Count on it.

Form No. 17230SL Rev D

Service Manual

Greensmaster 3120

© 2018—The Toro® Company
8111 Lyndale Avenue South
Bloomington, MN 55420

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

Revision History

Revision	Date	Description
A	10/2017	Initial issue.
B	01/2018	Added Revision History
C	04/2018	Updated Cutting Unit chapter.
D	05/2020	Added 1 schematic, 1 wire harness, reel restraining, universal groomer shaft repair

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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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 the Greensmaster 3120 (Model 04355).

Refer to the traction unit and cutting unit *Operator's Manuals* for operating, maintenance, and adjustment instructions. Keep a copy of the *Operator's Manuals* and *Parts Catalogs* for your machine with this *Service Manual* for reference. 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 and/or damage to property or equipment.

IMPORTANT

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

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

Overall Dimensions

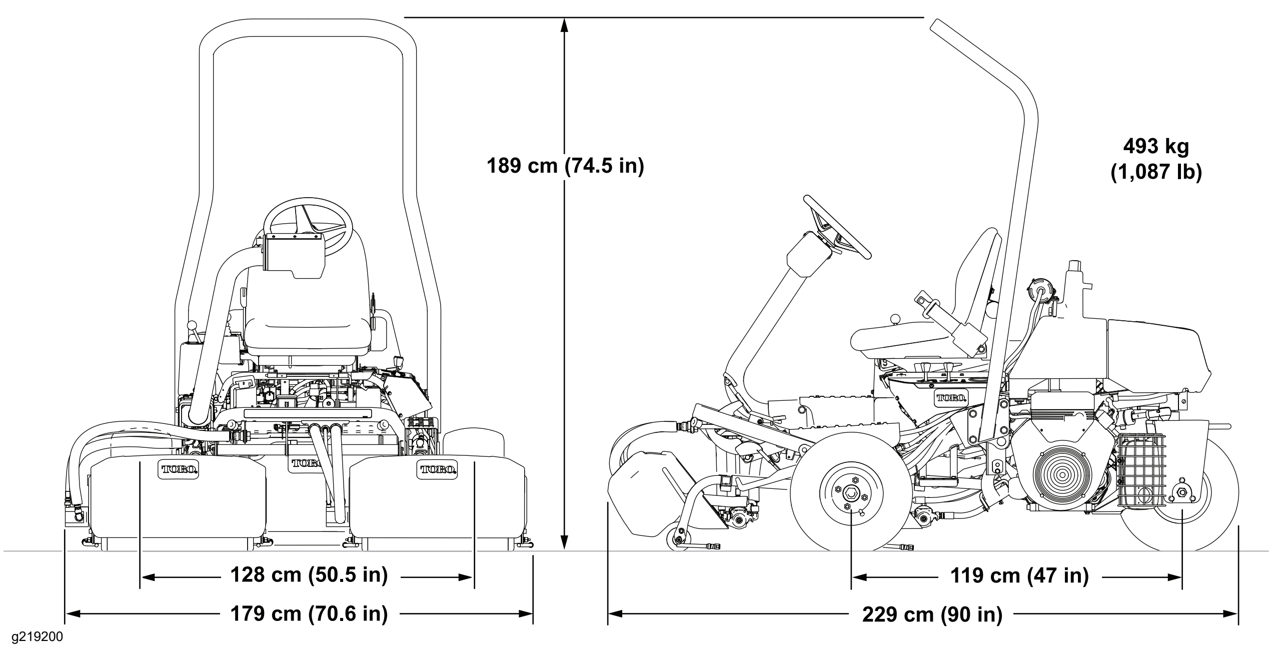


Figure 1

Greensmaster 3120

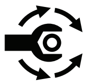
Service Procedure Icons

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 2–4).

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

Briggs & Stratton Vanguard V-Twin OHV Repair Manual

Hydro-Gear® P Series Hydrostatic Pumps Service 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 Greensmaster 3120 machine meets or exceeds safety standard specifications as identified in the *Operator's Manuals*. Although hazard control and accident prevention are dependent partially 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. The improper use or maintenance by the operator or owner of the machine can result in injury.

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 Manuals*, *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. To perform a site survey, follow the procedure outlined in the *Operator's Manuals*.

Before Operating the Machine

- Review and understand the contents of the *Operator's Manuals* and all of the operating and safety decals on the machine before starting and operating the machine. Additional copies of the *Operator's Manuals* are available at www.toro.com.
- Never allow children to operate the machine. Never allow adults to operate the machine without proper instructions.
- Become familiar with the controls and know how to stop the machine and engine quickly.
- 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.
- Always wear substantial shoes. Do not operate machine while wearing sandals, tennis shoes or sneakers. Do not wear loose fitting clothing which could get caught in moving parts and cause personal injury.
- Wearing safety glasses, safety shoes, long pants and a helmet is advisable and required by some local safety and insurance regulations.
- Make sure work area is clear of objects which might be picked up and thrown by the reels.
- Do not carry passengers on the machine. Keep everyone, especially children and pets, away from the area of operation.
- Ensure the safety interlocks are adjusted correctly so that the engine does not start unless the function control lever is in the NEUTRAL position, the traction pedal does not operate when the function control lever is in the NEUTRAL position, the cutting units stop (disengage) if the function control lever is moved to the NEUTRAL or TRANSPORT position, and the engine stops if

the seat is unoccupied or the parking brake is not applied when the function control lever is in the MOW or TRANSPORT position.

- Gasoline (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 a level within an inch of the top of the tank, not the filler neck. Do not overfill the fuel tank.
  - Replace the fuel tank and fuel container caps securely after refuelling the machine.
  - 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

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.

