Form No. 15216SL Rev E

Count on it.

Service Manual

Reelmaster® 5410/5510/5610 Series

(Models with InfoCenter Display)

8111 Lyndale Avenue South
Bloomington, MN 55420

Original Instructions (EN)
Contact us at www.Toro.com.

Revision History

Revision	Date	Description
–	03/2015	Initial issue.
A	01/2018	Incorporated 5610-D Model 03679
B	04/2018	Revised bedknife installation procedure and painted/aluminum side plate cutting unit information.
C	03/2019	Updated Chassis chapter.
D	05/2020	Updated wheel motor and brake service procedures, Cutting Unit, Universal Groomer and Electrical Drawings chapters.
E	06/2021	Updated Engine and Hydraulic chapters.

Reader Comments

The Toro Company Technical Assistance Center maintains a continuous effort to improve the quality and usefulness of its publications. To do this effectively, we encourage user feedback. Please comment on the completeness, accuracy, organization, usability, and readability of this manual by an e-mail to servicemanuals@toro.com

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NOTES:

Preface

The purpose of this publication is to provide the service technician with the information for troubleshooting, testing, and repair of the major systems and components of Reelmaster 5410, 5410-G, 5410-D, 5510, 5510-G, 5510-D, 5610, and 5610-D. Equipment model numbers covered in this manual include 03606, 03607, 03608, 03609, 03672, 03673, 03675, 03676, 03677, 03678, 03679, 03687, and 03689. All of these models include an InfoCenter Display on the operator control arm and several of the models comply with EPA Tier 4 emission regulations.

Refer to the *Operator's Manuals* for operating, maintenance, and adjustment instructions. Space is provided in Chapter 2 (page 2–1) of this book to insert the *Operator's Manuals* and *Parts Catalog* for your machine. Additional copies of the *Operator's Manuals* and *Parts Catalogs* are available at www.toro.com.

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

⚠ DANGER ⚠

This safety symbol means danger. When you see this symbol, carefully read the instructions that follow. Failure to obey the instructions could kill or cause serious permanent injury or disability.

⚠ WARNING ⚠

This safety symbol means warning. When you see this symbol, carefully read the instructions that follow. Failure to obey the instructions can result in serious injury.

⚠ CAUTION ⚠

This safety symbol means caution. When you see this symbol, carefully read the instructions that follow. Failure to obey the instructions can result in minor to moderate injury.

IMPORTANT

The *Important* notice will give the important instructions which you must follow to prevent damage to the systems or components on the machine.

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

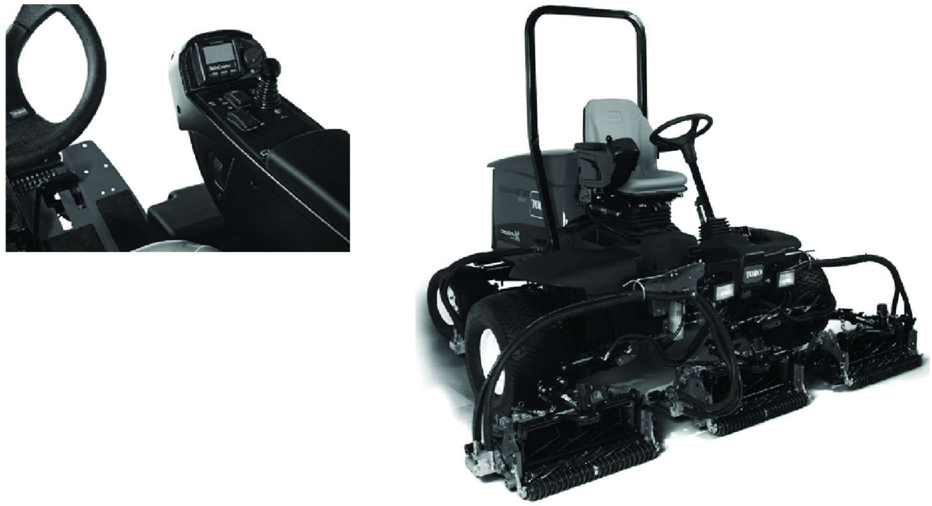

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Figure 1

Product Variations

<table>
<tr><th>Machine Name</th><th>Model Numbers</th><th>Engine</th><th>Traction Drive</th><th>Reel Drive</th><th>Cutting Unit</th></tr>
<tr><td>5410</td><td>03675</td><td>Kubota non-Tier4 compliant diesel engine</td><td rowspan="6">2-wheel drive</td><td rowspan="3">Smaller displacement gear pump</td><td rowspan="3">5 inch cutting units and smaller displacement reel motors without cross-over relief valves</td></tr>
<tr><td>5410-G</td><td>03608
03673</td><td>Kubota gasoline engine</td></tr>
<tr><td>5410-D</td><td>03606
03672</td><td>Yanmar Tier4 compliant engine</td></tr>
<tr><td>5510</td><td>03676</td><td>Kubota non-Tier4 compliant diesel engine</td><td rowspan="5">Larger displacement gear pump</td><td rowspan="5">7 inch cutting units and larger displacement reel motors with cross-over relief valves</td></tr>
<tr><td>5510-G</td><td>03609
03689</td><td>Kubota gasoline engine</td></tr>
<tr><td>5510-D</td><td>03607
03687</td><td>Yanmar Tier4 compliant engine</td></tr>
<tr><td>5610</td><td>03677
03678</td><td>Turbocharged Kubota non-Tier4 compliant diesel engine</td><td rowspan="2">4-wheel drive</td></tr>
<tr><td>5610-D</td><td>03679</td><td>Turbocharged Yanmar Tier4 compliant engine</td></tr>
</table>

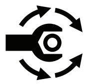
Service Procedure Icons

The following icons appear throughout this Service Manual to bring attention to specific important details of a service procedure.

Critical Process

This icon is used to highlight:

- installing safety equipment (shields, guards, seat belts, brakes and R.O.P.S. components) that may have been removed
- dimensions or settings that must be maintained for proper machine operation
- a specific fastener tightening sequence
- component orientation that may not be obvious



Critical Torque

This icon is used to highlight an assembly torque requirement that is different than what is recommended in the Standard Torque Tables; refer to Torque Specifications (page 2–5).

Fluid Specifications

This icon is used to highlight fluid specifications and capacities that are less common, and may not appear on the machine service decal or in the machine *Operator's Manual*.

Note: Refer to the service decal on the machine and the machine *Operator's Manual* for commonly used fluid specifications and capacities.

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Additional Reference Materials

Kubota Workshop Manual, Diesel Engine, 05-E3B Series

Yanmar TNV (Tier 4) Series Service Manual

Yanmar TNV (Tier 4) Series Troubleshooting Manual

Kubota Workshop Manual, WG1605-G-E3

Kubota Diagnosis Manual, ECM System, WG1605-G-E3

Danfoss LPV Closed Circuit Axial Piston Pump Service Manual

Eaton Delta Motors Parts and Repair Manual
Parker Torqmotor Service Procedure (TC, TB, TE, TJ, TF, TG, TH, and TL Series)
Danfoss Steering Unit Type OSPM Service Manual

Chapter 1

Safety

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Safety Instructions

The Reelmaster machines meets or exceeds safety standard specifications when weights are installed according to information in the *Operator's Manual*. Although hazard control and accident prevention are partially dependent upon the design and configuration of the machine, these factors are also dependent upon the awareness, concern, and proper training of the personnel involved in the operation, transport, maintenance, and storage of the machine. Improper use or maintenance of the machine can result in injury or death.

WARNING

To reduce the potential of injury or death, comply with the following safety instructions as well as information found in the *Operator's Manuals*.

Supervisor's Responsibilities

1. Ensure that the operators are fully trained and familiar with the *Operator's Manual*, *Operator's Training DVD*, and all of the operating and safety decals on the machine.
2. Establish your own special procedures and work rules for unusual operating conditions (e.g., slopes too steep for machine operation). Survey the mowing site completely to determine hills on which you can operate safely. When performing this site survey, always understand and take into consideration the turf condition and rollover risk.

Before Operating the Machine

- Review and understand the contents of the *Operator's Manuals* and *Operator's Training DVD* before starting and operating the machine. Become familiar with the controls and know how to stop the machine and engine quickly. Additional copies of the *Operator's Manuals* are available at www.toro.com.
- Keep all the shields, safety devices, and decals in place. If a shield, safety device, or decal is illegible or damaged, repair or replace it before operating the machine.
- Tighten any loose nuts, bolts, or screws to ensure that the machine is in safe operating condition.
- Ensure that the interlock switches are adjusted correctly so that the engine does not start unless the traction pedal is in the NEUTRAL position, and the reel engage switch is in the OFF (disengaged) position.
- Diesel fuel is highly flammable; handle it carefully.
  - Store fuel in containers specifically designed for storing fuel.
  - Do not remove the fuel tank cap of the machine while the engine is hot or running.
  - Do not smoke while handling fuel.
  - Fill the fuel tank outdoors and only to the bottom of the filler neck. Do not overfill the fuel tank.
  - After refueling the machine, install the fuel tank and fuel container caps.
  - If you spill fuel, do not attempt to start the engine but move the machine away from the spill. Avoid creating any source of ignition until fuel vapors have dissipated. Wipe up any spilled fuel.

While Operating the Machine

- Sit on the seat when starting and operating the machine.
- Anytime you park the machine (short or long term), lower the cutting decks to the ground.

IMPORTANT

When you lower the cutting deck to the ground, the pressure from the hydraulic lift circuit releases and prevents the cutting deck from accidentally lowering.

- If you park the machine on a slope, block or chock the wheels.

Before starting the machine

DANGER

The exhaust fumes are hazardous and have the potential of injury or death.

Do not run the engine in a confined area without adequate ventilation.

1. Set the parking brake.
2. Ensure that the traction pedal is in the NEUTRAL position and the reel engage switch is in the OFF (disengaged) position.
3. After you start the engine, release the parking brake and keep foot off the traction pedal. Ensure that the machine does not move.

   Note: If machine movement is evident, the traction pedal linkage is adjusted incorrectly; therefore, shut off the engine and adjust the traction pedal linkage until the machine does not move when you release the traction pedal; refer to the *Operator's Manual*.

CAUTION

Running the engine causes the engine, radiator, and exhaust system to become hot. Touching a hot engine, radiator, or exhaust system can burn you.

Do not touch the engine, radiator, or exhaust system while the engine is running or soon after you stop it.

Before stopping the machine

1. Ensure that the traction pedal is in the NEUTRAL position.
2. Lower and disengage the cutting decks and wait for all moving parts to stop.
3. Set the parking brake.
4. Shut off the engine and remove the key from the key switch.

Maintenance and Service

- Before servicing or making any adjustments to the machine, lower the cutting decks, set the parking brake, shut off the engine, and remove the key from the key switch.
- Ensure that the machine is in safe operating condition by keeping all the nuts, bolts, and screws tight.
- Do not store the machine or a fuel container inside where there is an open flame, such as near a water heater or furnace.
- Ensure that all of the hydraulic line connectors are tight and that all the hydraulic hoses and lines are in good condition before applying pressure to the hydraulic system.
- Keep your body and hands away from pin-hole leaks in the hydraulic lines that eject hydraulic fluid under high pressure. Use cardboard or paper to find hydraulic leaks. The hydraulic fluid escaping under pressure can penetrate the skin and cause injury. If hydraulic fluid is accidentally injected into the skin, you must have it surgically removed within a few hours by a doctor familiar with this type of injury. Otherwise, gangrene may result.
- Before disconnecting or performing any work on the hydraulic system, release all the pressure in the system by parking the machine on a level surface, lowering the cutting deck (or implement) completely, and then shutting off the engine.
- Use care when checking or servicing the cutting deck. Wear gloves and use caution when servicing the deck.
- To reduce potential fire hazards, keep the engine area free of excessive grease, grass, leaves, and dirt. Clean the protective screen on the machine frequently.
- If you must run the engine to perform maintenance or to make an adjustment, keep your hands, feet, clothing, and other parts of the body away from the cutting decks and other moving parts. Keep bystanders away.
- Do not overspeed the engine by changing the engine governor setting. To ensure safety and accuracy, check the maximum engine speed with a tachometer.
- Shut off the engine before checking or adding oil to the engine crankcase.
- Disconnect the battery before servicing the machine. Disconnect the negative battery cable and then the positive cable. If battery voltage is necessary for troubleshooting or test procedures, temporarily connect the battery. Connect the positive battery cable and then the negative cable.
- Battery acid is poisonous and can cause burns. Avoid acid contact with skin, eyes, and clothing. Protect your face, eyes, and clothing when working with a battery.
- Battery gases can explode. Keep cigarettes, sparks, and flames away from the battery.
- When changing the attachments, tires, or performing other service, use correct blocks, hoists, and jacks to raise and support the machine. Ensure that the machine is parked on a solid level surface, such as a concrete floor. Before you lift the machine, remove all the attachments that may interfere with the safe and correct lift of the machine. Always block the wheels with chocks. Use appropriate jack stands to support the raised machine. Failing to properly support the machine with appropriate jack stands can cause the machine to move or fall and can result in personal injury; refer to Jacking Instructions (page 1–6).
- If major repairs are necessary, contact your Authorized Toro Distributor.
- When welding on the machine, disconnect all the battery cables to prevent damage to the machine electronic equipment. Disconnect the negative

battery cable and then the positive cable. Disconnect the engine wire harness from the Toro Electronic Controller (TEC), disconnect and remove the engine ECU, and disconnect the terminal connector from the alternator, attach the welder ground cable not more than 610 mm (2 ft) from the welding location.

- Ensure to dispose of potentially harmful waste (e.g., fuel, oil, engine coolant, filters, battery) in an environmentally safe manner. Follow all local codes and regulations when recycling or disposing of waste.
- At the time of manufacture, the machine conformed to the safety standards for riding mowers. To ensure the optimum performance and continued safety certification of the machine, use genuine Toro replacement parts and accessories. The replacement parts and accessories of other manufacturers can result in non-conformance with the safety standards and can void the warranty.

Jacking Instructions

CAUTION

Failing to properly support the machine with appropriate jack stands can cause the machine to move or fall and can result in personal injury.

When changing the attachments, tires, or performing other services, do the following steps:

- **Use correct blocks, hoists, and jacks to raise and support the machine.**
- **Park the machine on a solid level surface, such as a concrete floor.**
- **Before you lift the machine, remove all the attachments that may interfere with the safe and correct lift of the machine.**
- **Always block the wheels with chocks.**
- **Use appropriate jack stands to support the raised machine.**
- **Do not use the cutting deck or implement as a jacking point.**

Raising the Front of the Machine

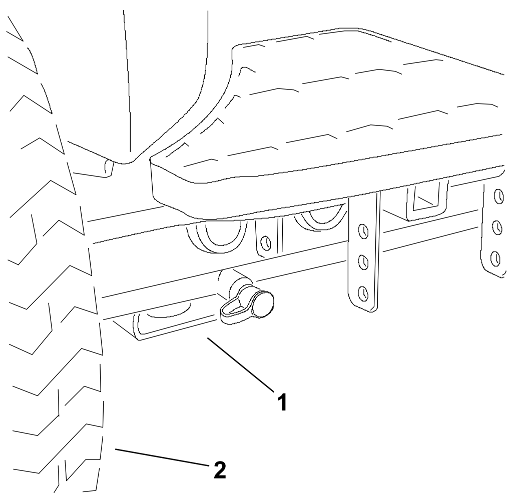

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Figure 2

1. Front jacking point
2. Front wheel

1. Set the parking brake and block the 2 rear wheels with chocks to prevent the machine from moving.
2. Position the jack under the rectangular pad on the front axle tube, just to the inside of the front wheel (Figure 2).
3. Use a jack to raise the front of the machine.
4. Position jack stands under the frame as close to the wheel as possible to support the machine.

Raising the Rear of the Machine

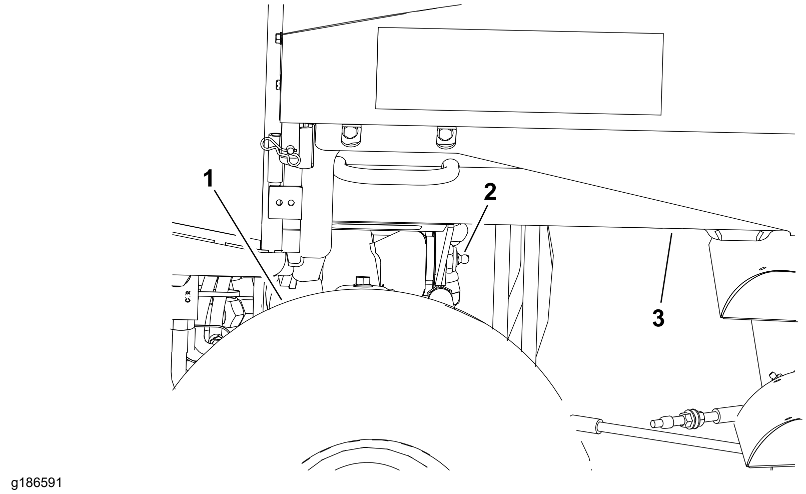

Figure 3

1. Rear wheel
2. Rear axle pivot bracket
3. Jack stand location

1. Set the parking brake and block the 2 front wheels with chocks to prevent the machine from moving.
2. Position the jack securely at the center of the rear axle under the axle pivot bracket. Lift the rear of the machine off the ground.
3. Position the jack stands under the frame to support the machine (Figure 3).

Safety and Instructional Decals

Numerous safety and instruction decals are affixed to the traction unit and cutting units of your Reelmaster. If any decal becomes illegible or damaged, install a new decal. Decal part numbers are listed in your *Parts Catalog*. Order replacement decals from Authorized Toro Distributor.

Specifications and Maintenance

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Specifications

Insert a copy of the *Operator's Manuals* and *Parts Catalogs* for your machine at the end of this chapter. Additionally, if any optional equipment or accessories are installed to your machine, insert the *Installation Instructions*, *Operator's Manuals*, and *Parts Catalogs* for those options at the end of this chapter.

The maintenance procedures and recommended service intervals for your machine are covered in the *Operator's Manuals*. Refer to this publication when performing the regular equipment maintenance. Several maintenance procedures have break-in intervals identified in the *Operator's Manual*. Refer to the *Engine Operator's Manual* for additional engine specific maintenance procedures.

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

Decimal and Millimeter Equivalents (continued)

Fractions			Decimals	mm	Fractions			Decimals	mm
		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 inch					**0.001 inch = 0.0254 mm**				

U.S. to Metric Conversions

	To Convert	Into	Multiply By
Linear Measurement	Miles	Kilometers	1.609
	Yards	Meters	0.914
	Feet	Meters	0.305
	Feet	Centimeters	30.48
	Inches	Meters	0.025
	Inches	Centimeters	2.54
	Inches	Millimeters	25.4
Area	Square Miles	Square Kilometers	2.59
	Square Feet	Square Meters	0.093
	Square Inches	Square Centimeters	6.452
	Acre	Hectare	0.405
Volume	Cubic Yards	Cubic Meters	0.765
	Cubic Feet	Cubic Meters	0.028
	Cubic Inches	Cubic Centimeters	16.39
Weight	Tons (Short)	Metric Tons	0.908
	Pounds	Kilograms	0.454
	Ounces (Avdp.)	Grams	28.349
Pressure	Pounds/Sq. In.	Kilopascal	6.895
	Pounds/Sq. In.	Bar	0.069
Work	Foot-pounds	Newton-Meters	1.356
	Foot-pounds	Kilogram-Meters	0.138
	Inch-pounds	Kilogram-Centimeters	1.152
Liquid Volume	Quarts	Liters	0.946
	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

The 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 the fasteners will apply to all the fasteners which do not have a specific requirement identified in this *Service Manual*. The following factors must be considered when applying the 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 (e.g., Nylock nut), hardness of the surface underneath the head of the fastener, or similar condition which affects the installation.

As noted in the following tables, the torque values should be reduced by 25% for the lubricated fasteners to achieve the similar stress as a dry fastener. The torque values must be reduced when the fastener is threaded into the 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 checking the torque can be performed by marking a line on the fastener (head or nut) and mating part, then back off the fastener 1/4 of a turn. Measure the torque necessary to tighten the fastener until the lines match up.

Identifying the Fastener

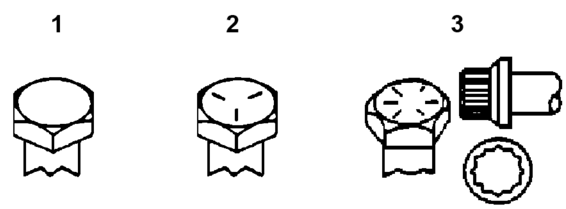

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Figure 4

Inch Series Bolts and Screws

1. Grade 1
2. Grade 5
3. Grade 8

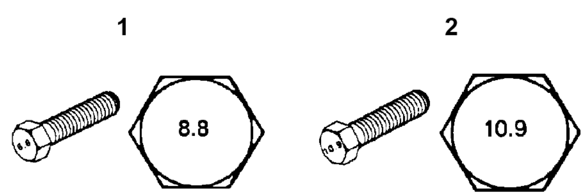

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Figure 5

Metric Bolts and Screws

1. Class 8.8
2. Class 10.9

Fasteners with a Locking Feature

Threaded fasteners can loosen when exposed to shock, vibration and other dynamic forces. In these situations, a locking feature may be used. A fastener with a locking feature is designed to resist loosening. Locking features can be

Fasteners with a Locking Feature (continued)

found on externally threaded fasteners such as screws, or on internally threaded fasteners such as nuts. Locking features are designed to create friction, so even after slight loosening, the friction continues to resist further loosening. Keep in mind, a fastener with a locking feature usually means there will be friction during assembly as well.

Most fasteners with a locking feature can be reused, but the force required to loosen the fastener may decline with subsequent reuses which will reduce the effectiveness of the locking feature. For this reason, Toro recommends replacing fasteners with a locking feature once they have been removed. Knowing that this is not always realistic, apply a threadlocker (Loctite) when reusing a fastener with a locking feature. Use the appropriate strength and type of threadlocker based on application, fastener size or information found in the product Operators Manual, Service Manual, or Installation Instructions.

Note: If a fastener is removed that has had a threadlocker previously applied, clean the fastener threads and apply new threadlocker to the fastener during assembly.

Calculating the Torque Values When Using a Drive-Adapter Wrench

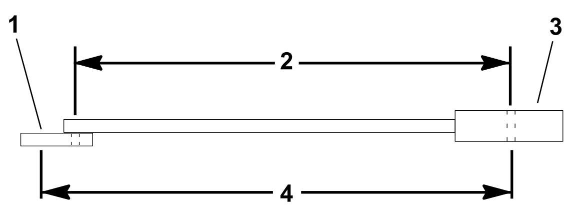


Figure 6

1. Drive-adapter wrench
2. Effective length of torque wrench
3. Torque wrench
4. Effective length of torque wrench + drive-adapter wrench

Using a drive-adapter wrench (e.g., crowfoot wrench) in any position other than 90° and 270° to the frame of the torque wrench will affect the torque value measured by the torque wrench because of the effective length (lever) of the torque wrench changes. When using a torque wrench with a drive-adapter wrench, multiply the listed torque recommendation by the calculated torque conversion factor (Figure 6) to determine proper tightening torque. When using a torque wrench with a drive-adapter wrench, the calculated torque 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 457 mm (18 inches).

The measured effective length of the torque wrench with the drive-adapter wrench installed (distance from the center of the handle to the center of the drive-adapter wrench) is 483 mm (19 inches).

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

If the listed torque recommendation for a fastener is **103 to 127 N·m (76 to 94 ft-lb)**, the proper torque when using this torque wrench with a drive-adapter wrench would be **98 to 121 N·m (72 to 89 ft-lb)**.

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

Thread Size	Grade 1, 5 and 8 with Thin Height Nuts	SAE Grade 1 Bolts, Screws, Studs, and Sems with Regular Height Nuts (SAE J995 Grade 2 or Stronger Nuts)		SAE Grade 5 Bolts, Screws, Studs, and Sems with Regular Height Nuts (SAE J995 Grade 2 or Stronger Nuts)		SAE Grade 8 Bolts, Screws, Studs, and Sems with Regular Height Nuts (SAE J995 Grade 2 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	169 ± 23	23 ± 3	262 ± 34
# 6 - 40 UNF				17 ± 2	192 ± 23	25 ± 3	282 ± 34
# 8 - 32 UNC	13 ± 2	25 ± 5	282 ± 56	29 ± 3	328 ± 34	41± 5	463 ± 56
# 8 - 36 UNF				31 ± 4	350 ± 45	43 ± 5	486 ± 56
# 10 - 24 UNC	18 ± 2	30 ± 5	339 ± 56	42 ± 5	475 ± 56	60 ± 6	678 ± 68
# 10 - 32 UNF				48 ± 5	542 ± 56	68 ± 7	768 ± 79
1/4 - 20 UNC	48 ± 7	53 ± 7	599 ± 79	100 ± 10	1130 ± 113	140 ± 15	1582 ± 169
1/4 - 28 UNF	53 ± 7	65 ± 10	734 ± 113	115 ± 12	1299 ± 136	160 ± 17	1808 ± 192
5/16 - 18 UNC	115 ± 15	105 ± 15	1186 ± 169	200 ± 25	2260 ± 282	300 ± 30	3390 ± 339
5/16 - 24 UNF	138 ± 17	128 ± 17	1146 ± 192	225 ± 25	2542 ± 282	325 ± 33	3672 ± 373
	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 ± 5	58 ± 7
3/8 - 24 UNF	17 ± 2	18 ± 2	24 ± 3	35 ± 4	47 ± 5	50 ± 6	68 ± 8
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 ± 6	75 ± 8	77 ± 8	104 ± 11
1/2 - 13 UNC	30 ± 3	48 ± 7	65 ± 9	75 ± 8	102 ± 11	105 ± 11	142 ± 15
1/2 - 20 UNF	32 ± 4	53 ± 7	72 ± 9	85 ± 9	115 ± 12	120 ± 12	163 ± 16
5/8 - 11 UNC	65 ± 10	88 ± 12	119 ± 16	150 ± 15	203 ± 20	210 ± 21	285 ± 28
5/8 - 18 UNF	75 ± 10	95 ± 15	129 ± 20	170 ± 18	230 ± 24	240 ± 24	325 ± 33
3/4 - 10 UNC	93 ± 12	140 ± 20	190 ± 27	265 ± 27	359 ± 37	375 ± 38	508 ± 52
3/4 - 16 UNF	115 ± 15	165 ± 25	224 ± 34	300 ± 30	407 ± 41	420 ± 43	569 ± 58
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 ± 48	644 ± 65	667 ± 66	904 ± 89

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

Note: The torque values must be reduced when installing the fasteners into threaded aluminum or brass. The specified torque value should be determined based on the aluminum or base material strength, fastener size, 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. The 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 ± 6 in-lb	644 ± 68 N·cm	78 ± 8 in-lb	881 ± 90 N·cm
M6 X 1.0	96 ± 10 in-lb	1085 ± 113 N·cm	133 ± 14 in-lb	1503 ± 158 N·cm
M8 X 1.25	19 ± 2 ft-lb	26 ± 3 N·m	28 ± 3 ft-lb	38 ± 4 N·m
M10 X 1.5	38 ± 4 ft-lb	52 ± 5 N·m	54 ± 6 ft-lb	73 ± 8 N·m
M12 X 1.75	66 ± 7 ft-lb	90 ± 10 N·m	93 ± 10 ft-lb	126 ± 14 N·m
M16 X 2.0	166 ± 17 ft-lb	225 ± 23 N·m	229 ± 23 ft-lb	310 ± 31 N·m
M20 X 2.5	325 ± 33 ft-lb	440 ± 45 N·m	450 ± 46 ft-lb	610 ± 62 N·m

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

Note: The torque values must be reduced when installing the fasteners into threaded aluminum or brass. The specified torque value should be determined based on the aluminum or base material strength, fastener size, 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

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

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)

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

**The hole size, material strength, material thickness, and material finish must be considered when determining the specified torque values. All the torque values are based on the non-lubricated fasteners.

Conversion Factors

in-lb X 11.2985 = N·cm

ft-lb X 1.3558 = N·m

N·cm X 0.08851 = in-lb

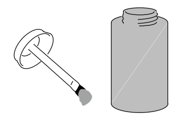
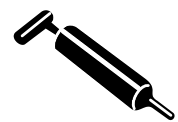
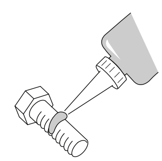
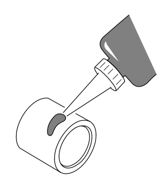
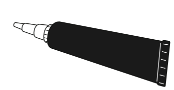
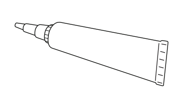
N·m X 0.7376 = ft-lb

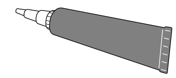
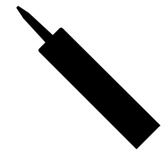
Shop Supplies

The procedures found in this *Service Manual* may recommend the use of commonly used shop supplies (lubricants, sealants and adhesives). A symbol denoting the use of a shop supply may appear in figures that support a procedure. Always refer to the written procedure for specific information regarding the type and the application of a shop supply.

IMPORTANT

Always follow manufacturers instructions when using or storing shop supplies.

ANTI-SEIZE LUBRICANT Used to prevent corrosion, galling and seizure between metal parts. Most often applied to shafts and bores during assembly. Unless otherwise specified, high viscosity regular grade lithium-graphite based anti-seize lubricant should be used.	
GREASE Can be used to pre-fill (pack) bearings, boots and seals prior to assembly, ease installation of components during assembly, or fill cavities between moving parts through grease fittings after assembly. Unless otherwise noted, refer to the machine *Operator's Manual* or *Installation Instructions* for grease specifications.	
THREAD LOCKING COMPOUND (Thread Locker) Used to lock threaded fasteners in position. Available in low, medium and high strength for various size fasteners and applications. Most thread locking compounds are applied immediately prior to fastener installation. Some thread locking compounds use a "Wicking" feature, and can be applied after fastener installation. Most thread locking compounds allow the fastener to be removed with standard tools once cured. High strength thread locking compounds may require applying heat to the fastener and the surrounding area to allow fastener removal. **Note:** Some fasteners have a dry thread locking compound pre-applied (Patch-Loc) so no additional thread locking compound is necessary when installing a "new" fastener. These fasteners are designed to be removed and re-installed only once before applying additional thread locking compound is necessary.	
RETAINING COMPOUND (bearings and sleeves) An adhesive used to secure bearings, bushings and cylindrical parts into housings or onto shafts. When cured, bearing and sleeve retaining compound fills the gap between mating parts with a hard resin that increases load distribution and protects against corrosion.	
ADHESIVE Used to secure a variety of components immediately prior to assembly. May be recommended for installing new components or when reusing a component that had a pre-applied adhesive such as hood seals, mouldings and weather-stripping.	
THREAD SEALANT Used to seal threaded fittings and sensors from air, fuel and oil pressure leaks and prevent galling and seizure between threaded parts. A thread sealant in paste firm is preferred over sealant tape. The sealant should remain semi-pliable to allow for component removal with standard tools. Some thread sealants may require the use of a cleaner or primer prior to use.	

GASKET COMPOUND Used to create a seal between mating parts. Gasket compounds may be used with or without the presence of a pre-formed gasket. Gasket compounds may be solvent or silicone based, and cure when exposed to air or designed to cure in an air-less environment (anaerobic). Most gasket compounds are designed to be applied to clean surfaces free of oil, chemical residue and previously used gaskets or gasket compounds.	
SILICONE SEALANT Designed for a broad variety of sealing and bonding requirements, silicone sealants are usually room temperature vulcanizing (RTV) which form a flexible silicone rubber that bonds to a wide variety of smooth or porous materials when cured. Standard silicone sealants are designed to perform in temperatures from -51F to 232C (-60F to 400F), while high temperature variants can preform in temperatures up to 343C (650F)	

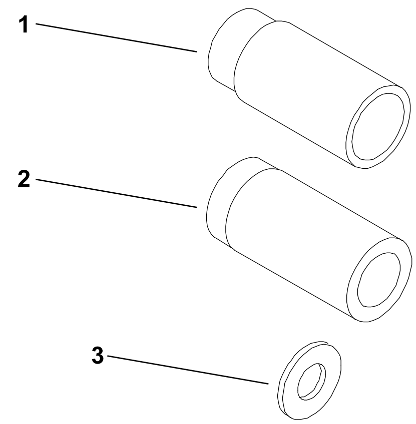
Special Tools

You can order these special tools from your Toro Distributor. Some tools may also be available from a local tool supplier.

Hydraulic Pressure Testing Kit

Toro Part No. TOR47009

Use this kit to take various pressure readings for diagnostic tests. Quick disconnect fittings are provided to attach directly to the mating fittings on the machine test ports without the tools. A high-pressure hose is given for remote readings. Contains 1 each: 6,900 kPa (1,000 psi), 34,500 kPa (5,000 psi), and 69,000 kPa (10,000 psi) gauges.



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57 LPM (15 GPM) Hydraulic Tester Kit

Toro Part No. TOR214678

Use this tester to test the hydraulic circuits and components for flow and pressure capacities. The tester flow measurement maximum is 57 LPM (15 GPM). This tester includes the following:

Inlet Hose – This hose connects the system circuit to the inlet side of the hydraulic tester.

Load Valve – Turn the valve to restrict the flow to create a simulated working load in the circuit.

Pressure Gauge – A glycerine filled pressure gauge 0 to 34,500 kPa (0 to 5,000 psi) to provide operating circuit pressure.

Flow Meter – This meter measures the actual fluid flow in the operating circuit with a gauge rated at 5 to 55 LPM (1 to 15 GPM).

Outlet Hose – A hose from the outlet side of the hydraulic tester that connects to the hydraulic system circuit.

Fittings – An assortment of hydraulic fittings are included with this kit.

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150 LPM (40 GPM) Hydraulic Tester

Toro Part No. AT40002

Use this tester to test the hydraulic circuits and components for flow and pressure capacities. The tester flow measurement maximum is 151 LPM (40 GPM). This tester includes the following:

Load Valve – Turn the valve to restrict the flow to create a simulated working load in the circuit.

Pressure Gauge – A glycerine filled pressure gauge 0 to 34,500 kPa (0 to 5,000 psi) to provide operating circuit pressure.

Flow Meter – This meter measures the actual fluid flow in the operating circuit with a gauge rated at 20 to 150 LPM (4 to 40 GPM).

Note: This tester does not include any hydraulic hoses or fittings; refer to Hydraulic Hose Kit Toro Part No. TOR6007 and Hydraulic Test Fitting Kit Tor Part No. TOR4079.

Hydraulic O-Ring Kit

Toro Part No. 117-2727

This kit includes O-rings in a variety of sizes for the face seal and port seal hydraulic connections. To help prevent a hydraulic leak, replace the O-rings when you open the hydraulic connection.

Hydraulic Hose Kit

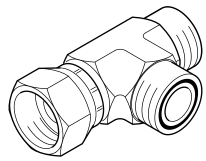
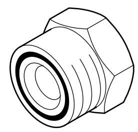
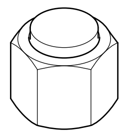
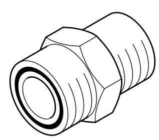
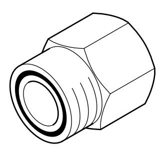
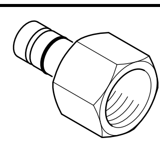
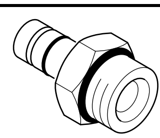
Toro Part No. TOR6007

This kit includes the fittings and hoses that are used to connect high flow hydraulic filter kit (TOR6011) to the machine hydraulic traction system components.

Hydraulic Test Fitting Kit

Toro Part No. TOR4079

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

FITTING TYPE	SIZE	PART NUMBER
 SWIVEL NUT RUN TEE (2 each)	4 ORFS (9/16–18) 6 ORFS (11/16–16) 8 ORFS (13–16–16) 10 ORFS (1–14)	TOR4079–3 TOR4079–12 TOR4079–4 TOR4079–5
 PLUG (2 each)	4 ORFS (9/16–18) 6 ORFS (11/16–16) 8 ORFS (13–16–16) 10 ORFS (1–14)	TOR4079–13 TOR4079–14 TOR4079–15 TOR4079–16
 CAP (2 each)	4 ORFS (9/16–18) 6 ORFS (11/16–16) 8 ORFS (13–16–16) 10 ORFS (1–14)	TOR4079–17 TOR4079–18 TOR4079–19 TOR4079–20
 UNION (1 each)	6 ORFS (11/16–16) to 8 SAE-ORB (3/4–16) 8 ORFS (13–16–16) to 8 SAE-ORB (3/4–16) 10 ORFS (1–14) to 8 SAE-ORB (3/4–16)	TOR4079–8 TOR4079–9 TOR4079–2
 REDUCER (1 each)	10 ORFS (1–14) to 8 SAE-ORB (3/4–16) 12 ORFS (1 3/16–12) to 8 SAE-ORB (3/4–16)	TOR4079–7 TOR4079–6
 TEST CONNECTOR – FEMALE THREAD (2 each)	4 ORFS (9/16–18) 6 ORFS (11/16–16) 8 ORFS (13/16–16) 10 ORFS (1–14)	TOR4079–10 TOR4079–11 TOR4079–21 TOR4079–1
 TEST CONNECTOR – MALE THREAD (2 each)	4 SAE-ORB (7/16–20) 1/8 NPTF	TOR4079–22 TOR4079–23

High Flow Hydraulic Filter Kit

Toro Part Number: TOR6011

The high flow hydraulic filter kit is designed with large flow (150 L/minute or 40 gallons/minute) and high pressure (34,500 kPa or 5,000 psi) capabilities. This kit provides for bi-directional filtration which prevents filtered unwanted material from entering into the circuit regardless of the flow direction.

If a component failure occurs in the closed loop traction circuit, contamination from the damaged part will remain in the circuit until you remove it. Install a high flow hydraulic-fluid filter into the circuit when you connect the hydraulic test gauges in order to test the traction circuit components or after you replace a failed traction circuit component (e.g., piston pump or wheel motor). This filter removes contamination from the hydraulic fluid in the traction circuit, thereby preventing additional component damage.

Note: This kit does not include the hydraulic hoses; refer to Hydraulic Hose Kit (page 2–13).

Note: The replacement filter element is Toro Part No. TOR6012. The filter element canister tightening torque is **34 N·m (25 ft-lb)**.

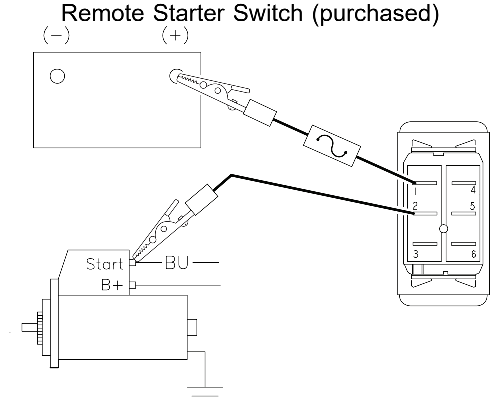
Remote Starter Switch

After flushing the hydraulic system or replacing a hydraulic component (e.g. gear pump, piston pump, drive motor), it is necessary to prime the hydraulic pumps. A remote starter switch can be used for this purpose. A remote starter switch can be purchased locally or fabricated as follows.

Remote Starter Switch (purchased)

IMPORTANT: When using a remote starter switch, it is highly recommended to include a 20 amp in−line fuse between the battery and switch connector for circuit protection.

A remote stater switch can also be constructed using Toro switch #106−2027, a length of 14 gauge wire, a 20 amp in−line fuse, two (2) alligator clips and necessary connectors. Connecting the wire to switch terminals 1 and 2 will allow the momentary switch contacts to be used for the remote starter switch.



Remote Starter Switch (fabricated)

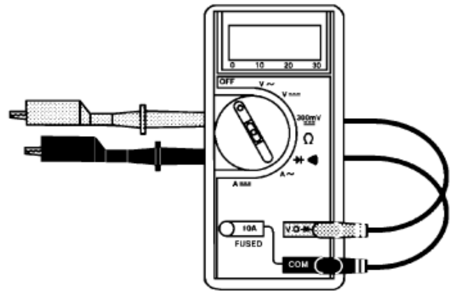
Note: For information on using the remote starter switch to prime the hydraulic pumps.

Multimeter

Obtain this tool locally

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

Note: Use a digital multimeter when testing the electrical circuits. The high impedance (internal resistance) of a digital meter in the voltage mode ensures that the excess current is not allowed through the meter. This excess current can damage the circuits that are not designed to carry it.



Battery Terminal Protector

Toro Part No. 107-0392

Use this aerosol spray on the battery terminals, ring terminals, and fork terminals to reduce corrosion problems. Apply the terminal protector to the connection after you secure the battery cable, ring terminal, or fork terminal.

Chapter 3

Kubota Diesel Engine

Table of Contents

Additional Reference Materials

Kubota Workshop Manual, Diesel Engine, 05-E3B Series

Specifications

Kubota Diesel Engine

Reelmaster 5410 and 5510

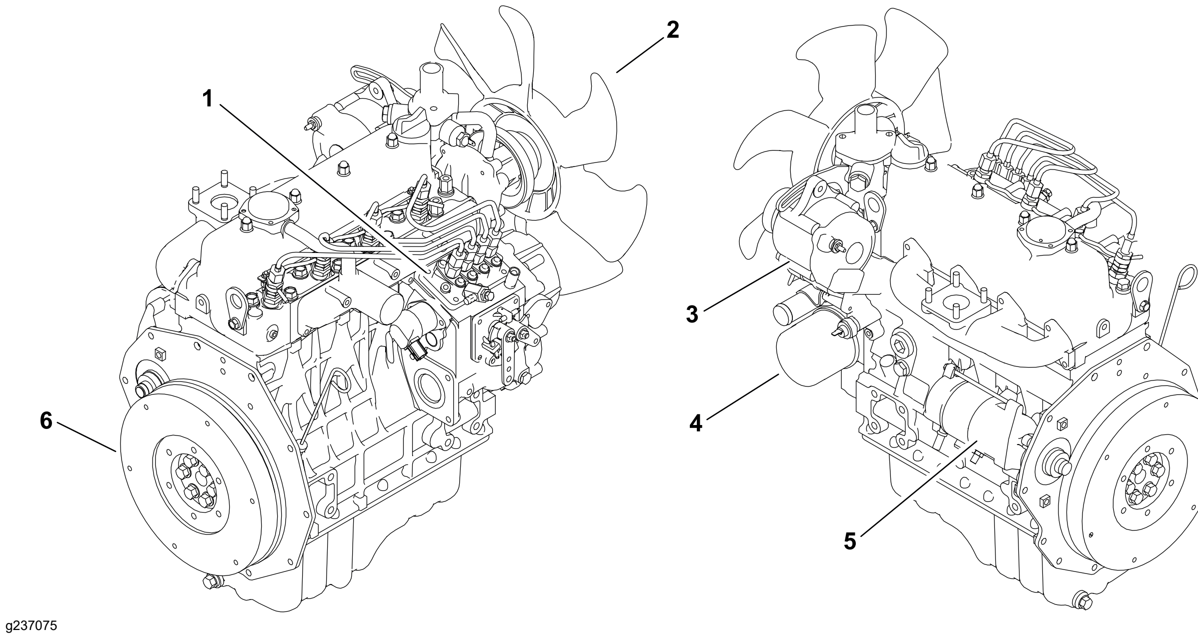


Figure 7

1. Fuel injection pump
2. Engine cooling fan
3. Alternator
4. Engine oil filter
5. Starter motor
6. Flywheel

Item	Description
Make/Designation	Kubota V1505-E3B, 4-stroke, Liquid Cooled, OHV Diesel
Number of Cylinders	4
Bore x Stroke	78 mm x 78.4 mm (3.07 x 3.09 inches)
Total Displacement	1,498 cm^3 (91.4 in^3)
Firing Order	1 (gear case end) - 3 - 4 (flywheel end) - 2
Fuel	Diesel or Biodiesel (up to B20) Fuel with Low or Ultra-Low Sulfur Content; refer to the *Traction Unit Operator's Manual* for additional fuel information
Fuel Injection Pump	Bosch MD Type Mini
Fuel Injector Nozzle	Mini Nozzle (DNOPD)
Fuel Tank Capacity	53 L (14 US gallons)
Governor	Centrifugal Mechanical
Low Idle Speed (no load)	1,250 to 1,350 rpm
High Idle Speed (no load)	3,050 to 3,250 rpm
Engine Oil	API Classification CH-4, CI-4, or Higher; refer to the *Traction Unit Operator's Manual* for additional engine oil information
Oil Pump	Gear Driven Trochoid Type
Crankcase-Oil Capacity	5.2 L (5.5 US qt) with Filter
Cooling System Capacity (including reserve tank)	6.6 L (7 US qt)
Starter	12 VDC 1.2 KW

Kubota Diesel Engine (continued)

Item	Description
Alternator/Regulator	12 VDC 40 A
Dry Weight (approximate)	110 kg (242 lb)

Reelmaster 5610

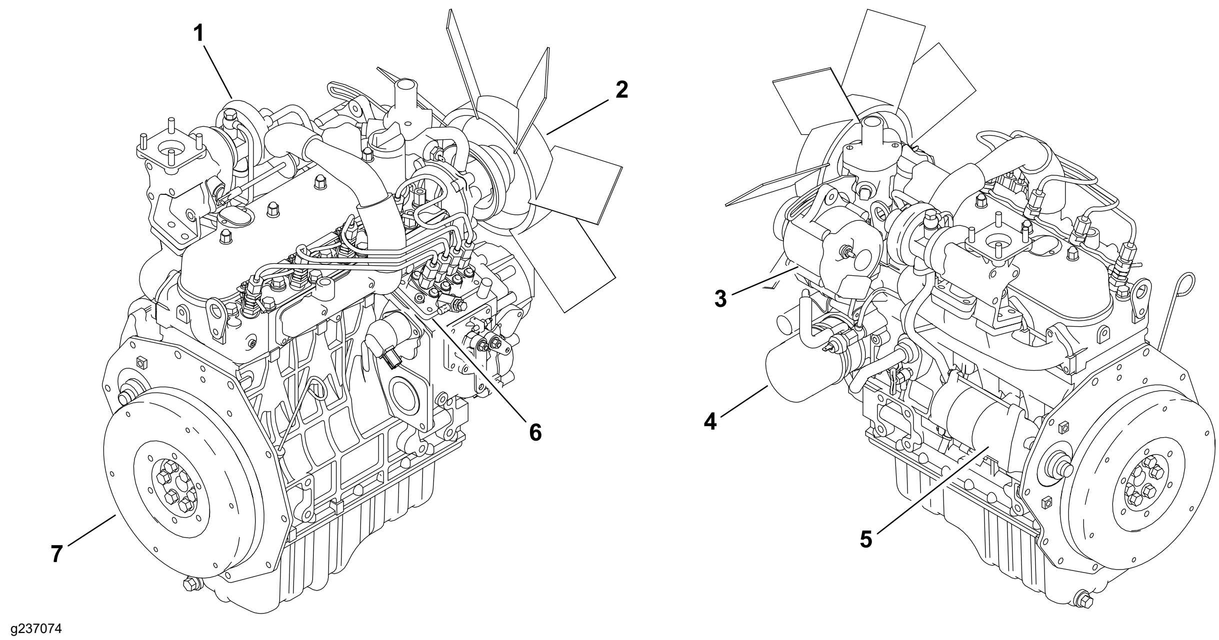


Figure 8

1. Turbocharger
2. Engine cooling fan
3. Alternator
4. Engine oil filter
5. Starter motor
6. Fuel injection pump
7. Flywheel

Item	Description
Make/Designation	Kubota V1505-T-E3B, 4-stroke, Liquid Cooled, OHV, Turbocharged Diesel
Number of Cylinders	4
Bore x Stroke	78 mm x 78.4 mm (3.07 x 3.09 inches)
Total Displacement	1,498 cm^3 (91.4 in^3)
Firing Order	1 (gear case end) - 3 - 4 (flywheel end) - 2
Fuel	Diesel or Biodiesel (up to B20) Fuel with Low or Ultra-Low Sulfur Content
Fuel Injection Pump	Bosch MD Type Mini
Fuel Injector Nozzle	Mini Nozzle (DNOPD)
Fuel Tank Capacity	53 L (14 US gallons)
Governor	Centrifugal Mechanical
Low Idle Speed (no load)	1,250 to 1,350 rpm
High Idle Speed (no load)	3,050 to 3,250 rpm
Engine Oil	API Classification CH-4, CI-4, or Higher; refer to *Traction Unit Operator's Manual* for additional engine oil information
Oil Pump	Gear Driven Trochoid Type

Kubota Diesel Engine (continued)

Item	Description
Crankcase-Oil Capacity	5.2 L (5.5 US qt) with Filter
Cooling System Capacity (including reserve tank)	9.5 L (10 US qt)
Starter	12 VDC 1.2 KW
Alternator/Regulator	12 VDC 40 A
Dry Weight (approximate)	114 kg (251 lb)

General Information

This chapter gives information about specifications, assembly and repair of the Kubota V1505-E3B and V1505-T-E3B diesel engine used in certain Reelmaster 5410, 5510, and 5610 machines.

Most repairs and adjustments require tools which are commonly available in many service shops. The use of some specialized test equipment is explained in the engine service manual included at the end of this chapter. 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 diesel engines are supplied through your local Toro Distributor. If a parts list is not available, be sure to provide your distributor with the Toro model and serial number.

Operator's Manuals

The *Traction Unit Operator's Manual* provides information regarding the operation, general maintenance, and maintenance intervals for the Kubota diesel engine that powers your Reelmaster machine. The *Kubota Operator's Manual* includes information specific to the engine used in your Reelmaster. Refer to these publications for additional information when servicing the machine.

Kubota Workshop Manual

The engine that powers your Reelmaster machine is a Kubota model V1505-E3B or V1505-T-E3B. The Kubota Workshop Manual, Diesel Engine, 05-E3B Series is available for these engines. Ensure that the correct engine manual is used when servicing the engine on your Reelmaster.

Shutting off the Engine (Reelmaster 5610)

IMPORTANT

After mowing or full load operation on machines with a turbo-charged engine, cool the turbo-charger by allowing the engine to run at low-idle speed for 5 minutes before shutting off the engine. This allows the turbocharger and internal engine components to cool-down. Failure to allow this cool-down period may lead to premature turbocharger and engine failure.

Adjustments

Adjusting the Throttle Control

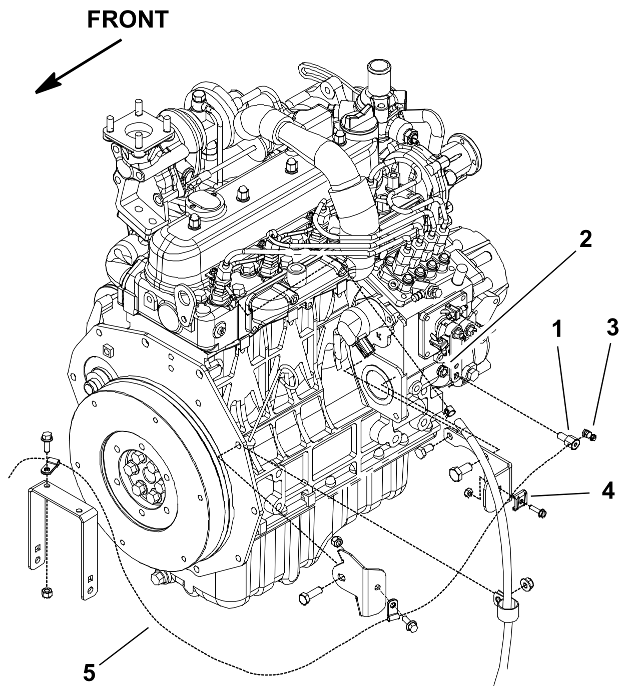


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Figure 9

1. Throttle cable swivel
2. Swivel locknut
3. Cable stop
4. Throttle cable clamp
5. Throttle cable

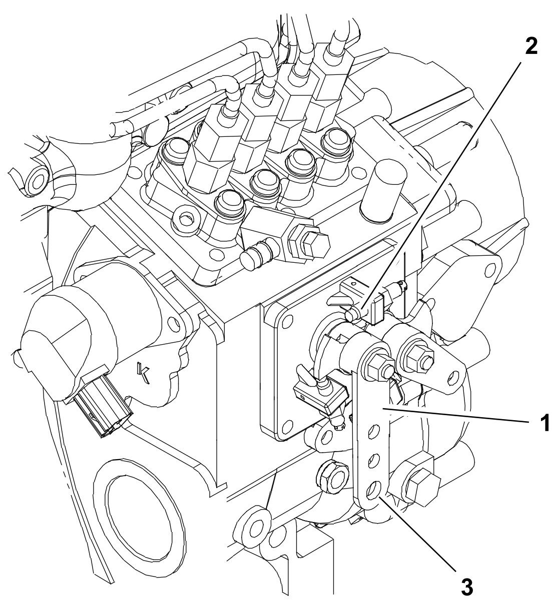

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Figure 10

1. Speed control lever
2. High speed screw
3. Cable swivel position

Proper throttle operation is dependent upon proper adjustment of throttle control. Ensure that the throttle control is operating properly.

Adjusting the Throttle Control (continued)

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. 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 clamp screw and repositioning control cable until speed control lever contacts high speed screw when the throttle control lever is in the FAST position. Tighten cable clamp screw after adjustment has been completed.

Service and Repairs

Air Cleaner Assembly

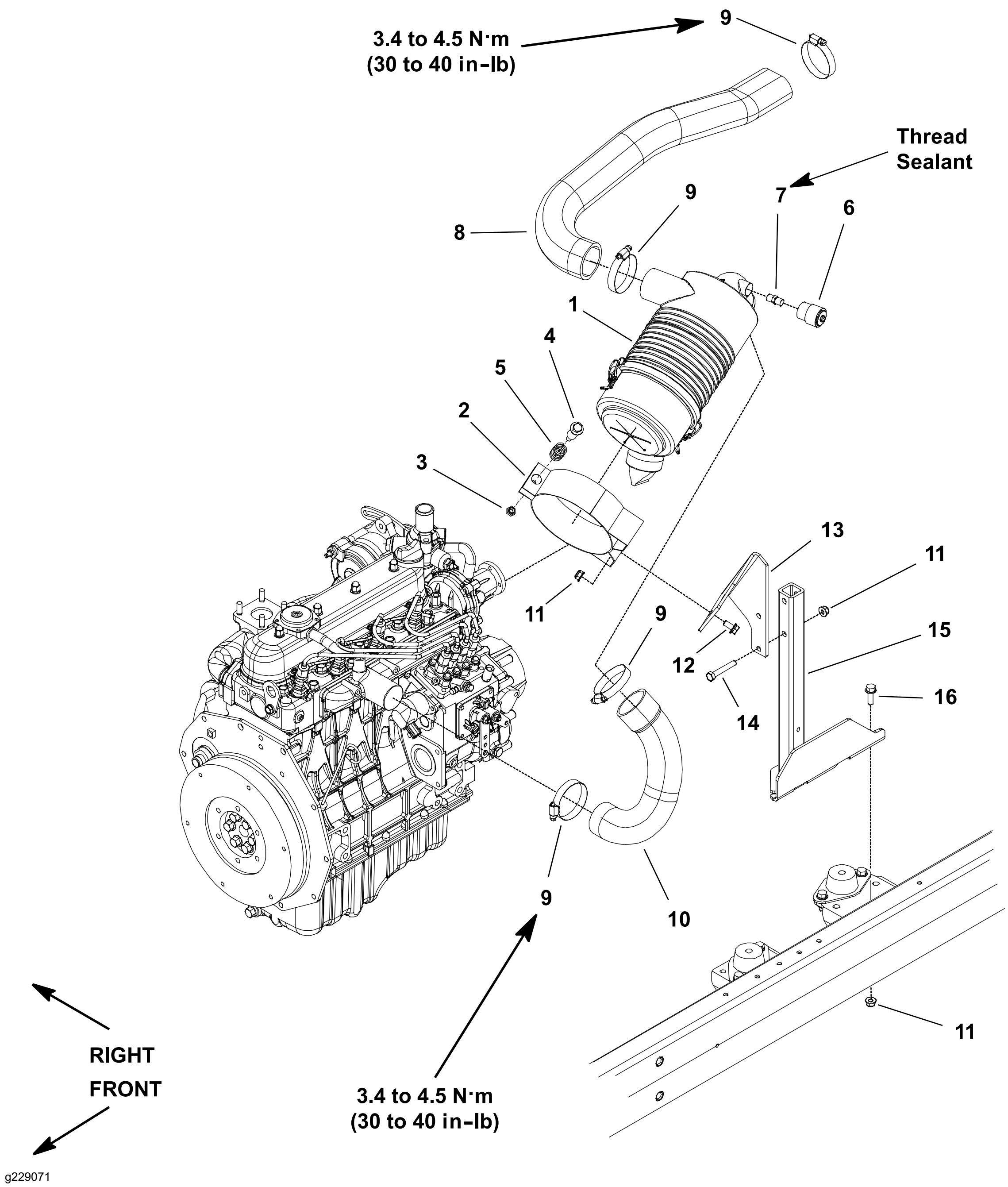


Figure 11

Reelmaster 5410/5510

1. Air cleaner assembly
2. Air cleaner mounting band
3. Hex nut
4. Shoulder bolt
5. Spring
6. Service indicator
7. Adapter
8. Air cleaner inlet hose
9. Hose clamp (4 each)
10. Air cleaner hose
11. Flange nut (7 each)
12. Flange-head screw (2 each)
13. Air cleaner bracket
14. Bolt (2 each)
15. Air cleaner mount bracket
16. Flange-head screw (3 each)

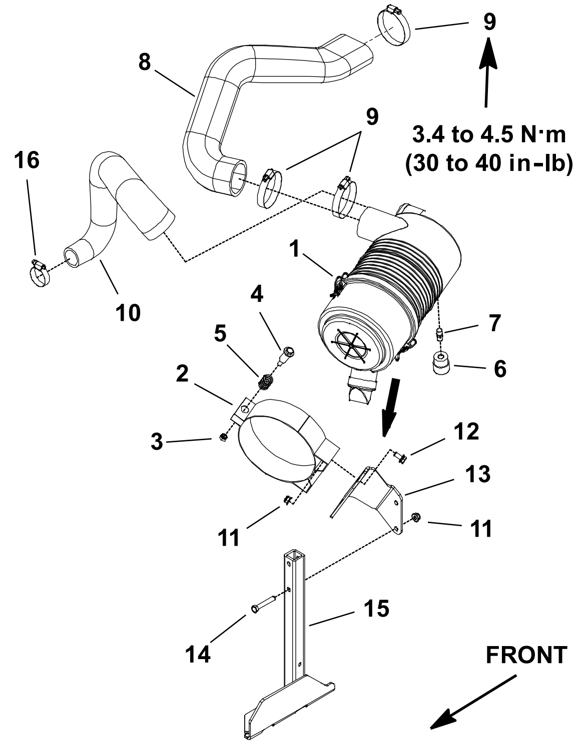


Figure 12

Reelmaster 5610

1. Air cleaner assembly
2. Mounting band
3. Hex nut
4. Shoulder bolt
5. Spring
6. Service indicator
7. Adapter
8. Inlet hose
9. Hose clamp
10. Air cleaner hose
11. Flange nut
12. Flange-head screw
13. Air cleaner bracket
14. Bolt
15. Mount bracket
16. Hose clamp

Note: Reelmaster 5010 series machines with a Kubota diesel engine have very similar air cleaner assemblies. Reelmaster 5410 and 5510 machines use the same air cleaner assembly (Figure 11). Reelmaster 5610 machines use a slightly different air cleaner assembly (Figure 12).

Removing the Air Cleaner Assembly

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the key switch. Raise and support hood.
2. Remove air cleaner components as necessary (Figure 11 or Figure 12).
3. Refer to *Traction Unit Operator's Manual* for air cleaner service and maintenance procedures.

Installing the Air Cleaner Assembly

IMPORTANT

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

Installing the Air Cleaner Assembly (continued)

1. Assemble air cleaner system (Figure 11 or Figure 12).

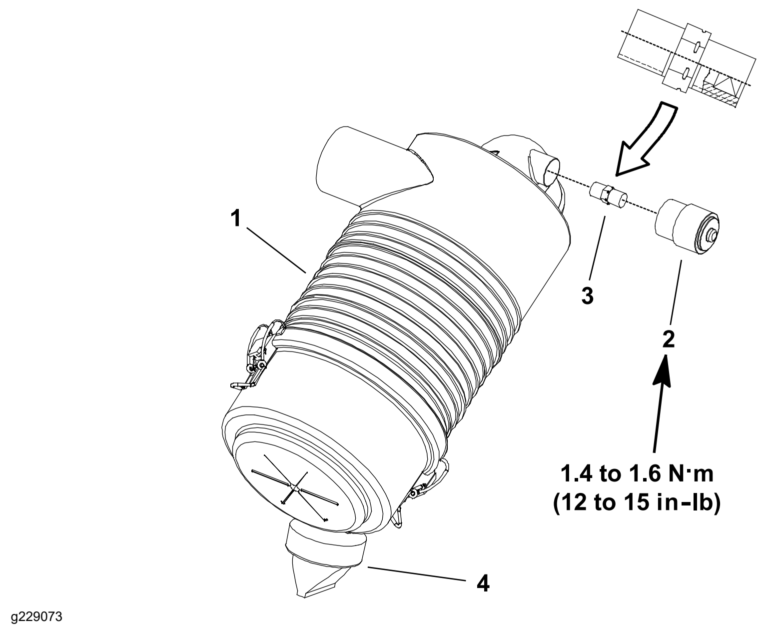


Figure 13

1. Air cleaner assembly
2. Service indicator
3. Adapter
4. Evacuator valve

A. If service indicator and adapter were removed from air cleaner housing, apply thread sealant to adapter threads before installing adapter and indicator to housing. Install adapter so that grooves in adapter hex and adapter filter element are installed toward service indicator (Figure 13). Torque the indicator to **1.4 to 1.6 N·m (12 to 15 in-lb)**.

B. Ensure that the evacuator valve on air cleaner assembly is pointed down after assembly.

C. Torque the hose clamps to **3.4 to 4.5 N·m (30 to 40 in-lb)**.

2. After air cleaner has been properly installed, lower and secure hood.

Exhaust System

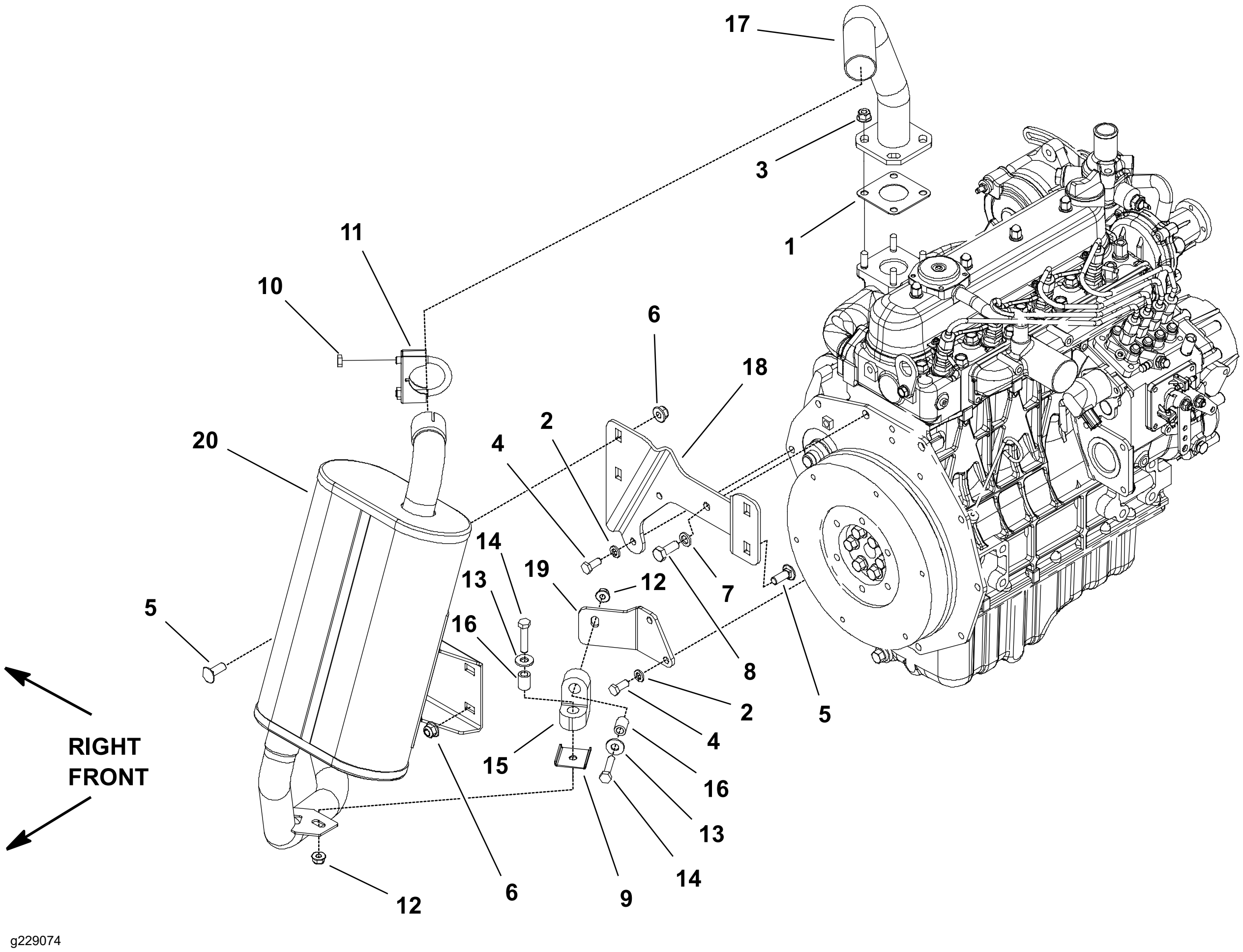


Figure 14

Reelmaster 5410/5510

1. Exhaust gasket	8. Bolt	15. Rubber hanger
2. Lock washer (4 each)	9. Isolator plate	16. Spacer (2 each)
3. Flange nut (4 each)	10. Hex nut (2 each)	17. Exhaust header
4. Bolt (4 each)	11. Clamp	18. Support bracket
5. Carriage screw (4 each)	12. Flange nut (2 each)	19. Tail pipe bracket
6. Flange nut (4 each)	13. Flat washer (2 each)	20. Muffler
7. Lock washer	14. Bolt (2 each)	

Note: Reelmaster 5010 series machines with a Kubota diesel engine have very similar exhaust systems. Reelmaster 5410 and 5510 machines use the same exhaust system (Figure 14). Reelmaster 5610 machines use a slightly different exhaust system (Figure 15).

Removing the Exhaust System

CAUTION

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

Removing the Exhaust System (continued)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the key switch. Raise and support hood.
2. Raise and support hood to gain access to exhaust system. Allow engine and exhaust system to cool before doing any disassembly of exhaust system components.

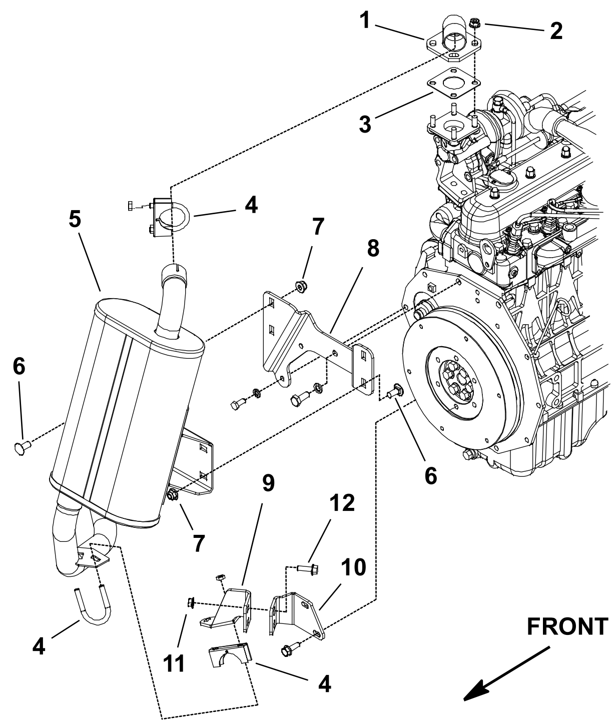


Figure 15
Reelmaster 5610

1.	Exhaust header	5.	Muffler	9.	Tailpipe bracket
2.	Flange nut (4 each)	6.	Carriage screw (4 each)	10.	Tailpipe bracket
3.	Exhaust gasket	7.	Flange nut (4 each)	11.	Flange nut (2 each)
4.	Clamp assembly (2 each)	8.	Support bracket	12.	Flange-head screw (2 each)

3. Remove exhaust system components from the engine as necessary (Figure 14 or Figure 15). Discard exhaust gasket if it is removed.

Installing the Exhaust System

Note: Ensure that all exhaust system flanges and sealing surfaces are free of debris or damage that may prevent a tight seal.

1. Ensure to install new exhaust gasket if old gasket was removed. Do not use any type of gasket sealant on gasket or flange surfaces.
2. Assemble all removed exhaust system components (Figure 14 or Figure 15).
   A. On Reelmaster 5410 and 5510 machines, shorter leg of rubber hanger (item 15 in Figure 14) should be attached to tailpipe.
   B. Ensure that the exhaust support brackets are secure to the engine before attaching any other exhaust system components.
   C. During exhaust system installation, loosely assemble all exhaust system components before fully tightening any of the fasteners. When tightening

fasteners, secure muffler to support bracket first and then tighten nuts that secure exhaust header to engine exhaust manifold. Once these connections are secure, tighten clamp to secure exhaust header to muffler inlet. Finally, tighten fasteners that secure muffler outlet to brackets.

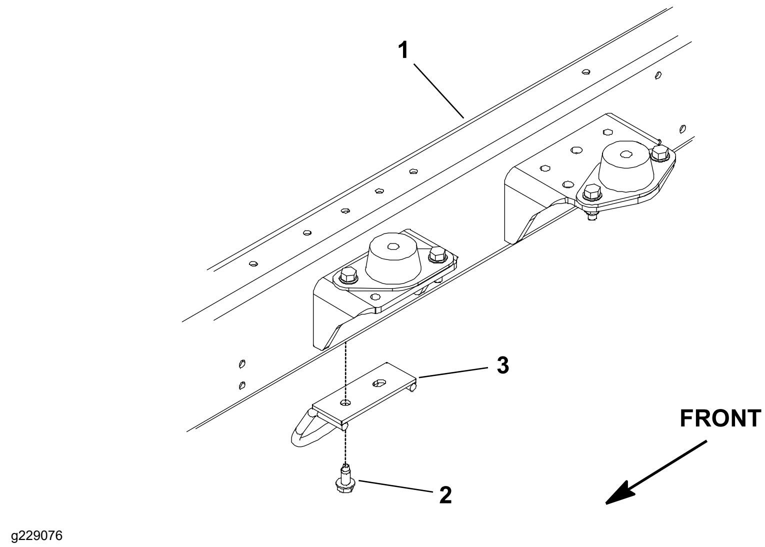


Figure 16

1. Right frame rail
2. Screw (2 each)
3. Muffler guard

D. Adjust muffler guard (item 3 in Figure 16) so that there is 9.5 mm (3/8 inch) clearance between exhaust outlet and guard in all directions.

Fuel System

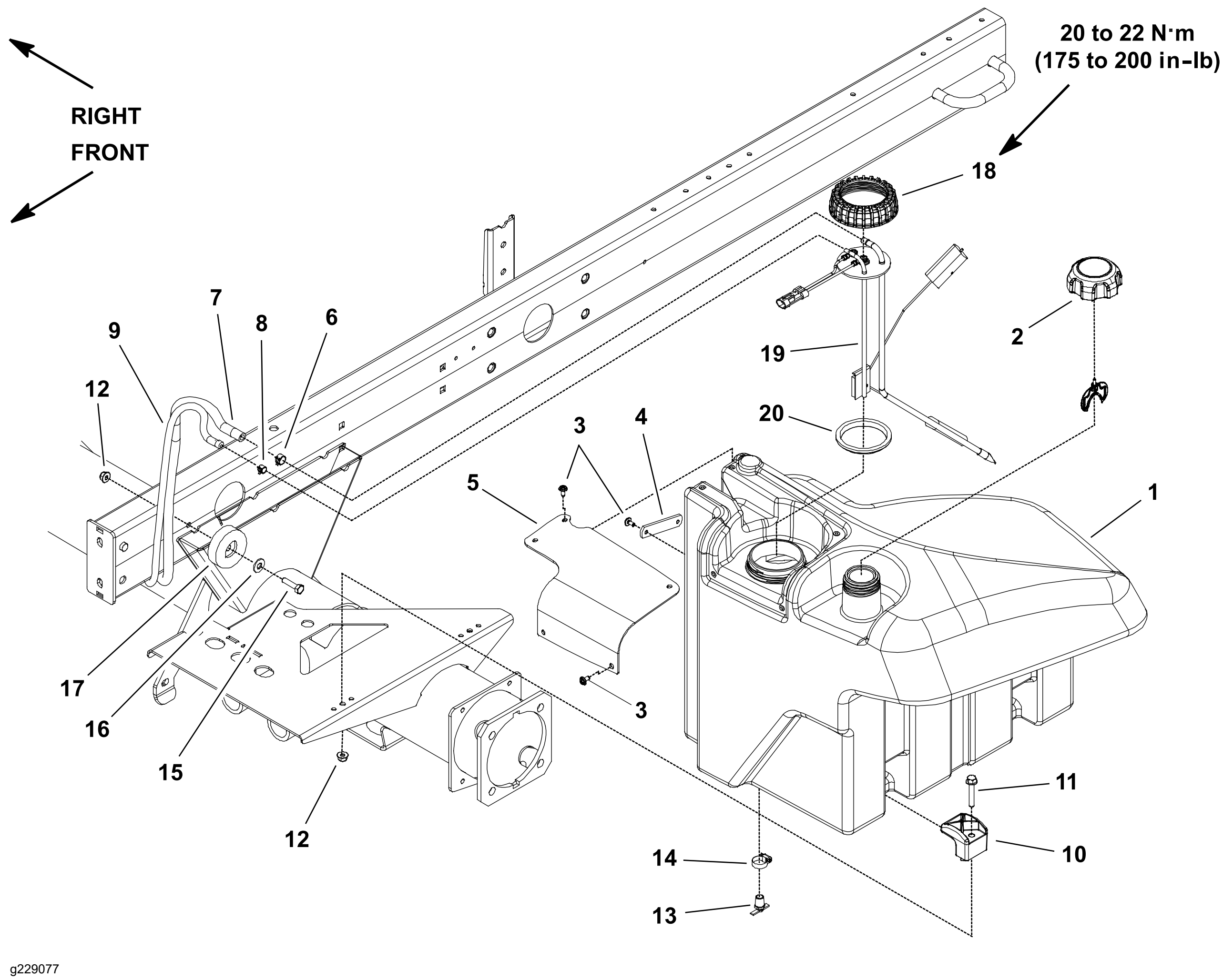


Figure 17

1. Fuel tank
2. Fuel tank cap
3. Screw (7 each)
4. Strap
5. Sender cover
6. Hose clamp
7. Fuel supply hose
8. Hose clamp
9. Fuel return hose
10. Clamp (2 each)
11. Flange-head screw (2 each)
12. Flange nut (3 each)
13. Draincock
14. Hose clamp
15. Bolt
16. Flat washer
17. Bumper
18. Fuel sender cap
19. Fuel sender
20. Gasket

DANGER

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

Checking the Fuel Lines and Connections

Check fuel lines and connections periodically as recommended in the *Traction Unit Operator's Manual*. Check lines for deterioration, damage, leakage or loose connections. Replace fuel hoses, clamps and connections as necessary.

Drain and Clean Fuel Tank

Drain and clean the fuel tank periodically as recommended in the *Traction Unit Operator's Manual*. Also, drain and clean the fuel tank if the fuel system becomes contaminated or if the machine is to be stored for an extended period.

IMPORTANT

Follow all local codes and regulations when recycling or disposing waste fuel.

To clean fuel tank, flush tank out with clean diesel fuel. Ensure that the tank is free of all contaminates and debris.

Priming the Fuel System

The fuel system needs to be primed before starting the engine for the first time, after running out of fuel or after fuel system maintenance (e.g., draining the filter/water separator, replacing a fuel hose). To prime the fuel system, Ensure that the fuel tank has fuel in it. Then, turn the key switch to the RUN position for 10 to 15 seconds which allows the fuel pump to prime the fuel system. Do not use the engine starter motor to crank the engine in order to prime the fuel system.

Removing the Fuel Tank

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the key switch.
2. Place drain pan under fuel tank. Ensure that drain pan is large enough to hold fuel tank contents; refer to Specifications (page 3–2).
3. Open draincock on bottom of fuel tank and allow tank to fully drain. Close draincock.
4. Disconnect wire harness connection from the fuel sender (item 19 in Figure 17).

   Note: Before removing fuel hoses from tank fittings, label hoses for assembly purposes.

IMPORTANT

To prevent damage to fuel hoses, numerous cable ties are used to secure hoses to machine components. Take note of all cable ties that are removed from machine during fuel tank removal so they can be properly replaced during tank installation.

5. Loosen hose clamps and carefully disconnect supply (item 7 in Figure 17) and return fuel hoses from fittings on the top of the fuel sender.
6. Remove fuel tank (Figure 17).

Removing the Fuel Tank (continued)

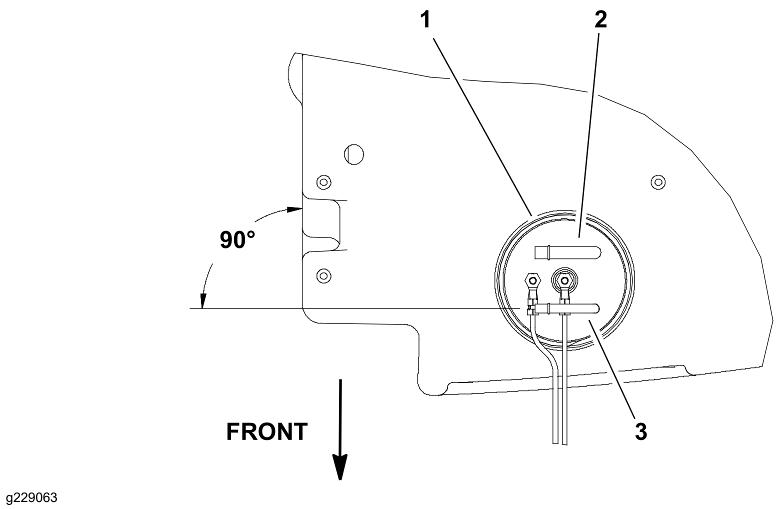


Figure 18

1. Fuel sender
2. Fuel supply fitting
3. Fuel return fitting

IMPORTANT

If fuel sender is removed from fuel tank, note orientation of fittings for assembly purposes (Figure 18).

Installing the Fuel Tank

1. Install fuel tank to frame (Figure 17). Secure fuel hoses with cable ties as noted during fuel tank removal.

   A. If fuel sender was removed from fuel tank, ensue that the fuel fittings on sender are orientated at 90° from right side of tank (Figure 18). Torque the fuel sender cap to **20 to 22 N·m (175 to 200 in-lb)**.

   B. Also, to prevent damage to fuel sender during assembly, ensure that the fuel sender does not turn as the sender cap is tightened.

2. Correctly connect supply (item 7 in Figure 17) and return fuel hoses to fittings on the top of the fuel sender. Secure fuel hoses with hose clamps.
3. Secure wire harness connector to fuel sender.
4. Ensure that the fuel tank draincock is closed. Fill fuel tank with clean fuel.
5. Prime the fuel system; refer to Priming the Fuel System (page 3–15).
6. Before returning machine to operation, ensure that no fuel leaks exist.

Radiator Assembly

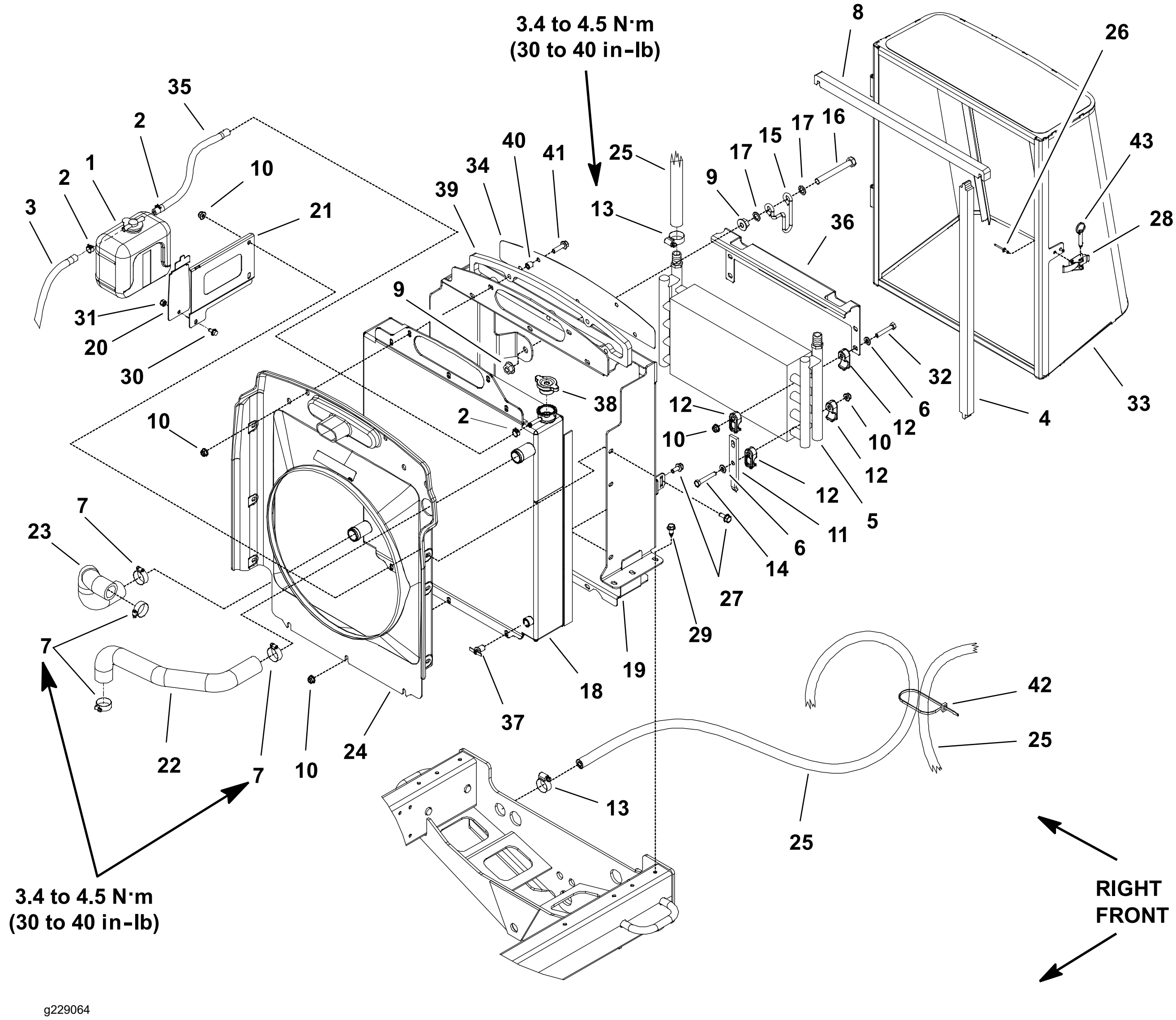


Figure 19

Reelmaster 5410 and 5510

1. Coolant reservoir
2. Hose clamp (3 each)
3. Overflow hose
4. Foam seal (2 each)
5. Oil cooler
6. Flat washer (8 each)
7. Hose clamp (4 each)
8. Foam seal (2 each)
9. Flange nut (4 each)
10. Flange nut (22 each)
11. Oil cooler mount plate (2 each)
12. Oil cooler clamp (8 each)
13. Hose clamp (4 each)
14. Bolt (4 each)
15. Wire form clamp (2 each)
16. Bolt (2 each)
17. Washer (4 each)
18. Radiator assembly
19. Radiator frame
20. Reservoir bracket
21. Reservoir bracket
22. Upper radiator hose
23. Lower radiator hose
24. Fan shroud
25. Hydraulic hose (2 each)
26. Pop rivet (2 each)
27. Flange-head screw (9 each)
28. Draw latch
29. Washer-head screw (6 each)
30. Flange-head screw
31. Locknut
32. Bolt (4 each)
33. Rear screen
34. Intake screen
35. Overflow hose
36. Oil cooler bracket
37. Draincock
38. Radiator cap
39. Foam seal
40. Spacer (5 each)
41. Flange-head screw (5 each)
42. Cable tie
43. Detent ball pin

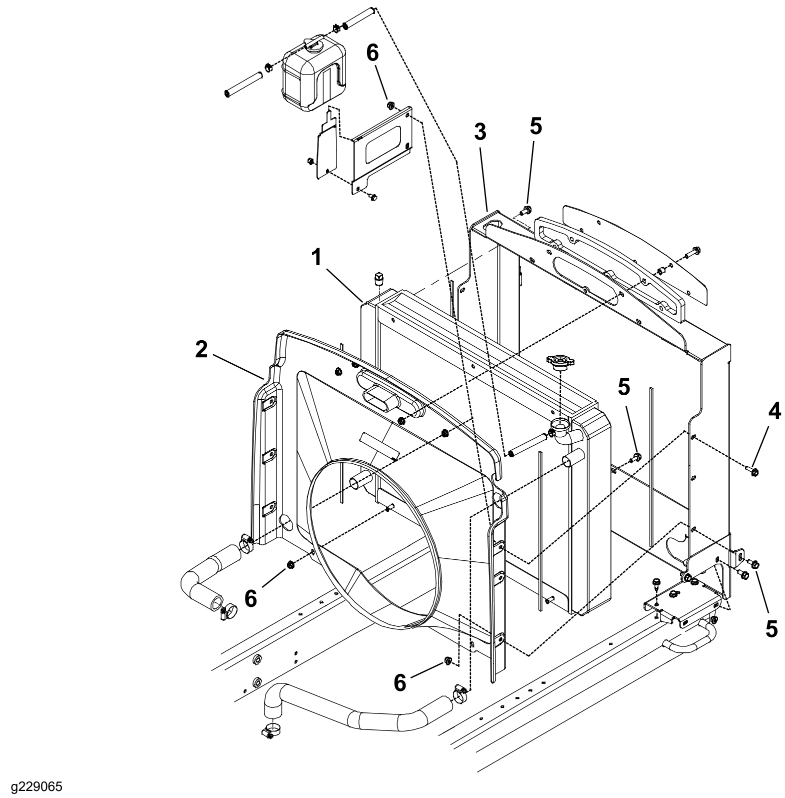


Figure 20

Reelmaster 5610

1.	Radiator	3.	Radiator frame	5.	Flange-head screw
2.	Fan shroud	4.	Flange-head screw	6.	Flange nut

Note: Two radiator assemblies are used on Reelmaster 5010 series machines with a Kubota diesel engine. Reelmaster 5410 and 5510 machines use the same radiator (Figure 19). Reelmaster 5610 machines use a slightly different radiator (Figure 20). All of these models use a similar procedure for radiator removal and installation.

Removing the Radiator Assembly

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the key switch.
2. Unlatch screen at rear of machine. Lift screen from hinges and remove screen from machine.
3. Raise and support hood.

CAUTION

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

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

4. Drain radiator into a suitable container either by using the draincock on the left side of the radiator or by disconnecting the lower radiator hose from the

Removing the Radiator Assembly (continued)

radiator. Ensure that the drain container is large enough to hold cooling system contents; refer to Specifications (page 3–2).

IMPORTANT

Follow all local codes and regulations when recycling or disposing engine coolant.

5. Disconnect radiator hoses (upper and lower) from the radiator.
6. Remove air cleaner inlet hose from air intake on fan shroud; refer to Air Cleaner Assembly (page 3–8).
7. Loosen hose clamp and remove overflow hose from radiator fill opening.
8. Remove 2 flange-head screws and 2 flange nuts that secure coolant reservoir and brackets to fan shroud. Carefully position reservoir and brackets away from the fan shroud.
9. Remove 5 flange-head screws and 5 flange nuts that secure air intake screen to radiator frame and fan shroud. Remove screen and foam seal. Locate and retrieve 5 spacers.
10. Remove flange-head screws and flange nuts that secure fan shroud and radiator to radiator frame. Position fan shroud away from the radiator.
11. Carefully pull radiator assembly from the machine. Plug radiator and hose openings to prevent contamination.
12. Inspect all foam seals placed between radiator, fan shroud and radiator frame. Replace damaged foam seals.

Installing the Radiator Assembly

1. Remove plugs placed in radiator and hose openings during the removal procedure.
2. Carefully position radiator assembly to the radiator frame. Position fan shroud to the radiator.
3. Secure fan shroud and radiator to radiator frame with removed flange-head screws and flange nuts. Ensure that at least 6.4 mm (0.250 inch) clearance exists at all points between shroud opening and fan.
4. Position coolant reservoir and brackets to the fan shroud. Secure reservoir to fan shroud and radiator frame with 2 flange-head screws and 2 flange nuts.
5. Place spacers into holes in foam seal. Position foam seal and air intake screen to radiator frame. Secure screen with 5 flange-head screws and 5 flange nuts.
6. Connect upper and lower radiator hoses to radiator and secure with clamps. Torque the clamps to **3.4 to 4.5 N·m (30 to 40 in-lb)**.
7. Connect overflow hose to radiator fill opening and secure with hose clamp.
8. Install and secure air cleaner inlet hose; refer to Air Cleaner Assembly (page 3–8).
9. Ensure radiator draincock is closed (threaded out fully). Fill radiator with coolant.
10. Lower and secure hood.
11. Install and secure screen to rear of machine.
12. Start engine. Check for coolant leaks and proper engine operation.

Installing the Radiator Assembly (continued)

13. After running engine for a short time, stop engine and Ensure radiator is full. Add coolant if necessary.

Engine

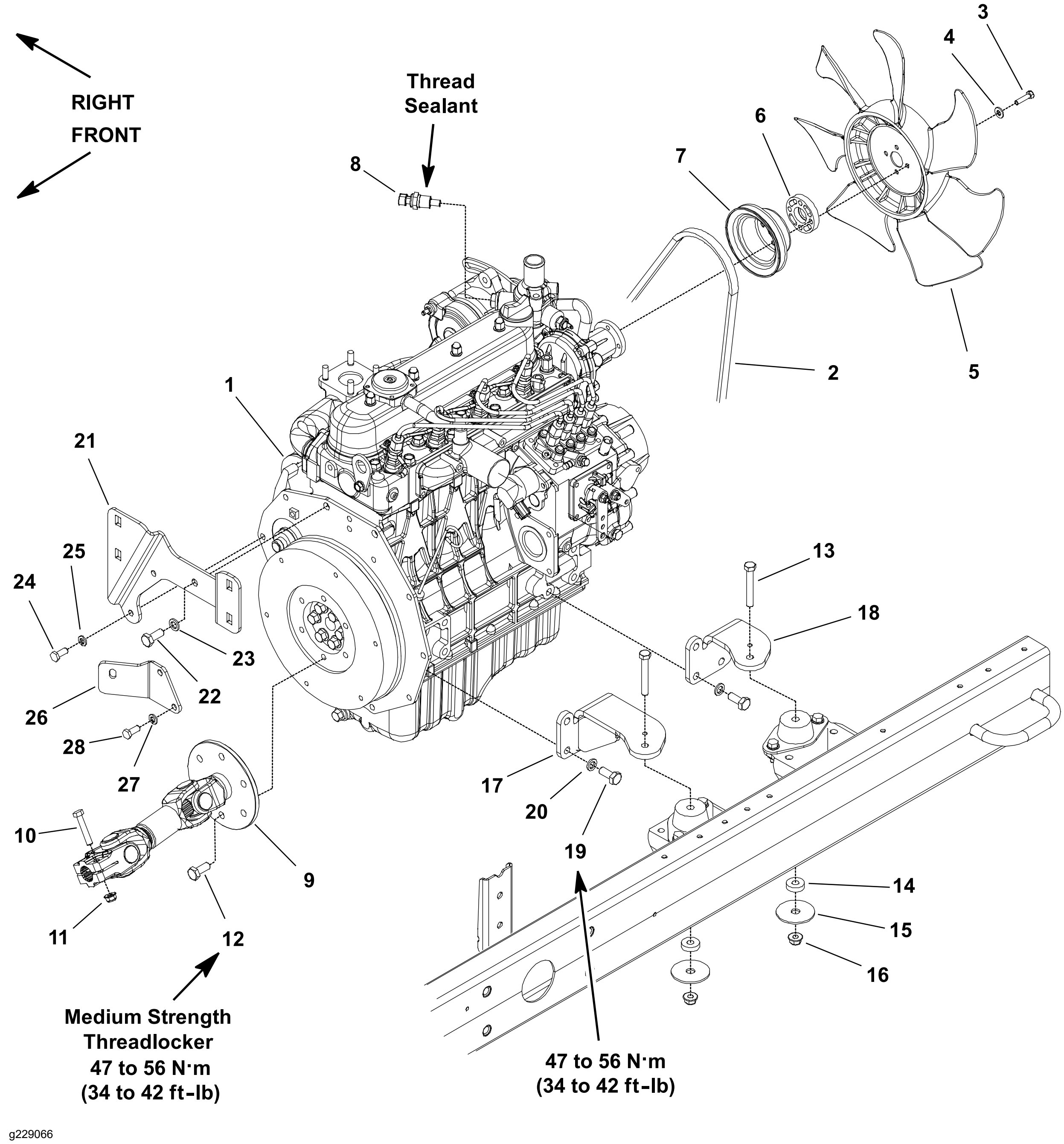


Figure 21
Reelmaster 5410 and 5510

1. Engine assembly
2. V-belt
3. Bolt (4 each)
4. Flat washer (4 each)
5. Cooling fan
6. Fan spacer
7. Pulley
8. Temperature sender
9. Driveshaft assembly
10. Bolt (2 each)
11. Flange nut (2 each)
12. Bolt (6 each)
13. Bolt (4 each)
14. Spacer (4 each)
15. Snubbing washer (4 each)
16. Flange nut (4 each)
17. Front engine mount bracket (2 each)
18. Rear engine mount bracket (2 each)
19. Bolt (3 each per mount)
20. Lock washer (3 each per mount)
21. Muffler bracket
22. Bolt
23. Lock washer
24. Bolt (2 each)
25. Lock washer (2 each)
26. Muffler tailpipe bracket
27. Lock washer (2 each)
28. Bolt (2 each)

Note: The engine removal and installation procedure is similar for all models with a Kubota diesel engine.

Removing the Engine

1. Park machine on a level surface, lower cutting units, stop engine and remove key from the key switch. Chock wheels to keep the machine from moving. Open hood.
2. If engine is to be disassembled, drain oil from engine.
3. Disconnect negative (-) and then positive (+) battery cables from the battery.

CAUTION

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

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

4. Drain coolant from radiator; refer to Radiator Assembly (page 3–17).
5. Remove air cleaner assembly from machine; refer to Air Cleaner Assembly (page 3–8).
6. Remove exhaust system from machine; refer to Exhaust System (page 3–11).

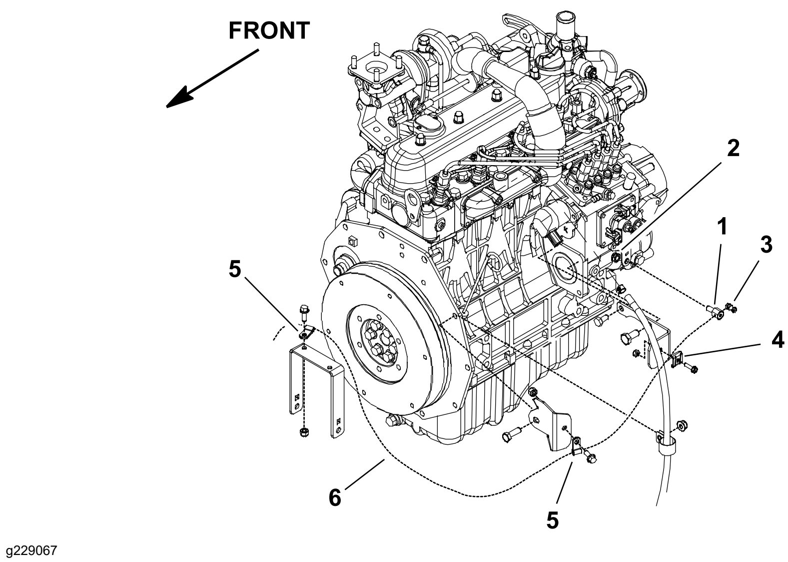


Figure 22

1. Throttle cable swivel
2. Locknut
3. Cable stop
4. Throttle cable clamp
5. Cable clamp (2 each)
6. Throttle cable

7. Remove throttle cable from injector pump (Figure 22):
   A. Remove Bolt that secures throttle cable end to swivel in speed control lever.
   B. Loosen throttle cable clamp (item 4 in Figure 22) and remove cable from clamp. Slide throttle cable end from swivel.
   C. Remove cable clamps that secure throttle cable to engine and driveshaft brackets. Position throttle cable away from the engine.
8. Disconnect hoses from engine:

A. Loosen clamps and remove upper and lower radiator hoses from the engine.

B. Loosen hose clamps and disconnect fuel supply and return hoses. Slide return hose from R-clamp on bracket attached to flywheel plate.

C. Plug disconnected hoses and engine openings to prevent leakage and contamination. Position disconnected hoses away from engine.

9. Disconnect hydraulic pump driveshaft from engine; refer to Hydraulic Pump Driveshaft (page 6–159). Support driveshaft away from engine.

IMPORTANT

To prevent damage to electrical harness, numerous cable ties are used to secure wire harness to machine components. Take note of all cable ties that are removed from machine during engine removal so they can be properly replaced during engine installation.

10. Label all engine wire harness leads for assembly purposes. Disconnect wire harness connectors from the following components:

A. The 2 engine wire harness connectors from the machine wire harness.

B. The positive battery cable and fusible link harness from the engine starter motor.

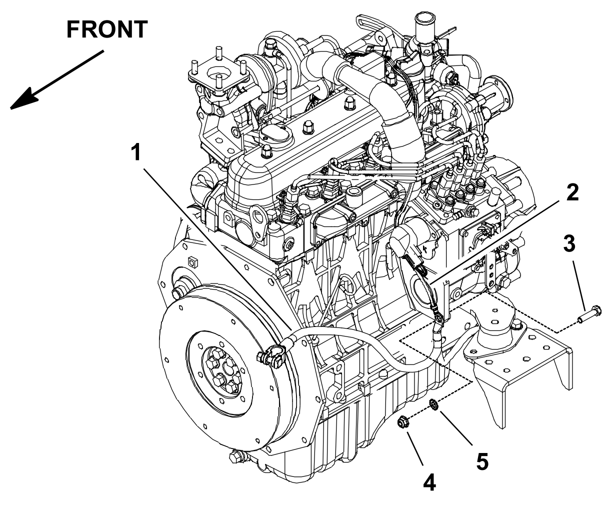


Figure 23

1. Negative battery cable	3. Bolt	5. Lock washer
2. Engine harness ground	4. Flange nut	

C. The negative battery cable and wire harness ground from engine flange near injector pump (Figure 23). Note location of lock washer between cable end and engine for assembly purposes.

D. The engine wire harness connectors from the glow relay and start relay.

E. The engine wire harness connector from the fuel pump.

11. Remove engine from machine:

A. Attach short section of chain between lift tabs located on each end of the cylinder head.

Removing the Engine (continued)

B. Connect a hoist or chain fall at the center of the short section of chain. Apply enough tension on the short chain so that the engine will be supported.

C. Remove fasteners that secure the engine (with mount brackets) to the engine mounts.

CAUTION

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

IMPORTANT

Ensure to not damage the engine, fuel hoses, hydraulic lines, electrical harness, radiator, battery or other parts while removing the engine.

D. Carefully raise engine and remove toward front of machine.

12. If necessary, remove engine mount brackets from engine.

Installing the Engine

1. Locate machine on a level surface with cutting units lowered and key removed from the key switch. Chock wheels to keep the machine from moving.
2. Ensure that the all parts removed from the engine during maintenance or rebuilding are installed to the engine.
3. If engine mount brackets were removed from the engine, secure brackets to engine with lock washers and bolts. Torque the bolts to **47 to 56 N·m (34 to 42 ft-lb)**.
4. Install engine to machine.
   A. Attach short section of chain between lift tabs located on each end of the cylinder head
   B. Connect a hoist or chain fall at the center of the short section of chain. Apply enough tension on the short chain so that the engine can be supported.

CAUTION

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

IMPORTANT

Ensure to not damage the engine, fuel hoses, hydraulic lines, electrical harness, radiator, battery or other parts while installing the engine.

   C. Carefully lower engine to the machine frame. Ensure that the fastener holes of the engine mount brackets are aligned with the holes in the engine mounts secured to the machine frame.
   D. Insert bolt down through each engine mount bracket and engine mount. Place spacer, snubbing washer and then flange nut on 4 bolts. Tighten fasteners to secure engine to engine mounts.
5. Connect hydraulic pump driveshaft to engine; refer to Hydraulic Pump Driveshaft (page 6–159).
6. Connect all wire harness connectors to correct engine components.
7. Remove plugs installed in hoses during disassembly. Connect hoses to the engine:

Installing the Engine (continued)

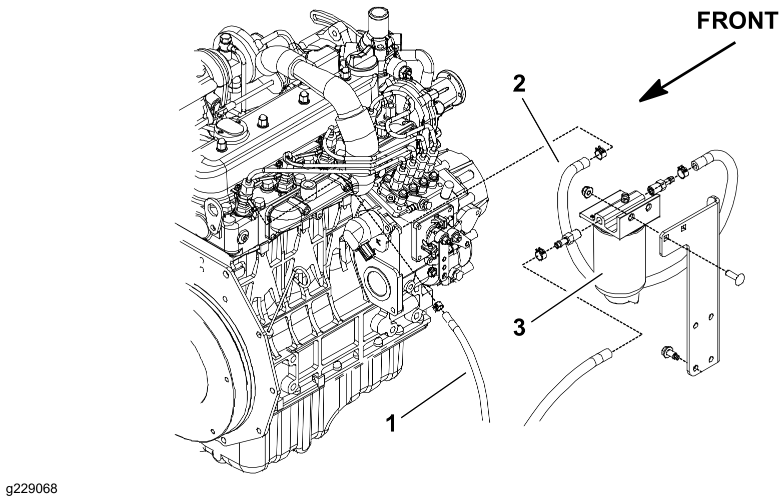


Figure 24

1. Fuel return hose
2. Fuel supply hose
3. Fuel/water filter

A. Connect fuel supply and fuel return hoses to engine fittings (Figure 24). Ensure that return hose is routed through R-clamp on bracket attached to flywheel plate. Secure hoses with hose clamps.

B. Connect upper and lower radiator hoses to the engine. Secure hoses with hose clamps.

8. Connect throttle cable to injector pump (Figure 22):

   A. Route throttle cable to injector pump on engine.

   B. Install the throttle cable end into the swivel in speed control lever. Secure cable end with bolt.

   C. Position throttle cable under cable clamp.

   D. Attach cable clamps that secure throttle cable to engine and driveshaft brackets. As clamps are tightened, ensure that the cable is not bent which could cause cable binding.

   E. Adjust throttle control; refer to Adjusting the Throttle Control (page 3–6).

9. Install air cleaner assembly; refer to Air Cleaner Assembly (page 3–8).
10. Install exhaust system to machine; refer to Exhaust System (page 3–11).
11. Fill radiator with coolant.
12. Check engine hydraulic-fluid level and adjust if necessary.
13. Close hood and connect positive (+) and then negative (-) battery cables to the battery.
14. Bleed fuel system.
15. Start engine. Check for fluid leaks and proper engine operation.
16. After running engine for a short time, stop engine and ensure radiator is full. Add coolant if necessary.
17. Secure hood before returning machine to operation.

Chapter 4

Yanmar Diesel Engine

Table of Contents

Additional Reference Materials

Yanmar TNV (Tier 4) Series Service Manual
Yanmar TNV (Tier 4) Series Troubleshooting Manual

Specifications

Yanmar Diesel Engine

Reelmaster 5410-D and 5510-D

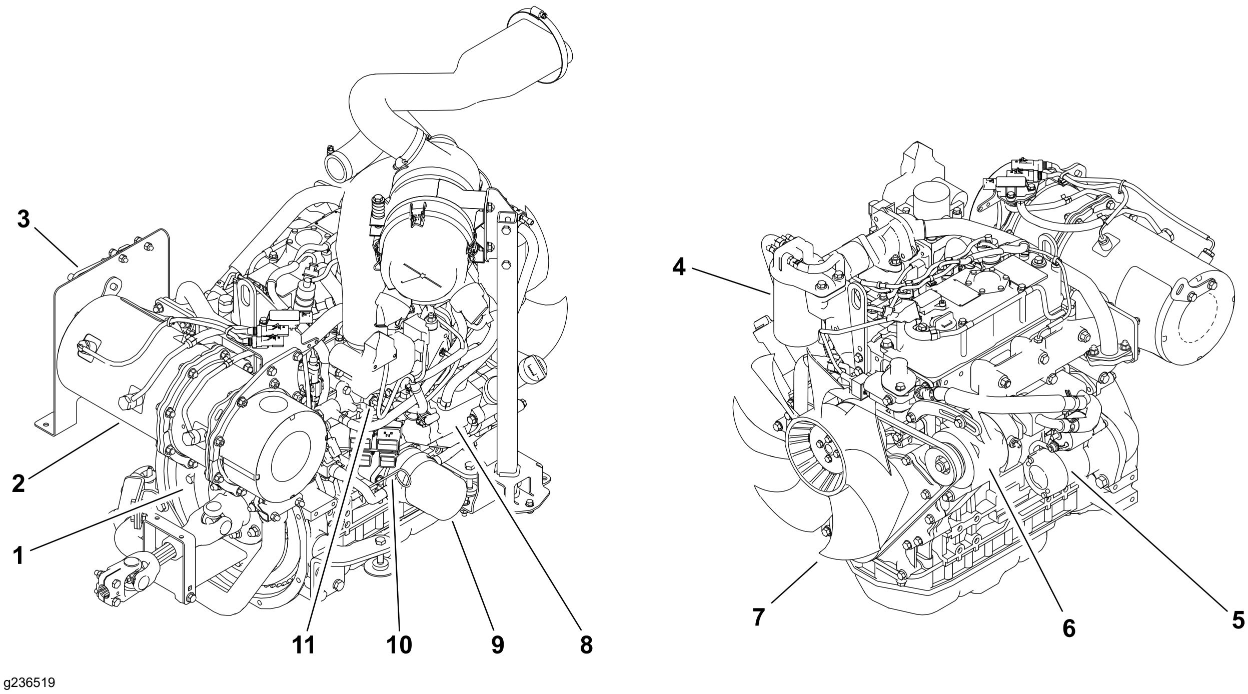


Figure 25

1. Flywheel
2. Diesel-particulate filter (DPF)
3. Engine ECU
4. Fuel filter
5. Starter motor
6. Alternator
7. Engine cooling fan
8. Supply pump
9. Engine oil filter
10. Engine oil cooler
11. Common rail

Item	Description
Make/Designation	Yanmar Model 3TNV88C-DTR: 4-Cycle, 3 Cylinder, Water Cooled, Tier 4 Diesel Engine
Number of Cylinders	3
Bore x Stroke	88 x 90 mm (3.465 x 3.543 inches)
Total Displacement	(1,642 cm^3) 100.2 in^3
Firing Order	1 (flywheel end) - 3 (fan end) - 2
Direction of Rotation	Counterclockwise (viewed from flywheel)
Fuel	Diesel or Biodiesel (up to B7) Fuel with Ultra-Low Sulfur Content; refer to the *Traction Unit Operator's Manual* for additional fuel information
Fuel Pump	Yanmar Supply Pump
Fuel Injection Type	Common Rail with Direct Injection
Fuel Tank Capacity	53 L (14 US gallons)
Governor	Electronic All Speed
Low Idle Speed (no load)	1,150 to 1,250 rpm
High Idle Speed (no load)	2,950 to 3,050 rpm

Yanmar Diesel Engine (continued)

Item	Description
Engine Oil	API CJ-4 or higher; refer to the *Traction Unit Operator's Manual* for additional engine oil information
Engine Oil Viscosity	Refer to the *Traction Unit Operator's Manual*
Oil Pump	Gear Driven Trochoid Type
Crankcase-Oil Capacity	5.2 L (5.5 US qt) with Filter
Cooling System Capacity (including reserve tank)	6.6 L (7 US qt)
Starter	12 VDC 1.7 KW
Alternator/Regulator	12 VDC 55 A
Dry Weight (approximate)	188 kg (414 lb)

Yanmar Diesel Engine (continued)

Reelmaster 5610-D

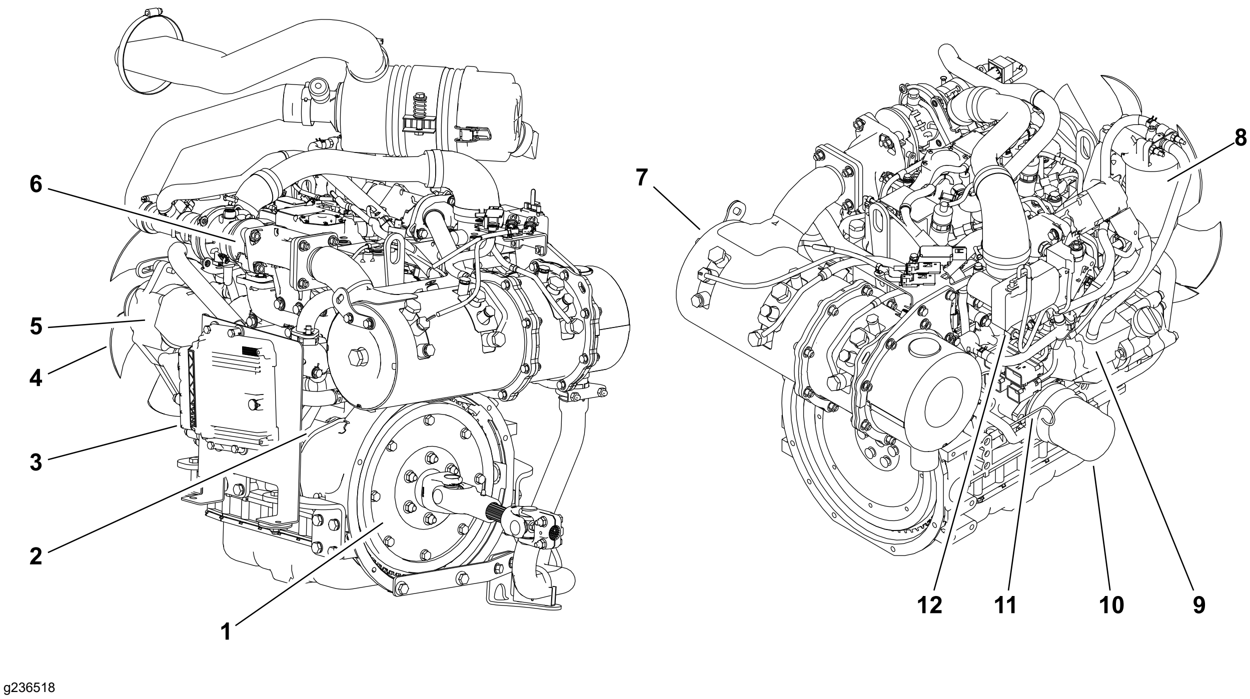


Figure 26

1. Flywheel
2. Starter motor
3. Engine ECU
4. Engine cooling fan
5. Alternator
6. Turbocharger
7. Diesel-particulate filter (DPF)
8. Fuel filter
9. Supply pump
10. Engine oil filter
11. Engine oil cooler
12. Common rail

Item	Description
Make/Designation	Yanmar 3TNV86CT: 4-cycle, 3 cylinder common-rail water cooled diesel with EGR, turbocharged, and diesel-particulate filter (DPF). EPA Tier 4 Final compliant.
Bore	86 mm (3.38 inches)
Stroke	90 mm (3.54 inches)
Total displacement	1568 cm^3 (95.68 in^3)
Firing order	1 (closest to the flywheel end) - 3 - 2
Direction of rotation	Counterclockwise (viewed from the flywheel)
Fuel	Diesel or Biodiesel fuel (up to B20) with ultra-low sulfur content
Fuel tank capacity	51.1 L (13.5 US gallons)
Fuel injection pump	CR supply pump
Fuel injection type	Common rail system (EPA Tier 4 certified)
Governor	Electronic
Low idle (no load)	1,175 to 1,225 rpm
High idle (no load)	3,005 to 3,055 rpm
Engine oil	API CJ-4, ACEA E-6, JASO DH-2
Engine-oil viscosity	Refer to the *Operator's Manual*

Yanmar Diesel Engine (continued)

Item	Description
Crankcase-oil capacity	4.7 L (4.9 US qt)
Oil pump	Yanmar trochoid pump
Coolant capacity	9.5 L (10 US qt)
Alternator/Regulator	12 VDC, 55 A
Engine weight (dry)	200 kg (441 lb)

General Information

This chapter gives information about specifications and repair of the Yanmar diesel engine used on certain Reelmaster 5410-D, 5510-D, and 5610-D machines. The general maintenance procedures are described in the *Operator's Manual*. Detailed information on engine troubleshooting, testing, disassembly, and assembly is identified in the Yanmar Engine Service Manual and Troubleshooting Manual.

Additionally, some engine repair procedures are described in this manual. The described adjustments and repairs require tools which are commonly available in many service shops. Special tools are described in the Yanmar Engine Service 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 the Yanmar engines are supplied through your Authorized Toro Distributor. If the parts list is not available, provide your distributor with the Toro Model and Serial Number of your machine.

Traction Unit Operator's Manual

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

Yanmar Engine Service and Troubleshooting Manuals

The engine that powers certain Reelmaster 5410-D, 5510-D machines is a Yanmar Model 3TNV88C-DTR Tier 4F compliant engine. The engine that powers certain Reelmaster 5610 machines is a Yanmar Model 3TNV86CT Tier 4F compliant engine. The Yanmar Engine Service Manual and Troubleshooting Manual are available for these engines. Ensure that the correct engine manuals are used when servicing the engine on your machine.

Engine Electronic Control Unit (ECU)

The Yanmar engine used in Reelmaster machines uses an electronic control unit (ECU) for engine management and to communicate with the machine Toro Electronic Controller (TEC) and the operator InfoCenter on the machine. All wire harness electrical connectors should be plugged into the ECU before the machine key switch is turned from the OFF position to either the ON or START position. The engine ECU is located at the right side of the machine near the diesel-particulate filter (DPF).

IMPORTANT

Do not plug or unplug the engine ECU for 30 seconds after the machine key switch is turned off. The engine ECU may remain energized even though the key switch is in the OFF position.

If you must disconnect the engine ECU for any reason, ensure that the key switch is in the OFF position with the key removed before disconnecting the engine ECU. Also, to prevent possible engine ECU damage when welding on the machine, disconnect and remove the engine ECU from the machine before welding.

Note: A ground wire is used to ground the ECU to the machine frame. The ground wire is connected to the ECU with 1 of the ECU mounting screws and is secured to the frame with a flange-head screw.

Engine Electronic Control Unit (ECU) (continued)

The engine electrical components (e.g., ECU, fuel injectors, EGR, and exhaust DPF) are identified and matched in the engine ECU program. If the engine electrical components are replaced, the Yanmar electronic tool must be used to update the ECU program which will ensure correct engine operation.

If the engine ECU identifies that an engine problem exists, the engine speed may be reduced or the engine may shut off. The Yanmar troubleshooting manual and electronic diagnosis tool should be used to provide assistance in identifying the cause of the problem and the repairs that are necessary. Contact your Toro distributor for any assistance in the Yanmar engine troubleshooting.

Yanmar Engine

Certain Reelmaster 5410-D, 5510-D and 5610-D machines use a Yanmar TNV Series diesel engine that complies with EPA Tier 4F emissions regulations. The engines include an electronic control unit (ECU), an exhaust gas recirculation valve (EGR), and a diesel exhaust particulate filter (DPF). The engine used in the Reelmaster 5610-D also includes a turbocharger.

The engine ECU, combined with numerous engine sensors, monitor and control the engine operation for optimum performance. During the operation of the engine, if conditions warrant, the engine ECU may generate an engine fault. Use the machine InfoCenter to identify the engine fault; refer to Engine Faults (page 7–35), the Yanmar Troubleshooting Manual, or contact an Authorized Toro Distributor for assistance.

Diesel Particulate Filter (DPF)

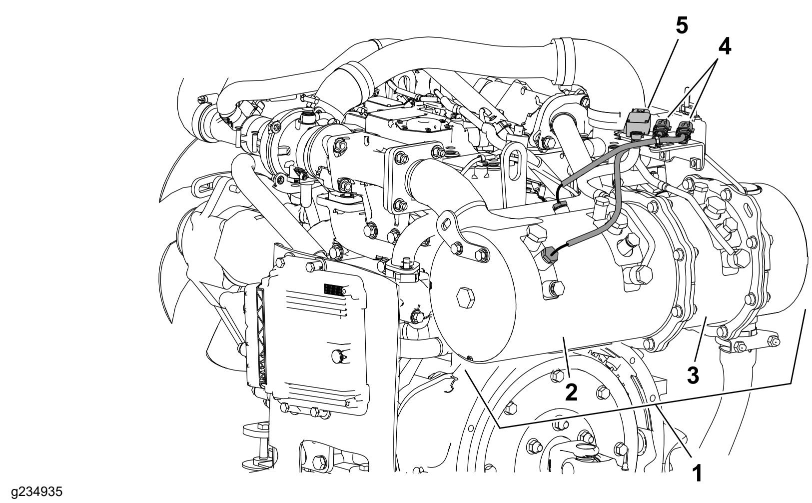


Figure 27

1. Diesel-particulate filter assembly (DPF)
2. Diesel oxidation catalyst (DOC)
3. Soot filter
4. Temperature sensor (2 each)
5. Pressure differential sensor

The diesel particulate filter (DPF) used on Yanmar Tier 4F compliant engines is designed to breakdown the hazardous elements in the exhaust and prevent the discharge of unburnt fuel or oil known as particulate matter or soot. The DPF includes a Diesel Oxidation Catalyst (DOC), a Soot Filter (SF), 2 temperature sensors, and a pressure differential sensor. Additional information regarding the Diesel Particulate Filter (DPF) can be found in the *Yanmar Operation Manual – Industrial Engines TNV* supplied with your machine.

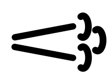
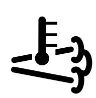
Regeneration

The engine ECU monitors the exhaust pressure before and after the soot filter in the DPF to determine if soot is accumulating. If soot is accumulating during normal engine operation, the pressure differential will increase. The increase in pressure will signal the engine to begin a process called Regeneration. Regeneration increases the exhaust temperature and the length of time the engine operates at a higher than normal exhaust temperature, incinerating the built up soot and turning it into ash. The different types of regeneration used are listed in order based on the amount of particulate matter in the soot filter (least to most).

Note: The user interface and InfoCenter displays for DPF regeneration changed with machine software 119-7798T. Use the InfoCenter About screen to verify the software installed on the machine.

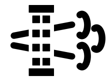
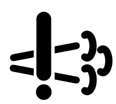
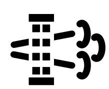
- For machines with software 119–7798A thru S: Complete DPF regeneration instructions can be found in the updated traction unit *Operator's Manual* for the specific machine. Visit www.toro.com to download the updated traction unit *Operator's Manual* for the machine.
- For machines with software 119–7798T and up: Complete DPF regeneration instructions can be found in the traction unit *Operator's Manual* for Model 03606/03607 machine serial number 401334001 and up, and Model 03679 machine serial number 401341001 and up. Model 03672/03687 machines should use Model 03606/03607 serial number 401334001 and up documentation. Visit www.toro.com to download the traction unit *Operator's Manual* with the correct DPF regeneration instructions for the machine.

Types of regeneration that are performed automatically (while the machine is operating)

Type	Conditions	Description
Passive	Occurs during normal operation of the machine at high engine speed or high engine load	The DPF processes high heat exhaust gasses, oxidizing harmful emissions and incinerating soot to ash. The InfoCenter does not display an icon during passive regeneration.
Assist	Occurs because of prolonged operation at low engine speed, low engine load, or when the engine ECU detects the soot filter is becoming obstructed.	The engine ECU adjusts the exhaust intake throttle to raise the exhaust temperature.  **For software 119–7798A thru S only:** the InfoCenter displays the assist regeneration icon.
Reset	Occurs every 100 hours of engine operation Occurs after an assist regeneration if the engine ECU determines the assist regeneration did not sufficiently reduce the soot level **Note:** Reset regeneration may be temporarily delayed if high exhaust temperatures would create an unsafe condition (the machine is operating indoors or outdoors around trees, brush, tall grass, or other temperature-sensitive plants or materials). Refer to Setting the Inhibit Regen in the traction unit*Operators Manual* for additional information.	The engine ECU adjusts the exhaust intake throttle and the injector timing to raise the exhaust temperature.  **For all software revisions:** the InfoCenter displays the high exhaust temperature icon.

Regeneration (continued)

Types of regeneration that are performed manually (while the machine is stationary)

Type	Conditions	Description
Parked	Occurs when exhaust back pressure in the DPF increases due to continued soot buildup. May be caused by prolonged operation at low engine speed, low engine load, or the use of incorrect fuel or engine oil. May occur if the InfoCenter is set to inhibit regen (preventing a Reset Regeneration) and machine operation is continued. Can be initiated when prompted by the engine ECU or after a minimum of 50 hours of engine operation. **For software 119–7798T and up:** if a parked regeneration is ignored, the machine mow function (PTO) will be disabled approximately 2 hours after the first notification.	Manually initiate a parked regeneration as soon as possible. A parked regeneration will take approximately 30 to 60 minutes and should not be started with less than 1/4 tank of fuel. The machine must remain stationary (cannot be operated) during the entire parked regeneration process.  **For all software revisions:** the InfoCenter displays advisory #188 and/or the stationary regeneration icon
Recovery	Occurs when exhaust back pressure in the DPF increases due to soot buildup reaching a critical level. Can only be initiated when prompted by the engine ECU. **For software 119–7798T and up:** the machine mow function (PTO) will be disabled at first notification.	Manually initiate a recovery regeneration as soon as possible. A recovery regeneration will take approximately 3 hours and should not be started with less than 1/2 tank of fuel. The machine must remain stationary (cannot be operated) during the entire recovery regeneration process. Use the InfoCenter About screen to verify the software installed on the machine. • Machines with software 119–7798A thru S: Recovery regeneration must be initiated by an Authorized Toro Distributor service technician using Yanmar SMARTASSIST-Direct • Machines with software 119–7798T and up: Recovery regeneration can be initiated from the machine InfoCenter  **For software 119–7798A thru S only:** the InfoCenter displays the recovery regeneration icon.  **For software 119–7798T and up:** the InfoCenter displays advisory #190 and/or the stationary regeneration icon. **Note:** Verify the model and serial number of the engine installed in the machine. 3TNV88C-DTR engines below serial number 02426, and 3TNV86CT-DTR engines below serial number 00391 cannot run a recovery regeneration without first reprogramming the engine ECU. Contact an Authorized Toro Distributor for assistance.

Soot Accumulation

If the types of regeneration that are performed automatically (while the machine is operating) are bypassed or not allowed to complete before shutting off the engine, soot will continue to accumulate in the soot filter. When enough soot accumulates, the engine ECU will generate an engine fault to prompt a parked or recovery regeneration. In addition to an engine fault appearing on the InfoCenter, the engine output power will be reduced.

Soot Accumulation Engine Faults

Fault Level	Fault Code	Engine Power Rating	Recommended Action
Level 1: Engine Warning	ADVISORY #179	De-rated to 85%	Perform a parked regeneration as soon as possible.
Level 2: Engine Warning	Check Engine SPN: 3251 FMI: 0 Occ: 1 See Service Manual	De-rated to 50%	Perform a recovery regeneration as soon as possible

Ash Accumulation

Ash is a result of the regeneration processes. The lighter ash is discharged through the exhaust system, while the heavier ash collects in the soot filter. When enough ash accumulates in the soot filter, the engine ECU will generate an engine fault to prompt servicing the DPF. In addition to an engine fault appearing on the InfoCenter, the engine output power and speed will be reduced.

Ash Accumulation Advisories and Engine Faults

Fault Level	Fault Code	Engine Power Rating	Engine Speed Reduction	Recommended Action
System Advisory (machine software 119–7798A thru S only)	ADVISORY #179	100%	None	Plan to service the DPF in the near future
Level 1: Engine Warning	Check Engine SPN: 3251 FMI: 0 Occ: 1 See Service Manual	De-rated to 85%	None	Service the DPF; Exhaust System (page 4–15)
Level 2: Engine Warning	Check Engine SPN: 3251 FMI: 0 Occ: 1 See Service Manual	De-rated to 50%	None	Service the DPF; Exhaust System (page 4–15)
Level 3: Engine Warning	Check Engine SPN: 3251 FMI: 0 Occ: 1 See Service Manual	De-rated to 50%	Maximum torque + 200 rpm	Service the DPF; Exhaust System (page 4–15)

Shutting Off the Engine (Reelmaster 5610-D)

IMPORTANT

After mowing or full load operation on machines with a turbo-charged engine, cool the turbo-charger by allowing the engine to run at low-idle speed for 5 minutes before shutting off the engine. This allows the turbocharger and internal engine components to cool-down. Failure to allow this cool-down period may lead to premature turbocharger and engine failure.

Service and Repairs

Air Cleaner System

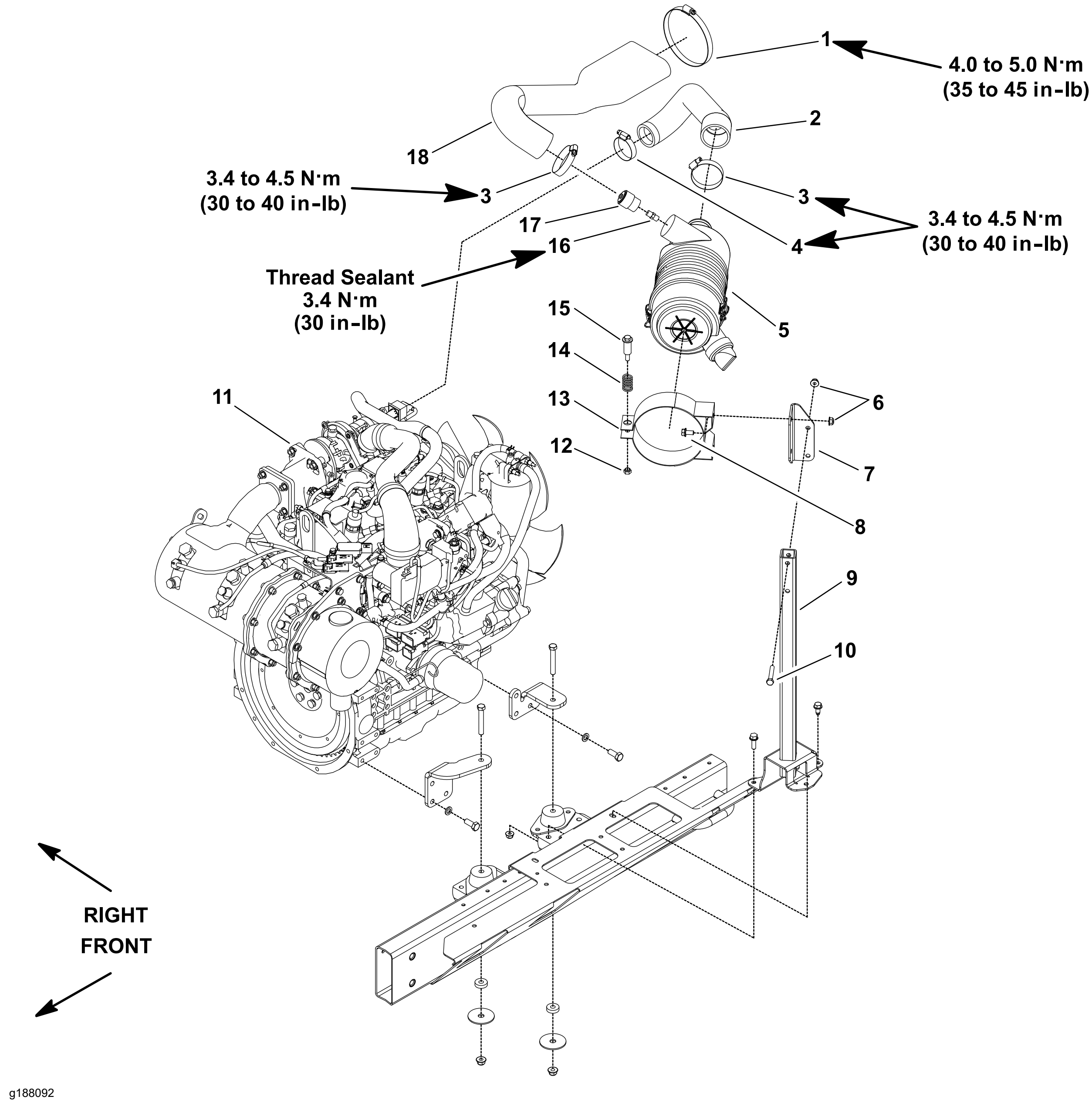


Figure 28

Reelmaster 5610-D

1.	Clamp	7.	Air cleaner bracket	13.	Air cleaner mounting band
2.	Air cleaner outlet hose	8.	Flange-head screw (2 each)	14.	Spring
3.	Hose clamp (2 each)	9.	Air cleaner stand	15.	Bolt
4.	Hose clamp	10.	Bolt (2 each)	16.	Adapter
5.	Air cleaner assembly	11.	Yanmar engine	17.	Service indicator
6.	Flange nut (4 each)	12.	Nut	18.	Air cleaner inlet hose

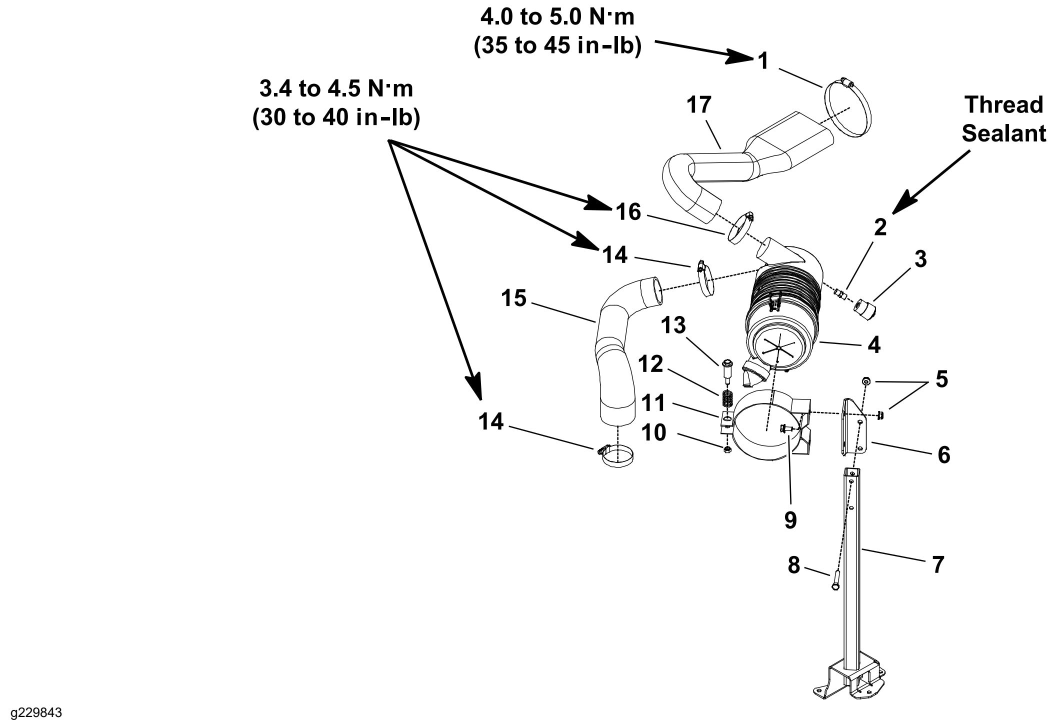


Figure 29

1. Hose clamp
2. Adapter
3. Service indicator
4. Air cleaner assembly
5. Flange nut (4 each)
6. Air cleaner bracket
7. Air cleaner stand
8. Bolt (2 each)
9. Flange-head screw (2 each)
10. Hex nut
11. Air cleaner mounting band
12. Spring
13. Shoulder bolt
14. Hose clamp (2 each)
15. Air cleaner hose
16. Hose clamp
17. Air cleaner inlet hose

Removing the Air Cleaner System

Note: Refer to the *Operator's Manual* for maintenance procedures and intervals of the air cleaner.

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Unlatch the hood and raise it.
3. Remove the air cleaner components as shown in Figure 28 or Figure 29.
4. Examine the air cleaner assembly (item 5 in Figure 28) for wear or damage that could cause possible air leaks.
5. Examine the air hoses for wear or damage and replace the hoses if necessary.
6. Examine the hood seals for wear or damage and replace the seals if necessary.

IMPORTANT

Leaks in the air filter system will allow dirt to enter into the engine and can cause serious engine damage. Ensure that all the air cleaner components are in good condition and are properly secured during installation.

1. Assemble the air cleaner system as shown in Figure 28 or Figure 29.
   A. If the service indicator and adapter were removed from the air cleaner assembly, apply thread sealant to the threads of the adapter before installing the adapter and service indicator to the housing (Figure 30). Install the adapter so that the grooves in the adapter hex and adapter filter element are installed toward service indicator. Torque the service indicator to **1.4 to 1.6 N·m (12 to 15 in-lb)**.

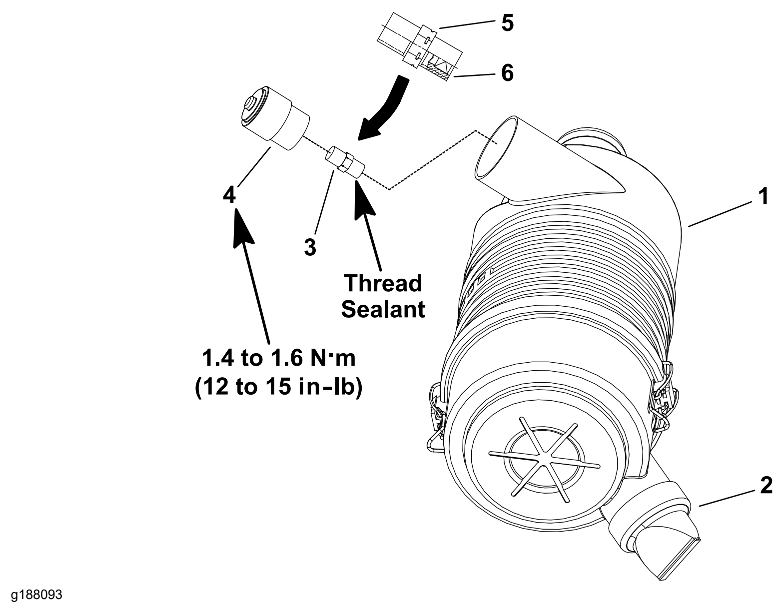


Figure 30

1.	Air cleaner assembly	3.	Adapter	5.	Groove
2.	Vacuator valve	4.	Service indicator	6.	Filter element

   B. Ensure that the vacuator valve (item 2 in Figure 30) is pointed down after installation.
   C. Torque the hose clamps to the values identified in Figure 28 or Figure 29.
2. Lower the hood and secure it with the latches.

Exhaust System

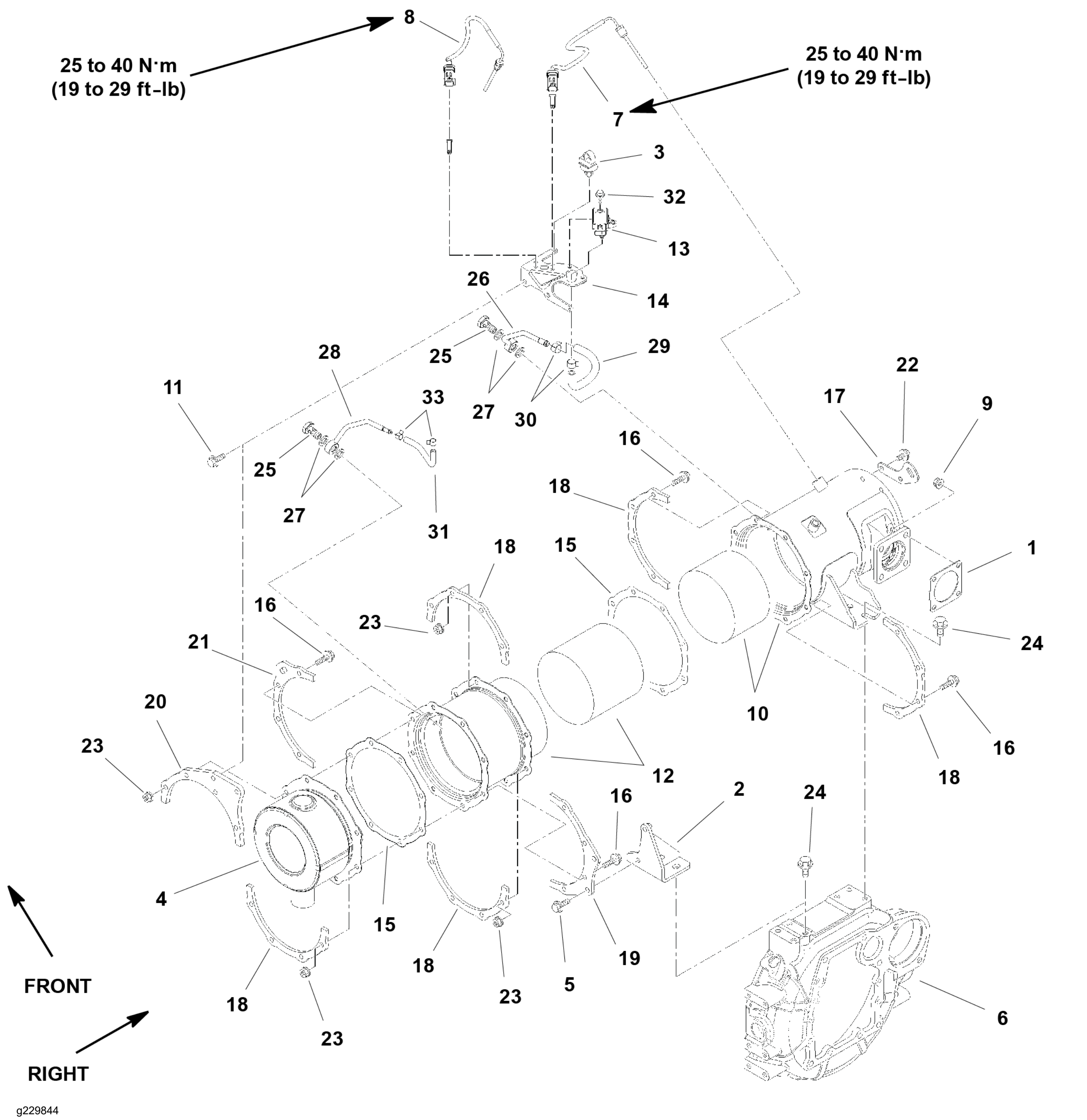


Figure 31

1. Gasket
2. Exhaust assembly stay
3. Clip band
4. DPF silencer
5. Bolt (2 each)
6. Engine flywheel housing
7. DOC temp sensor (inlet)
8. DOC temp sensor (outlet)
9. Flange nut (4 each)
10. DOC assembly
11. Bolt (2 each)
12. DPF assembly
13. Pressure sensor
14. Sensor bracket
15. DPF gasket (2 each)
16. Bolt (16 each)
17. DPF lifter
18. DPF stiffener (5 each)
19. DPF stiffener
20. DPF stiffener
21. DPF stiffener/lifter
22. Bolt (2 each)
23. Nut (16 each)
24. Bolt (4 each)
25. Pipe joint bolt (2 each)
26. Exhaust pressure pipe (DPF inlet)
27. Sensor gasket (4 each)
28. Exhaust pressure pipe (DPF outlet)
29. Exhaust hose
30. Hose clip (2 each)
31. Hose
32. Bolt (2 each)
33. Hose clip (2 each)

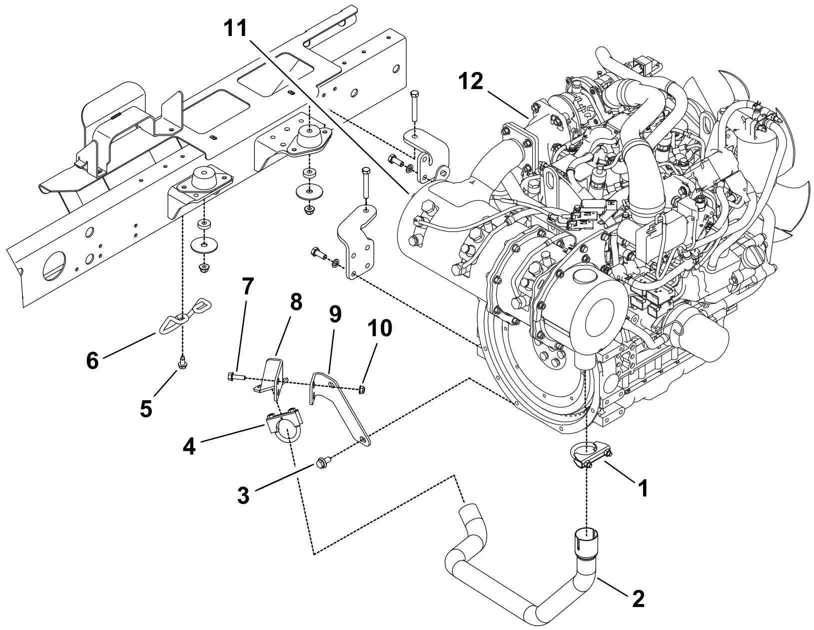


Figure 32

Reelmaster 5610-D

1. Muffler clamp
2. Exhaust tube
3. Flange-head screw (2 each)
4. Exhaust clamp
5. Washer-head screw (2 each)
6. Tailpipe guard
7. Flange-head screw (2 each)
8. Tailpipe bracket
9. Tailpipe bracket
10. Flange nut (2 each)
11. Diesel-particulate filter assembly (DPF includes DOC)
12. Engine

The exhaust system used in Reelmaster requires a diesel exhaust particulate filter (DPF). The DPF includes a Diesel Oxidation Catalyst (DOC), a Soot Filter (SF), a temperature sensor, and a pressure differential sensor. Under normal circumstances, the diesel oxidation catalyst requires replacement at approximately 6,000 hours. Under normal circumstances, the soot filter requires reconditioning or replacement at approximately 6,000 hours. Reconditioning the soot filter requires special equipment and should only be done by a company familiar with the reconditioning process. An alarm timer in the engine ECU must be reset when the soot filter is reconditioned or replaced. Contact an Authorized Toro Distributor for assistance.

Refer to the *Yanmar Engine Service Manual* for information on servicing, removing, and installing the DPF and its components. The following procedures describe removing and installing the remainder of the exhaust system (not including the diesel exhaust particulate filter (DPF).

Removing the Exhaust System

CAUTION

A hot engine and exhaust system can cause burns.

Allow the engine and the exhaust system to cool before working on or near them.

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.

Removing the Exhaust System (continued)

2. Block the wheels with chocks to prevent the machine from moving.
3. Unlatch the hood and raise it. Allow engine and exhaust system to cool before doing any disassembly of exhaust system components.
4. Remove the exhaust system components as shown in Figure 31 and Figure 32. Discard all gaskets that were removed (items 1 and 15 in Figure 31).

   Note: The exhaust system DPF and DOC can be removed from the exhaust system without removing the entire exhaust system from the engine. Refer to the Yanmar Engine Service Manual for complete disassembly and assembly procedures.

Installing the Exhaust System

Note: Ensure that all exhaust system flanges and sealing surfaces are free of debris or damage that may prevent a tight seal.

1. Ensure to install new gaskets in place of all gaskets that were removed. Do not use any type of gasket sealant on gasket or flange surfaces.
2. Assemble all exhaust system components that were removed (Figure 31 and Figure 32).
   A. If exhaust sensors (items 7 and 8 in Figure 31) were removed, torque the sensors to **25 to 40 N·m (19 to 29 ft-lb)**.
   B. If exhaust pressure pipes (items 26 and 28 in Figure 31) were removed, replace the sensor gaskets on both sides of the pressure pipe fitting.
   C. Adjust the muffler guard on frame so there is 9.5 mm (3/8 inch) clearance between the exhaust tube and the guard in all directions. Ensure that the rear cutting units and lift arms do not contact exhaust tube when the cutting units are fully raised.
3. Lower the hood and secure it with the latches.

Radiator

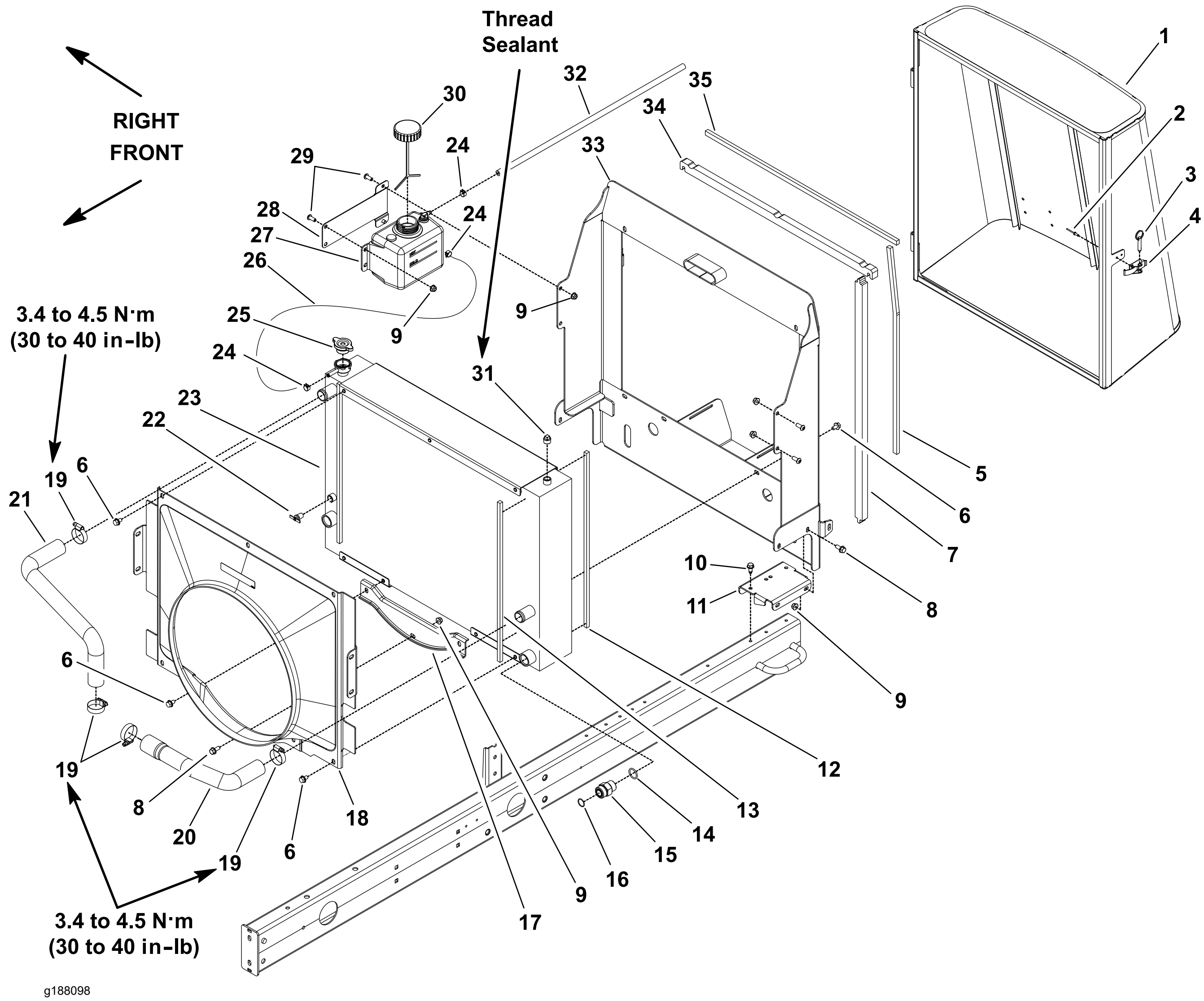


Figure 33

1.	Screen	10.	Washer-head screw (6 each)	19.	Hose clamp (4 each)	28.	Reservoir bracket
2.	Pop rivet (2 each)	11.	Mounting bracket (2 each)	20.	Lower radiator hose	29.	Button-head screw (5 each)
3.	Detent ball pin	12.	Foam seal (2 each)	21.	Upper radiator hose	30.	Reservoir cap
4.	Draw latch	13.	Foam seal (2 each)	22.	Draincock	31.	Pipe plug
5.	Foam seal (2 each)	14.	O-ring (2 each)	23.	Radiator and oil cooler assembly	32.	Reservoir hose
6.	Flange-head screw (14 each)	15.	Straight hydraulic fitting (2 each)	24.	Hose clamp (3 each)	33.	Radiator frame
7.	Foam seal (2 each)	16.	O-ring (2 each)	25.	Radiator cap	34.	Foam seal (2 each)
8.	Flange-head screw (5 each)	17.	Shroud cap	26.	Reservoir hose	35.	Foam seal
9.	Flange nut (10 each)	18.	Fan shroud	27.	Coolant reservoir assembly		

Note: The radiator on your Reelmaster is combined with the hydraulic oil cooler.

Removing the Radiator

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the screen (item 1 in Figure 33) from the machine.
3. Unlatch the hood and raise it.

DANGER

If the radiator or engine is hot, pressurized hot coolant can escape and cause burns.

Do not open the radiator cap or drain the radiator when the coolant is hot.

WARNING

Ethylene-glycol antifreeze is poisonous.

Keep the coolant away from children and pets.

Keep the coolant in a labelled container.

Discard the coolant in accordance with local hazardous waste ordinances.

4. Drain the coolant from the radiator as follows:
   A. Place a drain pan below the radiator draincock located at the bottom of the radiator. Ensure that the drain pan is large enough to hold the cooling system contents (5.2 L (5.5 US qt)).
   B. Loosen the radiator draincock (turn clockwise) and allow the coolant to drain from radiator.

IMPORTANT

Follow all local codes and regulations when recycling or disposing engine coolant.

5. Remove the air cleaner inlet hose from the top of the radiator frame; refer to Air Cleaner System (page 4–12).
6. Disconnect the upper and lower radiator hoses (items 21 and 20 in Figure 33) from the radiator.
7. Loosen the hose clamp and remove the reservoir hose (item 26 in Figure 33) from the radiator fill opening.
8. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 6–145).
9. Clean the hydraulic tube ends and oil cooler fittings to prevent hydraulic system contamination.
10. Disconnect the hydraulic tubes from the straight hydraulic fittings (Figure 34).
11. Cover or plug the hydraulic tubes to prevent contamination.
12. Remove the 2 button-head screws (item 29 in Figure 33) and 2 flange nuts that secure the coolant reservoir and reservoir bracket to the fan shroud.

Removing the Radiator (continued)

Carefully position the coolant reservoir and reservoir bracket away from the fan shroud.

13. On the left side of the machine, remove the 2 button-head screws (item 29 in Figure 33) and 2 flange nuts that secure the fan shroud to the radiator frame.
14. Remove the 14 flange-head screws (item 6 in Figure 33) that secure the fan shroud to the radiator, and radiator to the radiator frame. Position the fan shroud away from the radiator.
15. Carefully remove the radiator and oil cooler assembly from the machine.
16. If necessary, remove the 2 straight hydraulic fittings from the oil cooler and discard the O-rings.
17. Cover or plug the openings in oil cooler and disconnected coolant and hydraulic tubes to prevent contamination from entering the system.
18. Inspect all foam seals on the radiator, fan shroud, and radiator frame. Replace any foam seals that are damaged.

Installing the Radiator

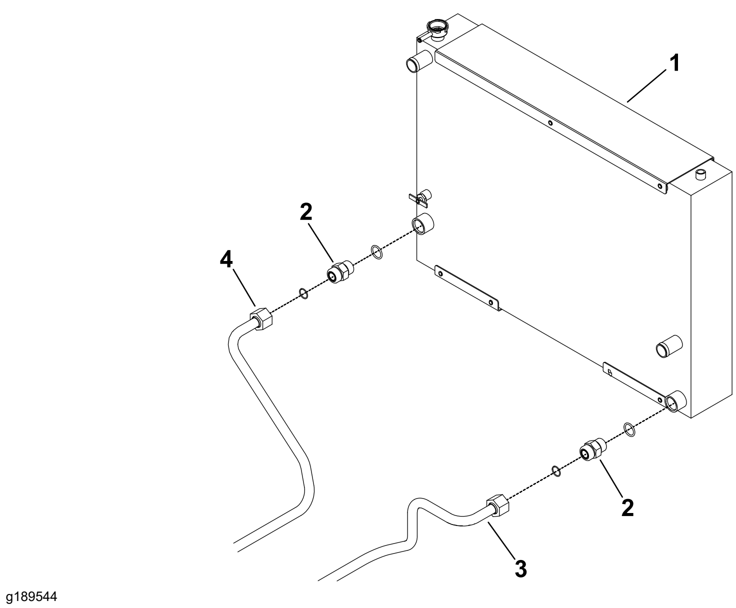


Figure 34

1.	Radiator	3.	Hydraulic tube
2.	Straight hydraulic fitting (2 each)	4.	Hydraulic tube

1. If the 2 straight hydraulic fittings (Item 2 in Figure 34) were removed from the oil cooler, lubricate and install new O-rings onto the fittings. Install the fittings into the port openings and tighten the fittings; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 6–13).
2. Carefully position the radiator and oil cooler assembly to the radiator frame. Position the fan shroud to the radiator.
3. Secure the radiator to the radiator frame with the 7 flange-head screws previously removed. Position the fan shroud to the radiator with the 7 fasteners previously removed. Ensure that at least **6.4 mm (0.250 inch)** clearance exists at all points between the fan shroud and the fan.

Installing the Radiator (continued)

4. Position the coolant reservoir and reservoir bracket to the fan shroud. Secure the reservoir bracket to the fan shroud and radiator frame with the 2 button-head screws (item 29 in Figure 33) and 2 flange nuts.
5. On the left side of the machine, secure the fan shroud to the radiator frame with the 2 button-head screws (item 29 in Figure 33) and 2 flange nuts.
6. Remove the covers and plugs from the openings in the radiator and the oil cooler and the disconnected coolant and hydraulic tubes that were installed during removal.
7. Connect the hydraulic tubes to the straight hydraulic fittings (Figure 34).
8. Connect the upper and lower radiator hoses to the radiator and secure the hoses with the hose clamps. Torque the hose clamps to **3.4 to 4.5 N·m (30 to 40 in-lb)**.
9. Connect the reservoir hose (item 26 in Figure 33) to the radiator fill opening and secure the reservoir hose with the hose clamp.
10. Install and secure the air cleaner inlet hose; refer to Air Cleaner System (page 4–12).
11. Ensure that the radiator draincock is closed.
12. To allow air to escape during radiator filling, remove the pipe plug (item 31 in Figure 33) from the top of the radiator. Fill the reservoir with coolant.

    Note: Ensure that the coolant level in the coolant reservoir is correct.
13. Apply thread sealant to the threads of the pipe plug.

    Note: Ensure to install the plug once all air is bled from the radiator.
14. Install the pipe plug into the radiator opening.
15. Add hydraulic fluid to the hydraulic reservoir as necessary to raise the hydraulic-fluid level to the operating range; refer to the *Operator's Manual*.
16. Start the engine and check for coolant and hydraulic fluid leaks. Repair any leaks as necessary before returning the machine to service.
17. Continue to run the engine to obtain the operating temperature. Check the coolant and hydraulic fluid levels and adjust as necessary.
18. Lower the hood and secure it with the latches.
19. Install and latch the screen (item 1 in Figure 33).

Fuel System

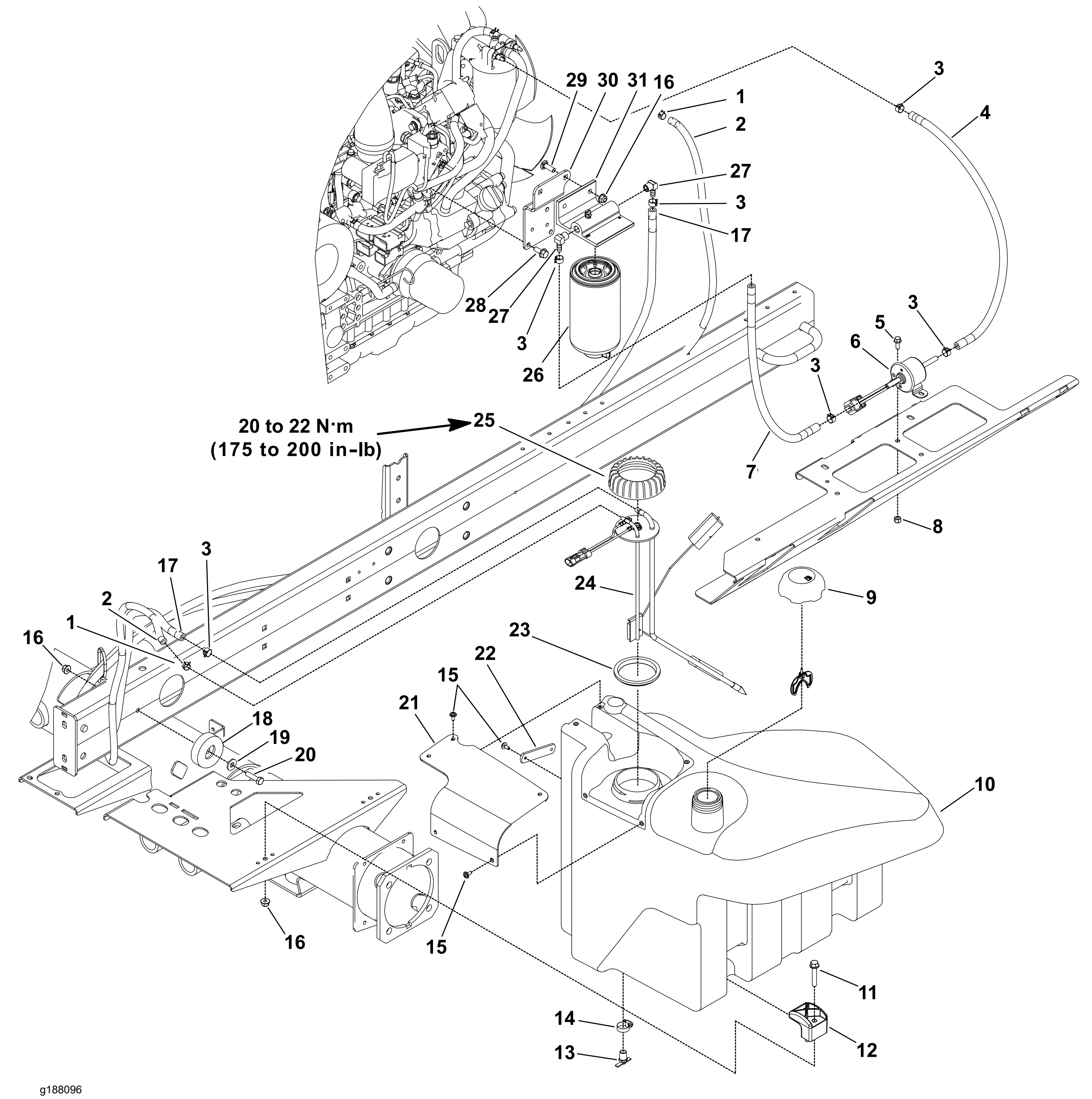


Figure 35

1. Hose clamp (2 each)
2. Fuel return hose
3. Hose clamp (6 each)
4. Fuel supply hose
5. Flange-head screw (2 each)
6. Fuel pump
7. Fuel supply hose
8. Locknut (2 each)
9. Fuel tank cap
10. Fuel tank
11. Washer-head screw (2 each)
12. Clamp (2 each)
13. Draincock
14. Hose clamp
15. Screw (7 each)
16. Flange nut (5 each)
17. Fuel supply hose
18. Recess bumper
19. Flat washer
20. Bolt
21. Sender cover
22. Cable strap
23. Fuel sender gasket
24. Fuel sender
25. Fuel sender cap
26. Fuel/water separator
27. 90° elbow fitting (2 each)
28. Flange-head screw (3 each)
29. Carriage screw (2 each)
30. Separator bracket
31. Fuel/water separator head

⚠ DANGER ⚠

Diesel fuel is highly flammable and explosive. A fire or an explosion from the fuel can burn you, burn other people, and damage property.

- **Use caution whenever you store or handle diesel fuel.**
- **Do not smoke while filling the fuel tank.**
- **Do not fill the fuel tank while the engine is running, while the engine is hot, or when the machine is in an enclosed area.**
- **Always fill the fuel tank outside and wipe up any spilled diesel fuel before starting the engine.**
- **Store fuel in a clean, safety-approved container and keep the cap in place.**
- **Use diesel fuel as an engine fuel only, not for any other purpose.**

Checking the Fuel Lines and Connections

Check the fuel lines and connections at the scheduled maintenance intervals recommended in the *Operator's Manual*. Check the lines for deterioration, damage, leaks, or loose connections. Replace the hoses, clamps, and fittings as necessary.

Priming the Fuel System

The fuel system needs to be primed before starting the engine for the first time, after running out of fuel, or after fuel system maintenance (e.g., draining the fuel/water separator, replacing the fuel filter or a fuel hose). To prime the fuel system, ensure that the fuel tank has fuel in it. Then, turn the key switch to the RUN position for 10 to 15 seconds, which allows the fuel pump to prime the fuel system. Do not turn the key switch to the START position to prime the fuel system.

Removing the Fuel Tank

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Unlatch the hood and raise it.
3. Remove the negative battery cable from the negative post of the battery.
4. Allow the engine to completely cool.
5. Place a drain pan under the fuel tank. Ensure that the drain pan is large enough to hold the fuel tank contents (refer to Specifications (page 4–2)).
6. Open the draincock at the bottom of the fuel tank and allow the tank to fully drain. Close the draincock.
7. Disconnect the wire harness connection from the fuel sender (item 24 in Figure 36).

   Note: Before removing the fuel hoses from the tank fittings, label the hoses for assembly purposes.

Removing the Fuel Tank (continued)

IMPORTANT

To prevent damage to the fuel hoses, numerous cable ties are used to secure the hoses to the machine components. Record the location of all cable ties that are removed from the machine during the fuel tank removal so that they can be properly replaced during the tank installation.

8. Loosen the hose clamps and carefully disconnect the fuel supply and return (items 17 and 2 in Figure 35) hoses from the fittings on the top of the fuel sender.
9. Cover or plug the fuel hoses or fitting openings to prevent contamination from entering the fuel system.
10. Remove the fuel tank as shown in Figure 35.

IMPORTANT

If the fuel sender is removed from the fuel tank, note the orientation of the fittings for assembly purposes (Figure 36).

Installing the Fuel Tank

1. Install the fuel tank to the frame (Figure 35). Secure the fuel hoses with the cable ties as recorded during the fuel tank removal.

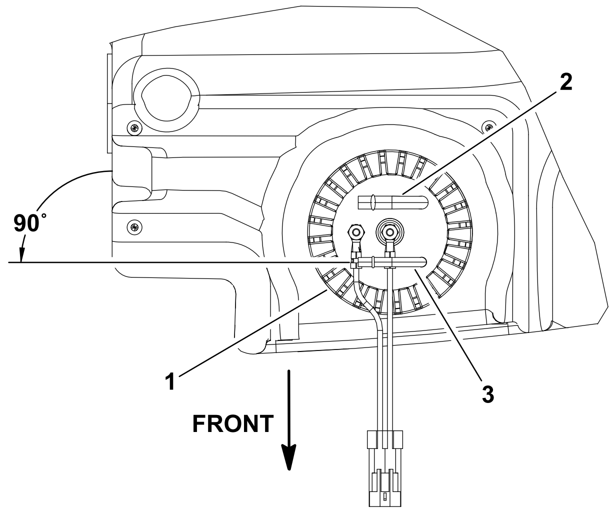


Figure 36

1. Fuel sender	2. Fuel supply fitting	3. Fuel return fitting

2. If the fuel sender was removed from the fuel tank, ensure that the fuel fittings on the sender are orientated at 90° from right side of the tank as shown in Figure 36. Torque the fuel sender cap to **20 to 22 N·m (175 to 200 in-lb)** and ensure that the fuel sender does not turn as the sender cap is tightened.
3. Connect the fuel supply and return (items 17 and 2 in Figure 35) hoses to the fittings on the top of the fuel sender. Secure the fuel hoses with the hose clamps.
4. Secure the wire harness connector to the fuel sender.
5. Connect the negative battery cable to the negative battery post.
6. Ensure that the fuel tank draincock is closed. Fill the fuel tank with clean fuel.
7. Prime the fuel system; refer to Priming the Fuel System (page 4–23).
8. Check the fuel hoses and fittings for leaks.

   Note: Repair all fuel leaks before returning the machine to service.
9. Lower the hood and secure it with the latches.

Engine

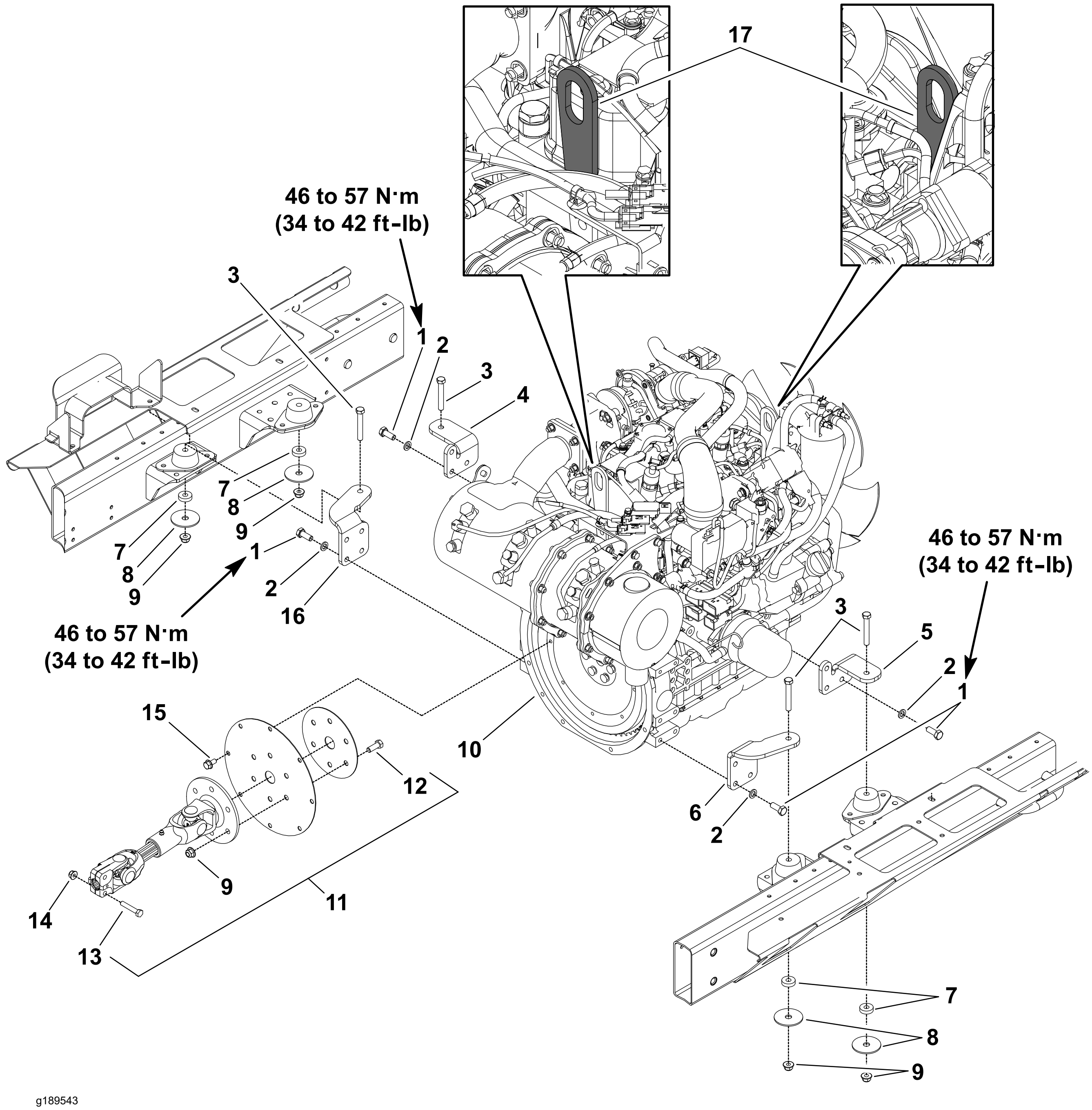


Figure 37

Reelmaster 5610-D

1. Bolt (14 each)
2. Lock washer (14 each)
3. Bolt (4 each)
4. Right rear engine mount
5. Left rear engine mount
6. Left front engine mount
7. Spacer (4 each)
8. Snubbing washer (4 each)
9. Flange nut (10 each)
10. Yanmar engine
11. Driveshaft assembly
12. Bolt (6 each)
13. Bolt (2 each)
14. Flange nut (10 each)
15. Flange-head screw (8 each)
16. Right front engine mount
17. Lift tab

Removing the Engine

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Unlatch the hood and raise it.
3. Disconnect both the battery cables at the battery. Disconnect the negative battery cable and then the positive battery cable; refer to Servicing the Battery (page 7–125).

DANGER

If the radiator or engine is hot, pressurized hot coolant can escape and cause burns.

Do not open the radiator cap or drain the coolant when the radiator or engine is hot.

WARNING

Ethylene-glycol antifreeze is poisonous.

Keep the coolant away from children and pets.

Keep the coolant in a labelled container.

Discard the coolant in accordance with local hazardous waste ordinances.

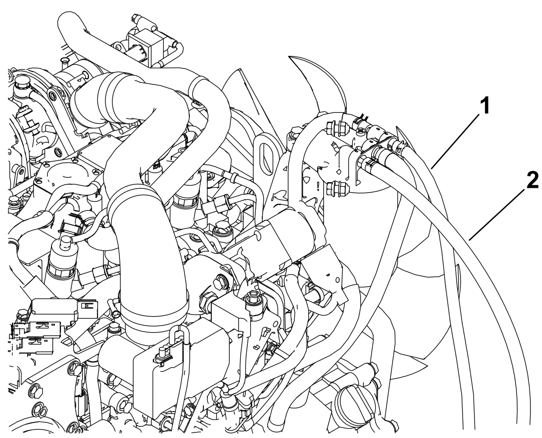


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Figure 38

1. Fuel return hose
2. Fuel supply hose

4. Drain the coolant from the radiator; refer to Removing the Radiator (page 4–19).
5. Remove the air cleaner assembly from the machine; refer to Removing the Air Cleaner System (page 4–13).
6. Remove the exhaust system from the machine; refer to Removing the Exhaust System (page 4–16).
7. Disconnect the hoses from the engine:
   A. Loosen the hose clamps and remove the upper and lower radiator hoses from the engine.

B. For assembly purposes, label the fuel hoses. Disconnect the fuel supply and return hoses from the fuel filter on the engine (Figure 38).

C. Cover or plug the fuel hoses and fuel filter fittings openings to prevent contamination. Position the disconnected hoses away from the engine.

8. Remove the hydraulic pump driveshaft; refer to Hydraulic Pump Driveshaft (page 6–159).

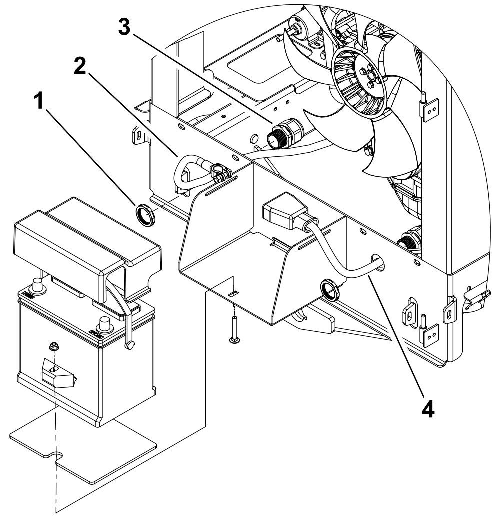

Figure 39

1. Cord grip locknut
2. Negative battery cable
3. Cord grip
4. Positive battery cable

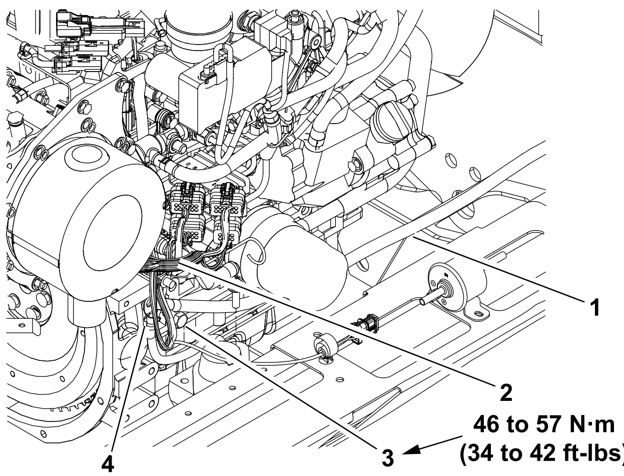

Figure 40

1. Negative battery cable
2. Engine wire harness
3. Bolt
4. Ground cable

IMPORTANT

To prevent damage to the electrical wire harness, numerous cable ties are used to secure the wire harness to the machine components. Record the location of all cable ties that are removed from the machine during the engine removal so that they can be properly replaced during the engine installation.

9. For assembly purposes, note the location of the cable ties used to secure the wire harness to the machine. Disconnect the wires and/or electrical connections from the following engine electrical components:
   A. The 2 engine wire harness connectors from the machine wire harness.
   B. The positive battery cable from the engine starter motor.
   C. The engine wire harness power cable from the battery clamp. Also, remove the harness power cable from the cord grip in frame so that the cable can be removed with the engine (Figure 39).
   D. The negative battery cable, engine wire harness ground cable and frame to engine ground cable at the engine block (Figure 40).
   E. The engine wire harness connectors from the main power, glow, start, and EGR relays (Figure 41).
   F. The engine wire harness connector from the fuel pump.
   G. The 2 engine wire harness connectors from the engine ECU.

⚠ CAUTION ⚠

The engine is very heavy, and a hoist not rated for the weight of the engine may fail, causing possible injury and damage to the engine.

Use hoist equipment rated to lift the engine, which is approximately 200 kg (441 lb).

10. Attach a suitable lift or hoist to the lift tabs on the front and rear of the engine (Figure 37). Support the engine with lift or hoist to prevent the engine from shifting or moving.
11. Remove the flange nuts (item 9 in Figure 37), snubbing washers, spacers, and bolts that secure the engine mount brackets to the engine mounts.

⚠ CAUTION ⚠

Use 1 person to operate the lift or hoist while the other person guides the engine from the machine.

IMPORTANT

When removing the engine ensure that you do not damage the engine, fuel hoses, hydraulic lines, electrical harness or other parts.

Removing the Engine (continued)

12. Carefully raise the engine from the machine moving it toward the front of the machine and away from the radiator assembly.
13. If necessary, remove the engine mount brackets from the engine.

Installing the Engine

IMPORTANT

Ensure that all parts are removed from the engine during maintenance or overhaul are correctly installed on the engine.

1. If the engine mount brackets were removed from the engine, secure the brackets to the engine with the lock washers and bolts. Torque the bolts to **46 to 57 N·m (34 to 42 ft-lb)**.

⚠ CAUTION ⚠

The engine is very heavy, and a hoist not rated for the weight of the engine may fail, causing possible injury and damage to the engine.

Use hoist equipment rated to lift the engine, which is approximately 200 kg (441 lb).

2. Attach a suitable lift or hoist to the lift tabs on the front and rear of the engine. Support the engine with lift or hoist to prevent the engine from shifting or moving.

⚠ CAUTION ⚠

Use 1 person to operate the lift or hoist while the other person guides the engine into the machine.

IMPORTANT

When installing the engine ensure that you do not damage the engine, fuel hoses, hydraulic lines, electrical harness, radiator or other parts.

3. Carefully lower the engine into the machine. Ensure that the fastener holes of the engine mount brackets aligned with the holes in the engine mounts.
4. Insert the bolt down through each engine mount bracket and engine mount. Install the spacer, snubbing washer, and flange nut on the 4 bolts. Tighten the fasteners to secure the engine to the engine mounts.
5. Install the hydraulic pump driveshaft; refer to Hydraulic Pump Driveshaft (page 6–159).
6. Connect the wire harness connectors to the following engine components:
   A. The 2 engine wire harness connectors to the machine wire harness.
   B. The positive battery cable to the engine starter motor.

Installing the Engine (continued)

C. The engine wire harness power cable to the battery clamp through the cord grip and tighten the cord grip (Figure 39).

Note: Make sure that the engine and frame ground surfaces are free from corrosion, oil and paint.

D. The negative battery cable, engine wire harness ground cable and frame to engine ground cable at the engine block (Figure 40).

E. Torque the engine ground bolt to **46 to 57 N·m (34 to 42 ft-lb)** and apply a coat of terminal protector.

F. Torque the frame ground bolt to **19.7 to 25.4 N·m (175 to 225 in-lb)** and apply a coat of terminal protector.

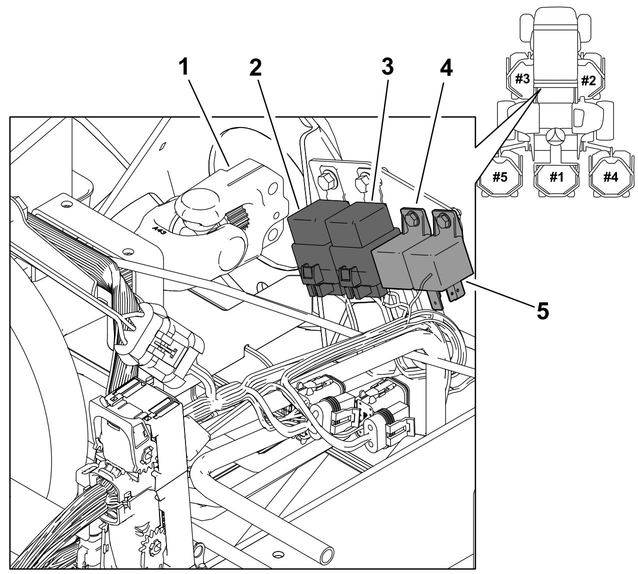

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Figure 41

1. Hydraulic pump driveshaft
2. EGR relay
3. Start relay
4. Glow relay
5. Main power relay

G. The engine wire harness connectors to the main power, glow, start, and EGR relays (Figure 41).

H. The engine wire harness connector to the fuel pump.

I. The 2 engine wire harness connectors from the engine ECU.

7. Use the notes that you recorded during removal, secure the wires with cable ties in proper locations.

8. Remove all of the covers and plugs from the hoses and engine openings that you placed while removing the engine. Connect the hoses to the engine:

   A. Use the labels that you attached during removal to correctly connect the fuel supply and return hoses to the fuel filter on the engine (Figure 38). Secure the fuel hoses with the hose clamps.

   B. Connect the upper and lower radiator hoses to the engine. Secure the radiator hoses with the hose clamps.

9. Install the air cleaner assembly; refer to Installing the Air Cleaner System (page 4–14).

Installing the Engine (continued)

10. Install the exhaust system to the machine; refer to Installing the Exhaust System (page 4–17). Ensure that the exhaust tube has 9.5 mm (0.375 inch) clearance with tailpipe guard in all directions after assembly.
11. Ensure that the radiator draincock is closed and fill the radiator and reservoir with coolant.
12. Connect both the battery cables to the battery. First, connect the positive battery cable and then the negative battery cable; refer to Servicing the Battery (page 7–125).
13. Ensure that all the wires, fuel lines, hydraulic hoses, and cables are clear of moving parts and secured to their original locations.
14. Check the engine-oil level and adjust as necessary.
15. Check the hydraulic-fluid level in the hydraulic reservoir and add correct quantity of fluid if necessary; refer to the *Operator's Manual*.
16. Prime the fuel system; refer to Priming the Fuel System (page 4–23).
17. Start the engine and operate the hydraulic controls to properly fill the hydraulic and engine coolant systems; refer to Charging the Hydraulic System (page 6–151) and refer to proper coolant fill procedure.
18. Lower the hood and secure it with the latches.

Kubota Gasoline Engine

Table of Contents

Additional Reference Materials

Kubota Workshop Manual, WG1605-G-E3

Kubota Diagnosis Manual, ECM System, WG1605-G-E3

Specifications

Kubota Gasoline Engine

Reelmaster 5410-G and 5510-G

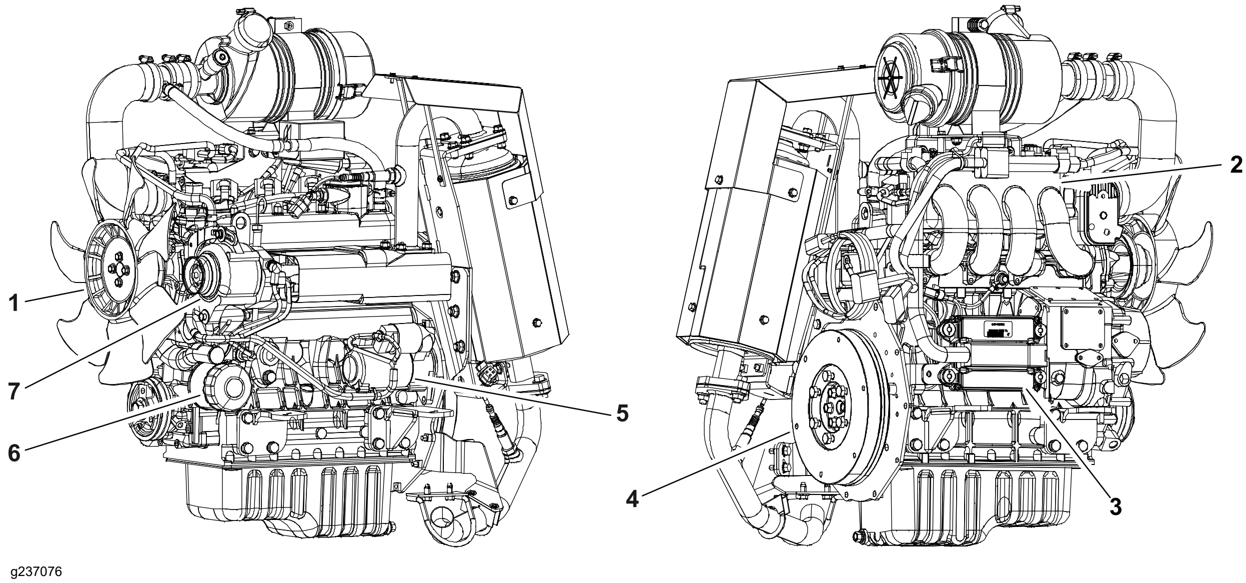


Figure 42

1. Engine cooling fan
2. Intake manifold
3. Engine ECU
4. Flywheel
5. Starter motor
6. Engine oil filter
7. Alternator

Item	Description
Make/Designation	Kubota Model WG1605-G-E3: 4-Cycle OHV, 4 Cylinder, Water Cooled, Gasoline Engine
Number of Cylinders	4
Bore x Stroke	79 mm x 78.4 mm (3.11 x 3.09 inches)
Total Displacement	1,573 cm^3 (93.8 in^3)
Firing Order	1 (gear case end) - 3 - 4 (flywheel end) - 2
Direction of Rotation	Counterclockwise (viewed from flywheel)
Fuel	Unleaded, regular grade gasoline (87 octane minimum)
Fuel Injection type	Electronic fuel injection
Fuel Pump	12 VDC, fuel tank mounted
Fuel Tank Capacity	53 L (14 US gallons)
Governor	Electronic
Low Idle Speed (no load)	1,150 to 1,250 rpm
High Idle Speed (no load)	2,950 to 3,050 rpm
Engine Oil	API SL or higher
Oil Pump	Gear Driven Trochoid Type
Crankcase-Oil Capacity	6.0 L (6.3 US qt) with Filter
Cooling System Capacity (including reserve tank)	6.6 L (7 US qt)

Kubota Gasoline Engine (continued)

Item	Description
Starter	12 VDC 1.0 KW
Alternator/Regulator	12 VDC 40 A
Dry Weight (approximate)	119 kg (262 lb)

General Information

This chapter gives information about specifications, troubleshooting, testing and repair of the Kubota gasoline engine used in Reelmaster 5410-G and 5510-G machines.

Most repairs and adjustments require tools which are commonly available in many service shops. The use of some specialized test equipment is explained in the engine service manual included at the end of this chapter. 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 gasoline engines are supplied through your local Toro Distributor. If a parts list is not available, be sure to provide your distributor with the Toro model and serial number.

Traction Unit Operator's Manual

The *Traction Unit Operator's Manual* provides information regarding the operation, general maintenance and maintenance intervals for the Kubota gasoline engine that powers your Reelmaster machine. The *Kubota Operator's Manual* includes information specific to the engine used in your Reelmaster. Refer to these publications for additional information when servicing the machine.

Kubota Workshop and Diagnosis Manuals

The engine that powers your Reelmaster machine is a Kubota model WG1605-G-E3. Both the Kubota Workshop Manual and Kubota Diagnosis Manual are available for this engine. Ensure that the correct engine manuals are used when servicing the engine on your Reelmaster.

Kubota Gasoline Engine

The engine used on your Reelmaster is a Kubota WG Series gasoline engine. Engine features include an electronic control unit (ECU) that controls a common rail fuel injection system with direct injection, electronic throttle body (ETB), an electronic governor and a catalytic muffler exhaust system with 2 oxygen sensors. Numerous engine sensors are used to allow the engine ECU to monitor and control engine operation for optimum engine performance.

The engine electrical components (e.g., ECU, O2 sensor, throttle control, power relay, and ETV relay) are identified and matched in the engine ECU program. If engine electrical components are replaced on the engine, the Kubota electronic tool must be used by your Toro distributor to update the ECU program which will ensure correct engine operation.

During machine operation, if an engine fault occurs, the machine InfoCenter display can be used to identify the fault. Also, the Kubota gasoline engine service tool can be used by your Toro distributor to confirm the real-time engine running status and to offer timely technical services.

Engine Electronic Control Unit (ECU)

The Kubota gasoline engine that powers your Reelmaster uses an electronic control unit (ECU) for engine management. The engine ECU also communicates with the machine Toro Electronic Controller (TEC) and the operator InfoCenter display on the machine through the machine CAN-bus system. All wire harness electrical connectors should be plugged into the engine ECU before the machine key switch is moved from the OFF position to either the ON/RUN or START position.

Engine Electronic Control Unit (ECU) (continued)

If the engine ECU identifies that an engine problem exists, the engine speed may be reduced or the engine might stop running. The Kubota Diagnosis Manual and Kubota Gasoline service tool should be used to provide assistance in identifying the cause of the problem and the repairs that are necessary. Contact your Toro distributor for assistance in Kubota gasoline engine troubleshooting.

IMPORTANT

Do not plug or unplug the engine ECU for a period of 30 seconds after the machine key switch is turned OFF. The ECU may remain energized even though the key switch is OFF.

If the engine ECU is to be disconnected for any reason, ensure that the key switch is in the OFF position with the key removed for a period of 30 seconds before disconnecting the engine ECU. Also, to prevent possible ECU damage when welding on the machine, disconnect and remove the engine ECU from the machine before welding.

Service and Repairs

Air Cleaner Assembly

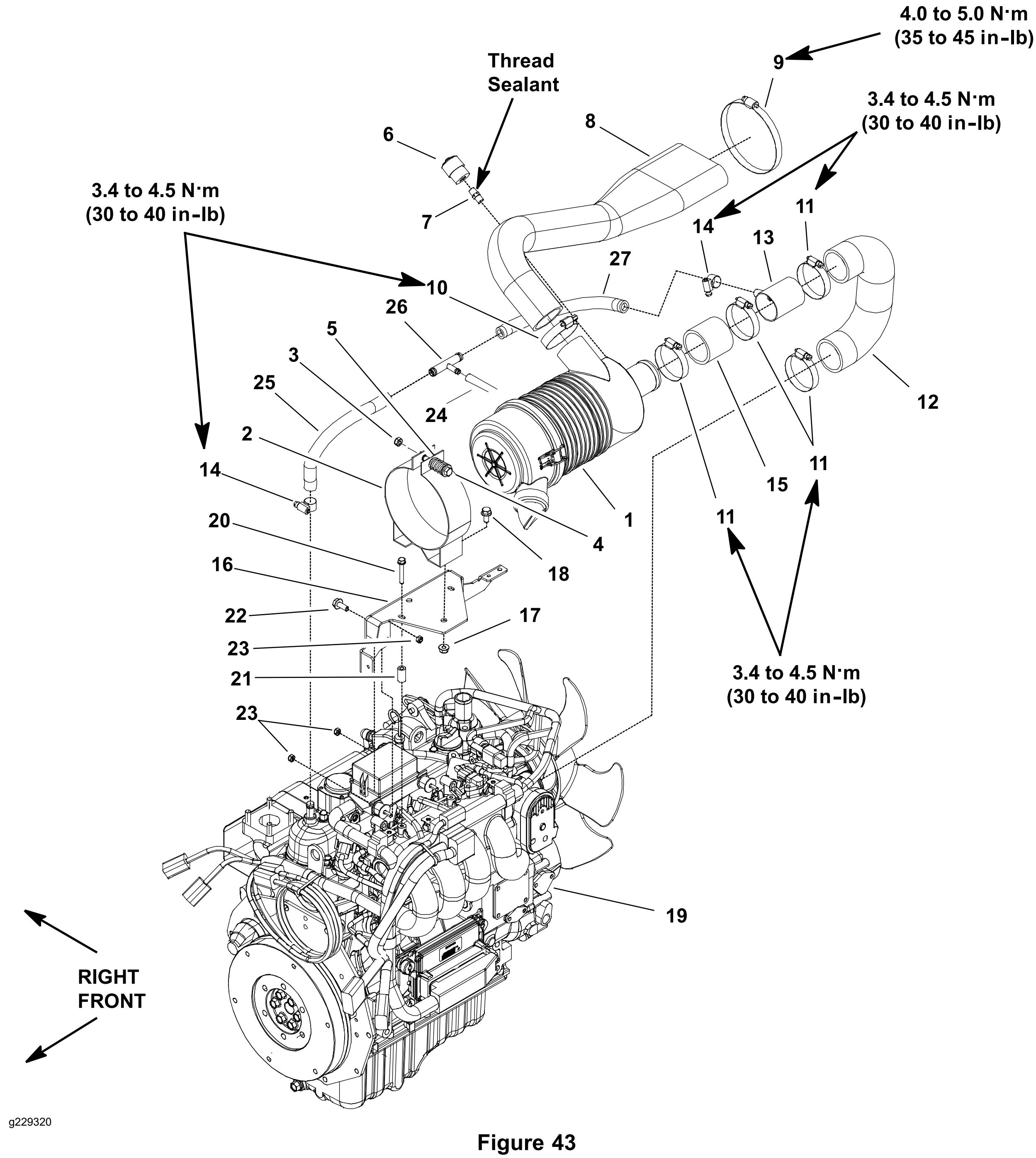


Figure 43

1.	Air cleaner assembly	10.	Hose clamp	19.	Engine assembly
2.	Air cleaner mounting band	11.	Hose clamp (4 each)	20.	Flange-head screw (2 each)
3.	Hex nut	12.	Air cleaner hose	21.	Spacer (2 each)
4.	Shoulder bolt	13.	Vent	22.	Flange-head screw (2 each)
5.	Spring	14.	Hose clamp (2 each)	23.	Locknut (4 each)
6.	Service indicator	15.	Air cleaner hose	24.	Hose (to EVAP control valve)
7.	Adapter	16.	Air cleaner bracket	25.	Hose
8.	Air cleaner inlet hose	17.	Flange nut (2 each)	26.	Tee fitting
9.	Hose clamp	18.	Flange-head screw (2 each)	27.	Hose

Removing the Air Cleaner Assembly

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the key switch. Raise and support hood.
2. Remove air cleaner components as necessary (Figure 43).
3. Refer to *Traction Unit Operator's Manual* for air cleaner service and maintenance procedures.

Installing the Air Cleaner Assembly

IMPORTANT

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

1. Assemble air cleaner system (Figure 43).

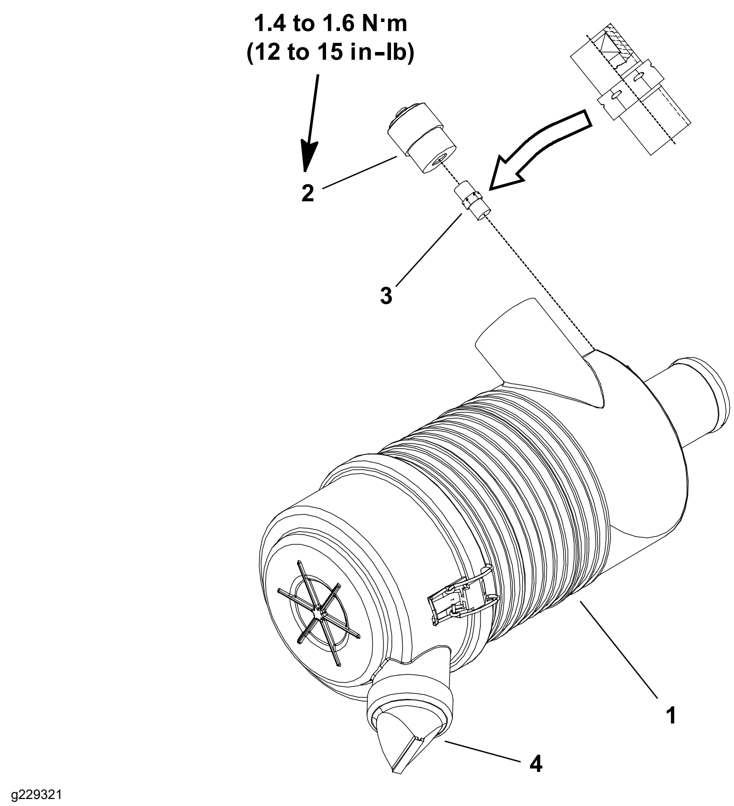


Figure 44

1. Air cleaner assembly
2. Indicator
3. Adapter
4. Evacuator valve

   A. If service indicator (item 6 in Figure 43) and adapter were removed from air cleaner housing, apply thread sealant to adapter threads before installing adapter and indicator to housing. Install adapter so that the grooves in adapter hex and adapter filter element are installed toward service indicator (Figure 44). Torque the indicator to **1.4 to 1.6 N·m (12 to 15 in-lb)**.

