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Form No. 12187SL Rev C

Service Manual

Greensmaster® TriFlex™ 3300/3400

(Models 04510 and 04520)

Revision History

[illegible]

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or Mail to:

Technical Publication Manager, Commercial
The Toro Company
8111 Lyndale Avenue South
Bloomington, MN 55420-1196
Phone: +1 952-887-8495

NOTES



Service Manual

(Models 04510 and 04520)

Greensmaster[®] TriFlex[™] 3300/3400

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 TriFlex 3300 and 3400.

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.

Greensmaster 3300



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Safety

Product Records
and Maintenance

Gasoline
Engine

Diesel
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Belt Driven Groomer (Optional)
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General Safety Instructions

Greensmaster TriFlex 3300 and 3400 machines have been tested and certified by TORO for compliance with existing safety standards and specifications. Although hazard control and accident prevention partially are dependent upon the design and configuration of the machine, these factors are also dependent upon the awareness, concern and proper training of the personnel involved in the operation, transport, maintenance and storage of the machine. Improper use or maintenance of the machine can result in injury or death. To reduce the potential for injury or death, comply with the following safety instructions.



WARNING

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

Before Operating

1. Review and understand the contents of the Operator's Manuals and Operator's DVD before starting and operating the vehicle. Become familiar with the controls and know how to stop the vehicle and engine quickly. Additional copies of the Operator's Manual are available on the internet at www.Toro.com.
2. Keep all shields, safety devices and decals in place. If a shield, safety device or decal is defective, illegible or damaged, repair or replace it before operating the machine. Also tighten any loose nuts, bolts or screws to ensure machine is in safe operating condition.
3. Assure interlock switches are adjusted correctly so engine cannot be started unless traction pedal is in NEUTRAL and cutting units are DISENGAGED.
4. Since fuel is flammable, handle it carefully:
 - A. Use an approved fuel container.
 - B. Do not remove fuel tank cap while engine is hot or running.
 - C. Do not smoke while handling fuel.
 - D. Fill fuel tank outdoors and only to within an inch of the top of the tank, not the filler neck. Do not overfill the fuel tank.
 - E. Wipe up any spilled fuel.

While Operating

1. Sit on the seat when starting and operating the machine.
2. Before starting 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 applied.
 - D. Proceed to start engine.
 - E. After engine is started, release parking brake and keep foot off traction pedal. Machine must not move. If movement is evident, the traction pedal linkage is adjusted incorrectly; therefore, shut engine off and adjust traction pedal linkage until machine does not move when traction pedal is released.
3. Do not run engine in a confined area without adequate ventilation. Exhaust fumes are hazardous and could possibly be deadly.
4. Do not touch engine, exhaust system components or radiator (if equipped) while engine is running or soon after it is stopped. These areas could be hot enough to cause burns.
5. Before getting off the seat:
 - A. Make sure cutting units are disengaged.
 - B. Verify that functional control lever is in neutral.
 - C. Apply the parking brake.
 - D. Stop the engine and remove key from ignition switch.
 - E. Toro recommends that anytime the machine is parked (short or long term), the cutting units should be lowered to the ground. This relieves pressure from the hydraulic lift circuit and eliminates the risk of cutting units accidentally lowering to the ground.
 - F. Do not park the machine on slopes unless wheels are chocked or blocked.

Maintenance and Service

1. The Traction Unit and Cutting Unit Operator's Manuals provide information regarding the operation, general maintenance and maintenance intervals for your Greensmaster machine. Refer to these publications for additional information when servicing the machine.
2. Before servicing or making adjustments, lower cutting units, stop engine, apply parking brake and remove key from the ignition switch.
3. Make sure machine is in safe operating condition by keeping all nuts, bolts and screws tight.
4. Never store the machine or fuel container inside where there is an open flame, such as near a water heater or furnace.
5. Make sure all hydraulic line connectors are tight and all hydraulic hoses and lines are in good condition before applying pressure to the hydraulic system.
6. Keep body and hands away from pin hole leaks in hydraulic lines that eject high pressure hydraulic fluid. Use cardboard or paper to find hydraulic leaks. Hydraulic fluid escaping under pressure can penetrate skin and cause injury. Fluid accidentally injected into the skin must be surgically removed within a few hours by a doctor familiar with this form of injury or gangrene may result.
7. Before disconnecting or performing any work on the hydraulic system, all pressure in system must be relieved by stopping engine and lowering cutting units to the ground.
8. If major repairs are ever needed or assistance is desired, contact an Authorized Toro Distributor.
9. To reduce potential fire hazard, keep engine area free of excessive grease, grass, leaves and dirt. Clean protective screen on machine frequently.
10. If engine must be running to perform maintenance or an adjustment, keep hands, feet, clothing and other parts of the body away from cutting units and other moving parts. Keep bystanders away.
11. Do not overspeed the engine by changing governor setting. To assure safety and accuracy, check maximum engine speed.
12. Shut engine off before checking or adding oil to the engine crankcase.
13. Disconnect battery before servicing the machine. Disconnect negative battery cable first and positive cable last. If battery voltage is required for troubleshooting or test procedures, temporarily connect the battery. Reconnect positive battery cable first and negative cable last.
14. Battery acid is poisonous and can cause burns. Avoid contact with skin, eyes and clothing. Protect your face, eyes and clothing when working with a battery.
15. Battery gases can explode. Keep cigarettes, sparks and flames away from the battery.
16. When welding on machine, disconnect both battery cables to prevent damage to machine electronic equipment. Disconnect negative battery cable first and positive cable last. Also, disconnect the wire harness connector from the TEC controller and the alternator connector(s). This will prevent damage to the electrical system of your Greensmaster.
17. 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.
18. 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 (see Jacking Instructions in this chapter).

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.

Safety

Front End Jacking

1. Apply parking brake and chock rear tire to prevent the machine from moving.
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 (Fig. 1).
 - B. The right side jacking point is the frame bracket behind the RH front wheel (Fig. 2).
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.
2. Place jack securely under the rear jacking point on the rear steering fork (Fig. 3).
3. Jack rear of machine off the ground.
4. Position appropriate jack stands under the frame to support the machine.

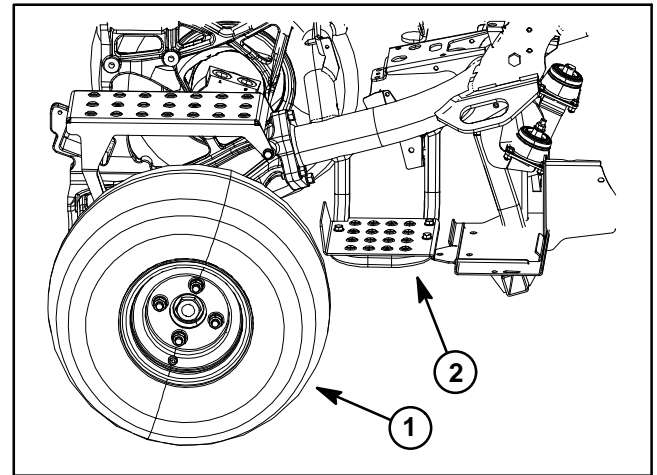


Figure 1

1. LH front wheel 2. Jacking point

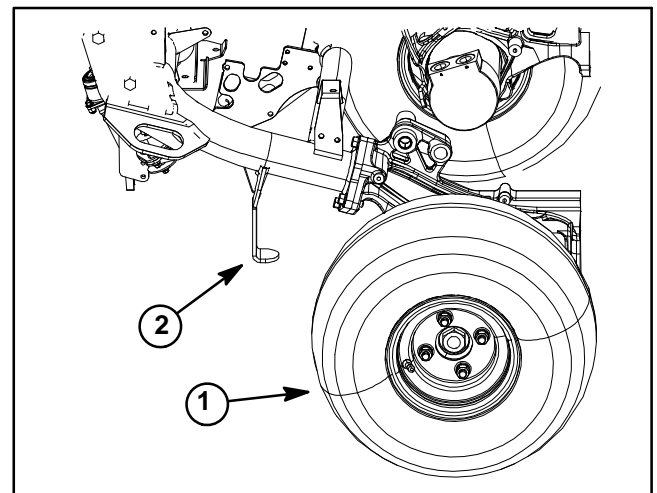


Figure 2

1. RH front wheel 2. Jacking point

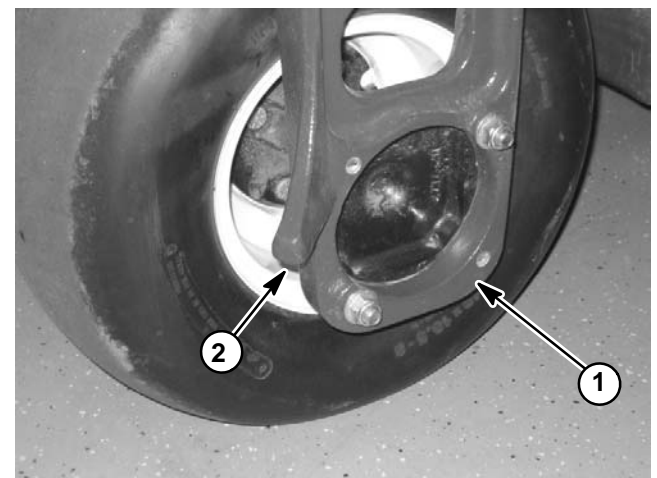


Figure 3

1. Rear steering fork 2. Rear jacking point

Safety and Instruction Decals

Numerous safety and instruction decals are affixed to the traction unit and the cutting units of Greensmaster TriFlex 3300 and 3400 machines. 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.



Product Records and Maintenance

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Product Records

Insert a copy of the Traction Unit and Cutting Unit Operator's Manuals and Parts Catalog for your Greensmaster at the end of this chapter. Additionally, if any optional equipment or accessories have been installed to your machine, insert the Installation Instructions, Operator's Manuals and Parts Catalogs for those options at the end of this chapter.

Maintenance

Maintenance procedures and recommended service intervals for your Greensmaster 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. Subtract 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

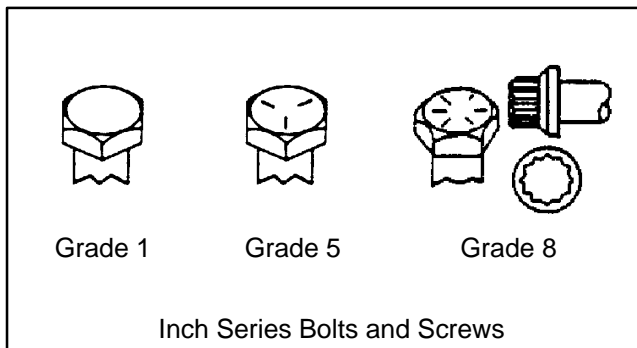


Figure 1

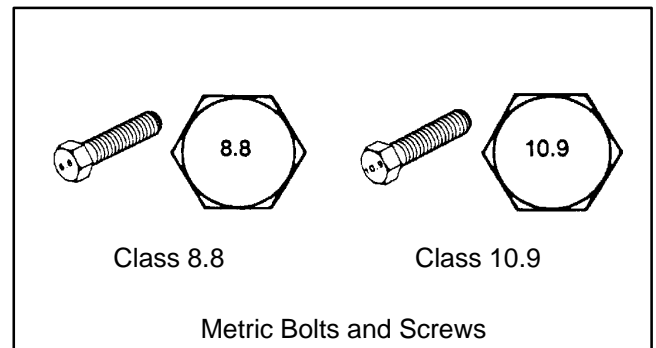


Figure 2

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.

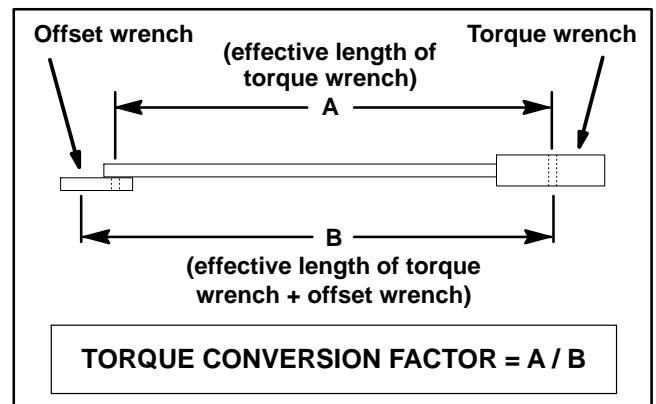


Figure 3

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 and finish must be considered when determining specific torque values. All torque values are based on non-lubricated fasteners.

Conversion Factors

$$\text{in-lb} \times 11.2985 = \text{N-cm}$$

$$\text{ft-lb} \times 1.3558 = \text{N-m}$$

$$\text{N-cm} \times 0.08851 = \text{in-lb}$$

$$\text{N-m} \times 0.7376 = \text{ft-lb}$$



Gasoline Engine

Gasoline
Engine

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BRIGGS & STRATTON VANGUARD V-TWIN OHV REPAIR MANUAL	

Specifications

Item	Description
Make / Designation	Briggs and Stratton, 4-cycle, V-Twin Cylinder, OHV, Air Cooled, Gasoline Engine – Model 385447
Bore x Stroke	2.97" x 2.76" (75.5 mm x 70 mm)
Total Displacement	38.3 in ³ (627 cc)
Governor	Mechanical Governor
Carburetor	Float Feed, Two Barrel
Fuel Pump	Pulsating Crankcase Vacuum
Fuel	Unleaded, regular grade gasoline
Fuel Tank Capacity	6.0 U.S. gallons (22.7 liters)
Low Idle (no load)	1650 ± 100 RPM
High Idle (no load)	2920 ± 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	20/50 Amp
Dry Weight (approximate)	85 lb (39 kg)

General Information

Information about specifications, maintenance, troubleshooting, testing and repair of the gasoline engine used in the Greensmaster TriFlex 3300 is included in this chapter and the Briggs & Stratton Vanguard V-Twin OHV Repair Manual.

Most engine repairs and adjustments require tools which are commonly available in many service shops. Special tools are described in the Briggs & Stratton 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 machine. Refer to the Operator's Manual for additional information when servicing the machine.

Fuel Evaporative Control System

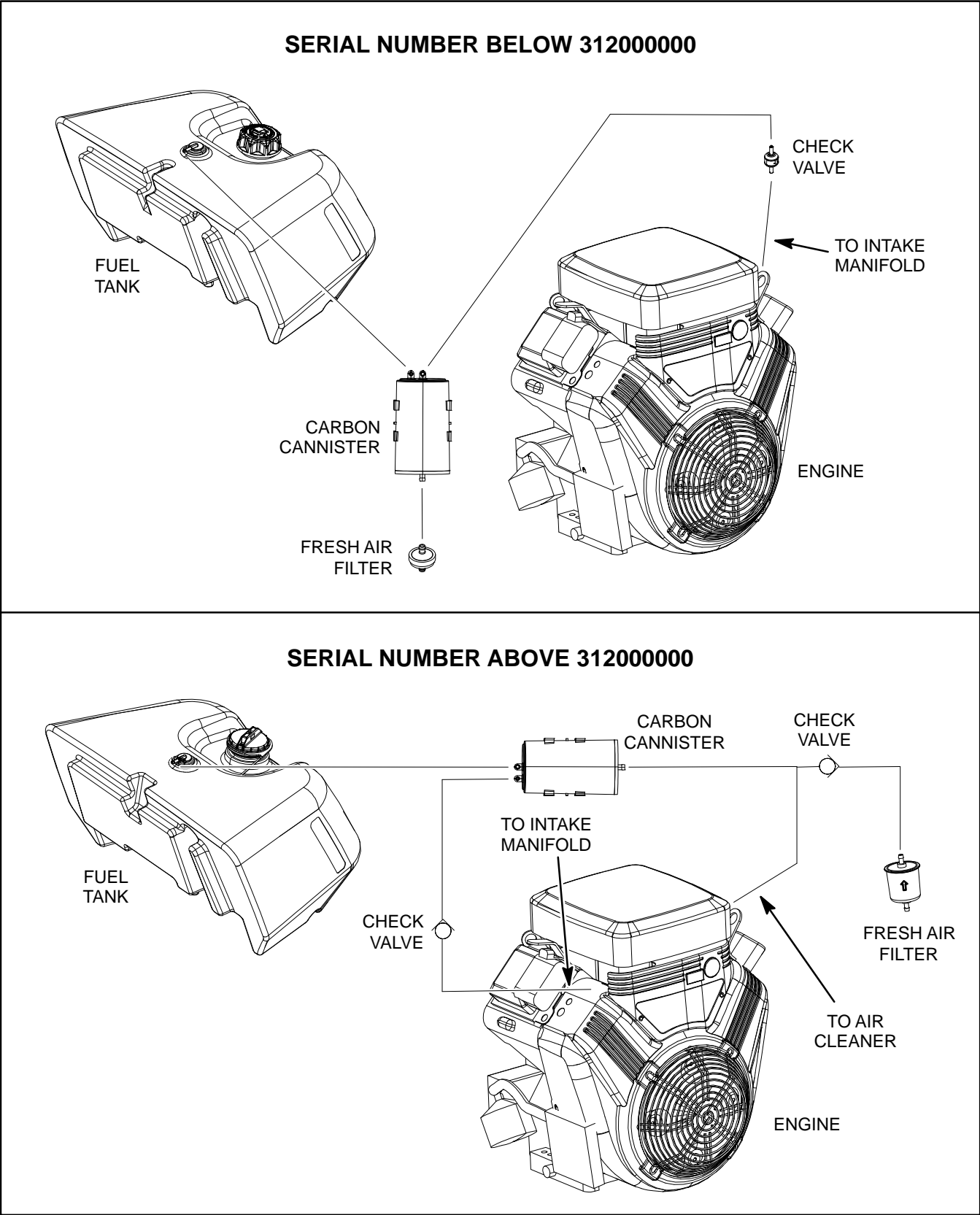


Figure 1

The function of the fuel evaporative control system is to collect and store evaporative emissions from the fuel tank and engine. The evaporate control system used on Greensmaster 3300 machines uses a carbon cannister to collect these evaporative emissions. Fuel vapors from the fuel tank are vented to the canister when the engine is not running. Vapors from the canister are consumed when the engine is running.

The fuel tank on Greensmaster 3300 machines uses a non-vented fuel cap. To connect the tank to the evaporative control system, a fuel vent valve is positioned in the top of the tank that allows tank venting through the carbon cannister.

NOTE: If there is restriction in the fresh air filter, the carbon cannister or the fuel vent valve, the fuel tank may distort due to venting issues. If the fuel tank returns to its normal shape when the fuel cap is removed, restriction in the evaporative control system is likely.

Components used in the evaporative control system on Greensmaster 3300 machines changed at serial number 312000000. Figure 1 illustrates the components used in the evaporative control system.

Machines With Serial Number Below 312000000

On machines with serial number below 312000000, the carbon canister is mounted under the fuel tank mount plate. One fitting at the engine intake manifold is used to connect the evaporative system to the engine. These machines use an inline check valve between the carbon cannister and the engine intake manifold fitting.

Machines With Serial Number Above 312000000

On machines with serial number above 312000000, the carbon canister is mounted between the hydraulic reservoir and leak detector tank. 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 include a check valve in two (2) locations as shown in Figure 1.

NOTE: The check valves used on machines with serial number above 312000000 are included as a component of the hose assembly and are 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 are removed, make sure that they are correctly installed to insure correct operation of the evaporative control system.

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Adjustments

Choke Cable Adjustment

1. Park machine on a level surface, disengage and lower cutting units, move functional control lever to neutral (N), engage parking brake, stop the engine and remove the key from the ignition switch. Wait for all machine movement to stop.
2. Remove air cleaner cover and air filter from engine.
3. Move choke control on control panel while watching choke plate in carburetor.
 - A. Choke plate should be fully open when choke control is pushed in.
 - B. Choke plate should be fully closed when choke control is pulled out.
4. If cable adjustment is needed, loosen cap screw and nut that secure choke cable clamp. Reposition cable to allow correct choke operation. Secure choke cable clamp.
5. After adjustment, move choke control several times to make sure that choke operation is correct.
6. Assemble air cleaner.

Throttle Cable Adjustment

1. Park machine on a level surface, disengage and lower cutting units, move functional control lever to neutral (N), engage parking brake, stop the engine and remove the key from the ignition switch. Wait for all machine movement to stop.
2. Adjust throttle control on console to the fast position. Inspect governor lever on engine to make sure that lever is fully rotated and against stop on governor control.
3. If throttle cable adjustment is needed (Fig. 2):
 - A. Loosen cap screw that secures throttle cable clamp on engine bracket.
 - B. Reposition cable to allow correct governor rotation.
 - C. Tighten screw to secure throttle cable clamp.
4. After adjustment, move throttle control on console from low idle to high idle to make sure that cable travel is correct.

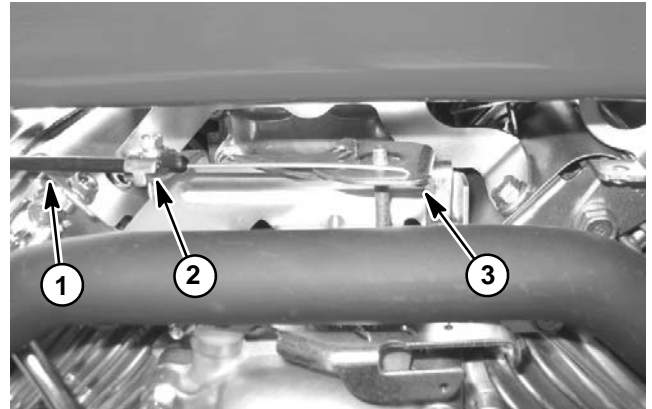


Figure 2

1. Throttle cable
2. Cable clamp
3. Governor control lever

Service and Repairs

Fuel Evaporative Control System (Serial Number Below 312000000)

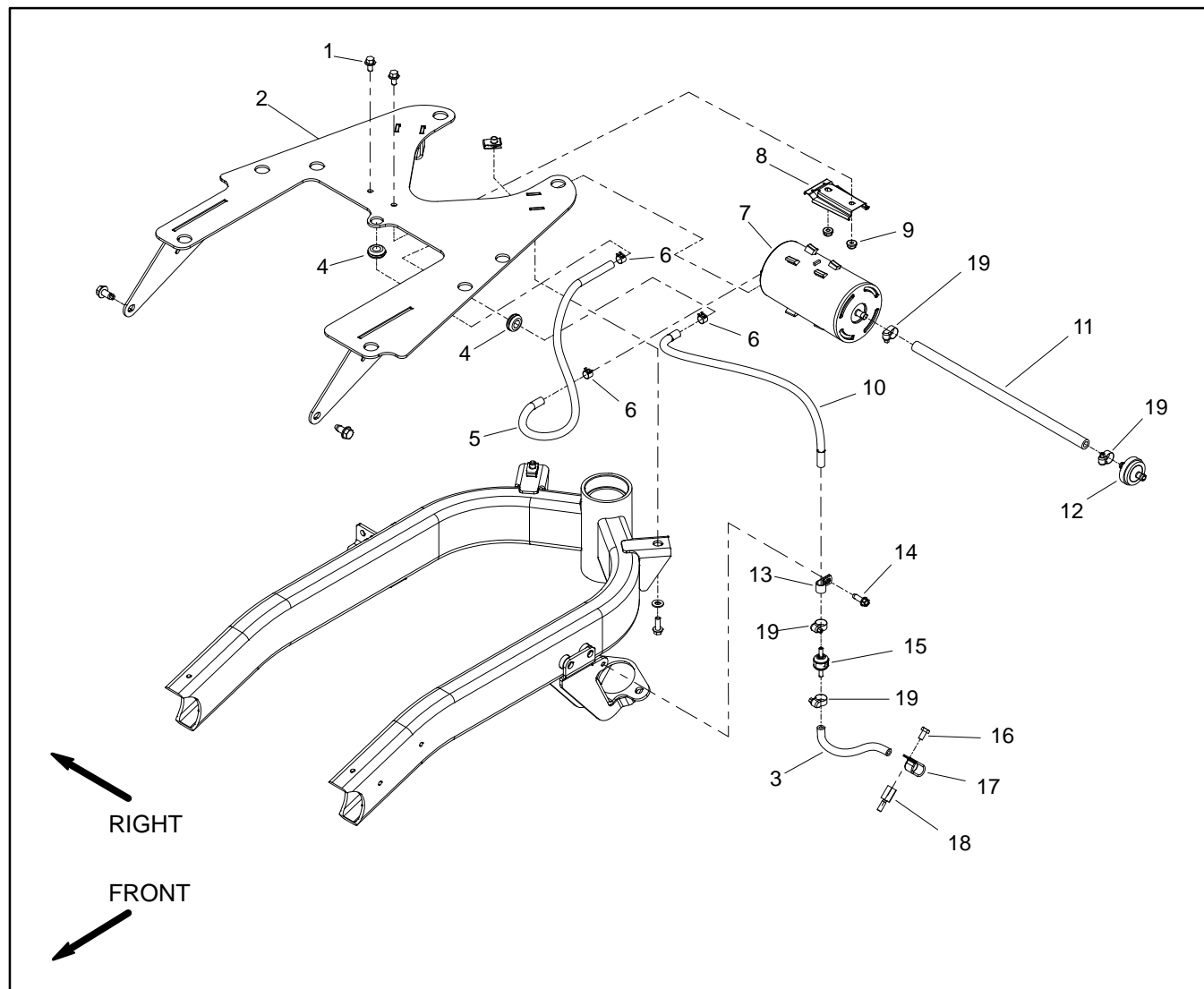


Figure 3

- | | | |
|--|--|---------------------------------------|
| 1. Flange head screw (2 used) | 8. Bracket | 14. Washer head screw |
| 2. Tank mount plate | 9. Flange nut (2 used) | 15. Check valve |
| 3. Fuel hose (to engine intake manifold) | 10. Fuel hose (cannister to check valve) | 16. Cap screw |
| 4. Grommet (2 used) | 11. Fuel hose | 17. R-clamp |
| 5. Fuel hose (cannister to tank vent) | 12. Fresh air filter | 18. Spacer screw (attached to engine) |
| 6. Hose clamp (3 used) | 13. R-clamp | 19. Worm clamp (4 used) |
| 7. Carbon canister | | |

Removal (Fig. 3)

1. Park machine on a level surface, disengage and lower cutting units, move functional control lever to neutral (N), engage parking brake, stop the engine and remove the key from the ignition switch. Wait for all machine movement to stop.



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. Access the carbon cannister under the fuel tank and between the rear frame sections. If necessary, raise and support tank mount plate assembly (hydraulic reservoir, fuel tank and tank mount plate) to reach the cannister (see Tank Mount Plate Assembly in the Service and Repairs section of Chapter 7 – Chassis).

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

4. Remove components as needed using Figure 3 as a guide.

A. If check valve (item 15) is removed, note direction of arrow on valve body for assembly purposes.

Installation (Fig. 3)

1. Install all removed components using Figure 3 as a guide.

A. If check valve (item 15) was removed, make sure that arrow on valve body points toward engine.

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

2. If tank mount plate assembly (hydraulic reservoir, fuel tank and tank mount plate) was raised to access the cannister, lower and secure tank mount plate assembly (see Tank Mount Plate Assembly in the Service and Repairs section of Chapter 7 – Chassis).

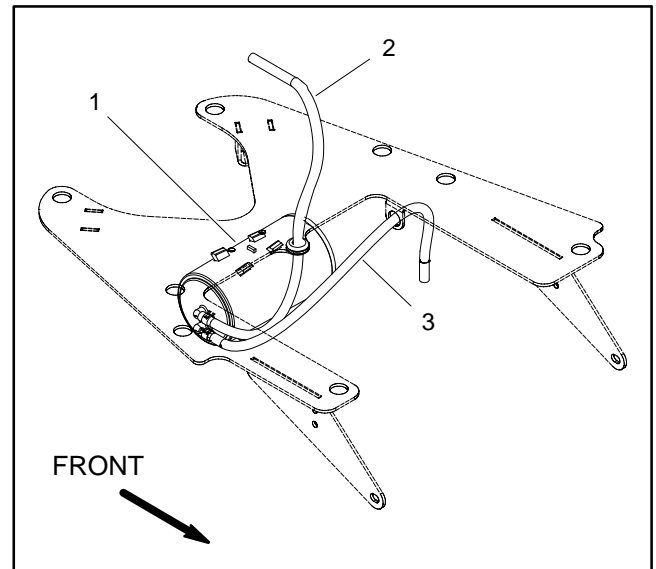


Figure 4

1. Carbon cannister
2. Hose to tank vent

3. Hose to engine

Fuel Evaporative Control System (Serial Number Above 312000000)

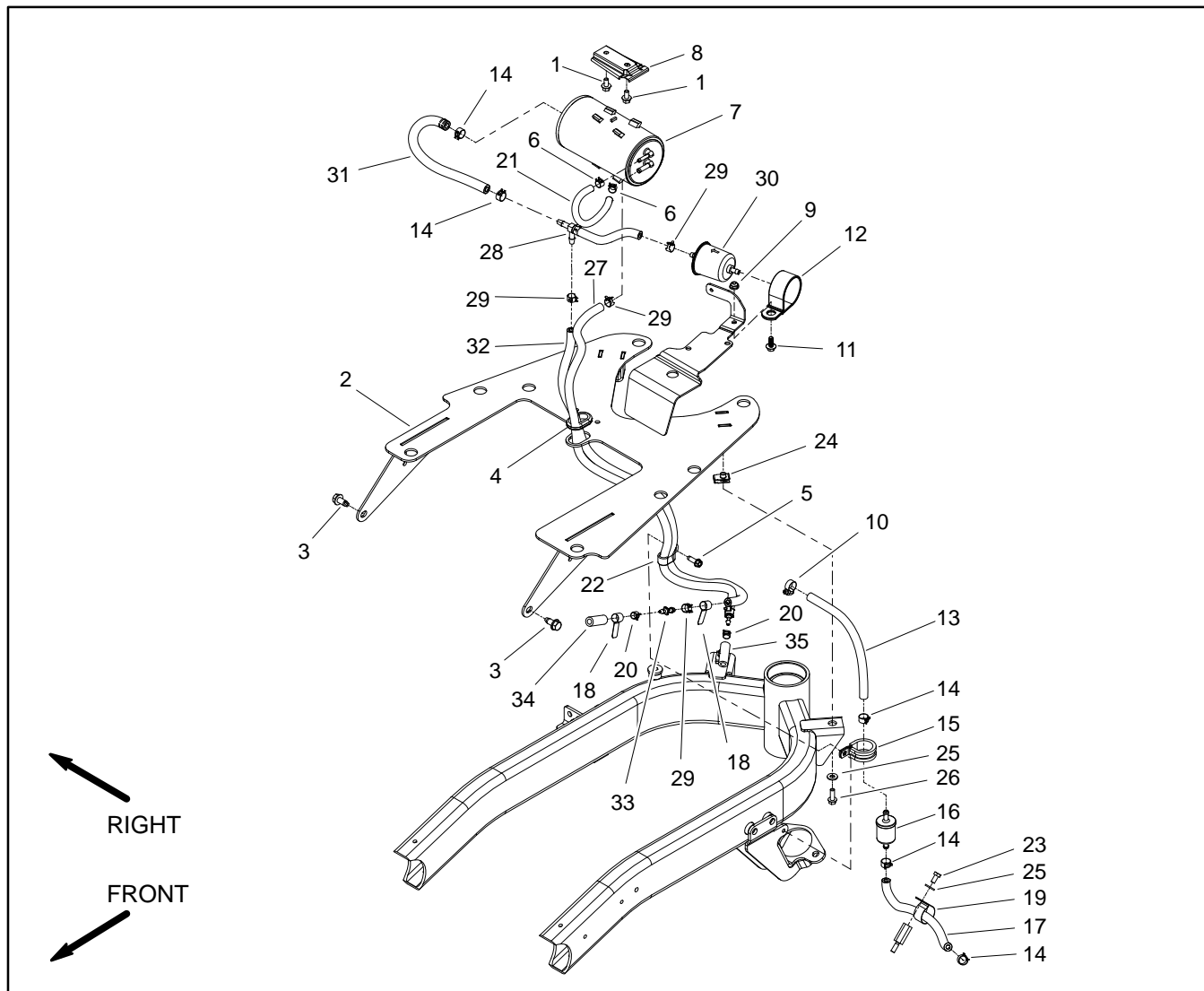


Figure 5

- | | | |
|-------------------------------|--|--------------------------------------|
| 1. Flange head screw (2 used) | 13. Fuel hose (fuel supply) | 25. Flat washer (3 used) |
| 2. Tank mount plate | 14. Hose clamp (5 used) | 26. Flange head screw (2 used) |
| 3. Washer head screw (2 used) | 15. R-clamp | 27. Purge hose assembly (see NOTE) |
| 4. Grommet (2 used) | 16. Fuel filter (fuel supply) | 28. Tee hose assembly (see NOTE) |
| 5. Washer head screw | 17. Fuel hose (fuel supply) | 29. Hose clamp (4 used) |
| 6. Hose clamp (2 used) | 18. Label (air cleaner) | 30. Fresh air filter |
| 7. Carbon cannister | 19. R-clamp | 31. Fuel hose |
| 8. Cannister bracket | 20. Hose clamp (2 used) | 32. Fuel hose |
| 9. Flange nut | 21. Fuel hose (to vent valve on fuel tank) | 33. Barbed fitting |
| 10. Worm clamp | 22. R-clamp | 34. Engine hose (to air cleaner) |
| 11. Cap screw | 23. Cap screw | 35. Engine hose (to intake manifold) |
| 12. R-clamp | 24. Clip (2 used) | |

The function of the fuel evaporative control system is to collect and store evaporative emissions from the fuel tank and engine. On machines with serial number above 312000000, a carbon canister mounted above the hydraulic reservoir is used to collect these evaporative emissions. Fuel vapors from the engine and fuel tank are vented to the canister when the engine is not running. Vapors from the canister are consumed when the engine is running.

NOTE: The purge hose assembly (item 27) and tee hose assembly (item 28) both include a check valve as a component of the assembly. The check valve is not available as a separate part. If either of these hose assemblies are removed, make sure that they are correctly installed to insure correct operation of the evaporative control system.

Removal (Fig. 5)

1. Park machine on a level surface, disengage and lower cutting units, move functional control lever to neutral (N), engage parking brake, stop the engine and remove the key from the ignition switch. Wait for all machine movement to stop.



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. Remove leak detector tank (machines with Turf Guardian™ Leak Detector System) or hydraulic reservoir cover (machines without Turf Guardian™ Leak Detector System) to gain access to carbon cannister (see Service and Repairs section of Chapter 5 – Hydraulic System).
3. Inspect carbon cannister and attached hoses for damage or obvious leaks. A damaged or leaking cannister should be replaced.
4. Remove components as needed using Figure 5 as a guide.

A. If either purge hose assembly (item 27) or tee hose assembly (item 28) 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.

Installation (Fig. 5)

1. Install all removed components using Figure 5 as a guide.
 - A. If either purge hose assembly (item 27) or tee hose assembly (item 28) 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.
2. Install leak detector tank (machines with Turf Guardian™ Leak Detector System) or hydraulic reservoir cover (machines without Turf Guardian™ Leak Detector System) (see Service and Repairs section of Chapter 5 – Hydraulic System).

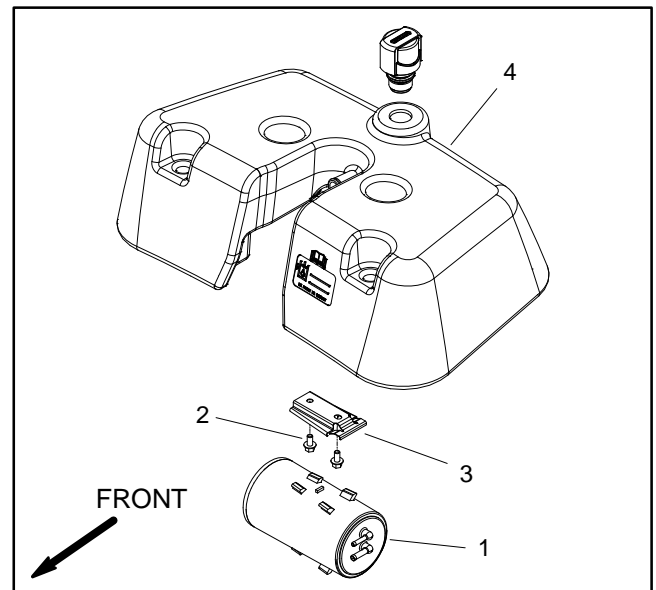


Figure 6

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|---------------------|-----------------------|
| 1. Carbon cannister | 3. Cannister bracket |
| 2. Screw (2 used) | 4. Leak detector tank |

Fuel Tank

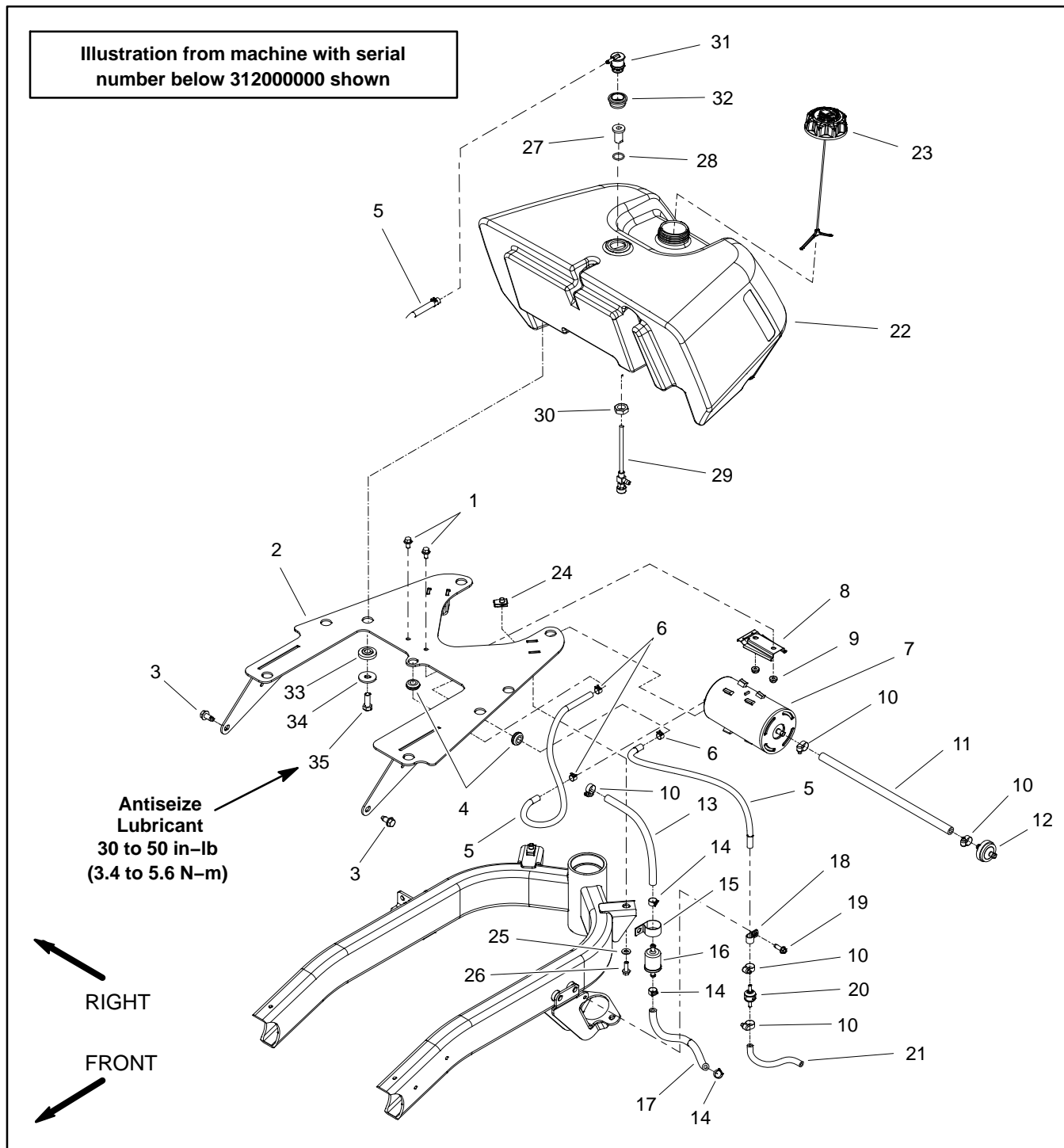


Figure 7

1. Flange head screw (2 used)
2. Tank mount plate
3. Washer head screw (2 used)
4. Grommet (2 used)
5. Fuel hose (2 used)
6. Hose clamp (3 used)
7. Carbon cannister
8. Bracket
9. Flange nut (2 used)
10. Worm clamp (5 used)
11. Fuel hose
12. Fresh air filter

13. Fuel supply hose
14. Hose clamp (3 used)
15. R-clamp
16. Fuel filter
17. Fuel hose
18. Clamp
19. Washer head screw
20. Check valve
21. Fuel hose
22. Fuel tank
23. Fuel tank cap
24. Clip (2 used)

25. Flat washer (2 used)
26. Flange head screw (2 used)
27. Fitting (LH thread)
28. O-ring
29. Shut-off valve
30. Nut (LH thread)
31. Fuel vent valve
32. Grommet
33. Flange bushing (4 used)
34. Washer (4 used)
35. Cap screw (4 used)

Fuel Tank Removal (Fig. 7)

1. Park machine on a level surface, disengage and lower cutting units, move functional control lever to neutral (N), engage parking brake, stop the engine and remove the key from the ignition switch. Wait for all machine movement to stop.



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:
 - A. Close fuel shut-off valve (item 29).
 - B. Disconnect fuel supply hose (item 13) at the fuel filter (item 16) and drain any fuel trapped in the fuel filter and fuel hose into a suitable container.
 - C. Place end of fuel hose into a suitable container for draining the tank.
 - D. Drain fuel tank by opening the fuel shut off valve.
3. Remove fuel hose (item 5) from fuel vent valve (item 31).
4. Remove four (4) cap screws (item 35), flat washers (item 34) and flange bushings (item 33) that secure the fuel tank to the tank mount plate (item 2). Remove the fuel tank from the machine.
5. If necessary, remove fuel supply hose (item 13) from fuel shut-off valve.
6. If necessary, remove shut-off valve and fitting assembly from fuel tank (Fig. 8). The nut and fitting have left hand threads.

Fuel Tank Installation (Fig. 7)

1. Install fitting assembly and shut-off valve into fuel tank if they were removed from tank (Fig. 8). The nut and fitting have left hand threads.
2. Position fuel tank on the tank mount plate.
3. Secure fuel tank to tank mount plate:
 - A. Apply antiseize lubricant to the threads of the four (4) cap screws (item 35).
 - B. Secure fuel tank to the tank mount plate with four (4) cap screws (item 35), flat washers (item 34) and flange bushings (item 33).
 - C. Torque cap screws from **30 to 50 in-lb (3.4 to 5.6 N-m)**.
4. Install fuel supply hose (item 13) to fuel shut-off valve and fuel filter. Secure supply hose with hose clamps.
5. Connect fuel hose (item 5) to fuel vent valve (item 31) and secure with hose clamp.
6. Fill fuel tank with fuel.
7. Open fuel shut-off valve. Check all fuel hoses and fuel tank for leaks.

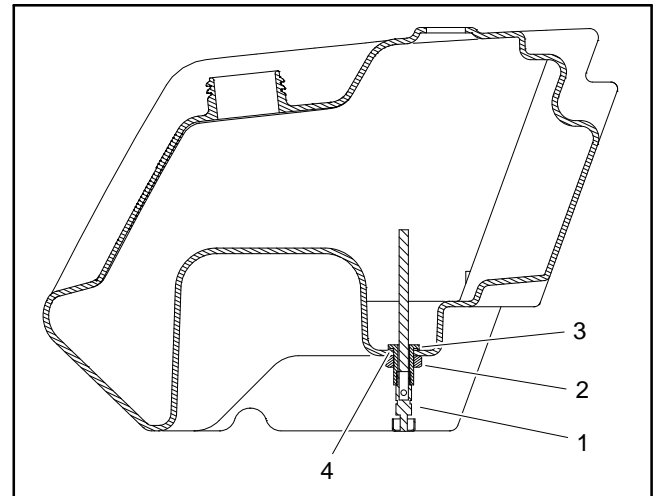


Figure 8

- | | |
|--------------------|------------------------|
| 1. Shut-off valve | 3. Fitting (LH thread) |
| 2. Nut (LH thread) | 4. O-ring |

Engine

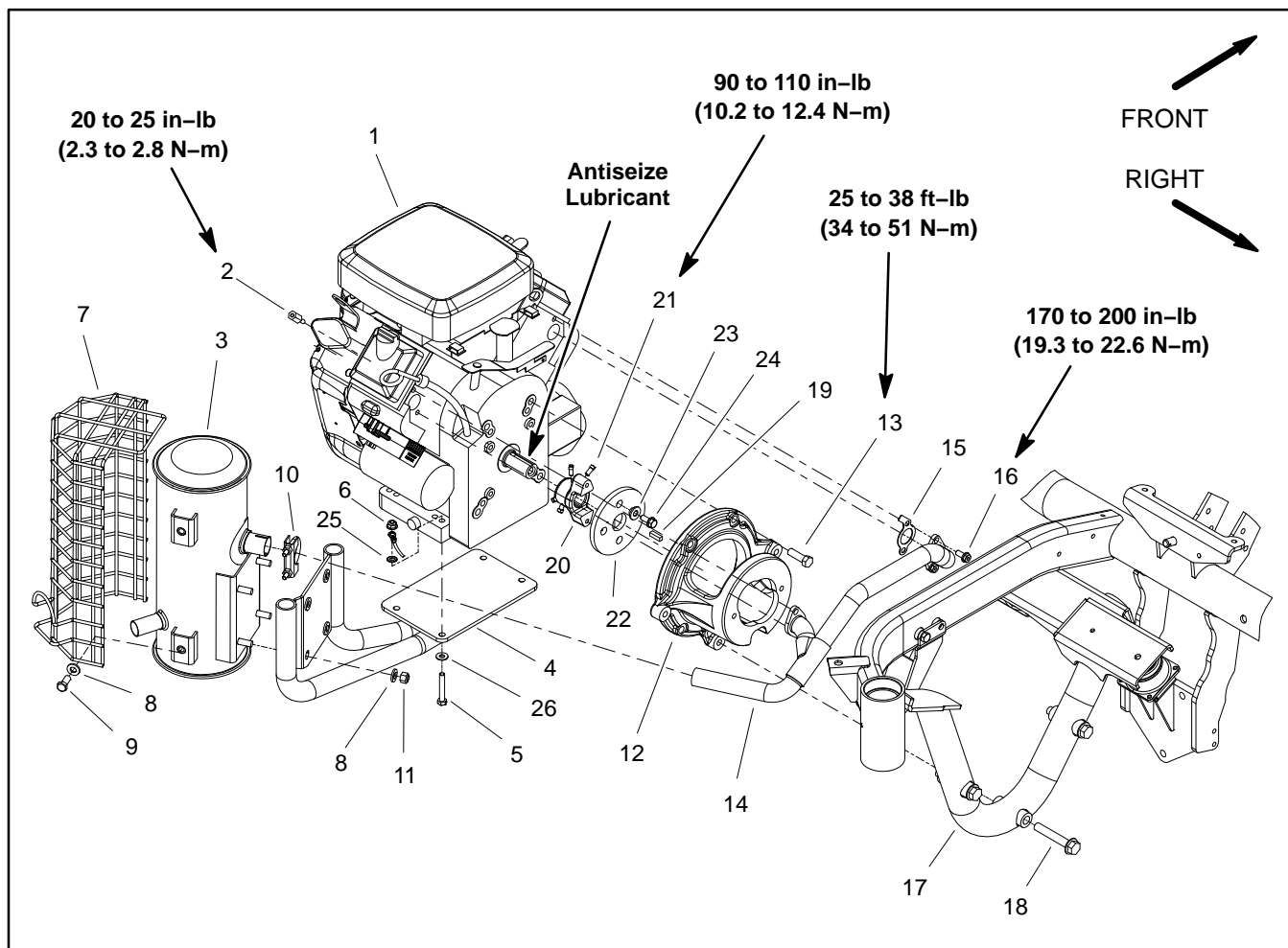


Figure 9

- | | | |
|-----------------------------|--------------------------------|--------------------------------|
| 1. Engine assembly | 10. Muffler clamp | 19. Square key |
| 2. Spacer screw | 11. Lock nut (4 used) | 20. Engine hub |
| 3. Muffler | 12. Pump mount | 21. Square head screw (2 used) |
| 4. Muffler mount | 13. Cap screw (4 used) | 22. Rubber coupling |
| 5. Cap screw (4 used) | 14. Exhaust manifold | 23. Coupling spacer (2 used) |
| 6. Flange nut (4 used) | 15. Gasket (2 used) | 24. Flange head screw (2 used) |
| 7. Muffler shield | 16. Flange head screw (4 used) | 25. Lock washer |
| 8. Hardened washer (8 used) | 17. Engine frame | 26. Flat washer (4 used) |
| 9. Cap screw (4 used) | 18. Flange head screw (3 used) | |

Engine Removal (Fig. 9)

1. Park machine on a level surface, disengage and lower cutting units, move functional control lever to neutral (N), engage parking brake, stop the engine and remove the key from the ignition switch. Wait for all machine movement to stop.



CAUTION

The engine and exhaust system may be hot. Avoid possible burns, allow engine and 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. Disconnect the negative (–) battery cable at the battery.

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

4. Disconnect fuel hoses from the fuel filter outlet and the check valve near rear engine cylinder head (Fig. 10). Drain any fuel trapped in the fuel filter and fuel hose into a suitable container.

5. Disconnect choke and throttle control cables from engine.

6. Loosen and remove cap screw (item 5), flat washer (item 26), lock washer (item 25) and flange nut (item 6) that secure wire harness ground connectors to engine assembly (Fig. 11).

7. Disconnect wire harness connectors from engine components:

NOTE: Before disconnecting wire harness connectors, label all electrical leads for assembly purposes.

A. Alternator (from regulator/rectifier) (Fig. 11)

B. Fuel solenoid (Fig. 11)

C. Magneto (Fig. 11)

D. Oil pressure switch (next to oil filter)

E. Starter motor (Fig. 11)

F. Ground wire at rear muffler mount screw

8. Loosen the two (2) square head screws (item 21) that secure the engine hub (item 20) to the engine crankshaft.

9. Support the engine assembly to prevent it from shifting or falling.

10. Remove four (4) cap screws (item 13) that secure engine assembly to pump mount (item 12).

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

11. Carefully move the engine assembly away from the pump mount to slide the engine crankshaft out of the engine hub (item 20). Once the crankshaft has cleared the hub, remove the engine from the machine.

12. Locate and retrieve square key (item 19) from engine crankshaft.

13. If necessary, remove exhaust system components from engine using Figure 9 as a guide.

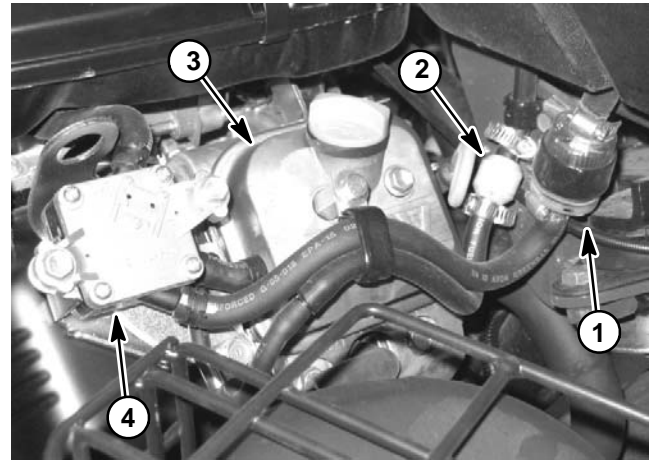


Figure 10

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|----------------|-----------------------|
| 1. Fuel filter | 3. Rear cylinder head |
| 2. Check valve | 4. Fuel pump |

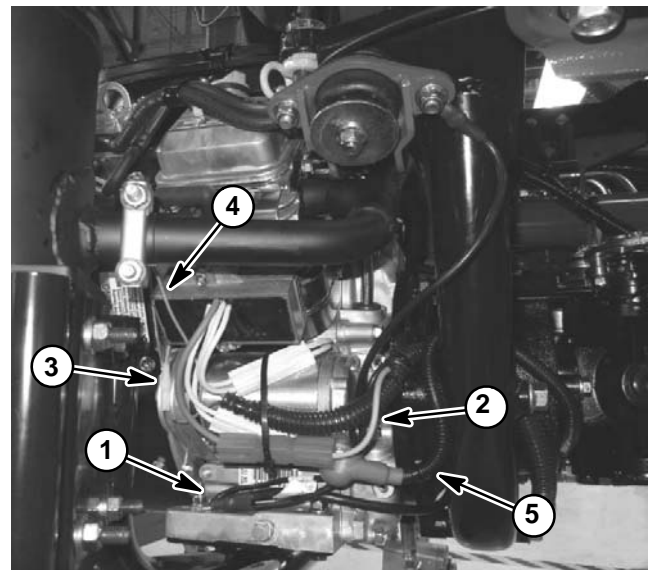


Figure 11

- | | |
|-----------------------|------------------------|
| 1. Ground connectors | 4. Magneto wire |
| 2. Alternator wire | 5. Starter motor cable |
| 3. Fuel solenoid wire | |

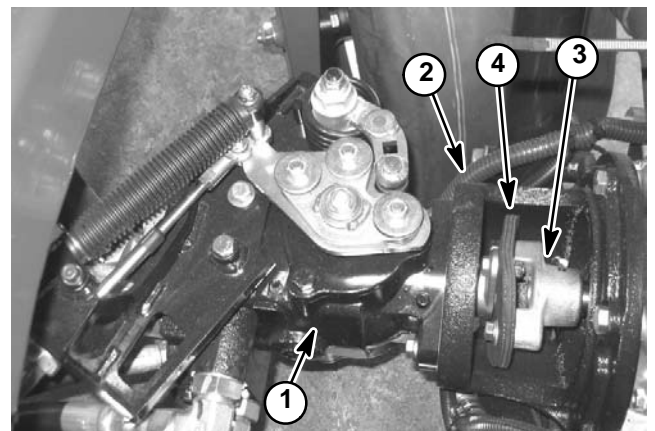


Figure 12

- | | |
|---------------------------|--------------------|
| 1. Piston (traction) pump | 3. Engine hub |
| 2. Pump mount | 4. Rubber coupling |

Engine Installation (Fig. 9)

1. Make sure that all removed engine components are correctly installed to the engine.
2. If exhaust system components were removed from engine, attach removed components using Figure 9 as a guide.
3. Apply antiseize lubricant to engine crankshaft. Position square key (item 19) to crankshaft.

IMPORTANT: Make sure to not damage the engine, fuel hose, hydraulic hoses, electrical harness, control cables or other parts while installing the engine.

4. Align the engine hub (item 20) with the engine crankshaft and square key.
5. While supporting the engine to prevent damaging the pump coupling, carefully move the engine so crankshaft slides into the engine hub (item 20) and toward the pump mount. Once the engine contacts the pump mount, align mounting holes and secure engine to pump mount with four (4) cap screws (item 13). Torque cap screws from **25 to 38 ft-lb (34 to 51 N-m)**.
6. Make sure that rubber coupling (item 22) is not distorted. Secure engine hub to engine crankshaft with two (2) square head screws (item 21). Torque screws from **90 to 110 in-lb (10.2 to 12.4 N-m)**.

7. Secure wire harness ground connector to engine assembly with cap screw (item 5), flat washer (item 26), lock washer (item 25) and flange nut (item 6) (Fig. 11). Make sure that lock washer is positioned between ground connector and engine flange to ensure ground connection to engine.

8. Connect all wire harness connectors to correct engine components.

9. Connect and adjust the choke control cable (see Adjusting the Choke Control in the Adjustments section of this chapter).

10. Connect and adjust the throttle control cable (see Adjusting the Throttle Control in the Adjustments section of this chapter).

11. Connect fuel hoses to the fuel filter outlet and check valve near rear engine cylinder head (Fig. 10). Secure hoses with hose clamps.

12. Open fuel tank shut-off valve and check fuel hose for leaks.

13. Check engine oil level and adjust if necessary.

14. Start the engine and check for proper operation.



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KUBOTA WORKSHOP MANUAL, DIESEL ENGINE, SM-E3B SERIES	

Specifications

Item	Description
Make / Designation	Kubota water-cooled, Diesel, Model D902-E3B
Number of Cylinders	3
Bore x Stroke	2.83" x 2.9" (72mm x 73.6mm)
Total Displacement	54.8 in ³ (898 cc)
Compression Ratio	24.0:1
Firing Order	1 (closest to gear case end) – 2 – 3 (closest to flywheel end)
Direction of Rotation	Counterclockwise (viewed from flywheel)
Fuel	Diesel or Biodiesel (up to B20) Fuel with Low or Ultra Low Sulfur Content
Fuel Injector Pump	Bosch MD Type Mini
Fuel Injection Nozzle	Bosch Throttle Type
Fuel Capacity	6.0 U.S. gallons (22.7 liters)
Governor	Centrifugal Mechanical
Low Idle (no load)	1500 +150/-100 RPM
High Idle (no load)	2880 ± 50 RPM
Engine Oil	API CH-4, CI-4 or higher
Engine Oil Viscosity	See Operator's Manual
Oil Pump	Gear Driven Trochoid Type
Crankcase Oil Capacity	3.9 U.S. quarts (3.7 liters) with filter
Cooling System Capacity (including reserve tank)	4.9 U.S. quarts (4.6 liters)
Starter	12 VDC 1.2 KW
Alternator/Regulator	12 VDC 60 AMP
Dry Weight (approximate)	159 lbs (72 kg)

General Information

Information about specifications, maintenance, troubleshooting, testing and repair of the diesel engine used in the Greensmaster TriFlex 3400 is included in this chapter and the Kubota Workshop Manual, Diesel Engine, SM-E3B Series.

Most engine repairs and adjustments require tools which are commonly available in many service shops. Special tools are described in the Kubota Workshop 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 Kubota 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.

Operator's Manual

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

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Adjustments

Adjust Throttle Control

Proper throttle operation is dependent upon proper adjustment of throttle control. Make sure throttle control is operating properly.

NOTE: The throttle cable swivel should be positioned in the lowest hole in the speed control lever.

1. Move throttle control lever on control console to **FAST** position.
2. Check position of the engine speed control lever on fuel injection pump (Fig. 1). The speed control lever should be contacting the high speed screw when the throttle control lever is in the **FAST** position.
3. If necessary, throttle control can be adjusted by loosening cable jam nuts and repositioning control cable until speed control lever contacts high speed screw when the throttle control lever is in the **FAST** position (Fig. 2). Tighten cable jam nuts after adjustment has been completed.

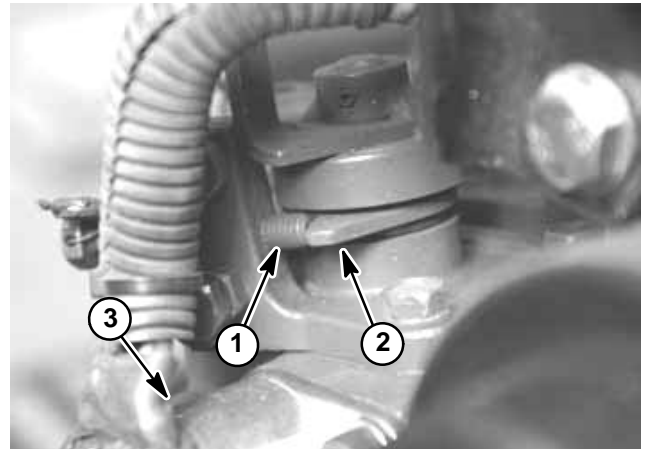


Figure 1

- | | |
|------------------------|------------------|
| 1. High speed screw | 3. Fuel solenoid |
| 2. Speed control lever | |

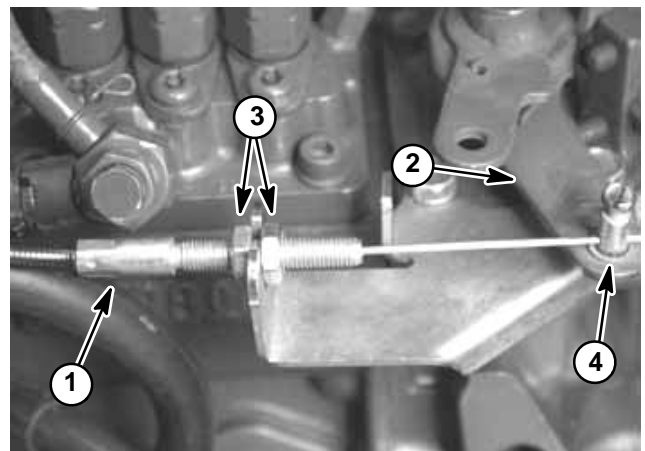


Figure 2

- | | |
|------------------------|--------------------------|
| 1. Throttle cable | 3. Cable jam nut |
| 2. Speed control lever | 4. Throttle cable swivel |

Service and Repairs

Air Cleaner Assembly

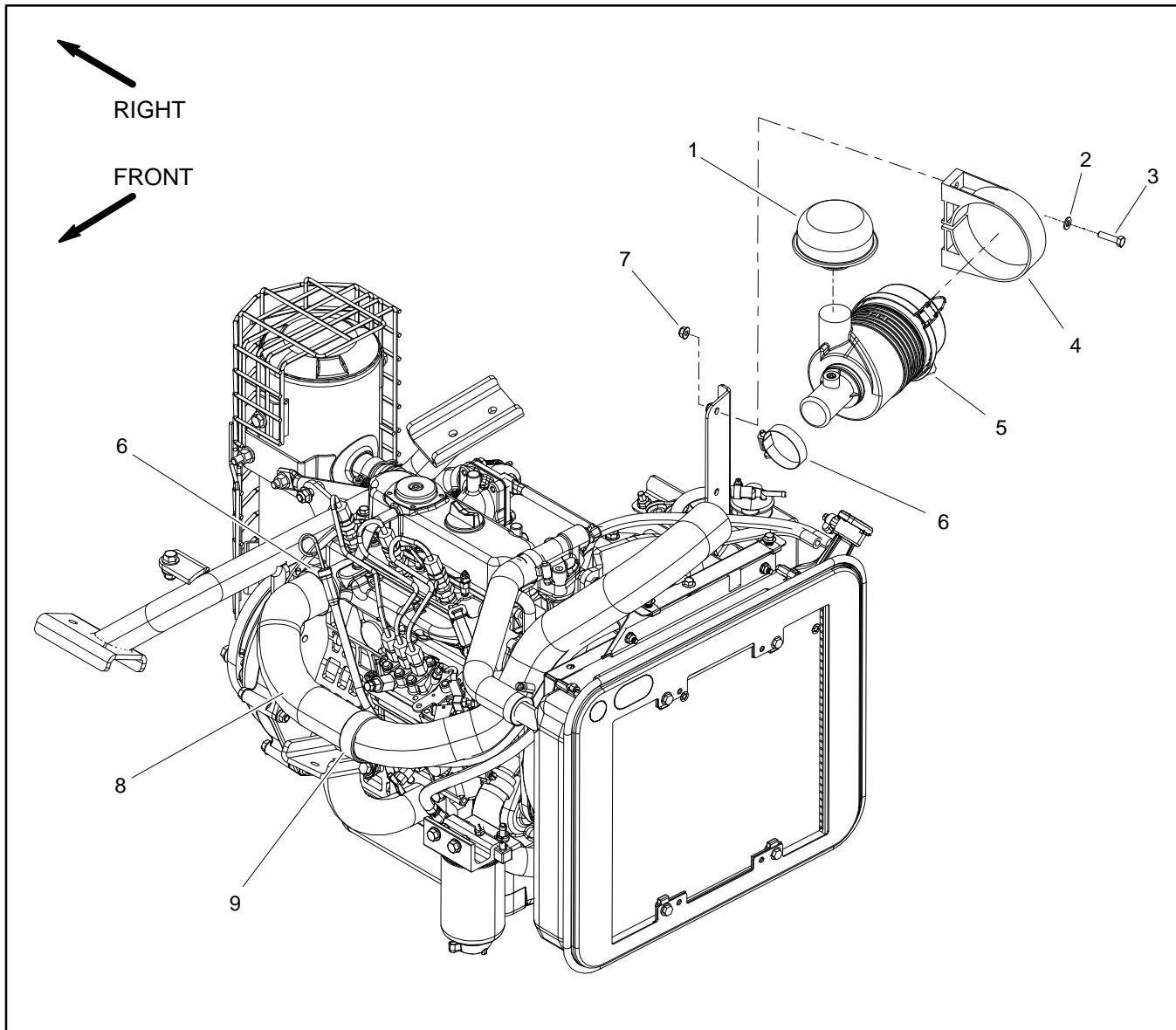


Figure 3

- 1. Air inlet hood
- 2. Flat washer (2 used)
- 3. Cap screw (2 used)

- 4. Mounting bracket
- 5. Air cleaner assembly
- 6. Hose clamp (2 used)

- 7. Flange nut (2 used)
- 8. Air intake hose
- 9. R-clamp

Air Cleaner Removal (Fig. 3)

1. Park machine on a level surface, lower the cutting units, stop the engine, engage parking brake and remove the key from the ignition switch.
2. Remove air cleaner components as needed using Figure 3 as a guide.
3. Check air intake hose (item 8) for damage or wear. Replace hose if damage is found.
4. Disassemble air cleaner as necessary (Fig. 4).
5. Check air cleaner housing and cover for damage that could cause possible air leaks.

Air Cleaner Installation (Fig. 3)

IMPORTANT: Any leaks in the air cleaner system will allow dirt into engine and will cause serious engine damage. Make sure that all air cleaner components are in good condition and are properly secured during assembly.

1. Assemble air cleaner system using Figures 3 and 4 as guides.
 - A. If plug was removed from air cleaner housing, apply sealant to threads of plug before assembly.
 - B. Make sure that vacuator valve on air cleaner assembly is pointed down after assembly.
 - C. Make sure that air intake hose (item 8) has clearance around it at all points after air cleaner installation is completed.

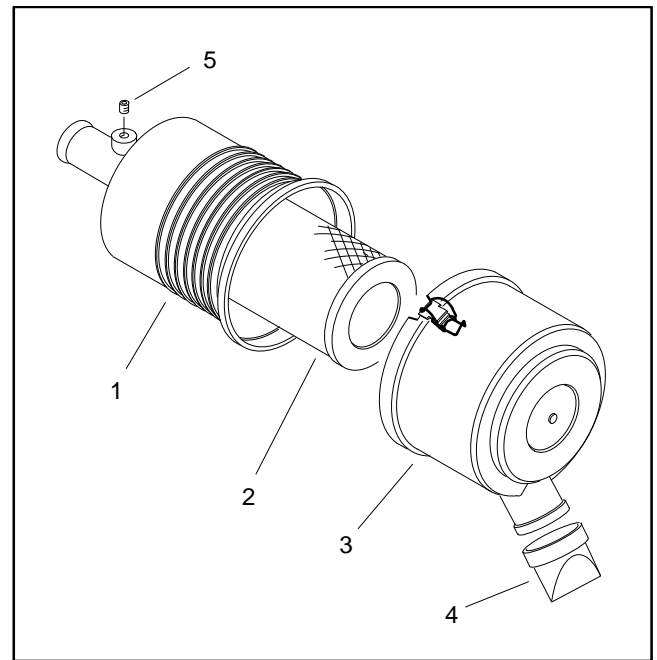


Figure 4

- | | |
|-------------------|-------------------|
| 1. Housing | 4. Vacuator valve |
| 2. Filter element | 5. Plug |
| 3. Cover | |

Exhaust System

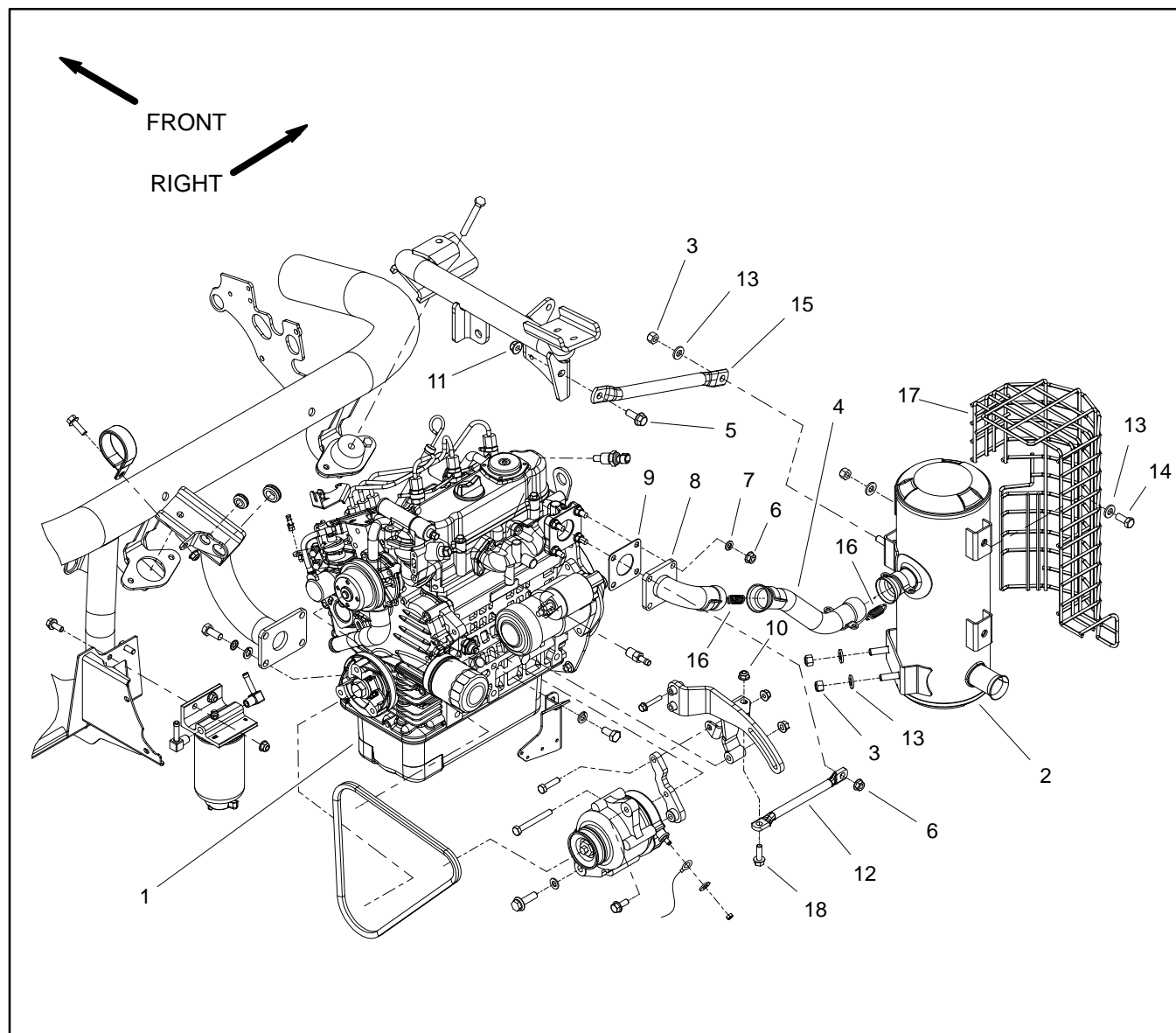
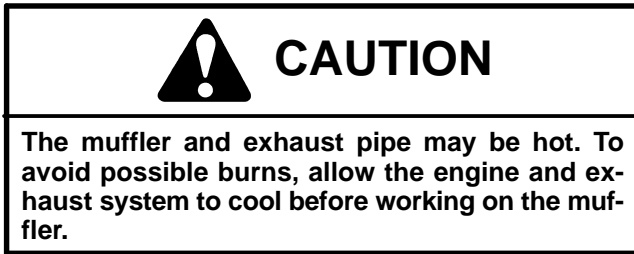


Figure 5

- | | | |
|------------------------|-------------------------|--------------------------|
| 1. Engine assembly | 7. Lock washer (3 used) | 13. Flat washer (8 used) |
| 2. Muffler assembly | 8. Exhaust plate | 14. Cap screw (4 used) |
| 3. Lock nut (4 used) | 9. Exhaust gasket | 15. Brace |
| 4. Exhaust pipe | 10. Flange nut | 16. Spring (4 used) |
| 5. Flange head screw | 11. Flange nut | 17. Muffler shield |
| 6. Flange nut (4 used) | 12. Brace | 18. Flange head screw |

Exhaust System Removal (Fig. 5)

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



2. Remove exhaust system components as needed using Figure 5 as a guide.

NOTE: Muffler assembly is secured to brackets on piston (traction) pump with lock nuts (item 3) and flat washers (item 13).

Exhaust System Installation (Fig. 5)

1. Make sure the engine is off.

IMPORTANT: If exhaust studs were removed from engine cylinder head, thoroughly clean threads in head and apply Loctite #277 (or equivalent) to stud threads before installing studs into head.

NOTE: Make sure exhaust plate and engine exhaust manifold sealing surfaces are free of debris or damage that may prevent a tight seal.

2. If exhaust gasket (item 9) was removed, place new exhaust gasket on the engine exhaust manifold.

NOTE: To ensure proper exhaust system sealing, mount all exhaust system components loosely before fully tightening any fastener.

3. Assemble all removed exhaust system components using Figure 5 as a guide.

4. After all exhaust components have been assembled, make sure that all fasteners are properly tightened.

Fuel Tank

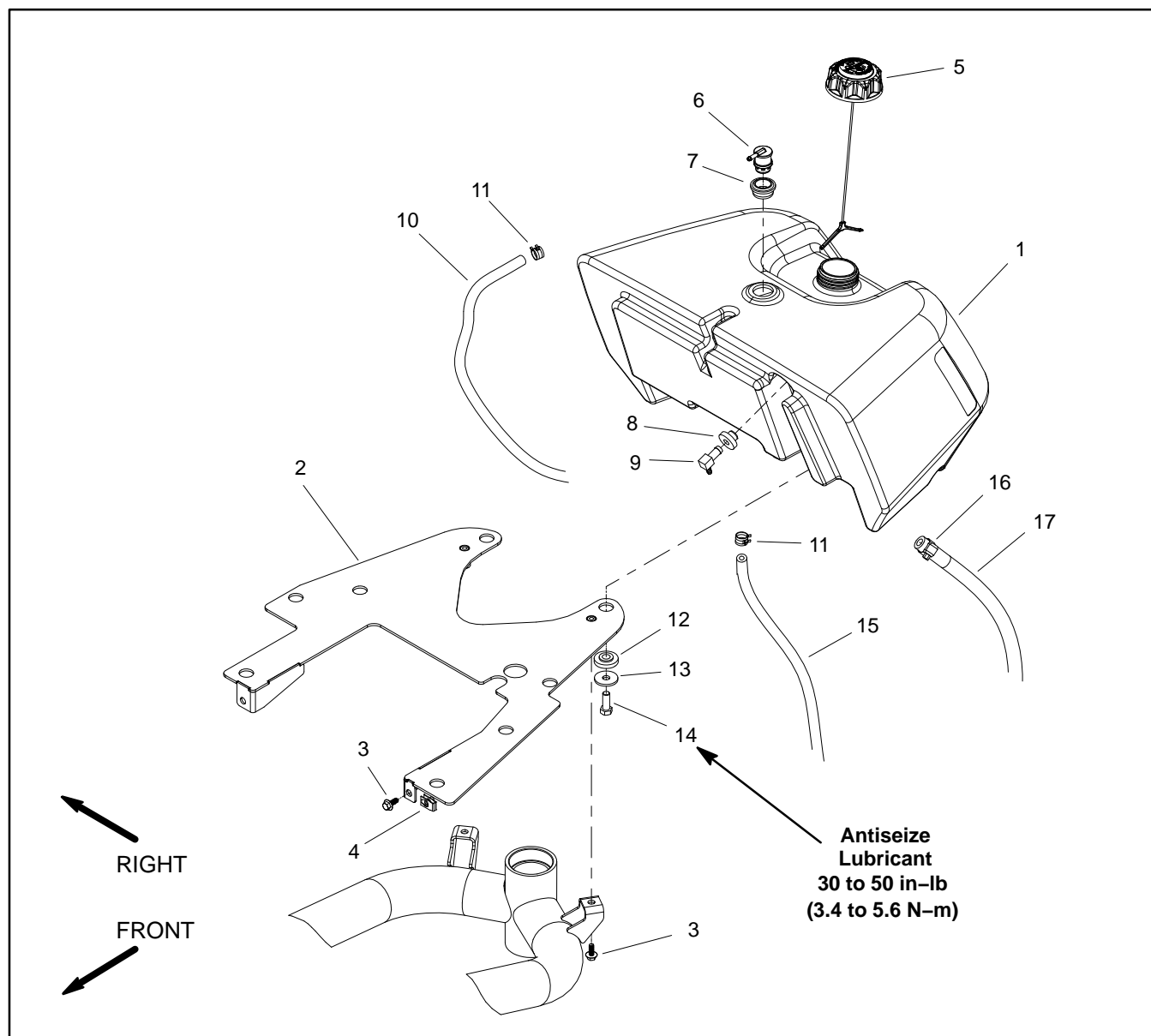


Figure 6

- | | | |
|-------------------------------|-----------------------------|--------------------------|
| 1. Fuel tank | 7. Grommet | 13. Flat washer (4 used) |
| 2. Tank mount plate | 8. Bushing | 14. Cap screw (4 used) |
| 3. Flange head screw (4 used) | 9. Elbow fitting | 15. Return hose |
| 4. Clip (2 used) | 10. Vent hose | 16. Hose clamp |
| 5. Fuel cap | 11. Hose clamp | 17. Fuel supply hose |
| 6. Fuel vent valve | 12. Flange bushing (4 used) | |

Fuel Tank Removal (Fig. 6)

1. Park machine on a level surface, disengage and lower cutting units, move functional control lever to neutral (N), engage parking brake, stop the engine and remove the key from the ignition switch. Wait for all machine movement to stop.



CAUTION

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



DANGER

Diesel fuel 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.

2. Drain fuel tank:
 - A. Close fuel shut-off valve on bottom of fuel tank.
 - B. Disconnect fuel supply hose (item 17) at the fuel filter and drain any fuel trapped in the fuel filter and fuel hose into a suitable container.
 - C. Place end of fuel hose into a suitable container for draining the tank.
 - D. Drain fuel tank by opening the fuel shut off valve.
3. To allow easier access to fasteners that secure fuel tank, raise and support tank mount plate assembly (hydraulic reservoir, fuel tank and tank mount plate) (see Tank Mount Plate Assembly in the Service and Repairs section of Chapter 7 – Chassis).
4. Remove vent hose (item 10) from fuel vent valve (item 6).
5. Remove four (4) cap screws (item 14), flat washers (item 13) and flange bushings (item 12) that secure the fuel tank to the tank mount plate (item 2).
6. Move fuel tank towards the rear of the machine to gain access to fuel return hose (item 15). Remove return hose from elbow fitting on front of tank.
7. Remove the fuel tank from the machine.
8. If necessary, remove fuel supply hose from shut-off valve.
9. If necessary, remove shut-off valve and fitting assembly from fuel tank (Fig. 7). The nut and fitting have left hand threads.
1. Install fitting assembly and shut-off valve into fuel tank if they were removed from tank (Fig. 7). The nut and fitting have left hand threads.
2. Position fuel tank on the tank mount plate.
3. Move fuel tank towards the rear of the machine and install return hose (item 15) to elbow fitting on front of tank. Secure hose with hose clamp.
4. Secure fuel tank to tank mount plate:
 - A. Apply antiseize lubricant to the threads of the four (4) cap screws (item 14).
 - B. Secure fuel tank to the tank mount plate with four (4) cap screws (item 14), flat washers (item 13) and flange bushings (item 12).
 - C. Torque cap screws from **30 to 50 in-lb (3.4 to 5.6 N-m)**.
5. Lower and secure tank mount plate assembly (hydraulic reservoir, fuel tank and tank mount plate) (see Tank Mount Plate Assembly in the Service and Repairs section of Chapter 7 – Chassis).
6. Connect fuel supply hose (item 17) to the fuel shut-off valve and fuel filter. Secure supply hose with hose clamps.
7. Connect vent hose (item 10) to fuel vent valve (item 6) and secure with hose clamp.
8. Fill fuel tank with fuel.
9. Open fuel shut-off valve. Check all fuel hoses and fuel tank for leaks.

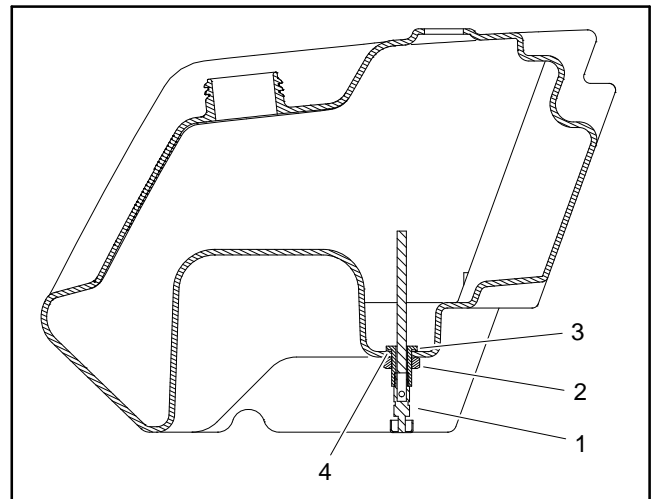


Figure 7

- | | |
|--------------------|------------------------|
| 1. Shut-off valve | 3. Fitting (LH thread) |
| 2. Nut (LH thread) | 4. O-ring |

Fuel Tank Installation (Fig. 6)

Radiator

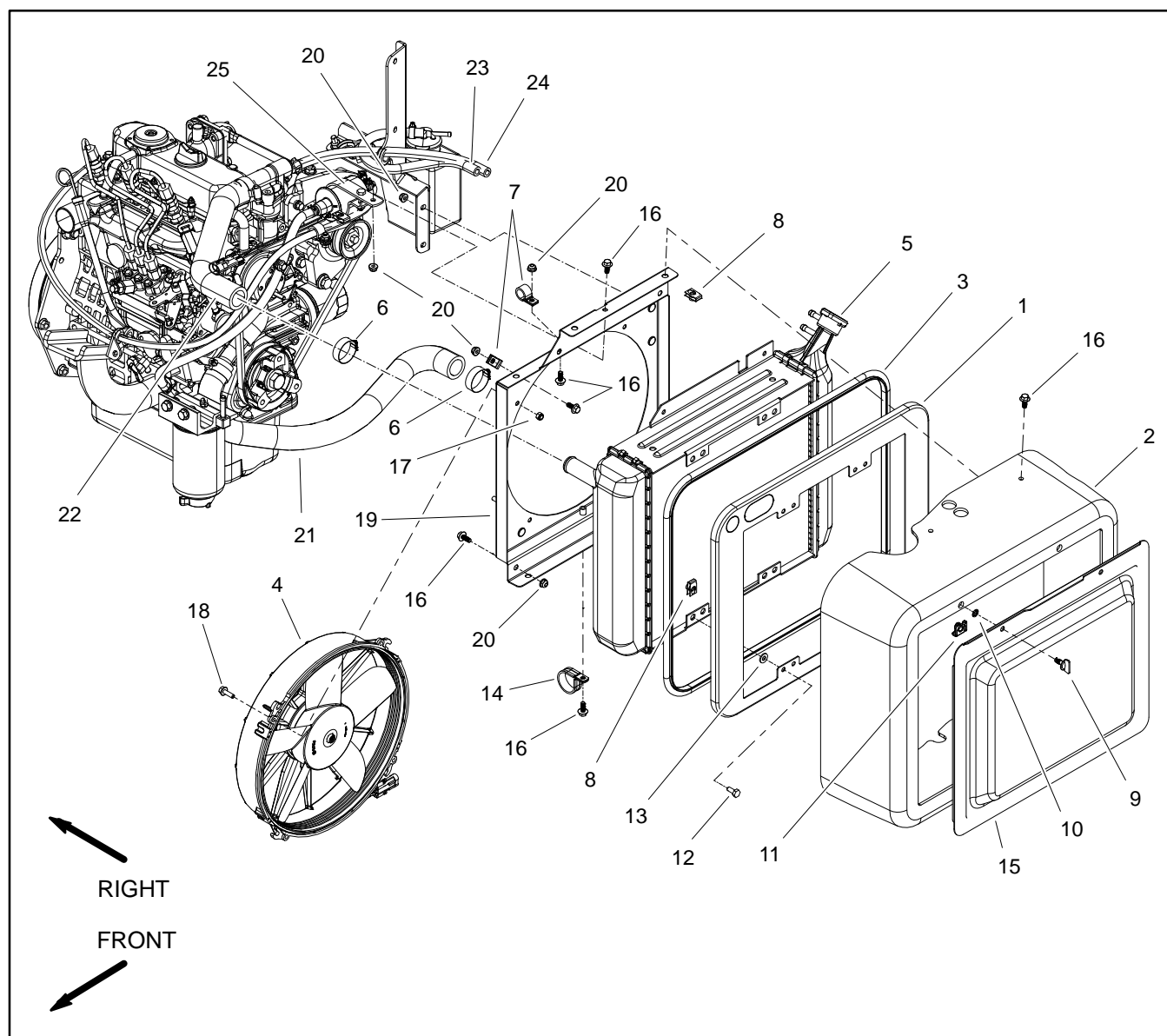



Figure 8

- | | | |
|------------------------|---------------------------------|--------------------------------------|
| 1. Seal panel | 10. Stud retainer (2 used) | 18. Flange head screw (4 used) |
| 2. Radiator shroud | 11. Receptacle (2 used) | 19. Front shroud |
| 3. Trim seal | 12. Cap screw (4 used) | 20. Flange nut (12 used) |
| 4. Fan assembly | 13. Flat washer (4 used) | 21. Lower radiator hose |
| 5. Radiator assembly | 14. R-clamp | 22. Upper radiator hose |
| 6. Hose clamp (2 used) | 15. Screen | 23. Breather hose (to thermostat) |
| 7. R-clamp (2 used) | 16. Flange head screw (12 used) | 24. Overflow hose (to overflow tank) |
| 8. Clip (8 used) | 17. Lock nut (4 used) | 25. Fuel pump assembly |
| 9. Stud (2 used) | | |

Radiator Removal (Fig. 8)

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

**CAUTION**

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

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

2. Remove the radiator cap.
3. Drain radiator into a suitable container by disconnecting lower radiator hose from the radiator.
4. Remove screen (item 15) from radiator shroud.
5. Remove four (4) flange head screws (item 16) that secure radiator shroud (item 2) to radiator assembly. Remove radiator shroud.
6. Remove flange head screw that secures R-clamp (item 14) to bottom of front shroud (item 19).
7. Remove the following hoses from the radiator:
 - A. Loosen hose clamps and disconnect breather hose (item 23) and overflow hose (item 24) from radiator filler neck.
 - B. Loosen hose clamps (item 6) and disconnect upper and lower radiator hoses (items 22 and 21).
8. Locate splice fitting in fuel return hose near fuel pump. Disconnect one of the return hose sections from splice fitting and remove return hose from both r-clamps (item 7) on front shroud (item 19).
9. Remove flange head screw and flange nut that secure fuel pump assembly to front shroud. Position fuel pump assembly away from radiator assembly.
10. Disconnect fan wire connector from machine wire harness.
11. Support radiator assembly to prevent it from falling.
12. Remove four (4) flange nuts that secure front shroud to machine. Remove radiator assembly from machine.
13. Remove components from radiator as necessary using Figure 8 as a guide.

Radiator Installation (Fig. 8)

1. Assemble all removed components to radiator using Figure 8 as a guide.
2. Position radiator assembly to machine. Secure front shroud to machine with four (4) flange nuts.
3. Position fuel pump assembly to radiator assembly and secure with flange head screw and flange nut.
4. Connect fan wire connector to machine wire harness.
5. Slide fuel return hose through both r-clamps (item 7) on front shroud (item 19). Connect return hose sections at splice fitting and secure with hose clamp.
6. Connect the following hoses to the radiator and secure with hose clamps:
 - A. Upper and lower radiator hoses (items 22 and 21).
 - B. Breather hose (item 23) and overflow hose (item 24) to radiator filler neck.
7. Secure R-clamp (item 14) to bottom of front shroud (item 19).
8. Secure radiator shroud (item 2) to radiator assembly with four (4) flange head screws (item 16).
9. Install screen (item 15) to radiator shroud.
10. Fill radiator with coolant. Check radiator and hoses for leaks.

Engine

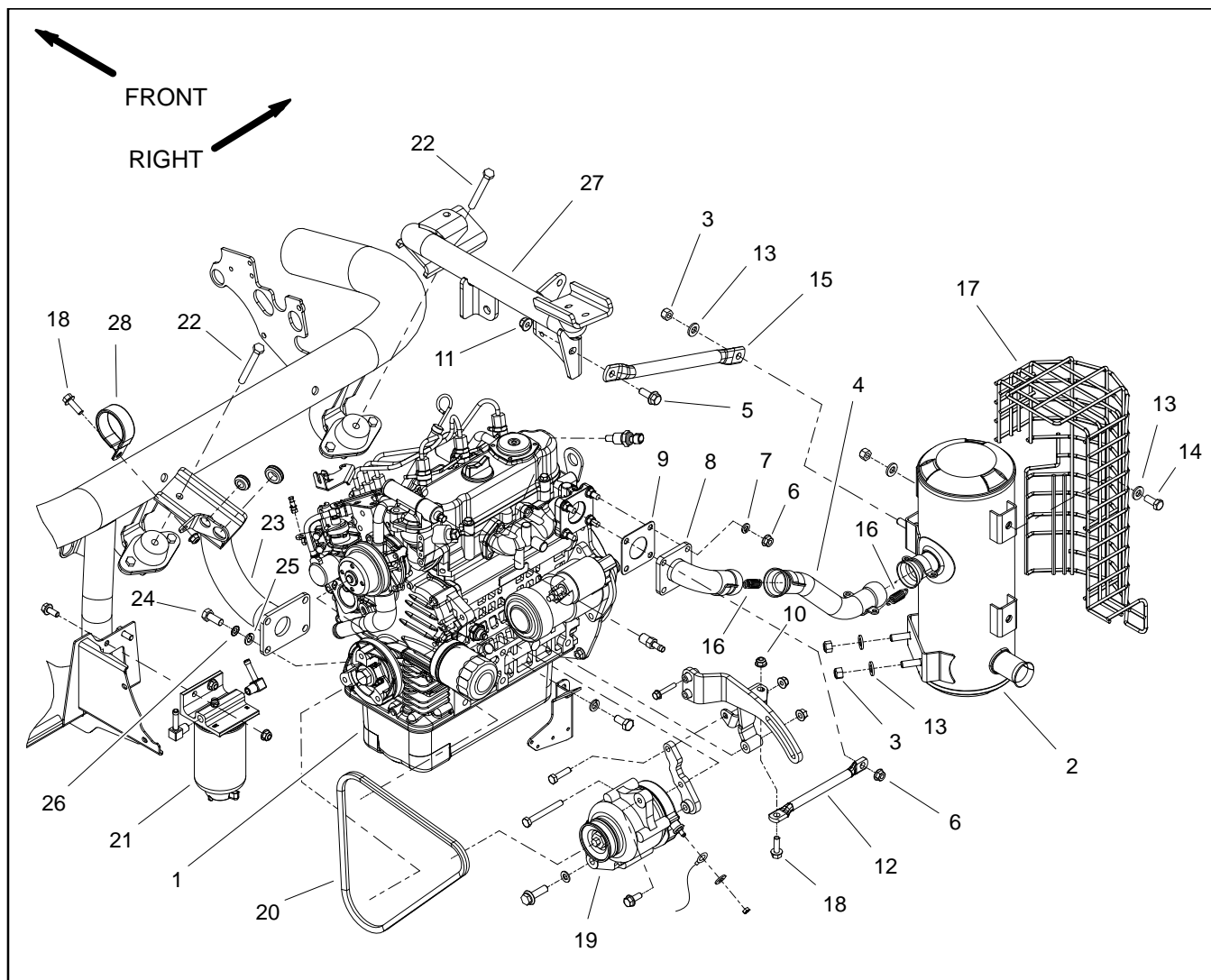


Figure 9

- | | | |
|-------------------------|--------------------------|-------------------------------------|
| 1. Engine assembly | 11. Flange nut | 20. V-belt |
| 2. Muffler assembly | 12. Brace | 21. Fuel/water separator |
| 3. Lock nut (4 used) | 13. Flat washer (8 used) | 22. Cap screw (2 used) |
| 4. Exhaust pipe | 14. Cap screw (4 used) | 23. Engine support |
| 5. Flange head screw | 15. Brace | 24. Cap screw (4 used) |
| 6. Flange nut (4 used) | 16. Spring (4 used) | 25. Lock washer (4 used) |
| 7. Lock washer (3 used) | 17. Muffler shield | 26. Lock washer (ground connection) |
| 8. Exhaust plate | 18. Flange head screw | 27. Rear engine mount |
| 9. Exhaust gasket | 19. Alternator assembly | 28. R-clamp (air intake hose) |
| 10. Flange nut | | |

Engine Removal (Fig. 9)

1. Park machine on a level surface, disengage and lower cutting units, move functional control lever to neutral (N), engage parking brake, stop the engine and remove the key from the ignition switch. Wait for all machine movement to stop.



CAUTION

The engine, radiator, exhaust system and hydraulic system may be hot. To avoid possible injury, allow machine to cool before working on the engine.

2. Close fuel shut-off valve on fuel tank.
3. Remove air cleaner and air intake hose from machine (see Air Cleaner Removal in this section).
4. Remove radiator from machine (see Radiator Removal in this section).
5. Remove exhaust system from machine (see Exhaust System Removal in this section).
6. Disconnect fuel supply hose from the injector pump and fuel return hose from the #3 injector. Drain any fuel trapped in the hoses into a suitable container. Remove hoses from grommets in engine support on front of engine. Plug hoses and position them away from engine assembly.
7. Loosen screw that secures the throttle cable to swivel on injector pump speed control lever. Disconnect cable from swivel and cable bracket (Fig. 10). Position cable away from engine.
8. Disconnect wire harness connectors from engine components:

NOTE: Before disconnecting wire harness connectors, label all electrical leads for assembly purposes.

- A. Negative battery cable and wire harness ground from lower engine mount fastener (Fig. 11).
- B. Fuel stop solenoid (Fig. 12).
- C. Glow plug bus (Fig. 12).
- D. Temperature sender (Fig. 12).
- E. Alternator connector and stud (Fig. 13).
- F. Starter motor solenoid and fusible link harness (Fig. 13).
- G. Oil pressure switch (near oil filter) (Fig. 13).



CAUTION

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

9. Support hydraulic pump assembly to prevent it from moving during engine removal.
10. Remove two (2) cap screws and flat washers that secure hydraulic pump assembly to bell housing on engine.

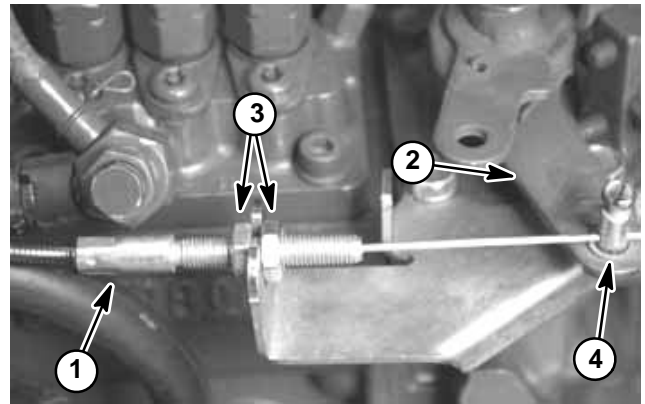


Figure 10

- | | |
|------------------------|--------------------------|
| 1. Throttle cable | 3. Cable jam nut |
| 2. Speed control lever | 4. Throttle cable swivel |

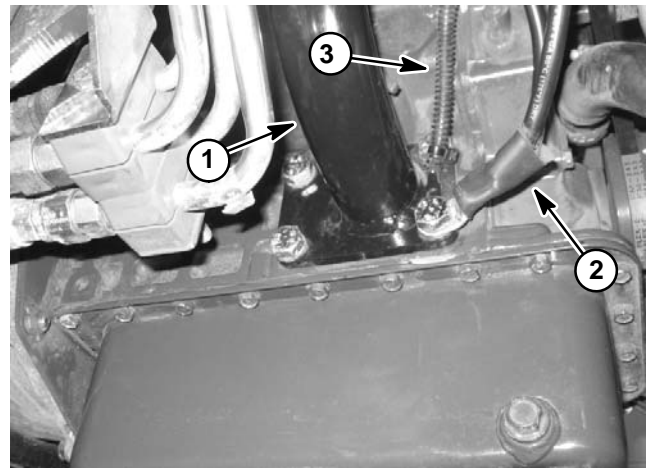


Figure 11

- | | |
|-------------------|------------------------|
| 1. Engine mount | 3. Wire harness ground |
| 2. Negative cable | |

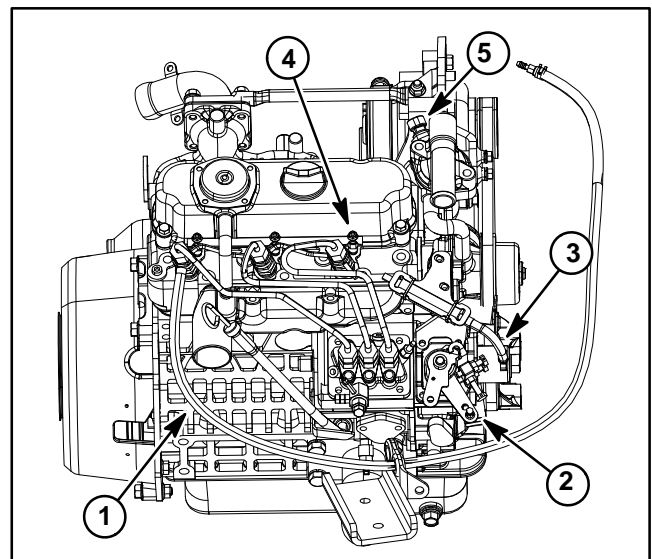


Figure 12

- | | |
|--------------------------|-----------------------|
| 1. Fuel return hose | 4. Glow plug bus |
| 2. Throttle cable swivel | 5. Temperature sender |
| 3. Fuel stop solenoid | |



CAUTION

When removing engine assembly, make sure lift or hoist can safely support 190 lbs (86 kg).

11. Attach a suitable lift or hoist to engine. Support engine with lift or hoist to prevent engine from shifting or moving.

12. Remove fasteners that secure engine to machine:

A. Remove cap screw, spacer, snubbing washer and flange nut that secure engine support to engine mount (Fig. 14).

B. Remove two (2) cap screws, washers and lock nuts that secure rear engine plate to rear engine mount (Fig. 15).

IMPORTANT: Make sure to not damage the engine, fuel hoses, hydraulic lines, electrical harness or other parts while removing the engine. Also, make sure that hydraulic pump assembly does not shift location during engine removal.

13. Slowly move the engine assembly away from the hydraulic pump assembly to allow the pump coupling to slide out of the engine coupling flange (Fig. 16). Once the engine has cleared the pump coupling, carefully remove the engine from the machine.

14. If necessary, remove engine support (item 23) from engine.

Engine Installation (Fig. 9)

1. Make sure that all removed engine components are correctly installed to the engine.

2. If engine support (item 23) was removed from engine, secure support to engine with removed fasteners.

3. Make sure that hydraulic pump assembly is well supported to prevent it from moving during engine installation.



CAUTION

When installing engine assembly, make sure lift or hoist can safely support 190 lbs (86 kg).

4. Attach a suitable lift or hoist to engine.

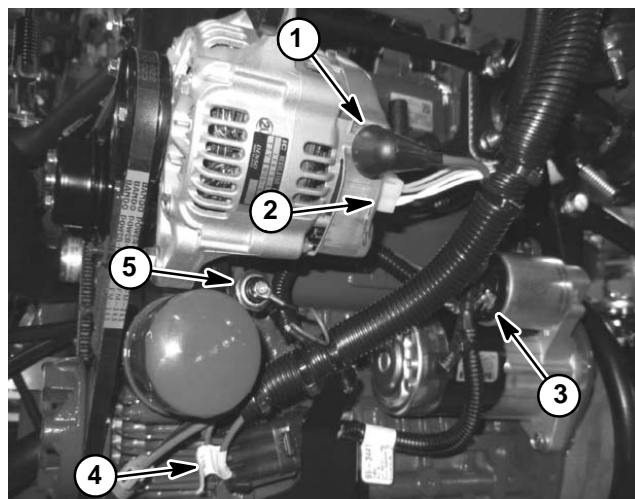


Figure 13

- | | |
|---------------------------|-------------------------|
| 1. Alternator stud | 4. Fusible link harness |
| 2. Alternator connector | 5. Oil pressure switch |
| 3. Starter motor solenoid | |

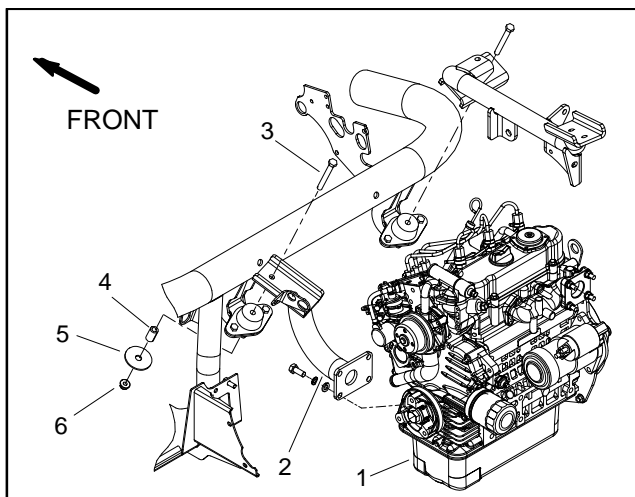


Figure 14

- | | |
|-------------------|-------------------|
| 1. Engine | 4. Spacer |
| 2. Engine support | 5. Rebound washer |
| 3. Cap screw | 6. Flange nut |

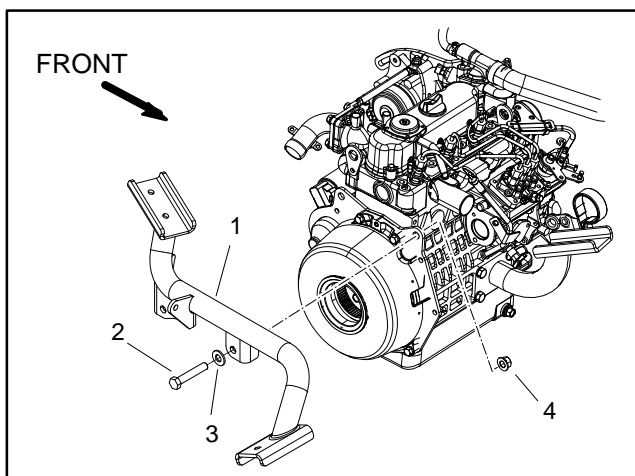


Figure 15

- | | |
|-----------------------|----------------------|
| 1. Rear engine mount | 3. Washer (2 used) |
| 2. Cap screw (2 used) | 4. Lock nut (2 used) |

IMPORTANT: Make sure to not damage the engine, fuel hoses, hydraulic lines, electrical harness or other parts while installing the engine. Also, make sure that hydraulic pump assembly does not shift location during engine installation.

5. Slowly move the engine assembly toward the hydraulic pump assembly to allow the pump coupling to slide into the engine coupling flange (Fig. 16).

6. Secure hydraulic pump assembly to bell housing on engine with two (2) cap screws and flat washers (Fig. 16).

7. Secure engine to machine:

A. Secure engine support (item 23) to engine mount with cap screw, spacer, snubbing washer and flange nut (Fig. 14).

B. Secure engine rear plate to rear engine mount with two (2) cap screws, washers and lock nuts (Fig. 15).

8. Connect all electrical harness connectors to engine using labels placed during engine removal.

9. Connect throttle cable to the swivel on injector pump speed control lever (Fig. 10). Adjust cable (see Adjust Throttle Control in the Adjustments section of this chapter).

10. Install exhaust system to machine (see Exhaust System Installation in this section).

11. Install radiator to machine (see Radiator Installation in this section).

12. Install air cleaner to machine (see Air Cleaner Installation in this section). Make sure that all hose clamps are properly tightened.

13. Insert fuel supply hose and fuel return hose through grommets in engine support on front of engine. Remove plugs placed during engine removal from hoses. Connect fuel supply hose to the injector pump fitting and fuel return hose to the #3 injector fitting. Secure fuel hoses with hose clamps.

14. Open fuel shutoff valve on fuel tank. Check tank and hoses for leaks.

15. Fill cooling system with coolant. Check radiator and hoses for leaks.

16. Make sure that alternator belt tension is properly adjusted.

17. Bleed fuel system.

18. Make sure that engine oil level is correct.

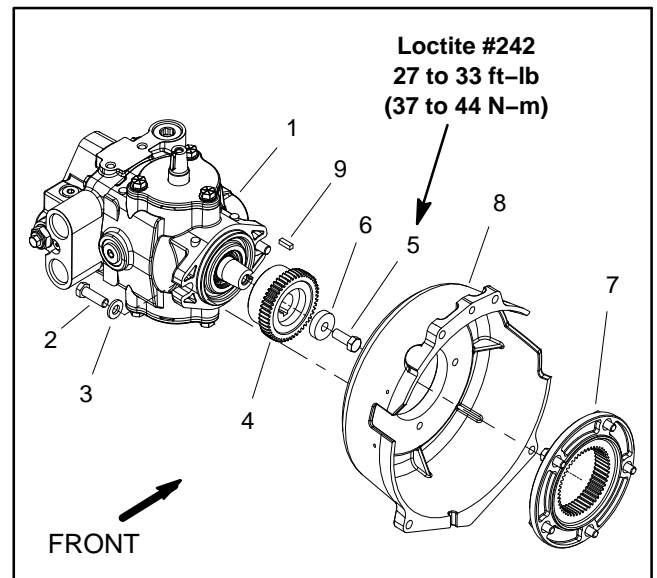


Figure 16

- | | |
|-------------------------|---------------------------|
| 1. Piston pump | 6. Spacer |
| 2. Cap screw (2 used) | 7. Engine coupling flange |
| 3. Flat washer (2 used) | 8. Bell housing |
| 4. Coupling | 9. Key |
| 5. Cap screw | |

Engine Bell Housing

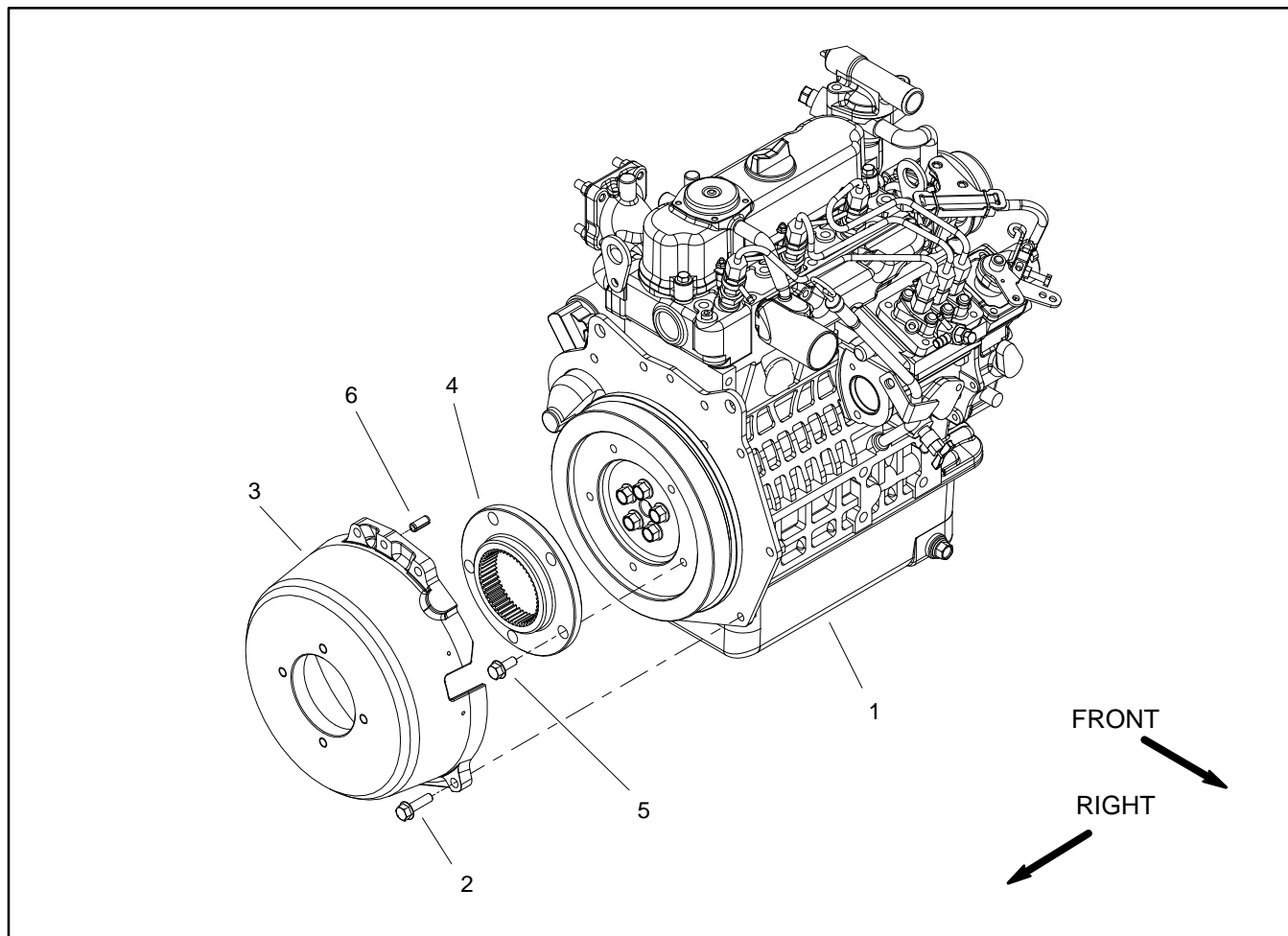


Figure 17

- | | | |
|-------------------------------|--------------------|-------------------------------|
| 1. Engine | 3. Bell housing | 5. Flange head screw (5 used) |
| 2. Flange head screw (5 used) | 4. Coupling flange | 6. Dowel pin (2 used) |

Removal (Fig. 17)

NOTE: The hydraulic pump assembly needs to be removed from engine before bell housing and coupling flange can be removed.

1. If engine is in machine, support engine from below to prevent it from shifting. Remove hydraulic pump assembly (see Piston (Traction) Pump Removal in the Service and Repairs section of Chapter 4 – Hydraulic System).
2. As necessary, remove bell housing and coupling flange from engine using Figure 17 as a guide.

Installation (Fig. 17)

1. If coupling flange was removed from engine flywheel, position flange to flywheel and align mounting holes. Secure flange to flywheel with five (5) flange head screws. Tighten screws in a star pattern.
2. If bell housing was removed from engine, make sure that spring pin is secure in upper hole of bell housing. Position bell housing to flywheel plate and secure with five (5) flange head screws. Tighten screws in a star pattern.
3. If engine is in machine, install hydraulic pump assembly (see Piston (Traction) Pump Installation in the Service and Repairs section of Chapter 5 – Hydraulic System).



Hydraulic System

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		DANFOSS STEERING UNIT TYPE OSPM SERVICE	
		MANUAL	

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Specifications

Item	Description
Piston (Traction) Pump Maximum Pump Displacement (per revolution)	Variable displacement piston pump (Eaton model 70160) 1.44 in ³ (23.6 cc)
Gear Pump Front Section Displacement (per revolution) Rear Section Displacement (per revolution)	2 section, positive displacement gear pump (Casappa) 0.58 in ³ (9.5 cc) 0.33 in ³ (5.4 cc)
Charge Circuit Relief Pressure	110 to 150 PSI (7.6 to 10.3 bar)
Traction Circuit Relief Pressure Forward Reverse	3000 PSI (207 bar) 3000 PSI (207 bar)
Front Wheel Motors Displacement (per revolution)	Orbital rotor motor (Parker TF Series) 10.3 in ³ (169 cc)
Rear Wheel Motor (Optional 3WD Kit) Displacement (per revolution)	Orbital rotor motor (Parker TG Series) 20.6 in ³ (337 cc)
Mow Circuit Relief Pressure	2700 to 3300 PSI (186 to 227 bar)
Cutting Reel Motor Maximum Pump Displacement (per revolution)	Gear motor (Casappa) 0.73 in ³ (12 cc)
Power Steering Valve Displacement (per revolution)	Hydrostatic Steering Unit (Sauer–Danfoss Type OSPMS) 4.5 in ³ (74 cc)
Steering/Lift Circuit Relief Pressure	1160 PSI (80 bar)
Hydraulic Filter	Spin-on cartridge type
Hydraulic Oil	See Operator's Manual
Hydraulic Reservoir Capacity Machines with Turf Defender™ Leak Detector Machines without Turf Defender™ Leak Detector	6.8 gal. U.S. (25.7 L) 5.5 gal. U.S. (20.8 L)

General Information

Operator's Manuals

The Traction Unit and Cutting Unit Operator's Manuals provide information regarding the operation, general maintenance procedures and maintenance intervals for your Greensmaster machine. Refer to these publications for additional information when servicing the machine.

Check Hydraulic Fluid Level

The hydraulic system on your Greensmaster machine is designed to operate on high quality hydraulic fluid. **Check level of hydraulic fluid daily.** Refer to Traction Unit Operator's Manual for fluid level checking procedure and hydraulic oil recommendations.

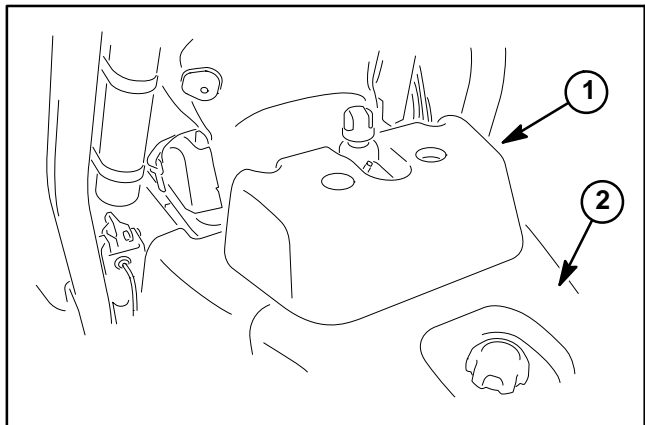


Figure 1

1. Hydraulic reservoir 2. Fuel tank

Pushing Traction Unit

In case of emergency, your Greensmaster can be pushed for a very short distance. However, Toro does not recommend this as a standard procedure.

1. Make sure that engine is not running.
2. Locate by-pass valve on piston (traction) pump (Fig. 2). Rotate by-pass valve so slot is vertical.

IMPORTANT: Do not push the machine faster than 2 mph (3.2 kph) because the traction system may be damaged. If machine must be moved a considerable distance (more than a few feet), transport it on a truck or trailer.

3. Slowly push machine.
4. Before starting engine, rotate piston (traction) pump by-pass valve so slot is horizontal. Do not start engine when by-pass valve is in the vertical position.

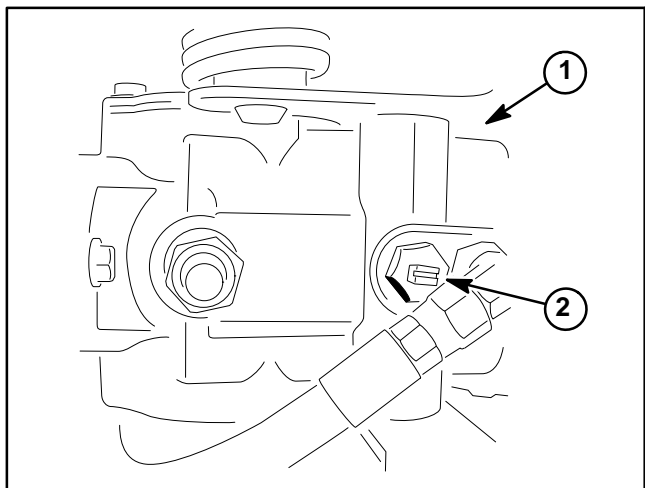


Figure 2

1. Piston (traction) pump 2. By-pass valve

Relieving Hydraulic System Pressure

Before disconnecting or performing any work on your Greensmaster hydraulic system, all pressure in the hydraulic system must be relieved.

To relieve hydraulic pressure in the traction circuit, park machine on a level surface with the cutting units lowered and off. Turn ignition switch to OFF and allow engine to stop. If machine is parked on an incline or slope, pressure in the traction circuit WILL NOT be relieved.

To relieve hydraulic pressure in lift circuit, fully lower the cutting units to the ground. Turn ignition switch to OFF and allow engine to stop. Make sure that after lowering, none of the cutting units are not being supported by the lift cylinders.

To relieve hydraulic pressure in the steering circuit, park machine on a level surface with the cutting units lowered and off. Turn ignition switch to OFF. After engine has come to a complete stop, rotate steering wheel in both directions.

Hydraulic pressure in the mow circuit is relieved when the ignition switch is turned to OFF.

Traction Circuit Component Failure

The traction circuit on your Greensmaster machine is a closed loop system that includes the piston (traction) pump and two (2) wheel motors (three (3) wheel motors are included if machine is equipped with optional 3WD kit). If a component in the traction circuit should fail, debris and contamination from the failed component will circulate throughout the traction circuit. This contamination can damage other components in the circuit so it must be removed to prevent additional component failure.

The recommended method of removing traction circuit contamination would be to temporarily install the Toro high flow hydraulic filter (see Special Tools in this chapter) into the circuit. This filter should be used 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 filter will ensure that contaminants are removed from the closed loop and thus, do not cause additional component damage.

Once the Toro high flow hydraulic filter kit has been placed in the circuit, raise and support the machine with all drive wheels off the ground. Then, operate the traction circuit to allow oil flow throughout the circuit. The filter will remove contamination from the traction circuit during operation. Because the Toro high flow filter is bi-directional, the traction circuit can be operated in both the forward and reverse direction. The filter should be removed from the machine after contamination has been removed from the traction circuit. See Filtering Closed-Loop Traction Circuit in the Service and Repairs section of this chapter for additional information on using the Toro high flow hydraulic filter.

The alternative to using the Toro high flow hydraulic filter kit after a traction circuit component failure would be to disassemble, drain and thoroughly clean all components, tubes and hoses in the traction circuit. If any debris remains in the traction circuit and the machine is operated, the debris can cause additional circuit component failure.

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.

Fitting 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

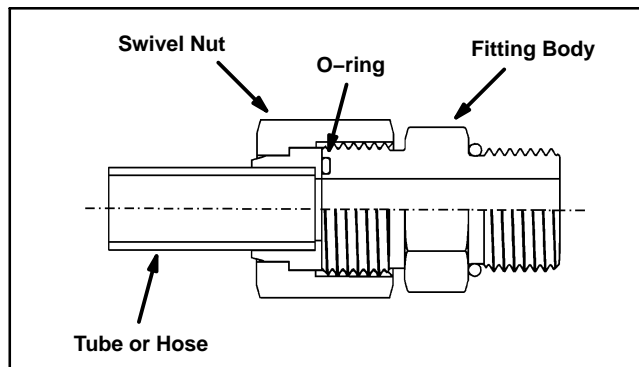


Figure 3

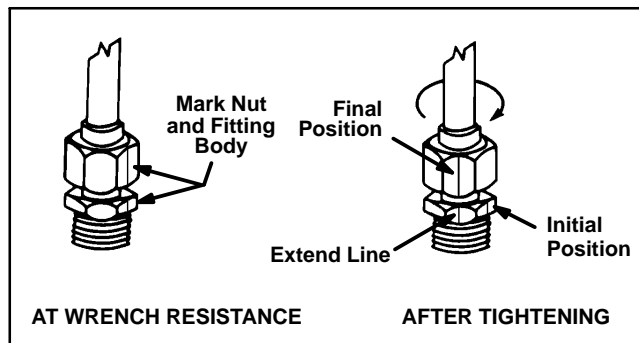


Figure 4

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.