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1. Sit on the seat when starting and operating the machine.
2. Check the safety interlocks daily for proper operation; refer to Checking the Interlock System Operation (page 5–10). Adjust or replace any malfunctioning switches or interlock mechanisms before operating the machine.
3. To start the engine:
   A. Sit on the seat and make sure cutting units are disengaged.
   B. Verify that function control lever is in neutral.
   C. Verify that parking brake is set.
   D. Proceed to start engine.
4. Using the machine demands operator attention. To prevent loss of machine control:
   A. Mow only in daylight or when there is good artificial light.
   B. Watch for holes or other hidden hazards.
   C. Do not drive close to sand traps, ditches, creeks or other hazards.
   D. Reduce speed when making sharp turns. Avoid sudden stops and starts.
   E. Before backing up, look to the rear to be sure no one is behind the machine.
   F. Watch out for traffic when near or crossing roads. Always yield the right-of-way.
   G. Apply the service brakes when going downhill to keep forward speed slow and to maintain control of the machine.
5. Keep hands, feet and clothing away from moving parts and the reel discharge area. The grass baskets must be in place during operation of the reels or thatchers for maximum safety. Shut the engine off before emptying the baskets.
6. Raise the cutting units when driving from one work area to another.
7. Do not touch the engine, muffler or exhaust pipe while the engine is running or soon after it is stopped because these areas could be hot enough to cause burns.
8. If a cutting unit strikes a solid object or vibrates abnormally, stop immediately, turn the engine off, wait for all motion to stop and inspect for damage. A damaged reel or bedknife must be repaired or replaced before operation is continued.
9. Traverse slopes carefully. Do not start or stop suddenly when traveling uphill or downhill.
10. **DON'T TAKE AN INJURY RISK!** When a person or pet appears unexpectedly in or near the mowing area, **STOP MOWING**. Careless operation, combined with terrain angles, ricochets or improperly positioned guards can lead to thrown object injuries. Do not resume mowing until the area is cleared.
11. Before getting off the seat:

While Operating the Machine (continued)

A. Make sure the cutting units are disengaged.

B. Verify that function control lever is in neutral.

C. Set the parking brake.

D. Lower the cutting units to the ground.

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

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

Maintenance and Service

- Before servicing or making any adjustments to the machine, lower the cutting units, 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.
- Wear gloves and use caution when checking or servicing the cutting units.
- 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 system 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 units completely, and then shutting off the engine.
- Use eye protection when working on the hydraulic system and its components.
- To reduce potential fire hazards, keep the engine area free of excessive grease, grass, leaves, and dirt. Never wash a warm engine or electrical connections with water.
- Check all fuel lines for tightness and wear on a regular basis. Tighten or repair fuel lines as needed.
- 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 units and other moving parts. Keep bystanders away.
- Do not over-speed 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 batteries 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 the battery.
- Battery gases can explode. Keep cigarettes, sparks, and flames away from the battery.
- If major repairs are necessary, contact your Authorized Toro Distributor.
- 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.
- When changing the attachments, tires, or performing other service; refer to Jacking Instructions (page 1–7).

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:

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

Raising the Machine

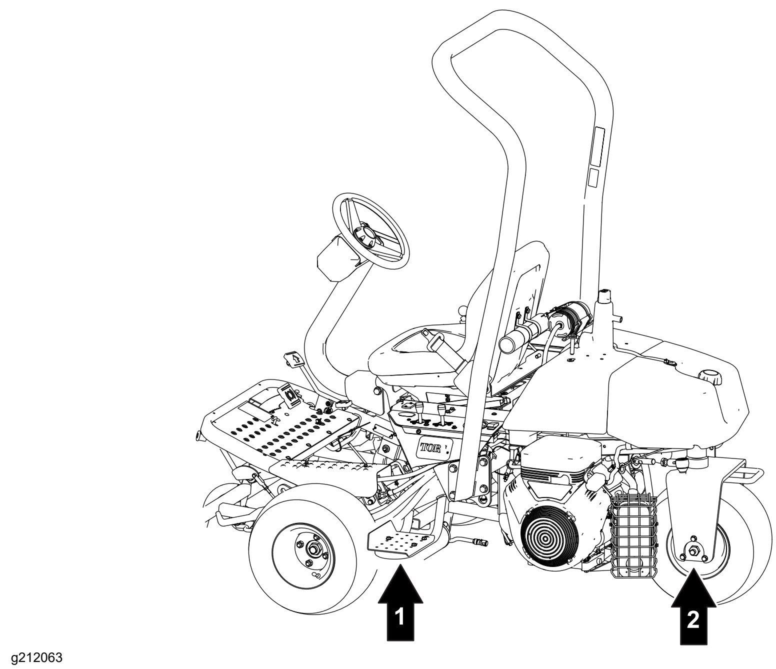

Figure 2

1. Left front jacking point (frame channel under the step behind the left front wheel)
2. Rear jacking point (rear wheel caster fork)

Raising the Machine (continued)

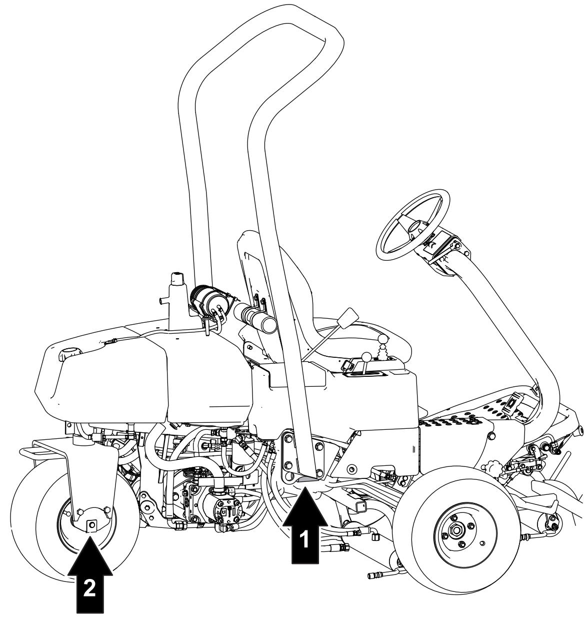

Figure 3

1. Right front jacking point (Roll Over Protection System “ROPS” support bracket behind the RH front wheel)
2. Rear jacking point (rear wheel caster fork)

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1. Lower the cutting units, set the parking brake and block the rear wheel with a chock to prevent the machine from moving.
2. Position the jack securely under the desired front jacking point:
3. After raising the front of the machine, use the appropriate jack stands under the frame as close to the wheel as possible to support the machine.