   B. Ensure that evacuator valve on air cleaner assembly is pointed down after assembly.

Installing the Air Cleaner Assembly (continued)

C. Torque the hose clamps to the values identified in Figure 43.

2. After air cleaner has been properly installed, lower and secure hood.

Exhaust System

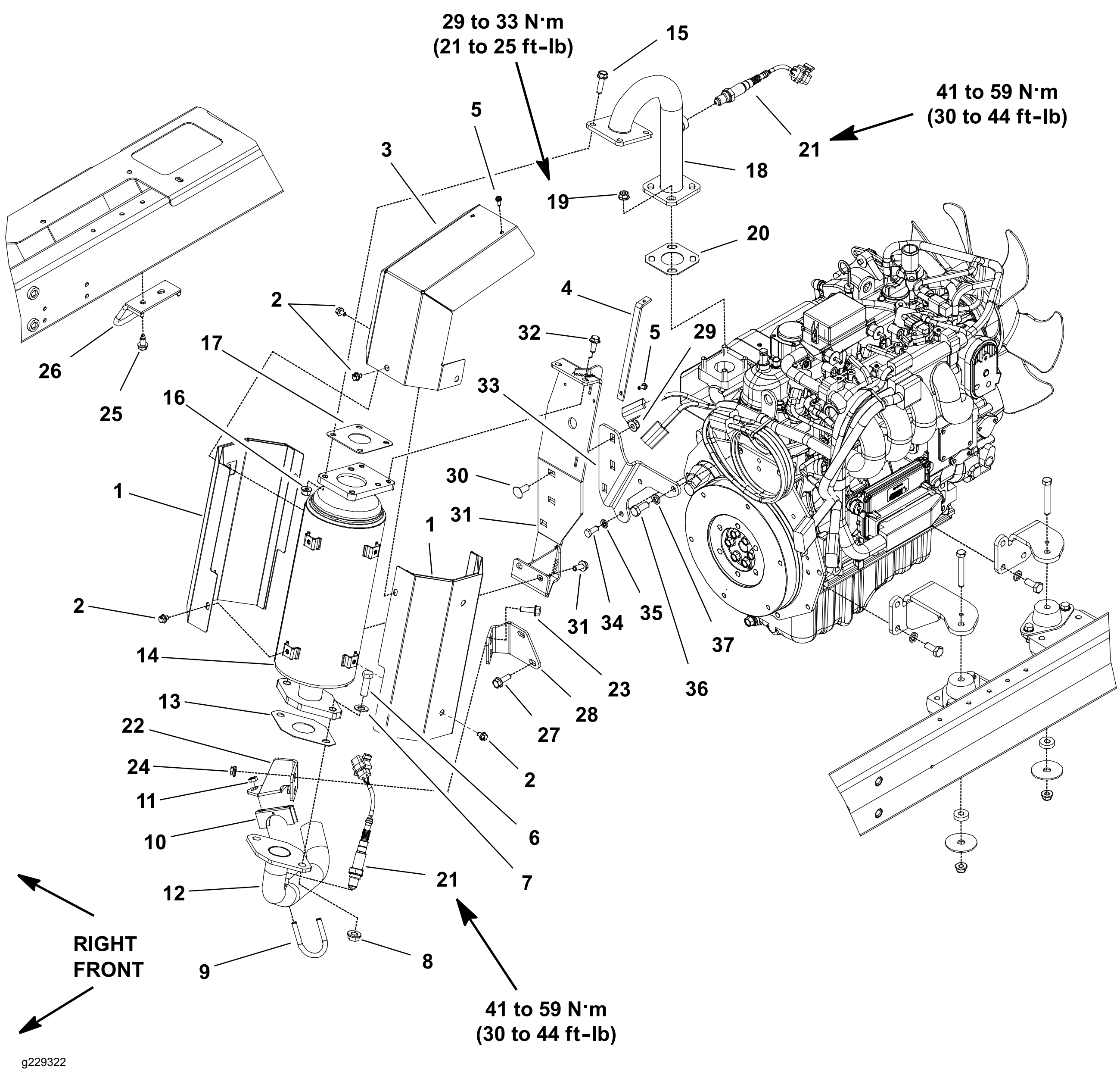


Figure 45

1. Heat shield (2 each)
2. Flange-head screw (8 each)
3. Heat shield
4. Shield strap (2 each)
5. Screw (4 each)
6. Bolt (2 each)
7. Flat washer (2 each)
8. Flange nut (2 each)
9. U-clamp
10. Clamp plate
11. Clamp nut (2 each)
12. Exhaust outlet
13. Outlet gasket
14. Catalytic muffler
15. Flange-head screw (4 each)
16. Flange nut (4 each)
17. Manifold outlet gasket
18. Exhaust manifold
19. Nut (4 each)
20. Exhaust manifold gasket
21. Oxygen sensor
22. Tailpipe bracket
23. Flange-head screw (2 each)
24. Flange nut (2 each)
25. Washer-head screw (2 each)
26. Muffler guard
27. Flange-head screw (2 each)
28. Tailpipe bracket
29. Flange nut (3 each)
30. Carriage screw 3 each)
31. Exhaust mount
32. Flange-head screw (4 each)
33. Exhaust support bracket
34. Bolt (2 each)
35. Lock washer (2 each)
36. Bolt
37. Lock washer

To meet gasoline engine emission requirements, the Kubota gasoline engine used on your Reelmaster has a catalytic muffler. In addition to providing sound damping and spark arresting, the muffler also includes a three way catalyst to treat the exhaust gases which are created from the combustion process. The 3-way catalyst consists of a honeycomb core coated with a mixture of precious metals. The hot exhaust gases flow through the catalyst where oxidation and reduction reactions take place. These chemical reactions reduce the amount of CO, HC, and NOx in the exhaust. Two oxygen sensors are included in the exhaust system and are used as inputs for the engine ECU to monitor exhaust system operation. The exhaust exits the catalytic muffler through the tailpipe outlet.

Removing the Exhaust System

CAUTION

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

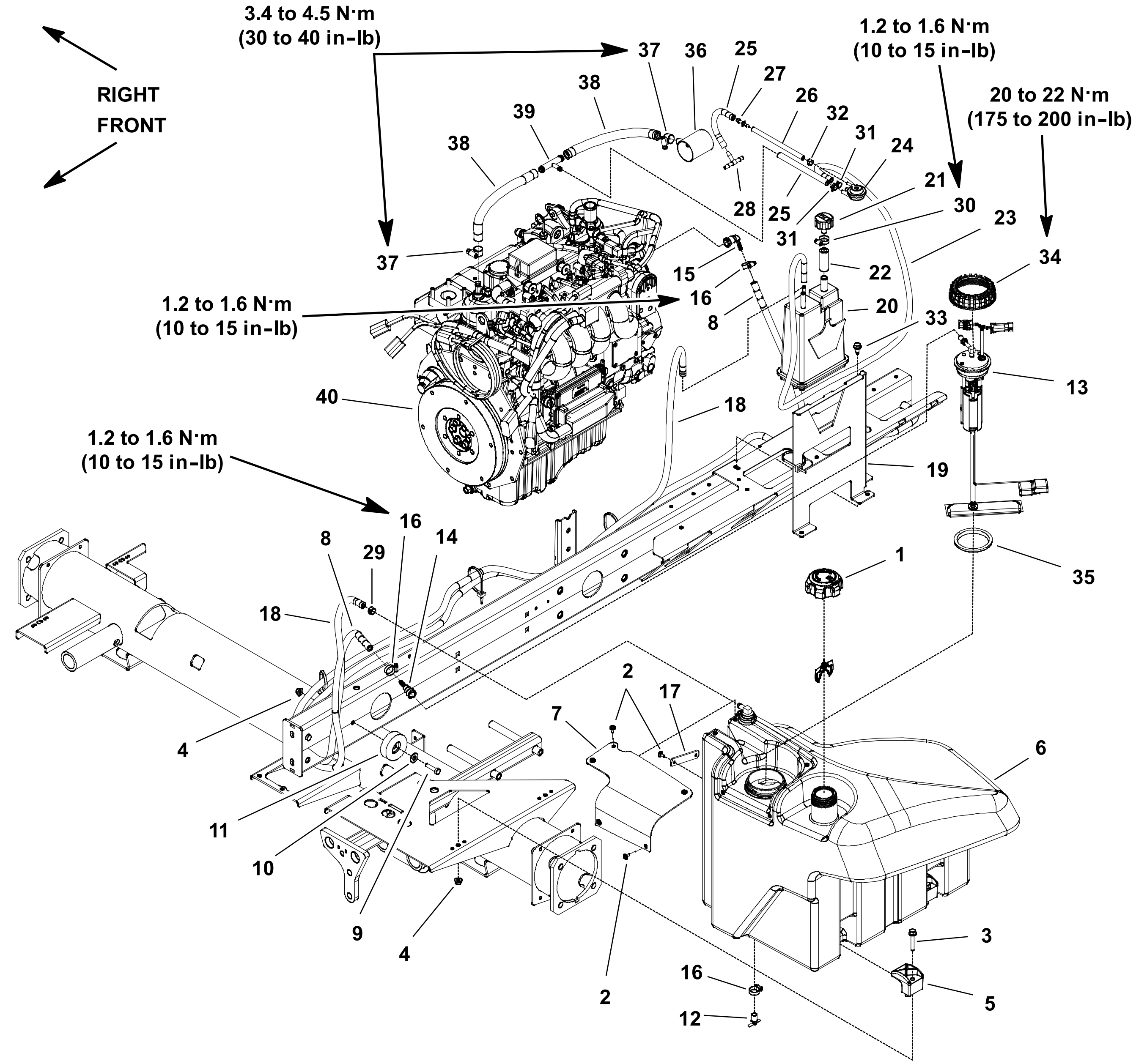
1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the key switch. Raise and support hood.
2. Raise and support hood to gain access to exhaust system. Allow engine and exhaust system to cool before doing any disassembly of exhaust system components.
3. Remove exhaust system components from the engine as necessary. Discard all removed gaskets (items 13, 17, and/or 20 in Figure 45).

Installing the Exhaust System

Note: Ensure that all exhaust system flanges and sealing surfaces are free of debris or damage that may prevent a tight seal.

1. Ensure to install new gaskets in place of all gaskets that were removed. Do not use any type of gasket sealant on gasket or flange surfaces.
2. Assemble all removed exhaust system components (Figure 45).
   - A. If exhaust manifold (item 18 in Figure 45) was removed from engine exhaust manifold, install new exhaust manifold gasket so that raised ridge side of gasket is mated to the exhaust manifold on the engine.
   - B. During exhaust system installation, finger tighten all exhaust system components before fully tightening any of the fasteners. When tightening fasteners, secure exhaust manifold (item 18 in Figure 45) to muffler first and then tighten nuts that secure exhaust manifold to engine exhaust manifold. Once these connections are secure, tighten fasteners for exhaust outlet and exhaust mount. Finally, secure lower heat shields and upper heat shield.
   - C. If oxygen sensors (item 21 in Figure 45) were removed, torque the sensors to **41 to 59 N·m (30 to 44 ft-lb)**. Plug sensor connectors into engine harness after installation.
   - D. Adjust muffler guard (item 26 in Figure 45) so that there is 9.5 mm (3/8 inch) clearance between exhaust outlet and guard in all directions.

Fuel System



g229323

Figure 46

1. Fuel cap
2. Screw (7 each)
3. Washer-head screw (2 each)
4. Flange nut (3 each)
5. Clamp (2 each)
6. Fuel tank
7. Pump cover
8. Fuel supply hose
9. Bolt
10. Flat washer
11. Recess bumper
12. Draincock
13. Fuel pump assembly
14. Fuel fitting
15. Fuel fitting
16. Hose clamp (3 each)
17. Strap
18. Vent hose
19. Canister bracket
20. Carbon canister
21. Breather
22. Fuel hose
23. Fuel hose
24. Vacuum control valve
25. Fuel hose (2 each)
26. Fuel hose
27. Straight fitting
28. Tee fitting
29. Hose clamp
30. Hose clamp
31. Hose clamp (2 each)
32. Hose clamp
33. Washer-head screw
34. Washer-head screw
35. Fuel pump gasket
36. Vent
37. Hose clamp (2 each)
38. Fuel hose (2 each)
39. Tee fitting
40. Gasoline engine

⚠ DANGER ⚠

Because gasoline is highly flammable, use caution when storing or handling it. Do not smoke while filling the fuel tank. Do not fill fuel tank while engine is running, when engine is hot or when machine is 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 container cap in place. Use gasoline for the engine only; not for any other purpose.

Checking the Fuel Lines and Connections

Check fuel lines and connections periodically as recommended in the *Traction Unit Operator's Manual*. Check lines for deterioration, damage, leakage or loose connections. Replace fuel hoses, clamps and connections as necessary.

Drain and Clean Fuel Tank

Drain and clean the fuel tank periodically as recommended in the *Traction Unit Operator's Manual*. Also, drain and clean the fuel tank if the fuel system becomes contaminated or if the machine is to be stored for an extended period.

IMPORTANT

Follow all local codes and regulations when recycling or disposing waste fuel.

To clean fuel tank, flush tank out with clean solvent. Ensure that the tank is free of all contaminates and debris.

Priming the Fuel System

The fuel system needs to be primed before starting the engine for the first time, after running out of fuel or after fuel system maintenance (e.g., replacing a fuel hose, cleaning the fuel tank). To prime the fuel system, ensure that the fuel tank has fuel in it. Then, turn the key switch to the RUN position for 10 to 15 seconds which allows the fuel pump to prime the fuel system. Do not use the engine starter motor to crank the engine in order to prime the fuel system.

Removing the Fuel Tank

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the key switch.
2. Place drain pan under fuel tank. Ensure that drain pan is large enough to hold fuel tank contents; refer to Specifications (page 3–2).
3. Open draincock on bottom of fuel tank and allow tank to fully drain. Close draincock.

IMPORTANT

To prevent damage to fuel hoses, numerous cable ties are used to secure hoses to machine components. Take note of all cable ties that are removed from machine during fuel tank removal so they can be properly replaced during tank installation.

Removing the Fuel Tank (continued)

4. Loosen hose clamps that secure fuel supply hose (item 8 in Figure 46) and vent hose to tank fittings. Carefully disconnect fuel supply hose and vent hose from tank fittings.
5. Remove fuel tank from machine (Figure 46).

   If fuel pump assembly is to be removed from fuel tank, note orientation of fuel pump fitting for assembly purposes (Figure 47).

Installing the Fuel Tank

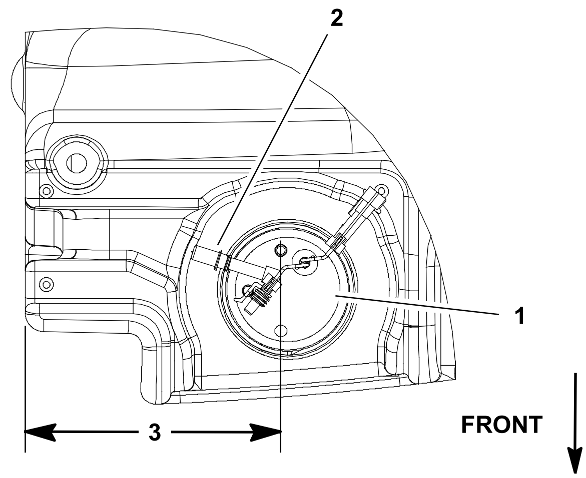


Figure 47

1. Fuel pump assembly
2. Fuel supply fitting
3. Parallel

---

1. Install fuel tank to frame (Figure 46). Secure fuel hoses with cable ties as noted during fuel tank removal.

   If fuel pump assembly was removed from fuel tank, ensure that fuel fitting on pump is orientated as Figure 47. Torque the fuel pump cap to **20 to 22 N·m (175 to 200 in-lb)**, ensure that fuel pump assembly does not turn as cap is tightened.
2. Connect fuel supply hose and vent hose to tank fittings. Secure hoses with hose clamps.
3. Ensure that fuel tank draincock is closed. Fill fuel tank with clean fuel.
4. Prime the fuel system; refer to Priming the Fuel System (page 5–12).

Fuel Evaporative Control System

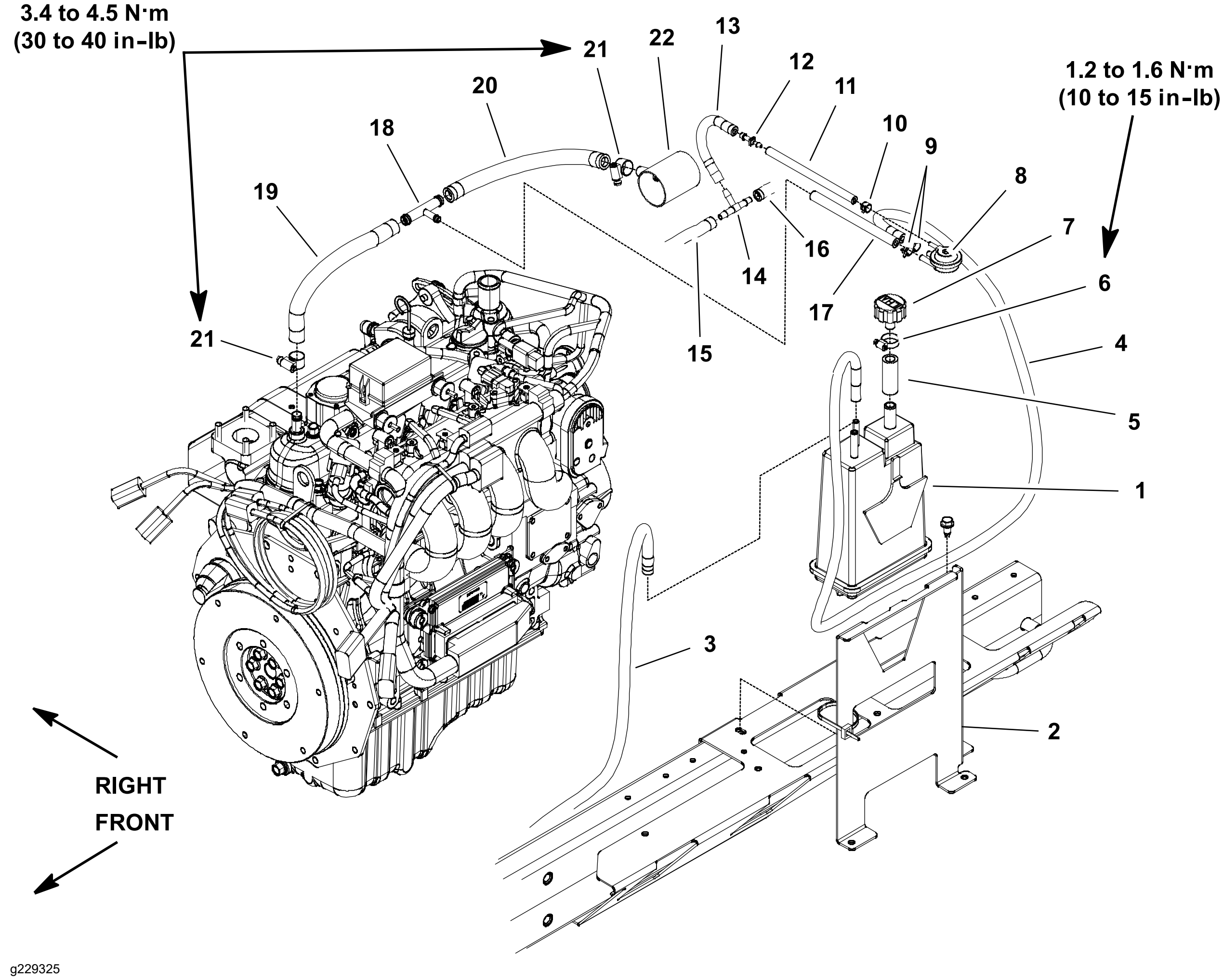


Figure 48

1. Carbon canister
2. Canister bracket
3. Fuel hose (to fuel tank vent)
4. Fuel hose (canister to control valve)
5. Hose
6. Hose clamp
7. Breather
8. Vacuum control valve
9. Hose clamp (2 each)
10. Hose clamp
11. Fuel hose
12. Straight fitting
13. Fuel hose
14. Tee fitting
15. Fuel hose (to PCV valve)
16. Fuel hose (to intake manifold)
17. Fuel hose
18. Tee fitting
19. Fuel hose
20. Fuel hose
21. Hose clamp (2 each)
22. Vent (engine air intake)

The function of the fuel evaporative control system is to collect and store evaporative emissions from the fuel tank and engine. A carbon canister that is mounted to the left side of the frame near the rear of the machine 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: If there is restriction in the canister breather, the carbon canister or the vacuum control valve, the fuel tank may distort due to venting issues. If the fuel tank returns to it’s normal shape when the fuel cap is removed, restriction in the evaporative control system is likely.

Removing the Fuel Evaporative Control System

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

DANGER

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

3. Inspect carbon cannister and attached hoses for damage or obvious leaks. A damaged or leaking cannister should be replaced.
4. Remove fuel evaporative control system components as necessary (Figure 48).

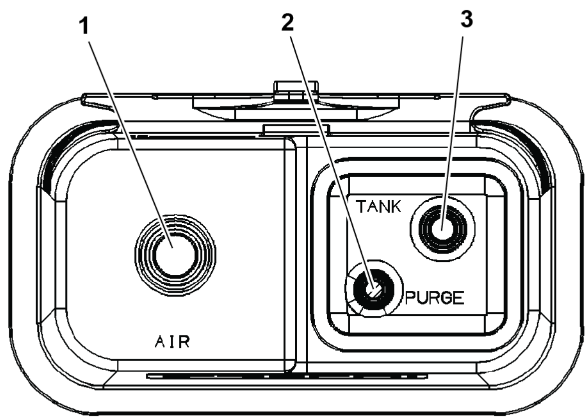


Figure 49

Carbon canister connections

1. To canister breather
2. To vacuum control valve
3. To fuel tank vent fitting

A. If hoses are removed from the carbon canister, note hose location for assembly purposes. Figure 49 identifies carbon canister hose location.

Removing the Fuel Evaporative Control System (continued)

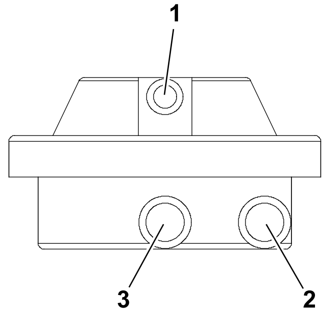


Figure 50

Vacuum control valve connections

1. To tee fitting in PCV system hose
2. To tee fitting and engine air intake vent
3. To middle (purge) canister port

B. If hoses are removed from vacuum control valve (item 8 in Figure 48), note hose location for assembly purposes. Figure 50 identifies control valve hose locations.

Installing the Fuel Evaporative Control System

1. Install all removed EVAP components (Figure 48, Figure 49, and Figure 50). Ensure that fuel hoses are not kinked after installation. Also, secure all hoses with hose clamps (Figure 48).
2. After all removed fuel evaporative control system components are installed, close and secure hood.

Radiator and Oil Cooler Assembly

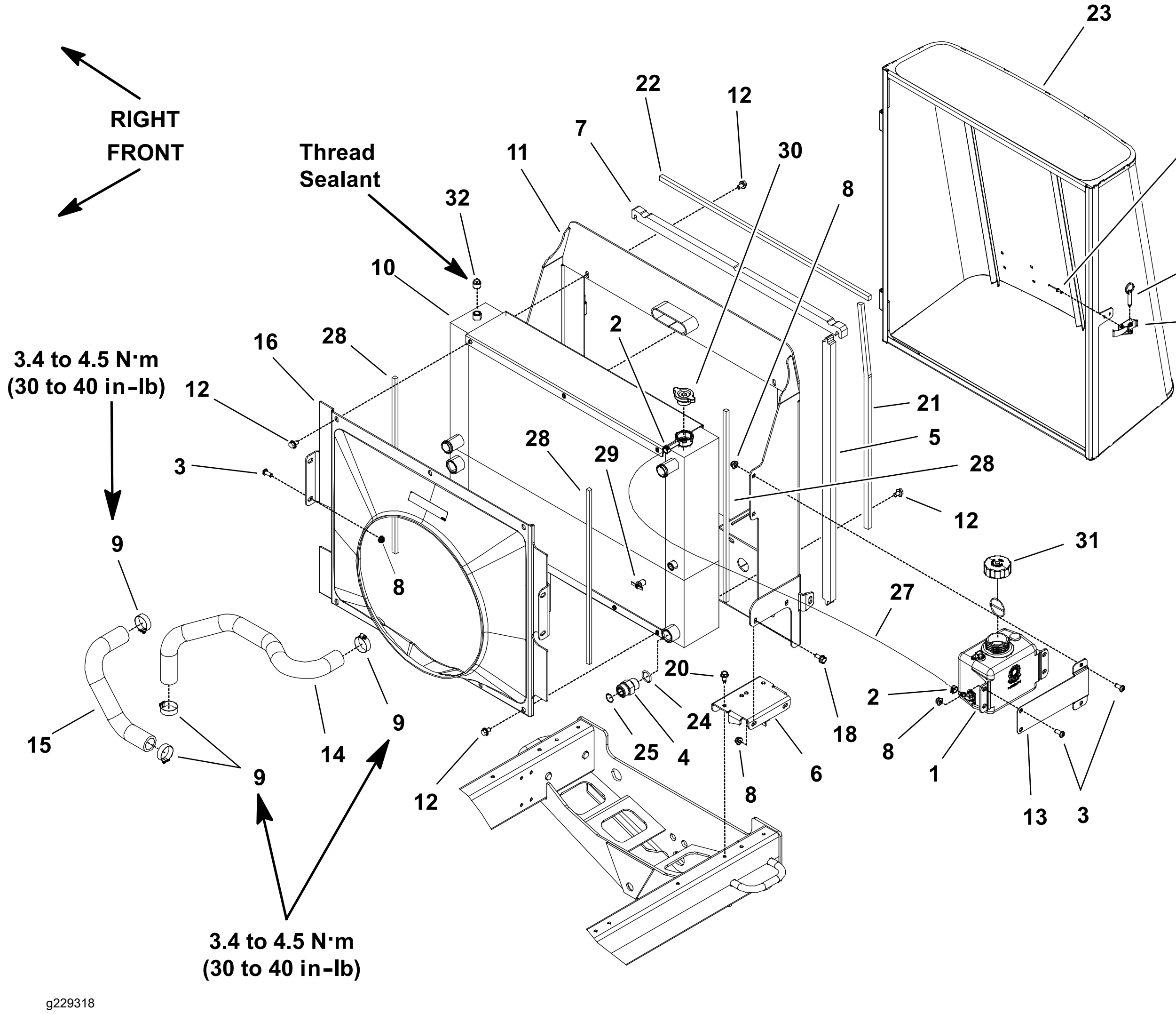


Figure 51

1.	Coolant reservoir	12.	Flange-head screw (14 each)	23.	Screen
2.	Hose clamp (2 each)	13.	Reservoir bracket	24.	O-ring
3.	Button-head screw (5 each)	14.	Upper radiator hose	25.	O-ring
4.	Hydraulic fitting (2 each)	15.	Lower radiator hose	26.	Detent ball pin
5.	Foam seal (2 each)	16.	Fan shroud	27.	Overflow hose
6.	Mounting bracket (2 each)	17.	Pop rivet (2 each)	28.	Foam seal (4 each)
7.	Foam seal (2 each)	18.	Flange-head screw (4 each)	29.	Draincock
8.	Flange nut (10 each)	19.	Draw latch	30.	Radiator cap
9.	Hose clamp (4 each)	20.	Washer-head screw (6 each)	31.	Reservoir cap
10.	Radiator and oil cooler assembly	21.	Foam seal (2 each)	32.	Plug
11.	Radiator frame	22.	Foam seal		

Removing the Radiator and Oil Cooler Assembly

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the key switch.
2. Unlatch screen (item 23 in Figure 51) at rear of machine. Lift screen from hinges and remove screen from machine.
3. Raise and support hood.

CAUTION

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

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

4. Drain radiator into a suitable container either by using the draincock (item 30 in Figure 51) on the left side of the radiator or by disconnecting the lower radiator hose from the radiator. Ensure that the drain container is large enough to hold cooling system contents; refer to Specifications (page 3–2).

IMPORTANT

Follow all local codes and regulations when recycling or disposing engine coolant.

5. Remove air cleaner inlet hose from inlet in top of radiator frame; refer to Air Cleaner Assembly (page 3–8).
6. Disconnect radiator hoses (upper and lower) from the radiator/oil cooler.
7. Loosen hose clamp and remove overflow hose from radiator fill opening.
8. Remove 2 button-head screws (item 3 in Figure 51) and flange nuts that secure coolant reservoir bracket to fan shroud and radiator frame. Carefully position reservoir and bracket away from the fan shroud.
9. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 6–145).

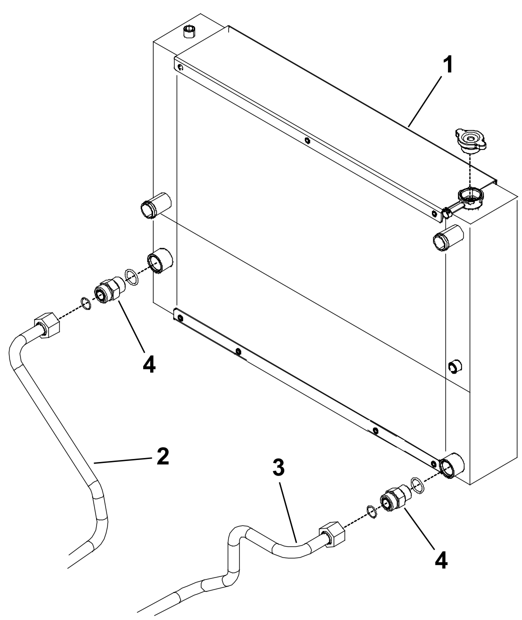


Figure 52

1. Radiator/oil cooler
2. Hydraulic tube
3. Hydraulic tube
4. Hydraulic fitting

Removing the Radiator and Oil Cooler Assembly (continued)

10. Clean hydraulic tubes at fittings in oil cooler ports (Figure 52). Disconnect hydraulic tubes and put caps or plugs on tubes and fittings to prevent contamination.
11. On right side of machine, remove 2 button-head screws and flange nuts that secure fan shroud to radiator frame.
12. Remove flange-head screws that secure fan shroud to radiator/oil cooler. Position fan shroud away from the radiator.
13. From rear of machine, remove flange-head screws that secure radiator/oil cooler to radiator frame.
14. Carefully separate radiator/oil cooler assembly from radiator frame and remove from machine. Plug radiator and hose openings to prevent contamination.
15. Inspect all foam seals placed between radiator/oil cooler, fan shroud and radiator frame. Replace damaged foam seals.
16. If necessary, remove hydraulic fittings (item 4 in Figure 51) from oil cooler and discard O-rings.

Installing the Radiator and Oil Cooler Assembly

1. If hydraulic fittings (item 4 in Figure 51) were removed from oil cooler, lubricate and place new O-rings onto fittings. Install fittings into port openings and tighten fittings; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 6–13).
2. Carefully position radiator/oil cooler assembly to the radiator frame.
3. From rear of machine, secure radiator/oil cooler to radiator frame with removed flange-head screws.
4. Position fan shroud to radiator/oil cooler and secure with removed flange-head screws. Ensure that at least 6.4 mm (0.250 inch) clearance exists at all points between shroud opening and fan.
5. Position coolant reservoir and bracket to the fan shroud. Secure bracket to fan shroud and radiator frame with 2 button-head screws and flange nuts.
6. On right side of machine, secure fan shroud to radiator frame with 2 button-head screws and flange nuts.
7. Remove plugs placed in radiator and hose openings during the removal procedure.
8. Connect upper and lower radiator hoses to radiator and secure with hose clamps. Torque the clamps to **3.4 to 4.5 N·m (30 to 40 in-lb)**.
9. Remove caps and plugs from hydraulic tubes and fittings in oil cooler ports. Connect hydraulic tubes to fittings; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 6–11).
10. Connect overflow hose to radiator fill opening and secure with hose clamp.
11. Install and secure air cleaner inlet hose; refer to Air Cleaner Assembly (page 3–8).
12. Ensure that the radiator draincock is closed (threaded out fully). Fill radiator with coolant.
13. Check and adjust hydraulic fluid level in hydraulic reservoir.
14. Start engine. Check for fluid leaks and proper engine operation.
15. After running engine for a short time, stop engine and ensure radiator and hydraulic reservoir are full. Add correct fluids if necessary.
16. Lower and secure hood.

Installing the Radiator and Oil Cooler Assembly (continued)

17. Install and secure screen (item 23 in Figure 51) to rear of machine.

Engine

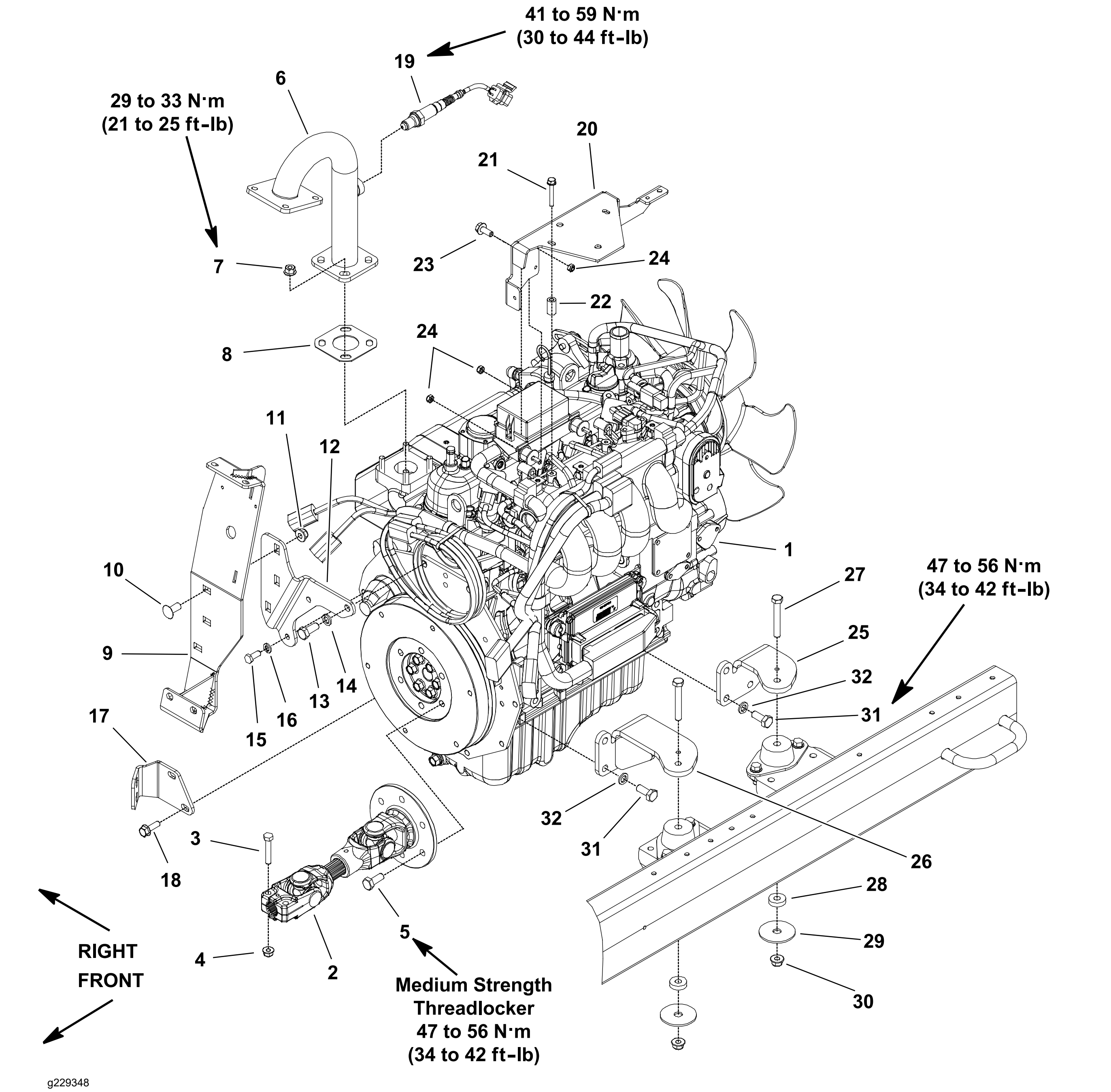


Figure 53

1. Gasoline engine assembly
2. Pump driveshaft assembly
3. Bolt (2 each)
4. Flange nut (2 each)
5. Bolt (6 each)
6. Exhaust manifold
7. Flange nut (4 each)
8. Exhaust manifold gasket
9. Exhaust mount
10. Carriage screw (3 each)
11. Flange nut (3 each)
12. Exhaust support bracket
13. Bolt
14. Lock washer
15. Bolt
16. Lock washer
17. Tailpipe bracket
18. Flange-head screw (2 each)
19. Oxygen sensor
20. Air cleaner bracket
21. Flange-head screw (2 each)
22. Spacer (2 each)
23. Flange-head screw (2 each)
24. Locknut (4 each)
25. Engine mount bracket (2 each)
26. Engine mount bracket (2 each)
27. Bolt (4 each)
28. Spacer (4 each)
29. Snubbing washer (4 each)
30. Flange nut (4 each)
31. Bolt (3 each per bracket)
32. Lock washer (3 each per bracket)

Removing the Engine

1. Park machine on a level surface, lower cutting units, stop engine and remove key from the key switch. Chock wheels to keep the machine from moving.
2. Unlatch screen at rear of machine. Lift screen from hinges and remove screen from machine.
3. Disconnect negative (-) and then positive (+) battery cables from battery; refer to Servicing the Battery (page 7–125).
4. If engine is to be disassembled, drain oil from engine.
5. Open and support hood.

CAUTION

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

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

6. Drain coolant from radiator; refer to Radiator and Oil Cooler Assembly (page 5–17).
7. Remove air cleaner from machine; refer to Air Cleaner Assembly (page 3–8).
8. Remove exhaust system from machine; refer to Exhaust System (page 3–11).
9. Disconnect hoses from engine:

   A. Loosen hose clamps and then remove upper and lower radiator hoses from the engine.

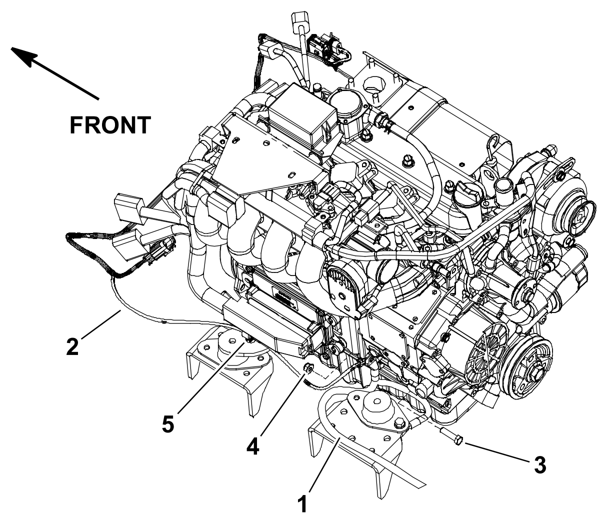


Figure 54

1.	Negative battery cable	3.	Bolt	5.	Harness retainer
2.	Wire harness ground	4.	Flange nut		

   B. Disconnect fuel supply and return hoses from engine (Figure 54). Position fuel hoses away from engine.

   C. Plug disconnected hoses and engine openings to prevent leakage and contamination. Position disconnected hoses away from engine.

Removing the Engine (continued)

10. Disconnect hydraulic pump driveshaft from engine; refer to Hydraulic Pump Driveshaft (page 6–159). Support driveshaft away from engine.

IMPORTANT

To prevent damage to electrical harness, numerous cable ties are used to secure harness to machine components. Take note of all cable ties that are removed from machine during engine removal so that they can be properly replaced during engine installation.

11. Note location of cable ties used to secure wire harness to the machine for assembly purposes. Disconnect wires and/or electrical connections from the following electrical components:
    A. The engine wire harness from the machine wire harness.
    B. The positive battery cable from the engine starter motor.
    C. The negative battery cable and wire harness connection at the engine block (left side near the engine ECU) (Figure 54).
    D. Remove harness retainer from forward engine mount bracket on left side of machine (Figure 54).

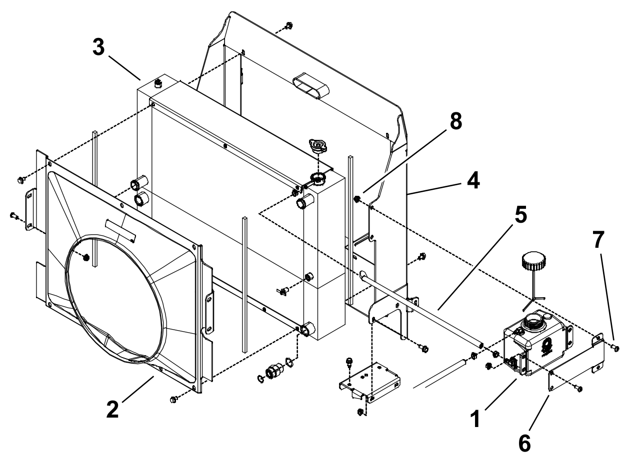


Figure 55

1.	Coolant reservoir	4.	Radiator frame	7.	Screw (2 each)
2.	Fan shroud	5.	Overflow hose	8.	Flange nut (2 each)
3.	Radiator/oil cooler	6.	Reservoir bracket		

12. Remove engine coolant reservoir and bracket from the machine (Figure 55):
    A. Loosen hose clamp and remove overflow hose from radiator fill opening.
    B. Remove 2 button-head screws and flange nuts that secure coolant reservoir bracket to fan shroud and radiator frame.
    C. Remove reservoir and bracket from the machine.
13. Connect lift or hoist to the lift brackets on each end of the engine cylinder head.
14. Remove flange nuts, snubbing washers, spacers, and bolts that secure the engine mount brackets to the engine mounts.

Removing the Engine (continued)

⚠ CAUTION ⚠

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

IMPORTANT

Ensure to not damage the engine, fuel hoses, hydraulic lines, electrical harness, radiator, or other parts while removing the engine.

15. Carefully raise engine moving it toward the front of the machine and remove from machine.
16. If necessary, remove engine mount brackets from engine.

Installing the Engine

1. Locate machine on a level surface with cutting units lowered and key removed from the key switch. Chock wheels to keep the machine from moving.
2. Ensure that all parts removed from the engine during maintenance or rebuilding are installed to engine.
3. If engine mount brackets were removed from the engine, secure brackets to engine with lock washers and bolts. Torque the bolts to **47 to 56 N·m (34 to 42 ft-lb)**.
4. Connect lift or hoist to the engine lift brackets.

⚠ CAUTION ⚠

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

IMPORTANT

Ensure to not damage the engine, fuel hoses, hydraulic lines, electrical harness, radiator, or other parts while removing the engine.

5. Carefully lower engine to the mounts secured to the machine frame. Ensure that the fastener holes of the engine mount brackets are aligned with the holes in the engine mounts.
6. Insert bolt down through each engine mount bracket and mount. Place spacer, snubbing washer, and then flange nut on 4 bolts. Tighten fasteners to secure engine to engine mounts.
7. Connect hydraulic pump driveshaft to engine; refer to Hydraulic Pump Driveshaft (page 6–159).
8. Connect all wire harness connectors to correct engine components.
9. Remove plugs installed in hoses during disassembly. Connect fuel and radiator hoses to the engine. Secure hoses with hose clamps.

Installing the Engine (continued)

10. Secure engine coolant reservoir and bracket to the fan shroud and radiator frame (Figure 55):
    A. Position coolant reservoir and bracket to the fan shroud. Secure bracket to fan shroud and radiator frame with 2 button-head screws and flange nuts.
    B. Connect overflow hose to radiator fill opening and secure with hose clamp.
11. Install air cleaner assembly; refer to Air Cleaner Assembly (page 3–8).

IMPORTANT

When installing the exhaust system, ensure to use the fastener tightening order identified in Exhaust System (page 3–11).

12. Install exhaust system to machine; refer to Exhaust System (page 3–11). Exhaust tube should have 9.5 mm (3/8 inch) clearance with guard in all directions after assembly.
13. Add engine coolant to radiator.
14. Check engine hydraulic-fluid level and adjust if necessary.
15. Close hood and connect positive (+) and then negative (-) battery cables to the battery.
16. Prime the fuel system; refer to Priming the Fuel System (page 5–12).
17. Start engine. Check for fluid leaks and proper engine operation.
18. After running engine for a short time, stop engine and ensure radiator and hydraulic reservoir are full. Add correct fluids if necessary.
19. Lower and secure hood.
20. Install and secure screen to rear of machine.

Chapter 6

Hydraulic System

Table of Contents

Additional Reference Materials

Danfoss LPV Closed Circuit Axial Piston Pump Service Manual
Eaton Delta Motors Parts and Repair Manual
Parker Torqmotor Service Procedure (TC, TB, TE, TJ, TF, TG, TH, and TL Series)
Danfoss Steering Unit Type OSPM Service Manual

Specifications

Hydraulic System

Reelmaster 5410/5410-G/5410-D/5510/5510-G/5510-D/5610

Item	Description
Piston (traction) pump Maximum pump displacement (per revolution)	Closed Circuit Axial Piston Design 35 cm³ (2.14 in³)
Gear pump Section P1/P2 displacement (per revolution) (RM 5410/5410-G/5410-D) Section P1/P2 displacement (per revolution) (RM 5510/5510-G/5510-D/5610) Section P3 displacement (per revolution) (all models) Section P4 displacement (per revolution) (all models)	4-section, positive displacement gear type pump 8.3 cm³ (0.50 in³) 10.8 cm³ (0.66 in³) 6.1 cm³ (0.37 in³) 3.9 cm³ (0.24 in³)
Traction charge circuit relief (R5) pressure	1,400 kPa (200 psi)
Traction circuit relief pressure Forward (R3) Reverse (R4)	 25,000 kPa (3,625 psi) 25,000 kPa (3,625 psi)
Front wheel motors	Geroler motor
Rear wheel motors (if equipped)	Orbital rotor motor
Mow circuit relief pressure Rear mow circuit (R1) Front mow circuit (R2)	 17,500 kPa (2,500 psi) 24,100 kPa (3,500 psi)
Cutting reel motor (RM 5410/5410-G/5410-D) Displacement (per revolution)	Gear motor 12 cm³ (0.73 in³)
Cutting reel motor (RM 5510/5510-G/5510-D/5610) Displacement (per revolution) Cross-over relief valve pressure	Gear motor 19.3 cm³ (1.18 in³) 10,300 kPa (1,500 psi)
Steering valve	Hydrostatic steering unit, open center
Steering circuit relief (R10) pressure	6,900 kPa (1,000 psi)
Lift circuit relief (SVRV) pressure	13,800 kPa (2,000 psi)
Lift circuit lower relief (R7) pressure	3,447 kPa (500 psi)
Hydraulic filter (traction charge and steering circuits)	Spin-on cartridge type with 340 kPa (50 psi) relief in adapter
Hydraulic filter (mow and lift circuits)	Spin-on cartridge type with 340 kPa (50 psi) relief in adapter (filter adapter includes filter change indicator)
Hydraulic fluid	Refer to the *Operator's Manual*
Hydraulic reservoir capacity	56.7 L (15 US gallons)

Hydraulic System (continued)

Reelmaster 5610-D (Model No. 03679)

Item	Description
Piston (traction) pump Maximum pump displacement (per revolution)	Sauer-Danfoss, LPV closed circuit axial piston design 35 cm³ (2.14 in³)
Gear pump Section P1 displacement (per revolution) Section P2 displacement (per revolution) Section P3 displacement (per revolution) Section P4 displacement (per revolution)	Casappa 4-section, positive displacement gear type pump 11.23 cm³ (0.68 in³) 11.23 cm³ (0.68 in³) 6.6 cm³ (0.40 in³) 3.96 cm³ (0.24 in³)
Charge circuit relief (R5) pressure	1,400 kPa (200 psi)
Traction circuit relief pressure Forward (R3) Reverse (R4)	 25,000 kPa (3,625 psi) 25,000 kPa (3,625 psi)
Bi-directional relief valve pressure	2,760 kPa (400 psi)
Front wheel motors Displacement (per revolution)	Eaton hydraulic 395 cm³ (24.1 in³)
Rear wheel motors Displacement (per revolution)	Parker Hannifin 310 cm³ (18.9 in³)
Mow circuit relief pressure Rear mow circuit (RV1) Front mow circuit (RV2)	 17,500 kPa (2,500 psi) 24,100 kPa (3,500 psi)
Cutting reel motor Displacement (per revolution) Cross-over relief valve pressure	Casappa gear motor 18.93 cm³ (1.16 in³) 10,000 kPa (1,450 psi)
Steering valve Displacement (per revolution)	Sauer-Danfoss steering unit, type OSPMS 100 cm³ (6.1 in³)
Steering circuit relief (R10) pressure	6,990 to 7,500 kPa (1,015 to 1,088 psi)
Lift circuit relief (SVRV) pressure	13,800 kPa (2,000 psi)
Lift circuit lower relief (R7) pressure	3,447 kPa (500 psi)
Hydraulic filter (charge and steering circuits)	Spin-on cartridge type with 172 kPa (25 psi) relief in adapter
Hydraulic filter (mow and lift circuits)	Spin-on cartridge type with 340 kPa (50 psi) relief in adapter (filter adapter includes filter change indicator)
Hydraulic fluid	Refer to the *Operator's Manual*
Hydraulic reservoir capacity	34.1 L (9 US gallons)

General Information

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

Checking the Hydraulic Fluid

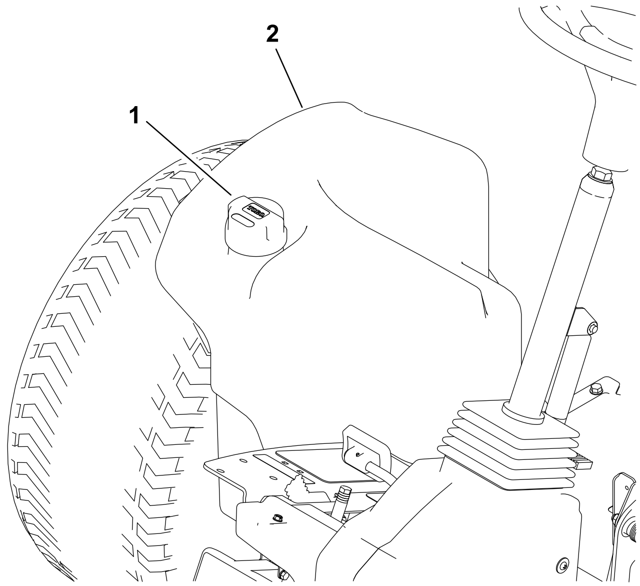


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Figure 56

1. Cap with dipstick
2. Hydraulic tank

The hydraulic system on your machine is designed to operate on anti-wear hydraulic fluid. The reservoir holds approximately 34.1 L (9 US gallons) of hydraulic fluid (Figure 56). Refer to the *Operator's Manual* for the procedure on checking the hydraulic-fluid level and hydraulic fluid recommendations.

IMPORTANT

Check the hydraulic-fluid level daily.

Pushing or Towing the Traction Unit

IMPORTANT

If towing limits are exceeded, severe damage to the piston (traction) pump may occur.

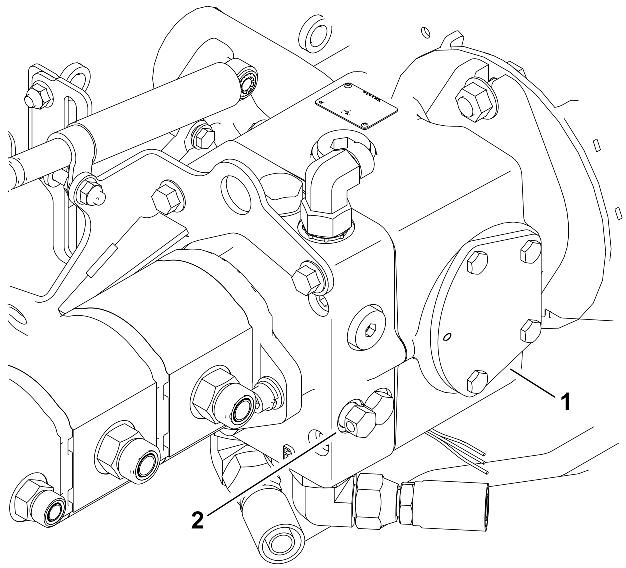

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Figure 57

1. Piston (traction) pump
2. Bypass valve

If it becomes necessary to tow or push the machine, tow or push at a speed below 4.8 km/h (3mph), and for a very short distance. If you must move the machine a considerable distance (more than a few feet), transport it on a truck or trailer. The piston (traction) pump is equipped with a bypass valve that needs to be loosened for towing or pushing (Figure 57). Refer to the *Traction Unit Operator's Manual* for towing procedures.

Releasing Pressure from the Hydraulic System

Release all the pressure in the hydraulic system before you work on the hydraulic system.

System pressure in the mow circuit is released when the cutting units are disengaged.

Releasing the Hydraulic Pressure from the Traction Circuit

Note: If you park the machine on an incline or slope, the pressure in the traction circuit does not release.

1. Park the machine on a level surface.
2. Lower the cutting units.
3. Turn the key switch to the OFF position and allow the engine to stop.
4. Move the traction pedal in both the forward and reverse direction.

Releasing the Hydraulic Pressure from the Lift Circuit

1. Turn the key switch to the ON (do not start the engine) and fully lower the cutting units to the ground.
2. Turn the key switch to the OFF position and allow the engine to stop.
3. After lowering the cutting units, ensure that the lift cylinder does not support the cutting units.

Releasing the Hydraulic Pressure from the Steering Circuit

1. Park the machine on a level surface.
2. Lower the cutting units.
3. Turn the key switch to the OFF position and allow the engine to stop.
4. After the engine has come to a complete stop, rotate the steering wheel in both directions.

Traction Circuit Component Failure

The traction circuit of the Reelsmaster 5010 series machines is a closed loop system that includes the piston (traction) pump and 2 front wheel motors (4 wheel motors on machines equipped with CrossTrax AWD). If a component failure occurs in the traction circuit (e.g., traction (piston) pump or wheel motor), unwanted material and contamination from the damaged component will circulate throughout the traction circuit. This contamination can damage other components in the circuit, so remove the contamination to prevent additional component failure.

The recommended method to remove contamination from the traction circuit is to temporarily install a Toro high flow hydraulic-fluid filter into the circuit; refer to Special Tools (page 6–44). Use a high flow hydraulic-fluid filter when you connect hydraulic test gauges in order to test the traction circuit components or after you replace a failed traction circuit component (e.g., traction (piston) pump or wheel motor). Using a high flow hydraulic-fluid filter will remove contaminates from the hydraulic fluid in the traction circuit, thereby preventing additional component damage.

After you have installed the Toro high flow hydraulic-fluid filter in the traction circuit, raise and support the machine with all the drive wheels off the ground. Then, operate the traction circuit to allow the hydraulic fluid to flow through the circuit. The filter removes contamination from the traction circuit during the circuit operation. Because the Toro high flow filter is bi-directional, the traction circuit can be operated in both the forward and reverse direction. When you are certain that the filter has removed the contaminates from the hydraulic fluid of the traction circuit, remove the filter. Refer to Filtering the Closed-Loop Traction Circuit (page 6–149) for additional information on using the Toro high flow hydraulic-fluid filter.

The alternative method to remove contamination from the traction circuit is to disassemble the entire traction circuit, drain the hydraulic fluid, and clean all the components, tubes, and hoses in the traction circuit. Operating the machine with contaminants in the traction circuit could cause additional damage to components of the traction circuit.

Note: The traction pump case drain could allow traction circuit contamination to contaminate other hydraulic circuits on the machine.

Hydraulic Hoses

The hydraulic hoses are subject to extreme conditions such as pressure differentials during operation and exposure to weather, sun, chemicals, very warm storage conditions, in addition to mishandling during operation and maintenance. These conditions can cause damage to the hose or deterioration to the hose material. Some hoses are more susceptible to these conditions than others. Examine all of the hydraulic hoses of the machine frequently for the following signs of deterioration or damage:

- A hose that is hard, cracked, cut, abraded, charred, leaking, or otherwise damaged.
- A hose that is kinked, crushed, flattened, or twisted.
- A hose cover that is blistered, soft, degraded, or loose.
- Hose fittings that are cracked, damaged, or badly corroded.

When you replace a hydraulic hose, ensure that the hose is straight (not twisted) before you tighten the fittings. Observe the imprint (layline) on the hose to do this. Using 2 wrenches, hold the hose straight with 1 wrench and tighten the hose swivel nut onto the fitting with the other wrench; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 6–11).

Note: If the hose has an elbow at 1 end, tighten the swivel nut on the elbow end before you tighten the nut on the straight end of the hose.

For more hydraulic hose information; refer to *Hydraulic Hose Servicing* of the Toro Basics Series Training Books (Part No. 94813SL) found on the Service Reference Set available from your Authorized Toro Distributor.

WARNING

Release all pressure in the hydraulic system before performing any work on the system; refer to Releasing Pressure from the Hydraulic System (page 6–8).

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

Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting)

1. Ensure that all the threads, the sealing surfaces of the hose/tube, and the fitting are free of burrs, nicks, scratches, or unwanted material.
2. To help prevent a hydraulic leak, replace the face seal O-ring when you open the connection. Ensure that the O-ring is installed and correctly seated in the groove of the fitting. Lightly lubricate the O-ring with clean hydraulic fluid.

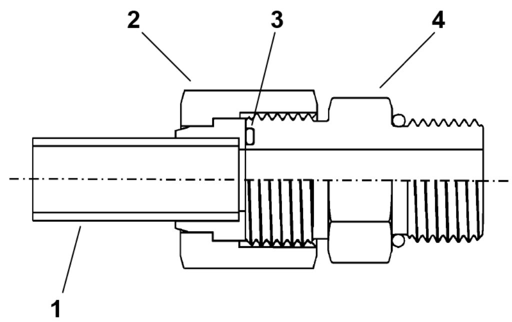

Figure 58

1. Tube or hose	3. O-ring
2. Swivel nut	4. Fitting body

3. Align the hose/tube against the body of the fitting so that the flat face of the hose/tube sleeve fully touches the O-ring in the fitting (Figure 58).
4. Use your hand to thread the swivel nut onto the fitting. While you hold the hose/tube in alignment with a wrench, use a torque wrench to tighten the swivel nut to the recommended torque value within the specified range of torque values; refer to the Hose/Tube Installation Torque Table (page 6–12). This procedure to tighten the swivel nut requires a drive-adapter wrench (e.g., crowfoot wrench).

   Note: It may be necessary to use a drive-adapter wrench (e.g., crowfoot wrench) to install a hydraulic fitting; refer to Calculating the Torque Values When Using a Drive-Adapter Wrench (page 2–6).

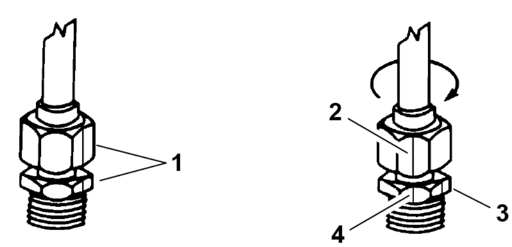

Figure 59

1. Mark nut and fitting body	3. Initial position
2. Final position	4. Extend line

5. If a torque wrench is not available or if space at the swivel nut prevents the use of a torque wrench, use the alternative procedure Flats From Wrench Resistance (FFWR) given below (Figure 59).
   A. Use a wrench to tighten the swivel nut onto the fitting until you feel light resistance with the wrench—approximately **3.39 N·m (30 in-lb)**.
   B. Put a mark on the swivel nut and body of the fitting. Hold the hose/tube in alignment with a wrench to prevent the hose/tube from turning.

Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (continued)

C. Use a second wrench to tighten the nut to the correct Flats From Wrench Resistance (FFWR); refer to the Flats From Wrench Resistance Table (page 6–12).

Note: The markings on the nut and body of the fitting show that the connection is correctly tightened.

Hose/Tube Installation Torque Table

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

Flats From Wrench Resistance Table

Size	FFWR
4 (1/4 inch nominal hose or tubing)	1/2 to 3/4
6 (3/8 inch)	1/2 to 3/4
8 (1/2 inch)	1/2 to 3/4
10 (5/8 inch)	1/2 to 3/4
12 (3/4 inch)	1/3 to 1/2
16 (1 inch)	1/3 to 1/2

Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port)

Installing the Non-Adjustable Fittings

1. Ensure that all the threads, the sealing surfaces of fitting, and the component port are free of burrs, nicks, scratches, or unwanted material.
2. To help prevent a hydraulic leak, replace the O-ring when you open the connection.

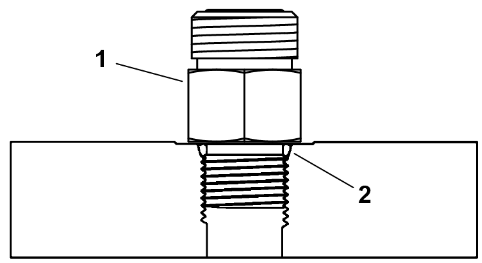

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Figure 60

1. Fitting
2. O-ring

3. Lightly lubricate the O-ring with clean hydraulic fluid. Ensure that the threads of the fitting are clean with no lubricant applied (Figure 60).

IMPORTANT

Before installing the fitting into the port, determine the material of which the port is made. Installing a fitting into an aluminum port requires a reduced installation torque.

4. Install the fitting into the port, then use a torque wrench and socket to tighten the fitting to the recommended torque value within the specified range of torque values; refer to the Fitting Installation Torque Table (page 6–13).

   Note: It may be necessary to use a drive-adapter wrench (e.g., crowfoot wrench) to install a hydraulic fitting; refer to Calculating the Torque Values When Using a Drive-Adapter Wrench (page 2–6).

5. If a torque wrench is not available or if space at the port prevents the use of a torque wrench, use the alternative procedure Flat From Finger Tight Table (page 6–16) given below;

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

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

Fitting Installation Torque Table

Fitting Dash Size	Fitting Port Side Thread Size (inch(es)—threads per inch)	Installation Torque Into Steel Port	Installation Torque Into Aluminum Port
4	7/16—20	21 to 25 N·m (15 to 19 ft-lb)	13 to 15 N·m (9 to 11 ft-lb)
5	1/2—20	25 to 29 N·m (18 to 22 ft-lb)	15 to 20 N·m (11 to 15 ft-lb)

Installing the Non-Adjustable Fittings (continued)

Fitting Installation Torque Table (continued)

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

Flat From Finger Tight Table

Size	FFFT
4 (1/4 inch nominal hose or tubing)	1.00 ± 0.25
6 (3/8 inch)	1.50 ± 0.25
8 (1/2 inch)	1.50 ± 0.25
10 (5/8 inch)	1.50 ± 0.25
12 (3/4 inch)	1.50 ± 0.25
16 (1 inch)	1.50 ± 0.25

Installing an Adjustable Fitting

1. Ensure that all the threads, the sealing surfaces of fitting, and the component port are free of burrs, nicks, scratches, or unwanted material.
2. To help prevent a hydraulic leak, replace the O-ring when you open the connection.

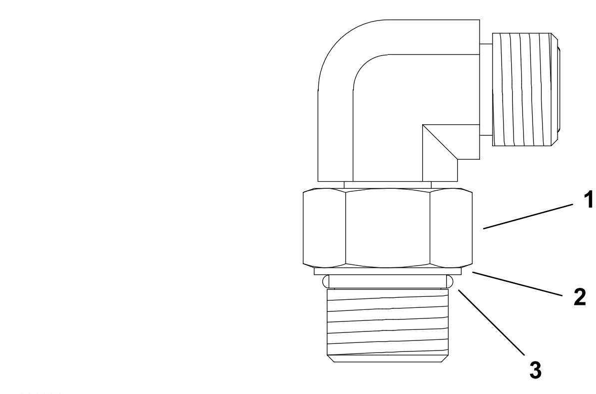


Figure 61

1. Locknut
2. Back-up washer
3. O-ring

Installing an Adjustable Fitting (continued)

3. Lightly lubricate the O-ring with clean hydraulic fluid. Ensure that the threads of the fitting are clean with no lubricant applied (Figure 61).

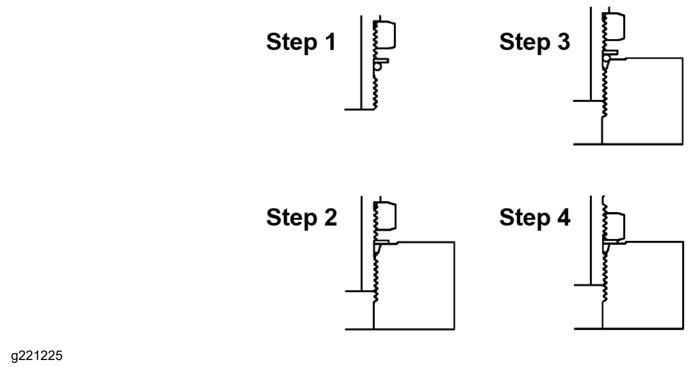


Figure 62

4. Turn back the locknut as far as possible. Ensure that the back-up washer is not loose and it is pushed up as far as possible (Step 1 in Figure 62).

IMPORTANT

Before installing the fitting into the port, determine the material of which the port is made. Installing a fitting into an aluminum port requires a reduced installation torque.

5. Install the adjustable fitting into the port by hand until the washer contacts the face of the port (Step 2 in Figure 62).
6. If the adjustable fitting needs to align with another component, rotate the fitting counterclockwise until it is aligned to the desired position (Step 3 in Figure 62). Do not rotate the adjustable fitting more than 1 turn counterclockwise.
7. Hold the fitting in the correct alignment with a wrench and use a torque wrench and tighten the fitting to the recommended torque value within the specified range of torque values; refer to the Fitting Installation Torque Table (page 6–13). This tightening procedure requires a drive-adapter wrench (e.g., crowfoot wrench).

   Note: It may be necessary to use a drive-adapter wrench (e.g., crowfoot wrench) to install a hydraulic fitting; refer to Calculating the Torque Values When Using a Drive-Adapter Wrench (page 2–6).
8. If a torque wrench is not available or if space at the port prevents the use of a torque wrench, use the alternative procedure Flat From Finger Tight Table (page 6–14) given below;

   A. Hold the fitting in the correct alignment with a wrench and, if the port material is steel, tighten the locknut with a second wrench to the listed FFFT (Step 4 in Figure 62).

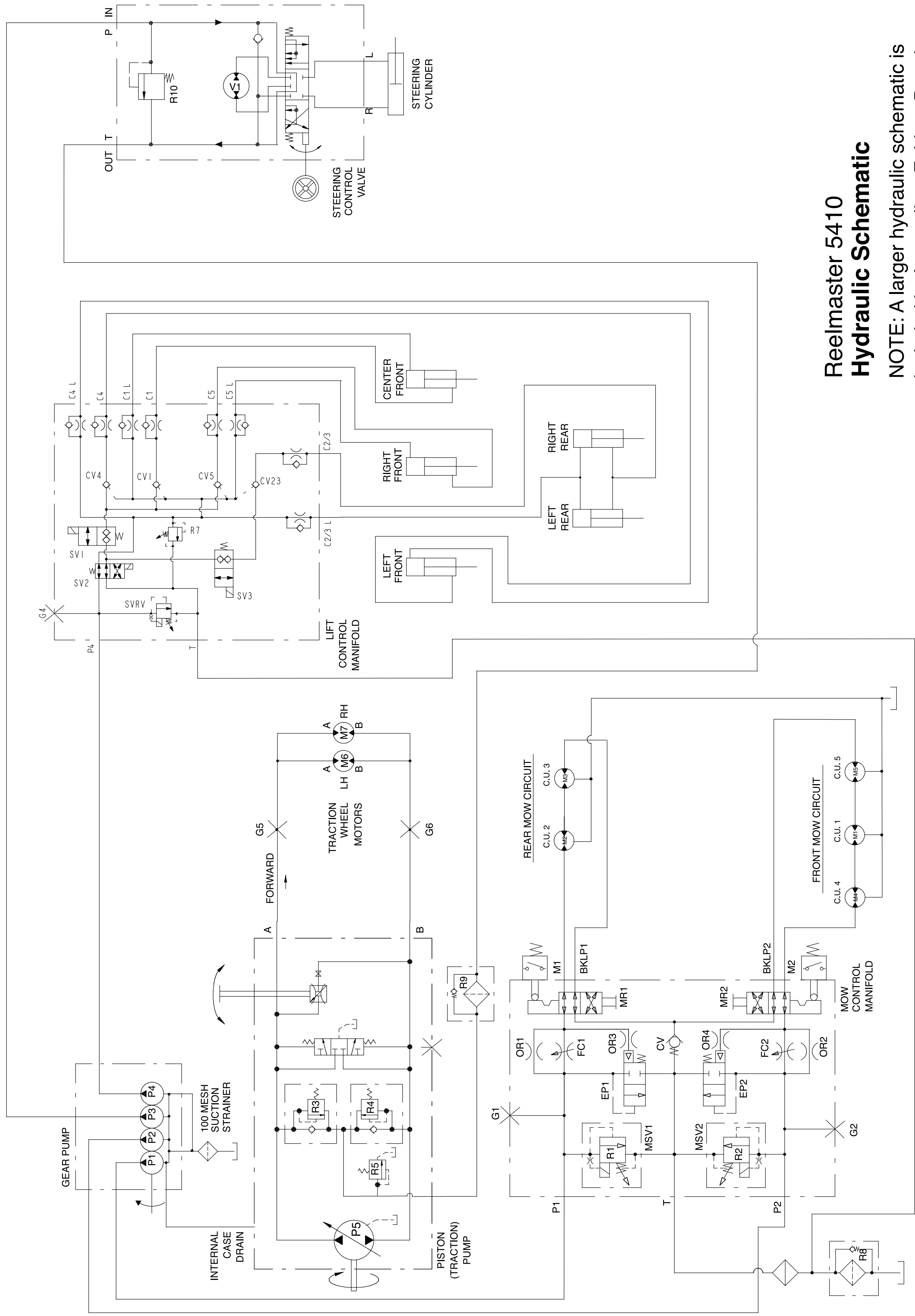
   B. If the port material is aluminum, tighten the fitting to 60% of the listed FFFT; refer to the Flat From Finger Tight Table (page 6–14).

Installing an Adjustable Fitting (continued)

Flat From Finger Tight Table

Size	FFFT
4 (1/4 inch nominal hose or tubing)	1.00 ± 0.25
6 (3/8 inch)	1.50 ± 0.25
8 (1/2 inch)	1.50 ± 0.25
10 (5/8 inch)	1.50 ± 0.25
12 (3/4 inch)	1.50 ± 0.25
16 (1 inch)	1.50 ± 0.25

Hydraulic Schematics



Reelmaster 5410
Hydraulic Schematic

NOTE: A larger hydraulic schematic is included in Appendix - Foldout Drawings

Figure 63

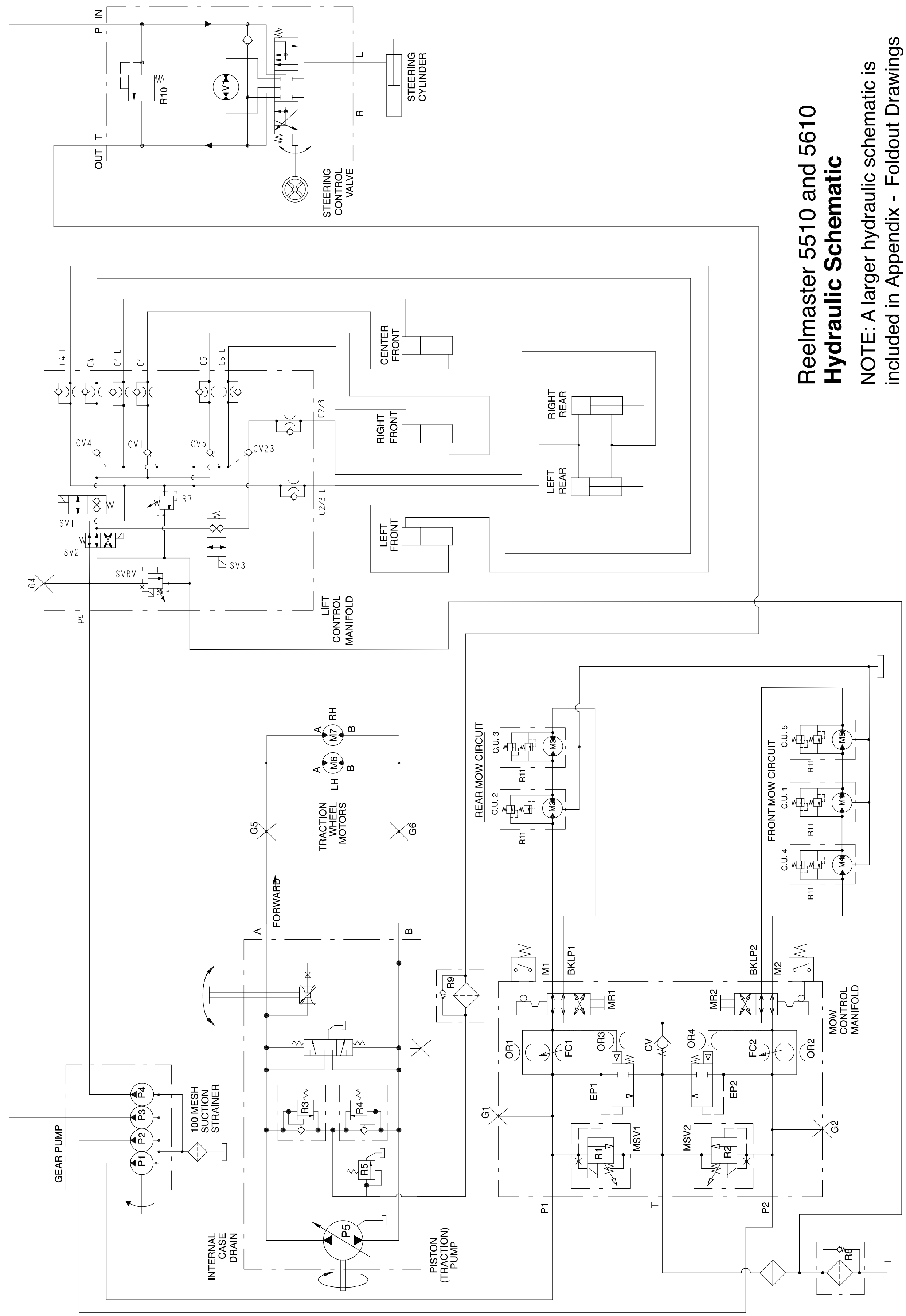


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Figure 64

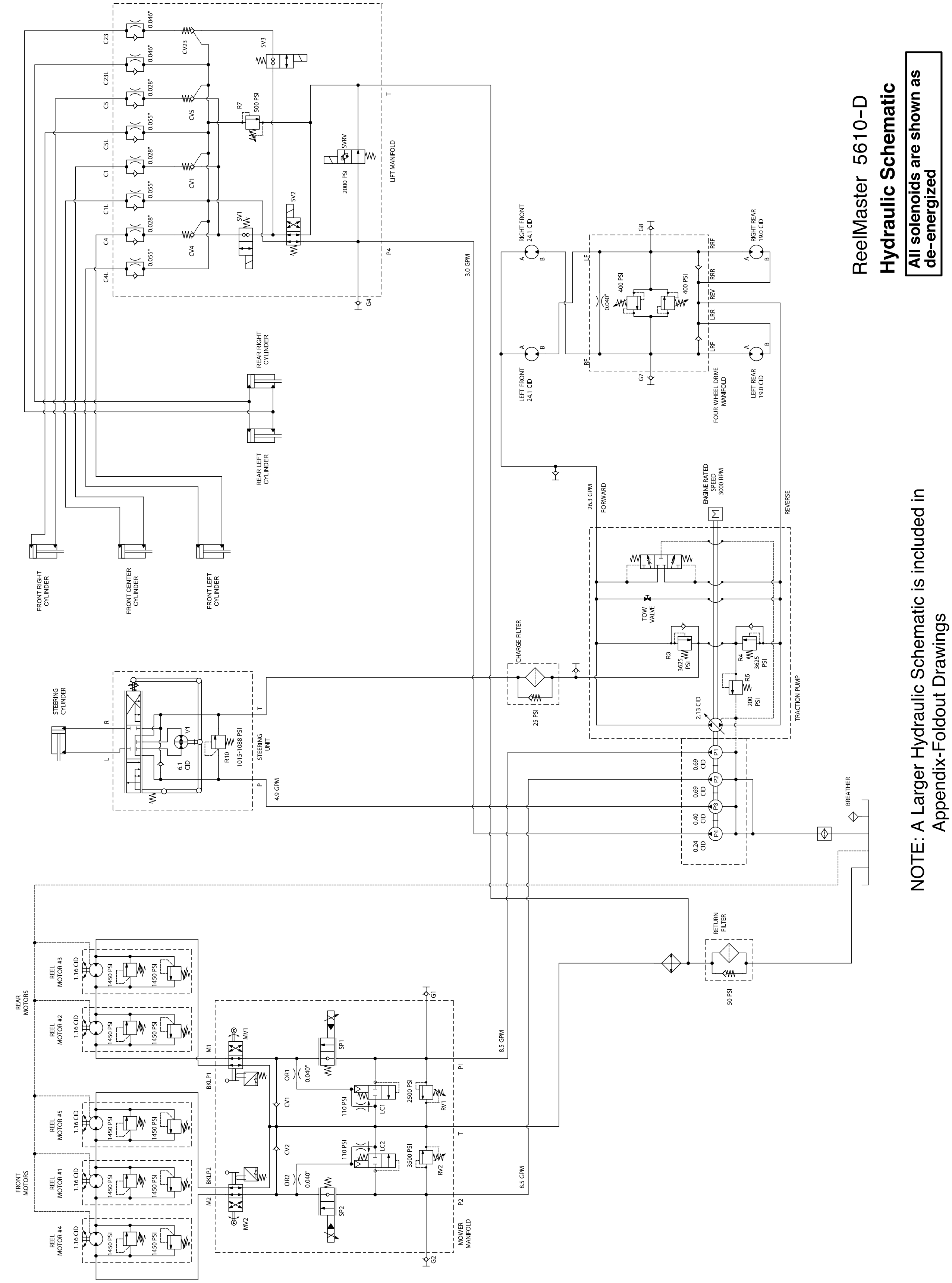

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Figure 65

Hydraulic Flow Diagrams (5410/5410-D/5510/5510-D/5610)

Traction Circuit (5410/5410-D/5510/5510-D/5610)

The hydraulic traction circuit consists of a variable displacement piston pump (P5) connected in a closed loop, parallel circuit to 2 orbital roller vane wheel motors. The traction pump input shaft is rotated by a driveshaft that is driven from the engine flywheel.

Traction circuit pressure (forward and reverse) can be measured at test ports located in the hydraulic tubes that connect the front wheel motors.

Forward Direction

Pushing the top of the traction pedal angles the traction pump swash plate to create a flow of fluid. This fluid flow is directed to the wheel motors via hydraulic hoses and tubes to drive the wheels in the forward direction. Forward traction pressure is limited to 25,000 kPa (3,625 psi) by the forward traction relief valve (R3) located in the traction pump.

Fluid flowing from the wheel motors returns to the variable displacement pump and is continuously pumped through the traction circuit as long as the traction pedal is pushed.

The angle of the swash plate determines pump flow and ultimately traction speed. When the traction pedal is pressed a small amount, a small swash plate rotation results in low pump output and lower traction speed. When the traction pedal is pressed fully, the pump swash plate rotates fully to provide maximum pump output and traction speed.

Gear pump section (P3) supplies fluid flow for the steering circuit and also provides a constant supply of charge fluid to the closed loop traction circuit. This charge fluid provides lubrication for traction circuit components and also replenishes traction circuit fluid that is lost due to internal leakage in the traction circuit.

Gear pump (P3) takes its suction from the hydraulic reservoir. Charge pump flow is directed to the low pressure side of the closed loop traction circuit. Charge pressure is limited by the charge relief valve (R5) located in the traction pump. The charge relief pressure to 1,400 kPa (200 psi).

The piston pump (P5) includes a flushing valve (R10) that bleeds off a small amount of hydraulic fluid for cooling of the closed loop traction circuit. The charge system replenishes fluid that is bled from the traction circuit by the flushing valve.

Reverse Direction

The traction circuit operates essentially the same in reverse as it does in the forward direction. However, the flow through the circuit is reversed. Pushing the bottom of the traction pedal rotates the traction pump swash plate to create a flow of fluid. This fluid is directed to the wheel motors to drive the wheels in the reverse direction. Reverse traction pressure is limited to 25,000 kPa (3,625 psi) by the reverse traction relief valve (R4) located in the traction pump.

Fluid flowing from the wheel motors returns to the traction pump and is continuously pumped through the closed loop traction circuit as long as the traction pedal is pushed.

The charge circuit and flushing valve (R10) function the same in reverse as they do in the forward direction.

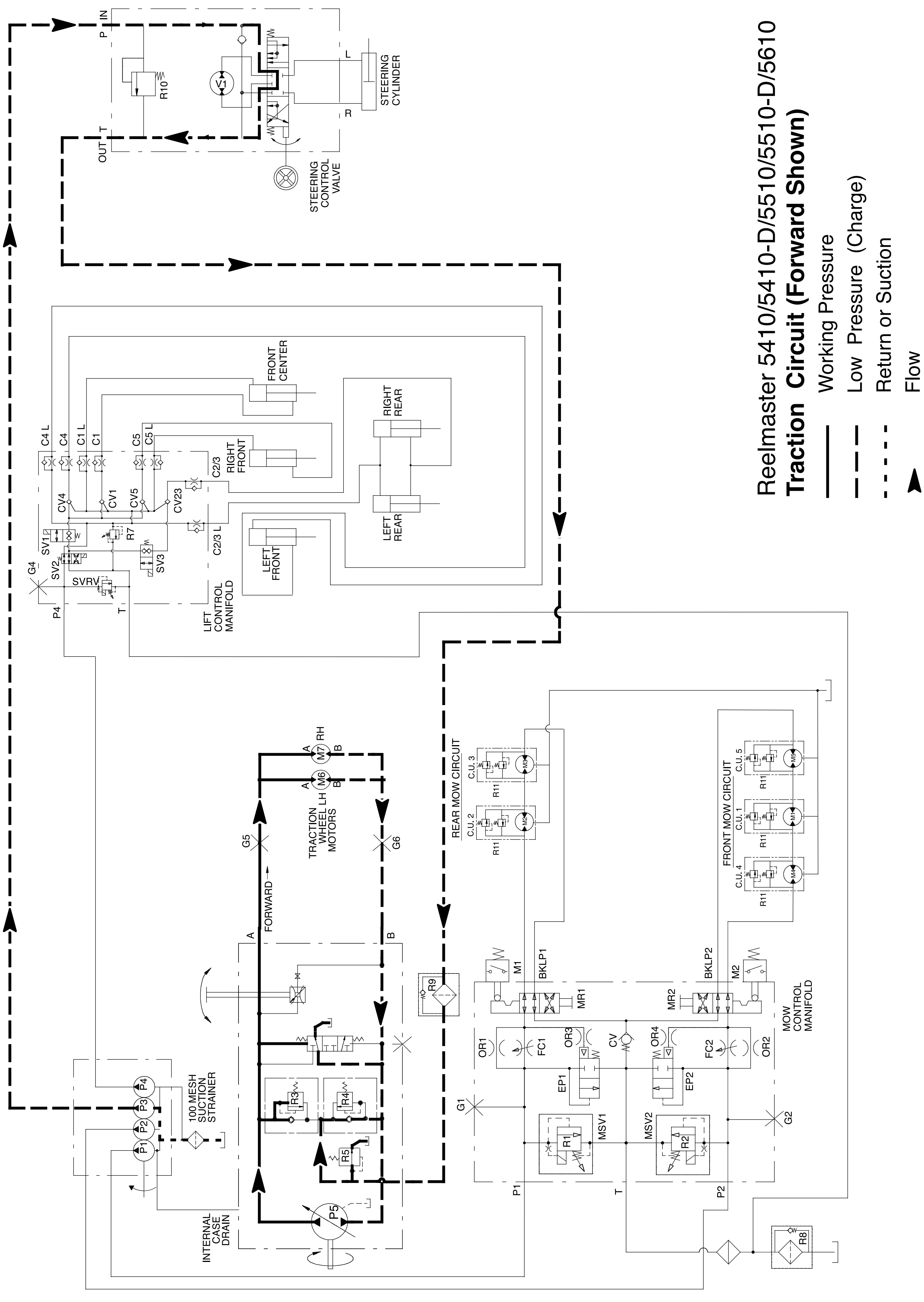

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Figure 66

CrossTrax™AWD (Optional)

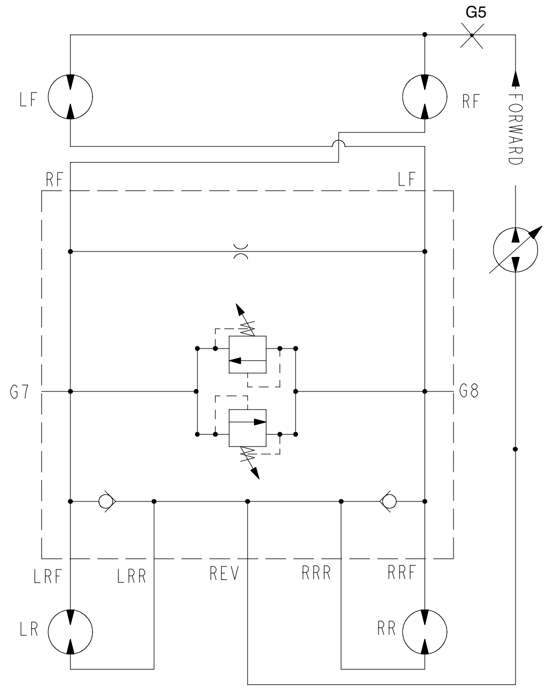

Figure 67

On machines equipped with optional CrossTrax AWD, 4 wheel motors are used (Figure 67). Traction pump flow is directed to the front tires and the opposite rear tires to maximize traction. To reduce tire scuffing when turning, traction system pressure is equalized in the AWD control manifold with an orifice and a bi-directional relief valve. Check valves in the AWD control manifold allow the rear wheel motors to over run during tight turns.

Mow Circuit (5410/5410-D/5510/5510-D/5610)

A 4-section gear pump is coupled to the piston (traction) pump. Gear pump sections (P1) and (P2) supply hydraulic flow for the mow circuit. These gear pumps take their suction from the hydraulic reservoir.

The mow control manifold contains 2 independent control circuits for the front and rear cutting units. Each circuit is supplied by its own pump section. Pump section (P1) supplies hydraulic power to the rear cutting units through mow control manifold port P1, solenoid relief valve (MSV1), and direction valve (MR1). Pump section (P2) supplies the front cutting units through manifold port P2, solenoid relief valve (MSV2), and direction valve (MR2). Both circuits share manifold port T, which drains to the oil cooler, oil filter, and hydraulic reservoir.

On the mow circuit supplied by pump section (P1) (rear cutting units), maximum system pressure is limited by solenoid relief valve (MSV1), which is set at 17,500 kPa (2,500 psi). On the circuit supplied by pump section (P2) (front cutting units), maximum system pressure is limited by solenoid relief valve (MSV2), which is set at 24,100 kPa (3,500 psi).

On Reelmaster 5510/5510-D/5610 machines, all cutting reel motors are equipped with cross over relief valves to prevent hydraulic component damage in case a cutting reel should stall.

The machine Toro Electronic Controller (TEC) uses inputs from various machine switches to determine when solenoid relief valves (MSV1) and (MSV2) are to be energized. The TEC also provides a slight delay in activation of front and rear cutting units.

When solenoid relief valves (MSV1) and (MSV2) are not energized (e.g., reel engage switch in the OFF position, cutting units in the raised position), flow from pump sections (P1) and (P2) is directed out the mow manifold port T and returns to the hydraulic reservoir, by-passing the reel motors.

Mow

When solenoid valve (MSV1) is energized by the TEC, pump section (P1) flow enters mow control manifold port P1 and is directed to reel speed control valve (FC1). Flow through the speed control valve is pressure compensated by logic cartridge valve (EP1). The logic cartridge valve maintains a pressure of 520 kPa (75 psi) across the speed control valve. Any excess flow is returned to the hydraulic reservoir. Regulated flow continues through valve (MR1) and out to the rear reel motors to rotate the cutting reels. When valve (MR1) is in the MOW position, the rear reels rotate correctly for mowing. Return fluid from the rear reel motors is directed to the reservoir through valve (MR1) and manifold port T.

Mow circuit pressure for the rear cutting units (pump section P1) can be measured at manifold port G1.

When solenoid valve (MSV2) is energized by the TEC, fluid flow from port P2 is directed through reel speed control valve (FC2). Flow through the speed control valve is pressure compensated by logic cartridge valve (EP2). The logic cartridge valve maintains a pressure of 520 kPa (75 psi) across the speed control valve. Any excess flow is returned to the hydraulic reservoir. Regulated flow continues through valve (MR2) and out to the front reel motors. When valve (MR2) is in the MOW position, the front reels rotate correctly for mowing. Return fluid from the front motors is directed to the reservoir through valve (MR2) and manifold port T.

Mow circuit pressure for the front cutting units (pump section P2) can be measured at manifold port G2.

Backlap

During the backlap mode of operation, the reel circuits operate the same as in the mow mode. When either valve (MR1) or (MR2) is set to the backlap position, the valve reverses the direction of hydraulic flow through the rear or front reel motors allowing the backlap operation.

Backlap (continued)

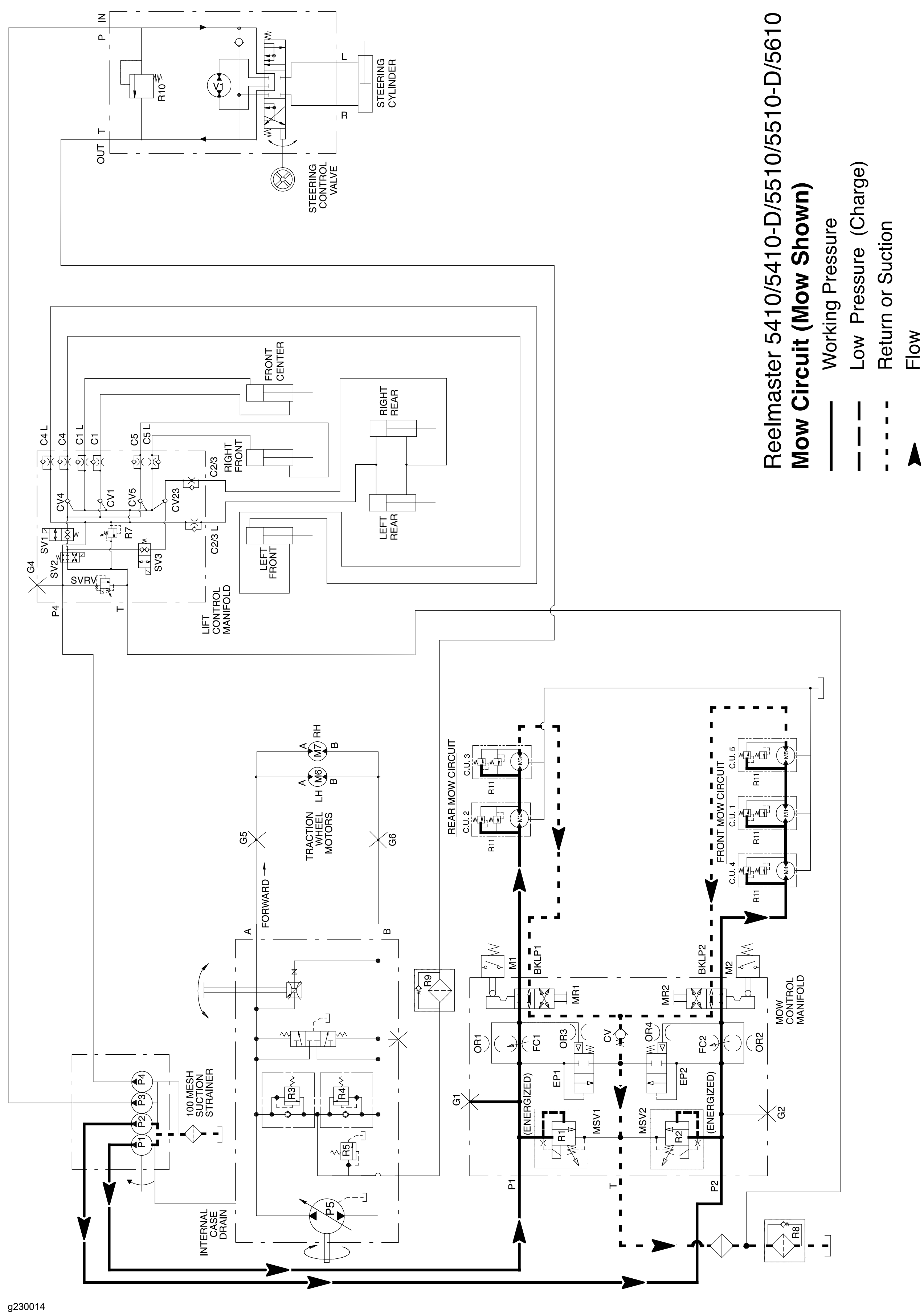

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Figure 68

Lift Circuit (5410/5410-D/5510/5510-D/5610)

A 4-section gear pump is coupled to the piston (traction) pump. Gear pump section (P4) supplies hydraulic flow to the lift control manifold and ultimately for the lift cylinders. The gear pump takes its suction from the hydraulic reservoir. Lift circuit pressure is limited to 13,800 kPa (2,000 psi) by a solenoid relief valve (SVRV) located in the lift control manifold.

The lift control manifold includes 4 electrically operated solenoid valves. Valve (SVRV) is used to direct gear pump flow to the lift cylinders when energized or bypass pump flow back to the reservoir when de-energized. Valve (SV2) is used to direct fluid flow to retract the lift cylinders when energized or extend them when de-energized. Valve (SV1) allows hydraulic flow to the front lift cylinders when energized. Valve (SV3) allows hydraulic flow to the rear lift cylinders when energized.

Lift circuit pressure can be monitored at lift control manifold port G4.

The Toro Electronic Controller (TEC) uses inputs from various machine switches to determine when lift manifold solenoid valves (SV1, SV2, SV3, and SVRV) are to be energized. The TEC also provides a partial raise position of the front outside cutting units.

During conditions of not raising or lowering the cutting units (joystick in the neutral (center) position), all 4 lift manifold solenoid valves (SV1, SV2, SV3, and SVRV) are de-energized. Hydraulic flow from gear pump section (P4) by-passes the lift cylinders to the oil cooler and then to the hydraulic reservoir.

Raise the Cutting Units

When the joystick is moved to the raise position with the engine running, solenoid valve (SVRV) energizes along with solenoid valves (SV1), (SV2), and (SV3). The energized solenoid valves direct gear pump section P4 fluid flow to the rod end of the lift cylinders. Hydraulic pressure against the rod side of the cylinders causes the shafts to retract, and raises the cutting units. Fixed orifices in the lift control manifold (C1L, C4L, C5L, and C23L) control the lifting speed by providing a restriction for the return flow from the lift cylinders.

When the joystick is returned to the neutral (center) position, the solenoid valves are de-energized and the lift cylinders (and cutting units) are held in the raised position. Piloted check valves in the lift control manifold (CV1, CV4, CV5, and CV23) prevent the lift cylinders (and cutting units) from dropping after they have been raised.

Raise the Cutting Units (continued)

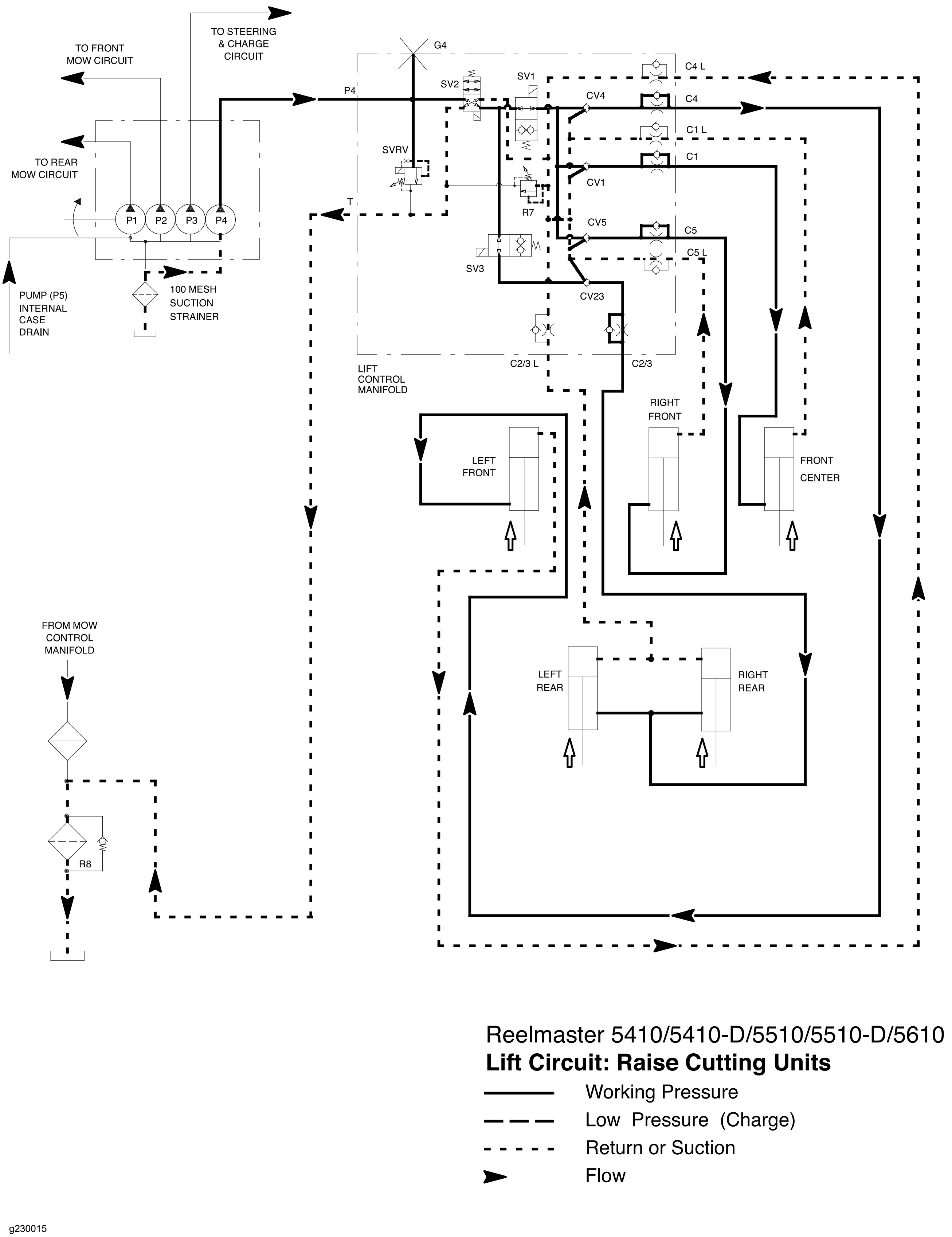


Figure 69

Lower the Cutting Units

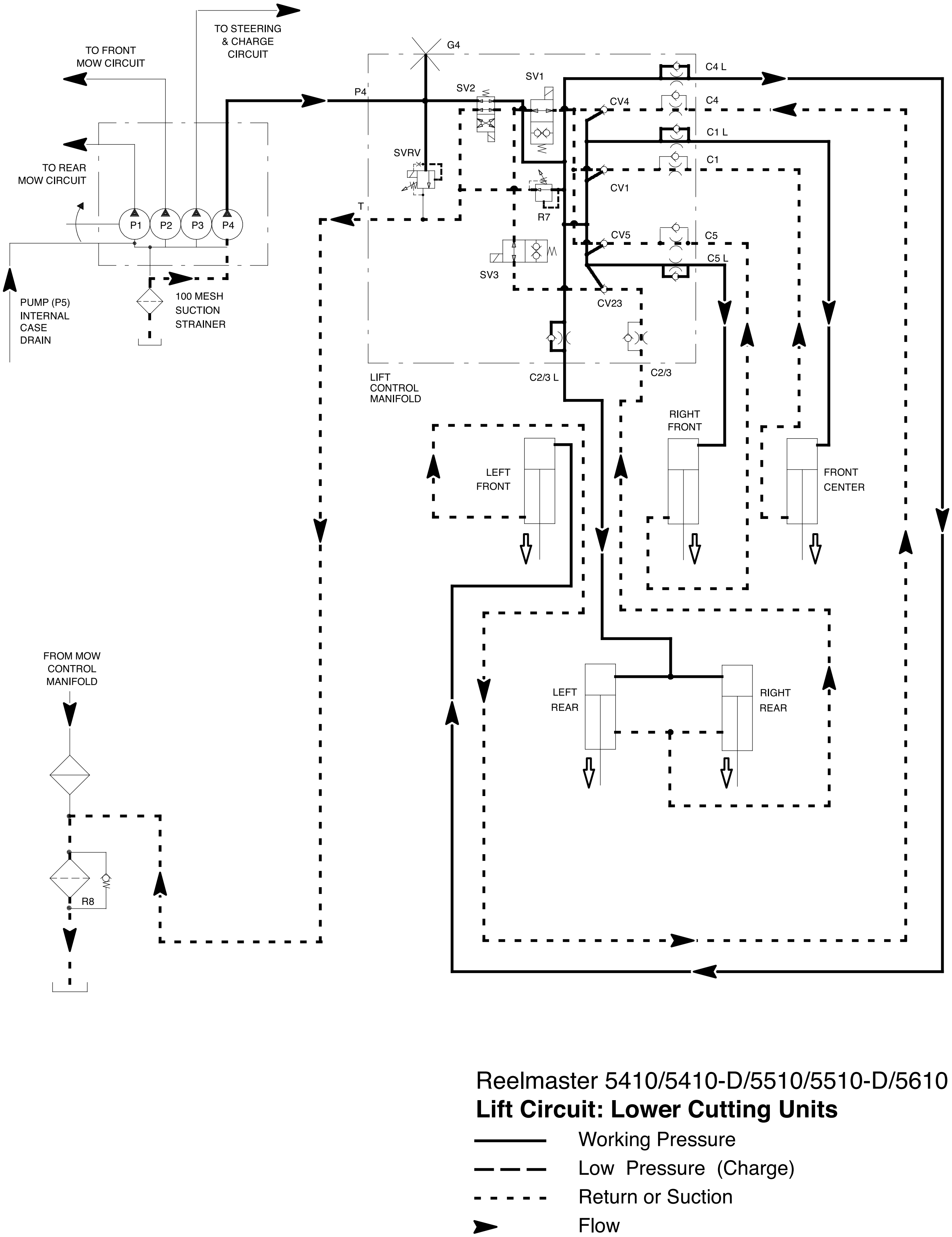
When the joystick is moved to the lower position with the engine running, solenoid valve (SVRV) energizes along with solenoid valves (SV1) and (SV3). Solenoid valve (SV2) is in its normally de-energized position, and directs fluid flow to the piston end of the lift cylinders. Hydraulic pressure against the piston side of the cylinder causes the shafts to extend, and lower the cutting units. The piloted check valves in the lift control manifold (CV1, CV4, CV5, and CV23) are shifted by hydraulic pressure to allow return flow from the extending lift cylinders. Fixed orifices in the lift control manifold (C1, C4, C5, and C23) control the lowering speed by providing a restriction for the return flow from the lift cylinders.

Because cutting unit weight assists in extending the lift cylinders when lowering the cutting units, less hydraulic pressure is necessary during the cutting unit lowering operation. Lift circuit lower relief valve (R7) allows lift circuit pressure to be limited to 3,447 kPa (500 psi) while lowering the cutting units.

Note: Adjustment of lift circuit lower relief valve (R7) is not recommended.

When the joystick is returned to the neutral (center) position, the solenoid valves are de-energized and the lift cylinders (and cutting units) are held in the lowered position.

Lower the Cutting Units (continued)



g230016

Figure 70

Steering Circuit (5410/5410-D/5510/5510-D/5610)

A 4-section gear pump is coupled to the piston (traction) pump. Gear pump section P3 supplies hydraulic flow to the steering control valve and for the traction charge circuit. The gear pump takes its suction from the hydraulic reservoir. Steering circuit pressure is limited to 6,900 kPa (1,000 psi) by a relief valve (R10) located in the steering control.

With the steering wheel in the neutral position and the engine running, flow enters the steering control valve at the P port and goes through the steering control spool valve, by-passing the rotary meter (V1) and steering cylinder. Flow leaves the control valve through the T port to the oil filter and traction charge circuit.

Left Turn

When a left turn is made with the engine running, the turning of the steering wheel positions the steering control spool valve so that flow is directed through the bottom of the spool. Flow entering the steering control valve at the P port goes through the spool and is routed to 2 places. First, most of the flow through the valve is bypassed out the T port back to the oil filter and traction charge circuit. Second, the remainder of the flow is drawn through the rotary meter (V1) and out the L port. Pressure contracts the steering cylinder piston for a left turn. The rotary meter ensures that the fluid flow to the steering cylinder is proportional to the amount of turning on the steering wheel. Fluid leaving the steering cylinder flows back through the steering control spool valve and then out of the steering control valve through the T port and to the oil filter and traction charge circuit.

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

Right Turn

When a right turn is made with the engine running, the turning of the steering wheel positions the steering control spool valve so that flow is directed through the top of the spool. Flow entering the steering control valve at the P port goes through the spool and is routed to 2 places. As in a left turn, most of the flow through the valve is by-passed out the T port back to the oil filter and traction charge circuit. Also like a left turn, the remainder of the flow is drawn through rotary meter (V1) but goes out port R. Pressure extends the steering cylinder piston for a right turn. The rotary meter ensures that the fluid flow to the steering cylinder is proportional to the amount of the turning on the steering wheel. Fluid leaving the steering cylinder flows back through the steering control spool valve then through the T port and to the oil filter and traction charge circuit.

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

Right Turn (continued)

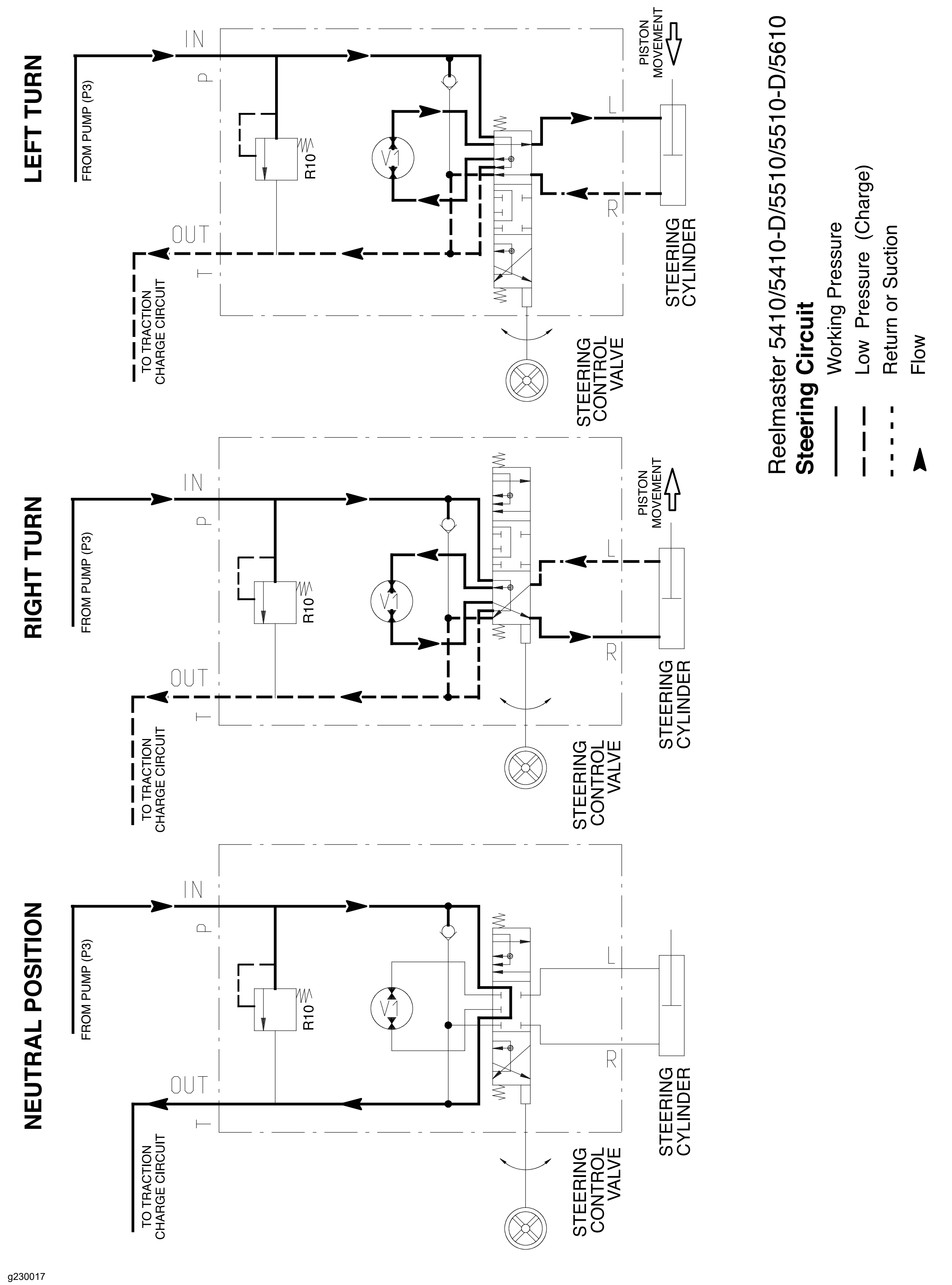


Figure 71

Hydraulic Flow Diagrams (5610-D)

Traction Circuit (5610-D)

The hydraulic traction circuit consists of a variable displacement piston pump (P5) connected in a closed loop, parallel circuit to 4 orbital roller vane wheel motors. The traction pump input shaft is rotated by a driveshaft that is driven from the engine flywheel.

The forward traction circuit pressure can be measured at the test port located in the hydraulic tube that connects the front wheel motors. The reverse traction circuit pressure can be measured at the test ports in the crosstrax manifold (Figure 72).

Forward Direction

Pressing the top of traction pedal, angles the traction pump swash plate to create a flow of fluid. This fluid flow is directed to the wheel motors via hydraulic hoses and tubes to drive the wheels in forward direction. The traction pump flow is directed to the front wheel motors and then to the opposite rear wheel motors to maximize the traction. To reduce the tire scuffing when turning, the traction system pressure is equalized in the crosstrax manifold with an orifice and a bi-directional relief valve. The bi-directional relief valve in the crosstrax manifold allow rear wheel motors to over-run during tight turns. The forward traction pressure is limited to 25,000 kPa (3,625 psi) by the forward traction relief valve (R3) located in the traction pump.

The fluid flowing from the wheel motors returns to the variable displacement pump and is continuously pumped through the traction circuit as long as the traction pedal is pressed.

The angle of the swash plate determines pump flow and ultimately traction speed. When the traction pedal is pressed a small amount, a small swash plate rotation results in low pump output and lower traction speed. When the traction pedal is pressed fully, the pump swash plate rotates fully to provide maximum pump output and traction speed.

The gear pump section (P3) supplies fluid flow for the steering circuit and also provides a constant supply of charge fluid to the closed loop traction circuit. This charge fluid provides lubrication for traction circuit components and also replenishes traction circuit fluid that is lost due to internal leakage in the traction circuit.

The gear pump section (P3) takes its suction from the hydraulic reservoir. The charge pump flow is directed to the low pressure side of the closed loop traction circuit. Charge relief valve (R5) located in the traction pump limits the charge relief pressure to 1,400 kPa (200 psi).

The piston pump is equipped with a case drain to allow internal leakage to be removed from the pump. The case drain is connected to the gear pump inlet.

The piston pump (P5) includes a flushing valve that bleeds off a small amount of hydraulic fluid for cooling of the closed loop traction circuit. The charge system replenishes fluid that is bled from the traction circuit by the flushing valve.

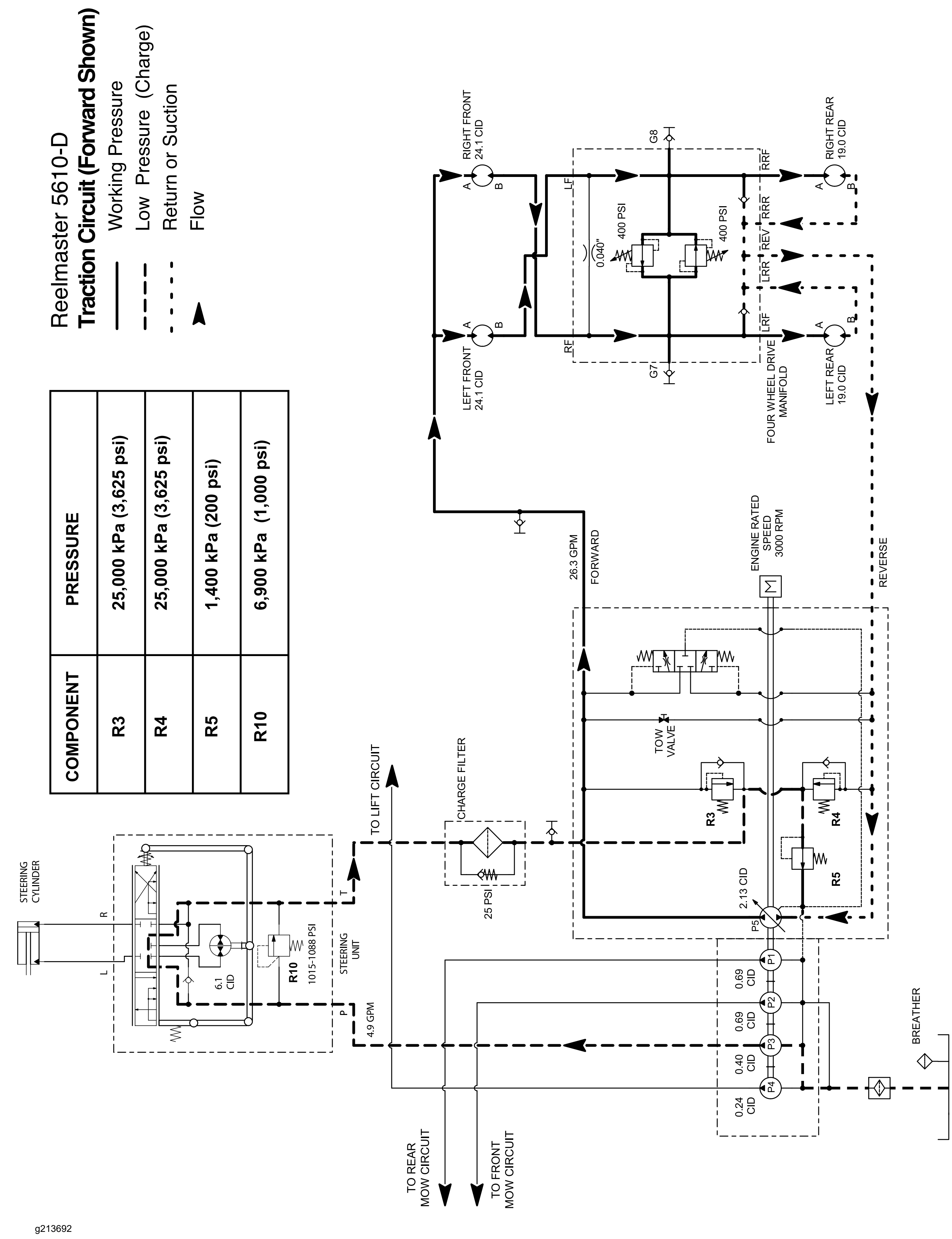
Reverse Direction

The traction circuit operates essentially the same in reverse as it does in the forward direction. However, in the reverse direction the rear wheel motors are bypassed from the circuit to prevent rear wheel spin and improve steering control. Pressing the bottom of the traction pedal, rotates the traction pump swash plate to create a flow of fluid. The fluid flow is directed to the crosstrax manifold where the 2 internal check valves allow the hydraulic fluid to bypass the rear wheel motors. Then the fluid flows to the front wheel motors, turning them in the reverse direction. The reverse traction pressure is limited to 25,000 kPa (3,625 psi) by the reverse traction relief valve (R4) located in the traction pump.

The fluid flowing from the wheel motors returns to the traction pump and is continuously pumped through the closed loop traction circuit as long as the traction pedal is pressed.

The charge circuit and flushing valve function the same in reverse as they do in the forward direction.

Reverse Direction (continued)



COMPONENT	PRESSURE
R3	25,000 kPa (3,625 psi)
R4	25,000 kPa (3,625 psi)
R5	1,400 kPa (200 psi)
R10	6,900 kPa (1,000 psi)

Figure 72

Mow Circuit (5610-D)

A 4-section gear pump is coupled to the piston (traction) pump. The gear pump sections (P1) and (P2) supply hydraulic flow for the mow circuit. These gear pumps take their suction from the hydraulic reservoir (Figure 73).

The mow control manifold contains 2 independent control circuits for the front and rear cutting units. Each circuit is supplied by its own pump section. The pump section (P1) supplies hydraulic power to the rear cutting units through mow control manifold port P1 and pump section (P2) supplies the front cutting units through manifold port P2. Each mow circuit includes a solenoid controlled proportional valve (SP1) and (SP2), a logic cartridge (LC1) and (LC2), a circuit relief cartridge (RV1) and (RV2), and a manually controlled direction valve (MV1) and (MV2). Both the circuits share manifold port T, which drains to the oil cooler, oil filter, and hydraulic reservoir.

The cutting reel motors are equipped with a cross-over relief valve to prevent hydraulic component damage in case a single cutting reel stalls.

The machine TEC uses inputs from various inputs to determine when the solenoid proportional valves (SP1) and (SP2) are to be energized. The TEC also provides a slight delay in activation of front and rear cutting units.

Reels Engaged

When the reel engage switch is turned ON and the cutting units are lowered, the proportional valves (SP1) and (SP2) are energized by the TEC. The energized valves shift to direct pump flow toward the cutting unit motors. The amount of flow from the valves is proportional to the current applied to the valve coil by the TEC. The reel speed (defined by the InfoCenter reel speed setting) provides the input for the TEC to output the appropriate amount of current to the proportional valve coils.

Flow through the proportional valves (SP1) and (SP2) is pressure compensated by the logic cartridge valves (LC1) and (LC2). The logic cartridge valve maintains a pressure of 758 kPa (110 psi) across the proportional valve. Any excess flow is returned to the oil cooler, return filter, and hydraulic reservoir.

The maximum mow circuit pressure is limited by relief valve (RV1) and (RV2). The rear cutting unit circuit is protected by relief valve (RV1) which is set at 17,237 kPa (2,500 psi). The front cutting unit circuit is protected by relief valve (RV2) which is set at 24,132 kPa (3,500 psi).

Mow circuit pressure for the rear cutting units (pump section P1) can be measured at the manifold port G1, and mow circuit pressure for the front cutting units (pump section P2) can be measured at manifold port G2.

Reels Disengaged

When the reel engage switch is in the OFF position or the cutting units are in the raised position, solenoid proportional valves (SP1) and (SP2) are not energized. Pump flow causes the pressure to increase, shifting the logic cartridges (LC1) and (LC2). The pump flow is routed through the shifted logic cartridge and out of manifold port T1. Return fluid from the manifold is directed to the oil cooler, return filter, and hydraulic reservoir.

When the reels are disengaged, the inertia load of the spinning reels over run the reel motors, effectively turning the reel motors into hydraulic pumps. Check valves (CV1) and (CV2) in the mow circuit will open to keep the reel motor circuit full of fluid so that the motors will not cavitate (fill with air).

Backlap

During the backlap mode of operation, the reel circuits operate the same as in the MOW mode. When either manual direction valve (MV1) or (MV2) is set to the backlap (R) position, the valve reverses the direction of hydraulic flow through the rear or front reel motors allowing the backlap operation.

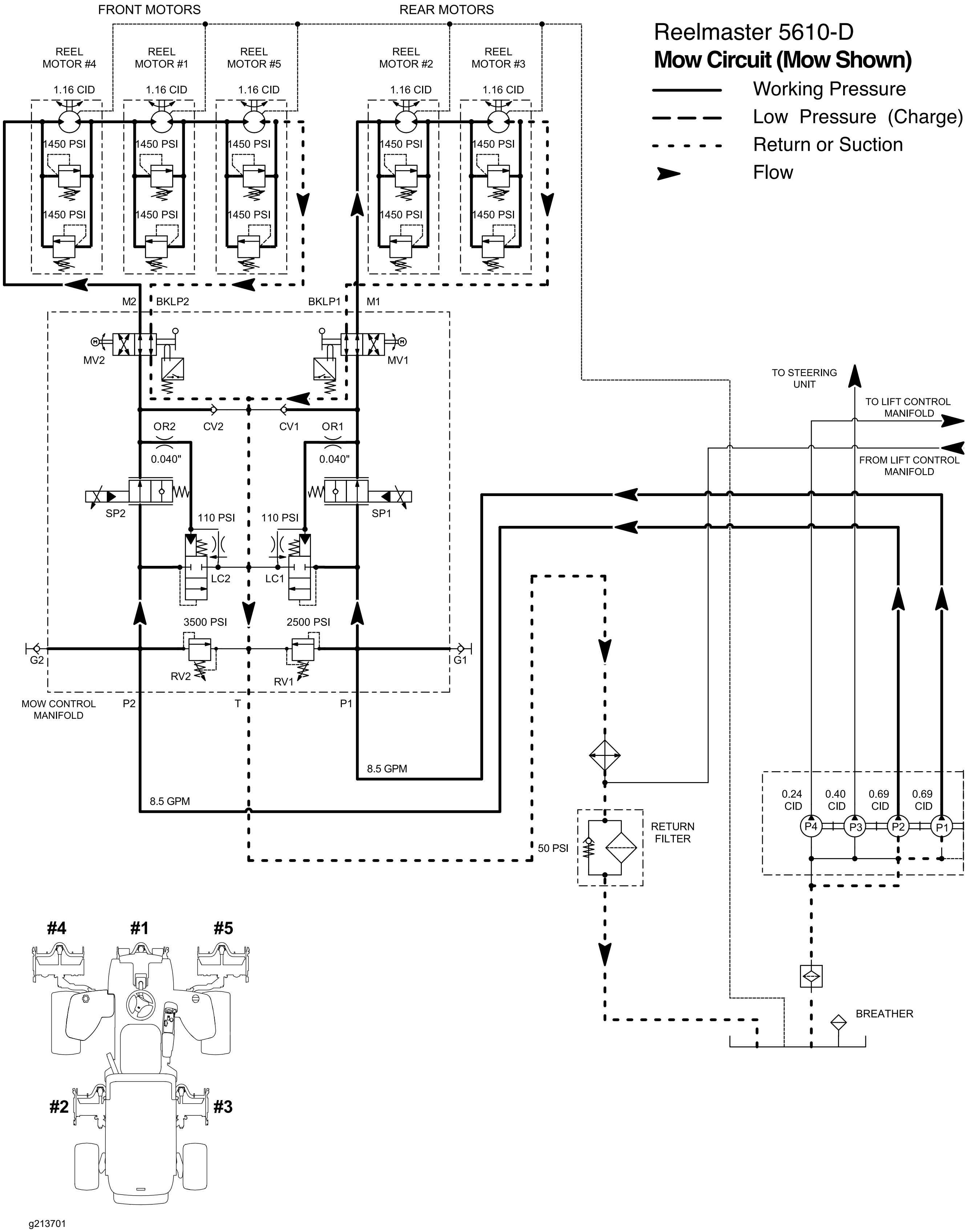

FRONT MOTORS
REAR MOTORS
Reelmaster 5610-D
Mow Circuit (Mow Shown)
Working Pressure
Low Pressure (Charge)
Return or Suction
Flow
REEL MOTOR #4
REEL MOTOR #1
REEL MOTOR #5
REEL MOTOR #2
REEL MOTOR #3
1.16 CID
1450 PSI
M2
BKLP2
BKLP1
M1
MV2
MV1
OR2
CV2
CV1
OR1
0.040"
SP2
SP1
110 PSI
LC2
LC1
3500 PSI
2500 PSI
G2
G1
RV2
RV1
MOW CONTROL MANIFOLD
P2
T
P1
8.5 GPM
TO STEERING UNIT
TO LIFT CONTROL MANIFOLD
FROM LIFT CONTROL MANIFOLD
RETURN FILTER
50 PSI
0.24 CID
0.40 CID
0.69 CID
P4
P3
P2
P1
BREATHER
#4
#1
#5
#2
#3
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Figure 73

Lift Circuit (5610-D)

A 4-section gear pump is coupled to the piston (traction) pump. The gear pump section (P4) supplies hydraulic flow to the lift control manifold and ultimately for the lift cylinders. The gear pump takes its suction from the hydraulic reservoir.

The lift control manifold includes 4 electrically operated solenoid valves. The solenoid relief valve (SVRV) located in the lift control manifold limits the lift circuit pressure to 13,800 kPa (2,000 psi). The valve (SVRV) is used to direct gear pump flow to the lift cylinders when energized or bypass pump flow back to the reservoir when de-energized. The valve (SV2) is used to direct fluid flow to retract the lift cylinders when energized or extend them when de-energized. The valve (SV1) allows hydraulic flow to the front lift cylinders when energized. The valve (SV3) allows hydraulic flow to the rear lift cylinders when energized.

The lift circuit pressure can be monitored at the lift control manifold port G4.

The Toro Electronic Controller (TEC) uses inputs from various machine switches to determine when the lift manifold solenoid valves (SV1, SV2, SV3, and SVRV) are to be energized. The TEC also provides a partial raise position of the front outside cutting units.

During the conditions of not raising or lowering the cutting units (joystick in the neutral (center) position), all 4 lift manifold solenoid valves (SV1, SV2, SV3, and SVRV) are de-energized. The hydraulic flow from the gear pump section (P4) bypasses the lift cylinders to the oil cooler and then to the hydraulic reservoir.

Raise the Cutting Units

When the joystick is moved to the raise position with the engine running, the solenoid valve (SVRV) energizes along with solenoid valves (SV1), (SV2), and (SV3). The energized solenoid valves direct gear pump section P4 fluid flow to the rod end of the lift cylinders. The hydraulic pressure against the rod side of the cylinders causes the shafts to retract, and raises the cutting units. Fixed orifices in the lift control manifold (C1L, C4L, C5L, and C23L) control the lifting speed by providing a restriction for the return flow from the lift cylinders.

When the joystick is returned to the neutral (center) position, the solenoid valves are de-energized and the lift cylinders (and cutting units) are held in the raised position. Piloted check valves in the lift control manifold (C1L, C4L, C5L, and C23L) prevent the lift cylinders (and cutting units) from dropping after they have been raised.

Raise the Cutting Units (continued)

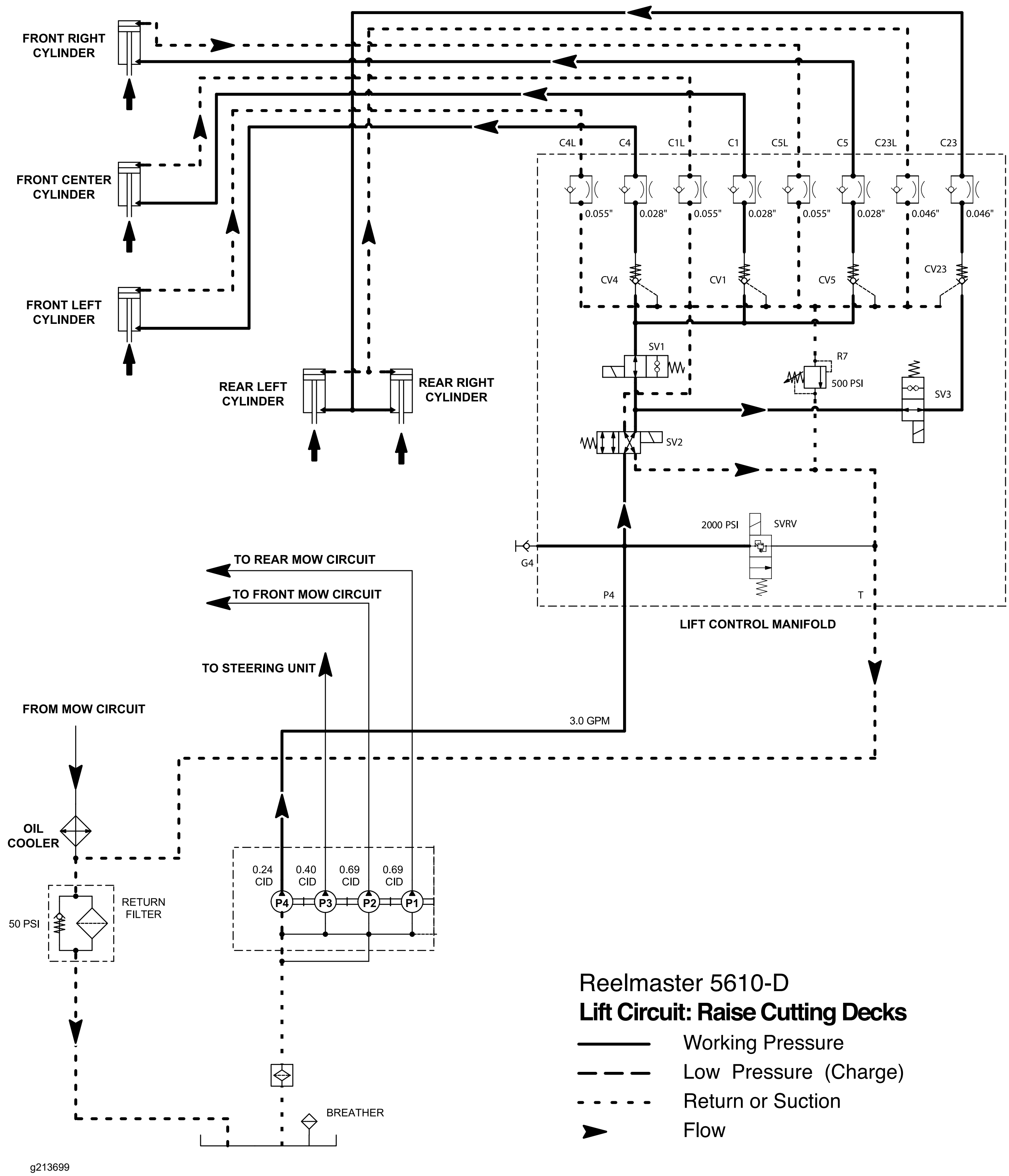

Figure 74

Lower the Cutting Units

When the joystick is moved to the lower position with the engine running, the solenoid valve (SVRV) energizes along with solenoid valves (SV1) and (SV3). The solenoid valve (SV2) is in its normally de-energized position, and directs fluid flow to the piston end of the lift cylinders. The hydraulic pressure against the piston side of the cylinder causes the shafts to extend, and lower the cutting units. The piloted check valves in the lift control manifold are shifted by hydraulic pressure to allow return flow from the extending lift cylinders. Fixed orifices in the lift control manifold (CV1, CV4, CV5, and CV23) control the lowering speed by providing a restriction for the return flow from the lift cylinders.

Because cutting unit weight assists in extending the lift cylinders when lowering the cutting units, less hydraulic pressure is necessary during the cutting unit lowering operation. Lift circuit lower relief valve (R7) allows lift circuit pressure to be limited to 3,447 kPa (500 psi) while lowering the cutting units.

Note: Do not adjust the lift circuit lower relief valve (R7).

When the joystick is returned to the neutral (center) position, the solenoid valves are de-energized and the lift cylinders (and cutting units) are held in the lowered position.

Lower the Cutting Units (continued)

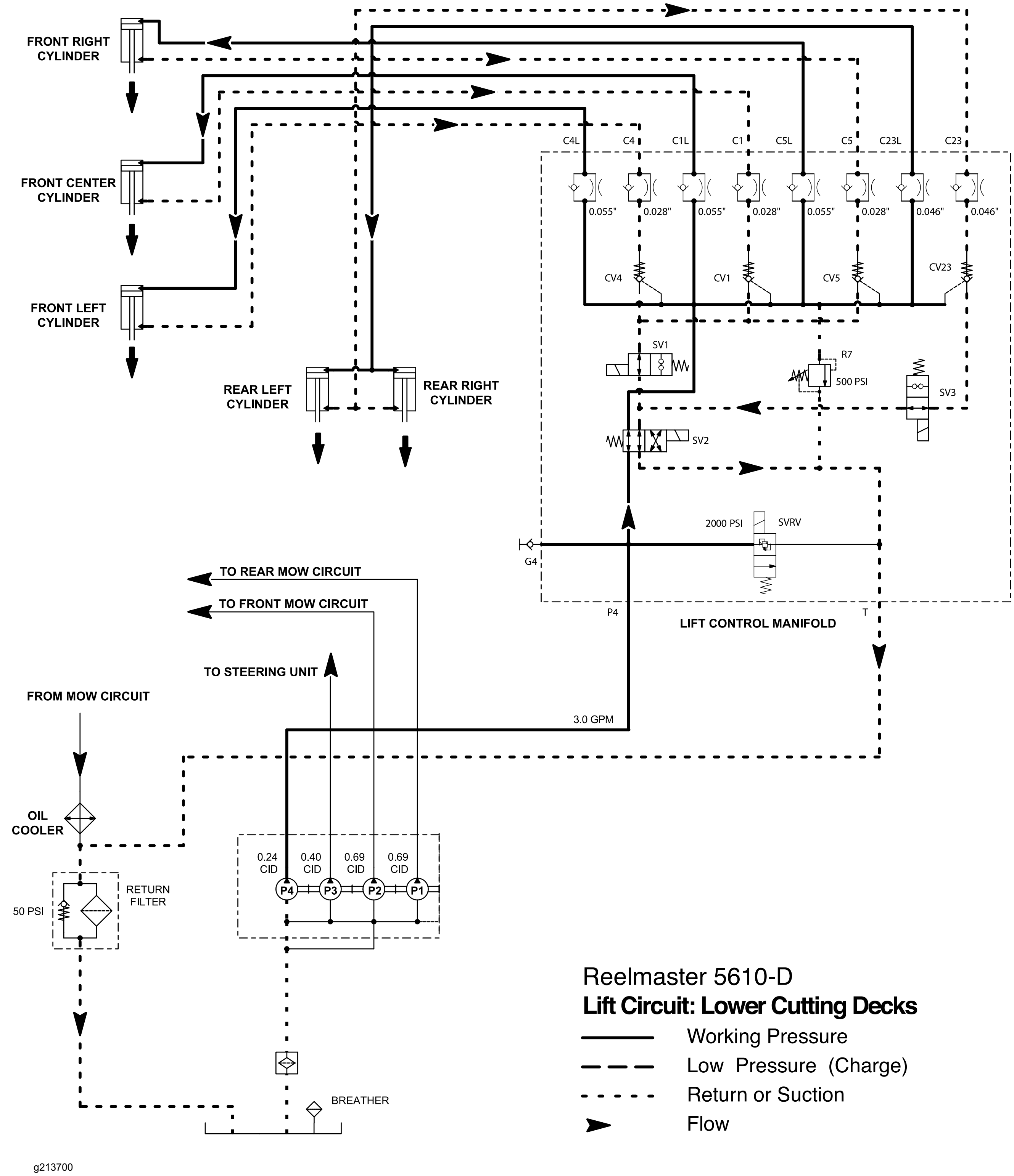

Figure 75

Steering Circuit (5610-D)

A 4-section gear pump is coupled to the piston (traction) pump. The gear pump section P3 supplies hydraulic flow to the steering control valve and for the traction charge circuit. The steering control valve receives the pump supply first, ensuring pressure and volume is always available for steering control, no matter the charge circuit demand. The gear pump takes its suction from the hydraulic reservoir. The steering circuit pressure is limited to 6,990 to 7,500 kPa (1,015 to 1,088 psi) by a relief valve (R10) located in the steering control valve.

With the steering wheel in the neutral position (Figure 76) and the engine running, the hydraulic flow enters the steering control valve at the P port and goes through the steering control spool valve, bypassing the rotary meter (V1) and steering cylinder. The flow leaves the control valve through the T port to the transmission oil filter and traction charge circuit.

Left Turn

When a left turn (Figure 76) is made with the engine running, the turning of the steering wheel, positions the steering control spool valve so that the flow is directed through the bottom of the spool. The flow entering the steering control valve at the P port goes through the spool and is routed to 2 places. First, most of the flow through the valve is bypassed out the T port back to the transmission oil filter and traction charge circuit. Second, the remainder of the flow is directed through the rotary meter (V1) and out through the L port. The pressure retracts the steering cylinder piston for a left turn. The rotary meter ensures that the fluid flow to the steering cylinder is proportional to the amount of turning on the steering wheel. The fluid leaving the steering cylinder flows back through the steering control spool valve and then out of the steering control valve through the T port.

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

Right Turn

When a right turn (Figure 76) is made with the engine running, the turning of the steering wheel, positions the steering control spool valve so that the flow is directed through the top of the spool. The flow entering the steering control valve at the P port goes through the spool and is routed to 2 places. As in a left turn, most of the flow through the valve is bypassed out through the T port back to the transmission oil filter and traction charge circuit. Also like a left turn, the remainder of the flow is directed through rotary meter (V1) but goes out through port R. The pressure extends the steering cylinder piston for a right turn. The rotary meter ensures that the fluid flow to the steering cylinder is proportional to the amount of the turning on the steering wheel. The fluid leaving the steering cylinder flows back through the steering control spool valve then through the T port and to the hydraulic reservoir.

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

Right Turn (continued)

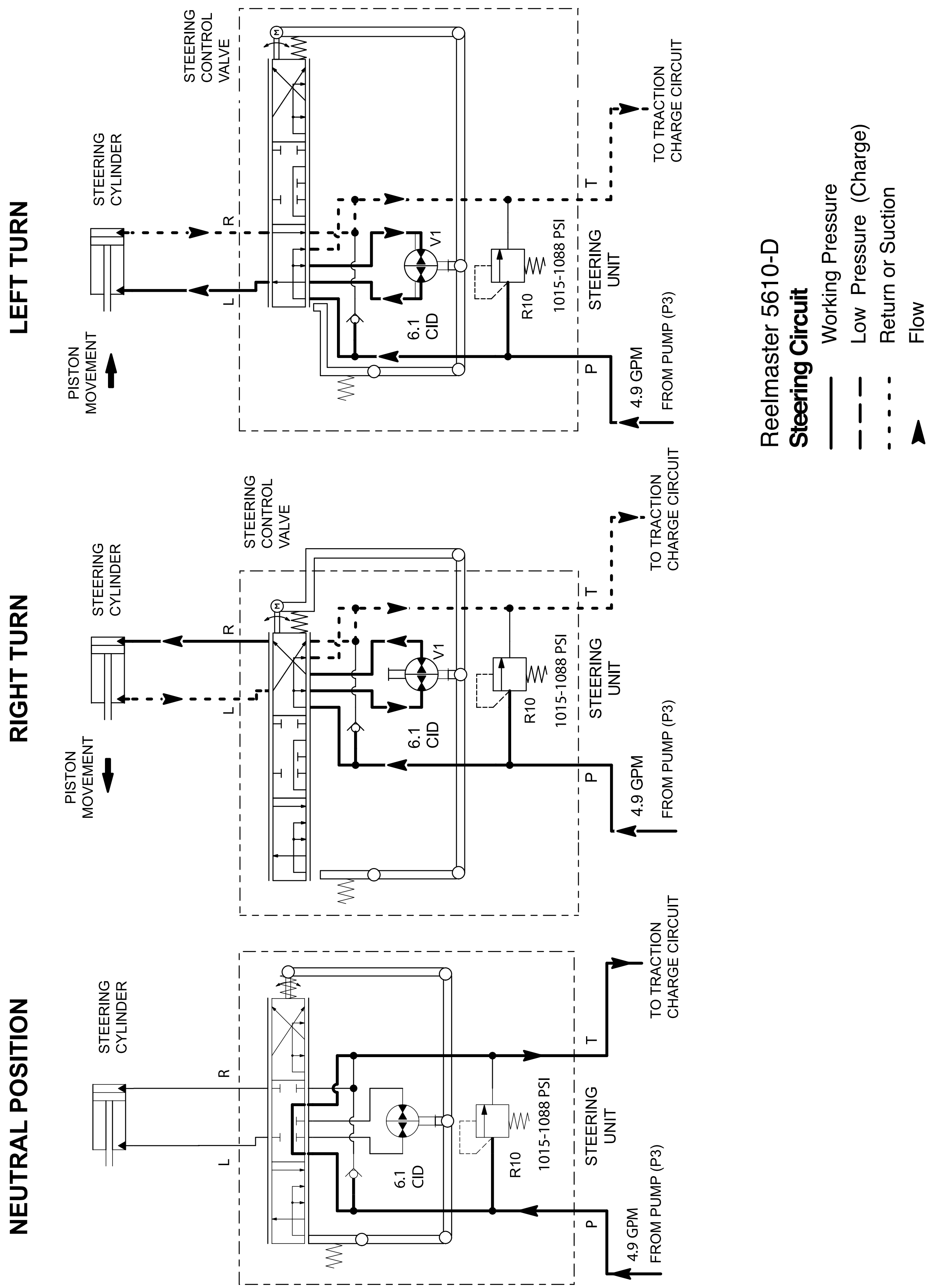

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Figure 76

Special Tools

You can order these special tools from your Toro Distributor. Some tools are also available from a local tool supplier.

Hydraulic Pressure Testing Kit

Toro Part No. TOR47009

Use this kit to take various pressure readings for diagnostic tests. Quick disconnect fittings are provided to attach directly to the mating fittings on the machine test ports without the tools. A high-pressure hose is given for remote readings. Contains 1 each: 6,900 kPa (1,000 psi), 34,500 kPa (5,000 psi), and 69,000 kPa (10,000 psi) gauges; refer to Testing the Hydraulic System (page 6–56).

15 GPM Hydraulic Tester Kit (Pressure and Flow)

Toro Part No. TOR214678

Use this tester to test the hydraulic circuits and components for flow and pressure capacities as recommended in Testing the Hydraulic System (page 6–56). This tester includes the following:

Inlet Hose – This hose connects the system circuit to the inlet side of the hydraulic tester.

Load Valve – Turn the valve to restrict the flow to create a simulated working load in the circuit.

Pressure Gauge – A glycerine filled pressure gauge 0 to 34,500 kPa (0 to 5,000 psi) to provide operating circuit pressure.

Flow Meter – This meter measures the actual fluid flow in the operating circuit with a gauge rated at 5 to 55 L/minute (1 to 15 gallons/minute).

Outlet Hose – A hose from the outlet side of the hydraulic tester that connects to the hydraulic system circuit.

Fittings – An assortment of hydraulic fittings are included with this kit.

40 GPM Hydraulic Tester (Pressure and Flow)

Toro Part No. AT40002

Use this tester to test the hydraulic circuits and components for flow and pressure capacities as recommended in Testing the Hydraulic System (page 6–56). This tester includes the following:

Load Valve – Turn the valve to restrict the flow to create a simulated working load in the circuit.

Pressure Gauge – A glycerine filled pressure gauge 0 to 35,000 kPa (0 to 5,000 psi) to provide operating circuit pressure.

Flow Meter – This meter measures the actual fluid flow in the operating circuit with a gauge rated at 20 to 150 L/minute (4 to 40 gallons/minute).

Note: This tester does not include the hoses; refer to Hydraulic Hose Kit (page 6–45).

Hydraulic Hose Kit

Toro Part No. TOR6007

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

O-Ring Kit

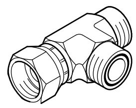
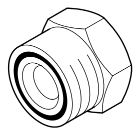
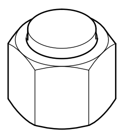
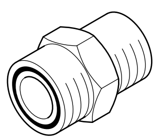
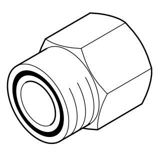
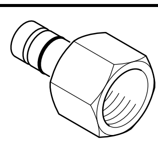
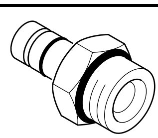
Toro Part No. 117-2727

This kit includes O-rings in a variety of sizes for the face seal and port seal hydraulic connections. To help prevent a hydraulic leak, replace the O-rings when you open the hydraulic connection.

Hydraulic Test Fitting Kit

Toro Part No. TOR4079

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

Fitting Type	Size	Part Number
 Swivel nut run tee (2 each)	4 ORFS (9/16–18)	TOR4079–3
	6 ORFS (11/16–16)	TOR4079–12
	8 ORFS (13–16–16)	TOR4079–4
	10 ORFS (1–14)	TOR4079–5
 Plug (2 each)	4 ORFS (9/16–18)	TOR4079–13
	6 ORFS (11/16–16)	TOR4079–14
	8 ORFS (13–16–16)	TOR4079–15
	10 ORFS (1–14)	TOR4079–16
 Cap (2 each)	4 ORFS (9/16–18)	TOR4079–17
	6 ORFS (11/16–16)	TOR4079–18
	8 ORFS (13–16–16)	TOR4079–19
	10 ORFS (1–14)	TOR4079–20
 Union (1 each)	6 ORFS (11/16–16) to 8 SAE-ORB (3/4–16)	TOR4079–8
	8 ORFS (13–16–16) to 8 SAE-ORB (3/4–16)	TOR4079–9
	10 ORFS (1–14) to 8 SAE-ORB (3/4–16)	TOR4079–2
 Reducer (1 each)	10 ORFS (1–14) to 8 SAE-ORB (3/4–16)	TOR4079–7
	12 ORFS (1 3/16–12) to 8 SAE-ORB (3/4–16)	TOR4079–6
 Test connector–Female thread (2 each)	4 ORFS (9/16–18)	TOR4079–10
	6 ORFS (11/16–16)	TOR4079–11
	8 ORFS (13/16–16)	TOR4079–21
	10 ORFS (1–14)	TOR4079–1
 Test connector–Male thread (2 each)	4 SAE-ORB (7/16–20)	TOR4079–22
	1/8 NPTF	TOR4079–23

High Flow Hydraulic Filter Kit

Toro Part No. TOR6011

The high flow hydraulic filter kit is designed with large flow (150 L/minute or 40 gallons/minute) and high pressure (34,500 kPa or 5,000 psi) capabilities. This kit provides for bi-directional filtration which prevents filtered unwanted material from entering into the circuit regardless of flow direction.

If a component failure occurs in the closed loop traction circuit, contamination from the damaged part will remain in the circuit until you remove it. Install a high flow hydraulic-fluid filter into the circuit when you connect the hydraulic test gauges in order to test the traction circuit components or after you replace a failed traction circuit component (e.g., piston pump or wheel motor). This filter removes contamination from the hydraulic fluid in the traction circuit, thereby preventing additional component damage.

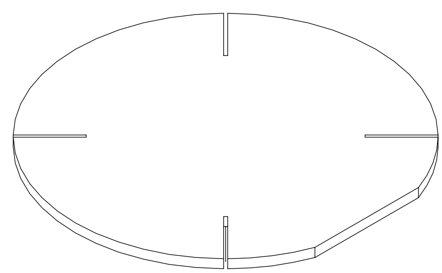
Note: This kit does not include the hoses; refer to Hydraulic Hose Kit (page 6–45).

Note: The replacement filter element is Toro Part No. TOR6012. The filter element cannister tightening torque is **34 N·m (25 ft-lb)**.

Spindle Plug

Toro Part No. 94-2703

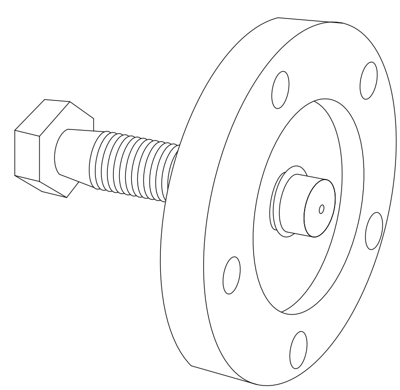
This spindle plug can be used to prevent contaminant entry into the cutting reel spindle assembly when the hydraulic motor is removed from the spindle.



Wheel Hub Puller

Toro Part No. TOR6004

The wheel hub puller allows you to safely remove the wheel hub from the wheel motor shaft.



Measuring Container

Toro Part No. TOR4077

Use this container to test hydraulic motor efficiency (motors with case drain lines only). Limit the outlet flow from the motor and measure the leakage from the case drain line to measure the efficiency of a hydraulic motor while the hydraulic system pressurizes the motor.

The table gives the gallons per minute (gpm) conversion for the measured milliliter or ounce motor case drain leakage.

GPM	mL/15 seconds	oz/15 seconds
0.1	95	3.2
0.2	189	6.4
0.3	284	9.6
0.4	378	12.8
0.5	473	16.0
0.6	568	19.2
0.7	662	22.4
0.8	756	25.6
0.9	852	28.8
1.0	946	32.0

Remote Starter Switch

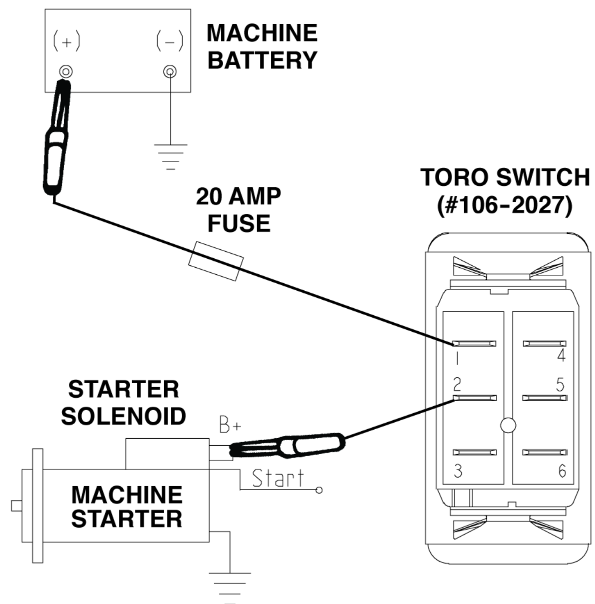
After flushing the hydraulic system or replacing a hydraulic component (e.g., gear pump, piston pump, or wheel motor), it is necessary to prime the hydraulic pumps. A remote starter switch (Figure 77) can be used for priming the hydraulic pumps. You can get this switch locally.

g221230
Figure 77

IMPORTANT

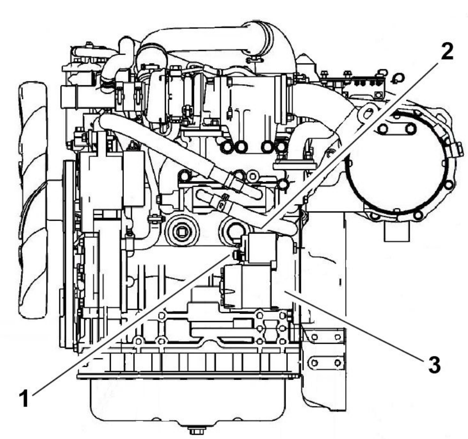
Important: When using a remote starter switch, it is highly recommended to include a 20 A in-line fuse between the battery and switch connector for circuit protection.

A remote stater switch can also be constructed using the Toro switch #106-2027, a length of 14 gauge wire, a 20 A in-line fuse, 2 alligator clips, and necessary connectors. Connecting the wire to switch terminals 1 and 2 will allow the momentary switch contacts to be used for the remote starter switch (Figure 78).



g186163
Figure 78

Note: For information on using the remote starter switch to prime the hydraulic pumps; refer to Priming the Hydraulic Pumps (page 6–146).



g193733
Figure 79

1. B+ terminal
2. Starter solenoid
3. Starter motor

Troubleshooting

The following chart contains suggestions that can be used to solve performance issues specific to the hydraulic system. The suggestions are not all-inclusive. There can be more than 1 cause for a machine malfunction.

Review the hydraulic schematic found in Appendix A (page A–1) and information on the hydraulic system operation in the Hydraulic Flow Diagrams (5410/5410-D/5510/5510-D/5610) (page 6–20) or Hydraulic Flow Diagrams (5610-D) (page 6–32). This information will be useful during the hydraulic troubleshooting process.

Refer to Testing the Hydraulic System (page 6–56) for precautions and specific hydraulic test procedures.

General Hydraulic System Problems

Problem	Possible Causes
The hydraulic fluid is leaking from the system.	• The fitting(s), hose(s), or tube(s) are loose or damaged. • The O-ring(s) or seal(s) are missing or damaged.
The hydraulic fluid foams excessively causing fluid leakage from the hydraulic tank breather. **Note:** Some aeration of the hydraulic fluid on this machine is normal. This aeration (foaming) may be more noticeable after initial filling of hydraulic tank.	• The hydraulic-fluid level in the hydraulic tank is low. • The hydraulic system has a wrong type of fluid. • One of the pump suction lines has an air leak. • Incompatible hydraulic fluids are mixed in the system. • There is water in the hydraulic system.
The hydraulic system operates hot.	• The traction system pressure is high due to load or dragging brakes. • The hydraulic-fluid level in the hydraulic tank is low or the inlet filter is loose or clogged. • The hydraulic fluid is contaminated or the fluid viscosity is too light. • The oil cooler is damaged or plugged. • The oil cooler air flow is obstructed. • The hydraulic-fluid filter is plugged. • The piston (traction) pump bypass valve is open or damaged. • The gear pump relief valve is stuck open. • The check valve in the piston (traction) pump is not seating or is damaged. • The charge pressure is low. • The piston (traction) pump or wheel motor(s) is worn or damaged. • Engine RPM is too low. • The engine fan is not operating properly. **Note:** If 1 traction circuit component has internal wear or damage, it is possible that the other traction components are also damaged.

Traction Circuit Problems

Problem	Possible Causes
The traction response is sluggish.	• The piston (traction) pump bypass valve is open or damaged. • The brake is dragging or binding. • The charge pressure is low. • The hydraulic fluid is very cold. • The piston (traction) pump check valve, relief valve, and/or flushing valve is leaking. • The piston (traction) pump or wheel motor(s) is worn or damaged. • The charge relief valve in the piston (traction) pump is not seating or is damaged. • The check relief valve in the piston (traction) pump is not seating or is damaged. **Note:** The check relief valves for forward and reverse are identical and can be reversed for testing purposes. • The flushing valve in the piston (traction) pump is not seating or is damaged. **Note:** If 1 traction circuit component has internal wear or damage, it is possible that the other traction components are also damaged.
Neutral is difficult to find or unit operates in one direction only.	• The traction control linkage is incorrectly adjusted, disconnected, binding, or damaged. • The check relief valve in the piston (traction) pump is not seating or is damaged. **Note:** The check relief valves for forward and reverse are identical and can be reversed for testing purposes. • The piston (traction) pump is worn or damaged.
No traction exists in either direction and the engine speed remains constant.	• The hydraulic-fluid level in the hydraulic tank is low. • The piston (traction) pump bypass valve is open. • The charge pressure is low. • The parking brake is applied, dragging or binding. • The traction control linkage is incorrectly adjusted, disconnected, binding, or damaged. • The flushing valve in the piston (traction) pump is not seating or is damaged. • The check relief valve in the piston (traction) pump is not seating or is damaged. • The piston (traction) pump or wheel motor(s) is worn or damaged. **Note:** If 1 traction circuit component has internal wear or damage, it is possible that the other traction components are also damaged.

Traction Circuit Problems (continued)

Problem	Possible Causes
The wheel motor does not turn.	• The brakes are binding. • The piston (traction) pump bypass valve is open. • The piston (traction) pump or wheel motor is worn or damaged. **Note:** If 1 traction circuit component has internal wear or damage, it is possible that the other traction components are also damaged.
The wheel motor does not hold load in the NEUTRAL position. **Note:** The machine may not be completely stationary if parked on an incline without the parking brake engaged.	• The charge pressure is low. • The check valves in the piston (traction) pump are damaged. • The valve plate(s) in the piston (traction) pump is worn or damaged. • The wheel motor is worn or damaged. **Note:** If 1 traction circuit component has internal wear or damage, it is possible that the other traction components are also damaged.
A single-wheel motor turns while unloaded, but slows down or stops when the load is applied.	• The piston (traction) pump bypass valve is open or leaking. • The wheel motor is worn or damaged. **Note:** If 1 traction circuit component has internal wear or damage, it is possible that the other traction components are also damaged.

Mow Circuit Problems

Problem	Possible Causes
All the 3 front cutting reel motors do not operate but rear cutting reel motors operate.	• The solenoid valve MSV2/SP2 on the mow control manifold is damaged. **Note:** The solenoid valves MSV1/SP1 and MSV2/SP2 are identical and can be reversed for testing purposes. • The mow/backlap lever for the front cutting units (MR2/MV2) is not rotated fully. • An electrical problem exists that prevents MSV2/SP2 solenoid coil on the mow control manifold from being energized (refer to Troubleshooting (page 7–26) or the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1)). • The front cutting reel(s) is (are) binding. • The gear pump section (P2) is worn or damaged.
Both rear cutting reel motors do not operate but front cutting reel motors operate.	• The solenoid valve MSV1/SP1 on the mow control manifold is damaged. **Note:** The solenoid valves MSV1/SP1 and MSV2/SP2 are identical and can be reversed for testing purposes. • The mow/backlap lever for the rear cutting units (MR1/MV1) is not rotated fully. • An electrical problem exists that prevents MSV1/SP1 solenoid coil on the mow control manifold from being energized (refer to Troubleshooting (page 7–26) or the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1)). • The rear cutting reel(s) is (are) binding. • The gear pump section (P1) is worn or damaged.
A single cutting reel motor does not operate, rotates slowly, or stops under load.	• The relief valve in the mow control manifold is bypassing. • Traction speed and cutting conditions (e.g., very tall or wet grass) exceed cutting unit capacity. • The cross-over relief valve in the cutting reel motor is stuck or damaged. (Reelmaster 5510/5510-D/5610/5610-D machines) • The cutting reel motor is worn or damaged. • The cutting reel motor has internal leakage (bypassing fluid). • The gear pump section (P2 or P3) is worn or damaged. **Note:** If appropriate, transfer a suspected damaged motor to another cutting reel. If problem follows the motor, motor needs to be repair or replacement.

Lift/Lower Circuit Problems

Problem	Possible Causes
One cutting reel raises slowly or not at all.	• The cutting reel has excessive unwanted elements. • The lift arm or lift cylinder is binding. • The pilot piston in the lift control manifold is stuck or damaged. • The flow control orifice in lift control manifold for the affected cutting reel is plugged, stuck, or damaged. • The lift cylinder leaks internally.
One or more cutting unit raises, but does not stay up. **Note:** The lift cylinders and control manifold cartridge valves cannot provide an absolutely perfect seal. The cutting units will eventually lower if left in the raised position. At minimum, the cutting units should remain in the raised transport position long enough to safely move from one fairway to the next.	• The lift circuit hydraulic lines or fittings are leaking. • Air exists in the lift circuit. • The lift cylinder for the affected cutting reel(s) leaks internally. • The check valve in the lift control manifold (CV1, CV4, CV5, and CV23) and solenoid valve (SV1 and SV3) leaks. • The pilot piston in the lift control manifold is stuck or damaged.
None of the cutting units will raise or lower. **Note:** The operator must be in the seat or the parking brake engaged and mow speed limiter must be in mow speed position in order to lower the cutting units.	• The fluid level in the hydraulic reservoir is low (other hydraulic systems are affected as well). • MR1/MV1 and/or MR2/MV2 in lift control manifold are in the backlap position. **Note:** Operator advisory should be displayed on InfoCenter Display. • An electrical problem exists that prevents SVRV solenoid coil on the lift control manifold from being energized (refer to Troubleshooting (page 7–26) or the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1)). • The solenoid valve SVRV in the lift control manifold is damaged. • The gear pump section (P4) is worn or damaged.
None of the front cutting units will raise or lower but the rear cutting units will raise and lower.	• The solenoid valve SV1 on the lift control manifold is damaged. • An electrical problem exists that prevents SV1 solenoid coil on the lift control manifold from being energized (refer to Troubleshooting (page 7–26) or the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1)).

Lift/Lower Circuit Problems (continued)

Problem	Possible Causes
Neither of the rear cutting units will raise or lower but the front cutting units will raise and lower.	• The solenoid valve SV3 on the lift control manifold is damaged. • An electrical problem exists that prevents SV3 solenoid coil on the lift control manifold from being energized (refer to Troubleshooting (page 7–26) or the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1)). • The flow control orifice in the lift control manifold for the rear cutting units (C23 or C23L) is plugged, stuck, or damaged. • The check valve in the lift control manifold for the rear cutting units (CV23) is stuck or damaged.
One cutting reel lowers very slowly or not at all.	• The lift arm or lift cylinder for the affected cutting reel is binding. • The lift cylinder for the affected cutting reel is damaged. • The flow control orifice in the lift control manifold for the affected cutting reel is plugged, stuck, or damaged. • The check valve in the lift control manifold (CV1, CV4, CV5, and CV23) is stuck or damaged.

Steering Circuit Problems

Problem	Possible Causes
The steering is inoperative or sluggish.	• The steering components (e.g., tie rods, steering cylinder ends) are worn or binding. • The steering cylinder is binding. • The fluid level in the hydraulic reservoir is low (other hydraulic systems are affected as well). • The steering relief valve (R10) in the steering control valve is stuck or damaged. • The steering cylinder leaks internally. • The steering control valve is worn or damaged. • The gear pump section (P3) is worn or damaged. **Note:** A worn or damaged gear pump section (P3) will also affect the traction (charge) circuit.
Turning the steering wheel turns the machine in wrong direction.	• Hoses to the steering cylinder are reversed.

Testing the Hydraulic System

The most effective procedure to isolate the problems in the hydraulic system is to use hydraulic test equipment, such as pressure gauges and flow meters in the circuits during different operational checks; refer to Special Tools (page 6–44).

WARNING

Opening the hydraulic system without releasing pressure from the system will cause the hydraulic fluid to escape, causing possible injury.

Before you disconnect the hydraulic components or work on the hydraulic system, release the pressure in the system; refer to Releasing Pressure from the Hydraulic System (page 6–8).

WARNING

Hydraulic fluid escaping under pressure can penetrate skin and cause injury.

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

CAUTION

Failing to use gauges having the recommended pressure (kPa/psi) rating could damage the gauge and cause personal injury from contact with hot, leaking hydraulic fluid.

Use gauges with the recommended pressure rating as listed in the test procedures.

IMPORTANT

Before performing the hydraulic tests, check all obvious areas, such as fluid supply, filter, binding linkages, loose fasteners, or improper adjustments before you assume that a hydraulic component is the source of the problem.

IMPORTANT

Use 2 people to perform all the tests, with 1 person in the seat and the other to read and record the test results.

1. Clean the machine fully before you disconnect or disassemble the hydraulic components.

   Note: Cleanliness is required whenever you work on the hydraulic equipment. Contamination causes too much wear on hydraulic components.

2. When you perform tests on the hydraulic system, wear eye protection.
3. Before you perform a test, check the traction control lever linkages for improper adjustment, binding, or broken parts.
4. Perform all the hydraulic tests with the hydraulic fluid at normal operating temperature.
5. Install clean metal caps or plugs on the hydraulic lines that are left open or exposed during the testing or component removal.
6. When you use a hydraulic tester (pressure and flow), ensure that the inlet and outlet hoses are properly connected and not reversed to prevent damaging the hydraulic tester or components. Fully open the tester load valve before you start the engine to reduce the possibility of damaging the components.
7. Install the hydraulic fittings by hand and ensure that they are not cross-threaded before you tighten them with a wrench.
8. Position the tester hoses to prevent the rotating machine parts from contacting and damaging the hoses or tester.
9. After you connect the test equipment, check the hydraulic-fluid level in the hydraulic tank and ensure that the tank has the correct fluid level.
10. When you use a hydraulic tester (pressure and flow), open the tester load valve fully before you start the engine to reduce the possibility of damaging the components.
11. Ensure that the engine is in good operating condition before performing any hydraulic test.

    Note: Use the InfoCenter to check the engine speed when you perform a hydraulic test. The engine speed can affect the accuracy of the tester readings.

12. If there is a traction circuit problem, perform 1 or more of the following tests: traction circuit relief valve (R3) and (R4) pressure, traction circuit charge pressure, gear pump (P3) flow, front wheel motor efficiency and/or piston (traction) pump flow tests.
13. If there is a lift circuit problem, perform 1 or more of the following tests: lift relief valve (SVRV) pressure, gear pump (P4) flow and/or lift cylinder internal leakage tests.
14. If there is a cutting (mow) circuit problem, perform 1 or more of the following tests: relief valve (R1) or (RV1) and (R2) or (RV2) pressure, gear pump (P1) and (P2) flow and/or cutting reel motor efficiency tests. The cutting reel motors used on the Reelmaster 5510/5510-D/5610/5610-D include a cross over relief valve that can also be tested.
15. If there is a steering circuit problem, perform 1 or more of the following tests: steering relief valve (R10) pressure, steering cylinder internal leakage and/or gear pump (P3) flow tests.

16. After hydraulic test procedures have been completed, check the hydraulic-fluid level in the hydraulic tank to ensure that the hydraulic-fluid level is correct.

Traction Circuit Relief Valve (R3) and (R4) Pressure Test (5410/5410-G/5410-D/5510/5510-G/5510-D/5610)

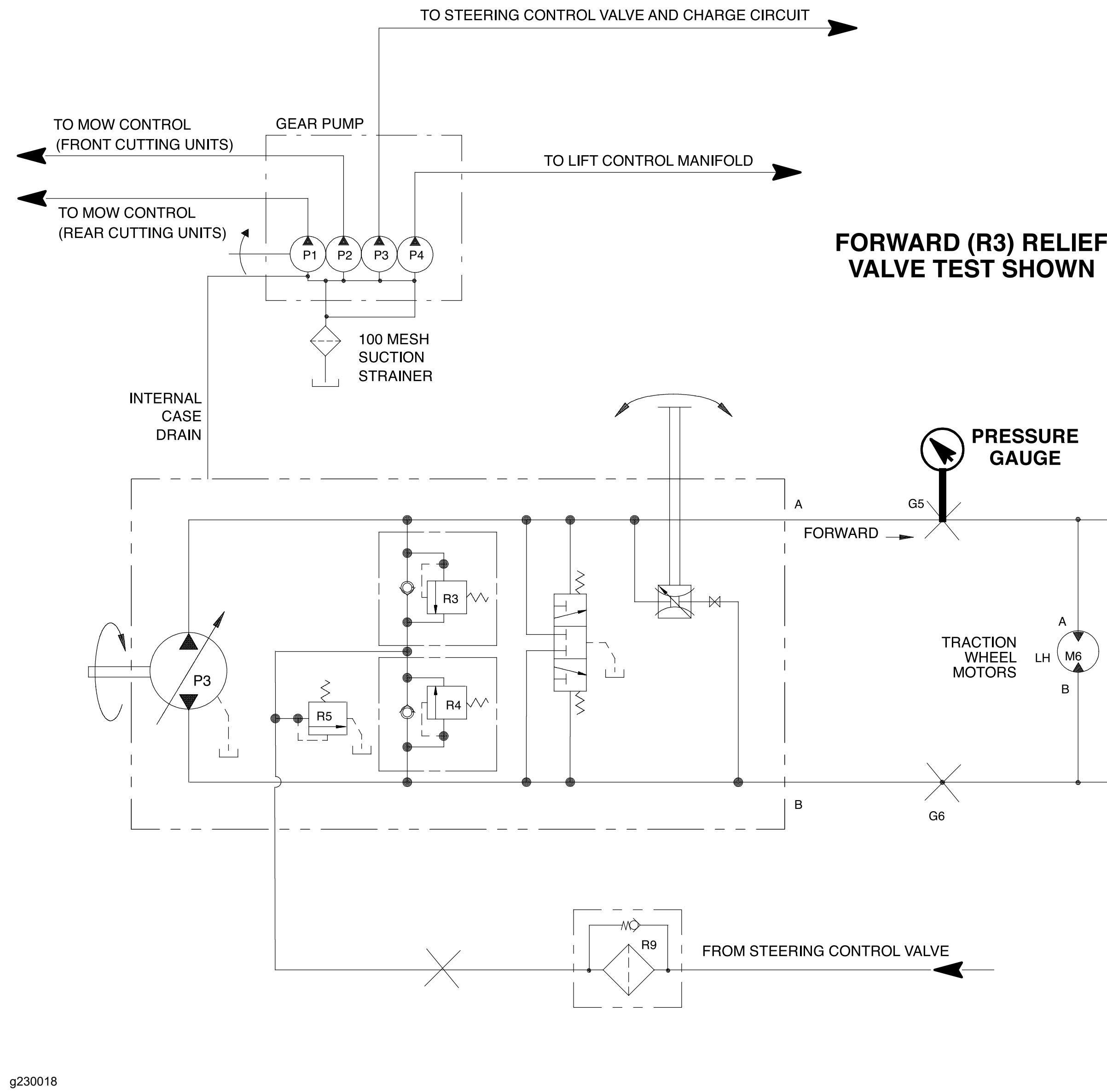


Figure 80

The traction circuit relief pressure test should be performed to ensure that the forward and reverse traction circuit relief pressures are correct.

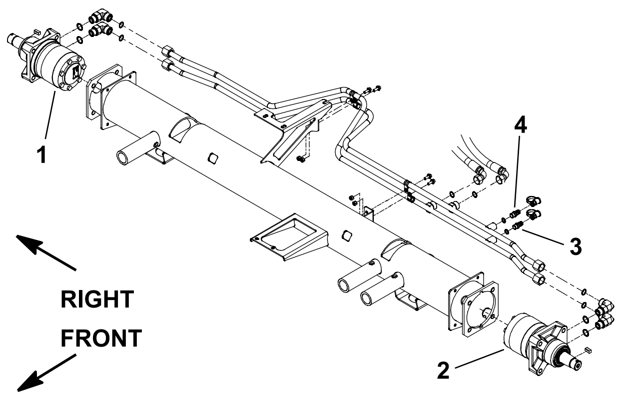
Test Procedure

1. Drive machine to an open area. Park machine on a level surface with the cutting units lowered and disengaged. Ensure that the engine is shut off. Apply the parking brake.
2. Read all Warning, Cautions, and precautions listed at the beginning of this section.

CAUTION

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).

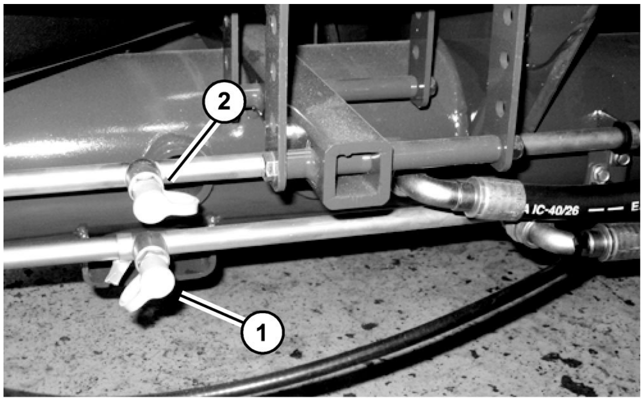
Note: If machine is equipped with optional CrossTrax AWD, reverse relief pressure test ports are located on CrossTrax hydraulic manifold.



g230033

Figure 81
2-wheel drive machine

1. Right wheel motor
2. Left wheel motor
3. Forward test port
4. Reverse test port



g230034

Figure 82
2-wheel drive machine

1. Forward test port
2. Reverse test port

3. Clean traction circuit test port on hydraulic tube for direction to be checked (Figure 81). Connect a 35,000 kPa (5,000 psi) pressure gauge to test port.
4. After installing pressure gauge, start engine and run at low idle speed. Check for any hydraulic leakage from test connections and correct before proceeding with test.

Test Procedure (continued)

5. Ensure that the hydraulic fluid is at normal operating temperature by operating the machine under load for approximately 10 minutes.
6. Sit on seat and increase engine speed to high idle speed.
7. Apply brakes and slowly press the traction pedal in the direction to be tested (forward or reverse). While pushing traction pedal down, carefully watch the pressure gauge needle. As the traction relief valve lifts, the gauge needle will momentarily stop. Traction system pressure as the relief valve opens should be approximately **25,000 kPa (3,625 psi)** in both forward (R3) and reverse (R4).

   Note: If traction pedal continues to be pressed after the relief valve has opened, system pressure may increase higher than relief pressure.
8. When relief pressure has been identified, release traction pedal, shut off the engine, and record test results.

   Note: Forward (R3) and reverse (R4) relief valves are identical. Relief valves can be switched in piston (traction) pump to help in identifying a damaged relief valve.

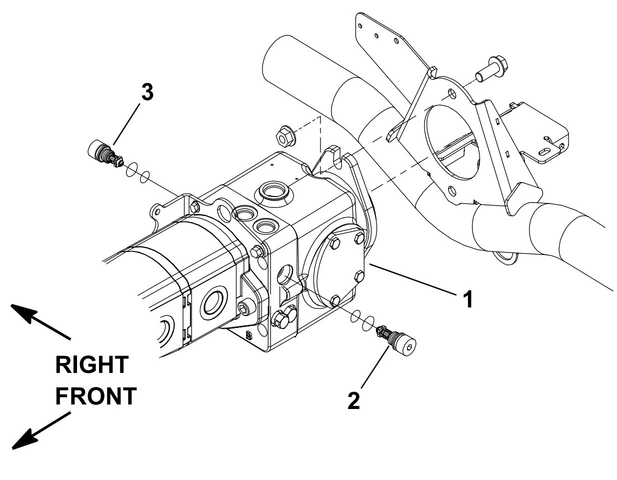


Figure 83

1. Piston (traction) pump
2. Reverse relief valve (R4)
3. Forward relief valve (R3)

9. If traction pressure problem occurs in 1 direction only, interchange the relief valves in the piston (traction) pump (Figure 83) to see if the problem changes to the other direction. Clean or replace valves as necessary. These cartridge type valves are factory set, and are not adjustable. If traction relief pressure is low and relief valves are in good condition, piston (traction) pump, and/or wheel motors should be suspected of wear and inefficiency.
10. After testing is completed, ensure that the engine is shut off and then relieve hydraulic system pressure; refer to Releasing Pressure from the Hydraulic System (page 6–8). Remove pressure gauge from machine and install dust cap to test port.

Traction Circuit Charge Pressure Test (5410/5410-G/5410-D/5510/5510-G/5510-D/5610)

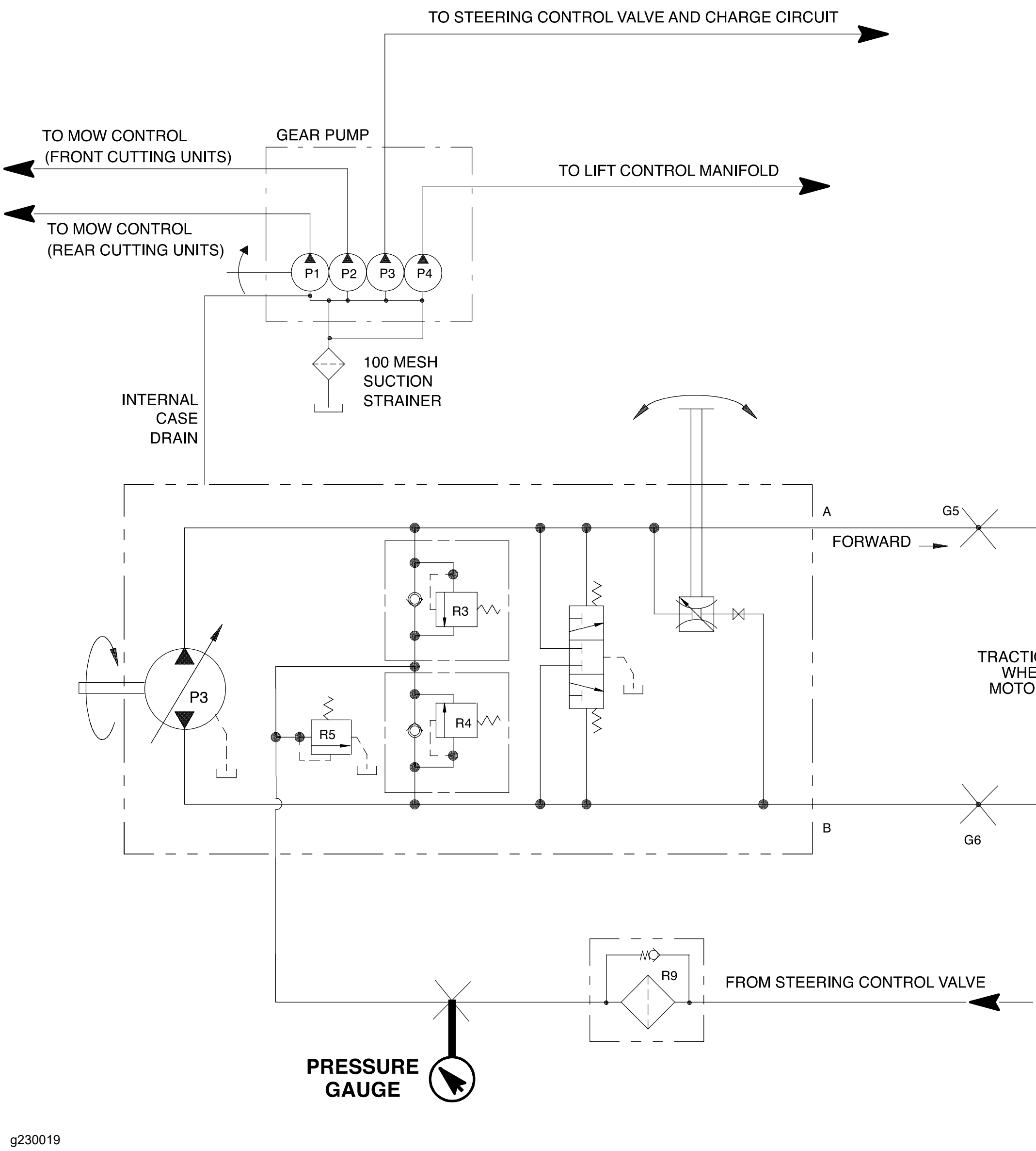


Figure 84

The traction circuit charge pressure test should be performed to ensure that the traction charge circuit is functioning correctly.

Test Procedure

1. Park machine on a level surface with the cutting units lowered and disengaged. Ensure that the engine is shut off. Apply the parking brake.
2. Read all Warning, Cautions, and precautions listed at the beginning of this section.
3. Raise and support operator seat to allow access to hydraulic pump assembly.

Test Procedure (continued)

CAUTION

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).

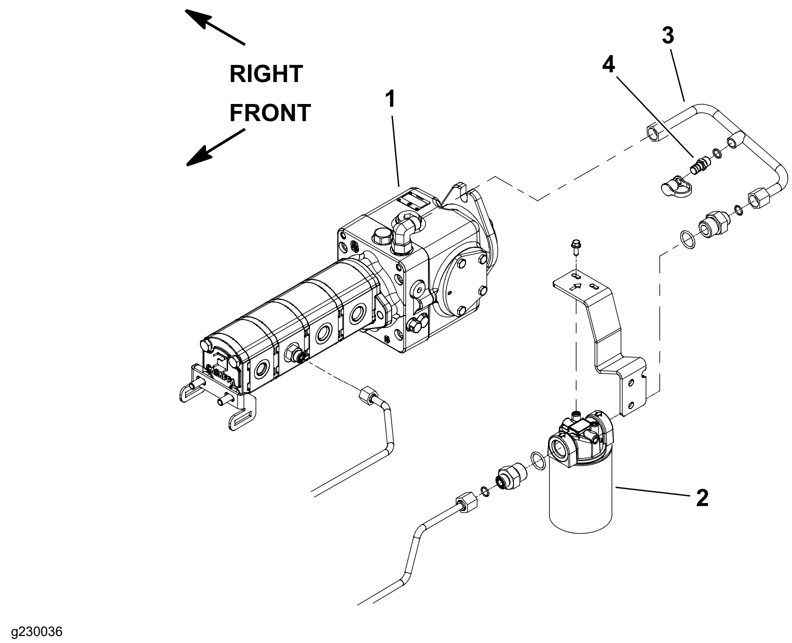


Figure 85

1. Piston (traction) pump
2. Oil filter/filter adapter
3. Hydraulic tube
4. Test port

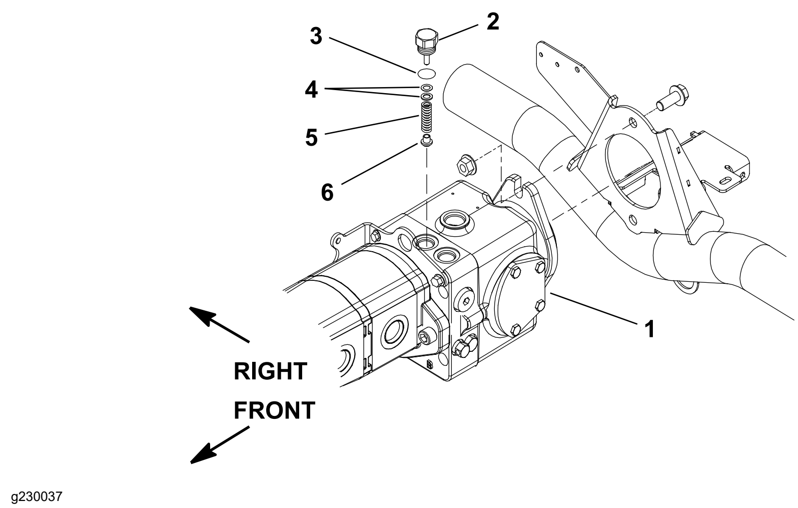


Figure 86

1. Piston (traction) pump
2. Plug
3. O-ring
4. Shim kit
5. Spring
6. Charge relief poppet

4. Clean test port on hydraulic tube between piston (traction) pump and oil filter (Figure 85). Connect a 6,900 kPa (1,000 psi) pressure gauge to test port.

Test Procedure (continued)

5. Start engine and run at idle speed. Check for any hydraulic leakage from test connections and correct before proceeding with test.
6. Ensure that the hydraulic fluid is at normal operating temperature by operating the machine under load for approximately 10 minutes.
7. Ensure that the traction pedal is in neutral, the steering wheel is stationary and parking brake is engaged.
8. Increase engine speed to high idle speed and monitor pressure gauge to determine no load traction circuit charge pressure. Record test results.

   Gauge reading to be approximately **1,400 kPa to 1,750 kPa (200 to 250 psi)**

9. Next, determine charge pressure under traction load by operating the machine in a direct forward and reverse direction (not steering). Release parking brake and ensure that the engine is running at high idle speed. Apply the brakes and press the traction pedal in the forward direction and then to reverse while monitoring the pressure gauge. shut off the engine and record test results.

   Gauge reading to be approximately **1,034 kPa to 1,750 kPa (150 to 250 psi)**

10. Compare measured charge pressure from step 8 with pressure from step 9:

    A. If charge pressure is good under no load (step 8), but drops below specification when under traction load (step 9), the piston (traction) pump should be suspected of wear and inefficiency. When the piston pump is worn or damaged, the charge system is not able to replenish lost traction circuit oil due to excessive leakage in the worn pump.

    B. If there is no charge pressure, or pressure is low, check for restriction in gear pump intake line. Inspect charge relief valve and valve seat in the piston (traction) pump; refer to Servicing the Piston (Traction) Pump (page 6–167). Also, consider a worn or damaged gear pump section (P3); refer to Gear Pump (P3) Flow Test (Using Tester with Flow Meter and Pressure Gauge) (5410/5410-G/5410-D/5510/5510-G/5510-D/5610) (page 6–65).

       Note: If gear pump (P3) is worn or damaged, both charge circuit and steering circuit will be affected.

11. After charge pressure testing is completed, ensure that the engine is not running and then relieve hydraulic system pressure; refer to Releasing Pressure from the Hydraulic System (page 6–8). Remove pressure gauge from test port and install dust cap to test port.
12. Lower and secure operator seat.

Gear Pump (P3) Flow Test (Using Tester with Flow Meter and Pressure Gauge) (5410/5410-G/5410-D/5510/5510-G/5510-D/5610)

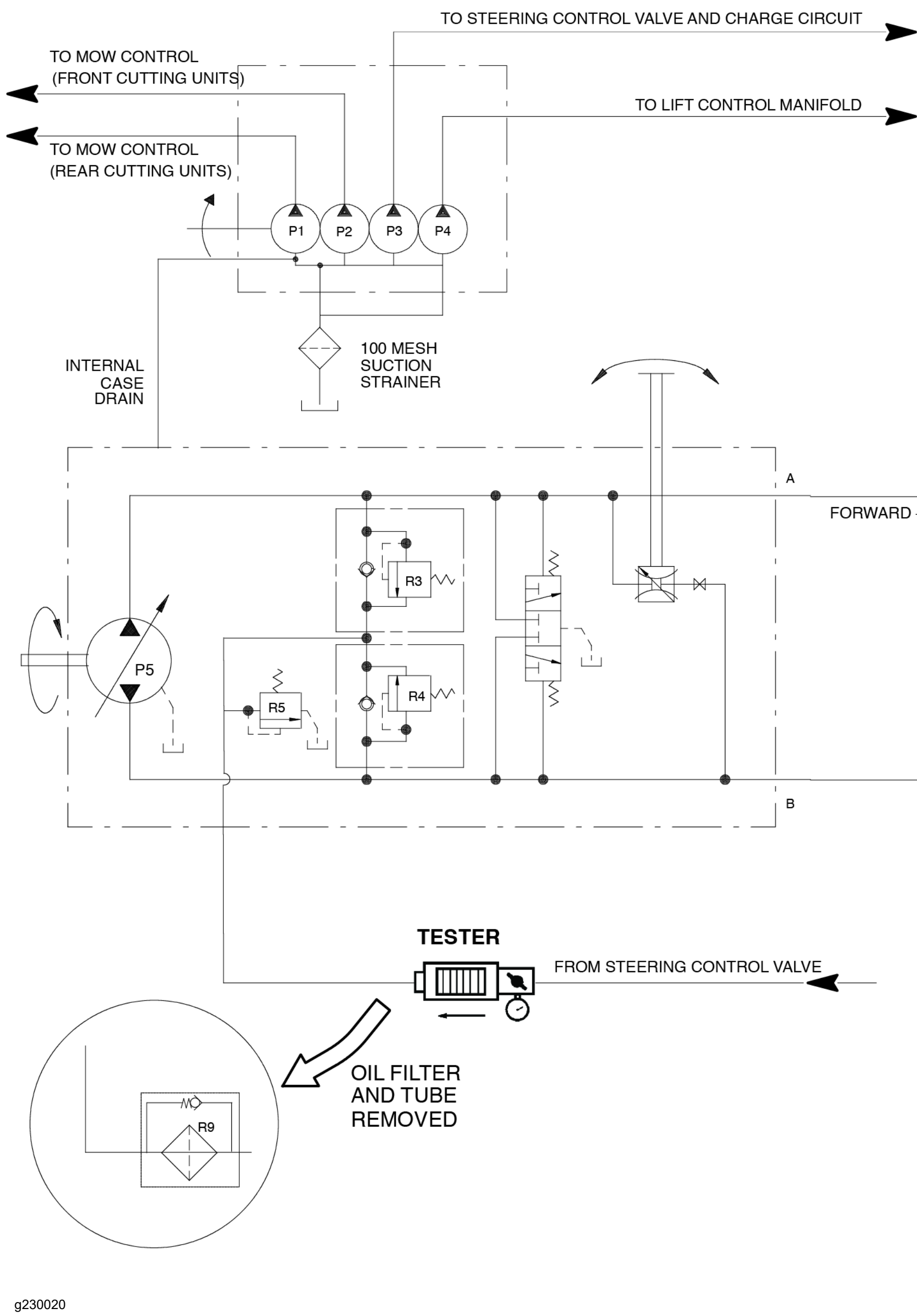


Figure 87

The gear pump (P3) flow test should be performed to ensure that the traction charge circuit and steering circuit have adequate hydraulic flow.

Test Procedure

1. Park machine on a level surface with the cutting units lowered and disengaged. Ensure that the engine is shut off. Apply the parking brake.
2. Read all Warning, Cautions, and precautions listed at the beginning of this section.

Test Procedure (continued)

CAUTION

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).

3. Raise and prop operator seat to allow access to hydraulic pump assembly.

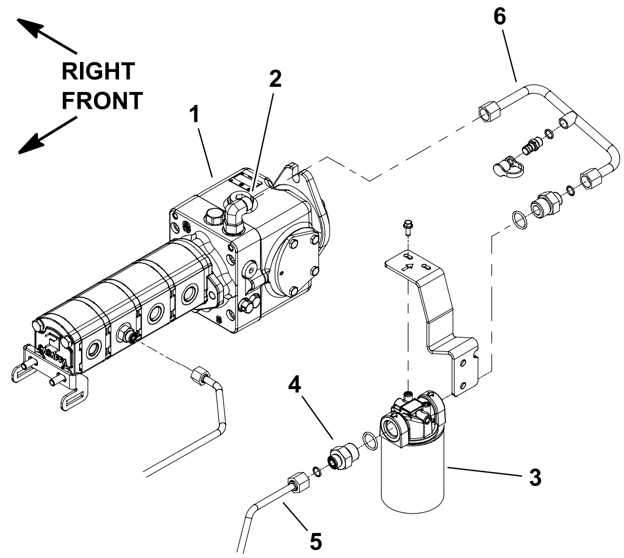


Figure 88

1. Piston (traction) pump	3. Oil filter/filter adapter	5. Hydraulic tube
2. Piston pump inlet fitting	4. Filter inlet fitting	6. Hydraulic tube

4. Clean the ends of the hydraulic tubes connected to the piston pump and oil filter inlets (Figure 88). Disconnect hydraulic tubes from piston pump and oil filter inlet fittings. Remove 2 flange-head screws that secure oil filter adapter to frame. Remove oil filter assembly with hydraulic tube from machine.

IMPORTANT

Ensure that the fluid flow indicator arrow on the flow meter is showing that the fluid will flow from the hydraulic tube, through the tester and into the piston (traction) pump.

5. Install tester with pressure gauge and flow meter in place of the removed oil filter assembly and hydraulic tube (Figure 88). Connect tester inlet hose to the hydraulic tube. Connect the tester outlet hose to the piston (traction) pump inlet fitting. Ensure that the flow control valve on tester is fully open.
6. Ensure that the traction pedal is in neutral, the steering wheel is stationary, and the parking brake is engaged.
7. Start engine and run at idle speed. Check for any hydraulic leakage from test connections and correct before proceeding with test.
8. Ensure that the hydraulic fluid is at normal operating temperature by operating the machine under load for approximately 10 minutes.

Test Procedure (continued)

9. Increase engine speed to high idle speed **(3,000 rpm)**. Use InfoCenter Display or phototac to verify that engine speed is correct.

   Note: The gear pump is a positive displacement type. If pump flow is completely restricted or shut off, damage to the pump, tester, or other components could occur.

10. While watching tester pressure gauge, slowly close the tester flow control valve until **5,500 kPa (800 psi)** is obtained on gauge. Ensure that the engine speed remains at 3,000 rpm.

    Note: If engine speed is not 3,000 rpm during this test, pump flow will be different than listed GPM/LPM.

11. Identify gear pump (P3) flow on tester:

    Flow tester reading to be: A pump (P3) in good condition should have a flow of approximately **17.4 L/minute (4.6 gallons/minute) at 5,500 kPa (800 psi)**.

12. Open the tester flow control valve, shut off the engine, and record test results.

13. If flow is less than **20 L/minute (4 gallons/minute)** or a pressure of **5,500 kPa (800 psi)** cannot be obtained, consider that a gear pump problem exists. Check for restriction in pump intake line. If pump intake is not restricted, remove gear pump and repair or replace pump as necessary; refer to Hydraulic Pump Assembly (page 6–163) and Servicing the Gear Pump (page 6–169).

    Note: If the flow from gear pump (P3) is low, the operation of both the charge circuit and the steering circuit will be affected.

14. .After testing is completed, ensure that the engine is shut off, then relieve hydraulic system pressure; refer to Releasing Pressure from the Hydraulic System (page 6–8). Remove hydraulic tester from hydraulic tube and pump fitting. Install oil filter assembly and then connect removed hydraulic tube to oil filter and piston pump fitting.

15. Lower and secure operator seat.

Front Wheel Motor Efficiency Test (5410/5410-G/5410-D/5510/5510-G/5510-D/5610)

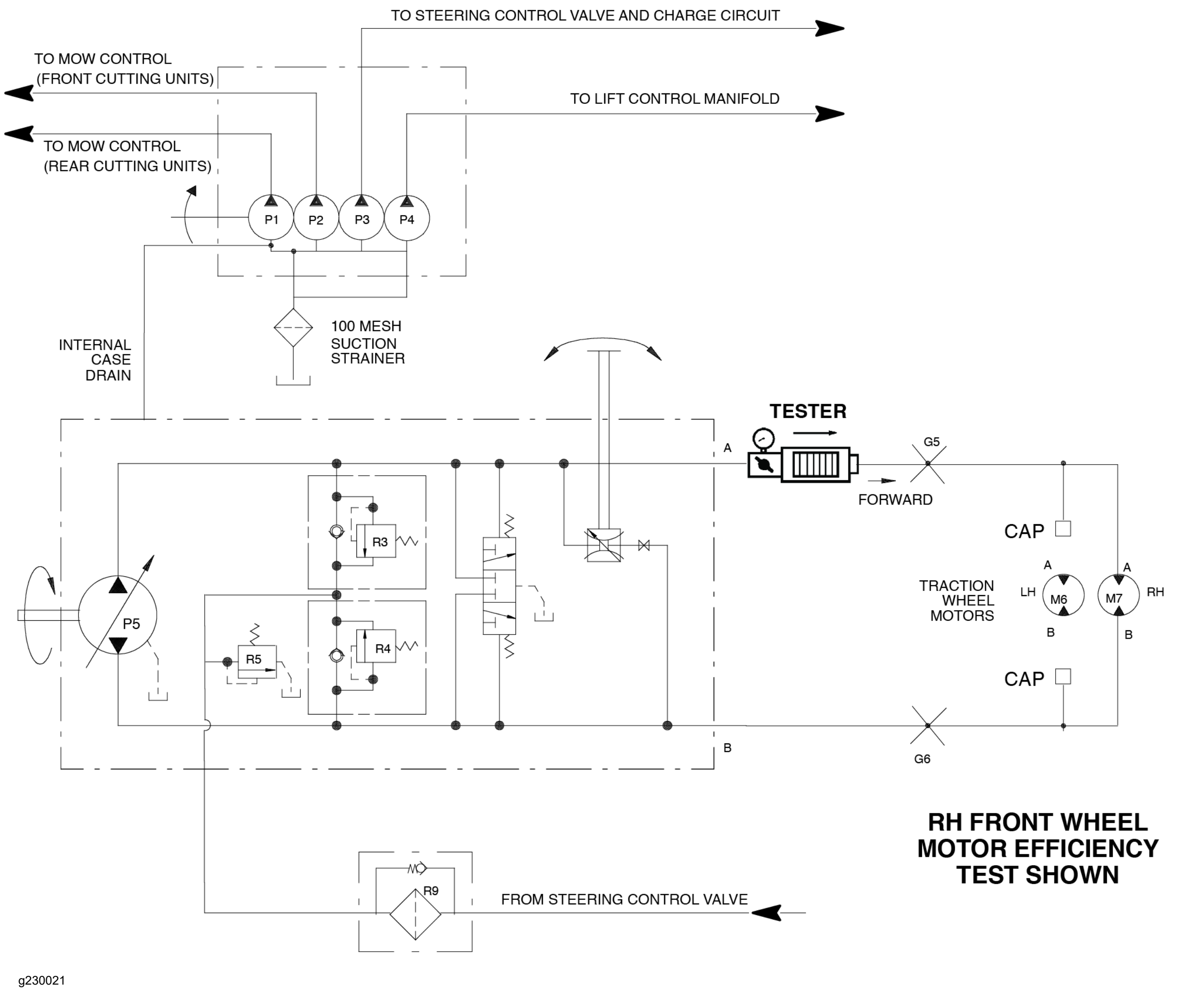


Figure 89

Test Procedure

Note: Over a period of time, a wheel motor can wear internally. A worn motor may by-pass fluid causing the motor to be less efficient. Eventually, enough fluid 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.

IMPORTANT

Refer to Traction Circuit Component Failure (page 6–9) for information regarding the importance of removing contamination from the traction circuit.

Test Procedure (continued)

Note: This test procedure includes steps to test efficiency of both front wheel motors together before testing individual wheel motors.

1. Ensure that the traction pedal is adjusted to the neutral position; refer to the *Traction Unit Operator's Manual*.
2. Drive machine to an open area. Park machine on a level surface with the cutting units lowered and disengaged. Ensure that the engine is shut off.
3. Read all Warning, Cautions, and precautions listed at the beginning of this section.

CAUTION

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).

4. Attach a heavy chain to the rear of the machine frame and an immovable object to prevent the machine from moving during testing.
5. Chock front wheels to prevent wheel rotation.

   Note: If machine is equipped with CrossTrax AWD, jack up and support the rear wheels off the ground to allow flow through the rear wheel motors.

