 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 Briggs & Stratton Vanguard V-Twin OHV engines are supplied through your local local Toro distributor. If no parts list is available, be sure to provide your distributor with the Toro model and serial number along with the engine model and serial number.

Operator's Manual

The Traction Unit Operator's Manual provides information regarding the operation, general maintenance and maintenance intervals for your Greensmaster 3150 machine. Refer to the Operator's Manual for additional information when servicing the machine.

Specifications

Item	Description
Make / Designation	Briggs and Stratton, 4–cycle, V–Twin Cylinder, OHV, Air Cooled, Gasoline Engine – Model 356447
Bore x Stroke	2.83” x 2.76” (72 mm x 70 mm)
Total Displacement	34.8 in^3 (570 cc)
Governor	Mechanical Governor
Carburetor	Float Feed
Fuel Pump	Pulsating Crankcase Vacuum
Fuel	Unleaded, regular grade gasoline
Fuel Tank Capacity	7.0 U.S. gallons (26.5 liters)
Low Idle (no load)	1650 $\pm$ 100 RPM
High Idle (no load)	2850 $\pm$ 50 RPM
Lubrication System	Pressure Lubrication, Gear Driven Geroter Oil Pump
Engine Oil	See Operator’s Manual
Crankcase Oil Capacity	1.75 U.S. quarts (1.65 liters) with new filter
Ignition System	Flywheel magneto, twin electronic armatures
Spark Plugs	Champion RC 14YC (or equivalent)
Spark Plug Gap	0.030” (0.76 mm)
Alternator	16 Amp
Dry Weight (approximate)	84 lb (38 kg)

Fuel Tank

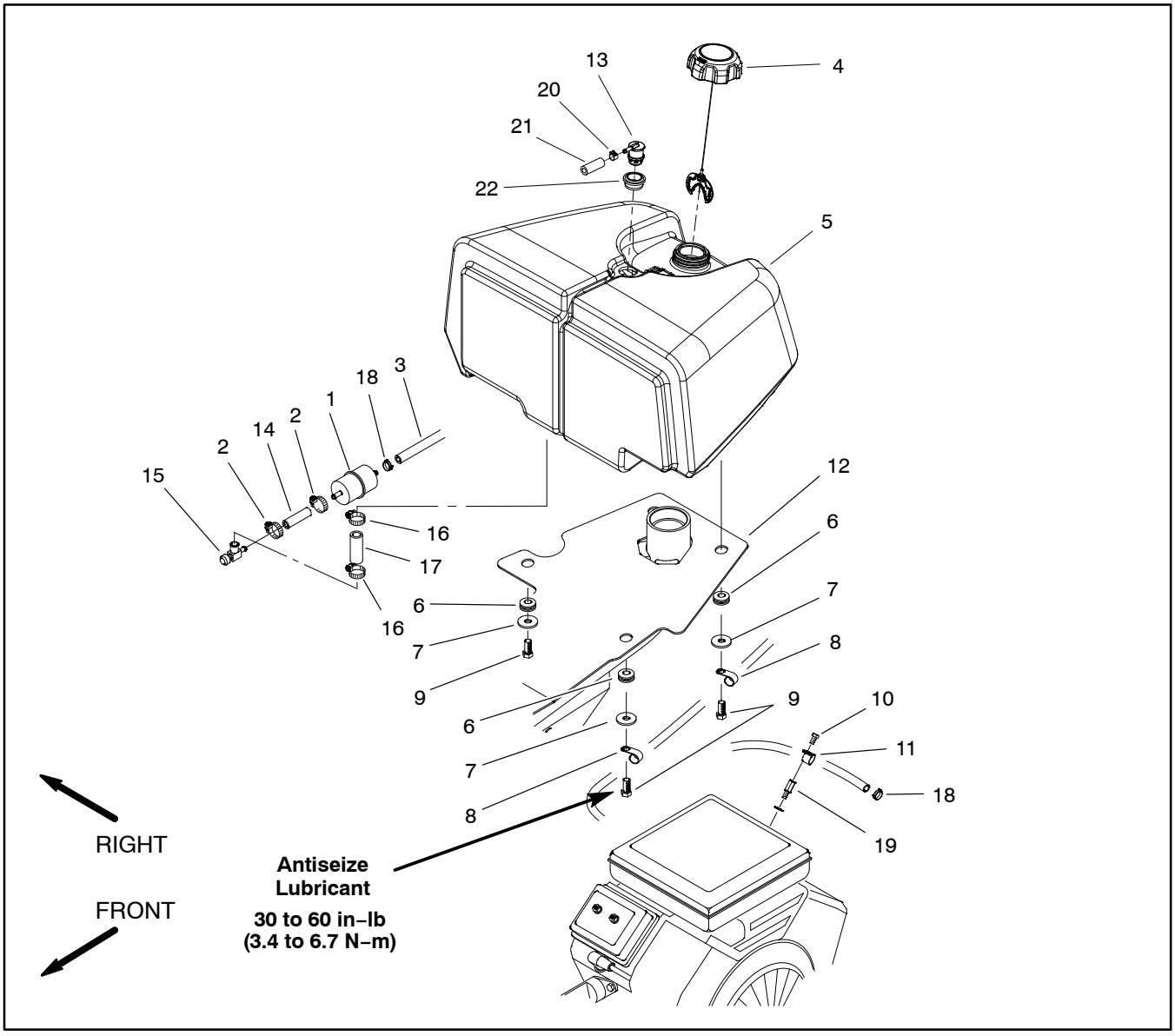

Figure 1

1. Fuel filter
2. Hose clamp
3. Fuel hose (filter to engine)
4. Fuel cap
5. Fuel tank
6. Grommet (4 used)
7. Flat washer (4 used)
8. Hose support clamp
9. Cap screw (4 used)
10. Cap screw
11. Hose support clamp
12. Vehicle frame
13. Fuel tank vent fitting
14. Fuel hose (shut–off valve to filter)
15. Fuel shut–off valve
16. Hose clamp
17. Fuel hose (tank to shut–off valve)
18. Hose clamp
19. Spacer
20. Hose clamp
21. Fuel vent hose (fitting to cannister)
22. Grommet

Fuel Tank Removal (Fig. 1)

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

CAUTION

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

DANGER

Gasoline is 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 or in an enclosed area. Always fill fuel tank outside and wipe up any spilled fuel before starting the engine. Store fuel in a clean, safety−approved container and keep the cap in place. Use gasoline for the engine only; not for any other purpose.

2. Drain fuel tank as follows:

   A. Close fuel shut−off valve (item 15).

   B. Disconnect fuel hose (item 14) at the fuel shut−off valve and drain any fuel trapped in the fuel filter and fuel hose into a suitable container.

   C. Install one end of a spare length of fuel hose to the fuel shut−off valve and place the other end of the hose into a suitable container for draining the tank.

   D. Drain fuel tank completely by opening the fuel shut off valve.

   E. Remove the spare length of fuel hose from the fuel shut−off valve.

3. Disconnect vent hose (item 21) from fuel tank vent fitting (item 13) on top of tank.

4. Remove four (4) cap screws (item 9), grommets (item 6) and flat washers (item 7) securing the fuel tank to the vehicle frame. Remove the fuel tank from the vehicle frame.

Fuel Tank installation (Fig. 1)

IMPORTANT: After fuel tank is installed, make sure that clearance between hydraulic reservoir and fuel tank if from 0.125" to 0.375" (3.2 to 9.5 mm).

1. Position fuel tank on the vehicle frame.

   A. Apply antiseize lubricant to the threads of the four (4) cap screws (item 9).

   B. Secure the fuel tank to the vehicle frame with four (4) flat washers (item 7), grommets (item 6) and cap screws (item 9). Make sure the grommets are between the flat washers and the frame. Also, make sure that fuel hose support clamps (item 8) are positioned correctly.

   C. Torque cap screws from **30 to 60 in−lb (3.4 to 6.7 N−m)**.

2. Connect vent hose (item 21) to fuel tank vent fitting (item 13) on top of tank and secure with hose clamp. Make sure that hose is not kinked or obstructed.

3. Connect fuel hose (item 14) to the fuel shut−off valve (item 15) and secure with hose clamp.

4. Open fuel shut−off valve and fill fuel tank with fuel. Check all fuel hoses and tank for leaks.

Engine

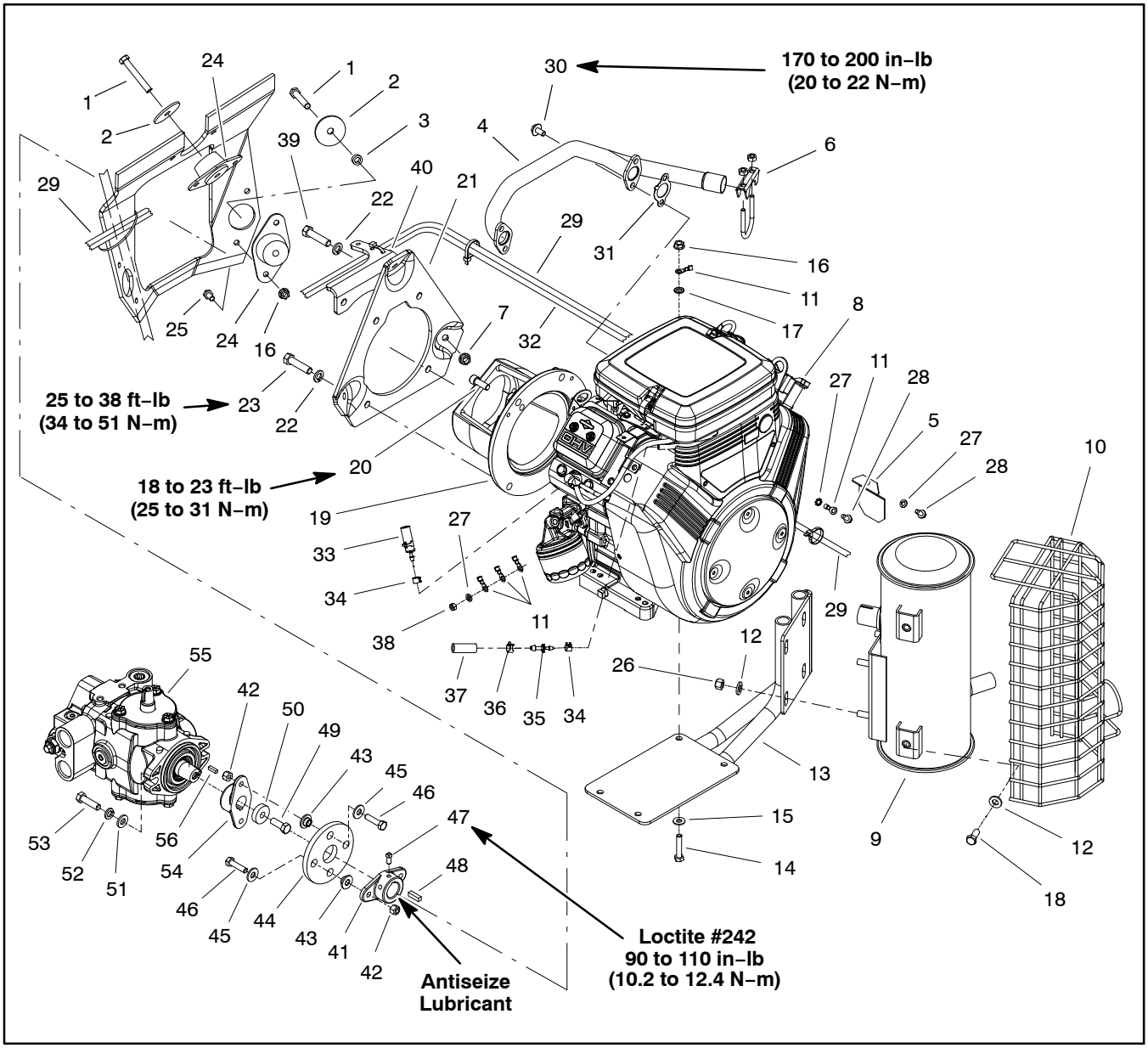

Figure 2

1. Cap screw (3 used)
2. Flat washer (3 used)
3. Spacer (3 used)
4. Exhaust manifold
5. Regulator shield
6. Muffler clamp
7. Flange nut (3 used)
8. Engine assembly
9. Muffler
10. Muffler shield
11. Ground wires
12. Flat washer (8 used)
13. Muffler mount
14. Cap screw (4 used)
15. Flat washer (4 used)
16. Hex flange nut (10 used)
17. Lock washer
18. Cap screw (4 used)
19. Pump adapter
20. Socket head screw (2 used)
21. Engine mount plate
22. Lock washer (4 used)
23. Cap screw (2 used)
24. Engine mount (3 used)
25. Cap screw (6 used)
26. Lock nut (4 used)
27. Spring washer (3 used)
28. Washer head screw (2 used)
29. Engine wire harness
30. Flange head screw (4 used)
31. Gasket (2 used)
32. Battery cable
33. Purge hose assy (to intake manifold)
34. Hose clamp (2 used)
35. Barbed fitting
36. Hose clamp
37. Hose (to air cleaner base)
38. Hex nut
39. Cap screw (2 used)
40. Spring bracket
41. Engine hub
42. Lock nut (4 used)
43. Coupling spacer (4 used)
44. Rubber coupling
45. Flat washer (4 used)
46. Cap screw (4 used)
47. Square head set screw (2 used)
48. Key
49. Cap screw
50. Spacer
51. Hardened washer (2 used)
52. Lock washer (2 used)
53. Cap screw (2 used)
54. Pump hub
55. Piston pump assembly
56. Key

Engine Removal (Fig. 2)

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

2. Disconnect negative (–) battery cable from battery.

CAUTION

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

DANGER

Gasoline is 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 or in an enclosed area. Always fill fuel tank outside and wipe up any spilled fuel before starting the engine. Store fuel in a clean, safety–approved container and keep the cap in place. Use gasoline for the engine only; not for any other purpose.

3. Close fuel shut–off valve on fuel tank.

4. Remove the fuel hose support clamp and disconnect fuel hose at the fuel pump (Fig. 3). Drain any fuel trapped in the fuel filter and fuel hose into a suitable container.

5. Disconnect the fuel evaporative control system hoses from engine (see Fuel Evaporative Control System in this section).

6. Disconnect the engine wiring harness (item 29), the choke control cable, the throttle control cable and the ground wires (item 11) at the engine.

7. Carefully disconnect extension spring on piston pump control assembly from spring bracket that is attached to engine mount plate (Fig. 4).

8. Loosen the two (2) set screws (item 47) securing the engine hub (item 41) to the engine shaft.

9. Support the piston pump assembly and remove the two (2) cap screws (item 53), lock washers (item 52) and hardened washers (item 51) securing the pump to the pump adapter (item 19). **Do Not** disconnect the hydraulic hoses or neutral control linkage from the pump.

10. Support the engine assembly and remove the three (3) engine mount flange nuts (item 7), cap screws (item 1), flat washers (item 2) and spacers (item 3).

11. Carefully move the engine away from the piston pump until the crankshaft clears the engine hub. Remove the engine from the machine. Locate and retrieve key (item 48) from crankshaft.

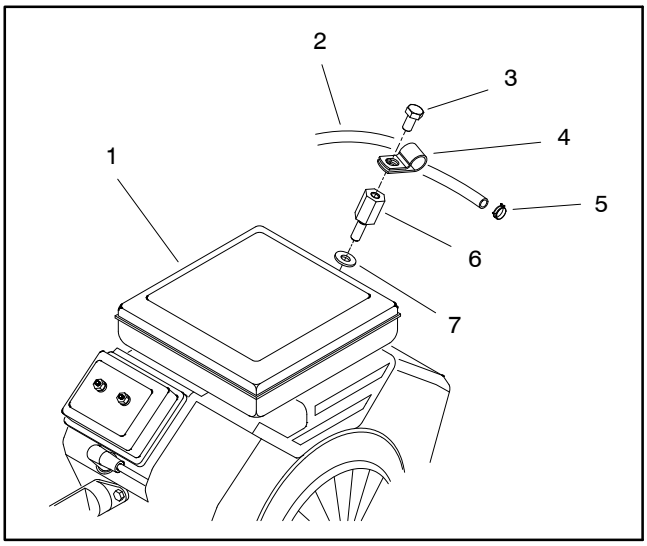

Figure 3

1. Engine assembly
2. Fuel supply hose
3. Cap screw
4. Support clamp
5. Hose clamp
6. Spacer screw
7. Washer

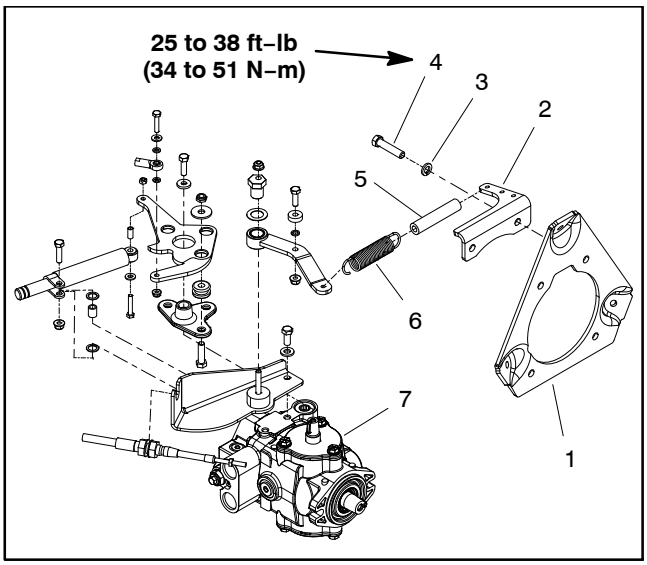

Figure 4

1. Engine mount plate
2. Spring bracket
3. Lock washer (2 used)
4. Cap screw (2 used)
5. Dampener hose
6. Extension spring
7. Piston pump assembly

Engine Installation (Fig. 2)

1. Make sure that all parts removed from the engine during maintenance or rebuilding are installed to the engine.

2. Apply antiseize lubricant to bore of engine hub. Place key (item 48) into slot on the engine crankshaft.

IMPORTANT: Make sure to not damage engine, fuel hose, hydraulic hoses, electrical harness, control cables or other parts while installing the engine. Make sure engine hub is in position before installing the engine mount cap screws.

3. Align the engine hub (item 41) with the engine shaft and key (item 48). Slide crankshaft into hub and move engine until the engine mount plate (item 21) is aligned with the three (3) engine mounts (item 24). Take care to not damage the rubber coupling (item 44) during engine installation.

4. Install the three (3) engine mount cap screws (item 1), flat washers (item 2), spacers (item 3) and flange nuts (item 7).

5. Position the piston pump assembly to the pump adapter (item 19) and secure with two (2) cap screws (item 53) lock washers (item 52) and hardened washers (item 51).

6. Position engine hub on crankshaft to best align the rubber coupling.

7. Apply Loctite #242 (or equivalent) to threads of engine hub set screws (item 47). Secure hub to crankshaft with two (2) set screws. Torque set screws from **90 to 110 in−lb (10.2 to 12.4 N−m)**.

8. Carefully connect extension spring on piston pump control assembly to spring bracket that is attached to engine mount plate (Fig. 4).

9. Connect the engine wiring harness (item 29) and ground wires (item 11) to the engine.

10. Connect and adjust the choke and throttle control cables.

11. Connect the fuel evaporative control system hoses to engine (see Fuel Evaporative Control System in this section).

12. Connect fuel hose to the fuel pump and secure with hose clamp. Install the fuel hose support clamp.

13. Secure negative (−) battery cable to battery.

14. Open fuel shut−off valve on fuel tank. Check fuel hose for leaks.

15. Check engine oil level and adjust if necessary.

16. Start the engine and check for proper engine operation.

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Fuel Evaporative Control System

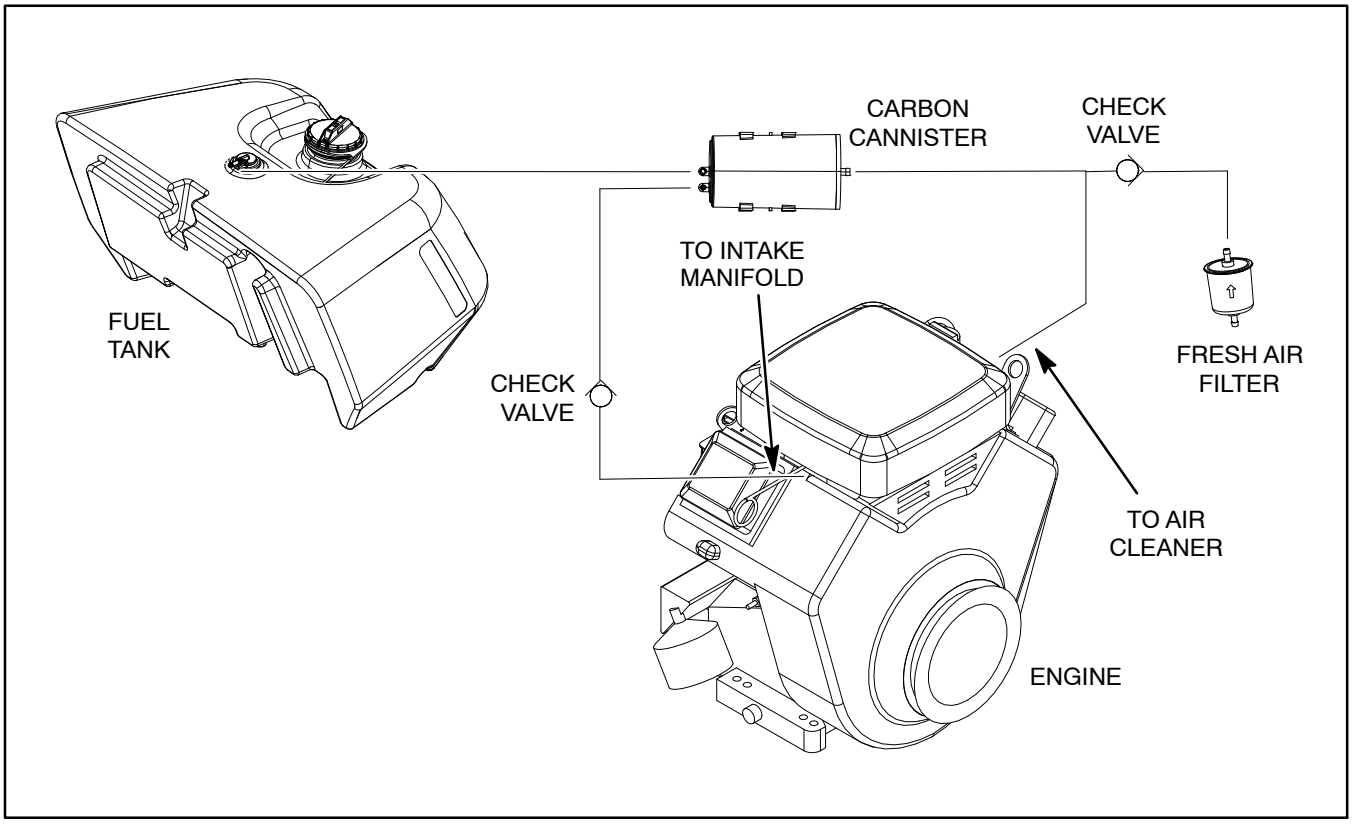

Figure 5

Greensmaster 3150 machines are equipped with a fuel evaporative control system designed to collect and store evaporative emissions from the fuel tank. The evaporate control system uses a carbon cannister to collect these evaporative emissions. Fuel vapors from the fuel tank are vented to the canister. Vapors from the canister are consumed when the engine is running.

The fuel tank on Greensmaster 3150 machines uses a non−vented fuel cap. To connect the tank to the evaporative control system, a fuel tank vent fitting is positioned in the top of the tank that allows tank venting through the carbon cannister.

NOTE: If there is restriction in the carbon cannister or the fuel tank vent fitting, the fuel tank may distort due to venting issues. If the fuel tank returns to it's normal shape when the fuel cap is removed, restriction in the evaporative control system is likely.

The carbon canister is mounted on the hydraulic leak detector tank (Fig. 6). The evaporative system includes two (2) connections to the engine: one to the intake manifold and the second to the air cleaner base. Venting hose assemblies (purge hose assembly and t−hose assembly) include check valves in two (2) locations as shown in Figure 5.

NOTE: The purge hose assembly (item 5 in Fig. 6) and tee hose assembly (item 10 in Fig. 6) both include a check valve as a component of the hose assembly. The check valve is not available as a separate part. To ensure proper operation of check valves, do not attempt to remove them from the hose assembly. If either of these hose assemblies is removed, make sure that they are correctly installed to ensure proper operation of the evaporative control system.

Disassembly (Fig. 6)

DANGER

Gasoline is flammable. Use caution when storing or handling it. Wipe up any spilled fuel before starting the engine.

1. Inspect carbon cannister and attached hoses for damage or obvious leaks. A damaged or leaking cannister should be replaced.

2. Remove components as needed using Figure 6 as a guide.

   A. If either purge hose assembly (item 5) or T−hose assembly (item 10) is to be removed, label ends of hose for assembly purposes. Both of these assemblies include a check valve so direction of installation is important for correct operation of the evaporative control system. The check valve is not available as a separate part so hose assembly replacement is necessary if the check valve or hose is faulty. To ensure proper operation of check valves, do not attempt to remove them from the hose assembly.

Assembly

1. Install all removed components using Figure 6 as a guide.

   A. If either purge hose assembly (item 5) or T−hose assembly (item 10) was removed, make sure that installation is correct.

   B. Make sure that fuel hoses are not kinked after installation. Also, secure all hoses with hose clamps.

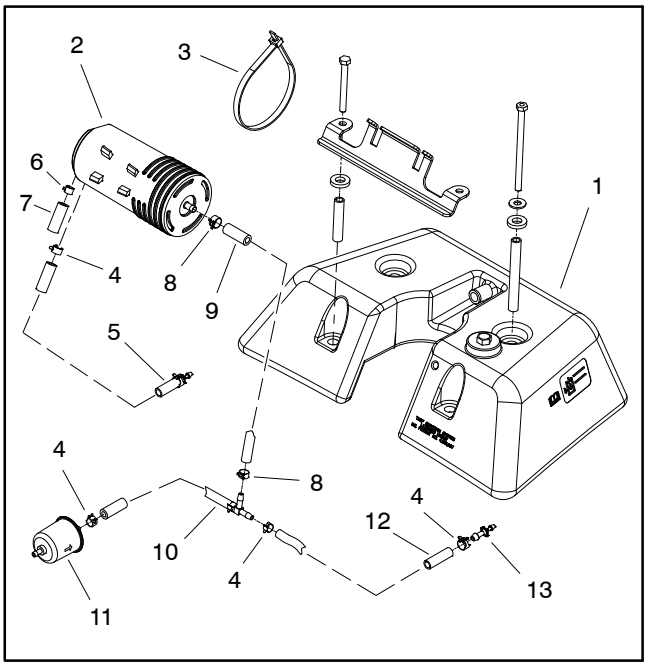

Figure 6

1. **Leak detector tank**
2. **Carbon cannister**
3. **Cable tie (2 used)**
4. **Hose clamp**
5. **Purge hose assembly**
6. **Hose clamp**
7. **Hose (to fuel tank vent)**
8. **Hose clamp**
9. **Hose (to t−fitting)**
10. **T−hose assembly**
11. **Fresh air filter**
12. **Hose (to air cleaner)**
13. **Barbed fitting**

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Chapter 4

Hydraulic System

Table of Contents

Specifications

Item	Description
Piston (Traction) Pump Maximum Pump Displacement (per revolution) Charge Pressure	Variable displacement piston pump 1.24 in^3 (20.3 cc) 110 to 150 PSI (8 to 10 bar)
Gear Pump Front Section (cutting reels) Displacement (per revolution) Rear Section (steering/lift) Displacement (per revolution)	2 section, positive displacement gear pump 0.58 in^3 (9.5 cc) 0.33 in^3 (5.4 cc)
Front Wheel Motors Displacement (per revolution)	Orbital rotor motor 10.3 in^3 (169 cc)
Rear Wheel Motor (Optional 3WD Kit) Displacement (per revolution)	Orbital rotor motor 20.6 in^3 (337 cc)
Cutting Reel Motor Displacement (per revolution)	Gear motor 0.73 in^3 (12 cc)
Steering Control Valve	Distributor valve with rotary meter
Implement (Steering and Lift) Relief Pressure	1160 PSI (80 bar) above Charge Pressure
Hydraulic Manifold Relief Valves Mow Circuit (S1R1) Cutting Unit Lower (R2)	 3000 PSI (207 bar) 400 PSI (28 bar) above Charge Pressure
Hydraulic Filter	Spin−on cartridge type
Hydraulic Oil	See Operator's Manual
Hydraulic Reservoir	Reservoir (with leak detector) capacity 8.5 gal. U.S. (32.2 L)

General Information

Operator's Manual

The Operator's Manual provides information regarding the operation, general maintenance and maintenance intervals for your Greensmaster 3150. Refer to that publication for additional information when servicing the machine.

Check Hydraulic System Fluid

The hydraulic system on the Greensmaster 3150 is designed to operate on high quality hydraulic fluid. Refer to the Operator's Manual for hydraulic fluid recommendations.

IMPORTANT: Check level of hydraulic fluid before engine is first started and daily thereafter. Do not overfill hydraulic reservoir.

NOTE: If changing from one type of hydraulic fluid to another, be certain to remove all the old fluid from the system, as some fluids are incompatible with others.

IMPORTANT: Use only types of hydraulic fluids specified in the Operator's Manual. Other fluids may cause system damage.

NOTE: A red dye additive for the hydraulic system fluid is available in 2/3 oz bottles. One bottle is sufficient for 4 to 6 gallons of hydraulic fluid. Order Part No. 44–2500 from your Authorized Toro Distributor.

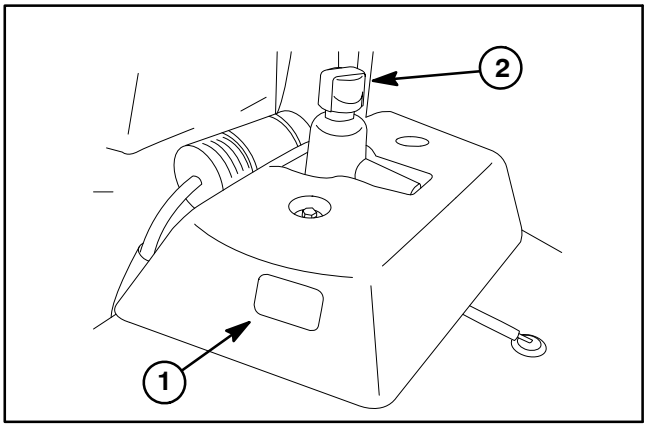


Figure 1

1. **Sight window**
2. **Hydraulic oil cap**

Towing Traction Unit

In case of emergency, the Greensmaster 3150 can be towed for a short distance. However, Toro does not recommend this as a standard practice.

IMPORTANT: Do not tow the machine faster than 2 to 3 mph because drive system may be damaged. If machine must be moved a considerable distance, transport it on a truck or trailer.

1. Locate by−pass valve on the rear side of the piston pump. Rotate valve 90º so the slot in the valve is vertical.

2. Before starting engine, close by−pass valve by rotating it back 90º so the slot in the valve is horizontal. Do not start engine when the valve is open.

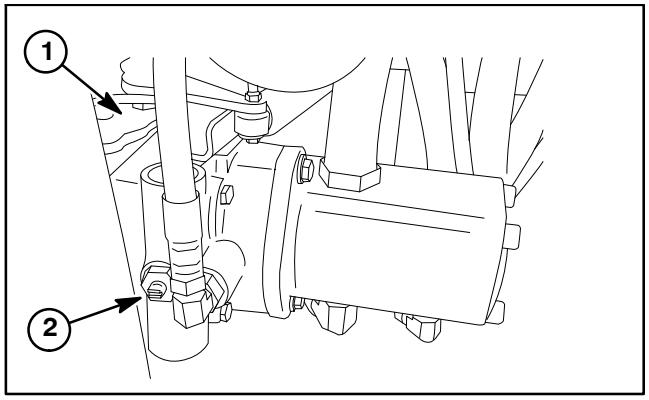


Figure 2

1. Piston pump
2. By−pass valve

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 and maintenance. These conditions can cause hose damage and deterioration. Some hoses are more susceptible to these conditions than others. Inspect all machine hydraulic hoses frequently for signs of deterioration or damage:

Hard, cracked, cut, abraded, charred, leaking or otherwise damaged hose.

Kinked, crushed, flattened or twisted hose.

Blistered, soft, degraded or loose hose cover.

Cracked, damaged or badly corroded hose fittings.

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 (layline) on the hose. Use two wrenches; hold the hose straight with one wrench and tighten the hose swivel nut onto the fitting with the other wrench (see Hydraulic Hose and Tube Installation in this section). If the hose has an elbow at one end, tighten the swivel nut on that end before tightening the nut on the straight end of the hose.

For additional hydraulic hose information, refer to Toro Service Training Book, Hydraulic Hose Servicing (Part Number 94813SL).

WARNING

Before disconnecting or performing any work on hydraulic system, relieve all pressure in system (see Relieving Hydraulic System Pressure in this section).

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 Hose and Tube Installation (O−Ring Face Seal Fitting)

1. Make sure threads and sealing surfaces of the hose/tube and the fitting are free of burrs, nicks, scratches or any foreign material.

2. As a preventative measure against leakage, it is recommended that the face seal O−ring be replaced any time the connection is opened. Make sure the O−ring is installed and properly seated in the fitting groove. Lightly lubricate the O−ring with clean hydraulic oil.

3. Place the hose/tube against the fitting body so that the flat face of the hose/tube sleeve fully contacts the O−ring in the fitting.

4. Thread the swivel nut onto the fitting by hand. While holding the hose/tube with a wrench, use a torque wrench to tighten the swivel nut to the recommended installation torque shown in Figure 5. This tightening process will require the use of an offset wrench (e.g. crowfoot wrench). Use of an offset wrench will affect torque wrench calibration due to the effective length change of the torque wrench. Tightening torque when using a torque wrench with an offset wrench will be lower than the listed installation torque (see Using a Torque Wrench with an Offset Wrench in the Torque Specifications section of Chapter 2 − Product Records and Maintenance).

5. If a torque wrench is not available or if space at the swivel nut prevents use of a torque wrench, an alternate method of assembly is the Flats From Wrench Resistance (F.F.W.R.) method (Fig. 2).

A. Using a wrench, tighten the swivel nut onto the fitting until light wrench resistance is reached (approximately 30 in−lb).

B. Mark the swivel nut and fitting body. Hold the hose/tube with a wrench to prevent it from turning.

C. Use a second wrench to tighten the nut to the correct Flats From Wrench Resistance (F.F.W.R.). The markings on the nut and fitting body will verify that the connection has been properly tightened.

Size	F.F.W.R.
4 (1/4 in. nominal hose or tubing)	1/2 to 3/4
6 (3/8 in.)	1/2 to 3/4
8 (1/2 in.)	1/2 to 3/4
10 (5/8 in.)	1/2 to 3/4
12 (3/4 in.)	1/3 to 1/2
16 (1 in.)	1/3 to 1/2

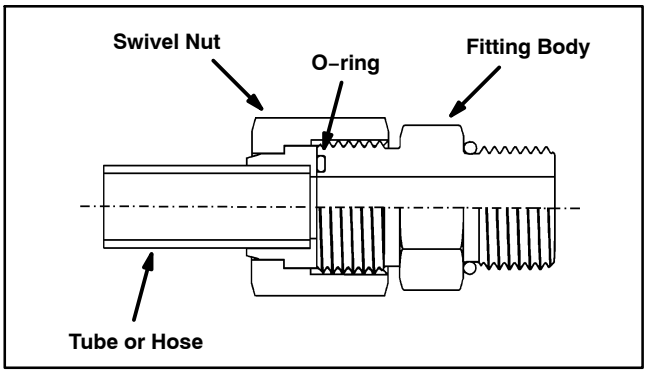


Figure 3

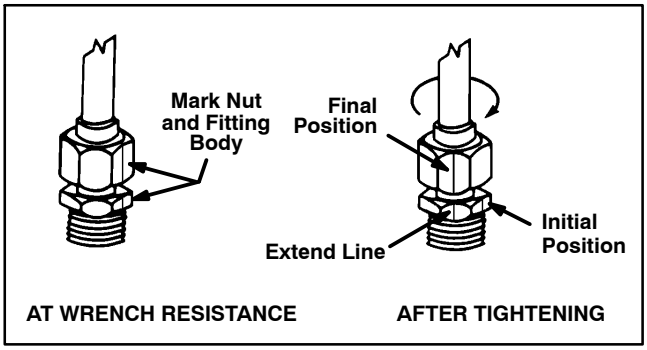


Figure 4

Fitting Dash Size	Hose/Tube Side Thread Size	Installation Torque
4	9/16 − 18	18 to 22 ft−lb (25 to 29 N−m)
6	11/16 − 16	27 to 33 ft−lb (37 to 44 N−m)
8	13/16 − 16	37 to 47 ft−lb (51 to 63 N−m)
10	1 − 14	60 to 74 ft−lb (82 to 100 N−m)
12	1 3/16 − 12	85 to 105 ft−lb (116 to 142 N−m)
16	1 7/16 − 12	110 to 136 ft−lb (150 to 184 N−m)
20	1 11/16 − 12	140 to 172 ft−lb (190 to 233 N−m)

Figure 5

Hydraulic Fitting Installation (SAE Straight Thread O−Ring Fitting into Component Port)

Non−Adjustable Fitting (Fig. 6)

1. Make sure all threads and sealing surfaces of fitting and component port are free of burrs, nicks, scratches or any foreign material.

2. As a preventative measure against leakage, it is recommended that the O−ring be replaced any time the connection is opened.

3. Lightly lubricate the O−ring with clean hydraulic oil. Fitting threads should be clean with no lubricant applied.

IMPORTANT: Before installing fitting into port, determine port material. If fitting is to be installed into an aluminum port, installation torque is reduced.

4. Install the fitting into the port. Then, use a torque wrench and socket to tighten the fitting to the recommended installation torque shown in Figure 7.

NOTE: Use of an offset wrench (e.g. crowfoot wrench) will affect torque wrench calibration due to the effective length change of the torque wrench. Tightening torque when using a torque wrench with an offset wrench will be less than the recommended installation torque. See Using a Torque Wrench with an Offset Wrench in the Torque Specifications section of Chapter 2 − Product Records and Maintenance to determine necessary conversion information.

5. If a torque wrench is not available, or if space at the port prevents use of a torque wrench, an alternate method of assembly is the Flats From Finger Tight (F.F.F.T.) method.

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

B. If port material is steel, tighten the fitting to the listed F.F.F.T. If port material is aluminum, tighten fitting to 60% of listed 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

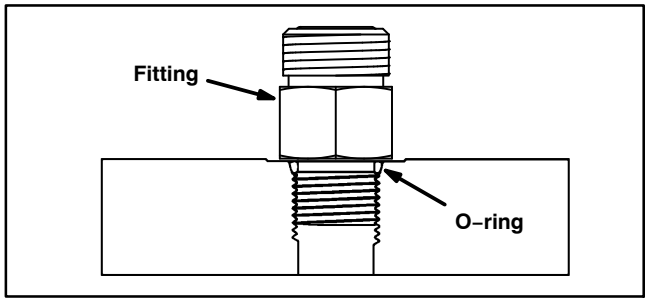


Figure 6

Fitting Dash Size	Fitting Port Side Thread Size	Installation Torque Into Steel Port	Installation Torque Into Aluminum Port
4	7/16 − 20	15 to 19 ft−lb (21 to 25 N−m)	9 to 11 ft−lb (13 to 15 N−m)
5	1/2 − 20	18 to 22 ft−lb (25 to 29 N−m)	11 to 15 ft−lb (15 to 20 N−m)
6	9/16 − 18	34 to 42 ft−lb (47 to 56 N−m)	20 to 26 ft−lb (28 to 35 N−m)
8	3/4 − 16	58 to 72 ft−lb (79 to 97 N−m)	35 to 43 ft−lb (48 to 58 N−m)
10	7/8 − 14	99 to 121 ft−lb (135 to 164 N−m)	60 to 74 ft−lb (82 to 100 N−m)
12	1 1/16 − 12	134 to 164 ft−lb (182 to 222 N−m)	81 to 99 ft−lb (110 to 134 N−m)
14	1 3/16 − 12	160 to 196 ft−lb (217 to 265 N−m)	96 to 118 ft−lb (131 to 160 N−m)
16	1 5/16 − 12	202 to 248 ft−lb (274 to 336 N−m)	121 to 149 ft−lb (165 to 202 N−m)
20	1 5/8 − 12	247 to 303 ft−lb (335 to 410 N−m)	149 to 183 ft−lb (202 to 248 N−m)

Figure 7

Adjustable Fitting (Fig. 8)

1. Make sure all threads and sealing surfaces of fitting and component port are free of burrs, nicks, scratches or any foreign material.

2. As a preventative measure against leakage, it is recommended that the O−ring be replaced any time the connection is opened.

3. Lightly lubricate the O−ring with clean hydraulic oil. Fitting threads should be clean with no lubricant applied.

4. Turn back the lock nut as far as possible. Make sure the back up washer is not loose and is pushed up as far as possible (Step 1 in Figure 9).

IMPORTANT: Before installing fitting into port, determine port material. If fitting is to be installed into an aluminum port, installation torque is reduced.

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 use a torque wrench to tighten the fitting to the recommended installation torque shown in Figure 7. This tightening process will require the use of an offset wrench (e.g. crowfoot wrench). Use of an offset wrench will affect torque wrench calibration due to the effective length change of the torque wrench. Tightening torque when using a torque wrench with an offset wrench will be lower than the listed installation torque (see Using a Torque Wrench with an Offset Wrench in the Torque Specifications section of Chapter 2 − Product Records and Maintenance).

8. If a torque wrench is not available, or if space at the port prevents use of a torque wrench, an alternate method of assembly is the Flats From Finger Tight (F.F.F.T.) method. Hold the fitting in the desired position with a wrench and, if port material is steel, tighten the lock nut with a second wrench to the listed F.F.F.T (Step 4). If port material is aluminum, tighten fitting to 60% of listed 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

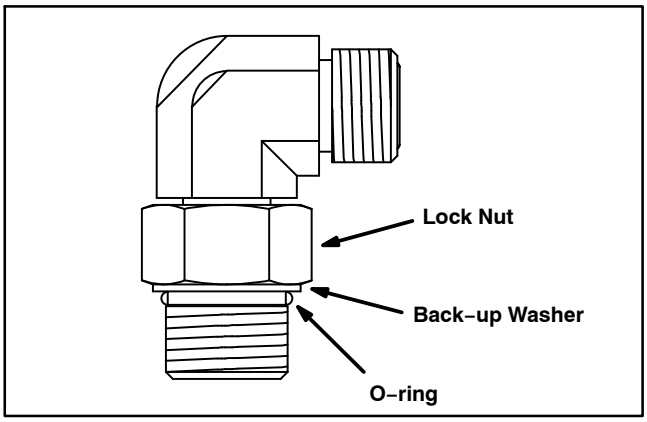


Figure 8

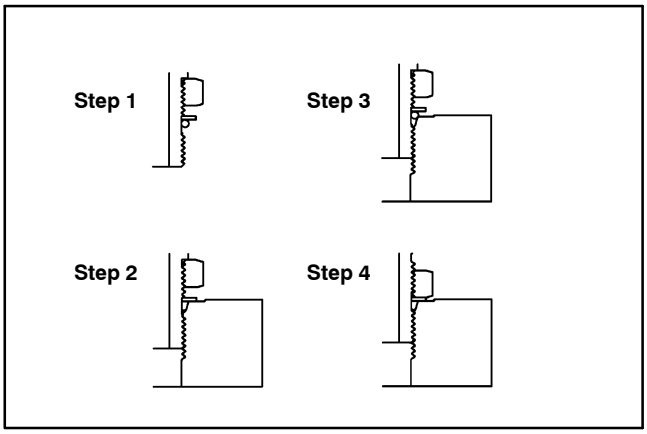
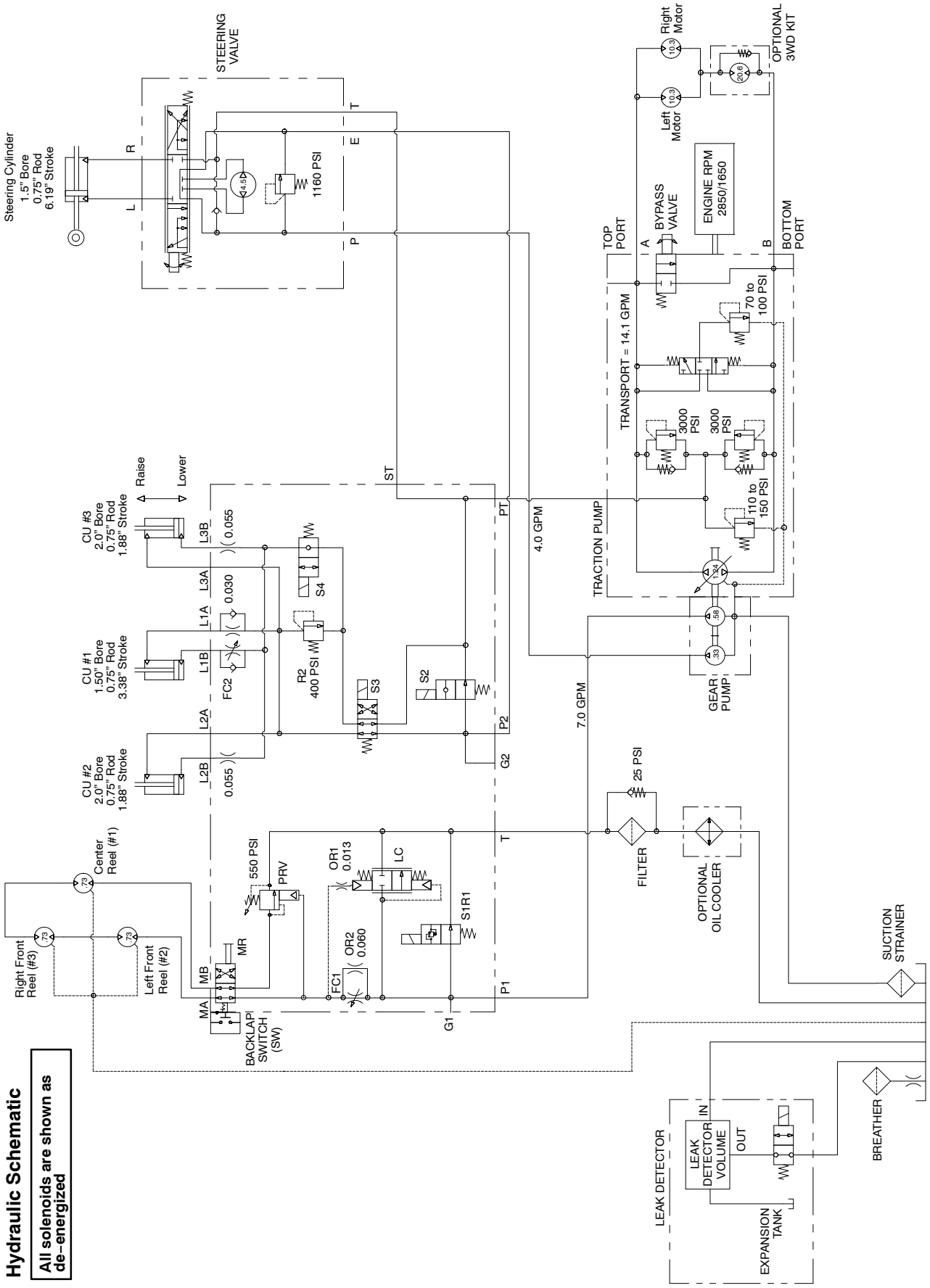


Figure 9

Hydraulic Schematic



Greensmaster 3150
Hydraulic Schematic

All solenoids are shown as de−energized

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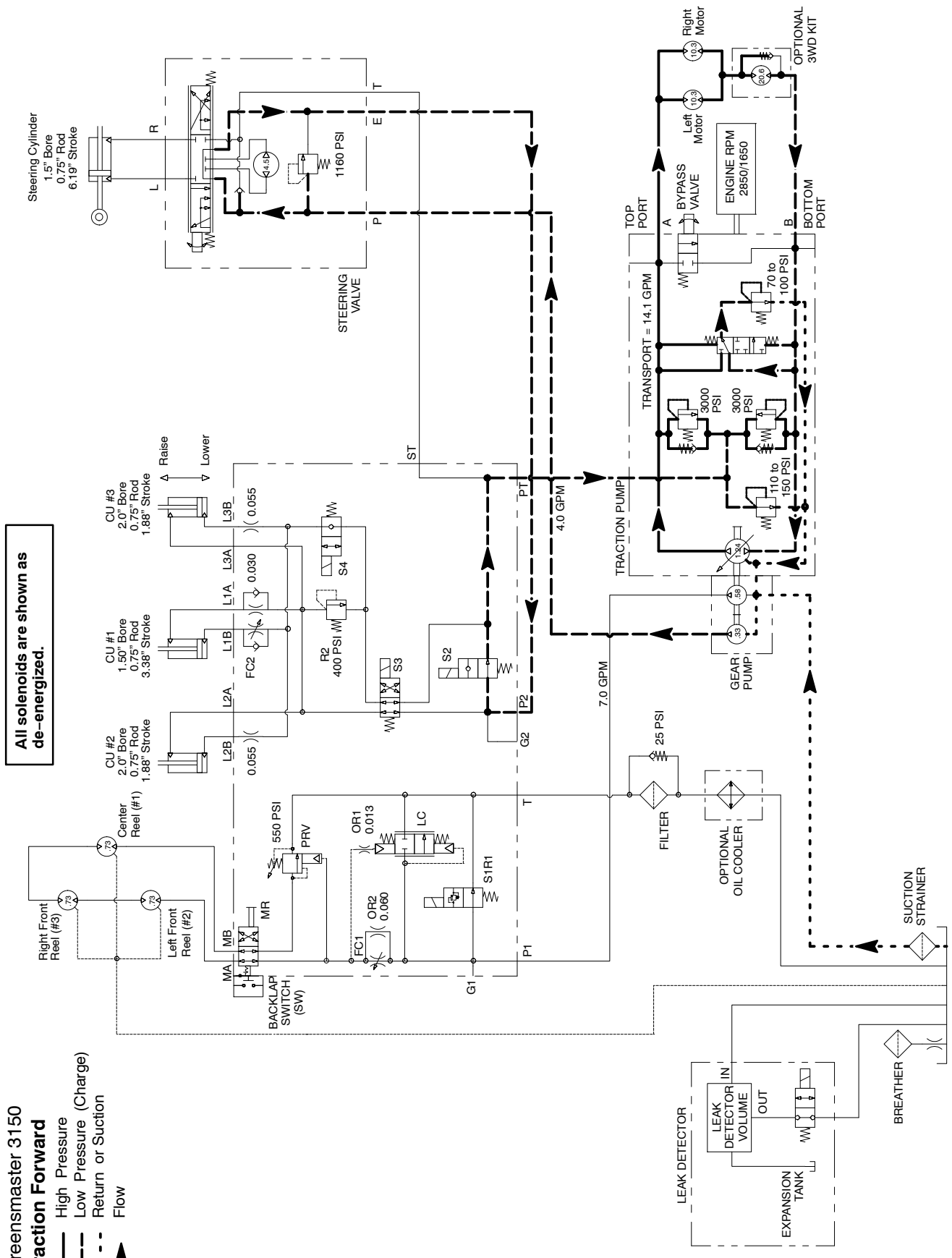
Hydraulic Flow Diagrams



Traction Forward and Reverse

Forward

The piston (traction) pump is driven directly by the engine. The traction circuit of the hydraulic system acts essentially as a closed loop. Taking its suction directly from the return side of the wheel motors of the traction circuit, the piston pump supplies oil flow to the wheel motors through the supply side of the traction circuit.

With the engine running and traction pedal in the neutral position, the piston pump supplies no flow to the wheel motors. When the traction pedal is pressed to the forward position, the linkage from the pedal positions the swash plate in the piston pump so oil flows out the top port of the pump. Oil flow out of the top port goes to the wheel motors and turns them in the forward direction.

Oil flowing out of the wheel motors returns to the bottom port of the piston pump and is continuously pumped out the top port as long as the traction pedal is pressed for the forward direction.

Hydraulic oil is supplied to the traction charge circuit from the rear gear pump section though the steering valve, control manifold and back through the charge circuit check valves in the piston (traction) pump. This oil replaces oil losses from flow through the internal case drain, shuttle valve and small amounts of traction circuit leakage. Charge circuit pressure is maintained by the charge relief valve that is attached to the piston pump back plate.

Reverse

The traction circuit operates essentially the same in reverse as it does in the forward direction. However, the flow through the circuit is reversed.

With the engine running and traction pedal in the neutral position, the piston pump supplies no flow to the wheel motors. When the traction pedal is pressed to the reverse position, the linkage from the pedal positions the swash plate in the piston pump so oil flows out the bottom port of the pump. Oil flow out of the bottom port goes to the wheel motors and turns them in the reverse direction.

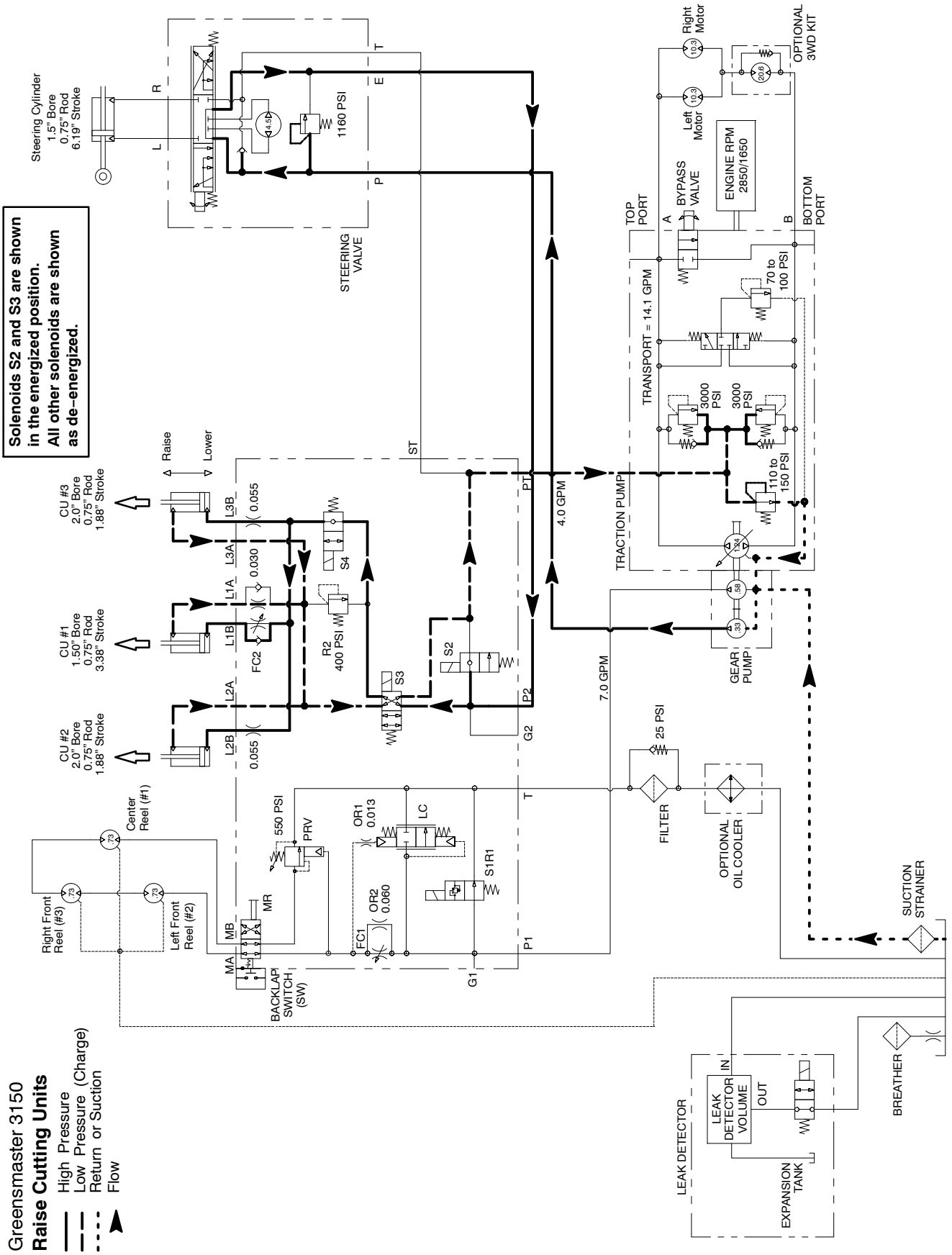
Oil flowing out of the wheel motors returns to the top port of the piston pump and is continuously pumped out the bottom port as long as the traction pedal is pressed for the reverse direction.

The charge circuit functions the same in reverse as it does in the forward direction.

Traction Circuit Cooling

The piston pump includes a shuttle valve that bleeds off a small amount of hydraulic fluid for cooling of the closed loop traction circuit. This valve allows a small amount of hydraulic oil to pass from the low pressure side of the traction circuit while operating the traction unit in either direction. A relief valve in the piston pump back plate prevents shuttle valve bleed off until the relief valve opens (70 to 100 PSI / 5 to 7 bar). The charge circuit replenishes oil that is bled from the traction circuit by the shuttle valve.

NOTE: The shuttle valve assembly is located in the piston pump back plate. Access to the shuttle valve requires removal of the back plate from the piston pump.


Greensmaster 3150
Raise Cutting Units
High Pressure
Low Pressure (Charge)
Return or Suction
Flow
Solenoids S2 and S3 are shown in the energized position.
All other solenoids are shown as de–energized.
Steering Cylinder
1.5" Bore
0.75" Rod
6.19" Stroke
STEERING VALVE
1160 PSI
Raise
Lower
CU #3
2.0" Bore
0.75" Rod
1.88" Stroke
CU #1
1.50" Bore
0.75" Rod
3.38" Stroke
CU #2
2.0" Bore
0.75" Rod
1.88" Stroke
L3B
L3A
L1A
L1B
L2A
L2B
0.055
0.030
FC2
R2
400 PSI
S4
S3
S2
ST
PT
P2
G2
P1
G1
T
4.0 GPM
7.0 GPM
TRACTION PUMP
TRANSPORT = 14.1 GPM
TOP PORT
BOTTOM PORT
BYPASS VALVE
ENGINE RPM
2850/1650
3000 PSI
3000 PSI
70 to 100 PSI
110 to 150 PSI
Right Motor
Left Motor
OPTIONAL 3WD KIT
GEAR PUMP
25 PSI
FILTER
OPTIONAL OIL COOLER
SUCTION STRAINER
550 PSI
PRV
OR1
0.013
OR2
0.060
LC
S1R1
FC1
MR
MB
MA
BACKLAP SWITCH (SW)
Center Reel (#1)
Right Front Reel (#3)
Left Front Reel (#2)
LEAK DETECTOR
LEAK DETECTOR VOLUME
IN
OUT
EXPANSION TANK
BREATHER

Raise and Lower Cutting Units

The tandem gear pump is directly coupled to the piston (traction) pump. The rear gear pump section supplies hydraulic flow for the steering circuit (priority flow), for raising and lowering the cutting units and for the traction charge circuit. The gear pump takes its suction from the hydraulic reservoir. Maximum circuit pressure of 1160 PSI (80 bar) is limited by the relief valve located in the steering valve.

During cutting unit hold (not raising or lowering) conditions, flow from the rear gear pump section is by−passed through the steering valve and de−energized solenoid valve (S2) in the hydraulic manifold directly to the traction charge circuit. Flow in excess of charge circuit requirements then returns to the gear pump inlet.

Raise Cutting Units

When the cutting units are to be raised, hydraulic manifold solenoid valve (S2) is energized and blocks flow directly to the traction charge circuit. Flow is directed to energized solenoid valve (S3), which directs flow to de−energized solenoid valve (S4) and the lift cylinders. Hydraulic pressure against the cylinder pistons moves their shafts causing the cutting units to raise. At the same time, the pistons push the hydraulic fluid out of the lift cylinders and back through energized solenoid valve (S3) to the charge circuit. Raise speed for the front cutting units is controlled by a 0.055 orifice. A 0.030 orifice in the return line for the center cutting unit allows a slight delay in raising that cutting unit.

When solenoid valves (S2) and (S3) de−energize, spring action returns the valves to their original position and by−passes flow back to the traction charge circuit stopping lift cylinder movement. The lift cylinder position is locked in place since there is no complete circuit of flow to and from the lift cylinders.

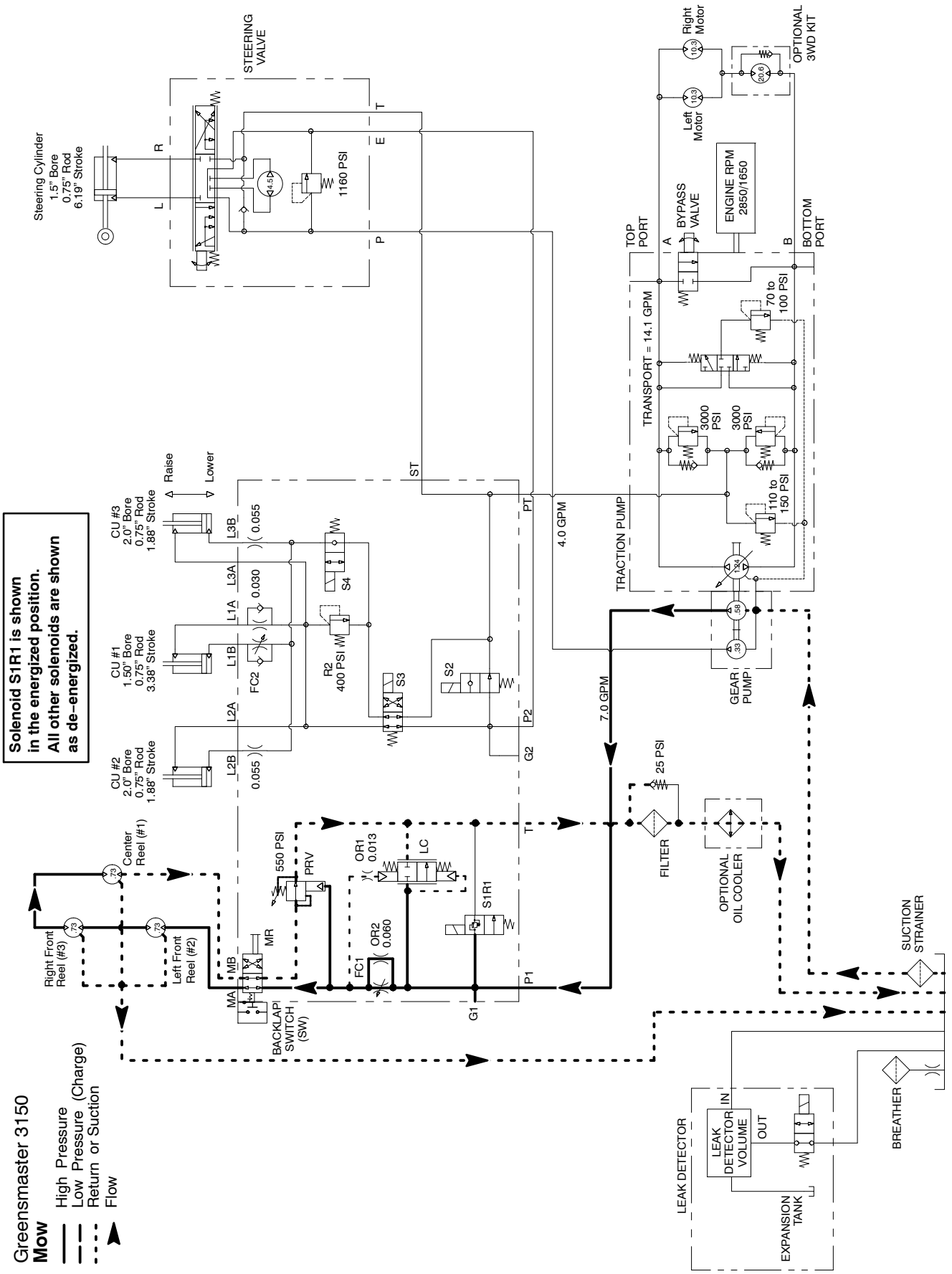
Lower Cutting Units

Circuit operation for lowering the lift cylinders is similar to raising them. However, the solenoid valve (S3) remains de−energized and solenoid valve (S4) is energized. Flow is reversed to and from the lift cylinders, lowering the cutting units.

When the cutting units are to be lowered, solenoid valve (S2) is energized and blocks flow directly to the traction charge circuit. Flow is directed to de−energized solenoid valve (S3), which directs flow to the lift cylinders. Hydraulic pressure against the cylinder pistons moves their shafts causing the cutting units to lower. At the same time, the pistons push the hydraulic fluid out of the lift cylinders to energized solenoid valve (S4). Flow continues back through solenoid valve (S3) to the charge circuit. Lower speed for the front cutting units is controlled by the 0.055 orifice. A 0.030 orifice and adjustable flow control valve for the center cutting unit allows a slight delay in lowering that cutting unit.

To control pressure while lowering the cutting units, the system is equipped with adjustable relief valve (R2) in the hydraulic manifold.

When solenoid valves (S2) and (S4) de−energize, spring action returns the valves to their original position and by−passes flow back to the traction charge circuit stopping lift cylinder movement.


Greensmaster 3150
Mow
High Pressure
Low Pressure (Charge)
Return or Suction
Flow
Solenoid S1R1 is shown in the energized position.
All other solenoids are shown as de−energized.
Steering Cylinder
1.5" Bore
0.75" Rod
6.19" Stroke
STEERING VALVE
1160 PSI
CU #3
2.0" Bore
0.75" Rod
1.88" Stroke
CU #1
1.50" Bore
0.75" Rod
3.38" Stroke
CU #2
2.0" Bore
0.75" Rod
1.88" Stroke
Raise
Lower
0.055
0.030
R2
400 PSI
FC2
S2
S3
S4
4.0 GPM
7.0 GPM
TRACTION PUMP
TRANSPORT = 14.1 GPM
TOP PORT
BOTTOM PORT
BYPASS VALVE
ENGINE RPM
2850/1650
3000 PSI
70 to 100 PSI
110 to 150 PSI
Right Motor
Left Motor
OPTIONAL 3WD KIT
GEAR PUMP
25 PSI
FILTER
OPTIONAL OIL COOLER
SUCTION STRAINER
BREATHER
LEAK DETECTOR
LEAK DETECTOR VOLUME
IN
OUT
EXPANSION TANK
Center Reel (#1)
Right Front Reel (#3)
Left Front Reel (#2)
BACKLAP SWITCH (SW)
MR
MA
MB
550 PSI
PRV
OR1
0.013
OR2
0.060
FC1
LC
S1R1
P1
P2
G1
G2
T
PT
ST
R
L
E
P

Mow and Backlap

The tandem gear pump is directly coupled to the piston (traction) pump. The front gear pump section supplies oil flow to the hydraulic manifold block and to the cutting reel motors. The gear pump takes its suction directly from the hydraulic reservoir. Maximum circuit pressure is limited by solenoid relief valve (S1R1) which is located in the hydraulic manifold.

With the engine running and the functional control and joystick levers positioned so the reels **will not** turn (see Operator's Manual), solenoid relief valve (S1R1) in the hydraulic manifold is de−energized. The de−energized (S1R1) by−passes flow from the front gear pump section to the oil filter and hydraulic reservoir. Additionally, the manifold pressure reducing valve (PRV) will remain seated to prevent the reel motors (and reels) from rotating.

Mow

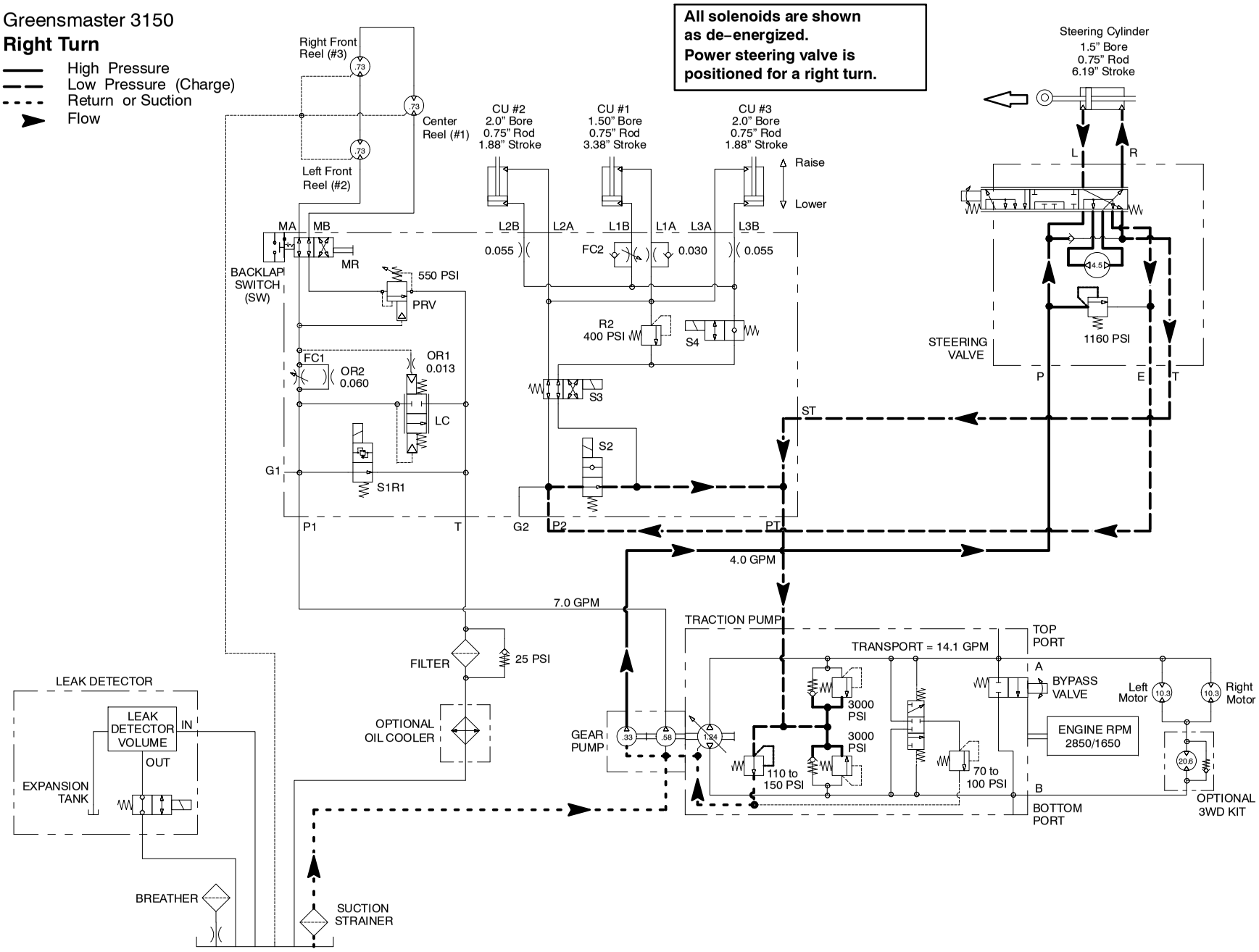
With the engine running and the functional control and joystick levers positioned so the reels **will** turn (see Operator's Manual), solenoid relief valve (S1R1) is energized. In the energized position, this valve directs oil flow to the reel motors and also functions as the mow circuit relief valve.

Oil flow from manifold port (P1) flows through the reel speed control valve (FC1). Flow across the speed control valve is pressure compensated by the logic cartridge valve (LC). The logic cartridge valve maintains a pressure differential of 75 PSI (5.2 bar) across the speed control valve. Any excess flow above the speed control valve setting is by−passed to the reservoir through the logic cartridge valve. With the backlap valve (MR) in the **mow** position, oil flows through the backlap valve, out manifold port (MA) and to the reel motors that are connected in series. Oil flows through the left front reel motor, right front motor and then center motor to turn the reel motors in the mow direction.

When in the **mow** position, mow circuit pressure will cause the hydraulic manifold pilot piston to shift and open the pressure reducing valve (PRV). The shifted pressure reducing valve allows circuit oil to return to the reservoir through the manifold block, oil filter and oil cooler (if equipped).

Backlap

Backlapping operation is the same as mowing operation, except for the position of the backlap valve (MR). When the backlap valve (MR) is in the **backlap** position, oil flows through the backlap valve, out manifold port (MB) and to the reel motors that are connected in series. Oil flows through the center reel motor, right front motor and then left front motor as it turns the reel motors in the backlap direction.


Greensmaster 3150
Right Turn
High Pressure
Low Pressure (Charge)
Return or Suction
Flow
All solenoids are shown as de-energized.
Power steering valve is positioned for a right turn.
Right Front Reel (#3)
Center Reel (#1)
Left Front Reel (#2)
.73
CU #2 2.0" Bore 0.75" Rod 1.88" Stroke
CU #1 1.50" Bore 0.75" Rod 3.38" Stroke
CU #3 2.0" Bore 0.75" Rod 1.88" Stroke
Raise
Lower
MA
MB
MR
L2B
L2A
L1B
L1A
L3A
L3B
0.055
FC2
0.030
0.055
BACKLAP SWITCH (SW)
550 PSI
PRV
R2
400 PSI
S4
S3
S2
FC1
OR2
0.060
OR1
0.013
LC
S1R1
G1
P1
T
G2
P2
PT
ST
Steering Cylinder
1.5" Bore
0.75" Rod
6.19" Stroke
L
R
14.5
1160 PSI
STEERING VALVE
P
E
T
4.0 GPM
7.0 GPM
TRACTION PUMP
TRANSPORT = 14.1 GPM
TOP PORT
A
BYPASS VALVE
Left Motor
10.3
Right Motor
3000 PSI
3000 PSI
ENGINE RPM 2850/1650
110 to 150 PSI
70 to 100 PSI
20.6
B
BOTTOM PORT
OPTIONAL 3WD KIT
FILTER
25 PSI
OPTIONAL OIL COOLER
GEAR PUMP
.33
.58
1.24
LEAK DETECTOR
LEAK DETECTOR VOLUME
IN
OUT
EXPANSION TANK
BREATHER
SUCTION STRAINER

Right and Left Turn

The tandem gear pump is directly coupled to the piston (traction) pump. The rear gear pump section supplies hydraulic flow for the steering circuit (priority flow), for raising and lowering the cutting units and for the traction charge circuit. The gear pump takes its suction from the hydraulic reservoir. Maximum circuit pressure of 1160 PSI (80 bar) is limited by the relief valve located in the steering valve.

With the steering wheel in the neutral position and the engine running, the spool valve in the steering valve is in the center position. Flow enters the steering control valve at Port (P) and goes through the spool valve, by–passing the steering cylinder. Flow leaves the control valve out port (E) to be available for the raise/lower and traction charge circuits.

Right Turn

When a right turn is made with the engine running, the turning of the steering wheel positions the spool valve in the steering valve so that flow goes through the bottom of the spool. Flow entering the steering valve at Port (P) goes through the spool and is routed to two places. First, most of the flow through the valve is by–passed out steering valve port (E) and is available for raising and lowering the cutting units and for the traction charge circuit. Second, the remainder of the flow is drawn through the steering valve rotary meter and out steering valve port (R). Pressure moves the steering cylinder piston to extend the cylinder for a right turn. The rotary meter ensures that the oil flow to the cylinder is proportional to the amount of turning on the steering wheel. Fluid leaving the cylinder flows back through the spool valve then out steering valve port (T) and then to the traction charge circuit.

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

Left Turn

When a left turn is made with the engine running, the turning of the steering wheel positions the spool valve in the steering valve so that flow goes through the top of the spool (Fig. 10). Flow entering the steering valve at Port (P) goes through the spool and is routed to two places. First, most of the flow through the valve is by–passed out steering valve port (E) and is available for raising and lowering the cutting units and for the traction charge circuit. Second, the remainder of the flow is drawn through the steering valve rotary meter and out steering valve port (L). Pressure moves the steering cylinder piston to retract the cylinder for a left turn. The rotary meter ensures that the oil flow to the cylinder is proportional to the amount of turning on the steering wheel. Fluid leaving the cylinder flows back through the spool valve then out steering valve port (T) and then to the traction charge circuit.

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

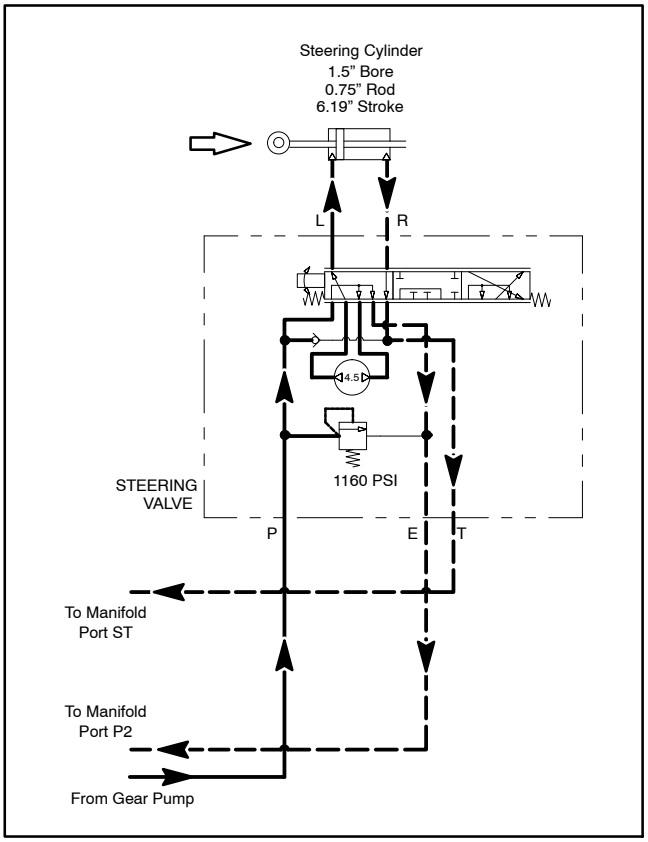


Figure 10

Special Tools

Order these special tools from your Toro Distributor.

Hydraulic Pressure Test Kit

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 the Testing section of this chapter.

Toro Part Number: **TOR47009**

Figure 11

Hydraulic Tester (Pressure and Flow)

This tester requires O−ring Face Seal (ORFS) adapter fittings for use on this machine (see Hydraulic Test Fitting Kit (TOR4079) in this section).

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. PRESSURE GAUGE: 0 to 5000 PSI gauge to provide operating circuit pressure.

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

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

Toro Part Number: **TOR214678**

Figure 12

O−ring Kit

The O−ring kit includes O−rings in a variety of sizes for face seal and port seal hydraulic connections. It is recommended that O−rings be replaced whenever a hydraulic connection is loosened.

Toro Part Number: **117−2727**

Figure 13

High Flow Hydraulic Filter Kit

The high flow hydraulic filter kit is designed with large flow (40 GPM/150 LPM) and high pressure (5000 PSI/345 bar) capabilities. This kit provides for bi−directional filtration which prevents filtered debris from being allowed back into the circuit regardless of flow direction.

If a component failure occurs in the closed loop traction circuit, contamination from the failed part will remain in the circuit until removed. When connecting hydraulic test gauges in order to test traction circuit components or after replacing a failed traction circuit component (e.g. piston (traction) pump or wheel motor), the high flow hydraulic filter can be installed in the traction circuit. The filter will ensure that contaminates are removed from the closed loop and thus, do not cause additional component damage.

Toro Part Number: **TOR6011**

NOTE: This kit does not include hydraulic hoses (see Hydraulic Hose Kit TOR6007 above).

NOTE: Replacement filter element is Toro part number TOR6012. Filter element cannister tightening torque is **25 ft−lb (34 N−m)**.

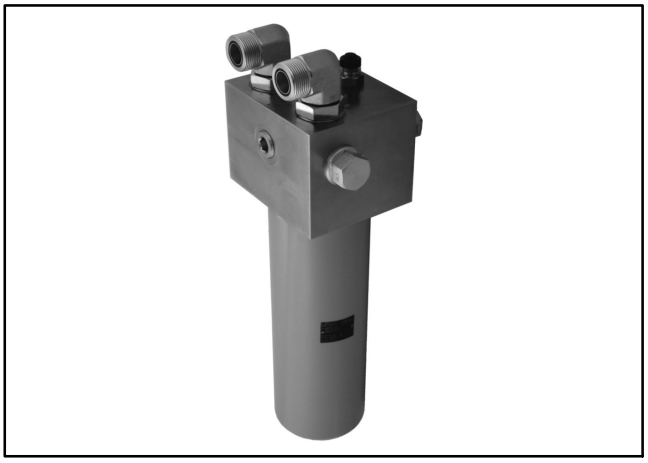


Figure 14

Hydraulic Hose Kit

This kit includes hydraulic fittings and hoses needed to connect 40 GPM hydraulic tester (AT40002) or high flow hydraulic filter kit (TOR6011) to machine hydraulic traction system components.

Toro Part Number: **TOR6007**

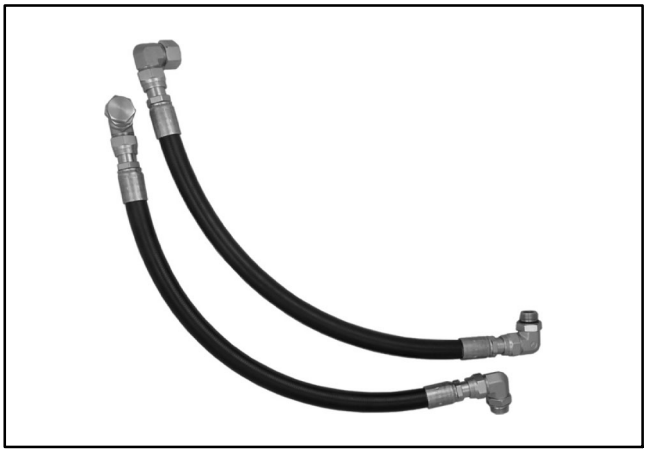


Figure 15

Hydraulic Test Fitting Kit

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.

Toro Part Number: **TOR4079**

TORO TEST FITTING KIT (NO. TOR4079)

FITTING	TOOL NUMBER
	Swivel Nut Run Tee (2 ea.) Size — Toro No. No. 4 — TOR4079-3 No. 6 — TOR4079-12 No. 8 — TOR4079-4 No. 10 — TOR4079-5
	Plug (2 ea.) Size — Toro No. No. 4 — TOR4079-13 No. 6 — TOR4079-14 No. 8 — TOR4079-15 No. 10 — TOR4079-16
	Cap (2 ea.) Size — Toro No. No. 4 — TOR4079-17 No. 6 — TOR4079-18 No. 8 — TOR4079-19 No. 10 — TOR4079-20

FITTING	TOOL NUMBER
	Union (1 ea.) Size — Toro No. No. 6 to No. 8 — TOR4079-8 No. 10 to No. 8 — TOR4079-2 No. 8 to No. 8 — TOR4079-9
	Reducer (1 ea.) Size — Toro No. No. 10 to No. 8 — TOR4079-7 No. 12 to No. 8 — TOR4079-6
	Test Cap Fitting (2 ea.) Size — Toro No. No. 4 — TOR4079-10 No. 6 — TOR4079-11 No. 8 — TOR4079-21 No. 10 — TOR4079-1
	Test Fitting (2 ea.) Size — Toro No. 7/16−20 ORB — TOR4079-22 1/8" Pipe Thd. — TOR4079-23

Figure 16

Measuring Container

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.

Toro Part Number: **TOR4077**

Figure 17

Wheel Hub Puller

The wheel hub puller allows safe removal of the wheel hub from the shaft of wheel motors.

Toro Part Number: **TOR4097**

Figure 18

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.

General Hydraulic System Problems

Problem	Possible Cause
Hydraulic oil leaks from system.	Fitting(s), hose(s) or tube(s) are loose or damaged. O−ring(s) or seal(s) are missing or damaged.
Hydraulic fluid foams.	Hydraulic reservoir oil level is low. Hydraulic system has wrong type of oil. The pump suction line has an air leak.
Hydraulic system operates hot.	Hydraulic reservoir oil level is low. Suction screen in reservoir is loose or clogged. Oil is contaminated or too light. Brakes are applied or are incorrectly adjusted. Piston pump by−pass valve is open or defective. Working load of machine (e.g. high ambient temperatures, use of verticutter) may require use of oil cooler. Oil cooler (if installed) is damaged or plugged. Cooler by−pass relief is stuck open or air flow is obstructed. Charge pressure is low (see Charge Pressure Relief Valve Pressure Test in the Testing section of this chapter). Wheel motor(s) or cutting reel motor(s) are worn or damaged (see Wheel Motor Efficiency and Reel Motor Case Drain Flow Tests in the Testing section of this chapter). Piston (traction) pump is worn or damaged (see Piston (Traction) Pump Flow Test in the Testing section of this chapter).

Traction Circuit Problems

Problem	Possible Cause
Neutral is difficult to find or machine operates in one direction only.	External control linkage is misadjusted, disconnected, binding or damaged. Piston (traction) pump is worn or damaged (see Piston (Traction) Pump Flow Test in the Testing section of this chapter).
Traction response is sluggish.	Hydraulic oil is very cold. Brakes are applied or are incorrectly adjusted. Piston pump by−pass valve is open or defective. Charge pressure is low (see Charge Pressure Relief Valve Pressure Test in the Testing section of this chapter). Piston (traction) pump relief valves are leaking or damaged. Piston (traction) pump or wheel motor(s) are worn or damaged (see Piston (Traction) Pump Flow and Wheel Motor Efficiency Tests in the Testing section of this chapter).
No traction exists in either direction.	Brakes are applied or are incorrectly adjusted. Hydraulic reservoir oil level is low (other hydraulic circuits affected as well). Piston pump by−pass valve is open. Charge pressure is low (see Charge Pressure Relief Valve Pressure Test in the Testing section of this chapter). Wheel motor(s) are worn or damaged (see Wheel Motor Efficiency Test in the Testing section of this chapter). Piston (traction) pump is worn or damaged (see Piston (Traction) Pump Flow Test in the Testing section of this chapter).
Wheel motor will not turn.	Brakes are binding. Key on wheel motor shaft is sheared or missing. Wheel motor is damaged.
Wheel motor will not hold load in neutral.	Make up fluid from charge pump is not available. Piston (traction) pump relief valves are leaking or damaged.

NOTE: The piston (traction) pump used on Greensmaster 3150 machines is equipped with relief valves for both the forward and reverse direction. Due to engine output, it is unlikely that traction pressure will reach relief valve settings. If, however, a piston pump relief valve is leaking or otherwise faulty, traction performance would be affected.

Mow Circuit Problems

Problem	Possible Cause
Gear pump is noisy (cavitation).	Hydraulic reservoir oil level is low (other hydraulic circuits affected as well). Hydraulic pump suction line is restricted. Hydraulic pump suction line has an air leak.
Cutting reel motors will not turn.	Hydraulic manifold solenoid valve S1R1 is stuck open (not shifting to its energized position). An electrical problem exists (see Chapter 5 – Electrical System). FC1 logic valve in control manifold is stuck open. PRV valve in control manifold is stuck closed. Pilot piston in control manifold is stuck or damaged. Front section of gear pump is damaged (see Gear Pump (Front Section) Flow Test in the Testing section of this chapter).
Cutting reel speed is erratic.	A cutting unit problem exists (see Chapter 7 – DPA Cutting Units). Hydraulic manifold reel circuit cartridge is leaking or damaged. Hydraulic manifold orifice (OR1 or OR2) is plugged.
Cutting reel speed is low.	A cutting unit problem exists (see Chapter 7 – DPA Cutting Units). Hydraulic manifold reel circuit cartridge is leaking or damaged. Excessive internal wear in reel motor exists (see Reel Motor Case Drain Flow Test in the Testing section of this chapter).

Lift/Lower Circuit Problems

Problem	Possible Cause
Cutting units will not lift or lift slowly.	Engine speed is too low. Hydraulic reservoir oil level is low. Lift cylinder linkage is binding or broken. Lift cylinder bushings are binding or worn. Charge circuit pressure is low (see Charge Relief Valve Pressure Test in the Testing section of this chapter). Implement relief valve is leaking or damaged (see Implement Relief Valve Pressure Test in the Testing section of this chapter). Hydraulic manifold solenoid valve (S2) is leaking or damaged (not shifting to its energized position). Relief valve (R2) is leaking or damaged (see Lower Cutting Units Relief Valve (R2) Pressure Test in the Testing section of this chapter). Lift cylinders leak internally. Spool in steering control valve is hung up (see Steering Control Valve Test in the Testing section of this chapter). Gear pump (rear section) is worn or damaged (see Gear Pump (Rear Section) Flow Test in the Testing section of this chapter).
Cutting units raise, but will not stay up.	Hydraulic manifold solenoid valve (S4) leaks or is damaged. Lift cylinders leak internally.

Steering Circuit Problems

Problem	Possible Cause
Steering wheel is hard to turn.	Oil supply to the steering control valve is insufficient (traction charge and lift circuits affected as well). Emergency steering ball in steering control valve is missing or damaged.
Regular adjustments to steering wheel are necessary because of difficulty of driving in a straight line.	Leaf springs in steering control valve are worn or broken. Gear wheel set in steering control valve is worn. Steering cylinder is seized or its piston seals are worn (see Steering Control Valve Test in the Testing section of this chapter).
Steering wheel will not return to the neutral position.	Spool and sleeve are sticking to steering control housing assembly (see Steering Control Valve Test in the Testing section of this chapter).
Steering wheel can turn on its own.	Leaf springs in steering control valve are broken or stuck. Spool and sleeve are sticking to steering control housing assembly (see Steering Control Valve Test in the Testing section of this chapter).
Backlash results when turning steering wheel.	Cardan shaft fork is worn or broken. Leaf springs in steering control valve are worn or broken.
Rear wheel shimmies when the steering wheel is turned.	Air is in the steering cylinder. Mechanical connections to the wheel or wheel bearing are worn.
The steering wheel can be turned without the rear wheel turning.	The steering cylinder is worn. The gear set in the steering control valve is worn.
Steering response is too slow and heavy when trying to turn quickly.	Oil supply to the steering control valve is insufficient (traction charge and lift circuits affected as well).
Turning steering wheel turns machine in the opposite direction.	Hoses to the steering cylinder are reversed.
Steering force (possibly to one side only) is insufficient.	Hydraulic flow to steering control valve is low (traction charge and lift circuits affected as well). Implement relief valve is leaking or damaged (see Implement Relief Valve Pressure Test in the Testing section of this chapter).

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, improper adjustments, solenoid valve operation or electrical connections/circuits 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.

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 testing tools (e.g. pressure gauge) and record test results.

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.

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. To prevent hydraulic system contamination, 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. Engine speed will affect test accuracy. Check pump speed with a phototac when performing hydraulic tests.

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

5. When using tester with pressure and flow capabilities, completely open load valve 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.

11. Record the results of all performed hydraulic tests.

Hydraulic Testing

1. Use the Hydraulic Schematic, Hydraulic Flow Diagrams and the Troubleshooting section found in this Chapter to assist in problem identification and solution.

2. Hydraulic system problems (e.g. low hydraulic oil level, contaminated oil, incorrect engine speed) will affect the entire hydraulic system.

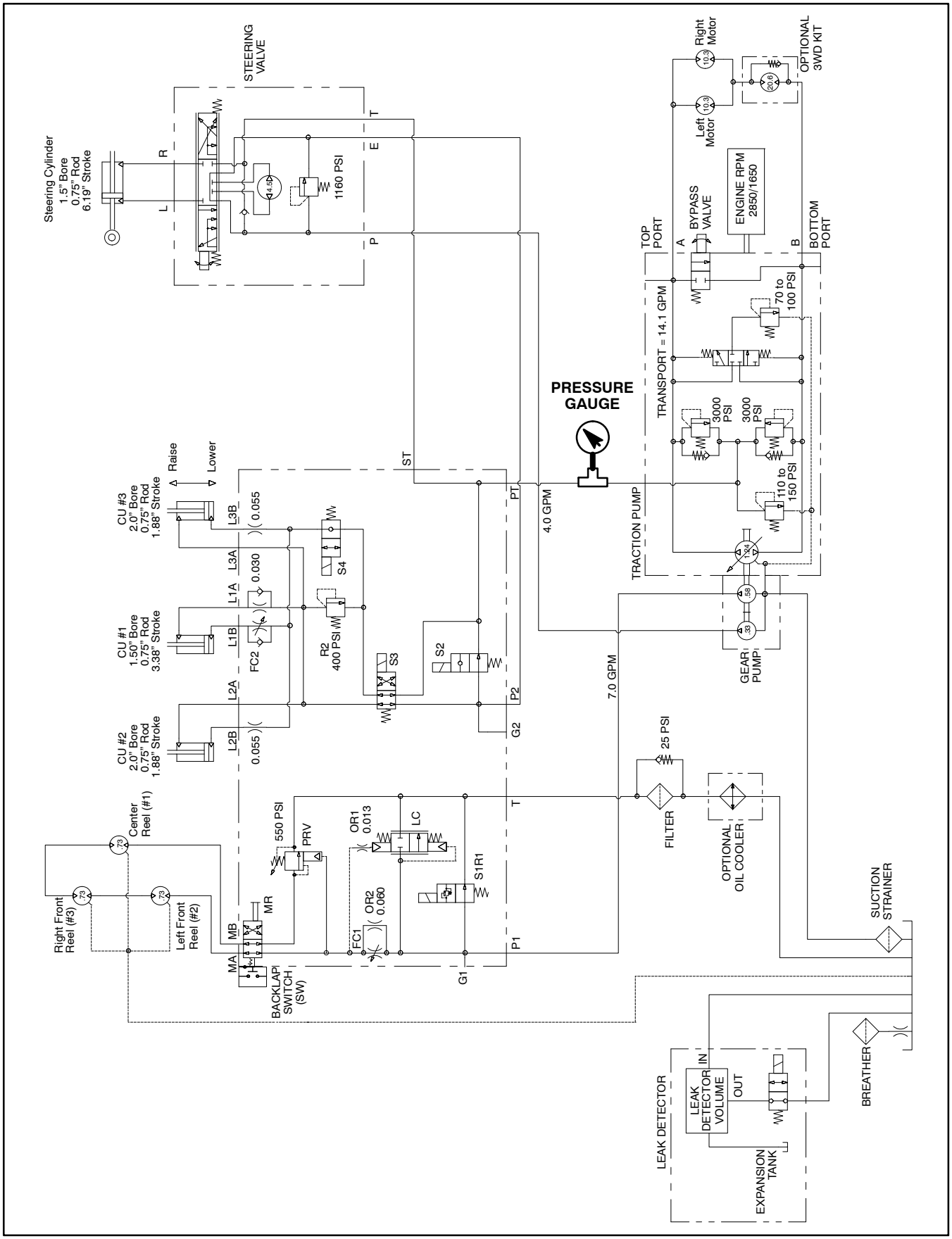
3. For traction related problems (e.g. machine will not go up an incline), consider performing the following hydraulic tests:

Charge Pressure Relief Valve Pressure Test
Wheel Motor Efficiency Test
Piston (Traction) Pump Flow Test

4. For problems with steering or cutting unit lift/lower, consider performing the following hydraulic tests:
   Charge Pressure Relief Valve Pressure Test
   Lower Cutting Units Relief Valve (R2) Pressure Test
   Implement Relief Valve Pressure Test
   Gear Pump (Rear Section) Flow Test
   Steering Valve Test

5. For issues with the cutting system, consider performing the following hydraulic tests:
   Mow Circuit Relief Valve (S1R1) Pressure Test
   Reel Motor Case Drain Flow Test
   Gear Pump (Front Section) Flow Test

Charge Relief Valve Pressure Test (Using Pressure Gauge)



Procedure for Charge Relief Valve Pressure Test

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

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

CAUTION

Before continuing further, read and become familiar with Precautions for Hydraulic Testing.