Safety and Instructional Decals

Numerous safety and instructional decals are affixed to the traction unit and the cutting units of the Greensmaster 3120. If any decal becomes illegible or damaged, replace it with a new decal. Part numbers are listed in your *Parts Catalog* and *Operator’s Manual*. Order replacement decals from your Authorized Toro Distributor

Chapter 2

Specifications and Maintenance

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Specifications

Insert a copy of the *Operator's Manuals* and *Parts Catalogs* for your machine (traction unit and cutting units) 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 these publications when performing regular equipment maintenance. 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
		31/64	0.484375	12.303			63/64	0.984375	25.003

Decimal and Millimeter Equivalents (continued)

Fractions			Decimals	mm	Fractions			Decimals	mm
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	Ounces	Milliliters	29.57
	Quarts	Liters	0.946
	Gallons	Liters	3.785
Liquid Flow	Gallons/Minute	Liters/Minute	3.785
Temperature	Fahrenheit	Celsius	Subtract 32 then multiply by 0.555

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 or fasteners with a wet thread locking compound applied** 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.

Calculating the Torque Values When Using a Drive-Adapter Wrench

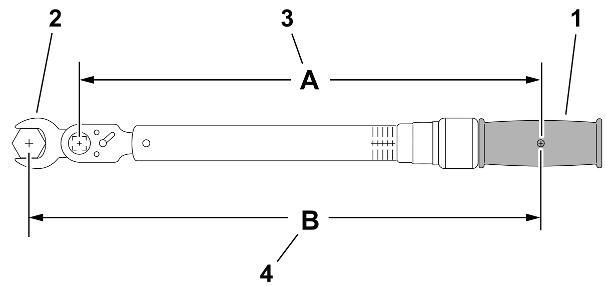


Figure 4

Torque Conversion Factor = A / B

1. Torque wrench
2. Drive-adapter wrench (crowsfoot)
3. A (effective length of torque wrench)
4. B (effective length of torque wrench and drive-adapter wrench)

Using a drive-adapter wrench (e.g., crowsfoot) in any position other than 90º and 270º 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; refer to Figure 4 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 (A = 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 (B = distance from the center of the handle to the center of the drive-adapter wrench) is 483 mm (19 inches).

Calculating the Torque Values When Using a Drive-Adapter Wrench (continued)

The calculated torque conversion factor (A/B) for this example would be 18/19 or 0.947.

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

Identifying the Fastener

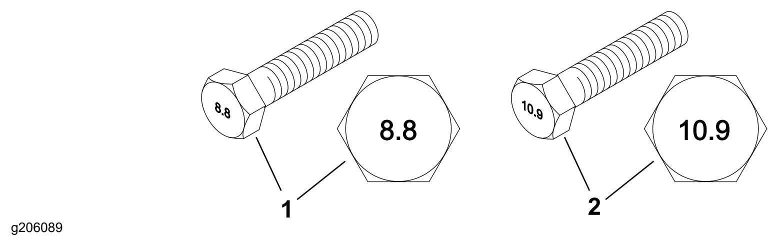


Figure 5

Metric Bolts and Screws

1. Class 8.8
2. Class 10.9

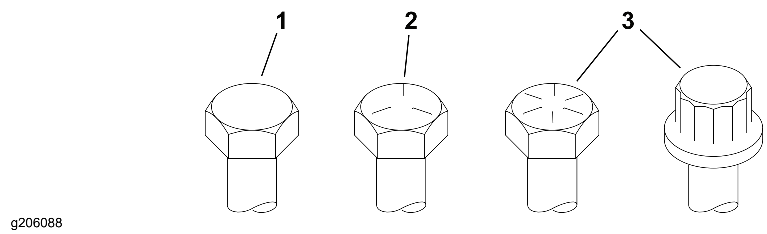


Figure 6

Inch Series Bolts and Screws

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

Fasteners with a Locking Feature

IMPORTANT

If a fastener with a locking feature or previously applied thread locking compound is reused, clean the fastener threads and apply new thread locker to the fastener during installation.

Locking features are designed to create friction and prevent a fastener from loosening. Locking features can be found on externally or internally threaded fasteners. Common examples are plastic inserts incorporated into the fastener and pre-applied “dry” thread locking compound. Keep in mind, a fastener with a locking feature usually means there will be friction during initial installation and removal.

Toro recommends replacing fasteners with a locking feature once they have been removed because the effectiveness of the locking feature diminishes with each reuse. If it is necessary to reuse a fastener with a locking feature; apply a thread locking compound (Loctite for example) to the fastener during installation. Use the appropriate strength and type of thread locking compound based on application, fastener size or information found in the product *Operators Manual*, *Service Manual* or *Installation Instructions*.

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

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: 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.

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 locking compound such as Loctite.

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

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: 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.

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 locking compound such as Loctite.