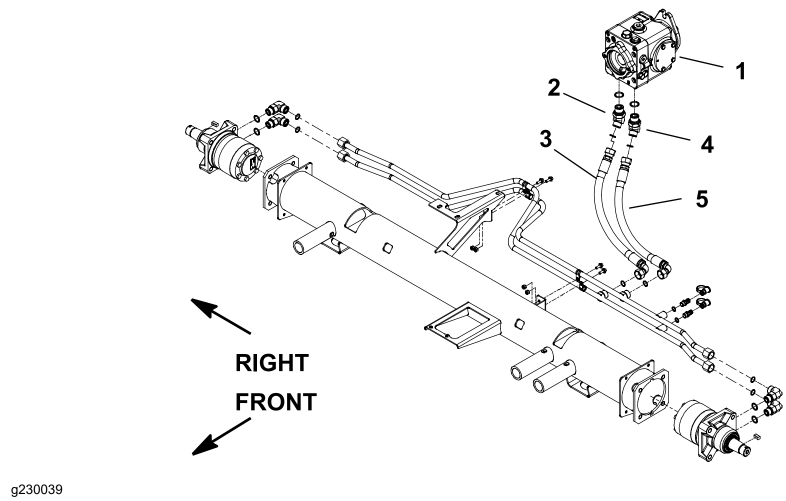


Figure 90

2-wheel drive machine

1. Traction pump	3. Hydraulic hose (forward)	5. Hydraulic hose (reverse)
2. Right elbow fitting	4. Left elbow fitting	

6. Clean junction of hydraulic hose and right side elbow fitting on bottom of piston pump (Figure 90). Disconnect hose from piston pump fitting.

IMPORTANT

Ensure that the fluid flow indicator arrow on the flow meter is showing that the fluid will flow from the pump, through the tester, and into the hydraulic hose.

Test Procedure (continued)

7. Install tester with pressure gauge and flow meter in series with the piston pump and the disconnected hose. Ensure that the tester flow control valve is fully open.
8. Start engine and increase engine speed to high idle speed. Ensure that the hydraulic fluid is at normal operating temperature by operating the machine under load for approximately 10 minutes.

CAUTION

Use extreme caution when performing test. The front tires on the ground will be trying to move the machine forward.

9. Fully apply the brakes to prevent the front wheels from rotating and slowly push traction pedal in forward direction until **6,900 kPa (1,000 psi)** is displayed on the tester pressure gauge.
10. Combined front wheel motor internal leakage will be shown on flow meter in GPM (LPM).
11. Release traction pedal, shut off the engine, rotate both front wheels, and retest. Testing of wheel motor leakage in 3 different wheel positions will provide the most accurate test results. Record measured front wheel motor internal leakage for all 3 wheel positions.
12. If combined leakage for the front wheel motors is less than **5.7 L/minute (1.5 gallons/minute)**, consider that the front wheel motors are in good condition. If combined leakage for the front wheel motors is more than **5.7 L/minute (1.5 gallons/minute)**, 1 or both of the motors may be damaged. Individual front wheel motor testing is necessary.
13. To test individual front wheel motors:
    A. Remove front wheel from wheel motor that is not being tested. Remove wheel shield to allow access to hydraulic tubes and fittings on wheel motor. Remove fasteners that secure front hydraulic tube R-clamps to frame.
    B. On the front wheel motor that is not being tested, clean junction of both hydraulic tubes and wheel motor fittings. Disconnect both hydraulic lines from wheel motor that is not being tested. Cap disconnected hydraulic lines and wheel motor fittings.
    C. Use the procedure described in steps 8 to 11 above to identify individual front wheel motor leakage. Individual motor internal leakage will be shown on flow meter in GPM (LPM). Flow should be less than **5.7 L/minute (1.5 gallons/minute)** for the tested wheel motor.
    D. If other front wheel motor requires testing, complete steps A, B, and C for remaining wheel motor.
14. After testing is completed, shut off the engine, and then relieve hydraulic system pressure; refer to Releasing Pressure from the Hydraulic System (page 6–8). Disconnect tester from hydraulic fitting and hose. Connect hose to pump elbow fitting. Remove caps from hydraulic tubes and reconnect tubes to wheel motor. Secure the hydraulic tubes to machine with R-clamps and removed fasteners. Install wheel shield and wheel(s); refer to Wheels (page 8–5).

Piston (Traction) Pump Flow Test (Using Tester with Flow Meter and Pressure Gauge) (5410/5410-G/5410-D/5510/5510-G/5510-D/5610)

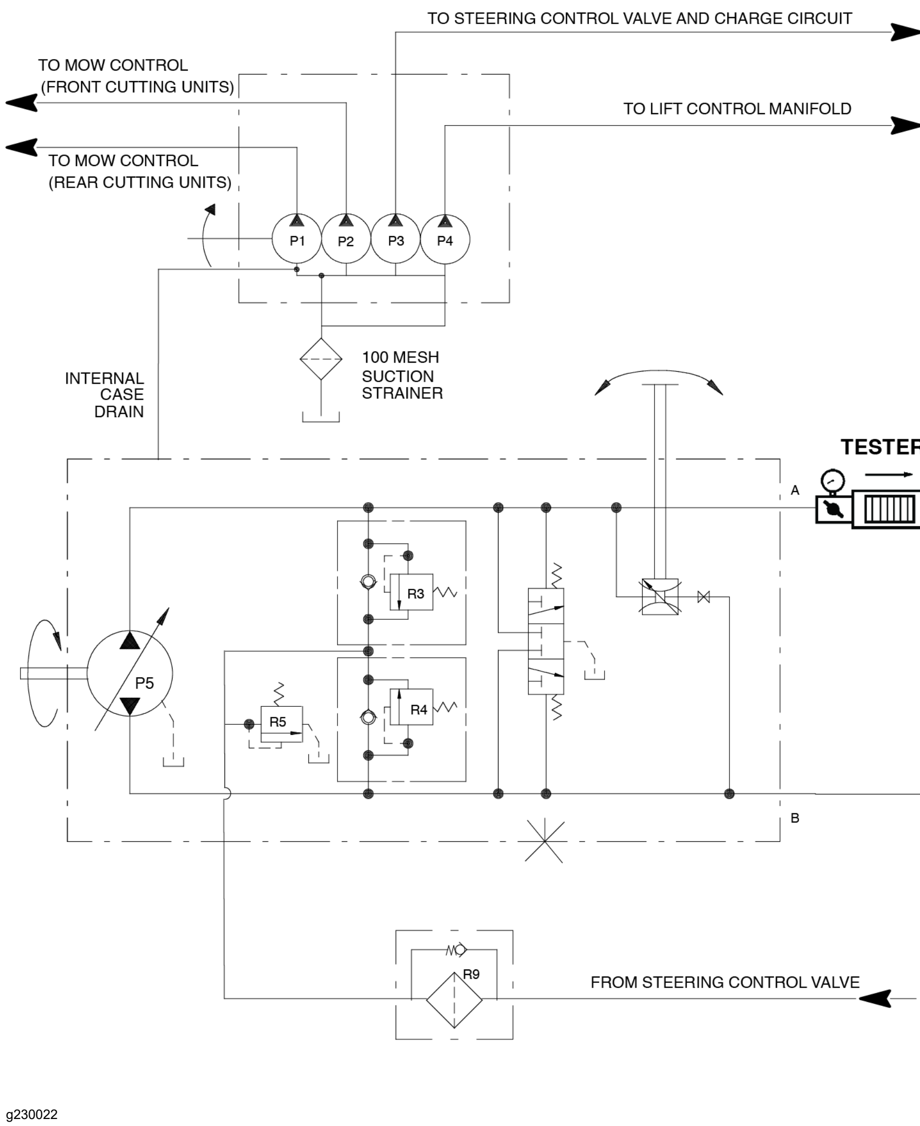


Figure 91

Test Procedure

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

IMPORTANT

Traction circuit flow for your Reelmaster is approximately 114 L/minute (30 gallons/minute). Use 150 L/minute (40 gallons/minute) hydraulic Tester #AT40002 (pressure and flow) for this test; refer to **Special Tools (page 6–44)****.**

1. Park machine on a level surface with the cutting units lowered and off. Shut off engine. Ensure that the mow speed limiter is in the transport position to allow full movement of traction pedal.

Test Procedure (continued)

2. Ensure that the hydraulic tank is full.
3. Read all Warning, Cautions, and precautions listed at the beginning of this section.

CAUTION

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic fluid; refer to **Releasing Pressure from the Hydraulic System (page 6–8)****.**

4. Ensure that the traction pedal is adjusted to the neutral position. Also, ensure that the traction pump is at full stroke when traction pedal is pushed into fully forward position.
5. Raise and support machine so all wheels are off the ground; refer to Jacking Instructions (page 1–6).

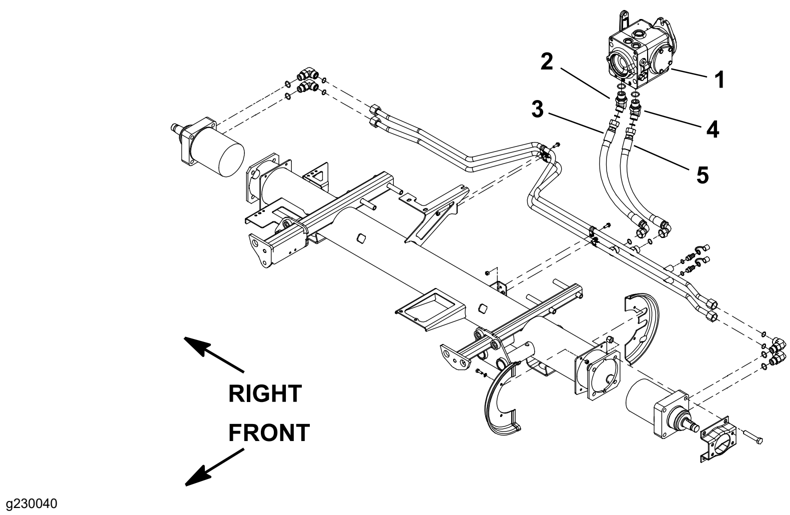


Figure 92

2-wheel drive machine

1.	Traction pump	3.	Hydraulic hose (forward)	5.	Hydraulic hose (reverse)
2.	Right elbow fitting	4.	Left elbow fitting		

6. Clean junction of hydraulic hose and right side fitting on bottom of traction pump (Figure 92). Disconnect hose from right side pump fitting.

IMPORTANT

Ensure that the fluid flow indicator arrow on the flow meter is showing that the fluid will flow from the pump, through the tester, and into the disconnected hydraulic hose.

7. Install tester with pressure gauge and flow meter in series between traction pump fitting and disconnected hose to allow flow from traction pump to tester. Use hydraulic hose kit; refer to Special Tools (page 6–44) to connect tester to machine. Ensure that the fitting and hose connections are properly tightened. Also, ensure that the flow control valve on tester is fully open.

Test Procedure (continued)

⚠ CAUTION ⚠

All wheels will be off the ground and rotating during this test. Ensure that the machine is supported so it will not move and accidentally fall to prevent injuring anyone near the machine.

---

8. Start engine and run at idle speed. Check for any hydraulic leakage from tester and hose connections. Correct any leaks before proceeding.
9. Increase engine speed to high idle speed. Ensure that the hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes.
10. Slowly push traction pedal to fully forward position. Keep pedal fully pressed in the forward position.
11. Have second person watch pressure gauge on tester carefully while slowly closing the flow control valve until **6,900 kPa (1,000 psi)** is obtained. Verify with a phototac that the engine speed is still **3,000 rpm**.

    Note: If engine speed is not 3,000 rpm during this test, pump flow will be different than listed GPM/LPM.
12. Observe flow gauge. Flow indication should be approximately **98 L/minute (26 gallons/minute)**.
13. Release traction pedal to the neutral position, open flow control valve on tester, and shut off the engine. Record test results.
14. If flow is less than **87 L/minute (23 gallons/minute),** consider the following:
    A. The traction pump swash plate is not being rotated fully (e.g., traction pedal linkage may need adjustment, mow speed limiter is not in the transport position).
    B. The piston (traction) pump needs to be repaired or replaced as necessary.
    C. Make necessary repairs before performing additional tests.
15. When testing is complete, disconnect tester and hose kit from pump fitting and machine hydraulic hose. Reconnect hose to pump fitting.

Relief Valve (R1) and (R2) Pressure Test (Cutting (Mow) Circuit) (5410/5410-G/5410-D/5510/5510-G/5510-D/5610)

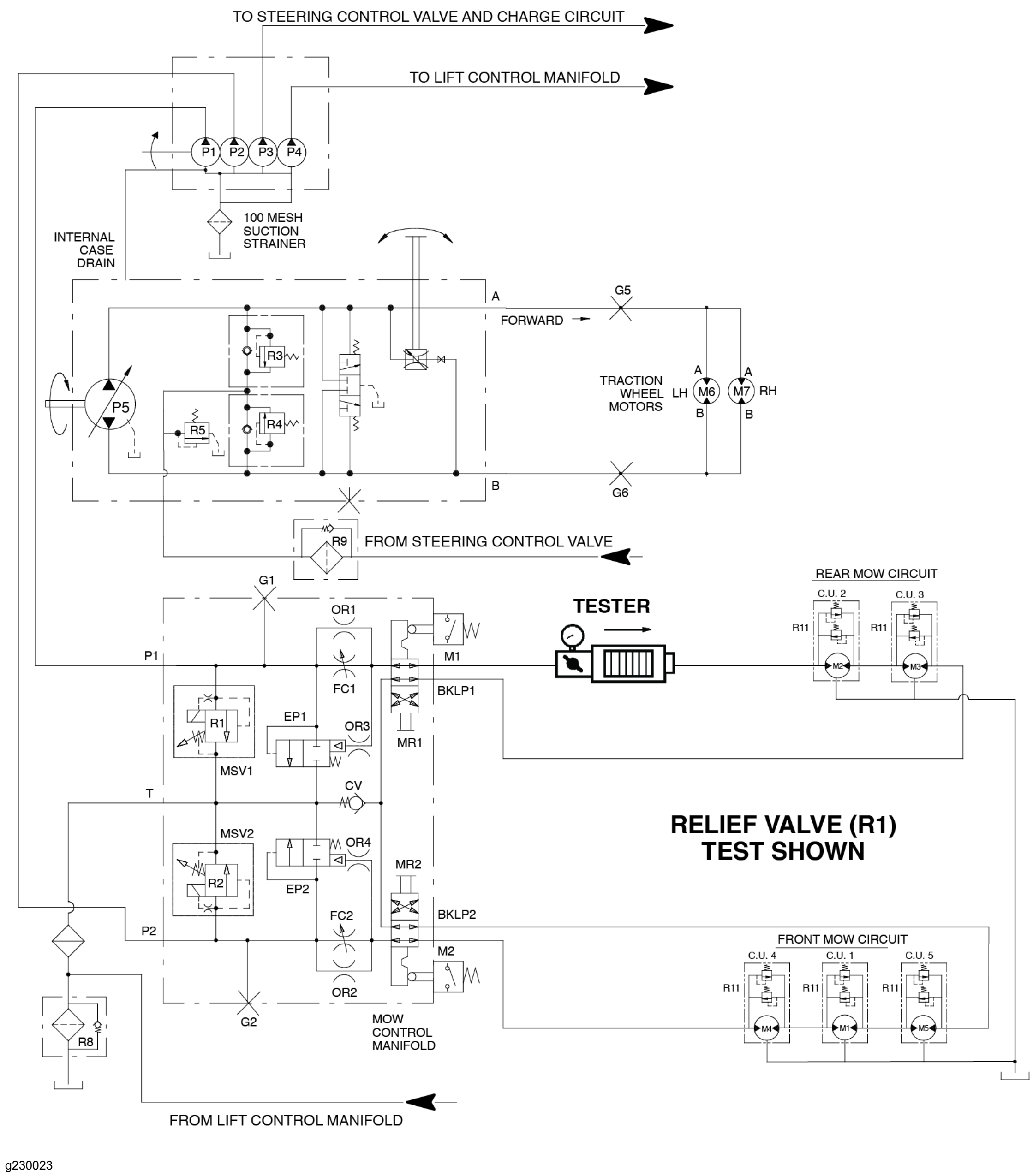


Figure 93

The relief valve (R1) and (R2) pressure test should be performed to ensure that the cutting unit circuit relief pressures are correct.

Note: The front cutting unit circuit is protected by relief valve (R2). The rear cutting unit circuit is protected by relief valve (R1); refer to Hydraulic Flow Diagrams (5410/5410-D/5510/5510-D/5610) (page 6–20).

Test Procedure

1. Ensure that the hydraulic fluid is at normal operating temperature by operating the machine under load for approximately 10 minutes.

Test Procedure (continued)

2. Park machine on a level surface with the cutting units lowered and reel engage switch OFF. Ensure that the engine is shut off and mow/transport lever is in MOW. Apply the parking brake.
3. Read all Warning, Cautions, and precautions listed at the beginning of this section.

CAUTION

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).

4. Raise and prop operator seat to allow access to hydraulic mow control manifold.
5. Set reel speed controls (FC1 and FC2) to full open (highest number). Ensure that the backlap levers are positioned in the MOW position.

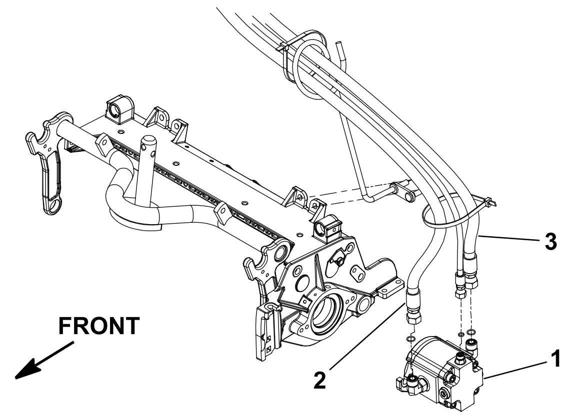


Figure 94

1. Cutting reel motor
2. Motor inlet hose
3. Motor outlet hose

6. Clean junction of hydraulic inlet hose and reel motor fitting on left side cutting unit for the relief valve to be tested. Disconnect hose from reel motor fitting (Figure 94):

   Left rear cutting unit (#2) for relief valve (R1)

   Left front cutting unit (#4) for relief valve (R2)

IMPORTANT

Ensure that the fluid flow indicator arrow on the flow meter is showing that the fluid will flow from the disconnected hose, through the tester and into the reel motor.

7. Install tester with pressure gauges and flow meter in series with the disconnected hose and hydraulic fitting on reel motor. Ensure that the flow control valve on tester is fully open.

Test Procedure (continued)

8. After installing tester, start engine, and run at idle speed. Check for any hydraulic leakage from test connections and correct before proceeding with test.
9. Increase engine speed to high idle speed.

CAUTION

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

10. Have a second person occupy seat, press reel engage switch to ON, and then move lower-mow/raise lever forward to engage cutting units.

IMPORTANT

When performing this test, do not hold over relief any longer than necessary to obtain pressure reading.

11. Watch pressure gauge carefully while slowly closing the tester flow control valve.
12. As the relief valve lifts, system pressure should be:

    From **16,900 to 17,900 kPa (2,450 to 2,600 psi)** for relief valve (R1)

    From **23,800 to 24,800 kPa (3,450 to 3,600 psi)** for relief valve (R2)
13. Open the tester flow control valve, disengage cutting units, and shut off the engine.
14. If pressure is incorrect, remove solenoid valve on mow manifold and clean or replace valve; refer to Servicing the Mow Control Manifold Assembly (page 6–190). Also, if pressure is still low after solenoid valve service, check for restriction in pump intake line. Gear pump (P2) (front cutting unit circuit) and/or pump (P1) (rear cutting unit circuit) could also be suspected of wear, damage, or inefficiency; refer to Gear Pump (P1) and (P2) Flow Test (Using Tester with Flow Meter and Pressure Gauge) (5410/5410-G/5410-D/5510/5510-G/5510-D/5610) (page 6–77).
15. After testing is completed, ensure that the engine is stopped, then relieve hydraulic system pressure; refer to Releasing Pressure from the Hydraulic System (page 6–8). Remove tester from machine and connect hydraulic hose to reel motor fitting.

Gear Pump (P1) and (P2) Flow Test (Using Tester with Flow Meter and Pressure Gauge) (5410/5410-G/5410-D/5510/5510-G/5510-D/5610)

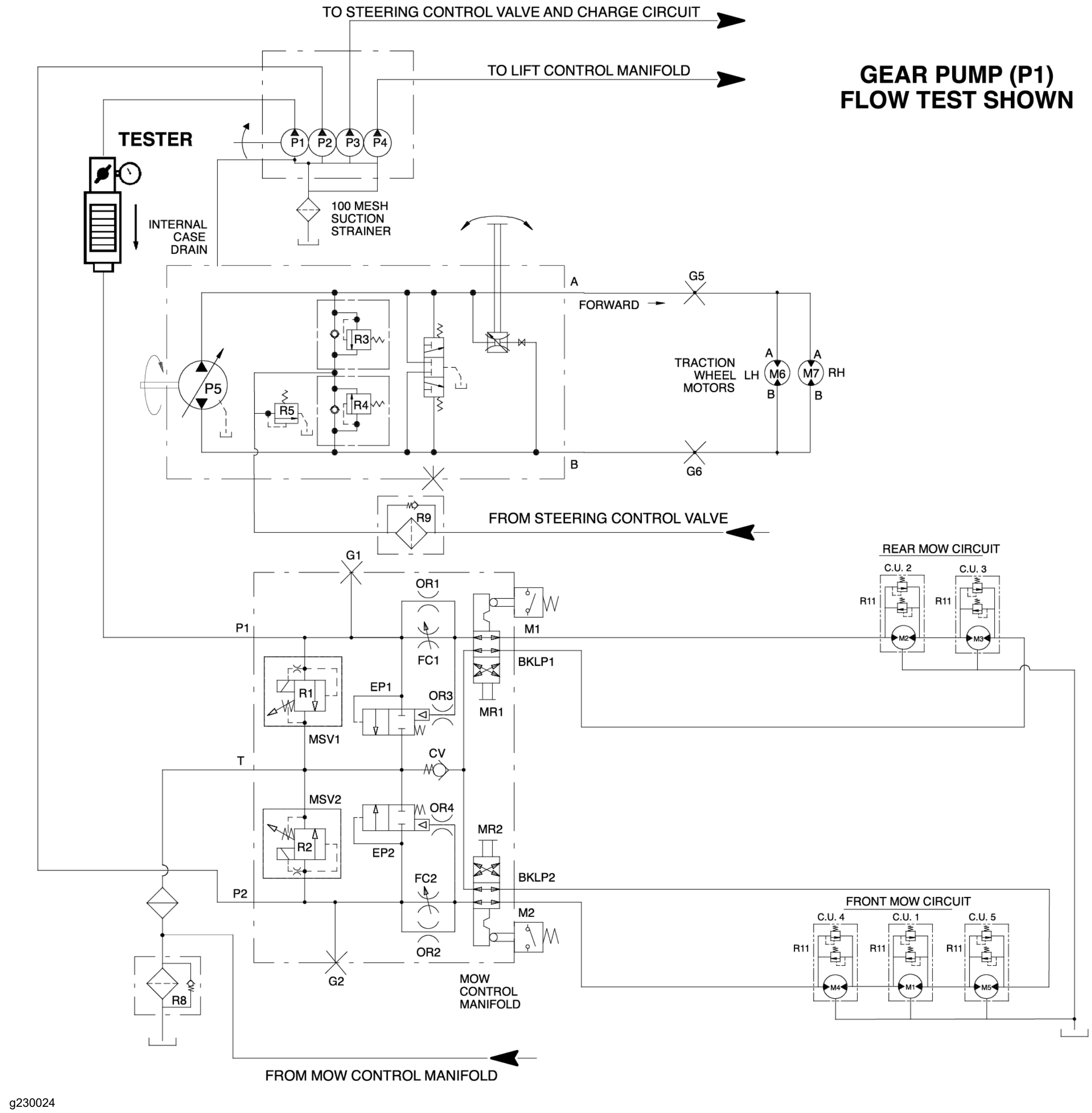


Figure 95

Over a period of time, the gears, and wear plates in the gear pump can wear. A worn pump will by-pass fluid and make the pump less efficient. Eventually, enough fluid can by-pass to cause the reels to stall in heavy cutting conditions. Continued operation with a worn, inefficient pump can generate excessive heat and cause damage to seals and other components in the hydraulic system.

Test Procedure

1. Park machine on a level surface with the cutting units lowered and reel engage switch OFF. Ensure that the engine is shut off. Apply the parking brake.

Test Procedure (continued)

2. Read all Warning, Cautions, and precautions listed at the beginning of this section.

CAUTION

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).

3. Raise and prop operator seat to allow access to hydraulic pump.

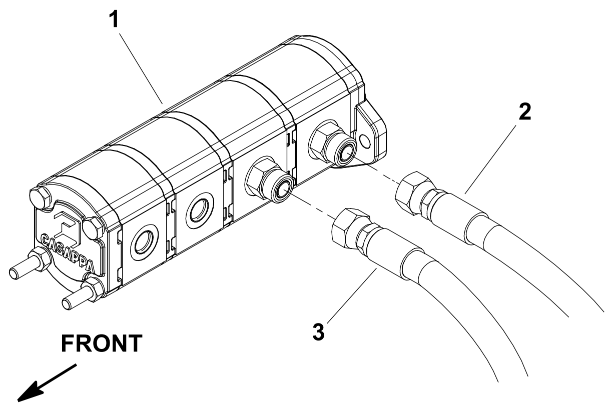


Figure 96

1. Gear pump
2. Section P1 outlet (rear)
3. Section P2 outlet (front)

4. Identify suspected bad pump section to be tested (Figure 96). Clean junction of gear pump fitting and hydraulic outlet hose. Disconnect hose from pump fitting:

   Pump section (P1) for rear cutting units

   Pump section (P2) for front cutting units

IMPORTANT

Ensure that the fluid flow indicator arrow on the flow gauge is showing that the fluid will flow from the gear pump, through the tester and into the hose.

5. Install tester with pressure gauge and flow meter in series between disconnected hose and gear pump fitting. Ensure that the flow control valve on tester is fully open.
6. After installing tester, start engine, and run at idle speed. Check for any hydraulic leakage from test connections and correct before proceeding with test.
7. Ensure that the hydraulic fluid is at normal operating temperature by operating the machine under load for approximately 10 minutes.
8. Ensure that the parking brake is engaged. Increase engine speed to high idle speed **(3,000 rpm)**. Do not engage the cutting units. Use a tachometer to verify that engine speed is correct.

Test Procedure (continued)

IMPORTANT

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

9. While watching pressure gauges, slowly close the tester flow control valve until **13,800 kPa (2,000 psi)** is obtained on gauge. Verify that the engine speed is still **3,000 rpm**.

   Note: If engine speed is not 3,000 rpm during this test, pump flow will be different than listed GPM/LPM.

   Flow tester reading to be:

   For RM 5410 series machines, a pump in good condition should have a flow of approximately **23.4 L/minute (6.2 gallons/minute)** at **13,800 kPa (2,000 psi)**.

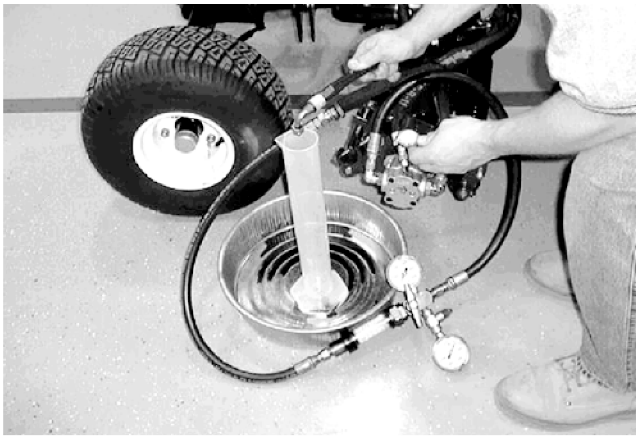
   For RM 5510 and 5610 series machines, a pump in good condition should have a flow of approximately **31 L/minute (8.2 gallons/minute)** at **13,800 kPa (2,000 psi)**.

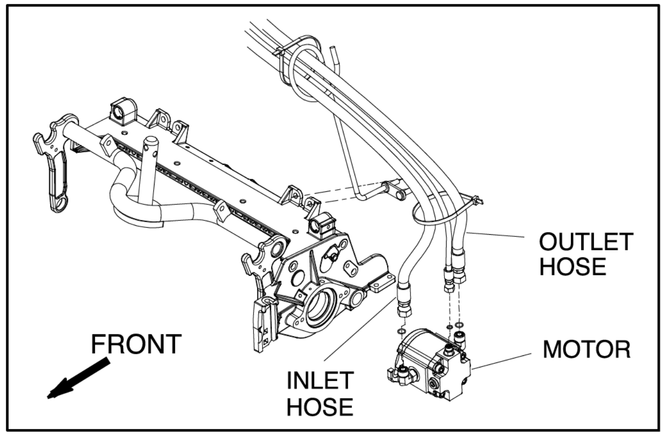
10. Open the tester flow control valve and shut off the engine. Record test results.

11. If flow is less than **20.4 L/minute (5.4 gallons/minute)** on a RM 5410 series machine, less than **26.8 L/minute (7.1 gallons/minute)** on a RM 5510/5610 series machine or a pressure of **13,800 kPa (2,000 psi)** cannot be obtained, consider that a pump problem exists. Check for restriction in pump intake line. If intake is not restricted, remove gear pump and repair or replace pump as necessary; refer to Servicing the Gear Pump (page 6–169).

12. After testing is completed, ensure that the engine is shut off, then relieve hydraulic system pressure; refer to Releasing Pressure from the Hydraulic System (page 6–8). Remove tester from machine and connect hydraulic hose to gear pump fitting.

Cutting Reel Motor Efficiency Test (Using Tester with Flow Meter and Pressure Gauge) (5410/5410-G/5410-D/5510/5510-G/5510-D/5610)





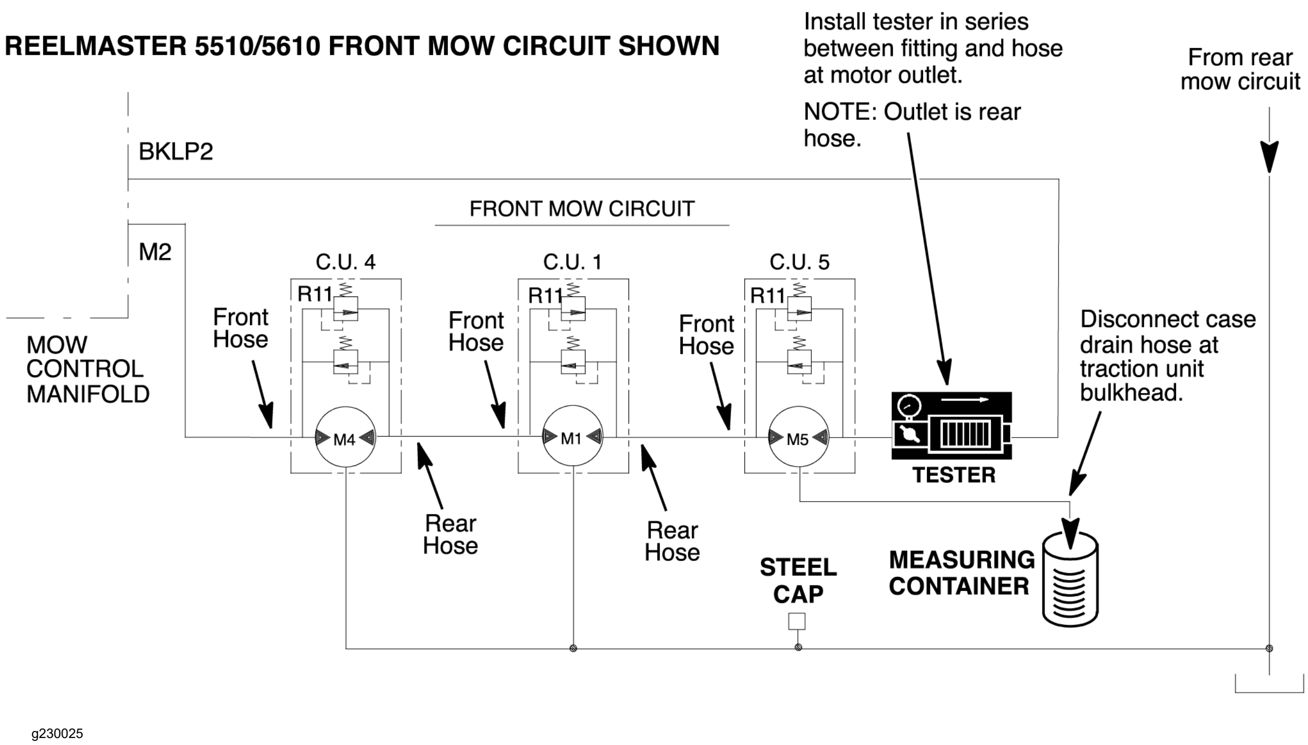


Figure 97

Note: Over a period of time, a reel motor can wear internally. A worn motor may by-pass fluid to its case drain causing the motor to be less efficient. Eventually, enough fluid loss will cause the reel motor to stall under heavy cutting 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 quality of cut.

Note: To find a damaged reel motor, have a person observe the machine while mowing in dense turf. A damaged motor will run slower than other motors, produce fewer clippings, and may cause clip marks (a choppy appearance) on the turf.

Test Procedure

1. Determine which reel motor is malfunctioning.
2. Park machine on a level surface with the cutting units lowered and reel engage switch OFF. Ensure that the engine is shut off and mow/transport lever is in MOW. Apply the parking brake.
3. Read all Warning, Cautions, and precautions listed at the beginning of this section.

CAUTION

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).

Note: The reel motors are connected in series. To isolate a damaged motor, all motors in the circuit may have to be tested by starting with the upstream motor first.

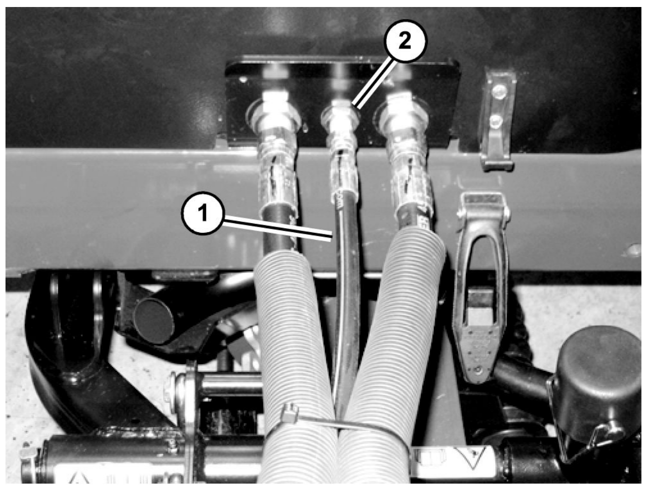


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Figure 98

1. Case drain hose
2. Bulkhead fitting

4. For reel motor to be tested, clean junction of the motor case drain hose (small diameter hose) where it connects to traction unit bulkhead (not at the motor) (Figure 98). Disconnect the case drain hose and put a steel cap on the bulkhead fitting at the traction unit. Leave the case drain hose from the motor open and place open end of disconnected hose into a drain pan.

IMPORTANT

Ensure that the fluid flow indicator arrow on the flow gauge is showing that the fluid will flow from the reel motor, through the tester and into the return hose.

5. On reel motor to be tested, clean junction of hydraulic return hose (rear hose) and reel motor fitting. Disconnect return hose from the motor. Install tester with pressure gauge and flow meter in series with the motor and disconnected return hose. Ensure that the flow control valve on tester is fully open.

Test Procedure (continued)

6. Use the InfoCenter Display to set reel speed control to the full speed position. Ensure that the mow/backlap lever on mow control manifold is in the MOW position.

   Note: Use a graduated measuring container, special tool TOR4077, to measure case drain leakage (Figure 97).

7. Start engine and run at idle speed. Check for any hydraulic leakage from test connections and correct before proceeding with test.

⚠ CAUTION ⚠

Cutting unit reels will rotate when performing the motor efficiency test. Keep away from cutting units during test to prevent personal injury from rotating reel blades. Do not stand in front of the machine.

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8. Sit on seat and increase engine speed to high idle speed. Engage cutting units.

9. While watching pressure gauge on tester, slowly close flow control valve on tester until a pressure of **8,274 kPa (1,200 psi)** is obtained.

10. After achieving **8,274 kPa (1,200 psi)**, place disconnected motor case drain hose into a graduated measuring container (e.g., Toro #TOR4077) and collect hydraulic fluid for 15 seconds. After 15 seconds, remove hose end from container. Then move the reel engage switch to OFF, open the tester flow control valve and shut off the engine.

11. Identify amount of fluid collected in the graduated measuring container. Record test results.

    For Reelmaster 5410 series machines, if flow was greater than **473 ml (16.0 fl oz) (0.5 gallons/minute/1.9 L/minute)**, repair or replace the tested reel motor; refer to Servicing the Cutting Reel Motor (Casappa) (page 6–204).

    For Reelmaster 5510 and 5610 series machines, if flow was greater than **662 ml (22.4 fl oz) (0.7 gallons/minute/2.6 L/minute)**, repair or replace the tested reel motor; refer to Servicing the Cutting Reel Motor (Casappa) (page 6–204).

    If flow is less than the listed specifications, the tested motor does not have excessive leakage.

12. After testing is completed, ensure that the engine is shut off, then relieve hydraulic system pressure; refer to Releasing Pressure from the Hydraulic System (page 6–8). Disconnect tester from motor and return hose. Connect return hose to the reel motor. Remove plug from machine bulkhead fitting and connect case drain hose to the fitting.

13. If necessary, perform reel motor efficiency test on other reel motors.

Cutting Reel Motor Cross-Over Relief Pressure Test (5510/5510-G/5510-D/5610)

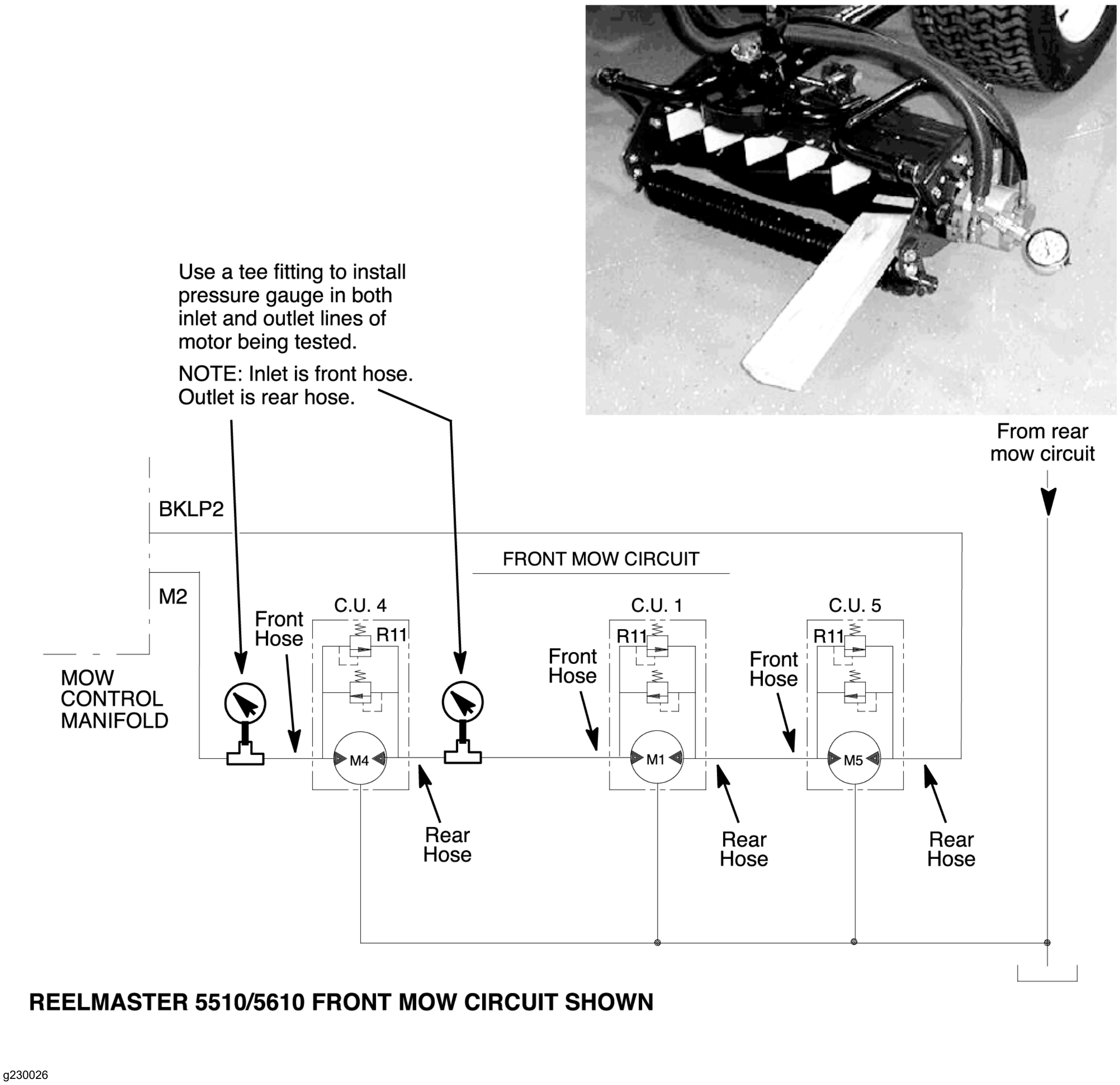

Figure 99

Note: One way to find a damaged reel motor is to have another person observe the machine while mowing in dense turf. A damaged motor will typically run slower, produce fewer clippings, and may cause clip marks (a choppy appearance) on the turf.

IMPORTANT

Do not perform the cutting reel motor cross-over relief pressure test on Reelmaster 5410 series machines. The reel motors on these machines do not have cross-over relief valves.

Note: Before testing the cutting reel motor cross-over relief pressure, ensure that the reel motor is in good condition by performing the cutting reel motor efficiency test; refer to Cutting Reel Motor Efficiency Test (Using Tester with Flow Meter and Pressure Gauge) (5410/5410-G/5410-D/5510/5510-G/5510-D/5610) (page 6–80).

Test Procedure

1. Determine which cutting reel motor needs to be tested by observing the machine during mowing.
2. Park machine on a level surface with the cutting units lowered and reel engage switch OFF. Ensure that the engine is shut off and mow/transport lever is in MOW. Apply the parking brake.
3. Read all Warning, Cautions, and precautions listed at the beginning of this section.

CAUTION

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).

Note: The reel motors are connected in series. To isolate a damaged motor, all motors in the circuit may have to be tested by starting with the up stream motor (closest to the pump) first.

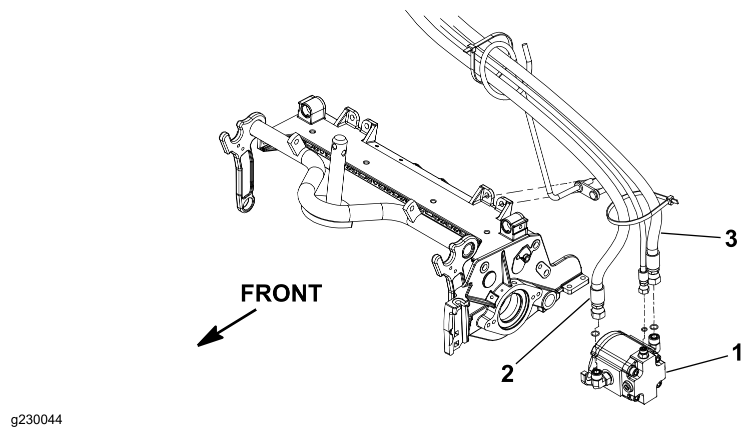

Figure 100

1. Cutting reel motor
2. Motor inlet hose
3. Motor outlet hose

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4. On reel motor to be tested, clean junction of motor inlet and outlet fittings and hydraulic hoses (Figure 100). Loosen and remove both hoses from fittings. Install a tee fitting with a 35,000 kPa (5,000 psi) pressure gauge between fitting and hose for both motor inlet and outlet.
5. Use the InfoCenter Display to set reel speed control to the full speed position. Ensure that the mow/backlap lever on mow control manifold is in the MOW position.
6. With cutting units in lowered position and engine shut off, insert a block of wood between cutting unit reel blades and carrier frame of cutting unit being tested to prevent reel from turning (Figure 99).
7. Start engine and run at low idle speed. Check for any hydraulic leakage from test connections and correct before proceeding with test.

Test Procedure (continued)

8. Ensure that the hydraulic fluid is at normal operating temperature by operating the machine under load for approximately 10 minutes. Do not engage cutting units.

CAUTION

Adjacent cutting unit reels will rotate when performing the cross-over relief test. Keep away from cutting units during test to prevent personal injury from rotating reel blades. Do not stand in front of the machine.

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9. One person should sit on the seat and operate the machine while a second person closely monitors both pressure gauges connected to the reel motor. Ensure that the engine speed is at low idle position **(1,200 rpm)** and engage the cutting units.
10. There should be a slight hesitation in pressure increase on the inlet side of motor as the cross-over relief valve opens. Once the relief valve is open, there will be a pressure differential between the gauges on the inlet and outlet side of the motor. Note this pressure difference which should be:

    Pressure differential between the 2 gauges should be approximately 12,400 kPa (1,800 psi)
11. Disengage the cutting units and shut off the engine. Record test results.
12. If the measured pressure differential is not approximately **12,400 kPa (1,800 psi)**, the cross-over relief valves on the tested motor may be leaking or damaged. Inspect relief valves in the reel motor; refer to Servicing the Cutting Reel Motor (Casappa) (page 6–204)).
13. After testing is completed, ensure that the engine is shut off, then relieve cutting unit hydraulic system pressure; refer to Releasing Pressure from the Hydraulic System (page 6–8). Remove pressure gauges and tee fittings from machine. Connect hydraulic hoses to reel motor fittings.
14. If necessary, test cross-over relief pressure on other cutting reel motors.

Lift Relief Valve (SVRV) Pressure Test (5410/5410-G/5410-D/5510/5510-G/5510-D/5610)

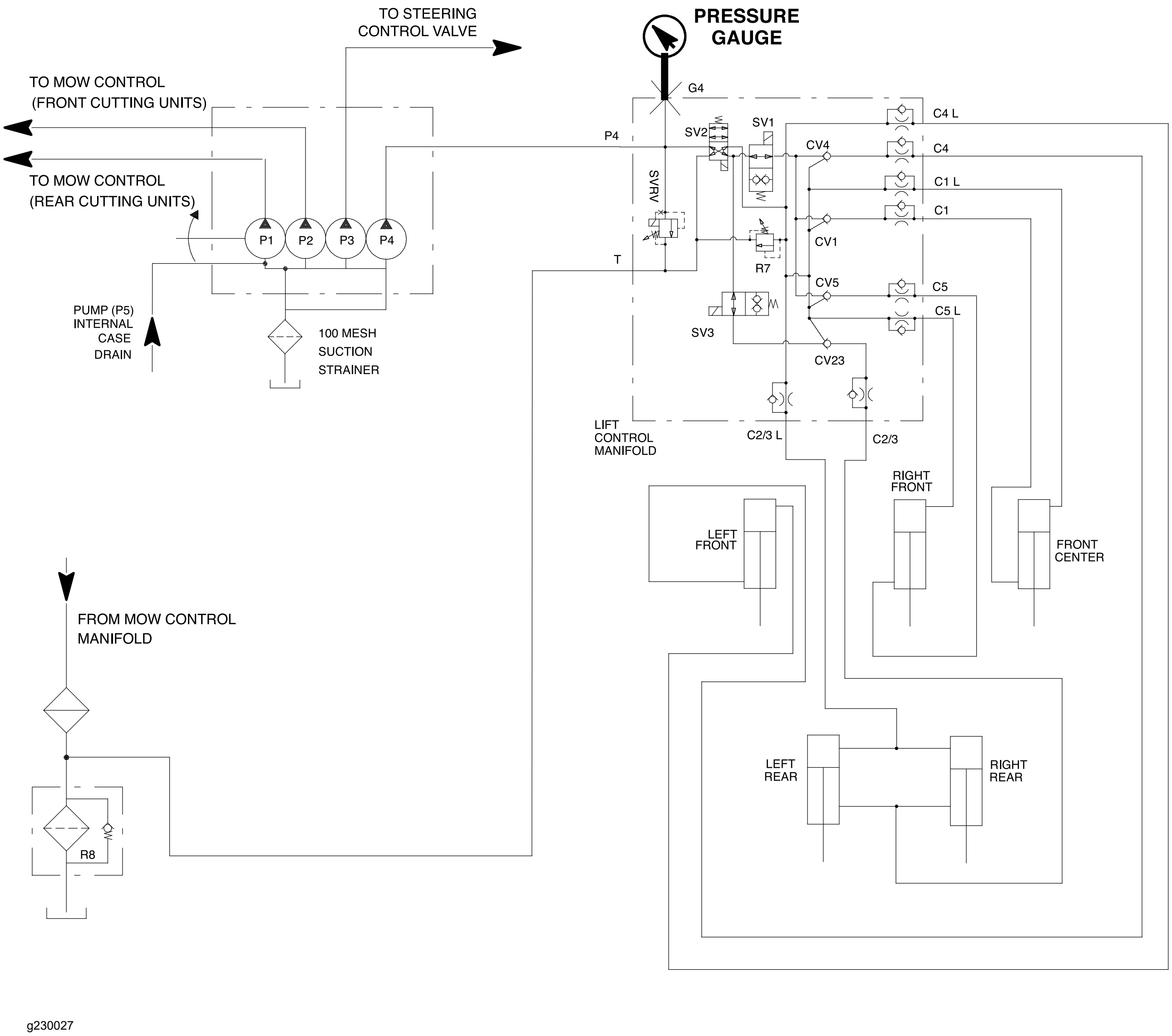


Figure 101

The lift relief valve (SVRV) pressure test should be performed to ensure that the lift circuit relief pressure is correct.

Test Procedure

1. Park machine on a level surface with the cutting units lowered and reel engage switch OFF. Ensure that the engine is shut off. Apply the parking brake.
2. Read all Warning, Cautions, and precautions listed at the beginning of this section.

Test Procedure (continued)

CAUTION

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic fluid; refer to **Releasing Pressure from the Hydraulic System (page 6–8)****.**

3. Gain access to hydraulic lift control manifold from below front of machine.

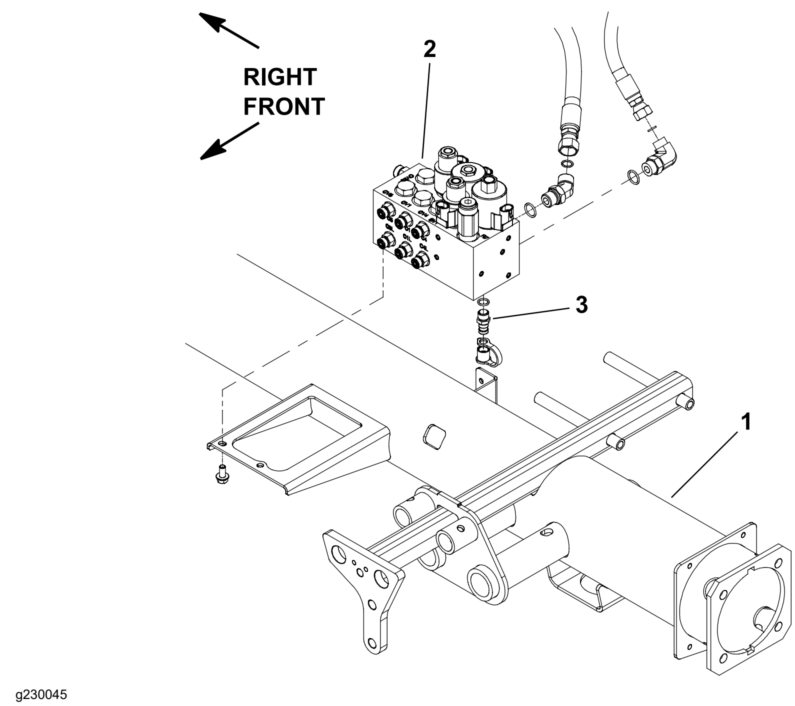


Figure 102

1. Front axle
2. Lift control manifold
3. Test port (G4)

4. Clean test port (G4) on the bottom of lift control manifold (Figure 102). Access to test port can be obtained from below the front of the machine. Connect a 35,000 kPa (5,000 psi) pressure gauge to test port.
5. After installing pressure gauge to manifold test port, start engine, and run at idle speed. Check for any hydraulic leakage from test connections and correct before proceeding with test.
6. Ensure that the hydraulic fluid is at normal operating temperature by operating the machine under load for approximately 10 minutes.
7. Ensure that the engine is running at high idle speed.

IMPORTANT

Do not allow pressure to exceed 17,500 kPa (2,500 psi).

Test Procedure (continued)

IMPORTANT

While performing this test, hold lower-mow/raise lever in the RAISE position only long enough to get a system pressure reading. Holding the lever in raise for an extended period may damage system components.

8. Ensure that the reel engage switch is OFF and then pull lower-mow/raise lever rearward to pressurize lift circuit. While holding lever in the raise (rearward) position, watch pressure gauge carefully. As the cutting units fully raise and the lift relief valve lifts, system pressure should be—approximately **13,800 kPa (2,000 psi)**.
9. Return the lower-mow/raise lever to the neutral position and shut off the engine. Record test results.
10. If measured pressure is incorrect, remove solenoid relief valve (SVRV) on lift control manifold and clean or replace valve; refer to Servicing the Lift Control Manifold (page 6–197). Also, if pressure is low, check for restriction in pump intake line. Internal lift cylinder leakage would also cause low lift circuit pressure; refer to Lift Cylinder Internal Leakage Test (5410/5410-G/5410-D/5510/5510-G/5510-D/5610) (page 6–92). Gear pump (P4) could also be suspected of wear, damage, or inefficiency.
11. After testing is completed, ensure that the engine is shut off, then relieve hydraulic system pressure; refer to Releasing Pressure from the Hydraulic System (page 6–8). Disconnect pressure gauge from lift control manifold test port.

Gear Pump (P4) Flow Test (Using Tester with Flow Meter and Pressure Gauge) (5410/5410-G/5410-D/5510/5510-G/5510-D/5610)

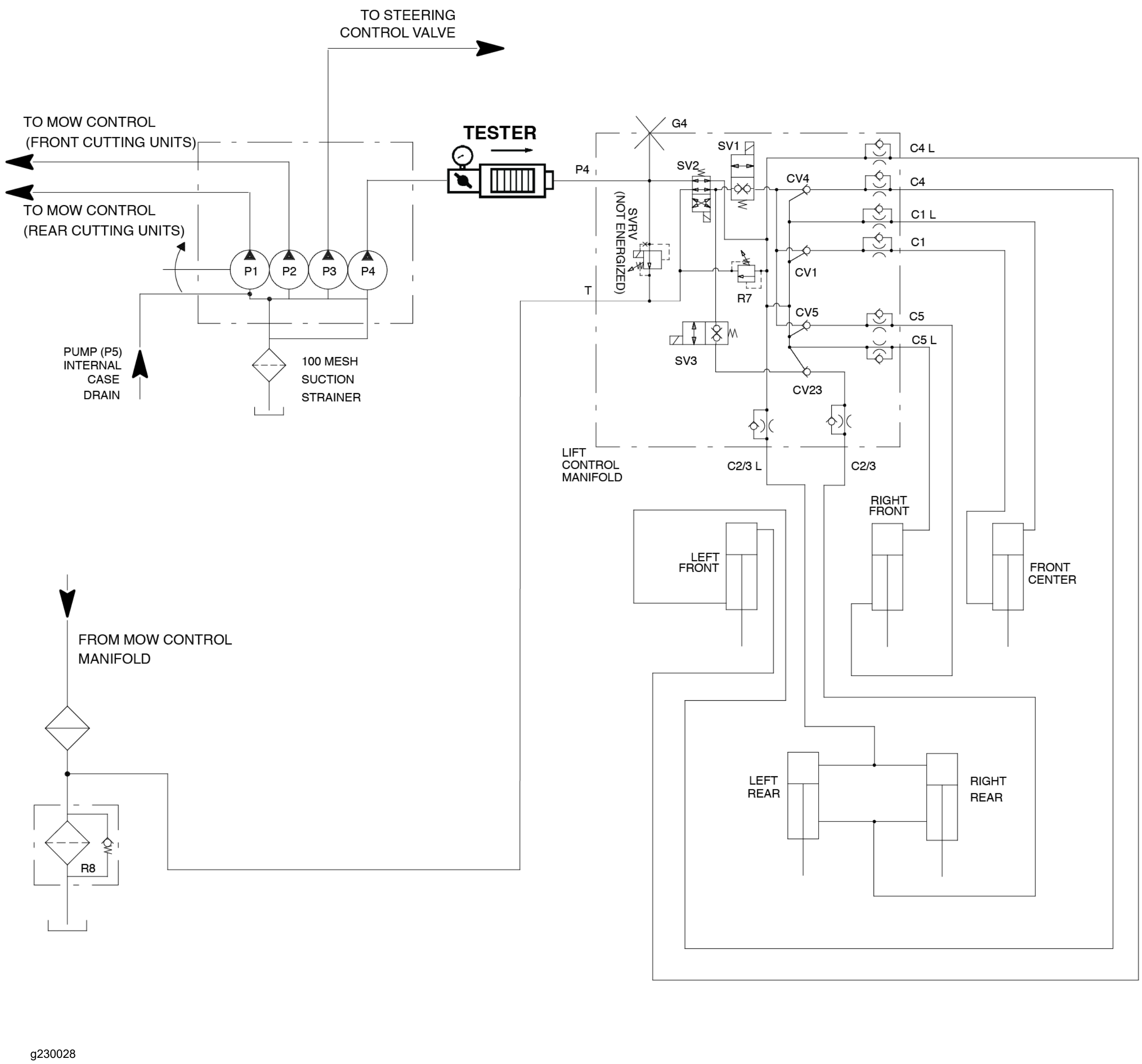


Figure 103

The gear pump (P4) flow test should be performed to ensure that the cutting unit lift circuit has adequate hydraulic flow.

Test Procedure

1. Park machine on a level surface with the cutting units lowered and reel engage switch OFF. Ensure that the engine is shut off. Apply the parking brake.
2. Read all Warning, Cautions, and precautions listed at the beginning of this section.

Test Procedure (continued)

⚠ CAUTION ⚠

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).

3. Raise and prop operator seat to allow access to hydraulic pump.

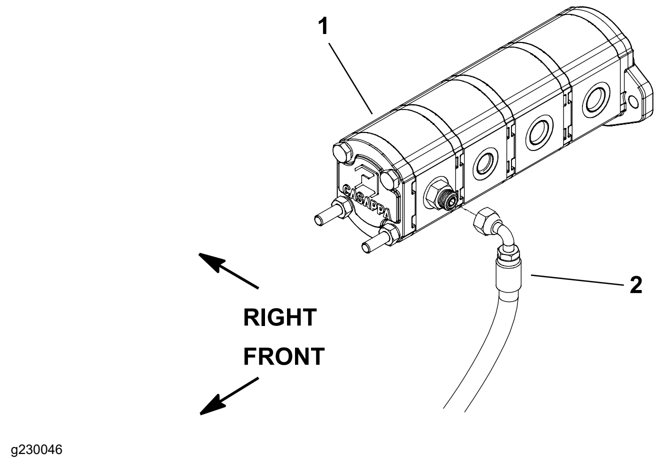


Figure 104

1. Gear Pump (P4)
2. Hydraulic hose

4. Clean junction of outlet fitting in gear pump (P4) and hydraulic outlet hose (Figure 104). Disconnect hose from pump fitting.

IMPORTANT

Ensure that the fluid flow indicator arrow on the flow gauge is showing that the fluid will flow from the gear pump (P4), through the tester and into the disconnected hose.

5. Install tester with pressure gauges and flow meter in series between gear pump fitting and disconnected hose. Ensure that the flow control valve on tester is fully open.
6. Ensure that the traction pedal is in neutral and the parking brake is engaged.
7. Start engine and run at idle speed. Check for any hydraulic leakage from test connections and correct before proceeding with test.
8. Ensure that the hydraulic fluid is at normal operating temperature by operating the machine under load for approximately 10 minutes.
9. Ensure that the engine is running at high idle speed **(3,000 rpm)**. Use a tachometer to verify that engine speed is correct.

IMPORTANT

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

10. While carefully watching pressure gauge on hydraulic tester, slowly close the tester flow control valve until **6,900 kPa (1,000 psi)** is obtained on gauge.
11. Pump flow will be displayed by flow meter on tester:

    Flow tester reading to be: A pump in good condition should have a flow of approximately **11.4 L/minute (3 gallons/minute)** at **6,900 kPa (1,000 psi)**.
12. Open the tester flow control valve, shut off engine and record test results.
13. If flow is less than **9.5 L/minute (2.5 gallons/minute)** or a pressure of **6,900 kPa (1,000 psi)** cannot be obtained, consider that a pump problem exists. Check for restriction in pump intake line. If intake is not restricted, remove gear pump and repair or replace pump as necessary; refer to Hydraulic Pump Assembly (page 6–163) and Servicing the Gear Pump (page 6–169).

    Note: If the flow from gear pump (P4) is low, the operation of all lift cylinders will be affected.
14. After testing is completed, ensure that the engine is shut off, then relieve hydraulic system pressure; refer to Releasing Pressure from the Hydraulic System (page 6–8). Remove hydraulic tester from hydraulic hose and pump fitting. Connect hydraulic hose to gear pump fitting.
15. Lower and secure operator seat.

Lift Cylinder Internal Leakage Test (5410/5410-G/5410-D/5510/5510-G/5510-D/5610)

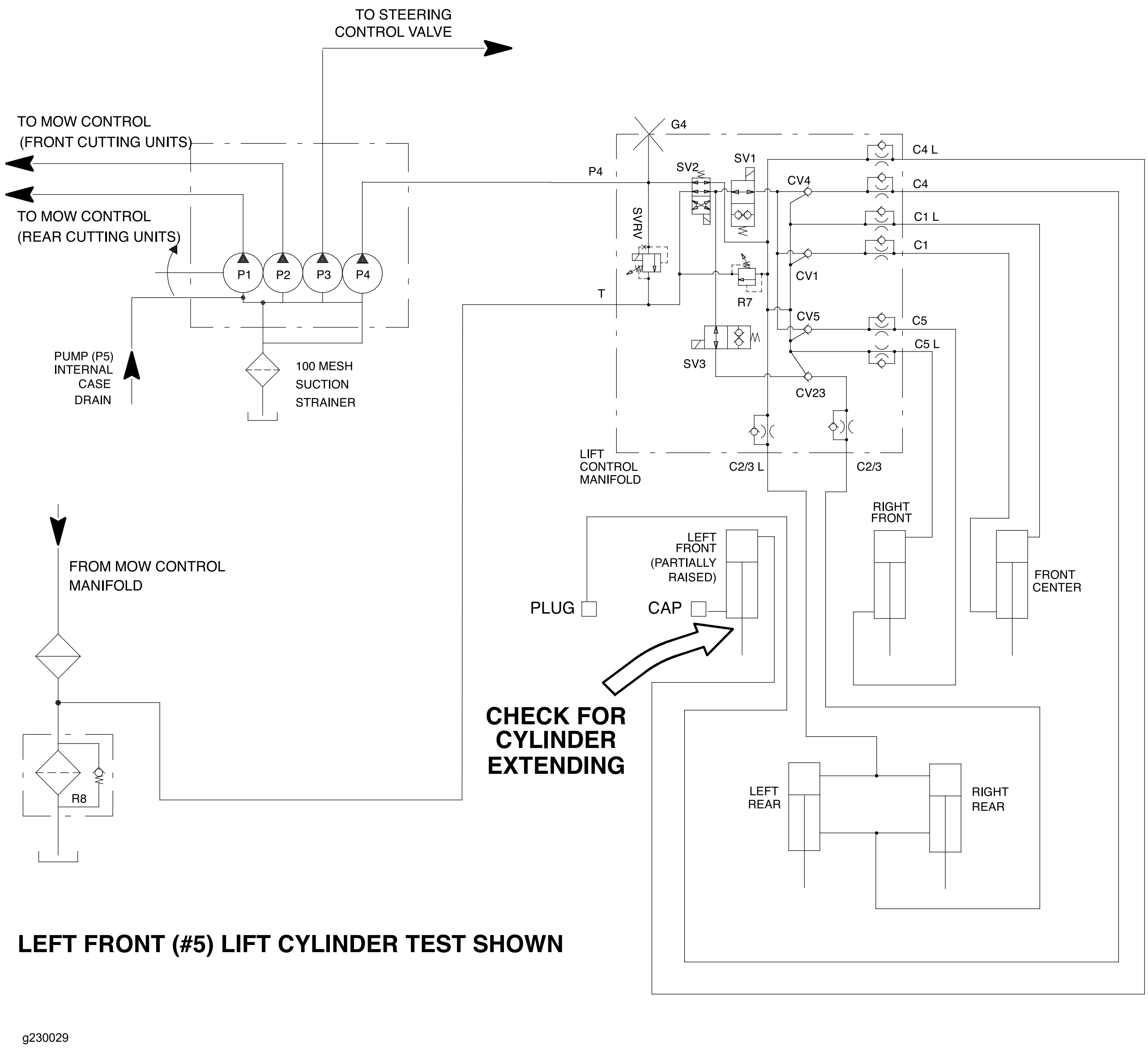


Figure 105

The lift cylinder internal leakage test should be performed if a cutting unit raise and lower problem is identified. This test will determine if a lift cylinder is damaged.

Note: Cutting unit raise/lower circuit operation will be affected by lift cylinder binding, extra weight on the cutting units, and/or binding of lift components. Ensure that the these items are checked before proceeding with lift cylinder internal leakage test.

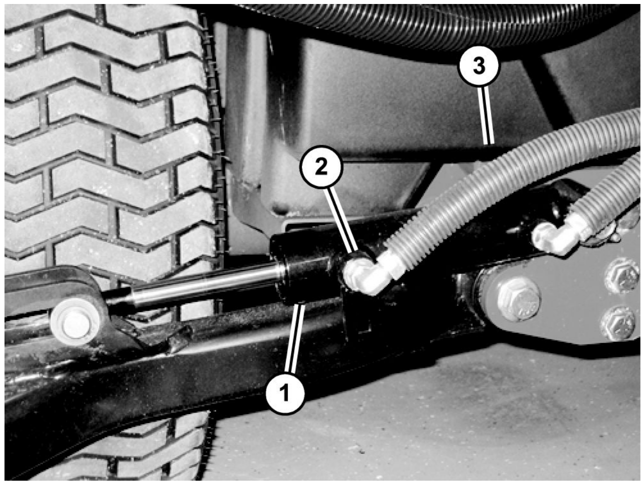
Test Procedure

1. Park machine on a level surface with the cutting units disengaged and in the turn-around position. Shut off the engine and apply the parking brake.
2. Read all Warning, Cautions, and precautions listed at the beginning of this section.

Test Procedure (continued)

3. For the lift cylinder that is to be tested, use a jack to raise the lift arm slightly. This will remove the load from the lift cylinder and relieve lift cylinder hydraulic pressure. Leave the jack under the lift arm to support the lift arm and to prevent the lift arm from lowering.

   Note: If either of the rear lift cylinders is being tested, both rear lift arms need to be supported.



g230047

Figure 106

1. Lift cylinder (#5)
2. Cylinder rod end fitting
3. Hydraulic hose

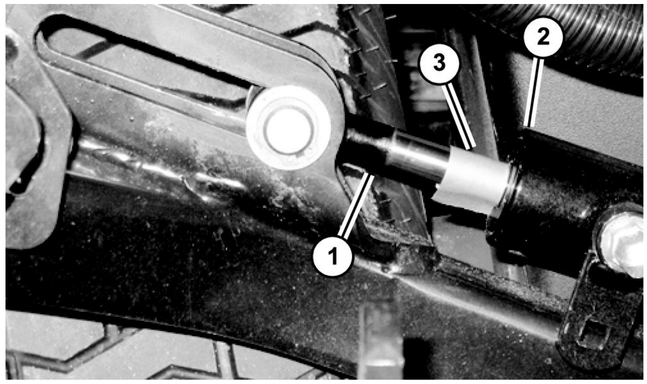
4. Clean the area around the end of the hydraulic hose at the rod end of the lift cylinder for the supported lift arm. Disconnect the hydraulic hose from the lift cylinder rod end fitting (Figure 106).

IMPORTANT

When capping lift cylinder fitting and hydraulic hose end, use a steel cap and plug to ensure that the fluid leakage will not occur. Plastic plugs will not hold hydraulic pressure that will be developed during this test procedure.

5. Place a steel cap on the open lift cylinder fitting to seal the lift cylinder. Also, install a steel plug in the open end of the disconnected hose to prevent leakage or contamination.
6. Slowly lower the jack and remove it from under the lift arm. The cutting unit should settle slightly and then be supported by the capped lift cylinder.

Test Procedure (continued)



g230048

Figure 107

1. Lift cylinder rod
2. Lift cylinder head
3. Tape (initial position)

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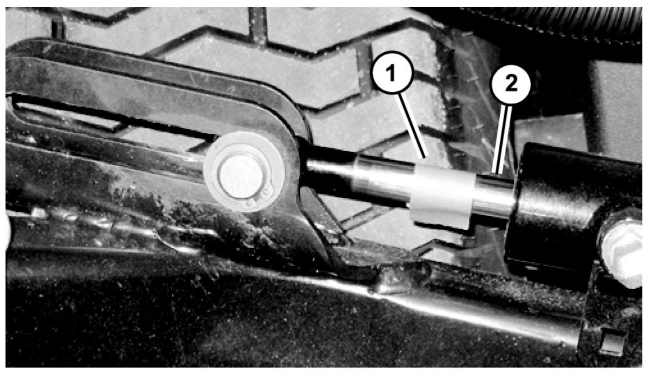
7. Mark the position of the lift cylinder rod at the lift cylinder head with a piece of tape (Figure 107).



g230049

Figure 108

1. Tape (after 2 hours)
2. Cylinder rod movement

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8. Leave the machine parked for 2 hours and monitor the lift cylinder. The weight of the cutting unit may cause the lift cylinder to gradually extend. Use the tape location to determine lift cylinder rod movement (Figure 108).

   A. If lift cylinder rod movement is less than 31.7 mm (1.250 inches) after 2 hours, ensure that the cutting unit has not settled to the ground. If the cutting unit is still suspended after 2 hours and lift cylinder rod movement is less than 31.7 mm (1.250 inches), consider that the lift cylinder is in good condition. A cylinder in good, usable condition will show minimal movement.

   B. Rod movement in excess of 31.7 mm (1.250 inches) after 2 hours indicates that the lift cylinder may have internal seal damage or excessive wear. Remove and inspect the lift cylinder; refer to Lift Cylinder (page 6–215) and Servicing the Lift Cylinder (page 6–218).

9. Once lift cylinder condition has been determined, use a jack to raise the lift arm slightly which will remove the load from the lift cylinder. Allow the jack to support the lift arm and to prevent it from lowering. Remove the cap from the cylinder fitting and the plug from the hydraulic hose. Connect the hydraulic hose to the lift cylinder fitting.

Test Procedure (continued)

10. Remove jack from under the lift arm. Start engine and operate lift cylinders through several up and down cycles. shut off the engine and check for any hydraulic leakage.
11. If necessary, repeat steps 3 through 9 for other lift cylinders.
12. After lift cylinder testing is completed, check hydraulic-fluid level in hydraulic reservoir and adjust as necessary.

Steering Relief Valve (R10) Pressure Test (5410/5410-G/5410-D/5510/5510-G/5510-D/5610)

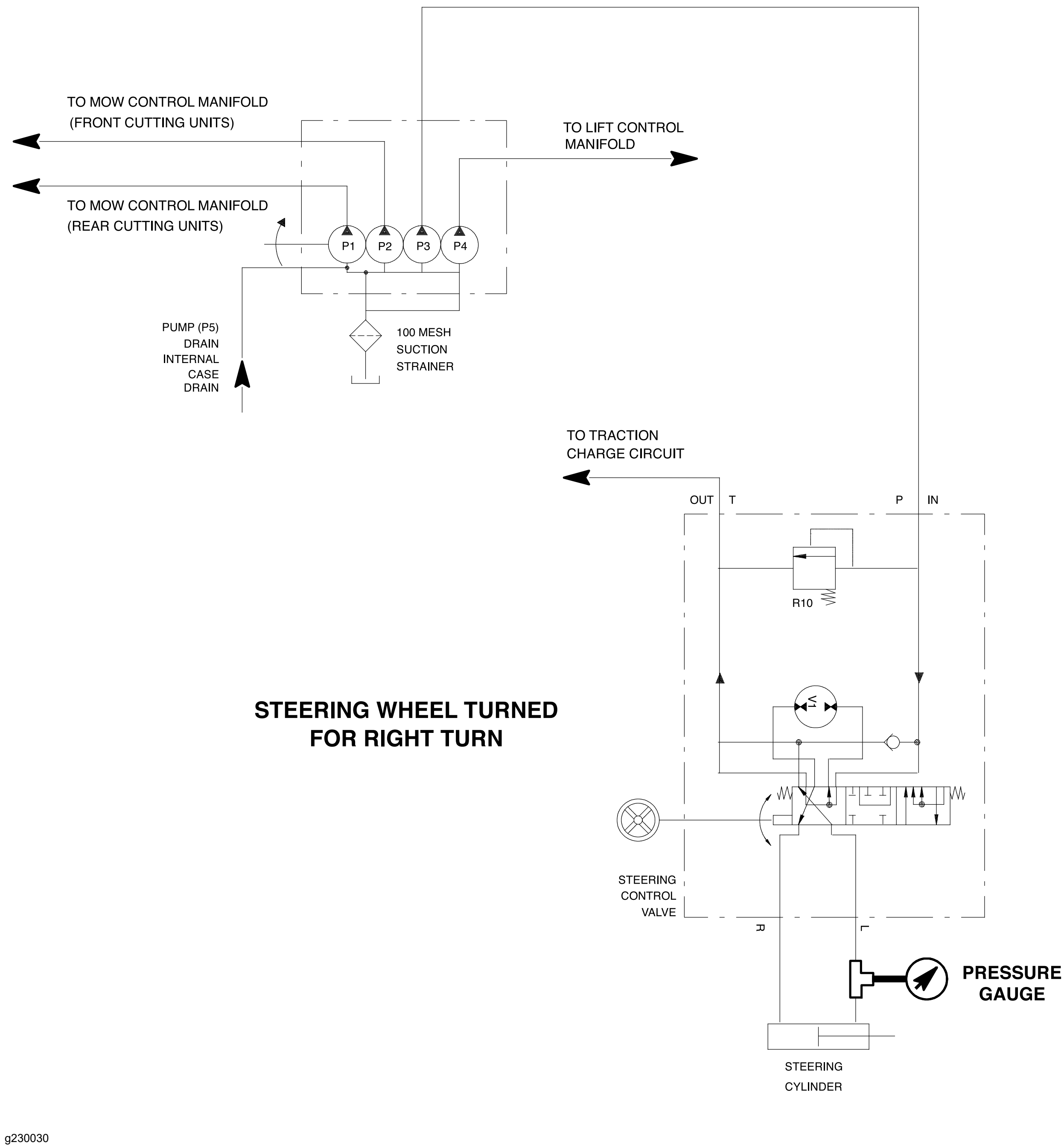


Figure 109

The steering relief valve (R10) pressure test should be performed to ensure that the steering circuit relief pressure is correct.

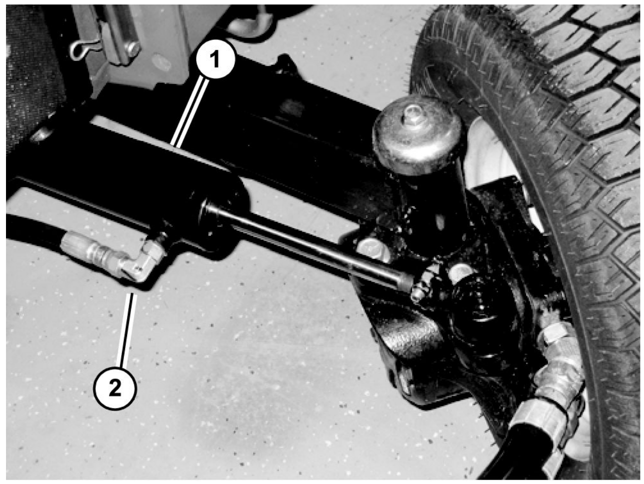
Test Procedure

1. Park machine on a level surface with the cutting units lowered and reel engage switch OFF. Ensure that the engine is shut off. Apply the parking brake.
2. Read all Warning, Cautions, and precautions listed at the beginning of this section.

Test Procedure (continued)

⚠ CAUTION ⚠

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).



g230050

Figure 110

1. Steering cylinder
2. Rod end fitting

3. Clean the area around the hydraulic hose and fitting at the rod end of the steering cylinder (Figure 110).
4. Remove hydraulic hose from the fitting on the rod end of the steering cylinder.
5. Install a tee fitting between the disconnected hydraulic hose and the steering cylinder fitting. Install a 34,500 kPa (5,000 psi) pressure gauge to the tee fitting.
6. After installing pressure gauge, start engine, and run at idle speed. Check for any hydraulic leakage from test connections and correct before proceeding with test.
7. Ensure that the hydraulic fluid is at normal operating temperature by operating the machine under load for approximately 10 minutes.
8. Ensure that the engine is running at high idle speed.

IMPORTANT

Hold steering wheel at full lock only long enough to get a system pressure reading. Holding the steering wheel against the stop for an extended period may damage the steering control valve.

IMPORTANT

As steering wheel is turned, ensure that the pressure gauge is not contacted by any machine parts.

Test Procedure (continued)

9. Watch pressure gauge carefully while turning the steering wheel for a left hand turn (counter-clockwise) and holding.
10. System pressure should be approximately 6,900 kPa (1,000 psi) as the steering relief valve lifts. After determining relief pressure, return steering wheel to the neutral position.
11. Shut off engine. Record test results.
12. If specification is not met, repair or replace steering control valve (relief valve in steering control valve is not replaceable). Gear pump section (P3) could also be suspected of wear, damage or inefficiency; refer to Gear Pump (P3) Flow Test (Using Tester with Flow Meter and Pressure Gauge) (5410/5410-G/5410-D/5510/5510-G/5510-D/5610) (page 6–65).

    Note: If the flow from the gear pump section (P3) is low, the traction charge circuit and steering circuit will both be affected.
13. After testing is completed, ensure that the engine is shut off, then relieve hydraulic system pressure; refer to Releasing Pressure from the Hydraulic System (page 6–8). Remove pressure gauge and tee fitting from hydraulic hose and steering cylinder. Connect hydraulic hose to steering cylinder fitting.

Steering Cylinder Internal Leakage Test (5410/5410-G/5410-D/5510/5510-G/5510-D/5610)

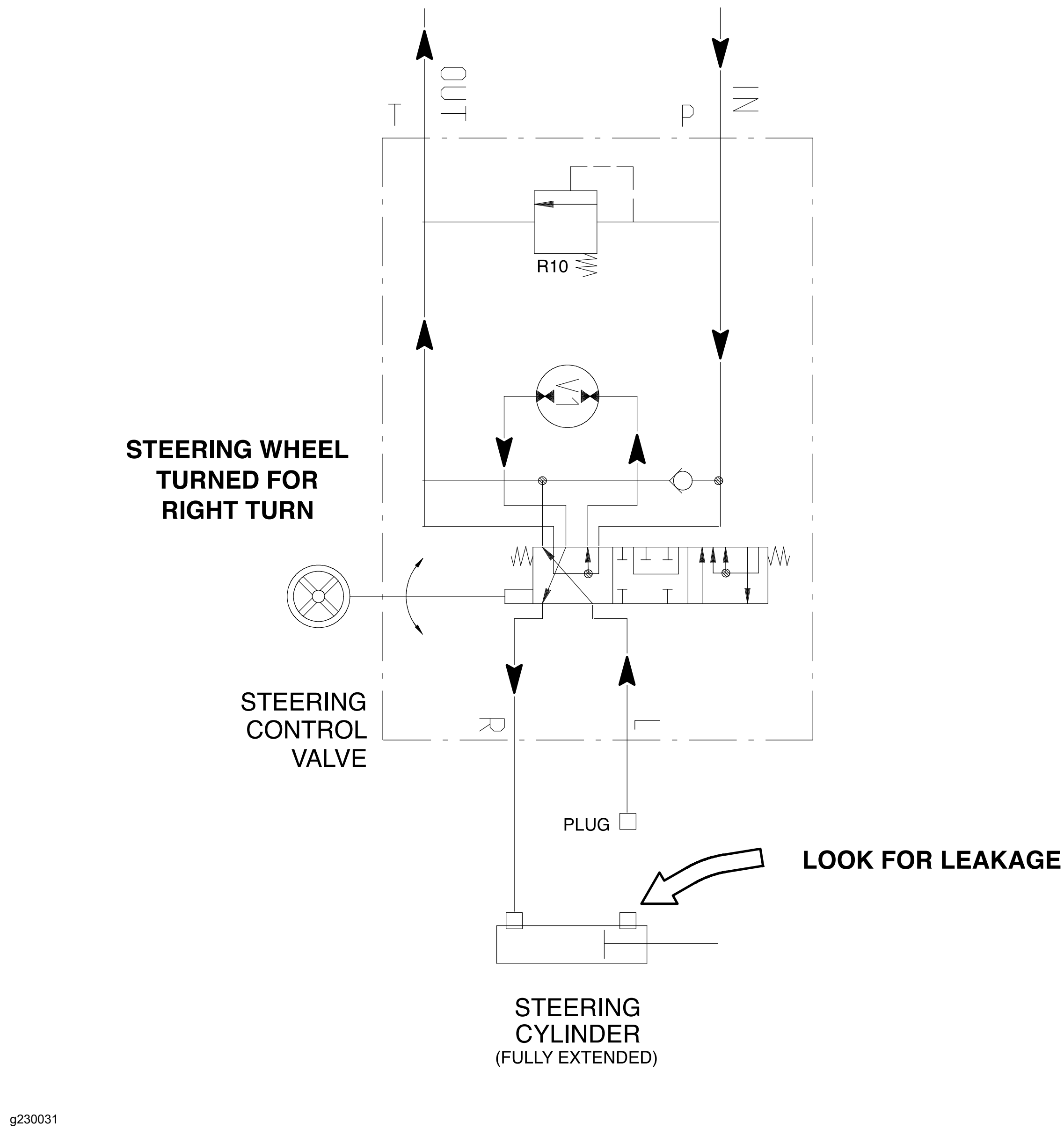


Figure 111

The steering cylinder internal leakage test should be performed if a steering problem is identified. This test will determine if the steering cylinder is damaged.

Note: Steering circuit operation will be affected by rear tire pressure, steering cylinder binding, extra weight on the vehicle and/or binding of rear axle steering components. Ensure that the these items are checked before proceeding with steering cylinder internal leakage test.

Test Procedure

1. Ensure that the hydraulic fluid is at normal operating temperature by operating the machine under load for approximately 10 minutes.
2. Park machine on a level surface with the cutting units lowered and reel engage switch OFF. Ensure that the engine is shut off. Apply the parking brake.

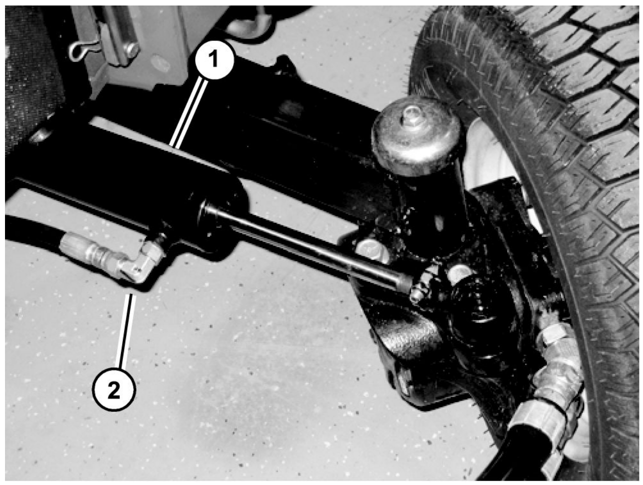
Test Procedure (continued)

3. Read all Warning, Cautions, and precautions listed at the beginning of this section.

CAUTION

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).

4. Turn the steering wheel for a right turn (clockwise) so the steering cylinder rod is fully extended.



g230051

Figure 112

1. Steering cylinder
2. Rod end fitting

5. Clean the area around the hydraulic hose and fitting at the rod end of the steering cylinder (Figure 112).
6. Place a drain pan under the steering cylinder. Remove hydraulic hose from the fitting on the rod end of the steering cylinder. Plug the end of the hose.
7. Remove all hydraulic fluid from drain pan. Ensure that the empty drain pan remains under the open fitting of the steering cylinder.
8. With the engine shut off, continue turning the steering wheel for a right turn (clockwise) with the steering cylinder fully extended. Observe the open fitting on the steering cylinder as the wheel is turned. If fluid comes out of the fitting while turning the steering wheel to the right, the steering cylinder has internal leakage and must be repaired or replaced; refer to Steering Control Valve (page 6–221) and Servicing the Steering Control Valve (page 6–225). Check drain pan for any evidence of fluid that would indicate cylinder leakage.
9. When testing is completed, remove plug from the hydraulic hose. Connect hose to the steering cylinder fitting.
10. If a steering problem exists and the steering cylinder tested acceptably, the steering control valve may require service; refer to Steering Control Valve (page 6–221) and Servicing the Steering Control Valve (page 6–225).
11. Check the hydraulic-fluid level in hydraulic reservoir and adjust if necessary.

Testing the Traction Circuit–Charge Pressure (5610-D)

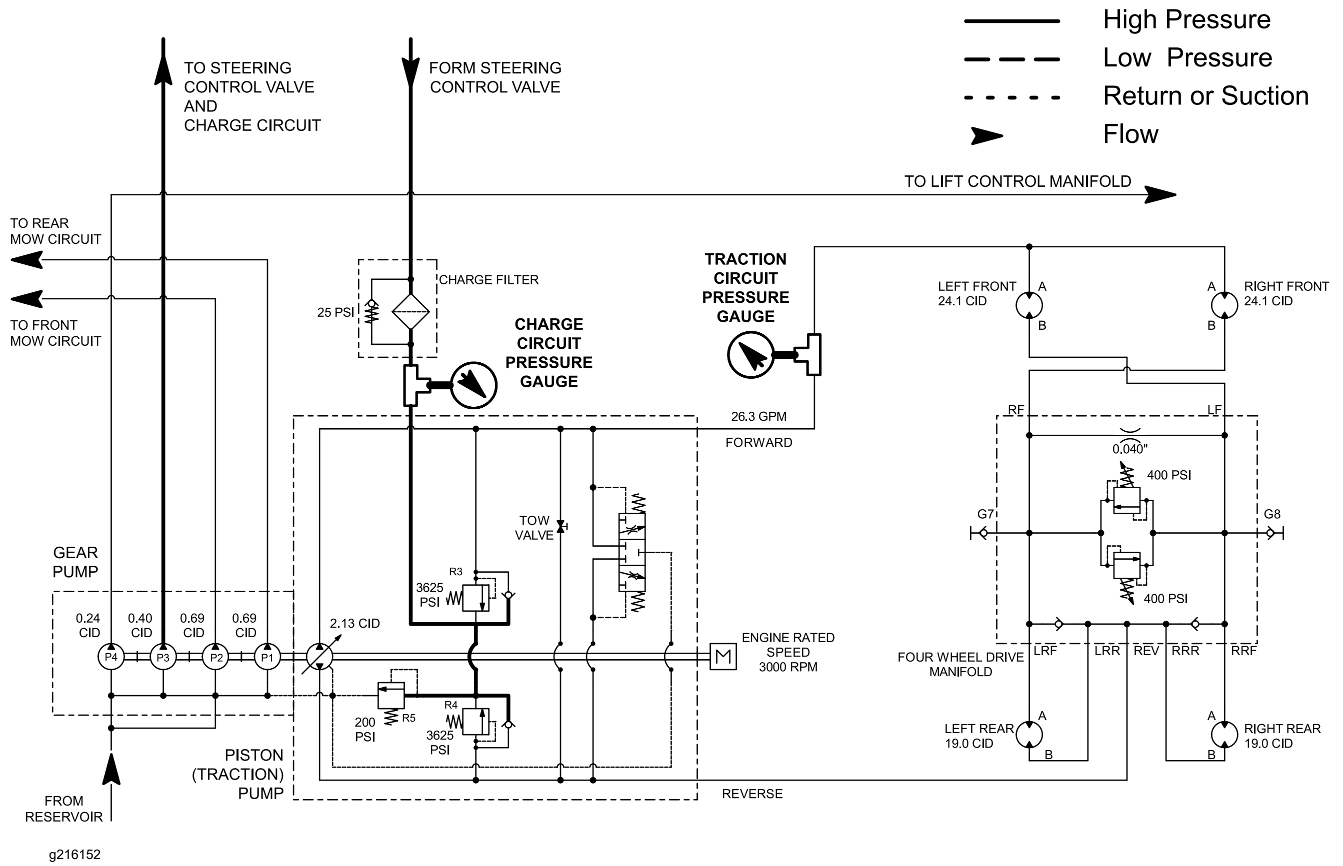


Figure 113

Test Procedure

The charge pressure test is the first in a series of tests recommended to determine traction circuit performance. A charge pressure drop of more than 20% indicates an internal leak in the piston pump/hydrostat. Continued unit operation can generate excessive heat, cause damage to seals and other components in the hydraulic system, and affect overall machine performance.

Special Equipment Required: Pressure gauge

1. Warm oil after test equipment is connected to prevent technician from working on a hot machine—applicable to tests when possible (any test that requires an open un-pluged/capped line (case drain tests) would not apply and oil should be warmed before disconnecting the lines).

CAUTION

Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).

2. Park the machine on a level surface with the reel engage switch off, lower the cutting units, shut off the engine, and set the parking brake.
3. Read all Warning, Cautions, and precautions listed at the beginning of this section.

Test Procedure (continued)

4. Raise and support the operator seat to get access to the hydraulic pump assembly.
5. Ensure that the traction pedal is in the NEUTRAL position, the steering wheel is stationary and parking brake is set.

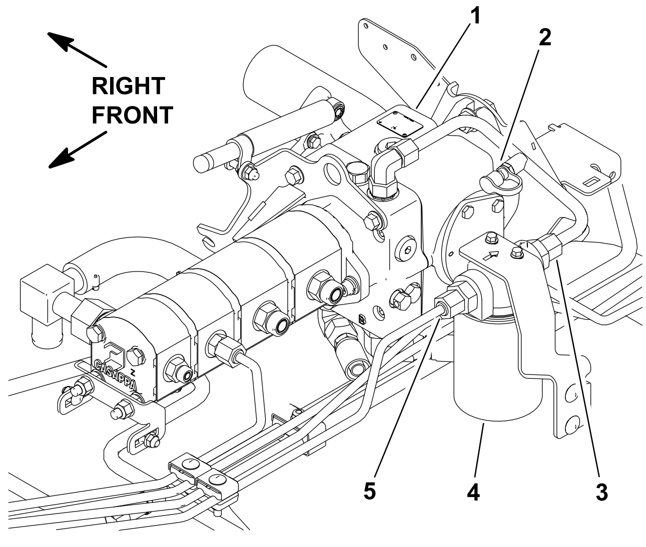


Figure 114

1. Traction pump
2. Charge circuit test port
3. Hydraulic tube
4. Oil filter/filter adapter
5. Hydraulic tube

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6. Connect a pressure gauge to the charge circuit test port (Figure 114).

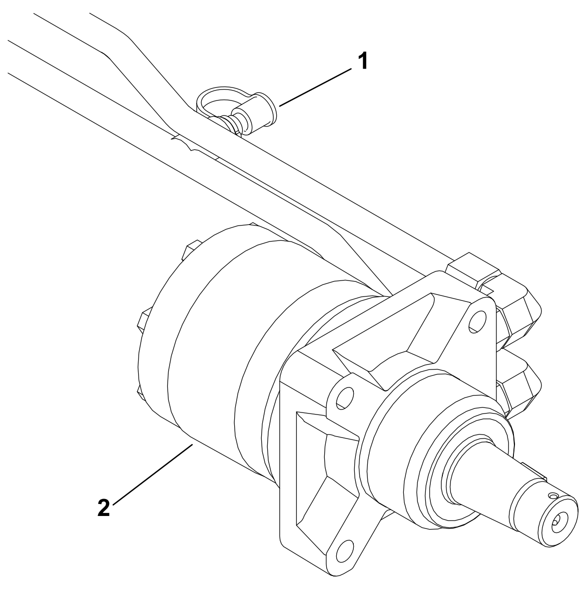

Figure 115

1. Traction circuit test port
2. Wheel motor (left front)

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7. Connect a pressure gauge to the traction circuit test port (Figure 115).
8. Attach a heavy chain to the rear of the machine frame and an immovable object to prevent the machine from moving during testing.

Test Procedure (continued)

9. Block the wheels with chocks to prevent the wheel rotation during testing.
10. Start the engine and press the engine speed switch to full speed **(3,005 to 3,055 rpm)** position. Use the InfoCenter to check that the engine speed is correct.
11. Record the reading on the charge circuit pressure gauge. The charge pressure (without load) should read from **1,034 to 1,379 kPa (150 to 200 psi)**. If the charge relief pressure specification is not met, consider the following:
    A. The gear pump (P3) is damaged (steering circuit performance will also be affected). Test the gear pump (P3) flow; refer to Testing the Steering Circuit–Gear Pump (P3) Flow (5610-D) (page 6–133).

    B. The piston pump charge relief valve is damaged. Repair or replace the piston pump charge relief valve; refer to Servicing the Piston (Traction) Pump (page 6–167).
12. Sit in the operator's seat, release the parking brake, and slowly press the traction pedal forward until **6,900 to 10,340 kPa (1,000 to 1,500 psi)** is reached on the traction circuit pressure gauge.
13. Record the reading on the charge circuit pressure gauge (under load). The charge pressure (under load) should not drop more than 20% when compared to charge pressure (without load) recorded in step 11.

    If specifications are not met, perform the piston pump/hydrostat flow and traction relief pressure test; refer to Testing the Traction Circuit–Piston Pump/Hydrostat Flow and Relief Pressure (5610-D) (page 6–110).
14. Release the traction pedal, press the engine speed switch to low speed position, and shut off the engine.
15. After you complete the charge pressure testing, ensure that the engine is not running and then release hydraulic system pressure; refer to Releasing Pressure from the Hydraulic System (page 6–8). Disconnect the pressure gauges from the test ports.
16. Lower and secure the operator seat.
17. Start the engine, check for hydraulic-fluid leaks, repair any leaks as necessary, and fill the hydraulic tank with the correct quantity of new hydraulic fluid before returning the machine to service.

Testing the Traction Circuit–Wheel Motor Efficiency (5610-D)

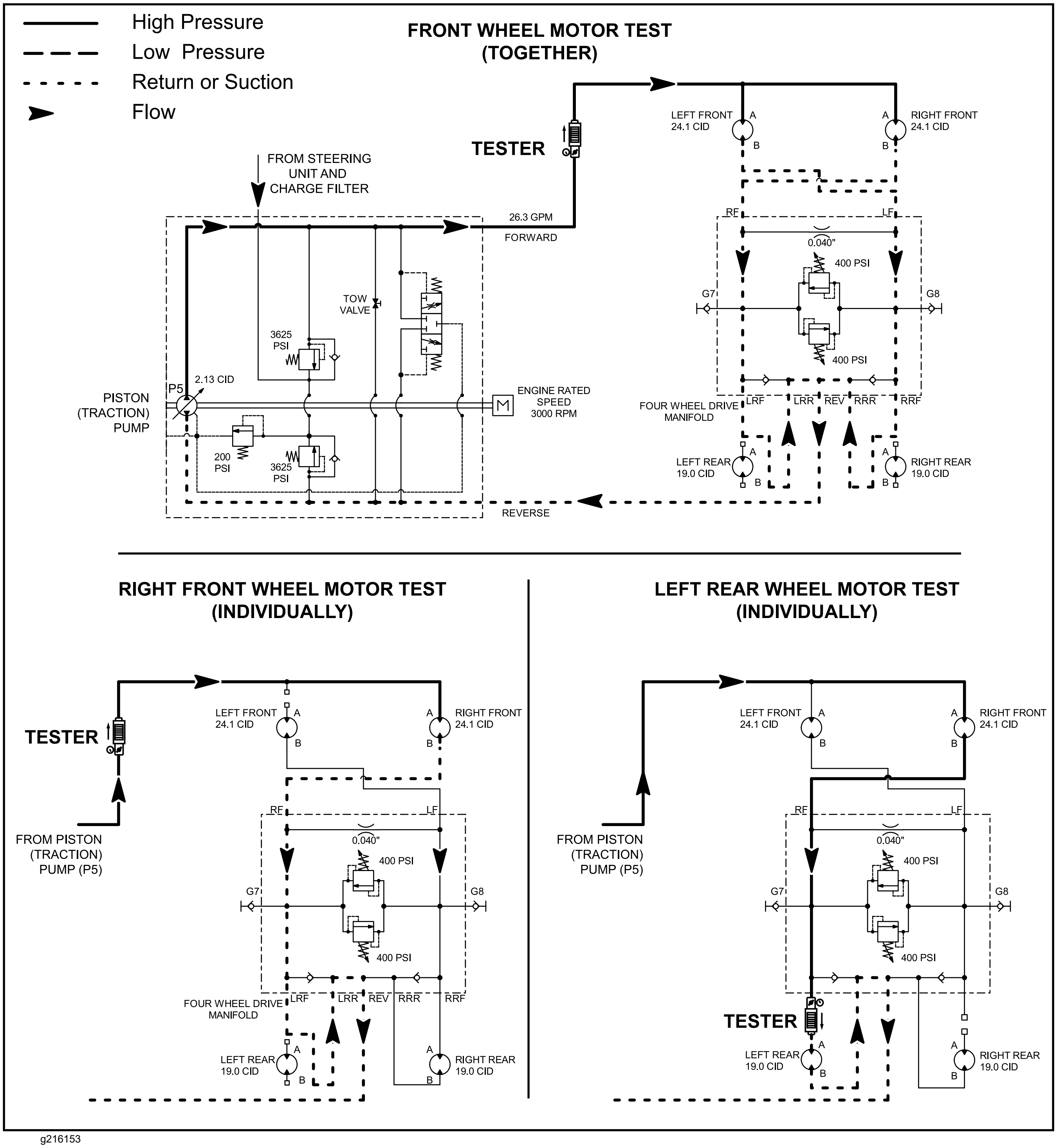


Figure 116

The wheel motor efficiency is the second in a series of tests recommended to determine the traction circuit performance. Hydraulic fluid flow of **5.7 L/minute (1.5 gallons/minute)** or more through a single stationary front wheel motor under load indicates an internal leak in the wheel motor. Hydraulic fluid flow of **4.5 L/minute (1.2 gallons/minute)** or more through a single stationary rear wheel motor under load indicates an internal leak in the wheel motor. A worn wheel motor is less efficient. Eventually, enough fluid bypass will cause the wheel motor to stall under heavy load conditions. Continued operation can generate excessive heat, cause damage to the seals and other components in the hydraulic system, and affect overall machine performance.

There are moments during wheel motor operation (geroller position) when fluid flow through the motor is less restricted. If a wheel motor is tested in this position, the test results will be higher and should not be used to determine wheel motor efficiency. Test the wheel motors in 3 different wheel positions to obtain accurate test results. Record the test readings for all the 3 wheel positions. In the forward direction, hydraulic fluid flows through both front wheel motors (in parallel) before passing through the rear wheel motor on the opposite side of the machine. In the reverse direction, hydraulic flow bypasses the rear wheel motors. Start by testing the front wheel motors combined, then test the front wheel or rear wheel motors individually as necessary.

Special Equipment Required:

- Pressure gauge
- Flow meter with pressure gauge that has at least a 68 L/minute (18 gallons/minute) capacity

IMPORTANT

Refer to Traction Circuit Component Failure (page 6–9) for information regarding the importance of removing contamination from the traction circuit.

1. Park the machine on a level surface with the reel engage switch off, lower the cutting units, shut off the engine, and set the parking brake.
2. Read all Warning, Cautions, and precautions listed at the beginning of this section.
3. Ensure that the traction pedal is correctly adjusted for the NEUTRAL position; refer to the *Operator's Manual*.
4. Attach a heavy chain to the rear of the machine frame and an immovable object to prevent the machine from moving during testing.

Testing the Front Wheel Motor

Hydraulic fluid flows through both front wheel motors (in parallel) before passing through the rear wheel motor (in series). To accurately test the front wheel motors, the rear wheel motor must be removed from the traction circuit.

1. Warm oil after test equipment is connected to prevent technician from working on a hot machine—applicable to tests when possible (any test that requires an open un-pluged/capped line (case drain tests) would not apply and oil should be warmed before disconnecting the lines).

CAUTION

Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).

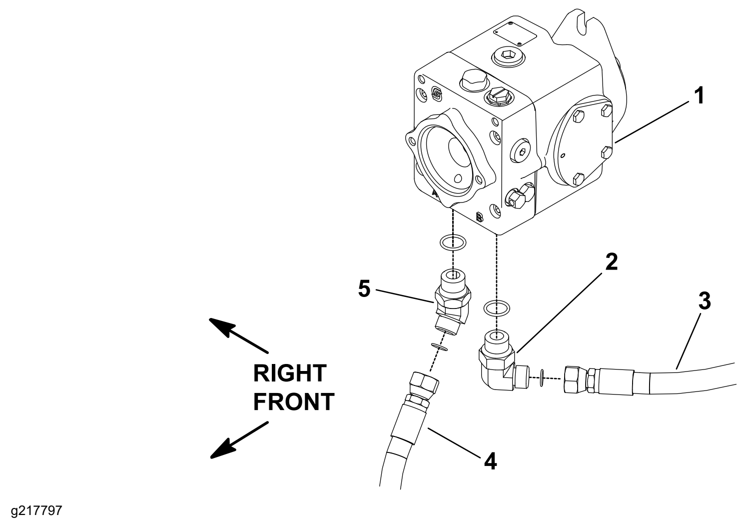


Figure 117

1. Traction pump
2. Left elbow fitting
3. Hydraulic hose (reverse)
4. Hydraulic hose (forward)
5. Right elbow fitting

2. Clean the junction of the hydraulic hose and right side elbow fitting on the bottom of the traction pump. Disconnect the hydraulic hose from the right side of the pump fitting (Figure 117).

IMPORTANT

Ensure that the fluid flow indicator arrow on the flow meter is showing that the fluid will flow from the pump, through the tester, and into the disconnected hydraulic hose.

3. Install a tester with pressure gauge and flow meter in series between the traction pump and disconnected hydraulic hose. Ensure that the flow control valve on the tester is fully open.
4. Disconnect both the hydraulic lines from each rear wheel motor, then connect the lines to each other. Plug the ports in wheel motors to prevent contamination.
5. Block the front wheels with chocks to prevent wheel rotation.
6. With the engine running, press the engine speed switch to full speed **(3,005 to 3,055 rpm)** position. Use the InfoCenter to check that the engine speed is correct.

Testing the Front Wheel Motor (continued)

⚠ CAUTION ⚠

The front wheel motors will try to move the machine forward.

Use extreme caution when performing the test.

7. Slowly press the traction pedal in the forward direction until **6,900 kPa (1,000 psi)** is displayed on the tester pressure gauge. Ensure that the front wheels are not rotating and record the flow meter reading.
8. Release the traction pedal, shut off the engine, rotate both the front wheels 90° and then test again. Release the traction pedal, shut off the engine, rotate both the front wheels 180° and then test again. Use the average of the 3 flow meter readings to judge the front wheel motor performance. Testing of wheel motor leakage in the 3 different wheel positions will provide the most accurate test results.
9. The total internal leakage for the front wheel motors combined will be shown on the flow meter. Leakage for the front wheel motors combined should be less than **11.3 L/minute (3 gallons/minute)**.

   Proceed to testing the rear wheel motor if test results are within specification. If the leakage specifications are not met, test the front wheel motors individually as follows:

   A. Remove the front wheel and wheel shield from the wheel motor that is not being tested to get access to the hydraulic tubes and fittings on the wheel motor. Remove the R-clamps that secure the hydraulic tubes to the frame.

   B. Clean and disconnect hydraulic lines from the front wheel motor that is not being tested. Cap the disconnected hydraulic lines and plug the ports of the disconnected wheel motor to prevent contamination.

   C. Repeat the procedure described in steps 6 through 8 to identify individual front wheel motor leakage. The flow should be less than **5.7 L/minute (1.5 gallons/minute)** for the tested wheel motor.

   D. If testing is required for other front wheel motor, complete steps A, B, and C for the remaining front wheel motor.

   E. If specifications are not met, repair or replace the worn wheel motor.
10. After you complete the testing, release pressure from the hydraulic system; refer to Releasing Pressure from the Hydraulic System (page 6–8).
11. Disconnect the tester from the hydraulic system.
12. Connect all the disconnected hydraulic hoses and tubes and secure the hydraulic tubes to the frame.
13. Install the wheel shield and wheels; refer to Wheels (page 8–5).
14. Start the engine, check for hydraulic-fluid leaks, repair any leaks as necessary, and fill the hydraulic tank with the correct quantity of new hydraulic fluid before returning the machine to service.

Testing the Rear Wheel Motors

Hydraulic fluid flows through both front wheel motors (in parallel) before passing through the rear wheel motors (in series). To accurately test the rear wheel motors, the front wheel motors must be allowed to rotate.

Testing the Rear Wheel Motors (continued)

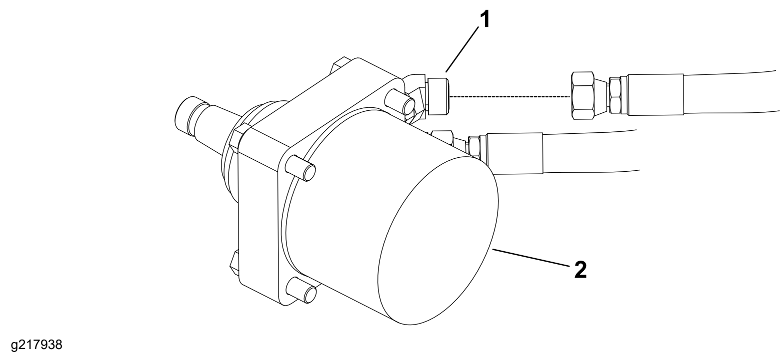


Figure 118

1. Upper hydraulic fitting
2. Right rear wheel motor

1. To test the right rear wheel motor, disconnect the hose from the upper hydraulic fitting of the wheel motor (Figure 118).

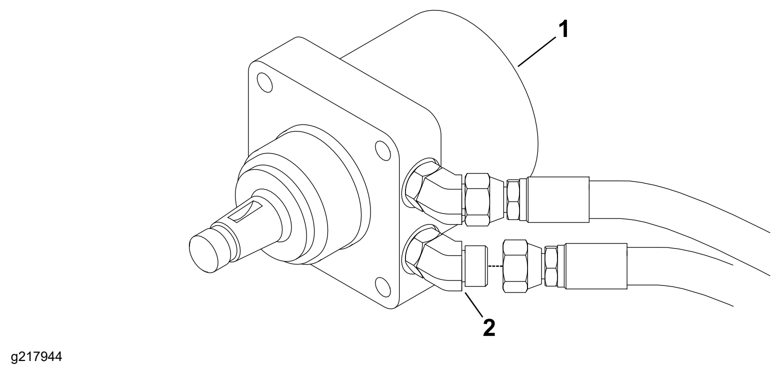


Figure 119

1. Left rear wheel motor
2. Lower hydraulic fitting

2. To test the left rear wheel motor, disconnect the hose from the lower hydraulic fitting of the wheel motor (Figure 119).
3. Install a tester with the pressure gauge and flow meter in series between the disconnected hydraulic hose and the rear wheel motor. Ensure that the tester flow control valve is fully open.

IMPORTANT

Before lifting the machine with a jack, review and follow Jacking Instructions (page 1–6).

4. Raise off the floor and support both front wheels.
5. Block the rear wheels with chocks to prevent wheel rotation.
6. With the engine running, press the engine speed switch to full speed **(3,005 to 3,055 rpm)** position. Use the InfoCenter to check that the engine speed is correct.

Testing the Rear Wheel Motors (continued)

CAUTION

The rear wheel motors will try to move the machine forward.

Use extreme caution when performing the test.

7. Slowly press the traction pedal in the forward direction until **6,900 kPa (1,000 psi)** is displayed on the tester pressure gauge. Ensure that the rear wheels are not rotating and record the flow meter reading.
8. Release the traction pedal, shut off the engine, rotate both the front wheels 90° and then test again. Release the traction pedal, shut off the engine, rotate both the front wheels 180° and then test again. Use the average of the 3 flow meter readings to judge the front wheel motor performance. Testing of wheel motor leakage in the 3 different wheel positions will provide the most accurate test results.
9. Leakage for a rear wheel motor should be less than **4.5 L/minute (1.2 gallons/minute)**.
10. If specifications are not met, repair or replace the worn wheel motor.
11. After you complete the testing, release pressure from the hydraulic system; refer to Releasing Pressure from the Hydraulic System (page 6–8).
12. Disconnect the tester from the hydraulic system.
13. Connect all the disconnected hydraulic hoses and tubes and secure the hydraulic tubes to the frame.
14. Start the engine, check for hydraulic-fluid leaks, repair any leaks as necessary, and fill the hydraulic tank with the correct quantity of new hydraulic fluid before returning the machine to service.

Testing the Traction Circuit–Piston Pump/Hydrostat Flow and Relief Pressure (5610-D)

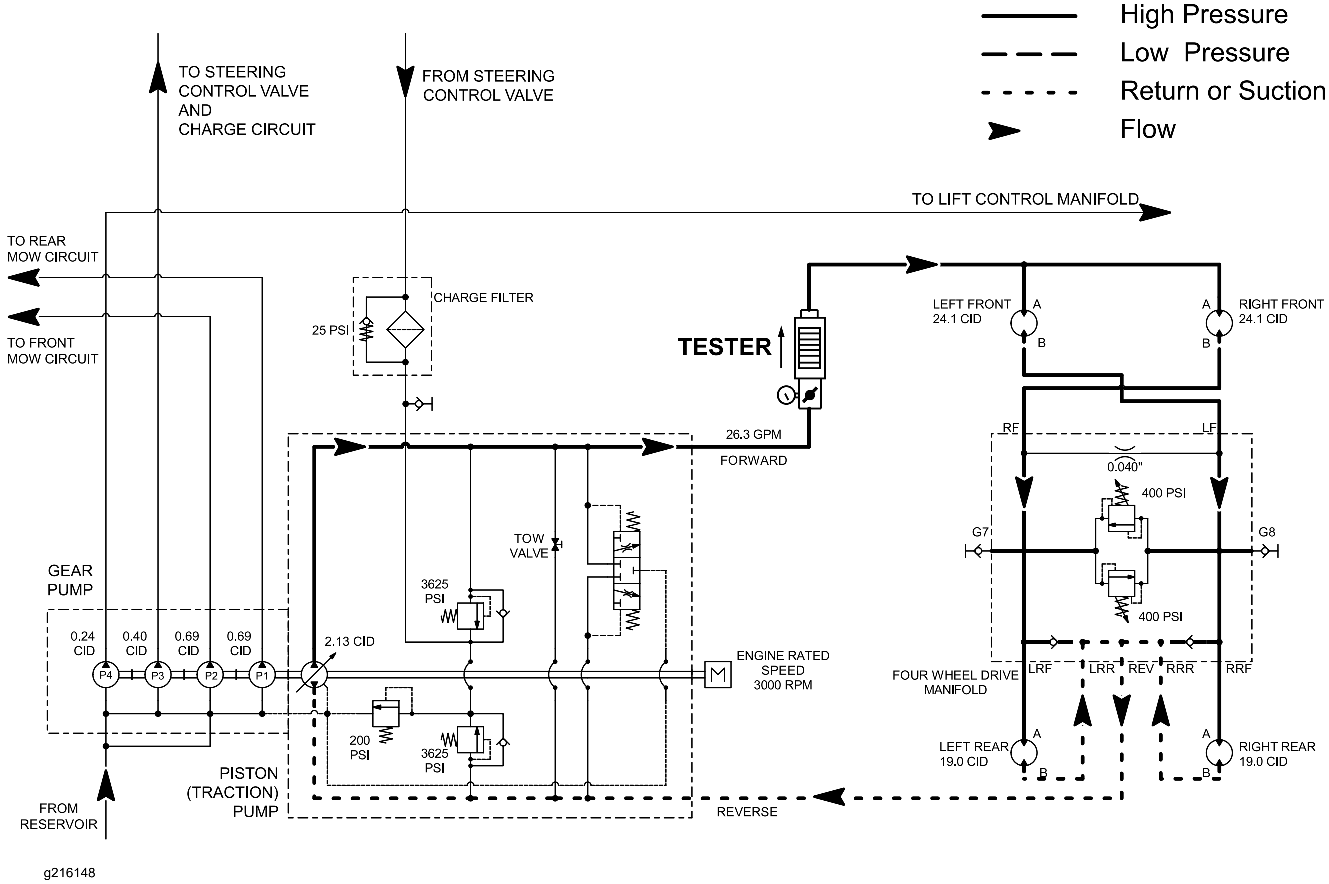


Figure 120

The hydrostat flow test is the third in a series of tests recommended to determine the traction circuit performance. This test compares fluid flow at No Load with fluid flow Under Load. A drop in flow under load of more than 12% indicates an internal leak or malfunctioning relief valve in the piston pump/hydrostat. A worn hydrostat or malfunctioning relief valve is less efficient. Eventually, enough fluid bypass will cause the unit to stall under heavy load conditions. Continued operation can generate excessive heat, cause damage to seals and other components in the hydraulic system, and affect overall machine performance.

Special Equipment Required:

- Pressure gauge
- Flow meter with pressure gauge that has at least a 114 L/minute (30 gallons/minute) capacity

Test Procedure

1. Warm oil after test equipment is connected to prevent technician from working on a hot machine—applicable to tests when possible (any test that requires an open un-pluged/capped line (case drain tests) would not apply and oil should be warmed before disconnecting the lines).

⚠ CAUTION ⚠

Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).

2. Park the machine on a level surface, lower the cutting units, shut off the engine. Ensure that the mow speed limiter is in the TRANSPORT position to allow full movement of the traction pedal.
3. Read all Warning, Cautions, and precautions listed at the beginning of this section.
4. Ensure that the traction pedal is correctly adjusted for the NEUTRAL position. Also, ensure that the traction pump is at full stroke when traction pedal is pressed fully in forward position.
5. Lift and support the machine so that all the wheels are off the ground; refer to Jacking Instructions (page 1–6).

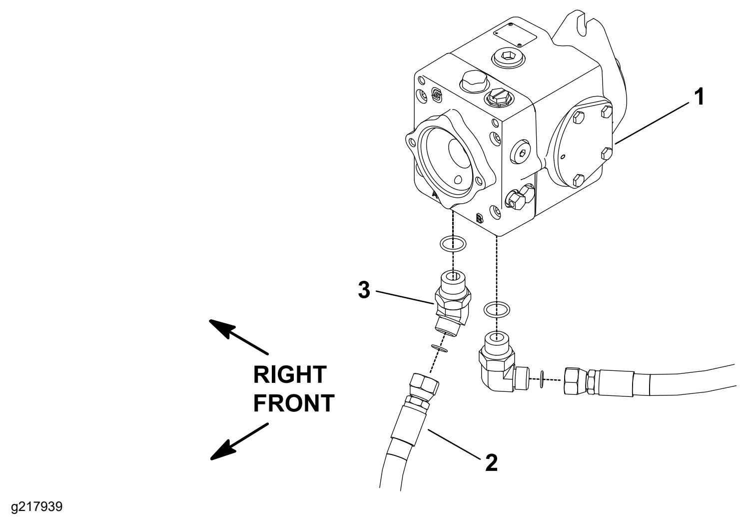


Figure 121

1. Traction pump
2. Hydraulic hose (forward)
3. Right elbow fitting

6. Clean the junction of the hydraulic hose and right side fitting on bottom of the traction pump (Figure 121), and disconnect the hose from fitting.

IMPORTANT

Ensure that the fluid flow indicator arrow on the flow meter is showing that the fluid will flow from the pump, through the tester, and into the disconnected hydraulic hose.

7. Install a tester with the pressure gauge and flow meter in series between traction pump fitting and the disconnected hose.
8. Use the hydraulic hose kit to connect tester to the machine; refer to Special Tools (page 6–44). Ensure that the fitting and hose connections are properly tightened. Also, ensure that the flow control valve on tester is fully open.

Test Procedure (continued)

⚠ CAUTION ⚠

During this procedure, all the wheels will be off the ground and rotating. Ensure that the machine is well supported so it will not move and accidentally fall to prevent injuring anyone around the machine.

9. Start the engine and run it at low-idle speed. Check for hydraulic-fluid leaks from the test connections and correct before continuing the test.
10. With the engine running, press the engine speed switch to full speed **(3,005 to 3,055 rpm)** position. Use the InfoCenter to check that the engine speed is correct.
11. Verify the pump flow at No Load as follows:
    A. Slowly press the traction pedal to fully forward position.
    B. Record the tester pressure and flow readings at no load. Unrestricted pump output should be approximately **98 L/minute (26 gallons/minute)** at **6,900 kPa (1,000 psi)**.
12. Verify the pump flow Under Load as follows:
    A. Slowly press the traction pedal to fully forward position, and keep the pedal pressed in the forward position.
    B. Apply an additional load of **6,900 to 10,340 kPa (1,000 to 1,500 psi)** by slowly closing the flow meter. The flow meter pressure gauge should read **13,800 to 17,500 kPa (2,000 to 2,500 psi)**.
    C. Record the tester pressure and flow readings under load.
13. Verify the traction relief valve operation as follows:
    A. Return the traction pedal to the NEUTRAL position.
    B. Fully close the flow meter flow control valve.
    C. Slowly set the traction pedal to full forward position.
    D. Record the tester pressure reading.

    The system pressure should reach **26,200 to 26,545 kPa (3,800 to 3,850 psi)** before the relief valve opens.

    Note: The relief valve setting is **25,000 kPa (3,625 psi)**. An additional **690 to 1,030 kPa (100 to 200 psi)** is necessary to overcome system charge pressure before the relief valve opens.

    E. Release the traction pedal, open flow control valve fully, press the engine speed switch to low speed, and shut off the engine.
14. If the relief pressure can not be met or is greater than specified, the traction relief valve is damaged and should be replaced.
15. The under load test flow reading (step 12C) should not drop more than 12% when compared to the no load test flow reading (step 11B). A difference of more than 12% may indicate the piston pump/hydrostat is worn and should be repaired or replaced.
16. After you complete the testing, disconnect the tester and connect the hose to the pump fitting.
17. Start the engine, check for hydraulic-fluid leaks, repair any leaks as necessary, and fill the hydraulic tank with the correct quantity of new hydraulic fluid before returning the machine to service.

Testing the Mow Circuit–Circuit Pressure (5610-D)

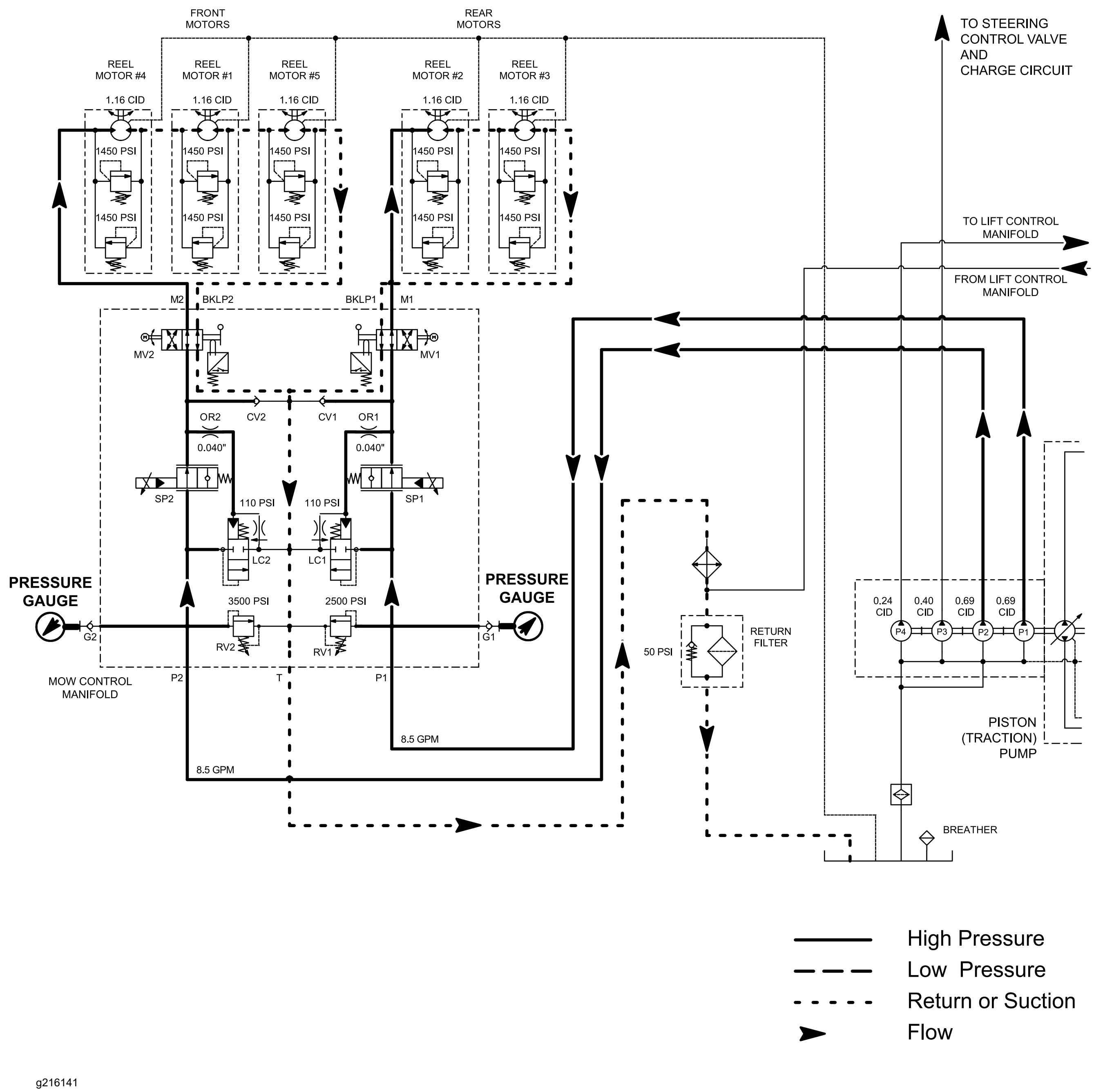


Figure 122

The cutting unit circuit pressure is the first in a series of tests recommended to check the cutting unit circuit performance. The results from this test will help determine which component(s) are the cause of cutting unit performance issues.

Special Equipment Required: Pressure gauge with extension hose.

Test Procedure

1. Ensure that the hydraulic fluid is at normal operating temperature by operating the machine for at least 10 minutes.
2. Park the machine on a level surface with the reel engage switch off, lower the cutting units, shut off the engine, set the mow speed limiter to the MOW position, and set the parking brake.
3. Ensure that the mow/backlap lever on the mow control manifold is in the MOW position.
4. Read all Warning, Cautions, and precautions listed at the beginning of this section.

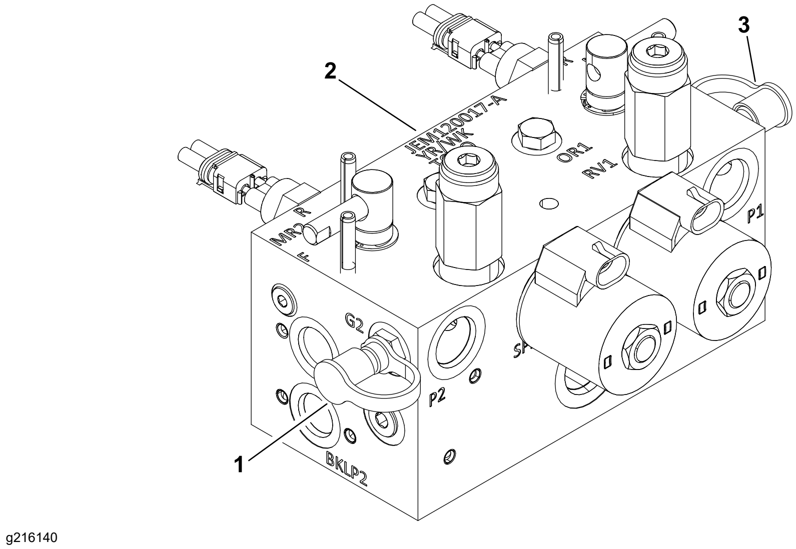


Figure 123

1. Test fitting (port G2)
2. Mow control manifold
3. Test fitting (port G1)

5. For testing the rear mow circuit, remove the cap from the test fitting at mow control manifold port (G1) and install a pressure gauge with hydraulic hose to the test fitting (Figure 123). If testing the front mow circuit, remove the cap from the test fitting at mow control manifold port (G2) and install a pressure gauge with hydraulic hose to the test fitting.

CAUTION

Keep away from the cutting units during test to prevent personal injury from the cutting reel blades.

6. Sit in the operator's seat, start the engine, and press the engine speed switch to full speed **(3,005 to 3,055 rpm)** position. Use the InfoCenter to check that the engine speed is correct.
7. Engage the cutting units. When engaged, the cutting circuit pressure may exceed manifold relief valve pressure setting of **24,100 kPa (3,500 psi)** for front mow circuit and **17,500 kPa (2,500 psi)** for rear mow circuit momentarily opening the relief valve. The circuit pressure should then stabilize at approximately **8,274 kPa (1,200 psi)**.
8. Safely secure the test pressure gauge and operate the machine under your specific mowing conditions. Monitor the test gauge while mowing. The cutting unit circuit pressure should be approximately: 10,340 to 13,800 kPa (1,500 to 2,000 psi) under low to normal load conditions.

Test Procedure (continued)

9. Disengage the cutting units, press the engine speed switch to the low speed **(1,175 to 1,225 rpm)** position, and shut off the engine.
10. If the pressure readings are within specifications and cutting reel performance is still in question, test the cutting reel motors individually; refer to Testing the Mow Circuit–Reel Motor Efficiency/Case Drain (5610-D) (page 6–116).
11. If the pressure specifications are not met, consider the following:
    A. The relief valve (RV1 or RV2) is damaged; refer to Testing the Mow Circuit–Relief Valve (RV1) and (RV2) Pressure (5610-D) (page 6–123).
    B. The gear pump (P1/P2) is damaged; refer to Testing the Mow Circuit–Gear Pump (P1) and (P2) Flow (5610-D) (page 6–127).
12. Disconnect the test equipment from the hydraulic manifold.
13. Start the engine, check for hydraulic-fluid leaks, repair any leaks as necessary, and fill the hydraulic tank with the correct quantity of new hydraulic fluid before returning the machine to service.

Testing the Mow Circuit–Reel Motor Efficiency/Case Drain (5610-D)

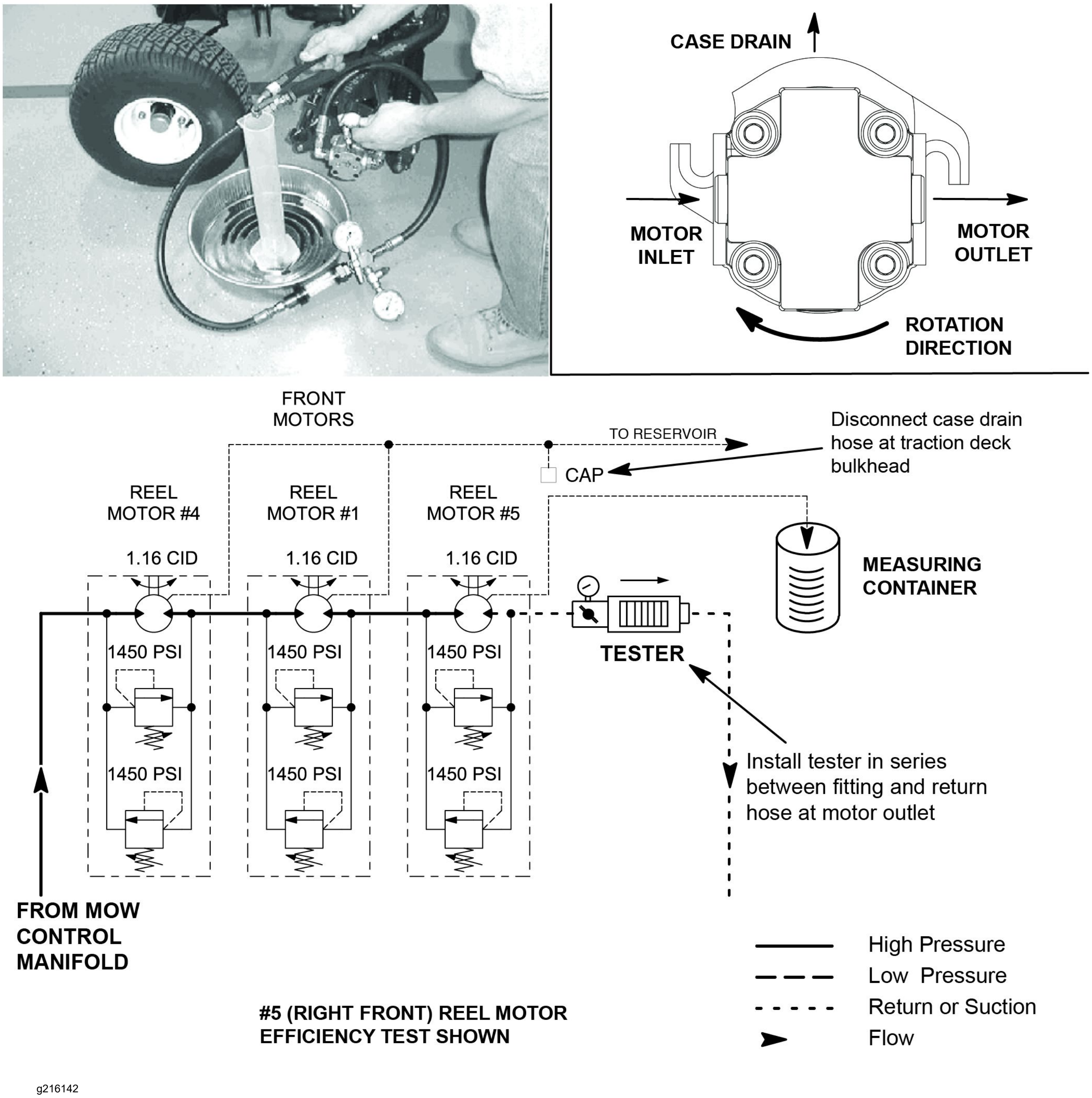


Figure 124

The reel motor efficiency/case drain test is the second in a series of tests recommended to check the cutting unit circuit performance. Over a period of time, a reel motor can wear internally. This test measures case drain volume while restricting flow across the motor ports. Case drain volume under load of more than 9% of total motor flow indicates the gears and wear plates in the motor have worn. A worn motor may bypass the hydraulic fluid to its case drain causing the motor to be less efficient. Eventually, enough fluid loss will cause the reel motor to stall under heavy cutting 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 quality of cut.

One method to find a failing or malfunctioning cutting reel motor is to have another person observe the machine while mowing in dense turf. A bad motor will run slower, produce fewer clippings and may cause a different appearance on the turf.

Special Equipment Required: Flow meter with pressure gauge that has at least a 45 L/minute (12 gallons/minute) capacity.

Test Procedure

1. Ensure that the hydraulic fluid is at normal operating temperature by operating the machine for at least 10 minutes.
2. Determine which of the reel motor is suspect and begin testing with that motor.
3. Park the machine on a level surface with the reel engage switch off, lower the cutting units, shut off the engine, mow speed limiter is in the MOW position, and set the parking brake.

CAUTION

Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).

4. Read all Warning, Cautions, and precautions listed at the beginning of this section.

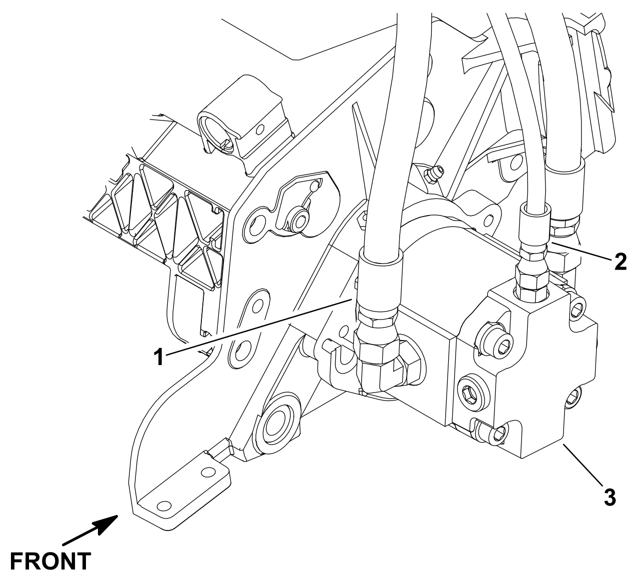


Figure 125

1. Return hose
2. Case drain hose
3. #5 cutting reel motor

Note: The cutting reel motors are connected in series. If a damaged reel motor is not obvious (based on quality of cut issues) you may have to test all motors in the circuit. If testing all cutting reel motors, start with the first motor in the series (front left).

5. For the reel motor that is to be tested, clean the junction of the motor case drain hose (small diameter hose) where it is connected to traction unit bulkhead (not at the motor) (Figure 125).

Test Procedure (continued)

6. Disconnect the case drain hose and put a steel cap on the fitting at the traction unit. Leave the case drain hose from the motor open and place the open end of the disconnected hose into a drain pan.

IMPORTANT

Ensure that the fluid flow indicator arrow on the flow gauge is showing that the fluid will flow from the reel motor, through the tester, and into the return hose.

7. For the reel motor that is to be tested, clean the junction of the hydraulic return hose and reel motor fitting at the motor outlet (Figure 125).
8. Disconnect the return hose from the motor, install the tester with the pressure gauge and flow meter in series with the motor and disconnected return hose. Ensure that the flow control valve on tester is fully open.

   Note: Use a graduated container, the special tool TOR4077, to measure the case drain leakage (Figure 124).
9. Use the InfoCenter display to set reel speed control to the full speed setting. Ensure that the mow/backlap lever on the mow control manifold is in the MOW position.
10. Start the engine and run it at low-idle speed. Check for hydraulic-fluid leaks from the test connections and correct before continuing the test.

CAUTION

The cutting unit reels will rotate when you perform the motor efficiency test. Keep away from the cutting units during the test to prevent personal injury from the rotating reel blades. Do not stand in front of the machine.

Note: This test requires 2 people (one in the seat and one at the cutting reel motor).

11. Sit on the seat with the engine running, press the engine speed switch to full speed **(3,005 to 3,055 rpm)** position. Use the InfoCenter to check that the engine speed is correct. Press the reel engage switch to ON position, and engage the cutting units.
12. Monitor the tester pressure gauge carefully while you slowly close the flow control valve until a pressure of **13,800 kPa (2,000 psi)** is obtained.
13. Have an assistant place the disconnected motor case drain hose into a container graduated in ounces or milliliters (Toro Part No. TOR4077) and collect the hydraulic fluid for 10 seconds.
14. After 10 seconds, remove the hose end from the container, and then move the reel engage switch to OFF position, open the tester flow control valve, and shut off the engine.
15. Identify the amount of fluid collected in the container. Record the test results. If the flow was greater than **651 ml (22 fl oz)** and **3.9 L/minute (1.02 gallons/minute)**, repair or replace the tested reel motor; refer to Servicing the Cutting Reel Motor (Casappa) (page 6–204).
16. After you complete the testing, shut off the engine. Disconnect the tester from the motor and return hose.

Test Procedure (continued)

17. Connect the return hose to the reel motor, remove the plug from the machine bulkhead fitting, and connect case drain hose to the fitting.
18. If necessary, perform the motor efficiency test on the other reel motors.

IMPORTANT

When testing more than one cutting unit motor, check and adjust the hydraulic-fluid level in the tank after testing each motor.

19. When testing is complete, start the engine, check for hydraulic-fluid leaks, repair any leaks as necessary, and fill the hydraulic tank with the correct quantity of new hydraulic fluid before returning the machine to service.

Testing the Mow Circuit–Reel Motor Cross−Over Relief Pressure (5610-D)

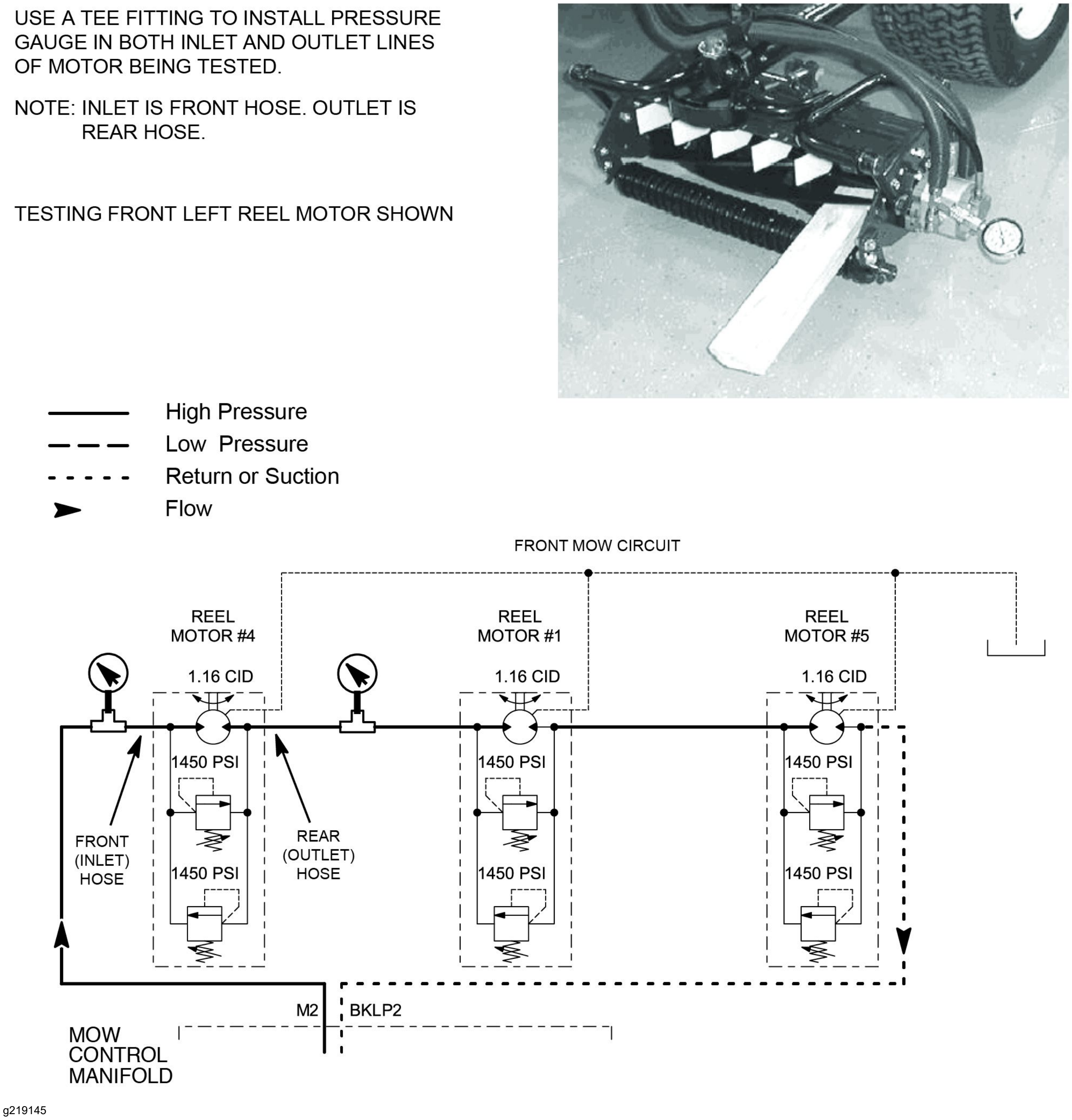


Figure 126

Note: One method to find a failing or malfunctioning cutting reel motor is to have another person observe the machine while mowing in dense turf. A bad motor will run slower, produce fewer clippings and may cause a different appearance on the turf.

Note: Before testing the cutting reel motor cross-over relief pressure, ensure that the reel motor is in good condition by performing the cutting reel motor efficiency test; refer to Testing the Mow Circuit–Reel Motor Efficiency/Case Drain (5610-D) (page 6–116).

Test Procedure

1. Ensure that the hydraulic fluid is at normal operating temperature by operating the machine for at least 10 minutes.
2. Determine which of the reel motor is suspect and begin testing with that motor.
3. Park the machine on a level surface with the reel engage switch off, lower the cutting units, shut off the engine, mow speed limiter is in the MOW position, and set the parking brake.

CAUTION

Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).

4. Read all Warning, Cautions, and precautions listed at the beginning of this section.

   Note: The cutting reel motors are connected in series. If a damaged reel motor is not obvious (based on quality of cut issues) you may have to test all motors in the circuit. If testing all cutting reel motors, start with the first motor in the series (front left).

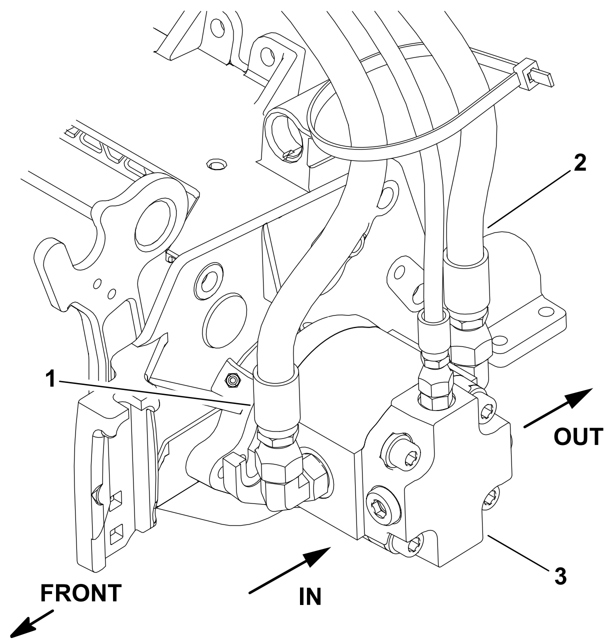


Figure 127

1. Reel motor inlet hose
2. Reel motor outlet hose
3. #4 cutting reel motor

5. For the reel motor that is to be tested, clean the motor inlet and outlet fittings and hydraulic hoses (Figure 127). Loosen and remove both hoses from the fittings. Install a tee fitting with a 35,000 kPa (5,000 psi) pressure gauge between the fitting and hose for both the motor inlet and outlet.
6. Insert a block of wood between the cutting unit reel blades and the carrier frame of cutting unit being tested to prevent reel from turning (Figure 126).

Test Procedure (continued)

7. Use the InfoCenter display to set reel speed control to the full speed setting. Ensure that the mow/backlap lever on the mow control manifold is in the MOW position.
8. Start the engine and run it at low-idle speed. Check for hydraulic-fluid leaks from the test connections and correct before continuing the test.

CAUTION

The adjacent cutting unit reels will rotate when you perform the cross-over relief pressure test. Keep away from cutting units during the test to prevent personal injury from the rotating reel blades. Do not stand in front of the machine.

Note: This test requires 2 people (one in the seat and one at the cutting reel motor).

9. Sit on the seat with the engine running, press the engine speed to low speed **(1,175 to 1,225 rpm)** position. Use the InfoCenter to check that the engine speed is correct. Press the reel engage switch to ON position, and engage the cutting units.
10. There should be a slight hesitation in pressure increase on the inlet side of motor as the cross-over relief valve opens. Record the pressure reading on both the inlet and outlet side pressure gauges.
11. Disengage the cutting units and shut off the engine.
12. Calculate the pressure differential between the 2 gauges. If the pressure differential is not approximately **10,000 kPa (1,450 psi)**, the cross-over relief valves on the tested motor may be leaking or damaged. Inspect the relief valves in the reel motor and replace if necessary; refer to Servicing the Cutting Reel Motor (Casappa) (page 6–204).
13. After you complete the testing, release the cutting unit hydraulic system pressure; refer to Releasing Pressure from the Hydraulic System (page 6–8). Remove the pressure gauges and tee fittings from the machine. Connect the hydraulic hoses to the reel motor fittings.
14. If necessary, test the cross-over relief pressure on other cutting reel motors.

IMPORTANT

When testing more than one cutting unit motor, check and adjust the hydraulic-fluid level in the tank after testing each motor.

15. When testing is complete, start the engine, check for hydraulic-fluid leaks, repair any leaks as necessary, and fill the hydraulic tank with the correct quantity of new hydraulic fluid before returning the machine to service.

Testing the Mow Circuit–Relief Valve (RV1) and (RV2) Pressure (5610-D)

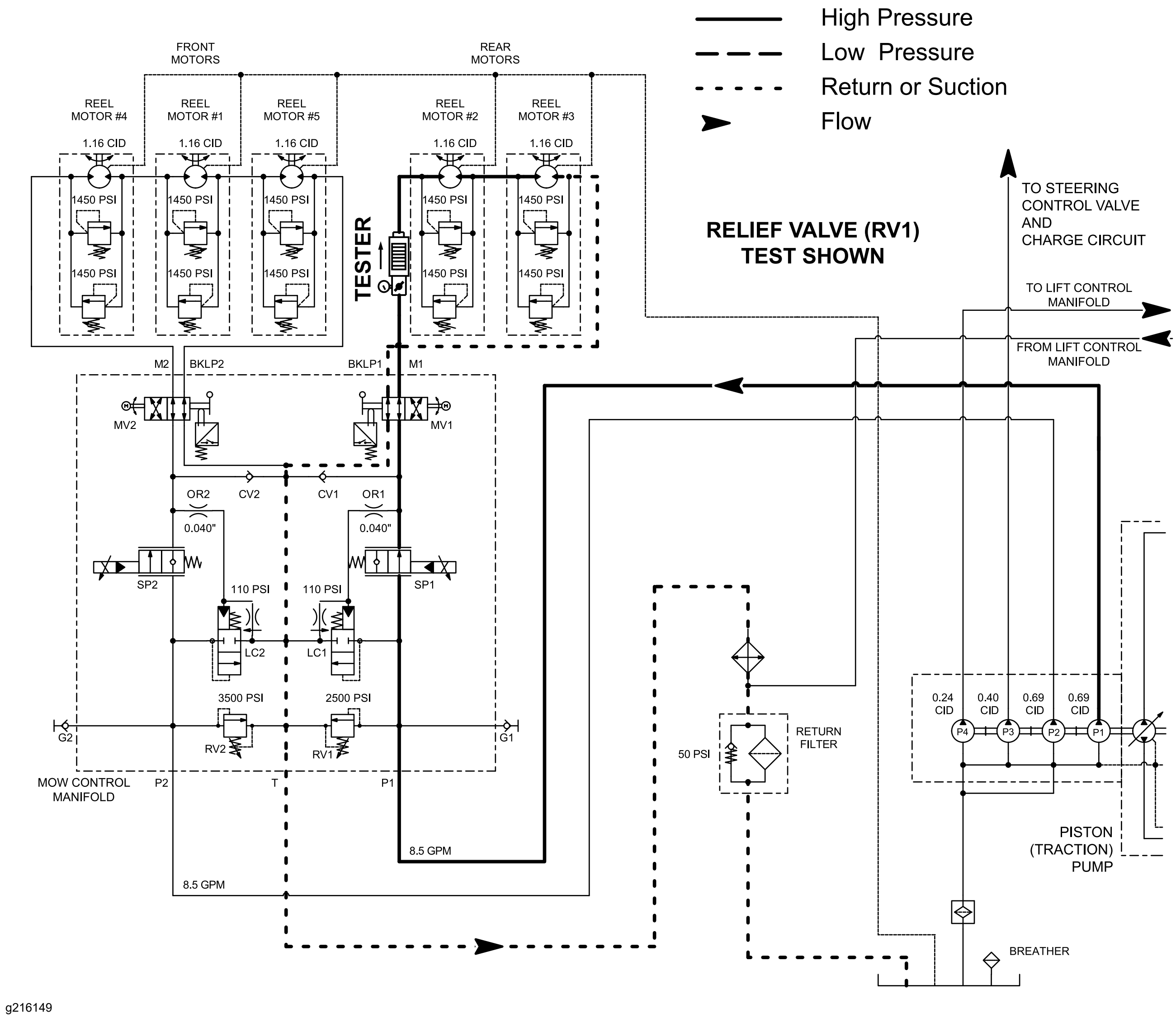


Figure 128

Test the performance of the mow control manifold relief valve (RV1) and (RV2) to ensure that the maximum amount of fluid is available to the cutting reel motors up to the set relief pressure. This test also ensures that pump (P1) and (P2) are capable of generating enough pressure to open properly functioning relief valves.

Note: The front cutting reel circuit is supplied by pump (P2) and protected by a relief valve (RV2) in the mow control manifold. The rear cutting reel circuit is supplied by pump (P1) and is protected by relief valve (RV1); refer to the Hydraulic Flow Diagrams (5610-D) (page 6–32).

Special Equipment Required: Flow meter with pressure gauge that has at least a 45 L/minute (12 gallons/minute) capacity.

Test Procedure

1. Park the machine on a level surface with the reel engage switch off, lower the cutting units, shut off the engine, mow speed limiter is in the MOW position, and set the parking brake.

CAUTION

Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).

2. Read all Warning, Cautions, and precautions listed at the beginning of this section.

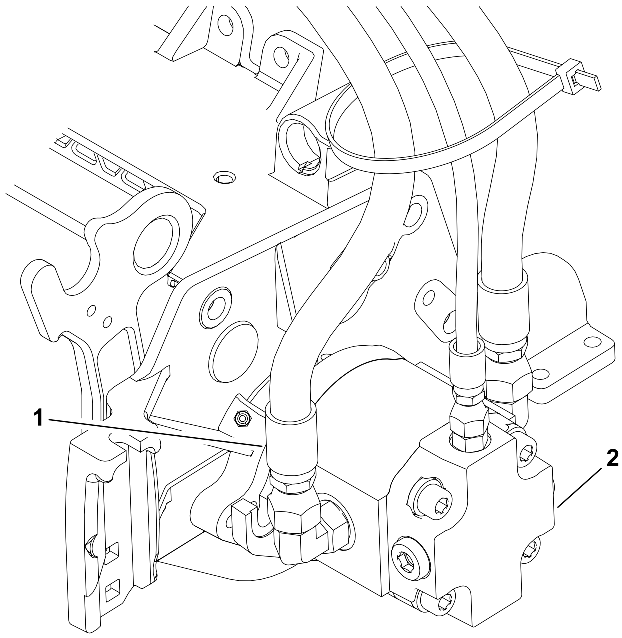


Figure 129

1. Reel motor inlet hose
2. #4 cutting reel motor

3. To test the front cutting unit circuit relief valve RV2, clean and disconnect the inlet hose to the #4 (front left) cutting unit motor (Figure 129).

Test Procedure (continued)

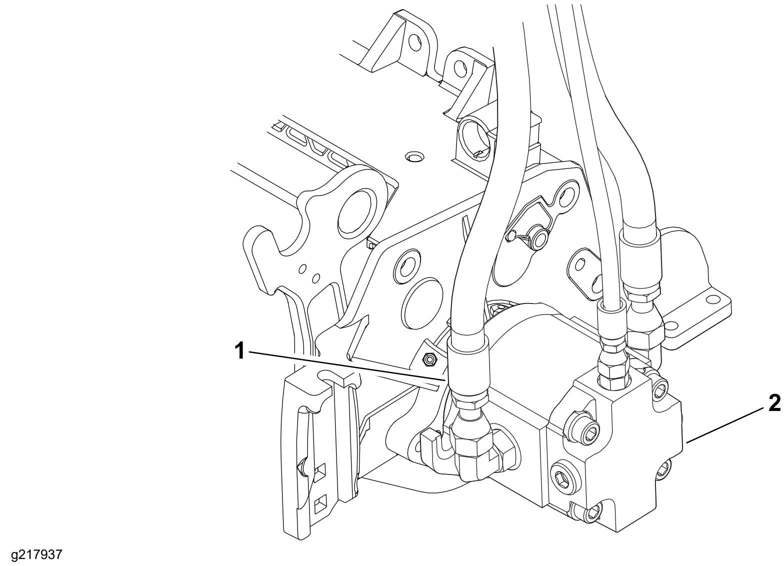


Figure 130

1. Reel motor inlet hose
2. #2 cutting reel motor

4. To test the rear cutting unit circuit relief valve RV1, clean and disconnect the inlet hose to the #2 (rear left) cutting unit motor (Figure 130).

IMPORTANT

Ensure that the fluid flow indicator arrow on the flow meter is showing that the fluid will flow from the disconnected hose, through the tester, and into the reel motor.

5. Install the tester with a pressure gauge and flow meter in series with the disconnected hose and the reel motor. Ensure that the flow control valve on tester is fully open.
6. Use the InfoCenter display to set reel speed control to the full speed setting. Ensure that the mow/backlap lever on the mow control manifold is in the MOW position.
7. Ensure that the hydraulic fluid is at normal operating temperature by operating the machine for at least 10 minutes.
8. With the engine running, press the engine speed switch to full speed **(3,005 to 3,055 rpm)** position. Use the InfoCenter to check that the engine speed is correct.

WARNING

Keep away from the cutting reel during the test to prevent personal injury.

9. Have a second person to occupy the seat, press the reel engage switch to ON position, and then move the joystick lever forward to engage the cutting units.

Test Procedure (continued)

IMPORTANT

Do not hold over relief for longer than necessary to obtain the pressure reading, while you perform this test.

10. Monitor the pressure gauge carefully while you slowly close the tester flow control valve. As the relief valve lifts, the pressure gauge needle will momentarily stop.

    Note: The system pressure will continue to increase, once the relief valve is opened.

11. Once the relief valve lifts, the system pressure should be:
    - Approximately **17,500 kPa (2,500 psi)** for the relief valve (RV1)
    - Approximately **24,100 kPa (3,500 psi)** for the relief valve (RV2)

12. Open the tester flow control valve, disengage the cutting units and shut off the engine.

13. If the pressure is incorrect, remove the RV valve on the mow manifold, and clean or replace the valve; refer to Servicing the Mow Control Manifold Assembly (page 6–190).

14. If you are not able to obtain relief pressure, check for a restriction in the pump intake line and/or check the gear pump (P2) (front cutting reel circuit) and/or pump (P1) (rear cutting reel circuit) for wear, damage, or inefficiency; refer to Testing the Mow Circuit–Gear Pump (P1) and (P2) Flow (5610-D) (page 6–127).

15. After you complete the testing, shut off the engine, and then release hydraulic system pressure; refer to Releasing Pressure from the Hydraulic System (page 6–8). Disconnect the tester from the machine and connect the hydraulic hose to the reel motor fitting.

16. Start the engine, check for hydraulic-fluid leaks, repair any leaks as necessary, and fill the hydraulic tank with the correct quantity of new hydraulic fluid before returning the machine to service.

Testing the Mow Circuit–Gear Pump (P1) and (P2) Flow (5610-D)

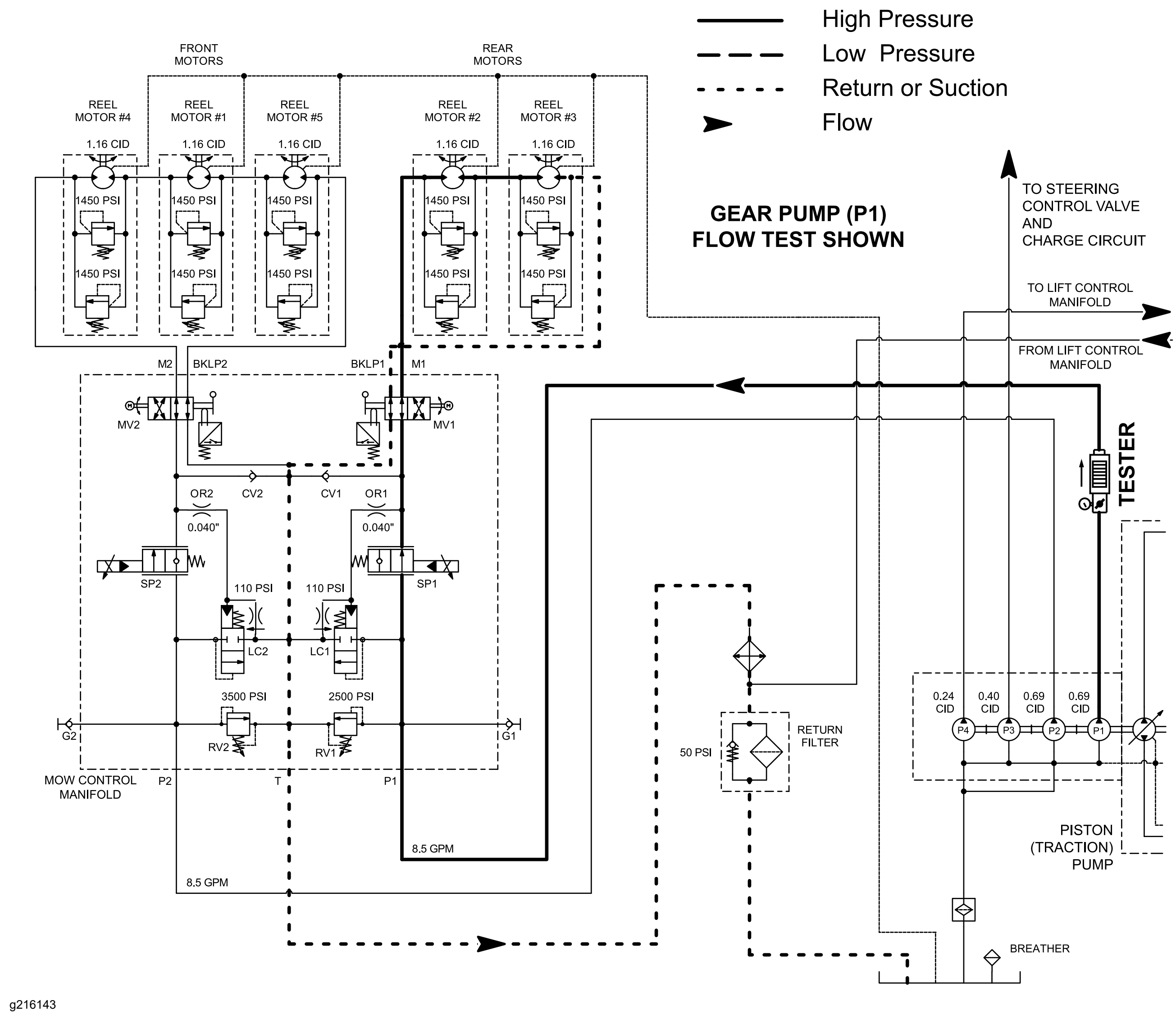


Figure 131

The gear pump (P1) and (P2) flow test is the last in a series of tests recommended to determine cutting unit circuit performance. The gear pump P1 supplies hydraulic flow to the rear cutting units, while gear pump P2 provides hydraulic flow to the front cutting units.

This test compares fluid flow at No Load with fluid flow Under Load. A drop in flow under load of more than 15% indicates the gears and wear plates in the pump have worn. A worn pump may bypass the hydraulic fluid that reduces the pump efficiency. After sometime, sufficient fluid loss causes the reel to stall under heavy load conditions. Continued operation with a worn, inefficient pump can generate excessive heat and cause damage to the seals and other components in the hydraulic system.

Special Equipment Required: Flow meter with pressure gauge that has at least a 45 L/minute (12 gallons/minute) capacity.

Test Procedure

1. Park the machine on a level surface with the reel engage switch off, lower the cutting units, shut off the engine, mow speed limiter is in the MOW position, and set the parking brake.

CAUTION

Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).

2. Read all Warning, Cautions, and precautions listed at the beginning of this section.
3. Lift and support the operator seat to get access to the hydraulic pump.

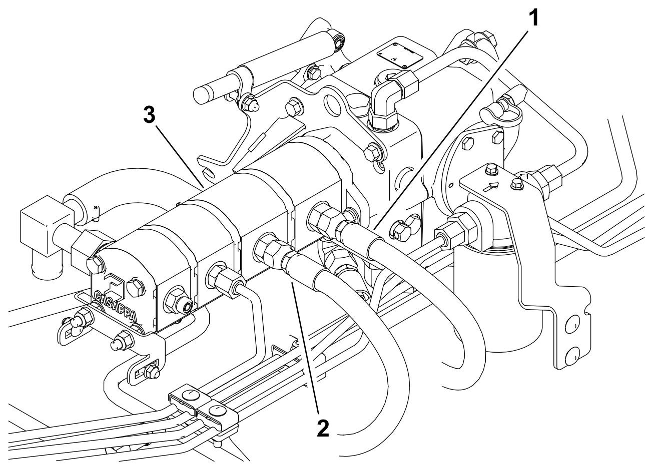


Figure 132

1. Pump P1 outlet hose
2. Pump P2 outlet hose
3. Gear pump assembly

4. Identify the suspect pump section that is to be tested (Figure 132).
5. Clean the junction of gear pump fitting and the hydraulic outlet hose, and then disconnect the hose from the pump fitting:
   - Pump section (P1) for the rear cutting units.
   - Pump section (P2) for the front cutting units.

IMPORTANT

Ensure that the fluid flow indicator arrow on the flow gauge is showing that the fluid will flow from the gear pump, through the tester, and into the hose. The engine needs to be started with the tester connected. Route the tester hoses so that the tester can be read while operator seat is fully lowered and occupied.

6. Install a tester with the pressure gauge and flow meter in series between the disconnected hose and the gear pump fitting. Ensure that the flow control valve on the tester is fully open.
7. Ensure that the hydraulic fluid is at normal operating temperature by operating the machine for at least 10 minutes.

Test Procedure (continued)

8. Start the engine and run it at low-idle speed. Check for hydraulic-fluid leaks from the test connections and correct before continuing the test.
9. With the engine running, press the engine speed switch to full speed **(3,005 to 3,055 rpm)** position. Do not engage the cutting units. Use the InfoCenter to check that the engine speed is correct.
10. Verify the pump flow at No Load as follows:

    Record the tester pressure and flow readings at no load. Unrestricted pump output should be approximately **32 L/minute (8.5 gallons/minute)**.
11. Verify the pump flow Under Load as follows:

CAUTION

Do not close the tester valve fully when performing this test. In this test, the hydraulic tester is positioned before the manifold relief valve.

Pump damage can occur if the fluid flow is fully restricted by fully closing the tester flow control valve.

    A. Monitor the tester pressure gauge carefully while you slowly close the flow control valve until you get **10,340 kPa (1,500 psi)**.
    B. Record the tester pressure and flow readings under load.
12. Press the engine speed switch to low speed **(1,175 to 1,225 rpm)** position and shut off engine.
13. The under load test flow reading (step 11B) should not drop more than 15% when compared to the no load test flow reading (step 10A). A difference in flow of more than 15%, or the inability to achieve specified pressure may indicate:
    A. A restriction in the pump inlet line.
    B. The gear pump being tested is worn and should be repaired or replaced; refer to Servicing the Gear Pump (page 6–169).
14. Release pressure from the hydraulic system; refer to Releasing Pressure from the Hydraulic System (page 6–8).
15. Disconnect the tester from the machine and connect the hydraulic hose to the gear pump fitting.
16. Start the engine, check for hydraulic-fluid leaks, repair any leaks as necessary, and fill the hydraulic tank with the correct quantity of new hydraulic fluid before returning the machine to service.
17. Lower and secure the operator seat.

Testing the Steering Circuit–Steering Control Valve, Relief Valve (R10) Pressure, and Steering Cylinder (5610-D)

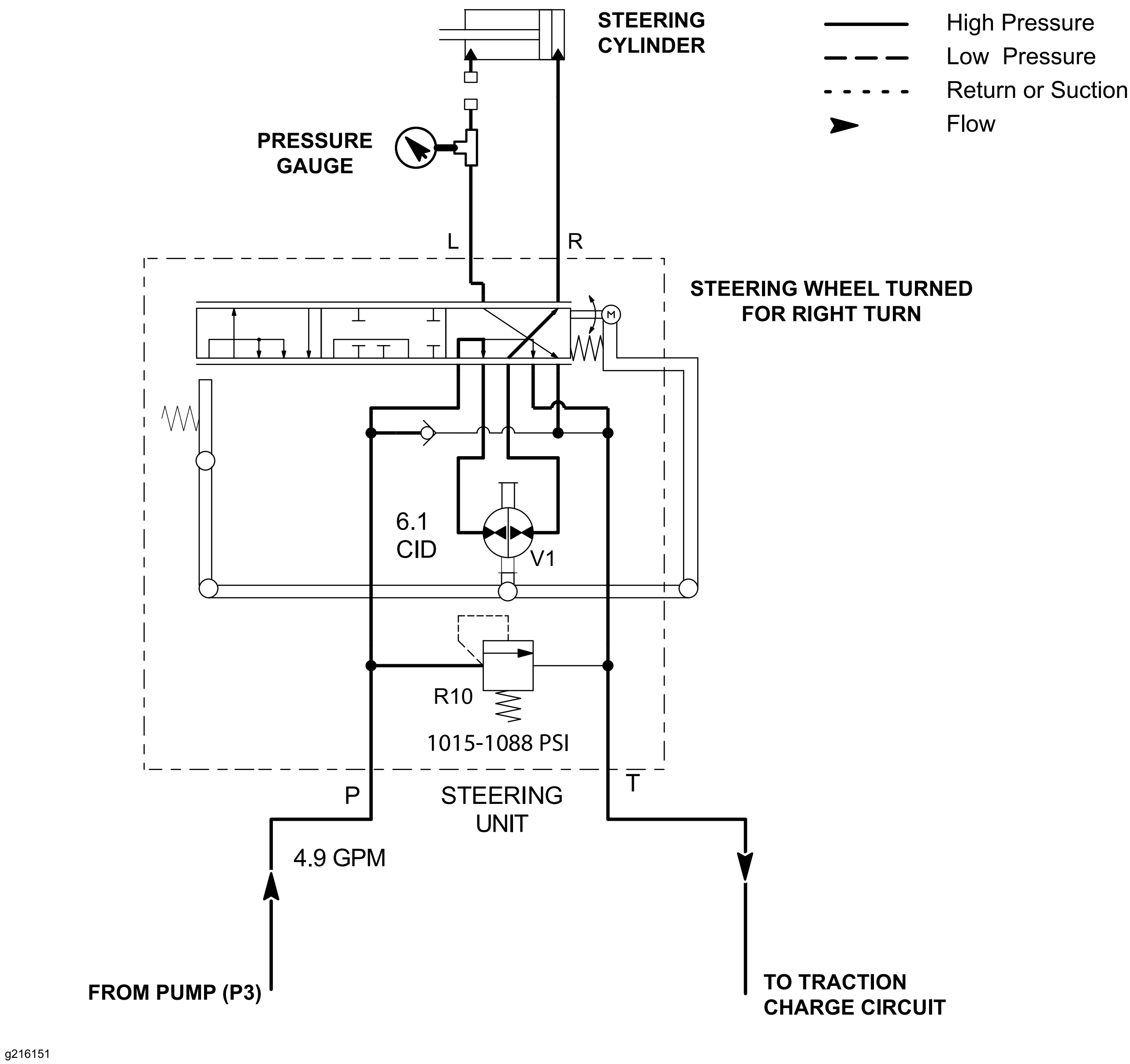


Figure 133

Unit steering performance can be affected by incorrect rear tire pressure, binding in the hydraulic steering cylinder, extra weight on the vehicle, and/or binding of the rear axle steering components. Ensure that these conditions are checked and functioning properly before proceeding with any steering system hydraulic testing.

Note: The relief valve for the steering circuit is integrated into the steering control valve.

Test Procedure

1. Ensure that the hydraulic fluid is at normal operating temperature by operating the machine for at least 10 minutes.
2. Drive the 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 wheels.
   B. The steering wheel movements should be followed immediately by a corresponding rear wheel movement without the steering wheel continuing to turn.
3. Stop unit with the engine running. Turn the steering wheel with small quick movements in both directions. Let go of the steering wheel after each movement.
   A. The steering control valve should respond to each steering wheel movement.
   B. When steering wheel is released, steering control should return to the neutral position with no additional turning.
4. If either of these performance tests indicate a steering problem, determine if the steering cylinder is damaged using the following procedure:
   A. Park the machine on a level surface with the reel engage switch off, lower the cutting units, and set the parking brake.
   B. With the engine running, turn the steering wheel to the right (clockwise) until the steering cylinder rod is fully extended and shut off the engine.
   C. Read all Warning, Cautions, and precautions listed at the beginning of this section.
   D. Clean the fitting and hose end, disconnect the hydraulic hose from the fitting on the rod end of the steering cylinder.
   E. Use an elbow or a tee fitting with a hole plugged and install a pressure gauge at the end of the disconnected hose.
   F. With the engine shut off, continue turning the steering wheel to the right (clockwise) with the steering cylinder fully extended. Monitor the open fitting on the steering cylinder as the wheel is turned. If the hydraulic fluid comes out of the fitting while turning the steering wheel to the left, the steering cylinder has internal leakage and should be repaired or replaced.
5. The steering circuit relief valve located in the steering control valve can be tested with the pressure gauge installed in the same location as the steering cylinder test (step 4) as follows:
   A. Start the engine and run it at low-idle speed. Check for hydraulic-fluid leaks from the test connections and correct before continuing the test.
   B. Set the engine speed to approximately 2,000 rpm. Use the InfoCenter to check that the engine speed is correct.

IMPORTANT

Hold the steering wheel at full lock only long enough to get a system pressure reading. Holding the steering wheel against the stop for an extended period may damage the steering control valve.

Test Procedure (continued)

IMPORTANT

As the steering wheel is turned, ensure that the pressure gauge is not contacted by any machine parts.

C. Monitor the pressure gauge carefully when turning the steering wheel for a right hand turn (clockwise) and holding.

D. The system pressure should be approximately **6,990 to 7,500 kPa (1,015 to 1,088 psi)** as the relief valve lifts.

E. Return the steering wheel to the NEUTRAL position, shut off the engine, and record the test results.

6. If the specification is not met, repair or replace the steering control valve; refer to Servicing the Steering Control Valve (page 6–225).
7. After you complete the testing, shut off the engine, and then release hydraulic system pressure; refer to Releasing Pressure from the Hydraulic System (page 6–8). Disconnect the pressure gauge, and connect removed hydraulic hose to the steering cylinder.
8. Start the engine, check for hydraulic-fluid leaks, repair any leaks as necessary, and fill the hydraulic tank with the correct quantity of new hydraulic fluid before returning the machine to service.

Testing the Steering Circuit–Gear Pump (P3) Flow (5610-D)

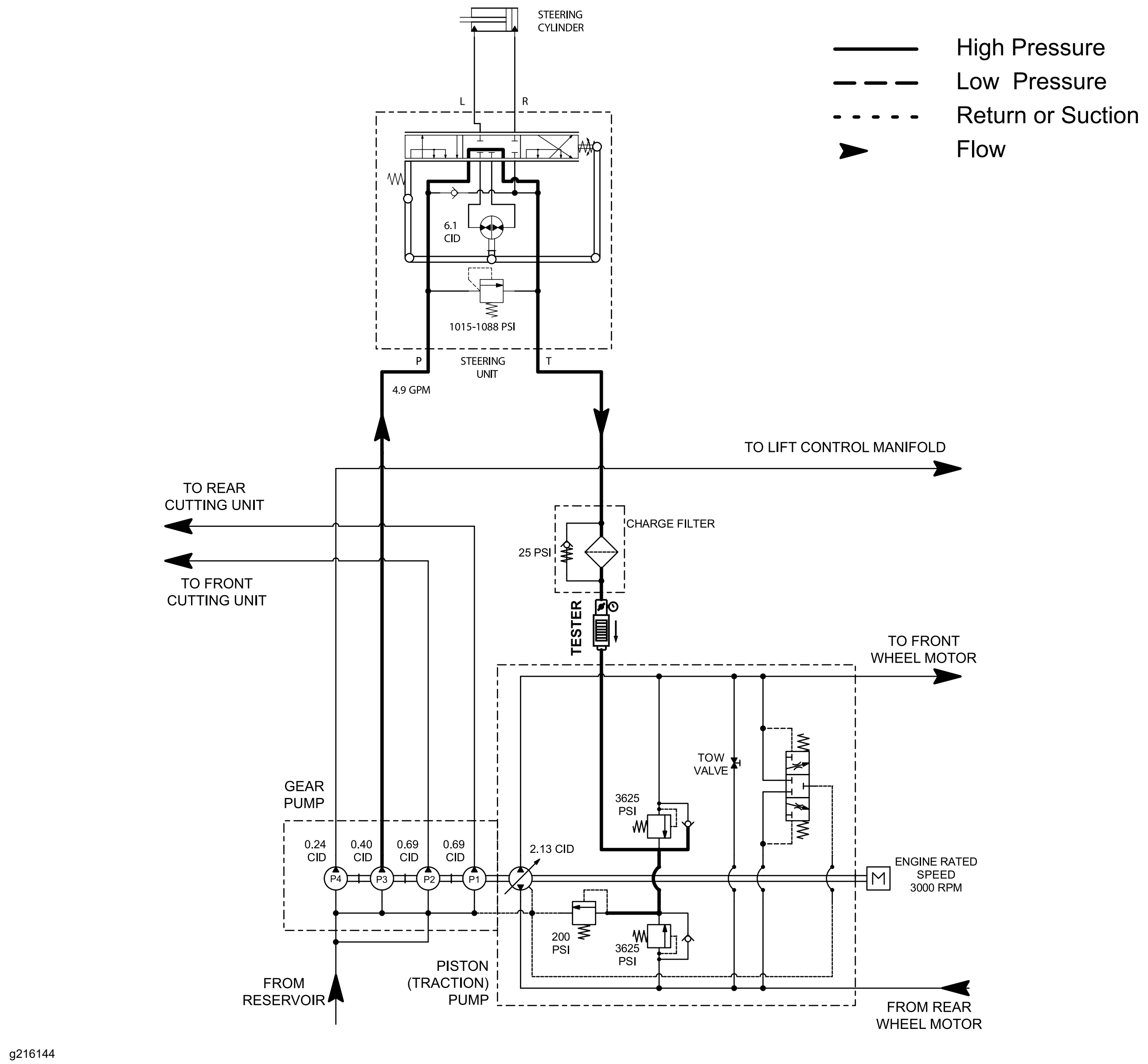


Figure 134

The gear pump (P3) is designed to satisfy the steering cylinder needs (at full speed). The gear pump (P3) flow test compares fluid flow at No Load with fluid flow Under Load. A drop in flow under load of more than 15% indicates the gears and wear plates in the pump have worn. Continued operation with a worn pump can generate excessive heat and cause damage to the seals and other components in the hydraulic system.

Special Equipment Required: Flow meter with pressure gauge that has at least a 16 L/minute (5 gallons/minute) capacity.

Test Procedure

1. Park the machine on a level surface with the reel speed switch off, lower the cutting units, shut off the engine, and set the parking brake.
2. Read all Warning, Cautions, and precautions listed at the beginning of this section.

Test Procedure (continued)

⚠ CAUTION ⚠

Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).

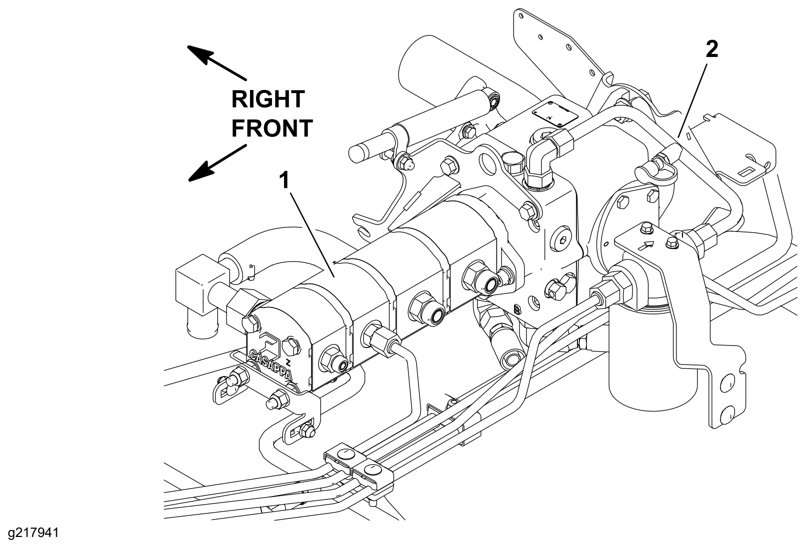


Figure 135

1. Gear pump (P3)
2. Hydraulic tube

3. Lift and support the operator seat to get access to the hydraulic pump assembly.
4. Clean both the ends of the hydraulic tube that connects charge filter outlet with the traction pump (Figure 135). Disconnect both ends of the hydraulic tube and remove it from the machine. Plug both ends of the removed hydraulic tube to prevent system contamination.

IMPORTANT

Ensure that the fluid flow indicator arrow on the flow meter is showing that the fluid will flow from the hydraulic tube, through the tester, and into the traction pump.

5. Install a tester with the pressure gauge and flow meter in place of the removed hydraulic tube. Connect the tester inlet hose to the charge filter fitting and outlet hose to the traction pump fitting. Ensure that the flow control valve on the tester is fully open.
6. Ensure that the hydraulic fluid is at normal operating temperature by operating the machine for at least 10 minutes.
7. Ensure that the traction pedal is in the NEUTRAL position, steering wheel is stationary, and parking brake is set.
8. Start the engine and run it at low-idle speed **(1,175 to 1,225 rpm)**. Check for hydraulic-fluid leaks from the test connections and correct before continuing the test.

9. With the engine running, press the engine speed switch to full speed **(3,005 to 3,055 rpm)** position. Use the InfoCenter to check that the engine speed is correct.
10. Verify the pump flow at No Load as follows:

    Record the tester pressure and flow readings at no load. Unrestricted pump output should be approximately **18.5 L/minute (4.9 gallons/minute)**.
11. Verify the pump flow Under Load as follows:

CAUTION

Do not close the tester valve fully when performing this test. In this test, the hydraulic tester is positioned in an unprotected part of the steering circuit.

Pump damage can occur if the fluid flow is fully restricted by fully closing the tester flow control valve.

   A. Monitor the tester pressure gauge carefully while you slowly close the flow control valve until you get **5,500 kPa (800 psi)**.

   B. Record the tester pressure and flow readings under load.

12. Press the engine speed to low speed **(1,175 to 1,225 rpm)** position and shut off the engine.
13. The under load test flow reading (step 11B) should not drop more than 15% when compared to the no load test flow reading (step 10A). A difference in flow of more than 15%, or the inability to achieve specified pressure may indicate:

    A. A restriction in the pump inlet line.

    B. The gear pump (P3) is worn and should be repaired or replaced; refer to Servicing the Gear Pump (page 6–169).
14. After you complete the testing, shut off the engine, and then release pressure from the hydraulic system; refer to Releasing Pressure from the Hydraulic System (page 6–8).
15. Disconnect the tester, and connect the removed hydraulic tube.
16. Start the engine, check for hydraulic-fluid leaks, repair any leaks as necessary, and fill the hydraulic tank with the correct quantity of new hydraulic fluid before returning the machine to service.
17. Lower and secure the operator seat.

Testing the lift Circuit–Relief Valve (SVRV) Pressure (5610-D)

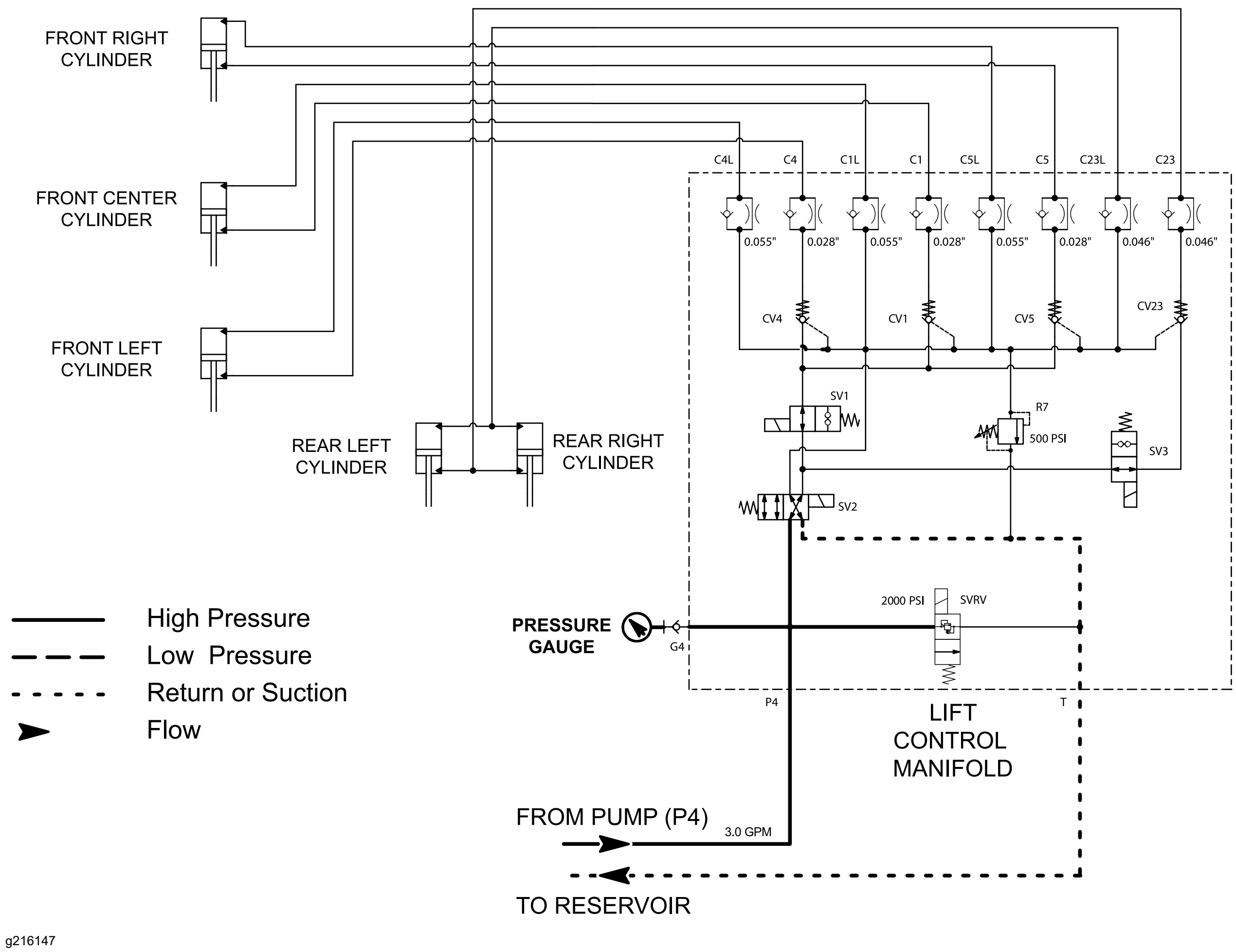


Figure 136

Perform the lift relief valve (SVRV) pressure test to ensure that the lift circuit relief pressure is correct.

Test Procedure

1. Ensure that the hydraulic fluid is at normal operating temperature by operating the machine for at least 10 minutes.
2. Park the machine on a level surface with the reel engage switch off, lower the cutting units, shut off the engine, mow speed limiter is in the MOW position, and set the parking brake.
3. Read all Warning, Cautions, and precautions listed at the beginning of this section.

Test Procedure (continued)

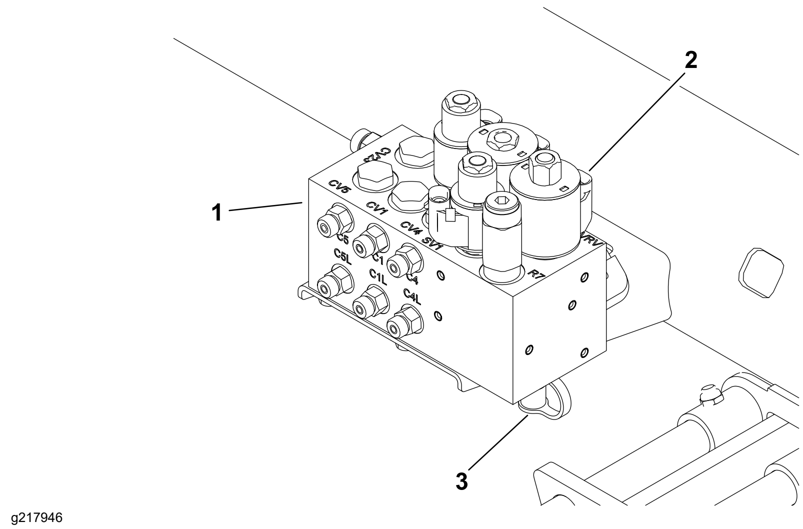


Figure 137

1. Lift control manifold
2. SVRV solenoid
3. Test port (G4)

4. Clean the test port (G4) on the bottom of lift control manifold, and then connect a **35,000 kPa (5,000 psi)** pressure gauge to the test port (Figure 137).
5. After installing the pressure gauge to the manifold test port, start the engine and run it at low-idle speed. Check for hydraulic-fluid leaks from the test connections and correct before continuing the test.
6. Press the engine speed switch to full speed **(3,005 to 3,055 rpm)** position. Use the InfoCenter to check that the engine speed is correct.

IMPORTANT

Do not allow the pressure to exceed 17,500 kPa (2,500 psi).

IMPORTANT

When performing this test, hold the joystick lever in the RAISE position, only long enough to get a system pressure reading. Holding the lever in RAISE for an extended period may damage system components.

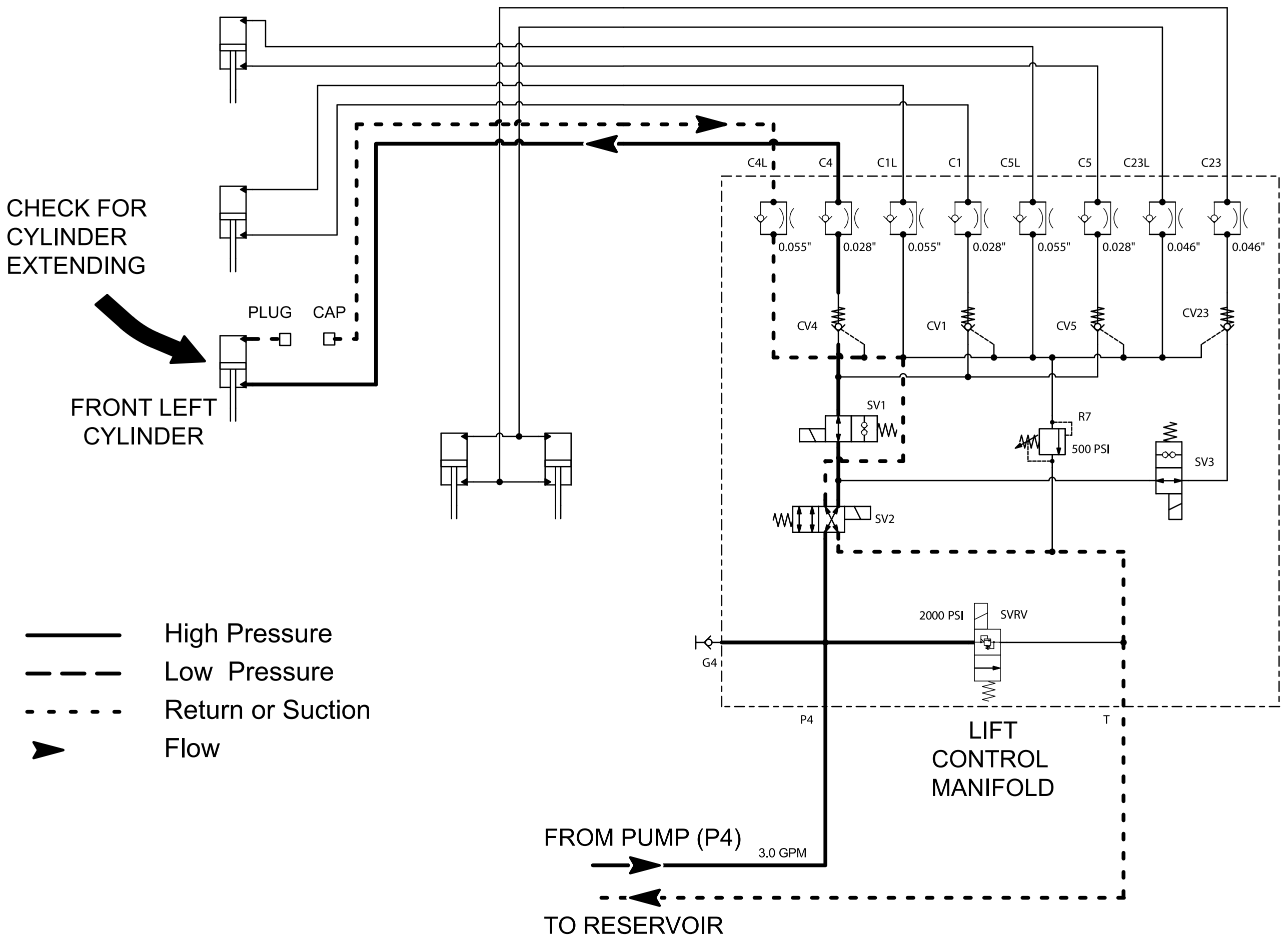
7. Ensure that the reel engage switch is OFF, and then pull the joystick lever rearward to pressurize the lift circuit. While holding lever in the RAISE (rearward) position, monitor the pressure gauge carefully.
8. When the cutting units reach the fully raised position and the lift relief valve lifts, the system pressure should be approximately **13,800 kPa (2,000 psi)**.
9. Return the joystick lever to the NEUTRAL position, and shut off the engine.
10. If the measured pressure is incorrect, remove the solenoid relief valve (SVRV) from the lift control manifold and clean or replace the valve; refer to Servicing the Lift Control Manifold (page 6–197).
11. Also, if the lift circuit pressure is low, check for the restriction in gear pump inlet line. The Internal lift cylinder leakage would also cause low lift circuit pressure; refer to Testing the Lift Circuit–Lift Cylinder Internal Leakage

Test Procedure (continued)

(5610-D) (page 6–139). The gear pump (P4) could also be suspected for wear, damage or inefficiency; refer to Testing the Lift Circuit–Gear Pump (P4) Flow (5610-D) (page 6–142).

12. After you complete the testing, shut off the engine, and disconnect the pressure gauge from the lift control manifold test port.
13. Start the engine, check for hydraulic-fluid leaks, repair any leaks as necessary, and fill the hydraulic tank with the correct quantity of new hydraulic fluid before returning the machine to service.

Testing the Lift Circuit–Lift Cylinder Internal Leakage (5610-D)



LEFT FRONT(#4) LIFT CYLINDER TEST SHOWN

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Figure 138

Perform the lift cylinder internal leakage test if you identify a cutting reel raise and lower problem. This test determines if the lift cylinder being tested is damaged. The lift cylinders must be tested individually.

Note: The raise/lower circuit operation can be affected by the lift cylinder binding, extra weight on the cutting reel, and/or binding of the lift components. Ensure that these items are checked before continuing with the lift cylinder internal leakage test.

Test Procedure

Note: When performing the lift cylinder internal leakage test, the cutting units should be attached to the lift arms.

1. Park the machine on a level surface with the reel engage switch off, position the cutting units in the turn-around position, shut off the engine, and set the parking brake.
2. For the lift cylinder that is to be tested, use a jack to raise the lift arm slightly. This removes the load from the lift cylinder and releases the lift cylinder hydraulic pressure.
3. Support the lift arm with jack stands to prevent the lift arm from lowering.

   Note: If either of the rear lift cylinders is being tested, both the rear lift arms need to be supported.

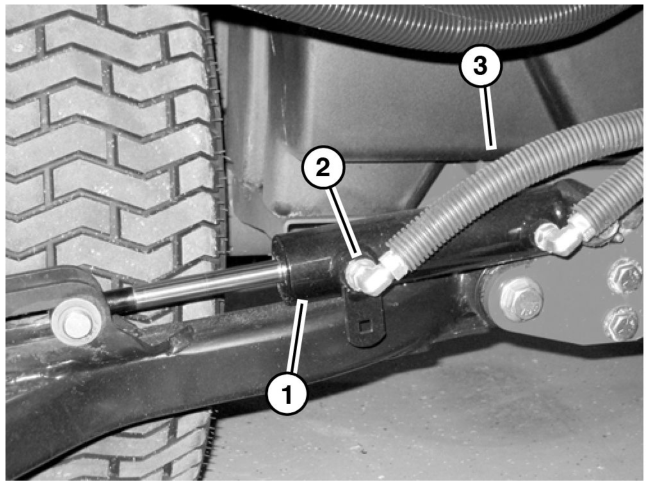

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Figure 139

1. #5 lift cylinder
2. Cylinder rod end fitting
3. Hydraulic hose

4. Clean the area around the hydraulic hose end at the barrel end of the lift cylinder. Disconnect the hydraulic hose from the lift cylinder barrel end fitting (Figure 139).

IMPORTANT

When capping the lift cylinder fitting and hydraulic hose end, use a steel cap and plug to ensure that there is no fluid leakage. The plastic plugs cannot hold the hydraulic pressure that is developed during this test procedure.

5. Install a steel cap on the open lift cylinder fitting to seal the lift cylinder. Also, install a steel plug in the open end of the disconnected hose to prevent leakage or contamination.
6. Raise the lift arm slightly with a jack and remove the jack stand, then lower and remove the jack.
7. The capped lift cylinder should be able to support the cutting unit long enough for the machine to move from one cutting area to another during operation.
8. If the lift cylinder allows the cutting reel to lower too quickly, replace or repair the lift cylinder; refer to Lift Cylinder (page 6–215) and Servicing the Lift Cylinder (page 6–218).

Test Procedure (continued)

9. Once the lift cylinder condition is determined, use a jack to raise lift arm slightly which removes the load from the lift cylinder.
10. Support the lift arm with jack stands to prevent it from lowering.
11. Remove the cap from the cylinder fitting and the plug from the hydraulic hose.
12. Connect the hydraulic hose to the lift cylinder fitting.
13. Carefully remove the jack from under the lift arm. Start the engine and operate the lift cylinders through several up and down cycles. Shut off the engine and check for any leakage.
14. If necessary, repeat the steps 2 through 13 for other lift cylinders.
15. Check and fill the hydraulic tank with the correct quantity of new hydraulic fluid before returning the machine to service.