3. Install 1000 PSI (70 bar) pressure gauge with hydraulic hose attached to test port in the tee fitting on the bottom of the control manifold (Fig. 19).

4. Make sure that traction pedal, steering wheel and joystick control are in the neutral position.

5. Start engine and operate at high idle speed **(2850 ± 50 RPM)**.

6. Pressure gauge should read approximately **100 to 150 PSI (7 to 10 bar)**.

7. Shut off engine. Record test results.

8. If specification is not met, remove piston pump back plate assembly that contains the charge relief valve (see Piston (Traction) Pump Service in the Service and Repairs section of this chapter). Repair or replace relief valve components as necessary.

9. A dynamic charge pressure test can be performed as follows:

A. Position machine so that a load can be placed on the traction system. For example, chain the machine to an immovable object or chock all drive wheels to prevent the machine from moving.

B. With pressure gauge still connected to control manifold test port, sit in the operator seat, start the engine and move throttle so engine is running at high idle speed. Move functional control lever to the transport position.

C. While monitoring the pressure gauge, push the traction pedal to allow traction system load.

D. The charge pressure should drop no more than 20% from no−load charge pressure measured in step 6 above (e.g. if charge pressure in step 6 is 125 PSI (9 bar), charge pressure in forward or reverse under load should be more than 100 PSI (7 bar).

E. If charge pressure is good under no load, but drops below specification when under traction load, the piston (traction) pump and/or wheel motors should be suspected of wear and inefficiency. When the pump and/or traction motor(s) are worn or damaged, the charge pump is not able to keep up with internal leakage in traction circuit components. Further testing of the traction circuit should be completed (see Piston (Traction) Pump Flow and Wheel Motor Efficiency Tests in this section).

10. When charge pressure testing is complete, disconnect pressure gauge from the test port and install dust cap on test port.

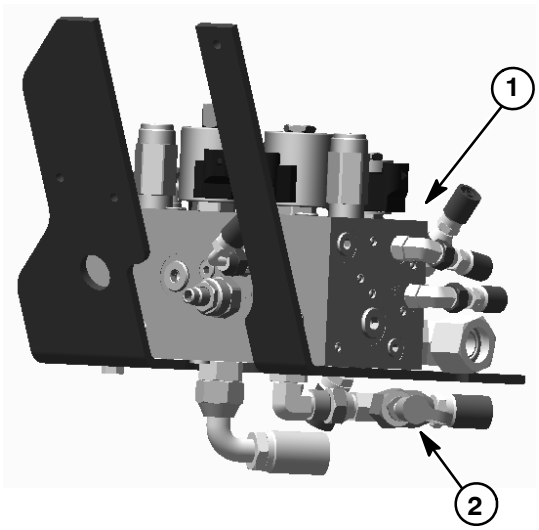
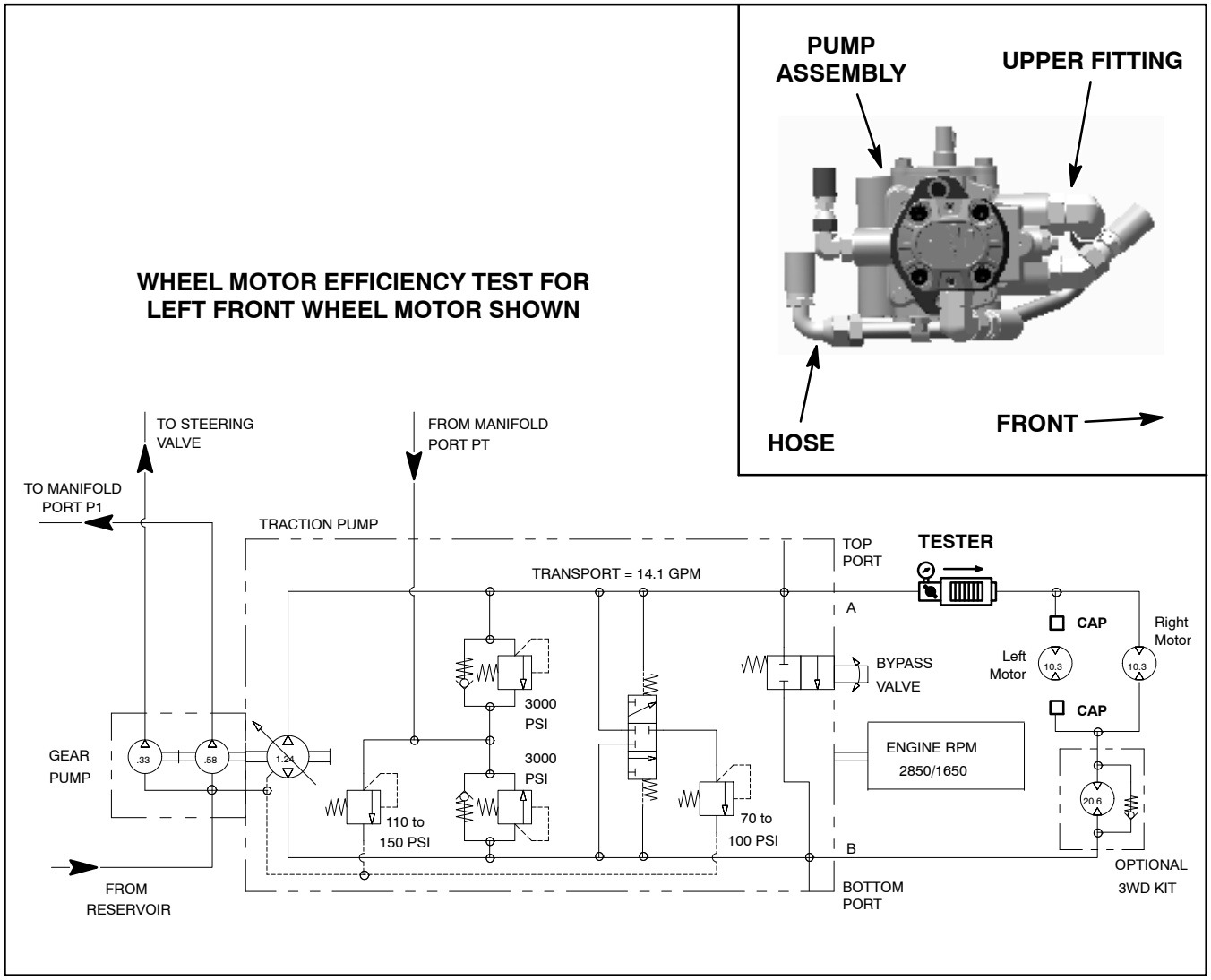


Figure 19

1. **Hydraulic manifold**
2. **Test port**

Wheel Motor Efficiency Test (Using Tester with Flowmeter and Pressure Gauge)



Procedure for Wheel Motor Efficiency Test

NOTE: Over a period of time, a wheel 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 wheel motor to stall under heavy load conditions. Continued operation with a worn, inefficient motor can generate excessive heat, cause damage to seals and other components in the hydraulic system and affect overall machine performance.

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

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

CAUTION

Before continuing further, read and become familiar with Precautions for Hydraulic Testing.

3. Make sure that traction pedal is adjusted to the neutral position (see Traction Unit Operator's Manual).

4. Attach a heavy chain to the rear of the machine frame and an immovable object to prevent the machine from moving during testing.

5. If machine has 3 wheel drive, block up the rear wheel off the ground to allow flow through the rear wheel motor.

6. Chock front wheel being tested to prevent rotation of the wheel.

7. Thoroughly clean junction of hydraulic lines and fittings at the front wheel motor that is **not** being tested. Disconnect hydraulic lines from front wheel motor that is **not** being tested. Cap the disconnected hydraulic lines and plug ports in wheel motor.

8. Thoroughly clean junction of hydraulic hose and hydraulic tube that connects to the upper hydraulic fitting on the front side of the piston pump (Fig. 20). Disconnect hose from the tube.

9. Install tester with pressure gauge and flow meter in series with the pump and the disconnected hose (same tester connections as Piston (Traction) Pump Flow Test). **Make sure the tester flow control valve is fully open.**

CAUTION

Use extreme caution when performing test. The wheel being tested will be trying to move the machine.

10. Start engine and move throttle to high idle speed **(2850 ± 50 RPM)**.

11. Slowly push traction pedal in **forward** direction until **1000 PSI (69 bar)** is displayed on the tester pressure gauge. Make sure that wheel does not rotate during test.

12. Wheel motor internal leakage will be shown on flow meter in GPM. Flow should be **less than 1.5 GPM** for the tested wheel motor.

13. Release traction pedal, rotate wheel being tested and retest. Testing of wheel motor leakage in three (3) different wheel positions will provide most accurate test results.

14. Release traction pedal and shut engine off. Record results of flow test.

15. If specification is not met, the tested wheel motor needs to be repaired or replaced as necessary.

16. Test second front wheel motor. Reconnect hydraulic lines to untested front wheel motor. Disconnect and cap hydraulic lines to previously tested front wheel motor. Complete steps 10 to 15 for the second front wheel motor.

17. If machine has 3 wheel drive, test rear wheel motor:

A. Both front wheel motors should have hydraulic lines connected. Block up both front wheels off the ground to allow flow through the rear wheel motors.

B. Attach a heavy chain to the rear of the machine frame and an immovable object to prevent the machine from moving during testing.

C. Position rear wheel on the ground and chock rear wheel to prevent it from turning.

CAUTION

Use extreme caution when performing test. The rear wheel will be trying to move the machine.

D. Complete steps 10 to 15 for rear wheel motor testing.

18. When testing is complete, disconnect tester from hydraulic tube and hose. Reconnect hose to hydraulic tube. Reconnect hydraulic lines to rear wheel motor.

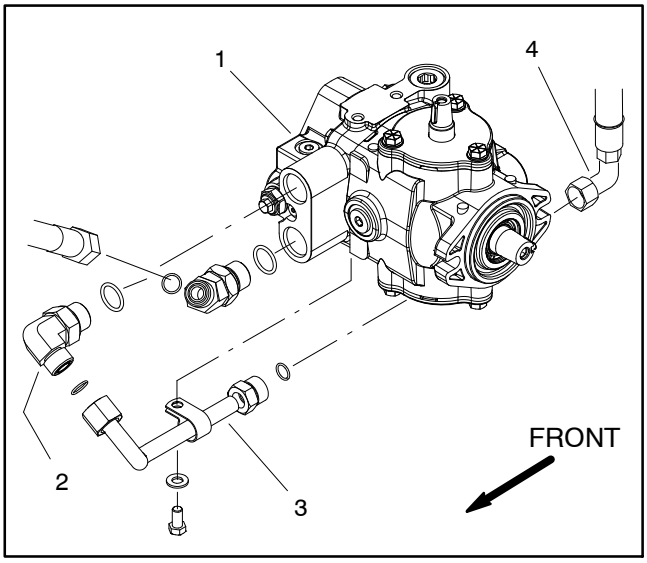
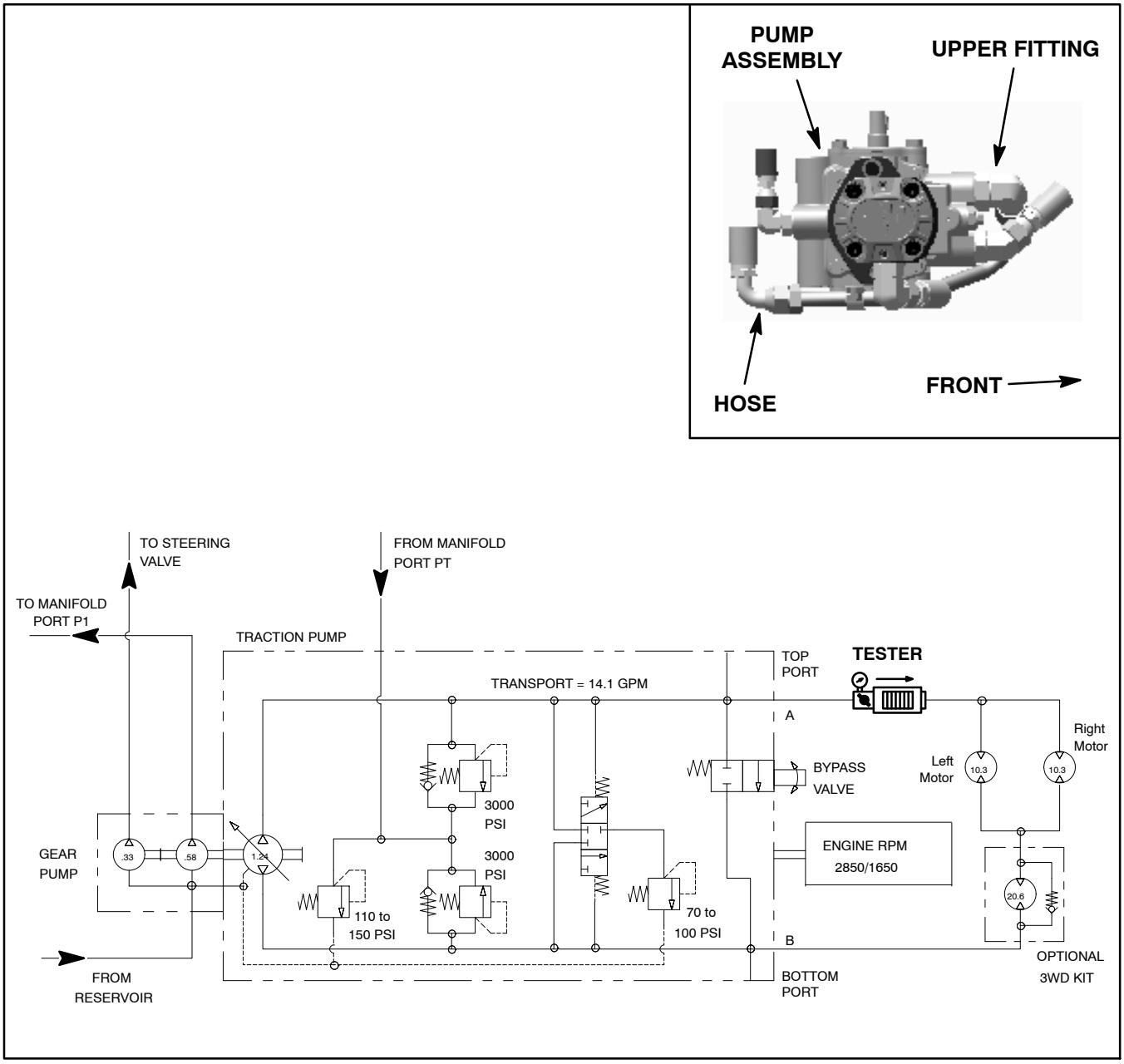


Figure 20

1. **Piston pump**
2. **Upper fitting**
3. **Hydraulic tube**
4. **Hydraulic hose**

Piston (Traction) Pump Flow Test (Using Tester with Flowmeter and Pressure Gauge)



Procedure for <u>Piston (Traction) Pump Flow</u> Test

This test measures piston (traction) pump output (flow). During this test, pump load is created at the flowmeter using the adjustable load valve on the tester.

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

2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off. Make sure the hydraulic reservoir is full.

CAUTION

Before continuing further, read and become familiar with Precautions for Hydraulic Testing.

3. Make sure the traction assembly is adjusted to the neutral position. Also, make sure that transport speed adjustment allows the piston pump to reach full stroke (refer to Traction Unit Operator's manual).

4. Block up front wheels off the ground (also rear wheel if machine is equipped with 3WD) to allow flow through the traction circuit.

5. Disconnect hydraulic hose from the hydraulic tube that connects to the upper hydraulic fitting on the front side of the piston pump (Fig. 21).

6. Install tester in series with the pump and the disconnected hose. **Make sure flow control valve on the tester is fully open.**

7. Start engine and move throttle to high idle speed **(2850 ± 50 RPM)** position.

8. Move functional control lever to the transport position.

CAUTION

The drive wheels will be off the ground and rotating during this test. Make sure machine is well supported so it will not move and accidentally fall to prevent injuring anyone near the machine.

9. Slowly push traction pedal into fully forward position.

10. Have second person carefully watch pressure gauge on tester while slowly closing the flow control valve until **1000 PSI (69 bar)** is obtained. Verify with a phototac that the engine speed has not changed.

NOTE: If engine speed drops, piston pump flow will decrease.

11. Observe flow gauge. If piston pump is in good condition, flow indication should be approximately **14.5 GPM (54.9 LPM)**.

12. Release traction pedal, open control valve on tester and turn off engine.

13. If flow is less than **12.3 GPM (46.6 LPM)**, consider the following:

A. The traction pedal and/or traction speed may need adjustment (see the Traction Unit Operator's Manual).

B. The piston pump needs to be repaired or replaced as necessary.

C. Make necessary repairs before performing additional tests.

14. If piston pump flow test results are met and a traction problem exists with machine, check wheel motor efficiency (see Wheel Motor Efficiency Test in this chapter).

15. If testing is complete, disconnect tester from hydraulic tube and hose. Reconnect hose to tube.

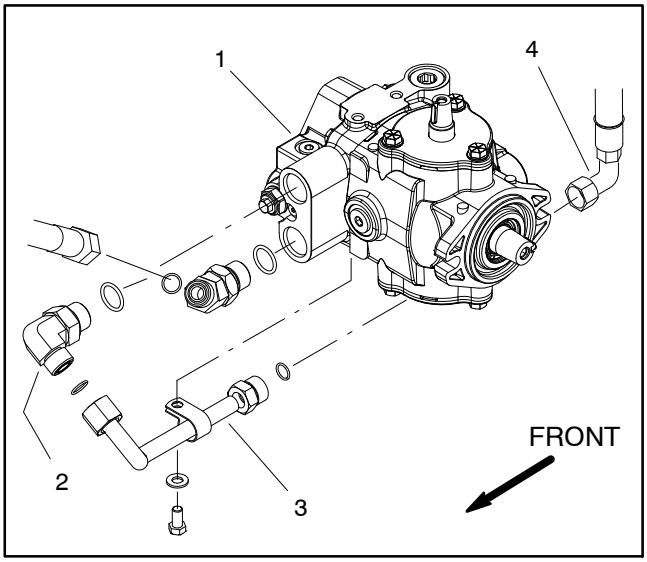
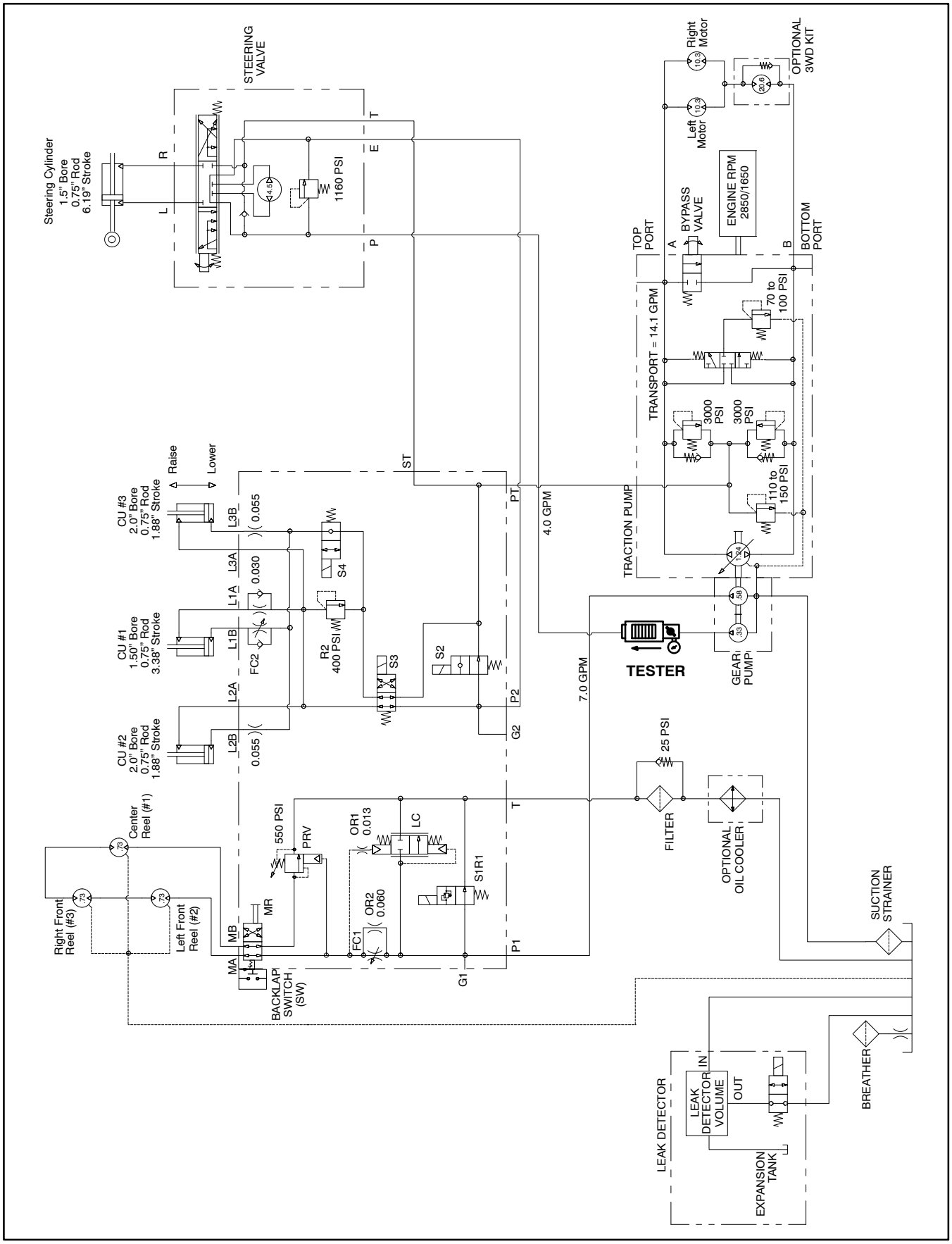


Figure 21

1. **Piston pump**
2. **Upper fitting**
3. **Hydraulic tube**
4. **Hydraulic hose**

Gear Pump (Rear Section) Flow Test (Using Tester with Flowmeter and Pressure Gauge)



Procedure for Gear Pump (Rear Section) Flow Test

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

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

CAUTION

Before continuing further, read and become familiar with Precautions for Hydraulic Testing.

3. Thoroughly clean junction of hydraulic hose and the hydraulic fitting in the rear gear pump section (Fig. 22). This hose leads to port P in the steering valve.

4. Disconnect the hose from the fitting in the rear gear pump section.

5. Install tester with pressure gauge and flow meter in series with the gear pump fitting and the disconnected hose. **Make sure flow control valve on the tester is fully open.**

6. Make sure that traction pedal and joystick control are in neutral and the parking brake is engaged.

7. Start engine and operate at high idle speed **(2850 ± 50 RPM)**.

IMPORTANT: Do not fully restrict oil flow through tester. In this test, the flow tester is positioned before the circuit relief valve. Gear pump damage can occur if the oil flow is fully restricted.

8. Watch flow and pressure gauge carefully while slowly closing the flow control valve on the tester until the pressure gauge reads **800 PSI (55 bar)**.

9. Flow gauge reading for a rear gear pump section in good condition should be approximately **3.8 GPM (14.4 LPM)**. Record test results.

10. Open control valve on tester and shut off engine.

11. If flow was less than **3.3 GPM (12.5 LPM)** or a pressure of **800 PSI (55 bar)** cannot be obtained, check for restriction in the pump intake line. If line is not restricted, remove gear pump and repair or replace as necessary.

NOTE: Implement Relief Valve Pressure and Lower Cutting Units Relief Valve (R2) Pressure can be measured with tester positioned as described in this check (see Implement Relief Valve Pressure Test and Lower Cutting Units Relief Valve (R2) Pressure Test in this section).

12. After testing is complete, disconnect tester from the gear pump fitting and hose. Reconnect hose to the gear pump fitting.

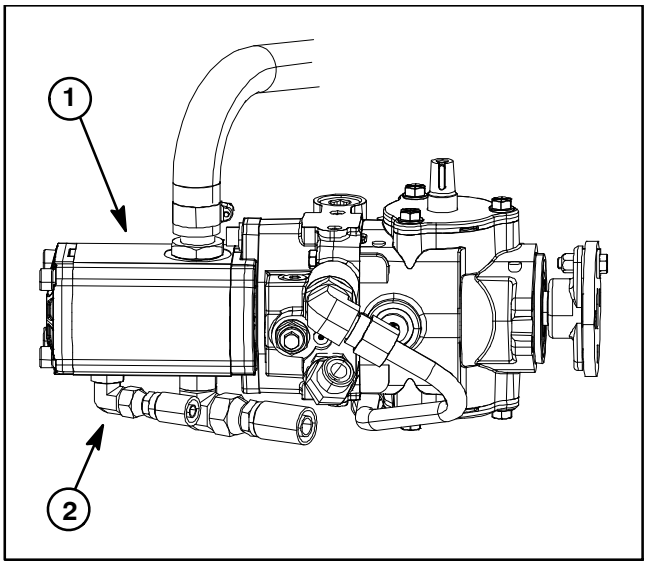
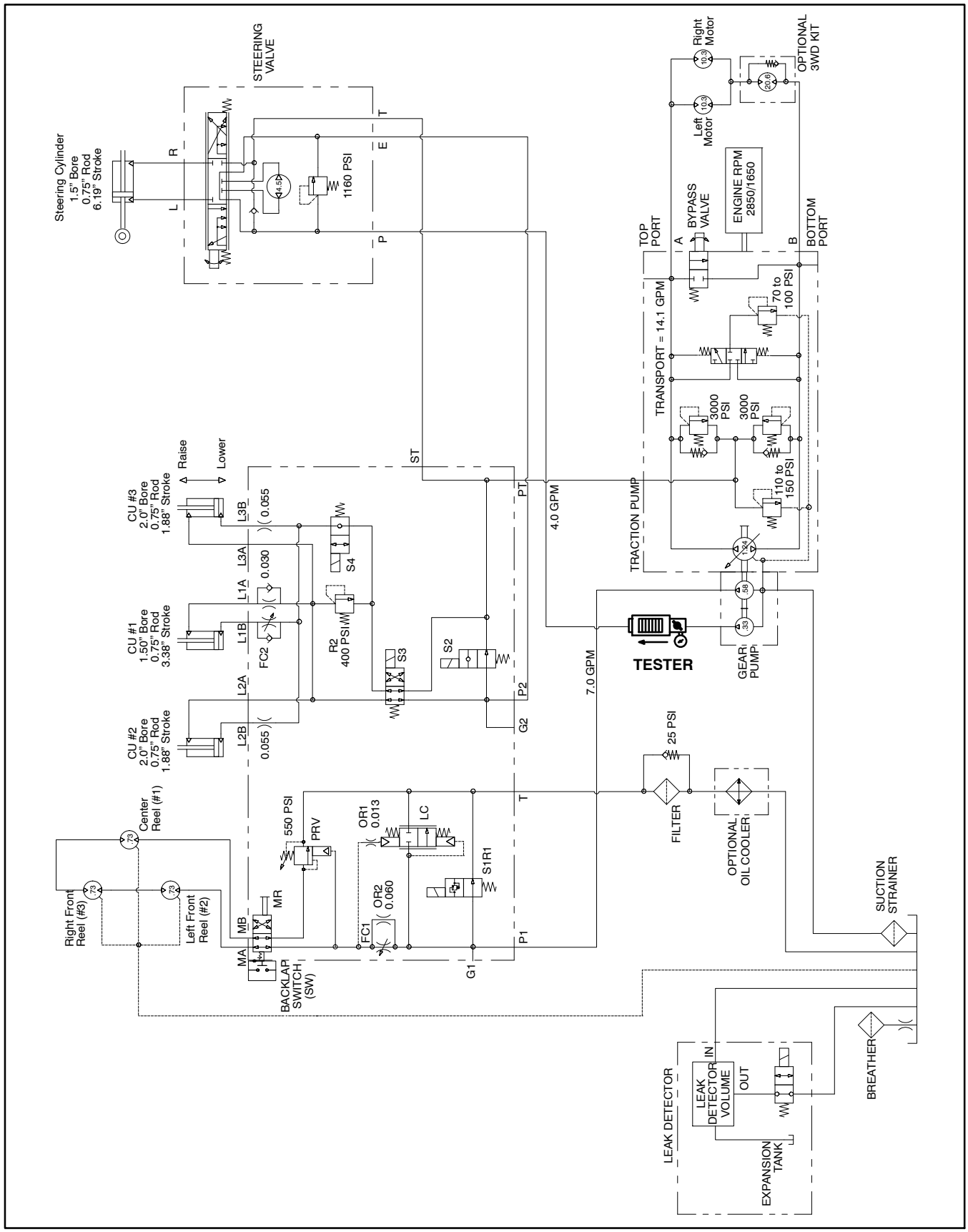


Figure 22

1. **Gear pump**
2. **Rear section fitting**

Implement Relief Valve Pressure Test (Using Tester with Flowmeter and Pressure Gauge)



Procedure for Implement Relief Valve Pressure Test

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

2. Park machine on a level surface with the cutting units lowered. Make sure engine is off. Make sure the hydraulic tank is full.

CAUTION

Before continuing further, read and become familiar with Precautions for Hydraulic Testing.

3. Measure and record charge relief valve pressure (see Charge Relief Valve Pressure Test in this section).

4. Thoroughly clean junction of hydraulic hose and the hydraulic fitting in the rear gear pump section (Fig. 23). This hose leads to port P in the steering valve.

5. Disconnect the hose from the fitting in the rear gear pump section.

6. Install tester with pressure gauge and flow meter in series with the gear pump fitting and the disconnected hose (same connections as Gear Pump (Rear Section) Flow Test). **Make sure flow control valve on the tester is fully open.**

7. Start and run engine at full speed **(2850 ± 50 RPM)**.

CAUTION

When performing test, do not allow system pressure to exceed 1400 PSI (83 bar).

8. Watch the pressure gauge on the tester and move the joystick control to the raise position. Momentarily hold the joystick with the cutting units fully raised causing the implement relief valve to open. Record pressure at which the relief valve opens.

9. Release joystick to the neutral position and shut off engine.

NOTE: The implement relief valve is in series with charge relief valve. Charge relief pressure will affect the implement relief pressure.

10. Implement relief valve pressure should be **1050 to 1250 PSI (73 to 86 bar) higher than the charge relief valve pressure** (e.g. if the charge relief valve pressure is 100 PSI (7 bar), the implement relief valve pressure should be from 1150 to 1350 PSI (80 to 93 bar)).

IMPORTANT: Hold steering wheel at full lock only long enough to get a system pressure reading.

11. The implement relief valve is also activated by the steering system. With tester still connected to gear pump outlet, start engine and watch the pressure gauge. Turn the steering wheel completely in one direction and hold. Relief valve should open just after rear wheel gets to the full lock position. Relief pressure measured with the steering system should be similar to results in step 10 above.

12. If implement relief valve pressure is incorrect, inspect relief valve located in the steering valve (see Steering Valve Service in the Service and Repairs section of this Chapter). Clean relief valve or service steering valve as needed.

NOTE: Gear Pump (Rear Section) Flow Test and Lower Cutting Units Relief Valve Pressure can be measured with tester positioned as described in this check (see Gear Pump (Rear Section) Flow Test and Lower Cutting Units Relief Valve Pressure Test in this section).

13. After testing is complete, remove tester from gear pump fitting. Reconnect hose to the gear pump fitting.

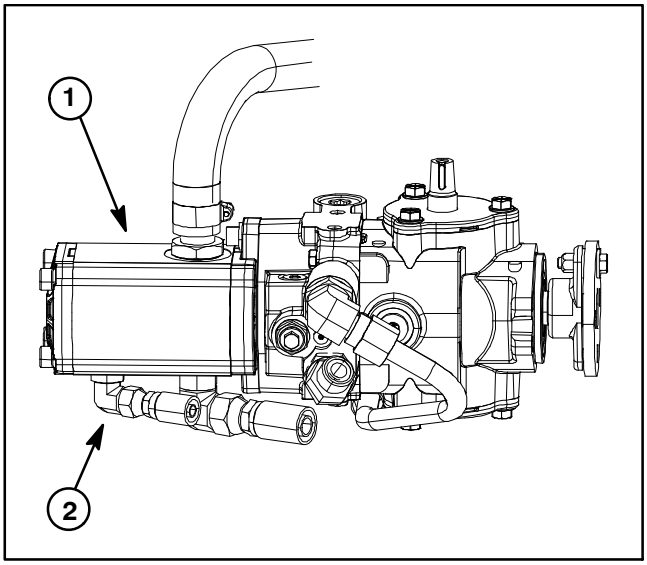
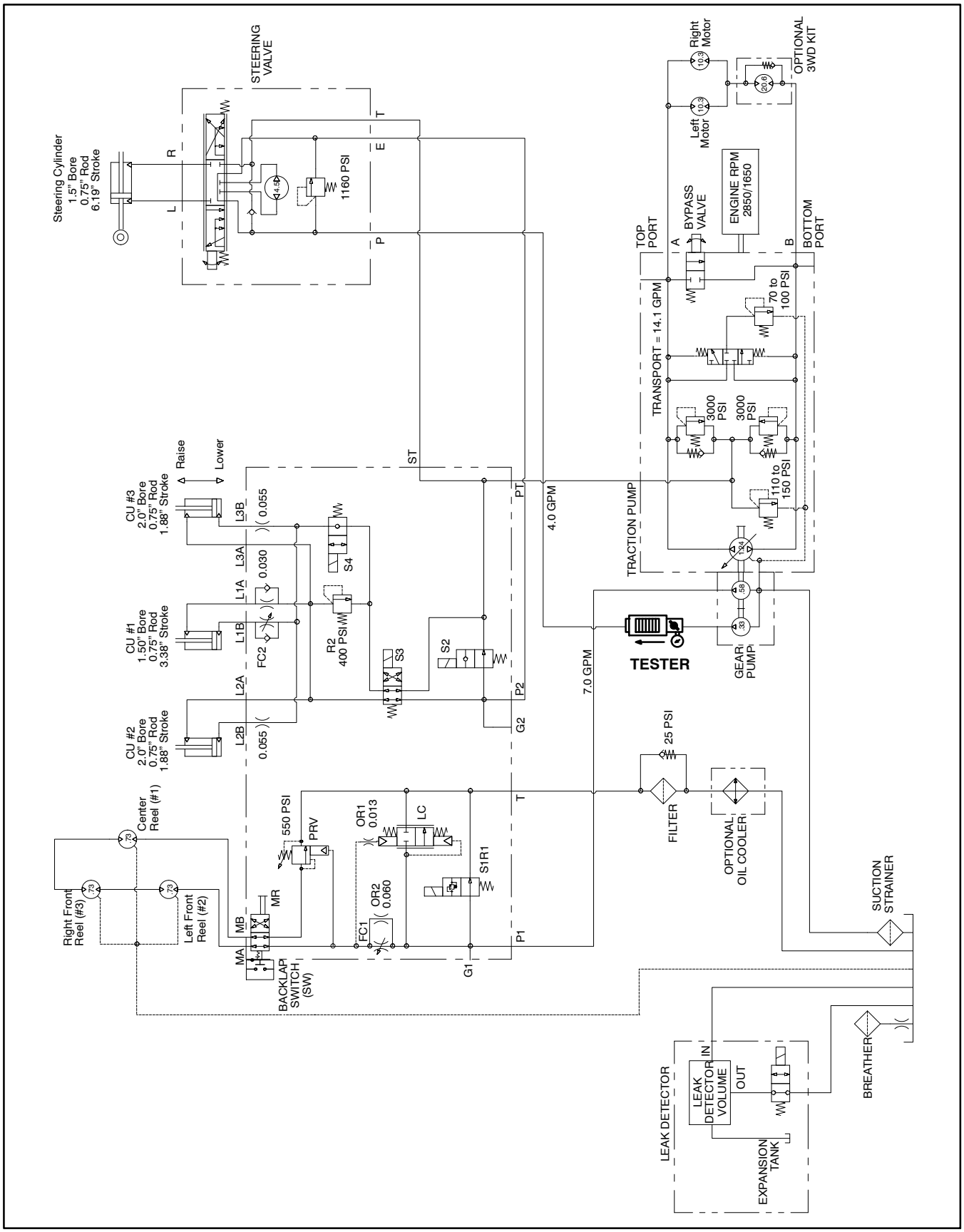


Figure 23

1. **Gear pump**
2. **Rear section fitting**

Lower Cutting Units Relief Valve (R2) Pressure Test (Using Tester with Flowmeter and Pressure Gauge)



Procedure for Lower Cutting Units Relief Valve (R2) Pressure Test

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

2. Park machine on a level surface with the cutting units lowered. Make sure engine is off. Make sure the hydraulic tank is full.

CAUTION

Before continuing further, read and become familiar with Precautions for Hydraulic Testing.

3. Measure and record charge relief valve pressure (see Charge Relief Valve Pressure Test in this section).

4. Thoroughly clean junction of hydraulic hose and the hydraulic fitting in the rear gear pump section (Fig. 24). This hose leads to port P in the steering valve.

5. Disconnect the hose from the fitting in the rear gear pump section.

6. Install tester with pressure gauge and flow meter in series with the gear pump fitting and the disconnected hose (same connections as Gear Pump (Rear Section) Flow Test). **Make sure flow control valve on the tester is fully open.**

7. Start engine and move throttle to full speed **(2850 ± 50 RPM)**. Make sure that cutting units are fully lowered and then engage the cutting units.

NOTE: The LOWER function is electrically timed and automatically turns off after approximately six (6) seconds.

8. Watch pressure gauge carefully while moving the joystick control lever to the LOWER position and note pressure that relief valve opens. Shut off engine and record test results.

NOTE: While performing this hydraulic test, if relief pressure cannot be determined within the LOWER function six (6) second timeframe, repeat this test procedure.

NOTE: The lower cutting units relief valve is in series with the charge relief valve. Charge relief pressure will affect the lower cutting units relief pressure.

9. The lower cutting units relief valve pressure should be approximately **400 PSI (28 bar) higher than charge relief pressure** (e.g. if charge relief valve pressure is 100 PSI (7 bar), the lower relief valve pressure should be approximately 500 PSI (35 bar)).

10. If lower cutting units relief valve pressure is incorrect, adjust control manifold relief valve (R2) (see Adjust Manifold Relief Valves in the Adjustments section of this Chapter). Retest relief valve pressure if adjustment is performed.

NOTE: Gear Pump (Rear Section) Flow Test and Implement Relief Valve Pressure can be measured with tester positioned as described in this check (see Gear Pump (Rear Section) Flow Test and Implement Relief Valve Pressure Test in this section).

11. After testing is complete, disconnect tester from gear pump and hose. Reconnect hose to hydraulic fitting on pump.

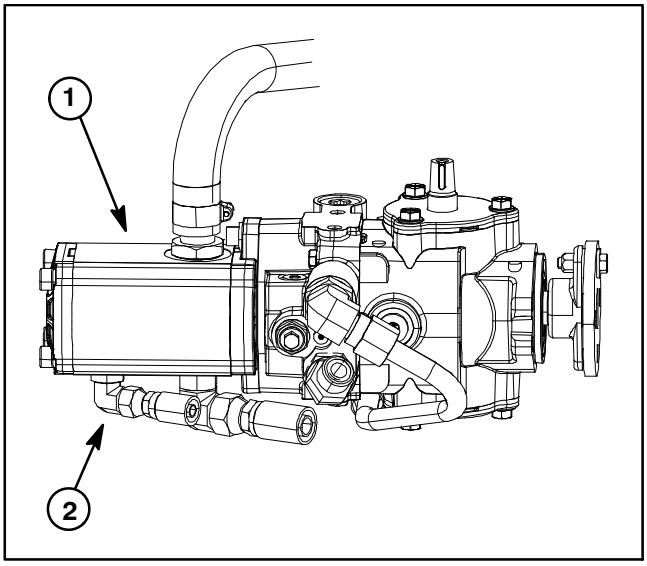


Figure 24

1. **Gear pump**
2. **Rear section fitting**

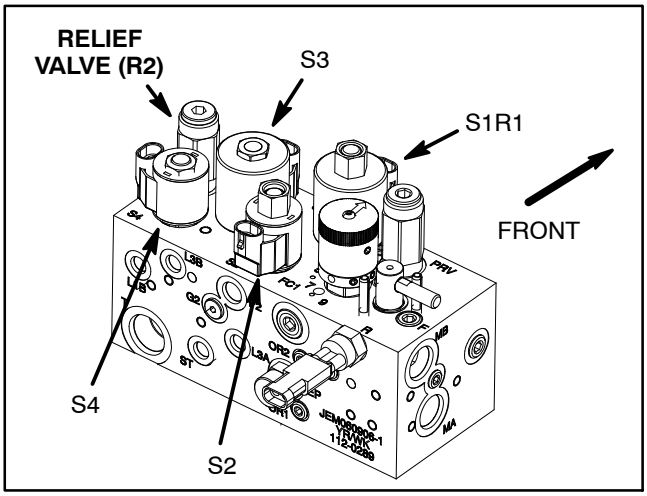
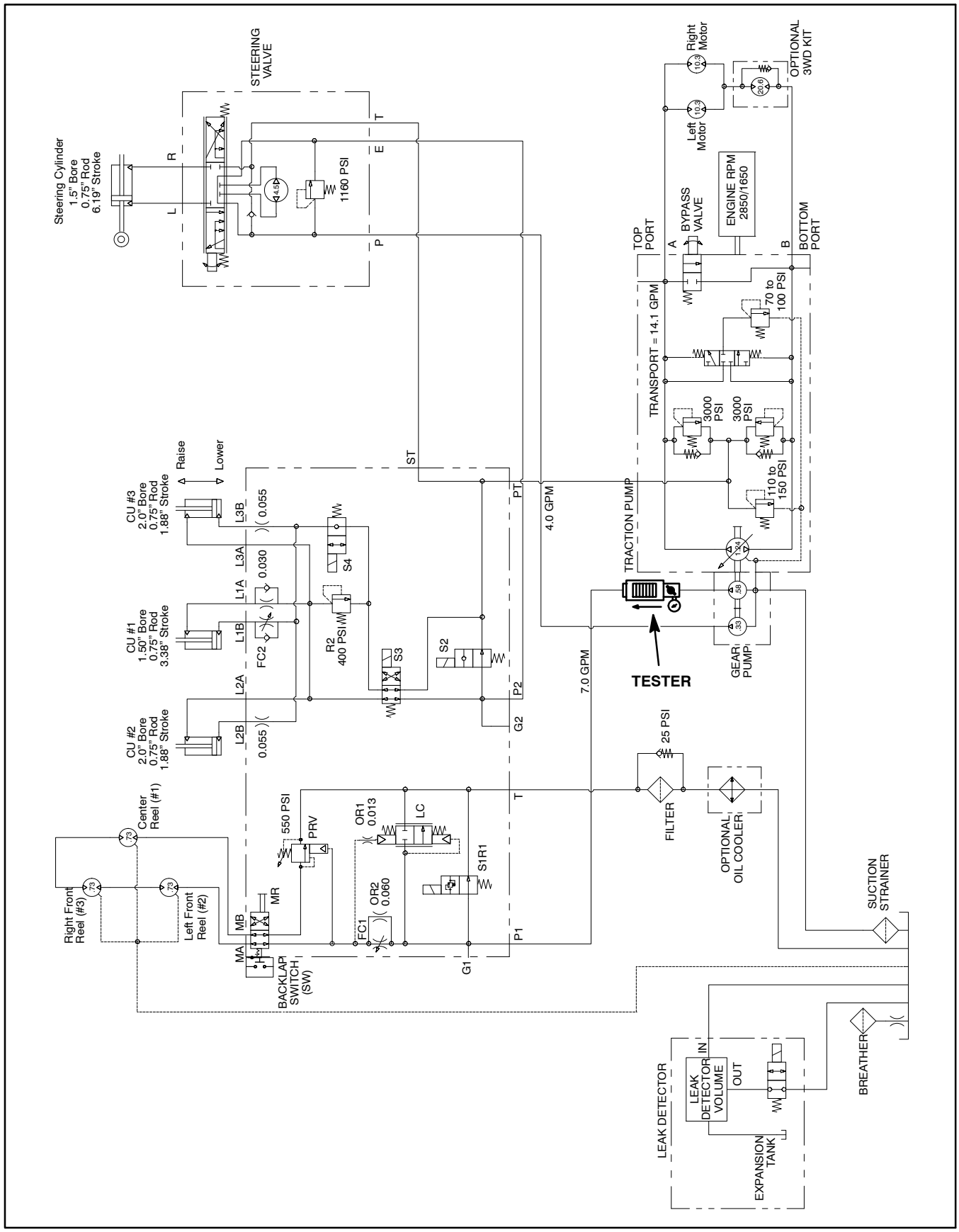


Figure 25

Gear Pump (Front Section) Flow Test (Using Tester with Flowmeter and Pressure Gauge)



Procedure for Gear Pump (Front Section) Flow Test

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

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

CAUTION

Before continuing further, read and become familiar with Precautions for Hydraulic Testing.

3. Disconnect the hose from the fitting in the front gear pump section (Fig. 26). This hose leads to port P1 on the hydraulic manifold.

4. Install tester with pressure gauge and flow meter in series with front gear pump section fitting and the disconnected hose. **Make sure the flow control valve on the tester is fully open.**

5. Make sure that reel speed is set to highest speed setting (fully open) and that backlap knob on the hydraulic manifold is in the **mow** position.

CAUTION

Do not engage the cutting units when performing this test.

6. Start engine and operate at high idle speed **(2850 ± 50 RPM)**.

IMPORTANT: Do not fully restrict oil flow through tester. In this test, the flow tester is positioned before the circuit relief valve. Gear pump damage can occur if the oil flow is fully restricted.

7. Watch pressure gauge carefully while slowly closing the flow control valve on the tester until **2000 PSI (138 bar)** is obtained.

8. Flow gauge reading for a gear pump section in good condition should be approximately **6.7 GPM (25.3 LPM)**. Record test results.

9. Once gear pump flow is recorded, open control valve on tester and shut off engine.

10. If flow was less than **5.7 GPM (21.6 LPM)** or a pressure of **2000 PSI (138 bar)** cannot be obtained, check for restriction in the gear pump intake line. If line is not restricted, remove gear pump and repair or replace as necessary.

11. When testing is complete, disconnect tester from gear pump fitting and hydraulic hose. Connect hose to pump fitting.

12. Adjust reel speed knob on mow control manifold to original setting.

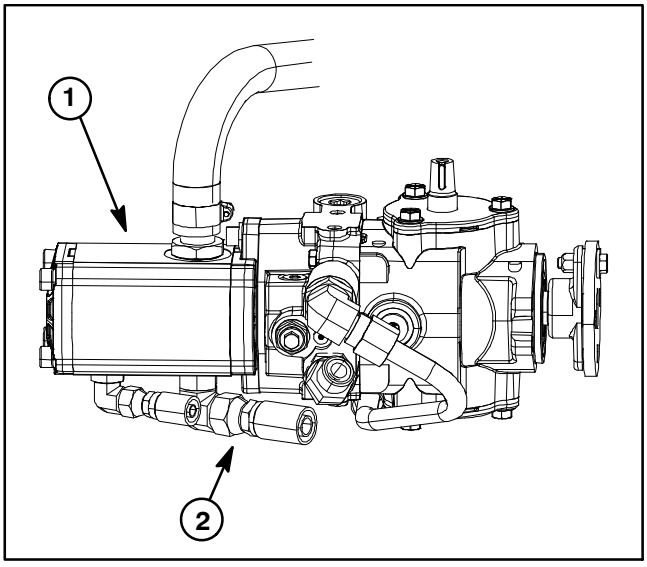
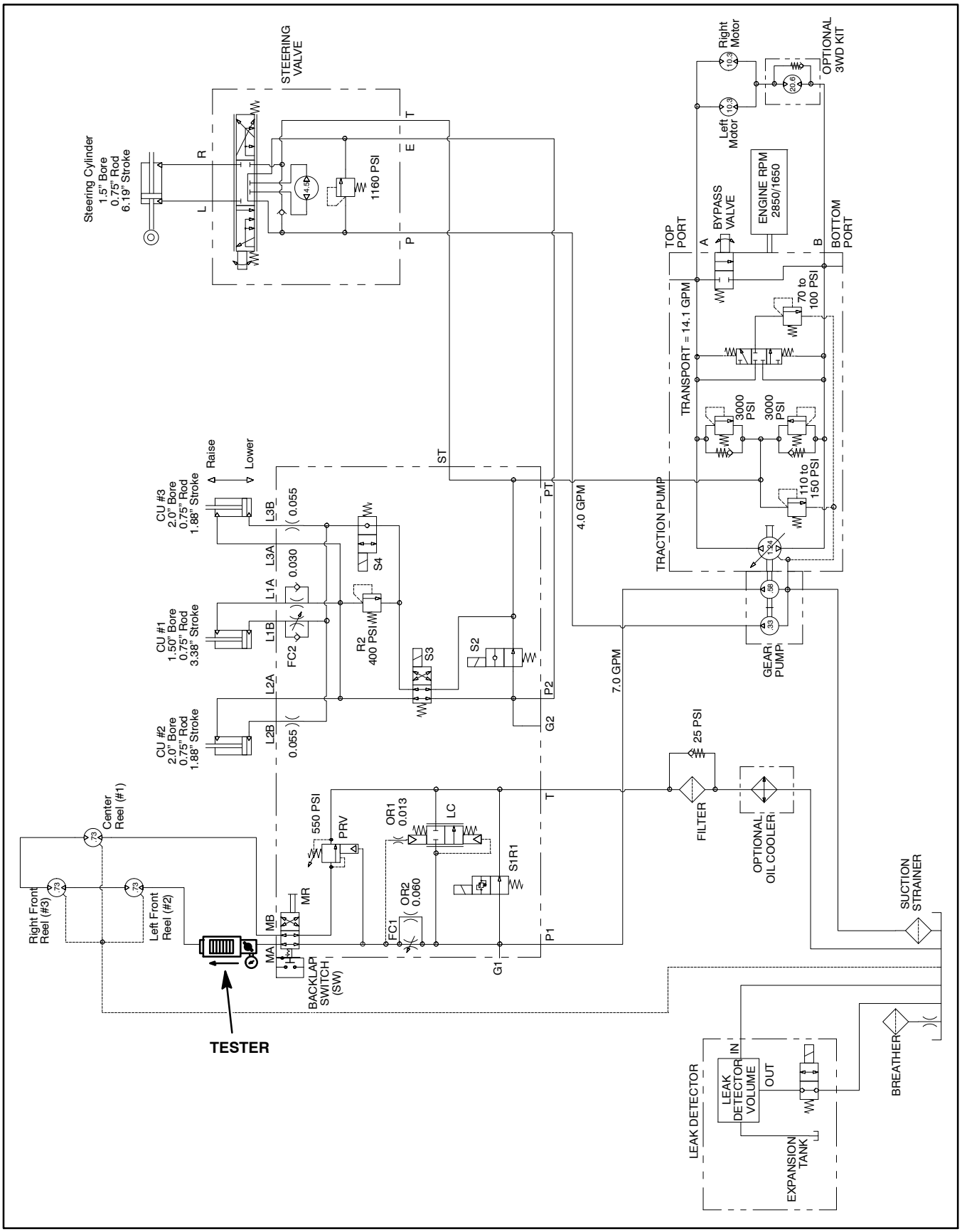


Figure 26

1. **Gear pump**
2. **Front section fitting**

Mow Circuit Relief Valve (S1R1) Pressure Test (Using Tester with Flowmeter and Pressure Gauge)



Procedure for Mow Circuit Relief Valve (S1R1) Pressure Test

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

2. Park machine on a level surface with the cutting units lowered. Make sure engine is off. Make sure the hydraulic tank is full.

CAUTION

Before continuing further, read and become familiar with Precautions for Hydraulic Testing.

3. Disconnect hydraulic hose from the front fitting of the left front cutting reel motor (Fig. 27).

4. Install tester with pressure gauge and flow meter in series with the disconnected hose and front reel motor fitting. **Make sure the flow control valve on the tester is fully open.**

5. To prevent reel damage, temporarily adjust bedknife to allow clearance between bedknife and reel (no contact).

6. Make sure that reel speed is set to highest speed setting (fully open) and that backlap knob on the hydraulic manifold is in the **mow** position.

CAUTION

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

7. Start engine and move throttle to high idle speed **(2850 ± 50 RPM)**. Engage the cutting units.

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

9. System pressure should be from **2700 to 3300 PSI (186 to 228 bar)** as manifold relief valve (S1R1) opens. Record test results.

10. After recording mow circuit relief pressure, disengage cutting units. Open control valve on tester and shut off engine.

A. If relief valve pressure **is** correct, go to step 11.

B. If relief valve pressure **is not** correct, remove solenoid relief valve (S1R1) on hydraulic control manifold (Fig. 28). Clean or replace valve (see Hydraulic Manifold Service in the Service and Repairs section of this chapter). After valve service, retest relief valve (S1R1) pressure.

11. When testing is complete, disconnect tester from reel motor fitting and hydraulic hose. Reconnect hose to the front motor fitting.

12. Correctly adjust cutting unit bedknife.

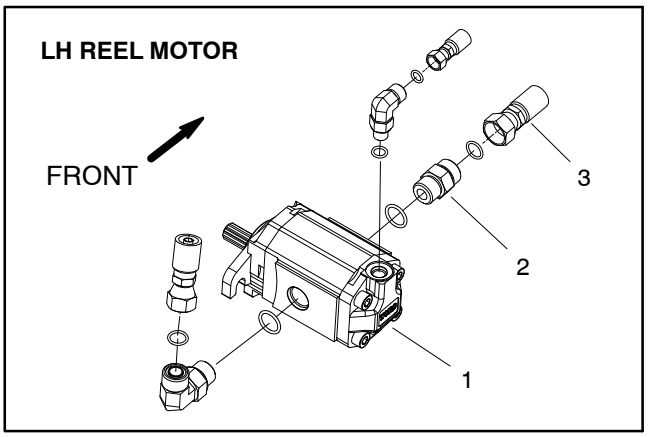


Figure 27

1. **LH reel motor**
2. **Front fitting**
3. **Hydraulic hose**

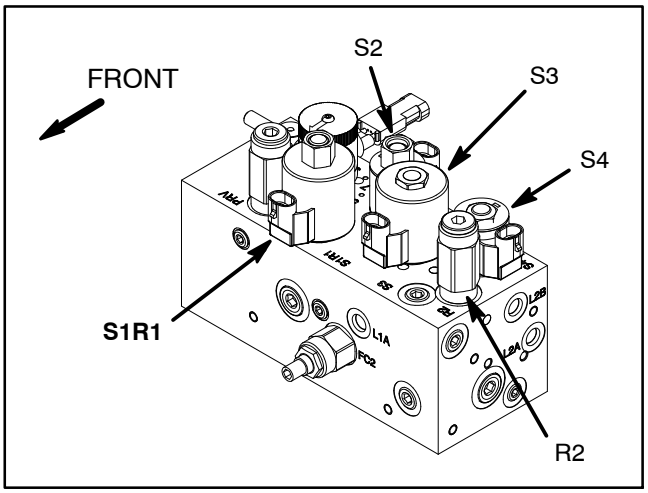
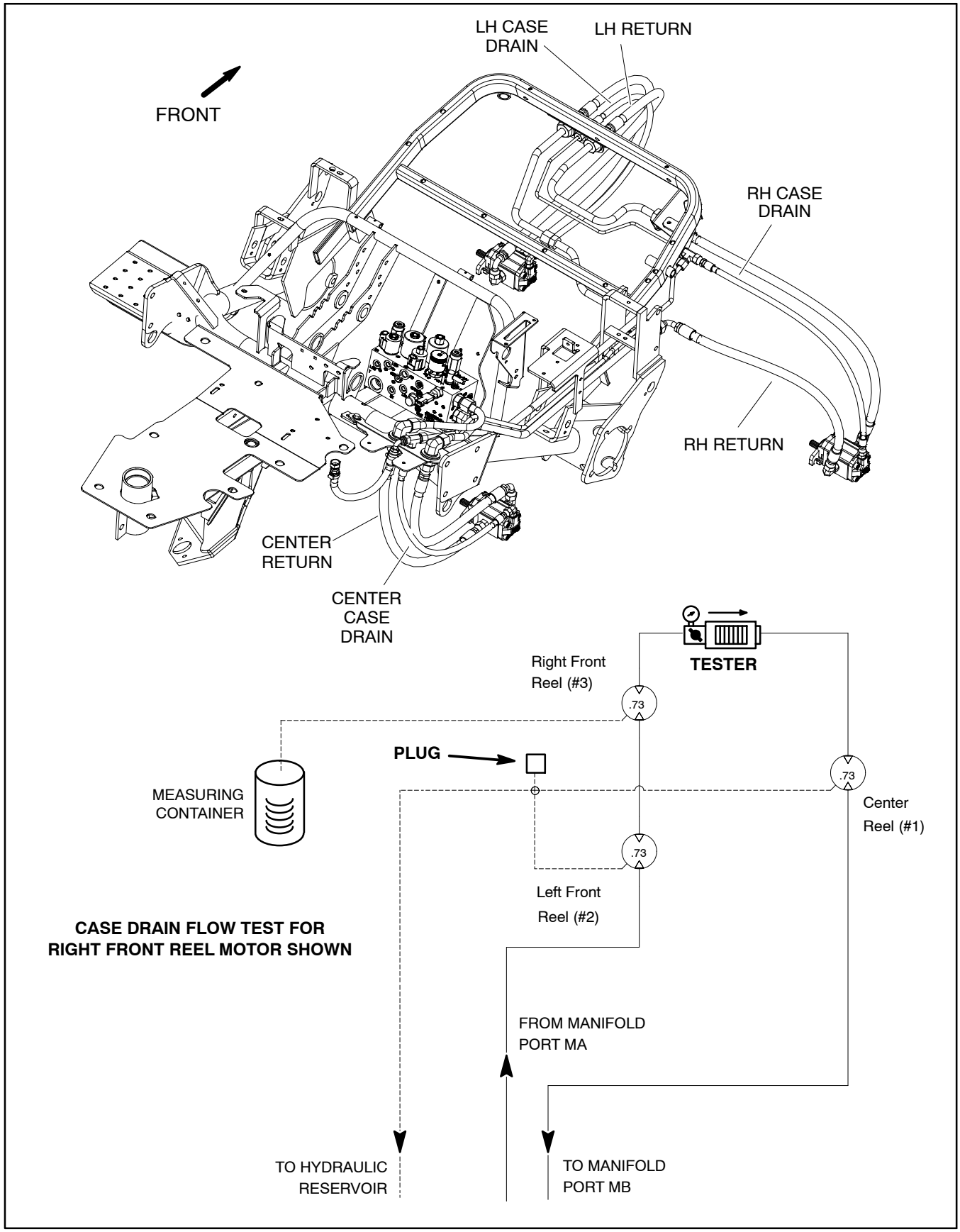


Figure 28

Reel Motor Case Drain Flow Test (Using Tester with Flowmeter and Pressure Gauge)



Procedure for Reel Motor Case Drain Flow Test:

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately ten (10) minutes. Make sure the hydraulic reservoir is full.

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

CAUTION

Before continuing further, read and become familiar with Precautions for Hydraulic Testing.

3. For the suspected bad cutting reel motor, disconnect return hose from the motor. The return hose connects to the fitting at the rear of the motor.

4. Install tester in series with the reel motor and the disconnected return hose. **Make sure the flow control valve on the tester is fully open.**

5. Make sure backlap knob on the hydraulic manifold is in the **mow** position and reel speed is set to maximum.

6. Disconnect hose from case drain of the motor to be tested at the bulkhead fitting.

   A. Plug the bulkhead port with a steel plug.

   B. Leave the case drain hose from the motor open and place open end of disconnected hose into a drain pan.

7. One person should sit on the seat and operate the machine while a second person reads the tester and measures case drain leakage.

8. Make sure functional control lever is in **NEUTRAL**. Start engine and move the throttle to high idle speed **(2850 ± 50 RPM)**.

CAUTION

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

9. Move the functional control lever to the **MOW** position and engage the cutting reels with the joystick control. While watching pressure gauge, slowly close flow control valve on the tester until a pressure of **1000 PSI (69 bar)** is obtained.

10. After achieving **1000 PSI (69 bar)**, place disconnected motor case drain hose into a container graduated in ounces or milliliters (Tool TOR4077: see Special Tools) and collect hydraulic fluid for **15 seconds** (Fig. 29). After **15 seconds**, remove hose end from container.

11. Disengage cutting units. Open control valve on tester and stop the engine.

12. Measure the amount of oil collected in the container. Record test results.

13. If case drain flow was greater than **16.0 ounces (473 milliliters) (0.5 GPM/1.9 LPM)** in **15 seconds**, repair or replace the reel motor as necessary.

14. When testing of the reel motor is completed, disconnect tester from reel motor and return hose. Reconnect return hose to the motor.

15. Remove plug from bulkhead fitting. Reconnect case drain hose to the bulkhead fitting.

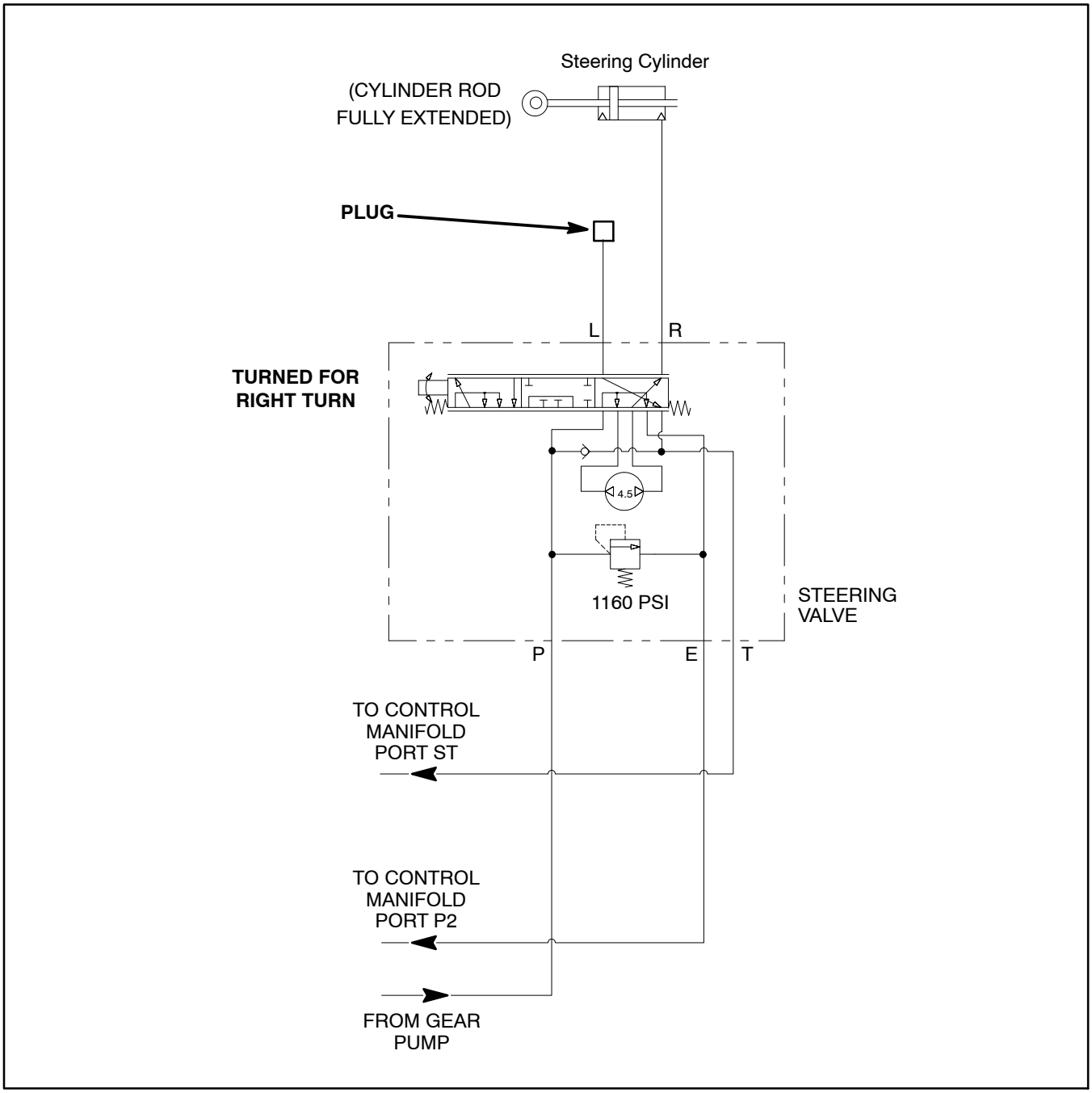
16. Test other cutting reel motors as needed.

Figure 29

GPM	Milliliters in 15 sec.	Ounces in 15 sec.
.1	95	3.2
.2	189	6.4
.3	284	9.6
.4	378	12.8
.5	473	16.0
.6	568	19.2
.7	662	22.4
.8	756	25.6
.9	852	28.8
1.0	946	32.0

Figure 30

Steering Control Valve Test



Procedure for <u>Steering Control Valve</u> Test:

1. Make sure the hydraulic reservoir is full.

2. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately ten (10) minutes.

3. Drive machine slowly in a figure eight on a flat level surface.

   A. There should be no shaking or vibration in the steering wheel or rear wheel.

   B. Steering wheel movements should be followed **immediately** by a corresponding rear wheel movement **without** the steering wheel continuing to turn.

4. Stop the machine with the engine running. Turn steering wheel with small quick movements in both directions. Let go of the steering wheel after each movement.

   A. The steering wheel must go back immediately to the neutral position.

   B. The steering wheel should **not** continue to turn.

NOTE: The steering wheel must be able to turn with no more than **45 in−lb (5.1 N−m)** of torque.

5. Perform the Implement Relief Valve Pressure and Gear Pump (Rear Section) Flow tests to make sure that relief valve and gear pump are functioning correctly.

NOTE: This steering test procedure will be affected by incorrect rear tire pressure, binding in the hydraulic steering cylinder, extra weight on the vehicle and/or binding of the steering fork assembly. Make sure that these items are checked before proceeding with any hydraulic testing procedure.

6. If either of these performance tests indicate a steering problem, determine if the steering cylinder is faulty using the following procedure.

A. Park machine on a level surface with the cutting units lowered and off. Apply the parking brake.

B. Turn the steering wheel all the way to the right (clockwise) so the steering cylinder rod is fully extended.

C. Turn engine off.

CAUTION

Before continuing further, read and become familiar with Precautions for Hydraulic Testing.

D. Read Precautions for Hydraulic Testing.

E. Remove hydraulic hose from the 90º fitting on the rod end of the steering cylinder (Fig. 31). Install steel plug in the end of the hose.

F. With the engine off, continue turning the steering wheel to the right (clockwise) with the steering cylinder fully extended. Observe the open fitting on the steering cylinder as the steering wheel is turned. If oil comes out of the fitting while turning the steering wheel to the right, the steering cylinder has internal leakage and must be repaired or replaced.

G. Remove plug from the hydraulic hose. Reconnect hose to the steering cylinder fitting.

7. If steering problem exists and steering cylinder tested acceptably, steering control valve requires service (see Steering Control Valve and Steering Control Valve Service in the Service and Repairs section of this chapter).

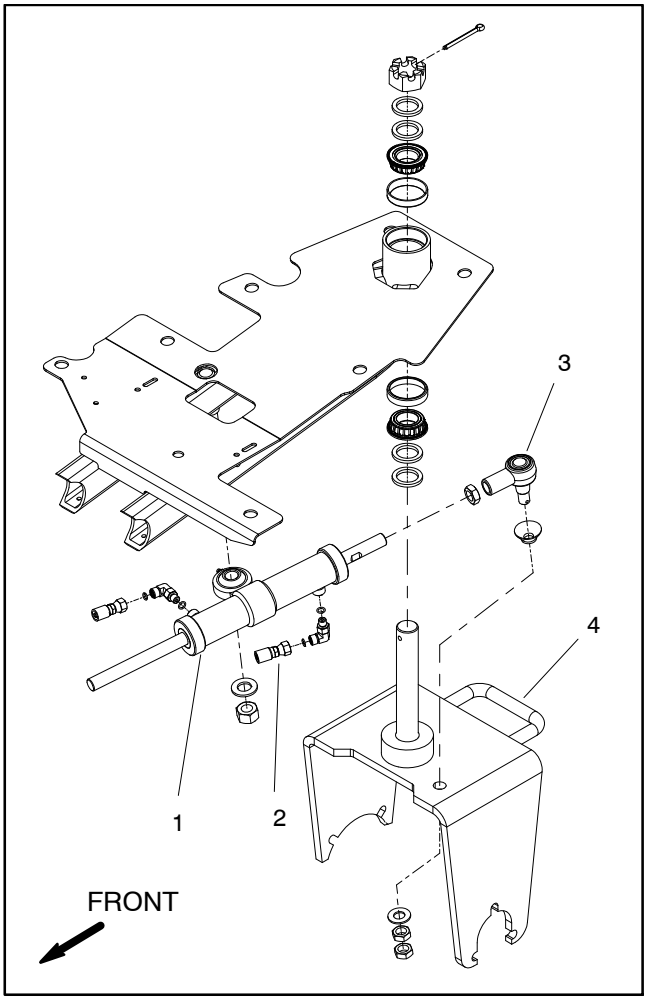


Figure 31

1. **Steering cylinder**
2. **Hydraulic hose**
3. **Rod end**
4. **Castor fork**

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Adjust Manifold Relief Valve (R2)

The hydraulic manifold includes an adjustable relief valve in the lift circuit (Fig. 32). If adjustment to this valve is necessary, follow the following procedure.

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

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.

1. Locate relief valve on control manifold.

2. Remove cap on relief valve with an allen wrench.

3. To **increase** pressure setting, turn the adjustment socket on the valve in a clockwise direction. A 1/8 turn on the socket will make a measurable change in relief pressure.

4. To **decrease** pressure setting, turn the adjustment socket on the valve in a counterclockwise direction. A 1/8 turn on the socket will make a measurable change in relief pressure.

5. Install and tighten cap on relief valve.

6. Recheck relief pressure and readjust as needed.

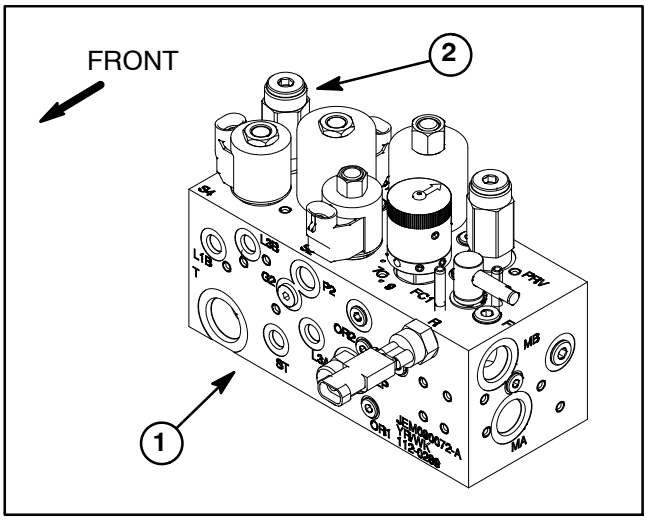

Figure 32

1. Hydraulic manifold **2. Relief valve (R2)**

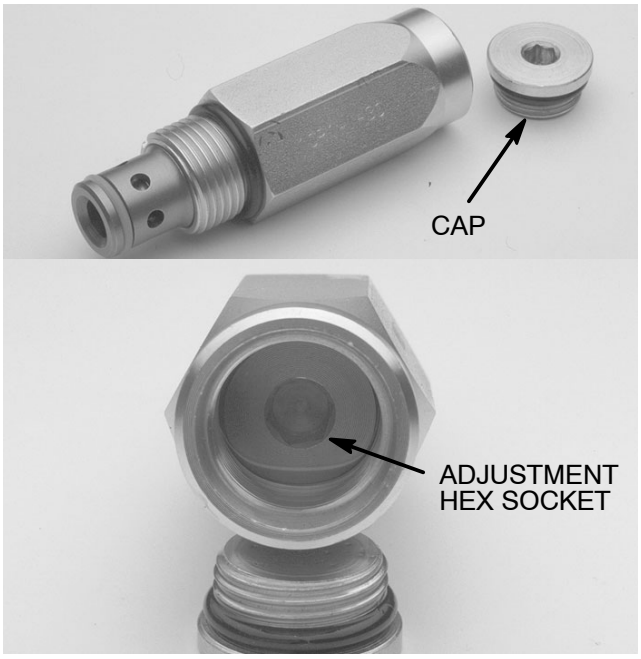

Figure 33

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

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

7. 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.

Flush Hydraulic System

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

IMPORTANT: Flush hydraulic system when changing from petroleum base hydraulic fluid. Operate machine under normal operating conditions for at least four (4) hours before draining.

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

CAUTION

Before continuing further, read and become familiar with General Precautions for Removing and Installing Hydraulic System Components.

2. Clean area around gear pump and pump inlet hose (Fig. 34). Clamp pump inlet hose. Remove hose from gear pump, release clamp and drain reservoir into a suitable container. Drain hydraulic system while making sure lift cylinders, hydraulic hoses, hydraulic tubes and all other components are drained from low points while the system is warm.

3. Clean hydraulic oil filter mounting area. Remove filter and drain into a suitable container. Discard filter.

4. Inspect and clean hydraulic reservoir (see Hydraulic Reservoir in the Service and Repairs section of this chapter).

5. Make sure filter mounting surface is clean. Apply hydraulic oil to gasket on the new filter. Screw filter on until gasket contacts mounting plate, then tighten filter 3/4 turn further.

NOTE: Use only hydraulic fluids (including biodegradable) specified in the Traction Unit Operator's Manual. Other fluids could cause system damage.

6. Reconnect all hydraulic hoses and lines that were disconnected prior to draining. Fill hydraulic reservoir.

7. Disconnect both spark plug wires from spark plugs to prevent the engine from starting.

8. Turn ignition key switch; engage starter for ten (10) seconds to prime the hydraulic pumps. Allow the starter to cool for one (1) minute and then repeat this step again.

9. Reconnect both spark plug wires to spark plugs.

10. Start engine and let it idle at low speed for a minimum of two (2) minutes. Increase engine speed to high idle for minimum of one (1) minute under no load.

11. Raise and lower cutting units several times. Rotate steering wheel in both directions several times.

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

13. Operate the machine for two (2) hours under normal operating conditions.

14. Check condition of hydraulic oil. If the new hydraulic oil shows any signs of contamination, or if you are changing to biodegradable fluid, repeat steps 1 through 13 again.

15. Assume normal operation and follow recommended maintenance intervals.

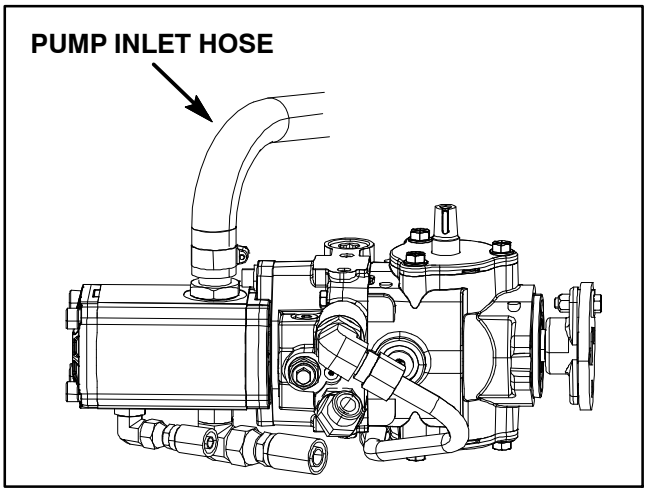

Figure 34

Filtering Closed−Loop Traction Circuit

Filtering of a closed−loop hydraulic system after a major component failure (e.g. piston (traction) pump or wheel motor) is a requirement to prevent debris from transmitting throughout the system. If a closed−loop hydraulic system filtering tool is not used to ensure system cleanliness, repeat failures, as well as subsequent damage to other hydraulic components in the affected system, will occur. To effectively remove contamination from closed−loop traction circuit, use of the Toro high flow hydraulic filter and hydraulic hose kits are recommended (see Special Tools in this chapter).

1. Park machine on a level surface with engine stopped and key removed from ignition switch.

2. Raise machine so all driven wheels are off the ground. Support raised machine with appropriate jackstands.

NOTE: If wheel motor was replaced, install high flow filter to the inlet of new motor instead of to piston (traction) pump fitting. This will prevent system contamination from entering and damaging the new motor.

3. Thoroughly clean junction of hydraulic hose and **lower** fitting on side of piston pump (Fig. 35). Disconnect hose from lower pump fitting.

4. Connect Toro high flow hydraulic filter in series between lower piston pump fitting and disconnected hose. Use hydraulic hose kit (see Special Tools in this chapter) to connect filter to machine. Make sure that fitting and hose connections are properly tightened.

IMPORTANT: Use only hydraulic fluids specified in Traction Unit Operator's Manual. Other fluids could cause system damage.

5. After installing high flow filter to machine, check and fill hydraulic reservoir with new hydraulic oil as required.

6. Start engine and run at idle speed. Check for any hydraulic leakage from filter and hose connections. Correct any leaks before proceeding.

CAUTION

All driven wheels will be off the ground and rotating during this operation. Make sure machine is well supported so it will not move and accidentally fall.

IMPORTANT: While engaging the traction circuit, monitor the indicator on the high flow hydraulic filter. If the indicator should show red, either reduce pressure on the traction pedal or reduce engine speed to decrease hydraulic flow through the filter.

7. With engine running at low idle speed, slowly move the traction pedal to the forward direction to allow flow through the traction circuit and high flow filter. Keep traction circuit engaged for five (5) minutes while gradually increasing both forward pressure on traction pedal and engine speed. Monitor filter indicator to make sure that green color is showing during operation.

IMPORTANT: If using a filter that is not the bi−directional Toro high flow filter, do not press the traction pedal in the reverse direction. If flow is reversed when using a filter that is not bi−directional, debris from the filter will re−enter the traction circuit.

8. With engine running at high idle speed, alternately move traction pedal from forward to reverse. While monitoring filter indicator, continue this process for an additional five (5) minutes.

9. Shut engine off and remove key from ignition switch.

10. Remove high flow hydraulic filter and hydraulic hose kit from machine. Connect hydraulic hose to lower piston pump fitting. Make sure to properly tighten hose (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

11. Lower machine to ground.

12. Check oil level in hydraulic reservoir and add correct oil if necessary.

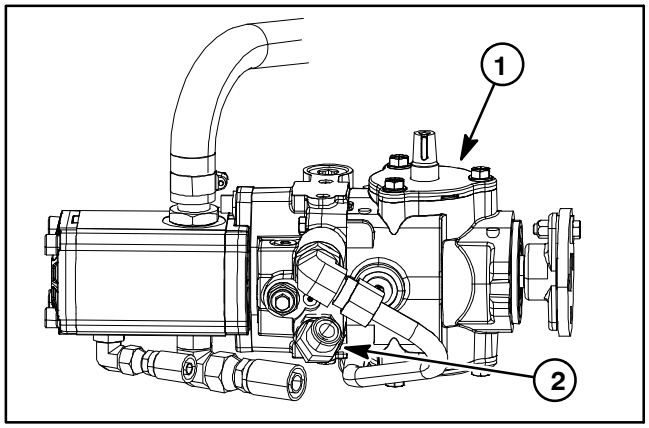

Figure 35

1. Piston pump
2. Lower pump fitting

Hydraulic System Start–up

NOTE: When initially starting the hydraulic system with new or rebuilt components such as motors, pumps or lift cylinders, it is important that this start–up procedure be used. This procedure reduces the chance of damaging the system or its components from not purging the system of air.

1. After the hydraulic system components have been properly installed and if the traction pump was rebuilt or replaced, make sure traction pump housing is at least half full of clean hydraulic oil.

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

3. Make sure hydraulic reservoir is full. Add correct oil if necessary. Drain, flush and refill hydraulic system reservoir and change oil filter if component failure was severe or system is contaminated.

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

5. Make sure functional control lever is in **neutral**.

6. Disconnect both spark plug wires from spark plugs to prevent the engine from starting.

7. Turn ignition key switch and engage starter for ten (10) seconds to prime pump. Return ignition switch to off and wait one (1) minute to allow starter to cool. Repeat step a second time.

8. Reconnect spark plug wires to spark plugs.

9. Make sure functional control lever is in **neutral** and cutting unit switch is **off**. Start engine and run at low idle speed. The charge pump should pick up oil and fill the hydraulic system. If there is no indication of fill in thirty (30) seconds, stop the engine and determine the cause.

CAUTION

Be careful when operating the cutting unit reels. Contact with the reel or other moving parts can result in personal injury.

10. After the hydraulic system starts to show signs of fill, accomplish the following:

    A. If a reel motor was replaced or rebuilt, run the cutting units at the minimum speed setting (under no load) for ten (10) minutes in **both** directions.

    B. If the gear pump was replaced or rebuilt, run the cutting units at the minimum speed setting (under no load) for ten (10) minutes.

    C. If the piston pump or a wheel motor was replaced or rebuilt, run the traction unit so the wheels turn slowly for ten (10) minutes.

11. Operate the traction unit and cutting units by gradually increasing their work load to full over a ten (10) minute period.

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

Gear Pump

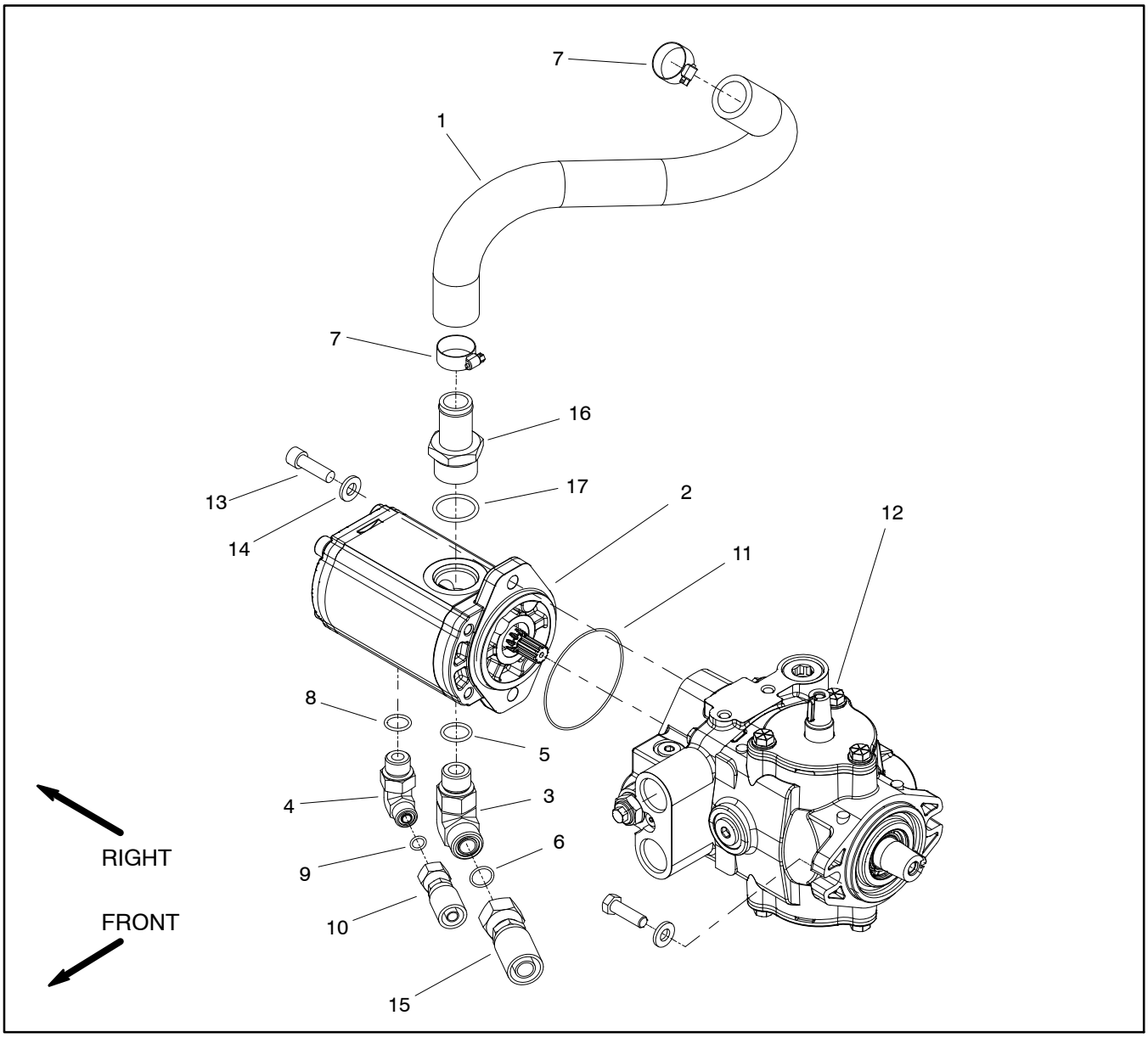

Figure 36

1. **Pump inlet hose**
2. **Gear pump**
3. **Hydraulic fitting**
4. **Hydraulic fitting**
5. **O–ring**
6. **O–ring**
7. **Hose clamp (2 used)**
8. **O–ring**
9. **O–ring**
10. **Hydraulic hose**
11. **O–ring**
12. **Piston pump**
13. **Socket head screw (2 used)**
14. **Flat washer (2 used)**
15. **Hydraulic hose**
16. **Hose connector**
17. **O–ring**

Removal (Fig. 36)

CAUTION

Before continuing further, read and become familiar with General Precautions for Removing and Installing Hydraulic System Components.

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

2. Label all hose connections for assembly purposes.

3. Clamp pump inlet hose to prevent draining the hydraulic reservoir.

4. Loosen hose clamp and remove pump inlet hose from the gear pump. Allow clamped hose to drain into a suitable container.

5. Disconnect hydraulic hoses from fittings on bottom of the gear pump. Allow hoses to drain into a suitable container. Plug hoses to prevent contamination.

IMPORTANT: Note position of hydraulic fittings for assembly purposes.

6. Mark hydraulic fitting orientation to allow correct assembly. Remove hydraulic fittings and O−rings from gear pump.

7. Support gear pump to prevent it from shifting. Separate gear pump from the piston pump by removing both socket head screws and flat washers. Remove O−ring from between the gear pump and piston pump.

NOTE: A case drain exists in the piston (traction) pump and a suction port is near the input shaft of the gear pump (Fig. 37). When the gear pump is removed from the piston pump, plug piston pump case drain hole to prevent draining the piston pump.

8. Discard all removed O−rings.

Installation (Fig. 36)

1. Make sure mounting and O−ring sealing surfaces on the gear pump and piston pump are clean.

2. Lubricate and place new O−ring (item 11) on the gear pump.

3. Position gear pump to the piston pump so that the pump inlet is facing up.

4. Secure gear pump to the piston pump with two (2) socket head screws and flat washers.

5. Inspect threads and sealing surfaces of hydraulic fittings and hydraulic hose connectors. Replace any damaged or worn fittings or hoses.

6. Lubricate and place new O−rings onto gear pump hydraulic fittings. Install fittings into pump openings making sure that fitting orientation is as noted during removal. Tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).

7. Remove plugs that were placed during disassembly from hydraulic hoses.

8. Using labels placed during gear pump removal, lubricate new O−rings and connect hydraulic hoses to lower gear pump fittings. Tighten hose connections (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

9. Install pump inlet hose to the hose connector on gear pump. Secure hose with hose clamp.

10. Remove clamp from pump inlet hose to allow hydraulic oil flow to the gear pump.

11. Check oil level in hydraulic reservoir and add correct oil if necessary.

12. Follow Hydraulic System Start−up procedures (see Hydraulic System Start−up in this section).

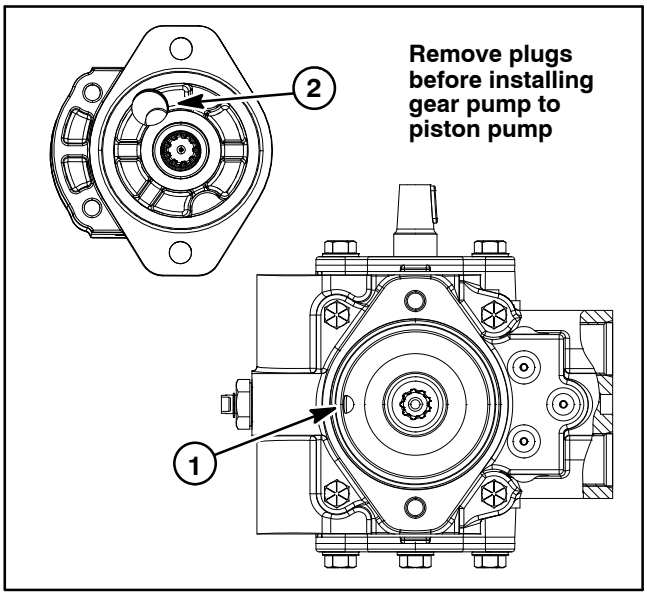

Figure 37

1. Piston pump case drain
2. Gear pump suction port

Gear Pump Service

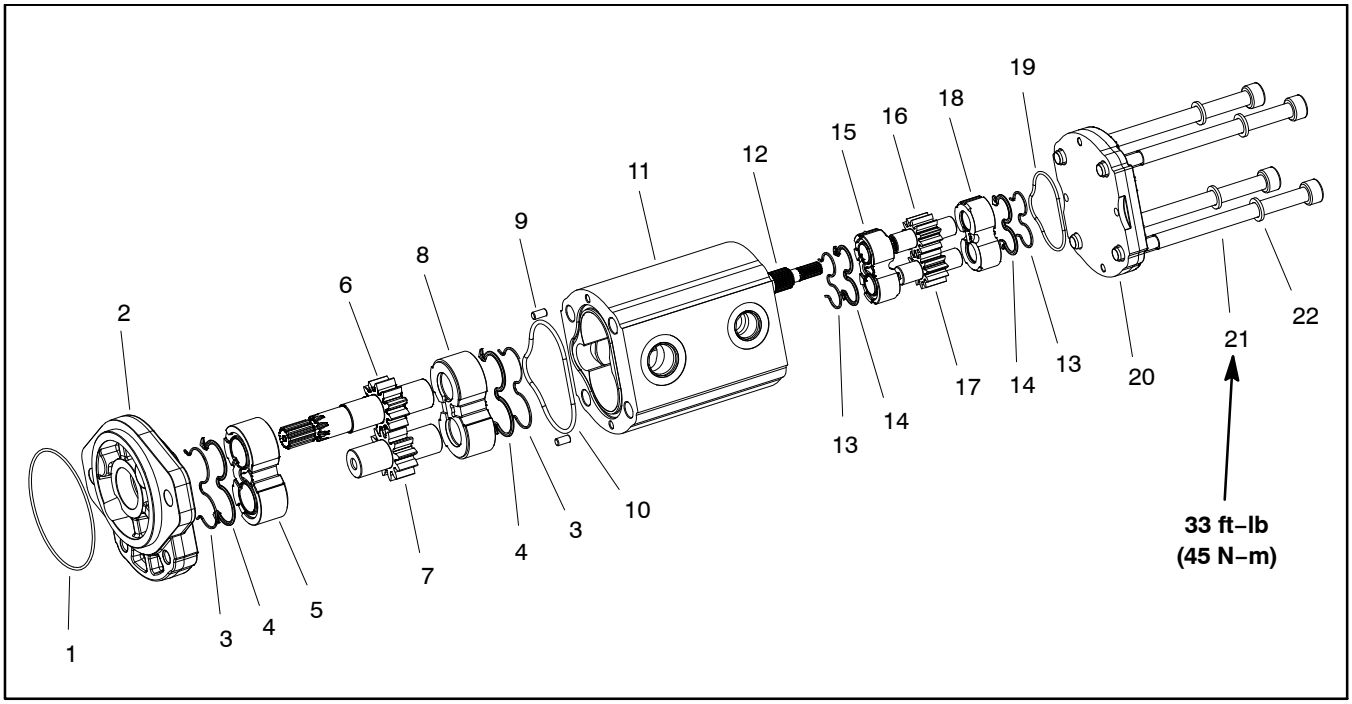

Figure 38

1. O–ring
2. Front cover
3. Back–up seal
4. Pressure seal
5. Thrust plate
6. Drive shaft
7. Idler gear
8. Thrust plate
9. Dowel pin
10. O–ring
11. Housing
12. Coupler
13. Back–up seal
14. Pressure seal
15. Thrust plate
16. Drive gear
17. Idler gear
18. Thrust plate
19. O–ring
20. End cover
21. Socket head screw (4 used)
22. Washer (4 used)

Gear Pump Disassembly (Fig. 38)

NOTE: Disassemble gear pump for cleaning, inspection and seal replacement only. Individual gears, housings and thrust plates are not available separately. If internal components are worn or damaged, the gear pump must be replaced as a complete assembly.

IMPORTANT: Keep gears and thrust plates for each pump section together; do not mix parts between pump sections.

1. Plug pump ports and thoroughly clean exterior of pump with cleaning solvent. Make sure work area is clean.

2. Use a marker to make a “V” across the front cover, housing and end cover for assembly purposes (Fig. 39).

IMPORTANT: Use caution when clamping gear pump in a vise to avoid distorting any pump components. Also, use a vise with soft jaws.

3. Secure the front cover of the pump in a vise with soft jaws with the drive shaft pointing down.

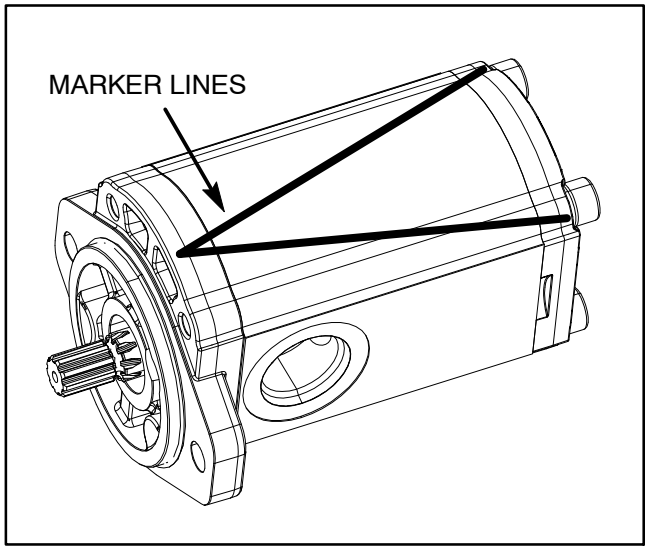

Figure 39

4. Loosen the four (4) socket head screws that secure pump assembly.

5. Remove pump from vise and remove fasteners.

6. Support the pump assembly and gently tap the pump housing with a soft face hammer to loosen the pump sections. Be careful to not drop parts or disengage gear mesh.

IMPORTANT: Mark the relative positions of the gear teeth and the thrust plates so they can be assembled in the same position. Do not touch the gear surfaces as residue on hands may be corrosive to gear finish.

7. Remove the thrust plates 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 assembly. Keep the parts for each pump section together; do not mix parts between sections.

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

9. Replace the entire pump assembly if any pump components are excessively worn or scored.

Gear Pump Assembly (Fig. 38)

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

NOTE: Pressure and back−up seals fit in grooves machined into thrust plates. Body O−rings fit in grooves machined in housing.