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

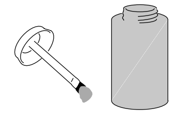
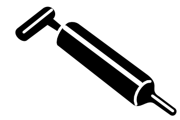
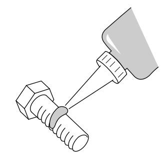
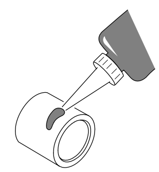
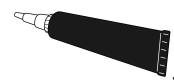
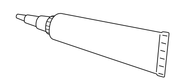
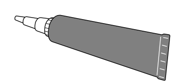
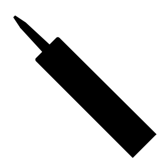
N·m X 0.7376 = ft-lb

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 before 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 (Threadlocker) 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 before 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 before 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 -51°F to 232°C (-60°F to 400°F), while high temperature variants can preform in temperatures up to 343°C (650°F).	

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

K-Line 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

K-Line 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

K-Line 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

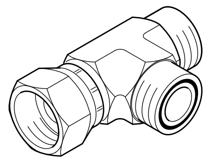
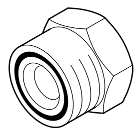
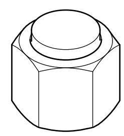
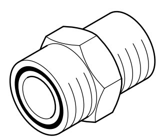
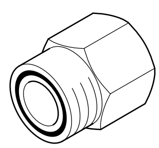
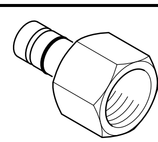
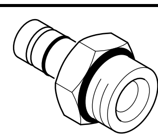
K-Line Part No. TOR6007

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

K-Line 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

K-Line 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 2–12).

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

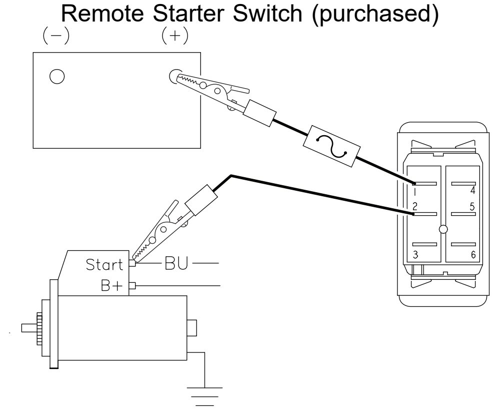
After flushing the hydraulic system or replacing a hydraulic component (e.g. gear pump, piston pump, drive motor), it is necessary to prime the hydraulic pumps. A remote starter switch can be used for this purpose. A remote starter switch can be purchased locally or fabricated as follows.

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.

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



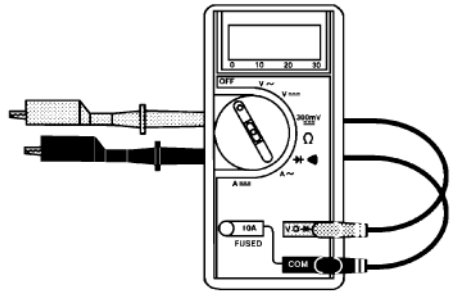
Remote Starter Switch (fabricated)

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.

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, disconnect 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.

Wheel Hub Puller

Wheel Hub Puller (continued)

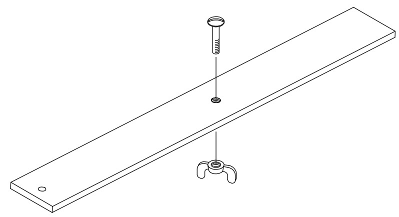
K-Line Part No. TOR4097

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

Gauge Bar Assembly

Toro Part No. 94–9010

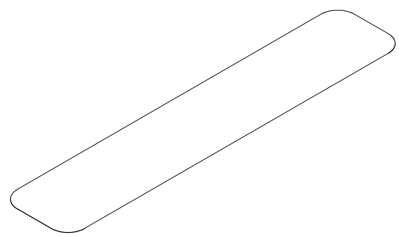
Use gauge bar to verify height-of-cut adjustment.



Cutting Reel Shim

Toro Part No. 125–5611

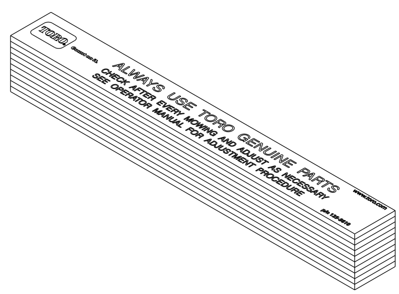
Use the 0.05 mm (0.002 in) shim like a feeler gauge to measure the gap between the reel and the bedknife during reel adjustment.



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.



Reel Drive Shaft

K-Line Part No. TOR4112

Use the drive shaft for rotating the reel during cutting unit adjustment or any time the cutting unit motor is removed.

Reel Thread Repair Taps

15/16–16 Right-Hand Thread – Toro Part No. 137–0926

15/16–16 Left-Hand Thread – Toro Part No. 137–0927

Use to clean or repair the internal threads of cutting unit reels.

Backlapping Brush Assembly

Toro Part No. 29–9100

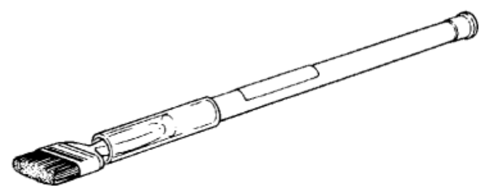
For applying lapping compound to cutting units while keeping hands a safe distance from the rotating reel.

Components for the brush assembly are also available individually.

Brush 36-4310

Handle 29-9080

Handle cap 2410-18



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 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.