Testing the Lift Circuit–Gear Pump (P4) Flow (5610-D)

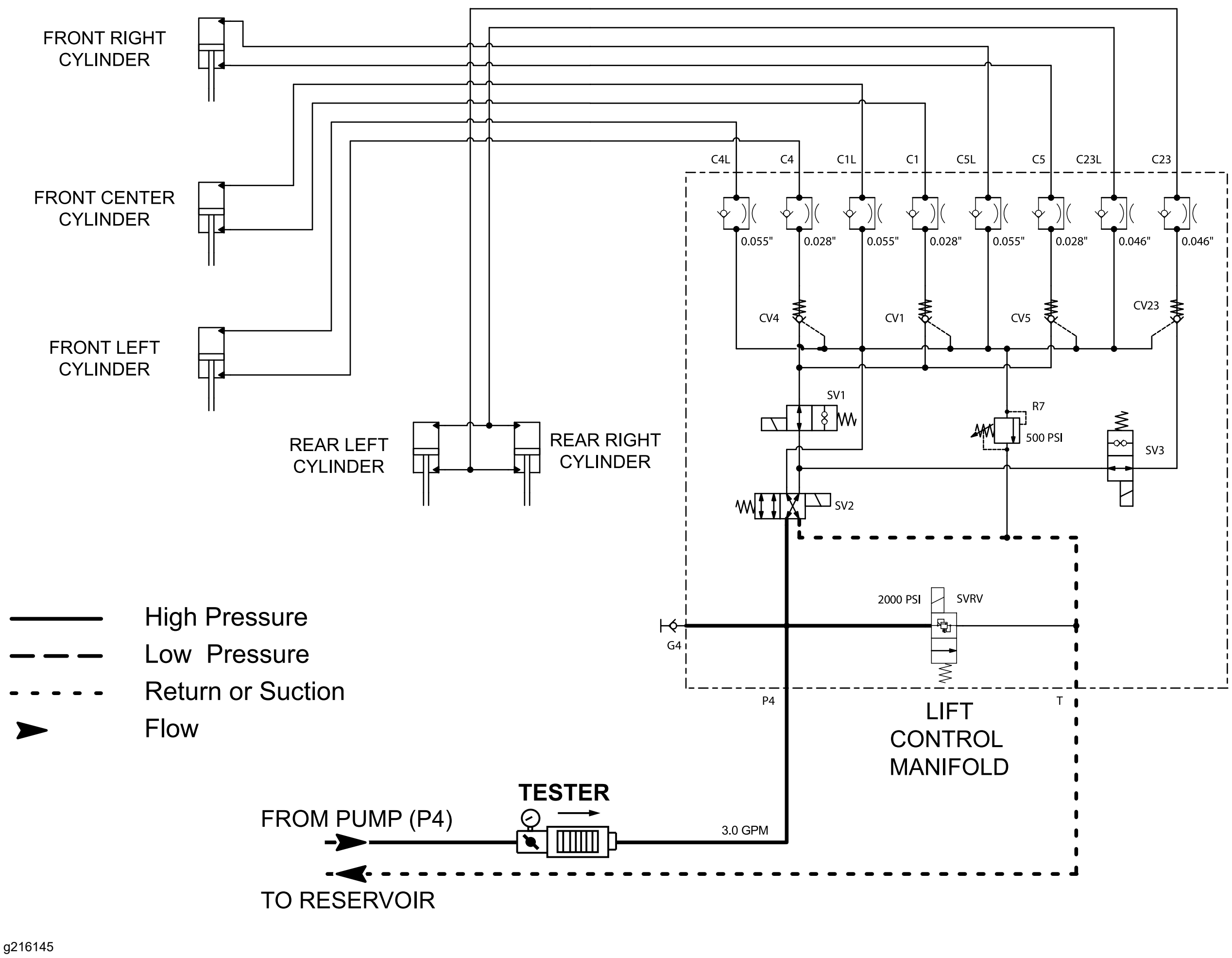

Figure 140

The gear pump (P4) is designed to satisfy the lift cylinder needs (at full speed). The gear pump (P4) flow test compares fluid flow at No Load with fluid flow Under Load. A drop in flow under load of more than 15% indicates the gears and wear plates in the pump have worn. Continued operation with a worn pump can generate excessive heat and cause damage to the seals and other components in the hydraulic system.

Special Equipment Required: Flow meter with pressure gauge that has at least a 16 L/minute (5 gallons/minute) capacity.

Note: If the flow from gear pump (P4) is low, the operation of all the lift cylinders will be affected.

Test Procedure

1. Park the machine on a level surface with the reel engage switch off, lower the cutting units, shut off the engine, mow speed limiter is in the MOW position, and set the parking brake.

Test Procedure (continued)

CAUTION

Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).

2. Read all Warning, Cautions, and precautions listed at the beginning of this section.
3. Lift and support the operator seat and remove the floor plate to get access to the hydraulic pump.

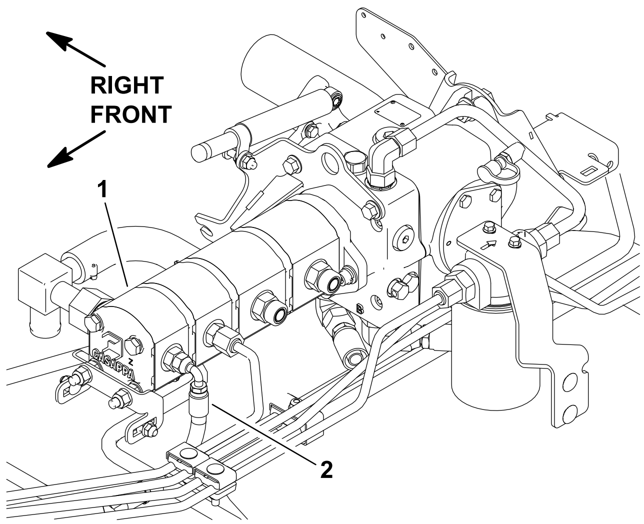

Figure 141

1. Gear pump (P4)
2. Hydraulic hose

4. Clean the hydraulic hose end and the pump fitting at the outlet of pump (P4) (Figure 141).

IMPORTANT

Ensure that the fluid flow indicator arrow on the flow gauge is showing that the fluid will flow from the pump (P4), through the tester, and to the lift control manifold.

5. Connect the tester inlet to the pump fitting, and connect the tester outlet to the disconnected hydraulic hose. Ensure that the flow control valve on tester is fully open.
6. Start the engine and run it at low-idle speed. Check for hydraulic-fluid leaks from the test connections and correct before continuing the test.
7. With the engine running, press the engine speed switch to full speed **(3,005 to 3,055 rpm)** position. Use the InfoCenter to check that the engine speed is correct.
8. Verify the pump flow at No Load as follows:

   Record the tester pressure and flow readings at no load. Unrestricted pump output should be approximately **11.4 L/minute (3 gallons/minute)**.

Test Procedure (continued)

9. Verify the pump flow Under Load as follows:

⚠ CAUTION ⚠

Do not close the tester valve fully when performing this test. In this test, the hydraulic tester is positioned before the manifold relief valve.

Pump damage can occur if the fluid flow is fully restricted by fully closing the tester flow control valve.

   A. Monitor the tester pressure gauge carefully while you slowly close the flow control valve until you get **8,274 kPa (1,200 psi)**.

   B. Record the tester pressure and flow readings under load.

10. Press the engine speed switch to low speed **(1,175 to 1,225 rpm)** position and shut off the engine.

11. The under load test flow reading (step 9B) should not drop more than 15% when compared to the no load test flow reading (step 8A). A difference in flow of more than 15%, or the inability to achieve specified pressure may indicate:

   A. A restriction in the pump inlet line.

   B. The gear pump (P4) is worn and should be repaired or replaced; refer to Servicing the Gear Pump (page 6–169).

12. After you complete the testing, shut off the engine, and then release pressure from the hydraulic system; refer to Releasing Pressure from the Hydraulic System (page 6–8).

13. Remove the tester, and connect the hydraulic hose to the gear pump (P4) outlet.

14. Start the engine, check for hydraulic-fluid leaks, repair any leaks as necessary, and fill the hydraulic tank with the correct quantity of new hydraulic fluid before returning the machine to service.

15. Install the floor plate, lower and secure the operator seat.

Service and Repairs

General Precautions for Removing and Installing the Hydraulic System Components

Before Repairing or Replacing the Components

1. Before removing any parts from the hydraulic system, park the machine on a level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Clean the machine before you disconnect, remove, or disassemble the hydraulic components.

   Note: Cleanliness is necessary whenever you work on the hydraulic equipment. Ensure that you clean the hydraulic components, hoses, connections, and fittings.
3. Label all the disconnected hydraulic lines and hoses for proper installation after repairs are completed.
4. Note the position of the hydraulic fittings (especially elbow fittings) on the hydraulic components before removal.

   Note: Mark the parts, if necessary before removal and ensure that they are aligned properly when installing the hydraulic fittings, hoses, and tubes.

CAUTION

Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to **Releasing Pressure from the Hydraulic System (page 6–8)****.**

5. The hydraulic fluid may be hot. Be careful when you loosen and remove the hydraulic system components.
6. Install clean caps or plugs on the hydraulic lines, hydraulic fittings, and components that are left open or exposed to prevent hydraulic system contamination. Cap the opening as soon as the line or port is exposed.

After Repairing or Replacing the Components

1. Check the hydraulic-fluid level in the hydraulic tank and add correct quantity of fluid if necessary. Use the hydraulic fluids that are specified in the *Operator's Manual*.

IMPORTANT

Drain and fill the hydraulic tank and change the oil filter if the component failure is severe or the system is contaminated; refer to **Flushing the Hydraulic System (page 6–147)****.**

2. If a component failure occurred in the closed-loop traction circuit (e.g., piston pump or wheel motor), filtering the traction circuit is necessary; refer to Filtering the Closed-Loop Traction Circuit (page 6–149).
3. Lubricate the O-rings and seals with clean hydraulic fluid before installing the hydraulic components.

After Repairing or Replacing the Components (continued)

4. Remove all the caps or plugs from the hydraulic tubes, hydraulic fittings, and components before connecting them again.
5. Use proper tightening procedures when installing the hydraulic hoses and fittings; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 6–11) and Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 6–13).
6. After you complete the repairs, check the control linkages or cables for proper adjustment, binding, or broken parts.
7. After you complete the repairs, clean the hydraulic components, hose connections, and fittings to prevent future accumulation of dirt and unwanted material on the hydraulic components.
8. After you disconnect or replace any hydraulic components, operate the machine functions slowly until the air is out of the system; refer to Charging the Hydraulic System (page 6–151).
9. Check for hydraulic-fluid leaks. Shut off the engine and repair leaks if necessary.
10. Check the hydraulic-fluid level in the hydraulic tank and add correct quantity of fluid if necessary.

Checking the Hydraulic Lines and Hoses

WARNING

Hydraulic fluid escaping under pressure can penetrate skin and cause injury.

- **Ensure that all hydraulic-fluid hoses and lines are in good condition and all hydraulic connections and fittings are tight before applying pressure to the hydraulic system.**
- **Keep your body and hands away from pinhole leaks or nozzles that eject high-pressure hydraulic fluid.**
- **Use a piece of cardboard or paper to find hydraulic leaks.**
- **Release all pressure in the hydraulic system before performing any work on the system.**
- **Seek immediate medical attention if hydraulic fluid is injected into your skin.**

IMPORTANT

Check the hydraulic lines and hoses daily for leaks, kinked lines, loose mounting supports, wear, loose fittings, and hose deterioration. Repair the damaged hydraulic lines and hoses before operating the machine.

Priming the Hydraulic Pumps

When the hydraulic system is flushed, the hydraulic system is charged, or the hydraulic components are installed, it is important to properly prime the hydraulic pumps. The hydraulic pump priming ensures that the gear pump and piston

Priming the Hydraulic Pumps (continued)

(traction) pump have sufficient fluid during initial start-up and running. The pumps can be primed by using a remote starter switch (refer to Remote Starter Switch (page 6–49)) to crank the engine which allows the pumps to prime.

Use the following procedure to prime the hydraulic pumps:

1. Ensure that the key switch is in the OFF position and the key is removed from the key switch.
2. Check the hydraulic-fluid level in the hydraulic reservoir and add correct quantity of fluid if necessary; refer to the *Operator's Manual*.

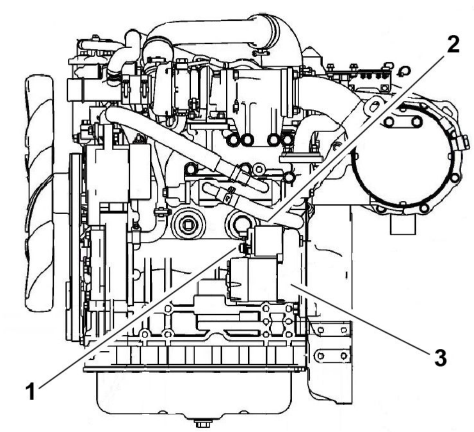

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Figure 142

1. B+ terminal
2. Starter solenoid
3. Starter motor

Note: A blue wire connects to the starter motor solenoid B+ terminal (Figure 142). It is not necessary to remove this blue wire from the solenoid terminal for hydraulic pump priming.

3. Connect the remote starter switch electrical leads to the starter motor solenoid B+ terminal and positive post of the battery.
4. Engage the remote starter switch and crank the starter for 30 seconds to prime the hydraulic pumps. Wait for 30 seconds to allow the starter motor and starter solenoid to cool. Repeat the cranking procedure for the second time.
5. Disconnect the remote starter switch leads from the starter motor solenoid terminal and positive post of the battery.

Flushing the Hydraulic System

IMPORTANT

Flush the hydraulic system whenever there is a severe component failure or the system is contaminated (for example, the fluid appears milky, black, or contains metal particles).

Flushing the Hydraulic System (continued)

IMPORTANT

If a component failure occurs in the traction circuit; refer to the Traction Circuit Component Failure (page 6–9) for information regarding the importance of removing contamination from the traction circuit.

1. Ensure that the hydraulic fluid is at normal operating temperature by operating the machine for at least 20 minutes.

CAUTION

Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).

2. Park the machine on a level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.

   Note: Ensure that you clean all the hydraulic connections that are disconnected for draining.

3. Drain the hydraulic fluid from the hydraulic tank. Remove the tank cap, screen filter, and clean the tank. Consider removing and cleaning the reservoir if necessary.
4. Clean the area around the mounting areas of the hydraulic-fluid filters. Remove and replace the hydraulic-fluid filters.
5. Inspect and clean the hydraulic tank; refer to Inspecting the Hydraulic Tank (page 6–155).

IMPORTANT

Follow all local codes and regulations when recycling or disposing hydraulic fluid and filters.

6. Drain the complete hydraulic system. Drain all the hoses, tubes, and components while the system is warm. Flush the hoses and tubes to remove any contamination.
7. Connect all the hydraulic hoses, tubes, and components that were disconnected while draining the system.
8. Ensure that the mounting surfaces of the hydraulic-fluid filters are clean. Apply clean hydraulic fluid to the gasket on new filters. Tighten the filters until the gasket contacts the mounting plate, then tighten the filter 3 quarters of a turn.

IMPORTANT

Using other hydraulic fluids could damage the hydraulic system. Use the hydraulic fluids that are specified in the *Operator's Manual*.

Flushing the Hydraulic System (continued)

9. Fill the hydraulic tank with the correct quantity of new hydraulic fluid.
10. Prime the hydraulic pumps; refer to Priming the Hydraulic Pumps (page 6–146).
11. Start the engine and operate it at low-idle speed for a minimum of 2 minutes. Increase the engine speed to high idle for a minimum of 1 minute under no load.
12. Raise and lower the cutting units several times. Turn the steering wheel fully left and right several times.
13. With the cutting units fully lowered and the operator seat occupied, engage the cutting units and let them run for several minutes. Disengage the cutting units.
14. Shut off the engine and check for hydraulic-fluid leaks.

    Note: Check the hydraulic-fluid level in the hydraulic tank and add correct quantity of fluid if necessary; refer to the *Operator's Manual*.
15. Operate the machine for 2 hours under normal operating conditions.
16. Check the condition of hydraulic fluid. If new fluid shows any signs of contamination, repeat steps 1 through 15 again until the fluid is clean.
17. When the hydraulic fluid is free from contamination, assume normal operation and follow the recommended maintenance intervals.

Filtering the Closed-Loop Traction Circuit

Filtering a closed-loop hydraulic system after a major component failure (e.g., traction (piston) pump or wheel motor) is necessary to prevent unwanted material from transmitting throughout the system. If a closed-loop hydraulic system filtering tool is not used to ensure the system cleanliness, repeat failures, as well as subsequent damage to other hydraulic components in the affected system, will occur. To effectively remove the contamination from the closed-loop traction circuit, use the Toro high flow hydraulic filter and hydraulic hose kits (refer to Special Tools (page 6–44)).

1. Park the machine on a level surface, shut of the engine, and remove the key from the key switch.

IMPORTANT

Before lifting the machine with a jack, review and follow Jacking Instructions (page 1–6).

2. Lift and support the machine so that all the wheels are off the ground.

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

Filtering the Closed-Loop Traction Circuit (continued)

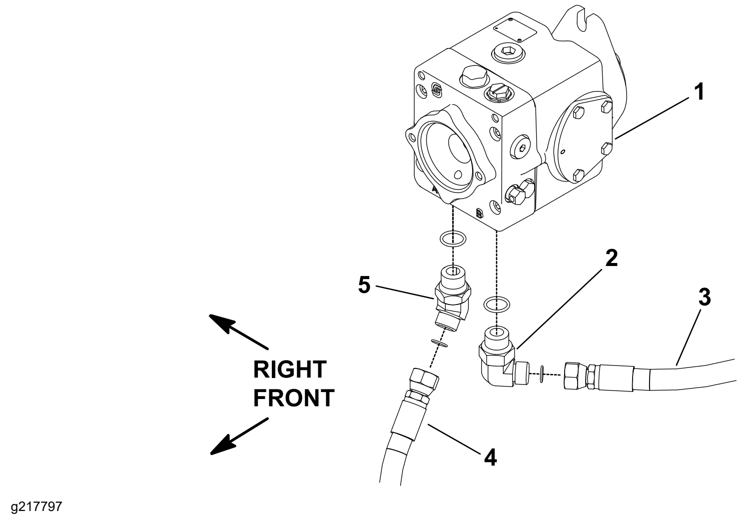

Figure 143

1. Traction pump
2. Left elbow fitting
3. Hydraulic hose (reverse)
4. Hydraulic hose (forward)
5. Right elbow fitting

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3. Clean the junction of the hydraulic hose and 90° hydraulic fitting at the bottom of the traction pump (Figure 143). Disconnect the hose from the pump fitting.
4. Connect the Toro high flow hydraulic filter in series between the traction pump fitting and disconnected hose. Use the hydraulic hose kit (refer to Hydraulic Hose Kit (page 6–45)) to connect the filter to the machine. Ensure that the fitting and hose connections are properly tightened.

IMPORTANT

Using other hydraulic fluids could damage the hydraulic system. Use the hydraulic fluids that are specified in the *Operator's Manual*.

5. After you install the high-flow filter to the machine, check and fill the hydraulic tank with the correct quantity of new hydraulic fluid.
6. Start the engine and run it at low-idle speed. Check for hydraulic-fluid leaks at the filter and hose connections. Correct any leaks before you proceed.

CAUTION

During this procedure, all the wheels will be off the ground and rotating.

Ensure that the machine is well supported so it will not move and accidentally fall to prevent injuring anyone around the machine.

Filtering the Closed-Loop Traction Circuit (continued)

IMPORTANT

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

7. With the 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 the traction circuit engaged in forward for 5 minutes while gradually increasing both forward pressure on the traction pedal and engine speed. Monitor the filter indicator to ensure that the green color is showing during operation.
8. With the engine running at high-idle speed and traction pedal moved to the forward direction, periodically apply brakes to increase pressure in the traction circuit. While monitoring the filter indicator, continue this process for 5 more minutes.

IMPORTANT

If you are using a filter that is not the Toro high flow filter that is bi-directional, do not press the traction pedal in the reverse direction. If the flow is reversed when using a filter that is not bi-directional, unwanted material from the filter will again enter the traction circuit.

9. With the engine running at high-idle speed, alternately move the traction pedal from forward to reverse. While monitoring the filter indicator, continue this process for 5 more minutes.
10. Shut off the engine and remove the key from the key switch.
11. Remove the high flow hydraulic filter and hydraulic hose kit from the machine. Connect the hydraulic hose to the 90° hydraulic fitting. Ensure that you properly tighten the hoses; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 6–11).
12. Lower the machine to the ground.
13. Check the hydraulic-fluid level in the hydraulic tank and add correct quantity of fluid if necessary; refer to the *Operator's Manual*.

Charging the Hydraulic System

Note: When initially starting the hydraulic system with new or rebuilt components such as pumps, wheel motors, or lift cylinders, it is important that the hydraulic system is charged properly. Remove the air from the system and its components to reduce the chance of damage.

IMPORTANT

Change the hydraulic-fluid filters when you repair or replace the hydraulic components.

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

Charging the Hydraulic System (continued)

2. After the hydraulic system components have been properly installed and if the traction pump was rebuilt or replaced, ensure that the traction pump housing is at least half full of clean hydraulic fluid.
3. Ensure that all of the hydraulic connections, lines, and components are secured tightly.

   Note: Flush and fill the hydraulic system and tank whenever there is a severe component failure or the system is contaminated; refer to Flushing the Hydraulic System (page 6–147).
4. Ensure that the hydraulic tank is full. Add correct quantity of hydraulic fluid if necessary; refer to the *Operator's Manual*.
5. Check the control linkage for proper adjustment, binding, or damaged parts.
6. Prime the hydraulic pumps; refer to Priming the Hydraulic Pumps (page 6–146).

IMPORTANT

Before lifting the machine with a jack, review and follow Jacking Instructions (page 1–6).

7. Lift and support the machine with jack stands so that all the drive wheels are off the ground.

CAUTION

Ensure that the machine is safely supported so that it does not move or accidentally fall and prevent injuring anyone under the machine.

8. Ensure that the traction pedal is in the NEUTRAL position. Start the engine and run it at low-idle speed.

   Note: The hydraulic pumps must pick up the hydraulic fluid and fill the hydraulic system. If there is no indication of fill in 30 seconds, shut off the engine and find the cause.
9. After the hydraulic system starts to show the signs of fill, actuate joystick switches until the lift cylinder rod moves in and out several times.
10. If the lift cylinder does not move after 3 to 5 seconds or if the pump emits abnormal sounds, shut off the engine immediately, and find the cause or problem. Inspect for the following:
    A. The oil filter or suction lines that are loose.
    B. An incorrect hose routing.
    C. The suction line that is blocked.
    D. The charge relief valve in the traction pump that is damaged.
    E. The gear pump that is damaged.
11. After the lift cylinder moves normally, proceed to step 12.
12. Turn the steering wheel in both directions so that the steering cylinders move in and out several times.
13. Operate the traction pedal in the forward and reverse directions. The drive wheels should rotate in the proper direction. If the wheels rotate in the wrong direction, shut off the engine, inspect the hydraulic line placement at

Charging the Hydraulic System (continued)

the traction pump and wheel motors. Correct the hydraulic line installation before you proceed.

14. Ensure that the traction pedal returns to the NEUTRAL position when released from the forward or reverse direction and adjust if necessary.

15. Check the operation of the traction interlock switches; refer to Checking the Operation of the Interlock Switches (page 7–45).

16. Shut off the engine and lower the machine to the ground.

17. If the traction pump was replaced or rebuilt, operate the traction circuit so that all the wheels rotate slowly for 10 minutes.

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

19. Stop the machine. Check the hydraulic-fluid level in the hydraulic tank and add correct quantity of fluid if necessary; refer to the *Operator's Manual*.

20. Check the hydraulic components for leaks and tighten any loose connections.

Hydraulic Tank

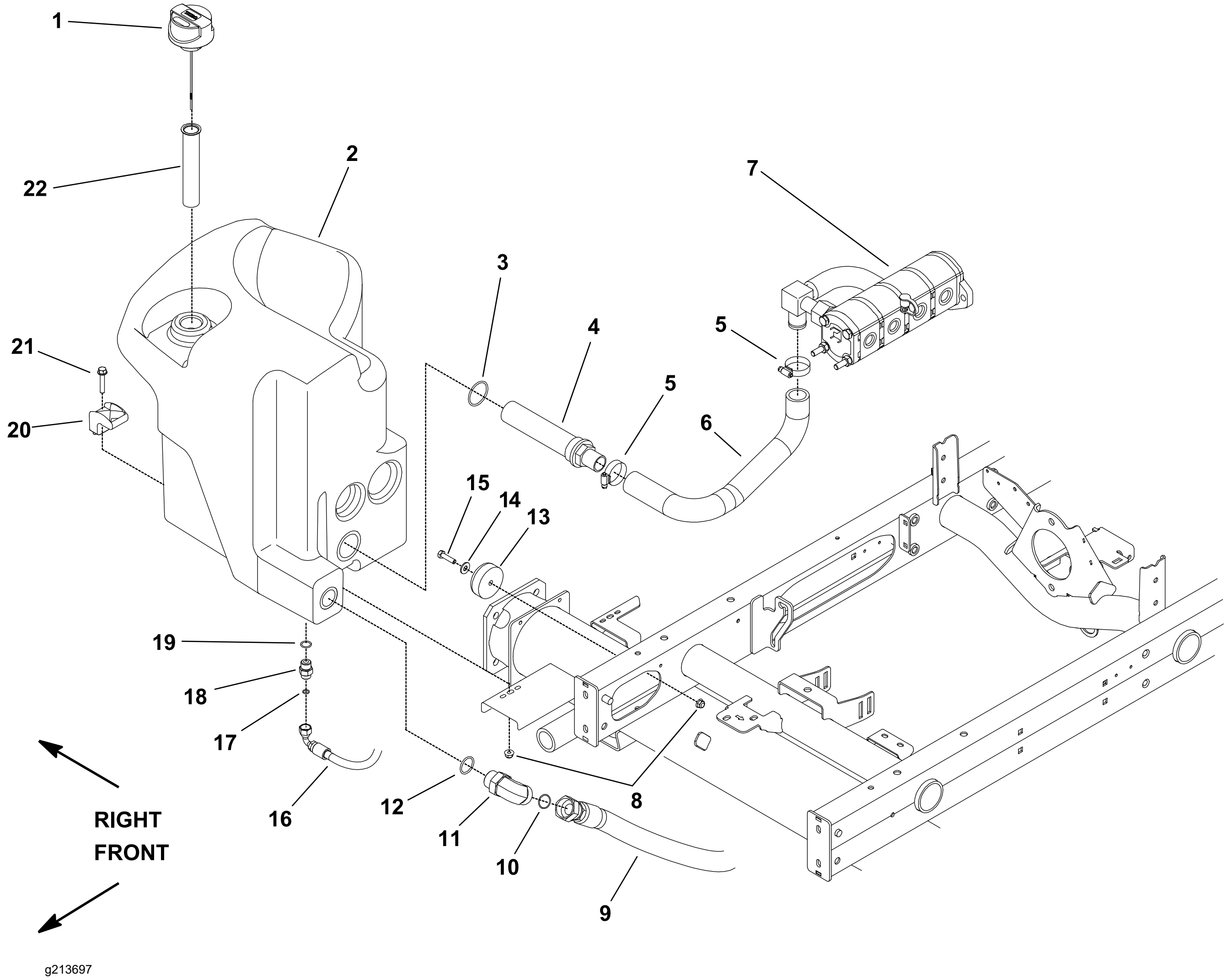

Figure 144

1. Hydraulic tank cap
2. Hydraulic tank
3. O-ring
4. Tank strainer
5. Clamp (2 each)
6. Hydraulic hose
7. Gear pump
8. Flange nut (3 each)
9. Hydraulic hose
10. O-ring
11. 90° hydraulic fitting
12. O-ring
13. Recess bumper
14. Flat washer
15. Bolt
16. Hydraulic hose
17. O-ring
18. Adapter
19. O-ring
20. Clamp (2 each)
21. Washer-head screw (2 each)
22. Screen filter

Removing the Hydraulic Tank

1. Park the machine on a level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Clean the hydraulic hose ends and fittings on the hydraulic tank to prevent contaminants from entering into the hydraulic system.
3. For assembly purposes, label all the hydraulic hoses and fittings.
4. Disconnect the hydraulic hose (item 16 in Figure 144) from the adapter fitting at the bottom of the hydraulic tank, and drain the hydraulic fluid from the tank into a suitable container.
5. Remove the remaining hydraulic hoses from the fittings on the hydraulic tank and drain the hoses into a suitable container.
6. Install clean caps or plugs on the hydraulic hoses and fittings to prevent system contamination.
7. Remove the hydraulic tank from the machine (Figure 144).
8. Remove the tank strainer (item 4 in Figure 144) from the hydraulic tank and discard the O-ring from the tank strainer.
9. If the hydraulic fittings are to be removed from the hydraulic tank, mark the fitting orientation for assembly purposes. Remove the fittings from the tank and discard the O-rings from the fittings.

Inspecting the Hydraulic Tank

1. Clean the hydraulic tank and tank strainer with solvent.
2. Inspect the hydraulic tank for leaks, cracks, or other damage.

Installing the Hydraulic Tank

1. If the hydraulic fittings were removed from the hydraulic tank, lubricate and install new O-rings to the fittings. To properly align and install the fittings into the tank openings, use the marks that you made during the removal process. Tighten the fittings; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 6–13).
2. Lubricate and install new tank strainer O-ring onto the strainer. Thread the tank strainer into the hydraulic tank with your hand. Then, use a wrench, turn the strainer into the tank port 1-1/2 to 2 full turns beyond finger tight.
3. Position the hydraulic tank to the machine. Ensure that the recess bumper (item 13 in Figure 144) on the right side of the frame is inserted into the recess in the tank.
4. Secure the hydraulic tank to the frame with the 2 clamps (item 20 in Figure 144), 2 washer-head screws, and 2 flange nuts.
5. Remove the caps or plugs that were installed to the hydraulic hoses and fittings during the removal process.
6. Use the labels that you attached during tank removal to correctly connect the hydraulic hoses to the fittings on the hydraulic tank; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 6–11).
7. Fill the hydraulic tank with the correct quantity of new hydraulic fluid.
8. Operate the machine. Check the hydraulic-fluid level and adjust if necessary.
9. Check the hydraulic components for leaks. Tighten any loose connections.

Piston (Traction) Pump Control Assembly

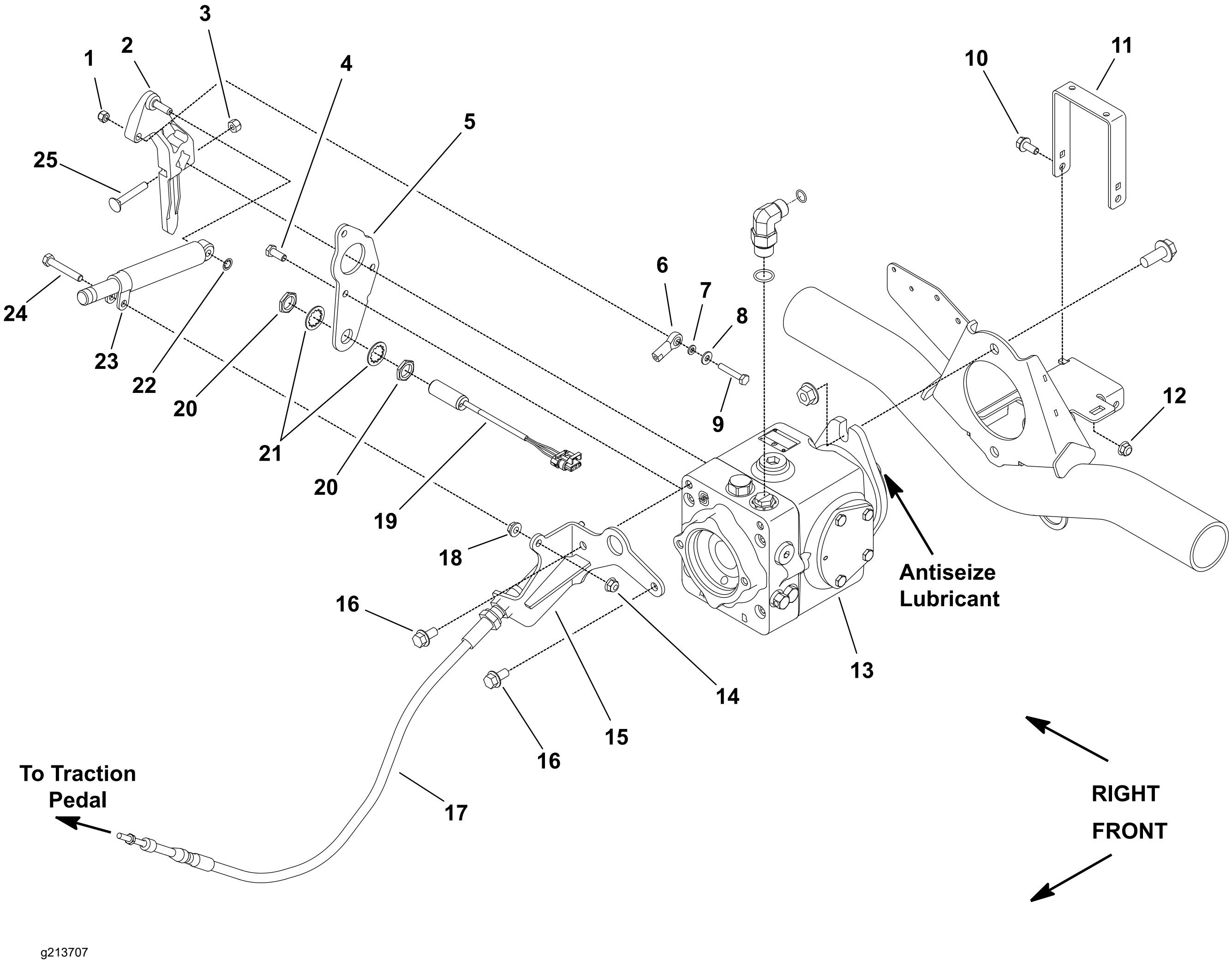

Figure 145

1. Locknut
2. Pump lever
3. Locknut
4. Bolt (3 each)
5. Pump plate
6. Cable rod end
7. Flat washer
8. Flat washer
9. Bolt
10. Flange-head screw (2 each)
11. Guard hoop
12. Flange nut (2 each)
13. Piston (traction) pump
14. Flange nut
15. Traction cable bracket
16. Flange-head screw (2 each)
17. Traction control cable
18. Flange nut
19. Traction neutral switch
20. Jam nut (2 each)
21. Lock washer (2 each)
22. Retaining ring
23. Lever damper
24. Bolt
25. Carriage screw

Disassembling the Piston (Traction) Pump Control Assembly

1. Park the machine on a level surface, set the parking brake, lower the cutting units, and shut off the engine, and remove the key from the key switch.
2. Remove the components from the traction pump control assembly as necessary (Figure 145 and Figure 146).

Assembling the Piston (Traction) Pump Control Assembly

IMPORTANT

To prevent the traction neutral switch (item 19 in Figure 145) damage, ensure that no pump control components contact the switch through entire traction pump control arm movement.

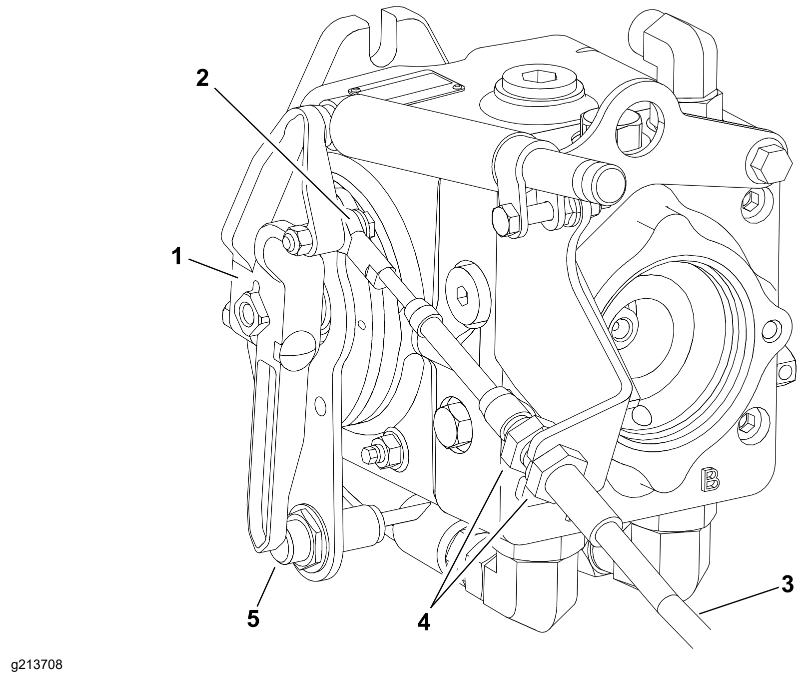

Figure 146

1. Pump lever
2. Cable rod end
3. Traction control cable
4. Cable jam nut (2 each)
5. Traction neutral switch

1. Install the components that were removed to the piston pump control assembly (Figure 145 and Figure 146).

Assembling the Piston (Traction) Pump Control Assembly (continued)

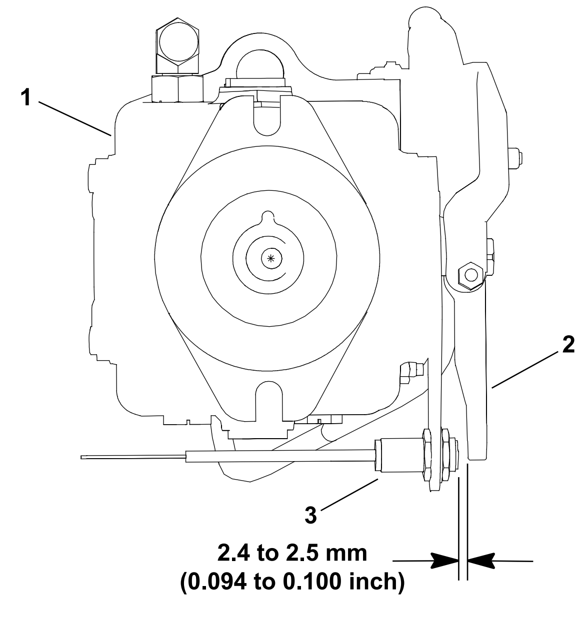

Figure 147

1. Traction pump
2. Pump lever
3. Traction neutral switch

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2. If the traction neutral switch was removed from the pump plate, adjust the location of the switch so that there is **2.4 to 2.5 mm (0.094 to 0.100 inch)** clearance between the head of the neutral switch and the traction pump lever (Figure 147); refer to the Traction Neutral Switch (page 7–46) for additional neutral switch information.
3. After the traction pump control assembly has been installed, ensure that the traction control assembly is adjusted for the neutral position so that the machine does not move or creep when the traction pedal is in neutral; refer to the *Traction Unit Operator's Manual*.

Hydraulic Pump Driveshaft

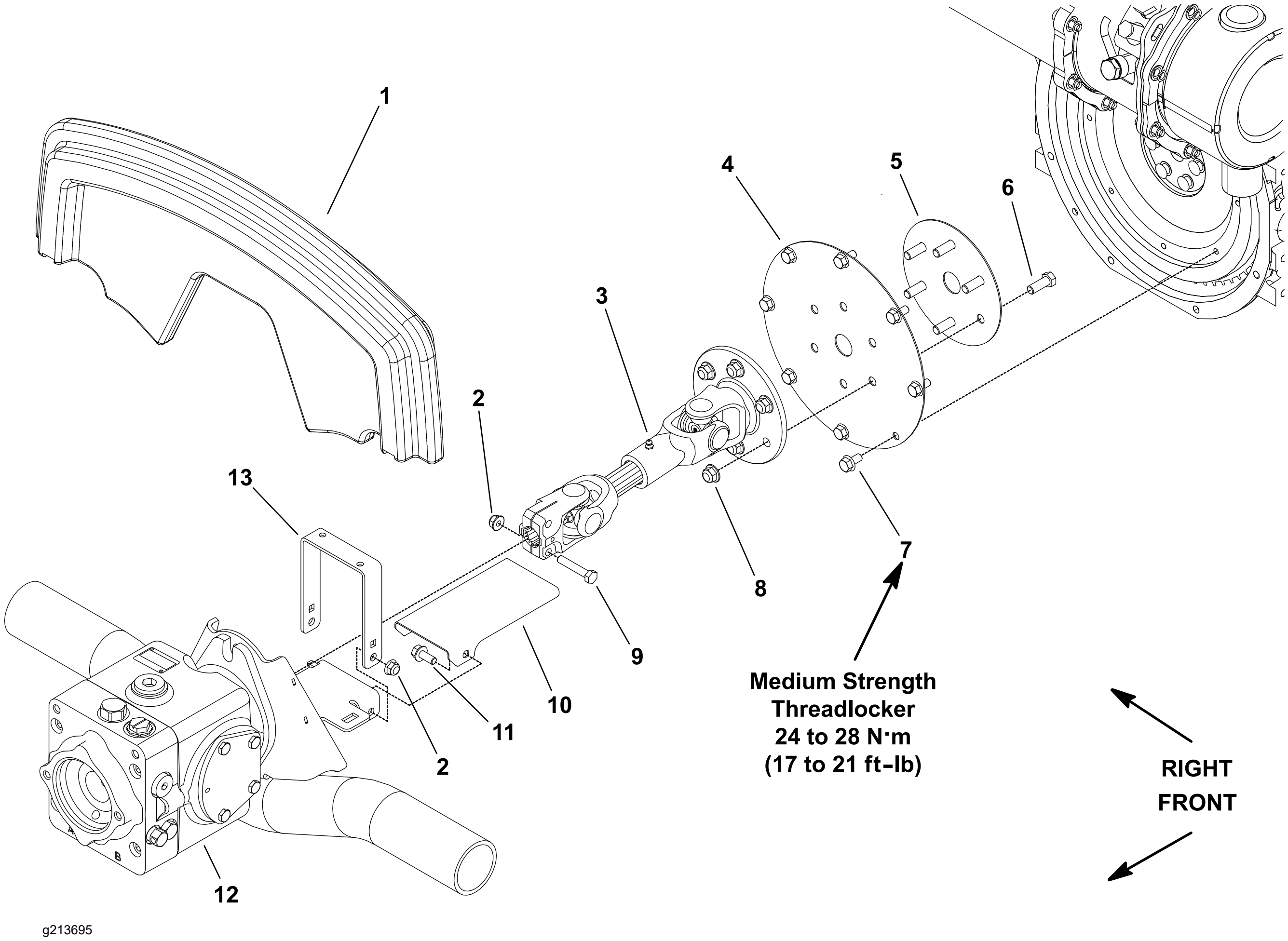

Figure 148

1. Hood saddle
2. Flange nut (4 each)
3. Driveshaft assembly
4. Flywheel adapter plate
5. Back-up ring
6. Bolt (6 each)
7. Flange-head screw (8 each)
8. Flange nut (6 each)
9. Bolt (2 each)
10. Heat shield
11. Flange-head screw (2 each)
12. Piston (traction) pump
13. Guard hoop

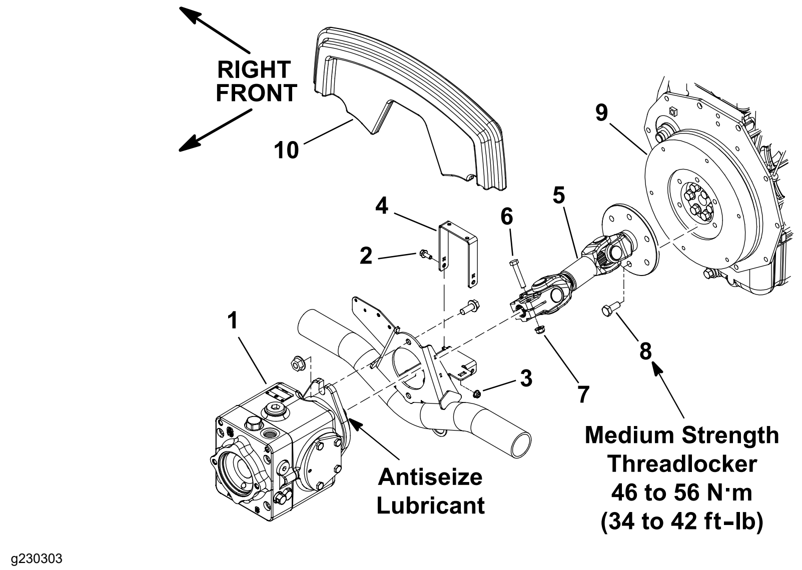

Figure 149

1. Piston (traction) pump
2. Flange nut (2 each)
3. Flange-head screw (2 each)
4. Guard hoop
5. Driveshaft assembly
6. Bolt (2 each)
7. Flange nut (2 each)
8. Bolt (6 each)
9. Engine flywheel
10. Hood saddle

Note: Machines with a Kubota gasoline or diesel engine use driveshaft assembly as shown in Figure 149. Machines with a Yanmar diesel engine use driveshaft assembly as shown in Figure 148.

Removing the Hydraulic Pump Driveshaft

1. Park the machine on a level surface, set the parking brake, lower the cutting units, shut off the engine, and remove the key from the key switch.
2. Raise and support the hood and operator seat. Lift the hood saddle from the frame brackets, and remove the saddle from the machine.
3. On machines with a Kubota gasoline or diesel engine (Figure 149), remove the 2 flange-head screws and 2 flange nuts that secure the driveshaft guard hoop to the machine frame, and remove the guard hoop.
4. On machines with a Yanmar diesel engine, remove the 2 flange-head screws (item 11 in Figure 148) and 2 flange nuts that secure the driveshaft guard hoop and heat shield to the machine frame, and remove the guard hoop and heat shield.
5. Remove the 2 bolts and 2 flange nuts that secure the driveshaft yoke to the traction pump input shaft.
6. On machines with a Yanmar diesel engine, remove the 8 flange-head screws (item 7 in Figure 148) that secure the flywheel adapter plate to the engine flywheel. On machines with a Kubota gasoline or diesel engine, remove the bolts that secure the driveshaft flange to the engine flywheel.
7. Remove the driveshaft assembly from the machine.
8. On machines with a Yanmar diesel engine, if necessary, remove the 6 bolts (item 6 in Figure 148), 6 flange nuts, and a back-up ring that secure the driveshaft assembly to the flywheel adapter plate.

Servicing the Driveshaft Cross and Bearing

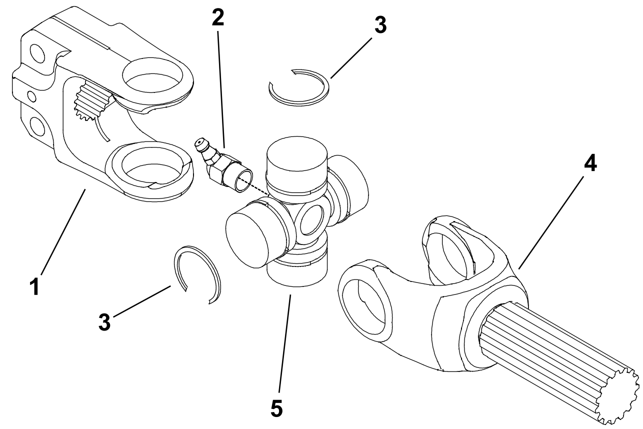

Figure 150

1. End yoke
2. Grease fitting
3. Snap ring (4 each)
4. Shaft yoke
5. Cross and bearing kit

---

1. Remove the snap rings that secure the bearings in the yokes.

IMPORTANT

Support the yokes when removing and installing the bearings to prevent damage.

---

2. Use a press to remove the cross and bearings from the yokes. Clean the driveshaft yokes.
3. Install new cross and bearings as follows:
   A. Apply a thick layer of grease to the bearing bores in the end yoke and shaft yoke.
   B. Press 1 bearing partially into yoke.
   C. Insert the cross into the yoke and bearing.
   D. Hold the cross in alignment and press the bearing in until it hits the yoke.
   E. Install the snap ring into the yoke groove to secure the installed bearing.
   F. Place second bearing into the yoke bore and onto the cross shaft. Press the bearing into the yoke and secure with the snap ring.
   G. Repeat the procedure for the other yoke.
   H. Apply grease to the cross until it comes out of all the 4 bearing cups.
4. Ensure that the assembled joint moves without any binding. Lightly rap the yoke lugs with a soft-faced hammer to remove slight binding. If the binding continues, disassemble the joint to identify the source of binding.

Installing the Hydraulic Pump Driveshaft

1. Apply anti-seize lubricant to the traction pump input shaft.
2. On machines with a Yanmar diesel engine, if removed, secure the driveshaft assembly to the flywheel adapter plate with the back-up ring, 6 bolts, and 6 flange nuts.
3. Position the driveshaft assembly to the engine and pump input shaft.

Installing the Hydraulic Pump Driveshaft (continued)

4. On machines with a Yanmar diesel engine, apply medium strength threadlocker to the threads of the flange-head screws (item 7 in Figure 148). Secure the driveshaft assembly to the engine flywheel with the 8 flange-head screws; torque the flange-head screws to **24 to 28 N·m (17 to 21 ft-lb)** in a criss-cross pattern.
5. On machines with a Kubota gas or diesel engine, apply medium strength threadlocker to the threads of the bolts. Secure the driveshaft assembly to the engine flywheel; torque the bolts to **46 to 56 N·m (34 to 42 ft-lb)** in a criss-cross pattern.
6. Slide the driveshaft yoke on the pump input shaft so that the yoke is flush with end of the input shaft. Secure the driveshaft yoke to the pump input shaft with the 2 bolts and 2 flange nuts.
7. On machines with a Kubota gasoline or diesel engine (Figure 149), install and secure the driveshaft guard hoop to the machine frame.
8. On machines with a Yanmar diesel engine, position the driveshaft guard hoop and heat shield to the machine frame and secure with the 2 flange-head screws (item 11 in Figure 148) and 2 flange nuts.
9. Lubricate the grease fittings on the driveshaft.
10. Install the hood saddle onto the frame brackets. Lower and secure the hood and operator seat.

Hydraulic Pump Assembly

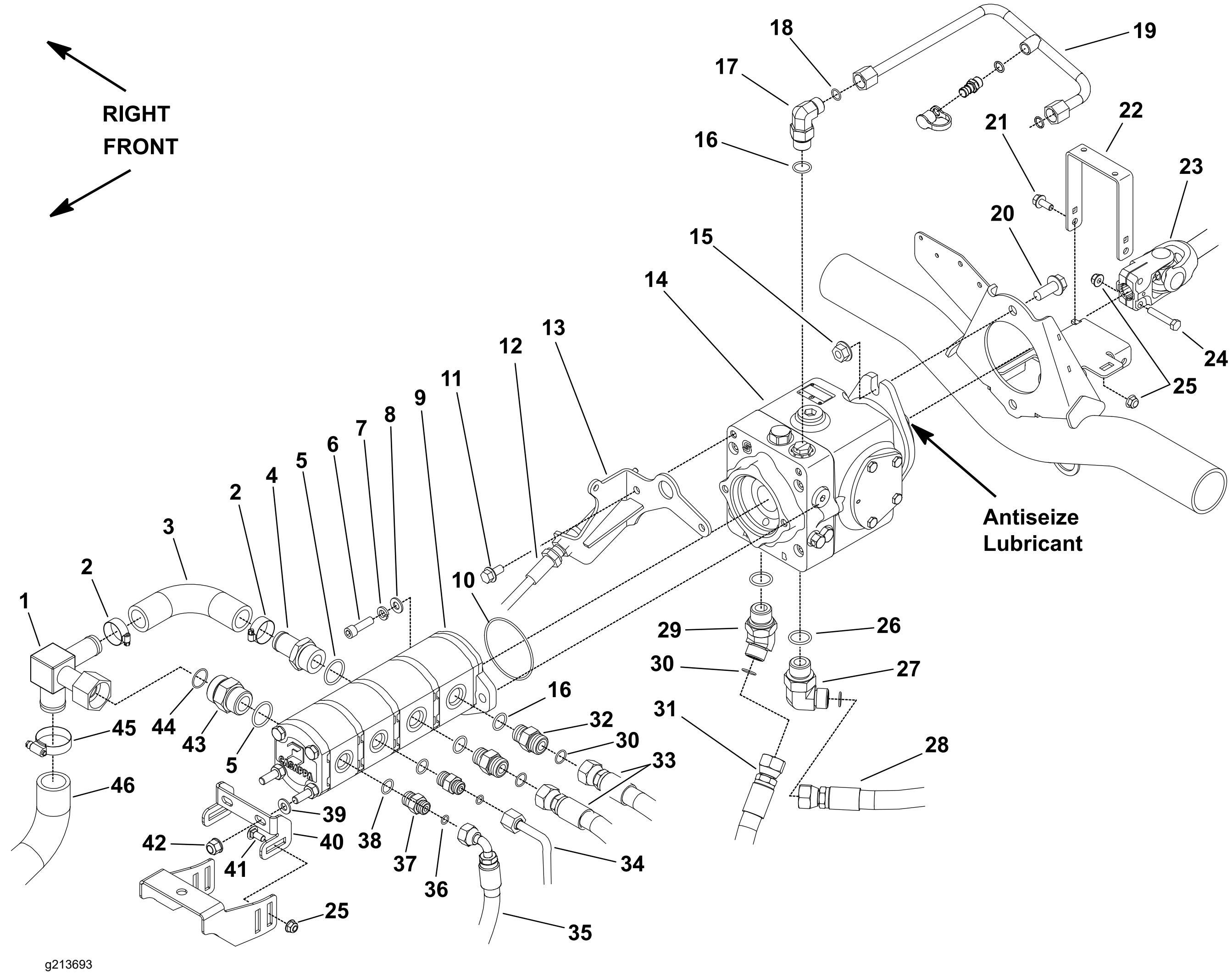

Figure 151

1.	Manifold tube	17.	90° hydraulic fitting	33.	Hydraulic hose (2 each)
2.	Hose clamp (2 each)	18.	O-ring	34.	Hydraulic tube
3.	Hydraulic hose	19.	Hydraulic tube	35.	Hydraulic hose
4.	Barbed fitting	20.	Flange-head screw (2 each)	36.	O-ring (2 each)
5.	O-ring (2 each)	21.	Flange-head screw (2 each)	37.	Straight fitting (2 each)
6.	Socket-head screw (2 each)	22.	Guard hoop	38.	O-ring (2 each)
7.	Lock washer (2 each)	23.	Driveshaft assembly	39.	Flat washer (2 each)
8.	Flat washer (2 each)	24.	Bolt (2 each)	40.	Pump support bracket
9.	Gear pump assembly	25.	Flange nut (6 each)	41.	Carriage screw (2 each)
10.	O-ring	26.	O-ring (2 each)	42.	Locknut (2 each)
11.	Flange-head screw (2 each)	27.	90° hydraulic fitting	43.	Straight fitting
12.	Traction cable	28.	Hydraulic hose	44.	O-ring
13.	Traction cable bracket	29.	45° hydraulic fitting	45.	Hose clamp
14.	Piston (traction) pump assembly	30.	O-ring (4 each)	46.	Hydraulic hose
15.	Flange nut (2 each)	31.	Hydraulic hose		
16.	O-ring (3 each)	32.	Straight fitting (2 each)		

Note: The traction pump and gear pump should be removed from machine as an assembly. Once removed from the machine, pumps can be separated for service.

Removing the Hydraulic Pump Assembly

CAUTION

Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).

1. Park the machine on a level surface, set the parking brake, lower the cutting units, and shut off the engine, and remove the key from the key switch.
2. Raise and support the hood and operator seat. Lift the hood saddle from the frame brackets and remove from the machine.
3. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 6–145).
4. Clean the traction and gear pump assembly and all hydraulic connections to prevent hydraulic system contamination.
5. For assembly purposes, label all the hydraulic connections.
6. Disconnect the hoses and tubes from the fittings on the traction and gear pump assembly. Allow the hydraulic lines to drain into a suitable container.
7. Install clean caps or plugs on the openings of pumps and disconnected lines to prevent contamination.
8. Remove the hydraulic pump driveshaft; refer to Removing the Hydraulic Pump Driveshaft (page 6–160).
9. Disconnect the traction control cable and neutral switch on the piston pump control assembly; refer to Piston (Traction) Pump Control Assembly (page 6–156). Carefully position the traction control cable and wire harness away from the piston pump.

CAUTION

The weight of the pump assembly is approximately 36 kg (80 lb).

Ensure that the lift or hoist can support the total weight of the pump assembly before removing the bolts from the pump assembly and frame.

10. Connect a lift or hoist to the hole in the traction cable bracket on the traction pump to support the pump assembly and for pump removal.
11. Loosen and remove the 2 carriage screws (item 41 in Figure 151) and 2 flange nuts that secure the pump support bracket to the frame.
12. Remove the 2 flange-head screws (item 20 in Figure 151) and 2 flange nuts that secure the traction pump flange to the machine frame.

IMPORTANT

Ensure that you do not damage the machine components while removing the pump assembly.

13. Carefully lift the pump assembly from the machine. Place the assembly on suitable workbench.

Removing the Hydraulic Pump Assembly (continued)

Note: A case drain exists in the piston (traction) pump and a suction port is near the input shaft of the gear pump (Figure 152). When the gear pump is removed from the piston pump, install plugs into the piston pump case drain hole and gear pump suction port to prevent draining the pumps.

14. Separate the traction and gear pumps as follows:
    A. Remove the 2 socket-head screws (item 6 in Figure 151), 2 lock washers, and 2 flat washers that secure the gear pump to the traction pump.
    B. Remove the gear pump from the traction pump. Locate and discard the O-ring (item 10 in Figure 151) from the pumps.
    C. If necessary, remove the 2 locknuts (item 42 in Figure 151) that secure the pump support bracket to the gear pump, and remove the bracket and 2 flat washers from the gear pump.
15. If necessary, remove the hydraulic fittings from the pumps. Note the orientation of the fittings for assembly purposes.
16. Remove and discard all the O-rings from the hydraulic hoses and fittings that were removed.

Installing the Hydraulic Pump Assembly

1. If the hydraulic fittings were removed from the pumps, lubricate and install new O-rings to the fittings. Install the fittings into the pumps; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 6–13).

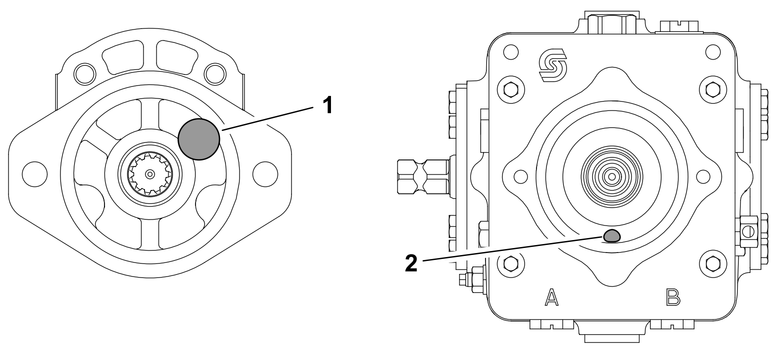

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Figure 152

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

IMPORTANT

A case drain exists in the piston (traction) pump and a suction port is near the input shaft of the gear pump (Figure 152). Before the gear pump is installed to the piston pump, ensure that the plugs placed in either of these ports are removed. Failure to remove the plugs will cause excessive pressure in the piston pump and damage seals. Also, before securing the gear pump to piston pump, fill the piston pump housing with clean hydraulic fluid through case drain hole.

---

2. Remove the plugs that were placed in the piston pump case drain and gear pump suction port. Fill the piston pump housing with new hydraulic fluid through case drain hole.
3. Assemble the traction and gear pumps as follows:

Installing the Hydraulic Pump Assembly (continued)

A. Lubricate and position new O-ring (item 10 in Figure 151) between the pumps.

B. Position the gear pump to the traction pump and secure with the 2 socket-head screws (item 6 in Figure 151), 2 lock washers, and 2 flat washers.

C. If the pump support bracket was removed from the gear pump, install the 2 flat washers (item 39 in Figure 151) and bracket to the gear pump and secure the pump with the 2 locknuts.

IMPORTANT

Ensure that you do not damage the machine components while installing the pump assembly.

4. Carefully lower the pump assembly into the machine frame. Align the piston pump input shaft to the pump driveshaft and slide the pump assembly to the machine frame.
5. Secure the pump assembly to the machine frame with the 2 flange-head screws (item 15 in Figure 151) and 2 flange nuts.
6. Secure the pump support bracket to the inside of the frame bracket with the 2 carriage screws (item 41 in Figure 151) and 2 flange nuts.
7. Use the labels that you attached during the removal process to correctly connect the hydraulic hoses and tubes to the fittings on the pump assembly; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 6–11).
8. Connect the machine wire harness electrical connector to the traction neutral switch.
9. Position the traction control cable to the piston (traction) pump. Secure the cable to the pump lever and cable bracket; refer to Piston (Traction) Pump Control Assembly (page 6–156).
10. Install the hydraulic pump driveshaft; refer to Installing the Hydraulic Pump Driveshaft (page 6–161).
11. Install the hood saddle onto the frame brackets. Lower and secure the hood and operator seat.
12. Check the hydraulic-fluid level in the hydraulic tank and add correct quantity of fluid if necessary; refer to the *Operator's Manual*.
13. Operate the machine functions slowly until air is out of system; refer to Charging the Hydraulic System (page 6–151).
14. Check the traction drive for neutral and traction neutral switch operation. Adjust if necessary.

Servicing the Piston (Traction) Pump

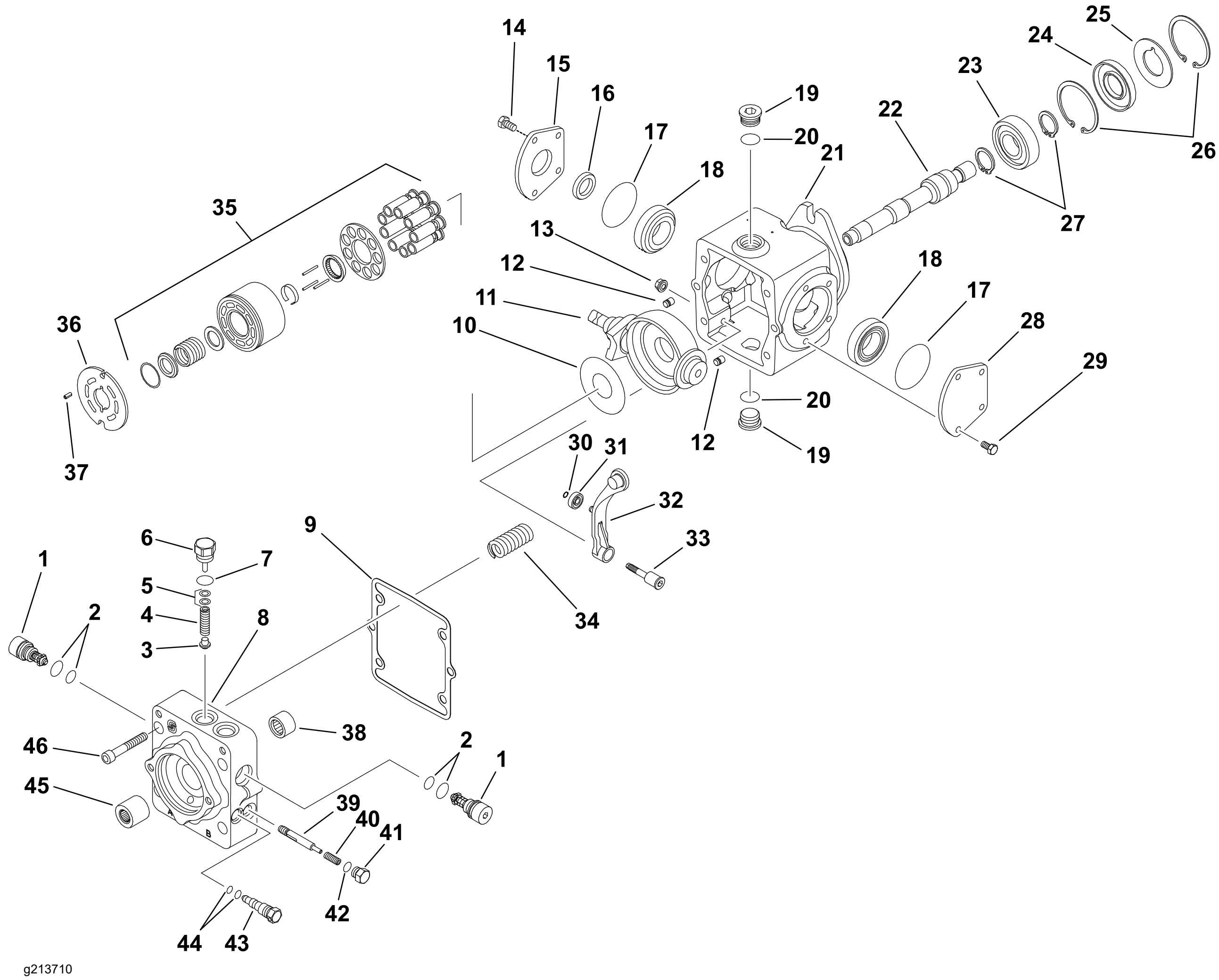

Figure 153

1. Relief valve (2 each)
2. Seal kit (2 each)
3. Charge relief poppet
4. Spring
5. Shim kit
6. Charge relief plug
7. O-ring
8. End cap
9. End cap gasket
10. Thrust plate
11. Swash plate
12. Pin (2 each)
13. Seal nut
14. Screw (4 each)
15. Trunnion cover
16. Seal
17. O-ring (2 each)
18. Bearing (2 each)
19. Plug (2 each)
20. O-ring (2 each)
21. Traction pump housing
22. Auxiliary shaft
23. Ball bearing
24. Seal
25. Backup washer
26. Retaining ring (2 each)
27. Retaining ring (2 each)
28. Trunnion cover
29. Screw (4 each)
30. Retaining ring
31. Bearing
32. Neutral return arm
33. Neutral return pivot
34. Spring
35. Cylinder block kit
36. Valve plate
37. Slotted pin
38. Needle bearing
39. Loop flushing spool
40. Spring
41. Plug
42. O-ring
43. Bypass valve
44. Seal kit
45. Coupling
46. Screw (4 each)

Note: For the piston (traction) pump repair information; refer to the Sauer-Danfoss LPV Closed Circuit Axial Piston Pumps Repair Instructions and Service Manual at the end of this chapter.

Servicing the Piston (Traction) Pump (continued)

IMPORTANT

If a piston (traction) pump failure occurs, refer to Traction Circuit Component Failure (page 6–9) for information regarding the importance of removing contamination from the traction circuit.

Servicing the Gear Pump

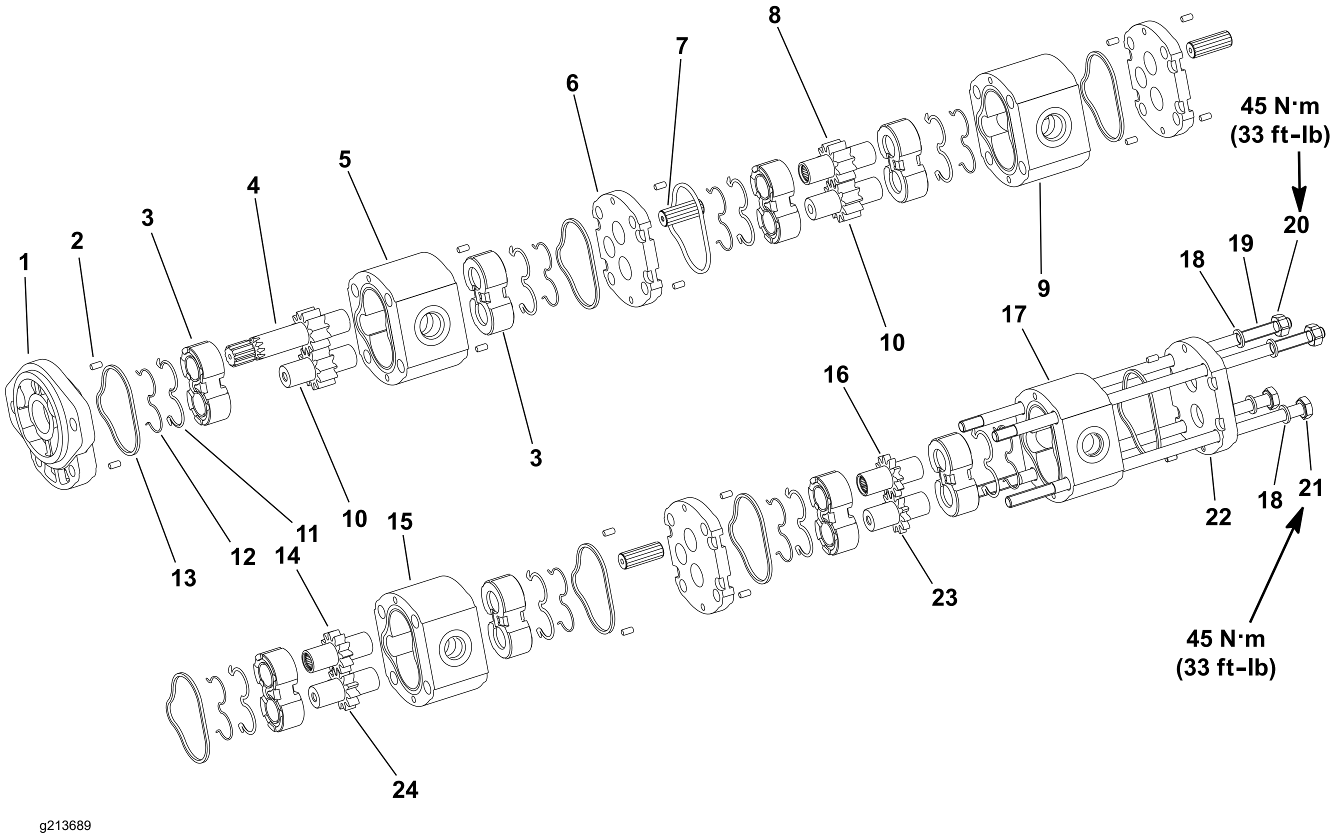

Figure 154

1.	Front cover	9.	Body (P2 section)	17.	Body (P4 section)
2.	Dowel pin (16 each)	10.	Driven gear (2 each)	18.	Washer (4 each)
3.	Thrust plate (8 each)	11.	Pressure seal (8 each)	19.	Stud bolt (2 each)
4.	Driveshaft	12.	Back-up ring (8 each)	20.	Nut (2 each)
5.	Body (P1 section)	13.	Square section seal (8 each)	21.	Bolt (2 each)
6.	Flange (3 each)	14.	Drive gear	22.	Rear cover
7.	Splined connecting shaft (3 each)	15.	Body (P3 section)	23.	Driven gear
8.	Drive gear	16.	Drive gear	24.	Driven gear

Disassembling the Gear Pump

Note: The gear pump must be replaced as a complete assembly. Individual gears, housings, and thrust plates are not available separately. Disassemble the gear pump for cleaning, inspection, and seal replacement only.

IMPORTANT

Keep bodies, gears, flanges, and thrust plates for each pump section together; do not mix the parts between the pump sections.

1. Plug the pump ports and clean the outer surface of the pump with cleaning solvent. Ensure that the work area is clean.

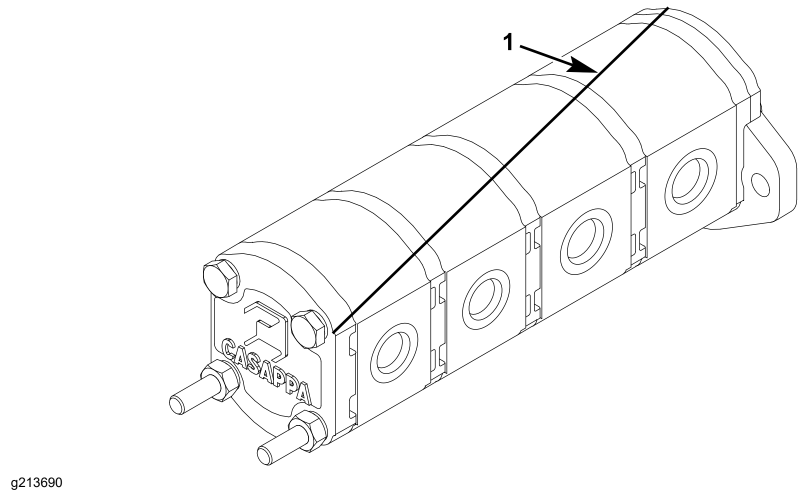

Figure 155

1. Diagonal line

2. Use a marker to make a diagonal line across the gear pump for assembly purposes (Figure 155).

IMPORTANT

Use caution when clamping the gear pump in a vise to avoid distorting any pump components.

3. Secure the front cover of the pump in a vise with the driveshaft pointing down.
4. Loosen the 2 bolts (item 21 in Figure 154) and 2 nuts that secures the pump assembly.
5. Remove the pump from the vise and remove the fasteners.
6. Support the pump assembly and gently tap the pump case with a soft-faced hammer to loosen the pump sections. Do not drop the parts or disengage the gear mesh.

IMPORTANT

Mark the relative positions of the gear teeth and thrust plates so that you can be assemble them in the same position. Do not touch the gear surfaces as residue on hands may be corrosive to gear finish.

Disassembling the Gear Pump (continued)

7. Remove the thrust plates and seals from each pump section. Before removing each gear set, apply marking dye to the mating teeth to retain timing. The 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 the parts between sections.

Inspecting the Gear Pump

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

CAUTION

Use eye protection such as goggles when using compressed air.

2. Clean all the gear pump parts with solvent and dry them with compressed air.

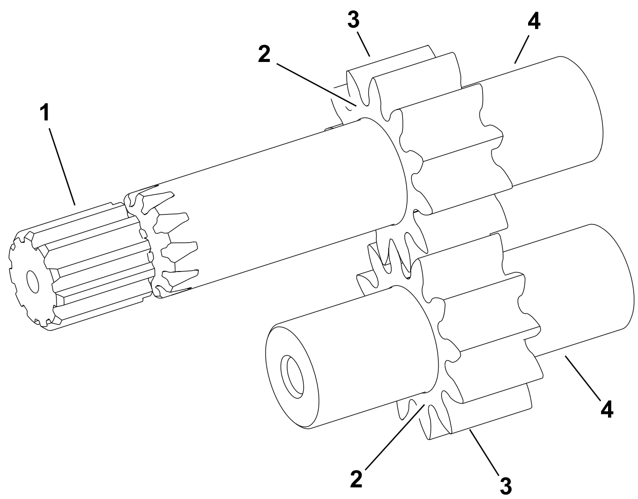

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Figure 156

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

3. Inspect the drive gears and idler gears for the following (Figure 156):
   A. Gear shafts should be free of scoring, rough surfaces, and excessive wear at the bushing points and sealing areas.
   B. Gear teeth should be free from excessive scoring, broken or nicked gear teeth, and visual wear.
   C. Inspect the gear face edge for sharpness because sharp edges of gears will mill into the wear plates.
4. Inspect the wear plates for the following:
   A. Bearing areas should not have excessive wear or scoring.
   B. Face of the wear plates that are in contact with gears should be free of wear, roughness, or scoring.
   C. Thickness of the wear plates should be equal.
5. Inspect the front flange and body for damage or wear.
6. Replace the entire pump assembly if the internal parts are excessively worn or damaged.

Assembling the Gear Pump

1. Apply clean hydraulic fluid to all the parts before you assemble them.

   Note: The pressure seals and back-up rings fit in the grooves machined into the thrust plates. The body seals fit in the grooves machined in the body faces.

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

3. After the pump has been assembled, tighten the bolts and nuts by hand. Rotate the driveshaft to check for binding. Protect the shaft if you use pliers.

4. Torque the bolts and nuts evenly to **45 N·m (33 ft-lb)** in a crossing pattern.

Front Wheel Motors

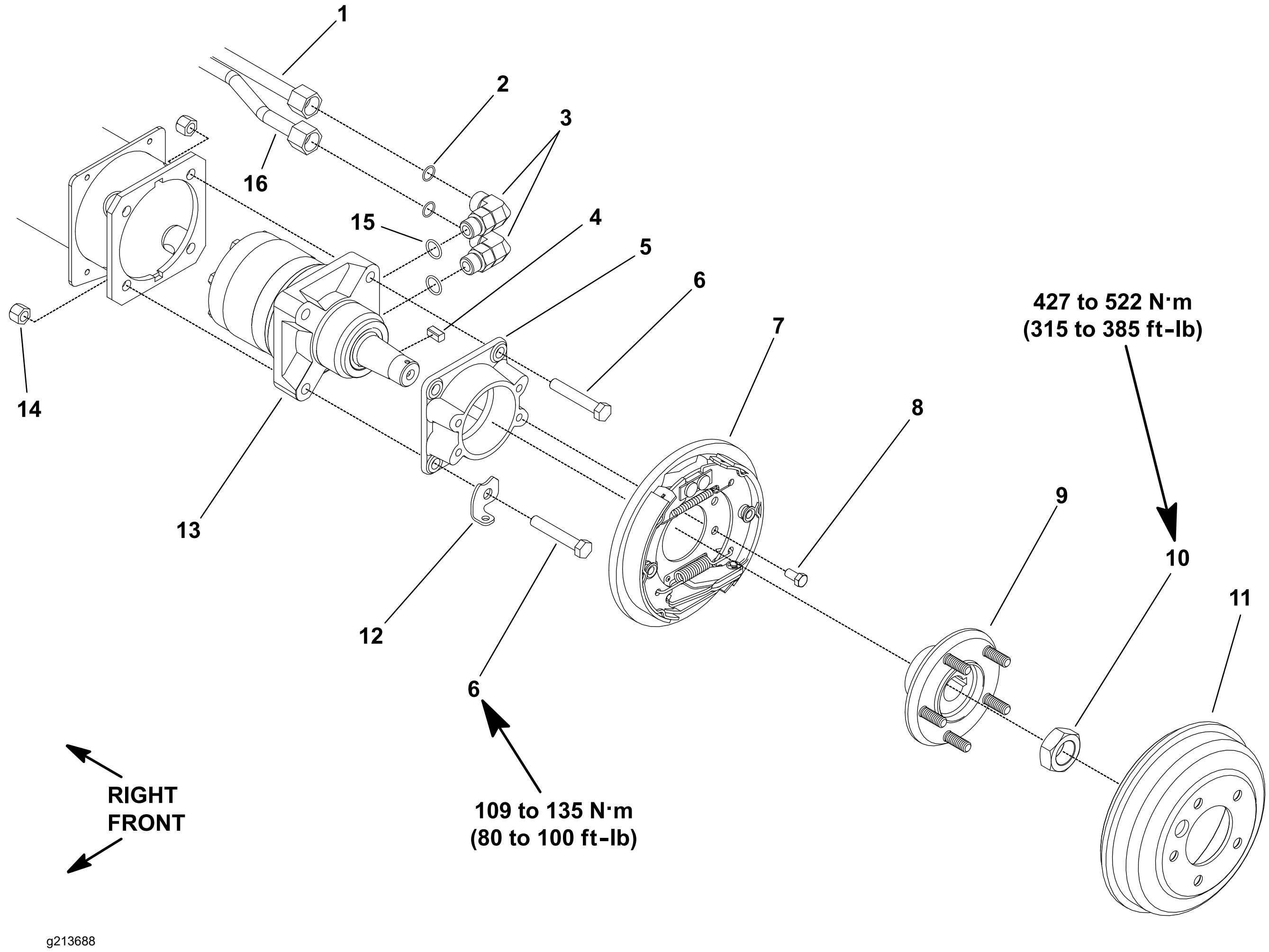

Figure 157

1. Hydraulic tube
2. O-ring (2 each)
3. 90° hydraulic fitting
4. Square key
5. Brake adapter
6. Bolt (4 each per wheel motor)
7. Left brake assembly
8. Bolt (4 each per brake assembly)
9. Wheel hub
10. Locknut
11. Brake drum
12. Left spring clip
13. Left wheel motor
14. Locknut (4 each per wheel motor)
15. O-ring (2 each)
16. Hydraulic tube

Removing the Front Wheel Motor

CAUTION

Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).

1. Park the machine on a level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Block the rear wheels with chocks to prevent the machine from moving.

Removing the Front Wheel Motor (continued)

3. Loosen, but do not remove the locknut (item 10 in Figure 157) that secures the wheel hub to the wheel motor.
4. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 6–145).
5. Remove the front wheel, brake drum, wheel hub, and brake assembly from the machine; refer to Servicing the Brakes (page 8–10).
6. Clean the hydraulic tube ends and fittings on the wheel motor to prevent contaminants from entering into the hydraulic system.
7. For assembly purposes, label all the hydraulic connections at the wheel motor.
8. Loosen and remove the hydraulic tubes from the fittings on the wheel motor. Allow the tubes to drain into a suitable container.
9. Install clean caps or plugs on the hydraulic tubes and fittings to prevent system contamination.
10. Support the wheel motor to prevent it from falling during removal. Remove the 4 locknuts (item 14 in Figure 157) from the 4 bolts that secure the motor and brake bracket to the frame.
11. Note the location of the spring clip (item 12 in Figure 157) for assembly purposes. Remove the 4 bolts, brake assembly with the brake adapter, and spring clip from the wheel motor and frame.
12. Remove the wheel motor from the machine.
13. If the hydraulic fittings are to be removed from the wheel motor, mark the fitting orientation for assembly purposes. Remove the fittings from the wheel motor and discard the O-rings from the fittings.

Installing the Front Wheel Motor

IMPORTANT

Because of the internal differences in the wheel motors, do not interchange the wheel motors on the machine (e.g., do not put the right motor on the left side of the machine). If necessary, use the *Parts Catalog* and Part Number on the wheel motor to identify the right and left motors, there is also a yellow dot on the left motor.

1. If the hydraulic fittings were removed from the wheel motor, lubricate and install new O-rings to the fittings. To properly align and install the fittings into the wheel motor ports, use the marks that you made during the removal process; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 6–13).
2. Position the wheel motor to the frame. Slide the brake adapter (item 5 in Figure 157), spring clip, and 4 bolts onto the wheel motor and frame. Ensure that the spring clip is positioned as noted during disassembly.
3. Install and tighten the 4 locknuts onto the 4 bolts to secure the motor and brake components to the frame. Torque the bolts to **109 to 135 N·m (80 to 100 ft-lb)**.
4. Remove the caps or plugs from the hydraulic tubes and wheel motor fittings.
5. Use the labels that you attached during the removal process to correctly connect the hydraulic tubes to the wheel motor fittings; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 6–11).

Installing the Front Wheel Motor (continued)

6. Clean the tapers of the wheel hub and wheel motor shaft.
7. Install the brake assembly, and wheel hub.
8. Tighten the wheel hub locknut (item 10 in Figure 157) to **407 to 542 N·m (300 to 400 ft-lb)**.
9. Install the brake drum and front wheel to the machine; refer to Installing the Wheel (page 8–6).
10. Charge the hydraulic system; refer to Charging the Hydraulic System (page 6–151).

Servicing the Front Wheel Motor

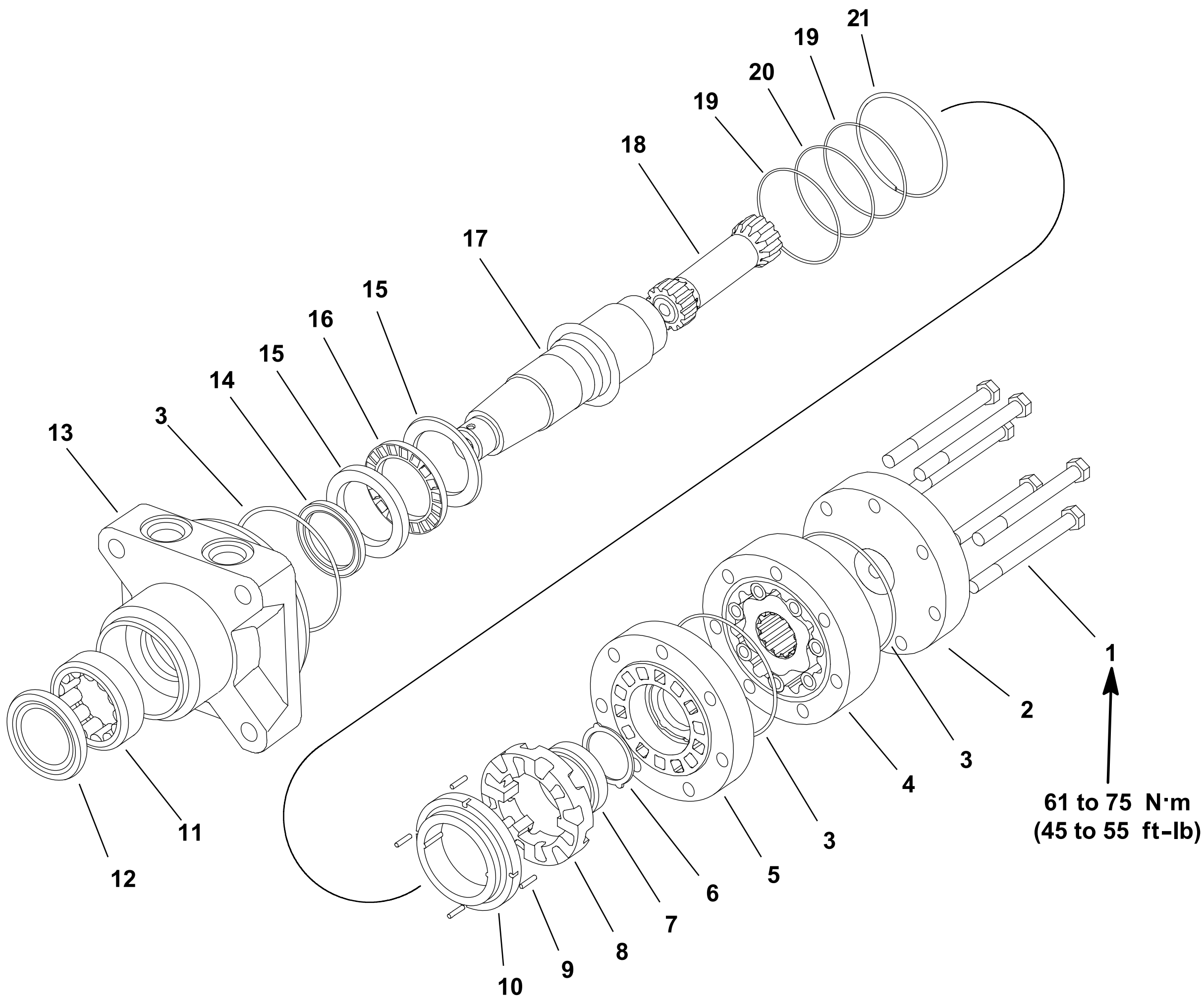

Figure 158

1. Bolt (7 each)
2. End cap
3. O-ring (3 each)
4. Geroler assembly
5. Valve plate
6. Thrust bearing
7. Bearing
8. Valve
9. Dowel pin (4 each)
10. Balancing ring
11. Bearing
12. Grease seal
13. Housing
14. Shaft seal
15. Bearing race (2 each)
16. Thrust bearing
17. Output shaft
18. Drive
19. Back-up ring (2 each)
20. O-ring
21. Valve spring

Note: The front wheel motors of your Reelmaster machine are Eaton Delta motors of the same basic design with minor differences. The right side motor has a reverse timed manifold to allow correct rotation direction for forward and reverse. The left side wheel motor can be identified by the machined groove on the end of the output shaft.

Note: For the front wheel motor repair procedures; refer to the Eaton Delta Motors Parts and Repair Manual at the end of this chapter.

Servicing the Front Wheel Motor (continued)

IMPORTANT

If a wheel motor fails; refer to the Traction Circuit Component Failure (page 6–9) for information regarding the importance of removing contamination from the traction circuit.

Rear Wheel Motors (Machine with CrossTrax AWD)

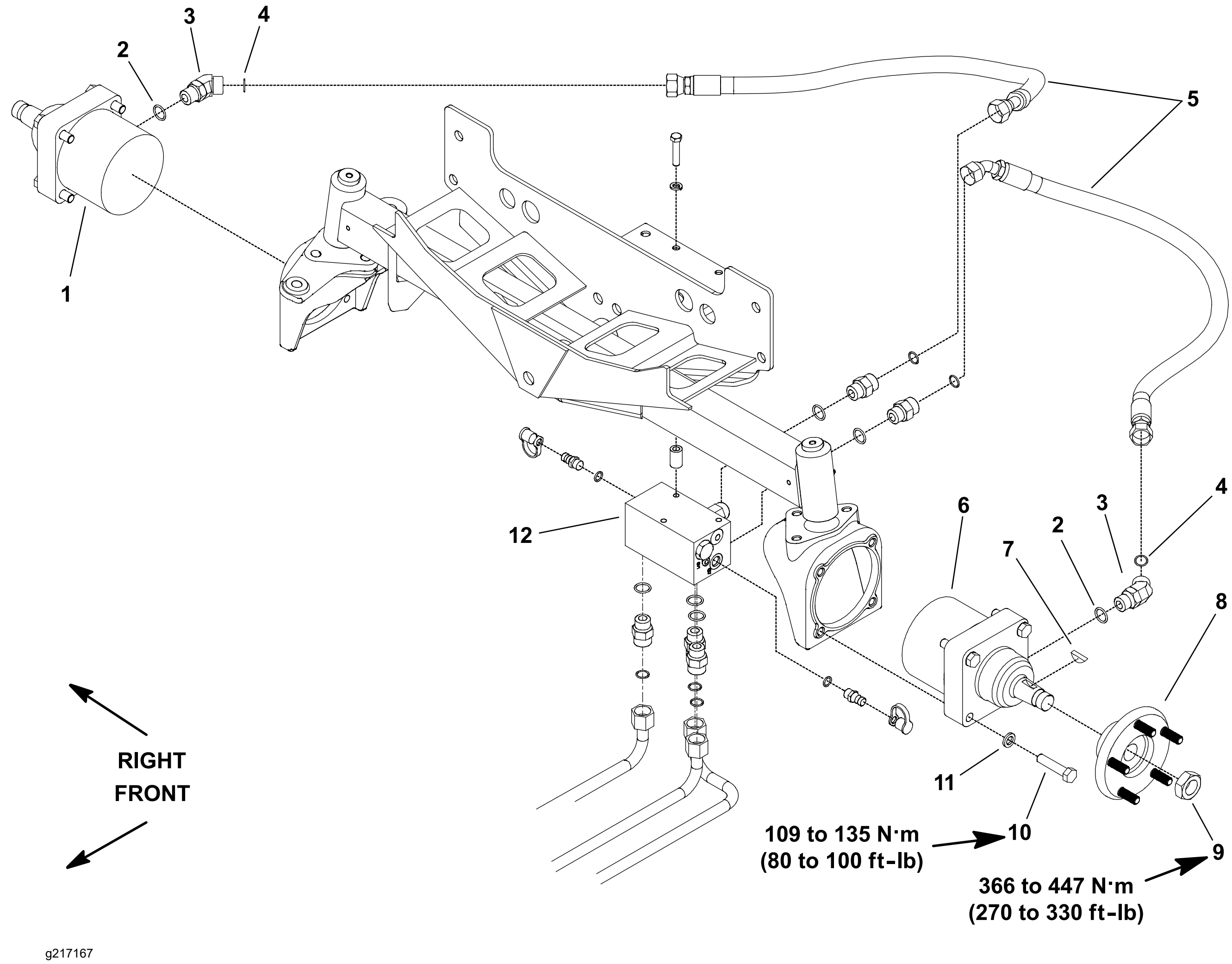

Figure 159

1. Wheel motor (right)
2. O-ring (2 each per motor)
3. 45° hydraulic fitting (2 each per motor)
4. O-ring (2 each per motor)
5. Hydraulic hose (2 each per motor)
6. Wheel motor (left)
7. Woodruff key
8. Wheel hub
9. Locknut
10. Bolt (4 each per motor)
11. Lock washer (4 each per motor)
12. CrossTrax control manifold

Removing the Rear Wheel Motor

CAUTION

Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to **Releasing Pressure from the Hydraulic System (page 6–8)****.**

1. Park the machine on a level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Block the front wheels with chocks to prevent the machine from moving.

Removing the Rear Wheel Motor (continued)

3. Loosen, but do not remove the locknut (item 9 in Figure 159) that secures the wheel hub to the wheel motor.
4. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 6–145).

IMPORTANT

Before lifting the machine with a jack, review and follow Jacking Instructions (page 1–6).

5. Lift the machine with a jack to remove the rear wheel, support the machine with jack stands.
6. Remove the rear wheel from the machine; refer to Removing the Wheel (page 8–6).
7. Remove wheel hub from the rear wheel motor as follows:

IMPORTANT

Do not hit the wheel hub, wheel-hub puller, or wheel motor with a hammer while removing or installing. Hammering can damage the wheel motor.

   A. Ensure that the locknut on the wheel motor shaft is loosened at least 2 turns.

   B. Use a hub puller (refer to Wheel Hub Puller (page 6–47)) to loosen the wheel hub from the wheel motor.

   C. Remove the locknut and wheel hub from the motor shaft. Discard the locknut.

   D. Locate and retrieve the woodruff key (item 7 in Figure 159) from the wheel motor shaft.

8. Clean the hydraulic hose ends and fittings on the wheel motor to prevent contaminants from entering into the hydraulic system.
9. For assembly purposes, label all the hydraulic connections at the wheel motor.
10. Loosen and remove the hydraulic tubes from the fittings on the wheel motor. Allow the hoses to drain into a suitable container.
11. Install clean caps or plugs on the hydraulic hoses and fittings to prevent system contamination.
12. Support the wheel motor to prevent it from falling during removal.
13. Remove the 4 bolts (item 10 in Figure 159) and 4 lock washers that secure the wheel motor to the motor housing.
14. Remove the wheel motor from the machine.
15. If the hydraulic fittings are to be removed from the wheel motor, mark the fitting orientation for assembly purposes. Remove the fittings from the wheel motor and discard the O-rings from the fittings.

Installing the Rear Wheel Motor

IMPORTANT

Because of the internal differences in the wheel motors, do not interchange the wheel motors on the machine (e.g., do not put the right motor on the left side of the machine). If necessary, use the *Parts Catalog* and Part Number on the wheel motor to identify the right and left motors, there is also a yellow dot on the left motor.

1. If the hydraulic fittings were removed from the wheel motor, lubricate and install new O-rings to the fittings. To properly align and install the fittings into the wheel motor ports, use the marks that you made during the removal process; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 6–13).
2. Position the rear wheel motor to the motor housing. Ensure that the ports in the wheel motor are facing toward the rear of the machine.
3. Secure the wheel motor to the housing with the 4 bolts and 4 lock washers. Torque the bolts to **109 to 135 N·m (80 to 100 ft-lb)**.
4. Remove the caps or plugs that were installed to the hydraulic hoses during the removal process.
5. Lubricate and install new O-rings to the fittings on the wheel motor. Use the labels that you attached during the removal process to correctly connect the hydraulic hoses to the wheel motor fittings; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 6–11).

IMPORTANT

Before the wheel hub is installed, clean the tapers of the wheel hub and wheel motor shaft. Ensure that the tapers are free of grease, oil, and dirt. Do not use anti-seize lubricant when installing the wheel hub.

6. Position the woodruff key (item 7 in Figure 159) to the keyslot in the wheel motor shaft.

IMPORTANT

Do not use the removed locknut to secure the wheel hub to the wheel motor.

7. Install the wheel hub onto the motor shaft and secure with new locknut (item 9 in Figure 159).
8. Install the rear wheel to the machine; refer to Installing the Wheel (page 8–6).
9. Ensure to torque the locknut to **366 to 447 N·m (270 to 330 ft-lb)**.
10. Fill the hydraulic tank with the correct quantity of new hydraulic fluid.
11. After you complete the assembly, ensure that the hydraulic hoses and fittings do not contact anything through the full range of axle motion. Also, check for any hydraulic-fluid leaks.
12. Operate the machine functions slowly until air is out of system; refer to Charging the Hydraulic System (page 6–151).

Installing the Rear Wheel Motor (continued)

13. Start the engine, check for hydraulic-fluid leaks, repair any leaks as necessary, and fill the hydraulic tank with the correct quantity of new hydraulic fluid before returning the machine to service.

Servicing the Rear Wheel Motor (Machine with CrossTrax AWD)

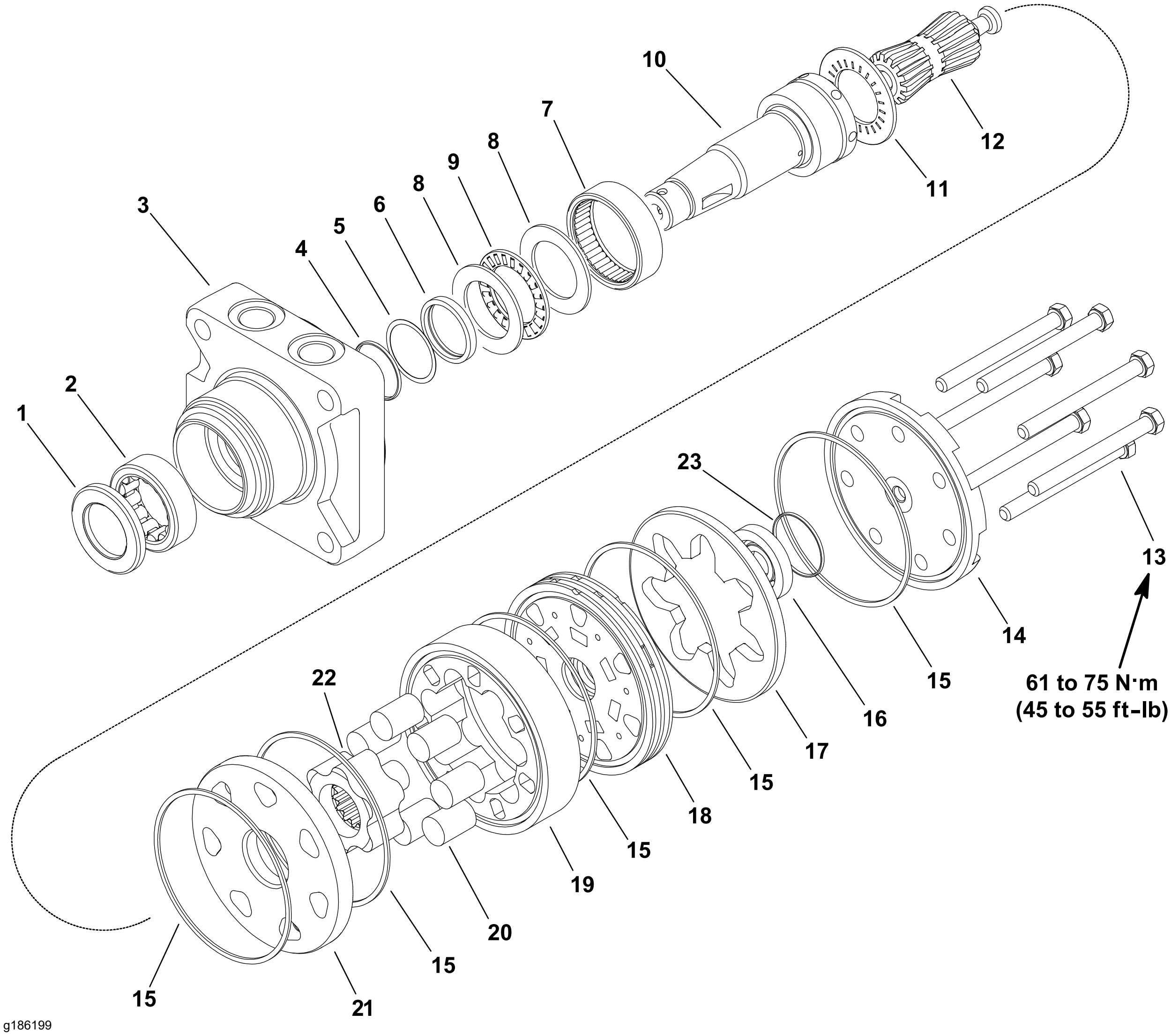

Figure 160

1. Dirt and water seal
2. Outer bearing
3. Housing
4. Back-up ring
5. Back-up washer
6. Shaft seal
7. Inner bearing
8. Thrust washer (2 each)
9. Thrust bearing
10. Coupling shaft
11. Thrust bearing
12. Drive link
13. Bolt (7 each)
14. End cover
15. Body seal (5 each)
16. Commutator
17. Commutator ring
18. Manifold
19. Stator
20. Vane (7 each)
21. Wear plate
22. Rotor
23. Commutator ring

Note: The rear wheel motors used on machines with the CrossTrax AWD are the Parker Torqmotor™ motors of the same basic design with minor differences. The right side motor has a reverse timed manifold to allow correct rotation direction for forward and reverse. The left side wheel motor is identified with a yellow dot on the motor housing near the B port.

Note: For the rear wheel motor repair procedures; refer to 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 fails; refer to the Traction Circuit Component Failure (page 6–9) for information regarding the importance of removing contamination from the traction circuit.

CrossTrax™ AWD Control Manifold Assembly

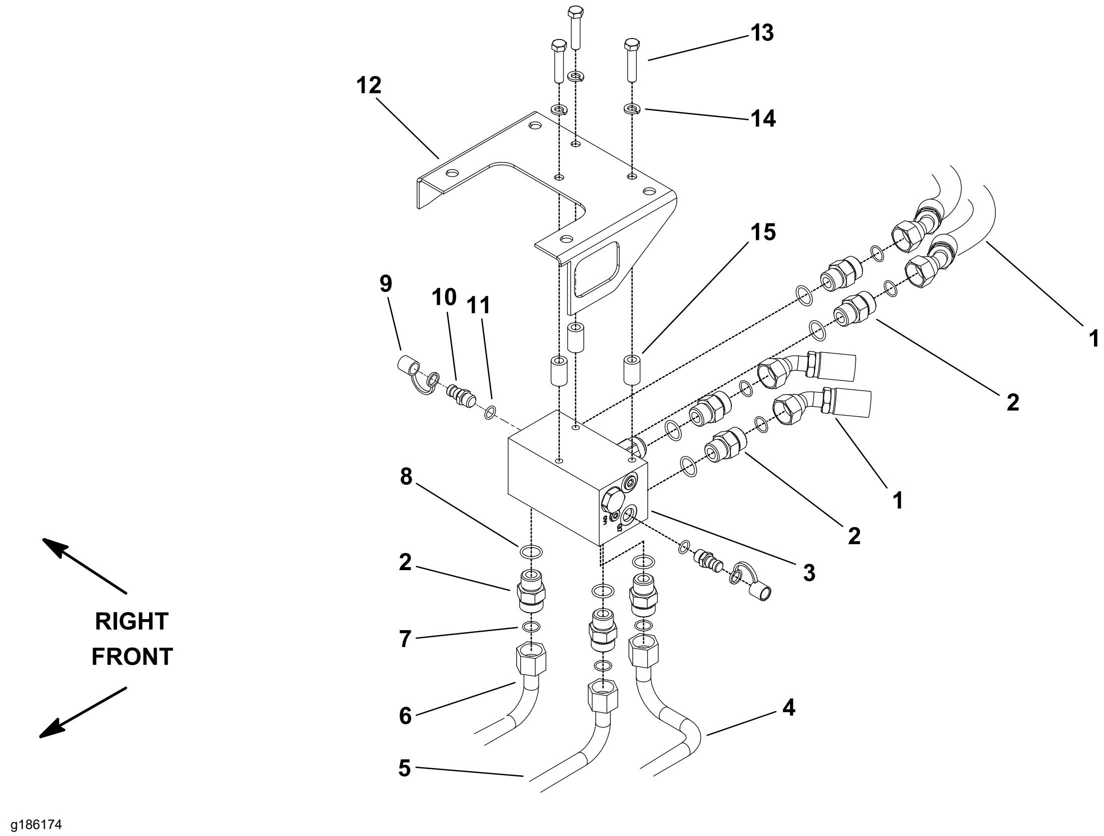

Figure 161

1. Hydraulic hose (4 each)
2. Straight fitting (7 each)
3. AWD control manifold
4. Hydraulic tube
5. Hydraulic tube
6. Hydraulic tube
7. O-ring (7 each)
8. O-ring (7 each)
9. Dust cap (2 each)
10. Diagnostic fitting (2 each)
11. O-ring (2 each)
12. Frame bracket
13. Bolt (3 each)
14. Lock washer (3 each)
15. Spacer (3 each)

Removing the CrossTrax AWD Control Manifold Assembly

1. Park the machine on a level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.

CAUTION

Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).

2. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 6–145).
3. Locate the CrossTrax AWD control manifold that is attached to the bracket at rear of the frame.
4. For assembly purposes, label all the hydraulic connections. Clean the hydraulic connections before loosening the hydraulic lines.

Removing the CrossTrax AWD Control Manifold Assembly (continued)

5. Disconnect the hydraulic hoses and tubes from the fittings in the AWD control manifold assembly. Allow the lines to drain into a suitable container. Remove and discard the O-rings from the fittings.
6. Install clean caps or plugs on the hydraulic lines and fittings to prevent system contamination.
7. Support the AWD control manifold assembly to prevent it from falling.
8. Remove the 3 bolts (item 13 in Figure 161) and 3 lock washers that secure the AWD control manifold to the frame bracket.
9. Locate and retrieve the 3 spacers between the frame bracket and the manifold.
10. Remove the AWD control manifold from the machine.
11. If necessary, remove the hydraulic fittings from the manifold. Discard the O-rings that were removed.

Installing the CrossTrax AWD Control Manifold Assembly

1. If the hydraulic fittings were removed from the AWD control manifold, lubricate new O-rings with clean hydraulic fluid, position the O-rings to the fittings, and install the fittings into the manifold; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 6–13).
2. Position the manifold and 3 spacers to the frame bracket. Install the 3 lock washers (item 14 in Figure 161) and 3 bolts but do not fully tighten the bolts.
3. Remove the caps and plugs from the hydraulic lines and fittings.
4. Lubricate and install new O-rings on the AWD control manifold fittings.
5. Use the labels that you attached during manifold removal, correctly connect the hydraulic hoses and tubes to the AWD control manifold assembly; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 6–11).
6. Tighten the 3 bolts to secure the AWD control manifold to the frame.
7. Check the hydraulic-fluid level in the hydraulic tank and add correct quantity of fluid if necessary; refer to the *Operator’s Manual*.
8. Operate the machine functions slowly until air is out of system; refer to Charging the Hydraulic System (page 6–151).

Servicing the CrossTrax AWD Control Manifold Assembly

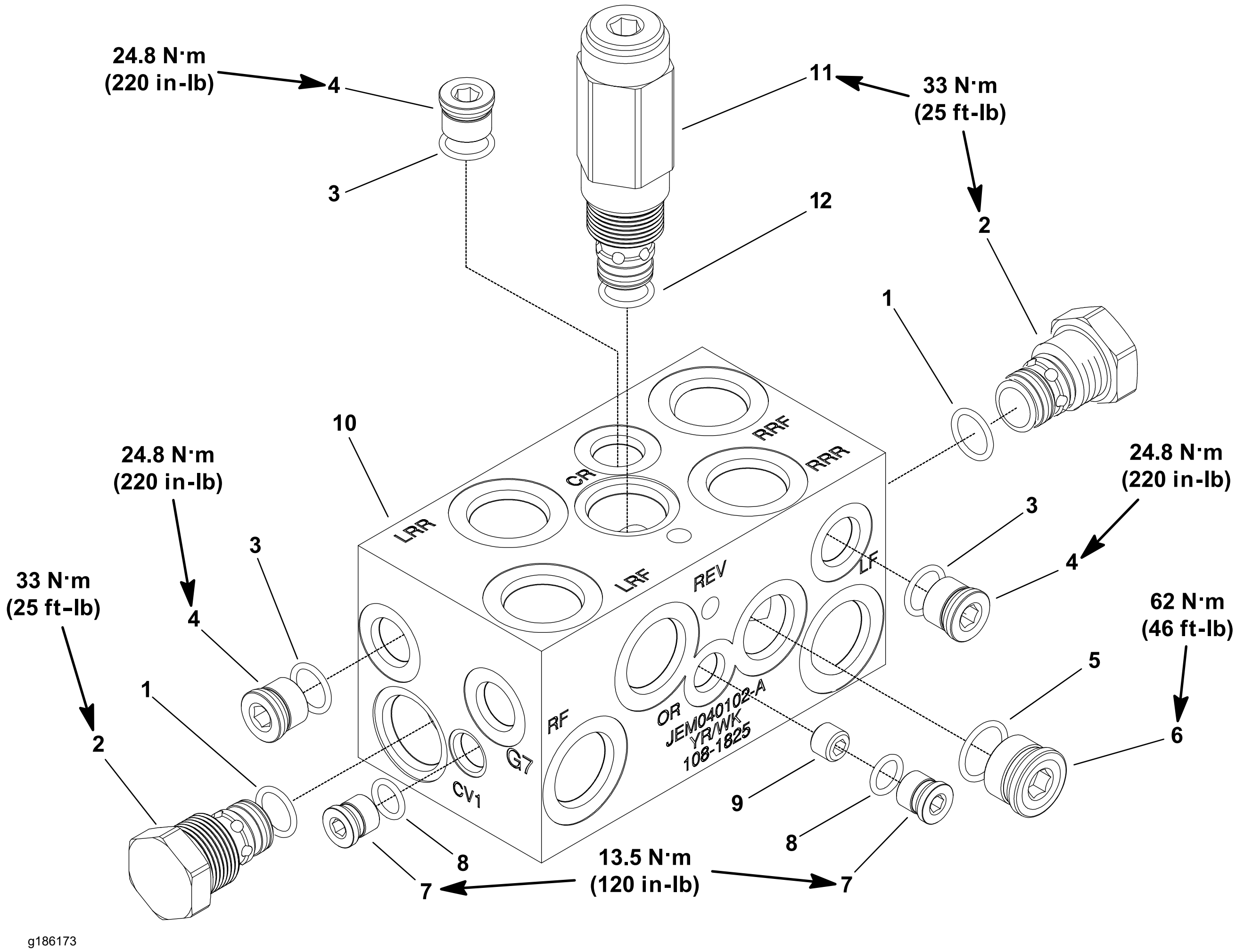

Figure 162

1. Seal kit (2 each)
2. Check valve (2 each)
3. O-ring (3 each)
4. #6 zero-leak plug (3 each)
5. O-ring
6. #8 zero-leak plug
7. #4 zero-leak plug (2 each)
8. O-ring (2 each)
9. Orifice (0.040)
10. AWD control manifold
11. Bi-directional relief valve
12. Seal kit

For the control manifold service procedures; refer to Servicing a Control Manifold Cartridge Valve (page 6–199). Refer to Figure 162 for CrossTrax AWD control manifold cartridge valve and plug installation torque.

Note: Do not adjust the bi-directional relief valve (item 11 in Figure 162).

Note: The CrossTrax AWD control manifold 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 as 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 the plugs into the control manifold; torque the plugs to the values identified in Figure 162.

Mow Control Manifold Assembly

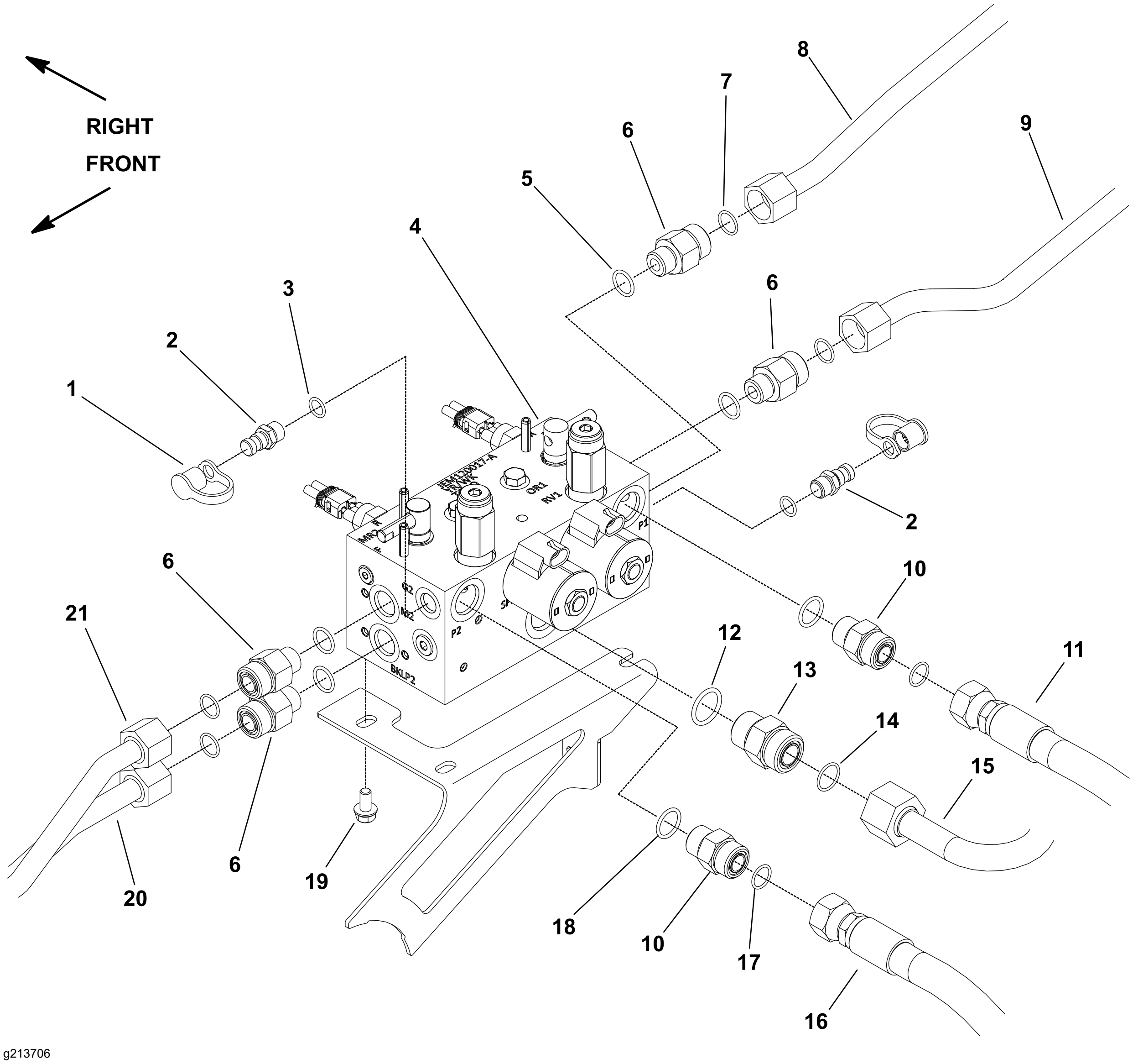

Figure 163

1. Dust cap (2 each)
2. Diagnostic fitting (2 each)
3. O-ring
4. Mow control manifold
5. O-ring (4 each)
6. Hydraulic fitting (4 each)
7. O-ring (4 each)
8. Hydraulic tube
9. Hydraulic tube
10. Hydraulic fitting (2 each)
11. Hydraulic hose
12. O-ring
13. Hydraulic fitting
14. O-ring
15. Hydraulic tube
16. Hydraulic hose
17. O-ring (2 each)
18. O-ring (2 each)
19. Flange-head screw (3 each)
20. Hydraulic tube
21. Hydraulic tube

Note: For testing the solenoid valve coils; refer to Testing the Hydraulic Solenoid Valve Coils (page 7–96).

Removing the Mow Control Manifold Assembly

⚠ CAUTION ⚠

Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).

1. Park the machine on a level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 6–145).
3. Tilt the operator seat and engage the seat prop to retain the seat in the raised position.
4. Locate the hydraulic mow control manifold.
5. For assembly purposes, label all the hydraulic and electrical connections. Clean the hydraulic connections before loosening the hydraulic lines.
6. Disconnect the hydraulic hoses and tubes from the fittings in the manifold. Allow the lines to drain into a suitable container. Remove and discard the O-rings from the fittings.
7. Install clean caps or plugs on the hydraulic tubes and fittings to prevent contamination.
8. Disconnect the wire harness leads from the solenoid coils and switches on the mow control manifold.
9. Remove the 3 flange-head screws (item 19 in Figure 163) that secure the mow control manifold to the bracket, and remove the mow control manifold from the machine.
10. If necessary, remove the hydraulic fittings from the manifold. Discard the O-rings that were removed.

Installing the Mow Control Manifold Assembly

1. If the hydraulic fittings were removed from the mow control manifold, lubricate new O-rings with clean hydraulic fluid, position the O-rings to the fittings, and install the fittings into the manifold ports; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 6–13).
2. Position the mow control manifold to the bracket and install the 3 flange-head screws (item 19 in Figure 163) but do not fully tighten.
3. Remove the caps and plugs from the hydraulic lines and fittings.
4. Lubricate and install new O-rings on the manifold fittings. Use the labels that you attached during removal, correctly connect the hydraulic lines to the fittings and tighten all the connections; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 6–11).
5. Tighten the 3 flange-head screws to secure the mow control manifold to the bracket.
6. Connect the wire harness leads to the solenoid coils and switches on the mow control manifold.
7. Lower and secure the operator seat.
8. Check the hydraulic-fluid level in the hydraulic tank and add correct quantity of fluid if necessary; refer to the *Operator's Manual*.

Installing the Mow Control Manifold Assembly (continued)

9. Operate the machine functions slowly until air is out of system; refer to Charging the Hydraulic System (page 6–151).

Servicing the Mow Control Manifold Assembly

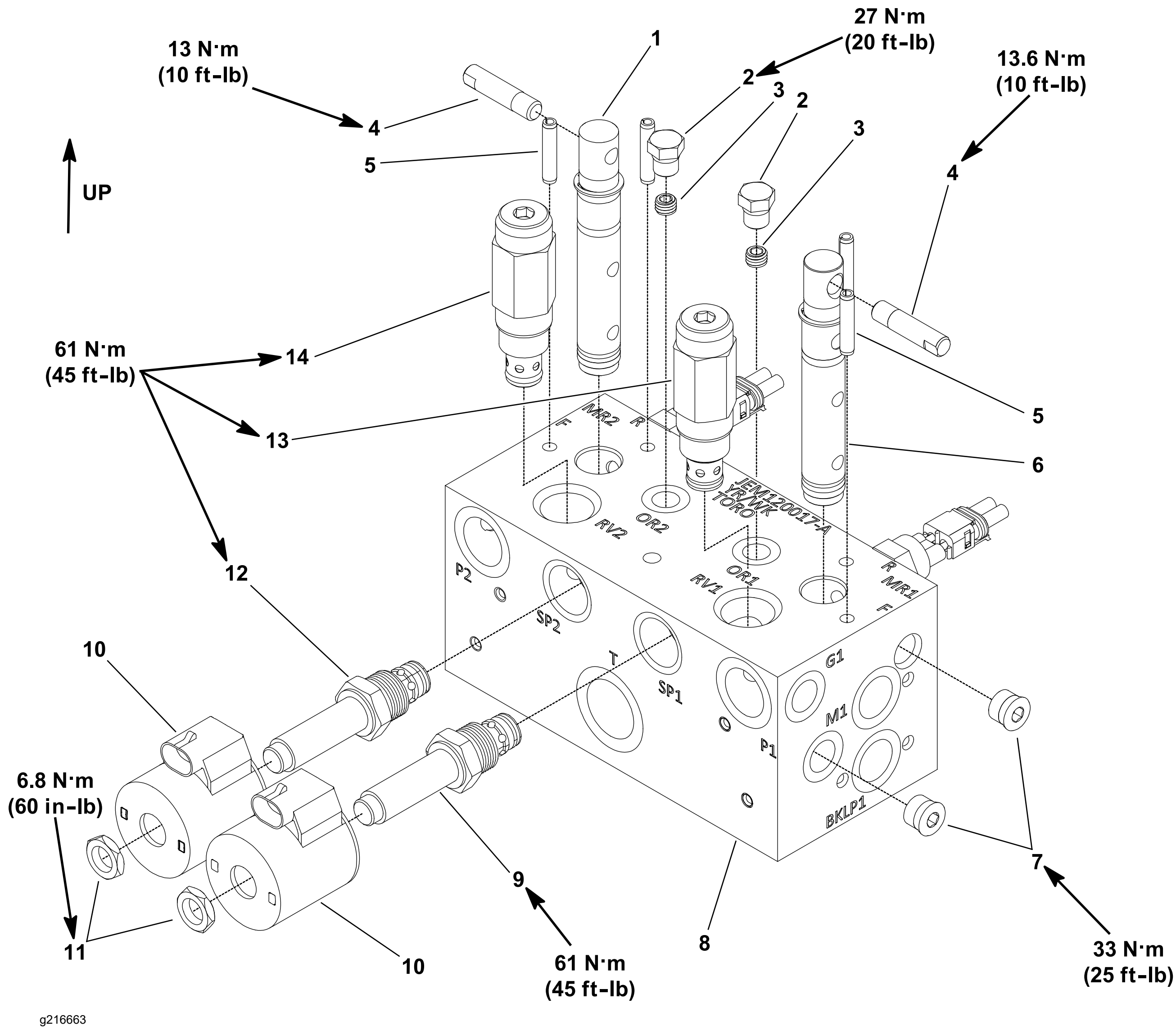

Figure 164

1. Backlap spool (front cutting units)
2. #4 zero-leak plug
3. Orifice (0.040) (2 each)
4. Spool handle
5. Spring pin (2 each per spool)
6. Backlap spool (rear cutting units)
7. #6 zero-leak plug
8. Mow control manifold
9. Solenoid proportional valve (SP1)
10. Solenoid coil (2 each)
11. Nut (2 each)
12. Solenoid proportional valve (SP2)
13. Relief valve (RV1)
14. Relief valve (RV2)

Note: The ports on the mow control manifold are marked for easy identification of the components. Example: P1 is the pump P1 connection port and RV2 is the location for the solenoid relief valve RV2; refer to the Hydraulic Schematic in Appendix A (page A–1) to identify the function of the hydraulic lines and cartridge valves at each manifold port.

WARNING

Before opening the hydraulic system, operate all the hydraulic controls to release all the pressure in the system and avoid injury from pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).

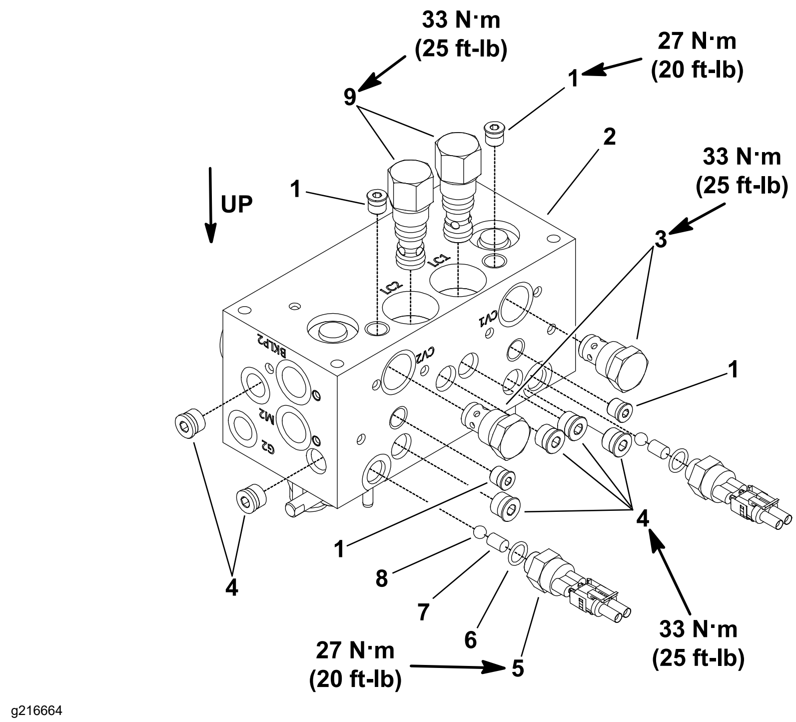

Figure 165

1. #4 zero-leak plug	4. #6 zero-leak plug	7. Dowel pin (2 each)
2. Mow control manifold	5. Backlap switch (2 each)	8. Ball (2 each)
3. Check valve (2 each)	6. O-ring (2 each)	9. Pressure compensator

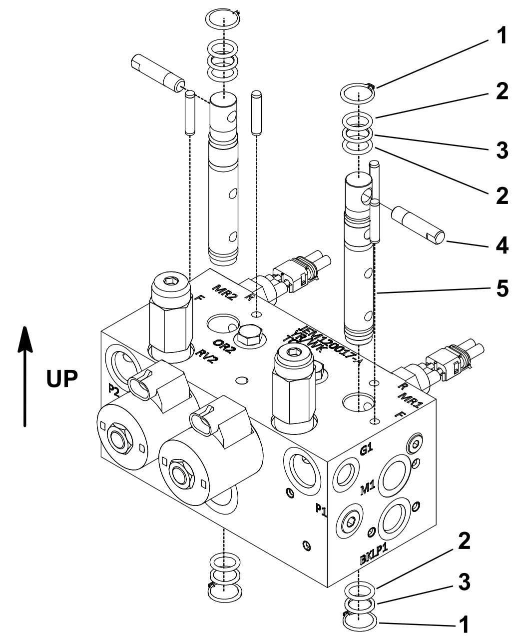

Figure 166

1. Retaining ring
2. O-ring
3. Back-up ring
4. Handle
5. Mow/backlap spool

For the mow control manifold cartridge valve service procedures; refer to Servicing a Control Manifold Cartridge Valve (page 6–199). Refer to Figure 164 and Figure 165 for cartridge valve and plug installation torque.

Note: The mow control manifold 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 as 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 the plugs; torque the plugs to the values identified in Figure 164 and Figure 165.

Servicing the Mow/Backlap Spool

IMPORTANT

Before removing the mow/backlap spool from the mow manifold, remove the backlap switch, dowel pin, and ball.

1. Remove the mow/backlap spool from the mow control manifold as follows:
   A. Remove the backlap switch from the mow manifold before you remove the mow/backlap spool (Figure 165). Remove the dowel pin and ball from the manifold port after the switch is removed. Remove and discard the O-ring from the switch.
   B. Remove the lower retaining ring from the mow/backlap spool. Raise the mow/backlap spool to get access to the retaining ring on upper end of the spool, and remove the upper retaining ring.
   C. Push the spool down until the O-ring and back-up ring are exposed at the bottom of the mow manifold. Remove the lower O-ring and back-up ring from the spool.

Servicing the Mow/Backlap Spool (continued)

D. Pull the spool up and out of the mow manifold. Remove the O-rings and back-up ring from the spool.

E. Discard the O-rings and back-up rings that were removed.

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

3. Install the mow/backlap spool in the mow control manifold as follows:

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

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

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

   D. Push the mow/backlap spool down and install the lower retaining ring to the spool.

   E. If the handle was removed from the spool, position the spool so that the handle location of spool is between the stop pins. Apply Loctite 603 Retaining Compound (or equivalent) to the threads on the handle and install the handle into the spool. Torque the handle to **13.6 N·m (10 ft-lb)**.

   F. Place the ball and dowel pin in the backlap switch manifold port (Figure 165). Install new O-ring onto the backlap switch. Thread the backlap switch into the port and torque the switch to **27 N·m (20 ft-lb)**.

Lift Control Manifold

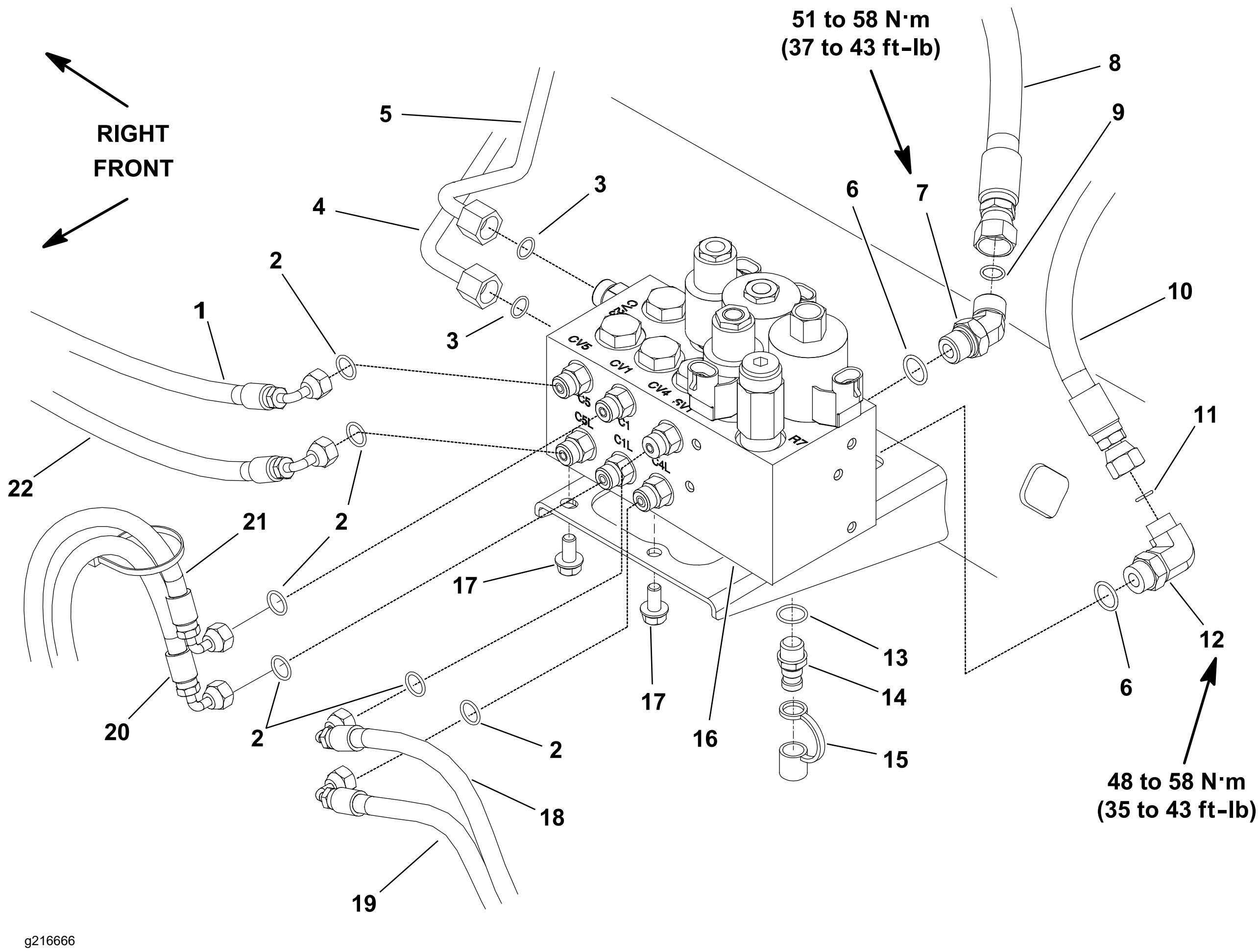

Figure 167

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

Note: For testing the solenoid valve coils; refer to Testing the Hydraulic Solenoid Valve Coils (page 7–96).

Removing the Lift Control Manifold

1. Park the machine on a level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 6–145).
3. Locate the hydraulic lift control manifold that is attached to the frame bracket under the front platform.
4. For assembly purposes, label all the hydraulic connections. Clean the hydraulic connections before loosening the hydraulic lines.

CAUTION

Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).

5. Disconnect the hydraulic hoses and tubes from the fittings in the manifold. Allow the lines to drain into a suitable container. Remove and discard the O-rings from the fittings.
6. Install clean caps or plugs on the hydraulic hoses and fittings to prevent system contamination.
7. For assembly purposes, label all the solenoid coil wire harness leads. Disconnect the wire harness leads from the solenoid coils on the manifold.
8. Remove the 2 flange-head screws that secure the manifold to the machine frame.
9. Remove the lift control manifold from the machine.

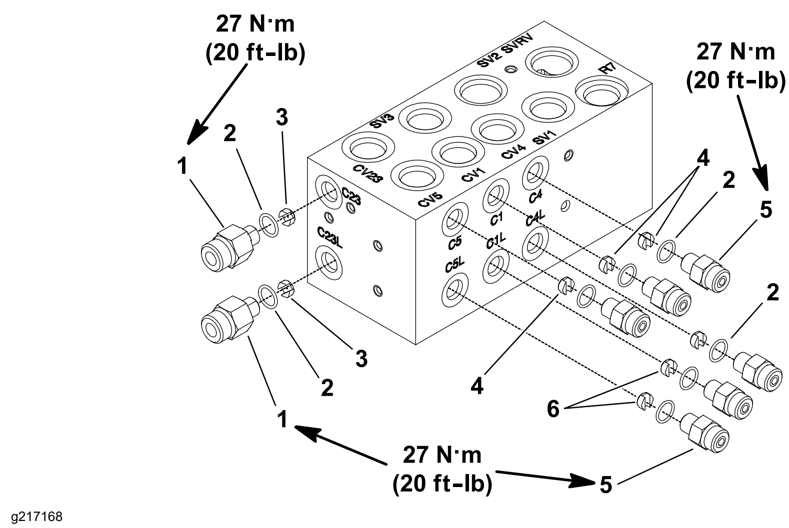

Figure 168

1.	Straight fitting (2 each)	3.	Orifice (0.046) (2 each)	5.	Straight fitting (6 each)
2.	O-ring (8 each)	4.	Orifice (0.028) (3 each)	6.	Orifice (0.055) (3 each)

IMPORTANT

A flow control orifice is placed below several hydraulic fittings on the lift control manifold (Figure 168). The lift control manifold uses 3 different orifice sizes. If the fittings are removed from the manifold and an orifice is in the manifold port, ensure that you remove the orifice and label its position for assembly purposes.

10. If necessary, remove the hydraulic fittings from the manifold, and discard the O-rings.
11. Locate, retrieve, and label the orifice from the manifold port (if equipped).

Installing the Lift Control Manifold

1. If the hydraulic fittings were removed from the lift control manifold, do the following:

   A. Lubricate new O-rings with clean hydraulic fluid, install the lubricated O-rings onto the fittings.

IMPORTANT

When installing the orifice in the manifold (Figure 168), ensure that the orifice is flat in the base of the fitting cavity. Letting the orifice stay cocked in the cavity can damage the manifold.

   B. For the manifold ports with orifice, install correct orifice in the port with the orifice slot facing out.

   C. Install the fittings into the manifold. Torque the fittings to the torque values identified in Figure 167 and Figure 168.

2. Position the lift control manifold to frame. Install the 2 flange-head screws but do not fully tighten.
3. Remove the caps and plugs from the hydraulic lines and fittings.
4. Lubricate and install new O-ring(s) on the manifold fittings. Correctly connect the hydraulic hoses and tubes to the hydraulic manifold fittings and tighten all the connections; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 6–11).
5. Tighten the 2 flange-head screws to secure the lift control manifold to the frame.
6. Use the labels that you attached during removal to connect the wire harness leads to the solenoid coils on the manifold.
7. Check the hydraulic-fluid level in the hydraulic tank and add correct quantity of fluid if necessary; refer to the *Operator's Manual*.
8. Operate the machine functions slowly until air is out of system; refer to Charging the Hydraulic System (page 6–151).

Servicing the Lift Control Manifold

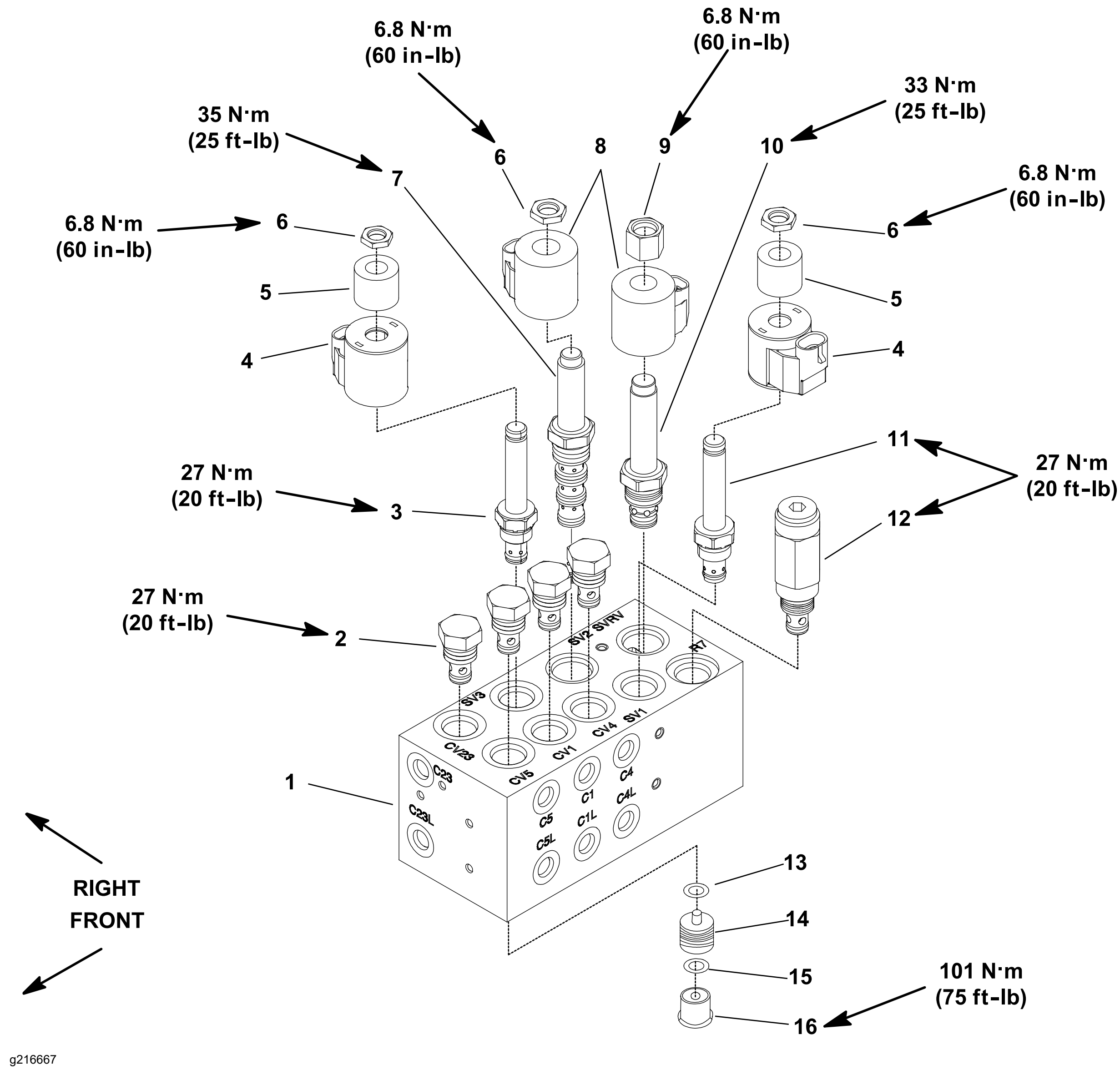

Figure 169

1. Lift control manifold
2. Check valve (4 each)
3. Solenoid valve (SV3)
4. Solenoid coil
5. Solenoid coil spacer
6. Nut
7. Solenoid valve (SV2)
8. Solenoid coil
9. Nut
10. Solenoid relief valve (SVRV)
11. Solenoid valve (SV1)
12. Relief valve (R7)
13. O-ring
14. Pilot piston (4 each)
15. O-ring
16. Hex plug (4 each)

Note: The ports on the lift control manifold are marked for easy identification of the components. Example: P is the gear pump (P4) connection port and SV2 is the location for solenoid valve SV2; refer to the Hydraulic Schematic in Appendix A (page A–1) to identify the function of the hydraulic lines and cartridge valves at each manifold port.

For the control manifold service procedures; refer to Servicing a Control Manifold Cartridge Valve (page 6–199). Refer to Figure 169 for cartridge valve installation torque. Refer to Figure 170 for hydraulic fitting installation torque values.

Note: Solenoid valves SV1 and SV2 on the lift control manifold use a coil spacer between the solenoid coil and nut.

Servicing the Lift Control Manifold (continued)

Note: Do not adjust the relief valve (R7).

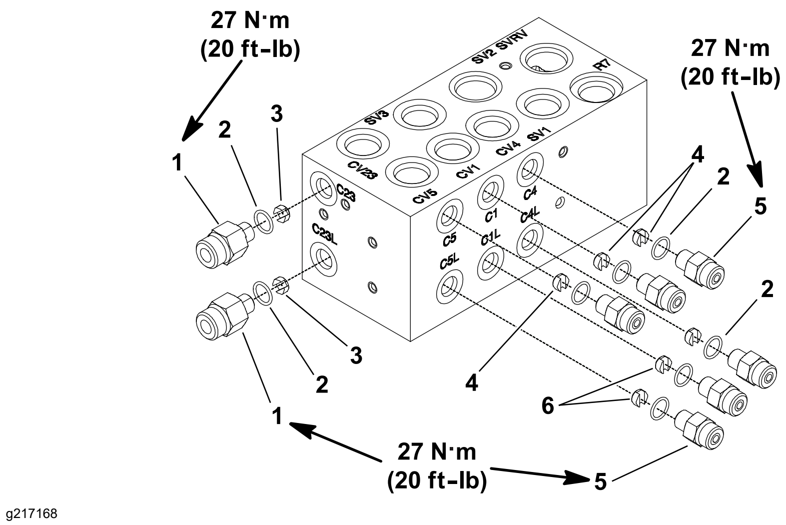

Figure 170

1. Straight fitting (2 each)
2. O-ring (8 each)
3. Orifice (0.046) (2 each)
4. Orifice (0.028) (3 each)
5. Straight fitting (6 each)
6. Orifice (0.055) (3 each)

IMPORTANT

A flow control orifice is placed below several hydraulic fittings on the lift control manifold (Figure 170). The lift control manifold uses 3 different orifice sizes. If the fittings are removed from the manifold and an orifice is in the manifold port, ensure that you remove the orifice and label its position for assembly purposes.

IMPORTANT

When installing the orifice in the manifold (Figure 170), ensure that the orifice is flat in the base of the fitting cavity. Letting the orifice stay cocked in the cavity can damage the manifold.

Servicing a Control Manifold Cartridge Valve

1. Ensure that the entire outer surface of the manifold is clean before you remove the cartridge valve.

WARNING

Before opening the hydraulic system, operate all the hydraulic controls to release all the pressure in the system and avoid injury from pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).

2. If the solenoid cartridge valve is being serviced, remove the nut that secures the solenoid coil to the cartridge valve. Carefully slide the solenoid coil off the valve.

IMPORTANT

Carefully handle the valve cartridge. Slight bending or distortion of the stem tube can cause binding and malfunction. When removing the cartridge valve from the control manifold, ensure that the deep well socket fully engages the valve base.

3. Remove the cartridge valve with a deep well socket wrench. Note the correct location of the O-rings, sealing rings, and back-up rings.
4. Remove and discard the seal kit.
5. Visually examine the port in the manifold for damaged sealing surfaces, damaged threads, and contamination. Also, inspect the cartridge valve for damaged sealing surfaces and contamination.
   A. Contamination can cause the valves to stick or hang up. Contamination can accumulate in small valve orifices or seal areas and cause malfunction.
   B. If the sealing surfaces of the valve are pitted or damaged, the hydraulic system can be too hot or there can be water in the system.

CAUTION

Use the eye protection such as goggles when using the compressed air.

CAUTION

Sudden movement of the internal valve spools can release the stored fluid suddenly.

6. Use clean-mineral spirits and clean the cartridge valve. Put the valve in the clean-mineral spirits to flush out contamination.

Servicing a Control Manifold Cartridge Valve (continued)

IMPORTANT

Particles as fine as talcum powder can affect the operation of high-pressure hydraulic valves.

If the cartridge design allows, use a wood or plastic probe to press the internal spool in and out for 20 to 30 times to flush out contamination.

Ensure that you do not damage the cartridge. Use the compressed air for cleaning.

7. Install the cartridge valve as follows:
   A. Lubricate the new seal kit components with clean hydraulic fluid and install them onto the valve.
   B. Install the O-rings, sealing rings, and back-up rings correctly on the cartridge valve for proper operation and sealing.

   IMPORTANT

   Carefully handle the valve cartridge. Slight bending or distortion of the stem tube can cause binding and malfunction. When installing the cartridge valve into the control manifold, ensure that the deep well socket fully engages the valve base.

   C. Turn the cartridge valve carefully into the manifold port until the top O-ring is met. The valve should go in easily without binding.
   D. Use a deep well socket and torque the cartridge valve to the values identified in control manifold illustration.
8. If the solenoid coil was removed from the cartridge valve, do the following steps:
   A. Carefully install the coil onto the valve.

   IMPORTANT

   Overtightening the nut can damage the solenoid or cause valve malfunction. Do not overtighten the nut.

   B. Install the nut and torque the nut to **6.8 N·m (60 in-lb)**.
9. If the problems still exist, remove the valve and clean it again or replace the valve.

Cutting Reel Motor

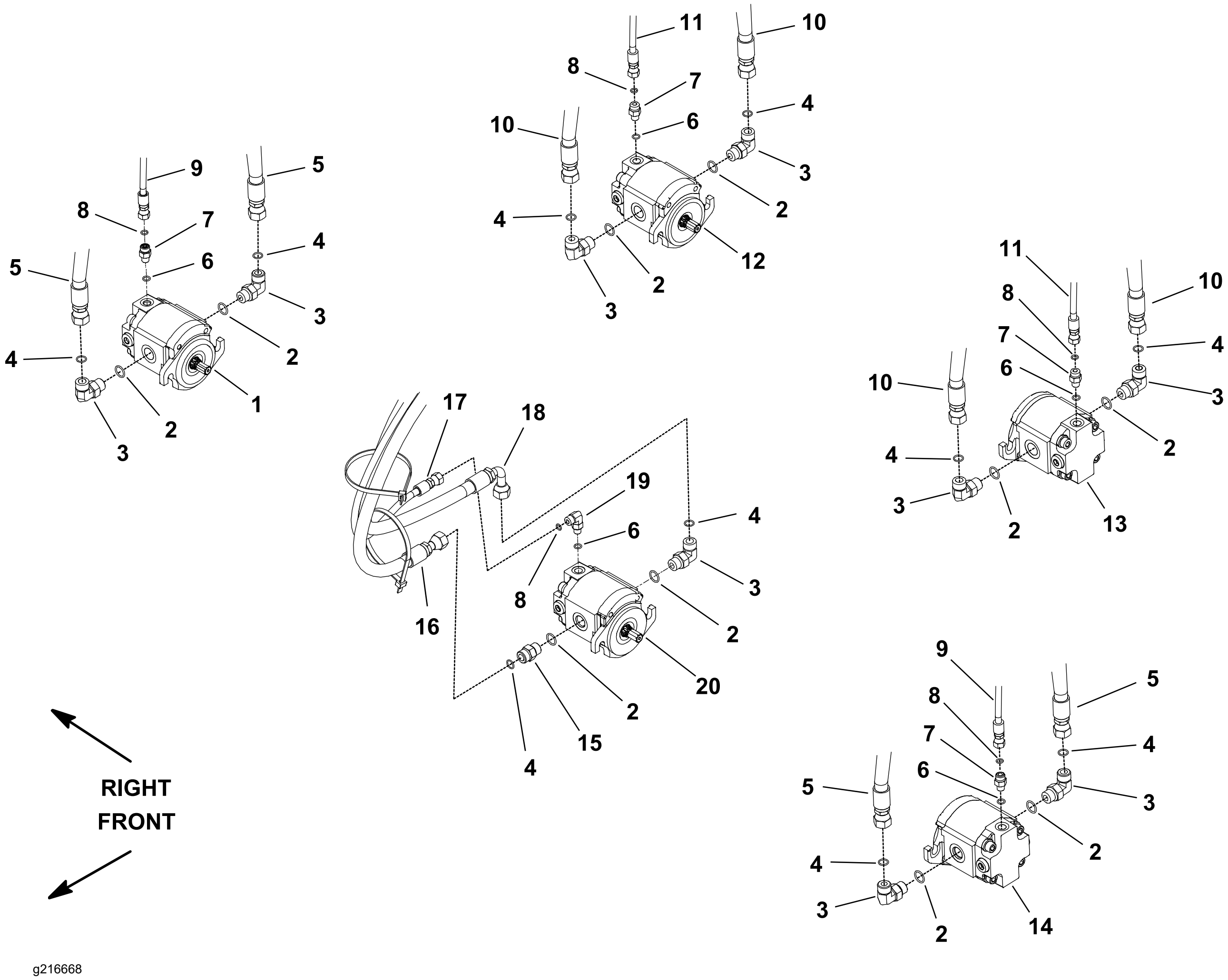

Figure 171

Reelmaster 5510/5610 series cutting reel motors

1. #5 hydraulic reel motor	6. O-ring	11. Hydraulic hose	16. Hydraulic hose
2. O-ring	7. Hydraulic fitting	12. #3 hydraulic reel motor	17. Hydraulic hose
3. 90° hydraulic fitting	8. O-ring	13. #2 hydraulic reel motor	18. Hydraulic hose
4. O-ring	9. Hydraulic hose	14. #4 hydraulic reel motor	19. 90° hydraulic fitting
5. Hydraulic hose	10. Hydraulic hose	15. Hydraulic fitting	20. #1 hydraulic reel motor

Note: Sauer-Danfoss cutting reel motors are used on Reelmaster 5410/5410-G/5410-D machines with serial numbers below 313999999. Casappa cutting reel motors are used on Reelmaster 5410/5410-G/5410-D machines with serial numbers above 313999999 and also Reelmaster 5510/5510-G/5510-D/5610/5610-D machines.

Removing the Cutting Reel Motor

1. Park the machine on a level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 6–145).

Removing the Cutting Reel Motor (continued)

3. For assembly purposes, label all the hydraulic connections. Clean the hydraulic connections before loosening the hydraulic lines from the reel motor.

CAUTION

Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).

4. Disconnect the hydraulic hoses from the fittings in the reel motor. Allow the lines to drain into a suitable container. Remove and discard the O-rings from the fittings.
5. Install clean caps or plugs on the hydraulic hoses and fittings to prevent system contamination.
6. Remove the reel motor from the cutting unit; refer to Removing the Hydraulic Reel Motor (page 9–17).
7. If the hydraulic fittings are to be removed from the motor, mark the fitting orientation for assembly purposes. Remove the fittings from the motor and discard the O-rings from the fittings.

Installing the Cutting Reel Motor

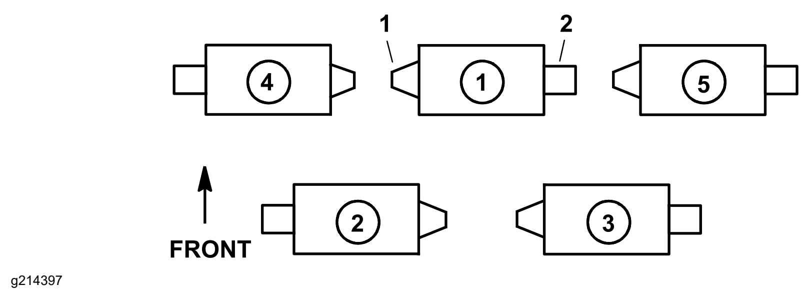

Figure 172

1. Weight location
2. Reel motor location

Note: Refer to Figure 172 for correct placement of cutting unit reel motors and weights.

1. If the hydraulic fittings were removed from the reel motor, lubricate and install new O-rings to the fittings. Install the fittings into the motor ports; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 6–13). Ensure that the fittings are orientated correctly.
2. Install the reel motor to the cutting unit; refer to Installing the Hydraulic Reel Motor (page 9–17).
3. Remove the caps or plugs from the hydraulic hoses and fittings.

IMPORTANT

When installing the hydraulic hoses, ensure that the hydraulic hoses are straight (not twisted) before tightening the hoses to the motor fittings.

4. Lubricate and install new O-rings to the fittings on the reel motor. Use the labels that you attached during the removal process to correctly connect the hydraulic hoses to the motor fittings. Tighten the hose connections; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 6–11).
5. Check the hydraulic-fluid level in the hydraulic tank and add correct quantity of fluid if necessary; refer to the *Operator's Manual*.
6. Operate the machine functions slowly until air is out of system; refer to Charging the Hydraulic System (page 6–151).

Servicing the Cutting Reel Motor (Casappa)

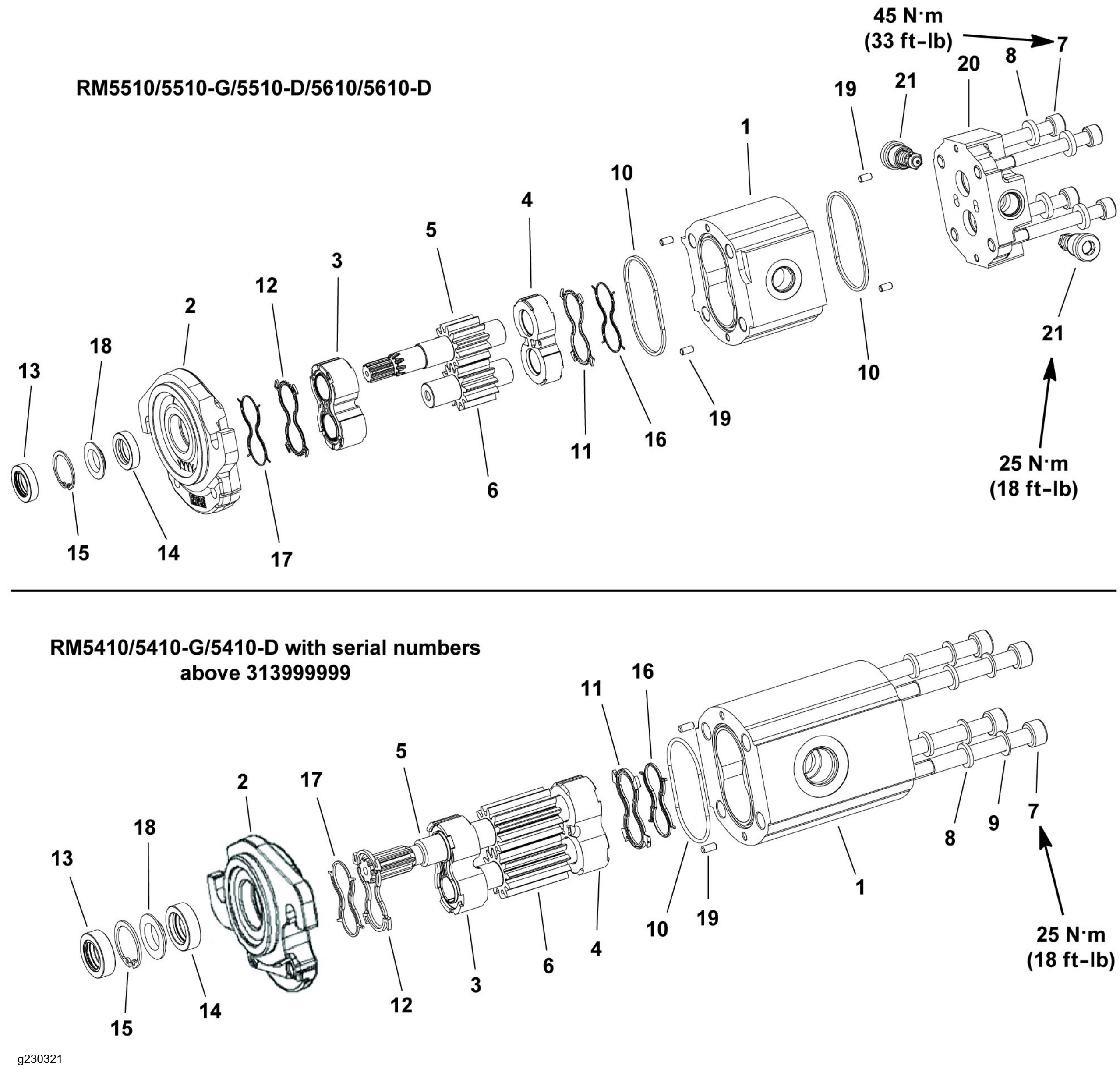

Figure 173

1. Body
2. Front flange
3. Front wear plate
4. Rear wear plate
5. Drive gear
6. Idler gear
7. Socket-head screw (4 each)
8. Flat washer (4 each)
9. Lock washer (RM 5410 series)
10. O-ring
11. Pressure seal
12. Pressure seal
13. Dust seal
14. Shaft seal
15. Retaining ring
16. Back-up seal
17. Back-up seal
18. Flange washer
19. Dowel pin
20. Rear cover (RM 5510/5610 series)
21. Relief cartridge (RM 5510/5610 series)

Note: Casappa cutting reel motors are used on Reelmaster 5410/5410-G/5410-D machines with serial numbers above 313999999 and also Reelmaster 5510/5510-G/5510-D/5610/5610-D machines.

Note: Casappa cutting reel motors used on Reelmaster 5410 series machines are different than reel motors used on Reelmaster 5510 and 5610 series machines. The motors used on Reelmaster 5510 and 5610 series have a separate rear cover that includes 2 cross-over relief valves. Both cutting reel motors are shown in Figure 173. The following disassembly, inspection, and assembly procedures can be used for either motor.

Disassembling the Cutting Reel Motor

Note: Internal components for a cutting reel motor are not available separately. Disassemble motor for cleaning, inspection, and seal replacement only.

1. Install clean plugs in the motor ports and clean the outer surface of the motor. After cleaning, remove the plugs and drain the hydraulic fluid out of the motor.

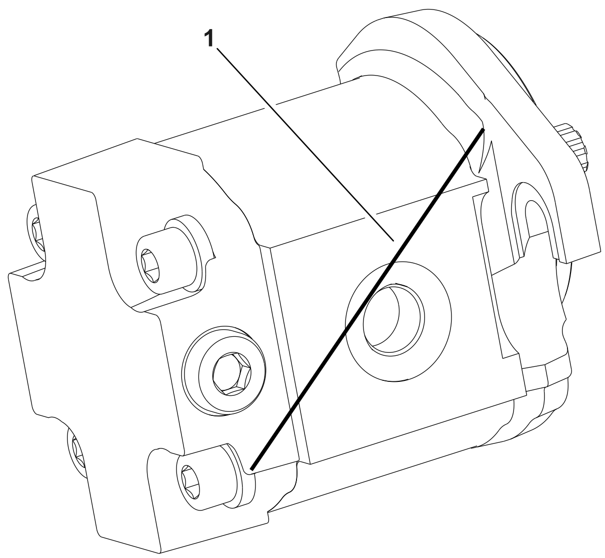

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Figure 174

1. Marker line

2. Use a marker to make a diagonal line across the front flange, body, and rear cover for assembly purposes (Figure 174).

IMPORTANT

When you clamp the motor in a vise, clamp the front flange only to prevent damage. Also, use a vise equipped with soft jaws.

3. Clamp the front flange of the motor in a vise with the shaft end down.
4. Loosen the socket-head screws from the rear of the body.
5. Remove the motor from the vise. Turn the motor so that the shaft end is facing down, and remove the socket-head screws and washers.
6. On Reelmaster 5510 and 5610 series reel motor, separate the rear cover from the body and lift the rear cover from the motor.
7. Lift the body straight up and carefully remove it. Ensure the rear wear plate remains on the drive and idler gear shafts.
8. Remove and discard the O-rings from the body. Locate and retrieve the dowel pins.

IMPORTANT

Before removing the wear plates, note the position of the open and closed side of the wear plates. Also identify the wear plates (front and rear) with a marker for proper assembly.

IMPORTANT

Mark the relative positions of the gear teeth and wear plates so that you can assemble them in the same position. Do not touch the gear surfaces as residue on hands may be corrosive to gear finish.

9. Carefully remove the rear wear plate, idler gear, drive gear, and front wear plate from the front flange.
10. Remove and discard the back-up gaskets and pressure seals from the wear plates.
11. Turn the front flange over, with the seal side up.

IMPORTANT

Ensure that you do not damage the front flange counterbore when removing the seals from the front flange.

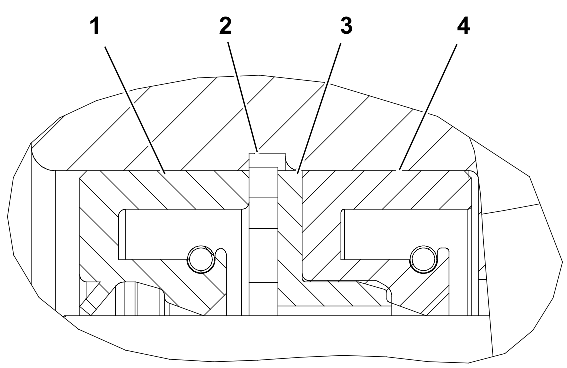

Figure 175

1. Dust seal
2. Retaining ring
3. Flange washer
4. Shaft seal

12. Carefully remove the dust seal, retaining ring, flange washer, and shaft seal from the front flange. Note the orientation of seal lips during removal (Figure 175). Discard the seals.
13. On Reelmaster 5510 and 5610 series motor, remove the cross-over relief valves from the rear flange if necessary.

Inspecting the Cutting Reel Motor

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

CAUTION

Use eye protection such as goggles when using compressed air.

2. Clean all the motor parts with solvent and dry them with compressed air.

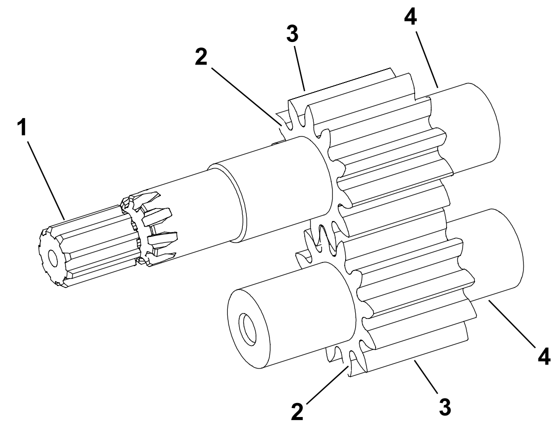

Figure 176

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

3. Inspect the drive gears and idler gears for the following (Figure 176):
   A. Gear shafts must be free of scoring, rough surfaces, and excessive wear at the bushing points and sealing areas. Replace the gears if you find any scoring, rough surfaces, or wear on the gear shafts.
   B. Gear teeth must be free from excessive scoring and wear. Replace the gears if you find broken or nicked gear teeth.
   C. Gear face edge must be free from sharpness. The sharp edges of gears will mill into the wear plates. Replace the gears if you find any sharp gear face edge.
4. Inspect the wear plates for the following:
   A. Bearing areas must not have excessive wear or scoring.
   B. Face of the wear plates that are in contact with the gears must be free of wear, roughness, or scoring.
   C. Thickness of the wear plates should be equal.
5. Inspect the front flange and rear cover for damage or wear.
6. If internal parts are found to be worn or damaged, motor replacement is necessary.

Assembling the Cutting Reel Motor

Note: When assembling the motor, check the marker line on each part to ensure that the parts are properly aligned.

1. Lubricate new O-rings, pressure seals, and back-up gaskets, and wear plate grooves with a thin coat of petroleum jelly. Lubricate all other internal parts freely with clean hydraulic fluid.
2. Install new seals into the front flange. Note the orientation of seal lips during installation (Figure 175):

A. Press the shaft seal into the front flange until it reaches the bottom of the bore.

B. Install the flange washer into the front flange and then install the retaining ring into the groove of the front flange.

C. Install new dust seals into the front flange. The inner dust seal should have the seal lip and spring toward the installed retaining ring. The outer dust seal should have the seal lip and spring toward the outside of the motor.

3. Place the front flange, seal side down, on a flat surface.
4. Install the pressure seals, flat side outward, into the grooves in the wear plates. Follow by carefully placing the back-up gaskets, flat side outward, between the pressure seals and the grooves in the wear plate.
5. Apply a light coating of petroleum jelly to the exposed side of the front flange.
6. Lubricate the drive gear shaft with clean hydraulic fluid.
7. Insert the drive end of the driveshaft through the wear plate with the pressure seal side down and the open side of the pressure seal pointing to the inlet side of the motor.
8. Carefully install the shaft into the front flange.
9. Lubricate the idler gear shaft with clean hydraulic fluid. Install the idler gear shaft into the remaining position in the front wear plate. Apply a light coating of clean hydraulic fluid to the gear faces.
10. Install the rear wear plate with a pressure seal side up and the open side of pressure seal pointing to the inlet side of the motor.
11. Apply a light coating of petroleum jelly to new O-rings and O-ring grooves in the body. Install new O-rings to the body.
12. Install the locating dowels in the body. Align the marker line on the body and front flange.

IMPORTANT

Do not dislodge the seals during installation.

13. Gently slide the body onto the assembly and align the dowels with firm hand pressure.
14. Check that the surface of the rear wear plate is slightly below the face of the body.

    Note: If the wear plate is not below the body, check the assembly for a shifted pressure seal, back-up gasket, or O-ring. Correct the shifting before you proceed.

15. On reel motor for Reelmaster 5510 or 5610 series, do as follows:

    A. Apply a light coating of petroleum jelly to the exposed side of the rear cover.

    B. Use the marker line for proper location and place the rear cover on the assembly, and align the dowels with firm hand pressure.

16. Install the 4 socket-head screws with 4 washers and tighten them by hand.

IMPORTANT

When you clamp the motor in a vise, clamp the front flange only to prevent damage. Also, use a vise equipped with soft jaws.

17. Clamp the front flange of the motor in a vise equipped with soft jaws.
18. Alternately torque the bolts to **45 N·m (33 ft-lb)**.
19. On Reelmaster 5510 and 5610 series reel motor, install the cross-over relief valves into the rear flange if they were removed; torque the relief valves to **25 N·m (18 ft-lb)**.
20. Remove the motor from the vise.
21. Put a small quantity of clean hydraulic fluid in the inlet of the motor and rotate the driveshaft away from the inlet for 1 revolution. If there is any binding, disassemble the motor and check for assembly problems.

Servicing the Cutting Reel Motor (Sauer-Danfoss)

Note: Sauer-Danfoss cutting reel motors are used on Reelmaster 5410/5410-G/5410-D machines with serial numbers below 313999999.

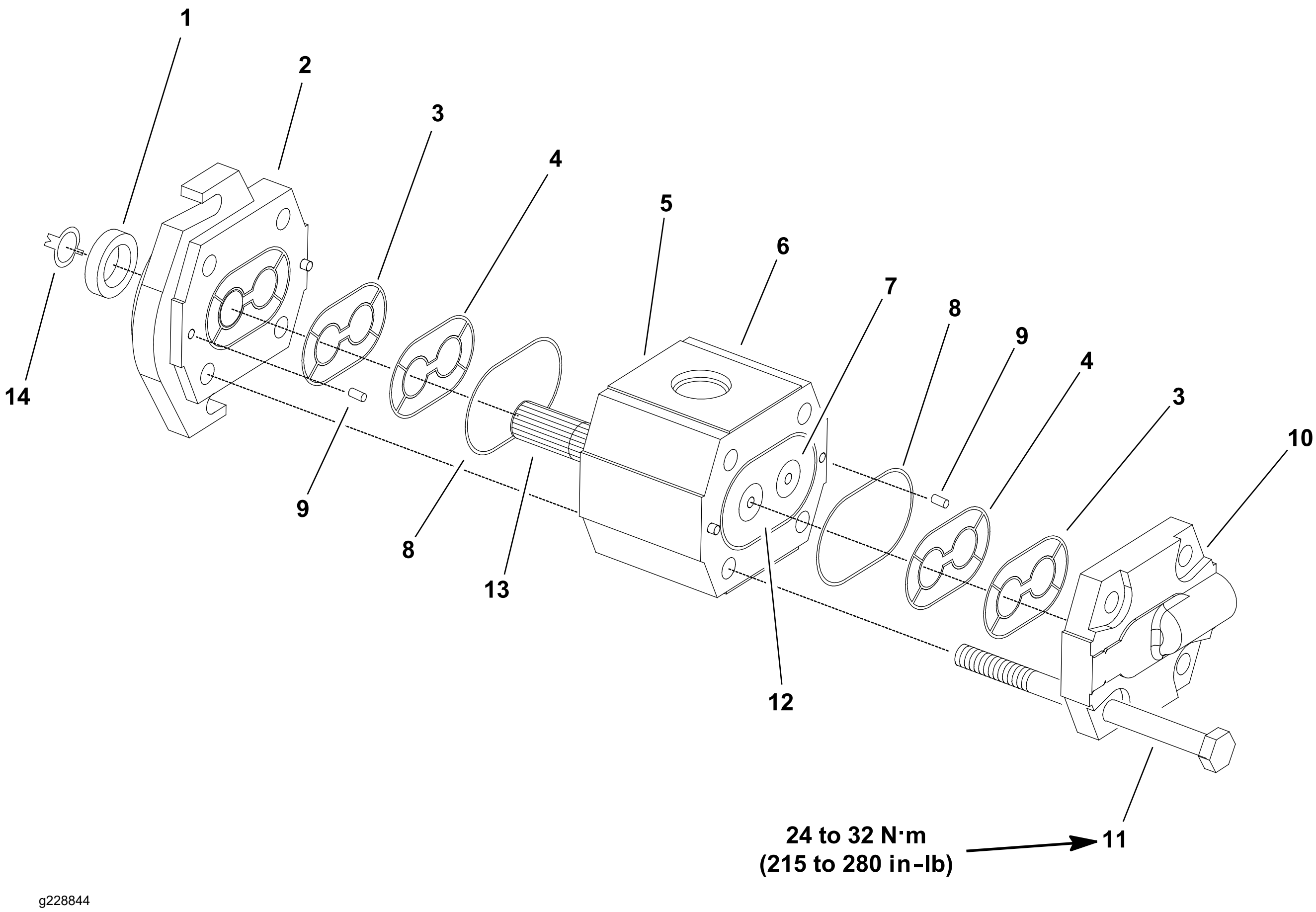

Figure 177

1. Seal
2. Front flange
3. Back-up ring (2 each)
4. Pressure seal (2 each)
5. Front bearing block
6. Body
7. Idler gear
8. O-ring (2 each)
9. Dowel pin (4 each)
10. Rear cover
11. Bolt (4 each)
12. Rear bearing block
13. Drive gear
14. Tab washer

Note: Internal components for a cutting reel motor are not available separately. Disassemble motor for cleaning, inspection and seal replacement only.

Disassembling the Cutting Reel Motor

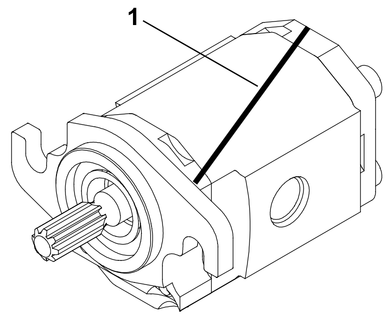

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Figure 178

1. Diagonal line

1. Plug motor ports and clean the outside of the motor. After cleaning, remove plugs and drain any fluid out of the motor.
2. Use a marker to make a diagonal line across the front flange, body and rear cover for assembly purposes (Figure 178).

IMPORTANT

Avoid using excessive clamping pressure on the motor flange to prevent damage.

3. Clamp front flange of motor in a vise with the shaft end down. Use of a vise with soft jaws is recommended.
4. Loosen bolts that secure rear cover.
5. Remove motor from vise and remove bolts.
6. Remove front flange from the body, then remove rear cover. Locate and remove dowel pins from body.

IMPORTANT

Mark the relative positions of the gear teeth and the bearing blocks so they can be reassembled in the same position. Do not touch the gear surfaces as residue on hands may be corrosive to gear finish.

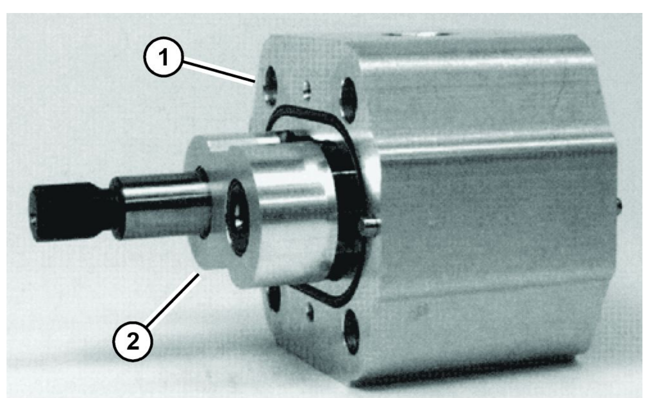

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Figure 179

1. Motor body
2. Bearing block and gear set

Disassembling the Cutting Reel Motor (continued)

7. Place motor on its side and push on the rear bearing block to remove bearing block and gear set (Figure 179).

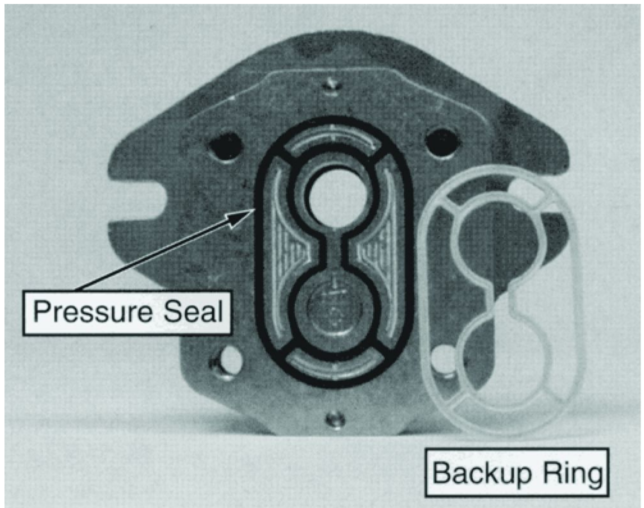

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Figure 180

Note: Pressure seals and back-up rings fit in grooves machined into front flange and rear cover (Figure 180).

8. Carefully remove and discard O-rings, pressure seals and back-up rings from motor. Be careful to not damage the machined grooves.

IMPORTANT

Ensure to not damage the front flange counterbore when removing the shaft seal.

9. Position front flange with seal side up. Remove tab washer and shaft seal.

Inspecting the Cutting Reel Motor

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

⚠ CAUTION ⚠

Use eye protection such as goggles when using compressed air.

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

Inspecting the Cutting Reel Motor (continued)

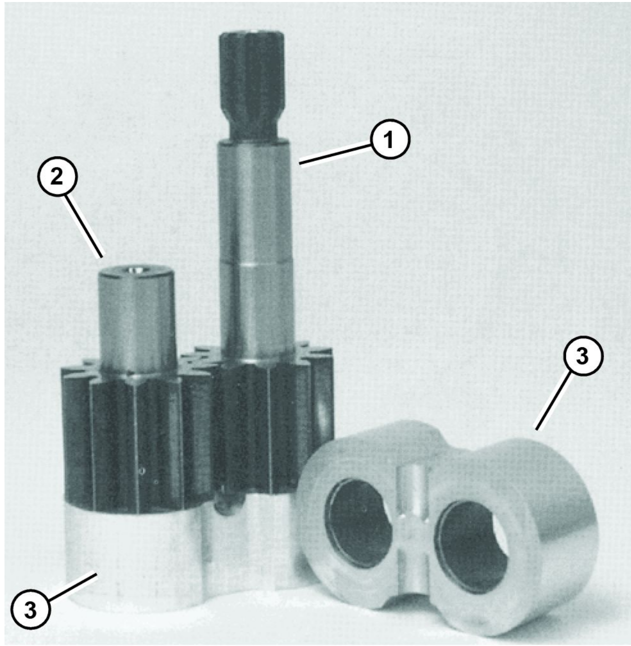

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Figure 181

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

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3. Inspect drive gear, idler gear and bearing blocks (Figure 181) for the following:
   A. Gear shafts should be free of rough surfaces and excessive wear at bushing points and sealing areas. Scoring, rough surfaces or wear on gear shafts indicates need for replacement.
   B. Gear teeth should be free of excessive scoring and wear. Any broken or nicked gear teeth must be replaced.
   C. Inspect gear face edge for sharpness. Sharp edges of gears will mill into bearing blocks and, thus, must be replaced.
   D. Bearing areas of bearing blocks should not have excessive wear or scoring.
   E. Face of bearing blocks that are in contact with gears should be free of wear, roughness or scoring.
4. Inspect front flange and rear cover for damage or wear.

Assembling the Cutting Reel Motor

Note: When assembling the motor, check the marker line made during disassembly to ensure that the parts are properly aligned during assembly.

1. Lubricate new O-rings, pressure seals, back-up gaskets, and seal grooves with a thin coat of petroleum jelly. Lubricate all other internal parts freely with clean hydraulic fluid.
2. Install new shaft seal into front flange. Install tab washer.

   Note: Pressure seals and back-up rings fit in grooves machined into front and rear cover (Figure 180).
3. Install lubricated pressure seals into the machined grooves and follow by carefully placing the back-up rings into the grooves.
4. Install lubricated O-rings to the body.

Assembling the Cutting Reel Motor (continued)

5. Lubricate gear faces and bearing surfaces of drive gear, idler gear, and bearing blocks with clean hydraulic fluid. Carefully assemble bearing blocks and gears noting identification marks made during disassembly.
6. Position the motor body on its side. Carefully slide bearing block and gear assembly into the body cavity using identification marks made during disassembly.
7. Remove any excess lubrication from mating surfaces of body, rear cover and front flange. Ensure that these surfaces are clean and dry.
8. Install dowel pins in body.

IMPORTANT

Do not dislodge O-rings, pressure seals, or back-up rings during final assembly.

9. Gently slide the rear cover onto the assembly using marker line for proper location. Firm hand pressure should be sufficient to engage the dowel pins.
10. Position the motor with rear cover downwards. Carefully slide the front flange onto the assembly using marker line for proper location. Take care to not damage the seal during front flange installation.
11. Install the 4 bolts and hand tighten.

IMPORTANT

Avoid using excessive clamping pressure on the motor front flange to prevent damage.

12. Place motor front flange in a vise and alternately torque the bolts to **24 to 32 N·m (215 to 280 in-lb)**.
13. Put a small amount of hydraulic fluid in port on motor and rotate driveshaft one revolution. Protect the shaft if using a pliers. If driveshaft binds, disassemble motor and repeat assembly process.
14. Remove motor from vise.

Lift Cylinder

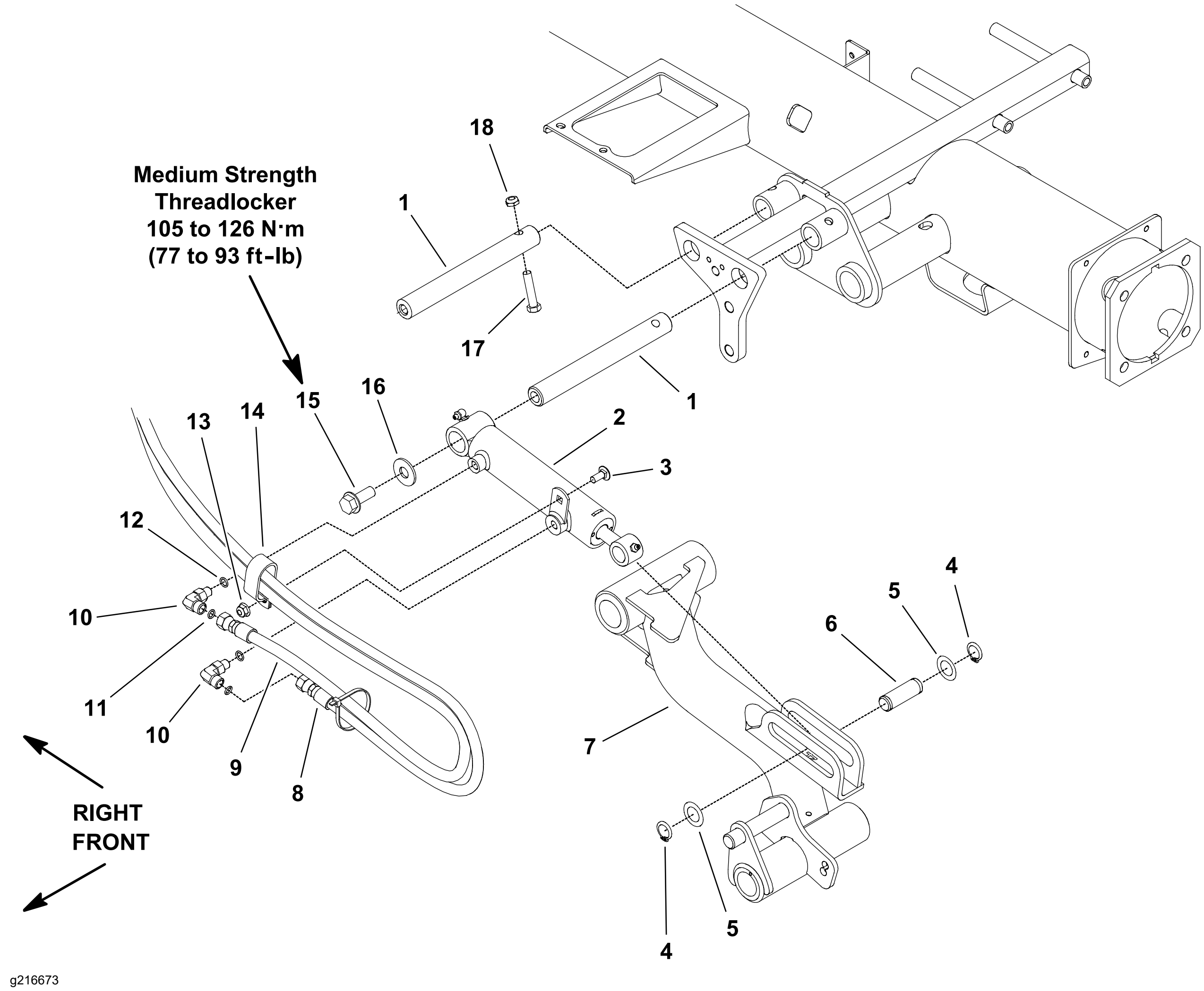

Figure 182

1. Cylinder pin
2. Lift cylinder
3. Carriage screw
4. Retaining ring (2 each)
5. Thrust washer (2 each)
6. Cylinder slide pin
7. #4 lift arm
8. Hydraulic hose
9. Hydraulic hose
10. 90° hydraulic fitting (2 each)
11. O-ring (2 each)
12. O-ring (2 each)
13. Flange nut
14. R-clamp
15. Flange-head screw
16. Flat washer
17. Bolt
18. Locknut

Note: The procedure for lift cylinder removal and installation is the same for all Reelmaster 5010 series lift cylinders. Figure 182 shows the lift cylinder for the left, front #4 cutting unit.

Removing the Lift Cylinder

1. Park the machine on a level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 6–145).
3. If the lift cylinder for outside front cutting units (#4 or #5) is being removed, remove the flange nut (item 13 in Figure 182) and carriage screw that secure the R-clamp to the lift cylinder.

Removing the Lift Cylinder (continued)

4. For assembly purposes, label all the hydraulic connections. Clean the hydraulic connections before loosening the hydraulic lines from the lift cylinder.

CAUTION

Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).

WARNING

Ensure that the cutting units are fully lowered before loosening the hydraulic lines from the lift cylinders.

If the cutting units are not fully lowered as the hydraulic lines are loosened, the cutting units may drop unexpectedly.

5. Disconnect the hydraulic hoses from the fittings in the lift cylinder that is to be removed. Allow the hoses to drain into a suitable container. Remove and discard the O-rings from the fittings.
6. Install clean caps or plugs on the hydraulic hoses and fittings to prevent contamination.
7. Remove 1 retaining ring (item 4 in Figure 182) and thrust washer from the cylinder slide pin. Pull the pin from the lift cylinder and lift arm. Locate and retrieve the second thrust washer.
8. Remove the flange-head screw (item 15 in Figure 182) and flat washer that secure the lift cylinder to the cylinder pin.
9. Remove the lift cylinder from the cylinder pin and frame.
10. If the hydraulic fittings are to be removed from the lift cylinder, mark the fitting orientation for assembly purposes. Remove the fittings from the lift cylinder and discard the O-rings from the fittings.

Installing the Lift Cylinder

1. If the hydraulic fittings were removed from the lift cylinder, lubricate new O-rings with clean hydraulic fluid, position the O-rings to the fittings, and install the fittings into the lift cylinder ports; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 6–13). Ensure that the fittings are orientated correctly.
2. Position the lift cylinder to the frame.

   Note: The lift cylinder barrel end should be attached to the machine frame.
3. Slide the barrel end of the lift cylinder onto the cylinder pin (item 1 in Figure 182).
4. Apply medium strength threadlocker to the threads of the flange-head screw (item 15 in Figure 182). Secure the cylinder with the flange-head screw and flat washer. Torque the flange-head screw to **105 to 126 N·m (77 to 93 ft-lb)**.
5. Align lift cylinder to the lift arm mounting holes. Slide the cylinder slide pin (item 6 in Figure 182) (with a thrust washer and retaining ring installed on

the one end) through the lift cylinder and lift arm. Install the second thrust washer on pin and secure with the retaining ring.

6. Remove the caps and plugs that were installed to the hydraulic hoses and fittings during the removal process.

7. Put a coating of clean hydraulic fluid on new fitting O-rings, install the O-rings, and connect the hydraulic hoses to the fittings on the lift cylinder. Tighten the hose connections; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 6–11).

8. If the lift cylinder for outside front cutting units (#4 or #5) was removed, secure the R-clamp to the lift cylinder with the flange nut (item 13 in Figure 182) and carriage screw.

9. Lubricate the lift cylinder grease fittings.

10. Check the hydraulic-fluid level in the hydraulic tank and add correct quantity of fluid if necessary; refer to the *Operator's Manual*.

11. Operate the machine functions slowly until air is out of system; refer to Charging the Hydraulic System (page 6–151).

Servicing the Lift Cylinder

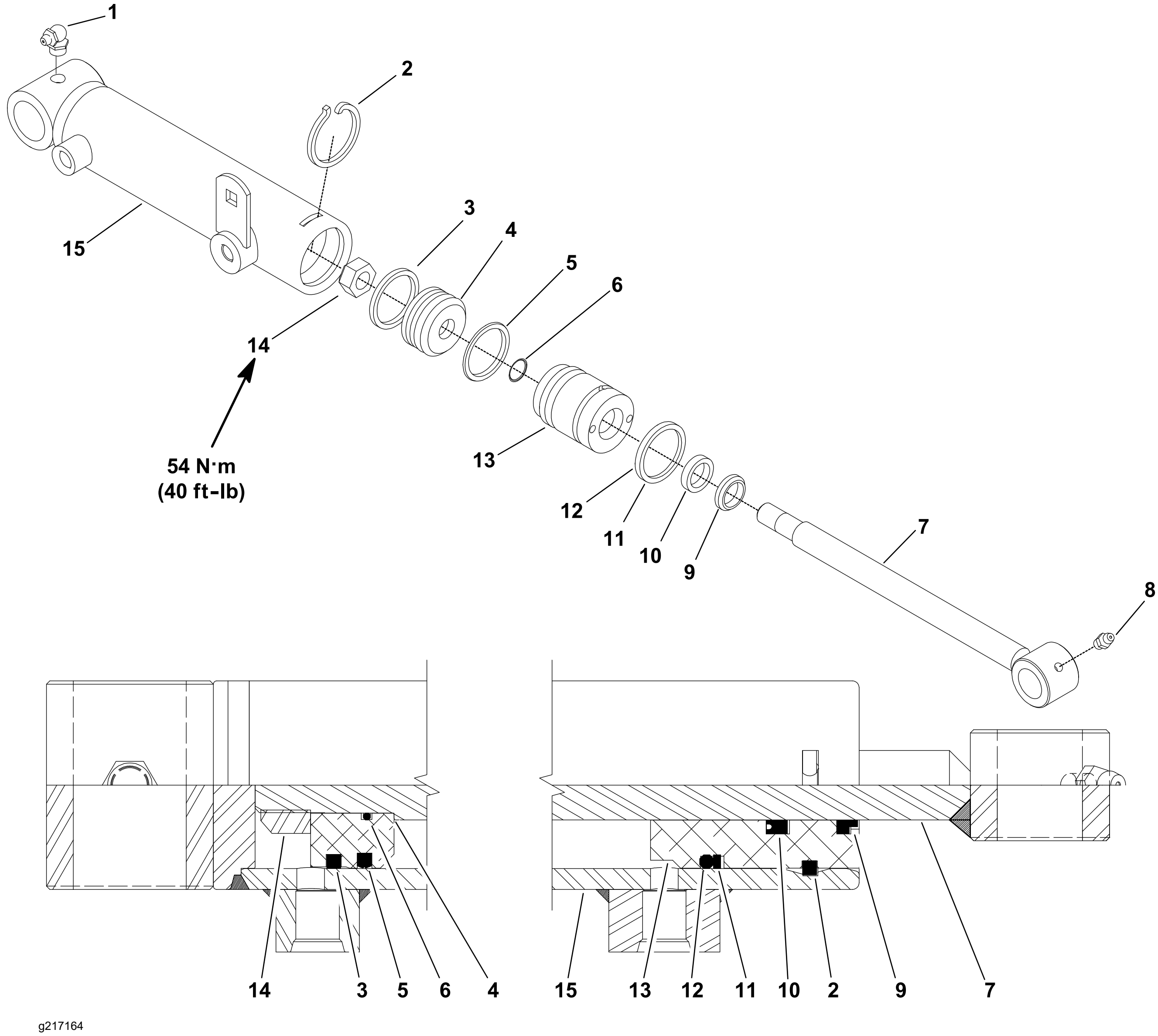

Figure 183

1.	Grease fitting	5.	BP seal	9.	Dust seal	13.	Head
2.	Retaining ring	6.	O-ring	10.	BS seal	14.	Locknut
3.	Wear ring	7.	Shaft	11.	Back-up washer	15.	Barrel
4.	Piston	8.	Grease fitting	12.	O-ring		

Note: The front, outside lift cylinders are longer with more stroke than the other lift cylinders which are identical. Service procedures for all lift cylinders used on Reelmaster 5010 machines are the same.

Disassembling the Lift Cylinder

1. Slowly pump the cylinder shaft to remove the hydraulic fluid from the lift cylinder into a drain pan. Plug both the ports and clean the outer surface of the cylinder.

Disassembling the Lift Cylinder (continued)

IMPORTANT

When you clamp the lift cylinder in a vise, clamp the clevis end of the barrel only to prevent damage.

2. Mount the lift cylinder in a vise. Use a vise equipped with soft jaws.
3. Use a spanner wrench, rotate the head clockwise until the edge of the retaining ring (item 2 in Figure 183) 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 counterclockwise to remove the retaining ring from the barrel and head.
4. Remove the plugs from the ports. Carefully twist and pull the shaft and remove the shaft with head and piston.

IMPORTANT

Clamping the vise jaws against the shaft surface could damage the shaft. When securing the shaft in a vise, clamp the shaft clevis only.

5. Mount the shaft in a vise by clamping on the clevis of the shaft. Remove the locknut and piston from the shaft. Carefully slide the head off the shaft.

   Note: Do not scratch or damage the piston.
6. Remove the wear ring, BP seal, and O-ring from the piston.

   Note: Do not scratch or damage the head.
7. Remove the O-ring, back-up washer, dust seal, and BS seal from the head.
8. Discard the seals and O-rings that were removed.

Inspecting the Lift Cylinder

CAUTION

Use eye protection such as goggles when using compressed air.

1. Wash all the cylinder components in clean solvent and dry them with compressed air.
2. Inspect the internal surface of the barrel for deep scratches, out-of-roundness, and bending.
3. Inspect the head, shaft, and piston for excessive pitting, scoring, and wear.
4. Replace the lift cylinder if the internal components are worn or damaged.

Assembling the Lift Cylinder

1. Ensure that all the parts are clean before assembly.
2. Put a coating of clean hydraulic fluid on new O-rings, back-up washer, and other seals.
   A. Carefully install the wear ring, BP seal, and O-ring to the piston.
   B. Carefully install the back-up washer, O-ring, dust seal, and BS seal to the head.

IMPORTANT

Clamping the vise jaws against the shaft surface could damage the shaft. When securing the shaft in a vise, clamp the shaft clevis only.

3. Mount the shaft in a vise by clamping on the clevis of the shaft, and do the following steps:
   A. Put a coating of clean hydraulic fluid on the shaft.
   B. Slide the head onto the shaft.

      Note: Ensure that you do not damage the seals.
   C. Install the piston onto the shaft and secure the piston with the locknut. Torque the locknut to **54 N·m (40 ft-lb)**.
   D. Remove the shaft from the vise.

IMPORTANT

When you clamp the lift cylinder in a vise, clamp the clevis end of the barrel only to prevent damage.

4. Mount the barrel in a vise by clamping on the clevis end of the barrel.

IMPORTANT

When installing the head into the barrel, pay careful attention to the retaining ring slot in the barrel to ensure that the piston and head seals do not lodge in the slot.

5. Put a light coating of clean hydraulic fluid on all internal parts. Carefully slide the piston, shaft, and head assembly into the barrel.

   Note: Do not damage the seals during assembly.
6. Secure the head in the barrel with retaining ring as follows:
   A. Align the retaining ring hole in the head with the access slot in the barrel.
   B. Insert the retaining ring hook into the hole and rotate the head clockwise until the retaining ring is completely pulled into the barrel and the ring ends are covered.
   C. Apply silicone sealer to the barrel access slot.

Steering Control Valve

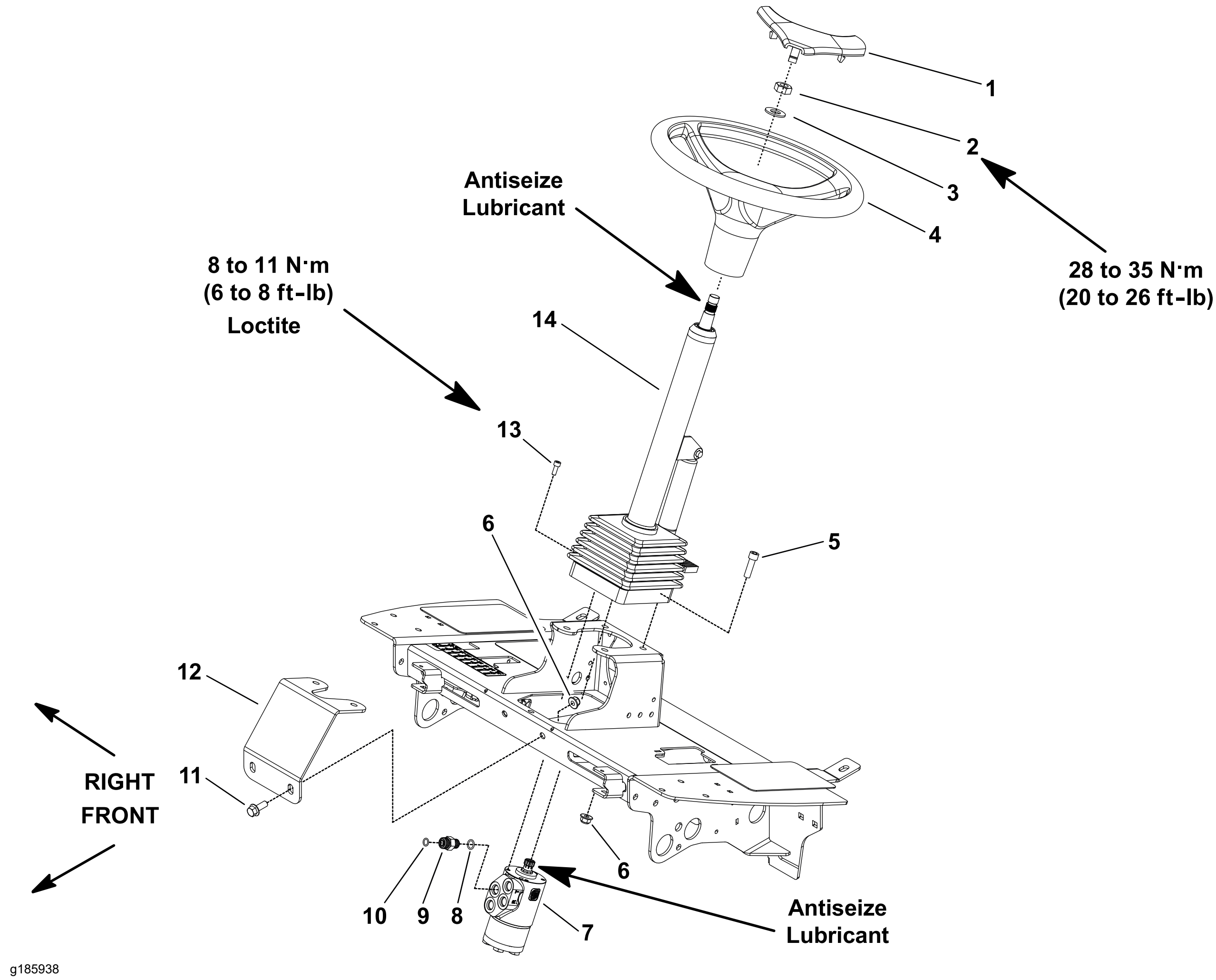

Figure 184

1. Steering wheel cover
2. Locknut
3. Flat washer
4. Steering wheel
5. Socket-head screw (4 each)
6. Flange nut (6 each)
7. Steering control valve
8. O-ring (4 each)
9. Straight hydraulic fitting (4 each)
10. O-ring (4 each)
11. Flange-head screw (2 each)
12. Column brace
13. Socket-head screw (4 each)
14. Steering column assembly

Removing the Steering Control Valve

1. Park the machine on a level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.

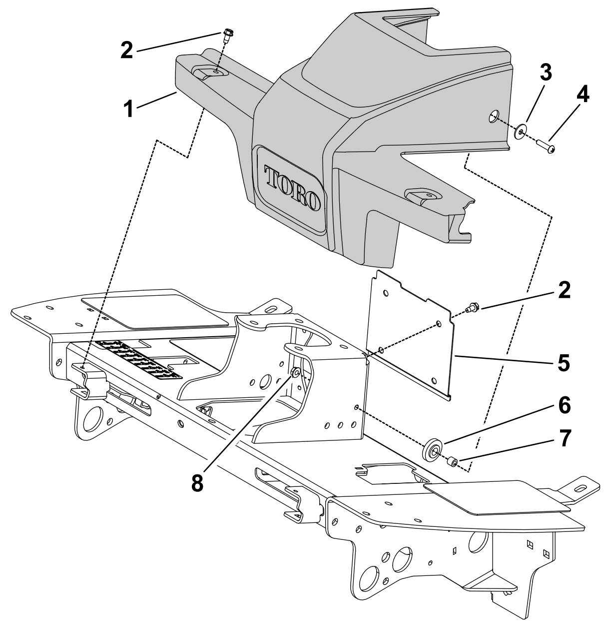

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Figure 185

1.	Platform shroud	3.	Washer (2 each)	5.	Cover plate	7.	Spacer (2 each)
2.	Washer-head screw (6 each)	4.	Screw (2 each)	6.	Bushing (2 each)	8.	Flange nut (2 each)

---

2. Remove the fasteners that secure the shroud to the front of the machine (Figure 185). Remove the shroud from the machine to get access to the steering control valve.
3. Locate and retrieve the 2 rubber bushings and spacers.
4. Slide the rubber bellows up from the bottom of the steering column.
5. Support the steering column to prevent it from falling.
6. Loosen and remove the 4 flange-head screws and 4 flange nuts that secure the steering column brace (item 12 in Figure 184) to the machine, and remove the brace.
7. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 6–145).