2. Assemble pump sections starting at front cover end. Apply grease or petroleum jelly to new section seals to hold them in position during gear pump assembly.

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

4. Tighten the socket head screws evenly in a crossing pattern to a torque of **33 ft−lb (45 N−m)**.

Piston (Traction) Pump Neutral Assembly

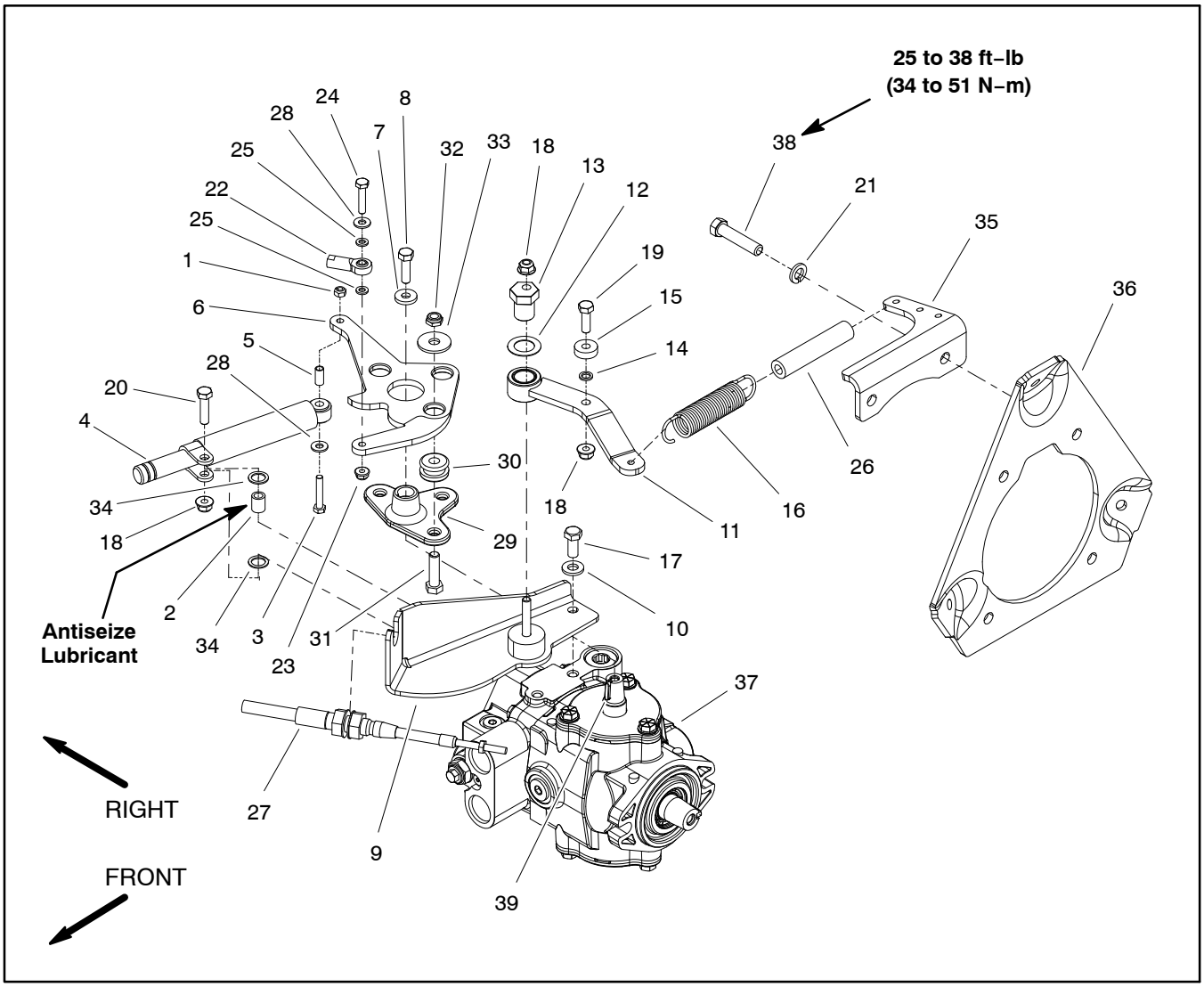

Figure 40

1. Lock nut
2. Pivot tube
3. Cap screw
4. Damper lever
5. Pivot spacer
6. Pump lever
7. Flat washer
8. Cap screw
9. Cable support
10. Flat washer (2 used)
11. Neutral arm
12. Thrust washer
13. Traction stud
14. Bearing spacer
15. Ball bearing
16. Extension spring
17. Cap screw (2 used)
18. Flange nut (3 used)
19. Cap screw
20. Cap screw
21. Lock washer (2 used)
22. Cable ball joint
23. Flange nut
24. Cap screw
25. Flat washer (2 used)
26. Dampener hose
27. Traction control cable
28. Flat washer (2 used)
29. Pivot plate
30. Mount (3 used)
31. Cap screw (3 used)
32. Lock nut (3 used)
33. Washer (3 used)
34. Nylon washer (2 used)
35. Spring bracket
36. Mount plate
37. Piston pump assembly
38. Cap screw (2 used)
39. Key

Disassembly (Fig. 40)

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

CAUTION

The extension spring (item 16) is under tension and may cause personal injury during removal. Use caution when removing the spring from the pump neutral assembly.

2. Remove components from traction neutral assembly as needed using Figure 40 as a guide.

Assembly (Fig. 40)

1. Install removed components to traction neutral assembly using Figure 40 as a guide along with the following:

CAUTION

The extension spring (item 16) is under tension and may cause personal injury during installation. Use caution when installing the spring to the pump neutral assembly.

A. If pivot plate (item 29) was removed from pump trunnion shaft, make sure that both trunnion shaft and plate bore are thoroughly cleaned before installing plate to shaft.

B. If damper lever (item 4) was removed, apply antiseize lubricant to pivot tube (item 2) before inserting into the bore of cable support (item 9).

C. Make sure that ball bearing (item 15) on neutral arm (item 11) is properly positioned in pump lever (item 6) after assembly.

2. After traction neutral assembly has been installed, make sure that the transmission is adjusted for the neutral position so that the machine does not move or creep when the traction pedal is in neutral.

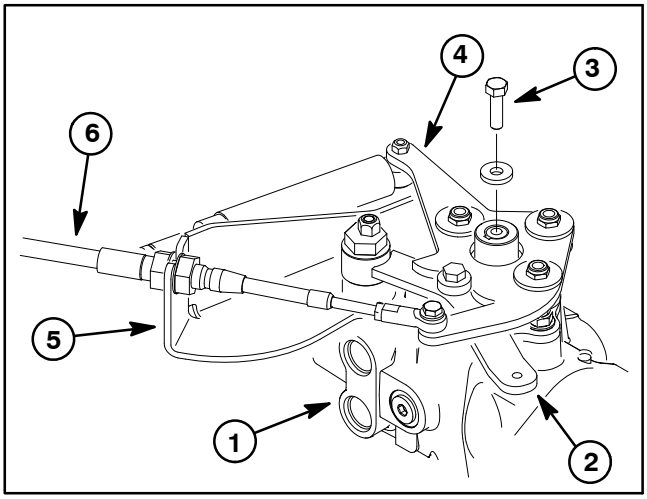

Figure 41

1. **Piston pump**
2. **Neutral arm**
3. **Cap screw**
4. **Pump lever**
5. **Cable support**
6. **Traction cable**

Piston (Traction) Pump

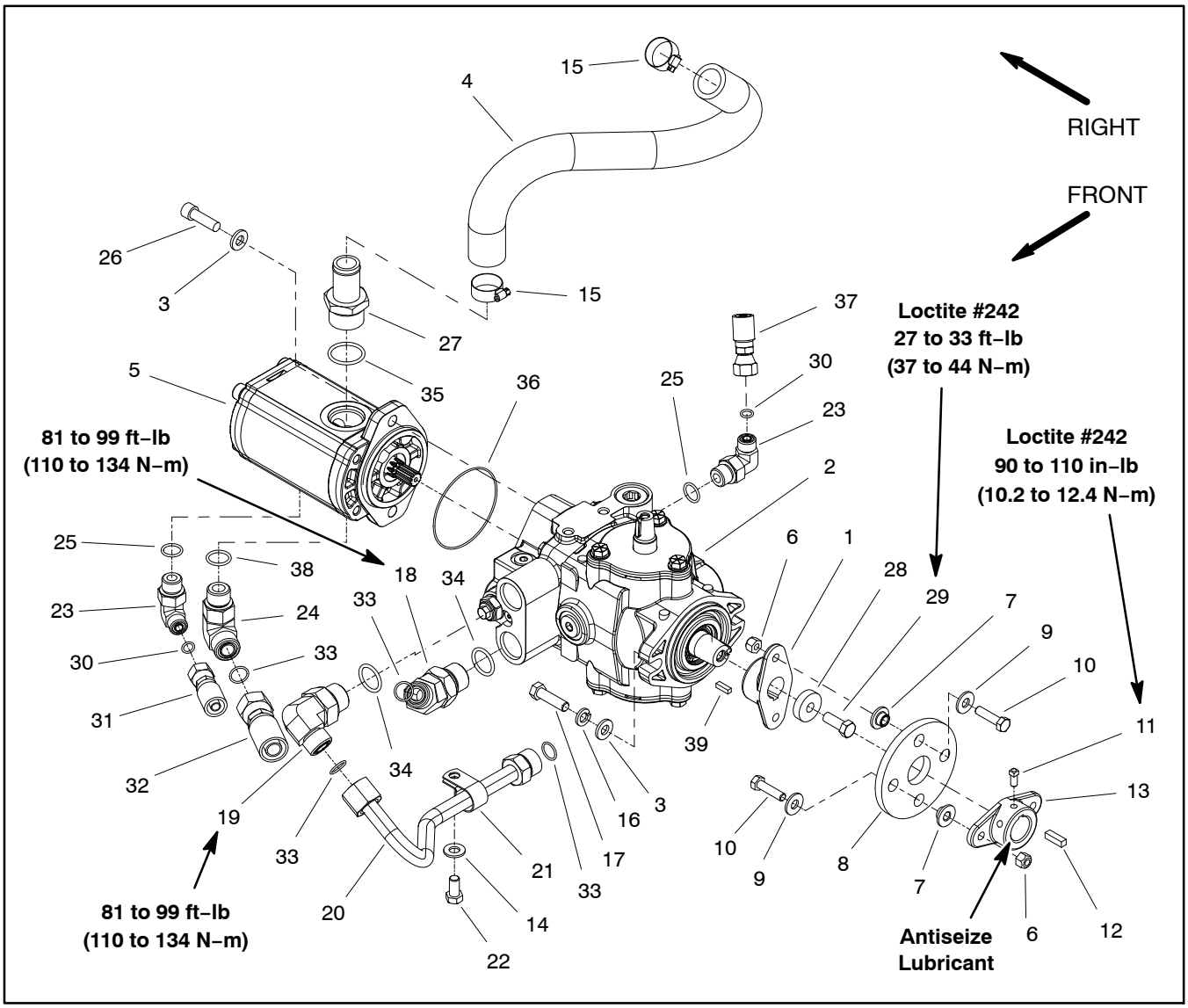

Figure 42

1. Pump hub
2. Piston pump
3. Flat washer (4 used)
4. Pump inlet hose
5. Gear pump
6. Lock nut (4 used)
7. Coupling spacer (4 used)
8. Rubber coupling
9. Flat washer (4 used)
10. Cap screw (4 used)
11. Square head set screw (2 used)
12. Square key
13. Engine hub
14. Flat washer
15. Hose clamp (2 used)
16. Lock washer (2 used)
17. Cap screw (2 used)
18. Hydraulic fitting
19. 90º hydraulic fitting
20. Hydraulic tube
21. Support clamp
22. Cap screw
23. 90º hydraulic fitting (2 used)
24. 90º hydraulic fitting
25. O–ring
26. Socket head screw (2 used)
27. Hose connector
28. Spacer
29. Cap screw
30. O–ring
31. Hydraulic hose
32. Hydraulic hose
33. O–ring
34. O–ring
35. O–ring
36. O–ring
37. Hydraulic hose
38. O–ring
39. Key

NOTE: The complete piston (traction) and gear pump assembly can be removed from the machine with the neutral assembly attached to the piston pump. See Piston (Traction) Pump Neutral Assembly in this section for information regarding servicing the neutral assembly.

Piston Pump Removal (Fig. 42)

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

CAUTION

Before continuing further, read and become familiar with General Precautions for Removing and Installing Hydraulic System Components.

2. Disconnect the traction control cable ball joint and jam nuts from the neutral arm (Fig. 43). Position traction cable away from the pump assembly.

CAUTION

The extension spring attached to the neutral arm is under tension and may cause personal injury during removal. Use caution when removing the spring from the pump neutral arm.

3. Disconnect one end of the extension spring attached to the neutral arm (Fig. 44).

4. Remove two (2) cap screws (item 10), flat washers (item 9), coupling spacers (item 7) and lock nuts (item 6) that secure pump hub to rubber coupling (item 8).

5. Thoroughly clean hydraulic hose ends and fittings on gear and piston (traction) pumps to prevent hydraulic system contamination.

6. Label all hydraulic hose connections on gear and piston pumps for assembly purposes.

7. Clamp pump inlet hose (item 4) to prevent draining the hydraulic reservoir.

8. Loosen hose clamp and remove inlet hose from the gear pump.

9. Disconnect hydraulic hoses from fittings on pump assembly. Allow hoses to drain into a suitable container. Plug hoses and fittings to prevent contamination.

CAUTION

Support the pump assembly when removing its supporting fasteners to prevent it from falling and causing personal injury.

10. Support pump assembly to prevent it from falling.

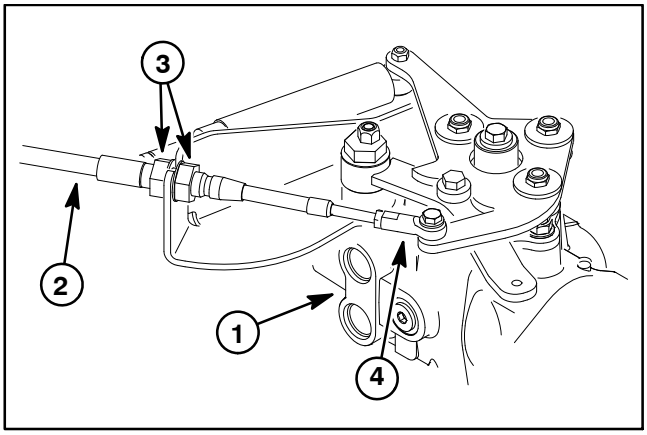

Figure 43

1. **Piston pump**
2. **Traction cable**
3. **Jam nut (2 used)**
4. **Cable ball joint**

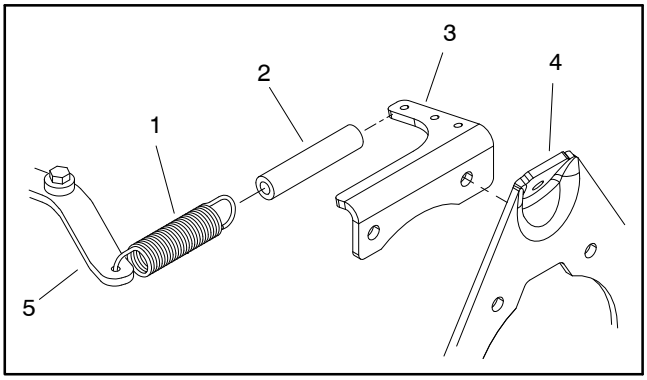

Figure 44

1. **Extension spring**
2. **Dampener hose**
3. **Spring bracket**
4. **Mount plate**
5. **Neutral arm**

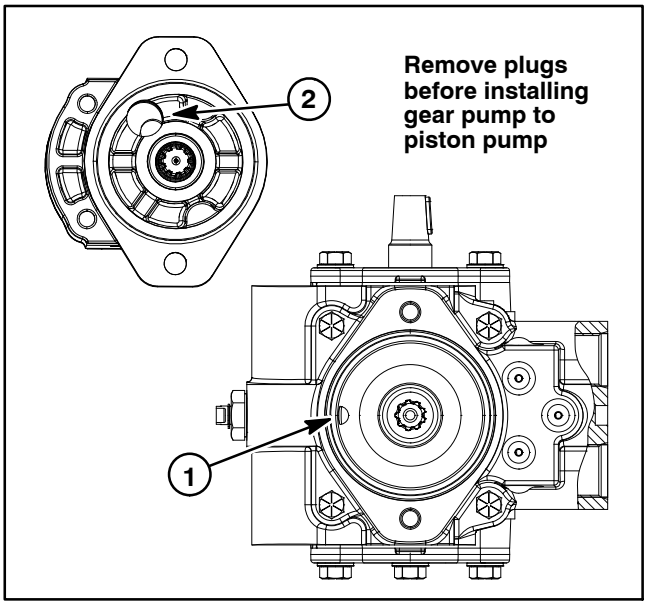

Figure 45

1. **Piston pump case drain port**
2. **Gear pump suction port**

11. Remove two (2) cap screws (item 17), lock washers (item 16) and flat washers (item 3) that secure pump assembly to pump adapter mounted to engine. Separate pump assembly from the pump adapter and remove from machine.

12. If necessary, remove pump hub (item 1) from pump input shaft. Locate and retrieve key (item 39).

13. Separate gear pump from the piston pump (see Gear Pump in this section).

IMPORTANT: If fittings are going to be removed from piston pump, note position of fittings for assembly purposes.

14. If fitting removal from piston pump is necessary, mark hydraulic fitting orientation to allow correct assembly. Remove hydraulic fittings and O−rings from piston pump. Discard removed O−rings.

15. If necessary, remove the neutral assembly attached to the piston pump (see Piston (Traction) Pump Neutral Assembly in this section).

Piston Pump Installation (Fig. 42)

1. If any neutral assembly components were removed from piston pump, install them to pump (see Piston (Traction) Pump Neutral Assembly in this section).

2. Make sure the flange surfaces of the gear pump and piston pump are thoroughly clean.

IMPORTANT: A case drain exists in the piston (traction) pump and a suction port is near the input shaft of the gear pump (Fig. 45). Before the gear pump is installed to the piston pump, make sure that plugs placed in either of these ports are removed. Failure to remove plugs will cause excessive pressure in the piston pump and damage seals.

3. Install gear pump to the piston pump (see Gear Pump in this section).

4. If removed, secure hub (item 1) to piston pump shaft:

   A. Make sure that pump shaft and bore of hub are thoroughly cleaned.

   B. Position key (item 39) to pump shaft.

   C. Apply Loctite #242 (or equivalent) to the threads of the cap screw used to secure hub to pump shaft.

   D. Slide hub onto pump shaft and secure with spacer (item 28) and cap screw (item 29). Torque cap screw from **27 to 33 ft−lb (37 to 44 N−m)**.

5. Inspect threads and sealing surfaces of hydraulic fittings and hydraulic hose connectors. Replace any damaged or worn fittings or connectors.

6. Lubricate and place new O−rings onto all removed hydraulic fittings. Install fittings into pump openings making sure that fitting orientation is as noted during removal. Tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).

7. Position pump assembly to pump adapter on engine and align pump hub with rubber coupling (item 8). Secure pump assembly to pump adapter with two (2) cap screws (item 17), lock washers (item 16) and flat washers (item 3).

8. Secure pump hub to rubber coupling (item 8) with two (2) cap screws (item 10), flat washers (item 9), coupling spacers (item 7) and lock nuts (item 6).

CAUTION

The neutral arm extension spring is under tension and may cause personal injury during installation. Use caution when installing the spring to the pump neutral arm.

9. Connect the extension spring to the neutral arm (Fig. 44).

10. Connect the traction control cable to the neutral arm (Fig. 43):

   A. Secure traction cable ball joint to neutral arm.

   B. Secure control cable to neutral arm with cable jam nuts. Make sure that a washer is positioned on each side of the neutral arm.

11. Remove plugs from hydraulic fittings and hoses that were placed during pump removal.

12. Using labels placed during pump removal, lubricate new O−rings and connect hydraulic hoses to gear pump and piston pump fittings. Tighten hose connections (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

13. Make sure that gear pump inlet hose is installed to pump fitting and secured with hose clamp. Remove clamp from gear pump inlet hose.

14. Check oil level in hydraulic reservoir and add correct oil if necessary.

15. Follow Hydraulic System Start−up procedures (see Hydraulic System Start−up in this section).

16. Check neutral position of the traction pedal. If adjustment is required, see Adjust Transmission for Neutral in the Traction Unit Owner's Manual.

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Piston (Traction) Pump Service

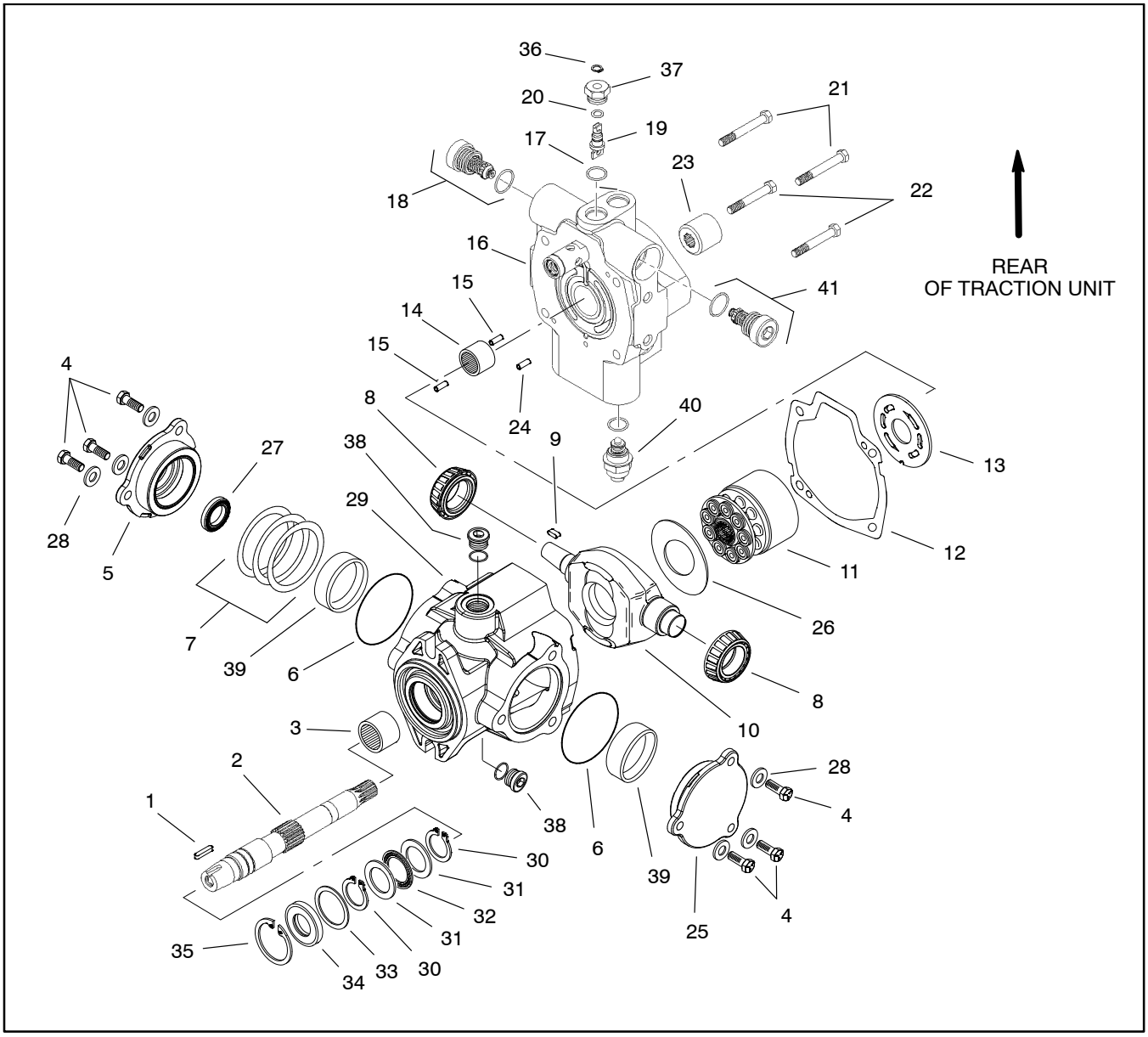

Figure 46

1. Key
2. Drive shaft
3. Bearing
4. Cap screw (3 used per plate)
5. Cover plate
6. O−ring
7. Shim kit (for crush ring replacement)
8. Bearing cone
9. Key
10. Swash plate
11. Rotating kit
12. Gasket
13. Valve plate
14. Bearing
15. Dowel pin
16. Back plate
17. O−ring
18. Forward relief valve
19. Bypass valve
20. O−ring
21. Cap screw (2 used)
22. Cap screw (2 used)
23. Coupler
24. Roll pin
25. Cover plate
26. Swash plate insert
27. Shaft seal
28. Washer
29. Housing
30. Retaining ring
31. Bearing race
32. Thrust bearing
33. Washer
34. Shaft seal
35. Retaining ring
36. Retaining ring
37. Plug
38. Plug with O−ring (2 used)
39. Bearing cup
40. Shuttle relief valve with O−ring
41. Reverse relief valve

For repair of the piston pump, see Eaton, Medium Duty Piston Pump, Repair Information, Model 70160 Variable Displacement Piston Pump at the end of this chapter.

NOTE: The charge relief valve is attached to the piston pump back plate (shown in Fig. 47). The back plate must be removed to service the relief valve.

NOTE: The piston pump is equipped with relief valves (items 18 and 41) for both the forward and reverse direction. Due to engine output, it is unlikely that traction pressure will reach relief valve settings. If, however, a piston pump relief valve is leaking or otherwise faulty, traction performance would be affected.

IMPORTANT: The shim kit (item 7) is used to replace the original crush ring (not shown) in the cover plate (item 25). If the swash plate (item 10), cover plate (item 25) or housing (item 29) is replaced during servicing, the old crush ring must be replaced. For information on crush ring replacement, see Piston Pump Crush Ring Replacement in this section in conjunction with the piston pump service manual at the end of this chapter.

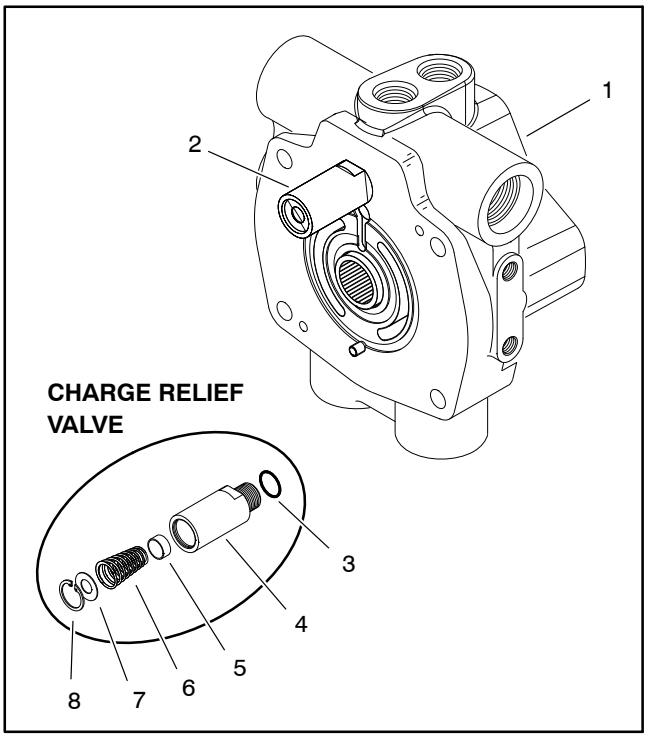

Figure 47

1. **Back plate**
2. **Charge relief valve**
3. **O–ring**
4. **Housing**
5. **Poppet**
6. **Spring**
7. **Washer**
8. **Retaining ring**

Piston Pump Crush Ring Replacement

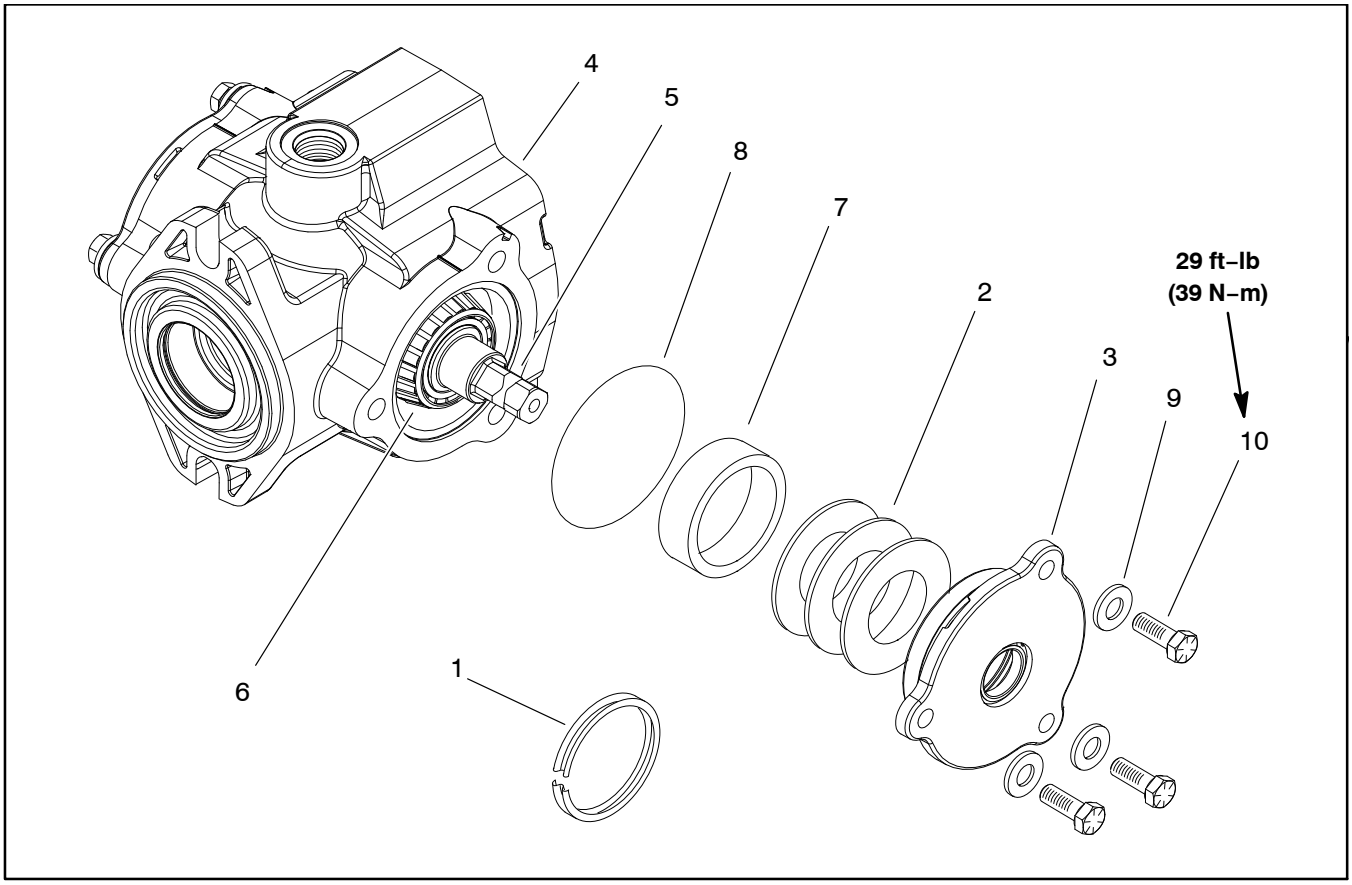

Figure 48

1. **Crush ring**
2. **Shims**
3. **Cover plate**
4. **Housing**
5. **Swash plate (control shaft)**
6. **Bearing cone**
7. **Bearing cup**
8. **O–ring**
9. **Washer (3 used)**
10. **Cap screws (3 used)**

NOTE: The shims replace the crush ring in the cover plate. If the camplate, cover plate or housing is replaced during servicing of the pump, the old crush ring can not be used to make sure of proper preload.

1. Remove crush ring from the cover plate. Measure thickness of crush ring.

2. Stack shims to the thickness of the crush ring.

3. Insert shims into the cover plate in the same location that the crush ring was removed from.

4. Assemble housing sub assembly consisting of the housing, camplate, bearing cone, bearing cup and cover plate (see Eaton, Medium Duty Piston Pump, Repair Information, Model 70160 Variable Displacement Piston Pump at the end of this chapter).

5. Install washers and cap screws to the cover plate and housing. Torque cap screws to **29 ft–lbs (39 N–m)**.

6. Check torque required to rotate control shaft. Torque should be **5 to 15 in–lbs (0.6 to 1.7 N–m)**.

A. If torque is **too low**, add additional shims and repeat steps 3 through 6 until the specified torque is achieved.

B. If torque is **too high**, remove shims and repeat steps 3 through 6 until the specified torque is achieved.

7. Complete assembly of the pump (see Eaton, Medium Duty Piston Pump, Repair Information, Model 70160 Variable Displacement Piston Pump at the end of this chapter).

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Front Wheel Motors

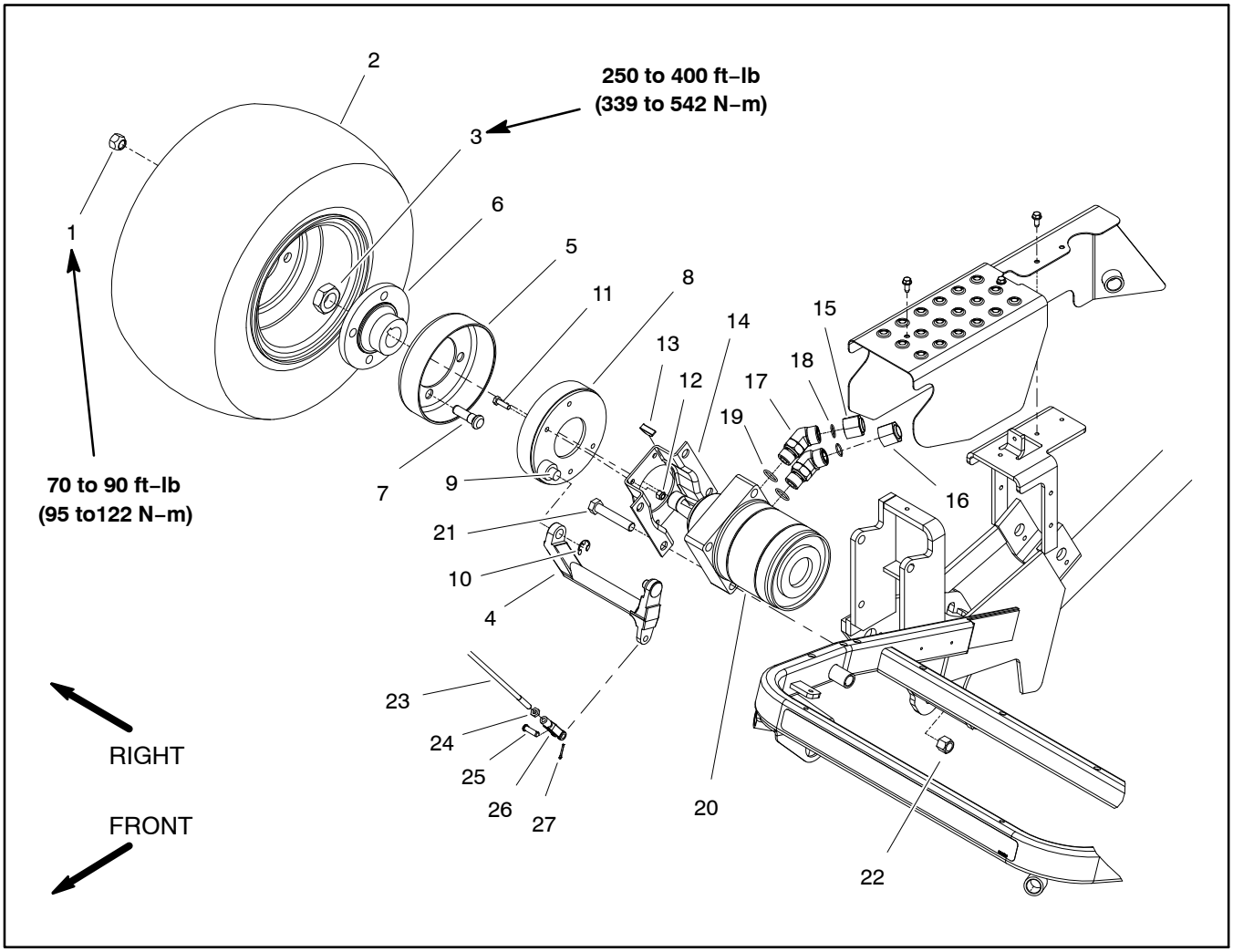

Figure 49

1. Lug nut (4 per wheel)
2. Wheel assembly
3. Lock nut
4. Brake lever
5. Brake drum
6. Wheel hub
7. Drive stud (4 per hub)
8. Brake assembly
9. Brake cam
10. Retaining ring
11. Cap screw (4 per brake)
12. Lock nut (4 per brake)
13. Woodruff key
14. Brake bracket
15. Hydraulic hose
16. Hydraulic hose
17. 45º Hydraulic fitting (2 per motor)
18. O−ring
19. O−ring
20. Hydraulic motor
21. Cap screw (4 per motor)
22. Lock nut (4 per motor)
23. Brake rod
24. Jam nut
25. Clevis pin
26. Swivel clevis
27. Cotter pin

Front Wheel Motor Removal (Fig. 49)

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

2. Remove front wheel, brake drum assembly and brake assembly from machine (see Front Wheel and Brake in the Service and Repairs section of Chapter 6 – Chassis).

CAUTION

Before continuing further, read and become familiar with General Precautions for Removing and Installing Hydraulic System Components.

3. Label all wheel motor hydraulic connections for assembly purposes.

4. Disconnect both hose assemblies and O–rings from the hydraulic fittings on the wheel motor. Allow hoses to drain into a suitable container. Discard removed O–rings.

5. Mark wheel motor fitting orientation to allow correct assembly. Remove hydraulic fittings and O–rings from motor. Discard removed O–rings.

6. Put caps or plugs on disconnected hoses and motor port openings to prevent contamination.

7. Remove four (4) cap screws (item 21) and lock nuts (item 22) that secure brake bracket (item 14) and hydraulic wheel motor to machine. Remove brake bracket and motor from the frame.

Front Wheel Motor Installation (Fig. 49)

1. Position hydraulic wheel motor and brake bracket (item 14) to the frame. Make sure ports of motor face the rear of the machine. Secure motor and brake bracket to the frame with four (4) cap screws (item 21) and lock nuts (item 22).

2. Remove plugs from wheel motor ports. Lubricate and place new O–rings onto fittings. Install fittings into motor openings making sure that fitting orientation is as noted during removal. Tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).

3. Remove caps from disconnected hydraulic lines.

4. Lubricate and position new O–rings to fittings on wheel motor. Use labels placed during the removal process to properly install hydraulic lines to wheel motor fittings (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

5. Install brake assembly, brake drum assembly and front wheel to machine (see Front Wheel and Brake in the Service and Repairs section of Chapter 6 – Chassis).

WARNING

Failure to maintain proper wheel lug nut and wheel hub lock nut torque could result in failure or loss of wheel and may result in personal injury.

6. Make sure to properly torque lock nut from **250 to 400 ft–lb (339 to 542 N–m)** and wheel lug nuts from **70 to 90 ft–lb (95 to 122 N–m)**.

7. Check oil level in hydraulic reservoir and add correct oil if necessary.

8. Follow Hydraulic System Start–up procedures (see Hydraulic System Start–up in this section).

Rear Wheel Motor (Optional 3WD)

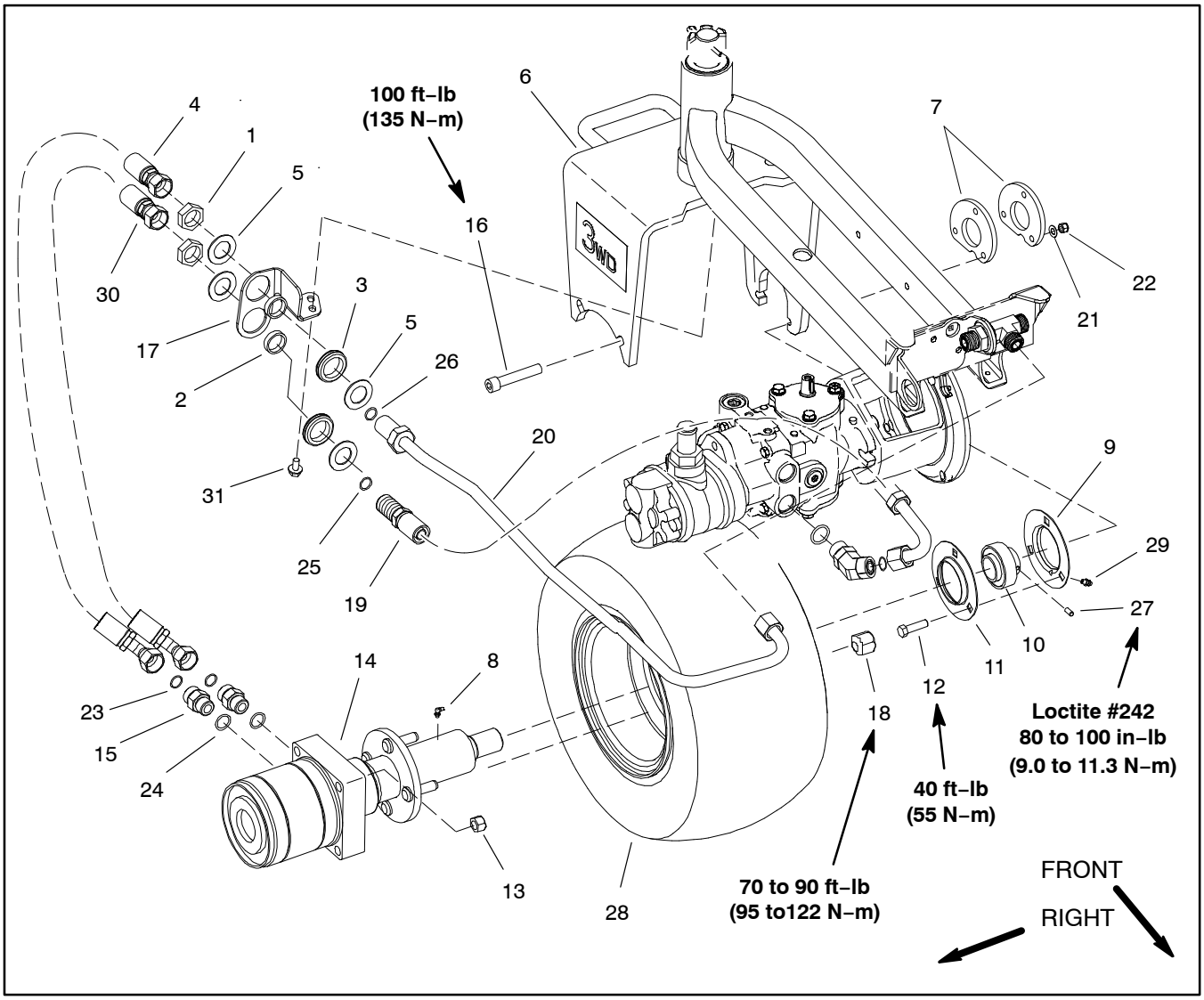

Figure 50

1. Lock nut (2 used)
2. Spacer (2 used)
3. Grommet (2 used)
4. Hydraulic hose assembly
5. Washer (4 used)
6. Castor fork
7. Mount spacer (2 used)
8. Grease fitting
9. Bearing flangette (lube)
10. Bearing
11. Bearing flangette
12. Cap screw (3 used)
13. Lock nut (2 used)
14. Wheel motor & hub assembly
15. Adapter (2 used)
16. Socket head screw (2 used)
17. Bulkhead bracket
18. Lug nut (4 used)
19. Hydraulic hose assembly
20. Hydraulic tube assembly
21. Washer (3 used)
22. Lock nut (3 used)
23. O–ring
24. O–ring
25. O–ring
26. O–ring
27. Set screw
28. Wheel assembly
29. Grease fitting
30. Hydraulic hose assembly
31. Washer head screw (2 used)

NOTE: For service of the hub and motor assembly (item 14) on machines equipped with 3WD, see Rear Wheel (Optional 3WD) and Rear Wheel Hub and Motor Assembly (Optional 3WD) in the Service and Repairs section of Chapter 6 – Chassis.

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Wheel Motor Service

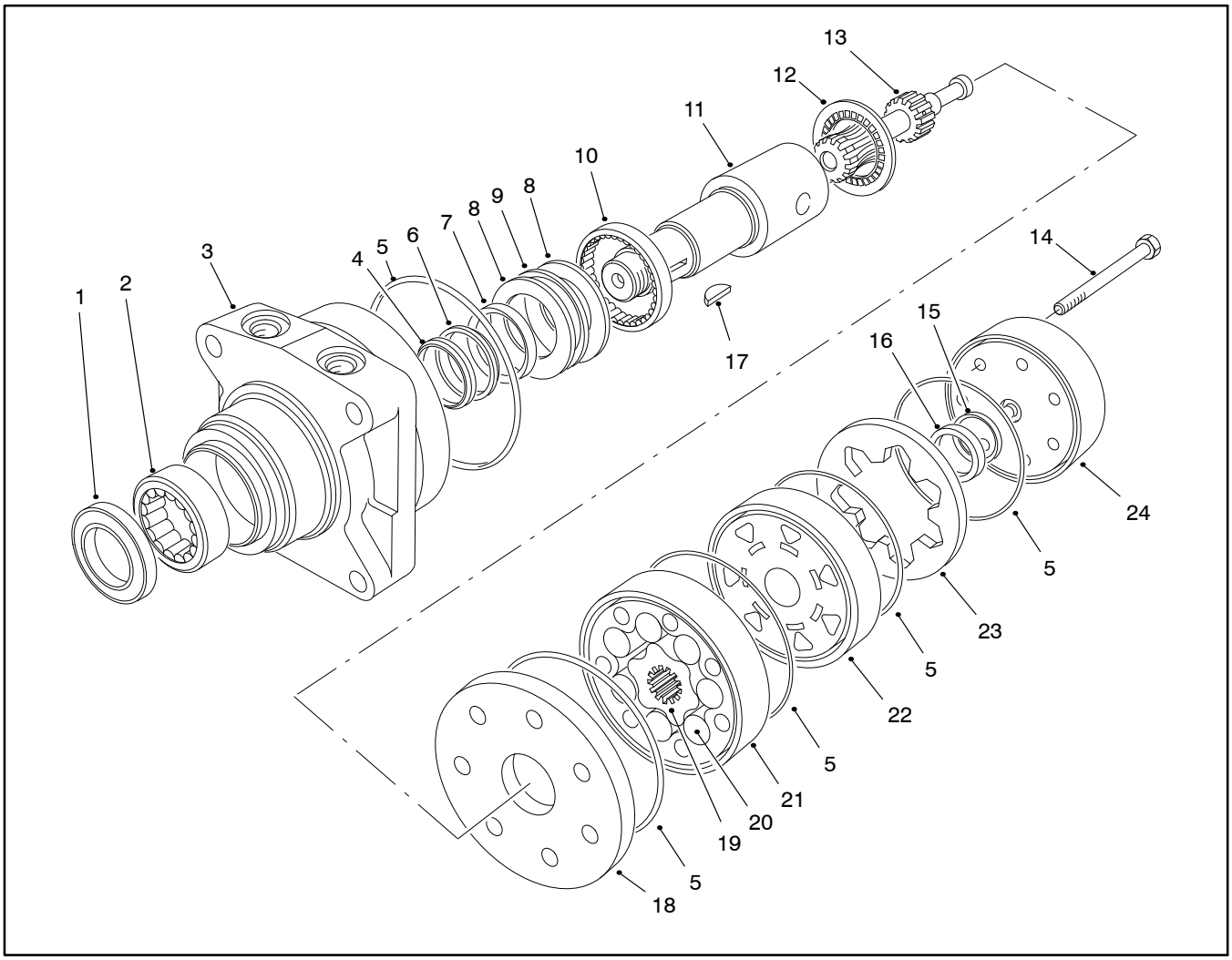

Figure 51

1. **Dirt seal**
2. **Bearing**
3. **Housing**
4. **Back–up washer**
5. **Seal ring**
6. **Back–up washer**
7. **Inner seal**
8. **Thrust washer**
9. **Thrust bearing**
10. **Bearing**
11. **Coupling shaft**
12. **Thrust bearing**
13. **Drive link**
14. **Cap screw**
15. **Commutator seal**
16. **Commutator**
17. **Woodruff key**
18. **Wear plate**
19. **Rotor**
20. **Vane**
21. **Stator**
22. **Manifold**
23. **Commutator ring**
24. **End cover**

NOTE: For repair of the wheel motors, see the Parker Torqmotor™ Service Procedure (TC, TB, TE, TJ, TF, TG, TH and TL Series) at the end of this chapter.

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Cutting Reel Motors

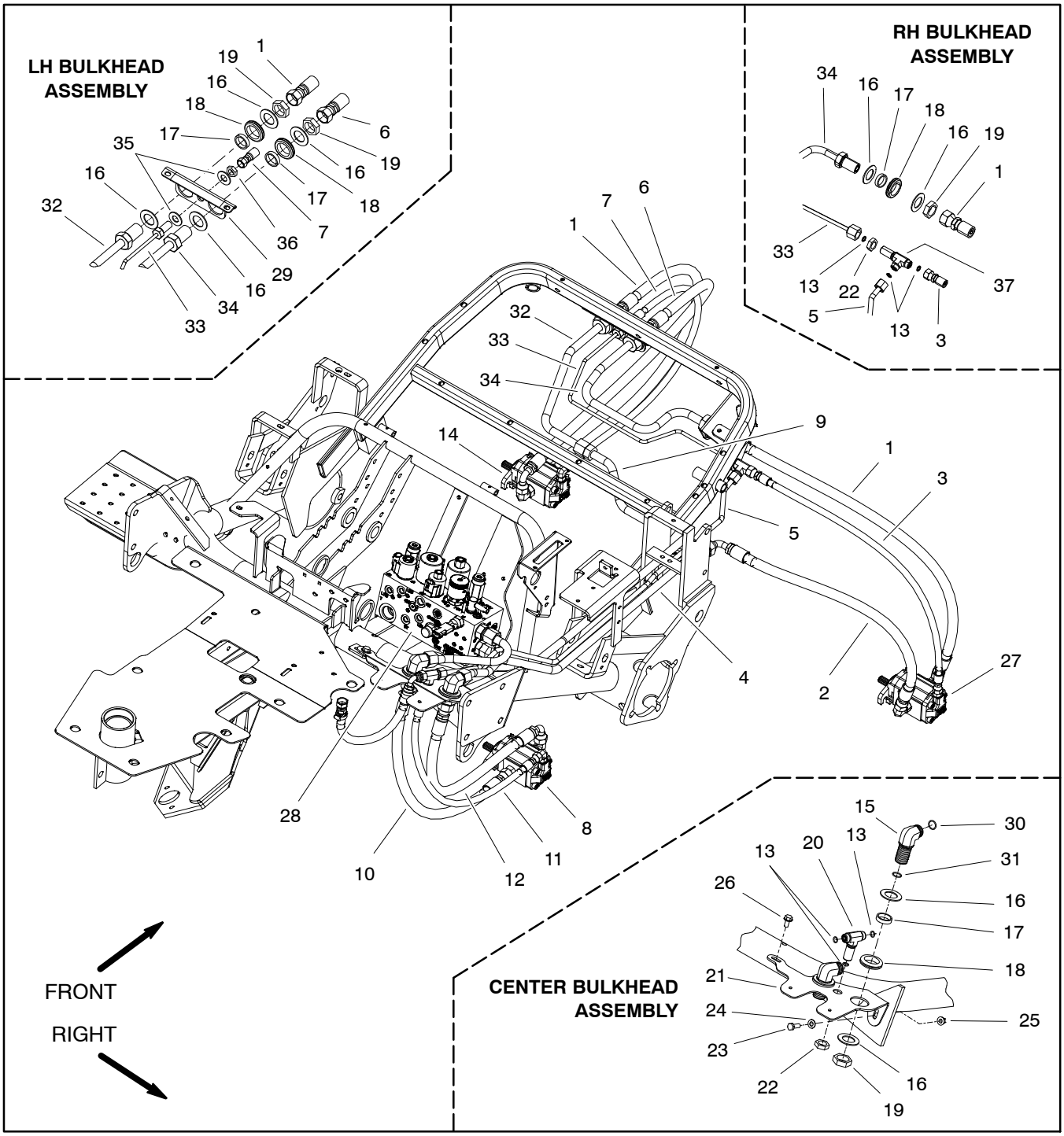

Figure 52

1. Hydraulic hose (2 used)
2. Hydraulic hose
3. Hydraulic hose
4. Hydraulic tube
5. Hydraulic tube
6. Hydraulic hose
7. Hydraulic hose
8. Center reel motor
9. Hydraulic tube
10. Hydraulic hose
11. Hydraulic hose
12. Hydraulic hose
13. O−ring
14. LH reel motor
15. Bulkhead fitting
16. Washer
17. Spacer
18. Rubber grommet
19. Bulkhead nut
20. Bulkhead tee fitting
21. Bulkhead bracket
22. Bulkhead nut
23. Cap screw
24. Flat washer
25. Flange nut
26. Washer head screw
27. RH reel motor
28. Hydraulic manifold
29. Bulkhead bracket
30. O−ring
31. O−ring
32. Hydraulic tube
33. Hydraulic tube
34. Hydraulic tube
35. Washer
36. Bulkhead nut
37. Bulkhead tee fitting

Removal (Fig. 52)

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

CAUTION

Before continuing further, read and become familiar with General Precautions for Removing and Installing Hydraulic System Components.

NOTE: The position of hydraulic fittings on the reel motor is critical to properly connect hydraulic hoses to the motors.

2. Label all hydraulic hose connections for assembly purposes. Matchmark reel motor and all hydraulic fittings for assembly purposes.

3. Remove hose connections from the hydraulic fittings on the reel motor. Allow hydraulic oil to drain from hoses into a suitable container. Put caps or plugs on ends of hoses to prevent contamination.

4. Loosen two (2) flange head screws that secure the hydraulic reel motor to the cutting unit side plate (Fig. 53). Rotate motor clockwise and remove motor from cutting unit.

5. Inspect reel insert splines for wear. Replace if necessary (see Reel Assembly Removal and Installation in the Service and Repairs section of Chapter 7 – DPA Cutting Units).

6. Remove hydraulic fittings and O–rings from the reel motor (Figs. 54, 55 and 56). Put caps or plugs in motor openings to prevent contamination.

Installation (Fig. 52)

1. Inspect threads and sealing surfaces of fittings and hydraulic hoses. Replace any worn or damaged fittings.

2. If fittings were removed from reel motor, lubricate and place new O–rings onto fittings. Install fittings into motor ports using marks made during the removal process to properly orientate fittings (Figs. 54, 55 and 56). Tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).

3. Coat spline shaft of the reel motor with No. 2 multipurpose lithium base grease.

4. Install the flange head screws for the reel drive motor into the cutting unit side plate and leave approximately 1/2 inch (13 mm) of threads exposed on each screw.

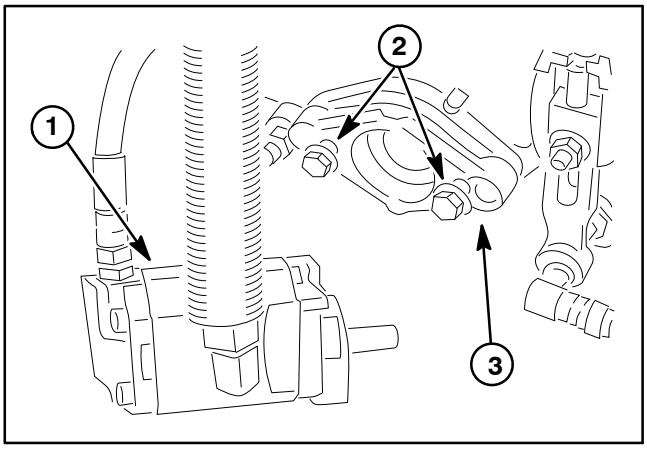

Figure 53

1. Cutting reel motor
2. Flange head screw
3. Cutting unit

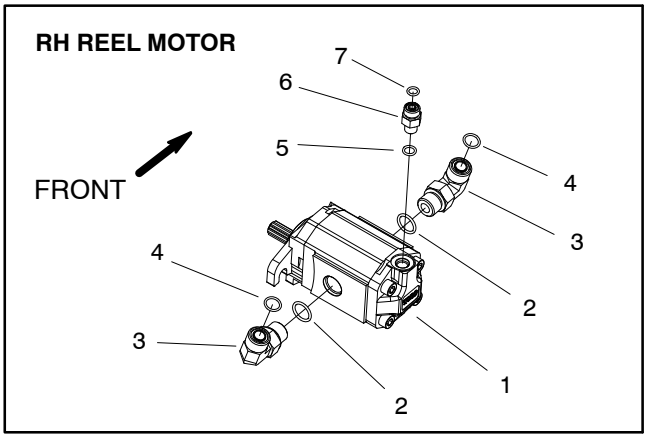

Figure 54

1. RH cutting reel motor
2. O–ring
3. Hydraulic fitting
4. O–ring
5. O–ring
6. Hydraulic fitting
7. O–ring

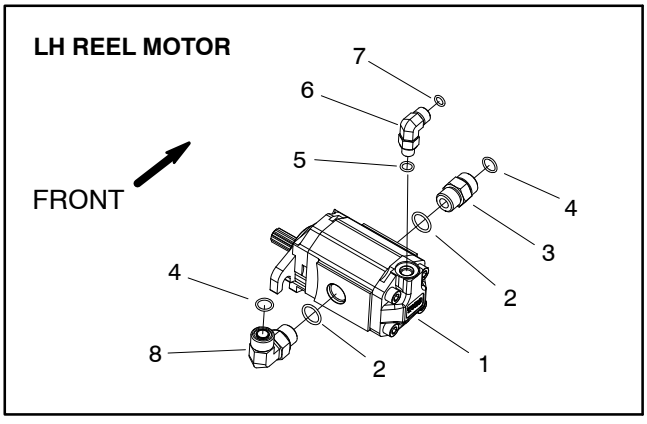

Figure 55

1. LH cutting reel motor
2. O–ring
3. Hydraulic fitting
4. O–ring
5. O–ring
6. Hydraulic fitting
7. O–ring
8. Hydraulic fitting

5. Rotate the motor clockwise so the motor flanges clear the cap screws in the cutting unit side plates. Align reel motor shaft splines with cutting reel insert splines. Slide motor shaft into reel insert.

6. Rotate the motor counter−clockwise until the motor flanges are encircling the cap screws. Tighten two (2) flange head screws to secure reel motor to cutting unit.

7. Remove caps or plugs from hydraulic fittings and hoses. Connect hydraulic hoses to reel motor (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

8. After assembly is completed, verify that hydraulic hoses and fittings are not contacted by any moving components.

9. Check oil level in hydraulic reservoir and add correct oil if necessary.

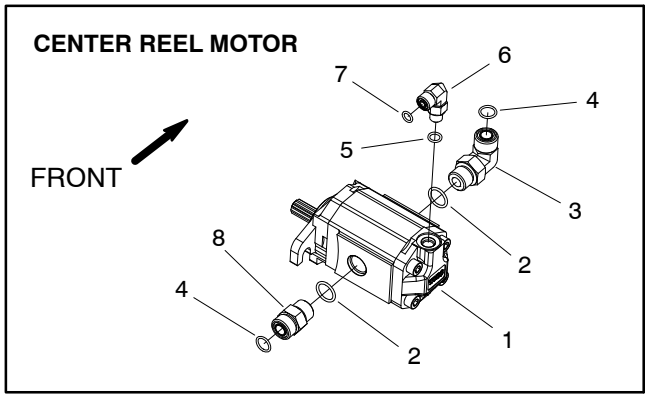

Figure 56

1. **Center cutting reel motor**
2. **O−ring**
3. **Hydraulic fitting**
4. **O−ring**
5. **O−ring**
6. **Hydraulic fitting**
7. **O−ring**
8. **Hydraulic fitting**

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Cutting Reel Motor Service

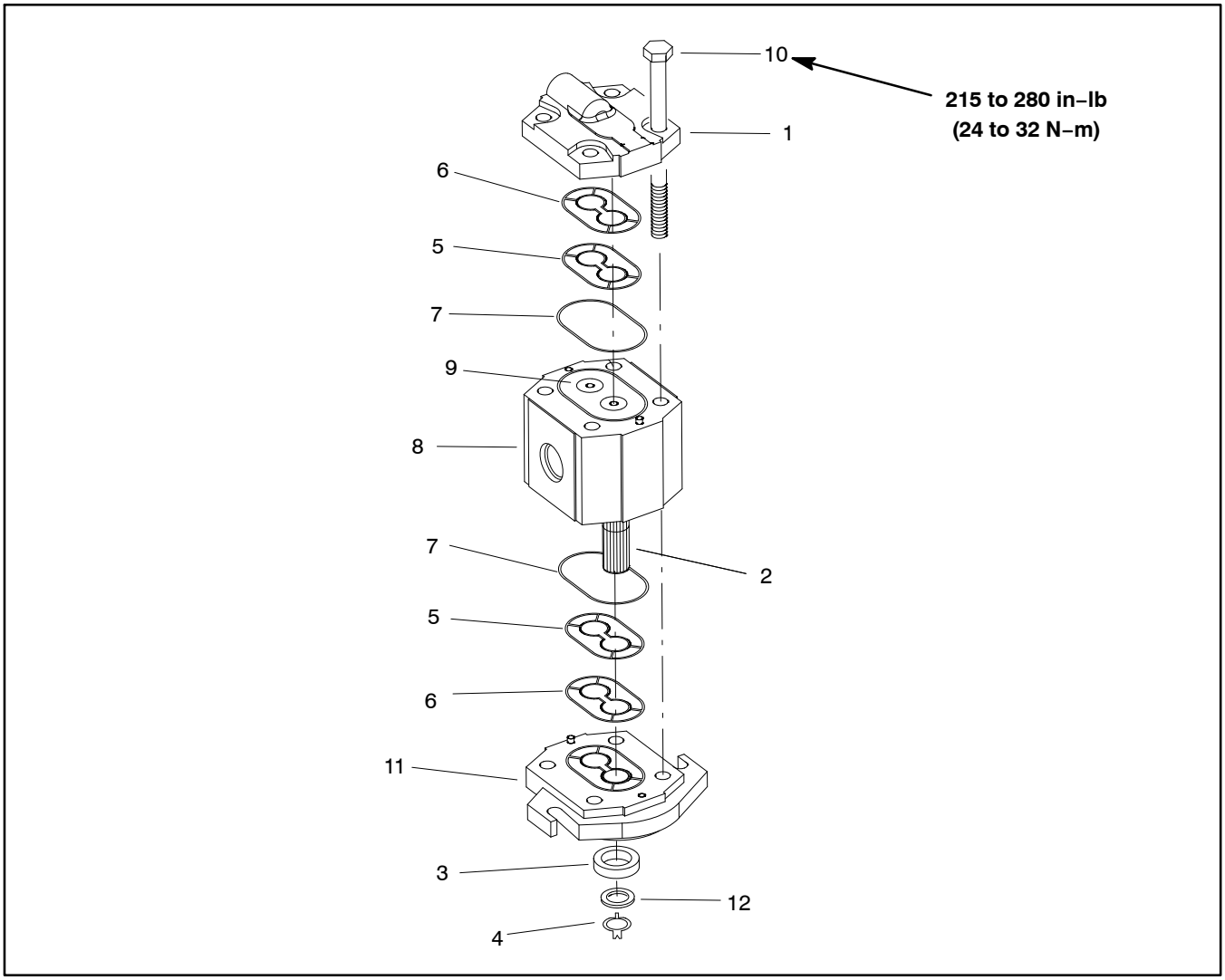

Figure 57

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

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. 58).

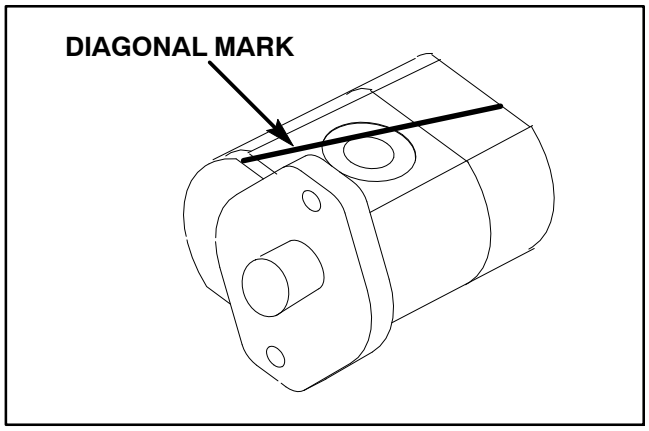

Figure 58

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 re-assembled 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. 59).

8. Carefully remove and discard O−rings, pressure seals and back−up rings (Fig. 60) from motor. Do not cause any damage to the machined grooves during the removal process.

IMPORTANT: Make sure to not 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.

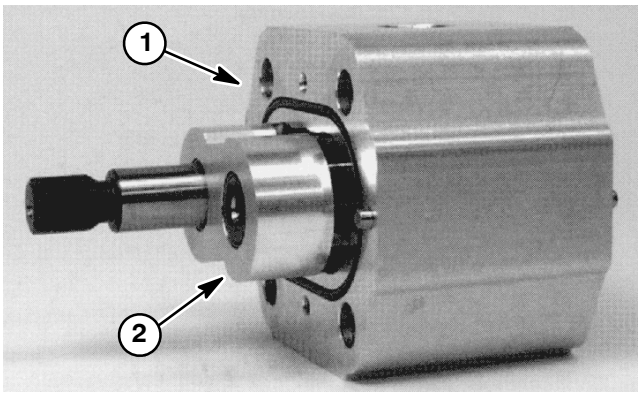

Figure 59

1. **Motor body**
2. **Bearing block & gear set**

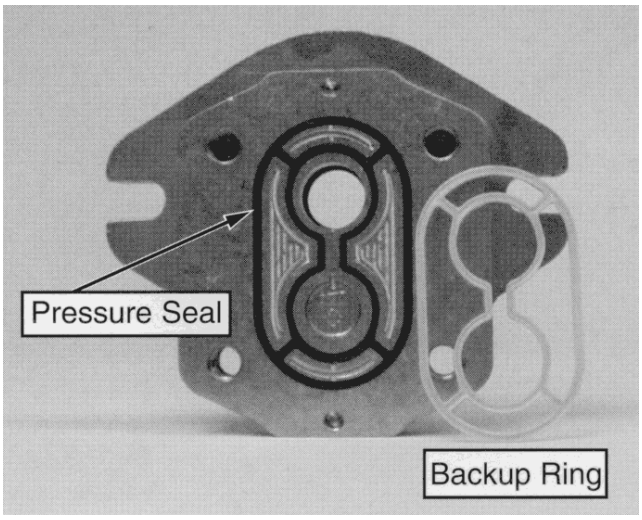

Figure 60

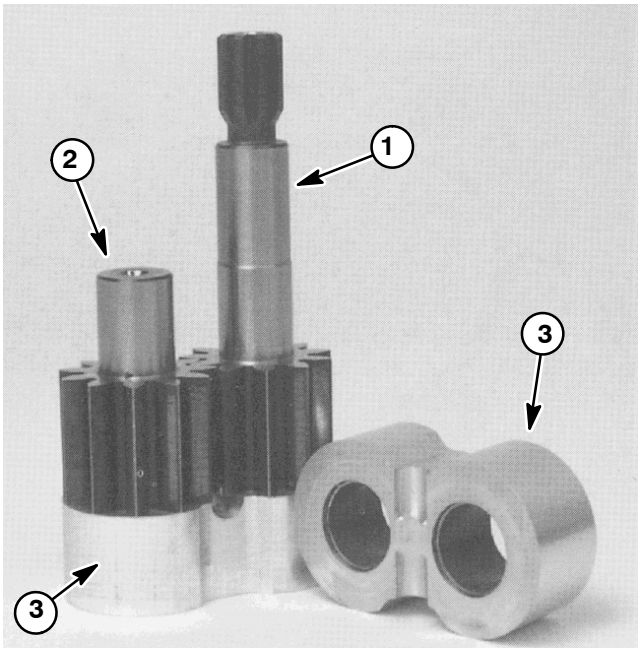

Figure 61

1. **Drive gear**
2. **Idler gear**
3. **Bearing block**

3. Inspect drive gear, idler gear and bearing blocks (Fig. 61) 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.

Assembly

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 (4) 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 in−lb (24 to 32 N−m)**.

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.

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Front Lift Cylinders

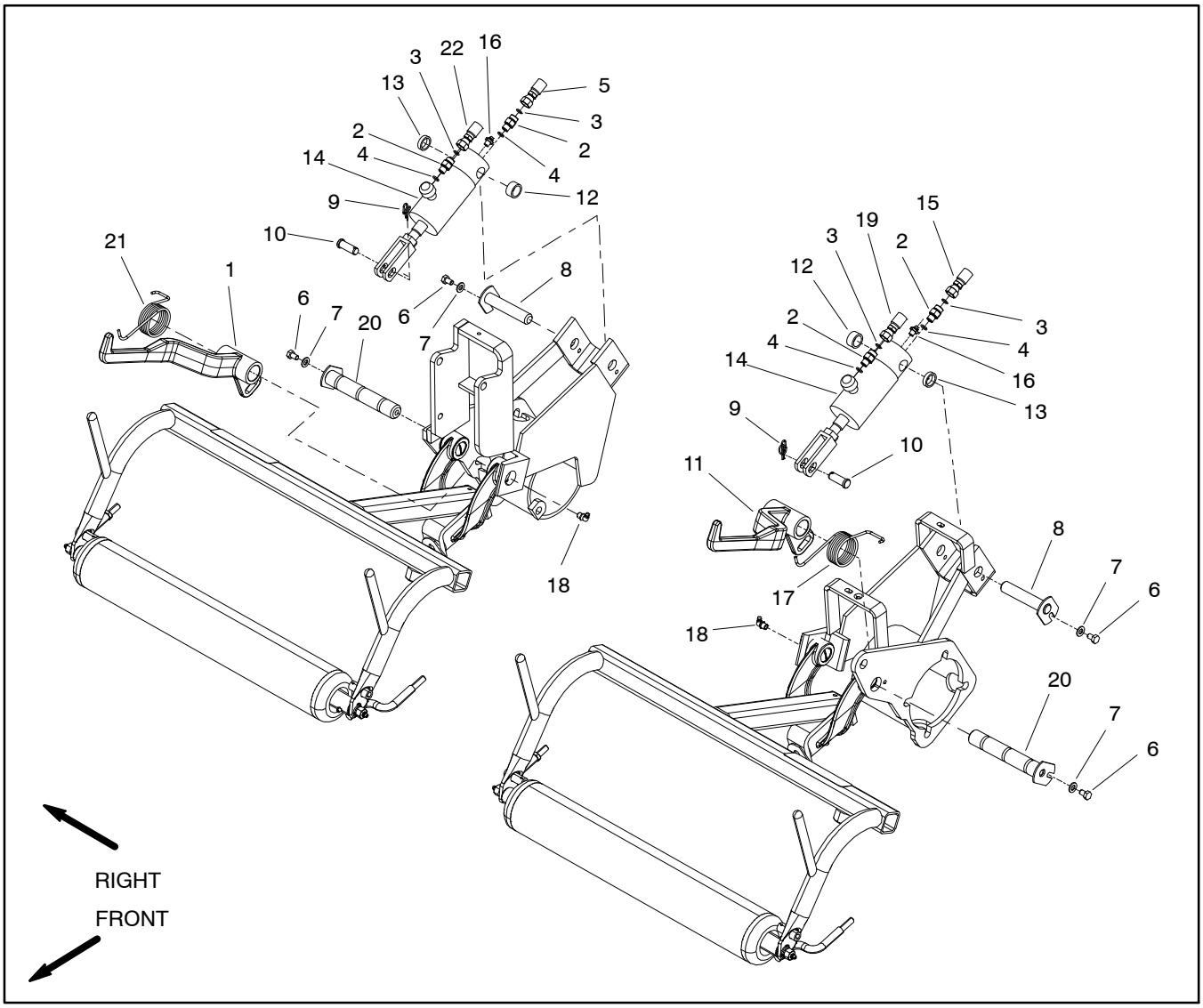

Figure 62

1. RH lift arm
2. Straight hydraulic fitting
3. O−ring
4. O−ring
5. Hydraulic hose
6. Cap screw
7. Washer
8. Pivot pin
9. Cotter pin
10. Clevis pin
11. LH lift arm
12. Spacer
13. Spacer
14. Hydraulic cylinder
15. Hydraulic hose
16. Grease fitting
17. LH torsion spring
18. Grease fitting
19. Hydraulic hose
20. Hinge pin
21. RH torsion spring
22. Hydraulic hose

Front Lift Cylinder Removal (Fig. 62)

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

CAUTION

Before continuing further, read and become familiar with General Precautions for Removing and Installing Hydraulic System Components.

2. Label all hydraulic connections for assembly purposes.

3. Disconnect hydraulic hoses and O−rings from the hydraulic fittings at the lift cylinder. Allow hoses to drain into a suitable container.

4. Remove cotter pin and clevis pin that secure the lift cylinder clevis to the lift arm.

5. Support lift cylinder to prevent it from dropping.

   A. Remove cap screw and washer from the pivot pin (item 8).

   B. Pull pivot pin from the frame, spacers and lift cylinder. Note that thicker spacer is toward the center of the machine.

   C. Remove hydraulic cylinder from the frame.

6. If necessary, remove hydraulic fittings from lift cylinder.

NOTE: See Lift Cylinder Service in this section for information on lift cylinder service.

Front Lift Cylinder Installation (Fig. 62)

1. If fittings were removed from lift cylinder, lubricate and place new O−rings onto fittings. Install fittings into lift cylinder ports. Tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).

2. Position lift cylinder to the machine.

3. Insert pivot pin (item 8) through the outer frame bracket, thinner spacer, lift cylinder, thicker spacer and inner frame bracket. Secure pin to frame with cap screw and washer.

4. Position clevis of the lift cylinder to the lift arm. Secure lift cylinder clevis to the lift arm with clevis pin and cotter pin.

5. Connect hydraulic hoses with new O−rings to the hydraulic fittings on the lift cylinder. Tighten hose connections (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

6. Make sure that hydraulic reservoir is at correct level.

7. Start machine. Run machine at idle for several minutes to circulate hydraulic fluid and remove any air trapped in the system. Stop machine and recheck hydraulic reservoir level.

Center Lift Cylinder

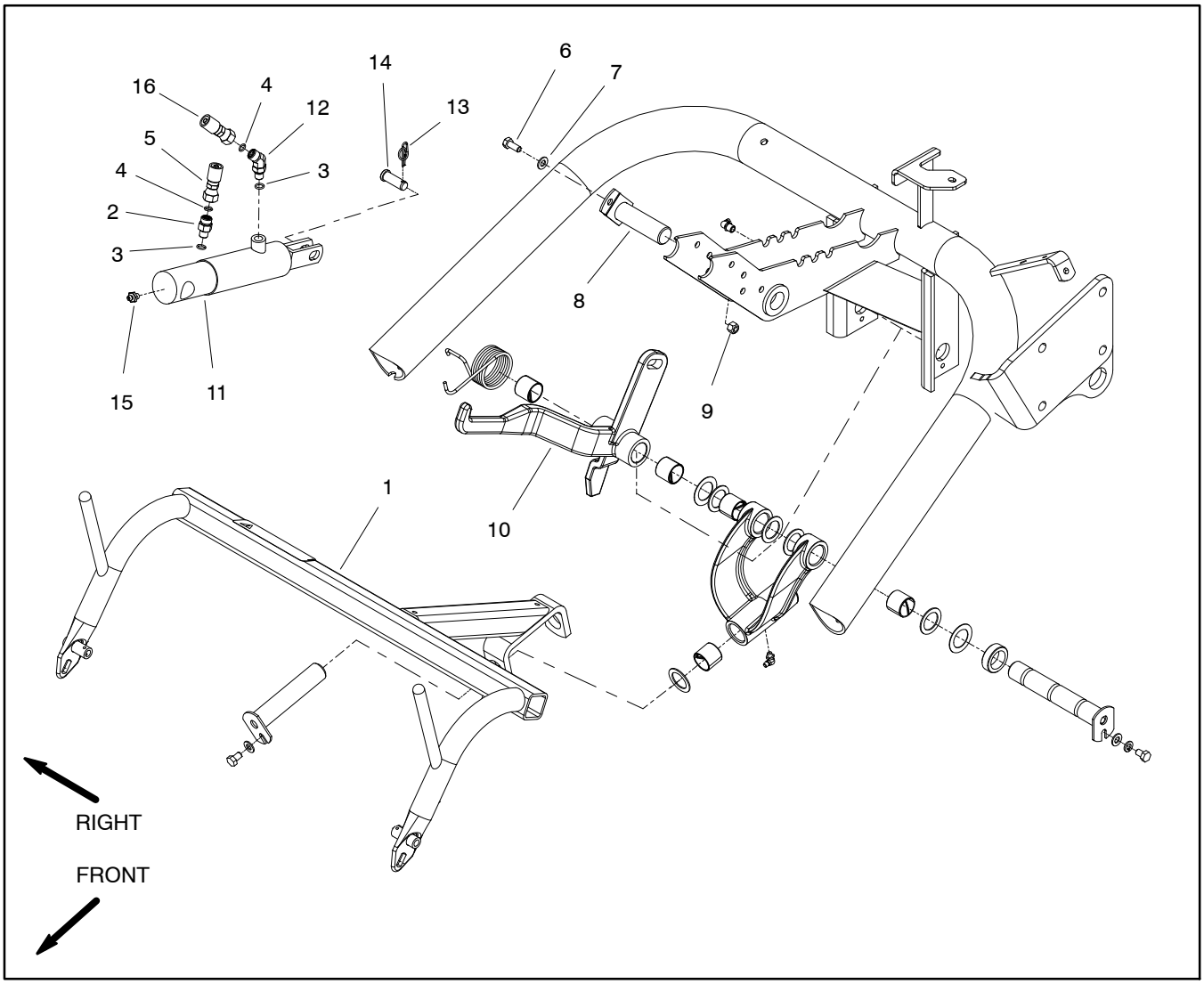

Figure 63

1. **Pull frame**
2. **Straight hydraulic fitting**
3. **O−ring**
4. **O−ring**
5. **Hydraulic hose**
6. **Cap screw**
7. **Washer**
8. **Pivot pin**
9. **Lock nut**
10. **Lift arm**
11. **Hydraulic cylinder**
12. **45º hydraulic fitting**
13. **Cotter pin**
14. **Clevis pin**
15. **Grease fitting**
16. **Hydraulic hose**

Center Lift Cylinder Removal (Fig. 63)

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

CAUTION

Before continuing further, read and become familiar with General Precautions for Removing and Installing Hydraulic System Components.

2. Label all hydraulic connections for assembly purposes.

3. Disconnect hose assemblies and O−rings from the hydraulic fittings at the lift cylinder. Allow hoses to drain into a suitable container.

4. Support lift cylinder to prevent it from dropping.

   A. Remove cap screw, washer and lock nut from the pivot pin (item 8). Pull pivot pin from the frame and lift cylinder.

   B. Remove cotter pin from clevis pin (item 14). Slide clevis pin from lift cylinder and lift arm.

   C. Separate hydraulic cylinder from the frame and lift arm. Remove cylinder from machine.

5. If hydraulic fitting removal is necessary, matchmark lift cylinder and 45º hydraulic fitting for assembly purposes. Remove hydraulic fittings from lift cylinder.

NOTE: See Lift Cylinder Service in this section for information on lift cylinder service.

Center Cylinder Installation (Fig. 63)

1. If fittings were removed from lift cylinder, lubricate and place new O−rings onto fittings. Install fittings into lift cylinder ports. Tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).

2. Position lift cylinder to the machine.

3. Insert pivot pin (item 8) through the frame brackets and lift cylinder. Secure pin to frame with cap screw, washer and lock nut.

4. Position clevis of the lift cylinder to the lift arm. Secure lift cylinder clevis to the lift arm with clevis pin (item 14) and cotter pin.

5. Connect hydraulic hoses with new O−rings to the hydraulic fittings on the lift cylinder. Tighten hose connections (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

6. Make sure that hydraulic reservoir is at correct level.

7. Start machine. Run machine at idle for several minutes to circulate hydraulic fluid and remove any air trapped in the system. Stop machine and recheck hydraulic reservoir level.

Lift Cylinder Service

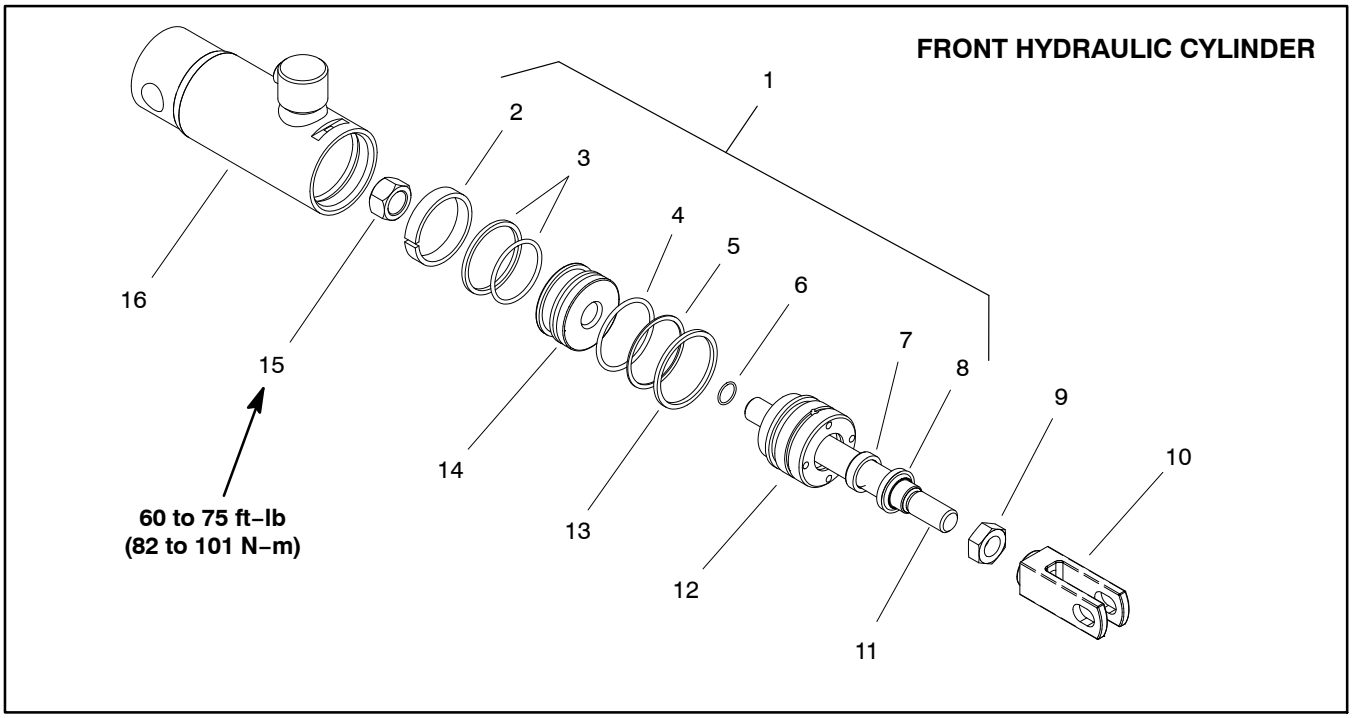

Figure 64

1. Seal kit
2. Wear ring
3. Seal with loader
4. O–ring
5. Back–up ring
6. O–ring
7. Seal
8. Wiper
9. Jam nut
10. Rod clevis
11. Rod
12. Head
13. Retaining ring
14. Piston
15. Lock nut
16. Barrel

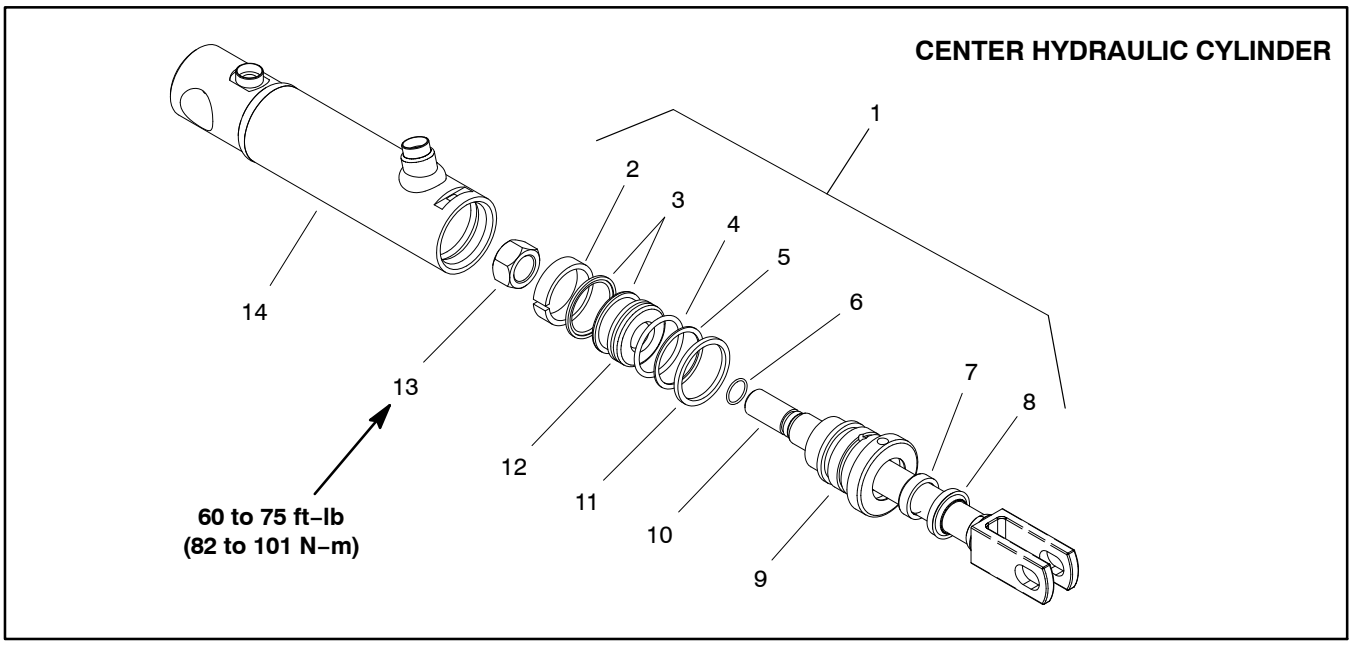

Figure 65

1. Seal kit
2. Wear ring
3. Seal with loader
4. O–ring
5. Back–up ring
6. O–ring
7. Seal
8. Wiper
9. Head
10. Rod
11. Retaining ring
12. Piston
13. Lock nut
14. Barrel

Disassembly (Figs. 64 and 65)

1. Remove the oil from the cylinder by slowly pumping the cylinder shaft while holding the cylinder over a drain pan. Plug both ports and clean the outside of the cylinder.

IMPORTANT: Prevent damage when clamping the hydraulic cylinder into a vise; clamp on the cap end only. Do not close vise enough to distort the barrel.

2. Mount lift cylinder in a vise. Use of a vise with soft jaws is recommended.

3. Using a spanner wrench, 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.

4. 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.

5. Mount shaft securely in a vise by clamping on the clevis or eye of the shaft. Remove lock nut and piston from the shaft. Slide head off the shaft.

6. Remove wear ring and seal with loader from the piston. Remove O−ring, back−up ring, seal and wiper from the head. Remove O−ring from rod.

CAUTION

Use eye protection such as goggles when using compressed air to dry cylinder parts.

7. Wash parts in clean solvent. Dry parts with compressed air. Do not wipe parts dry with paper towels or cloth. Lint in a hydraulic system will cause damage.

8. Carefully inspect internal surface of barrel for damage (deep scratches, out−of−round, etc.). Inspect shaft, head and piston for evidence of excessive scoring, pitting or wear. Replace entire cylinder if internal components are found to be worn or damaged.

Assembly (Figs. 64 and 65)

1. Make sure all parts are clean before reassembly.

2. Coat new seal kit components with clean hydraulic oil.

   A. Install wear ring and seal with loader on the piston.

   B. Install O−ring, back−up ring and seal on the head.

   C. Install O−ring to groove in rod.

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 or eye of the shaft. Use of a vise with soft jaws is recommended.

   A. Coat shaft with clean hydraulic oil.

   B. Carefully slide head onto the shaft. Install wiper onto shaft and into head.

   C. Install piston and nut onto the shaft. Torque nut from **60 to 75 ft−lb (82 to 101 N−m)**.

   D. Remove shaft from the vise.

IMPORTANT: Prevent damage when clamping the hydraulic cylinder into a vise; clamp on the cap end only. Do not close vise enough to distort the barrel.

4. Mount barrel in a vise.

5. Coat all internal parts with a light coat of clean hydraulic oil. Slide piston, shaft and head assembly into the barrel being careful not to damage the seals.

6. Secure head in barrel by installing retaining ring. 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 Manifold

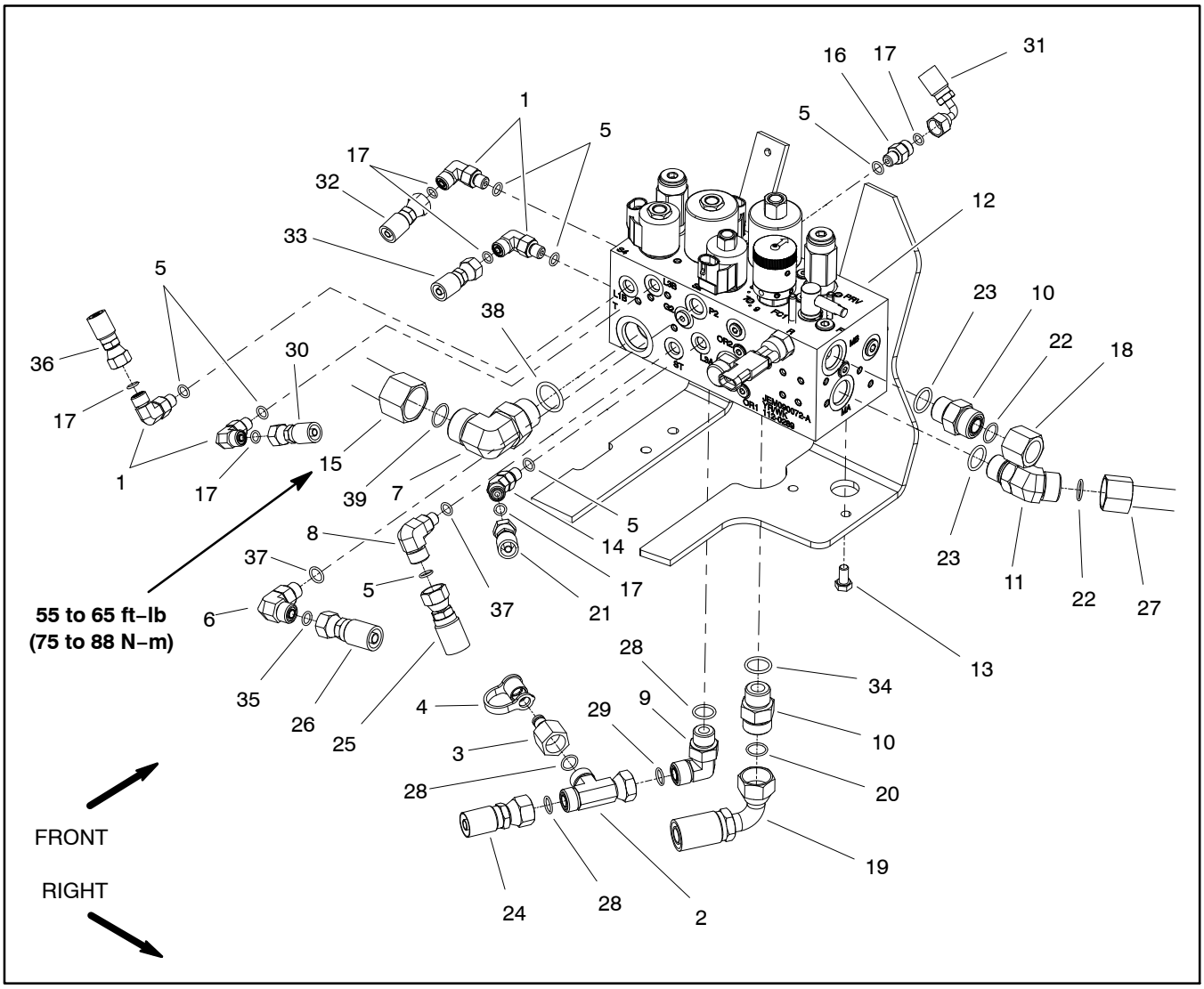

Figure 66

1. 90º hydraulic fitting (4 used)
2. Tee hydraulic fitting
3. Hydraulic test fitting
4. Dust cap
5. O–ring
6. 90º hydraulic fitting
7. 90º hydraulic fitting
8. 90º hydraulic fitting
9. 90º hydraulic fitting
10. Straight hydraulic fitting (2 used)
11. 45º hydraulic fitting
12. Hydraulic manifold assembly
13. Cap screw (2 used)
14. 45º hydraulic fitting
15. Hydraulic tube
16. Straight hydraulic fitting
17. O–ring
18. Hydraulic tube
19. Hydraulic hose
20. O–ring
21. Hydraulic hose
22. O–ring
23. O–ring
24. Hydraulic hose
25. Hydraulic hose
26. Hydraulic hose
27. Hydraulic tube
28. O–ring
29. O–ring
30. Hydraulic hose
31. Hydraulic hose
32. Hydraulic hose
33. Hydraulic hose
34. O–ring
35. O–ring
36. Hydraulic hose
37. O–ring
38. O–ring
39. O–ring

NOTE: The ports on the manifold are marked for easy identification of components. Example: FC1 is the reel circuit flow control valve and P1 is the gear pump connection port (see Hydraulic Schematic to identify the function of the hydraulic lines and cartridge valves at each port location).

Removal (Fig. 66)

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

CAUTION

Before continuing further, read and become familiar with General Precautions for Removing and Installing Hydraulic System Components.

2. Label all hydraulic connections and electrical connections for assembly.

3. Disconnect wire harness connectors from manifold solenoid coils and backlap switch.

IMPORTANT: Before disconnecting any hydraulic lines from the hydraulic fittings, make sure each line is labeled to ensure it is reconnected to the correct manifold fitting/port.

4. Disconnect hose and tube assemblies and remove their respective O−rings from the hydraulic fittings. Allow hoses and tubes to drain into a suitable container.

5. Remove two (2) cap screws (item 13) from the hydraulic manifold. Remove manifold assembly from the machine.

IMPORTANT: Before disconnecting any hydraulic fittings from the hydraulic manifold block, make sure the position of each fitting is observed and recorded to ensure proper installation.

IMPORTANT: A flow control orifice is located beneath the fitting in manifold port L1A. If this fitting is removed from the manifold, make sure to remove orifice and label its position for assembly purposes. When installing the orifice in the manifold, make sure that the orifice is flat in the base of the port. Manifold damage is possible if the orifice is cocked in the port.

6. If necessary, remove hydraulic fittings and O−rings from the manifold.

Installation (Fig. 66)

1. Install hydraulic fittings and their respective O−rings to the manifold assembly and orient to position recorded during removal. Torque fittings to the values identified in Figure 66.