Fitting 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

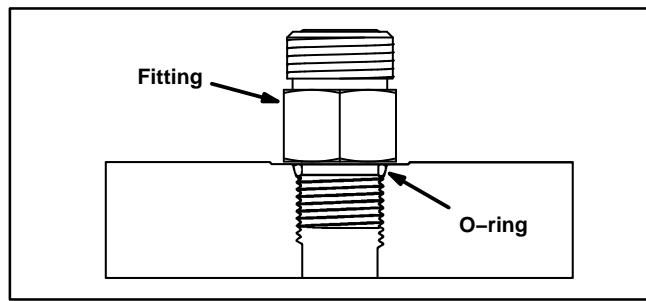


Figure 6

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.

Fitting 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

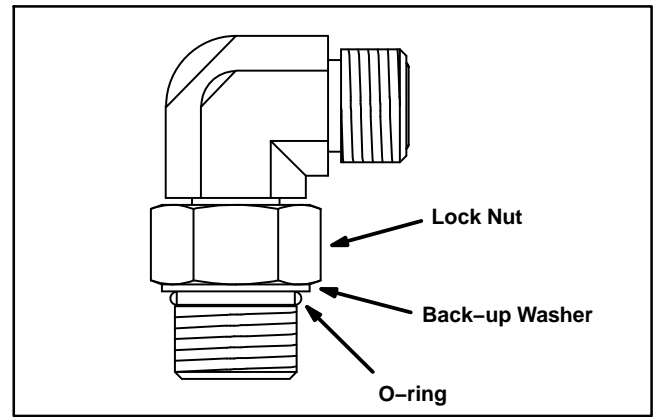


Figure 8

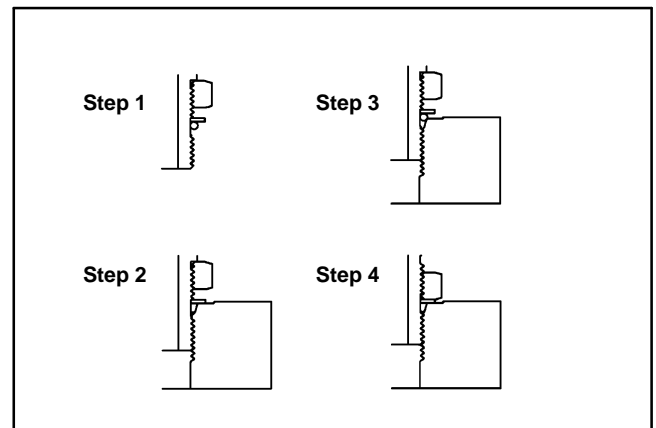
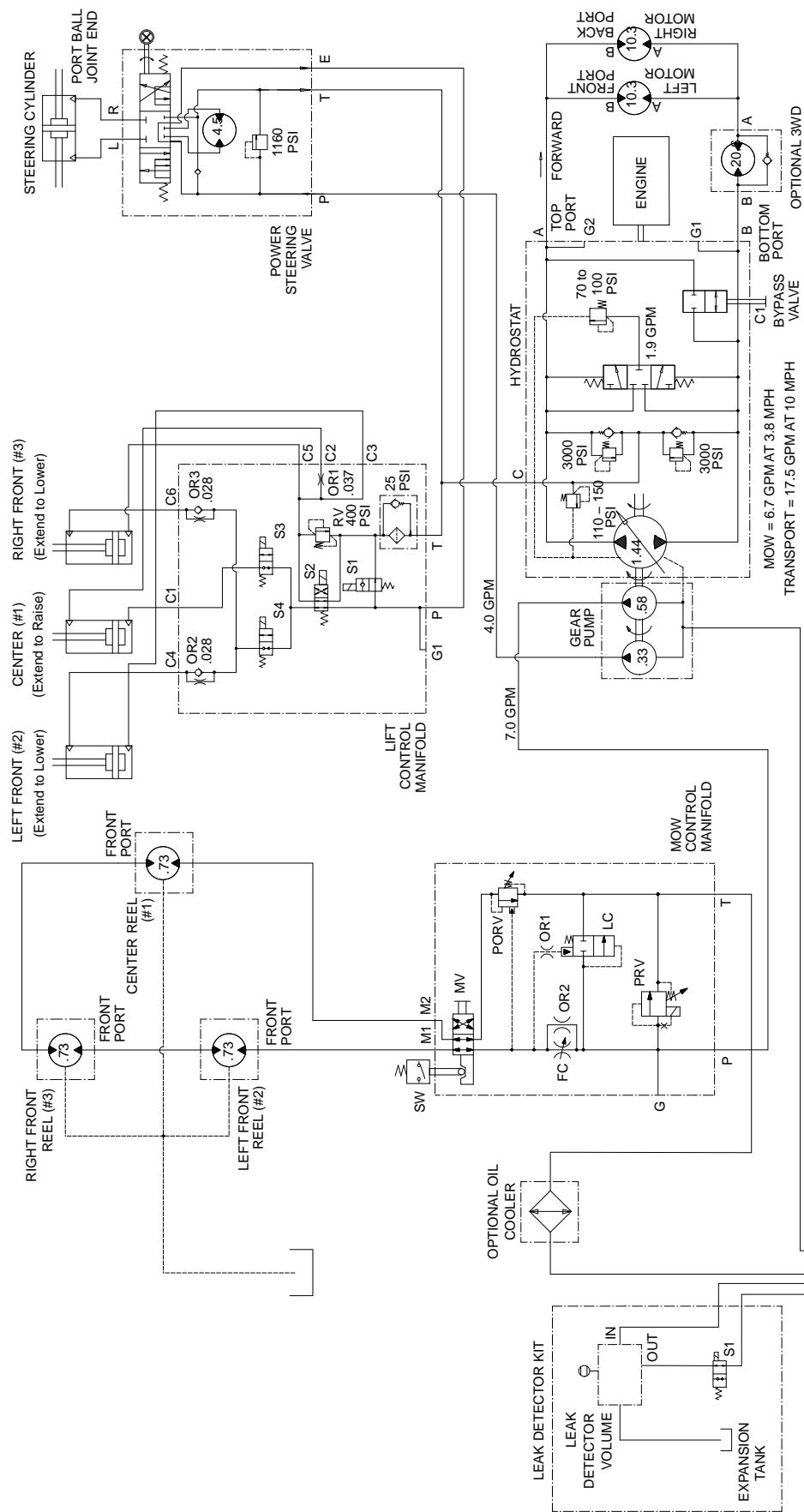


Figure 9

Hydraulic Schematic

NOTE: A larger hydraulic schematic is included in Chapter 9 – Foldout Drawings



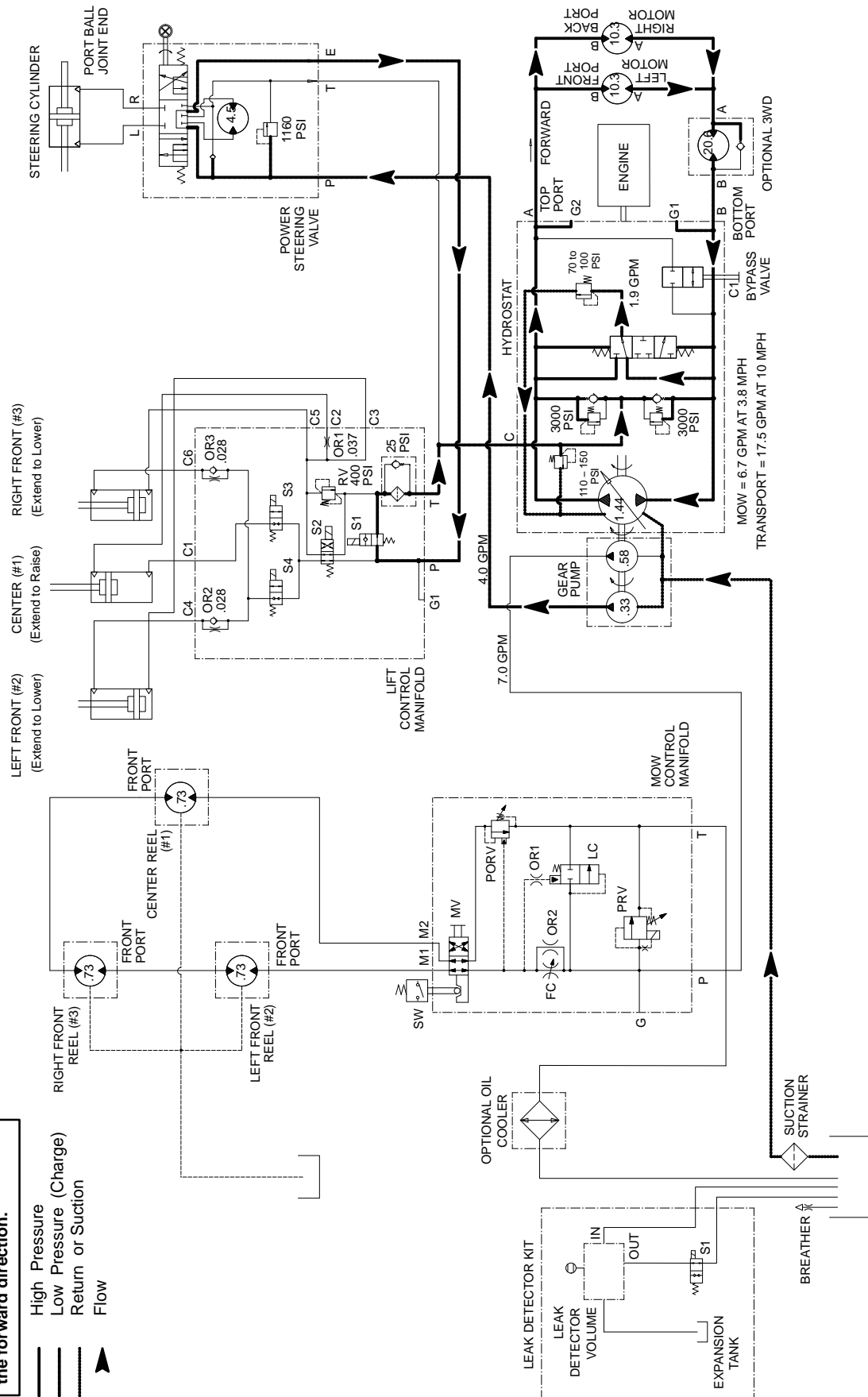
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Hydraulic Flow Diagrams

Greensmaster 3300/3400 Traction Circuit (Forward Direction Shown)

All solenoids are shown as de-energized.
Traction pedal is pressed for the forward direction.

High Pressure
Low Pressure (Charge)
Return or Suction
Flow



Traction Circuit

The traction circuit piston pump is a variable displacement pump that is directly coupled to the engine. Pushing the traction pedal controls the variable displacement piston pump swash plate to create a flow of oil. This oil is directed to the wheel motors. Operating pressure on the high pressure side of the closed traction circuit loop is determined by the amount of load developed at the fixed displacement wheel motors. As the load increases, circuit pressure can increase to relief valve settings: 3000 PSI (207 bar) in both forward and reverse. If pressure exceeds the relief setting, oil flows through the relief valve to the low pressure side of the closed loop traction circuit.

The traction circuit pump and wheel motors use a small amount of hydraulic fluid for internal lubrication. Fluid is designed to leak across traction pump and motor components into the case drain. This leakage results in the loss of hydraulic fluid from the closed loop traction circuit that must be replaced. The charge circuit is designed to replace this traction circuit leakage.

The gear pump section that supplies oil to the steering and lift circuits also provides charge circuit oil. This gear pump is driven directly off the piston (traction) pump. It provides a constant supply of charge oil to the traction circuit to make up for oil that is lost due to internal leakage in the traction pump and wheel motors.

Charge pump flow is directed to the low pressure side of the closed loop traction circuit. Charge circuit pressure (110 to 150 PSI / 7.6 to 10.3 bar) is maintained by the charge relief valve that is attached to the piston pump back plate.

The functional control lever on TriFlex Greensmaster machines has positions for neutral, mow and transport. When the functional control lever is in the neutral position, the traction pedal is secured in the neutral position. The mow position allows traction pedal inputs that are appropriate for mow speeds by limiting the movement of the piston pump swash plate. The transport position allows full movement of the traction pedal so complete pump swash rotation is possible.

Forward

The piston (traction) pump is driven directly by the engine. The hydraulic traction circuit 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.

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.

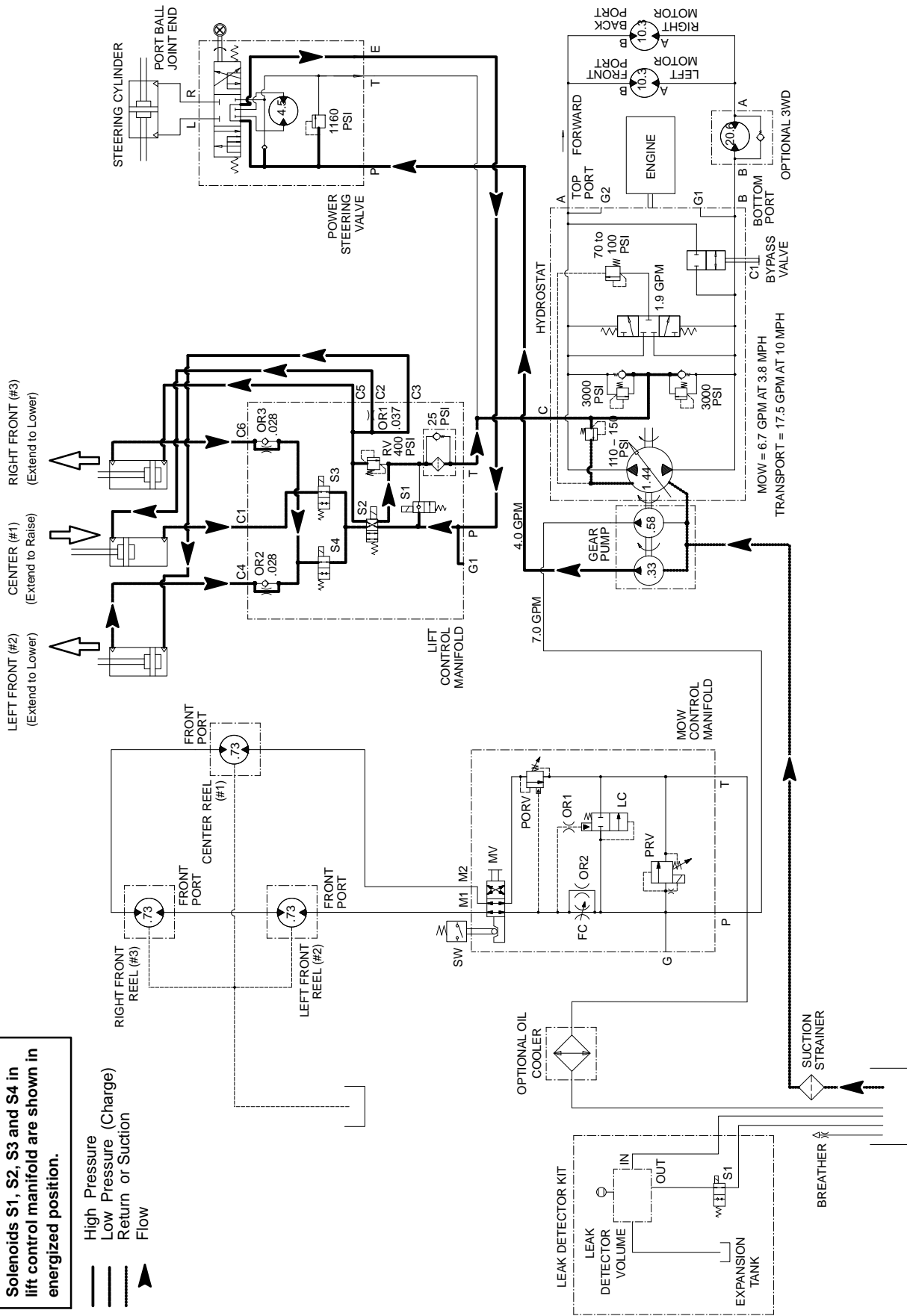
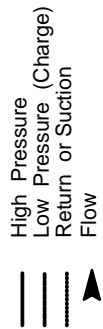
Traction Circuit Cooling

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 / 4.9 to 6.8 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 3300/3400 Lower Cutting Units

Solenoids S1, S2, S3 and S4 in lift control manifold are shown in energized position.



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 power steering valve.

The lift control manifold includes four (4) electrically operated solenoid valves. Solenoid valve S1 causes circuit flow to by-pass the lift cylinders when de-energized and directs flow to the cylinders when energized. Directional solenoid valve S2 is used to direct oil flow to raise the cutting units when de-energized and lower them when energized. When energized, solenoid valve S4 allows hydraulic flow to and from the front cutting unit lift cylinders (#2 and #3) and prevents oil passage to and from the lift cylinders when de-energized. When energized, solenoid valve S3 allows hydraulic flow to and from the center cutting unit lift cylinder (#1) and prevents oil passage to and from the lift cylinder when de-energized.

The console arm joystick is used to raise and lower the cutting units. The joystick acts as an input to the TEC controller to send electrical outputs to appropriate lift control manifold solenoid coils in order to raise or lower the cutting units.

While operating the machine during conditions of not raising or lowering the cutting units (joystick in the neutral (center) position), all of the lift manifold solenoid valves (S1, S2, S3 and S4) are de-energized. Flow from the rear gear pump section is directed through the power steering valve, de-energized solenoid valve S1 in the lift control manifold, oil filter and to the traction charge circuit. Flow in excess of charge circuit needs then returns to the gear pump input.

Lower Cutting Units

When the joystick is moved to the lower position, the Toro Electronic Controller (TEC) energizes all of the lift control manifold solenoid valves for approximately three (3) seconds. This time frame ensures that the cutting units will be fully lowered to allow them to float during operation. The controller also provides a short delay in energizing solenoid valve S3 which delays the lowering of the center cutting unit (#1).

Energized lift manifold solenoids S1 and S2 direct circuit flow toward the lift cylinders in the correct direction to lower the cutting units. The front lift cylinders extend to lower the cutting units while the center lift cylinder retracts to lower the cutting unit. Hydraulic pressure against the lift cylinder pistons moves their shafts causing the cutting units to lower. At the same time, the lift cylinder pistons push the hydraulic fluid out of the cylinders to energized solenoid valves S4 (front lift cylinders) and S3 (center lift cylinder). Return flow continues through energized solenoid valve S2, to the oil filter and then to the traction charge circuit.

Lowering speed for each of the front cutting units (#2 and #3) is controlled by a 0.028 orifice (OR2 and OR3) in the lift control manifold. A 0.037 orifice (OR1) controls lowering speed for the center cutting unit (#1).

If the lift cylinders should reach the end of their stroke while the lift manifold solenoids are still energized, lift circuit pressure will increase. The lift circuit lower relief valve (RV) in the lift control manifold allows lift circuit pressure to be limited to 400 PSI (27.6 bar) while lowering the cutting units.

NOTE: Adjustment of the lift control manifold lift circuit lower relief valve (RV) is not recommended.

When the lift control manifold solenoid valves are de-energized by the TEC controller, spring action returns the valves to their original position 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. Hydraulic flow by-passes the lift cylinders and is routed to the oil filter and charge circuit.

Solenoids S1, S3 and S4 in lift control manifold are shown in energized position.

LEFT FRONT (#2) CENTER (#1) RIGHT FRONT (#3)
(Extend to Lower) (Extend to Raise) (Extend to Lower)



Raise 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 power steering valve.

The lift control manifold includes four (4) electrically operated solenoid valves. Solenoid valve S1 causes circuit flow to by-pass the lift cylinders when de-energized and directs flow to the cylinders when energized. Directional solenoid valve S2 is used to direct oil flow to raise the cutting units when de-energized and lower them when energized. When energized, solenoid valve S4 allows hydraulic flow to and from the front cutting unit lift cylinders (#2 and #3) and prevents oil passage to and from the lift cylinders when de-energized. When energized, solenoid valve S3 allows hydraulic flow to and from the center cutting unit lift cylinder (#1) and prevents oil passage to and from the lift cylinder when de-energized.

The console arm joystick is used to raise and lower the cutting units. The joystick acts as an input to the TEC controller to send electrical outputs to appropriate lift control manifold solenoid coils in order to raise or lower the cutting units.

While operating the machine during conditions of not raising or lowering the cutting units (joystick in the neutral (center) position), all of the lift manifold solenoid valves (S1, S2, S3 and S4) are de-energized. Flow from the rear gear pump section is directed through the power steering valve, de-energized solenoid valve S1 in the lift control manifold, oil filter and to the traction charge circuit. Flow in excess of charge circuit needs then returns to the gear pump input.

Raise Cutting Units

When the joystick is moved to the raise position, the Toro Electronic Controller (TEC) energizes lift control manifold solenoid valves S1, S3 and S4 for approximately three (3) seconds. This time frame ensures that the cutting units will be fully raised. The controller provides a short delay in energizing solenoid valve S3 which delays the raising of the center cutting unit (#1).

Energized lift manifold solenoids S1, S4 (front lift cylinders) and S3 (center lift cylinder) direct circuit flow toward the lift cylinders in the correct direction to raise the cutting units. The front lift cylinders retract to raise the cutting units while the center lift cylinder extends to raise the cutting unit. Hydraulic pressure against the lift cylinder pistons moves their shafts causing the cutting units to raise. At the same time, the lift cylinder pistons push the hydraulic fluid out of the cylinders to de-energized solenoid valve S2. Return flow continues to the oil filter and then to the traction charge circuit.

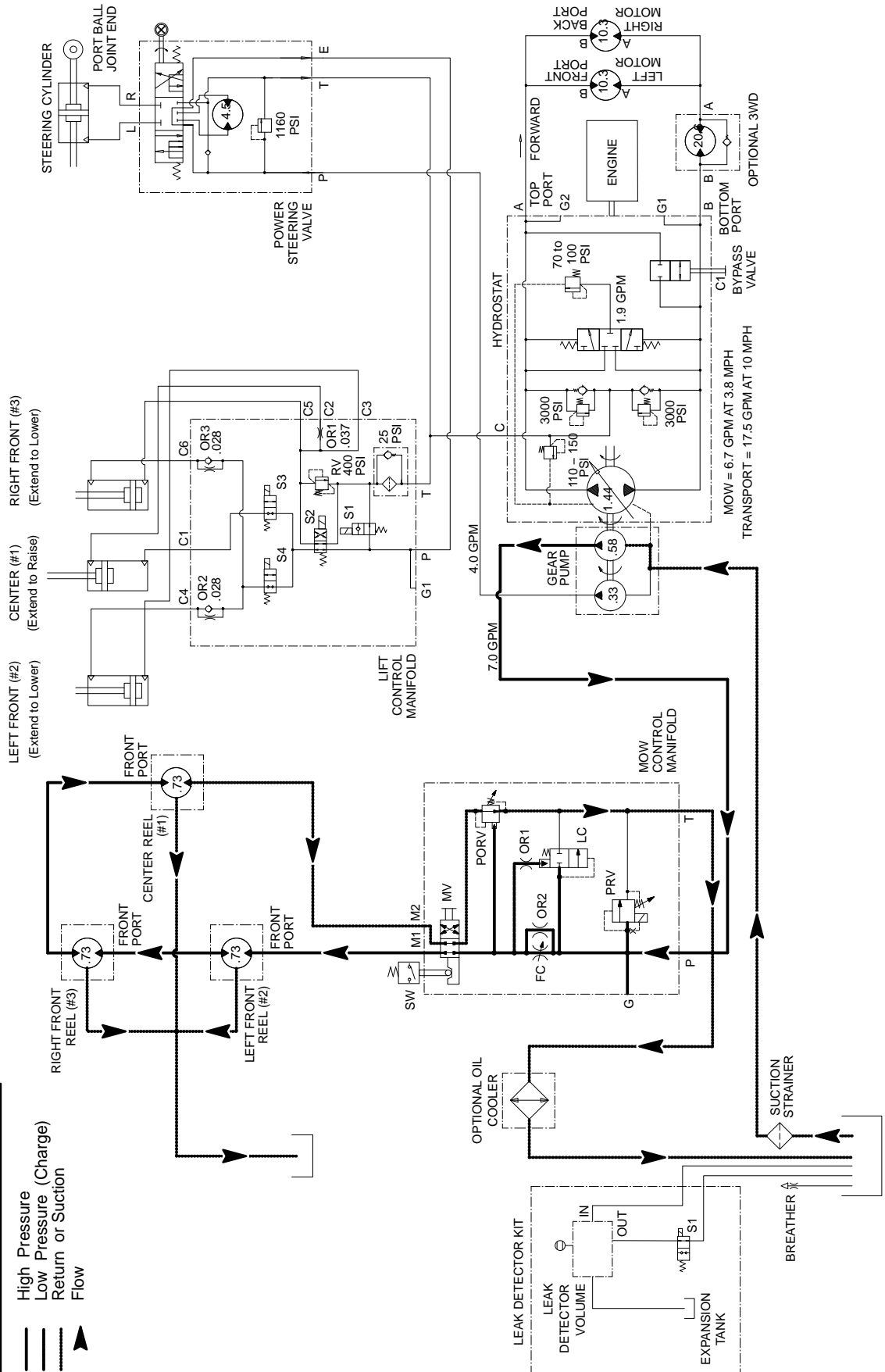
A 0.037 orifice (OR1) controls raising speed for the center cutting unit (#1). Flow to the front lift cylinders (cutting units #2 and #3) bypasses the lift manifold orifices (OR2 and OR3) when the front cutting units are being raised.

When the lift control manifold solenoid valves are de-energized by the TEC controller, spring action returns the valves to their original position 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. Hydraulic flow by-passes the lift cylinders and is routed to the oil filter and charge circuit.

Greensmaster 3300/3400 Mow

Pressure Reducing Valve (PRV)
in mow control manifold is shown
in energized position.

High Pressure
Low Pressure (Charge)
Return or Suction
Flow



Mow and Backlap

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

With the functional control lever and joystick not in the mow position, proportional relief valve (PRV) in the mow control manifold is de-energized. The de-energized PRV routes gear pump flow directly to the hydraulic reservoir by-passing the cutting reel motors. Additionally, manifold pressure reducing valve (PORV) will remain seated to prevent the reel motors (and reels) from rotating.

Mow

With the engine running, the functional control lever in MOW and the joystick moved to the reels lower position, proportional relief valve (PRV) is energized by the TEC controller. In the energized position, this valve directs oil flow toward the reel motors and also functions as the mow circuit relief valve.

Oil flow from manifold port P flows through the flow control valve (FC) used to adjust reel speed. Flow across the flow 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 (MV) in the **mow** position, oil flows through the backlap valve, out manifold port (M1) and to the reel motors that are connected in series. Oil flows through the left (#2), right (#3) and then center reel motor (#1) as it turns the motors in the mow direction.

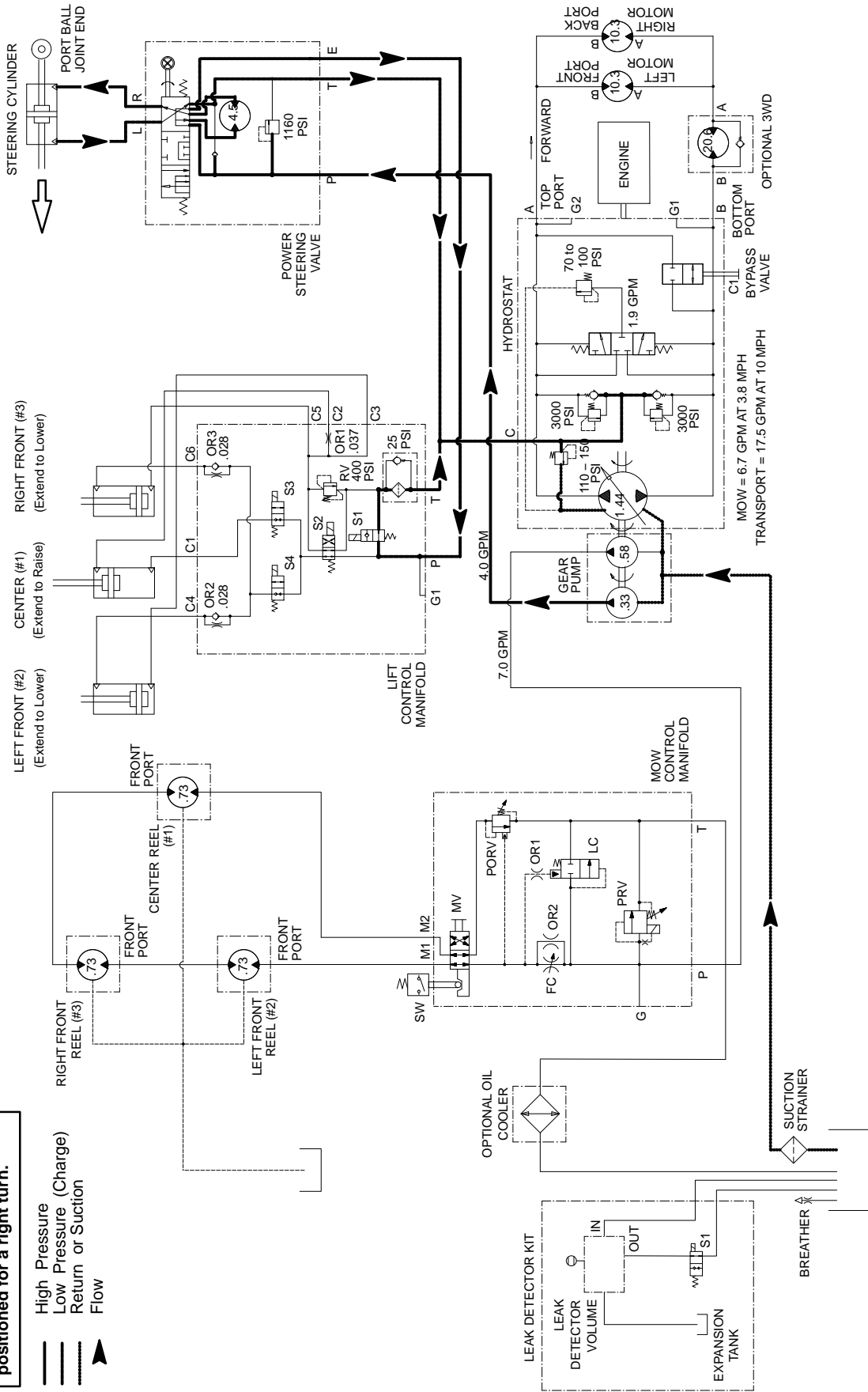
When in the **mow** position, mow circuit pressure will cause the mow control manifold pilot piston to shift and open the pressure reducing valve (PORV). The shifted pressure reducing valve allows circuit oil to return to the reservoir through the manifold block.

Backlap

Backlapping operation is the same as mowing operation, except for the position of the backlap valve (MV) in the mow control manifold. When the backlap valve (MV) is in the **backlap** position, oil flows through the center (#1), right (#3) and then left (#2) reel motor as it turns the motors in the backlap direction.

Right Turn

All solenoids are shown as de-energized. Power steering valve is positioned for a right turn.



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 power steering valve. 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 power steering valve.

With the steering wheel in the neutral position (not turned) and the engine running, the power steering valve spool is in the center position. Gear pump flow enters the power steering valve at port (P) and goes through the spool valve, by-passing the steering cylinder. Flow leaves the steering valve from 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 power steering valve spool so that gear pump flow goes through the top of the spool. Flow entering the power 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 port (E) and becomes available for the raise/lower and traction charge circuits. Second, the remainder of the flow is drawn through the steering valve rotary meter and out steering valve port (R). Pressure extends the steering cylinder for a left turn. The rotary meter ensures that the oil flow to the cylinder is proportional to the amount of the turning on the steering wheel. Fluid leaving the cylinder flows back through the spool valve, out steering valve port (T) and then to the traction charge circuit.

rotary meter ensures that the oil flow to the cylinder is proportional to the amount of the turning on the steering wheel. Fluid leaving the cylinder flows back through the spool valve, out steering valve port (T) and then to the traction charge circuit.

The power 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 power steering valve spool so that gear pump flow goes through the bottom of the spool. Flow entering the power 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 port (E) and becomes available for the raise/lower and traction charge circuits. Second, the remainder of the flow is drawn through the steering valve rotary meter and out steering valve port (L). Pressure extends the steering cylinder for a left turn. The rotary meter ensures that the oil flow to the cylinder is proportional to the amount of the turning on the steering wheel. Fluid leaving the cylinder flows back through the spool valve, out steering valve port (T) and then to the traction charge circuit.

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

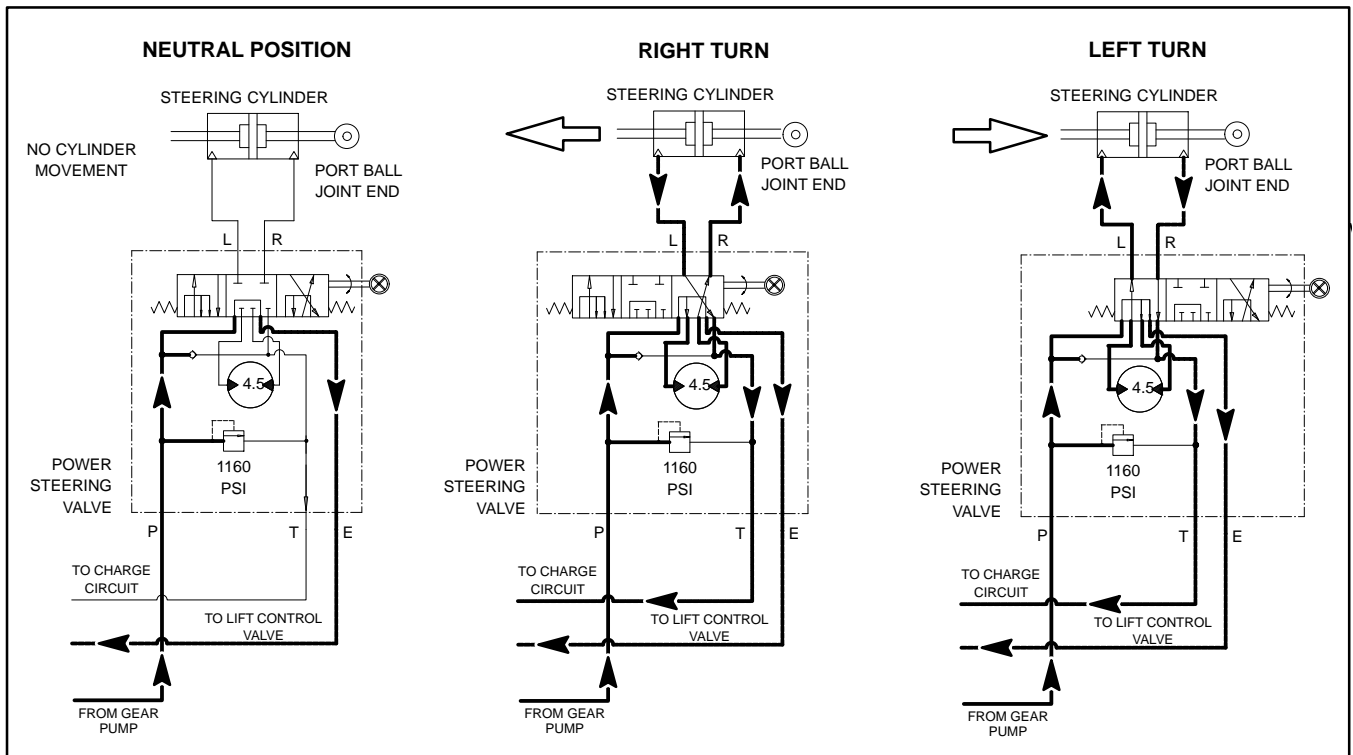


Figure 10

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

40 GPM Hydraulic Tester (Pressure and Flow)

Use to test hydraulic circuits and components for flow and pressure capacities as recommended in the Testing section of this chapter. This tester includes the following:

1. **LOAD VALVE:** A simulated working load is created in the circuit by turning the valve to restrict flow.
2. **PRESSURE GAUGE:** Glycerine filled 0 to 5000 PSI gauge to provide operating circuit pressure.
3. **FLOW METER:** This meter measures actual oil flow in the operating circuit with a gauge rated from 4 to 40 GPM (20 to 150 LPM).

Toro Part Number: **AT40002**

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



Figure 13

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**

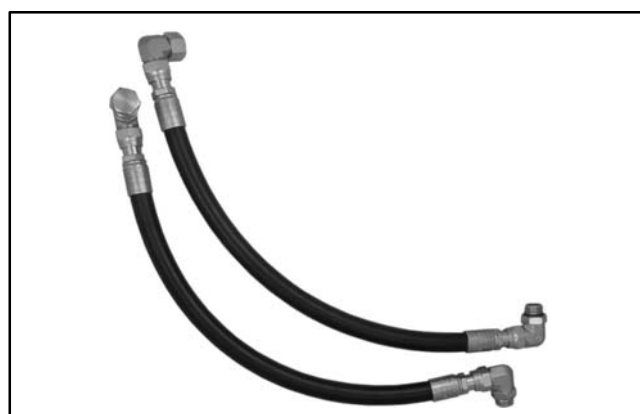


Figure 14

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 15

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 contaminants 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 16

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 17

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 18

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 19

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.	Oil level in reservoir is low. Hydraulic system has wrong type of oil. The pump suction line has an air leak.
Hydraulic system operates hot.	Oil level in reservoir is low or inlet filter is loose or clogged. Oil is contaminated or too light. Parking brake is applied or incorrectly adjusted. Piston pump by-pass valve is open or defective. Working load of machine may require use of oil cooler. Oil cooler (if installed) is damaged or plugged. Oil cooler (if installed) by-pass relief is stuck open or air flow is obstructed. Charge pressure is low. Wheel motor(s) or reel motor(s) are worn or damaged. Piston 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 unit operates in one direction only.	<p>External control linkage is misadjusted, disconnected, binding or damaged.</p> <p>Piston (traction) pump is worn or damaged (see Piston (Traction) Pump Flow Test in the Testing section of this chapter).</p>
Traction response is sluggish.	<p>Hydraulic oil is very cold.</p> <p>Parking brake is applied or incorrectly adjusted.</p> <p>Piston pump by-pass valve is open or defective.</p> <p>Charge pressure is low (see Charge Relief Valve Pressure Test in the Testing section of this chapter).</p> <p>Relief valve(s) in piston (traction) pump are leaking or damaged.</p> <p>Wheel motor(s) is worn or damaged (see Wheel Motor Efficiency Test in the Testing section of this chapter).</p> <p>Piston (traction) pump is worn or damaged (see Piston (Traction) Pump Flow Test in the Testing section of this chapter).</p>
No traction exists in either direction.	<p>Parking brake is applied or incorrectly adjusted.</p> <p>Oil level in reservoir is low (other hydraulic systems also affected).</p> <p>Piston pump by-pass valve is open.</p> <p>Charge pressure is low.</p> <p>Relief valve(s) in piston (traction) pump are leaking or damaged.</p> <p>Wheel motor(s) are worn or damaged (see Wheel Motor Efficiency Test in the Testing section of this chapter).</p> <p>Piston pump is worn or damaged (see Piston (Traction) Pump Flow Test in the Testing section of this chapter).</p>
Wheel motor will not turn.	<p>Brakes are binding.</p> <p>Key on wheel motor shaft is sheared or missing.</p> <p>Wheel motor is damaged.</p>
Wheel motor will not hold load in neutral.	<p>Make up fluid from charge pump is not available.</p> <p>Piston pump relief valves are faulty.</p>

NOTE: The piston pump used on Greensmaster Tri-Flex 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).	Reservoir oil level is low. Gear pump suction line is restricted. Gear pump suction line has an air leak.
Reels will not turn.	Proportional relief valve (PRV) in mow control manifold is stuck open (not shifting to its energized position). An electrical problem exists that prevents correct operation of proportional relief valve (PRV) in mow control manifold (see Chapter 5 – Electrical System). Pressure reducing valve (PORV) in mow control manifold is not shifting. Logic cartridge valve (LC) in mow control manifold is stuck open. Front gear pump section for mow circuit is damaged (see Mow Circuit Gear Pump Flow Test in the Testing section of this chapter).
Reel speed is erratic.	A cutting unit problem exists (see Cutting Unit chapter). Mow control manifold cartridge valve is leaking or damaged. Mow control manifold orifice is plugged.
Reel speed is low.	Engine speed is too low. Reel speed on mow control manifold not adjusted correctly. A cutting unit problem exists (see Cutting Unit chapter). Mow control manifold cartridge valve 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.	<p>Engine speed is too low.</p> <p>Reservoir oil level is low.</p> <p>Lift cylinder linkage is binding or broken.</p> <p>Lift cylinder bushings are binding.</p> <p>Relief valve in power steering valve is leaking or damaged (see Steering/Lift Relief Valve Pressure Test in the Testing section of this chapter).</p> <p>Solenoid valve (S1) in lift control manifold is leaking or damaged (not shifting to its energized position).</p> <p>Lift cylinders leak internally.</p> <p>Spool in power steering valve is hung up (see Power Steering Valve Test in the Testing section of this chapter).</p> <p>Rear gear pump section is worn or damaged (steering and charge circuits affected as well) (see Steering/Lift Circuit Gear Pump Flow Test in the Testing section of this chapter).</p>
Front cutting units (#2 and #3) raise, but will not stay up. (NOTE: Lift cylinders and control manifold check valves cannot provide an absolutely perfect seal. The cutting units will eventually lower if left in the raised position)	<p>Solenoid valve (S4) in lift control manifold is leaking or damaged.</p> <p>Front lift cylinders leak internally.</p>
Center cutting unit (#1) raises, but will not stay up. (NOTE: Lift cylinders and control manifold valves cannot provide an absolutely perfect seal. The cutting units will eventually lower if left in the raised position)	<p>Solenoid valve (S3) in lift control manifold is leaking or damaged.</p> <p>Center lift cylinder leaks internally.</p>

Steering Circuit Problems

Problem	Possible Cause
Steering wheel is hard to turn.	Power steering valve has insufficient oil flow (see Steering/Lift Circuit Gear Pump Flow Test in the Testing section of this chapter). Emergency steering ball in power steering valve is missing or damaged.
Regular adjustments to steering wheel are necessary because of difficulty to drive in a straight line.	Leaf springs in power steering valve are worn or broken. Gear wheel set in power steering valve is worn. Steering cylinder is seized or its piston seals are worn (see Power Steering Valve Test in the Testing section of this chapter).
Steering wheel will not return to the neutral position.	Spool and sleeve are sticking to power steering housing assembly (see Power Steering Valve Test in the Testing section of this chapter).
Steering wheel can turn on its own.	Leaf springs in power steering valve are broken or stuck. Spool and sleeve are sticking to power steering housing assembly (see Power Steering Valve Test in the Testing section of this chapter).
Backlash results when turning steering wheel.	Cardan shaft fork in power steering valve is worn or broken. Leaf springs in power steering valve are worn or broken. Splines on the steering column are worn.
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 power steering valve is worn.
Steering response is too slow and heavy when trying to turn quickly.	The rear gear pump section is worn or damaged (steering and charge circuits affected as well) (see Steering/Lift Circuit Gear Pump Flow Test in the Testing section of this chapter).
Turning steering wheel turns machine in the opposite direction.	Hoses to the steering cylinder are reversed. Hoses to the power steering valve are not connected to correct ports.
Steering force (possibly to one side only) is insufficient.	Relief valve in power steering valve is leaking or damaged (see Steering/Lift Relief Valve Pressure Test in the Testing section of this chapter). Rear gear pump section is worn or damaged (steering and charge circuits affected as well) (see Steering/Lift Circuit Gear Pump Flow Test in the Testing section of this chapter).

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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).

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



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. See Relieving Hydraulic System Pressure in the General Information section.



CAUTION

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



CAUTION

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



WARNING

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

Precautions for Hydraulic Testing

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 other 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.

Which Hydraulic Tests Are Necessary?

Before beginning any hydraulic test, identify if the problem is related to the traction circuit, mow circuit, lift/lower circuit or steering circuit. Once the faulty system has been identified, perform tests that relate to that circuit.

1. Use the Hydraulic Schematic, Hydraulic Flow Diagrams and the Troubleshooting section found in this Chapter to assist in hydraulic 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 one or more of the following tests:

- A. Charge Relief Valve Pressure.
- B. Piston (Traction) Pump Flow.
- C. Wheel Motor Efficiency.

NOTE: The piston pump used on Greensmaster Tri-Flex 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.

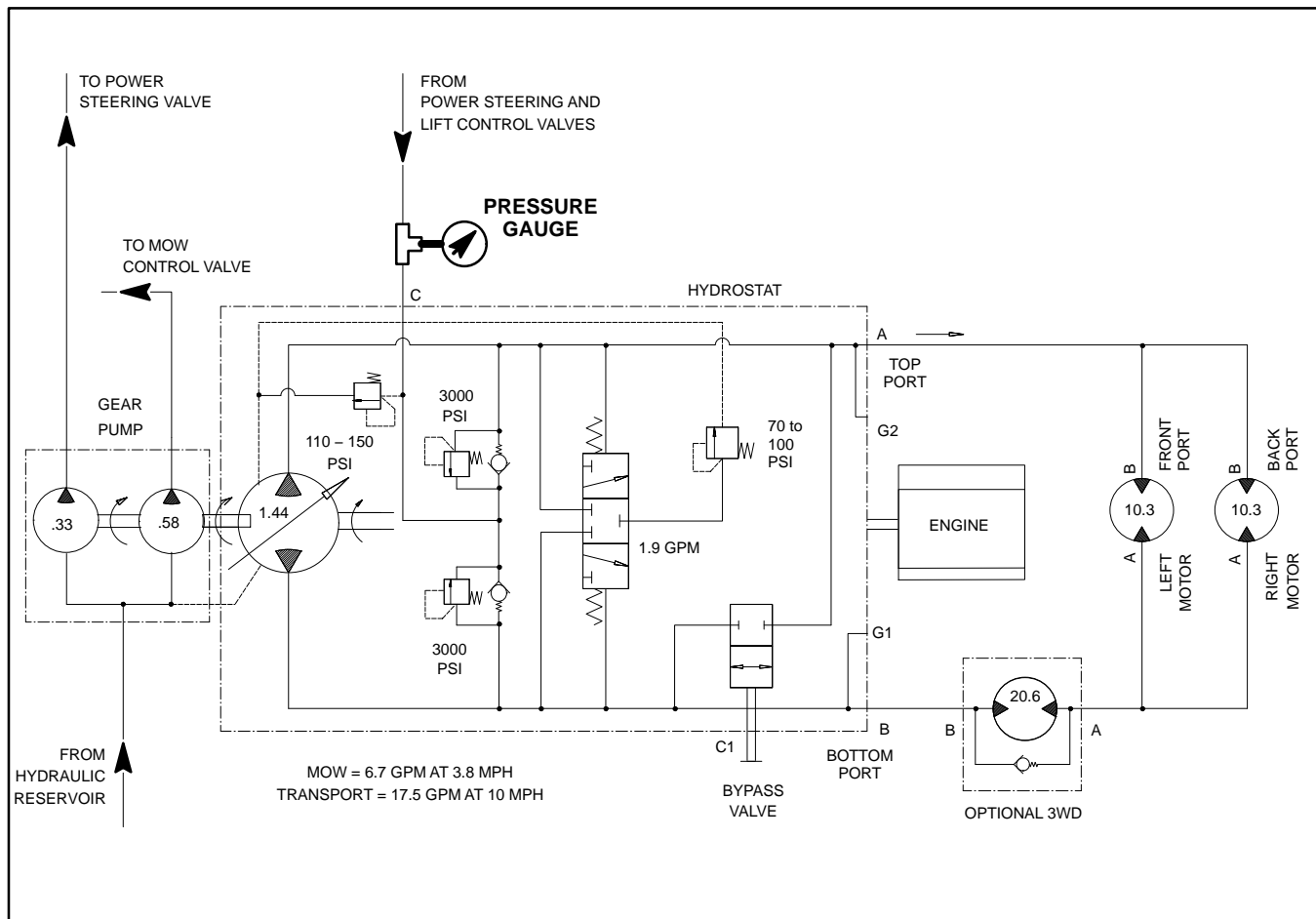
4. For problems with the steering and lift/lower circuit, consider performing one or more of the following tests:

- A. Steering/Lift Relief Valve Pressure.
- B. Lower Cutting Units Relief Valve (RV) Pressure.
- C. Steering/Lift Circuit Gear Pump Flow.
- D. Power Steering Valve.

5. For issues with the mow circuit, consider performing one or more of the following tests:

- A. Mow Circuit Gear Pump Flow.
- B. Mow Circuit Relief Valve Pressure.
- C. Reel Motor Case Drain Flow.

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



The traction charge circuit is designed to replace loss of hydraulic fluid from the closed loop traction circuit. The charge relief valve pressure test will identify if charge pressure is correct.

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 tank is full.



CAUTION

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

3. Thoroughly clean junction of hydraulic hose and hydraulic tube that runs under piston (traction) pump (Figs. 20 or 21). Disconnect hydraulic hose from the hydraulic tube.
4. Install a tee fitting between the disconnected hose and tube. Install a 1000 PSI (70 bar) pressure gauge to the tee fitting.
5. Make sure that traction pedal, steering wheel and joystick are in the neutral position.
6. Start engine and run at low idle speed. Check for hydraulic leakage at pressure gauge and correct before proceeding with test.
7. Move throttle so engine is running at high idle speed.
8. Pressure gauge should read approximately **110 to 150 PSI (7.6 to 10.3 bar)**.
9. Shut off engine. Record test results.

10. 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.

11. 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, 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 in the appropriate direction (forward or reverse) to allow traction system load.

D. The charge pressure should drop no more than 20% from no-load charge pressure measured in step 8 above (e.g. if charge pressure in step 8 is 125 PSI (8.6 bar), charge pressure in forward or reverse under load should be more than 100 PSI (6.9 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).

12. When charge pressure testing is complete, disconnect pressure gauge and tee fitting from the hydraulic hose and hydraulic tube. Connect hose to tube.

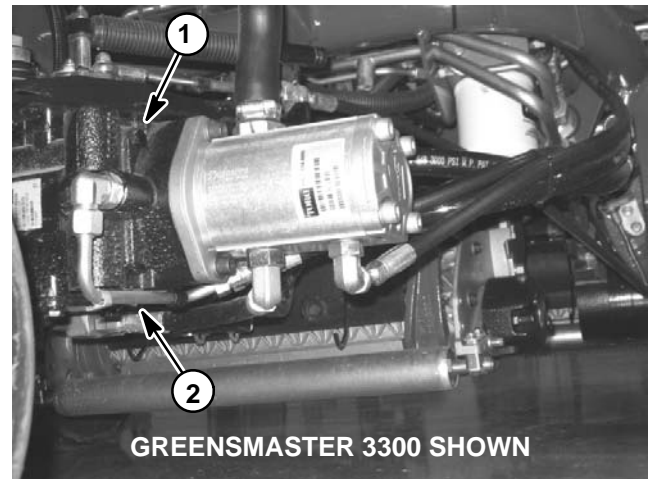


Figure 20

1. Piston (traction) pump 2. Hydraulic tube

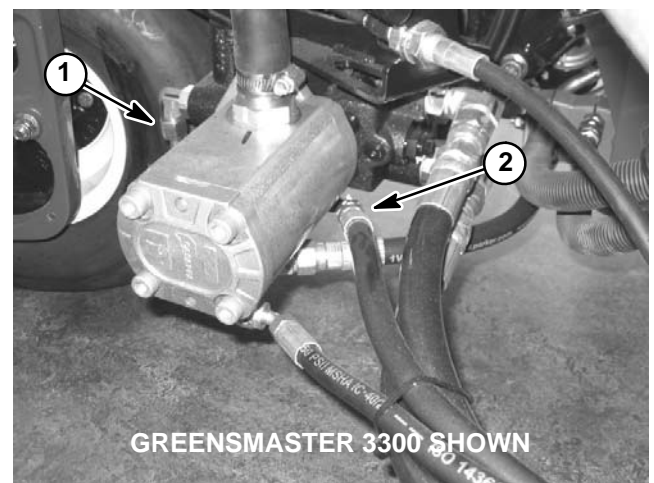
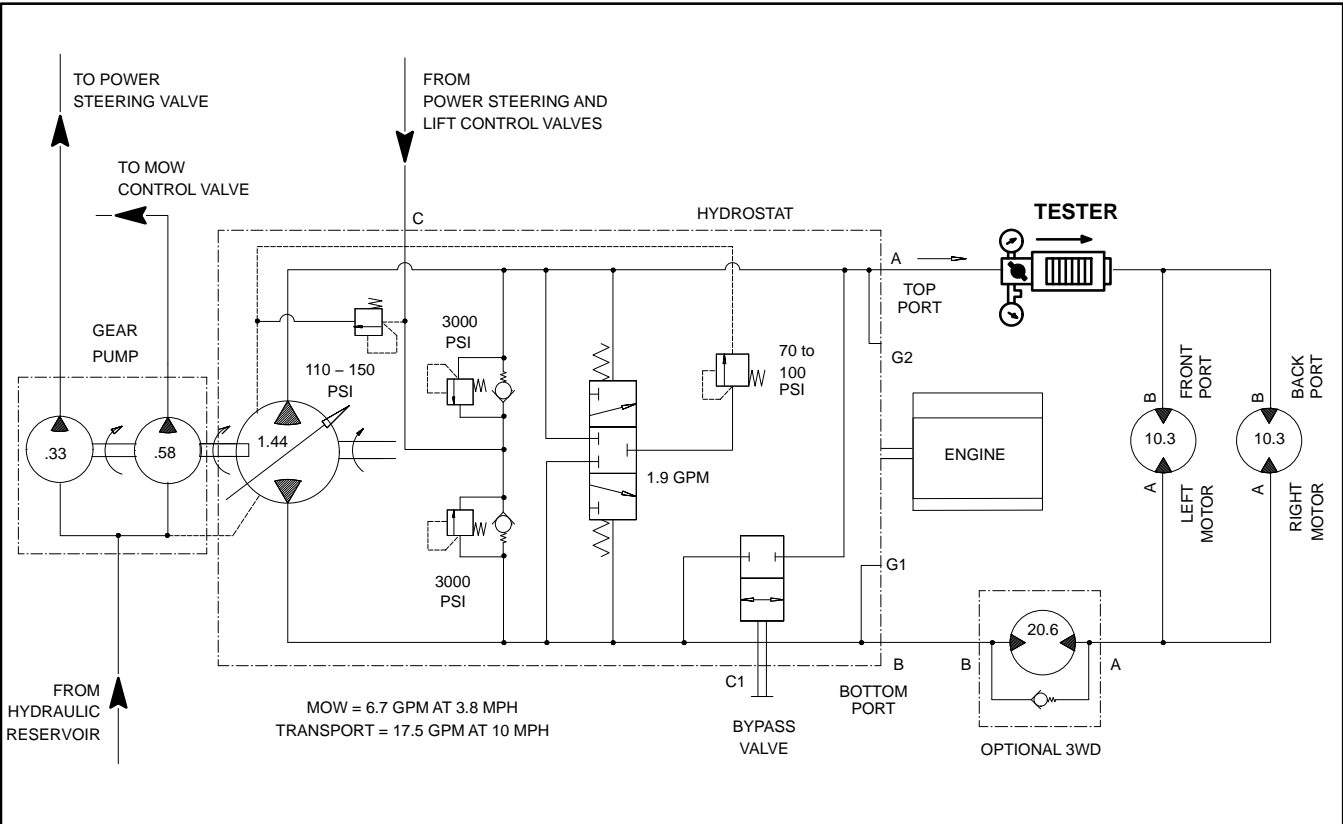


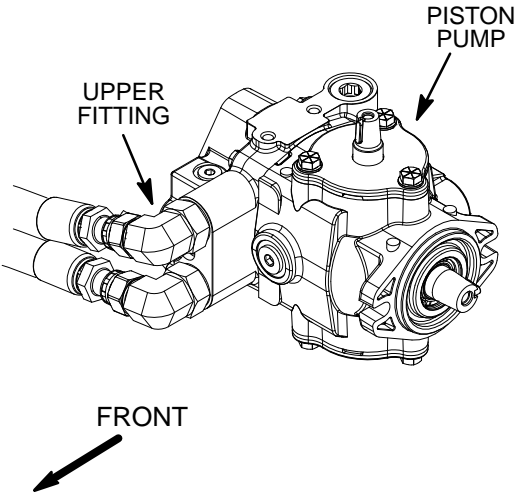
Figure 21

1. Hydraulic tube location 2. Hose and tube junction

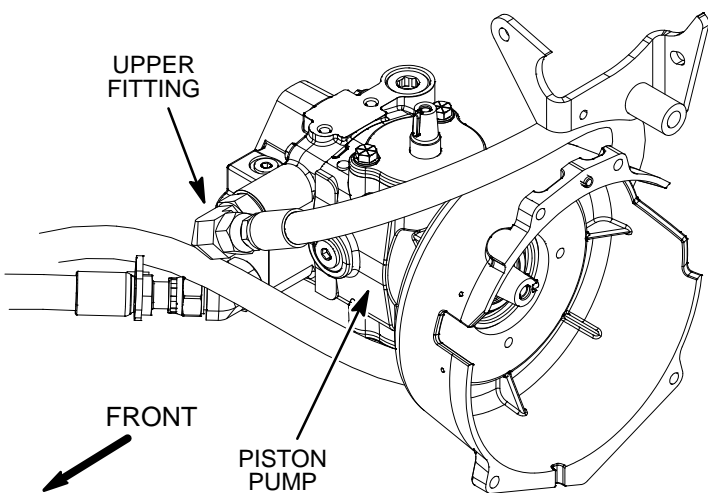
Piston (Traction) Pump Flow Test (Using Tester with Flowmeter and Pressure Gauge)



PUMP FROM GREENSMaster 3300



PUMP FROM GREENSMaster 3400



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

Procedure for Piston (Traction) Pump 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 and off. Make sure engine is off. Make sure the hydraulic tank is full.

**CAUTION**

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


3. Make sure the traction pedal is adjusted to the neutral position. Also, make sure that transport speed is properly adjusted.
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. Thoroughly clean junction of hydraulic hose and **upper** hydraulic fitting on front side of piston pump (forward port). Disconnect hose from upper pump fitting.

IMPORTANT: Traction circuit flow for Greensmaster TriFlex machines is approximately 17 GPM (65 LPM). Use 40 GPM Hydraulic Tester #AT40002 (pressure and flow) for this test (see Special Tools in this chapter).

6. Install 40 GPM Hydraulic Tester #AT40002 (pressure and flow) in series between piston pump fitting and disconnected hose to allow flow from piston pump to tester. Use hydraulic hose kit (see Special Tools in this chapter) to connect tester to machine. Make sure that fitting and hose connections are properly tightened. Also, make sure the flow control valve on tester is fully open.

7. After installing tester, start engine and run at low idle speed. Check for hydraulic leakage and correct before proceeding with test.

8. Move functional lever to the transport position.

**CAUTION**

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

9. Move throttle so engine is running at high idle speed.
10. Slowly push traction pedal to fully forward position. Keep pedal fully depressed in the forward position.
11. 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.

12. Observe flow gauge. If piston pump is in good condition, flow indication should be approximately **17.1 GPM (64.7 LPM)**.

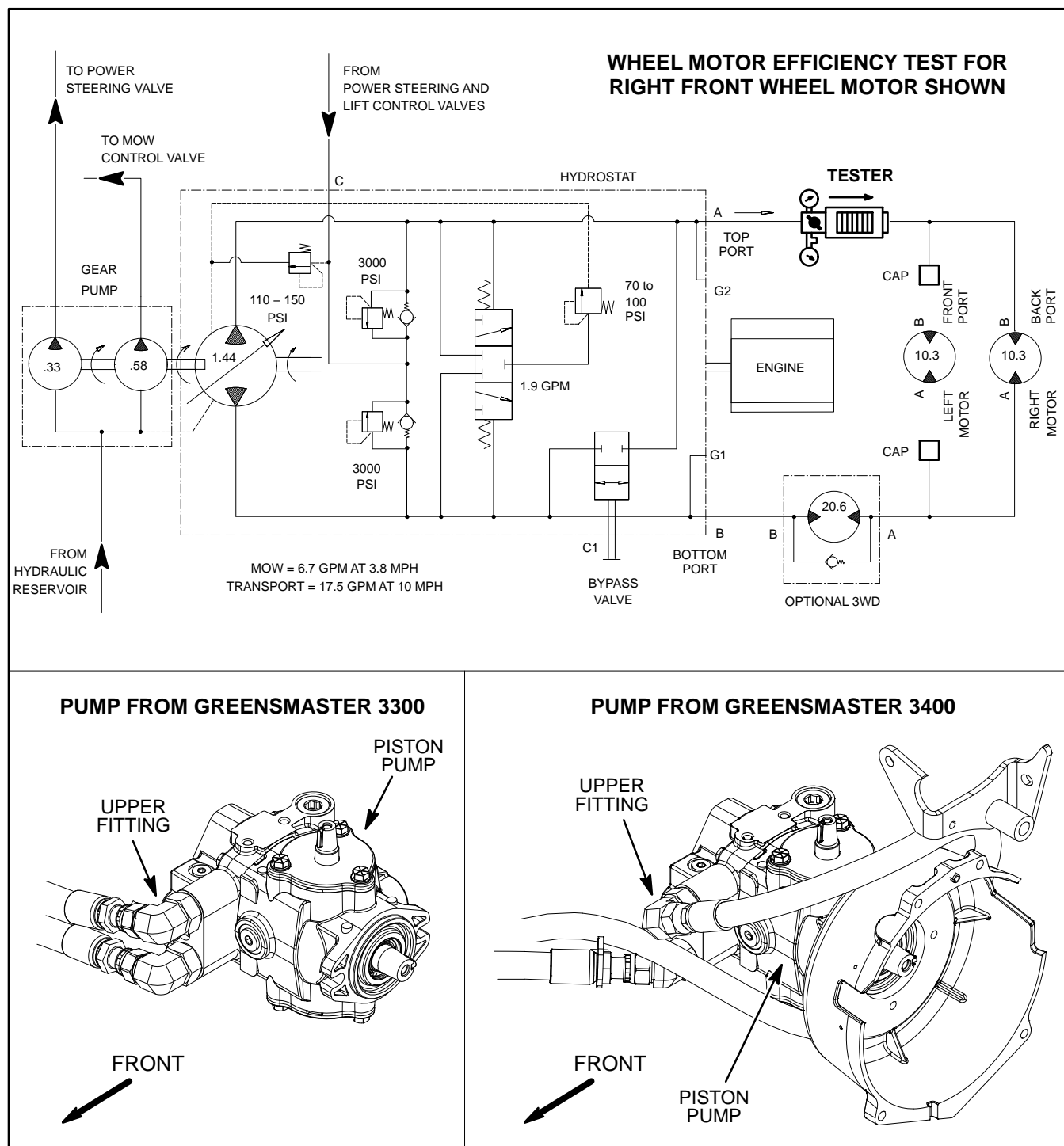
13. Release traction pedal, open control valve on tester and turn off engine. Record test results.

14. If flow is less than **15.3 GPM (57.9 LPM)**, consider the following:

- A. The traction pedal and/or traction speed may need adjustment.
- B. The piston pump needs to be repaired or replaced as necessary.
- C. Make necessary repairs before performing additional hydraulic traction circuit tests.

15. When piston pump flow testing is complete, disconnect tester from pump fitting and hose. Connect hydraulic hose to pump fitting.

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



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.

Procedure for Wheel Motor Efficiency Test:

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. Make sure the hydraulic tank is full.



CAUTION

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

3. Read Precautions for Hydraulic Testing in this section.

4. Make sure the transmission is adjusted to the neutral position.

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

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

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

8. Thoroughly clean junction of hydraulic lines and fitting on 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 fittings in wheel motor.

9. Thoroughly clean junction of hydraulic hose and **upper** hydraulic fitting on front side of piston pump (forward port). Disconnect hose from upper pump fitting.

10. Install hydraulic tester (pressure and flow) in series between piston pump fitting and disconnected hose to allow flow from piston pump to tester (same tester connections as Piston (Traction) Pump Flow Test). Make sure that fitting and hose connections are properly tightened. Also, make sure the flow control valve on tester is fully open.

11. Start engine and run at low idle speed. Check for hydraulic leakage and correct before proceeding with test.



CAUTION

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

12. Move throttle so engine is running at high idle speed.

13. Slowly push traction pedal in **forward** direction until **1000 PSI (69 bar)** is displayed on the tester pressure gauge. Make sure that wheel motor being tested is not rotating.

14. 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.

15. Release traction pedal to the neutral position and release brakes. Rotate wheel being tested and retest. Testing of wheel motor leakage in three (3) different wheel positions will provide most accurate test results.

16. Release traction and brake pedals. Shut engine off. Record results of wheel motor leakage test.

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

18. To test second front wheel motor:

A. Reconnect hydraulic lines to untested front wheel motor.

B. Disconnect and cap hydraulic lines to tested front wheel motor.

C. Complete steps 11 to 17 for the second front wheel motor.

19. 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. Front wheels need to turn freely when testing rear wheel motor.

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.



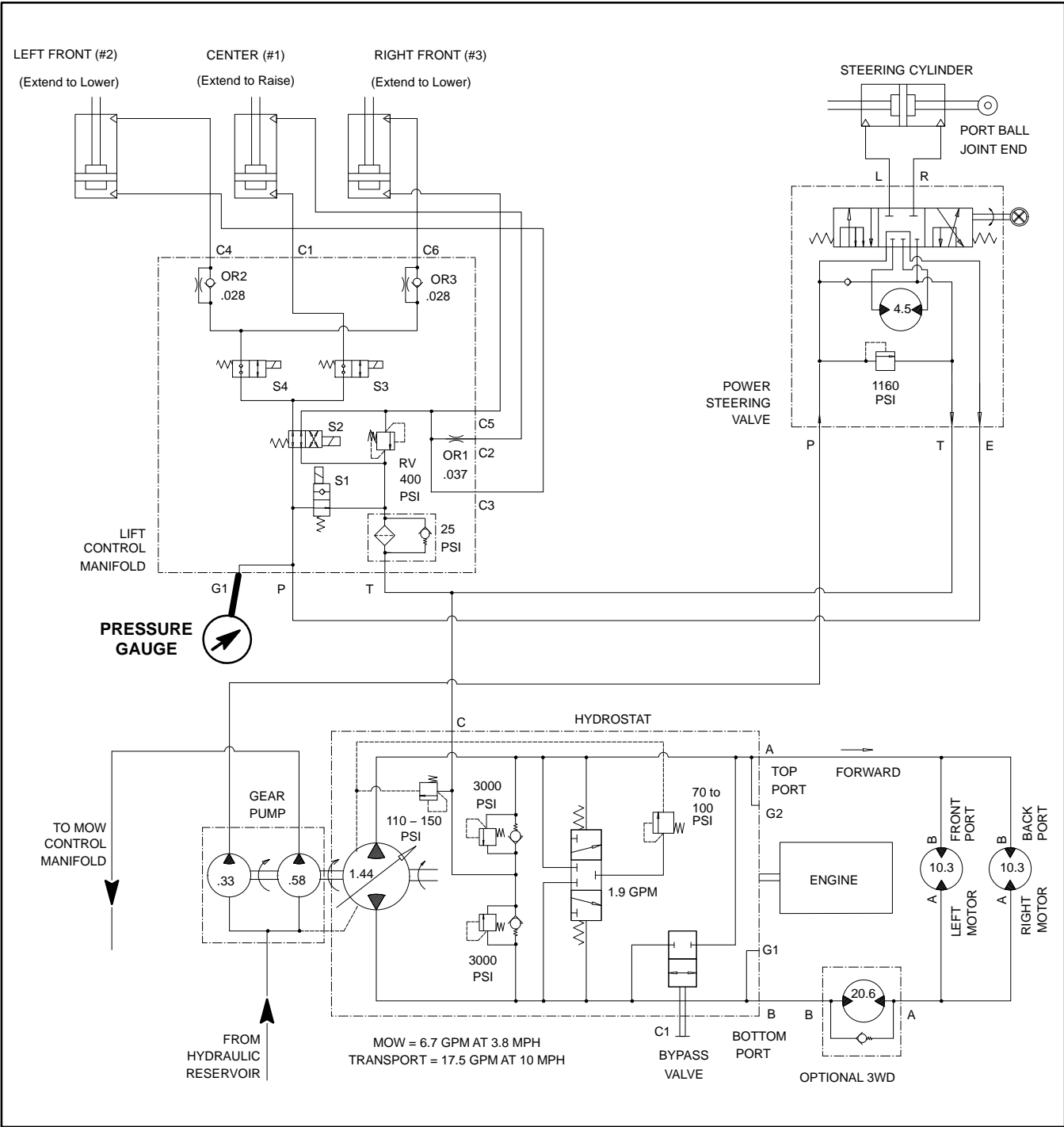
CAUTION

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

D. Complete steps 11 to 17 to test rear wheel motor leakage.

20. When testing is completed, disconnect tester from hydraulic hose and pump fitting. Connect hose to pump fitting. Make sure that hydraulic connections at wheel motors are all secure.

Steering/Lift Relief Valve Pressure Test (Using Pressure Gauge)



The steering/lift relief valve pressure test should be performed to make sure that the relief pressure for the steering and lift circuits is correct.

Procedure for Steering/Lift 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 tank is full.




CAUTION

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

NOTE: The steering/lift relief valve is in series with the traction charge relief valve. Traction charge pressure will therefore affect steering/lift relief valve pressure.

3. Measure and record charge relief valve pressure (see Charge Relief Valve Pressure Test in this section).
4. Remove right side cover next to operator seat to allow access to lift control manifold.
5. Install 5000 PSI (350 bar) pressure gauge with hydraulic hose attached to lift control manifold test port (G) (Fig. 22).
6. Make sure that traction pedal and joystick are in neutral and the parking brake is engaged.
7. Start engine and run at low idle speed. Check for hydraulic leakage and correct before proceeding with test.
8. Move throttle so engine is running at high idle speed.



CAUTION

While measuring steering/lift relief valve pressure, do not allow circuit pressure to exceed 1400 PSI (82.8 bar).

9. Watch the pressure gauge and move the joystick to the **raise** position. Momentarily hold the joystick with the cutting units fully raised causing the relief valve to open. Release the joystick when the relief pressure is identified.

10. Shut off engine. Record pressure at which the relief valve opens.

11. Steering/lift valve pressure should be approximately **1160 PSI (80 bar) higher than the charge relief valve pressure** (e.g. if the charge relief valve pressure is 125 PSI (8.6 bar), the steering/lift relief valve pressure should be approximately 1285 PSI (88.6 bar)).

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

NOTE: The lower cutting units relief valve (RV) pressure can also be measured with pressure gauge positioned as described in this test (see Lower Cutting Units Relief Valve (RV) Pressure Test in this section).

13. When testing is complete, disconnect pressure gauge from lift control manifold test port. Install dust cap to test port fitting. Install right side cover.

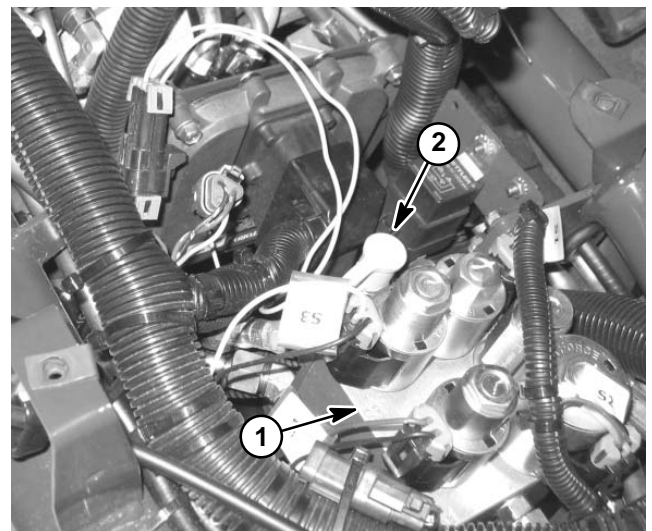
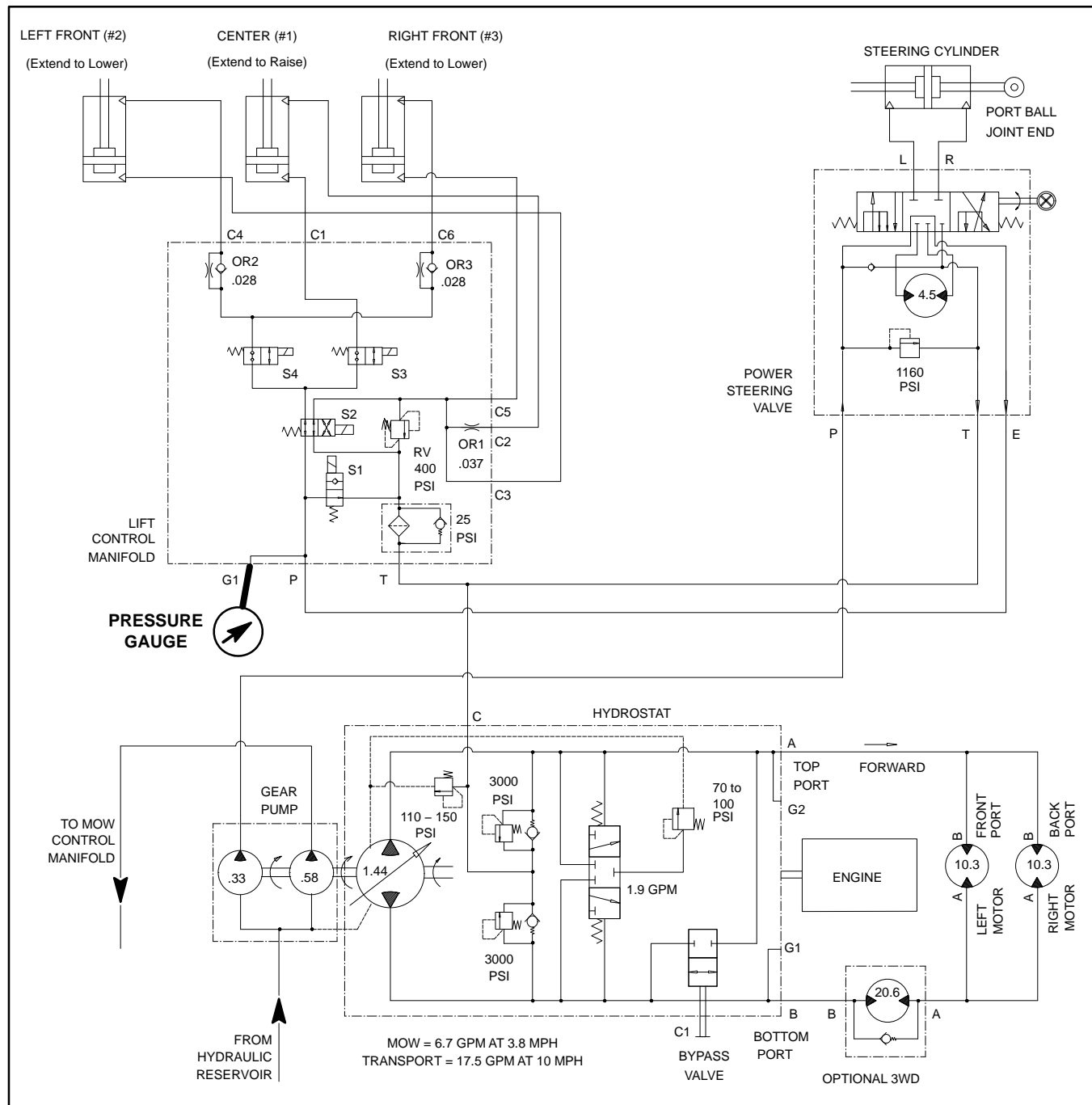


Figure 22

1. Lift control manifold 2. Test port

Lower Cutting Units Relief Valve (RV) Pressure Test (Using Pressure Gauge)



The lower cutting units relief valve (RV) pressure test should be performed to make sure that the relief pressure for lowering the cutting units is correct.

Procedure for Lower Cutting Units Relief Valve (RV) 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 tank is full.



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

3. Measure and record charge relief valve pressure (see Charge Relief Valve Pressure Test in this section).
4. Remove right side cover next to operator seat to allow access to lift control manifold.
5. Install 1000 PSI (70 bar) pressure gauge with hydraulic hose attached to lift control manifold test port (G) (Fig. 23).
6. After installing pressure gauge, start engine and run at low idle speed. Check for hydraulic leakage and correct before proceeding with test.
7. Move throttle so engine is running at high idle speed.

NOTE: The lower cutting units function is electrically timed and automatically turns off after approximately three (3) seconds.

8. Watch pressure gauge carefully while moving the joystick to LOWER and note pressure that relief valve opens. Release joystick, shut off engine and record test results.

NOTE: While performing this hydraulic test, if relief pressure cannot be determined within the LOWER function three (3) second timeframe, repeat this test procedure.

9. The lower cutting units relief pressure should be approximately **400 PSI (27.6 bar) higher than charge relief pressure** (e.g. if charge relief valve pressure is 125 PSI (8.6 bar), the lower relief valve pressure should be approximately 525 PSI (36.2 bar)).

10. If the lower relief valve pressure is incorrect, adjust lower cutting units relief valve on lift control manifold (Fig. 24) (see Adjust Manifold Relief Valves in the Adjustments section of this Chapter). Retest relief valve pressure after adjustment is performed.

NOTE: The steering/lift circuit relief valve pressure can also be measured with pressure gauge positioned as described in this test (see Steering/Lift Relief Valve Pressure Test in this section).

11. When testing is complete, disconnect pressure gauge from lift control manifold test port. Install dust cap to test port fitting. Install right side cover.

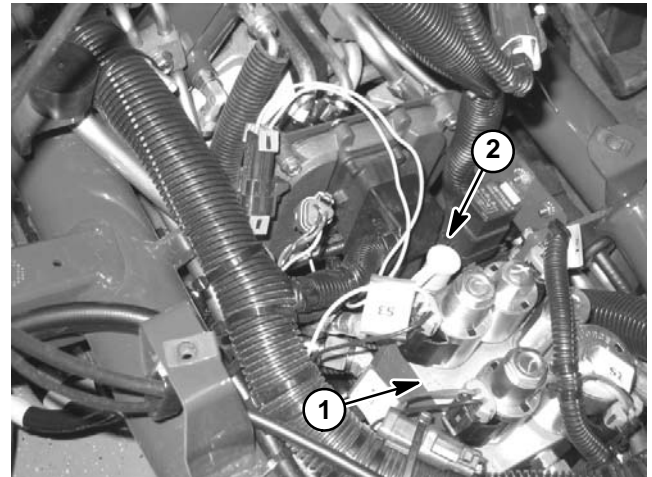


Figure 23

1. Lift control manifold 2. Test port

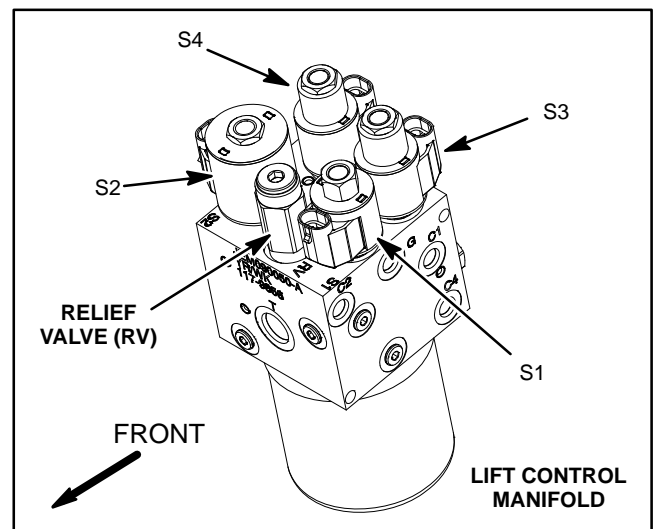
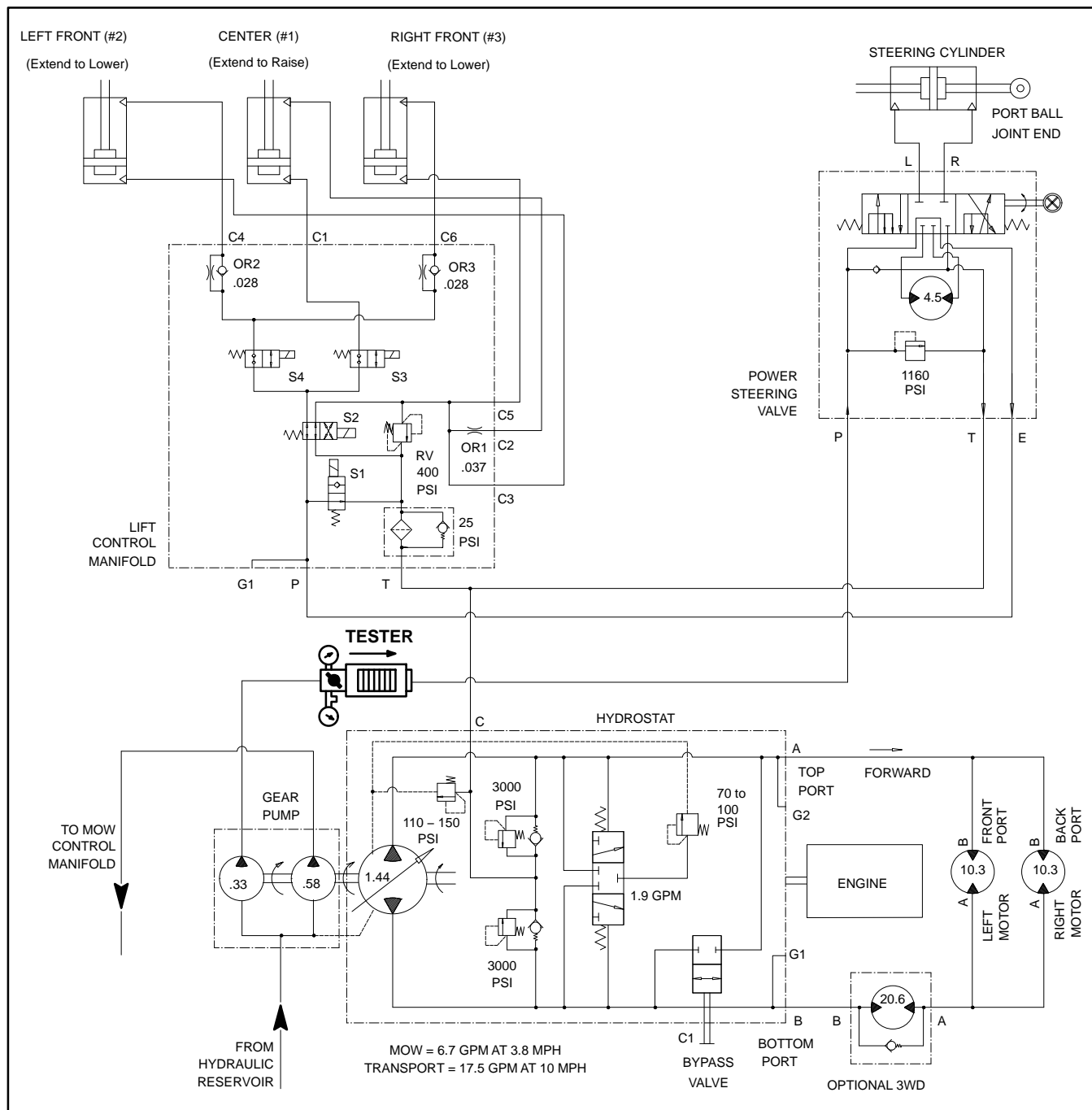


Figure 24

Steering/Lift Circuit Gear Pump Flow Test (Using Tester with Flowmeter and Pressure Gauge)



The steering/lift circuit gear pump flow test should be performed to make sure that the steering, lift and traction charge circuits have adequate hydraulic flow.

Procedure for Steering/Lift Circuit Gear Pump 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.



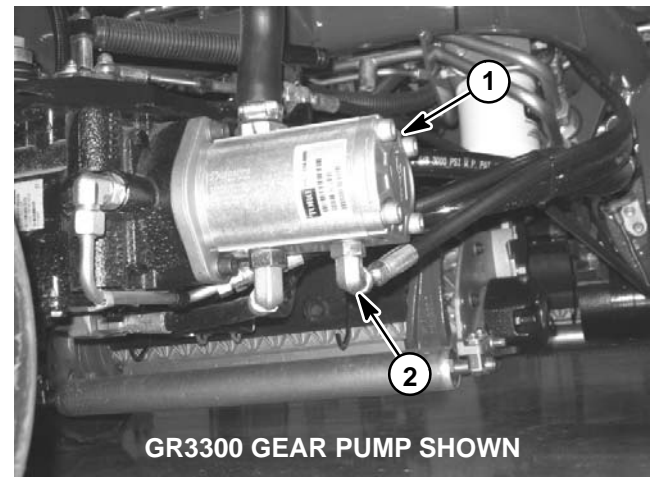
CAUTION

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

3. Thoroughly clean junction of hydraulic hose and discharge fitting of rear gear pump section (Fig. 25). Disconnect hose from pump fitting.
4. Install hydraulic tester (pressure and flow) in series with the rear gear pump section and the disconnected hose. Make sure that tester flow arrow points from the pump discharge and toward the disconnected hose. **Also, make sure flow control valve on the tester is fully open.**
5. Make sure that traction pedal and joystick are in neutral and the parking brake is engaged.
6. Start engine and run at low idle speed. Check for hydraulic leakage and correct before proceeding with test.
7. Move throttle so engine is running at high idle speed.

IMPORTANT: Do not fully restrict oil flow through tester. In this test, the flow tester is positioned before the circuit relief valve. 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 (55.2 bar)**.
9. Flow gauge reading for a gear pump in good condition should be approximately **3.9 GPM (14.8 LPM)**.
10. Open control valve on tester and shut off engine. Record test results.
11. If gear pump flow is less than **3.5 GPM (13.2 LPM)**, check for restriction in the pump intake line. If no restriction is found, repair or replace rear gear pump section.
12. When testing is complete, disconnect tester from the gear pump fitting and hydraulic hose. Connect hose to pump fitting.



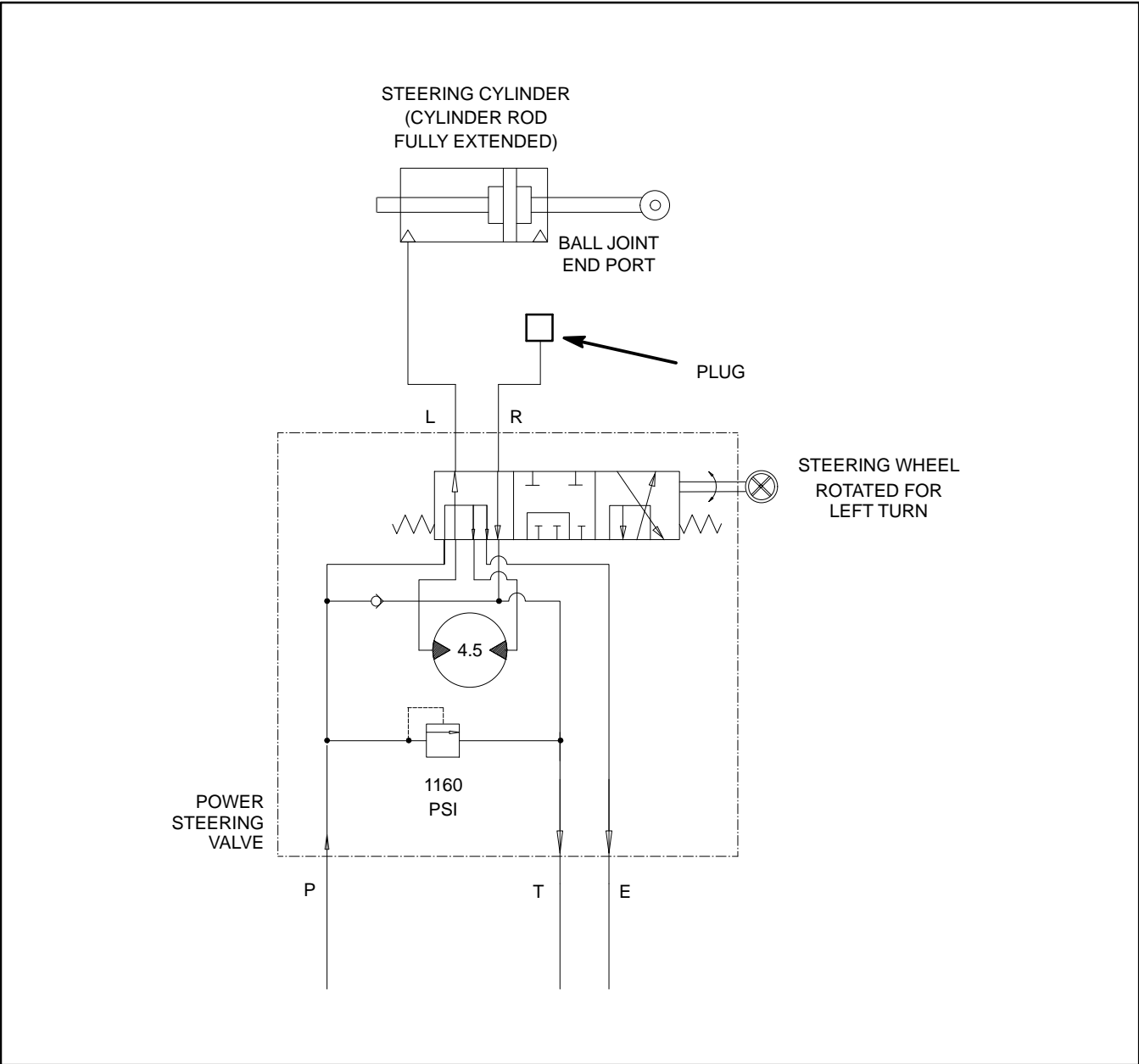
GR3300 GEAR PUMP SHOWN

1. Gear pump

2. Rear section fitting

Figure 25

Power Steering Valve Test



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.

Procedure for Power Steering Valve Test:

1. Make sure the hydraulic tank is full.
2. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately ten (10) minutes.
3. Perform the Steering/Lift Relief Valve Pressure and Steering/Lift Circuit Gear Pump Flow Tests to make sure that relief valve and gear pump are functioning correctly (see Steering/Lift Relief Valve Pressure and Steering/Lift Circuit Gear Pump Flow Tests in this section).
4. 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.

5. Stop the unit 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.

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. Make sure engine is off and the parking brake is engaged.

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

C. Turn engine off.



CAUTION

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

D. Read Precautions for Hydraulic Testing.

E. Remove hydraulic hose from the fitting on the ball joint end of the steering cylinder. Plug the end of the hose.

F. With the engine off, continue turning the steering wheel to the left (counterclockwise) 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 left, the steering cylinder has internal leakage and must be repaired or replaced.

G. When steering cylinder testing is completed, remove plug from the hydraulic hose. Connect hose to the steering cylinder fitting.

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

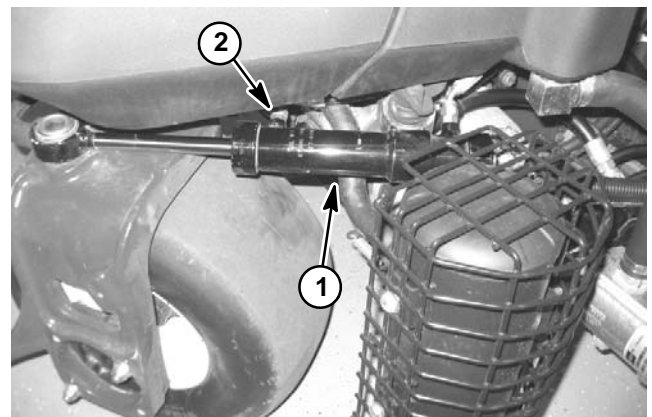
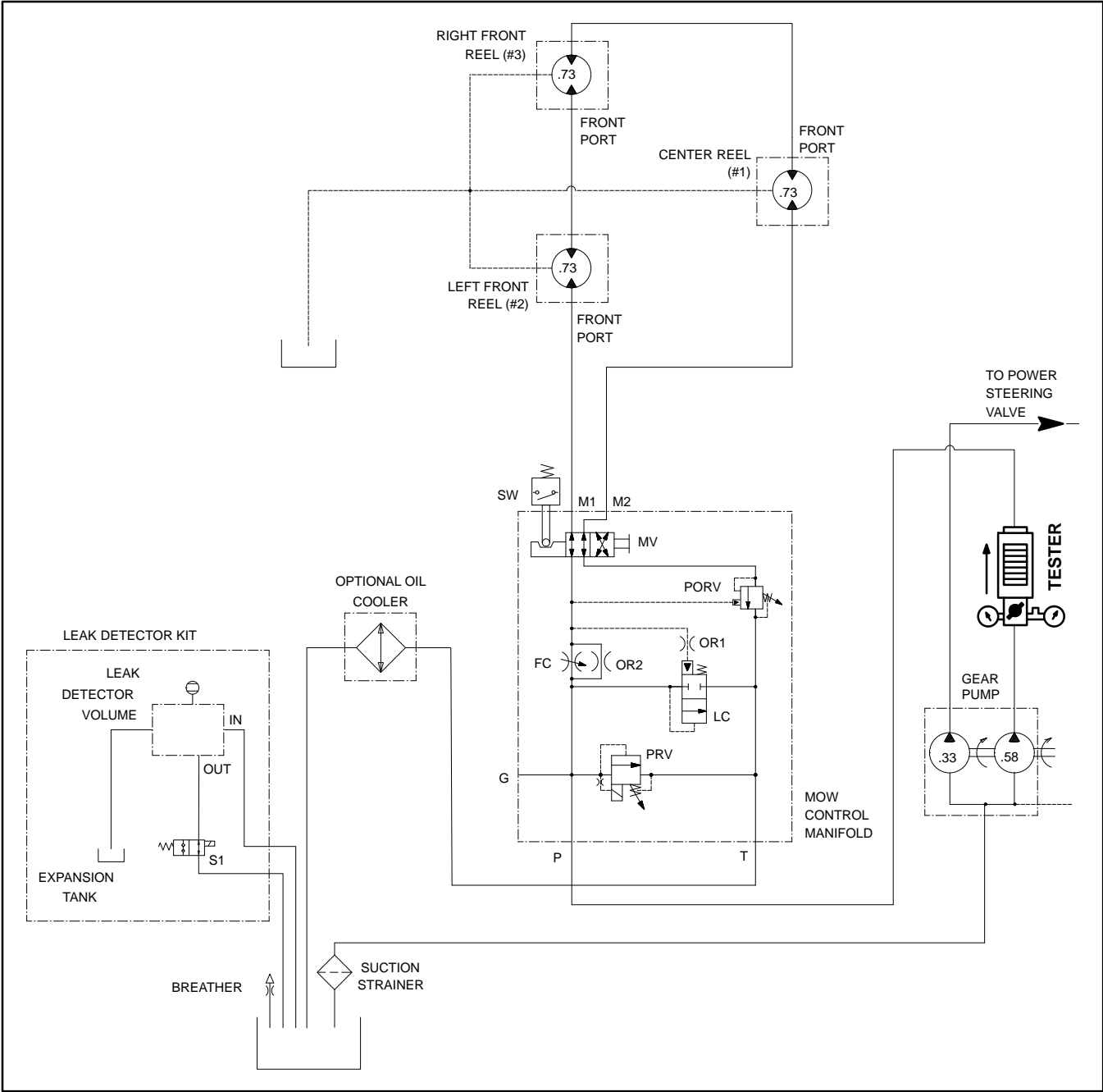


Figure 26

1. Steering cylinder

2. Ball joint end hose

Mow Circuit Gear Pump Flow Test (Using Tester with Flowmeter and Pressure Gauge)



The mow circuit gear pump flow test should be performed to make sure that the mow circuit has adequate hydraulic flow.

Procedure for Mow Circuit Gear Pump 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**

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

3. Thoroughly clean junction of hydraulic hose and discharge fitting of front gear pump section (Fig. 27). Disconnect hose from pump fitting.
4. Install hydraulic tester (pressure and flow) in series with the front gear pump section and the disconnected hose. Make sure that tester flow arrow points from the pump discharge and toward the disconnected hose. **Also, make sure flow control valve on the tester is fully open.**
5. Make sure backlap lever on the mow control manifold is in the **mow** position and reel speed knob (FC) is set to highest speed setting (fully open).

**CAUTION**

Do not engage the cutting units when performing this test.

6. After hydraulic tester has been connected, start engine and run at low idle speed. Check for hydraulic leakage and correct before proceeding with test.

7. Move throttle so engine is running at high idle speed.

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

8. Watch pressure gauge carefully while slowly closing the flow control valve on the tester until **2000 PSI (138 bar)** is obtained.
9. Flow gauge reading for a gear pump in good condition should be approximately **6.9 GPM (26 LPM)**. Record test results.

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

11. If flow was less than **6.1 GPM (23.1 LPM)** or a pressure of **2000 PSI (138 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.

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

13. Adjust reel speed knob (FC) on mow control manifold to original setting.

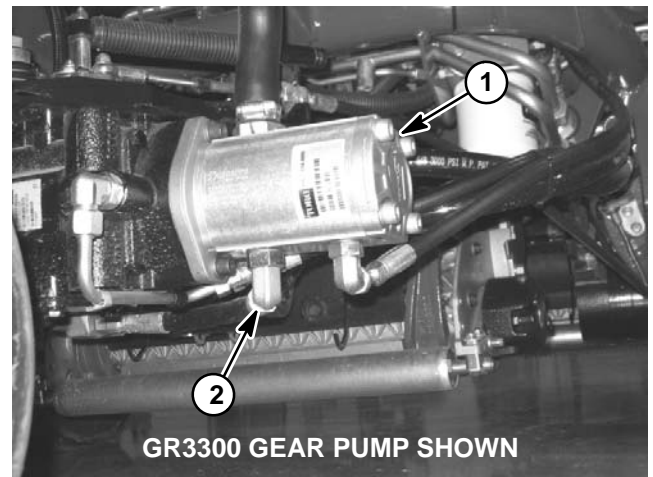
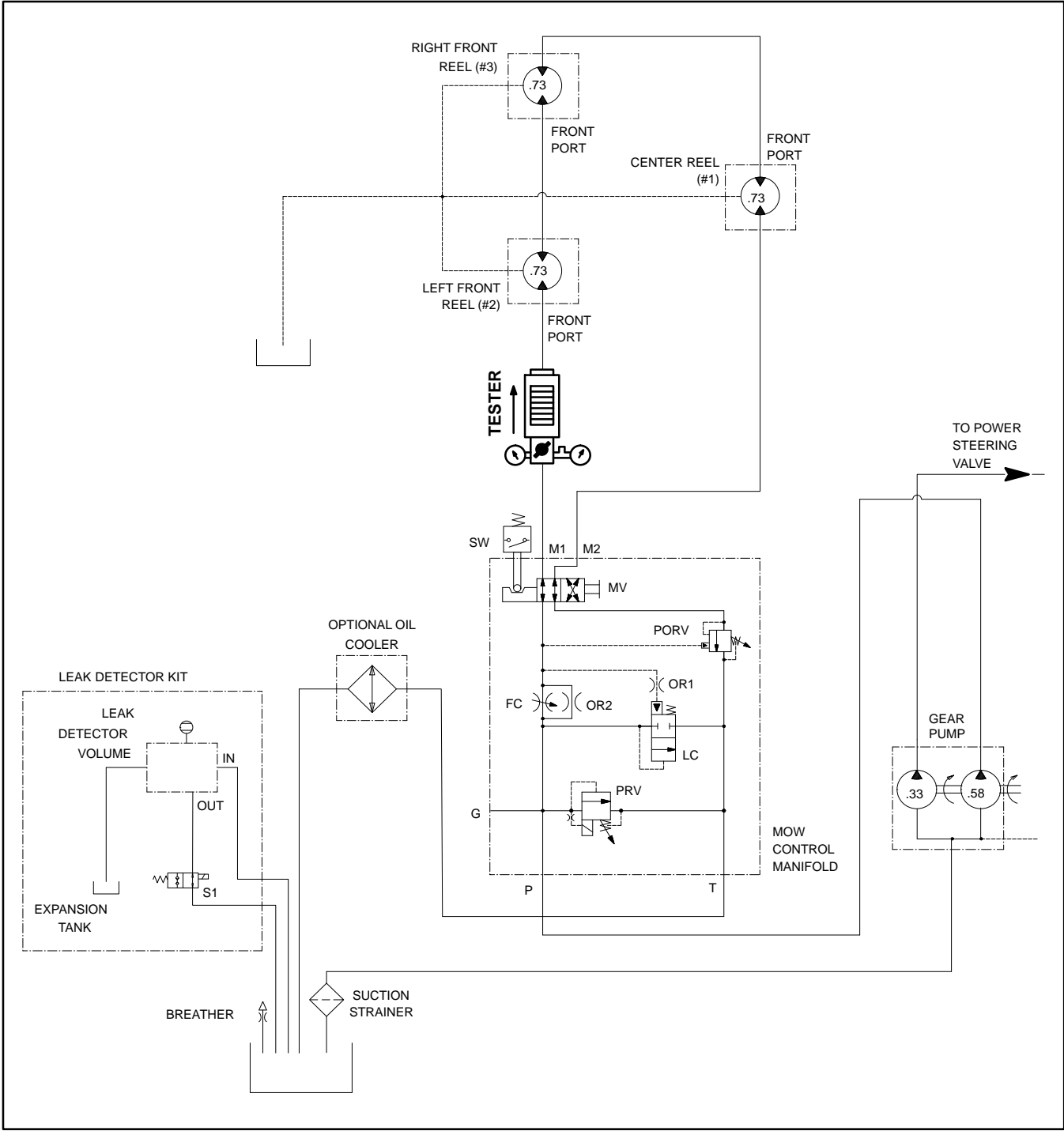


Figure 27

1. Gear pump

2. Front section fitting

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



The mow circuit relief valve pressure test should be performed to make sure that the relief pressure for the mow circuit is correct.

Procedure for Mow Circuit 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 tank is full.



3. Thoroughly clean junction of hydraulic hose and front fitting on the left front cutting reel motor (#2 cutting unit) (Fig. 28). Disconnect hose from motor fitting.
4. Install hydraulic tester (pressure and flow) in series with the disconnected hose and the motor fitting. Make sure that tester flow arrow points from the disconnected hose and toward the motor. **Also, make sure flow control valve on the tester is fully open.**
5. To prevent reel damage, temporarily adjust bedknife on all cutting units to allow clearance between bedknife and reel (no contact).
6. Make sure backlap lever on the mow control manifold is in the **mow** position and reel speed knob (FC) is set to highest speed setting (fully open).



7. After hydraulic tester has been connected, start engine and run at low idle speed. Check for hydraulic leakage and correct before proceeding with test.
8. Move throttle so engine is running at high idle speed. Engage the cutting units.
9. Watch pressure gauge carefully while slowly closing the flow control valve on the tester to fully closed.

10.As relief valve opens, system pressure should be from **2700 to 3300 PSI (186 to 227 bar)**. Record test results.

11.Disengage cutting units. Open control valve on tester and shut off engine.

12.If relief valve specification **is not** met, remove proportional relief valve (PRV) on mow control manifold (Fig. 29). Clean or replace valve (see Hydraulic Manifold Service in the Service and Repairs section of this chapter). Retest mow circuit relief valve pressure after servicing valve.

13.When testing is complete, disconnect tester from reel motor fitting and hose. Connect hydraulic hose to the reel motor.

14.Adjust reel speed knob (FC) on mow control manifold to original setting. Correctly adjust bedknife on all cutting units.

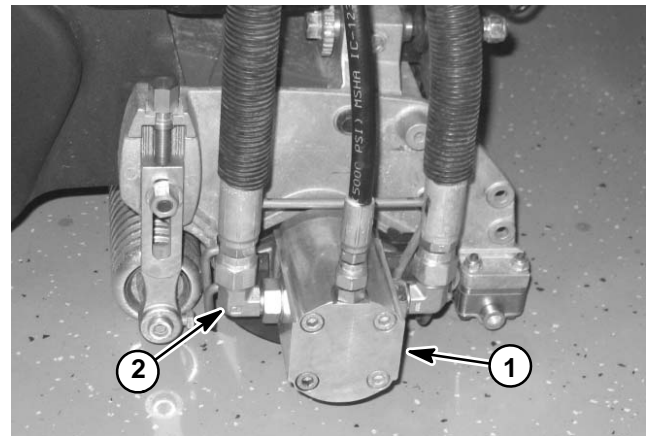


Figure 28

1. #2 reel motor
2. Front fitting

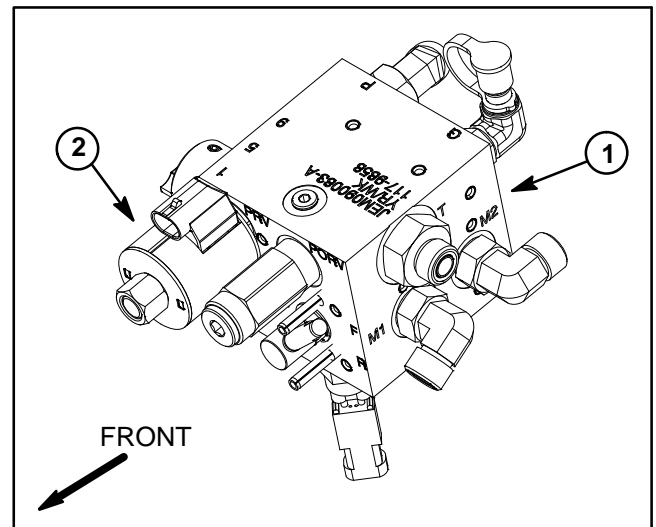
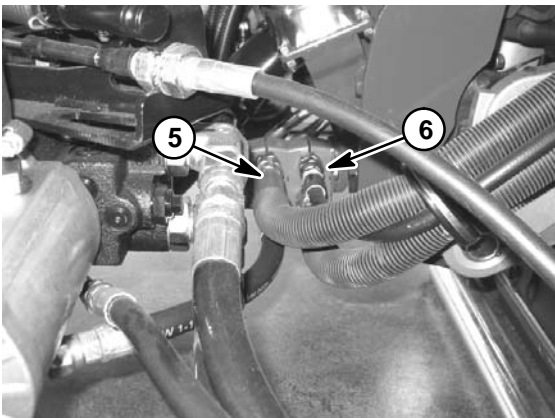
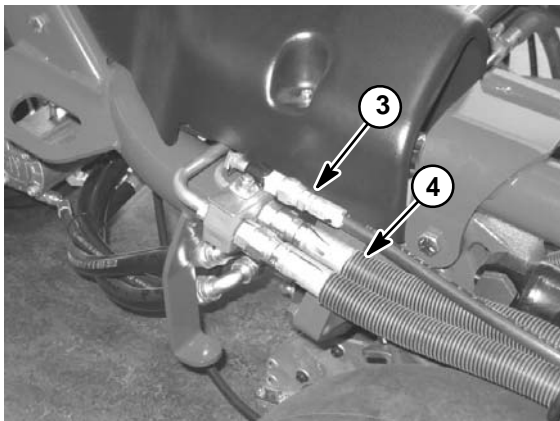
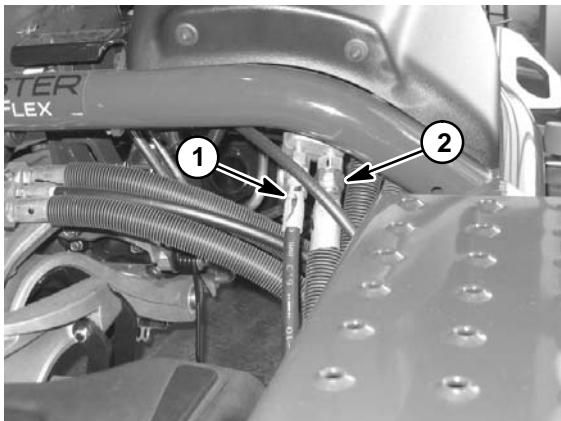


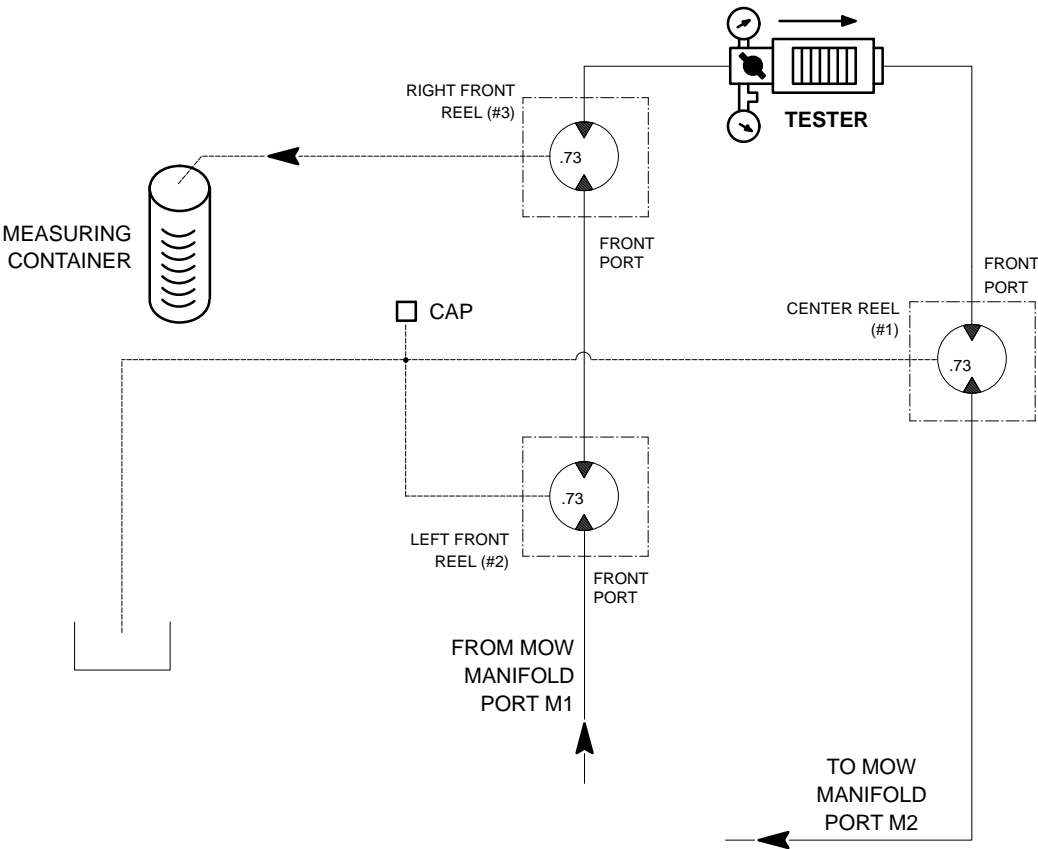
Figure 29

1. Mow control manifold
2. Proportional relief valve

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



- 1. Left motor case drain hose
- 2. Left motor return hose
- 3. Right motor case drain hose
- 4. Right motor return hose
- 5. Center motor return hose
- 6. Center motor case drain hose



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

**CAUTION**

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

3. For the suspected faulty reel motor, thoroughly clean junction of hydraulic return hose and rear fitting. Disconnect hose from motor fitting.
4. Install hydraulic tester (pressure and flow) in series with the reel motor fitting and the disconnected hose. Make sure that tester flow arrow points from the motor and toward the disconnected hose. **Also, make sure flow control valve on the tester is fully open.**
5. Make sure backlap lever on the mow control manifold is in the **mow** position and reel speed knob (FC) is set to highest speed setting (fully open).
6. Disconnect hose from case drain of the motor to be tested at the bulkhead fitting.
 - A. Cap the bulkhead port.
 - 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 another person reads the tester and measures case drain leakage. Make sure functional control lever is in **NEUTRAL**. Start engine and move the throttle to full speed.

**CAUTION**

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

8. Engage reels by positioning the functional control lever to **MOW** position. While watching pressure gauge, slowly close flow control valve on the tester until a pressure of **1000 PSI (69 bar)** is obtained.

9. After achieving **1000 PSI (69 bar)**, place disconnected reel 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. 30). After **15 seconds**, remove hose end from container.

10. Disengage cutting units, open control valve on tester and stop the engine.

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

12. If case drain flow was greater than **16 ounces (473 ml)** in **15 seconds (0.5 GPM/1.9 LPM)**, repair or replace the reel motor as necessary.

13. After case drain flow has been determined, disconnect tester from reel motor fitting and return hose. Connect hose to the motor fitting.

14. Remove plug from bulkhead fitting. Connect case drain hose to the bulkhead fitting.

15. Test reel motor case drain flow for other reel motors as needed.



Figure 30

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 31

Adjustments

Adjust Manifold Relief Valves

Both the lift and mow control manifold include an adjustable relief valve. If adjustment of either of these valves 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 when the cap is off. Personal injury may result. Always install and tighten the cap 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. Relief valve cap

2. Adjustment socket

Adjust Traction Control Assembly

Proper control of the traction circuit is accomplished by the traction pedal, cables and piston (traction) pump neutral assembly. Adjustments to these components may be required for correct operation. Use the following information and the illustrations in the right column when adjusting the traction control on your Greensmaster.

With the functional lever placed in the transport position, the traction pedal should bottom against pedal stop on platform in the full forward direction when piston pump is at full stroke. If pump reaches full stroke before pedal contacts stop, traction cable can experience premature wear.

When functional lever is placed in the neutral position with the traction pedal locked in place, the pedal should be at a right angle (90°) to platform (Fig. 34). If necessary, adjust location of ball joint on neutral lock cable to allow correct angle of pedal.

In the neutral position, there should be no tension on the traction cable. If cable is adjusted too tight, machine could creep when in the neutral position. Adjust jam nuts on traction cable to reduce tension on cable.

An eccentric on the piston pump neutral assembly can be adjusted to eliminate machine creep when in the neutral position (Fig. 35). Adjustments to traction pedal, traction cable and neutral lock cable should be checked before adjusting the eccentric. Eccentric adjustment should be done with engine running and the traction pedal locked in the neutral position.

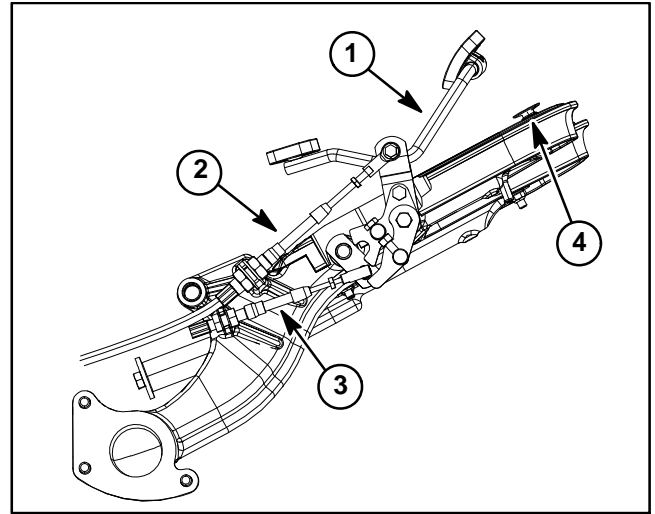


Figure 33

- | | |
|-------------------|-----------------------|
| 1. Traction pedal | 3. Neutral lock cable |
| 2. Traction cable | 4. Pedal stop |

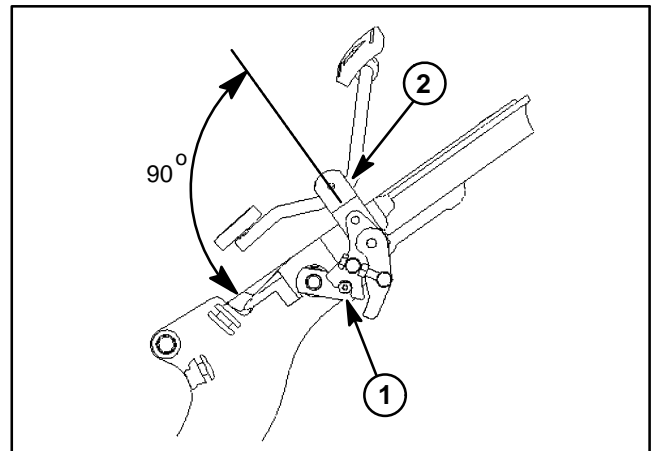


Figure 34

- | | |
|-----------------------|-------------------|
| 1. Neutral lock shaft | 2. Traction pedal |
|-----------------------|-------------------|

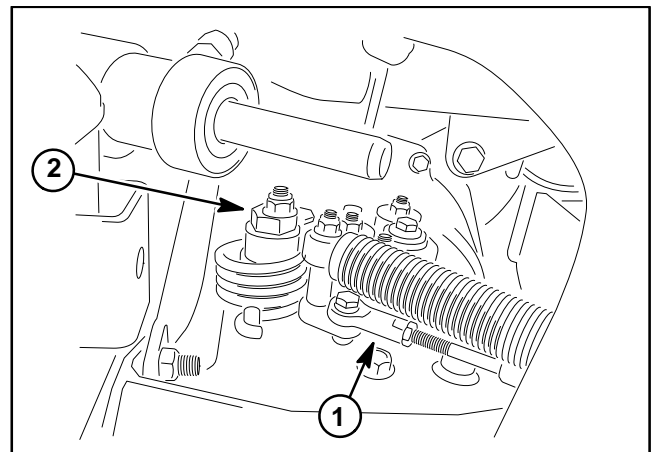


Figure 35

- | | |
|-------------------|--------------|
| 1. Traction cable | 2. Eccentric |
|-------------------|--------------|

Service and Repairs

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, disengage and lower cutting units, move functional control lever to neutral (N), engage parking brake and stop the engine. Remove the key from the ignition switch. Wait for all machine movement to stop before getting off machine.
2. Clean machine before disconnecting, removing or disassembling any hydraulic components. Make sure hydraulic components, hose connections and fittings are cleaned thoroughly. Always keep in mind the need for cleanliness when working on hydraulic equipment.



CAUTION

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil. See Relieving Hydraulic System Pressure in the General Information section of this chapter.

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 tubes 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 in this section).
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 lines, hydraulic fittings and components before reconnecting hydraulic lines.
4. Use proper tightening methods when installing hydraulic fittings and lines (see Hydraulic Fitting Installation and Hydraulic Hose and Tube Installation in the General Information section of this chapter).
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 System 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 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 in this section.

2. Clean area around gear pump suction (inlet) hose (Fig. 36). Clamp pump inlet hose. Remove inlet hose from gear pump, release clamp and drain reservoir into a suitable container. Drain entire 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 oil filter mounting area. Remove filter and drain into a suitable container. Discard filter.

4. Inspect and clean reservoir (see Hydraulic Reservoir in this section).

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

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

6. Connect all hydraulic hoses and lines that were disconnected prior to system draining (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

7. Fill hydraulic reservoir with new hydraulic oil.

8. Disconnect appropriate electrical component(s) to prevent the engine from starting:

A. On machines with gasoline engine, disconnect both spark plug wires from spark plugs.

B. On machines with diesel engine, disconnect wire harness electrical connector from the engine fuel stop solenoid.

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

10. Reconnect engine electrical component(s) that were disabled in step 8 above.

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

12. Raise and lower cutting units several times.

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

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

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

16. Assume normal operation and follow recommended maintenance intervals.

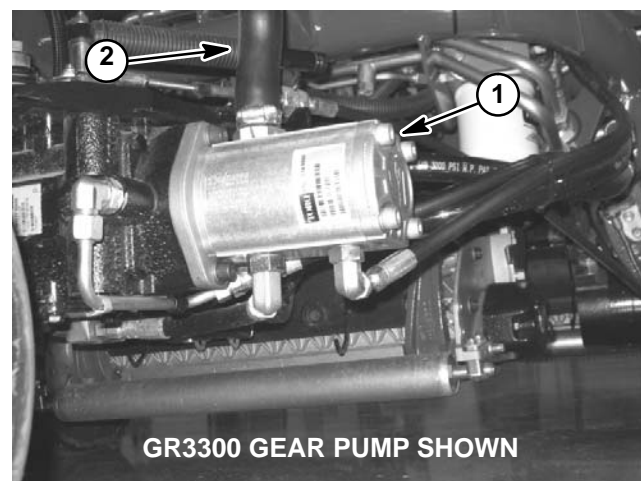


Figure 36

1. Gear pump

2. Suction (inlet) hose

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 and support machine so all wheels are off the ground (see Jacking Instructions in Chapter 1 – Safety).