Removing the Steering Control Valve (continued)

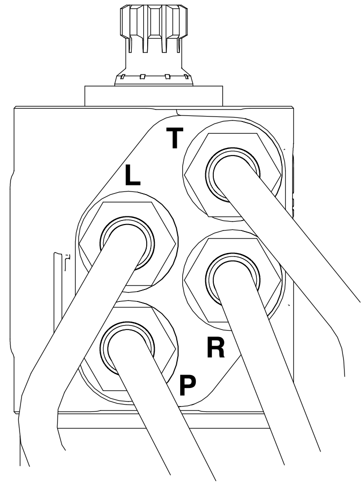

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Figure 186

8. For assembly purposes, label all the hydraulic connections. Note the port designations on the steering control valve (Figure 186).
9. Clean the hydraulic connections before loosening the hydraulic lines.

CAUTION

Before opening hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).

10. Disconnect the hydraulic lines from the steering control valve. Allow the lines to drain into a suitable container.
11. Install clean caps or plugs on the hydraulic lines and fittings to prevent contamination.
12. Loosen and remove the remaining 2 socket-head screws and 2 flange nuts that secure the steering column to the machine.
13. Remove the steering column and steering control valve assembly from the machine.
14. Loosen and remove the 4 socket-head screws that secure the steering control valve to the steering column.
15. Remove the steering control valve from the steering column.
16. If necessary, remove the hydraulic fittings from the steering control valve.
17. Remove and discard the O-rings from the fittings.

Installing the Steering Control Valve

1. If the hydraulic fittings were removed from the steering control valve, lubricate new O-rings with clean hydraulic fluid, position the O-rings to the fittings, and install the fittings to the steering control valve; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 6–13).
2. Apply anti-seize lubricant to the splines of the steering control valve input shaft.

Installing the Steering Control Valve (continued)

3. Apply loctite to four (4) socket-head screws. Slide the steering control valve input shaft into the steering column universal joint. Position the control valve with the ports toward front of the machine. Secure the steering control valve to the steering column with the 4 socket-head screws. Torque the socket-head screws to **8 to 11 N·m (6 to 8 ft-lb)** in a criss-cross pattern.
4. Position the steering column assembly to the machine. Secure the steering column in place with the 2 socket-head screws and 2 flange nuts at rear two mounting holes.
5. Remove the caps and plugs that were installed to the hydraulic lines and fittings during the removal process.
6. Lubricate new O-rings and use the labels that you attached during valve removal to connect the hydraulic lines to the fittings on the steering control valve. Tighten the connections; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 6–11).
7. Position the steering column brace (item 12 in Figure 184) to the machine and secure with the 4 flange-head screws and 4 flange nuts.
8. Slide the rubber bellows to the bottom of the steering column.
9. Place the rubber bushings and spacers into the holes of the shroud (Figure 185). Position the shroud in place and secure with the removed fasteners.
10. Check the hydraulic-fluid level in the hydraulic tank and add correct quantity of fluid if necessary; refer to the *Operator's Manual*.
11. Operate the machine functions slowly until air is out of system; refer to Charging the Hydraulic System (page 6–151).

Servicing the Steering Control Valve

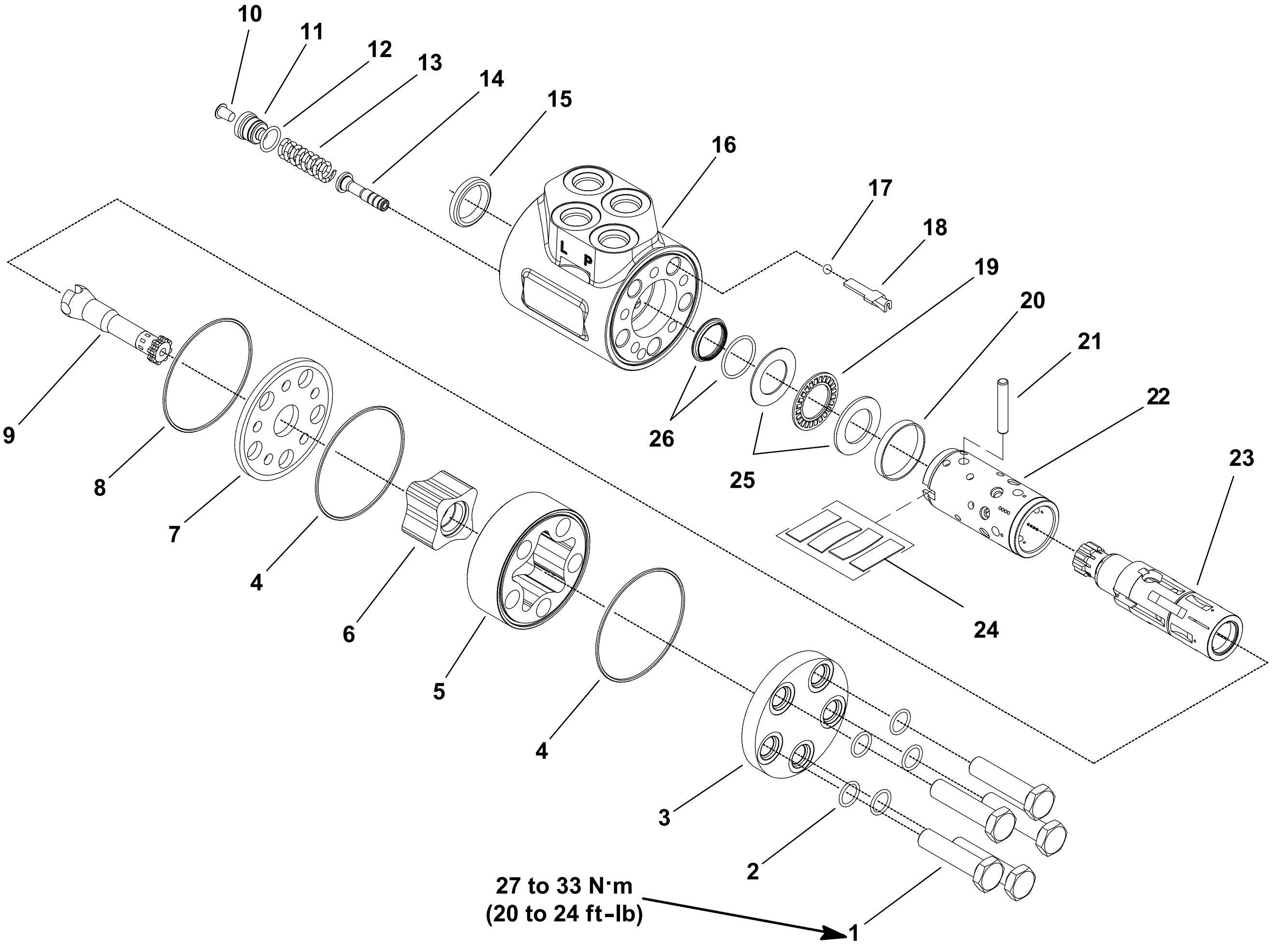


Figure 187

1. Screw (5 each)
2. O-ring (5 each)
3. End cover
4. O-ring
5. Outer gearwheel
6. Inner gearwheel
7. Distributor plate
8. O-ring
9. Cardan shaft
10. Plug
11. Plug
12. O-ring
13. Spring
14. Relief valve
15. Dust seal ring
16. Housing
17. Check ball
18. Ball stop
19. Bearing
20. Ring
21. Cross pin
22. Sleeve
23. Spool
24. Spring set
25. Thrust washer
26. Shaft seal

Note: For the steering control valve repair procedures, refer to the Sauer-Danfoss Steering Unit Type OSPM Service Manual at the end of this chapter.

Steering Cylinder

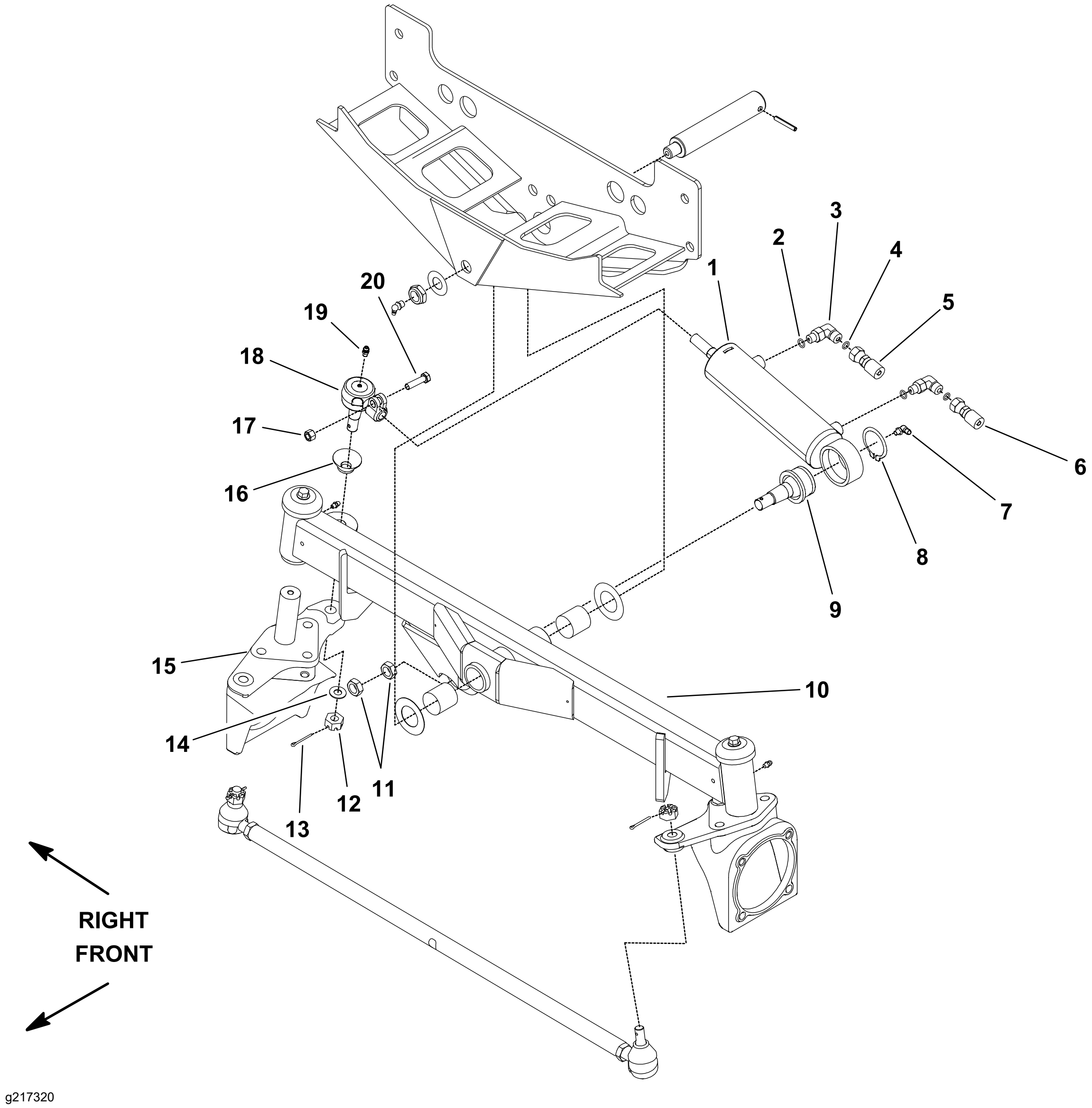


Figure 188

1. Steering cylinder
2. O-ring (2 each)
3. 90° hydraulic fitting (2 each)
4. O-ring (2 each)
5. Hydraulic hose
6. Hydraulic hose
7. 90° grease fitting
8. Retaining ring
9. Ball joint
10. Rear axle
11. Jam nut (2 each)
12. Slotted hex nut
13. Cotter pin
14. Washer
15. Right drag link
16. Seal
17. Hex nut
18. Ball joint
19. Grease fitting
20. Bolt

Removing the Steering Cylinder

1. Park the machine on a level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 6–145).

Removing the Steering Cylinder (continued)

CAUTION

Before opening the hydraulic system, operate all the hydraulic controls to release system pressure and avoid injury from the pressurized hydraulic fluid; refer to Releasing Pressure from the Hydraulic System (page 6–8).

3. For assembly purposes, label all the hydraulic hoses and tubes that are connected to the fittings on the steering cylinder.
4. Clean the hydraulic hose ends before you disconnect the hoses from the steering cylinder.
5. Disconnect the hydraulic hoses from the steering cylinder.
6. Install caps or plugs on the disconnected hoses and fittings to prevent contamination.
7. Remove the 2 jam nuts (item 11 in Figure 188) that secure the steering cylinder to the axle. Remove the cotter pin (item 13 in Figure 188) and slotted hex nut that secure the steering cylinder to the right drag link.
8. Separate the steering cylinder ball joints from the axle assembly. Remove the steering cylinder from the machine.

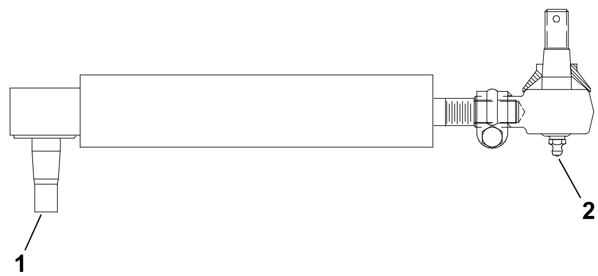


Figure 189

1. Cylinder shaft ball joint
2. Ball joint

9. If necessary, remove the ball joint from the steering cylinder barrel and shaft. If the ball joint is to be removed from the cylinder shaft, fully retract the cylinder shaft and measure the ball joints center to center length for easy installation of the ball joint into the cylinder shaft (Figure 189).
10. If the hydraulic fittings are to be removed from the steering cylinder, mark the fitting orientation for assembly purposes. Remove the fittings from the steering cylinder and discard the O-rings from the fittings.

Installing the Steering Cylinder

1. If the hydraulic fittings were removed from the steering cylinder, lubricate new O-rings with clean hydraulic fluid, position the O-rings to the fittings, and install the fittings into the steering cylinder ports; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 6–13). Ensure that the fittings are orientated correctly.
2. If removed, press the ball joint (item 9 in Figure 188) into the barrel and secure the ball joint with the retaining ring. Ensure that the retaining ring is fully seated in groove in the steering cylinder barrel.
3. If the ball joint (item 18 in Figure 188) was removed from the cylinder shaft, fully retract the cylinder shaft and thread the ball joint into the shaft so that

the center to center length is as measured during removal process. Tighten the bolt and hex nut.

4. Clean the tapers on the ball joints and axle assembly.
5. Position the steering cylinder to the machine.
6. Secure the steering cylinder to the axle with the 2 jam nuts (item 11 in Figure 188). Tighten the first jam nut and then, while holding the first jam nut with wrench, tighten the second jam nut.
7. Secure the steering cylinder to the right drag link with the washer (item 14 in Figure 188), slotted hex nut, and cotter pin.
8. Remove the caps and plugs from the hydraulic hoses and fittings.
9. Lubricate and install new O-rings on the steering cylinder fittings. Correctly connect the hydraulic hoses to the steering cylinder; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 6–11).
10. Check the hydraulic-fluid level in the hydraulic reservoir and add correct quantity of fluid if necessary; refer to the *Operator's Manual*.
11. Lubricate the steering cylinder ball joint grease fittings.
12. Operate the machine functions slowly until air is out of system; refer to Charging the Hydraulic System (page 6–151).
13. Check that the steering cylinder does not contact the axle or frame as cylinder moves from fully retracted to fully extended. Also, check that the distance between the drag links and steering stops are equal on both sides of the machine. If necessary, adjust the location of the ball joint on the cylinder shaft.

Servicing the Steering Cylinder

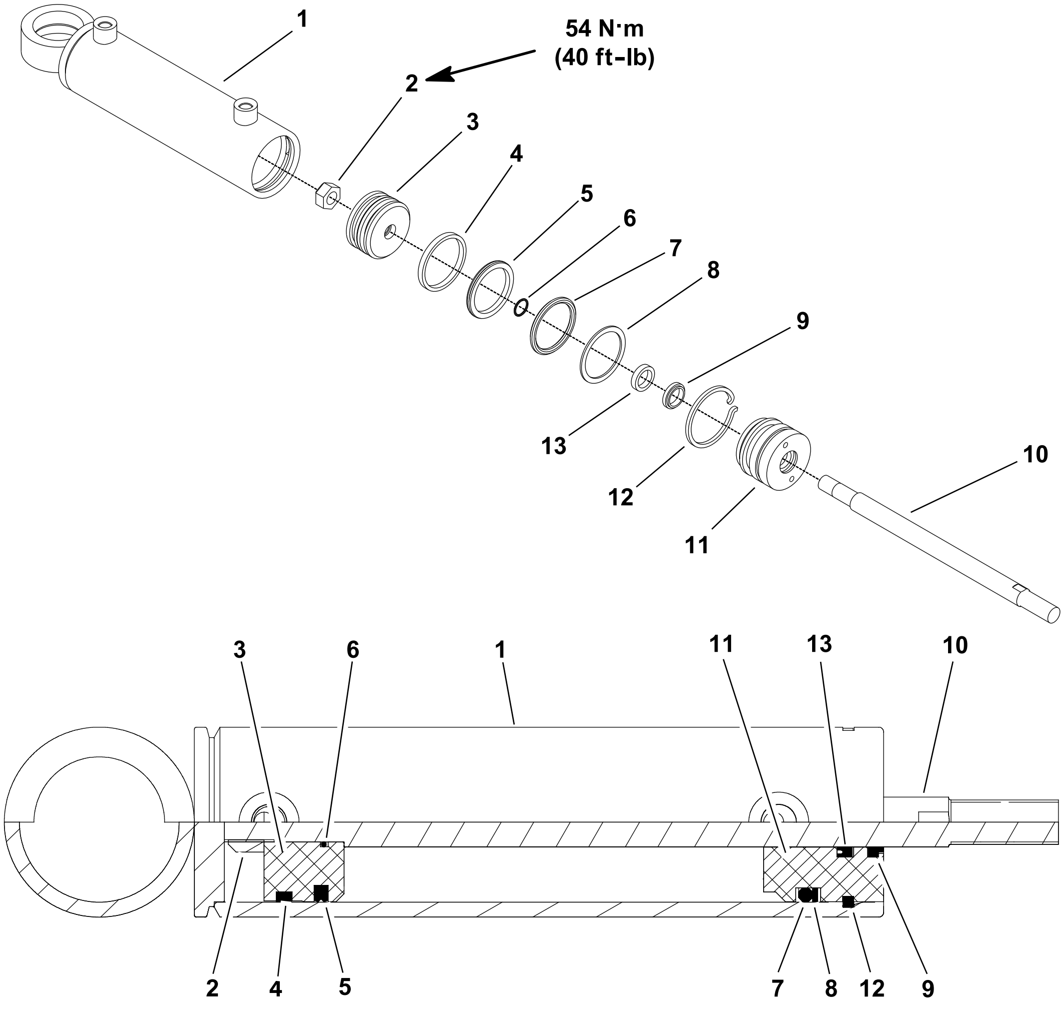


Figure 190

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

Disassembling the Steering Cylinder

1. Slowly pump the cylinder shaft to remove the hydraulic fluid from the steering cylinder into a drain pan. Plug both the ports and clean the outer surface of the cylinder.

IMPORTANT

When you clamp the steering cylinder in a vise, clamp the barrel clevis only to prevent damage. Do not close the vise on the barrel.

2. Mount the steering cylinder securely in a vise by clamping on the barrel clevis. Use a vise equipped with soft jaws.
3. Use a spanner wrench, rotate the head clockwise until the edge of the retaining ring appears in the barrel opening. Insert a screwdriver under the

Disassembling the Steering Cylinder (continued)

beveled edge of the retaining ring to start the retaining ring through the opening. Rotate the head counterclockwise to remove the retaining ring from the barrel and head..

4. Remove the plugs from the ports. Carefully twist and pull the shaft and remove the shaft with head and piston.

IMPORTANT

Clamping the vise jaws against the shaft surface could damage the shaft. When securing the shaft in a vise, clamp the shaft clevis only.

5. Use a wrench on shaft flats to prevent the shaft from rotating, remove the locknut.
6. Carefully slide the piston and then head off the shaft.

   Note: Do not scratch or damage the piston.
7. Remove the wear ring, BP seal, and O-ring from the piston.

   Note: Do not scratch or damage the head.
8. Remove the O-ring, back-up washer, dust seal, and BS seal from the head.
9. Discard the seals and O-rings that were removed.

Inspecting the Steering Cylinder

⚠ CAUTION ⚠

Use eye protection such as goggles when using compressed air.

1. Wash all the cylinder components in clean solvent and dry them with compressed air.
2. Inspect the internal surface of the barrel for deep scratches, out-of-roundness, and bending.
3. Inspect the head, shaft, and piston for excessive pitting, scoring, and wear.
4. Replace the steering cylinder if the internal components are worn or damaged.

Assembling the Steering Cylinder

1. Ensure that all the parts are clean before assembly.
2. Put a coating of clean hydraulic fluid on new O-rings, back-up washer, and other seals.
   A. Carefully install the wear ring, BP seal, and O-ring to the piston.
   B. Carefully install the back-up washer, O-ring, dust seal, and BS seal to the head.
3. Put a coating of clean hydraulic fluid on the shaft. Slide the head and piston onto the shaft.

IMPORTANT

Clamping the vise jaws against the shaft surface could damage the shaft. When securing the shaft in a vise, clamp the shaft clevis only.

Assembling the Steering Cylinder (continued)

4. Use a wrench on the shaft flats to prevent the shaft from rotating, secure the piston with the locknut. Torque the locknut to **54 N·m (40 ft-lb)**.

IMPORTANT

When you clamp the steering cylinder in a vise, clamp the clevis end of the barrel only to prevent damage.

5. Mount the barrel in a vise by clamping on the clevis end of the barrel.

IMPORTANT

When installing the head into the barrel, pay careful attention to the retaining ring slot in the barrel to ensure that the piston and head seals do not lodge in the slot.

6. Put a light coating of clean hydraulic fluid on all internal parts. Carefully slide the piston, shaft, and head assembly into the barrel.

   Note: Do not damage the seals during assembly.

7. Secure the head in the barrel with the retaining ring as follows:

   A. Align the retaining ring hole in the head with the access slot in the barrel.

   B. Insert the retaining ring hook into the hole and rotate the head clockwise until the retaining ring is completely pulled into the barrel and the ring ends are covered.

   C. Apply silicone sealer to the barrel access slot.

Oil Cooler (5410/5510/5610)

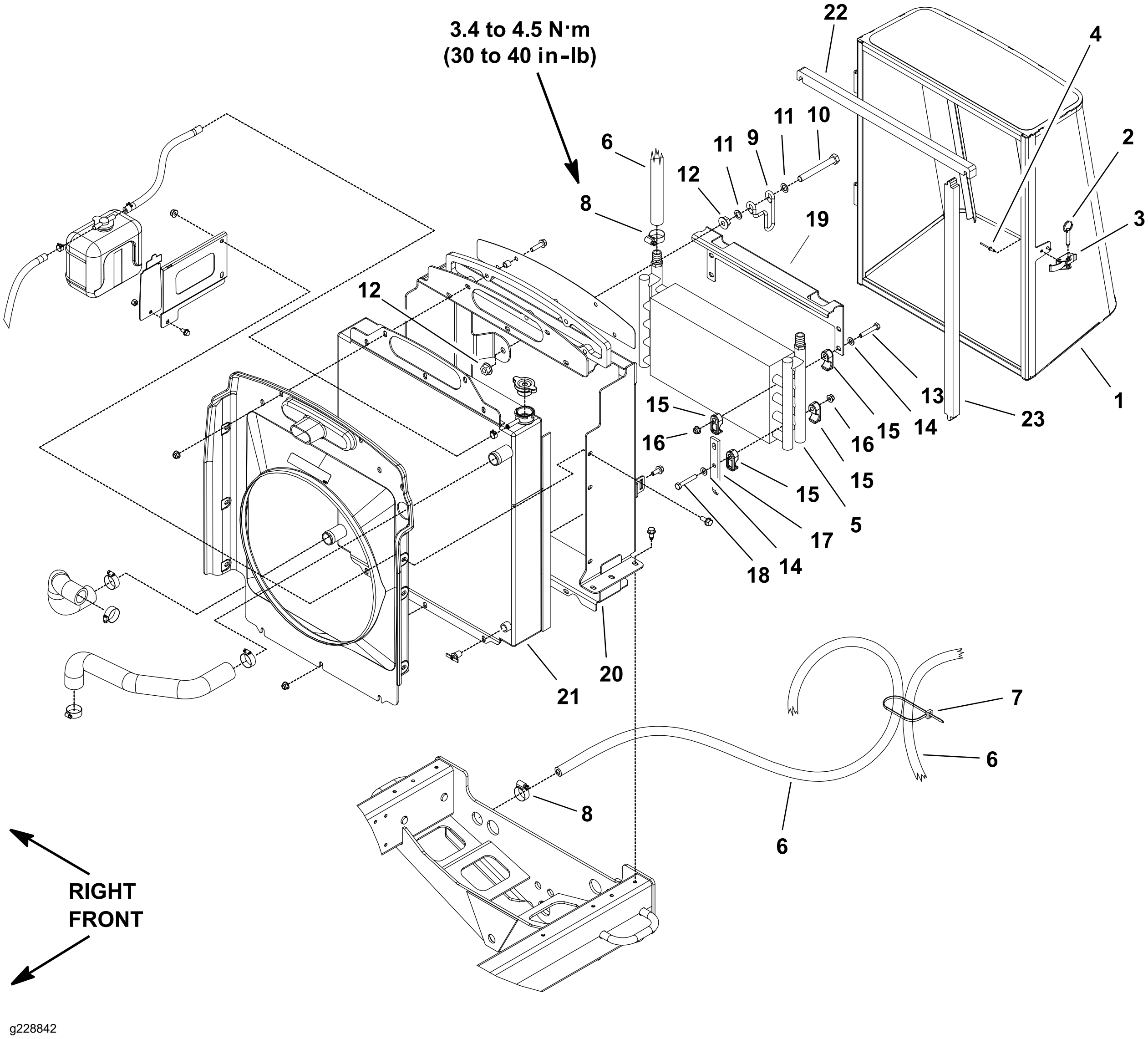


Figure 191
Reelmaster 5410 and 5510

1. Rear screen
2. Detent ball pin
3. Draw latch
4. Pop rivet (2 each)
5. Oil cooler
6. Hydraulic hose (2 each)
7. Cable tie
8. Hose clamp (4 each)
9. Wire form clamp (2 each)
10. Bolt (2 each)
11. Washer (4 each)
12. Flange nut (4 each)
13. Bolt (4 each)
14. Flat washer (8 each)
15. Oil cooler clamp (8 each)
16. Flange nut (8 each)
17. Oil cooler mount plate (2 each)
18. Bolt (4 each)
19. Oil cooler bracket
20. Radiator frame
21. Radiator assembly
22. Foam seal (2 each)
23. Foam seal (2 each)

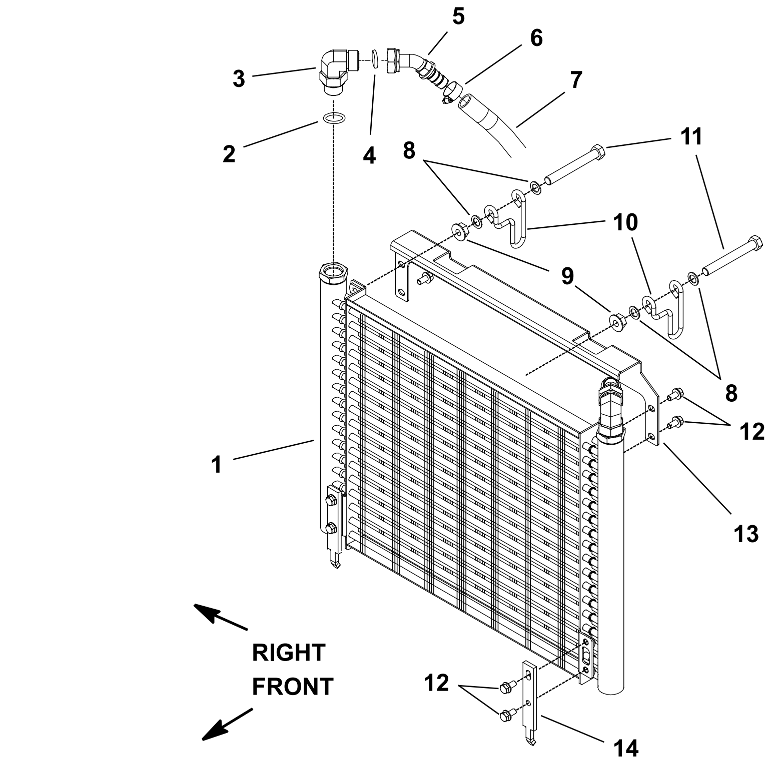


Figure 192
Reelmaster 5610

1.	Oil cooler	6.	Hose clamp	11.	Bolt (2 each)
2.	O-ring	7.	Hydraulic fitting (2 each)	12.	Screw (8 each)
3.	Hydraulic fitting (2 each)	8.	Flat washer	13.	Oil cooler bracket
4.	O-ring	9.	Flange nut (4 each)	14.	Mount plate (2 each)
5.	Hydraulic fitting (2 each)	10.	Clamp (2 each)		

Note: The oil cooler used on Reelmaster 5410 and 5510 machines with a Kubota diesel engine is Figure 191. The oil cooler used on Reelmaster 5610 machines with a Kubota diesel engine is shown in Figure 192. Service procedures is similar for all Reelmaster machines with a Kubota diesel engine.

Removing the Oil Cooler

1. Park machine on a level surface, lower cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Unlatch and open the rear screen.
3. Label all hydraulic connections for assembly purposes. Clean hydraulic connections before you loosen the hydraulic hoses.
4. Loosen hose clamps that secure hydraulic hoses to oil cooler fittings. Carefully remove hose ends from barbed fittings on oil cooler. Allow hoses to drain into a suitable container.
5. Rotate clamps that secure oil cooler to radiator frame.
6. Carefully remove oil cooler from machine.
7. If necessary, remove clamps and brackets from oil cooler (Figure 191 or Figure 192).
8. If hydraulic fittings are to be removed from oil cooler on Reelmaster 5610 machines, mark fitting orientation to allow correct assembly. Remove fittings from cooler and discard O-rings.

Inspecting the Oil Cooler

1. Back flush oil cooler with cleaning solvent. After cooler is clean, ensure all solvent is drained from the cooler.

CAUTION

Use eye protection such as goggles when using compressed air.

2. Dry inside of oil cooler using compressed air in the opposite direction of the oil flow.
3. Plug both ends of oil cooler. Carefully clean exterior of cooler. Ensure oil cooler fins are clear of dirt and unwanted material.
4. The oil cooler should be free of corrosion, cracked tubes, and excessive pitting of tubes.

Installing the Oil Cooler

1. If fittings were removed from oil cooler on Reelmaster 5610 machines, lubricate and place new O-rings onto fittings. Install fittings into cooler openings using marks made during the removal process to properly orientate fittings. Tighten fittings; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 6–13).
2. If removed, install clamps and brackets to oil cooler (Figure 191 or Figure 192).
3. Position oil cooler to radiator frame and secure with clamps.
4. Install hydraulic hoses to oil cooler barbed fittings. Secure hoses with hose clamps.
5. Close and secure rear screen.
6. Check the hydraulic-fluid level in the hydraulic reservoir and add correct quantity of fluid if necessary.
7. Operate the machine functions slowly until air is out of system; refer to Charging the Hydraulic System (page 6–151).

Radiator and Oil Cooler Assembly (5410-G/5410-D/5510-G/5510-D/5610-D)

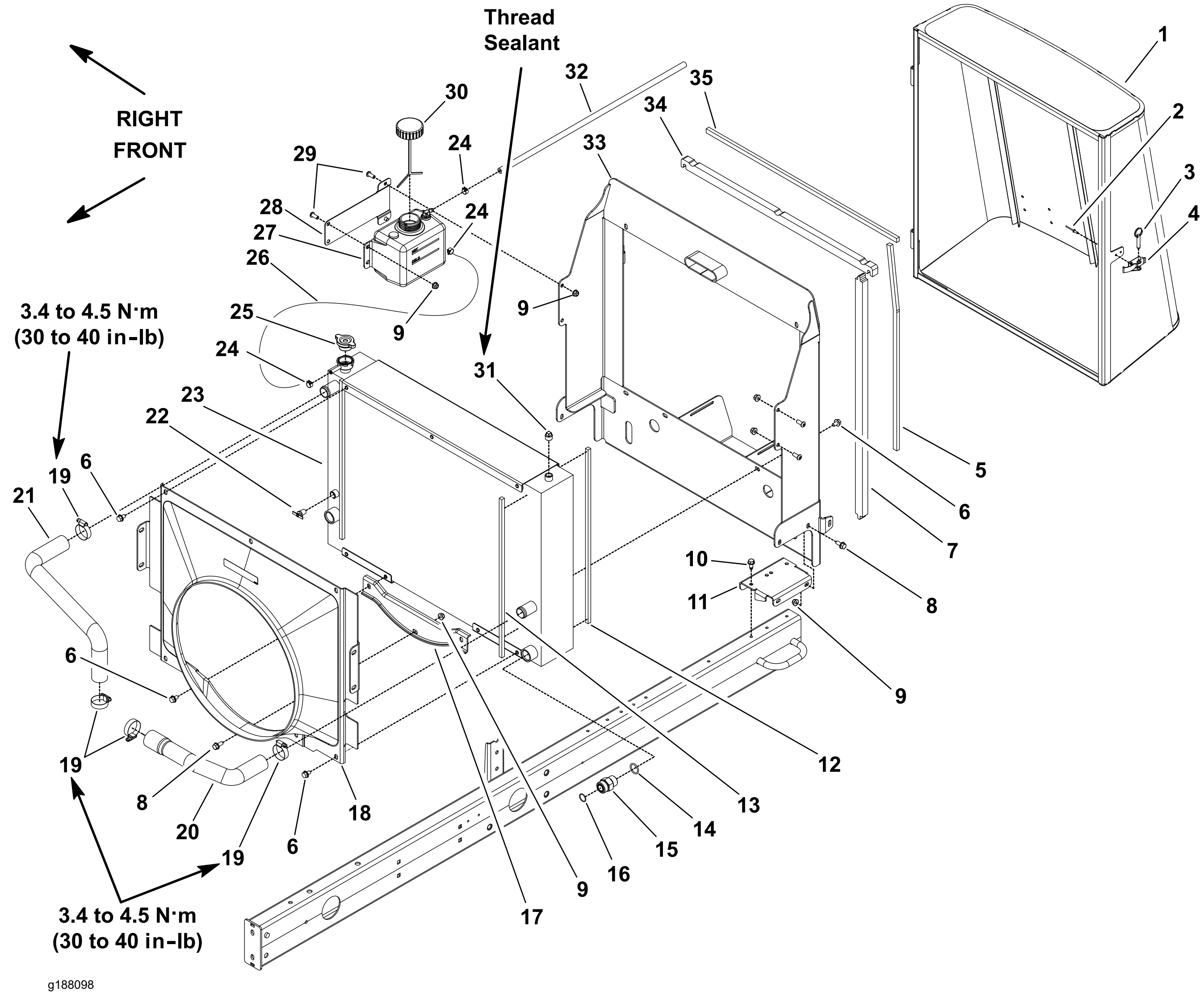


Figure 193

1. Screen
2. Pop rivet (2 each)
3. Detent ball pin
4. Draw latch
5. Foam seal (2 each)
6. Flange-head screw (14 each)
7. Foam seal (2 each)
8. Flange-head screw (5 each)
9. Flange nut (10 each)
10. Washer-head screw (6 each)
11. Mounting bracket (2 each)
12. Foam seal (2 each)
13. Foam seal (2 each)
14. O-ring (2 each)
15. Straight hydraulic fitting (2 each)
16. O-ring (2 each)
17. Shroud cap
18. Fan shroud
19. Hose clamp (4 each)
20. Lower radiator hose
21. Upper radiator hose
22. Draincock
23. Radiator and oil cooler assembly
24. Hose clamp (3 each)
25. Radiator cap
26. Reservoir hose
27. Coolant reservoir assembly
28. Reservoir bracket
29. Button-head screw (5 each)
30. Reservoir cap
31. Pipe plug
32. Reservoir hose
33. Radiator frame
34. Foam seal (2 each)
35. Foam seal

Radiator and Oil Cooler Assembly (5410-G/5410-D/5510-G/5510-D/5610-D) (continued)

Note: For Reelmaster machines with either a Yanmar diesel or Kubota gasoline engine, the hydraulic oil cooler is combined with the radiator. For 5410-D/5510-D/5610-D machines, refer to Radiator (page 4–18) and for 5410-G/5510-G machines, refer to Radiator and Oil Cooler Assembly (page 5–17) for information on removal and installation of the radiator and oil cooler assembly.

Electrical System

Table of Contents

General Information

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

Electrical Schematic and Wire Harness Drawings/Diagrams

The electrical schematics and wire harness drawings/drawings for Reelmaster 5410, 5410-G, 5410-D, 5510, 5510-G, 5510-D, 5610, and 5610-D machines are located in Appendix A (page A–1). Refer to these drawings when servicing the electrical system on your machine.

Toro Electronic Controller (TEC)

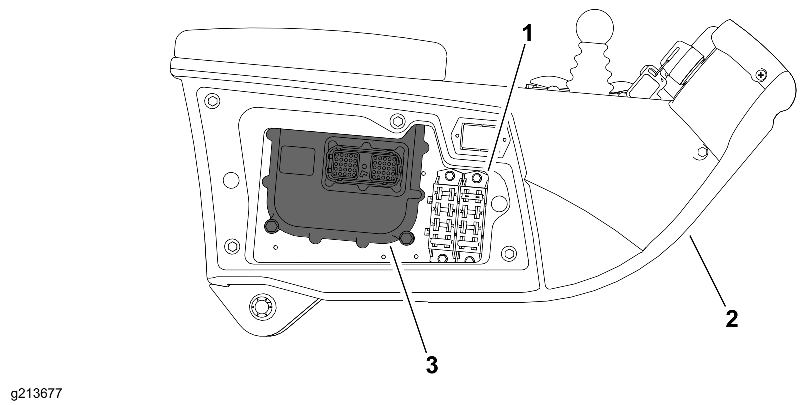


Figure 194

1. Fuse block
2. Control arm
3. TEC

The Reelmaster 5010 machines use a Toro Electronic Controller (TEC) to manage the machine electrical functions. The controller is a microprocessor controlled device that monitors the condition of various switches and sensors (inputs) and then directs electrical power to control the appropriate machine functions (outputs) based on the inputs. Communication between the TEC, InfoCenter display, and engine ECU (if equipped) is provided by a CAN-bus system. The status of inputs to the controller as well as outputs from the controllers can be monitored with the InfoCenter display.

The TEC is located behind the control arm access cover next to the fuse block.

IMPORTANT

Before performing any welding on the machine, do the following to prevent damaging the electrical system of the machine:

- Disconnect the battery cables from the battery.
- Disconnect the wire harness connector from the Toro Electronic Controller.
- Disconnect the wire harness connectors from the engine ECU.
- Disconnect the terminal connector from the alternator.

CAN-bus Communications

The TEC, Yanmar engine ECU (if equipped), and InfoCenter display used on the Reelmaster 5010 machines communicate with each other on a CAN-bus system. This system allows the traction unit to fully integrate all the different electrical

CAN-bus Communications (continued)

components of the machine and bring them together as one. The CAN-bus system reduces the number of electrical components and connections that are used on the machine and allows the number of wires in the wire harness to be significantly reduced. The integration of the electrical functions also allows the InfoCenter display to assist with the electrical system diagnostics.

The CAN identifies the controller area network that is used between control components on the machine. The 2 specially designed, twisted cables form the bus. The bus wires are black/white and red/white. These wires provide the data pathways between the TEC, Yanmar engine ECU (if equipped), and InfoCenter display used on the machine. The engineering term for these cables are the CAN High and CAN Low. At the ends of the twisted pair of bus cables are the 120-ohm terminator resistors. One of these resistors is included in the wire harness near the InfoCenter display and the second is either inside the engine ECU or included in the engine wire harness.

The CAN-bus link controls each of the components that requires only 4 wires to operate and communicate to the system: CAN High, CAN Low, B+ (power), and ground. The CAN-bus needs the key switch ON/RUN input for the TEC and engine ECU to be activated.

IMPORTANT

The terminator resistors at the ends of the bus cables are required for proper electrical system operation.

Yanmar Engine Electronic Control Unit (ECU)

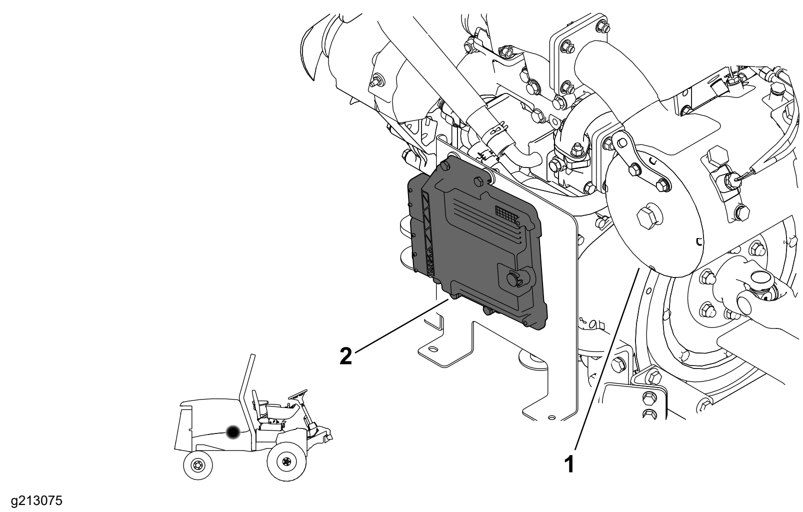


Figure 195

1. Diesel-particulate filter (DPF)
2. Electronic Control Unit (ECU)

Machines with a Yanmar diesel engine use an electronic control unit (ECU) for engine management and to communicate with the TEC and InfoCenter display on the machine. If you must disconnect the engine ECU for any reason, ensure that the key switch is in the OFF position with the key removed for a minimum of 30 seconds before disconnecting the engine ECU.

Yanmar Engine Electrical Components

When operating a machine with a Yanmar diesel engine, if an engine electrical component fault occurs, the machine InfoCenter display can be used to identify the engine fault.

When servicing or troubleshooting the engine electrical components use the Yanmar Engine Service Manual and Troubleshooting Manual. Contact your Toro distributor for additional engine troubleshooting assistance.

Kubota Gasoline Engine Electronic Control Unit (ECU)

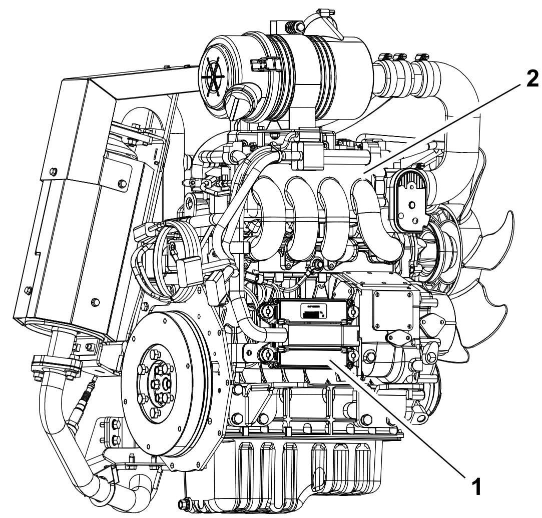


Figure 196

1. Electronic control unit
2. Intake manifold

Machines with a Kubota gasoline engine use an electronic control unit (ECU) for engine management. The engine ECU also communicates with the machine Toro Electronic Controller (TEC) and the operator InfoCenter Display through the machine CAN-bus system. All wire harness electrical connectors should be plugged into the engine ECU before the machine key switch is moved from the OFF position to either the ON/RUN or START position. If the engine ECU is to be disconnected for any reason, ensure that the key switch is in the OFF position with the key removed for a minimum of 30 seconds before disconnecting the engine ECU; refer to Chapter 5: Kubota Gasoline Engine (page 5–1) for additional engine ECU information.

IMPORTANT

Do not plug or unplug the engine ECU for a period of 30 seconds after the machine key switch is turned OFF. The ECU may remain energized even though the key switch is OFF.

Kubota Gasoline Engine Electrical Components

When operating a machine with a Kubota gasoline engine, if an engine electrical component fault occurs, the machine InfoCenter display can be used to identify the fault.

When servicing or troubleshooting Kubota gasoline engine electrical components, use the Kubota model WG1605-G-E3 Workshop Manual and Diagnosis Manual that are available for this engine. Also, your Toro distributor can use the Kubota gasoline engine service tool to confirm the real-time engine running status and to offer timely technical services. Contact your Toro distributor for assistance in Kubota gasoline engine troubleshooting.

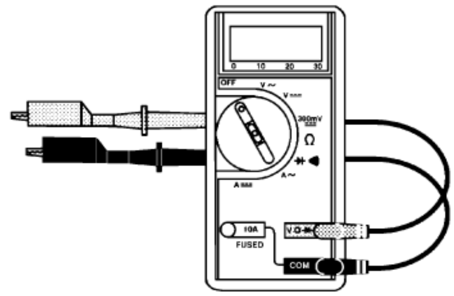
Special Tools

You can order these special tools from your Authorized Toro Distributor. Some tools are also available from a local supplier.

Multimeter

The meter can test the electrical components and circuits for current, resistance, or voltage. You can get the digital multimeter locally.

Note: Use a digital multimeter when testing the electrical circuits. The high impedance (internal resistance) of a digital meter in the voltage mode ensures that the excess current is not allowed through the meter. This excess current can damage the circuits that are not designed to carry it.



Terminal Protector

Toro Part No. 107-0392

Use this aerosol spray on the battery terminals, ring terminals, and fork terminals to reduce corrosion problems. Apply the terminal protector to the connection after you secure the battery cable, ring terminal, or fork terminal.

Battery Hydrometer

Use the battery hydrometer when measuring the specific gravity of the battery electrolyte. You can get this tool locally.

Dielectric Gel

Toro Part No. 107-0342

Use the dielectric gel to prevent corrosion of unsealed connection terminals. To ensure complete coating of the terminals, liberally apply the gel to the component and wire harness connector, plug the connector into the component, unplug the connector, apply the gel to both surfaces again, and connect the harness connector to the component again. The connectors must be fully packed with gel for effective results.

Note: Do not use the dielectric gel on the sealed connection terminals as the gel can unseat the connector seals during assembly.

InfoCenter Display

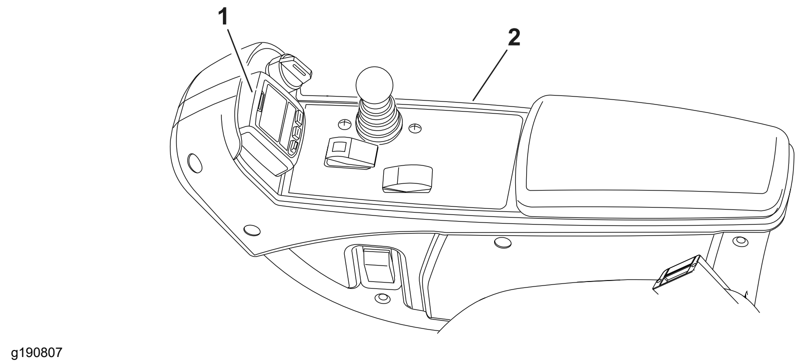


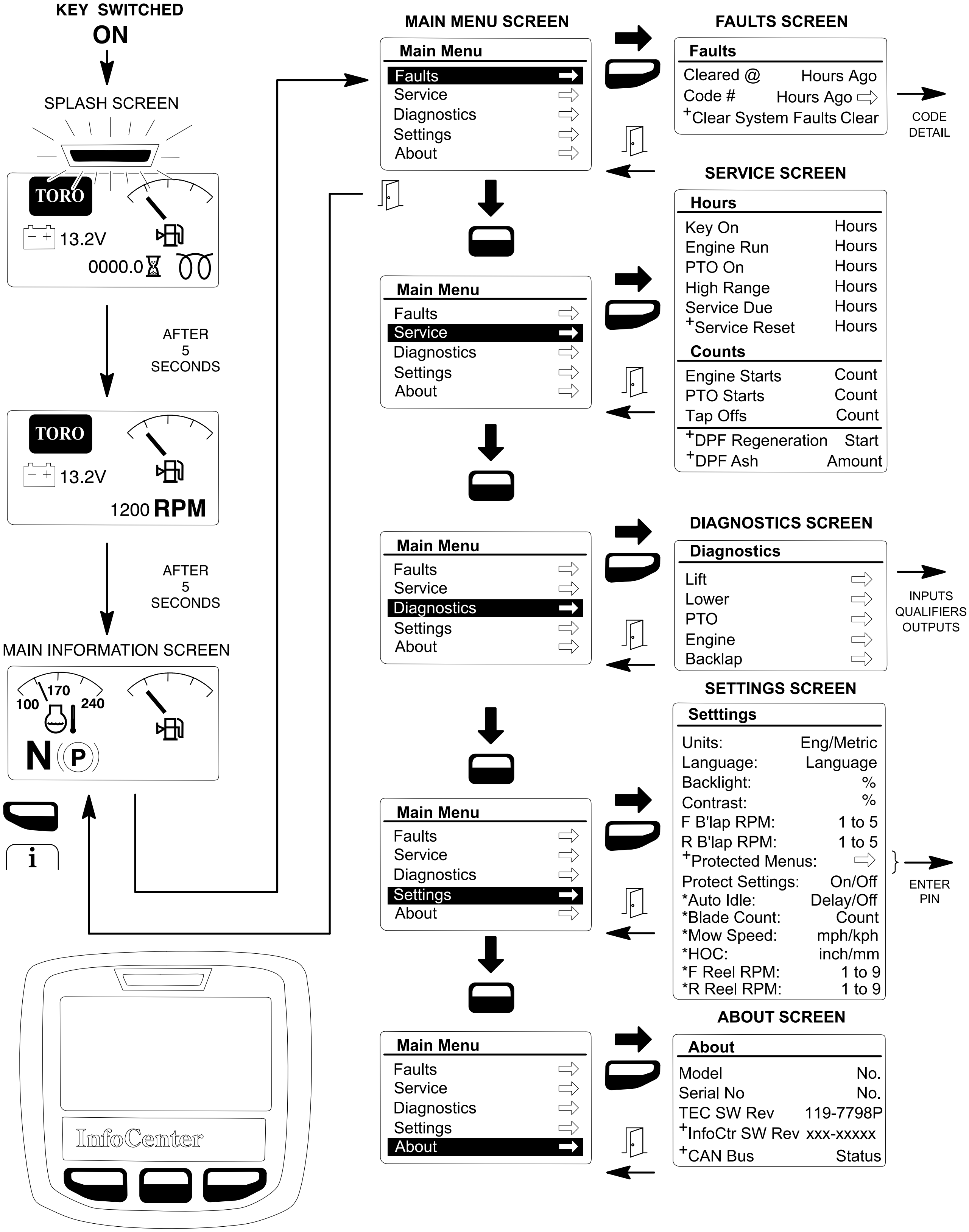
Figure 197

1. InfoCenter display
2. Control arm

The InfoCenter display used on your Reelmaster is a LCD device that is located on the control arm (Figure 197). The InfoCenter provides information to the operator during the operation of the machine, provides the electrical system diagnostic assistance for the technicians, and allows inputs for the adjustable machine settings (Figure 198).

The power for the InfoCenter is available when the main power relay is energized (key switch in the RUN or START position). A CAN-bus system involving the machine TEC, Yanmar engine ECU (if equipped), InfoCenter, and cutting unit motors provide necessary machine communication for the InfoCenter operation.

Note: Icons that are used on the InfoCenter display are identified in the *Traction Unit Operator's Manual*.



Software Version 120-6370 Rev J Shown

* Item not visible until PIN has been entered if the **Protect Settings** is ON

+ Item not visible until PIN has been entered if the **Protect Settings** is ON

g213684

Figure 198

Splash Screen

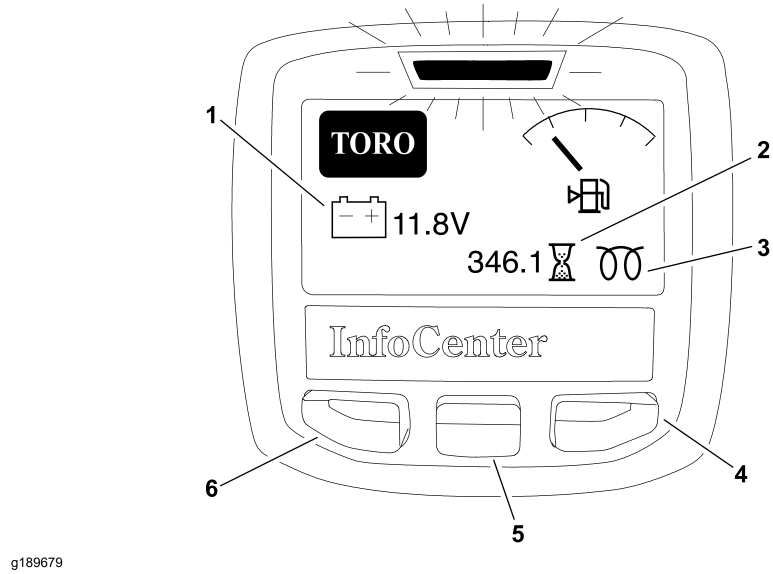


Figure 199

1. Battery voltage
2. Fuel gauge
3. Hour meter
4. Glow plugs energized
5. Left/right button
6. Down button
7. Menu/back button

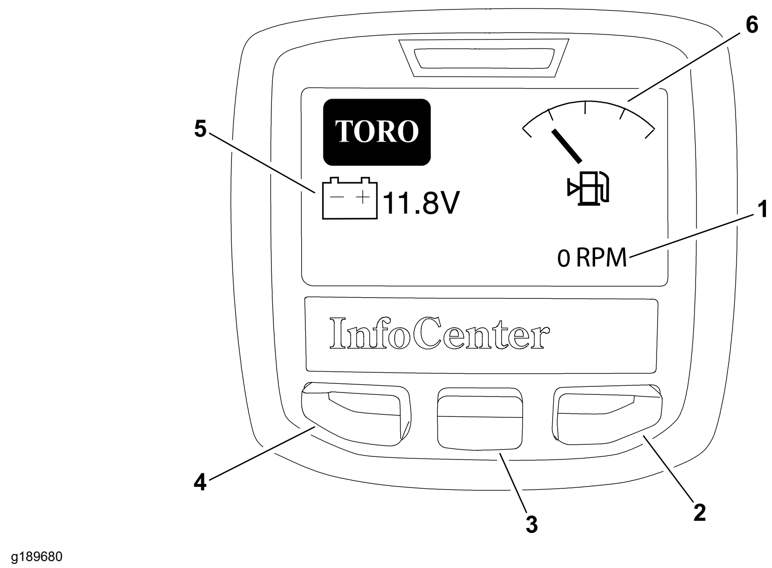


Figure 200

1. Engine RPM
2. Left/right button
3. Down button
4. Menu/back button
5. Battery voltage
6. Fuel gauge

When the key switch is initially turned to the RUN or START position, the fault indicator illuminates for a few seconds to verify indicator operation and the InfoCenter splash screen appears (Figure 199 and Figure 200). The splash screens allow basic machine information to be reviewed by the operator. The splash screen provides the following information to the operator:

- Battery voltage
- Fuel tank level
- Hour meter (displayed for first 5 seconds)

Splash Screen (continued)

- Glow plug indicator (displayed only while glow plugs are energized)
- Engine RPM (displayed after 5 seconds)

After the splash screen has been displayed for 10 seconds, the main information screen will appear on the InfoCenter.

Main Information Screen

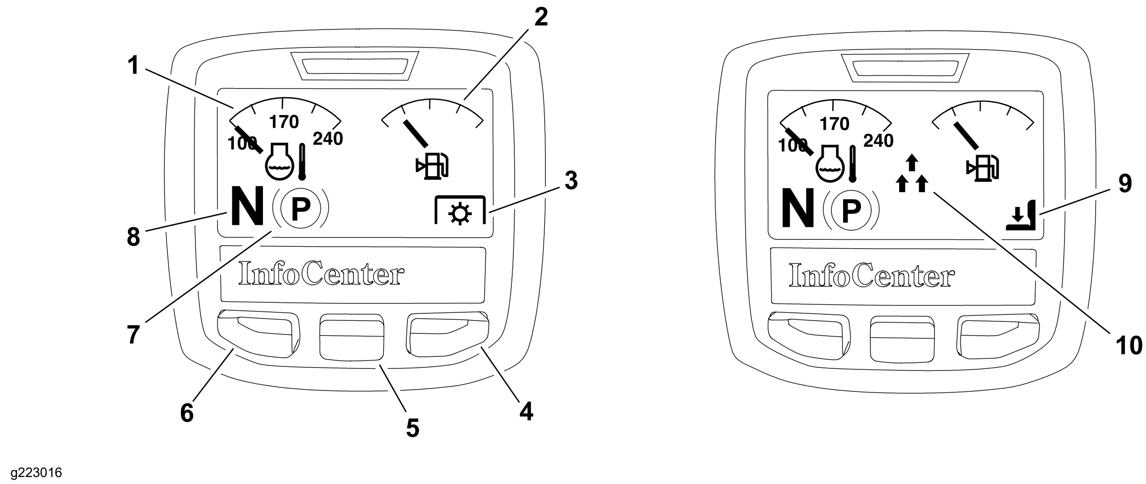


Figure 201

1. Engine coolant temperature
2. Fuel gauge
3. Reels (engaged)
4. Left/right button
5. Down button
6. Menu/back button
7. Parking brake (engaged)
8. Traction system (neutral)
9. Operator seat (unoccupied)
10. Cutting units (raising)

The InfoCenter main information screen (Figure 201) is displayed after the initial splash screen has been displayed for 10 seconds. The main information screen is the default screen as it will be displayed during normal machine operation. The main information screen provides the following information to the operator:

- Engine coolant temperature
- Fuel tank level
- Traction system

  Either the neutral, high (transport) speed range, or low (mow) speed range icon will appear at all times.
- Parking brake

  The icon appears when the parking brake is engaged.
- Cutting units

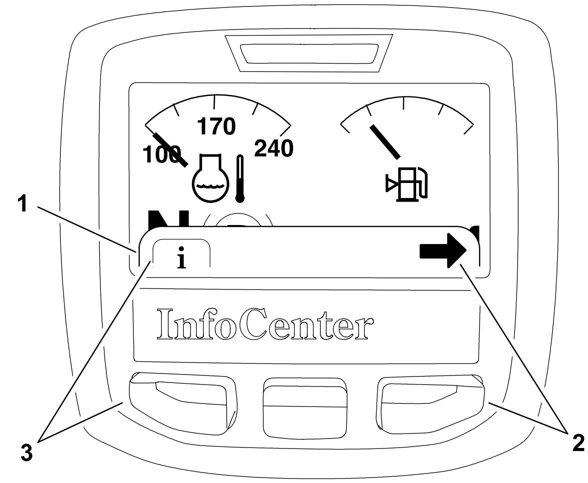
  Up icon appears while the cutting units are raising.

  Down icon appears while the cutting units are lowering.
- Reels

  The icon appears when the reels are engaged.
- Operator seat

  The icon appears when the operator is out of the seat and the seat must be occupied before machine operation can continue.

Main Information Screen (continued)



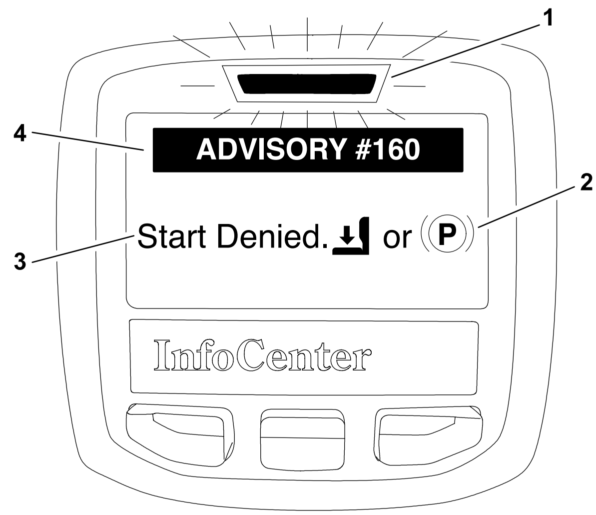
g189676

Figure 202

1.	Navigation pane	2.	Left/right button	3.	Menu/back button

Press the menu/back button once to expose the navigation pane, then press the left/right button (as indicated by the ➡ in the navigation pane) to toggle between the main information screen and the splash screen (tachometer) (Figure 202). The navigation pane will close automatically if another button is not pressed within 6 seconds.

Operator Advisory Screen



g187150

Figure 203

1.	Fault indicator	3.	Advisory description
2.	Advisory qualifier	4.	Advisory number/code

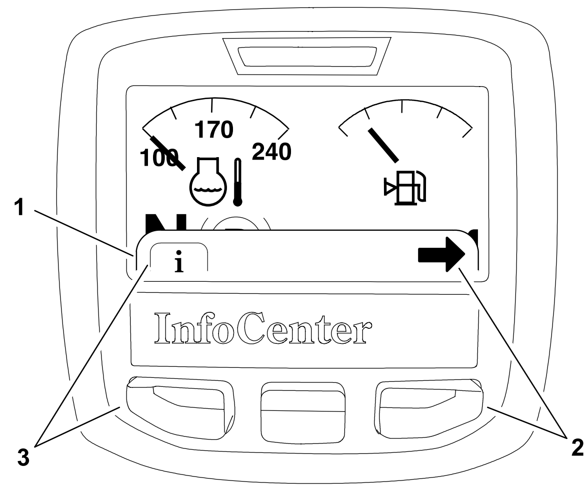
If the Toro Electronic Controller (TEC) inputs are not in the correct position to allow certain machine operations, or are malfunctioning, the fault indicator will illuminate and an advisory screen will appear on the InfoCenter display (Figure 203). Each advisory screen has 3 elements: the advisory number/code, advisory description, and advisory qualifier.

Operator Advisory Screen (continued)

An advisory qualifier denotes the condition(s) that triggered the advisory and provides instruction on eliminating the advisory. An operator advisory may involve one or more advisory qualifier. Typically, an advisory can be eliminated by changing the position of the operator control(s) referenced by the advisory qualifier. Once the first qualifier displayed is satisfied, any additional qualifiers that remain to be satisfied will appear in the operator advisory screen individually.

Note: If a machine fault occurs during machine operation, the InfoCenter fault indicator will blink to notify the operator. Accessing the fault log is described in the Faults Screen (page 7–16).

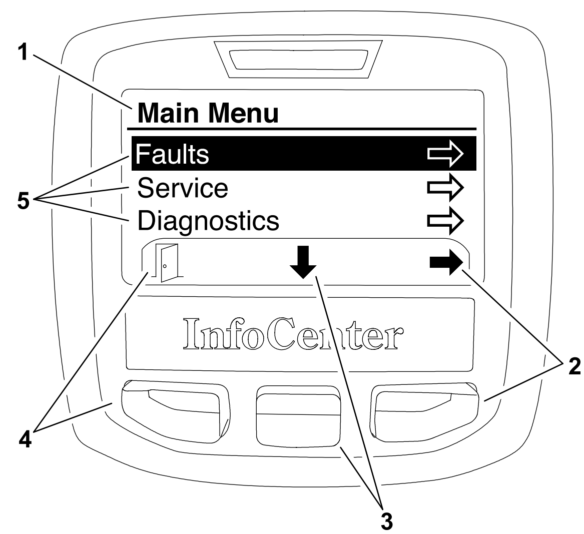
Main Menu Screen



g214492

Figure 204

1. Navigation pane
2. Left/right button
3. Menu/back button



g187148

Figure 205

1. Main menu
2. Left/right button
3. Down button
4. Menu/back button
5. Menu items

Main Menu Screen (continued)

The main menu screen (Figure 205) is accessed from the InfoCenter main information screen. Press the menu/back button once to expose the navigation pane (Figure 204), then press the menu/back button again (as indicated by the i in the navigation pane). The main menu screen provides access to the following menu screens:

- Faults
- Service
- Diagnostics
- Settings
- About

Press the down button (as indicated by the ⬇ at the bottom of the screen) to highlight the desired menu screen, then press the left/right button (as indicated by the ➡ at the bottom of the screen) to enter the highlighted menu screen.

To return to the main information screen from the main menu screen, press the menu/back button (as indicated by the at the bottom of the screen).

Faults Screen

Machine Faults

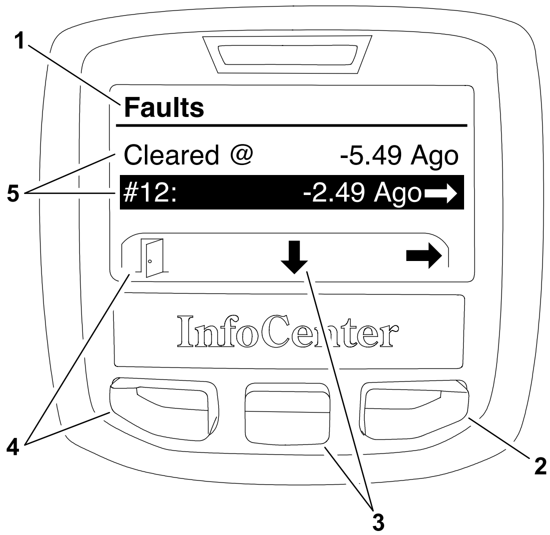


Figure 206

1. Fault menu
2. Left/right button
3. Down button
4. Menu/back button
5. Fault items

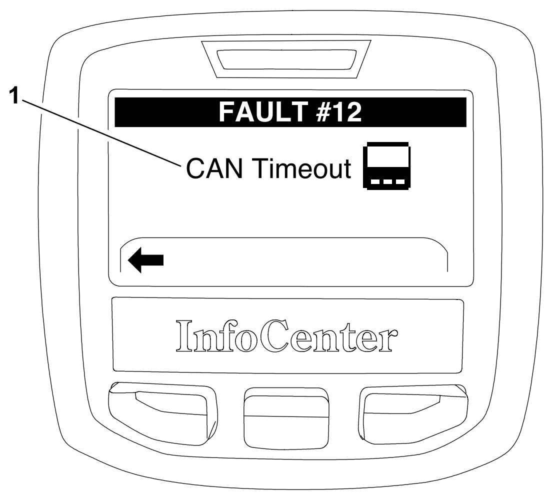


Figure 207

1. Fault description

The faults screen (Figure 206 and Figure 207) will list all machine electrical faults that have occurred since the faults were last cleared from the InfoCenter. The faults will be identified by a number code and when the fault occurred. The faults that might occur on the machine are listed in the Machine Faults (page 7–32).

If a machine fault occurs during operation, the InfoCenter fault indicator will blink to notify the operator, and machine functionality may be affected due to the fault. To regain full machine functionality:

1. Disengage the cutting units, release the traction pedal.
2. Turn the key switch OFF and allow all machine functions to stop.

Machine Faults (continued)

3. Allow the machine to remain OFF for at least 1 minute.
4. Restart the engine and check the machine operation.
5. If a fault continues to occur, further system evaluation and possible component repair or replacement will be necessary.

To view a description of a fault that has occurred since the faults were last cleared from the InfoCenter, press the down button (as indicated by the ⬇ at the bottom of the screen) to highlight the desired fault, then press the left/right button (as indicated by the ➡).

To return to the previous screen, press the menu/back button (as indicated by the at the bottom of the screen).

Clear System Faults (PIN required) If the correct passcode (PIN) has been entered (refer to the Protected Menus in the Settings Screen (page 7–21)) the InfoCenter fault log can be cleared by selecting Clear System Faults. The cleared faults will be removed from the InfoCenter list but will be retained in the TEC memory. Contact your Toro Distributor to view faults stored in the TEC memory.

Engine Faults

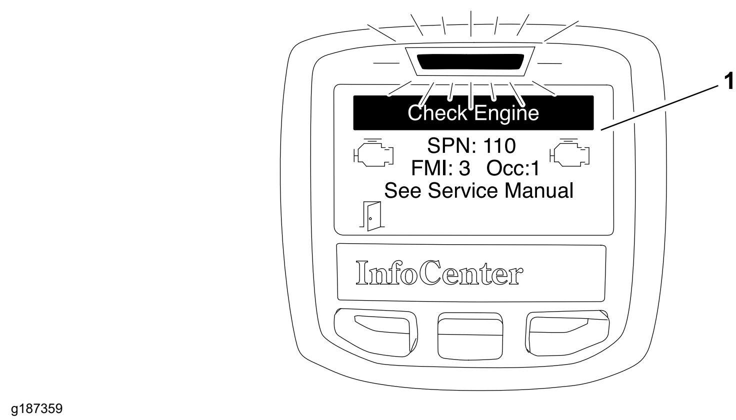


Figure 208

1. Engine fault (Yanmar diesel engine)

Yanmar Diesel Engines – If an engine fault occurs during machine operation, the fault indicator will illuminate and the fault will be displayed on the InfoCenter to notify the operator (Figure 208). The engine fault will continue to appear until the offending condition is corrected. Once the offending condition has been corrected, the engine fault will be retained in the engine electronic control unit (ECU) and can only be viewed using the engine diagnostic tool. Engine faults are not stored in the Toro Electronic Controller (TEC) so that the engine fault history cannot be viewed using the InfoCenter faults screen.

Note: Refer to the Yanmar Engine Service Manual and Troubleshooting Manual for additional information.

Service Screen

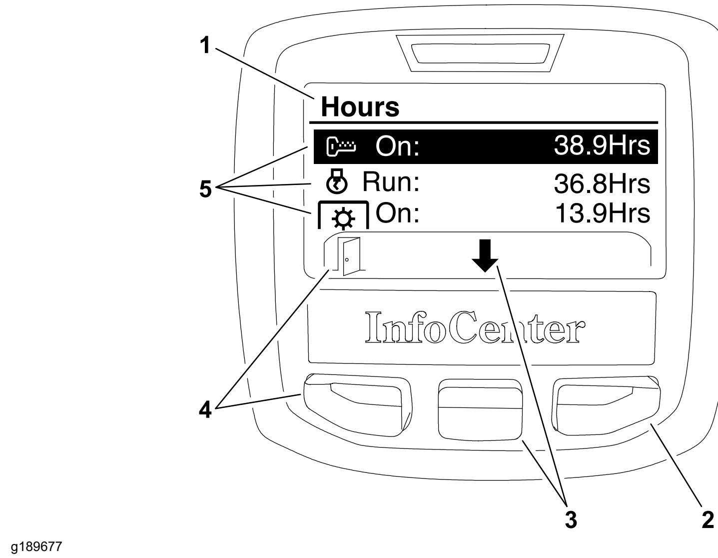


Figure 209

1. Service screen (hours)
2. Left/right button
3. Down button
4. Menu/back button
5. Service items

The service screen (Figure 209) contains operational information of the machine including hours, counts, and DPF regeneration. Values listed for these service menu items cannot be changed. If the correct passcode (PIN) has been entered (refer to the Protected Menus in the Settings Screen (page 7–21)) the service screen provides information on DPF ash accumulation and allows resetting the Service Due timer. To scroll through the list of service records and view the current values, press the down button (as indicated by the at the ⬇ bottom of the screen).

To return to the previous screen, press the menu/back button (as indicated by the at the bottom of the screen).

Hours provides access to the following information:

- **Key On** identifies the number of hours that the key switch has been in the ON position.
- **Engine Run** identifies the number of hours that the engine has been running.
- **PTO On** identifies the number of hours that the machine has been operated with the cutting units engaged.
- **High Range** identifies the number of hours that the machine has been operated in HIGH (transport) speed range.
- **Service Due** identifies the number of hours before the next scheduled maintenance is due. This is a count down timer and the numbers of hours displayed will decrease as the machine is used.
- **Service Reset** (PIN required) identifies the total number of hours between scheduled maintenance intervals. Reset the Service Due timer to the service interval (250 hours) by pressing the left/light button (as indicated by the ➡ at the bottom of the screen) and then pressing the down button (as indicated by the Yes or ➡ at the bottom of the screen).

Counts provides access to the following information:

- **Engine Starts** identifies the number of times that the engine has been started.

Service Screen (continued)

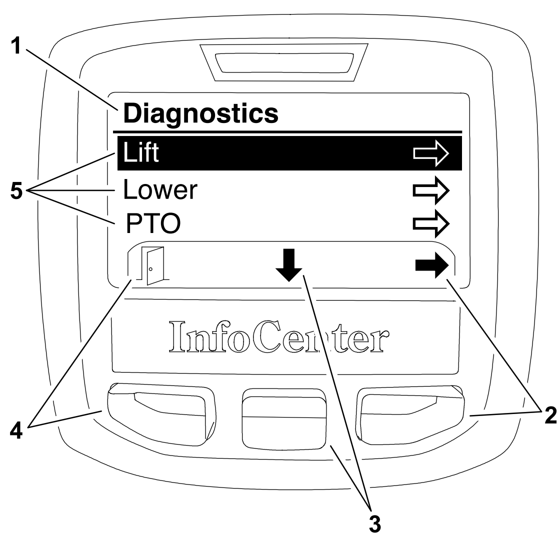
- **PTO Starts** identifies the number of times that the reel engage switch has been engaged.
- **Tap Offs**

DPF Regeneration (PIN required) allows the operator or technician to initiate a parked (stationary) diesel exhaust particulate filter (DPF) regeneration on machines with Yanmar Tier 4F compliant engines. The parked (stationary) regeneration icon will appear in the InfoCenter display and the engine power will be de-rated to 85% when a parked (stationary) regeneration is necessary. Do not continue to operate the machine in a normal manner when a parked (stationary) regeneration request appears. Perform a parked (stationary) regeneration as soon as possible; refer to the traction unit *Operator's Manual* for additional information and parked (stationary) regeneration procedures specific to your machine.

Move the machine to a well ventilated area and initiate a stationary DPF regeneration by pressing the left/right button (as indicated by the ➡ at the bottom of the screen) and then pressing the down button (as indicated by the Yes or ➡ at the bottom of the screen). Additional information can be found in the Yanmar Engine Service Manual.

DPF Ash (PIN required) DPF ash is the level of ash accumulated in the DPF (diesel-particulate filter) on the machines with Yanmar diesel engines. Ash is the byproduct of performing numerous regeneration operations. An engine fault will be generated if the ash accumulation exceeds 50 g/l. If excessive ash accumulation levels exist, DPF replacement may be necessary.

Diagnostics Screen



g189672

Figure 210

1. Diagnostics menu
2. Left/right button
3. Down button
4. Menu/back button
5. Diagnostics items

The diagnostics screen (Figure 210) lists a variety of machine operations and the current state of the Toro Electronic Controller (TEC) inputs, qualifiers, and outputs required to allow the operation to proceed. The diagnostics screen should be used to troubleshoot machine operation issues, and check that

Diagnostics Screen (continued)

necessary components and circuit wiring are functioning correctly (refer to Troubleshooting (page 7–26)). To scroll through the list of operations and select (highlight) the operation to be viewed, press the down button (as indicated by the ⬇ at the bottom of the screen).

To return to the previous screen, press the menu/back button (as indicated by the at the bottom of the screen).

For each of the diagnostics screen items, inputs, qualifiers, and outputs are identified. The diagnostics screen includes the following:

Lift identifies the machine requirements necessary to allow the TEC to raise the cutting units.

Inputs	Qualifiers	Outputs
Joystick Raise	Engine Running	Solenoid SV1
		Solenoid SV2
		Solenoid SV3
		Solenoid SVRV

Lower identifies the machine requirements necessary to allow the TEC to lower the cutting units.

Inputs	Qualifiers	Outputs
Joystick Lower	Low Range	Solenoid SV1
	Seat or P Brake	Solenoid SV3
		Solenoid SVRV

PTO identifies the requirements necessary to allow the TEC to engage the cutting units.

Inputs	Qualifiers	Outputs
Input	Joystick Lower OFF	Front MSV1
	Low Range	Rear MSV2
	In Seat	
	Engine Temp OK	
	Engine Running	
	Cutting Units Down	

Engine identifies the requirements necessary to allow the TEC to start and run the engine.

Note: The components for engine operation (i.e., glow plugs, starter) are controlled by the Yanmar engine ECU.

Inputs	Qualifiers	Outputs
Key Start	Key Run	ETR
	Neutral	Engine Start
	Joystick Lower OFF	
	Joystick Raise OFF	
	Seat or P Brake	
	Reel Engage Switch OFF	

Diagnostics Screen (continued)

Backlap identifies the requirements necessary to allow the TEC to engage the cutting units in the reverse direction for backlapping cutting units.

Inputs	Qualifiers	Outputs
Front Backlap	Neutral	Front MSV1
Rear Backlap	Parking Brake	Rear MSV2
Reel Engage Switch	Cutting Units Down	
	Engine Running	

Settings Screen

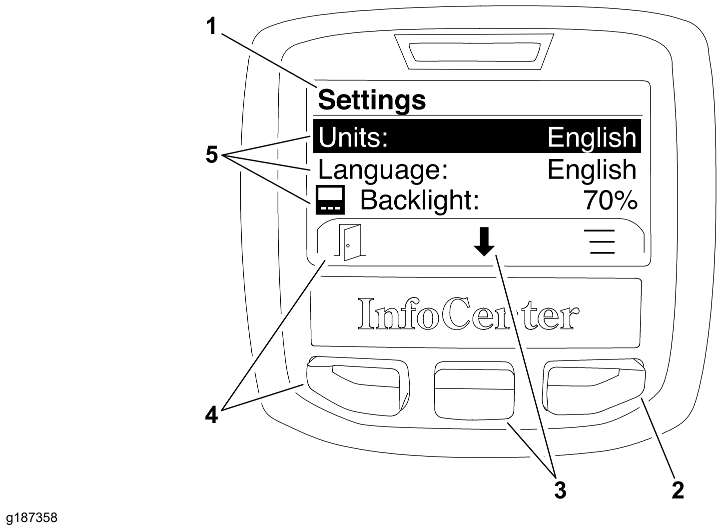
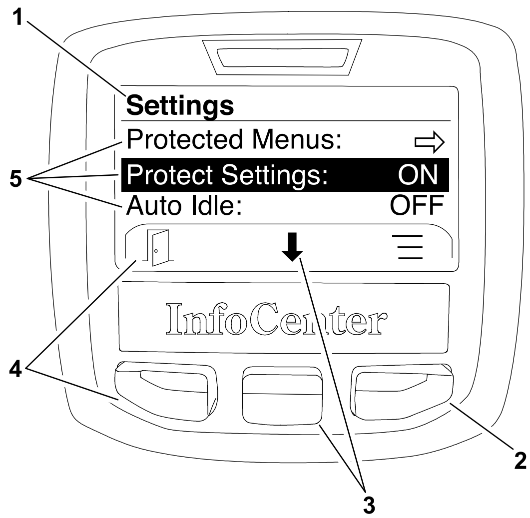


Figure 211

1. Settings menu
2. Left/right button
3. Down button
4. Menu/back button
5. Settings items

Settings Screen (continued)



g213685

Figure 212

1. Settings menu
2. Left/right button
3. Down button
4. Menu/back button
5. Settings items

The settings screen (Figure 211 and Figure 212) allows the operator or technician to customize the InfoCenter display, modify a variety of machine functions, and provides access to unlock various protected menus and settings. To scroll through the list of functions, view its current setting, and select (highlight) the setting to be modified, press the down button (as indicated by the ⬇ at the bottom of the screen).

To return to the previous screen, press the menu/back button (as indicated by the at the bottom of the screen).

Units: Use the left/right button (as indicated by the ☰ at the bottom of the screen) to select between metric or English units of measure. Allow the desired selection to remain in view for 5 seconds.

Language: Use the left/right button (as indicated by the ☰ at the bottom of the screen) to select from numerous language options. Allow the desired selection to remain in view for 5 seconds.

Backlight: Press the left/right button (as indicated by the ➡ at the bottom of the screen) then use the down button to decrease or the left/right button to increase the InfoCenter display brightness (as indicated by the – and the + at the bottom of the screen).

Contrast: Press the left/right button (as indicated by the ➡ at the bottom of the screen) then use the down button to decrease or the left/right button to increase the InfoCenter display contrast (as indicated by the – and the + at the bottom of the screen).

Protected Menus: Authorized individuals can enter the 4 digit passcode (PIN) to reveal the following service functions (refer to Faults Screen (page 7–16) and Service Screen (page 7–18)):

- Clear System Faults
- Service Reset

Settings Screen (continued)

- DPF Regeneration
- DPF Ash

Entering the correct PIN will also reveal and allow adjustment of various machine functions on the settings screen if Protect Settings is set to On (refer to the Protected Menus in the Settings Screen (page 7–21)).

Use the down button and left/right button (as indicated by the ⬇ and the ➡ at the bottom of the screen) to enter the 4 digit passcode (PIN). Once the correct PIN has been entered, press the down button (as indicated by the ✓ at the bottom of the screen). PIN will appear in the upper right hand corner of the InfoCenter display. The protected items will be visible as long as the key switch remains in the Run position.

To edit the passcode (PIN), enter the current PIN as previously described (PIN will appear in the upper right hand corner). Select Protected Menus again and use the down button and left/right button (as indicated by the ⬇ and the ➡ at the bottom of the screen) to enter a new 4 digit PIN. Press the down button to save the change (as indicated by the 🖫 at the bottom of the screen).

The initial PIN will either be 1234 or 0000. If the PIN has been changed and is forgotten, you can obtain a temporary PIN from your Toro distributor.

The following settings will only be visible if the Protect Settings is set to On and the correct passcode (PIN) has been entered, or Protect Settings is set to Off:

Note: To change the machine PIN, access the protected menu items by entering the current PIN. The InfoCenter display screen should indicate “PIN” in the upper right hand corner after the current PIN number is entered. Select the protected menu item again and note that “Edit PIN” is indicated on InfoCenter display screen. A new PIN can be entered and then saved.

Protect Settings: Use the left/right button (as indicated by the ☰ at the bottom of the screen) to select Off or On. When the Protect Settings is set to Off, the remaining settings will be visible and adjustable at all times. When the Protect Settings is set to On, the remaining settings will be visible and adjustable only after the correct passcode (PIN) has been entered (refer to the Protected Menus in the Settings Screen (page 7–21)).

Auto Idle: (Yanmar diesel or Kubota gasoline engines only) When the engine is running and the machine is in neutral, the engine will automatically return to the low idle setting after the set time delay. When the engine is running and the machine is not in neutral , the engine will automatically return to the high idle setting after the set time delay. Use the left/right button (as indicated by the ☰ at the bottom of the screen) to select 8, 10, 15, 20, or 30 seconds or the auto idle feature can be set to Off. Engine speed automatically returns to the previously set speed when either the traction pedal is moved from neutral or the joystick is moved to either raise or lower.

Settings Screen (continued)

Blade Count: The blade count setting should match the number of blades on the cutting unit reels installed on the machine. The blade count setting is used by the TEC to manage the cutting unit reel speed. Use the left/right button (as indicated by the ☰ at the bottom of the screen) to select 8 or 11. The fault indicator will illuminate and an operator advisory #176 (Reel Speed Changed) will appear on the InfoCenter display to confirm that the change has been recorded.

Mow Speed: The mow speed setting should match the current mow speed limiter setting on the machine. The mow speed setting is used by the TEC to manage the cutting unit reel speed. Press the left/right button (as indicated by the ☰ at the bottom of the screen) then use the down button to decrease or the left/right button to increase the mow speed in 0.8 kph (0.5 mph) increments. The fault indicator will illuminate and an operator advisory #176 (Reel Speed Changed) will appear on the InfoCenter display to confirm that the change has been recorded.

Height of Cut (HOC): The HOC (height of cut) setting should match the current cutting unit HOC. The HOC setting is used by the TEC to manage the cutting unit reel speed. Press the left/right button (as indicated by the ☰ at the bottom of the screen) then use the down button to decrease or the left/right button to increase the HOC in 1.59 mm (0.063 inch) increments. The fault indicator will illuminate and an operator advisory #176 (Reel Speed Changed) will appear on the InfoCenter display to confirm that the change has been recorded.

F Reel RPM: Initially, the front reel speed is set by the TEC based on the values entered for blade count, mow speed, and HOC. The front reel RPM can also be manually adjusted. Use the left/right button (as indicated by the ☰ at the bottom of the screen) to manually adjust the reel RPM. The fault indicator will illuminate and an operator advisory #176 (Reel Speed Changed) will appear on the InfoCenter display to confirm that the change has been recorded. The TEC calculated RPM is referenced by when reel RPM is manually set.

A manual RPM adjustment will remain active until the blade count, mow speed, or HOC setting is changed. When one of the cutting unit settings is changed, the reel RPM will return to the TEC calculated speed.

R Reel RPM: Initially, the rear reel speed is set by the TEC based on the values entered for blade count, mow speed, and HOC. The rear reel RPM can also be manually adjusted. Use the left/right button (as indicated by the ☰ at the bottom of the screen) to manually adjust the reel RPM. The fault indicator will illuminate and an operator advisory #176 (Reel Speed Changed) will appear on the InfoCenter display to confirm that the change has been recorded. The TEC calculated RPM is referenced by when reel RPM is manually set.

A manual RPM adjustment will remain active until the blade count, mow speed, or HOC setting is changed. When one of the cutting unit settings is changed, the reel RPM will return to the TEC calculated speed.

About Screen

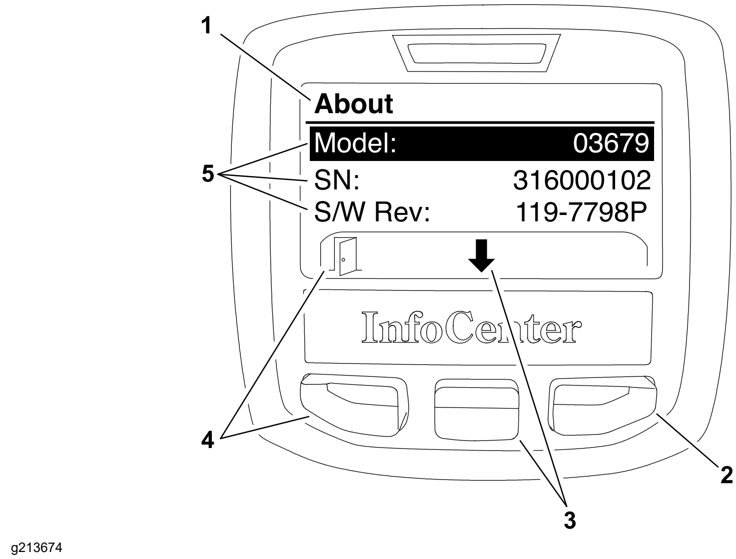


Figure 213

1. About menu
2. Left/right button
3. Down button
4. Menu/back button
5. About items

The about screen (Figure 213) identifies the machine model number, serial number, and software revision for the machine. If the correct passcode (PIN) has been entered (refer to the Protected Menus in the Settings Screen (page 7–21)), the InfoCenter software is displayed, and the CAN−bus status will be visible. Press the down button to scroll through the screen items (as indicated by the ⬇ at the bottom of the screen). The information found in the about screen can only be edited by your Toro Distributor.

To return to the previous screen, press the menu/back button (as indicated by the at the bottom of the screen).

Troubleshooting

⚠ CAUTION ⚠

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

For the effective troubleshooting and repairs, you must have a good understanding of the electrical circuits and components that are used on this machine; refer to the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1).

If the machine has any interlock switches that are bypassed, connect the switches for the correct troubleshooting and safety.

Note: Use the InfoCenter display when troubleshooting a Reelmaster electrical problem.

Operator Advisories

If controls are not selected properly to allow certain machine operations, the InfoCenter indicator light will illuminate and an advisory will be displayed on the InfoCenter display, refer to Operator Advisory Screen (page 7–13).

Advisory numbers, descriptions, and reason for advisories are listed in the Advisories Table (page 7–26). Some advisories can be caused by several machine settings.

Advisories Table

Advisory Number	Advisory Description	Possible Reason for Advisory
160	Inhibit start	Neither seat occupied nor parking brake applied Traction pedal is not in NEUTRAL position Wait to start until system functions have been initialized Joystick is in RAISE position Joystick is in LOWER position
161	Inhibit PTO	No operator in seat Engine coolant temperature is excessive
162	Inhibit cutting unit lower	Mow speed limiter is in TRANSPORT position
169	Engine shutdown	No operator in seat Parking brake is applied Engine coolant temperature is excessive Engine oil pressure is low
170	Recycle key switch	Engine starter motor has been engaged for 30 seconds

Operator Advisories (continued)

Advisories Table (continued)

Advisory Number	Advisory Description	Possible Reason for Advisory
171	Auto idle engaged	Engine RPM has been reduced to low idle speed as machine has been inactive for the set period of time. Inactive means the traction pedal is in the NEUTRAL, reel engage switch is in the DISENGAGED position, joystick is in the NEUTRAL position, and the engine speed switch is not pressed. Auto idle feature timing can be reduced, increased, or turned OFF as necessary.
173	Master Address Claim	Check the TEC and InfoCenter wire harness connections
176	Reel Speed Changed	Identifies that reel speed has been changed
177	Reel Speed Changed Out of Range	Check the reel settings (blade count, mow speed, and HOC) using the InfoCenter Settings screen.
178	Low fuel	Fuel level in the fuel tank is low
179	Ash cleaning warning	Excessive ash accumulated in DPF
180	New value saved in Permanent Memory	An item on the Settings screen has been changed
181	Regen related	

Advisory Qualifiers	Qualifiers Description
160	Engine is running
162	Version check restriction
163	Sit down or set parking brake
164	Machine not in neutral
171	Raise switch closed
172	Lower switch closed
173	Operator not in seat
174	High range engaged
176	Engine is overheating
179	Reel engage switch closed
184	Parking brake is set
188	Loss of CAN
189	Key start held too long
190	Safety shutdown
208	Recycle key switch

Using the InfoCenter Display for Troubleshooting

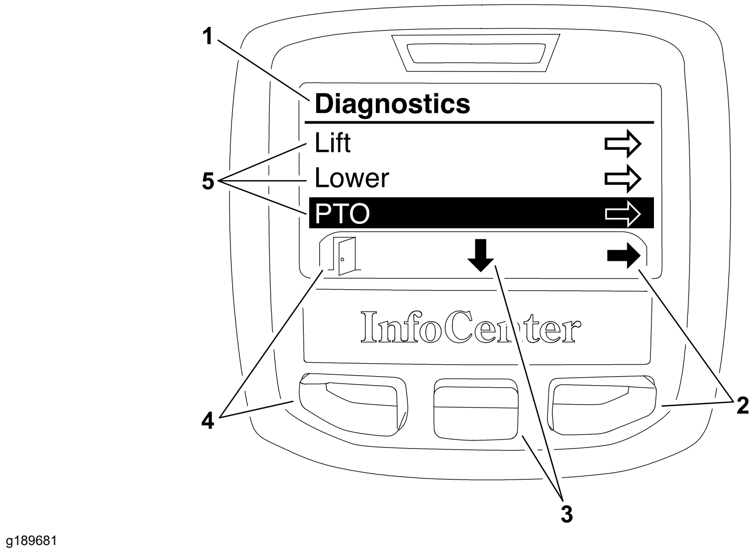


Figure 214

1. Diagnostics menu
2. Left/right button
3. Down button
4. Menu/back button
5. Diagnostics items

The diagnostics screen of the InfoCenter display can be very helpful when troubleshooting machine operation issues (refer to Diagnostics Screen (page 7–19)). The diagnostics screen (Figure 214) lists a variety of machine operations and the current state of the inputs, qualifiers, and outputs required to allow the operation to proceed. The electrical components involved in the following machine operations can be evaluated using the diagnostics screen prior to testing each component individually:

- **Lift** The components necessary to raise the cutting units.
- **Lower** The components necessary to lower the cutting units.
- **PTO** The components necessary to engage the cutting units.
- **Engine** The components necessary to start and run the engine.
- **Backlap** The components necessary to engage the cutting units in the reverse direction for backlapping.

If a machine operation is malfunctioning, the following procedure can help identify the cause of the component or circuit wiring causing the malfunction.

1. Park the machine on a level surface, lower the cutting units, set the parking brake, and shut off the engine.
2. Set the key switch to the ON position and navigate to the InfoCenter Diagnostic Screen.

Using the InfoCenter Display for Troubleshooting (continued)

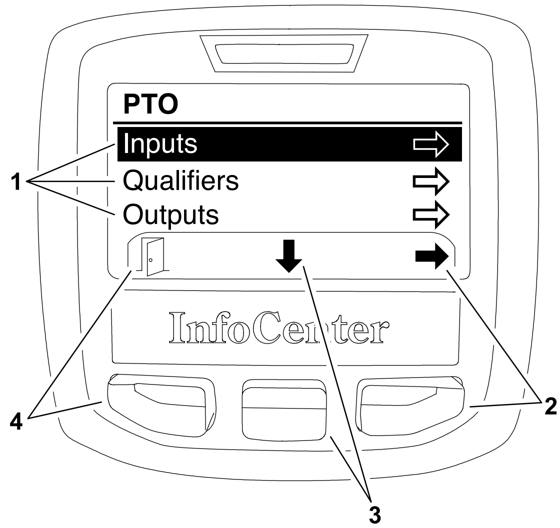


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Figure 215

1. Diagnostics items
2. Left/right button
3. Down button
4. Menu/back button

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3. Select (highlight) the malfunctioning machine operation and press the left/right button (as indicated by the ➡ at the bottom of the screen). For this example, the PTO operation has been selected (Figure 215).
4. Select (highlight) the Inputs and press the left/right button (as indicated by the ➡ at the bottom of the screen).

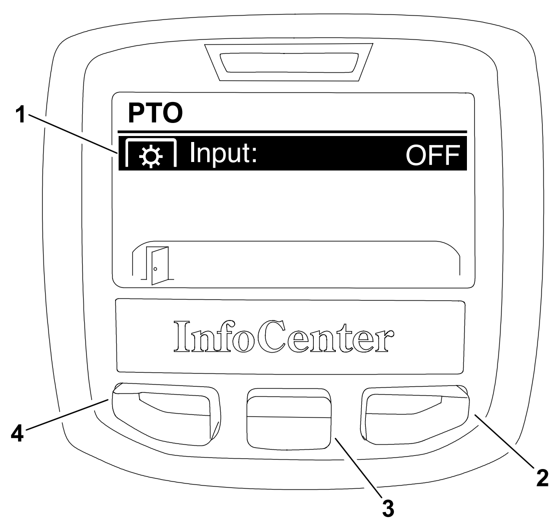

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Figure 216

1. Input items
2. Left/right button
3. Down button
4. Menu/back button

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5. Manually operate each input item listed (Figure 216). The input condition on the InfoCenter display should alternate ON and OFF as the input is switched open and closed. If ON and OFF do not alternate during input operation, the input component or its circuit wiring is damaged and should be tested; refer to Testing the Electrical Components (page 7–54).

Using the InfoCenter Display for Troubleshooting (continued)

In the PTO operation example, the only input is the reel engage switch. If ON and OFF do not alternate when the switch is moved back and forth from ENABLE to DISABLE, the switch or the circuit wiring for the switch is damaged and should be tested as described.

6. Press the menu/back button (as indicated by the at the bottom of the screen). Select (highlight) the Qualifiers and press the left/right button (as indicated by the ➡ at the bottom of the screen).

Note: All of the qualifiers for the machine operation must be in the desired condition (☑) before the operation Outputs can be energized.

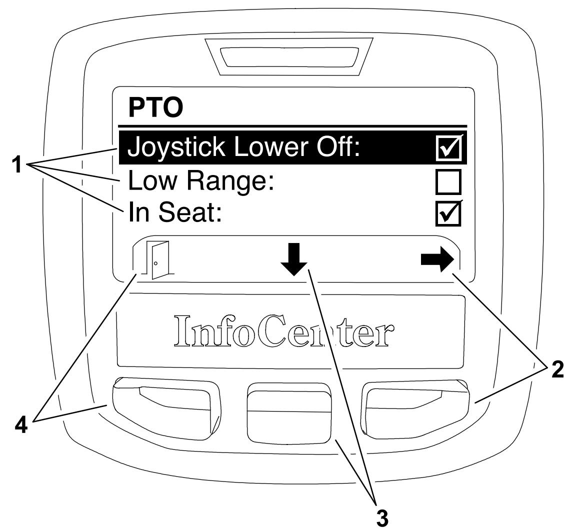

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Figure 217

1. Qualifier items
2. Left/right button
3. Down button
4. Menu/back button

7. Manually operate each qualifier listed (Figure 217). The qualifier condition on the InfoCenter display should alternate ☑ and ☐ as the qualifiers condition is changed. If ☑ and ☐ do not alternate during qualifier operation, the qualifier component or its circuit wiring is damaged and should be tested; refer to Testing the Electrical Components (page 7–54).

CAUTION

It may be necessary to start and run the engine, raise and lower the cutting units, or otherwise operate the machine during the troubleshooting process.

Ensure that the machine is in a well ventilated area and keep your hands and feet away from the cutting units and moving parts while troubleshooting to prevent personal injury.

In the PTO operation example, the following qualifiers must be in the desired condition (☑) before any operation Outputs can be energized:

- Joystick lower off
- Mow/transport switch in LOW (mow) range
- Operator must be in seat (seat switch)

Using the InfoCenter Display for Troubleshooting (continued)

- Engine temperature is ok
- Engine must be running

  Engine RPM above 800 as reported by engine ECU

- Cutting units must be lowered below turn-around position (cutting unit down limit switch)

If ☑ and ☐ do not alternate when the qualifier condition is changed, the qualifier or the circuit wiring for the qualifier is damaged and should be tested as described.

8. Press the menu/back button (as indicated by the at the bottom of the screen). Select (highlight) the Outputs and press the left/right button (as indicated by the ➡ at the bottom of the screen).

9. If all the Inputs are ON and all the Qualifiers are in their desired condition (☑), the Outputs for the machine operation should be ON. If the outputs remain OFF, the Toro Electronic Controller (TEC) or TEC software may be damaged and require reloading or replacement. Contact your Toro Distributor for assistance.

10. If the outputs listed on the InfoCenter display are ON, and the operation is still malfunctioning:

    - Test the specific output and output wiring; refer to Testing the Electrical Components (page 7–54).
    - Test the hydraulic components related to the operation; refer to Chapter 6: Hydraulic System (page 6–1).

    In the PTO operation example, the outputs are the front MSV1 and rear MSV2 solenoid valves. If ON appears next to these outputs on the InfoCenter display:

    - Test the hydraulic solenoid valve coils; refer to Hydraulic Solenoid Valve Coils (page 7–95).
    - Perform the cutting unit hydraulic circuit tests; refer to Chapter 6: Hydraulic System (page 6–1).

Machine Faults

The Machine Fault Table (page 7–33) identifies the fault codes that are generated by the Toro Electronic Controller (TEC) to identify an electrical system fault (malfunction) that occurred during the operation of the machine. Use the InfoCenter display to view faults that have occurred since the faults were last cleared from the InfoCenter; refer to Faults Screen (page 7–16).

The Yanmar engine ECU can also generate electrical faults. The faults generated by the ECU are specific to the engine; refer to Engine Faults (page 7–35).

Note: Fault codes identify electrical problems that typically will prevent normal machine operation. For fault codes that identify problems with TEC inputs (e.g., switches, sensors), use the InfoCenter display to check the different switch positions before removing or replacing the component. Fault codes that identify problems with TEC outputs (e.g., solenoid coils) might involve issues with the wire harness or the actual output device.

Using Machine Faults

If an electrical fault is identified by the machine controllers (TEC and cutting unit motors), the InfoCenter display will identify the fault code number and when the fault occurred. An electrical fault can cause disruption in how the machine functions but in some instances, the fault may occur with little, if any, change in machine operation. The following suggestions should be considered when using fault codes that are displayed.

- If a fault code is displayed on the InfoCenter and machine operation remains normal, continue to use the machine. The fault code number can be retrieved in the future by using the InfoCenter faults screen.
- If a fault code is displayed on the InfoCenter and machine operation has changed, move the machine to a level surface, disengage the cutting units, and turn the key switch to the OFF position. Leave the switch in the OFF position for 30 seconds and then start the machine. During this system reboot process, the machine controllers often can reset the electrical components to allow normal machine operation. Assuming that the fault code is no longer displayed, continue to use the machine. The fault code number can be retrieved in the future by using the InfoCenter faults screen.
- There is the possibility that an electrical issue can result with several fault codes being generated. For example, a broken wire or damaged fuse would prevent operation of a cutting unit motor and multiple fault codes could be displayed. Reviewing the fault code descriptions should suggest possible causes for the circuit problem. Using the electrical schematic and electrical wire harness drawings will also help in problem diagnosis.
- The InfoCenter will display fault code numbers as an indication that the machine electrical system has experienced an unusual change that might be very minor resulting in no change of the machine operation or more severe which could prevent machine use. Use the fault codes in conjunction with noting what machine operations have changed, when did the change occur, and whether the problem occurs all the time or is intermittent to help identify the source of a machine problem.
- The InfoCenter faults screen can be used to list all machine electrical faults that have occurred since the faults were last cleared from the InfoCenter. If a fault that is listed on the InfoCenter faults screen occurred at some point in the distant past and has not reoccurred, that fault is likely not causing a current machine problem. Recurring faults may indicate a problem with a particular circuit or component.
- When machine electrical issues occur and fault codes have been displayed on the InfoCenter display, consider contacting your Toro Distributor for additional assistance.

Using Machine Faults (continued)

The Machine Fault Table (page 7–33) identifies the fault codes that are generated by the TEC to identify an electrical system malfunction (fault) that occurred during machine operation. Use the InfoCenter Display for fault retrieval.

Note: The following list of fault codes identifies electrical problems that typically will prevent normal machine operation. The InfoCenter Display will identify existing faults if they should occur. Fault codes 13 through 24 identify problems with inputs (e.g., switches, sensors) to the TEC. For input problems, use the InfoCenter Display to check the different switch positions before removing or replacing the component.

Note: Fault codes 26 through 58 identify problems with outputs (e.g., solenoid coils, light bulbs) from the TEC. These output problems might involve issues with the wire harness or the actual output device (solenoid coil or bulb).

Note: If an electrical engine fault occurs during machine operation, the fault will be displayed on the InfoCenter to notify the operator. The engine fault will be retained in the engine ECU and can be viewed using the engine diagnostic tool by your Toro Distributor. Engine faults are not stored in the TEC so they cannot be viewed using the InfoCenter Faults Screen.

Machine Fault Table

Fault Code	Fault Description	Service Suggestions
1	Excessive engine coolant temperature (above 105°C) caused PTO to disengage	Check the radiator and screen for debris buildup Check the engine cooling fan and drive belt Check the engine coolant level
2	Excessive engine coolant temperature (above 115°C) caused engine to stop	Check the radiator and screen for debris buildup Check the engine cooling fan and drive belt Check the engine coolant level
3	One of the TEC output fuses (7.5 A) is damaged	Check the TEC output fuses
4	IPE voltage is low indicating that the TEC fuses or TEC is damaged	Check the TEC fuses Consider that the TEC is damaged
5	Main power relay is damaged	Check the main power relay and circuit wiring
6	The key switch was held in the START position for more than 30 seconds or the key switch is damaged	Cycle the key switch Check the fuel level in the fuel tank Check the key switch and circuit wiring Check the fuel pump and circuit wiring Check engine run solenoid and circuit wiring (machines with Kubota diesel engine)
7	TEC software needs to be reprogrammed	Contact Toro Distributor for reprogramming assistance
8	Engine alternator charging is too high	Check the engine alternator

Using Machine Faults (continued)

Machine Fault Table (continued)

Fault Code	Fault Description	Service Suggestions
9	Engine alternator charging is too low	Check the alternator drive belt Check the engine alternator and circuit wiring
10	Engine has not been seen on the CAN-bus for 10 seconds (machines with Yanmar diesel or Kubota gasoline engine)	Check CAN-bus connection to engine ECU Verify battery power exists at engine ECU Check CAN-bus terminator resistors
12	InfoCenter has not been seen on the CAN-bus for 1 second	Check CAN-bus connection to InfoCenter Display Verify battery power exists at InfoCenter Display Check CAN-bus terminator resistors
13	Key switch is damaged	Check the switch and circuit wiring
15	Engine speed switch is damaged (machines with Yanmar diesel or Kubota gasoline engine)	Check the control arm engine speed switch and circuit wiring
19	Engine coolant temperature sensor circuit has open or short	Check the engine coolant sensor and circuit wiring
24	Joystick raise and lower switches closed at same time	Check the joystick switches and circuit wiring
26	TEC output current to energize start relay is excessive	Check the start relay and circuit wiring
27	TEC output current to fuel pump is excessive	Check the fuel pump and circuit wiring
37	TEC output current to energize glow relay is excessive	Check the glow relay and circuit wiring
53	TEC output current for hydraulic solenoid coil SV1 is excessive	Check the lift control manifold solenoid coil SV1 and circuit wiring
54	TEC output current for hydraulic solenoid coil SV2 is excessive	Check the lift control manifold solenoid coil SV2 and circuit wiring
55	TEC output current for hydraulic solenoid coil SV3 is excessive	Check the lift control manifold solenoid coil SV3 and circuit wiring
56	TEC output current for hydraulic solenoid coil SVRV is excessive	Check the lift control manifold solenoid coil SVRV and circuit wiring
57	TEC output current for hydraulic solenoid coil MSV1 is excessive	Check the mow control manifold solenoid coil MSV1 and circuit wiring
58	TEC output current for hydraulic solenoid coil MSV2 is excessive	Check the mow control manifold solenoid coil MSV2 and circuit wiring
68	Alternator not charging	Check the engine alternator and circuit wiring
69	Low engine oil pressure	Check the engine oil pressure switch and circuit wiring

Engine Faults

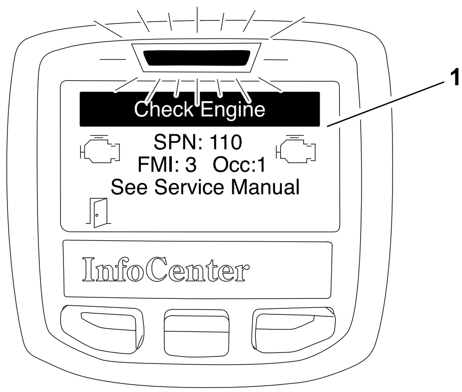

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Figure 218

1. Engine fault (Yanmar diesel engine)

The engine faults are generated by the Yanmar engine ECU to identify an electrical system malfunction (fault) pertaining to the engine during operation. When an engine fault occurs, the fault indicator will flash and the InfoCenter will display information about the fault. The number of flashes and/or the flashing pattern vary depending on the type or source of the fault, enabling quick-fix. Depending on the severity of the fault, a Stop icon may display as well.

The Toro Electronic Controllers (TECs) can also generate electrical faults. The faults generated by the TECs are specific to the machine; refer to Machine Faults (page 7–32).

If an engine fault occurs:

1. The engine fault information will be displayed on the InfoCenter (Figure 218).
2. If a Stop fault is displayed on the InfoCenter, the operator should cease operation of the machine and the engine as quickly and as safely as possible to reduce damage to the engine.
3. If a Check Engine fault is displayed on the InfoCenter, the operator should take the machine for service as soon as possible.
4. Return to the previous screen by pressing the menu/back button (as indicated by the  at the bottom of the screen).

The engine fault will continue to appear until the fault is cleared. In order to clear the displayed fault, the engine problem has to be resolved. Refer to the Yanmar Engine Service Manual and Troubleshooting Manual for additional information.

Note: The engine faults that are no longer active are stored in the Yanmar engine ECU and can only be viewed by using the engine diagnostic tool. Contact your Toro distributor for any assistance in the Yanmar engine troubleshooting.

Engine Faults (continued)

Starting Problems

Problem	Possible Causes
All the electrical power is dead, including the InfoCenter display.	• The battery is discharged or damaged. • The battery cables are loose or corroded. • The fuse F1-1 (15 A) or F1-2 (10 A) is damaged. • The ground connection is loose or corroded. • The key switch or circuit wiring is damaged. • The in-line main power supply fuse (25 A) is damaged (machine with gasoline engine). • The fusible link harness at the engine starter motor is damaged (machine with diesel engine).
The starter solenoid clicks, but the starter does not crank. **Note:** If the starter solenoid clicks, the problem is not in the interlock circuit.	• The battery charge is low. • The battery is discharged or damaged. • The battery cables are loose or corroded. • The ground connection is loose or corroded. • The wiring at the starter motor is damaged. • The starter solenoid or starter motor is damaged.
The engine cranks, but does not start. **Note:** After 30 seconds of engine cranking, the Toro Electronic Controller (TEC) output to the engine starter motor will de-energize even if the key switch is kept in the START position. This is designed to prevent overheating of the starter motor.	• The fuel tank is empty. • The fuel filter is plugged. • The wiring in the engine crank circuit is loose, corroded, or damaged; refer to the Electrical Schematic in Appendix A (page A–1). • The engine and/or fuel can be too cold. • The engine fuel pump or circuit wiring is damaged. • The engine glow plug circuit does not operate properly. • The engine fuel stop solenoid or circuit wiring is damaged (machine with diesel engine). • The engine or fuel system is malfunctioning; refer to Chapter 3: Kubota Diesel Engine (page 3–1), Chapter 4: Yanmar Diesel Engine (page 4–1), or Chapter 5: Kubota Gasoline Engine (page 5–1). • The hydraulic load is slowing engine cranking speed (disconnect the hydraulic pump driveshaft from the engine to test).

Engine Faults (continued)

Starting Problems (continued)

Problem	Possible Causes
The glow plug circuit does not operate properly.	• The wiring in the engine glow circuit is loose, corroded, or damaged; refer to the Electrical Schematic in Appendix A (page A–1). • The engine glow plugs are damaged. • The glow relay is damaged. • The fusible link harness at the engine starter motor is damaged. • The TEC fuses are damaged. • The TEC is damaged.
The engine cranks, but should not, when the traction pedal is pressed.	• The traction neutral switch is out of adjustment. • The traction neutral switch or circuit wiring is damaged.
The engine starts, but stops when the key switch is released from the START position (machine with diesel engine).	• Engine fuel stop solenoid or circuit wiring is damaged (pull coil operates but hold coil is damaged). • Engine or fuel system is malfunctioning; refer to Chapter 3: Kubota Diesel Engine (page 3–1) or Chapter 4: Yanmar Diesel Engine (page 4–1). • The key switch is damaged.

Engine Faults (continued)

Starting Problems (continued)

Problem	Possible Causes
Nothing happens when you attempt to start the engine. The InfoCenter display operates with the key switch in the RUN position. **Note:** An operator advisory is displayed on the InfoCenter if the interlock switches for engine start are not functioning. Use the InfoCenter display to assist with identifying the problem.	• The traction pedal is not in the NEUTRAL position. • The operator seat is unoccupied or the parking brake is not applied. • The cutting units are engaged (the reel engage switch is in the ON position or it is damaged). • The joystick is not in the center position. • The battery is discharged or damaged. • The battery cables are loose or corroded. • The ground connection is loose or corroded. • The traction neutral switch is out of adjustment. • The traction neutral switch or circuit wiring is damaged. • The seat switch or circuit wiring is damaged. • The parking brake switch or circuit wiring is damaged. • The joystick switch or circuit wiring is damaged. • The key switch or circuit wiring is damaged. • The start relay or circuit wiring is damaged. • The main power relay or circuit wiring is damaged (headlights and power point inoperative as well). • The TEC fuses (in-line 2 A or fuse block 7.5 A) are damaged. • The fusible link at battery is open (machine with diesel engine). • The fusible link harness at the engine starter motor is damaged. • The wiring to start circuit components is loose, corroded, or damaged; refer to the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1). • The starter solenoid is damaged. • The temperature sender or circuit wiring is damaged. • The TEC is damaged. • The starter motor is damaged. • The engine ECU or circuit wiring is damaged.

General Run and Transport Problems

Problem	Possible Causes
The engine continues to run, but should not, when the key switch is turned to the OFF position.	• The engine fuel stop solenoid is damaged (machine with diesel engine). • The key switch or circuit wiring is damaged. • The main power relay or circuit wiring is damaged. • The engine or fuel system is malfunctioning; refer to Chapter 4: Yanmar Diesel Engine (page 4–1).
The engine continues to run, but should not, when the traction pedal is engaged with no operator in the seat.	• The seat switch or circuit wiring is damaged. • The TEC fuses (in-line 2 A or fuse block 7.5 A) are damaged. • The traction neutral switch is out of adjustment. • The traction neutral switch or circuit wiring is damaged. • The TEC is damaged.
The engine shuts off during the operation, but it is able to start again. **Note:** Excessive coolant temperature will cause the cutting units to be disengaged and can cause the engine to shutdown. If the excessive engine coolant temperature causes the engine to shutdown, the operator can start the engine by moving the machine to a short distance. After starting the engine in this condition, the engine runs for approximately 10 seconds before it shuts off again.	• The parking brake is engaged. • The operator is raising from the seat (the seat switch is not fully pressed). • The seat switch or circuit wiring is damaged. • The temperature sender or circuit wiring is damaged. • The key switch or circuit wiring is damaged. • The engine coolant temperature is excessive (above 115°C/240°F). • The machine is being operated on a slope with a low fuel level. • The engine or fuel system is malfunctioning; refer to Chapter 4: Yanmar Diesel Engine (page 4–1).

General Run and Transport Problems (continued)

Problem	Possible Causes
The engine shuts off when the traction pedal is pressed. **Note:** If the machine controls are not in the correct position for operating the machine (e.g., the parking brake is engaged), an advisory message may be displayed on the InfoCenter display.	• The parking brake is engaged. • The operator is not fully pressing the seat switch. • The seat switch or circuit wiring is damaged. • The key switch or circuit wiring is damaged. • The engine coolant temperature is excessive. • The machine is operated on a slope with a low fuel level. • The TEC fuses (in-line 2 A or fuse block 7.5 A) are damaged. • The TEC is damaged.
The battery does not charge.	• A loose, corroded, or broken wires exist in the charging circuit; refer to the Electrical Schematic in Appendix A (page A–1). • The engine alternator belt is loose or damaged. • The battery cables are loose or corroded. • The fusible link connecting the engine starter motor is damaged (machine with diesel engine). • The alternator is damaged. • The battery is damaged.

Cutting Unit Operating Problems

Problem	Possible Causes
The cutting units remain engaged, but should not, with no operator in the seat.	• The seat switch or circuit wiring is damaged. • The TEC is damaged.
The cutting units run, but should not, when raised. The cutting units shut off with the reel engage switch.	• The cutting unit down limit switch or circuit wiring is damaged. • A hydraulic problem in the cutting unit circuit exists; refer to Troubleshooting (page 6–50). • The TEC is damaged.
The cutting units run, but should not, when raised. The cutting units do not shut off with the reel engage switch.	• Both the cutting unit down limit switch (or circuit wiring) and reel engage switch (or circuit wiring) is damaged. • A hydraulic problem in the cutting unit circuit exists; refer to Troubleshooting (page 6–50). • The TEC is damaged.

General Run and Transport Problems (continued)

Cutting Unit Operating Problems (continued)

Problem	Possible Causes
None of the cutting units operate. Cutting units are able to raise and lower. **Note:** For cutting unit operation, the operator seat needs to be occupied, mow speed limiter needs to be in MOW position, cutting units need to be fully lowered, and the reel engage switch needs to be engaged.	• The reel engage switch is in the OFF position. • The operator seat is unoccupied. • High coolant temperature has disabled the cutting units. • The seat switch or circuit wiring is damaged. • The reel engage switch or circuit wiring is damaged. • The cutting unit down limit switch or circuit wiring is damaged. • The mow/transport switch or circuit wiring is damaged. • The temperature sender or circuit wiring is damaged. • The circuit wiring to the hydraulic solenoids may be damaged. • A hydraulic problem in the cutting unit circuit exists; refer to Troubleshooting (page 6–50). • The TEC is damaged.
The cutting units run, but should not, when lowered with joystick and the reel engage switch in the OFF position.	• The reel engage switch or circuit wiring is damaged. • The TEC is damaged.
The front cutting units do not operate in either direction (mow or backlap). The rear cutting units operate. The cutting units are able to raise and lower.	• The mow control manifold MSV2 solenoid coil or circuit wiring is damaged. • A hydraulic problem in the front mow circuit exists; refer to Troubleshooting (page 6–50). • The TEC is damaged.
The rear cutting units do not operate in either direction (mow or backlap). The front cutting units operate. The cutting units are able to raise and lower.	• The mow control manifold MSV1 solenoid coil or circuit wiring is damaged. • A hydraulic problem in the rear mow circuit exists; refer to Troubleshooting (page 6–50). • The TEC is damaged.

General Run and Transport Problems (continued)

Cutting Unit Operating Problems (continued)

Problem	Possible Causes
The cutting units do not run when placed in the backlap direction.	• The parking brake is not applied. • The reel engage switch is in the OFF position. • The cutting units are not fully lowered to ground. • The joystick is not in the center position. • High engine coolant temperature has disabled cutting unit operation. • The front or rear backlap switch or circuit wiring is damaged. • The cutting unit down limit switch or circuit wiring is damaged. • A hydraulic problem in the cutting unit circuit exists; refer to Troubleshooting (page 6–50).
The cutting units do not backlap, but run in the forward direction instead.	• A hydraulic problem in the cutting unit circuit exists; refer to Troubleshooting (page 6–50).

General Run and Transport Problems (continued)

Cutting Unit Lift/Lower Problems

Problem	Possible Causes
None of the cutting units will lower.	• The seat switch or circuit wiring is damaged. • The mow speed limiter is in the TRANSPORT position. • The lower/mow switch on the joystick or circuit wiring is damaged. • The mow/transport switch or circuit wiring is damaged. • The lift control manifold SVRV solenoid coil or circuit wiring is damaged. • The lift control manifold SV2 solenoid coil or circuit wiring is damaged. • A hydraulic problem in the cutting unit lift/lower circuit exists; refer to Troubleshooting (page 6–50). • The TEC is damaged.
None of the cutting units will raise.	• The front and/or rear backlap levers are in backlap position. • The seat switch or circuit wiring is damaged. • The raise switch on the joystick or circuit wiring is damaged. • The front and/or rear backlap switch or circuit wiring is damaged. • The lift control manifold SVRV solenoid coil or circuit wiring is damaged. • The lift control manifold SV2 solenoid coil or circuit wiring is damaged. • A hydraulic problem in the cutting unit lift/lower circuit exists; refer to Troubleshooting (page 6–50). • The TEC is damaged.
The front cutting units will not raise or lower, but the rear cutting units will raise and lower.	• The lift control manifold solenoid SV1 or circuit wiring is damaged. • A hydraulic problem in the cutting unit lift/lower circuit exists; refer to Troubleshooting (page 6–50).
The rear cutting units will not raise or lower, but the front cutting units will raise and lower.	• The lift control manifold solenoid SV3 or circuit wiring is damaged. • A hydraulic problem in the cutting unit lift/lower circuit exists; refer to Troubleshooting (page 6–50).
One cutting unit (either front or rear) will not raise or lower, but all other cutting units will raise and lower.	• Binding of lift cylinder or lift components for affected cutting unit exists. • A hydraulic problem in the cutting unit lift/lower circuit exists; refer to Troubleshooting (page 6–50). • The TEC is damaged.

Electrical System Quick Checks

Testing the Battery (Open Circuit Test)

Use a multimeter to measure the voltage between the battery terminals; refer to Battery Test Table (page 7–44).

Set the multimeter to the DC volts settings. The battery must be at a temperature of 16°C to 38°C (60°F to 100°F). Ensure that the key switch is in the OFF position and all the accessories are turned off.

Connect the positive (+) multimeter lead to the positive battery post and negative (-) multimeter lead to the negative battery post.

Measure and record the battery voltage. Use the Battery Test Table (page 7–44) to determine charge level of the battery.

Note: This test provides a relative condition of the battery. The load testing of the battery provides additional and more accurate information; refer to Servicing the Battery (page 7–125).

Battery Test Table

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

Testing the Charging System

This is a simple test that determines if a charging system is functioning. It tells you if the charging system has an output, but not its capacity.

Note: The InfoCenter display can be used to identify battery voltage during the operation of the machine.

Tool required: Digital multimeter set to DC volts.

Test instructions: Connect the positive (+) multimeter lead to the positive battery post and negative (-) multimeter lead to the negative battery post. Keep the test leads connected to the battery posts and record the battery voltage.

Note: When starting the engine, the battery voltage drops and then must increase once the engine is running.

Note: Depending upon the condition of the battery charge and battery temperature, the battery voltage increases at different rates as the battery charges.

Start the engine and run it at high-idle speed **(3,005 to 3,055 rpm)**. Allow the battery to charge for a minimum time of 3 minutes. Record the battery voltage.

Note: After running the engine for a minimum time of 3 minutes, the battery voltage must be minimum 0.50 V higher than that of the initial battery voltage.

Refer to the Battery Voltage Table (page 7–45) for an example of a charging system that is functioning.

Testing the Charging System (continued)

Battery Voltage Table

At least 0.50 V over the initial battery voltage.	
Initial battery voltage	= 12.30 V
Battery voltage after 3 minutes charge	= 12.85 V
Difference	= +0.55 V

Testing the Glow Plug System (Machines with Kubota Diesel Engine)

This is a fast, simple test that can help to determine the integrity and operation of your Reelmaster glow plug system used on a Kubota diesel engine. 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 manufacturer's instructions) and set the multimeter to the correct scale. With the key 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 key switch to ON/RUN and record the multimeter results.

The Reelmaster glow plug system should have a reading of approximately 9 A per glow plug (27 A total on Reelmaster 5210 and 36 A total on models with 4 cylinder engine). If low current reading is observed, 1 (or more) glow plugs is damaged.

Checking the Operation of the Interlock Switches

⚠ CAUTION ⚠

Do not disconnect the safety switches. They are for the operator's protection.

Check the operation of the interlock switches daily for proper operation.

Replace any malfunctioning switches before operating the machine.

Your Reelmaster is equipped with a Toro Electronic Controller (TEC) which monitor interlock switch operation. If all of the interlock switches necessary to allow a specific machine operation are not in their desired position, an Operator's Advisory will appear on the InfoCenter display; refer to Operator Advisories (page 7–26).

The interlock system used on your Reelmaster includes the key switch, seat switch, traction neutral switch, parking brake switch, reels down switch, mow/transport switch, reel engage switch, and 2 cutting unit backlap switches. Testing of individual interlock switches is included in Testing the Electrical Components (page 7–54).

Note: Use the InfoCenter display to test the Toro Electronic Controller inputs and outputs before further troubleshooting of an electrical problem on your Reelmaster.

Adjustments

Traction Neutral Switch

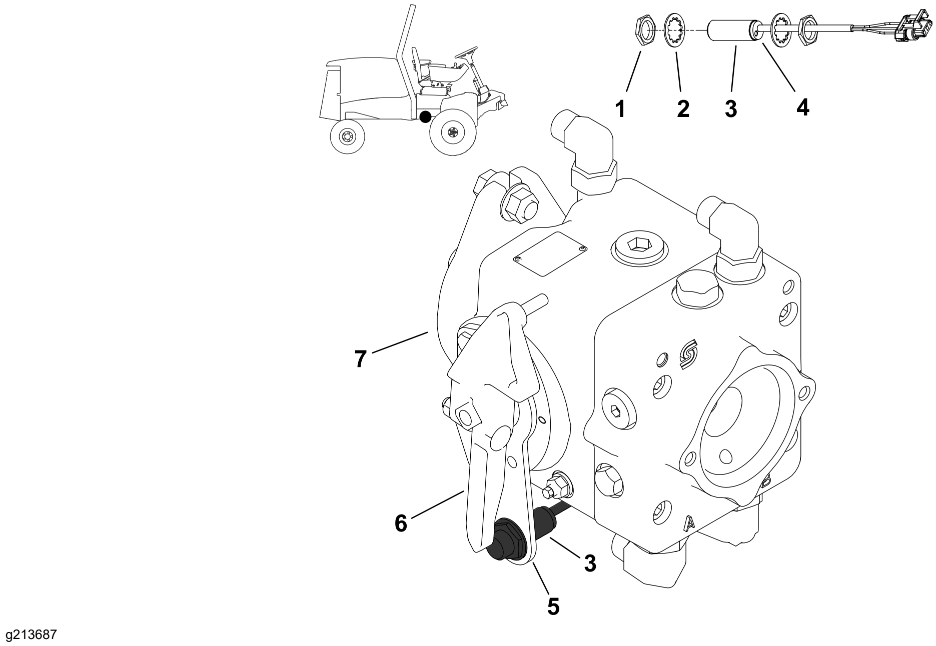


Figure 219

1. Jam nut (2 each)
2. Lock washer (2 each)
3. Traction neutral switch
4. Switch LED location
5. Pump plate
6. Pump lever
7. Traction pump

The traction neutral switch is a normally open proximity switch that closes when the traction pedal is in the NEUTRAL position. The switch mounts to a pump plate on the traction pump (Figure 219). The sensing plate for the traction neutral switch is the pump lever that is secured to the traction pump.

Adjusting the Traction Neutral Switch

1. Before adjusting the traction neutral switch, check and adjust the traction system neutral position; refer to the *Traction Unit Operator's Manual*.

IMPORTANT

To prevent the traction neutral switch damage, ensure that no components contact switch through entire traction pump control arm movement.

2. Park the machine on a level surface, set the parking brake, lower the cutting units, shut off the engine, and remove the key from the key switch.

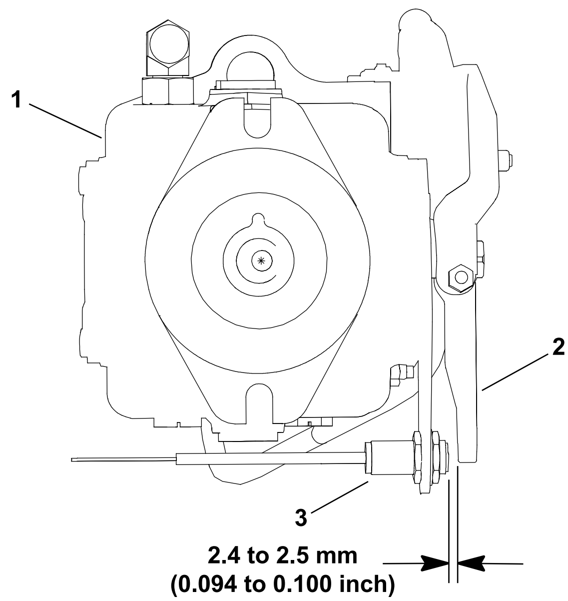


Figure 220

1. Traction pump
2. Pump lever
3. Traction neutral switch

3. When the traction pedal is in the NEUTRAL position, the gap between the head of the neutral switch and the pump lever should be **2.4 to 2.5 mm (0.094 to 0.100 inch)** (Figure 220).
4. If gap is incorrect, loosen the jam nuts that secure the neutral switch to the pump plate. Position the switch with jam nuts to allow correct gap between the switch and the pump lever. Torque the jam nuts to **18.4 to 22.4 N·m (162 to 198 in-lb)**. After the jam nuts are tightened, ensure that clearance between the head of the neutral switch and the pump plate has not changed.
5. After adjustment to the traction neutral switch, use the InfoCenter display to verify that the traction neutral switch and circuit wiring are functioning correctly; refer to Using the InfoCenter Display for Troubleshooting (page 7–28).

Parking Brake Switch

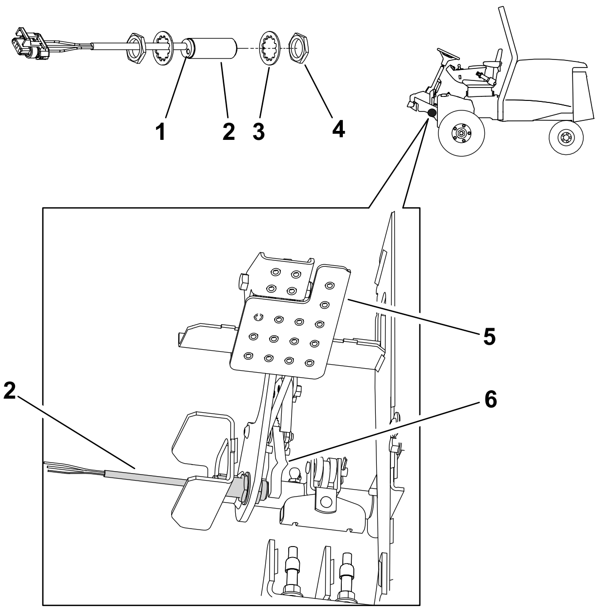


Figure 221

1.	Switch LED location	3.	Lock washer (2 each)	5.	Brake pedal
2.	Parking brake switch	4.	Jam nut (2 each)	6.	Parking brake detent

The parking brake switch is a normally open proximity switch. The parking brake switch is attached to the bottom of the brake pedal (Figure 221).

When the parking brake is not set, the parking brake detent is positioned near the target end of the parking brake switch so that the switch is closed. The parking brake detent is moved away from the switch when the parking brake is set causing the switch to open.

Adjusting the Parking Brake Switch

IMPORTANT

To prevent the parking brake switch damage, ensure that no components contact switch through entire brake pedal movement.

1. Park the machine on a level surface, set the parking brake, lower the cutting units, shut off the engine, and remove the key from the key switch.

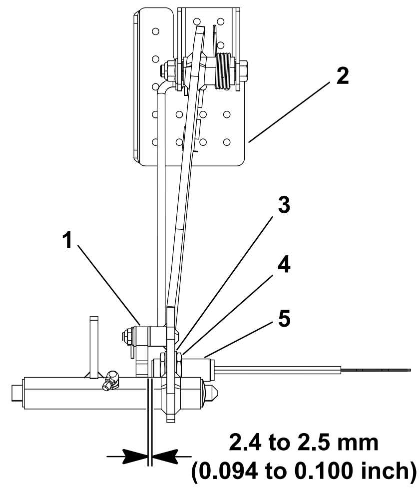


Figure 222

1. Parking brake detent
2. Brake pedal
3. Lock washer (2 each)
4. Jam nut (2 each)
5. Parking brake switch

2. When the parking brake is not set, the gap between the parking brake switch and the tab on the parking brake detent should be **2.4 to 2.5 mm (0.094 to 0.100 inch)** (Figure 222).
3. If gap is incorrect, loosen the jam nuts that secure the switch to the brake pedal. Position the switch with jam nuts to allow correct gap between the switch and the detent tab. Tighten the jam nuts to secure the adjustment. Torque the jam nuts to **18.4 to 22.4 N·m (162 to 198 in-lb)**. After the jam nuts are tightened, ensure that clearance between the head of the parking brake switch and the tab on the parking brake detent has not changed.
4. After adjustment to the parking brake switch, use the InfoCenter display to verify that the parking brake switch and circuit wiring are functioning correctly; refer to Using the InfoCenter Display for Troubleshooting (page 7–28).

Cutting Unit Down Limit Switch

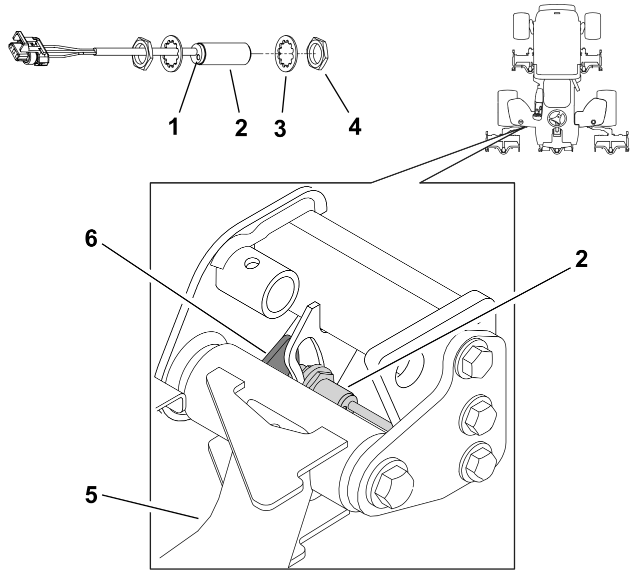


Figure 223

1. Switch LED location
2. Down limit switch
3. Lock washer (2 each)
4. Jam nut (2 each)
5. Lift arm
6. Bracket

The cutting unit down limit switch is a normally open proximity switch that closes when the front, outside cutting units are in the turn-around position. The down limit switch is attached to a frame bracket inside the front, right lift arm pivot tube. A bracket on the front, right lift arm acts as the sensing plate for the down limit switch (Figure 223).

Adjusting the Cutting Unit Down Limit Switch

Note: The vertical location of the down limit switch on the switch bracket will determine the turn-around position of the front, outside cutting units (cutting units #4 and #5). Raising the switch on the bracket will allow a lower turn-around position of the cutting units. Lowering the switch on the bracket will allow a higher turn-around position of the cutting units.

IMPORTANT

To prevent the cutting unit down limit switch damage, ensure that no components contact switch through entire lift arm movement.

1. Park the machine on a level surface, set the parking brake, lower the cutting units, shut off the engine, and remove the key from the key switch.

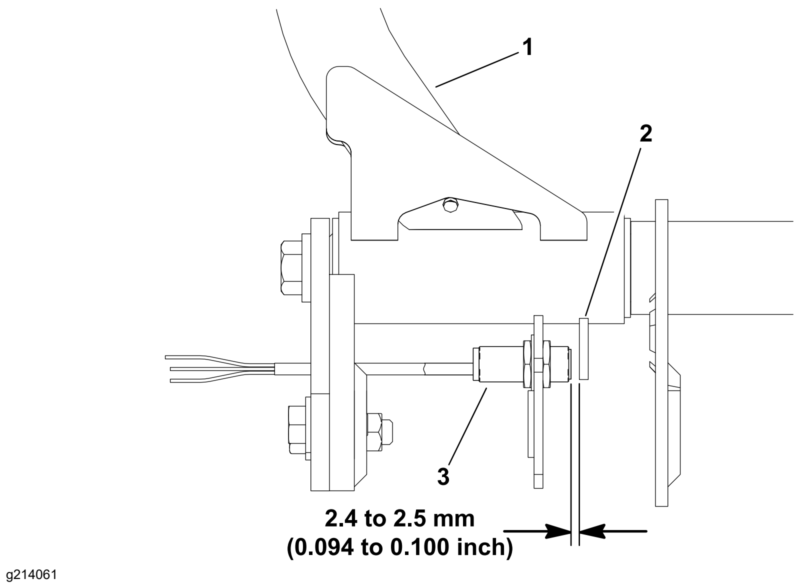


Figure 224

1. Lift arm
2. Bracket
3. Down limit switch

2. The distance between the down limit switch and the sensing plate on lift arm should be **2.4 to 2.5 mm (0.094 to 0.100 inch)** (Figure 224).
3. If distance is incorrect, loosen the jam nuts that secure the switch to the machine frame. Position the switch with jam nuts to allow correct clearance between the switch and the sensing plate. Tighten the jam nuts to secure the adjustment. Torque the jam nuts to **18.4 to 22.4 N·m (162 to 198 in-lb)**. After the jam nuts are tightened, ensure that clearance between the head of the down limit switch and the sensing plate on the has not changed.
4. After adjustment to the down limit switch, use the InfoCenter display to verify that the down limit switch and circuit wiring are functioning correctly; refer to Using the InfoCenter Display for Troubleshooting (page 7–28).

Mow/Transport Switch

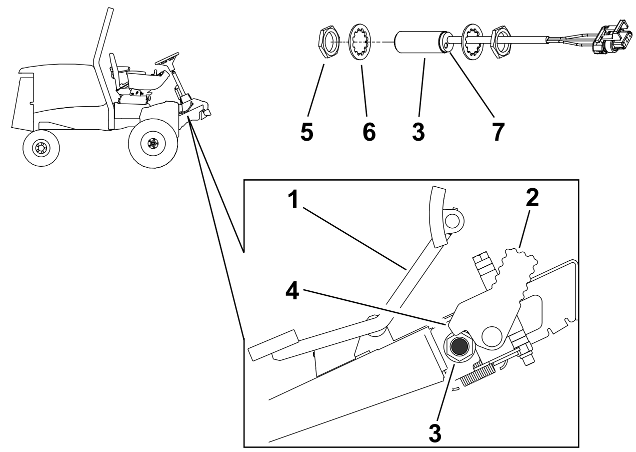


Figure 225

1. Traction pedal
2. Mow speed limiter
3. Mow/transport switch
4. Mow speed limiter tab
5. Jam nut (2 each)
6. Lock washer (2 each)
7. Switch LED location

The mow/transport switch is a normally closed proximity switch that opens when the mow speed limiter is placed in the TRANSPORT position. The switch mounts to a bracket on the footrest platform (Figure 225). The sensing plate for the mow/transport switch is the mow speed limiter.

Adjusting the Mow/Transport Switch

IMPORTANT

To prevent the mow/transport switch damage, ensure that no components contact switch through entire mow speed limiter movement.

1. Park the machine on a level surface, set the parking brake, lower the cutting units, shut off the engine, and remove the key from the key switch.

Adjusting the Mow/Transport Switch (continued)

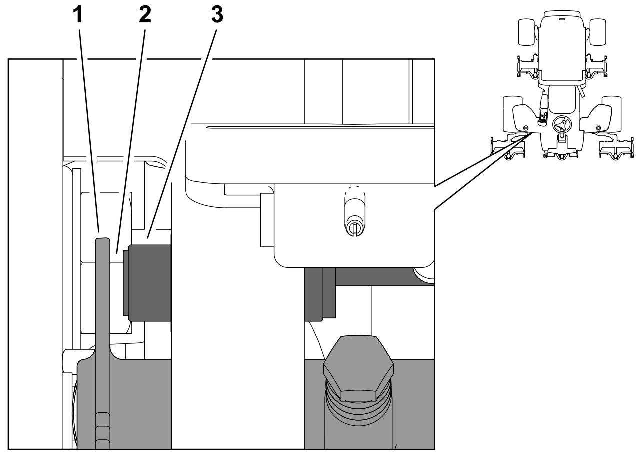


Figure 226

1. Mow speed limiter
2. Gap
3. Mow/transport switch

2. The gap (Figure 226) between the mow/transport switch and the mow speed limiter should be **2.4 to 2.5 mm (0.094 to 0.100 inch)**.
3. If gap is incorrect, loosen the jam nuts that secure the switch to the footrest platform. Position the switch with jam nuts to allow correct gap between the switch and the mow speed limiter. Tighten the jam nuts to secure the adjustment. Torque the jam nuts to **18.4 to 22.4 N·m (162 to 198 in-lb)**. After the jam nuts are tightened, ensure that clearance between the head of the mow/transport switch and the mow speed limiter has not changed.
4. After adjustment to the mow/transport switch, use the InfoCenter display to verify that the mow/transport switch and circuit wiring are functioning correctly; refer to Using the InfoCenter Display for Troubleshooting (page 7–28).

Testing the Electrical Components

For accurate resistance and/or continuity checks, electrically disconnect the component being tested from the circuit (e.g., unplug the key switch connector before doing a continuity check of the switch).

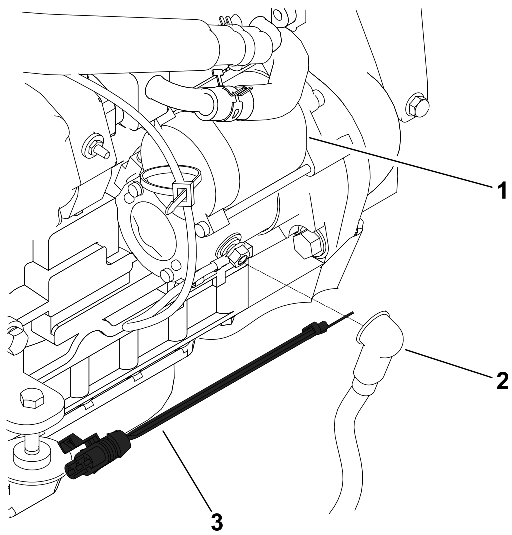
Note: Use the InfoCenter display to test the TEC inputs and outputs before further troubleshooting of an electrical problem on your Reelmaster.

Note: For engine component testing information; refer to the Yanmar Engine Service Manual or Troubleshooting Manual.

IMPORTANT

When testing the electrical components for continuity with a multimeter (ohms setting), ensure that you disconnect the power to the circuit.

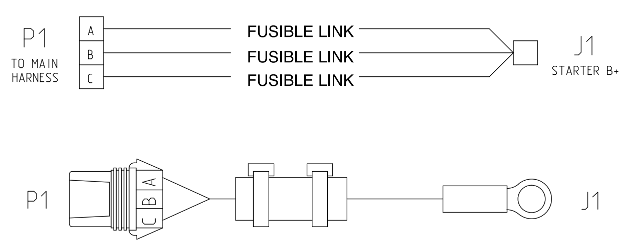
Fusible Link Harness (Machines with Kubota or Yanmar Diesel Engine)



g190798

Figure 227

1. Starter motor
2. Positive battery cable
3. Fusible link harness



g223020

Figure 228

Machines with either a Kubota or Yanmar diesel engine use 3 fusible links for the circuit protection. These fusible links are located in a harness that connects the starter B+ terminal to the wire harness (Figure 227 and Figure 228). If any of these links fail, current to the protected circuit stops; refer to the Electrical Schematic in Appendix A (page A–1) for additional circuit information.

Testing the Fusible Link Harness

1. Ensure that the key switch is in the OFF position, disconnect the negative battery cable from the battery terminal, and then disconnect the positive cable from the battery; refer to Servicing the Battery (page 7–125).
2. Locate and unplug the fusible link connector P1 from the main wire harness.
3. Use a multimeter to ensure that the continuity exists between each terminal pin in the connector P1 and connector J1 at the starter (Figure 228).
4. If any of the fusible links are open, replace the fusible link harness.

   Note: Do not replace individual fusible link conductors of the fusible link harness. If any of the harness links are open (failed), replace the entire fusible link harness.
5. After you complete the testing, ensure that the fusible link harness connectors are correctly attached to the starter and main wire harness. Connect the positive battery cable to the battery terminal and then connect the negative cable to the battery.

System Fuses

Note: For gasoline engine fuses; refer to Engine Fuses (Gasoline Engine) (page 7–59).

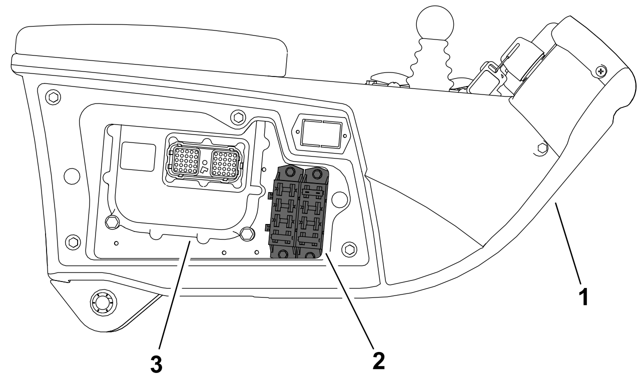


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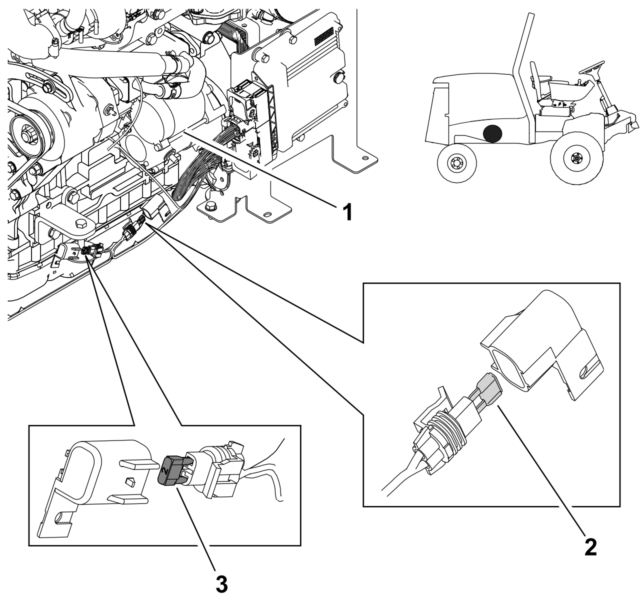
Figure 229

1. Control arm
2. Fuse block
3. TEC (Toro Electronic Controller)



g213681

Figure 230

1. Starter motor
2. 10 A fuse
3. 2 A fuse

The fuse block is located behind the control arm access cover (Figure 229).

In addition to the fuses in the fuse block, there are 2 additional fuses included in the engine wire harness. These fuses plug into the in-line fuse holders near the starter motor (Figure 230). The fuses have the following functions:

2 A fuse: Protects the TEC logic power circuit.

10 A fuse (machines with a Yanmar diesel engine): Protects the engine ECU and EGR relay power circuit.

25 A fuse (machines with a Kubota gasoline engine): Protects the machine power supply.

Identification and Function

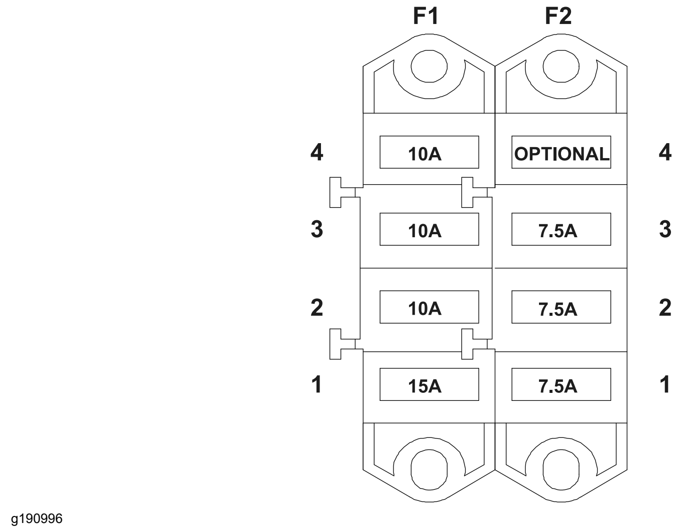


Figure 231

Refer to Figure 231 to identify each individual fuse and its correct amperage. The fuses have the following functions.

F1-1 (15 A): Protects starter circuit power supply.

F1-2 (10 A): Protects main power supply.

F1-3 (10 A): Protects power supply for headlights.

F1-4 (10 A): Protects power supply for power point.

F2-1 (7.5 A): Protects power supply for TEC outputs.

F2-2 (7.5 A): Protects power supply for TEC outputs.

F2-3 (7.5 A): Protects power supply for TEC outputs.

F2-4 (20 A) (if equipped): Protects power supply for the optional air ride operator seat.

Testing the Fuses

Turn the key switch to the ON position (do not start the engine). With the fuse installed in the fuse block, use a multimeter to check that 12 VDC exists at both of the terminal test points on the fuse. If 12 VDC exists at 1 of the fuse test points but not at the other, the fuse is damaged.

If necessary, remove the fuse from the fuse block for testing. The fuse should have continuity between the fuse terminals.

1. Ensure that the key switch is in the OFF position and the key is removed from the key switch.
2. Locate the fuse(s) to be tested behind the control arm access cover.
3. Remove the fuse(s) from the fuse holder for testing. The fuse should have continuity between the fuse terminals.

IMPORTANT

If fuse replacement is necessary, ensure that replacement fuse has the correct Amp rating.

4. Replace the fuse if testing determines that it is damaged.

Testing the Fuses (continued)

5. After you complete the fuse testing, install the control arm access cover.

Engine Fuses (Gasoline Engine)

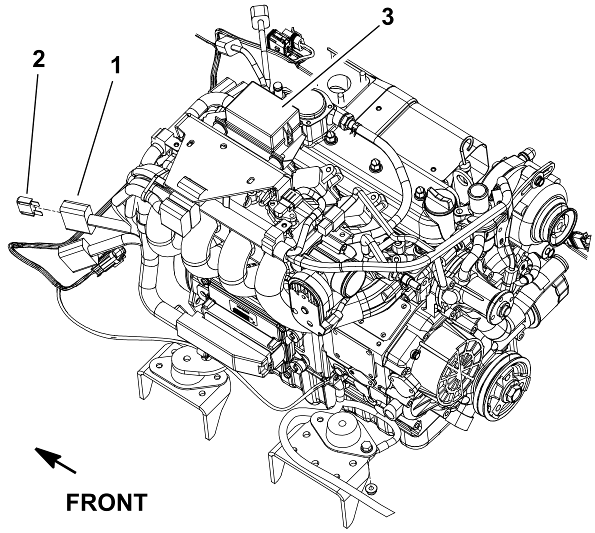


Figure 232

1. In-line fuse holder	2. 60 A maxi-fuse	3. Power center location

The engine fuses that protect Kubota gasoline engine electrical circuits are installed in the engine power center located on the engine (Figure 232).

In addition to the fuses in the power center, a 60 A maxi-fuse is included in the engine wire harness to protect the charging circuit. This maxi-fuse resides in an in-line fuse holder near the engine starter motor (Figure 232).

Identification and Function

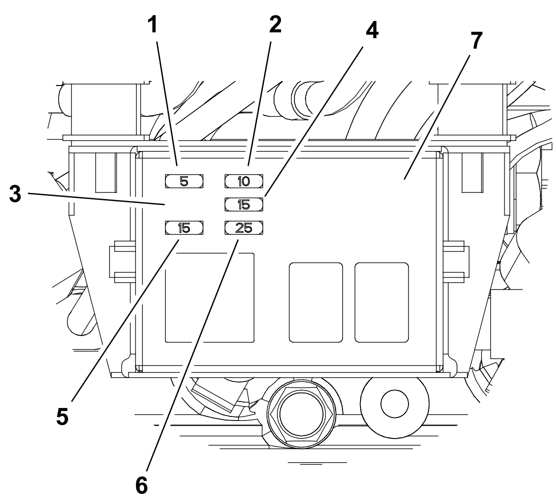


Figure 233

1. Fuse F-1 (5 A)	4. Fuse F-4 (15 A)	7. Engine power center
2. Fuse F-2 (10 A)	5. Fuse F-5 (15 A)	
3. Fuse F-3 (not used)	6. Fuse F-6 (25 A)	

Identification and Function (continued)

Use Figure 233 to identify each individual fuse and its correct amperage. Engine fuses have the following function:

Fuse F-1 (5 A): Protects engine VSW (key switch voltage) circuit power supply.

Fuse F-2 (10 A): Protects engine ECU power supply.

Fuse F-3: Not used.

Fuse F-4 (15 A): Protects power supply for engine electrical system.

Fuse F-5 (15 A): Protects fuel pump circuit power supply.

Fuse F-6 (25 A): Protects starter motor circuit power supply.

Testing the Fuses

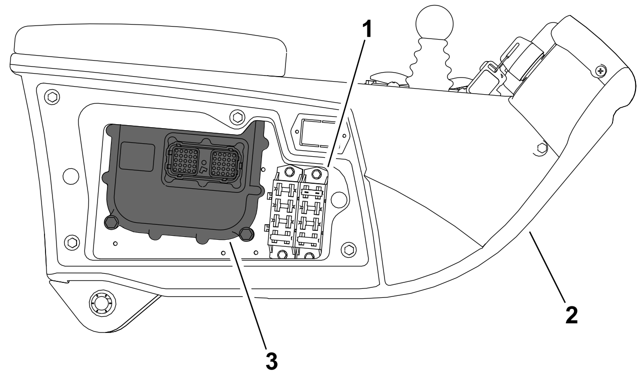
1. Ensure that the key switch is in the OFF position and key is removed from key switch.
2. Raise and support hood to access engine fuses. Remove engine power center cover if necessary. Locate fuse(s) to be tested.
3. Remove fuse(s) from the fuse holder for testing. Fuse should have continuity between fuse terminals.

IMPORTANT

If fuse replacement is necessary, ensure that the replacement fuse has the correct Amp rating.

4. Replace fuse if testing determines that it is damaged.
5. After fuse testing is completed, install engine power center cover if it was removed. Lower and secure hood.

Toro Electronic Controller (TEC)



g213677

Figure 234

1. Fuse block
2. Control arm
3. TEC (Toro Electronic Controller)

The Reelmaster 5010 machines use a Toro Electronic Controller (TEC) to monitor the condition of various switches (inputs) and then direct power output to allow certain machine functions. The controller is located behind the control arm access cover next to the fuse block (Figure 234). Use the InfoCenter display when checking the inputs and outputs of the TEC used on your machine.

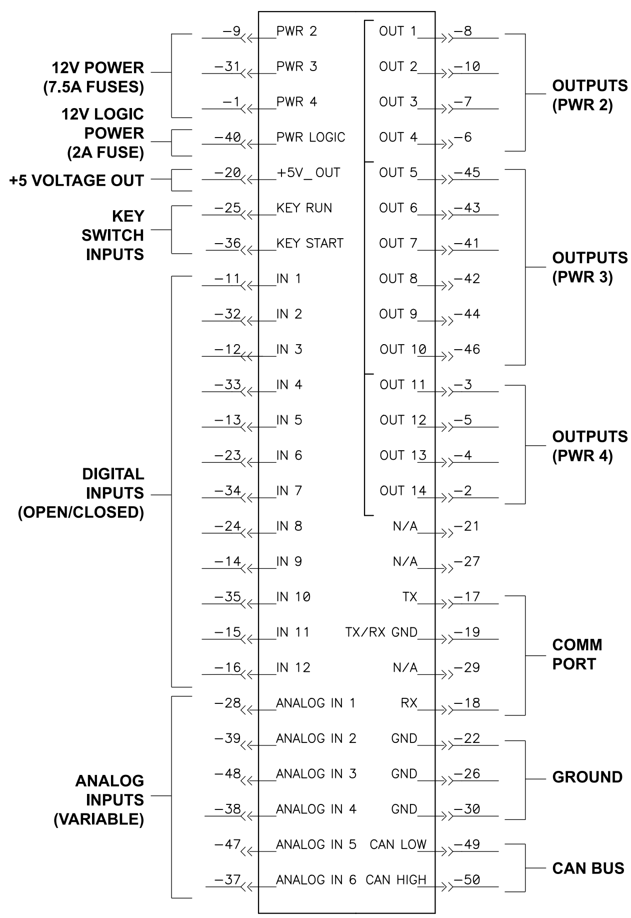


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Figure 235

Toro Electronic Controller (TEC) (continued)

The logic power is provided to the controller as long as the battery cables are connected to the battery. Circuit protection for this logic power to the controller is provided by 2 A fuse.

The inputs from the key, neutral, parking brake, reel engage, seat, mow/transport, joystick lower/raise, cutting reels down limit, engine speed (if equipped), temperature sender, and engine oil pressure switches are all monitored by the controller.

The current output to the following components are controlled based on the inputs received by the controller.

- Mow circuit hydraulic valve solenoid coils
- Lift circuit hydraulic valve solenoid coils
- Fuel pump and engine ECU

The InfoCenter displays a machine fault code and description when an issue is detected.

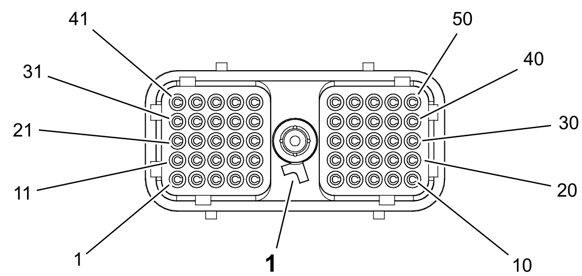


Figure 236

1. Note tab position

The connection terminal functions for the TEC are shown in Figure 235. Note that electrical power for the controller outputs is provided through 3 connectors (PWR 2, PWR 3, and PWR 4) each protected with a 7.5 A fuse. A 50 pin wire harness connector attaches to the controller. The connector pins are identified in Figure 235. The layout of the wire harness connector that plugs into the TEC is shown in Figure 236.

IMPORTANT

When testing for wire harness continuity at the connector for the TEC, ensure that you do not damage the connector pins with the multimeter test leads. If the connector pins are enlarged or damaged during testing, connector repair will be necessary for proper machine operation.

The machine Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1) can be used to identify possible circuit problems between the controller and the input/output devices (e.g., switches and solenoid coils).

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 (e.g., digital multimeter).

Toro Electronic Controller (TEC) (continued)

IMPORTANT

Before performing any welding on the machine, disconnect both negative and positive battery cables from the battery, disconnect the wire harness connector from the TEC and engine ECU (if equipped), and disconnect the terminal connector from the alternator. This will prevent damage to the electrical system of your Reelmaster.

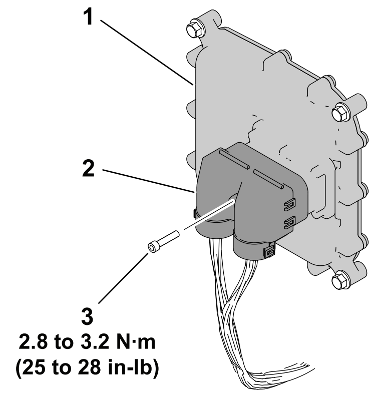
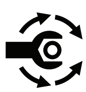


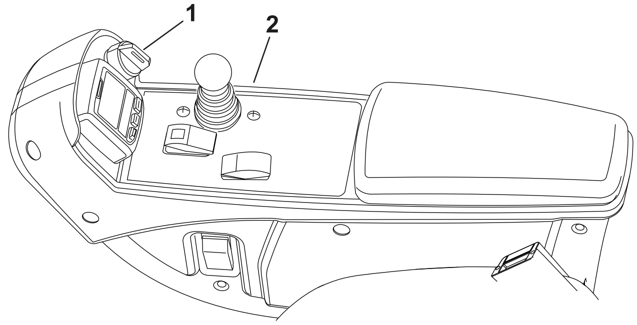
Figure 237

1. TEC controller
2. Machine harness connector
3. Socket head screw



If the wire harness connector is removed from the TEC controller for any reason, tighten the harness connector screw from **2.8 to 3.2 N·m (25 to 28 in-lb)**.

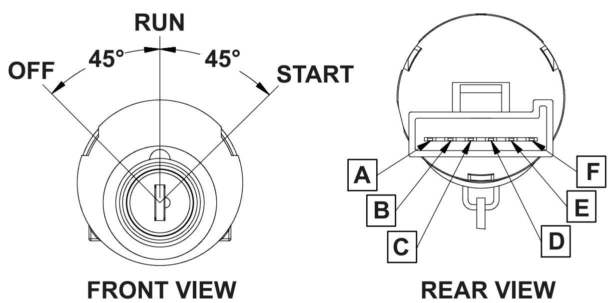
Key Switch



g190808

Figure 238

1. Key switch
2. Control arm



g190999

Figure 239

The key switch (Figure 238) is located on the control arm and has three positions: OFF, RUN, and START (Figure 239).

The Toro Electronic Controller (TEC) monitors the operation of the key switch.

Testing the Key Switch

1. Park the machine on a level surface, lower the cutting units, set the parking brake, and shut off the engine. Remove the key from the key switch.
2. Before you disconnect the key switch for testing, ensure that you test the switch and its circuit wiring as a TEC electrical input with the InfoCenter display; refer to Using the InfoCenter Display for Troubleshooting (page 7–28).
3. If the input testing verifies that the key switch and circuit wiring are functioning correctly, no further key switch testing is necessary.
4. If the input testing determines that the key switch and circuit wiring are not functioning correctly, proceed with the following key switch testing procedure.
5. Remove the right control arm cover to get access to the key switch; refer to Disassembling the Control Arm (page 8–23).
6. Ensure that the key switch is in the OFF position. Disconnect the wire harness connector from the key switch.
7. The key switch terminals are identified in Figure 239 and the circuitry of the switch is shown in the Circuit Logic Table (page 7–65). With the use of a multimeter (ohms setting), test the switch functions to determine if continuity exists between the various terminals for each switch position. Check the continuity between the switch terminals.

Testing the Key Switch (continued)

Circuit Logic Table

Switch Position	Circuits
OFF	None
RUN	B+C+F, D+E
START	A+B+C

8. Replace the key switch if testing determines that it is damaged.
9. If the key switch testing is correct and a circuit problem still exists, check the wire harness; refer to the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1).
10. After you complete the testing, connect the main wire harness connector to the key switch.
11. Secure the right control arm cover to the machine; refer to Assembling the Control Arm (page 8–25).

Reel Engage Switch

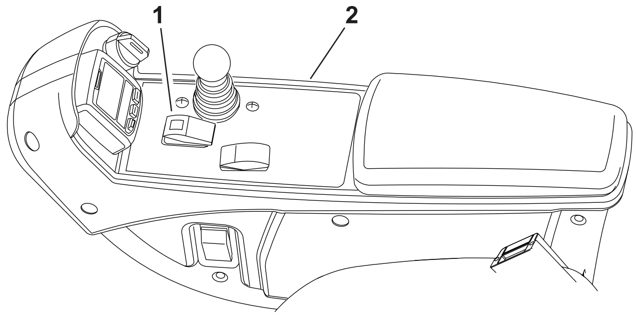


Figure 240

1. Reel engage switch
2. Control arm

The reel engage switch is located on the control arm (Figure 240) and allows the cutting units to operate when the front of the switch is pressed. An indicator light on the switch identifies when the reel engage switch is engaged.

The TEC monitors the position of the reel engage switch (up or down). Using inputs from the engage switch and other switches in the interlock system, the TEC controls the energizing of the hydraulic solenoid valves used to drive the cutting unit motors.

Note: To raise or lower the cutting units, the seat has to be occupied, the mow speed limiter has to be in the MOW position, and the cutting units have to be fully lowered.

Testing the Reel Engage Switch

1. Park the machine on a level surface, lower the cutting units, set the parking brake, and shut off the engine.
2. Before you disconnect the reel engage switch for testing, ensure that you test the switch and its circuit wiring as a TEC electrical input with the InfoCenter display; refer to Using the InfoCenter Display for Troubleshooting (page 7–28).
3. If the InfoCenter verifies that the reel engage switch and circuit wiring are functioning correctly, no further switch testing is necessary.
4. If the InfoCenter determines that the reel engage switch and circuit wiring are not functioning correctly, proceed with the test.
5. Remove the control arm covers to get access to the reel engage switch; refer to Disassembling the Control Arm (page 8–23).
6. Ensure that the key switch is in the OFF position. Disconnect the wire harness electrical connector from the reel engage switch.

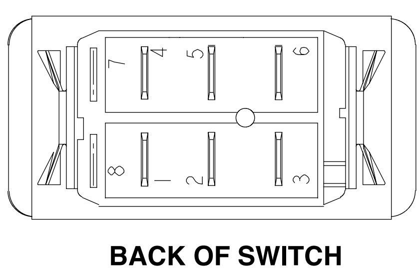


Figure 241

Testing the Reel Engage Switch (continued)

7. The reel engage switch terminals are identified in Figure 241 and the circuitry of the switch is shown in the Circuit Logic Table (page 7–67). With the use of a multimeter (ohms setting), test the switch functions to determine if continuity exists between the various terminals for each switch position. Check the continuity between the switch terminals.

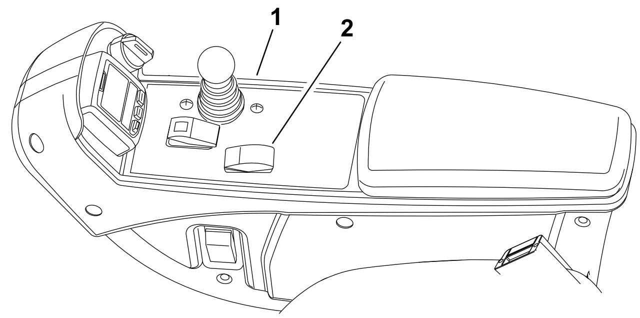
Circuit Logic Table

Switch Position	Normal Circuits	Other Circuits
ON	2+3	5+6
OFF	2+1	5+4

Note: The reel engage switch terminals 1 and 4 are not used on Reelmaster 5010 machines.

8. Replace the reel engage switch if testing determines that the switch is damaged.
9. If the reel engage switch testing is correct and a circuit problem still exists, check the wire harness; refer to the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1).
10. After you complete the testing, connect the wire harness connector to the reel engage switch.
11. Secure the control arm covers to the machine; refer to Assembling the Control Arm (page 8–25).

Engine Speed Switch (If Equipped)



g190806

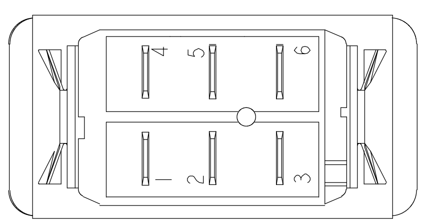
Figure 242

1. Control arm
2. Engine speed switch

The engine speed switch is used on machines with either a Yanmar diesel engine or Kubota gasoline engine. The engine speed switch is used as an input for the TEC to signal the engine ECU via the CAN-bus to increase or decrease the engine speed. When the switch is pressed and held in the forward position, the engine speed will increase. Conversely, when the rear of the switch is pressed, the engine speed will decrease. The engine speed switch is located on the control arm (Figure 242).

Testing the Engine Speed Switch

1. Park the machine on a level surface, lower the cutting units, set the parking brake, and shut off the engine.
2. Before you disconnect the engine speed switch for testing, ensure that you test the switch and its circuit wiring as TEC input with the InfoCenter display; refer to Using the InfoCenter Display for Troubleshooting (page 7–28).
3. If the InfoCenter verifies that the engine speed switch and circuit wiring are functioning correctly, no further switch testing is necessary.
4. If the InfoCenter determines that the engine speed switch and circuit wiring are not functioning correctly, proceed with the test.
5. Remove the control arm covers to get access to the engine speed switch; refer to Disassembling the Control Arm (page 8–23).
6. Ensure that the key switch is in the OFF position. Disconnect the wire harness electrical connector from the engine speed switch.



BACK OF SWITCH

g223017

Figure 243

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7. The engine speed switch terminals are identified in Figure 243 and the circuitry of the switch is shown in the Circuit Logic Table (page 7–69). With the use of a multimeter (ohms setting), test the switch functions to determine if continuity exists between the various terminals for each switch position. Check the continuity between the switch terminals.

Testing the Engine Speed Switch (continued)

Circuit Logic Table

Switch Position	Normal Circuits	Other Circuits
DECREASE	2+1	5+4
OFF	None	None
INCREASE	2+3	5+6

Note: The engine speed switch terminals 4, 5, and 6 are not used on the Reelmaster machines.

8. Replace the engine speed switch if testing determines that the switch is damaged.
9. If the engine speed switch testing is correct and a circuit problem still exists, check the wire harness; refer to the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1).
10. After you complete the testing, connect the wire harness connector to the engine speed switch.
11. Secure the control arm covers to the machine; refer to Assembling the Control Arm (page 8–25).

Lower/Raise Joystick Switches

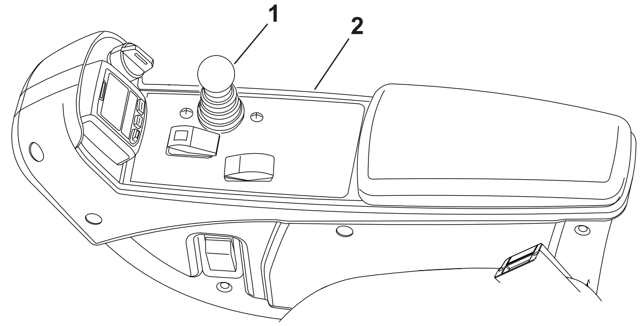


Figure 244

1. Joystick
2. Control arm

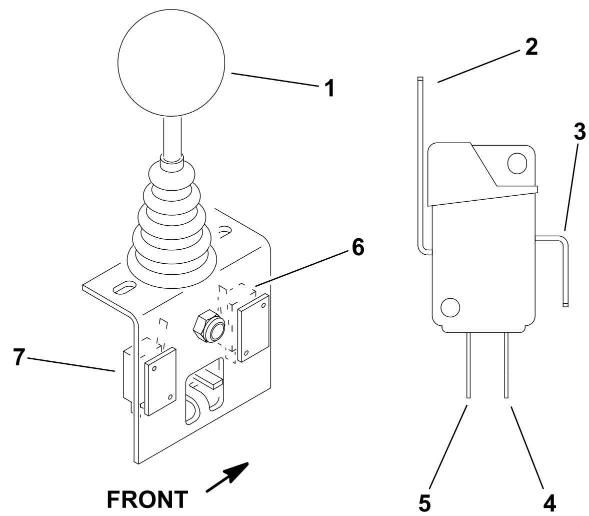


Figure 245

1. Joystick
2. Switch lever
3. Common terminal
4. Normally Open (NO) terminal
5. Normally Closed terminal (not used)
6. Raise switch
7. Lower switch

The 2 micro switches for the joystick are located on the lower mow/raise lever that is attached to the control arm (Figure 244). When the joystick is pushed forward, the rear switch on the control is used to lower (and engage) the cutting units. When the joystick is pulled backward, the front switch is used to raise (and disengage) the cutting units (Figure 245). The switches are identical. A normally open contact in the switch closes when the joystick is positioned to either lower or raise the cutting units Each switch has an electrical connector to ensure the normally closed contact on the switch is not used. The raise switch has pink/blue and black harness wires connected to it and the lower switch has orange/white and black harness wires connected to it.

The Toro Electronic Controller (TEC) monitors the position of the normally open lower/raise switches. The lower/raise joystick switches are inputs used by the TEC to manage various machine functions.

Testing the Lower/Raise Joystick Switches

1. Park the machine on a level surface, lower the cutting units, set the parking brake, and shut off the engine.
2. Before you disconnect the joystick switches for testing, ensure that you test the switches and its circuit wiring as TEC input with the InfoCenter display; refer to Using the InfoCenter Display for Troubleshooting (page 7–28).
3. If the InfoCenter verifies that the joystick switches and circuit wiring are functioning correctly, no further switch testing is necessary.
4. If the InfoCenter determines that the joystick switches and circuit wiring are not functioning correctly, proceed with the test.
5. Remove the control arm covers to get access to the joystick switches; refer to Disassembling the Control Arm (page 8–23).
6. Ensure that the key switch is in the OFF position. Disconnect the wire harness electrical connectors from the raise and lower switches on the joystick assembly.
7. Connect a multimeter (ohms setting) across the switch connector terminals to check the continuity of the switches as follows:
   A. With the joystick in the NEUTRAL position, continuity should only exist between the common and normally closed (NC) terminals.
   B. With the joystick in the RAISE position (raise switch) or LOWER position (lower switch) continuity should only exist between the common and normally open (NO) terminals.
8. Replace the switch if testing determines that the switch is damaged.
9. If the switch testing is correct and a circuit problem still exists, check the wire harness; refer to the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1).
10. After you complete the testing, connect the wire harness connectors to the joystick switches.
11. Secure the control arm covers to the machine; refer to Assembling the Control Arm (page 8–25).

Headlight Switch

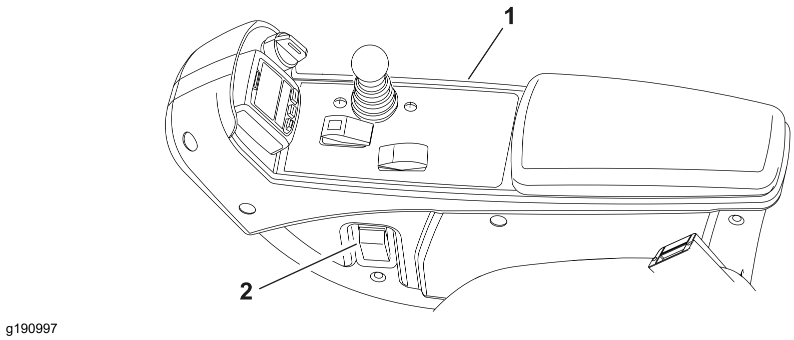


Figure 246

1. Control arm
2. Headlight switch

The headlight switch is located on the operator side of the control arm (Figure 246). This rocker switch allows the headlights to be turned on and off.

Testing the Headlight Switch

1. Park the machine on a level surface, lower the cutting units, set the parking brake, and shut off the engine.
2. Remove the left control arm cover to get access to the headlight switch; refer to Disassembling the Control Arm (page 8–23).
3. Ensure that the key switch is in the OFF position. Disconnect the wire harness electrical connector from the headlight switch.

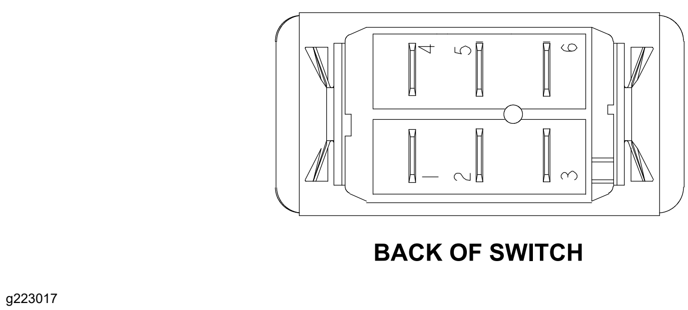


Figure 247

4. The headlight switch terminals are identified in Figure 247 and the circuitry of the switch is shown in the Circuit Logic Table (page 7–72). With the use of a multimeter (ohms setting), test the switch functions to determine if continuity exists between the various terminals for each switch position. Check the continuity between the switch terminals.

Circuit Logic Table

Switch Position	Normal Circuits	Other Circuits
ON	2+3	5+6
OFF	2+1	5+4

Note: The headlight switch terminals 1, 4, 5, and 6 are not used on the Reelmaster machines.

5. Replace the headlight switch if testing determines that the switch is damaged.

Testing the Headlight Switch (continued)

6. If the switch testing is correct and a circuit problem still exists, check the wire harness; refer to the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1).
7. After you complete the testing, connect the wire harness connector to the headlight switch.
8. Secure the left control arm cover to the machine; refer to Assembling the Control Arm (page 8–25).

Seat Switch

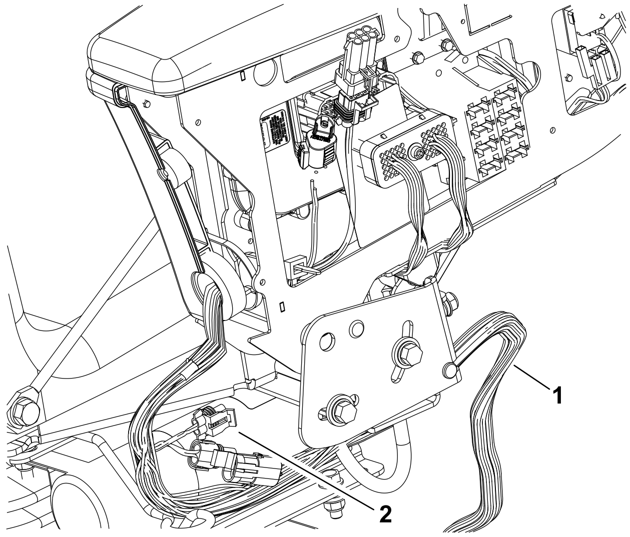


Figure 248

1. Main wire harness
2. Seat switch connector

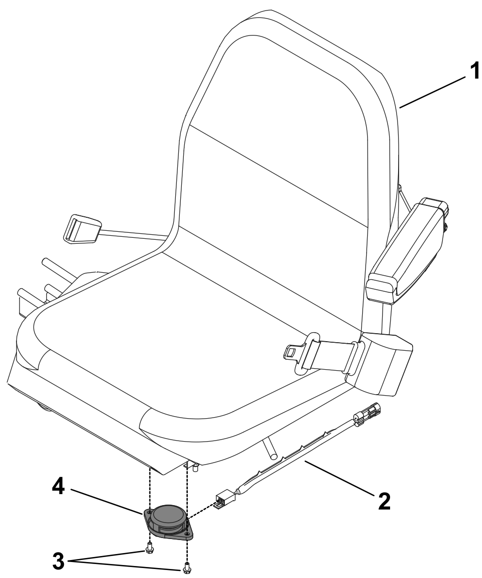


Figure 249

1. Operator seat
2. Seat switch harness
3. Washer-head screw (2 each)
4. Seat switch

The seat switch is normally open and closes when the operator is on the seat. If the traction system or reel engage switch is engaged when the operator raises out of the seat, an operator advisory will be displayed on the InfoCenter. The seat switch and its electrical connector are located directly under the operator seat (Figure 249). Testing of the switch can be done without seat removal by disconnecting the switch wire from the main wire harness (Figure 248).

The Toro Electronic Controller (TEC) monitors the operation of the seat switch.

Testing the Seat Switch

1. Park the machine on a level surface, lower the cutting units, set the parking brake, and shut off the engine.
2. Before you disconnect the seat switch for testing, ensure that you test the switch and its circuit wiring as a TEC electrical input with the InfoCenter display; refer to Using the InfoCenter Display for Troubleshooting (page 7–28).
3. If the InfoCenter verifies that the seat switch and circuit wiring are functioning correctly, no further switch testing is necessary.
4. If the InfoCenter determines that the seat switch and circuit wiring are not functioning correctly, proceed with the test.
5. Ensure that the key switch is in the OFF position.
6. Disconnect the main wire harness electrical connector from the seat switch harness electrical lead near the operator manual tube under the operator seat (Figure 248).
7. Connect a multimeter (ohms setting) across the seat switch harness connector terminals to check the continuity of the seat switch.
   A. With no pressure on the seat, ensure that there is no continuity between the harness terminals of the seat switch.
   B. Press directly onto the seat switch through the seat cushion. Ensure that there is continuity between the harness terminals of the seat switch as the seat cushion approaches the bottom of its travel indicating that the seat switch is functioning.
8. Replace the seat switch if testing determines that the switch is damaged.
9. If the seat switch testing is correct and a circuit problem still exists, check the main wire harness; refer to the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1).
10. After you complete the seat switch testing, connect the main wire harness connector to the seat switch electrical lead. Lower the seat assembly. Check the operation of the seat switch.

Cutting Unit Down Limit Switch

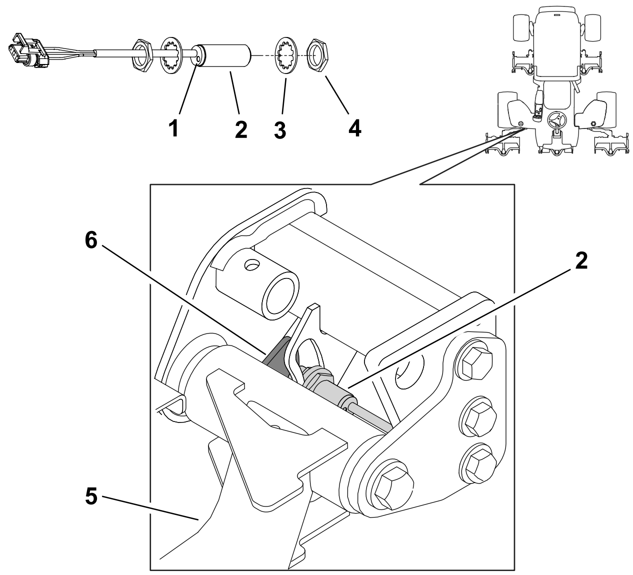


Figure 250

1. Switch LED location
2. Down limit switch
3. Lock washer (2 each)
4. Jam nut (2 each)
5. Lift arm
6. Bracket

The cutting unit down limit switch is a normally open proximity switch that closes when the front, outside cutting units are in the turn-around position. The down limit switch is attached to a frame bracket inside the front, right lift arm pivot tube. A bracket on the front, right lift arm acts as the sensing plate for the down limit switch (Figure 250).

The Toro Electronic Controller (TEC) monitors the operation of the cutting unit down limit switch.

Testing the Down Limit Switch

1. Park the machine on a level surface, lower the cutting units, set the parking brake, and shut off the engine.
2. Before you disconnect the down limit switch for testing, ensure that you test the switch and its circuit wiring as a TEC electrical input with the InfoCenter display; refer to Using the InfoCenter Display for Troubleshooting (page 7–28).
3. If the InfoCenter verifies that the down limit switch and circuit wiring are functioning correctly, no further switch testing is necessary.
4. If the InfoCenter determines that the down limit switch and circuit wiring are not functioning correctly, proceed with the test.
5. Locate the down limit switch (Figure 250).
6. Turn the key switch to the RUN position (do not start the engine) and check the LED on the cable end of the down limit switch.
7. The down limit switch LED should be illuminated when the cutting units are lowered. The LED should not be illuminated when the cutting units are raised to the turn-around position.
8. If the down limit switch LED did not function correctly, do the following:
   A. Ensure that the down limit switch is properly adjusted; refer to Adjusting the Cutting Unit Down Limit Switch (page 7–51). If necessary, adjust the switch and return to step 6.

Testing the Down Limit Switch (continued)

B. Ensure that the key switch is in the OFF position and disconnect the down limit switch connector from the main wire harness.

C. Use a multimeter (ohms setting), check that the main wire harness connector terminal for black wire is closed (continuity) to the ground.

D. Turn the key switch to the RUN position (do not start the engine) and check with a multimeter that the main wire harness connector terminal for pink wire has system voltage (12 VDC) present.

E. Turn the key switch to the OFF position.

F. If the black wire is closed to the ground, the pink wire has system voltage present, and the switch LED did not function, replace the down limit switch. Adjust the switch after installation; refer to Adjusting the Cutting Unit Down Limit Switch (page 7–51).

9. Replace the down limit switch if testing determines that the switch is damaged.

10. If the down limit switch testing is correct and a circuit problem still exists, check the main wire harness; refer to the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1).

11. After you complete the down limit switch testing, ensure that the switch connector is plugged into main wire harness.

Traction Neutral Switch

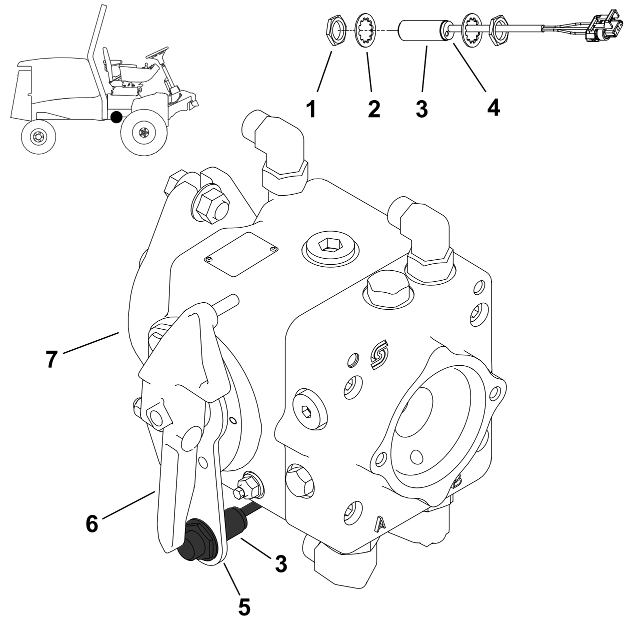


Figure 251

1.	Jam nut (2 each)	4.	Switch LED location	7.	Traction pump
2.	Lock washer (2 each)	5.	Pump plate		
3.	Traction neutral switch	6.	Pump lever		

The traction neutral switch is a normally open proximity switch that closes when the traction pedal is in the NEUTRAL position. The switch mounts to a pump plate on the traction pump (Figure 251). The sensing plate for the traction neutral switch is the pump lever that is secured to the traction pump.

The Toro Electronic Controller (TEC) monitors the operation of the traction neutral switch.

Testing the Traction Neutral Switch

1. Park the machine on a level surface, lower the cutting units, set the parking brake, and shut off the engine.
2. Before you disconnect the neutral switch for testing, ensure that you test the switch and its circuit wiring as a TEC electrical input with the InfoCenter display; refer to Using the InfoCenter Display for Troubleshooting (page 7–28).
3. If the input testing verifies that the neutral switch and circuit wiring are functioning correctly, no further neutral switch testing is necessary.
4. If the input testing determines that the neutral switch and circuit wiring are not functioning correctly, proceed with the test.
5. Locate the traction neutral switch (Figure 251).
6. Turn the key switch to the RUN position (do not start the engine) and check the LED on the cable end of the neutral switch. The LED should be illuminated when the traction pedal is in the NEUTRAL position.
7. With the key switch still in the RUN position (do not start the engine), press the traction pedal out of the NEUTRAL position and check the LED on the cable end of the neutral switch. The LED should not be illuminated when the traction pedal is not in the NEUTRAL position.

Testing the Traction Neutral Switch (continued)

8. If the neutral switch LED did not function correctly, do the following:

   A. Ensure that the neutral switch is properly adjusted; refer to Adjusting the Traction Neutral Switch (page 7–47). If necessary, adjust the switch and return to step 6.

   B. Ensure that the key switch is in the OFF position and disconnect the traction neutral switch connector from the main wire harness.

   C. Use a multimeter (ohms setting), check that the main wire harness connector terminal for black wire is closed (continuity) to the ground.

   D. Turn the key switch to the RUN position (do not start the engine) and check with a multimeter that the main wire harness connector terminal for pink wire has system voltage (12 VDC) present.

   E. Turn the key switch to the OFF position.

   F. If the black wire is closed to the ground, the pink wire has system voltage present, and the switch LED did not function, replace the traction neutral switch. Adjust the switch after installation; refer to Adjusting the Traction Neutral Switch (page 7–47).

9. If the neutral switch testing is correct and a circuit problem still exists, check the main wire harness; refer to the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1).

10. After you complete the neutral switch testing, ensure that the switch connector is plugged into main wire harness.

Parking Brake Switch

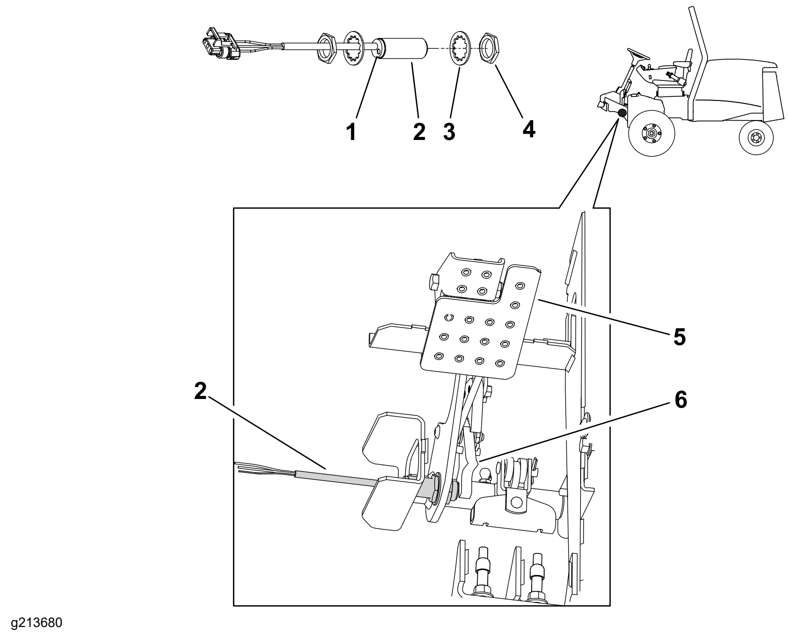


Figure 252

1.	Switch LED location	3.	Lock washer (2 each)	5.	Brake pedal
2.	Parking brake switch	4.	Jam nut (2 each)	6.	Parking brake detent

The parking brake switch is a normally open proximity switch. The parking brake switch is attached to the bottom of the brake pedal (Figure 252).

The machine is equipped with an interlock switch on the parking brake. The engine shuts off if the traction control pedal is moved from the NEUTRAL position with the parking brake engaged. Refer to the Checking the Interlock Switches in the *Traction Unit Operator's Manual*.

When the parking brake is not set, the parking brake detent is positioned near the target end of the parking brake switch so that the switch is closed. The parking brake detent is moved away from the switch when the parking brake is set causing the switch to open.

The Toro Electronic Controller (TEC) monitors the operation of the parking brake switch.

Testing the Parking Brake Switch

1. Park the machine on a level surface, lower the cutting units, set the parking brake, and shut off the engine.
2. Before you disconnect the parking brake switch for testing, ensure that you test the switch and its circuit wiring as a TEC electrical input with the InfoCenter display; refer to Using the InfoCenter Display for Troubleshooting (page 7–28).
3. If the input testing verifies that the parking brake switch and circuit wiring are functioning correctly, no further parking brake switch testing is necessary.
4. If the input testing determines that the parking brake switch and circuit wiring are not functioning correctly, proceed with the test.
5. Locate the parking brake switch (Figure 252).

   Note: Ensure that the parking brake is not set.

Testing the Parking Brake Switch (continued)

6. Turn the key switch to the RUN position (do not start the engine) and check the LED on the cable end of the parking brake switch. The LED should be illuminated when the parking brake is not set.
7. With the key switch still in the RUN position (do not start the engine), set the parking brake and check the LED on the cable end of the parking brake switch. The LED should not be illuminated when the parking brake is set.
8. If the parking brake switch LED did not function correctly, do the following:
   A. Ensure that the parking brake switch is properly adjusted; refer to Adjusting the Parking Brake Switch (page 7–49). If necessary, adjust the switch and return to step 6.

   B. Ensure that the key switch is in the OFF position and disconnect the parking brake switch connector from the main wire harness.

   C. Use a multimeter (ohms setting), check that the main wire harness connector terminal for black wire is closed (continuity) to the ground.

   D. Turn the key switch to the RUN position (do not start the engine) and check with a multimeter that the main wire harness connector terminal for pink wire has system voltage (12 VDC) present.

   E. Turn the key switch to the OFF position.

   F. If the black wire is closed to the ground, the pink wire has system voltage present, and the switch LED did not function, replace the parking brake switch. Adjust the switch after installation; refer to Adjusting the Parking Brake Switch (page 7–49).
9. If the parking brake switch testing is correct and a circuit problem still exists, check the main wire harness; refer to the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1).
10. After you complete the parking brake switch testing, ensure that the switch connector is plugged into main wire harness.

Mow/Transport Switch

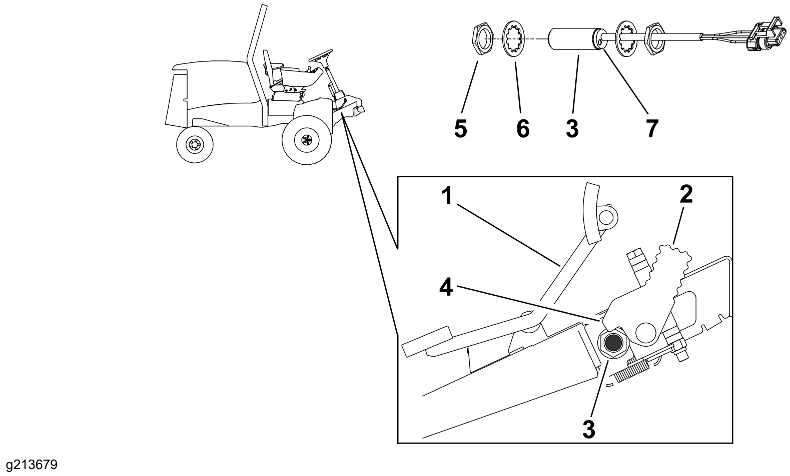


Figure 253

1.	Traction pedal	4.	Mow speed limiter tab	7.	Switch LED location
2.	Mow speed limiter	5.	Jam nut (2 each)		
3.	Mow/transport switch	6.	Lock washer (2 each)		

The mow/transport switch is a normally closed proximity switch that opens when the mow speed limiter is placed in the TRANSPORT position. The switch mounts to a bracket on the footrest platform (Figure 253). The sensing plate for the mow/transport switch is the mow speed limiter.

The Toro Electronic Controller (TEC) monitors the operation of the mow/transport switch.

Testing the Mow/Transport Switch

1. Park the machine on a level surface, lower the cutting units, set the parking brake, and shut off the engine.
2. Before you disconnect the mow/transport switch for testing, ensure that you test the switch and its circuit wiring as a TEC electrical input with the InfoCenter display; refer to Using the InfoCenter Display for Troubleshooting (page 7–28).
3. If the input testing verifies that the mow/transport switch and circuit wiring are functioning correctly, no further mow/transport switch testing is necessary.
4. If the input testing determines that the mow/transport switch and circuit wiring are not functioning correctly, proceed with the test.
5. Locate the mow/transport switch (Figure 253).
6. Turn the key switch to the RUN position (do not start the engine) and check the LED on the cable end of the mow/transport switch. The LED should be illuminated mow speed limiter is in the MOW position. The LED should not be illuminated when the limiter is in the TRANSPORT position.
7. If the mow/transport switch LED did not function correctly, do the following:
   A. Ensure that the mow/transport switch is properly adjusted; refer to Adjusting the Mow/Transport Switch (page 7–52). If necessary, adjust the switch and return to step 6.

   B. Ensure that the key switch is in the OFF position and disconnect the mow/transport switch connector from the main wire harness.

   C. Use a multimeter (ohms setting), check that the main wire harness connector terminal for black wire is closed (continuity) to the ground.

Testing the Mow/Transport Switch (continued)

D. Turn the key switch to the RUN position (do not start the engine) and check with a multimeter that the main wire harness connector terminal for pink wire has system voltage (12 VDC) present.

E. Turn the key switch to the OFF position.

F. If the black wire is closed to the ground, the pink wire has system voltage present, and the switch LED did not function, replace the mow/transport switch. Adjust the switch after installation; refer to Adjusting the Mow/Transport Switch (page 7–52).

8. If the mow/transport switch testing is correct and a circuit problem still exists, check the main wire harness; refer to the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1).

9. After you complete the mow/transport switch testing, ensure that the switch connector is plugged into main wire harness.

Backlap Switches

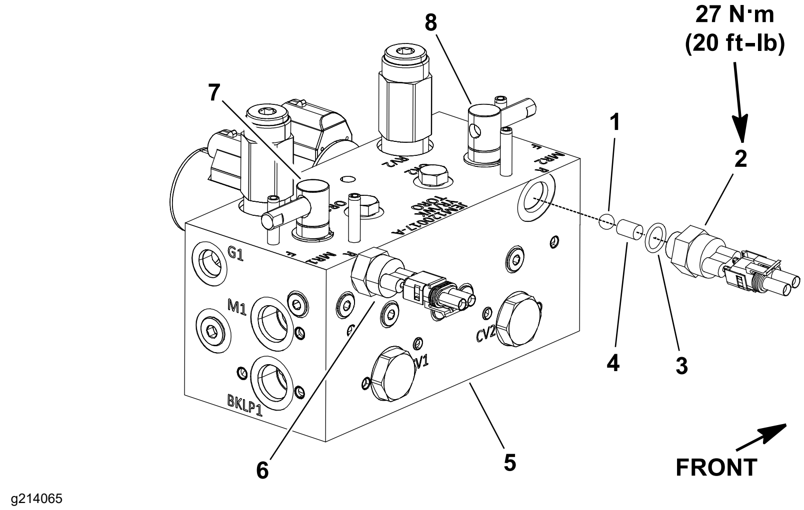


Figure 254

1. Ball
2. Front backlap switch
3. O-ring
4. Dowel pin
5. Mow control manifold
6. Rear backlap switch
7. Rear backlap lever
8. Front backlap lever

The front and rear backlap switches are normally closed ball switches that are in the normal, closed state when a backlap lever on the hydraulic mow control manifold is in the BACKLAP position. When a backlap lever is in the MOW position, the switch opens. The backlap switches are attached to the hydraulic mow control manifold located under the seat (Figure 254).