2. Position manifold assembly to the support frame. Secure assembly to the frame with two (2) cap screws (item 13).

3. Using labels placed during disassembly, connect hydraulic hoses and tubes and their respective O−rings to correct hydraulic fittings.

   A. When installing hydraulic tube (item 15) to 90º hydraulic fitting in manifold port T, torque tube from **55 to 65 ft−lb (75 to 88 N−m)**.

4. Connect wire harness connectors to manifold solenoid coils and backlap switch.

5. Make sure that hydraulic reservoir is at correct level.

6. Start machine. Run machine at idle for several minutes to circulate hydraulic fluid and remove any air trapped in the system. Stop machine and recheck hydraulic reservoir level.

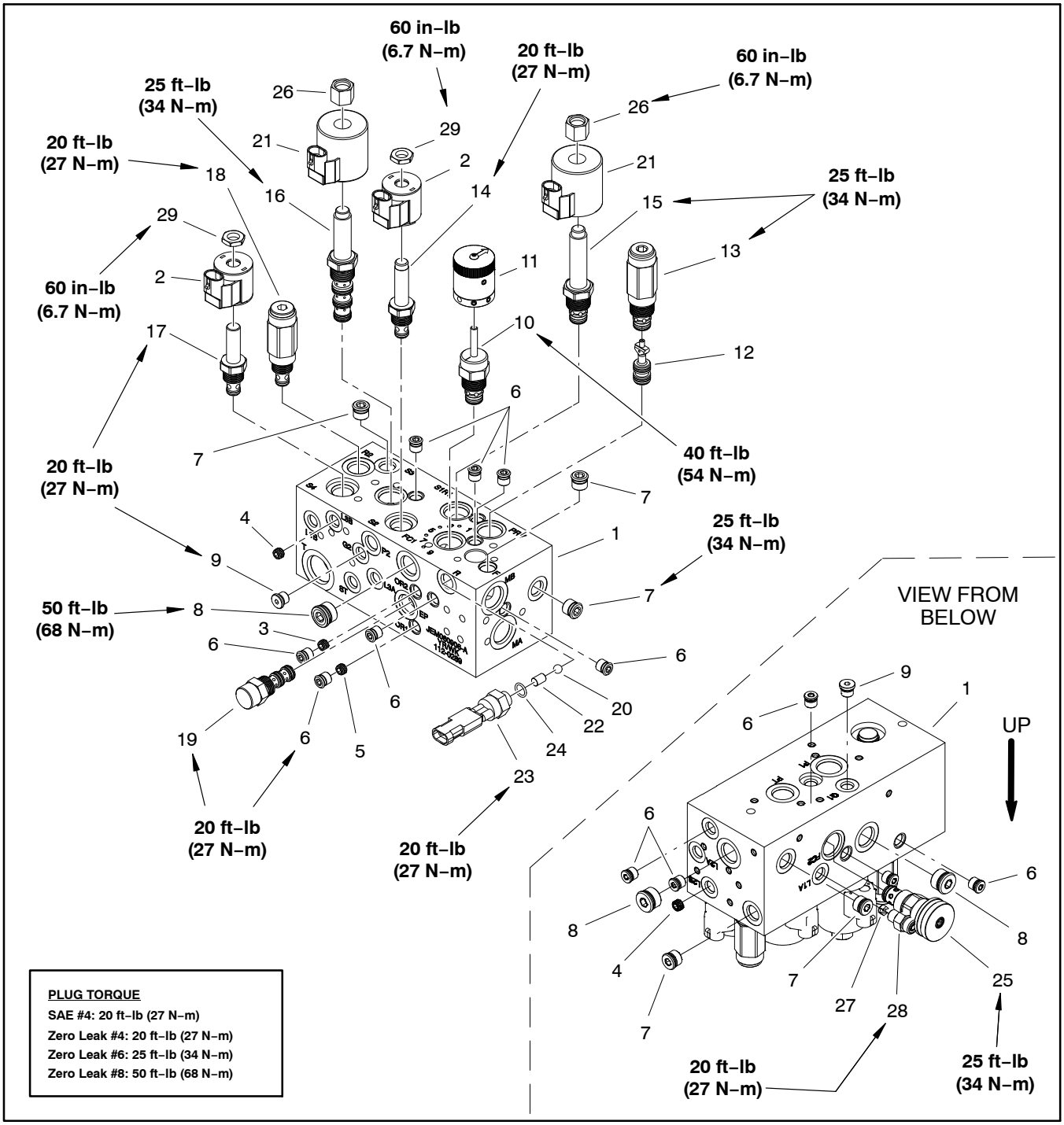

Figure 67

1. Manifold body
2. Solenoid coil
3. Flow control orifice (.060)
4. Orifice plug (.055) (2 used)
5. Flow control orifice (.013)
6. Plug (Zero Leak #4) (12 used)
7. Plug (Zero Leak #6) (5 used)
8. Plug (Zero Leak #8) (3 used)
9. Plug (SAE #4) (2 used)
10. Rotary cartridge valve (FC1)
11. Rotary handle assembly
12. Pilot piston
13. Relief cartridge valve (PRV)
14. Solenoid cartridge valve (S2)
15. Solenoid relief cartridge valve (S1R1)
16. Solenoid cartridge valve (S3)
17. Solenoid cartridge valve (S4)
18. Relief cartridge valve (R2)
19. Logic control cartridge valve (OR1)
20. Ball
21. Solenoid coil
22. Dowel pin
23. Ball switch (N.O.)
24. O−ring
25. Flow control cartridge valve (FC2)
26. Nut
27. Flow control orifice (.025)
28. Hydraulic fitting
29. Nut

NOTE: The ports on the hydraulic manifold are marked for easy identification of components. Example: FC1 is the flow control valve and P1 is the gear pump connection port (see Hydraulic Schematic to identify the function of the hydraulic lines and cartridge valves at each port location).

NOTE: The hydraulic manifold shown in Figure 67 uses several zero leak plugs. These plugs have a tapered sealing surface on the plug head that is designed to resist vibration induced plug loosening. The zero leak plugs also have an O−ring to provide a secondary seal. If zero leak plug removal is necessary, lightly rap the plug head using a punch and hammer before using an allen wrench to remove the plug: the impact will allow plug removal with less chance of damage to the socket head of the plug. When installing plugs into the manifold, torque plugs to the values identified in Figure 67.

IMPORTANT: A flow control orifice (item 27) is located beneath the fitting in manifold port L1A. If this fitting is removed from the manifold, make sure to remove orifice and label its position for assembly purposes. When installing the orifice in the manifold, make sure that the orifice is flat in the base of the port. Manifold damage is possible if the orifice is cocked in the port.

Solenoid Operated, Relief and Logic Control Cartridge Valves (Fig. 67)

1. Make sure the manifold is clean before removing the cartridge valve and seal kit.

2. If solenoid valve is to be removed from manifold, remove nut securing solenoid to the cartridge valve. Carefully slide solenoid off the valve.

IMPORTANT: Use care when removing the cartridge valve. Slight bending or distortion of the stem tube can cause binding and malfunction. Make sure that deep well socket fully engages the valve base.

3. Make sure manifold is clean before removing the cartridge valve. Remove cartridge valve from manifold with a deep well socket. Note location of O−rings and backup rings on valve. Remove and discard removed seal kit.

4. Visually inspect the manifold port and cartridge valve for damage to sealing surfaces, damaged threads and contamination.

   A. Contamination may cause valves to stick or hang up. Contamination can become lodged in small valve orifices or seal areas causing valve 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.

5. Cleaning cartridge valves:

   A. For non−solenoid operated valves:
   Submerge valve in clean mineral spirits to flush out contamination. If valve design allows, 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 cartridge with compressed air.

   B. For solenoid operated valves:
   Temporarily install solenoid on cartridge valve and connect a 12 volt power source to the solenoid. While energized, flush out any contamination with a non−flammable aerosol brake cleaner. De−energize the solenoid. Repeat the flush while energized procedure 5 or 6 times. Particles as fine as talcum powder can affect the operation of high pressure hydraulic valves. Remove solenoid from cartridge.

6. Reinstall the cartridge valve into the manifold:

   A. Lubricate new O-rings and backup rings of seal kit with clean hydraulic oil and install on cartridge. The O-rings and backup rings must be arranged properly on the cartridge valve for proper operation and sealing.

   IMPORTANT: Use care when installing the cartridge valve. Slight bending or distortion of the stem tube can cause binding and malfunction. Make sure that deep well socket fully engages the valve base.

   B. Lubricate threads on cartridge valve with clean hydraulic oil. Thread cartridge valve carefully into correct manifold port. The valve should go in easily without binding.

   C. Torque cartridge valve using a deep well socket to specification shown in Figure 67.

7. For solenoid valve, slide solenoid coil onto the cartridge valve. Install and torque nut to **60 in−lb (6.7 N−m)**.

8. If problems still exist, remove valve and clean again or replace valve.

Rotary Cartridge Valve

1. Remove rotary handle from valve (Fig. 68):

   A. Loosen two (2) set screws that secure handle cap.

   B. Remove screw and then lift handle cap from valve.

   C. Locate and retrieve detent pin, compression spring, bushing and lip seal. The sleeve bearing should stay in the cap.

   D. Loosen two (2) set screws that secure handle base to flow control valve and remove base.

IMPORTANT: Use care when removing the rotary cartridge valve. Slight bending or distortion of the stem tube can cause binding and malfunction. Make sure that deep well socket fully engages the valve base.

2. Make sure manifold is clean before removing the rotary cartridge valve. Remove cartridge valve from manifold with a deep well socket. Note location of O–rings and backup rings on valve. Remove and discard removed seal kit.

3. Visually inspect the manifold port and cartridge valve for damage to sealing surfaces, damaged threads and contamination.

   A. Contamination may cause valves to stick or hang up, it can become lodged in small valve orifices or seal areas causing valve 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. 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. Clean and dry with compressed air.

5. Reinstall rotary cartridge valve into manifold port:

   A. Lubricate new O-rings and backup rings of seal kit with clean hydraulic oil and install. The O-rings and backup rings of seal kit must be arranged properly on the cartridge valve for proper operation and sealing.

   IMPORTANT: Use care when installing the rotary cartridge valve. Slight bending or distortion of the stem tube can cause binding and malfunction. Make sure that deep well socket fully engages the valve base.

   B. Lubricate threads on cartridge valve with clean hydraulic oil. Thread rotary cartridge valve carefully into the manifold port. The valve should go in easily without binding. Torque valve to specification shown in Figure 67.

6. Install rotary handle (Fig. 68):

   A. Place handle base on flow control valve and position alignment mark on base with number 1 on manifold. Secure base with two (2) set screws. Apply a light coating of grease to chamfer on top of base to ease seal installation.

   B. Make sure that sleeve bearing is in handle cap. If necessary, press sleeve bearing into cap. Install lip seal on cap with seal lip facing down.

   C. While pressing on the cap to keep the lip seal in place, rotate cap in a clockwise direction until the arrow on the cap aligns with number 1 on the manifold. By rotating the cap clockwise, the valve will remain closed. Install screw to retain cap.

   D. Make sure that alignment marks on cap and base are in line and that arrow on cap is pointing to number 1 on manifold. Tighten two (2) set screws to secure handle cap.

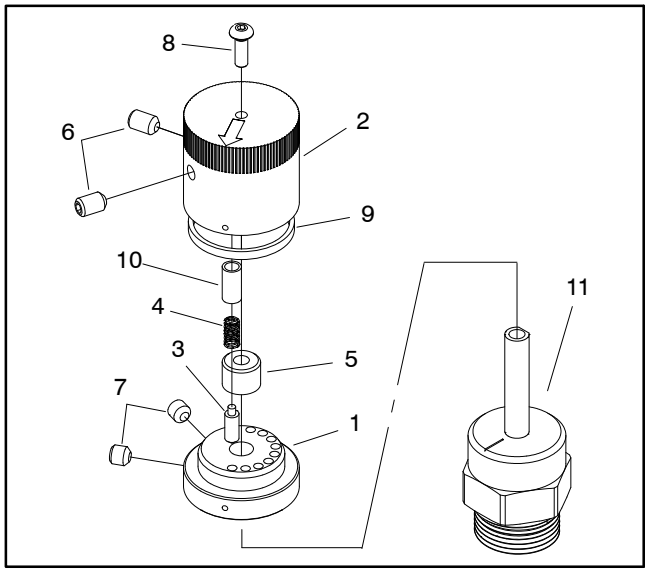

Figure 68

1. **Handle Base**
2. **Handle Cap**
3. **Detent Pin**
4. **Compression Spring**
5. **Bushing**
6. **Set Screw (2 used)**
7. **Set Screw (2 used)**
8. **Screw**
9. **Lip Seal**
10. **Sleeve Bearing**
11. **Flow Control Valve**

Mow/Backlap Spool (Fig. 69)

1. Remove mow/backlap spool from manifold:

   A. Remove backlap switch from manifold before removing mow/backlap spool. Remove dowel pin and ball from manifold port after switch is removed. Remove and discard O−ring from switch.

   B. Remove lower retaining ring from mow/backlap spool. Raise mow/backlap spool to allow access to retaining ring on upper end of spool. Remove upper retaining ring.

   C. Push spool down until lower O−ring and back−up ring are exposed on bottom of manifold. Remove lower O−ring and back−up ring from spool.

   D. Pull spool up and out of manifold. Remove O−rings and back−up ring from spool.

   E. Discard removed O−rings and back−up rings.

2. Visually inspect the spool and manifold port for damage to the sealing surfaces and contamination.

3. Install mow/backlap spool into manifold:

   A. Install O−rings and back−up ring to upper grooves on spool. Apply a light coating of grease to O−rings.

   B. Carefully push spool down into manifold port until lower O−ring and back−up ring groove is exposed on bottom of manifold. Install lower O−ring and back−up ring to spool. Apply a light coating of grease to O−ring.

   C. Install lower retaining ring to spool.

   D. Carefully raise mow/backlap spool until upper retaining ring groove on spool is exposed on top of manifold. Install upper retaining ring.

   E. If handle was removed from spool, position spool so handle location of spool is between stop pins in manifold. Apply Loctite #603 Retaining Compound (or equivalent) to threads on handle and install handle into spool.

   F. Place ball and dowel pin in backlap switch manifold port. Install new O−ring onto backlap switch. Thread backlap switch into port and torque **20 ft−lb (27 N−m)**.

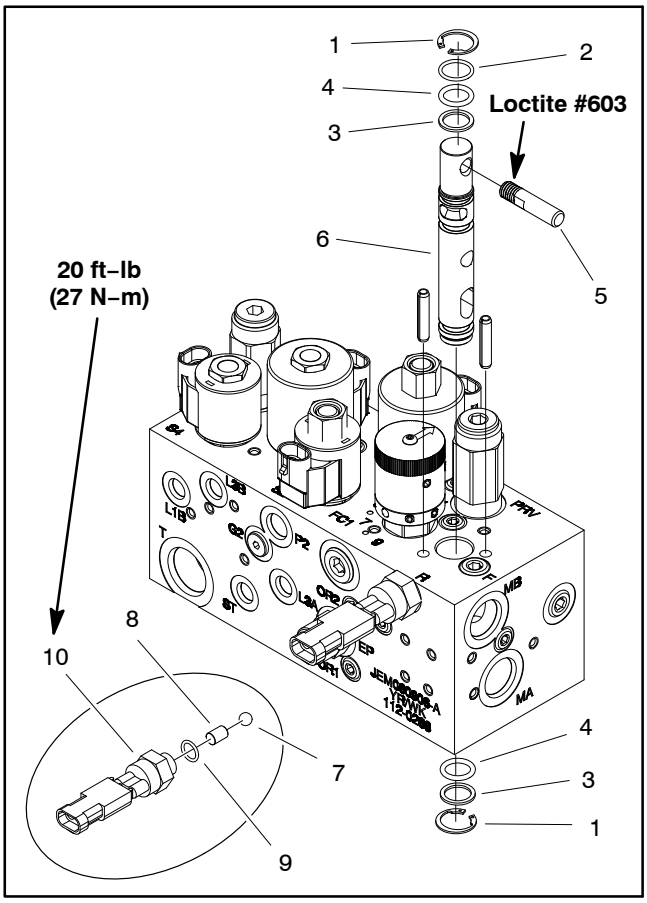

Figure 69

1. **Retaining ring**
2. **O−ring**
3. **Back−up ring**
4. **O−ring**
5. **Spool handle**
6. **Rotary spool**
7. **Ball**
8. **Dowel pin**
9. **O−ring**
10. **Backlap switch**

Steering Control Valve

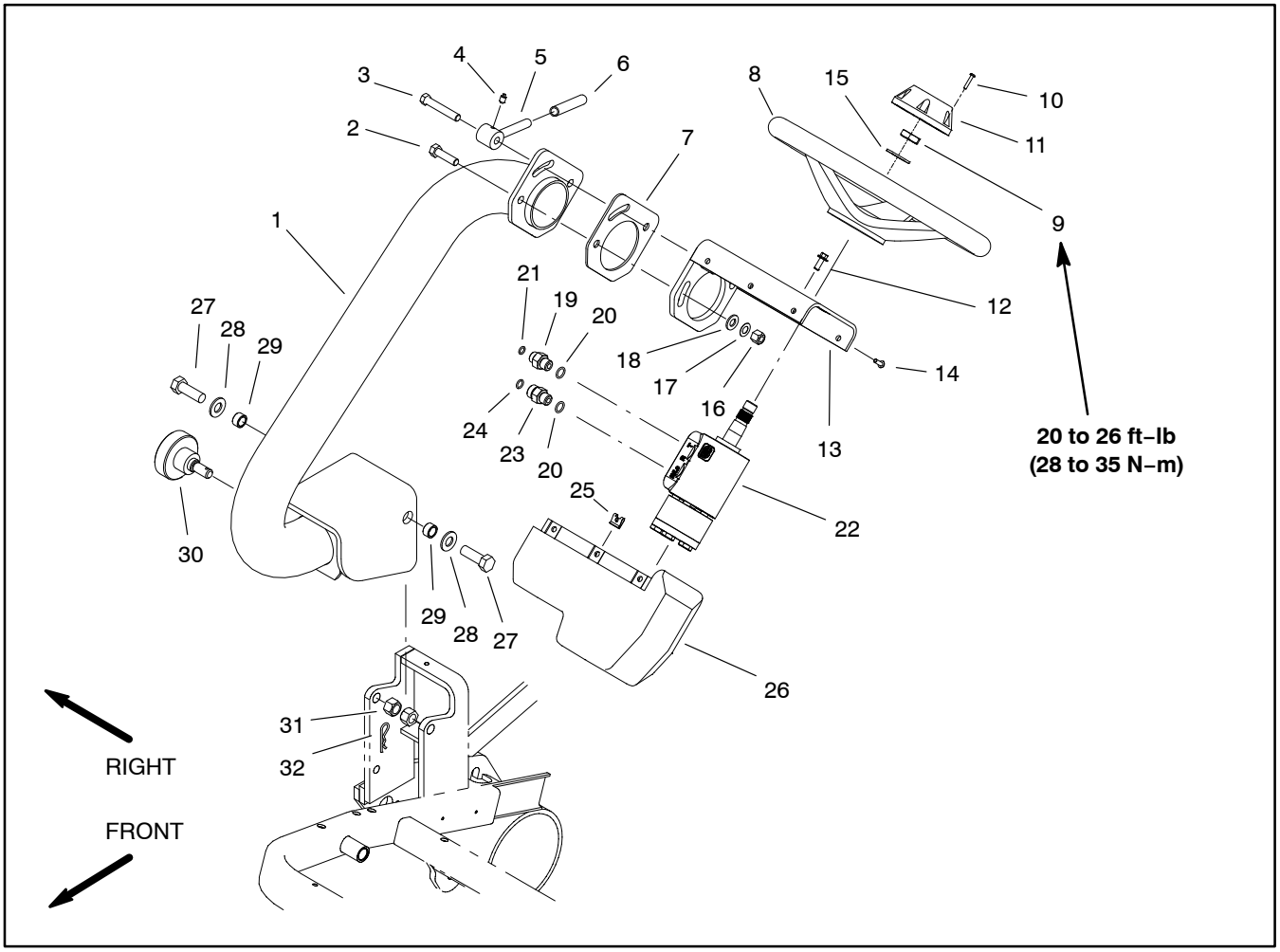

Figure 70

1. Steering arm
2. Cap screw (2 used)
3. Cap screw
4. Set screw
5. Lever
6. Handle
7. Friction plate
8. Steering wheel
9. Hex nut
10. Screw
11. Steering wheel cover
12. Cap screw (4 used)
13. Steering mount
14. Cap screw (6 used)
15. Flat washer
16. Lock nut (2 used)
17. Lock washer (2 used)
18. Flat washer (2 used)
19. Straight hydraulic fitting (2 used)
20. O–ring
21. O–ring
22. Steering valve
23. Straight hydraulic fitting (2 used)
24. O–ring
25. Panel nut (6 used)
26. Steering valve cover
27. Cap screw (2 used)
28. Flat washer (2 used)
29. Spacer (2 used)
30. Knob
31. Lock nut (2 used)
32. Hair pin

Removal (Fig. 70)

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

CAUTION

Before continuing further, read and become familiar with General Precautions for Removing and Installing Hydraulic System Components.

2. Remove screw (item 10) and steering wheel cover (item 11) from the steering wheel.

3. Remove steering wheel nut (item 9), flat washer (item 15) and steering wheel from the steering valve shaft.

4. Remove screws (item 14) and remove the steering valve cover (item 26).

5. Remove cap screws (item 12) that secure steering control valve to steering mount.

6. Lower steering control valve (with hydraulic hoses attached) from steering mount.

7. Label all hydraulic hoses connected to the steering control valve for assembly purposes. Thoroughly clean hydraulic hose ends.

8. Disconnect hydraulic hoses from fittings on the steering control valve. Allow hoses to drain into a suitable container. Cap or plug hoses and control valve fittings to prevent contamination.

9. Remove steering control valve from machine.

10. If necessary, remove hydraulic fittings and O−rings from steering control valve. Discard all removed O−rings.

Installation (Fig. 70)

1. If fittings were removed from steering control valve, lubricate and place new O−rings onto fittings. Install fittings into steering valve openings. Tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).

2. Position steering control valve to steering mount.

3. Using labels placed during control valve removal, lubricate new O−rings and connect hydraulic hoses to steering control valve. Tighten hose connections (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

4. Install any cable ties removed from the hose assemblies.

5. Slide steering control valve (with hydraulic hoses attached) to steering mount. Secure steering valve to mount with four (4) cap screws (item 12).

6. Install steering valve cover (item 26) with cap screws (item 14).

7. Install steering wheel, flat washer (item 15) and nut (item 9). Torque nut from **20 to 26 ft−lb (28 to 35 N−m)**.

8. Secure steering wheel cover (item 11) with screw (item 10).

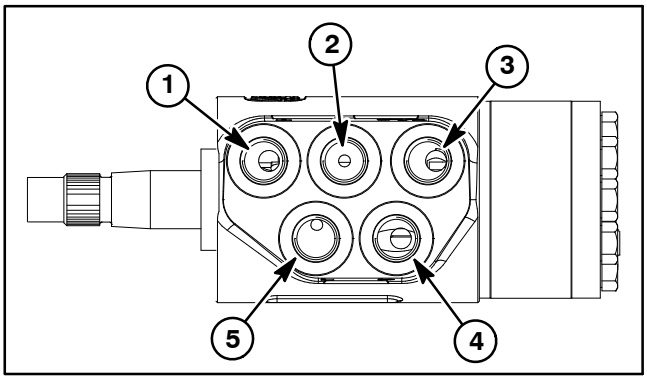

Figure 71

1. T port
2. R port
3. E/Ls port
4. P port
5. L port

Steering Control Valve Service

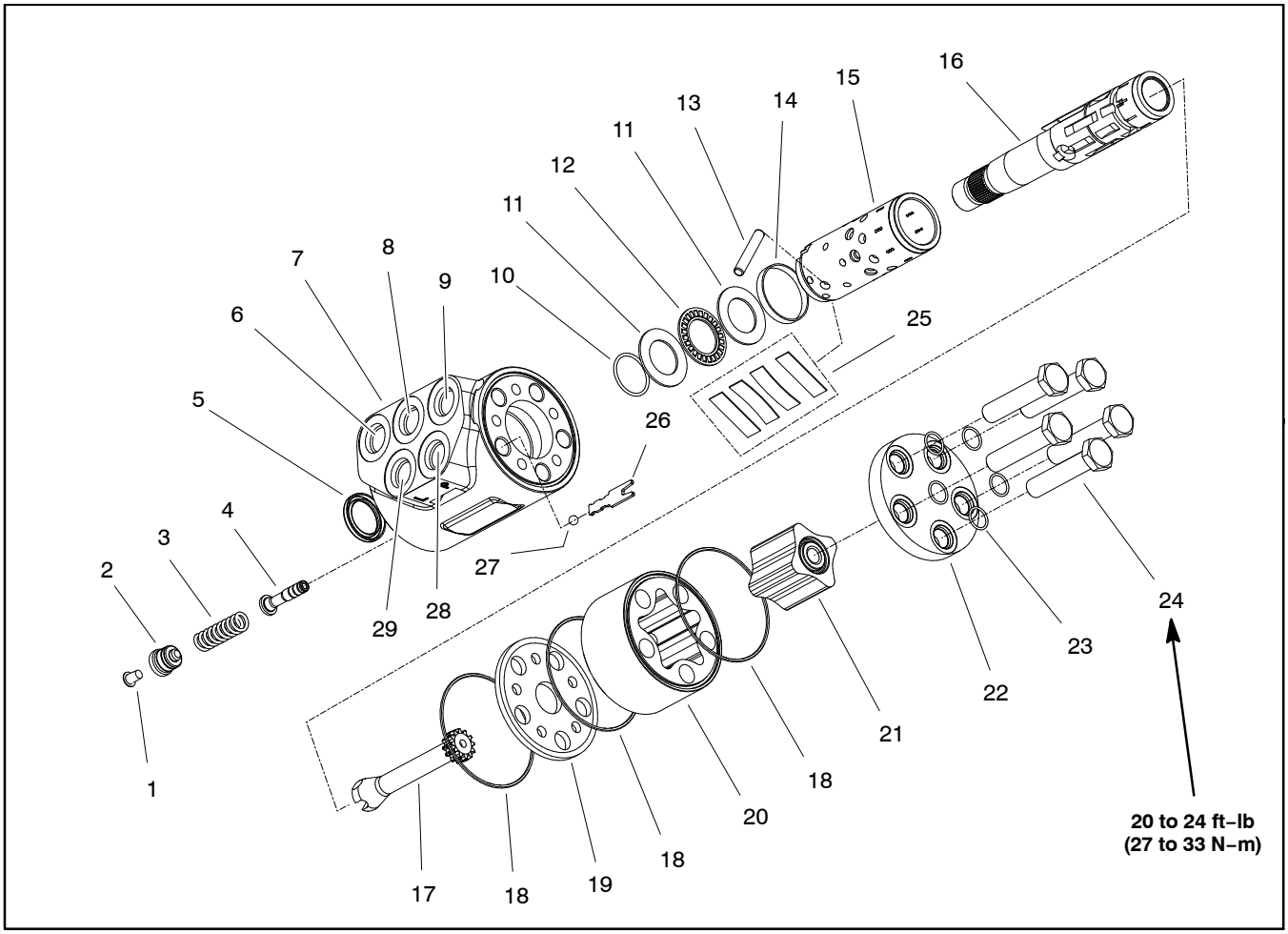

Figure 72

1. Plug
2. Plug
3. Spring
4. Relief valve
5. Dust seal
6. T port
7. Housing
8. R port
9. E port
10. Shaft seal
11. Thrust washer
12. Bearing
13. Cross pin
14. Ring
15. Sleeve
16. Spool
17. Cardan shaft
18. O–ring
19. Distribution plate
20. Outer gearwheel
21. Inner gearwheel
22. End cover
23. O–ring (5 used)
24. Cap screw (5 used)
25. Spring set
26. Ball stop
27. Ball
28. P port
29. L port

NOTE: For service of the steering control valve shown in Figure 72, see the Sauer/Danfoss Steering Unit Type OSPM Service Manual at the end of this chapter.

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Steering Cylinder

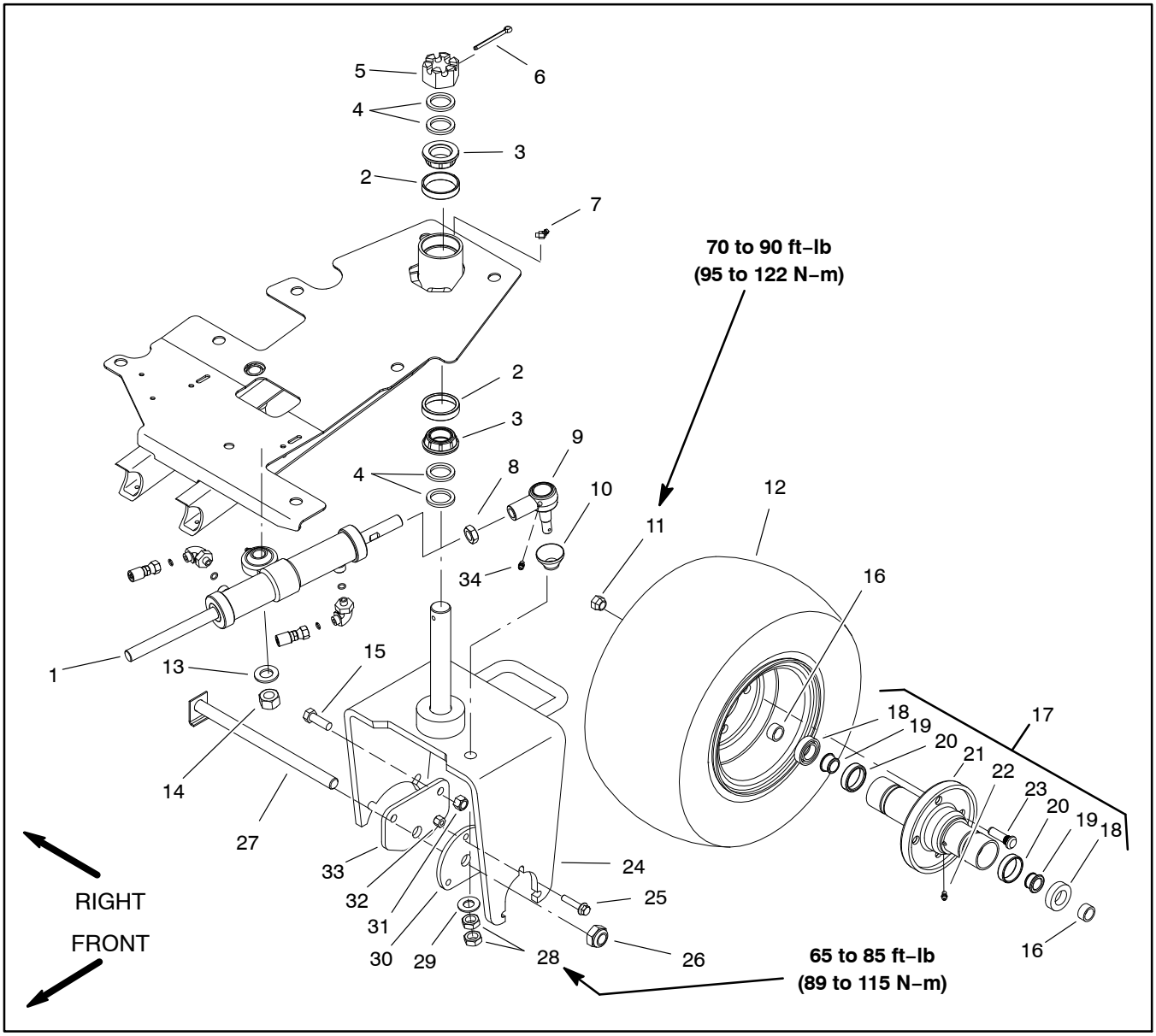

Figure 73

1. Steering cylinder
2. Bearing cup (2 used)
3. Bearing cone (2 used)
4. Washer (4 used)
5. Slotted hex nut
6. Cotter pin
7. Grease fitting
8. Jam nut
9. Rod end
10. Dust seal
11. Lug nut (4 used)
12. Wheel assembly
13. Washer
14. Lock nut
15. Cap screw (2 used)
16. Spacer (2 used)
17. Hub assembly
18. Seal (2 used)
19. Bearing cone (2 used)
20. Bearing cup (2 used)
21. Hub
22. Grease fitting
23. Drive stud (4 used)
24. Castor fork
25. Flange head screw (3 used)
26. Lock nut
27. Castor bolt
28. Jam nut (2 used)
29. Flat washer
30. Adapter plate
31. Lock nut (2 used)
32. Lock nut (3 used)
33. Motor adapter plate
34. Grease fitting

Removal (Fig. 73)

1. Before removing any parts from the hydraulic system, park machine on a level surface, set brake, lower cutting units and stop engine.

CAUTION

Before continuing further, read and become familiar with General Precautions for Removing and Installing Hydraulic System Components.

2. Label all hose connections for assembly purposes

3. Remove hose assemblies and O−rings from hydraulic fittings at the steering cylinder. Allow hoses to drain into a suitable container.

4. Remove lock nut and flat washer from barrel mounting stud. Remove steering cylinder from barrel stud.

5. Remove two (2) jam nuts and flat washer from cylinder rod end at rear wheel castor fork.

6. Remove steering cylinder from traction unit.

7. Note fitting orientation on cylinder for assembly purposes. Remove fittings and O−rings from cylinder ports. Discard O−rings.

8. If rod end (item 9) is to be removed from cylinder rod, fully retract cylinder rod and measure distance from center of rod end to end of cylinder for assembly purposes (Fig. 74). Record measured distance. Loosen jam nut and then remove rod end and jam nut from cylinder rod.

Installation (Fig. 73)

1. If rod end (item 9) was removed from cylinder rod, fully retract cylinder shaft and thread rod end onto shaft so that distance is as measured during removal process (Fig. 74). Tighten jam nut to retain rod end.

2. Install hydraulic fittings and O−rings to the steering cylinder. Make sure that fittings are orientated as noted during removal.

3. Thoroughly clean tapered surfaces of steering cylinder ball joint and cylinder attachment bore on castor fork.

4. Secure cylinder rod end to the castor fork with two (2) jam nuts and flat washer. Install first jam nut and torque from **65 to 85 ft−lb (89 to 115 N−m)**. Then, while holding first jam nut with wrench, tighten second jam nut and torque from **65 to 85 ft−lb (89 to 115 N−m)**.

5. Install steering cylinder over barrel mounting stud and secure with flat washer and lock nut.

6. Connect hydraulic hoses and O−rings to the hydraulic fittings. Tighten hose connections (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

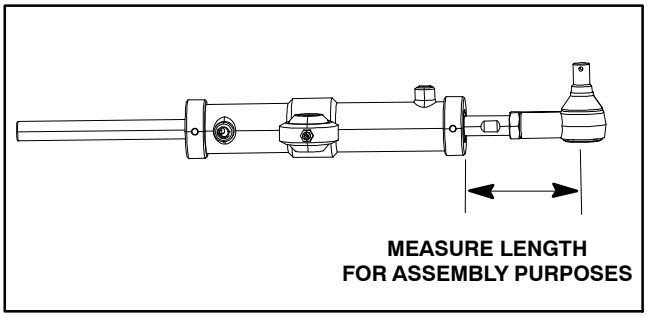

Figure 74

Steering Cylinder Service

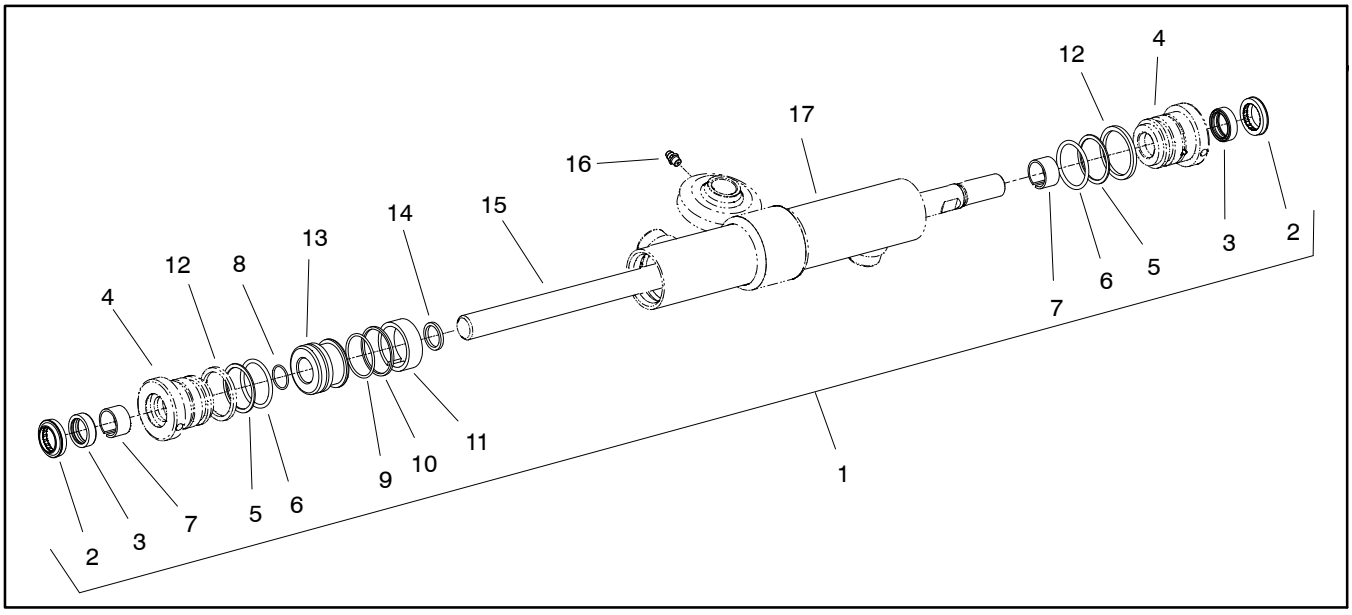

Figure 75

1. **Seal kit**
2. **Rod wiper**
3. **Seal**
4. **Head**
5. **Back–up ring**
6. **O–ring**
7. **Wear ring**
8. **O–ring**
9. **Back–up ring**
10. **Seal**
11. **Wear ring**
12. **Retaining ring**
13. **Piston**
14. **Retaining ring**
15. **Rod**
16. **Grease fitting**
17. **Barrel**

NOTE: The steering cylinder design does not allow removal of the piston (item 13) from the rod. This cylinder design prevents replacing the O–ring (item 8) or retaining ring (item 14) on the inside of the piston. If leakage or damage exists at the piston O–ring, steering cylinder replacement will be necessary.

Disassembly (Fig. 75)

1. Pump oil out of cylinder into a drain pan by slowly moving rod in and out of cylinder bore. Plug ports and clean outside of cylinder.

IMPORTANT: To prevent damage when clamping cylinder barrel in a vise, clamp only on ball joint location. Do not clamp the vise jaws against the cylinder barrel or rod surface.

2. Mount cylinder in a vise by clamping vise on barrel ball joint location of cylinder. Use of a vise with soft jaws is recommended.

3. Remove both heads from the barrel:

   A. Use a spanner wrench to rotate head clockwise until the edge of the retaining ring appears in the barrel opening.

   B. 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. Slide head from cylinder barrel and rod.

4. Grasp end of rod and use a twisting and pulling motion to carefully extract rod assembly (with piston) from cylinder barrel.

NOTE: Piston (item 13) is not removable from cylinder rod.

5. Remove and discard rod wipers (item 2), seals (item 3), O−rings (item 6), back−up rings (item 5) and wear rings (item 7) from both heads (item 4). Also, remove seal (item10), back−up ring (item 9) and wear ring (item 11) from piston.

CAUTION

Use eye protection such as goggles when using compressed air to dry cylinder parts.

6. Wash cylinder parts in clean solvent. Dry parts with compressed air. Do not wipe parts dry with paper or cloth towels. Lint from towels in a hydraulic system will cause damage.

7. Carefully inspect internal surface of barrel for damage (deep scratches, out−of−round, etc). Inspect rod, both heads and piston for evidence of excessive scoring, pitting or wear. Replace entire steering cylinder if internal components are damaged.

Assembly (Fig. 75)

1. Identify components from seal kit that are to be used in cylinder repair. Put a coating of clean hydraulic oil on all new seals, back−up rings and O−rings.

2. Install new wear rings (item 7), seals (item 3), rod wipers (item 2), back−up rings (item 5) and O−rings (item 6) onto both heads (item 4). Position backup ring, seal and wear ring to the piston (item 13).

IMPORTANT: During cylinder assembly, pay careful attention to the retaining ring slots in the barrel to insure that the piston and head seals do not lodge in the slots.

3. Coat all internal cylinder parts with a light coat of clean hydraulic oil. Carefully slide rod assembly into the barrel being careful to not damage seals on piston.

4. Lubricate head (item 4) assemblies with clean hydraulic oil and carefully slide them onto rod and into barrel.

5. Secure both heads to barrel:

   A. Align retaining ring hole in the head with the access slot in the barrel.

   B. 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.

   C. Apply silicone sealer to barrel access slot.

Leak Detector

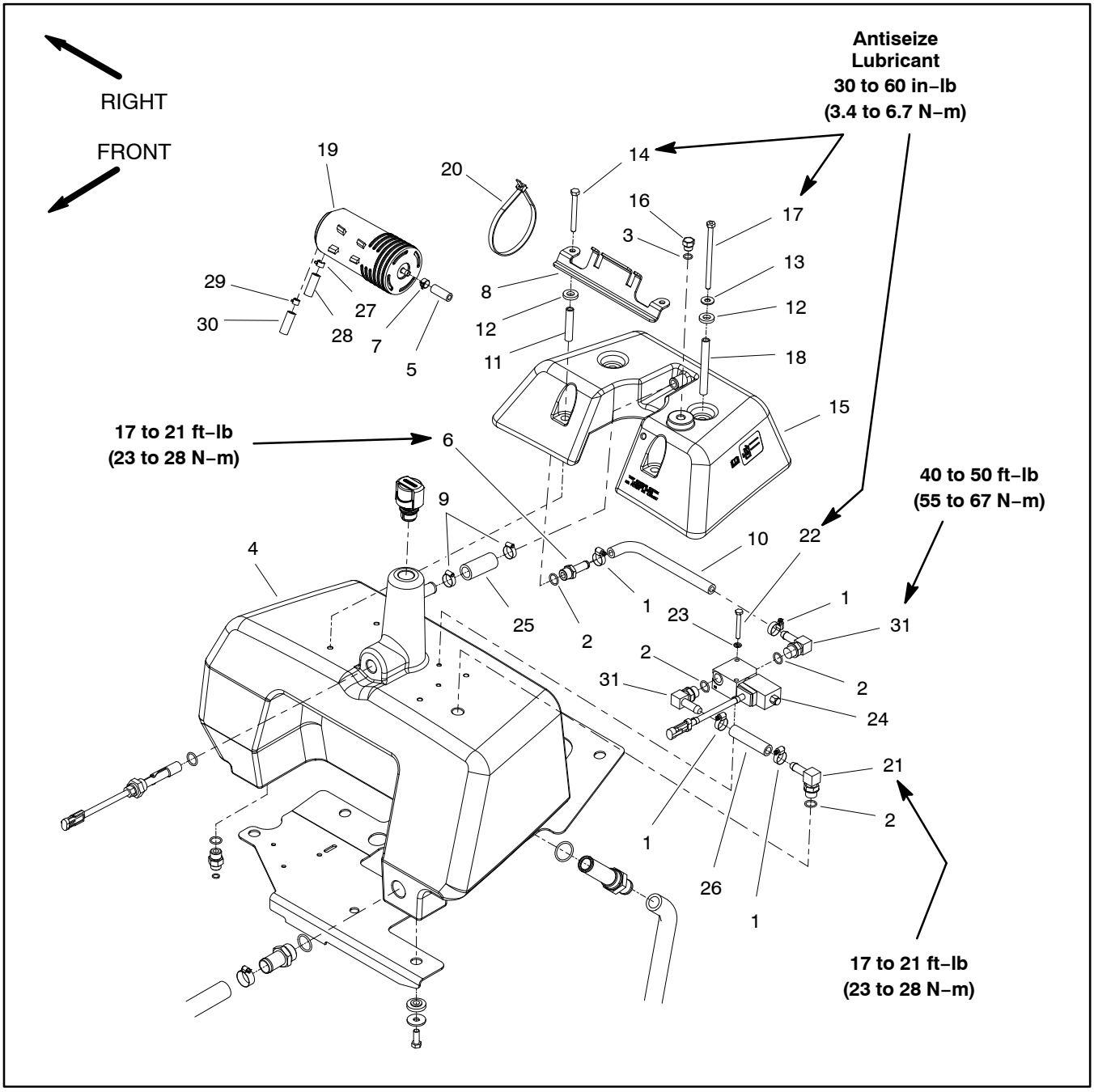

Figure 76

1. Hose clamp (4 used)
2. O–ring
3. O–ring
4. Hydraulic reservoir
5. Hose (to tee fitting)
6. Straight barb fitting
7. Hose clamp
8. Canister bracket
9. Hose clamp (2 used)
10. Valve hose
11. Short spacer (2 used)
12. Neoprene washer (4 used)
13. Flat washer (2 used)
14. Cap screw (2 used)
15. Leak detector tank
16. Plug
17. Cap screw (2 used)
18. Long spacer (2 used)
19. Carbon canister
20. Cable tie (2 used)
21. 90º barb fitting
22. Cap screw (2 used)
23. Lock washer (2 used)
24. Solenoid valve assembly
25. Overflow hose
26. Tank valve hose
27. Hose clamp
28. Purge hose assembly
29. Hose clamp
30. Vent hose (to fuel tank vent)
31. 90º barb fitting (2 used)

NOTE: See Turf Guardian™ Leak Detector System in Chapter 5 – Electrical System for leak detector operation information.

Removal (Fig. 76)

1. Before removing any parts from the hydraulic system, park machine on a level surface, set brake, lower cutting units and stop engine.

CAUTION

Before continuing further, read and become familiar with General Precautions for Removing and Installing Hydraulic System Components.

2. Place a clean container, large enough to collect 2 gallons (7.6 liters), under the hydraulic pump assembly to collect hydraulic oil.

3. Clamp pump inlet hose to control drainage. Remove inlet hose from gear pump (Fig. 77). Release clamp from hose and drain about 2 gallons (7.6 liters) from the hydraulic reservoir.

4. Clamp pump inlet hose to prevent draining additional hydraulic oil.

5. Unplug leak detector solenoid harness from the machine wire harness.

6. Remove four (4) cap screws (items 14 and 17), flat washers (item 13), neoprene washers (item 12) and spacers (items 11 and 18).

7. Carefully position carbon canister and bracket away from leak detector tank.

8. Loosen either hose clamp (item 9) and disconnect overflow hose (item 25).

9. Lift leak detector tank slightly, loosen hose clamp (item 1) and disconnect valve hose (item 10) at barb fitting (item 31) on solenoid valve assembly. Remove leak detector tank assembly.

10. If necessary, remove solenoid valve assembly, fittings and hoses using Figure 76 as a guide.

11. If needed, disassemble solenoid valve manifold using Figure 78 as a guide.

12. Inspect leak detector components for the following:

A. Leaking, cracked or damaged leak detector tank.

B. Worn or leaking hydraulic hoses. Replace if necessary.

C. Visibly worn or damaged parts.

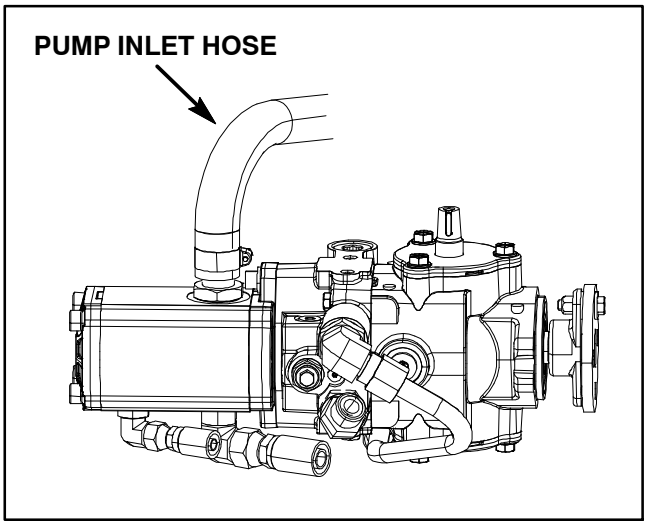

Figure 77

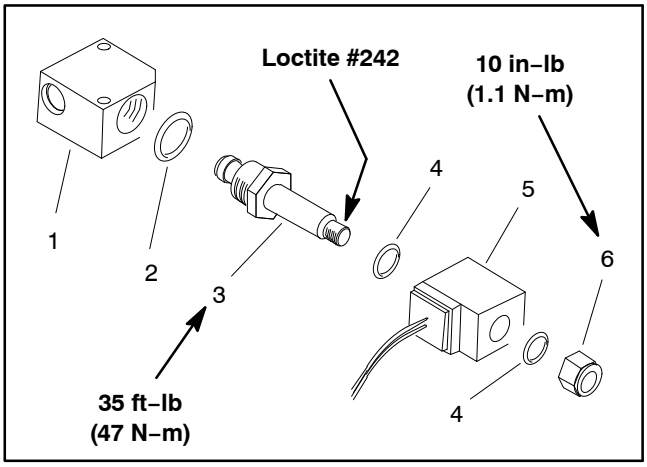

Figure 78

1. **Manifold**
2. **Valve seal**
3. **Solenoid valve**
4. **O–ring**
5. **Solenoid coil**
6. **Nut**

Installation (Fig. 76)

1. During assembly, coat all O–rings with clean hydraulic oil.

2. If removed, assemble solenoid valve manifold (Fig 78):

A. When installing cartridge valve, torque valve **35 ft–lb (47 N–m)**.

B. When installing solenoid coil, apply a drop of Loctite #242 (or equivalent) to threads of valve and torque nut **10 in–lb (1.1 N–m)**.

C. If fittings were removed from manifold, torque fittings from **40 to 50 ft–lb (55 to 67 N–m)**.

3. If removed, install solenoid valve assembly, fittings and hoses using Figure 76 as a guide.

A. Torque fittings to values shown in Figure 76.

B. If solenoid valve manifold was removed from hydraulic reservoir, apply antiseize lubricant to threads of cap screws (item 22). Torque screws from **30 to 60 in−lb (3.4 to 6.7 N−m)**.

4. Position leak detector tank to hydraulic reservoir. Connect valve hose (item 10) to solenoid valve fitting and secure with hose clamp (item 1).

5. Connect overflow hose (item 25) and secure with hose clamp (item 9).

6. Position carbon canister and bracket to the leak detector tank.

IMPORTANT: Do not over tighten cap screws that secure leak detector tank. Threads in hydraulic reservoir may become damaged if screws are over tightened.

7. Secure leak detector tank to hydraulic reservoir:

A. Apply antiseize lubricant to threads of cap screws (items 14 and 17) used to secure leak detector tank.

B. Install four (4) cap screws (items 14 and 17), flat washers (item 13), neoprene washers (item 12) and spacers (items 11 and 18).

C. Torque cap screws from **30 to 60 in−lb (3.4 to 6.7 N−m)**.

8. Connect leak detector harness to main wire harness.

9. Connect pump inlet hose to gear pump and secure with hose clamp (Fig. 77).

NOTE: Monitor hydraulic fluid level in sight window on leak detector tank. As air is removed from the hydraulic circuit, fluid level may need to be topped off after initial fill.

10. Remove cap from hydraulic reservoir and slowly fill to the cold fill level mark.

11. Check leak detector with ignition key switch in RUN position. The leak detector alarm should sound when leak detector test switch is held down for one (1) second.

12. If the alarm fails to sound, check to see if all connections are secure.

13. Verify leak detector operation.

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Hydraulic Reservoir

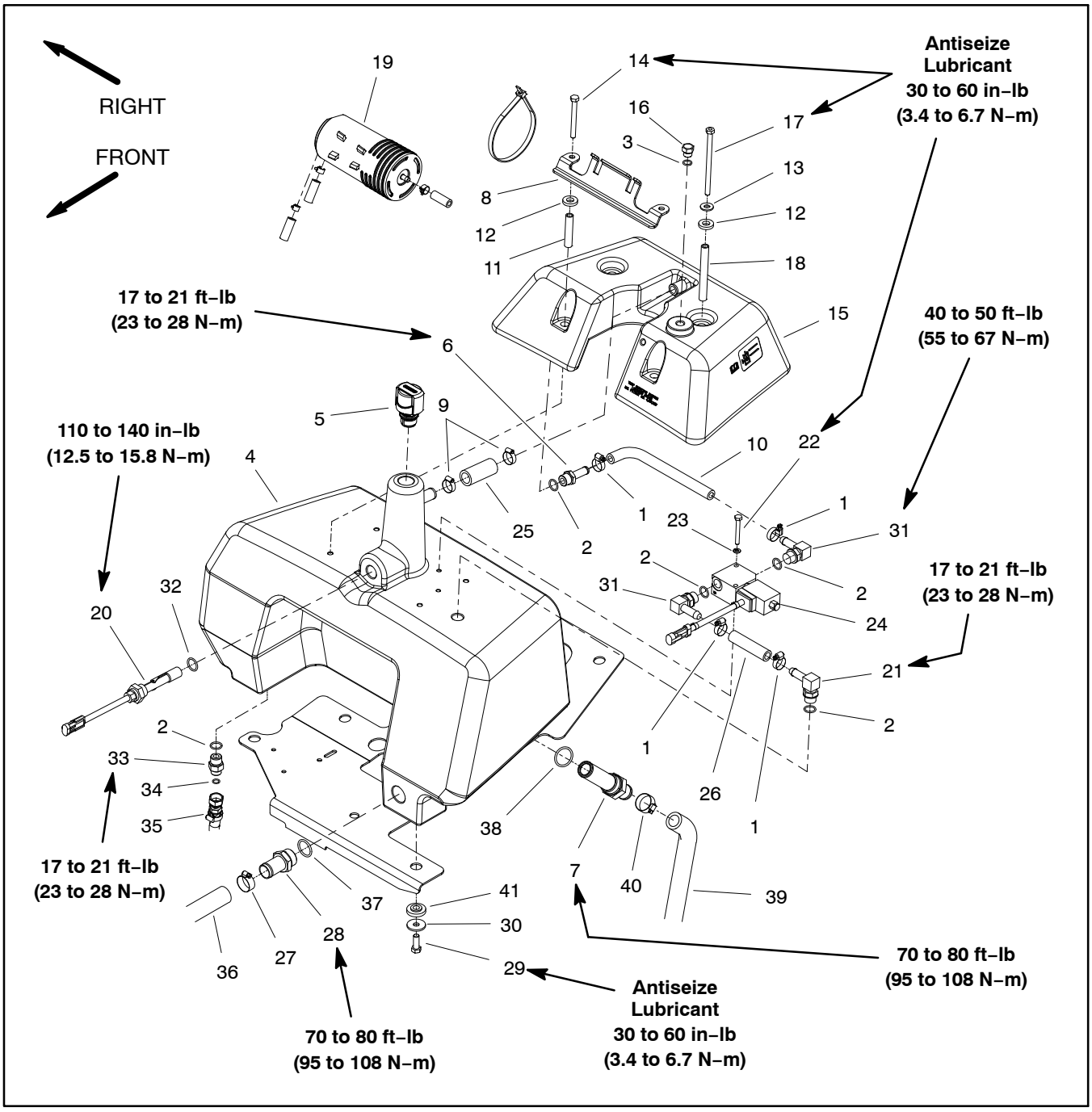

Figure 79

1. Hose clamp (4 used)
2. O−ring
3. O−ring
4. Hydraulic reservoir
5. Reservoir cap
6. Straight barb fitting
7. Strainer
8. Canister bracket
9. Hose clamp (2 used)
10. Valve hose
11. Short spacer (2 used)
12. Neoprene washer (4 used)
13. Flat washer (2 used)
14. Cap screw (2 used)
15. Leak detector tank
16. Plug
17. Cap screw (2 used)
18. Long spacer (2 used)
19. Carbon canister
20. Oil level sensor
21. 90º barb fitting
22. Cap screw (2 used)
23. Lock washer (2 used)
24. Solenoid valve assembly
25. Overflow hose
26. Tank valve hose
27. Hose clamp
28. Barbed fitting
29. Cap screw (3 used)
30. Flat washer (3 used)
31. 90º barb fitting (2 used)
32. O−ring
33. Straight hydraulic fitting
34. O−ring
35. Hydraulic hose
36. Hydraulic hose
37. O−ring
38. O−ring
39. Hydraulic hose (pump inlet)
40. Hose clamp
41. Flange bushing (3 used)

Removing Hydraulic Reservoir (Fig. 79)

1. Before removing any parts from the hydraulic system, park machine on a level surface, set brake, lower cutting units and stop engine.

CAUTION

Before continuing further, read and become familiar with General Precautions for Removing and Installing Hydraulic System Components.

2. Remove leak detector assembly (see Leak Detector in this section).

3. Drain remaining hydraulic oil from hydraulic reservoir through pump inlet hose into a suitable container.

4. Unplug wire harness connector from oil level sensor (item 20).

5. Label all hydraulic reservoir hose connections for assembly purposes.

6. Remove hose assemblies from reservoir hydraulic fittings. Allow hoses to drain into a suitable container.

7. Remove three (3) cap screws (item 29), flat washers (item 30) and bushings (41) securing the hydraulic reservoir to the machine frame.

8. Remove hydraulic reservoir from machine.

9. Remove hydraulic fittings and oil level sensor from hydraulic reservoir if necessary.

Inspecting Reservoir Parts (Fig. 79)

1. Clean reservoir and filler screen with solvent.

2. Inspect reservoir for leaks, cracks or other damage.

3. Replace hydraulic hoses if worn or leaking.

Installing Hydraulic Reservoir (Fig. 79)

1. Install all removed hydraulic fittings into hydraulic reservoir ports. Torque fittings to values shown in Figure 79.

2. If oil level sensor was removed from reservoir, install sensor in reservoir making sure that arrow on sensor is pointing down (Fig. 81). Torque sensor nut from **110 to 140 in−lb (12.5 to 15.8 N−m)**.

3. Position hydraulic reservoir onto the machine frame.

IMPORTANT: After hydraulic reservoir is installed, make sure that clearance between hydraulic reservoir and fuel tank if from 0.125” to 0.375” (3.2 to 9.5 mm).

4. Apply antiseize lubricant to threads of three (3) cap screws (item 29). Secure hydraulic reservoir to the machine frame with three (3) cap screws, flat washers (item 30) and bushings (item 41). Torque cap screws from **30 to 60 in−lb (3.4 to 6.7 N−m)**.

5. Using notes taken during reservoir removal, connect hydraulic hoses to the reservoir fittings. Tighten hose connections (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

6. Secure pump inlet hose to gear pump with hose clamp (Fig. 80).

7. Connect wire harness connector to oil level sensor (item 20).

8. Install leak detector assembly (see Leak Detector in this section). Make sure that reservoir oil level is correct.

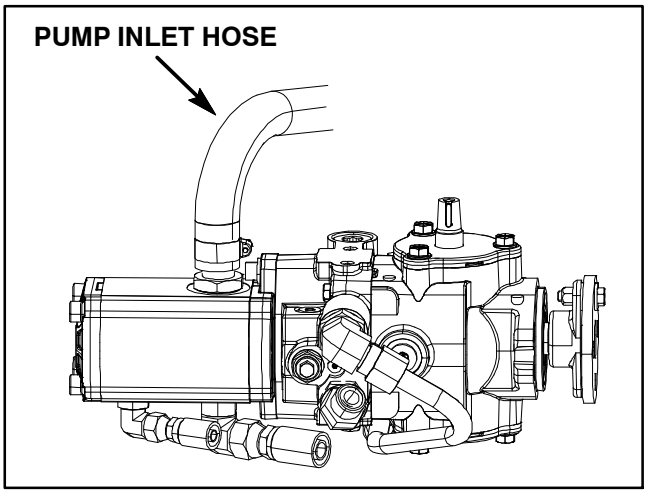

Figure 80

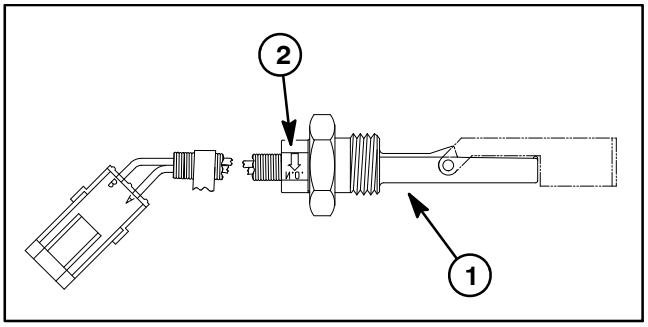

Figure 81

1. **Oil level sensor**
2. **Sensor arrow**

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Chapter 5

Electrical System

Table of Contents

General Information

Operator's Manual

The Operator's Manual provides information regarding the operation, general maintenance and maintenance intervals for your Greensmaster 3150. Refer to that publication for additional information when servicing the machine.

Electrical Drawings

The electrical schematic and other electrical drawings for the Greensmaster 3150 are located in Chapter 9 – Foldout Drawings.

Special Tools

Order special tools from your Toro Distributor. Some tools may also be available from a local supplier.

Multimeter

The multimeter can test electrical components and circuits for current, resistance or voltage. Obtain this tool locally.

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.

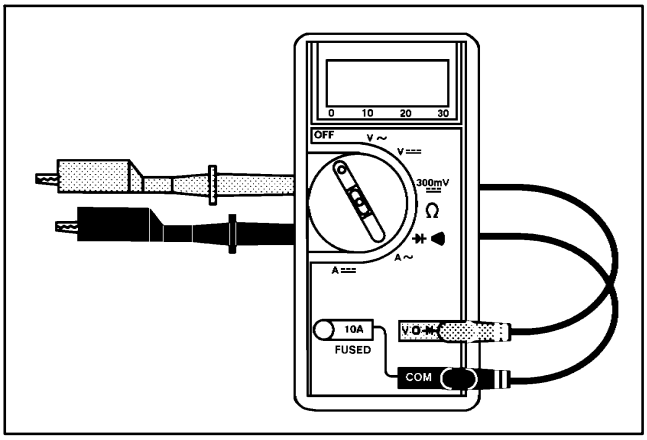

Figure 1

Skin–Over Grease

Special non–conductive grease which forms a light protective skin which helps waterproof electrical switches and contacts.

Toro Part Number: **TOR50547**

Figure 2

Battery Terminal Protector

Aerosol spray that should be used on battery terminals to reduce corrosion problems. Apply terminal protector after the battery cable has been secured to the battery terminal.

Toro Part Number: **107–0392**

Figure 3

Dielectric Lubricant/Sealant

Dielectric lubricant should be used to prevent corrosion of connection terminals. To ensure complete coating of terminals, liberally apply lubricant to both component and wire harness connector, plug connector to component, unplug connector, reapply lubricant to both surfaces and reconnect harness connector to component. Connectors should be thoroughly packed with lubricant for effective results.

Toro Part Number: **107–0342**

Figure 4

Battery Hydrometer

Use the Battery Hydrometer when measuring specific gravity of battery electrolyte. Obtain this tool locally.

Figure 5

Turf Guardian™ Leak Detector System Operation

Before Start-Up (Cold Oil)

With ignition switch in the OFF position, solenoid valve is open. Before start-up, hydraulic fluid is at level mark of sight gauge (oil cold). Float is in raised position, keeping alarm circuit open.

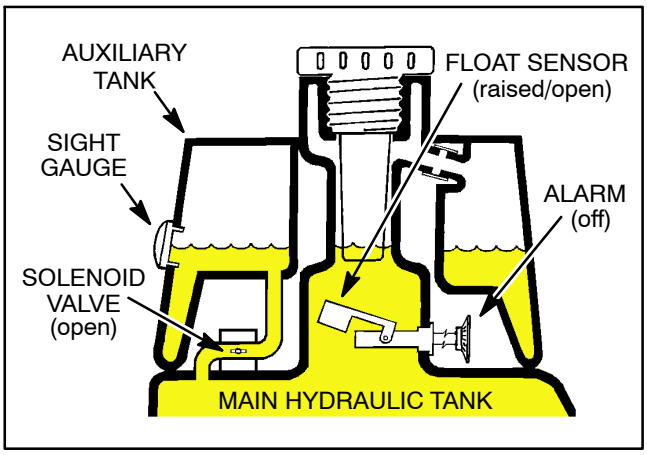

Figure 6

Normal Operation (Warm Oil)

When ignition switch is turned to the RUN position, solenoid valve closes. During normal operation, hydraulic fluid expands, causing it to overflow into auxiliary tank. The float stays in the raised position keeping alarm circuit open.

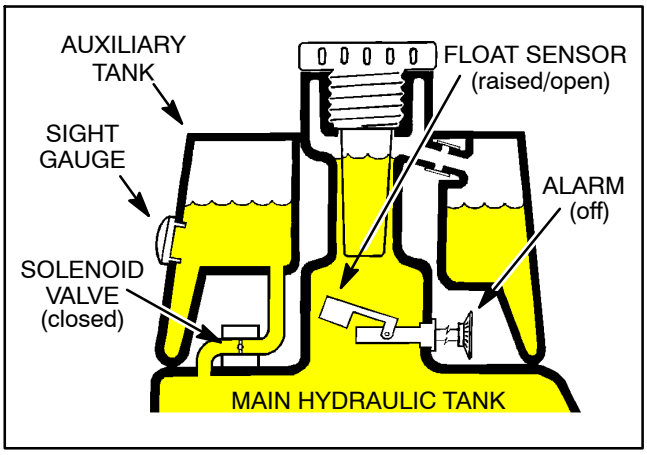

Figure 7

Leak Alert!

If hydraulic fluid leaks during operation, the fluid level in the main hydraulic tank drops. This causes the float to lower, closing the alarm circuit. The alarm will sound after a one second time delay.

NOTE: During normal operation, with cutting units lowered, approximately 5 oz (148 ml) of hydraulic fluid will leak before the float closes the alarm circuit and activates the alarm.

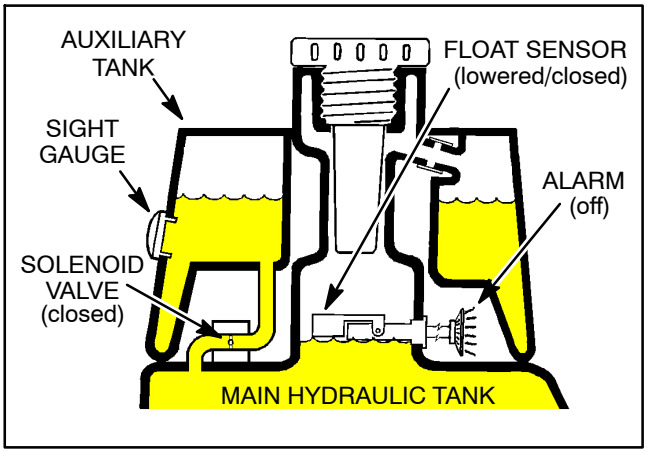

Figure 8

Troubleshooting

CAUTION

Remove all jewelry, especially rings and watches, before doing any electrical trouble-shooting 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 Chapter 9 – Foldout Drawings).

If the machine has any interlock switches by–passed, they must be reconnected for proper troubleshooting and safety.

Starting Problems

Problem	Possible Causes
Starter solenoid clicks, but starter will not crank. **NOTE:** If solenoid clicks, problem is not in safety interlock system.	Battery charge is low. Battery cables are loose or corroded. Battery ground to frame is loose or corroded. Wiring at starter is faulty. Starter solenoid is faulty. Starter mounting bolts are loose or not supplying a sufficient ground for starter operation. Starter is faulty.
Nothing happens when start attempt is made.	Functional control lever is not in the neutral position. Battery cables are loose or corroded. Battery ground to frame is loose or corroded. Fuse F1 (20 amp) is loose or faulty. Fuse F3 (10 amp) is loose or faulty. Fusible link at starter solenoid (included in main wire harness) is faulty. Wiring to the start circuit components is loose, corroded or damaged (see Electrical Schematic and Circuit Diagrams in Chapter 9 – Foldout Drawings). Start safety relay (K2) is faulty. Neutral switch is out of adjustment or faulty. Starter solenoid fusible link is faulty. Ignition switch is faulty. Starter solenoid is faulty. Fuse block is faulty. Battery is faulty.

Starting Problems (continued)

Problem	Possible Causes
Engine cranks, but does not start.	Wiring to start circuits is loose, corroded or damaged (see Electrical Schematic and Circuit Diagrams in Chapter 9 – Foldout Drawings). Wiring to engine is is loose, corroded or damaged (see Electrical Schematic and Circuit Diagrams in Chapter 9 – Foldout Drawings). Diode D1–A circuit is open. Engine or fuel system is malfunctioning (see Chapter 3 – Engine). Kill relay (K1) is faulty. Engine and fuel may be too cold. Engine fuel solenoid is faulty.
Engine cranks (but should not) with the functional control lever in the MOW or TRANSPORT position.	Neutral switch is out of adjustment, faulty or short circuited.

General Run and Transport Problems

Problem	Possible Causes
Engine kills when the functional control lever is in the MOW or TRANSPORT position with the operator in the seat.	Operator is sitting too far forward on the seat (seat switch not depressed). Parking brake is set. Parking brake sensor is faulty. Seat switch is faulty. Seat switch wiring is loose, corroded or damaged.
Battery does not charge.	Wiring to the charging circuit components is loose, corroded or damaged (see Electrical Schematic and Circuit Diagrams in Chapter 9 – Foldout Drawings). Voltage regulator is loose or not grounded to engine. Voltage regulator is faulty. Alternator stator (under engine flywheel) is faulty. Alternator fusible link (included in engine wire harness) is open. Ignition switch is faulty. Battery is faulty.
Engine kills during operation (operator sitting on seat).	Operator moved too far forward on the seat (seat switch not depressed). Wiring to the run circuits components are faulty or disconnected (see Electrical Schematic and Circuit Diagrams in Chapter 9 – Foldout Drawings). Engine or fuel system is malfunctioning (see Chapter 3 – Engine).

Cutting Unit Operating Problems

Problem	Possible Causes
Cutting units run (but should not) when raised.	Joystick relay (K3) is faulty. Mow relay (K4) is faulty. Mow switch is out of adjustment or faulty. A hydraulic problem exists (see Chapter 4 – Hydraulic System).
Cutting units do not run when lowered with the functional control lever in the MOW position.	Wiring to run/mow/backlap circuits components is loose, corroded or damaged (see Electrical Schematic and Circuit Diagrams in Chapter 9 – Foldout Drawings). Fuse block or fuse is faulty. Solenoid coil S1R1 is faulty. Mow switch and/or mow relay (K4) is faulty. Raise or lower switch and/or joystick relay (K3) is faulty. A hydraulic problem exists (see Chapter 4 – Hydraulic System).
Cutting units will not raise.	Wiring to raise circuit components is loose, corroded or damaged (see Electrical Schematic and Circuit Diagrams in Chapter 9 – Foldout Drawings). Fuse block or fuse is faulty. Diode D3 is open. Raise switch is faulty. Raise relay (K6) is faulty. Solenoid coil S3 and/or S2 is faulty. A hydraulic problem exists (see Chapter 4 – Hydraulic System).

Cutting Unit Operating Problems (Continued)

Problem	Possible Causes
Cutting units will not lower.	Wiring to lower circuit components is loose, corroded or damaged (see Electrical Schematic and Circuit Diagrams in Chapter 9 – Foldout Drawings). Fuse block or fuse is faulty. Diode D2 is open. Raise switch is faulty. Lower switch is faulty. Joystick relay (K3) is faulty. Lower relay (K5) is faulty. 6 second delay timer is faulty. Solenoid coil S2 or S4 is faulty.

Electrical System Quick Checks

Battery Test

Use a multimeter to measure the voltage between the battery terminals.

Set the multimeter to the DC volts setting. The battery should be at a temperature of 60º to 100º F (16º to 38º 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 to 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

Charging System Test

This is a simple test used to determine if a charging system is functioning. It will tell you if the charging system has an output, but not its capacity.

Use a digital multimeter set to DC volts. Connect the positive (+) multimeter lead to the positive battery post and the negative (–) multimeter lead to the negative battery post. Keep the test leads connected to the battery posts and record the battery voltage.

NOTE: Upon starting the engine, the battery voltage will drop and then should increase once the engine is running.

NOTE: Depending upon the condition of the battery charge and battery temperature, the battery voltage will increase at different rates as the battery charges.

Start the engine and run at high idle **(2850 RPM)**. Allow the battery to charge for at least three (3) minutes. Record the battery voltage.

After running the engine for at least three (3) minutes, battery voltage should be at least 0.50 volt higher than initial battery voltage.

An example of a charging system that is functioning:

At least 0.50 volt over initial battery voltage.	
Initial Battery Voltage	= 12.30 v
Battery Voltage after 3 Minute Charge	= 12.95 v
Difference	= +0.65 v

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 on the switch).

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 (3) positions (OFF, RUN and START). The terminals are marked as shown in Figure 9. The circuitry of the ignition switch is shown in the chart below. 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

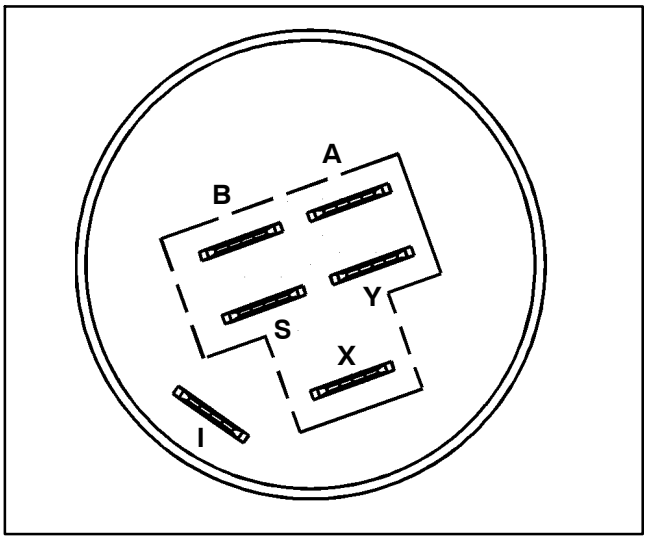

Figure 9

Fuse Block

Fuses can be removed to check continuity. Use a multimeter to make sure that fuse resistance is **less than 1 ohm**.

Fuses supply power to the following (Fig. 10):

1. The 20 amp fuse (F1) supplies power to engine run circuits and also to the hydraulic solenoid coils.

2. The 10 amp fuse (F2) supplies power to the light/test switch and the optional light circuit.

3. The 10 amp fuse (F3) supplies power to the engine run circuits and also to the hydraulic solenoid coils.

4. The 10 amp fuse (F4) supplies power to leak detector solenoid and the cutting unit control circuits.

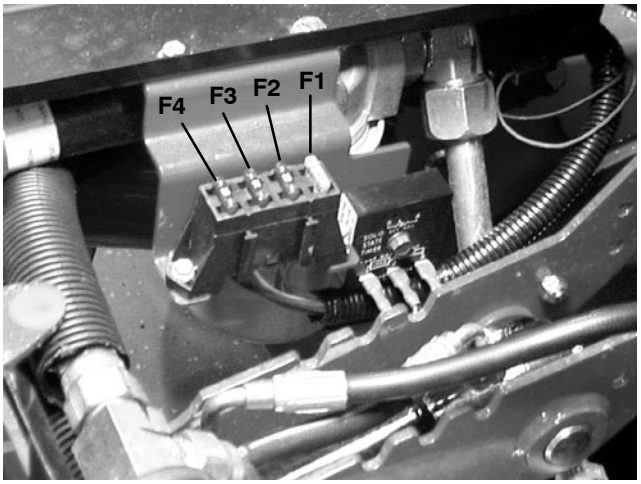

Figure 10

Hour Meter

The hour meter is located on the control panel.

Testing

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 (6) minutes.

4. Disconnect the voltage source from the hour meter.

5. Replace the hour meter if necessary.

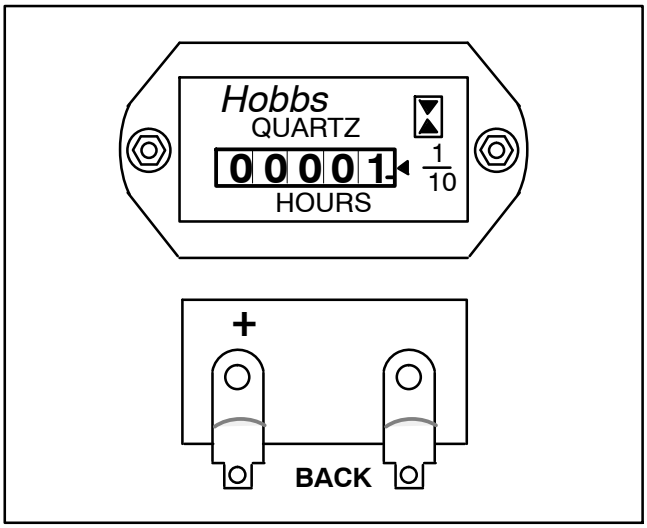

Figure 11

Seat Switch

The seat switch is normally open and closes when the operator is on the seat. If the functional control lever is moved out of neutral (neutral switch opens) and the operator raises out of the seat, the engine magneto will ground and the engine will stop. The switch and its electrical connector are located directly under the seat.

Testing

1. Make sure the engine and ignition switch is OFF.

2. Remove seat from the support assembly by removing four (4) lock nuts from the seat bolts.

3. Disconnect electrical connector from the seat switch.

4. Check the continuity of the switch by connecting a multimeter (ohms setting) across the connector terminals.

5. With no operator in the seat, there should be no continuity between the terminals.

6. Press directly onto the seat switch through the seat cushion. There should be continuity as the seat cushion approaches the bottom of its travel.

7. Connect switch electrical connector.

8. Secure seat to support assembly with removed fasteners.

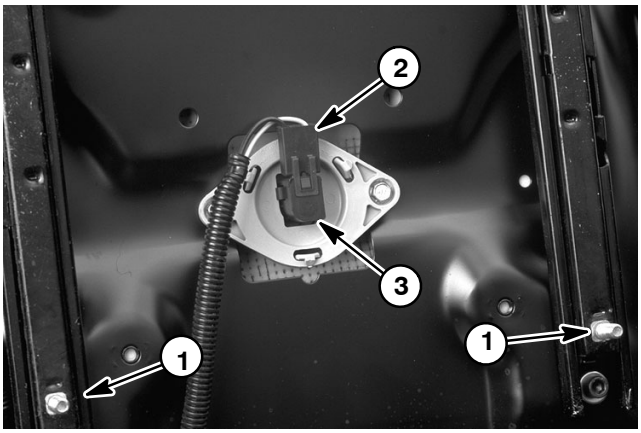

Figure 12

1. **Seat bolts**
2. **Electrical connector**
3. **Seat switch**

Safety Relays

Several safety relays are used on Greensmaster 3150 machines. The safety relays are identical, five (5) terminal relays that are used for circuit control.

Safety Relay Function

The start safety relay ensures that the functional control lever is in neutral before engine starting is allowed. The start relay is located under the control panel on the left side of the operator seat.

When energized, the kill relay provides a complete circuit to allow the starter solenoid to be energized. Also, when de−energized, the kill relay provides a ground for the engine magnetos which stops the engine. The kill relay is located under the control panel on the left side of the operator seat.

The charge circuit relay allows alternator output to reach the machine electrical circuits as long as the engine is running. The charge circuit relay is located under the operator seat.

When energized, the lower relay allows current flow to hydraulic solenoid coils S2 and S4 causing the cutting units to lower. The lower relay is located under the control panel on the left side of the operator seat.

The joystick relay allows cutting unit operation when energized by the joystick lower switch. The joystick relay is located under the control panel on the left side of the operator seat.

The mow relay allows the reel engage solenoid coil (S1R1) to be energized for cutting reel operation. The mow relay is located under the control panel on the left side of the operator seat.

When energized, the raise relay allows current flow to hydraulic solenoid coils S2 and S3 causing the cutting units to raise. The raise relay is located under the control panel on the left side of the operator seat.

When in backlap, the backlap relay prevents the cutting reels from being engaged during engine cranking. The backlap relay is located near the functional control lever.

NOTE: Refer to Circuit Diagrams in Chapter 9 – Foldout Drawings for additional relay operation information.

Relay Testing

1. Park machine on a level surface. Make sure the engine and ignition switch are OFF.

2. Locate relay that is to be tested.

3. Disconnect wire harness connector from relay that is to be tested. If desired, remove relay from machine for testing.

NOTE: Use illustration in Figure 13 to identify relay terminals.

4. Use a multimeter (ohms setting) to measure resistance between the following relay terminals:

   A. There should be continuity between terminals 87A and 30

   B. There should not be continuity between terminals 87 and 30.

   C. Resistance between terminals 86 and 85 (relay coil) should be from 80 to 90 ohms.

5. Connect multimeter (ohms setting) leads to relay terminals 30 and 87. Ground terminal 86 and apply +12 VDC to terminal 85. The relay should make and break continuity between terminals 30 and 87 as 12 VDC is applied and removed from terminal 85.

6. Disconnect voltage from terminal 85 and multimeter lead from terminal 87.

7. Connect multimeter (ohms setting) leads to relay terminals 30 and 87A. Apply +12 VDC to terminal 85. The relay should break and make continuity between terminals 30 and 87A as 12 VDC is applied and removed from terminal 85.

8. Disconnect ground, voltage and multimeter leads from relay terminals.

9. Replace relay if testing determines that relay is faulty.

10. When testing is complete, secure relay to machine if it was removed. Connect wire harness connector to relay.

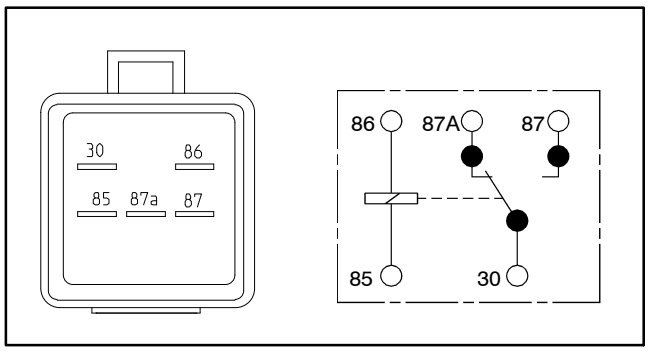

Figure 13

Neutral and Mow Switches

The neutral and mow switches are used to determine when the functional control lever is in the NEUTRAL or MOW position. These switches are identical and are normally open reed switches. They close when the actuator comes in close proximity to the switch. The switches are attached to the functional control lever bracket under the console panel (Fig. 14). The actuator is attached to the functional control lever.

Testing

1. Park machine on a level surface. Make sure the engine and ignition switch are OFF.

2. Remove console from right side of operator seat.

3. Disconnect electrical connectors to both switches. Check continuity of both switches by connecting a multimeter (ohms setting) across the connector terminals.

4. Place the functional control lever in the NEUTRAL position. The NEUTRAL switch should be closed (continuity) and the MOW switch should be open (Fig. 14).

5. Place the functional control lever in the MOW position. The NEUTRAL switch should be open and the MOW switch should be closed (continuity) (Fig. 14).

6. The distance between the sensing end of each switch and the traction bracket should be from 0.725 to 0.775 inch (18.4 to 19.7 mm) (Fig. 15).

7. To adjust or install actuator, place functional control lever in the NEUTRAL position. Position actuator in lever until the NEUTRAL switch just closes and then rotate actuator two (2) complete turns closer to the NEUTRAL switch.

8. When adjusting the switches or actuator, torque jam nuts from **40 to 60 in−lb (4.5 to 6.7 N−m)**.

9. After switch or actuator adjustment, check continuity of both switches and interlock operation (See Verify Interlock System Operation in the Service and Repairs section of this chapter). Readjust switch or actuator if necessary.

10. Install console to right side of operator seat.

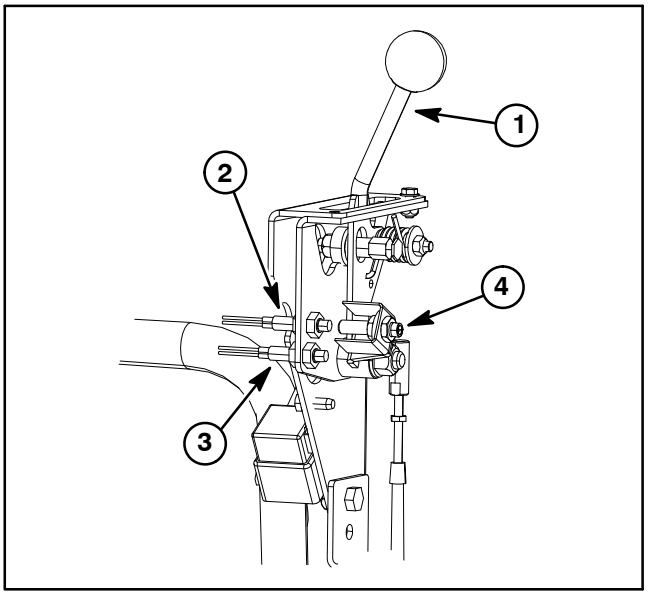

Figure 14

1. **Functional control lever**
2. **Mow switch**
3. **Neutral switch**
4. **Actuator**

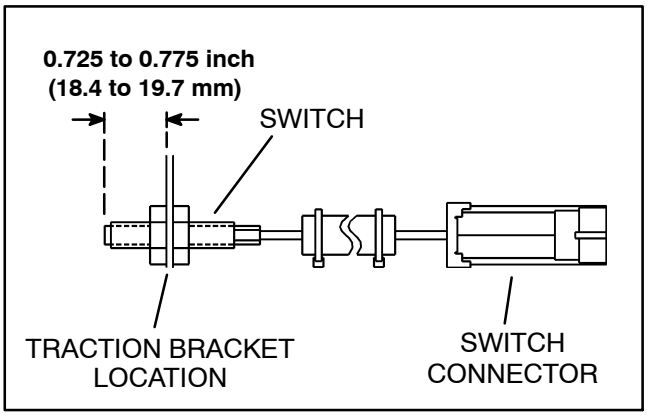

Figure 15

Parking Brake Sensor

The parking brake sensor is normally closed and opens when the operator sets the parking brake. If the functional control lever is moved out of neutral (neutral switch opens) and the parking brake is set, the engine magneto will ground and the engine will stop. The sensor and its electrical connector are located directly under the operator foot panel.

Testing

1. Park machine on a level surface. Make sure the engine and ignition switch are OFF. Set brake and block front wheels.

2. Disconnect electrical connector from the parking brake sensor.

3. Check the continuity of the sensor by connecting a multimeter (ohms setting) across the connector terminals.

4. With the parking brake set, there should be no continuity (open) across the sensor terminals.

5. Release the parking brake. There should be continuity (closed) across the sensor terminals.

6. Connect sensor electrical connector. Reset the parking brake.

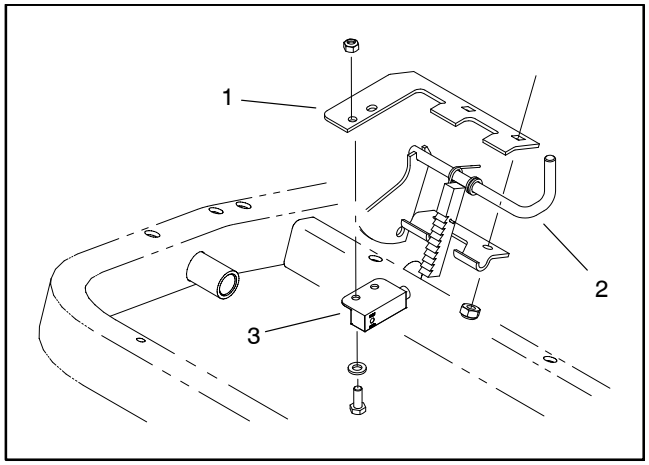

Figure 16

1. **Mounting plate**
2. **Latch assembly**
3. **Parking brake sensor**

Joystick Raise and Lower Switches

The joystick raise and lower switches are located on the lift control mechanism. The rear switch is used to lower the reels and the front switch to raise them (Fig. 17). The switches are identical and are shown in Figure 18.

Testing

1. Make sure the engine and ignition switch are OFF. Remove the plastic cover and disconnect the harness connectors from the joystick switches.

2. Check the continuity of the raise switch by connecting a multimeter (ohms setting) across the switch connector terminals as follows:

   A. With the joystick in the rest position, continuity should only exist between the common and NC terminals (blue and green/black wires).

   B. With the joystick in the raise position, continuity should only exist between the common and NO terminals (blue and green/gray wires).

3. Check the continuity of the lower switch by connecting a multimeter (ohms setting) across the switch connector terminals as follows:

   A. With the joystick in the rest position, continuity should only exist between the common and NC terminals (open terminal and green/black wires).

   B. With the joystick in the lower position, continuity should only exist between the common and NO terminals (green/black and gray/black wires).

4. After testing, connect the harness connectors to the joystick switches and reinstall the plastic cover.

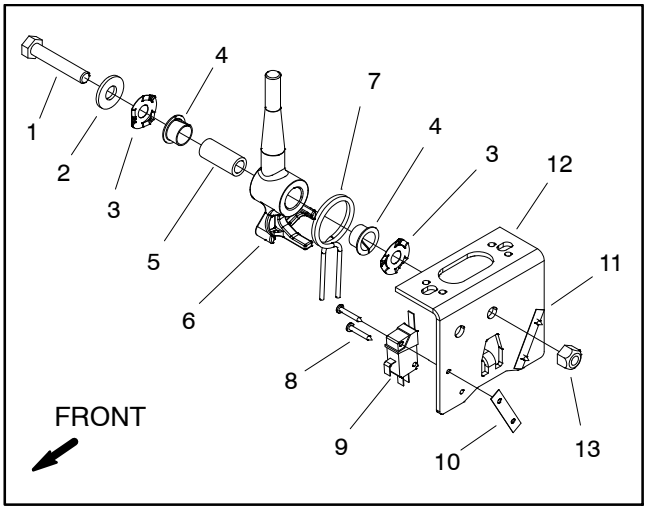

Figure 17

1. **Cap screw**
2. **Flat washer**
3. **Spring washer (2 used)**
4. **Bushing (2 used)**
5. **Spacer**
6. **Joystick**
7. **Spring**
8. **Screw (4 used)**
9. **Raise switch**
10. **Speed nut (2 used)**
11. **Lower switch**
12. **Joystick bracket**
13. **Lock nut**

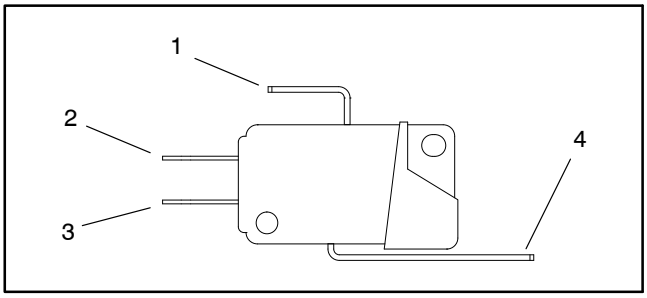

Figure 18

1. **Common terminal**
2. **NO terminal**
3. **NC terminal**
4. **Switch lever**

Lower Reels Time Delay

The lower reels time delay is a solid state timer used to energize the lower relay (K5) long enough to make sure that the cutting units will lower fully when the joystick is moved. When the lower relay is energized, hydraulic manifold solenoid valves S2 and S4 are energized causing the cutting unit lift cylinders to retract and lower the cutting units.

Upon the application of electrical power to the time delay, the load is energized and the time delay is started. After six (6) seconds the load is de−energized.

Testing

1. Park machine on a level surface. Make sure the engine and ignition switch are OFF.

2. Raise seat to allow access to lower reels time delay (Fig. 19).

3. Connect voltmeter across test load and test load to timer. Connect 12VDC source to timer and load. Make sure to observe polarity. After six (6) seconds, there should be no voltage across the load.

4. After testing is complete, disconnect timer from 12VDC source and test load.

5. Lower operator seat.

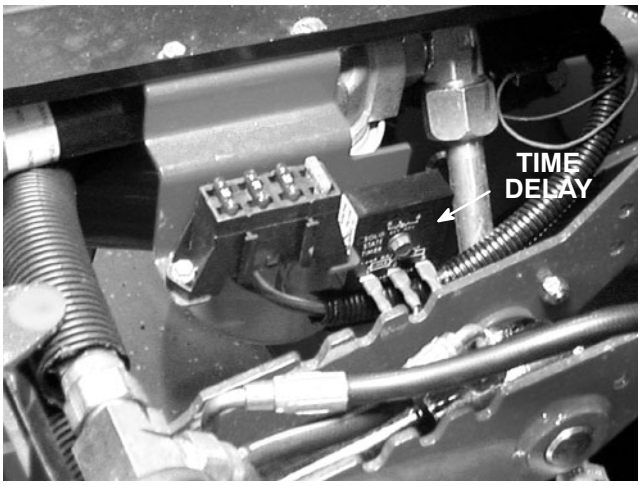

Figure 19

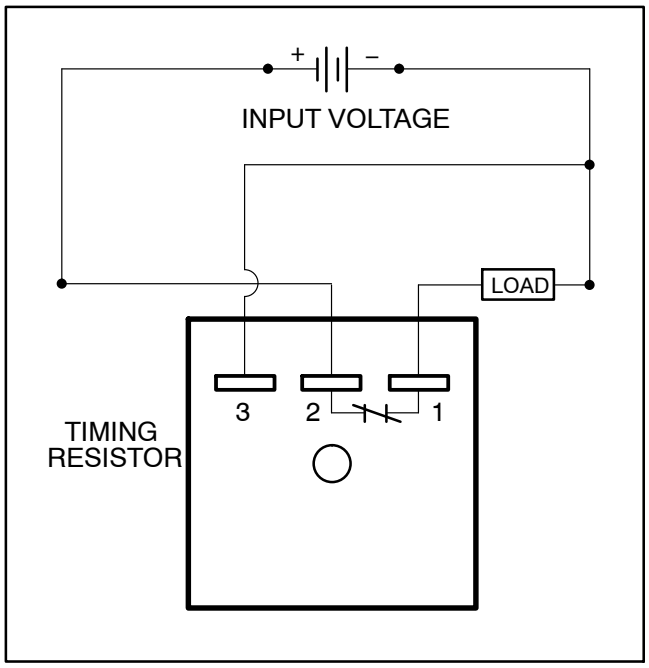

Figure 20

Starter Solenoid

The starter solenoid used on the Greensmaster 3150 allows current flow from the battery to the engine starter motor when energized. The starter solenoid is attached to the rear frame in front of the battery (Fig. 21).

Testing

1. Park machine on a level surface. Make sure the engine and ignition switch are OFF.

2. Disconnect negative (black) cable from battery and then disconnect positive (red) cable (see Battery Service in the Service and Repairs section of this chapter).

3. Note wire locations on starter solenoid for assembly purposes. Disconnect cables and wire harness connectors from solenoid.

NOTE: Prior to taking small resistance readings with a digital multimeter, short the meter 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 the measured value of the component you are testing.

4. Apply 12 VDC directly across the solenoid coil posts. The solenoid should click as the solenoid coil is energized. Make sure resistance across the main contact posts is less than **1 ohm**.

5. Remove voltage from solenoid coil posts. The solenoid should click as the solenoid coil is de−energized. Make sure resistance across the main contact posts is **infinite ohms**.