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. 37). Disconnect hose from lower pump fitting.

4. Connect Toro high flow hydraulic filter in series between 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 wheels will be off the ground and rotating during this procedure. Make sure machine is well supported so it will not move and accidentally fall to prevent injuring anyone around machine.

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.

Hydraulic System

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.

8. With engine running at high idle speed and traction pedal moved to the forward direction, periodically apply brakes to increase pressure in traction circuit. While monitoring filter indicator, continue this process for an additional five (5) minutes.

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.

9. 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.

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

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

12. Lower machine to ground.

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

**PUMP FROM GREENSMaster
3300 SHOWN**

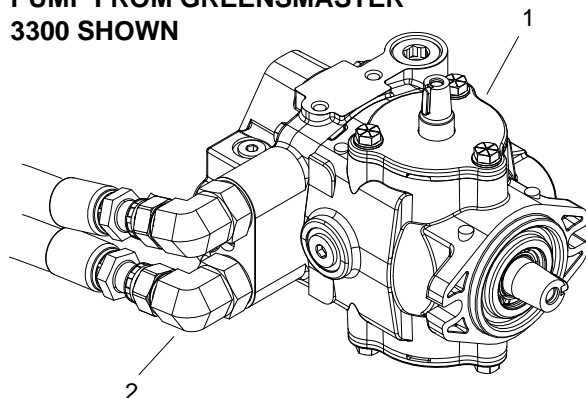


Figure 37

1. Piston (traction) pump
2. Lower 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 piston pump was rebuilt or replaced, make sure piston 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 the functional control lever is in the neutral (N) position.

6. Disconnect appropriate electrical component(s) to prevent the engine from starting:

A. On machines with gasoline engine, disconnect both spark plug wires from spark plugs.

B. On machines with diesel engine, disconnect wire harness electrical connector from the engine fuel stop solenoid.

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

8. Reconnect engine electrical component(s) that were disabled in step 6 above.

9. With the functional control lever in the neutral (N) position, 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 slowly turn 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

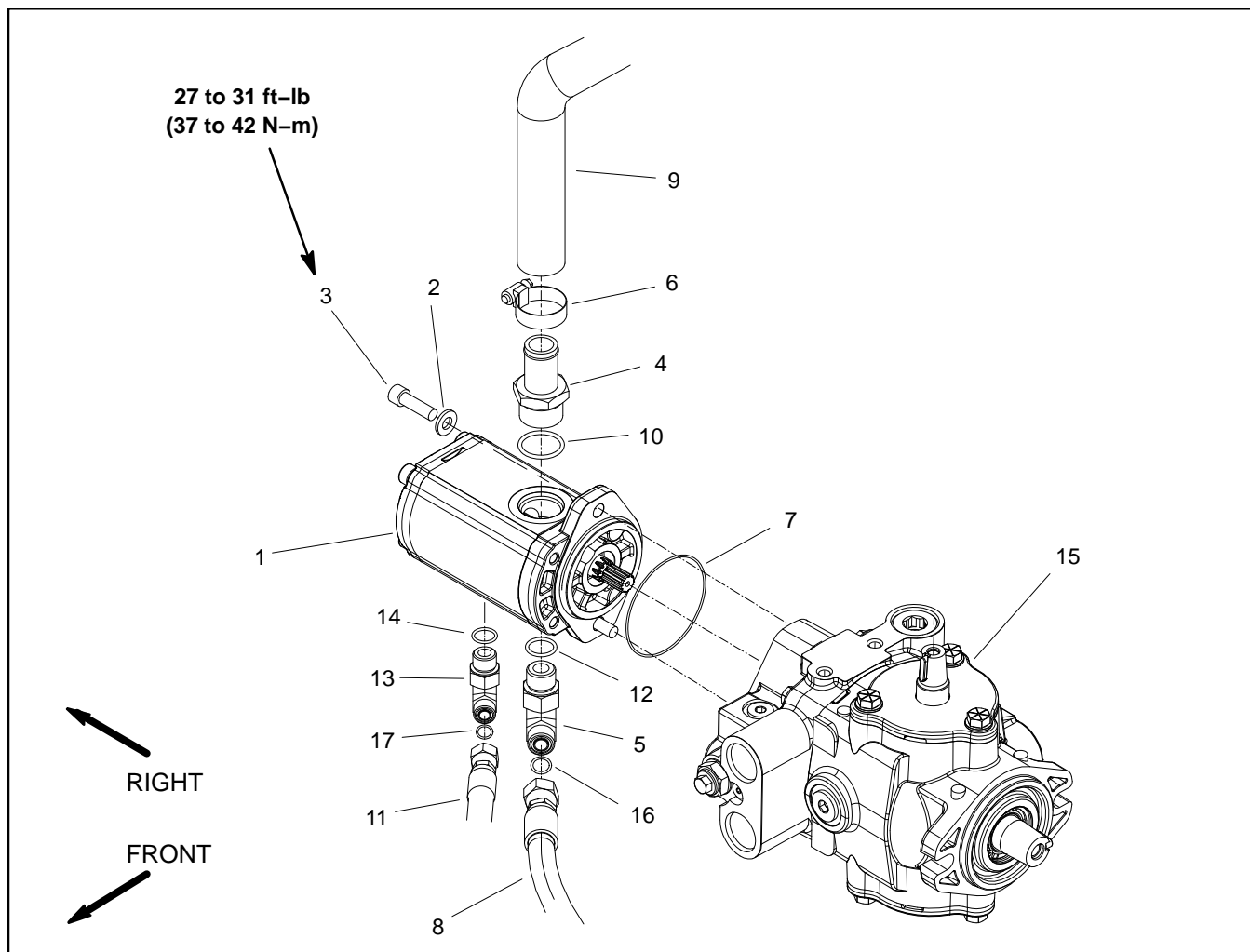


Figure 38

- | | | |
|-------------------------------|---|----------------------------|
| 1. Gear pump | 7. O-ring | 13. 90° hydraulic fitting |
| 2. Flat washer (2 used) | 8. Hydraulic hose (mow supply) | 14. O-ring |
| 3. Socket head screw (2 used) | 9. Suction (inlet) hose | 15. Piston (traction) pump |
| 4. Hydraulic fitting | 10. O-ring | 16. O-ring |
| 5. 90° hydraulic fitting | 11. Hydraulic hose (steering/lift supply) | 17. O-ring |
| 6. Hose clamp | 12. O-ring | |

Removal (Fig. 38)



CAUTION

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

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

2. Thoroughly clean hydraulic hose ends and fittings on gear pump to prevent hydraulic system contamination.

3. Label all hose connections on gear pump for assembly purposes.

4. Clamp gear pump suction (inlet) hose to prevent draining the hydraulic tank.

5. Loosen hose clamp and remove suction hose from the gear pump.

6. 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.

7. Mark hydraulic fitting orientation to allow correct assembly. Remove hydraulic fittings and O-rings from gear pump. Discard removed O-rings.

NOTE: A case drain exists in the piston (traction) pump and a suction port is near the input shaft of the gear pump (Fig. 39). When the gear pump is removed from the piston pump, plug piston pump case drain hole to prevent draining the piston pump.

8. Support gear pump to prevent it from falling. Separate gear pump from the piston pump by removing two (2) socket head screws and flat washers.

9. Remove O-ring from between the gear pump and piston pump. Discard O-ring.

10. Inspect threads and sealing surfaces of fittings and gear pump ports. Replace components if damage is found.

Installation (Fig. 38)

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

2. Apply clean hydraulic oil to gear pump flange O-ring (item 7). Place O-ring on the gear pump.

IMPORTANT: A case drain exists in the piston (traction) pump and a suction port is near the input shaft of the gear pump (Fig. 47). 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.

IMPORTANT: Position gear pump to the piston (traction) pump so that the gear pump inlet (suction) port is facing up.

3. Position gear pump to the piston (traction) 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. Torque screws from **27 to 31 ft-lb (37 to 42 N-m)**.

5. 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).

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

7. 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).

8. Install suction hose to the gear pump inlet fitting and secure with hose clamp.

9. Remove clamp from pump suction (inlet) hose to allow hydraulic oil flow to the gear pump.

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

11. Follow Hydraulic System Start-up procedures (see Hydraulic System Start-up in this section).

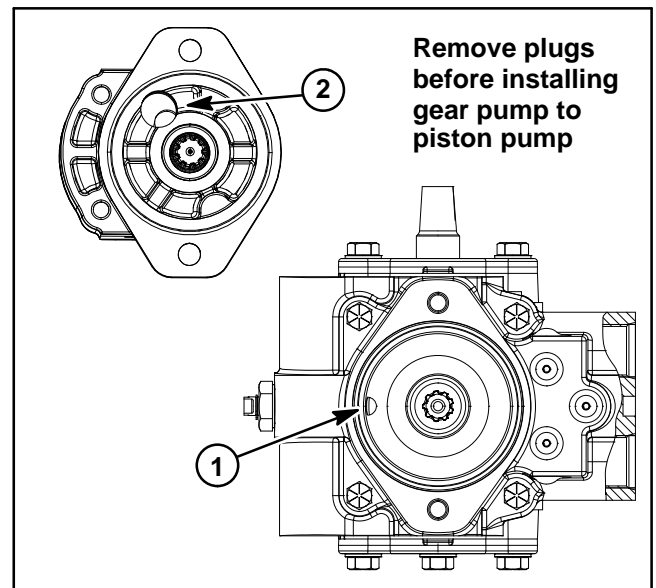


Figure 39

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

Gear Pump Service

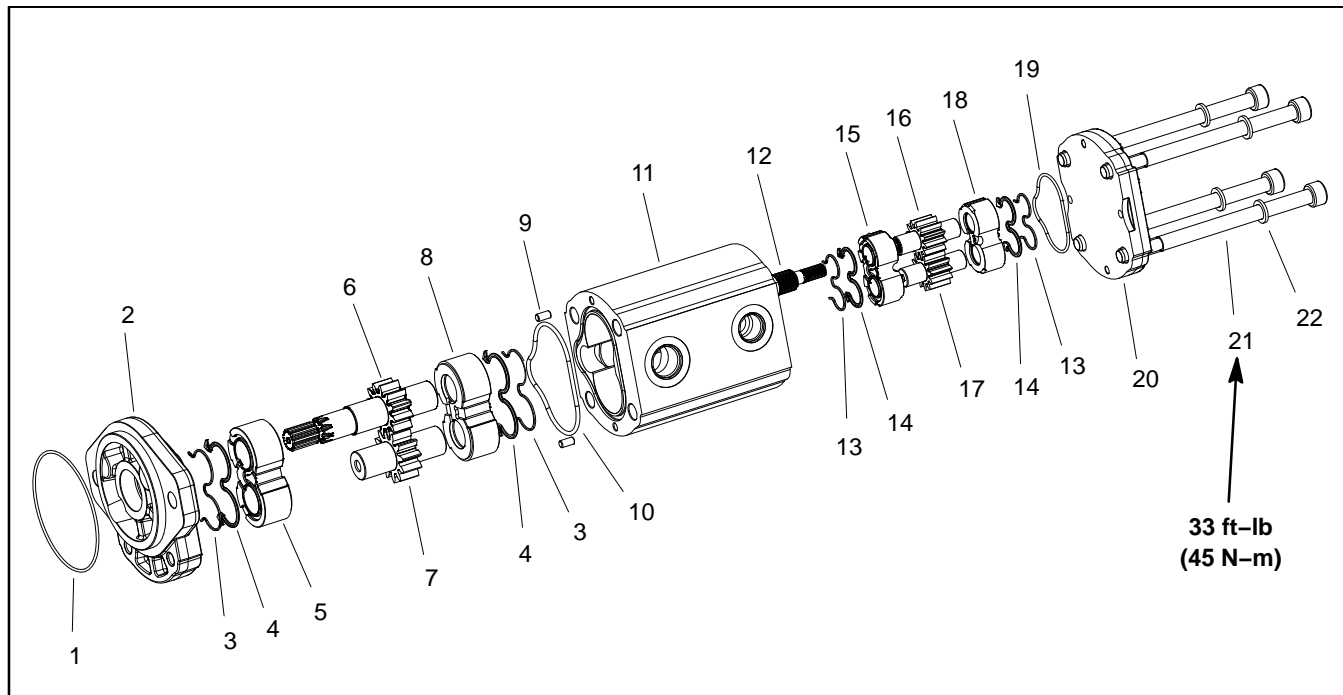


Figure 40

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

Gear Pump Disassembly (Fig. 40)

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. 41).

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.

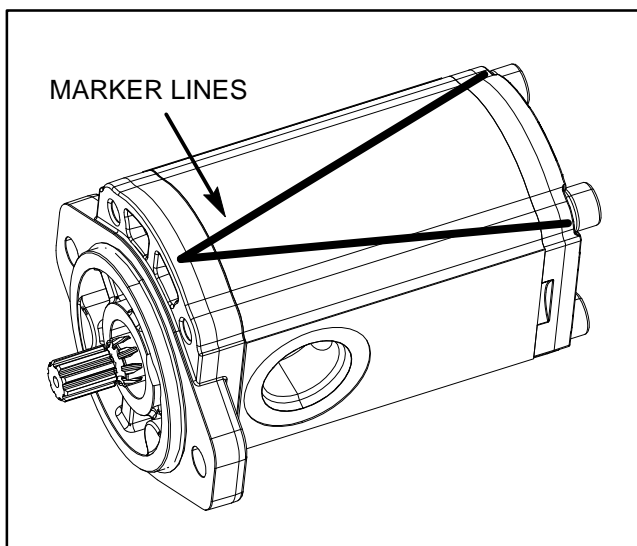


Figure 41

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. 40)

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

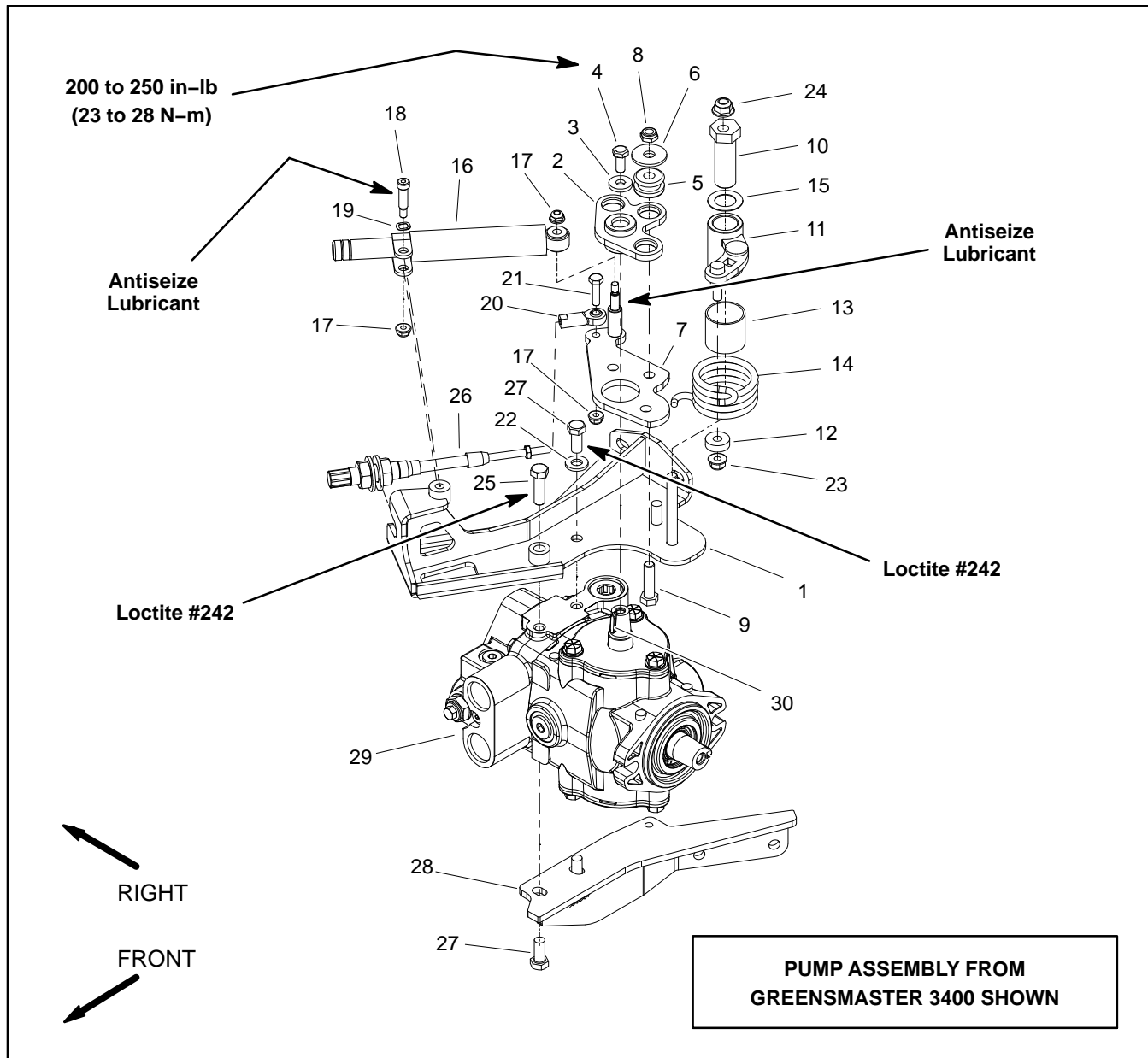


Figure 42

- | | | |
|---------------------------------|--------------------------|---------------------------------|
| 1. Cable support (diesel shown) | 11. Neutral arm | 21. Cap screw |
| 2. Plate | 12. Ball bearing | 22. Washer |
| 3. Flat washer | 13. Spring spacer | 23. Flange nut |
| 4. Cap screw | 14. Torsion spring | 24. Flange nut |
| 5. Mount (3 used) | 15. Nylon washer | 25. Cap screw |
| 6. Washer (3 used) | 16. Damper lever | 26. Traction control cable |
| 7. Pump lever | 17. Flange nut (3 used) | 27. Cap screw (2 used) (diesel) |
| 8. Lock nut (3 used) | 18. Shoulder bolt | 28. Muffler bracket (diesel) |
| 9. Cap screw (3 used) | 19. Wave washer | 29. Piston (traction) pump |
| 10. Eccentric stud | 20. Cable end ball joint | 30. Key |

NOTE: The piston pump neutral assembly used on all Greensmaster TriFlex machines are very similar. The pump assembly from the Greensmaster 3400 machine is shown in Figure 42.

Disassembly (Fig. 42)

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



CAUTION

The torsion spring (item 14) 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 42 as a guide.

Assembly (Fig. 42)

1. Install removed components to traction neutral assembly using Figure 42 as a guide along with the following:



CAUTION

The torsion spring (item 14) is under tension and may cause personal injury during installation. Use caution when installing the spring to the pump neutral assembly.

- A. If cable support (item 1) was removed from pump, apply Loctite #242 (or equivalent) to threads of screws that secure support to pump.
 - B. If plate (item 2) was removed from pump trunnion shaft, make sure that both trunnion shaft and plate bore are thoroughly cleaned before installing plate to shaft. Secure plate to trunnion shaft with flat washer (item 3) and cap screw (item 4). Torque cap screw from **200 to 250 in-lb (23 to 28 N-m)**.
 - C. If damper lever (item 16) was removed, apply anti-seize lubricant to post on pump lever (7) and shoulder of bolt (item 18) during assembly.
 - D. Make sure that ball bearing (item 12) on neutral arm (item 11) is properly positioned in pump lever (item 7) 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.

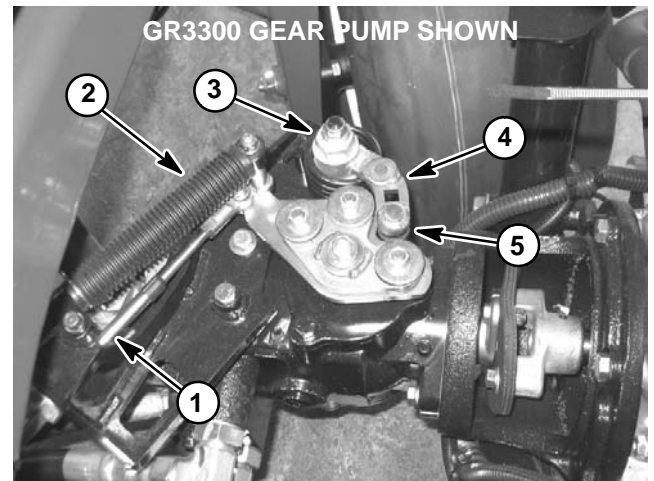


Figure 43

- | | |
|---------------------------|-----------------|
| 1. Traction control cable | 4. Neutral arm |
| 2. Damper lever | 5. Ball bearing |
| 3. Eccentric stud | |

Piston (Traction) Pump

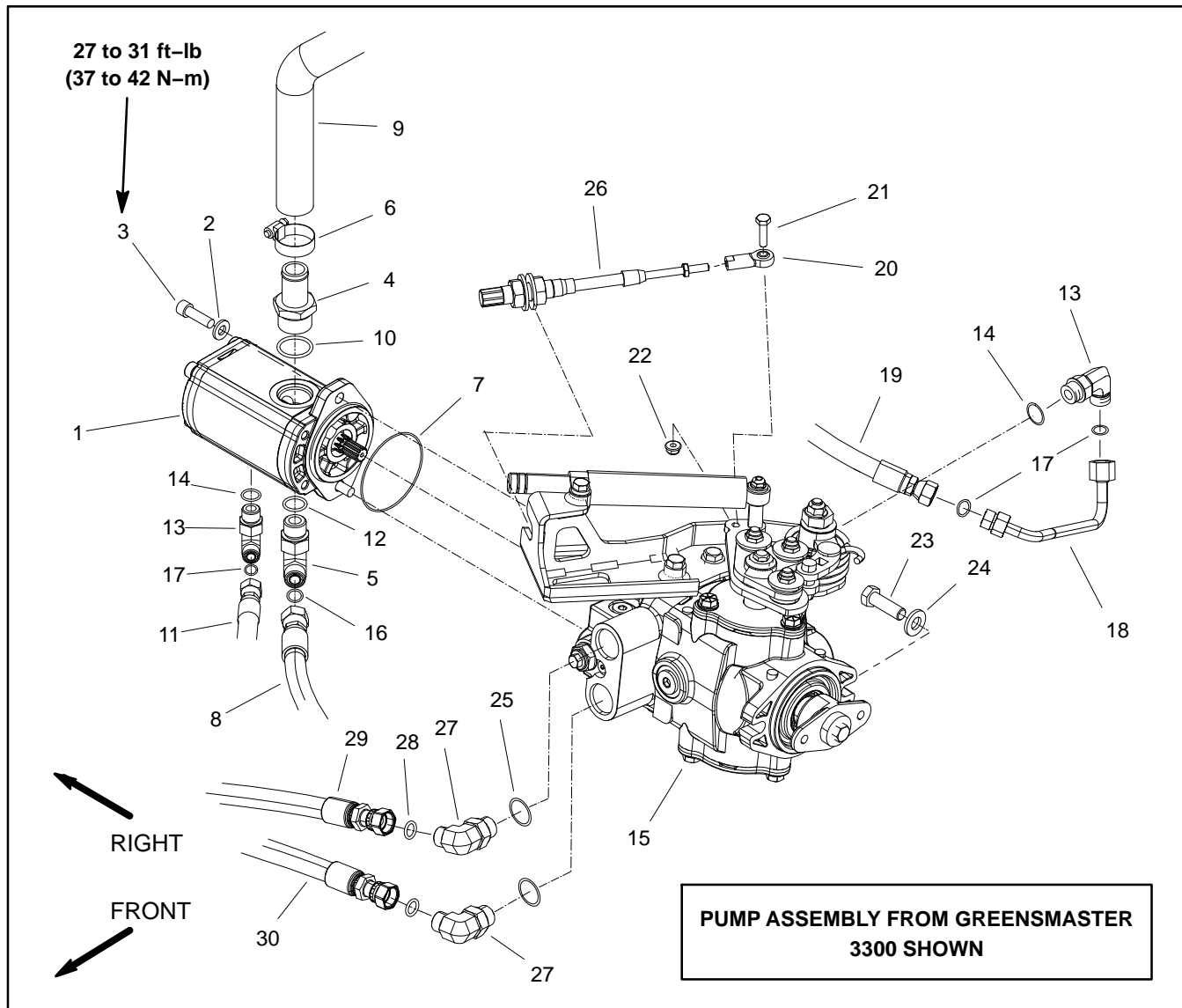


Figure 44

- | | | |
|--------------------------------|---|---------------------------------------|
| 1. Gear pump | 11. Hydraulic hose (steering/lift supply) | 21. Cap screw |
| 2. Hardened washer (2 used) | 12. O-ring | 22. Flange nut |
| 3. Socket head screw (2 used) | 13. 90° hydraulic fitting | 23. Cap screw (2 used) |
| 4. Hydraulic fitting | 14. O-ring | 24. Flat washer (2 used) |
| 5. 90° hydraulic fitting | 15. Piston (traction) pump | 25. O-ring |
| 6. Hose clamp | 16. O-ring | 26. Traction control cable |
| 7. O-ring | 17. O-ring | 27. 90° hydraulic fitting (2 used) |
| 8. Hydraulic hose (mow supply) | 18. Hydraulic tube | 28. O-ring |
| 9. Suction (inlet) hose | 19. Hydraulic hose (charge supply) | 29. Hydraulic hose (traction forward) |
| 10. O-ring | 20. Ball joint | 30. Hydraulic hose (traction reverse) |

NOTE: The 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.

NOTE: The piston pump assembly used on all Greensmaster TriFlex machines are very similar. The pump assembly from the Greensmaster 3300 machine is shown in Figure 44.

Piston Pump Removal (Fig. 44)

1. Park 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 in this section.

2. Disconnect the traction control cable ball joint (item 20) from the pump lever. Loosen traction control cable jam nuts that secure traction control cable to the cable support. Position cable away from the pump assembly.

3. On machines with gasoline engine, remove two (2) cap screws, coupling spacers and flange nuts that secure pump hub to rubber coupling (Fig. 45).

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

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

6. Clamp pump suction hose (item 9) to prevent draining the hydraulic reservoir.

7. Loosen hose clamp and remove suction hose from the gear pump.

8. 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 gear and piston pump assembly when removing its supporting fasteners to prevent it from falling and causing damage or personal injury.

9. Support pump assembly to prevent it from falling.

10. Remove two (2) cap screws (item 23) and flat washers (item 24) that secure pump assembly to pump mount. Separate pump assembly from the pump mount and remove pump from machine.

11. If necessary, remove pump hub (Greensmaster 3300 machines shown in Figure 45) or coupling (Greensmaster 3400 shown in Figure 46). Locate and retrieve key from pump shaft.

Greensmaster 3300/3400

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

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

13. 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.

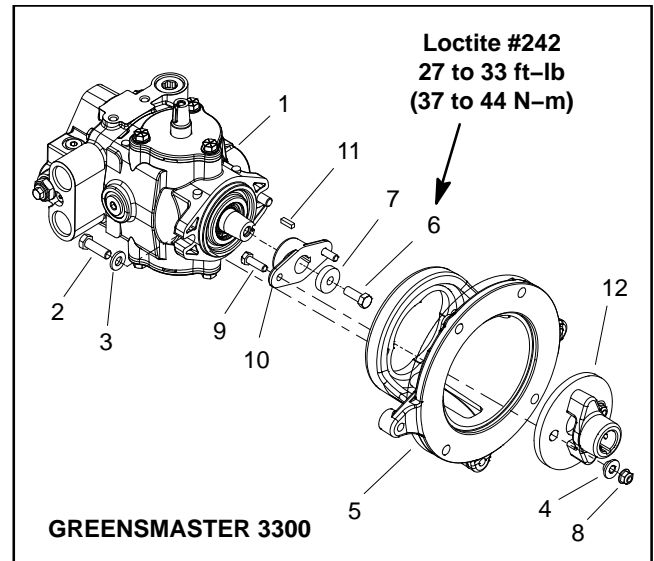


Figure 45

- | | |
|-----------------------------|------------------------|
| 1. Piston pump | 7. Spacer |
| 2. Cap screw (2 used) | 8. Flange nut (2 used) |
| 3. Flat washer (2 used) | 9. Cap screw (2 used) |
| 4. Coupling spacer (2 used) | 10. Pump hub |
| 5. Pump mount | 11. Key |
| 6. Cap screw | 12. Rubber coupling |

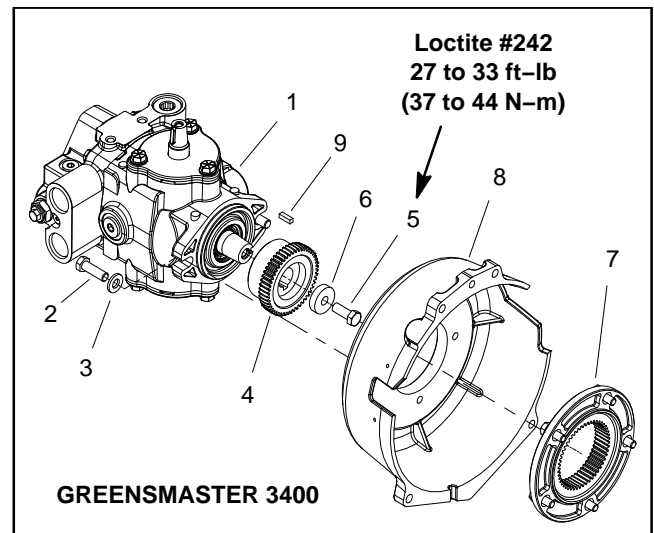


Figure 46

- | | |
|-------------------------|---------------------------|
| 1. Piston pump | 6. Spacer |
| 2. Cap screw (2 used) | 7. Engine coupling flange |
| 3. Flat washer (2 used) | 8. Bell housing |
| 4. Coupling | 9. Key |
| 5. Cap screw | |

Piston Pump Installation (Fig. 44)

1. 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. 47). 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.

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

3. If removed, secure pump hub (Greensmaster 3300 machines shown in Figure 45) or coupling (Greensmaster 3400 machines shown in Figure 46) to piston pump shaft:

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

B. Position key to pump shaft.

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

D. Slide hub/coupling onto pump shaft and secure with spacer and cap screw. Torque cap screw from **27 to 33 ft-lb (37 to 44 N-m)**.

4. On Greensmaster 3300 machines, secure pump hub to rubber coupling with two (2) cap screws, coupling spacers and flange nuts (Fig. 45).

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 mount and secure with two (2) cap screws (item 23) and flat washers (item 24).

8. Remove plugs that were placed during disassembly from hydraulic fittings and hoses.

9. 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).

10. Connect the traction control cable to the neutral arm:

A. Secure cable ball joint to neutral arm with cap screw (item 21) and flange nut (item 22).

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

11. Remove clamp from gear pump suction hose (item 9).

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

13. Follow Hydraulic System Start-up procedures (see Hydraulic System Start-up in this section).

14. Check neutral position of the traction pedal. If adjustment is required, see Adjust Transmission for Neutral in the Traction Unit Owners Manual.

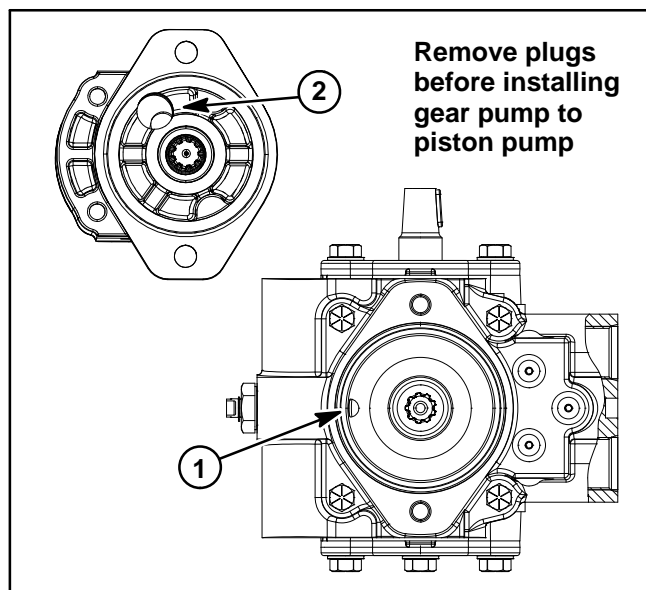


Figure 47

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

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Piston (Traction) Pump Service

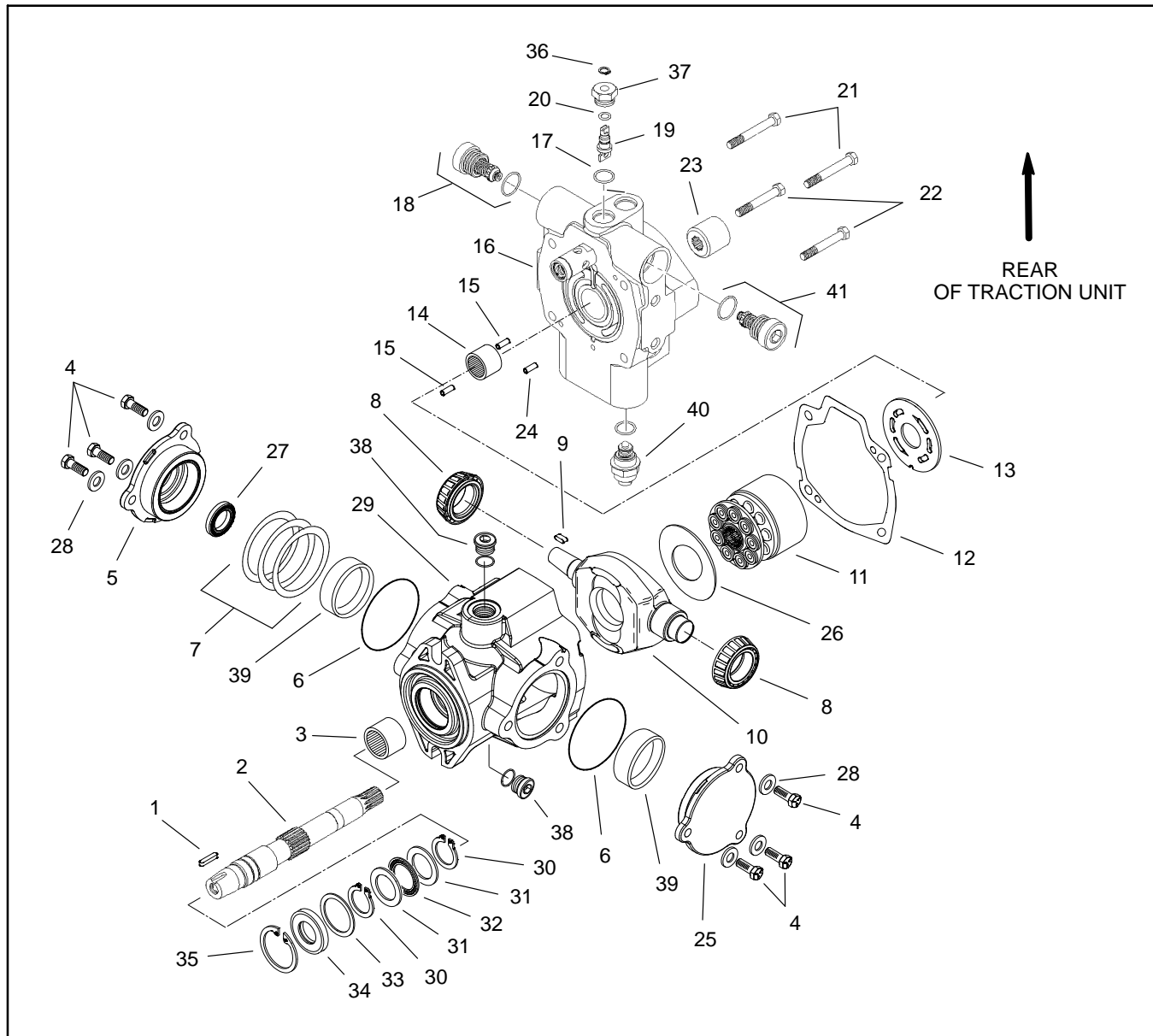


Figure 48

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

For repair of the piston (traction) 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 (Fig. 49). The back plate must be removed to service the relief valve.

NOTE: The piston (traction) pump 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 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 camplate (item 10), cover plate (item 25) or housing (item 29) is replaced during servicing, the old crush ring must be replaced. See Piston Pump Crush Ring Replacement in this section in conjunction with the piston pump service manual at the end of this chapter.

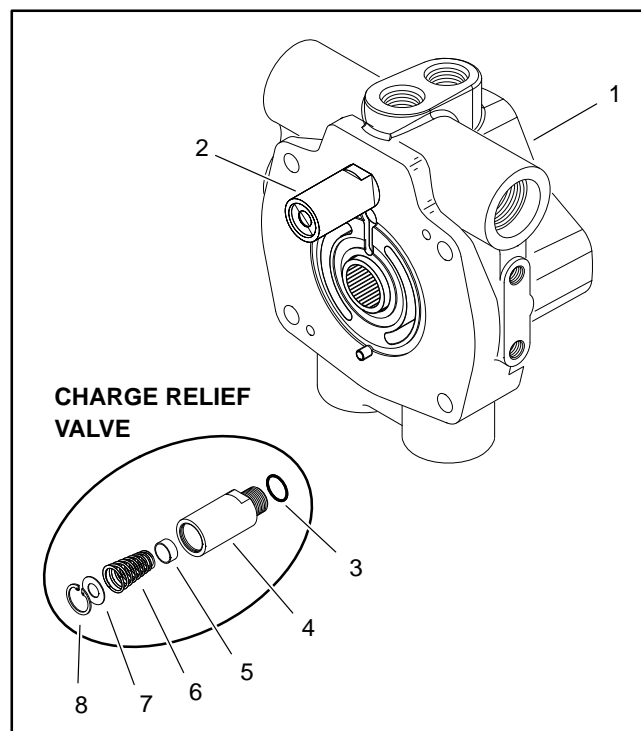


Figure 49

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

Piston Pump Crush Ring Replacement

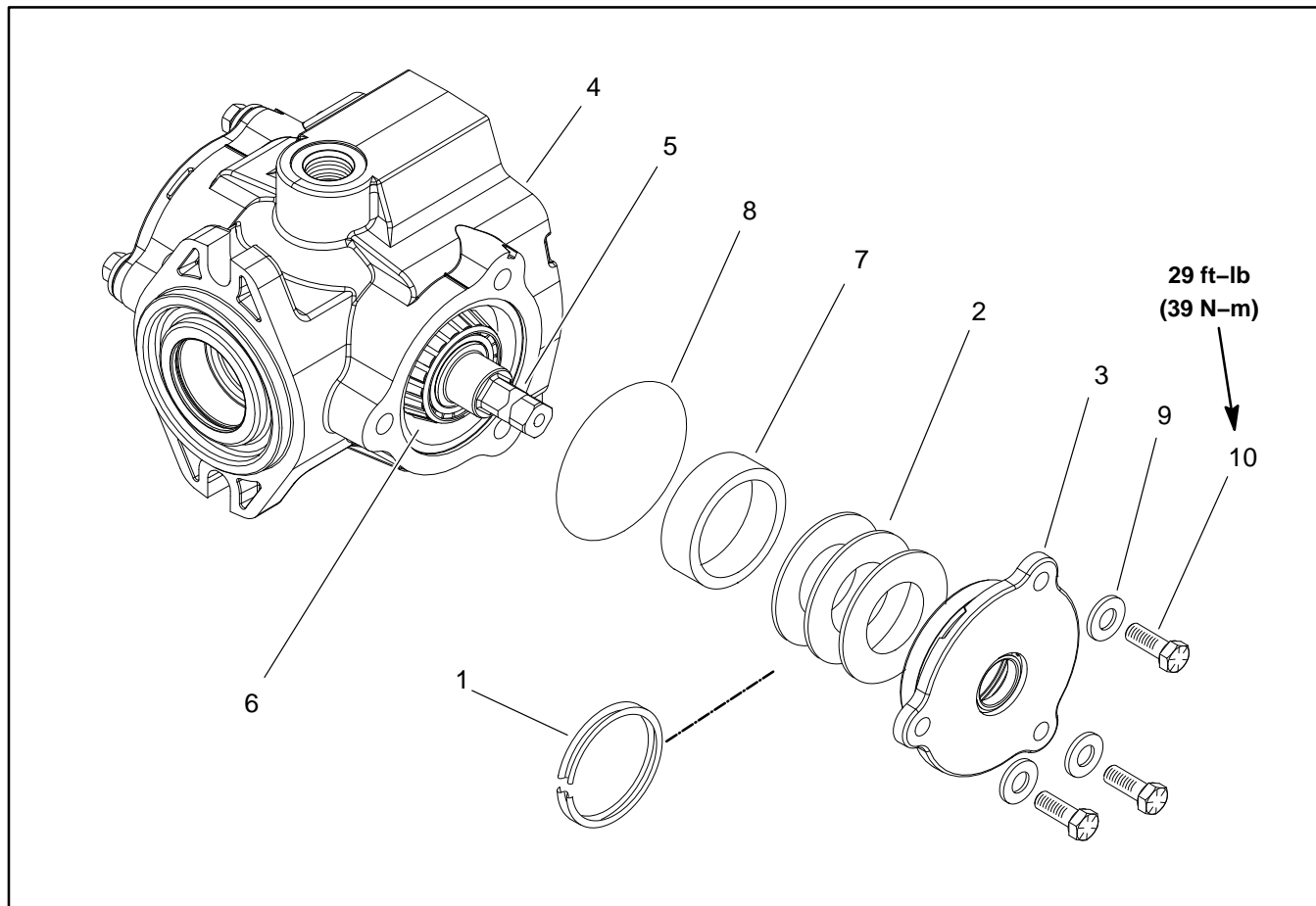


Figure 50

1. Crush ring
2. Shims
3. Cover plate
4. Housing

5. Camplate (control shaft)
6. Bearing cone
7. Bearing cup

8. O-ring
9. Washer (3 used)
10. Cap screw (3 used)

Piston Pump Crush Ring Replacement (Fig. 50)

NOTE: The shims (item 2) replace the crush ring (item 1) 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 from **15 to 25 in-lbs (1.7 to 2.8 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

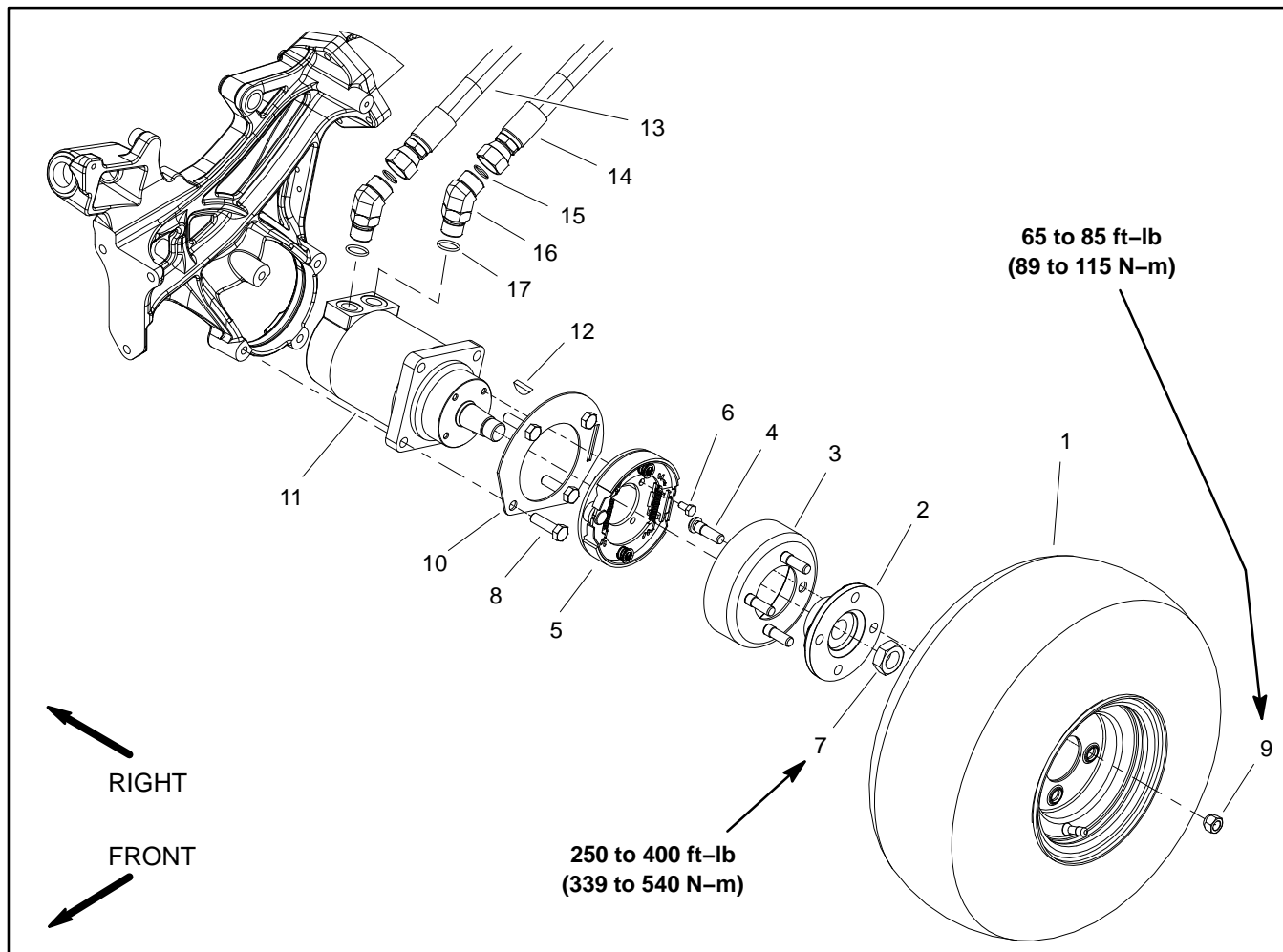


Figure 51

- | | | |
|------------------------------|--------------------------------|---|
| 1. Wheel assembly | 7. Lock nut | 13. Hydraulic hose |
| 2. Wheel hub | 8. Cap screw (4 per motor) | 14. Hydraulic hose |
| 3. Brake drum | 9. Lug nut (4 per wheel) | 15. O-ring |
| 4. Wheel stud (4 per wheel) | 10. Brake lever tab | 16. 45° hydraulic fitting (2 per motor) |
| 5. Brake assembly (LH shown) | 11. Hydraulic motor (LH shown) | 17. O-ring |
| 6. Cap screw (4 per brake) | 12. Woodruff key | |

Front Wheel Motor Removal (Fig. 51)

1. Park 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 in this section.

2. Loosen, but do not remove, lug nuts (item 9) and lock nut (item 7). 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 jack stands beneath the frame to support the machine.

4. Remove lug nuts and wheel assembly.

5. Remove e-ring and clevis pin that secure brake cable clevis to brake actuator lever (Fig. 52). Position brake cable clevis away from actuator lever.

IMPORTANT: DO NOT hit brake drum assembly, wheel hub puller or wheel motor with a hammer during wheel hub removal or installation. Hammering may cause damage to the wheel motor.

6. Make sure that lock nut 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.

7. Remove lock nut and brake drum assembly. Locate and retrieve woodruff key (item 12).

8. Remove four (4) cap screws that secure brake assembly to wheel motor. Remove brake assembly. If brake service is required, see Brake Service in the Service and Repairs section of Chapter 7 – Chassis.

9. Thoroughly clean hydraulic line ends and fittings on wheel motor to prevent hydraulic system contamination.

10. Label hydraulic connections at wheel motor for assembly purposes.

11. Disconnect hydraulic lines from fittings on wheel motor. Allow lines to drain into a suitable container.

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

13. Put caps or plugs on disconnected lines and motor port openings to prevent contamination.

14. Support wheel motor to prevent it from falling. Remove four (4) cap screws that secure wheel motor and brake lever tab (item 10) to frame. Remove brake lever tab and wheel motor from machine.

Front Wheel Motor Installation (Fig. 51)

1. Position hydraulic wheel motor to the frame with motor ports facing up. Place brake lever tab (item 10) to frame with slot toward rear of machine. Secure motor and brake lever tab to the frame with four (4) cap screws.

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. Position brake assembly to wheel motor and align brake actuator lever with slot in brake lever tab. Secure brake assembly to wheel motor with four (4) cap screws.

6. Thoroughly clean wheel motor shaft and wheel hub taper.

7. Install woodruff key into the wheel motor shaft key-slot. Align brake drum assembly with woodruff key and slide drum assembly onto motor shaft. Secure drum assembly with lock nut.

8. Secure brake cable clevis to brake actuator lever with clevis pin and e-ring (Fig. 52).

9. Install front wheel to machine and secure with four (4) lug nuts.



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.

10. Lower machine to ground. Torque lock nut from **250 to 400 ft-lb (339 to 540 N-m)** and wheel lug nuts from **65 to 85 ft-lb (89 to 115 N-m)**.

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).

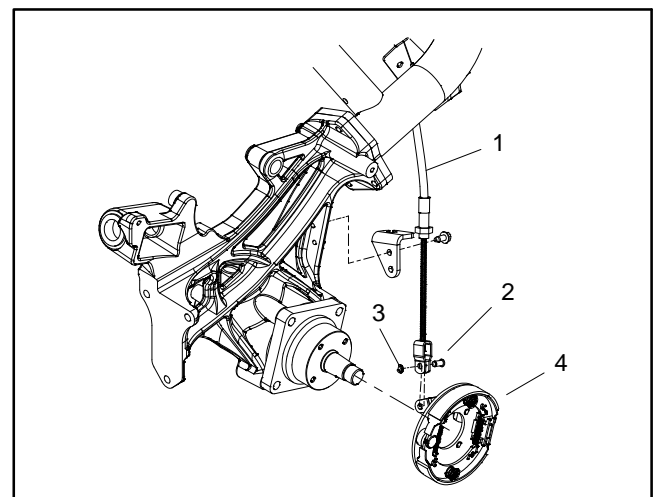


Figure 52

1. Brake cable
2. Clevis pin

3. E-ring
4. Brake assembly

Rear Wheel Motor (Optional 3WD)

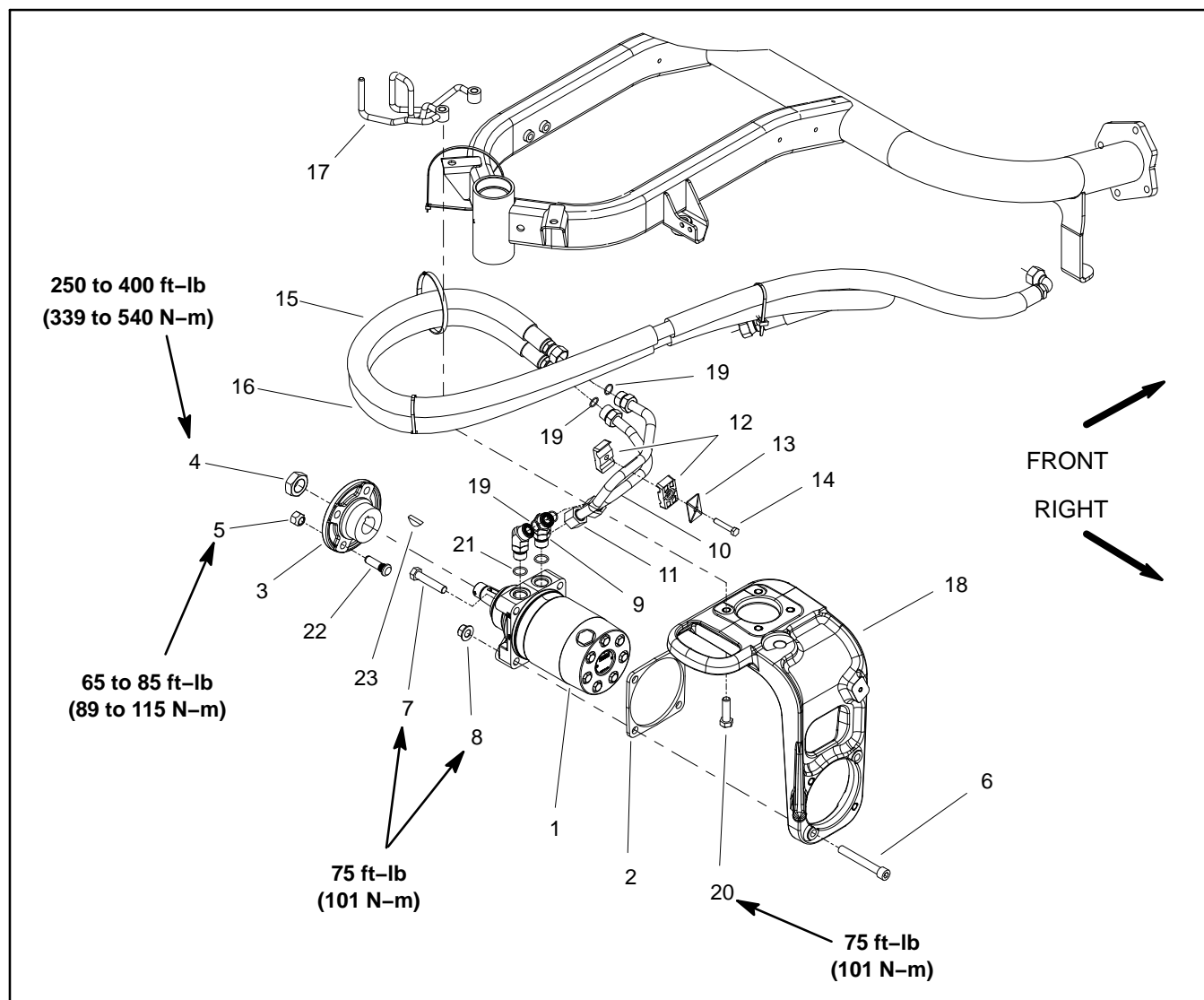
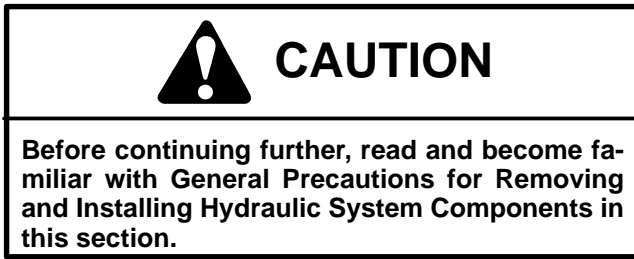


Figure 53

- | | | |
|-------------------------------|-----------------------------------|-------------------------|
| 1. Wheel motor | 9. 45° hydraulic fitting (2 used) | 17. Hose guide |
| 2. Motor plate | 10. Hydraulic tube | 18. Rear fork |
| 3. Wheel hub | 11. Hydraulic tube | 19. O-ring |
| 4. Lock nut | 12. Tube clamp (2 used) | 20. Cap screw (2 used) |
| 5. Lug nut (4 used) | 13. Cover plate | 21. O-ring |
| 6. Socket head screw (2 used) | 14. Cap screw | 22. Wheel stud (4 used) |
| 7. Cap screw (2 used) | 15. Hydraulic hose | 23. Woodruff key |
| 8. Lock nut (2 used) | 16. Hydraulic hose | |

Rear Wheel Motor (Optional 3WD) Removal (Fig. 53)

1. Park 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, rear wheel lug nuts (item 5) and lock nut (item 4). Loosen lock nut at least two (2) turns.

3. Chock both front wheels to prevent the machine from moving. Lift rear wheel off the ground using a jack and place appropriate jack stands beneath the frame to support the machine.

4. Remove lug nuts and rear wheel assembly.

IMPORTANT: DO NOT hit wheel hub, wheel hub puller or wheel motor with a hammer during wheel hub removal or installation. Hammering may cause damage to the wheel motor.

5. Use wheel hub puller (see Special Tools in this chapter) to loosen wheel hub from rear wheel motor.

6. Remove lock nut and wheel hub from rear wheel motor. Locate and retrieve woodruff key (item 23).

7. Thoroughly clean hydraulic tube ends and fittings on rear wheel motor to prevent hydraulic system contamination.

8. Label hydraulic connections at rear wheel motor for assembly purposes.

9. Disconnect hydraulic tubes from fittings on wheel motor. Allow lines to drain into a suitable container.

10. Put caps or plugs on disconnected tubes and fittings to prevent contamination.

11. Support wheel motor to prevent it from falling. Remove two (2) cap screws (item 7), two (2) socket head screws (item 6) and two (2) flange nuts (item 8) that secure wheel motor to rear fork. Remove rear wheel motor and motor plate (item 2) from machine.

12. If fitting removal from wheel motor is necessary, mark fitting orientation to allow correct assembly. Remove hydraulic fittings and O-rings from motor. Discard removed O-rings.

Rear Wheel Motor (Optional 3WD) Installation (Fig. 53)

1. If fittings were removed from rear wheel motor, lubricate and place new O-rings onto motor 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).

2. Place motor plate (item 2) on rear wheel motor and position motor to rear fork. Secure wheel motor to rear fork with two (2) cap screws (item 7), two (2) socket head screws (item 6) and two (2) flange nuts (item 8). Torque fasteners to **75 ft-lb (101 N-m)**.

3. Remove caps from disconnected hydraulic tubes.

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

5. Thoroughly clean wheel motor shaft and wheel hub taper.

6. Install woodruff key into the wheel motor shaft key-slot. Align wheel hub with woodruff key and slide wheel hub onto motor shaft. Secure hub with lock nut.

7. Install rear wheel to machine and secure with four (4) lug nuts.



8. Lower machine to ground. Torque lock nut from **250 to 400 ft-lb (339 to 540 N-m)** and wheel lug nuts from **65 to 85 ft-lb (89 to 115 N-m)**.

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

10. Follow Hydraulic System Start-up procedures (see Hydraulic System Start-up in this section).

Wheel Motor Service

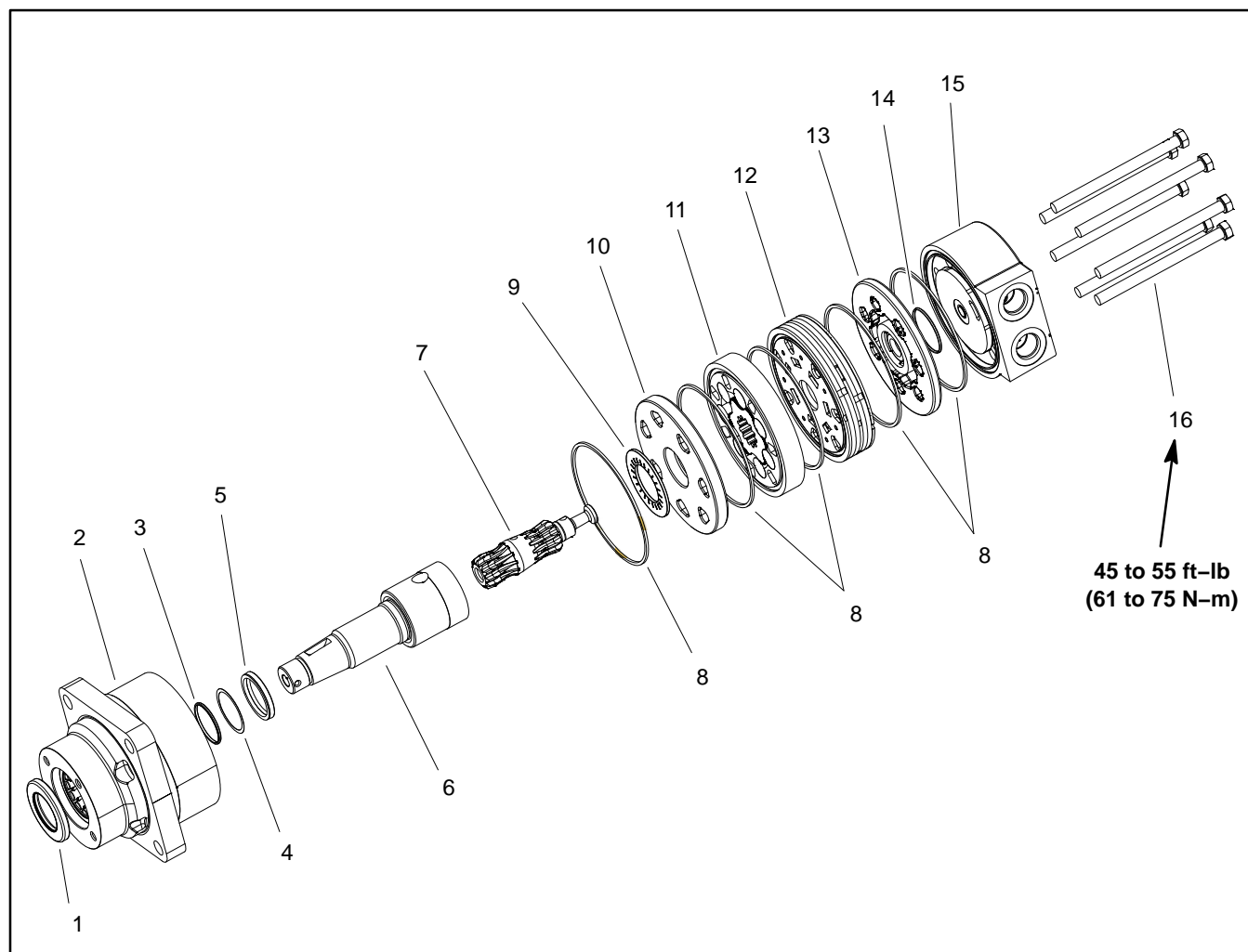


Figure 54

- 1. Dirt seal
- 2. Housing
- 3. Back-up ring
- 4. Back-up washer
- 5. Shaft seal
- 6. Coupling shaft

- 7. Drive link
- 8. Seal ring (5 used)
- 9. Thrust bearing
- 10. Wear plate
- 11. Rotor assembly

- 12. Manifold assembly
- 13. Commutator assembly
- 14. Commutator seal
- 15. End cover
- 16. Cap screw (7 used)

NOTE: The wheel motors used on your Greensmaster have the same basic construction. The left wheel motor(s) has a yellow sticker on the port side of the stator. The right wheel motor(s) has a reverse timed manifold.

NOTE: If machine is equipped with optional 3WD kit, the rear wheel motor has the same basic construction as the front wheel motors.

IMPORTANT: DO NOT interchange wheel motors on machine (i.e. do not put RH motor on left side of machine). If necessary, use parts catalog and part number on wheel motor to identify RH and LH motors.

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

IMPORTANT: If a wheel motor failure occurred, refer to Traction Circuit (Closed Loop) Component Failure in the General Information section for information regarding the importance of removing contamination from the traction circuit.

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Cutting Reel Motors

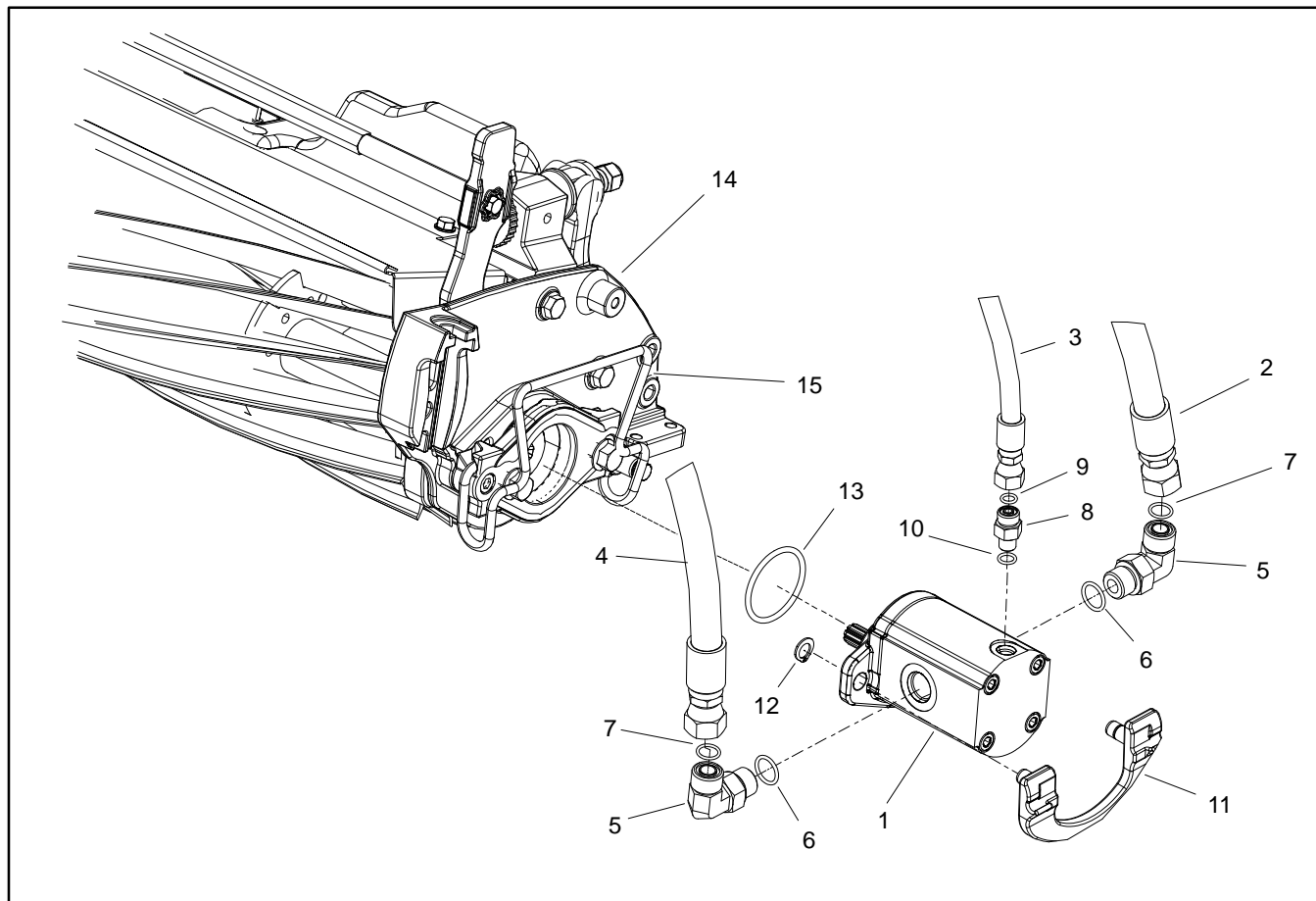


Figure 55

- | | | |
|--|----------------------|----------------------------------|
| 1. Reel motor | 6. O-ring | 11. Motor mount |
| 2. Hose assembly | 7. O-ring | 12. Retaining ring (2 per mount) |
| 3. Hose assembly | 8. Hydraulic fitting | 13. O-ring |
| 4. Hose assembly | 9. O-ring | 14. Cutting unit |
| 5. 90° hydraulic fitting (2 per motor) | 10. O-ring | 15. Motor clamp |

Removal (Fig. 55)

1. Park 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 in this section.

2. Thoroughly clean hydraulic hose ends and fittings on reel motor to prevent hydraulic system contamination.

3. Label hydraulic hoses for assembly purposes.

4. Disconnect hydraulic hoses from fittings on the reel motor. Allow hoses to drain into a suitable container. Cap or plug hoses and motor fittings to prevent contamination.

5. Remove reel motor from the cutting unit:

A. Push the motor clamp out of the slots on the motor mount toward the cutting unit sideplate (Fig. 56).

B. Slide reel motor from cutting unit (Fig. 57).

6. Remove two (2) retaining rings that secure motor mount (item 11) to reel motor. Remove motor mount from motor.

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

7. If hydraulic fittings are to be removed from reel motor, mark fitting orientation to allow correct assembly. Remove hydraulic fittings and O-rings from motor. Discard removed O-rings.

8. Inspect threads and sealing surfaces of fittings and motor ports. Replace components if damage is found.

Installation (Fig. 55)

1. If fittings were removed from reel motor, lubricate and place new O-rings onto fittings. Install fittings into reel 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).

2. Position motor mount to reel motor flange and secure with two (2) retaining rings.

3. Install reel motor to the cutting unit:

A. Coat splines of reel motor shaft with clean grease.

B. Align reel motor shaft splines with splines in cutting reel. Slide reel motor into cutting unit side plate (Fig. 57).

C. Pull motor clamp toward the motor until clamp fully engages slots on both sides of the motor mount (Fig. 58). There should be an audible click as clamp engages mount.

4. Remove caps and plugs from disconnected hydraulic hoses and motor fittings.

5. Using labels placed during reel motor removal, lubricate new O-rings and connect hydraulic hoses to reel motor. Tighten hose connections (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

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

7. Follow Hydraulic System Start-up procedures (see Hydraulic System Start-up in this section).

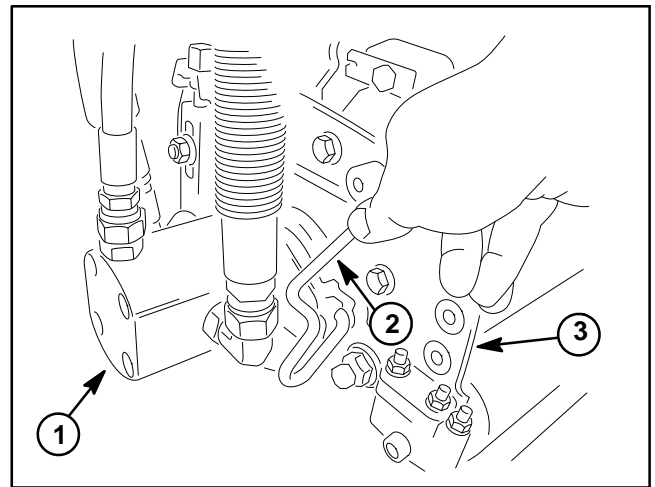


Figure 56

- 1. Reel motor
- 2. Motor clamp
- 3. Cutting unit sideplate

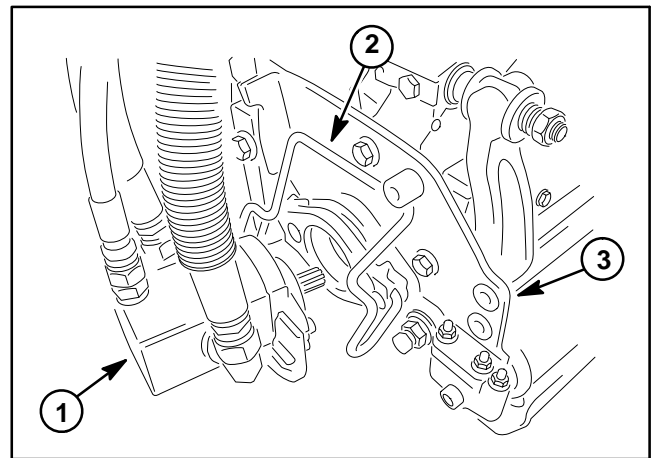


Figure 57

- 1. Reel motor
- 2. Motor clamp
- 3. Cutting unit sideplate

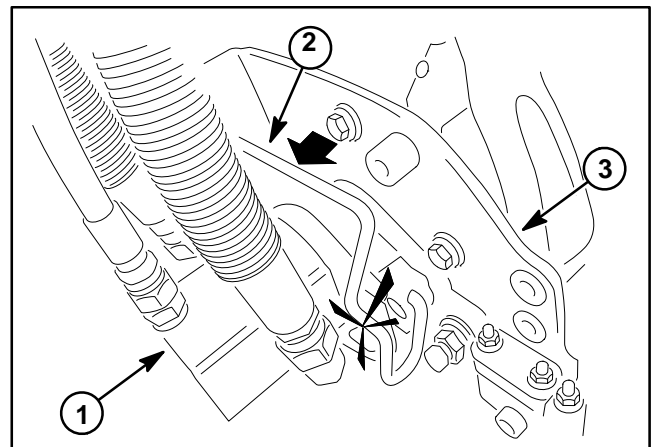


Figure 58

- 1. Reel motor
- 2. Motor clamp
- 3. Cutting unit sideplate

Cutting Reel Motor Service

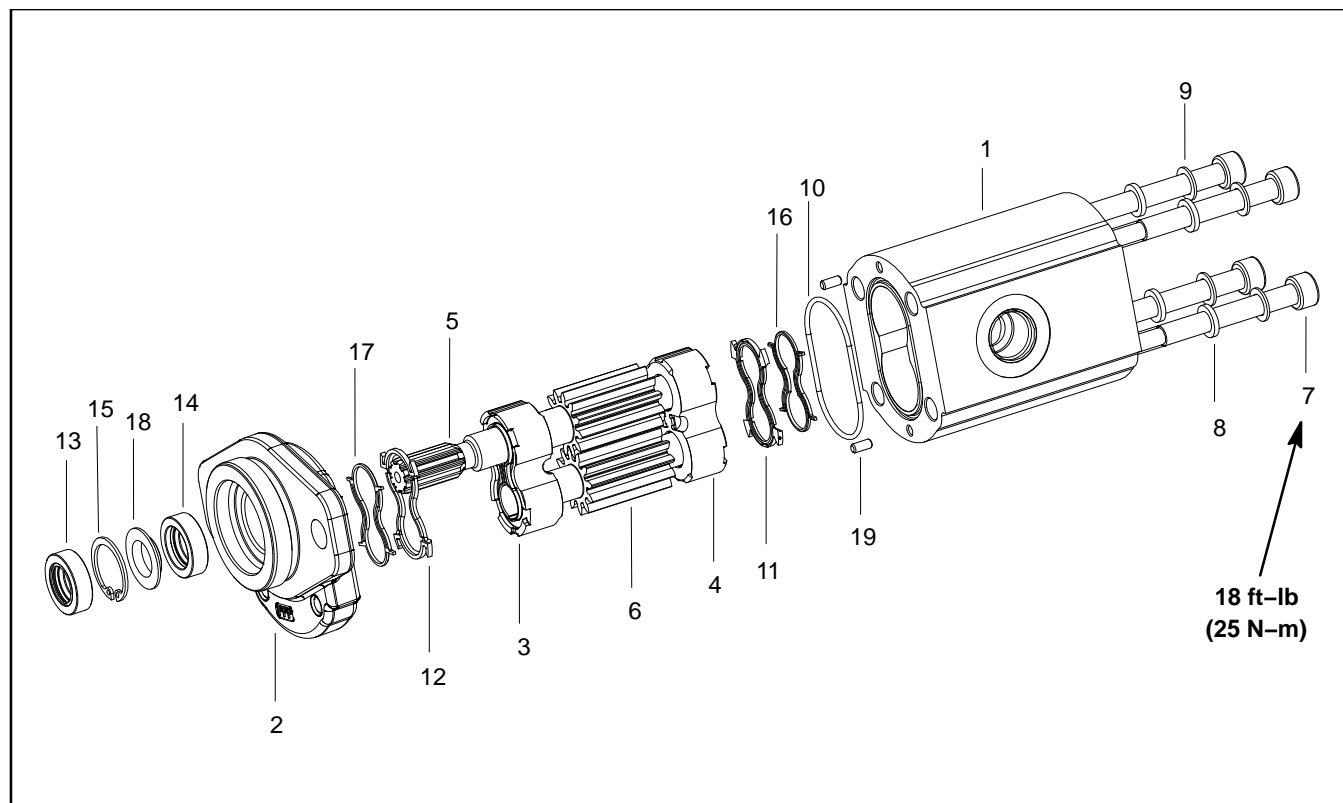


Figure 59

- | | | |
|-------------------------------|-------------------------|------------------------|
| 1. Body | 8. Flat washer (4 used) | 14. Shaft seal |
| 2. Front cover | 9. Lock washer (4 used) | 15. Retaining ring |
| 3. Front thrust plate | 10. O-ring | 16. Back-up seal |
| 4. Rear thrust plate | 11. Pressure seal | 17. Back-up seal |
| 5. Drive gear | 12. Pressure seal | 18. Back-up washer |
| 6. Idler gear | 13. Dust seal | 19. Dowel pin (2 used) |
| 7. Socket head screw (4 used) | | |

Disassembly (Fig. 59)

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 to make a **diagonal** line across the front cover and body for assembly purposes (Fig. 60).

IMPORTANT: Prevent damage when clamping the motor into a vise; clamp on the front flange only. Also, use a vise with soft jaws.

3. Clamp front flange of motor in a vise with soft jaws with the shaft end down.

4. Loosen four (4) socket head screws on rear of pump.

5. Remove motor from the vise. Turn motor so that the shaft end is facing down. Remove socket head screws.

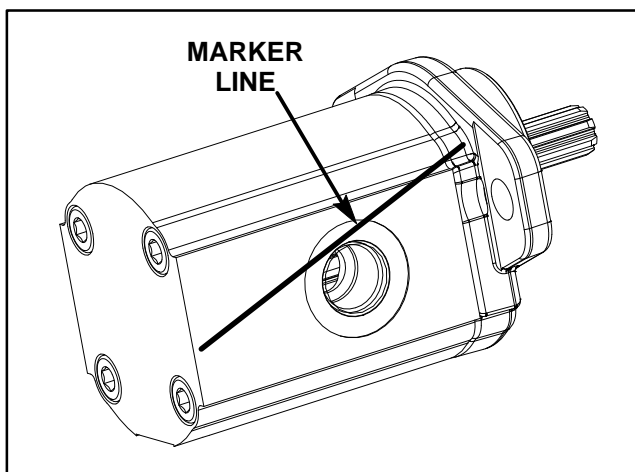


Figure 60

6. Carefully remove body from front cover. Lift body straight up to remove. Make sure the rear thrust plate remains on the drive and idler gear shafts. Remove and discard O-ring from the body. Locate and retrieve dowel pins (item 19).

IMPORTANT: Note position of the open and closed side of the thrust plates before removing. Also, identify thrust plates (front and rear) with a marker for proper assembly.

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. Carefully remove rear thrust plate, idler gear, drive gear and front thrust plate from the front cover.

8. Remove and discard back-up and pressure seals from thrust plates.

9. Turn front cover over, with seal side up.

IMPORTANT: Make sure to not damage the front cover counter bore when removing the seals from the cover.

10. Carefully remove dust seal, retaining ring, back-up washer and shaft seal from the front cover (Fig. 61). Discard removed seals.

Inspection

1. Remove any nicks and burrs from all parts with emery cloth.



2. Clean all parts with solvent. Dry all parts with compressed air.

3. Inspect drive gears and idler gears for the following (Fig. 62):

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 wear plates and, thus, must be replaced.

4. Inspect wear plates for the following:

A. Bearing areas should not have excessive wear or scoring.

B. Face of wear plates that are in contact with gears should be free of wear, roughness or scoring.

C. Thickness of wear plates should be equal.

5. Inspect front flange and rear cover for damage or wear.

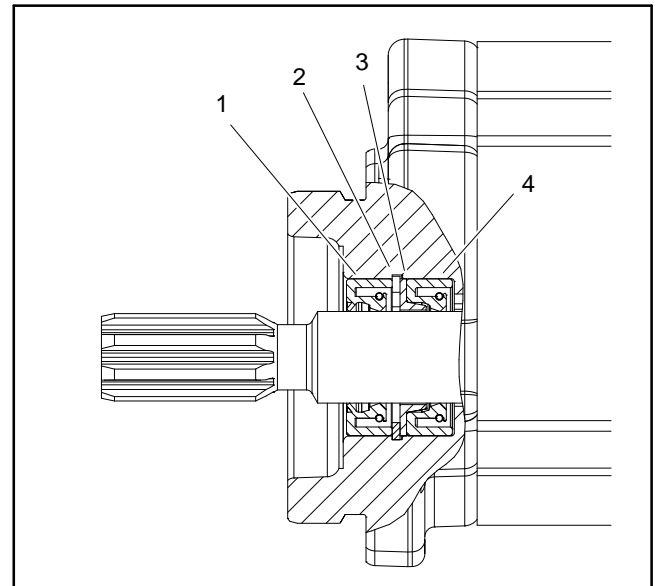


Figure 61

- | | |
|-------------------|-------------------|
| 1. Dust seal | 3. Back-up washer |
| 2. Retaining ring | 4. Shaft seal |

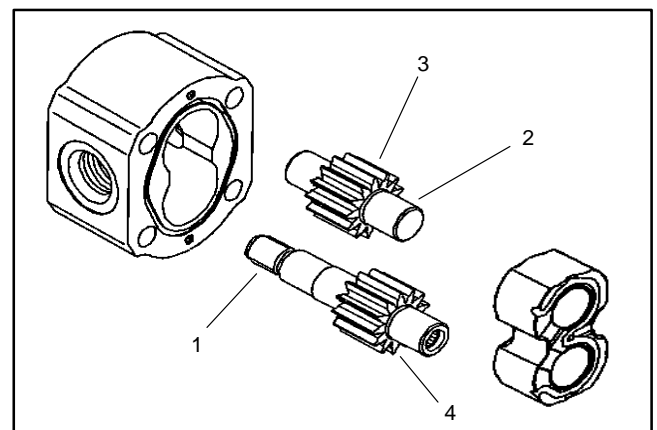


Figure 62

- | | |
|----------------------|-------------------|
| 1. Gear shaft spline | 3. Gear teeth |
| 2. Gear shaft | 4. Gear face edge |

Assembly (Fig. 59)

NOTE: When assembling the motor, check the marker line on each part to make sure the parts are properly aligned during assembly.

1. Lubricate O-rings, pressure seals, back-up seals and thrust plate grooves with a thin coat of petroleum jelly. Lubricate all other internal parts freely with clean hydraulic oil.
2. Install new seals into front cover (Fig. 61):
 - A. Press shaft seal into front cover until it reaches the bottom of the bore.
 - B. Install back-up washer into front cover and then install retaining ring into the groove of the front cover. Make sure that retaining ring is fully seated in front cover groove.
 - C. Install new dust seal into front cover.
3. Place front cover, seal side down, on a flat surface.
4. Install the pressure seals, flat side outward, into the grooves in the thrust plates. Follow by carefully placing the back-up seals, flat side outward, between the pressure seals and the grooves in the thrust plate.
5. Apply a light coating of petroleum jelly to the exposed side of the front cover.
6. Lubricate the drive gear shaft with clean hydraulic oil. Insert the drive end of the drive shaft through the thrust plate with the pressure seal side down and the open side of the pressure seal pointing to the inlet side of the motor. Carefully install shaft into front cover.

7. Lubricate the idler gear shaft with clean hydraulic oil. Install idler gear shaft into the remaining position in the front thrust plate. Apply a light coating of clean hydraulic oil to gear faces.

8. Install rear thrust plate with pressure seal side up and open side of the pressure seal pointing to the inlet side of the motor.

9. Apply a light coating of petroleum jelly to new O-ring and O-ring groove in the body. Install new O-ring to the body.

10. Install locating dowel pins in body. Align marker line on the body and front cover.

IMPORTANT: Do not dislodge seals during installation.

11. Gently slide the body onto the assembly. Firm hand pressure should be sufficient to engage the dowel pins.

12. Install the four (4) socket head screws with washers and hand tighten screws.

IMPORTANT: Prevent damage when clamping the motor into a vise; clamp on the front flange only. Also, use a vise with soft jaws.

13. Place front flange of the motor into a vise with soft jaws and alternately torque the cap screws **18 ft-lb (25 N-m)**.

14. Remove motor from vise.

15. Place a small amount of clean hydraulic oil in the inlet of the motor and rotate the drive shaft away from the inlet one revolution. If any binding is noted, disassemble the motor and check for assembly problems.

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Mow Control Manifold

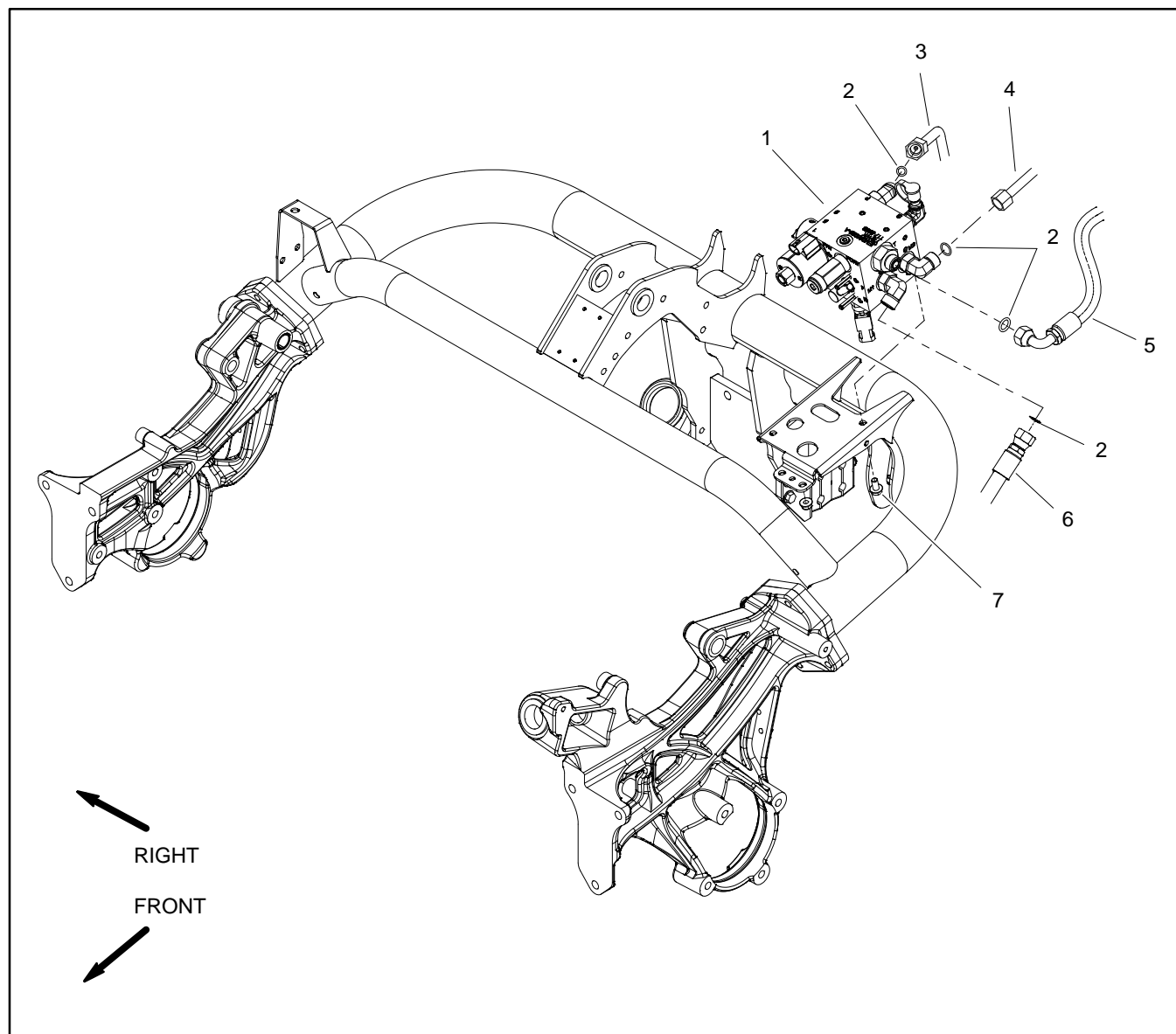


Figure 63

- 1. Mow control manifold
- 2. O-ring
- 3. Hydraulic tube

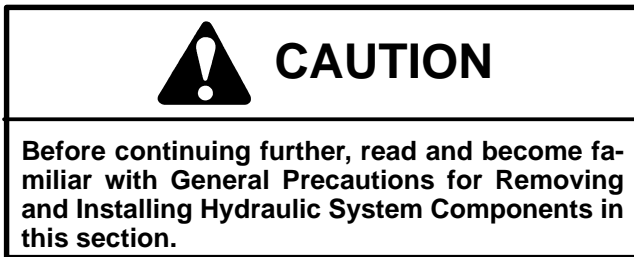
- 4. Hydraulic tube
- 5. Hydraulic hose

- 6. Hydraulic hose
- 7. Flange head screw (2 used)

NOTE: The ports on the mow control manifold are marked for easy identification of components. Example: PRV is the proportional relief valve and T is the return port (see Hydraulic Schematic to identify the function of the hydraulic lines and cartridge valves at each port location).

Removal (Fig. 63)

1. Park machine on a level surface, engage parking brake, lower cutting units and stop the engine.
2. Remove left side cover next to operator seat to allow access to mow control manifold.



3. Thoroughly clean hydraulic hose ends and fittings on mow control manifold to prevent hydraulic system contamination.
4. Label all hydraulic and electrical connections for assembly purposes.
5. Disconnect wire harness connectors from solenoid valve and backlap switch.

IMPORTANT: Before disconnecting hydraulic lines from the manifold fittings, make sure each hose is labeled to ensure it can be connected to the correct manifold fitting/port.

6. 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. Cap or plug hoses and manifold fittings to prevent contamination.

7. Remove two (2) flange head screws (item 7) that secure manifold to machine frame. Remove manifold assembly from the machine.

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

8. If hydraulic fittings are to be removed from manifold, mark fitting orientation to allow correct assembly. Remove hydraulic fittings and O-rings from manifold (Fig. 64). Discard removed O-rings.

Installation (Fig. 63)

1. If fittings were removed from manifold, lubricate and place new O-rings onto fittings. Install fittings into manifold openings making sure that fitting orientation is as noted during removal (Fig. 64). Properly tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).
2. Position manifold assembly to the machine frame. Secure assembly to the frame with two (2) flange head screws (item 7).
3. Remove caps and plugs from disconnected hydraulic lines and manifold fittings.
4. Lubricate and position new O-rings to fittings on manifold. Use labels placed during the removal process to properly install hydraulic lines to manifold fittings (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).
5. Connect wire harness connectors to solenoid valve and backlap switch.
6. Install left side cover.

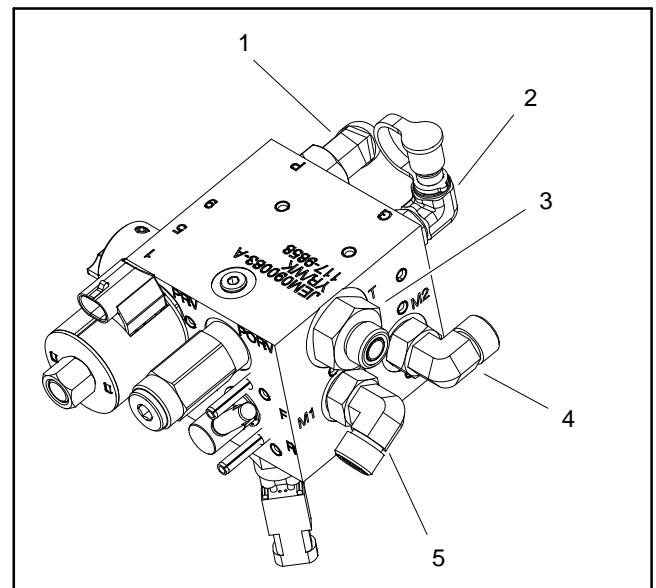


Figure 64

- | | |
|-----------------------------|--------------------------|
| 1. 45° fitting | 4. 90° fitting (port M2) |
| 2. Test fitting | 5. 90° fitting (port M1) |
| 3. Adapter fitting (port T) | |

Mow Control Manifold Service

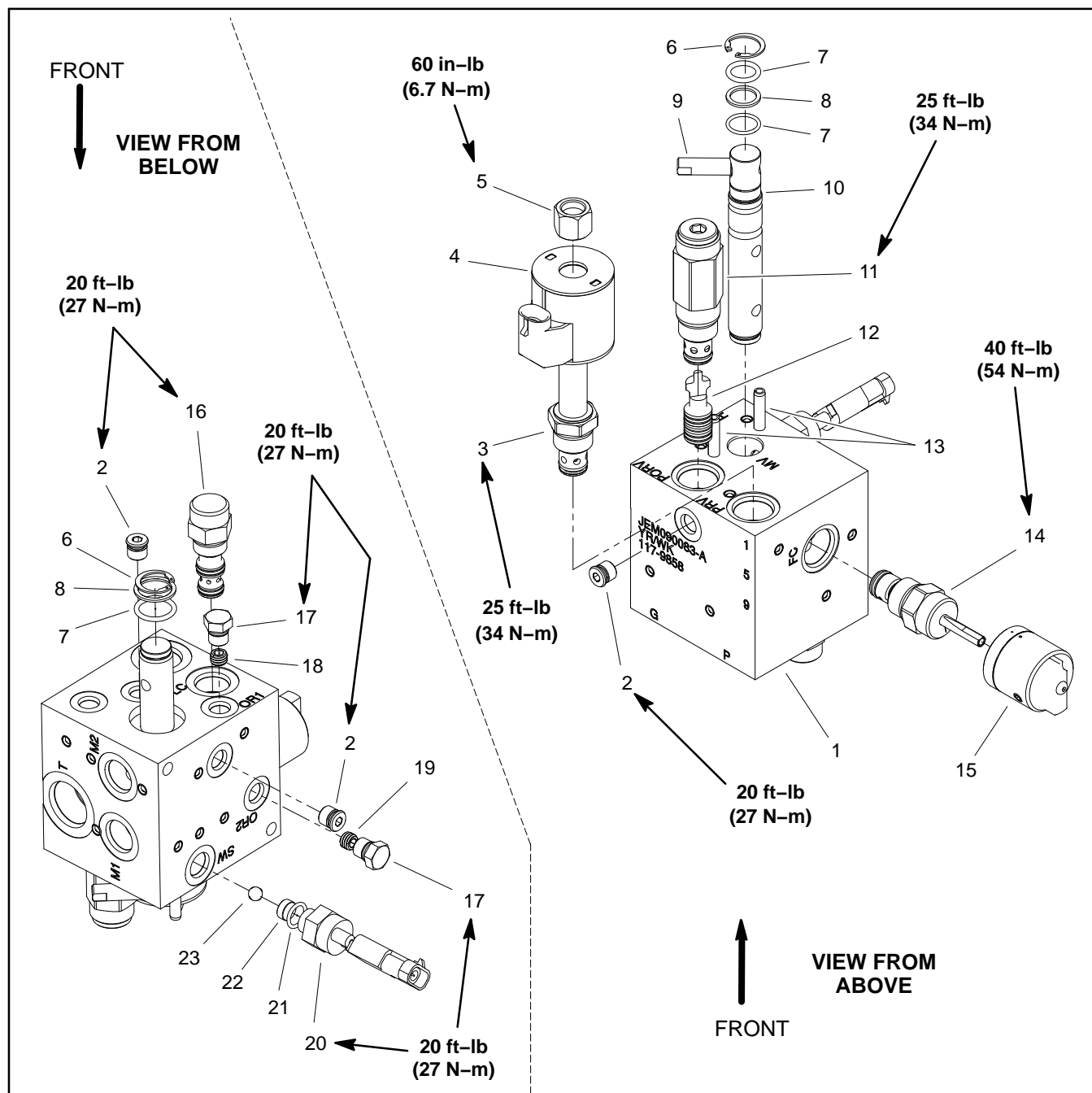


Figure 65

- | | | |
|---|--------------------------------------|--------------------------------|
| 1. Mow manifold | 9. Spool handle | 17. Zero leak plug (2 used) |
| 2. Zero leak plug (3 used) | 10. Spool (port MV) | 18. Orifice (0.013) (port OR1) |
| 3. Proportional relief valve (port PRV) | 11. Relief valve (port PORV) | 19. Orifice (0.060) (port OR2) |
| 4. Solenoid coil | 12. Pilot piston (port PORV) | 20. Backlap switch (port SW) |
| 5. Nut | 13. Spring pin (2 used) | 21. O-ring |
| 6. Retaining ring (2 used) | 14. Flow control cartridge (port FC) | 22. Shim |
| 7. O-ring | 15. Rotary handle assembly | 23. Ball |
| 8. Backup ring | 16. Pressure compensator (port LC) | |

NOTE: The ports on the mow control manifold are marked for easy identification of components. Example: PRV is the proportional relief valve and T is the return 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 65 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 65.

IMPORTANT: A flow control orifice (items 18 and 19) is located beneath the plugs in mow manifold ports OR1 and OR2. If either of these plugs 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.

Cartridge Valve Service

For cartridge valve service procedures, see Control Manifold Cartridge Valve Service in this section. Refer to Figure 65 for mow manifold cartridge valve and plug installation torque.

Rotary Handle Assembly (Fig. 66)

1. To remove rotary handle from valve:

- 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.

2. To install rotary handle:

IMPORTANT: Make sure that flow control cartridge valve is properly secured in manifold before installing rotary handle to valve.

- 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.

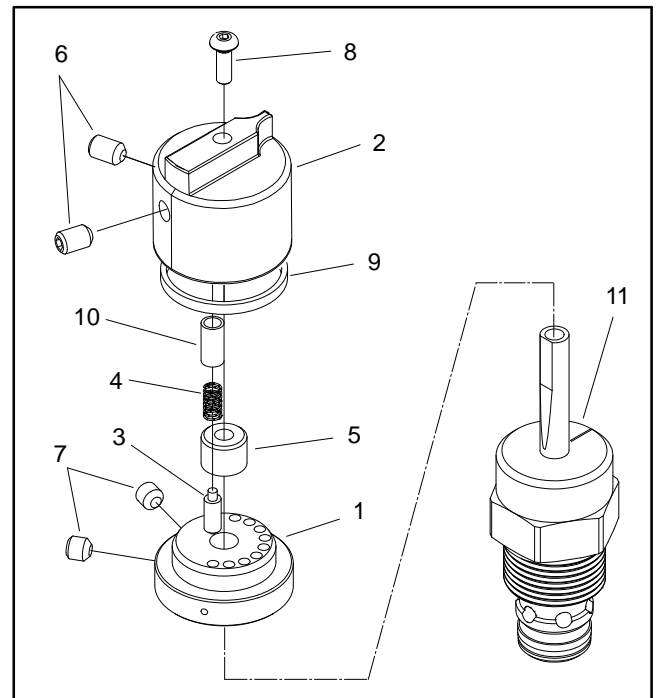


Figure 66

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

Mow/Backlap Spool (Fig. 67)

1. To remove mow/backlap spool from manifold:
 - A. Remove backlap switch from manifold before removing mow/backlap spool (Fig. 65). Remove shim 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. To 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 spring pins in manifold. Apply Loctite 603 Retaining Compound (or equivalent) to threads on handle and install handle into spool. Torque handle **10 ft-lb (13.5 N-m)**.
 - F. Place ball and shim in manifold port SW (backlap switch). Install new O-ring onto backlap switch. Thread backlap switch into port and torque **20 ft-lb (27 N-m)**.

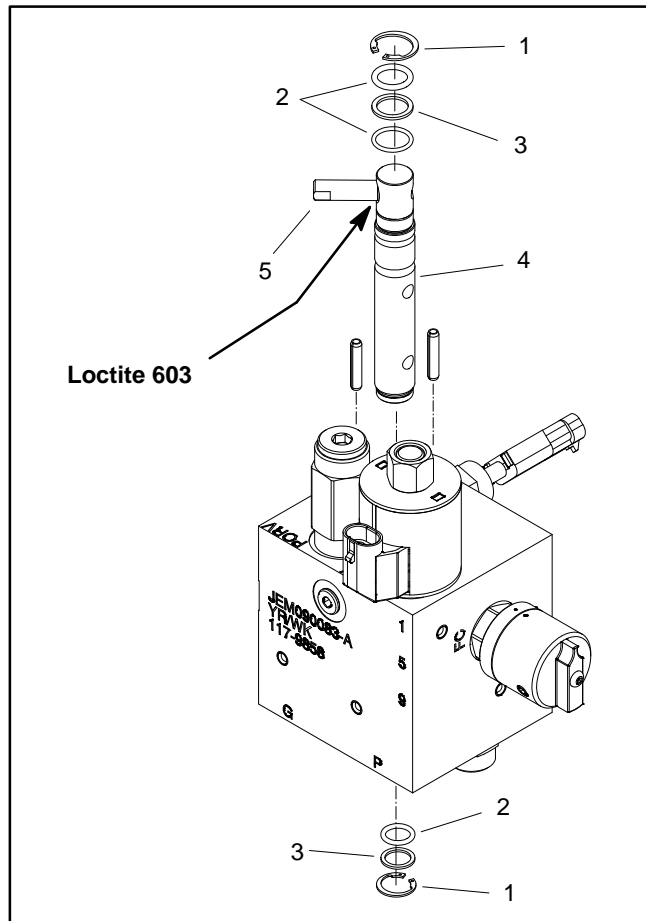


Figure 67

- | | |
|-------------------|-----------------|
| 1. Retaining ring | 4. Rotary spool |
| 2. O-ring | 5. Spool handle |
| 3. Back-up ring | |

Control Manifold Cartridge Valve Service



CAUTION

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

1. Make sure the control manifold is clean before removing the cartridge valve from the control manifold.
2. If cartridge valve is solenoid operated, remove nut securing solenoid coil to the cartridge valve. Carefully slide coil off the valve.

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

3. Remove cartridge valve from manifold using a deep socket wrench. Note correct location for O-rings, sealing rings and backup rings. Remove seal kit from cartridge valve and discard removed seals.
4. Visually inspect the port in the manifold for damage to the sealing surfaces, damaged threads and contamination.
5. Visually inspect cartridge valve for damaged sealing surfaces and contamination.
 - A. Contamination may cause valves to stick or hang up. Contamination can become lodged in small valve orifices or seal areas causing malfunction.
 - B. If valve sealing surfaces appear pitted or damaged, the hydraulic system may be overheating or there may be water in the system.



CAUTION

Use eye protection such as goggles when using compressed air.

6. 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. If cartridge design allows, use a wood or plastic probe to push the internal spool in and out 20 to 30 times to flush out contamination. Be extremely careful not to damage cartridge. Use compressed air for cleaning.

7. Install the cartridge valve into the manifold:

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

B. Dip assembled cartridge into clean hydraulic oil.

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

C. Thread cartridge valve carefully into manifold port by hand until the top O-ring is met. The valve should go into manifold port easily without binding.

D. Torque cartridge valve using a deep socket wrench to value identified in control manifold illustration.

8. If cartridge valve is solenoid operated, carefully install solenoid coil to the cartridge valve. Secure coil to valve with nut and torque nut to **60 in-lb (6.8 N-m)**.

9. If problems still exist after manifold assembly, remove cartridge valve and clean again or replace valve.

Lift Cylinders

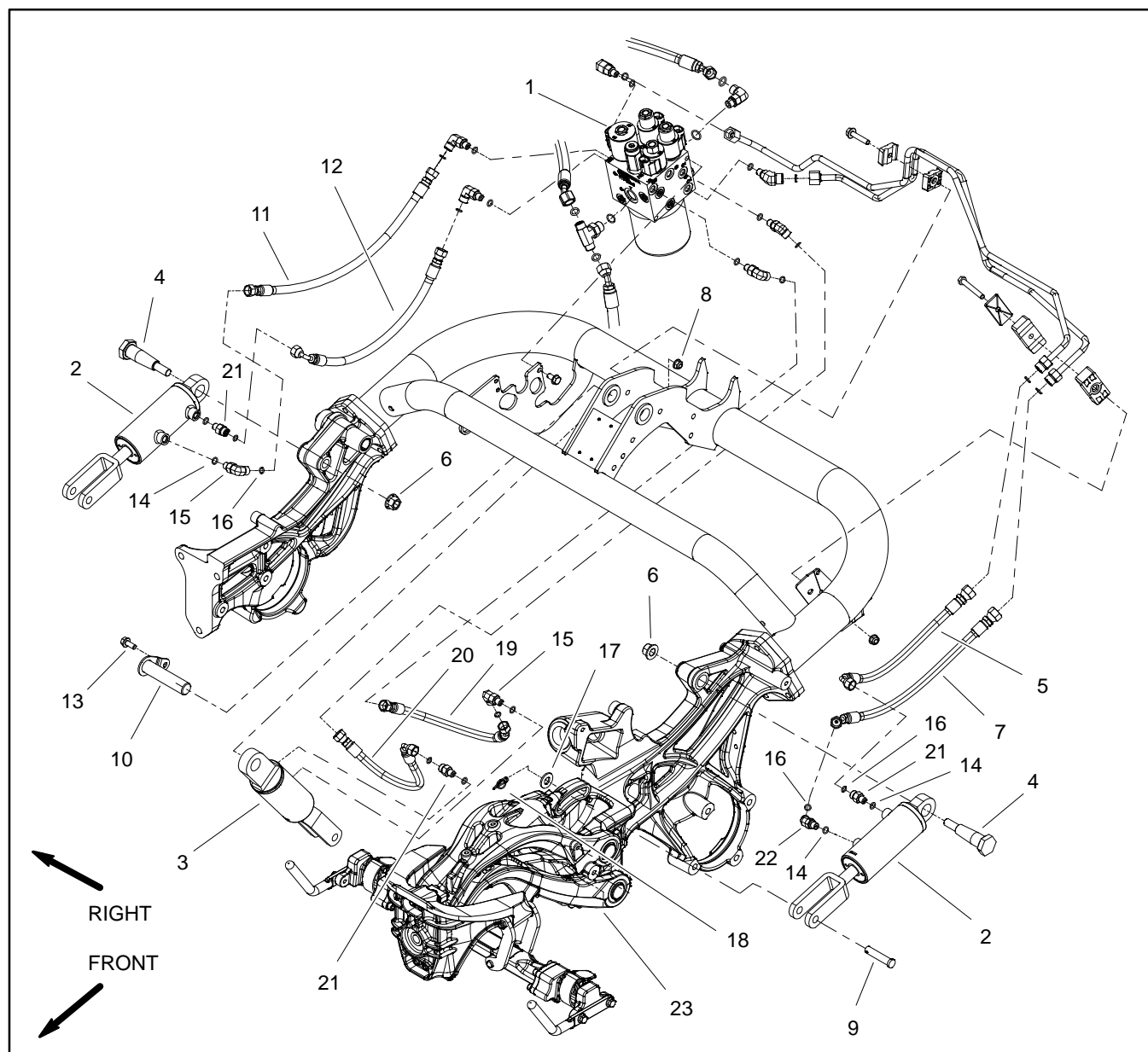



Figure 68

- | | | |
|---|------------------------------------|---|
| 1. Lift control manifold | 9. Clevis pin (3 used) | 17. Washer (3 used) |
| 2. Hydraulic lift cylinder (#2 and #3 CU) | 10. Pivot pin | 18. Rue ring (3 used) |
| 3. Hydraulic lift cylinder (#1 CU) | 11. Hydraulic hose | 19. Hydraulic hose |
| 4. Tapered pin (2 used) | 12. Hydraulic hose | 20. Hydraulic hose |
| 5. Hydraulic hose | 13. Flange head screw | 21. Straight hydraulic fitting (3 used) |
| 6. Lock nut (2 used) | 14. O-ring | 22. 45° hydraulic fitting |
| 7. Hydraulic hose | 15. 90° hydraulic fitting (2 used) | 23. Cutting unit suspension |
| 8. Flange nut | 16. O-ring | |


Lift Cylinder Removal (Fig. 68)

1. 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 in this section.

2. Thoroughly clean hydraulic hose ends and fittings on lift cylinder to prevent hydraulic system contamination.
3. Label hydraulic hoses for assembly purposes.

**WARNING**

Make sure that cutting units are fully lowered before loosening hydraulic lines at lift cylinder. If cutting units are raised as lift cylinder hoses are loosened, cutting units may drop unexpectedly.

4. Disconnect hydraulic hoses from fittings on the lift cylinder. Allow hoses to drain into a suitable container. Cap or plug hoses and cylinder fittings to prevent contamination.
5. Remove rue ring (item 18), washer (item 17) and clevis pin (item 9) that secure cylinder rod clevis to cutting unit suspension. Separate lift cylinder clevis from suspension.
6. Support lift cylinder to prevent it from dropping. Separate lift cylinder from frame:
 - A. For front (#2 or #3 cutting unit) lift cylinder, remove lock nut (item 6) and tapered pin (item 4) that secure lift cylinder to frame.
 - B. For center (#1 cutting unit) lift cylinder, remove flange nut (item 8) and flange head screw (item 13) that secure pivot pin (item 10) to frame. Slide pivot pin from frame and lift cylinder.
7. Remove hydraulic cylinder from machine.

8. If hydraulic fittings are to be removed from lift cylinder, mark fitting orientation to allow correct assembly. Remove hydraulic fittings and O-rings from cylinder. Discard removed O-rings.

9. Inspect threads and sealing surfaces of fittings and lift cylinder ports. Replace components if damage is found.

Lift Cylinder Installation (Fig. 68)

1. If fittings were removed from lift cylinder, lubricate and place new O-rings onto fittings. Install fittings into cylinder ports making sure that fitting orientation is as noted during removal. Tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).

2. Position barrel end of lift cylinder to frame attachment point. Separate lift cylinder from frame:

A. For front (#2 or #3 cutting unit) lift cylinder, make sure that tapered surfaces of pin (item 4) and frame mount are thoroughly clean. Slide tapered pin through lift cylinder and frame. Secure assembly with lock nut (item 6).

B. For center (#1 cutting unit) lift cylinder, slide pivot pin (item 10) through frame and lift cylinder. Secure pivot pin to frame with flange head screw (item 13) and flange nut (item 8).

3. Position clevis of the lift cylinder to the cutting unit suspension. Secure cylinder clevis to suspension with clevis pin (item 9), washer (item 17) and rue ring (item 18).

4. Position clevis of the hydraulic cylinder to the lift arm. Install clevis pin and cotter pin through cylinder clevis.

5. Remove caps and plugs from disconnected hydraulic hoses and lift cylinder fittings.

6. Using labels placed during lift cylinder removal, lubricate new O-rings and connect hydraulic hoses to cylinder. Tighten hose connections (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

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).

Lift Cylinder Service

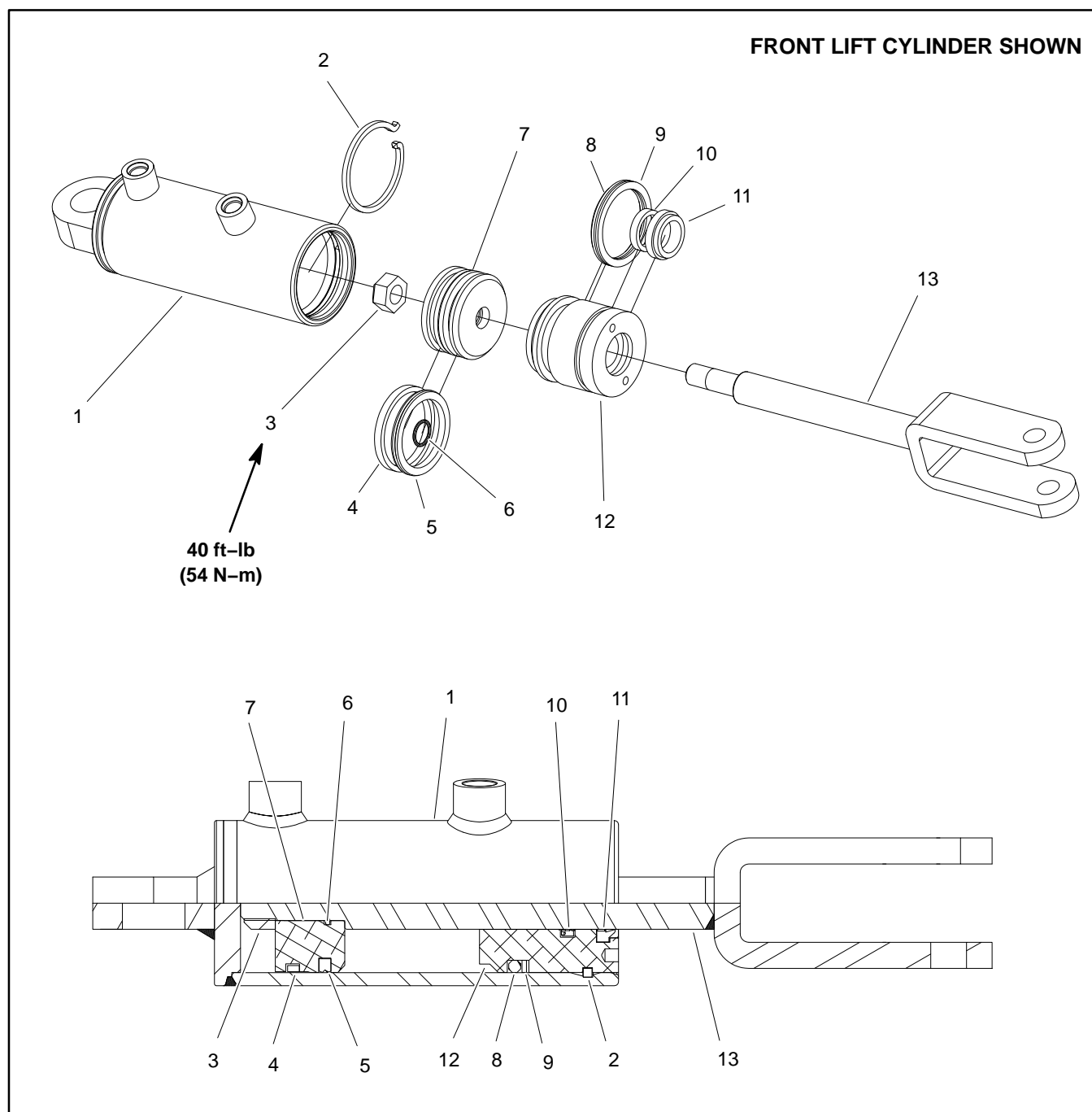


Figure 69

- | | | |
|-------------------|-----------------|---------------|
| 1. Barrel | 6. O-ring | 10. Head seal |
| 2. Retaining ring | 7. Piston | 11. Dust seal |
| 3. Lock nut | 8. O-ring | 12. Head |
| 4. Wear ring | 9. Back-up ring | 13. Shaft |
| 5. Piston seal | | |

NOTE: The center lift cylinder (#1 cutting unit) has less stroke than the front lift cylinders (#2 and #3 cutting units) which are identical. Service procedures for all lift cylinders used on Greensmaster TriFlex machines are the same.

Disassembly (Fig. 69)

1. Remove the oil from the lift 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 lift cylinder in a vise; clamp on the rear mounting flange only. Do not close vise on 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 (item 2) 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 assembly 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 of the shaft. Remove lock nut and piston from the shaft. Slide head off the shaft.

6. Remove wear ring, piston seal and O-ring from the piston. Remove O-ring, back-up ring, head seal and dust seal from the head.



7. Wash lift cylinder 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 (Fig. 69)

1. Make sure all lift cylinder parts are clean before assembly.

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

A. Install wear ring, piston seal and O-ring on the piston.

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

IMPORTANT: Do not clamp vise jaws against the shaft surface. Protect shaft surface before mounting in a vise.

3. Mount shaft securely in a vise by clamping on the clevis of the shaft. Use of a vise with soft jaws is recommended.

A. Coat shaft with clean hydraulic oil.

B. Carefully slide head onto the shaft.

C. Install piston and lock nut onto the shaft. Torque lock nut from **40 ft-lb (54 N-m)**.

D. Remove shaft from the vise.

IMPORTANT: Prevent damage when clamping the hydraulic cylinder into a vise; clamp on the rear mounting flange only. Do not close vise on the barrel.

4. Mount barrel in a vise. Use of a vise with soft jaws is recommended.

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

Lift Control Manifold

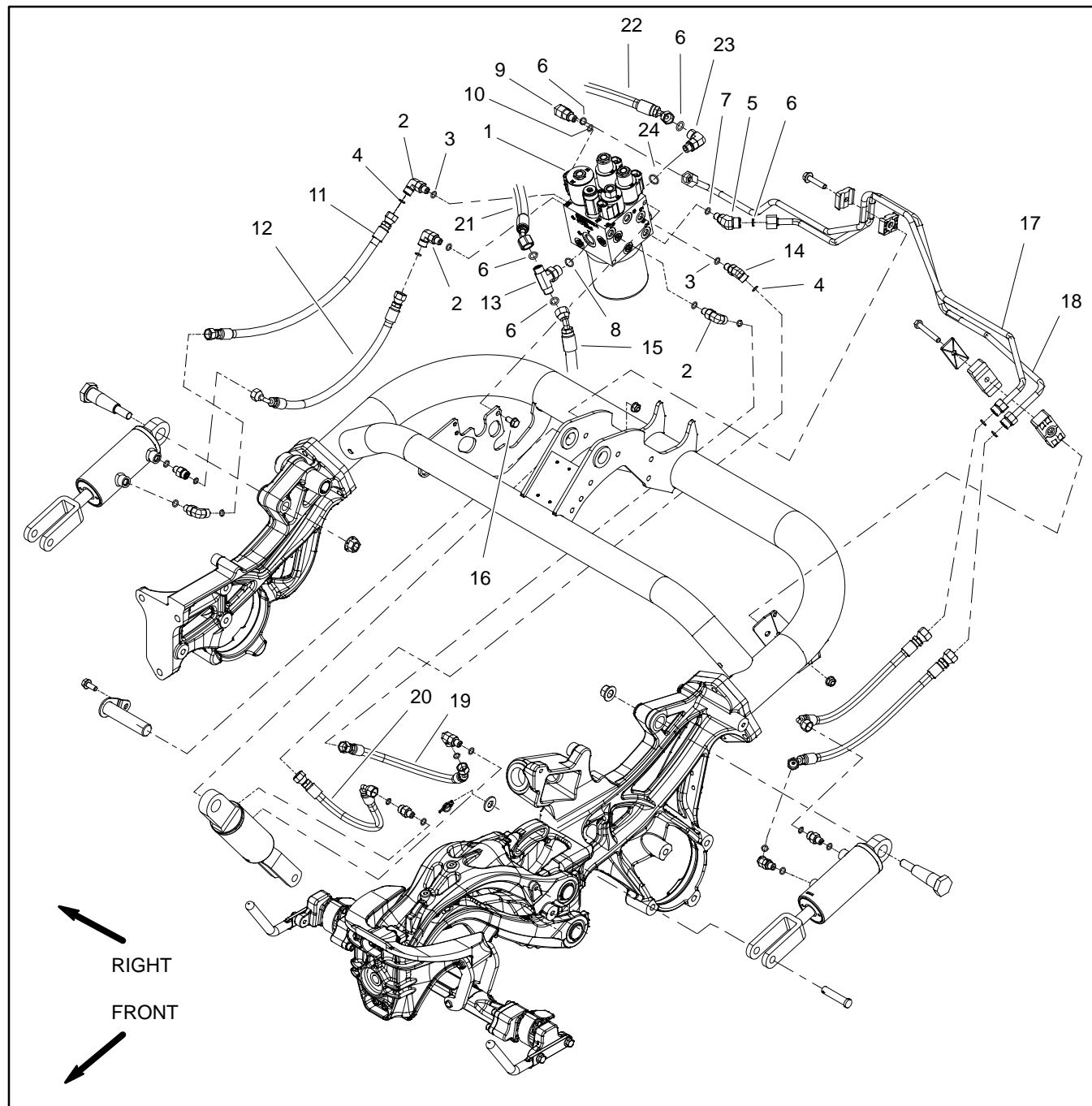



Figure 70

- | | | |
|-----------------------------------|--------------------------------|---------------------------|
| 1. Lift control manifold | 9. 90° hydraulic fitting | 17. Hydraulic tube |
| 2. 90° hydraulic fitting (3 used) | 10. O-ring | 18. Hydraulic tube |
| 3. O-ring | 11. Hydraulic hose | 19. Hydraulic hose |
| 4. O-ring | 12. Hydraulic hose | 20. Hydraulic hose |
| 5. 45° hydraulic fitting | 13. Tee fitting | 21. Hydraulic hose |
| 6. O-ring | 14. 45° hydraulic fitting | 22. Hydraulic hose |
| 7. O-ring | 15. Hydraulic hose | 23. 90° hydraulic fitting |
| 8. O-ring | 16. Flange head screw (2 used) | 24. O-ring |


NOTE: The ports on the lift control manifold are marked for easy identification of components. Example: S1 is the solenoid valve and P is the supply port (see Hydraulic Schematic to identify the function of the hydraulic lines and cartridge valves at each port location).

**WARNING**

If lift manifold is attached to machine, make sure that cutting units are fully lowered before loosening hydraulic lines or cartridge valves from lift manifold. If cutting units are raised as components are loosened in manifold, cutting units may drop unexpectedly.

Removal (Fig. 70)

1. Park machine on a level surface, engage parking brake, lower cutting units and stop the engine.
2. Remove right side cover next to operator seat to allow access to lift control manifold.

**CAUTION**

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

3. Thoroughly clean hydraulic line ends and fittings on lift control manifold to prevent hydraulic system contamination.
4. Label all hydraulic and electrical connections for assembly purposes.
5. Disconnect wire harness connectors from solenoid valve coils on lift manifold.