The Toro Electronic Controller (TEC) uses the backlap switches as inputs to prevent some normal operations during backlapping (e.g., to prevent the cutting reels from raising during backlapping).

Testing the Backlap Switches

1. Park the machine on a level surface, lower the cutting units, set the parking brake, and shut off the engine.
2. Before you disconnect the backlap switch for testing, ensure that you test the switch and its circuit wiring as TEC input with the InfoCenter display; refer to Using the InfoCenter Display for Troubleshooting (page 7–28).
3. If the InfoCenter verifies that the backlap switch and circuit wiring are functioning correctly, no further switch testing is necessary.
4. If the InfoCenter determines that the backlap switch and circuit wiring are not functioning correctly, proceed with the test.
5. Ensure that the key switch is in the OFF position.
6. Raise and secure the operator seat to get access to the backlap switch. Locate the backlap switch on the hydraulic mow control manifold (Figure 254).
7. Disconnect the wire harness electrical connector from the backlap switch.
8. Check the continuity of the switch by connecting a multimeter (ohms setting) across the switch connector terminals.
9. With the key 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.
10. Turn the backlap lever to the MOW position while watching the multimeter. Continuity should be broken as the switch opens.

Testing the Backlap Switches (continued)

11. Replace the backlap switch if testing determines that the switch is damaged; refer to Backlap Switches (page 7–122).
12. If the backlap switch testing is correct and a circuit problem still exists, check the wire harness; refer to the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1).
13. After you complete the testing, connect the wire harness connector to the backlap switch.
14. Lower and secure the operator seat.

Oil Pressure Switch (Machine with Kubota Engine)

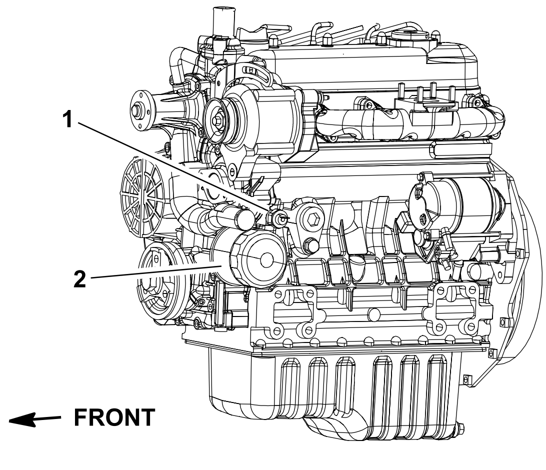


Figure 255

1. Oil pressure switch
2. Oil filter

The engine oil pressure switch is a normally closed switch that opens with pressure during normal engine operation. The oil pressure switch is located on the engine near the oil filter (Figure 255). On machines with a Kubota diesel engine, the Toro Electronic Controller (TEC) monitors the operation of the oil pressure switch. The oil pressure switch in machines with a Kubota gasoline engine is monitored by the engine ECU.

Note: Low engine oil pressure, a damaged oil pressure switch or damaged wiring to the oil pressure switch could cause a closed circuit that would lead to engine shutdown with an InfoCenter display identifying Advisory #169.

Testing the Oil Pressure Switch

1. Park the machine on a level surface, set the parking brake, lower the cutting units, and shut off the engine. Remove the key from the key switch.
2. Raise and support hood. Locate oil pressure switch on engine and disconnect the wire harness connector from the switch.

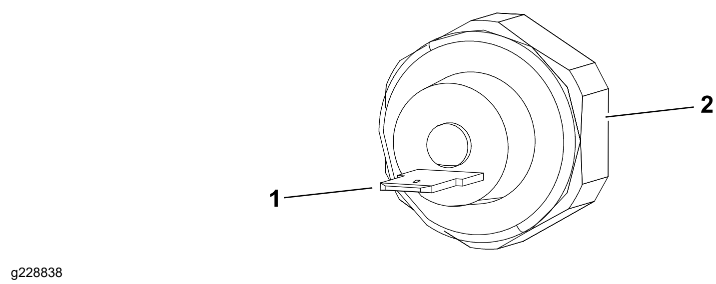


Figure 256

1. Switch terminal
2. Switch base

3. Use a digital multimeter to measure continuity between the oil pressure switch terminal and the switch base (ground connection) (Figure 256).
   A. With the engine not running, the oil pressure switch should be closed so there should be continuity between the switch terminal and the switch base (0 ohms).
   B. With the engine running, the oil pressure switch should be open so there should not be continuity between the switch terminal and the switch base (infinite ohms).

Testing the Oil Pressure Switch (continued)

4. Replace the oil pressure switch if testing determines that the switch is damaged.
5. If testing of oil pressure switch determines that switch operation is normal and the InfoCenter display is identifying low engine oil as the cause of engine shutdown, check for damaged wire in the oil pressure switch circuit.
6. After testing is completed, connect the wire harness connector to the oil pressure switch. Lower and secure hood.

   Note: Refer to appropriate engine workshop manual for information regarding engine lubrication system and testing.

Relays with 4 Terminals

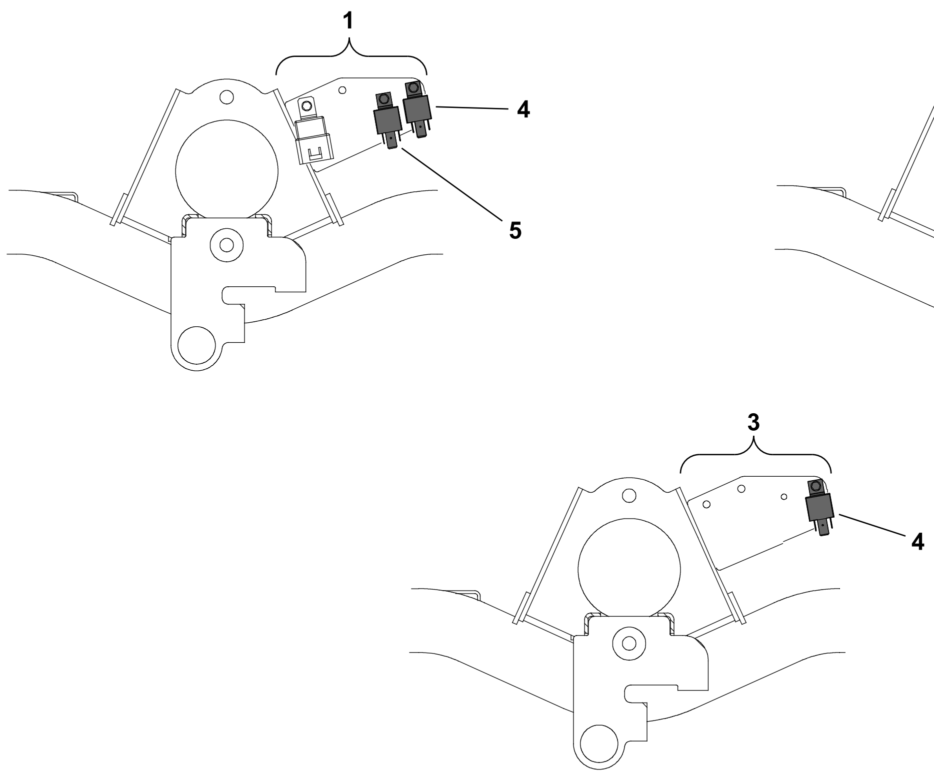


Figure 257

1. Kubota diesel relays
2. Yanmar diesel relays
3. Kubota gas relays
4. Main power relay
5. Glow relay

A number of electrical relays that have 4 terminals are used in the machine electrical system. A tag near the wire harness relay connector can be used to identify each relay.

The main power relay is used to provide current to the operator seat, InfoCenter, TEC, headlights, power point, and optional electric equipment. When the key switch is in the RUN or START position, the main power relay is energized.

The glow relay is used on machines with a Kubota or Yanmar diesel engine to provide current to the engine glow plugs. On machines with a Kubota diesel engine, the glow relay is energized by the TEC. The glow relay is energized by the engine ECU on machines with a Yanmar diesel engine.

The main power and glow relay are attached to a frame bracket under the hood next to the hydraulic pump driveshaft (Figure 257).

Note: A fault code may be displayed on the InfoCenter display if the main power relay, glow relay or circuit wiring is damaged.

Testing the Relays with 4 Terminals

1. Park the machine on a level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Open the hood to get access to the relays. Remove the hood saddle from the machine for easier access to relay.
3. To ensure that the machine operation does not occur unexpectedly, disconnect the negative (-) cable from the battery and then disconnect the

positive (+) cable from the battery; refer to Servicing the Battery (page 7–125).

4. Locate the relay that is to be tested.
5. Disconnect the wire harness electrical connector from the relay. Remove the relay from the mounting bracket for testing.

   Note: Before taking the small resistance readings with a digital multimeter, short the multimeter test leads together. The meter displays a small resistance value (usually 0.5 ohms or less). This resistance is because of the internal resistance of the multimeter and test leads. Subtract this value from the measured value of the component that you are testing.

6. Check the coil resistance between the terminals 85 and 86 with a multimeter (ohms setting). The resistance must be approximately 72 ohms (Figure 258).

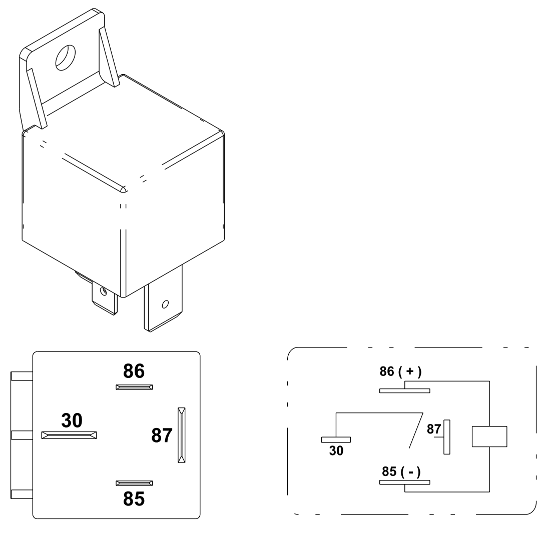


Figure 258

7. Connect the multimeter (ohms setting) leads to the relay terminals 30 and 87. Then ground terminal 85 and apply +12 VDC to terminal 86. The relay should make and break the continuity between the terminals 30 and 87 as +12 VDC is set and removed from terminal 86 (Figure 258).
8. Disconnect the voltage and leads from the relay terminals.
9. Replace the relay if testing determines that the relay is damaged.
10. If the relay testing is correct and a circuit problem still exists, check the main wire harness; refer to the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1).
11. Secure the relay to the mounting bracket and connect the wire harness electrical connector to the relay.
12. Connect the positive (+) cable to the battery and then connect the negative (-) cable to the battery; refer to Servicing the Battery (page 7–125).
13. Install the hood saddle. Lower and secure the hood.

Relays with 5 Terminals (Diesel Engine)

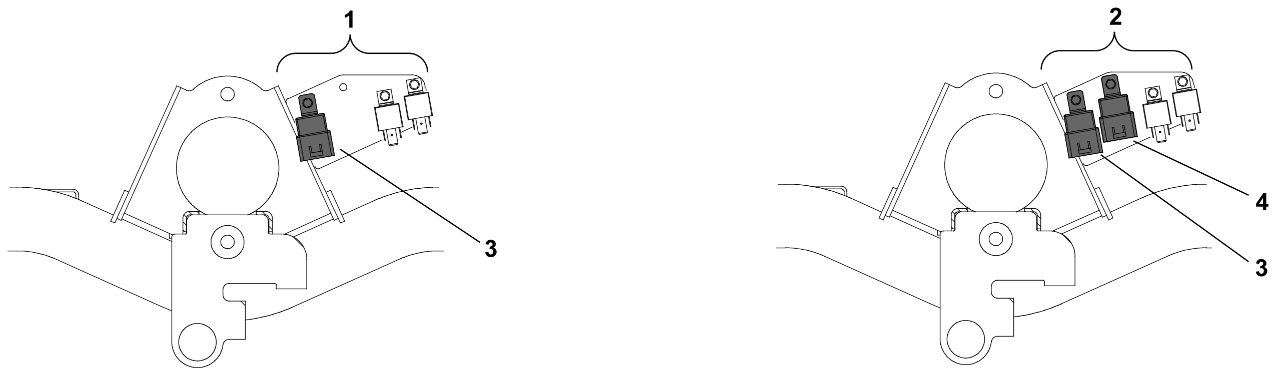


Figure 259

1. Kubota diesel relays
2. Yanmar diesel relays
3. Start relay
4. EGR relay

The electrical system in machines with a Kubota or Yanmar diesel engine include electrical relays that have 5 terminals. A tag near the wire harness relay connector can be used to identify each relay.

The start relay is used to provide current to the engine starter solenoid. On machines with a Kubota diesel engine, the start relay is energized by the Toro Electronic Controller (TEC). The start relay is energized by the engine ECU on machines with a Yanmar diesel engine.

The EGR relay is used on machines with a Yanmar diesel engine to provide current to the engine EGR valve when energized by the engine ECU.

The start relay and EGR relay are attached to a frame bracket under the hood next to the hydraulic pump driveshaft (Figure 259).

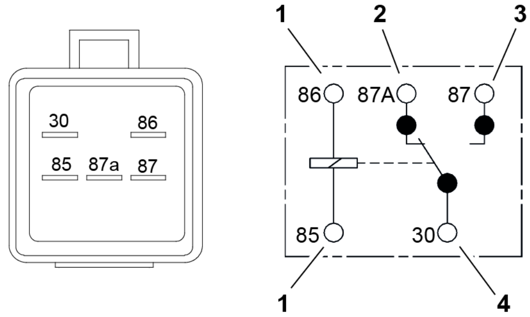
Note: A fault code may be displayed on the InfoCenter display if the start relay, EGR relay or circuit wiring is damaged.

Testing the Relays with 5 Terminals

1. Park the machine on a level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Open the hood to get access to the relays. Remove the hood saddle from the machine for easier access to relay.
3. Ensure that the machine operation does not occur unexpectedly, disconnect the negative (-) cable from the battery and then disconnect the positive (+) cable from the battery; refer to Servicing the Battery (page 7–125).
4. Locate the relay that is to be tested.
5. Disconnect the wire harness electrical connector from the relay. Remove the relay from the mounting bracket for testing.

   Note: Before taking the small resistance readings with a digital multimeter, short the multimeter test leads together. The meter displays a small resistance value (usually 0.5 ohms or less). This resistance is because of the internal resistance of the multimeter and test leads. Subtract this value from the measured value of the component that you are testing.

Testing the Relays with 5 Terminals (continued)



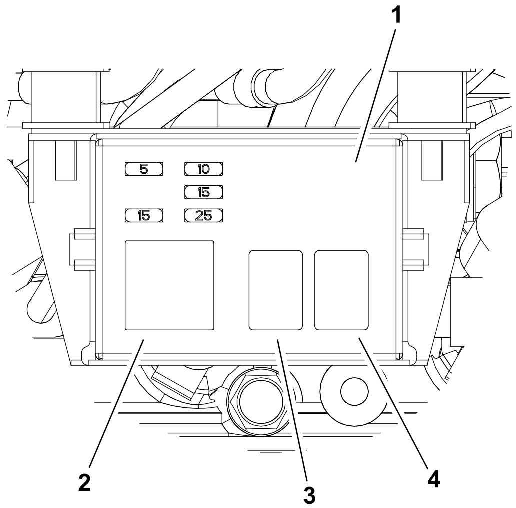
g223021

Figure 260

1. Coil terminal
2. Normally closed term
3. Normally open term
4. Common terminal

6. Check the coil resistance between the terminals 85 and 86 with a multimeter (ohms setting). The resistance must be approximately 71 to 88 ohms (Figure 260).
7. Connect the multimeter (ohms setting) leads to the relay terminals 30 and 87. Then ground terminal 85 and apply +12 VDC to terminal 86. The relay should make and break the continuity between the terminals 30 and 87 as +12 VDC is set and removed from terminal 86.
8. Disconnect the voltage from terminal 85 and multimeter lead from terminal 87.
9. Connect the multimeter (ohms setting) leads to the relay terminals 30 and 87A and apply +12 VDC to the terminal 85. The relay should make and break continuity between the terminals 30 and 87A as +12 VDC is set and removed from the terminal 85.
10. After testing, disconnect the voltage and multimeter test leads from the relay terminals.
11. Replace the relay if testing determines that the relay is damaged.
12. If the relay testing is correct and a circuit problem still exists, check the main wire harness; refer to the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1).
13. Secure the relay to the mounting bracket and connect the wire harness electrical connector to the relay.
14. Connect the positive (+) cable to the battery and then connect the negative (-) cable to the battery; refer to Servicing the Battery (page 7–125).
15. Install the hood saddle. Lower and secure the hood.

Engine Relays with 5 Terminals (Gasoline Engine)



g228830

Figure 261

1. Engine power center
2. Start relay
3. Power relay
4. Fuel pump relay

The engine electrical system in machines with a Kubota gasoline engine includes 3 electrical relays that have 5 terminals. These relays are installed in the engine power center located on the engine (Figure 261).

The start relay is used to provide current to the engine starter solenoid. The start relay is energized by the engine ECU.

The power relay is used to provide electrical power to several engine electrical components when energized by the engine ECU.

The fuel pump relay is used to provide electrical power to the fuel pump when energized by the engine ECU.

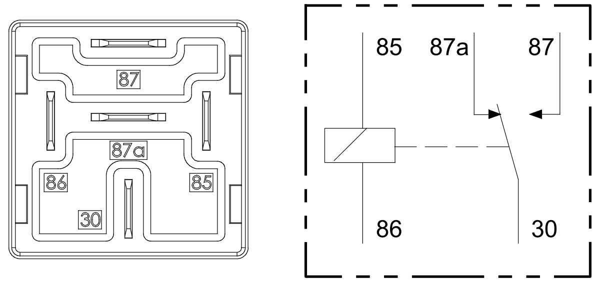
Note: An engine fault code may be displayed on the InfoCenter Display if the power relay, fuel pump relay or circuit wiring is damaged.

Testing the Engine Relays with 5 Terminals

1. Park machine on a level surface, lower cutting units, shut off the engine, apply parking brake and remove key from key switch.
2. Raise and support hood to access engine relays. Remove engine power center cover and locate relay(s) to be tested. Remove relay from the engine power center for 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 component you are testing.

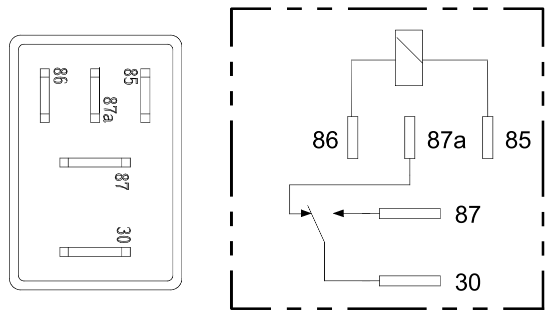
Testing the Engine Relays with 5 Terminals (continued)



g228831

Figure 262

Start relay



g228832

Figure 263

Power and fuel pump relay

3. Using a multimeter (ohms setting), measure coil resistance between terminals 85 and 86 (Figure 262 or Figure 263). Resistance should be as listed in table below.

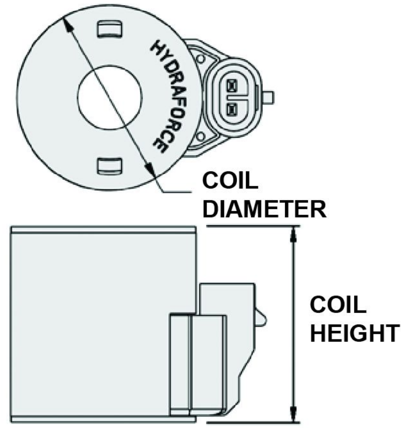
Relay	Coil Resistance
Start	81 to 99 ohms
Power or Fuel Pump	111 to 135 ohms

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 have continuity between terminals 30 and 87 as +12 VDC is applied to terminal 85. The relay should not have continuity between terminals 30 and 87 as +12 VDC is removed from terminal 85.
5. Disconnect voltage from terminal 85 and multimeter lead from terminal 87. Replace relay if testing determines that it is damaged.
6. Install relay into power center, install power center cover and lower hood when relay testing is complete.
7. Connect multimeter (ohms setting) leads to relay terminals 30 and 87A. Apply +12 VDC to terminal 85. The relay should not have continuity between terminals 30 and 87A as +12 VDC is applied to terminal 85. The relay should have continuity between terminals 30 and 87A as +12 VDC is removed from terminal 85.
8. Disconnect voltage and multimeter leads from the relay terminals. Replace relay if testing determines that it is damaged.

Testing the Engine Relays with 5 Terminals (continued)

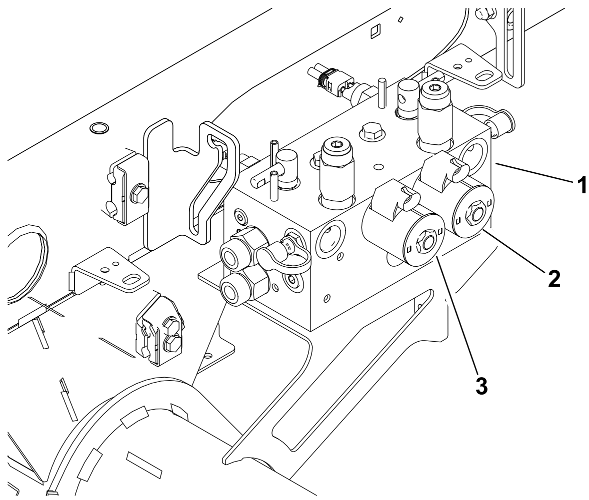
9. Secure relay to machine and connect machine wire harness connector to relay.
10. Install hood saddle. Lower and secure hood.

Hydraulic Solenoid Valve Coils



g191003

Figure 264



g214067

Figure 265

1. Mow control manifold	2. MSV1 solenoid	3. MSV2 solenoid

The Reelmaster hydraulic control manifolds use several hydraulic solenoid valve coils for system control. The mow control manifold includes 2 solenoid valves (Figure 265) and the lift control manifold includes 4 solenoid valves (Figure 266). When the solenoid coils are energized, the hydraulic valve shift occurs to control the hydraulic fluid flow. The correct resistance of a coil can be identified by measuring the height and diameter of the coil (Figure 264). Refer to Solenoid Valve Coil Specifications Table (page 7–97). Testing of the coils can be done with the coil installed on the hydraulic valve.

Note: The 2 solenoid valve coils on the mow control manifold (MSV1 and MSV2) are identical. The solenoid valve coils SV2 and SVRV on the lift control manifold are identical and are the same as those used on the mow control manifold. The remaining 2 lift control manifold coils (SV1 and SV3) are identical. To assist in troubleshooting, identical 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, and hydraulic problem).

Note: If electrical problems exist with a solenoid valve coil, a fault may have occurred that would be indicated by a fault code on the InfoCenter display. Before considering that solenoid valve coil service work is necessary, check for any existing fault codes.

Testing the Hydraulic Solenoid Valve Coils

Note: Before you disconnect the solenoid valve coils, test the solenoids and their circuit wiring as TEC outputs with the InfoCenter display; refer to Using the InfoCenter Display for Troubleshooting (page 7–28). If the InfoCenter verifies that the solenoid coils and circuit wiring are functioning correctly, then no more testing is necessary.

1. Park the machine on a level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.

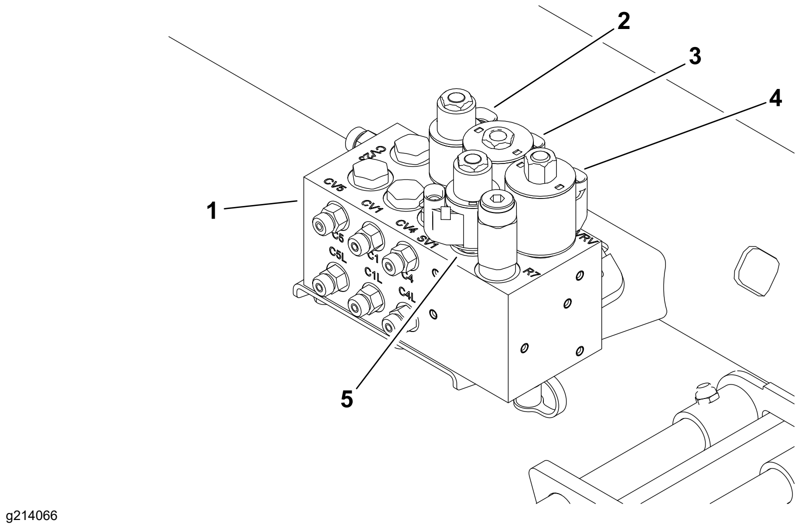


Figure 266

1. Lift control manifold
2. SV3 solenoid
3. SV2 solenoid
4. SVRV solenoid
5. SV1 solenoid

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2. To get access to the mow control manifold, raise and support the operator seat (Figure 265). To get access to the lift control manifold, remove the operator floor plate (Figure 266).
3. Identify the coil by measuring the height and diameter of the coil.
4. Disconnect the wire harness connector from the hydraulic solenoid valve coil that is to be tested.

   Note: Before taking the small resistance readings with a digital multimeter, short the multimeter test leads together. The multimeter displays a small resistance value (usually 0.5 ohms or less). This resistance is because of the internal resistance of the multimeter and test leads. Subtract this value from the measured value of the component that you are testing.

   Note: The solenoid coil resistance should be measured with solenoid at approximately 20°C (68°F). Resistance may be slightly different than listed at different temperatures. Typically, a damaged solenoid coil will either be shorted (very low or no resistance) or open (infinite resistance).

5. Use a multimeter (ohms setting), measure the resistance between the 2 connector terminals on the solenoid coil. The resistance for the solenoid coils is identified in the Solenoid Valve Coil Specifications Table (page 7–97).

Testing the Hydraulic Solenoid Valve Coils (continued)

Solenoid Valve Coil Specifications Table

Solenoid Valve Coil	Diameter	Height	Resistance
MSV1 and MSV2 (mow)	46.7 mm (1.84 inches)	49.9 mm (1.96 inches)	7.1 ohms
SV2 and SVRV (lift)	46.7 mm (1.84 inches)	49.9 mm (1.96 inches)	7.1 ohms
SV1 and SV3 (lift)	35.8 mm (1.41 inches)	36.3 mm (1.43 inches)	8.8 ohms

6. If the solenoid coil resistance is incorrect, replace the solenoid coil; refer to Hydraulic Solenoid Valve Coils (page 7–120).
7. If the solenoid coil testing is correct and a circuit problem still exists, check the main wire harness; refer to the Electrical Schematic and Wire Harness Drawings/Diagrams in Appendix A (page A–1).
8. After testing the coils, connect the wire harness electrical connector to the solenoid valve coil.
9. Lower and secure the operator seat if the mow control manifold was accessed. Install the operator floor plate if the lift control manifold was accessed.

Temperature Sender (Machine with Kubota Diesel Engine)

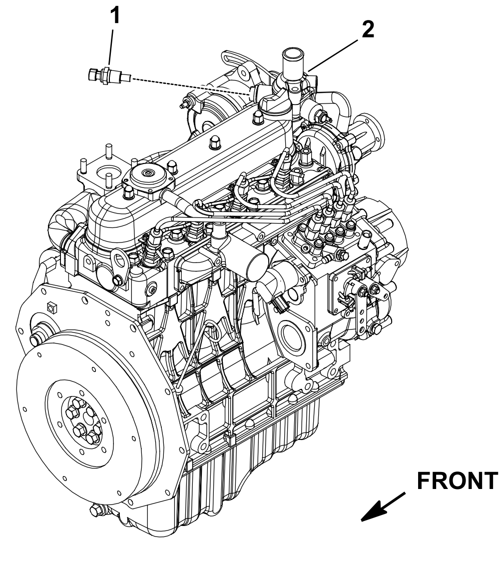


Figure 267

1. Temperature sender
2. Water flange

The temperature sender used on machines with a Kubota diesel engine is attached to the water flange on the engine (Figure 267). The Toro Electronic Controller (TEC) monitors the operation of the temperature sender.

The resistance of the temperature sender reduces as the engine coolant temperature increases. The changing resistance of the temperature sender is used as an analog input to the TEC. The InfoCenter display indicates engine coolant temperature during machine operation based on CAN communication with the TEC.

If engine coolant temperature rises to approximately 105°C (221°F), the TEC input causes the cutting reels to be disengaged and the InfoCenter display to indicate an operator advisory. If coolant temperature continues to rise to approximately 115°C (239°F), the engine will be shutdown by the controller and a fault will be generated to help identify the problem; refer to Faults Screen (page 7–16).

Note: Excessive engine coolant temperature, a damaged temperature sender or damaged wiring to the temperature sender could cause the cutting units to be disengaged or the engine to be shutdown. The InfoCenter display would identify either an advisory or a fault to help identify the problem.

If excessive coolant temperature causes engine shutdown, the operator can start the engine to allow the machine to be moved a short distance. After a start in this condition, the engine will run for approximately 10 seconds before the engine shuts down again.

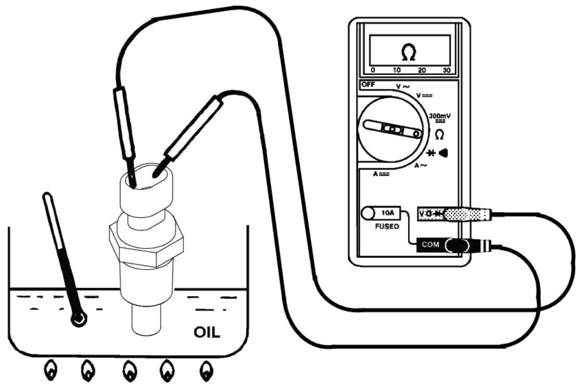
Testing the Temperature Sender

1. Park the machine on a level surface, set the parking brake, lower the cutting units, and shut off the engine. Remove the key from the key switch. Open hood to get access to engine.
2. Locate temperature sender on engine water flange and disconnect wire harness connector from sender.
3. Lower coolant level in the engine and remove the temperature sender from water flange.

Testing the Temperature Sender (continued)

CAUTION

Ensure engine is cool before removing the temperature sender from engine.



g228834

Figure 268

4. Put sender in a container of oil with a thermometer and slowly heat the oil (Figure 268).

CAUTION

Handle the hot oil with extreme care to prevent personal injury or fire.

Note: Prior to taking 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) 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 temperature increases and record measured resistance values. Compare to specifications below. Replace sender if specifications are not met.

Oil Temperature	Temperature Sender Resistance
20°C (68°F)	11.4 to 13.6 K ohms
60°C (140°F)	2.3 to 2.6 K ohms
100°C (212°F)	0.6 to 0.7 K ohms

6. When temperature sender testing is complete, install temperature sender to the water flange.
   A. Clean threads of water flange and temperature sender. 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.
7. Fill engine cooling system.
8. Close and secure hood.

Engine Run Solenoid (Machine with Kubota Diesel Engine)

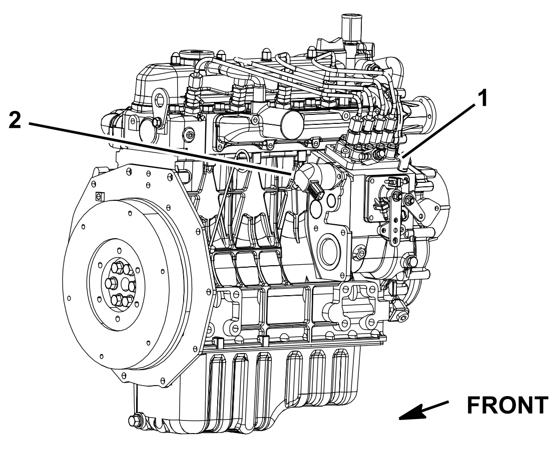


Figure 269

1. Injection pump
2. Fuel stop solenoid

The engine run solenoid used on a machine with a Kubota diesel engine must be energized for the diesel engine to run. The Toro Electronic Controller (TEC) controls the operation of the engine run solenoid. The solenoid is mounted to the injection pump on the engine (Figure 269).

Testing the Engine Run Solenoid

1. Park the machine on a level surface, lower the cutting units, shut off the engine, apply parking brake, and remove key from the key switch. Open hood to get access to engine.
2. Disconnect wire harness connector from fuel stop solenoid.

   Note: The fuel stop solenoid may be removed from the engine or tested in place.
3. If the solenoid is removed from the engine, ensure that the solenoid plunger moves freely and is free of dirt, unwanted material, and corrosion.

   Note: Prior to taking small resistance readings with a digital multimeter, short the test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from the measured value of the tested component.

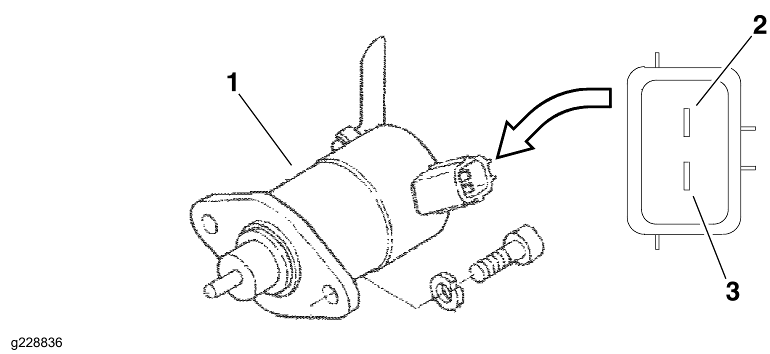


Figure 270

1. Fuel stop solenoid
2. Pull coil terminal
3. Hold coil terminal

4. Use a digital multimeter (ohms setting), touch one test lead to the pull coil terminal and the other test lead to the fuel stop solenoid frame (ground)

Testing the Engine Run Solenoid (continued)

(Figure 270). The resistance of the pull coil should be less than 1 ohm (but not zero).

5. Use a digital multimeter (ohms setting), touch one test lead to the hold coil terminal and the other test lead to the fuel stop solenoid frame (ground) (Figure 270). The resistance of the hold coil should be approximately 15 ohms.
6. If either coil resistance is incorrect, replace fuel stop solenoid.
7. When testing is completed, connect wire harness connector to the fuel stop solenoid.
8. Lower and secure hood.

Fuel Sender (Diesel Engine)

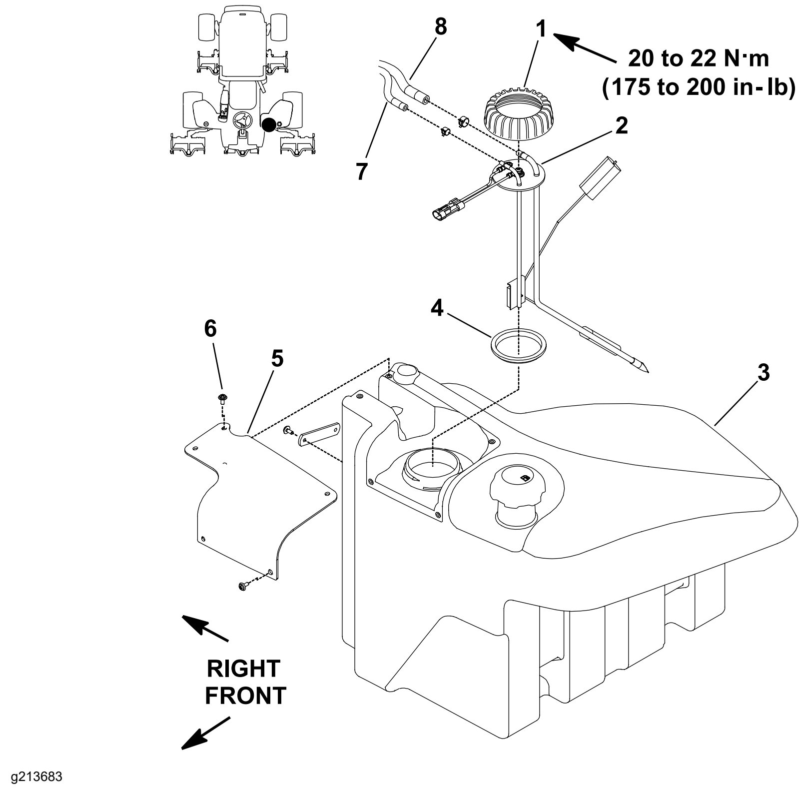


Figure 271

1. Fuel sender cap
2. Fuel sender
3. Fuel tank
4. Fuel sender gasket
5. Sender cover
6. Screw (5 each)
7. Fuel return hose
8. Fuel supply hose

On machine with a diesel engine, the fuel sender is a variable resistance device that is located in the fuel tank (Figure 271). The resistance of the fuel sender increases as the fuel level in the fuel tank decreases. The TEC uses the fuel sender as an input to generate an output for the InfoCenter fuel gauge.

Testing the Fuel Sender

1. Park the machine on a level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the 5 screws that secure the sender cover to the fuel tank (Figure 271). Lift the cover from the tank.
3. Disconnect the wire harness connector from the fuel sender.

⚠ CAUTION ⚠

Turning the key switch to the RUN position when the circuit wiring is not connected could lead to sparking, resulting in fire or an explosion.

When testing the circuit wiring and fuel sender, ensure that the wire connections are secure before turning the key switch to the RUN position.

Testing the Fuel Sender (continued)

4. To test the circuit wiring and InfoCenter fuel gauge, use a jumper wire to connect the 2 terminals in the wire harness connector. Ensure that the jumper wire connections are secure.
5. Turn the key switch to the RUN position. The InfoCenter display should indicate a full fuel tank if the circuit wiring and InfoCenter are working correctly. Turn the key switch to the OFF position and continue testing fuel sender if the circuit wiring and InfoCenter are acceptable.
6. Loosen the hose clamps and carefully disconnect the fuel supply and return hoses from the fittings on the top of the fuel sender.

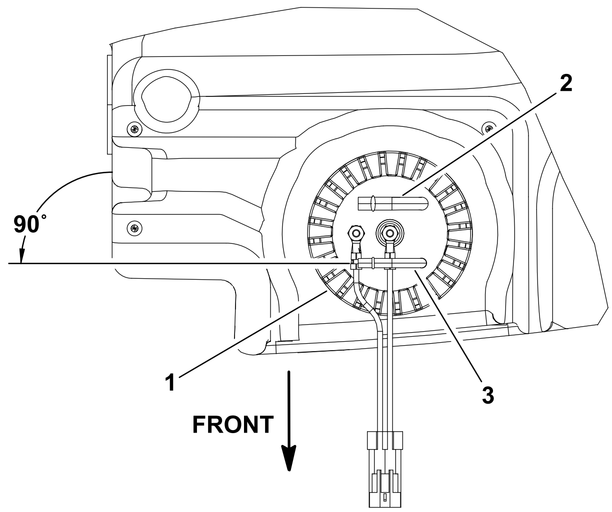


Figure 272

1. Fuel sender
2. Fuel supply fitting
3. Fuel return fitting

IMPORTANT

Before removing the fuel sender from the tank, note the orientation of the fuel sender fittings for assembly purposes (Figure 272).

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7. Carefully remove the fuel sender cap that secures the fuel sender in the fuel tank.
8. Lift the fuel sender and sender gasket from the fuel tank. Clean all the fuel from the sender.

CAUTION

Ensure that the fuel sender is completely dry (no fuel on it) before the testing. Perform the test away from the tank to prevent an explosion or fire from sparks.

Testing the Fuel Sender (continued)

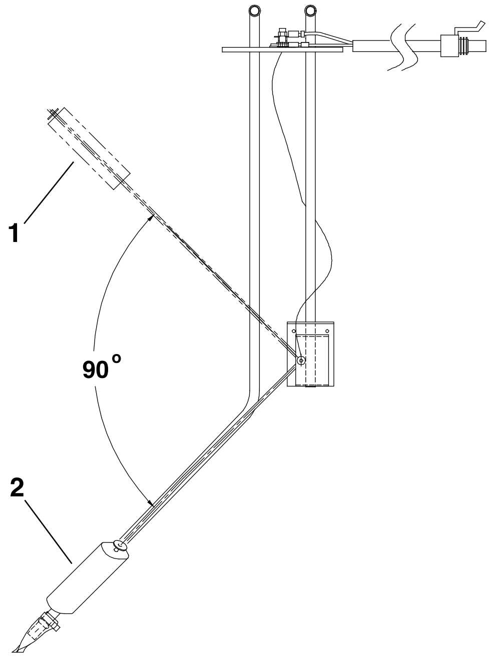

Figure 273

1. Sender full position
2. Sender empty position

9. Use a multimeter to check the resistance of the fuel sender across the 2 sender terminals (Figure 273).
   A. The resistance with the float in the full position (completely up) should be 5 to 8 ohms.
   B. The resistance with the float in the empty position (completely down) should be 89 to 95 ohms.
10. Replace the fuel sender if testing determines that it is damaged.
11. After testing, install the sender into the fuel tank and secure the sender with the sender gasket and fuel sender cap. Ensure that the fuel fittings on the sender are orientated at 90° from right side of the tank as shown in Figure 272. Also, to prevent damage to the fuel sender during assembly, ensure that the fuel sender does not turn as the sender cap is tightened. Torque the fuel sender cap to **20 to 22 N·m (175 to 200 in-lb)**.
12. Install the fuel supply and return hoses to the fittings on the sender and secure the hoses with the hose clamps.
13. Connect the fuel sender connector to the wire harness.
14. Secure the sender cover to the fuel tank with the screws that were removed.

Fuel Sender (Gasoline Engine)

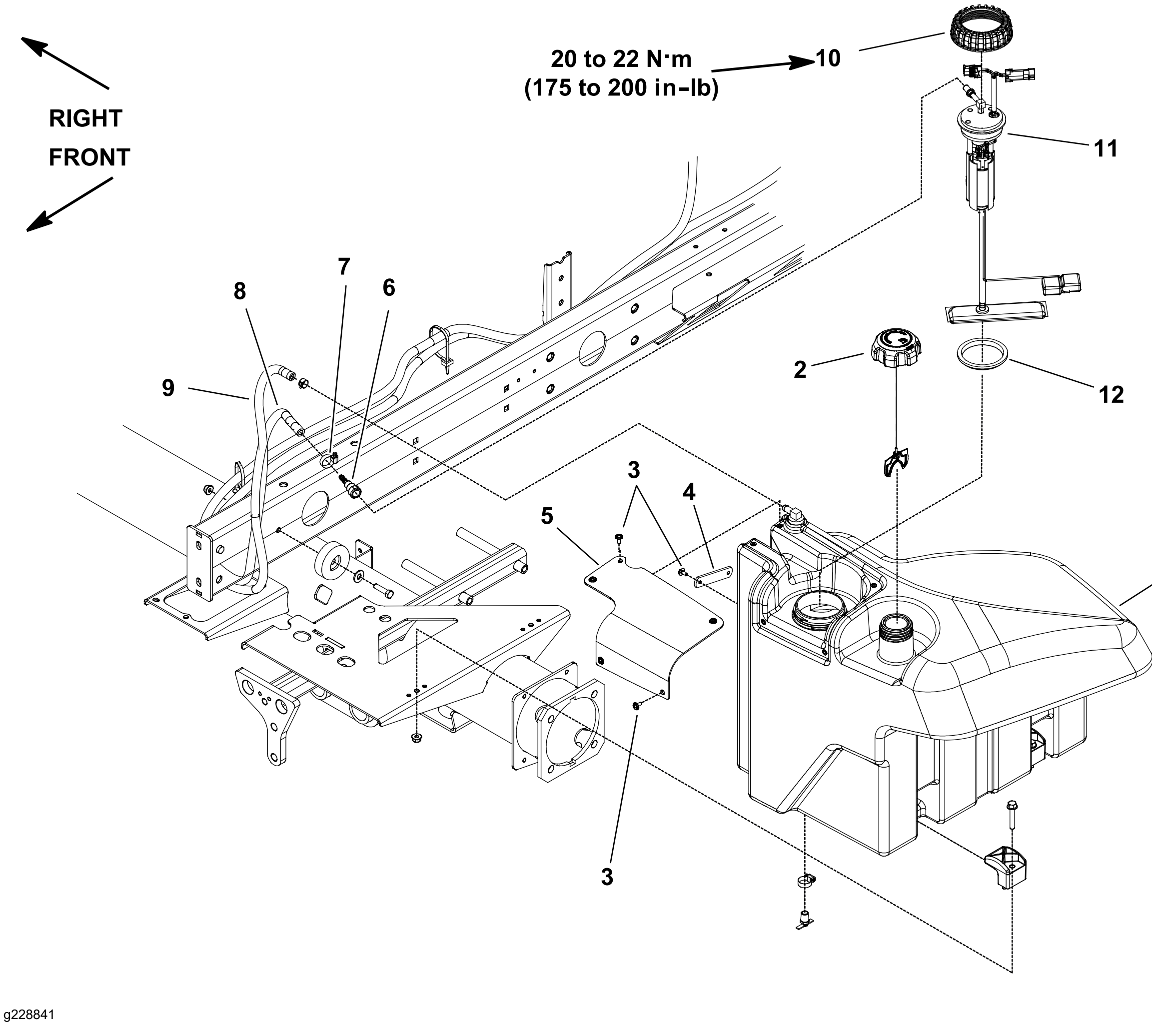

Figure 274

1. Fuel tank
2. Fuel tank cap
3. Screw (7 each)
4. Strap
5. Sender cover
6. Fuel fitting
7. Hose clamp
8. Fuel supply hose
9. Fuel vent hose
10. Fuel pump cap
11. Fuel pump assembly
12. Gasket

On a machine with a Kubota gasoline engine, the fuel sender is a component of the fuel pump assembly which is secured to the top of the fuel tank. The resistance of the fuel sender increases as the fuel level in the fuel tank decreases. The Toro Electronic Controller (TEC) uses the fuel sender as an input to generate an output for the InfoCenter fuel gauge.

Testing the Fuel Sender

1. Park the machine on a level surface, lower the cutting units, shut off the engine, and set the parking brake. Remove the key from key switch. Raise the operator seat and hood.

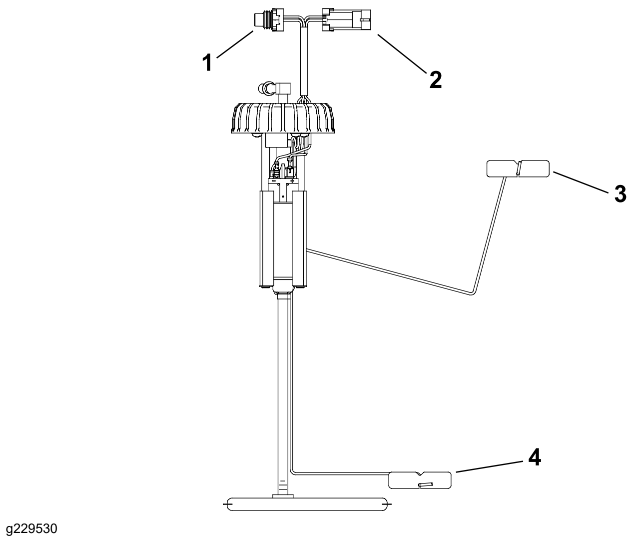

Figure 275

1. Fuel sender connector
2. Fuel pump connector
3. Full position
4. Empty position

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2. Carefully disconnect both machine wire harness connectors from the fuel pump assembly. The fuel pump assembly connectors for the fuel sender and fuel pump are identified in Figure 275.
3. To test the circuit wiring and InfoCenter fuel gauge, use a jumper wire to connect the 2 wire harness connector pins and turn key switch to ON/RUN. InfoCenter fuel gauge should indicate full if circuit wiring and InfoCenter fuel gauge are acceptable. Turn key switch OFF. Proceed with fuel sender testing if circuit wiring and fuel gauge are functioning correctly.
4. Carefully disconnect fuel fitting from fitting on the top of the fuel pump assembly. Fuel supply hose can stay attached to the fuel fitting.

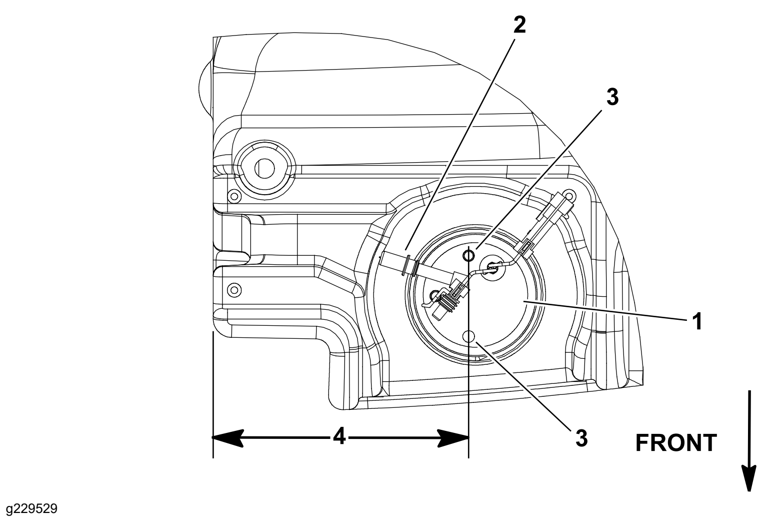

Figure 276

1. Fuel sender
2. Fuel supply fitting
3. Alignment hole
4. Parallel

IMPORTANT

Note orientation of fitting on fuel pump assembly for installation purposes (Figure 276).

5. Remove fuel pump cap and carefully lift fuel pump assembly and gasket from fuel tank. Clean all fuel from the pump assembly including fuel sender.

CAUTION

Ensure that the fuel sender is completely dry (no fuel on it) before testing. Perform test away from the fuel tank to prevent an explosion or fire from sparks.

6. Use a multimeter at the fuel sender connector, check resistance of the sender with the float in the full and empty positions (Figure 275). Expected resistance values are as follows:
   A. In the full position, sender resistance should be approximately 102 ohms.
   B. In the empty position, sender resistance should be approximately 2 ohms.
7. Replace fuel pump assembly if resistance testing determines that the fuel sender is damaged.
8. When testing is complete, carefully install gasket and fuel pump assembly to fuel tank.
9. Ensure that alignment holes in top of fuel pump assembly are orientated parallel to the right side of tank as Figure 276. Secure fuel pump assembly in tank with fuel pump cap. Torque cap to **20 to 22 N·m (175 to 200 in-lb)**. To prevent damage to fuel pump assembly during installation, ensure that the pump assembly does not turn as pump cap is tightened.
10. Secure wire harness connectors to fuel pump assembly.
11. Connect fuel fitting with attached fuel supply hose to fitting on the top of the fuel pump assembly.
12. Prime the fuel system; refer to Priming the Fuel System (page 5–12).
13. Before returning machine to operation, ensure that no fuel leaks exist.

Fuel Pump (Machine with Yanmar Diesel Engine)

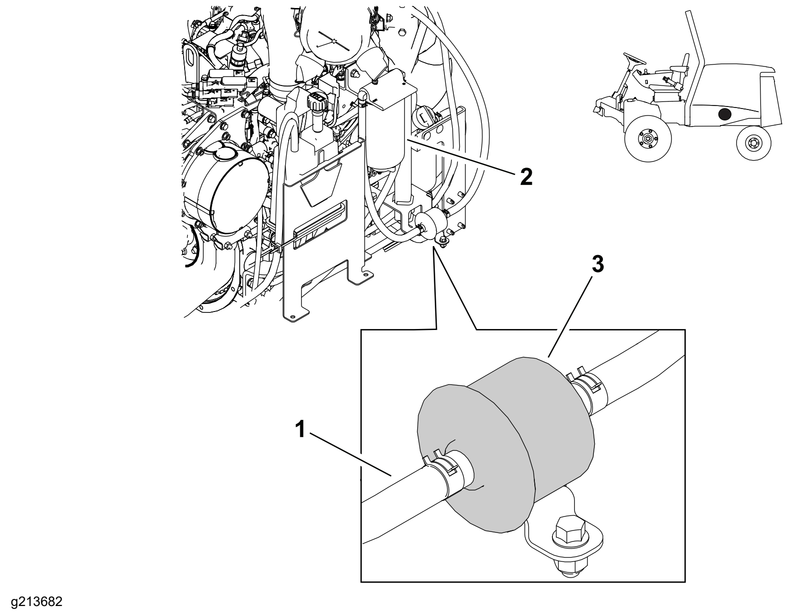

Figure 277

1. Pump discharge hose
2. Fuel/water separator
3. Fuel pump

On machines with a Yanmar diesel engine, the fuel pump is attached to the air cleaner stand adapter below the fuel/water separator (Figure 277). Electrical current is available for the fuel pump when the key switch is in either the RUN or START position.

The Toro Electronic Controller (TEC) energizes the fuel pump.

IMPORTANT

When testing the fuel pump, ensure that the pump is not operated without fuel.

DANGER

Diesel fuel is highly flammable.

- **Use caution whenever you handle diesel fuel.**
- **Do not smoke while testing the fuel pump.**
- **Do not test the fuel pump while the engine is hot.**
- **Ensure that there is adequate ventilation when testing.**
- **Always wipe up any spilled diesel fuel before starting the engine.**

Testing the Fuel Pump Capacity

1. Park the machine on a level surface, lower the cutting units, shut off the engine, and set the parking brake. Ensure that the key switch is in the OFF position.
2. Unlatch the hood and raise it.
3. Ensure that the fuel hoses attached to the fuel pump are free of obstructions.

Testing the Fuel Pump Capacity (continued)

4. Disconnect the fuel pump discharge hose from the inlet fitting of the fuel/water separator.
5. Place the disconnected end of the pump discharge hose into a large, graduated cylinder sufficient enough to collect 0.9 L (32 fl oz).

IMPORTANT

When testing the fuel pump output, do not turn the key switch to the START position.

6. Turn the key switch to the ON position and collect the fuel in the graduated cylinder. Allow the pump to run for 30 seconds and then turn the switch to the OFF position.

   Note: The amount of fuel pumped in 30 seconds must be approximately 350 ml (11.8 fl oz).
7. Replace the fuel pump if output specification is not met.

IMPORTANT

If the fuel pump is replaced, ensure that replacement pump is the correct pump for your Reelmaster by using your *Parts Catalog*. If incorrect pump is used, the fuel system damage can occur.

8. Connect the fuel pump discharge hose to the fuel/water separator. Ensure to secure the hose with the hose clamp.
9. Prime the fuel system; refer to Priming the Fuel System (page 4–23).

Fuel Pump Specifications

Pump Capacity	700 ml/minute (23.5 fl oz/minute)
Pressure	22.8 kPa (3.3 psi)
Maximum Current Draw	0.9 A

10. Lower the hood and secure it with the latches.

Fuel Pump (Machine with Kubota Diesel Engine)

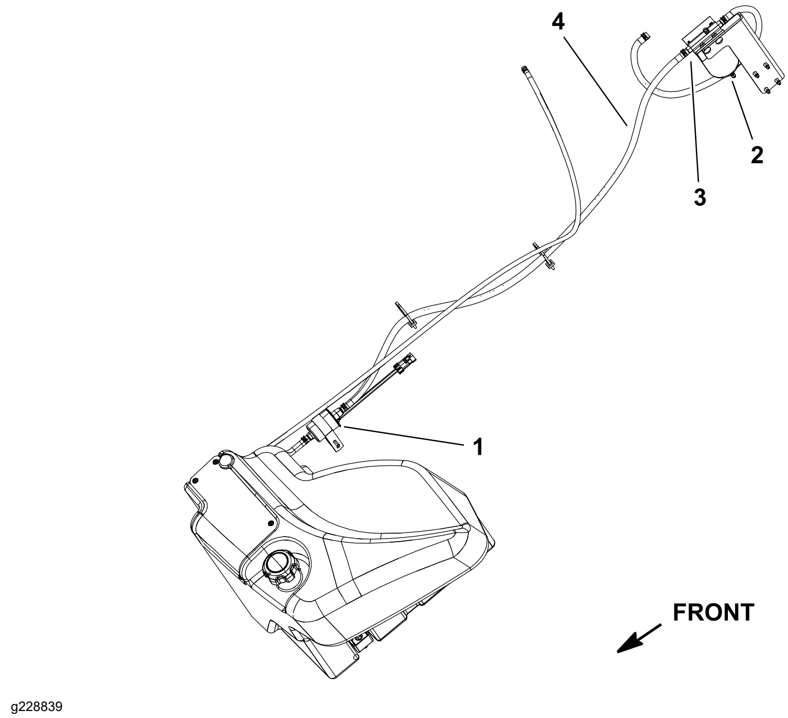

Figure 278

1. Fuel pump
2. Fuel/water separator
3. Inlet fitting
4. Fuel supply hose

On a machine with a Kubota diesel engine, the fuel pump is attached to the inside of the left side frame rail near the fuel tank (Figure 278).

IMPORTANT

When testing fuel pump, ensure that pump is not operated without fuel.

DANGER

Because diesel fuel is highly flammable, use caution when handling it. Do not smoke while testing the fuel pump. Do not test fuel pump while engine is hot. Ensure that there is adequate ventilation when testing. Always wipe up any spilled fuel before starting the engine.

Testing the Fuel Pump Capacity

1. Park machine on a level surface, lower cutting units, shut off the engine and set the parking brake. Remove key from key switch. Raise operator seat and hood.
2. Disconnect wire harness electrical connector from the engine fuel stop solenoid to prevent the engine from starting; refer to Engine Run Solenoid (Machine with Kubota Diesel Engine) (page 7–100).
3. Ensure fuel supply hoses attached to the fuel pump and fuel sender in fuel tank are free of obstructions.

Testing the Fuel Pump Capacity (continued)

4. Disconnect fuel supply hose (pump discharge) from the fuel/water separator inlet fitting (Figure 278).
5. Place disconnected fuel hose into a large, graduated cylinder sufficient enough to collect 0.95 L (32 fl oz).

IMPORTANT

When testing the fuel pump, Do not turn key switch to START.

6. Collect fuel in the graduated cylinder by turning key switch to the ON/RUN position. Allow pump to run for 15 seconds, then return switch to OFF.
7. The amount of fuel collected in the graduated cylinder should be approximately 475 ml (16 fl oz) after 15 seconds.
8. Replace fuel pump if testing determines that it is damaged.
9. Install fuel hose to the fuel/water separator. Ensure to secure fuel hose with hose clamp.
10. Connect wire harness electrical connector to the engine fuel stop solenoid.
11. Bleed the fuel system; refer to Priming the Fuel System (page 3–15).
12. Lower and secure operator seat and hood.

Fuel Pump Specifications

Fuel pump specifications for machines with Kubota diesel engine are as follows:

Pump Capacity	**1.9 L/minute (64 fl oz/minute)**
Pressure	48.3 kPa (7 psi)
Current Draw	2.0 A

Fuel Pump (Machine with Kubota Gasoline Engine)

The electric fuel pump assembly used on machines with a Kubota gasoline engine is a combination positive displacement fuel pump and a fuel level sending unit. The fuel pump assembly provides pressurized fuel to the engine fuel rail in a return-less system and includes a regulator to maintain fuel pressure of approximately 276 kPa (40 psi). The fuel pump/sender assembly is attached to the top of the fuel tank.

Electrical power for the fuel pump is available when the fuel pump relay is energized by the engine ECU. The fuel pump electrical circuit is protected by a 15 A fuse that is located in the engine power center.

Note: When the key switch is turned to ON/RUN, the engine ECU energizes the fuel pump relay for approximately 3 seconds which allows the fuel system to be pressurized. Once the engine is running, the fuel pump relay is always energized.

Testing the Fuel Pump

1. Park the machine on a level surface, lower the cutting units, shut off the engine, and set the parking brake. Remove the key from the key switch. Raise and support the hood.

CAUTION

The fuel supply hose will contain pressurized fuel. Be careful when disconnecting fuel supply hose. Wipe up any spilled fuel before starting the engine.

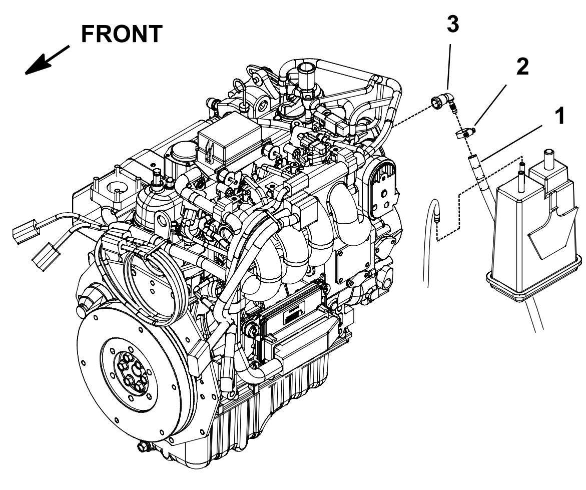

Figure 279

1. Fuel supply hose
2. Hose clamp
3. Fuel fitting

2. Loosen hose clamp that secures fuel supply hose to fuel fitting on engine fuel rail. Carefully disconnect fuel supply hose from fuel fitting (Figure 279).
3. Install a fuel pressure gauge capable of measuring 350 kPa (50 psi) to the disconnected hose.
4. While monitoring pressure gauge, turn key switch to ON/RUN (do not start engine) so that the fuel pump relay and fuel pump are energized. The fuel pressure displayed on the gauge should rise. After pump relay is de-energized (approximately 3 seconds), turn key switch to OFF and then back to ON/RUN (do not start engine) to re-energize the fuel pump relay and fuel pump. Fuel pump pressure should be approximately 276 kPa (40 psi).

Testing the Fuel Pump (continued)

5. If fuel pump pressure is low, ensure that electrical power is available to fuel pump and then consider a clogged fuel filter or damaged fuel pump; refer to Fuel System (page 5–11).
6. After testing is completed, remove pressure gauge from fuel supply hose. Connect fuel supply hose to fuel fitting on engine fuel rail and secure with hose clamp.
7. Lower and secure hood.

CAN-bus Terminator Resistor

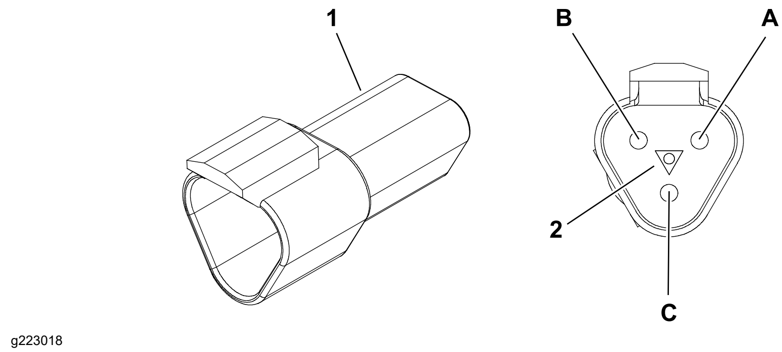

Figure 280

1. CAN-bus terminator resistor
2. Keyway

The system communication between the electrical components on the Reelmaster machine is accomplished on a CAN-bus communication system. The 2 specially designed, twisted cables form the bus for the network are used on the machine. These wires provide the data pathways between the machine components.

The 120 ohm CAN-bus terminator resistor plugs into the main wire harness in the control arm. The resistor can be accessed by removing the left control arm cover.

On machines with a Kubota diesel engine, the second CAN-bus terminator resistor plugs into the engine wire harness near the engine starter motor. The engine wire harness connector has a blue insert to identify the proper location for the terminator resistor.

On machines with a Yanmar diesel engine or Kubota gasoline engine, the second CAN-bus terminator resistor is included in the engine ECU. This resistor cannot be accessed for testing.

Note: The insulator wedge in the terminator resistor is blue for identification purposes. There is also a center keyway to prevent the terminator resistor from plugging into the wrong wire harness connector.

Note: Refer to the Electrical Schematic and Wire Harness Drawings/Diagrams for additional information on the location of the terminator resistor and wire connections.

IMPORTANT

The terminator resistor is required for proper electrical system operation.

Testing the CAN-bus Terminator Resistor

1. The CAN-bus terminator resistor (Figure 280) can be tested using a digital multimeter (ohms setting). Locate the CAN-bus terminator resistor and remove the cable tie that secures the resistor to the wire harness. Unplug the resistor from the wire harness for testing.
2. Use a digital multimeter (ohms setting) to measure the resistance value for the CAN-bus terminator resistor. There should be **120 ohms** resistance between the terminals A and B. The terminal C is not used.
3. If the testing determines that the CAN-bus terminator resistor is damaged, replace the CAN-bus terminator resistor.

Testing the CAN-bus Terminator Resistor (continued)

4. After you complete the testing, ensure that the CAN-bus terminator resistor is fully installed into the wire harness connector and secured to the wire harness with cable tie.

Resistor Assembly (Machine with Yanmar Diesel or Kubota Gasoline Engine)

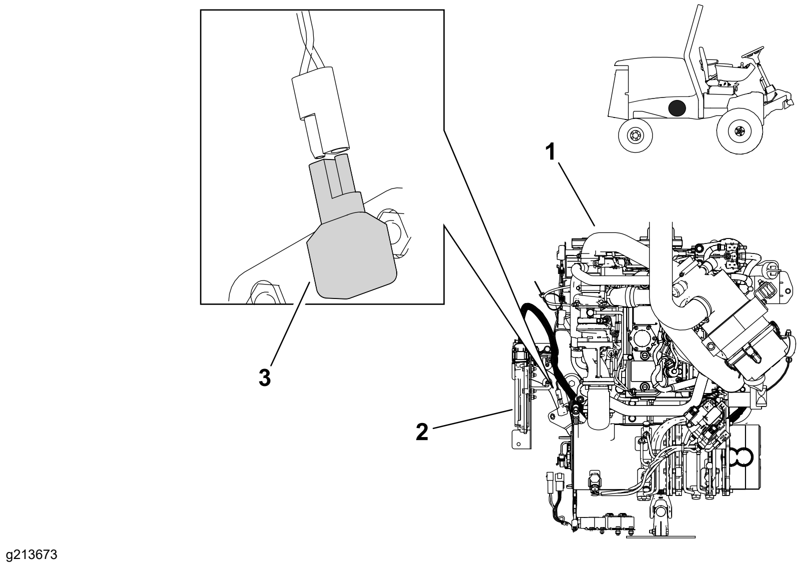

Figure 281

1. Engine
2. Engine ECU
3. 75 ohm resistor

On machines with a Yanmar diesel engine or Kubota gasoline engine, a 75 ohm resistor (Figure 281) is necessary for proper key switch operation on all Reelmaster machines. The resistor plugs into the engine wire harness near the engine ECU; refer to the Engine Wire Harness Drawing/Diagram in Appendix A (page A–1).

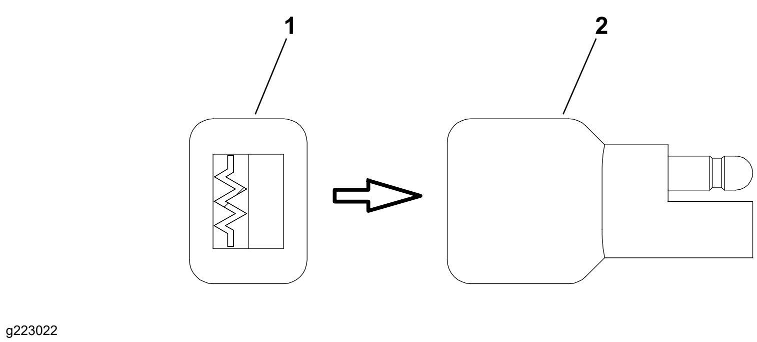

Figure 282

1. End of the resistor body
2. Resistor assembly

The resistor assembly can be identified by its gray color and resistor symbol on the end of the resistor assembly body (Figure 282).

Testing the Resistor Assembly

1. Park the machine on a level surface, set the parking brake, lower the cutting units, and shut off the engine, and remove the key from the key switch.
2. Locate the resistor assembly in the engine wire harness and remove the cable tie that secures the resistor to the wire harness. Unplug the resistor from the wire harness for testing.
3. Use a digital multimeter (ohms setting) to measure the resistance value for the resistor. The resistance across the resistor terminals should be **75** ohms.

Testing the Resistor Assembly (continued)

4. If the testing determines that the resistor is damaged, replace the resistor assembly.
5. After you complete the testing, ensure that the resistor is fully installed into the wire harness connector and secured to the wire harness with cable tie.

Diode Assemblies (Diesel Engine)

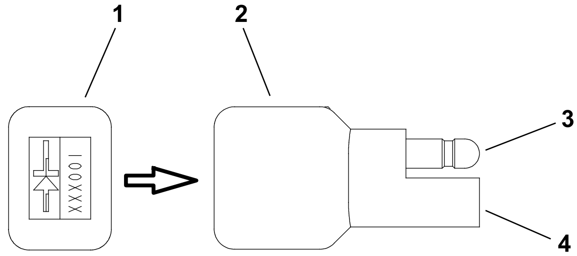

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Figure 283

1. End of the diode body
2. Diode assembly
3. Male terminal
4. Female terminal

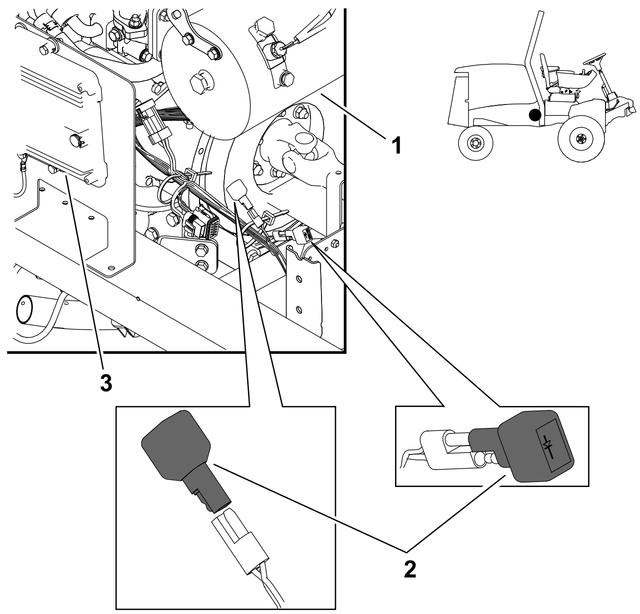

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Figure 284

1. Diesel-particulate filter (DPF)
2. Diode (2 each)
3. Engine ECU

The engine wire harness on machines with either a Kubota or Yanmar diesel engine includes 2 identical diodes. The maximum current allowed through any of the diodes is 6 A. The diode assemblies can be identified by a black color, diode symbol, and Toro Part Number on the end of the diode assembly body (Figure 283). The 2 diodes plug into the engine wire harness near the Yanmar engine ECU (Figure 284); refer to the Engine Wire Harness Drawing/Diagram in Appendix A (page A–1).

A diode assembly (D1) is used for circuit protection from the voltage spikes that occur when the engine starter solenoid is de-energized.

A diode assembly (D2) is used to protect the engine ECU from reverse polarity in the EGR relay circuit.

Testing the Diode Assembly

1. Park the machine on a level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.

Testing the Diode Assembly (continued)

2. Locate the diode assembly that is to be tested and remove the cable tie that secures the diode to the wire harness. Unplug the diode from the wire harness for testing.
3. The diode (Figure 283) can be tested by using a digital multimeter (diode test or ohms setting) and the Diode Test Table (page 7–119).
4. Replace the diode assembly if testing determines that the diode is damaged.
5. After you complete the testing, ensure that the diode is fully installed into the wire harness connector and secured to the harness with cable tie.

Diode Test Table

Multimeter Red Lead (+) on Terminal	Multimeter Black Lead (-) on Terminal	Continuity
Female	Male	Yes
Male	Female	No

Service and Repairs

Note: Refer to the appropriate engine service manual for engine electrical component repair information.

Hydraulic Solenoid Valve Coils

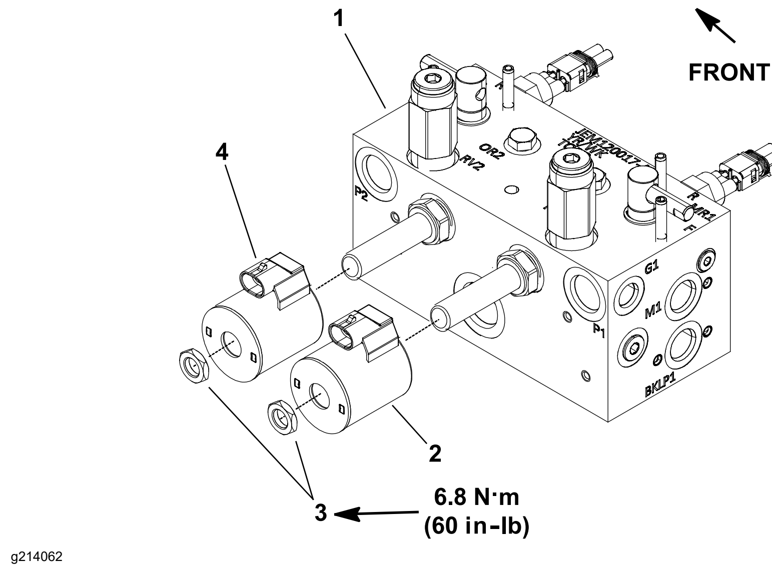

Figure 285

1. Mow control manifold
2. Solenoid coil MSV1
3. Nut
4. Solenoid coil MSV2

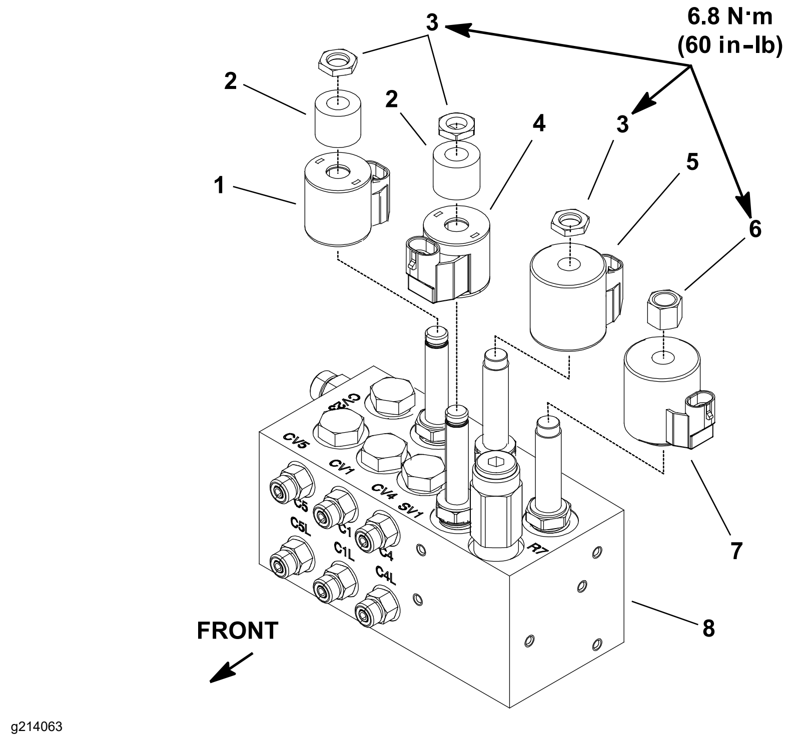

Figure 286

1. Solenoid coil SV3
2. Coil spacer
3. Nut
4. Solenoid coil SV1
5. Solenoid coil SV2
6. Nut
7. Solenoid coil SVRV
8. Lift control manifold

You can replace a hydraulic solenoid valve coil on the mow control manifold (Figure 285) or lift control manifold (Figure 286) without opening the hydraulic system.

Removing the Hydraulic Solenoid Valve Coils

1. Park the machine on a level surface, lower the cutting units, set the parking brake, shut off the engine, and remove the key from the key switch.
2. Locate the solenoid valve coil that you replace.
   A. Tilt the operator seat up to get access to the mow control manifold. Refer to Figure 285 for the location of solenoid coils on the mow control manifold.
   B. The lift control manifold is attached to a frame bracket under the operator floor plate. To get access to the lift control manifold, remove the operator floor plate. Refer to Figure 286 for the location of solenoid coils on the lift control manifold.
3. Disconnect the wire harness electrical connector from the solenoid valve coil that you replace. Note the orientation of the electrical connector on the coil for assembly purposes.
4. Remove the nut from the hydraulic valve.
5. If equipped (SV1 or SV3 on the lift control manifold), remove the coil spacer from the hydraulic valve.
6. Slide the solenoid coil from the valve.
7. Clean any corrosion or dirt from the valve.

   Note: If the cartridge valve needs to be removed or installed; refer to Servicing a Control Manifold Cartridge Valve (page 6–199).

Installing the Hydraulic Solenoid Valve Coils

1. Slide the coil assembly onto the hydraulic valve. Position the coil so that the connector is properly orientated.
2. If equipped (SV1 and SV3 on the lift control manifold), slide the coil spacer onto the hydraulic valve.
3. Install the nut onto the valve and torque the nut to **6.8 N·m (60 in-lb)**.

   Note: Do not overtighten the nut.
4. Connect the main wire harness connector to the solenoid coil.
5. Lower and secure the seat if the mow control manifold was accessed. Install the operator floor plate if the lift control manifold was accessed.

Backlap Switches

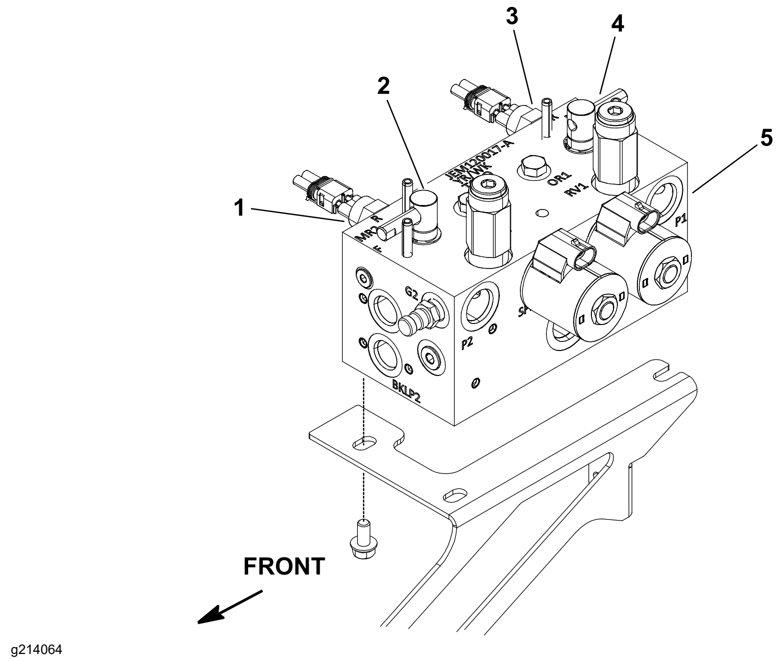

Figure 287

1. Front backlap switch
2. Front backlap lever
3. Rear backlap switch
4. Rear backlap lever
5. Mow control manifold

The backlap switches are attached to the hydraulic mow control manifold under the operator seat on the right side of the machine.

Note: Before removing a backlap switch, the switch and its circuit wiring can be tested as a Toro Electronic Controller (TEC) input with the InfoCenter display; refer to Using the InfoCenter Display for Troubleshooting (page 7–28).

Removing the Backlap Switches

1. Park the machine on a level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Raise and support the operator seat to get access to the hydraulic mow control manifold.
3. Locate the backlap switch on the mow control manifold that you replace (Figure 287).
4. Disconnect the wire harness electrical connector from the backlap switch that is to be removed.
5. Loosen and remove the backlap switch from the hydraulic manifold. Remove and discard the O-ring from the switch.

Installing the Backlap Switches

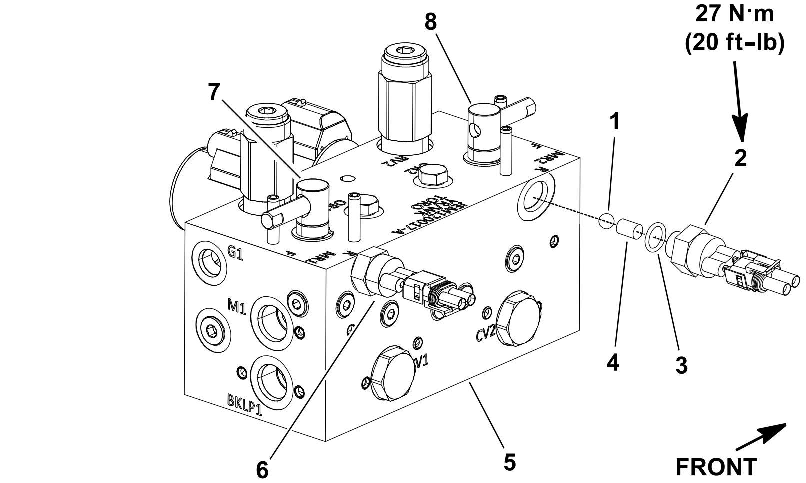

Figure 288

1.	Ball	3.	O-ring	5.	Mow control manifold
2.	Front backlap switch	4.	Dowel pin	6.	Rear backlap switch

1. Ensure that the dowel pin and ball are placed in the manifold port as shown in Figure 288.
2. Install the backlap switch with new O-ring into the manifold port and torque the switch to **27 N·m (20 ft-lb)**.
3. Connect the harness electrical connector to the backlap switch. Use the InfoCenter display (refer to Diagnostics Screen (page 7–19) (Backlap item)) to verify that the backlap switches are functioning correctly.
4. Lower the operator seat.

Battery Storage

If you store the machine for more than 30 days:

1. Ensure that the key switch is in the OFF position. Remove the battery and charge it fully; refer to Servicing the Battery (page 7–125).
2. Either store the battery on a shelf or on the machine.
3. Disconnect the cables if the battery is kept on the machine.
4. Store the battery in a cool atmosphere to avoid quick deterioration of the battery charge.
5. To prevent the battery from freezing during storage, ensure that you charge it fully; refer to Servicing the Battery (page 7–125).

Battery Care

1. The 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 the temperatures are extremely high, the battery will discharge more rapidly than if the machine is stored in a location where the temperatures are cool.

WARNING

The gases are explosive; also, they can cause nausea.

- **Wear safety goggles and rubber gloves when working with electrolyte. Charge the battery in a well ventilated place so that the gasses produced while charging can dissipate.**
- **Keep open flames and electrical sparks away from the battery; do not smoke.**
- **Disconnect the charger from the electrical outlet before connecting or disconnecting charger leads to or from the battery posts.**

IMPORTANT

Do not remove battery fill caps while cleaning.

2. Check the battery condition weekly or after every 50 hours of operation. Keep the terminals and entire battery case clean because a dirty battery will discharge slowly.
   A. Clean the battery by washing entire case with a solution of baking soda and water. Flush the battery case with clear water.
   B. Coat the battery posts and cable connectors with the battery terminal protector (refer to Terminal Protector (page 7–7)) or petroleum jelly to prevent corrosion.
3. Tighten the battery cables on the battery terminals to provide a good electrical contact.

Battery Care (continued)

⚠ WARNING ⚠

Connecting the cables to the wrong battery post could result in personal injury and/or damage to the electrical system.

Ensure that the cables are properly connected to the correct battery posts before operating the machine.

4. If corrosion occurs at the battery terminals, disconnect the cables. Always disconnect the negative (-) cable first. Clean the cable clamps and terminals separately. Connect the cables with the positive (+) cable first. Apply a layer of terminal protector (Toro Part No. 107-0392) or a light coat of petroleum jelly to the terminals to reduce corrosion after you make the connections.
5. Check the battery-electrolyte level every 25 operating hours and every 30 days if machine is in storage.
6. Maintain the cell level with the distilled or demineralized water.

   Note: Do not fill the cells above the fill line.

Servicing the Battery

The battery is the heart of the electrical system. With the regular and correct service, the battery life can be extended. Additionally, the battery and electrical component failure can be prevented.

⚠ CAUTION ⚠

Battery-electrolyte is corrosive and can burn skin and eyes and damage clothing.

While working with the batteries, use extreme caution to avoid splashing or spilling of the electrolyte. Always wear the safety goggles and a face shield while working with batteries.

Battery Specifications

Battery-electrolyte specific gravity	Fully Charged: 1.250 to 1.280 Discharged: less than 1.240
Battery specifications	BCI Group Size: 55 585 CCA at -18°C (0°F) Reserve Capacity of 75 minutes at 27°C (80°F)
Battery dimensions (including terminal posts and caps)	Length 23.1 cm (9.1 inches) Width 15.2 cm (6.0 inches) Height 21.6 cm (8.5 inches)

Removing and Installing the Battery

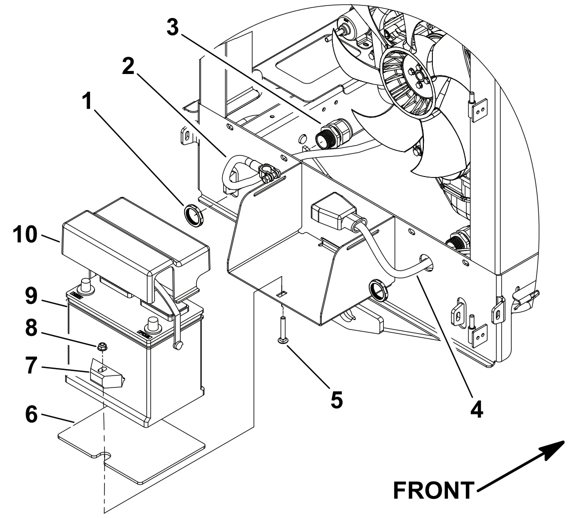

Figure 289

1. Cord grip locknut	5. Carriage screw	9. Battery (rear location)
2. Negative cable	6. Battery mat	10. Battery cover
3. Cord grip	7. Battery retainer	
4. Positive cable	8. Flange nut	

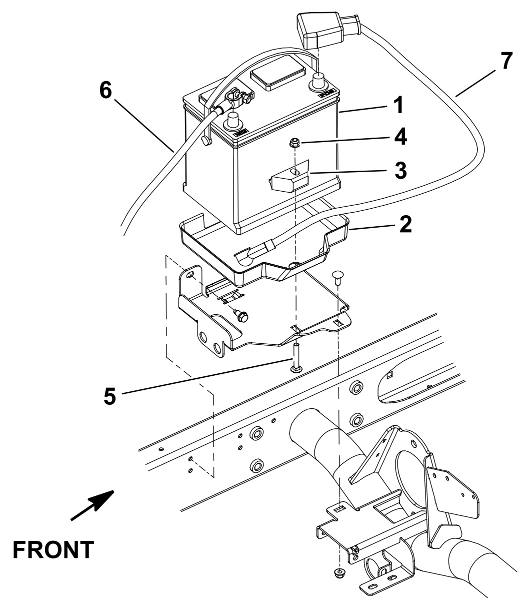

Figure 290

1. Battery (under hood)	4. Flange nut	7. Positive battery cable
2. Battery tray	5. Carriage screw	
3. Retainer	6. Negative battery cable	

The battery on machines with a Yanmar diesel engine or a Kubota gasoline engine is located at the rear of the machine (Figure 289). The battery on machines with a Kubota diesel engine is located in front of the engine under the hood (Figure 290).

1. Park the machine on level surface, lower the cutting units, shut off the engine, apply parking brake, and remove the key from the key switch.

Removing and Installing the Battery (continued)

2. Open screen at rear of the machine or raise and support hood to access the battery. Remove the battery cover (if equipped).

IMPORTANT

Be careful when removing the battery cables and ensure that you do not damage the terminal posts or cable connectors.

3. Loosen and remove the negative (-) cable from the battery. After you disconnect the negative cable from the battery, loosen and remove the positive cable (+) from the battery.
4. Remove the flange nut, carriage screw, and battery retainer that secure the battery.
5. Carefully remove the battery from the machine.
6. Install the battery in reverse order and ensure to connect and tighten the positive (+) cable to the battery before connecting negative (-) cable. Use 2 wrenches when tightening the cables.

   Note: Before connecting the negative (ground) cable to the battery, connect a digital multimeter (set to DC Amps) between the negative battery post and the negative (ground) cable connector. The reading should be less than 0.1 A. If the reading is 0.1 A or more, the electrical system of the machine should be tested for short circuits or damaged components and repaired.
7. Coat battery posts and cable connectors with battery terminal protector (Toro Part No. 107-0392) or petroleum jelly to prevent corrosion.
8. Install the battery cover (if equipped). Close and secure the screen or hood.

Inspecting, Maintaining, and Testing the Battery

1. Do the following inspections and maintenance:
   A. Check for cracks. Replace the battery if cracked or leaking.
   B. Check the battery terminal posts for corrosion. Use the wire brush to clean corrosion from the posts.

   IMPORTANT

   Before cleaning the battery, tape or block the vent holes of the filler caps and ensure that the caps are tight.

   C. Check for the 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 and water, then rinse it with clean water.
   D. Check that the cover seal is not broken away. Replace the battery if the seal is broken or leaking.
   E. Check the electrolyte level in each cell. If the level is below the tops of the plates in any cell, fill all the cells with distilled water between the minimum and maximum fill lines. Charge at 15 to 25 A for 15 minutes to allow sufficient mixing of the electrolyte; refer to Charging the Battery (page 7–129).
2. Perform the hydrometer test of the battery-electrolyte.

IMPORTANT

Ensure that the area around the cells is clean before opening the battery caps.

A. Use a hydrometer to measure the specific gravity of each cell. Pull the electrolyte in and out of the hydrometer barrel before 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 5.5°C (10°F) above 27°C (80°F) add 0.004 to the specific gravity reading. For each 5.5°C (10°F) below 27°C (80°F) subtract 0.004 from the specific gravity reading; refer to the Cell Specific Gravity Example (page 7–128).

Cell Specific Gravity Example

Cell Temperature	100°F
Cell Specific Gravity	1.245
38°C minus 27°C equals 11°C (100°F minus 80°F equals 20°F)	
11°C multiply by 0.004/5.5°C equals 0.008 (20°F multiply by 0.004/10°F equals 0.008)	
ADD (conversion above)	0.008
Correction to 27°C (80°F)	1.253

C. If the difference between the highest and lowest cell specific gravity is 0.050 or more or the lowest cell specific gravity is less than 1.225, charge the battery.

D. Charge at the rate and time given in Charging the Battery (page 7–129) or until all cells specific gravity is 1.225 or greater with the difference in specific gravity between the highest and lowest cell is less than 0.050. If you can not meet these charging conditions, replace the battery.

3. Do a high-discharge test with an adjustable load tester. This is 1 of the most reliable means of testing a battery as it simulates the cold-cranking test. A commercial battery load tester is required to do this test.

CAUTION

Follow the manufacturer's instructions when using a battery load tester.

A. Check the voltage across the battery terminals before testing the battery. If the voltage is less than 12.4 VDC, charge the battery before continuing the test; refer to Charging the Battery (page 7–129).

B. Ensure that the battery terminals are free of corrosion.

C. Measure the electrolyte temperature of the center battery cell.

D. Connect a battery load tester to the battery terminals following the manufacturer's instructions. Connect a digital multimeter to the battery terminals.

Inspecting, Maintaining, and Testing the Battery (continued)

E. If you charge the battery, apply a 150 A load for 15 seconds to remove the surface charge. Wait for 10 minutes before proceeding with load test.

F. Apply a test load of 270 A (1/2 the cranking performance rating of the battery) for 15 seconds.

G. After test load has been applied for 15 seconds, take a test voltage reading and then remove the load. Record the test voltage reading.

H. Use the Minimum Voltage Table (page 7–129), determine the minimum voltage for the center cell electrolyte temperature reading.

Minimum Voltage Table

Minimum Voltage	Battery-Electrolyte Temperature	
9.6	70°F (and up)	21.1°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, replace the battery. If the test voltage is at or above the minimum, return the battery to service.

4. After you make the connections, apply terminal protector (Toro Part No. 107-0392) or a light layer of grease on all the battery posts and cable connectors to reduce corrosion.

Charging the Battery

To minimize damage to the battery and allow the battery to charge fully, do the following slow charging procedure. You can do this charging procedure with a constant current battery charger that is locally available.

IMPORTANT

Follow the manufacturer's instructions when using a battery charger.

Note: Using specific gravity of the battery cells is the most accurate procedure of determining the 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

Charging the Battery (continued)

2. Determine the charging time and rate using the manufacturer's battery charger instructions or the following Battery Charge Level Table (page 7–130).

Battery Charge Level Table

Battery Reserve Capacity (Minutes)	Battery Charge Level (Percent of Fully Charged)			
	75%	50%	25%	0%
80 or less	3.8 hrs @ 3 A	7.5 hrs @ 3 A	11.3 hrs @ 3 A	15 hrs @ 3 A
81 to 125	5.3 hrs @ 4 A	10.5 hrs @ 4 A	15.8 hrs @ 4 A	21 hrs @ 4 A
126 to 170	5.5 hrs @ 5 A	11 hrs @ 5 A	16.5 hrs @ 5 A	22 hrs @ 5 A
171 to 250	5.8 hrs @ 6 A	11.5 hrs @ 6 A	17.3 hrs @ 6 A	23 hrs @ 6 A
above 250	6 hrs @ 10 A	12 hrs @ 10 A	18 hrs @ 10 A	24 hrs @ 10 A

CAUTION

Charging a frozen battery can cause explosion and can cause personal injury. Let the battery warm to 15.5°C (60°F) before connecting to a charger.

- **Charge the battery in a well-ventilated place to dissipate the gases produced from the charging.**
- **These gases are explosive; keep open flame and electrical spark away from the battery. Do not smoke.**
- **Inhaling the battery gases can cause nausea.**
- **Unplug the charger from the electrical outlet before connecting or disconnecting the charger leads from the battery posts.**

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3. Follow the battery charger manufacturer's instructions, connect the charger cables to the battery posts. Ensure that you make a good connection.
4. Charge the battery following the manufacturer's instructions.
5. Occasionally check the temperature of the battery-electrolyte. If the temperature is more than 52°C (125°F) or the electrolyte is violently gassing or spewing, lower and temporarily stop the charging rate.

Charging the Battery (continued)

6. Three hours before the end of the charging, measure the specific gravity of a battery cell once per hour.

   Note: 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 3 consecutive readings.

Chassis

Table of Contents

Specifications

Chassis

Item	Description
Front tire pressure (26.5×14.0-12, 4 ply, tubeless)	83 to 103 kPa (12 to 15 psi)
Rear tire pressure (20×12.0-10, 4 ply, tubeless)	83 to 103 kPa (12 to 15 psi)
Wheel lug nut torque	95 to 122 N·m (70 to 90 ft-lb)
Steering control valve mounting screws	9.5 to 13.5 N·m (84 to 120 in-lb) (tighten in a criss-cross pattern)
Steering wheel mounting nut	28 to 35 N·m (20 to 26 ft-lb)
Front wheel motor/wheel hub locknut torque	407 to 542 N·m (300 to 400 ft-lb)
Rear wheel motor/wheel hub locknut torque (machines with CrossTrax AWD installed)	366 to 447 N·m (270 to 330 ft-lb)
Wheel motor mounting bolts	109 to 135 N·m (80 to 100 ft-lb)
Rear axle pivot pin nut	123 to 162 N·m (90 to 120 ft-lb)
Lift arm pin retainer plate bolts	102 to 128 N·m (75 to 95 ft-lb) (use medium strength threadlocker)
Lift arm pivot bolts	183 to 223 N·m (135 to 165 ft-lb) (use medium strength threadlocker)

General Information

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

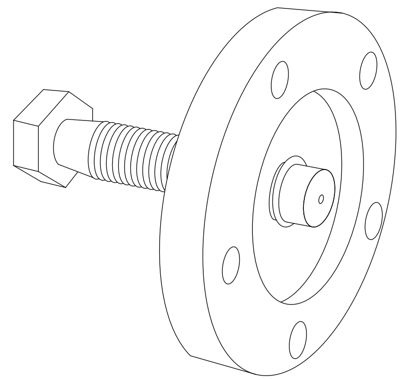
Special Tools

You can order the special tools from your Toro Distributor.

Wheel Hub Puller

Toro Part No. TOR6004

The wheel hub puller allows you to safely remove the wheel hub from the wheel motor shaft. If the machine is equipped with the optional CrossTrax™ Kit, this wheel hub puller is necessary for removing the rear wheel hub from the rear wheel motor.



Service and Repairs

Wheels

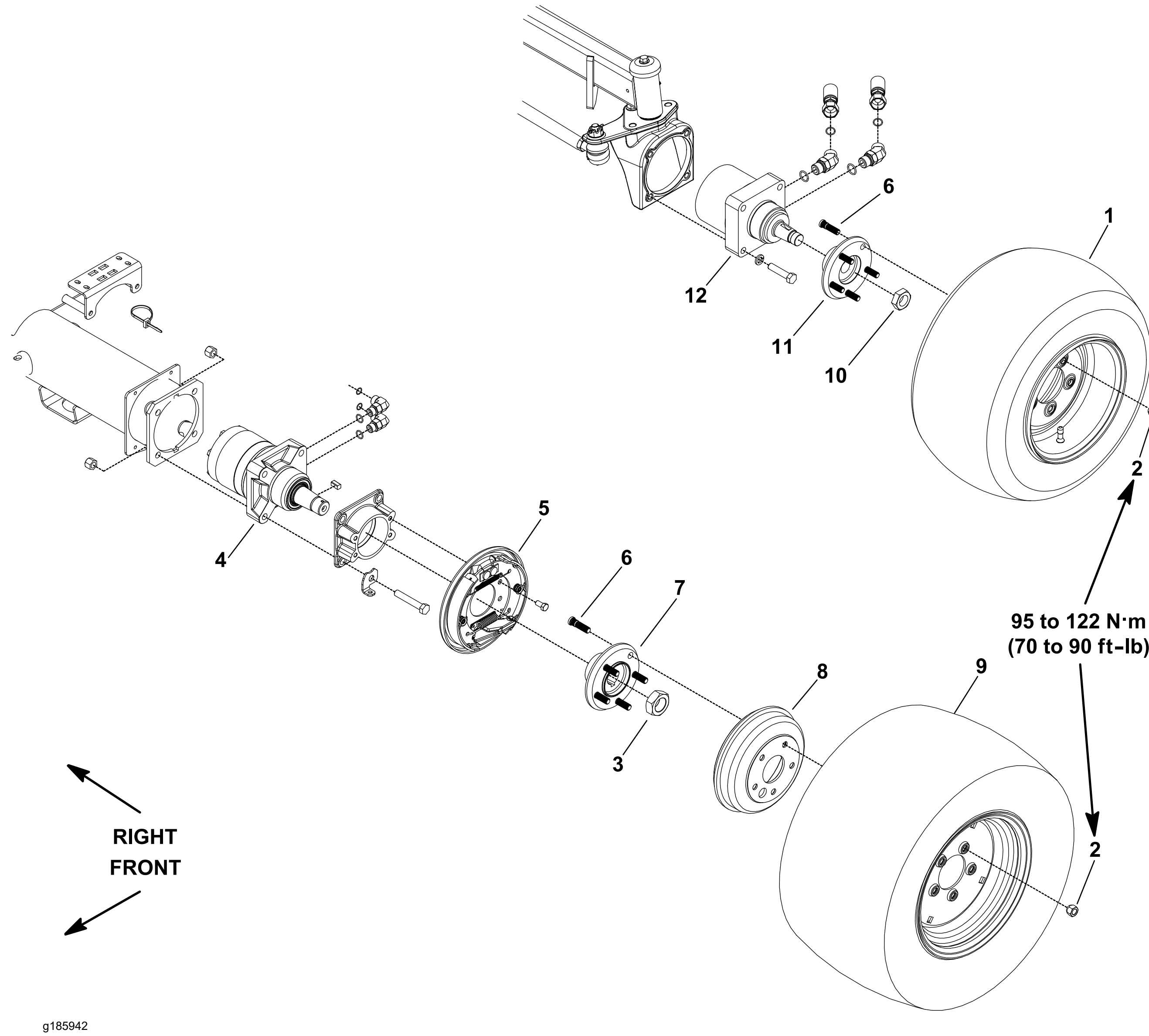


Figure 291

Drive axles from machines with 4-wheel drive

1. Rear wheel
2. Wheel-lug nut (5 each per wheel)
3. Locknut
4. Front wheel motor (left)
5. Brake assembly (left)
6. Wheel stud (5 each per hub)
7. Front wheel hub
8. Brake drum
9. Front wheel
10. Locknut
11. Rear wheel hub
12. Rear wheel motor (left)

Removing the Wheel

1. Park the machine on a level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Block the wheels that are not removed with chocks to prevent the machine from moving.
3. Loosen, but do not remove the 5 wheel-lug nuts that attach the wheel to the machine.

IMPORTANT

Before lifting the machine with a jack, review and follow Jacking Instructions (page 1–6).

4. Lift the machine with a jack until the wheel to be removed is off the ground. Support the machine with appropriate jack stands.
5. Remove the 5 wheel-lug nuts that attach the wheel to the machine, and remove the wheel.

Installing the Wheel

1. Install the wheel to the machine with the 5 wheel-lug nuts.
2. Lower the machine to the ground.

WARNING

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

Maintain the proper torque of the wheel-lug nuts.

3. Torque the wheel-lug nuts evenly to **95 to 122 N·m (70 to 90 ft-lb)** in a crossing pattern.
4. Check and adjust the tire pressures; refer to Specifications (page 8–2).

Steering Column

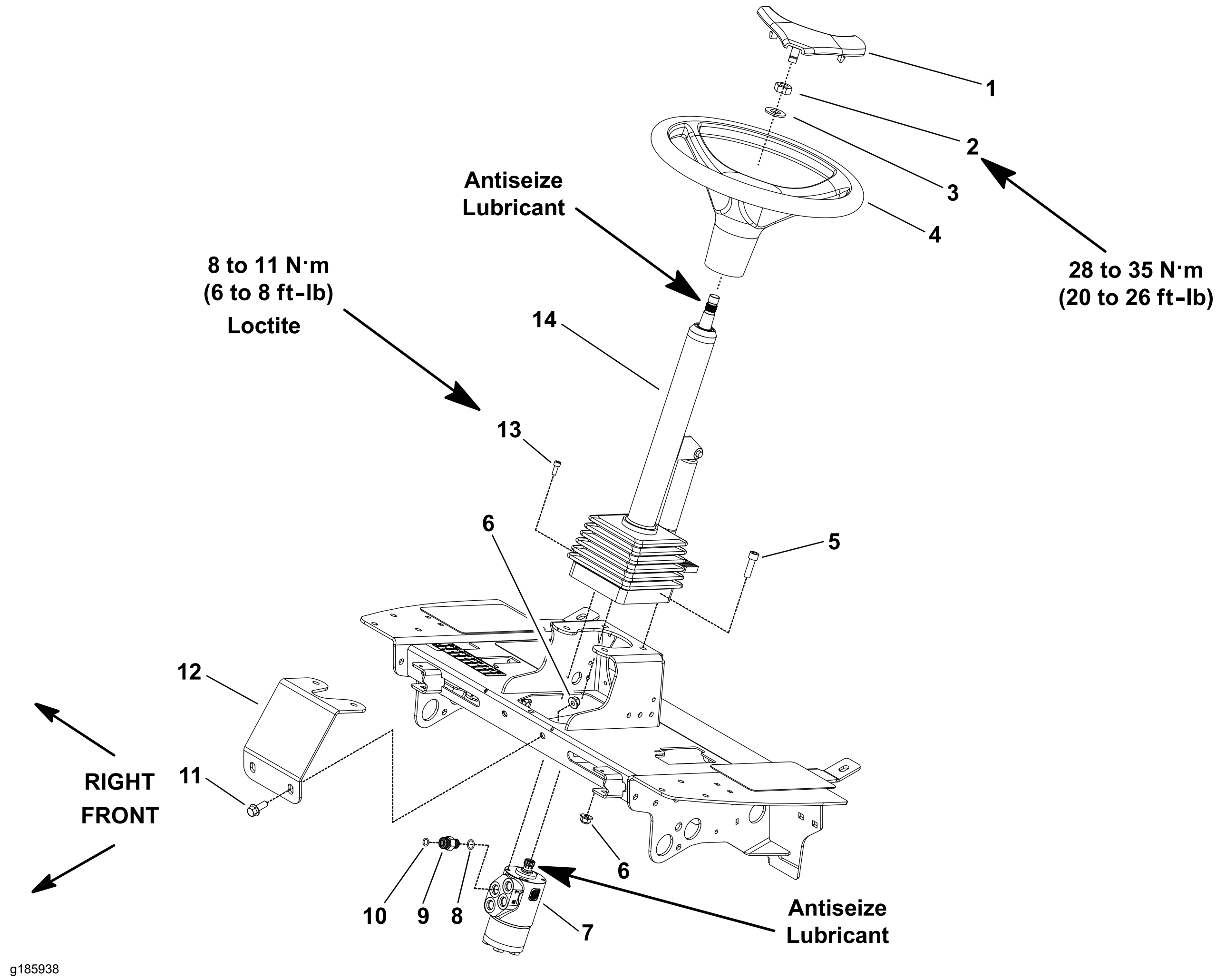


Figure 292

1.	Steering wheel cover	6.	Flange nut (6 each)	11.	Flange-head screw (2 each)
2.	Locknut	7.	Steering control valve	12.	Column brace
3.	Flat washer	8.	O-ring (4 each)	13.	Socket-head screw (4 each)
4.	Steering wheel	9.	Straight hydraulic fitting (4 each)	14.	Steering column assembly
5.	Socket-head screw (4 each)	10.	O-ring (4 each)		

Removing the Steering Column

1. Park the machine on a level surface, set the parking brake, lower the cutting units, shut off the engine, and remove the key from the key switch.
2. Remove the steering wheel cover (item 1 in Figure 292) from the steering wheel by carefully prying up on one of the cover spokes.
3. Remove the locknut (item 2 in Figure 292) and flat washer that secure the steering wheel to the steering column.
4. Use a suitable puller to remove the steering wheel from the steering column assembly (item 14 in Figure 292).

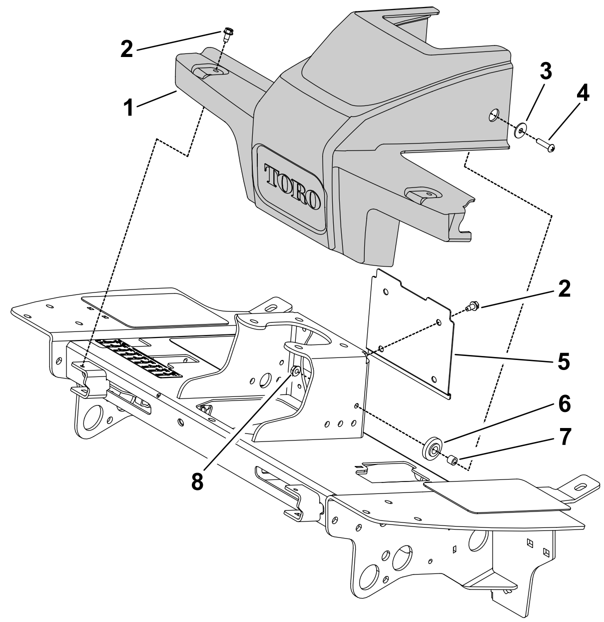


Figure 293

1.	Platform shroud	3.	Washer (2 each)	5.	Cover plate	7.	Spacer (2 each)
2.	Washer-head screw (6 each)	4.	Screw (2 each)	6.	Bushing (2 each)	8.	Flange nut (2 each)

5. Remove the platform shroud (item 1 in Figure 293) from the machine to get access to the steering column fasteners as follows:
   A. Remove the cover plate from the platform.
   B. Remove the platform shroud from the machine.
   C. Locate and retrieve the 2 rubber bushings and 2 spacers.
6. Slide the rubber bellows up the steering column to get access to the fasteners that secure the steering column to the machine.
7. Support the steering control valve (item 7 in Figure 292) to prevent it from falling during the steering column removal.

   Note: Do not allow the steering control valve to hang from the hydraulic lines.
8. Loosen and remove the 4 socket-head screws (item 13 in Figure 292) that secure the steering control valve to the steering column.
9. Loosen and remove the 4 socket-head screws (item 5 in Figure 292) and 4 flange nuts that secure the steering column to the machine.
10. Slide the steering column assembly from the steering control valve and the machine.
11. Disassemble the steering column assembly as necessary (Figure 294).

Installing the Steering Column

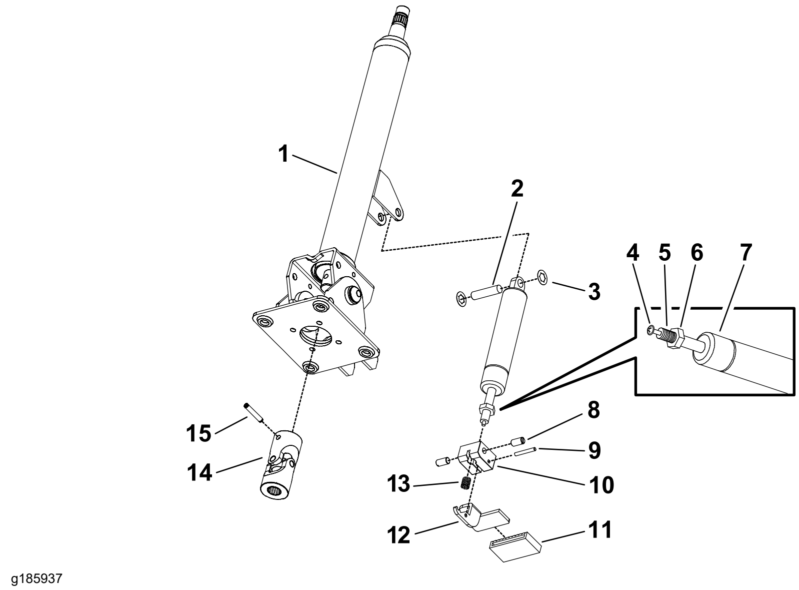


Figure 294

1.	Steering column	5.	Cylinder shaft	9.	Pin	13.	Spring
2.	Pin	6.	Jam nut	10.	Pedal block	14.	Universal joint
3.	Lock washer (2 each)	7.	Cylinder	11.	Pedal cover	15.	Pin
4.	Release pin	8.	Bolt (2 each)	12.	Pedal		

1. Assemble the steering column (Figure 294). After assembly, ensure that the release pin on the end of the cylinder shaft is positioned against the pedal. The jam nut on the cylinder shaft can be used to adjust the location of the release pin.
2. Apply anti-seize lubricant to the input shaft of the steering control valve (item 7 in Figure 292).
3. Slide the steering column assembly (item 14 in Figure 292) onto the steering control valve. Secure the steering column in place with the 4 socket-head screws (item 5 in Figure 292) and 4 flange nuts.
4. Secure the steering control valve to the steering column with the 4 socket-head screws (item 13 in Figure 292); torque the socket-head screws to **9.5 to 13.5 N·m (84 to 120 in-lb)** in a criss-cross pattern.
5. Slide the rubber bellows to the bottom of the steering column.
6. Place the 2 rubber bushings and 2 spacers into the holes of the platform shroud (Figure 293). Position the platform shroud in place and secure with the fasteners that were removed.
7. Install the cover plate to the platform.
8. Clean the tapered surfaces of the steering wheel (item 4 in Figure 292) and steering column.
9. Apply anti-seize lubricant to the splines of steering column and ensure to keep the anti-seize lubricant from the steering column taper. Slide the steering wheel onto the steering column.
10. Secure the steering wheel to the steering column assembly with the flat washer and locknut; torque the locknut to **28 to 35 N·m (20 to 26 ft-lb)**.
11. Install the steering wheel cover (item 1 in Figure 292) onto the steering wheel.

Servicing the Brakes

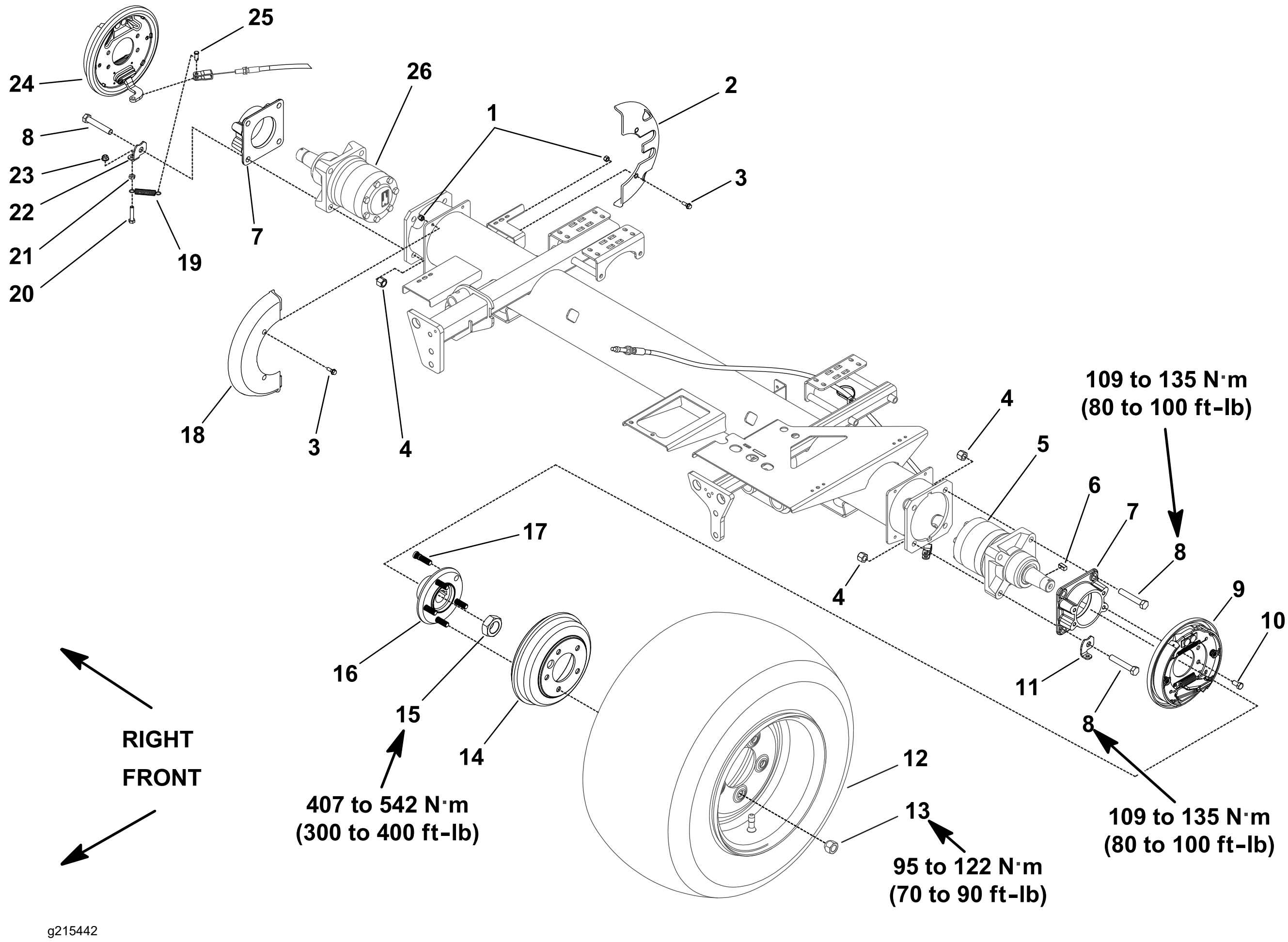


Figure 295

1. Locknut (2 each per wheel shield)
2. Wheel shield (right rear)
3. Flange-head screw (2 each per wheel shield)
4. Locknut (4 each per wheel motor)
5. Left wheel motor
6. Square key (2 each)
7. Brake adapter (2 each)
8. Bolt (4 each per wheel motor)
9. Left brake assembly
10. Bolt (4 each per brake assembly)
11. Left spring clip
12. Front wheel (left)
13. Wheel-lug nut (5 each per wheel)
14. Brake drum (2 each)
15. Locknut (2 each)
16. Wheel hub
17. Wheel stud (5 each per hub)
18. Front wheel shield (right front)
19. Brake return spring (2 each)
20. Bolt (2 each)
21. Jam nut (2 each)
22. Right spring clip
23. Flange nut (2 each)
24. Right brake assembly
25. Clevis pin (2 each)
26. Right wheel motor

Disassembling the Brake

1. Park the machine on a level surface, lower the cutting units, shut off the engine, and remove the key from the key switch.
2. Block the rear wheels with chocks to prevent the machine from moving.
3. Remove the front wheel assembly; refer to Removing the Wheel (page 8–6).
4. Ensure that the parking brake is disengaged.

   Note: The clevis pin (item 25 in Figure 295) that secures the brake cable to the brake actuator lever is secured with the brake return spring.

Disassembling the Brake (continued)

5. Remove the brake return spring (item 19 in Figure 295) and clevis pin that attach the brake cable to the brake actuator lever.
6. Remove the brake drum (item 14 in Figure 295) from the brake assembly.

IMPORTANT

Do not hit the wheel hub, wheel-hub puller, or wheel motor with a hammer while removing or installing the wheel hub. Hammering can damage the wheel motor.

7. Ensure that the locknut (item 15 in Figure 295) on the wheel motor shaft is loosened at least to 2 turns. Use a hub puller (refer to Special Tools (page 8–4)) to loosen the wheel hub from the wheel motor shaft.
8. Remove the locknut and wheel hub from the motor shaft. Discard the locknut. Locate and retrieve the square key.

   Note: If necessary, the complete brake assembly can be removed from the machine for disassembly (refer to step 12).

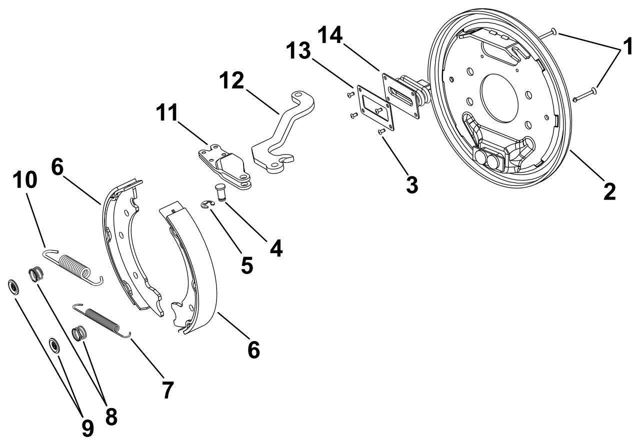


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Figure 296

1.	Hold-down pin (2 each)	6.	Brake shoe (2 each)	11.	Brake actuator
2.	Backing plate	7.	Shoe spring	12.	Brake actuator lever
3.	Rivet (4 each)	8.	Hold-down spring (2 each)	13.	Back-up plate
4.	Clevis pin	9.	Hold-down cup (2 each)	14.	Boot
5.	Retaining ring	10.	Shoe spring (actuator)		

9. Remove the 2 shoe springs (items 10 and 7 in Figure 296) from the brake shoes.
10. Remove the 2 hold-down cups (item 9 in Figure 296) and 2 hold-down springs.
11. Remove the 2 brake shoes (item 6 in Figure 296) and 2 hold-down pins from the backing plate.
12. If necessary, remove the 4 bolts (item 10 in Figure 295) to remove the brake backing plate from the brake adapter.

Assembling the Brake

1. Use a wire brush to remove rust and unwanted material from all the brake parts before the installation. Clean all the parts.

Assembling the Brake (continued)

2. Visually examine the brake shoes and contact surfaces of the brake drum for excessive wear. Replace the parts that are worn and damaged.
3. If the brake backing plate was removed from the machine, secure the backing plate to the brake adapter with the 4 bolts (item 10 in Figure 295).
4. Lightly lubricate the brake shoe pivot points with general purpose grease.
5. Position the brake shoe to the backing plate. Install the hold-down pin and secure with the hold-down spring and hold-down cup. Repeat for the second brake shoe.

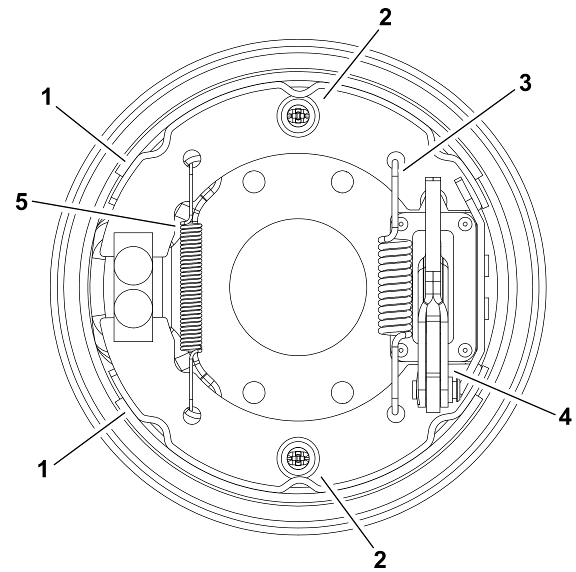

Figure 297

1. Brake shoe
2. Hold-down components
3. Shoe spring (actuator)
4. Brake actuator
5. Shoe spring

Note: The shoe spring (actuator) must be installed at the actuator end of the brake shoes.

6. Install the 2 shoe springs (items 10 and 7 in Figure 296) to the brake shoes. Ensure that the brake shoes are properly positioned to the pivot and actuator points.

IMPORTANT

Before installing the wheel hub, clean the tapers of the wheel hub and wheel motor shaft. Ensure that the tapers are free of grease, oil, rust, and dirt. Do not use anti-seize lubricant, when you install the wheel hub.

7. Mount the square key in the wheel motor shaft, and then install the wheel hub onto the wheel motor shaft.

IMPORTANT

Do not use the locknut previously removed to attach the wheel hub to the wheel motor.

Assembling the Brake (continued)

8. Install new locknut (item 15 in Figure 295) onto the wheel motor shaft to secure the wheel hub to the motor shaft.
9. Install the brake drum (item 14 in Figure 295).
10. Position the end of the brake cable to the brake actuator lever (item 12 in Figure 296). Attach the cable to the brake actuator lever with the clevis pin and brake return spring.
11. Install the front wheel assembly; refer to Installing the Wheel (page 8–6).
12. Check and adjust the brakes; refer to the *Operator's Manual*.
13. Lower the machine to the ground.

WARNING

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

Maintain the proper torque of the wheel-lug nuts.

14. Torque the wheel hub locknut (item 15 in Figure 295) that secures the wheel hub to **407 to 542 N·m (300 to 400 ft-lb)**.

CAUTION

After servicing the brakes, always check the brakes for proper operation in a wide open, level area that is free of other persons and obstructions.

15. Check for the operation of the brake, before you return the machine to operation.

Burnish Brake Pads

After the brake pad replacement, burnish (break-in) the brakes before use.

1. Bring the machine to full speed and apply the brakes to rapidly stop the machine without skidding or locking up the wheels.
2. Repeat this procedure for 10 times. To avoid overheating the brakes, wait 1 minute between each stop.

Rear Wheel Bearings (Machines with 2-Wheel Drive)

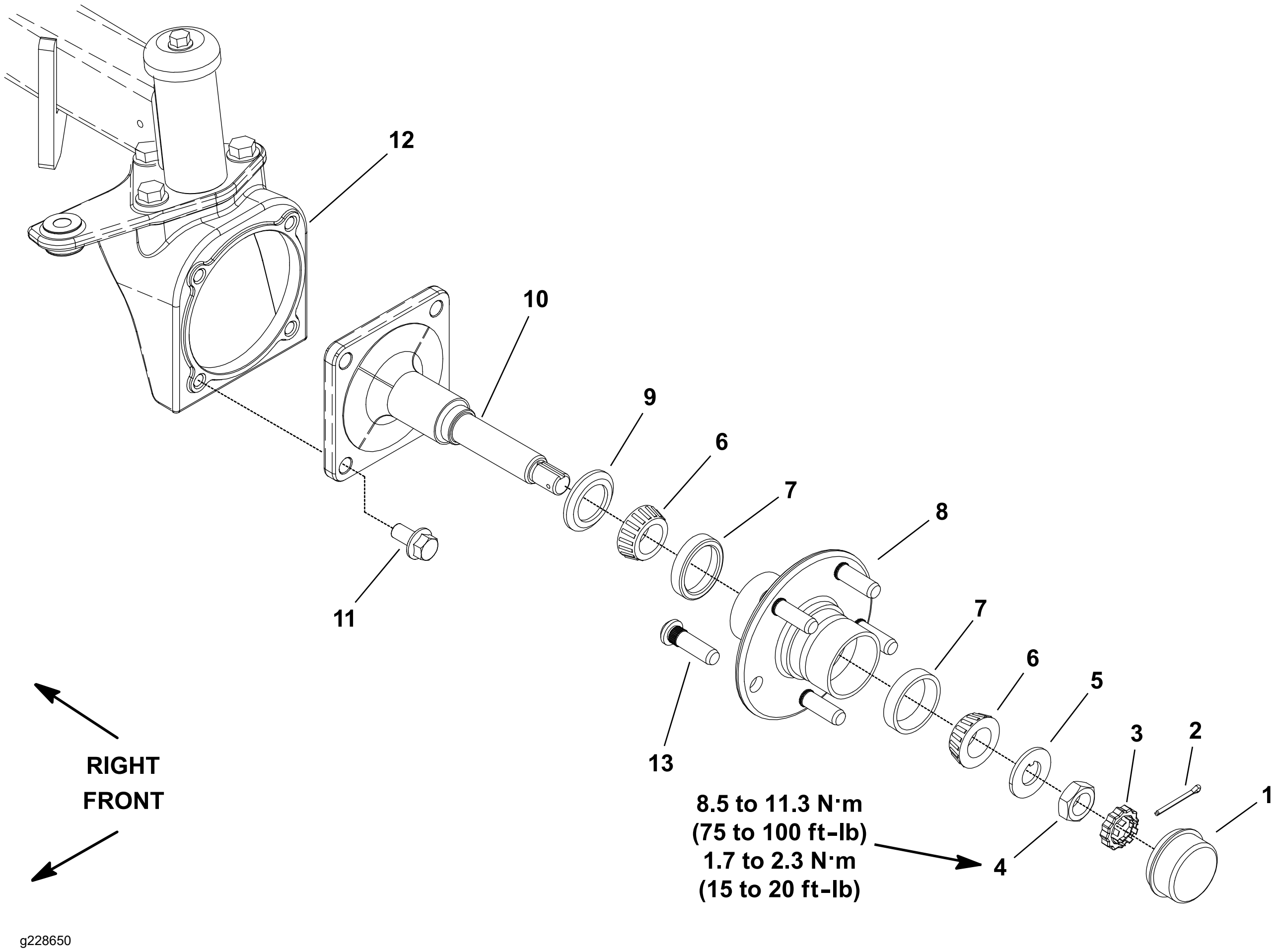

Figure 298

1. Dust cap
2. Cotter pin
3. Retainer
4. Jam nut
5. Tab washer
6. Bearing cone
7. Bearing cup
8. Wheel hub
9. Seal
10. Spindle
11. Flange-head screw (4 each)
12. Housing
13. Wheel stud (5 each)

Disassembling the Rear Wheel Bearings (Machines with 2-Wheel Drive)

1. Chock front wheels to prevent machine from shifting.
2. Remove rear wheel; refer to Wheels (page 8–5). Ensure to support machine with jack stands.
3. Remove the dust cap from the wheel hub.
4. Remove the cotter pin, retainer, jam nut, and tab washer. Slide the wheel hub from the spindle shaft.
5. Pull the seal out of the wheel hub. Discard seal.
6. Remove the bearing cones from both sides of the wheel hub. Clean the bearings in solvent. Ensure that 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.
7. Clean spindle surface and check for wear or damage. Replace spindle if necessary.

Assembling the Rear Wheel Bearings (Machines with 2-Wheel Drive)

1. If bearing cups were removed from the wheel hub, press new cups into the hub until they seat against the shoulder of the 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.

2. Pack both bearings with grease. Install one bearing into the bearing cup on inboard side of the wheel hub. Lubricate the inside of a new seal and press it into the wheel hub with the seal lip toward the bearing.
3. Fill wheel hub cavity between bearings approximately 50% full of grease. Position remaining bearing into the outer bearing cup.
4. 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.
5. While rotating the wheel hub by hand, torque the jam nut to **8.5 to 11.3 N·m (75 to 100 in-lb)** to set the bearings. Then, loosen the nut until the hub has end-play.
6. While rotating the wheel hub by hand, torque the jam nut to **1.7 to 2.3 N·m (15 to 20 in-lb)**. After tightening, ensure that the wheel hub does not have any free play.
7. Install retainer with slot aligned to cotter pin hole in spindle. Install cotter pin.
8. Fill dust cap approximately half full of grease. Install dust cap.
9. Install rear wheel; refer to Wheels (page 8–5).
10. Lower the machine to the ground.
11. Torque the wheel-lug nuts evenly in a crossing pattern to **95 to 122 N·m (70 to 90 ft-lb)**.

Rear Axle Motor Housings

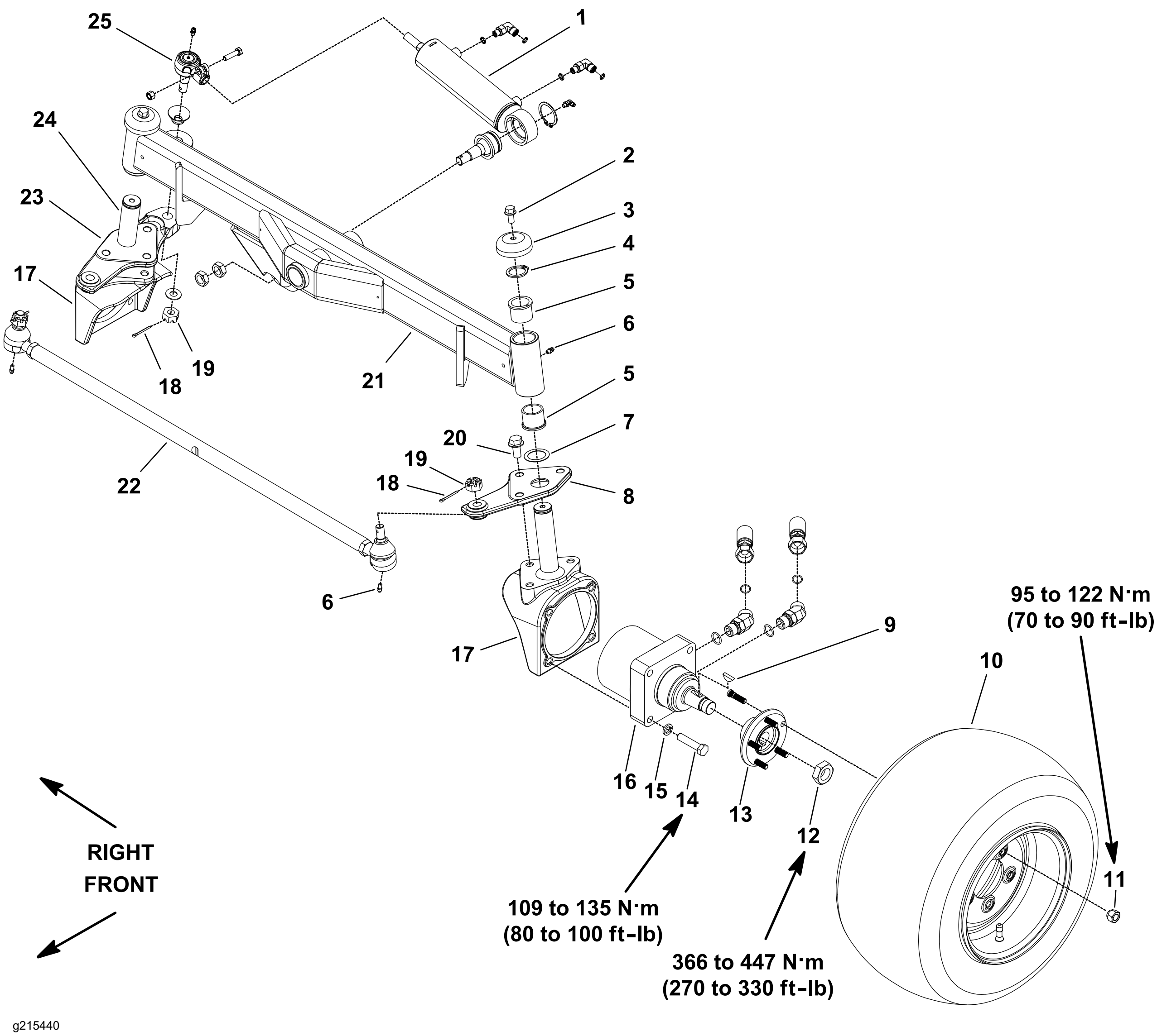

Figure 299

Machines with CrossTrax AWD

1.	Steering cylinder	8.	Left drag link	15.	Lock washer (4 each per motor)	22.	Tie rod
2.	Flange-head screw (2 each)	9.	Woodruff key	16.	Rear wheel motor (left)	23.	Right drag link
3.	Spindle cap (2 each)	10.	Rear wheel (left)	17.	Motor housing (2 each)	24.	Motor housing shaft
4.	Retaining ring (2 each)	11.	Wheel-lug nut (5 each per wheel)	18.	Cotter pin (3 each)	25.	Ball joint
5.	Flange bushing (4 each)	12.	Locknut	19.	Slotted hex nut (3 each)		
6.	Grease fitting (4 each)	13.	Wheel hub	20.	Flange-head screw (3 each per link)		
7.	Thrust washer (2 each)	14.	Bolt (4 each per motor)	21.	Rear axle		

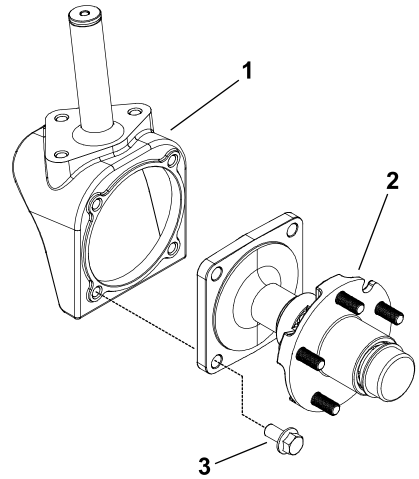

Figure 300
Machines with 2-wheel drive

1. Motor housing
2. Hub and spindle assembly
3. Flange-head screw (7 each per side)

Removing the Rear Axle Motor Housings

1. Park the machine on a level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Block the front wheels with chocks to prevent the machine from moving.
3. Remove the rear wheel assembly; refer to Removing the Wheel (page 8–6).
4. Remove the cotter pin and slotted hex nut that secure the tie rod end (item 22 in Figure 299) to the drag link. Use a ball joint removal tool (pickle fork) and separate the tie rod end from the drag link.
5. If the right side motor housing is being removed, remove the cotter pin and slotted hex nut that secure the steering cylinder ball joint (item 25 in Figure 299) to the drag link. Use a ball joint removal tool (pickle fork) and separate the steering cylinder from the drag link.
6. For the machines equipped with CrossTrax AWD, remove the 4 bolts (item 14 in Figure 299) and 4 lock washers that secure the wheel motor to the motor housing. Slide the wheel motor assembly (with the wheel hub and hydraulic hoses attached) from the motor housing. Position the wheel motor away from the housing.
7. Support the motor housing to prevent it from falling.

   Note: Do not allow the wheel motor assembly to hang from the hydraulic hoses.
8. Remove the flange-head screw (item 2 in Figure 299), spindle cap, and retaining ring that secure the motor housing shaft into the axle tube. Slide the motor housing out of the axle tube.
9. Locate and retrieve the thrust washer (item 7 in Figure 299) from the motor housing shaft.
10. If necessary, remove the drag link from the motor housing.
11. If necessary, on 2-wheel drive machines, remove the hub and spindle assembly (item 2 in Figure 300) from housing.
12. Clean the motor housing shaft. Inspect the shaft for wear and replace the motor housing if the shaft is worn or damaged.

Removing the Rear Axle Motor Housings (continued)

13. Clean the rear axle bore and inspect the flange bushings (item 5 in Figure 299) in the rear axle for wear or damage. If the bushings need replacement, do the following steps:

    Note: Do not damage the bore of the axle tube during bushing removal.

    A. Use a bushing removal tool to extract both the flange bushings from the axle tube.

    B. Clean the inside of the axle tube to remove any dirt or unwanted material.

    C. Apply grease to the inner and outer surfaces of new flange bushings.

    D. Press the new flange bushings into the top and bottom of the axle tube until bushing flange bottoms on the tube.

    E. After bushing installation, ensure that the motor housing shaft slides easily into the bushings. If there is any binding, locate and correct the source of binding.

Installing the Rear Axle Motor Housings

1. If removed, secure the drag link to the motor housing.
2. Apply a light coating of grease to the motor housing shaft.
3. Install the thrust washer (item 7 in Figure 299) onto the motor housing shaft and slide the shaft up through the axle tube.
4. Hold the motor housing in place and install the retaining ring (item 4 in Figure 299) onto the end of the spindle shaft.
5. Place the spindle cap (item 3 in Figure 299) to the top of the motor housing shaft and secure with the flange-head screw.
6. If the hub and spindle assembly (item 2 in Figure 300) was removed (2-wheel drive machines), secure the assembly to housing with the flange-head screws.
7. For the machines equipped with CrossTrax AWD (Figure 299), slide the wheel motor assembly (with the wheel hub and hydraulic hoses attached) into the motor housing. Secure the wheel motor to the motor housing with the 4 bolts and 4 lock washers; torque the bolts to **109 to 135 N·m (80 to 100 ft-lb)**.
8. Clean the tapered surfaces of both mating parts before installation, connect the tie rod end (item 22 in Figure 299) to the drag link with the slotted hex nut and cotter pin.
9. If the right side motor housing was removed, clean the tapered surfaces of both mating parts before installation, and secure the steering cylinder ball joint (item 25 in Figure 299) to the drag link the with the slotted hex nut and cotter pin.
10. Lubricate the motor housing shafts through the grease fittings on the rear axle.
11. Install the rear wheel assembly; refer to Installing the Wheel (page 8–6).
12. Check the rear wheel toe-in; refer to the *Operator's Manual*.
13. Ensure that there is no contact between the machine components including hydraulic hoses while the rear wheels move from lock to lock. Adjust if necessary.

Rear Axle

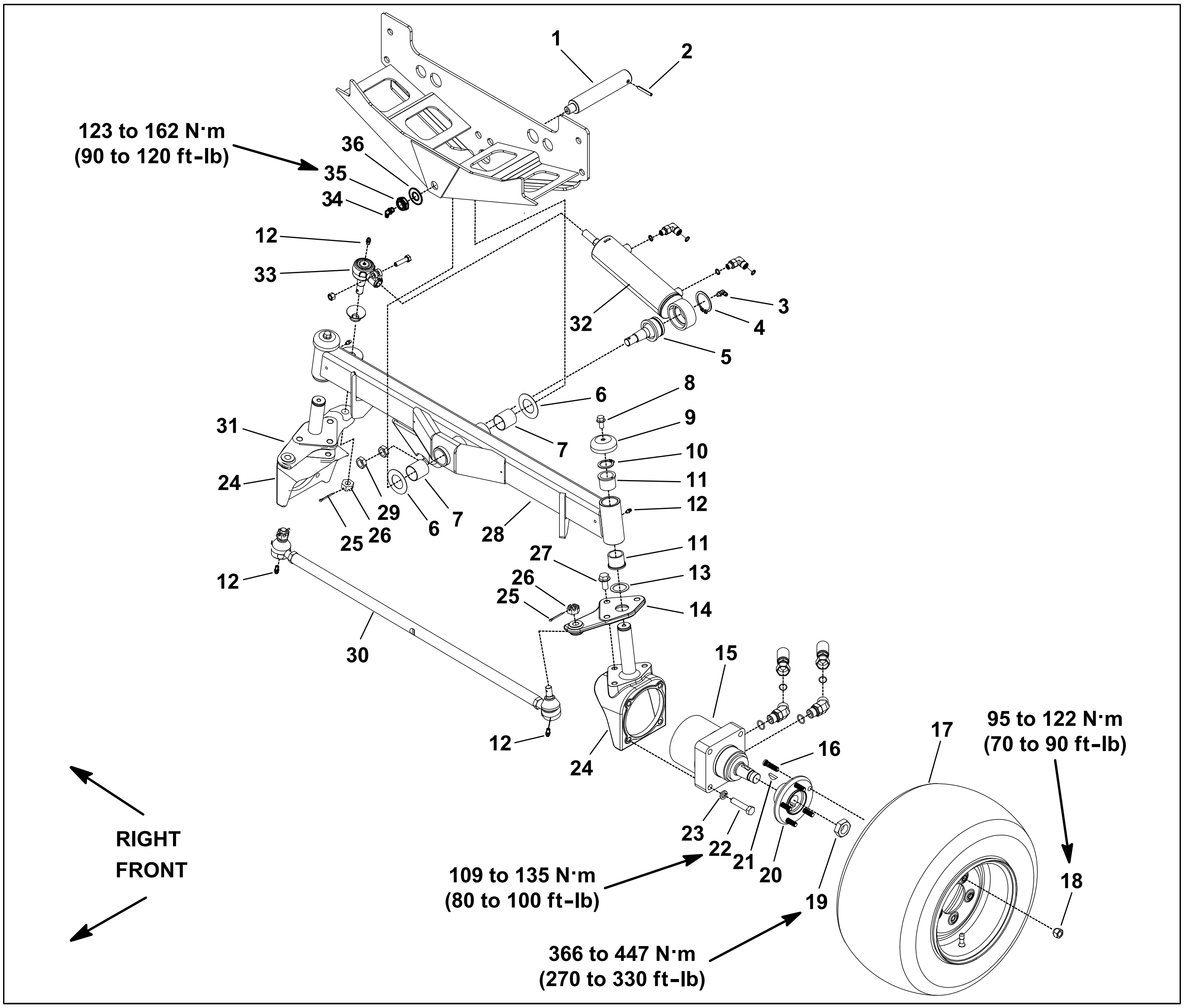

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Figure 301

Machines with CrossTrax AWD

1. Axle pivot pin
2. Roll pin
3. 90° grease fitting
4. Retaining ring
5. Ball joint
6. Thrust washer (2 each)
7. Axle bushing (2 each)
8. Flange-head screw (2 each)
9. Spindle cap (2 each)
10. Retaining ring (2 each)
11. Flange bushing (4 each)
12. Grease fitting (5 each)
13. Thrust washer (2 each)
14. Left drag link
15. Wheel motor (left)
16. Wheel stud (5 each per hub)
17. Rear wheel assembly
18. Wheel-lug nut (5 each per wheel)
19. Locknut
20. Wheel hub
21. Woodruff key
22. Bolt (4 each per motor)
23. Lock washer (4 each per motor)
24. Motor housing (2 each)
25. Cotter pin (3 each)
26. Slotted hex nut (3 each)
27. Flange-head screw (3 each per link)
28. Rear axle
29. Jam nut (2 each)
30. Tie rod
31. Right drag link
32. Steering cylinder
33. Ball joint
34. 90° grease fitting
35. Jam nut
36. Thrust washer

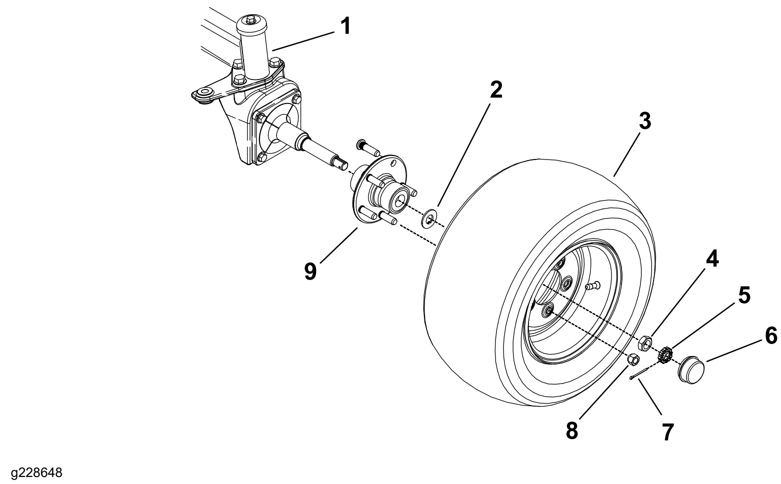

Figure 302

Machines with 2-wheel drive

1.	Rear axle assembly	4.	Jam nut	7.	Cotter pin
2.	Tab washer	5.	Nut retainer	8.	Wheel-lug nut (5 each per wheel)
3.	Wheel assembly	6.	Dust cap	9.	Wheel hub assembly

Removing the Rear Axle

1. Park the machine on a level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Block the front wheels with chocks to prevent the machine from moving.
3. Remove the 2 rear wheel assemblies; refer to Removing the Wheel (page 8–6).
4. Remove the steering cylinder (with the hydraulic hoses attached) from the rear axle; refer to Removing the Steering Cylinder (page 6–226).
5. Remove both wheel motor housings from the rear axle; refer to Removing the Rear Axle Motor Housings (page 8–17).
6. On machines equipped with CrossTrax AWD, do as follows:
   A. Unlatch and open the radiator screen assembly.
   B. Remove the 3 bolts (item 2 in Figure 304), 3 lock washers, and 3 spacers that secure the CrossTrax AWD control manifold to the frame so that the rear axle pivot pin (item 1 in Figure 301) can be accessed. Lower and support the manifold, ensure that you do not damage the hydraulic tubes.
7. Remove the jam nut (item 35 in Figure 301) and thrust washer that secure the axle pivot pin to the frame.
8. Support the rear axle to prevent it from falling.
9. Pull the axle pivot pin from the frame and rear axle. This releases the rear axle and 2 thrust washers (item 6 in Figure 301) from the frame.

   Note: On machines with CrossTrax AWD, do not damage the CrossTrax AWD control manifold or attached hydraulic tubes during axle removal.
10. Carefully remove the rear axle from the machine.

Servicing the Rear Axle

1. Clean the rear axle pivot pin. Inspect the pin for wear and replace the pivot pin if it is worn or damaged.

Servicing the Rear Axle (continued)

2. Clean the rear axle bushings and inspect the axle bushings (item 7 in Figure 301) for wear or damage. If the bushings need replacement, do the following steps:

   Note: Do not damage the bore of the axle during bushing removal.

   A. Use a bushing removal tool to extract both the axle bushings from the axle pivot.

   B. Clean the inside of the axle pivot to remove any dirt or unwanted material.

   C. Apply grease to the inner and outer surfaces of new axle bushings.

   D. Press the new axle bushings into the axle pivot bore until bushing is flush with the axle.

   E. After bushing installation, ensure that the pivot pin slides easily into the bushings. If there is any binding, locate and correct the source of binding.

Servicing the Tie Rod Assembly

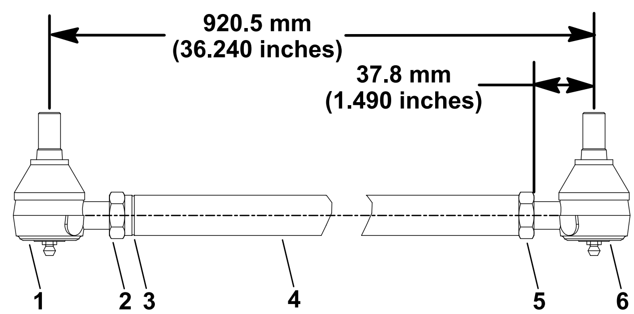

Figure 303

1.	Ball joint (left-hand thread)	3.	Tie rod groove	5.	Jam nut (right-hand thread)
2.	Jam nut (left-hand thread)	4.	Tie rod	6.	Ball joint (right-hand thread)

Note: The tie rod ball joint and jam nut at the grooved end of the tie rod have left hand threads.

1. Loosen the jam nuts and then remove the ball joints from the tie rod.
2. Thread new ball joints equally into the tie rod so that the ball joint center to center length is **920.5 mm (36.240 inches)**.
3. Clean the tapered surfaces of the tie rod ball joints before you install the tie rod to the drag links on the rear axle.

Installing the Rear Axle

Note: On machines with CrossTrax AWD, do not damage the CrossTrax AWD control manifold or attached hydraulic tubes during axle installation.

1. Position the rear axle assembly to the frame. Install the thrust washer (item 6 in Figure 301) between each side of the axle and frame. Slide the pivot pin through the frame, thrust washers, and axle. Ensure that the roll pin on the pivot pin is positioned in the frame reliefs.
2. Install a thrust washer (item 36 in Figure 301) and jam nut onto the pivot pin. Torque the jam nut to **123 to 162 N·m (90 to 120 ft-lb)**. Ensure that the rear axle can still pivot freely after the jam nut is tightened.

Installing the Rear Axle (continued)

3. On machines with CrossTrax AWD, do as follows:

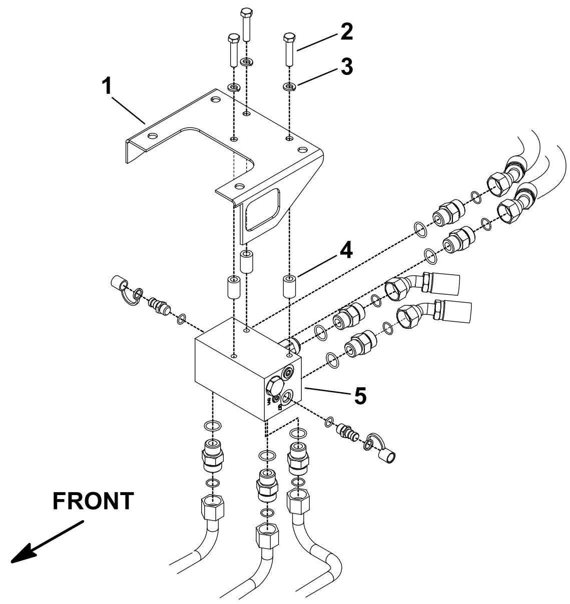

Figure 304

1.	Frame bracket	3.	Lock washer (3 each)	5.	AWD control manifold
2.	Bolt (3 each)	4.	Spacer (3 each)		

   A. Raise the CrossTrax AWD control manifold to the frame. Position the spacers between the manifold and the frame (Figure 304). Secure the manifold to the frame with the 3 bolts and 3 lock washers.

   B. Close and latch the radiator screen assembly.

4. Install the wheel motor housings to the rear axle; refer to Installing the Rear Axle Motor Housings (page 8–18).
5. Install the steering cylinder to the rear axle; refer to Installing the Steering Cylinder (page 6–227).
6. Install the 2 rear wheel assemblies; refer to Installing the Wheel (page 8–6).
7. Check the rear wheel toe-in; refer to the *Operator's Manual*.
8. Check the hydraulic-fluid level in the hydraulic reservoir and add correct quantity of fluid if necessary; refer to the *Operator's Manual*.
9. Lubricate the rear axle grease fittings.
10. Ensure that there is no contact between the machine components including hydraulic hoses while the rear wheels move from lock to lock. Adjust if necessary.
11. Operate the machine and check the hydraulic connections for leaks.

Control Arm

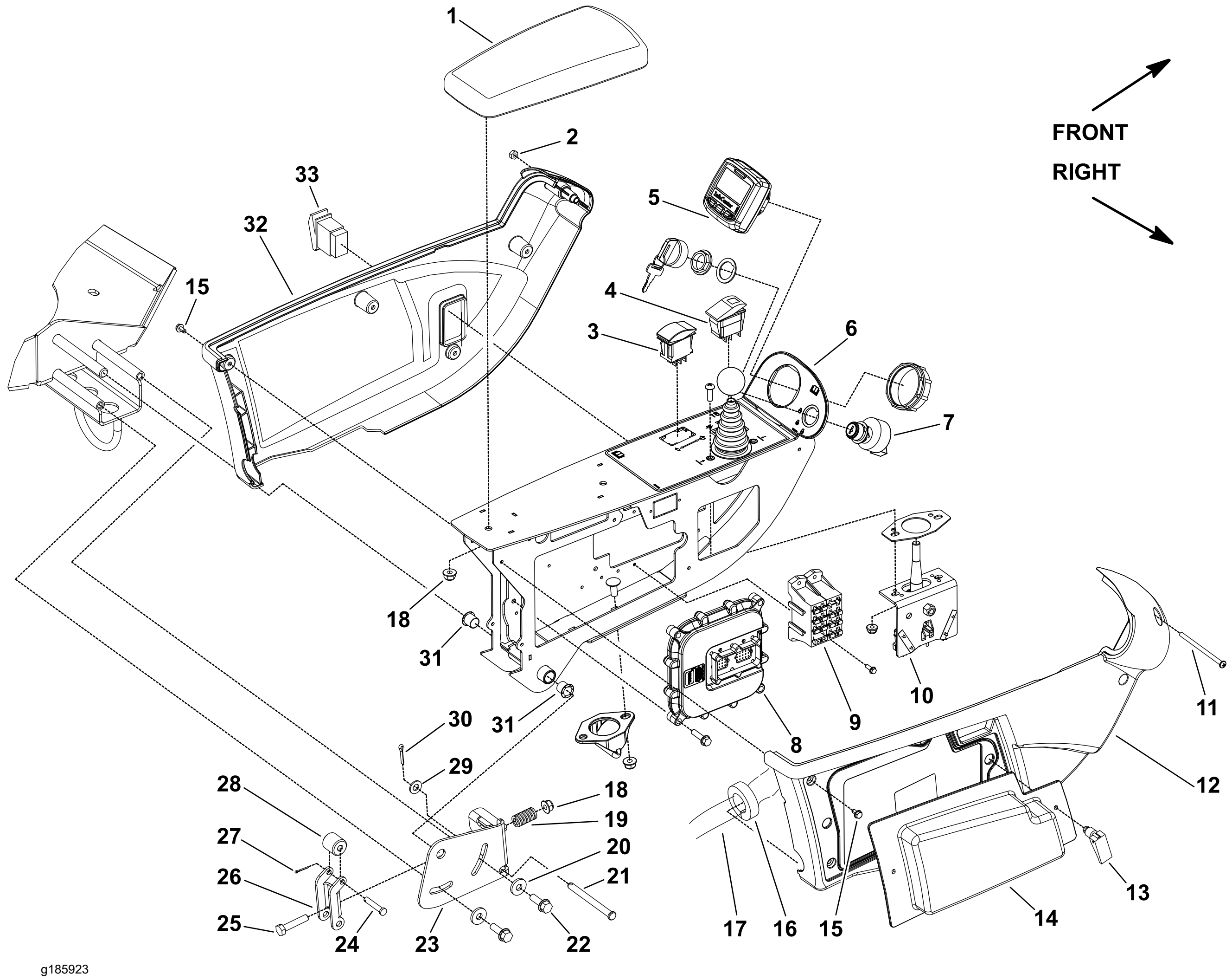

Figure 305

1.	Arm rest	12.	Right control arm cover	23.	Retainer bracket
2.	Locknut	13.	Swell latch (2 each)	24.	Clevis pin
3.	Engine speed switch	14.	Access cover	25.	Bolt
4.	Reel engage switch	15.	Washer-head screw (10 each)	26.	Latch
5.	InfoCenter display	16.	Foam seal	27.	Cotter pin
6.	Control arm	17.	Platform wire harness	28.	Spacer
7.	Key switch	18.	Flange nut (3 each)	29.	Flat washer
8.	TEC (Toro Electronic Controller)	19.	Spring	30.	Cotter pin
9.	Fuse block	20.	Flat washer (2 each)	31.	Nylon bushing (2 each)
10.	Joystick assembly	21.	Clevis pin	32.	Left control arm cover
11.	Screw	22.	Flange-head screw (2 each)	33.	Headlight switch

Disassembling the Control Arm

1. Park the machine on a level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Disconnect the negative battery cable from the battery; refer to Servicing the Battery (page 7–125).

Disassembling the Control Arm (continued)

3. Loosen the 2 swell latches (item 13 in Figure 305) and remove the access cover from outside of the control arm.
4. At the front of the control arm, remove the screw (item 11 in Figure 305) and locknut that secure the control arm covers to each other.
5. Remove the 5 washer-head screws (item 15 in Figure 305) that secure each cover to the control arm.
6. Remove the control arm covers from the machine. As the left control arm cover (item 32 in Figure 305) is removed from the control arm, disconnect the wire harness connector from the headlight switch.
7. Remove the electrical components from the control arm as necessary (Figure 305).

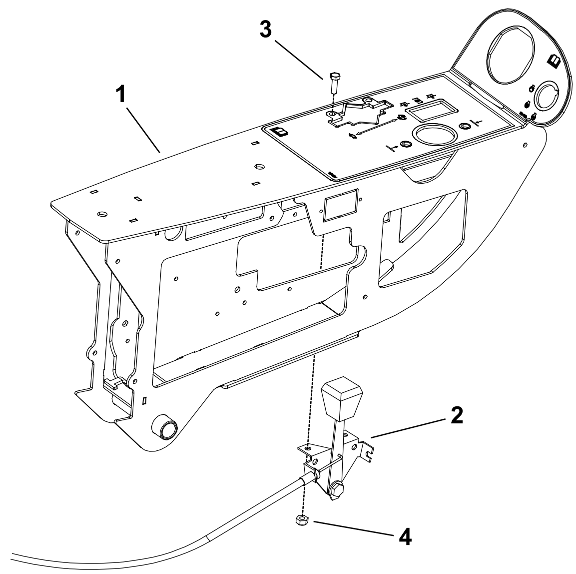

Figure 306

1. Control arm frame
2. Throttle control
3. Screw (2 each)
4. Locknut (2 each)

Note: Reelmaster machine with a Kubota diesel engine have a control arm mounted throttle control to adjust engine speed (Figure 306).

Disassembling the Control Arm (continued)

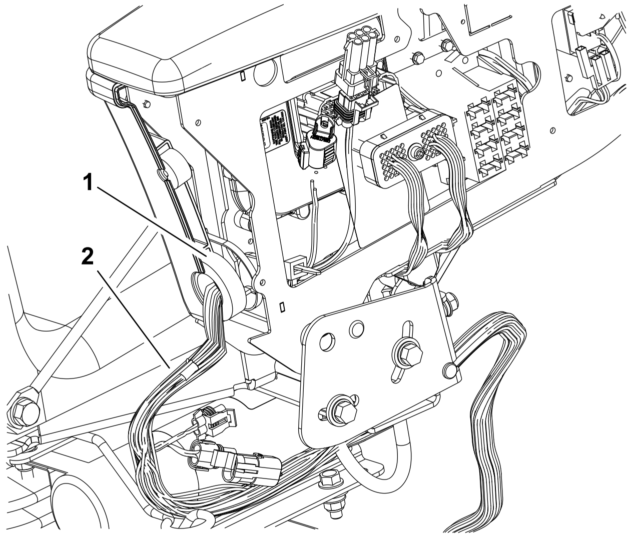

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Figure 307

1. Foam seal
2. Platform wire harness

Assembling the Control Arm

1. Install all the electrical components that were removed from the control arm (Figure 305).
2. Position the covers to the control arm. As the left control arm cover (item 32 in Figure 305) is placed, connect the wire harness connector to the headlight switch. Also, ensure that the platform wire harness is routed correctly through the cover openings and the harness foam seal is captured between the control arm covers (Figure 307).
3. Secure each cover to the control arm with the 5 washer-head screws (item 15 in Figure 305). Install the screw (item 11 in Figure 305) and locknut to secure the covers at the front of the control arm.
4. Install the access cover to outside of the control arm.
5. Connect the negative battery cable to the battery; refer to Servicing the Battery (page 7–125).

Operator Seat

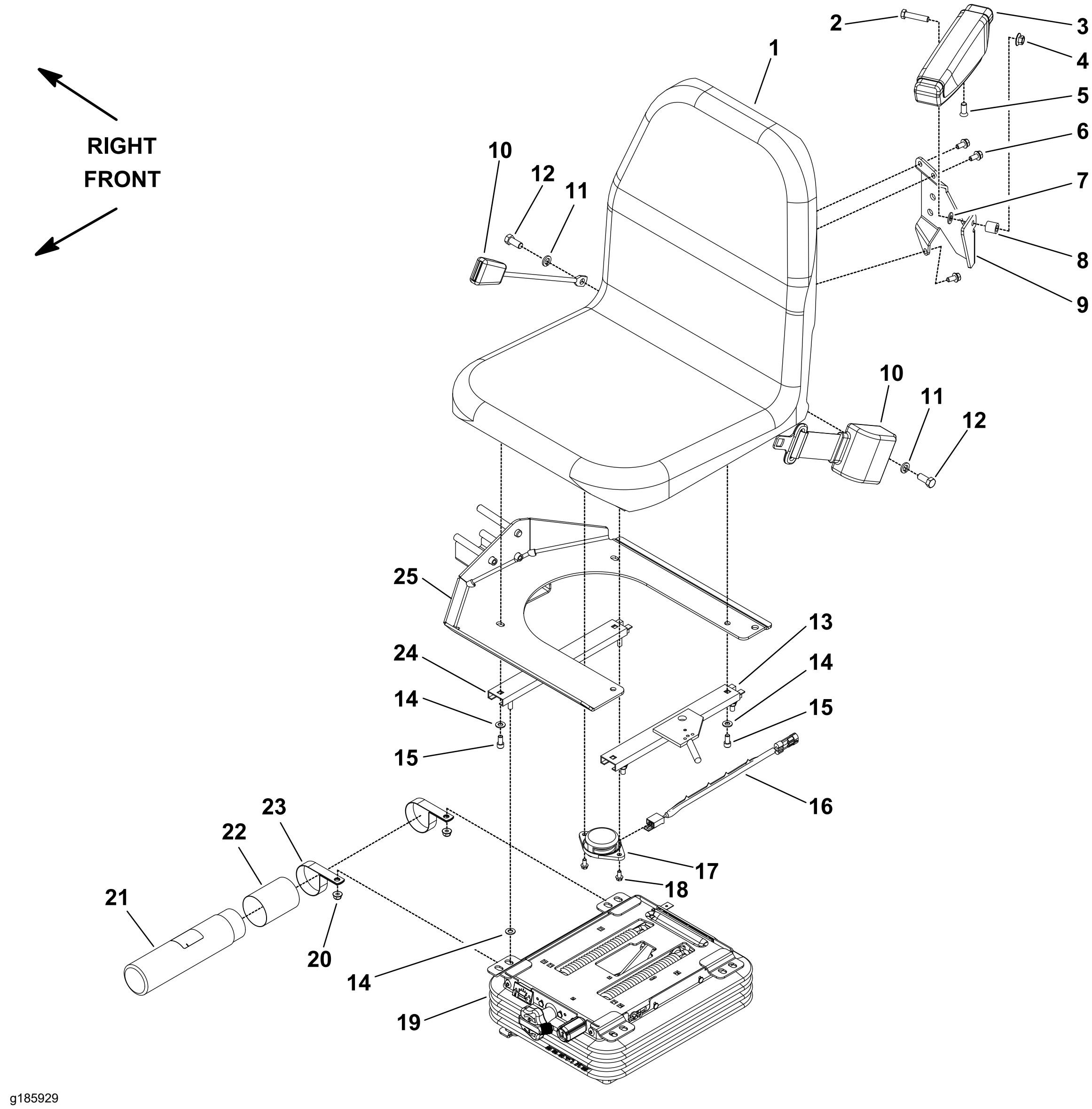

Figure 308

1. Seat
2. Bolt
3. Left armrest
4. Flange nut
5. Screw
6. Flange-head screw (3 each)
7. Flat washer
8. Spacer
9. Armrest bracket
10. Seat belt
11. Lock washer (2 each)
12. Bolt (2 each)
13. Seat adjuster w/latch
14. Flat washer (8 each)
15. Socket-head screw (4 each)
16. Seat switch harness
17. Seat switch
18. Washer-head screw (2 each)
19. Seat suspension
20. Flange nut (4 each)
21. Manual tube
22. Housing cap
23. R-clamp (2 each)
24. Seat adjuster
25. Seat base

IMPORTANT

The operator seat, seat base, and control arm assembly are attached to the machine with the same fasteners. Support the seat base and control arm to prevent them from shifting when removing the seat. Damage to the control arm electrical components and platform wiring harness, and throttle cable (if equipped) can occur if the seat base and control arm are not properly supported during seat removal.

Removing the Operator Seat

1. Park the machine on a level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Disconnect the negative battery cable from the battery; refer to Servicing the Battery (page 7–125).

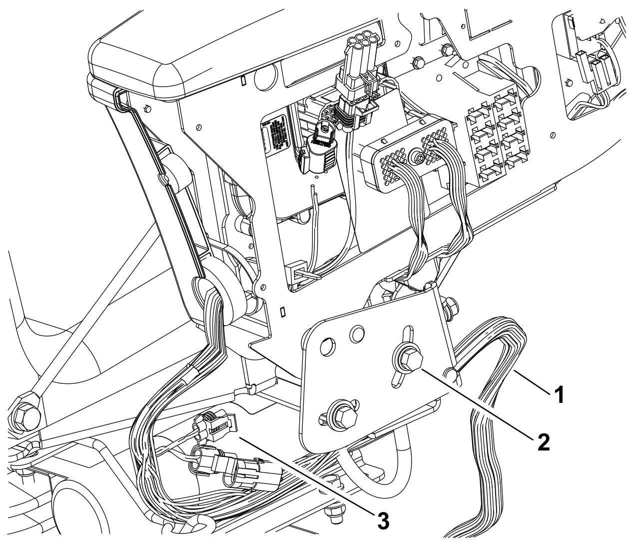

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Figure 309

1. Platform wire harness
2. Flange-head screw (2 each)
3. Seat switch connector

3. Disconnect the seat switch wire harness connector from the platform wire harness (Figure 309).
4. Record the position of the control arm before removal. The control arm angle is adjustable for operator comfort.

Removing the Operator Seat (continued)

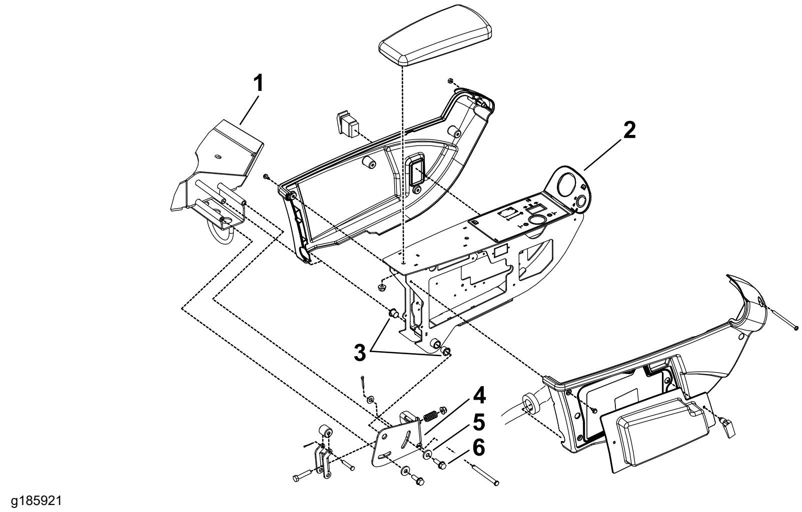

Figure 310

1. Seat base
2. Control arm
3. Bushing (2 each)
4. Retainer bracket
5. Flat washer (2 each)
6. Flange-head screw (2 each)

5. Remove the 2 flange-head screws and 2 flat washers that secure the control arm assembly to the seat base (Figure 309 and Figure 310).

IMPORTANT

Do not damage the platform wire harness when removing the seat and control arm assembly from the machine.

6. Carefully slide the control arm assembly from the seat base. Locate and retrieve the 2 bushings (item 3 in Figure 310). Position and support the control arm assembly to allow seat removal.
7. Remove the 4 socket-head screws (item 15 in Figure 308) and 4 flat washers that secure the seat and seat base to the seat adjusters.
8. Record which set of seat mounting holes are used, remove the operator seat and seat base from the seat adjusters.

Installing the Operator Seat

1. Use the mounting holes that were recorded during removal, position the seat and seat base to the seat adjusters.
2. Secure the seat and seat base to the seat adjusters with the 4 flat washers and 4 socket-head screws (item 15 in Figure 308).

IMPORTANT

Do not damage the platform wire harness when installing the control arm assembly to the machine.

3. Ensure that the 2 bushings (item 3 in Figure 310) are positioned in the control arm. Carefully slide the control arm assembly onto the seat base post. Secure the control arm assembly to the seat base with the 2 flange-head screws and 2 flat washers (Figure 309 and Figure 310).

Installing the Operator Seat (continued)

4. Connect the seat switch wire harness connector to the platform wire harness (Figure 309).
5. Connect the negative battery cable to the battery; refer to Servicing the Battery (page 7–125).

Mechanical Seat Suspension

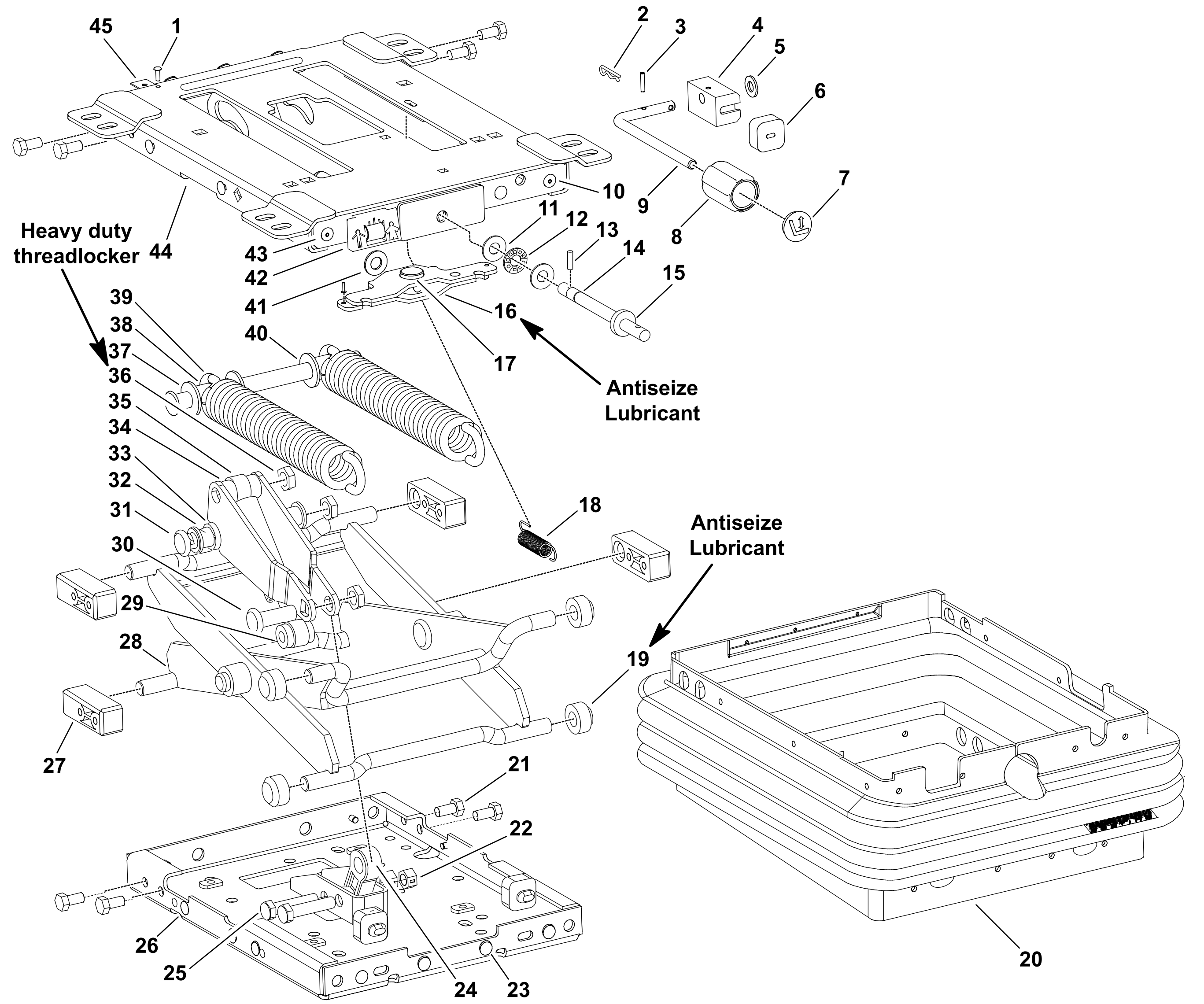

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Figure 311

1. Rivet (2 each)
2. Cotter pin
3. Roll pin
4. Up-stop bumper block
5. Flat washer
6. Bumper (3 each)
7. Height adjust knob cap
8. Height adjust knob
9. Height adjust rod
10. Female snap rivet (2 each)
11. Thrust race (2 each)
12. Thrust bearing
13. Roll pin
14. Weight adjust spacer
15. Weight adjust shaft
16. Weight adjuster
17. Weight adjust nut
18. Extension spring
19. Roller (4 each)
20. Suspension boot
21. Thread forming screw (8 each)
22. Locknut (2 each)
23. Push clip (21 each)
24. Guide link
25. Lower shock bolt (2 each)
26. Lower housing
27. Shaft block (4 each)
28. Scissor assembly
29. Lower shock bushing (2 each)
30. Roller pin
31. Pivot pin
32. Bearing tube (2 each)
33. Drive arm
34. Upper shock bushing (2 each)
35. Damper
36. Hex nut (3 each)
37. Flat washer
38. Spring shaft
39. Extension spring (2 each)
40. Spring bushing (2 each)
41. Flat washer
42. Weight indicator assembly
43. Male snap rivet (2 each)
44. Upper housing
45. Weight adjust tape

Removing the Mechanical Seat Suspension

1. Park the machine on a level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the seat from the machine; refer to Removing the Operator Seat (page 8–27).

IMPORTANT

Do not damage the platform wire harness when removing the seat suspension from the machine.

3. Tilt and support the seat frame to get access to the seat suspension fasteners.
4. Support the seat suspension to prevent it from falling.
5. Record which set of mounting holes are used, remove the 4 flange-head screws (item 4 in Figure 312) and 4 flange nuts that secure the seat suspension to the seat frame.
6. Remove the seat suspension from the machine.

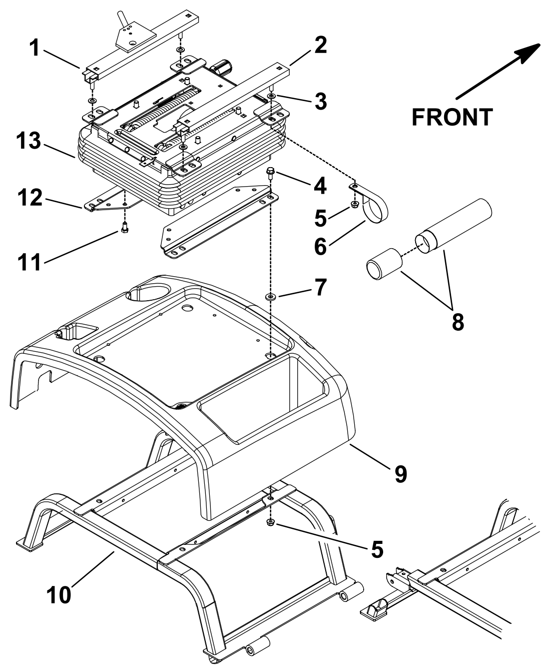

Figure 312

1. Seat adjuster w/latch
2. Seat adjuster
3. Flat washer (4 each)
4. Flange-head screw (4 each)
5. Flange nut (8 each)
6. R-clamp (2 each)
7. Spacer (4 each)
8. Manual tube
9. Seat base cover
10. Seat frame
11. Bolt (4 each)
12. Seat suspension bracket (2 each)
13. Seat suspension

7. Locate and retrieve the 4 spacers (item 7 in Figure 312) from the seat suspension and seat frame.
8. Remove the seat suspension components as necessary (Figure 311 and Figure 312). If the seat adjusters are being removed, record the seat adjuster mounting holes used.

Installing the Mechanical Seat Suspension

1. Install all the seat suspension components that were removed (Figure 311 and Figure 312). If removed, use the seat adjuster mounting holes that were recorded during removal.

IMPORTANT

Do not damage the electrical harness when installing the seat suspension to the machine.

2. Position the seat base cover and 4 spacers (item 7 in Figure 312) to the seat frame.
3. Use the mounting holes that were recorded during removal, position the seat suspension to the seat frame and secure with the 4 flange-head screws (item 4 in Figure 312) and 4 flange nuts.
4. Install the seat to the machine; refer to Installing the Operator Seat (page 8–28). Ensure to connect the harness electrical connector to the seat switch.

Front Lift Arms

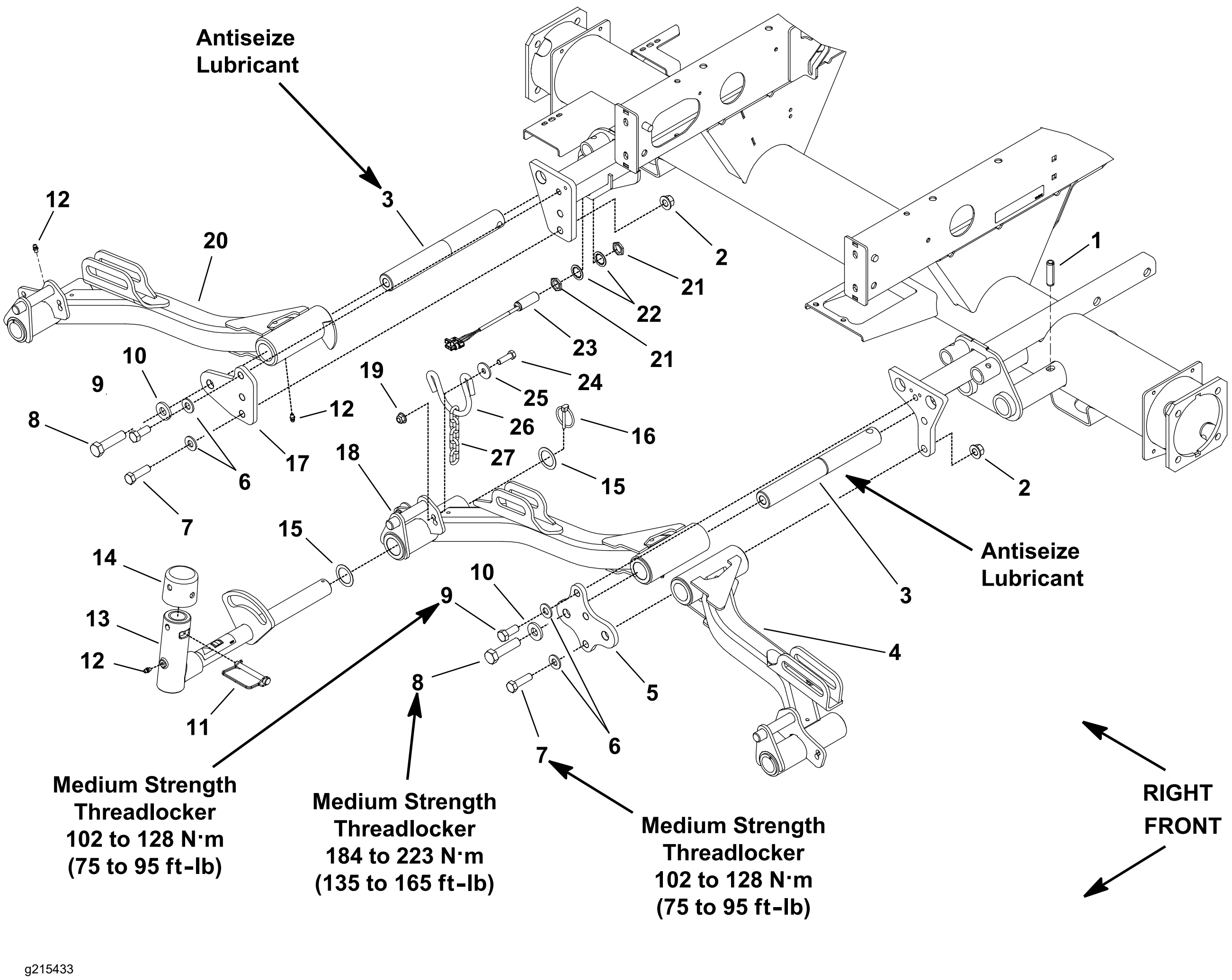

Figure 313

1. Roll pin (3 each)
2. Locknut (4 each)
3. Lift arm pivot shaft (3 each)
4. #4 lift arm
5. Bridge plate
6. Thrust washer (6 each)
7. Bolt (4 each)
8. Bolt (1 each per lift arm)
9. Bolt (2 each)
10. Flat washer (1 each per lift arm)
11. Snapper pin (1 each per lift arm)
12. Grease fitting
13. Pivot yoke (3 each)
14. Cap (1 each per lift arm)
15. Thrust washer (2 each per yoke)
16. Lynch pin (3 each)
17. Bridge plate
18. #1 lift arm
19. Flange nut (2 each per chain hoop)
20. #5 lift arm
21. Jam nut (2 each)
22. Lock washer (2 each)
23. Down limit switch
24. Bolt (2 each per chain hoop)
25. Washer (2 each per chain hoop)
26. Chain hoop (3 each)
27. Chain (3 each)

Removing the Front Lift Arms

1. Park the machine on a level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the cutting unit from the front lift arm to be removed.

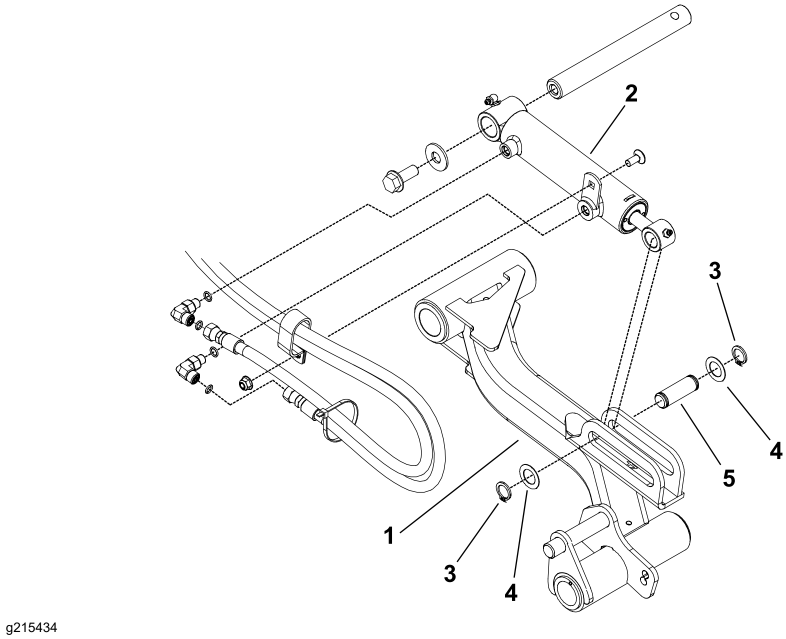

Figure 314

1. #4 lift arm	4. Thrust washer (2 each)
2. Lift cylinder	5. Cylinder slide pin
3. Retaining ring (2 each)	

3. Disconnect the lift cylinder from the lift arm (item 1 in Figure 314) as follows:
   A. Remove 1 retaining ring and thrust washer from the cylinder pin that secures the lift cylinder to the lift arm.
   B. Pull the cylinder pin from the lift cylinder and lift arm. Locate and retrieve the second thrust washer.
   C. Pivot the lift cylinder rod end away from the lift arm.
4. Remove the lynch pin (item 16 Figure 313) and slide the pivot yoke assembly from the lift arm. Locate and retrieve 2 thrust washers.
5. Remove the fasteners that secure the bridge plate (item 5 or 17 Figure 313) to the machine.
6. Slide the front lift arm from the lift arm pivot shaft (item 3 in Figure 313).

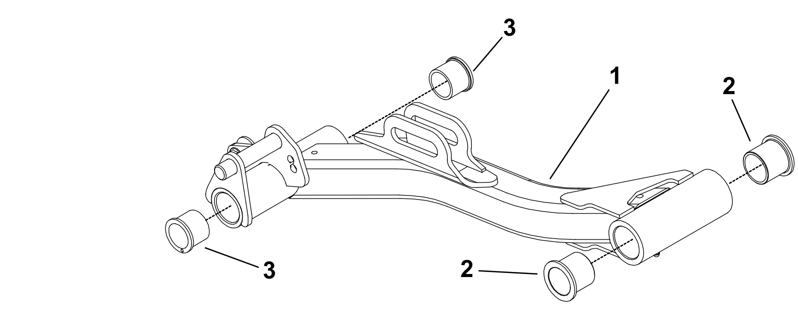

Figure 315

1. #5 lift arm	2. Lift arm bushing (2 each)	3. Pivot yoke bushing (2 each)

Removing the Front Lift Arms (continued)

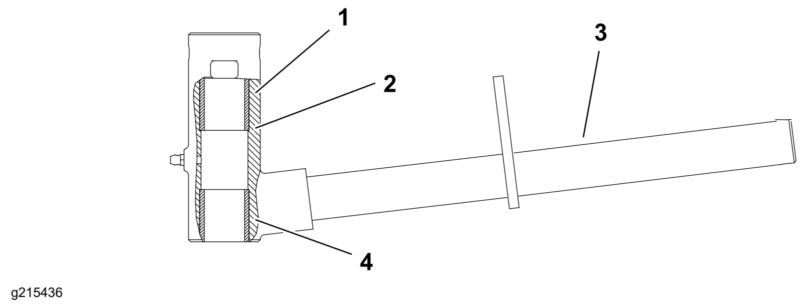

Figure 316

1. Upper bushing
2. Pivot yoke shoulder
3. Pivot yoke
4. Lower bushing

---

7. Inspect the flange bushings in the lift arm and pivot yoke for wear or damage. If necessary, replace the bushings as follows (Figure 315 and Figure 316):

   Note: Do not damage the bore of the lift arm and pivot yoke during bushing removal.

   A. Use a bushing removal tool to extract both the flange bushings from the lift arm or pivot yoke.

   B. Clean inside of the bore to remove any dirt or unwanted material.

   C. Apply grease to the inner and outer surfaces of the new bushings.

   D. Use an arbor press to install the bushings into the lift arm or pivot yoke. The lift arm bushings should be pressed until the bushing flange is against the lift arm bore. The upper pivot yoke bushing should be pressed fully to the shoulder in the pivot yoke bore. The lower pivot yoke bushing should be flush with the yoke tube.

   E. After bushing installation, ensure that the lift arm slides easily onto the pivot shaft. If there is any binding, locate and correct the source of binding.

8. Check the lift arm pivot shaft (item 3 in Figure 313) for wear or damage. If necessary, remove the roll pin that secures the pivot shaft to the frame, and remove the pivot shaft from the frame. Discard the roll pin.

Installing the Front Lift Arms

1. If the lift arm pivot shaft (item 3 in Figure 313) was removed from the frame, apply anti-seize lubricant to the pivot shaft surface and insert the shaft into the frame. Align the holes in the frame with the pivot shaft. Secure the pivot shaft with new roll pin.
2. Slide the front lift arm onto the pivot shaft.
3. Apply medium strength threadlocker to the threads of the bolts (items 7, 8, and 9 in Figure 313) that secure the bridge plate (items 5 or 17 in Figure 313). Secure the lift arm to the machine with the bridge plate. Torque the bolts that secure the bridge plate to the torque values identified in Figure 313.
4. Position the thrust washer (item 15 in Figure 313) onto the pivot yoke shaft, and slide the pivot yoke into the lift arm bushings. Place the second thrust washer on the pivot yoke shaft and secure with the lynch pin.
5. Connect the lift cylinder to the lift arm (item 1 in Figure 314) as follows:

   A. Align the lift cylinder rod end with the lift arm mounting hole.

   B. Slide the cylinder pin with the retaining ring and thrust washer through the lift cylinder and lift arm.

Installing the Front Lift Arms (continued)

C. Install the second thrust washer on the pin and secure with the second retaining ring.

6. Mount the cutting unit to the lift arm.
7. Lubricate the grease fittings on the lift arm, pivot yoke, and lift cylinder.
8. Check operation of lift arm down limit switch and adjust if necessary; refer to Cutting Unit Down Limit Switch (page 7–76).

Rear Lift Arms

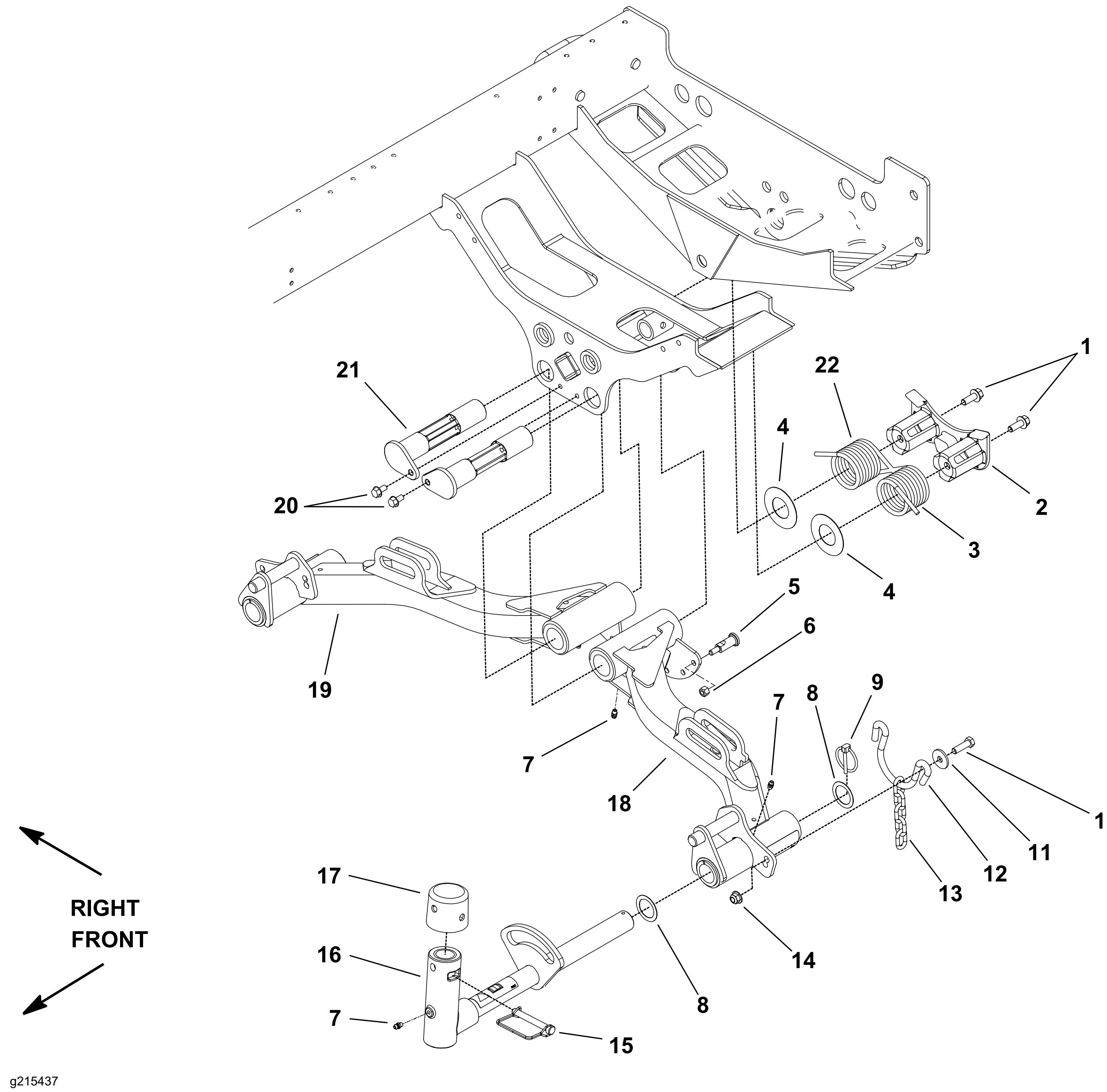

Figure 317

1.	Flange-head screw (2 each)	9.	Lynch pin (2 each)	17.	Cap (1 each per yoke)
2.	Housing	10.	Bolt (2 each per chain hoop)	18.	#2 lift arm
3.	Left torsion spring	11.	Washer (2 each per chain hoop)	19.	#3 lift arm
4.	Washer (2 each)	12.	Chain hoop (2 each)	20.	Washer-head screw (1 each per shaft)
5.	Shoulder stud (6 each)	13.	Chain (2 each)	21.	Pivot shaft (2 each)
6.	Locknut (6 each)	14.	Flange nut (2 each per chain hoop)	22.	Right torsion spring
7.	Grease fitting	15.	Snapper pin (1 each per yoke)		
8.	Thrust washer (2 each per yoke)	16.	Pivot yoke (2 each)		

Removing the Rear Lift Arms

1. Park the machine on a level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the cutting unit from the rear lift arm to be removed.

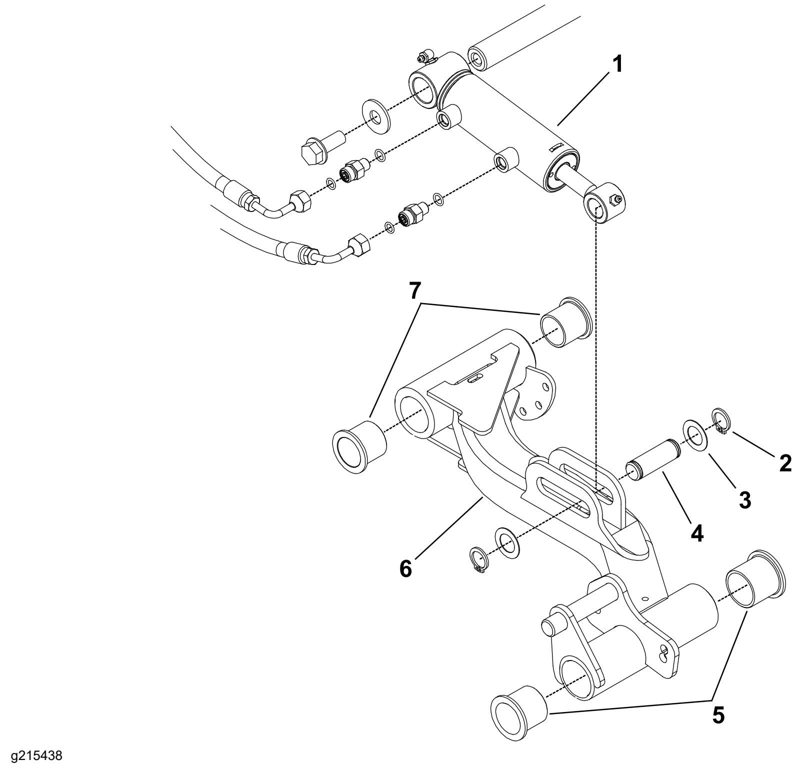

Figure 318

1.	Lift cylinder	4.	Cylinder pin	7.	Lift arm bushing (2 each)
2.	Retaining ring (2 each)	5.	Pivot yoke bushing (2 each)		
3.	Washer (2 each)	6.	#2 lift arm		

3. Disconnect the lift cylinder from the lift arm (item 6 in Figure 318) as follows:
   A. Remove 1 retaining ring and thrust washer from the cylinder pin that secures the lift cylinder to the lift arm.
   B. Pull the cylinder pin from the lift cylinder and lift arm. Locate and retrieve the second thrust washer.
   C. Pivot the lift cylinder rod end away from the lift arm.
4. Remove the lynch pin and thrust washer from the rear of the pivot yoke (item 16 in Figure 317). Slide the pivot yoke assembly from the lift arm. Locate and retrieve the front thrust washer.

CAUTION

Be careful when removing tension from the torsion spring on the rear lift arms. The spring is under heavy load and may cause personal injury.

5. Remove tension from the torsion springs on the rear of the lift arm pivot shaft:
   A. Note which shoulder stud (item 5 in Figure 317) the torsion spring end is attached for assembly purposes.

B. Insert a nut driver or small piece of pipe onto the end of the torsion spring that is secured on the rear of the lift arm shoulder stud.