6. When testing is complete, secure cables and wire harness connections to solenoid. Torque nuts on solenoid coil posts from **15 to 20 in−lb (1.7 to 2.3 N−m)** and nuts on main contact posts from **50 to 60 in−lb (5.7 to 6.8 N−m)**.

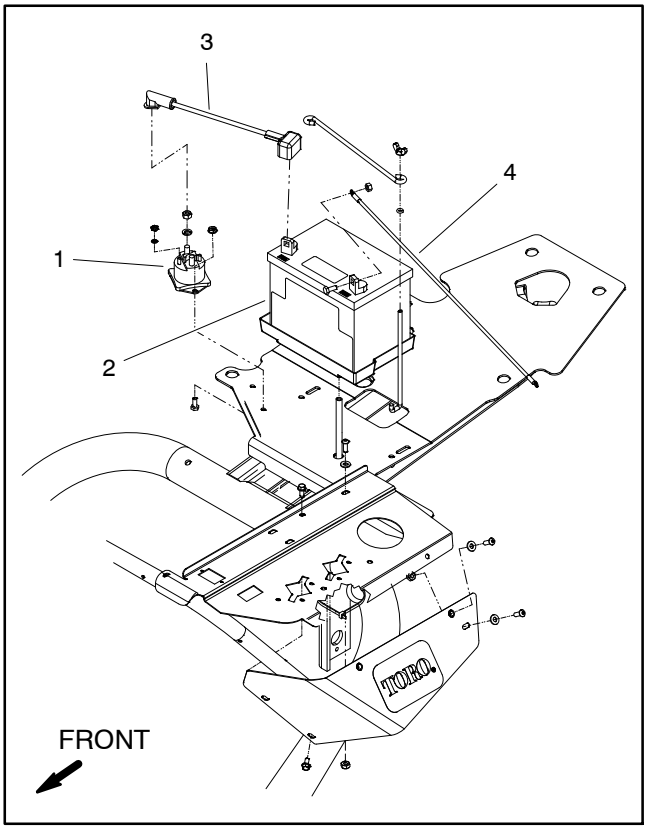

Figure 21

1. **Starter solenoid**
2. **Battery**
3. **Positive (+) cable**
4. **Negative (−) cable**

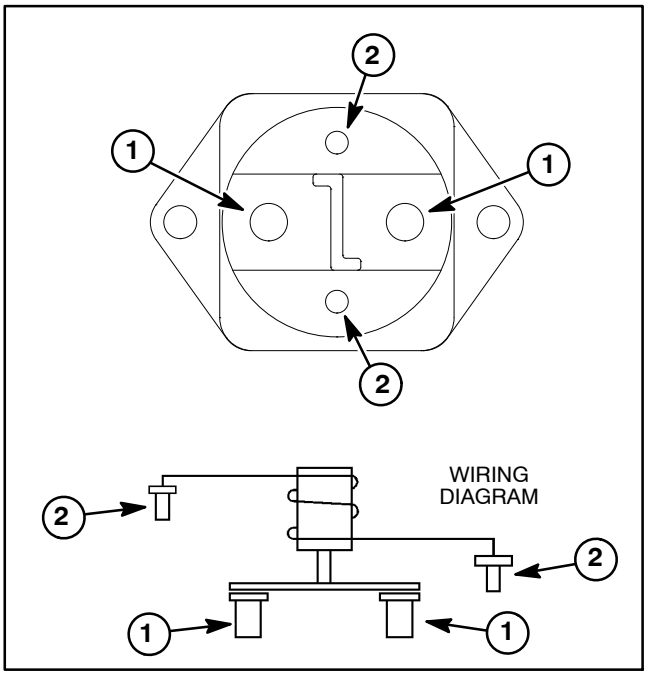

Figure 22

1. **Main contact post**
2. **Solenoid coil post**

Solenoid Valve Coils

The Greensmaster hydraulic control manifold uses several hydraulic solenoid valve coils for system control. When the solenoid coils are energized, hydraulic valve shift occurs to control hydraulic circuit flow. Testing of the coils can be done with the coil installed on the hydraulic valve.

Testing

1. Determine solenoid coil(s) that is to be tested and locate coil on hydraulic manifold (Fig. 23). Disconnect harness electrical connector from solenoid valve coil.

NOTE: Prior to taking small resistance readings with a digital multimeter, short the meter test leads together. The meter may 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 the measured value of the solenoid coil being testing.

NOTE: Solenoid coil resistance should be measured with solenoid at approximately 68°F (20°C). Resistance may be slightly different than listed at different temperatures. Typically, a failed solenoid coil will either be shorted (very low or no resistance) or open (infinite resistance).

2. Using a multimeter (ohms setting), measure resistance between the two (2) connector terminals on the solenoid valve coil. The resistance for the solenoid coils is identified below:

Solenoid Valve Coil	Resistance
S1R1 and S3	7.1 ohms
S2 and S4	8.6 ohms

3. If solenoid coil resistance is incorrect, replace solenoid coil (refer to control manifold service procedures in the Service and Repairs section of Chapter 4 – Hydraulic System).

NOTE: To assist in troubleshooting, identical solenoid valve coils can be exchanged. If the problem follows the exchanged coil, an electrical problem likely exists with the coil. If the problem remains unchanged, something other than the solenoid coil is the problem source (e.g. switch, circuit wiring, hydraulic problem). The control manifold S1R1 coil is the same as the manifold S3 coil. The manifold S2 and S4 coils are identical.

4. After coil testing is completed, connect wire harness electrical connector to the solenoid valve coil.

5. Secure all machine components that were removed to access hydraulic manifold.

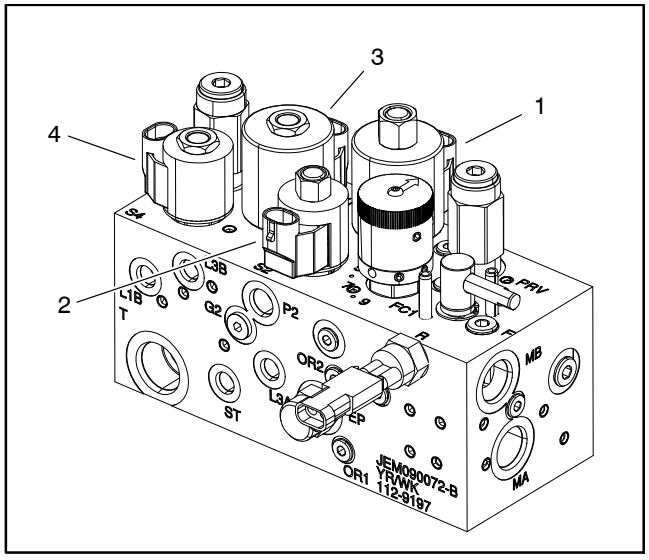

Figure 23

1. **Solenoid S1R1 (7.1 ohm)**
2. **Solenoid S2 (8.6 ohm)**
3. **Solenoid S3 (7.1 ohm)**
4. **Solenoid S4 (8.6 ohm)**

Backlap Switch

The backlap switch is a normally open ball switch that is in the normal, open state when the backlap lever is in the mow position. When the backlap lever is in the backlap position, the switch closes. The backlap switch is attached to the front of the hydraulic control manifold located under the operator seat (Fig. 24).

Testing

1. Park machine on a level surface. Make sure the engine and ignition switch are OFF.

2. Raise operator seat to allow access to hydraulic control manifold. Locate the backlap switch on the front of the manifold. Disconnect the wire harness electrical connector from the backlap switch.

3. Check the continuity of the switch by connecting a multimeter (ohms setting) across the switch connector terminals.

4. With the ignition switch in the OFF position, turn the backlap lever to the backlap position while watching the multimeter. Continuity should be made as the switch closes.

5. Turn the backlap lever to the mow position while watching the multimeter. Continuity should be broken as the switch opens.

6. If the backlap switch is faulty, replace switch. Make sure that dowel and ball are placed in the manifold port before installing new switch in manifold. Torque switch to **20 ft–lb (27 N–m)**.

7. If the backlap switch tests correctly and a circuit problem still exists, check wire harness (see Electrical Schematic and Wire Harness Drawings in Chapter 9 – Foldout Drawings).

8. After testing is completed, connect wire harness electrical connector to the backlap switch. Lower operator seat.

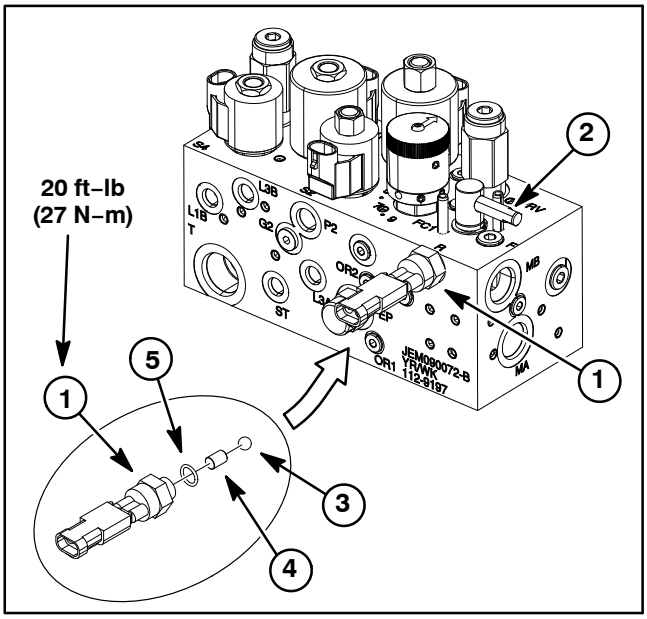

Figure 24

1. **Backlap switch**
2. **Backlap lever**
3. **Ball**
4. **Dowel**
5. **O–ring**

Diodes

The main wiring harness contains six (6) diodes. Diodes D2 and D3 are connected to the harness at separate locations. Diodes D1−A, D1−B, D1−C and D1−D are connected to the main harness by a four (4) position circuit board located near the front of the left side control panel. The diodes are used for circuit protection from inductive voltage spikes and for safety circuit logic.

Apply dielectric grease (Toro part number 107−0342) to circuit board contacts whenever the circuit board is installed into the wire harness.

Diode D1−A

Allows the engine to start only with the functional control lever in NEUTRAL (neutral switch closed). Also, it allows the engine to continue to run with either the functional control lever in NEUTRAL (neutral switch closed) or the operator sitting in the seat (seat switch closed).

Diode D1−B

Prevents a negative spike from damaging the neutral switch and seat switch by allowing a ground path for the start safety relay (K2) when it de−energizes.

Diode D1−C

Maintains current flow to the joystick relay (K3) after the momentary lower switch of the joystick opens.

Diode D1−D

Prevents a negative spike from damaging the mow and backlap switches by allowing a ground path for the mow relay (K4) when it de−energizes.

Diode D2

This diode prevents current flow to solenoid S4 when solenoids S2 and S3 are energized through raise relay (K6).

Diode D3

This diode prevents current flow to solenoid S3 when solenoids S2 and S4 are energized through lower relay (K5).

Testing

The diodes can be individually tested using a digital multimeter (ohms setting) and the table to the right.

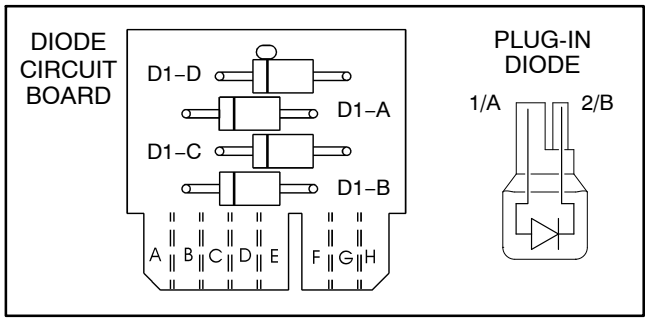

Figure 25

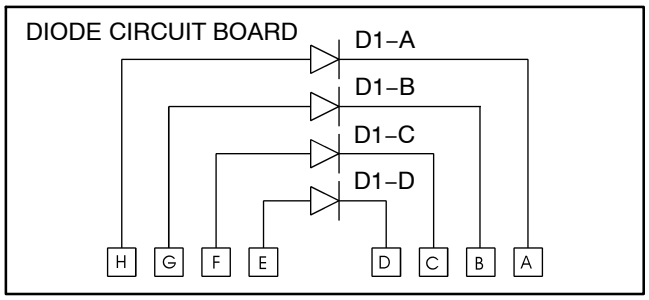

Figure 26

Type	Red (+)	Black (–)	Continuity
Circuit Board	H	A	YES
	A	H	NO
	G	B	YES
	B	G	NO
	F	C	YES
	C	F	NO
	E	D	YES
	D	E	NO
Plug-In	1/A	2/B	YES
	2/B	1/A	NO

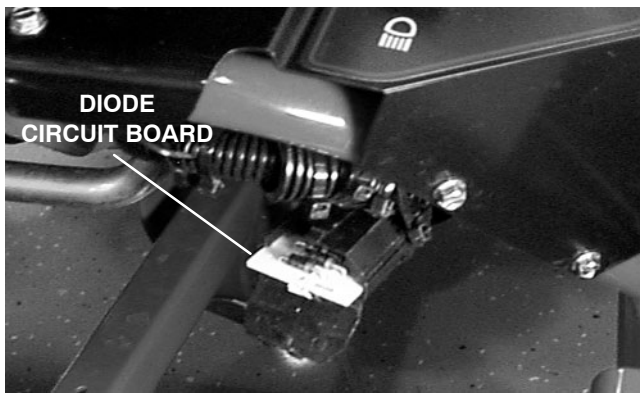

Figure 27

Fusible Links

The electrical system on Greensmaster 3150 machines includes two (2) fusible links for machine circuit protection.

One of these fusible links is included in the main wire harness. This fusible link and the positive (+) battery cable attach to one of the starter solenoid main contact posts. The second fusible link is included in the engine wire harness. This fusible link connects to the output lead at the regulator/rectifier.

If either of these links should fail, current to the protected circuit will cease. Refer to the electrical schematic and wire harness drawings in Chapter 9 – Foldout Drawings for additional circuit information.

Testing

Make sure that ignition switch is OFF. Disconnect negative (–) battery cable from battery terminal and then disconnect positive (+) cable from battery (see Battery Service in the Service and Repairs section of this chapter). Locate fusible link in wire harness. Use a multimeter to make sure that continuity exists across the fusible link. If a fusible link is open, replace the fusible link.

After testing is complete, make sure that all wire harness connectors are secured. Connect positive (+) battery cable to battery terminal first and then connect negative (–) cable to battery.

Leak Detector Test/Light Switch

The leak detector test/light switch is used to perform two machine functions. When the switch is pressed to the rearward, momentary position, the leak detector alarm can be tested. The switch is also used to operate the optional lights by pressing the front of the switch. The leak detector test/light switch is located on the control panel (Fig. 28).

Testing

1. Park machine on a level surface. Make sure the engine and ignition switch are OFF.

2. Remove control panel shield to gain access to leak detector test/light switch.

3. Make sure ignition switch is in the OFF position. Disconnect machine wire harness electrical connector from the switch.

4. The leak detector test/light switch terminals are identified in Figure 29 and the circuitry of the switch is shown in Figure 30. 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 switch position. Verify continuity between switch terminals.

5. Replace leak detector test/light switch if testing determines that it is faulty.

6. If the leak detector test/light switch tests correctly and a circuit problem still exists, check wire harness (see Electrical Schematics and Wire Harness Drawings in Chapter 9 – Foldout Drawings).

7. After testing is complete, connect machine wire harness connector to leak detector test/light switch. Secure control panel shield to machine with removed fasteners.

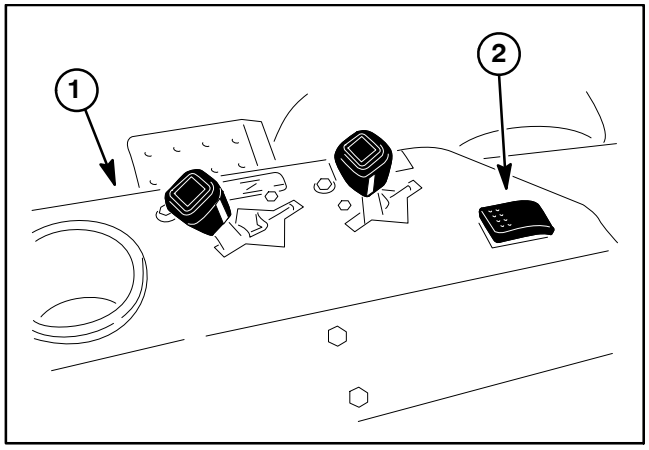

Figure 28

1. **Control panel**
2. **Leak test/light switch**

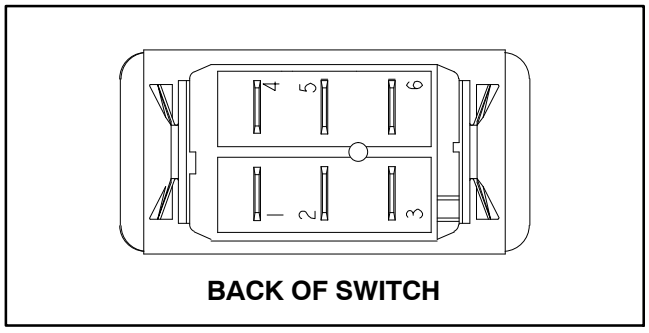

Figure 29

SWITCH POSITION	NORMAL CIRCUITS	OTHER CIRCUITS
RAISE	2 + 1	5 + 4
OFF	NONE	NONE
LOWER	2 + 3	5 + 6

Figure 30

Leak Detector Alarm and Delay Timer

The leak detector alarm is used to notify the operator that a hydraulic leak has occurred. To prevent the leak detector system from sounding false alarms during normal operation, the alarm circuit includes a one (1) second delay timer.

NOTE: For information on leak detector operation refer to Turf Guardian™ Leak Detector System Operation in this chapter.

Testing

1. Park machine on a level surface. Make sure the engine and ignition switch are OFF.

2. Turn ignition switch to the RUN position (do not start the engine), then move leak detector test switch rearward and hold. After a one (1) second time delay, the alarm should sound.

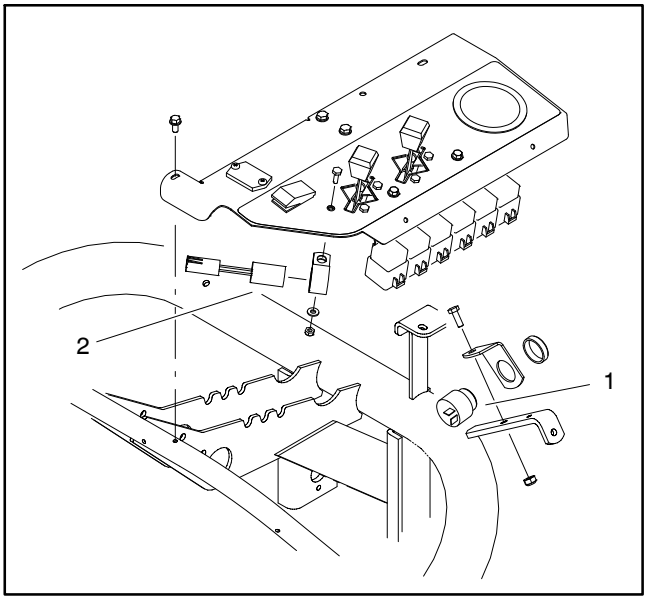

Figure 31

1. **Alarm**
2. **Delay timer**

Leak Detector Float Sensor

The leak detector float sensor closely monitors the hydraulic fluid level in the main hydraulic tank. The sensor contacts are open when the float is in the raised position and oil level in the hydraulic tank is correct. The sensor closes when the float is in the lowered position caused by a low oil level and potential oil leak.

NOTE: For information on leak detector operation refer to Turf Guardian™ Leak Detector System Operation in this chapter.

Testing

1. If the float sensor is connected to the main harness, remove hydraulic tank cap and screen from filler neck of hydraulic tank. Turn ignition switch to the RUN position (do not start the engine). Insert a clean rod or screw driver into filler neck and gently push down on sensor float (Fig. 33). Alarm should sound after a one (1) second time delay.

2. If the float sensor is removed or disconnected from the main harness, connect a continuity tester across the float sensor wire terminals. There should be continuity across the terminals only when the float is pushed down. There should be no continuity across the terminals when the float is in the raised position.

3. If oil level sensor was removed from reservoir, install oil level sensor into reservoir making sure that arrow on sensor is pointing down (Fig. 34). Torque sensor nut from **110 to 140 in−lb (12.5 to 15.8 N−m)**.

4. After testing, make sure that hydraulic oil level in reservoir is correct.

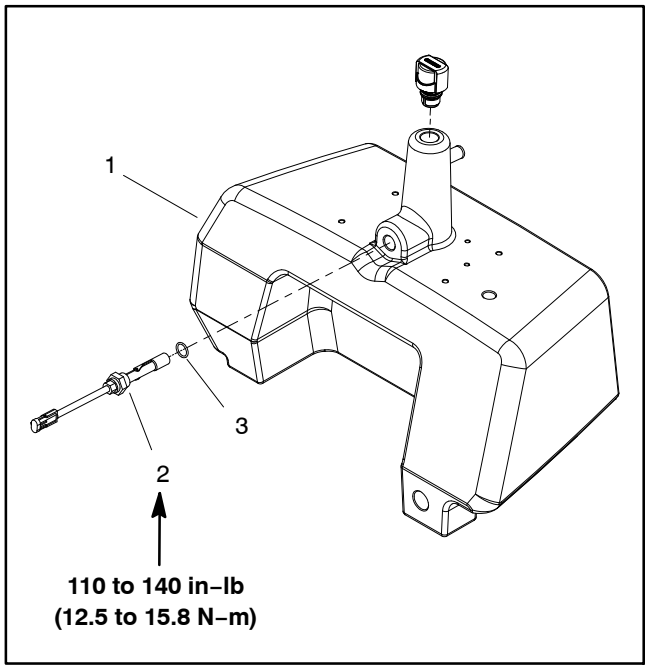

Figure 32

1. **Main hydraulic tank**
2. **Float sensor**
3. **O−ring**

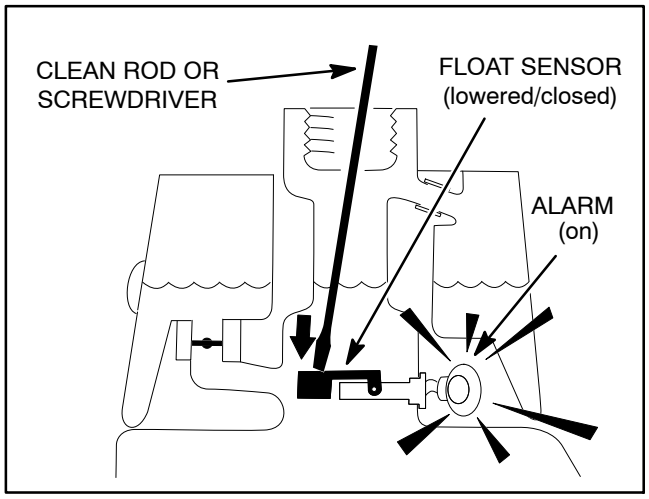

Figure 33

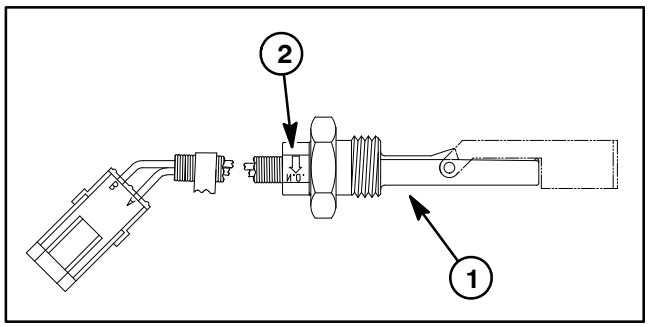

Figure 34

1. **Oil level sensor**
2. **Sensor arrow**

Leak Detector Solenoid Valve

The leak detector solenoid valve is a normally open valve that allows hydraulic fluid to flow from the auxiliary tank to the main hydraulic tank while the ignition is OFF. This feature fills the main hydraulic tank with fluid from the auxiliary tank prior to starting the machine. The valve closes when the ignition switch is in the RUN position and during machine operation.

NOTE: For information on leak detector operation refer to Turf Guardian™ Leak Detector System Operation in this chapter.

Testing

1. Disconnect the wiring connector at the valve solenoid.

2. Connect 12VDC power across the solenoid terminals. The valve spool should retract completely.

3. If valve does not retract smoothly or does not retract completely, replace the valve.

4. To check the solenoid valve supply power, turn the ignition switch to the RUN position (do not start the engine). Use a multimeter to make sure that the solenoid valve wire harness connector has 12 volts present.

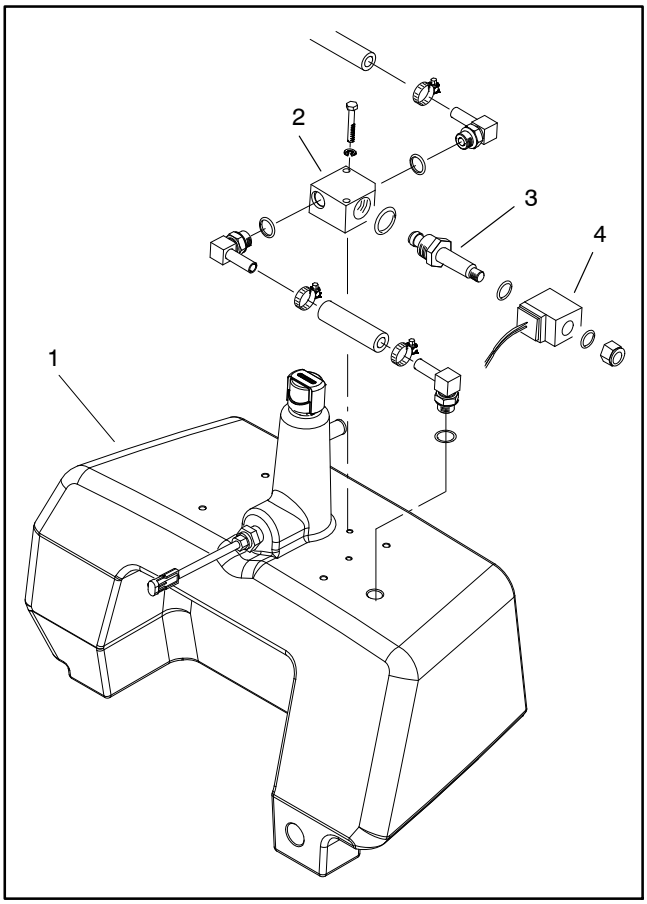

Figure 35

1. **Main hydraulic tank**
2. **Valve body**
3. **Valve spool**
4. **Solenoid**

Verify Interlock System Operation

CAUTION

The interlock switches are for the operator's protection; do not disconnect them. Check the operation of the switches daily to assure the interlock system is operating. If a switch is defective, replace it before operating the machine.

The purposes of the interlock switches are to:

A. Prevent the engine from cranking or starting unless the functional control lever is in NEUTRAL.

B. Prevent operating the traction pedal with the functional control lever in NEUTRAL.

C. Shut off the engine if the operator leaves the seat without the functional control lever in NEUTRAL.

D. Shut off the reels if the functional control lever is moved to NEUTRAL or TRANSPORT.

1. Sit on the seat, engage parking brake and move functional control lever to NEUTRAL. Try to depress traction pedal. If the pedal does not depress, the interlock system is operating correctly. Correct problem if not operating properly.

2. Sit on the seat, engage parking brake, keep traction pedal in neutral and place functional control lever in MOW or TRANSPORT. Try to start the engine. If the engine does not crank, the interlock system is operating correctly. Correct problem if not operating properly.

3. Sit on the seat and start engine. Move functional control lever to MOW. Raise off the seat. If the engine stops, the interlock system is operating correctly. Correct problem if not operating properly.

4. Sit on the seat and start engine. Move functional control lever to TRANSPORT. Raise off the seat. If the engine stops, the interlock system is operating correctly. Correct problem if not operating properly.

5. Sit on the seat, engage parking brake, keep traction pedal in neutral and place functional control lever in NEUTRAL. Start the engine. Move Raise / Lower – Mow Control Lever forward to lower the cutting units. If the units do not start rotating, the interlock system is operating correctly. Correct problem if not operating properly.

6. Sit on the seat and set the parking brake. Start the engine and move the functional control lever to MOW. If the engine stops, the interlock system is operating correctly. Correct problem if not operating properly.

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 discharge 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 battery 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.

2. Keep top of battery clean by washing periodically with a brush dipped in baking soda (sodium bicarbonate) solution. Flush top surface with water after cleaning. Do not remove the fill caps while cleaning.

3. Battery cables must be tight on battery terminals to provide good electrical contact.

WARNING

Connecting battery cables to the wrong battery post could result in personal injury and/or damage to the electrical system.

4. If corrosion occurs at battery terminals, disconnect battery cables. Always disconnect negative (–) cable first. Clean cable clamps and terminals separately. Reconnect battery cables with positive (+) cable first. Coat terminals with battery terminal protector (see Special Tools in this chapter) or a light coat of grease to reduce corrosion after connections are made.

5. Check battery electrolyte level every twenty five (25) operating hours and every thirty (30) days if machine is in storage.

6. Maintain battery cell level with distilled or demineralized water. Do not fill cells above the fill line.

Battery Storage

If the machine will be stored for more than thirty (30) days:

1. Make sure ignition switch is in the OFF position. Remove the battery and charge it fully (see Battery Service in this section).

2. Either store battery on a shelf or on the machine. Leave cables disconnected if the battery is stored on the machine.

3. Store battery in a cool atmosphere to avoid quick deterioration of the battery charge.

4. To help prevent the battery from freezing during storage, make sure it is fully charged (see Battery Service in this section).

Battery Service

The battery is the heart of the electrical system. With regular and proper service, battery life can be extended. Additionally, battery and electrical component failure can be prevented.

Battery Specifications

BCI Group Size U1
300 Amp Cranking Performance at 0ºF (–18ºC)
28 Minute Reserve Capacity at 80ºF (27ºC)
Electrolyte Specific Gravity (fully charged): from 1.250 to 1.280
Electrolyte Specific Gravity (discharged): 1.240

CAUTION

When working with batteries, use extreme caution to avoid splashing or spilling electrolyte. Electrolyte can destroy clothing and burn skin or eyes. Always wear safety goggles and a face shield when working with batteries.

Battery Removal (Fig. 36)

IMPORTANT: Be careful to not damage terminal posts or cable connectors when removing the battery cables.

1. Disconnect the ground cable (–) first to prevent short circuiting the battery, other components or the operators hands. Then, disconnect the positive (+) cable.

2. Remove two (2) wing nuts and battery hold down rod.

3. Make sure that the battery filler caps are on tightly.

4. Remove battery from the battery compartment to a service area. This will minimize possible battery damage and allow better access for inspection and service.

Battery Installation (Fig. 36)

IMPORTANT: To prevent possible electrical problems, install only a fully charged battery.

1. Make sure the ignition switch and all accessories are off.

2. Make sure the battery compartment is clean and repainted if necessary.

3. Make sure battery cables and battery retainer are in good condition.

4. Place the battery into battery tray. Make sure battery is level and flat. Push the positive (+) cable connector onto positive battery post. Do not hammer as this will damage the battery. Tighten cable clamp fasteners with two (2) wrenches.

5. Install and secure battery hold down rod with two (2) wing nuts. Do not overtighten to prevent cracking or distorting the battery case.

6. Connect a digital multimeter (set to amps) between the negative battery post and the negative (–) 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.

7. Connect the negative (ground) cable connector to the negative battery post. Tighten cable clamp fasteners with two (2) wrenches.

8. Coat terminals with battery terminal protector (see Special Tools in this chapter) or a light coat of grease to reduce corrosion after connections are made.

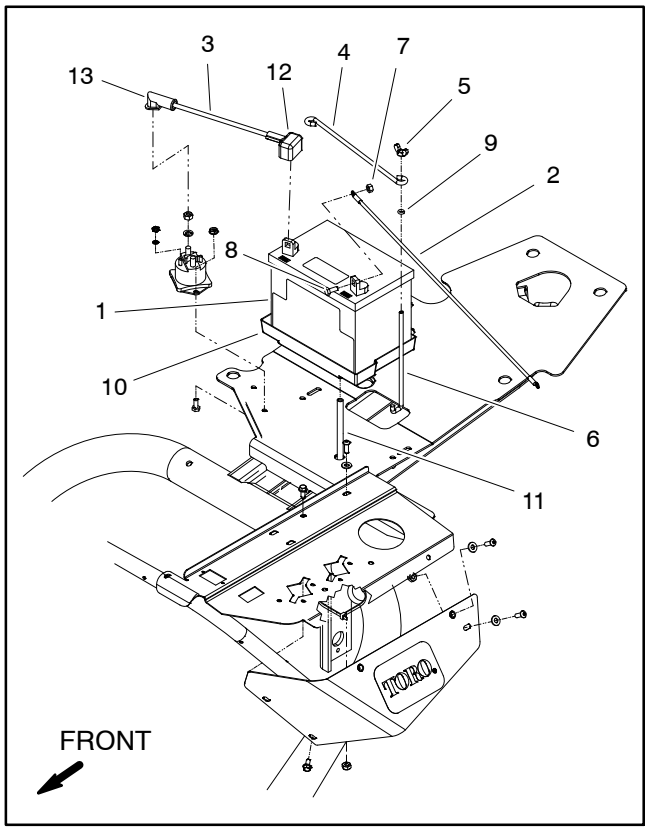

Figure 36

1. **Battery**
2. **Negative (–) cable**
3. **Positive (+) cable**
4. **Hold down rod**
5. **Wing nut (2 used)**
6. **Battery post (2 used)**
7. **Hex nut (2 used)**
8. **Cap screw (2 used)**
9. **O–ring (2 used)**
10. **Battery tray**
11. **Drain tube**

Battery Inspection and Maintenance

1. Check for cracks caused by overly tight or loose hold down rod. Replace battery if cracked or leaking.

2. Check battery terminal posts for corrosion. Use a terminal brush or steel wool to clean corrosion from the battery terminal posts.

IMPORTANT: Before cleaning the battery, tape or block the vent holes to the filler caps and make sure the caps are on tightly.

3. 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. Clean the battery with a solution of baking soda and water, then rinse it with clean water.

IMPORTANT: Make sure the area around the cells is clean before opening the battery caps.

4. Check the electrolyte level in each cell. If necessary, fill all cells with distilled water to the bottom of the cap tubes. Charge at 15 to 25 amps for fifteen (15) minutes to allow sufficient mixing of the electrolyte.

Battery Testing

1. 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 10ºF (6ºC) above 80ºF (27ºC) add 0.004 to the specific gravity reading. For each 10ºF (6ºC) below 80ºF (27ºC) subtract 0.004 from the specific gravity reading.

Example:	Cell Temperature 100ºF	
	Cell Gravity	1.245
	ADD (20º above 80ºF)	0.008
	Correction to 80ºF	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 (see Battery Charging below) or until the specific gravity of all cells 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.

2. 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 12.0 VDC, recharge the battery.

B. If the battery has been charged, apply a 150 amp load for fifteen (15) seconds to remove the surface charge. Use a battery load tester following the manufacturer's instructions.

C. Make sure the 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 instructions. Connect a digital multimeter to the battery terminals.

F. Apply a test load of 270 amps (one half the battery Cranking Performance Specification) to the battery for fifteen (15) seconds.

G. Take a battery voltage reading at fifteen (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	70ºF (and up)	21ºC (and up)
9.5	60ºF	16ºC
9.4	50ºF	10ºC
9.3	40ºF	4ºC
9.1	30ºF	–1ºC
8.9	20ºF	–7ºC
8.7	10ºF	–12ºC
8.5	0ºF	–18ºC

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.

Battery 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 60ºF (15ºC) 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 125ºF (52ºC) or the electrolyte is violently gassing or spewing, the charging rate must be lowered or temporarily stopped.

6. Three (3) 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 (3) consecutive readings.

Chapter 6

Chassis

Table of Contents

Specifications

Item	Description
Front tire pressure (18 x 9.50 x 8, 2 ply)	8 to 12 PSI (55 to 83 kPa)
Rear tire pressure (18 x 9.50 x 8, 2 ply)	8 to 15 PSI (55 to 103 kPa)
Wheel lug nut torque	70 to 90 ft–lb (95 to 122 N–m)

General Information

Operator's Manual

The Operator's Manual provides information regarding the operation, general maintenance and maintenance intervals for your Greensmaster 3150. Refer to that publication for additional information when servicing the machine.

Special Tools

Order this special tool from your Toro Distributor.

Wheel Hub Puller

The wheel hub puller allows safe removal of the wheel hub from the shaft of wheel motors.

Toro part number: **TOR4097**

Figure 1

Front Wheel and Brakes

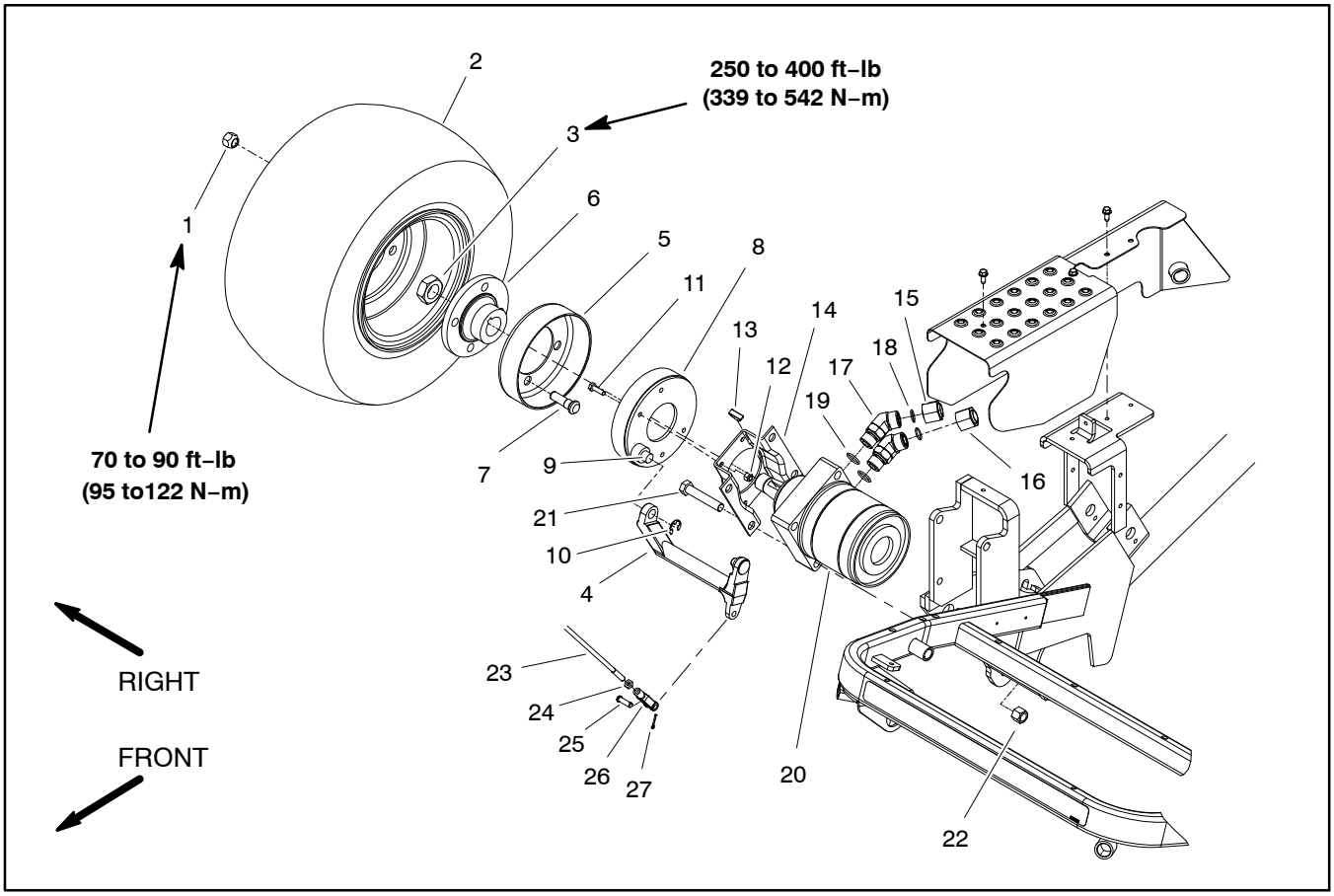

Figure 2

1. Lug nut (4 per wheel)
2. Wheel assembly
3. Lock nut
4. Brake lever
5. Brake drum
6. Wheel hub
7. Drive stud (4 per hub)
8. Brake assembly
9. Brake cam
10. Retaining ring
11. Cap screw (4 per brake)
12. Lock nut (4 per brake)
13. Woodruff key
14. Brake bracket
15. Hydraulic hose
16. Hydraulic hose
17. 45º Hydraulic fitting (2 per motor)
18. O–ring
19. O–ring
20. Hydraulic motor
21. Cap screw (4 per motor)
22. Lock nut (4 per motor)
23. Brake rod
24. Jam nut
25. Clevis pin
26. Swivel clevis
27. Cotter pin

Removal (Fig. 2)

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

2. Loosen, but do not remove, lug nuts (item 1) and lock nut (item 3). Loosen lock nut at least two (2) turns.

3. Chock front and rear of wheels not being lifted to prevent the machine from moving. Lift front wheel off the ground using a jack and place appropriate jackstands beneath the frame to support the raised machine (see Jacking Instructions in Chapter 1 – Safety).

4. Remove lug nuts and wheel assembly from drive studs.

IMPORTANT: DO NOT hit wheel hub (item 6) with a hammer during removal or installation. Hammering may cause damage to the hydraulic wheel motor.

NOTE: The brake drum assembly consists of the wheel hub (item 6), brake drum (item 5) and drive studs (item 7).

5. Make sure that lock nut (item 3) on wheel motor shaft is loosened at least two (2) turns. Use hub puller (see Special Tools in this chapter) to loosen brake drum assembly from wheel motor.

6. Remove lock nut and brake drum assembly. Locate and retrieve woodruff key (item 13).

7. Remove return springs from brake shoes (Fig. 3). Remove brake shoes from backing plate.

8. Remove brake backing plate to machine if necessary:

A. Remove retaining clip (item 10) from the brake cam (item 9). Separate brake lever (item 4) from brake cam.

B. Remove four (4) cap screws (item 11), lock nuts (item 12) and brake backing plate from the brake bracket (item 14).

9. Brake parts should be clean and free of rust. Inspect contact surfaces of brake shoes and brake drum for excessive wear. Replace any worn or damaged parts.

10. If wheel hub (item 6), brake drum (item 5) or drive studs (item 7) need replacement, press four (4) drive studs from wheel hub and separate hub from brake drum.

Installation (Figs. 2 and 3)

1. If wheel hub was separated from brake drum, position hub to drum and secure by pressing four (4) drive studs through hub. Make sure that studs are pressed fully into hub.

2. If brake backing plate was removed from machine:

A. Secure backing plate to the brake bracket (item 14) with four (4) cap screws (item 11) and lock nuts (item 12).

B. Install brake cam into backing plate if it was removed.

C. Apply antiseize lubricant to spline area of brake cam. Slide brake lever (item 4) onto brake cam and secure with retaining clip (10). Make sure that brake lever pivot is inserted into machine frame during assembly.

3. Position both brake shoes on the backing plate (Fig. 3). Insert return springs into the holes of both brake shoes.

4. Make sure that wheel hub bore and wheel motor shaft are thoroughly cleaned. Install woodruff key (item 13) to the wheel motor shaft. Slide brake drum assembly over shaft and key.

5. Secure brake drum assembly to motor shaft with lock nut (item 3).

6. Install front wheel and secure with four (4) lug nuts. Tighten lug nuts evenly in a crossing pattern.

WARNING

Failure to maintain proper wheel lug nut and wheel hub lock nut torque could result in failure or loss of wheel and may result in personal injury.

7. Lower machine to ground. Torque lock nut from **250 to 400 ft−lb (339 to 542 N−m)** and wheel lug nuts from **70 to 90 ft−lb (95 to 122 N−m)**.

8. Check and adjust brakes.

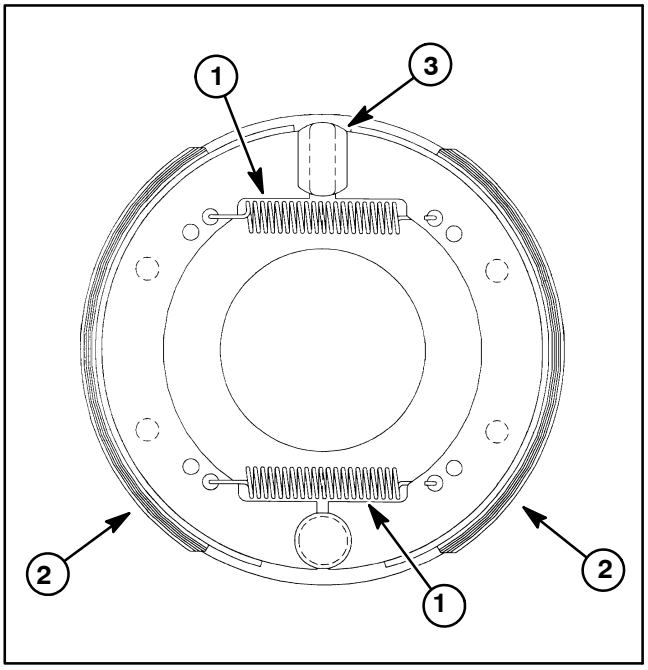

Figure 3

1. **Return spring**
2. **Brake shoe**
3. **Brake cam**

Rear Wheel (2WD)

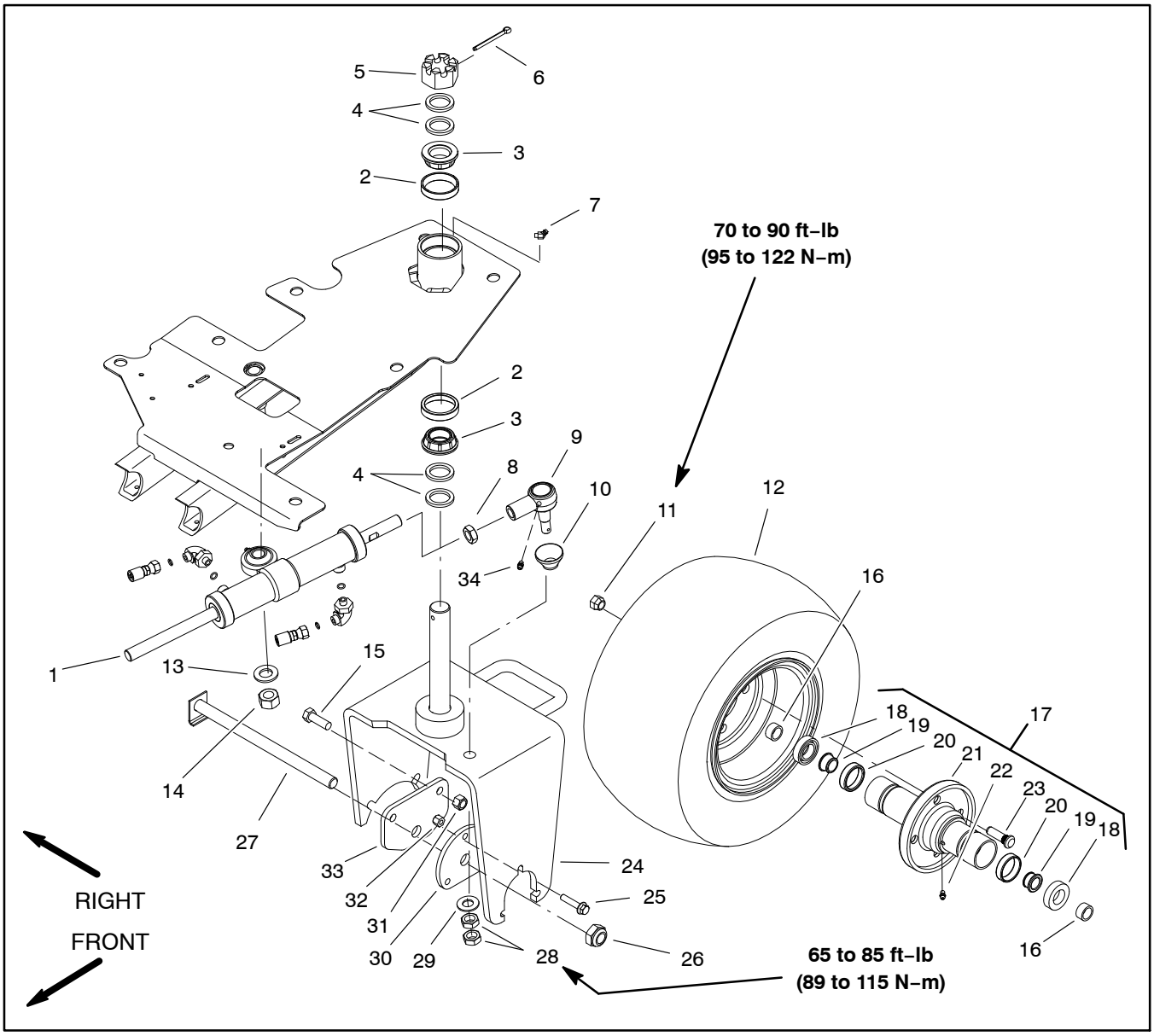

Figure 4

1. Steering cylinder
2. Bearing cup (2 used)
3. Bearing cone (2 used)
4. Washer (4 used)
5. Slotted hex nut
6. Cotter pin
7. Grease fitting
8. Jam nut
9. Rod end
10. Dust seal
11. Lug nut (4 used)
12. Wheel assembly
13. Washer
14. Lock nut
15. Cap screw (2 used)
16. Spacer (2 used)
17. Hub assembly
18. Seal (2 used)
19. Bearing cone (2 used)
20. Bearing cup (2 used)
21. Hub
22. Grease fitting
23. Drive stud (4 used)
24. Castor fork
25. Flange head screw (3 used)
26. Lock nut
27. Castor bolt
28. Jam nut (2 used)
29. Flat washer
30. Adapter plate
31. Lock nut (2 used)
32. Lock nut (3 used)
33. Motor adapter plate
34. Grease fitting

Removal (Fig. 4)

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

2. Chock both front wheels to prevent the machine from moving.

3. Use a jack or hoist to lift rear wheel off the ground and then place appropriate jackstands beneath the frame to support the raised machine.

4. Remove lock nut (item 26) from castor bolt (item 27). Pull bolt from both adapter plates (items 30 and 33), two (2) rear spindle spacers (item 16) and the wheel and hub assembly.

5. Remove wheel and hub assembly from the castor fork.

6. If necessary, remove four (4) lug nuts (item 11) from the drive studs (item 23). Separate wheel and hub assemblies.

NOTE: If castor fork removal is necessary, see Rear Castor Fork in this section.

Wheel Hub Disassembly (Fig. 5)

NOTE: The wheel hub assembly consists of the wheel hub, oil seals, bearing cones, bearing cups, grease fitting and drive studs (Fig. 5).

1. If drive studs are bent or damaged, press studs from the wheel hub.

2. Pull oil seals, bearing cones and bearing cups from the wheel hub.

Wheel Hub Assembly (Fig. 5)

1. Press new bearing cups into the wheel hub with the thick edges towards the inside.

2. Pack new bearing cones with #2 multi−purpose lithium base grease.

3. Install new bearing cones into the wheel hub. Press new oil seals into the hub with the lip of the seals facing towards the inside.

4. If removed, press new drive studs into the wheel hub fully to the shoulder of the stud flange.

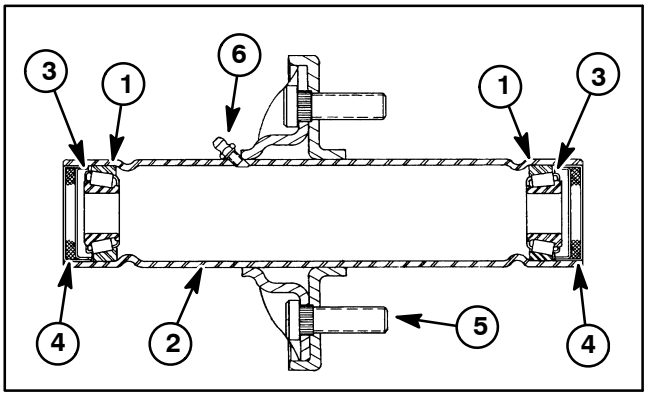

Figure 5

1. **Bearing cup (2 used)**
2. **Wheel hub**
3. **Bearing cone (2 used)**
4. **Shaft seal (2 used)**
5. **Drive stud (4 used)**
6. **Grease fitting**

Installation (Fig. 4)

1. If wheel was removed from hub, slide wheel assembly onto the drive studs. Secure wheel to wheel hub assembly with four (4) lug nuts (item 11). Torque lug nuts evenly in a crossing pattern to a torque from **70 to 90 ft−lb (95 to 122 N−m)**.

2. Install wheel and hub assembly into the castor fork. Insert castor bolt (item 27) into motor adapter plate (item 33) mounting hole. Install a spindle spacer (item 16) and slide bolt through the wheel and hub assembly.

3. Install second spindle spacer onto the bolt. Route the bolt through the adapter plate (item 30) mounting hole.

4. Position bent lip of the bolt head under the bottom edge of the motor adapter plate. Install and tighten lock nut (item 26) to secure wheel to the castor fork. Do not overtighten lock nut, the wheel must rotate freely.

5. Lower machine to ground.

6. Clean grease fitting (item 22) on hub. Pump grease into hub until grease is seen exiting at both hub seals (item 18). Wipe up excess grease.

Rear Wheel (Optional 3WD)

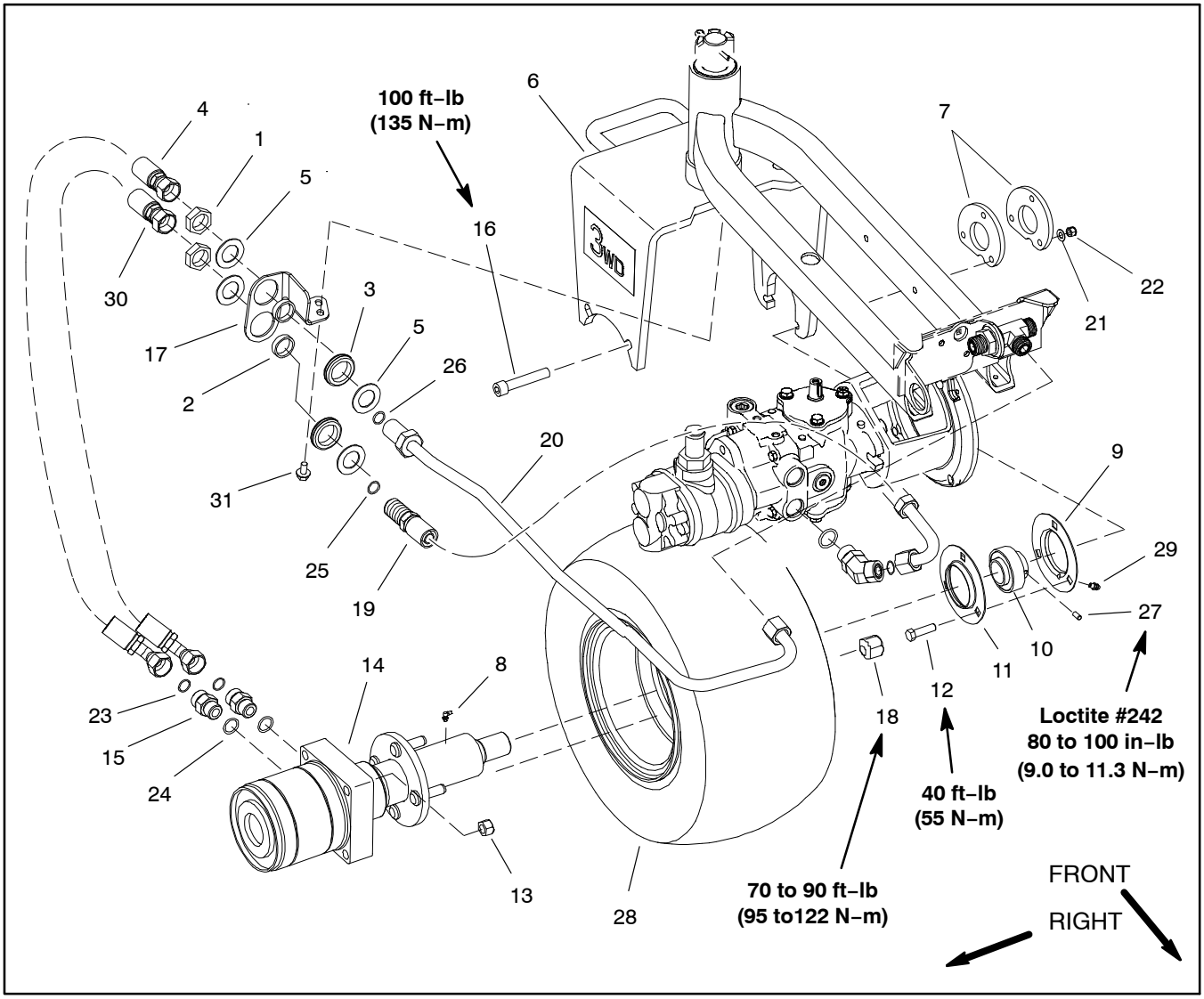

Figure 6

1. Lock nut (2 used)
2. Spacer (2 used)
3. Grommet (2 used)
4. Hydraulic hose assembly
5. Washer (4 used)
6. Castor fork
7. Mount spacer (2 used)
8. Grease fitting
9. Bearing flangette (lube)
10. Bearing
11. Bearing flangette
12. Cap screw (3 used)
13. Lock nut (2 used)
14. Wheel motor & hub assembly
15. Adapter (2 used)
16. Socket head screw (2 used)
17. Bulkhead bracket
18. Lug nut (4 used)
19. Hydraulic hose assembly
20. Hydraulic tube assembly
21. Washer (3 used)
22. Lock nut (3 used)
23. O–ring
24. O–ring
25. O–ring
26. O–ring
27. Set screw
28. Wheel assembly
29. Grease fitting
30. Hydraulic hose assembly
31. Washer head screw (2 used)

Removal (Fig. 6)

1. Park machine on a level surface. Make sure engine is off. Set brake and block front wheels.

2. Loosen, but do not remove, lug nuts (item 18).

3. Chock both front wheels to prevent the machine from moving.

4. Use a jack or hoist to lift rear wheel off the ground and then place appropriate jackstands beneath the frame to support the raised machine.

CAUTION

Support wheel (item 28) and motor and hub assembly (item 14) to prevent dropping the assembly and causing personal injury.

5. Support rear wheel, hydraulic motor and hub assembly to prevent it from falling.

6. Remove wheel (item 28) and hydraulic motor and hub assembly (item 14) from the castor fork (item 6) as follows:

A. Remove cap screws (item 12), lock nuts (item 22) and washers (item 21) securing flangettes (items 9 and 11) and mount spacers (item 7) to castor fork.

B. Remove both socket head screws (item 16) and lock nuts (item 13) securing the hydraulic motor and hub assembly to the castor fork.

C. Lower wheel and hydraulic motor and hub assembly from the castor fork.

7. Loosen set screw (item 27) on bearing (item 10). Pull flangettes (items 9 and 11) and bearing from the hydraulic motor shaft.

8. Remove grease fitting (item 8) from the hydraulic motor and hub assembly. Remove four (4) lug nuts (item 18) and wheel (item 28) from the hub drive studs.

NOTE: If wheel hub and motor assembly need to be serviced, see Rear Wheel Hub and Motor Assembly (Optional 3WD) in this section. If castor fork removal is necessary, see Rear Castor Fork in this section.

Installation (Fig. 6)

1. Secure wheel (item 28) to the drive studs of the hydraulic motor and hub assembly with four (4) lug nuts (item 18). Torque nuts from **70 to 90 ft–lb (95 to 122 N–m)**.

2. Reinstall grease fitting (item 8) into hydraulic motor and hub assembly so it points away from the wheel.

3. Install flangette (item 11), bearing (item 10) and relube flangette (item 9) onto the motor shaft.

4. Position hydraulic motor and hub assembly, flangettes with bearing and wheel into the castor fork. Make sure hose fittings on the motor face to the rear.

5. Loosely secure hydraulic motor and hub assembly to the right inside of the castor fork with both socket head screws (item 16) and lock nuts (item 13).

6. Position flangette grease fitting facing downward. Then, loosely secure flangettes (items 9 and 11) and bearing (item 10) to the left inside of the castor fork with cap screws (item 12), mount spacers (item 7), washers (item 21) and lock nuts (item 22).

7. Secure wheel (item 28) and hydraulic motor and hub assembly (item 14) to the castor fork:

A. Torque socket head screws (item 16) to **100 ft–lb (135 N–m)**.

B. Torque cap screws (item 12) to **40 ft–lb (55 N–m)**.

8. Apply loctite to bearing set screw (item 27). Torque set screw from **80 to 100 in–lb (9.0 to 11.3 N–m)**.

9. Lower machine to the ground. Check that lug nuts are properly torqued from **70 to 90 ft–lb (95 to 122 N–m)**.

Rear Wheel Hub and Motor Assembly (Optional 3WD)

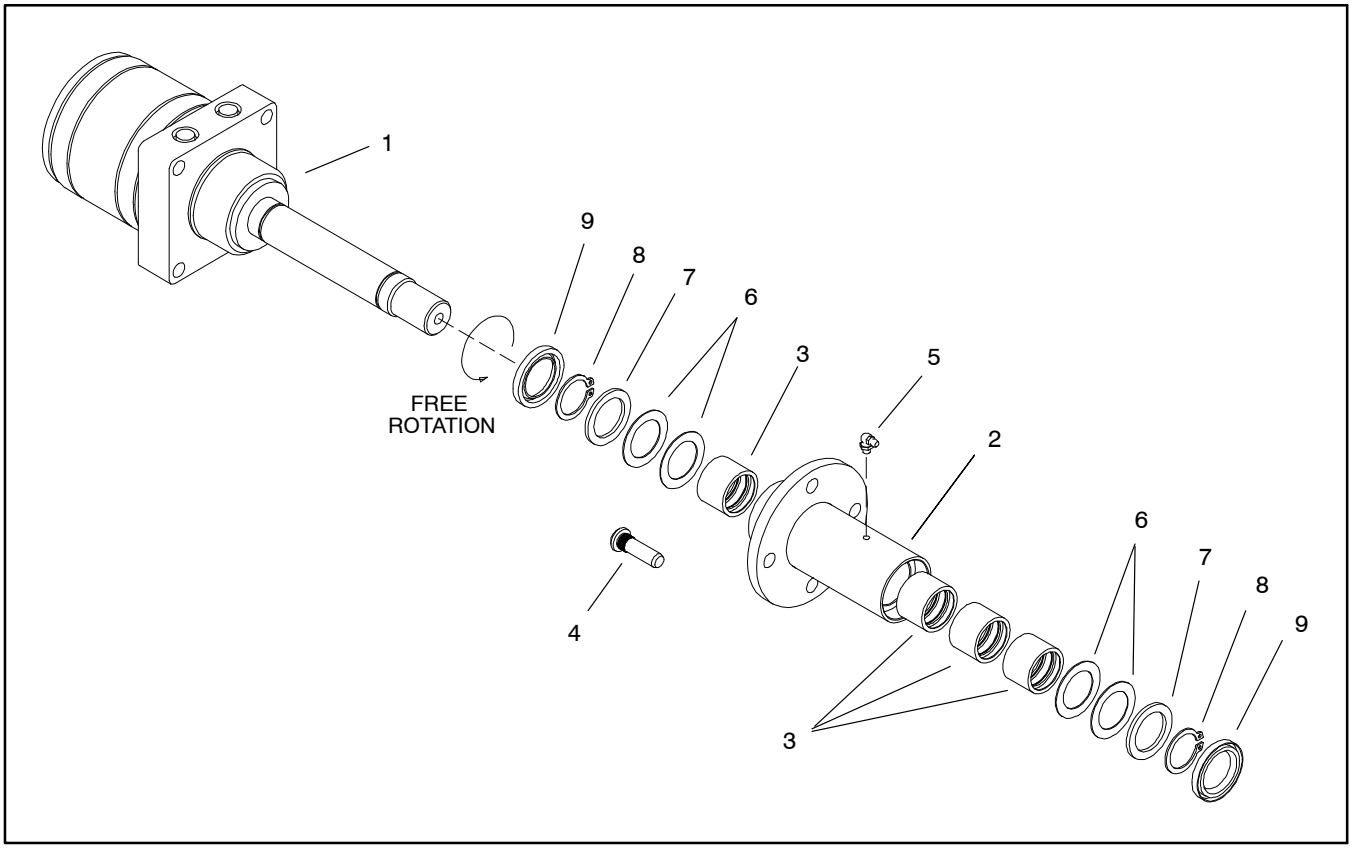

Figure 7

1. **Hydraulic motor**
2. **Hub**
3. **Clutch roller bearing**
4. **Drive stud (4 used)**
5. **Grease fitting**
6. **Thrust washer**
7. **Washer**
8. **Snap ring**
9. **Grease seal**

The following procedures assume the rear wheel hub and motor assembly has been removed from the machine (see Rear Wheel (Optional 3WD) in this section).

Disassembly (Fig. 7)

CAUTION

Before continuing further, read and become familiar with General Precautions for Removing and Installing Hydraulic System Components in the Service and Repairs section of Chapter 4 – Hydraulic System.

1. Thoroughly clean junction of hydraulic hoses and fittings on hydraulic motor (Fig. 8).

2. Label hydraulic hoses that connect to rear wheel motor for assembly purposes. Remove hose assemblies and O–rings from the hydraulic fittings on the hydraulic motor. Allow hoses to drain into a suitable container.

3. Place rear wheel hub and motor assembly on a clean workbench.

4. Remove grease seal (item 9) and snap ring (item 8) from the long end of hub.

5. Remove washer (item 7), two (2) thrust washers (item 6) and hub (item 2) from the hydraulic motor shaft. Remove remaining two (2) thrust washers (item 6), washer (item 7), snap ring (item 8) and grease seal (item 9) from the shaft.

6. If drive studs (item 4) are bent or damaged, press studs from the wheel hub.

7. Press clutch roller bearings (item 3) from the hub.

8. If rear wheel motor needs to be serviced, see Wheel Motor Service in the Service and Repairs section of Chapter 4 – Hydraulic System.

Assembly (Fig. 7)

1. If drive studs (item 4) were removed, press new studs fully to the shoulder of the wheel hub.

NOTE: Arrow on the side of the clutch roller bearings (item 3) must point to the long side of the end of the hub.

2. Press clutch roller bearings (item 3) into the hub as follows (Fig. 9):

A. Press three (3) roller bearings into flange end of the hub. The outer edge of the third bearing must be flush with the recessed edge within the hub.

B. Press final roller bearing into opposite end of hub. The outer edge of the bearing must be flush with the recessed edge within the hub.

C. The installed bearings must not interfere with grease fitting hole in the hub.

3. Grease inner edge of the new grease seals (item 9) with No. 2 multipurpose lithium base grease. Slide one (1) seal onto motor shaft past groove closest to the motor. Install snap ring (item 8) into groove.

4. Slide flat washer (item 7) and two (2) thrust washers (item 6) onto the motor shaft. Slide hub onto the shaft with the short end first.

5. Slide remaining thrust washers (item 6) and flat washer (item 7) onto the motor shaft. Install remaining snap ring (item 8) into the shaft groove. Slide remaining new grease seal (item 9) onto motor shaft.

IMPORTANT: The hub should spin freely in the forward direction, but lock on the hydraulic motor shaft when it is rotated in the reverse direction.

6. Press grease seals (item 9) into the hub so they are flush with the end of the hub.

7. Lubricate and position new O−rings to fittings on hydraulic motor. Use labels placed during the removal process to properly install hydraulic hoses to motor adapters (see Hydraulic Hose and Tube Installation in the General Information section of Chapter 4 − Hydraulic System).

8. Install rear wheel hub and motor assembly to rear castor fork of machine (see Rear Wheel (Optional 3WD) in this section).

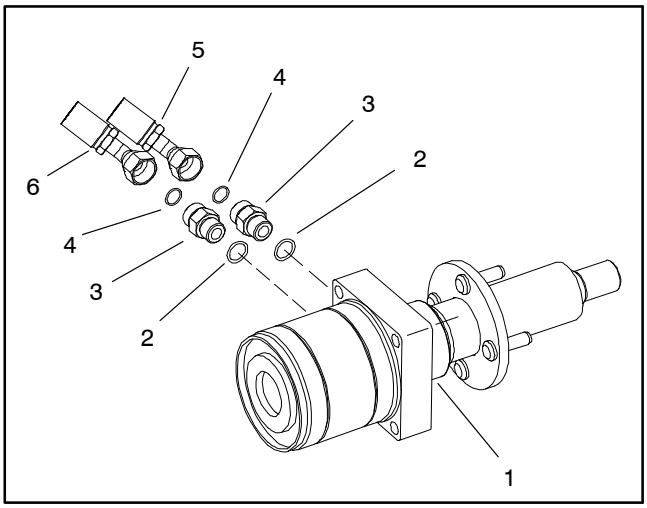

Figure 8

1. **Hub and motor assembly**
2. **O−ring**
3. **Adapter**
4. **O−ring**
5. **Hydraulic hose**
6. **Hydraulic hose**

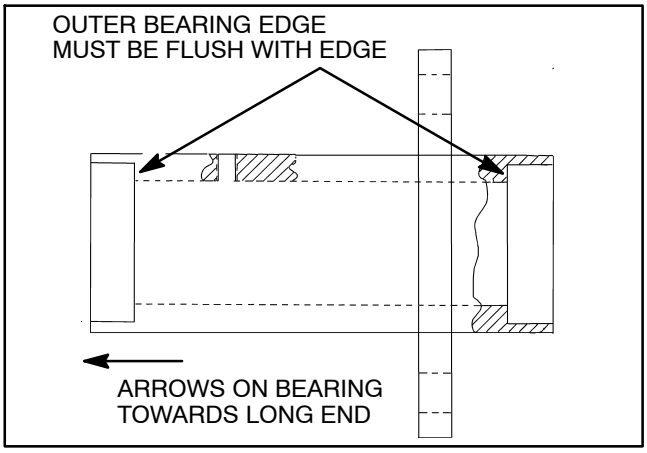

Figure 9

Rear Castor Fork

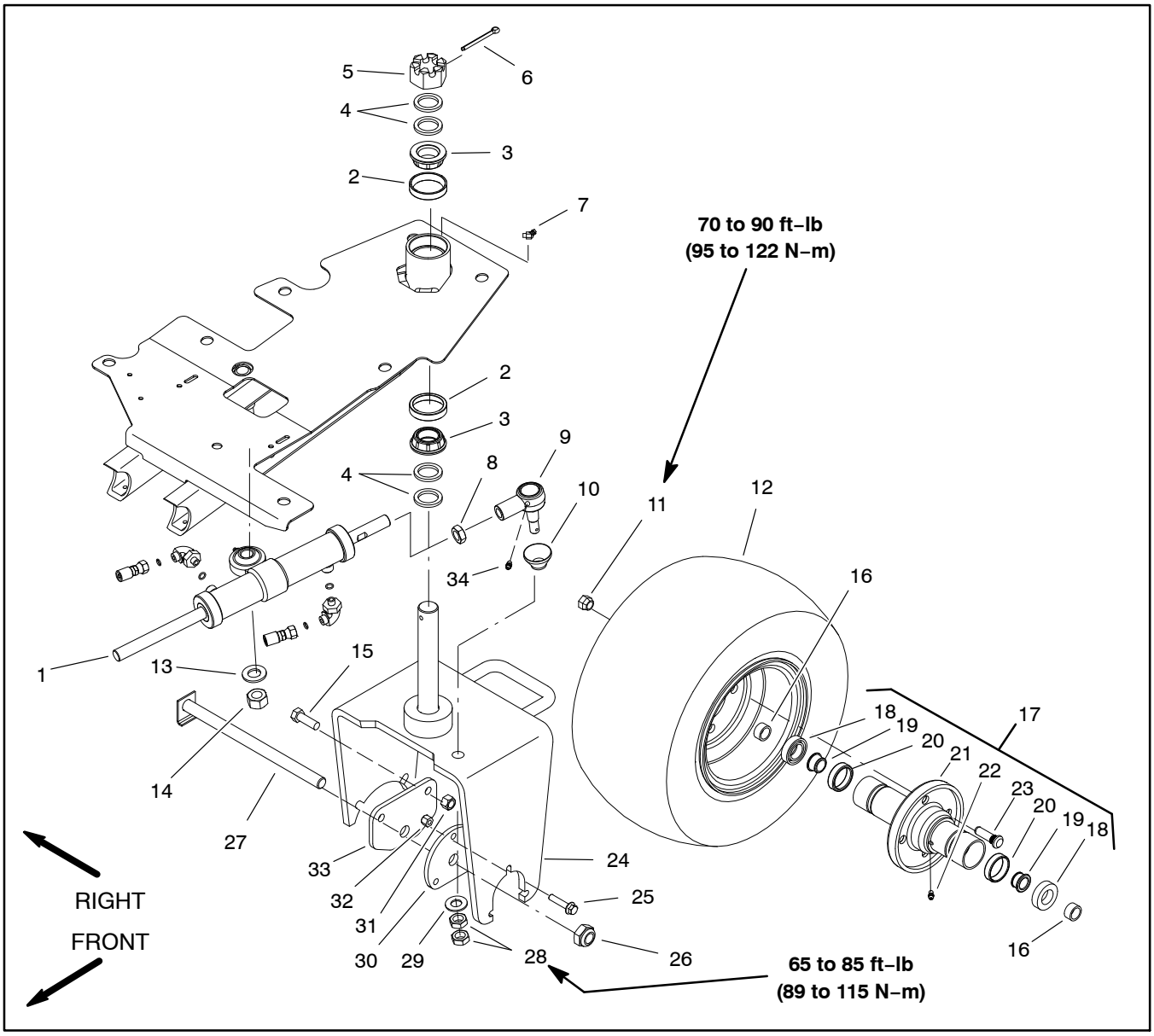

Figure 10

1. Steering cylinder
2. Bearing cup (2 used)
3. Bearing cone (2 used)
4. Washer (4 used)
5. Slotted hex nut
6. Cotter pin
7. Grease fitting
8. Jam nut
9. Rod end
10. Dust seal
11. Lug nut (4 used)
12. Wheel assembly
13. Washer
14. Lock nut
15. Cap screw (2 used)
16. Spacer (2 used)
17. Hub assembly
18. Seal (2 used)
19. Bearing cone (2 used)
20. Bearing cup (2 used)
21. Hub
22. Grease fitting
23. Drive stud (4 used)
24. Castor fork
25. Flange head screw (3 used)
26. Lock nut
27. Castor bolt
28. Jam nut (2 used)
29. Flat washer
30. Adapter plate
31. Lock nut (2 used)
32. Lock nut (3 used)
33. Motor adapter plate
34. Grease fitting

Removal (Fig. 10)

1. Park machine on a level surface. Make sure engine is off. Engage parking brake and block front wheels.

2. Jack up and secure the rear wheel off the ground.

3. Remove rear wheel assembly from the castor fork (see Rear Wheel (2WD) or Rear Wheel (Optional 3WD) in this section).

4. Remove fuel tank from machine to allow access to castor fork (see Fuel Tank in the Service and Repairs section of Chapter 3 – Engine).

5. Remove both jam nuts (item 28) and flat washer (item 29) securing the steering cylinder ball joint (item 9) to the castor fork. Separate ball joint from castor fork.

CAUTION

Support castor fork while removing the slotted hex nut (item 5) to prevent the fork from dropping and causing personal injury.

6. Support the castor fork to prevent it from falling.

7. Remove cotter pin (item 6) and slotted hex nut (item 5) from the castor fork shaft. Lower castor fork from frame.

8. Remove bearing cones (item 3) and washers (item 4) from the castor fork and frame. Note location of washers for assembly purposes.

9. Inspect upper and lower bearing cups (item 2) in frame for damage and replace if necessary.

Installation (Fig. 10)

1. If bearing cups (item 2) were removed from frame, press new cups into the castor fork pivot housing with the thick side of the cups facing each other. Make sure that cups are pressed fully to shoulder of frame housing.

2. Pack both bearing cones (item 3) with #2 multi–purpose lithium base grease.

3. Place two (2) washers (item 4) onto the castor fork shaft. Place lower bearing cone on top of washers with the thick edge touching the washers.

4. Insert castor fork shaft up through the frame pivot housing and bearing cups.

5. Place upper bearing cone on the castor fork shaft with the wide edge up. Place two (2) washers on top of the bearing cone.

6. Thread slotted hex nut (item 5) onto castor fork shaft until drag is felt while rotating the castor fork. Back–off hex nut to align shaft hole with a slot in the nut. Install and secure new cotter pin (item 6) to the shaft.

7. Secure steering cylinder ball joint (item 9) to the castor fork with flat washer (item 29) and both jam nuts (item 28). Torque jam nuts from **65 to 85 ft–lbs (89 to 115 N–m)**.

8. Install fuel tank to the machine (see Fuel Tank in the Service and Repairs section of Chapter 3 – Engine).

9. Install rear wheel to castor fork (see Rear Wheel (2WD) or Rear Wheel (Optional 3WD) in this section).

10. Lower machine to the ground.

11. Clean grease fitting (item 7) on frame pivot housing. Pump grease into pivot housing until grease is seen exiting at both ends of the housing. Wipe up excess grease.

Cutting Unit Pull Frame

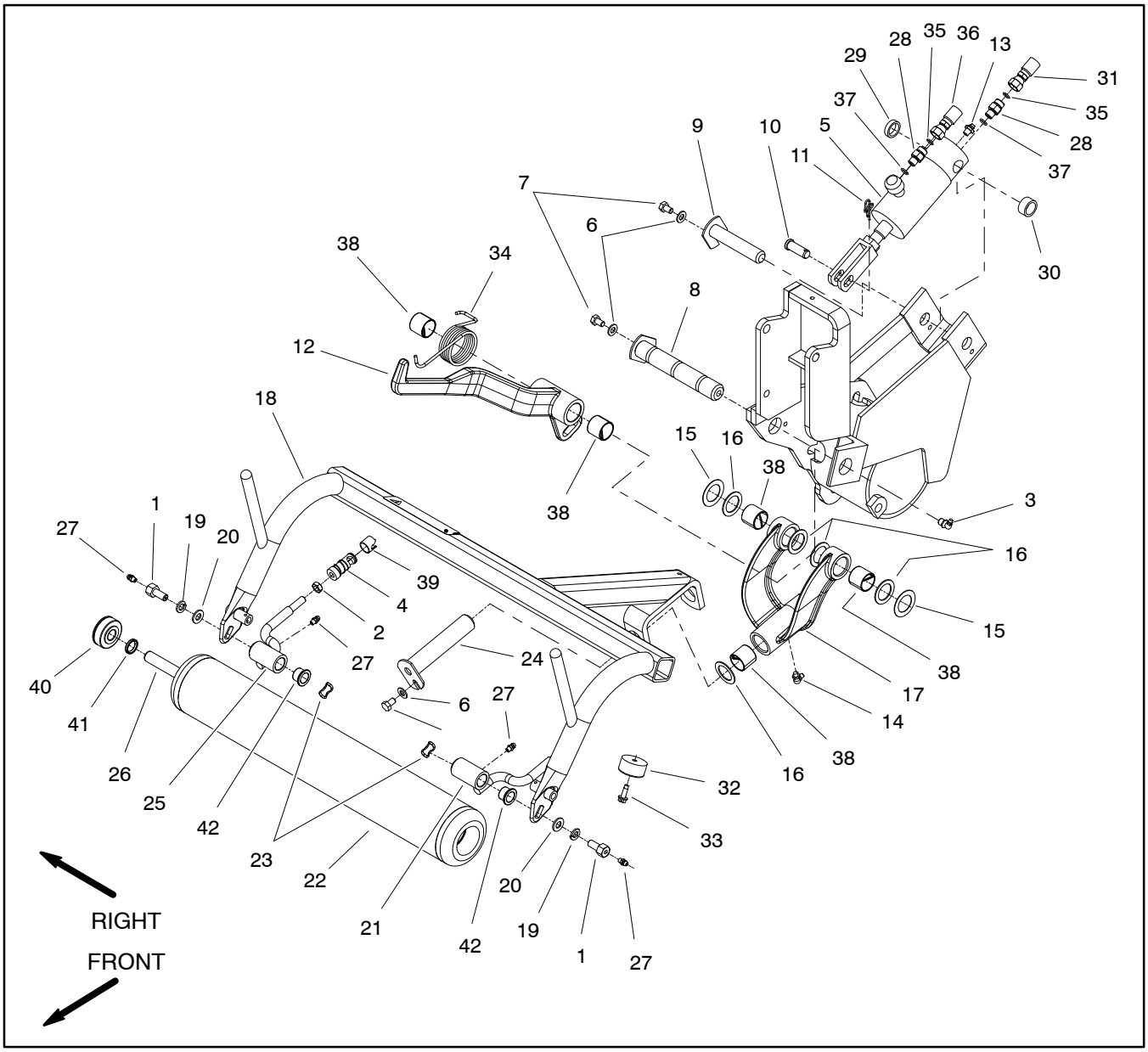

Figure 11

1. Roller shaft screw (2 used)
2. Nut (2 used)
3. Grease fitting
4. Ball joint receiver (2 used)
5. Hydraulic lift cylinder
6. Flat washer (3 used)
7. Cap screw (3 used)
8. Hinge pin
9. Pivot pin
10. Clevis pin
11. Cotter pin
12. Lift arm
13. Grease fitting
14. Grease fitting
15. Shim washer (as needed)
16. Thrust washer (6 used)
17. Pivot hinge
18. Pull frame (RH shown)
19. Lock washer (2 used)
20. Flat washer (2 used)
21. Pull arm
22. Roller
23. Spring washer (2 used)
24. Pivot pin
25. Pull arm
26. Roller shaft
27. Grease fitting
28. Hydraulic fitting (2 used)
29. Spacer
30. Spacer
31. Hydraulic hose
32. Bumper (2 used)
33. Washer head screw (2 used)
34. Torsion spring
35. O−ring
36. Hydraulic hose
37. O−ring
38. Bushing
39. Ball joint sleeve (2 used)
40. Ball bearing (2 used)
41. Oil seal (2 used)
42. Flange bushing (2 per pull arm)

NOTE: The pull frame assemblies used on Greensmaster 3150 machines are slightly different depending on location (right front, left front and center positions). Service of the pull frame assembly is similar regardless of position on the machine. The right front pull frame assembly is shown in Figure 11.

Disassembly (Fig. 11)

1. Park machine on a level surface with cutting units lowered to the ground. Make sure engine is off. Engage parking brake.

NOTE: Depending on service that is required, it might be easier to remove cutting unit from pull frame.

2. Remove cutting unit pull frame components from machine as required using Figure 11 as a guide.

Assembly (Fig. 11)

1. Install all removed cutting unit pull frame components to machine using Figure 11 as a guide.

   A. If bushings (item 38) in lift arm or pivot hinge are being replaced, install new bushing so that grease groove opening is orientated inward. The bushing with grease groove is shown in Figure 13.

   B. If pivot hinge (item 17) was removed, make sure that side play clearance of pivot hinge is less than 0.060" (1.5 mm). Adjust clearance with shims (item 15) and thrust washers (item 16) as required.

   C. If roller assembly was disassembled, install oil seal with seal lip toward end of roller (Fig. 14). Also, ball bearing should be installed with seal toward end of roller.

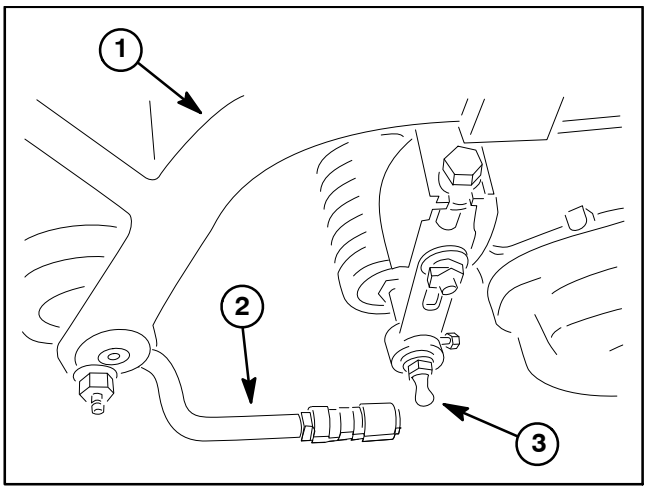

Figure 12

1. **Pull frame**
2. **Pull arm**
3. **Cutting unit ball stud**

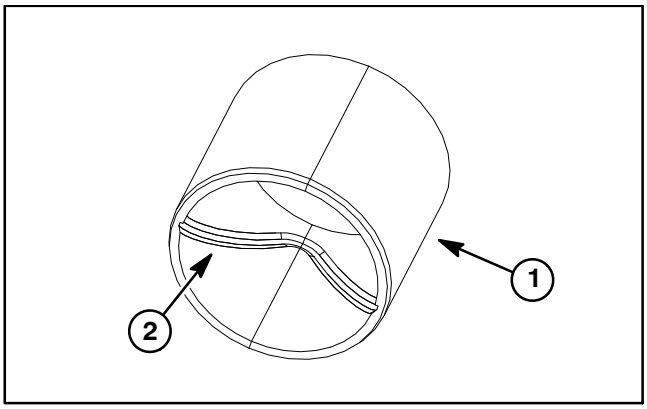

Figure 13

1. **Bushing**
2. **Grease groove**

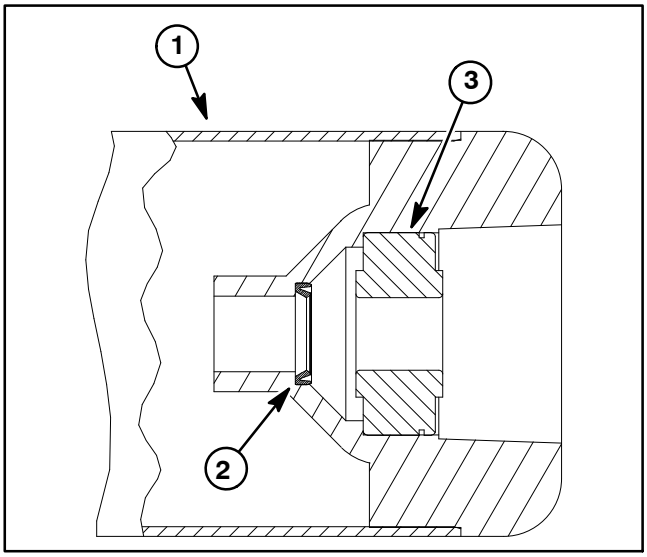

Figure 14

1. **Roller**
2. **Oil seal**
3. **Ball bearing**

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Chapter 7

DPA Cutting Units

Table of Contents

Specifications

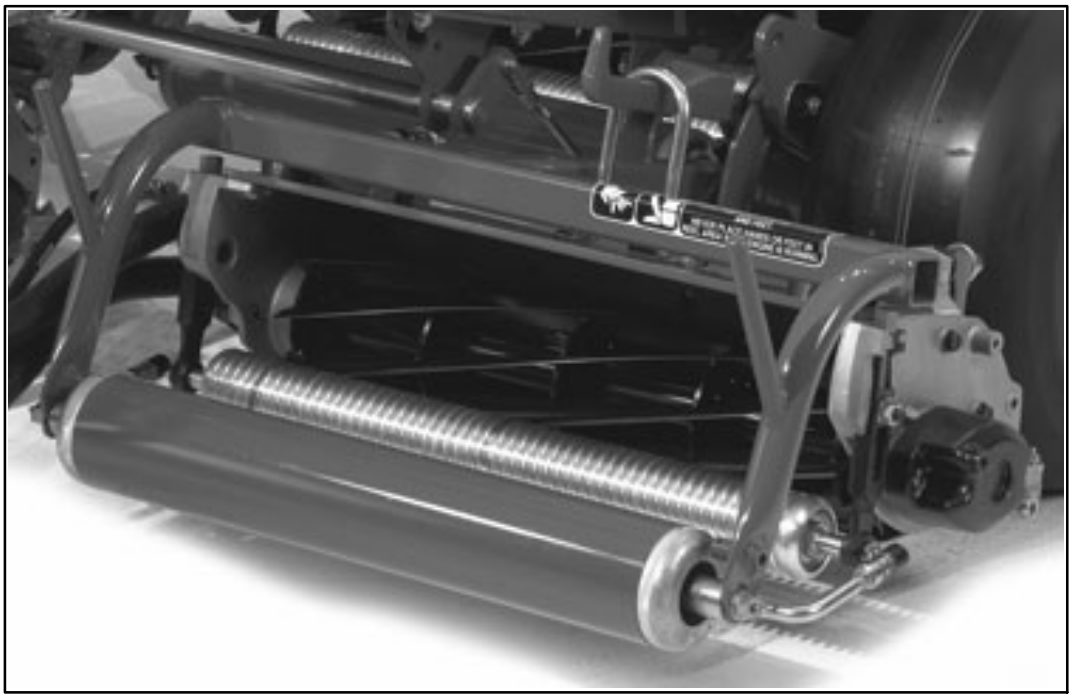

Figure 1

Frame Construction: Precision machined die cast aluminum cross member with two (2) bolt−on cast aluminum side plates.

Reel Construction: Reels are 21 inches (53.3 cm) in length and 5 inch (12.7 cm) in diameter. High strength, low alloy steel blades are thru hardened and impact resistant. Reels are available in 8, 11 and 14 blade configurations.

Reel Bearings: Two (2) sealed stainless steel, deep groove ball bearings support the reel shaft with inboard seal for protection.

Reel Drive: The reel weldment shaft is a 1.350 inch (34.3 mm) diameter tube with a drive insert threaded into the right end. The reel drive insert has an internal eight (8) tooth spline.

Height−of−Cut (HOC): Cutting height is adjusted on the front roller by two (2) vertical screws. Effective HOC may vary depending on turf conditions, type of bedknife, roller type and installed attachments.

Bedknife: Replaceable, single edged, high carbon steel bedknife is fastened to a machined cast iron bedbar with thirteen (13) screws. Optional bedknives are available.

Bedknife Adjustment: Dual screw adjustment to the reel; detents corresponding to 0.0007 inch (0.018 mm) bedknife movement for each indexed position.

Front and Rear Rollers: Greaseless through−shaft front and rear rollers are used with the Greensmaster 3150 DPA cutting units. All greens rollers use the same heavy duty ball bearing and seal package.

Counterbalance Weight: A cast iron weight mounted opposite to the hydraulic reel motor balances the cutting unit.

Cutting Unit Weight (Approximate):

8 Blade	**65 lb (30 kg)**
11 Blade	**68 lb (31 kg)**
14 Blade	**71 lb (32 kg)**

Options:
Refer to Cutting Unit Operator's Manual for available options for your Greensmaster 3150 DPA cutting unit.

General Information

Cutting Unit Operator's Manual

The Cutting Unit Operator's Manual provides information regarding the operation, general maintenance and maintenance intervals for the DPA cutting units on your Greensmaster 3150 machine. Additionally, if optional kits have been installed on the cutting units (e.g. rear roller brush), the installation instructions for the kit includes set–up and operation information. Refer to those publications for additional information when servicing the cutting units.

Supporting Cutting Unit when Servicing

Whenever the cutting unit has to be tipped to expose the bedknife or cutting reel, support the rear of the cutting unit to make sure the lock nuts on the back of the bedbar adjuster screws are not resting on the work surface.

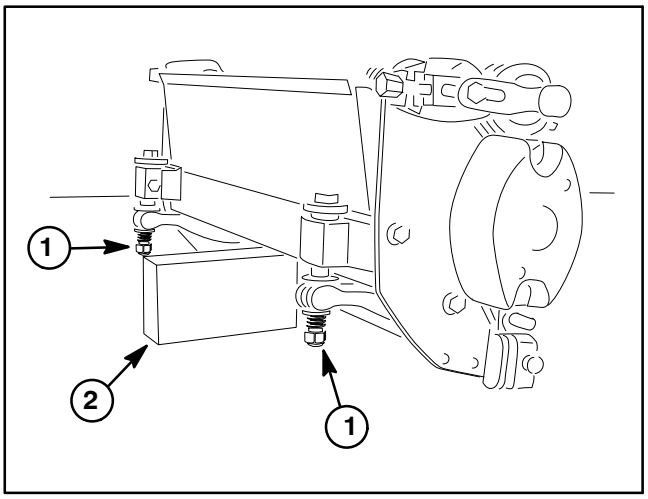

Figure 2

1. **Lock nut**
2. **Support**

Special Tools

Special tools for servicing Toro Commercial Products are available from your Toro Distributor. Some of these tools may have been supplied with your machine or are available as Toro parts.

Gauge Bar Assembly

Use gauge bar to verify height−of−cut adjustment.

Toro Part Number: **108−6715**

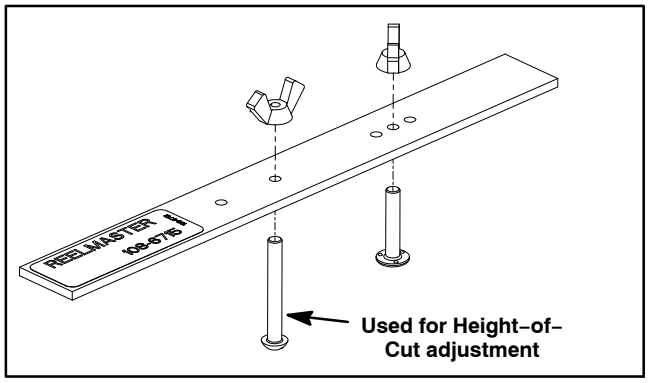

Figure 3

Bedknife Screw Tool

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: To prevent damage to the bedbar, DO NOT use an air or manual impact wrench with this tool.

Toro Part Number: **TOR510880**

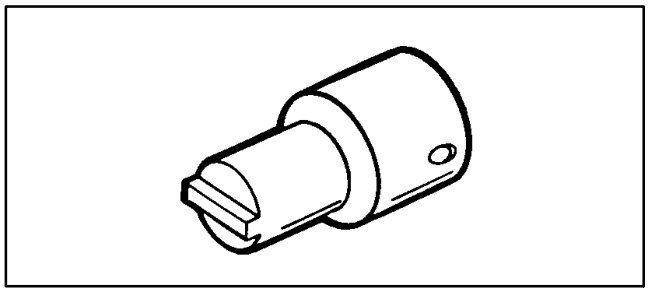

Figure 4

Handle Assembly

For applying lapping compound to cutting units while keeping hands a safe distance from the rotating reel.

Toro Part Number: **29−9100**

Components for the handle assembly are available individually as follows:

Brush	36−4310
Handle	29−9080
Handle cap	2410−18

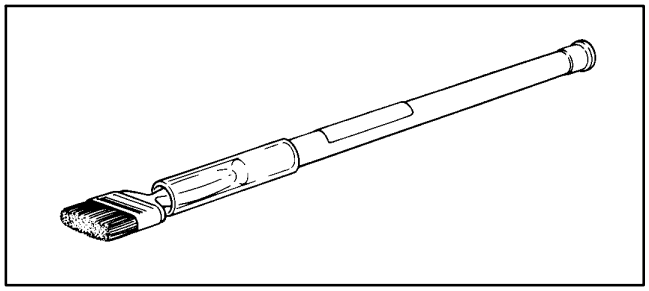

Figure 5

Roller Bearing Installation Tools

Washers and spacer used to install bearings and seals into front and rear rollers (Fig. 6).