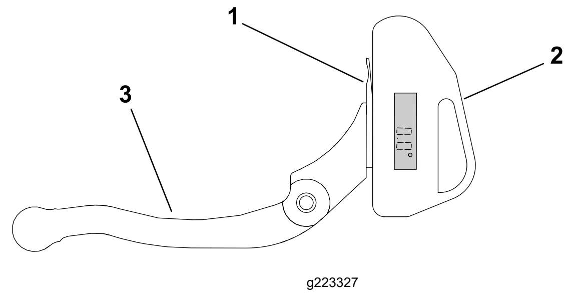


Figure 7

1. Bedknife
2. Angle Indicator
3. Bedbar

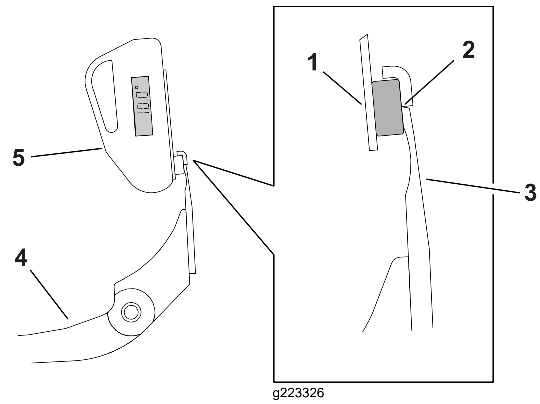


Figure 8

1. Angle indicator surface
2. Magnetic mount
3. Bedknife
4. Bedbar
5. Angle indicator

Bedknife Screw Tool

K-Line 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.

Diameter/Circumference Measuring Tape

Diameter/Circumference Measuring Tape (continued)

K-Line Part No. TOR6023

Spring steel measuring tape for accurately measuring the circumference and outside diameter of cutting reel and other spherical components. Tape calibration is in fixed inch readings (no adjustments).

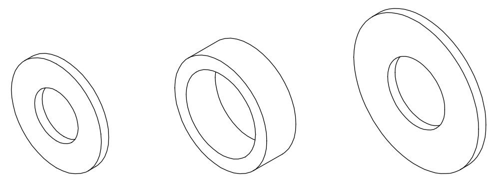
Roller Rebuilding Tools

The following combination of washers and spacers can be used to install bearings and seals into the front and rear rollers (2 each required).

Bearing installation washer: 107-8133 (black)

Seal installation spacer: 107-3505

Seal installation washer: 104-6126 (yellow)



107-8133 **107-3505** **104-6126**

K-Line Part No. TOR4105

As an alternative to using the washers and spacer listed above, this special tool set can be used to install bearings and seals into the front and rear rollers.

Turf Evaluator Tool

Toro Part No. 04399

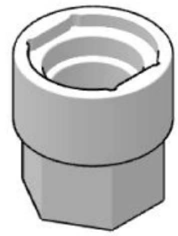
Many turf discrepancies are subtle and require closer examination. In these instances, the Turf Evaluator grass viewing tool is helpful. It can assist turf managers and service technicians in determining causes for poor reel mower performance and in comparing the effective height-of-cut of one mowed 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) available from your local authorized Toro Distributor.

Drive Shaft Removal Tool

Drive Shaft Removal Tool (continued)

Toro Part No. 137-0920

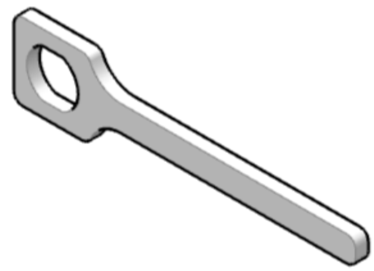
Use to remove the optional Universal Groomer drive shaft from the reel if the drive shaft hex is damaged.



Adapter Wrench

Toro Part No. 137-0921

Use to hold the optional Universal Groomer drive shaft securely when removing or installing the drive adapter.



Syringe – 50cc (2 ounce)

Toro Part No. 137-0872

Aids in accurately filling the optional Universal Groomer gear box with oil.

Chapter 3

Engine

Table of Contents

Additional Reference Materials

Briggs & Stratton Vanguard V-Twin OHV Repair Manual

Specifications

Engine

Item	Description
Make/Designation	Briggs and Stratton, 4–cycle, V–Twin Cylinder, OHV, Air Cooled, Gasoline Engine – Model 305447.
Bore	68 mm (2.68 inches)
Stroke	66 mm (2.60 inches)
Total displacement	479 cc^3 (29.2 in^3)
Governor	Mechanical
Carburetor	Float Controlled
Fuel Pump	Pulsating Crankcase Vacuum
Fuel	Refer to the *Traction Unit Operator's Manual*
Fuel tank capacity	26.6 L (7.0 US gallons)
Low idle (no load)	1,650 rpm ± 100
High idle (no load)	2,850 rpm ± 50
Engine oil	Refer to the *Traction Unit Operator's Manual*
Crankcase-oil capacity	1.4 L (1.5 qt) with new filter
Ignition System	Flywheel magneto, twin electronic armatures
Spark Plugs	Champion RC 14YC (or equivalent)
Spark Plug Gap	0.76 mm (0.030 inches)
Alternator/Regulator	12 VDC, 16A
Engine Weight (dry)	38 kg (84 lb)

General Information

This chapter gives information about specifications and repair of the gasoline engine used in the Greensmaster 3120 machine. The general maintenance procedures are described in the *Operator's Manual*. Detailed information on engine troubleshooting, testing, disassembly, and assembly is identified in the *Briggs & Stratton Vanguard V-Twin OHV Repair Manual*.

Most repairs and adjustments require tools which are commonly available in many service shops. Special tools are described in the *Briggs & Stratton Vanguard V-Twin OHV Repair Manual*. The use of some specialized test equipment is explained. However, the cost of the test equipment and the specialized nature of some repairs may dictate that the work be done at an engine repair facility.

Service and repair parts for Briggs & Stratton Vanguard V-Twin OHV engines are supplied through your local Toro distributor. If no parts list is available, be sure to provide your distributor with the Toro model and serial number along with the engine model and serial number.

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.