IMPORTANT: Before disconnecting hydraulic lines from the manifold fittings, make sure each hose or tube is labeled to ensure it can be connected to the correct manifold fitting/port.

6. Disconnect hydraulic hose and tube assemblies and remove their respective O-rings from the manifold fittings. Allow hoses and tubes to drain into a suitable container. Cap or plug hoses and manifold fittings to prevent contamination.

7. Remove two (2) flange head screws (item 16) that secure lift manifold to machine frame. Remove manifold assembly from the machine.

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

IMPORTANT: A flow control orifice is placed beneath hydraulic fittings in lift control manifold ports C4 and C6. If either of these fittings is removed from the lift junction manifold, make sure to remove orifice and label its position for assembly purposes. Also note location of groove in orifice for assembly purposes.

8. If hydraulic fittings are to be removed from manifold, mark fitting orientation to allow correct assembly. Remove hydraulic fittings and O-rings from manifold. Discard removed O-rings.

Installation (Fig. 70)

IMPORTANT: If installing an orifice in manifold port, make sure that orifice is flat in the base of the manifold port. Manifold damage is possible if the orifice is cocked in the cavity.

1. If fittings were removed from junction manifold, lubricate and place new O-rings onto fittings. Install fittings into manifold openings making sure that orifice (ports C4 and C6) is correctly placed before threading fitting into manifold. Use marks made during the removal process to correctly orientate fittings. Properly tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).
2. Position manifold assembly to the machine frame. Secure assembly to the frame with two (2) flange head screws (item 16).
3. Remove caps and plugs from disconnected hydraulic lines and manifold fittings.
4. Lubricate and position new O-rings to fittings on manifold. Use labels placed during the removal process to properly install hydraulic lines to manifold fittings (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).
5. Connect wire harness connectors to solenoid valve coils on lift manifold.
6. Install right side cover.

Lift Control Manifold Service

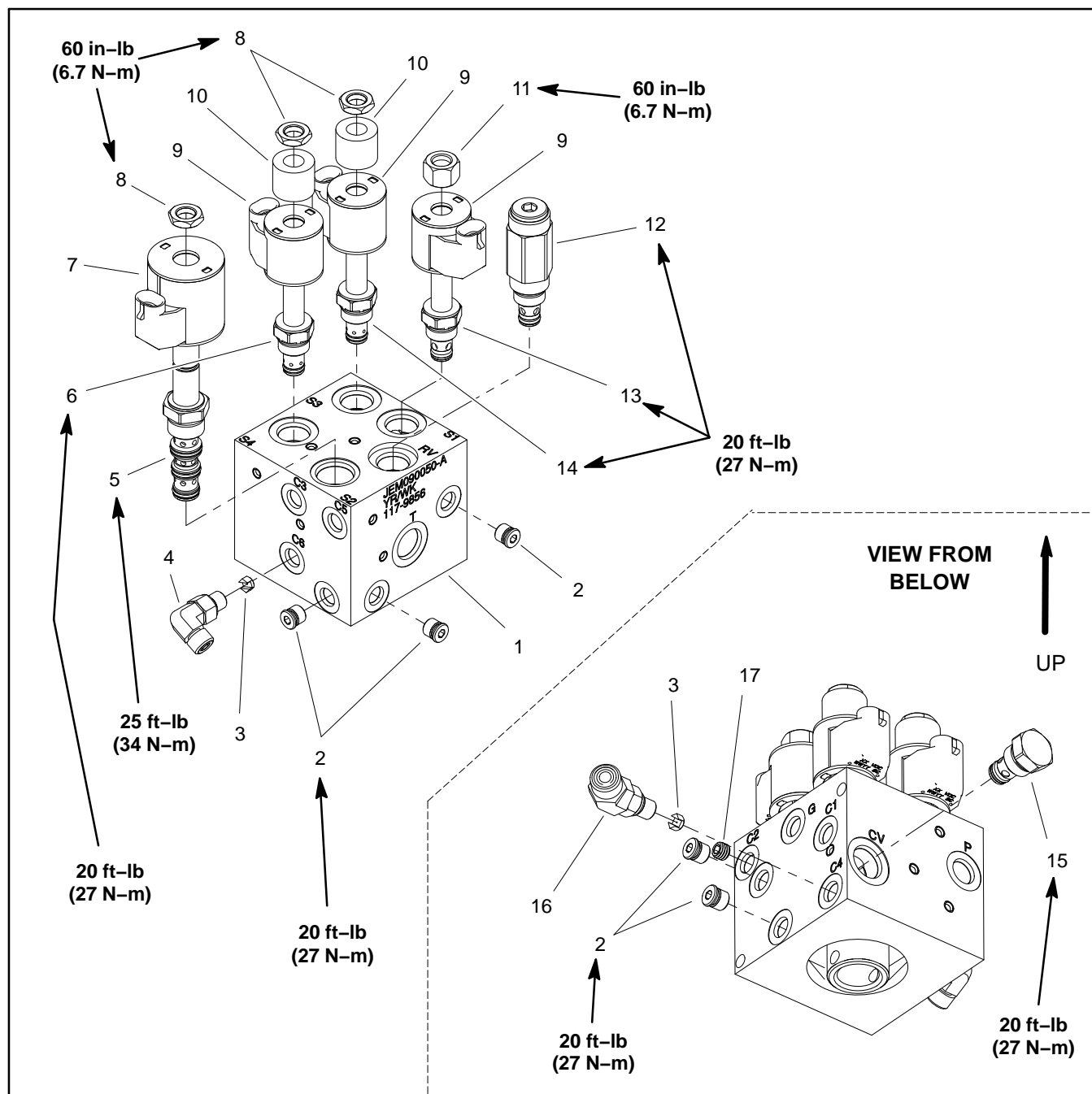


Figure 71

- | | | |
|--------------------------------------|----------------------------|-------------------------------|
| 1. Lift manifold | 7. Solenoid coil | 13. Solenoid valve (port S1) |
| 2. Zero leak plug (5 used) | 8. Nut | 14. Solenoid valve (port S3) |
| 3. Orifice (0.028) (ports C4 and C6) | 9. Solenoid coil (3 used) | 15. Check valve (port CV) |
| 4. 90° fitting | 10. Coil spacer | 16. 45° fitting |
| 5. Solenoid valve (port S2) | 11. Nut | 17. Orifice (0.037) (port C2) |
| 6. Solenoid valve (port S4) | 12. Relief valve (port RV) | |

NOTE: The ports on the lift control manifold are marked for easy identification of components. Example: S1 is the solenoid valve and P is the supply port (see Hydraulic Schematic to identify the function of the hydraulic lines and cartridge valves at each port location).



CAUTION

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



WARNING

If lift manifold is attached to machine, make sure that cutting units are fully lowered before loosening hydraulic lines or cartridge valves from lift manifold. If cutting units are raised as components are loosened in manifold, cutting units may drop unexpectedly.

NOTE: The hydraulic manifold shown in Figure 71 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 71.

For cartridge valve service procedures, see Control Manifold Cartridge Valve Service in this section. Refer to Figure 71 for lift manifold cartridge valve and plug installation torque.

Power Steering Valve

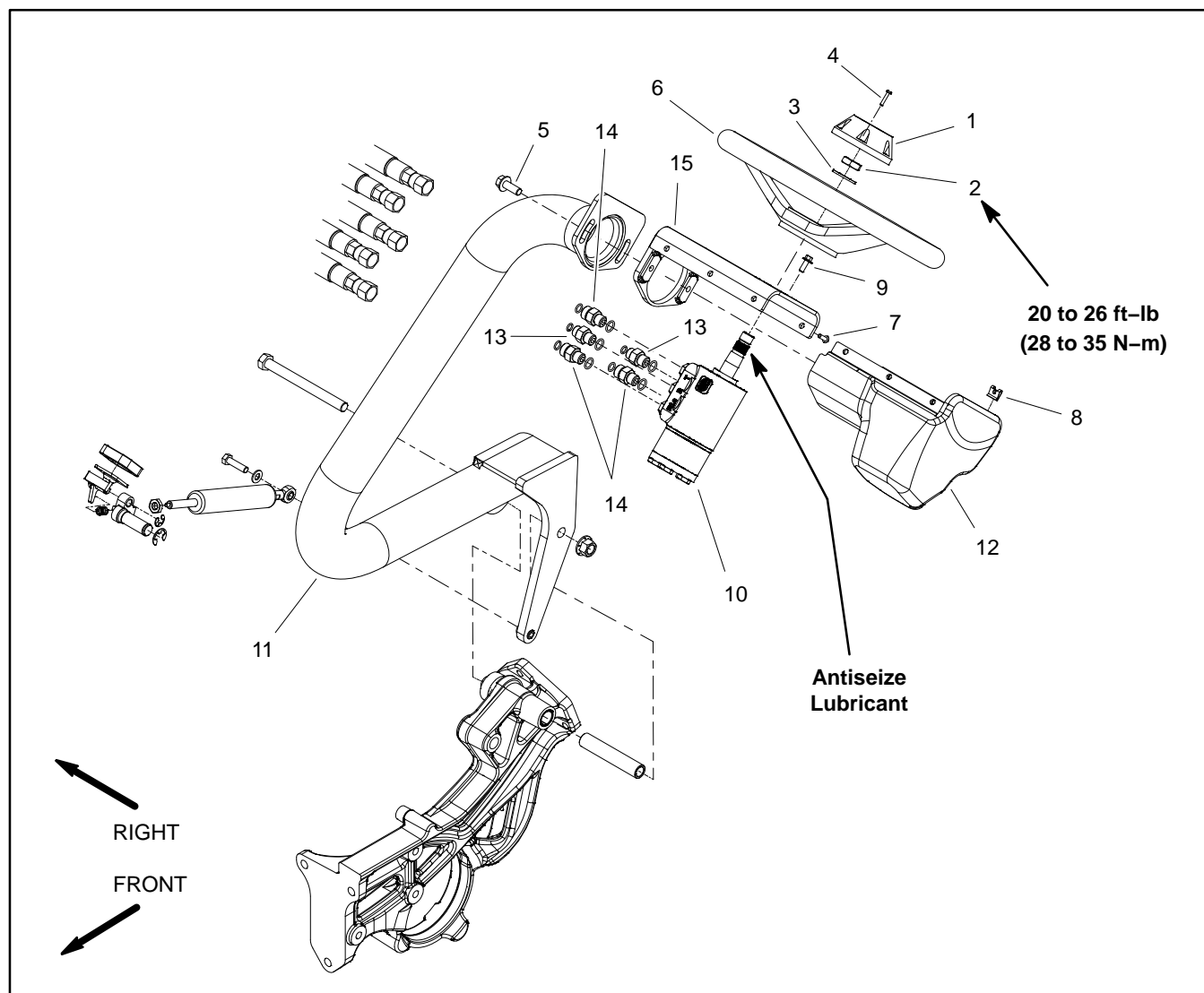
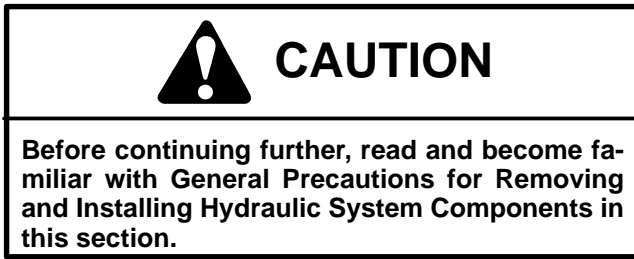


Figure 72

- | | | |
|-------------------------------|-------------------------------|---|
| 1. Steering wheel cap | 6. Steering wheel | 11. Steering arm |
| 2. Hex nut | 7. Button head screw (6 used) | 12. Steering valve cover |
| 3. Flat washer | 8. Tinnerman nut (6 used) | 13. Straight hydraulic fitting (3 used) |
| 4. Screw | 9. Flange head screw (4 used) | 14. Straight hydraulic fitting (2 used) |
| 5. Flange head screw (2 used) | 10. Power steering valve | 15. Steering mount |

Removal (Fig. 72)

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



2. Operate all hydraulic controls to relieve hydraulic system pressure.

3. Remove steering wheel from power steering valve:

A. Remove screw and steering wheel cap from steering wheel.

B. Remove hex nut and flat washer that secure steering wheel to power steering valve shaft.

C. Use a suitable puller to remove steering wheel from power steering valve.

4. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

5. Loosen and remove four (4) flange head screws that secure power steering valve to steering mount.

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

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

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

9. Remove steering valve from machine.

10. If necessary, remove hydraulic fittings and O-rings from power steering valve. Discard removed O-rings.

Installation (Fig. 72)

1. If fittings were removed from power steering 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 power steering valve to steering mount.

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

4. Slide power steering valve (with hydraulic hoses attached) to steering mount. Secure steering valve to mount with four (4) flange head screws.

5. Install steering wheel to power steering valve:

A. Apply antiseize lubricant to splines of power steering valve shaft taking care to keep antiseize lubricant from tapered surface of shaft. Slide steering wheel onto steering valve.

B. Secure steering wheel to steering valve shaft with flat washer and hex nut. Torque nut from **20 to 26 ft-lb (28 to 35 N-m)**.

C. Install steering wheel cap to steering wheel.

6. Check fluid level in hydraulic oil reservoir and adjust as required.

7. After assembly is completed, rotate steering wheel in both directions to verify that there are no leaks from hydraulic connections.

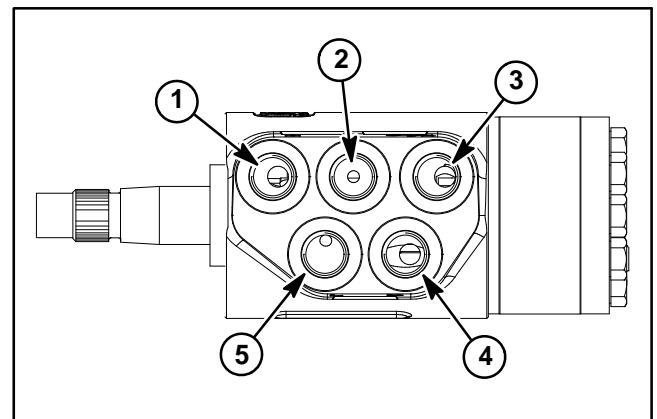


Figure 73

- 1. T port
- 2. R port
- 3. E/Ls port

- 4. P port
- 5. L port

Power Steering Valve Service

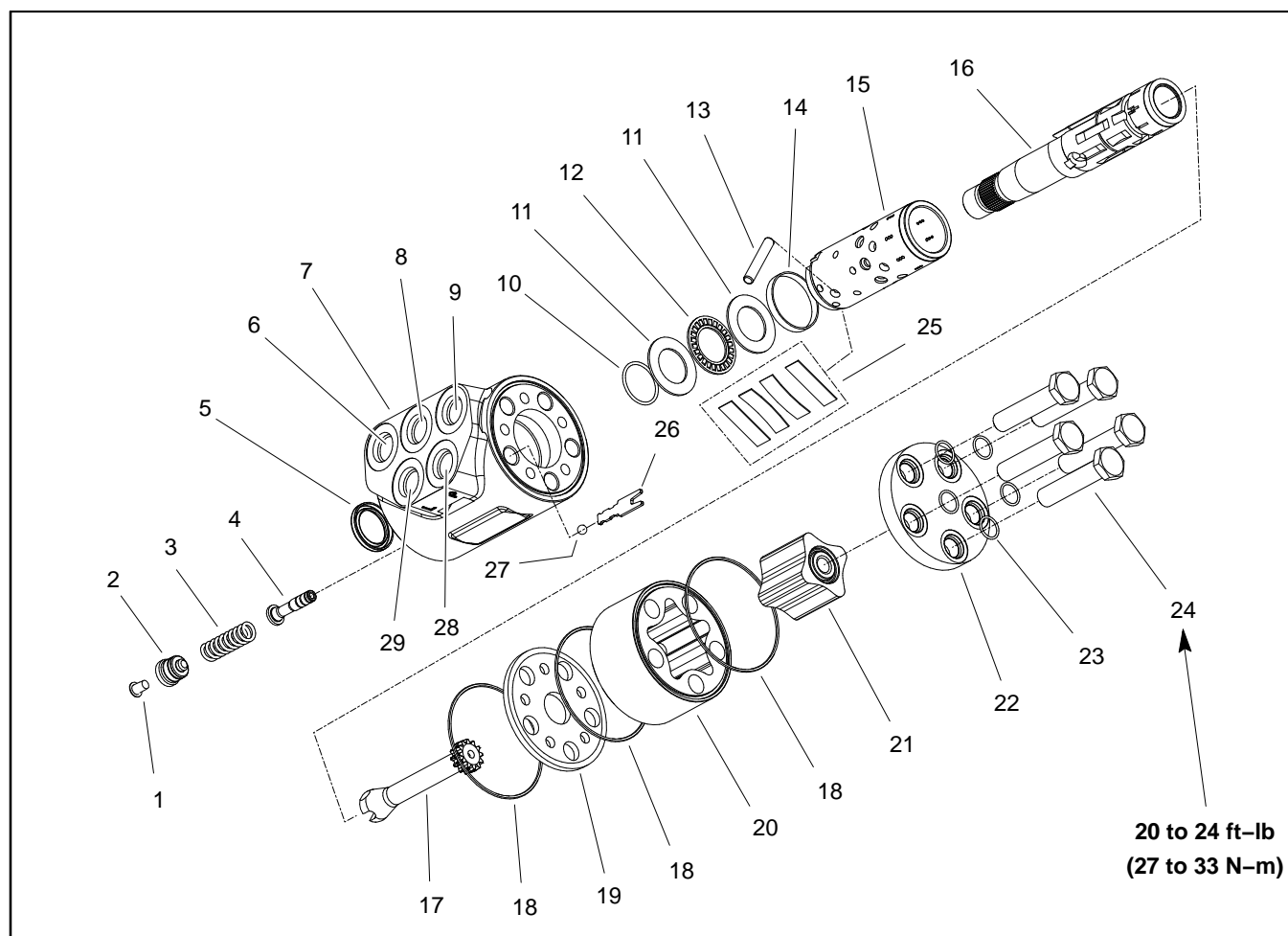


Figure 74

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

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

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Steering Cylinder

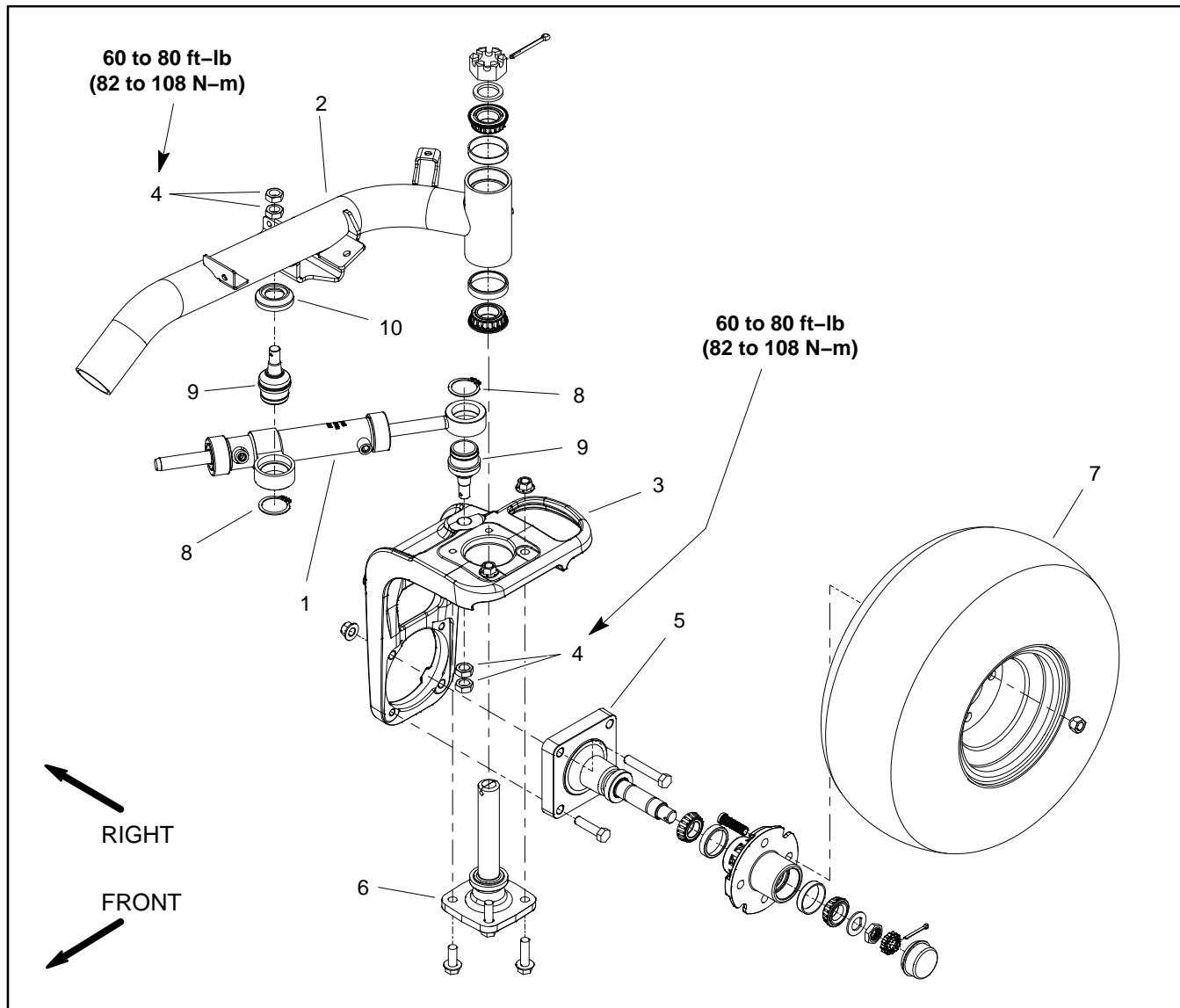


Figure 75

- | | | |
|-----------------------|------------------------|----------------------------|
| 1. Steering cylinder | 5. Rear wheel spindle | 8. Retaining ring (2 used) |
| 2. Frame | 6. Steering spindle | 9. Ball joint (2 used) |
| 3. Rear steering fork | 7. Rear wheel and tire | 10. Cylinder spacer |
| 4. Jam nut (4 used) | | |

Removal (Fig. 75)

1. Park 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 in this section.

2. Operate all hydraulic controls to relieve hydraulic system pressure.

3. To allow easier access to steering cylinder, raise and support tank mount plate assembly (hydraulic reservoir, fuel tank and tank mount plate) (see Tank Mount Plate Assembly in the Service and Repairs section of Chapter 7 – Chassis).

4. Label steering cylinder hydraulic hoses for assembly purposes. Thoroughly clean hydraulic hose ends prior to disconnecting the hoses from steering cylinder.

5. Remove hose assemblies and O-rings from hydraulic fittings at the cylinder. Allow hoses to drain into a suitable container.
6. Put clean caps or plugs on disconnected hoses and fittings to prevent contamination.
7. Support steering cylinder to prevent it from falling.
8. Remove jam nuts that secure cylinder ball joints to frame and rear fork assembly.
9. Separate cylinder ball joints from frame and rear fork. Remove steering cylinder from machine. Locate and retrieve cylinder spacer (item 10).
10. If necessary, remove hydraulic fittings from steering cylinder and discard O-rings.
11. If necessary, remove ball joints from steering cylinder. Discard removed ball joints.

Installation (Fig. 75)

1. If ball joints were removed from steering cylinder, press new ball joints into steering cylinder and secure with retaining rings.
2. If fittings were removed from steering cylinder, lubricate and place new O-rings onto fittings. Install fittings into cylinder port openings. Tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).
3. Thoroughly clean tapered surfaces of steering cylinder ball joints and cylinder attachment bores on machine.
4. Place cylinder spacer (item 10) onto cylinder barrel ball joint.
5. Insert ball joints of cylinder into attachment points on frame and rear fork assembly.
6. Secure both steering cylinder ball joints to machine with two (2) jam nuts (item 4). Install first jam nut and torque from **60 to 80 ft-lb (82 to 108 N-m)**. Then, while holding first jam nut with wrench, tighten second jam nut and torque from **60 to 80 ft-lb (82 to 108 N-m)**.

7. Remove caps and plugs from disconnected hoses and fittings.
8. Lubricate new O-rings and connect hydraulic hoses to steering cylinder (Fig. 76). Tighten hose connections (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).
9. Lower and secure tank mount plate assembly (hydraulic reservoir, fuel tank and tank mount plate) (see Tank Mount Plate Assembly in the Service and Repairs section of Chapter 7 – Chassis).
10. Check fluid level in hydraulic oil reservoir and adjust as required.
11. After assembly is completed, operate steering cylinder to verify that hydraulic hoses and fittings are not contacted by anything and that there are no leaks. Also, make sure that a clockwise rotation of the steering wheel turns the rear wheel for a right turn.

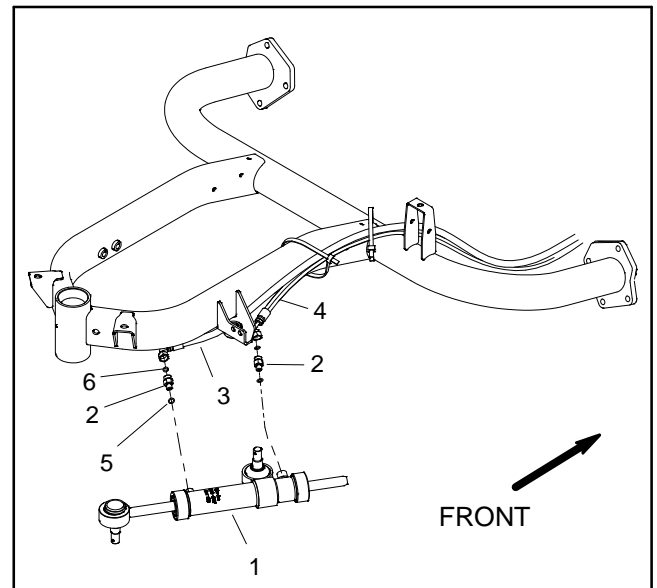


Figure 76

- | | |
|-------------------------------|-------------------|
| 1. Steering cylinder | 4. Hydraulic hose |
| 2. Hydraulic fitting (2 used) | 5. O-ring |
| 3. Hydraulic hose | 6. O-ring |

Steering Cylinder Service

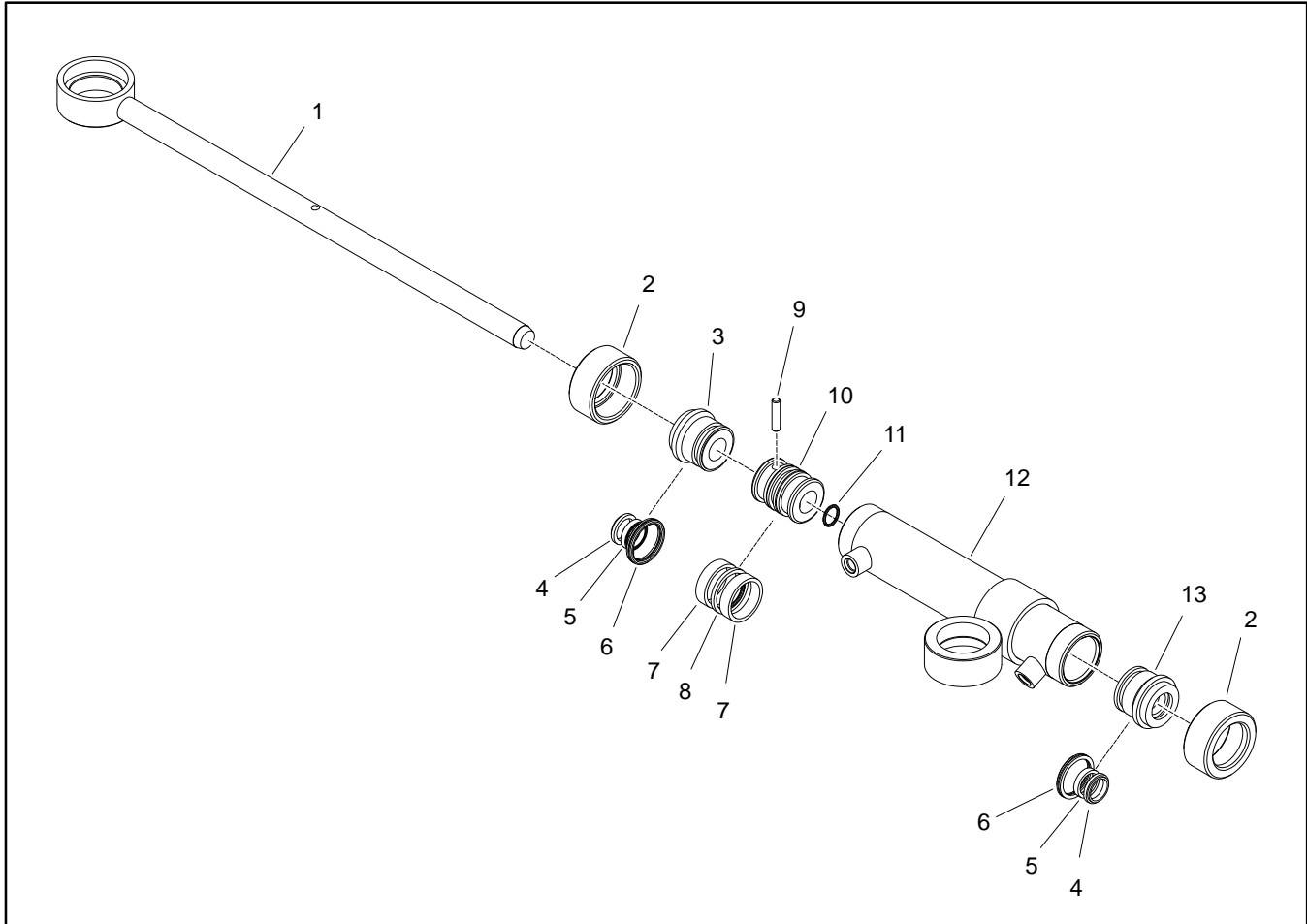


Figure 77

- 1. Shaft
- 2. Collar
- 3. Head (ball joint end)
- 4. Dust seal
- 5. Shaft seal

- 6. O-ring and backup ring
- 7. Wear ring
- 8. Piston seal
- 9. Dowel pin

- 10. Piston
- 11. O-ring
- 12. Barrel
- 13. Head (non-ball joint end)

Disassembly (Fig. 77)

1. Pump oil out of cylinder into a drain pan by slowly moving shaft 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 shaft 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. Using a pipe wrench, carefully remove both collars (item 2) from cylinder barrel.

4. Carefully remove non-ball joint end head (item 13) from end of barrel.

5. Grasp end of shaft and use a twisting and pulling motion to carefully extract shaft assembly (with collar, ball joint end head and piston) from cylinder barrel.

6. Remove wear ring from piston to allow access to dowel pin (item 9) that secures piston to shaft.

7. Use press to carefully remove dowel pin (item 9) from piston and shaft.

8. Slide piston (item 10), ball joint end head (item 3) and collar (item 2) from shaft.

9. Remove and discard seals, back-up rings, wear rings and O-rings from piston and both heads.



10. 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.

11. Carefully inspect internal surface of barrel for damage (deep scratches, out-of-round, etc). Inspect shaft, both heads and piston for evidence of excessive scoring, pitting or wear. Replace entire steering cylinder if internal components are damaged.

Assembly (Fig. 77)

1. Put a coating of clean hydraulic oil on all new seals, back-up rings, wear rings and O-rings.

2. Install new shaft seal, dust seal, back up ring and O-ring onto both heads (items 3 and 13).

3. Install piston seal and O-ring to the piston (item 10). Also, install one (1) wear ring onto piston in groove that does not contain hole for dowel pin. Second wear ring will be installed after piston is secured to shaft.

4. Carefully slide collar (item 2), ball joint end head (item 3), second piston wear ring and piston (item 10) onto shaft taking care to not damage seals. Make sure that hole in piston for dowel pin is orientated toward ball joint end of shaft.

5. Align holes in piston and shaft. Use press to install dowel pin (item 9) into piston and shaft. Make sure that dowel pin ends do not extend into the piston wear ring location.

6. Install second wear ring into piston groove that contains hole for dowel pin.

7. Coat all internal cylinder parts with a light coat of clean hydraulic oil. Carefully slide shaft assembly (with collar, ball joint end head and piston) into the barrel being careful to not damage seals.

8. Lubricate non-ball joint end head (item 13) assembly with clean hydraulic oil and carefully slide it onto shaft and into barrel.

9. Using a pipe wrench, install collars to secure both heads in cylinder barrel.

Hydraulic Reservoir (Machines Equipped with Turf Guardian™ Leak Detector System)

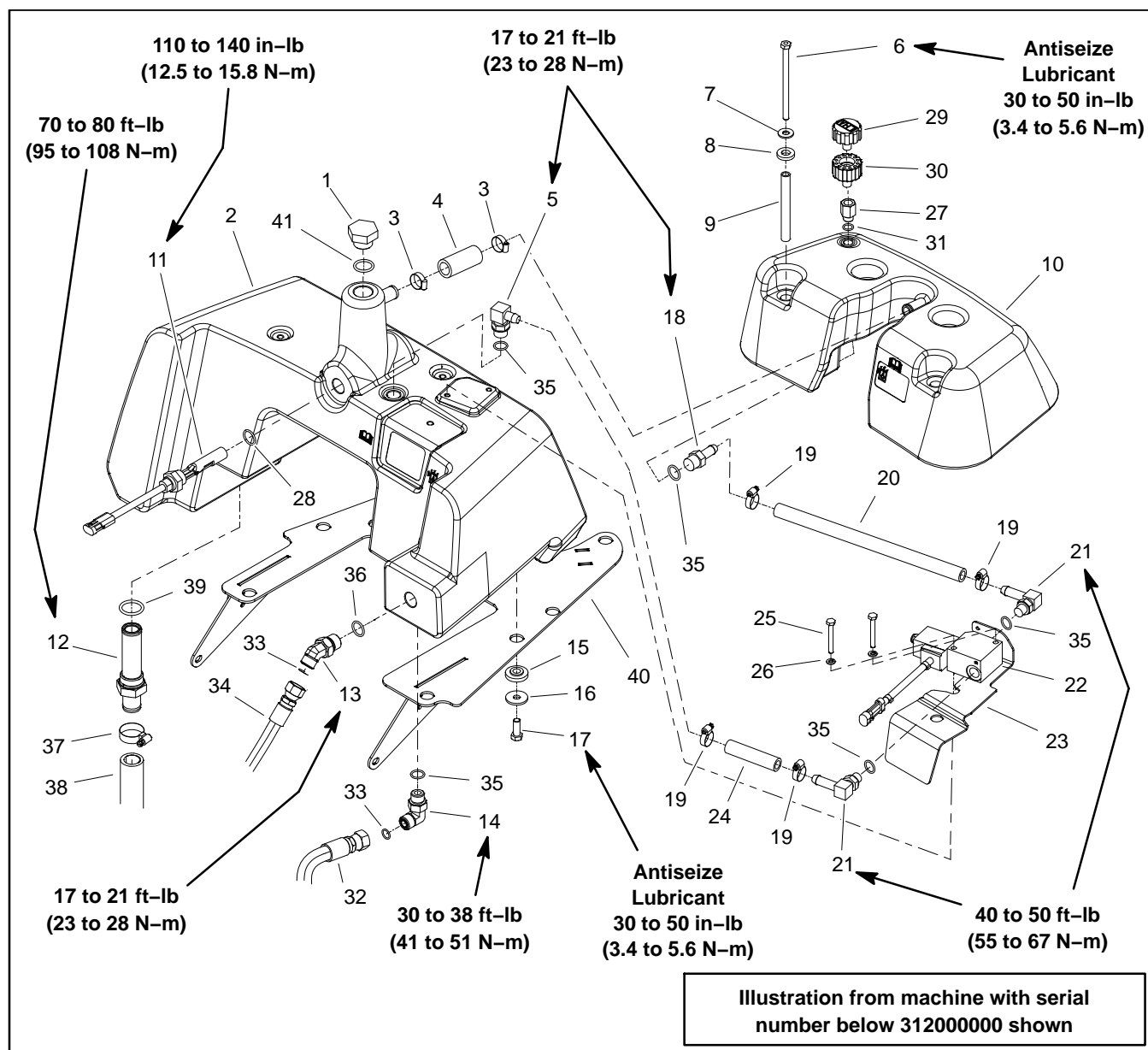


Figure 78

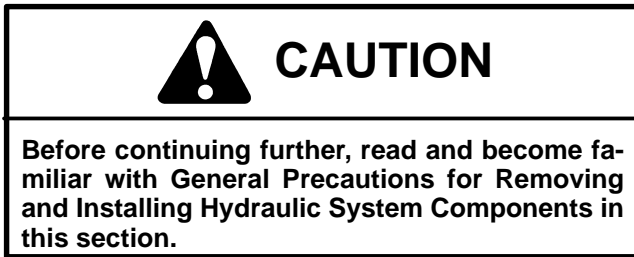
- | | | |
|-----------------------------|------------------------------------|----------------------|
| 1. Plug | 15. Flange bushing (4 used) | 29. Breather |
| 2. Hydraulic reservoir | 16. Flat washer (4 used) | 30. Breather adapter |
| 3. Hose clamp (2 used) | 17. Cap screw (4 used) | 31. O-ring |
| 4. Overflow hose | 18. Straight barb fitting | 32. Hydraulic hose |
| 5. 90° hydraulic fitting | 19. Hose clamp (4 used) | 33. O-ring |
| 6. Cap screw (4 used) | 20. Valve hose | 34. Hydraulic hose |
| 7. Flat washer (4 used) | 21. 90° hydraulic fitting (2 used) | 35. O-ring |
| 8. Neoprene washer (4 used) | 22. Solenoid valve assembly | 36. O-ring |
| 9. Spacer (4 used) | 23. Cover | 37. Hose clamp |
| 10. Leak detector tank | 24. Tank hose | 38. Suction hose |
| 11. Oil level sensor | 25. Cap screw (2 used) | 39. O-ring |
| 12. Strainer | 26. Lock washer (2 used) | 40. Tank mount plate |
| 13. 45° hydraulic fitting | 27. Fitting | 41. O-ring |
| 14. 90° hydraulic fitting | 28. O-ring | |

NOTE: Greensmaster machines with gasoline engines are equipped with the Turf Guardian™ Leak Detector System. On machines with a diesel engine, the Leak Detector System is optional.

NOTE: See Turf Guardian™ Leak Detector System in Chapter 6 – Electrical System for leak detector operation information.

Removing Hydraulic Reservoir (Fig. 78)

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



2. Disconnect oil level sensor wire connector from machine wire harness.

3. Remove leak detector tank (see Leak Detector Tank Removal in this section).

4. Remove leak detector solenoid valve assembly from hydraulic reservoir (see Leak Detector Solenoid Valve Assembly in this section).

5. Completely drain hydraulic oil from hydraulic reservoir through gear pump inlet (suction) hose into a suitable container.

6. Label hydraulic reservoir hoses for assembly purposes. Thoroughly clean hydraulic hose ends prior to disconnecting the hoses from reservoir fittings.

7. Remove hose assemblies and O-rings from reservoir fittings. Allow hoses to drain into suitable container.

8. Put clean caps or plugs on disconnected hoses and fittings to prevent contamination.

9. To allow easier access to fasteners that secure hydraulic reservoir, raise and support tank mount plate assembly (hydraulic reservoir, fuel tank and tank mount plate) (see Tank Mount Plate Assembly in the Service and Repairs section of Chapter 7 – Chassis).

10. Remove four (4) cap screws (item 17), flat washers (item 16) and flange bushings (item 15) that secure the hydraulic reservoir (item 2) to the tank mount plate.

11. Remove hydraulic reservoir from machine.

12. If hydraulic fittings are to be removed from reservoir, mark fitting orientation to allow correct assembly. Remove hydraulic fittings from hydraulic reservoir as needed. Discard O-rings from removed fittings.

13. Remove oil level sensor (item 11) from hydraulic reservoir. Discard O-ring from sensor.

14. Clean hydraulic reservoir and reservoir components with clean solvent. Inspect reservoir for leaks, cracks or other damage.

Installing Hydraulic Reservoir (Fig. 78)

1. Lubricate and place new O-rings onto all removed fittings. Install fittings into reservoir openings. Use marks made during the removal process to correctly orientate fittings. Refer to Figure 78 for reservoir fitting installation torque specifications.

2. Install oil level sensor into reservoir making sure that arrow on sensor is pointing down (Fig. 79). Torque sensor nut from **110 to 140 in-lb (12.5 to 15.8 N-m)**.

3. Position hydraulic reservoir onto tank mount plate.

4. Apply antiseize lubricant to threads of four (4) cap screws (item 17). Secure hydraulic reservoir to the tank mount plate with four (4) cap screws, flat washers (item 16) and flange bushings (item 15). Torque cap screws from **30 to 50 in-lb (3.4 to 5.6 N-m)**.

5. Lower and secure tank mount plate assembly (hydraulic reservoir, fuel tank and tank mount plate) (see Tank Mount Plate Assembly in the Service and Repairs section of Chapter 7 – Chassis).

6. Remove caps and plugs from disconnected hydraulic hoses and reservoir fittings.

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

8. Install leak detector solenoid valve assembly to hydraulic reservoir (see Leak Detector Solenoid Valve Assembly in this section).

9. Install leak detector tank (see Leak Detector Tank Installation in this section).

10. Connect oil level sensor wire connector to machine wire harness.

11. Fill hydraulic reservoir with new hydraulic oil.

12. Verify leak detector operation.

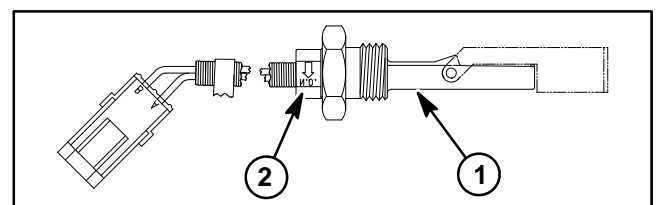


Figure 79

1. Oil level sensor

2. Sensor arrow

Hydraulic Reservoir (Machines Not Equipped with Turf Guardian™ Leak Detector System)

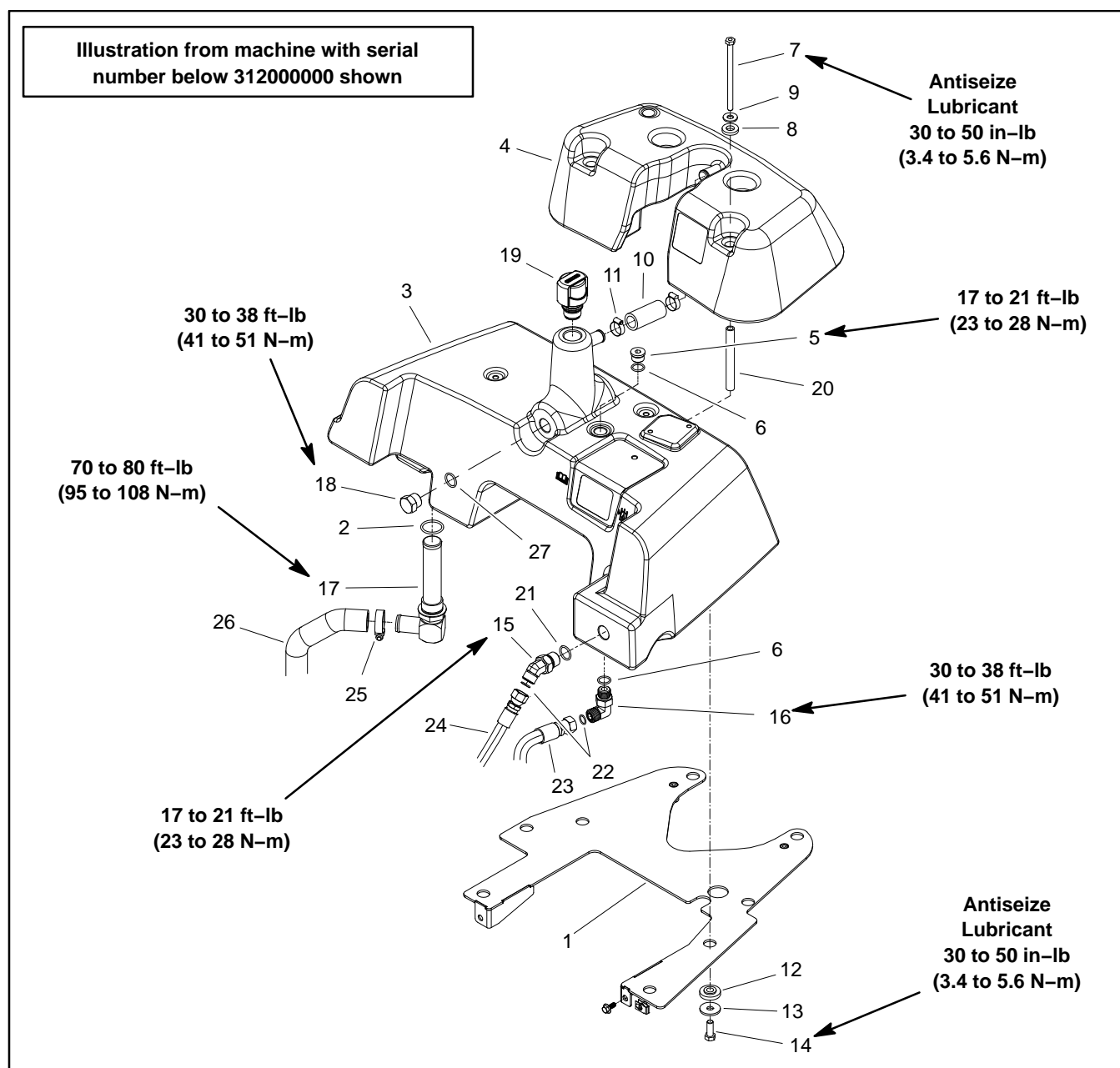


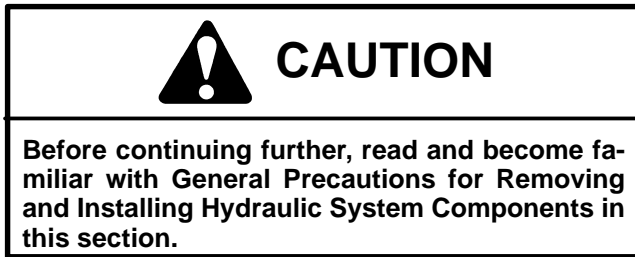
Figure 80

- | | | |
|-----------------------------|-----------------------------|---------------------|
| 1. Tank mount plate | 10. Overflow hose | 19. Breather |
| 2. O-ring | 11. Hose clamp (2 used) | 20. Spacer (4 used) |
| 3. Hydraulic reservoir | 12. Flange bushing (4 used) | 21. O-ring |
| 4. Reservoir cover | 13. Flat washer (4 used) | 22. O-ring |
| 5. Plug | 14. Cap screw (4 used) | 23. Hydraulic hose |
| 6. O-ring | 15. 45° hydraulic fitting | 24. Hydraulic hose |
| 7. Cap screw (4 used) | 16. 90° hydraulic fitting | 25. Hose clamp |
| 8. Neoprene washer (4 used) | 17. Strainer | 26. Suction hose |
| 9. Flat washer (4 used) | 18. Plug | |

NOTE: Greensmaster machines with gasoline engines are equipped with the Turf Guardian™ Leak Detector System. On machines with a diesel engine, the Leak Detector System is optional.

Removing Hydraulic Reservoir (Fig. 80)

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



2. Remove four (4) cap screws (item 7), flat washers (item 9), neoprene washers (item 8) and spacers (item 20) that secure reservoir cover to hydraulic reservoir.

3. Loosen hose clamp and disconnect overflow hose (item 10) from reservoir cover barb.

NOTE: On Greensmaster 3300 machines with serial number above 312000000, the fuel system carbon canister is attached to the reservoir cover. See Fuel System Carbon Canister (Serial Number Above 312000000) in the Service and Repairs section of Chapter 3 – Gasoline for information on disconnecting the canister.

4. Remove reservoir cover from machine.
5. Completely drain hydraulic oil from reservoir through gear pump suction hose into a suitable container.

6. Label reservoir hydraulic hoses for assembly purposes. Thoroughly clean hydraulic hose ends prior to disconnecting hoses from hydraulic reservoir fittings.

7. Remove hydraulic hoses and O-rings from hydraulic reservoir fittings. Drain hoses into a suitable container.

8. Put clean caps or plugs on disconnected hoses and fittings to prevent contamination.

9. To allow easier access to fasteners that secure hydraulic reservoir, raise and support tank mount plate assembly (hydraulic reservoir, fuel tank and tank mount plate) (see Tank Mount Plate Assembly in the Service and Repairs section of Chapter 7 – Chassis).

10. Remove four (4) cap screws (item 14), flat washers (item 13) and flange bushings (item 12) that secure the hydraulic reservoir (item 3) to the tank mount plate.

11. Remove hydraulic reservoir from machine.

12. If reservoir fittings are to be removed, mark fitting orientation to allow correct assembly. Remove hydraulic fittings and plugs from hydraulic reservoir as needed. Discard O-rings from removed fittings and plugs.

13. Clean hydraulic reservoir and reservoir components with clean solvent. Inspect reservoir for leaks, cracks or other damage.

Installing Hydraulic Reservoir (Fig. 80)

IMPORTANT: When installing reservoir cover and reservoir to machine, do not over-tighten cap screws. Threads in reservoir may become damaged.

1. Lubricate and place new O-rings onto all removed fittings and plugs. Install fittings and plugs into reservoir openings. Use marks made during the removal process to correctly orientate fittings. Refer to Figure 80 for reservoir fitting and plug installation torque specifications.

2. Position hydraulic reservoir onto the tank mount plate.

3. Apply antiseize lubricant to threads of four (4) cap screws (item 14). Secure hydraulic reservoir to the tank mount plate with four (4) cap screws, flat washers (item 13) and flange bushings (item 12). Torque cap screws from **30 to 50 in-lb (3.4 to 5.6 N-m)**.

4. Lower and secure tank mount plate assembly (hydraulic reservoir, fuel tank and tank mount plate) (see Tank Mount Plate Assembly in the Service and Repairs section of Chapter 7 – Chassis).

5. Remove caps and plugs from disconnected hydraulic hoses and reservoir fittings.

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

NOTE: On Greensmaster 3300 machines with serial number above 312000000, see Fuel System Carbon Canister (Serial Number Above 312000000) in the Service and Repairs section of Chapter 3 – Gasoline for information on connecting the fuel system carbon canister.

7. Position reservoir cover to top of hydraulic reservoir.

8. Connect overflow hose (item 10) to reservoir cover barb and secure with hose clamp.

9. Apply antiseize lubricant to threads of four (4) cap screws (item 7). Secure reservoir cover to hydraulic reservoir with four (4) spacers (item 20), cap screws (item 7), flat washers (item 9) and neoprene washers (item 8). Torque cap screws from **30 to 50 in-lb (3.4 to 5.6 N-m)**.

10. Fill hydraulic reservoir with new hydraulic oil.

Leak Detector Tank (Machines Equipped with Turf Guardian™ Leak Detector System)

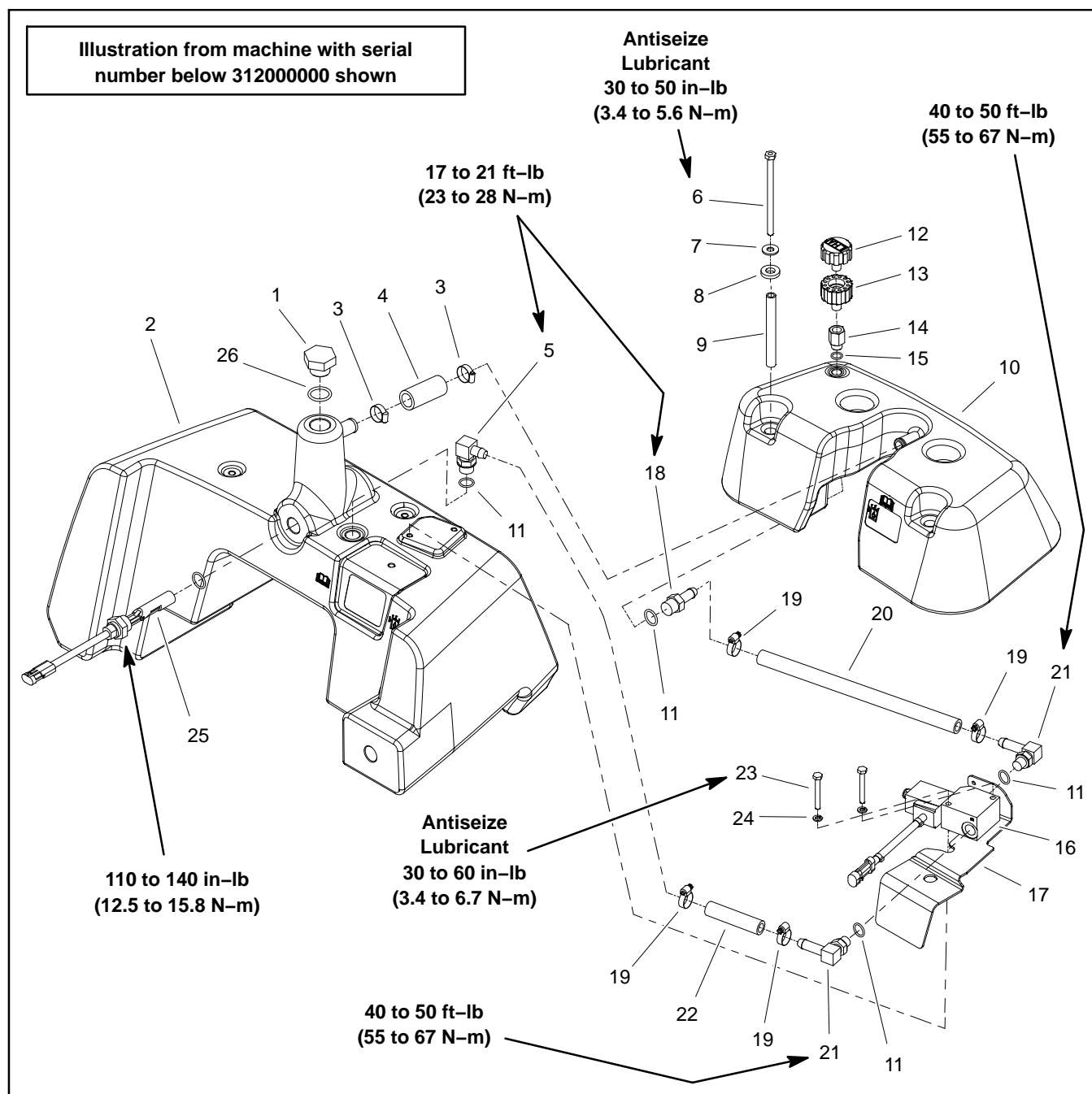


Figure 81

- | | | |
|-----------------------------|-----------------------------|-------------------------------|
| 1. Plug | 10. Leak detector tank | 19. Hose clamp (4 used) |
| 2. Hydraulic reservoir | 11. O-ring | 20. Valve hose |
| 3. Hose clamp (2 used) | 12. Breather | 21. 90° barb fitting (2 used) |
| 4. Overflow hose | 13. Breather adapter | 22. Tank hose |
| 5. 90° hydraulic fitting | 14. Hydraulic fitting | 23. Cap screw (2 used) |
| 6. Cap screw (4 used) | 15. O-ring | 24. Lock washer (2 used) |
| 7. Flat washer (4 used) | 16. Solenoid valve assembly | 25. Oil level sensor |
| 8. Neoprene washer (4 used) | 17. Cover | 26. O-ring |
| 9. Spacer (4 used) | 18. Straight barb fitting | |

NOTE: Greensmaster machines with gasoline engines are equipped with the Turf Guardian™ Leak Detector System. On machines with a diesel engine, the Leak Detector System is optional.

NOTE: See Turf Guardian™ Leak Detector System in Chapter 6 – Electrical System for leak detector operation information.

Removal (Fig. 81)

1. Park machine on a level surface, set 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 in this section.

2. Place a clean container, large enough to collect two (2) gallons (7.6 liters), under the pump assembly to collect hydraulic oil.

3. Clamp pump inlet hose to control drainage from reservoir. Remove pump inlet hose from gear pump. Release clamp from hose and drain about two (2) gallons (7.6 liters) of oil from the hydraulic reservoir (Fig. 82).

4. Clamp pump inlet hose to prevent draining additional hydraulic oil from hydraulic reservoir.

5. Remove four (4) cap screws (item 6), flat washers (item 7), neoprene washers (item 8) and spacers (item 9) that secure leak detector tank to hydraulic reservoir.

6. Thoroughly clean junction of overflow hose (item 4) and leak detector tank barb. Loosen hose clamp (item 3) and disconnect overflow hose from tank barb.

7. Lift leak detector tank slightly and clean junction of valve hose (item 20) at solenoid valve fitting (item 21). Loosen hose clamp (item 19) and disconnect valve hose at solenoid valve fitting.

NOTE: On Greensmaster 3300 machines with serial number above 312000000, the fuel system carbon canister is attached to the leak detector tank (Fig. 83). See Fuel System Carbon Canister (Serial Number Above 312000000) in the Service and Repairs section of Chapter 3 – Gasoline for information on disconnecting the canister.

8. Remove leak detector tank assembly from machine.

9. If necessary, remove valve hose (item 20), hydraulic fitting (item 18) and breather assembly from leak detector tank. Discard all removed O-rings.

10. Clean leak detector tank and tank components with clean solvent. Inspect tank for leaks, cracks or other damage.

NOTE: If solenoid valve (item 16) removal is necessary, see Leak Detector Solenoid Valve Assembly in this section.

Greensmaster 3300/3400



Figure 82

1. Gear pump

2. Pump inlet hose

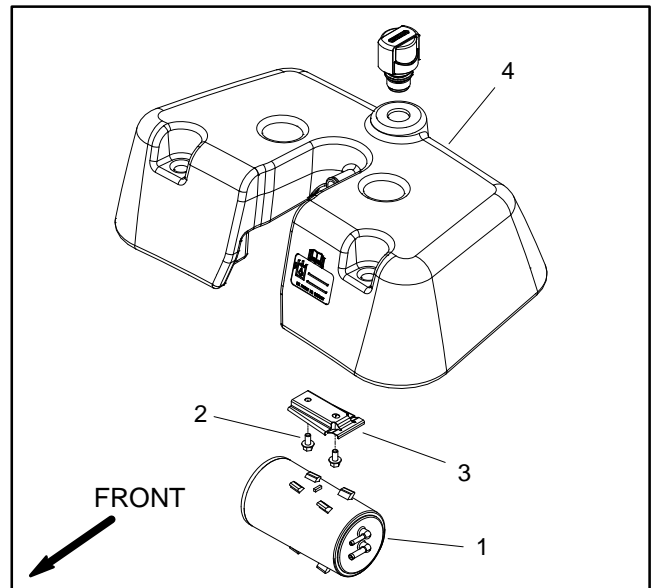


Figure 83

1. Carbon canister

2. Screw (2 used)

3. Cannister bracket

4. Leak detector tank

Installation (Fig. 81)

1. If hydraulic fitting (item 18) and breather assembly were removed from leak detector tank, lubricate and place new O-rings onto fittings. Install components into tank openings. Tighten fitting (item 18) from **17 to 21 ft-lb (23 to 28 N-m)**.

2. Connect valve hose (item 20) to tank fitting (item 18) and secure with hose clamp (item 19).

NOTE: On Greensmaster 3300 machines with serial number above 312000000, see Fuel System Carbon Canister (Serial Number Above 312000000) in the Service and Repairs section of Chapter 3 – Gasoline for information on connecting the fuel system carbon canister.

3. Position leak detector tank assembly over hydraulic reservoir and connect valve hose (item 20) to solenoid valve fitting (item 21). Secure hose with hose clamp.

4. Connect overflow hose (item 4) to leak detector tank barb and secure with hose clamp (item 3).

5. Apply antiseize lubricant to the end threads of the four (4) cap screws (item 6) used to secure leak detector tank to hydraulic reservoir.

IMPORTANT: Do not over-tighten cap screws when securing leak detector tank to hydraulic reservoir. Threads in reservoir may become damaged.

6. Secure leak detector tank to hydraulic reservoir with four spacers (item 9), neoprene washers (item 8), flat washers (item 7) and cap screws (item 6). Torque cap screws from **30 to 50 in-lb (3.4 to 5.6 N-m)**.

NOTE: Monitor hydraulic fluid level in leak detector tank window. As air is removed from the hydraulic circuit, additional oil may have to be added to reservoir.

7. Remove cap from main hydraulic reservoir and slowly fill to cold fill level mark next to sight window on leak detector tank.

8. Verify leak detector operation.

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Leak Detector Solenoid Valve Assembly (Machines Equipped with Turf Guardian™ Leak Detector System)

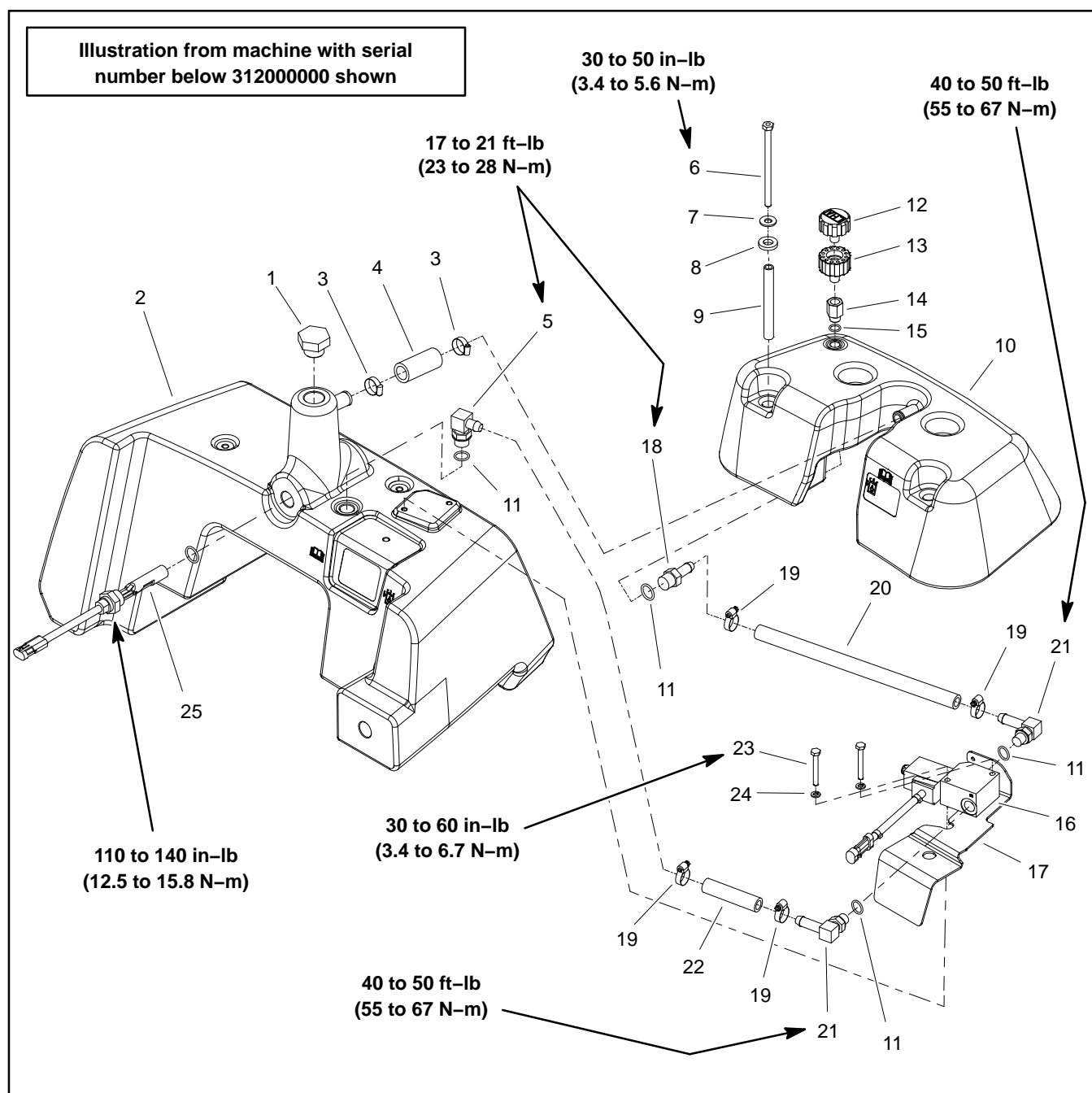


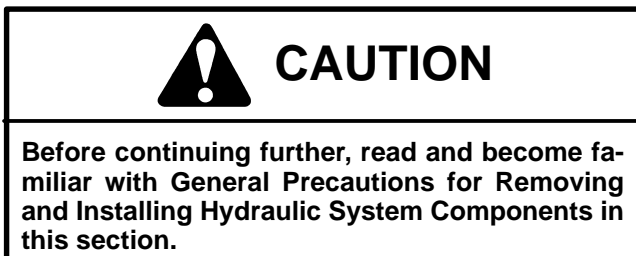
Figure 84

- | | | |
|-----------------------------|-----------------------------|-------------------------------|
| 1. Plug | 10. Leak detector tank | 18. Straight barb fitting |
| 2. Hydraulic reservoir | 11. O-ring | 19. Hose clamp (4 used) |
| 3. Hose clamp (2 used) | 12. Breather | 20. Valve hose |
| 4. Overflow hose | 13. Breather adapter | 21. 90° barb fitting (2 used) |
| 5. 90° hydraulic fitting | 14. Hydraulic fitting | 22. Tank hose |
| 6. Cap screw (4 used) | 15. O-ring | 23. Cap screw (2 used) |
| 7. Flat washer (4 used) | 16. Solenoid valve assembly | 24. Lock washer (2 used) |
| 8. Neoprene washer (4 used) | 17. Cover | 25. Oil level sensor |
| 9. Spacer (4 used) | | |

NOTE: Greensmaster machines with gasoline engines are equipped with the Turf Guardian™ Leak Detector System. On machines with a diesel engine, the Leak Detector System is optional.

Removal (Fig. 84)

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



2. Remove leak detector tank (see Leak Detector Removal in this section).
3. Clean junction of tank hose (item 22) at solenoid valve fitting (item 21). Loosen hose clamp (item 19) and disconnect tank hose at solenoid valve fitting.
4. Unplug machine wire harness connector from the solenoid valve connector.
5. Remove two (2) cap screws (item 23) and lock washers (item 24) that secure solenoid valve assembly to hydraulic reservoir.
6. Remove solenoid valve assembly from machine.
7. If necessary, remove fittings from solenoid valve manifold. Discard removed O-rings.

Manifold Service

1. Disassemble solenoid valve manifold as needed using Figure 85 as a guide.
2. For cartridge valve service procedures, see Control Manifold Cartridge Valve Service in this section.
 - 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)**.

Installation (Fig. 84)

1. If fittings were removed from solenoid valve manifold, lubricate and place new O-rings onto fittings. Install fittings into manifold openings. Tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter). Torque fittings from **40 to 50 ft-lb (55 to 67 N-m)**.
2. Apply antiseize lubricant to the end threads of the two (2) cap screws used to secure solenoid valve assembly to hydraulic reservoir.
3. Position cover (item 17) and solenoid valve assembly to hydraulic reservoir. Orientate the solenoid valve assembly so the solenoid coil is closer to the front of the reservoir.
4. Secure solenoid valve assembly to hydraulic reservoir with two (2) cap screws (item 23) and lock washers (item 24). Torque cap screws from **30 to 60 in-lb (3.4 to 6.7 N-m)**.
5. Connect tank hose (item 22) to solenoid valve fitting (item 21) and secure with hose clamp (item 19).
6. Install leak detector tank (see Leak Detector Installation in this section).

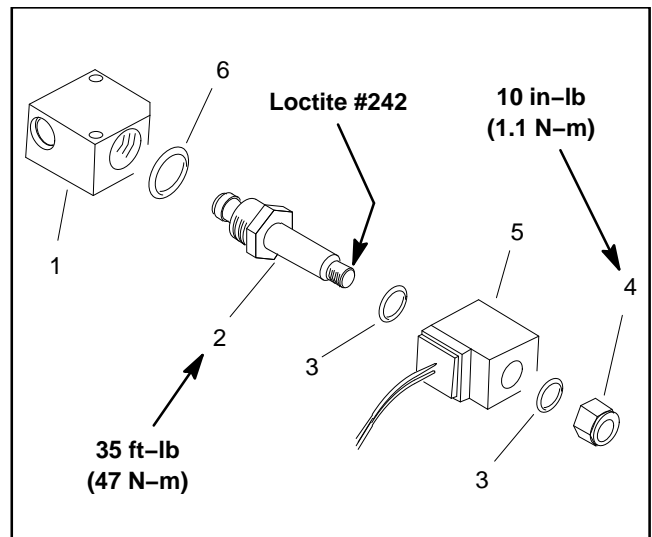


Figure 85

- | | |
|--------------------|-------------------|
| 1. Manifold | 4. Nut |
| 2. Cartridge valve | 5. Solenoid coil |
| 3. Seal | 6. Cartridge seal |

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Electrical System

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General Information

Operator's Manual

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

Electrical Drawings

The electrical schematic and wire harness drawings for Greensmaster TriFlex 3300 and 3400 machines are located in Chapter 10 – Foldout Drawings.

Toro Electronic Controller (TEC)

Greensmaster TriFlex 3300 and 3400 machines use a Toro Electronic Controller (TEC) to manage machine electrical functions. The controller is microprocessor controlled that senses the condition of various switches (inputs) and directs electrical power to control appropriate machine functions (outputs) based on the inputs. The status of inputs to the controller as well as outputs from the controller can be monitored with the Diagnostic Display (see Special Tools in this chapter).

IMPORTANT: Before performing any welding on the machine, disconnect the battery cables from the battery, disconnect the wire harness connector from the Toro Electronic Controller(s) and disconnect the terminal connector from the alternator. These steps will prevent damage to the machine electrical system.

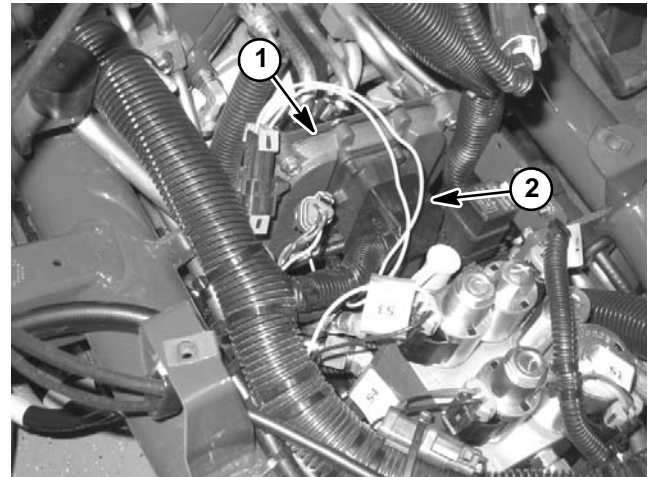


Figure 1

1. TEC controller

2. Harness connector

CAN-bus Communications

The TEC controller communicates with other electrical components on a CAN-bus communication system. The CAN-bus system reduces the number of electrical components and connections used on the machine and allows the number of wires in the wire harness to be reduced.

CAN identifies the Controller Area Network that is used on the Greensmaster. Two (2) twisted wires form the bus. These wires provide the data pathways between machine components. The engineering term for these two (2) wires are CAN-high and CAN-low. At the ends of the twisted pair of bus wires are 120 ohm termination resistors.

Each of the components that is controlled by the CAN-bus link only needs four (4) wires to operate and communicate to the system: CAN-high, CAN-low, B+ (power) and ground.

IMPORTANT: The termination resistors at the ends of the bus wires are required for proper electrical system operation.

Turf Guardian™ Leak Detector System Operation

The Turf Guardian™ Leak Detector System oil level sensor closely monitors the hydraulic fluid level in the main hydraulic reservoir. The sensor is open when the sensor float is in the raised position and closed when the float is in the lowered position.

NOTE: Greensmaster 3300 machines are equipped with the Turf Guardian™ Leak Detector System. On Greensmaster 3400 machines, the Leak Detector System is optional.

Before Start-Up (Cold Oil)

With ignition switch OFF, solenoid valve is open. Before start-up, hydraulic fluid is at level mark of sight gauge (oil cold). Oil level sensor float is in raised position, keeping alarm circuit open.

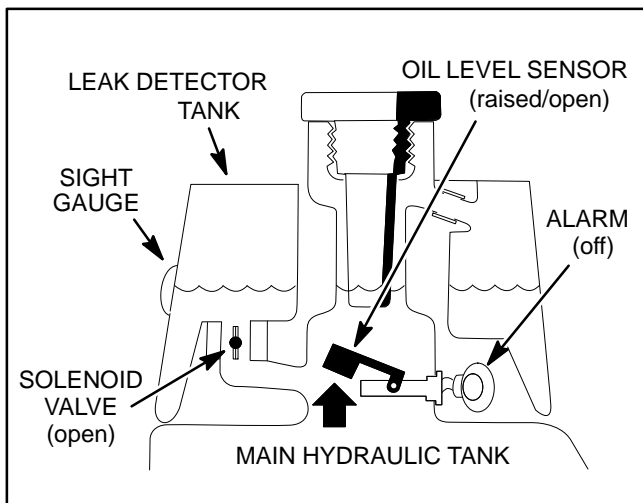


Figure 2

Normal Operation (Warm Oil)

When ignition switch is turned ON, solenoid valve closes. During normal operation, hydraulic fluid expands, causing it to overflow into leak detector tank. The oil level sensor stays in the raised position keeping alarm circuit open.

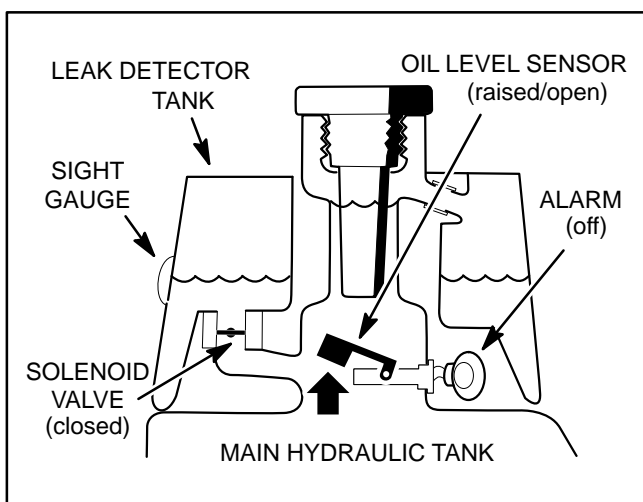


Figure 3

Leak Alert!

If hydraulic fluid leaks during operation, the fluid level in the main hydraulic tank drops. This causes the oil level sensor float to lower, closing the alarm circuit. The alarm will sound and the console indicator light will illuminate after a one (1) second time delay.

NOTE: During normal operation, with cutting units lowered, approximately 5 oz (148 ml) of hydraulic fluid will leak before the oil level sensor float closes the alarm circuit and activates the alarm.

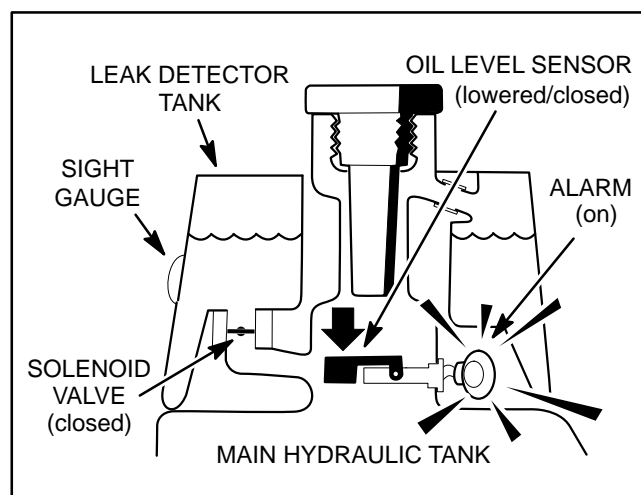


Figure 4

Special Tools

Order special tools from your Toro Distributor. Some tools may also be available from a local supplier.

Multimeter

The meter can test electrical components and circuits for current, resistance or voltage. 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.

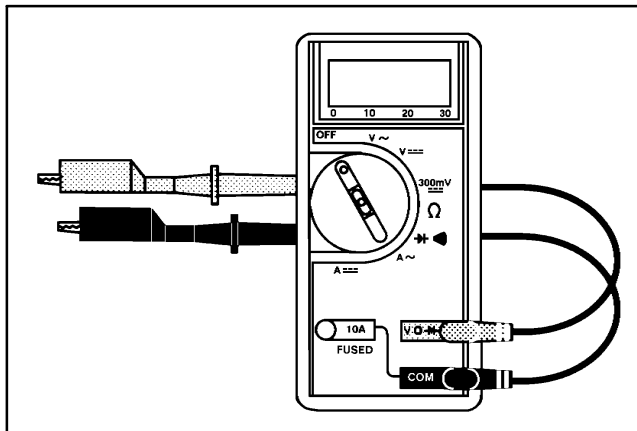


Figure 5

Diagnostic Display

The Diagnostic Display (Fig. 6) can be connected to the wiring harness communication connector located under the operator seat to verify correct electrical functions of the Toro Electronic Controller (TEC). TEC inputs and outputs can be checked using the Diagnostic Display.

Toro Part Number for Diagnostic Display: **85–4750**

Toro Part Number for Greensmaster 3300/3400 Overlay (English): **115–8227**

NOTE: Diagnostic Display overlays are available in several languages for your Greensmaster. Refer to your Parts Catalog for overlay language options and part numbers.

NOTE: An error exists on the overlay for OUTPUT LEDs 9 and 10. Output 9 actually represents the circuit for solenoid valve S4, and output 10 actually represents the circuit for solenoid valve S3. Refer to the electrical schematics in this revised manual if necessary.

IMPORTANT: The Diagnostic Display must not be left connected to the machine. It is not designed to withstand the environment of the machine's every day use. When use of Diagnostic Display is completed, disconnect it from the machine and reconnect loopback connector to harness connector. Machine will not operate without loopback connector installed on harness. Store Diagnostic Display in a dry, secure, indoor location and not on machine.



Figure 6

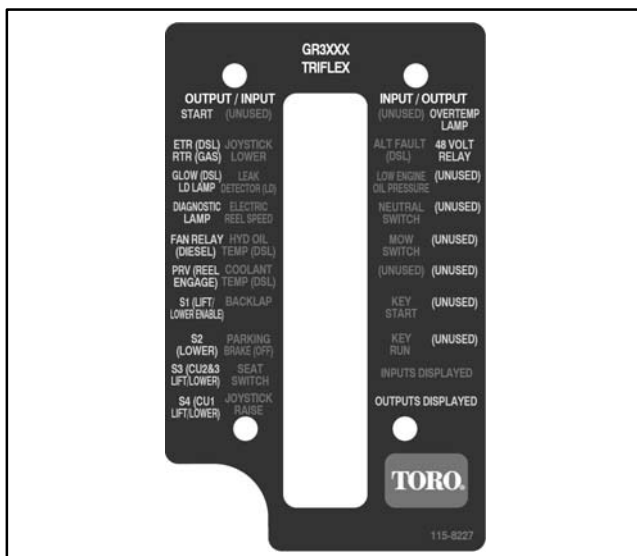


Figure 7

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 8

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 9

Dielectric Gel

Dielectric gel should be used to prevent corrosion of connection terminals. To ensure complete coating of terminals, liberally apply gel to both component and wire harness connector, plug connector to component, unplug connector, reapply gel to both surfaces and reconnect harness connector to component. Connectors should be thoroughly packed with gel for effective results.

Toro Part Number: **107-0342**



Figure 10

Battery Hydrometer

Use the Battery Hydrometer when measuring specific gravity of battery electrolyte. Obtain this tool locally.



Figure 11

Troubleshooting



CAUTION

Remove all jewelry, especially rings and watches, before doing any electrical troubleshooting or testing. Disconnect the battery cables unless the test requires battery voltage.

For effective troubleshooting and repairs, there must be a good understanding of the electrical circuits and components used on this machine (see electrical schematic and wire harness drawings in Chapter 10 – Foldout Drawings).

If the machine has any interlock switches by-passed, they must be reconnected for proper troubleshooting and safety.

Diagnostic Light

Greensmaster TriFlex machines are equipped with a diagnostic light that indicates if the machine electrical system is functioning correctly. The diagnostic light is located on the control panel (Fig. 12).

When the ignition switch is moved to the RUN position and the machine electrical system is functioning properly, the diagnostic light will be illuminated for approximately three (3) seconds and then will turn off. The light should remain off during normal machine operation.

If the machine TEC controller detects an electrical system malfunction (fault) during machine operation, the diagnostic light will flash rapidly. The light will stop flashing and will automatically reset when the ignition switch is turned to the OFF position. The fault, however, will be retained in controller memory and can be retrieved at a future time (see Retrieving Fault Codes below).

If the diagnostic light does not illuminate when the ignition switch is turned to the RUN position, possible causes are:

- The loopback connector is not connected to the machine wire harness (Fig. 13).
- The diagnostic light (or circuit wiring) is faulty.
- TEC controller fuses are faulty (see Fuses in the Component Testing section of this chapter).
- The TEC controller is faulty.

Check electrical connections, controller fuses and the diagnostic light to determine malfunction. Make sure that the loopback connector (located under right side cover next to operator seat) is secured to the wire harness connector.

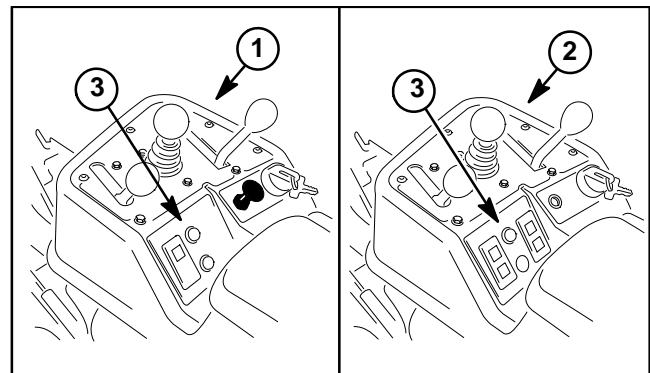


Figure 12

1. Console (GR3300)
2. Console (GR3400)
3. Diagnostic light

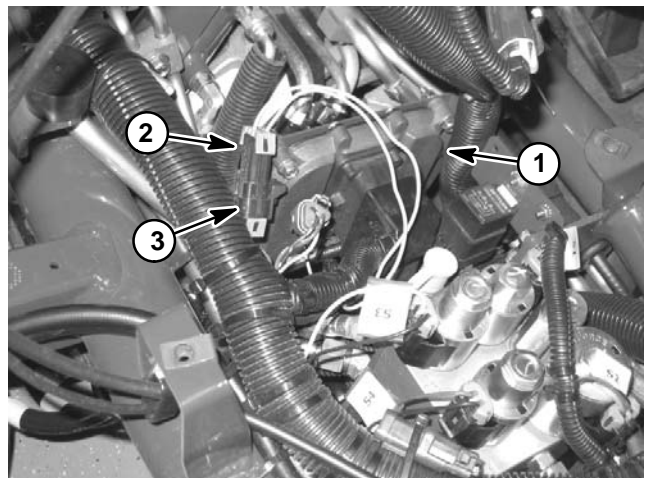


Figure 13

1. TEC controller location
2. Loopback connector
3. Harness connector

Retrieving Fault Codes

All machine fault codes are retained in the TEC controller memory. The three (3) most recent fault codes that have occurred within the last forty (40) hours of operation can be retrieved using the diagnostic light. To retrieve these fault codes from the controller memory, perform the following switch sequence:

1. Operator seat should be UNOCCUPIED.
2. Place functional control lever in the TRANSPORT position.
3. Make sure that backlap valve on mow control manifold is in the MOW position.
4. Move and hold joystick in the RAISE position.
5. Turn ignition switch to the RUN position.
6. Monitor the diagnostic light for fault code(s).

NOTE: Once the diagnostic light begins to display fault codes, the joystick can be released.

Fault codes displayed by the diagnostic light consist of a two digit number. Fault codes are listed in the chart below. There will be a one (1) second pause between the first and second digit of a code. Up to three (3) fault codes retained in controller memory will be displayed by the diagnostic light in order from the most recent fault to the oldest fault. If there are multiple faults in controller memory, there will be a three (3) second pause between codes. The fault codes will continually repeat after a five (5) second pause until the ignition key is turned off.

If there are no faults that have occurred within the last forty (40) hours of operation, the diagnostic light will flash continuously after performing the above fault retrieval switch sequence.

If a fault code is not retrieved from the controller memory within forty (40) hours of machine operating time, the fault cannot be retrieved from controller memory using this procedure. If necessary, contact your Toro distributor to retrieve older fault codes.

Fault Code (Lamp Flashes)	Fault Description
2 – 1	Controller has been replaced causing machine identification to be in error
2 – 9	TEC controller is faulty
3 – 1	Coolant sensor is faulty
3 – 2	Excessive engine temperature has caused engine shutdown
3 – 7	Current to fan relay is excessive
3 – 9	TEC controller is faulty
4 – 3	Optional hydraulic oil temperature sensor is faulty (GR3400)
4 – 7	Current to console high temperature warning light is excessive (GR3400)
5 – 2	Engine alternator voltage output is excessive
5 – 4	Right fuse 2 (7.5 amp) for TEC outputs is faulty
5 – 5	Right fuse 3 (7.5 amp) for TEC outputs is faulty
5 – 6	Right fuse 4 (7.5 amp) for TEC outputs is faulty
5 – 7	Current to leak detector alarm (GR3300) or glow relay (GR3400) is excessive
6 – 4	Main power relay is faulty
6 – 7	Current to solenoid coil S1 (lift/lower manifold) is excessive
7 – 1	Current to solenoid coil S2 (lift/lower manifold) is excessive
7 – 4	Current to solenoid coil S4 (lift/lower manifold) is excessive
7 – 6	Current to solenoid coil S3 (lift/lower manifold) is excessive
7 – 8	Current to solenoid coil PRV (mow manifold) is excessive
8 – 1	Current to start relay is excessive

Clearing Fault Codes

After fault codes have been retrieved, clearing of those faults can be completed using the following switch sequence:

1. Place machine switches in fault retrieval (see above). The diagnostic light should be displaying the fault codes.
2. Operator seat should remain UNOCCUPIED.
3. Move backlap valve on mow control manifold to the BACKLAP position.
4. Move joystick to the RAISE position.
5. Monitor the diagnostic light for continuous flashing indicating that all faults have been cleared from the controller memory.

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Diagnostic Display

Your Greensmaster is equipped with a Toro Electronic Controller (TEC) which controls machine electrical functions. The controller monitors various input switches (e.g. ignition switch, seat switch, etc.) and energizes outputs to actuate solenoids or relays for the requested machine function.

For the controller to properly control the machine, each of the input switches, output solenoids and relays must be connected and functioning properly.

The Diagnostic Display (see Special Tools in this chapter) is a tool to help the technician verify correct electrical functions of the machine.

IMPORTANT: The Diagnostic Display must not be left connected to the machine. It is not designed to withstand the environment of the machine's every day use. When use of the Diagnostic Display is completed, disconnect it from the machine and reconnect loopback connector to harness connector. The machine will not operate without the loopback connector installed on the harness. Store the Diagnostic Display in a dry, secure, indoor location, not on machine.



CAUTION

The interlock switches are for the protection of the operator and bystanders and to ensure correct operation of the machine. Do not bypass or disconnect interlock switches. Check the operation of the interlock switches daily for proper operation. Replace any malfunctioning switches before operating the machine.

Verify Diagnostic Display Input Functions

1. Park machine on a level surface, lower the cutting units, engage the parking brake and stop the engine.
2. Remove right side cover next to operator seat to allow access to the TEC controller. Locate wire harness and connectors near TEC controller. Carefully unplug loopback connector from harness connector (Fig. 14).
3. Connect the Diagnostic Display connector to the harness connector. Make sure correct overlay decal is positioned on the Diagnostic Display (Fig. 15).
4. Turn the ignition switch to the RUN position, but do not start machine.

NOTE: The **red** text on the overlay decal refers to controller inputs and the **green** text refers to outputs.

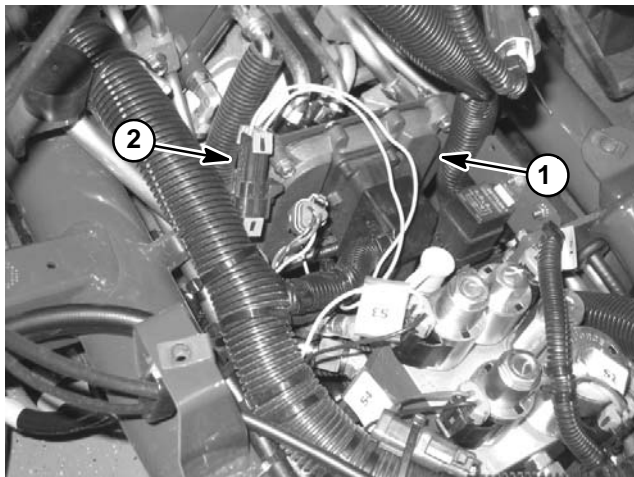


Figure 14

1. TEC controller

2. Loopback connector

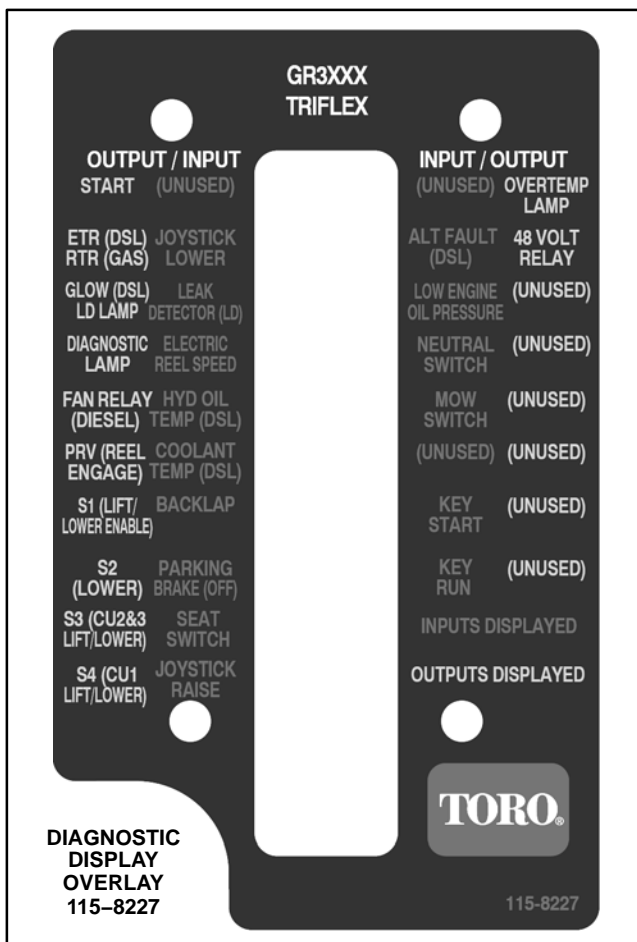


Figure 15

5. The “INPUTS DISPLAYED” LED, on lower right column of the Diagnostic Display, should be illuminated. If the green “OUTPUTS DISPLAYED” LED is illuminated, press the toggle button on the Diagnostic Display to change to “INPUTS DISPLAYED” LED.

6. The Diagnostic Display will illuminate the LED associated with each of the inputs when that input is in the position identified on the Diagnostic Display overlay. Individually, change the position of each of the inputs (i.e. sit on seat, move joystick, etc.), and note that the appropriate LED on the Diagnostic Display toggles on and off when the input state is changed (see Diagnostic Display Inputs and LED Operation chart on next page). Repeat for all inputs that can be changed by hand.

7. If appropriate LED does not toggle on and off when input state is changed, check all wiring and connections to the switch for that input and/or test switch (see Component Testing in this chapter). Replace all defective switches and repair any damaged wiring.

NOTE: The LEAK DETECTOR controller input is only used on Greensmaster 3300 machines. The COOLANT TEMP and ALT FAULT controller inputs are only used on Greensmaster 3400 machines. The HYD TEMP controller input is only used on Greensmaster 3400 machines equipped with the optional hydraulic oil cooler. The ELECTRIC REEL SPEED controller input is not used on Greensmaster 3300 or 3400 machines.

NOTE: On Greensmaster 3400 machines, the ALT FAULT controller input cannot be reliably tested by grounding the harness leads at the alternator. If the alternator is faulty, a TEC controller fault should have been detected. Refer to Diagnostic Light in this section for information on retrieval and clearing of TEC controller faults.

NOTE: When the ignition switch is in the OFF position, all Diagnostic Display LED's should be OFF.

8. After input function testing is completed, disconnect the Diagnostic Display from wire harness. Plug loop-back connector into wire harness connector. Install right side cover next to operator seat.

Diagnostic Display TEC Controller Inputs	Diagnostic Display LED Operation
JOYSTICK LOWER	Joystick moved to lower (forward) position: LED ON Joystick NOT moved to lower position: LED OFF
LEAK DETECTOR (LD) (Greensmaster 3300 machines only)	Leak detector switch closed (oil level is low): LED ON Leak detector switch open (oil level is OK): LED OFF
ELECTRIC REEL SPEED	Not used on Greensmaster 3300 or 3400 machines.
HYD OIL TEMP (DSL) (Optional for Greensmaster 3400 machines only)	Hydraulic temperature, temp switch and circuit wiring OK: LED ON Hydraulic temperature, temp switch or circuit wiring faulty: LED OFF
COOLANT TEMP (DSL) (Greensmaster 3400 machines only)	Engine coolant temperature has exceeded 220°F (105°C): LED ON Engine coolant temperature below 220°F (105°C): LED OFF
BACKLAP	Cutting reels in backlap position: LED ON Cutting reels NOT in backlap position: LED OFF
PARKING BRAKE (OFF)	Parking brake released: LED ON Parking brake engaged: LED OFF
SEAT SWITCH	Seat occupied: LED ON Seat NOT occupied: LED OFF
JOYSTICK RAISE	Joystick moved to raise (rear) position: LED ON Joystick NOT moved to raise (rear) position: LED OFF
ALT FAULT (DSL) (Greensmaster 3400 machines only)	Engine not running OR alternator faulty: LED ON Alternator OK: LED OFF
LOW ENGINE OIL PRESSURE	Engine not running OR low engine oil pressure: LED ON Engine oil pressure OK: LED OFF
NEUTRAL SWITCH	Functional control lever in neutral position: LED ON Functional control lever in mow or transport position: LED OFF
MOW SWITCH	Functional control lever in mow position: LED ON Functional control lever in neutral or transport position: LED OFF
KEY START (NOTE: Place Functional Control Le- ver in MOW or TRANSPORT so en- gine will not start when turning ignition switch to START)	Ignition switch in START position: LED ON Ignition switch in RUN position: LED OFF
KEY RUN	Ignition switch in RUN or START position: LED ON

NOTE: When the ignition switch is in the OFF position, all Diagnostic Display LED's should be OFF.

NOTE: The COOLANT TEMP (DSL) input can be simulated by disconnecting the wire harness connector from the temperature sender on the engine and then using a jumper wire to connect the two (2) connector terminals. The COOLANT TEMP (DSL) LED on the Diagnostic Display should illuminate when the terminals are connected and the ignition switch is in the ON position.

Verify Diagnostic Display Output Functions

The Diagnostic Display has the ability to detect which output solenoids or relays are turned on by the TEC controller. This is a quick way to determine if a machine malfunction is electrical or hydraulic.

NOTE: An open output (e.g. an unplugged connector or a broken wire) cannot be detected with the Diagnostic Display.

1. Park machine on a level surface, lower the cutting units, engage the parking brake and stop the engine.
2. Remove right side cover next to operator seat to allow access to access TEC controller. Locate wire harness and connectors near TEC controller. Carefully unplug loopback connector from harness connector (Fig. 16).
3. Connect the Diagnostic Display connector to the harness connector. Make sure correct overlay decal is positioned on the Diagnostic Display (see Special Tools in this chapter).
4. Turn the ignition switch to the RUN position.

NOTE: The **red** text on the overlay decal refers to controller inputs and the **green** text refers to controller outputs.

NOTE: An error exists on the overlay for OUTPUT LEDs 9 and 10. Output 9 actually represents the circuit for solenoid valve S4, and output 10 actually represents the circuit for solenoid valve S3. Refer to the electrical schematics in this revised manual if necessary.

5. The green "OUTPUTS DISPLAYED" LED, on lower right column of the Diagnostic Display, should be illuminated. If "INPUTS DISPLAYED" LED is illuminated, press the toggle button on the Diagnostic Display to change the LED to "OUTPUTS DISPLAYED".

NOTE: It may be necessary to toggle between "INPUTS DISPLAYED" and "OUTPUTS DISPLAYED" several times to perform the following step. To change from inputs to outputs, press toggle button once. This may be done as often as required. **Do not press and hold toggle button.**

6. Sit on seat, start engine and attempt to operate the desired function of the machine. The appropriate output LED's should illuminate on the Diagnostic Display to indicate that the TEC controller is turning on that function (see Diagnostic Display Outputs and LED Operation chart on next page). The outputs can be checked with the ignition switch in the RUN position and the engine not running.

NOTE: If the "DIAG. LAMP" output LED is blinking, this indicates that the TEC controller has detected a fault during machine operation. Refer to Diagnostic Light in this section for information on retrieval and clearing of controller faults.

A. If the correct output LED's do not illuminate, verify that the required input switches are in the necessary positions to allow that function to occur (see TEC Controller Logic Chart in this section). Verify correct switch function.

B. If the output LED's are on as specified, but the machine does not function properly, consider that the controller is operating correctly and a problem exists with some other component. Inspect electrical components and circuit for the affected function. Also, suspect a non-electrical problem (e.g. hydraulic component problem). Repair as necessary.

C. If each input switch is in the correct position and functioning correctly, but the output LED's are not correctly illuminated, this may indicate a controller problem. If this occurs, contact your Toro Distributor for assistance.

7. After output function testing is completed, disconnect the Diagnostic Display from wire harness. Plug loopback connector into harness connector. Install right side cover next to operator seat.

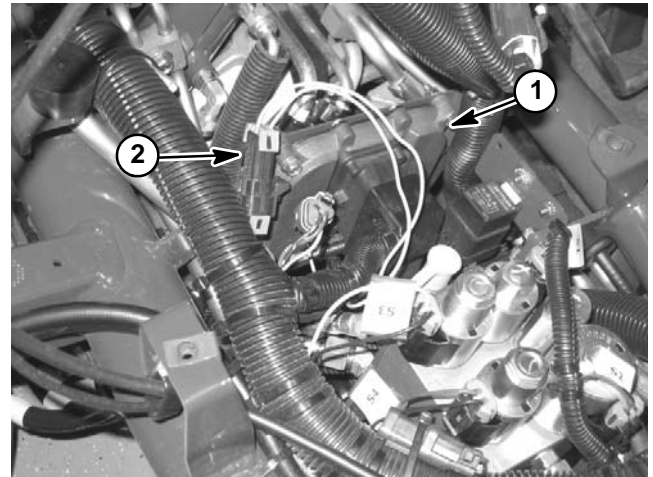


Figure 16

1. TEC controller location 2. Loopback connector

Diagnostic Display Outputs	Diagnostic Display LED Operation
START	TEC output exists to energize starter solenoid (Greensmaster 3300) or starter relay (Greensmaster 3400): LED ON No TEC output to starter solenoid or starter relay: LED OFF
ETR (DSL) RTR (Gas)	TEC output exists to energize engine run components (see NOTE below): LED ON No TEC output to engine run components: LED OFF
GLOW (DSL) LD LAMP	TEC output exists to energize leak detector indicator light and alarm (Greensmaster 3300) or glow plug relay (Greensmaster 3400): LED ON No TEC output to leak detector light/alarm or glow plug relay: LED OFF
DIAGNOSTIC LAMP	Diagnostic lamp is ON or FLASHING: LED ON or FLASHING Diagnostic lamp is not ON or FLASHING: LED OFF
FAN RELAY (DIESEL) (Greensmaster 3400 machines only)	TEC output exists to energize cooling fan: LED ON No TEC output to energize cooling fan: LED OFF
PRV (REEL ENGAGE)	TEC output exists to energize mow manifold solenoid coil PRV: LED ON No TEC output to energize mow manifold solenoid coil PRV: LED OFF
S1 (LIFT/ LOWER ENABLE)	TEC output exists to energize lift manifold solenoid coil S1: LED ON No TEC output to lift manifold solenoid coil S1: LED OFF
S2 (LOWER)	TEC output exists to energize lift manifold solenoid coil S2: LED ON No TEC output to lift manifold solenoid coil S2: LED OFF
S3 (CU1 LIFT/LOWER)	TEC output exists to energize lift manifold solenoid coil S3: LED ON No TEC output to lift manifold solenoid coil S3: LED OFF
S4 (CU2&3 LIFT/LOWER)	TEC output exists to energize lift manifold solenoid coil S4: LED ON No TEC output to lift manifold solenoid coil S4: LED OFF
OVERTEMP LAMP (Greensmaster 3400 machines only)	Console high temperature warning light is ON: LED ON Console high temperature warning light is not ON: LED OFF
48 VOLT RELAY	Not used on Greensmaster 3300 or 3400 machines.

NOTE: ETR (Energize To Run) engine run components on Greensmaster 3400 machines (diesel engine) include the fuel pump and fuel solenoid hold coil. RTR (Relay To Run) engine run components on Greensmaster 3300 machines (gasoline engine) include the kill relay, charge relay and carburetor fuel solenoid.

Starting Problems

Problem	Possible Causes
Starter solenoid clicks, but starter will not crank (if solenoid clicks, problem is not in safety interlock system).	<p>Battery cables are loose or corroded.</p> <p>Battery ground to frame is loose or corroded.</p> <p>Battery is discharged or faulty.</p> <p>Wiring at starter is loose or faulty.</p> <p>Starter mounting bolts are loose or not supplying a sufficient ground.</p> <p>Starter solenoid is faulty.</p> <p>Starter motor is faulty.</p>
Nothing happens when start attempt is made.	<p>Functional control lever is not in the NEUTRAL position.</p> <p>The parking brake is disengaged and the operator seat is unoccupied.</p> <p>Battery cables are loose or corroded.</p> <p>Battery ground to frame is loose or corroded.</p> <p>Battery is discharged or faulty.</p> <p>Fuse(s) is (are) faulty.</p> <p>The fusible link harness at the engine starter motor is faulty.</p> <p>Wiring to the start circuit components is loose, corroded or damaged (see electrical schematic in Chapter 10 – Foldout Drawings).</p> <p>The ignition switch or circuit wiring is faulty.</p> <p>Starter solenoid or circuit wiring is faulty.</p> <p>Main power relay or circuit wiring is faulty.</p> <p>Fuse block is faulty.</p> <p>Neutral switch is out of adjustment or is faulty.</p> <p>TEC controller is faulty.</p>

Starting Problems (continued)

Problem	Possible Causes
Engine cranks (but should not) with the functional control lever in the MOW or TRANSPORT position.	<p>Neutral switch is out of adjustment or is faulty.</p> <p>Circuit wiring for neutral switch is loose, corroded or damaged.</p>
Engine cranks, but does not start.	<p>The fuel tank is empty.</p> <p>The fuel filter is plugged.</p> <p>Engine and/or fuel may be too cold.</p> <p>Wiring to start circuits is loose, corroded or damaged (see electrical schematic in Chapter 10 – Foldout Drawings).</p> <p>Engine or fuel system is malfunctioning (see Chapter 3 – Gasoline Engine or Chapter 4 – Diesel Engine).</p> <p>Kill relay or circuit wiring is faulty (Greensmaster 3300).</p> <p>Fusible link to fuel solenoid pull coil is faulty (Greensmaster 3400).</p> <p>Fuel solenoid or circuit wiring is faulty.</p> <p>Fuel pump or circuit wiring is faulty (Greensmaster 3400).</p> <p>The engine glow plug circuit does not operate properly (Greensmaster 3400) (see below).</p>
The engine glow plug circuit does not operate properly (Greensmaster 3400).	<p>Wiring in the engine glow circuit is loose, corroded or damaged (see electrical schematic in Chapter 10 – Foldout Drawings).</p> <p>One (or more) of the engine glow plugs is faulty.</p> <p>Fuse(s) is (are) faulty.</p> <p>The fusible link harness at the engine starter motor is faulty.</p> <p>The glow relay is faulty.</p> <p>The TEC Controller is faulty.</p>
The engine starts, but stops when the ignition switch is released from the START position (Greensmaster 3400).	<p>The engine fuel stop solenoid or circuit wiring is faulty (pull coil operates but hold coil or circuit wiring is faulty).</p> <p>Fuse(s) is (are) faulty (other electrical components most likely affected as well).</p> <p>The ignition switch is faulty.</p>

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.	<p>Operator is sitting too far forward on the seat (seat switch not depressed).</p> <p>Parking brake is engaged.</p> <p>Parking brake switch is out of adjustment or is faulty.</p> <p>Parking brake switch wiring is loose, corroded or damaged.</p> <p>Seat switch is faulty.</p> <p>Seat switch wiring is loose, corroded or damaged.</p>
Battery does not charge.	<p>Wiring to the charging circuit components is loose, corroded or damaged (see electrical schematic in Chapter 10 – Foldout Drawings).</p> <p>The engine alternator belt is loose or damaged (Greensmaster 3400).</p> <p>Voltage regulator is loose or not grounded to engine (Greensmaster 3300).</p> <p>Charge circuit relay or circuit wiring is faulty (Greensmaster 3300).</p> <p>Alternator fusible link in the fusible link harness is faulty.</p> <p>Battery is faulty.</p> <p>Alternator/voltage regulator is faulty.</p>
Engine kills during operation (operator sitting on seat).	<p>Operator moved too far forward on the seat (seat switch not depressed).</p> <p>The parking brake was engaged or the parking brake sensor is out of adjustment or faulty.</p> <p>The seat switch or circuit wiring is faulty.</p> <p>Wiring to run circuit components is loose, corroded or damaged (see electrical schematic in Chapter 10 – Foldout Drawings).</p>

Cutting Unit Operating Problems

Problem	Possible Causes
Cutting units run (but should not) when raised.	<p>Mow switch is faulty or out of adjustment.</p> <p>A hydraulic problem exists (see Chapter 5 – Hydraulic System).</p> <p>The TEC Controller is faulty.</p>
Cutting units do not run when lowered with the functional control lever in the MOW position.	<p>Wiring to run/mow/backlap circuit components is loose, corroded or damaged (see electrical schematic in Chapter 10 – Foldout Drawings).</p> <p>Fuse or fuse block is faulty.</p> <p>Mow switch is out of adjustment.</p> <p>Mow switch or circuit wiring is faulty.</p> <p>Mow control manifold solenoid coil PRV or circuit wiring is faulty.</p> <p>A hydraulic problem exists (see Chapter 5 – Hydraulic System).</p> <p>The TEC Controller is faulty.</p>
Cutting units will not raise.	<p>Wiring to raise circuit components is loose, corroded or damaged (see electrical schematic in Chapter 10 – Foldout Drawings).</p> <p>Fuse or fuse block is faulty.</p> <p>Raise switch in joystick assembly is faulty.</p> <p>Lift manifold solenoid valve coil(s) (S1, S3 and/or S4) or circuit wiring is faulty.</p> <p>A hydraulic problem exists (see Chapter 5 – Hydraulic System).</p> <p>The TEC Controller is faulty.</p>
Cutting units will not lower.	<p>Wiring to lower circuit components is loose, corroded or damaged (see electrical schematic in Chapter 10 – Foldout Drawings).</p> <p>Fuse or fuse block is faulty.</p> <p>Lower switch in joystick assembly is faulty.</p> <p>Lift manifold solenoid valve coil(s) (S1, S2, S3 and/or S4) or circuit wiring is faulty.</p> <p>A hydraulic problem exists (see Chapter 5 – Hydraulic System).</p> <p>The TEC Controller is faulty.</p>

TEC Logic Chart (Greensmaster 3300)

Each line of the following chart identifies the necessary component position (INPUTS) in order for the TEC controller to energize the appropriate OUTPUTS for machine operation.

KEY TO CHART

X	Component (Input) Position
	Not Relevant for Function
P	Component (Output) Energized
M	Momentarily Closed
O	Open

MACHINE FUNCTION	INPUTS										OUTPUTS							
	Ignition Key in RUN	Ignition Key in START	Neutral	Seat Occupied	Parking Brake Applied	Joystick Raise (Pulled to Rear)	Joystick Lower (Pushed Forward)	Mow/Transport Lever in Mow	Backlap	Engine Run	Engine Start	Leak Detector	Diag Lamp	PRV Energized	S1 Energized (Lift/Lower Enable)	S2 Energized (Directional)	S3 Energized (C/U 1 Hold/Lower)	S4 Energized (C/U 2 & 3 Hold/Lower)
Start (No Operator in Seat)		X	X		X					P	P	P						
Start (Operator in Seat)		X	X	X						P	P	P						
Run (No Operator in Seat)	X		X		X					P		P						
Run (Operator in Seat)	X									P		P						
Lower Cutting Units	X						M	X		P		P			P	P	P	P
Mow	X			X			M	X		P		P		P				
Cutting Unit Tap Off	X			X		M				P		P						
Raise Cutting Units	X			X		M				P		P			P		P	P
Inititate Backlap	X		X		X		X		X	P		P		P				
Stop Backlap	X		X		X	M			X	P		P						
Diag Lamp TEC Fault Retrieval	X		X		O	X							P					
Clearing TEC Faults	X		X		O	X			X				P					

NOTE: TEC controller outputs for raising and lowering the cutting units (S1, S2, S3 and S4) are timed by the controller. This timing requires a momentary input by the operator to initiate the output and then keeps the appropriate solenoid coils energized long enough to complete the desired machine function.

TEC Logic Chart (Greensmaster 3400)

Each line of the following chart identifies the necessary component position (INPUTS) in order for the TEC controller to energize the appropriate OUTPUTS for machine operation.

KEY TO CHART

X	Component (Input) Position
	Not Relevant for Function
P	Component (Output) Energized
M	Momentarily Closed
O	Open

MACHINE FUNCTION	INPUTS													OUTPUTS												
	Ignition Key in RUN	Ignition Key in START	Neutral	Seat Occupied	Parking Brake Applied	Hydraulic Oil Temperature	Joystick Raise (Pulled to Rear)	Joystick Lower (Pushed Forward)	Mow/Transport Lever in Mow	Backlap	Engine Coolant Temperature			Engine Glow Plugs Energized	Engine Run	Engine Start	Leak Detector	Diag Lamp	Fan Energize	PRV Energized	S1 Energized (Lift/Lower Enable)	S2 Energized (Directional)	S3 Energized (C/U 1 Hold/Lower)	S4 Energized (C/U 2 & 3 Hold/Lower)	Coolant Over-Temp	
Preheat	X													P			P									
Start (No Operator in Seat)		X	X		X									P	P	P	P									
Start (Operator in Seat)		X	X	X										P	P	P	P									
Run (No Operator in Seat)	X		X		X										P		P								O	
Run (Operator in Seat)	X			X											P		P								O	
Lower Cutting Units	X						M	X							P		P				P	P	P	P	O	
Mow	X			X			M	X							P		P			P					O	
Cutting Unit Tap Off	X			X			M								P		P								O	
Raise Cutting Units	X			X			M								P		P				P		P	P	O	
Inititate Backlap	X		X		X		X			X					P		P			P					O	
Stop Backlap	X		X		X		M			X					P		P								O	
Diag Lamp TEC Fault Retrieval	X		X	O			X											P								
Clearing TEC Faults	X		X	O			X			X								P								
Fan on	X										X								P							

NOTE: TEC controller outputs for raising and lowering the cutting units (S1, S2, S3 and S4) are timed by the controller. This timing requires a momentary input by the operator to initiate the output and then keeps the appropriate solenoid coils energized long enough to complete the desired machine function.

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 60° to 100° F (16° to 37° C). The ignition key should be off and all accessories turned off. Connect the positive (+) meter lead to the positive battery post and the negative (–) meter lead the 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 (see Battery Service in the Service and Repairs section of this chapter).

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. 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	= 12.85 v
Difference	= +0.55 v

Glow Plug System Test (Greensmaster 3400)

This is a fast, simple test that can help to determine the integrity and operation of your Greensmaster 3400 glow plug system. The test should be run anytime hard starting (cold engine) is encountered on a diesel engine equipped with a glow plug system.

Use a digital multimeter and/or inductive ammeter (AC/DC Current Transducer). Properly connect the ammeter to the digital multimeter (refer to manufacturers' instructions) and set the multimeter to the correct scale. With the ignition switch in the OFF position, place the

ammeter pickup around the main glow plug power supply wire and read the meter prior to activating the glow plug system. Adjust the meter to read zero (if applicable). Activate the glow plug system by turning the ignition switch to RUN and record the multimeter results.

The Greensmaster 3400 glow plug system should have a reading of approximately 27 amps total (nine (9) amps per glow plug). If low current reading is observed, one (or more) of the glow plugs is faulty.

Adjustments

Parking Brake Switch

The parking brake switch is a normally open proximity switch that mounts to the frame bracket used to attach the parking brake lever assembly (Fig. 17). The sensing plate for the brake switch is a tab on the parking brake lever assembly. The Toro Electronic Controller (TEC) monitors the operation of the parking brake switch.

When the parking brake is not applied, the tab on the parking brake lever is positioned near the target end of the parking brake switch causing the switch to close. The tab on the parking brake lever is moved away from the switch when the parking brake is applied causing the switch to open.

Adjustment

1. When the parking brake is not applied, the gap between the parking brake switch and the tab on the parking brake lever should be 0.125" (3.2 mm) (Fig. 17).

2. If gap is incorrect, loosen jam nuts that secure switch to frame bracket. Position switch with jam nuts to allow correct gap between switch and brake lever tab. Tighten jam nuts to secure adjustment. Jam nuts should be torqued from **162 to 198 in-lb (18.4 to 22.3 N-m)**. After jam nuts are tightened, make sure that clearance between head of parking brake switch and tab on the parking brake lever has not changed.

3. After adjustment to the parking brake switch, use the Diagnostic Display to verify that parking brake switch and circuit wiring are functioning correctly (see Diagnostic Display in the Troubleshooting section of this chapter).

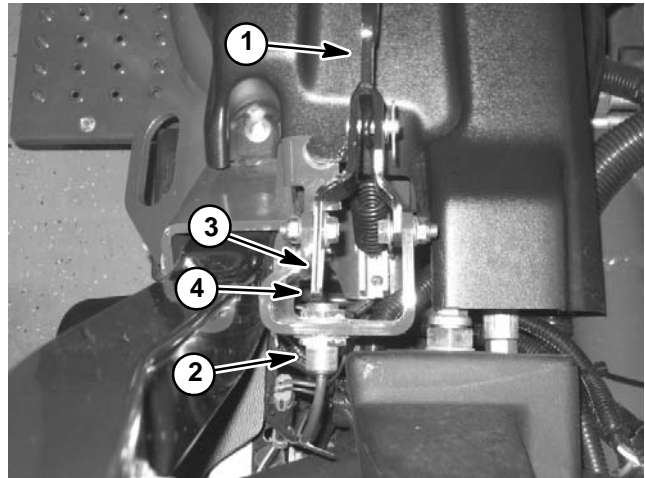


Figure 17

- | | |
|-------------------------|--------------------|
| 1. Brake lever | 3. Brake lever tab |
| 2. Parking brake switch | 4. Gap |

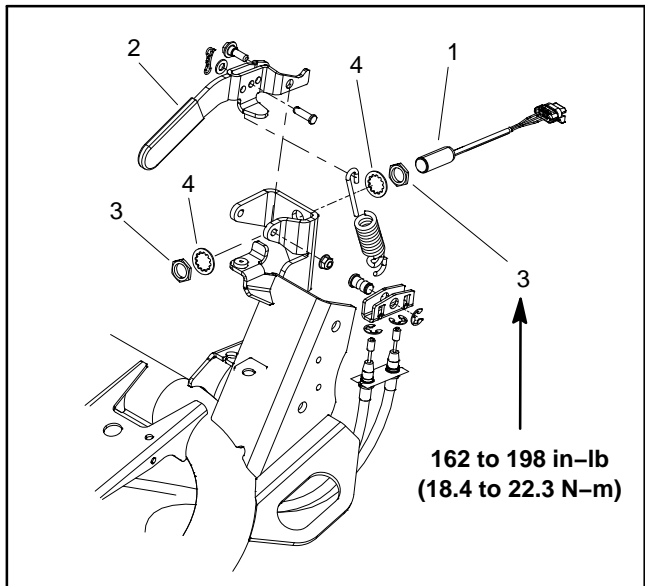


Figure 18

- | | |
|-------------------------|-------------------------|
| 1. Parking brake switch | 3. Jam nut (2 used) |
| 2. Parking brake lever | 4. Lock washer (2 used) |

Neutral and Mow Switches

The neutral and mow switches are normally open proximity switches that mount to the console assembly (Fig. 17). The sensing plate for these switches is a tab on the functional control lever. The Toro Electronic Controller (TEC) monitors the operation of the neutral and mow switches.

When the functional control lever is in the neutral position, the tab on the lever is positioned near the target end of the neutral switch causing the switch to close. The tab on the functional control lever is moved away from the neutral switch when the lever is in either the mow or transport position causing the switch to be in its normal open state.

When the functional control lever is in the mow position, the tab on the lever is positioned near the target end of the mow switch causing the switch to close. The tab on the functional control lever is moved away from the mow switch when the lever is in either the neutral or transport position causing the switch to be in its normal open state.

Adjustment

1. Remove console cover from console assembly to gain access to switches (see Control Console Disassembly in the Service and Repairs section of Chapter 7 – Chassis).

2. When the functional control lever is placed in the neutral or mow position, the gap between the appropriate switch head and the tab on the functional lever should be from 0.090" to 0.120" (2.3 to 3.0 mm) (Fig. 20).

3. If gap is incorrect, loosen jam nuts that secure switch to console bracket. Position switch with jam nuts to allow correct gap between switch head and functional lever tab. Tighten jam nuts to secure adjustment. Jam nuts should be torqued from **162 to 198 in-lb (18.4 to 22.3 N-m)**. After jam nuts are tightened, make sure that clearance between head of switch and tab on the functional lever has not changed.

4. After adjustment to the switch(es), use the Diagnostic Display to verify that neutral and mow switches and circuit wiring are functioning correctly (see Diagnostic Display in the Troubleshooting section of this chapter).

5. Secure console cover to console assembly (see Control Console Assembly in the Service and Repairs section of Chapter 7 – Chassis).