Seal installation washer: 107−8133
Seal installation spacer: 107−3505
Bearing installation washer: 104−6126

As an alternative to using washers and spacers listed above, a special tool set is available that can be used for roller bearing and seal installation (Fig. 7).

Toro Part Number: **TOR4105**

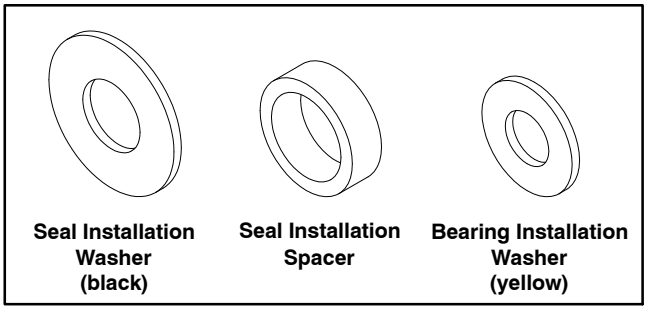

Figure 6

Figure 7

Diameter/Circumference Measuring Tape

Spring steel measuring tape for accurately measuring the circumference and outside diameter of cutting reel and other spherical components. Tape calibration is in fixed inch readings (no adjustments).

Toro Part Number: **TOR6023**

Figure 8

Turf Evaluator Tool

Many turf discrepancies are subtle and require closer examination. In these instances, the Turf Evaluator grass viewing tool is helpful. It can assist turf managers and service technicians in determining causes for poor reel mower performance and in 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).

Toro Model Number: **04399**

Figure 9

Bedknife Top Angle Indicator and Mount

Toro Part Numbers: **131−6828** and **131−6829**

Because the top grind angle on bedknives is critical for edge retention, and therefore after− cut appearance, Toro has developed these service tools for accurately measuring the top grind angle on all bedknives.

Since there can be variations in the mounting surface of the bedbar, it is necessary to grind the bedknife after installing it to the bedbar.

1. Place the angle indicator on the bottom side of the bedknife with the digital display facing you as shown (Fig. 10).

2. Press the Alt Zero button on the angle indicator.

3. Remove the angle indicator and place the angle−indicator mount on the edge of the bedknife so the face of the magnet is flat against the top of the bedknife (Fig. 11).

4. Place the angle indicator on the mount with the digital display facing you as shown (Fig. 11). The angle displayed on the indicator is the current bedknife top angle.

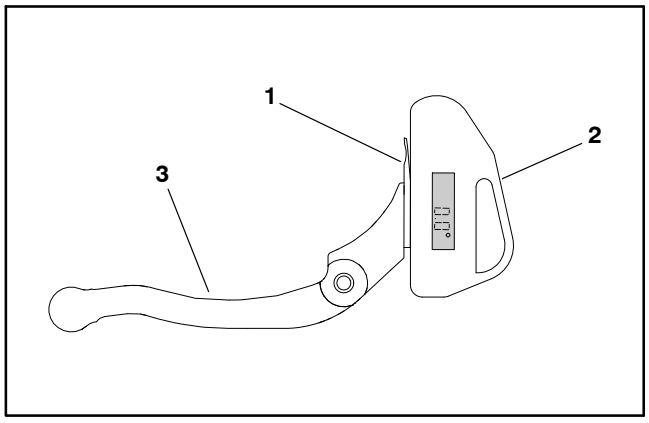

Figure 10

1. **Bedknife**
2. **Angle indicator**
3. **Bedbar**

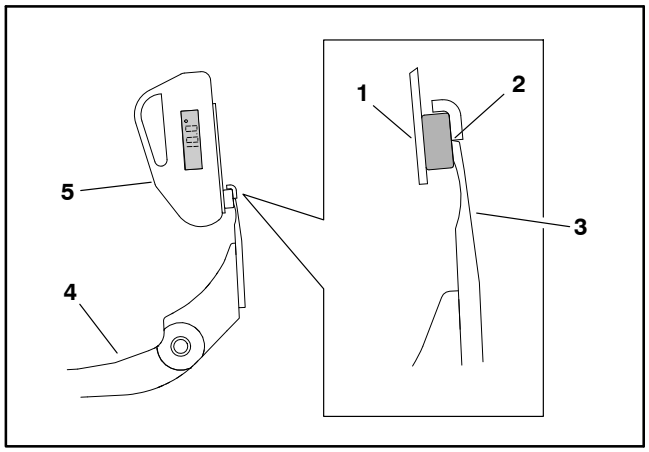

Figure 11

1. **Angle indicator mount**
2. **Magnet**
3. **Bedknife**
4. **Angle indicator**
5. **Bedbar**

Reel Thread Repair Taps

15/16−16 Right−Hand Thread − Toro Part No. 137−0926

15/16−16 Left−Hand Thread − Toro Part No. 137−0927

Use to clean or repair the internal threads of cutting unit reels.

Factors That Can Affect Cutting Performance

There are a number of factors that can contribute to unsatisfactory quality of cut, some of which may be turf conditions. Turf conditions such as excessive thatch, “sponginess” or attempting to cut off too much grass height may not always be overcome by adjusting the cutting unit. It is important to remember that the lower the height−of−cut, the more critical these factors are.

Refer to the Cutting Unit’s Operator’s Manual for detailed cutting unit adjustment procedures. For cutting unit repair information, refer to the Service and Repairs section of this chapter.

NOTE: For additional information regarding cutting unit troubleshooting, see **Aftercut Appearance Troubleshooting Aid (Toro part no. 00076SL)**.

Factor	**Possible Problem/Correction**
Tire pressure	Check tire pressure of all traction unit tires. Adjust tire pressure as necessary. See the Traction Unit Operator’s manual.
Governed engine speed	For best cutting performance and appearance, engine should be run at maximum governed speed during machine operation. Check maximum governed engine speed. Adjust engine to specifications if necessary. See Chapter 3 − Engine.
Reel speed	All cutting reels must rotate at the same speed (within 100 rpm) (see Troubleshooting in Chapter 4 − Hydraulic System). All cutting units must have equal bedknife to reel and height−of−cut adjustments. Make sure that reel speed selection is correct (see Reel Speed Chart in Traction Unit Operator’s Manual).
Reel bearing condition	Check reel bearings for wear and replace if necessary. See Reel Assembly Service in the Service and Repairs section of this chapter.
Bedknife to reel adjustment	Check bedknife to reel contact daily. The bedknife must have light contact across the entire reel. No contact will dull the cutting edges. Excessive contact accelerates wear of both edges. Quality of cut is adversely affected by both conditions (see Bedknife to Reel Adjustment in the Cutting Unit Operator’s Manual).

Factor	Possible Problem/Correction
Reel and bedknife sharpness	A reel and/or bedknife that has rounded cutting edges or “rifling” (grooved or wavy appearance) **cannot** be corrected by tightening the bedknife to reel contact. Grind cutting reel to remove taper and/or rifling. Grind bedknife to sharpen and/or remove rifling. The most common cause of rifling is bedknife to reel contact that is too tight. Dull cutting edges must be corrected by grinding the bedknife and cutting reel (see Preparing Reel for Grinding in the Service and Repairs section of this chapter). **A new bedknife must be ground flat (within 0.002”) after installation to the bedbar. Backlapping may be required to properly mate the reel and bedknife after installation into the cutting unit.** **NOTE:** On cutting units equipped with optional bedknives, slightly dull cutting edges may be corrected by backlapping (see Backlapping in the Service and Repairs section of this chapter).
Rear roller adjustment	Adjust the rear roller brackets to correct position depending on the height−of−cut range desired. See Rear Roller Adjustment in the Cutting Unit Operator’s Manual.
Height−of−cut	“Effective” or actual height−of−cut depends on the cutting unit weight and turf conditions. Effective height−of−cut will be different from the bench set height−of−cut. See Height−of−Cut Adjustment in the Cutting Unit Operator’s Manual.
Proper bedknife selection for height−of−cut desired	If the bedknife is incorrect for effective height−of−cut, poor quality of cut will result. See Cutting Unit Operator’s Manual for bedknife options.
Stability of bedbar	Make sure bedbar pivot bolts are seated securely. Check condition of the bushings in the side plates. See Bedbar Removal and Installation in the Service and Repairs section of this chapter.
Number of reel blades	Use correct number of reel blades for clip frequency and optimum height−of−cut range.

Factor	Possible Problem/Correction
Roller condition and roller type	Make sure rollers rotate freely. Repair roller bearings as necessary. See Roller Service in the Service and Repairs section of this chapter. Refer to Cutting Unit Operator's Manual for roller options.
Cutting unit accessories	A variety of cutting unit accessories are available that can be used to enhance aftercut appearance. Refer to Operator's Manual for a listing of available accessories.

Set Up and Adjustments

Characteristics

CAUTION

Never install or work on the cutting units or cutting unit suspension with the engine running. Always stop engine and remove key first.

The dual knob bedknife–to–reel adjustment system incorporated in this cutting unit simplifies the adjustment procedure needed to deliver optimum mowing performance. The precise adjustment possible with this design gives the necessary control to provide a continual self–sharpening action. This feature maintains sharp cutting edges, assures good quality of cut and greatly reduces the need for routine backlapping.

In addition, the rear roller positioning system allows for various height-of-cut ranges and aggressiveness of cut selections.

If a cutting unit is determined to be out of adjustment, complete the following procedures in the specified order to adjust the cutting unit properly.

1. Adjust the bedknife parallel to the reel.

2. Determine desired height–of–cut range and install rear roller mounting shim(s) accordingly.

3. Adjust the height–of–cut.

See Cutting Unit Operator's Manual for cutting unit adjustment procedures for your Greensmaster 3150 machine.

Leveling Rear Roller

The precision machined components of the cutting unit frame keep the rear roller and cutting reel in alignment (parallel). If the side plates are disassembled or as the cutting reel wears, a limited amount of side plate adjustment is possible to make sure that the cutting unit is properly aligned.

1. Place the assembled cutting unit on a surface plate.

2. Make sure that bedknife is properly adjusted to cutting reel.

3. Using the surface plate, check if rear roller is level to cutting reel by using a 0.005” (0.13 mm) shim at each end of rear roller. If the shim will pass under the roller at one end but not the other, a frame adjustment should be made.

4. Loosen, but do not remove, the two (2) shoulder bolts that secure the side plate to the frame opposite the side that is not level (Fig. 12).

5. Adjust the position of the side plate to parallel the rear roller and cutting reel. Then, tighten the shoulder bolts to a torque from **210 to 240 in−lb (24 to 27 N−m)**.

6. After tightening the side plate, recheck the rear roller. If necessary, loosen and adjust second side plate.

7. After leveling rear roller, complete cutting unit set−up and adjustment sequence.

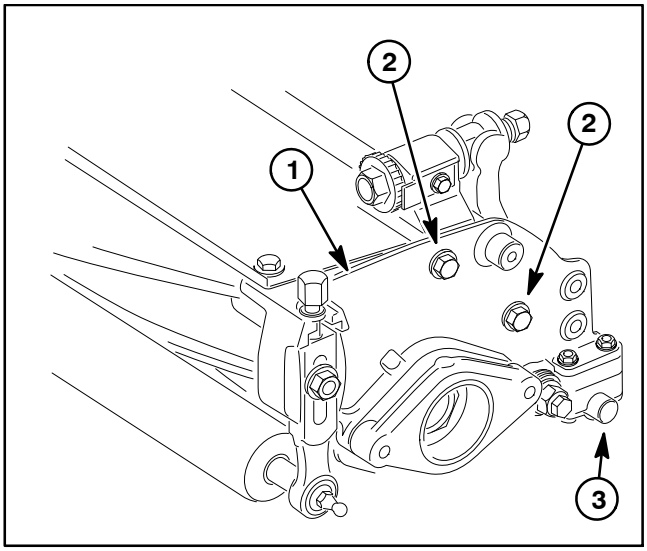

Figure 12

1. **Side plate**
2. **Shoulder bolt**
3. **Rear roller**

Backlapping

DANGER

TO AVOID PERSONAL INJURY OR DEATH:
- **Never place hands or feet in the reel area while the engine is running.**
- **When backlapping, run engine at idle speed only.**
- **While backlapping, the reels may stall and then restart.**
- **Do not attempt to restart reels by hand or foot.**
- **Do not adjust reels while the engine is running.**
- **If a reel stalls, stop engine before attempting to clear the reel.**
- **Reel motors are connected in series: rotating one motor causes rotation in other motors.**

NOTE: Additional instructions and procedures on backlapping are available in the Toro General Service Training Book, Reel Mower Basics (part no. 09168SL).

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

2. Raise the operator seat to access hydraulic mow manifold.

3. Locate the reel speed control and backlap lever on the hydraulic mow manifold (Fig. 13). Rotate the reel speed control to position “1” and the backlap lever to the R (backlap) position.

4. Make initial reel to bedknife adjustments appropriate for backlapping on all cutting units which are to be backlapped.

5. Start engine and run at low idle speed.

6. Use joystick on the control console to engage the cutting units.

IMPORTANT: To prevent damage to the reel, do not rotate the backlap lever from the backlap position to the mow position while the engine is running.

7. Apply lapping compound to cutting unit blades with a long handle brush (see Special Tools in this chapter) (Fig. 14). Never use a short handled brush to apply lapping compound.

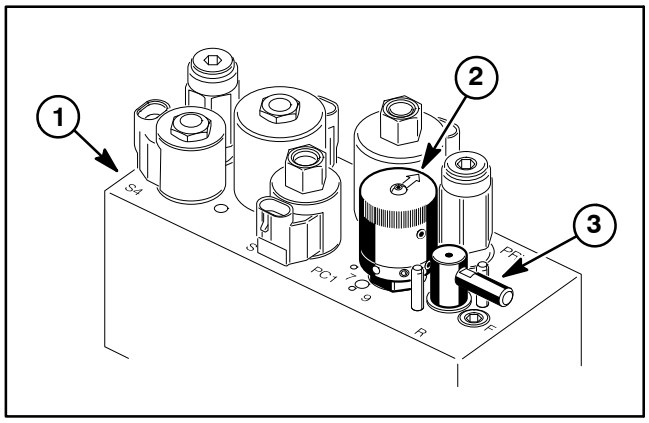

Figure 13

1. **Hydraulic manifold**
2. **Reel speed control**
3. **Backlap lever**

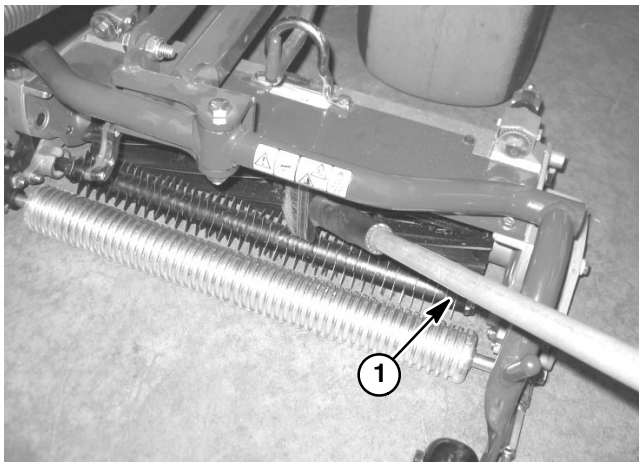

Figure 14

1. **Long Handle Brush**

DANGER

Reels may stall while backlapping. Do not attempt to restart reels by hand or touch reels while backlapping. Stop engine and turn reel speed adjustment knob one position toward ”9.”

8. If reels stall or become erratic while backlapping, stop backlapping by disengaging the PTO with the joystick. Once the reels have stopped, move the reel speed selector knob one position closer to “9.” Resume backlapping by engaging the PTO with the joystick.

9. To make an adjustment to the cutting units while backlapping, disengage the PTO with the joystick and turn the engine OFF. Wait for all machine movement to stop. After adjustments have been completed, repeat steps 5 through 8.

10. When the backlapping operation is completed, stop the engine and remove the key from the ignition switch. Run a file across the front face of the bedknife. This will remove any burrs or rough edges that may have built up on the cutting edge (Fig. 15).

11. Repeat procedure for all cutting units to be backlapped.

12. When backlap operation has been completed, return the backlap lever to the F (mow) position, set reel speed control to desired speed, lower operator seat and wash all lapping compound off cutting units. Adjust cutting unit reel to bedknife as needed.

NOTE: If the backlap lever is not returned to the F (mow) position after backlapping, the cutting units will not function properly.

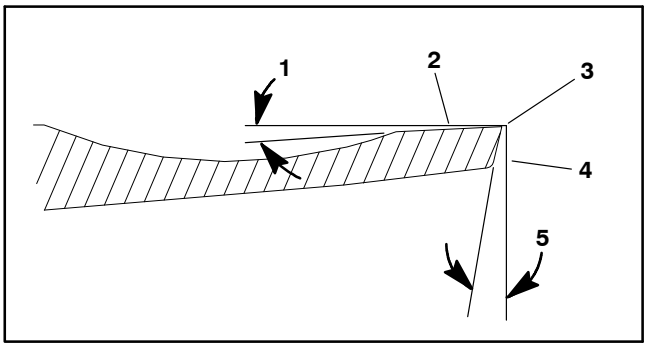

Figure 15

1. **Top angle**
2. **Top surface**
3. **Remove burr**
4. **Front surface**
5. **Front angle**

Bedbar Assembly

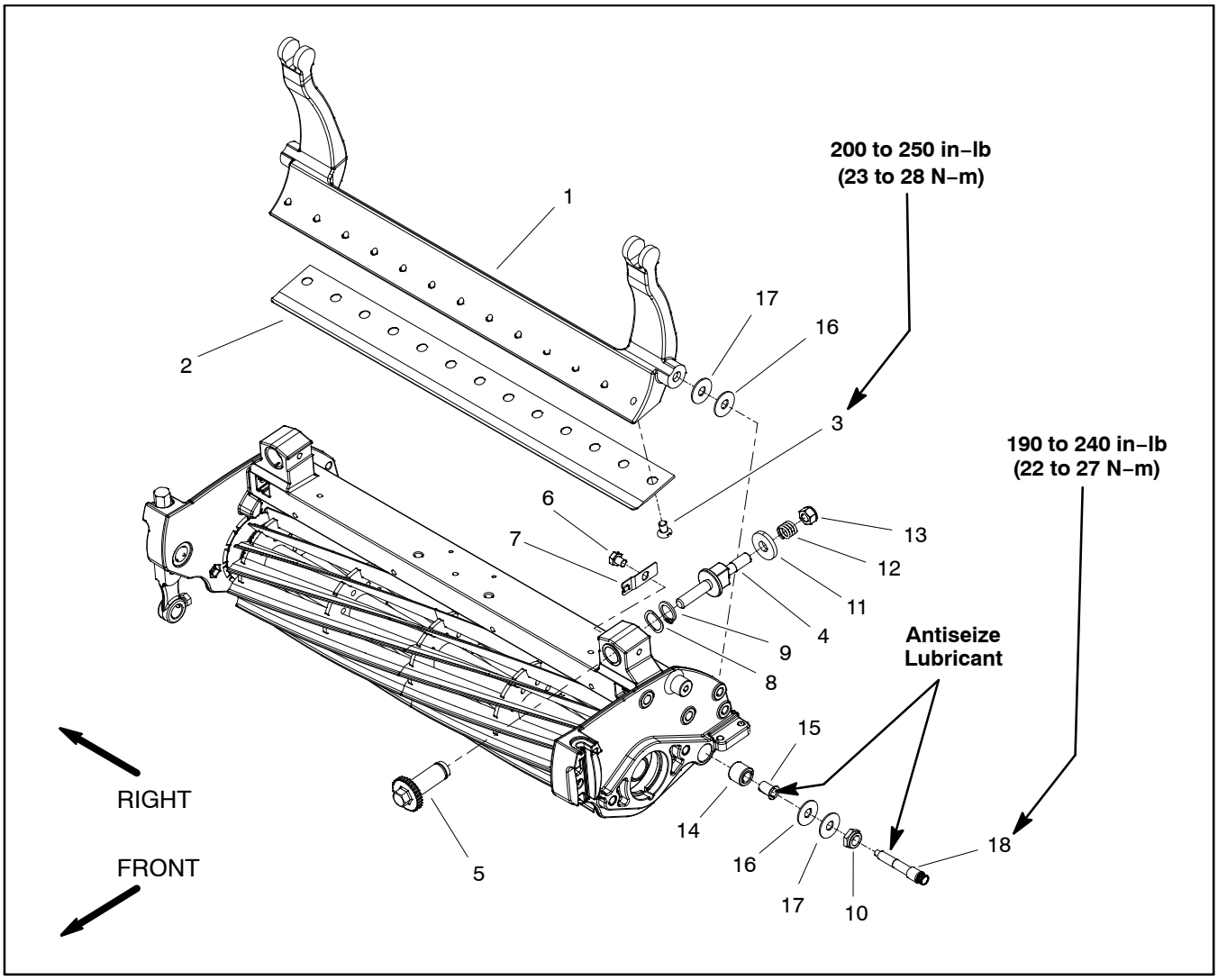

Figure 16

1. Bedbar
2. Bedknife
3. Screw (13 used)
4. Bedbar adjuster screw (2 used)
5. Bedbar adjuster shaft (2 used)
6. Cap screw (2 used)
7. Detent (2 used)
8. Wave washer (2 used)
9. Retaining ring (2 used)
10. Lock nut (2 used)
11. Washer (2 used)
12. Compression spring (2 used)
13. Lock nut (2 used)
14. Rubber bushing (2 used)
15. Nylon bushing (2 used)
16. Plastic washer (4 used)
17. Metal washer (4 used)
18. Bedbar pivot bolt (2 used)

Bedbar Removal (Fig. 16)

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

2. Remove the cutting unit from the machine and place cutting unit on a flat work area.

3. Tip the cutting unit to expose the bedknife. Support the rear of the cutting unit (see Supporting Cutting Unit when Servicing in the General Information section of this chapter).

4. Loosen the lock nuts (item 13) on the end of each bedbar adjuster assembly until washer (item 11) is loose.

5. Loosen the lock nuts (item 10) on each bedbar pivot bolt (item 18).

6. Remove two (2) bedbar pivot bolts (item 18), four (4) metal washers (item 17) and four (4) plastic washers (item 16) from the cutting unit side plates.

CAUTION

Contact with the reel, bedknife or other cutting unit parts can result in personal injury. Use heavy gloves when handling the bedbar.

7. Remove bedbar assembly from cutting unit.

8. Inspect nylon bushings (item 15) and rubber bushings (item 14) in side plates for wear or damage. Remove bushings and replace if necessary.

Bedbar Installation (Fig. 16)

1. If rubber bushing was removed from either cutting unit side plate, apply grease to outside surface of new bushing and install into side plate. The bushing should be installed flush with the inside of the side plate (Fig. 17).

2. If removed, install the nylon bushings (item 15) with flange facing outward. Apply antiseize lubricant to inside of flange bushing.

3. Apply antiseize lubricant to the bedbar threads and the shoulder area of each bedbar pivot bolt (Fig. 17).

IMPORTANT: When installing washers (items 16 and 17), make sure that plastic washers are positioned on either side of the cutting unit sideplate (Fig. 17).

4. Slide one (1) metal washer (item 17) and then one (1) plastic washer (item 16) onto each bedbar pivot bolt.

CAUTION

Contact with the reel, bedknife or other cutting unit parts can result in personal injury. Use heavy gloves when handling the bedbar.

5. Position bedbar into cutting unit. Make sure that the top of each bedbar arm is between washer (item 11) and adjuster screw flange (item 4).

6. Position one (1) metal washer (item 17) and one (1) plastic washer (item 16) between bedbar and each cutting unit side plate (Fig. 17).

7. Install the bedbar pivot bolt assemblies. Make sure that plastic washers are not caught on the threads of the pivot bolts. Torque each bedbar pivot bolt from **190 to 240 in–lb (22 to 27 N–m)**.

8. Tighten both lock nuts (item 10) until outside washers do not have any endplay but still can be rotated. Do not over tighten the lock nuts as this can distort the side plates and affect reel bearing adjustment. When the lock nut is correctly tightened, there may be a gap at the inside washers.

9. Tighten the lock nut (item 13) on each bedbar adjuster assembly until the adjuster spring is fully compressed, then loosen lock nut 1/2 turn.

10. Adjust cutting unit (see Cutting Unit Operator's Manual).

11. Install cutting unit to machine.

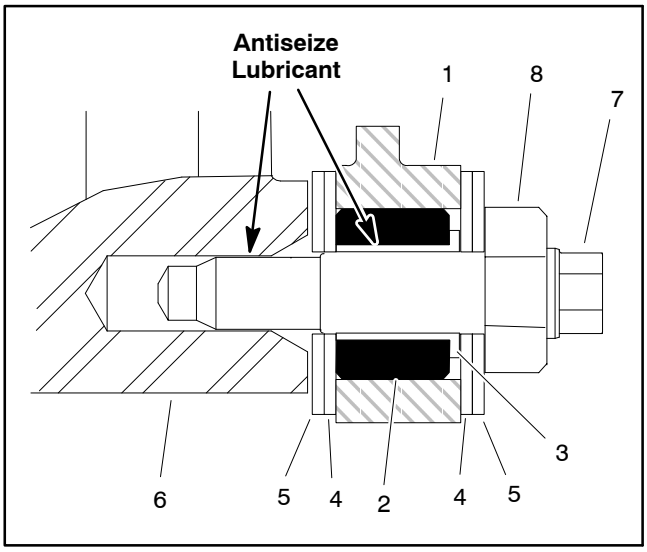

Figure 17

1. Cutting unit sideplate
2. Rubber bushing
3. Nylon bushing
4. Plastic washer
5. Metal washer
6. Bedbar
7. Bedbar pivot bolt
8. Lock nut

Bedknife Replacement and Grinding

Bedknife Removal

1. Remove bedbar from cutting unit (see Bedbar Removal in this section).

2. Remove screws from bedbar using a socket wrench and bedknife screw tool (see Special Tools in this chapter). Discard screws. Remove bedknife from the bedbar (Fig. 18).

3. See bedknife grinding information on the following pages.

Bedknife Installation

1. Use scraper to remove all rust, scale and corrosion from bedbar surface. Lightly oil bedbar surface before installing bedknife.

2. Make sure that screw threads in bedbar (5/16−18UNC−2A) are clean.

IMPORTANT: Do not use an impact wrench to tighten screws into the bedbar.

3. Use new screws to secure bedknife to bedbar. Apply antiseize lubricant to the threads of new screws. Do not apply antiseize lubricant to the taper of the screw heads.

4. Install all screws but do not tighten.

5. Using a torque wrench and bedknife screw tool, tighten the 2 outer screws to **10 in−lb (1 N−m)**.

6. Working from the center of the bedknife toward each end (Fig. 19), tighten screws from **200 to 250 in−lb (23 to 28 N−m)**.

7. After installing bedknife to bedbar, grind bedknife.

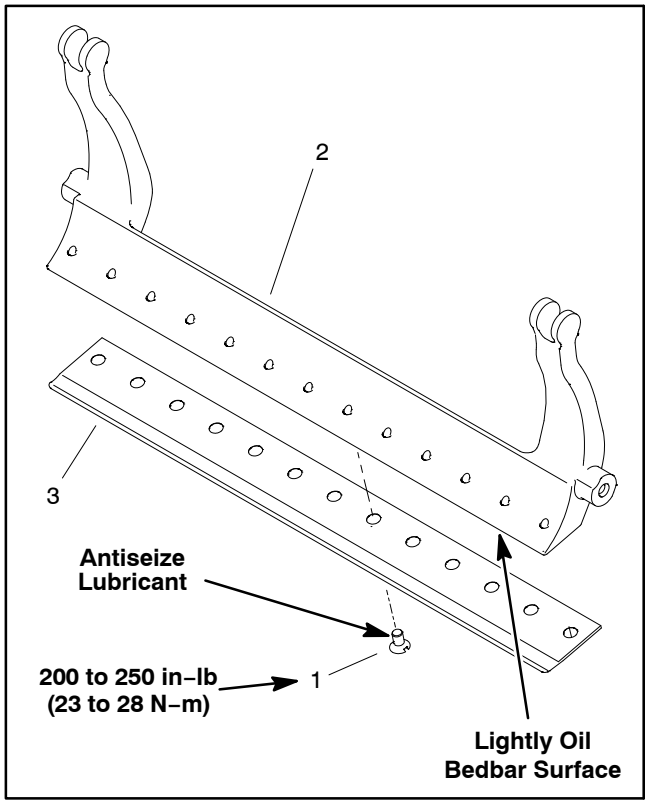

Figure 18

1. Screw (13)
2. Bedbar
3. Bedknife

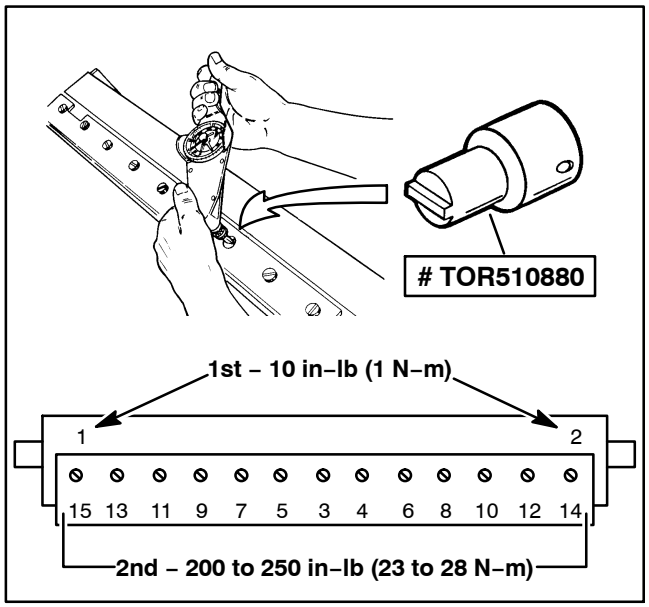

Figure 19

Bedknife Grinding

Since there can be variations in the mounting surface of the bedbar, it is necessary to grind the bedknife after installing it to the bedbar. Follow the bedknife grinding specifications provided (Fig. 20). Grind only enough so the top surface of the bedknife is true (Fig. 21).

IMPORTANT: Do Not grind the bedknife below it's service limit (Fig 22). Operating the cutting unit with the bedknife below the service limit may result in poor after−cut appearance and reduce the structural integrity of the bedknife.

The bedknife service limit occurs when the reel contacts the back of the bedknife scallop during operation. Check for reel contact marks at the back of the bedknife scallop prior to grinding. The bedknife service limit may also occur when the bottom of the bedknife scallop is reached when grinding the bedknife.

When grinding the bedknife, be careful to not overheat the bedknife. Remove small amounts of material with each pass of the grinder. **Also, clean and dress grinding stone often during the grinding process.**

NOTE: EdgeMax® bedknives are extremely hard. Using a diamond grinding wheel is recommended to prevent overheating or damaging the bedknife edge while grinding.

Because the top grind angle on bedknives is critical for edge retention, and therefore after−cut appearance, Toro has developed special service tools for accurately measuring the top grind angle on all bedknives; refer to the Angle Indicator and Magnetic Mount in the Special Tools section of this Chapter.

1. Use Toro General Service Training Book, Reel Mower Basics (part no. 09168SL) and grinder manufacturer's instructions for bedknife grinding information.

2. After bedknife grinding is complete, install bedbar to cutting unit (see Bedbar Installation in this section).

NOTE: Always adjust the cutting unit after grinding the reel and/or bedknife; refer to the Cutting Unit Operator's Manual. If a properly adjusted cutting unit does not cut paper cleanly after grinding, the grind angle may be incorrect. To extend the cutting unit performance by allowing the reel and the bedknife to hold their edge longer, an additional adjustment may be required after the first few minutes of operation as the reel and bedknife conform to each other.

Bedknife Grinding Specifications (see Fig. 21)	
Standard bedknife relief angle	3º minimum
Fairway bedknife relief angle	3º minimum
Extended bedknife relief angle	7º minimum
Front Angle Range	13º to 17º

Figure 20

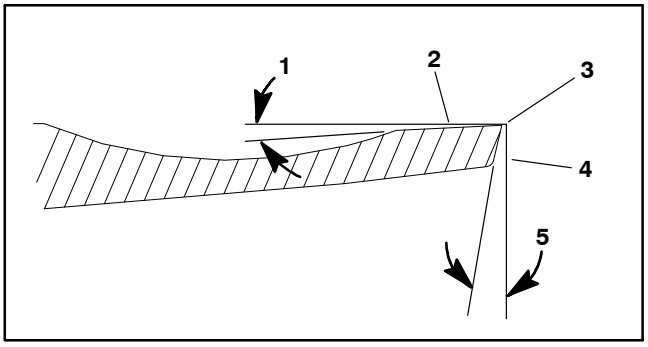

Figure 21

1. **Top angle**
2. **Top surface**
3. **Remove burr (without dulling sharp corner)**
4. **Front surface**
5. **Front angle**

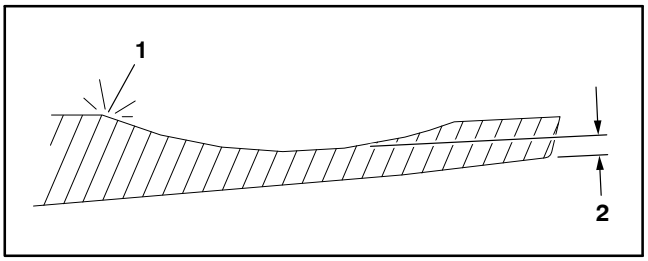

Figure 22

1. **Service limit (reel contacts back of bedknife scallop during operation)**
2. **Service limit (bottom of bedknife scallop reached when grinding)**

Bedbar Adjuster Service

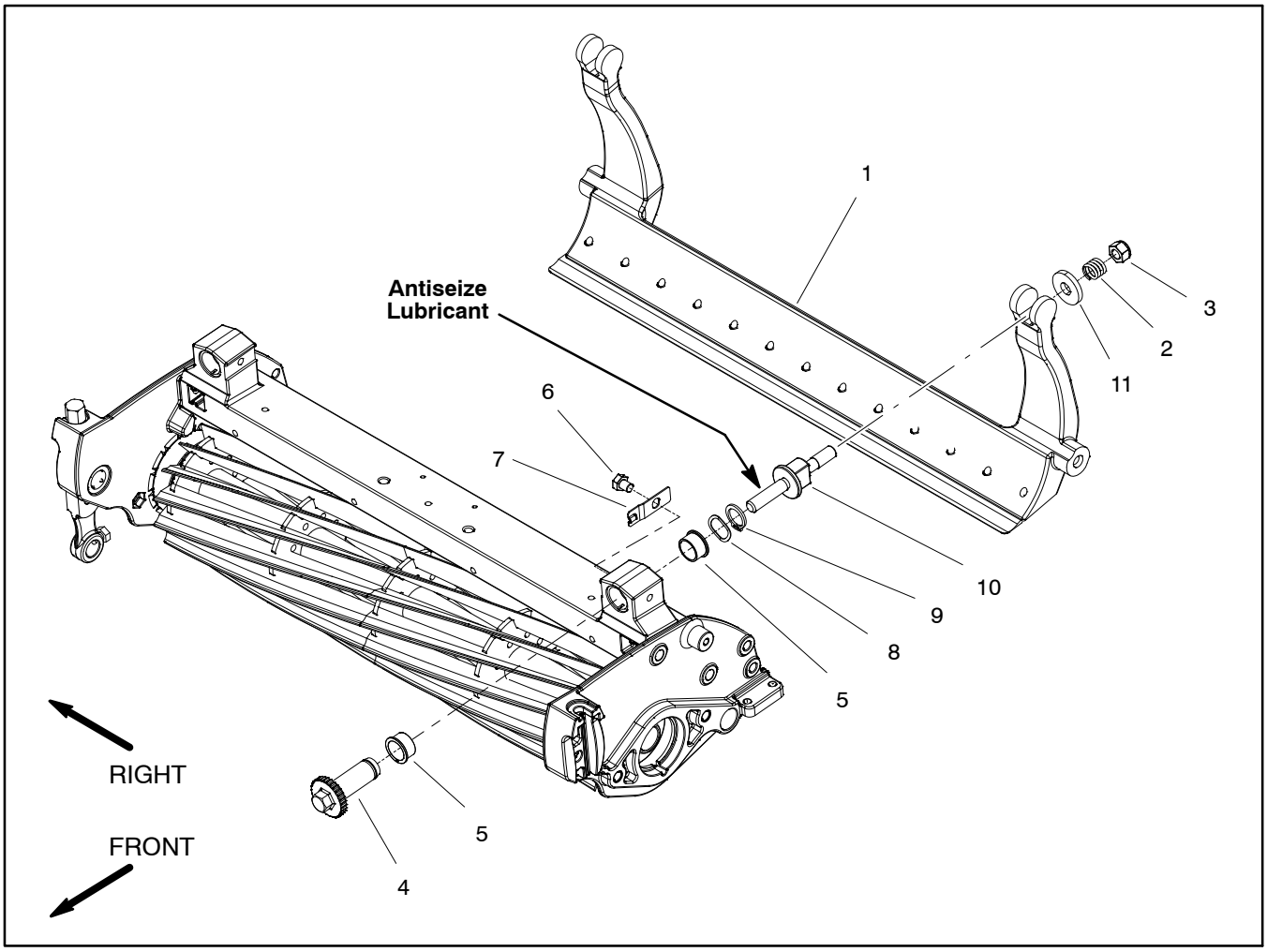

Figure 23

1. **Bedbar assembly**
2. **Compression spring**
3. **Lock nut**
4. **Bedbar adjuster shaft**
5. **Flange bushing**
6. **Cap screw**
7. **Detent**
8. **Wave washer**
9. **Retaining ring**
10. **Bedbar adjuster screw**
11. **Washer**

Removal (Fig. 23)

1. Remove lock nut (item 3), compression spring (item 2) and washer (item 11) from bedbar adjuster screw.

2. Remove bedbar (see Bedbar Removal in this section).

NOTE: Bedbar adjuster shaft (item 4) has left–hand threads.

3. Unscrew bedbar adjuster shaft (item 4) from the bedbar adjuster screw (item 10).

4. Remove retaining ring (item 9) and wave washer (item 8) from adjuster shaft and remove adjuster shaft from cutting unit frame.

5. Inspect flange bushings (item 5) in cutting unit side plate and remove if necessary.

6. If detent (item 7) is damaged, remove it from cutting unit side plate by removing the cap screw (item 6).

Installation (Fig. 23)

1. If detent (item 7) was removed, secure detent to cutting unit side plate with cap screw.

2. If flange bushings (item 5) were removed, align key on bushing to slot in frame and install bushings.

3. Slide adjuster shaft (item 4) into flange bushings in cutting unit side plate. Secure adjuster shaft with wave washer (item 8) and retaining ring (item 9).

NOTE: Bedbar adjuster shaft (item 4) has left–hand threads.

4. Apply antiseize lubricant to threads of bedbar adjuster screw that fit into adjuster shaft. Thread bedbar adjuster screw (item 10) into adjuster shaft.

5. Install bedbar (see Bedbar Installation in this section).

6. Install washer (item 11), spring (item 2) and lock nut (item 3) onto adjuster screw. Tighten the lock nut on each bedbar adjuster assembly until the compression spring is fully compressed, then loosen lock nut 1/2 turn.

7. Adjust cutting unit (see Cutting Unit Operator's Manual).

Reel Assembly

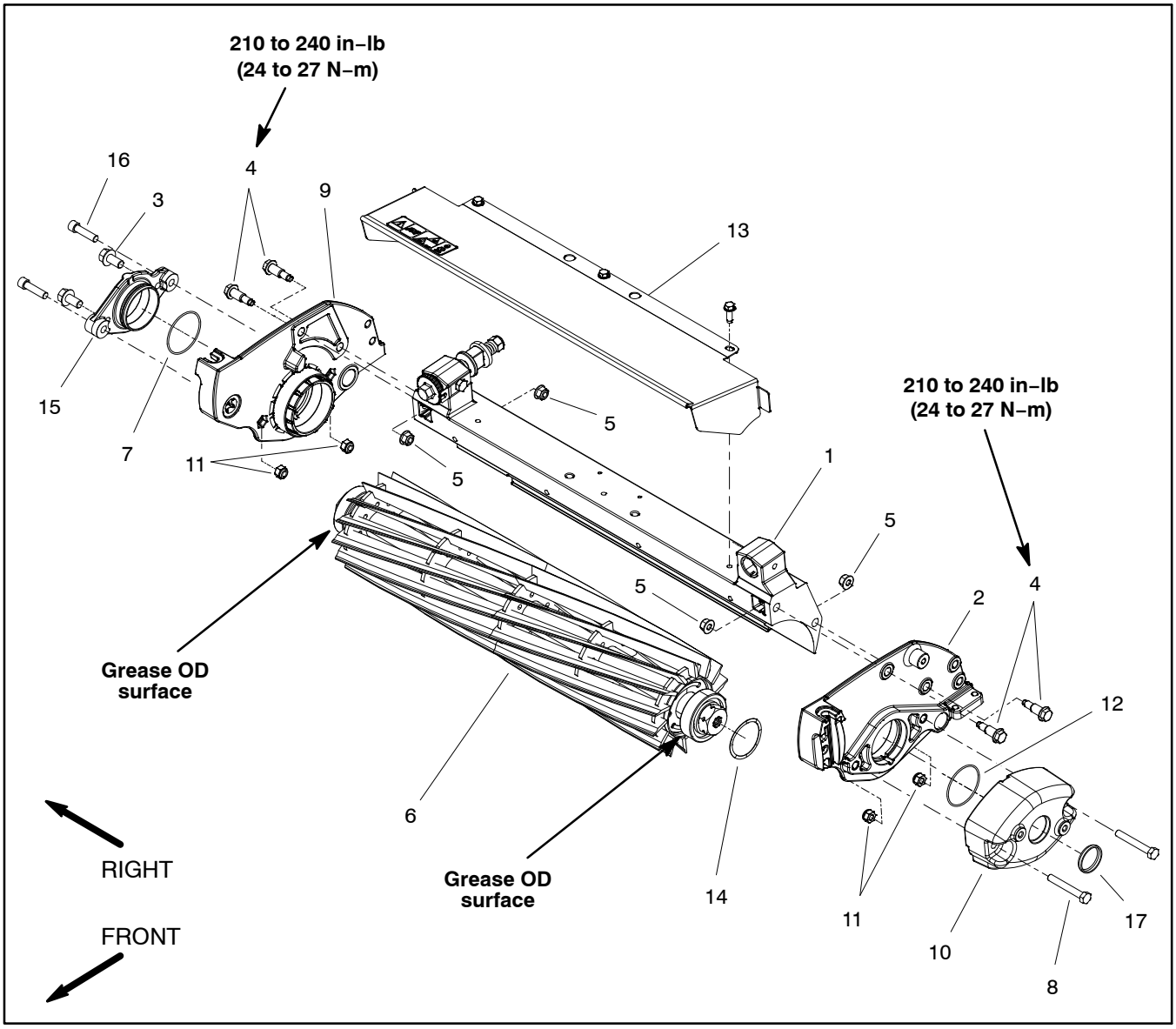

Figure 24

1. Crossmember
2. LH side plate
3. Flange head screw (2 used)
4. Shoulder bolt (2 used per side plate)
5. Flange nut (2 used per side plate)
6. Cutting reel assembly
7. O–ring
8. Cap screw (2 used)
9. RH side plate
10. Weight
11. Hex nut (4 used)
12. O–ring
13. Grass shield
14. Flat wire spring
15. Reel motor adapter
16. Socket head screw (2 used)
17. Expansion plug

NOTE: This section provides the procedure for removing and installing the cutting reel assembly (cutting reel, flocked seals, reel bearings, bearing lock screw and reel nut) from the cutting unit. Refer to Reel Assembly Service later in this section for information on servicing the cutting reel assembly.

NOTE: Removal of the cutting reel requires removal of the LH side plate from the cutting unit crossmember. The RH side plate does not have to be removed from the frame when using the following procedure.

Reel Assembly Removal (Fig. 24)

CAUTION

Contact with the reel, bedknife or other cutting unit parts can result in personal injury. Use heavy gloves when removing the cutting reel.

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

2. Remove the cutting unit from the machine and place cutting unit on a flat work area.

3. If cutting unit is equipped with an optional groomer or rear roller brush, remove drive components for those options from cutting unit. See Service and Repairs section of Chapter 8 – Belt Driven Groomer, or Chapter 9 – Universal Groomer for information on groomer. See Rear Roller Brush in this section for information on rear roller brush.

4. Remove two (2) cap screws and nuts that secure weight (item 10) to the LH side plate. Remove weight from the cutting unit. Remove and discard O–ring from weight.

IMPORTANT: If the reel bearings or seals are being replaced, the reel nuts must be removed. Use the following procedure to restrain the reel and loosen the reel nuts before removing the rollers.

5. Loosen the reel nuts (Fig. 25):

A. Tip up the cutting unit to access the bottom of the reel.

B. Insert a long–handled pry bar (3/8 x 12 inch with screwdriver handle recommended) through the bottom of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move (Fig. 26).

IMPORTANT: To avoid grinding the reel, do not contact the cutting edge of any blade with the pry bar as this may damage the cutting edge and/or cause a high blade.

C. Move the pry bar against the weld side of the reel support plate closest to the reel nut being loosened.

IMPORTANT: The reel nut on the left end of the cutting reel has a black finish and has left–hand threads. The reel nut on the right end of the cutting reel has a silver finish and has right–hand threads (Fig. 25).

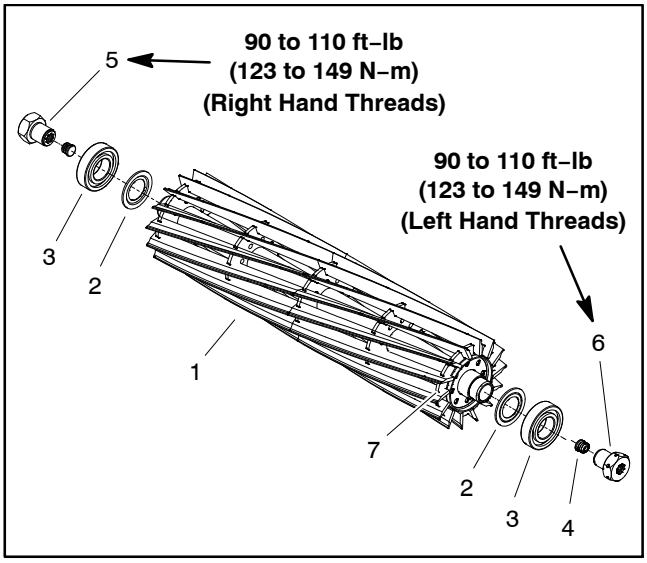

Figure 25

1. **Cutting reel**
2. **Flocked seal (2 used)**
3. **Bearing (2 used)**
4. **Plug (2 used)**
5. **Bearing lock screw**
6. **Reel nut (LH threads)**
7. **Reel groove location**

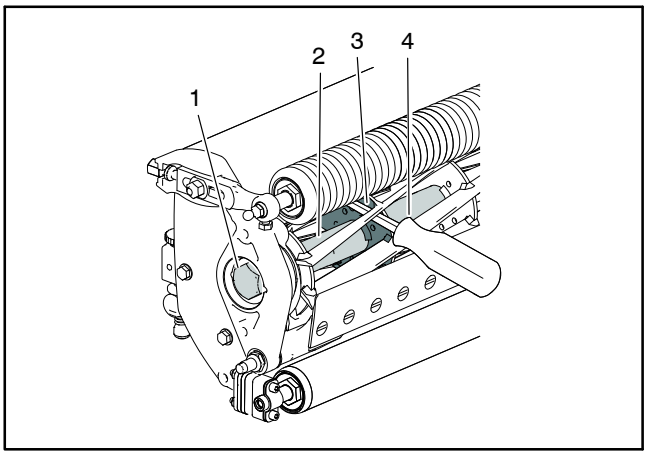

Figure 26

1. **Reel nut**
2. **Reel shaft**
3. **Support plate, weld side**
4. **Pry bar**

D. Rest the handle of the pry bar against the front roller and loosen the reel nut closest to the pry bar.

E. Position the pry bar in the same manner on the opposite end of the reel and loosen the remaining reel nut.

F. Tip the cutting unit back onto its rollers.

6. Remove the bedbar pivot bolt and washers from the LH side plate. Note location of plastic and steel washers for assembly purposes (see Bedbar Removal in this section).

7. Loosen fasteners that secure front and rear rollers to LH side plate (see Front Roller Removal and Rear Roller Removal in this section).

8. Support cutting reel to prevent it from shifting or falling.

9. Remove shoulder bolts (item 4) and flange nuts (item 5) that secure the LH side plate to the cutting unit crossmember. Remove the LH side plate from the reel shaft, rollers, bedbar and cutting unit crossmember.

10. Carefully slide the cutting reel assembly (with flocked seals, reel bearings and reel nuts) from the RH side plate.

Reel Assembly Installation (Fig. 24)

1. Thoroughly clean side plates and other cutting unit components. Inspect side plates for wear or damage and replace components if needed.

2. Make sure that flocked seals, reel bearings and reel nuts are properly positioned on cutting reel (see Reel Assembly Service in this section). Apply thin coat of grease to outside of bearings on cutting reel to ease reel installation.

CAUTION

Contact with the reel, bedknife or other cutting unit parts can result in personal injury. Use heavy gloves when installing the cutting reel.

3. Position the cutting unit on a flat work area. The rollers, bedbar and cutting unit crossmember should be attached to RH side plate.

4. Carefully slide the cutting reel assembly (with flocked seals, reel bearings and reel nuts) into the RH side plate. Make sure that bearing is fully seated into side plate.

5. Place flat wire spring (item 14) into bearing bore of LH side plate. Carefully slide the LH side plate onto the cutting reel assembly, front roller and rear roller. Make sure that side plate is fully seated onto bearing on reel shaft.

6. Install shoulder bolts (item 4) and flange nuts (item 5) to secure the LH side plate to the crossmember. Torque the shoulder bolts from **210 to 240 in–lb (24 to 27 N–m)**.

7. Secure front and rear rollers to LH side plate (see Front Roller Installation and Rear Roller Installation in this section).

8. Secure the bedbar assembly to LH side plate (see Bedbar Installation in this section). Make sure that plastic and steel washers are properly positioned.

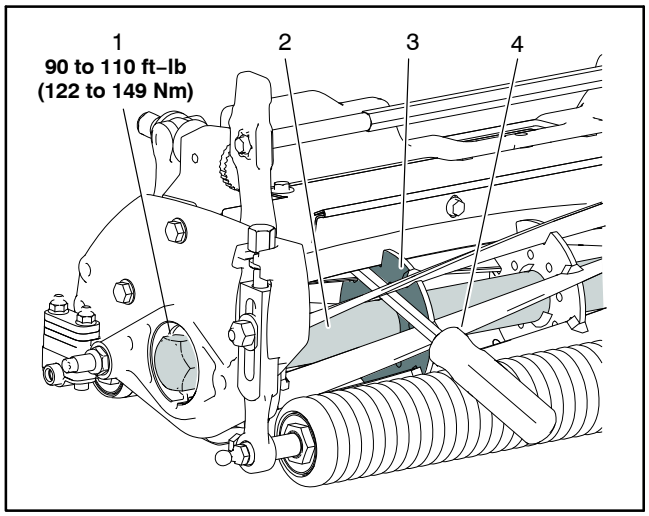

Figure 27

1. **Reel nut (2 each)**
2. **Reel shaft**
3. **Support plate, weld side**
4. **Pry bar**

9. Tighten the reel nuts (Fig. 25):

A. Insert a long–handled pry bar (3/8 x 12 inch with a screwdriver handle recommended) through the front of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move (Fig. 27).

IMPORTANT: To avoid grinding the reel, do not contact the cutting edge of any blade with the pry bar as this may damage the cutting edge and/or cause a high blade.

B. Move the pry bar against the weld side of the reel support plate closest to the reel nut being tightened.

IMPORTANT: The reel nut on the left end of the cutting reel has a black finish and has left–hand threads. The reel nut on the right end of the cutting reel has a silver finish and has right–hand threads (Fig. 25).

C. Rest the handle of the pry bar against the front roller and tighten the reel nut closest to the pry bar. Tighten the reel nut from **90 to 110 ft–lb (123 to 149 N·m)**.

D. Position the pry bar in the same manner on the opposite end of the reel and tighten the remaining reel nut.

E. Fill the reel nut splines with high temp Mobil XHP¿222 grease or equivalent.

10. Thoroughly fill spline area of reel nuts with grease.

11. Adjust cutting unit (see Cutting Unit Operator's Manual).

NOTE: The parallel position of the rear roller to the cutting reel is controlled by the precision machined crossmember and side plates of the cutting unit. If necessary, the cutting unit side plates can be loosened and a slight adjustment can be made to parallel the rear roller with the cutting reel (see Leveling Rear Roller in the Set–Up and Adjustments section of this Chapter).

12. Install new O–ring (item 12) on weight (item 10). Secure weight to LH side plate with two (2) cap screws and nuts.

13. If cutting unit is equipped with optional groomer or rear roller brush, install components for those options to cutting unit. See Service and Repairs section of Chapter 8 – Belt Driven Groomer, or Chapter 9 – Universal Groomer for information on groomer. See Rear Roller Brush in this section for information on rear roller brush.

14. Install cutting unit to the machine.

Reel Assembly Service

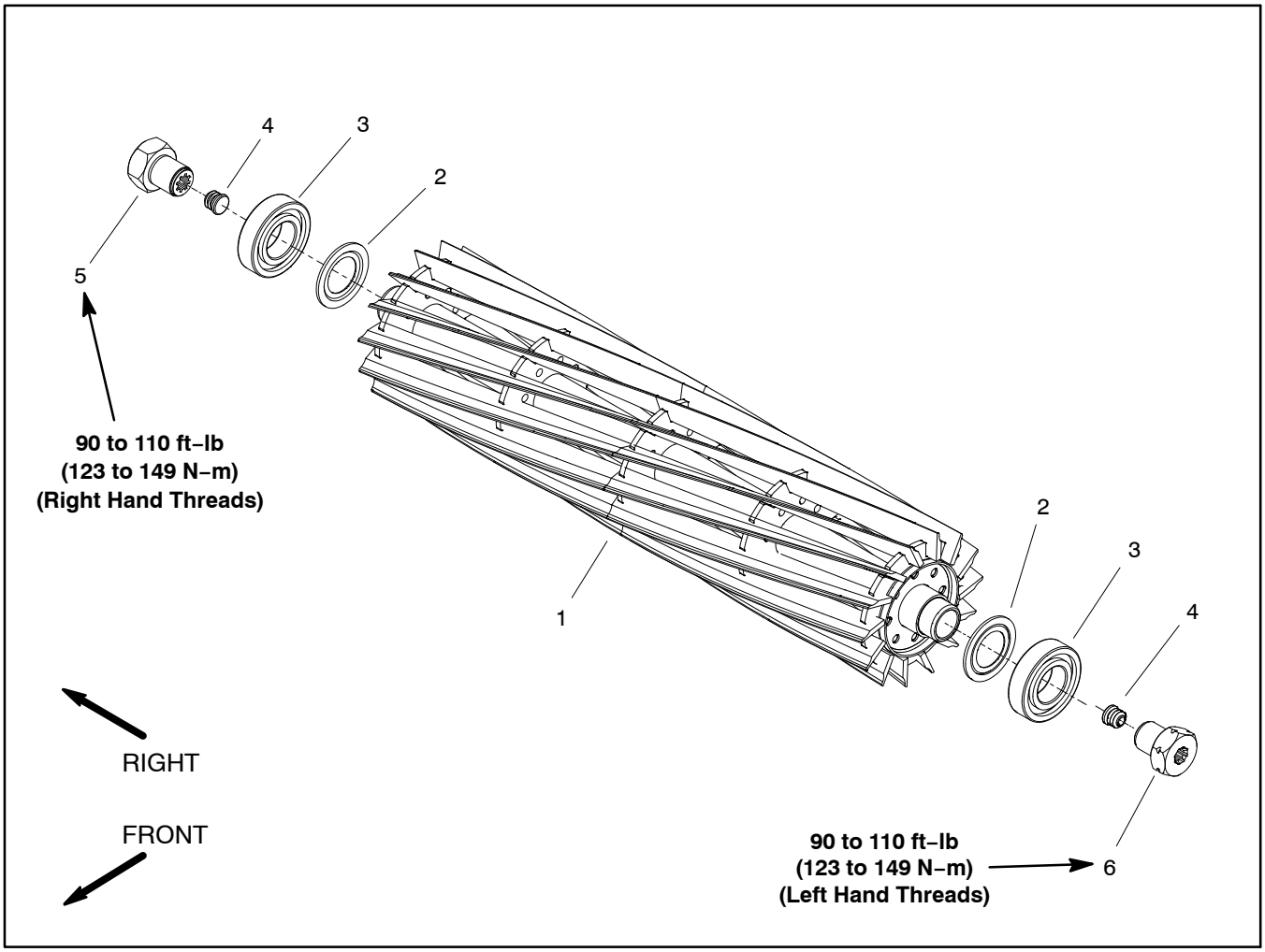

Figure 28

1. **Cutting reel**
2. **Flocked seal (2 used)**
3. **Bearing (2 used)**
4. **Plug (2 used)**
5. **Reel nut (RH thread)**
6. **Reel nut (LH thread)**

NOTE: The reel nuts (items 5 and 6) are different. The reel nut with left hand threads (item 6) has a black finish and has notches on the head. The reel nut with right hand threads (item 5) has a zinc finish and does not have notches on the head.

Disassembly of Cutting Reel (Fig. 28)

1. Remove reel nuts (items 5 and 6) from cutting reel. The black reel nut (item 6) has LH threads and is installed in end of reel shaft identified with a groove that is just inside of reel spider (Fig. 29).

2. Slide bearings from reel shaft.

3. Note orientation of flocked seals for assembly purposes. Remove seals from reel shaft.

Inspection of Cutting Reel (Fig. 28)

1. Inspect reel bearings to insure that they spin freely and have minimal axial play.

2. Inspect the reel shaft as follows. If reel damage is detected, replace reel.

   A. Check the reel shaft for bending and distortion by placing the shaft ends in V−blocks.

   B. Check the reel blades for bending or cracking.

   C. Check the service limit of the reel diameter (see Preparing a Reel for Grinding in this section).

   D. Check threads in ends of reel shaft.

3. Check the splines in the reel nuts (items 5 and 6) for excessive wear or distortion. Replace reel nuts if damage is evident.

Assembly of Cutting Reel (Fig. 28)

1. If bearings and/or flocked seals were removed from reel shaft, discard removed components and replace.

IMPORTANT: The flocked seal should be installed so the flocked side of the seal is toward the bearing location.

2. Slide flocked seals (flocked side orientated toward bearing location) and bearings fully onto reel shaft. Bearings and seals should bottom on reel shaft shoulder.

3. Install reel nuts (items 5 and 6) into reel shaft to secure bearings. Black reel nut (item 6) has LH threads and should be installed in end of reel shaft identified with a groove that is just inside of reel spider (Fig. 29).

NOTE: Installation torque for reel nuts is from **90 to 110 ft−lb (123 to 149 N−m)**. It is easiest to torque these items after the cutting reel is installed in the cutting unit frame (see Reel Assembly Removal and Installation in this section).

4. Thoroughly fill spline area of reel nuts with grease.

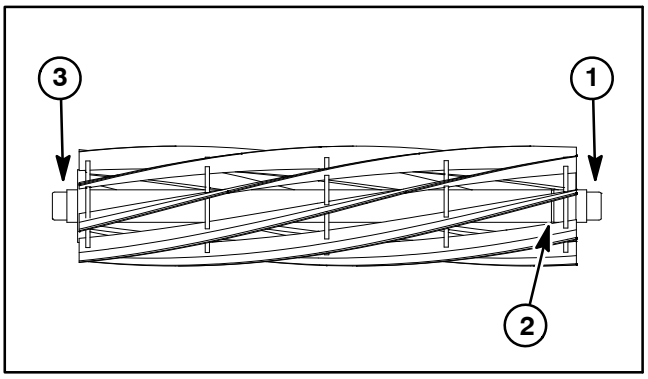

Figure 29

1. **LH threads**
2. **Groove**
3. **RH threads**

Preparing Reel for Grinding

NOTE: Before grinding a cutting reel, make sure that all cutting unit components are in good condition. Depending on type of grinder used, faulty cutting unit components can affect grinding results.

NOTE: When grinding, be careful to not overheat the cutting reel blades. Remove small amounts of material with each pass of the grinder.

1. Follow reel grinder manufacturer's instructions to grind cutting reel to Toro specifications (see Reel Grinding Specifications chart to the right). Additional reel grinding information can be found in the Toro General Service Training Book, Reel Mower Basics (part no. 09168SL).

2. After completing the reel grinding process, adjust cutting unit (see Cutting Unit Operator's Manual).

Reel Grinding Specifications	
Reel Diameter (New)	5.06 in (128.5 mm)
Service Limit - Reel Diameter	4.50 in (114.3 mm)
Reel Shaft Diameter (OD)	1.375 in (34.9 mm)
Blade Relief Angle	30º
Blade Relief Angle Range	28º to 32º
Blade Land Width	0.040 in (1.0 mm)
Blade Land Width Range	0.030 to 0.050 in (0.8 to 1.2 mm)
Service Limit - Reel Diameter Taper	0.010 in (0.25 mm)

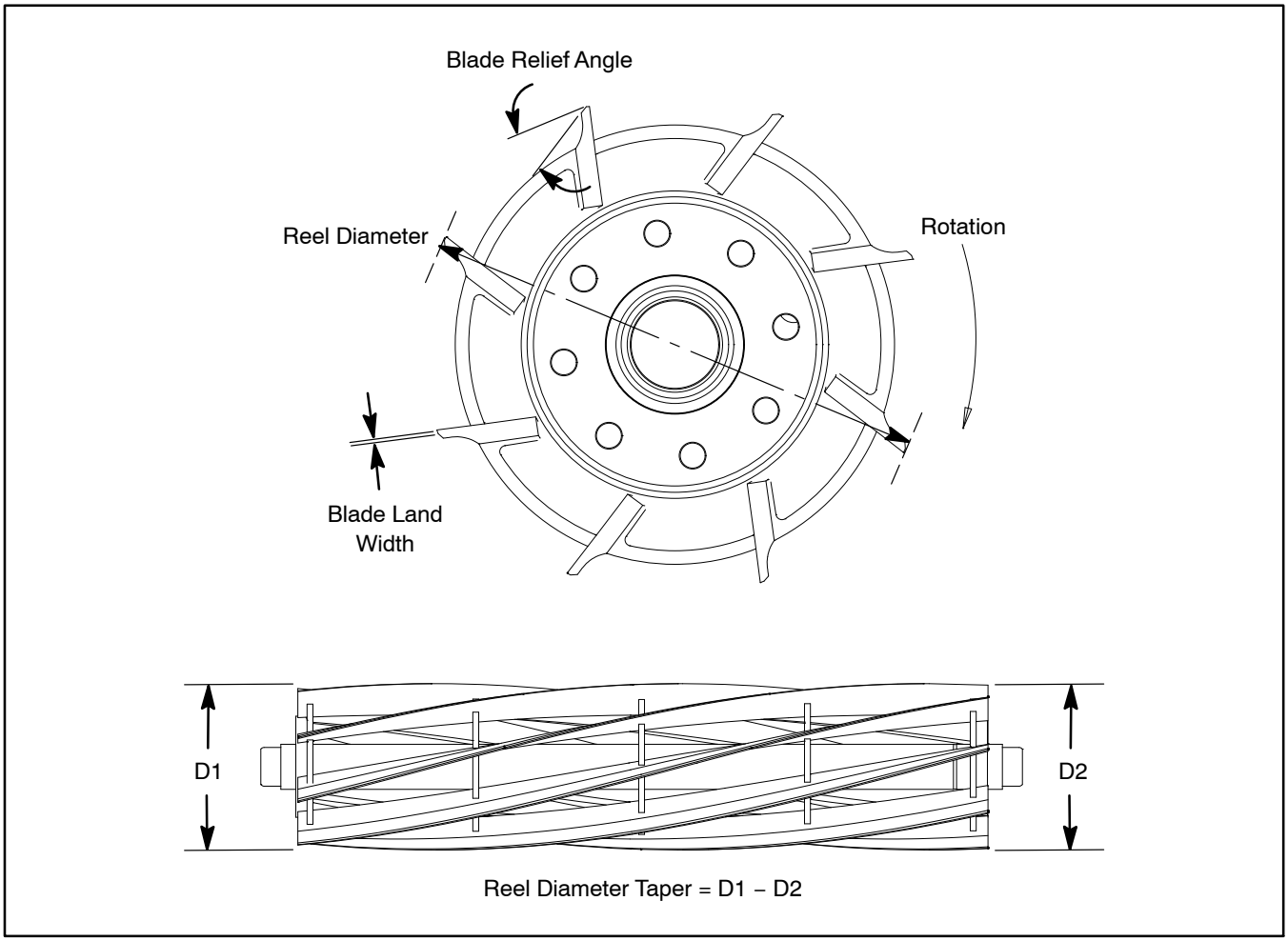

Figure 30

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Front Roller

Removal (Fig. 31)

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

2. Remove the cutting unit from the machine and place on a level working surface. Use appropriate support to raise front roller from work surface.

3. Loosen cap screw (item 1) that secures the front roller shaft to each front height−of−cut arm.

4. On one of the height−of−cut arms, remove HOC nut (item 7), HOC washer (item 6) and plow bolt (item 4) that secure HOC arm to the cutting unit side plate. Remove the HOC arm from the cutting unit.

5. Slide the front roller assembly from the remaining HOC arm on the cutting unit.

6. If necessary, remove the second HOC arm from the cutting unit.

Installation (Fig. 31)

1. Place cutting unit on a level working surface and use appropriate support to support front of cutting unit.

2. Inspect condition of HOC screws (item 5) in both HOC arms. If necessary, apply antiseize lubricant to threads of new HOC screw. Thread new HOC screw into HOC arm.

NOTE: When assembling HOC arms to side plates, make sure that ring on HOC screw fits into the notch on the side plate.

3. If both HOC arms were removed from cutting unit side plate, position one of the arms to side plate. Secure arm to side plate with plow bolt (item 4), HOC washer (item 6) and HOC nut (item 7). Tab on HOC washer should be positioned into HOC arm slot and orientated down toward the roller.

4. Slide front roller shaft into arm attached to the cutting unit. Slide second HOC arm onto the other end of roller shaft. Secure second arm to cutting unit side plate with plow bolt (item 4), HOC washer (item 6) and HOC nut (item 7).

5. Center front roller to the cutting reel and secure to HOC arms with cap screws (item 1).

6. Adjust cutting unit (see Cutting Unit Operator's Manual).

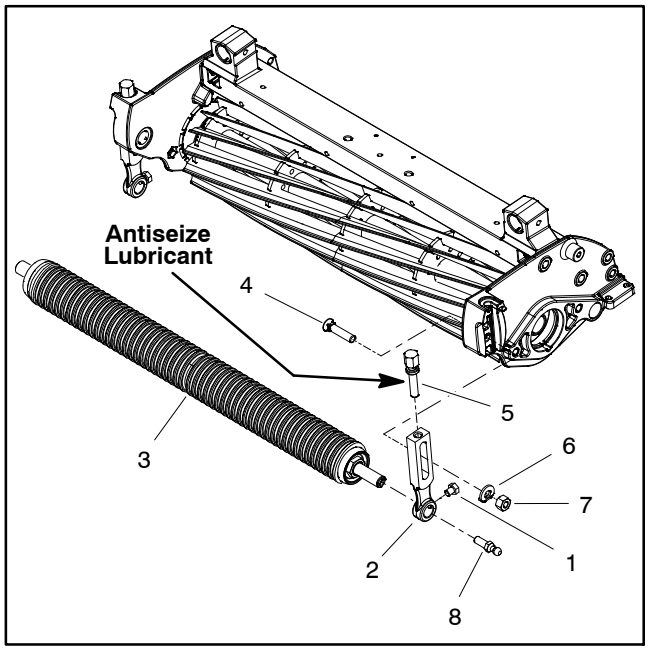

Figure 31

1. Cap screw
2. HOC arm
3. Front roller assembly
4. Plow bolt
5. HOC screw
6. HOC washer
7. HOC nut
8. Ball stud

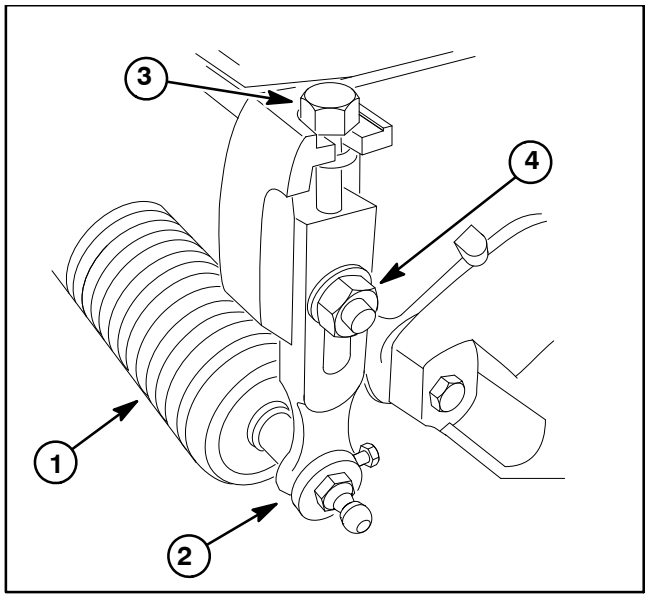

Figure 32

1. Front roller assembly
2. HOC arm
3. HOC screw
4. HOC washer & nut

Rear Roller

Removal (Fig. 33)

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

2. Remove the cutting unit from the machine and place on a level working surface. Place support blocks under bedbar to raise rear roller from work surface.

3. Loosen two (2) flange nuts that secure the rear roller shaft to each rear roller shaft retainer.

4. On one of the rear roller shaft retainer assemblies:

NOTE: On cutting units equipped with optional High Height of Cut Kit, there will be additional roller shims installed between roller height spacer and cutting unit side plate.

A. Note quantity and location of roller shims for assembly purposes.

B. Remove flange nuts and socket head screws that secure shaft retainer, roller height spacer and roller shims to the cutting unit side plate.

C. Remove the shaft retainer, height spacer and roller shims from the rear roller and cutting unit.

5. Slide the rear roller assembly from the remaining rear roller retainer assembly on the cutting unit.

6. If necessary, remove the second rear roller retainer assembly from the cutting unit.

Installation (Fig. 33)

1. Place cutting unit on a level working surface.

NOTE: Refer to Cutting Unit Operator's Manual for number of roller shims required for various height of cut settings.

2. If both rear roller retainer assemblies were removed from cutting unit, position shaft retainer, roller height spacer and roller shims to one of the side plates. Install two (2) carriage screws and flange nuts to retain assembly in position but do not fully tighten flange nuts.

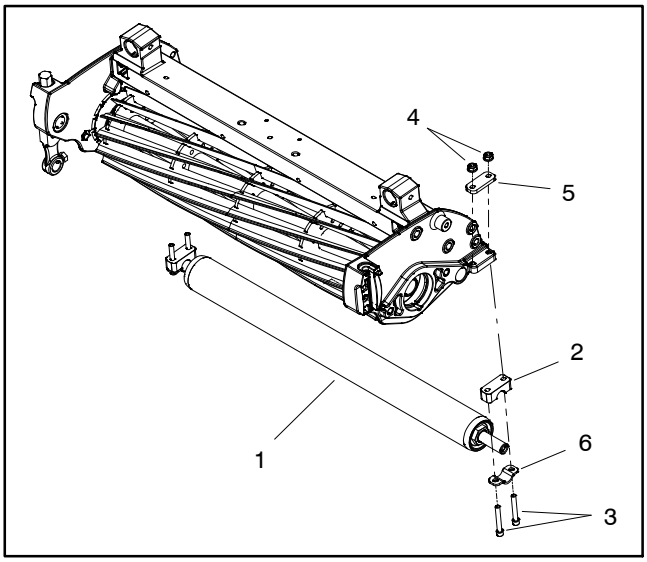

Figure 33

1. **Rear roller assembly**
2. **Roller height spacer**
3. **Socket head screw**
4. **Flange nut**
5. **Roller shim**
6. **Shaft retainer**

3. Slide rear roller shaft into the retainer assembly attached to the cutting unit. Slide second rear roller shaft retainer, roller height spacer and roller shims onto the other end of roller shaft. Secure second retainer assembly to cutting unit side plate with two (2) carriage screws and flange nuts. Do not fully tighten flange nuts.

4. Center rear roller to the cutting reel and secure in place by tightening four (4) flange nuts.

5. Adjust cutting unit (see Cutting Unit Operator's Manual).

Roller Service

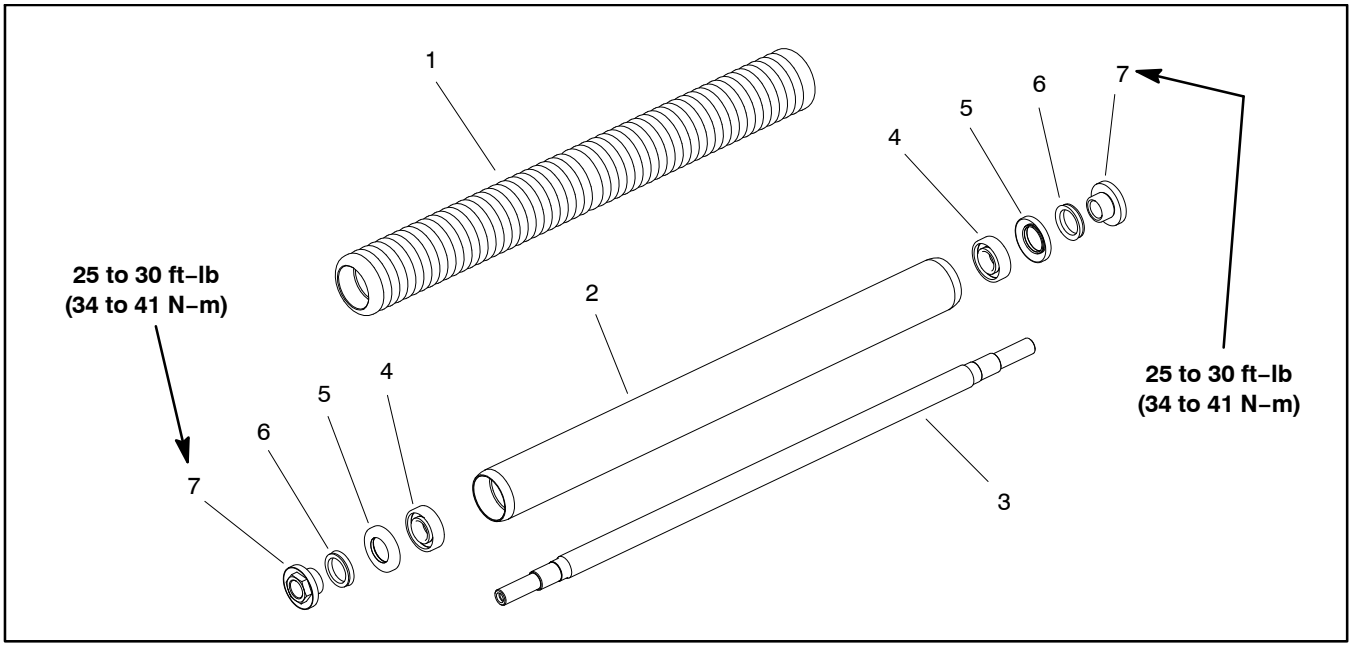

Figure 34

1. **Wiehle roller**
2. **Smooth roller**
3. **Roller shaft**
4. **Ball bearing**
5. **Seal**
6. **V–ring**
7. **Bearing lock nut**

Disassembly

1. To hold roller shaft for bearing lock nut removal, install a 3/8–24 UNF 2B screw into threaded end of roller shaft and secure screw in place with jam nut. While retaining shaft, remove bearing lock nut from each end of roller shaft.

2. Remove V–ring from each end of roller.

3. Carefully inspect seating surface and threads of bearing lock nuts. Replace lock nut if any damage is found.

4. Loosely secure roller assembly in bench vise and lightly tap one end of roller shaft until seal and bearing are removed from roller cavity. Remove second seal and bearing from roller cavity by tapping on shaft.

5. Clean bearing cavity in roller and remove any rust with crocus cloth.

Assembly

1. Place roller shaft into roller.

NOTE: If bearing lock nuts are being replaced, use original lock nuts for assembly purposes, if possible. This will preserve the patch lock feature in the new lock nuts. Use the new nuts only after new bearings and seals have been installed.

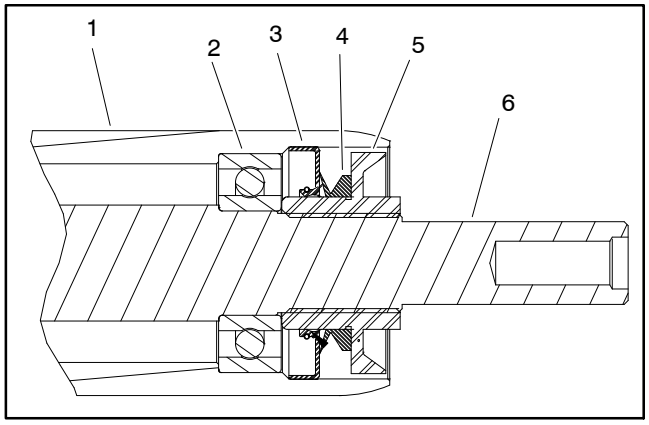

Figure 35

1. **Roller**
2. **Ball bearing**
3. **Seal**
4. **V–ring**
5. **Bearing lock nut**
6. **Roller shaft**

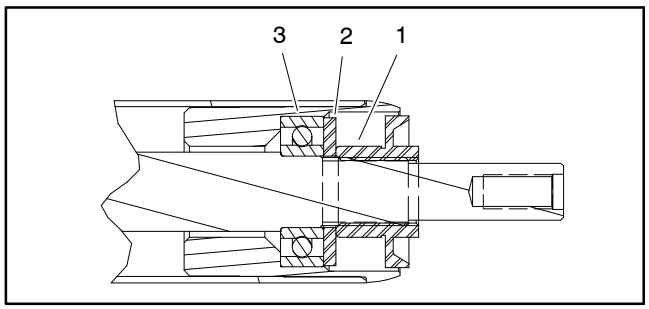

Figure 36

1. **Bearing lock nut**
2. **Black assembly washer**
3. **Bearing**

NOTE: Special tool TOR4105 (see Special Tools) can be used instead of washers and spacer when installing bearings and seals in roller.

2. Position a new bearing, black assembly washer (see Special Tools) and original lock nut onto each end of the roller shaft (Fig. 36).

3. Tighten nuts until the bearings are seated into each end of the roller.

4. Remove nut and black assembly washer from each end of the roller.

IMPORTANT: Failure to grease bearing lock nut before seal installation may result in seal damage.

5. Apply a coating of grease to the nut surface to prevent seal damage during seal installation (Fig. 37).

6. Carefully install seals onto bearing lock nuts. Pack the back of the seal 75 to 90% full with #2 grease (Fig. 37).

7. Install a nut with seal onto each end of the roller shaft. Tighten nuts until they bottom against bearings (Fig. 38). Remove nuts from roller shaft.

8. Position an assembly spacer and yellow assembly washer (see Special Tools) on each end of roller shaft (Fig. 39). Thread nut onto each end of shaft.

9. Tighten each nut until the yellow assembly washers bottom out against the roller housing. Remove nuts, assembly washers and assembly spacers from roller shaft.

10. Lubricate lips of installed seals with #2 grease.

11. Carefully slide a dry V−ring onto each bearing lock nut. The V−rings should be installed without any lubrication.

NOTE: If original bearing lock nut(s) are being used, apply Loctite #242 (or equivalent) to threads of lock nut(s).

12. Install bearing lock nut with V−ring onto each end of the roller shaft. Torque lock nuts from **25 to 30 ft−lb (34 to 41 N−m)**.

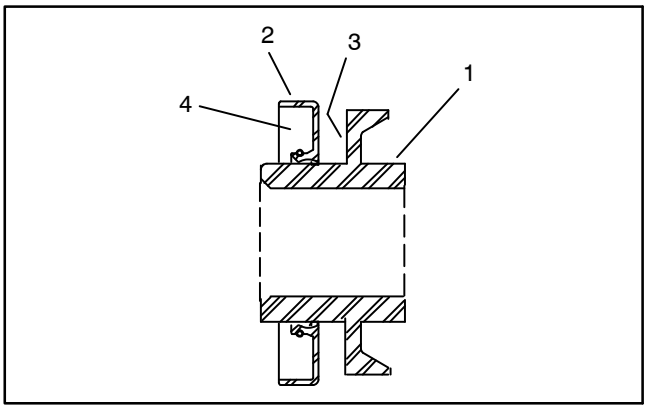

Figure 37

1. **Bearing lock nut**
2. **Seal**
3. **Grease nut surface**
4. **Pack with grease**

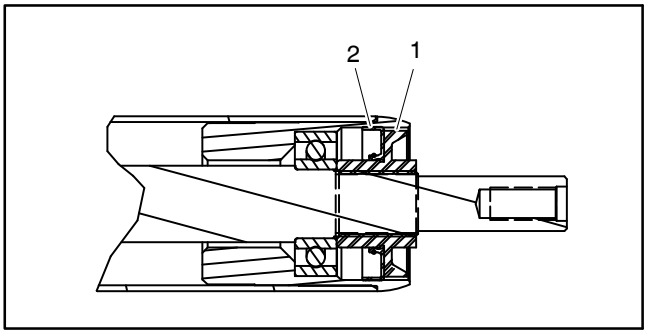

Figure 38

1. **Bearing lock nut**
2. **Seal**

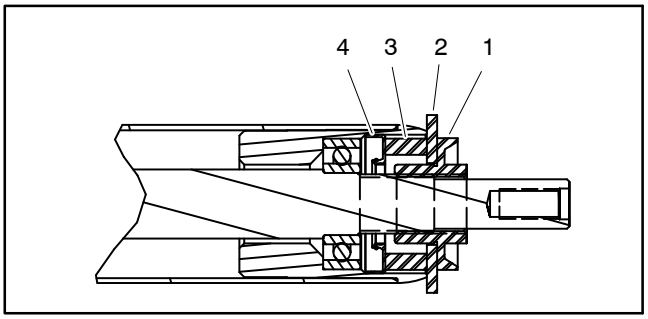

Figure 39

1. **Bearing lock nut**
2. **Yellow assembly washer**
3. **Assembly spacer**
4. **Seal**

Rear Roller Brushes (Optional)

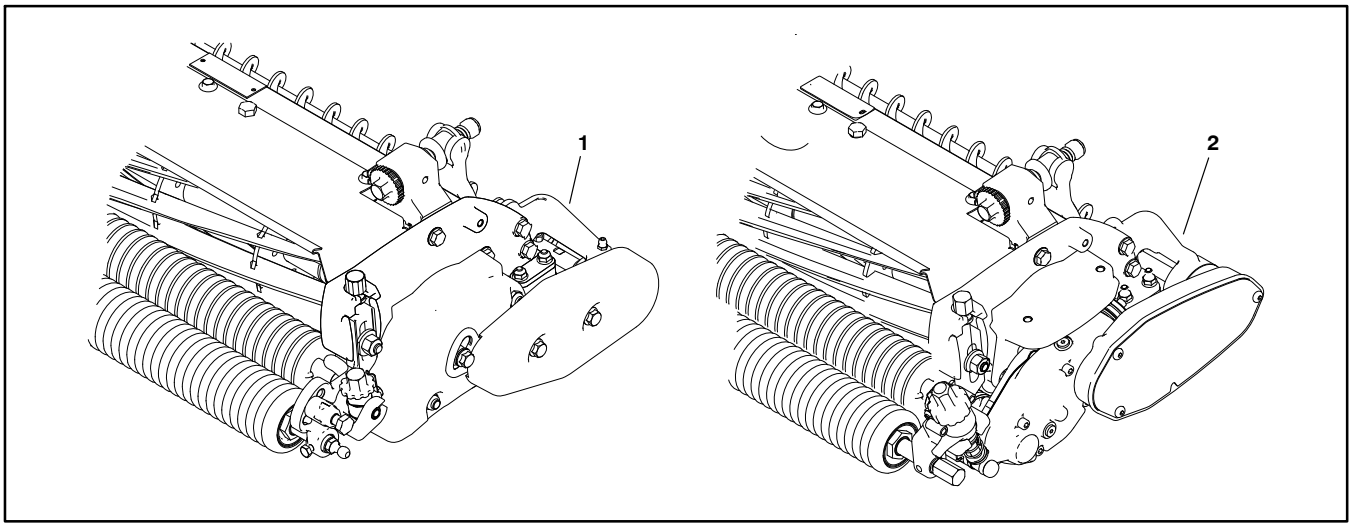

Figure 40

1. Rear roller brush for cutting units with or without a belt driven groomer
2. Rear roller brush for cutting units with or without a universal groomer

There are two different types of rear roller brush kits for Greensmaster 3150 cutting units. The earlier type of kit is designed to fit on cutting units with or without a belt driven groomer. A later type of kit is designed to fit on cutting units with or without a universal groomer. Please take a moment to determine which type of rear roller brush kit is installed on the cutting unit as the service information is different for each rear roller brush type.

Note: The *Installation Instructions* for the rear roller brush kit has detailed information regarding assembly and adjustment. Use the *Installation Instructions* along with this *Service Manual* when servicing the rear roller brush.

Drive components for the rear roller brush are located on the left side of the cutting unit (opposite from the hydraulic cutting unit motor).

Servicing the Rear Roller Brush (with or without a belt driven groomer)

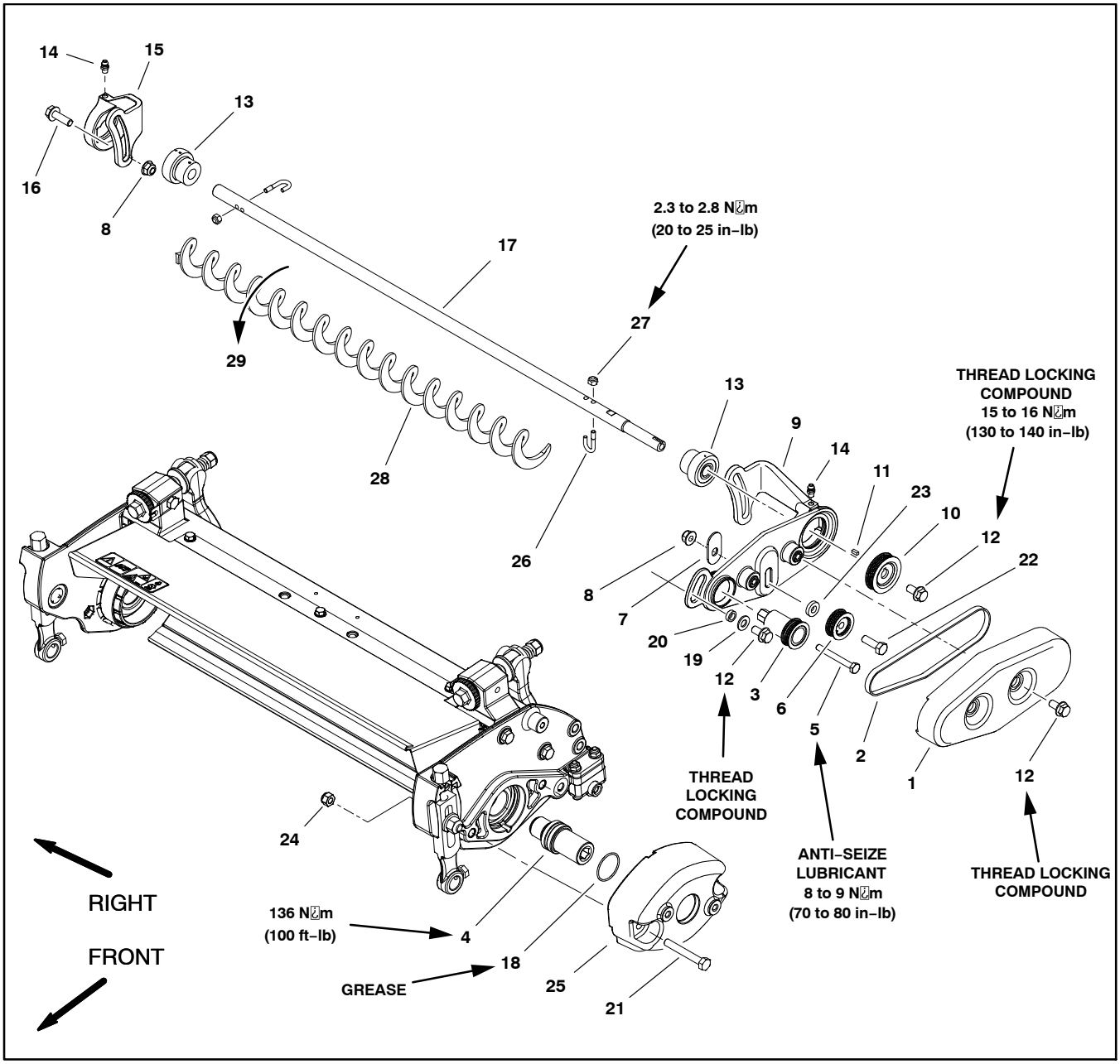

Figure 41

1. Cover
2. Drive belt
3. Drive pulley
4. Pulley driver (used without groomer)
5. Cap screw
6. Idler pulley assembly
7. Cover plate
8. Flange nut (5 used)
9. Drive plate
10. Driven pulley
11. Square key
12. Flange head screw (4 used)
13. Roller bearing assembly (2 used)
14. Grease fitting (2 used)
15. RH brush support
16. Flange head screw (4 used)
17. Brush shaft
18. O–ring
19. Flat washer
20. Bearing spacer
21. Cap screw (2 used)
22. Cap screw
23. Bearing spacer
24. Hex nut (2 used)
25. Counterweight
26. J–bolt (2 used)
27. Lock nit (2 used)
28. Brush element
29. Direction of brush rotation

CAUTION

Contact with the reel or other cutting unit parts can result in personal injury. Use heavy gloves when handling the cutting reel.

Replacing the Roller Brush Element

1. Remove the cutting unit from the machine and place it on a level work surface.

2. Loosen the set screw in the bearing locking collar on right side of brush shaft.

3. Using the blind hole in the bearing locking collar as an impact point, unlock the collar by striking it with a punch in the opposite direction of brush rotation.

4. Remove the RH brush support, bearing and locking collar.

5. Remove the brush element from the shaft.

6. Slide the new brush element onto the shaft while rotating the brush.

7. Install the J−bolts and lock nuts making sure the threaded portion of the J−bolts are installed on the outside of the brush element. Tighten the lock nuts from **2.3 to 2.8 N·m (20 to 25 in−lb)**.

8. Install the RH bearing support.

9. Tighten the bearing locking collar.

   A. Slide the locking collars outward onto the bearing collars. Rotate the locking collars by hand in the direction of normal brush rotation until the collars are tight on the shaft.

   B. Using the blind hole in the bearing locking collar as an impact point, lock the collar by striking it with a punch in the normal direction of the brush rotation.

   C. Tighten the set screw in the locking collar.

IMPORTANT: If brush to roller contact is incorrect, brush operation will be adversely affected.

10. Check that the roller brush is parallel to the rear roller within **0.25 mm (0.010 inch) clearance to light contact**. Adjust the roller support or drive plate as necessary.

Replacing the Drive Belt

1. Remove the cover.

2. Loosen the idler pulley assembly from the drive plate to relieve the belt tension.

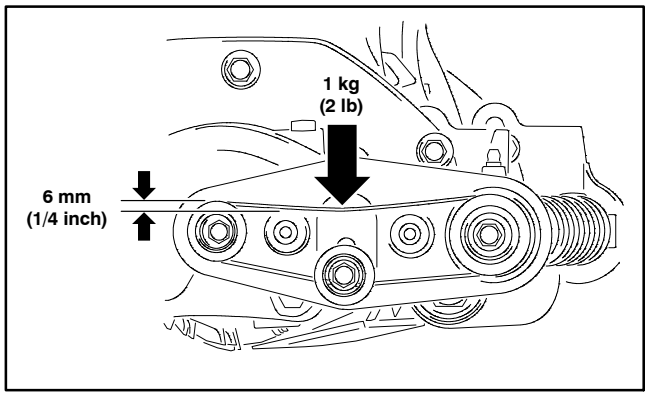

Figure 42

3. Replace the drive belt making sure that the belt and the pulley grooves are aligned and the belt is centered in the pulleys.

4. Push down on the idler pulley and secure it to the drive plate. Make sure the cover plate (item 7 in Fig. 41) is positioned to prevent debris from entering the drive area.

5. The drive belt should deflect approximately **6 mm (1/4 inch) when 1 kg (2 lb)** of force is applied to the belt halfway between the pulleys. Adjust the idler puller as necessary.

Drive and Support Components

Refer to Fig. 41 for this procedure.

1. Disassemble the roller brush components as necessary. Retrieve and discard the drive plate O−ring.

2. Clean and inspect all components for wear or damage and replace as necessary.

3. If the pulley driver (item 4 in Fig. 41) requires replacement (machines without a belt driven groomer):

   A. Tip up the cutting unit to access the bottom of the reel to remove the pulley driver.

   B. Insert a long−handled pry bar (3/8 x 12 inch with screwdriver handle recommended) through the bottom of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

   IMPORTANT: To avoid grinding the reel, do not contact the cutting edge of any blade with the pry bar as this may damage the cutting edge and/or cause a high blade.

   C. Move the pry bar against the welded side of the reel support plate closest to the rear roller brush pulley driver.

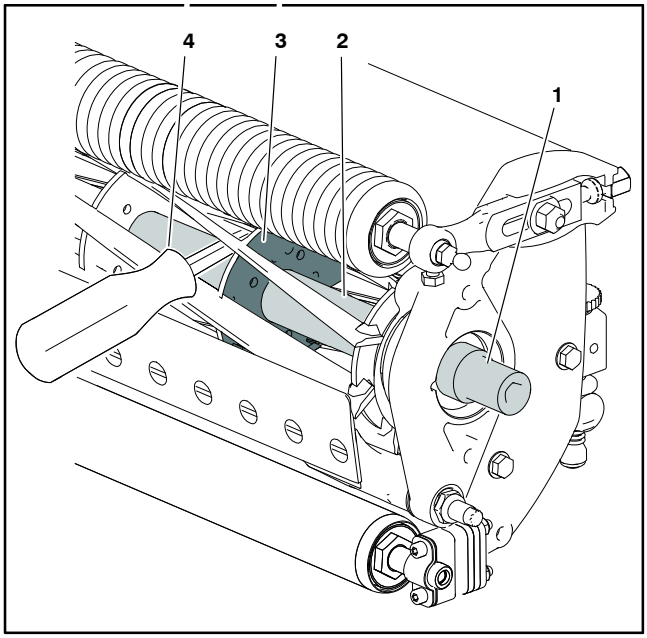

Figure 43

1. Pulley driver
2. Reel shaft
3. Unwelded side of support plate
4. Pry bar

IMPORTANT: The pulley driver and drive adapter have left−hand threads. Turn the pulley driver or drive adapter clockwise to loosen.

D. Rest the handle of the pry bar against the front roller and loosen the pulley driver.

E. Tip the cutting unit back onto its rollers.

F. Clean the threads in the end of the reel shaft. A left−hand thread tap is available to clean or repair the threads if necessary; refer to Reel Thread Repair Taps in the Special Tools section of this chapter.