Briggs & Stratton Repair Manual

The engine that powers your Greensmaster machine is a Briggs & Stratton Model 305447 engine. The *Briggs & Stratton Vanguard V-Twin OHV Repair Manual* is available for this engine. Ensure that the correct engine manual is used when servicing the engine on your machine.

Service and Repairs

Fuel Tank

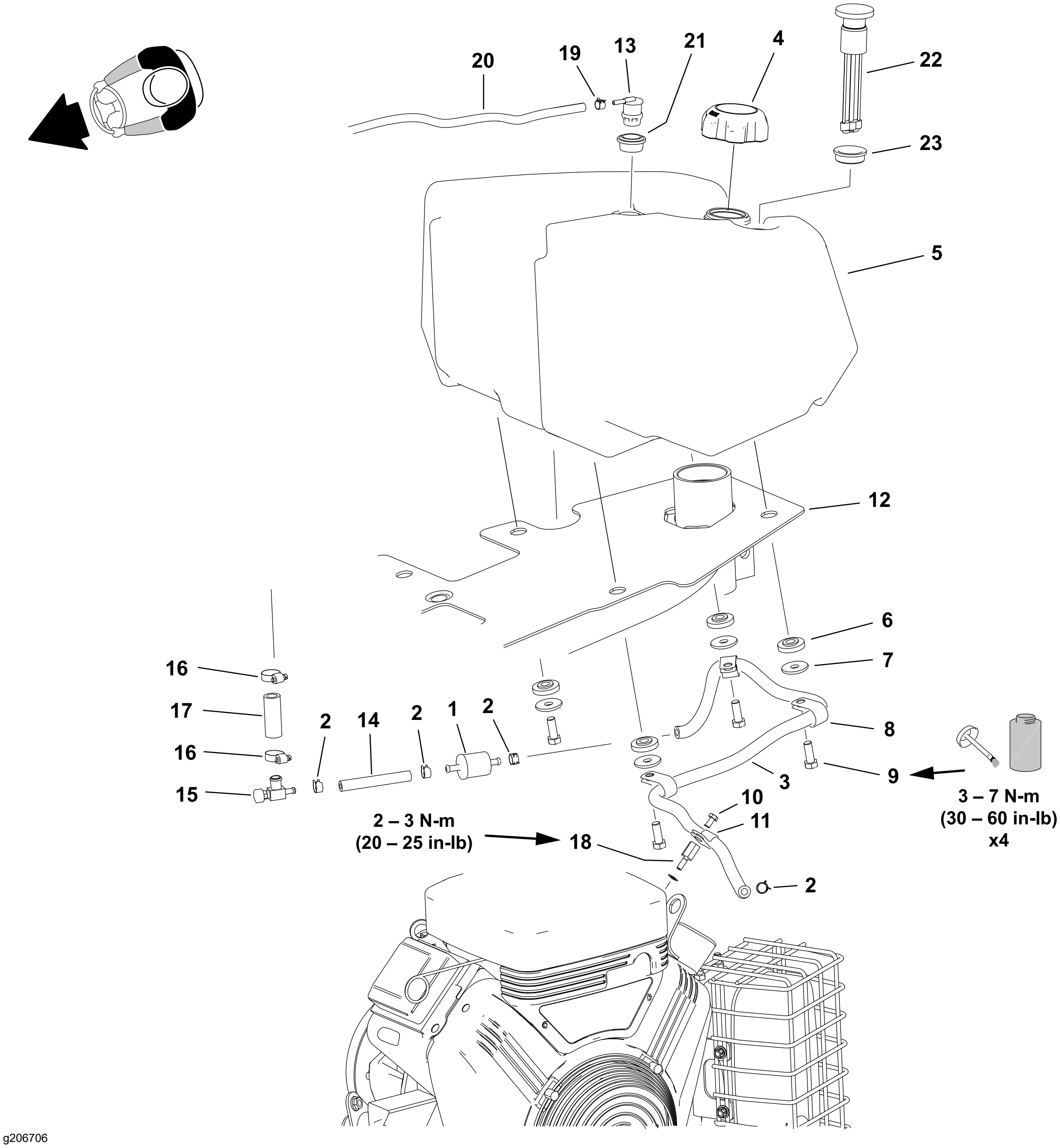


Figure 9

1. Fuel filter
2. Hose clamp (4 each)
3. Fuel hose (filter to engine)
4. Fuel cap
5. Fuel tank
6. Grommet (4 each)
7. Flat washer (4 each)
8. Hose clamp (3 each)
9. Cap screw (4 each)
10. Cap screw
11. Hose clamp
12. Frame
13. Vent fitting
14. Fuel hose (valve to filter)
15. Fuel shut-off valve
16. Hose clamp (2 each)
17. Fuel hose (tank to valve)
18. Spacer
19. Hose clamp
20. Vent hose (tank to canister)
21. Grommet
22. Fuel gauge (if equipped)
23. Grommet (machines with fuel gauge)

DANGER

Gasoline 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 gasoline.**
- **Do not smoke while handling gasoline.**
- **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 gasoline before starting the engine.**
- **Store gasoline in a clean, safety-approved container and keep the cap in place.**
- **Use gasoline as an engine fuel only, not for any other purpose.**

CAUTION

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

Checking the Fuel Lines and Connections

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

Removing the Fuel 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. Allow the engine to completely cool.
3. Drain fuel tank:
   A. Close fuel shut-off valve
   B. Disconnect fuel hose (item 14 in Figure 9) at the fuel shut-off valve and drain any fuel trapped in the fuel filter and fuel hose into a suitable container.
   C. Use a spare length of fuel hose and the fuel shut-off valve to drain fuel tank contents completely into a suitable container.
4. Disconnect the vent hose from the top of the fuel tank.
5. Remove four (4) cap screws, grommets and flat washers securing the fuel tank to the vehicle frame and remove the fuel tank.