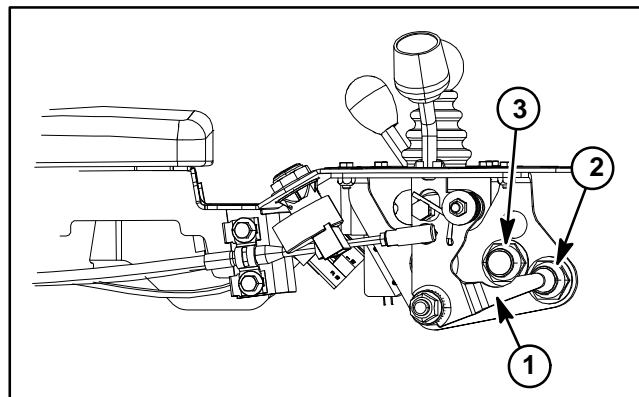


Figure 19

- | | |
|-------------------------|-------------------|
| 1. Functional lever tab | 3. Neutral switch |
| 2. Mow switch | |

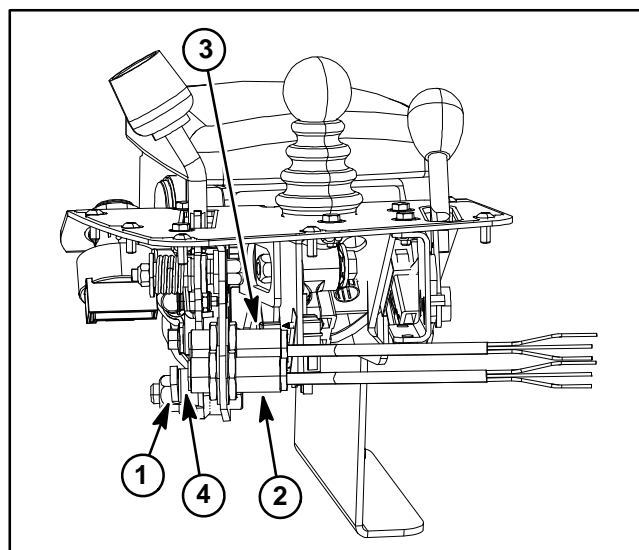


Figure 20

- | | |
|-------------------------|-------------------|
| 1. Functional lever tab | 3. Neutral switch |
| 2. Mow switch | 4. Gap |

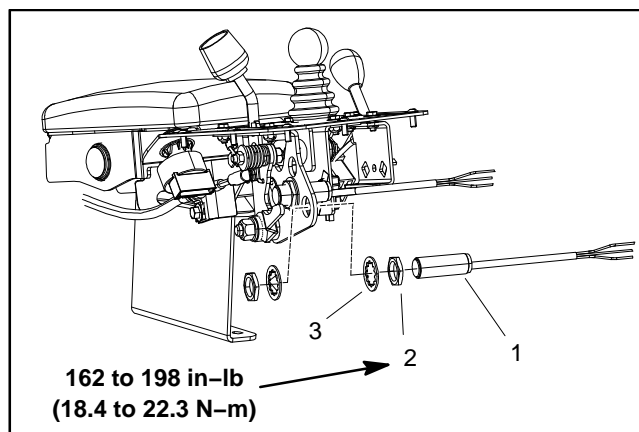



Figure 21

- | | |
|-----------------------|-------------------------|
| 1. Switch (mow shown) | 3. Lock washer (2 used) |
| 2. Jam nut (2 used) | |

Component Testing

For accurate resistance and/or continuity checks, electrically disconnect the component being tested from the circuit (e.g. unplug the ignition switch connector before doing a continuity check).

NOTE: For engine component testing information, refer to the appropriate engine service manual (Briggs & Stratton Repair Manual or Kubota Workshop Manual).

**CAUTION**

When testing electrical components for continuity with a multimeter (ohms setting), make sure that power to the circuit has been disconnected.

Ignition Switch (Serial Number Below 312000000)

The ignition (key) switch is located on the control panel and has three (3) positions: STOP, RUN and START (Fig. 22). The Toro Electronic Controller (TEC) monitors the operation of the ignition switch.

NOTE: The engine can only be started when the functional control lever is in the NEUTRAL position and either the seat is occupied or the parking brake is engaged. Also, the TEC controller limits engine cranking time to thirty (30) seconds.

Testing

1. Park machine on a level surface, lower cutting units, engage parking brake and stop engine. Remove key from ignition switch.
2. Before disconnecting the ignition switch for testing, the switch and its circuit wiring should be tested as a TEC electrical input using the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If input testing verifies that the ignition switch and circuit wiring **are** functioning correctly, no further ignition switch testing is necessary. If, however, input testing determines that the ignition switch and circuit wiring **are not** functioning correctly, proceed with the following ignition switch testing procedure.
3. Remove console cover from console assembly to gain access to ignition switch (see Control Console Disassembly in the Service and Repairs section of Chapter 7 – Chassis).
4. Make sure ignition switch is in the OFF position. Disconnect wire harness connector from ignition switch.
5. The ignition switch terminals are identified in Figure 22 and the circuitry of the switch is shown in the chart in Figure 23. With the use of a multimeter (ohms setting), the switch functions can be tested to determine whether continuity exists between the various terminals for each switch position. Verify continuity between switch terminals.

6. Replace ignition switch if testing determines that it is faulty.
7. If the ignition switch tests correctly and a circuit problem still exists, check wire harness (see Electrical Schematics and Wire Harness Drawings in Chapter 10 – Foldout Drawings).
8. After testing is complete, connect machine wire harness connector to ignition switch. Secure console cover to machine with removed fasteners.

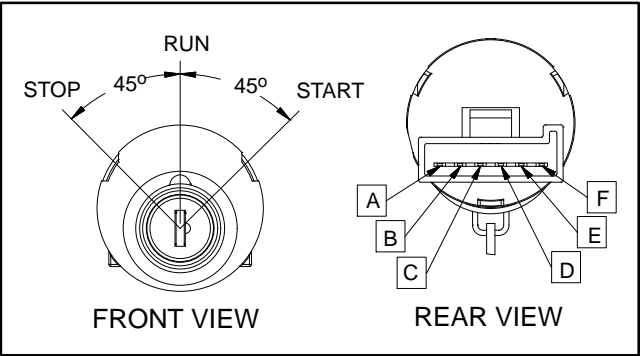


Figure 22

SWITCH POSITION	CIRCUITS
STOP	NONE
RUN	B + C + F, D + E
START	A + B + C

Figure 23

Ignition Switch (Serial Number Above 312000000)

The ignition (key) switch is located on the control panel and has three (3) positions: STOP, RUN and START (Fig. 24). The Toro Electronic Controller (TEC) monitors the operation of the ignition switch.

NOTE: The engine can only be started when the functional control lever is in the NEUTRAL position and either the seat is occupied or the parking brake is engaged. Also, the TEC controller limits engine cranking time to thirty (30) seconds.

Testing

1. Park machine on a level surface, lower cutting units, engage parking brake and stop engine. Remove key from ignition switch.
2. Before disconnecting the ignition switch for testing, the switch and its circuit wiring should be tested as a TEC electrical input using the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If input testing verifies that the ignition switch and circuit wiring **are** functioning correctly, no further ignition switch testing is necessary. If, however, input testing determines that the ignition switch and circuit wiring **are not** functioning correctly, proceed with the following ignition switch testing procedure.
3. Remove console cover from console assembly to gain access to ignition switch (see Control Console Disassembly in the Service and Repairs section of Chapter 7 – Chassis).
4. Make sure ignition switch is in the OFF position. Disconnect wire harness connector from ignition switch.
5. The ignition switch terminals are identified in Figure 24 and the circuitry of the switch is shown in the chart in Figure 25. With the use of a multimeter (ohms setting), the switch functions can be tested to determine whether continuity exists between the various terminals for each switch position. Verify continuity between switch terminals.

6. Replace ignition switch if testing determines that it is faulty.
7. If the ignition switch tests correctly and a circuit problem still exists, check wire harness (see Electrical Schematics and Wire Harness Drawings in Chapter 10 – Foldout Drawings).
8. After testing is complete, connect machine wire harness connector to ignition switch. Secure console cover to machine with removed fasteners.

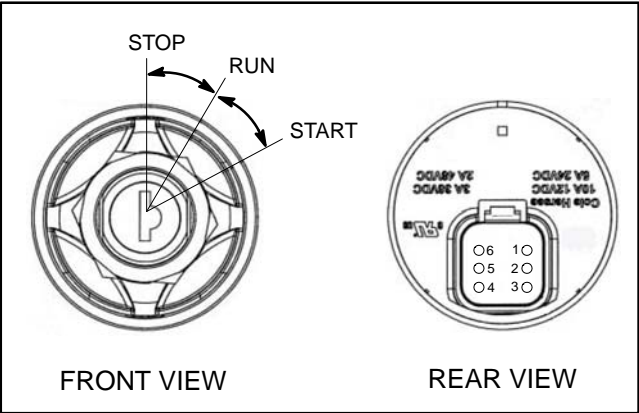


Figure 24

SWITCH POSITION	CIRCUITS
STOP	1 + 6
RUN	1 + 3 + 4 + 5 + 6
START	1 + 2 + 4 + 5 + 6

Figure 25

NOTE: Ignition switch terminals 1 and 6 are connected internally. Terminals 4 and 5 are also connected internally. These terminals should have continuity regardless of switch position.

Engine Oil Pressure Indicator Light (Greensmaster 3300)

The engine oil pressure indicator light should come on when the ignition switch is in the RUN position with the engine not running. Also, it should illuminate with the engine running if the engine oil pressure drops to an unsafe level.

IMPORTANT: If the oil pressure indicator light is illuminated with the engine running, shut off the engine immediately.

To test the oil pressure light and circuit wiring, ground the wire attached to oil pressure switch located on the engine near the oil filter. Turn ignition switch to the RUN position; the engine oil pressure light should come on indicating correct operation of the indicator light and circuit wiring.

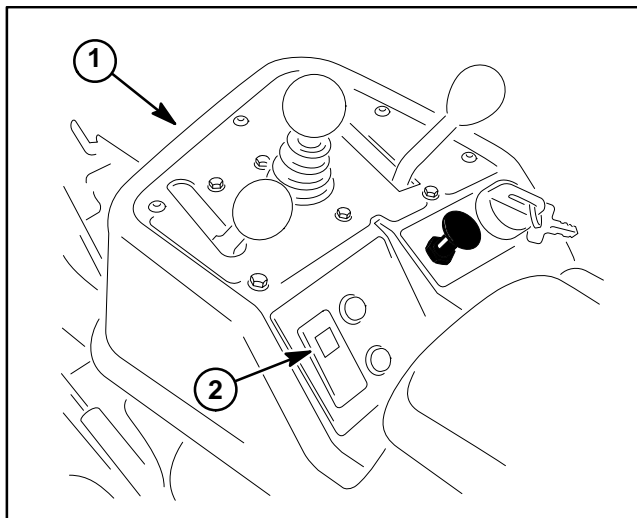


Figure 26

1. Control console

2. Oil pressure light

Indicator Lights (Greensmaster 3400)

Charge Indicator Light

The charge indicator light should come on when the ignition switch is in the RUN position with the engine not running. Also, it should illuminate with an improperly operating charging circuit while the engine is running.

Engine Oil Pressure Light

The engine oil pressure light should come on when the ignition switch is in the RUN position with the engine not running. Also, it should illuminate with the engine running if the engine oil pressure drops to an unsafe level.

IMPORTANT: If the oil pressure indicator light is illuminated with the engine running, shut off the engine immediately.

To test the oil pressure light and circuit wiring, ground the wire attached to oil pressure switch located on the engine near the oil filter. Turn ignition switch to the RUN position; the engine oil pressure light should come on indicating correct operation of the indicator light and circuit wiring.

High Temperature Warning Light

If the engine coolant temperature reaches 220°F (105°C) (approximate), the high temperature warning light will come on.

To test the high temperature warning light and circuit wiring, turn ignition switch to the RUN position and ground the wire attached to high temperature warning switch located on the engine water pump housing (see High Temperature Warning Switch in this section). The high temperature warning light should illuminate when the wire is grounded.

Glow Plug Indicator Light

The glow plug indicator light should come on when the ignition switch is placed in the RUN position prior to placing the ignition switch in START. The light should stay lit for approximately six (6) seconds while the ignition switch is left in the RUN position.

Testing Indicator Lights

1. Remove console cover from console assembly to gain access to indicator lights (see Control Console Disassembly in the Service and Repairs section of Chapter 7 – Chassis).
2. Apply 12 VDC to terminals 1A and 2A (Fig. 28) and ground terminals 1B and 2B (Fig. 28).
3. Both indicator lights should illuminate.

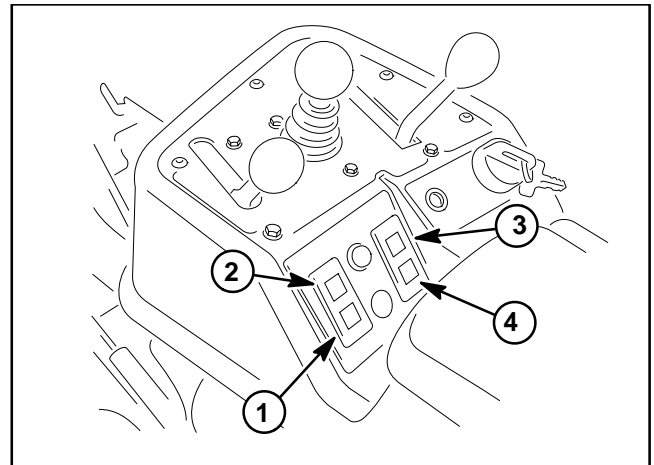


Figure 27

- | | |
|---------------------------|----------------------------|
| 1. Charge indicator light | 3. High temp warning light |
| 2. Oil pressure light | 4. Glow plug light |

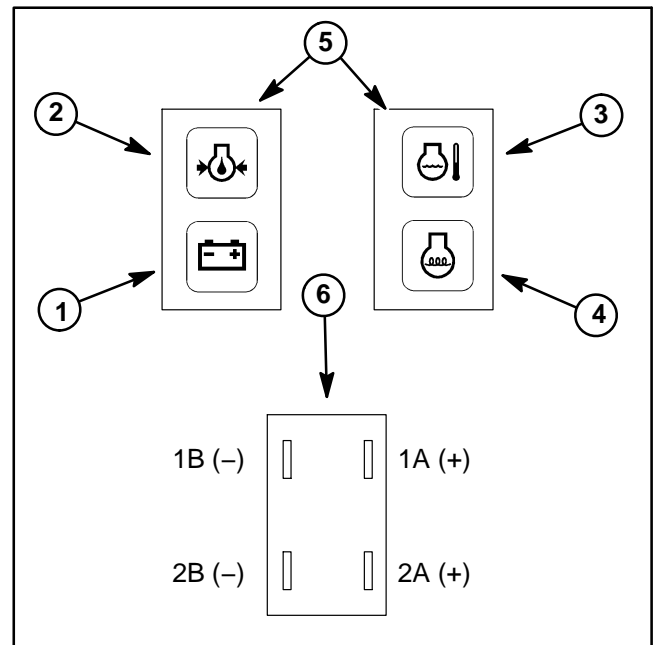


Figure 28

- | | |
|------------------------|--------------------------|
| 1. Charge indicator | 4. Glow plug indicator |
| 2. Engine oil pressure | 5. Indicator light front |
| 3. High temperature | 6. Indicator light back |

Hour Meter

1. Park machine on a level surface, lower cutting units, engage parking brake and stop engine. Remove key from ignition switch.
2. Remove console cover from console assembly to gain access to hour meter (see Control Console Disassembly in the Service and Repairs section of Chapter 7 – Chassis).
3. Disconnect machine wire harness electrical connector from the hour meter.
4. Connect the positive (+) terminal of a 12 VDC source to the positive terminal of the hour meter.
5. Connect the negative (–) terminal of the voltage source to the other terminal of the hour meter.
6. The hour meter should move 1/10 of an hour in six (6) minutes.
7. Disconnect the voltage source from the hour meter.
8. Replace the hour meter if necessary.
9. Connect harness electrical connector to the hour meter.
10. After testing is complete, connect machine wire harness connector to the hour meter. Secure console cover to machine with removed fasteners.

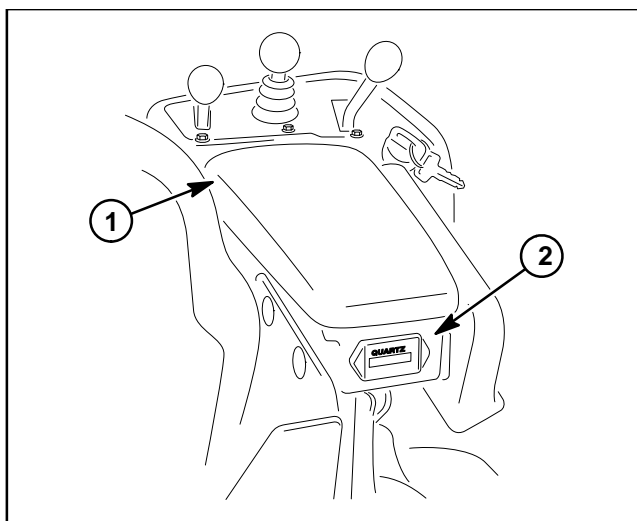


Figure 29

1. Control console

2. Hour meter

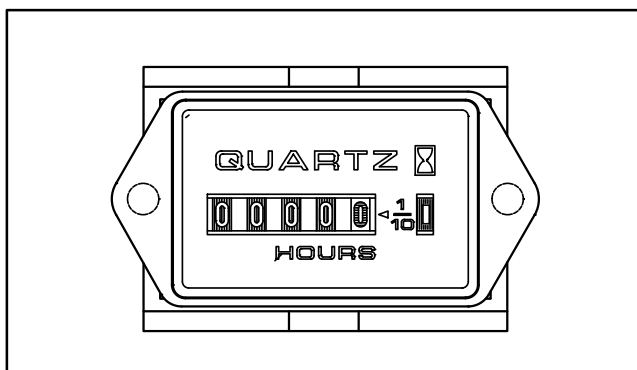


Figure 30

Fuse Block (Greensmaster 3300)

The fuse block on Greensmaster 3300 machines is attached to the frame under the operator seat (Fig. 31).

Fuse Identification and Function

Use Figure 32 to identify each individual fuse and its correct amperage. Fuses for Greensmaster 3300 machines have the following function:

Right Fuse 1 (2 Amp): Protects TEC logic and ignition switch power supply circuits.

Right Fuse 2 (7.5 Amp): Protects TEC output power supply for start solenoid, charge circuit relay, kill relay, fuel solenoid, leak detector (alarm and indicator light) and console diagnostic light.

Right Fuse 3 (7.5 Amp): Protects TEC output power supply for cutting reels engage solenoid, lift enable solenoid (S1), lift/lower solenoid (S2) and optional hydraulic oil cooling fan relay.

Right Fuse 4 (7.5 Amp): Protects TEC output power supply for lift solenoids S4 (front cutting units) and S3 (center cutting unit).

Left Fuse 1 (10 Amp): Protects power supply for hour meter, low engine oil pressure indicator light and proximity switches (parking brake, neutral and mow).

Left Fuse 2 (15 Amp): Protects power supply for Turf Defender™ Leak Detector solenoid and optional lights.

Left Fuse 3: Not used.

Left Fuse 4 (15 Amp): Protects power supply for optional hydraulic oil cooling fan.

Fuse Testing

Make sure that ignition switch is OFF and key is removed from switch. Remove fuses from the fuse block for testing. Fuse should have continuity between fuse terminals.

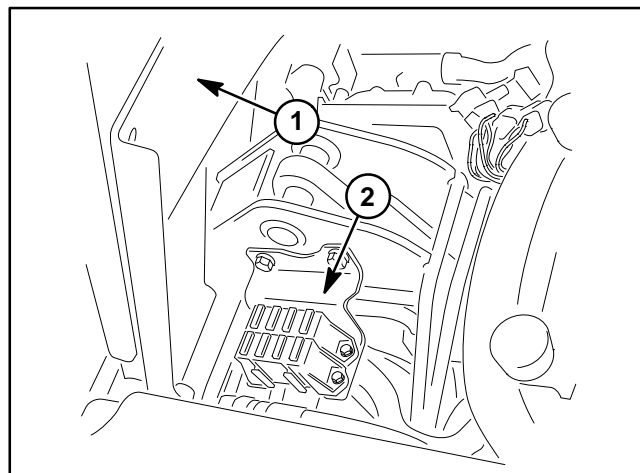


Figure 31

1. Seat base (raised)
2. Fuse block

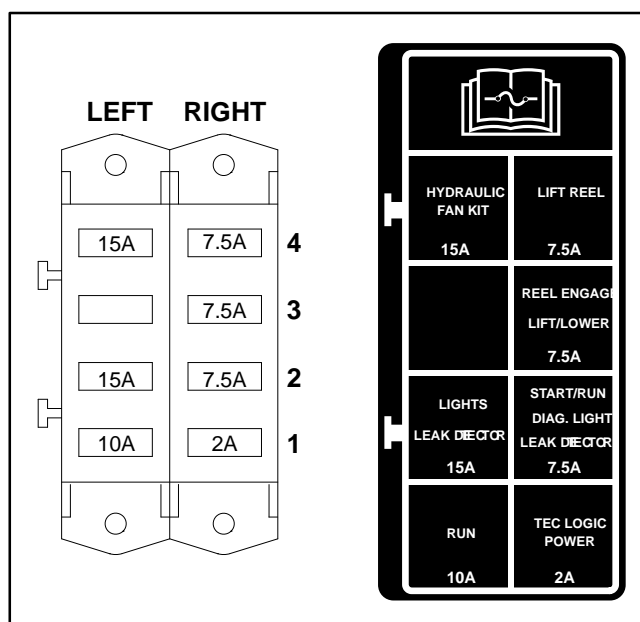


Figure 32

Fuse Block (Greensmaster 3400 with Serial Number Below 312000000)

The fuse block on Greensmaster 3400 machines is attached to the frame under the operator seat (Fig. 33).

In addition to the fuses in the fuse block, a 50 amp maxi-fuse is included in the wire harness. This fuse protects the engine cooling fan circuit and resides in a fuse holder under the right side cover next to operator seat.

Fuse Identification and Function

Use Figure 34 to identify each individual fuse and its correct amperage. Fuses for Greensmaster 3400 machines Greensmaster 3400 machines with a serial number below 312000000 have the following function:

Right Fuse 1 (2 Amp): Protects TEC logic and ignition switch power supply circuits.

Right Fuse 2 (7.5 Amp): Protects TEC output power supply for start relay, engine run solenoid, fuel pump, glow relay, glow plug indicator light and console diagnostic light.

Right Fuse 3 (7.5 Amp): Protects TEC output power supply for fan relay, cutting reels engage solenoid, lift enable solenoid (S1) and lift/lower solenoid (S2).

Right Fuse 4 (7.5 Amp): Protects TEC output power supply for lift solenoids S4 (front cutting units), S3 (center cutting unit) and over temperature indicator light.

Left Fuse 1 (10 Amp): Protects power supply for hour meter, low engine oil pressure indicator light, alternator and proximity switches (parking brake, neutral and mow).

Left Fuse 2 (15 Amp): Protects power supply for start relay and solenoid.

Left Fuse 3 (15 Amp): Protects power supply for optional Turf Defender™ Leak Detector system and optional lights.

Left Fuse 4: Not used.

Fuse Testing

Make sure that ignition switch is OFF and key is removed from switch. Remove fuses from the fuse block for testing. Fuse should have continuity between fuse terminals.

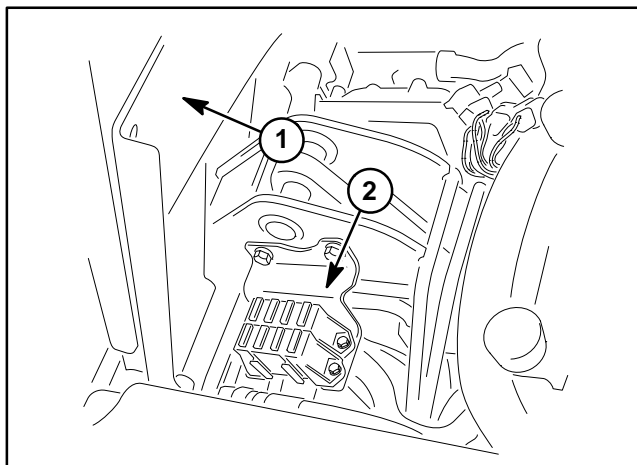


Figure 33

1. Seat base (raised) 2. Fuse block

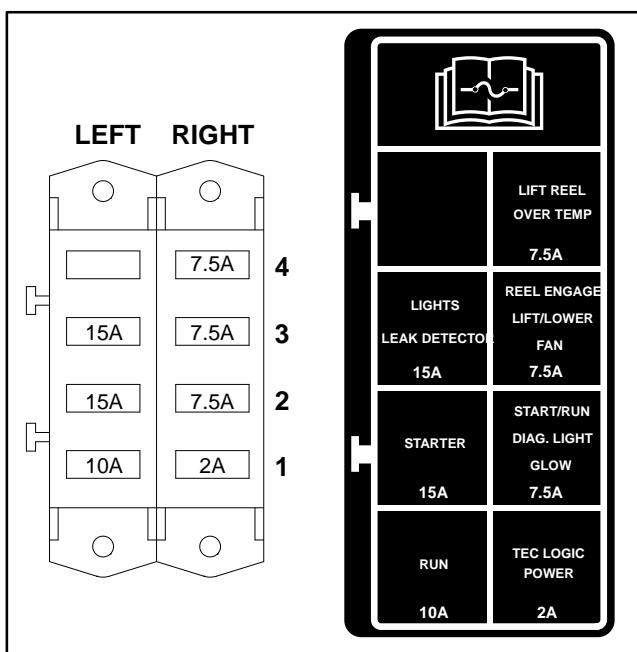


Figure 34

Fuse Block (Greensmaster 3400 with Serial Number Above 312000000)

The fuse block on Greensmaster 3400 machines is attached to the frame under the operator seat (Fig. 35).

In addition to the fuses in the fuse block, a 50 amp maxi-fuse is included in the wire harness. This fuse protects the engine cooling fan circuit and resides in a fuse holder under the right side cover next to operator seat.

Fuse Identification and Function

Use Figure 36 to identify each individual fuse and its correct amperage. Fuses for Greensmaster 3400 machines with a serial number above 312000000 have the following function:

Right Fuse 1 (2 Amp): Protects TEC logic and ignition switch power supply circuits.

Right Fuse 2 (7.5 Amp): Protects TEC output power supply for start relay, engine run solenoid, fuel pump, glow relay, glow plug indicator light and console diagnostic light.

Right Fuse 3 (7.5 Amp): Protects TEC output power supply for fan relay, cutting reels engage solenoid, lift enable solenoid (S1) and lift/lower solenoid (S2).

Right Fuse 4 (7.5 Amp): Protects TEC output power supply for lift solenoids S4 (front cutting units), S3 (center cutting unit) and over temperature indicator light.

Left Fuse 1 (10 Amp): Protects power supply for start relay and solenoid.

Left Fuse 2 (10 Amp): Protects power supply for hour meter, low engine oil pressure indicator light, alternator and proximity switches (parking brake, neutral and mow).

Left Fuse 3 (15 Amp): Protects power supply for optional Turf Defender™ Leak Detector system and optional lights.

Left Fuse 4: Not used.

Fuse Testing

Make sure that ignition switch is OFF and key is removed from switch. Remove fuses from the fuse block for testing. Fuse should have continuity between fuse terminals.

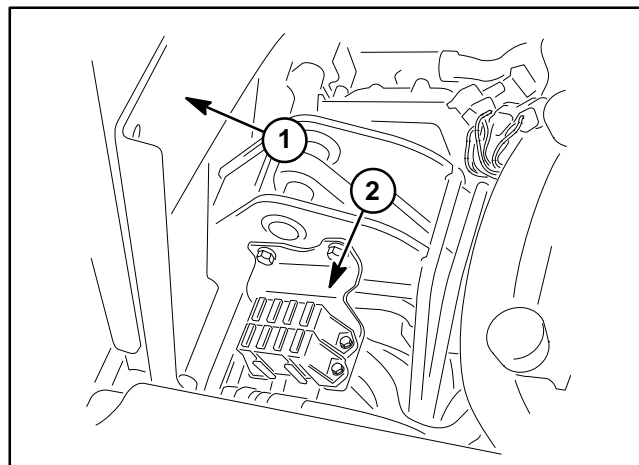


Figure 35

1. Seat base (raised) 2. Fuse block

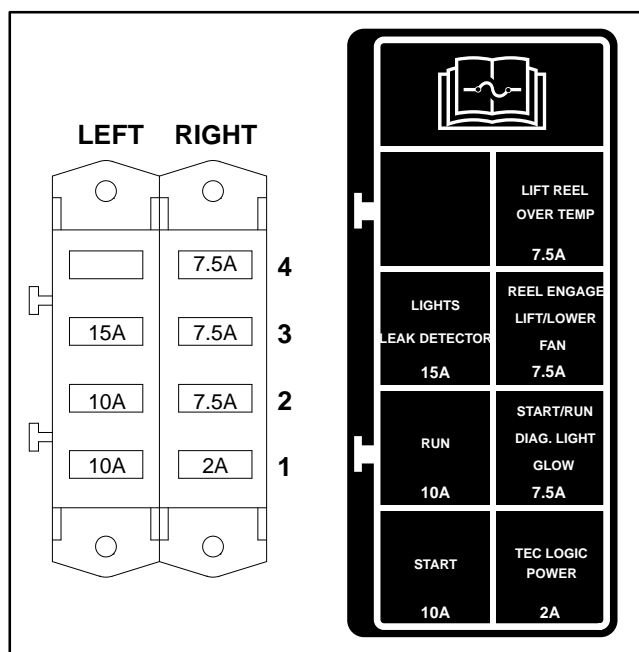


Figure 36

Fusible Links

The electrical system on TriFlex Greensmaster machines include a harness with three (3) fusible links for machine circuit protection. This fusible link harness connects the machine wire harness to the positive (+) battery terminal.

Greensmaster 3300 machines (gasoline engine) use only two (2) of the harness fusible links. The fusible link harness on Greensmaster 3300 machines is connected to the starter solenoid (Fig. 37).

Greensmaster 3400 machines (diesel engine) use all three (3) of the harness fusible links. The fusible link harness on Greensmaster 3400 machines is connected to the starter B+ terminal (Fig. 38). Greensmaster 3400 machines use an additional fusible link that is included in the wire harness and connects the starter G terminal to the engine run solenoid pull coil.

If any of these links should fail, current to the protected circuit will cease. Refer to the electrical schematic and wire harness drawings in Chapter 10 – 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 harness and unplug fusible link connector from wire harness. Use a multimeter to make sure that continuity exists between the fusible link terminals. If a fusible link is open, replace the fusible link harness.

After testing is complete, make sure that fusible link is securely attached to engine component and wire harness. Connect positive battery cable to battery terminal first and then connect negative cable to battery.

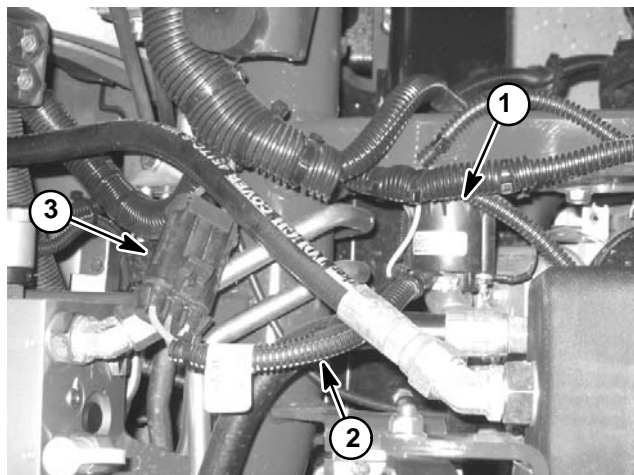


Figure 37

- 1. Starter solenoid
- 2. Fusible link harness
- 3. Harness connector

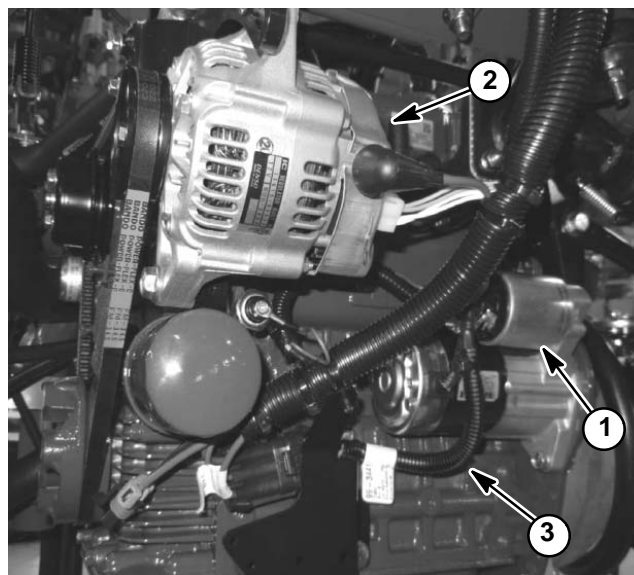


Figure 38

- 1. Starter solenoid
- 2. Alternator
- 3. Fusible link harness

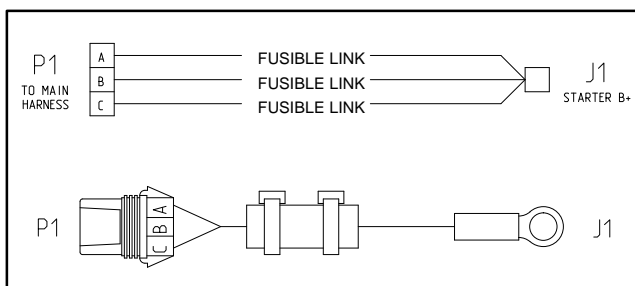


Figure 39

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 will stop. The seat switch and its electrical connector are located directly under the seat (Fig. 40).

Testing

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

2. Before disconnecting the seat switch for testing, the switch and its circuit wiring should be tested as a TEC electrical input using the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If input testing verifies that the seat switch and circuit wiring **are** functioning correctly, no further seat switch testing is necessary. If, however, input testing determines that the seat switch and circuit wiring **are not** functioning correctly, proceed with the following seat switch testing procedure.

3. Make sure ignition switch is in the OFF position.

4. Disconnect seat switch wire harness connector from machine wire harness at rear of operator seat (Fig. 41).

5. Check the continuity of the switch by connecting a multimeter (ohms setting) across the seat switch wire harness connector terminals.

6. With no pressure on the seat, there should be no continuity (open) between the harness terminals.

7. Press directly onto the seat switch through the seat cushion. There should be continuity (closed) between the harness terminals as the seat cushion approaches the bottom of its travel.

8. If continuity checks determine faulty seat switch operation, check seat switch wire harness for problems before replacing seat switch.

9. If the seat switch tests correctly and a circuit problem still exists, check machine wire harness (see Electrical Schematic and Wire Harness Drawings in Chapter 10 – Foldout Drawings).

10. After seat switch testing is complete, connect seat switch wire harness connector to machine wire harness.

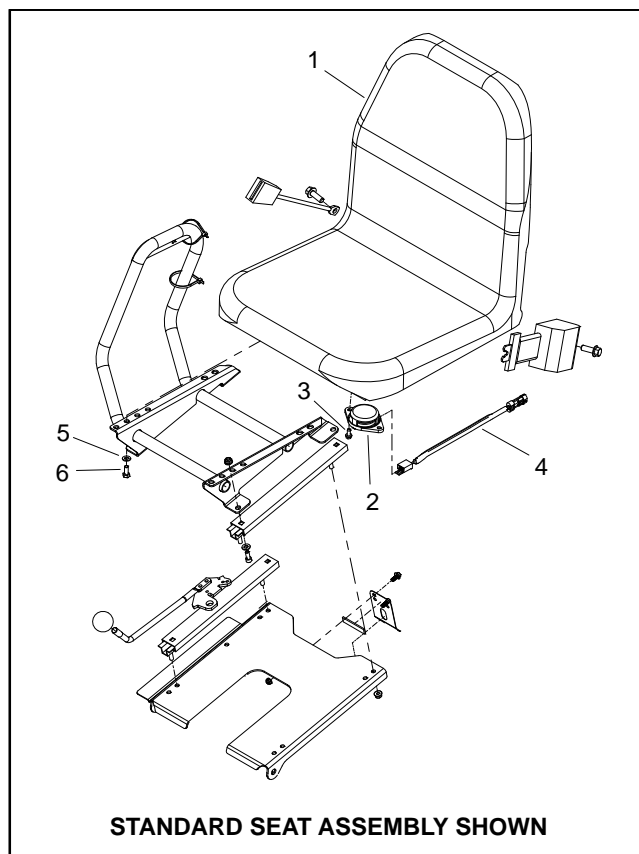


Figure 40

- | | |
|-----------------------|-------------------------|
| 1. Operator seat | 4. Seat switch harness |
| 2. Seat switch | 5. Flat washer (4 used) |
| 3. Cap screw (2 used) | 6. Cap screw (4 used) |

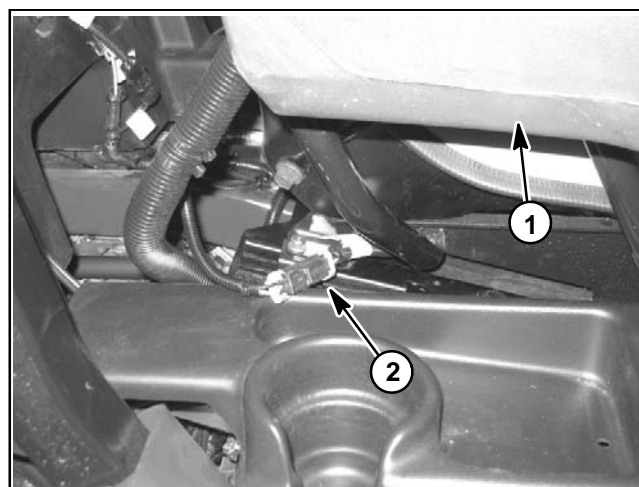


Figure 41

- | | |
|------------------|--------------------------|
| 1. Operator seat | 2. Seat switch connector |
|------------------|--------------------------|

Neutral and Mow Switches

The neutral and mow switches are normally open proximity switches that mount to the console assembly (Fig. 42). The sensing plate for these switches is a tab on the functional control lever. The Toro Electronic Controller (TEC) monitors the operation of the neutral and mow switches.

When the functional control lever is in the neutral position, the tab on the lever is positioned near the target end of the neutral switch causing the switch to close. The tab on the functional control lever is moved away from the neutral switch when the lever is in either the mow or transport position causing the switch to be in its normal open state.

When the functional control lever is in the mow position, the tab on the lever is positioned near the target end of the mow switch causing the switch to close. The tab on the functional control lever is moved away from the mow switch when the lever is in either the neutral or transport position causing the switch to be in its normal open state.

Testing

1. Park machine on level surface, lower cutting units, stop engine and remove key from ignition switch.

2. Before disconnecting the neutral or mow switch for testing, the switch and its circuit wiring should be tested as a TEC electrical input using the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If input testing verifies that the switch and circuit wiring **are** functioning correctly, no further switch testing is necessary. If, however, input testing determines that the switch and circuit wiring **are not** functioning correctly, proceed with the following switch testing procedure.

3. Remove console cover from console assembly to gain access to neutral and mow switches (see Control Console Disassembly in the Service and Repairs section of Chapter 7 – Chassis). Locate switch that is to be tested (Fig. 42).

4. Turn ignition switch to the RUN position (do not start engine) and check LED on cable end of switch.

A. The neutral switch LED **should be** illuminated **only** when the functional control lever is in the neutral position. The neutral switch LED **should not be** illuminated when the functional control lever is in either the mow or transport position.

B. The mow switch LED **should be** illuminated **only** when the functional control lever is in the mow position. The mow switch LED **should not be** illuminated when the functional control lever is in either the neutral or transport position.

5. If the tested switch LED did not function correctly:

A. Make sure that switch is properly adjusted (see Neutral and Mow Switches in the Adjustments section of this chapter). If necessary, adjust switch and return to step 4 above.

B. Make sure ignition switch is OFF and disconnect the switch connector from the machine wire harness.

C. Using a multimeter, verify that the machine wire harness connector terminal for black wire is closed (continuity) to ground.

D. Turn ignition switch to the RUN position (do not start engine) and verify with a multimeter that machine wire harness connector terminal for pink wire has system voltage (12 VDC) present.

E. If black wire is closed to ground, pink wire has system voltage present and switch LED did not function correctly (step 4 above), replace tested switch. Adjust switch after installation (see Neutral and Mow Switches in the Adjustments section of this chapter).

6. After switch testing is complete, make sure that switch connector is plugged into machine wire harness. Install console cover (see Control Console Assembly in the Service and Repairs section of Chapter 7 – Chassis).

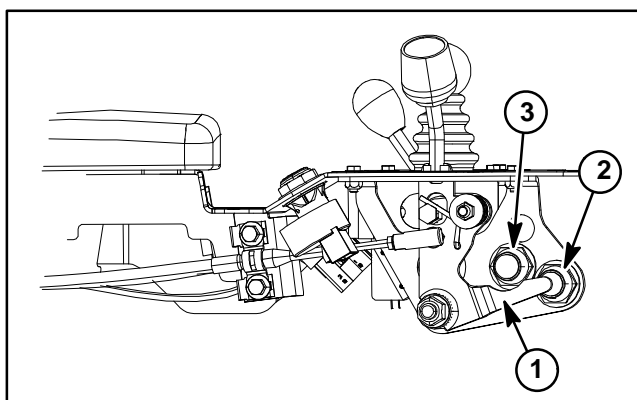


Figure 42

- | | |
|-------------------------|-------------------|
| 1. Functional lever tab | 3. Neutral switch |
| 2. Mow switch | |

Parking Brake Switch

The parking brake switch is a normally open proximity switch that mounts to the frame bracket used to attach the parking brake lever assembly (Fig. 43). The sensing plate for the brake switch is a tab on the parking brake lever assembly. The Toro Electronic Controller (TEC) monitors the operation of the parking brake switch.

When the parking brake is not applied, the tab on the parking brake lever is positioned near the target end of the parking brake switch so the switch is closed. The tab on the parking brake lever is moved away from the switch when the parking brake is applied causing the switch to open.

Testing

1. Park machine on level surface, lower cutting units, stop engine and remove key from ignition switch.

2. Before disconnecting the parking brake switch for testing, the switch and its circuit wiring should be tested as a TEC electrical input using the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If input testing verifies that the brake switch and circuit wiring **are** functioning correctly, no further brake switch testing is necessary. If, however, input testing determines that the brake switch and circuit wiring **are not** functioning correctly, proceed with the following parking brake switch testing procedure.

3. Locate parking brake switch. Make sure that parking brake is not applied.

4. Turn ignition switch to the RUN position (do not start engine) and check LED on cable end of parking brake switch. The switch LED **should be** illuminated when the parking brake **is not** applied.

5. With the ignition switch still in the RUN position (do not start engine), apply parking brake and check LED on cable end of parking brake switch. The switch LED **should not be** illuminated when the parking brake **is** applied.

6. If the brake switch LED did not function correctly:

A. Make sure that parking brake switch is properly adjusted (see Parking Brake Switch in the Adjustments section of this chapter). If necessary, adjust switch and return to step 4 above.

B. Make sure ignition switch is OFF and disconnect the parking brake switch connector from the machine wire harness.

C. Using a multimeter, verify that the machine wire harness connector terminal for black wire is closed (continuity) to ground.

D. Turn ignition switch to the RUN position (do not start engine) and verify with a multimeter that machine wire harness connector terminal for pink wire has system voltage (12 VDC) present.

E. If black wire is closed to ground, pink wire has system voltage present and switch LED did not function, replace parking brake switch. Adjust switch after installation (see Parking Brake Switch in the Adjustments section of this chapter).

7. After brake switch testing is complete, make sure that switch connector is plugged into machine wire harness.

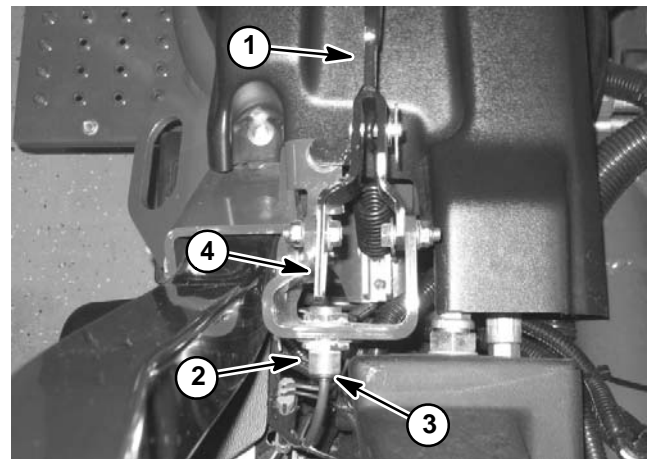


Figure 43

- | | |
|-------------------------|------------------------|
| 1. Brake lever | 3. Switch LED location |
| 2. Parking brake switch | 4. Brake lever tab |

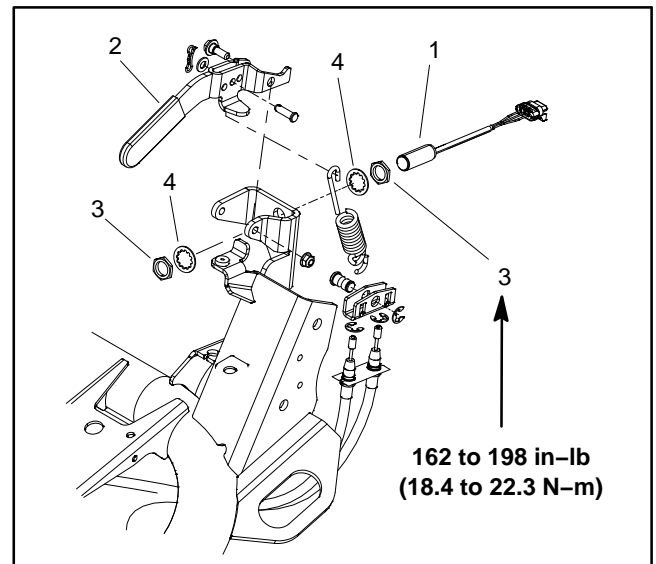


Figure 44

- | | |
|-------------------------|-------------------------|
| 1. Parking brake switch | 3. Jam nut (2 used) |
| 2. Parking brake lever | 4. Lock washer (2 used) |

Joystick Raise and Lower Switches

The joystick raise and lower switches are located on the joystick assembly that is attached to the control console. The rear switch is used to lower the cutting units and the front switch to raise them (Fig. 45). The switches are identical and are shown in Figure 46. The Toro Electronic Controller (TEC) monitors the operation of the joystick raise and lower switches.

Testing

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

2. Before disconnecting the joystick switches for testing, the switches and their circuit wiring should be tested as a TEC electrical input using the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If input testing verifies that the joystick switches and circuit wiring **are** functioning correctly, no further switch testing is necessary. If, however, input testing determines that the joystick switches and circuit wiring **are not** functioning correctly, proceed with the following joystick switch testing procedure.

3. Remove console cover from console assembly to gain access to joystick switches (see Control Console Disassembly in the Service and Repairs section of Chapter 7 – Chassis).

4. Make sure ignition switch is in the OFF position. Disconnect wire harness connectors from joystick switches.

5. 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 neutral position, continuity should only exist between the common and NC terminals.

B. With the joystick in the raise position, continuity should only exist between the common and NO terminals.

6. 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 neutral position, continuity should only exist between the common and NC terminals.

B. With the joystick in the lower position, continuity should only exist between the common and NO terminals.

7. Replace joystick switch if necessary.

8. After switch testing is completed, connect the harness connectors to the joystick switches. Install console cover (see Control Console Assembly in the Service and Repairs section of Chapter 7 – Chassis).

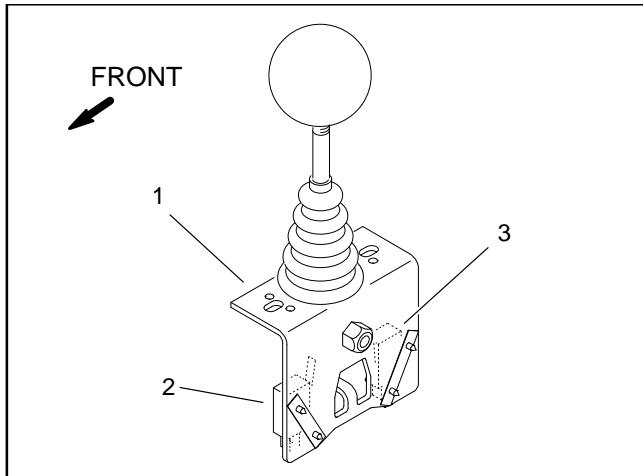


Figure 45

- | | |
|----------------------|-----------------|
| 1. Joystick assembly | 3. Lower switch |
| 2. Raise switch | |

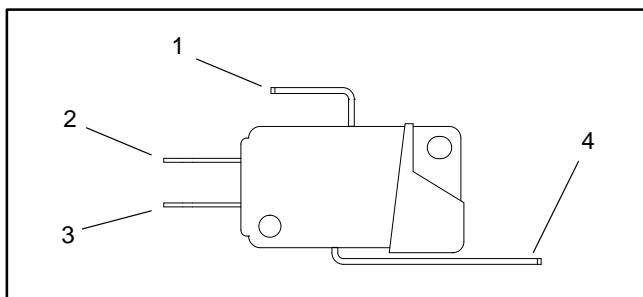


Figure 46

- | | |
|--------------------|-----------------|
| 1. Common terminal | 3. NC terminal |
| 2. NO terminal | 4. Switch lever |

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 bottom of the hydraulic mow control manifold located under the left side cover next to operator seat (Fig. 47). The Toro Electronic Controller (TEC) uses the backlap switch as an input to allow only one person to backlap the cutting reels and also to prevent the cutting reels from raising during backlapping.

Testing

1. Park machine on level surface, lower cutting units, stop engine, apply parking brake and remove key from ignition switch.
2. Before disconnecting the backlap switch for testing, the switch and its circuit wiring should be tested as a TEC electrical input using the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If input testing verifies that the backlap switch and circuit wiring **are** functioning correctly, no further switch testing is necessary. If, however, input testing determines that the backlap switch and circuit wiring **are not** functioning correctly, proceed with the following backlap switch testing procedure.
3. Make sure ignition switch is in the OFF position.
4. Remove left side cover next to operator seat to allow access to hydraulic mow control manifold. Locate the backlap switch on the bottom of the manifold. Disconnect the harness electrical connector from the backlap switch.
5. Check the continuity of the switch by connecting a multimeter (ohms setting) across the switch connector terminals.
6. 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.
7. Turn the backlap lever to the mow position while watching the multimeter. Continuity should be broken as the switch opens.
8. If backlap switch is faulty, replace switch.

9. If the backlap switch tests correctly and a circuit problem still exists, check wire harness (see Electrical Schematic and Wire Harness Drawings in Chapter 10 – Foldout Drawings).

10. After testing is completed, connect harness electrical connector to the backlap switch. Install left side cover next to operator seat.

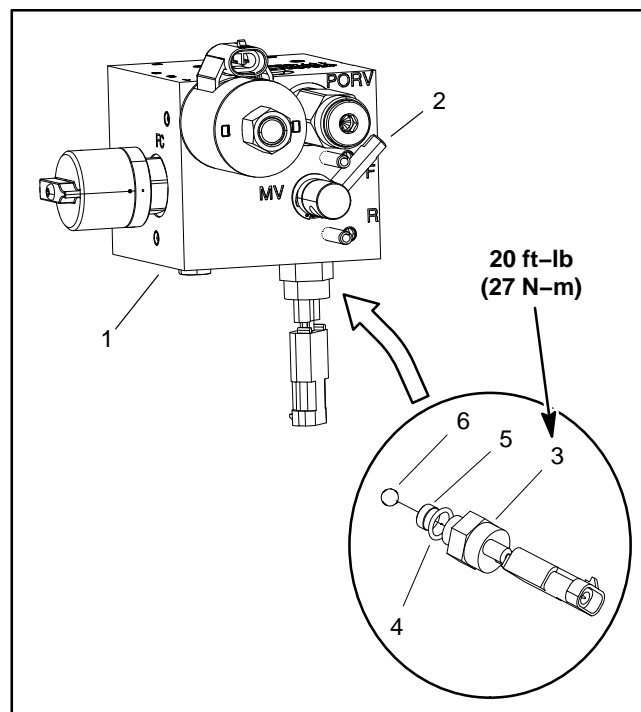


Figure 47

- | | |
|---------------------------|-----------|
| 1. Hydraulic mow manifold | 4. O-ring |
| 2. Backlap lever | 5. Shim |
| 3. Backlap switch | 6. Ball |

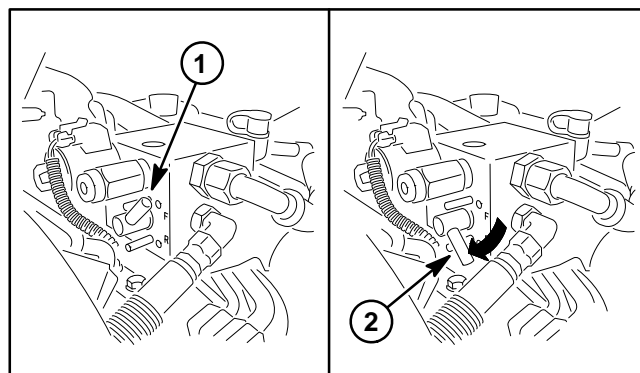


Figure 48

- | | |
|----------------------------|----------------------------|
| 1. Backlap lever (forward) | 2. Backlap lever (backlap) |
|----------------------------|----------------------------|

Hydraulic Solenoid Valve Coils

The Greensmaster hydraulic control manifolds use several hydraulic solenoid valve coils for system control. The lift manifold includes four (4) solenoid valves and the mow manifold includes a single solenoid valve. On machines equipped with the Turf Guardian™ Leak Detector, the leak detector manifold includes a single solenoid valve. 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

NOTE: Before disconnecting and testing solenoid valve coils, test the TEC controller outputs with the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If the Diagnostic Display verifies that the TEC outputs **are** functioning correctly, consider that a problem with the solenoid valve coil or circuit wiring may exist. An open or shorted controller output (e.g. a failed solenoid valve coil, an unplugged connector or a broken wire) cannot be detected with the Diagnostic Display. Conversely, if the Diagnostic Display verifies that the TEC outputs **are not** functioning correctly, consider that a problem with controller inputs, controller fuses or the TEC controller may exist.

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

2. Determine solenoid coil(s) that are to be tested and locate coil on correct hydraulic manifold:

A. Remove right side cover next to operator seat to allow access to lift control manifold.

B. Remove left side cover next to operator seat to allow access to mow control manifold.

C. To gain access to leak detector manifold, see Leak Detector Solenoid Valve Assembly in the Service and Repairs section of Chapter 5 – Hydraulic System.

3. Disconnect harness electrical connector from hydraulic solenoid valve coil that is to be tested (Figs. 49, 50 or 51).

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.

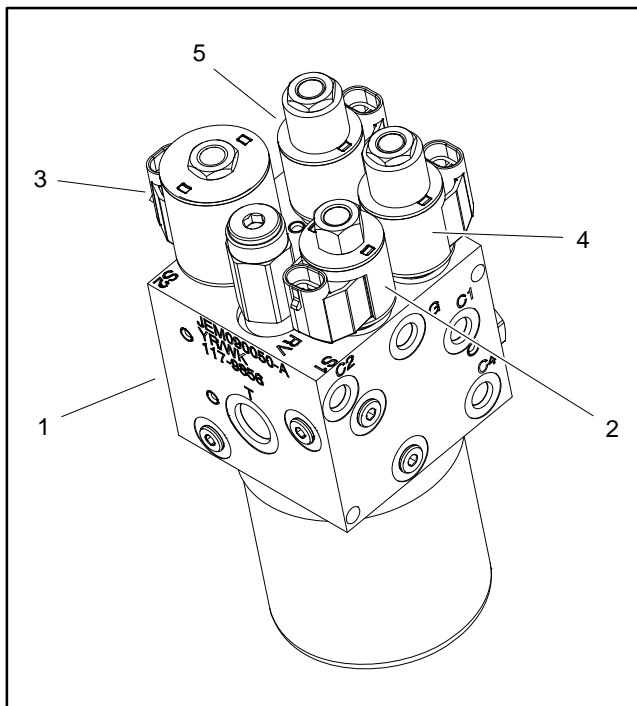


Figure 49

- | | |
|----------------------------|----------------------|
| 1. Hydraulic lift manifold | 4. Solenoid valve S3 |
| 2. Solenoid valve S1 | 5. Solenoid valve S4 |
| 3. Solenoid valve S2 | |

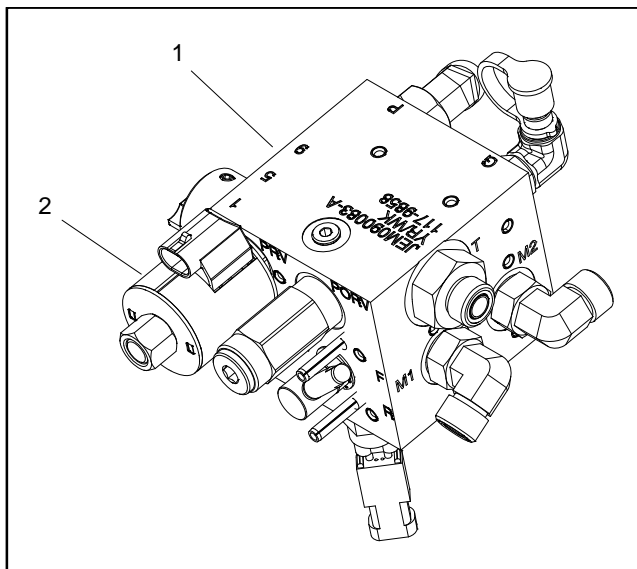


Figure 50

- | | |
|---------------------------|-------------------------|
| 1. Hydraulic mow manifold | 2. Solenoid valve (PRV) |
|---------------------------|-------------------------|

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).

4. 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
PRV (mow)	7.1 ohms
S1, S3 and S4 (lift)	8.8 ohms
S2 (lift)	7.1 ohms
Leak Detector	7.2 ohms

5. If solenoid coil resistance is incorrect, replace solenoid (refer to appropriate control manifold service procedures in the Service and Repairs section of Chapter 5 – 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 mow manifold PRV coil is the same as the lift manifold S2 coil. The lift manifold S1, S3 and S4 coils are identical.

6. After coil testing is completed, connect wire harness electrical connector to the solenoid valve coil.

7. Secure all machine components that were removed to access hydraulic manifold.

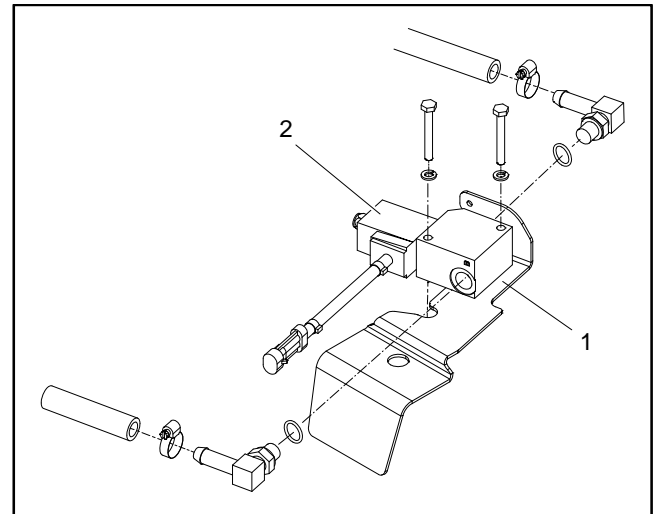


Figure 51

1. Leak detector manifold 2. Solenoid valve

Main Power, Charge Circuit (Greensmaster 3300), Glow (Greensmaster 3400) and Fan (Greensmaster 3400) Relays

The Greensmaster TriFlex electrical system includes several identical, four (4) terminal relays for current control. The relays are located under the right side cover next to the operator seat (Fig. 52). Relays can be identified by a tag near the relay wire harness connector.

The main power relay provides electrical current to the fuse blocks when energized by the ignition switch in the RUN or START position. The main power relay is used on both Greensmaster 3300 and 3400 machines.

The charge circuit relay on Greensmaster 3300 machines provides a current path for alternator output to reach the machine's electrical system. The charge circuit relay is energized by the Toro Electronic Controller (TEC) when the ignition switch is in the RUN or START position.

The glow relay on Greensmaster 3400 machines provides electrical current to the engine glow plugs when energized by the TEC controller.

The fan relay on Greensmaster 3400 machines provides electrical current to the engine cooling fan when energized by the TEC controller. The fan relay is energized when engine coolant temperature reaches approximately 185°F (85°C).

The charge circuit, glow and fan relays along with their circuit wiring **should** be tested as a TEC controller output with the Diagnostic Display before disconnecting and testing the relay (see Diagnostic Display in the Troubleshooting section of this chapter).

Testing

1. Park machine on a level surface, lower cutting units, stop engine, apply parking brake and remove key from ignition switch. Remove right side cover next to operator seat to allow access to relays.

2. Make sure ignition switch is in the OFF position. Locate the relay to be tested and disconnect wire harness electrical connector from relay. Remove relay from bracket for easier testing.

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 relay being testing.

3. Measure coil resistance between terminals 85 and 86 with a multimeter (ohms setting) (Fig. 53). Resistance should be approximately **72 ohms**.

4. 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.

5. Disconnect voltage and leads from the relay terminals. Replace relay if necessary.

6. After testing is completed, secure relay to bracket and connect wire harness electrical connector to relay.

7. Install right side cover next to operator seat.

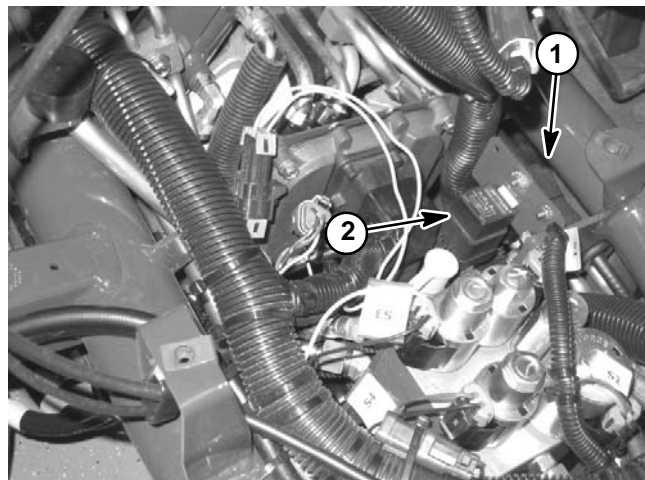


Figure 52

1. Relay (4 terminal)

2. Relay (5 terminal)

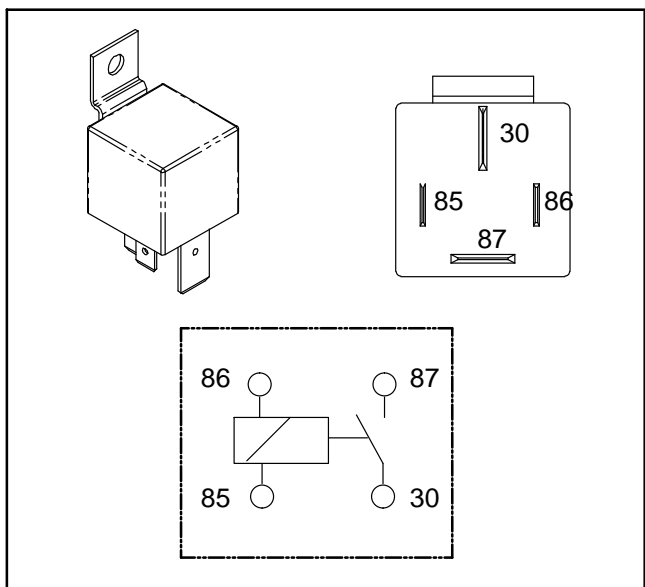


Figure 53

Kill (Greensmaster 3300) and Start (Greensmaster 3400) Relays

The Greensmaster TriFlex electrical system includes a five (5) terminal relay for current control. The kill relay is used only on Greensmaster 3300 machines. The start relay is used only on Greensmaster 3400 machines. These relays are located under the right side cover next to the operator seat (Fig. 54) and can be identified by a tag near the relay wire harness connector.

When energized by the TEC controller, the kill relay on Greensmaster 3300 machines provides a grounding path for the engine starter solenoid. While energized, the kill relay also allows the engine magneto (ignition) system to function. When the kill relay is de-energized, a grounding path is made for the engine magneto armatures to prevent ignition function and stop the engine.

The start relay on Greensmaster 3400 machines provides electrical current to the engine starter solenoid when energized by the TEC controller.

Testing

1. Park machine on a level surface, lower cutting units, stop engine, apply parking brake and remove key from ignition switch. Remove right side cover next to operator seat to allow access to relays.

2. Locate relay to be tested and disconnect the machine wire harness connector from the relay. Remove relay from bracket for easier testing.

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 relay being testing.

3. Using a multimeter (ohms setting), measure coil resistance between terminals 85 and 86 (Fig. 55). Resistance should be between **70 and 90 ohms**.

4. Connect multimeter (ohms setting) leads to relay terminals 30 and 87. Ground terminal 86 and apply +12 VDC to terminal 85. The relay terminals 30 and 87 should have continuity as +12 VDC is applied to terminal 85. The relay terminals 30 and 87 should not have continuity as +12 VDC is removed from terminal 85.

5. Disconnect voltage from terminal 85 and multimeter lead from terminal 87.

6. Connect multimeter (ohms setting) leads to relay terminals 30 and 87A. With terminal 86 grounded, apply +12 VDC to terminal 85. The relay terminals 30 and 87A should not have continuity as +12 VDC is applied to terminal 85. The relay terminals 30 and 87A should have continuity as +12 VDC is removed from terminal 85.

7. When relay testing is completed, disconnect voltage and multimeter leads from the relay terminals. Replace relay if necessary.

8. Secure relay to machine and connect machine wire harness connector to relay.

9. Install right side cover next to operator seat.

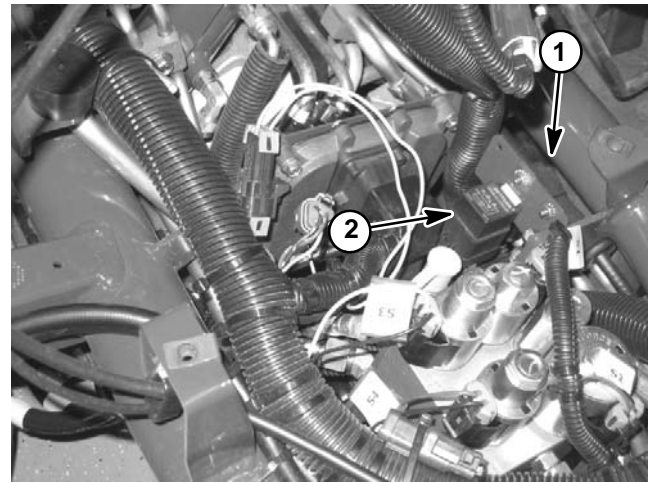


Figure 54

1. Relay (4 terminal)

2. Relay (5 terminal)

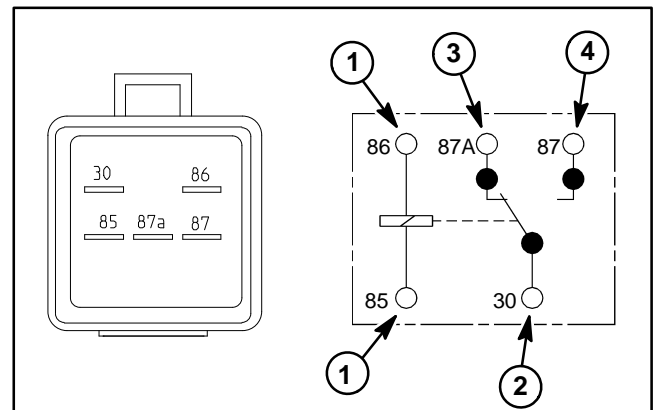


Figure 55

1. Coil terminal

2. Common terminal

3. Normally closed term.

4. Normally open term.

Toro Electronic Controller (TEC)

Greensmaster TriFlex machines use a Toro Electronic Controller (TEC) to monitor the condition of various switches (inputs) and then direct electrical power output to allow certain machine functions. The controller is attached to the frame under the right side cover next to operator seat (Fig. 56).

Inputs from the ignition, neutral, parking brake, seat, joystick, mow, backlap and engine oil pressure are all monitored by the TEC controller. TEC inputs on Greensmaster 3300 machines also include the leak detector sensor. TEC inputs on Greensmaster 3400 machines also include the alternator, engine temperature sender and hydraulic temperature sender.

On all TriFlex Greensmaster machines, TEC controller current output to the mow circuit hydraulic valve solenoid coil (PRV), lift circuit hydraulic valve solenoid coils (S1, S2, S3 and S4) and console diagnostic light are controlled based on the inputs received by the controller. TEC outputs on Greensmaster 3300 machines also include the start solenoid, fuel solenoid, charge circuit relay, kill relay and Turf Defender™ Leak Detector indicator light and alarm. TEC outputs on Greensmaster 3400 machines also include the start relay, glow relay, fuel pump, engine run solenoid (hold coil), fan relay, console indicator lights.

The diagram in Figure 57 depicts the connection terminal functions of the TEC controller. A fifty (50) pin wire harness connector attaches to the controller. The connector pins are listed in the diagram. Note that electrical power for controller outputs is provided through three (3) connectors each protected with a 7.5 amp fuse.

The handheld Diagnostic Display (see Special Tools in this chapter) with the correct Display overlay should be used when checking inputs and outputs of the controller used on your Greensmaster (see Diagnostic Display in the Troubleshooting section of this chapter). If the controller detects a malfunction in any of the controlled circuits, the diagnostic light can be used to identify the fault (see Diagnostic Light in the Troubleshooting section of this chapter).

Because of the solid state circuitry built into the controller, there is no method to test it directly. The controller may be damaged if an attempt is made to test it with an electrical test device, such as a digital multimeter.

IMPORTANT: Before performing any welding on the machine, disconnect both positive and negative battery cables from the battery, disconnect the wire harness connector from the TEC controller and disconnect the terminal connector from the alternator. This will prevent damage to the electrical system of your Greensmaster.

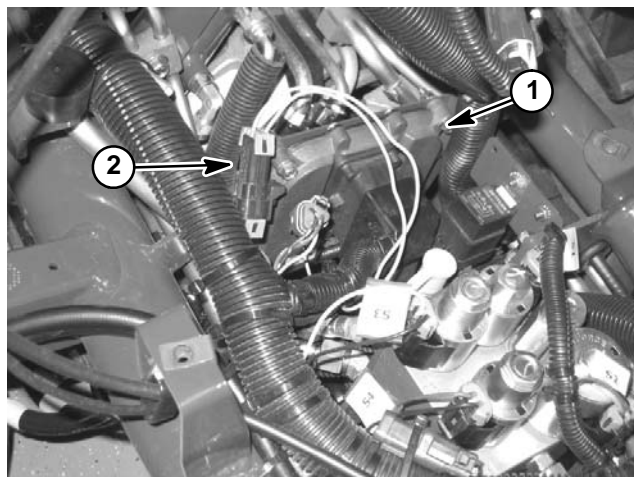


Figure 56

1. TEC controller
2. Loopback connector

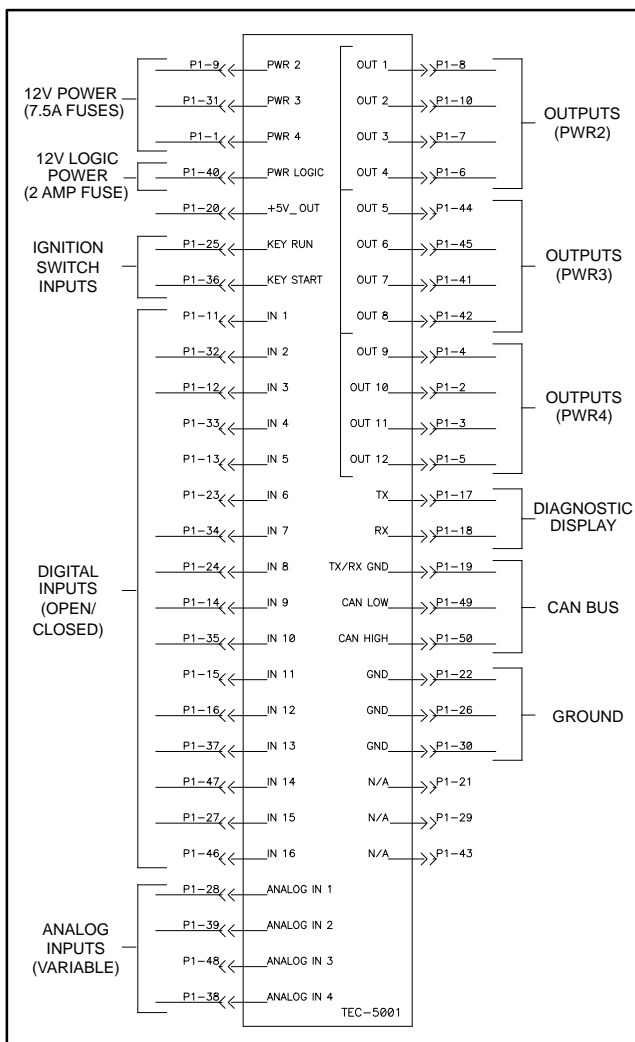


Figure 57

CAN-bus Termination Resistors

System communication between electrical components on Greensmaster TriFlex machines is accomplished on a CAN-bus communication system. Two (2) specially designed, twisted cables form the bus for the electrical system. These wires provide the data pathways between machine components. At the ends of the twisted pair of bus cables are 120 ohm termination resistors.

The resistors plug into the wire harness near the hydraulic lift control manifold under the right side cover next to the operator seat.

NOTE: Refer to the Electrical Schematics and Wire Harness Drawings in Chapter 10 – Foldout Drawings for additional information on termination resistor locations and wire connections.

Resistor Test

The termination resistors (Fig. 58) can be individually tested using a digital multimeter (ohms setting). There should be 120 ohms resistance between terminals A and B. Terminal C is not used on Greensmaster TriFlex machines.

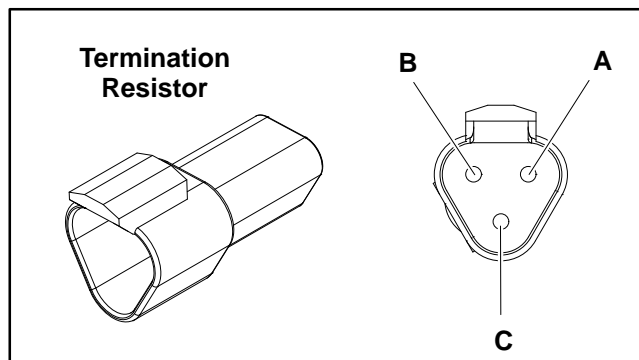


Figure 58

Turf Guardian™ Leak Detector Oil Level Sensor (If Equipped)

NOTE: Greensmaster 3300 machines are equipped with the Turf Guardian™ Leak Detector System. On Greensmaster 3400 machines, the Leak Detector System is optional.

The leak detector oil level sensor closely monitors the hydraulic fluid level in the main hydraulic reservoir. The sensor is open when the sensor float is in the raised position and closed when the float is in the lowered position. See Turf Guardian™ Leak Detector System Operation in this chapter for information regarding Leak Detector System operation.

Oil Level Sensor Testing

NOTE: On Greensmaster 3300 machines, the leak detector oil level sensor is an input for the TEC controller. Before disconnecting the oil level sensor for testing, the sensor and its circuit wiring should be tested as a TEC electrical input using the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If input testing verifies that the oil level sensor and circuit wiring **are** functioning correctly, no further sensor testing is necessary. If, however, input testing determines that the oil level sensor and circuit wiring **are not** functioning correctly, proceed with the following sensor testing procedure.

1. If the oil level sensor is connected to the main wire harness, remove hydraulic tank cap from filler neck of hydraulic reservoir. Start the engine. Insert a clean rod or screw driver into filler neck and gently push down on sensor float (Fig. 60). Alarm should sound and console leak detector indicator light should illuminate after a one (1) second time delay.

2. If the oil level sensor is removed or disconnected from the main wire harness, connect a continuity tester across the sensor wire terminals. There should be continuity (low resistance) across the sensor connector terminals when the float is pushed down. There should not be continuity (infinite resistance) across the sensor connector 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. 61). 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.

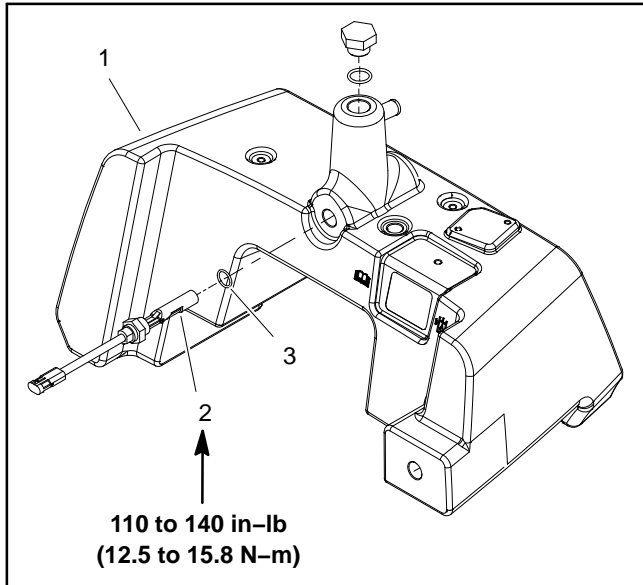


Figure 59

- 1. Hydraulic reservoir
- 2. Oil level sensor
- 3. O-ring

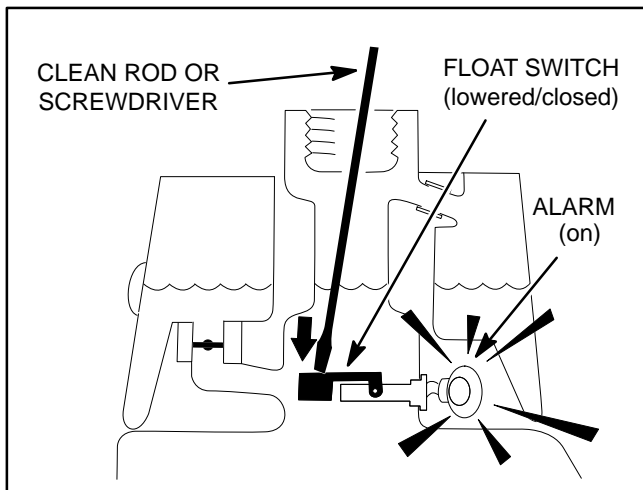


Figure 60

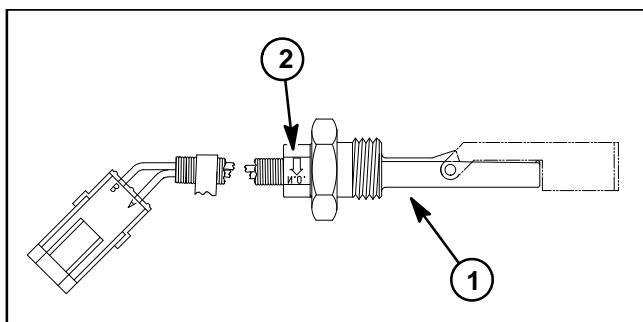


Figure 61

- 1. Oil level sensor
- 2. Sensor arrow

Turf Guardian™ Leak Detector Alarm (If Equipped)

NOTE: Greensmaster 3300 machines are equipped with the Turf Guardian™ Leak Detector System. On Greensmaster 3400 machines, the Leak Detector System is optional.

Machines equipped with the Turf Guardian™ Leak Detector System include an alarm that sounds if a hydraulic leak is detected by the system. The alarm is attached to the outside of the control console assembly.

Testing

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

2. Remove console cover from console assembly to gain access to alarm (see Control Console Disassembly in the Service and Repairs section of Chapter 7 – Chassis).

IMPORTANT: Make sure to observe polarity on the alarm terminals when testing. Damage to the alarm may result from an improper connection.

3. Disconnect wire harness connector from alarm. Correctly connect 12VDC source to the alarm terminals (Fig. 62). Alarm should sound.

4. Remove voltage source from the alarm. Replace alarm if necessary. Connect wire harness connector to alarm.

5. Install console cover (see Control Console Assembly in the Service and Repairs section of Chapter 7 – Chassis).

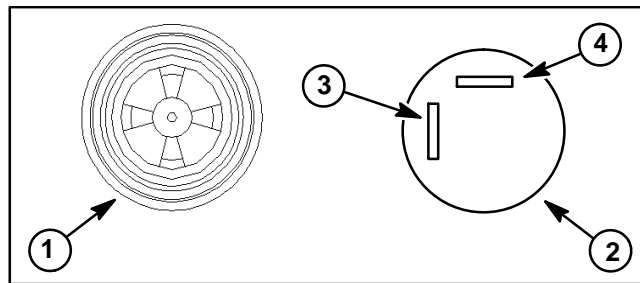


Figure 62

- | | |
|----------------|--------------------------|
| 1. Top view | 3. Positive (+) terminal |
| 2. Bottom view | 4. Negative (-) terminal |

Starter Solenoid (Greensmaster 3300)

The starter solenoid used on Greensmaster 3300 machines allows current flow from the battery to the engine starter motor when energized. This solenoid is energized by the TEC controller when the ignition switch is in the START position. The starter solenoid is attached to the left side of the rear frame beneath the hydraulic oil reservoir (Fig. 63).

Testing

NOTE: Before disconnecting and testing starter solenoid, test the TEC controller outputs with the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If the Diagnostic Display verifies that the TEC outputs **are** functioning correctly, consider that a problem with the starter solenoid or circuit wiring may exist. An open or shorted controller output (e.g. a failed starter solenoid, an unplugged connector or a broken wire) cannot be detected with the Diagnostic Display. Conversely, if the Diagnostic Display verifies that the TEC outputs **are not** functioning correctly, consider that a problem with controller inputs, controller fuses or the TEC controller may exist.

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

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 (steel). The solenoid should click as the solenoid coil is energized. Make sure resistance across the main contact posts (copper) is less than **1 ohm**.

5. Remove voltage from solenoid coil posts (steel). The solenoid should click as the solenoid coil is de-energized. Make sure resistance across the main contact posts (copper) is **infinite ohms**.

6. Resistance across the solenoid coil posts (steel) should be approximately **13.5 ohms**.

7. Replace starter solenoid if necessary.

8. Connect positive battery cable to one main contact post on starter solenoid, starter cable to the other main contact post and two (2) wire harness connectors to solenoid posts.

9. Connect battery cables to battery. Make sure to connect positive (red) battery cable first and then connect negative (black) cable.

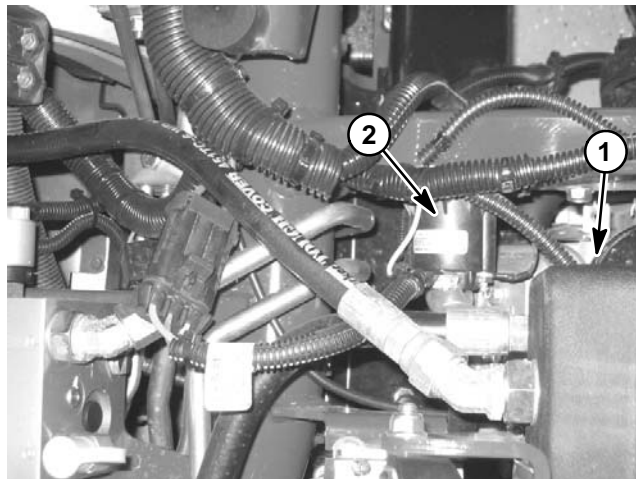


Figure 63

1. Hydraulic reservoir 2. Starter solenoid

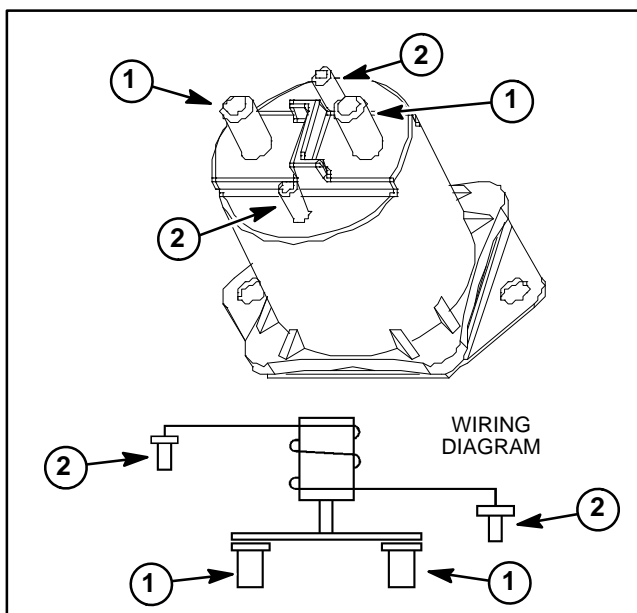


Figure 64

1. Main posts (copper) 2. Solenoid posts (steel)

Fuel Pump (Greensmaster 3400 machines)

The fuel pump on Greensmaster 3400 machines is secured to the radiator assembly with an r-clamp (Fig. 65). The Toro Electronic Controller (TEC) energizes the fuel pump when the ignition switch is in either the RUN or START position.

IMPORTANT: When testing fuel pump, make sure that pump is not operated without fuel.



DANGER

Because diesel fuel is flammable, use caution when handling it. Do not smoke while testing the fuel pump. Do not test fuel pump while engine is hot. Make sure that there is adequate ventilation when testing. Always wipe up any spilled fuel before starting the engine.

Fuel Pump Capacity Test

1. Park machine on a level surface, lower cutting units, stop engine and engage parking brake.
2. Raise operator seat and remove starter fuse from fuse block to prevent the engine from cranking (see Fuse Block (Greensmaster 3400) (serial number dependant) in this section).
3. Disconnect machine fuel supply hose from the fuel pump outlet (Fig. 65).
4. Make sure fuel hose attached to the fuel pump inlet is free of obstructions. Also, make sure that fuel shut-off valve on fuel tank is open.
5. For fuel pump testing, place section of fuel hose on fuel pump outlet and secure in place with hose clamp. Place other end of fuel hose into a large, graduated cylinder sufficient enough to collect 1 quart (0.95 liter).

IMPORTANT: When testing the fuel pump, DO NOT turn ignition switch to START.

6. Collect fuel in the graduated cylinder by turning ignition switch to the RUN position. Allow pump to run for fifteen (15) seconds, then turn ignition switch to OFF.

7. Fuel collected in the graduated cylinder should be approximately 16 fl oz (475 ml) after fifteen (15) seconds.

8. Replace fuel pump if necessary.

9. Remove fuel hose from pump outlet and install machine fuel supply hose to the pump outlet. Make sure to secure fuel hose with hose clamp.

10. Install starter fuse into fuse block.

11. Bleed the fuel system.

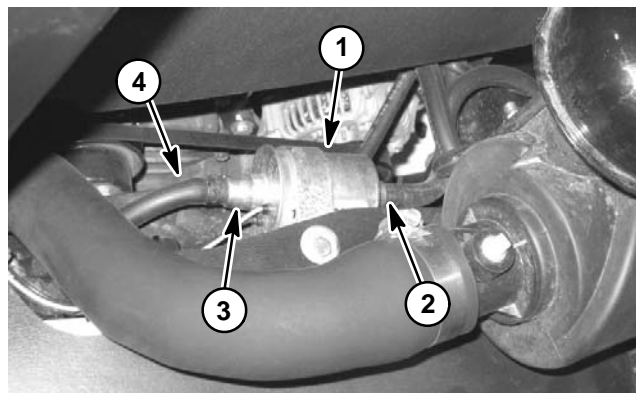


Figure 65

- | | |
|--------------------|---------------------|
| 1. Fuel pump | 3. Fuel pump outlet |
| 2. Fuel pump inlet | 4. Fuel supply hose |

Fuel Pump Specifications

Pump Capacity	64 fl oz/min (1.9 l/min)
Pressure	7 PSI (48.3 kPa)
Current Draw	2.0 amp

Fuel Solenoid (Greensmaster 3400 machines)

The fuel solenoid used on Greensmaster 3400 machines must be energized for the diesel engine to run. The fuel solenoid is mounted to the injection pump on the engine (Fig. 66). The Toro Electronic Controller (TEC) energizes the fuel solenoid when the ignition switch is in either the RUN or START position.

The fuel solenoid includes two (2) coils for operation: the pull coil and the hold coil. When the ignition switch is turned to START, the fuel solenoid pull coil is energized and the solenoid plunger retracts. Once the plunger is retracted, the hold coil will keep it retracted for continued engine operation. When the solenoid is de-energized, the plunger extends to shut off fuel supply to the engine causing the engine to stop running.

NOTE: A fusible link in the machine wire harness protects the fuel solenoid pull coil circuit. If this link should fail, the fuel solenoid will not function and the engine will not run. Refer to electrical drawings in Chapter 10 – Foldout Drawings when troubleshooting the fuel solenoid.

NOTE: See Kubota Workshop Manual, Diesel Engine, SM-E3B Series for information regarding fuel solenoid testing procedure.

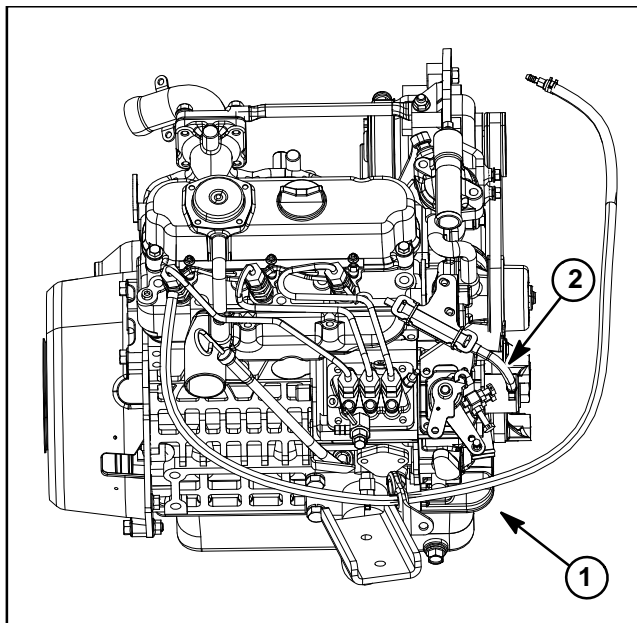


Figure 66

1. Engine assembly

2. Fuel stop solenoid

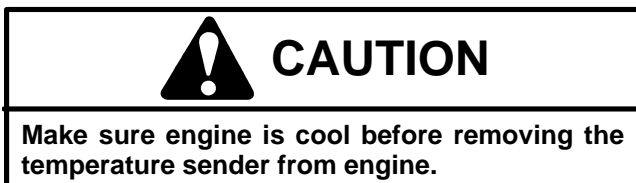
Temperature Sender (Greensmaster 3400 machines)

The temperature sender is located near the alternator on the water flange attached to the engine cylinder head (Fig. 67).

The resistance of the temperature sender reduces as the engine coolant temperature increases. The changing resistance of the temperature sender signals the console temperature gauge to indicate engine coolant temperature during machine operation.

Temperature Sender Test

1. Park machine on a level surface, lower cutting units, stop engine, apply parking brake and remove key from ignition switch.
2. Locate temperature sender on engine and disconnect wire harness connector from sender.



3. Lower coolant level in the engine and remove the temperature sender from water flange.
4. Put sender in a container of oil with a thermometer and slowly heat the oil (Fig. 68).



NOTE: Prior to taking resistance readings with a digital multi meter, short the meter test leads together. The meter will display a small resistance value (usually 0.5 ohms or less) due to the internal resistance of the meter and test leads. Subtract this value from the measured value of the component you are testing.

5. Check resistance of the sender with a multimeter (ohms setting) as the oil temperature increases.
 - A. The meter should indicate from 11.4 to 13.6 K-ohms at 68°F (20°C).
 - B. The meter should indicate from 2.3 to 2.6 K-ohms at 140°F (60°C).
 - C. The meter should indicate from 0.6 to 0.7 K-ohms at 212°F (100°C).

6. Replace temperature sender if specifications are not met.
7. Install temperature sender to the water flange.
 - A. Clean threads of water flange and temperature sender thoroughly. Apply thread sealant to the threads of the sender.
 - B. Screw sender into the water flange until it is finger tight. Then, tighten sender an additional 2 to 3 full turns.
 - C. Connect wire harness connector to sender.
8. Fill engine cooling system.

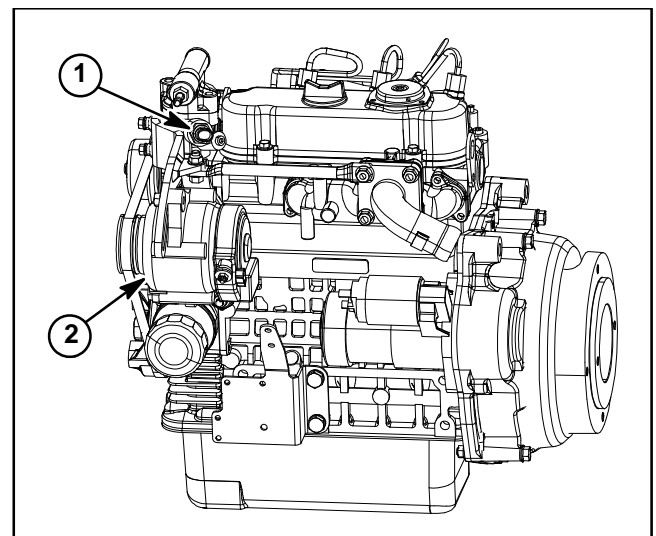


Figure 67

1. Temperature sender 2. Alternator

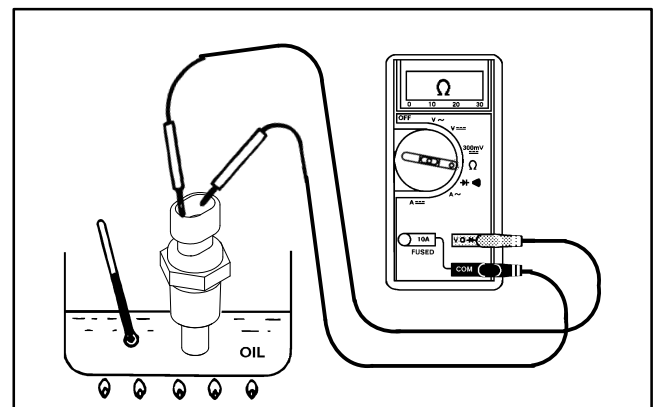


Figure 68

Diode Assembly (Greensmaster 3400)

The Greensmaster 3400 wire harness contains a diode that is used for circuit protection from voltage spikes when the engine starter solenoid is de-energized. The diode plugs into the wiring harness in the engine area (see Greensmaster 3400 Wire Harness Drawing in Chapter 10 – Foldout Drawings).

Diode Test

The diode (Fig. 69) can be tested using a digital multimeter (diode test or ohms setting) and the table to the right.

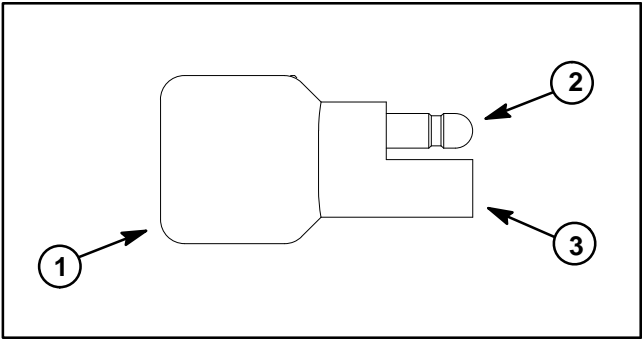


Figure 69

1. Diode
2. Male terminal
3. Female terminal

Multimeter Red Lead (+) on Terminal	Multimeter Black Lead (-) on Terminal	Continuity
Female	Male	YES
Male	Female	NO

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Service and Repairs

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. Prevent operating the traction pedal with the parking brake engaged.
- D. Shut off the engine if the operator leaves the seat without the functional control lever in NEUTRAL.
- E. Shut off the reels if the functional control lever is moved to NEUTRAL or TRANSPORT.

Interlock Switch Verification

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. With the engine not running, 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 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.

4. 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.

5. 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.

6. Sit on the seat, engage parking brake, keep traction pedal in neutral and place functional control lever in NEUTRAL. Start the engine. Move joystick 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.


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.
3. Leave cables disconnected if the battery is stored on the machine.
4. Store battery in a cool atmosphere to avoid quick deterioration of the battery charge.
5. To help prevent the battery from freezing during storage, make sure it is fully charged (see Battery Service in this section).

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 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.



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.

Greensmaster 3300 Battery Specifications

BCI Group U1 Battery
300 Amp Cranking Performance at 0°F (−18°C)
28 minute Reserve Capacity at 80°F (27°C)
Electrolyte Specific Gravity (fully charged): from 1.250 to 1.280
Electrolyte Specific Gravity (discharged): 1.240

Greensmaster 3400 Battery Specifications

BCI Group 55 Battery
585 Amp Cranking Performance at 0°F (−18°C)
95 minute Reserve Capacity at 80°F (27°C)
Electrolyte Specific Gravity (fully charged): from 1.250 to 1.280
Electrolyte Specific Gravity (discharged): 1.240

Battery Removal (Fig. 70 or 71)

IMPORTANT: Be careful to not damage terminal posts or cable connectors when removing the battery cables.

1. Disconnect the negative cable (−) from the battery first to prevent short circuiting the battery, other components or the operators hands. Then disconnect the positive (+) cable.
2. Remove fasteners and retainer components that secure battery to frame.
3. Make sure that the 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.

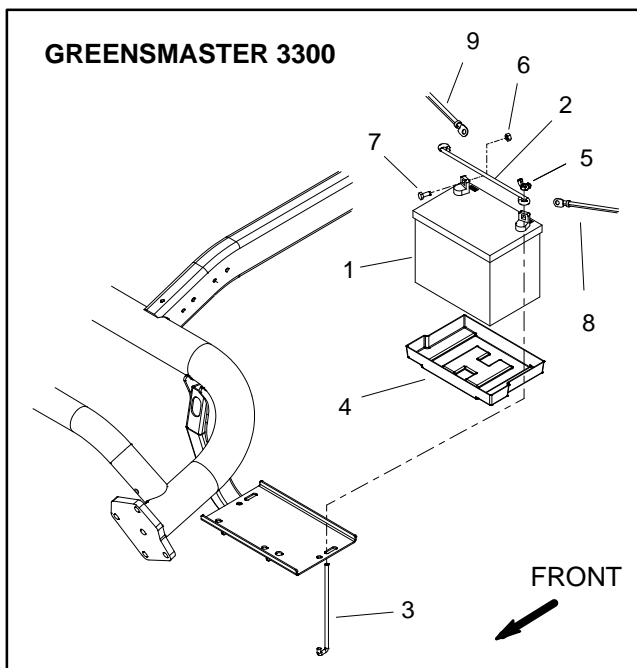


Figure 70

- | | |
|----------------------|---------------------------|
| 1. Battery | 6. Hex nut (2 used) |
| 2. Hold down rod | 7. Cap screw (2 used) |
| 3. Post (2 used) | 8. Positive battery cable |
| 4. Battery tray | 9. Negative battery cable |
| 5. Wing nut (2 used) | |

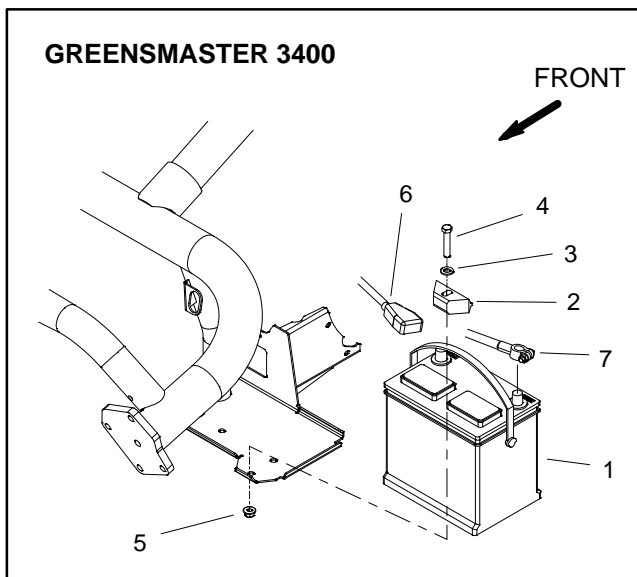


Figure 71

- | | |
|---------------------|---------------------------|
| 1. Battery | 5. Flange nut |
| 2. Battery retainer | 6. Positive battery cable |
| 3. Flat washer | 7. Negative battery cable |
| 4. Cap screw | |

Battery Inspection and Maintenance

1. Perform following inspections and maintenance:

A. Check for cracks caused by overly tight or loose hold-down rod. Replace battery if cracked and leaking.

B. 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.

C. Check for signs of wetness or leakage on the top of the battery which might indicate a loose or missing filler cap, overcharging, loose terminal post or overfilling. Also, check the battery case for dirt and oil. Clean the battery with a solution of baking soda (sodium bicarbonate) and water, then rinse it with clean water.

D. Check that the cover seal is not broken away. Replace the battery if the seal is broken or leaking.

IMPORTANT: Make sure the area around the cells is clean before opening the battery caps.

E. Check the electrolyte level in each cell. If the level is below the tops of the plates in any cell, fill all cells with **distilled** water 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 Installation (Fig. 70 or 71)

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 that battery cables, retainer components and posts are in good condition.

4. Place the battery in its compartment. Make sure battery is level and flat.

5. Secure battery to frame with removed fasteners and retainer components. Do not overtighten fasteners to prevent cracking or distorting the battery case.

6. Connect the positive cable to the positive battery post. Tighten bolt with two wrenches.

NOTE: Before connecting the negative (ground) cable, connect a digital multimeter (set to amps) between the negative battery post and the negative (ground) cable connector. The reading should be less than 0.1 amp. If the reading is 0.1 amp or more, the machine's electrical system should be tested for short circuits or faulty components and repaired.

7. Connect the negative (ground) cable to the negative battery post.

8. Coat battery posts and cable connectors with battery terminal protector (see Special Tools in this chapter) or petroleum jelly to prevent corrosion.

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 10°F (6°C) above 80°F (27°C) add 0.004 to the specific gravity reading. For each 10°F (6°C) below 80°F (27°C) subtract 0.004 from the specific gravity reading.

Example: Cell Temperature 100°F
Cell Gravity 1.245
ADD (20° above 80°F) 0.008
Correction to 80°F 1.253

C. If the difference between the highest and lowest cell specific gravity is 0.050 or greater or the lowest cell specific gravity is less than 1.225, charge the battery. Charge at the recommended rate and time given in **Battery Charging** or until all cells specific gravity is 1.225 or greater with the difference in specific gravity between the highest and lowest cell less than 0.050. If these charging conditions can not be met, replace the battery.

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 battery load tester manufacturer's instructions when using a load 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 150 amps (one half the cranking performance rating of the battery) for fifteen (15) seconds.

G. Take a battery voltage reading after fifteen (15) seconds, then remove the load.


H. Using the table below, determine the minimum voltage for the center cell temperature reading.

Minimum Voltage	Battery Electrolyte Temperature	
9.6	70°F (and up)	21°C (and up)
9.5	60°F	16°C
9.4	50°F	10°C
9.3	40°F	4°C
9.1	30°F	-1°C
8.9	20°F	-7°C
8.7	10°F	-12°C
8.5	0°F	-18°C

I. If the test voltage is below the minimum voltage listed in the table, 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 battery charger 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 specific gravity or open 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 battery charger manufacturer's instructions** or the following table.

Battery Reserve Capacity (Minutes)	Battery Charge Level (Percent of Fully Charged)			
	75%	50%	25%	0%
80 or less (GR3300)	3.8 hrs @ 3 amps	7.5 hrs @ 3 amps	11.3 hrs @ 3 amps	15 hrs @ 3 amps
81 to 125 (GR3400)	5.3 hrs @ 4 amps	10.5 hrs @ 4 amps	15.8 hrs @ 4 amps	21 hrs @ 4 amps
126 to 170	5.5 hrs @ 5 amps	11 hrs @ 5 amps	16.5 hrs @ 5 amps	22 hrs @ 5 amps
171 to 250	5.8 hrs @ 6 amps	11.5 hrs @ 6 amps	17.3 hrs @ 6 amps	23 hrs @ 6 amps
above 250	6 hrs @ 10 amps	12 hrs @ 10 amps	18 hrs @ 10 amps	24 hrs @ 10 amps



CAUTION

Do not charge a frozen battery because it can explode and cause injury. Let the battery warm to 60°F (16°C) before connecting to a charger.

Charge the battery in a well-ventilated place to dissipate gases produced from charging. These gases are explosive; keep open flame and electrical spark away from the battery. Do not smoke. Nausea may result if the gases are inhaled. Unplug the charger from the electrical outlet before connecting or disconnecting the charger leads from the battery posts.

3. **Following the battery charger manufacturer's instructions**, connect the charger cables to the battery. Make sure a good connection is made.

4. Charge the battery **following the battery charger manufacturer's instructions**.

5. Occasionally check the temperature of the battery electrolyte. If the temperature exceeds 125°F (52°C) 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 consecutive readings.

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Chapter 7

Chassis

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Specifications

Item	Description
Front tire pressure (19 x 10.50 x 8) (4 ply)	12 to 16 PSI (83 to 110 kPa)
Rear tire pressure (19 x 10.50 x 8) (4 ply)	12 to 16 PSI (83 to 110 kPa)
Wheel lug nut torque	65 to 85 ft-lb (89 to 115 N-m)
Wheel motor/wheel hub lock nut torque	250 to 400 ft-lb (339 to 542 N-m)

General Information

Operator's Manuals

The Traction Unit and Cutting Unit Operator's Manuals provide information regarding the operation, general maintenance procedures and maintenance intervals for your Greensmaster TriFlex machine. Refer to these publications for additional information when servicing the machine.

Special Tools

Wheel Hub Puller

The wheel hub puller allows safe removal of the wheel hub from the shaft of the hydraulic wheel motors used on Greensmaster TriFlex machines.

Toro Part Number: **TOR4097**



Figure 1

Grease Fitting

This grease fitting can be used to allow the frame tube to be filled with grease after service of the rear steering fork.

Toro Part Number: **302-5**

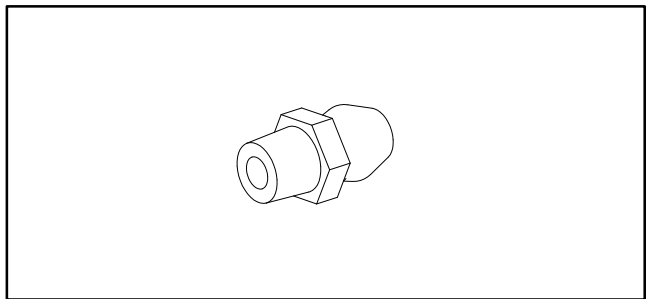


Figure 2

Adjustments

Parking Brake Adjustment

1. Park machine on a level surface, engage the parking brake, lower the cutting units and stop the engine. Remove key from the ignition switch.
2. With parking brake engaged, measure the distance between the centers of the two (2) pins that secure the brake spring to the brake lever and the equalizer bracket. This distance should be from 6.120" to 6.240" (156 to 158 mm) (Fig. 3).
3. If necessary, adjust location of brake cable jam nuts at brake cable bracket so that distance between pins is correct.
4. After adjusting parking brake cables, check that brake actuator levers are fully released when parking brake is not applied. Also, when parking brake is not applied, front wheels should rotate freely.

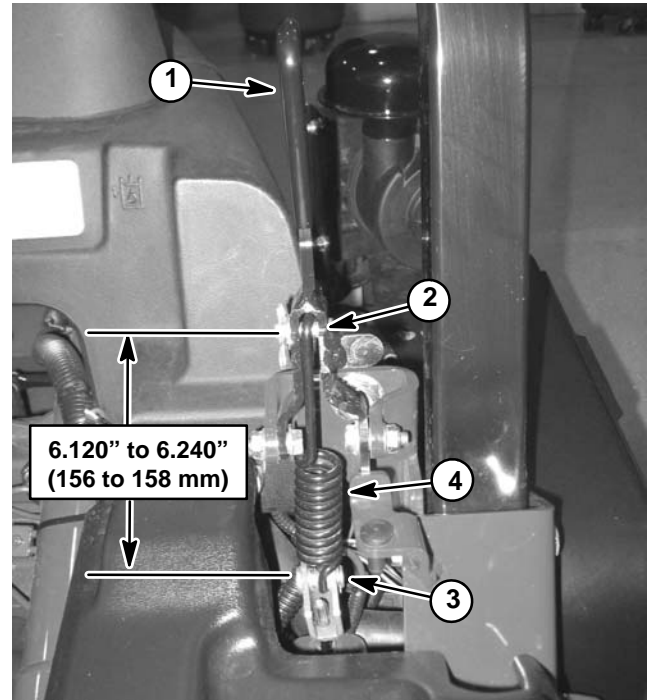


Figure 3

- | | |
|--------------------------|------------------|
| 1. Brake lever (engaged) | 3. Equalizer pin |
| 2. Lever pin | 4. Brake spring |

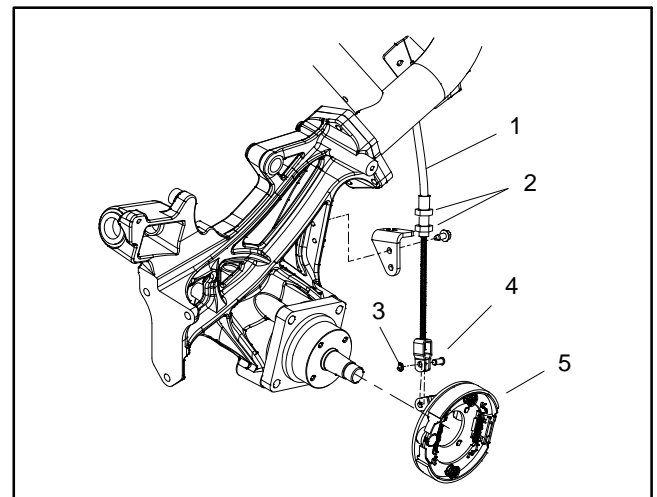


Figure 4

- | | |
|---------------------------|-------------------|
| 1. Brake cable (RH shown) | 4. Clevis pin |
| 2. Jam nuts | 5. Brake assembly |
| 3. E-ring | |

Service and Repairs

Wheels

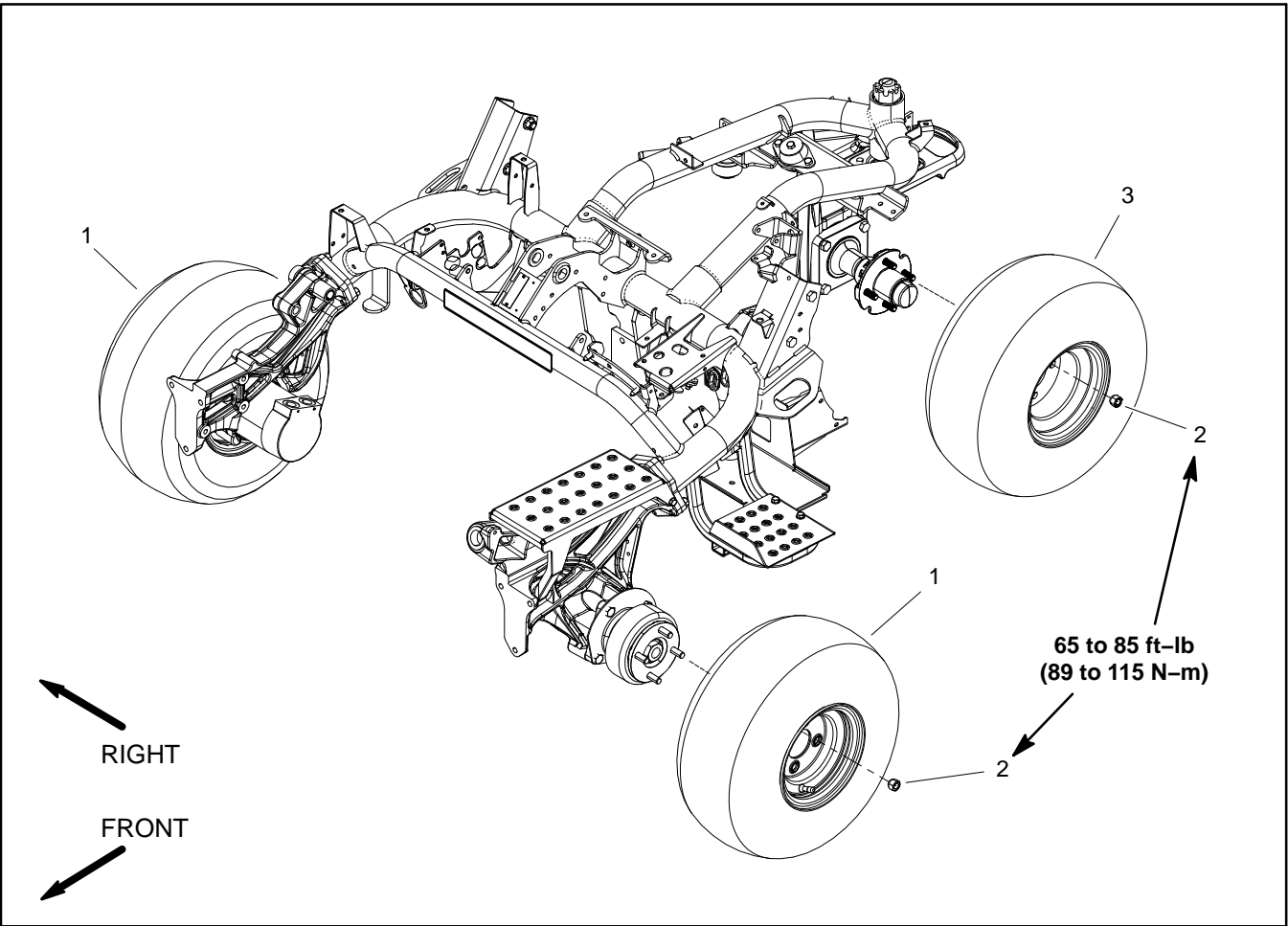



Figure 5

- 1. Front wheel
- 2. Lug nut (4 used per wheel)
- 3. Rear wheel

Removal (Fig. 5)

1. Park 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 wheels to prevent machine from shifting.
3. Loosen, but do not remove, lug nuts.

**CAUTION**

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

4. Using a jack, raise machine so wheel is off ground (see Jacking Instructions in Chapter 1 – Safety). Support machine with appropriate jack stands.
5. Remove lug nuts and then remove wheel from machine.

Installation (Fig. 5)

1. Install wheel and secure with four (4) lug nuts.
2. Lower machine to ground.

**WARNING**

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

3. Torque lug nuts evenly in a crossing pattern from 65 to 85 ft-lb (89 to 115 N-m).

Brake Service

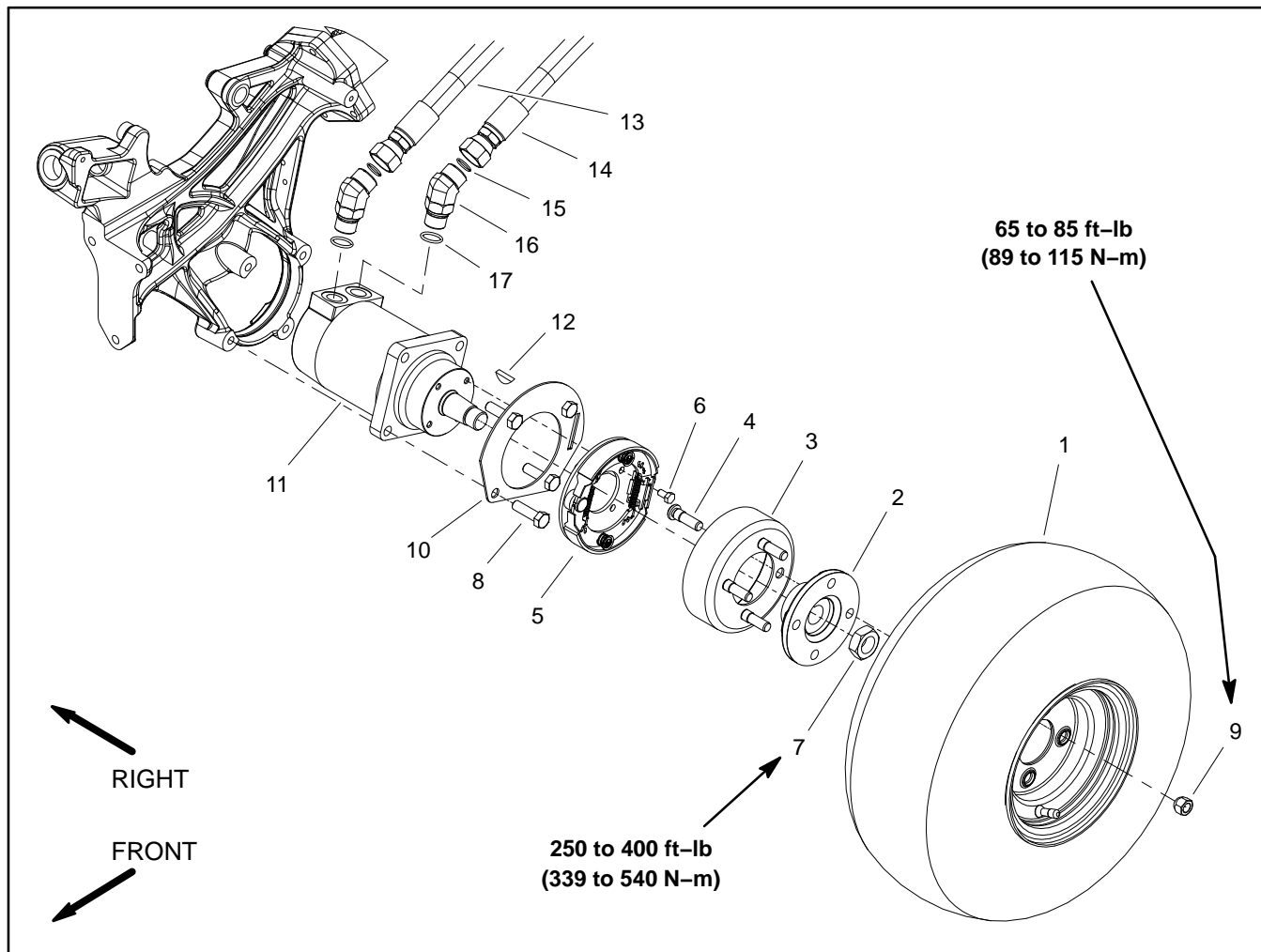


Figure 6

- | | | |
|------------------------------|--------------------------------|---|
| 1. Wheel assembly | 7. Lock nut | 13. Hydraulic hose |
| 2. Wheel hub | 8. Cap screw (4 per motor) | 14. Hydraulic hose |
| 3. Brake drum | 9. Lug nut (4 per wheel) | 15. O-ring |
| 4. Wheel stud (4 per wheel) | 10. Brake lever tab | 16. 45° hydraulic fitting (2 per motor) |
| 5. Brake assembly (LH shown) | 11. Hydraulic motor (LH shown) | 17. O-ring |
| 6. Cap screw (4 per brake) | 12. Woodruff key | |

Removal (Fig. 6)

1. Park machine on a level surface, lower the cutting units and stop the engine. Remove key from the ignition switch.
2. Chock wheels to prevent machine from shifting.
3. Loosen, but do not remove, lock nut (item 7) from wheel motor shaft.
4. Remove front wheel assembly (see Wheel Removal in this section). Make sure to support machine with jack stands.
5. Make sure parking brake is disengaged.
6. Remove e-ring and clevis pin that secure brake cable to brake actuator lever. Position brake cable end away from lever (Fig. 7).
7. Make sure that lock nut on wheel motor shaft is loosened at least two (2) turns. Use wheel hub puller (see Special Tools in this chapter) to loosen brake drum assembly from motor.
8. Remove lock nut and brake drum assembly from motor shaft. Discard lock nut. Locate and retrieve woodruff key.

IMPORTANT: DO NOT hit brake drum assembly, puller or wheel motor with a hammer during drum assembly removal or installation. Hammering may cause damage to the wheel motor.

NOTE: If desired, the complete brake assembly can be removed from the machine for disassembly (see step 11 below).

9. Remove shoe springs from brake shoes (Fig. 8).

10. Remove shoe hold down cups and springs. Remove brake shoes and hold down pins from backing plate (Fig. 8).

11. If necessary, remove backing plate from machine by removing four (4) cap screws (item 6).

12. If necessary, press wheel studs from brake drum assembly to allow separation of brake drum and wheel hub.

Installation (Fig. 6)

1. Remove rust and debris from all parts with a wire brush prior to installation. Clean all parts. Inspect brake shoe contact surfaces of the brake drum for excessive wear. Replace any worn or damaged parts.

2. If backing plate was removed from machine, position backing plate to wheel motor with brake lever inserted into slot of brake lever tab. Secure backing plate to wheel motor with four (4) cap screws (item 6).

3. Lightly lubricate brake shoe pivot points with general purpose grease.

4. Position one brake shoe to the backing plate. Install brake hold down pin and secure with hold down spring and cup (Fig. 8). Repeat for second brake shoe.

5. Install shoe springs to brake shoes (Fig. 8). Make sure that brake shoes are properly positioned to pivot and actuator points.

6. If brake drum was separated from wheel hub, align holes in drum and hub. Secure hub to drum by pressing wheel studs into assembly. Make sure that stud shoulders are fully pressed against drum surface.