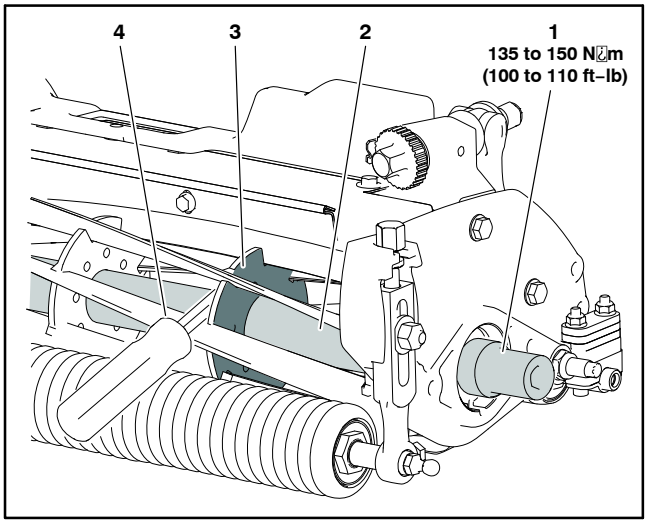

Figure 44

1. Pulley driver
2. Reel shaft
3. Unwelded side of support plate
4. Pry bar

G. To install the pulley driver, insert a long−handled pry bar through the front of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

H. Move the pry bar against the weld side of the reel support plate closest to the pulley driver.

IMPORTANT: The pulley driver and drive adapter have left−hand threads. Turn the pulley driver or drive adapter counterclockwise to tighten.

I. Rest the handle of the pry bar against the front roller and tighten the pulley driver from **135 to 150 N·m (100 to 110 ft−lb)**.

4. For machines without a belt driven groomer, install the counterweight.

Note: The screws used to secure the cover, driven pulley and the front of the drive plate have a locking feature to prevent the screws from loosening. If the original screws are being re−used, apply a medium strength thread locker (Loctite #242 or equivalent).

5. For machines with a belt driven groomer, apply a light coating of grease to a new drive plate O−ring and install the O−ring and the drive plate.

6. Install the roller brush with the bearings and locking collars loose on the brush shaft.

7. Install the driven pulley and key. Tighten the flange head screw from **15 to 16 N·m (130 to 140 in−lb)**.

8. Install the brush support.

9. Install the drive pulley. Apply anti−seize lubricant the cap screw threads and tighten from **8 to 9 N·m (70 to 80 in−lb)**.

IMPORTANT: The brush drive belt may fail prematurely if the pulleys are not properly aligned.

10. Using a straight edge, move the roller brush as necessary to align the pulleys.

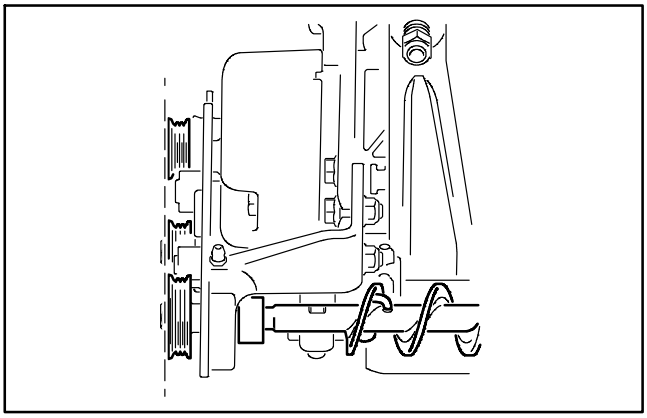

Figure 45

11. Tighten the roller brush bearing locking collars.

A. Slide the locking collars outward onto the bearing collars. Rotate the locking collars by hand in the direction of normal brush rotation until the collars are tight on the shaft.

B. Using the blind hole in the bearing locking collar as an impact point, lock each collar by striking it with a punch in the normal direction of the brush rotation.

C. Tighten the set screw in the locking collars to secure the bearing assembly to the brush shaft.

D. Check the brush assembly for end−play and adjust the bearings if necessary.

IMPORTANT: If brush to roller contact is incorrect, brush operation will be adversely affected.

12. Check that the roller brush is parallel to the rear roller within **0.25 mm (0.010 inch) clearance to light contact**. Adjust the roller support or drive plate as necessary.

13. Install and adjust the drive belt and install the cover.

14. Lubricate the grease fittings on the brush support and the drive plate until grease is visible. Wipe up any excess grease.

Servicing the Rear Roller Brush (with or without a universal groomer)

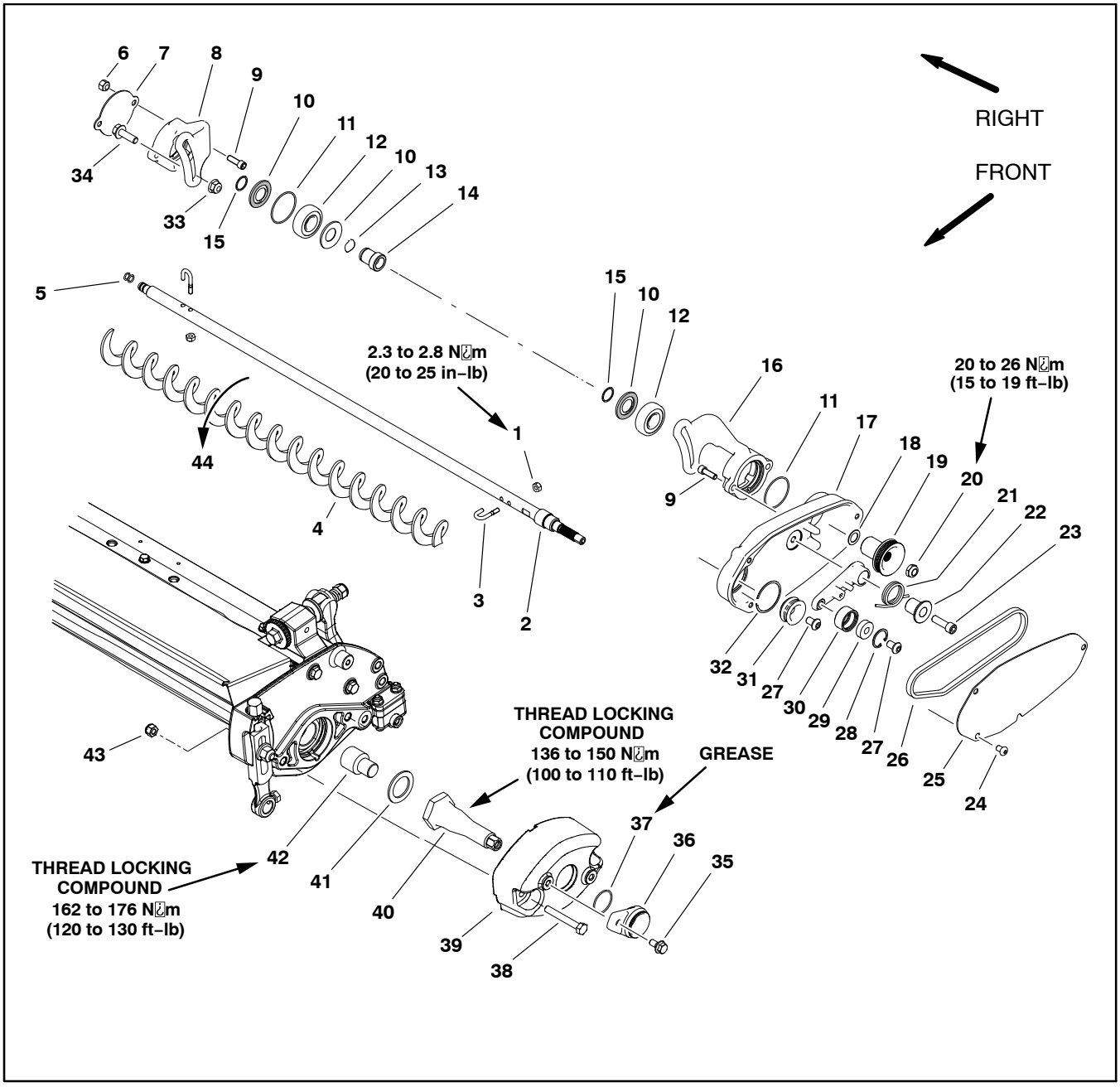

Figure 46

1. Lock nut (2 used)
2. Brush shaft
3. J–bolt (2 used
4. Brush element
5. O–ring (2 used)
6. Lock nut (2 used)
7. Cover
8. Bearing bracket RH
9. Socket head screw (4 used)
10. Flocked seal (3 used)
11. O–ring (2 used)
12. Bearing (2 used)
13. Retaining ring
14. Collar
15. Retaining ring (2 used)
16. Bearing bracket LH
17. Drive housing
18. Spacer (as required)
19. Driven pulley
20. Lock nut
21. Torsion spring
22. Idler bushing
23. Socket head screw
24. Socket head screw (3 used)
25. Cover
26. Drive belt
27. Socket head screw (2 used)
28. Retaining ring
29. Bearing
30. Idler pulley
31. Drive pulley
32. Retaining ring
33. Flange nut (4 used)
34. Flange head screw (4 used)
35. Flange head screw
36. Adapter housing (used without groomer)
37. O–ring
38. Cap screw (2 used)
39. Weight
40. Drive shaft (used without groomer)
41. Shim (used without groomer)
42. Drive adapter (used without groomer)
43. Lock nut (2 used)
44. Direction of brush rotation

CAUTION

Contact with the reel or other cutting unit parts can result in personal injury. Use heavy gloves when handling the cutting reel.

Replacing the Roller Brush Element

Refer to Fig. 46 for this procedure.

1. Remove the cutting unit from the machine and place it on a level work surface.

2. Remove the RH bearing bracket assembly.

3. Remove the brush element from the shaft.

4. Slide the new brush element onto the shaft while rotating the brush.

5. Install the J−bolts and lock nuts making sure the threaded portion of the J−bolts are installed on the outside of the brush element. Tighten the lock nuts from **2.3 to 2.8 N·m (20 to 25 in−lb)**.

6. Apply a thin coating of grease to the O−rings on the brush shaft and install the RH bearing bracket.

IMPORTANT: If brush to roller contact is incorrect, brush operation will be adversely affected.

7. Check that the roller brush is parallel to the rear roller within **0.25 mm (0.010 inch) clearance to light contact**. Adjust the bearing brackets as necessary.

Drive and Support Components

Refer to Fig. 46 for this procedure.

1. Disassemble the roller brush components as necessary. Retrieve and discard the adapter housing O−ring (machines without a universal groomer).

2. Clean and inspect all components for wear or damage and replace as necessary.

3. If the drive shaft and drive adapter (items 40 or 42) require replacement (machines without a universal groomer):

A. Tip up the cutting unit to access the bottom of the reel to remove the drive shaft assembly.

IMPORTANT: To avoid grinding the reel, do not contact the cutting edge of any blade with the pry bar as this may damage the cutting edge and/or cause a high blade.

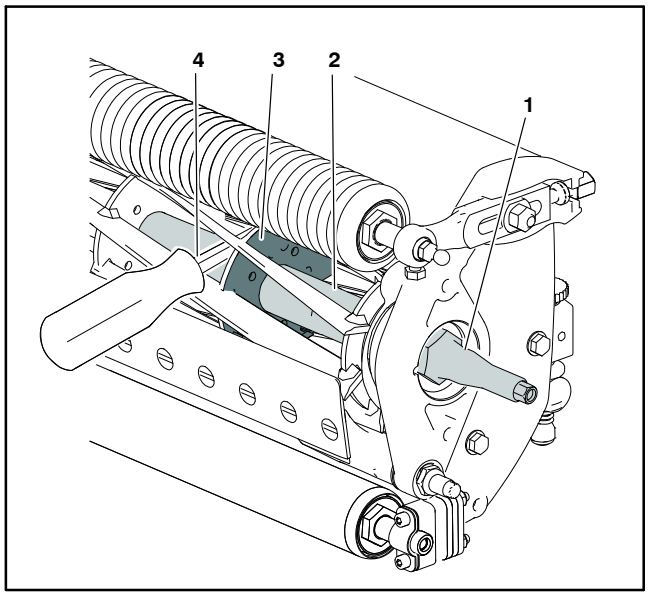

Figure 47

1. **Drive shaft assembly**
2. **Reel shaft**
3. **Unwelded side of reel support plate**
4. **Pry bar**

B. Insert a long−handled pry bar (3/8 x 12 inch with screwdriver handle recommended) through the bottom of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

C. Move the pry bar against the weld side of the reel support plate closest to the rear roller brush drive shaft.

IMPORTANT: The drive shaft and drive adapter have left−hand threads. Turn the drive shaft or drive adapter clockwise to loosen.

D. Rest the handle of the pry bar against the front roller and use the large hex (1.375 inch) to loosen the drive shaft assembly.

E. Retrieve the shim (item 41 in Fig. 46).

F. Tip the cutting unit back onto its rollers.

G. Clean the threads in the end of the reel shaft. A right−hand thread and left−hand thread tap is available to clean or repair the threads if necessary; refer to Reel Thread Repair Taps in the Special Tools section of this chapter.

H. Install the shim and assemble the drive shaft and drive adapter (machines without a universal groomer) with a medium strength thread locking compound (Loctite 243 or equivalent) and tighten from **150 to 163 N·m (110 to 120 ft−lb)**.

I. Insert a long−handled pry bar through the front of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

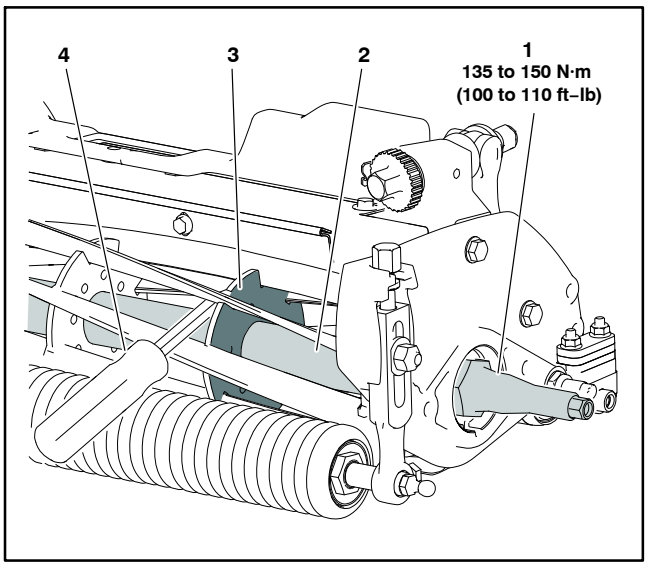

Figure 48

1. Drive shaft assembly
2. Reel shaft
3. Unwelded side of reel support plate
4. Pry bar

J. Move the pry bar against the weld side of the reel support plate closest to the drive shaft assembly.

IMPORTANT: The drive shaft and drive adapter have left–hand threads. Turn the drive shaft or drive adapter counterclockwise to tighten.

K. Rest the handle of the pry bar against the front roller. Use the large hex (1.375 inch) and tighten the drive shaft from **135 to 150 N·m (100 to 110 ft–lb)**.

4. For units without a universal groomer, install the counterweight.

Note: The screw used to secure the adapter housing has a locking feature to prevent the screw from loosening. If the original screw is being re–used, apply a medium strength thread locker (Loctite #242 or equivalent).

5. Install and apply a light coating of grease to a new O–ring and install the adapter housing (machines without a universal groomer).

6. Install the drive housing and LH bearing bracket.

7. Apply a thin coating of grease to the O–rings on the brush shaft and fit the RH bearing bracket over the brush shaft.

Note: Install all flocked seals with the flocked surface against the bearing.

8. Install a flocked seal and the retaining ring onto the brush shaft.

9. Install the brush and RH bearing bracket assembly.

10. Install the drive pulley.

IMPORTANT: The brush drive belt may fail prematurely if the pulleys are not properly aligned.

11. Using a straight edge, determine the number of spacers necessary under the driven pulley to align the pulleys. Tighten the lock nut securing the driven pulley from **20 to 26 N·m (15 to 19 ft–lb)**.

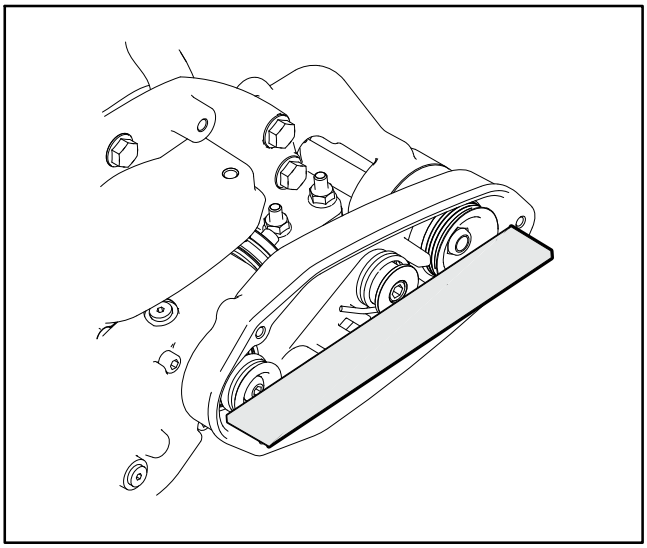

Figure 49
(shown with universal groomer installed)

12. Install and adjust the drive belt and install the cover.

IMPORTANT: If brush to roller contact is incorrect, brush operation will be adversely affected.

13. Check that the roller brush is parallel to the rear roller within **0.25 mm (0.010 inch) clearance to light contact**. Adjust the bearing brackets as necessary.

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Chapter 8

Belt Driven Groomer (Optional)

Table of Contents

Specifications

Belt Driven Groomer (Optional)

Item	Description
Grooming reel diameter	6 cm (2.375 inches)
Groomer blade type	**Spring Steel:** 42 steel blades with 1/2 inch blade spacing. **Carbide:** 42 steel blades with 1/2 inch blade spacing. **Thin blade:** 82 steel blades with 1/4 inch blade spacing. A soft or stiff groomer brush can be installed in place of the grooming reel.
Groomer mounting	The groomer is mounted to the cutting unit side plates. The drive assembly for the grooming reel is located on the opposite side of the cutting unit from the hydraulic cutting reel motor.
Groomer height setting	**Mowing:** 0.8 to 15.7 mm (0.030 to 0.620 inch). **HOC range:** 1.5 to 19.1 mm (0.060 to 0.750 inch).
Width-of-groomer	49.2 cm (19.38 inches).
Height adjustment knob	Allows a 0.003 inch (0.08 mm) increment of height adjustment for each click of the adjuster.
Quick-up feature	Allows grooming reel to be raised above the height/depth adjustment for no grooming reel action while mowing.
Groomer drive	The groomer drive assembly is attached to the right side of the cutting unit.

General Information

Installation Instructions

The *Installation Instructions* for the groomer provides information regarding the set-up, operation, general maintenance procedures, and maintenance intervals for the groomer assembly on your Greensmaster machine. Refer to the *Installation Instructions* for additional information when servicing the groomer assembly.

Grooming Performance

There are a number of factors that can affect the performance of grooming. These factors vary for different golf courses and from fairway to fairway. It is important to inspect the turf frequently and vary the grooming practice with turf needs.

IMPORTANT

Improper or overaggressive use of the groomer (e.g., too deep or too frequent grooming) may cause unnecessary stress on the turf leading to severe turf damage. Use the groomer carefully. Read and understand the groomer operation instructions before operating or testing the groomer performance.

It is important to remember that the same factors that affect quality of cut also affect grooming performance.

Variables that Affect the Use and Performance of the Groomer:

1. The growing season and weather conditions.
2. General turf conditions.
3. The frequency of grooming/cutting–number of cuttings per week and how many passes per cutting.
4. The height-of-cut.
5. The grooming depth.
6. The type of grass.
7. The amount of time that a groomer reel has been in use on a particular turf area.
8. The amount of traffic on the turf.
9. The overall turf management program–irrigation, fertilizing, weed control, coring, over-seeding, sand dressing, disease control, and pest control.
10. Stress periods for turf–high temperatures, high humidity, and unusually high traffic.

Troubleshooting

Problem	Possible Causes	Correction
The groomer reel does not rotate.	Seized grooming reel or idler bearing(s) in groomer side plate(s).	Identify and replace faulty bearing(s).
	Broken or damaged drive belt idler spring.	Replace idler .
	The groomer drive belt is worn, broken or damaged.	If the belt slips, it probably is worn and must be replaced. Repair or replace belt if necessary. A broken or worn belt could be the result of improper belt routing or seized bearings in groomer assembly.
The turf is damaged or has uneven grooming.	The groomer is set too aggressively.	Refer to groomer Installation Instructions for groomer set-up information.
	The groomer reel blades are bent, damaged, or missing.	Repair or replace the blades if necessary.
	The groomer reel shaft is bent or damaged.	Replace the groomer reel shaft.
	Grooming depth is not equal on both ends of the groomer reel.	Adjust the depth if necessary. Check and adjust the cutting unit set up (level bed knife to reel, level rear roller to reel, set the height-of-cut, etc.).

Service and Repairs

Replacing the Groomer Drive Belt

1. Park the machine on a clean and level surface, lower the cutting units completely to the ground, stop the engine, engage the parking brake and remove the key from the ignition switch.
2. If equipped, remove rear roller brush from cutting unit; refer to Servicing the Rear Roller Brush (with or without a belt driven groomer in Chapter 7 – DPA Cutting Unit in this manual.

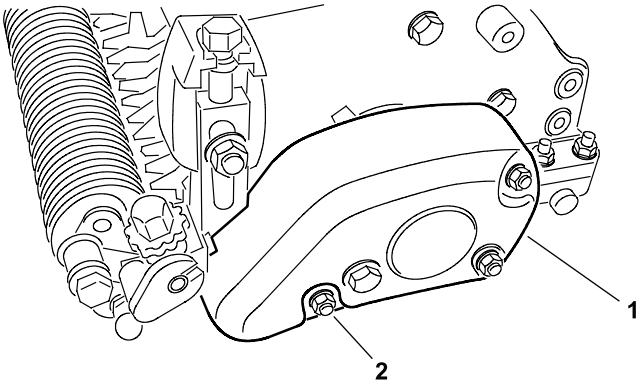

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Figure 1

1. Groomer drive cover
2. Lock nut (3 each)

3. Remove the three lock nuts that secure the groomer drive cover, then remove the cover.

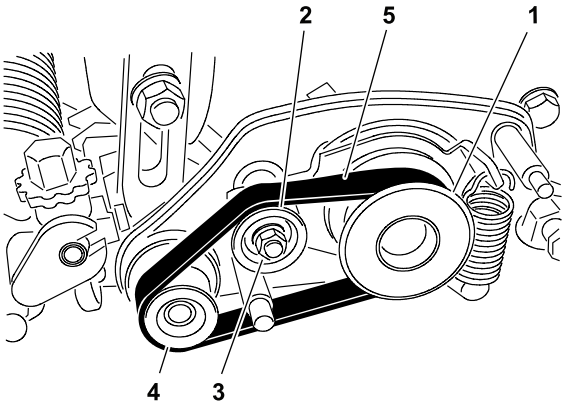

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Figure 2

1. Drive pulley
2. Idler pulley
3. Idler pulley nut
4. Driven pulley
5. Groomer drive belt

4. Pivot the idler pulley by placing a 12 mm wrench on the pulley nut and rotating the idler bracket to relax the belt tension. Slip the groomer drive belt off the pulleys and carefully release the idler bracket.

IMPORTANT

Make sure that the drive belt is centered on the pulleys and correctly aligned with pulley grooves after installation.

Replacing the Groomer Drive Belt (continued)

5. Install a new drive belt to the drive pulley, idler pulley and the driven pulley observing correct belt routing.
6. Secure the belt cover to the machine with three lock nuts.
7. If equipped, install the rear roller brush to the cutting unit; refer to Servicing the Rear Roller Brush (with or without a belt driven groomer in Chapter 7 – DPA Cutting Unit in this manual.

The Groomer Plate Assemblies

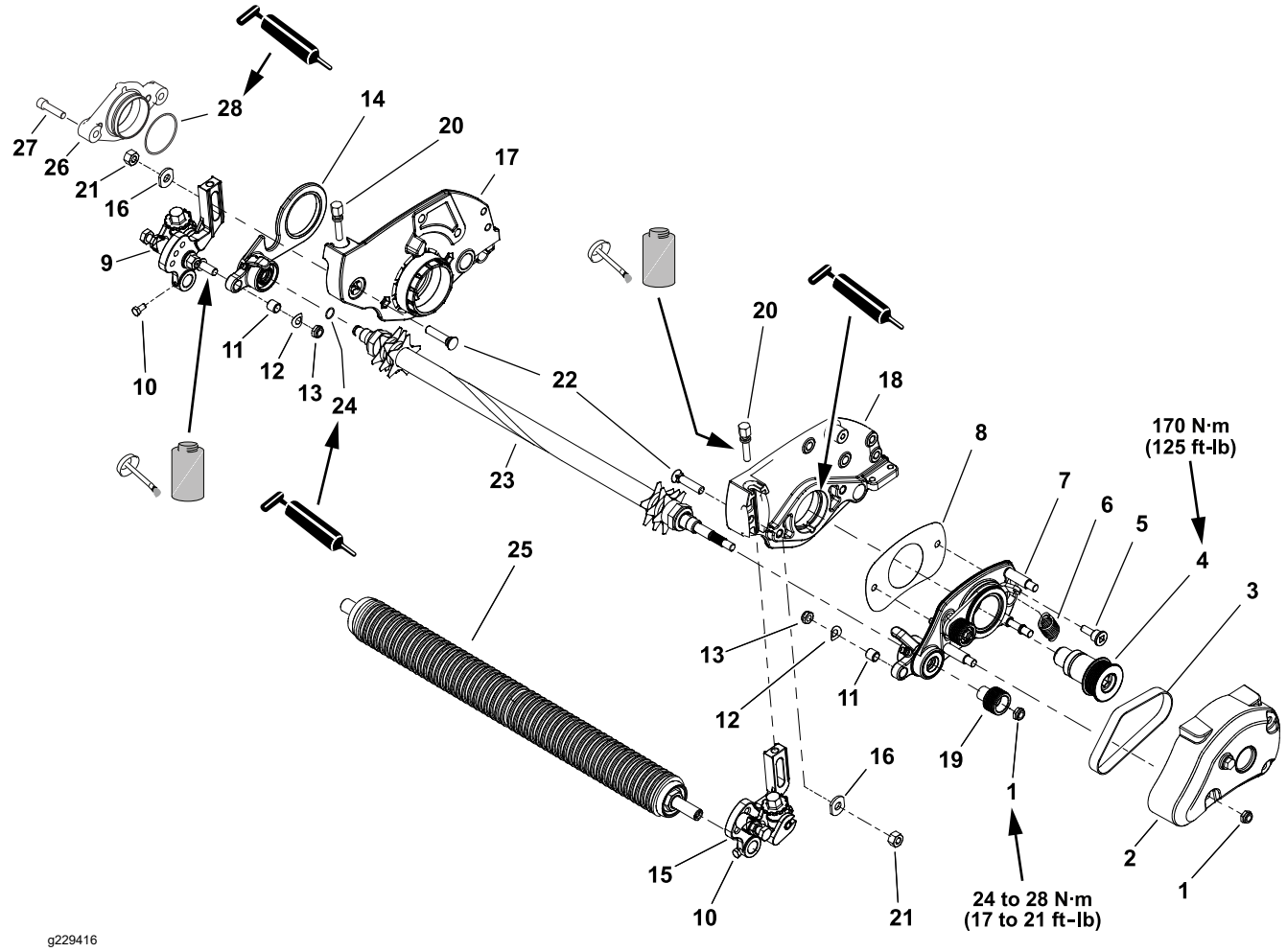

Figure 3

1. Lock nut (4 each)
2. Drive cover
3. Drive belt
4. Drive pulley
5. Shoulder bolt (2 each)
6. Extension spring
7. Drive plate assembly
8. Shim
9. Groomer arm – RH
10. Pinch bolt (2 each)
11. Bushing (2 each)
12. Spring washer (2 each)
13. Lock nut (2 each)
14. Support plate assembly
15. Groomer arm – LH
16. Tabbed washer (2 each)
17. Cutting unit side plate – RH
18. Cutting unit side plate – LH
19. Driven pulley
20. Height adjustment bolt (2 each)
21. Lock nut (2 each)
22. Plow bolt (2 each)
23. Grooming reel assembly
24. O-ring
25. Front roller assembly
26. Motor adapter
27. Socket head screw (2 each)
28. O-ring

Removing the Drive Plate

Refer to Figure 3 for this procedure.

1. Park the machine on a clean and level surface, lower the cutting units completely to the ground, stop the engine, engage the parking brake and remove the key from the ignition switch.
2. Remove the cutting unit from the machine and place cutting unit on a flat work surface.
3. If equipped, remove rear roller brush from cutting unit; refer to Servicing the Rear Roller Brush (with or without a belt driven groomer in Chapter 7 – DPA Cutting Unit in this manual.
4. Remove the groomer drive cover and drive belt.
5. Loosen and remove the drive pulley from the cutting reel:
   A. Tip up the cutting unit to access the bottom of the reel.

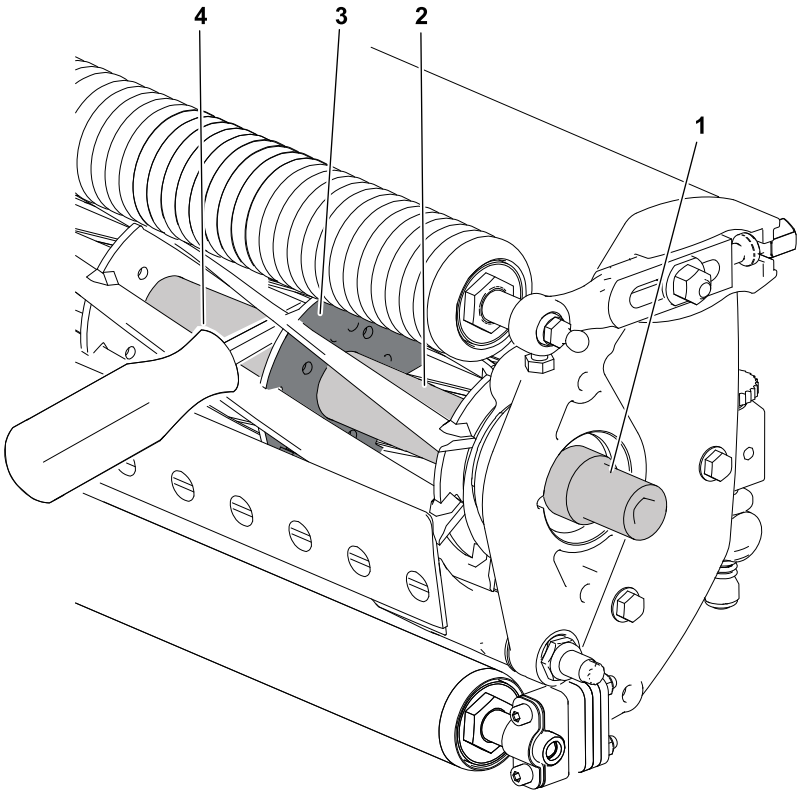

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Figure 4

1. Drive pulley
2. Reel shaft
3. Unwelded side of reel support plate
4. Pry bar

   B. Insert a long-handled pry bar (3/8 x 12 inch with screwdriver handle recommended) through the bottom of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

IMPORTANT

To avoid grinding the reel, do not contact the cutting edge of any blade with the pry bar as this may damage the cutting edge and/or cause a high blade.

C. Move the pry bar against the weld side of the reel support plate closest to the drive pulley.

IMPORTANT

The drive pulley has left-hand threads. Turn the pulley driver or drive adapter clockwise to loosen.

D. Rest the handle of the pry bar against the front roller and loosen the drive pulley.

E. Tip the cutting unit back onto its rollers.

F. Clean the threads in the end of the reel shaft. A left-hand thread tap is available to clean or repair the threads if necessary; refer to Reel Thread Repair Taps in the Special Tools section of Chapter 7 – DPA Cutting Unit in this manual.

6. Loosen pinch bolts that secure the front roller shaft to the groomer arms.

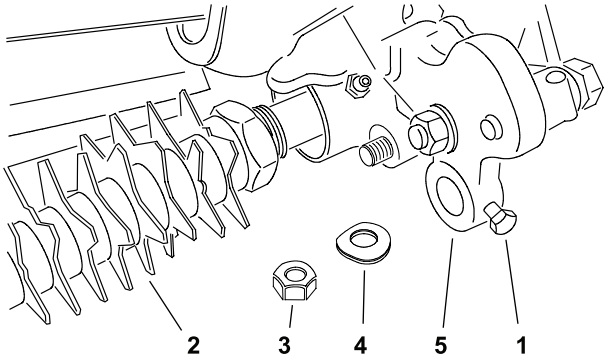

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Figure 5

1. Pinch bolt
2. Groomer reel
3. Lock nut
4. Spring washer
5. Groomer arm – LH

7. Remove the lock nut and spring washer that secure the LH groomer arm to the drive plate assembly.

Note: To speed cutting unit setup after installing the groomer reel, do not change the height adjustment bolt or the groomer adjuster setting.

8. Remove the lock nut, special washer and plow bolt that secure the LH groomer arm assembly to the cutting unit side plate.
9. Remove the LH groomer arm and the front roller from the cutting unit.
10. Using the flats provided on the groomer reel shaft to prevent the groomer reel from turning, remove the locknut that secures the driven pulley to the groomer reel and remove the driven pulley.

Removing the Drive Plate (continued)

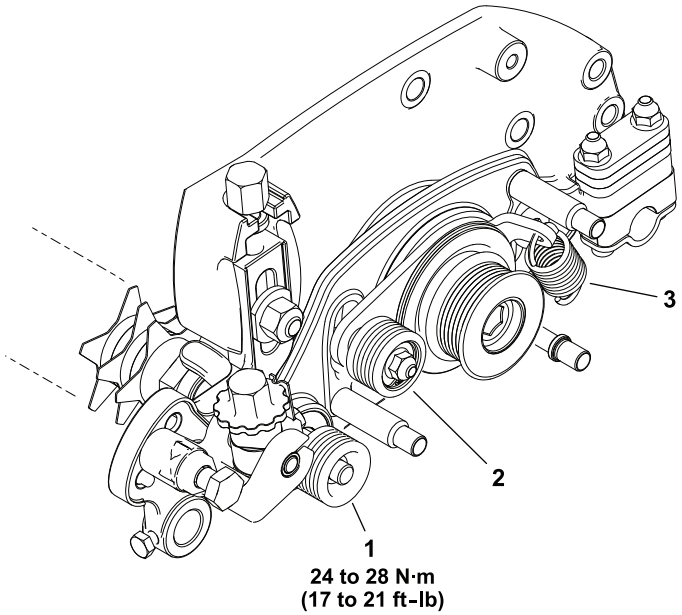

Figure 6

1. Driven pulley
2. Idler pulley
3. Idler arm extension spring

11. Remove the idler arm extension spring.
12. Remove the two shoulder bolts that secure the drive plate assembly to the cutting unit and remove the groomer drive plate assembly. Locate and retrieve the shim.
13. Inspect the seals, bushings and bearings in the drive plate, support plate and groomer arms for wear or damage. Replace components as needed.

Removing the Support Plate

Refer to Figure 3 for this procedure.

1. Park the machine on a clean and level surface, lower the cutting units completely to the ground, stop the engine, engage the parking brake and remove the key from the ignition switch.
2. Remove the cutting unit from the machine and place cutting unit on a flat work surface.
3. If equipped, remove rear roller brush from cutting unit; refer to Servicing the Rear Roller Brush (with or without a belt driven groomer in Chapter 7 – DPA Cutting Unit in this manual.
4. Loosen pinch bolts that secure the front roller shaft to the groomer arms.

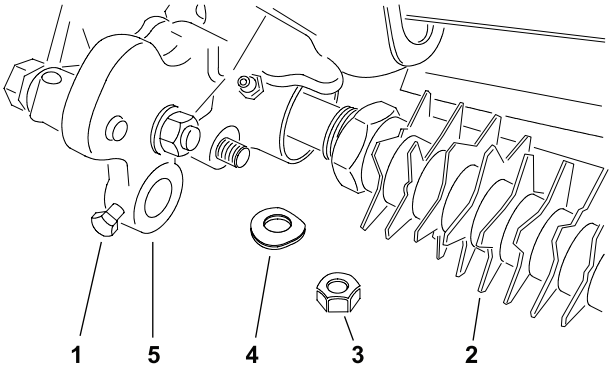

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Figure 7

1. Pinch bolt
2. Groomer reel
3. Lock nut
4. Spring washer
5. Groomer arm – RH

5. Remove the lock nut and spring washer that secure the RH groomer arm to the drive plate assembly.

   Note: To speed cutting unit setup after installing the groomer reel, do not change the height adjustment bolt or the groomer adjuster setting.
6. Remove the lock nut, tabbed washer and plow bolt that secure the RH groomer arm assembly to the cutting unit side plate.
7. Remove the RH groomer arm and the front roller from the cutting unit.
8. Remove the motor adapter and support plate.

Servicing the Drive and Support Plates

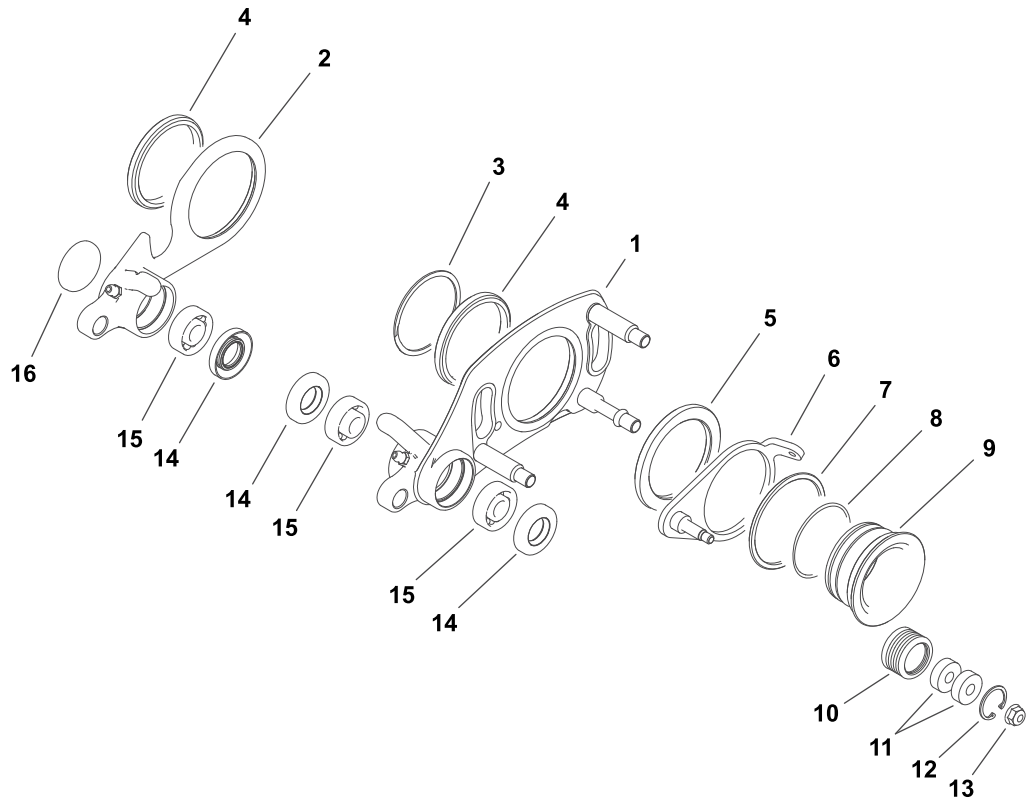

Figure 8

1. Drive plate
2. Support plate
3. Retaining ring
4. Bushing (2 each)
5. Spacer
6. Idler arm
7. Spacer
8. O-ring
9. Reel hub
10. Idler pulley
11. Bearing (2 each)
12. Retaining ring
13. Flange nut
14. Shaft seal (3 each)
15. Shaft bearing (3 each)
16. Expansion plug

---

1. Remove the retaining ring and separate the reel hub, spacers and idler arm from the drive plate.
2. Replace idler pulley bearings if necessary.
3. Remove and discard the O-ring and the groomer shaft seals.

   Note: Remove the expansion plug from the support plate to access the groomer shaft bearing.
4. Remove and discard the groomer shaft bearings.
5. Clean and inspect bearing bores in the drive and support plates. Inspect the drive and support plate bushings and replace as necessary.

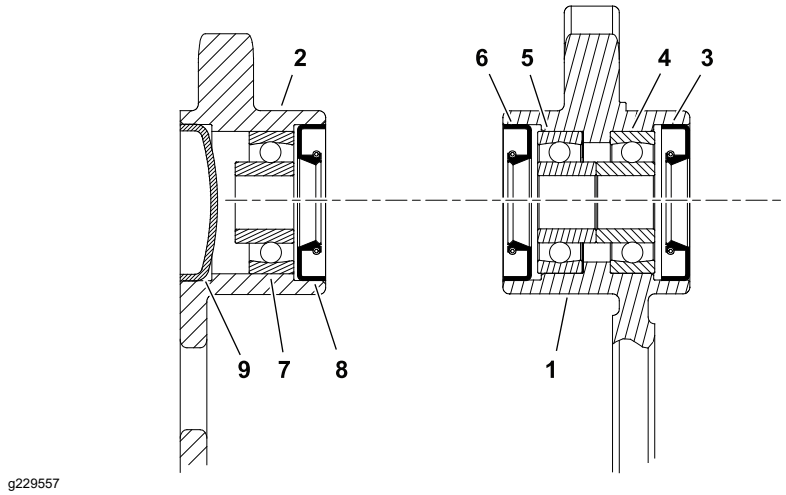

Figure 9

1. Drive plate
2. Support plate
3. Outer shaft seal
4. Outer bearing
5. Inner bearing
6. Inner shaft seal
7. Bearing
8. Seal
9. Expansion plug

IMPORTANT

Bearings should be installed with extended inner races toward center of plate. Apply pressure equally to inner and outer bearing races when installing bearings. Seals should be installed with the face of the seal toward the outside of the plate.

6. Install new groomer shaft bearings and seals:
   A. Press the outer bearing fully to the shoulder of the drive plate bore. Install the outer shaft seal as shown.
   B. Press the inner bearing into the drive plate until the inner race contacts the outer bearing. Install the inner shaft seal as shown.
   C. Press the bearing into the support plate until it is flush with shoulder of the bearing bore. Install the shaft seal and the expansion plug as shown.
7. Assemble the reel hub, spacers and idler arm to the drive plate and install the retaining ring.
8. Install a new O-ring on the reel hub.

Installing the Support Plate

Refer to Figure 3 for this procedure.

1. Fit the support plate over the motor adapter.
2. Apply a light coating of grease to the support plate end of the groomer reel shaft and to the seal lip in the support plate.
3. Apply a light coating of grease to the O-ring on the motor adapter and the pilot bore of the cutting unit side plate.
4. Carefully fit the support plate and motor adapter onto the groomer shaft and into the pilot bore of the cutting unit side plate. Secure the motor adapter to the cutting unit side plate with two socket head screws and lock nuts. Make sure the groomer reel and the support plate rotate freely after installation.
5. Insert the front roller into the LH groomer arm.
6. Install the RH groomer arm:
   A. Apply anti-seize lubricant to the shoulder of the groomer arm lift rod.
   B. Position the groomer arm over the front roller, through the support plate bushing and against the cutting unit side plate. Make sure the cutting unit side plate fits between the height adjustment bolt head and shoulder.
   C. Secure the groomer arm to the cutting unit side plate with the plow bolt, special washer and lock nut.

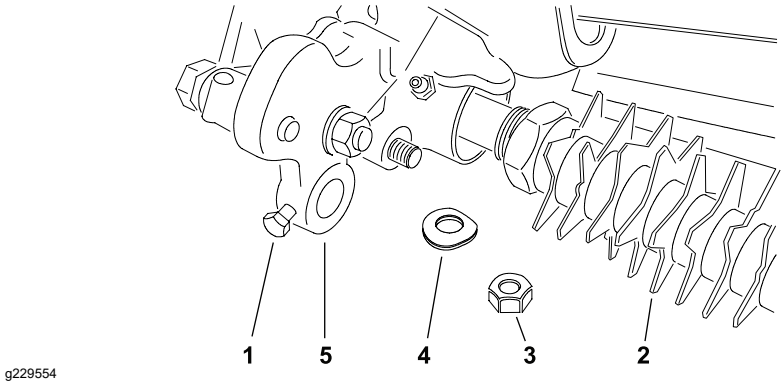

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Figure 10

1. Pinch bolt
2. Groomer reel
3. Lock nut
4. Spring washer
5. Groomer arm – RH

   D. Secure the groomer arm to the drive plate with the spring washer and lock nut.
7. Center the front roller in the cutting unit and tighten both pinch bolts.
8. If equipped, install rear roller brush to cutting unit; refer to Servicing the Rear Roller Brush (with or without a belt driven groomer in Chapter 7 – DPA Cutting Unit in this manual.
9. Check and adjust cutting unit height-of-cut and groomer height settings; refer to the *Cutting Unit Operators Manual* and the *Groomer Installation Instructions*.
10. Lubricate the groomer bearings; refer to the *Groomer Installation Instructions*.

    Note: After greasing the groomer bearings, operate the groomer for 30 seconds, stop the machine and wipe any excess grease from the groomer shaft and seals.

Installing the Drive Plate

Refer to Figure 3 for this procedure.

1. Make sure that all drive plate bearings, bushings and seals are in good condition and properly installed.
2. Apply a light coating of grease to the drive end of the groomer reel shaft and to the seal lips in the drive plate.
3. Position the shim on the drive plate assembly.
4. Apply a light coating of grease to the O-ring on the drive plate pivot hub and the pilot bore of the cutting unit side plate.
5. Carefully fit the drive plate assembly onto the groomer shaft and into the pilot bore of the cutting unit side plate. Secure the drive plate to the cutting unit side plate with two shoulder bolts. Make sure the groomer reel, the drive plate and the idler arm rotate freely after installation.
6. Install the idler arm extension spring.

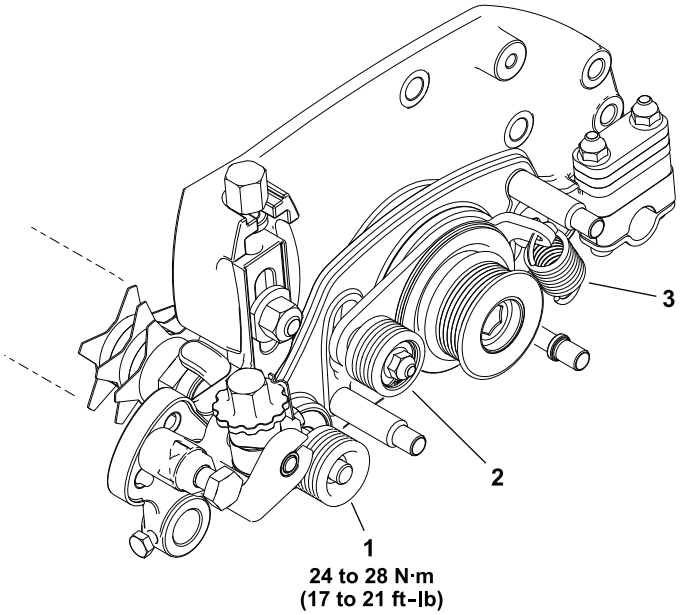

Figure 11

1. Driven pulley
2. Idler pulley
3. Idler arm extension spring

7. Install the driven pulley and lock nut onto the grooming reel shaft. Using the flats provided on the groomer reel shaft to prevent the groomer reel from turning, tighten the locknut from **24 to 28 N·m (17 to 21 ft-lb)**.
8. Insert the front roller into the RH groomer arm.
9. Install the LH groomer arm:
   A. Apply anti-seize lubricant to the shoulder of the groomer arm lift rod.
   B. Position the groomer arm over the front roller, through the drive plate bushing and against the cutting unit side plate. Make sure the cutting unit side plate fits between the height adjustment bolt head and shoulder.
   C. Secure the groomer arm to the cutting unit side plate with the plow bolt, special washer and lock nut.

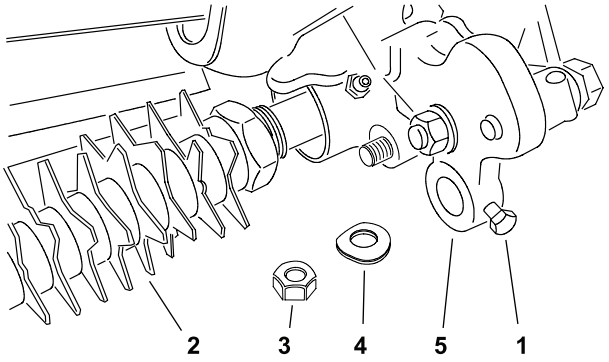

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Figure 12

1. Pinch bolt
2. Groomer reel
3. Lock nut
4. Spring washer
5. Groomer arm – LH

D. Secure the groomer arm to the drive plate with the spring washer and lock nut.

10. Center the front roller in the cutting unit and tighten both pinch bolts.

11. Install the drive pulley:

A. Insert a long-handled pry bar through the front of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

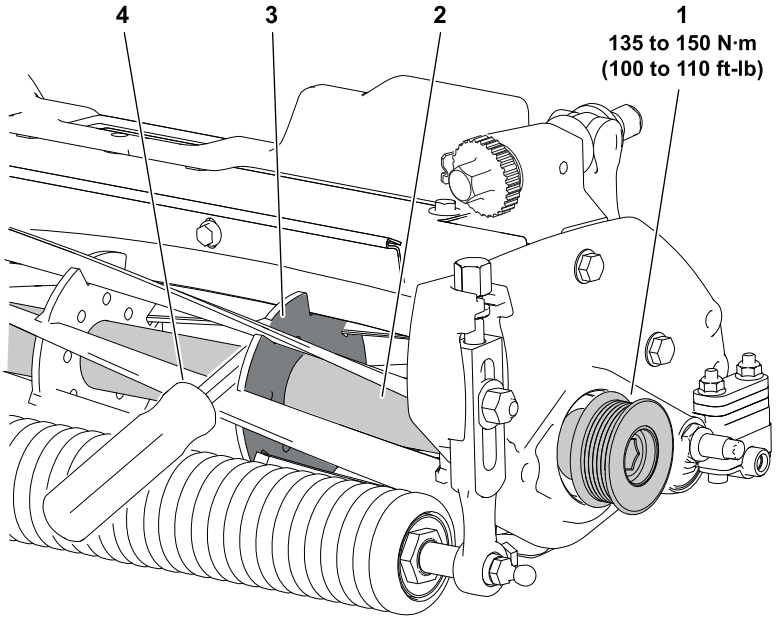

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Figure 13

1. Drive pulley
2. Reel shaft
3. Unwelded side of reel support plate
4. Pry bar

B. Move the pry bar against the weld side of the reel support plate closest to the drive pulley.

IMPORTANT

The drive pulley has left-hand threads. Turn the drive pulley counterclockwise to tighten.

C. Rest the handle of the pry bar against the front roller and tighten the drive pulley from **135 to 150 N·m (100 to 110 ft-lb)**.

12. Install the groomer drive belt and drive cover.
13. If equipped, install rear roller brush to cutting unit; refer to Servicing the Rear Roller Brush (with or without a belt driven groomer in Chapter 7 – DPA Cutting Unit in this manual.
14. Check and adjust cutting unit height-of-cut and groomer height settings; refer to the *Cutting Unit Operators Manual* and the *Groomer Installation Instructions*.
15. Lubricate the groomer bearings; refer to the *Groomer Installation Instructions*.

    Note: After greasing the groomer bearings, operate the groomer for 30 seconds, stop the machine and wipe any excess grease from the groomer shaft and seals.

The Groomer Reel

Removing the Groomer Reel

1. Remove the groomer drive plate; refer to Removing the Drive Plate (page 8–8)
2. Carefully pull the grooming reel from the support plate on the right side of the cutting unit.
3. Retrieve and discard the O-ring from the support plate end of the groomer reel shaft.

Servicing the Groomer Reel

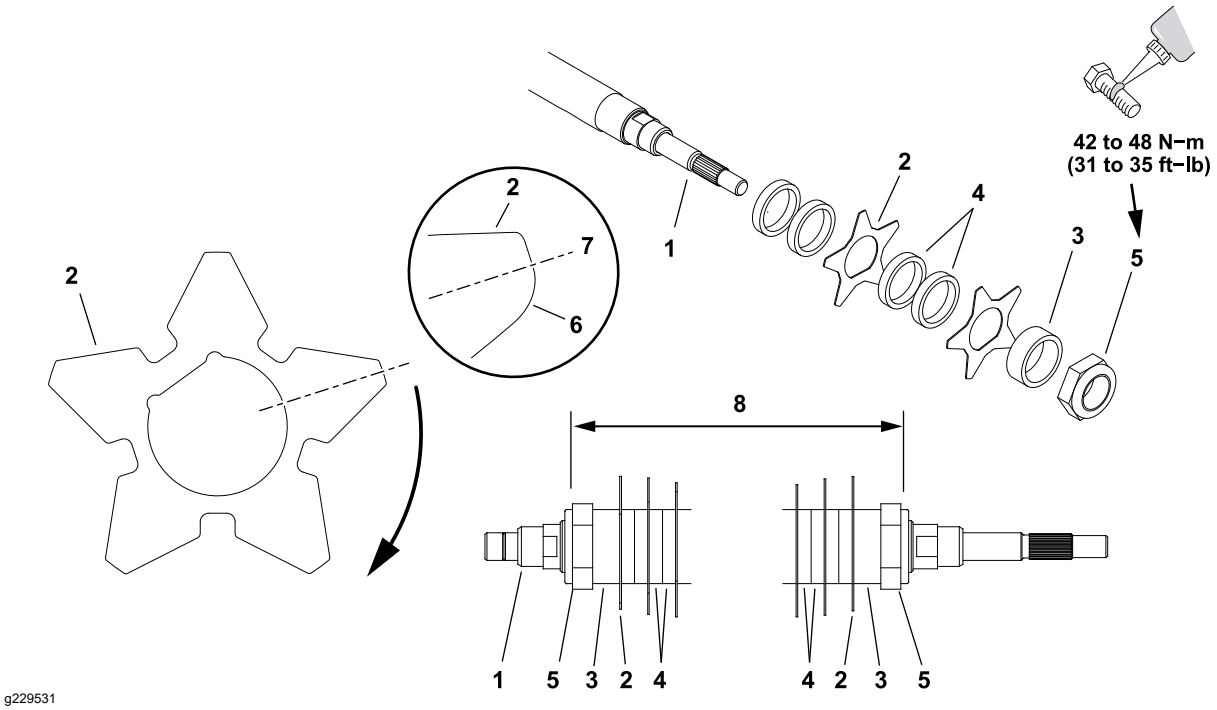


Figure 14

1. Groomer reel shaft
2. Groomer blade (42 each)
3. Spacer – thick (2 each)
4. Spacer – thin (82 each)
5. Locknut (2 each)
6. Rounded edge
7. Midpoint
8. Centered on shaft

Inspect the groomer reel blades frequently for any damage and wear. Straighten the bent blades. Either replace the worn blades or reverse the individual blades to put the sharpest blade edge forward. The blades that are rounded to the midpoint of the blade tip must be reversed or replaced for best groomer performance: refer to Figure 14.

1. Park the machine on a clean and level surface, lower the cutting units completely to the ground, set the parking brake, and remove the key from the key switch.
2. Remove the groomer reel from the cutting unit; refer to Removing the Groomer Reel (page 8–18).
3. Remove the lock nut from either end of the groomer reel shaft.
4. Remove the blades and from the groomer shaft. If necessary, remove second lock nut from the shaft.
5. Inspect and replace worn or damaged components.
6. Assemble the groomer reel as follows:

Note: New lock nuts have an insert to prevent the lock nut from loosening. If a used lock nut is being installed, apply a medium strength thread locker (Loctite #242 or equivalent) to the threads of the lock nut.

A. Install a lock nut on one end of the groomer reel shaft.

B. Install a single 12 mm (0.46 inch) spacer against the lock nut. Then, place the first blade against the spacer installed.

Note: For standard 13 mm (1/2 inch) spacing, fit two 5.6 mm (0.22 inch) spacers between each blade.

C. Install the remaining spacers and blades in an alternating manner making sure that all blades are separated by one or more spacers.

D. When all the blades have been installed, install the second lock nut onto the shaft. Center the blades and spacers on the shaft by adjusting the lock nuts.

E. Use the flats provided on the groomer reel shaft to prevent the shaft from rotating and tighten the second lock nut to **42 to 48 N·m (31 to 35 ft-lb)**. After tightening the lock nut, spacers should not be free to rotate and the groomer blades should be centered on the shaft.

7. Install the groomer reel back onto the cutting unit; refer to Installing the Groomer Reel (page 8–19).

Installing the Groomer Reel

1. Make sure that all support plate bearings, bushings and seals are in good condition and properly installed.
2. Install a new O-ring on the support plate end of the groomer reel shaft.
3. Apply a light coat of grease to the O-ring, the support plate end of the groomer reel shaft and to the seal lip in the support plate.
4. Carefully fit the groomer reel into the support plate.
5. Install the groomer drive plate; refer to Installing the Drive Plate (page 8–15).

The Groomer Arm Assemblies

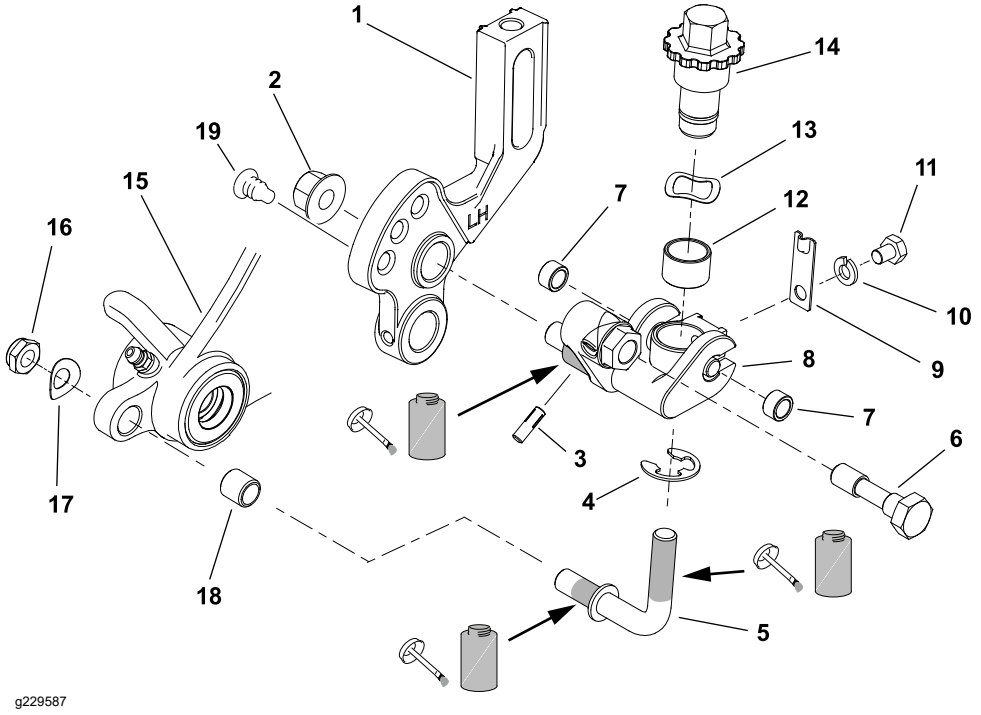


Figure 15

1.	Groomer arm – LH	8.	Lift arm assembly	15.	Drive plate
2.	Flange nut	9.	Detent spring	16.	Lock nut
3.	Grooved pin	10.	Lock washer	17.	Spring washer
4.	E-ring	11.	Cap screw	18.	Bushing
5.	Lift rod	12.	Bushing	19.	Plastic plug
6.	Lock screw	13.	Wave washer		
7.	Bushing (2 each)	14.	Adjuster		

The right side and left side groomer arms and lift arm assemblies are unique, the remaining components are the same on both side of the groomer.

Removing the Groomer Arms

1. Loosen pinch bolts that secure the front roller shaft to the groomer arms.
2. Remove the lock nut and spring washer that secure the either groomer arm to the plate assembly.
3. Remove the lock nut, special washer and plow bolt that secure the groomer arm to the cutting unit side plate.
4. Remove the groomer arm and the front roller from the cutting unit.
5. Repeat the procedure for the remaining groomer arm.
6. Disassemble the groomer arm as necessary. Clean and inspect all components and replace items as necessary.

Installing the Groomer Arms

1. Paying attention to the orientation of the components for either the left side or the right side application, assemble the groomer arm as necessary.
   A. Install the lock screw before installing the grooved pin. The grooved pin is used to retain the lock screw.
   B. Apply anti-seize lubricant to the threads of the lift rods before installing the adjusters.

Installing the Groomer Arms (continued)

2. Apply anti-seize lubricant to the shoulder of the groomer arm lift rods and the shoulder of the lift arm studs.
3. Position either groomer arm through the drive plate bushing and against the cutting unit side plate. Make sure the cutting unit side plate fits between the height adjustment bolt head and shoulder.
4. Secure the groomer arm to the cutting unit side plate with the plow bolt, special washer and lock nut.
5. Secure the groomer arm to the plate with the spring washer and lock nut.
6. Insert the front roller into the installed groomer arm.
7. Repeat the procedure for the remaining groomer arm.
8. Center the front roller in the cutting unit and tighten both pinch bolts.

The Grooming Brushes (Optional)

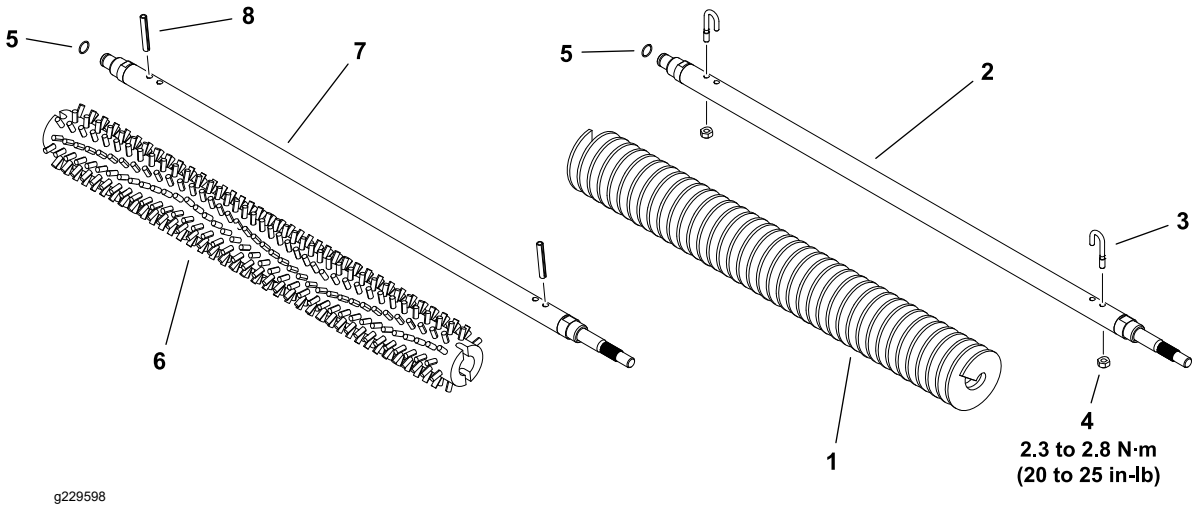


Figure 16

1. Spiral brush
2. Spiral brush shaft
3. J-bolt (2 each)
4. Lock nut (2 each)
5. O-ring
6. Grooming brush
7. Grooming brush shaft
8. Roll pin (2 each)

The optional grooming brush attaches to the groomer in place of the groomer reel. The grooming brush is removed and installed from the groomer in the same manner as the groomer reel; refer to The Groomer Reel (page 8–18).

The grooming brush elements or shafts can be serviced separately.

To remove the spiral grooming brush from the shaft, remove the lock nut and J-bolt from both ends of the brush assembly and slide the brush from the shaft. When assembling the spiral brush to the shaft, make sure that the J-bolts are installed with the threaded portion on the outside of the brush (as shown) and tighten the lock nuts from **2.3 to 2.8 N·m (20 to 25 in-lb)**.

Chapter 9

Universal Groomer (Optional)

Table of Contents

Specifications

Universal Groomer

Item	Description
Grooming reel diameter	6 cm (2.375 inches)
Groomer blade type	**Spring Steel:** 40 steel blades with 1/2 inch blade spacing. **Carbide:** 40 steel blades with 1/2 inch blade spacing. **Thin blade:** 81 steel blades with 1/4 inch blade spacing. The groomer brush can be installed in place of grooming reel.
Groomer mounting	The groomer is mounted to the cutting unit side plates. The drive assembly for the grooming reel is located on the opposite side of the cutting unit from the hydraulic cutting reel motor.
Groomer height setting	**Mowing:** 0.8 to 15.7 mm (0.030 to 0.620 inch). **HOC range:** 1.5 to 19.1 mm (0.060 to 0.750 inch).
Width-of-groomer	54.6 cm (21.5 inches).
Height adjustment knob	Allows a 0.003 inch (0.08 mm) increment of height adjustment for each click of the adjuster.
Quick-up feature	Allows grooming reel to be raised above the height/depth adjustment for no grooming reel action while mowing.
Groomer drive	The groomer drive assembly is attached to the right side of the cutting unit.

General Information

Installation Instructions

The *Installation Instructions* for the groomer provides information regarding the set-up, operation, general maintenance procedures, and maintenance intervals for the groomer assembly on your Greensmaster machine. Refer to the *Installation Instructions* for additional information when servicing the groomer assembly.

Troubleshooting

Grooming Performance

There are a number of factors that can affect the performance of grooming. These factors vary for different golf courses and from fairway to fairway. It is important to inspect the turf frequently and vary the grooming practice with turf needs.

IMPORTANT

Improper or overaggressive use of the groomer (e.g., too deep or too frequent grooming) may cause unnecessary stress on the turf leading to severe turf damage. Use the groomer carefully. Read and understand the groomer operation instructions before operating or testing the groomer performance.

It is important to remember that the same factors that affect quality of cut also affect grooming performance.

Variables that Affect the Use and Performance of the Groomer:

1. The growing season and weather conditions.
2. General turf conditions.
3. The frequency of grooming/cutting–number of cuttings per week and how many passes per cutting.
4. The height-of-cut.
5. The grooming depth.
6. The type of grass.
7. The amount of time that a groomer reel has been in use on a particular turf area.
8. The amount of traffic on the turf.
9. The overall turf management program–irrigation, fertilizing, weed control, coring, over-seeding, sand dressing, disease control, and pest control.
10. Stress periods for turf–high temperatures, high humidity, and unusually high traffic.

Groomer Reel Mechanical Problems

Problem	Possible Causes	Correction
The groomer reel does not rotate.	The groomer drive is in neutral.	Engage the groomer drive to forward or reverse.
	The groomer drive gears are damaged or seized.	Repair the groomer drive.
The turf is damaged or has uneven grooming.	The groomer is set too aggressively.	Refer to groomer Installation Instructions for groomer set-up information.
	The groomer reel blades are bent, damaged, or missing.	Repair or replace the blades if necessary.
	The groomer reel shaft is bent or damaged.	Replace the groomer reel shaft.
	Grooming depth is not equal on both ends of the groomer reel.	Adjust the depth if necessary. Check and adjust the cutting unit set up (level bed knife to reel, level rear roller to reel, set the height-of-cut, etc.).

Special Tools

Special tools for servicing Toro Commercial Products are available from your Toro Distributor. Some of these tools may have been supplied with your machine, are available as Toro parts, or may also be available from a local tool supplier.

Reel Thread Repair Taps

15/16–16 Right-Hand Thread – Toro Part No. 137–0926

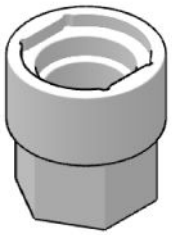
15/16–16 Left-Hand Thread – Toro Part No. 137–0927

Use to clean or repair the internal threads of cutting unit reels.

Drive Shaft Removal Tool

Toro Part No. 137–0920

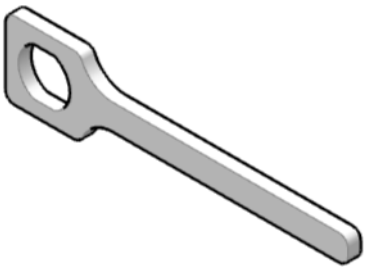
Use to remove the optional Universal Groomer drive shaft from the reel if the drive shaft hex is damaged.



Adapter Wrench

Toro Part No. 137-0921

Use to hold the optional Universal Groomer drive shaft securely when removing or installing the drive adapter.



Syringe – 50cc (2 ounce)

Toro Part No. 137-0872

Aids in accurately filling the optional Universal Groomer gear box with oil.

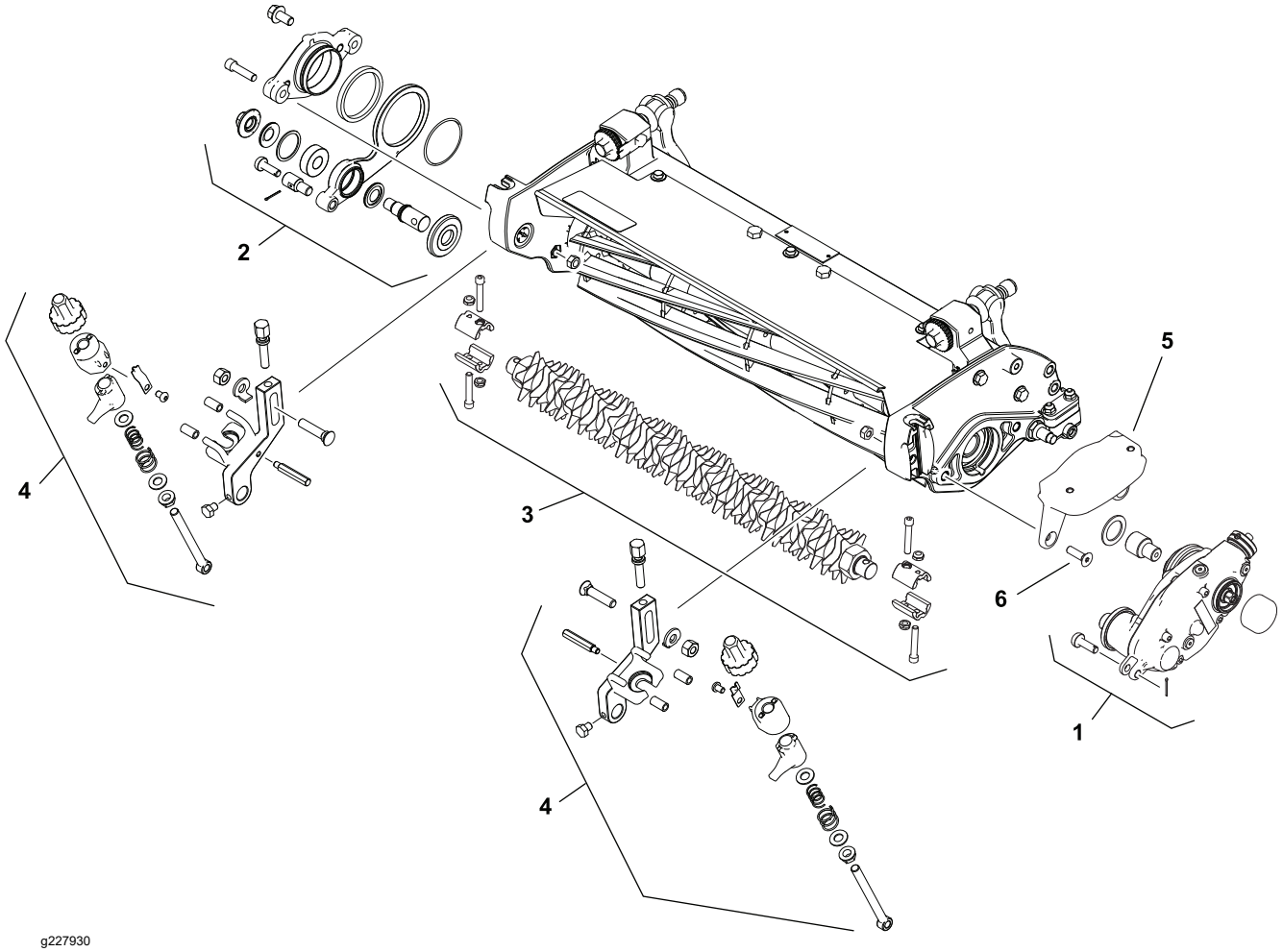


Figure 17

1. Gear box assembly
2. Idler assembly
3. Groomer reel
4. Height adjuster assembly (2 each)
5. Weight
6. Flat head screw (2 each)

⚠ CAUTION ⚠

Never work on the groomer with the engine running. Always stop the engine, remove the key from the ignition switch and wait for all machine movement to stop before working on the groomer.

The Gear Box Assembly

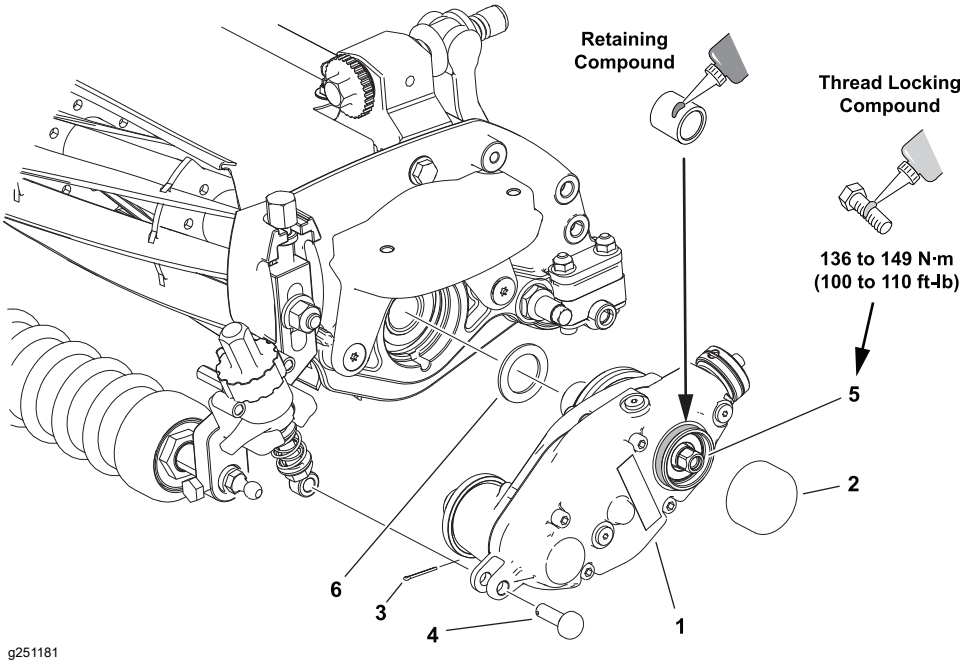


Figure 18

1. Gear box assembly
2. Drive shield
3. Cotter pin
4. Clevis pin
5. Input shaft
6. Shim

The groomer gear box assembly is located on the opposite side of the cutting unit from the cutting unit hydraulic motor.

Removing the Gear Box Assembly

IMPORTANT

All of the groomer gear boxes for this machine are installed on the left side of the cutting unit. Groomer gear boxes installed on the left side of the cutting unit use a left hand thread. Turn the input shaft (rear roller brush drive shaft) clockwise to remove the gear box.

1. Park the machine on a clean and level surface, lower the cutting units completely to the ground, set the parking brake, and remove the key from the key switch.
2. Remove the groomer reel assembly; refer to Removing the Groomer Reel (page 9–20).
3. Remove the drive shield, or, if the cutting unit is equipped with an optional powered rear roller brush, remove the rear roller brush drive assembly to service the groomer; refer to Rear Roller Brush (Optional) in Chapter 7 – DPA Cutting Units.
4. Install a 5/16–18 X 5/8 inch square head set screw (Toro p/n 1-803022) in the end of the drive shaft and tighten to **13 N·m (120 in-lb)**; refer to Figure 19.
5. Remove the cotter pin and clevis pin from the height adjustment rod at the front of the groomer gear box. Discard the cotter pin.

6. Tip up the cutting unit to access the bottom of the reel to remove the drive shaft assembly.

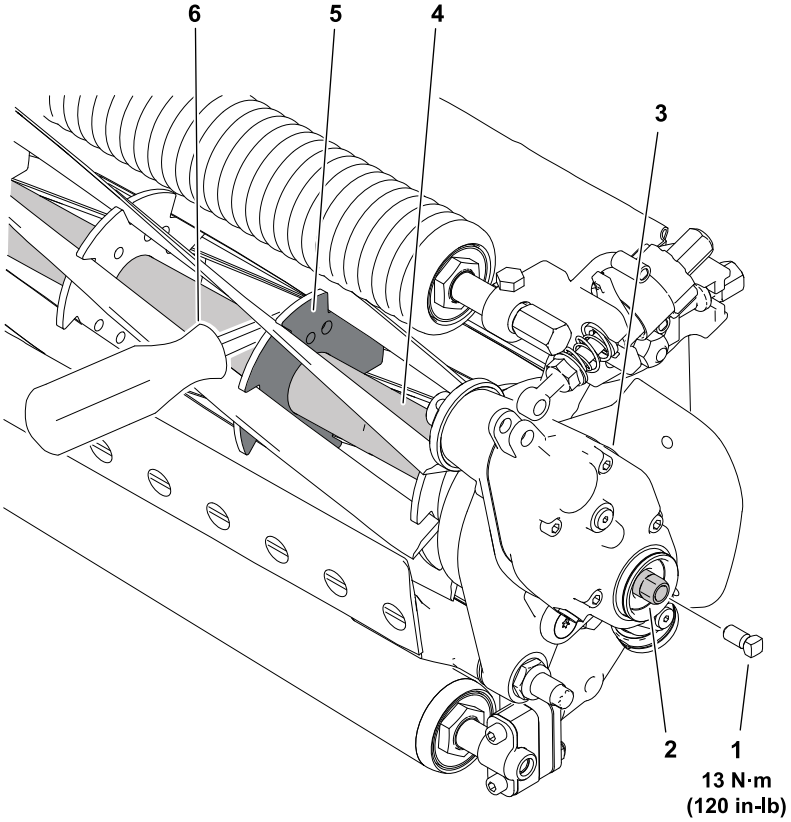


Figure 19

1. 5/16–18 X 5/8 inch square head set screw
2. Input shaft assembly
3. Groomer gear box assembly
4. Reel shaft
5. Unwelded side of reel support plate
6. Pry bar

7. Insert a long-handled pry bar (3/8 x 12 inch with screwdriver handle recommended) through the bottom of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

IMPORTANT

To avoid grinding the reel, do not contact the cutting edge of any blade with the pry bar as this may damage the cutting edge and/or cause a high blade.

8. Move the pry bar against the weld side of the reel support plate closest to the groomer gear box.

IMPORTANT

You must use a 6-point socket with a heavy wall to remove the gear box from the reel. Do not use an impact wrench. Groomer gear boxes installed on the left side of the cutting unit use a left hand thread; turn the drive shaft clockwise to remove the gear box.

9. Rest the handle of the pry bar against the front roller and turn the drive shaft clockwise to loosen it from the reel. Continue to unscrew the drive shaft and remove the gear box from the cutting unit.
10. Retrieve the shim (item 6 in Figure 18).
11. If the hex head on the end of the drive shaft is damaged during removal:
    A. Remove the drain/fill plug and drain the oil from the gear box.

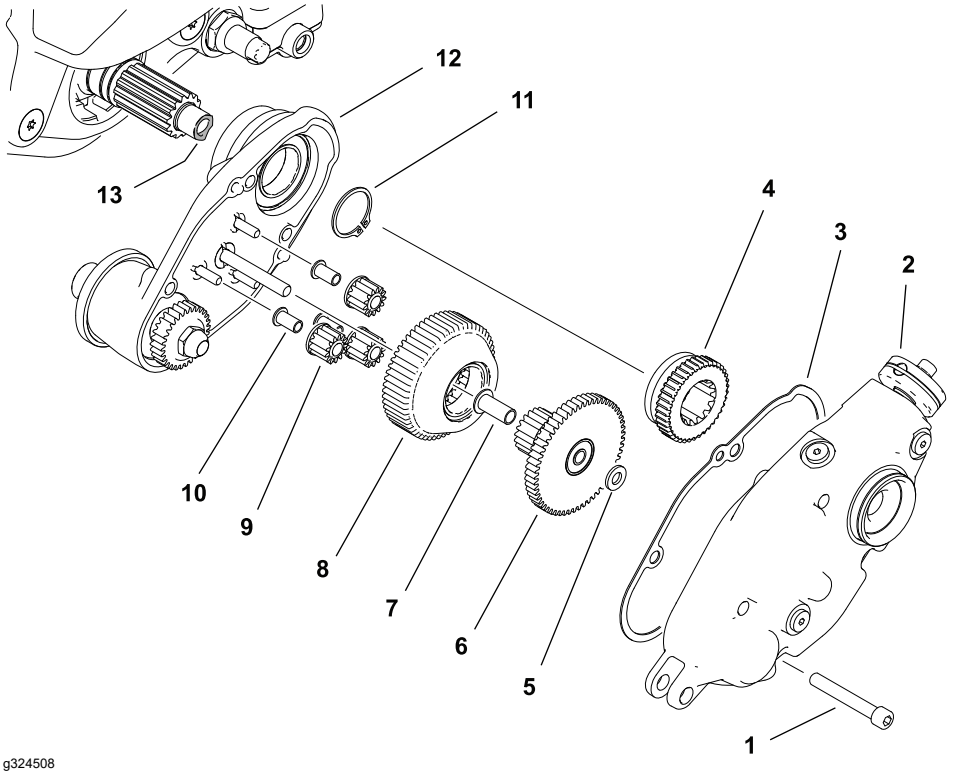


Figure 20

1. Socket head screw (4 each)
2. Gear box cover assembly
3. Cover gasket
4. Driven gear
5. Thrust washer
6. Ring gear
7. Flange bushing
8. Sun gear
9. Planet gear (3 each)
10. Flange bushing (3 each)
11. Retaining ring
12. Gear box housing assembly
13. Damaged drive shaft

    B. Remove the 4 socket-head screws and remove the gear box cover assembly and driven gear. Remove and discard the cover gasket.
    C. Slide the thrust washer, ring gear and bushing from the gear box housing.
    D. Slide the sun gear, and planet gears and bushings from the pins on the gear box housing.

E. Remove the retaining ring from the drive shaft.

F. Slide the groomer housing assembly from the drive shaft.

G. Tip up the cutting unit to access the bottom of the reel to remove the drive shaft assembly.

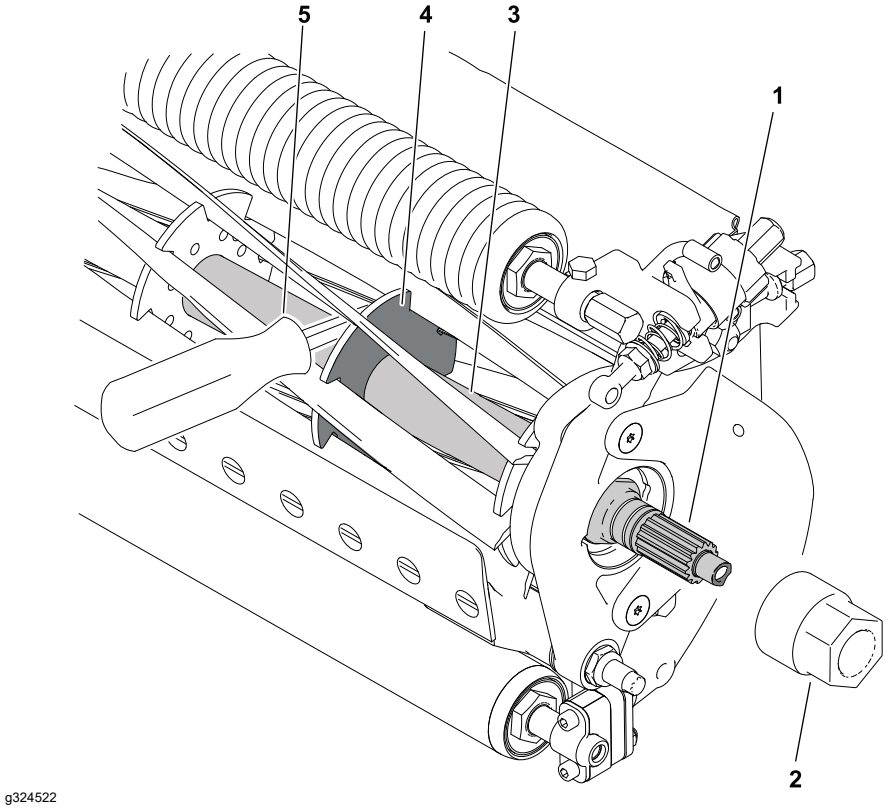


Figure 21

1. Damaged input shaft assembly
2. Drive shaft removal tool
3. Reel shaft
4. Unwelded side of reel support plate
5. Pry bar

H. Insert a long-handled pry bar (3/8 x 12 inch with screwdriver handle recommended) through the bottom of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

IMPORTANT

To avoid grinding the reel, do not contact the cutting edge of any blade with the pry bar as this may damage the cutting edge and/or cause a high blade.

I. Move the pry bar against the weld side of the reel support plate closest to the drive shaft assembly.

J. Use the drive shaft removal tool on the large flats of the drive shaft assembly; refer to Drive Shaft Removal Tool (page 9–6).

IMPORTANT

The drive shaft for groomer gear boxes installed on the left side of the cutting unit use a left hand thread.

K. Rest the handle of the pry bar against the front roller and turn the drive shaft clockwise to loosen it from the reel.

12. Retrieve the shim (item 6 in Figure 18.
13. Tip the cutting unit back onto its rollers.
14. Clean the threads in the end of the reel shaft. A right-hand thread and left-hand thread tap is available to clean or repair the threads if necessary; refer to Reel Thread Repair Taps (page 9–6).

Servicing the Gear Box

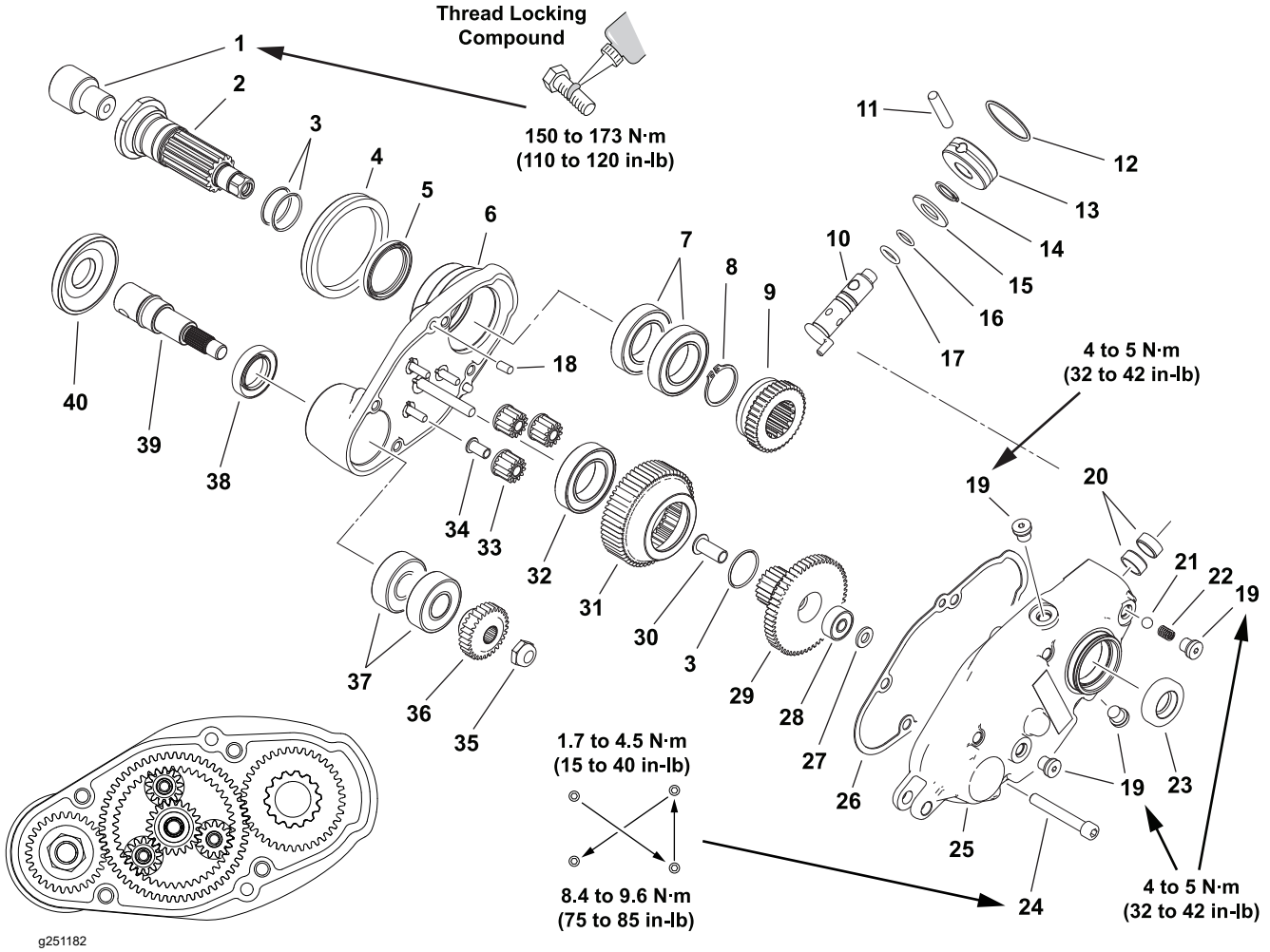


Figure 22

1. Drive adapter
2. Input shaft
3. O-ring (3 each)
4. V-ring
5. Oil seal
6. Groomer housing
7. Ball bearing (2 each)
8. Retaining ring
9. Driven gear
10. Actuator shaft
11. Pin
12. O-ring
13. Knob
14. Retaining ring
15. Thrust washer
16. O-ring
17. O-ring
18. Dowel pin (2 each)
19. Drain/fill plug (4 each)
20. Straight bushing (2 each)
21. Detent ball
22. Detent spring
23. Oil seal
24. Socket-head screw(4 each)
25. Groomer cover
26. Gasket
27. Thrust washer
28. Ball bearing
29. Ring gear
30. Flange bushing
31. Sun gear
32. Bearing
33. Planet gear (3 each)
34. Flange bushing (3 each)
35. Locknut
36. Driver gear
37. Bearing (2 each)
38. Oil seal
39. Driven shaft
40. Shield

1. Remove the drain/fill plug and drain the oil from the gear box.
2. Remove the 4 socket-head screws and separate the gear box cover and housing. Remove and discard the cover gasket.
3. Slide the sun gear, ring gear, and planet gears from the pins on the gear box housing.
4. Continue to disassemble the gear box as necessary.
5. If the drive adapter requires replacement, apply medium strength thread locking compound (Loctite 243 or equivalent) to the internal threads of the drive shaft and the larger threads of the drive adapter (reel end). Allow the thread locking compound to cure for 15 minutes before continuing this procedure.

⚠ CAUTION ⚠

Use the large 1.375 inch flats on the drive shaft to prevent the drive shaft from rotating during drive adapter removal and installation. DO NOT use the 0.5 inch hex head on the drive shaft for drive adapter removal or installation as drive shaft damage may occur.

Note: A special tool is available to hold the drive shaft if necessary; refer to Adapter Wrench (page 9–6).

6. Tighten the drive adapter from **150 to 163 N·m (110 to 120 ft-lb)**.
7. Carefully clean all the gasket material from the gear box housing and cover.
8. Inspect the V-ring, seals, bearings, gears, and bushings in the gear box assembly. Replace the damaged or worn components as necessary.
9. If the sun gear, ring gear, or the gear box housing bearings are replaced, press the bearings all the way to shoulder into the part.
10. If the flange bushings are replaced, ensure that the flange bushing is fully seated against the part.
11. Assembly the gearbox.
    - Ensure that all the retaining rings and O-rings are fully seated in the ring groove during assembly.
    - Lubricate the seal lips and O-rings before installing the shafts.
    - Lubricate the planet gear and sun gear pins in the gear box housing with the gear oil prior to installing the gears.
12. Clean the gasket surface on the gear box housing and cover with the solvent and install new gasket.
13. Fit the gear box cover over dowel pins and install the 4 socket-head screws. Tighten the screws from **1.7 to 4.5 N·m (15 to 40 in-lb)**. In an alternating cross pattern, tighten the screws from **8.4 to 9.6 N·m (75 to 85 in-lb)**.
14. Fill the gear box with 80W−90 gear oil and tighten the drain/fill plug from **4 to 5 N·m (32 to 42 in-lb)**.

    The gear box oil capacity is **50 ml (1.7 fluid ounces)**.
15. Operate the groomer gear box by hand to check for proper operation prior to installation.

Installing the Gear Box Assembly

Refer to Figure 18 for this procedure.

1. Apply medium strength thread locking compound (Loctite 243 or equivalent) to the threads in the reel and allow the thread locking compound to cure for 15 minutes before continuing this procedure.
2. Fit the shim (item 6 in Figure 18) over the input shaft.
3. Insert a long-handled pry bar through the front of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

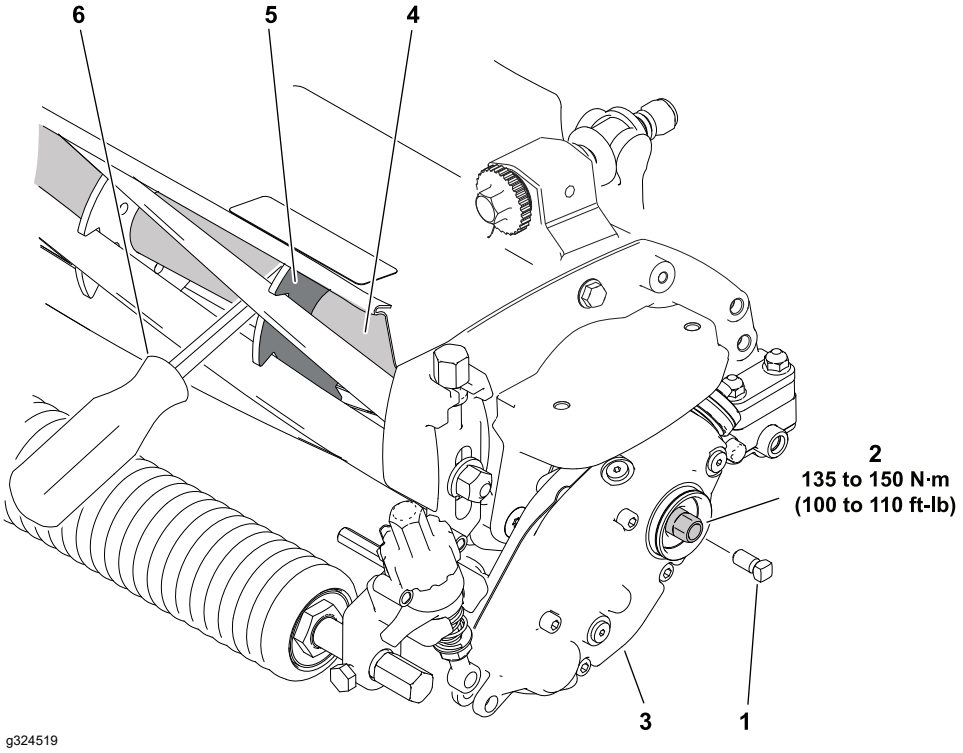


Figure 23

1. 5/16–18 X 5/8 inch square head set screw
2. Input shaft assembly
3. Groomer gear box assembly
4. Reel shaft
5. Unwelded side of reel support plate
6. Pry bar

4. Move the pry bar against the weld side of the reel support plate closest to the gear box assembly and rest the handle of the pry bar against the front roller.