Installing the Fuel Tank

IMPORTANT

After fuel tank is installed, make sure that clearance between fuel tank and hydraulic tank is from 3.2 to 9.5 mm (0.125 to 0.375 inches).

1. Secure the fuel tank to the vehicle frame:
   A. Apply anti-seize lubricant to the threads of the four (4) cap screws.
   B. Install the cap screws through the fuel hose clamps, the flat washers and the bushings. Make sure the bushings are between the flat washers and the frame.
   C. Tighten the cap screws from **3.4 to 6.7 N·m (30 to 60 in-lb)**.
2. Connect the fuel hose to the fuel shut-off valve and secure with the hose clamp.
3. Connect the vent hose to the top of the fuel tank and secure with the hose clamp. Make sure that the hose is not kinked or obstructed.
4. Open the fuel shut-off valve and fill the fuel tank with fuel.
5. Check the fuel system for leaks and repair as necessary before returning the machine to service.

Engine

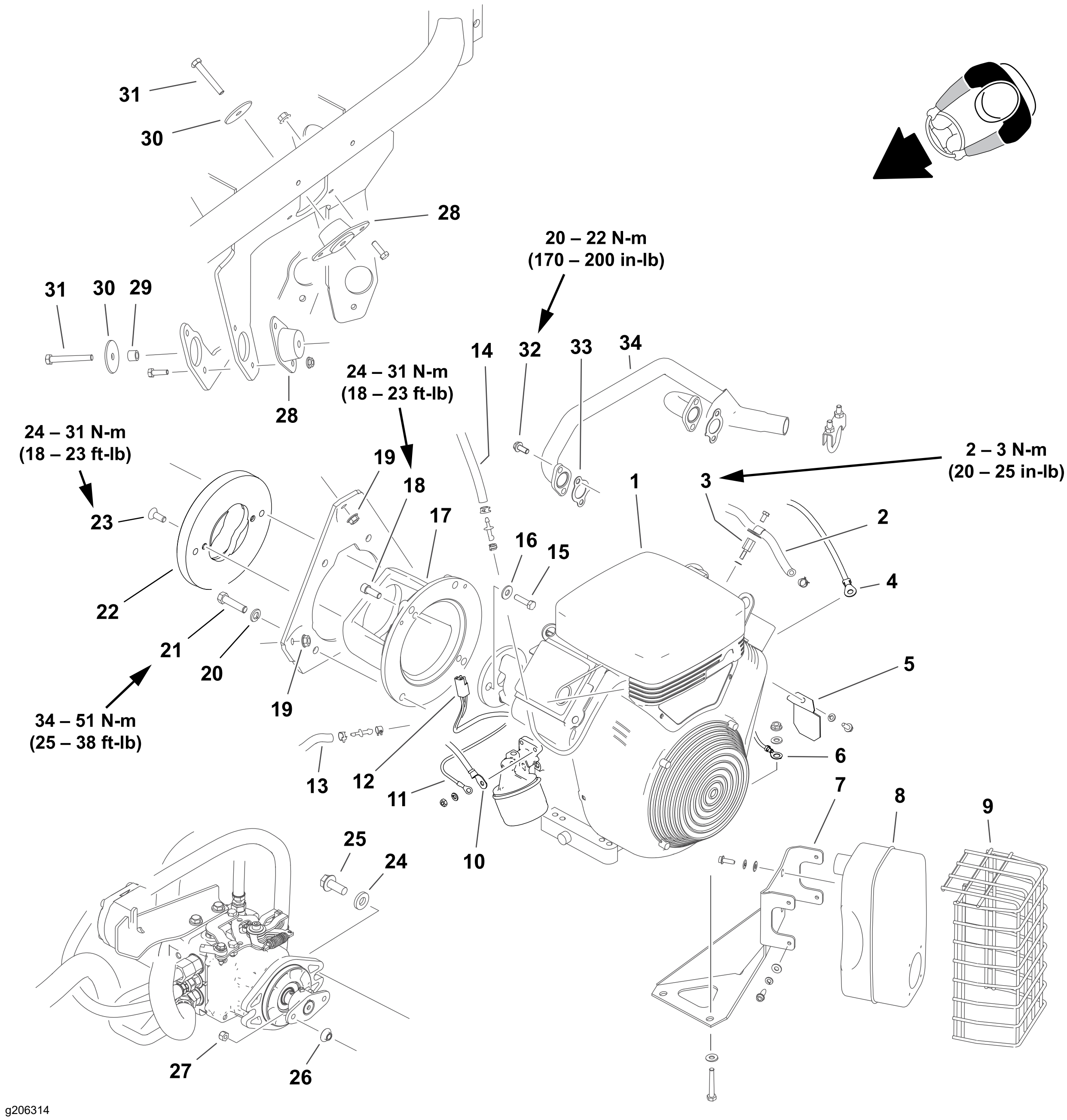


Figure 10

1. Engine
2. Fuel hose and clamp
3. Spacer
4. Positive (+) cable
5. Regulator shield
6. Regulator ground
7. Muffler bracket
8. Muffler
9. Muffler guard
10. Ground (-) cable
11. Engine wire harness ground
12. Engine wire harness
13. Evaporative system hose (air cleaner to tee)
14. Evaporative system hose (manifold to canister)
15. Cap screw (2 each)
16. Flat washer (2 each)
17. Pump adapter
18. Socket head screw (2 each)
19. Flange nut (3 each)
20. Lock washer (4 each)
21. Cap screw (4 each)
22. Adapter plate
23. Flat head screw (2 each)
24. Hardened washer (2 each)
25. Flange head screw (2 each)
26. Spacer (2 each)
27. Lock nut (2 each)
28. Engine mount (3 each)
29. Spacer (2 each)
30. Flat washer (2 each)
31. Cap screw (3 each)
32. Flange head screw (4 each)
33. Exhaust gasket (2 each)
34. Exhaust manifold