IMPORTANT: Before brake drum assembly is installed, thoroughly clean tapers of wheel hub and wheel motor shaft. Make sure that tapers are free of grease, oil and dirt. Do not use antiseize lubricant when installing drum assembly.

7. Mount key in the wheel motor shaft, then install the brake drum assembly onto the wheel motor shaft.

8. Install new lock nut (item 7) onto the wheel motor shaft to secure brake drum assembly.

9. Position brake cable end to brake actuator lever. Secure cable to actuator lever with clevis pin and e-ring (Fig. 7).

10. Install front wheel assembly (see Wheel Installation in this section).

11. Lower machine to ground.



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.

12. Torque lug nuts evenly in a crossing pattern from **65 to 85 ft-lb (98 to 115 N-m)**. Torque lock nut (item 17) that secures wheel hub from **250 to 400 ft-lb (339 to 542 N-m)**.

13. Check and adjust parking brake.

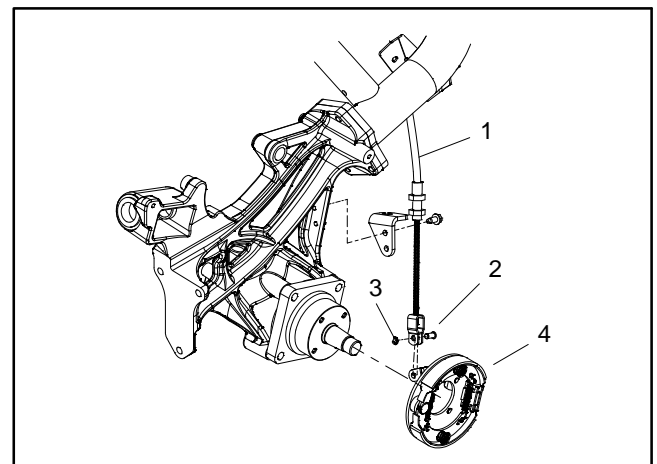


Figure 7

- | | |
|---------------------------|-------------------|
| 1. Brake cable (RH shown) | 3. E-ring |
| 2. Clevis pin | 4. Brake assembly |

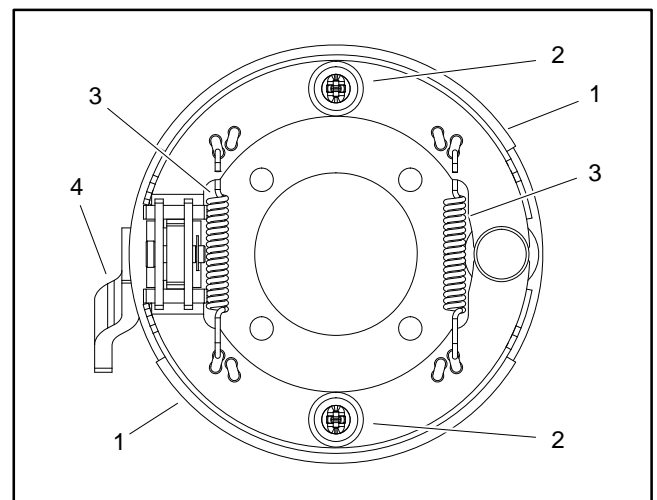


Figure 8

- | | |
|------------------------|-------------------|
| 1. Brake shoe | 3. Shoe spring |
| 2. Cup, spring and pin | 4. Actuator lever |

Brake Cables

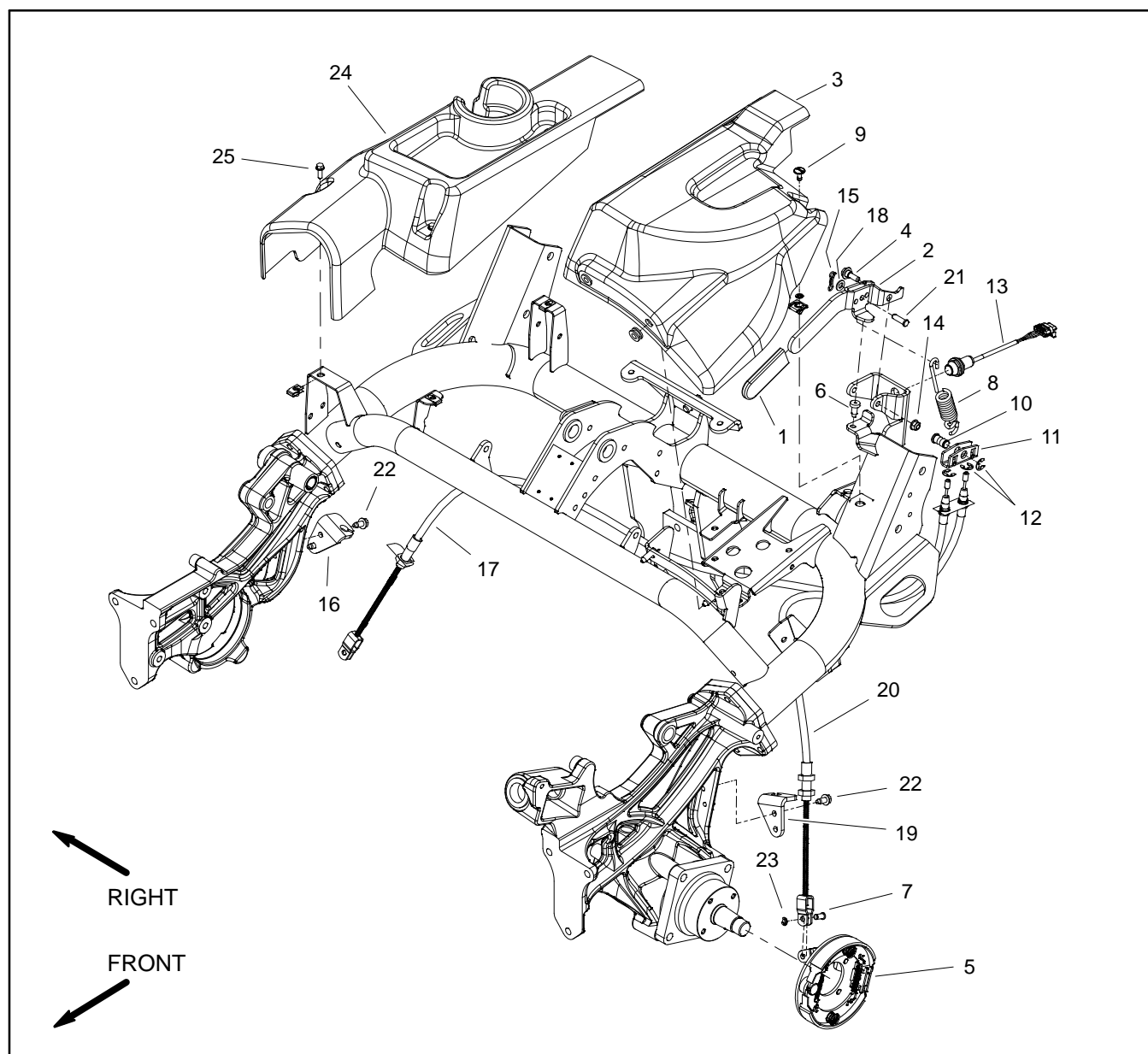


Figure 9

- | | | |
|------------------------------|-----------------------------|--------------------------------|
| 1. Handle grip | 10. Pin | 18. Flat washer |
| 2. Brake lever assembly | 11. Equalizer bracket | 19. LH brake cable bracket |
| 3. LH cover | 12. Retaining ring (3 used) | 20. LH brake cable |
| 4. Shoulder screw (2 used) | 13. Proximity sensor | 21. Yoke pin |
| 5. Brake assembly (LH shown) | 14. Flange nut (2 used) | 22. Washer head screw (4 used) |
| 6. Rubber bumper | 15. Cotter pin | 23. E-ring (2 used) |
| 7. Clevis pin (2 used) | 16. RH brake cable bracket | 24. RH cover |
| 8. Extension spring | 17. RH brake cable | 25. Flange head screw (3 used) |
| 9. Screw | | |

Brake Cable Removal (Fig. 9)

1. Park machine on a level surface, lower cutting units, stop engine and remove key from the ignition switch. Make sure that parking brake is not applied.
2. Chock front wheels to prevent machine from moving.
3. Remove cover(s) (items 3 and 24) from machine to allow access to brake cable that is to be removed.
4. Disconnect brake cable from brake actuator lever:
 - A. Remove e-ring (item 23) and clevis pin (item 7) that secure brake cable clevis to brake actuator lever.
 - B. At brake cable bracket, loosen upper cable jam nut to allow slack in cable. Then remove lower jam nut from threads on brake cable.
 - C. Separate brake cable from brake cable bracket and brake actuator lever.
5. Disconnect brake cable from equalizer bracket at brake lever:
 - A. Remove e-ring that secures brake cable to frame bracket.
 - B. Remove cable end from equalizer bracket.
 - C. Separate brake cable from frame bracket.
6. Note location of cable ties and routing of brake cable for assembly purposes. Remove brake cable from machine.

Brake Cable Installation (Fig. 9)

1. Using notes taken during brake cable removal, route brake cable onto machine. Make sure that parking brake is not applied.
2. Connect brake cable to equalizer bracket at brake lever:
 - A. Route brake cable end through hole in frame bracket.
 - B. Connect cable end to equalizer bracket.
 - C. Secure brake cable to frame bracket with e-ring.
3. Connect brake cable to brake actuator lever:
 - A. Position brake cable clevis to brake actuator lever. Secure cable to actuator lever with clevis pin (item 7) and e-ring (item 23).
 - B. Route end of brake cable through brake cable bracket (item 19).
 - C. Install lower jam nut onto brake cable threads.
4. Secure brake cables to machine with cable ties in locations noted during cable removal.
5. Adjust brake cables (see Parking Brake Adjustment in the Adjustments section of this chapter).
6. Install cover(s) (items 3 and 24) to machine.
7. After brake cables have been installed and adjusted, make sure to check operation of parking brake and brake interlock system.

Rear Wheel Spindle Assembly

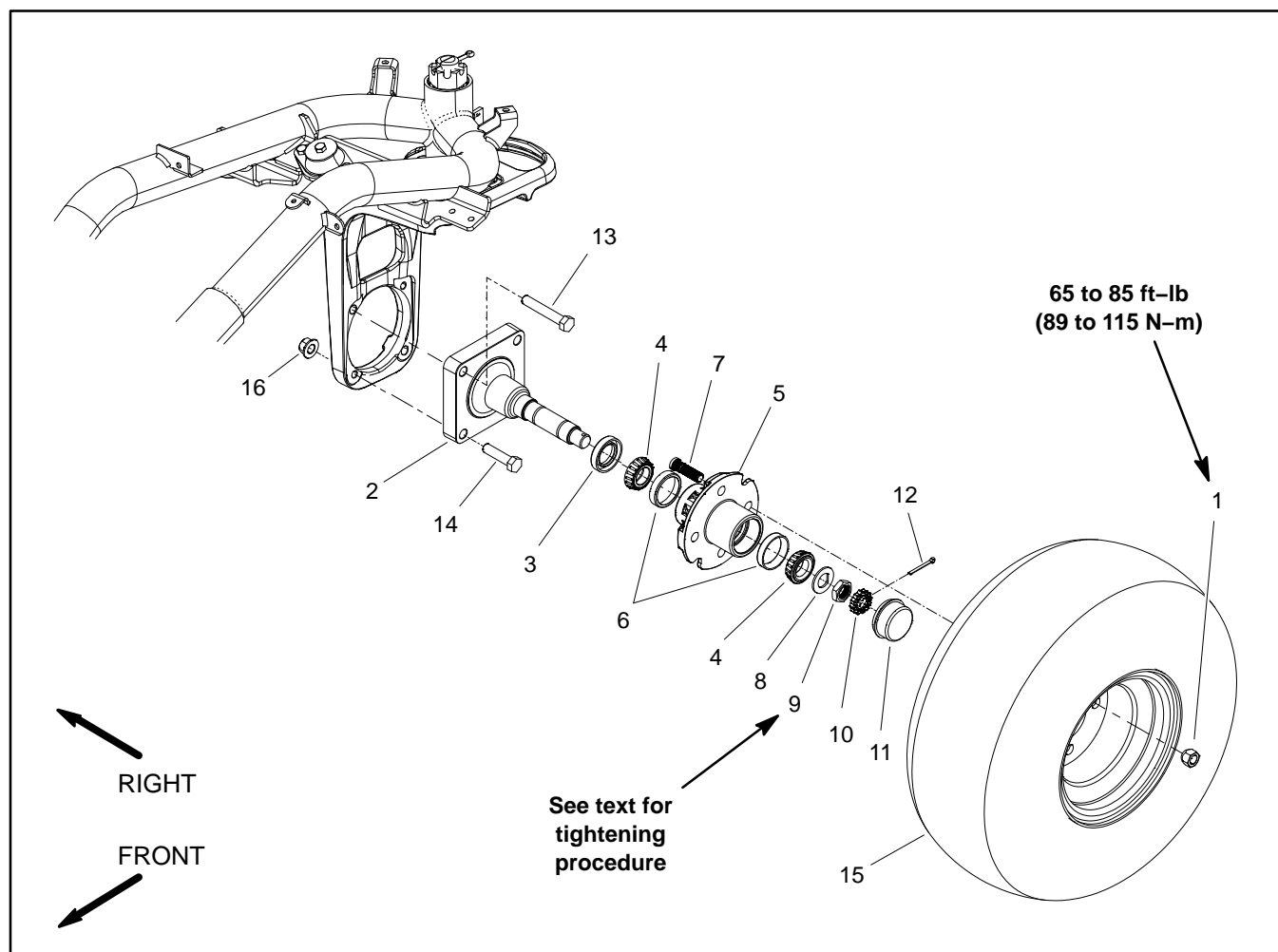


Figure 10

- 1. Lug nut (4 used)
- 2. Wheel spindle
- 3. Seal
- 4. Bearing cone (2 used)
- 5. Wheel hub
- 6. Bearing cup (2 used)

- 7. Wheel stud (4 used)
- 8. Tab washer
- 9. Jam nut
- 10. Retainer
- 11. Dust cap

- 12. Cotter pin
- 13. Cap screw (2 used)
- 14. Cap screw (2 used)
- 15. Rear wheel assembly
- 16. Flange nut (2 used)

Disassembly (Fig. 10)

1. Park 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 front wheels to prevent machine from shifting.
3. Remove rear wheel (see Wheel Removal in this section). Make sure to support machine with jack stands.
4. Remove the dust cap from the wheel hub.
5. Remove the cotter pin, retainer, jam nut and tab washer. Slide the wheel hub from the spindle shaft.
6. Pull the seal out of the wheel hub. Discard seal.
7. Remove the bearing cones from both sides of the wheel hub. Clean the bearings in solvent. Make sure the bearings are in good operating condition. Clean the inside of the wheel hub. Check the bearing cups for wear, pitting or other damage. Replace worn or damaged parts.
8. If necessary, press wheel studs from wheel hub.
9. Inspect wheel spindle for wear or damage. If required, remove cap screws and flange nuts that secure spindle to rear fork and remove spindle from machine.

Assembly (Fig. 10)

1. If wheel spindle was removed from rear fork, position spindle to fork and secure with cap screws and flange nuts.
2. If bearing cups were removed from the wheel hub, press new cups into the hub until they seat against the shoulder of the hub.
3. If wheel studs were removed from wheel hub, press wheel studs into hub. Make sure that stud shoulders are fully pressed against hub surface.
4. Apply a light coating of grease to wheel spindle.
5. Pack both bearing cones with grease. Install one bearing into the bearing cup on inboard side of the wheel hub.

IMPORTANT: The lip of the seal must be toward the bearing. The seal should be pressed in so it is flush with the end of the wheel hub.

6. Lubricate the inside of a new seal and press it into the wheel hub with the seal lip toward the bearing.
7. Fill wheel hub cavity between bearings approximately 50% full of grease. Position remaining bearing into the outer bearing cup.
8. Carefully slide the wheel hub assembly onto the spindle shaft and secure it in place with the tab washer and jam nut. DO NOT fully tighten the nut or install the cotter pin.
9. While rotating the wheel hub by hand, torque the jam nut from 75 to 100 in-lb (8.5 to 11.3 N-m) to set the bearings. Then, loosen the nut until the hub has endplay.
10. Again, while rotating the wheel hub by hand, torque the jam nut from **15 to 20 in-lb (1.7 to 2.3 N-m)**. After tightening, make sure that the wheel hub does not have any free play.
11. Install retainer with slot aligned to cotter pin hole in spindle. Install cotter pin.
12. Fill dust cap approximately half full of grease. Install dust cap.
13. Install rear wheel (see Wheel Installation in this section).
14. Lower machine to ground.



WARNING

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

15. Torque wheel lug nuts evenly in a crossing pattern from **65 to 85 ft-lb (98 to 115 N-m)**.

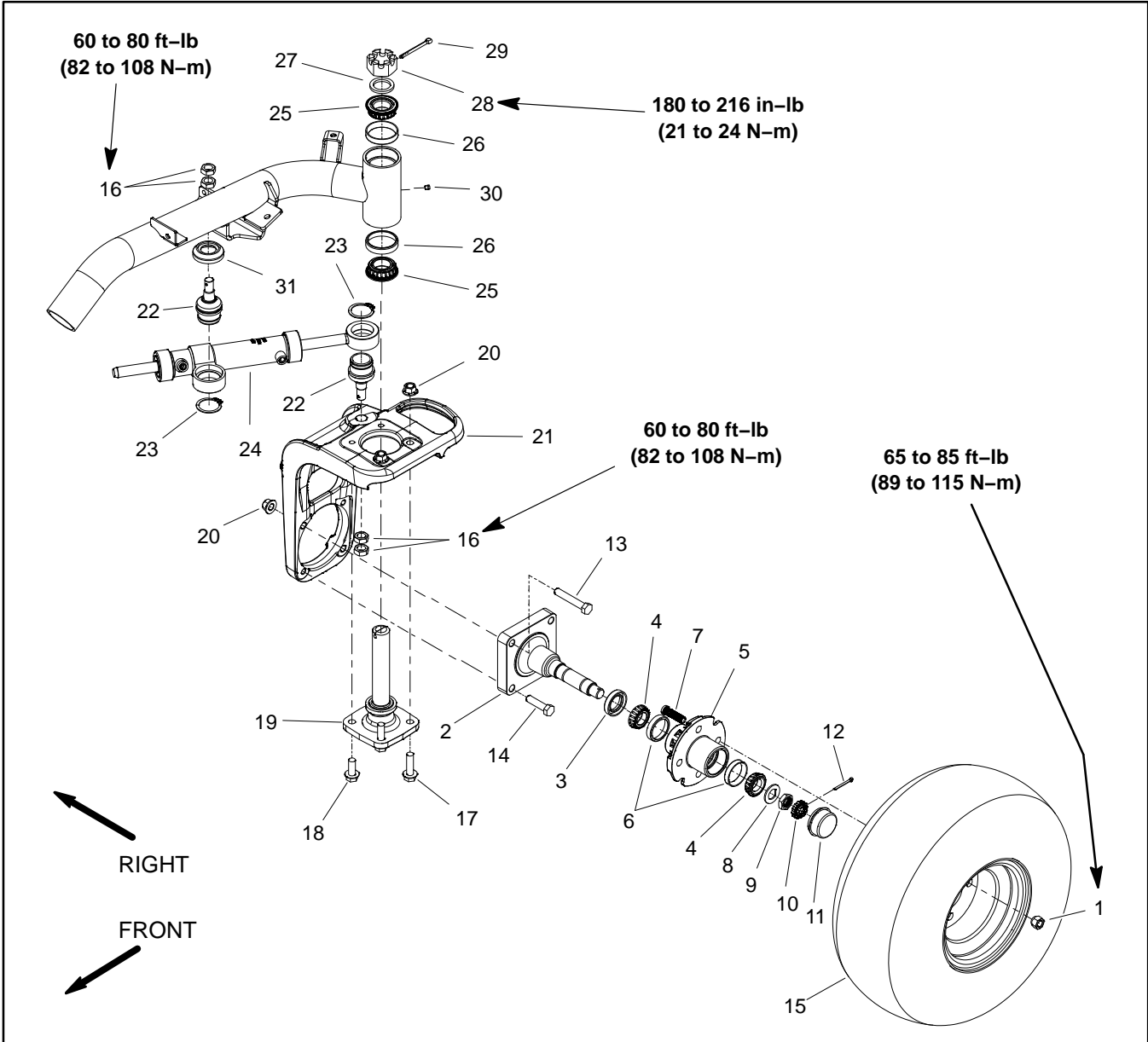


Figure 11

- | | | |
|--------------------------|--------------------------------|-----------------------------|
| 1. Lug nut (4 used) | 12. Cotter pin | 22. Ball joint (2 used) |
| 2. Wheel spindle | 13. Cap screw (2 used) | 23. Retaining ring (2 used) |
| 3. Seal | 14. Cap screw (2 used) | 24. Steering cylinder |
| 4. Bearing cone (2 used) | 15. Rear wheel assembly | 25. Bearing cone (2 used) |
| 5. Wheel hub | 16. Jam nut (4 used) | 26. Bearing cup (2 used) |
| 6. Bearing cup (2 used) | 17. Flange head screw (2 used) | 27. Steering washer |
| 7. Wheel stud (4 used) | 18. Flange head screw (2 used) | 28. Slotted hex nut |
| 8. Tab washer | 19. Steering spindle | 29. Cotter pin |
| 9. Jam nut | 20. Flange nut (2 used) | 30. Plug |
| 10. Retainer | 21. Rear steering fork | 31. Cylinder spacer |
| 11. Dust cap | | |

Removal (Fig. 11)

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

2. To allow access to rear steering fork, remove tank mount plate assembly (hydraulic reservoir, fuel tank and tank mount plate) from machine (see Tank Mount Plate Assembly in this section).
3. Chock front wheels to prevent machine from shifting.

4. Loosen, but do not remove, rear wheel lug nuts.
5. Jack up rear of machine and support machine with jack stands (see Jacking Instructions in Chapter 1 – Safety).
6. Remove rear wheel assembly (see Wheel Removal in this section).
7. Remove two (2) jam nuts (item 16) that secure steering cylinder rod end to the rear steering fork. Separate steering cylinder rod end from the steering fork.
8. If machine is equipped with optional 3WD kit, remove rear wheel motor from rear steering fork (see Rear Wheel Motor (Optional 3WD) Removal in the Service and Repairs section of Chapter 5 – Hydraulic System). Carefully, position wheel motor assembly away from steering fork taking care to not damage hydraulic lines.
9. Support rear steering fork assembly to prevent it from falling.



CAUTION

Support rear steering fork assembly when removing it to prevent it from falling and causing personal injury. Assembly weighs approximately 25 pounds (11 kg).

10. Remove cotter pin (item 29) and slotted hex nut (item 28) that secure the steering fork spindle into the frame tube. Slide the rear steering fork assembly out of the frame. Locate and retrieve steering washer (item 27) and both bearing cones (item 25).
11. Clean the bearing cones and make sure the bearings are in good condition. Clean the inside of the frame tube. Check the bearing cups for wear, pitting or other damage. Replace worn or damaged parts.
12. If necessary, remove wheel spindle assembly from rear steering fork. Cut-outs in wheel hub will allow access to cap screws that secure spindle assembly to steering fork.
13. Thoroughly clean the steering fork spindle. Inspect the spindle for wear and replace steering spindle (item 19) if spindle is worn or damaged.

Installation (Fig. 11)

1. If bearing cups were removed from the frame tube, press new cups into the tube until they seat against the shoulder of the frame.
2. Apply a light coating of grease to steering fork spindle.

3. Pack both bearing cones with grease. Install one bearing onto the steering spindle.
4. Install steering fork assembly into frame:
 - A. Insert steering fork spindle up through frame tube.
 - B. Hold the steering fork in place. Install the steering washer and upper bearing cone onto the spindle.
 - C. Secure steering fork in frame with slotted hex nut (item 28). Torque nut from **180 to 216 in-lb (21 to 24 N-m)** so that slot in nut aligns with hole in shaft.
 - D. Install cotter pin.
 - E. Remove plug (item 30) from back of frame tube and temporarily install grease fitting (Toro part #302-5 or equivalent). Fill frame tube with grease until grease is seen exiting at both ends of the tube. Wipe up excess grease. Remove grease fitting and reinstall plug in frame.

5. If machine is equipped with optional 3WD kit, install rear wheel motor to rear steering fork (see Rear Wheel Motor (Optional 3WD) Installation in the Service and Repairs section of Chapter 5 – Hydraulic System).
6. If wheel spindle assembly was removed from rear steering fork, secure spindle assembly to steering fork. Cut-outs in wheel hub will allow access to cap screws that secure spindle assembly to steering fork.
7. Insert the steering cylinder rod end into the rear steering fork.
8. Secure steering cylinder to steering fork with two (2) jam nuts (item 16). Install first jam nut and torque from **60 to 80 ft-lb (82 to 108 N-m)**. Then, while holding first jam nut with wrench, tighten second jam nut and torque from **60 to 80 ft-lb (82 to 108 N-m)**.
9. Install rear wheel assembly (see Wheel Installation in this section).



WARNING

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

10. Lower machine to ground and make sure that lug nuts are torqued evenly in a crossing pattern from **65 to 85 ft-lb (98 to 115 N-m)**.
11. Install tank mount plate assembly to machine (see Tank Mount Plate Assembly in this section).

Control Console

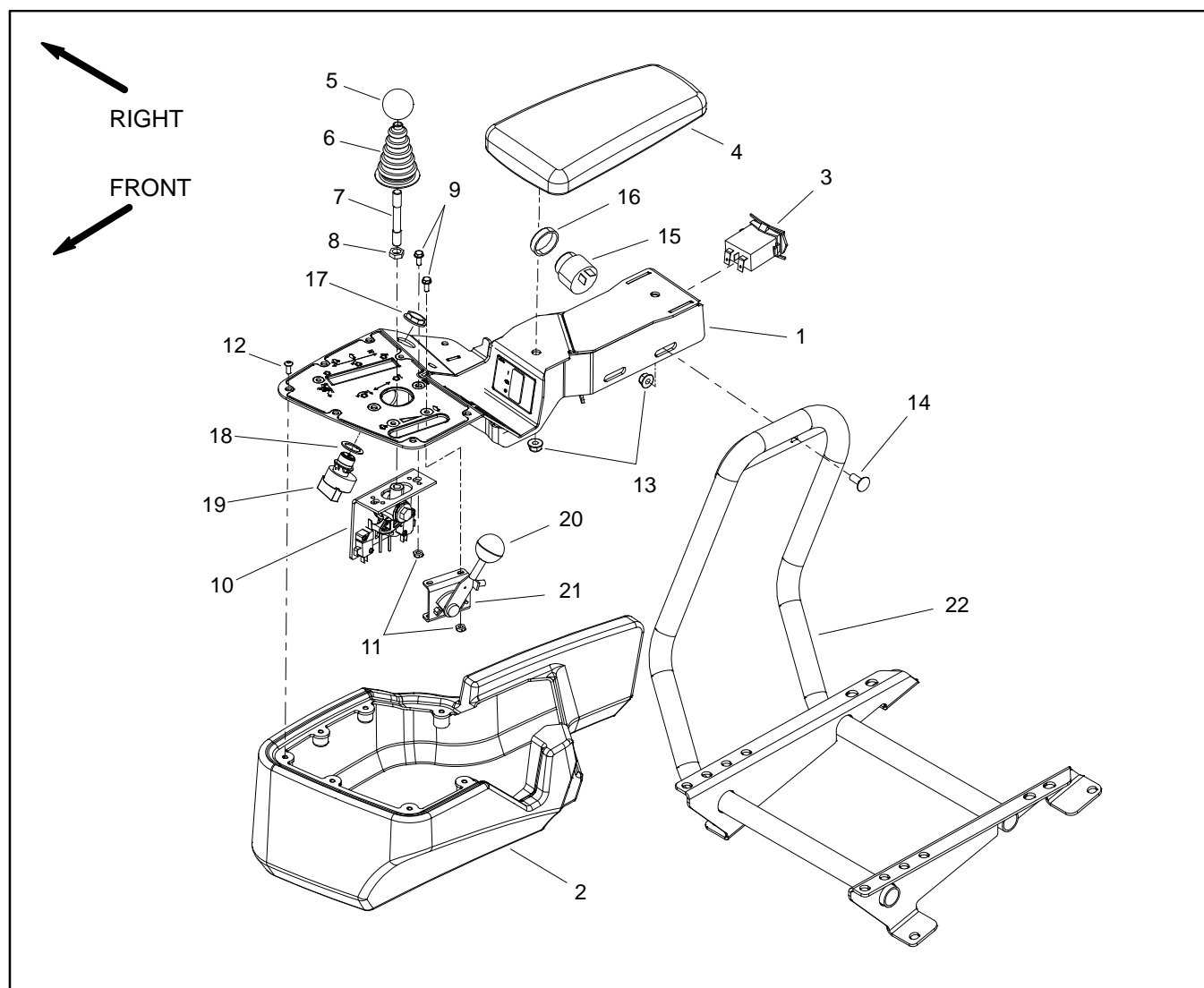


Figure 12

- | | | |
|------------------|--------------------------------------|-------------------------------------|
| 1. Console | 9. Washer head screw (2 per control) | 16. Alarm nut (if equipped) |
| 2. Console cover | 10. Joystick assembly | 17. Nut |
| 3. Hour meter | 11. Lock nut (2 per control) | 18. Washer |
| 4. Arm rest | 12. Screw (7 used) | 19. Ignition switch |
| 5. Knob | 13. Flange nut (4 used) | 20. Knob |
| 6. Lever boot | 14. Carriage screw (2 used) | 21. Throttle control |
| 7. Joystick rod | 15. Alarm (if equipped) | 22. Console support (standard seat) |
| 8. Jam nut | | |

Disassembly (Fig. 12)

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

2. Remove screws (item 12) that secure console cover (item 2) to console. Lower cover to allow access to console components.

3. Remove components from control console as needed using Figure 12 as a guide.

4. Disassemble functional control lever assembly as needed using Figure 13 as a guide.

5. Disassemble joystick assembly as needed using Figure 14 as a guide.

NOTE: The alarm (item 15) is used on machines that are equipped with the Turf Guardian™ Leak Detector System.

NOTE: Refer to Chapter 6 – Electrical System for information regarding electrical components on console.

Assembly (Fig. 12)

1. If functional control lever assembly was disassembled, assemble control lever using Figure 13 as a guide.

2. If joystick assembly was disassembled, assemble joystick using Figure 14 as a guide. If finger spring washers (item 7 in Fig. 14) were removed, position washers so that fingers on washer point towards pivot hub.

3. Install all removed components to control console using Figure 12 as a guide.

4. Position console cover (item 2) to console and secure with screws (item 12).

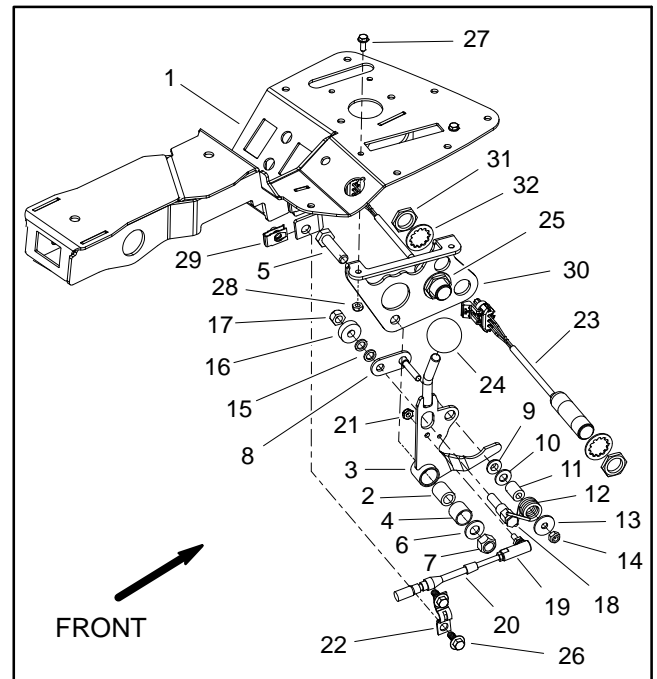


Figure 13

- | | |
|-----------------------------|--------------------------|
| 1. Console | 17. Lock nut |
| 2. Pivot tube | 18. Spring pin |
| 3. Functional lever | 19. Ball joint |
| 4. Split bushing | 20. Neutral lock cable |
| 5. Cap screw | 21. Lock nut |
| 6. Flat washer | 22. Cable clamp |
| 7. Lock nut | 23. Neutral sensor |
| 8. Roller pivot | 24. Knob |
| 9. Bushing | 25. Mow sensor |
| 10. Flat washer | 26. Screw (2 used) |
| 11. Spring spacer | 27. Screw (2 used) |
| 12. Torsion spring | 28. Lock nut (2 used) |
| 13. Flat washer | 29. Clip (2 used) |
| 14. Lock nut | 30. Lever bracket |
| 15. Bearing spacer (2 used) | 31. Jam nut (4 used) |
| 16. Bearing | 32. Lock washer (4 used) |

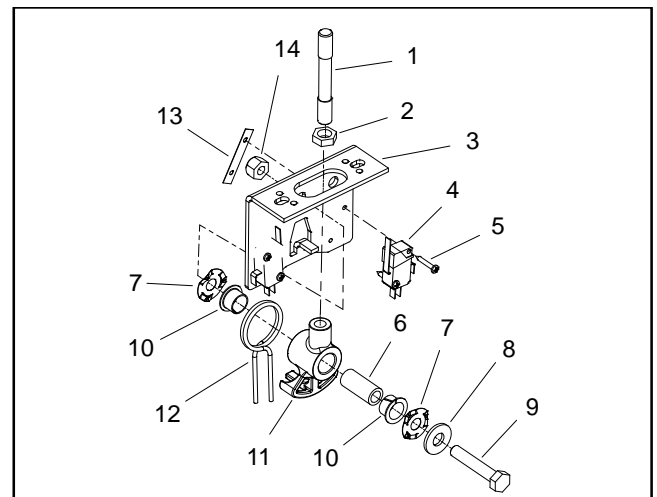


Figure 14

- | | |
|-------------------------|------------------------|
| 1. Joystick rod | 8. Flat washer |
| 2. Jam nut | 9. Cap screw |
| 3. Joystick bracket | 10. Bushing |
| 4. Switch (2 used) | 11. Pivot hub |
| 5. Screw (2 per switch) | 12. Torsion spring |
| 6. Spacer | 13. Speed nut (2 used) |
| 7. Finger spring washer | 14. Lock nut |

Tank Mount Plate Assembly

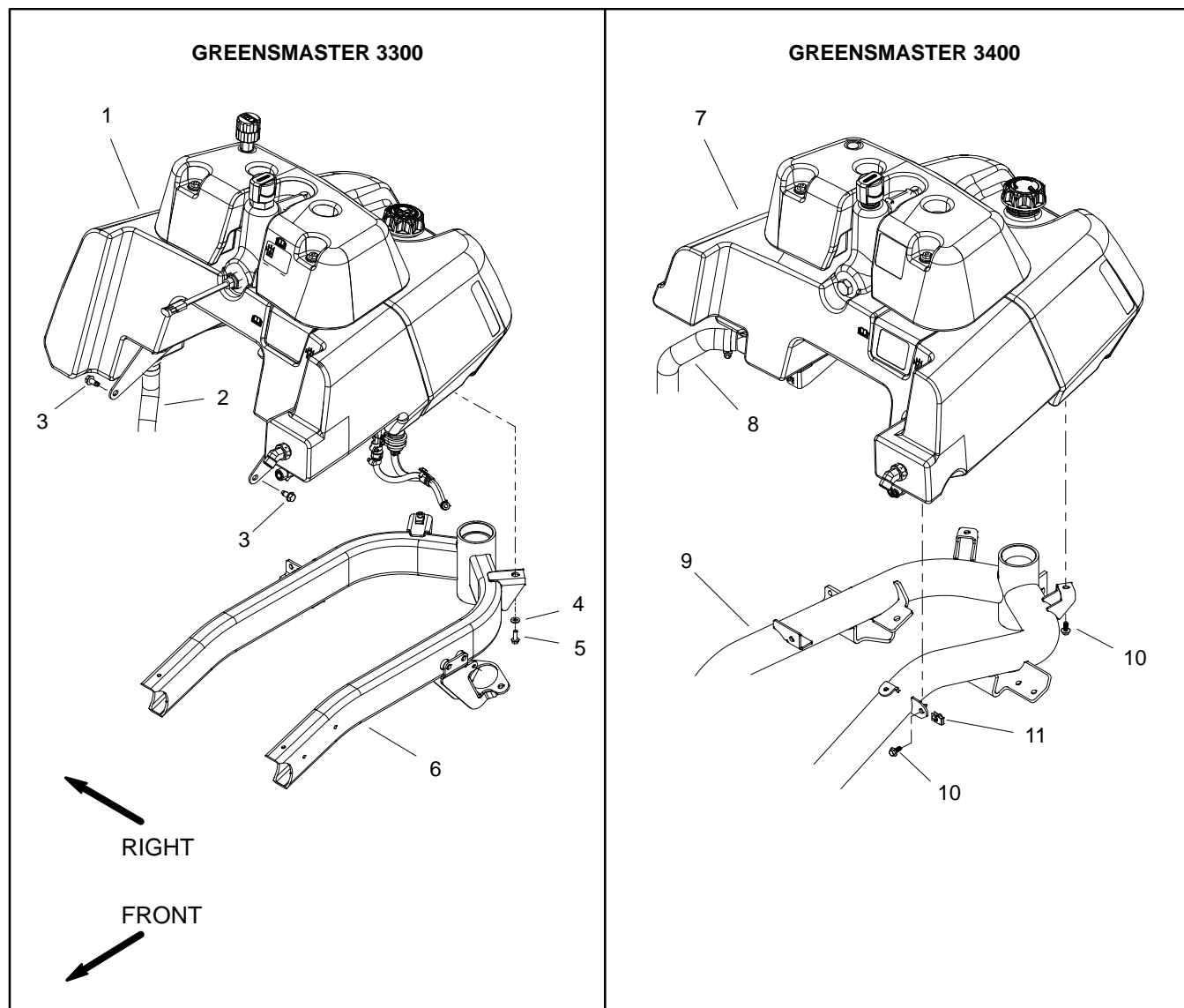


Figure 15

- | | | |
|---------------------------------------|---------------------------------------|--------------------------------|
| 1. Tank mount plate assembly (GR3300) | 5. Flange head screw (2 used) | 9. Frame (GR3400) |
| 2. Suction hose (to gear pump) | 6. Frame (GR3300) | 10. Flange head screw (4 used) |
| 3. Flange head screw (2 used) | 7. Tank mount plate assembly (GR3400) | 11. Clip (2 used) |
| 4. Flat washer (2 used) | 8. Suction hose (to gear pump) | |

NOTE: For access to fasteners that secure hydraulic reservoir and fuel tank and also to access machine components at rear of machine (e.g. steering cylinder, rear steering fork), the tank mount plate assembly (hydraulic reservoir, fuel tank and tank mount plate) can be raised and supported. If necessary, the complete tank mount plate assembly can be removed from the machine.



CAUTION

Before disconnecting any hydraulic hoses, read and become familiar with General Precautions for Removing and Installing Hydraulic System Components in the Service and Repairs section of Chapter 5 – Hydraulic System.

Raise Tank Mount Plate Assembly

1. Park machine on a level surface, engage the parking brake, lower the cutting units and stop the engine. Remove key from the ignition switch.
2. Locate and remove four (4) screws that secure tank mount plate to frame.
3. Carefully lift tank mount plate assembly (hydraulic reservoir, fuel tank and tank mount plate) up from machine. Take care to not damage fuel lines, hydraulic hoses or electrical components as assembly is raised. Support mount plate assembly in a raised position to allow access to machine components.
4. If additional clearance below the tank mount plate assembly is desired, the suction hose can be clamped and disconnected from the gear pump:
 - A. Clamp suction hose to prevent draining the hydraulic tank.
 - B. Thoroughly clean junction of suction hose and gear pump inlet fitting.
 - C. Disconnect suction hose from gear pump inlet fitting.
 - D. Carefully raise and support the tank mount plate assembly.
5. After completing service work below the tank mount plate assembly, carefully lower assembly to machine frame. Secure assembly to frame with removed screws. If suction hose was disconnected from gear pump, connect hose to pump fitting and secure with hose clamp.

Remove Tank Mount Plate Assembly

1. Park machine on a level surface, engage the parking brake, lower the cutting units and stop the engine. Remove key from the ignition switch.
2. Completely drain hydraulic oil from hydraulic reservoir through gear pump suction hose into a suitable container.
3. Disconnect hydraulic hoses from fittings on hydraulic tank. Put clean caps or plugs on hoses and fittings.
4. Close fuel shut off valve on fuel tank.
5. Disconnect additional fuel system hoses:
 - A. On Greensmaster 3300 machines, disconnect hoses from fuel filter and check valve that are located next to rear cylinder head (Fig. 16). Also, remove cable tie that secures hose from carbon cannister to rear frame tube under tank mount plate.

B. On Greensmaster 3400 machines, disconnect fuel supply hose from shut off valve on fuel tank and fuel return hose from hose splicer fitting above radiator. Also, remove vent hose from grommet in engine support.

6. If machine is equipped with the Turf Guardian™ Leak Detector System, disconnect wire harness connectors from oil level sensor and solenoid coil.
7. Remove four (4) screws that secure tank mount plate to frame.
8. Lift tank mount plate assembly (hydraulic reservoir, fuel tank and tank mount plate) from machine.
9. After completing service work below the tank mount plate assembly, install assembly to machine:
 - A. Carefully position tank mount plate assembly to machine frame. Secure assembly to frame with removed screws.
 - B. Connect and secure all hydraulic hoses (see Hydraulic Hose and Tube Installation in the General Information section of Chapter 5 – Hydraulic System).
 - C. Connect and secure all fuel hoses. Open fuel shut off valve on fuel tank.
 - D. If machine is equipped with the Turf Guardian™ Leak Detector System, connect wire harness connectors to oil level sensor and solenoid coil.
 - E. Fill hydraulic reservoir with new hydraulic oil.

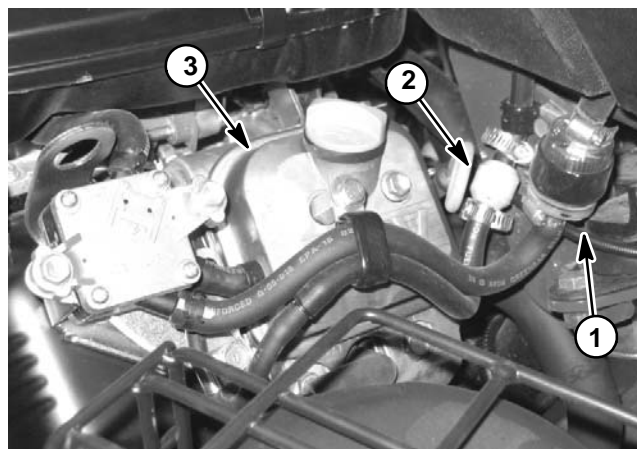


Figure 16

- | | |
|----------------|-----------------------|
| 1. Fuel filter | 3. Rear cylinder head |
| 2. Check valve | |

Cutting Unit Suspension Crossarm Assembly

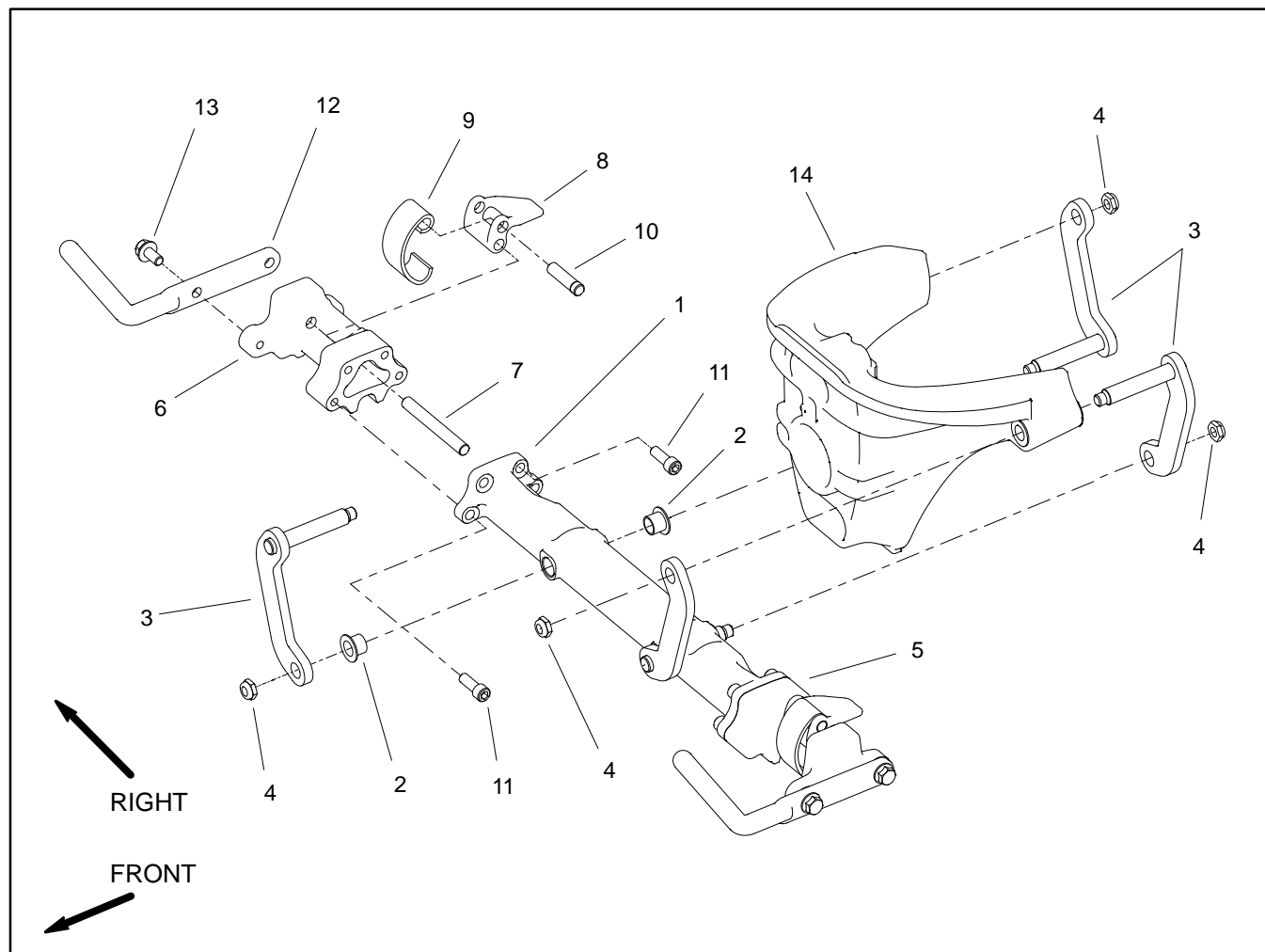


Figure 17

- | | | |
|----------------------------|------------------------|--------------------------------|
| 1. Crossarm | 6. RH crossarm mount | 11. Socket head screw (8 used) |
| 2. Flange bushing (4 used) | 7. Pivot pin (2 used) | 12. Basket horn (2 used) |
| 3. Link (4 used) | 8. Lever (2 used) | 13. Flange head screw (4 used) |
| 4. Lock nut (4 used) | 9. Spring (2 used) | 14. Suspension steering head |
| 5. LH crossarm mount | 10. Pivot pin (2 used) | |

NOTE: Three (3) identical cutting unit suspension assemblies are used on Greensmaster TriFlex machines. The cutting unit attaches to the crossarm assembly which is attached to the front of the cutting unit suspension assembly.

Disassembly (Fig. 17)

1. Park machine on a level surface, engage the parking brake, lower the cutting units and stop the engine. Remove key from the ignition switch.
2. Remove grass basket from suspension assembly.
3. Remove cutting unit from suspension assembly (see Traction Unit Operator's Manual).
4. Disassembly crossarm assembly as required using Figure 17 as a guide.

NOTE: The flange head screws (item 13) used to secure the basket horn (item 12) to the crossarm assembly have a patch lock to prevent loosening of the screws. If screws are removed, replace screws.

Assembly (Fig. 17)

1. Assemble crossarm assembly using Figure 17 as a guide.
2. Install cutting unit to suspension assembly (see Traction Unit Operator's Manual).
3. Install grass basket.

Cutting Unit Suspension Assembly

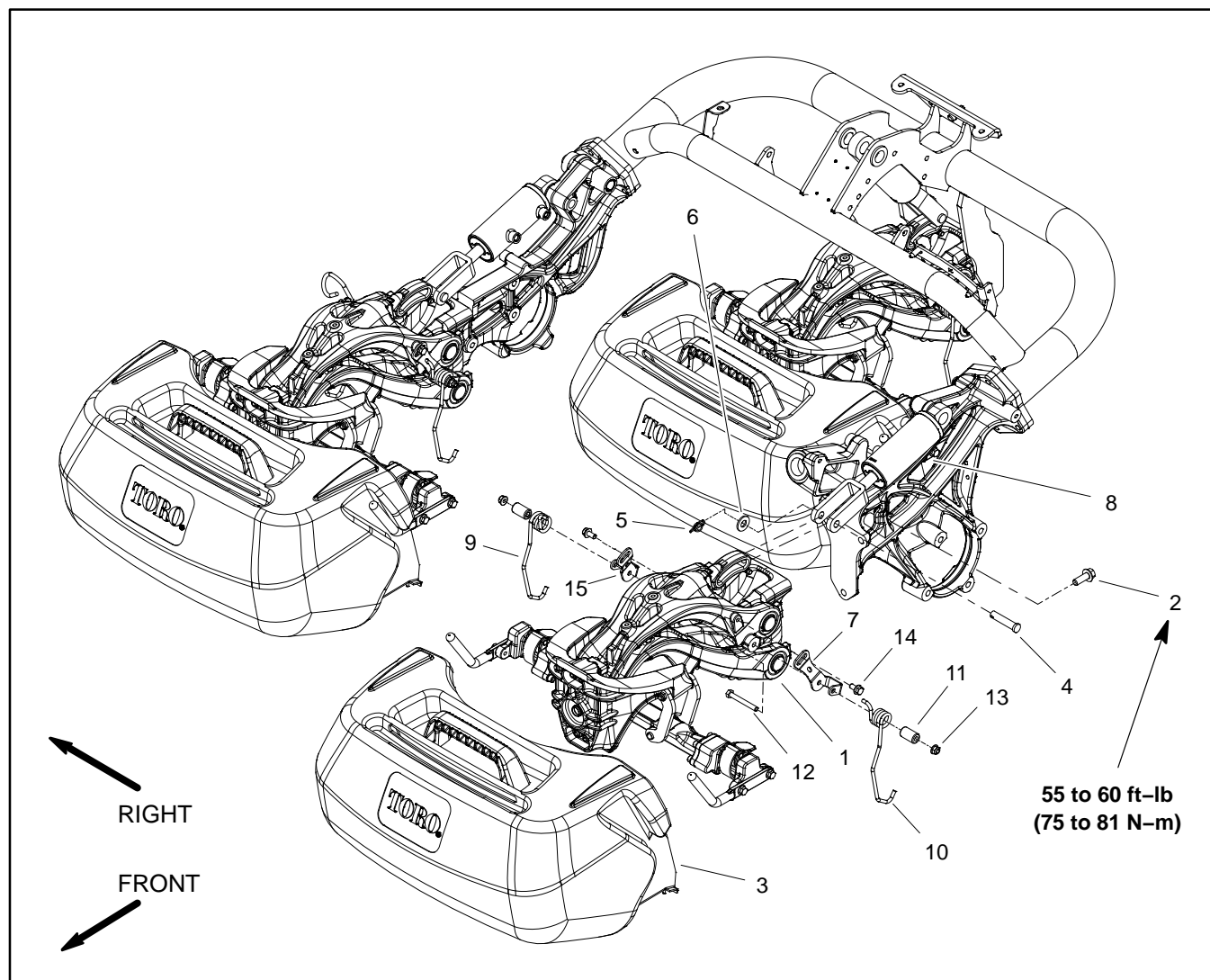


Figure 18

- | | | |
|------------------------------------|--------------------------------|---------------------------------|
| 1. Suspension assembly (3 used) | 6. Washer (3 used) | 11. Spacer (6 used) |
| 2. Flange screw (3 per suspension) | 7. LH spring retainer (3 used) | 12. Cap screw (6 used) |
| 3. Basket | 8. Lift cylinder | 13. Flange nut (6 used) |
| 4. Clevis pin (3 used) | 9. RH stabilizer spring | 14. Flange head screw (6 used) |
| 5. Cotter pin (3 used) | 10. LH stabilizer spring | 15. RH spring retainer (3 used) |

NOTE: Three (3) identical cutting unit suspension assemblies are used on Greensmaster TriFlex machines. The cutting unit attaches to the crossarm assembly which is attached to the front of the cutting unit suspension assembly. The crossarm assembly can be serviced with the suspension assembly attached to the machine (see Cutting Unit Suspension Crossarm Assembly in this section).

Removal (Fig. 18)

1. Park machine on a level surface, engage the parking brake, lower the cutting units and stop the engine. Remove key from the ignition switch.
2. Remove grass basket from suspension assembly.
3. Remove cutting unit from suspension assembly (see Traction Unit Operator's Manual).
4. If front suspension assembly is to be removed, remove front wheel (see Wheel Removal in this section). This will allow easier access to flange head screws that secure suspension assembly to frame.
5. Remove hydraulic hose bracket from suspension assembly (Fig. 19 or 20).
6. Position and support reel motor and attached hydraulic hoses away from suspension assembly.



CAUTION

Support suspension assembly when removing it to prevent it from falling and causing personal injury. Suspension assembly weighs approximately 65 pounds (30 kg).

7. Support suspension assembly to prevent it from shifting or falling.
8. Remove three (3) flange head screws (item 2) that secure suspension assembly to machine frame. Remove suspension assembly from machine.

Installation (Fig. 18)

1. Make sure that all suspension components are correctly assembled.
2. Position suspension assembly to frame. Align mounting holes and secure suspension with three (3) flange head screws (item 2). Torques screws from **55 to 60 ft-lb (75 to 81 N-m)**.
3. Position reel motor and attached hydraulic hoses to suspension assembly. Insert reel motor shaft into storage location on front of suspension assembly.
4. Secure hydraulic hose bracket to suspension assembly (Fig. 19 or 20). Torque two (2) socket head screws from **85 to 115 in-lb (9.6 to 12.9 N-m)**.
5. Install cutting unit to suspension assembly (see Traction Unit Operator's Manual).
6. Install grass basket to suspension assembly.

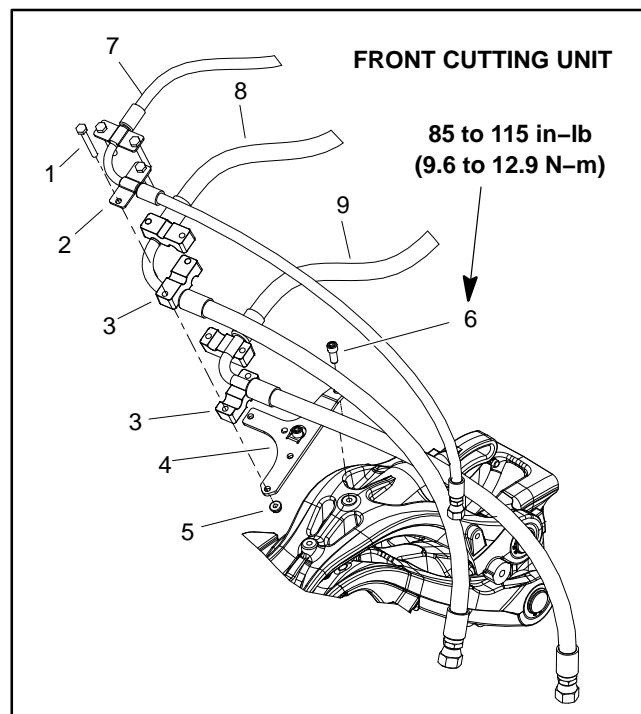


Figure 19

- | | |
|------------------------|--------------------------|
| 1. Cap screw (4 used) | 6. Socket screw (2 used) |
| 2. Strap (2 used) | 7. Case drain hose |
| 3. Tube clamp (4 used) | 8. Pressure hose |
| 4. Hose bracket | 9. Return hose |
| 5. Flange nut (4 used) | |

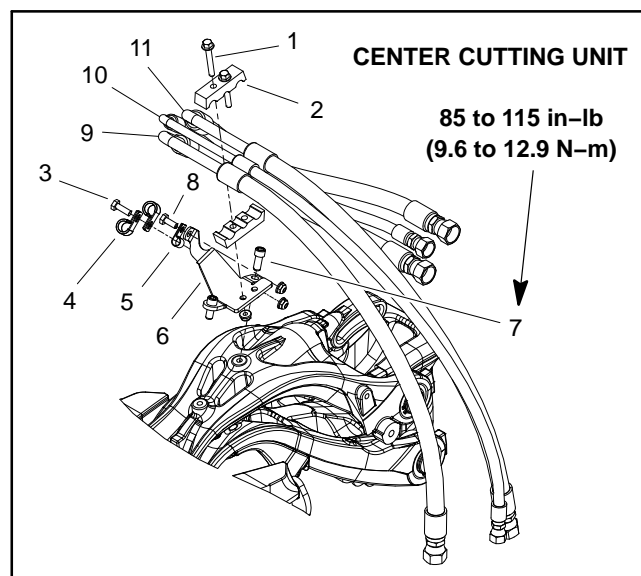


Figure 20

- | | |
|------------------------|--------------------------|
| 1. Screw (2 used) | 7. Socket screw (2 used) |
| 2. Tube clamp (2 used) | 8. Cap screw |
| 3. Cap screw | 9. Pressure hose |
| 4. R-clamp (2 used) | 10. Case drain hose |
| 5. R-clamp | 11. Return hose |
| 6. Hose bracket | |

Cutting Unit Suspension Service

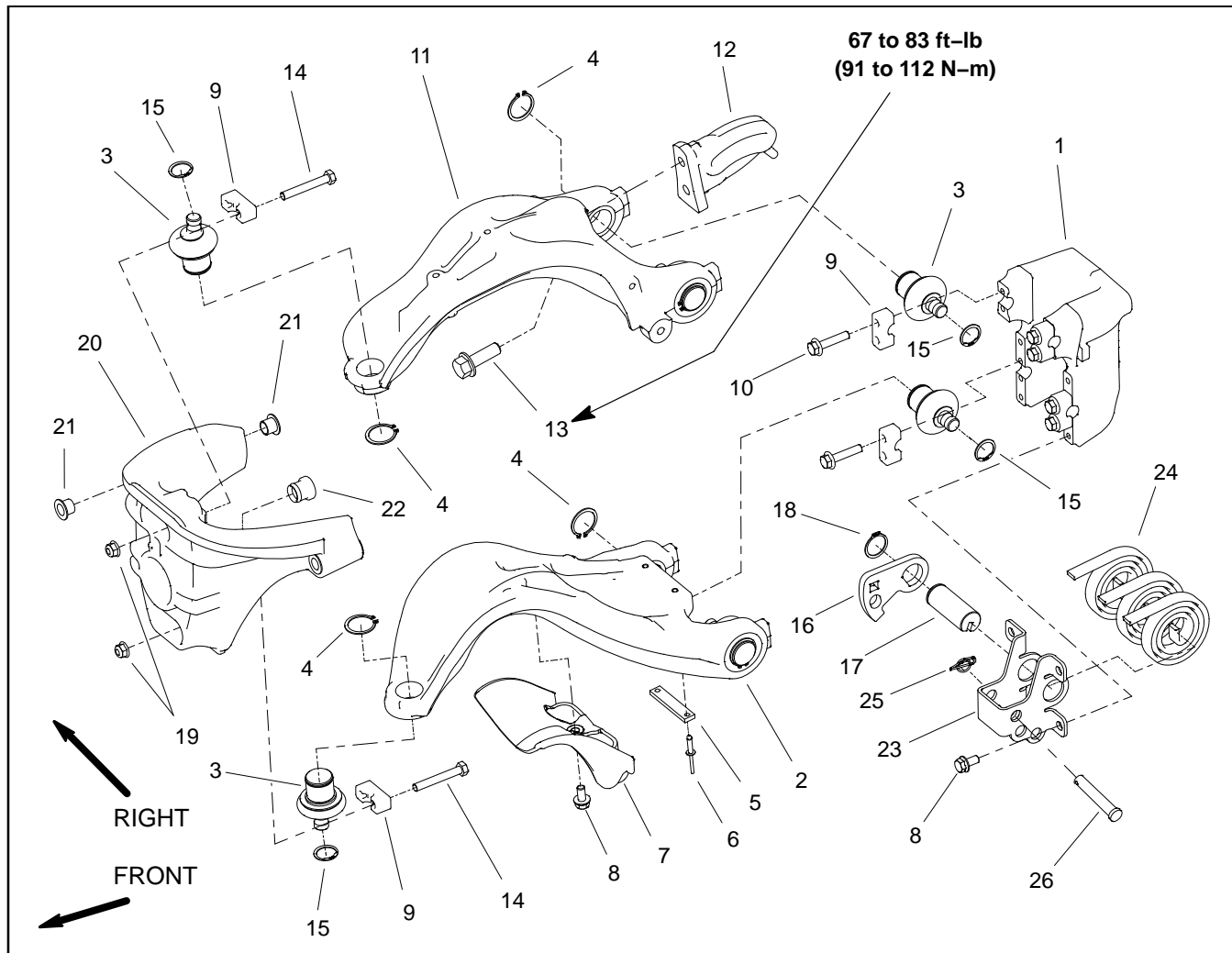


Figure 21

- | | | |
|-------------------------------|--------------------------------|------------------------------------|
| 1. Pivot mount | 10. Flange head screw (8 used) | 19. Flange nut (4 used) |
| 2. Lower A-arm | 11. Upper A-arm | 20. Steering head |
| 3. Ball joint (6 used) | 12. Lift plate | 21. Flange bushing (4 used) |
| 4. Retaining ring (6 used) | 13. Flange head screw (2 used) | 22. Grommet |
| 5. Striker plate | 14. Cap screw (4 used) | 23. Counterbalance mount |
| 6. Pop rivet (2 used) | 15. Retaining ring (6 used) | 24. Counterbalance spring (3 used) |
| 7. Steering stop | 16. Tensioner arm | 25. Cotter pin |
| 8. Flange head screw (5 used) | 17. Pin | 26. Clevis pin |
| 9. Clamp (6 used) | 18. Retaining ring | |

NOTE: Three (3) identical cutting unit suspension assemblies are used on Greensmaster TriFlex machines. The cutting unit attaches to the crossarm assembly which is attached to the front of the cutting unit suspension assembly. See Cutting Unit Suspension Crossarm Assembly in this section for information regarding service of the crossarm assembly.

Disassembly (Fig. 21)

1. Remove tension from suspension counterbalance assembly:



CAUTION

Be careful when removing tension from the suspension counterbalance system. The counterbalance spring is under heavy load and may cause personal injury.

- A. Remove cotter pin from clevis pin that secures counterbalance tensioner arm.

B. Use 3/8" drive breaker bar in tensioner arm square drive hole to hold tensioner arm in place so that clevis pin can be removed.

C. Remove clevis pin and allow counterbalance springs to relax.

2. Disassemble suspension assembly as required using Figure 21 as a guide.

NOTE: Medium strength Loctite #609 retaining compound is applied to ball joint housing during assembly. Localized heat around the ball joint housing will allow easier ball joint removal from A-arm.

Assembly (Fig. 21)

1. Install all removed suspension assembly components using Figure 21 as a guide.

A. If any ball joint (item 3) was removed from A-arm, clean ball joint housing and A-arm bore with Loctite cleaning solvent (or equivalent) and allow to dry. Apply Loctite #609 retaining compound (or equivalent) to ball joint housing before inserting ball joint into A-arm.

B. If any clamp (item 9) was removed, make sure that raised boss in clamp bore is positioned in groove of ball joint stud before securing clamp.

C. If lift plate (item 12) was removed from A-arm, secure lift plate with two (2) flange head screws (item 13). Torque screws from **67 to 83 ft-lb (91 to 112 N-m)**.



CAUTION

Be careful when assembling the suspension counterbalance system. The counterbalance spring is under heavy load and may cause personal injury.

D. Install clevis pin (item 26) into upper holes in counterbalance mount (item 23) and hole in tensioner arm (item 16). Tensioner arm can be rotated with breaker bar (3/8" square drive) to align holes. Figure 22 shows correct location of clevis pin.

E. If stabilizer springs were removed from suspension assembly, move and support suspension assembly so that upper a-arm has stabilizer spring attachment hole positioned 5.710" (145.0 mm) from rear of pivot mount. Then, adjust location of spring so the center of the spring end is 8.760" (222.5 mm) from rear of pivot mount. Figure 24 shows dimensions for correct stabilizer spring adjustment.

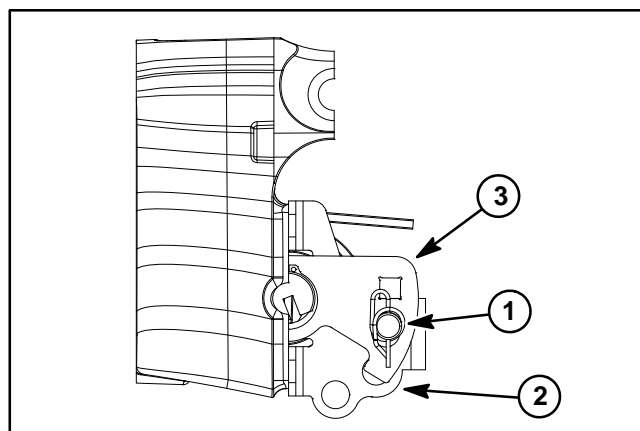


Figure 22

- | | |
|-------------------------|------------------|
| 1. Clevis pin | 3. Tensioner arm |
| 2. Counterbalance mount | |

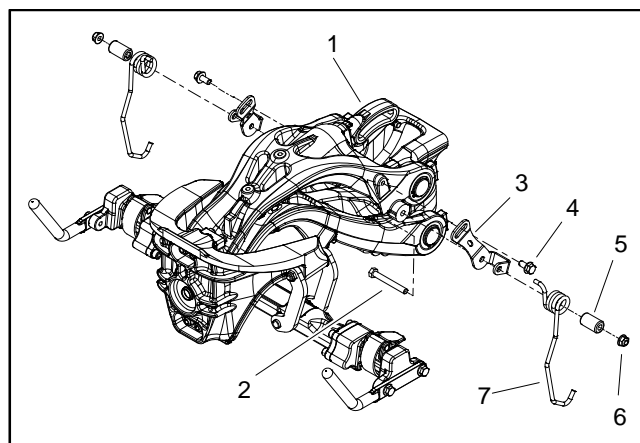


Figure 23

- | | |
|------------------------|----------------------|
| 1. Suspension assembly | 5. Spacer |
| 2. Cap screw | 6. Flange nut |
| 3. Spring retainer | 7. Stabilizer spring |
| 4. Flange head screw | |

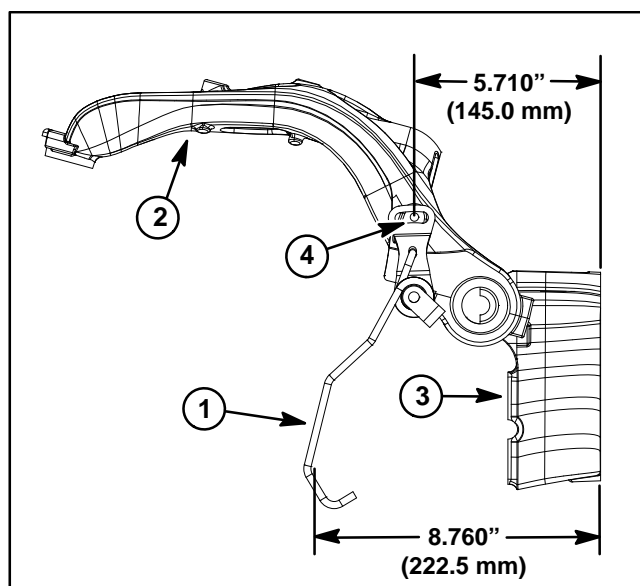


Figure 24

- | | |
|----------------------|----------------|
| 1. Stabilizer spring | 3. Pivot mount |
| 2. Upper a-arm | 4. Spring hole |

Frame Assembly

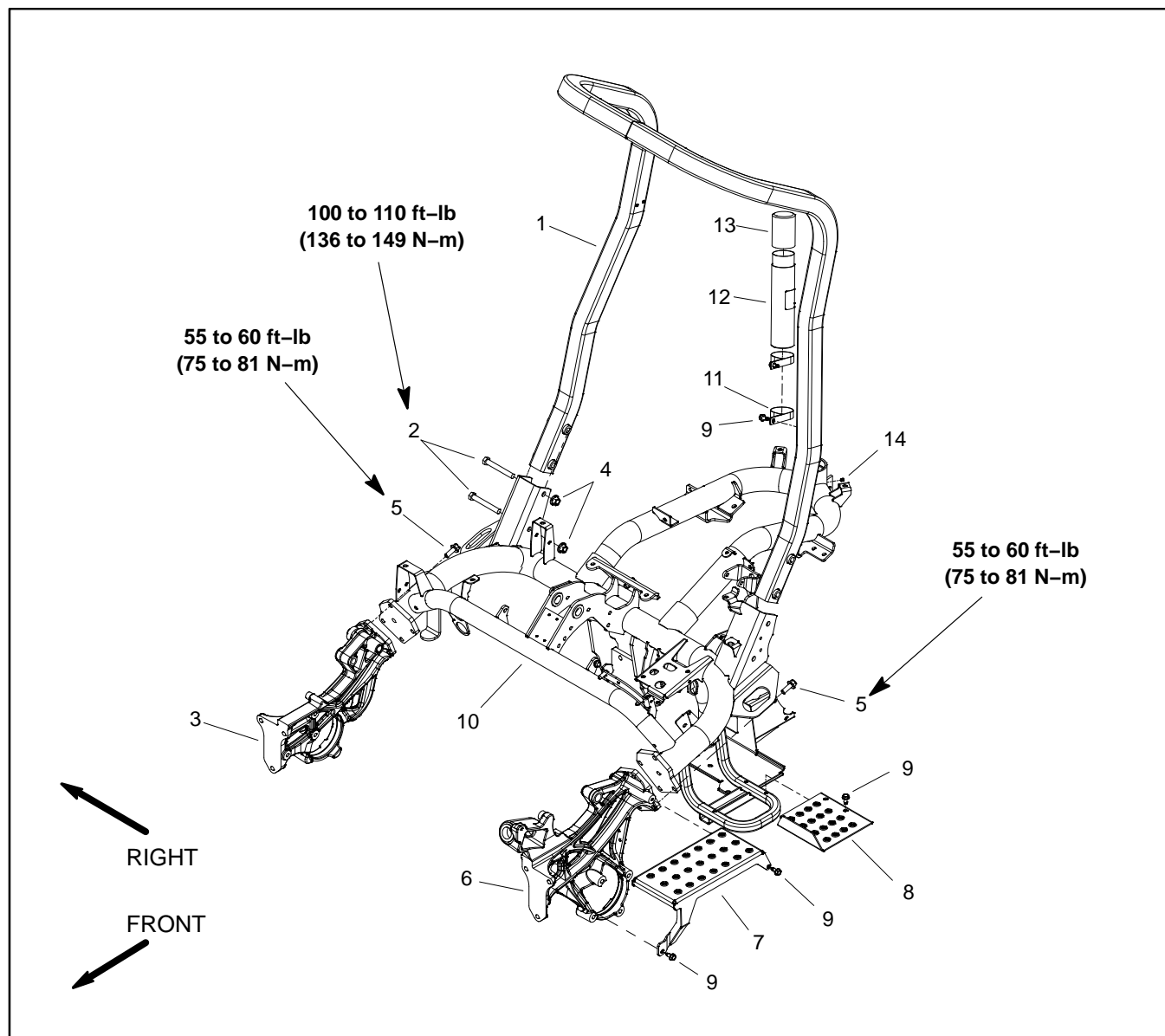


Figure 25

- | | | |
|-------------------------------|-------------------------------|----------------------|
| 1. ROPS assembly | 6. LH side casting | 11. R-clamp (2 used) |
| 2. Cap screw (4 used) | 7. Step | 12. Manual tube |
| 3. RH side casting | 8. Step plate | 13. Cap |
| 4. Lock nut (4 used) | 9. Washer head screw (9 used) | 14. Plug |
| 5. Flange head screw (8 used) | 10. Frame assembly | |

The Greensmaster TriFlex frame assembly is illustrated in Figure 25. If the fasteners used to secure the front castings or ROPS assembly are loosened or removed, refer to Figure 25 for fastener tightening torque recommendations.



DPA Cutting Units

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Specifications

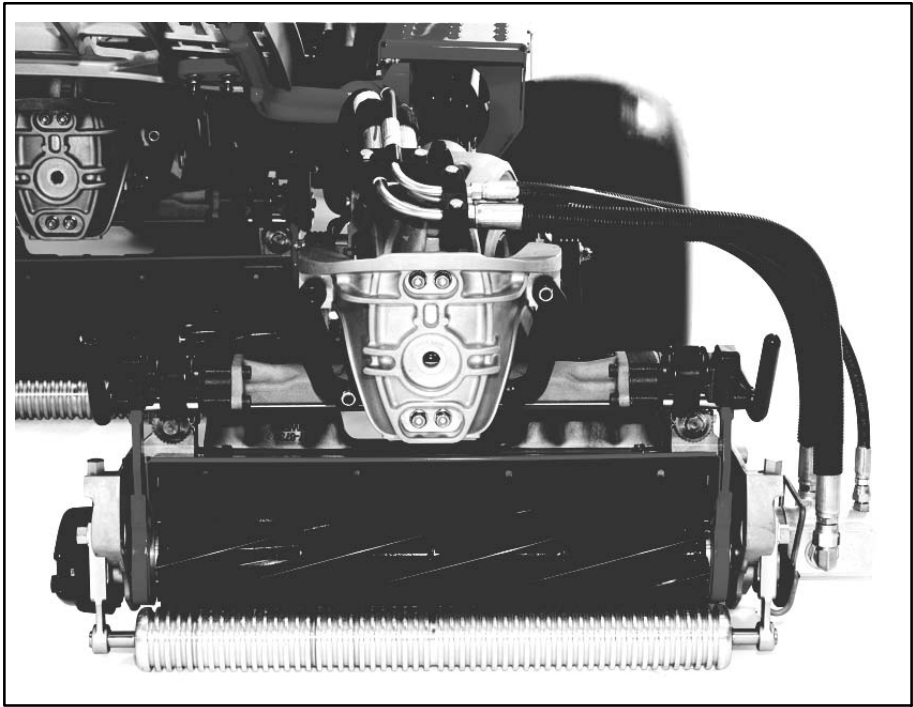


Figure 1

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 left 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 bed-bar 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 TriFlex 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:	
21" Reel, 8 Blade	71 lb (32 kg)
21" Reel, 11 Blade	74 lb (34 kg)
21" Reel, 14 Blade	77 lb (35 kg)

Options:
Refer to Cutting Unit Operator's Manual for available options for your Greensmaster 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 TriFlex 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.

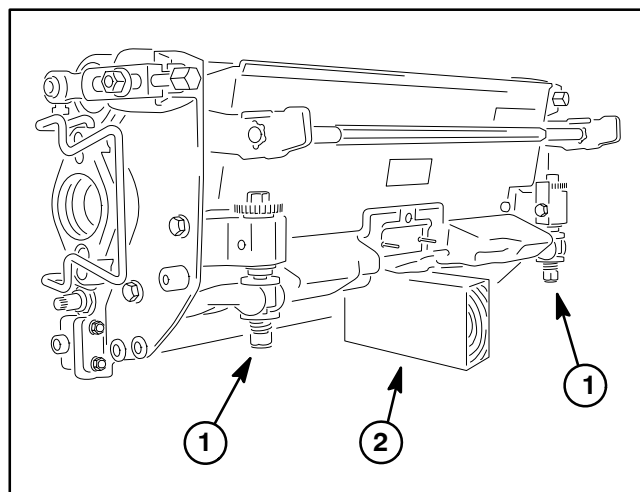


Figure 2

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**

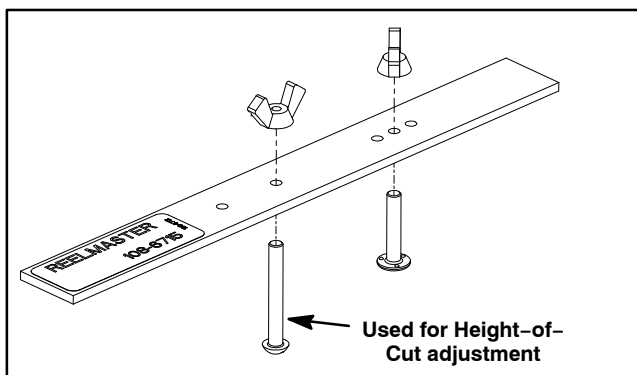


Figure 3

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**

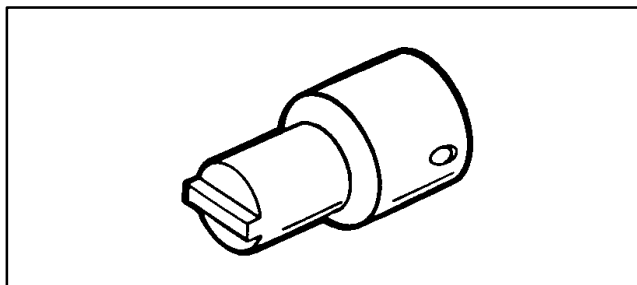


Figure 4

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

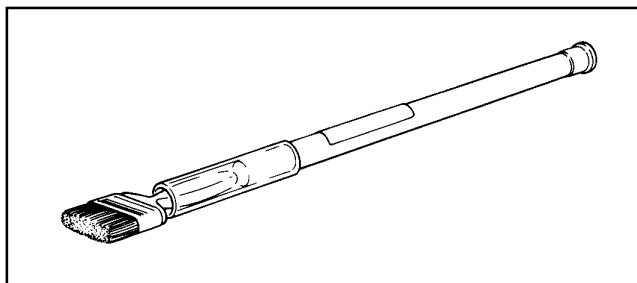


Figure 5

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**

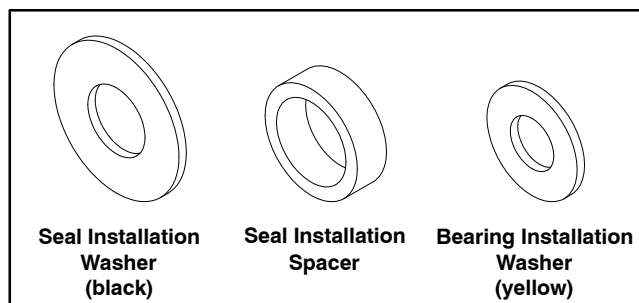


Figure 6



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.

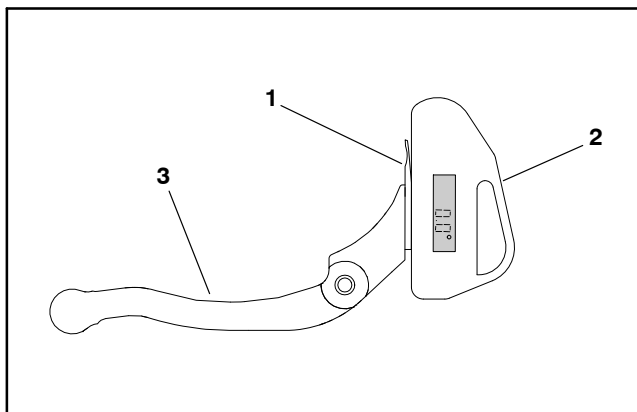


Figure 10

- | | |
|--------------------|-----------|
| 1. Bedknife | 3. Bedbar |
| 2. Angle indicator | |

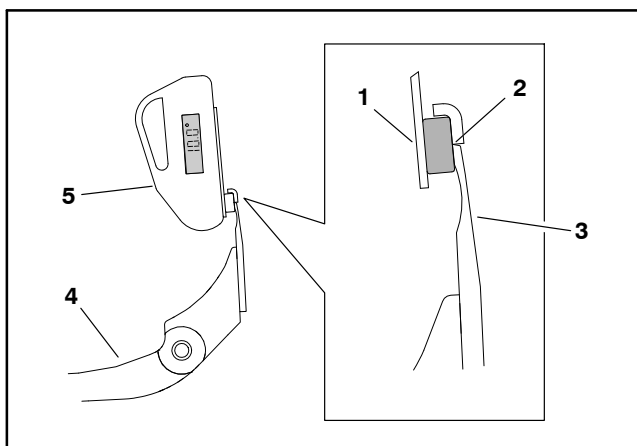


Figure 11

- | | |
|--------------------------|--------------------|
| 1. Angle indicator mount | 4. Angle indicator |
| 2. Magnet | 5. Bedbar |
| 3. Bedknife | |

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	<p>Check tire pressure of all traction unit tires. Adjust tire pressure as necessary.</p> <p>See the Traction Unit Operator’s manual.</p>
Governed engine speed	<p>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.</p> <p>See Chapter 3 – Gasoline Engine or Chapter 4 – Diesel Engine.</p>
Reel speed	<p>All cutting reels must rotate at the same speed (within 100 rpm) (see Troubleshooting in Chapter 5 – Hydraulic System).</p> <p>All cutting units must have equal bedknife to reel and height-of-cut adjustments.</p> <p>Make sure that reel speed selection is correct (see Reel Speed Chart in Traction Unit Operator’s Manual).</p>
Reel bearing condition	<p>Check reel bearings for wear and replace if necessary.</p> <p>See Reel Assembly Service in the Service and Repairs section of this chapter.</p>
Bedknife to reel adjustment	<p>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).</p>

Factor	Possible Problem/Correction
Reel and bedknife sharpness	<p>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.</p> <p>The most common cause of rifling is bedknife to reel contact that is too tight.</p> <p>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).</p> <p>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.</p> <p>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).</p>
Rear roller adjustment	<p>Adjust the rear roller brackets to correct position depending on the height-of-cut range desired.</p> <p>See Rear Roller Adjustment in the Cutting Unit Operator’s Manual.</p>
Height-of-cut	<p>“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.</p> <p>See Height-of-Cut Adjustment in the Cutting Unit Operator’s Manual.</p>
Proper bedknife selection for height-of-cut desired	<p>If the bedknife is incorrect for effective height-of-cut, poor quality of cut will result.</p> <p>See Cutting Unit Operator’s Manual for bedknife options.</p>
Stability of bedbar	<p>Make sure bedbar pivot bolts are seated securely. Check condition of the bushings in the side plates.</p> <p>See Bedbar Removal and Installation in the Service and Repairs section of this chapter.</p>
Number of reel blades	<p>Use correct number of reel blades for clip frequency and optimum height-of-cut range.</p>

Factor	Possible Problem/Correction
Roller condition and roller type	<p>Make sure rollers rotate freely. Repair roller bearings as necessary.</p> <p>See Roller Service in the Service and Repairs section of this chapter.</p> <p>Refer to Cutting Unit Operator's Manual for roller options.</p>
Cutting unit accessories	<p>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.</p>

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 TriFlex 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.

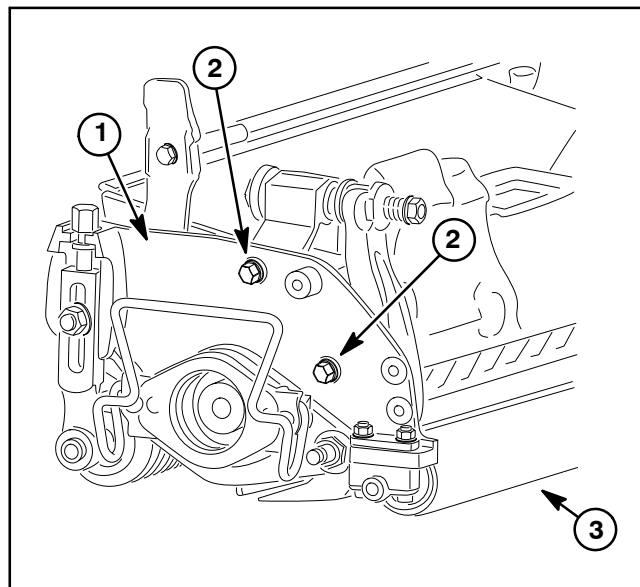


Figure 12

- | | |
|------------------|----------------|
| 1. Side plate | 3. Rear roller |
| 2. Shoulder bolt | |

Service and Repairs

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. Remove the console cover to expose controls.

3. Locate the reel speed control and backlap lever on the hydraulic mow manifold (Figs. 13 and 14). 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 **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 with a long handle brush (see Special Tools in this chapter) (Fig. 15). Never use a short handled brush to apply lapping compound.

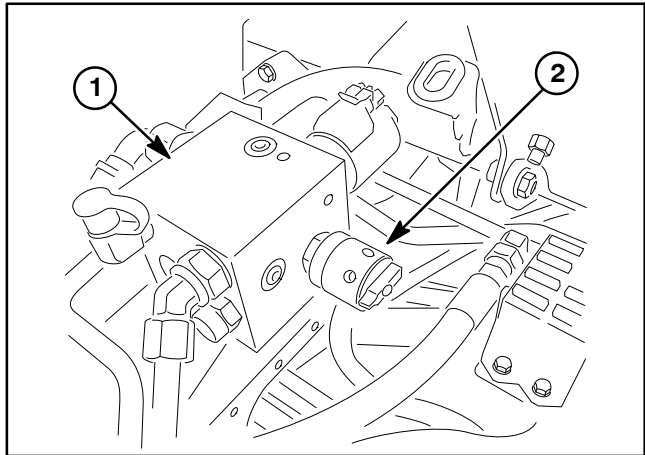


Figure 13

1. Mow manifold

2. Reel speed control

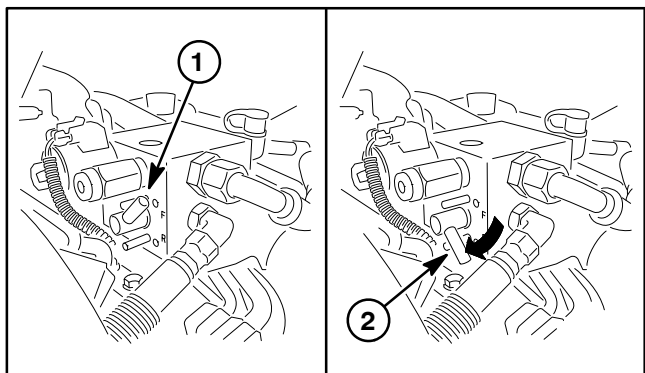


Figure 14

1. Backlap lever (forward)

2. Backlap lever (backlap)

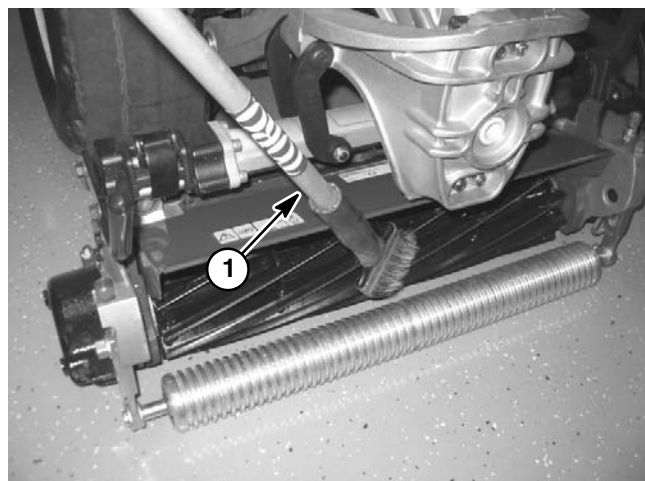


Figure 15

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.

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, install console cover 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.

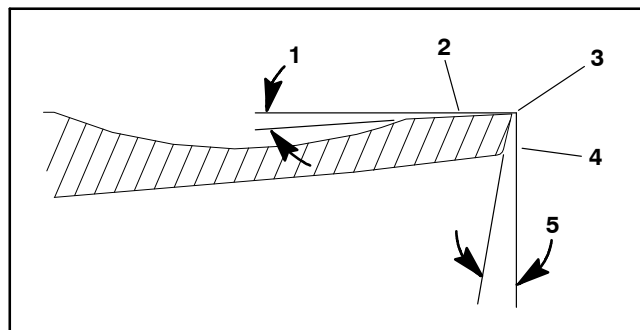


Figure 16

- | | |
|----------------|------------------|
| 1. Top angle | 4. Front surface |
| 2. Top surface | 5. Front angle |
| 3. Remove burr | |

Bedbar Assembly

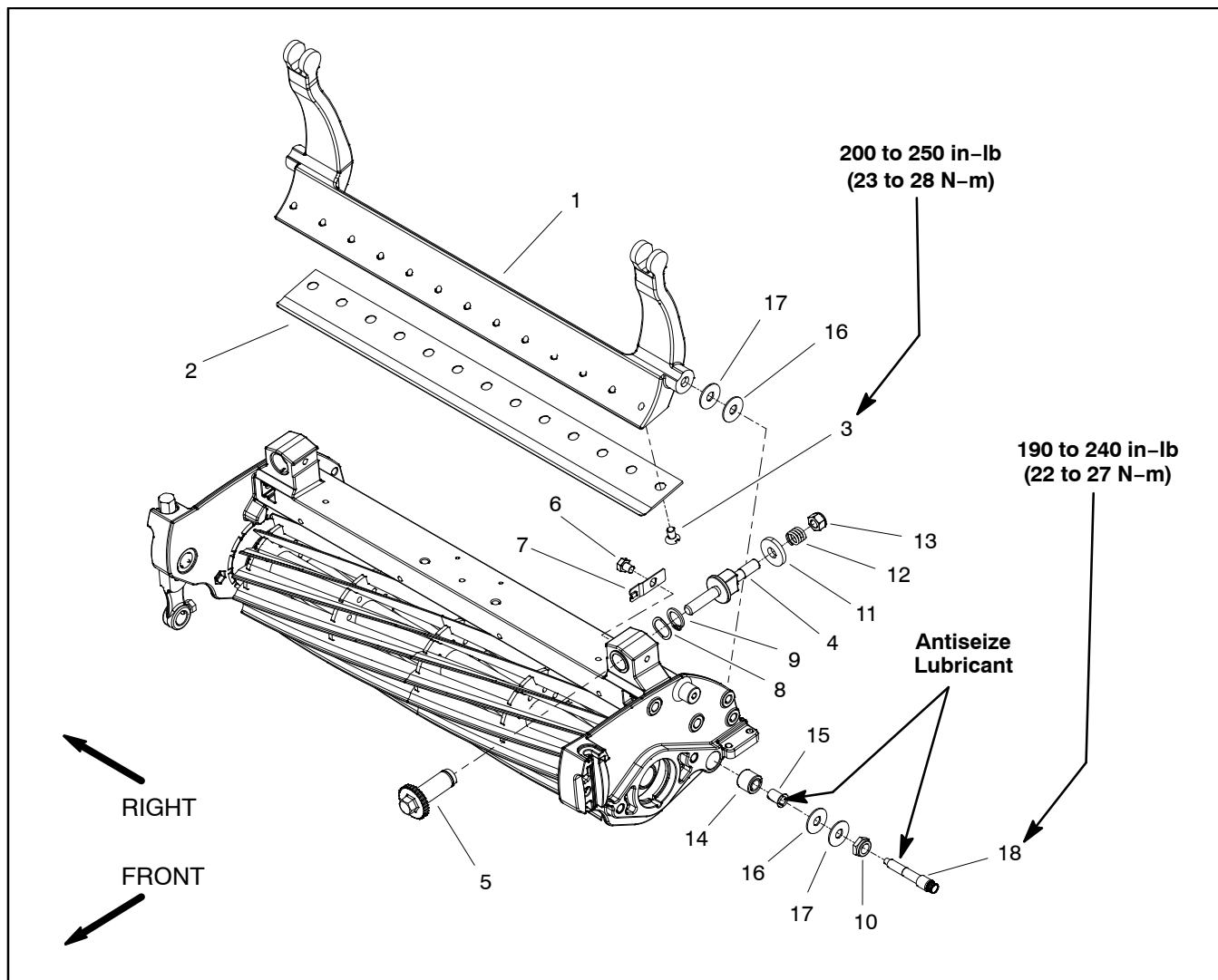


Figure 17

- | | | |
|-----------------------------------|---------------------------------|--------------------------------|
| 1. Bedbar | 7. Detent (2 used) | 13. Lock nut (2 used) |
| 2. Bedknife | 8. Wave washer (2 used) | 14. Rubber bushing (2 used) |
| 3. Screw (13 used) | 9. Retaining ring (2 used) | 15. Nylon bushing (2 used) |
| 4. Bedbar adjuster screw (2 used) | 10. Lock nut (2 used) | 16. Plastic washer (4 used) |
| 5. Bedbar adjuster shaft (2 used) | 11. Washer (2 used) | 17. Metal washer (4 used) |
| 6. Cap screw (2 used) | 12. Compression spring (2 used) | 18. Bedbar pivot bolt (2 used) |

Bedbar Removal (Fig. 17)

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. 17)

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. 18).
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. 18).

IMPORTANT: When installing washers (items 16 and 17), make sure that plastic washers are positioned on either side of the cutting unit sideplate (Fig. 18).

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. 18).

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.

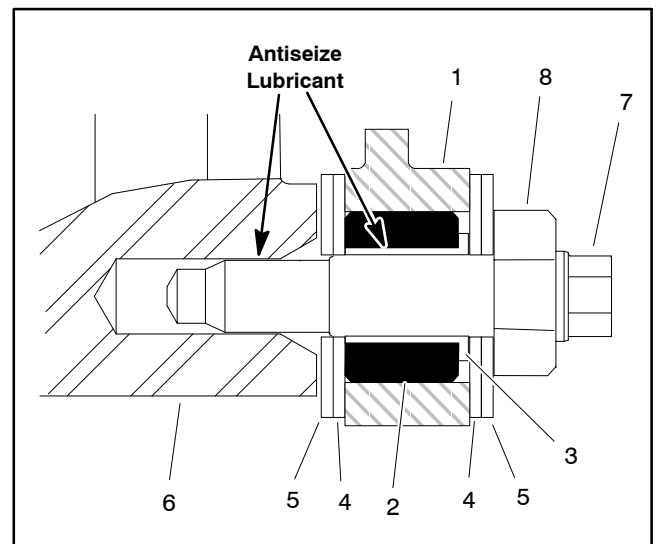


Figure 18

- | | |
|---------------------------|----------------------|
| 1. Cutting unit sideplate | 5. Metal washer |
| 2. Rubber bushing | 6. Bedbar |
| 3. Nylon bushing | 7. Bedbar pivot bolt |
| 4. Plastic washer | 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. 19).
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. 20), tighten screws from **200 to 250 in-lb (23 to 28 N-m)**.
7. After installing bedknife to bedbar, grind bedknife.

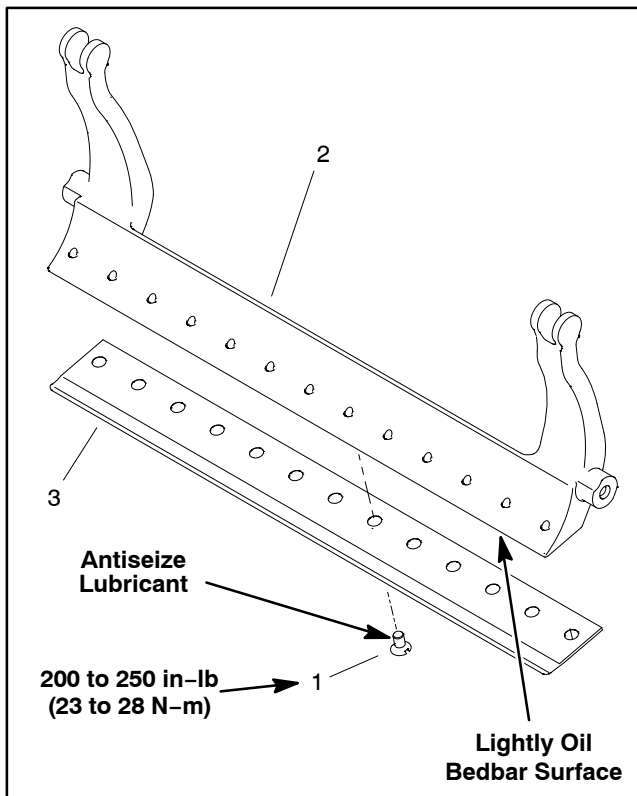


Figure 19

1. Screw (13)
2. Bedbar
3. Bedknife

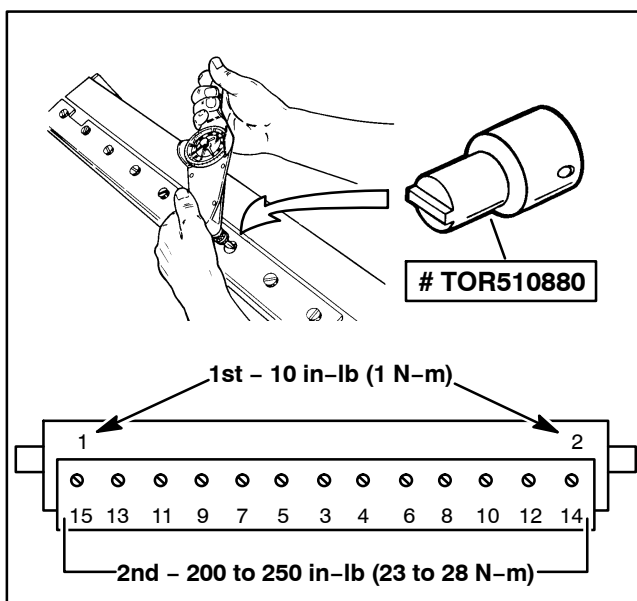


Figure 20

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. 21). Grind only enough so the top surface of the bedknife is true (Fig. 22).

IMPORTANT: Do Not grind the bedknife below its service limit (Fig 23). 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. 22)	
Standard bedknife relief angle	3° minimum
Fairway bedknife relief angle	3° minimum
Extended bedknife relief angle	7° minimum
Front Angle Range	13° to 17°

Figure 21

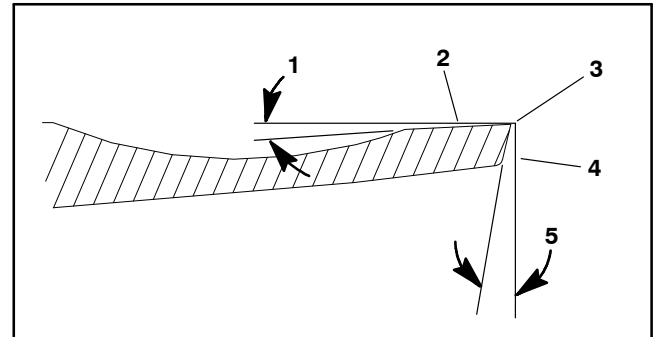


Figure 22

1. Top angle
2. Top surface
3. Remove burr (without dulling sharp corner)
4. Front surface
5. Front angle

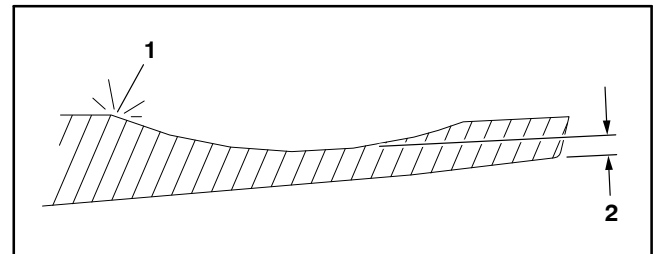


Figure 23

1. Service limit (reel contacts back of bedknife scallop during operation)
2. Service limit (bottom of bedknife scallop reached when grinding)

Bedbar Adjuster Service

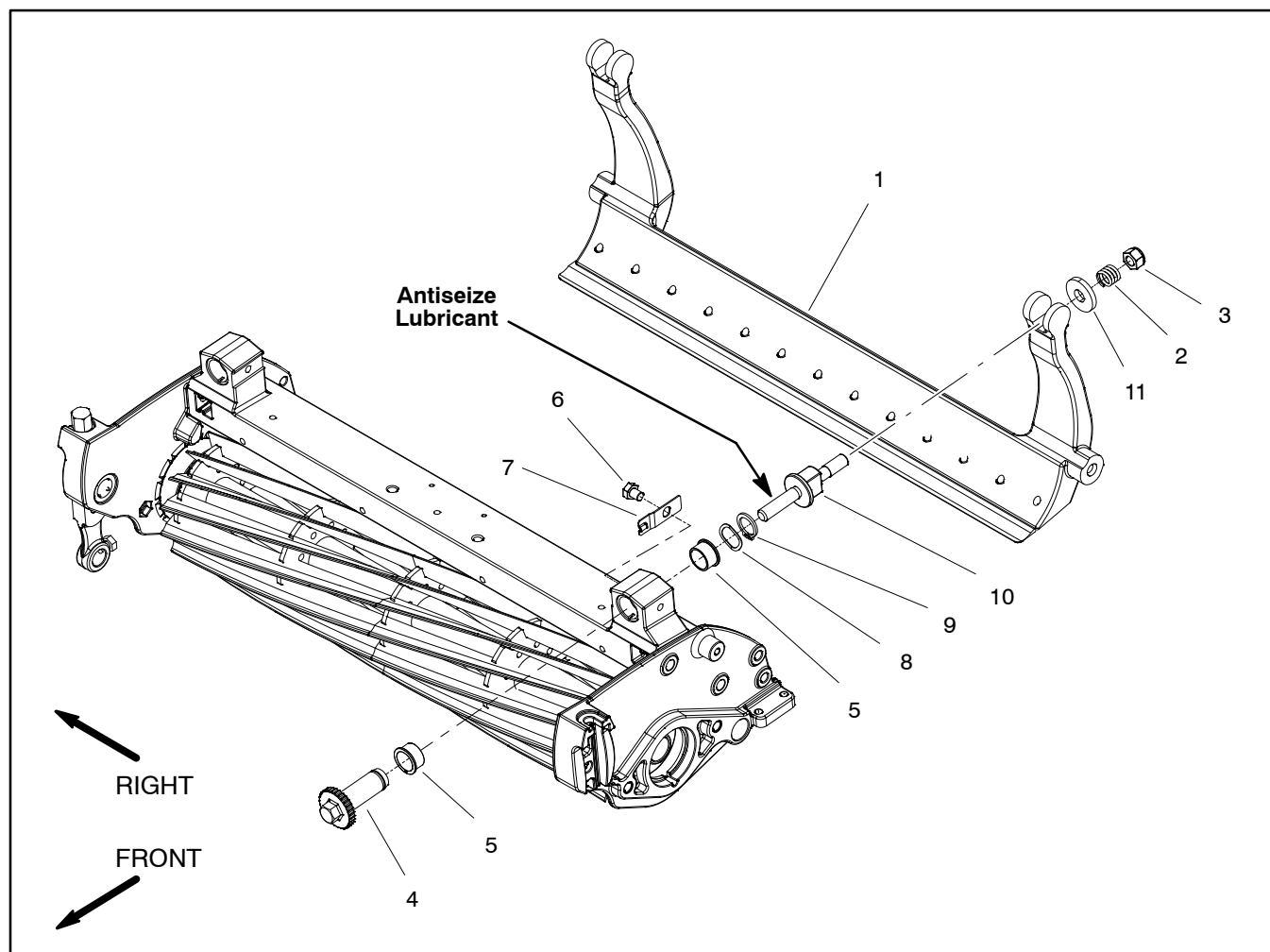


Figure 24

- 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. 24)

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: Adjuster shaft (item 4) has left-hand threads.

3. Unscrew bedbar adjuster shaft (item 4) from the bedbar adjuster screw.
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. 24)

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: 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

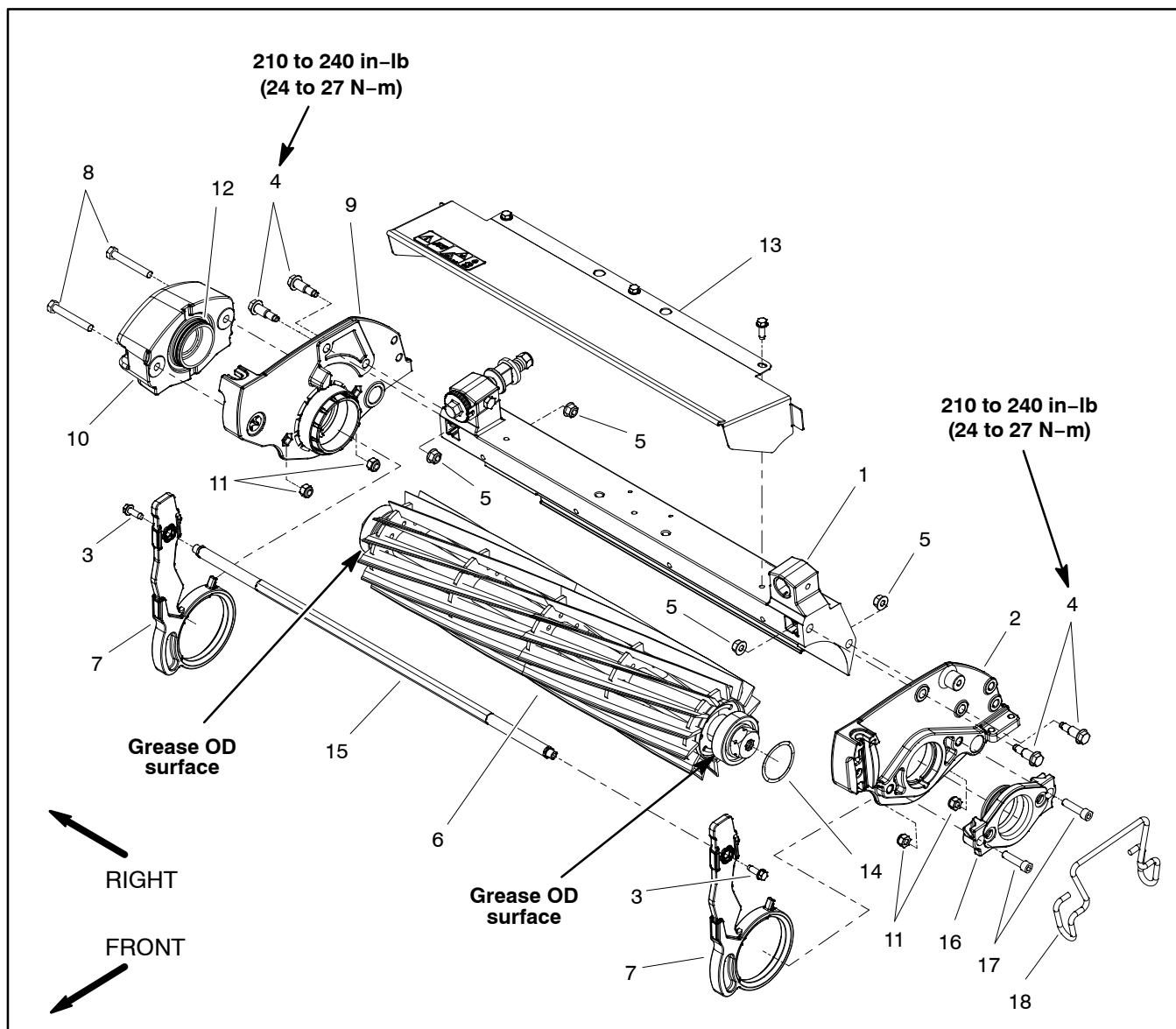


Figure 25

- | | | |
|--|-----------------------|--------------------------------|
| 1. Crossmember | 7. Pitch arm (2 used) | 13. Grass shield |
| 2. LH side plate | 8. Cap screw (2 used) | 14. Flat wire spring |
| 3. Washer head screw (2 used) | 9. RH side plate | 15. Crosslink |
| 4. Shoulder bolt (2 used per side plate) | 10. Weight | 16. Reel motor adapter |
| 5. Flange nut (2 used per side plate) | 11. Hex nut (4 used) | 17. Socket head screw (2 used) |
| 6. Cutting reel assembly | 12. O-ring | 18. Motor clamp |

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. 25)



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. Remove two (2) cap screws and nuts that secure weight (item 10) to the RH side plate. Remove weight from the cutting unit. Remove and discard O-ring from weight.
4. 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 9 – Groomer for information on groomer. See Rear Roller Brush in this section for information on rear roller brush.
5. If bearings or seals are to be removed from cutting reel, put a block of wood between the cutting reel blades to prevent the reel from rotating. Loosen bearing lock nut (RH threads) and reel nut (LH threads) to allow easier removal after reel assembly is removed from cutting unit (Fig. 26).
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. Remove washer head screws (item 3) that secure crosslink (item 15) to pitch arms. Remove crosslink.
9. Support cutting reel to keep it from shifting or falling.
10. 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. Locate and remove flat wire spring (item 14). Remove pitch arm (item 7) from side plate.
11. Carefully slide the cutting reel assembly (with flocked seals, reel bearings, bearing lock screw and reel nut) from the RH side plate.

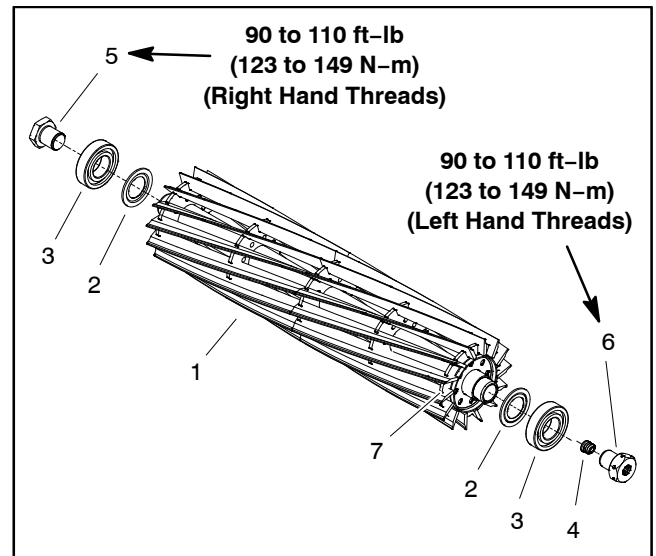


Figure 26

- | | |
|--------------------------|--------------------------|
| 1. Cutting reel | 5. Bearing lock screw |
| 2. Flocked seal (2 used) | 6. Reel nut (LH threads) |
| 3. Bearing (2 used) | 7. Reel groove location |
| 4. Plug | |

Reel Assembly Installation (Fig. 25)

1. Thoroughly clean side plates and other cutting unit components. Inspect side plates and pitch arms for wear or damage and replace components if needed.
2. Make sure that flocked seals, reel bearings, bearing lock screw and reel nut 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. Make sure that pitch arm (item 7) is fitted to RH side plate.
4. Carefully slide the cutting reel assembly (with flocked seals, reel bearings, bearing lock screw and reel nut) into the RH side plate. Make sure that bearing is fully seated into side plate.
5. Place flat wire spring into bearing bore of LH side plate. Carefully slide the LH side plate with pitch arm 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 plates to the crossmember. Torque the shoulder bolts from **210 to 240 in-lb (24 to 27 N-m)**.

7. Position crosslink to pitch arms and secure with washer head screws (item 3).

8. If bearing lock nut (RH threads) and reel nut (LH threads) were loosened during cutting reel service, put a block of wood between the cutting reel blades to prevent the reel from rotating. Torque bearing lock nut (RH threads) and reel nut (LH threads) from **90 to 110 ft-lb (123 to 149 N-m)** (Fig. 26).

9. Thoroughly fill spline area of reel nut (left side of cutting reel) with grease.

10. Secure the bedbar assembly to LH side plate (see Bedbar Installation in this section). Make sure that plastic and steel washers are properly positioned.

11. Secure front and rear rollers to LH side plate (see Front Roller Installation and Rear Roller Installation in this section).

12. 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).

13. Install new O-ring (item 12) on weight (item 10). Secure weight to RH side plate with two (2) cap screws and nuts.

14. 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 9 – Groomer for information on groomer. See Rear Roller Brush in this section for information on rear roller brush.

15. Install cutting unit to the machine.

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Reel Assembly Service

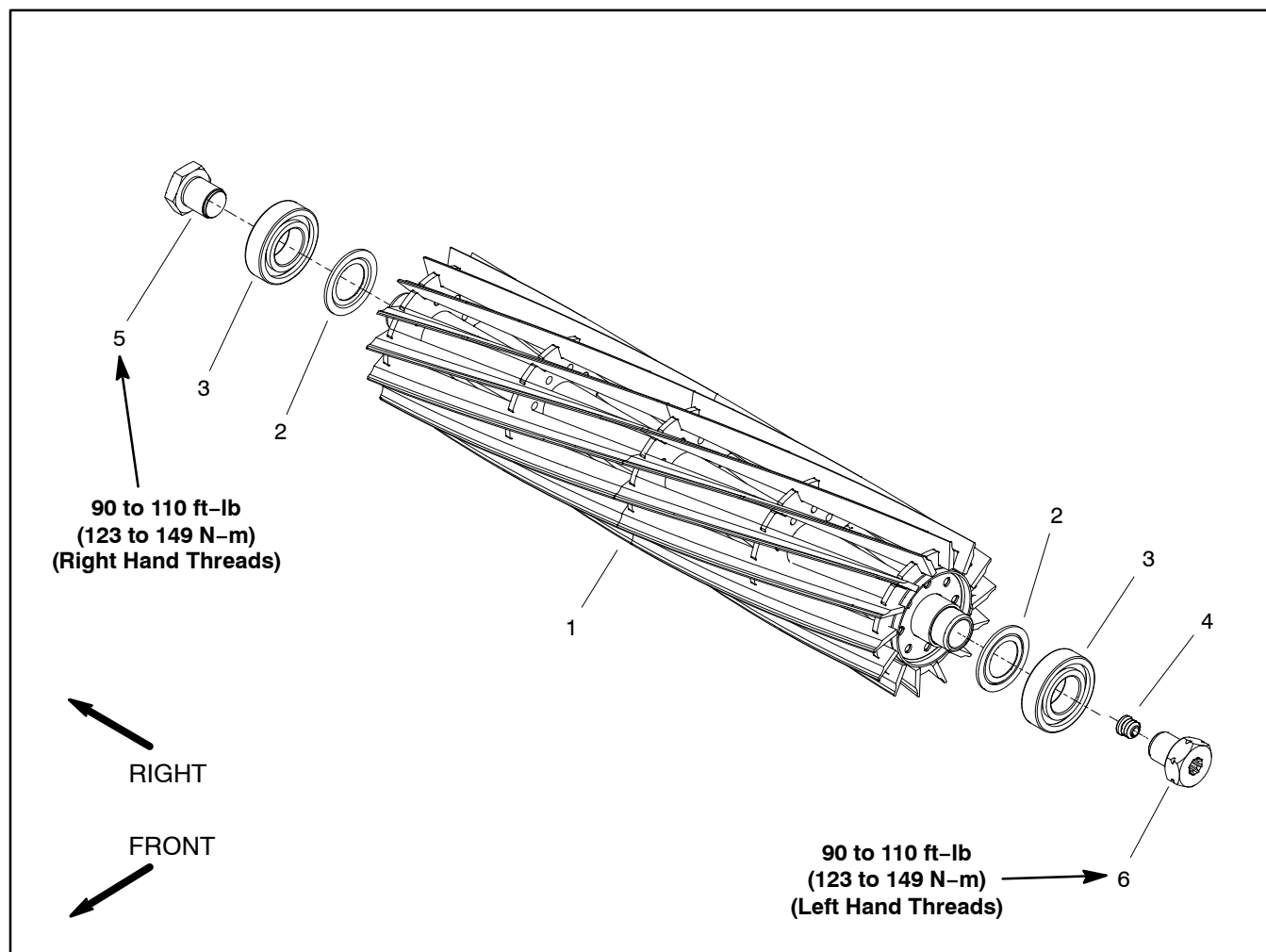


Figure 27

- 1. Cutting reel
- 2. Flocked seal (2 used)

- 3. Bearing (2 used)
- 4. Plug

- 5. Bearing lock screw (RH thread)
- 6. Reel nut (LH thread)

Disassembly of Cutting Reel (Fig. 27)

1. Remove bearing lock screw (item 5) and reel nut (item 6) from cutting reel. Reel nut has LH threads and is in end of reel shaft identified with a groove that is just inside of reel spider (Fig. 28).
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. 27)

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 nut (item 6) for excessive wear or distortion. Replace reel nut if damage is evident.

Assembly of Cutting Reel (Fig. 27)

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 bearing lock screw (item 5) and reel nut (item 6) into reel shaft to secure bearings. Reel nut has LH threads and should be installed in end of reel shaft identified with a groove that is just inside of reel spider (Fig. 28).

NOTE: Installation torque for bearing lock screw and reel nut 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 nut (left side of cutting reel) with grease.

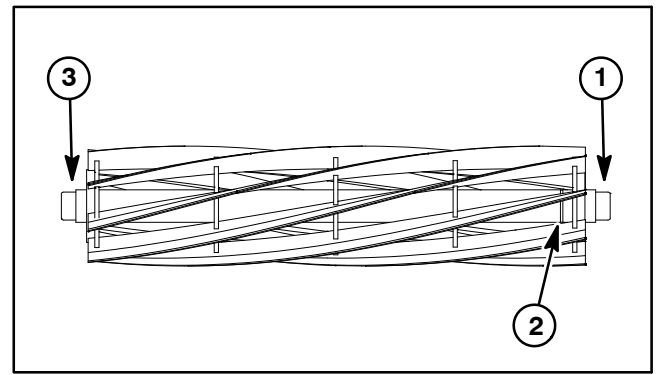


Figure 28

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	30°
Blade Relief Angle Range	28° to 32°
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)

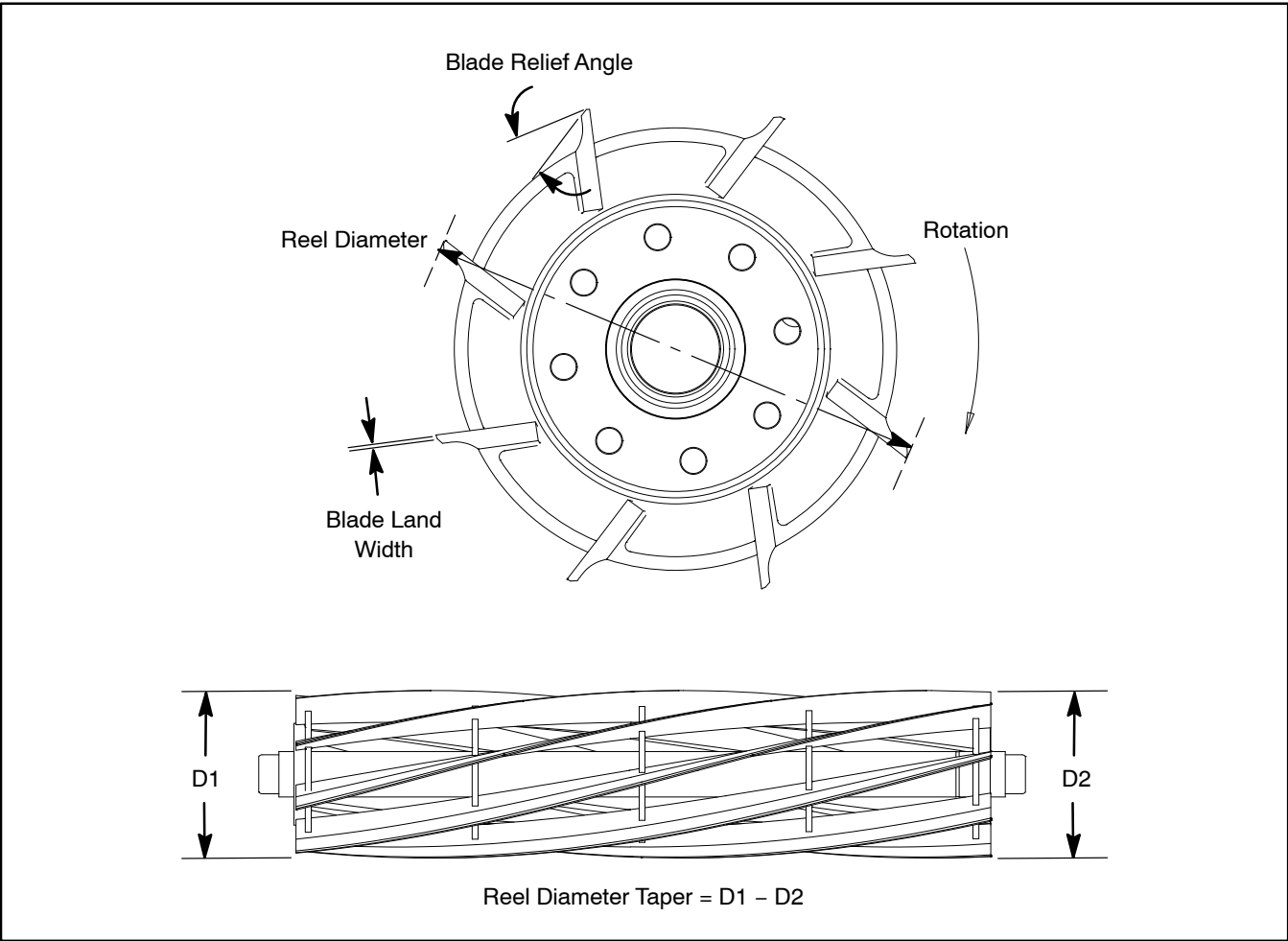


Figure 29

Reel Motor Adapter

Removal

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 hydraulic reel motor from the cutting unit (see Cutting Reel Motors in the Service and Repairs section of Chapter 5 – Hydraulic System). Move motor to storage location on front of cutting unit suspension assembly.