C. Push down and rearward on the spring end to unhook the spring from the shoulder stud on the lift arm.

Note: The Reelmaster machines use 1 of 2 methods to secure and center the torsion springs on the rear lift arms. One type (shown in Figure 317) uses a one piece housing to secure the springs. The other type (shown in Figure 319) uses a spring catch and spacers to secure the springs.

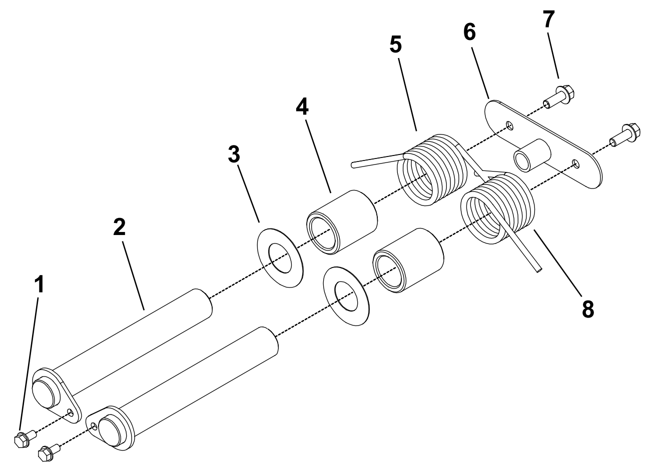

Figure 319

1.	Screw (1 each per shaft)	3.	Washer (2 each)	5.	Right torsion spring	7.	Flange-head screw (2 each)
2.	Pivot shaft (2 each)	4.	Spacer (2 each)	6.	Spring catch	8.	Left torsion spring

6. Remove the torsion springs and components that secure the springs to the machine (Figure 317 or Figure 319). Locate and retrieve the 2 washers.
7. Remove the washer-head screw that secures the pivot shaft (item 21 in Figure 317) to the frame.
8. Support the rear lift arm to prevent it from falling. Slide the pivot shaft from the frame and lift arm, and remove the rear lift arm.

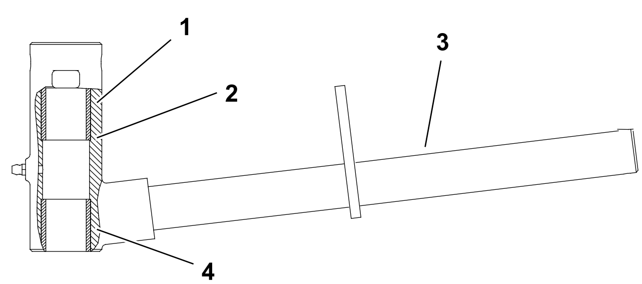

Figure 320

1.	Upper bushing	3.	Pivot yoke
2.	Pivot yoke shoulder	4.	Lower bushing

9. Inspect the bushings in the lift arm and pivot yoke for wear or damage. If necessary, replace the bushings (Figure 318 and Figure 320).

Note: Do not damage the bore of the lift arm or pivot yoke during bushing removal.

A. Use the bushing removal tool to extract both the bushings from the lift arm or pivot yoke.

B. Clean the inside of the bore to remove any dirt or unwanted material.

C. Apply grease to the inner and outer surfaces of the new bushings.

D. Use an arbor press to install the bushings into the lift arm or pivot yoke. The lift arm bushings should be pressed until the bushing flange is against the lift arm bore. The upper pivot yoke bushing should be pressed fully to the shoulder in the pivot yoke bore. The lower pivot yoke bushing should be flush with the yoke tube.

Installing the Rear Lift Arms

1. Position the rear lift arm to the frame and slide the pivot shaft through frame bosses and lift arm. Secure the shaft flange to the frame with the washer-head screw.
2. Install the torsion springs and components that secure the springs to the machine (Figure 317 or Figure 319). Position the long leg of spring forward and pointing out from top of the spring. On the machines that include a housing to secure the torsion springs (shown in Figure 317), the short leg of the torsion springs should be against the stop on the housing.
3. Align the lift cylinder rod end to the lift arm mounting slot. Slide the cylinder pin (item 4 in Figure 318) with the retaining ring and thrust washer through the lift cylinder and lift arm. Install the second thrust washer on the pin and secure with the second retaining ring.

CAUTION

Be careful when applying tension to the torsion spring on the rear lift arms. The spring is under heavy load and may cause personal injury.

4. Apply tension to the torsion springs:

   A. Insert a nut driver or small piece of pipe onto the long leg of the torsion spring on the rear of the lift arm pivot pin.

   B. Push down and forward on the spring end to hook the spring to the shoulder stud on the lift arm. Ensure that the spring end is positioned on stud as noted during disassembly.
5. Mount the cutting unit to the lift arm.
6. Lubricate the grease fittings on the lift arm, pivot yoke, and lift cylinder.

Hood

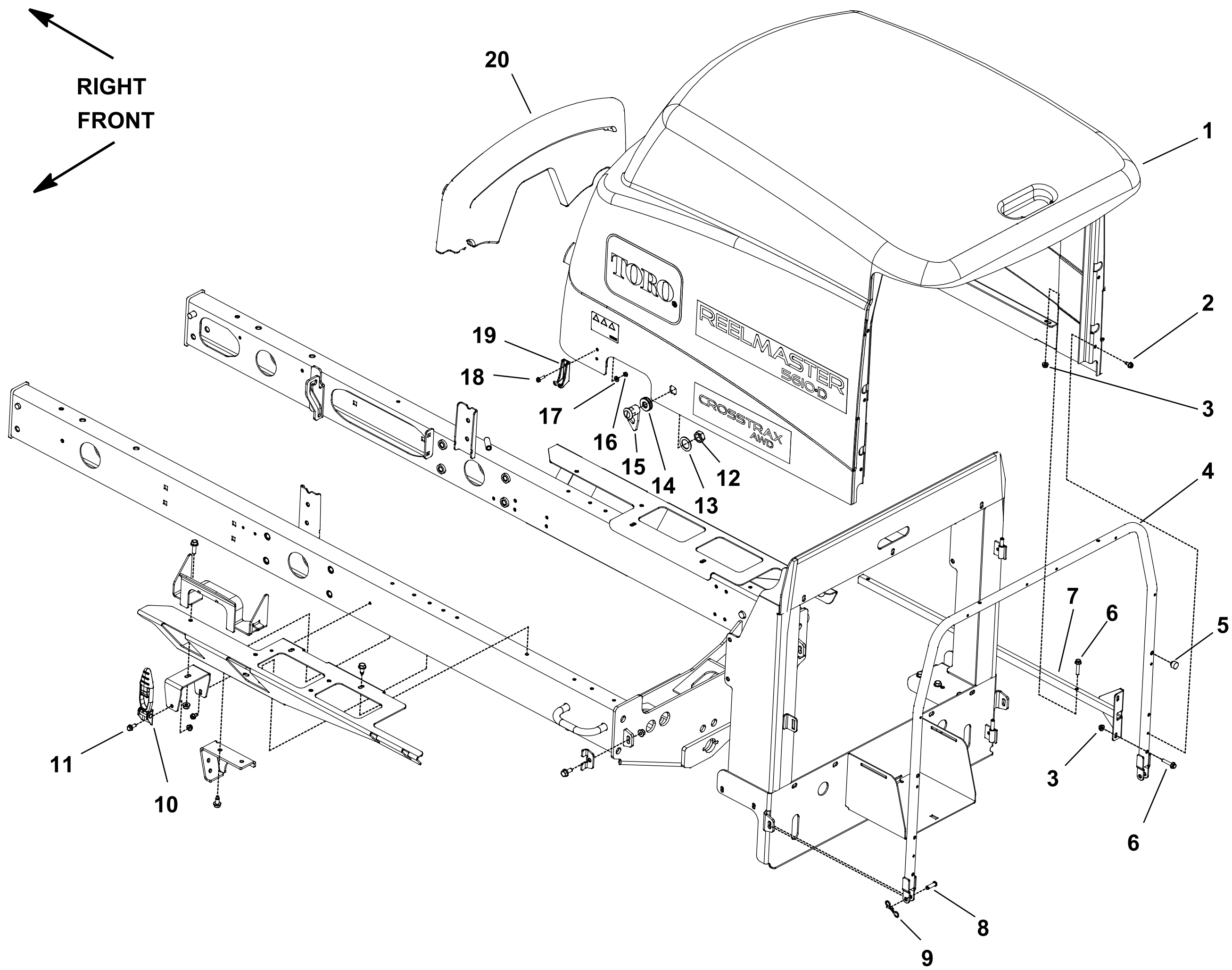

Figure 321

1. Hood
2. Washer-head screw (12 each)
3. Flange nut (12 each)
4. Rear hood frame tube
5. Rubber bumper (2 each)
6. Flange-head screw (10 each)
7. Side hood frame tube (2 each)
8. Clevis pin (2 each)
9. Bow tie pin (2 each)
10. Rubber latch (2 each)
11. Flange-head screw (2 each)
12. Hex nut
13. Spacer
14. Grommet
15. Latch
16. Locknut (4 each)
17. Flat washer (4 each)
18. Washer-head screw (4 each)
19. Catch latch (2 each)
20. Hood saddle

There are some variations in the hoods used on Reelmaster 5410, 5510, and 5610 series machines depending on model number and engine. The hood shown in Figure 321 is for a Reelmaster 5410-G/5410-D/5510-G/5510-D/5610-D. Hood service is similar for all models.

Removing the Hood

1. Park the machine on a level surface, lower the cutting units, shut off the engine, and remove the key from the key switch.
2. Unlatch the hood.
3. Remove the bow tie pins (item 9 in Figure 321) and clevis pins to allow hood removal.
4. Lift the hood assembly from the machine.
5. Remove the hood components as necessary (Figure 321).
6. Check the condition of all seals on the hood. Replace the seals that are damaged or missing.

   Note: The hood used on Reelmaster 5610 machines powered by a Kubota turbocharged diesel engine has additional shields on the underside of the hood. Check the shields and replace if there is any damage.

Installing the Hood

1. Install all the hood components that were removed (Figure 321).
2. Position the hood assembly to the machine.
3. Install the clevis pins (item 8 in Figure 321) and secure with the bow tie pins.
4. Latch the hood.

Cutting Unit

Table of Contents

Specifications

Cutting Unit Specifications

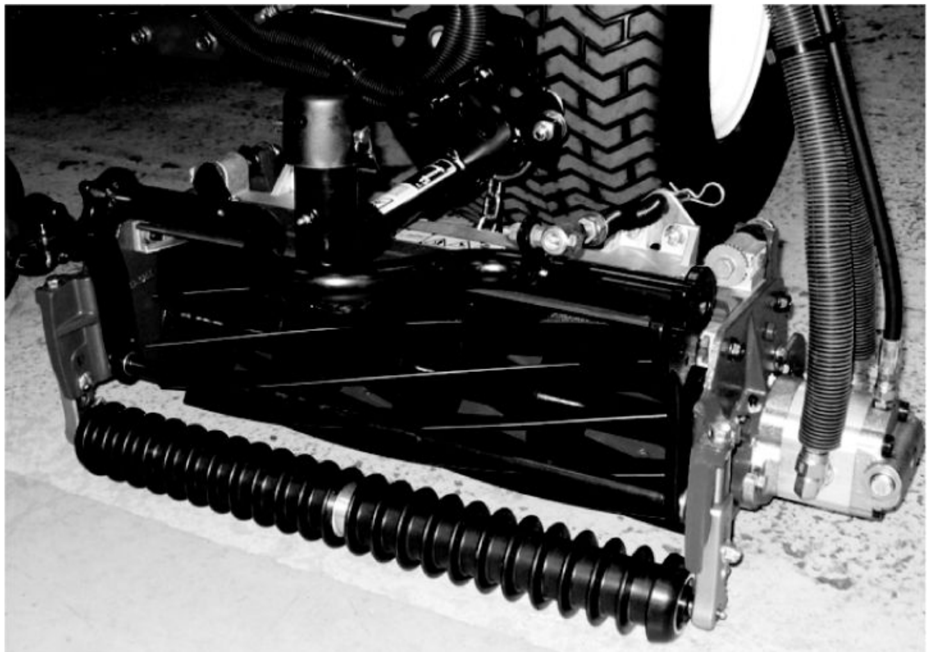

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Figure 322

Frame construction: Precision machined die cast aluminum crossmember with 2 bolt-on side plates. Side plates are either cast ductile iron (painted) or aluminum (non-painted).

Reel construction: The reels are 55.9 cm (22 inches) in length and are available in 12.7 cm (5 inches) and 17.8 cm (7 inches) in diameter. High strength, low alloy steel blades are through hardened and impact resistant. The cutting reels are available in 8 and 11 blade configurations.

Reel bearings (cutting unit with cast iron side plates): Two double row, self-aligning ball bearings press fit onto the reel shaft with inboard seal for protection. The reel bearing adjustment is maintained by an adjuster nut in the LH side plate of the cutting unit.

Reel bearings (cutting unit with aluminum side plates):

- Cutting units with painted side plates have two double row, self-aligning ball bearings press fit onto reel shaft with inboard seal for protection. Reel bearing adjustment is maintained by an adjuster nut in the LH side plate of the cutting unit.
- Cutting units with aluminum side plates have two stainless steel sealed radial ball bearings pressed onto the reel shaft. Reel end play is maintained by an internal wave spring (no adjustment required).

Reel drive: The reel weldment shaft is a 33.3 mm (1 5/16 inches) diameter tube with drive inserts threaded into both ends. The drive inserts for 5 inch reels have an internal 8 tooth spline. The drive inserts for 7 inch reels have an internal 9 tooth spline.

Height-of-cut (HOC): Cutting height is adjusted on the front roller by 2 vertical screws. Effective HOC may vary depending on turf conditions, type of bedknife, roller type, and installed attachments.

Cutting Unit Specifications (continued)

Bedknife: Replaceable, tool steel EdgeMax™ bedknife is fastened to a machined cast iron bedbar with 8 screws. Optional bedknives are available.

Bedknife adjustment: Dual screw assemblies allow for precise bedknife adjustment. Adjustment detents correspond to bedknife movement for each indexed position as follows:

- 0.018 mm (0.0007 inch) for 5 inch reel
- 0.022 mm (0.0009 inch) for 7 inch reel

Front and rear rollers: Greaseable through-shaft front and rear rollers are used with these cutting units. All rollers use the same heavy duty, stainless steel ball bearings and seal package.

Counterbalance weight: A cast iron weight or a groomer and/or a powered rear roller brush accessory is mounted opposite to the hydraulic drive motor to balance the cutting unit.

Cutting unit weight (with cast iron side plates) (without counterbalance weight):

8 Blade, 5 inch reel	51 kg (112 lb)
11 Blade, 5 inch reel	52 kg (116 lb)
8 Blade, 7 inch reel	67 kg (147 lb)
11 Blade, 7 inch reel	69 kg (151 lb)

Cutting unit weight (with aluminum side plates) (without counterbalance weight):

8 Blade, 5 inch reel	41 kg (90 lb)
11 Blade, 5 inch reel	42 kg (93 lb)
8 Blade, 7 inch reel	54 kg (118 lb)
11 Blade, 7 inch reel	55 kg (121 lb)

Options: Refer to the *Cutting Unit Parts Catalog* for available options for your Reelmaster cutting unit.

General Information

The *Cutting Unit Operator's Manual* provides information regarding the operation, general maintenance, and maintenance intervals for the cutting units on your Reelmaster machine. Additionally, if optional kits have been installed on the cutting units (e.g., groomer, rear roller brush), the installation instructions for the kit includes set-up and operation information. Refer to the *Cutting Unit Operator's Manual* for additional information when servicing the cutting units.

Special Tools

You can order these special tools from your Toro Distributor. Some tools may have been supplied with your machine or are available as Toro parts.

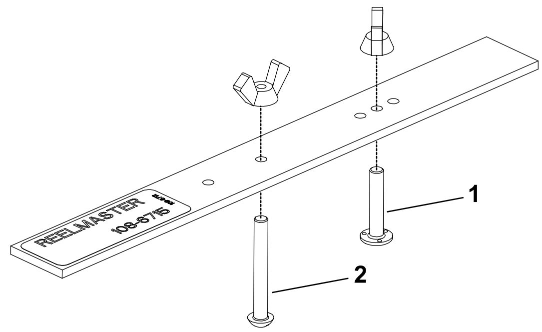
Gauge Bar Assembly

Toro Part No. 108-6715

Use gauge bar to verify height-of-cut adjustment. Also used for adjustment of optional groomer.

1. Used for groomer adjustment

2. Used for height-of-cut adjustment



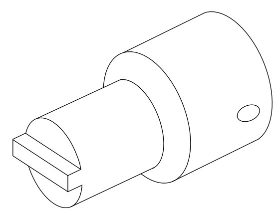
Bedknife Screw Tool

Toro Part No. TOR510880

This screwdriver-type bit is made to fit Toro bedknife attaching screws. Use this bit with a torque wrench to secure the bedknife to the bedbar.

IMPORTANT

Important: To prevent damage to the bedbar, do not use an air or manual impact wrench with this tool.



Handle Assembly

Toro Part No. 29-9100

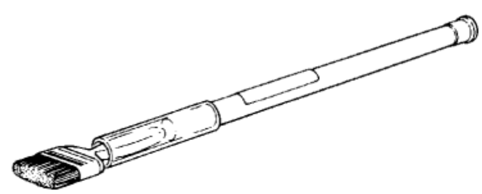
Used to apply lapping compound to cutting units while keeping the operator's hands at a safe distance from the rotating reel.

Components for the handle assembly are available individually as follows:

• Brush 36-4310

• Handle 29-9080

• Handle cap 2410-18

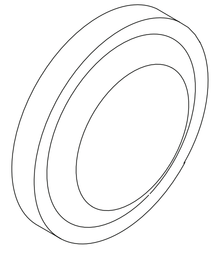


Plastic Plug

Toro Part No. 94-2703 (for 7 inch reels)

Toro Part No. 2410-30 (for 5 inch reels)

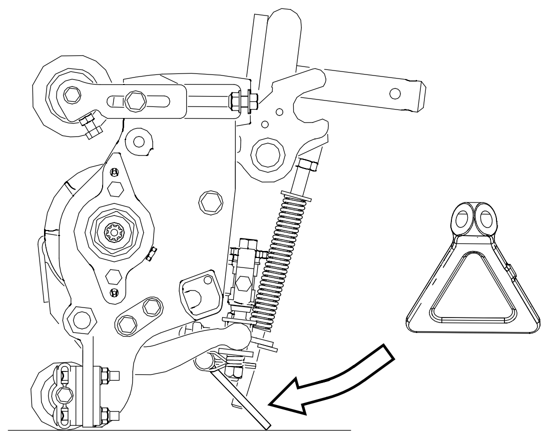
This cap is used for placement into the cutting unit side plate when the cutting reel motor is removed. It prevents dirt and unwanted material from entering the cutting reel bearing area.



Cutting Unit Kickstand

Toro Part No. 119-8010-03

The cutting unit kickstand is used to prop up the rear of the cutting unit during service. Use of this tool stabilizes the cutting unit and prevents the bedbar adjusting screws from resting on the work surface.

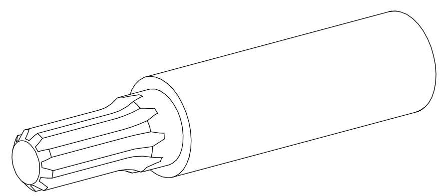


Spline Insert Tool

Toro Part No. TOR4112 (8 tooth for 5 inch reels)

Toro Part No. TOR4074 (9 tooth for 7 inch reels)

Use the spline insert tool for rotating the cutting reel when motor is removed. Also use this tool for installation of threaded inserts into the cutting reel shaft.



Roller Bearing and Seal Installation Tools

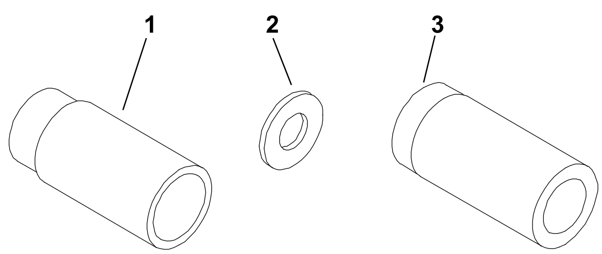
Toro Part No. 115-0803

This tool kit is used to assemble the cutting unit rollers. The tools in this kit are also available individually as follows:

1. Inner seal tool: 115-0852

2. Bearing installation washer: 107-8133

3. Bearing/outer seal tool: 115-0853



Turf Evaluator Tool

Toro Model No. 04399

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 Turf Evaluator (Toro Part No. 97931SL).

Diameter/Circumference Measuring Tape

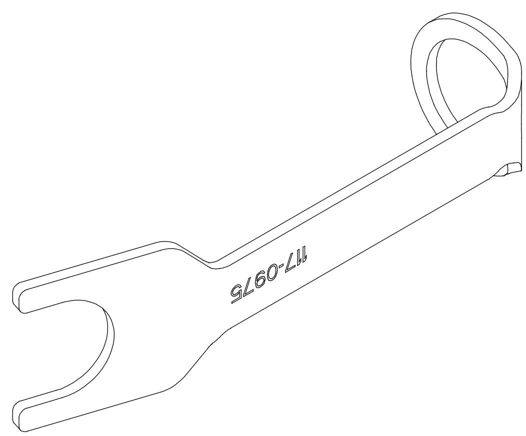
Toro Part No. TOR6023

Spring steel measuring tape for accurately measuring the circumference and outside diameter of the cutting reel and other spherical components. Tape calibration is in fixed inch readings (no adjustments).

Reel Bearing Installation Tool (cutting units with painted side plates)

Toro Part No. 117-0975

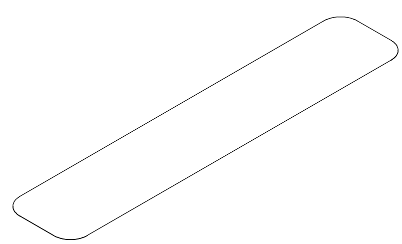
Use the reel bearing installation tool to keep the reel bearing aligned as the cutting unit side plate is installed on the bearing. This installation tool is only necessary for cutting reel service on cutting units that have cast iron side plates (spherical reel bearings).



Cutting Reel Shim

Toro Part No. 125-5611

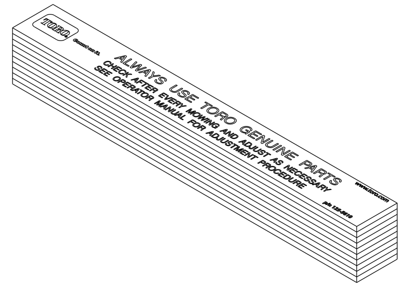
The cutting reel shim (0.05 mm/0.002 inch) is used to help parallel the bedknife and cutting reel.



Cutting Performance Paper

Toro Part No. 125–5610 (300 strips)

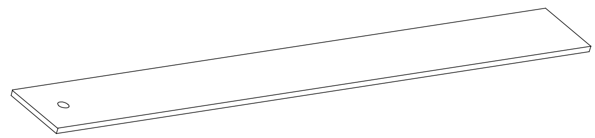
Cutting performance paper is used to test the cutting reel performance after adjusting the reel to bedknife clearance. 10 packs (30 strips per pack) of cutting performance paper are included in this part number.



Pulley Alignment Tool

Toro Part No. 114-5446

Use the pulley alignment tool to verify alignment of groomer and/or rear roller brush drive and driven pulleys.



Angle Indicator and Magnetic Mount

Angle Indicator: Toro Part No. 131–6828

Magnetic Mount: Toro Part No. 131–6829

Because the top grind angle on bedknives is critical for edge retention, and therefore after-cut appearance, Toro has develop 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.

2. Press the Alt Zero button on the angle indicator.

3. Remove the angle indicator and place the magnetic mount on the edge of the bedknife so that the face of the magnet is flat against the top angle of the bedknife.

4. Place the angle indicator on the mount with the digital display facing you as shown. The angle displayed on the indicator is the current bedknife top angle.

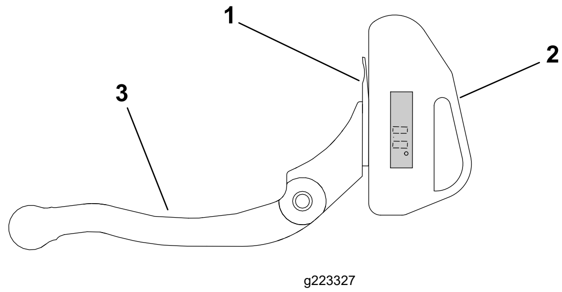


Figure 323

1. Bedknife
2. Angle Indicator
3. Bedbar

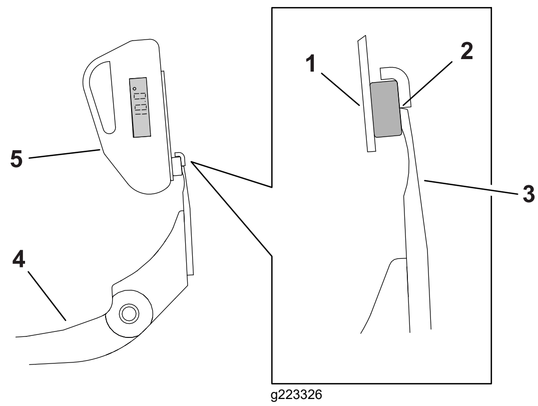


Figure 324

1. Angle indicator surface
2. Magnetic mount
3. Bedknife
4. Bedbar
5. Angle indicator

Aftercut Appearance

There are a number of factors that can contribute to unsatisfactory quality of cut, some of which may be turf conditions. The 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 Operator's Manual* for detailed cutting unit adjustment procedures. For cutting unit repair information, refer to Service and Repairs (page 9–17).

Note: For additional information regarding the cutting unit troubleshooting, refer to *Aftercut Appearance Troubleshooting Aid (Toro Part No. 00076SL)*.

Factors That Can Affect Quality of Cut

Factor	Possible Problem/Correction
Tire pressure	Check the tire pressure of all the traction unit tires. Adjust to the pressures specified in the *Operator's Manual*.
Governed engine speed	For best cutting performance and appearance, engine should be run at high-idle speed during machine operation (use the InfoCenter display to check the engine speed); refer to Chapter 4: Yanmar Diesel Engine (page 4–1) for high-idle speed specification.
Reel speed	All the cutting reels should rotate at the same speed (within 100 rpm). All the cutting units should have equal bedknife to reel and height-of-cut adjustments. Ensure that the reel speed selection is correct (use the InfoCenter display to check and adjust the reel speed). Refer to the *Traction Unit Operator's Manual* for recommendations for reel speed settings.
Reel bearing condition	Check the reel bearings for wear and replace if necessary. Refer to Reel Assembly in the Service and Repairs section of this chapter.
Bedknife to reel adjustment	All cutting units must have equal bedknife to reel and height-of-cut adjustments. Check the bedknife to reel contact daily. The bedknife should 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; refer to Bedknife to Reel Adjustment in the *Cutting Unit Operator's Manual*.

Factors That Can Affect Quality of Cut (continued)

Factor	Possible Problem/Correction
Reel and bedknife sharpness **Note:** After grinding the reel and/or bedknife, check the reel to bedknife contact again after cutting 2 fairways. During this initial use, any burrs will be removed from the reel and bedknife which can create improper reel to bedknife clearance and thus accelerate wear. This practice of checking the reel to bedknife contact after grinding will extend the longevity of the sharpness of the edge of the reel and bedknife.	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 the cutting reel to remove taper and/or rifling. Grind the bedknife to sharpen and/or remove rifling. The most common cause of rifling is bedknife to reel contact that is too tight. Dull cutting edges should be corrected by grinding the bedknife and cutting reel; refer to (page). A new bedknife should be ground flat (within 0.05 mm (0.002 inch)) after installation to the bedbar. Backlapping may be required to properly mate the reel and bedknife after installation into the cutting unit. **Note:** On the cutting units equipped with optional bedknives, slightly dull cutting edges may be corrected by backlapping; refer to Backlapping (page 9–19).
Rear roller adjustment	Adjust the rear roller brackets to correct position depending on the height-of-cut range and aggressiveness of cut that is desired. Refer to Rear Roller Adjustment in the *Cutting Unit Operator's Manual*.
Height-of-cut	Effective or actual height-of-cut depends on the cutting unit weight and turf conditions. The effective height-of-cut will be different from the bench set height-of-cut. Refer to Height-of-Cut Adjustment in the *Cutting Unit Operator's Manual*.
Proper bedknife selection for height-of-cut desired	If the bedknife is incorrect for effective height-of-cut, poor quality of cut will result. Refer to the *Cutting Unit Operator's Manual* for bedknife options.
Stability of bedbar	Ensure that the bedbar pivot bolts are seated securely. Check the condition of the bushings in the side plates. Refer to Bedbar Assembly (page 9–20).
Number of reel blades	Use correct number of reel blades for clip frequency and optimum height-of-cut range. Refer to the Clip Chart in the *Traction Unit Operator's Manual*.
Cutting unit alignment and carrier frame ground following	Check the carrier frames and lift arms for damage, binding conditions, or bushing wear. Repair if necessary.
Roller condition and roller type	Ensure that the rollers rotate freely. Repair the roller bearings as necessary; refer to Servicing the Roller (page 9–52). Refer to the *Cutting Unit Operator's Manual* for roller options.

Factors That Can Affect Quality of Cut (continued)

Factor	Possible Problem/Correction
Turf compensation spring adjustment	Refer to the *Traction Unit Operator's Manual* for turf compensation spring adjustment procedure.
Rear lift arm counterbalance spring adjustment	Refer to the *Traction Unit Operator's Manual* for rear lift arm counterbalance spring adjustment procedure.
Cutting unit accessories	A variety of cutting unit accessories are available that can be used to enhance aftercut appearance. Refer to the *Cutting Unit Operator's Manual* for a listing of available accessories.

Adjustments

Characteristics

⚠ CAUTION ⚠

Do not install or work on the cutting units or lift arms with the engine running. Always shut off the engine and remove the key from the key switch.

The dual knob bedknife-to-reel adjustment system incorporated in this cutting unit simplifies the adjustment procedure necessary 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.

Note: Refer to the *Cutting Unit Operator's Manual* for cutting unit adjustment procedures for your Reelmaster machine.

1. Adjust the bedknife parallel to the reel.
2. Determine the desired height-of-cut range and install the rear roller mounting shim(s) accordingly.
3. Adjust the height-of-cut.

Adjusting the Reel Bearing (cutting units with painted side plates)

Note: Cutting units that have aluminum side plates do not require reel bearing adjustment.

To ensure cut quality and long life of the cutting reel bearings on a cutting unit with cast iron side plates, periodically check the reel bearing adjustment.

Checking the Reel Bearing Adjustment

1. Remove the hydraulic reel motor from the cutting unit; refer to Removing the Hydraulic Reel Motor (page 9–17).
2. Loosen the bedknife to reel adjustment until no contact exists; refer to the *Cutting Unit Operator's Manual*.

⚠ CAUTION ⚠

Contact with the reel, bedknife, or other cutting unit parts can result in personal injury.

Use heavy gloves when handling the cutting reel.

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3. Hold on to the reel shaft and try to move the reel assembly side to side. If reel end-play exists, side to side movement will be detected.

Checking the Reel Bearing Adjustment (continued)

4. Use a suitable torque wrench and spline insert tool (refer to (page)), measure the rolling resistance of the cutting reel. The cutting reel rolling torque should not exceed **1.1 N·m (10 in-lb)**.
5. If reel has end-play or if rolling torque is incorrect, perform the reel bearing adjustment; refer to Adjusting the Reel Bearing (page 9–14).
6. After checking or adjusting the reel bearings, adjust the cutting unit; refer to the *Cutting Unit Operator's Manual*.
7. Install the hydraulic reel motor to the cutting unit; refer to Installing the Hydraulic Reel Motor (page 9–17).

Adjusting the Reel Bearing

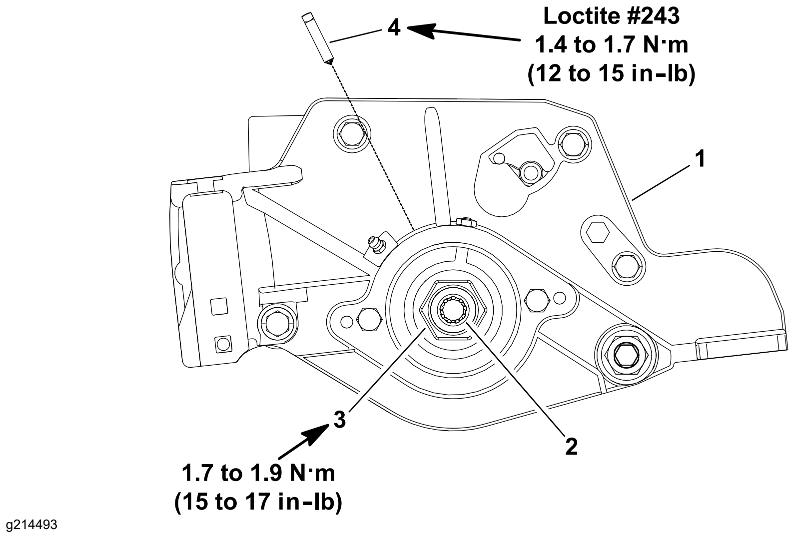

Figure 325

1. LH side plate
2. Threaded insert
3. Bearing adjuster nut
4. Set screw

1. Ensure that there is no contact between the bedknife and the reel.
2. Remove the cutting unit components on the LH side plate to get access to the bearing adjuster nut. If the cutting unit is equipped with a rear roller brush; refer to the Rear Roller Brush – Optional (cutting units with painted side plates) (page 9–56). If the cutting unit is equipped with a groomer; refer to the Groomer chapters in this manual.
3. Loosen the set screw that secures the bearing adjuster nut in the LH side plate of the cutting unit.

IMPORTANT

Over tightening the reel bearing adjuster nut may damage the reel bearings.

4. With the cutting unit and reel in a horizontal position, use a 1 3/8 inch socket and torque wrench to overtighten the bearing adjuster nut to **4.5 to 5.1 N·m (40 to 45 in-lb)**.
5. Loosen the bearing adjuster nut and then torque the bearing adjuster nut to **1.7 to 1.9 N·m (15 to 17 in-lb)**.

Adjusting the Reel Bearing (continued)

6. Use a suitable torque wrench and spline insert tool (refer to (page)), check that the reel rolling torque does not exceed **1.1 N·m (10 in-lb)**. Also, check if reel bearing end-play exists. If end-play exists, replace the cutting reel bearings and seals; refer to Reel Assembly (cutting units with painted side plates) (page 9–29) and Reel Assembly Service (cutting units with painted side plates) (page 9–36).
7. Apply Loctite #243 (or equivalent) to the threads of the set screw and secure the bearing adjuster nut in place with the set screw; torque the set screw to **1.4 to 1.7 N·m (12 to 15 in-lb)**.
8. After adjusting the reel bearing, install all the removed cutting unit components to the cutting unit.

Leveling the 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 ensure that the cutting unit is properly aligned.

1. Place the assembled cutting unit on a surface plate.
2. Ensure that the bedknife is properly adjusted to the cutting reel.
3. Check if the rear roller is level to the cutting reel by using a 0.13 mm (0.005 inch) feeler gauge to determine the clearance between the surface plate and the rear roller at each end of the roller. As the rear roller is rotated 1 full turn, check if the feeler gauge will consistently pass under the roller at one end but will not pass under the opposite end. Check the rear roller with the feeler gauge just inside the machined ends of the roller. A frame adjustment should be made if there is consistently more than 0.13 mm (0.005 inch) clearance under the roller on one end but not on the other.

   Note: Cutting units with 5 inch diameter reel use 2 shoulder bolts to secure the side plates to the frame. Cutting units with 7 inch diameter reel use 3 shoulder bolts to secure the side plates to the frame.

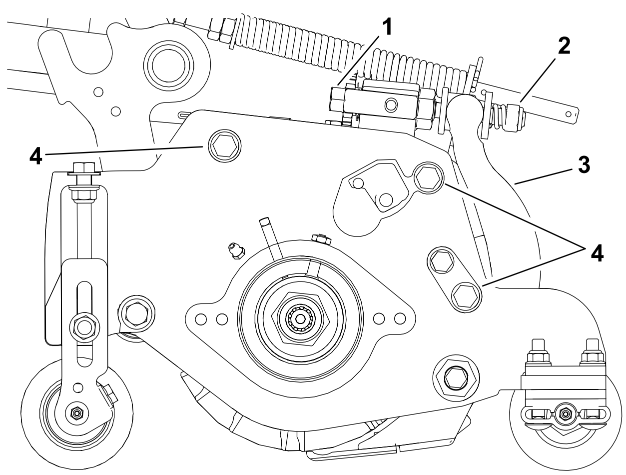

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Figure 326

1. Bedbar adjuster screw	3. Bedbar
2. Spring tension locknut	4. Shoulder bolt

4. Loosen, but do not remove the shoulder bolts that secure the side plate to the frame opposite the side that is not level (Figure 326).

Leveling the Rear Roller (continued)

5. Adjust the position of the side plate to parallel the rear roller and cutting reel. Tighten the shoulder bolts to **37 to 44 N·m (27 to 33 ft-lb)**.
6. After tightening the side plate, check the rear roller. If necessary, loosen and adjust the second side plate.

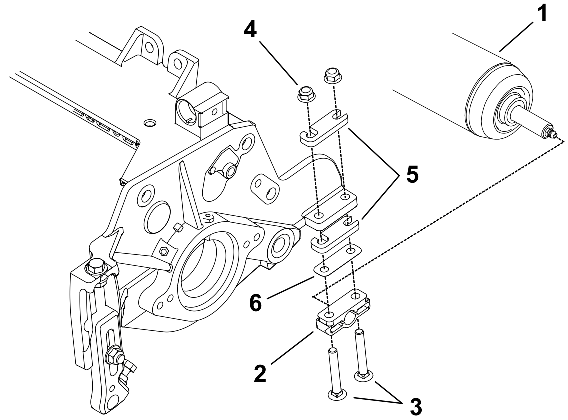

Figure 327

1. Rear roller bracket
2. 0.010 inch shim (if necessary)
3. Flange nut (2 each)
4. Flat washer (2 each)
5. Rear roller assembly
6. Roller shim (2 each)
7. Carriage screw (2 each)

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7. If the rear roller is still not level after adjusting both side plates, check to see if the cutting reel is tapered; refer to (page). If the cutting reel is not tapered and rear roller is not level, a 0.010 inch shim (Toro Part No.107-4001) is available to allow additional rear roller adjustment. The shim would be used on one side of the rear roller and should be installed between the rear roller bracket and the roller shim (Figure 327).
8. After leveling the rear roller, complete the cutting unit set-up and adjustment sequence.

Service and Repairs

Hydraulic Reel Motor

IMPORTANT

When performing the maintenance procedures on the cutting units, carefully position the cutting unit reel motors to prevent damage to the motors or hydraulic hoses.

Removing the Hydraulic Reel Motor

1. Park the machine on a clean and level surface, lower the cutting units completely to the ground, shut off the engine, set the parking brake, and remove the key from the key switch.

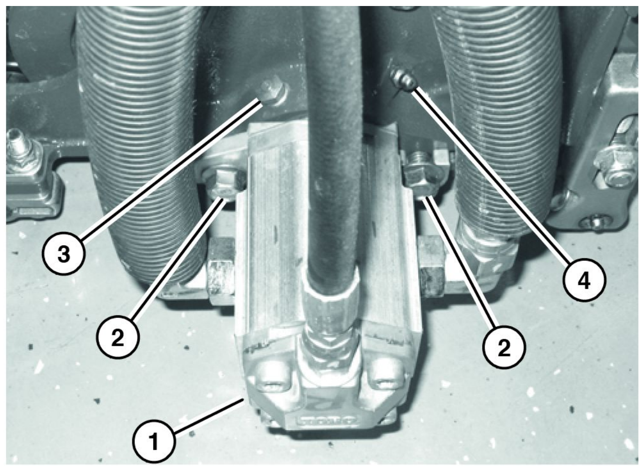

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Figure 328

Cutting unit with cast iron side plate

1.	Hydraulic reel motor	3.	Relief vent
2.	Bolt (2 each)	4.	Grease fitting

2. Loosen the 2 bolts (item 2 in Figure 328) that secure the hydraulic reel motor to the cutting unit side plate. Rotate the motor clockwise and remove the motor from the cutting unit.
3. Place a protective plastic cap (refer to (page)) into the hole in the cutting unit side plate to prevent unwanted material entering into the reel bearing area.

Installing the Hydraulic Reel Motor

Check the reel insert splines for wear. Replace the inserts if necessary; refer to Reel Assembly Service (cutting units with painted side plates) (page 9–36) or (page).

Installing the Hydraulic Reel Motor (continued)

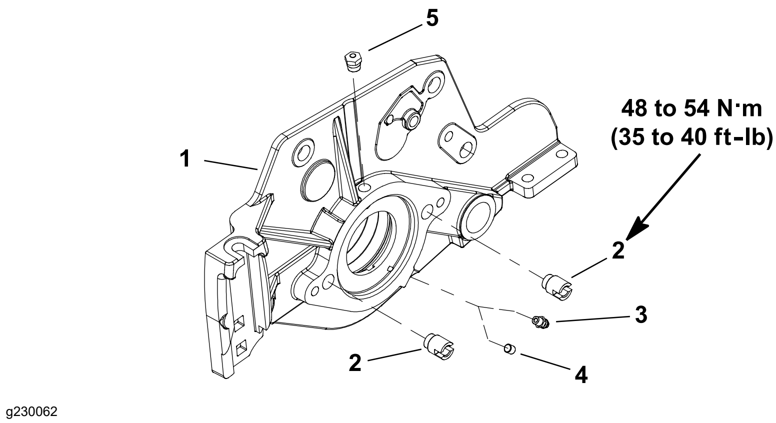

Figure 329

1. Aluminum side plate
2. Threaded insert
3. Grease fitting
4. Set screw
5. Relief vent

Note: Cutting units with aluminum side plates have threaded inserts for the reel motor mounting bolts (Figure 329). Check the condition of these inserts whenever the reel motor is removed. Replace the inserts if there is any damage. Tighter inserts to **48 to 54 N·m (35 to 40 ft-lb)** during installation.

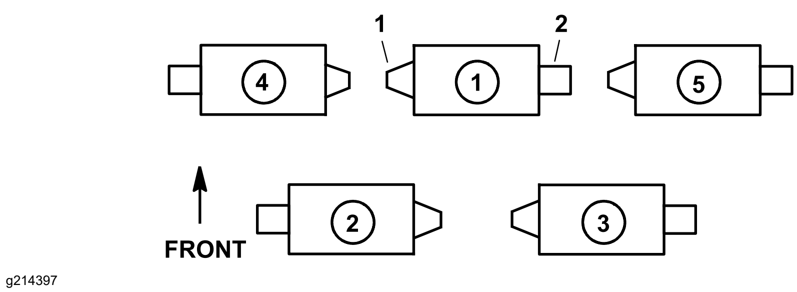

Figure 330

1. Weight location
2. Reel motor location

Note: Refer to Figure 330 for correct placement of cutting unit reel motors and weights.

1. Coat the spline shaft of the reel motor with No. 2 multipurpose lithium base grease.
2. Install the cap screws for the reel drive motor into the cutting unit side plate and leave approximately 12.7 mm (1/2 inch) of threads exposed on each screw.
3. Rotate the motor clockwise so that the motor flanges clear the bolts in the cutting unit side plates. Align the reel motor shaft splines with the cutting reel insert splines. Slide the motor shaft into the reel insert.

Backlapping

⚠ DANGER ⚠

To Avoid Personal Injury or Death

- **Never place hands or feet in the reel area while the engine is running. Stay away from the cutting reels when backlapping.**
- **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.**

Instructions and procedures on backlapping are available in the *Traction Unit Operator's Manual* and the Toro General Service Training Book, *Reel Mower Basics (part no. 09168SL)*.

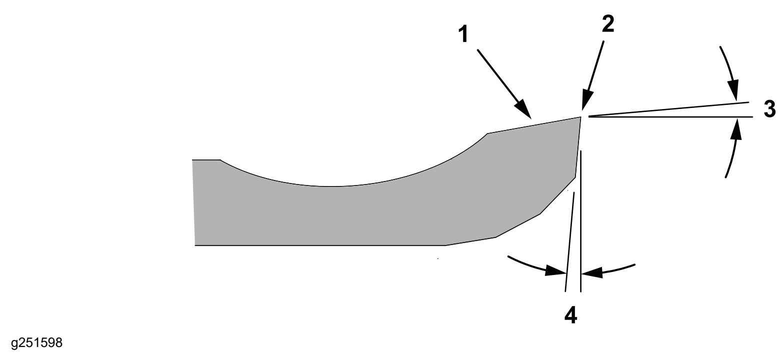

Figure 331

1. Top surface
2. Remove burr (without dulling sharp corner)
3. Top angle
4. Front angle

For a better cutting edge, run a file across the front face of the bedknife when the lapping operation is completed. This will remove any burrs or rough edges that may have built up on the cutting edge.

Bedbar Assembly

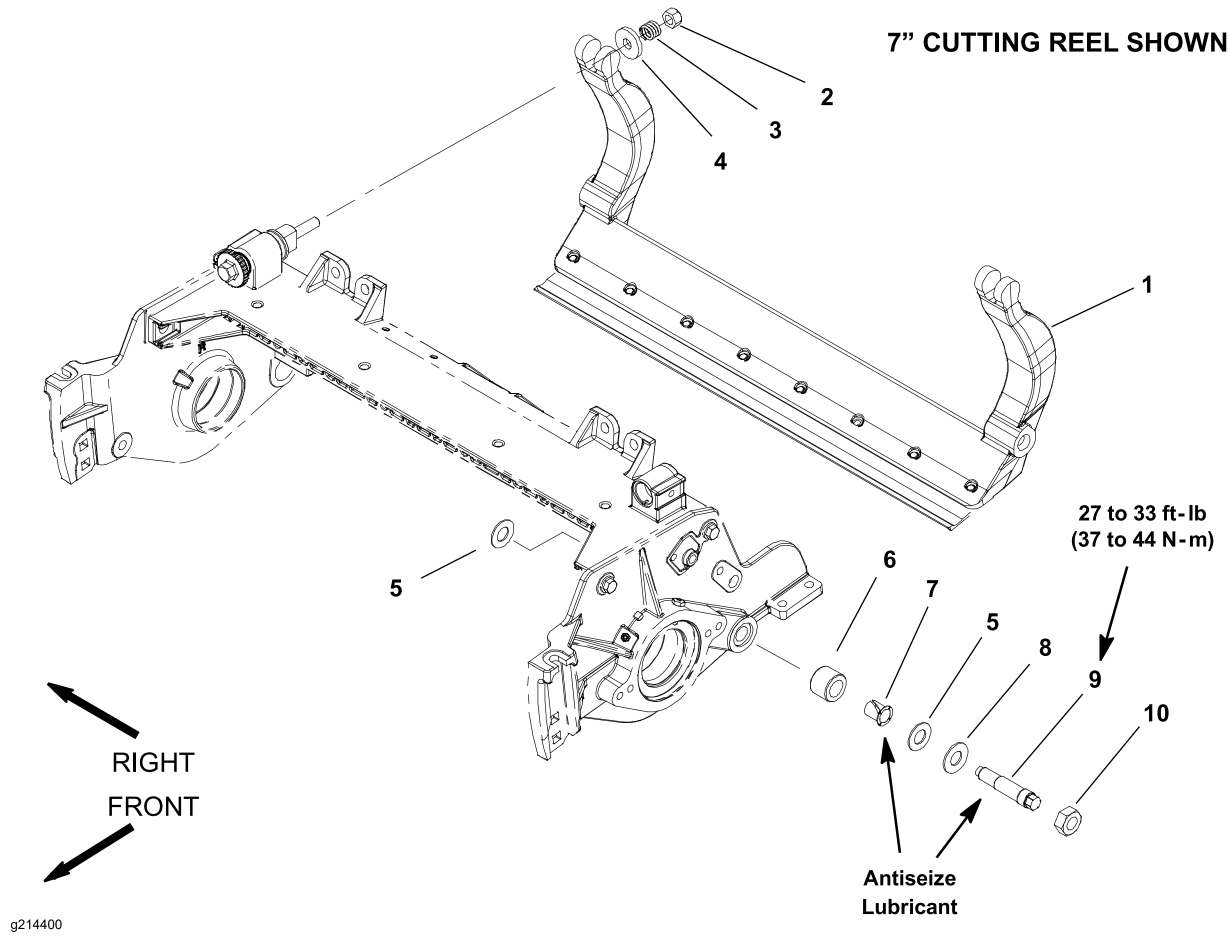

Figure 332

1. Bedbar assembly
2. Locknut (2 each)
3. Compression spring (2 each)
4. Washer (2 each)
5. Plastic washer (4 each)
6. Rubber bushing (2 each)
7. Flange bushing (2 each)
8. Metal washer (2 each)
9. Bedbar pivot bolt (2 each)
10. Locknut (2 each)

Removing the Bedbar Assembly

1. Park the machine on a clean and level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the cutting unit from the machine. Use the cutting unit kickstand to support the cutting unit; refer to (page).
3. Loosen the locknut (item 2 in) on the end of each bedbar adjuster assembly until the washer is loose.
4. Loosen the locknut (item 10) on each bedbar pivot bolt.
5. Remove the 2 bedbar pivot bolts (item 9), 2 metal washers, and 4 plastic washers 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.

Removing the Bedbar Assembly (continued)

6. Carefully remove the bedbar assembly from the cutting unit.
7. Inspect the flange bushings (item 7) and rubber bushings (item 6) in the side plates for wear or damage. Remove the bushings and replace if necessary.

Installing the Bedbar Assembly

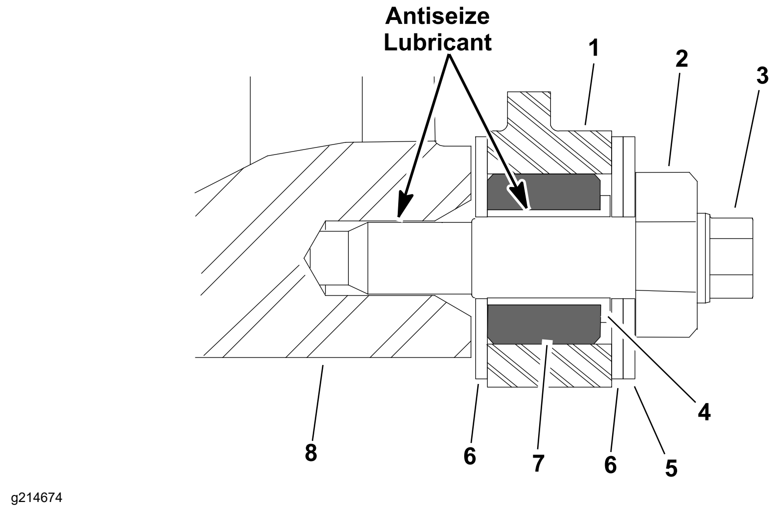

Figure 333

1.	Cutting unit side plate	3.	Bedbar pivot bolt	5.	Metal washer	7.	Rubber bushing
2.	Locknut	4.	Flange bushing	6.	Plastic washer	8.	Bedbar

1. If the rubber bushing was removed from either cutting unit side plate, install a new bushing. The bushing installed should be flush with the inside of the side plate (Figure 333).
2. If removed, install the flange bushings with the flange facing outward. Apply anti-seize lubricant to the inside of the flange bushing.
3. Apply anti-seize lubricant to the bedbar threads and the shoulder area of each bedbar pivot bolt.
4. Slide a metal washer and a plastic washer 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 the bedbar into the cutting unit. Ensure that the top of each bedbar arm is between the washer and the bedbar adjuster screw flange.
6. Position a plastic washer between the bedbar and each cutting unit side plate (Figure 333).
7. Install the bedbar pivot bolt assemblies:
   A. Push each bedbar pivot bolt through the side plate and into the bedbar enough to hold the bedbar in position.

IMPORTANT

Do Not use a powered wrench or an impact wrench to install the bedbar pivot bolts.

B. Start threading of one of the pivot bolts into the bedbar and continue until the pivot bolt bottoms out. Repeat for remaining pivot bolt.

C. Make sure that plastic washers are not caught on the threads of the pivot bolts.

D. Tighten each bedbar pivot bolt from **37 to 44 N·m (27 to 33 ft-lbs)**.

8. Tighten both locknuts (item 10) until the outside metal washer just rotates. Do not over tighten the lock nuts as this can distort the side plates and affect reel to bedknife contact, or in the case of cutting units with painted side plates, reel bearing adjustment. The plastic washer between the bedbar and side plate should be loose

9. Tighten the locknut (item 2) on each bedbar adjuster assembly until the adjuster spring is fully compressed, then loosen the locknut 1/2 turn.

10. Adjust the cutting unit; refer to the *Cutting Unit Operator's Manual*.

11. Install the cutting unit to the machine.

Bedknife Replacement and Grinding

Removing the Bedknife

1. Remove the bedbar from the cutting unit; refer to Bedbar Assembly (page 9–20).

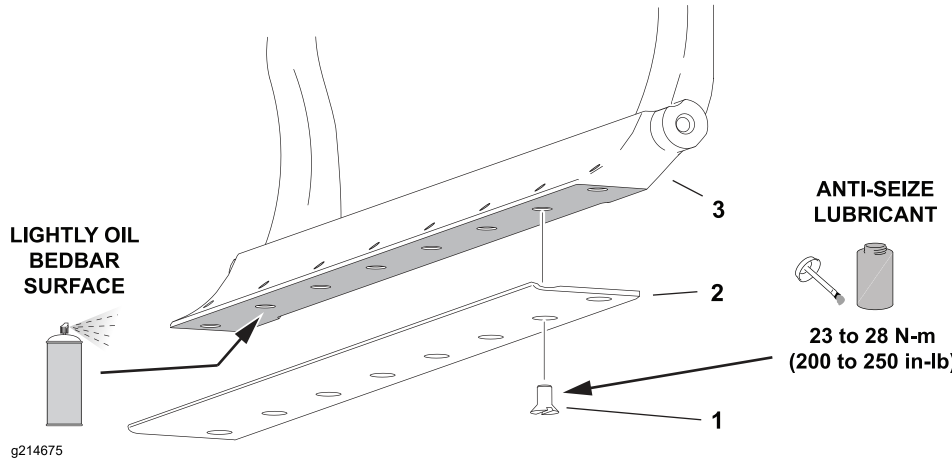

Figure 334

1. Screw (8 each)
2. Bedknife
3. Bedbar

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2. Remove the screws from the bedbar with a socket wrench and bedknife screw tool (refer to (page)). Discard the screws. Remove the bedknife from the bedbar (Figure 334).
3. Refer to Grinding the Bedknife (page 9–24) for additional information.

Installing the Bedknife

1. Use a scraper to remove all rust, scale and corrosion from the bedbar surface. Lightly oil the bedbar surface before installing the bedknife.
2. Ensure that the screw threads in the bedbar (5/16-18UNC-2A) are clean.

IMPORTANT

Do not use an impact wrench to tighten the screws into the bedbar.

---

3. Use new screws to secure bedknife to bedbar. Apply anti-seize lubricant to the threads of new screws. Do not apply anti-seize lubricant to the taper of the screw heads.
4. Install all screws but do not tighten.

Installing the Bedknife (continued)

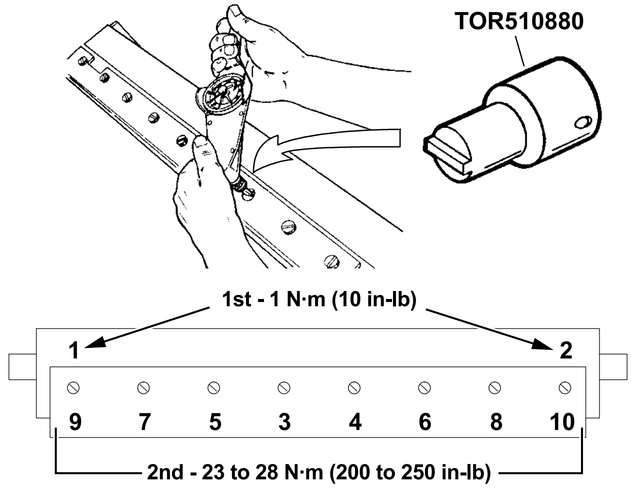

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Figure 335

5. Using a torque wrench and bedknife screw tool, tighten the 2 outer screws to **1 N·m (10 in-lb)**.
6. Working from the center of the bedknife toward each end, tighten screws from **23 to 28 N·m (200 to 250 in-lb)**.
7. After installing the bedknife to the bedbar, grind the bedknife.

Grinding the Bedknife

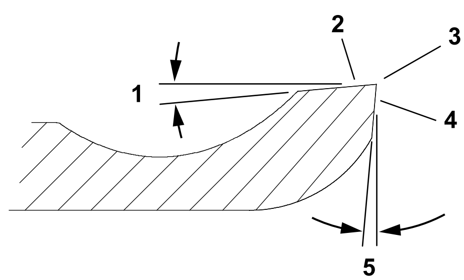

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Figure 336

1. Top angle
2. Top surface
3. Remove burr (without dulling sharp corner)
4. Front surface
5. Front angle

Bedknife Grinding Specifications

<table>
<tr><th>Bedknife</th><th>Lip Height Service Limit</th><th>Top Angle</th><th>Front Angle</th></tr>
<tr><td>EdgeMax® Low HOC</td><td rowspan="8">4.8 mm (0.190 inch)</td><td rowspan="5">10°</td><td rowspan="3">5°</td></tr>
<tr><td>Premium Low HOC</td></tr>
<tr><td>Standard Low HOC</td></tr>
<tr><td>Extended EdgeMax® Low HOC</td><td rowspan="2">10°</td></tr>
<tr><td>Extended Low HOC</td></tr>
<tr><td>EdgeMax® Standard HOC</td><td>5°</td><td rowspan="3">5°</td></tr>
<tr><td>Standard Standard HOC</td><td rowspan="2">10°</td></tr>
<tr><td>Heavy Duty Standard HOC</td></tr>
</table>

Grinding the Bedknife (continued)

Since there can be variations in the mounting surface of the bedbar, a new bedknife will not be perfectly flat after it is installed to the bedbar. Because of this, it is necessary to grind a new bedknife after installing it to the bedbar. Follow the bedknife grinding specifications provided and grind only enough to ensure that the top surface of the bedknife is true; refer to Bedknife Grinding Specifications (page 9–24) and Figure 336.

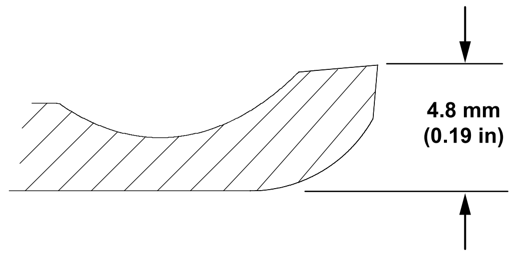

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Figure 337

Lip Height Service Limit

IMPORTANT

Do Not grind the bedknife below it's service limit; refer to Figure 337. 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 for impacts.

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 (page).

Note: Some bedknives were produced with a 5° top angle. Use a 10° top angle when regrinding all bedknives.

1. Use Toro General Service Training Book, *Reel Mower Basics* (Toro Part No. 09168SL), and grinder manufacturer's instructions for bedknife grinding information.

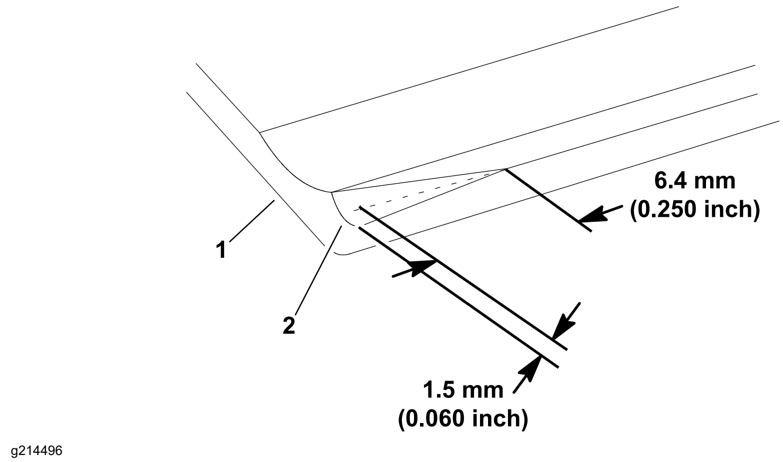

Figure 338

1. Bedknife
2. Lead-in chamfer

2. A lead−in chamfer is ground into all new bedknives; refer to Figure 338. The original chamfer should last for the first 40% of the bedknife service life. Check and re-grind the lead-in chamfer as necessary.
3. After you complete the bedknife grinding, install the bedbar to the cutting unit; refer to Installing the Bedknife (page 9–23).

Servicing the Bedbar Adjuster

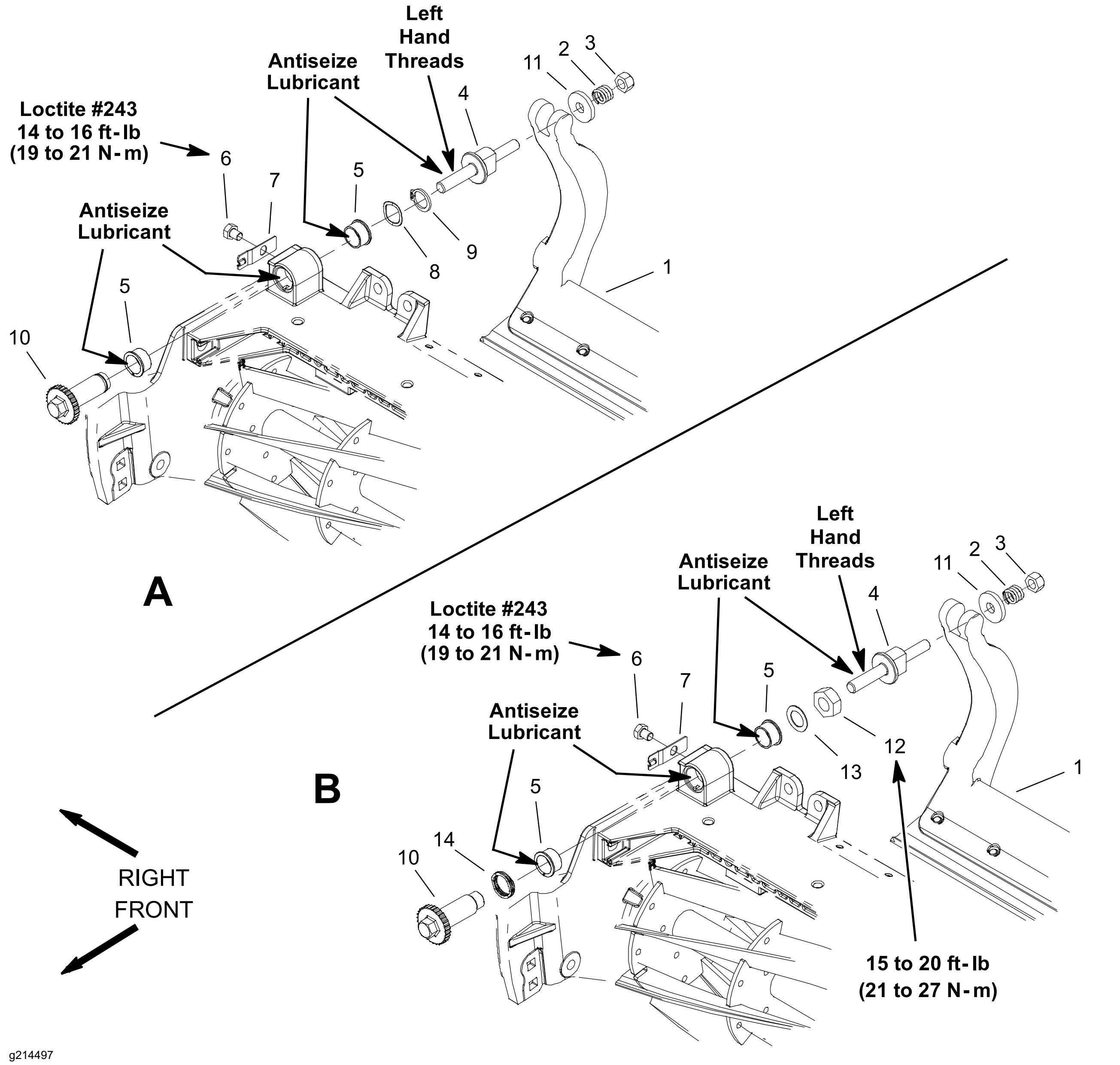

Figure 339

1. Bedbar assembly
2. Compression spring
3. Lock nut
4. Bedbar adjuster screw
5. Flange bushing (2 each)
6. Cap screw
7. Detent
8. Wave washer
9. Retaining ring
10. Bedbar adjuster shaft
11. Washer
12. Lock nut
13. Flat washer
14. Wave washer

Note: The bedbar adjuster system for early production DPA cutting units (Figure 339A) used a retaining ring on the end of the bedbar adjuster shaft. Current production DPA cutting units (Figure 339B) include a lock nut on the end of the bedbar adjuster shaft. Upgrading to the current production style adjusters is recommended using Heavy Duty DPA Kit p/n 120-7230. The bedbar adjuster service procedures for either style of adjuster shaft is very similar.

Removing the Bedbar Adjuster

1. Remove the locknut (item 3) , compression spring, and washer from the bedbar adjuster screw (item 4).
2. Remove the bedbar assembly; refer to the Removing the Bedbar Assembly (page 9–20).
3. Remove bedbar adjuster screw (left hand threads) from the bedbar adjuster shaft (item 10).
4. Remove adjuster shaft from cutting unit frame:
   A. On early production cutting units (Figure 339A), remove retaining ring and wave washer from adjuster shaft. Slide adjuster shaft from cutting unit frame.
   B. On current production cutting units (Figure 339B), remove lock nut and flat washer from adjuster shaft. Slide adjuster shaft and wave washer from cutting unit frame.
5. Inspect flange bushings (item 5) in cutting unit frame and replace if necessary.
6. If detent (item 7) is damaged, remove it from cutting unit side plate.

Installing the Bedbar Adjuster

1. If the detent (item 7) was removed, apply Loctite #243 (or equivalent) to threads of cap screw and secure detent to cutting unit side plate with cap screw. Tighten cap screw from **19 to 21 N·m (14 to 16 ft-lb)**.
2. If flange bushings (item 5) were removed, apply antiseize lubricant to bore of cutting unit frame. Align key on bushing to slot in frame and install bushings into frame. Apply antiseize lubricant to bore of each flange bushing.
3. Install adjuster shaft to cutting unit frame:
   A. On early production cutting units (Figure 339A), slide bedbar adjuster shaft into flange bushings in cutting unit frame. Secure adjuster shaft with wave washer and retaining ring.
   B. On current production cutting units (Figure 339B), slide wave washer onto adjuster shaft and then slide adjuster shaft into flange bushings in cutting unit frame. Secure adjuster shaft with flat washer and lock nut. Tighten lock nut to shoulder of adjuster shaft and then torque lock nut from **21 to 27 N·m (15 to 20 ft-lb)**.
4. Apply antiseize lubricant to the left hand threads of bedbar adjuster screw (item 4). Thread bedbar adjuster screw into adjuster shaft (item 10).
5. Install washer (item 11), compression spring and lock nut onto adjuster screw.
6. Install the bedbar; refer to the Installing the Bedbar Assembly (page 9–21).
7. Adjust the cutting unit; refer to the *Cutting Unit Operator's Manual*.

Reel Assembly (cutting units with painted side plates)

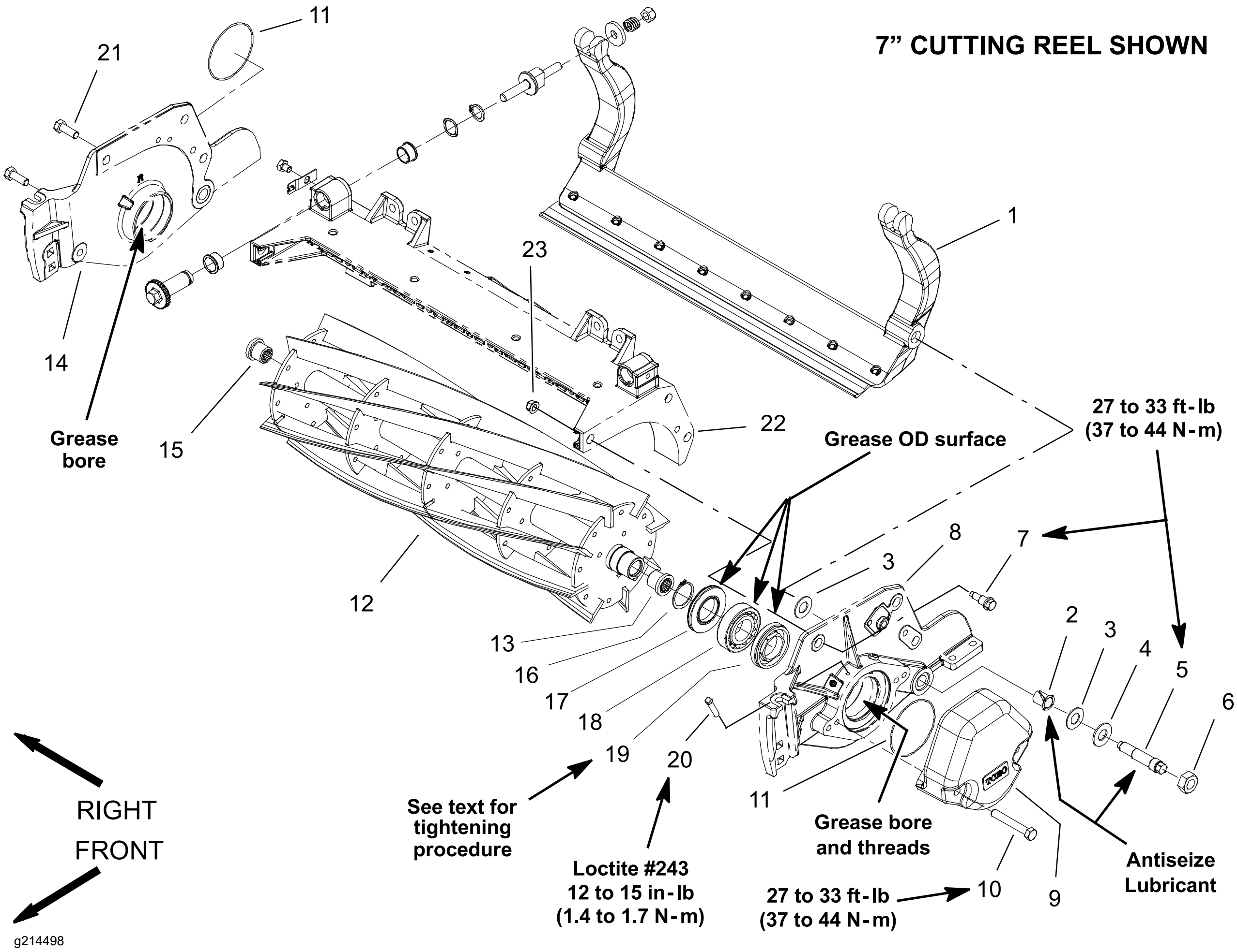

Figure 340

1. Bedbar assembly
2. Flange bushing (2 each)
3. Plastic washer (4 each)
4. Metal washer (2 each)
5. Bedbar pivot bolt (2 each)
6. Lock nut (2 each)
7. Shoulder bolt (3 per side plate)
8. LH side plate
9. Weight
10. Cap screw(2 each)
11. O-ring
12. Cutting reel
13. Spline insert (left-hand thread)
14. RH side plate
15. Spline insert (right-hand thread)
16. Retaining ring (2 each)
17. Grease seal (2 each)
18. Bearing (2 each)
19. Bearing adjuster nut
20. Set screw
21. Cap screw(2 each)
22. Cutting unit frame
23. Flange nut (3 per side plate)

Note: This section provides the procedure for removing and installing the cutting reel assembly (cutting reel, spline inserts, grease seals and bearings) from the cutting unit.

Note: Refer to Reel Assembly Service (cutting units with painted side plates) (page 9–36) for information on replacing cutting reel grease seals, bearings and spline inserts.

Note: Removal of the cutting reel requires removal of the LH side plate from the cutting unit frame. The RH side plate does not have to be removed from the frame.

Removing the Reel Assembly

1. Park the machine on a clean and level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.

2. Remove the cutting unit from the machine and place on a flat work surface.
3. If cutting unit is equipped with a counterweight or accessory on LH side plate, remove the counter weight or accessory from the cutting unit. Remove and discard O-ring from counter weight. Refer to Service and Repairs (page 10–6) for additional belt driven groomer information. Refer to Service and Repairs (page 10–6) for additional universal groomer information. Refer to Rear Roller Brush – Optional (cutting units with painted side plates) (page 9–56) for additional rear roller brush information.

CAUTION

Contact with the reel, bedknife or other cutting unit parts can result in personal injury. Use heavy gloves when removing the cutting reel.

IMPORTANT

If the reel bearings or seals are being replaced, the reel spline inserts must be removed. Use the following procedure to restrain the reel and loosen the spline insert before removing the rollers.

4. Loosen the spline inserts:
   A. Tip the cutting unit to access the bottom of the reel.

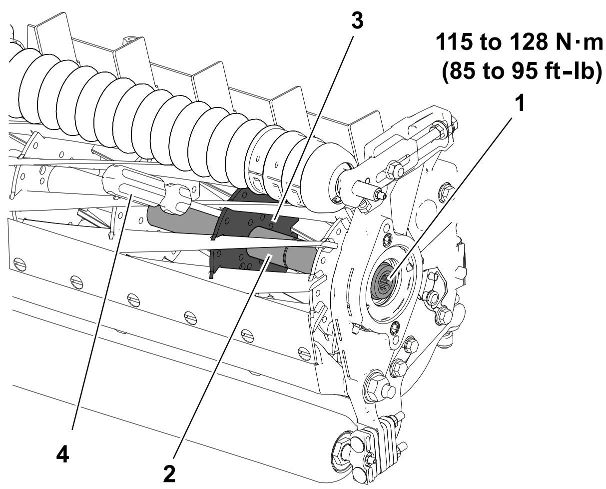

Figure 341

1. Spline insert (LH)
2. Reel shaft
3. Reel support plate
4. Pry bar

   B. Insert a long-handled pry bar (3/8 x 12 inch with screwdriver handle recommended) through the bottom of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move; refer to Figure 341.

IMPORTANT

To avoid grinding the reel, do not contact the cutting edge of any blade with the pry bar as this may damage the cutting edge and/or cause a high blade.

C. Move the pry bar against the weld side of the reel support plate closest to the spline insert being loosened. Use correct spline insert tool (see Special Tools (page 9–5)).

IMPORTANT

The spline insert on the left end of the cutting reel has left hand threads and the spline insert on the right end of the cutting reel has right hand threads.

D. Rest the handle of the pry bar against the front roller and loosen the spline insert closest to the pry bar.

E. Position the pry bar in the same manner on the opposite end of the reel and loosen the remaining spline insert.

F. Tip the cutting unit back onto its rollers.

5. Remove the bedbar; refer to Removing the Bedbar Assembly (page 9–20).
6. Remove the front roller; refer to Removing the Front Roller (page 9–48).
7. Remove the rear roller; refer to Removing the Rear Roller (page 9–50).

Removing the Reel Assembly (continued)

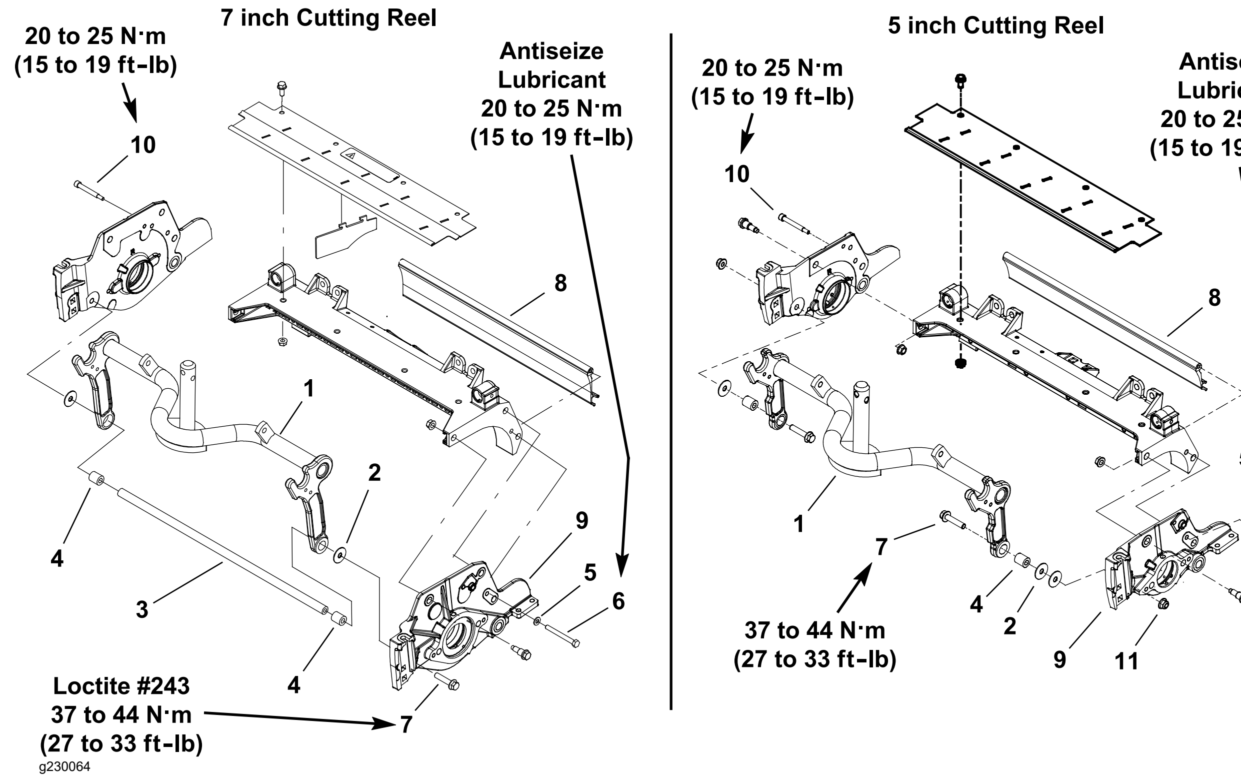

Figure 342

1. Carrier frame	5. Flat washer	9. LH side plate
2. Shim (if equipped)	6. Cap screw	10. Socket-head screw
3. Support tube	7. Flange-head screw	11. Flange nut
4. Frame spacer	8. Rear grass shield	

8. Remove the bolt and flat washer that secure the rear grass shield to the LH side plate.
9. Remove flange head screw that secures support tube, frame spacer and carrier frame to LH side plate

   Note: The reel bearings and seals are press fit on the cutting reel shaft and should remain on the reel when removing the LH side plate.

   Note: Side plates on 5” cutting units attach to cutting unit frame with two (2) shoulder bolts and flange nuts. Side plates on 7” cutting units use three (3) shoulder bolts and flange nuts.

10. Remove shoulder bolts (item 7) and flange nuts that secure the LH side plate to the cutting unit frame. Remove the LH side plate from the reel shaft, rollers, bedbar assembly and cutting unit frame.

CAUTION

Contact with the reel, bedknife, or other cutting unit parts can result in personal injury.

Use heavy gloves when removing the cutting reel.

11. Carefully pull the cutting reel with the bearings and seals from the RH side plate.

Removing the Reel Assembly (continued)

12. Inspect and service the cutting reel assembly as necessary; refer to Reel Assembly Service (cutting units with painted side plates) (page 9–36).

Installing the Reel Assembly

1. Clean the side plates and other cutting unit components. Inspect the side plates for wear or damage and replace if necessary.

   Note: Check that the grease seals on the cutting reel shaft are flush to 1.5 mm (0.060 inch) away from the retaining ring on the reel shaft. If necessary, adjust the position of the grease seals for proper clearance.
2. Make sure that grease seals and bearings are properly greased and positioned on cutting reel (see Reel Assembly Service in this section). Apply thin coat of grease to outside of grease seals and bearings on cutting reel to ease reel installation. Also, apply grease to bearing bores and threads in side plates.

⚠ CAUTION ⚠

Contact with the reel, bedknife, or other cutting unit parts can result in personal injury.

Use heavy gloves when installing the cutting reel.

IMPORTANT

During cutting reel installation, keep inner and outer bearing races aligned. If bearing races are not aligned, binding will occur and reel installation may cause bearing damage. Use reel bearing installation tool (Toro part number 117-0975) to help with bearing alignment during reel installation.

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3. Using reel bearing installation tool to keep reel bearing aligned, carefully slide the cutting reel with bearings and grease seals into the RH side plate; refer to (page). Make sure that bearing is fully seated into side plate.
4. On the LH side plate, loosen the set screw (item 20) and back-off (loosen) the bearing adjuster nut 1 complete turn.
5. Slide the LH side plate onto the cutting reel assembly, front roller and rear roller. Make sure that reel end in RH side plate does not shift in position.
6. Install the shoulder bolts (item 7) and flange nuts that secure the LH side plate to the cutting unit frame; tighten the shoulder bolts from **37 to 44 N·m (27 to 33 ft-lb)**.
7. Apply Loctite #243 (or equivalent) to threads of flange head screw that secures support tube, frame spacer and carrier frame to LH side plate. Install screw and torque from **37 to 44 N·m (27 to 33 ft-lbs)**. After tightening screw, check the clearance between the carrier frame and side plate. If clearance is more than 2.3 mm (0.090 inch), remove flange head screw and position shim(s) (part number 67-9410) between carrier frame and side plate so that clearance is less than 2.3 mm (0.090 inch). Make sure that the carrier frame pivots freely after assembly.
8. Install cap screw and flat washer that secure rear grass shield to LH side plate. Tighten screw from **20 to 25 N·m (15 to 19 ft-lbs)**.

Installing the Reel Assembly (continued)

9. Install the bedbar assembly; refer to Installing the Bedbar Assembly (page 9–21).
10. Install the rear roller; refer to Installing the Rear Roller (page 9–50).
11. Install the front roller; refer to Installing the Front Roller (page 9–48).

IMPORTANT

Over tightening reel bearing adjuster nut may damage reel bearings.

12. Adjust the reel bearings; refer to Adjusting the Reel Bearing (cutting units with painted side plates) (page 9–13).
13. Adjust the cutting unit; refer to the *Cutting Unit Operator's Manual*.

    Note: The parallel position of the rear roller to the cutting reel is controlled by the precision machined frame 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; refer to Leveling the Rear Roller (page 9–15).

14. If the cutting unit is equipped with optional groomer or rear roller brush, install the components for those options to the LH side plate of the cutting unit. Refer to Service and Repairs (page 10–6) for information on belt driven groomer. Refer to Rear Roller Brush – Optional (cutting units with painted side plates) (page 9–56) for information on the rear roller brush.

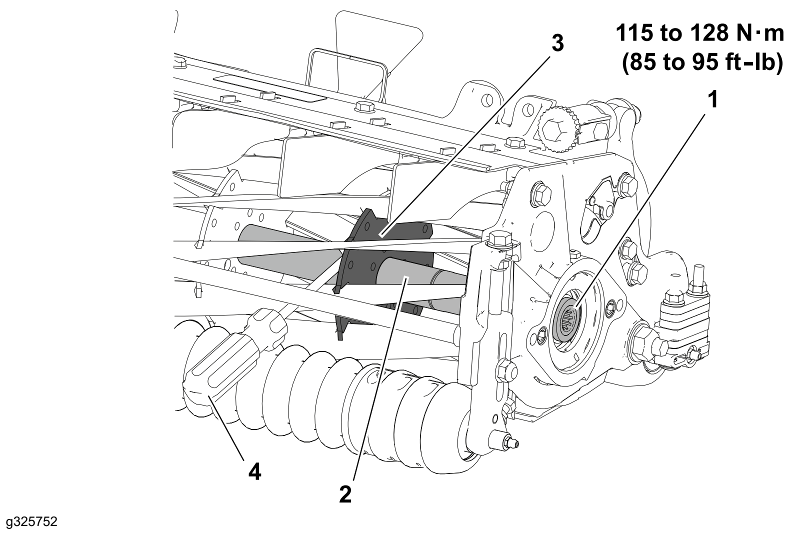

Figure 343

1. Spline insert (LH)
2. Reel shaft
3. Reel support plate
4. Pry bar

15. Tighten the spline inserts:

    A. Insert a long-handled pry bar (3/8 x 12 inch with a screwdriver handle recommended) through the front of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move; refer to Figure 343.

Installing the Reel Assembly (continued)

IMPORTANT

To avoid grinding the reel, do not contact the cutting edge of any blade with the pry bar as this may damage the cutting edge and/or cause a high blade.

B. Move the pry bar against the weld side of the reel support plate closest to the spline insert being tightened.

IMPORTANT

The spline insert on the left end of the cutting reel has left hand threads and the spline insert on the right end of the cutting reel has right hand threads.

C. Rest the handle of the pry bar against the front roller and tighten the spline insert closest to the pry bar. The spline inserts are installed with thread locking compound (Loctite #243 or equivalent). Tighten the spline insert from **115 to 128 N·m (85 to 95 ft-lb)**. Use correct spline insert tool (see Special Tools (page 9–5)).

D. Position the pry bar in the same manner on the opposite end of the reel and tighten the remaining spline insert.

16. If the counterweight was removed from the cutting unit, install new O-ring (item 11) on counterweight. Secure the counterweight to the cutting unit side plate with the 2 bolts; torque the bolts to **37 to 44 N·m (27 to 33 ft-lb)**.

17. Lubricate the cutting unit grease fittings until grease purges from the relief vents in the side plates. Initial greasing may require several pumps of a hand grease gun. Remove the unwanted grease from the fittings and relief vents.

18. Install the cutting unit to the machine.

Reel Assembly Service (cutting units with painted side plates)

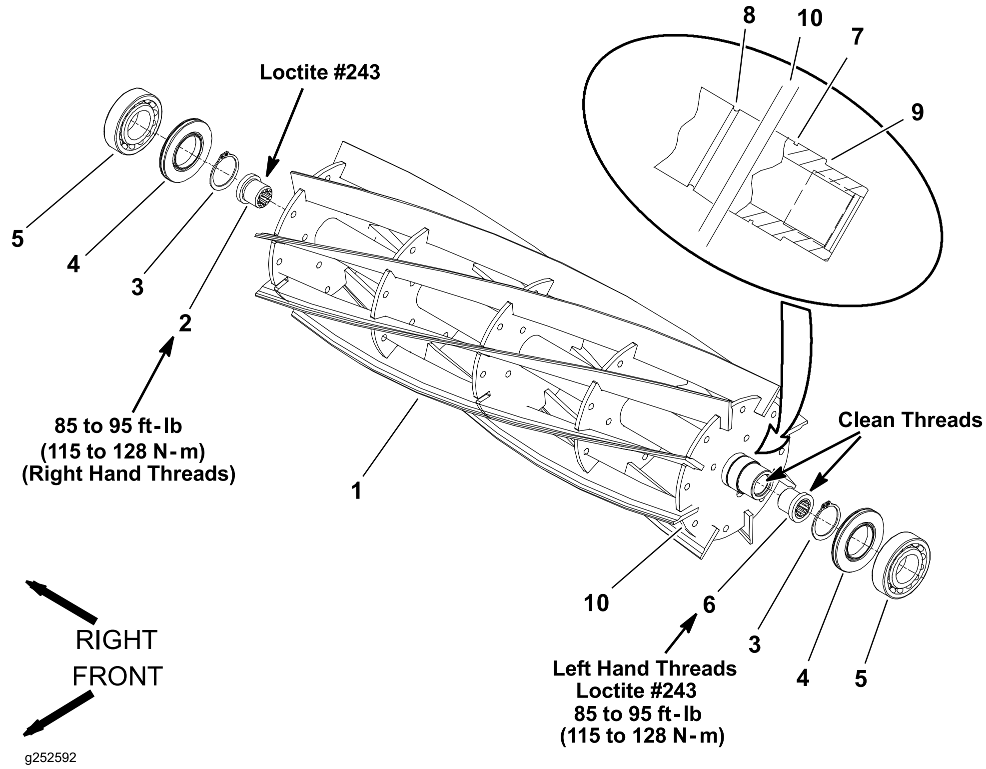

Figure 344

1. Cutting reel
2. Threaded insert (RH thread)
3. Retaining ring
4. Grease seal
5. Bearing
6. Threaded insert (left-hand thread)
7. Retaining ring groove
8. Groove indicating LH threads
9. Bearing shoulder
10. Reel spider

Inspecting the Cutting Reel

1. Inspect reel bearings to insure that they spin freely and have minimal axial play. The bearing balls must be free of deformation and scoring.
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; refer to (page).
3. Check the threaded inserts in the reel shaft for excessive wear or distortion. Replace inserts if damage is evident.
   A. The threaded inserts are installed with thread locking compound (Loctite #243 or equivalent). One insert has LH threads and the other RH threads. The insert with LH threads has an identification groove on the flange face. A groove on the reel shaft identifies the reel end that has LH threads; refer to.
   B. To remove or install the threaded spline inserts, use correct spline insert tool; refer to (page).
   C. To install the spline insert into the cutting reel, clean the threads of the insert and cutting reel shaft. Apply Loctite #243 (or equivalent) to the threads of the insert, thread the insert into the reel shaft and tighten the insert from**115 to 128 N·m (85 to 95 ft-lb)**.

Assembling the Cutting Reel

1. If the seals and/or bearings were removed from the reel shaft, discard the components that were removed and replace.
2. Ensure that the 2 retaining rings are fully seated into the grooves on the cutting reel shaft.
3. If the bearings and seals were removed from the reel shaft, do the following steps:
   A. Ensure that the bore of the seals are clean with no grease or lubricant applied to the inner diameter of the seal.

   IMPORTANT

   The grease seal should be installed so that the metal side of the seal is toward the bearing location.

   B. Press the grease seals onto the reel shaft with the metal side orientated toward the bearing location. Final position of the seal should be flush to 1.5 mm (0.060 inch) away from the retaining ring on the reel shaft. Do not force the seal against the retaining ring. The seal must be perpendicular to the reel shaft after installation.
   C. Pack the replacement reel bearings with high temp Mobil XHP-222 grease or equivalent.
   D. Press grease packed bearings fully onto the reel shaft. The bearings should bottom on the reel shaft shoulder. Press equally on inner and outer bearing race when installing the bearings onto the reel shaft.
4. Fill threaded insert splines with high temp Mobil XHP-222 grease or equivalent.

Reel Assembly (cutting units with aluminum side plates)

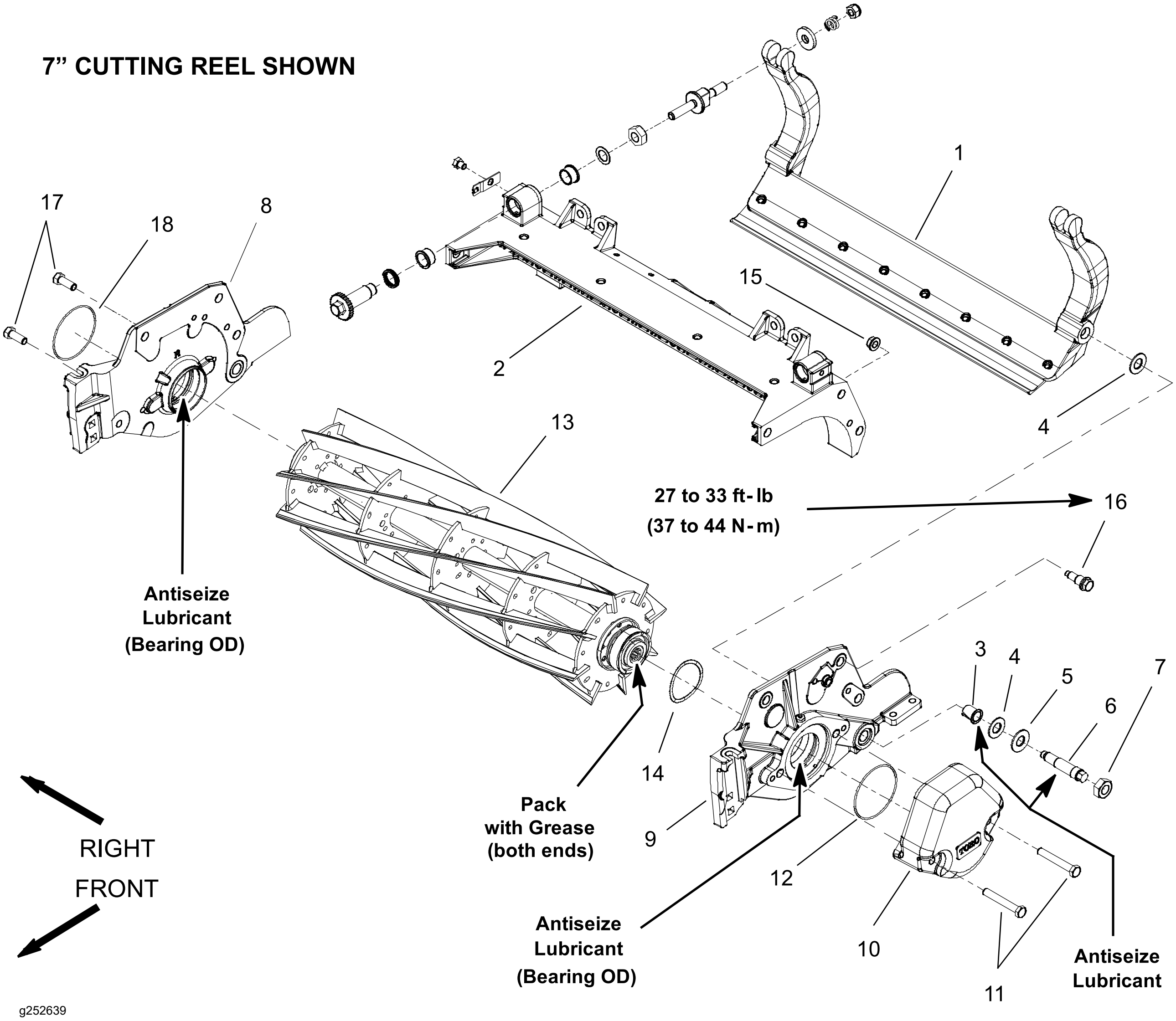

Figure 345

1. Bedbar assembly
2. Cutting unit frame
3. Flange bushing (2 each)
4. Plastic washer (4 each)
5. Metal washer (2 each)
6. Bedbar pivot bolt (2 each)
7. Lock nut (2 each)
8. RH side plate
9. LH side plate
10. Weight
11. Cap screw (2 each)
12. O-ring
13. Cutting reel assembly
14.
15. Wire spring
16. Flange nut (3 per side plate)
17. Cap screw (2 each)
18. O-ring

Note: This section provides the procedure for removing and installing the cutting reel assembly (cutting reel, spline inserts, grease seals and bearings) from the cutting unit.

Note: Refer to Reel Assembly Service (cutting units with aluminum side plates later in this section for information on replacing cutting reel seals and bearings.

Note: Removal of the cutting reel requires removal of the LH side plate from the cutting unit frame. The RH side plate does not have to be removed from the frame.

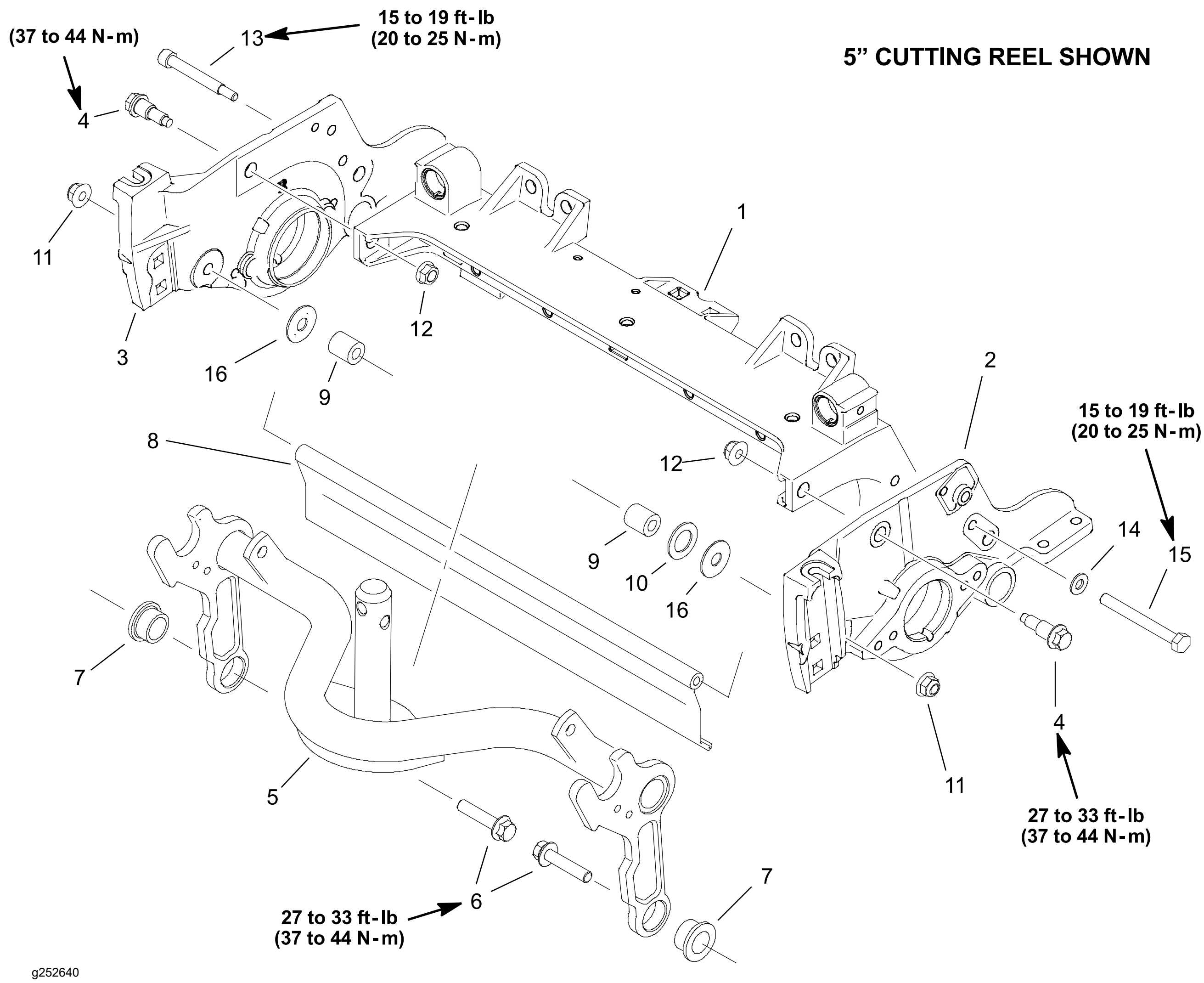

Figure 346

1. Frame
2. LH side plate
3. RH side plate
4. Shoulder bolt (4 or 6 each)
5. Carrier frame
6. Flange head screw (2 each)
7. Flange bushing (2 each)
8. Rear grass shield
9. Spacer (2 each)
10. Shim (0.060” – as required)
11. Flange nut (2 each)
12. Flange nut (4 each)
13. Special screw
14. Flat washer
15. Cap screw
16. Washer (2 each)

Removing the Reel Assembly

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 flat work area.
3. If cutting unit is equipped with a counterweight or accessory on LH side plate, remove the counter weight or accessory from the cutting unit. Remove and discard O-ring from counter weight. Refer to Service and Repairs (page 10–6) for additional belt driven groomer information. Refer to Service and Repairs (page 11–4) for additional universal groomer information. Refer to Rear Roller Brush – Optional (cutting units with aluminum side plates) (page 9–62) for additional rear roller brush information.

CAUTION

Contact with the reel, bedknife or other cutting unit parts can result in personal injury. Use heavy gloves when removing the cutting reel.

IMPORTANT

If the reel bearings or seals are being replaced, the reel spline inserts must be removed. Use the following procedure to restrain the reel and loosen the spline insert before removing the rollers.

4. Loosen the spline inserts:

   A. Tip the cutting unit to access the bottom of the reel.

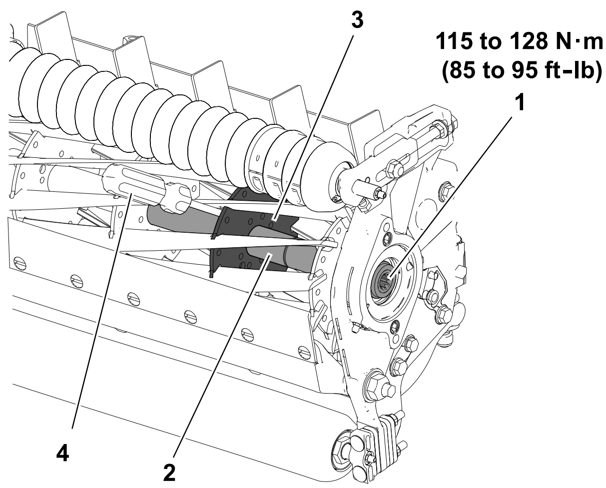

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Figure 347

1. Spline insert (LH)
2. Reel shaft
3. Reel support plate
4. Pry bar

   B. Insert a long-handled pry bar (3/8 x 12 inch with screwdriver handle recommended) through the bottom of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

IMPORTANT

To avoid grinding the reel, do not contact the cutting edge of any blade with the pry bar as this may damage the cutting edge and/or cause a high blade.

   C. Move the pry bar against the weld side of the reel support plate closest to the spline insert being loosened. Use correct spline insert tool (see Special Tools (page 9–5)).

Removing the Reel Assembly (continued)

IMPORTANT

The spline insert on the left end of the cutting reel has left hand threads and the spline insert on the right end of the cutting reel has right hand threads.

D. Rest the handle of the pry bar against the front roller and loosen the spline insert closest to the pry bar.

E. Position the pry bar in the same manner on the opposite end of the reel and loosen the remaining spline insert.

F. Tip the cutting unit back onto its rollers.

5. Remove the bedbar assembly; refer to Removing the Bedbar Assembly (page 9–20).
6. Remove the front roller; refer to Removing the Front Roller (page 9–48).
7. Remove the rear roller; refer to Removing the Rear Roller (page 9–50).
8. Remove cap screw and flat washer that secure rear grass shield to LH side plate.
9. Remove flange head screw and flange nut that secures frame spacer and carrier frame to LH side plate.

   Note: The reel bearings and grease seals are press fit on the cutting reel shaft and should remain on the reel when removing the LH side plate.

   Note: Side plates on 5” cutting units attach to cutting unit frame with two (2) shoulder bolts and flange nuts. Side plates on 7” cutting units use three (3) shoulder bolts and flange nuts.
10. Remove the shoulder bolts and flange nuts that secure the LH side plate to the cutting unit frame. Remove the LH side plate from the reel shaft and cutting unit frame.

⚠ CAUTION ⚠

Contact with the reel, bedknife or other cutting unit parts can result in personal injury. Use heavy gloves when removing the cutting reel.

11. Carefully pull the cutting reel assembly from the RH side plate.
12. Inspect and service cutting reel assembly as required; refer to (page).

Reel Assembly Installation

1. Thoroughly clean side plates and other cutting unit components. Inspect side plates for wear or damage and replace if needed.
2. Make sure that grease seals and bearings are properly installed on cutting reel; refer to (page).
3. Cutting unit serial nos. 315000001 & Up have O-rings in the reel bearing bore of each side plate. Make sure the O-rings are in good condition and properly installed in the side plates.

Reel Assembly Installation (continued)

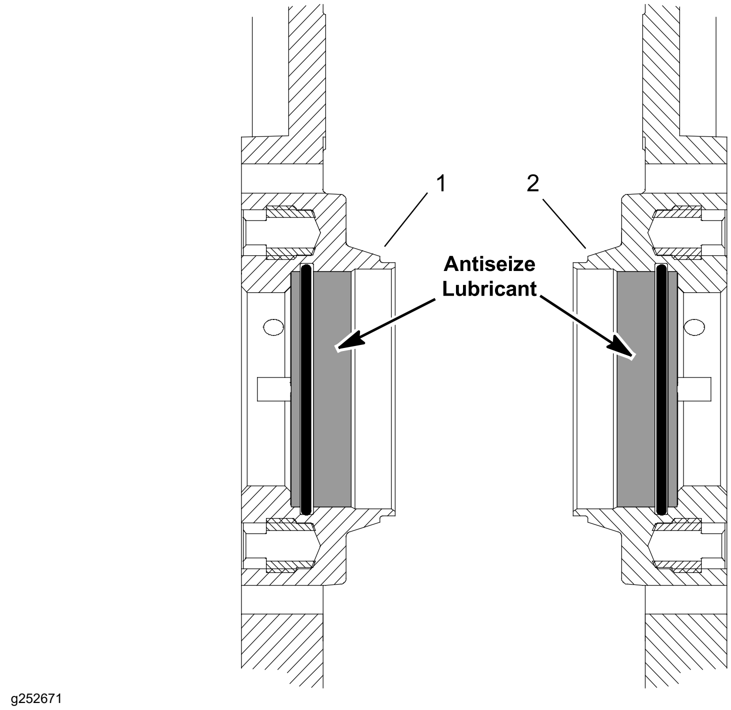


Figure 348

1. RH side plate
2. LH side plate

4. Apply a thin coat of antiseize lubricant to the reel bearing bore of each side plate.
5. Make sure that flat wire spring (item 14) is installed into LH side plate.

CAUTION

Contact with the reel, bedknife or other cutting unit parts can result in personal injury. Use heavy gloves when installing the cutting reel.

6. Carefully slide the RH end of the cutting reel assembly (no groove in reel shaft or on face of threaded insert) into the RH side plate. Make sure that bearing is fully seated into side plate.
7. Slide the LH side plate onto the cutting reel assembly.
8. Install shoulder bolts and flange nuts that secure the LH side plate to the cutting unit frame. Tighten the shoulder bolts from **37 to 44 N·m (27 to 33 ft-lbs)**.
9. Apply Loctite #243 (or equivalent) to threads of flange head screw that secures frame spacer and carrier frame to LH side plate. Install screw and tighten from **37 to 44 N·m (27 to 33 ft-lbs)**. After tightening screw, check the clearance between the carrier frame and side plate. If clearance is more than 0.065” (1.6 mm), remove flange head screw and position shim(s) between carrier frame and side plate so that clearance is less than 0.065” (1.6 mm). Make sure that the carrier frame pivots freely after assembly.
10. Install cap screw and flat washer that secure rear grass shield to LH side plate. Torque screw from **20 to 25 N·m (15 to 19 ft-lbs)**.
11. Install the rear roller; refer to Installing the Rear Roller (page 9–50).
12. Install the front roller; refer to Installing the Front Roller (page 9–48).

Reel Assembly Installation (continued)

13. Install the bedbar assembly; refer to Installing the Bedbar Assembly (page 9–21).

14. Adjust the cutting unit; refer to the *Cutting Unit Operator's Manual*.

    Note: The parallel position of the rear roller to the cutting reel is controlled by the precision machined frame 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; refer to Leveling the Rear Roller (page 9–15).

15. Install accessories if equipped. Refer to Service and Repairs (page 10–6) for additional belt driven groomer information. Refer to Service and Repairs (page 11–4) for additional universal groomer information. Refer to Rear Roller Brush – Optional (cutting units with aluminum side plates) (page 9–62) for additional rear roller brush information.

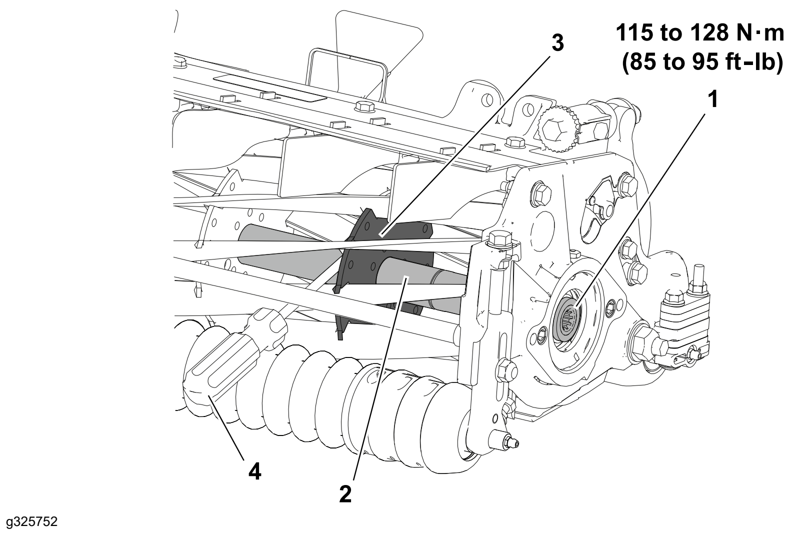


Figure 349

1. Spline insert (LH)
2. Reel shaft
3. Reel support plate
4. Pry bar

16. Tighten the spline inserts:

    A. Insert a long-handled pry bar (3/8 x 12 inch with a screwdriver handle recommended) through the front of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

IMPORTANT

To avoid grinding the reel, do not contact the cutting edge of any blade with the pry bar as this may damage the cutting edge and/or cause a high blade.

    B. Move the pry bar against the weld side of the reel support plate closest to the spline insert being tightened.

IMPORTANT

The spline insert on the left end of the cutting reel has left hand threads and the spline insert on the right end of the cutting reel has right hand threads.

C. Rest the handle of the pry bar against the front roller and tighten the spline insert closest to the pry bar. The spline inserts are installed with thread locking compound (Loctite #243 or equivalent). Tighten the spline insert from **115 to 128 N·m (85 to 95 ft-lb)**. Use correct spline insert tool (see Special Tools (page 9–5)).

D. Position the pry bar in the same manner on the opposite end of the reel and tighten the remaining spline insert.

17. If counterweight was removed from cutting unit, install new O-ring on counter weight. Secure counter weight to cutting unit side plate with two (2) flange nuts. Torque screws from **37 to 44 N·m (27 to 33 ft-lbs)**.

18. install cutting unit to the machine.

Reel Assembly Service (cutting units with aluminum side plates)

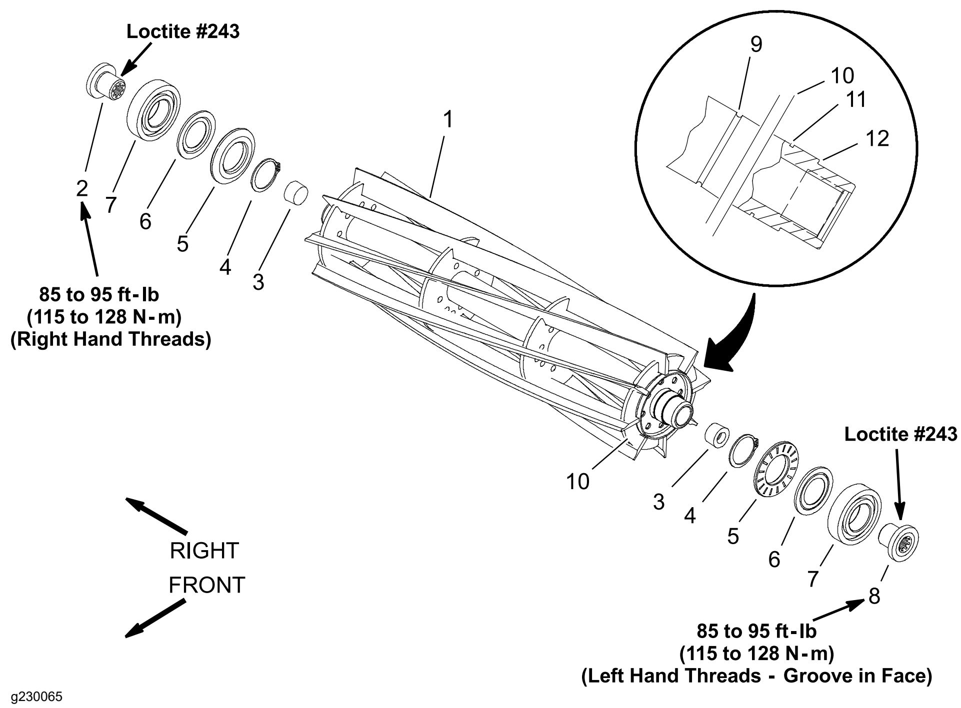


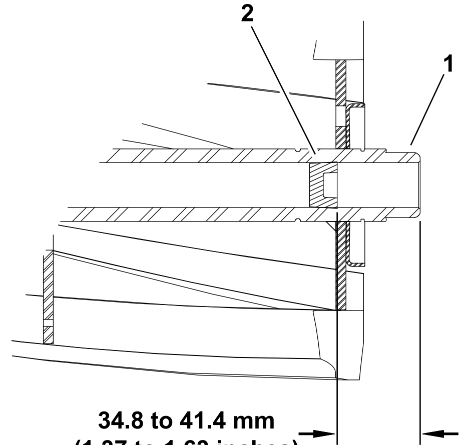
Figure 350

1. Cutting reel
2. Threaded insert (right hand thread)
3. Plastic plug (2 each)
4. Retaining ring (2 each)
5. Special washer (2 each)
6. Flocked seal (2 each)
7. Sealed bearing (2 each)
8. Threaded insert (left hand threads)
9. Groove indicating left hand threads
10. Reel spider
11. Retaining ring groove
12. Bearing shoulder

Inspecting the Reel Assembly

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; refer to (page).
3. Check the threaded inserts in the reel shaft for excessive wear or distortion. Replace inserts if damage is evident.
   A. One insert has LH threads and the other insert has RH threads. The insert with LH threads has a groove on the insert face. A groove is cut in the end of the reel shaft that has LH threads.
   B. Use correct spline insert tool to remove threaded inserts; refer to (page).

Assembling the Cutting Reel (Cutting Unit with Aluminum Side Plates)



g230298

Figure 351

1. Reel shaft
2. Plastic plug (2 each)

---

1. If removed, install new plastic plugs into cutting reel shaft. Plugs should be recessed into reel shaft from **34.8 to 41.4 mm (1.370 to 1.630 inches)** (Figure 351).

   Note: One insert has LH threads and the other insert has RH threads. The insert with LH threads has a groove on the insert face. A groove is cut in the end of the reel shaft that has LH threads.
2. If previously removed, use correct spline insert tool to install threaded inserts; refer to (page). Apply thread locking compound (Loctite #243 or equivalent) to threaded portion of insert. Tighten threaded insert from **115 to 128 N·m (85 to 95 ft-lb)**.
3. Ensure that the 2 retaining rings are fully seated into the grooves on the cutting reel shaft.
4. Carefully drive special washers onto reel shaft with tapered side of washers toward reel (flat side toward bearing location). Installed washers should be tight against retaining ring and should not wobble as the reel is rotated.

IMPORTANT

The flocked seal should be installed so that the flocked (red) side of the seal is toward the bearing location.

5. Slide the flocked seals (flocked (red) side orientated toward bearing location) and bearings fully onto the reel shaft. Flocked seals and bearings should bottom on reel shaft shoulder.
6. Fill threaded insert splines with high temperature Mobil XHP-222 grease or equivalent.

Preparing the Reel for Grinding

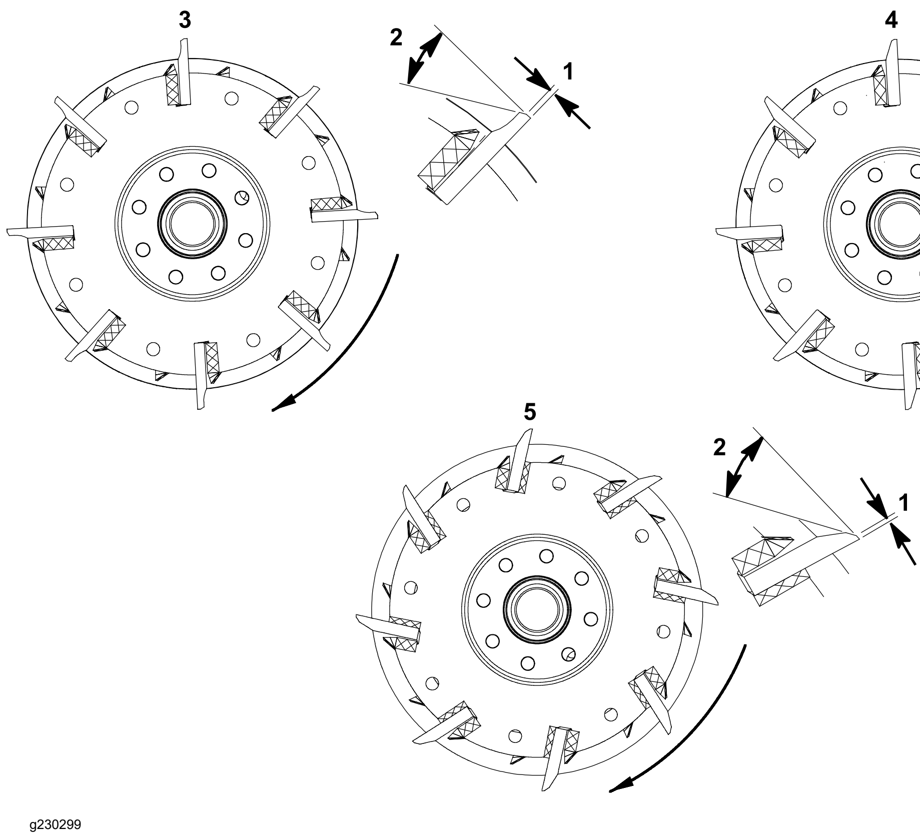


Figure 352

1. Blade land width
2. Blade relief angle
3. Scalloped radial reel
4. Tapered radial reel
5. Tapered forward sweep reel

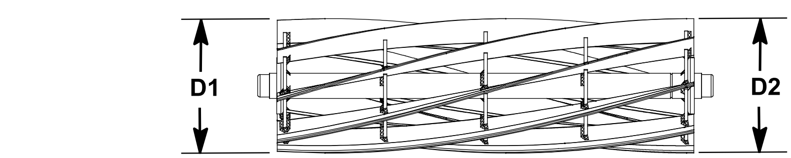


Figure 353

Reel diameter taper = D1 - D2

Preparing the Reel for Grinding (continued)

Three types of cutting reel designs are used in cutting units for Reelmaster machines: scalloped radial reel, tapered radial reel, and tapered forward swept reel. The different types of individual reel blades are shown in Figure 352. The radial reel designs have blades that are placed in line with the center of the reel shaft. The rear of the blades either have a scalloped relief or a tapered relief. The forward swept reel have blades that have a slight forward slant. The rear of the forward swept reel blades have a tapered relief. Before grinding a reel, ensure to identify the type of reel design to ensure that the grinding is correctly done.

Before grinding a cutting reel, ensure that all the cutting unit components are in good condition. Depending on the type of grinder used, damaged cutting unit components can affect grinding results. When grinding, be careful to not overheat the cutting reel blades. Remove small amounts of material with each pass of the grinder.

Follow the reel grinder manufacturer’s instructions to grind the cutting reel to Toro specifications; refer to the Reel Grinding Specifications Table (page 9–47). Additional reel grinding information can be found in your *Cutting Unit Operator’s Manual* and the Toro General Service Training Book, *Reel Mower Basics (Toro Part No. 09168SL)* found on the Service Reference Set available from your Authorized Toro Distributor.

Reel Grinding Specifications Table

	5 inch Dia.Reels	7inch Dia.Reels
Reel diameter (new)	128.5 mm (5.060 inches)	179.3 mm (7.060 inches)
Service limit-reel diameter	114 mm (4.500 inches) for 5 inch reel	168 mm (6.600 inches) for 7 inch reel
Reel shaft diameter (outer diameter)	33.3 mm (1.313 inches)	
Service limit-reel diameter taper (Figure 353)	0.25 mm (0.010 inch)	
Blade land width	1.3 to 1.8 mm (0.050 to 0.070 inch) Service Limit: 3 mm (0.120 in)	
Blade relief angle	30° ± 5°	

Relief grind the reel blades to the minimum blade land width if the reel blade land width exceeds the service limit. Spin grind the reel to restore its cylindrical shape.

Note: Spin grind the reel and establish the specified blade land width after relief grinding.

After grinding the reel and/or bedknife, adjust the cutting unit; refer to the *Cutting Unit Operator's Manual*. Check the reel to bedknife contact again after cutting two (2) fairways. During this initial use, any burrs will be removed from reel and bedknife which may create improper reel to bedknife clearance and thus accelerate wear. This practice of re-checking the reel to bedknife contact after grinding will extend the longevity of the sharpness of the edge of the reel and the bedknife.

Front Roller

Removing the Front Roller

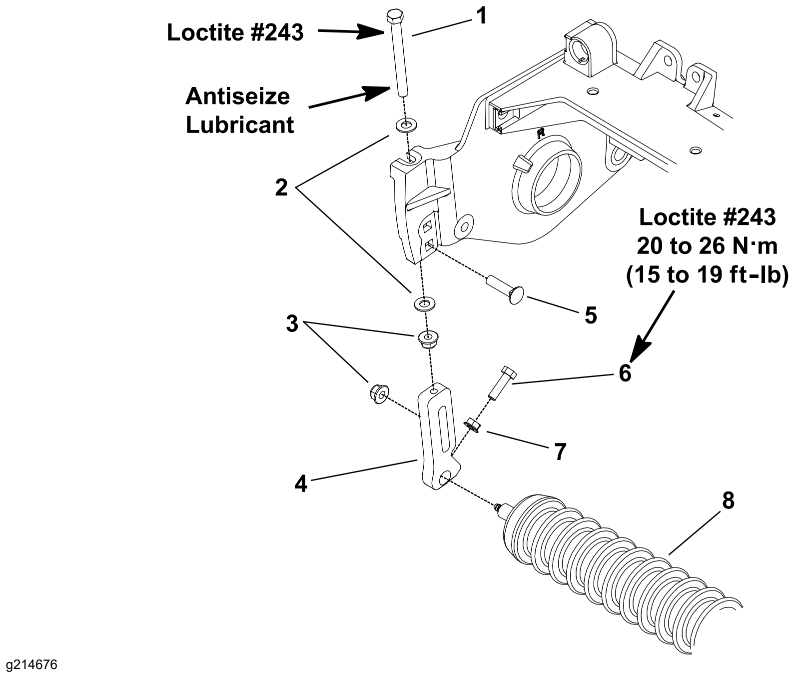


Figure 354

1. Cap screw
2. Flat washer
3. Flange nut
4. HOC (roller) bracket
5. Carriage screw
6. Cap screw
7. Flange nut
8. Front roller assembly

---

1. Park the machine on a clean and level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the cutting unit from the machine and place on a level working surface. Use cutting unit kickstand (refer to (page)) to raise the front roller from the work surface.
3. Loosen the flange nut and cap screw that secure the front roller shaft to each front height-of-cut (roller) bracket.
4. On one of the height-of-cut (roller) brackets, do the following:
   A. Remove the flange nut and carriage screw that secure the bracket to the cutting unit side plate.
   B. Remove the height-of-cut (roller) bracket from the cutting unit.
5. Slide the front roller assembly from the remaining height-of-cut (roller) bracket on the cutting unit.
6. If necessary, remove the second height-of-cut (roller) bracket from the cutting unit.

Installing the Front Roller

1. Place the cutting unit on a level working surface and use cutting unit kickstand to support the cutting unit; refer to (page).
2. Inspect the condition of the cap screws (item 1) in both height-of-cut (roller) brackets. Replace the bolt(s) if necessary:
   A. Place the 2 flat washers on bolt and thread the flange nut onto the bolt to a position **19 mm (0.750 inch)** from screw head.

Installing the Front Roller (continued)

B. Apply anti-seize lubricant to the threads of the bolt that will extend into the height-of-cut (roller) bracket.

C. Thread the bolt into the bracket.

Note: When assembling the height-of-cut (roller) brackets to the side plate, ensure that the bolt head and 1 washer are above the adjustment flange on the side plate and second washer and flange nut are below the flange.

3. If both front height-of-cut (roller) brackets were removed from the cutting unit side plate, position one of the brackets to the side plate. Secure the bracket to the side plate with the carriage screw and flange nut.

4. Slide the front roller shaft into the bracket attached to the cutting unit. Slide the second height-of-cut (roller) bracket onto the other end of the roller shaft. Secure the second bracket to the cutting unit side plate with the carriage screw and flange nut.

5. Apply Loctite #243 (or equivalent) to exposed threads of cap screw (item 1) between flange of side plate and position of flange lock nut (item 3) on cap screw. Tighten flange lock nut on cap screw and then loosen nut 1/4 to 1/2 turn. Cap screw should rotate freely with little (if any) endplay after lock nut installation.

6. Apply Loctite #243 (or equivalent) to the threads of the 2 cap screws (item 6). Center the front roller to the cutting reel and secure in place with the 2 cap screws. Tighten the cap screws to **20 to 26 N·m (15 to 19 ft-lb)**. Secure the cap screws with the flange nuts.

7. Lubricate the front roller.

8. Adjust the cutting unit; refer to the *Cutting Unit Operator's Manual*.

Rear Roller

Removing the Rear Roller

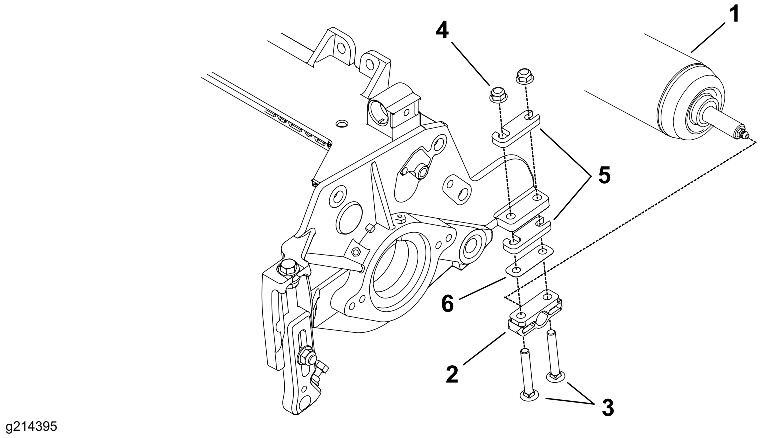


Figure 355

1. Rear roller assembly
2. Rear roller bracket
3. Carriage screw (2 each)
4. Flange nut (2 each)
5. Roller shim (2 each)
6. 0.010 inch shim (if necessary)

---

1. Park the machine on a clean and level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the cutting unit from the machine and place on a level working surface. Place the support blocks under bedbar to raise the rear roller from the work surface.
3. Loosen the 2 flange nuts that secure the rear roller shaft to each rear roller bracket.
4. On one of the rear roller brackets, do the following:

   Note: On the cutting units equipped with optional High Height of Cut Kit, there will be additional roller shims installed between the rear roller bracket and the cutting unit side plate.

   A. Remove the flange nuts and carriage screws that secure the rear roller bracket and roller shims to the cutting unit side plate.

   B. Remove the roller bracket and roller shims from the rear roller and cutting unit.
5. Slide the rear roller assembly from the remaining rear roller bracket on the cutting unit.
6. If necessary, remove the second rear roller bracket and roller shims from the cutting unit.

Installing the Rear Roller

1. Place the cutting unit on a level working surface.

   Note: Refer to the *Cutting Unit Operator's Manual* for number of roller shims required for various height of cut settings.

   Note: A 0.010 inch shim (Toro Part No. 107-4001) is available to allow for leveling of the rear roller; refer to Leveling the Rear Roller (page 9–15). If necessary, this shim can be used on one side of the rear roller and should be installed between the rear roller bracket and the roller shim.
2. If both rear roller brackets were removed from cutting unit side plate, position brackets and roller shims to one of the side plates. Install two (2) carriage

screws and flange nuts to retain bracket in position. Do not fully tighten flange nuts.

3. Slide rear roller shaft into the rear roller bracket attached to the cutting unit. Slide second rear roller bracket onto the other end of roller shaft. Secure second roller bracket and shims to cutting unit side plate with two (2) carriage screws and flange nuts. Do not fully tighten flange nuts.
4. Center the rear roller to the cutting reel and secure in place with the 4 flange nuts.
5. Lubricate the rear roller.
6. Adjust the cutting unit; refer to the *Cutting Unit Operator's Manual*.

Servicing the Roller

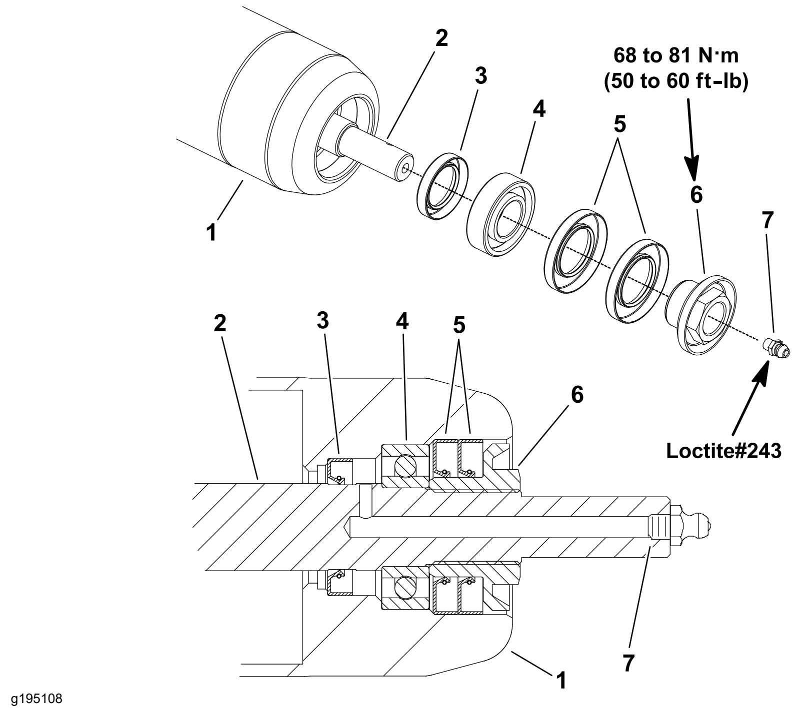


Figure 356

1. Roller tube
2. Roller shaft
3. Inner seal
4. Bearing
5. Outer seal
6. Bearing lock nut
7. Grease fitting

Disassembling the Roller

1. Remove the bearing locknut from each end of the roller shaft.
2. Loosely secure the roller assembly in a bench vise and lightly tap one end of the roller shaft until the outer seals and bearing are removed from opposite end of the roller tube. Remove the second set of outer seals and bearing from the roller tube by tapping on opposite end of the shaft. Remove the shaft from the roller tube.
3. Carefully remove the inner seal from both ends of the roller tube, ensure that you do not damage the tube surfaces.
4. Discard the seals and bearings that were removed.
5. Clean the roller shaft and all surfaces on the inside of the roller tube. Inspect components for wear or damage. Also, carefully inspect the seating surface and threads of the bearing locknuts. Replace all the components that were damaged.

Assembling the Roller

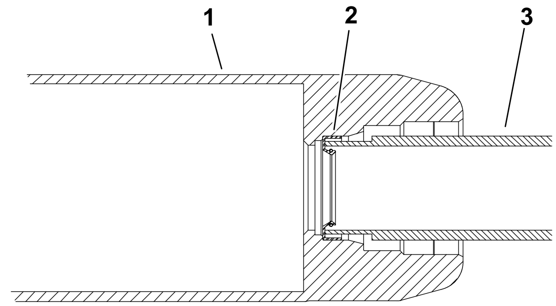


Figure 357

1. Roller tube
2. Inner seal
3. Inner seal tool

1. Install the inner seals into the roller tube and ensure that the seal lip (and garter spring) faces end of the tube. Use the inner seal tool and soft-faced hammer to fully seat seals against the roller shoulder; refer to (page). Apply a small quantity of grease around the lip of both inner seals after installation.

IMPORTANT

During assembly process, frequently check that the bearings rotate freely and do not bind. If there is any binding, remove the components and install them again.

2. Install a new bearing and the outer seals into one end of the roller tube as follows:

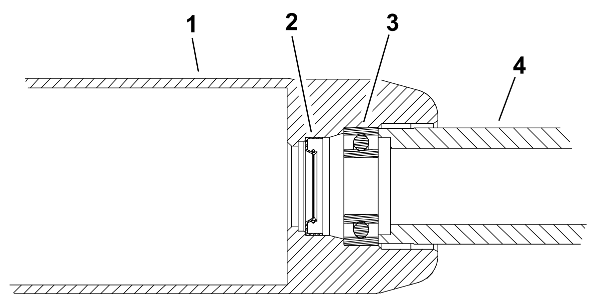


Figure 358

1. Roller tube
2. Inner seal
3. Bearing
4. Bearing/outer seal tool

   A. Position a new bearing into one end of the roller tube. Use the bearing/outer seal tool with a soft-faced hammer to fully seat bearing against the roller shoulder; refer to (page). After the bearing installation, ensure that the bearing rotates freely without binding.

   B. Apply a small quantity of grease around the lip of both outer seals.

Assembling the Roller (continued)

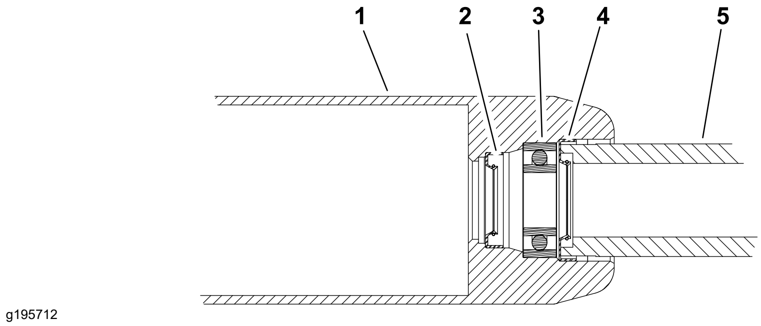


Figure 359

1. Roller tube
2. Inner seal
3. Bearing
4. Outer seal
5. Bearing/outer seal tool

C. Install the first outer seal into the roller tube and ensure that the seal lip (and garter spring) faces end of the tube. Use a bearing/outer seal tool and a soft-faced hammer to lightly seat seal against the roller shoulder; refer to (page). Ensure that the bearing still freely rotates after the seal installation.

D. Use the same process, install the second outer seal and ensure not to crush the installed outer seal. Again, ensure that the bearing still freely rotates.

3. From the roller tube end with only the inner seal installed, carefully install the roller shaft into the roller tube. Ensure that the seals are not damaged as the shaft is installed.

4. Install the new bearing and outer seals into the second end of the roller tube as follows:

   A. Position a second new bearing to the roller shaft and tube. Position the washer on the bearing to press both the inner and outer bearing races at the same time.

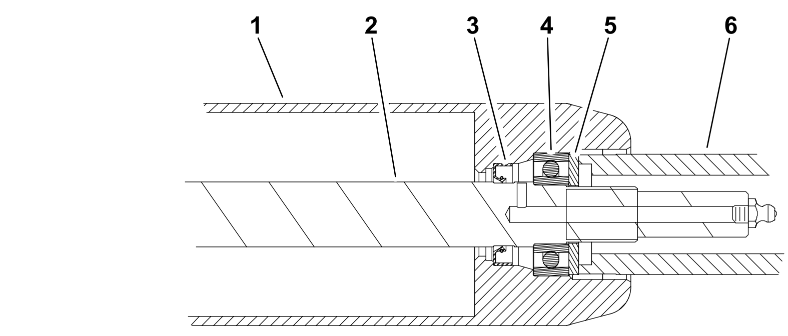


Figure 360

1. Roller tube
2. Roller shaft
3. Inner seal
4. Bearing
5. Washer
6. Bearing/outer seal tool

B. Use the washer and bearing/outer seal tool with a soft-faced hammer to fully seat bearing ; refer to (page). After the bearing installation, ensure that the shaft freely rotates and that there is no binding. If necessary, lightly tap the bearing and/or shaft ends to align the shaft and bearings. Remove the washer from the roller.

C. Apply a small quantity of grease around the lip of both outer seals.

Assembling the Roller (continued)

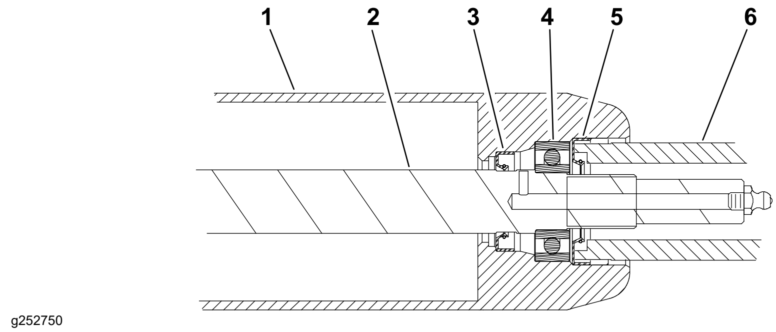


Figure 361

1. Roller tube
2. Roller shaft
3. Inner seal
4. Bearing
5. Outer seal
6. Bearing/outer seal tool

D. Carefully install the first outer seal into the roller tube and ensure that the seal lip (and garter spring) faces end of the tube. Use a bearing/outer seal tool and a soft-faced hammer to lightly seat seal; refer to (page). Ensure that the shaft and bearings still freely rotate after the seal installation.

E. Using the same process, install the second outer seal and make sure not to crush the installed outer seal. Again, ensure that the shaft and bearings still freely rotate.

IMPORTANT

Ensure that all grease is removed from the shaft threads to prevent the loosening of the bearing locknut.

5. Clean the threads on both ends of the roller shaft.

   Note: If original bearing locknut(s) are being used, apply the Loctite #243 (or equivalent) to the threads of the locknut(s).

6. Install the bearing locknut onto each end of the roller shaft. Ensure that the outer seals are not damaged during the nut installation. Torque the locknut to **68 to 81 N·m (50 to 60 ft-lb)**.

7. After the roller is installed to the cutting deck, lubricate the roller grease fittings, rotate the roller to properly distribute grease in bearings and clean excess grease from the roller ends. A properly assembled roller should rotate with less than **0.68 N·m (5 in-lb)** resistance.

Rear Roller Brush – Optional (cutting units with painted side plates)

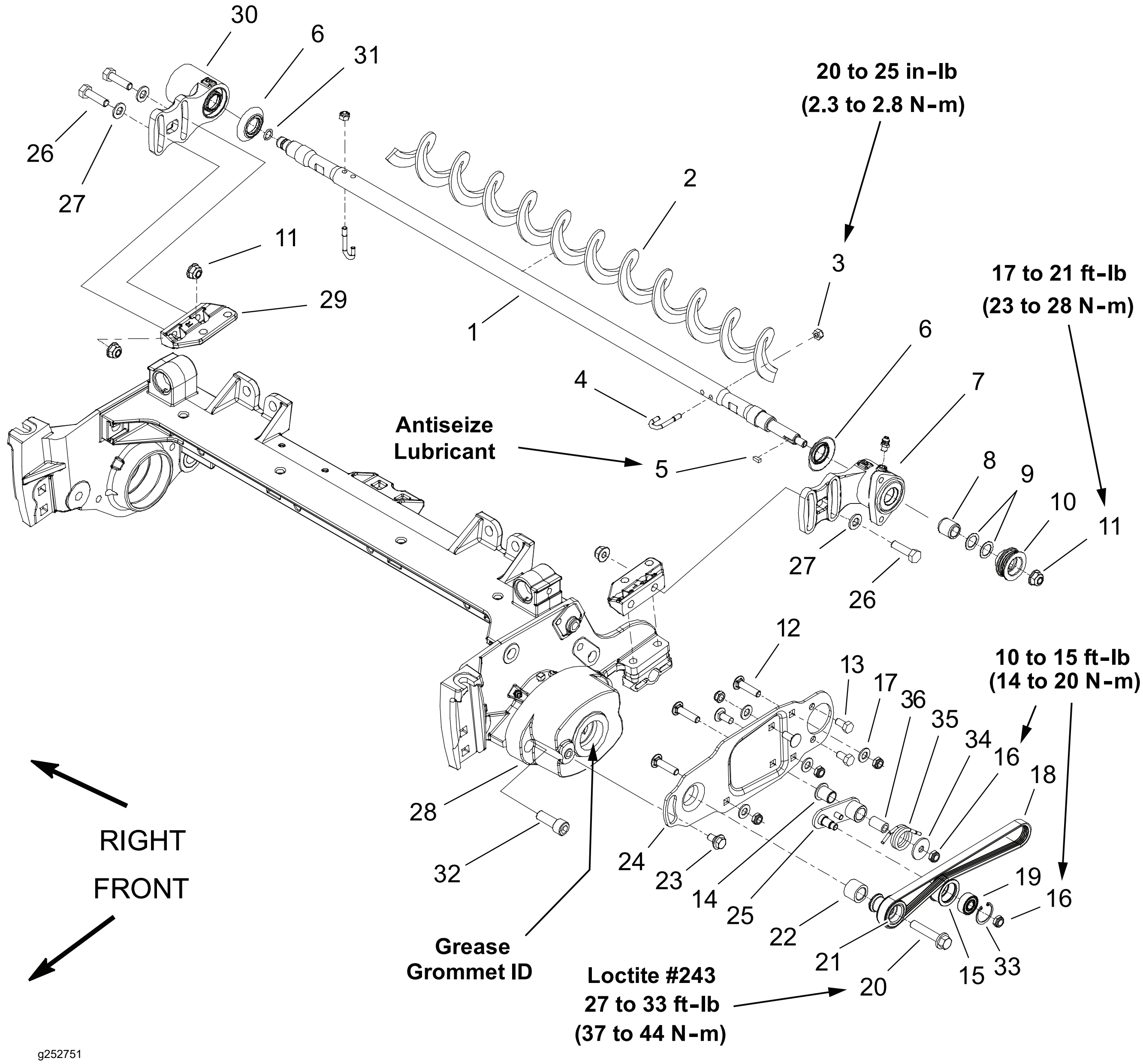


Figure 362

1. Roller brush shaft
2. Roller brush
3. Lock nut (2 each)
4. J-bolt (2 each)
5. Square key
6. Excluder seal (2 each)
7. Brush bearing housing (drive)
8. Spacer
9. Flat washer (as necessary)
10. Driven pulley
11. Flange nut
12. Carriage screw (2 each)
13. Cap screw (2 each)
14. Flange bushing
15. Idler pulley
16. Lock nut
17. Flat washer (2 each)
18. Drive belt
19. Bearing
20. Flange head screw
21. Drive pulley
22. Spacer
23. Shoulder bolt
24. Brush plate
25. Idler arm
26. Cap screw (4 each)
27. Flat washer (4 each)
28. Drive bearing housing
29. Mounting bracket (2 each)
30. Brush bearing housing (non-drive)
31. O-ring
32. Socket head screw (2 each)
33. Retaining ring
34. Washer
35. Idler spring
36. Idler spacer

Note: The drive components for the rear roller brush are located on the opposite side of the cutting unit from the cutting reel hydraulic motor. Figure 362 shows components used when the brush drive is on the left 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.

Disassembling the Rear Roller Brush

1. Park the machine on a clean and level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the roller brush from the brush shaft as follows:
   A. Remove the non-drive brush bearing housing (item 30) from the cutting unit.
   B. Slide the excluder seal from the roller brush shaft.
   C. Remove the locknut and J-bolt from both ends of the brush.
   D. While rotating the brush, slide the brush from the shaft.
3. Disassemble the rear roller brush components as necessary.

Assembling the Rear Roller Brush

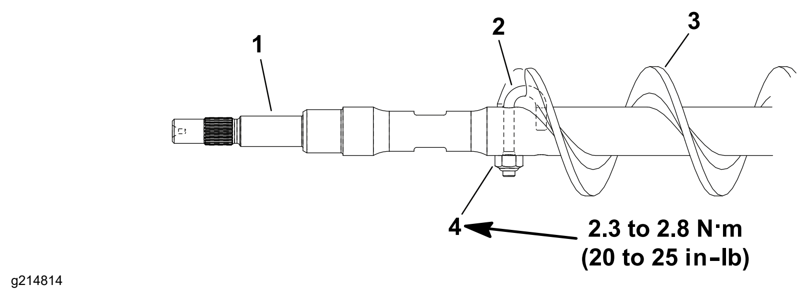


Figure 363

1. Roller brush shaft	3. Roller brush
2. J-bolt	4. Locknut

1. If brush was removed from 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. Tighten the lock nuts from **2.3 to 2.8 N·m (20 to 25 in-lb)**.

Assembling the Rear Roller Brush (continued)

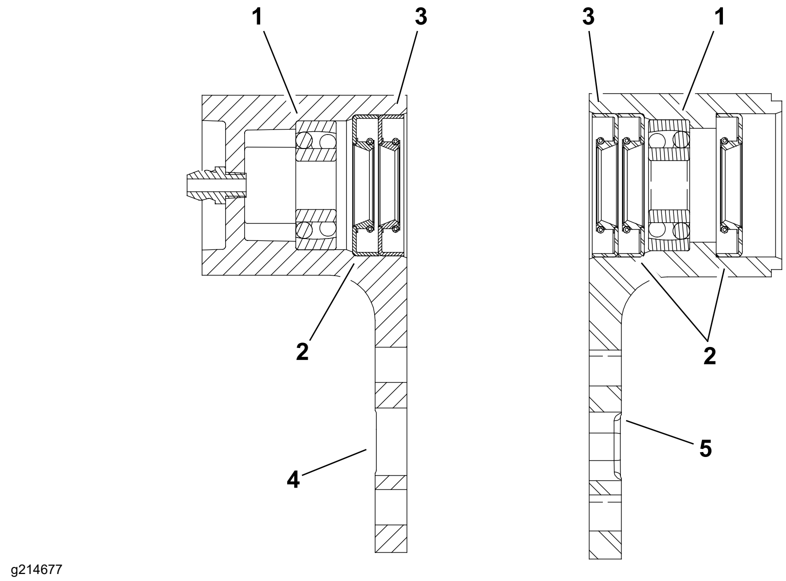


Figure 364

1. Bearing
2. Inner grease seal
3. Outer grease seal
4. Housing (non-driven)
5. Housing (driven)

2. If seals or bearings were removed from brush bearing housings, install new components noting proper orientation.
   A. Pack bearings with high temperature Mobil XHP-222 grease (or equivalent) before installation.
   B. Press bearing into bearing housing so that bearing contacts shoulder in housing bore.
   C. Install grease seals so that seal lips are positioned toward the brush location. Press inner seals into housing so that seal contacts bore shoulder. Press outer seals into housing until inner seal is contacted.

Assembling the Rear Roller Brush (continued)

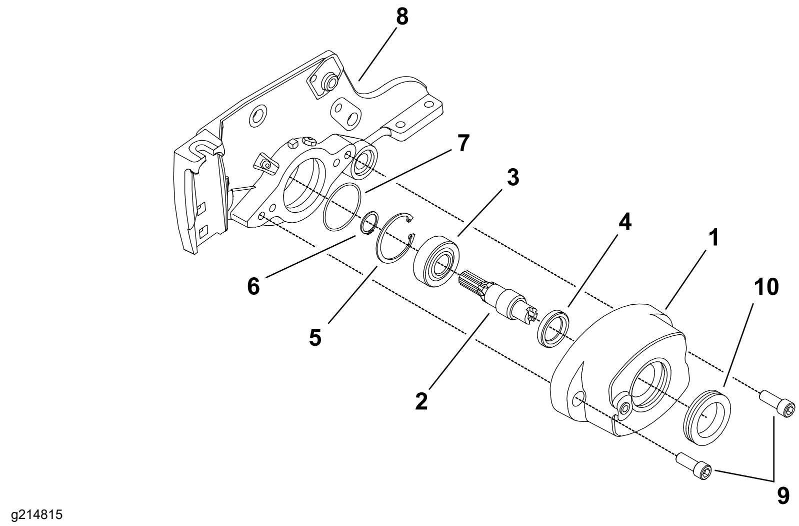


Figure 365

1.	Bearing housing	6.	Snap ring
2.	Drive shaft	7.	O-ring
3.	Ball bearing	8.	Side plate
4.	Grease seal	9.	Socket-head screw (2 each)
5.	Retaining ring	10.	Grommet

3. If drive bearing housing was disassembled, install new components noting proper orientation.
   A. Install bearing on shaft by pressing equally on the inner and outer bearing races. Install the bearing so that the bearing seal is closest to the shoulder on the shaft. Install snap ring onto shaft to retain bearing.
   B. Install new grease seal into housing with the lip of the seal toward the drive shaft splines. Apply grease to lip of seal.

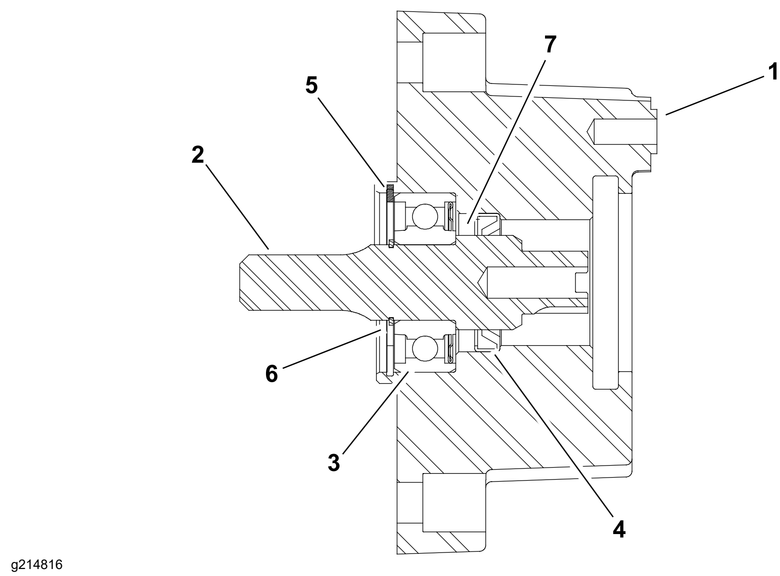


Figure 366

1.	Bearing housing	5.	Retaining ring
2.	Drive shaft	6.	Snap ring
3.	Ball bearing	7.	Fill cavity 50 to 75% full with grease
4.	Grease seal		

Assembling the Rear Roller Brush (continued)

C. Fill cavity between bearing location and grease seal 50% to 75% full with high temperature Mobil XHP-222 grease (or equivalent).

D. Carefully slide shaft and bearing fully into pivot hub bore taking care to not damage the grease seal. Secure bearing in pivot hub with retaining ring.

4. Assemble roller brush components using Figure 373 as guides along with the following:

A. Apply a light coating of grease to inner diameter of the grommet in drive bearing housing.

B. When installing drive pulley (item 21), make sure that tabs on pulley engage slot in drive shaft.

C. Apply antiseize lubricant to square key or splines that engage driven pulley onto roller brush shaft.

D. During assembly, apply Loctite #243 (or equivalent) where indicated and torque fasteners as shown.

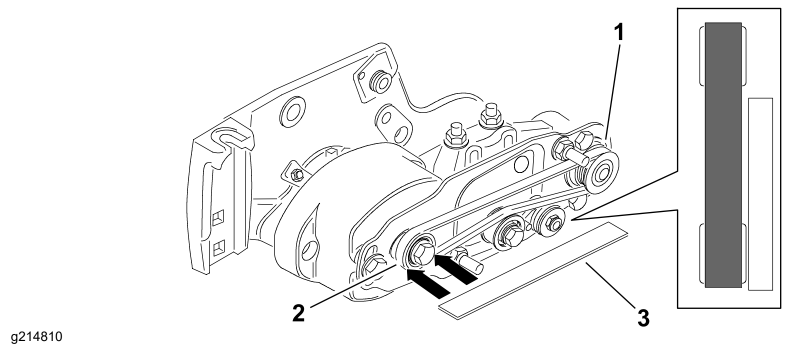


Figure 367

1. Driven pulley
2. Drive pulley
3. Pulley alignment tool

E. Check alignment of pulleys with a straight edge placed along the outer face of the driven pulley. The outer faces of the driven and drive pulleys (not the idler pulley) should be in line within 0.030” (0.76 mm). If necessary to align pulleys, remove driven pulley from brush shaft and add or remove washer(s) until drive and driven pulleys are aligned.

F. Position excluder seals on brush shaft so that seals just touch bearing housings.

G. After drive belt installation, make sure that the ribs on the belt are properly seated in the grooves of both the drive and driven pulleys and that the belt is in the center of the idler pulley.

H. Make sure that idler arm is free to rotate and the spring is installed so it can rotate the idler arm upward and apply tension to the drive belt.

Assembling the Rear Roller Brush (continued)

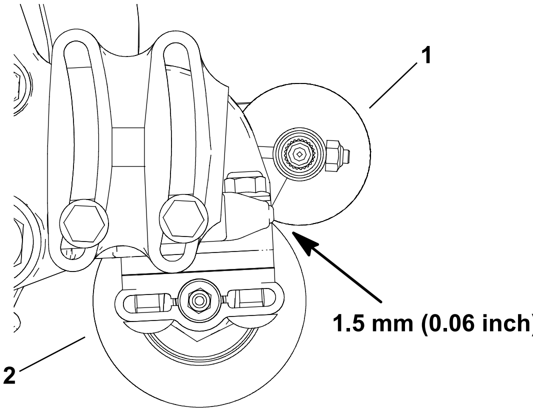


Figure 368

1. Rear roller brush
2. Rear roller

IMPORTANT

The roller brush shaft must nor contact the cutting unit side plate. Also, heavy brush contact on the rear roller will cause premature brush wear.

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5. Check that brush is parallel to rear roller with **1.5 mm (0.060")** clearance to light contact with rear roller. If contact is incorrect, brush operation will be adversely affected.
6. Install cover. There should not be a set screw installed in the bottom of the cover.
7. Lubricate grease fittings on brush housings until grease purges past inboard seals. Wipe excess grease from seals and fittings.

Rear Roller Brush – Optional (cutting units with aluminum side plates)

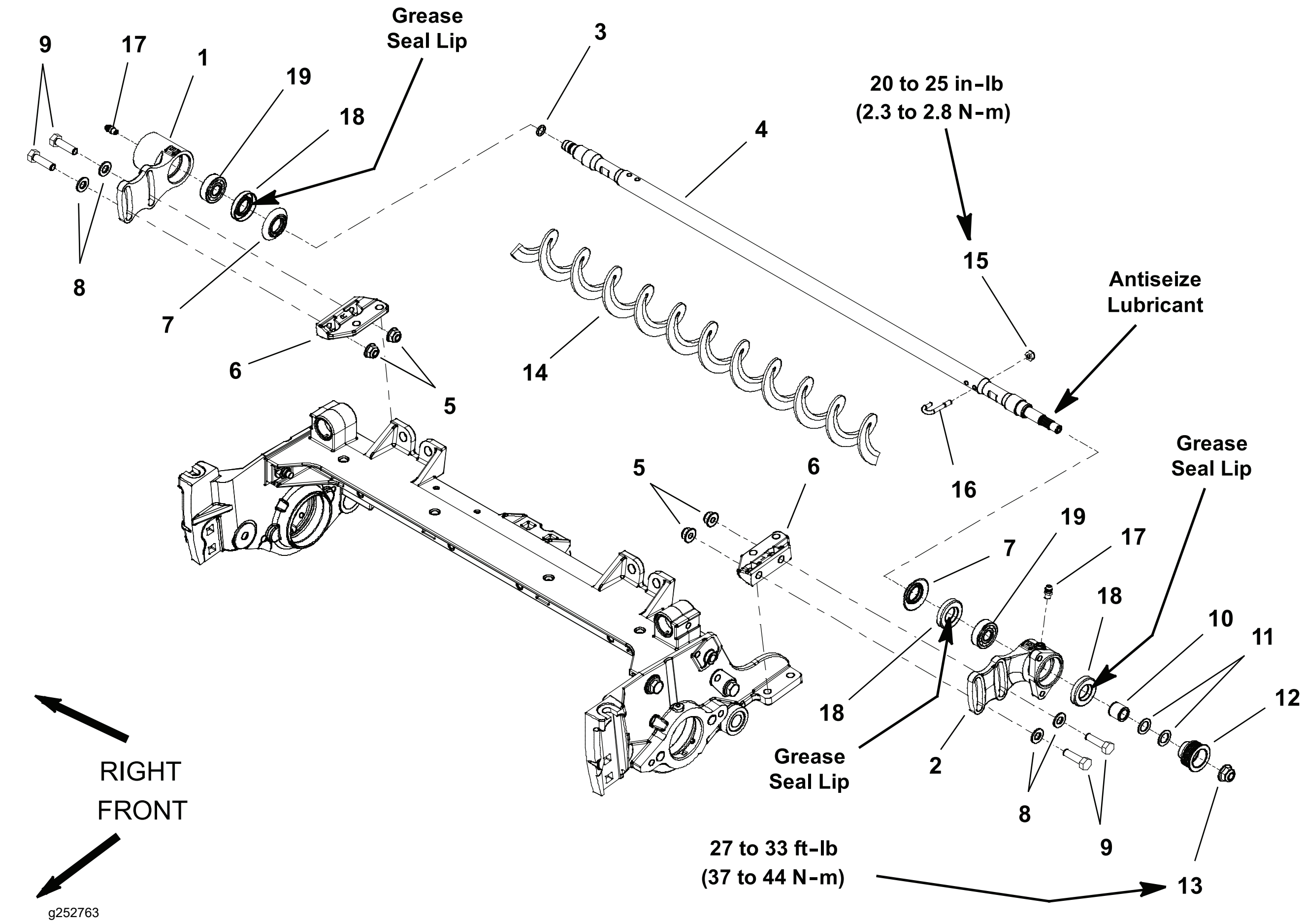

Figure 369

1. Brush bearing housing (non-driven)
2. Brush bearing housing (drive)
3. O-ring
4. Roller brush shaft
5. Flange nut (4 each)
6. Mounting bracket (2 each)
7. Excluder seal (2 each)
8. Flat washer (4 each)
9. Cap screw (4 each)
10. Spacer
11. Flat washer (for pulley alignment)
12. Driven pulley
13. Flange nut
14. Roller brush
15. Lock nut
16. J-bolt (2 each)
17. Grease fitting (2 each)
18. Grease seal (3 each)
19. Ball bearing (2 each)

Note: Drive components for the rear roller brush are located on the opposite side of the cutting unit from the cutting reel motor. Figure 369 shows components used when the brush drive is on the left 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.

Disassembling the Rear Roller Brush

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. Remove the non-drive brush bearing housing (item 1) from cutting unit.
   B. Slide excluder seal from roller brush shaft.

Disassembling the Rear Roller Brush (continued)

   C. Remove lock nut and J-bolt from both ends of the brush.

   D. While rotating brush, slide brush from the shaft.

3. Disassemble roller brush components as necessary. If brush bearing housing (item 2) or driven pulley (item 12) need to be removed, brush cover and drive belt removal will be necessary; refer to Disassembling the Drive System (page 9–65).

Assembling the Rear Roller Brush

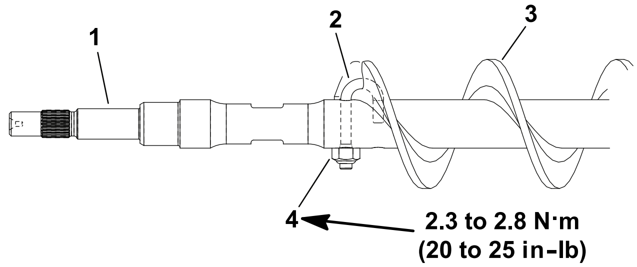

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Figure 370

1. Roller brush shaft
2. J-bolt
3. Roller brush
4. Locknut

1. If roller brush was removed from roller 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. Tighten lock nuts from **2.3 to 2.8 N·m (20 to 25 in-lb)**.

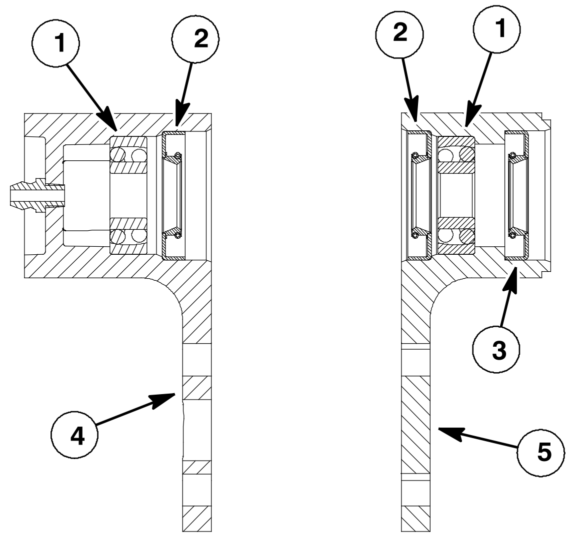

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Figure 371

1. Bearing
2. Inner grease seal
3. Outer grease seal
4. Housing (non-driven)
5. Housing (driven)

2. If seals or bearings were removed from brush bearing housings, install new components noting proper orientation.

   A. Pack bearings with high temp Mobil XHP-222 grease (or equivalent) before installation.

   B. Press bearing into bearing housing so that bearing contacts shoulder in housing bore.

C. Install grease seals so that seal lips are positioned toward the brush. Press seals into housing so that seal contacts bore shoulder.

3. Assemble roller brush components noting the following items:

   A. Apply coating of grease to lips of grease seals in brush bearing housing before inserting brush shaft into housing.

   B. Position excluder seals on brush shaft so that seals just touch bearing housings.

   C. If driven pulley (item 12) was removed from roller brush shaft, apply antiseize lubricant to splines of pulley bore and slide pulley onto shaft. Install and tighten flange nut until pulley is seated onto shaft and then torque flange nut from **37 to 44 N·m (27 to 33 ft-lb)**. Use a ½ wrench on roller brush shaft flats to prevent shaft from rotating when tightening nut.

   D. Check and adjust alignment of drive and driven pulleys; refer to Assembling the Drive System (page 9–66).

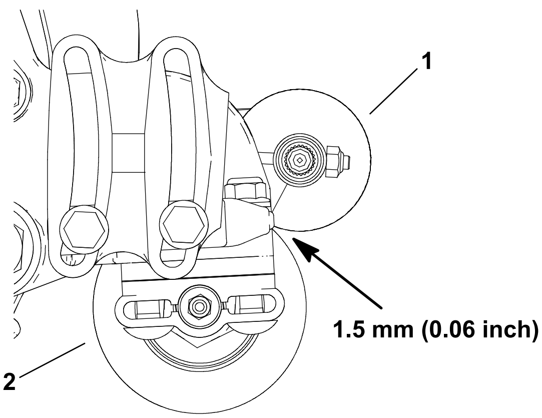

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Figure 372

1. Rear roller brush
2. Rear roller

IMPORTANT

The roller brush shaft must nor contact the cutting unit side plate. Also, heavy brush contact on the rear roller will cause premature brush wear.

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4. Check that brush is parallel to rear roller with **1.5 mm (0.060”)** clearance to light contact with rear roller. If contact is incorrect, brush operation will be adversely affected.

5. Lubricate grease fittings on brush housings until grease purges past inboard seals. Wipe excess grease from seals and fittings.

Disassembling the Drive System

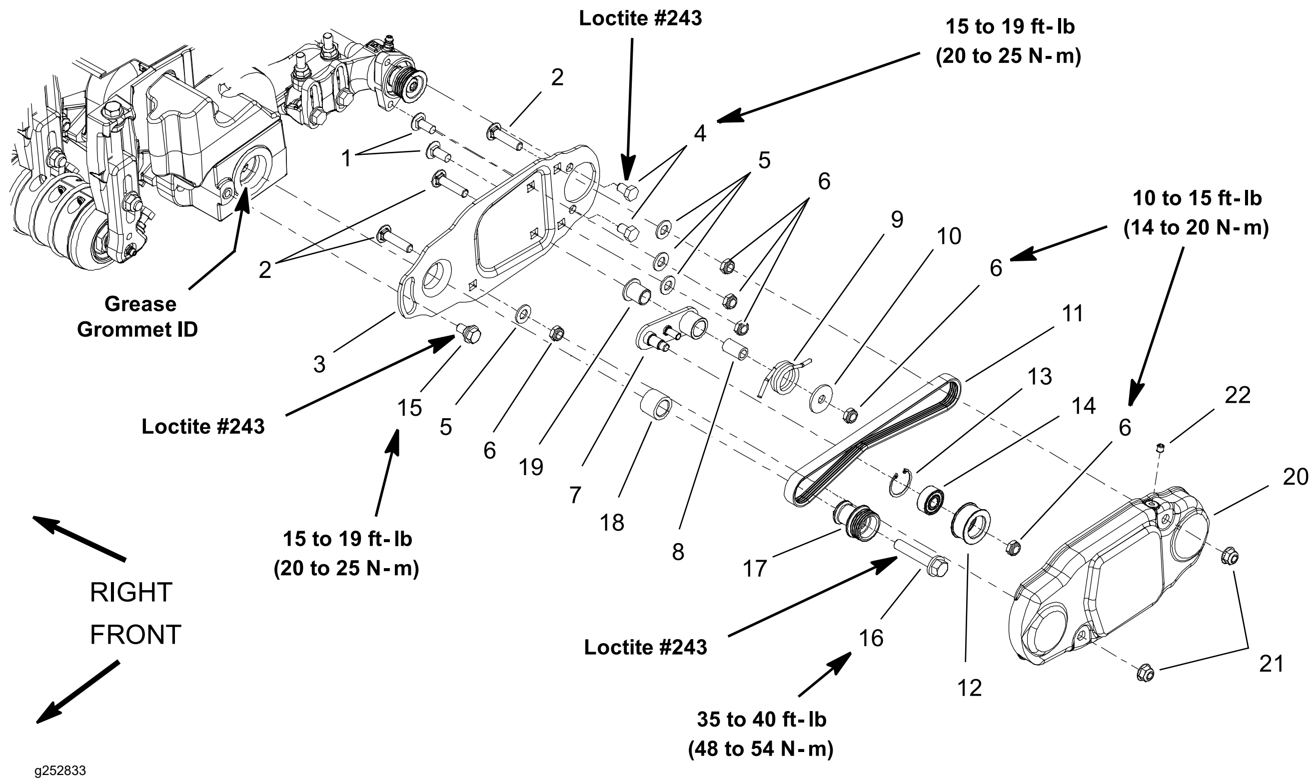


Figure 373

1. Carriage screw (2 each)
2. Carriage screw (3 each)
3. Brush plate
4. Cap screw (2 each)
5. Flat washer (4 each)
6. Lock nut (6 each)
7. Idler arm
8. Idler spacer
9. Idler spring
10. Pivot washer
11. Drive belt
12. Idler pulley
13. Retaining ring
14. Bearing
15. Shoulder screw
16. Flange head screw
17. Drive pulley
18. Spacer
19. Flange bushing
20. Cover
21. Flange nut (2 each)
22. Set screw (top of cover only)

Note: Drive components for the rear roller brush are located on the opposite side of the cutting unit from the cutting reel motor.Figure 373 shows components used when the brush drive is on the left 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.

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 cover (item 20) to access rear roller brush drive components.
3. Remove roller brush drive components as necessary using Figure 66 as a guide.
4. Remove roller brush drive shaft if needed:

Disassembling the Drive System (continued)

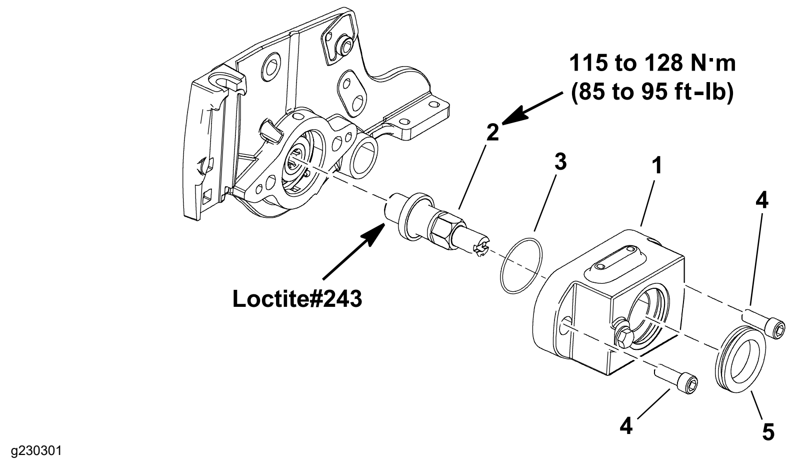


Figure 374

1. Drive housing
2. Drive shaft
3. O-ring
4. Socket-head screw
5. Grommet

A. Remove socket head screws that secure drive housing to cutting unit side plate and remove housing from cutting unit.

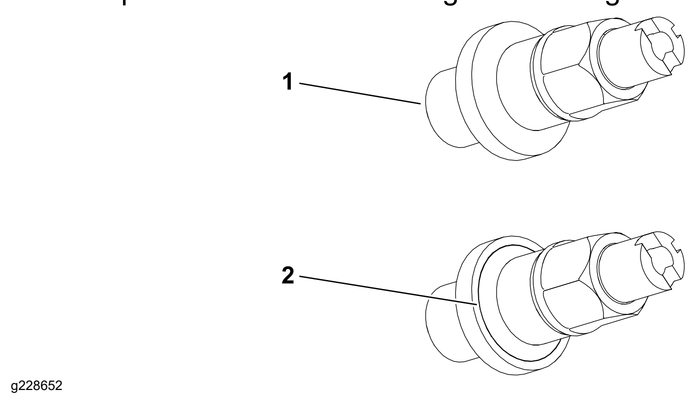


Figure 375

1. Drive shaft with right-hand threads (no groove)
2. Drive shaft with left-hand threads (with groove)

IMPORTANT

If rear roller brush drive is on left side of cutting unit, drive shaft has left hand threads and can be identified by a groove on the flange. If the rear roller brush drive is on right side of cutting unit, drive shaft has right hand threads and does not have a groove on the flange.

B. Loosen and remove drive shaft from cutting reel.

Assembling the Drive System

1. Install drive shaft if it was removed:

   A. Apply Loctite #243 (or equivalent) to threads of drive shaft. Thread drive shaft into cutting reel and torque from **115 to 128 N·m (85 to 95 ft-lb)**.

   B. Make sure that O-ring is placed on inner flange of drive housing.

Assembling the Drive System (continued)

C. Position housing to cutting unit side plate and secure to cutting unit with two (2) socket head screws.

D. Make sure that grommet groove is correctly seated on flange in drive housing bore.

2. Assemble roller brush components using Figure 373 as guides along with the following:

A. During assembly, apply Loctite #243 (or equivalent) where indicated and torque fasteners as shown.

B. Apply a light coating of grease to inner diameter of the grommet in drive bearing housing before installing brush plate.

C. Brush plate should be installed so that idler pulley assembly is toward the bottom of the plate. Also, the shoulder bolt (item 15) should not clamp the brush plate to the drive housing during assembly.

D. When installing drive pulley (item 17), make sure that tabs on pulley engage slot in drive shaft.

E. Idler arm (item 7) should be free to rotate after assembly to brush plate. Make sure that idler spring is installed so that it can rotate the idler arm and pulley and apply tension to the drive belt.

F. After drive belt installation, make sure that the ribs on the belt are properly seated in the grooves of both the drive and driven pulleys and that the belt is in the center of the idler pulley.

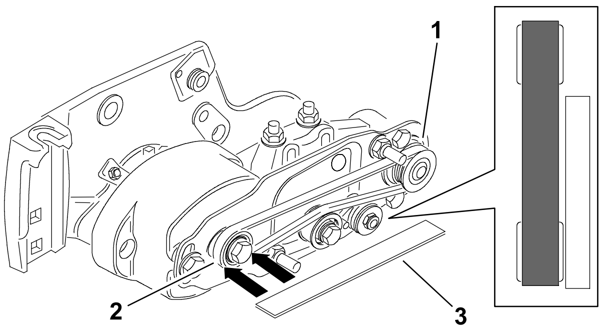


Figure 376

1. Driven pulley
2. Drive pulley
3. Pulley alignment tool

3. After assembly (including drive belt installation), check alignment of pulleys with a straight edge placed along the outer face of the drive pulley.

A. The outer faces of the drive and driven pulleys (not the idler pulley) should be in-line within 0.030” (0.76 mm).

Assembling the Drive System (continued)

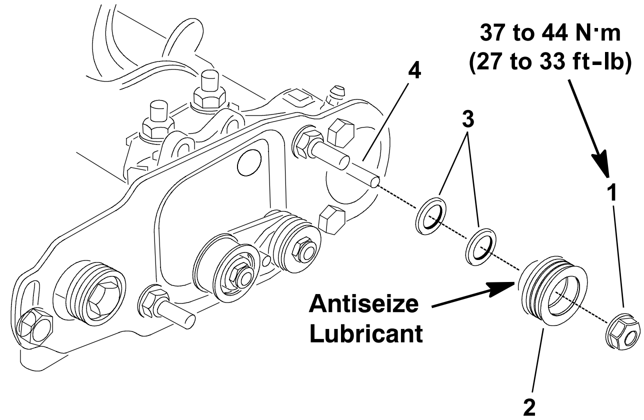


Figure 377

1. Flange nut	3. Flat washer
2. Driven pulley	4. Roller brush shaft

B. If necessary to align pulleys, remove driven pulley from brush shaft and add or remove flat washer(s) until drive and driven pulleys are correctly aligned.

C. If driven pulley was removed from roller brush shaft, apply antiseize lubricant to splines of pulley bore and slide pulley onto shaft. Install and tighten flange nut until pulley is seated onto shaft and then torque flange nut from **37 to 44 N·m (27 to 33 ft-lb)**. Use a ½ wrench on roller brush shaft flats to prevent shaft from rotating when tightening nut.

IMPORTANT

The roller brush shaft must nor contact the cutting unit side plate. Also, heavy brush contact on the rear roller will cause premature brush wear.

4. Check that brush is parallel to rear roller with **1.5 mm (0.060")** clearance to light contact with rear roller. If contact is incorrect, brush operation will be adversely affected.
5. Install cover (item 20).There should not be a set screw installed in the bottom of the cover.
6. Lubricate grease fittings on brush housings until grease purges past inboard seals. Wipe excess grease from seals and fittings.

Chapter 10

Belt Driven Groomer (Optional)

Table of Contents

General Information

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 factors affecting quality of cut also affect grooming performance.

Variables That Affect the Use and Performance of the Groomers:

1. The growing season and weather conditions.
2. General turf conditions.
3. The frequency of grooming/cutting—number of cuttings per week and how many passes per cutting.
4. The height-of-cut.
5. The grooming depth.
6. The type of grass.
7. The amount of time that a groomer reel has been in use on a particular turf area.
8. The amount of traffic on the turf.
9. The overall turf management program—irrigation, fertilizing, weed control, coring, over-seeding, sand dressing, disease control, and pest control.
10. Stress periods for turf—high temperatures, high humidity, and unusually high traffic.

Groomer Reel Mechanical Problems

Problem	Possible Causes	Correction
No rotation of the groomer reel.	The groomer drive belt needs to be adjusted.	Adjust the groomer drive belt.
	Failed groomer idler bearing(s) in the groomer side plate(s).	Replace the bearing(s) that are damaged.
	Broken or damaged idler spring.	Replace the spring.
	The groomer drive belt is worn, broken, or damaged.	If the drive belt slips, it probably is out of adjustment or worn. Repair or replace the drive belt if necessary. A broken or worn belt could be the result of improper belt routing or seized bearings in the groomer assembly.
	Grooming depth is too deep.	Change the grooming depth.
	Groomer drive pulley square key is damaged or missing.	Replace the missing or damaged square key.
	Flange-head screw that secures the groomer drive pulley is loose or damaged.	Tighten the groomer drive pulley with existing flange-head screw. Replace the screw, if threads are damaged.
The turf is damaged or has uneven grooming.	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. Also, check and adjust the cutting unit set up (level the bedknife to the reel, level rear roller to reel, set height-of-cut, etc.).

Adjustments

CAUTION

Do not work on the groomer with the engine running.

Always shut off the engine, remove the key from the key switch, and wait for all machine movement to stop before working on the groomer.

Note: The Installation Instructions for the groomer has detailed information regarding assembly and adjustment. Use those Instructions along with this Service Manual when servicing the groomer.

Adjusting the Height/Depth of the Groomer

Note: Grooming is performed above the soil level. When adjusting the groomer height/depth, the groomer blades should not penetrate the soil.

1. Park the machine on a clean and level surface, lower the cutting units completely to the ground, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Ensure that the rollers are clean and the cutting unit is set to the desired height-of-cut; refer to the *Cutting Unit Operator's Manual*.

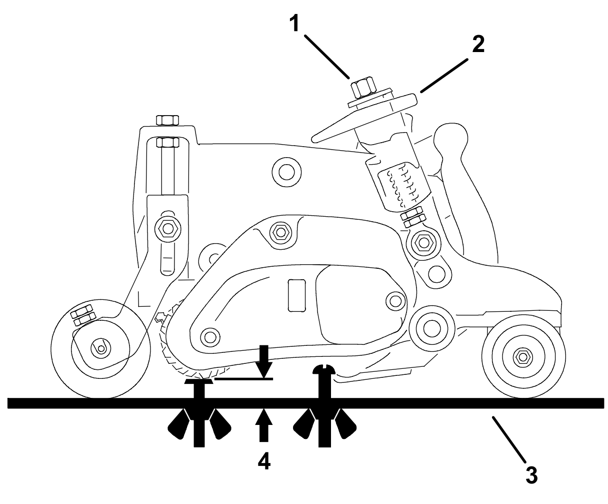


Figure 378

1. Groomer height adjuster
2. Quick-up lever
3. Gauge bar assembly
4. Groomer height

3. Position the groomer reel to the lowered, grooming position (Figure 378).

   Note: Improper or over-aggressive 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 cautiously.

   Note: Use the gauge bar assembly (refer to (page)) to determine the groomer height.

4. On one end of the groomer reel, measure the distance from the lowest tip of the groomer blade to the working surface. Turn the groomer height adjuster to raise or lower the groomer blade tip to the desired height (Figure 378).

Adjusting the Height/Depth of the Groomer (continued)

5. Repeat step 4 on the opposite end of the groomer. Check the setting on the first side of the groomer. The height settings on both the ends of the groomer should be identical.

Service and Repairs

CAUTION

Do not work on the groomer with the engine running.

Always shut off the engine, remove the key from the key switch, and wait for all machine movement to stop before working on the groomer.

Note: The Groomer Kit Installation Instructions provide information regarding the installation, set-up, and operation of the optional groomer on your Reelmaster machine. Refer to this publication for additional information when servicing the groomer.

Replacing the Groomer Drive Belt

The groomer drive belt should be inspected/replaced annually or after 750 hours of operation.

1. Park the machine on a level surface, lower the cutting units completely to the ground, shut off the engine, set the parking brake, and remove the key from the key switch.

   Note: If the cutting unit is equipped with the powered rear roller brush, removal of the roller brush components will be necessary to replace the groomer drive belt; refer to the Rear Roller Brush – Optional (cutting units with painted side plates) (page 9–56).

   Note: When removing the groomer cover, the groomer weight does not have to be removed from the cover.

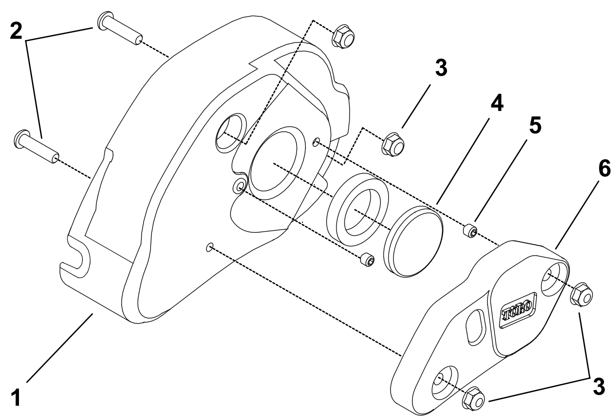


Figure 379

1. Groomer cover
2. Socket-head screw (2 each)
3. Flange nut (4 each)
4. Rubber grommet
5. Set screw (2 each)
6. Groomer weight

2. Remove the 2 flange nuts that secure the groomer cover, and remove the cover (Figure 379).

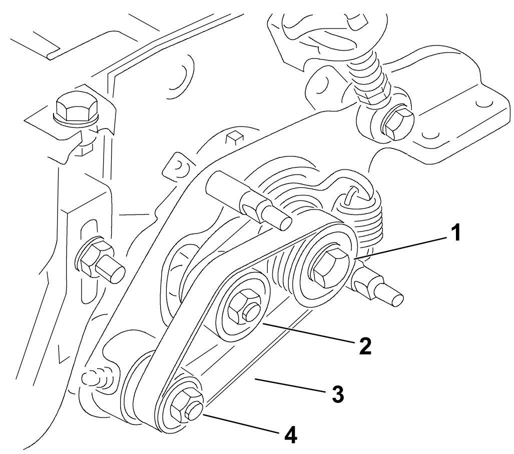


Figure 380

1. Drive pulley
2. Idler pulley
3. Groomer drive belt
4. Driven pulley

Replacing the Groomer Drive Belt (continued)

3. Remove the groomer belt tension by pivoting idler plate and pulley using a wrench on the pulley nut. Slip the groomer drive belt off the pulleys (Figure 380). Carefully release the idler plate and pulley.
4. Install a new drive belt to the drive pulley, idler pulley, and driven pulley observing correct belt routing (Figure 380). Ensure that the groomer drive belt is above the idler pulley after belt installation.
5. Install the groomer cover and secure with the 2 flange nuts.

Groomer Plate Assembly

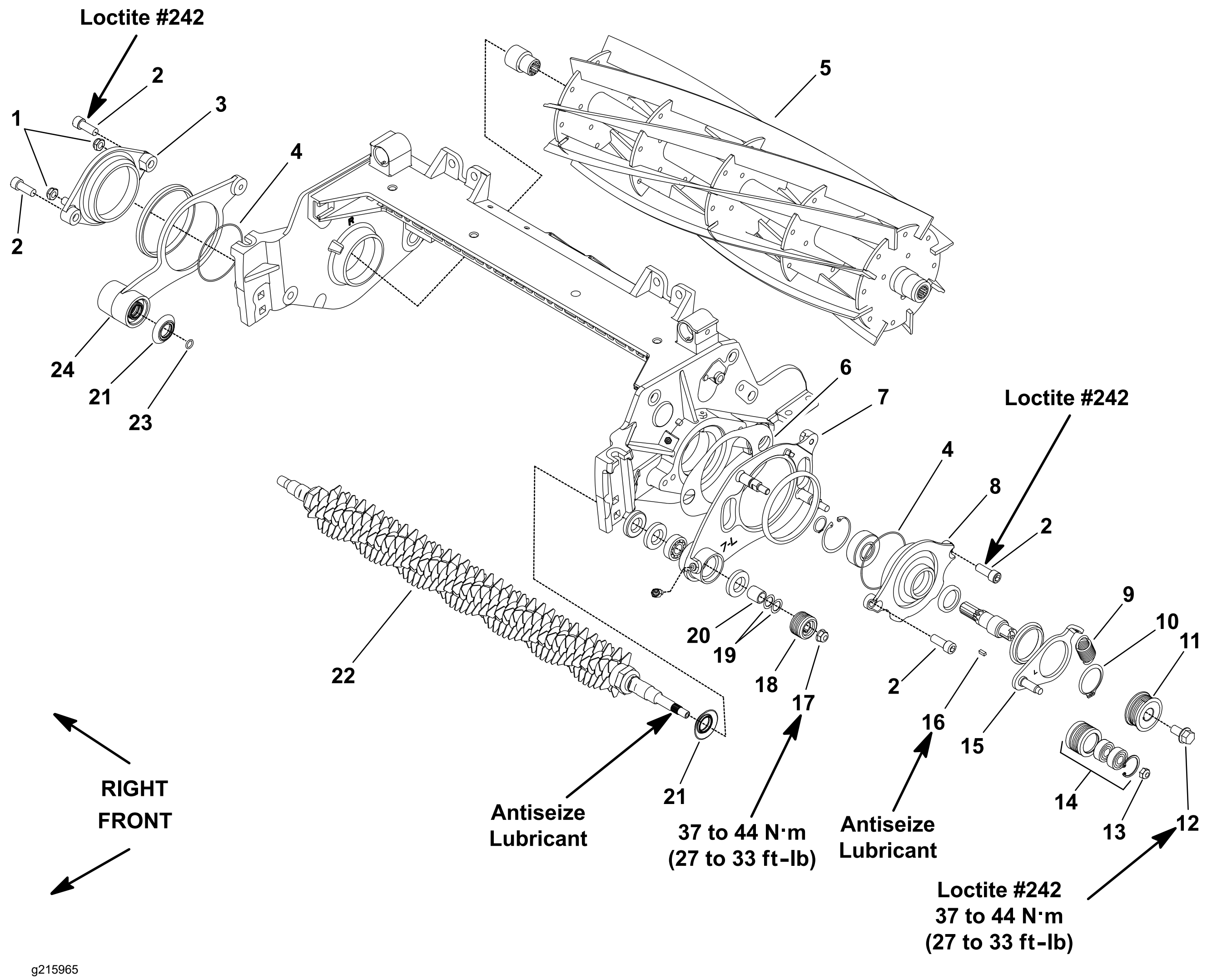


Figure 381

7 inch cutting reel with cast iron side plates

1. Flange nut (2 each)
2. Socket-head screw (4 each)
3. Pivot hub assembly (non-drive)
4. O-ring (2 each)
5. Cutting reel
6. Groomer shim
7. Groomer plate (drive)
8. Pivot hub assembly (drive)
9. Extension spring
10. Retaining ring
11. Drive pulley
12. Flange-head screw
13. Locknut
14. Idler pulley assembly
15. Idler plate
16. Square key
17. Flange nut
18. Driven pulley
19. Washer (as necessary)
20. Pulley spacer
21. Excluder seal (2 each)
22. Groomer reel
23. O-ring
24. Groomer plate (non-drive)

Note: The groomer reel drive is located on the opposite side of the cutting unit from the cutting reel hydraulic motor. Figure 381 shows the components used when the groomer reel drive is on the left side of the cutting unit.

Disassembling the Groomer Plate Assembly

1. Park the machine on a clean and level surface, lower the cutting units completely to the ground, shut off the engine, set the parking brake, and remove the key from the key switch.

   Note: If the cutting unit is equipped with the powered rear roller brush, removal of the roller brush components will be necessary to service the groomer plate assemblies; refer to the Rear Roller Brush – Optional (cutting units with painted side plates) (page 9–56).

2. Remove the groomer plate assembly from the groomer drive side of the cutting unit as follows:

   A. Remove the groomer belt cover and groomer drive belt from the groomer drive; refer to Replacing the Groomer Drive Belt (page 10–7).

   Note: To prevent the cutting reel from turning when removing the drive pulley, block the reel with a piece of wood.

   B. Remove the flange-head screw (item 12 in Figure 381) that retains the drive pulley. Pull the drive pulley from the driveshaft. Locate and retrieve the square key from the driveshaft.

   Note: To prevent the groomer shaft from turning when removing the driven pulley, use a wrench on the groomer shaft flats to hold the groomer shaft.

   C. Remove the flange nut (item 17 in Figure 381) that secures the driven pulley to the groomer shaft. Slide the driven pulley from the shaft.

   D. Slide the washer(s) (item 19 in Figure 381) and pulley spacer from the groomer shaft.

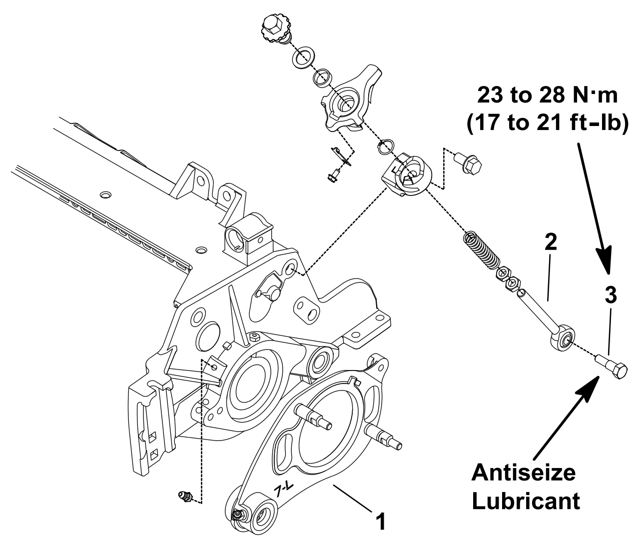


Figure 382

1. Groomer plate
2. Quick-up ball joint rod
3. Shoulder bolt

   E. Remove the shoulder bolt that secures the quick-up ball joint rod to the groomer plate (Figure 382).

   F. Disconnect the extension spring (item 9 in Figure 381) from the stud on the groomer plate.

   G. Remove the 2 socket-head screws (item 2 in Figure 381) that secure the groomer components to the cutting unit side plate.

Disassembling the Groomer Plate Assembly (continued)

Note: Cutting units with cast iron side plates (Figure 381) use a groomer driveshaft that is secured to the pivot hub assembly and is driven by the splined insert in cutting reel. Cutting units with aluminum side plates use a groomer driveshaft that threads into the cutting reel shaft so that the driveshaft will remain attached to the reel shaft when the pivot hub is removed.

H. Remove the pivot hub and idler plate assembly from the cutting unit.

I. Support the groomer shaft to prevent it from falling. Carefully slide the drive side groomer plate from the groomer shaft and cutting unit. Remove the groomer shim.

3. Remove the groomer plate assembly from the groomer non-drive side of the cutting unit as follows:

   A. Remove the hydraulic reel motor from the cutting unit; refer to Hydraulic Reel Motor (page 9–17).

   B. Remove the 2 socket-head screws (item 2 in Figure 381) that secure the groomer components to the cutting unit side plate.

   C. Remove the pivot hub from the cutting unit.

   D. Support the groomer shaft to prevent it from falling. Carefully slide the non-drive side groomer plate from the groomer shaft and cutting unit.

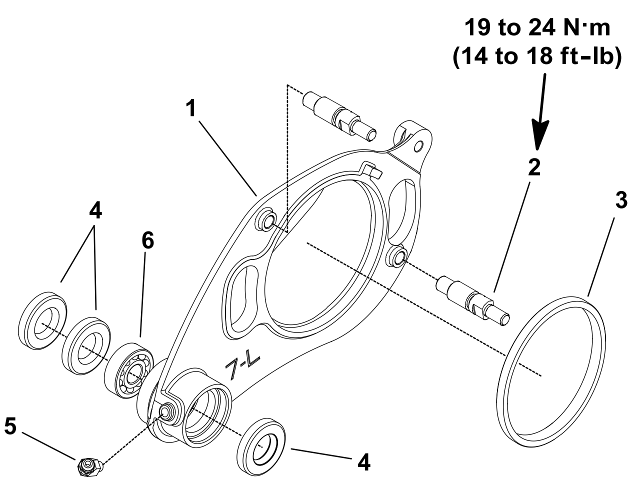


Figure 383

Drive side groomer plate

1.	Groomer plate	3.	Bushing	5.	Grease fitting
2.	Groomer stud (2 each)	4.	Seal (3 each)	6.	Bearing

Disassembling the Groomer Plate Assembly (continued)

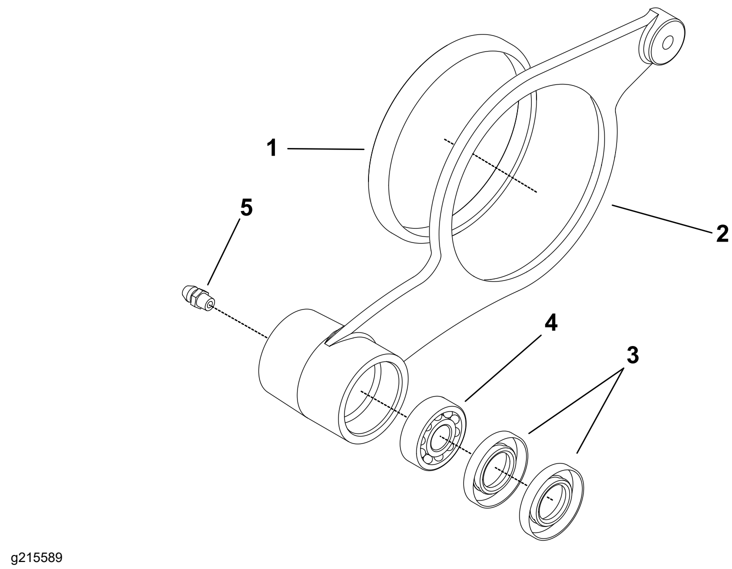


Figure 384

Non-drive side groomer plate

1.	Bushing	3.	Seal (2 each)	5.	Grease fitting
2.	Groomer plate	4.	Bearing		

4. Inspect the seals, bearings, and bushing in the groomer plate(s) that were removed (Figure 383 and Figure 384). Remove and discard the components that are worn or damaged.

   Note: Groomer plates used on cutting units with cast iron side plates are shown in Figure 383 and Figure 384. Groomer plates used on cutting units with aluminum side plates (not shown) use a single seal rather than a double seal.

Assembling the Groomer Plate Assembly

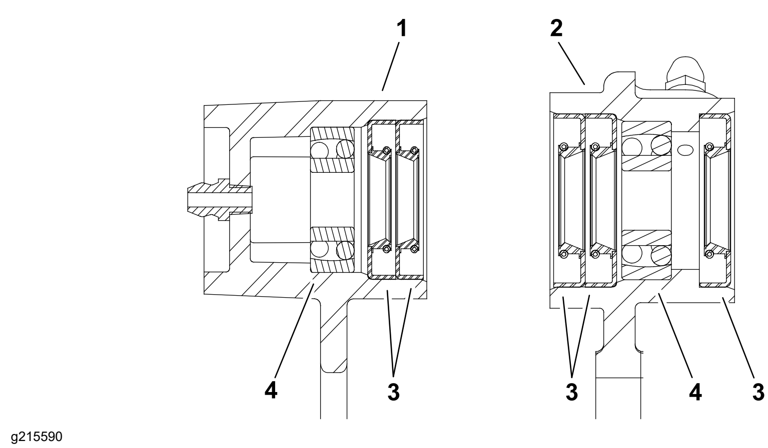


Figure 385

1.	Non-drive groomer plate	3.	Grease seal
2.	Drive side groomer plate	4.	Bearing

1. If the seals, bearings, or bushing were removed from the groomer plate(s), install new components noting proper orientation as shown in Figure 383, Figure 384, and Figure 385.

Assembling the Groomer Plate Assembly (continued)

A. Pack the bearings with grease before installation.

B. Press the bearings into the groomer plate so that the bearings contact the shoulder in the groomer plate bore.

C. Install the grease seals so that the seal lips are positioned toward the groomer blade location. Seals should be flush with the surface of the groomer plate.

D. Press the bushings into the groomer plate until the bushing contacts the shoulder in the groomer plate bore.

2. If the groomer studs (item 2 in Figure 383) were removed from the drive side of groomer plate, apply Loctite #243 (or equivalent) to the threads of the studs. New studs have patch lock on the threads. Install the studs into the plate; torque the studs to **19 to 24 N·m (14 to 18 ft-lb)**.

3. Install the groomer plate assembly to the groomer non-drive side of the cutting unit as follows:

   A. Carefully position the non-drive side groomer plate onto the groomer shaft and slide to the cutting unit.

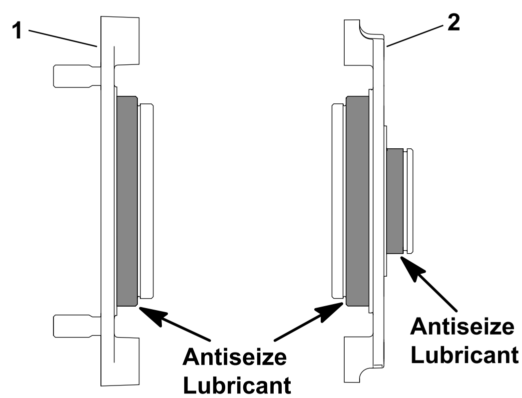


Figure 386

1. Pivot hub (non-drive side)
2. Pivot hub (drive side)

   B. Apply anti-sieze lubricant to the outside diameter of the pivot hub and position the pivot hub to the cutting unit (Figure 386).