IMPORTANT

Groomer gear boxes installed on the left side of the cutting unit use a left hand thread; turn the drive shaft counterclockwise to install the gear box.

5. Position the gear box assembly against the cutting unit and turn the drive shaft assembly counterclockwise until it is seated against the reel.

IMPORTANT

You must use a 6-point socket with a heavy wall to install the gear box to the reel. Do not use an impact wrench.

6. Tighten the drive shaft assembly from **135 to 150 N·m (100 to 110 ft-lb)**.
7. Remove the square head set screw from the end of the drive shaft.
8. Install the clevis pin and a new cotter pin to secure the height adjustment rod to the front of the groomer gear box.
9. Apply a retaining compound (Loctite 609 or equivalent) to the lip of the drive housing and install the drive shield, or, if the cutting unit is equipped with an optional powered rear roller brush, install the rear roller brush drive assembly; refer to Rear Roller Brush (Optional) in Chapter 7 – DPA Cutting Units.
10. Install the groomer reel assembly; refer to Installing the Groomer Reel (page 9–22).

The Idler Assembly

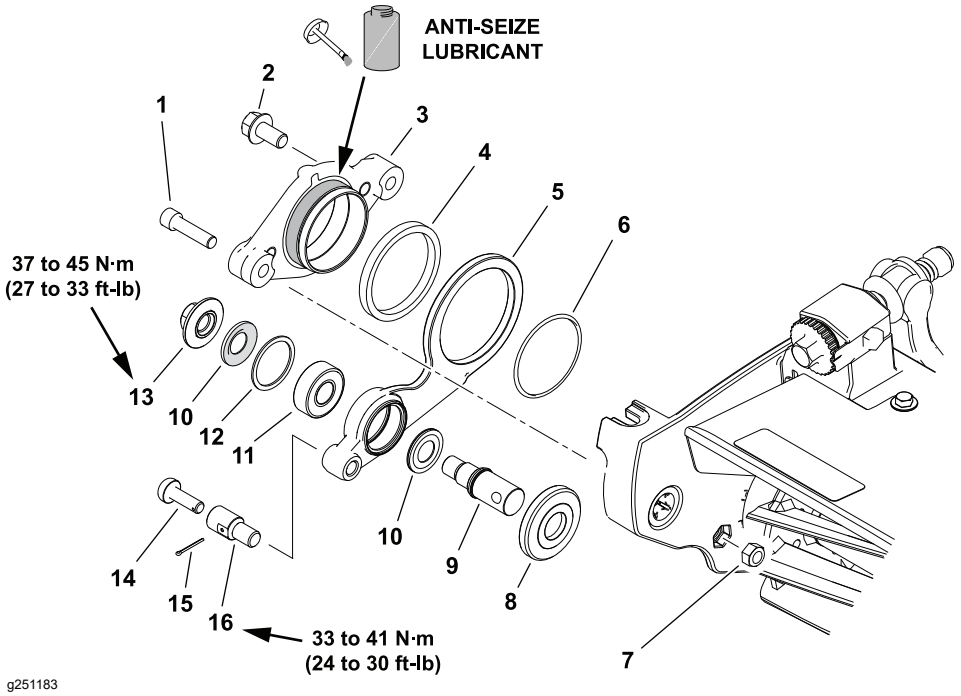


Figure 24

1.	Socket-head screw (2 each)	9.	Stub shaft
2.		10.	Flocked seal (2 each)
3.	Motor adapter	11.	Bearing
4.	Bushing	12.	Retaining ring
5.	Idler arm	13.	Flange nut
6.	O-ring	14.	Clevis pin
7.	Lock nut (2 each)	15.	Cotter pin
8.	Shield	16.	Collar

The groomer idler assembly is located on the opposite side of the groomer gear box.

Removing the Idler Assembly

1. Park the machine on a clean and level surface, lower the cutting units completely to the ground, set the parking brake, and remove the key from the key switch.
2. Remove the reel motor from the cutting unit.
3. Remove the groomer reel assembly; refer to Removing the Groomer Reel (page 9–20).
4. Remove the cotter pin and clevis pin from the height adjustment rod at the front of the idler arm. Discard the cotter pin.
5. Remove the two socket-head screws that secure the motor adapter to the cutting unit, and remove the adapter and idler assembly. Retrieve and discard the O-ring and lock nuts.
6. Inspect the shields, bearing, and bushing in the idler assembly. Replace any components that are worn or damaged.

Installing the Idler Assembly

1. If the shields, bearing, or bushing was removed from the idler arm:
   A. Press the bushing into a groomer plate until the bushing is centered in the idler arm bore.
   B. Press the bearing into the idler arm so that the bearing contacts the shoulder in idler arm bore and install the bearing retaining ring.
   C. Install the bearing shields with the flocked side of the shield toward the bearing.
   D. Insert the stub shaft through the shields and bearing. Use the through hole in the shaft to prevent the shaft from rotating and tighten the flange nut from **37 to 45 N·m (27 to 33 ft-lb)**.
   E. If the collar was removed from the idler arm, install the collar and tighten from **33 to 41 N·m (24 to 30 ft-lb)**.
2. Fit a new O-ring to the motor adapter.
3. Apply anti-seize lubricant to the outside diameter of the motor adapter and position the idler arm over the adapter.
4. Use new lock nuts and secure the motor adapter and idler arm to the cutting unit side plate.
5. Install the clevis pin and a new cotter pin to secure the height adjustment rod to the front of the idler arm.
6. Install the reel motor.

The Groomer Reel

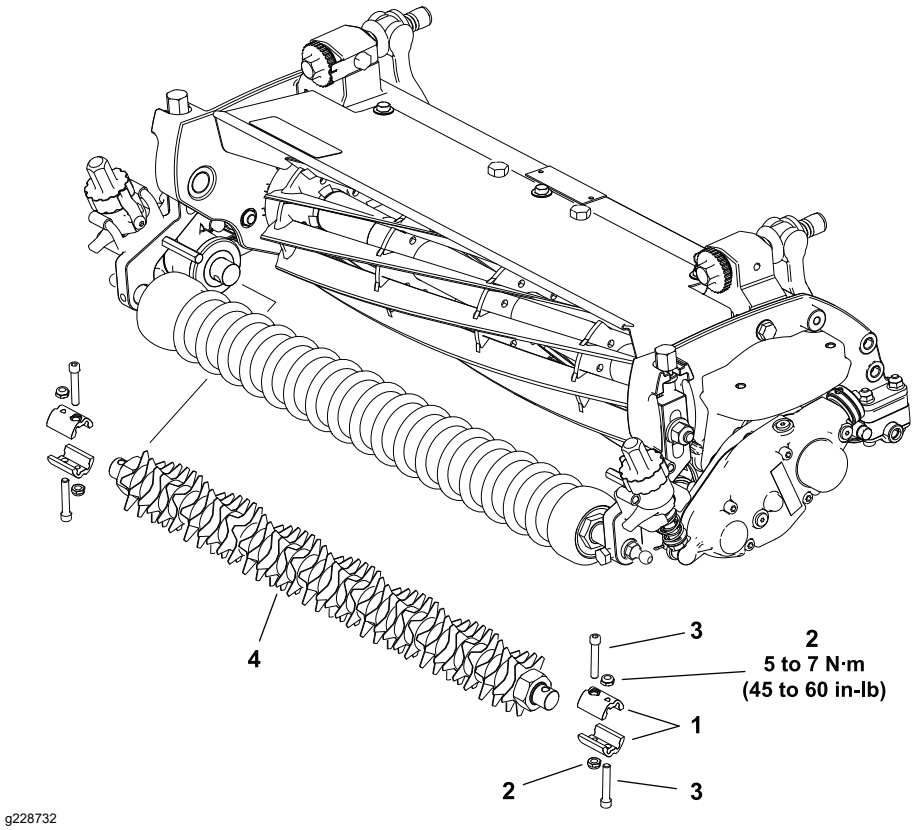


Figure 25

1. Shaft clamp (4 each)
2. Jam nut (4 each)
3. Bolt (4 each)
4. Groomer reel

Remove the groomer reel to replace individual groomer blades or replace the shaft. The groomer reel can be reversed to provide additional blade life.

Removing the Groomer Reel

1. Park the machine on a clean and level surface, lower the cutting units completely to the ground, set the parking brake, and remove the key from the key switch.

⚠ CAUTION ⚠

Contact with the reel or other cutting unit parts can result in personal injury.

Use heavy gloves when handling the groomer reel.

2. Carefully remove the 4 jam nuts, 4 bolts, and 4 shaft clamps that secure the groomer reel to the output and stub shafts.
3. Lift the groomer reel from the cutting unit.
4. Inspect the shields, stub shaft, driven shaft and shaft bearings for wear or damage and replace components as necessary; refer to The Gear Box Assembly (page 9–9) and The Idler Assembly (page 9–18).

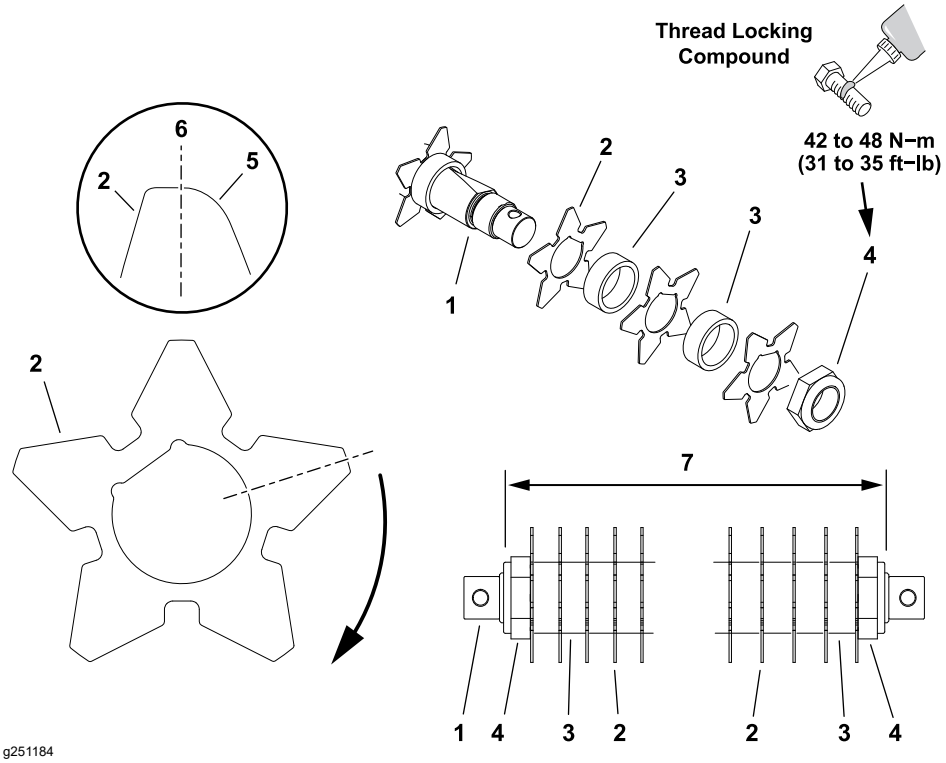


Figure 26

1. Groomer reel shaft
2. Groomer blade (40 each)
3. Spacer (39 each)
4. Locknut (2 each)
5. Rounded edge
6. Midpoint
7. Centered on shaft

Inspect the groomer reel blades frequently for any damage and wear. Straighten the bent blades. Either replace the worn blades or reverse the individual blades to put the sharpest blade edge forward. The blades that are rounded to the midpoint of the blade tip must be reversed or replaced for best groomer performance: refer to Figure 26.

1. Park the machine on a clean and level surface, lower the cutting units completely to the ground, set the parking brake, and remove the key from the key switch.
2. Remove the groomer reel from the cutting unit; refer to Removing the Groomer Reel (page 9–20).
3. Remove the lock nut from either end of the groomer reel shaft.
4. Remove the blades and from the groomer shaft. If necessary, remove second lock nut from the shaft.
5. Inspect and replace worn or damaged components.
6. Assemble the groomer reel as follows:

   Note: New lock nuts have an adhesive patch to prevent the lock nut from loosening. If a used lock nut is being installed, apply a medium strength thread locker (Loctite #242 or equivalent) to the threads of the lock nut.

   A. Install a lock nut on one end of the groomer reel shaft.

   B. Install a groomer blade against the lock nut.

   C. Install the remaining spacers and blades in an alternating manner making sure that all blades are separated by a spacer.

Servicing the Groomer Reel (continued)

D. When all the blades have been installed, install the second lock nut onto the shaft. Center the blades and spacers on the shaft by adjusting the lock nuts.

E. Use the through holes in shaft to prevent the shaft from rotating and tighten the second lock nut to **42 to 48 N·m (31 to 35 ft-lb)**. After tightening the lock nut, spacers should not be free to rotate and the groomer blades should be centered on the shaft.

7. Install the groomer reel back onto the cutting unit; refer to Installing the Groomer Reel (page 9–22).

Installing the Groomer Reel

1. Position the cutting unit on a level surface. If the cutting unit is attached to the traction unit, set the parking brake, and remove the key from the key switch.
2. Position the groomer reel between the groomer driven and stub shafts.
3. Secure the groomer reel to the cutting unit with the 4 jam nuts, 4 bolts, and 4 shaft clamps. Tighten the bolts from **5 to 7 N·m (45 to 60 in-lb)**.
4. Check the groomer reel height and mower height-of-cut settings and adjust as necessary.

The Height Adjuster Assembly

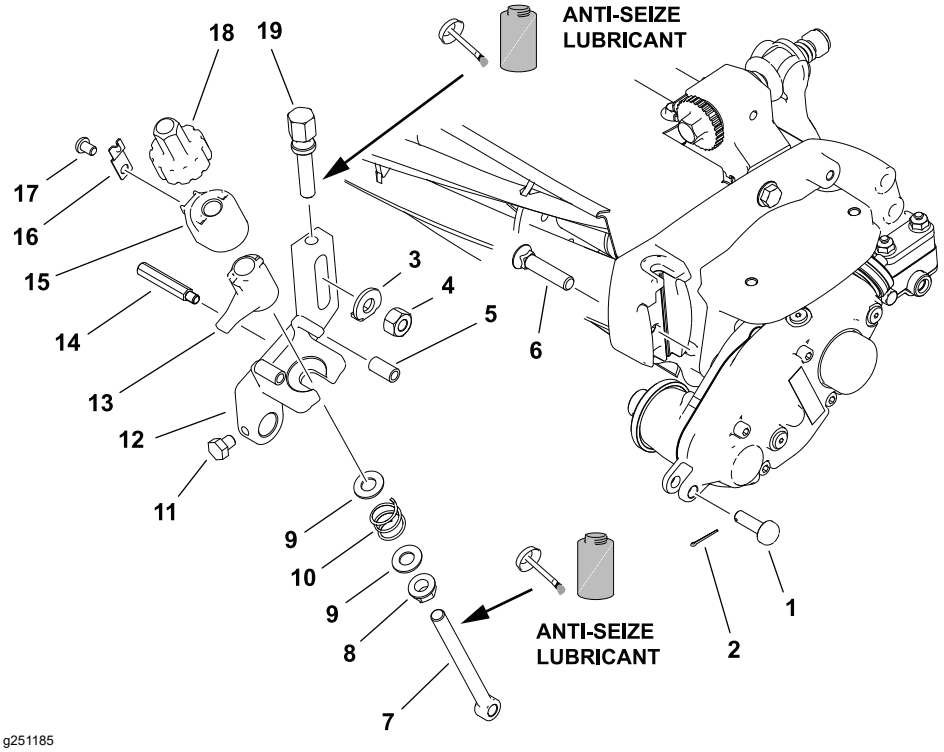


Figure 27

1. Clevis pin
2. Cotter pin
3. Tabbed washer
4. Lock nut
5. Bumper
6. Plow bolt
7. Height adjustment rod
8. Flange nut
9. Washer (2 each)
10. Compression spring
11. Pinch bolt
12. Height-of-cut bracket
13. Quick up lever
14. Groomer pin
15. Quick up cover
16. Detent spring
17. Button-head screw
18. Height adjuster knob
19. Height adjustment bolt

Note: Early universal groomers used 2 compression springs on non-adjustable height adjustment rods. Retrofitting the assemblies on each side of the cutting unit with new compression springs, height adjustment rods, and adding flange nuts to enable spring adjustment is recommended; refer to Figure 27.

Disassembling the Height Adjuster

1. Park the machine on a clean and level surface, lower the cutting units completely to the ground, set the parking brake, and remove the key from the key switch.
2. Remove the cutting unit from the machine.
3. Remove the cotter pins and clevis pins that secure the height adjustment rods to the groomer gear box and idler arm. Discard the cotter pins.
4. Loosen the pinch bolts that secure the front roller to the height-of-cut brackets.
5. Remove the hex nuts, tabbed washers and plow bolts that secure the height-of-cut brackets to the cutting unit side plates, and remove the height adjusters and front roller from the cutting unit.

Disassembling the Height Adjuster (continued)

6. Disassemble the height adjuster assembly as necessary.
7. Replace components that are worn or damaged.

Assembling the Height Adjuster

1. Apply anti-seize lubricant to the upper threads of the adjustment rod and lower threads of the height adjusters. Assemble the height adjuster assembly.
2. If both the height adjusters are removed, fit 1 height adjuster assembly to the cutting unit side plate and secure it with a plow bolt, tabbed washer and lock nut. Tighten the lock nut finger tight.
3. Position front roller between the height adjuster assemblies and secure the remaining height adjuster assembly to the cutting unit side plate with a plow bolt, tabbed washer and lock nut. Tighten the lock nut finger tight.
4. center the front roller between the height-of-cut brackets and tighten the front roller pinch bolts
5. Install new cotter pins and clevis pins and secure the height adjustment rods to the groomer gear box and idler arm.
6. Adjust the cutting unit height-of-cut; refer to *Cutting Unit Operators Manual*.
7. Check the groomer reel height and adjust as necessary.

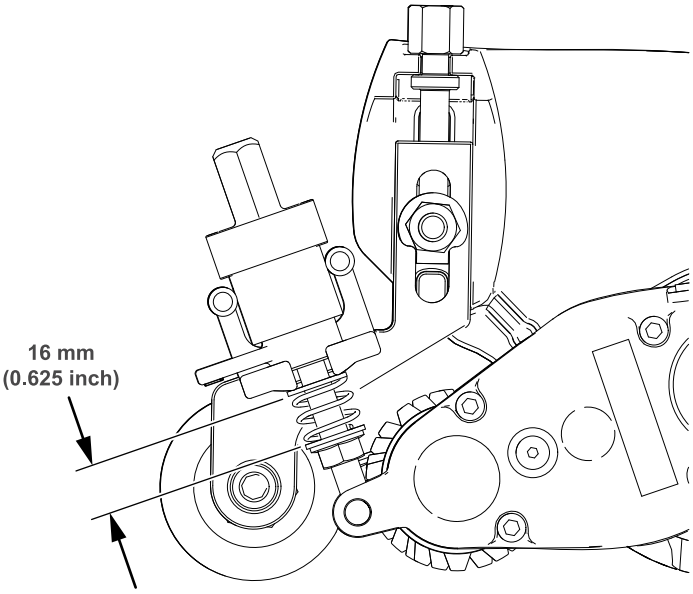


Figure 28

8. Adjust the flange nuts on the groomer height adjustment rods until the springs are compressed to **16 mm (0.625 inch)**.

The Grooming Brush (Optional)

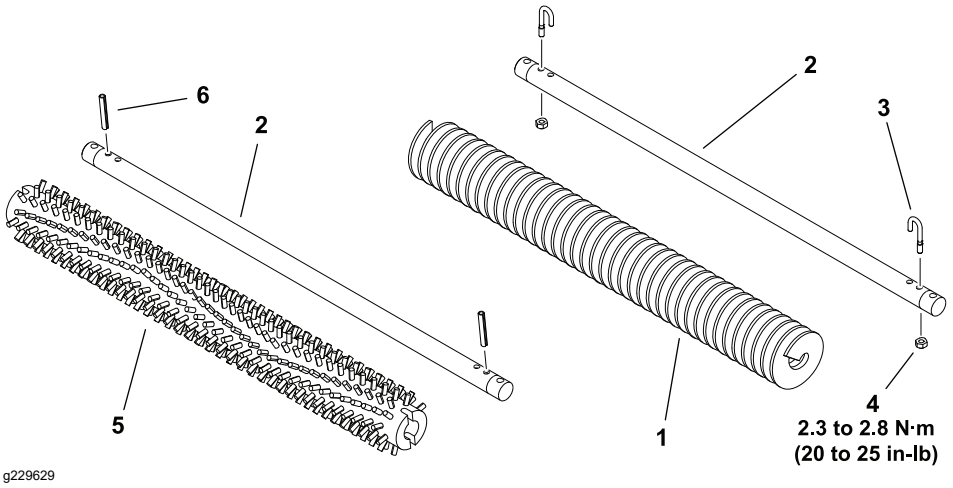


Figure 29

1. Spiral brush
2. Brush shaft
3. J-bolt (2 each)
4. Lock nut (2 each)
5. Grooming brush
6. Roll pin (2 each)

The optional grooming brush attaches to the groomer in place of the groomer reel. The grooming brush is removed and installed from the groomer in the same manner as the groomer reel; refer to The Groomer Reel (page 9–20).

The grooming brush element or shaft can be serviced separately.

To remove the spiral grooming brush from the shaft, remove the lock nut and J-bolt from both ends of the brush assembly and slide the brush from the shaft. When assembling the spiral brush to the shaft, make sure that the J-bolts are installed with the threaded portion on the outside of the brush and tighten the lock nuts from **2.3 to 2.8 N·m (20 to 25 in-lb)**.

Appendix A

Foldout Drawings

Table of Contents

Electrical Drawing Designations

Note: A splice used in a wire harness will be identified on the wire harness diagram by SP. The manufacturing number of the splice is also identified on the wire harness diagram (e.g., SP01 is splice number 1).

Wire Color

The following abbreviations are used for wire harness colors on the electrical schematics and wire harness drawings in this chapter.

ABBREVIATION	COLOR
BK	BLACK
BR or BN	BROWN
BU	BLUE
GN	GREEN
GY	GRAY
OR	ORANGE
PK	PINK
R or RD	RED
T	TAN
VIO	VIOLET
W or WH	WHITE
Y or YE	YELLOW

Numerous harness wires used on the Toro machines include a line with an alternate color. These wires are identified with the wire color and line color with either a / or _ separating the color abbreviations listed above (e.g., R/BK is a red wire with a black line, OR_BK is an orange wire with a black line).

Wire Size

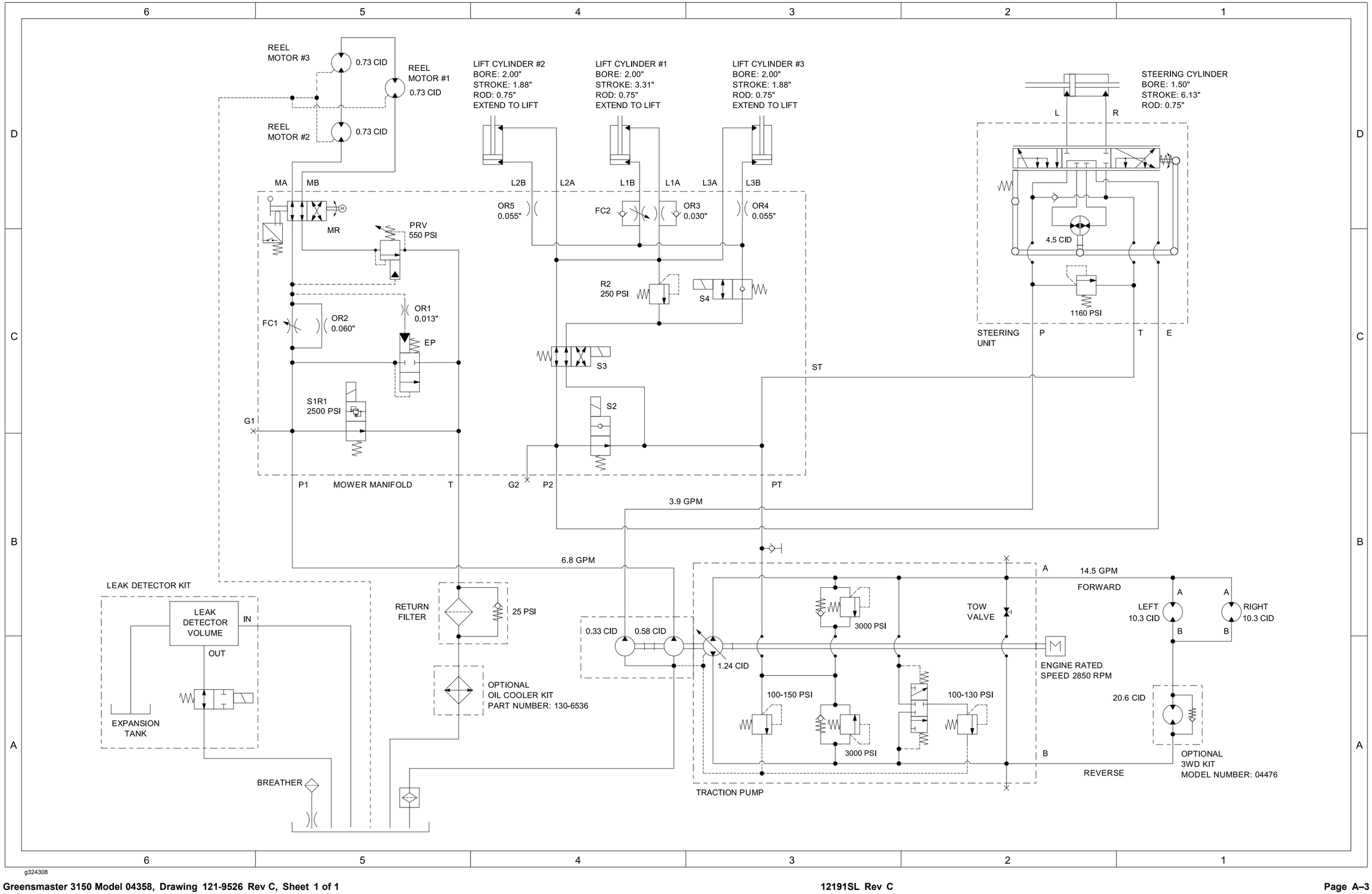
The individual wires of the electrical harness diagrams in this chapter identify both the wire color and the wire size.

Examples:

- 16 BK = 16 AWG (American Wire Gauge) wire that has a black insulator
- 050 R = 0.5 mm metric wire that has a red insulator (AWG equivalents for metric wire appear in the following table)

AWG Equivalents for Metric Wire		
Diagram Label	**Metric Size**	**AWG Equivalent**
050	0.5 mm	20 GA
175	0.75 mm	18 GA
100	1.0 mm	16 GA
150	1.5 mm	14 GA

Hydraulic Schematic



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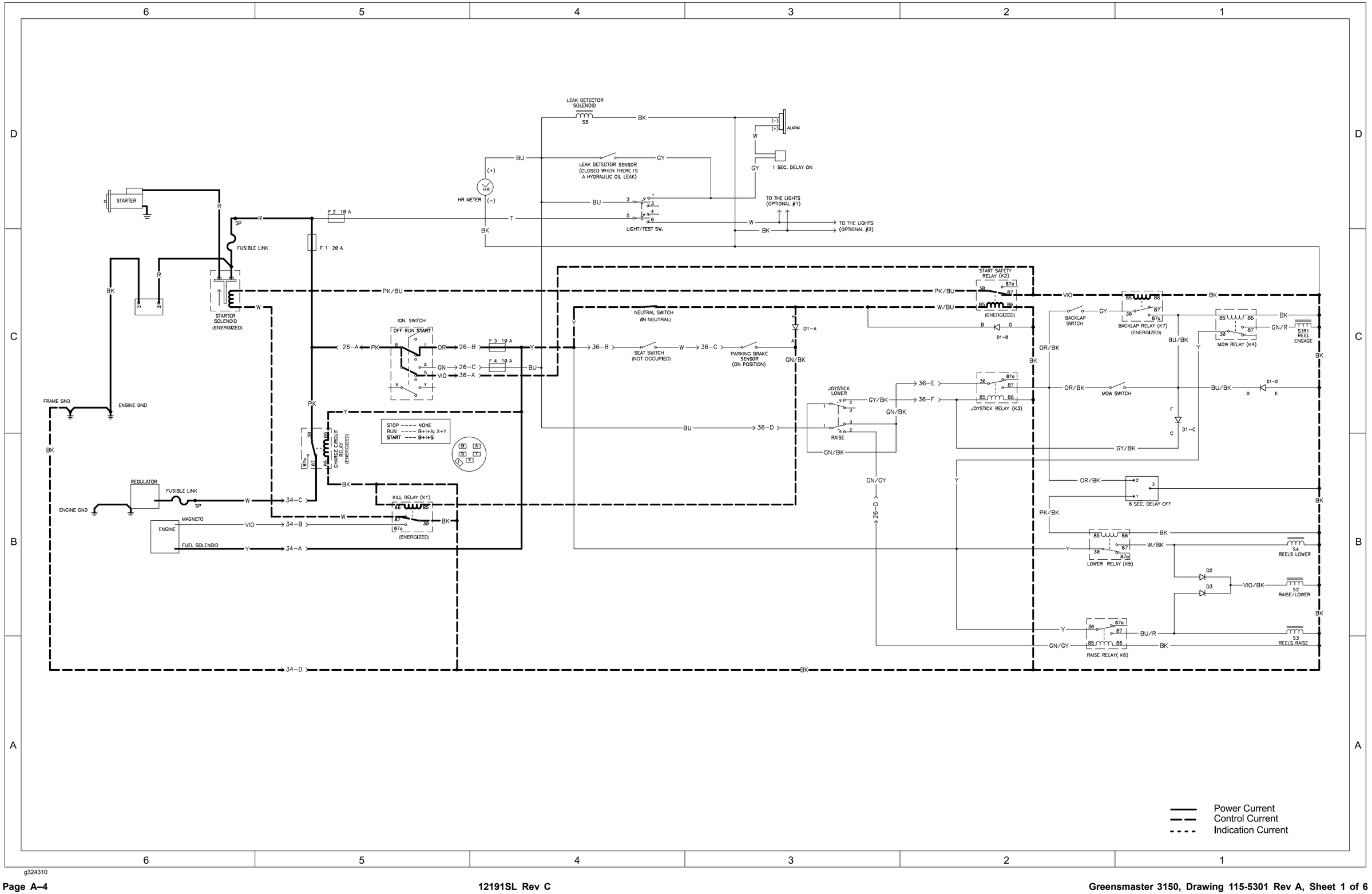
LEAK DETECTOR SOLENOID
SS
BK
(–)
(+)
ALARM
W
GY
1 SEC. DELAY ON
BU
LEAK DETECTOR SENSOR (CLOSED WHEN THERE IS A HYDRAULIC OIL LEAK)
GY
HR METER
HR
(+)
(–)
BU
TO THE LIGHTS (OPTIONAL #1)
T
LIGHT/TEST SW.
W
TO THE LIGHTS (OPTIONAL #2)
BK
STARTER
R
SP
F 2 10 A
F 1 20 A
FUSIBLE LINK
STARTER SOLENOID (ENERGIZED)
BK
PK/BU
W
IGN. SWITCH
OFF RUN START
26–A
PK
OR
26–B
F 3 10 A
GN
26–C
F 4 10 A
VIO
36–A
BU
NEUTRAL SWITCH (IN NEUTRAL)
36–B
SEAT SWITCH (NOT OCCUPIED)
W
36–C
PARKING BRAKE SENSOR (ON POSITION)
D1–A
GN/BK
START SAFETY RELAY (K2)
(ENERGIZED)
D1–B
W/BU
VIO
BACKLAP SWITCH
GY
BACKLAP RELAY (K7)
(ENERGIZED)
BK
MOW RELAY (K4)
GN/R
S1R1 REEL ENGAGE
OR/BK
BU/BK
MOW SWITCH
D1–D
D
E
F
D1–C
C
FRAME GND
ENGINE GND
BK
Y
PK
STOP ----- NONE
RUN ----- B+I+A; X+Y
START --- B+I+S
CHARGE CIRCUIT RELAY (ENERGIZED)
JOYSTICK LOWER
RAISE
GY/BK
GN/BK
36–E
36–F
JOYSTICK RELAY (K3)
GN/GY
26–D
REGULATOR
FUSIBLE LINK
SP
W
34–C
ENGINE GND
MAGNETO
VIO
34–B
ENGINE
FUEL SOLENOID
Y
34–A
KILL RELAY (K1)
(ENERGIZED)
34–D
6 SEC. DELAY OFF
PK/BK
W/BK
S4 REELS LOWER
LOWER RELAY (K5)
D2
D3
VIO/BK
S2 RAISE/LOWER
BU/R
S3 REELS RAISE
RAISE RELAY(K6)
Power Current
Control Current
Indication Current

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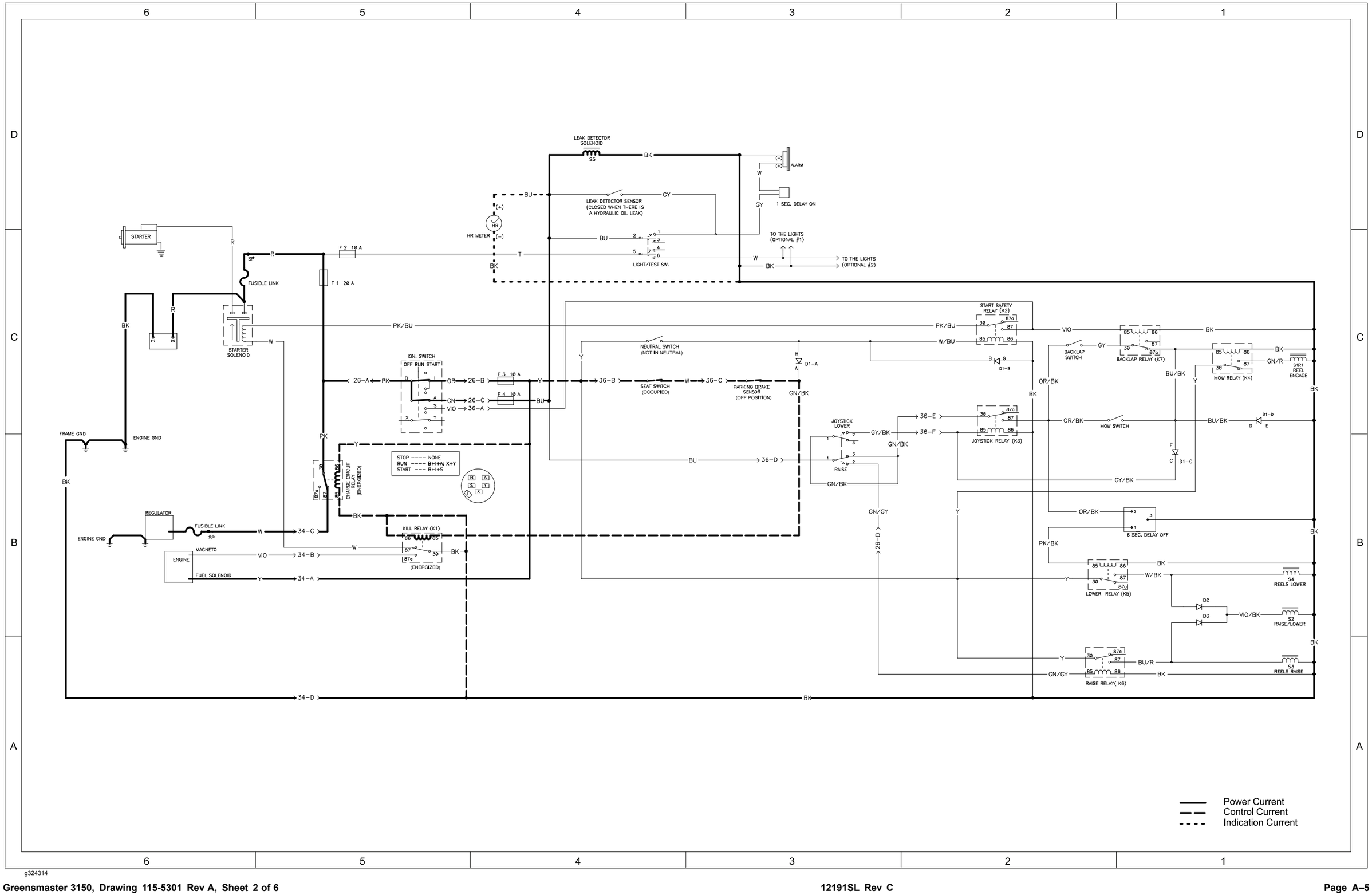
Electrical Circuit Diagrams – Run Circuits (typical)



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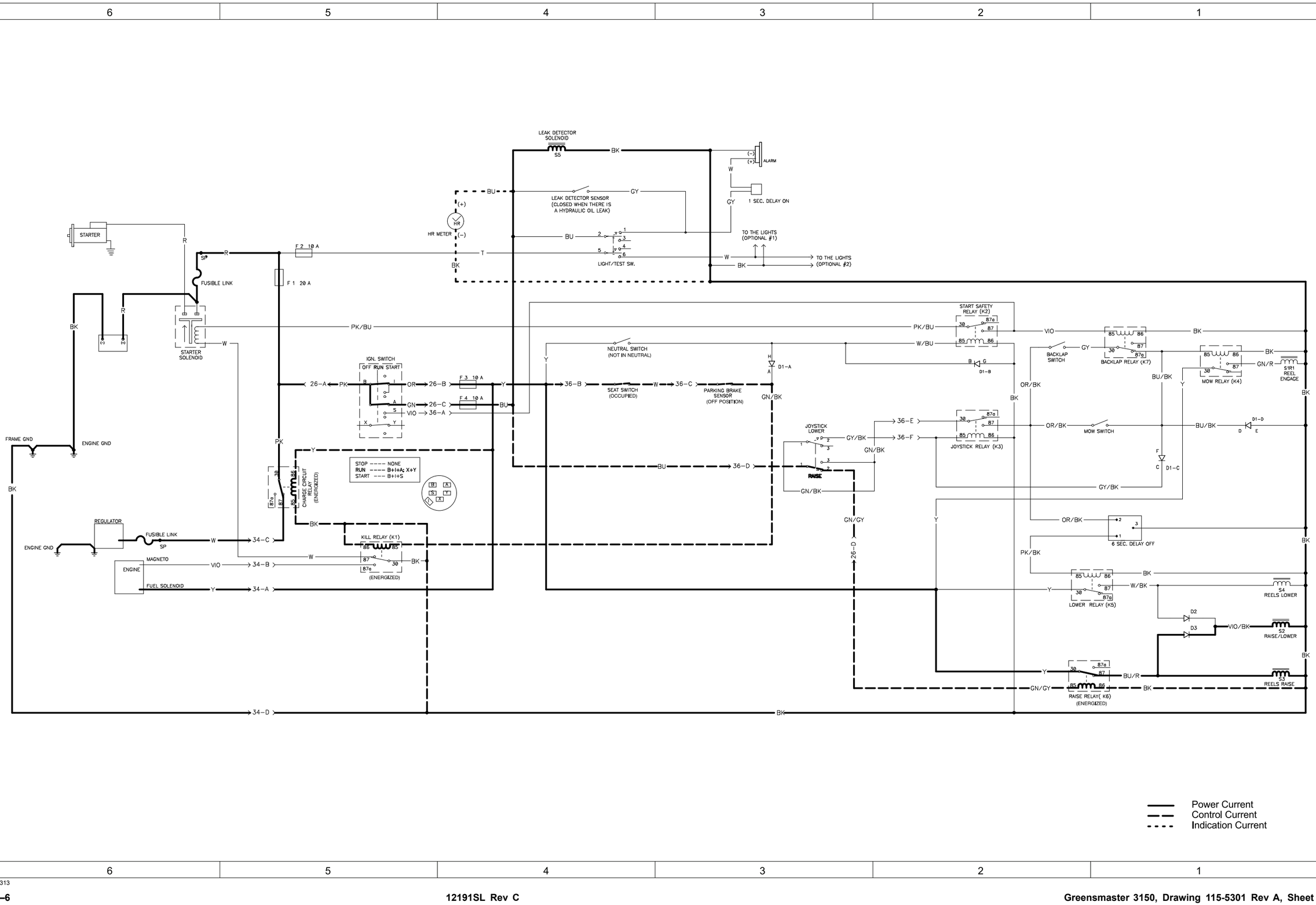
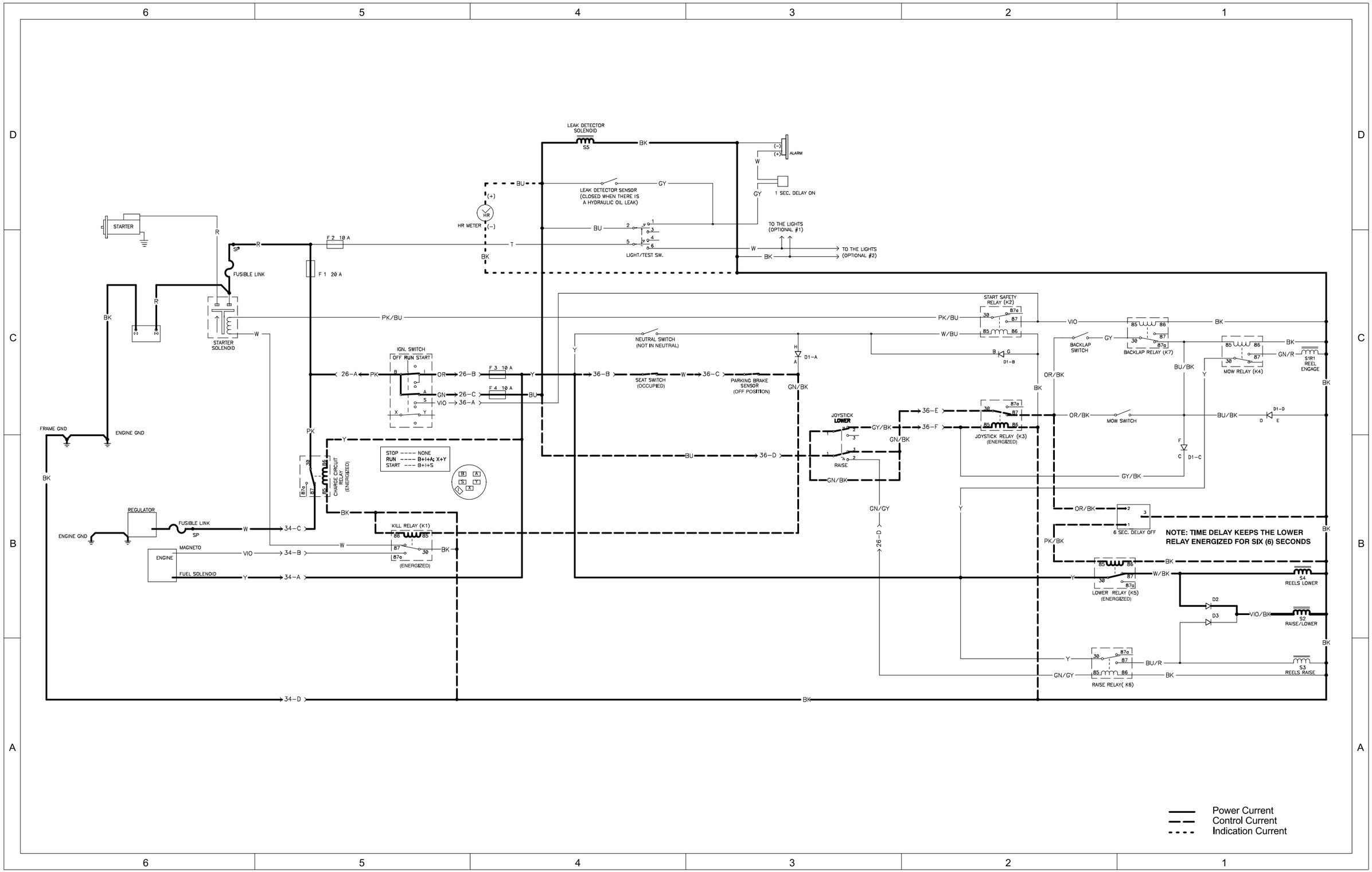
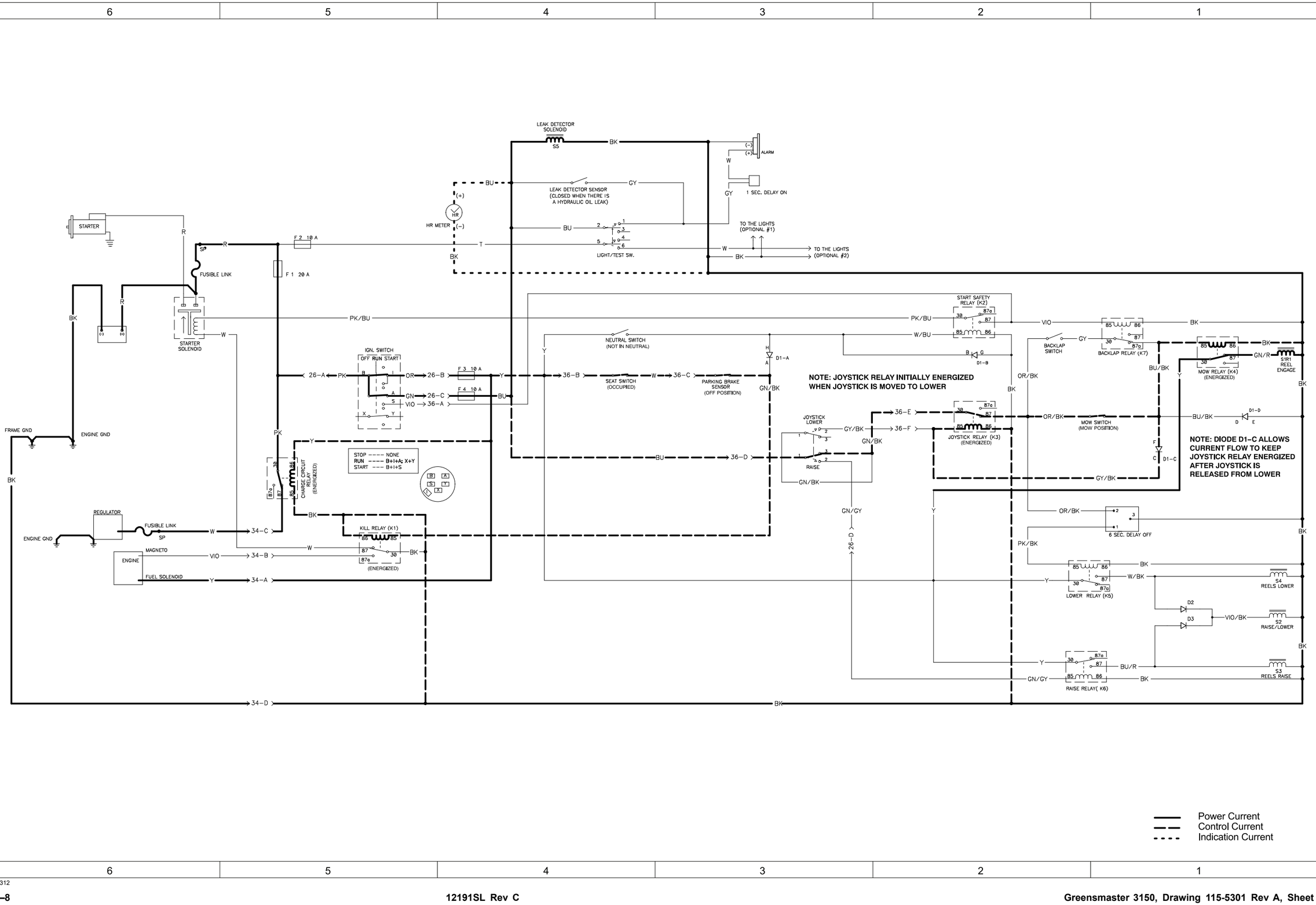

LEAK DETECTOR SOLENOID
S5
BK
(–)
(+)
ALARM
W
GY
1 SEC. DELAY ON
LEAK DETECTOR SENSOR (CLOSED WHEN THERE IS A HYDRAULIC OIL LEAK)
BU
GY
(+)
HR
HR METER
(–)
BU
2
1
3
5
4
6
LIGHT/TEST SW.
TO THE LIGHTS (OPTIONAL #1)
W
BK
TO THE LIGHTS (OPTIONAL #2)
STARTER
R
R
F 2 10 A
SP
FUSIBLE LINK
F 1 20 A
R
BK
PK/BU
W
STARTER SOLENOID
START SAFETY RELAY (K2)
30
87a
87
85
86
PK/BU
W/BU
VIO
BACKLAP SWITCH
GY
BACKLAP RELAY (K7)
BK
MOW RELAY (K4)
GN/R
S181 REEL ENGAGE
BK
BU/BK
Y
OR/BK
BK
IGN. SWITCH
OFF RUN START
B
I
A
S
X
Y
26–A
PK
OR
26–B
F 3 10 A
GN
26–C
F 4 10 A
VIO
36–A
BU
Y
36–B
NEUTRAL SWITCH (NOT IN NEUTRAL)
SEAT SWITCH (OCCUPIED)
W
36–C
PARKING BRAKE SENSOR (OFF POSITION)
H
A
D1–A
GN/BK
B
C
D1–B
JOYSTICK LOWER
GY/BK
GN/BK
36–E
36–F
JOYSTICK RELAY (K3)
OR/BK
MOW SWITCH
BU/BK
D
E
D1–D
F
C
D1–C
GY/BK
FRAME GND
ENGINE GND
BK
PK
Y
BU
36–D
STOP ----- NONE
RUN ----- B+I+A; X+Y
START --- B+I+S
B
A
S
Y
X
CHARGE CIRCUIT RELAY (ENERGIZED)
REGULATOR
ENGINE GND
FUSIBLE LINK
SP
W
34–C
KILL RELAY (K1)
86
85
87
87a
30
BK
(ENERGIZED)
MAGNETO
ENGINE
VIO
34–B
FUEL SOLENOID
Y
34–A
GN/GY
26–D
Y
OR/BK
6 SEC. DELAY OFF
PK/BK
BK
W/BK
LOWER RELAY (K5)
S4 REELS LOWER
D2
D3
VIO/BK
S2 RAISE/LOWER
BK
Y
BU/R
GN/GY
BK
RAISE RELAY(K6)
(ENERGIZED)
S3 REELS RAISE
34–D
BK
Power Current
Control Current
Indication Current

g324313

Electrical Circuit Diagrams – Lower Cutting Units (6 seconds) Circuits (typical)

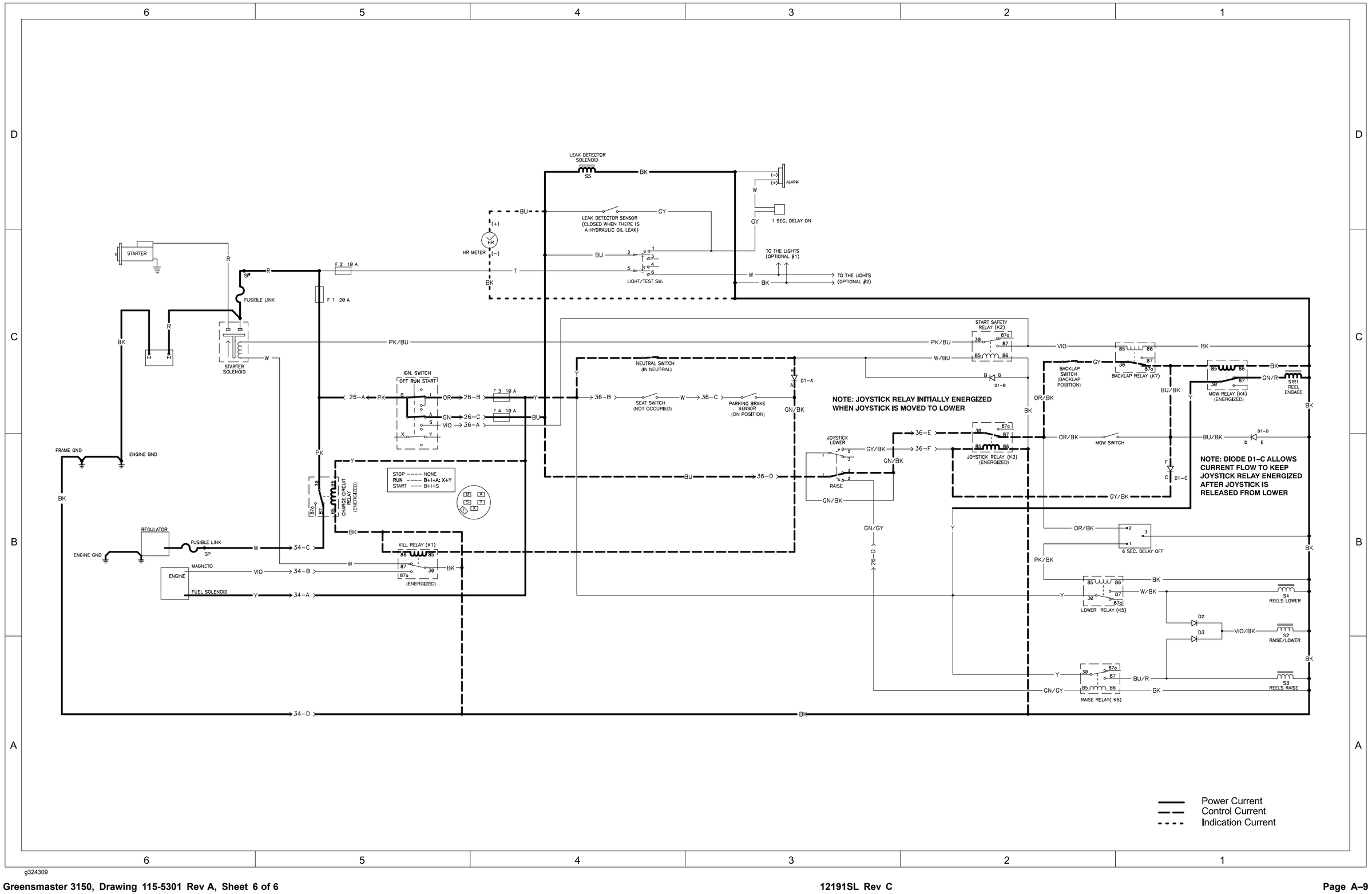


g324311


LEAK DETECTOR SOLENOID
SS
BK
(–)
(+)
ALARM
W
GY
1 SEC. DELAY ON
BU
LEAK DETECTOR SENSOR (CLOSED WHEN THERE IS A HYDRAULIC OIL LEAK)
GY
HR METER
(+)
(–)
BU
TO THE LIGHTS (OPTIONAL #1)
LIGHT/TEST SW.
W
BK
TO THE LIGHTS (OPTIONAL #2)
STARTER
R
SP
F 2 10 A
F 1 20 A
FUSIBLE LINK
T
BK
R
BK
C1
C2
STARTER SOLENOID
W
PK/BU
START SAFETY RELAY (K2)
PK/BU
W/BU
VIO
BACKLAP SWITCH
GY
BACKLAP RELAY (K7)
BK
GN/R
S181 REEL ENGAGE
MOW RELAY (K4) (ENERGIZED)
BU/BK
IGN. SWITCH
OFF RUN START
26–A
PK
OR
26–B
F 3 10 A
GN
26–C
VIO
36–A
F 4 10 A
BU
Y
36–B
NEUTRAL SWITCH (NOT IN NEUTRAL)
SEAT SWITCH (OCCUPIED)
W
36–C
PARKING BRAKE SENSOR (OFF POSITION)
GN/BK
D1–A
NOTE: JOYSTICK RELAY INITIALLY ENERGIZED WHEN JOYSTICK IS MOVED TO LOWER
OR/BK
BK
JOYSTICK LOWER
GY/BK
36–E
36–F
GN/BK
RAISE
JOYSTICK RELAY (K3) (ENERGIZED)
MOW SWITCH (MOW POSITION)
BU/BK
D1–D
NOTE: DIODE D1–C ALLOWS CURRENT FLOW TO KEEP JOYSTICK RELAY ENERGIZED AFTER JOYSTICK IS RELEASED FROM LOWER
D1–C
GY/BK
FRAME GND
ENGINE GND
PK
Y
STOP ----- NONE
RUN ----- B+I+A; X+Y
START ---- B+I+S
CHARGE CIRCUIT RELAY (ENERGIZED)
BU
36–D
GN/GY
26–D
REGULATOR
FUSIBLE LINK
SP
W
34–C
ENGINE GND
KILL RELAY (K1)
MAGNETO
ENGINE
VIO
34–B
FUEL SOLENOID
Y
34–A
(ENERGIZED)
OR/BK
6 SEC. DELAY OFF
PK/BK
W/BK
LOWER RELAY (K5)
S4 REELS LOWER
D2
D3
VIO/BK
S2 RAISE/LOWER
BU/R
RAISE RELAY(K6)
S3 REELS RAISE
34–D
Power Current
Control Current
Indication Current

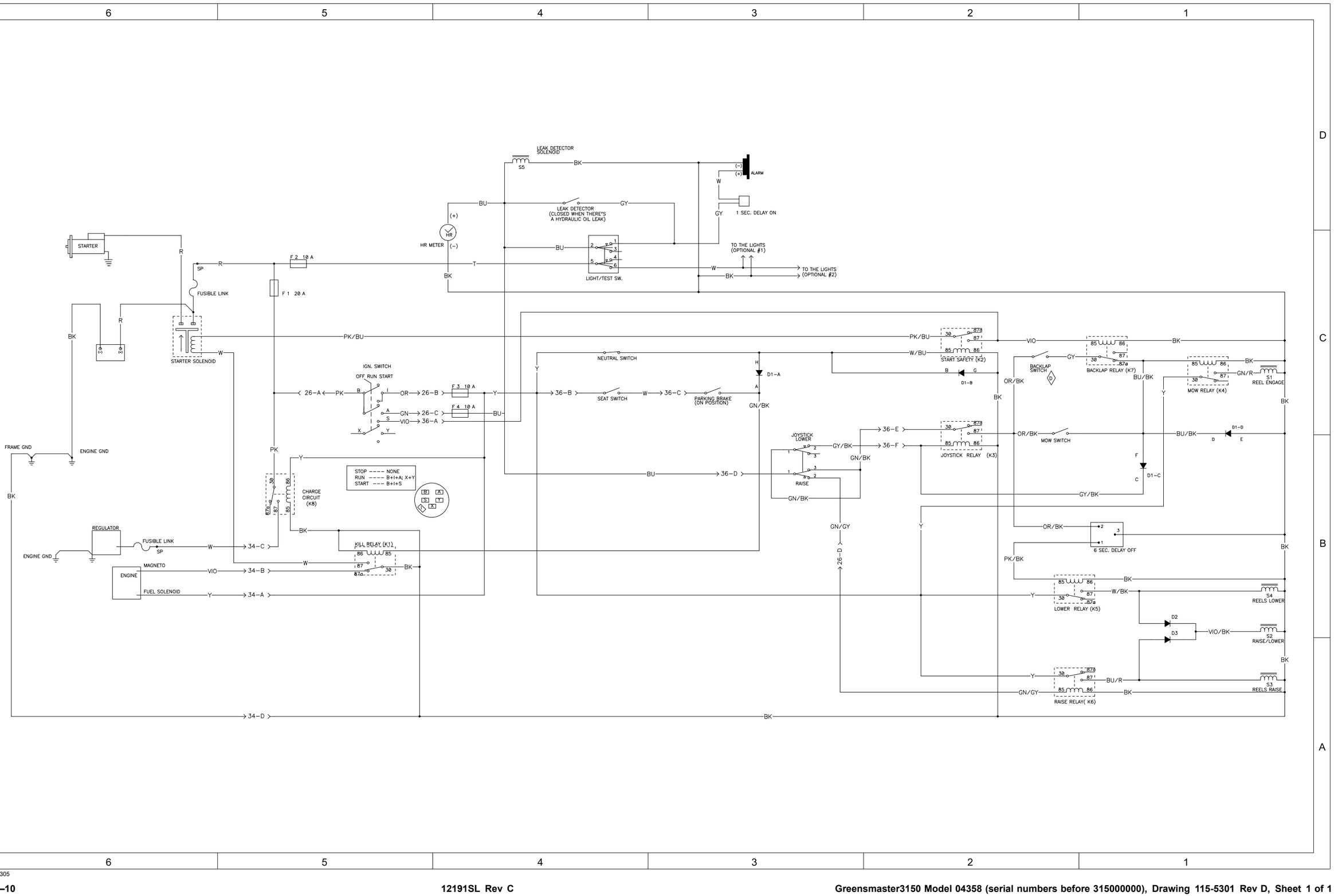
g324312

Electrical Circuit Diagrams – Backlap Circuits (typical)



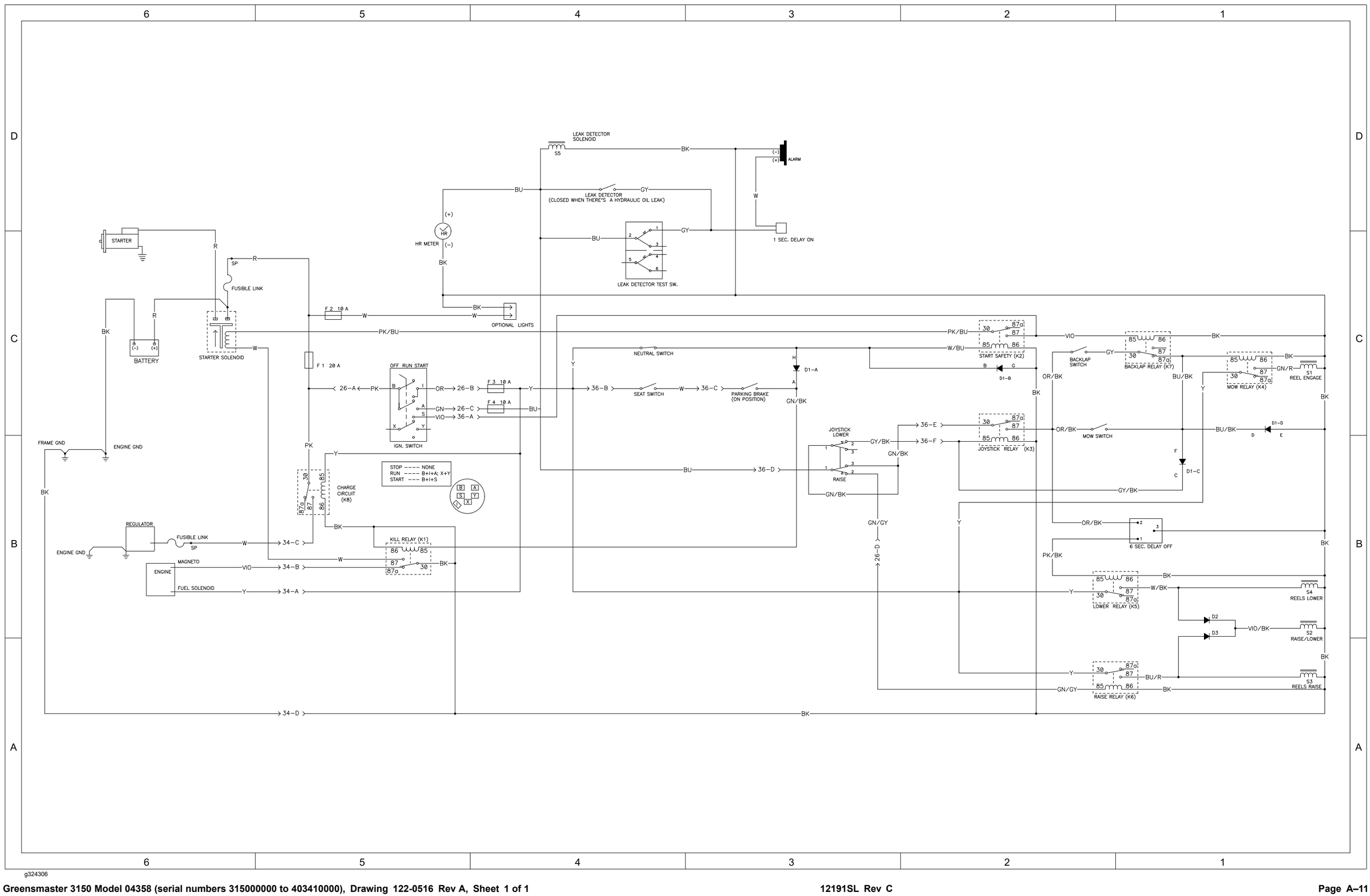
g324309

Electrical Schematic (serial numbers before 315000000)



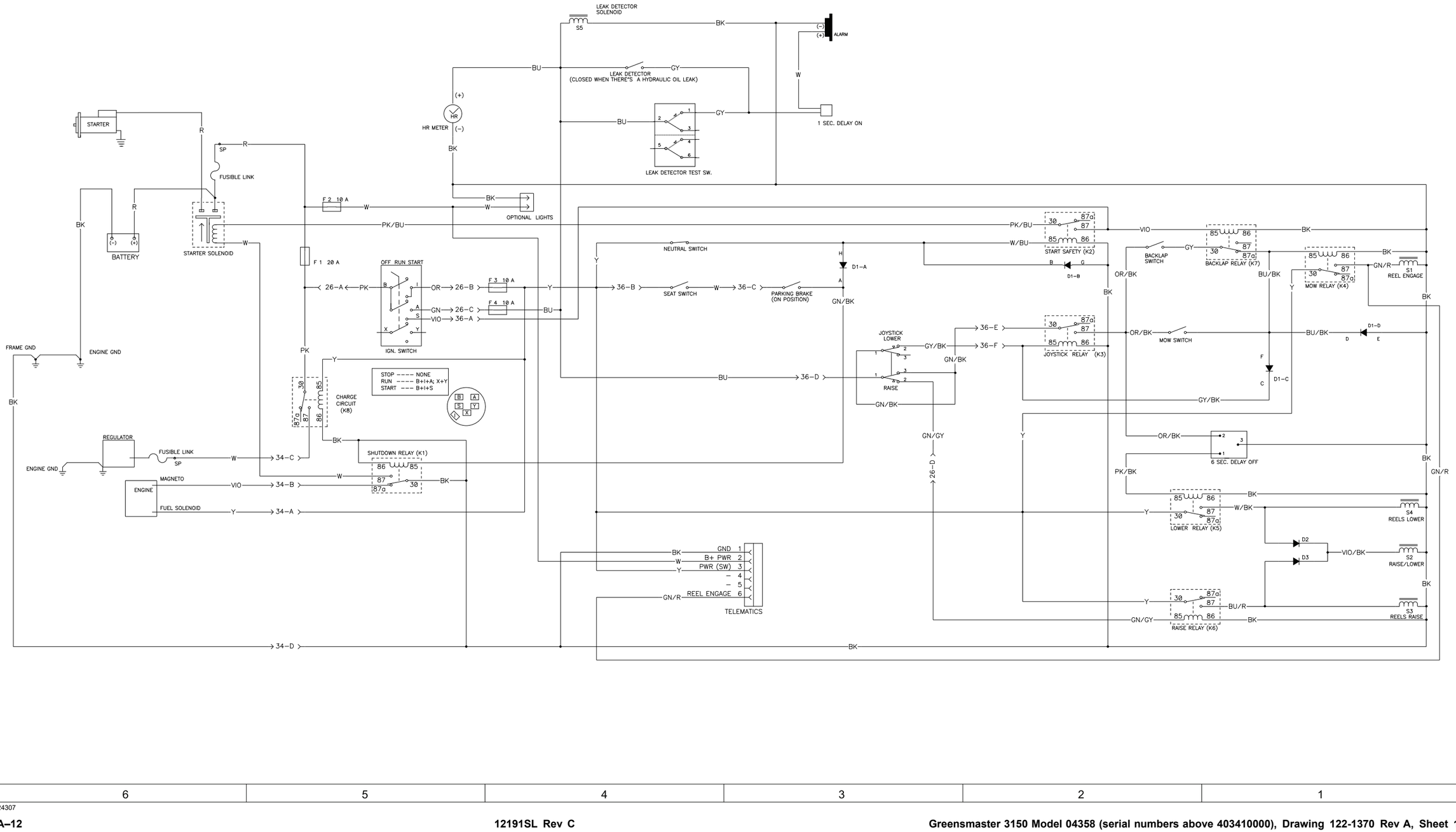
g324305

Electrical Schematic (serial numbers 315000000 to 403410000)



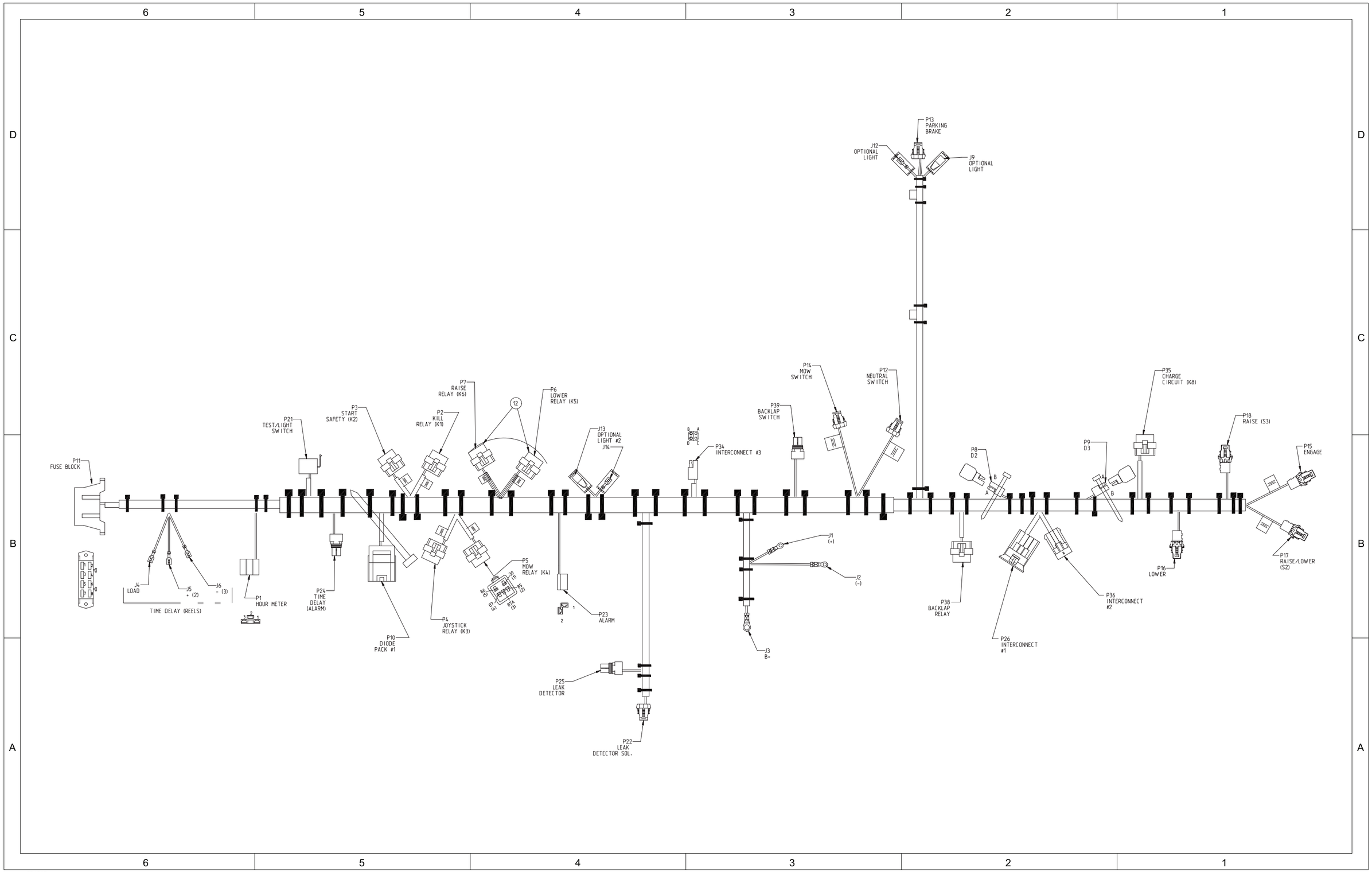
g324306

Electrical Schematic (serial numbers above 403410000)



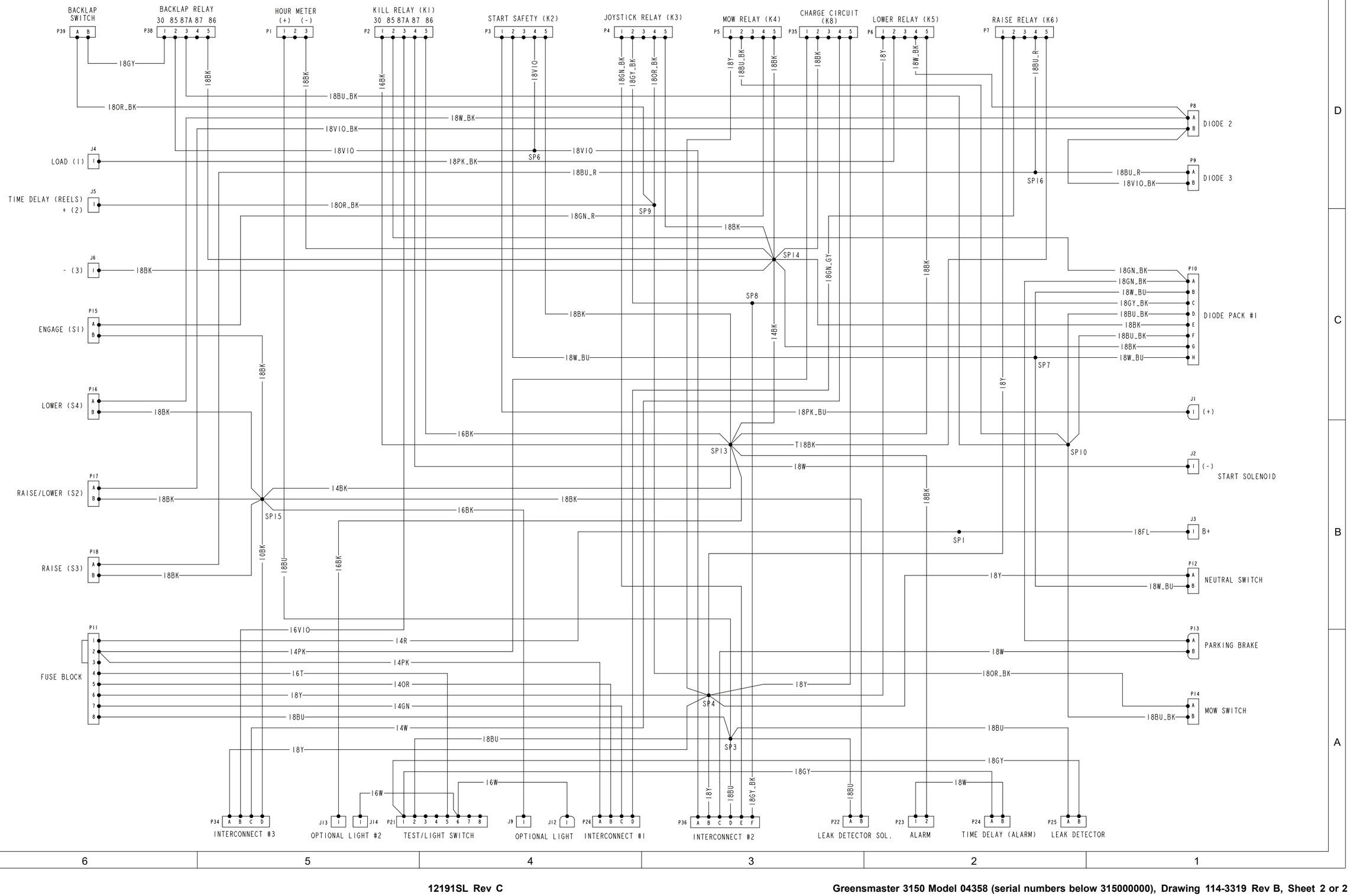
g324307

Main Wire Harness Drawing (serial numbers below 315000000)



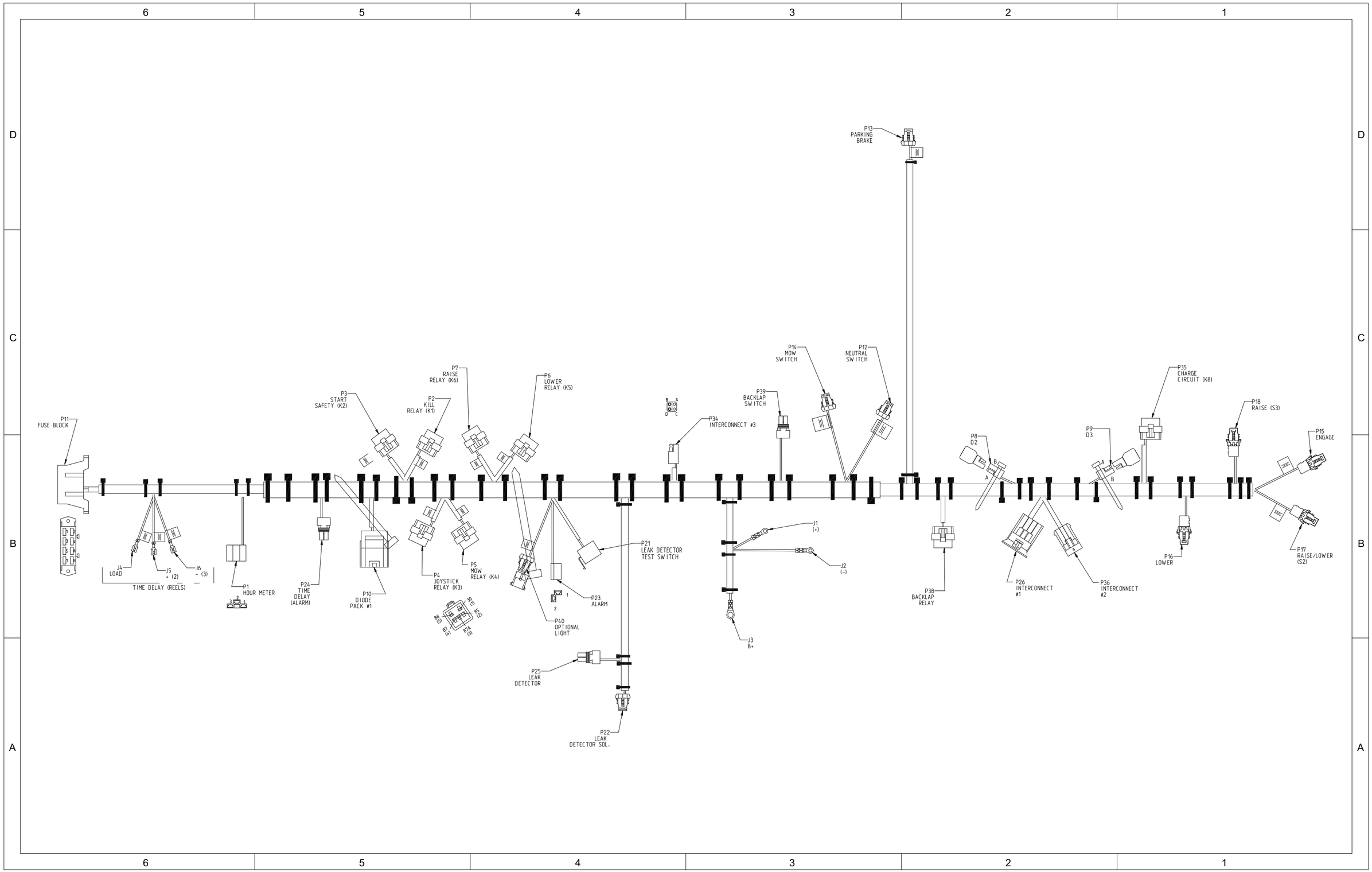
g324317

Main Wire Harness Diagram (serial numbers below 315000000)



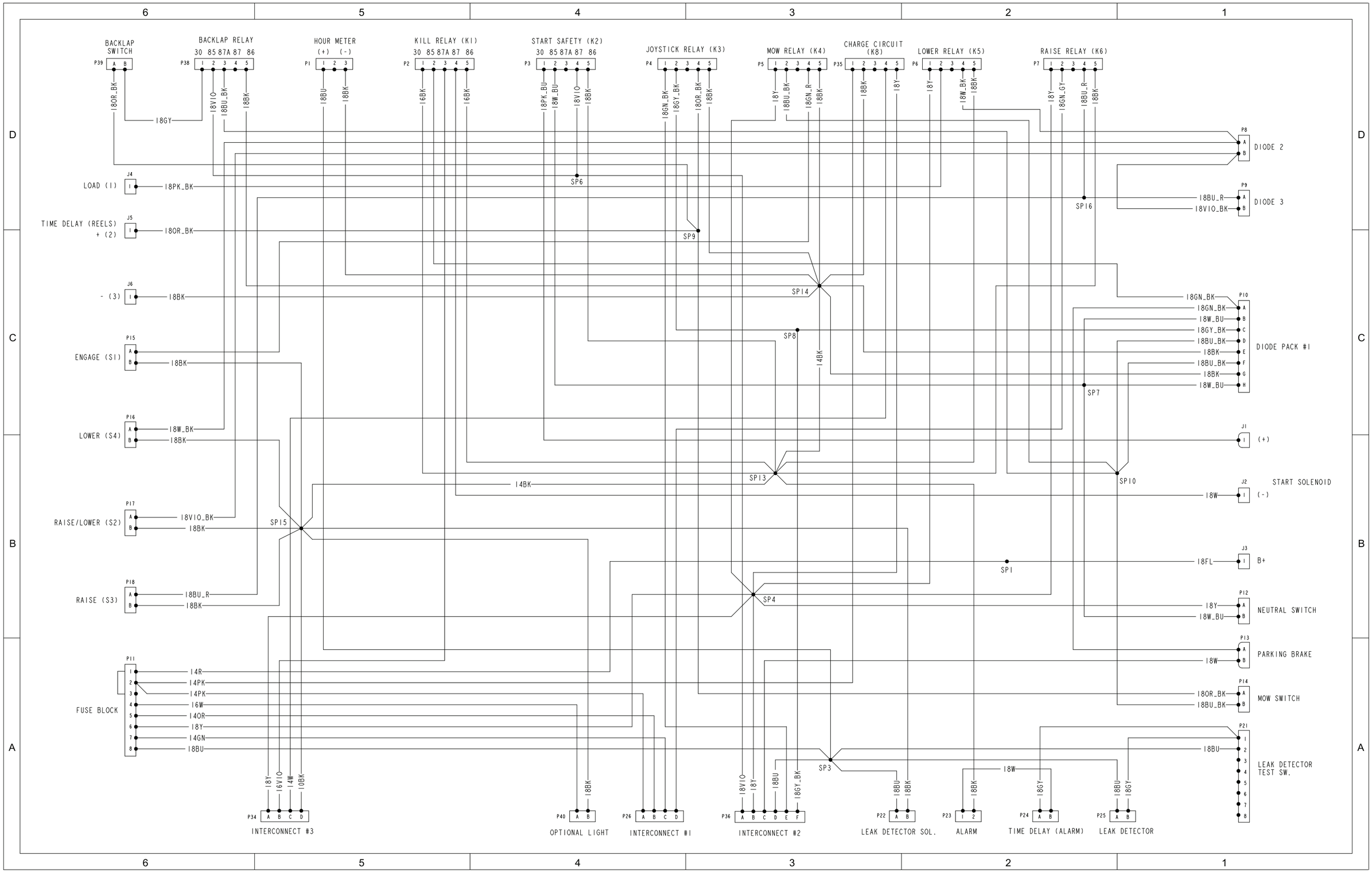
g324315

Main Wire Harness Drawing (serial numbers 315000000 to 403410000)



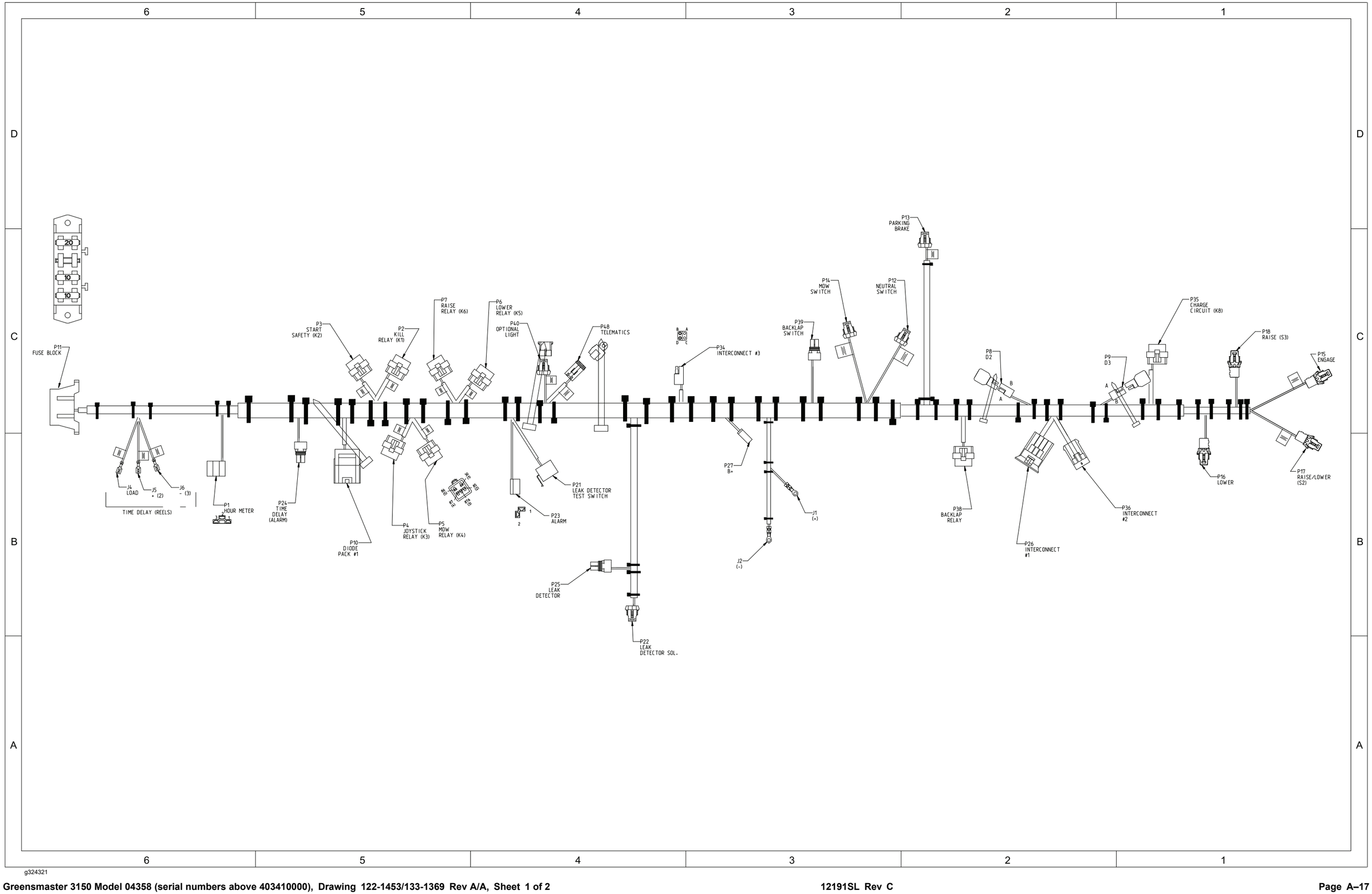
g324318

Main Wire Harness Diagram (serial numbers 315000000 to 403410000)



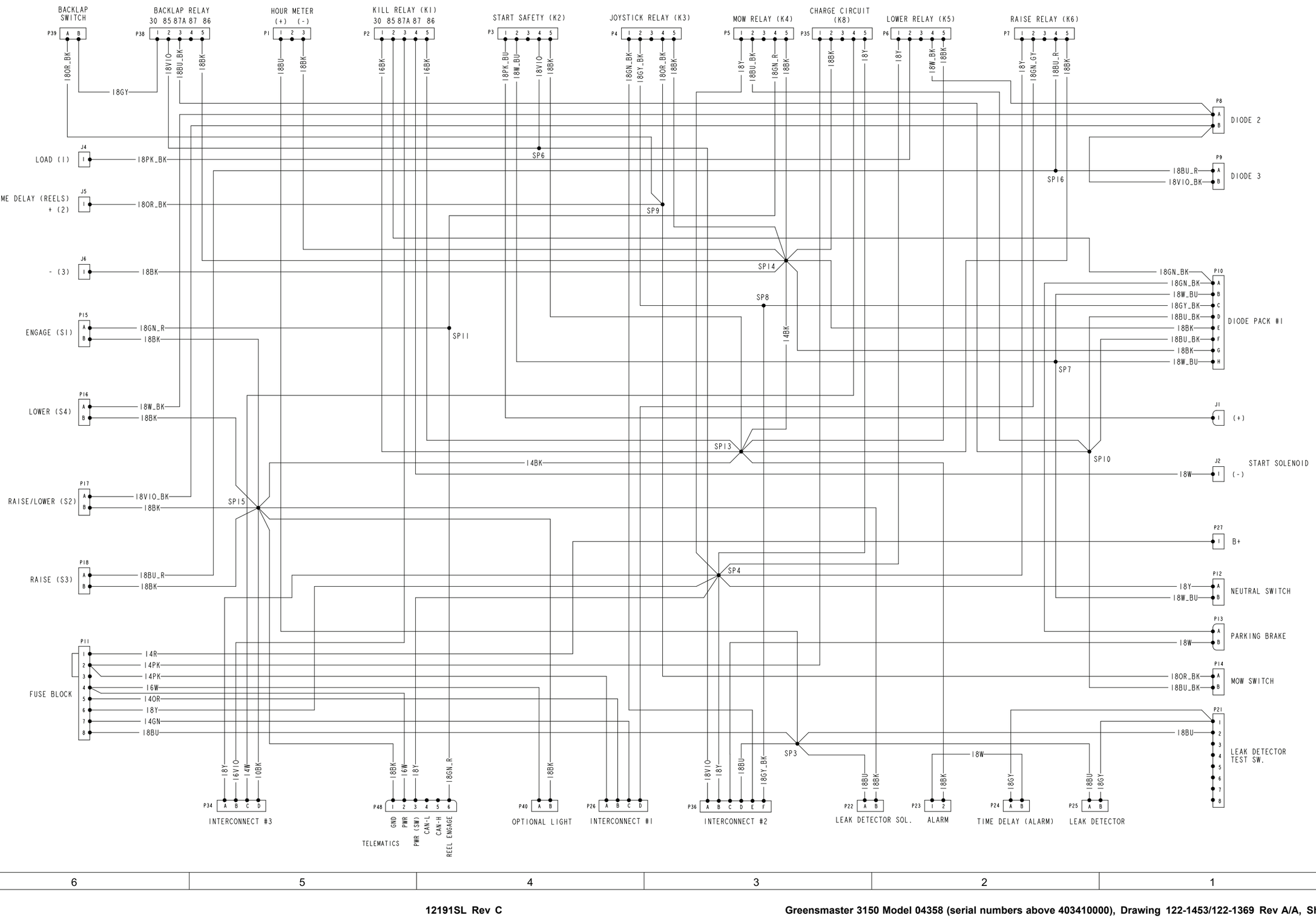
g324316

Main Wire Harness Drawing (serial numbers above 403410000)



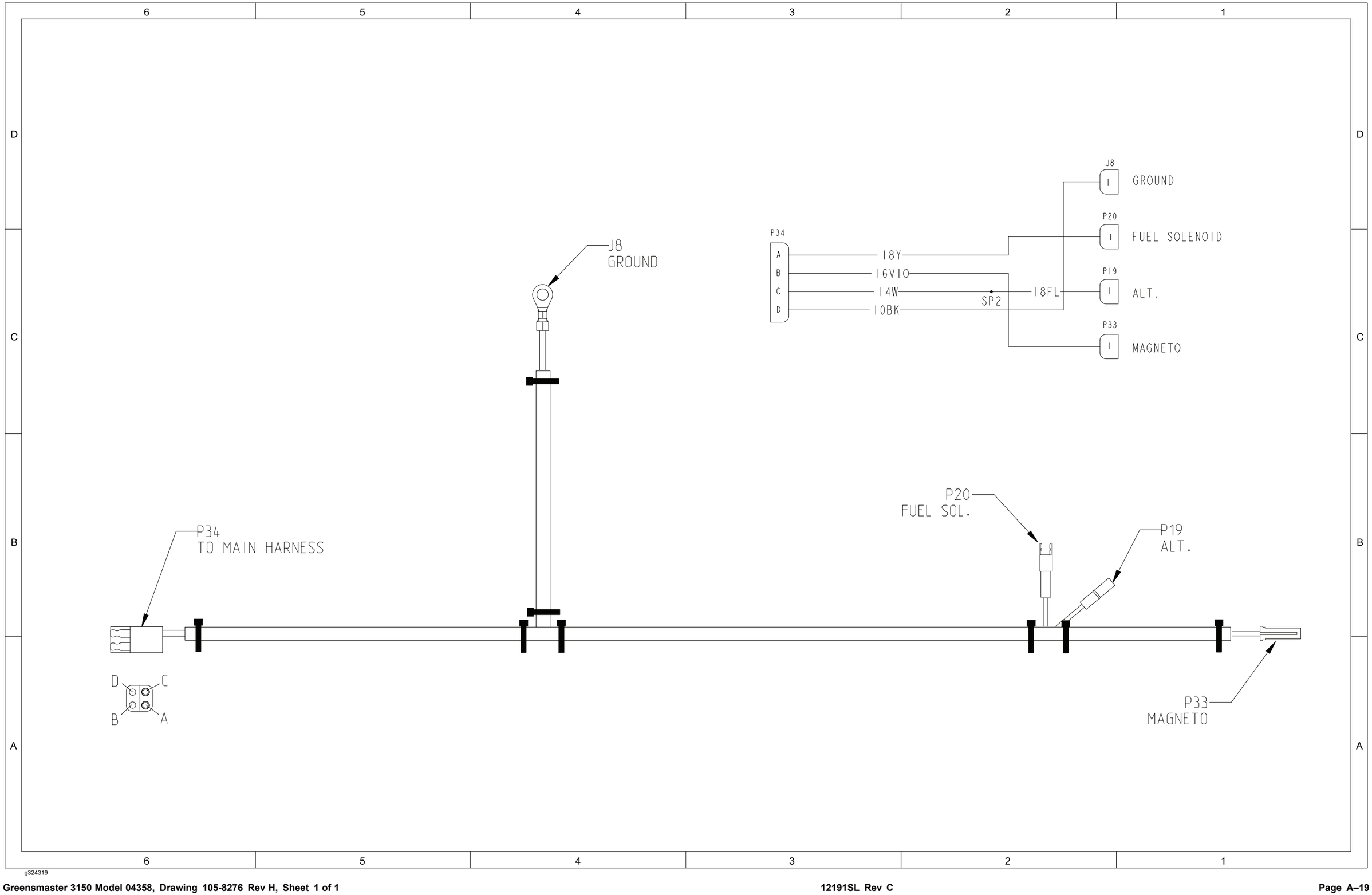
g324321

Main Wire Harness Diagram (serial numbers above 403410000)



g324320

Engine Wire Harness



g324319

Count on it.