3. Remove reel motor adapter from cutting unit side plate using Fig. 30 as a guide.

4. Remove O-rings as necessary from motor adapter (Fig. 31).

Installation

1. If large O-ring was removed from flange of motor adapter, lubricate O-ring with grease. Small O-rings should be installed into motor adapter without lubrication. Make sure that O-rings are correctly positioned in grooves in adapter.

2. Install reel motor adapter to cutting unit side plate using Fig. 30 as a guide.

3. Secure hydraulic reel motor to the cutting unit (see Cutting Reel Motors in the Service and Repairs section of Chapter 5 – Hydraulic System).

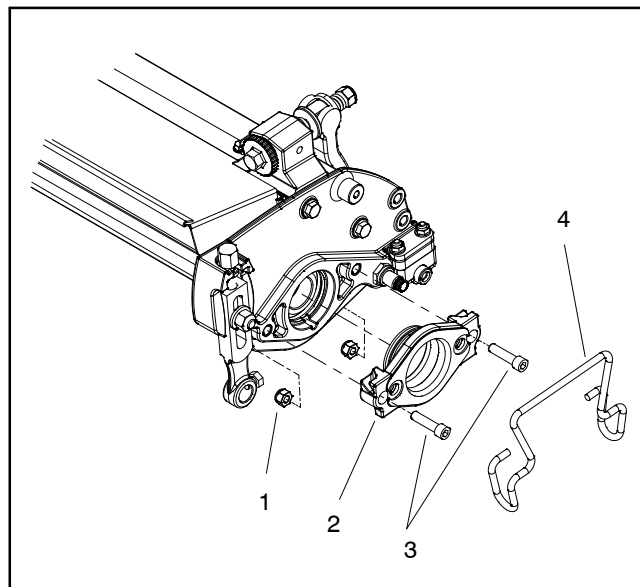


Figure 30

- | | |
|-----------------------|----------------------|
| 1. Hex nut | 3. Socket head screw |
| 2. Reel motor adapter | 4. Motor clamp |

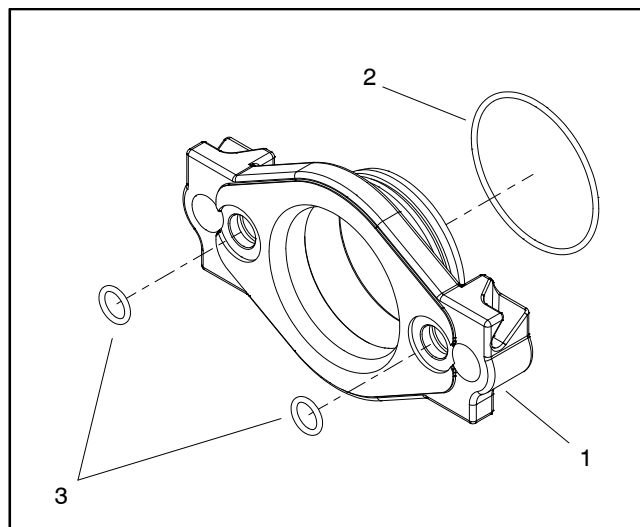


Figure 31

- | | |
|------------|-----------|
| 1. Adapter | 3. O-ring |
| 2. O-ring | |

Front Roller

Removal (Fig. 32)

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. 32)

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).

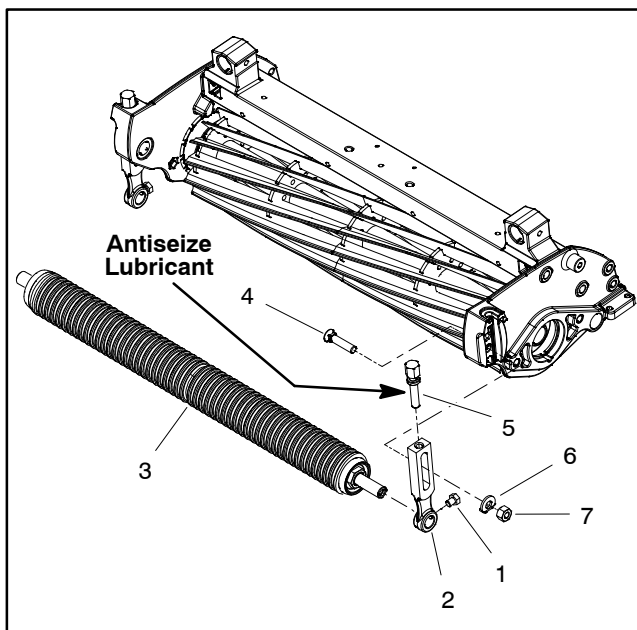


Figure 32

- | | |
|--------------------------|---------------|
| 1. Cap screw | 5. HOC screw |
| 2. HOC arm | 6. HOC washer |
| 3. Front roller assembly | 7. HOC nut |
| 4. Plow bolt | |

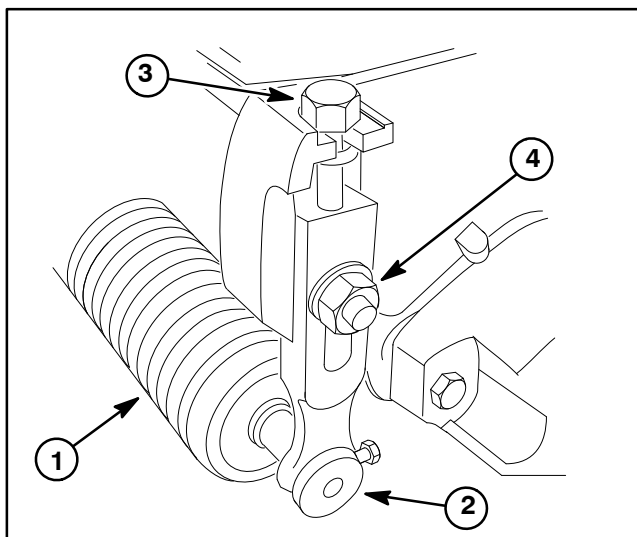


Figure 33

- | | |
|--------------------------|---------------------|
| 1. Front roller assembly | 3. HOC screw |
| 2. HOC arm | 4. HOC washer & nut |

Rear Roller

Removal (Fig. 34)

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. 34)

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.

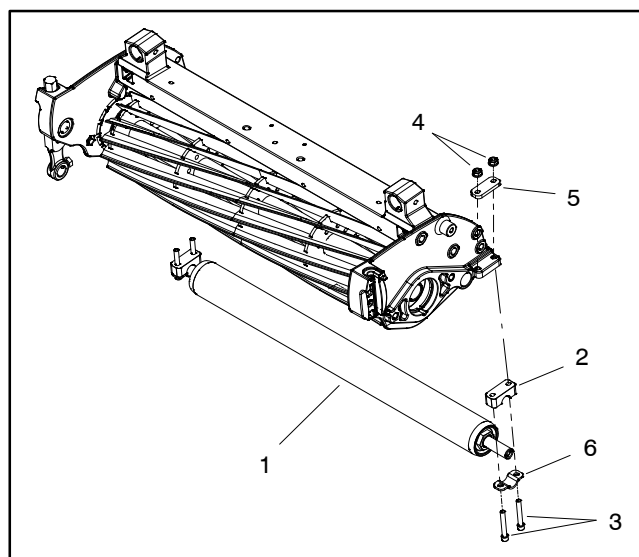


Figure 34

- | | |
|-------------------------|-------------------|
| 1. Rear roller assembly | 4. Flange nut |
| 2. Roller height spacer | 5. Roller shim |
| 3. Socket head screw | 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

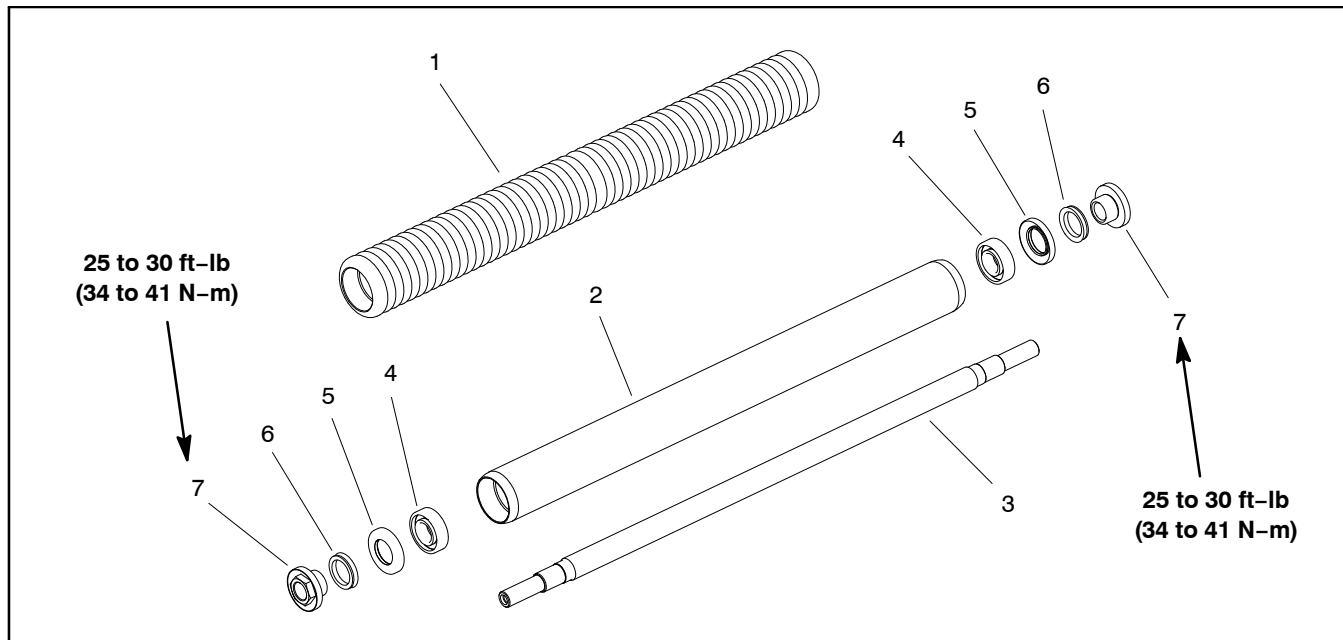


Figure 35

1. Wihle 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.

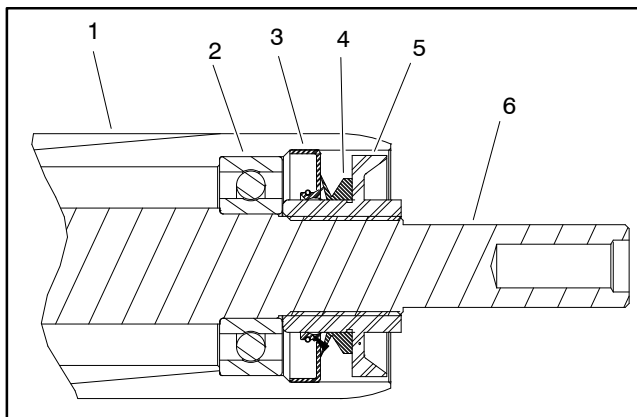


Figure 36

1. Roller
2. Ball bearing
3. Seal

4. V-ring
5. Bearing lock nut
6. Roller shaft

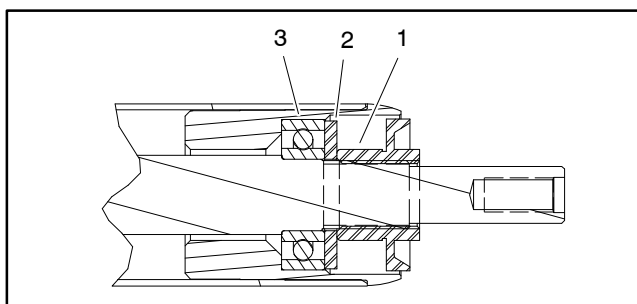


Figure 37

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. 37).

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. 38).

6. Carefully install seals onto bearing lock nuts. Pack the back of the seal 75 to 90% full with #2 grease (Fig. 38).

7. Install a nut with seal onto each end of the roller shaft. Tighten nuts until they bottom against bearings (Fig. 39). Remove nuts from roller shaft.

8. Position an assembly spacer and yellow assembly washer (see Special Tools) on each end of roller shaft (Fig. 40). 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)**.

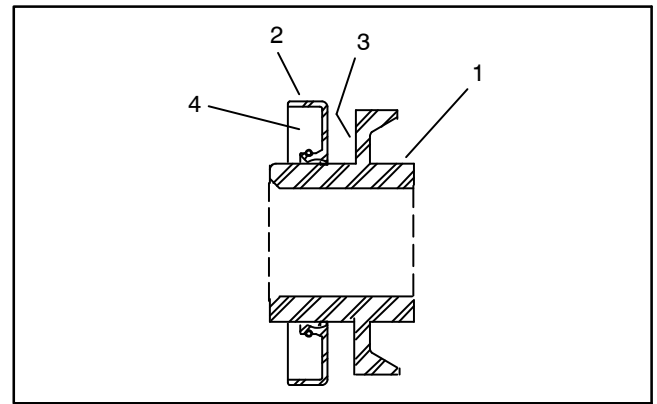


Figure 38

- | | |
|---------------------|-----------------------|
| 1. Bearing lock nut | 3. Grease nut surface |
| 2. Seal | 4. Pack with grease |

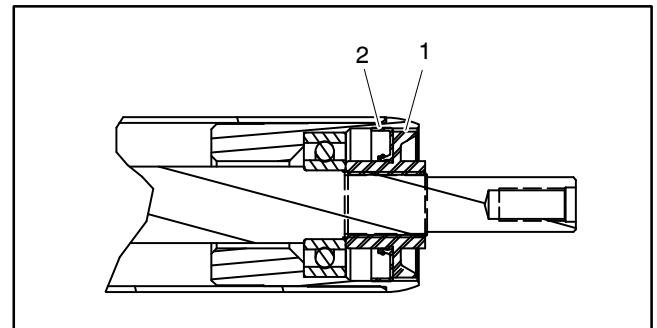


Figure 39

- | | |
|---------------------|---------|
| 1. Bearing lock nut | 2. Seal |
|---------------------|---------|

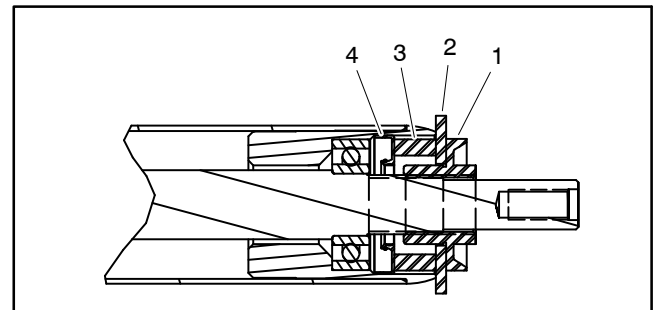


Figure 40

- | | |
|---------------------------|--------------------|
| 1. Bearing lock nut | 3. Assembly spacer |
| 2. Yellow assembly washer | 4. Seal |

Rear Roller Brush (Optional)

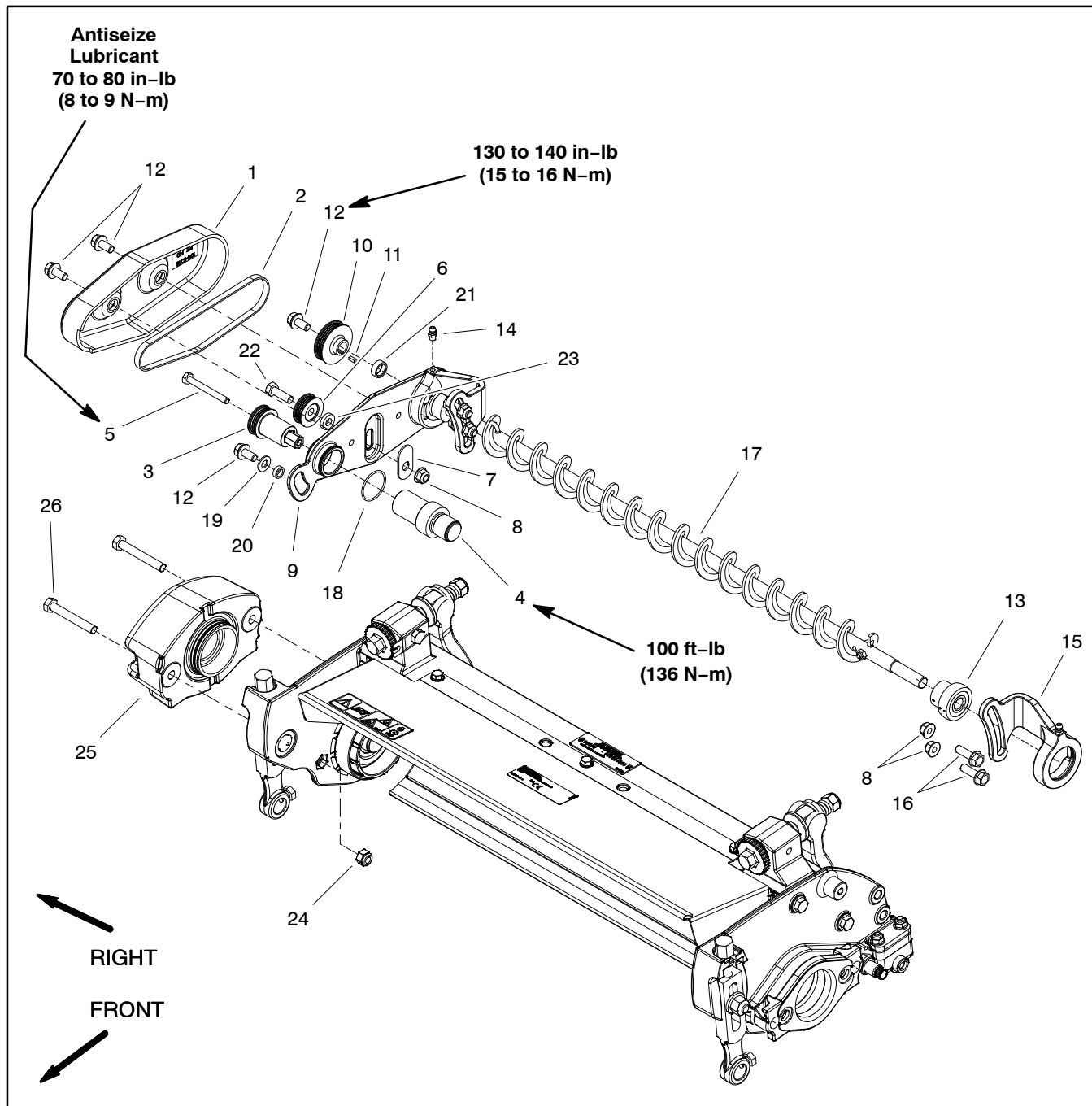


Figure 41

- | | | |
|--------------------------|--------------------------------------|------------------------|
| 1. Cover | 10. Driven pulley | 19. Flat washer |
| 2. Drive belt | 11. Square key | 20. Bearing spacer |
| 3. Drive pulley | 12. Threadlock screw (4 used) | 21. Spacer |
| 4. Pulley driver | 13. Roller bearing assembly (2 used) | 22. Cap screw |
| 5. Cap screw | 14. Grease fitting (2 used) | 23. Bearing spacer |
| 6. Idler pulley assembly | 15. LH brush support | 24. Hex nut (2 used) |
| 7. Cover plate | 16. Flange head screw (4 used) | 25. Weight |
| 8. Flange nut (5 used) | 17. Brush assembly | 26. Cap screw (2 used) |
| 9. Drive plate | 18. O-ring | |

NOTE: Drive components for the rear roller brush are located on the right side of the cutting unit.

NOTE: The Installation Instructions for the rear roller brush kit has detailed information regarding assembly and adjustment. Use those Instructions along with this Service Manual when servicing the rear roller brush.

Disassembly (Fig. 41)

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. To remove roller brush from brush shaft:
 - A. Loosen set screw in the bearing locking collar on left side of brush shaft.
 - B. Using blind hole in bearing locking collar as an impact point, unlock collar by striking it with a punch in the opposite direction of brush rotation.
 - C. Remove the LH brush support (item 15), bearing and locking collar from brush shaft and cutting unit.
 - D. Remove lock nut and J-bolt from both ends of the brush (Fig. 42).
 - E. While rotating brush, slide brush from the shaft.



CAUTION

Contact with the reel or other cutting unit parts can result in personal injury. Use heavy gloves when handling the cutting reel.

3. To remove roller brush drive belt (item 2):
 - A. Loosen cap screw (item 22) and flange nut (item 8) that secure idler pulley assembly (item 6) to drive plate.
 - B. Move idler pulley to loosen drive belt.
 - C. Carefully remove drive belt from drive, driven and idler pulleys.
4. Disassemble roller brush components as necessary using Figure 41 as a guide.

Assembly (Fig. 41)

1. If roller brush was removed from brush shaft, slide brush onto shaft while rotating brush. Secure brush to shaft with two (2) J-bolts and lock nuts. Make sure that the J-bolts are installed with the threaded portion on the outside of the brush (Fig. 42). Torque lock nuts from **20 to 25 in-lb (2.3 to 2.8 N-m)**.

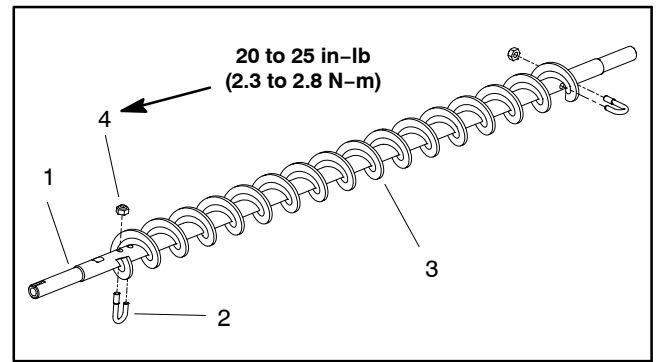


Figure 42

- | | |
|-----------------------|-----------------|
| 1. Roller brush shaft | 3. Roller brush |
| 2. J-bolt | 4. Lock nut |

2. Assemble roller brush components using Figure 41 as a guide and the following assembly notes:

A. The screws (item 12) that are used to secure the cover (item 1), driven pulley (item 10) and drive plate (item 9) have a threadlock feature to prevent the screws from loosening. If original screws are being re-used during assembly, apply Loctite #242 (or equivalent) to threads of screws.

B. Apply a light coating of grease to O-ring (item 18) before installing on drive plate flange. Make sure that O-ring is correctly positioned in groove in flange.

C. Apply antiseize lubricant to threads of cap screw (item 5) that retains drive pulley (item 3). Torque cap screw from **70 to 80 in-lb (8 to 9 N-m)** to secure drive pulley to pulley driver.

D. Secure driven pulley (item 10) to brush shaft with threadlock screw (item 12). Torque screw from **130 to 140 in-lb (15 to 16 N-m)**.

E. Secure pulley driver (item 4) to cutting reel shaft with **100 ft-lb (136 N-m)** torque.

3. If either of the bearing locking collars was loosened, tighten locking collar onto brush shaft:

A. Slide locking collar outward on brush shaft onto the bearing collar. Rotate locking collar by hand in the direction of normal brush rotation until the collar is tight on the shaft.

B. Using blind hole in bearing locking collar as an impact point, lock collar by striking it with a punch in the normal direction of brush rotation.

C. Tighten set screw in locking collar to secure the bearing assembly to the brush shaft.

IMPORTANT: The brush drive belt may fail prematurely if the pulleys are not properly aligned.

4. Check alignment of pulleys with a straight edge placed along the outer face of the pulleys (Fig. 43). The outer faces of the drive, driven and idler pulleys should be aligned. If necessary to align pulleys, loosen locking collars on brush bearings and move brush assembly until pulleys are aligned. Once pulleys are aligned, secure brush with bearing locking collars.

IMPORTANT: Make sure that idler pulley is loosened before installing brush drive belt.

5. To install brush drive belt (item 2):

A. Make sure that idler pulley (item 6) is loose on drive plate.

B. Carefully install drive belt around drive, driven and idler pulleys.

C. After belt installation, make sure that belt and pulley grooves are aligned and that belt is centered in pulleys.

6. To tension the drive belt:

A. Push down on the idler pulley and secure with cap screw (item 22) and flange nut (item 8). Make sure that cover plate (item 7) is covering the slot in the drive plate to prevent debris from entering the brush drive area.

B. After idler pulley is secured, check that drive belt has approximately 1/4" (6 mm) deflection at the center of the belt with 2 lb (1 kg) of force applied to the belt (Fig. 44).

7. Check that roller brush is parallel to rear roller with 0.010" (0.25 mm) clearance to light contact with roller. If contact is incorrect, brush operation will be adversely affected.

8. Lubricate grease fittings on brush support and drive plate until grease is visible. Wipe up excess grease.

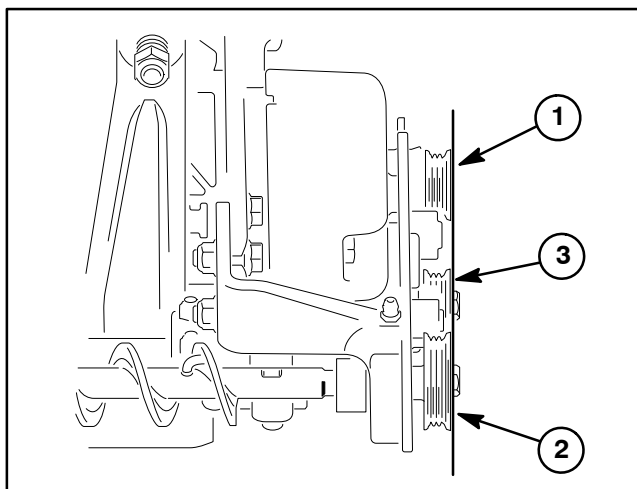


Figure 43

- 1. Drive pulley
- 2. Driven pulley

3. Idler pulley

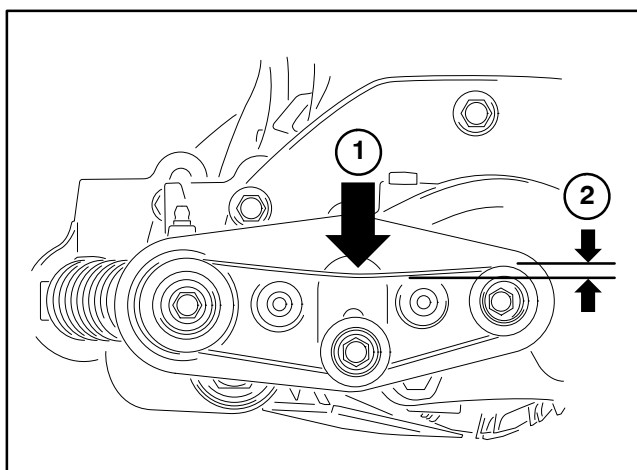


Figure 44

1. 2 lb (1 kg) of force

2. 1/4" (6 mm) deflection

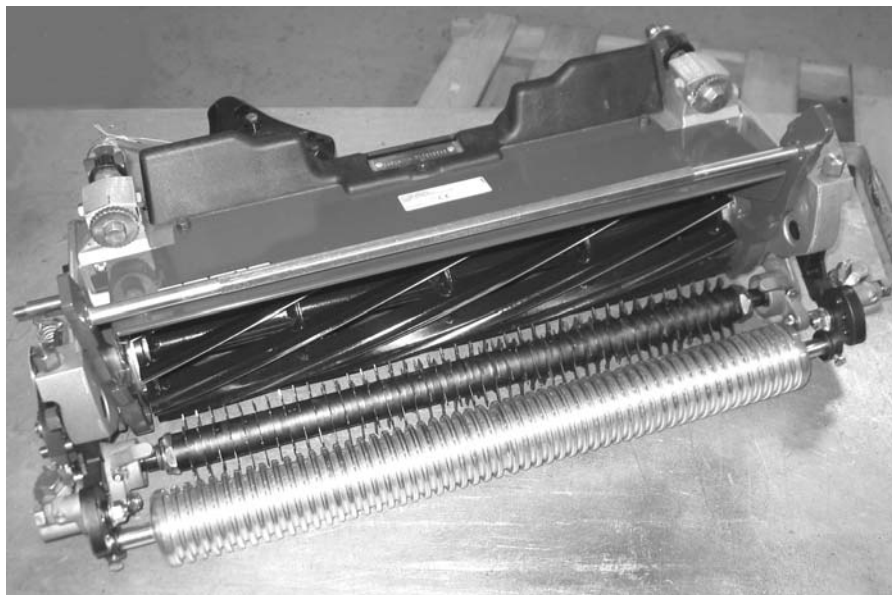


Belt Driven Groomer (Optional)

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Specifications



MOUNTING: The groomer is mounted to the DPA cutting unit side plates.

GROOMING REEL CONSTRUCTION: 2.375 inch (6 cm) diameter, 41 steel blades with 1/2 inch blade spacing. Blade spacing can be adjusted to 1/4 inch or 3/4 inch by altering the number and position of blade spacers on the groomer. Grooming reel is available with either steel or carbide tipped blades. Groomer brush can be installed in place of grooming reel.

GROOMER HEIGHT SETTING: From 0.030 to 0.620 inch (0.8 to 15.7 mm) at mowing HOC range of 0.060 to 0.750 inch (1.5 to 19.1 mm).

WIDTH-OF-GROOMER: 19.380 inches (49.2 cm).

HEIGHT ADJUSTMENT KNOB: Allows a 0.003 inch (0.08 mm) increment of height adjustment for each click of the adjuster.

UP-DOWN FEATURE: Allows grooming reel to be raised above the height/depth adjustment for no grooming reel action while cutting.

GROOMER DRIVE: Both forward rotating and counter rotating groomer drive systems are available for the Greensmaster 3320 and 3420. The groomer drive assembly is attached to the right side of the cutting unit.

General Information

Installation Instructions

The Installation Instructions for the groomer provide information regarding the operation, general maintenance procedures and maintenance intervals for the groomer assembly on your Greensmaster TriFlex machine. Refer to this publication for additional information when servicing the groomer assembly.

Troubleshooting

Factors Affecting Grooming

There are a number of factors that can affect the performance of grooming. These factors vary for different golf courses and from green to green. It is important to inspect the turf frequently and vary the grooming practice with turf needs.

It is important to remember that factors affecting quality of cut also affect grooming performance.

Variables That Affect the Use and Performance of Grooming Reels:

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 blade spacing on the grooming reel.
5. The height-of-cut.
6. The grooming depth.
7. The type of grass on the green.
8. The amount of time that a grooming reel has been in use on a particular turf area.
9. The amount of traffic on the turf.
10. The overall turf management program (e.g. irrigation, fertilizing, weed control, coring, overseeding, disease control, sand dressing and pest control).
11. Stress periods for turf (e.g. high temperatures, high humidity, unusually high traffic).

IMPORTANT: Improper or overaggressive use of the grooming reel, such as too deep or frequent grooming, may cause unnecessary stress on the turf leading to severe turf damage. Use the groomer carefully. READ AND UNDERSTAND THE INSTALLATION INSTRUCTIONS BEFORE OPERATING OR TESTING GROOMER PERFORMANCE.

Grooming Reel Mechanical Problems

Problem	Possible Causes	Correction
The grooming reel rotates when it is in the raised, transport position (forward rotating groomer drive).	The grooming reel should rotate whenever the cutting reel is engaged.	Normal operation.
No rotation of the grooming reel (forward rotating groomer drive).	Seized grooming reel or idler bearing(s) in groomer side plate(s). Broken or damaged drive belt idler spring. The groomer drive belt is worn, broken or damaged.	Identify and replace faulty bearing(s). Replace idler spring. 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.
No rotation of the grooming reel (counter rotating groomer drive).	Handle on groomer cover is rotated rearward so that groomer drive is disengaged. Seized grooming reel or idler bearing(s) in groomer side plate(s). Broken or damaged drive idler spring. Groomer drive gears are worn or damaged.	Handle needs to be rotated toward the front of the machine to engage the groomer drive. Identify and replace faulty bearing(s). Replace idler spring. Inspect groomer drive assembly and replace damaged drive components.
The turf is damaged or has uneven grooming.	The groomer is set too aggressively. The grooming reel blades are bent, damaged or missing. The grooming reel shaft is bent or damaged. Grooming depth is not equal on both ends of grooming reel.	Refer to groomer Installation Instructions for groomer set-up information. Repair or replace blades if necessary. Replace grooming reel shaft. Adjust depth if necessary. Check and adjust cutting unit set up (level bedknife to reel, level rear roller to reel, set height-of-cut, etc.).

Adjustments



CAUTION

Never work on the cutting unit with the engine running. Always stop the engine and remove the key from the ignition switch before working on the mower.

NOTE: See the Groomer installation instructions for adjustment procedures for the groomer on your Greensmaster.

Height/Depth of Groomer Adjustment

NOTE: Grooming is performed above the soil level. When adjusting groomer height/depth, groomer blades should never penetrate the soil.

1. Park machine on a clean and level surface, lower cutting units completely to the ground, stop engine, engage parking brake and remove key from the ignition switch.
2. Make sure rollers are clean and cutting reel is set to the desired height-of-cut (see Cutting Unit Operator's Manual for cutting unit adjustment procedures).
3. Position the grooming reel to the lowered, grooming position (Fig. 1).

NOTE: Improper or over-aggressive use of the grooming reel (i.e. too deep or too frequent grooming) may cause unnecessary stress on the turf leading to severe greens damage. Use the groomer cautiously.

4. On one end of the grooming reel, measure the distance from the lowest tip of the groomer blade to the working surface. Lift and turn height adjustment knob to raise or lower the blade tip (Fig. 1). Each notch on the adjustment knob changes the groomer height approximately 0.003 inch (0.08 mm).

5. Repeat step 4 on the opposite end of the groomer. Then, recheck setting on the first side of groomer. Height setting on both ends of groomer should be identical.

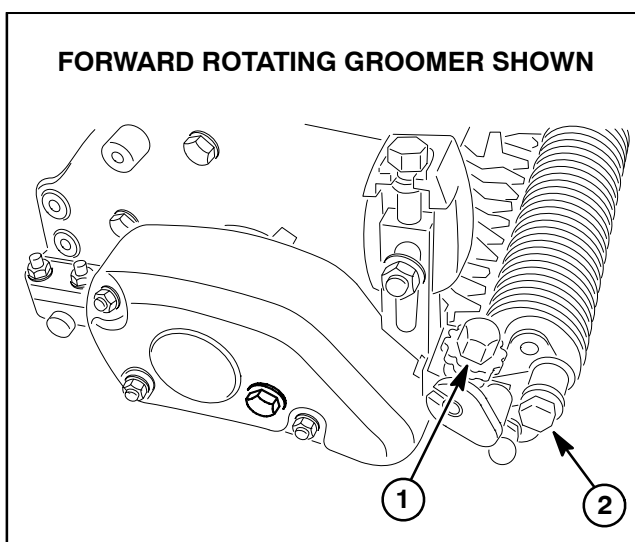


Figure 1

1. Height adjustment knob 2. Lock screw

Service and Repairs

Groomer Belt Replacement (Forward Rotating Groomer Drive)

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

2. If equipped, remove rear roller brush from cutting unit (see Rear Roller Brush Removal in the Service and Repairs section of Chapter 8 – DPA Cutting Units).

3. Remove three (3) lock nuts that secure groomer drive cover, then remove cover (Fig. 2).

4. Pivot idler pulley by placing a 12mm wrench on pulley nut and rotating idler bracket to relax belt tension. Slip groomer drive belt off pulleys (Fig. 3). Carefully release idler bracket.

IMPORTANT: Make sure that the drive belt is centered on the pulleys and correctly aligned with pulley grooves after installation.

5. Install new drive belt to drive pulley, idler pulley and driven pulley observing correct belt routing (Fig. 3).

6. Secure belt cover to machine with three (3) lock nuts (Fig. 2).

7. If equipped, install rear roller brush to cutting unit (see Rear Roller Brush Installation in the Service and Repairs section of Chapter 8 – DPA Cutting Units).

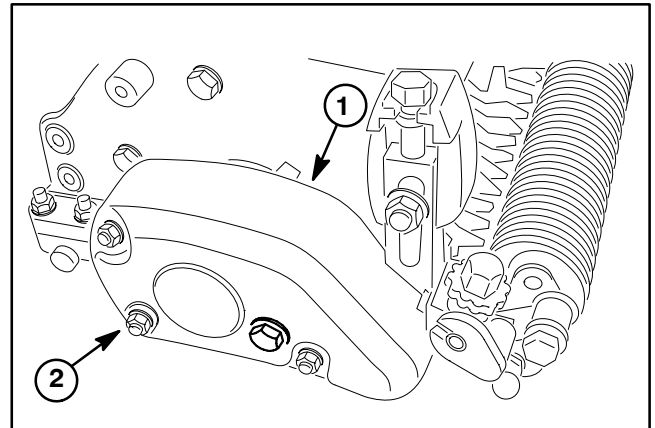


Figure 2

1. Groomer drive cover 2. Lock nut (3 used)

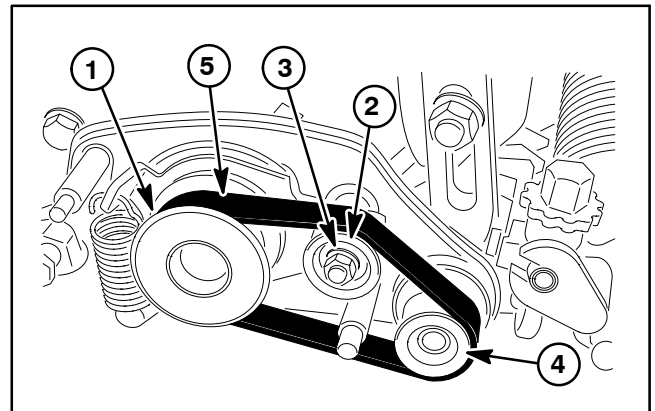


Figure 3

1. Drive pulley 4. Driven pulley
2. Idler pulley 5. Groomer drive belt
3. Idler pulley nut

Groomer Cover (Counter Rotating Groomer Drive)

On TriFlex machines with the counter rotating groomer, the groomer cover includes a handle which engages and disengages the groomer drive. When the handle is rotated toward the front of the machine, the groomer is engaged.

Removal

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

2. If equipped, remove rear roller brush from cutting unit (see Rear Roller Brush Removal in the Service and Repairs section of Chapter 8 – DPA Cutting Units).

3. Make sure that handle on groomer cover is rotated toward front of machine so that groomer drive is engaged.

4. Remove groomer cover assembly from machine (Fig. 4):

A. Remove five (5) flange head screws that secure groomer cover assembly to RH drive plate.

B. Remove groomer cover assembly and gasket from machine. Discard gasket.

5. If necessary, remove shaft from groomer cover (Fig. 5):

A. Loosen set screw (item 9) on top of shaft and slide handle from shaft.

B. Remove retaining ring (item 8) and thrust washer (item 5) from shaft.

C. Remove plunger detent (item 6) from groomer cover.

D. Slide shaft out of groomer cover. Remove and discard O-ring (item 4) from shaft.

6. Remove grease from inside groomer cover and RH drive plate on cutting unit. Thoroughly clean and inspect all groomer drive components.

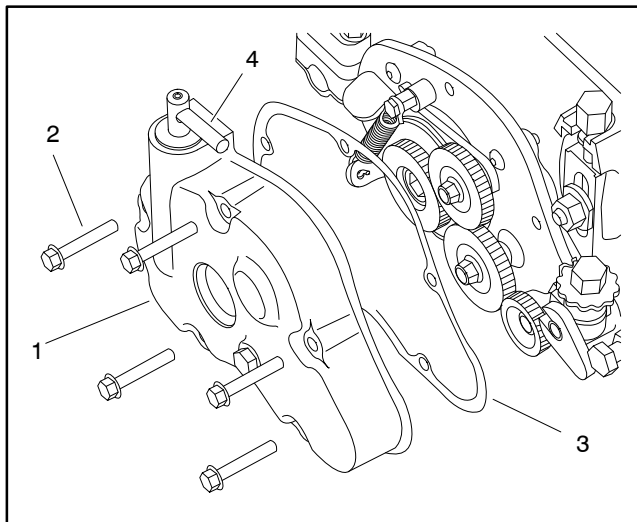


Figure 4

- | | |
|---------------------------|-----------|
| 1. Groomer cover assembly | 3. Gasket |
| 2. Screw (5 used) | 4. Handle |

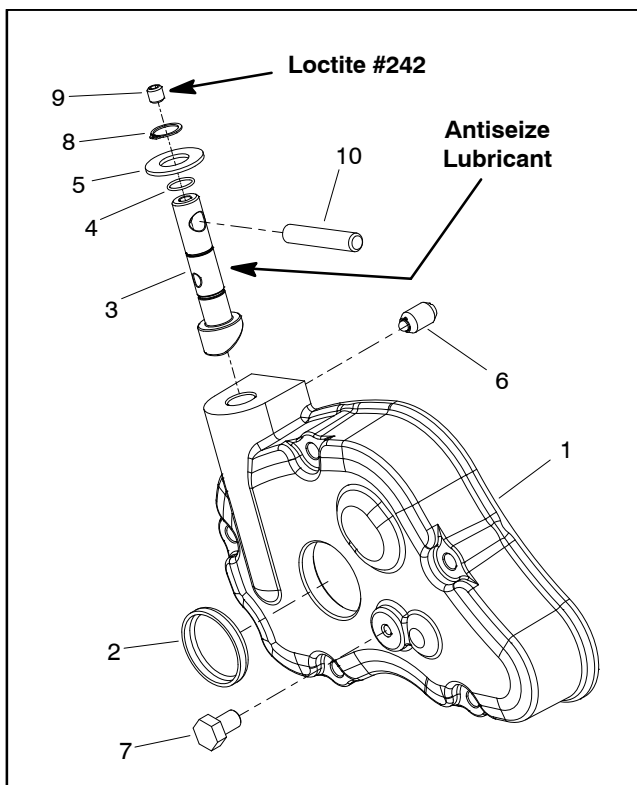


Figure 5

- | | |
|------------------|-------------------|
| 1. Groomer cover | 6. Plunger detent |
| 2. Plug | 7. Cap screw |
| 3. Shaft | 8. Retaining ring |
| 4. O-ring | 9. Set screw |
| 5. Thrust washer | 10. Handle |

Installation

1. If removed, install shaft into groomer cover (Fig. 5):

- A. Install new O-ring into groove of shaft.
- B. Apply antiseize lubricant to shaft surface that is below the retaining ring groove.
- C. Slide shaft up through bore of cover and secure with thrust washer and retaining ring. Position shaft in cover so that cam point of shaft is located away from the gasket surface (Fig. 6).
- D. Install plunger detent into groomer cover so that end of plunger is flush to 0.020" (0.5 mm) extending from cover surface (Fig. 6).
- E. Slide handle into shaft so that it extends toward the front of the cover.
- F. Apply Loctite #242 (or equivalent) to threads of set screw. Install set screw into end of shaft to secure handle in place.

2. Install groomer cover assembly to RH drive plate assembly (Fig. 4):

- A. Make sure that handle on groomer cover is rotated toward the front of the machine.
- B. Fill groomer cover with approximately five (5) ounces (142 grams) of Mobil XHP221 grease (or equivalent).
- C. Install new gasket and then groomer cover assembly to RH drive plate. Secure cover with five (5) flange head screws.

3. If equipped, install rear roller brush to cutting unit (see Rear Roller Brush Installation in the Service and Repairs section of Chapter 8 – DPA Cutting Units).

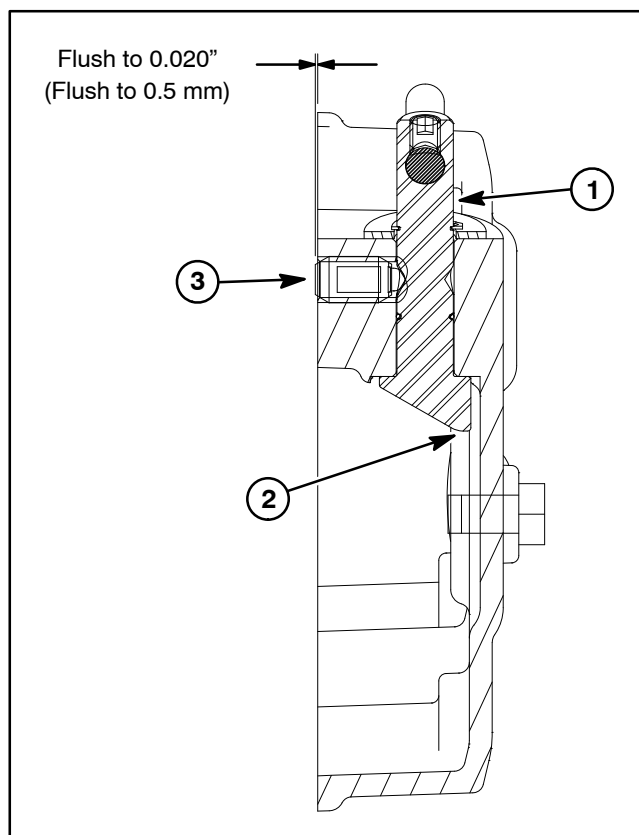


Figure 6

- | | |
|--------------|-------------------|
| 1. Shaft | 3. Plunger detent |
| 2. Cam point | |

Grooming Reel (Forward Rotating Groomer Drive)

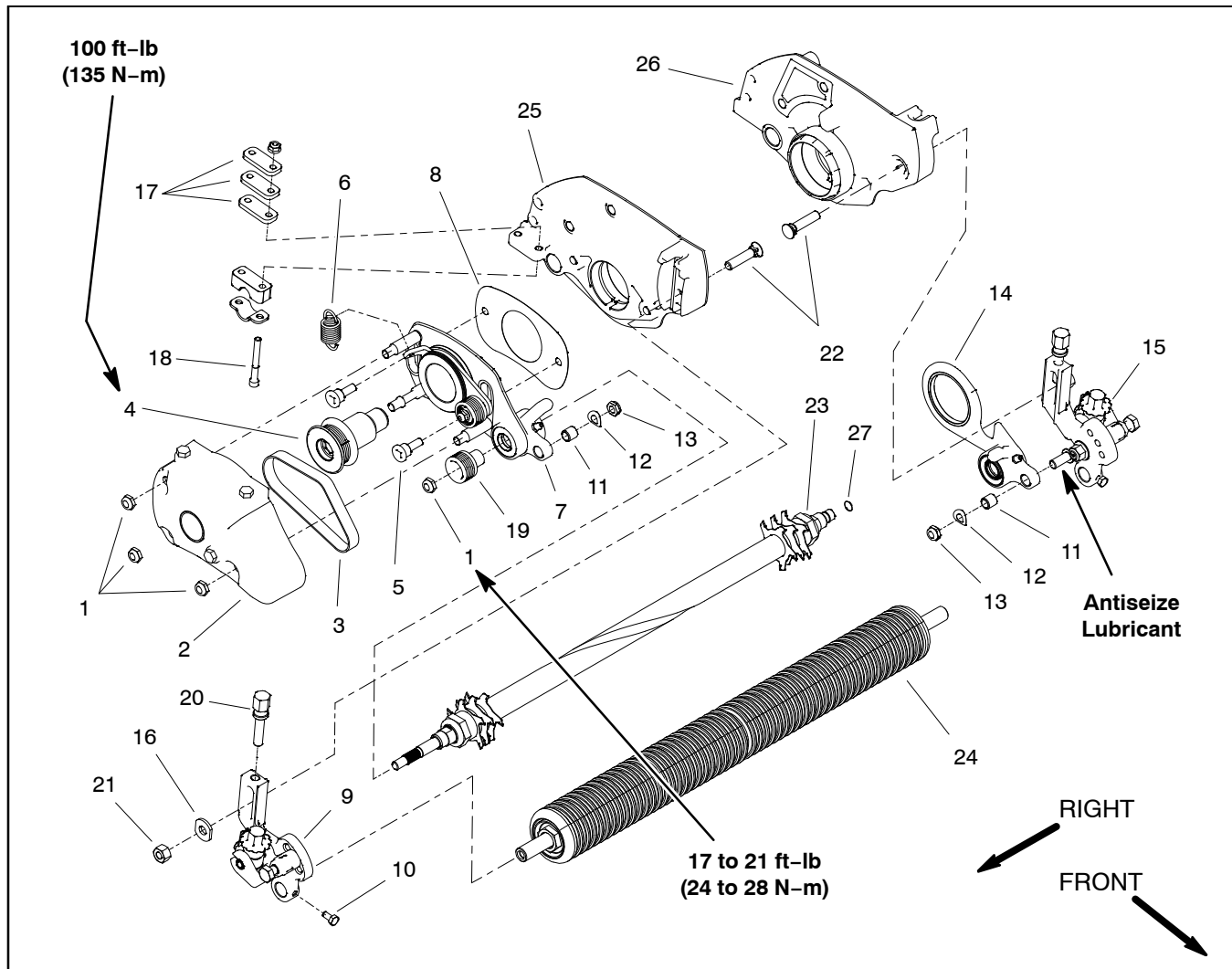


Figure 7

- | | | |
|----------------------------|--------------------------------|-------------------------------|
| 1. Lock nut (4 used) | 10. Cap screw (2 used) | 19. Driven pulley |
| 2. Drive cover | 11. Bushing (2 used) | 20. HOC screw (2 used) |
| 3. Groomer drive belt | 12. Spring washer (2 used) | 21. HOC nut (2 used) |
| 4. Drive pulley | 13. Lock nut (2 used) | 22. Plow bolt (2 used) |
| 5. Shoulder bolt (2 used) | 14. LH support plate | 23. Grooming reel assembly |
| 6. Spring | 15. LH groomer arm assembly | 24. Front roller assembly |
| 7. RH drive plate assembly | 16. Special washer (2 used) | 25. RH cutting unit sideplate |
| 8. Groomer shim | 17. Rear roller height shim | 26. LH cutting unit sideplate |
| 9. RH groomer arm assembly | 18. Socket head screw (4 used) | 27. O-ring |

Remove the grooming reel to replace individual blades, to replace worn groomer components, to reverse the blades on the shaft (if not equipped with carbide blades) or to replace the grooming shaft.

Removal (Fig. 7)

1. Park machine on a clean and level surface, lower cutting units completely to the ground, 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 equipped, remove rear roller brush from cutting unit (see Rear Roller Brush Removal in the Service and Repairs section of Chapter 8 – DPA Cutting Units).

4. Remove groomer drive cover (item 2) and groomer drive belt (item 3) from groomer drive (see Groomer Belt Replacement in this section).

5. Loosen cap screws (item 10) that secure front roller shaft to groomer arms.
6. Remove lock nut (item 13) and spring washer (item 12) that secure RH groomer arm lift rod to RH drive plate assembly. Location of these items are shown in Figure 8.
7. Remove lock nut (item 21), special washer (item 16) and plow bolt (item 22) that secure RH groomer arm assembly to RH drive plate assembly. Do not change height-of-cut screw adjustment. Remove RH groomer arm assembly from cutting unit.
8. Remove front roller assembly from cutting unit.

NOTE: To prevent grooming reel shaft from turning when removing driven pulley (item 19), use wrench on shaft flats to hold shaft.

9. Remove the lock nut (item 1) that secures driven pulley (item 19) to grooming reel shaft. Remove driven pulley from shaft.

NOTE: To prevent cutting reel from turning when removing drive pulley (item 4), block reel with piece of wood.

10. Loosen and remove drive pulley (item 4) from the cutting reel shaft.

11. Remove two (2) shoulder bolts (item 5) that secure the RH drive plate assembly to the cutting unit frame. Remove the groomer drive plate assembly from grooming shaft and cutting unit. Locate and retrieve groomer shim (item 8).

12. Carefully pull the grooming reel assembly from the LH support plate.

13. Inspect seals, bushings and bearings in RH drive plate, LH support plate and groomer arms for wear or damage. Also, inspect pulleys and idler components for wear or damage. Replace components as needed.

Installation (Fig. 7)

1. Apply a light coating of grease to ends of grooming shaft and also to seal lips in RH drive and LH support plates. Make sure that all bearings, bushings and seals are properly installed.
2. Make sure that O-ring (item 27) is installed on grooming shaft. Apply light coating of grease to O-ring.
3. Carefully place grooming reel assembly into the LH support plate taking care to not damage seal in support plate or O-ring on shaft.

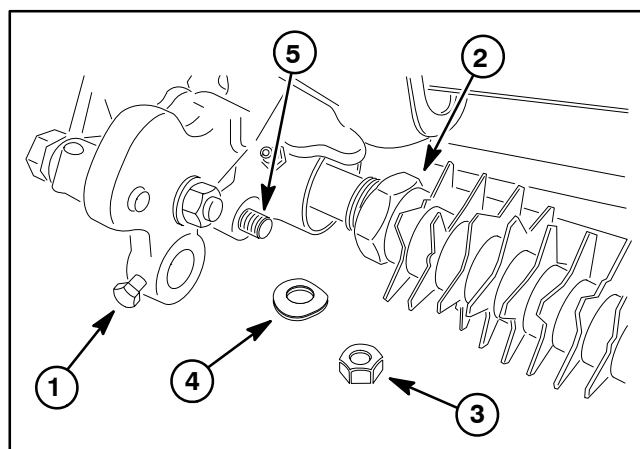


Figure 8

- | | |
|---------------------------|-------------------------|
| 1. Roller cap screw | 4. Spring washer |
| 2. Grooming reel assembly | 5. Groomer arm lift rod |
| 3. Lock nut | |

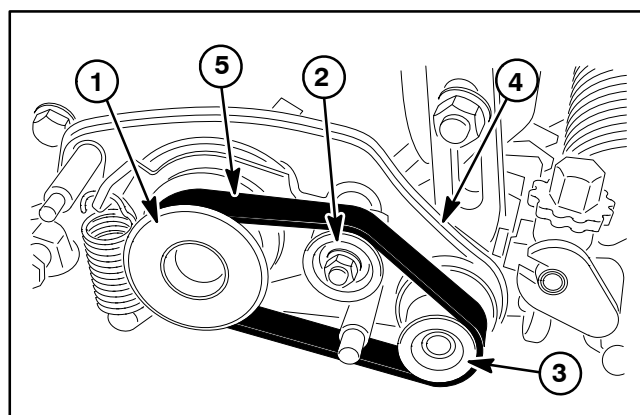


Figure 9

- | | |
|------------------|-------------------------|
| 1. Drive pulley | 4. Drive plate assembly |
| 2. Idler pulley | 5. Groomer drive belt |
| 3. Driven pulley | |

4. Apply light coating of grease to O-ring on RH drive plate assembly pivot hub and pilot bore of cutting unit side plate.

5. Position groomer shim (item 8) to drive plate assembly.

6. Carefully place RH drive plate assembly onto groomer shaft taking care to not damage seals in drive plate. Position drive plate to the cutting unit frame and secure with two (2) shoulder bolts (item 5). Make sure that drive plate rotates freely after installation.

7. Apply light coating of grease to hub on driven pulley (item 19) taking care to not get grease on belt surface of pulley. Slide driven pulley onto the grooming reel shaft taking care to not damage seal in side plate.

NOTE: To prevent grooming reel shaft from turning when installing driven pulley (item 19), use wrench on shaft flats to hold shaft.

8. Secure driven pulley to grooming reel shaft with lock nut (item 1). Torque lock nut from **17 to 21 ft-lb (24 to 28 N-m)**.

NOTE: To prevent cutting reel from turning when installing drive pulley (item 4), block reel with piece of wood.

9. Secure drive pulley (item 4) to cutting reel shaft. Torque pulley to **100 ft-lb (135 N-m)**.

10. Insert front roller into LH groomer arm assembly.

11. Make sure that bushing (item 11) is installed in RH drive plate assembly.

12. Apply antiseize lubricant to threads of RH groomer arm lift rod.

13. Position RH groomer arm assembly to front roller, RH drive plate and cutting unit frame. Secure groomer arm to cutting unit with plow bolt (item 22), special washer (item 16) and lock nut (item 21).

14. Secure RH groomer arm assembly to drive plate with spring washer (item 12) and lock nut (item 13).

15. Center front roller to cutting unit and tighten cap screws (item 10) to secure roller.

16. Install groomer drive belt (item 3) and groomer drive cover (item 2) to drive plate (see Groomer Belt Replacement in this section).

17. If equipped, install rear roller brush to cutting unit (see Rear Roller Brush Installation in the Service and Repairs section of Chapter 8 – DPA Cutting Units).

18. Check grooming reel height and mower height-of-cut settings. Adjust as needed.

19. Install cutting unit to the machine.

20. Lubricate groomer bearings (see Groomer Installation Instructions).

NOTE: After greasing groomer bearings, operate groomer for 30 seconds, stop machine and wipe excess grease from groomer shaft and seals.

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Grooming Reel (Counter Rotating Groomer Drive)

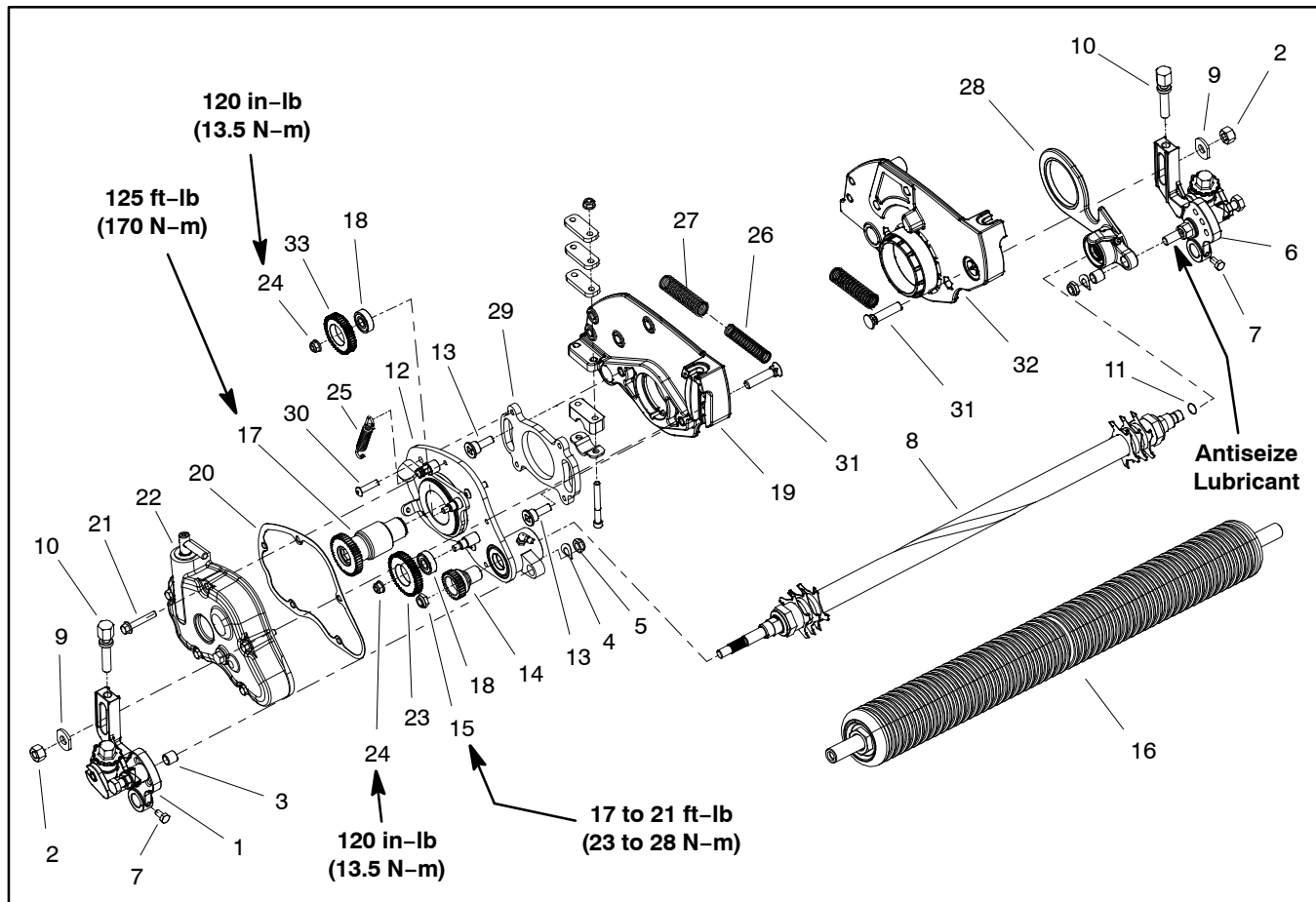


Figure 10

- | | | |
|----------------------------|--------------------------------|--------------------------------|
| 1. RH groomer arm assembly | 12. RH drive plate assembly | 23. 47T idler gear |
| 2. HOC nut (2 used) | 13. Shoulder bolt (2 used) | 24. Flange nut (2 used) |
| 3. Bushing (2 used) | 14. Driven gear (30T) | 25. Extension spring |
| 4. Spring washer (2 used) | 15. Lock nut | 26. Inner spring (2 used) |
| 5. Lock nut (2 used) | 16. Front roller | 27. Outer spring (2 used) |
| 6. LH groomer arm assembly | 17. Groomer drive gear (45T) | 28. LH support plate assembly |
| 7. Cap screw (2 used) | 18. Bearing (2 used) | 29. Support plate |
| 8. Grooming reel assembly | 19. RH cutting unit side plate | 30. Button head screw (4 used) |
| 9. HOC washer (2 used) | 20. Gasket | 31. Plow bolt (2 used) |
| 10. HOC screw (2 used) | 21. Flange head screw (5 used) | 32. LH cutting unit side plate |
| 11. O-ring | 22. Groomer cover assembly | 33. 43T idler gear |

Remove the grooming reel to replace individual blades, to replace worn groomer components, to reverse the blades on the shaft (if not equipped with carbide blades) or to replace the grooming shaft.

Removal (Fig. 10)

1. Park machine on a clean, level surface. Lower cutting units completely to the ground, 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. Make sure that handle on groomer cover is rotated toward front of machine so that groomer drive is engaged.

Belt Driven Groomer (Optional)

4. Remove groomer cover assembly (item 22) and gasket (item 20) from machine (see Groomer Cover (Counter Rotating Groomer Drive) in this section). Discard gasket.

5. Carefully remove extension spring from anchor points on RH drive plate (Fig. 11).

6. Remove the two (2) idler gears (43T and 47T) from the RH drive plate assembly (Fig. 12). The bearings are pressed into the gears.

7. Loosen cap screws (item 7) that secure front roller shaft to groomer arms.

8. Remove lock nut and spring washer that secure RH groomer arm lift rod to RH drive plate assembly (Fig. 13).

9. Remove HOC nut (item 2), HOC washer (item 9) and plow bolt (item 31) that secure RH groomer arm assembly to RH drive plate assembly. Do not change height-of-cut screw adjustment. Remove RH groomer arm assembly from cutting unit.

10. Remove front roller from cutting unit.

NOTE: To prevent grooming reel shaft from turning when removing driven gear (item 14), use wrench on shaft flats to hold shaft.

11. Remove the lock nut (item 15) that secures driven gear (item 14) to grooming reel shaft. Remove driven gear from shaft.

NOTE: To prevent cutting reel from turning when removing groomer drive gear (item 17), block reel with piece of wood.

12. Loosen and remove groomer drive gear (item 17) from the cutting reel shaft.

13. Remove four (4) button head screws (item 30) that secure the RH drive plate assembly (item 12) to the support plate on the cutting unit frame. Remove the RH drive plate assembly from grooming shaft and cutting unit.

14. Carefully pull the grooming reel assembly from the LH support plate.

15. Inspect seals, bushings and bearings in RH drive plate, LH support plate and groomer arms for wear or damage. Also, inspect gears and idler components for wear or damage. Replace components as needed.

Installation (Fig. 10)

1. Apply a light coating of grease to ends of grooming reel shaft and also to seal lips in RH drive plate and LH support plate. Make sure that all bearings, bushings and seals are properly installed.

2. Make sure that O-ring (item 11) is installed on grooming reel shaft. Apply light coating of grease to O-ring.

3. Carefully place grooming reel assembly into the LH support plate taking care to not damage seal in support plate or O-ring on shaft.

4. Apply light coating of grease to O-ring on RH drive plate assembly pivot hub and pilot bore of cutting unit side plate.

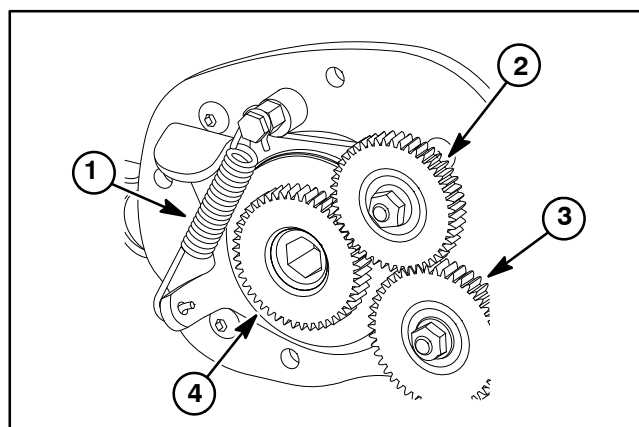


Figure 11

- | | |
|---------------------|-----------------------|
| 1. Extension spring | 3. 47T idler gear |
| 2. 43T idler gear | 4. Groomer drive gear |

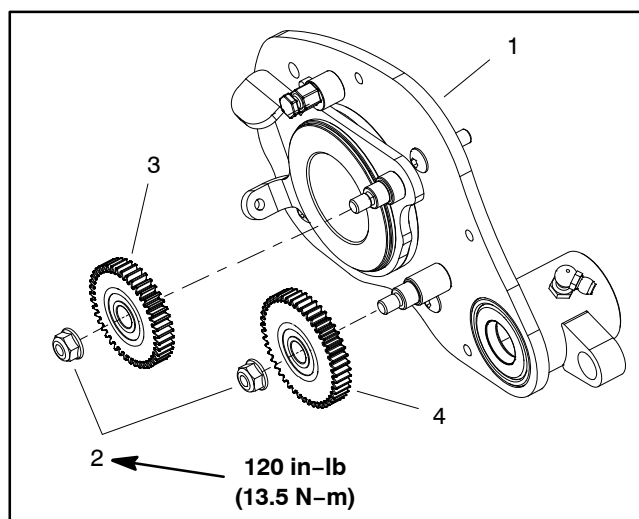


Figure 12

- | | |
|------------------------|---------------------|
| 1. RH drive plate assy | 3. 43T gear/bearing |
| 2. Flange nut | 4. 47T gear/bearing |

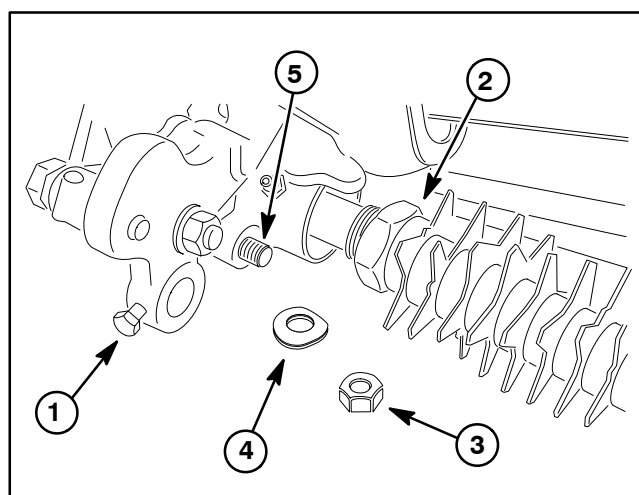


Figure 13

- | | |
|---------------------------|-------------------------|
| 1. Roller cap screw | 4. Spring washer |
| 2. Grooming reel assembly | 5. Groomer arm lift rod |
| 3. Lock nut | |

5. Carefully slide RH drive plate onto grooming reel shaft taking care to not damage seals in drive plate. Position drive plate to the support plate on the cutting unit frame and secure with four (4) button head screws (item 30). Make sure that drive plate rotates freely after installation.

6. Install driven gear (item 14) onto grooming reel shaft:

A. Apply light coating of grease to hub on driven gear (item 14).

B. Carefully slide driven gear onto the grooming reel shaft taking care to not damage seal in drive plate.

NOTE: To prevent grooming reel shaft from turning when securing driven gear, use wrench on shaft flats to hold shaft.

C. Secure gear to shaft with lock nut (item 15). Torque lock nut from **17 to 21 ft-lb (24 to 28 N-m)**.

NOTE: To prevent cutting reel from turning when installing groomer drive gear (item 17), block reel with piece of wood.

7. Secure groomer drive gear (item 17) to cutting reel shaft. Torque gear to **125 ft-lb (170 N-m)**.

8. Install the two (2) idler gears (43T and 47T) to RH drive plate assembly (Fig. 12). Secure gears with flange nuts and torque flange nuts **120 in-lb (13.5 N-m)**.

9. Install extension spring to RH drive plate assembly (Fig. 11).

10. Insert front roller into LH groomer arm assembly.

11. Make sure that bushing (item 3) is installed in RH drive plate assembly.

12. Apply antiseize lubricant to threads of RH groomer arm lift rod.

13. Position RH groomer arm assembly to front roller, RH drive plate and cutting unit frame. Secure groomer arm to cutting unit with plow bolt (item 31), HOC washer (item 9) and HOC nut (item 2).

14. Secure RH groomer arm assembly to drive plate with spring washer (item 4) and lock nut (item 5).

15. Center front roller to cutting unit and tighten cap screws (item 7) to secure roller.

16. Fill groomer cover with approximately five (5) ounces (142 grams) of Mobil XHP221 grease (or equivalent). Install new gasket and then groomer cover assembly to RH drive plate (see Groomer Cover (Counter Rotating Groomer Drive) in this section).

17. Check grooming reel height and mower height-of-cut settings. Adjust as needed.

18. Install cutting unit to the machine.

19. Lubricate groomer bearings (see Groomer Installation Instructions).

NOTE: After greasing groomer bearings, operate groomer for 30 seconds, stop machine and wipe excess grease from groomer shaft and seals.

Grooming Reel Service

Inspect grooming reel blades frequently for damage and wear. Straighten bent blades with a pliers. Replace blades that are worn or damaged.

Carbide tipped grooming blades (Fig. 15) should be replaced if the carbide tip is worn, loose or missing. Also, if the blade is eroded around the carbide insert, the blade should be replaced.

Grooming blades without a carbide tip (Fig. 16) should be replaced if worn or damaged. Blades without a carbide tip that are rounded to the midpoint of the blade tip can be reversed on the grooming shaft to extend the life of the blade.

Disassembly (Fig. 14)

1. Remove grooming reel from cutting unit (see Grooming Reel Removal in this section).
2. Remove lock nut from either end of the shaft (Fig. 14).
3. Remove spacers and blades from groomer shaft as necessary.

Assembly (Fig. 14)

1. Start by placing thick spacer against the lock nut installed on one end of groomer shaft. Then, place first blade against installed spacer (Fig. 14).

IMPORTANT: If groomer is equipped with blades with carbide tips, make sure that blades are installed with the tips in the same direction.

2. For 1/2 inch (1.3 cm) blade spacing, make sure there are two (2) blade spacers between blades (Fig. 14).

3. When all blades have been installed, place second thick spacer on shaft and then thread second lock nut onto the shaft.

4. Position lock nuts to allow blades and spacers to be centered on the shaft (Fig. 17). Torque lock nuts from **200 to 250 in-lb (23 to 28 N-m)** so spacers are **not** free to rotate.

5. Install grooming reel back onto cutting unit (see Grooming Reel Installation in this section).

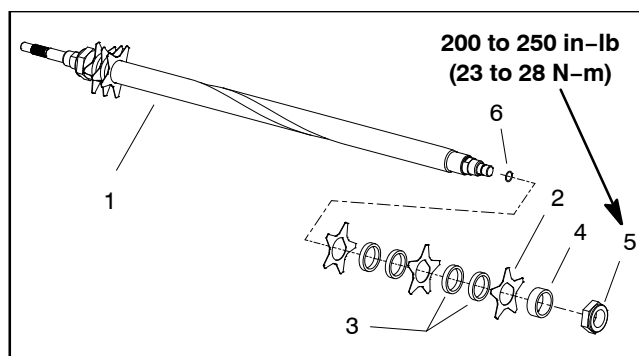


Figure 14

- | | |
|------------------------|--------------------------|
| 1. Grooming reel shaft | 4. Thick spacer (2 used) |
| 2. Groomer blade | 5. Lock nut (2 used) |
| 3. Blade spacer | 6. O-ring |

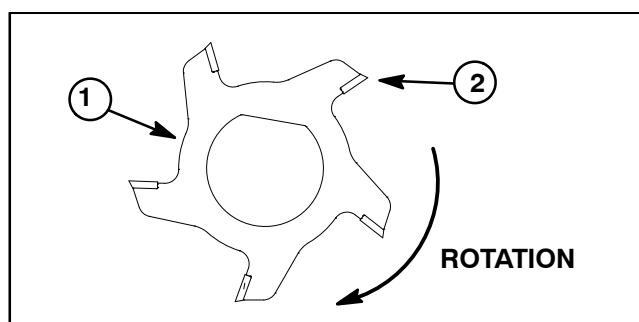


Figure 15

- | | |
|-------------------|----------------|
| 1. Grooming blade | 2. Carbide tip |
|-------------------|----------------|

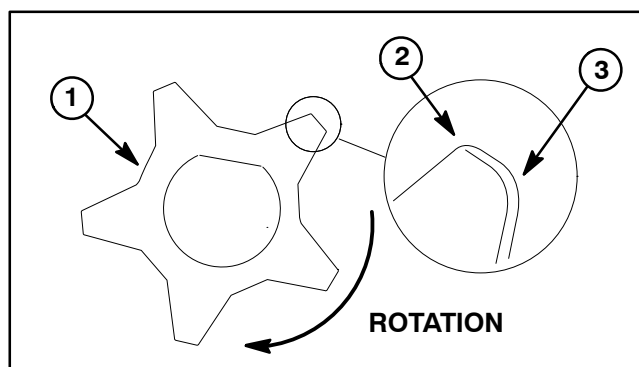


Figure 16

- | | |
|-------------------|------------------------|
| 1. Grooming blade | 3. Dull (rounded) edge |
| 2. Sharp edge | |

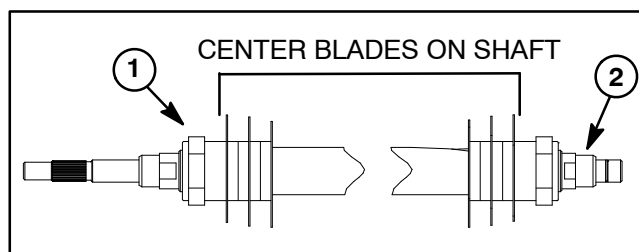


Figure 17

- | | |
|-------------|-------------------|
| 1. Lock nut | 2. Grooming shaft |
|-------------|-------------------|

Grooming Reel Bearing Replacement

Bearing Removal

1. Park machine on a clean, level surface. Lower cutting units completely to the ground, 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. To remove groomer drive plate assembly from right side of cutting unit, remove front roller, grooming reel and then drive plate assembly (see Grooming Reel (Forward Rotating or Counter Rotating) in this section).

4. To remove support plate assembly from left side of cutting unit (Fig. 18):

A. Remove two (2) socket head screws and lock nuts that secure motor mount to cutting unit (Fig. 18). Remove motor mount from cutting unit.

B. Remove lock nut and spring washer that secure LH groomer arm lift rod to support plate (Fig. 19). Remove support plate from cutting unit.

5. Remove grooming reel seals and bearings from RH drive plate and LH support plate assemblies (Figs. 20, 21 and 22). Discard all removed seals and bearings.

Bearing Installation

1. Install new grooming reel bearings and seals into RH drive plate and LH support plate assemblies (Fig. 23):

IMPORTANT: Bearings should be installed with extended inner races toward center of housing. Also, apply pressure equally to inner and outer bearing races when installing bearings.

A. Press new outer bearing fully to shoulder of RH drive plate bore. Then, install new inner bearing until inner race contacts outer bearing race.

B. Press new bearing into LH support plate until it is flush with shoulder of bearing bore.

C. Install new seals into groomer side plates. **NOTE:** Seals should be installed so the lip side of the seal will face the center of the cutting reel. When bearings are greased, grease will purge from inner seals.

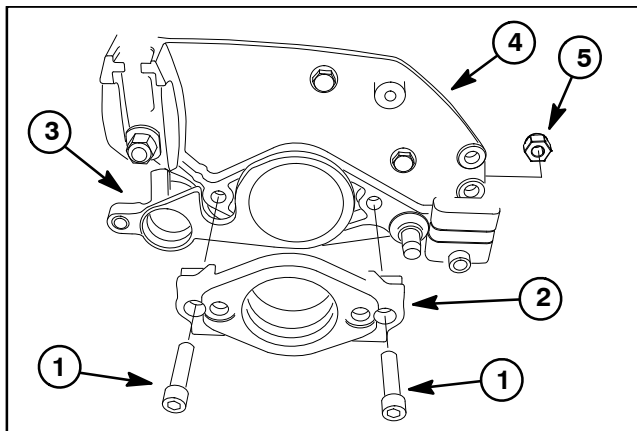


Figure 18

- | | |
|----------------------------|----------------------|
| 1. Socket head screw | 4. Cutting unit |
| 2. Motor mount | 5. Lock nut (2 used) |
| 3. Groomer side plate (RH) | |

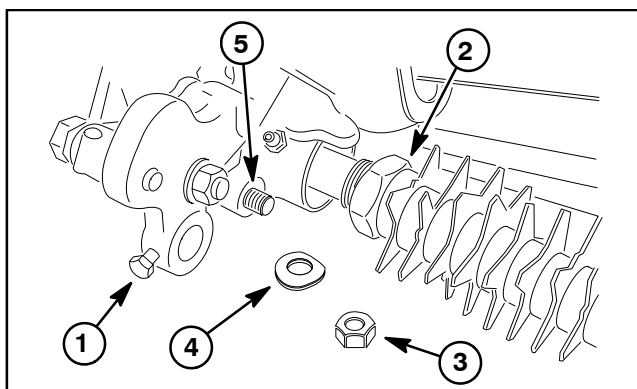


Figure 19

- | | |
|---------------------------|-------------------------|
| 1. Front roller cap screw | 4. Spring washer |
| 2. Grooming reel assembly | 5. Groomer arm lift rod |
| 3. Lock nut | |

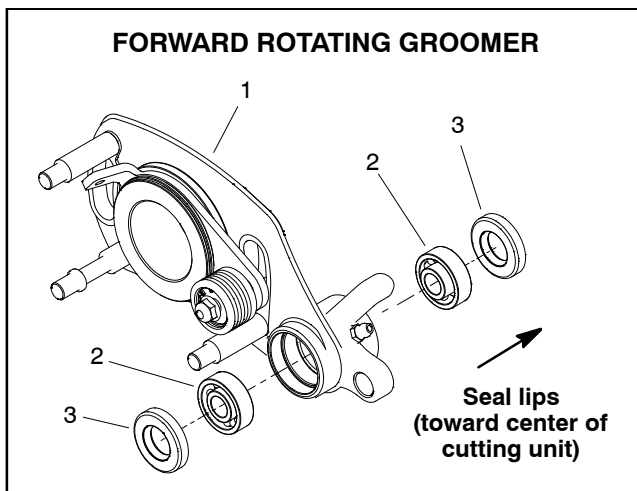


Figure 20

- | | |
|------------------------|------------------|
| 1. RH drive plate assy | 3. Seal (2 used) |
| 2. Bearing (2 used) | |

2. Install LH support plate to left side of cutting unit:
 - A. Apply antiseize lubricant to threads of LH groomer arm lift rod.
 - B. Position support plate to cutting unit making sure that LH groomer arm lift rod is positioned through bushing in support plate.
 - C. Place spring washer and lock nut on lift rod threads (Fig. 19). Tighten lock nut.
 - D. Position motor mount to groomer support plate (Fig. 18). Secure motor mount and support plate to cutting unit with two (2) socket head screws and lock nuts.

3. Install grooming reel, front roller and RH drive plate to cutting unit (see Grooming Reel (Forward Rotating or Counter Rotating) in this section).

4. Check and adjust grooming reel height and mower height-of-cut settings.

5. Install cutting unit to the machine.

6. Lubricate groomer bearings.

NOTE: After greasing groomer bearings, operate groomer for 30 seconds, stop machine and wipe any excess grease from groomer shaft and seals.

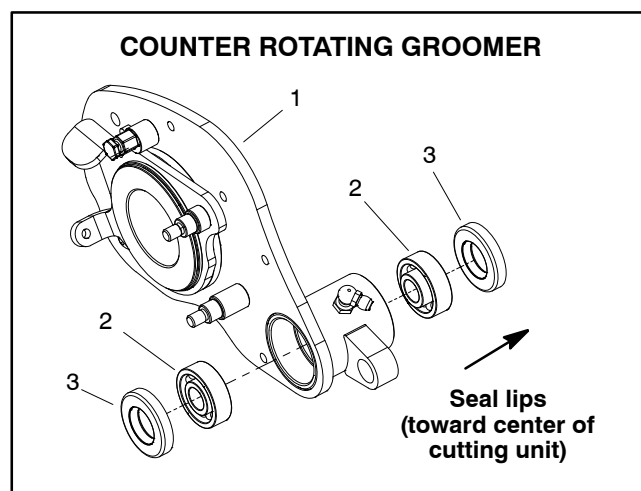


Figure 21

- | | |
|------------------------|------------------|
| 1. RH drive plate assy | 3. Seal (2 used) |
| 2. Bearing (2 used) | |

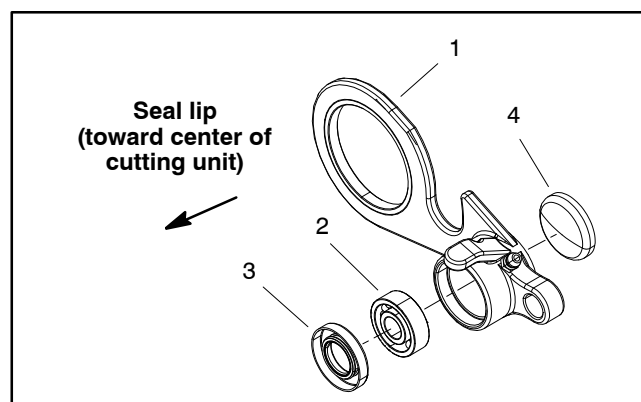


Figure 22

- | | |
|---------------------|---------|
| 1. LH support plate | 3. Seal |
| 2. Bearing | 4. Plug |

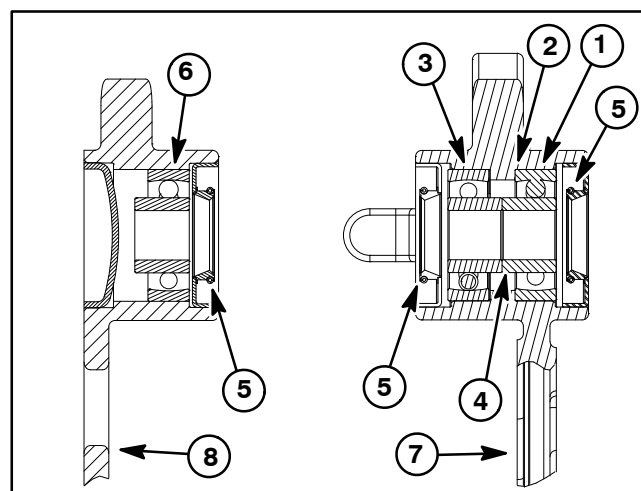


Figure 23

- | | |
|-------------------------|----------------------------|
| 1. Outer bearing | 5. Seal lip |
| 2. Drive plate shoulder | 6. Support plate bearing |
| 3. Inner bearing | 7. Drive plate (RH side) |
| 4. Inner race | 8. Support plate (LH side) |

Idler Assembly (Forward Rotating Groomer Drive)

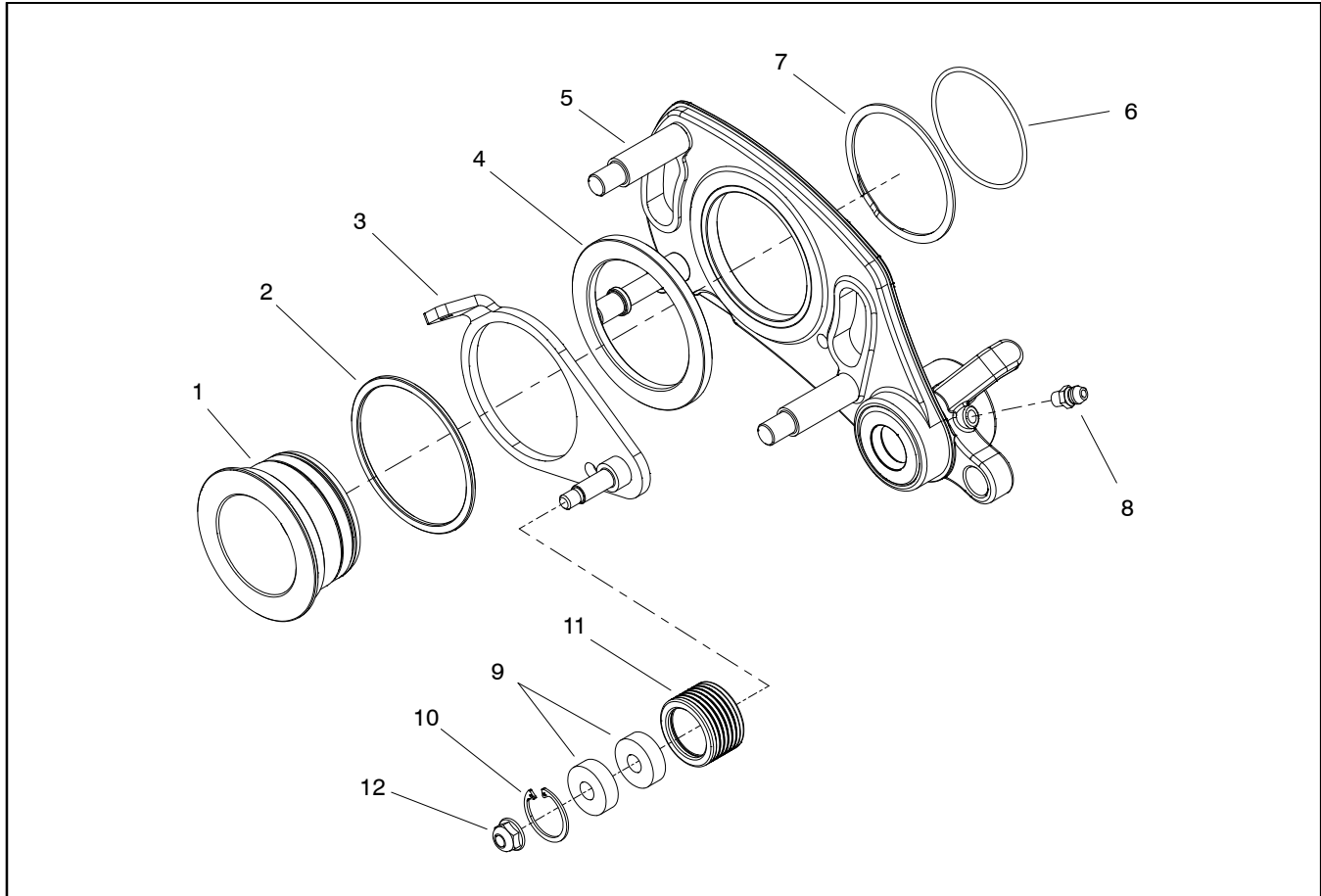


Figure 24

- | | | |
|------------------|-------------------|---------------------|
| 1. Pivot hub | 5. RH drive plate | 9. Bearing (2 used) |
| 2. Spacer | 6. O-ring | 10. Retaining ring |
| 3. Idler bracket | 7. Retaining ring | 11. Idler pulley |
| 4. Spacer | 8. Grease fitting | 12. Lock nut |

The groomer drive side plate assembly incorporates the idler system for tensioning the groomer drive belt. The idler system uses a spring to maintain proper belt tension.

Removal

1. Park machine on a clean, level surface. Lower cutting units completely to the ground, stop engine, engage parking brake and remove key from the ignition switch.
2. Disconnect the cutting units from the electrical power supply by separating the cutting unit power disconnect couplers (see Opening Electrical Circuit to Cutting Units in the General Information section of this chapter). This will prevent unexpected cutting unit operation.
3. Remove groomer belt cover, drive belt and drive pulley from right side of cutting unit (see Grooming Reel (Forward Rotating Groomer Drive) Removal in this section).
4. Using Figures 24 and 25 as guides, remove idler bracket, idler pulley and/or idler bearings as needed.

Installation

1. Assemble removed components using Figures 24 and 25 as guides.
- NOTE:** When properly installed, the idler pulley should move freely from side to side on the idler bracket pin.
2. Install drive pulley, drive belt and belt cover to right side of cutting unit (see Grooming Reel (Forward Rotating Groomer Drive) Installation in this section).
 3. Check and adjust grooming reel height and mower height-of-cut settings.
 4. Connect the cutting unit power disconnect couplers.

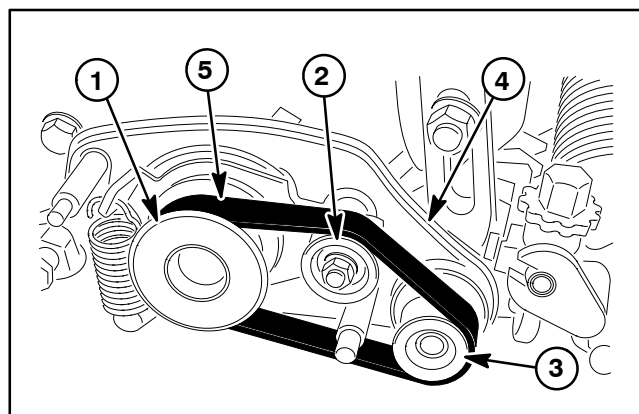


Figure 25

- | | |
|--------------------------|-------------------------|
| 1. Drive pulley | 4. Drive plate assembly |
| 2. Idler pulley assembly | 5. Groomer drive belt |
| 3. Driven pulley | |

Idler Assembly (Counter Rotating Groomer Drive)

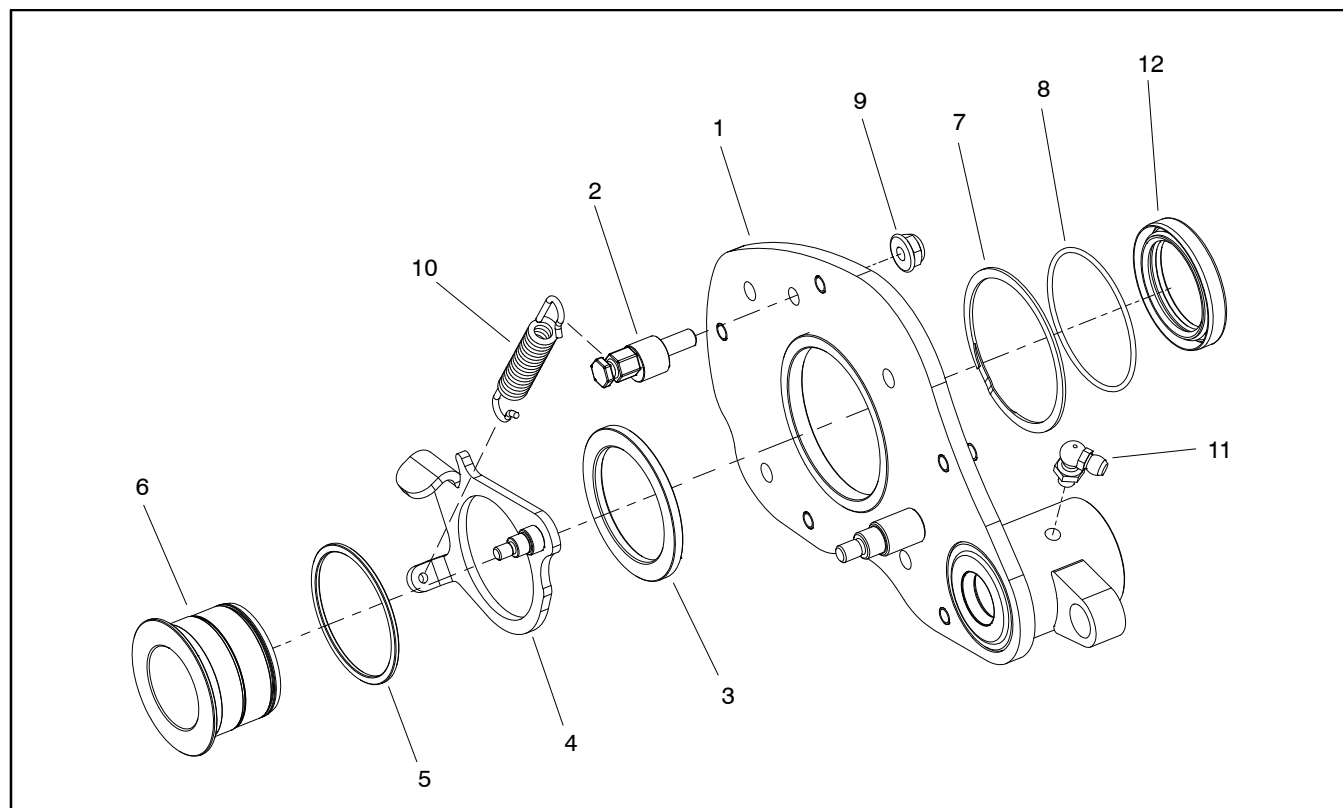


Figure 26

- 1. RH drive plate
- 2. Adjustment cam
- 3. Spacer
- 4. Idler bracket

- 5. Spacer
- 6. Reel hub
- 7. Retaining ring
- 8. O-ring

- 9. Flange nut
- 10. Extension spring
- 11. Grease fitting
- 12. Grease seal

The groomer RH drive plate assembly incorporates the idler system for engaging the groomer gear drive.

Disassembly (Fig. 26)

1. Park machine on a clean, level surface. Lower cutting units completely to the ground, stop engine, engage parking brake and remove key from the ignition switch.

2. Disconnect the cutting units from the electrical power supply by separating the cutting unit power disconnect couplers (see Opening Electrical Circuit to Cutting Units in the General Information section of this chapter). This will prevent unexpected cutting unit operation.

3. Make sure that handle on groomer cover is rotated toward front of machine so that groomer drive is engaged.

4. Remove groomer cover assembly and gasket from groomer drive on right side of cutting unit (see Groomer Cover (Counter Rotating Groomer Drive) in this section).

5. Remove RH drive plate assembly from right side of cutting unit (see Grooming Reel (Counter Rotating Groomer Drive) in this section).

6. Using Figure 26 as a guide, remove idler components from RH drive plate as needed.

Assembly (Fig. 26)

1. Assemble idler components to RH drive plate using Figure 26 as a guide. Make sure that retaining ring (item 7) is fully seated in groove of reel hub after assembly.

NOTE: When properly installed, the idler bracket (item 4) should pivot freely on reel hub.

2. Install RH drive plate assembly to right side of cutting unit (see Grooming Reel (Counter Rotating Groomer Drive) in this section). Make sure that groomer drive gear and grooming reel driven gear are properly torqued. Do not install idler gears, extension spring or groomer cover assembly to drive plate assembly at this time.

3. Check adjustment of adjustment cam (Fig. 28):

A. Rotate idler bracket so the bracket stop is against the adjustment cam.

B. While holding bracket stop against the cam, measure the distance between the idler gear bearing surfaces on the idler bracket and the drive plate. This distance should be 1.484" (37.7 mm).

C. If distance is incorrect, loosen flange nut that secures adjustment cam to drive plate. Rotate the adjustment cam until distance is correct. Then, tighten flange nut to secure adjustment. Make sure that distance is still correct after tightening the nut.

4. Install idler gears to drive plate assembly (Fig. 29). Torque flange nuts that secure idler gears **120 in-lb (13.5 N-m)**.

5. Install extension spring to idler bracket and adjustment cam.

6. Fill groomer cover with approximately five (5) ounces (142 grams) of Mobil XHP221 grease (or equivalent). Install new gasket and then groomer cover assembly to RH drive plate (see Groomer Cover (Counter Rotating Groomer Drive) in this section).

7. Check and adjust grooming reel height and mower height-of-cut settings.

8. When all adjustments have been completed, connect the cutting unit power disconnect couplers.

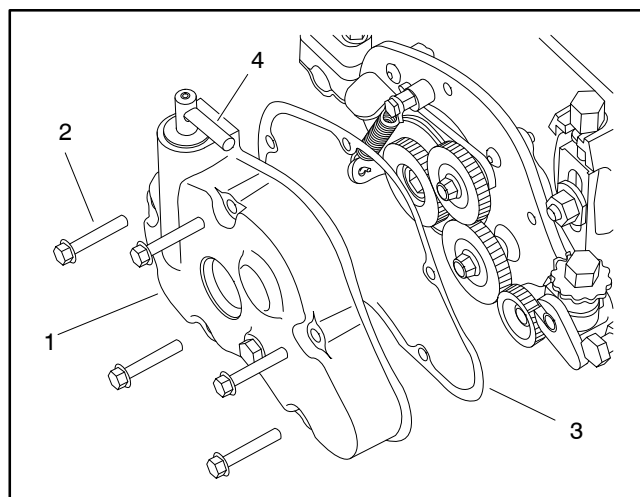


Figure 27

- | | |
|---------------------------|-----------|
| 1. Groomer cover assembly | 3. Gasket |
| 2. Screw (5 used) | 4. Handle |

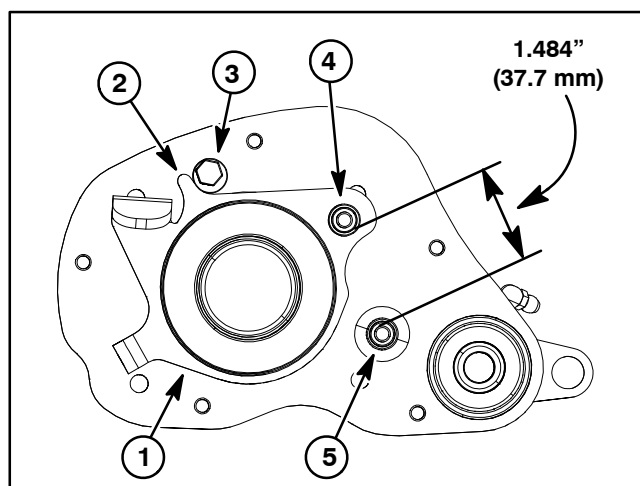


Figure 28

- | | |
|-----------------------|---------------------------|
| 1. Idler bracket | 4. Idler bearing location |
| 2. Idler bracket stop | 5. Plate bearing location |
| 3. Adjustment cam | |

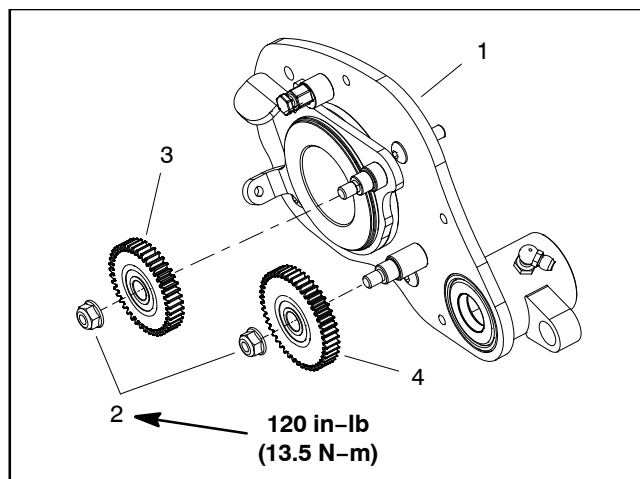


Figure 29

- | | |
|------------------------|---------------------------|
| 1. RH drive plate assy | 3. 43T idler gear/bearing |
| 2. Flange nut | 4. 47T idler gear/bearing |

Lift Arm Assembly

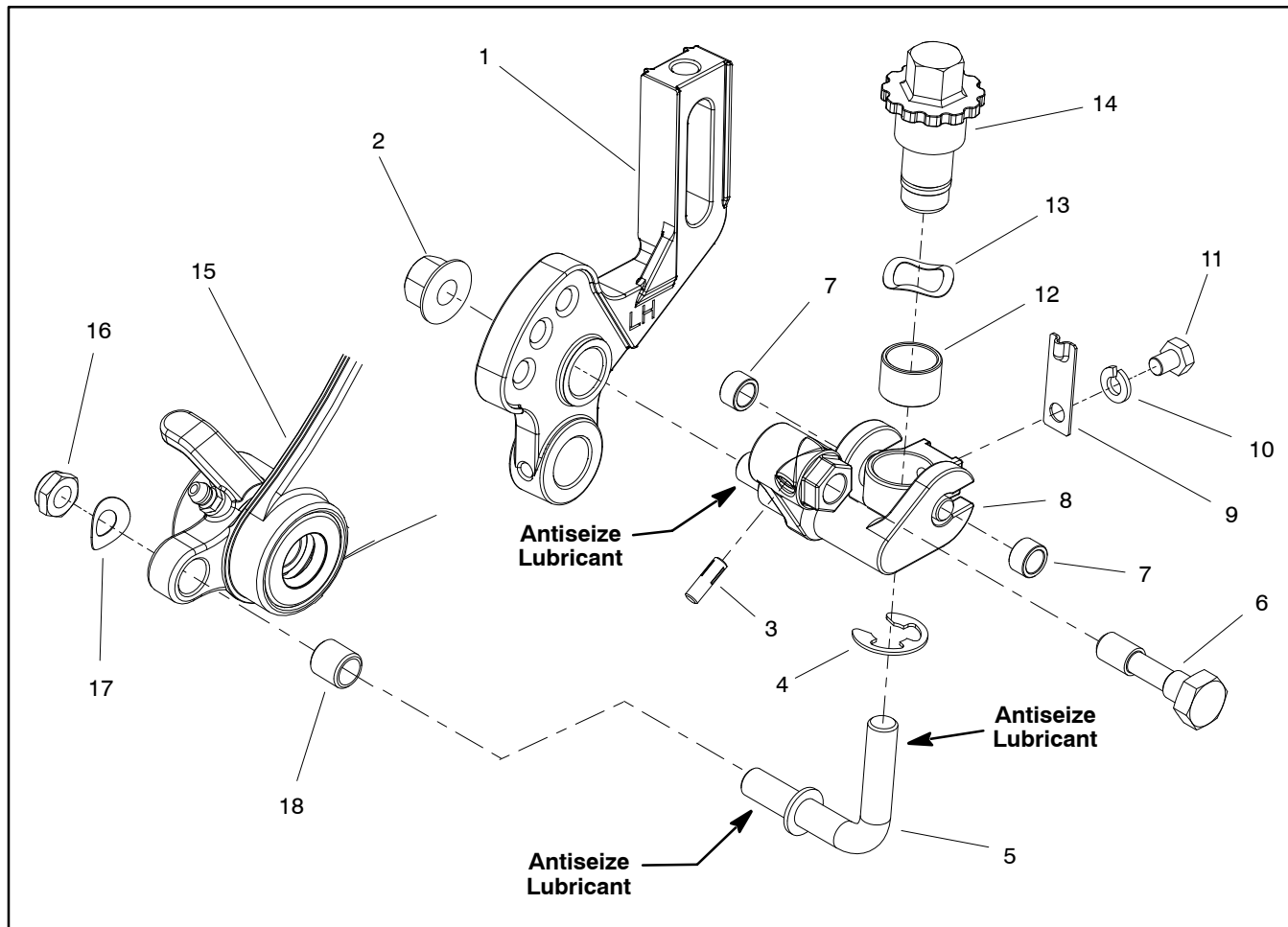


Figure 30

- 1. HOC groomer arm (LH shown)
- 2. Flange nut
- 3. Grooved pin
- 4. E-ring
- 5. Groomer lift rod
- 6. Lock screw

- 7. Bushing
- 8. Lift arm assembly (LH shown)
- 9. Detent spring
- 10. Spring washer
- 11. Cap screw
- 12. Bushing

- 13. Wave washer
- 14. Groomer adjuster
- 15. Side plate (LH shown)
- 16. Lock nut
- 17. Spring washer
- 18. Bushing

Disassembly (Fig. 30)

1. Remove flange nut (item 2) that secures lift arm to HOC groomer arm. Remove lock nut (item 16) and spring washer (item 17) that secure lift arm to side plate. Loosen lock screw (item 6) completely.
2. Remove flange nut (item 2) that secures lift arm assembly to HOC groomer arm. Remove lock nut (item 16) and spring washer (item 17) that secure lift arm assembly to side plate. Loosen lock screw (item 6) completely.
3. Remove lift arm assembly from cutting unit.
4. Disassemble lift arm using Figure 30 as a guide.

NOTE: Right and left side HOC groomer arms (item 1) and lift arm assemblies (item 8) are different; other components shown in Figure 30 are the same on both sides of cutting unit.

NOTE: Grooved pin (item 3) is used to retain lock screw (item 6) to lift arm assembly.

Assembly (Fig. 30)

1. Assemble lift arm using Figure 30 as a guide.
2. Apply antiseize lubricant to threads of groomer lift rod (item 5) and lift arm assembly stud (item 8).
3. Install lift arm assembly onto cutting unit. Secure with flange nut (item 2) and lock nut (item 16) with spring washer (item 17).
4. Secure groomer in raised or lowered position with lock screw (item 6).
5. Check and adjust grooming reel height and mower height-of-cut settings.

Groomer Brush

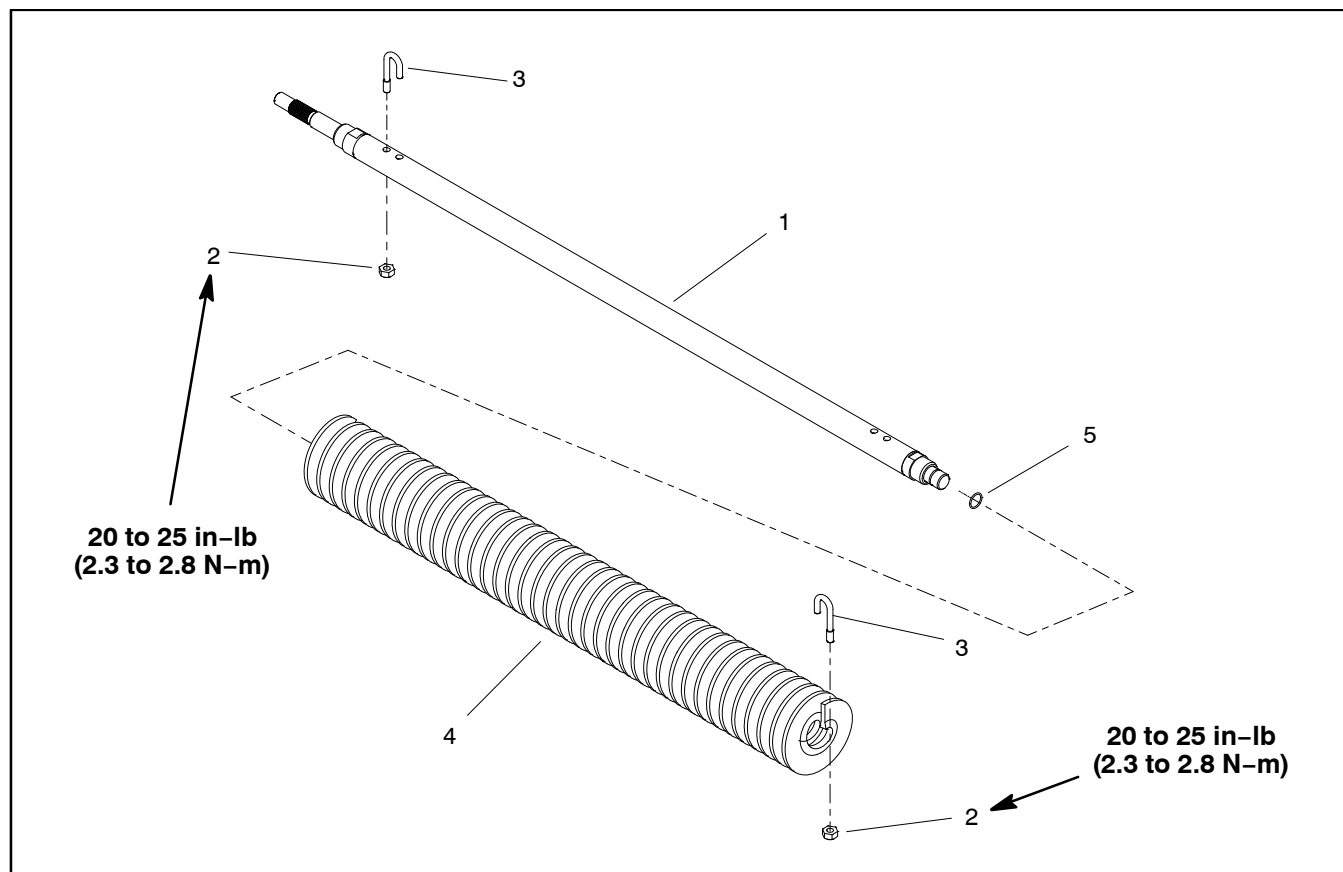


Figure 31

- 1. Groomer brush shaft
- 2. Lock nut

- 3. J-bolt
- 4. Groomer brush

- 5. O-ring

The groomer brush attaches to the groomer drive in place of the grooming reel. Removal and installation of the groomer brush uses the same procedure as removal and installation of the grooming reel (see Grooming Reel in this section).

To remove the groomer brush from the shaft, remove the lock nut and J-bolt from both ends of the brush and slide the brush from the shaft. When assembling the brush to the shaft, secure the assembly with J-bolts and lock nuts. Make sure that the J-bolts are installed with the threaded portion on the outside of the brush (Fig. 32). Torque lock nuts from **20 to 25 in-lb (2.3 to 2.8 N-m)**.

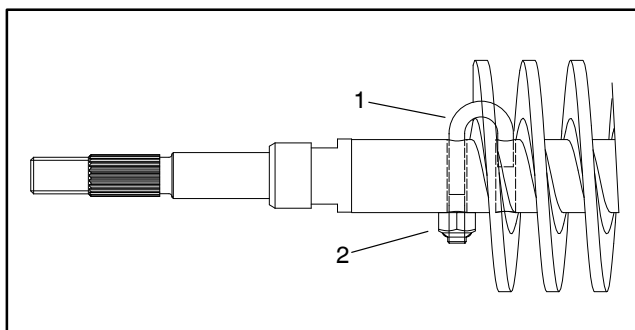


Figure 32

- 1. J-bolt

- 2. Lock nut



Universal Groomer (Optional)

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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.

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.

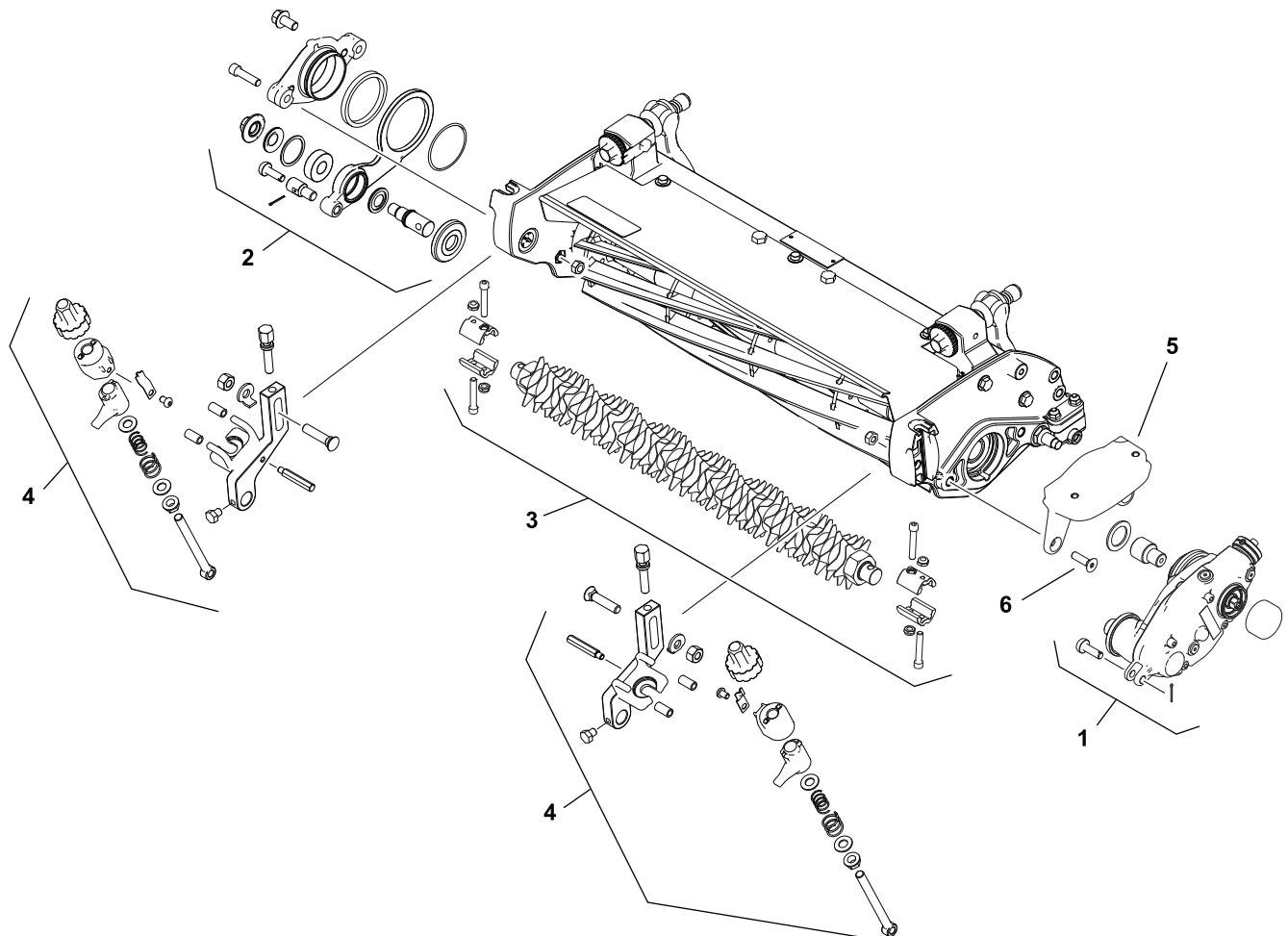
Variables that Affect the Use and Performance of the Groomer:

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.	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.).

Service and Repairs



g227930

Figure 1

- | | | |
|----------------------|--------------------------------------|-----------------------------|
| 1. Gear box assembly | 3. Groomer reel | 5. Weight |
| 2. Idler assembly | 4. Height adjuster assembly (2 each) | 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

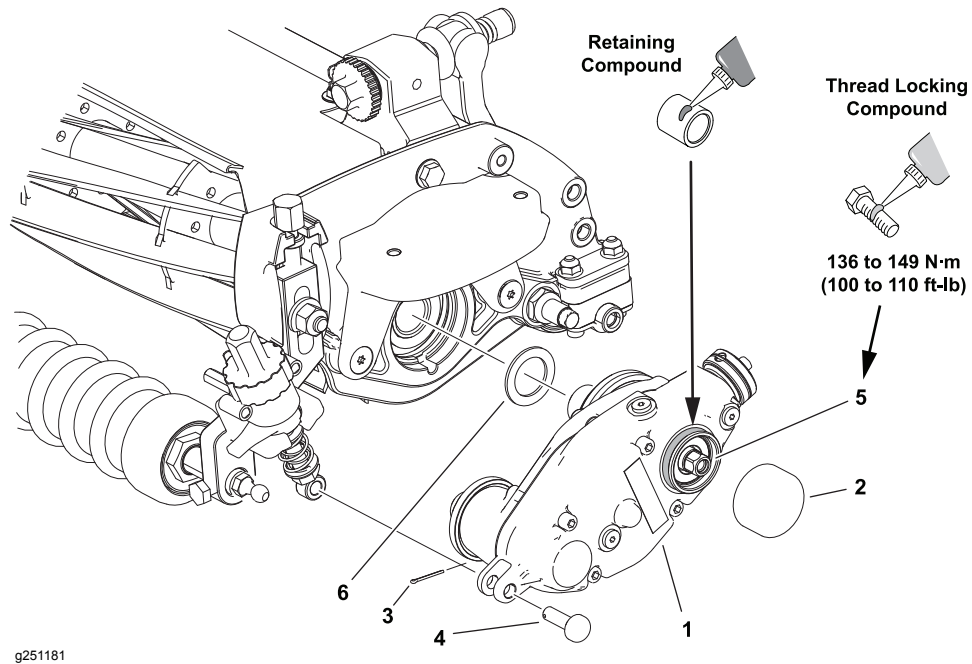


Figure 2

- | | |
|----------------------|----------------|
| 1. Gear box assembly | 4. Clevis pin |
| 2. Drive shield | 5. Input shaft |
| 3. Cotter pin | 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

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 \(page 10–12\)](#).
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 drive.
4. Safely prevent the reel from rotating by blocking the cutting reel with a piece of wood near one of the reel spiders.

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.

5. Remove the gear box from the cutting unit as follows:
 - A. Turn the input shaft clockwise to loosen it from the reel.
 - B. Remove the cotter pin and clevis pin from the height adjustment rod at the front of the groomer gear box. Discard the cotter pin.