   C. Secure the groomer components to the cutting unit side plate with the 2 socket-head screws (item 2 in Figure 381).

   D. Install the hydraulic reel motor to the cutting unit; refer to the Hydraulic Reel Motor (page 9–17).

4. Install the groomer plate assembly to the groomer drive side of the cutting unit as follows:

   A. Position the groomer shim to the cutting unit side plate. Carefully position the drive side groomer plate onto the groomer shaft and slide to the cutting unit.

   B. Apply anti-sieze lubricant to the outside diameter of the pivot hub and position the pivot hub to the cutting unit (Figure 386). Apply Loctite to the 2 socket-head screws and secure the pivot hub to the cutting unit side plate.

   C. Apply anti-sieze lubricant to the outside diameter of the pivot hub and position the idler plate assembly to the pivot hub.

Assembling the Groomer Plate Assembly (continued)

D. Connect the extension spring (item 9 in Figure 381) to the stud on the groomer plate. Ensure that the spring is in the stud groove and that the spring hook is positioned toward the drive pulley.

E. Secure the quick-up ball joint rod to the drive side of the groomer plate with the shoulder bolt (Figure 382). Apply anti-seize lubricant to the shoulder of the shoulder bolt before installation; torque the shoulder bolt to **23 to 28 N·m (17 to 21 ft-lb)**.

F. Slide the pulley spacer (item 20 in Figure 381) and washer(s) onto the groomer shaft.

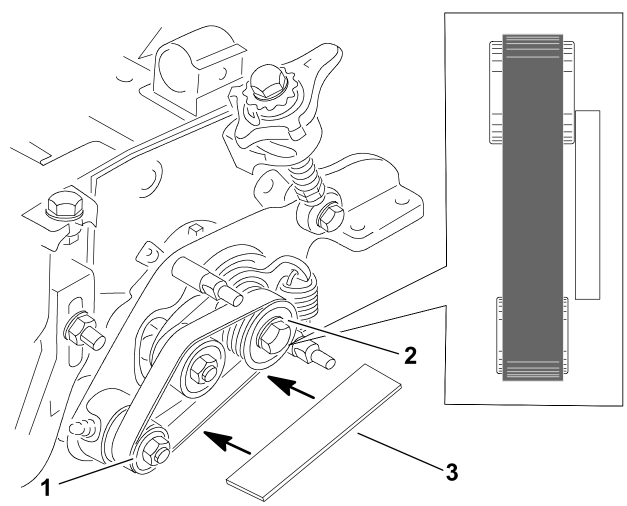
G. Apply anti-seize lubricant to the square key (item 16 in Figure 381) that locates the drive pulley. Position the key into the shaft slot.

Note: To prevent the cutting reel from turning when installing the drive pulley, block the cutting reel with a piece of wood.

H. Apply Loctite #243 to the threads of the flange-head screw that secures the drive pulley to the pivot hub shaft. Slide the drive pulley onto the shaft and secure with the flange-head screw; torque the screw to **37 to 44 N·m (27 to 33 ft-lb)**.

Note: To prevent the groomer shaft from turning when installing the driven pulley, use a wrench on the groomer shaft flats.

I. Apply anti-seize lubricant to the driven pulley splines on the groomer shaft. Slide the driven pulley onto the groomer shaft and secure with the flange nut; torque the flange nut to **37 to 44 N·m (27 to 33 ft-lb)**.



g215591

Figure 387

1. Driven pulley
2. Drive pulley
3. Pulley alignment tool

J. Check the pulley alignment by laying the pulley alignment tool (refer to (page)) along the outer face of the drive pulley (Figure 387). The drive and driven pulleys should be in line within 0.76 mm (0.030 inch). If necessary, align pulleys by removing the driven pulley and installing or removing the washer(s) between the driven pulley and the pulley spacer.

K. After the pulleys are aligned, install the groomer drive belt and groomer belt cover; refer to Replacing the Groomer Drive Belt (page 10–7).

5. Check that the excluder seals just touch the groomer plate assembly. Position the excluder seals again on the groomer shaft if necessary.

Assembling the Groomer Plate Assembly (continued)

6. Check that the groomer reel height and mower height-of-cut settings. Adjust as necessary.
7. Lubricate the groomer bearings.

   Note: After greasing the groomer bearings, operate the groomer for 30 seconds, stop the machine, and remove the unwanted grease from the groomer shaft and seals.

Groomer Reel

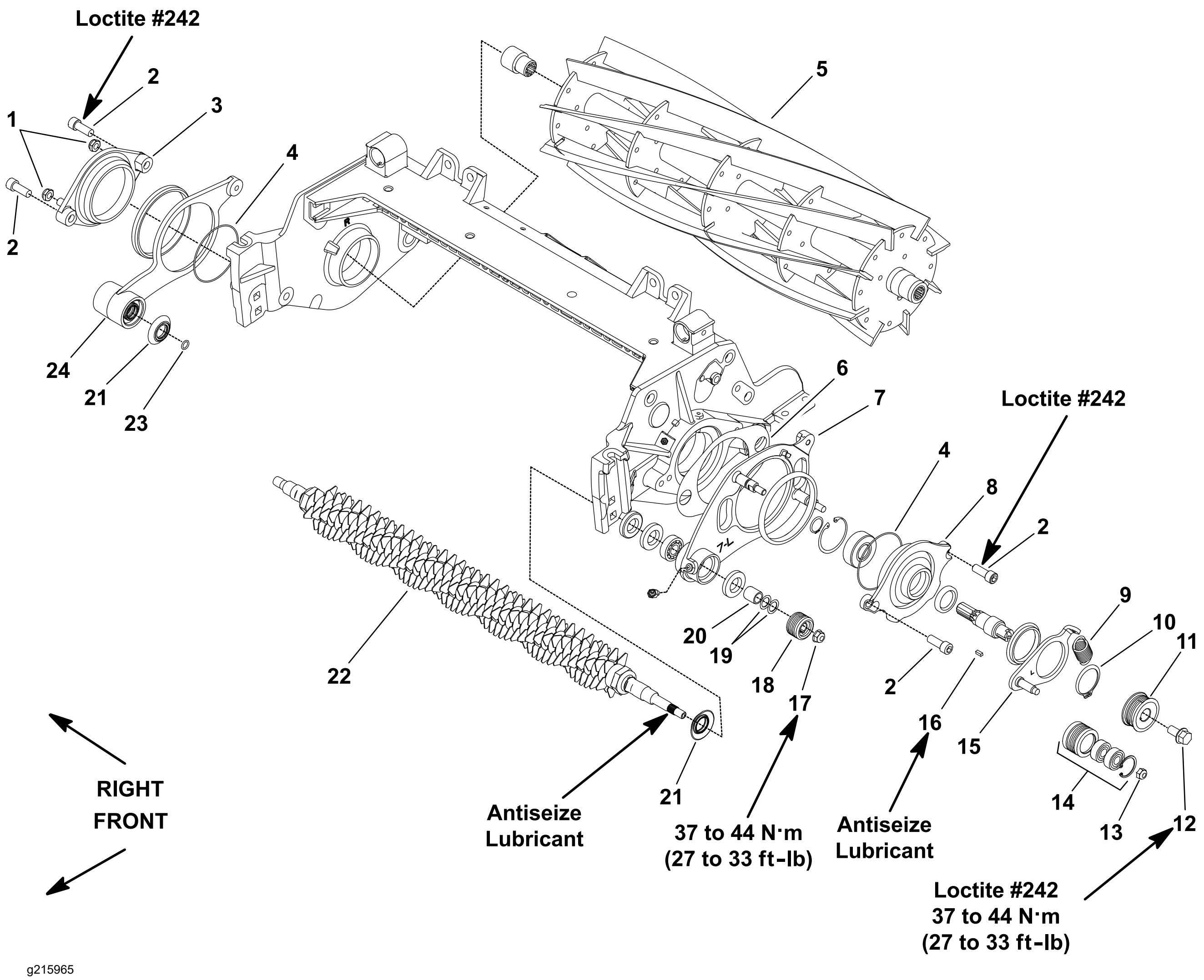


Figure 388

7 inch cutting reel with cast iron side plates

1. Flange nut (2 each)
2. Socket-head screw (4 each)
3. Pivot hub assembly (non-drive)
4. O-ring (2 each)
5. Cutting reel
6. Groomer shim
7. Groomer plate (drive)
8. Pivot hub assembly (drive)
9. Extension spring
10. Retaining ring
11. Drive pulley
12. Flange-head screw
13. Locknut
14. Idler pulley assembly
15. Idler plate
16. Square key
17. Flange nut
18. Driven pulley
19. Washer (as necessary)
20. Pulley spacer
21. Excluder seal (2 each)
22. Groomer reel
23. O-ring
24. Groomer plate (non-drive)

Remove the groomer reel to replace individual groomer blades or replace the shaft. The groomer blades can be reversed on the shaft to provide additional blade life.

Note: The groomer reel drive is located on the opposite side of the cutting unit from the cutting reel hydraulic motor. Figure 388 shows the components used when the groomer reel drive is on the left side of the cutting unit.

Removing the Groomer Reel

1. Park the machine on a clean and level surface, lower the cutting units completely to the ground, shut off the engine, set the parking brake, and remove the key from the key switch. If necessary, remove the cutting unit from the machine; refer to the *Traction Unit Operator's Manual*.

   Note: If the cutting unit is equipped with the powered rear roller brush, removal of the roller brush components will be necessary to remove the groomer reel; refer to the Rear Roller Brush – Optional (cutting units with painted side plates) (page 9–56).

2. Remove the groomer plate assembly from the groomer drive side of the cutting unit; refer to the Groomer Plate Assembly (page 10–9).
3. Carefully pull the groomer reel from the non-drive side groomer plate assembly.
4. Inspect all the seals, bushings, and bearings in the groomer plate assemblies for wear or damage. Replace the components as necessary; refer to the Groomer Plate Assembly (page 10–9).

Installing the Groomer Reel

1. Position the cutting unit on a level surface. If cutting unit is attached to the traction unit, ensure to shut off the engine, set the parking brake, and remove the key from the key switch.
2. Apply a light coating of grease to the seal lips in the groomer plate assemblies.
3. Ensure that the excluder seals (item 21 in Figure 388) and O-ring are positioned on the groomer shaft. The excluder seal lips should be toward the end of the groomer shaft. Apply a film of grease onto the seal lips.

   Note: Ensure that you do not damage the seals in the groomer plate assembly.

4. Carefully slide the groomer reel into the non-drive side groomer plate assembly.
5. Carefully install the groomer plate assembly to the groomer reel and groomer drive side of the cutting unit; refer to the Groomer Plate Assembly (page 10–9).

Installing the Groomer Reel (continued)

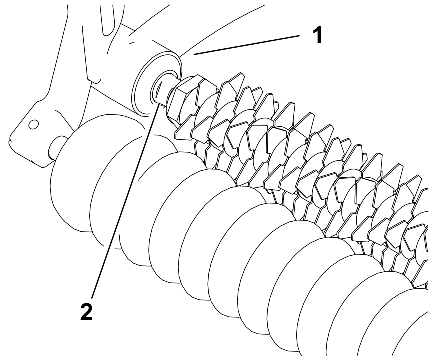


Figure 389

1. Groomer plate
2. Excluder seal

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6. Check that the excluder seals just touch the groomer plate assembly (Figure 389). Position the excluder seals on the groomer shaft if necessary.
7. Check the groomer reel height and mower height-of-cut settings. Adjust as necessary.
8. Lubricate the groomer bearings.

   Note: After greasing the groomer bearings, operate the groomer for 30 seconds, stop the machine, and remove the unwanted grease from the groomer shaft and seals.

Servicing the Groomer Reel

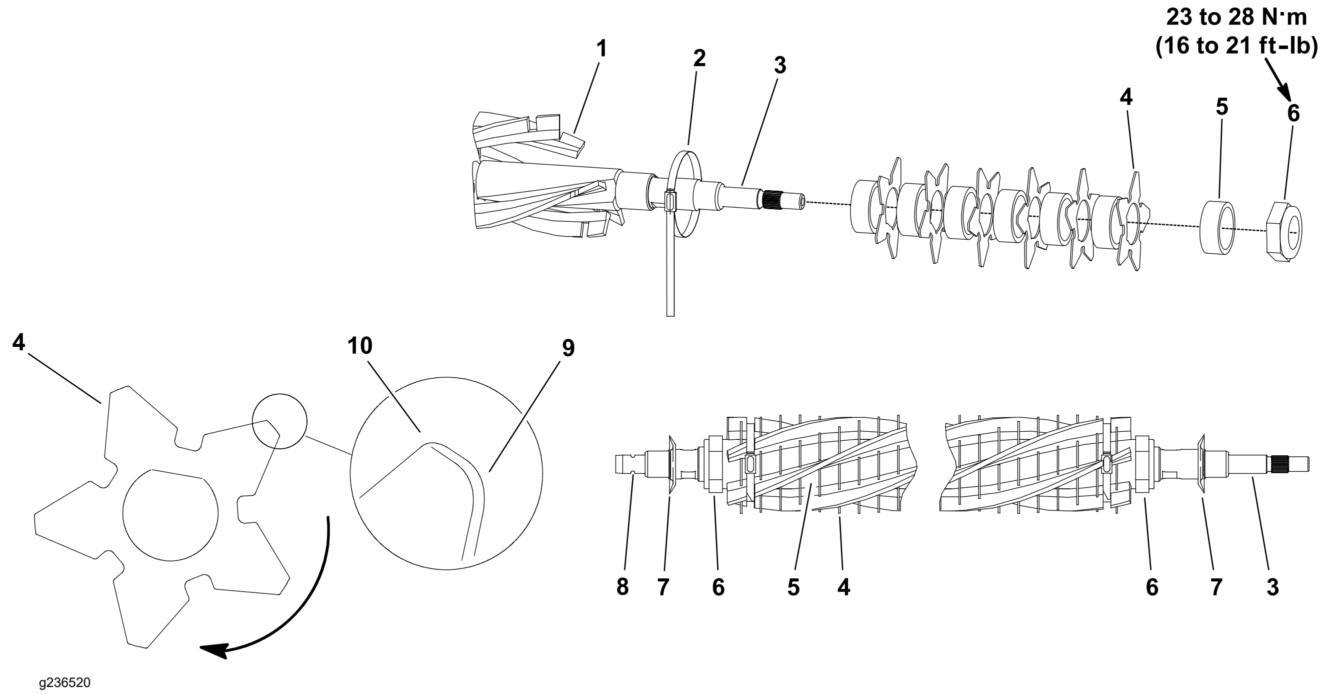

Figure 390

1. Broomer brush (5 each)
2. Broomer strap (4 each)
3. Groomer shaft
4. Groomer blade (42 each)
5. Spacer (43 each)
6. Locknut (2 each)
7. Excluder seal (2 each)
8. O-ring groove
9. Dull (rounded) edge
10. Sharp edge

Inspect the groomer reel blades frequently for damage and wear. Straighten the bent blades with a pliers. Either replace the worn blades or reverse the blades to put the sharpest blade edge forward (Figure 390). The blades that are rounded to the midpoint of the blade tip must be reversed or replaced for best groomer performance.

Disassembling the Groomer Reel

1. Remove the groomer reel from the cutting unit; refer to the Groomer Reel (page 10–15).
2. Remove the O-ring on the non-drive end of the groomer shaft.
3. Remove the 2 excluder seals from the groomer reel.
4. If the groomer reel is equipped with the broomer kit, remove the straps and broomer brushes from the reel (Figure 391).
5. Remove the locknut from either end of the shaft.
6. Remove the spacers and blades from the groomer shaft. If necessary, remove the second locknut from the shaft.

Assembling the Groomer Reel

1. Ensure that the first locknut is installed on the groomer shaft. Place the spacer and then the first blade on the shaft.
2. Alternately install the spacers and blades and ensure that all the blades are separated by a spacer.

Assembling the Groomer Reel (continued)

3. When all the blades have been installed, place the final spacer on the shaft and then thread the second locknut onto the shaft. Center the blades on the shaft with the locknuts.
4. Use a wrench on the shaft flats to prevent the shaft from turning, torque the second locknut to **23 to 28 N·m (16 to 21 ft-lb)**. After you torque the locknut, the spacers should not be free to rotate and the groomer blades should be centered on the shaft.
5. If the groomer reel is equipped with the broomer kit:
   A. Loosen the groomer blade retaining nuts on each end of the groomer shaft.

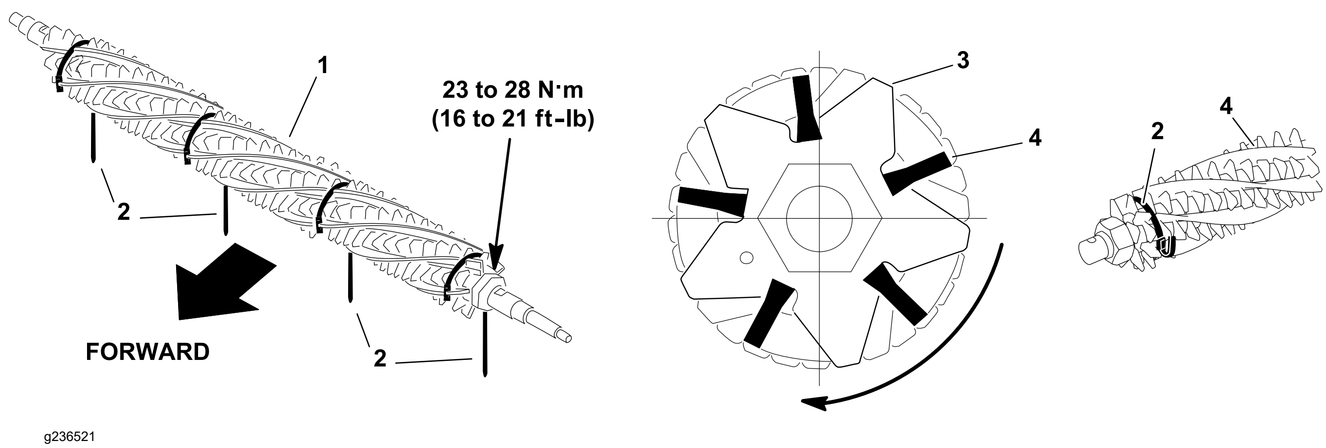

Figure 391

1. Groomer reel
2. Broomer strap (4 each)
3. Blade
4. Brush

   B. Slide a brush into each groove around the full length of the groomer reel. Ensure that the brushes are seated in groomer blade slots (Figure 391).

IMPORTANT

The straps must be wrapped around the groomer blade and brush assembly in the correct direction.

   C. Loosely wrap the straps around the groomer reel shaft and brushes as shown in Figure 391. The straps should be positioned in the pre-cut notches of each brush between the blades 1-2, 14-15, 28-29, and 41-42.

   Position the broomer brushes properly in the blade slots, and tighten the groomer blade—retaining nuts to **23 to 28 N·m (16 to 21 ft-lb)**.

   D. While holding strap buckle in place, pull the straps tight into the pre-cut notches of each brush.

   E. Cut off the strap extension approximately 6 mm (0.25 inch) beyond the retainer and fold the excess strap over the buckle (Figure 391).

6. Place the excluder seals on the groomer shaft.
7. Install the O-ring onto the non-drive end of the groomer shaft.
8. Install the groomer reel back onto the cutting unit; refer to the Groomer Reel (page 10–15).
9. Check the groomer reel height and mower height-of-cut settings. Adjust as necessary.

10. Lubricate the groomer bearings.

    Note: After greasing the groomer bearings, operate the groomer for 30 seconds, stop the machine, and remove the unwanted grease from the groomer shaft and seals.

Groomer Pivot Hub

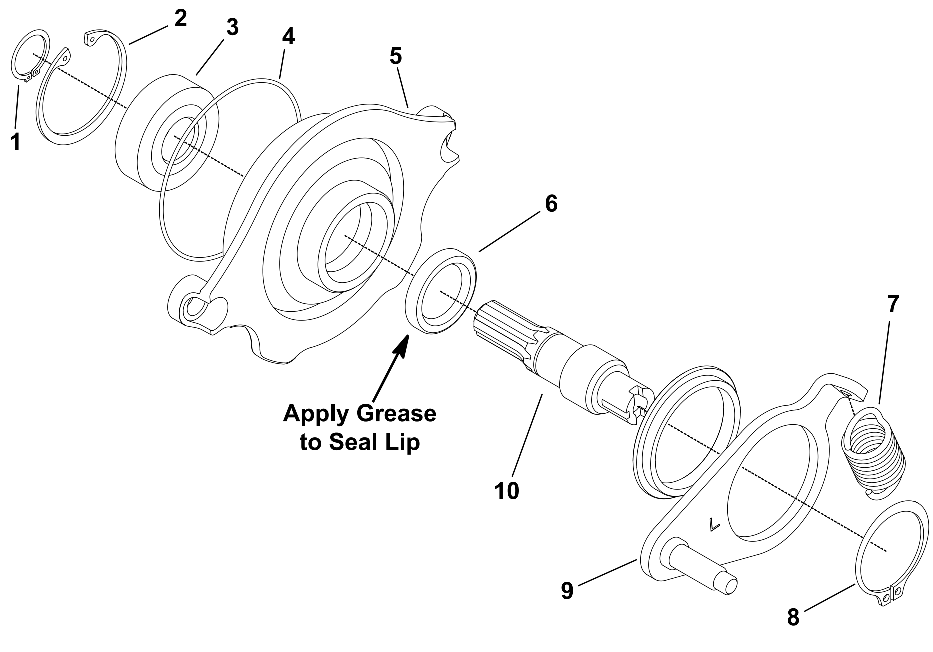

Figure 392

Pivot hub for cutting reel with cast iron side plates

1. Retaining ring
2. Retaining ring
3. Ball bearing
4. O-ring
5. Pivot hub
6. Grease seal
7. Extension spring
8. Retaining ring
9. Idler plate
10. Groomer driveshaft

Note: The groomer reel drive is located on the opposite side of the cutting unit from the cutting reel hydraulic motor. Figure 392 shows the components used when the groomer reel drive is on the left side of the cutting unit with cast iron side plates.

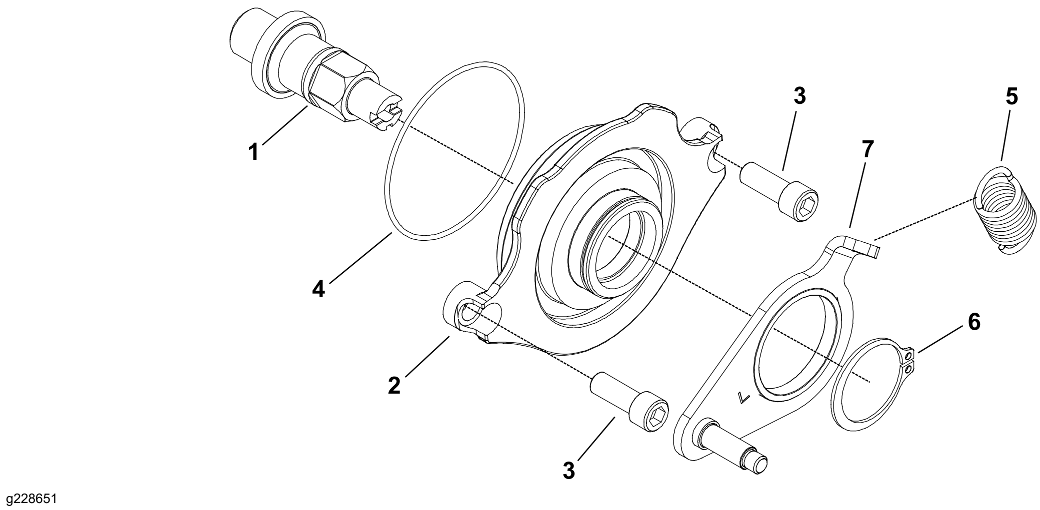

Figure 393

Pivot hub for cutting reel with aluminum side plates

1. Groomer driveshaft
2. Pivot hub
3. Socket-head screw
4. O-ring
5. Extension spring
6. Retaining ring
7. Idler plate

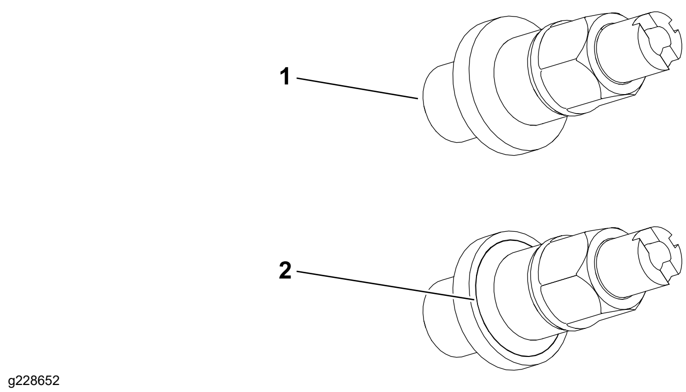

Figure 394

1. Driveshaft with right-hand threads (no groove)
2. Driveshaft with left-hand threads (with groove)

Note: Cutting units with aluminum side plates use a groomer driveshaft that threads into the cutting reel shaft (Figure 393). The pivot hub on these cutting units does not use internal components to support the groomer driveshaft. Also, the groomer driveshaft does not have to be removed from the cutting reel shaft in order to remove the pivot hub.

Disassembling the Groomer Pivot Hub

1. Remove the pivot hub assembly (with the idler plate) from the cutting unit; refer to the Groomer Plate Assembly (page 10–9).
2. Remove the retaining ring that secures the idler plate to the pivot hub. Slide the idler plate from the pivot hub.
3. If equipped, remove and discard the O-ring from the flange of the pivot hub.
4. If the cutting unit has cast iron side plates, disassemble the pivot hub (Figure 392 and Figure 395) as follows:
   A. Remove the retaining ring that retains the ball bearing into the pivot hub. Slide the driveshaft and bearing out of the hub.

Disassembling the Groomer Pivot Hub (continued)

B. Remove the retaining ring that retains the bearing on the driveshaft. Press the ball bearing from the shaft. Discard the bearing.

C. Remove the grease seal from the pivot hub. Discard the seal.

5. Clean all the pivot hub components and inspect for wear or damage.

Assembling the Groomer Pivot Hub

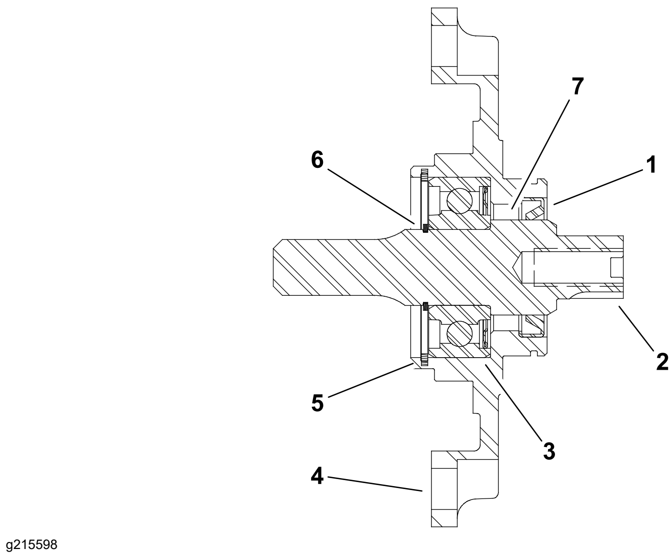

Figure 395

1.	Oil seal	4.	Pivot hub	7.	Cavity
2.	Driveshaft	5.	Retaining ring		
3.	Bearing	6.	Retaining ring		

1. If the cutting unit has cast iron side plates, assemble the pivot hub (Figure 392 and Figure 395) as follows:

   A. Install the bearing on the driveshaft by pressing equally on the inner and outer bearing races. Install the bearing so that the bearing seal is closest to the shoulder on the shaft. Install the retaining ring onto the shaft to retain the bearing.

   B. Install the new grease seal into the housing with the lip of the seal toward the outside of the housing. Apply grease to the lip of the seal.

   C. Fill the cavity between the bearing location and the grease seal 50% to 75% full with high-temperature Mobil XHP-222 grease (or equivalent) (Figure 395).

   D. Carefully slide the shaft and bearing fully into the pivot hub bore and ensure that you do not damage the grease seal. Install the retaining ring to secure the bearing in the pivot hub.

2. If equipped, install new O-ring into the groove in the pivot hub flange.

3. Slide the idler plate onto the pivot hub and secure with the retaining ring.

4. Install the pivot hub and idler plate assembly to the cutting unit; refer to the Groomer Plate Assembly (page 10–9).

Height Adjuster Assembly

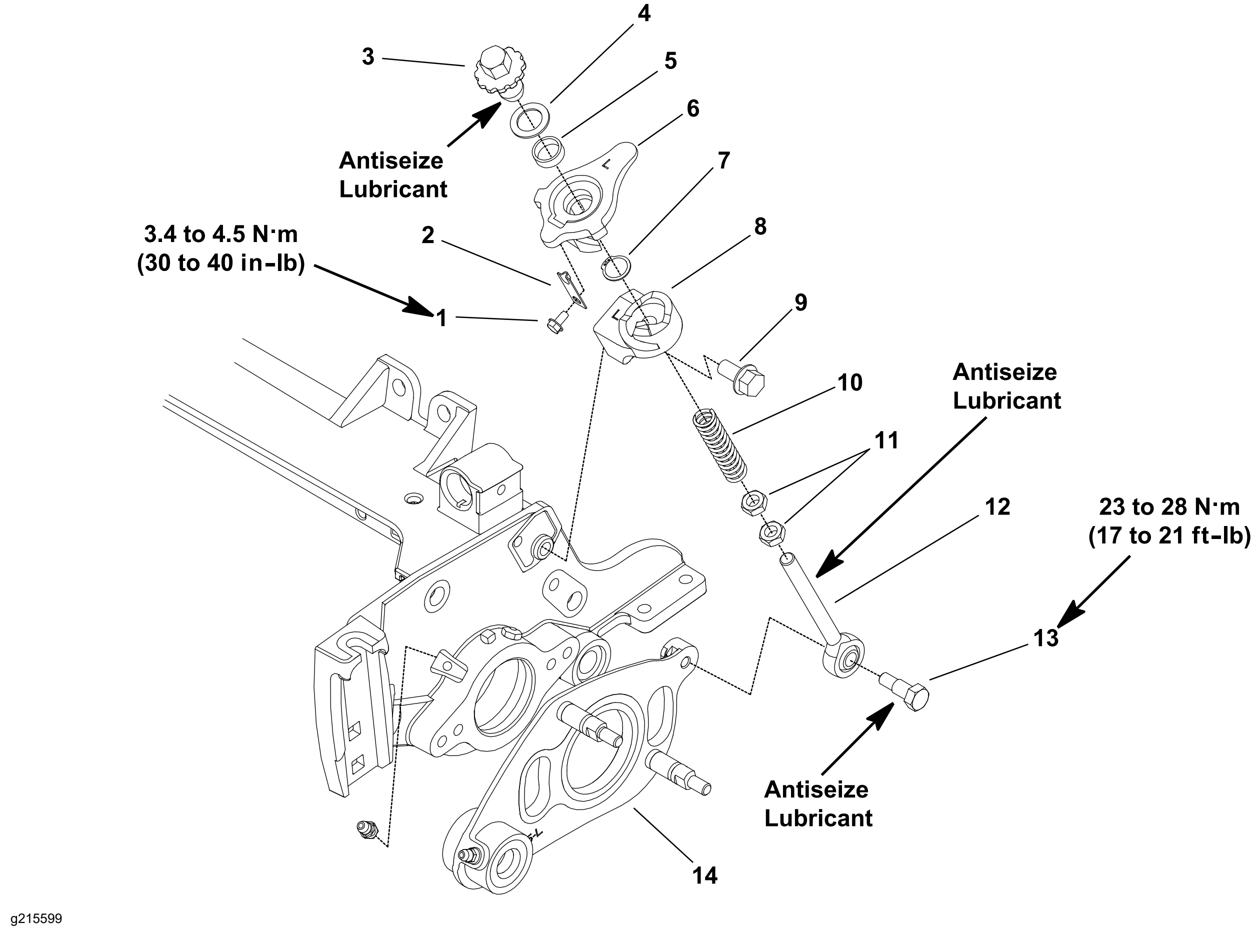

Figure 396

1. Washer-head screw
2. Detent spring
3. Groomer adjuster
4. Flat washer
5. Bushing
6. Upper ramp
7. External snap ring
8. Lower ramp
9. Flange-head screw
10. Compression spring
11. Jam nut (2 each)
12. Ball joint rod
13. Shoulder bolt
14. Groomer plate (left drive)

Note: The groomer reel drive is located on the opposite side of the cutting unit from the cutting reel hydraulic motor. Figure 396 shows the components used when the groomer reel drive is on the left side of the cutting unit.

Disassembling the Height Adjuster Assembly

1. Park the machine on a clean and level surface, lower the cutting units completely to the ground, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Disassemble the height adjuster as shown in Figure 396.
3. Clean all the components and inspect for wear or damage. Replace all the components that are worn or damaged.

Assembling the Height Adjuster Assembly

1. Assemble the height adjuster (Figure 396) noting the following items:
   A. If the bushing (item 5 in Figure 396) was removed from the upper ramp, press a new bushing into the housing fully to the shoulder in the bore.
   B. If the 2 jam nuts (item 11 in Figure 396) were removed from the ball joint rod, apply anti-seize lubricant to the threads of the rod where the jam nuts will be positioned. Install the 2 jam nuts so that the distance from the end of the ball joint rod to the bottom of the lower nut is 8.1 to 8.4 cm (3.190 to 3.310 inches).
   C. Apply anti-seize lubricant to the threads of the groomer adjuster (item 3 in Figure 396) before you install it on the threads of the ball joint rod.
   D. If the detent spring (item 2 in Figure 396) was removed, secure the detent spring to the upper ramp with the washer-head screw; torque the screw to **3.4 to 4.5 N·m (30 to 40 in-lb)**.
2. Apply anti-seize lubricant to the shoulder of the shoulder bolt (item 13 in Figure 396) that secure the ball joint rod to the groomer plate. Install the shoulder bolt and torque the bolt to **23 to 28 N·m (17 to 21 ft-lb)** to secure the ball joint rod.
3. Check the groomer reel height and adjust as necessary.
4. After the groomer height has been adjusted, adjust the location of the jam nuts so that the compression spring length is 3.4 to 3.6 cm (1.320 to 1.440 inches) when the groomer handle is in the disengaged position (handle toward the rear of the cutting unit).

Servicing the Grooming Brush (Optional)

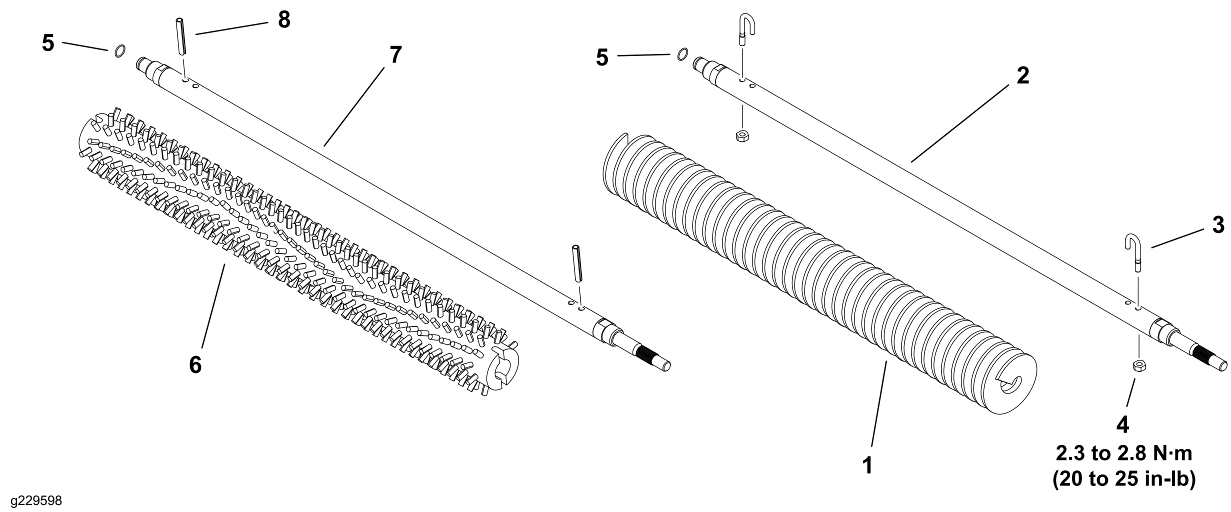

Figure 397

1. Spiral brush
2. Spiral brush shaft
3. J-bolt (2 each)
4. Locknut (2 each)
5. O-ring
6. Grooming brush
7. Grooming brush shaft
8. Roll pin (2 each)

The optional grooming brush attaches to the groomer in place of the groomer reel. The grooming brush is removed and installed from the groomer in the same manner as the groomer reel; refer to Groomer Reel (page 10–15).

The grooming brush elements or shafts can be serviced separately (Figure 397).

To remove the spiral grooming brush from the shaft, remove the locknut 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, ensure that the J-bolts are

Servicing the Grooming Brush (Optional) (continued)

installed with the threaded portion on the outside of the brush and tighten the locknuts to **2.3 to 2.8 N·m (20 to 25 in-lb)**.

Chapter 11

Universal Groomer (Optional)

Table of Contents

General Information

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 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 instruction before operating or testing the groomer performance.

It is important to remember that factors affecting quality of cut also affect grooming performance.

Variables that Affect the Use and Performance of the Groomers:

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

Groomer Reel Mechanical Problems

Problem	Possible Causes	Correction
The groomer reel does not rotate.	The groomer drive is in neutral.	Engage the groomer drive to forward or reverse.
	The groomer drive gears are damaged or seized.	Repair the groomer drive.
The turf is damaged or has uneven grooming.	The groomer is set too aggressively.	Refer to groomer *Installation Instructions* for groomer set-up information.
	The groomer reel blades are bent, damaged, or missing.	Repair or replace the blades if necessary.
	The groomer reel shaft is bent or damaged.	Replace the groomer reel shaft.
	Grooming depth is not equal on both ends of the groomer reel.	Adjust the depth if necessary. Check and adjust the cutting unit set up (level bed knife to reel, level rear roller to reel, set the height-of-cut, etc.).

Service and Repairs

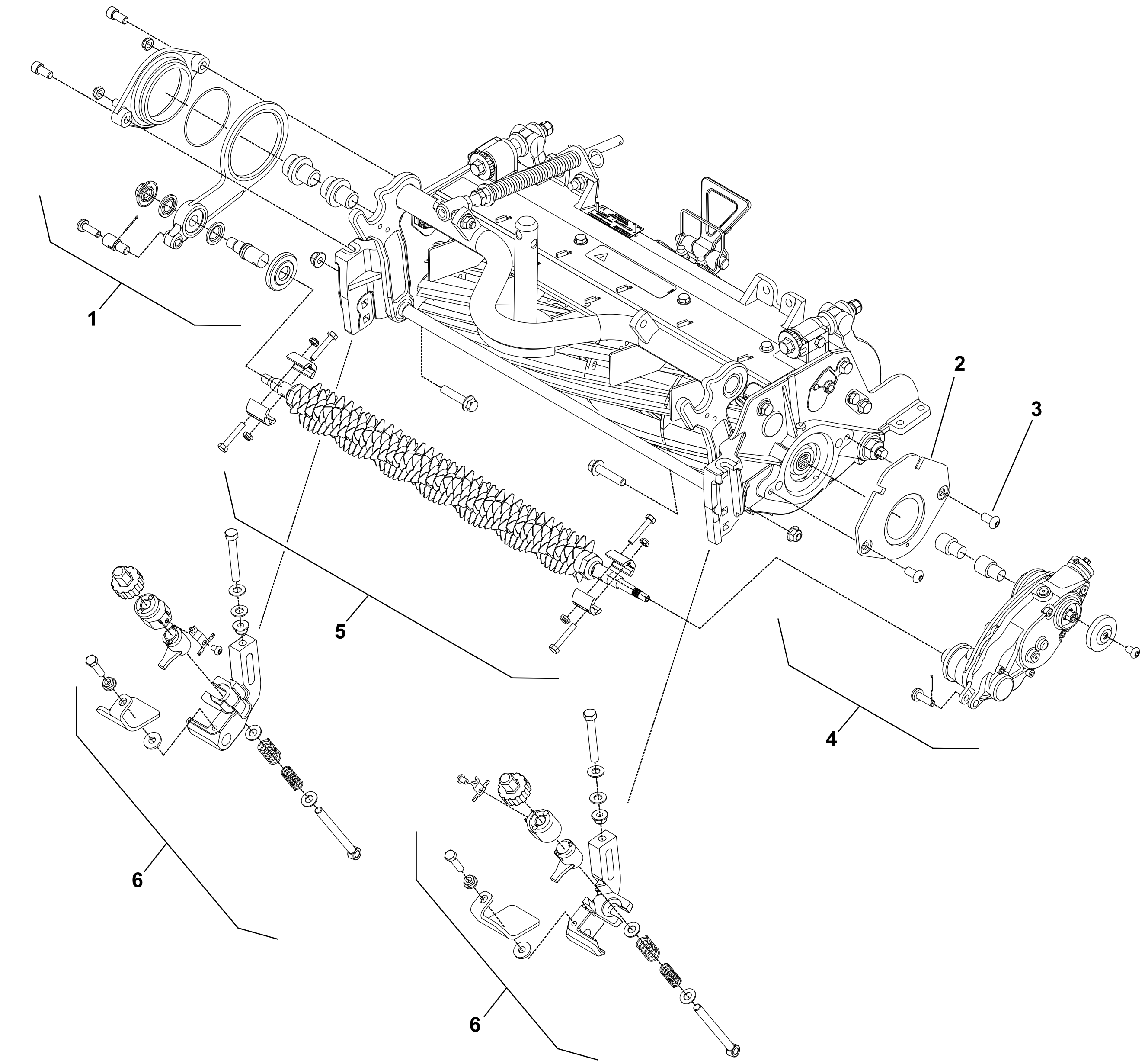

Figure 398

1. Idler assembly
2. Weight bracket
3. Button-head screw (2 each)
4. Gear box assembly
5. Groomer reel
6. Height adjuster assembly (2 each)

CAUTION

Do not work on the groomer with the engine running.

Always shut off the engine, remove the key from the key switch, and wait for all machine movement to stop before working on the groomer.

Note: The *Groomer Operator's Manual* provides information regarding the installation, set-up, operation, and maintenance of the universal groomer on your machine. Refer to these instructions for additional information when servicing the groomer.

Gear Box Assembly

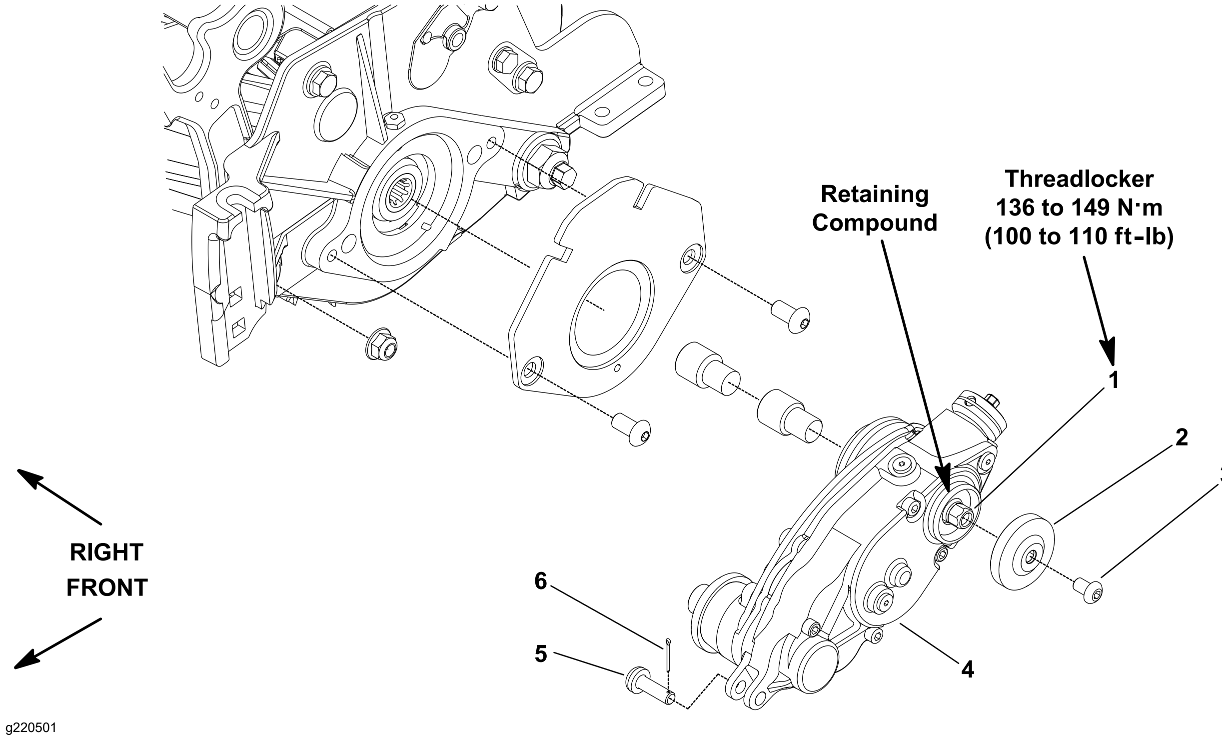

Figure 399

1. Input shaft
2. Rear roller brush drive shield
3. Button-head screw
4. Groomer drive box assembly
5. Clevis pin
6. Cotter pin

Note: 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, shut off the engine, 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 11–17).

   Note: If the cutting unit is equipped with an optional powered rear roller brush, remove the rear roller brush cover, drive belt, and drive housing assembly to service the groomer drive; refer to Rear Roller Brush – Optional (cutting units with painted side plates) (page 9–56) for additional information.

⚠ CAUTION ⚠

Contact with the reel or other cutting unit parts can result in personal injury.

Use heavy gloves when handling the cutting reel.

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3. Safely prevent the reel from rotating by blocking the cutting reel with a piece of wood near one of the reel spiders.
4. If installed, remove the rear roller brush drive shield from the gear box.

Removing the Gear Box Assembly (continued)

IMPORTANT

The groomer gear box installed on the left side of the cutting unit use a left-hand thread. Turn the input shaft (rear roller brush driveshaft) clockwise to remove the gear box. The groomer gear box installed on the right side of the cutting unit use a right-hand thread. Turn the input shaft counterclockwise to remove the gear box.

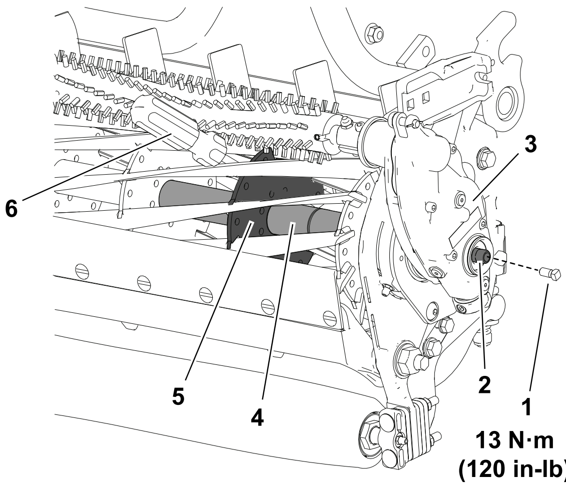

Figure 400

1. Square head set screw
2. Input shaft assembly
3. Gear box assembly
4. Reel shaft
5. Reel support plate
6. Pry bar

5. Install a 5/16–18 X 5/8 inch square head set screw (Toro p/n 1-803022) in the end of the drive shaft and tighten to **13 N·m (120 in-lb)**; refer to Figure 400.
6. Remove the cotter pin and clevis pin from the height adjustment rod at the front of the groomer gear box. Discard cotter pin.
7. Tip up the cutting unit to access the bottom of the reel to remove the drive shaft assembly.
8. Insert a long-handled pry bar (3/8 x 12 inch with screwdriver handle recommended) through the bottom of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

IMPORTANT

To avoid grinding the reel, do not contact the cutting edge of any blade with the pry bar as this may damage the cutting edge and/or cause a high blade.

9. Move the pry bar against the weld side of the reel support plate closest to the groomer gear box.

Removing the Gear Box Assembly (continued)

IMPORTANT

You must use a 6-point socket with a heavy wall to remove the gear box from the reel. Do not use an impact wrench. Groomer gear boxes installed on the left side of the cutting unit use a left hand thread; turn the drive shaft in correct direction to remove the gear box.

10. Rest the handle of the pry bar against the front roller and turn the drive shaft in correct direction to loosen it from the reel. Continue to unscrew the drive shaft and remove the gear box from the cutting unit.

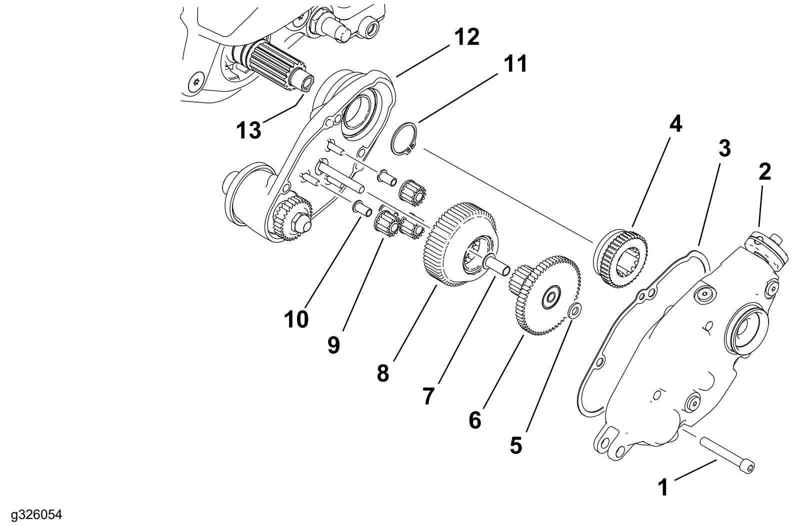

Figure 401

1. Socket head screw (4)
2. Gear box cover assembly
3. Cover gasket
4. Driven gear
5. Thrust washer
6. Ring gear
7. Flange bushing
8. Sun gear
9. Planet gear (3)
10. Flange bushing
11. Retaining ring
12. Gear box housing assembly
13. Damaged drive shaft

11. If the hex head on the end of the drive shaft is damaged during removal:
    A. Remove the drain/fill plug and drain the oil from the gear box.
    B. Remove the 4 socket-head screws and remove the gear box cover assembly and driven gear. Remove and discard the cover gasket.
    C. Slide the thrust washer, ring gear and bushing from the gear box housing.
    D. Slide the sun gear, and planet gears and bushings from the pins on the gear box housing.
    E. Remove the retaining ring from the drive shaft.
    F. Slide the groomer housing assembly from the drive shaft.
    G. Tip up the cutting unit to access the bottom of the reel to remove the drive shaft assembly.
    H. Insert a long-handled pry bar (3/8 x 12 inch with screwdriver handle recommended) through the bottom of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

Removing the Gear Box Assembly (continued)

IMPORTANT

To avoid grinding the reel, do not contact the cutting edge of any blade with the pry bar as this may damage the cutting edge and/or cause a high blade.

I. Move the pry bar against the weld side of the reel support plate closest to the drive shaft assembly.

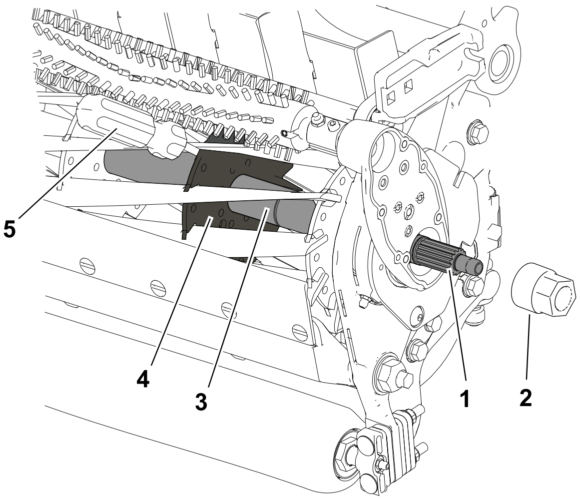

Figure 402

1. Damaged input shaft assembly
2. Drive shaft removal tool
3. Reel shaft
4. Reel support plate
5. Pry bar

J. Use the drive shaft removal tool (Toro p/n 137-0920) on the large flats of the drive shaft assembly; refer to Figure 402.

K. Rest the handle of the pry bar against the front roller and turn the drive shaft in correct direction to loosen it from the reel.

12. Tip the cutting unit back onto its rollers.
13. Clean the threads in the end of the reel shaft. A right– hand thread and left-hand thread tap is available to clean or repair the threads if necessary:
    - 15/16–16 Right-Hand Thread – Toro p/n. **137–0926**
    - 15/16–16 Left-Hand Thread – Toro p/n. **137–0927**

Disassembling the Groomer Drive Assembly

The gear box assembly have 2 additional idler gear assemblies (item 44 in Figure 403).

1. If necessary, remove the input shaft adapter (item 20 in Figure 403).
2. Remove the drain/fill plug (item 5 in Figure 403) and drain the oil from the gear box.
3. Remove the 4 socket-head screws (item 37 in Figure 403) and separate the gear box cover and housing.
4. Remove and discard the cover gasket.
5. Slide the sun gear (item 10 in Figure 403), ring gear, and planet gears from the pins on the gear box housing.

Disassembling the Groomer Drive Assembly (continued)

6. 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 adapter removal. Do not use the 1/2 inch hex on the input shaft to secure the shaft during adapter removal or input shaft damage may occur.

---

7. If the drive adapter requires replacement, apply high strength threadlocker (loctite 243 or equivalent) to the 5/8 inch threads of the drive adapter and tighten the adapter to **150 to 173 N·m (110 to 120 ft-lb)**.
8. Carefully clean all the gasket material from the gear box housing and cover.
9. Inspect the V-ring (item 17 in Figure 403), seals, bearings, gears, and bushings in the gear box assembly. Replace the damaged or worn components as necessary.

Assembling the Groomer Drive Assembly

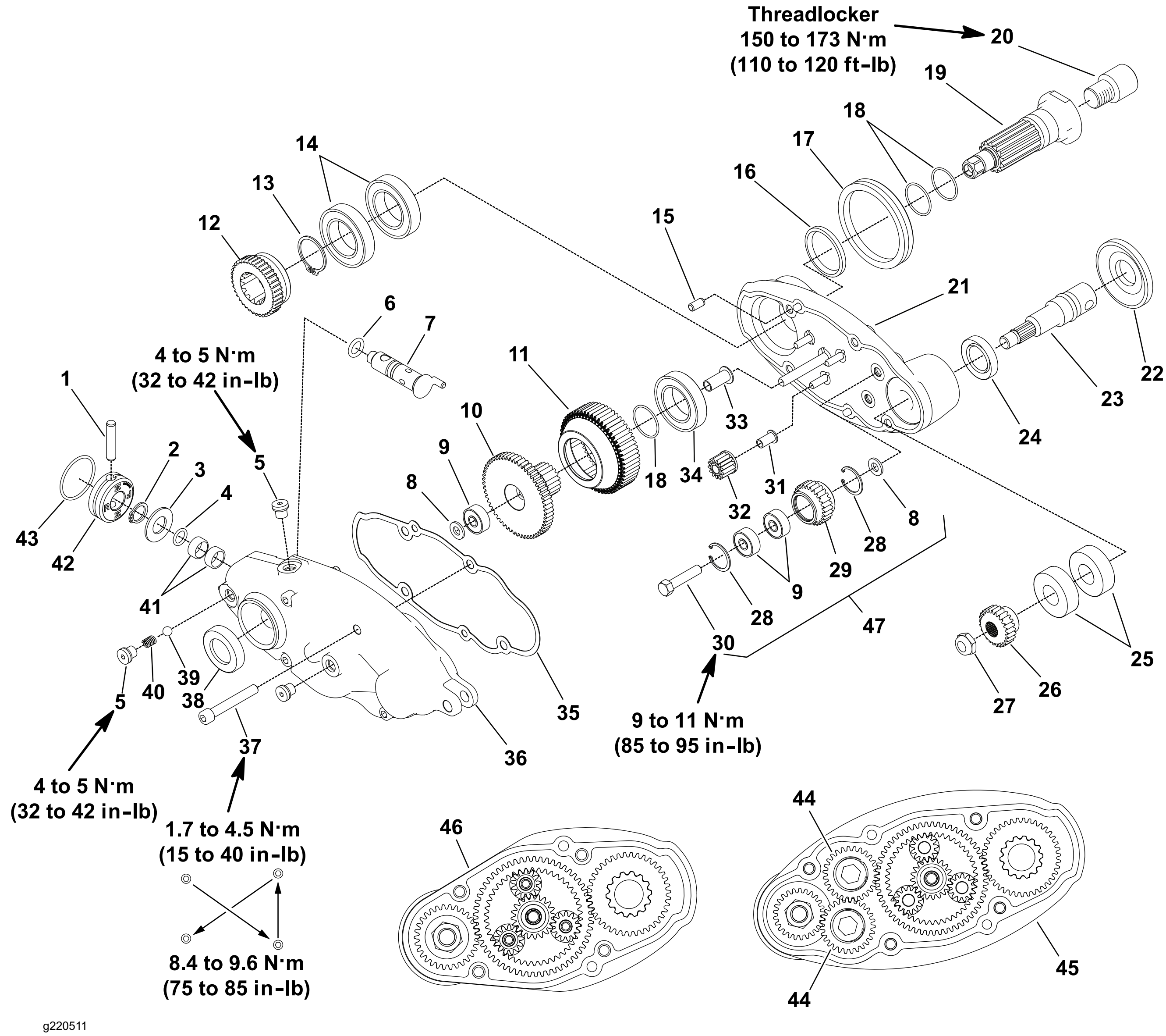

Figure 403

1. Dowel pin
2. Retaining ring
3. Thrust washer
4. O-ring
5. Drain/fill plug (4 each)
6. O-ring
7. Shifter shaft
8. Thrust washer
9. Bearing (3 each)
10. Sun gear
11. Ring gear
12. Slider gear
13. Retaining ring
14. Bearing (2 each)
15. Dowel pin (2 each)
16. Oil seal
17. V-ring
18. O-ring (2 each)
19. Input shaft
20. Threaded adapter
21. Housing
22. Shield
23. Output shaft
24. Oil seal
25. Bearing (2 each)
26. Output gear
27. Locknut
28. Retaining ring (2 each)
29. Idler gear (2 each)
30. Bolt (2 each)
31. Bushing (3 each)
32. Planet gear (3 each)
33. Bushing
34. Bearing
35. Gasket
36. Cover
37. Socket-head screw (4 each)
38. Oil seal
39. Detent ball
40. Detent spring
41. Bushing (2 each)
42. Knob
43. O-ring
44. Idler gear (2 each)
45. Gear box assembly (7 inch reel cutting units)
46. Gear box assembly (5 inch reel cutting units)
47. 7 inch reel cutting units only

Assembling the Groomer Drive Assembly (continued)

1. If the sun gear (item 10 in Figure 403), ring gear, or the gear box housing bearings are replaced, press the bearings all the way to shoulder in part.
2. If the flange bushings are replaced, ensure that the flange bushing is fully seated against the part.
3. Ensure that all the retaining rings and O-rings are fully seated in the ring groove.
4. Lubricate the seal lips and O-rings before installing the shafts.
5. If the idler gear assemblies were removed, tighten the idler gear bolt to **9 to 11 N·m (85 to 95 in-lb)**.
6. Lubricate the planet gear and sun gear pins in the gear box housing with the gear oil and install the planet, ring, and sun gears.
7. Clean the gasket surface on the gear box housing and cover with the solvent and install new gasket.
8. Fit the gear box cover over dowel pins and install the 4 socket-head screws. Tighten the screws to **1.7 to 4.5 N·m (15 to 40 in-lb)**. In an alternating cross pattern, tighten the screws to **8.4 to 9.6 N·m (75 to 85 in-lb)**.
9. Fill the gear box with 80W−90 gear oil and tighten the drain/fill plug to **4 to 5 N·m (32 to 42 in-lb)**.

   The gear box oil capacity for reel cutting units is **90 ml (3 fl oz)**.

CAUTION

Use the 1−3/8 inch flats on the input shaft to prevent the input shaft from rotating during adapter installation. Do not use the 1/2 inch hex on the input shaft to secure the shaft during adapter installation or input shaft damage may occur.

10. If removed, install the threaded adapter in the input shaft. If using a previously installed adapter, apply medium strength threadlocker to the smaller (5/8–11) threads only. Tighten the threaded adapter to **150 to 173 N·m (110 to 120 ft-lb)**.
11. 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, shut off the engine, 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 cutting reel.

2. Safely prevent the reel from rotating by blocking the cutting reel with a piece of wood near one of the reel spiders.

Installing the Gear Box Assembly (continued)

IMPORTANT

The groomer gear box installed on the left side of the cutting unit use a left-hand thread. Turn the input shaft (rear roller brush driveshaft) counterclockwise to install the gear box. The groomer gear box installed on the right side of the cutting unit use a right-hand thread. Turn the input shaft clockwise to install the gear box.

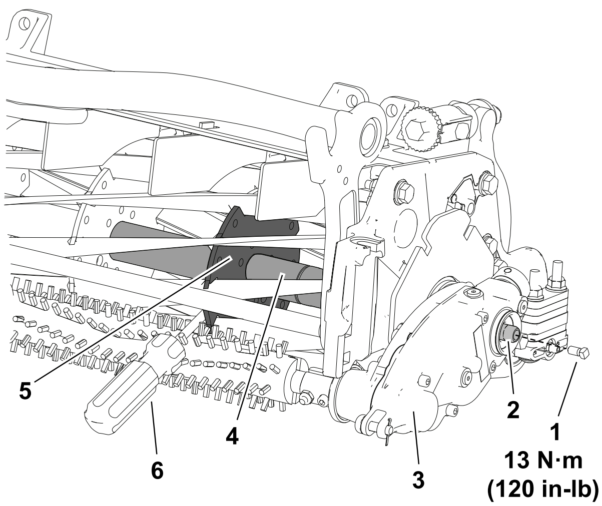

Figure 404

1. Square head set screw
2. Input shaft assembly
3. Gear box assembly
4. Reel shaft
5. Reel support plate
6. Pry bar

3. Insert a long-handled pry bar through the front of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.
4. Move the pry bar against the weld side of the reel support plate closest to the gear box assembly and rest the handle of the pry bar against the front roller.
5. Position the gear box assembly against the cutting unit and turn the drive shaft assembly in correct direction until it is seated against the reel.

IMPORTANT

You must use a 6-point socket with a heavy wall to install the gear box to the reel. Do not use an impact wrench. Groomer gear boxes installed on the left side of the cutting unit use a left hand thread; turn the drive shaft in correct direction to install the gear box.

6. Tighten the input shaft to **136 to 149 N·m (100 to 110 ft-lb)**.
7. Remove the square head set screw from the end of the drive shaft.
8. Use a new cotter pin and install the cotter pin and clevis pin securing the height adjustment rod to the front of the groomer gear box.
9. Install the rear roller brush drive shield if previously removed.

Installing the Gear Box Assembly (continued)

Note: If the cutting unit is equipped with an optional powered rear roller brush, install the rear roller brush drive housing assembly, drive belt, and cover; refer to Rear Roller Brush – Optional (cutting units with painted side plates) (page 9–56) for additional information.

10. Install the groomer reel assembly; refer to Installing the Groomer Reel (page 11–18).

Idler Assembly

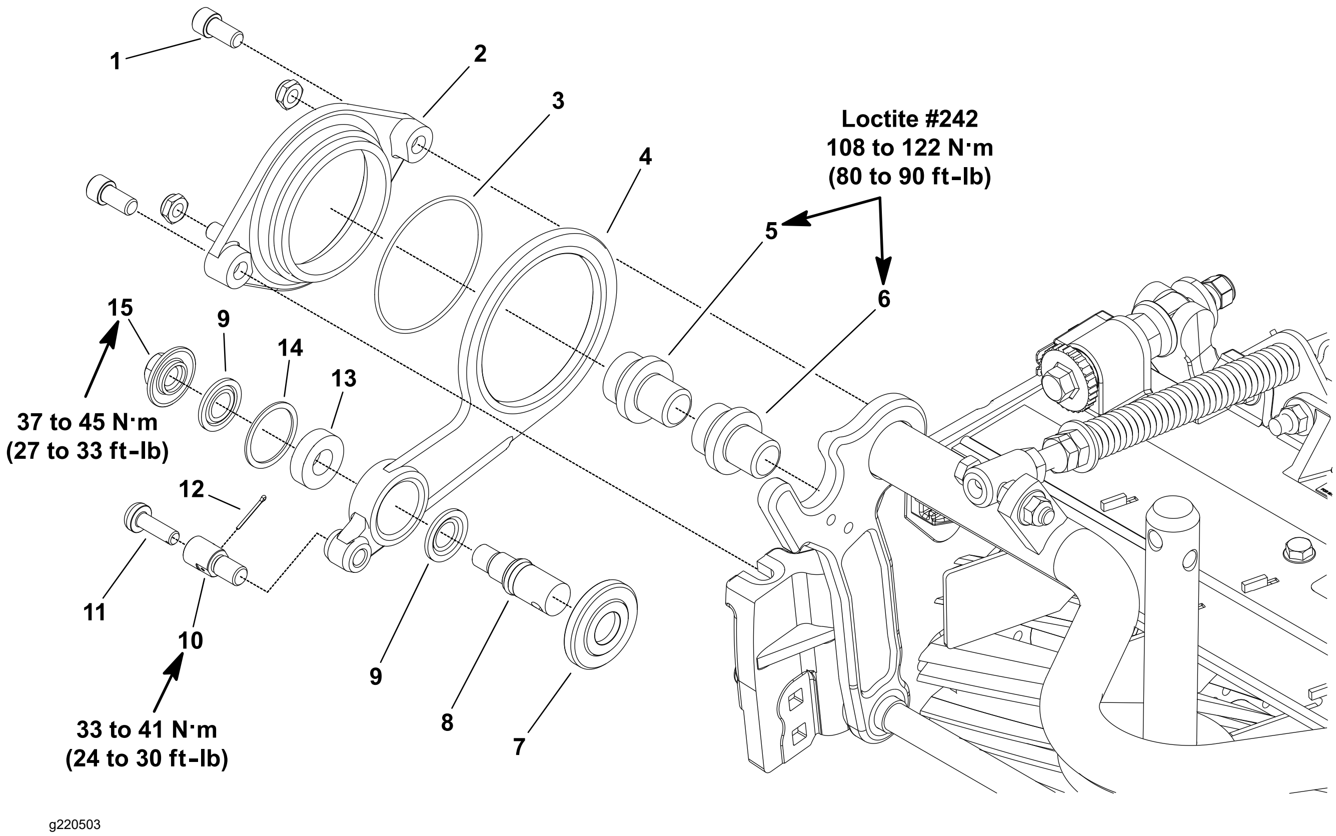

Figure 405

1. Socket-head screw (2 each)
2. Pivot hub
3. O-ring
4. Idler arm
5. Threaded insert (left)
6. Threaded insert (right)
7. Shield
8. Stub shaft
9. Flocked bearing shield (2 each)
10. Collar
11. Clevis pin
12. Cotter pin
13. Bearing
14. Retaining ring
15. Flange nut

Note: The groomer idler assembly is located on the same side of the cutting unit as the cutting unit hydraulic motor.

Removing the Idler Assembly

1. Park the machine on a clean and level surface, lower the cutting units completely to the ground, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the hydraulic reel motor from the cutting unit; refer to Removing the Hydraulic Reel Motor (page 9–17).
3. Remove the groomer reel assembly; refer to Removing the Groomer Reel (page 11–17).
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 2 socket-head screws (item 1 in Figure 405) that secure the pivot hub to the cutting unit, and remove the pivot hub and idler assembly from the cutting unit.
6. Inspect the shields, bearing, and bushing in the idler assembly. Remove and discard the components that are worn or damaged.

Installing the Idler Assembly

1. If the shields, bearing, or bushing was removed from the idler arm, install new components as follows:

   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 flocked side of shield toward the bearing.

   D. Check the idler arm orientation (left or right cutting unit) and insert the stub shaft (item 8 in Figure 405) through shields and bearing. Use the through hole in the shaft to prevent shaft from rotating, tighten the flange nut to **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 to **33 to 41 N·m (24 to 30 ft-lb)**.

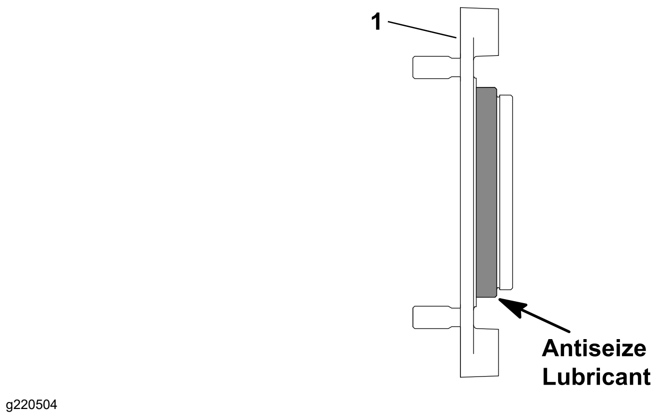

Figure 406

1. Pivot hub

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2. Apply anti-seize lubricant to the outside diameter of the pivot hub (Figure 406). Position the idler arm over the pivot hub.
3. Apply Loctite to the 2 socket-head screws and secure the pivot hub and idler arm to the cutting unit side plate.
4. Install a new cotter pin and clevis pin and secure the height adjustment rod to the front of the idler arm.
5. Install the hydraulic reel motor to the cutting unit; refer to Installing the Hydraulic Reel Motor (page 9–17).

Groomer Reel

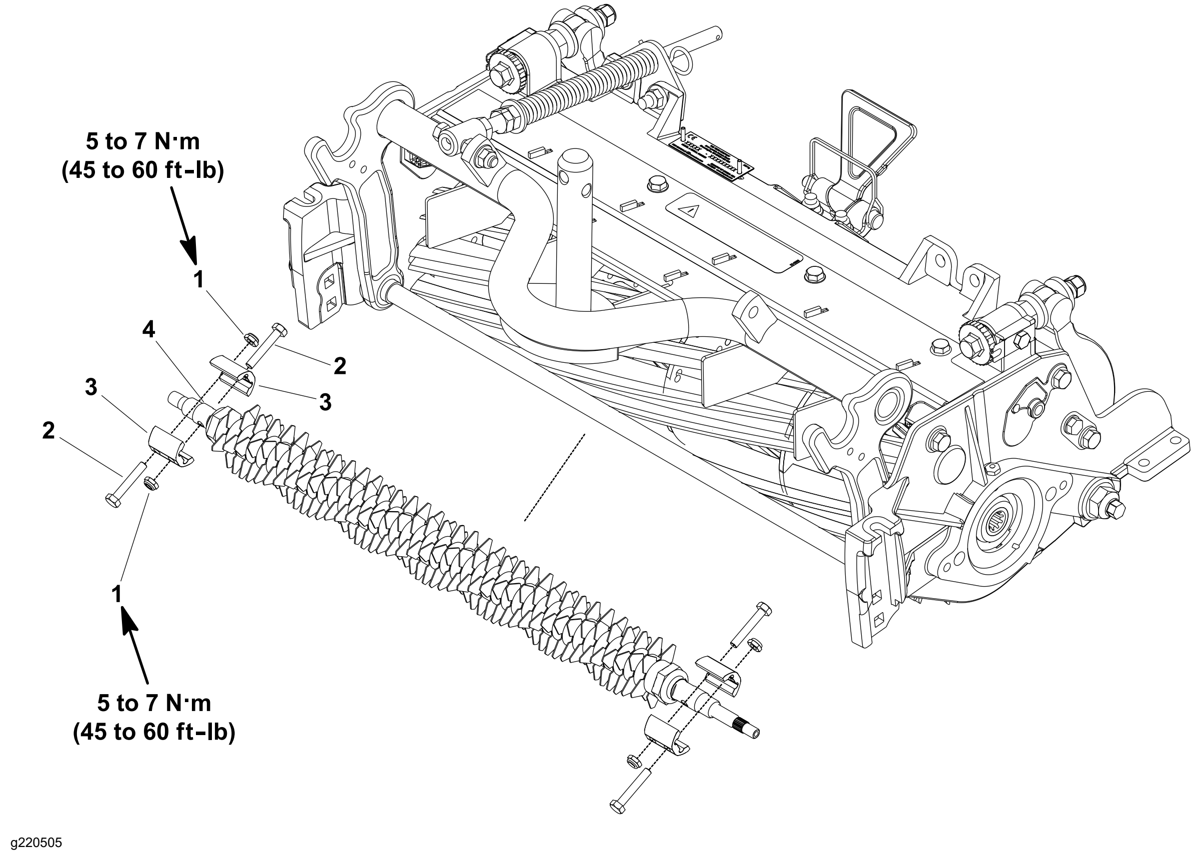

Figure 407

1. Jam nut (4 each)
2. Bolt (4 each)
3. Shaft clamp (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, shut off the engine, set the parking brake, and remove the key from the key switch. If necessary, remove the cutting unit from the machine; refer to the *Traction Unit Operator's Manual*.

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 (item 1 in Figure 407), 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 seal, shields, bushing, and bearings for wear or damage. Replace the components as necessary; refer to Gear Box Assembly (page 11–6) and Idler Assembly (page 11–15).

Installing the Groomer Reel

1. Position the cutting unit on a level surface. If the cutting unit is attached to the traction unit, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Position the groomer reel between the groomer output and stub shafts.
3. Secure the groomer reel to the cutting unit with the 4 jam nuts, 4 bolts, and 4 shaft clamps; torque the bolts to **5 to 7 N·m (45 to 60 in-lb)**.
4. Check the groomer reel height and mower height-of-cut settings. Adjust as necessary.

Servicing the Groomer Reel

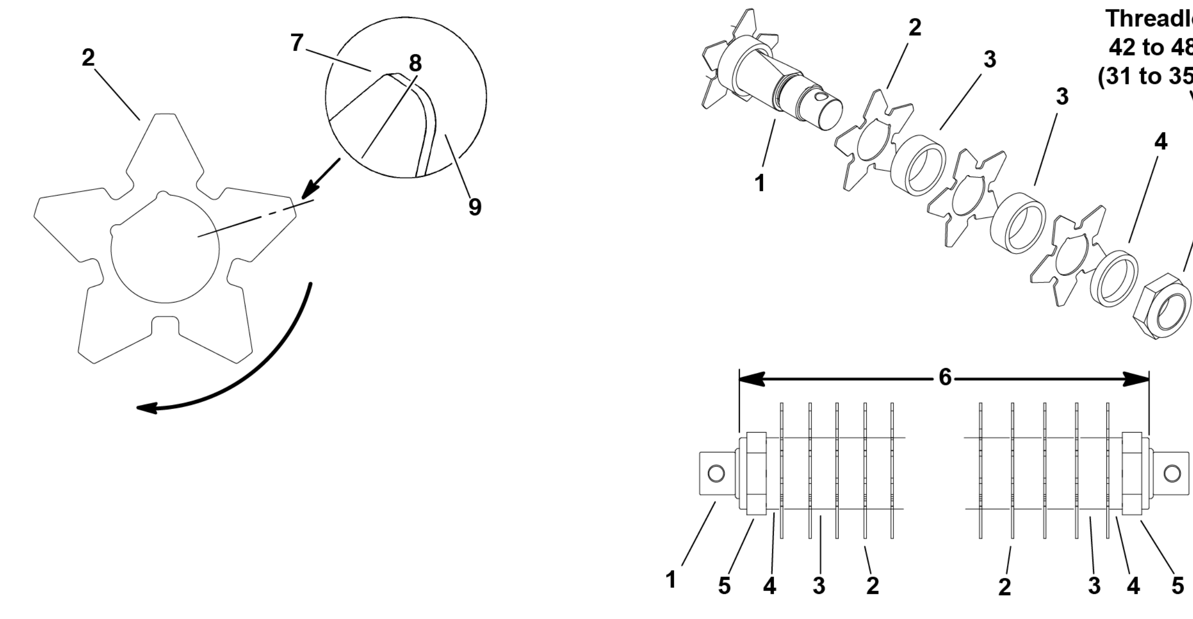

Figure 408

1. Groomer reel shaft
2. Groomer blade (40 each)
3. 31.7 mm (1–1/4 inch) spacer (39 each)
4. 6.3 mm (1/4 inch) spacer (2 each)
5. Locknut (2 each)
6. Centered on shaft
7. Sharp edge
8. Midpoint
9. Dull (rounded) edge

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 (Figure 408). The blades that are rounded to the midpoint of the blade tip must be reversed or replaced for best groomer performance.

Disassembling the Groomer Reel

1. Park the machine on a clean and level surface, lower the cutting units completely to the ground, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the groomer reel from the cutting unit; refer to Groomer Reel (page 11–17).
3. If the groomer reel is equipped with broomer kit, remove the straps and broomer brushes from the reel (Figure 409).
4. Remove the locknut (item 5 in Figure 408) from either end of the shaft.
5. Remove the spacers and blades from the groomer shaft. If necessary, remove second locknut from the shaft.
6. Inspect and replace the components that are worn or damaged.

Assembling the Groomer Reel

Note: New locknuts have an adhesive patch to prevent the locknut from loosening. If a used locknut is being installed, apply a medium strength threadlocker (Loctite #243 or equivalent) to the threads of the locknut.

1. Install the locknut on drive end of the groomer shaft. Place a 6.3 mm (1/4 inch) spacer on the groomer shaft followed by the first groomer blade.

2. Alternately install 31.7 mm (1−1/4 inch) spacers and blades, ensure that all the blades are separated by a spacer.
3. When all the blades have been installed, place the remaining 6.3 mm (1/4 inch) spacer on the shaft. Install the second locknut onto the shaft. Center the blades on shaft by adjusting locknuts.
4. Use the through holes in shaft to prevent the shaft from rotating, tighten the second locknut to **42 to 48 N·m (31 to 35 ft-lb)**. After tightening the locknut, spacers should not be free to rotate and the groomer blades should be centered on the shaft.
5. If the groomer reel is equipped with the broomer kit:
   A. Loosen the groomer blade retaining nuts on each end of the groomer shaft.

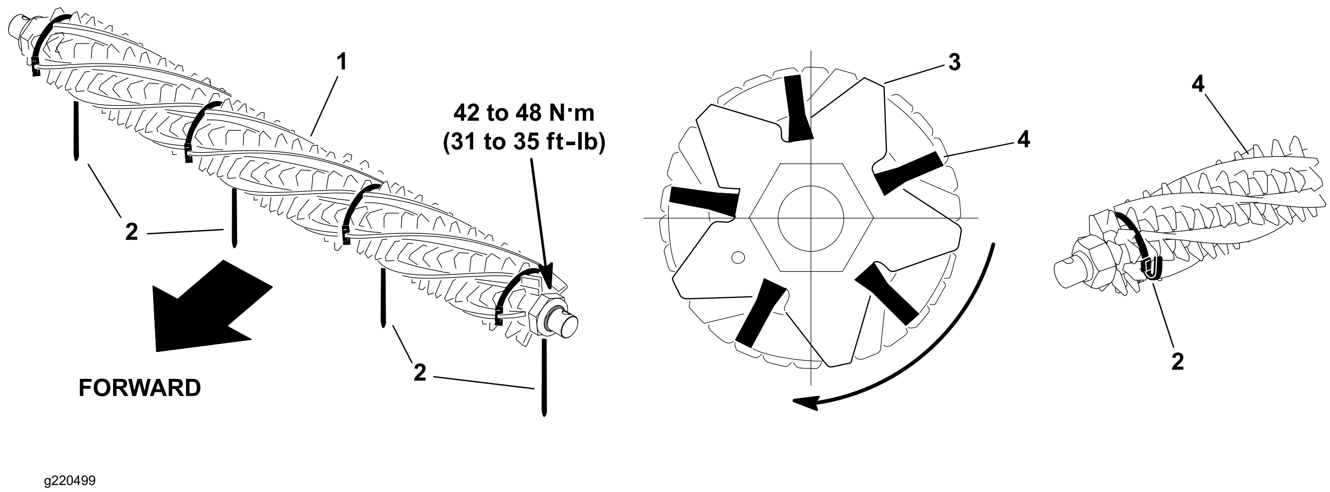

Figure 409

1. Groomer reel
2. Broomer strap (4 each)
3. Blade
4. Brush

   B. Slide a brush into each groove around the full length of the groomer reel. Ensure that the brushes are seated in groomer blade slots (Figure 409).

IMPORTANT

The straps must be wrapped around the groomer blade and brush assembly in the correct direction.

   C. Loosely wrap the straps around the groomer reel shaft and brushes as shown in Figure 409. The straps should be positioned in the pre-cut notches of each brush between the blades 2-3, 14-15, 26-27, and 38-39.

   Position the broomer brushes properly in the blade slots, and tighten the groomer blade—retaining nuts to **42 to 48 N·m (31 to 35 ft-lb)**.

   D. While holding strap buckle in place, pull the straps tight into the pre-cut notches of each brush.

   E. Cut off the strap extension approximately 6 mm (0.25 inch) beyond the retainer and fold the excess strap over the buckle (Figure 409).

6. Install the O-ring on the non-drive end of the groomer shaft.
7. Install the groomer reel back onto the cutting unit; refer to Groomer Reel (page 11–17).

Height Adjuster Assembly

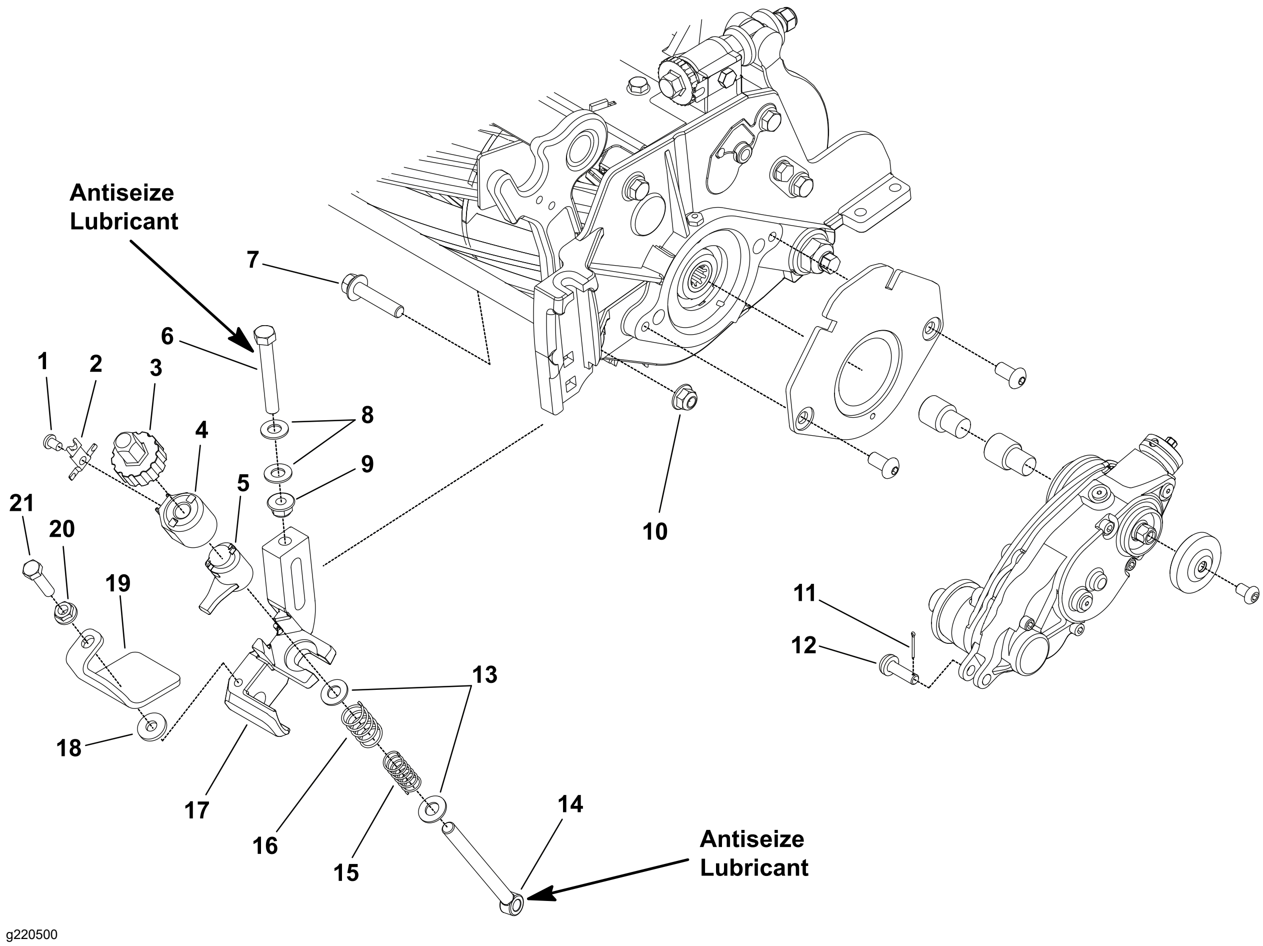

Figure 410

1.	Button-head screw	8.	Washer (2 each)	15.	Compression spring
2.	Detent spring	9.	Locknut	16.	Compression spring
3.	Height adjuster knob	10.	Flange nut	17.	Height-of-cut bracket
4.	Quick up cover	11.	Cotter pin	18.	Flat washer
5.	Quick up lever	12.	Clevis pin	19.	Groomer bumper (left)
6.	Height adjustment bolt	13.	Washer (2 each)	20.	Locknut
7.	Flange-head bolt	14.	Height adjustment rod	21.	Pinch bolt (front roller)

Disassembling the Height Adjuster Assembly

1. Park the machine on a clean and level surface, lower the cutting units completely to the ground, shut off the engine, set the parking brake, and remove the key from the key switch.
2. 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.
3. Loosen the 2 height adjustment bolt locknuts.
4. Loosen the 2 front roller pinch bolt locknuts and bolts.
5. Remove the flange nut (item 10 in Figure 410) and flange-head bolt that secure the height adjuster assembly to the cutting unit side plate, and remove the front roller and height adjuster from the cutting unit.

Disassembling the Height Adjuster Assembly (continued)

6. Disassemble the height adjuster assembly (Figure 410).
7. Clean all the components and inspect for wear or damage. Replace all the components that are worn or damaged.

Assembling the Height Adjuster Assembly

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 (Figure 410).
2. If both the height adjusters are removed, fit 1 height adjuster assembly to the cutting unit side plate and secure it with the flange-head bolt and flange nut. Do not tighten the flange nut at this time. Ensure that the height adjustment bolt and 1 washer is above the slot in the side plate and 1 washer and locknut is below the slot in the side plate.
3. Position front roller between the height adjuster assemblies and secure height adjuster assembly to cutting unit side plate with flange-head bolt and flange nut. Do not tighten the flange nut at this time. Ensure the height adjustment bolt and 1 washer is above slot in side plate and 1 washer and locknut is below slot in side plate.
4. Install new cotter pins and clevis pins and secure the height adjustment rods to the groomer gear box and idler arm.
5. Adjust the cutting unit height-of-cut; refer to *Cutting Unit Operators Manual*.
6. Check the groomer reel height and adjust as necessary.

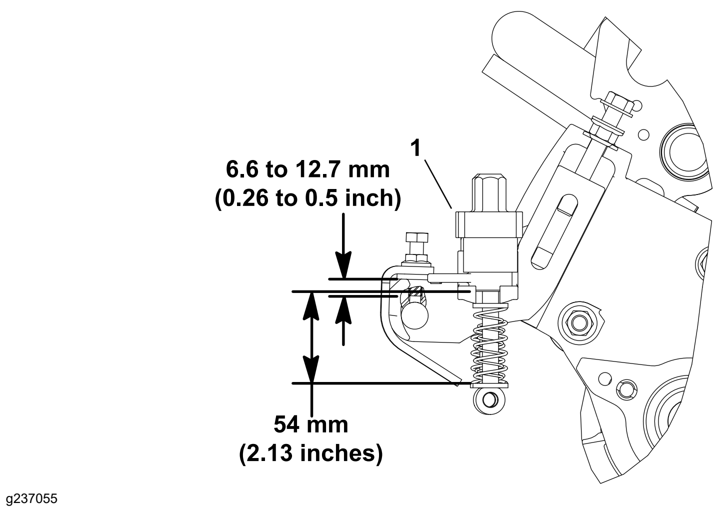

Figure 411

1. Height adjustment knob

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7. Thread the pinch bolts (item 21 in Figure 410) to 6.6 to 12.7 mm (0.26 to 0.5 inch) into the height-of cut bracket until the springs on the groomer height adjustment rods are compressed to 54 mm (2.13 inches).

Servicing the Grooming Brush (Optional)

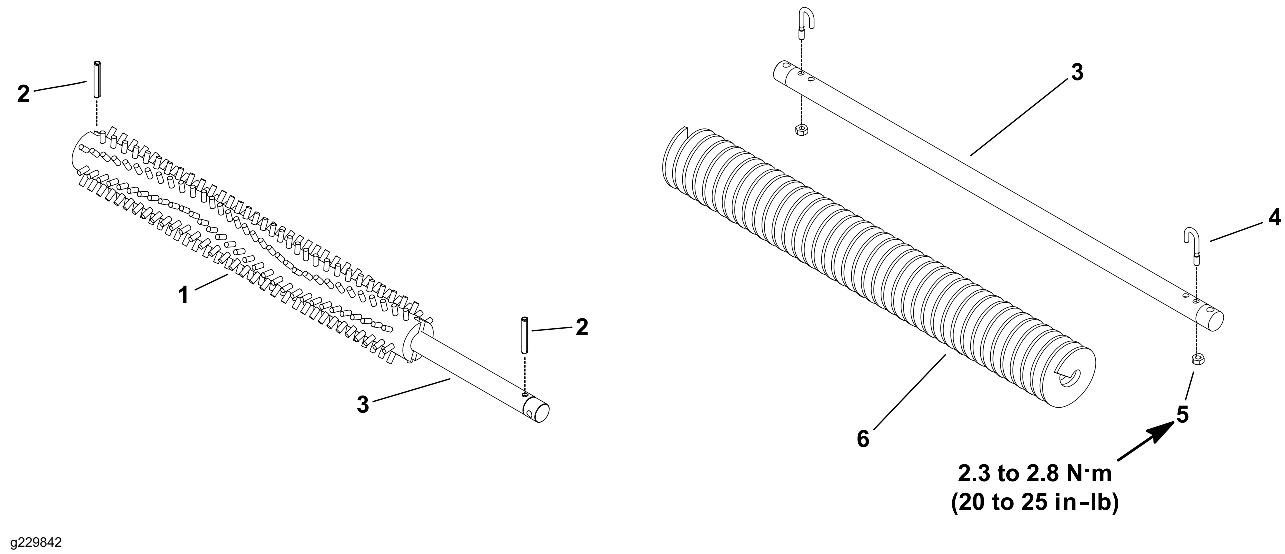


Figure 412

1. Brush element
2. Roll pin (2 each)
3. Brush shaft
4. J-bolt (2 each)
5. Locknut (2 each)
6. Spiral brush

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 Groomer Reel (page 11–17).

The grooming brush element or shaft can be serviced separately (Figure 412).

To remove the spiral grooming brush from the shaft, remove the locknut 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, ensure that the J-bolts are installed with the threaded portion on the outside of the brush and tighten the locknuts to **2.3 to 2.8 N·m (20 to 25 in-lb)**.

Foldout Drawings

Table of Contents

Electrical Drawing Designations

Note: A splice used in a wire harness will be identified on the wire harness diagram by SP. The manufacturing number of the splice is also identified on the wire harness diagram (e.g., SP01 is splice number 1).

Wire Color

The following abbreviations are used for wire harness colors on the electrical schematics and wire harness drawings in this chapter.

ABBREVIATION	COLOR
BK	BLACK
BR or BN	BROWN
BU	BLUE
GN	GREEN
GY	GRAY
OR	ORANGE
PK	PINK
R or RD	RED
T	TAN
VIO	VIOLET
W or WH	WHITE
Y or YE	YELLOW

Numerous harness wires used on the Toro machines include a line with an alternate color. These wires are identified with the wire color and line color with either a / or _ separating the color abbreviations listed above (e.g., R/BK is a red wire with a black line, OR_BK is an orange wire with a black line).

Wire Size

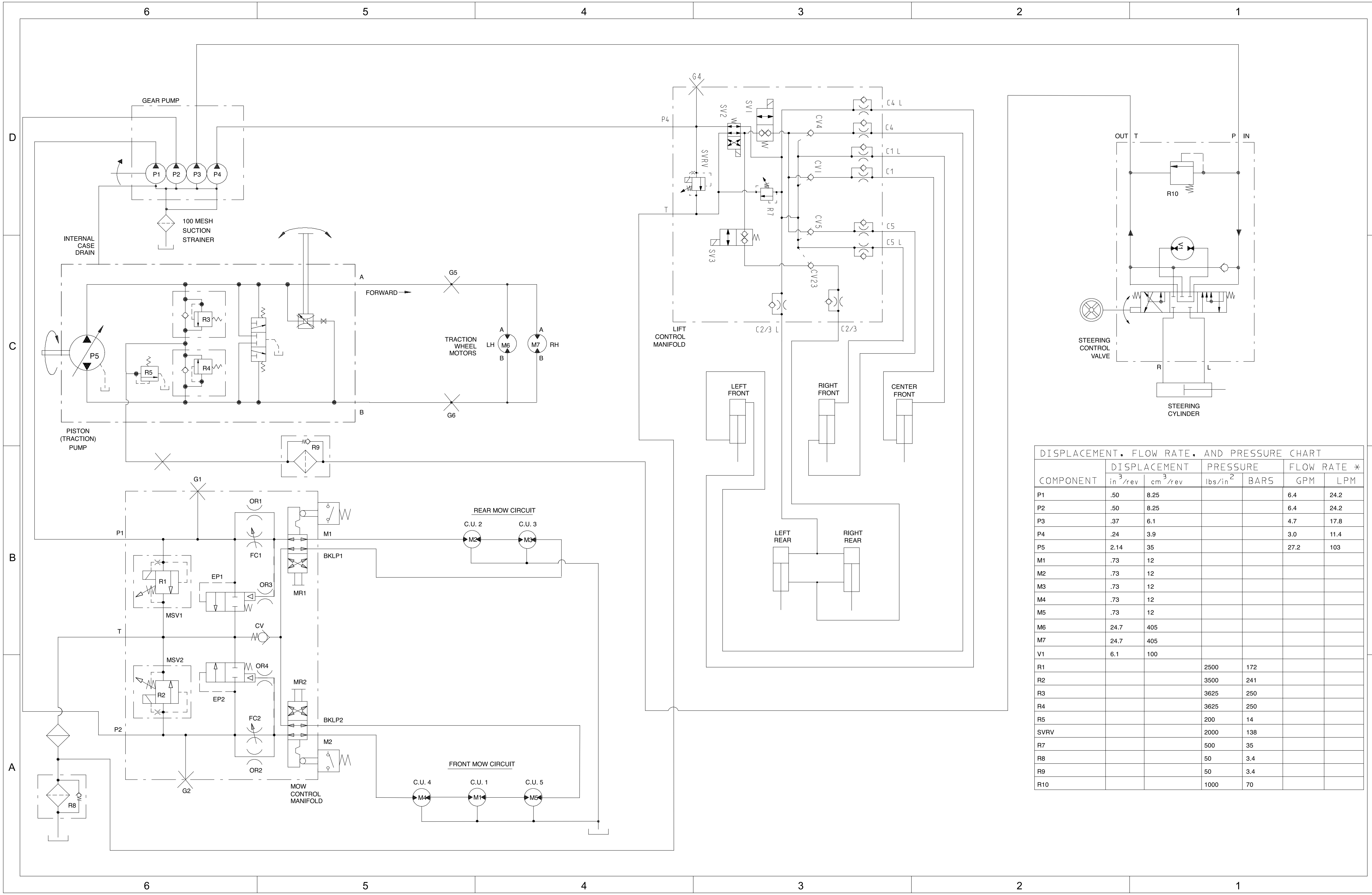
The individual wires of the electrical harness diagrams in this chapter identify both the wire color and the wire size.

Examples:

- 16 BK = 16 AWG (American Wire Gauge) wire that has a black insulator
- 050 R = 0.5 mm metric wire that has a red insulator (AWG equivalents for metric wire appear in the following table)

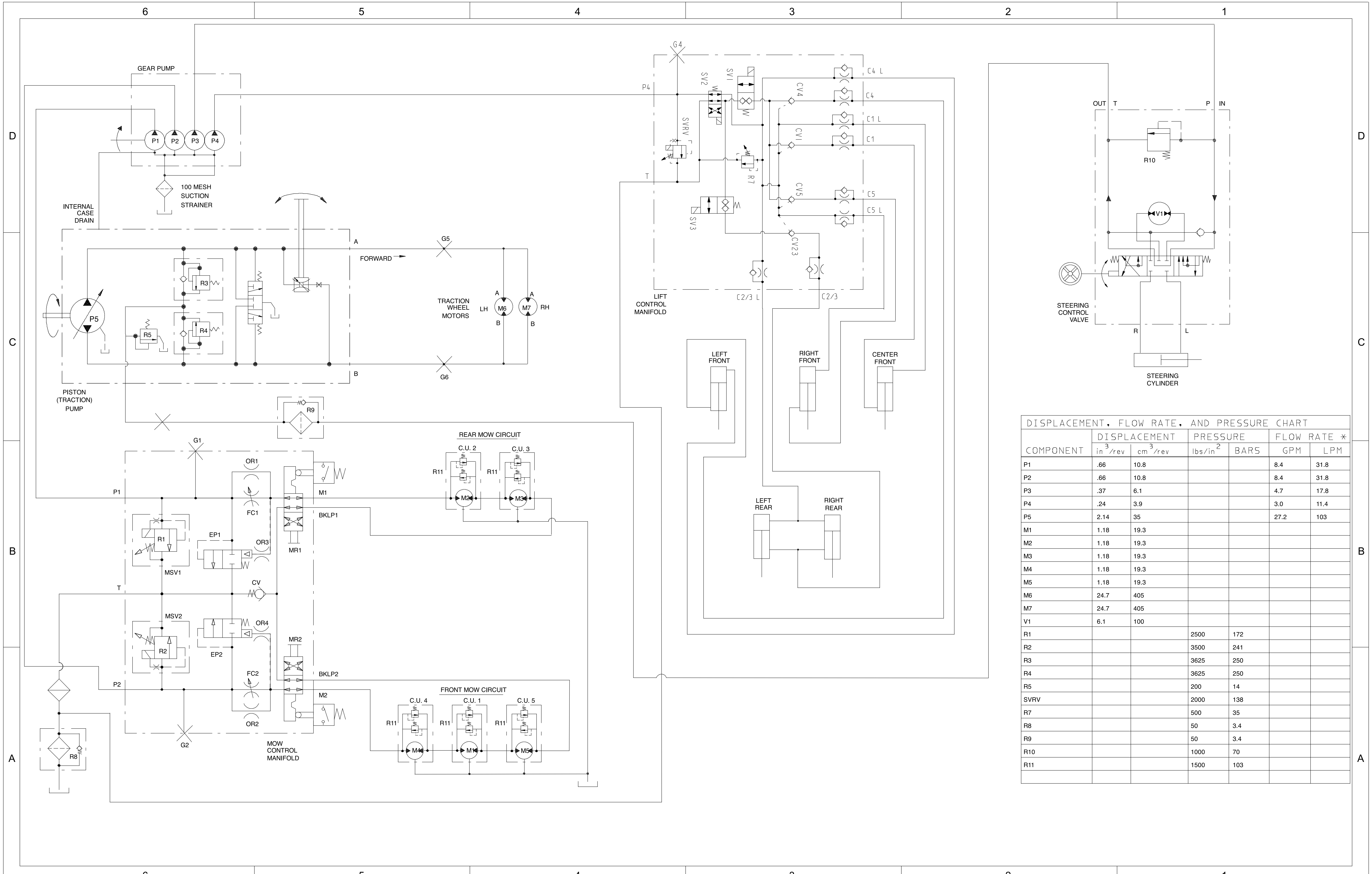
AWG Equivalents for Metric Wire		
Diagram Label	**Metric Size**	**AWG Equivalent**
050	0.5 mm	20 GA
175	0.75 mm	18 GA
100	1.0 mm	16 GA
150	1.5 mm	14 GA

Hydraulic Schematic-5410/5410-D



DISPLACEMENT, FLOW RATE, AND PRESSURE CHART

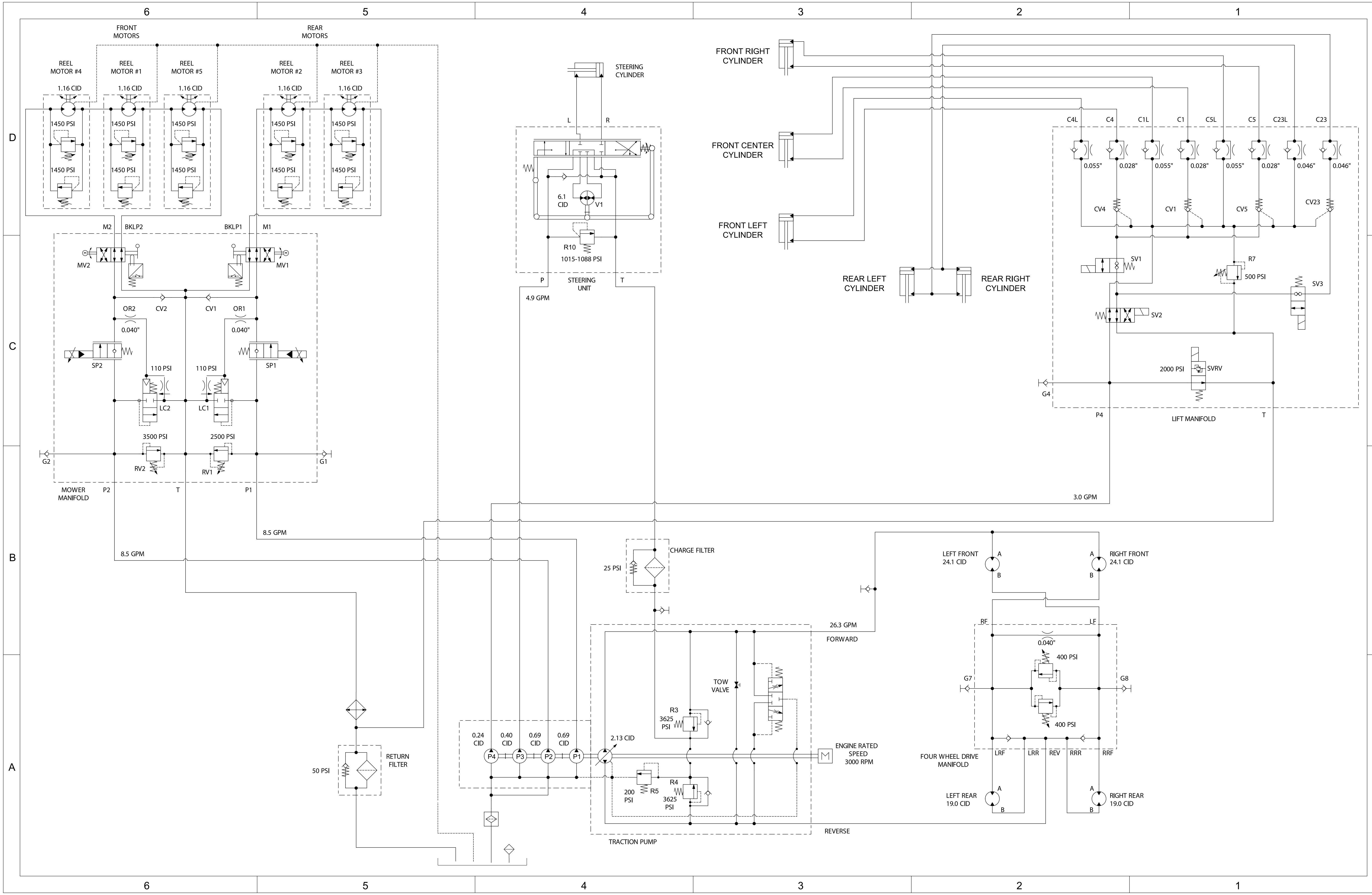
COMPONENT	DISPLACEMENT in^3/rev	DISPLACEMENT cm^3/rev	PRESSURE lbs/in^2	PRESSURE BARS	FLOW RATE * GPM	FLOW RATE * LPM
P1	.50	8.25			6.4	24.2
P2	.50	8.25			6.4	24.2
P3	.37	6.1			4.7	17.8
P4	.24	3.9			3.0	11.4
P5	2.14	35			27.2	103
M1	.73	12				
M2	.73	12				
M3	.73	12				
M4	.73	12				
M5	.73	12				
M6	24.7	405				
M7	24.7	405				
V1	6.1	100				
R1			2500	172		
R2			3500	241		
R3			3625	250		
R4			3625	250		
R5			200	14		
SVRV			2000	138		
R7			500	35		
R8			50	3.4		
R9			50	3.4		
R10			1000	70		



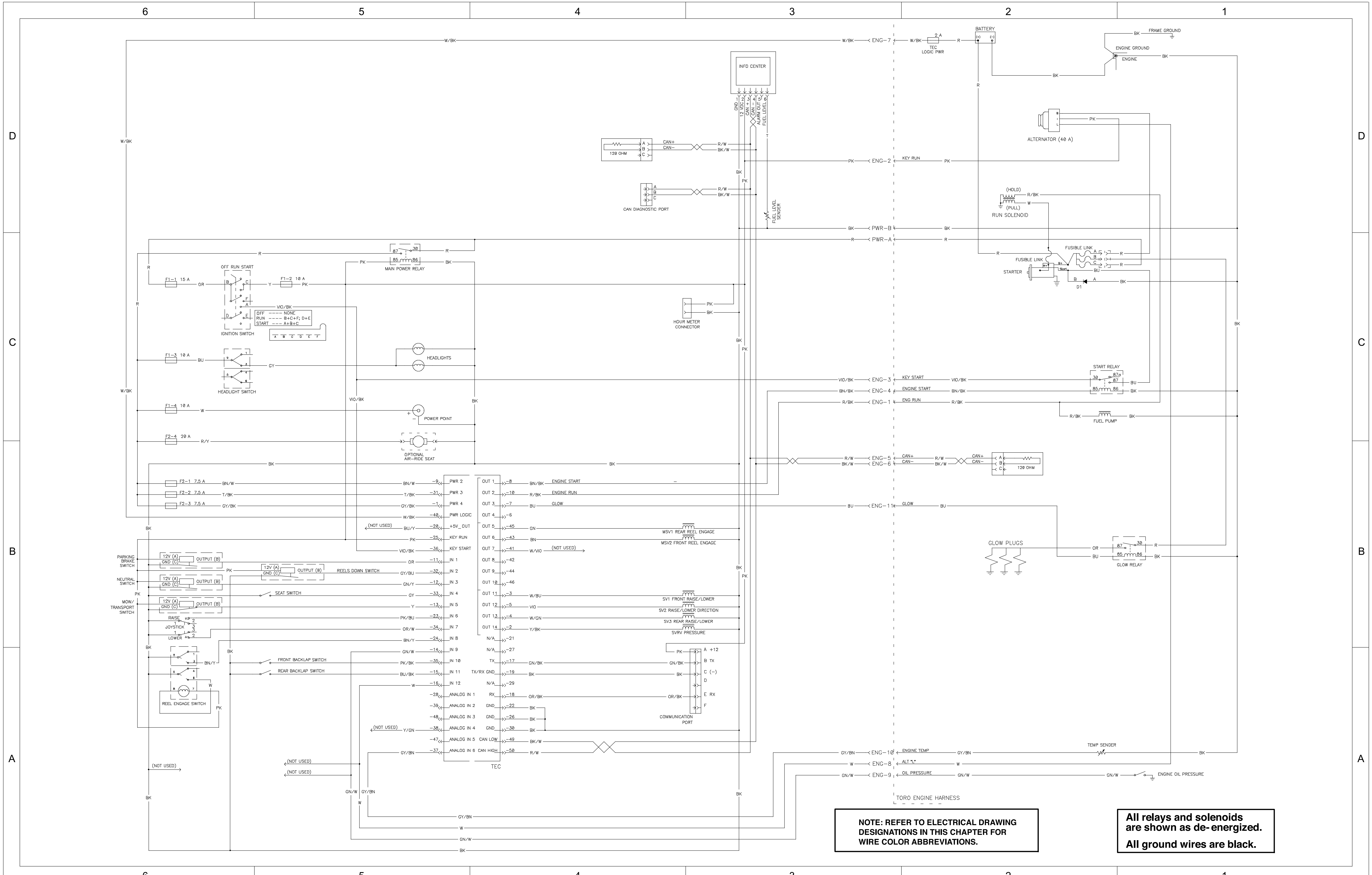
DISPLACEMENT, FLOW RATE, AND PRESSURE CHART

COMPONENT	DISPLACEMENT in^3/rev	DISPLACEMENT cm^3/rev	PRESSURE lbs/in^2	PRESSURE BARS	FLOW RATE * GPM	FLOW RATE * LPM
P1	.66	10.8			8.4	31.8
P2	.66	10.8			8.4	31.8
P3	.37	6.1			4.7	17.8
P4	.24	3.9			3.0	11.4
P5	2.14	35			27.2	103
M1	1.18	19.3				
M2	1.18	19.3				
M3	1.18	19.3				
M4	1.18	19.3				
M5	1.18	19.3				
M6	24.7	405				
M7	24.7	405				
V1	6.1	100				
R1			2500	172		
R2			3500	241		
R3			3625	250		
R4			3625	250		
R5			200	14		
SVRV			2000	138		
R7			500	35		
R8			50	3.4		
R9			50	3.4		
R10			1000	70		
R11			1500	103		

Hydraulic Schematic-5610-D

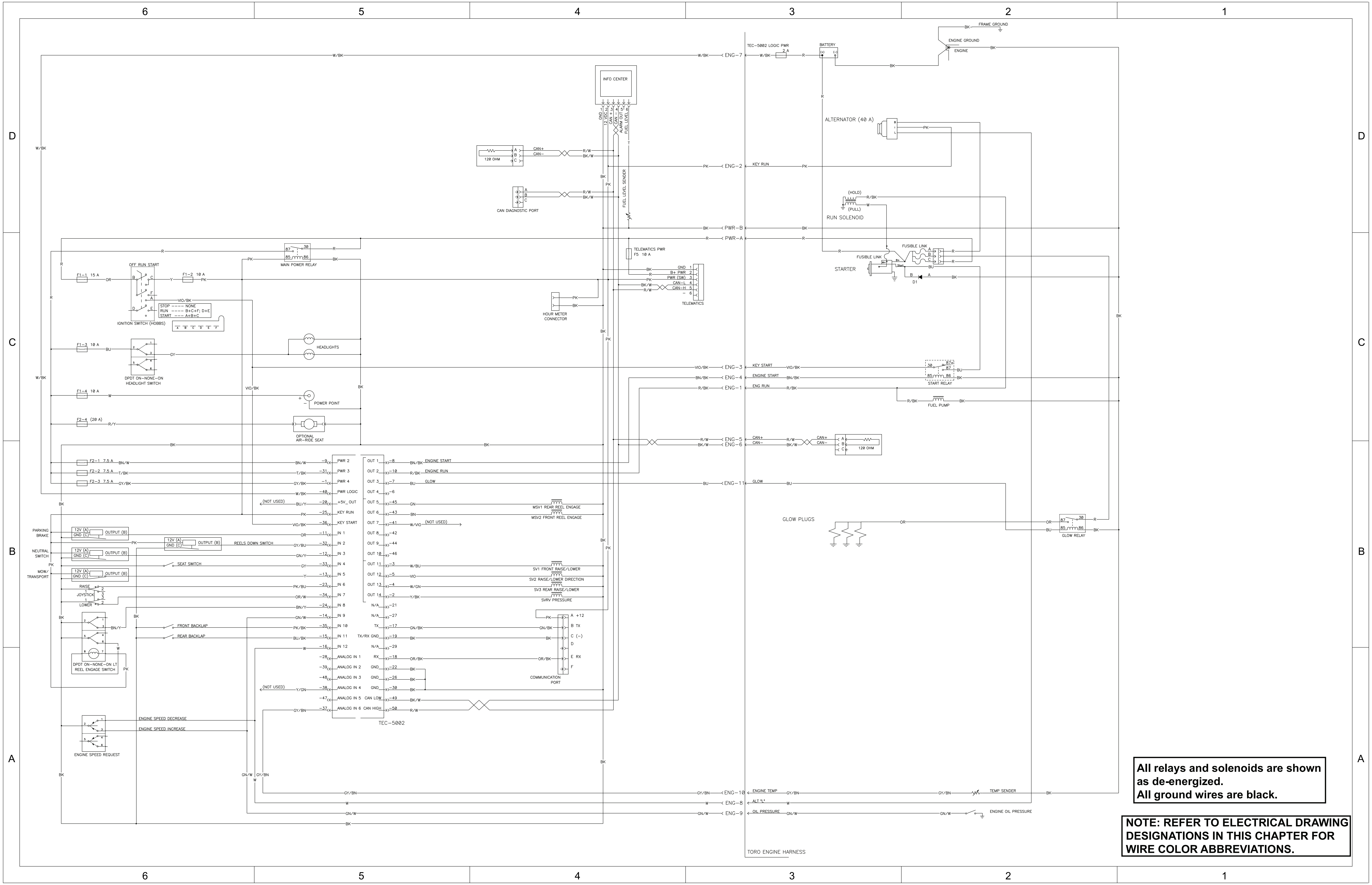


Electrical Schematic-5410/5510/5610 (Models with Kubota Diesel Engine) (Serial Numbers Below 403430000)



g229518

Electrical Schematic-5410/5510/5610 (Models with Kubota Diesel Engine) (Serial Numbers Above 403430000)

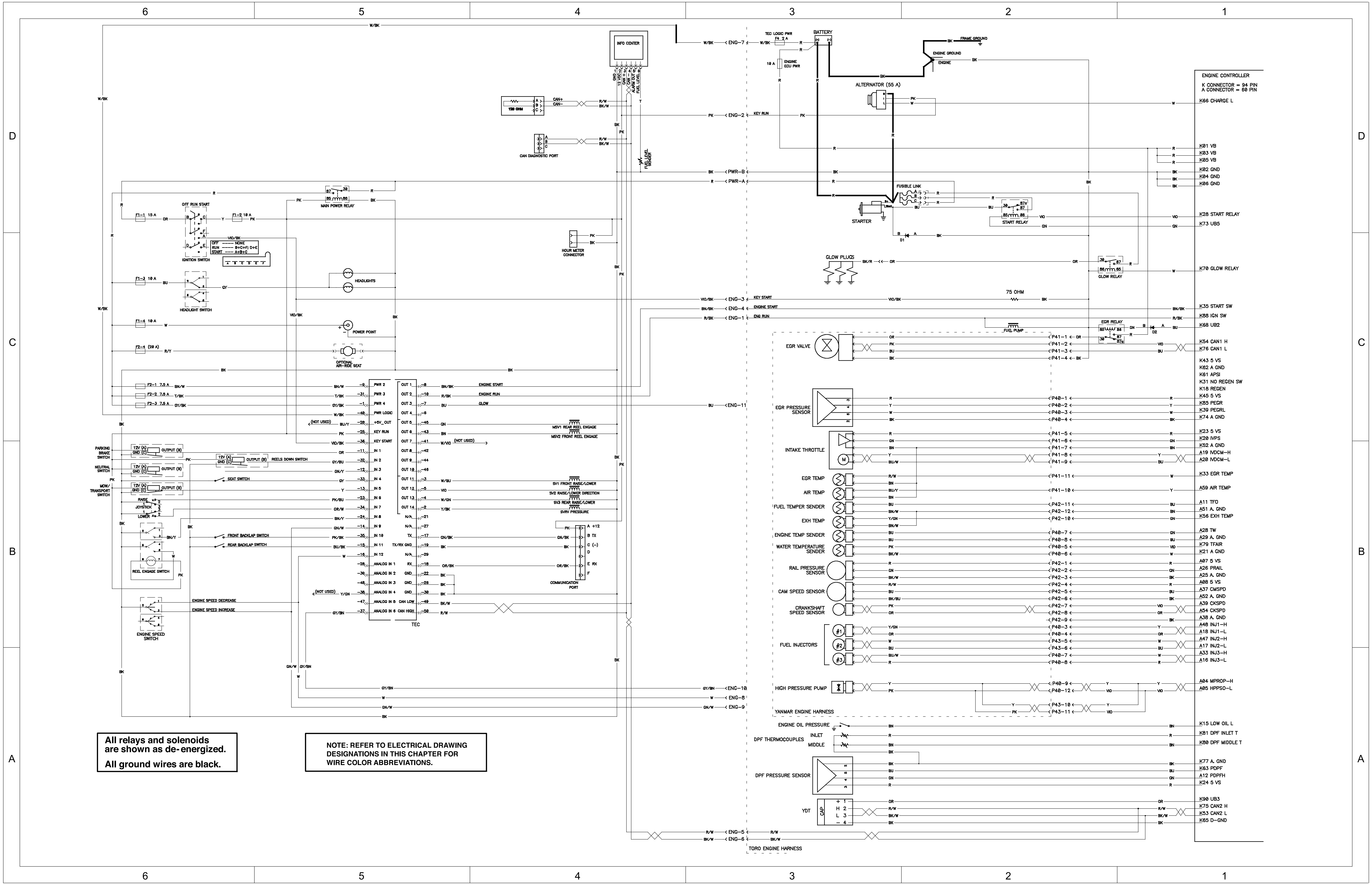


All relays and solenoids are shown as de-energized.
All ground wires are black.

NOTE: REFER TO ELECTRICAL DRAWING DESIGNATIONS IN THIS CHAPTER FOR WIRE COLOR ABBREVIATIONS.

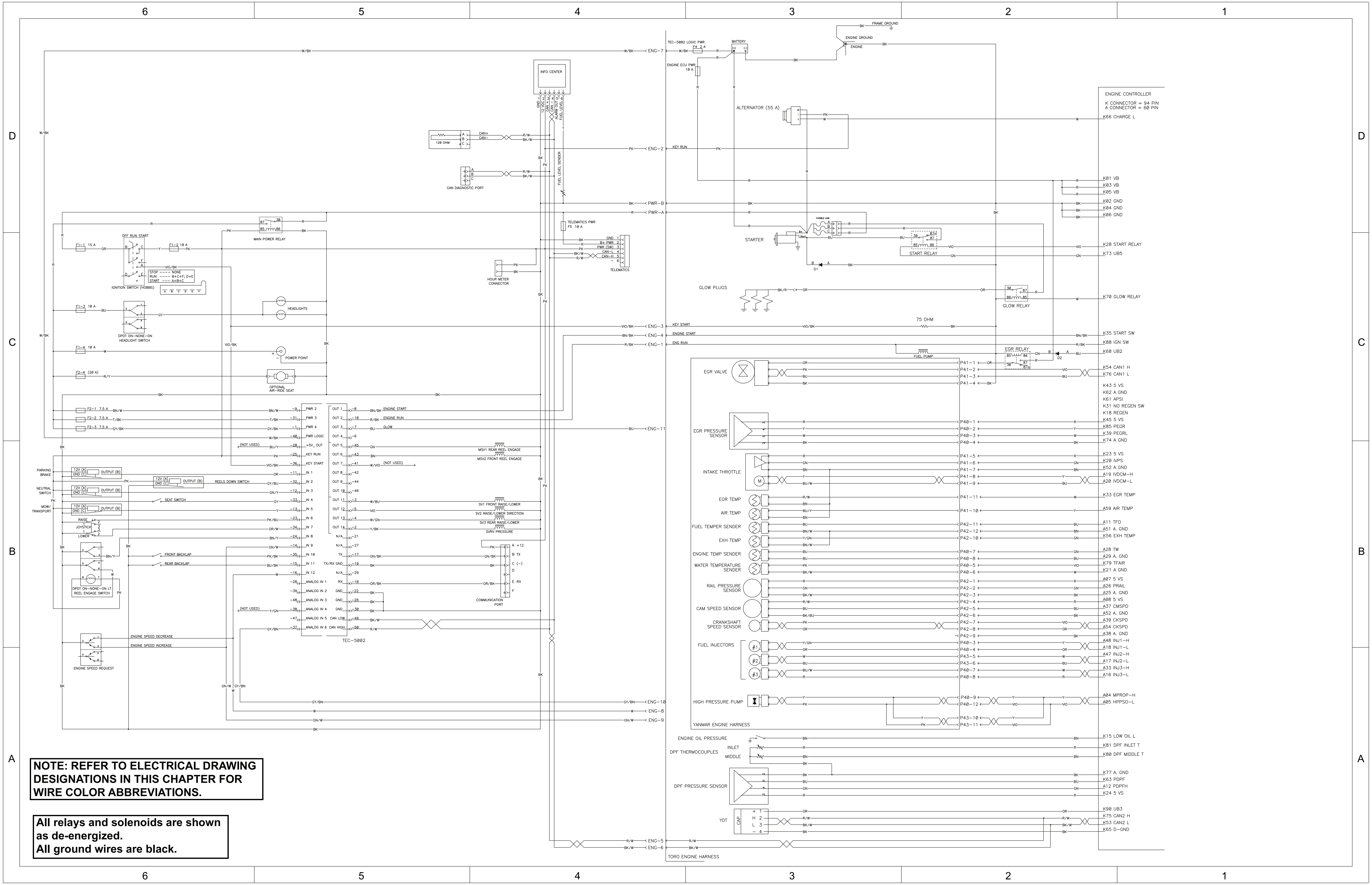
g325688

Electrical Schematic-5410-D/5510-D/5610-D (Models with Yanmar Diesel Engine) (Serial Numbers Below 403430000)



g229521

Electrical Schematic-5410-D/5510-D/5610-D (Models with Yanmar Diesel Engine) (Serial Numbers Above 403430000)



g325685

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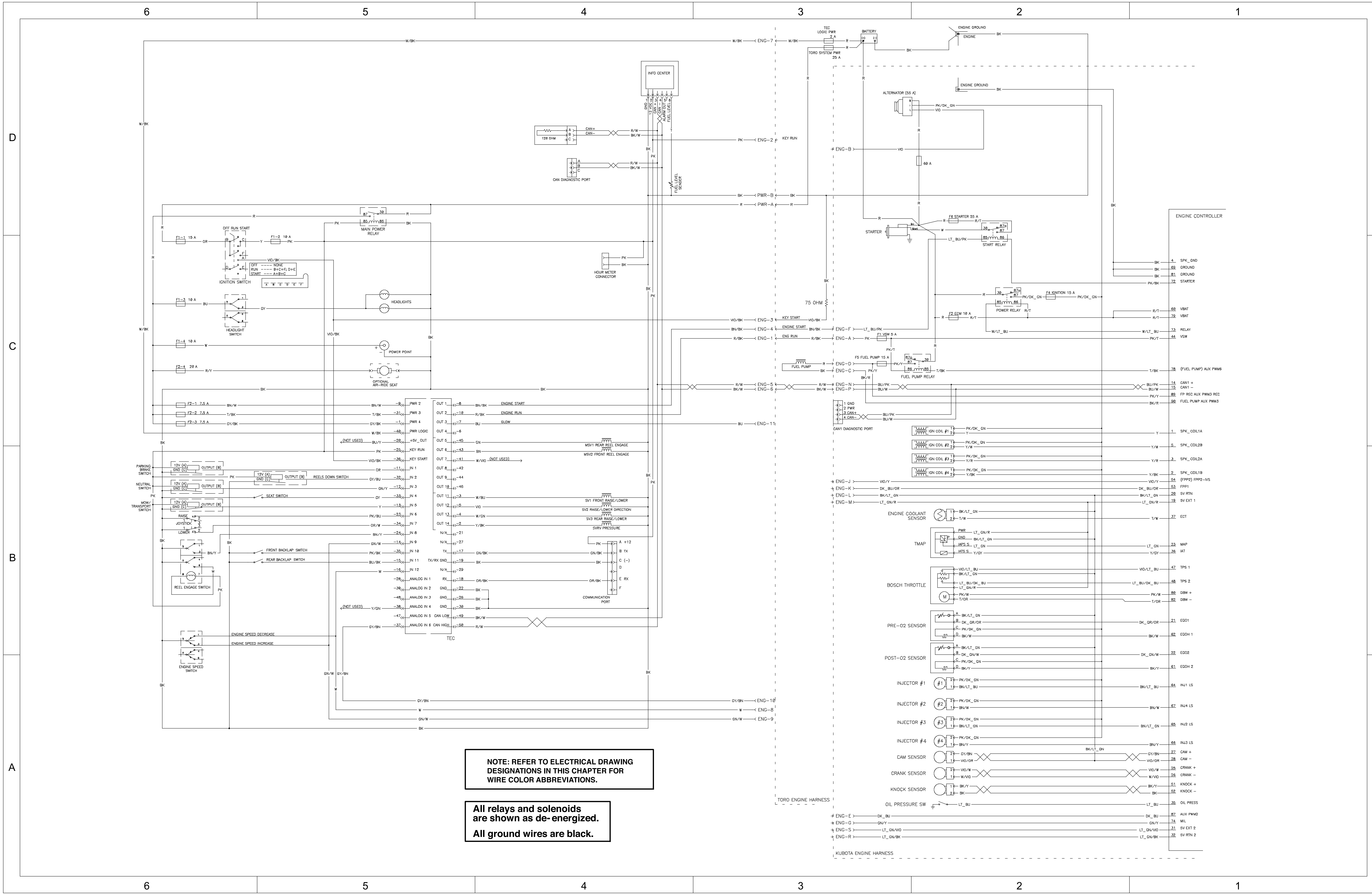
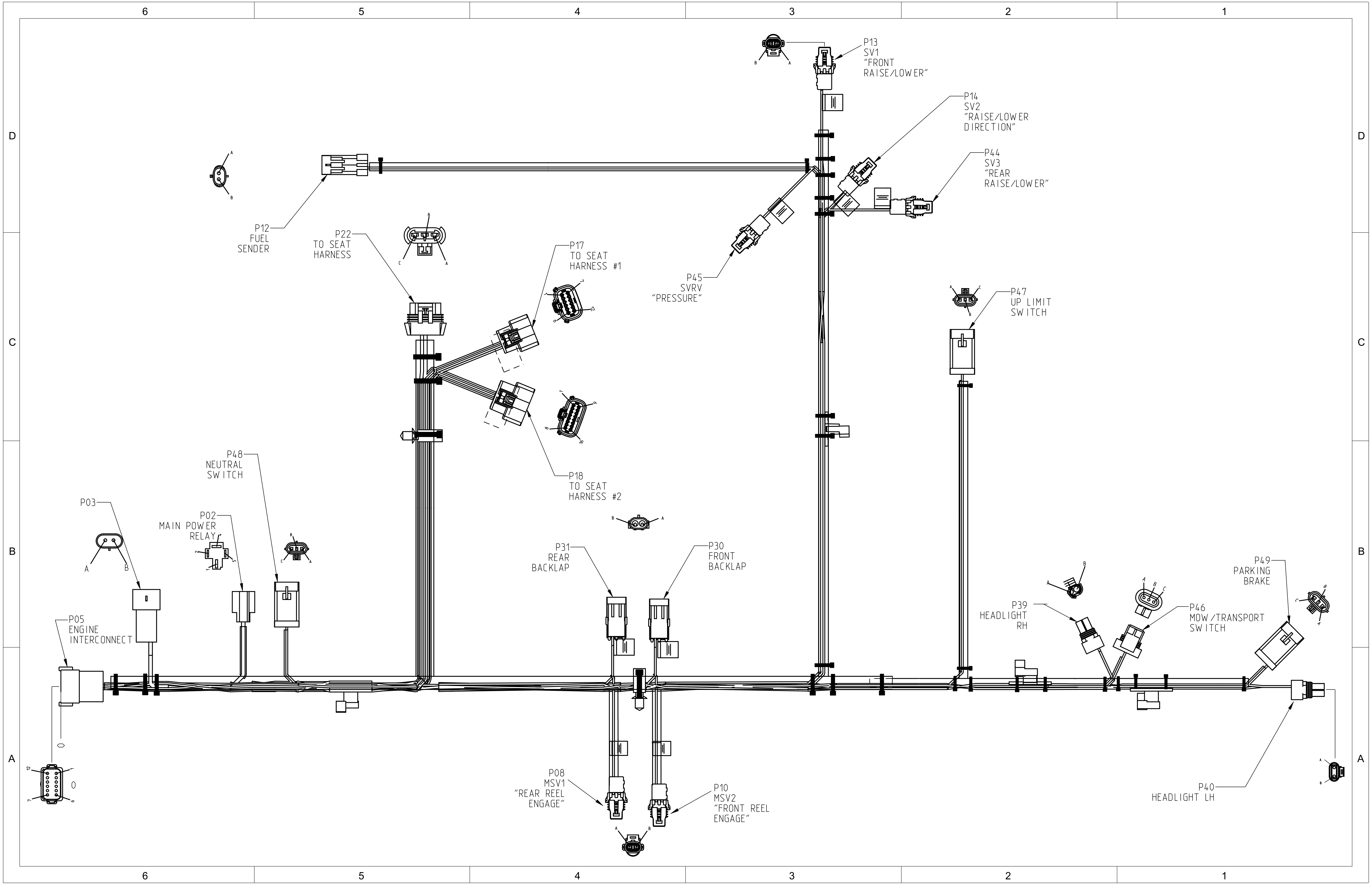
g326106

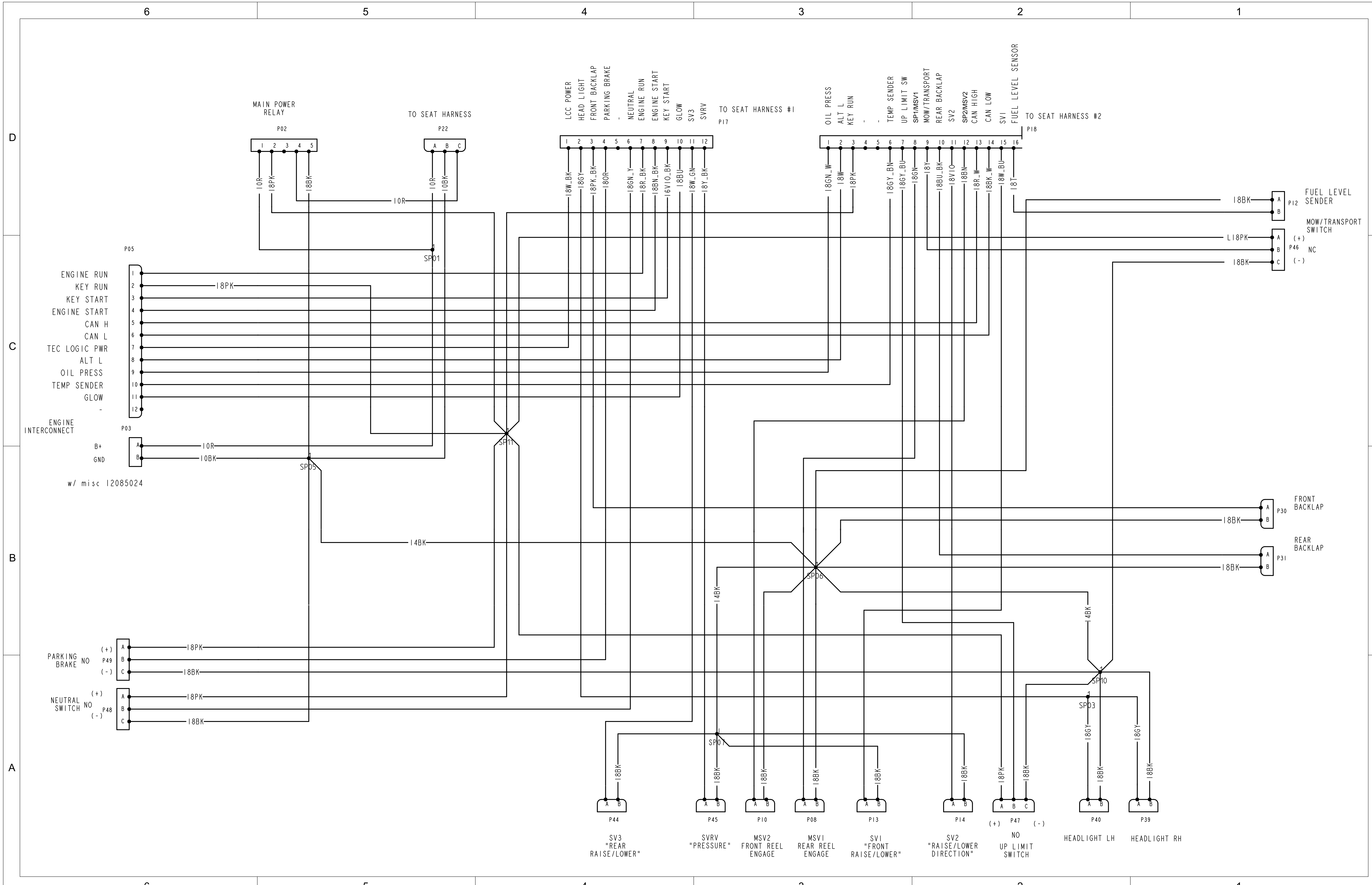
Electrical Schematic-5410-G/5510-G (Models with Kubota Gasoline Engine)



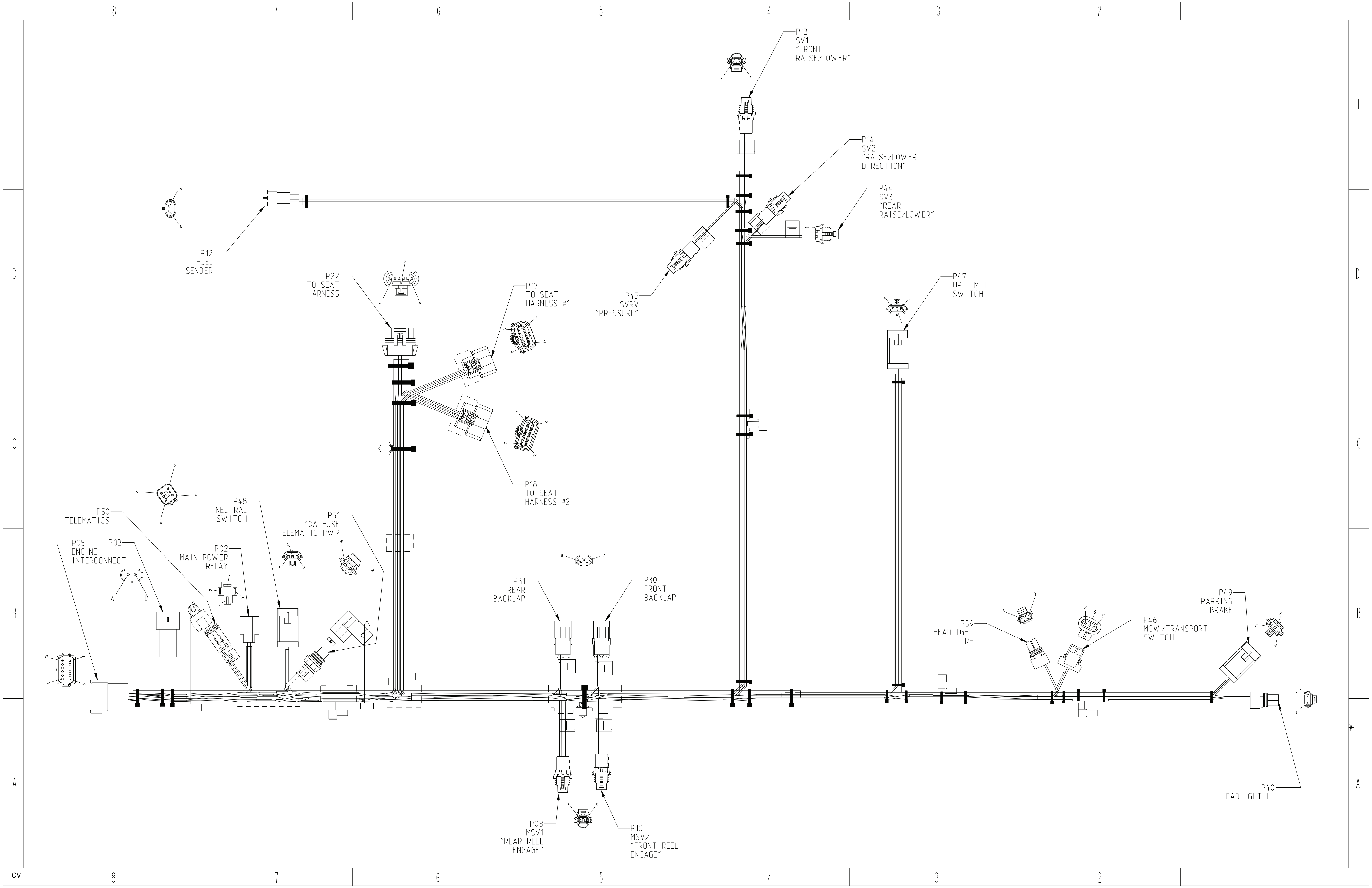
g229525


P13
SV1
"FRONT
RAISE/LOWER"
P14
SV2
"RAISE/LOWER
DIRECTION"
P44
SV3
"REAR
RAISE/LOWER"
P12
FUEL
SENDER
P22
TO SEAT
HARNESS
P17
TO SEAT
HARNESS #1
P45
SVRV
"PRESSURE"
P47
UP LIMIT
SWITCH
P18
TO SEAT
HARNESS #2
P48
NEUTRAL
SWITCH
P03
P02
MAIN POWER
RELAY
P31
REAR
BACKLAP
P30
FRONT
BACKLAP
P49
PARKING
BRAKE
P39
HEADLIGHT
RH
P46
MOW/TRANSPORT
SWITCH
P05
ENGINE
INTERCONNECT
P08
MSV1
"REAR REEL
ENGAGE"
P10
MSV2
"FRONT REEL
ENGAGE"
P40
HEADLIGHT LH
g219150

Wire Harness Drawing-Main (Serial Number Below 403430000)

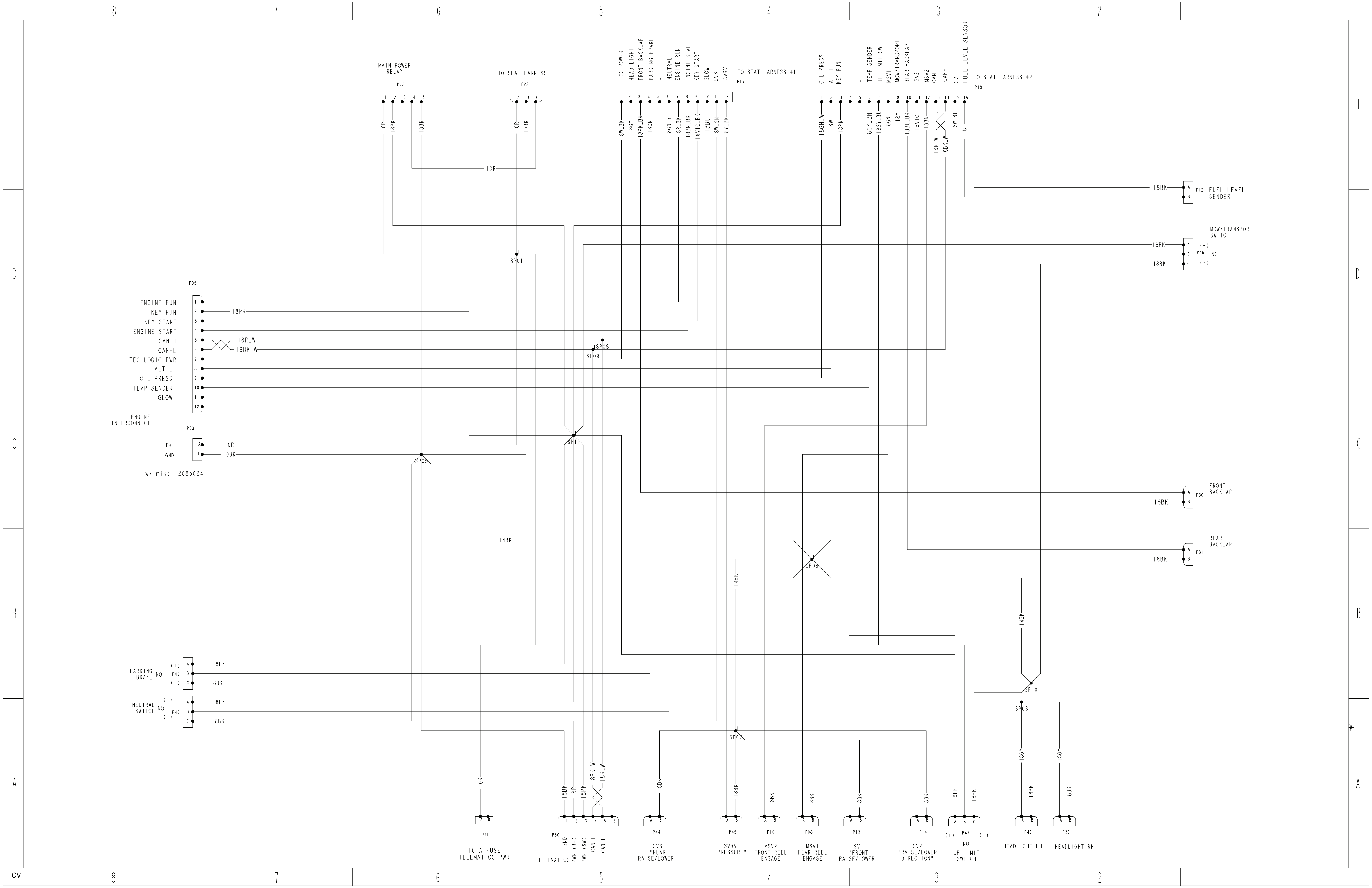


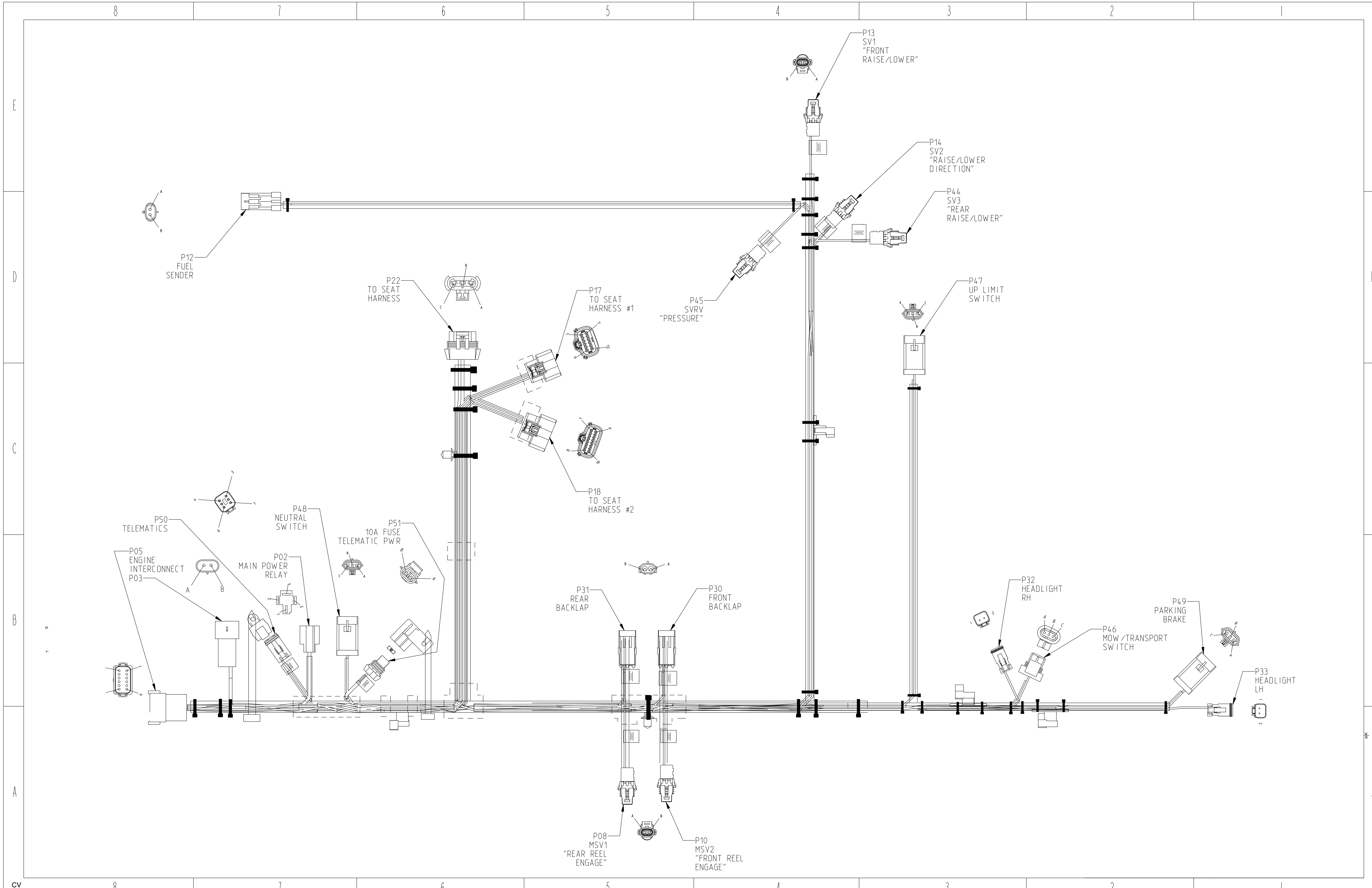
g219151


8
7
6
5
4
3
2
1
E
D
C
B
A
P13
SV1
"FRONT
RAISE/LOWER"
P14
SV2
"RAISE/LOWER
DIRECTION"
P44
SV3
"REAR
RAISE/LOWER"
P12
FUEL
SENDER
P22
TO SEAT
HARNESS
P17
TO SEAT
HARNESS #1
P45
SVRV
"PRESSURE"
P47
UP LIMIT
SWITCH
P18
TO SEAT
HARNESS #2
P50
TELEMATICS
P48
NEUTRAL
SWITCH
P51
10A FUSE
TELEMATIC PWR
P05
ENGINE
INTERCONNECT
P03
P02
MAIN POWER
RELAY
P31
REAR
BACKLAP
P30
FRONT
BACKLAP
P49
PARKING
BRAKE
P39
HEADLIGHT
RH
P46
MOW/TRANSPORT
SWITCH
P40
HEADLIGHT LH
P08
MSV1
"REAR REEL
ENGAGE"
P10
MSV2
"FRONT REEL
ENGAGE"
CV

g325686

Wire Harness Drawing-Main (Serial Numbers 403430001 to 405680000)

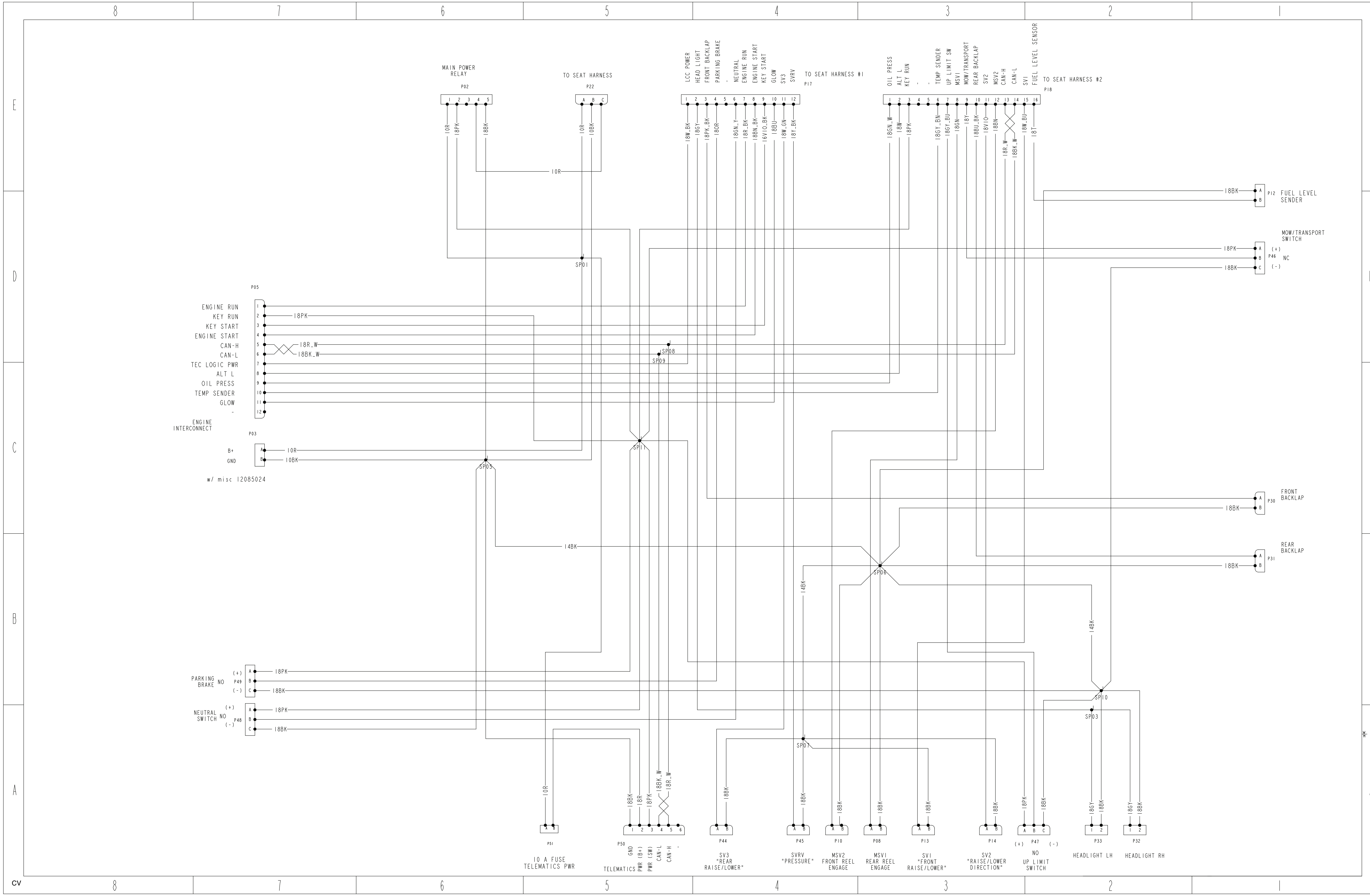


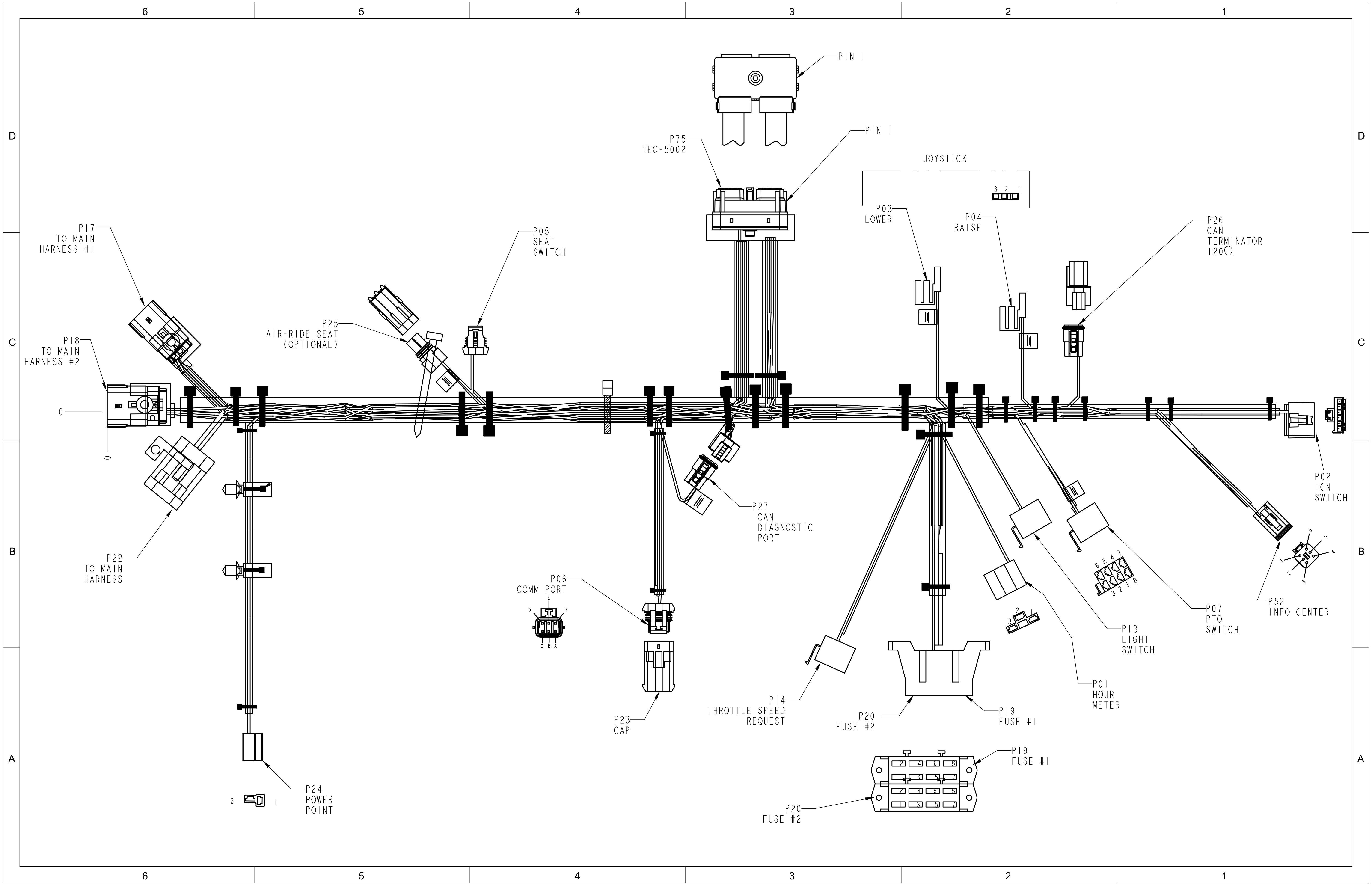


P13
SV1
"FRONT
RAISE/LOWER"
P14
SV2
"RAISE/LOWER
DIRECTION"
P44
SV3
"REAR
RAISE/LOWER"
P12
FUEL
SENDER
P22
TO SEAT
HARNESS
P17
TO SEAT
HARNESS #1
P45
SVRV
"PRESSURE"
P47
UP LIMIT
SWITCH
P18
TO SEAT
HARNESS #2
P50
TELEMATICS
P48
NEUTRAL
SWITCH
P51
10A FUSE
TELEMATIC PWR
P05
ENGINE
INTERCONNECT
P03
P02
MAIN POWER
RELAY
P31
REAR
BACKLAP
P30
FRONT
BACKLAP
P32
HEADLIGHT
RH
P49
PARKING
BRAKE
P46
MOW/TRANSPORT
SWITCH
P33
HEADLIGHT
LH
P08
MSV1
"REAR REEL
ENGAGE"
P10
MSV2
"FRONT REEL
ENGAGE"
CV

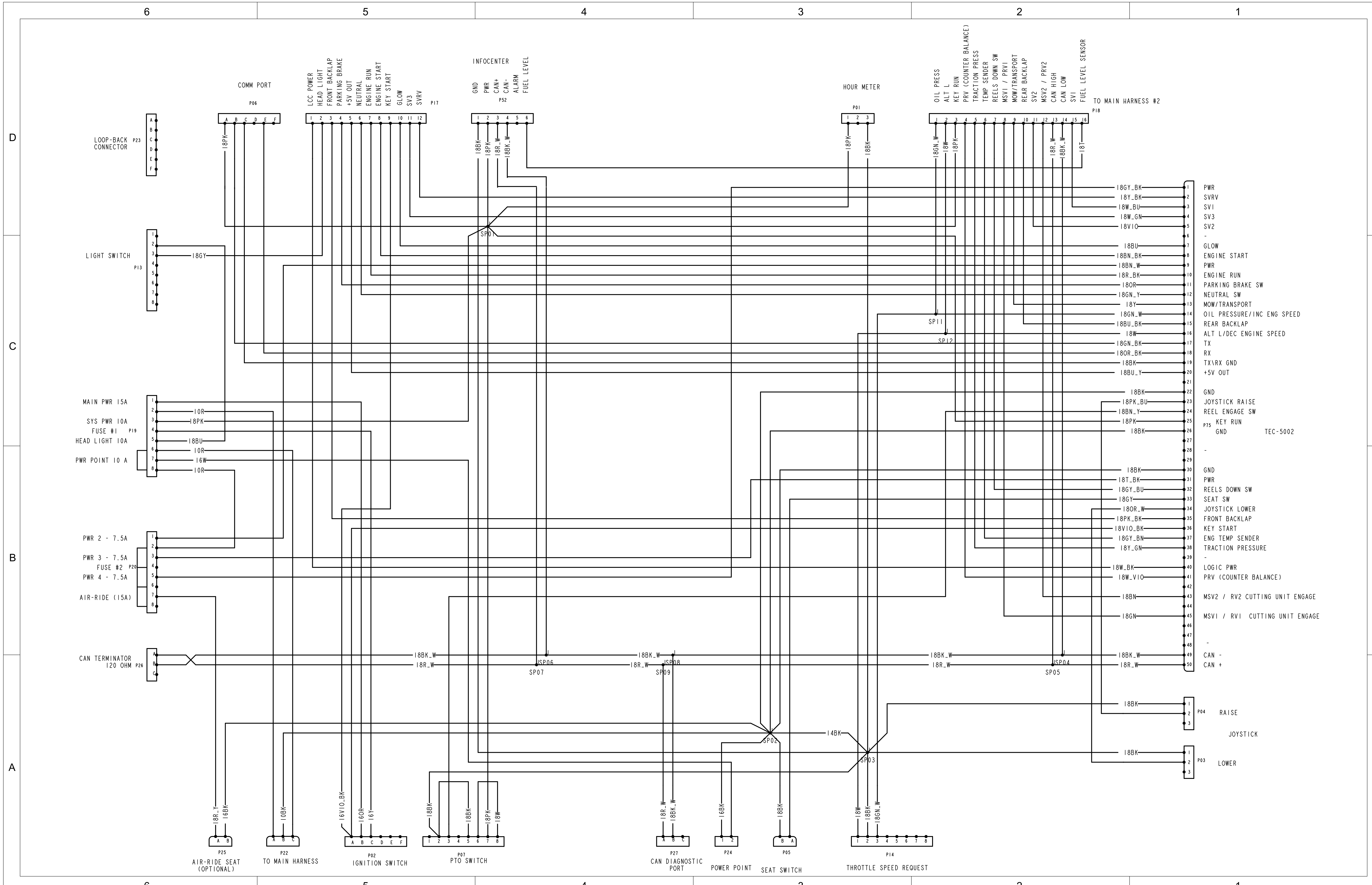
g325689

Wire Harness Drawing-Main (Serial Numbers Above 405680001)




PIN 1
P75
TEC-5002
PIN 1
JOYSTICK
P03
LOWER
P04
RAISE
P26
CAN
TERMINATOR
120Ω
P17
TO MAIN
HARNESS #1
P05
SEAT
SWITCH
P25
AIR-RIDE SEAT
(OPTIONAL)
P18
TO MAIN
HARNESS #2
P02
IGN
SWITCH
P22
TO MAIN
HARNESS
P27
CAN
DIAGNOSTIC
PORT
P06
COMM PORT
P52
INFO CENTER
P07
PTO
SWITCH
P13
LIGHT
SWITCH
P01
HOUR
METER
P14
THROTTLE SPEED
REQUEST
P20
FUSE #2
P19
FUSE #1
P23
CAP
P24
POWER
POINT
P19
FUSE #1
P20
FUSE #2

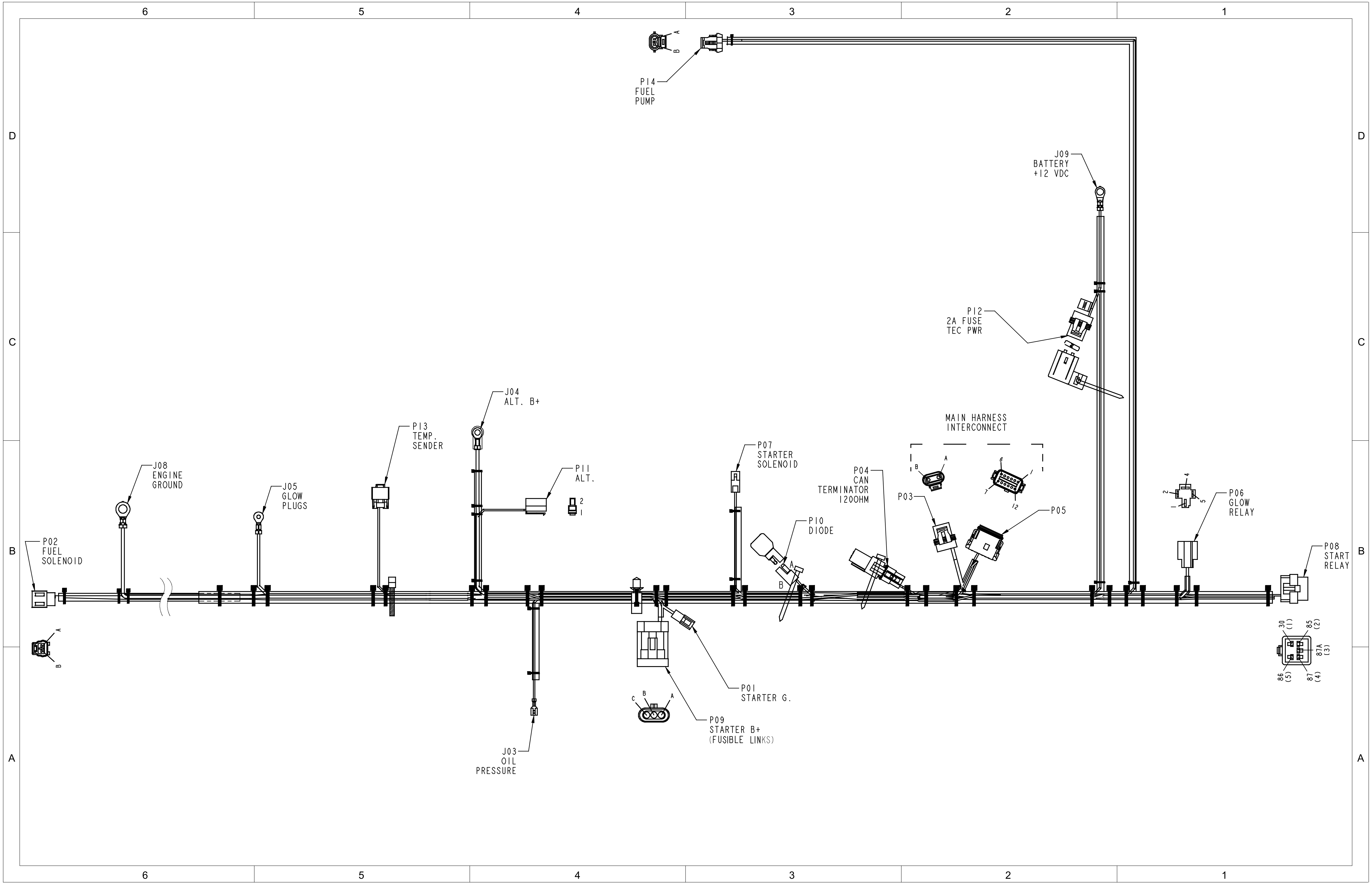
g219152



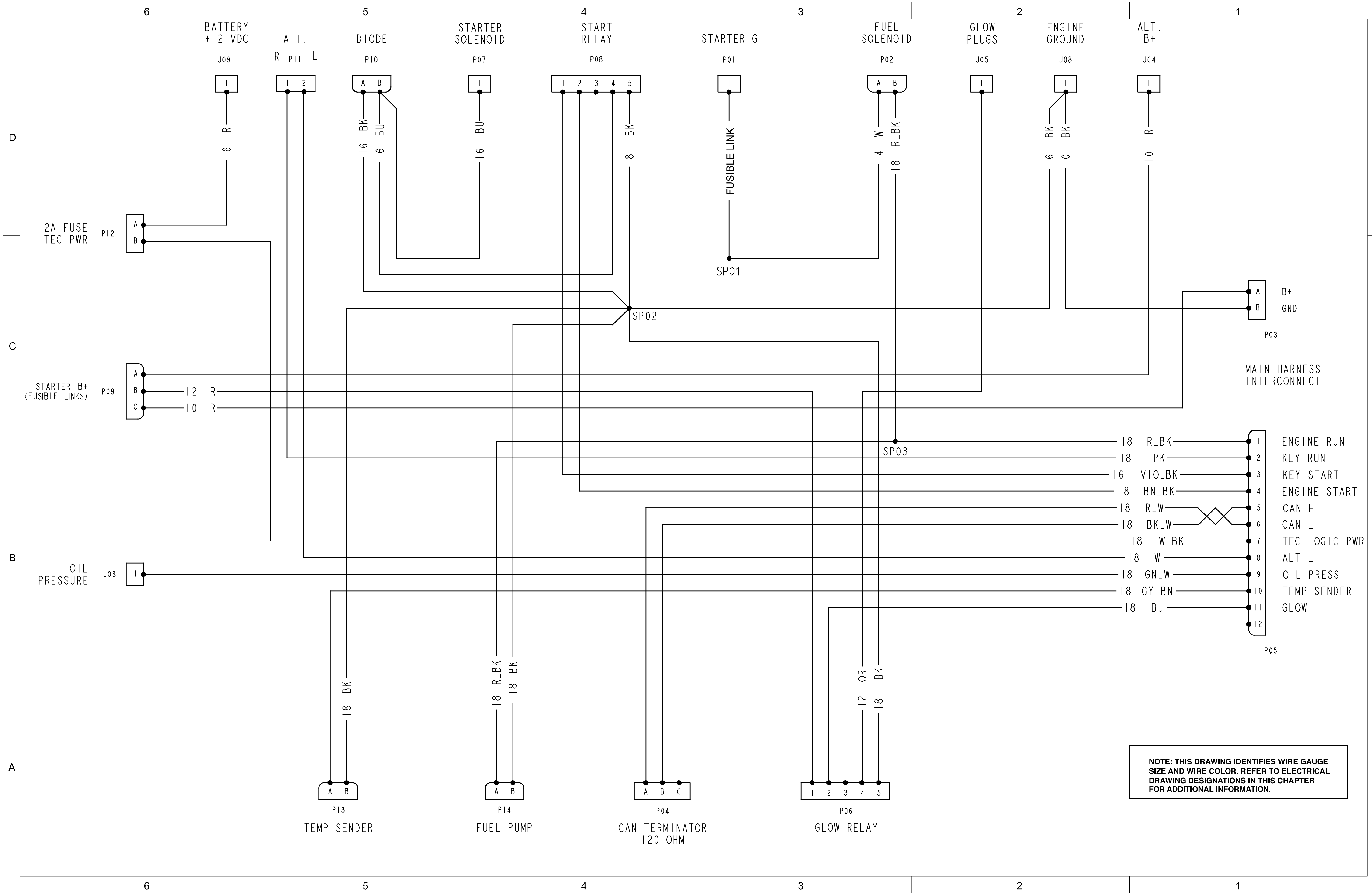
COMM PORT
P06
LCC POWER
HEAD LIGHT
FRONT BACKLAP
PARKING BRAKE
+5V OUT
NEUTRAL
ENGINE RUN
ENGINE START
KEY START
GLOW
SV3
SVRV
P17
INFOCENTER
GND
PWR
CAN+
CAN-
ALARM
FUEL LEVEL
P52
HOUR METER
P01
OIL PRESS
ALT L
KEY RUN
PRV (COUNTER BALANCE)
TRACTION PRESS
TEMP SENDER
REELS DOWN SW
MSV1 / PRV1
MOW/TRANSPORT
REAR BACKLAP
SV2
MSV2 / PRV2
CAN HIGH
CAN LOW
SV1
FUEL LEVEL SENSOR
TO MAIN HARNESS #2
P18
LOOP-BACK CONNECTOR P23
LIGHT SWITCH
P13
MAIN PWR 15A
SYS PWR 10A
FUSE #1 P19
HEAD LIGHT 10A
PWR POINT 10 A
PWR 2 - 7.5A
PWR 3 - 7.5A
FUSE #2 P20
PWR 4 - 7.5A
AIR-RIDE (15A)
CAN TERMINATOR
120 OHM P26
SP01
SP02
SP03
SP04
SP05
SP06
SP07
SP08
SP09
SP11
SP12
PWR
SVRV
SV1
SV3
SV2
GLOW
ENGINE START
PWR
ENGINE RUN
PARKING BRAKE SW
NEUTRAL SW
MOW/TRANSPORT
OIL PRESSURE/INC ENG SPEED
REAR BACKLAP
ALT L/DEC ENGINE SPEED
TX
RX
TX\RX GND
+5V OUT
GND
JOYSTICK RAISE
REEL ENGAGE SW
P75 KEY RUN
GND TEC-5002
GND
PWR
REELS DOWN SW
SEAT SW
JOYSTICK LOWER
FRONT BACKLAP
KEY START
ENG TEMP SENDER
TRACTION PRESSURE
LOGIC PWR
PRV (COUNTER BALANCE)
MSV2 / RV2 CUTTING UNIT ENGAGE
MSV1 / RV1 CUTTING UNIT ENGAGE
CAN -
CAN +
P04 RAISE
JOYSTICK
P03 LOWER
P25
AIR-RIDE SEAT (OPTIONAL)
P22
TO MAIN HARNESS
P02
IGNITION SWITCH
P07
PTO SWITCH
P27
CAN DIAGNOSTIC PORT
P24
POWER POINT
P05
SEAT SWITCH
P14
THROTTLE SPEED REQUEST

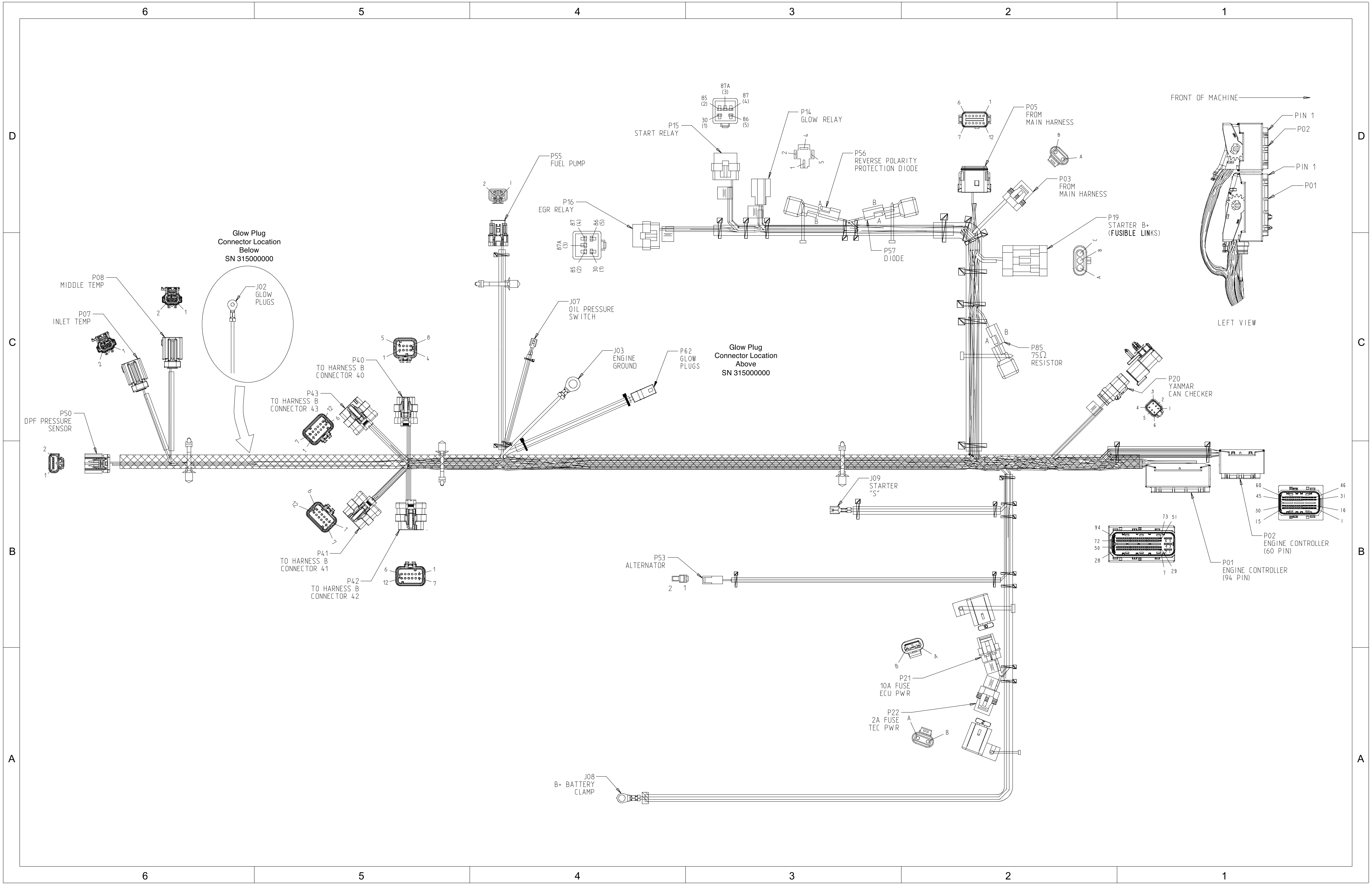
g219153

Engine Wire Harness Drawing-5410/5510/5610 (Models with Kubota Diesel Engine)



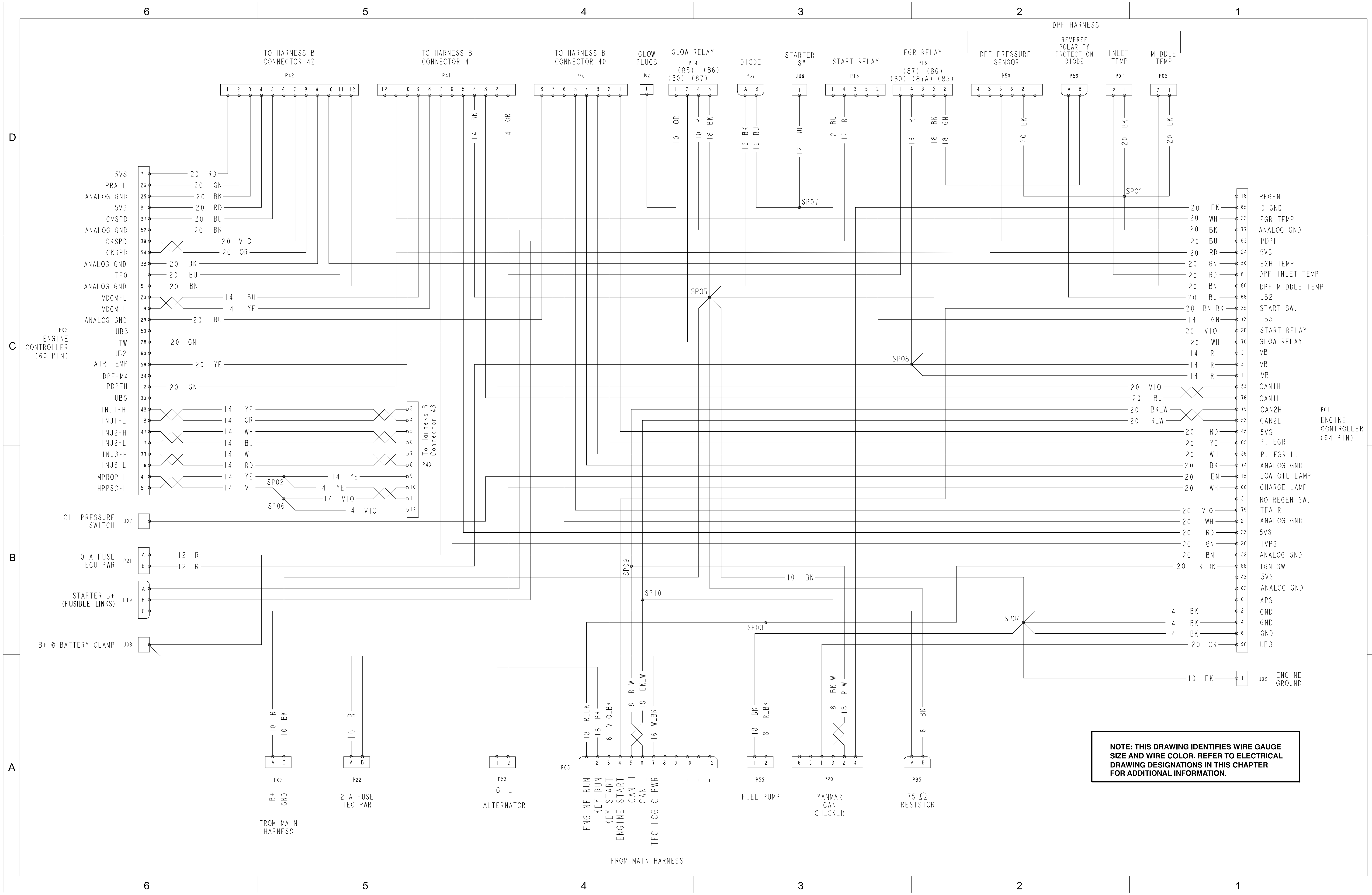
Engine Wire Harness Diagram-5410/5510/5610 (Models with Kubota Diesel Engine)





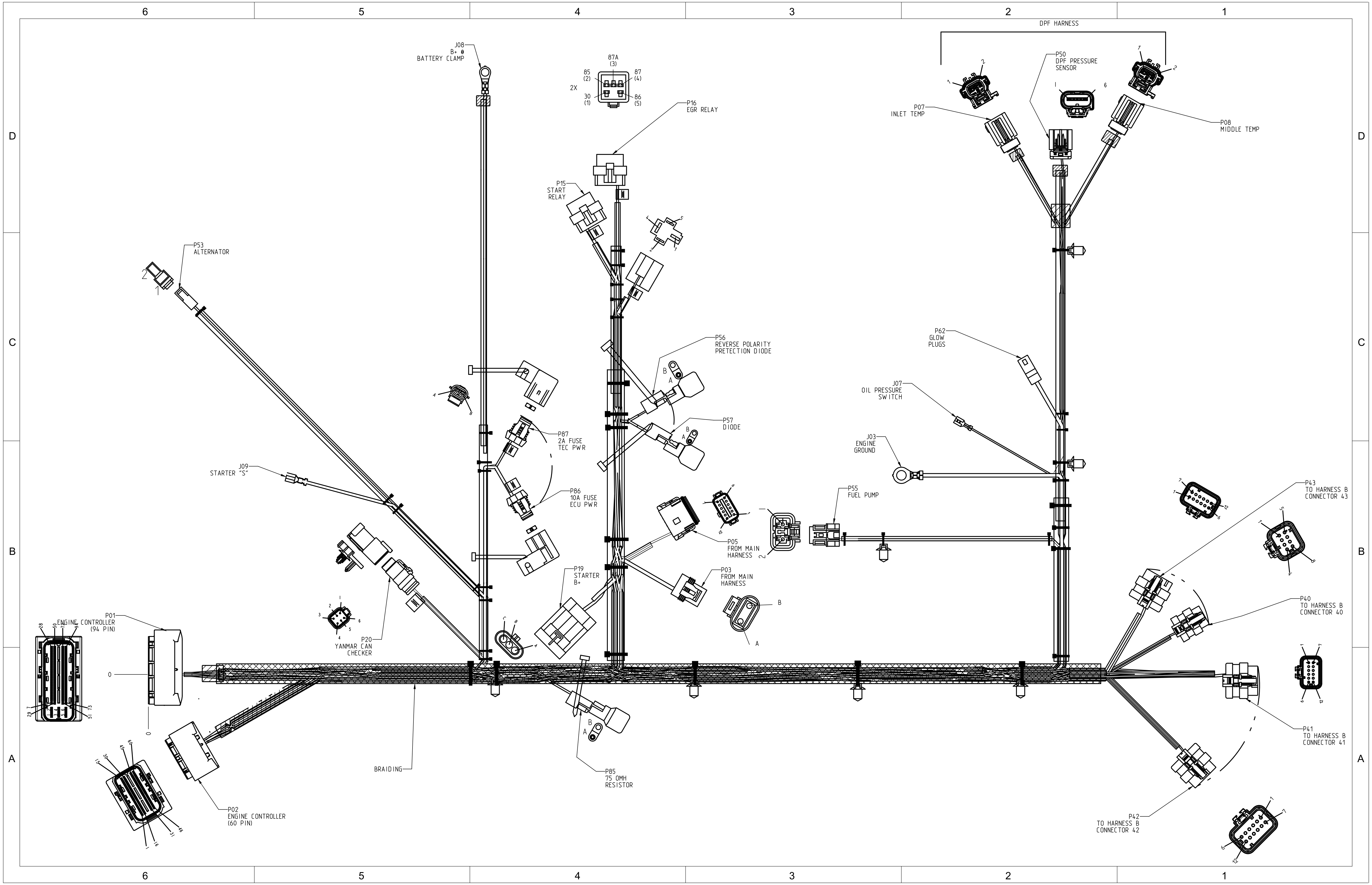
FRONT OF MACHINE
PIN 1
P02
PIN 1
P01
LEFT VIEW
P15 START RELAY
P14 GLOW RELAY
P56 REVERSE POLARITY PROTECTION DIODE
P05 FROM MAIN HARNESS
P03 FROM MAIN HARNESS
P19 STARTER B+ (FUSIBLE LINKS)
P55 FUEL PUMP
P16 EGR RELAY
P57 DIODE
Glow Plug Connector Location Below SN 315000000
J02 GLOW PLUGS
P08 MIDDLE TEMP
P07 INLET TEMP
J07 OIL PRESSURE SWITCH
J03 ENGINE GROUND
P62 GLOW PLUGS
Glow Plug Connector Location Above SN 315000000
P85 75Ω RESISTOR
P20 YANMAR CAN CHECKER
P40 TO HARNESS B CONNECTOR 40
P43 TO HARNESS B CONNECTOR 43
P50 DPF PRESSURE SENSOR
J09 STARTER "S"
P41 TO HARNESS B CONNECTOR 41
P42 TO HARNESS B CONNECTOR 42
P53 ALTERNATOR
P02 ENGINE CONTROLLER (60 PIN)
P01 ENGINE CONTROLLER (94 PIN)
P21 10A FUSE ECU PWR
P22 2A FUSE TEC PWR
J08 B+ BATTERY CLAMP
g229524

Engine Wire Harness Diagram-5410-D/5510-D (Models 03672 and 03687 with Yanmar Diesel Engine)

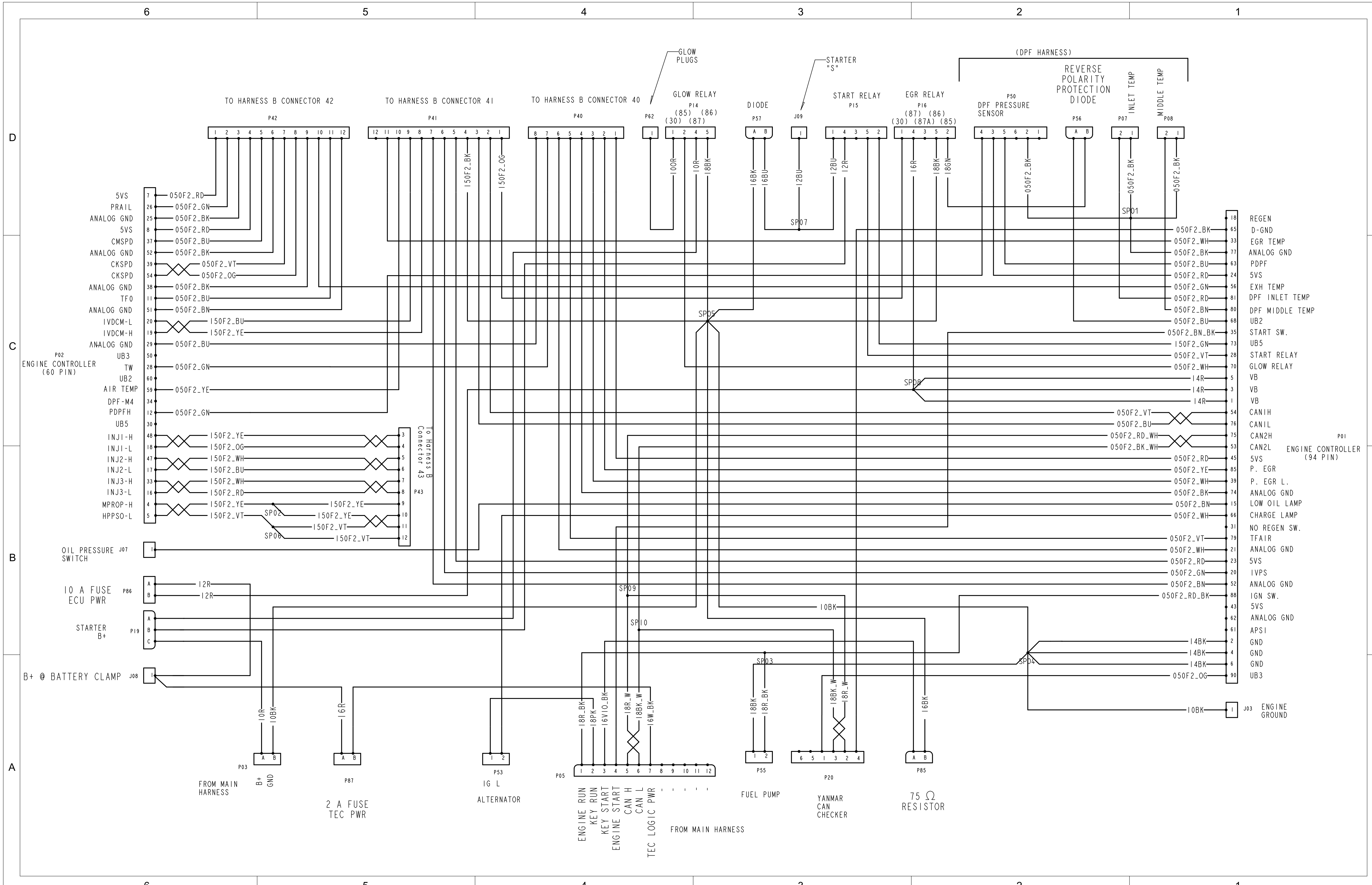


NOTE: THIS DRAWING IDENTIFIES WIRE GAUGE SIZE AND WIRE COLOR. REFER TO ELECTRICAL DRAWING DESIGNATIONS IN THIS CHAPTER FOR ADDITIONAL INFORMATION.

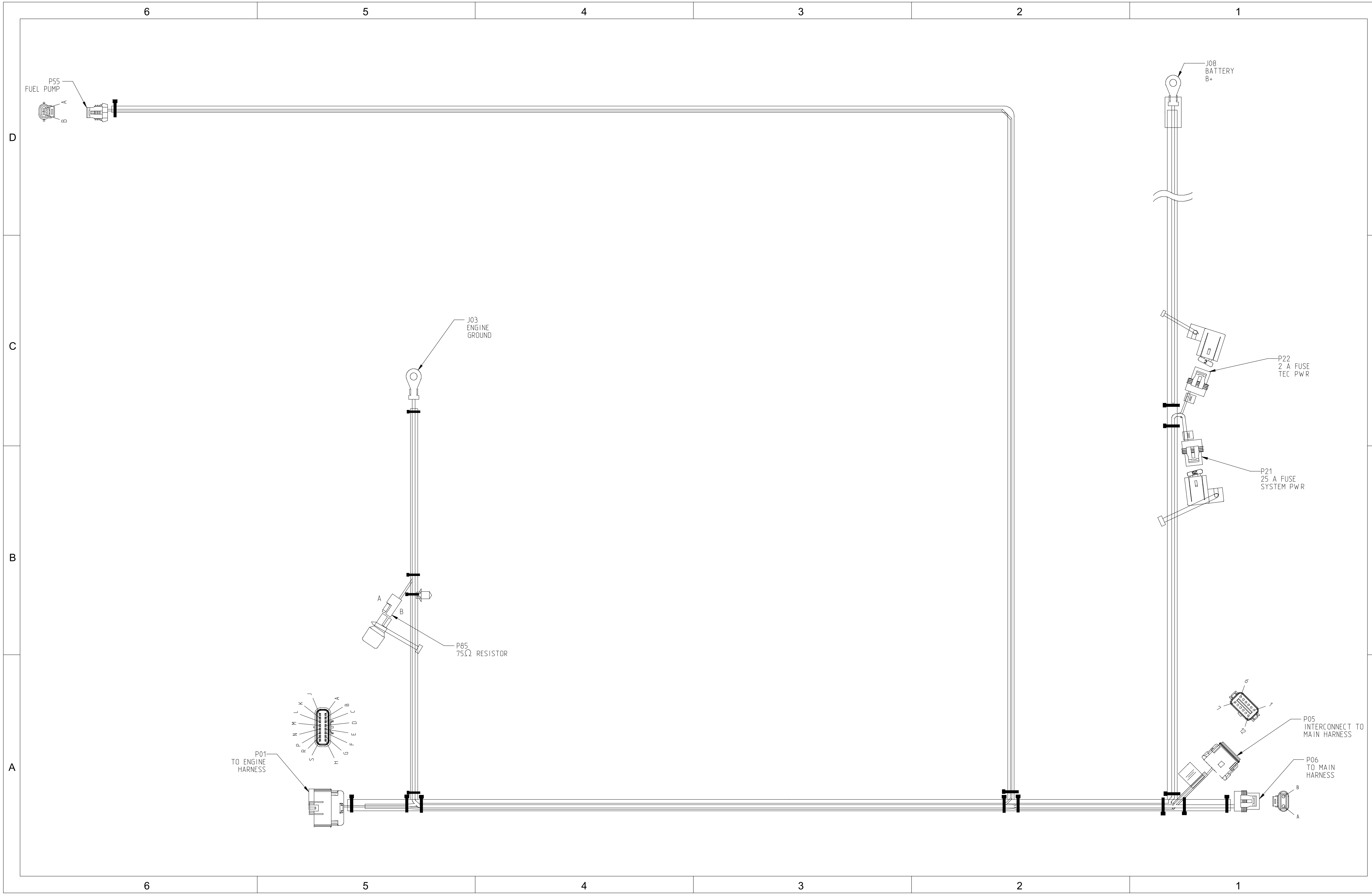
Engine Wire Harness Drawing-5410-D/5510-D/5610-D (Models 03606, 03607, and 03679)

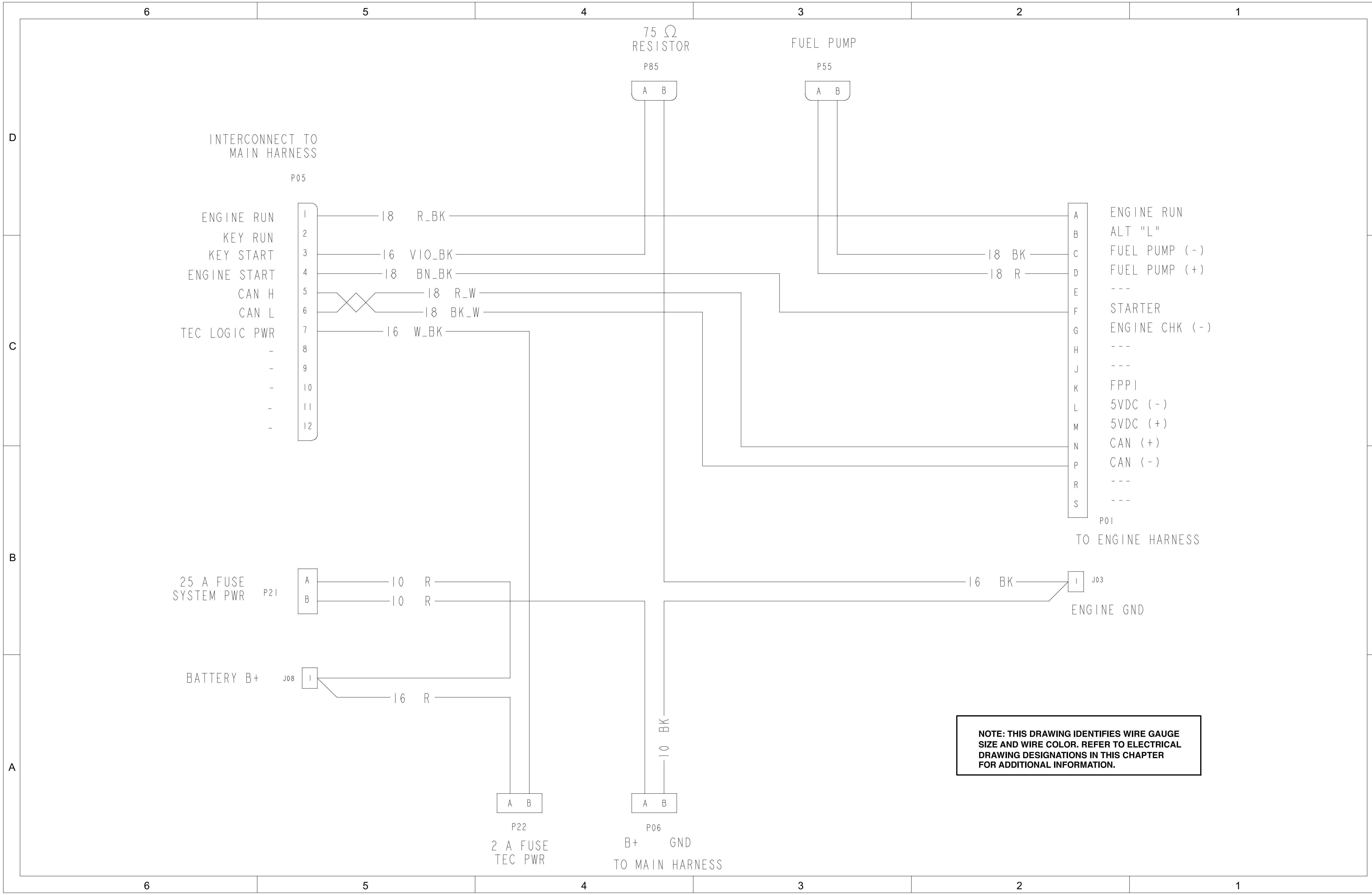


Engine Wire Harness Diagram-5410-D/5510-D/5610-D (Models 03606, 03607, and 03679)



g219148


P55
FUEL PUMP
J08
BATTERY
B+
J03
ENGINE
GROUND
P22
2 A FUSE
TEC PWR
P21
25 A FUSE
SYSTEM PWR
P85
75Ω RESISTOR
P01
TO ENGINE
HARNESS
P05
INTERCONNECT TO
MAIN HARNESS
P06
TO MAIN
HARNESS
g229527


75 Ω RESISTOR
P85
FUEL PUMP
P55
INTERCONNECT TO MAIN HARNESS
P05
ENGINE RUN
KEY RUN
KEY START
ENGINE START
CAN H
CAN L
TEC LOGIC PWR
18 R_BK
16 VIO_BK
18 BN_BK
18 R_W
18 BK_W
16 W_BK
18 BK
18 R
ENGINE RUN
ALT "L"
FUEL PUMP (-)
FUEL PUMP (+)
STARTER
ENGINE CHK (-)
FPPI
5VDC (-)
5VDC (+)
CAN (+)
CAN (-)
P01
TO ENGINE HARNESS
25 A FUSE SYSTEM PWR
P21
10 R
10 R
16 BK
J03
ENGINE GND
BATTERY B+
J08
16 R
10 BK
P22
2 A FUSE TEC PWR
P06
B+ GND
TO MAIN HARNESS
NOTE: THIS DRAWING IDENTIFIES WIRE GAUGE SIZE AND WIRE COLOR. REFER TO ELECTRICAL DRAWING DESIGNATIONS IN THIS CHAPTER FOR ADDITIONAL INFORMATION.
g229526

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Count on it.