Removing the Gear Box Assembly (continued)

C. Continue to unscrew the input shaft and remove the gear box from the cutting unit.

D. Retrieve the shim (item 6 in [Figure 2](#)).

Servicing the Gear Box

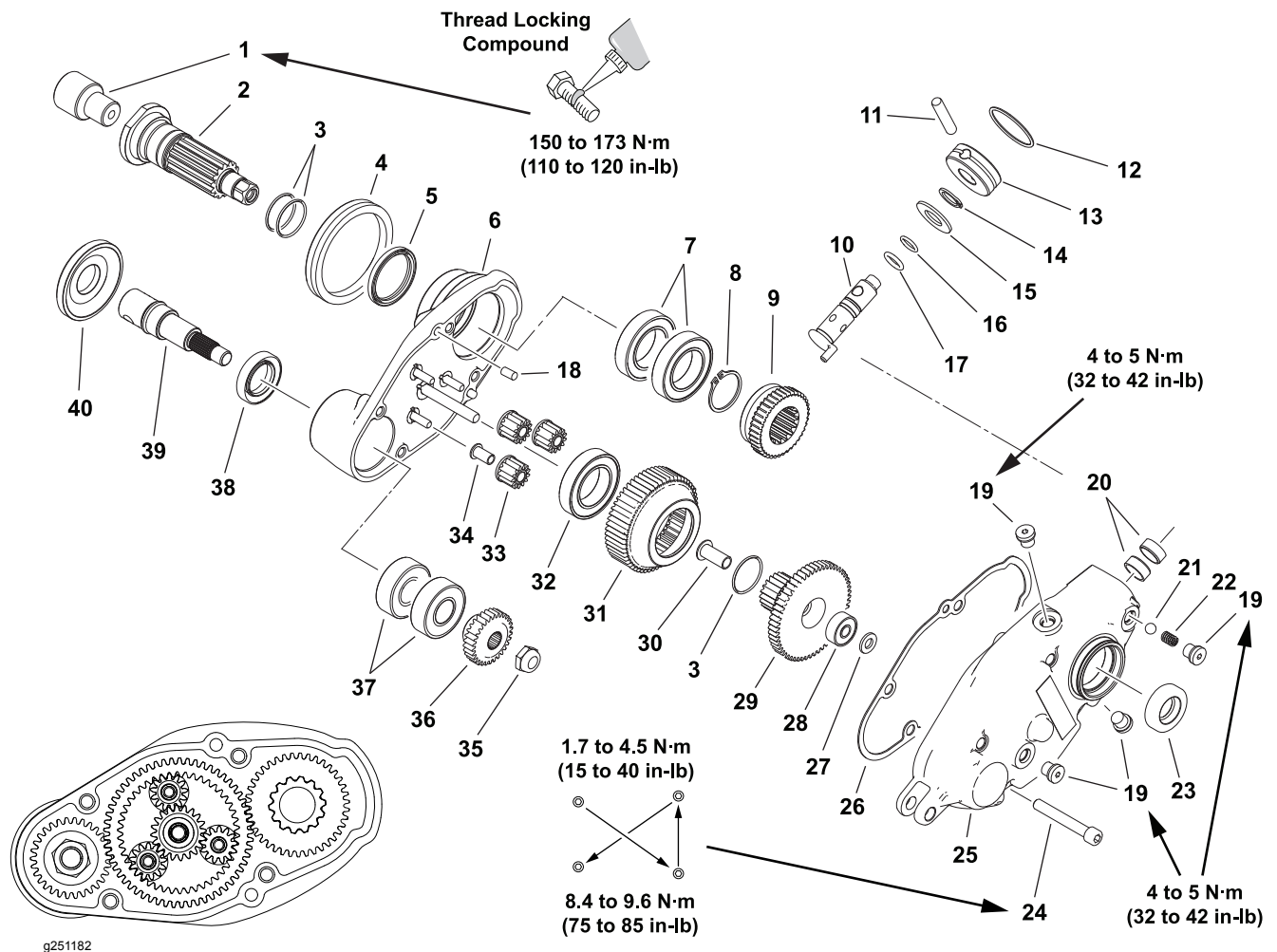


Figure 3

- | | | |
|--------------------------|--------------------------------|-----------------------------|
| 1. Drive adapter | 15. Thrust washer | 29. Ring gear |
| 2. Input shaft | 16. O-ring | 30. Flange bushing |
| 3. O-ring (3 each) | 17. O-ring | 31. Sun gear |
| 4. V-ring | 18. Dowel pin (2 each) | 32. Bearing |
| 5. Oil seal | 19. Drain/fill plug (4 each) | 33. Planet gear (3 each) |
| 6. Groomer housing | 20. Straight bushing (2 each) | 34. Flange bushing (3 each) |
| 7. Ball bearing (2 each) | 21. Detent ball | 35. Locknut |
| 8. Retaining ring | 22. Detent spring | 36. Driver gear |
| 9. Driven gear | 23. Oil seal | 37. Bearing (2 each) |
| 10. Actuator shaft | 24. Socket-head screw (4 each) | 38. Oil seal |
| 11. Pin | 25. Groomer cover | 39. Driven shaft |
| 12. O-ring | 26. Gasket | 40. Shield |
| 13. Knob | 27. Thrust washer | |
| 14. Retaining ring | 28. Ball bearing | |

Servicing the Gear Box (continued)

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.



CAUTION



Use the 1-3/8 inch flats on the input shaft to prevent the input shaft from rotating during drive adapter removal and installation. DO NOT use the 1/2 inch hex on the input shaft for drive adapter removal or installation as input shaft damage may occur.

5. If the drive adapter requires replacement, apply high strength thread locker (Loctite 243 or equivalent) to the 5/8 inch threads of the drive adapter and tighten the adapter from **150 to 173 N·m (110 to 120 ft-lb)**.
6. Carefully clean all the gasket material from the gear box housing and cover.
7. Inspect the V-ring, seals, bearings, gears, and bushings in the gear box assembly. Replace the damaged or worn components as necessary.
8. 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.
9. If the flange bushings are replaced, ensure that the flange bushing is fully seated against the part.
10. Assemble 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.
11. Clean the gasket surface on the gear box housing and cover with the solvent and install new gasket.
12. 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)**.
13. 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)**.
14. Operate the groomer gear box by hand to check for proper operation prior to installation.

Installing the Gear Box 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. Safely prevent the reel from rotating by blocking the cutting reel with a piece of wood near one of the reel spiders.

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) counter-clockwise to install the gear box.

3. Install the gear box to the cutting unit as follows:
 - A. Fit the shim (item 6 in [Figure 2](#)) over the input shaft.
 - B. Apply medium strength thread locking compound to the input shaft threads and turn the input shaft counter-clockwise until it is seated against the reel.
 - C. Install the clevis pin and a new cotter pin to secure the height adjustment rod to the front of the groomer gear box.
 - D. Tighten the input shaft from **136 to 149 N·m (100 to 110 ft-lb)**.
4. 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.
5. Install the groomer reel assembly; refer to [Installing the Groomer Reel \(page 10–14\)](#).

The Idler Assembly

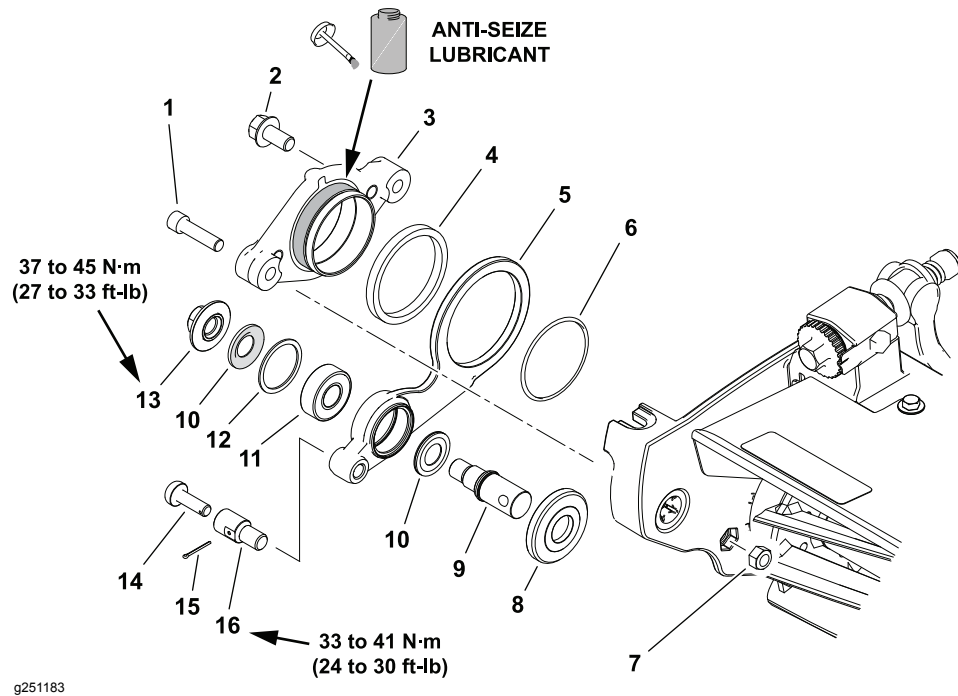


Figure 4

- | | |
|-------------------------------|---------------------------|
| 1. Socket-head screw (2 each) | 9. Stub shaft |
| 2. Motor adapter | 10. Flocked seal (2 each) |
| 3. Bushing | 11. Bearing |
| 4. Idler arm | 12. Retaining ring |
| 5. O-ring | 13. Flange nut |
| 6. Lock nut (2 each) | 14. Clevis pin |
| 7. Shield | 15. Cotter pin |
| | 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 \(page 10–12\)](#).
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

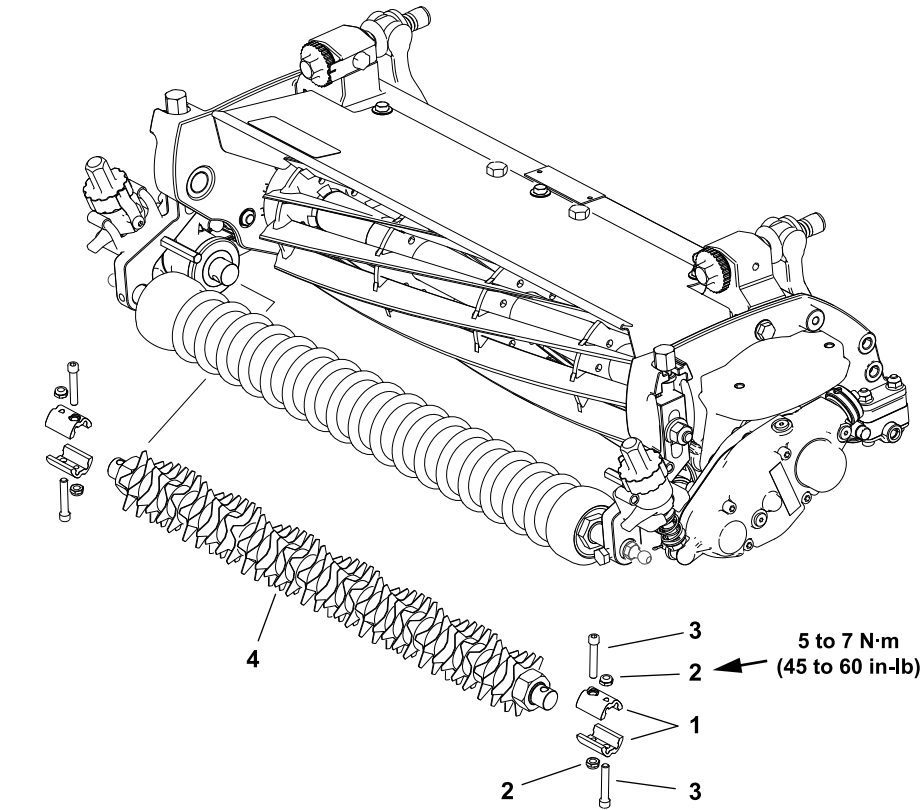


Figure 5

- | | |
|-------------------------|------------------|
| 1. Shaft clamp (4 each) | 3. Bolt (4 each) |
| 2. Jam nut (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 \(page 10–6\)](#) and [The Idler Assembly \(page 10–10\)](#).

Servicing the Groomer Reel

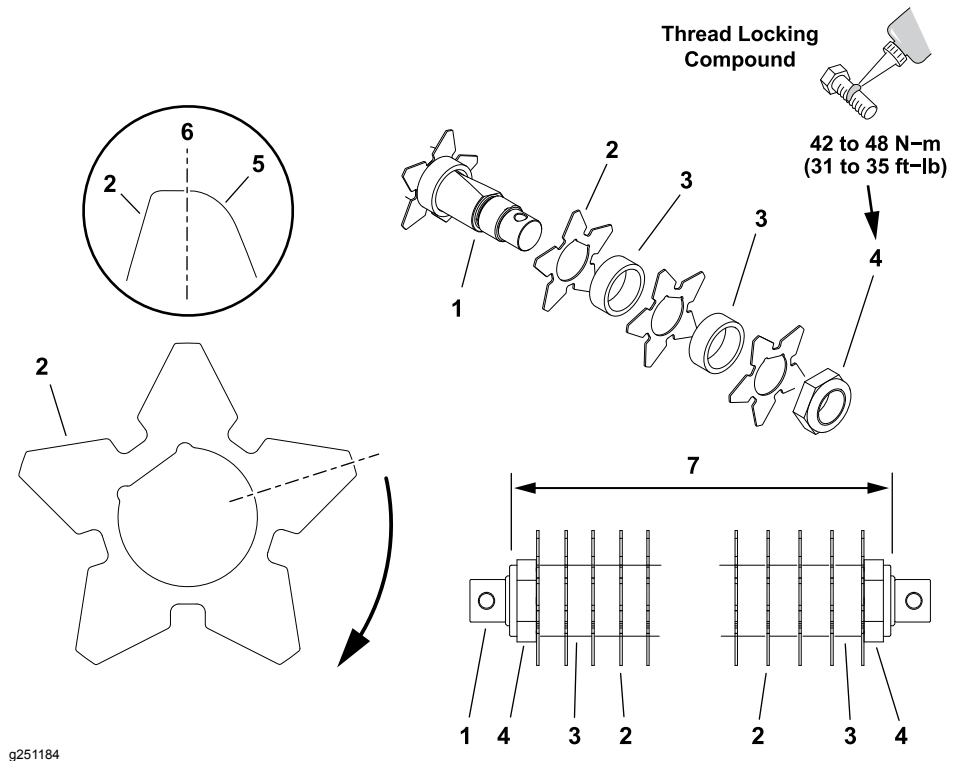


Figure 6

- | | |
|----------------------------|----------------------|
| 1. Groomer reel shaft | 5. Rounded edge |
| 2. Groomer blade (40 each) | 6. Midpoint |
| 3. Spacer (39 each) | 7. Centered on shaft |
| 4. Locknut (2 each) | |

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 6](#).

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 \(page 10–12\)](#).
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 \(page 10–14\)](#).

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

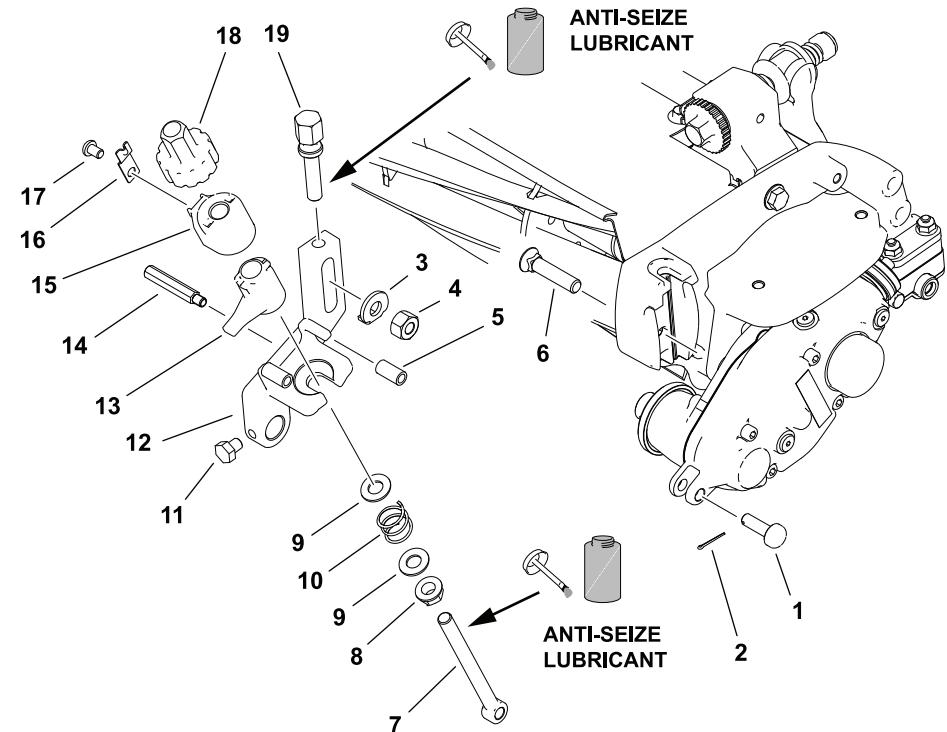


Figure 7

- | | |
|--------------------------|----------------------------|
| 1. Clevis pin | 11. Pinch bolt |
| 2. Cotter pin | 12. Height-of-cut bracket |
| 3. Tabbed washer | 13. Quick up lever |
| 4. Lock nut | 14. Groomer pin |
| 5. Bumper | 15. Quick up cover |
| 6. Plow bolt | 16. Detent spring |
| 7. Height adjustment rod | 17. Button-head screw |
| 8. Flange nut | 18. Height adjuster knob |
| 9. Washer (2 each) | 19. Height adjustment bolt |
| 10. Compression spring | |

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 7](#).

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.

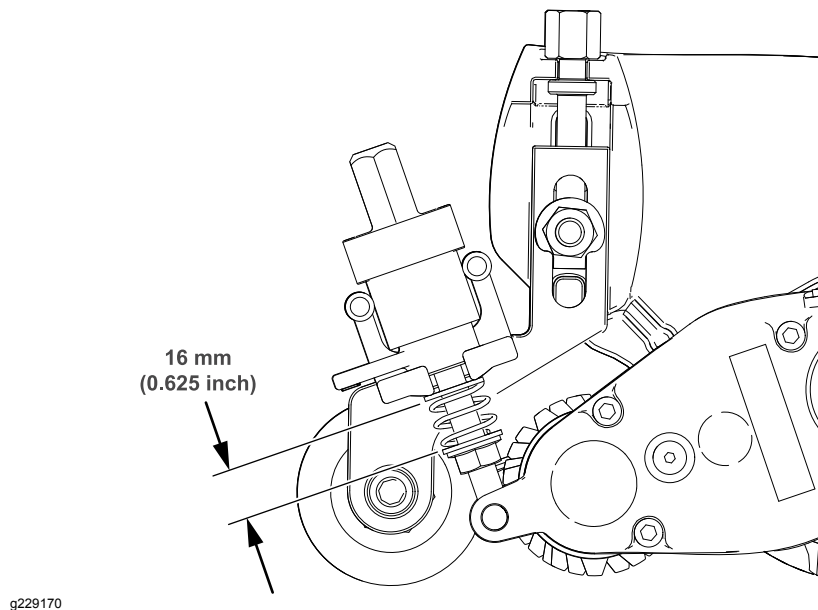


Figure 8

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)

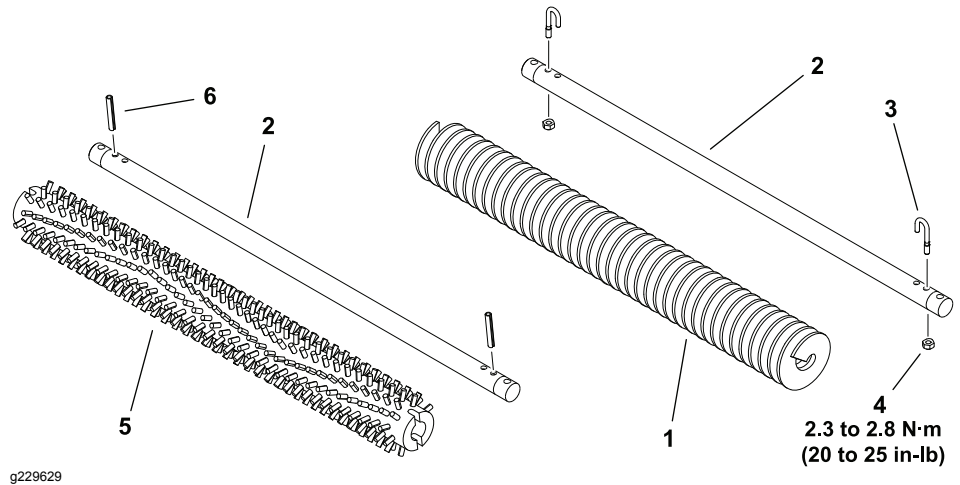


Figure 9

- | | |
|--------------------|----------------------|
| 1. Spiral brush | 4. Lock nut (2 each) |
| 2. Brush shaft | 5. Grooming brush |
| 3. J-bolt (2 each) | 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 \(page 10–12\)](#).

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)**.

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Foldout Drawings

Foldout
Drawings

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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.

<u>ABBREVIATION</u>	<u>COLOR</u>
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 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

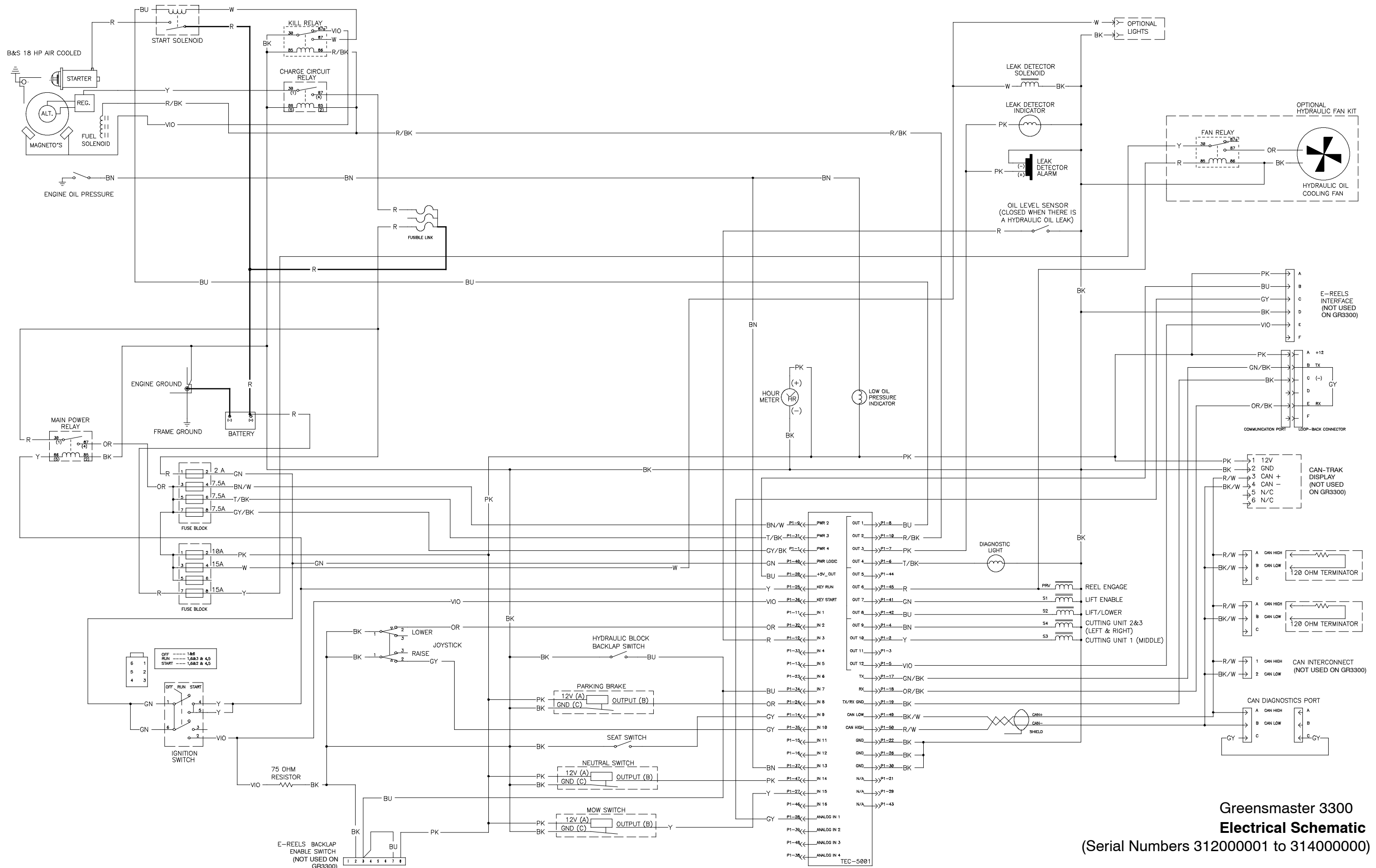
The individual wires of the electrical harness diagrams in this chapter identify both the wire color and the wire size.

Examples:

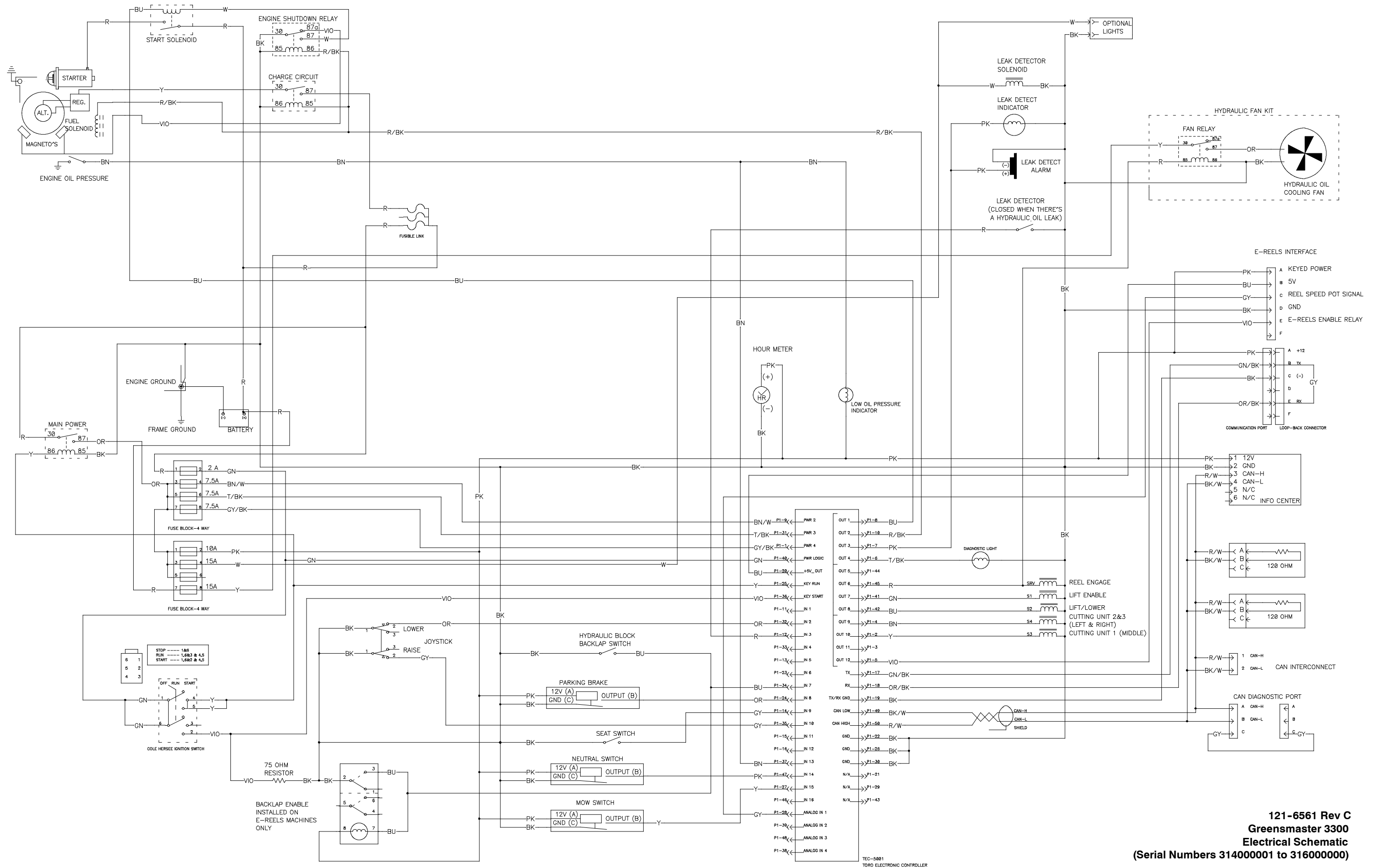
16 BK = 16 AWG (American Wire Gauge) wire that has a black insulator

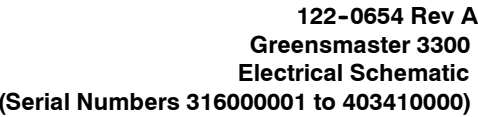
050 R = 0.5 mm metric wire that has a red insulator (AWG equivalents for metric wire appear in the following table)

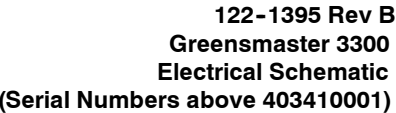
AWG EQUIVALENTS FOR METRIC WIRE		
DIAGRAM LABEL	METRIC SIZE	AWG EQUIVALENT
050	0.5 mm	20 GA
175	0.75 mm	18 GA
100	1.0 mm	16 GA
150	1.5 mm	14 GA

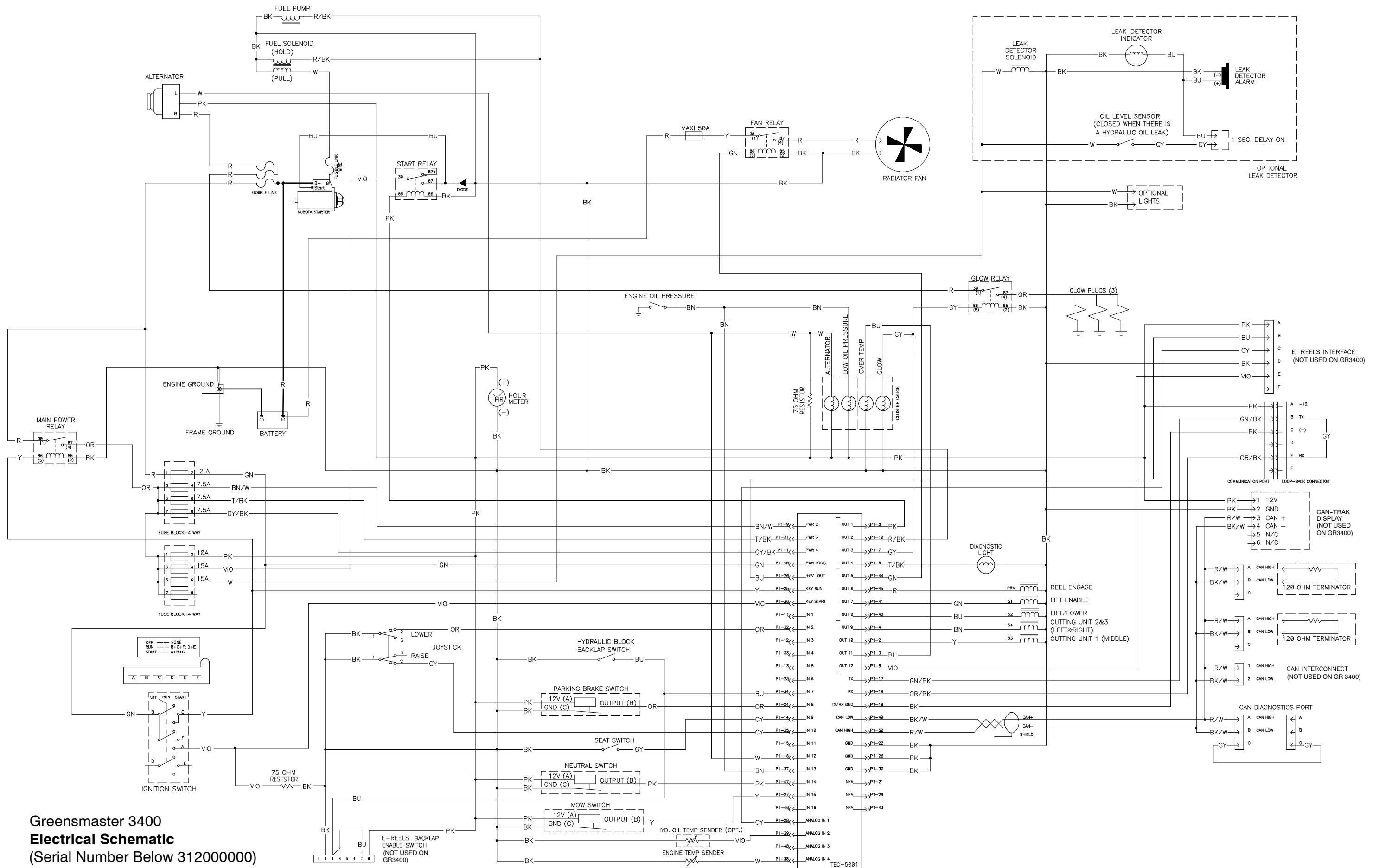


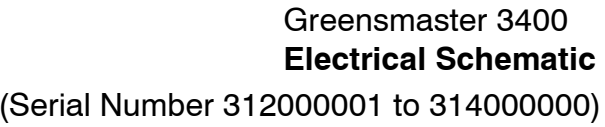
**Greensmaster 3300
Electrical Schematic**
(Serial Numbers 312000001 to 314000000)

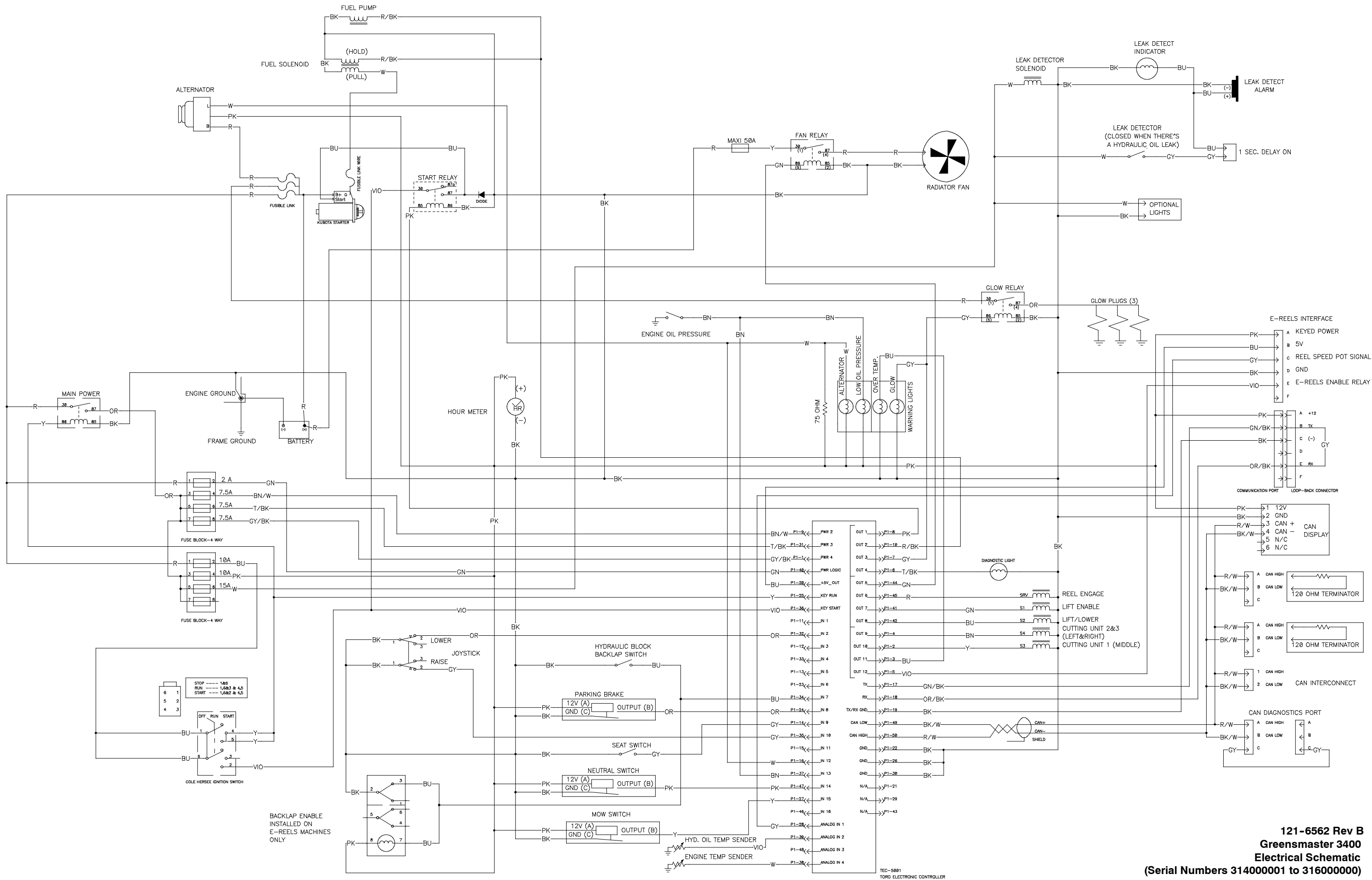


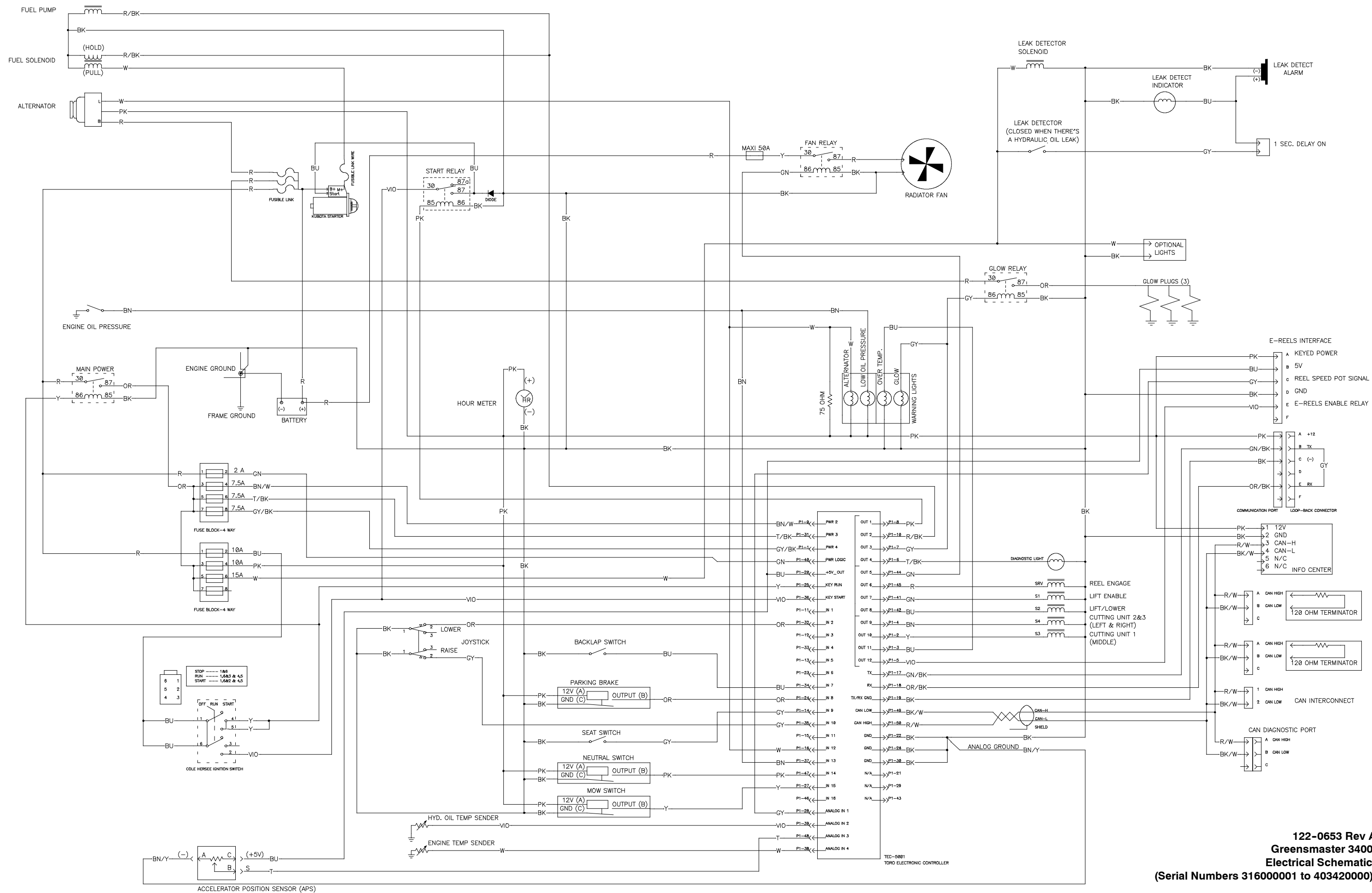


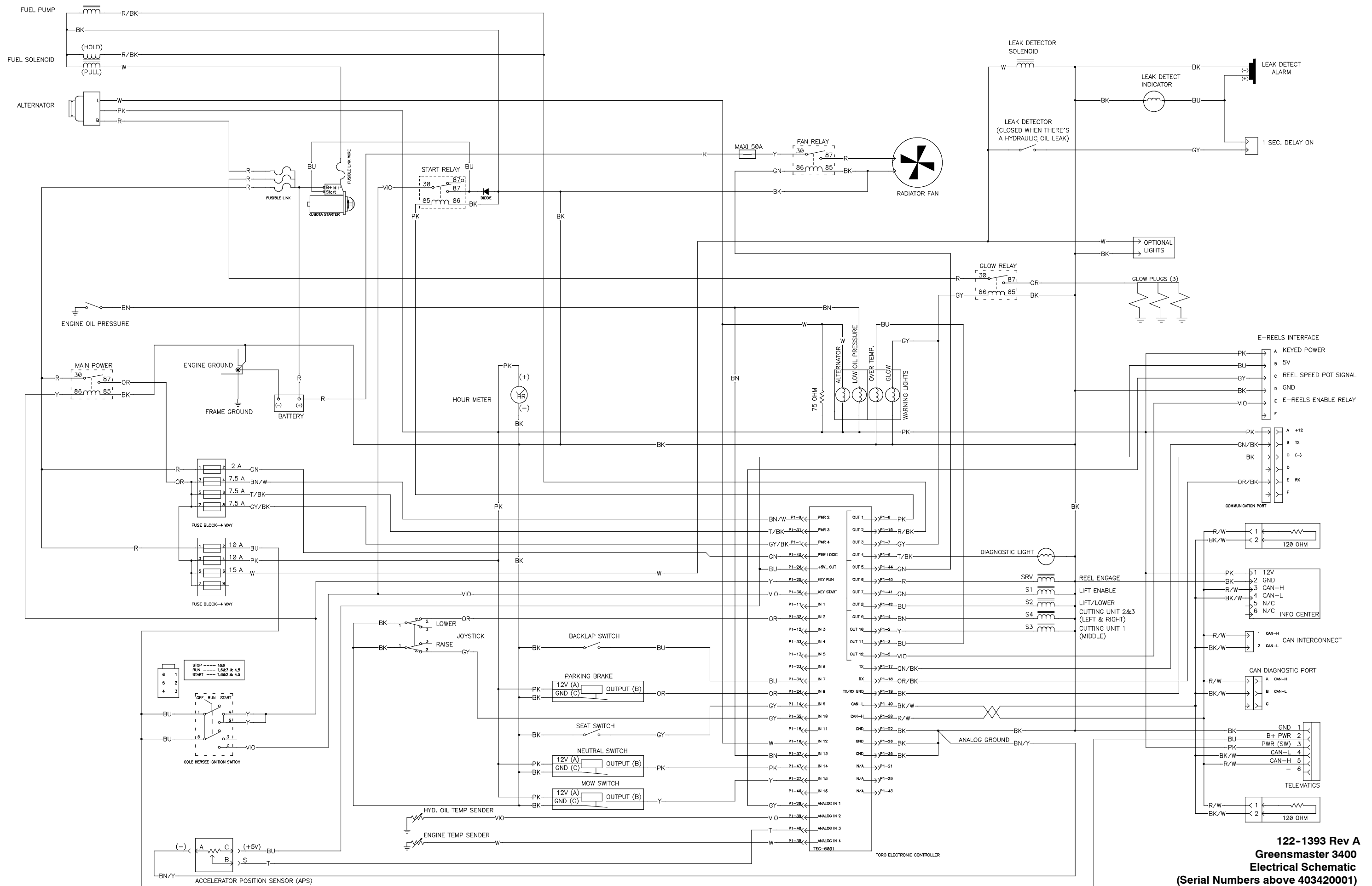


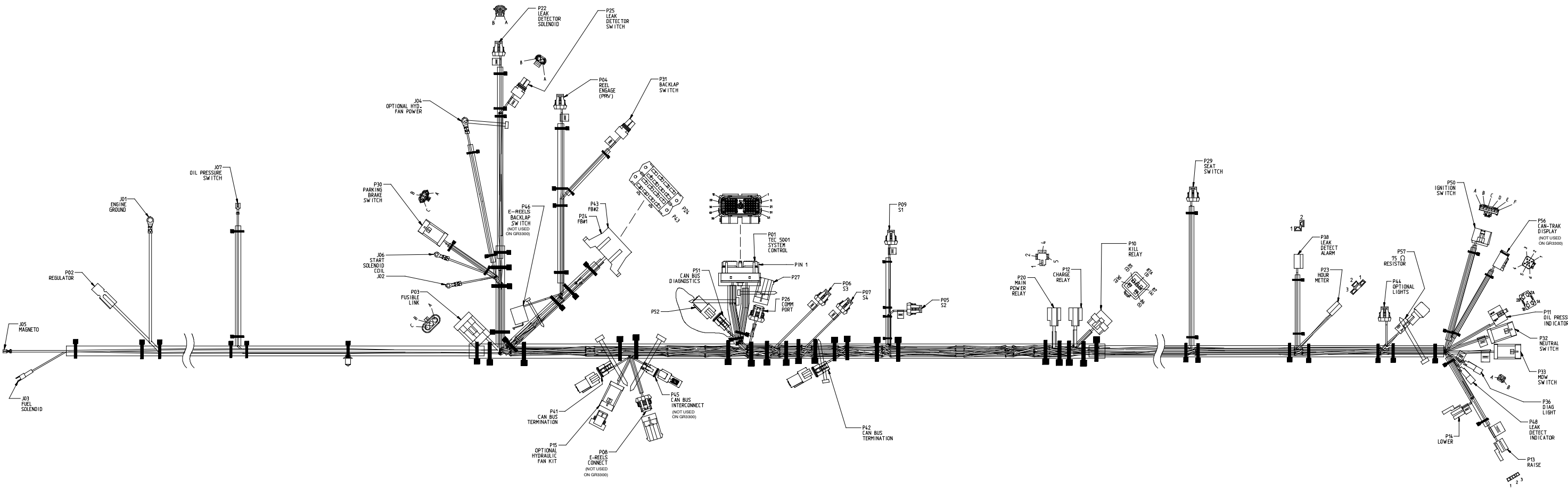




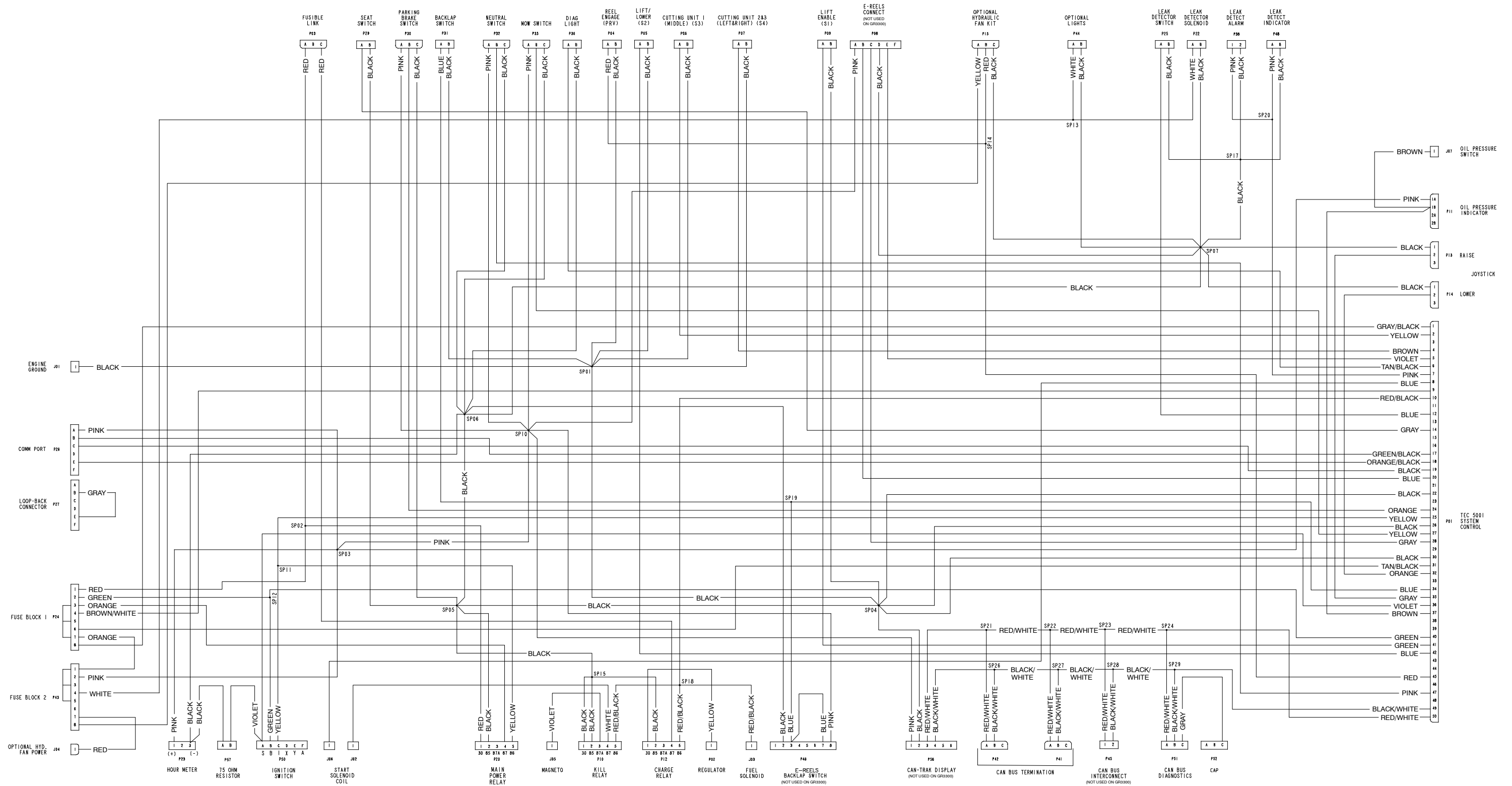






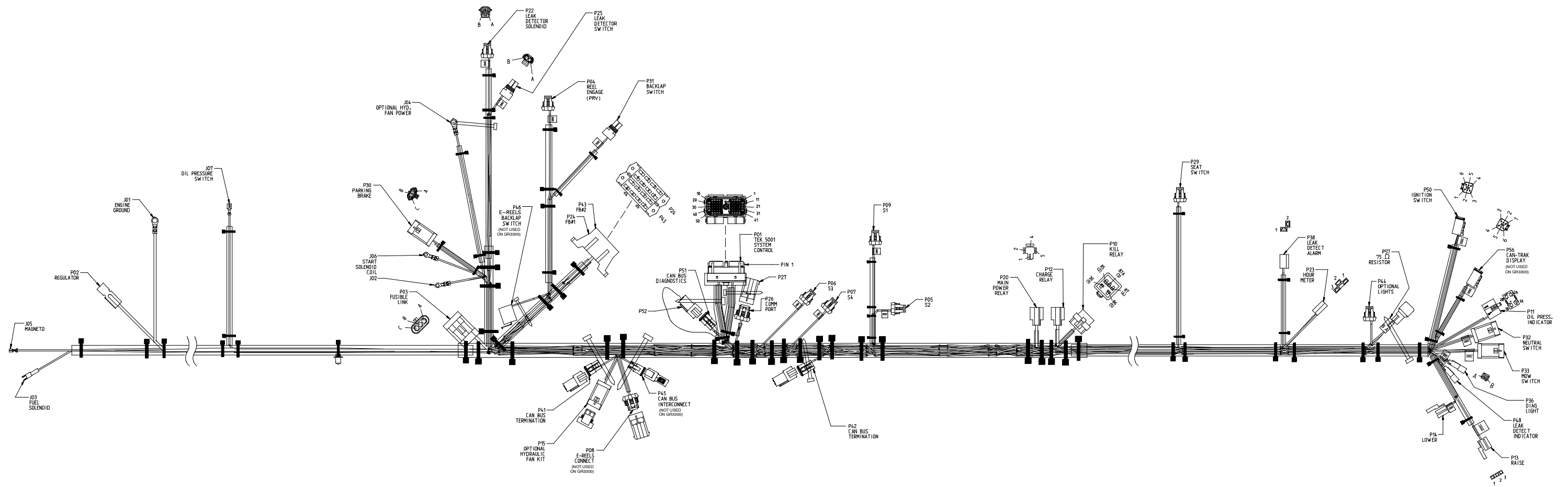


Greensmaster 3300
Wire Harness Drawing
(Serial Number Below 312000000)

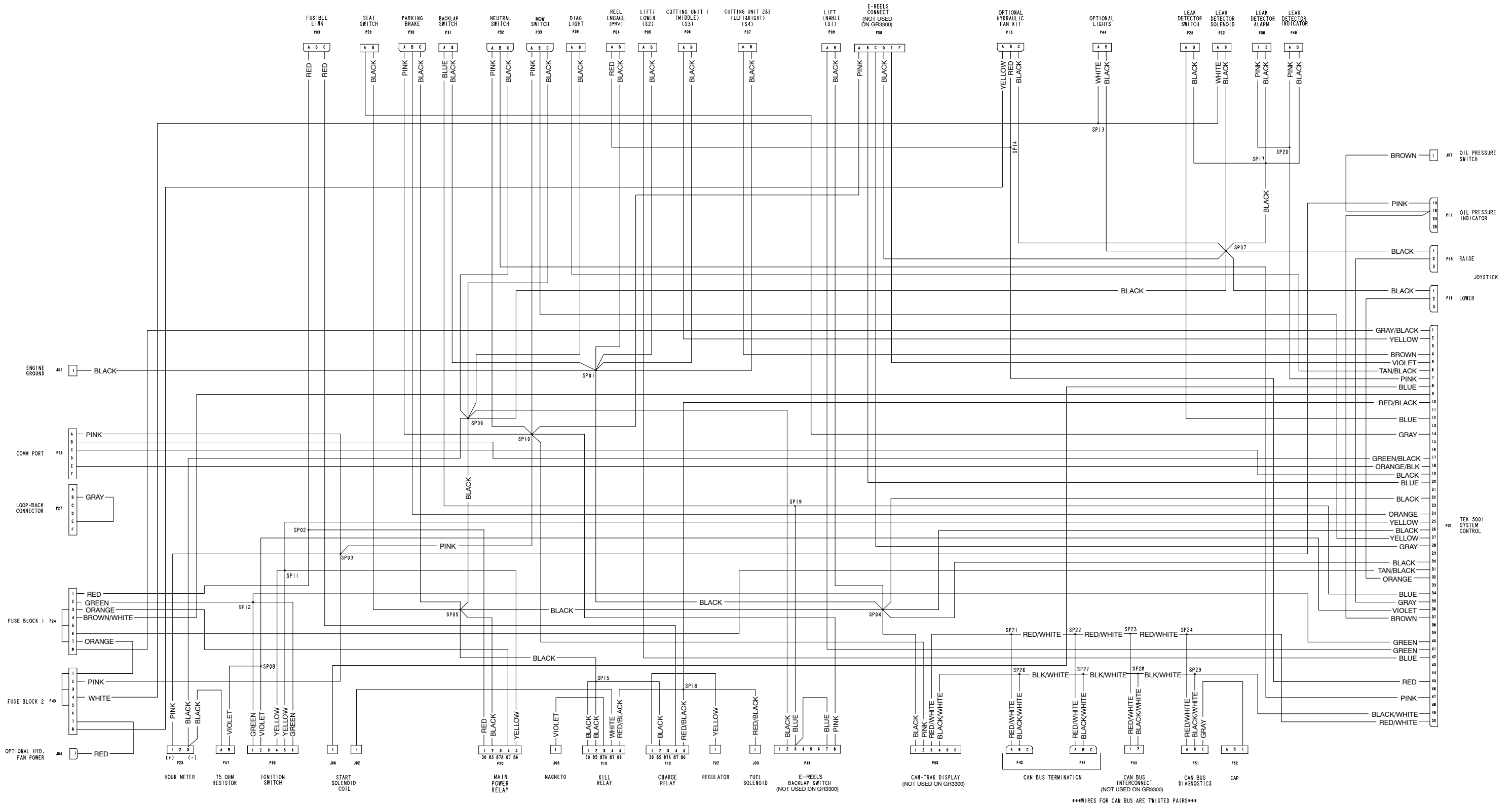


WIRES FOR CAN BUS ARE TWISTED PAIRS

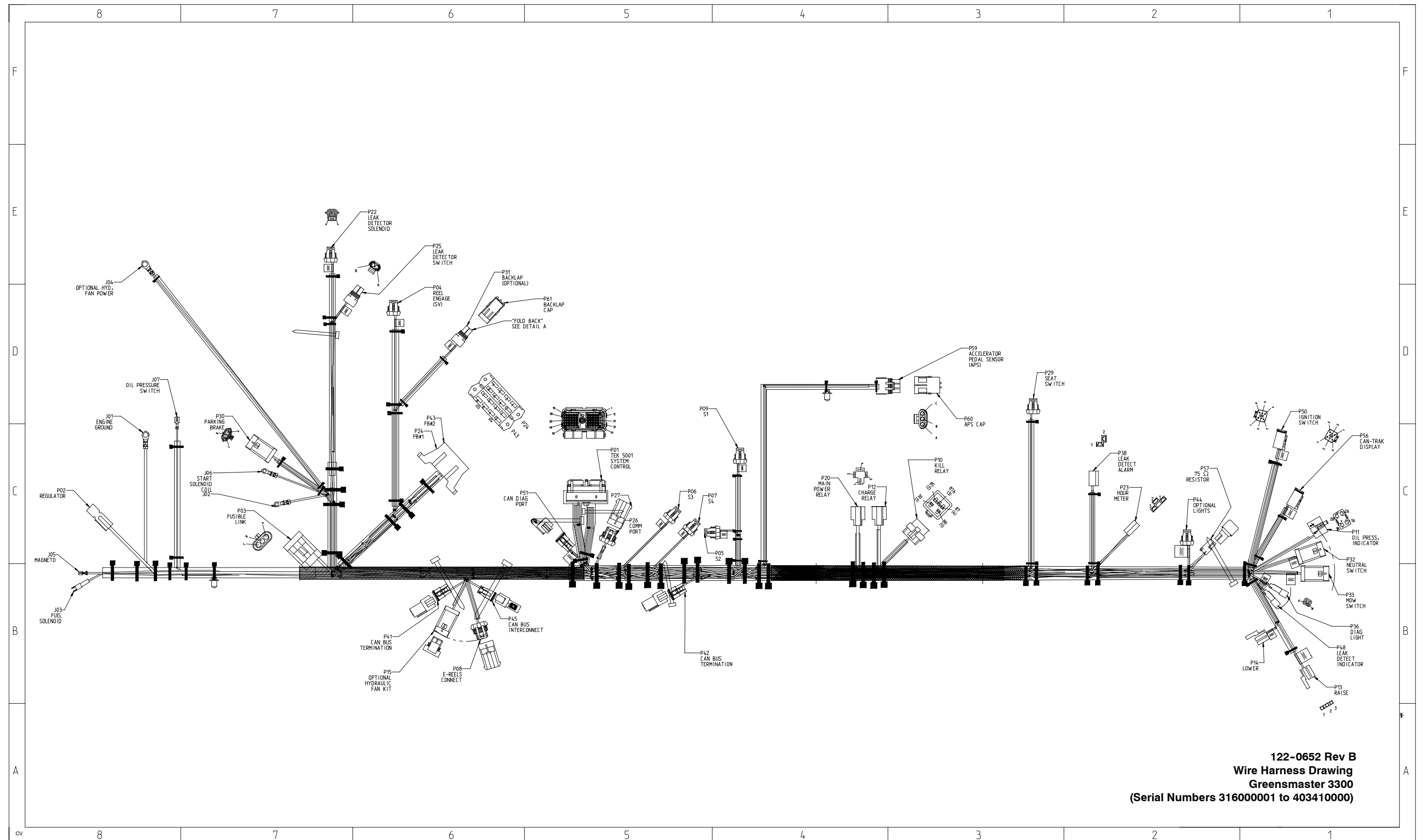
Greensmaster 3300
Wire Harness Diagram
(Serial Number Below 312000000)

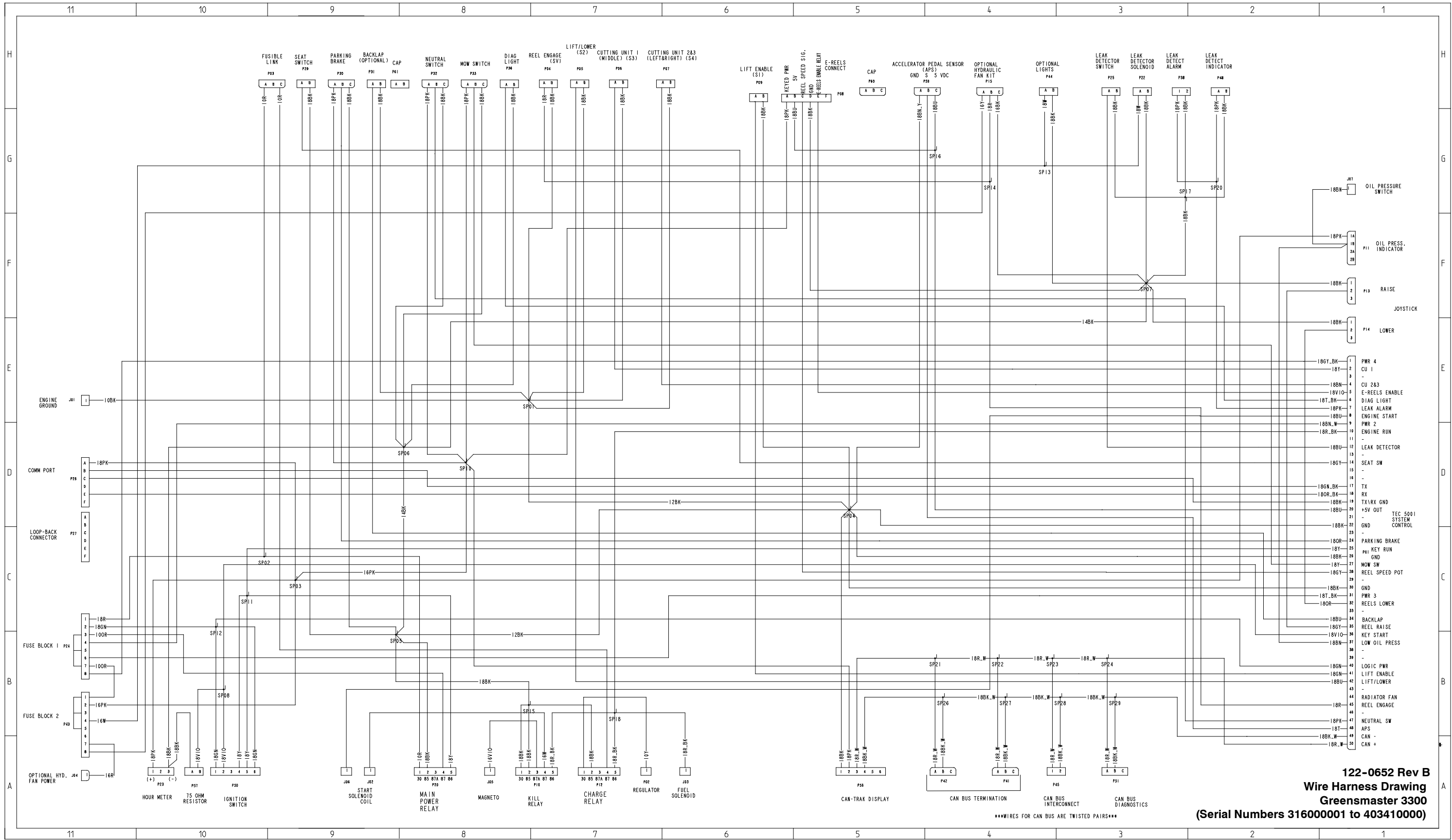


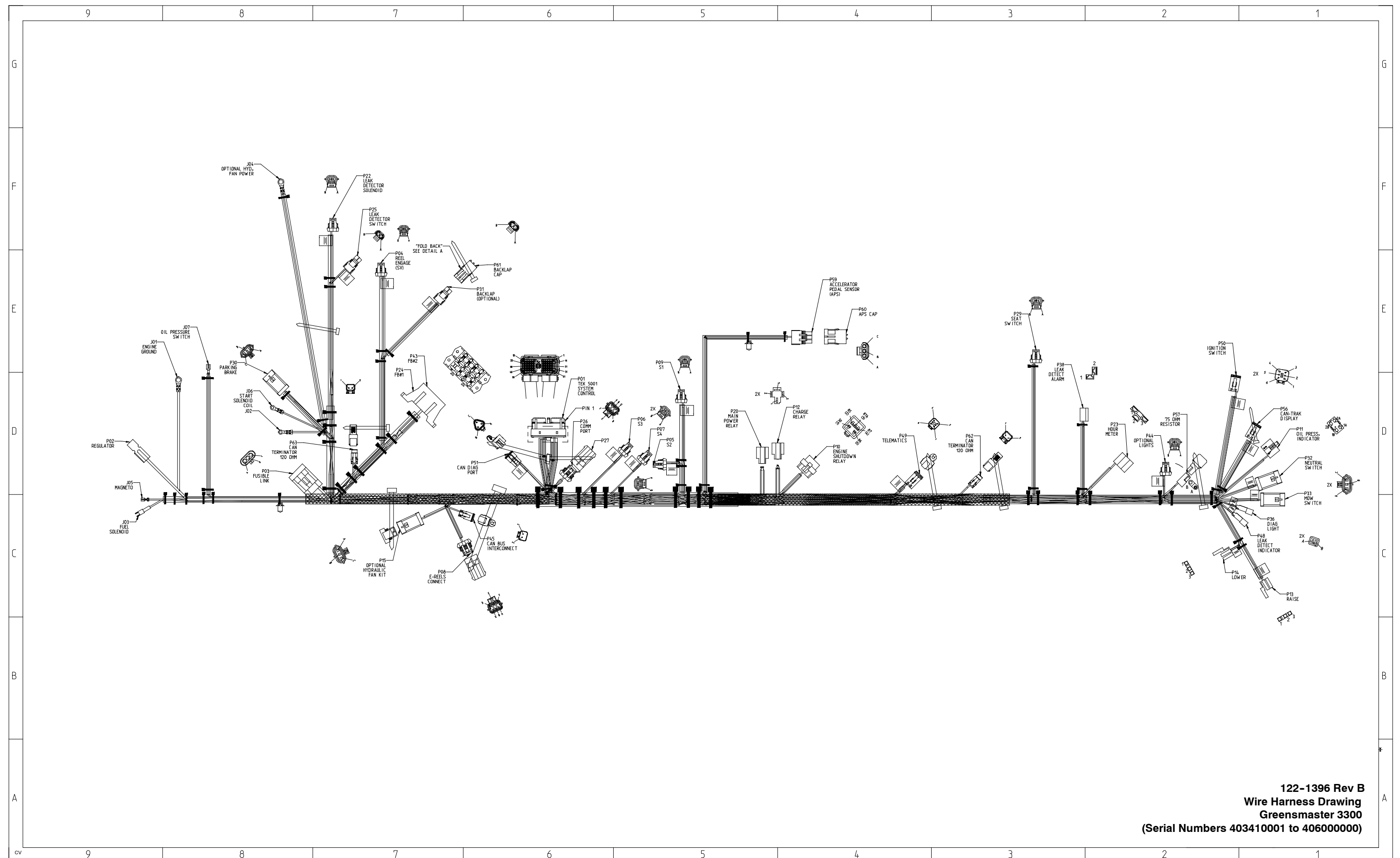
Greensmaster 3300
Wire Harness Drawing
 (Serial Numbers 312000001 to 316000000)

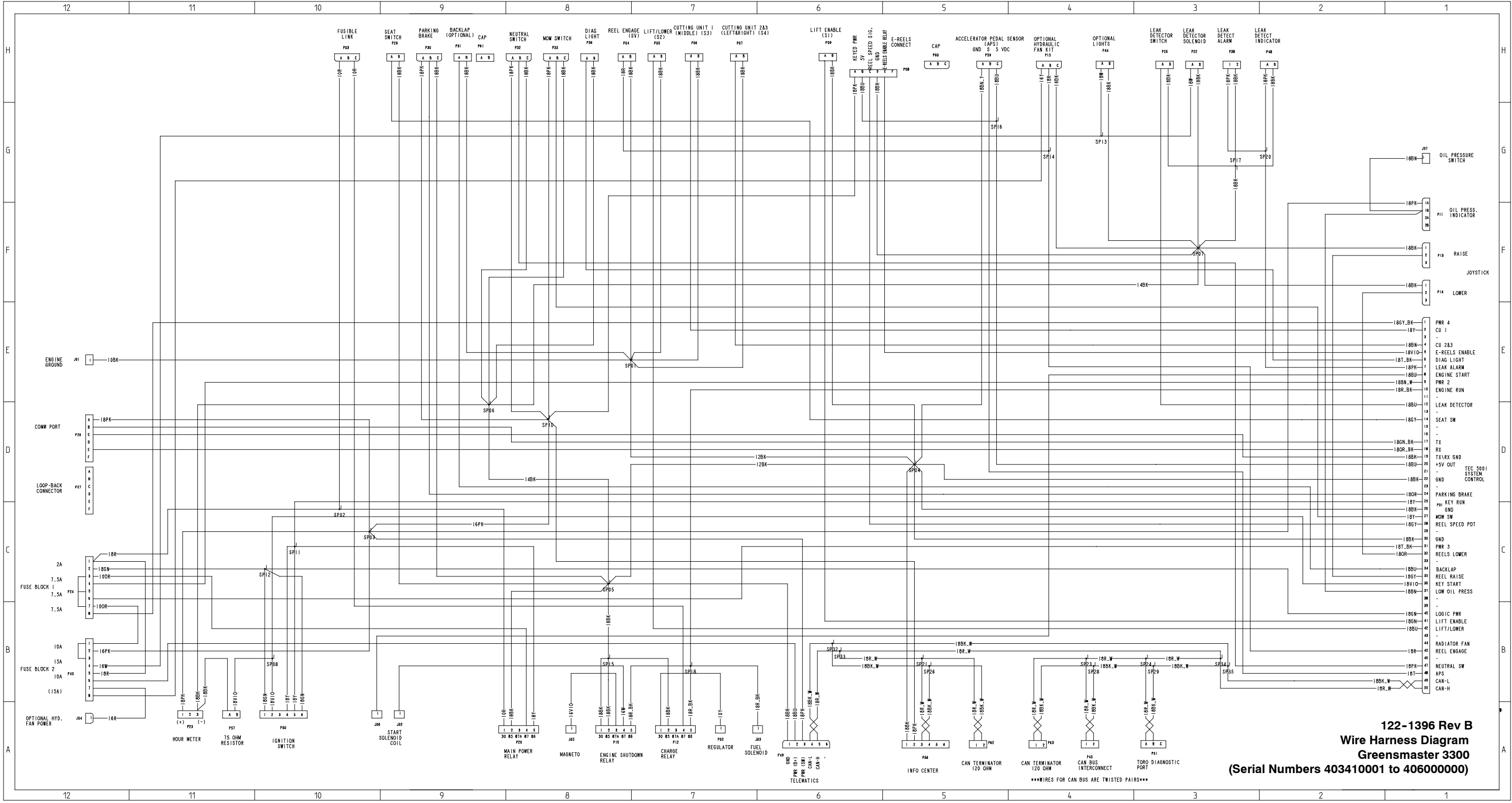


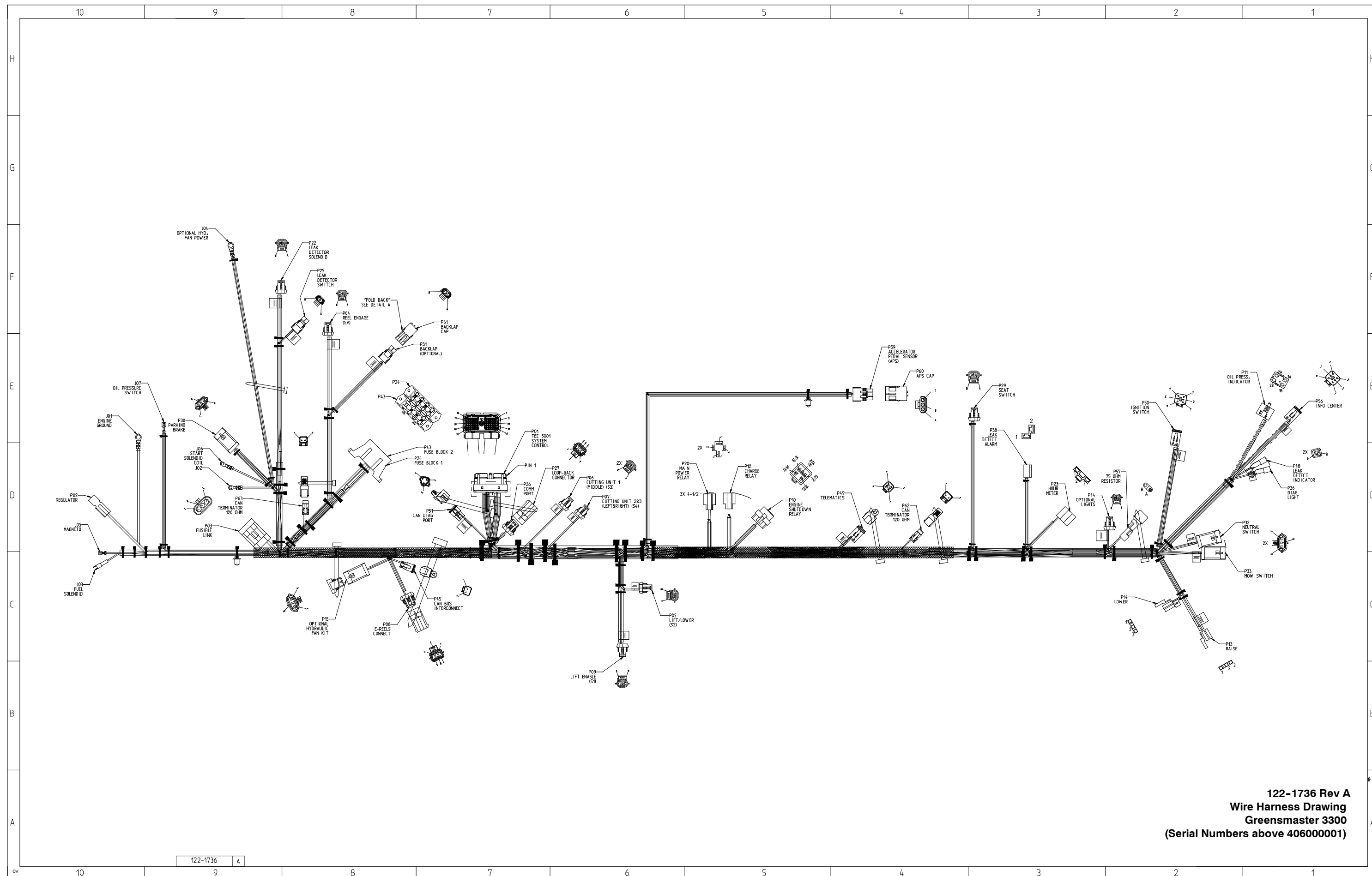
Greensmaster 3300
Wire Harness Diagram
(Serial Numbers 312000001 to 316000000)

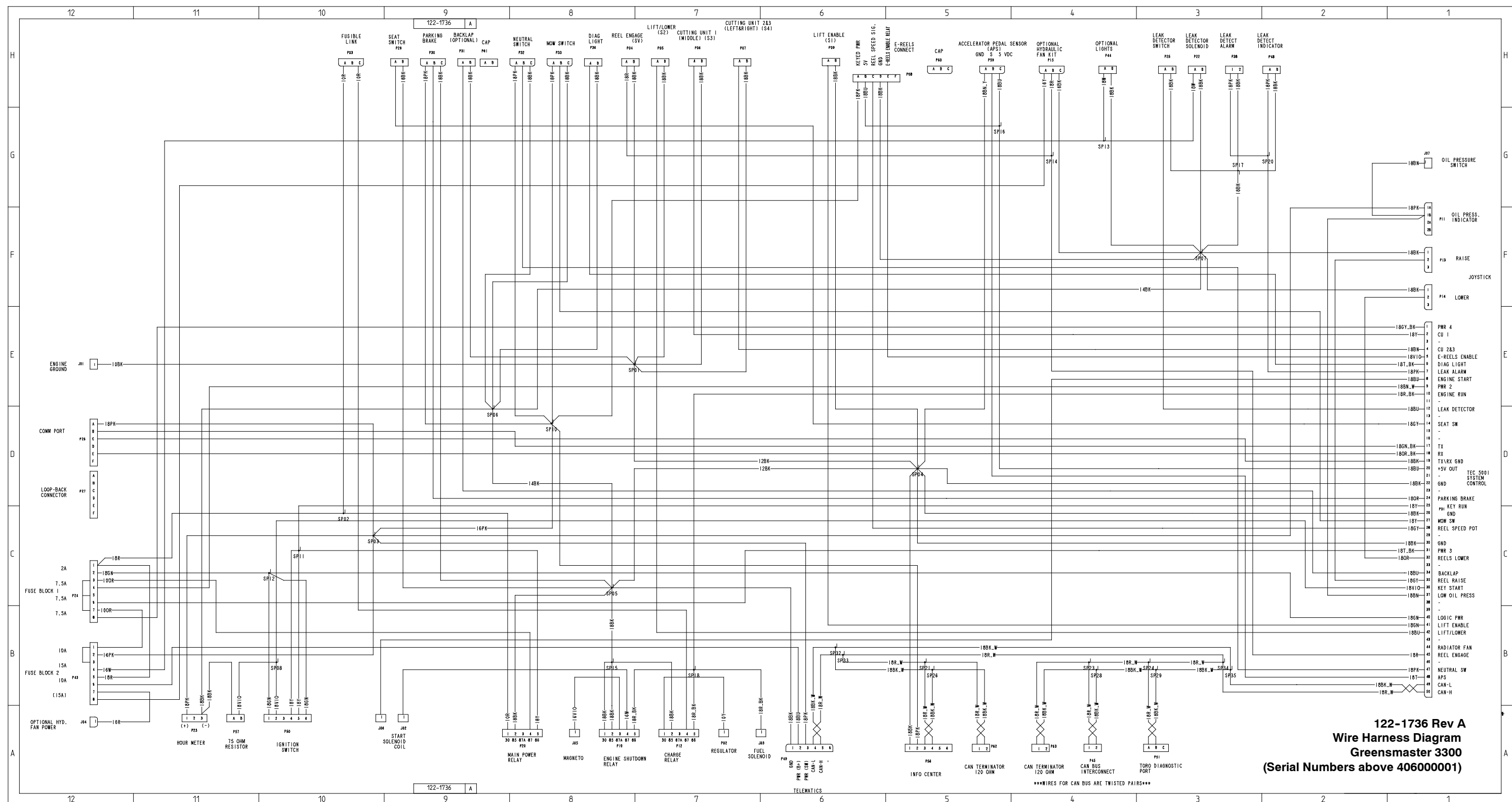


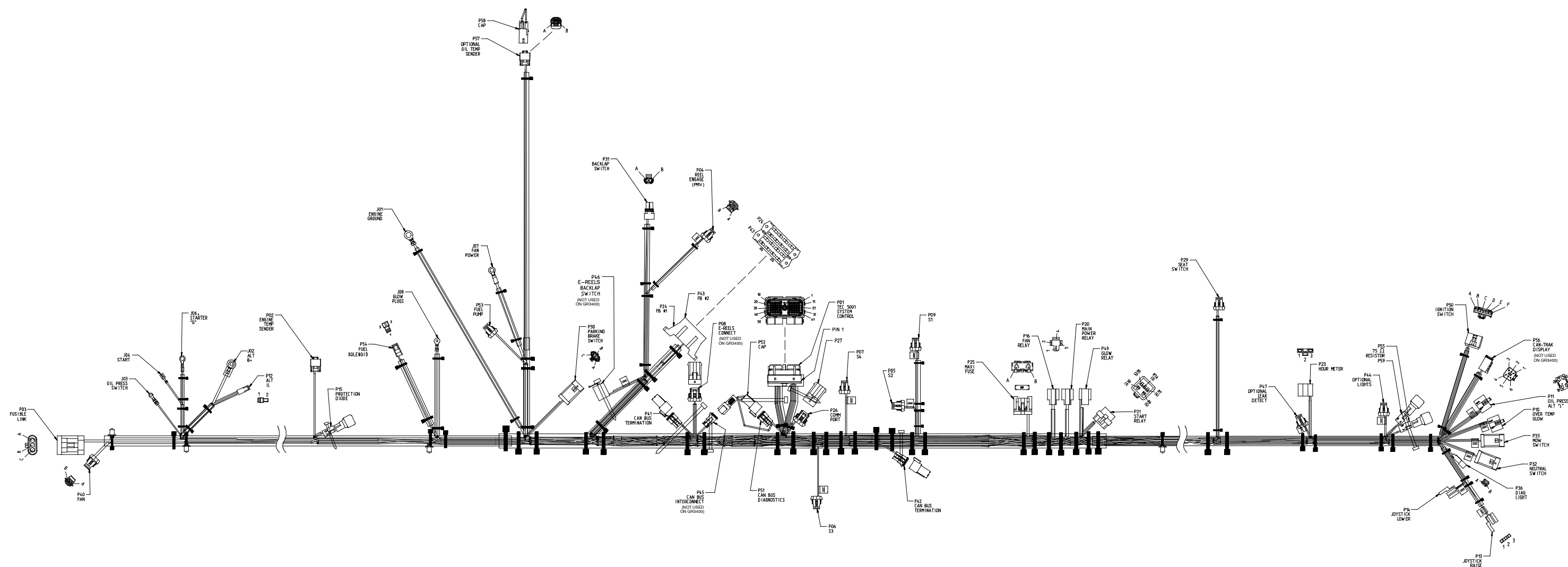




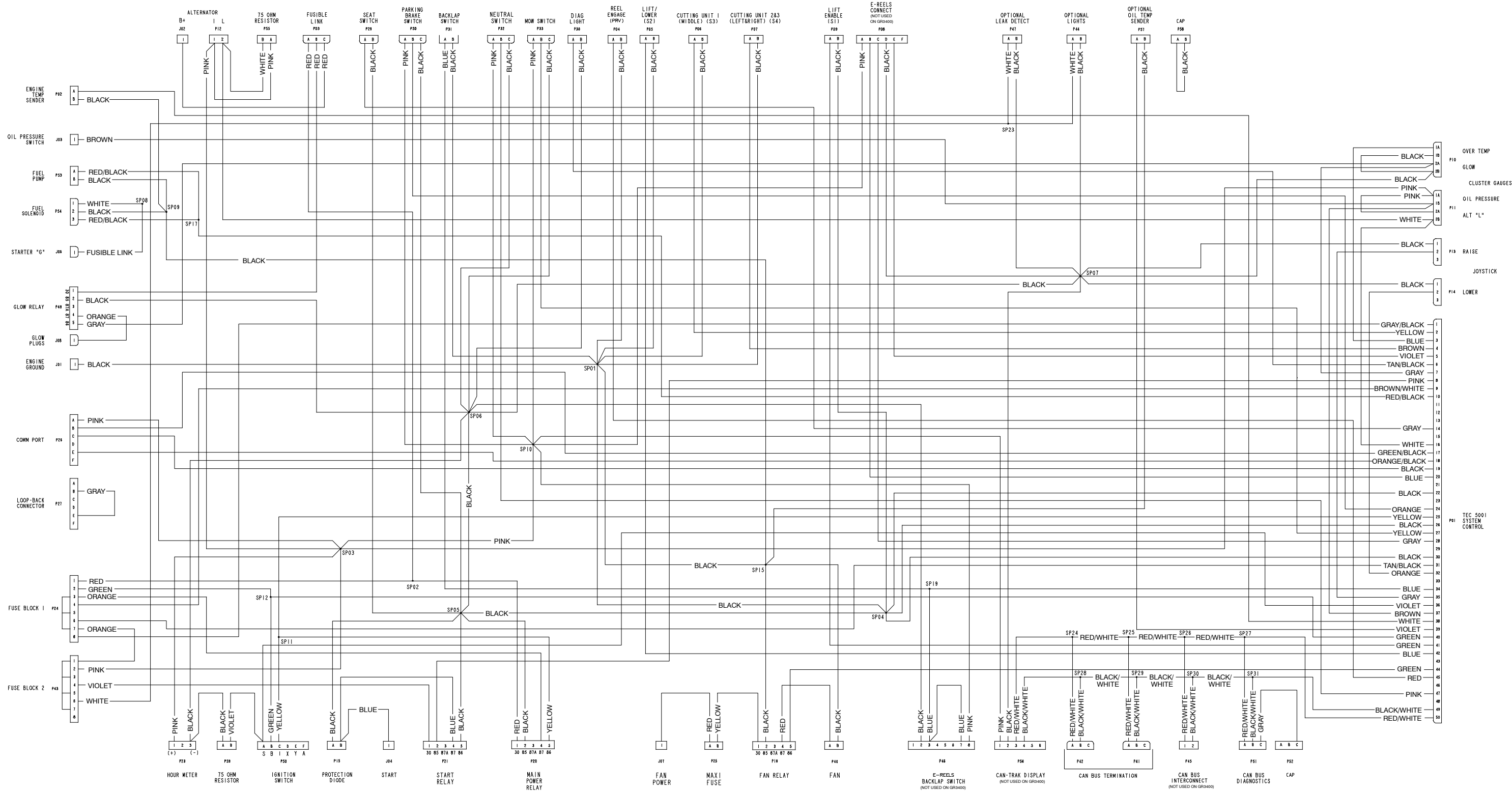








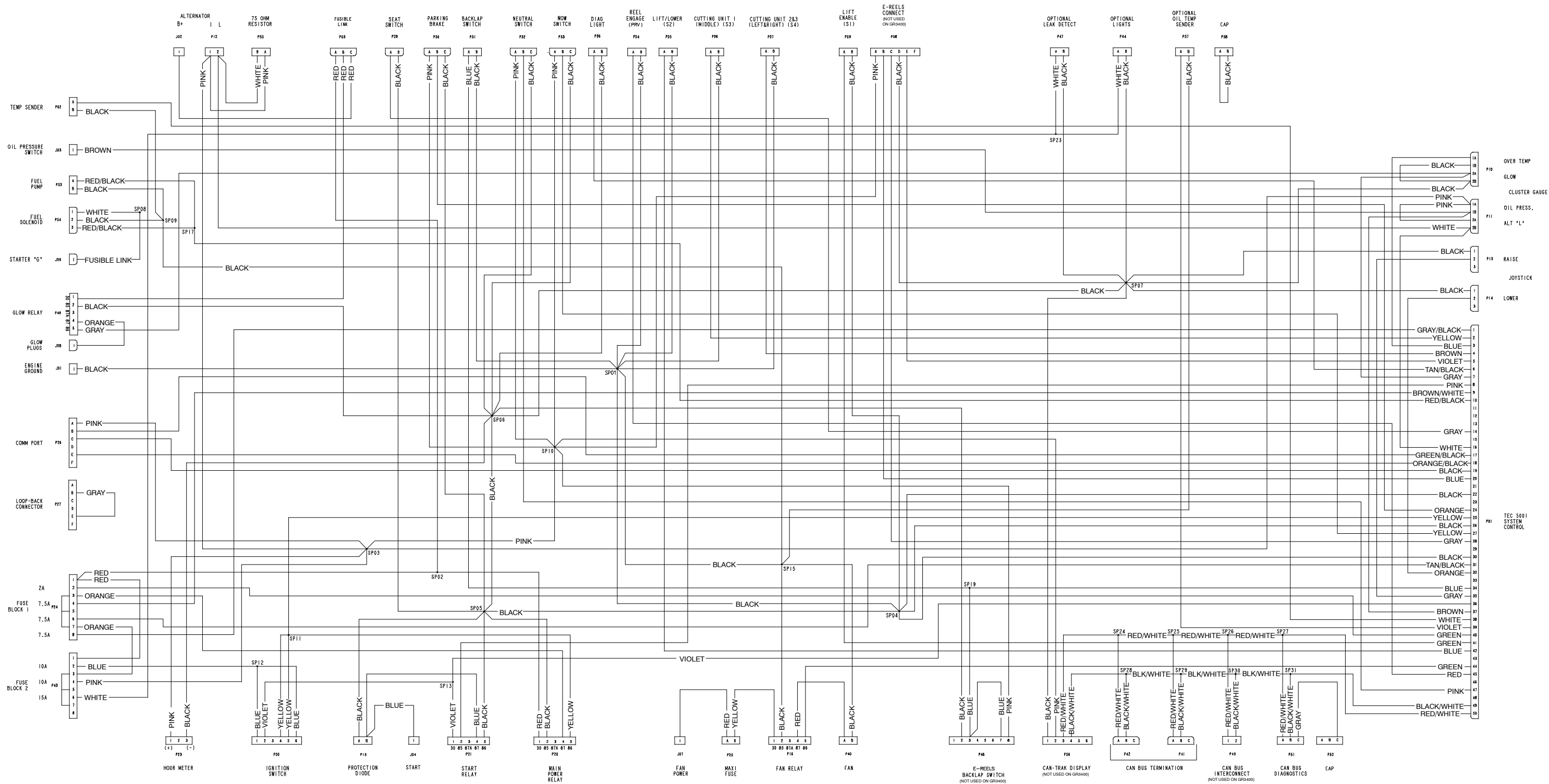
Greensmaster 3400
Wire Harness Drawing
 (Serial Number Below 312000000)



WIRES FOR CAN BUS ARE TWISTED PAIRS

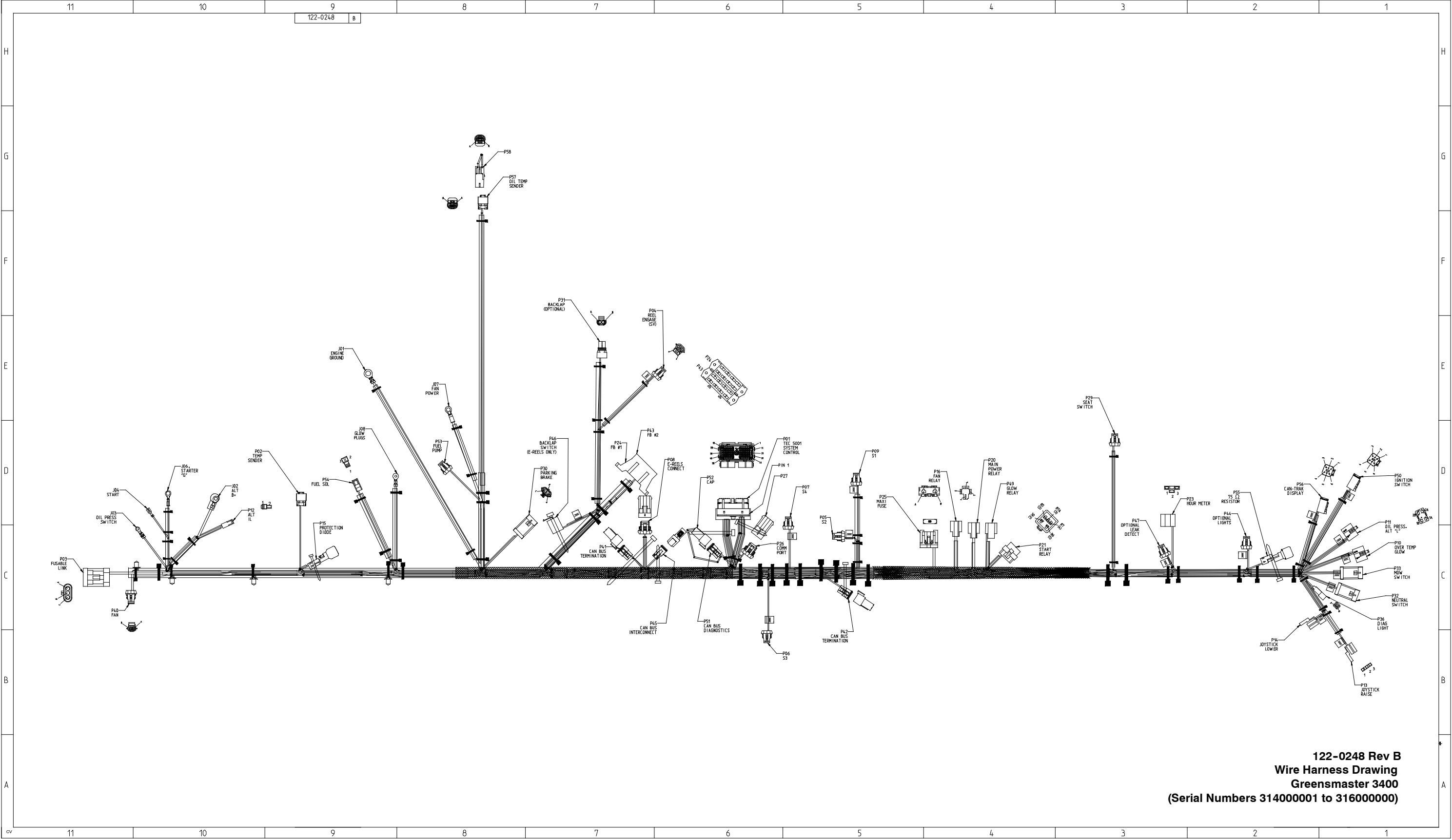
Greensmaster 3400
Wire Harness Diagram
(Serial Number Below 312000000)

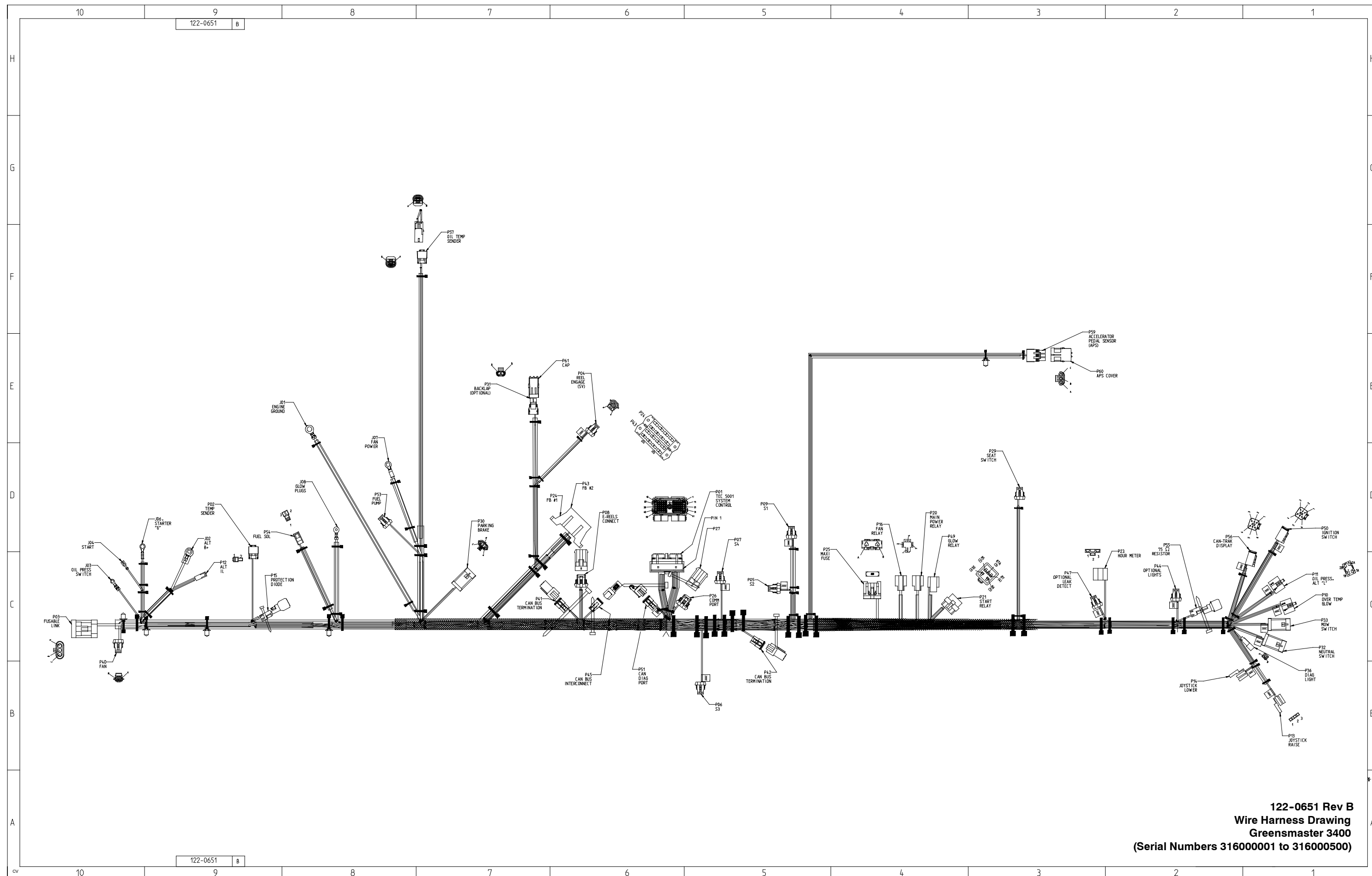




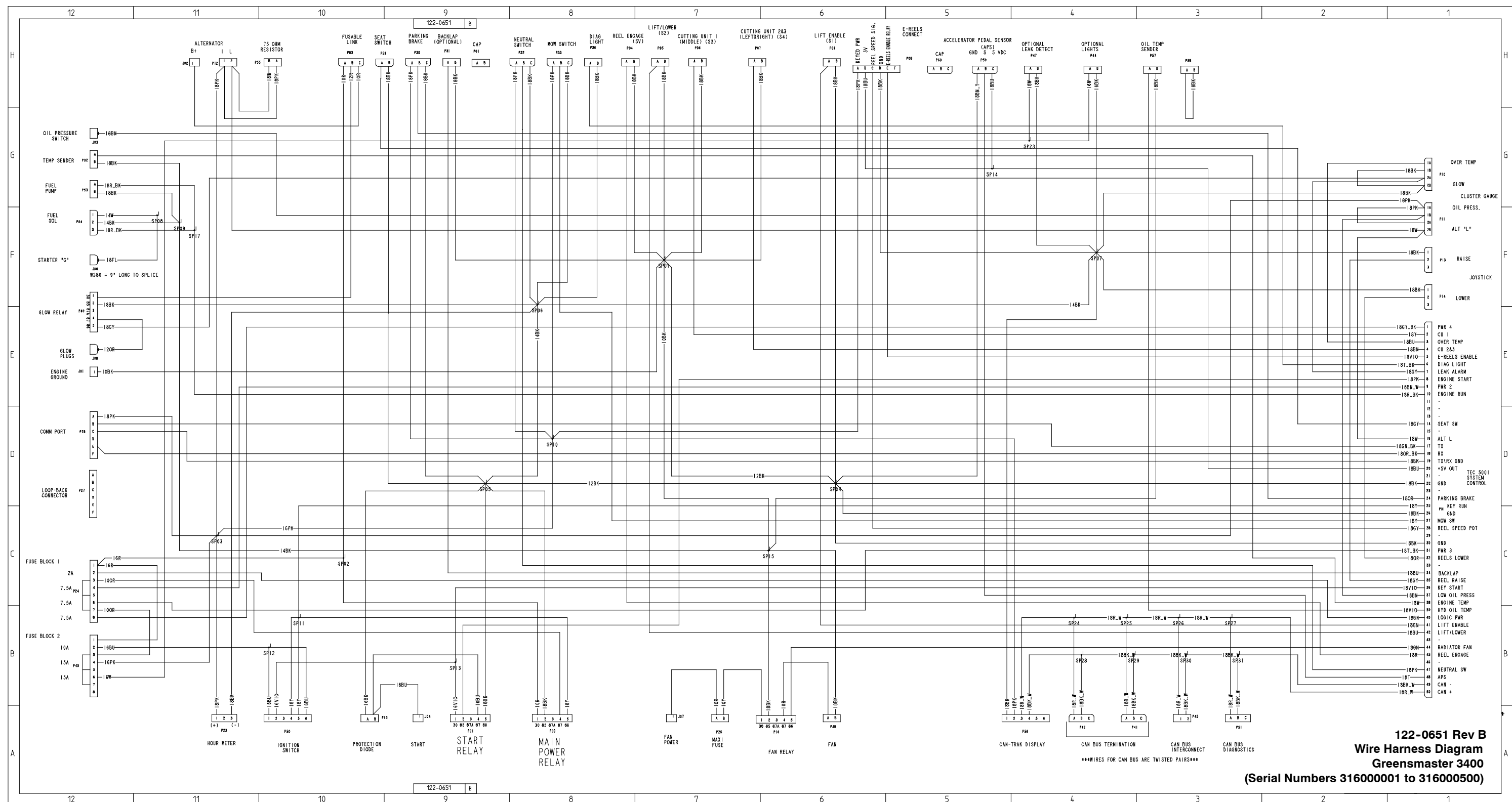
WIRES FOR CAN BUS ARE TWISTED PAIRS

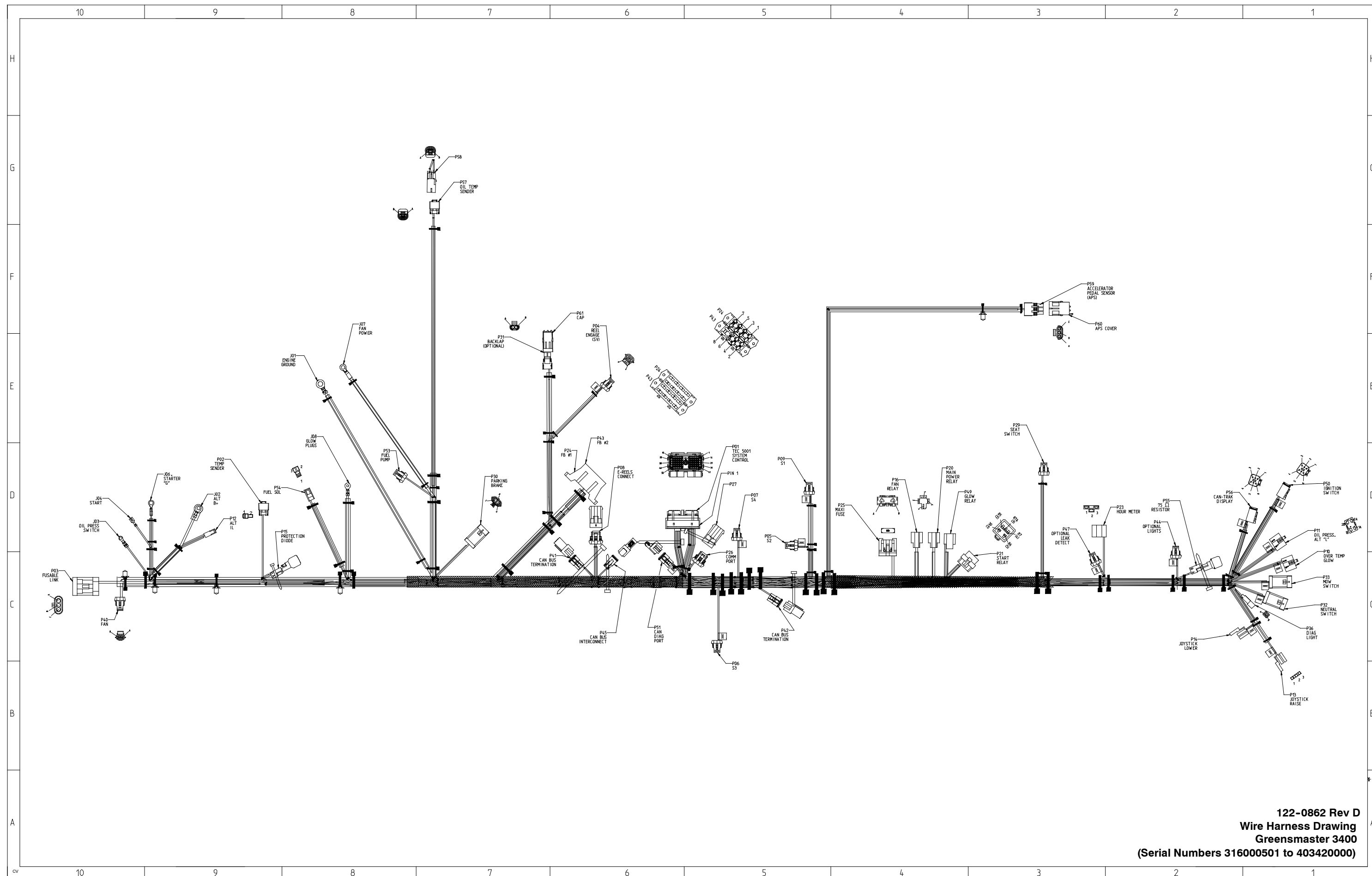
Greensmaster 3400
Wire Harness Diagram
(Serial Numbers 312000000 to 314000000)

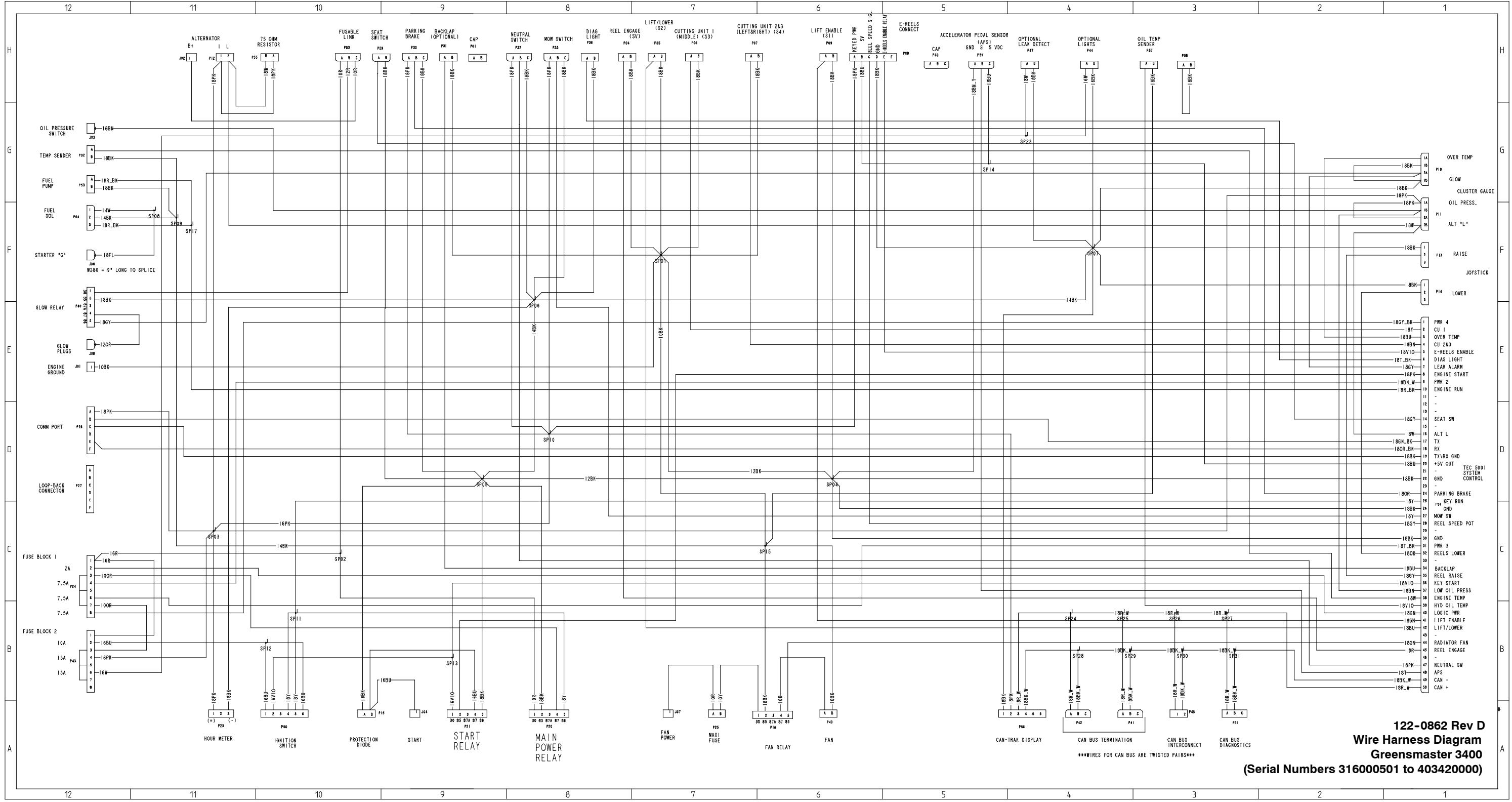


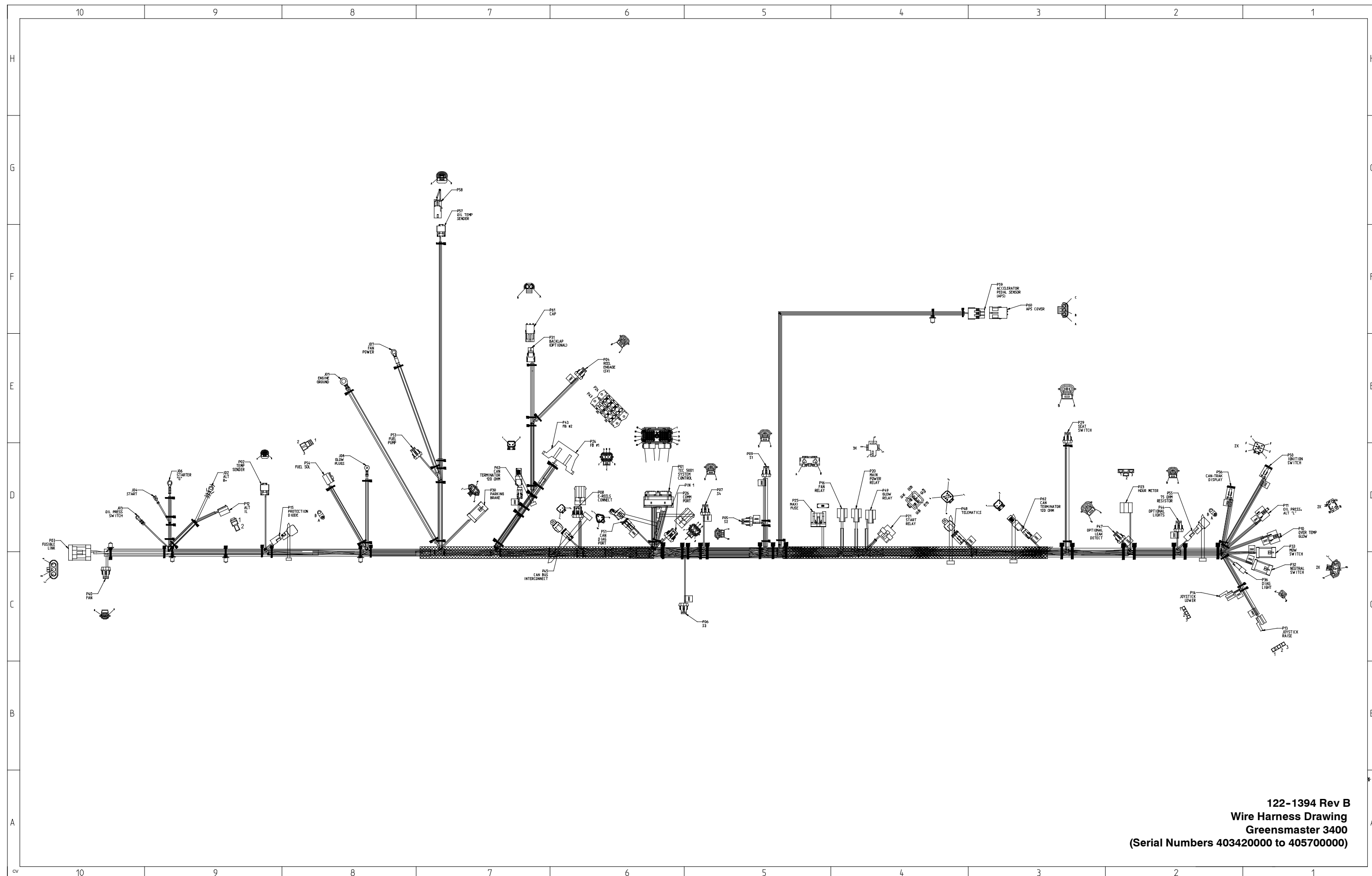


122-0651 Rev B
Wire Harness Drawing
Greensmaster 3400
(Serial Numbers 316000001 to 316000500)

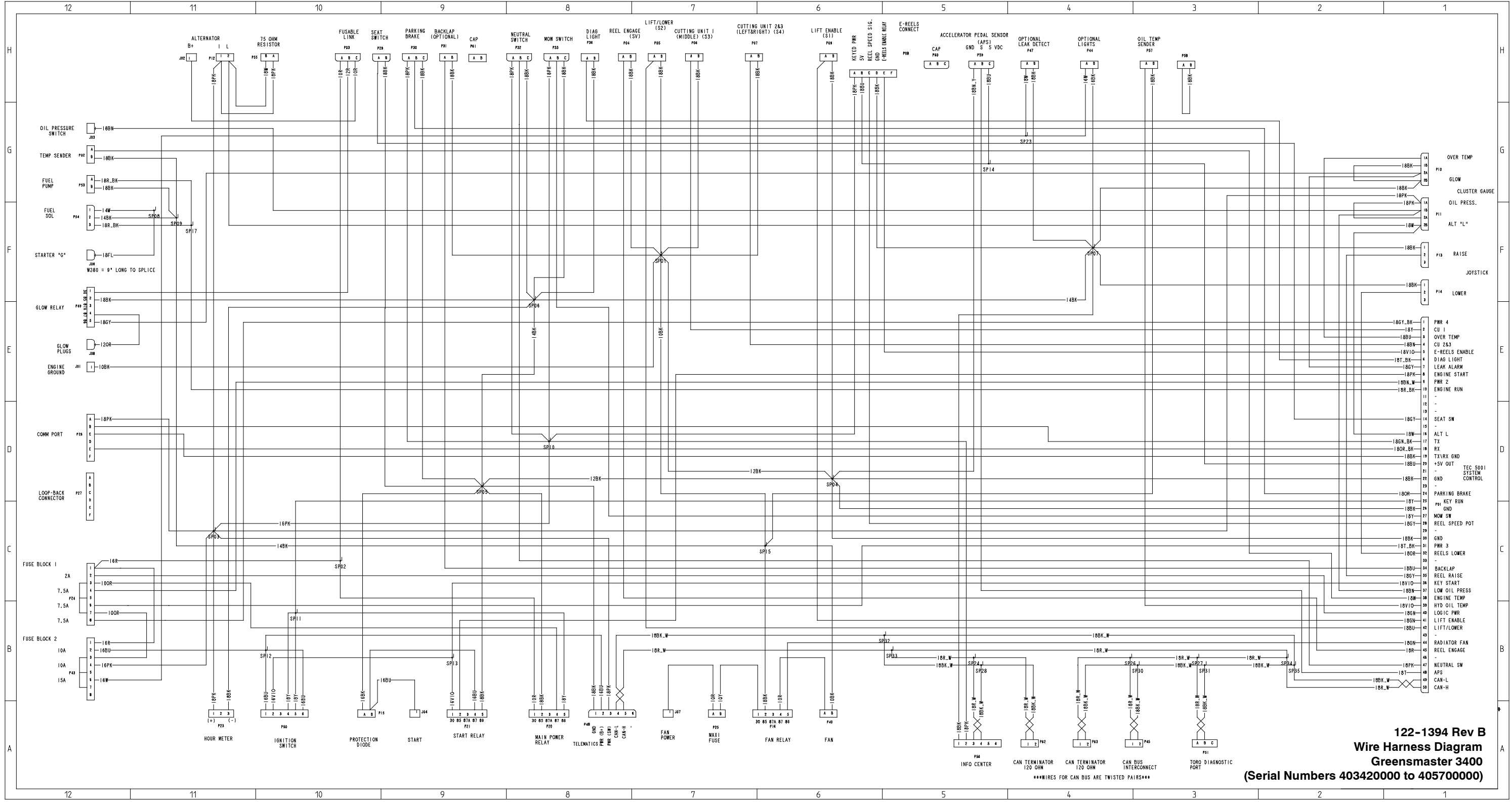


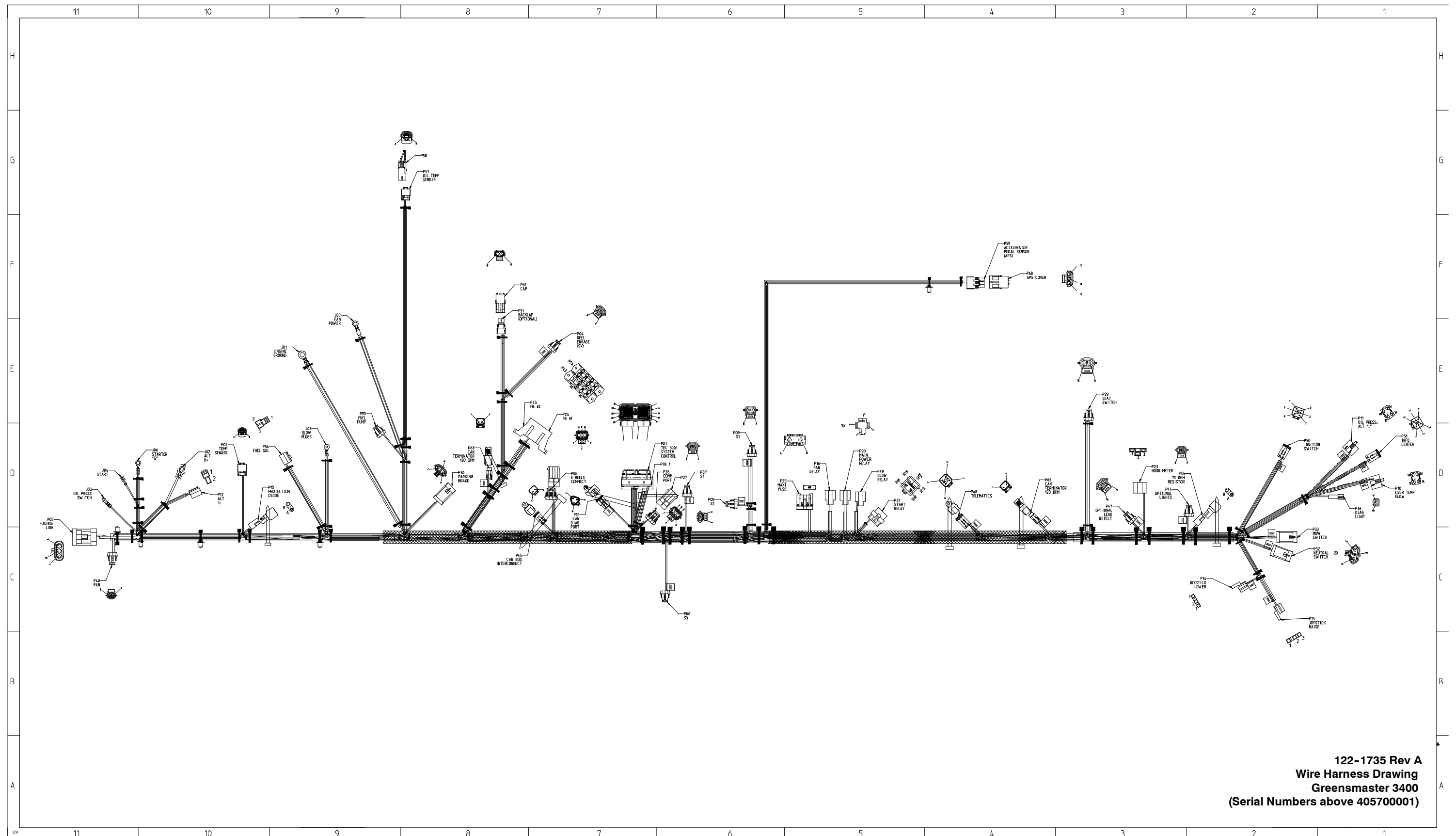




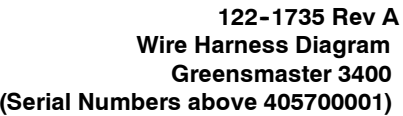


122-1394 Rev B
Wire Harness Drawing
Greensmaster 3400
(Serial Numbers 403420000 to 405700000)





122-1735 Rev A
Wire Harness Drawing
Greensmaster 3400
(Serial Numbers above 405700001)



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