Removing the Engine

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. Close fuel shut-off valve below fuel tank.
3. Disconnect the negative (–) battery cable at the battery.
4. Remove the fuel hose and clamp (item 2 in Figure 10) and disconnect the fuel hose at the fuel pump. Drain any fuel trapped in the fuel filter and hose into a suitable container.
5. Disconnect the fuel evaporative system hoses (items 13 and 14 in Figure 10) from the engine
6. Disconnect the electrical system wiring from the engine:
   - The engine wire harness connector at the main wire harness
   - The battery ground (-) cable near the oil filter
   - The battery positive (+) cable at the starter
7. Disconnect the choke and throttle cables from the engine.
8. Remove the two (2) cap screws (item 15 in Figure 10), the flat washers and the lock nuts securing the pump hub to the drive coupler.
9. Support the pump assembly and remove the two (2) cap screws and the hardened washers securing the pump assembly to the adapter plate. It should not be necessary to disconnect the hydraulic hoses or traction cable from the pump assembly.

⚠ CAUTION ⚠

The engine assembly weighs approximately 45 kg (100 lb). Use an appropriate lift to support the engine assembly.

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10. Support the engine assembly and remove the three (3) engine mount flange nuts, the cap screws and the flat washers. Locate and retrieve the two (2) spacers used on the lower engine mounts.
11. Carefully move the engine away from the pump assembly until the pump hub clears the adapter plate. Locate and retrieve the two (2) spacers in the drive coupler.
12. Continue to disassemble the engine as necessary.

Installing the Engine

IMPORTANT

Ensure that all parts removed from the engine during maintenance are installed.

1. If the exhaust manifold was removed during maintenance, use new exhaust gaskets and tighten the manifold screws from **20 to 22 N·m (170 to 200 in-lb)**.

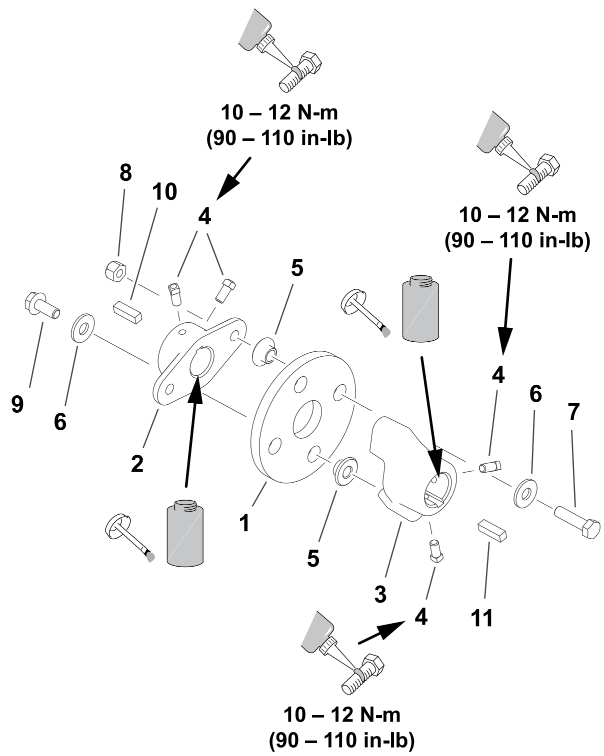

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Figure 11

1. Rubber coupler
2. Pump hub
3. Engine hub
4. Set screw (4 each)
5. Spacer (4 each)
6. Flat washer (4 each)
7. Cap screw (2 each)
8. Lock nut (2 each)
9. Flange head screw (2 each)
10. Square key – pump
11. Square key – engine

2. If the engine hub or the pump hub was removed (Figure 11), apply anti-seize lubricant to the bore of the hub and install the hub and key. Apply medium strength thread locker to the hub set screws and tighten from **10 to 12 N·m (90 to 110 in-lb)**.

   Note: Do Not tighten the engine hub set screws until **after** the engine and the pump have been installed on the machine.

CAUTION

The engine assembly weighs approximately 45 kg (100 lb). Use an appropriate lift to support the engine assembly.

Installing the Engine (continued)

IMPORTANT

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

3. Move the engine assembly into position and loosely install the three (3) engine mount cap screws (item 31 Figure 10) with flat washers, spacers (bottom engine mounts only) and flange nuts.
4. Secure the pump assembly to the adapter plate with two (2) cap screws and hardened washers.
5. Secure the pump hub to the drive coupler with two (2) spacers, cap screws and flat washers. If previously removed, tighten engine hub set screws from **10 to 12 N·m (90 to 110 in-lb)** at this time.
6. Tighten the three (3) engine mount cap screws.
7. Connect and adjust the choke control cable and the throttle control cable.
   A. Set the choke control at the operator control panel to the full choke position, and set the choke lever at the carburetor to the full closed position before securing the choke control cable clamp.
   B. Set the throttle control at the operator control panel to the fast position, and set the throttle linkage at the carburetor against the high speed stop before securing the throttle control cable clamp.
8. Connect the electrical system wiring to the engine:
   - The engine wire harness connector at the main wire harness
   - The battery ground (-) cable near the oil filter
   - The battery positive (+) cable at the starter
9. Connect the fuel evaporative system hoses (items 13 and 14 in Figure 10) to the engine
10. Install the fuel hose and clamp (item 2 in Figure 10). Open the fuel shut-off valve and check fuel hose for leaks.
11. Ensure that all the hoses, tubes, and wires are clear of moving parts and secured to their original locations.
12. Connect the negative (-) battery cable at the battery.
13. Check engine oil level and adjust if necessary; refer to traction unit *Operator's Manual*.
14. Operate the machine and check for proper operation, hydraulic fluid leaks and fuel leaks before returning the machine to service.

Evaporative Control System

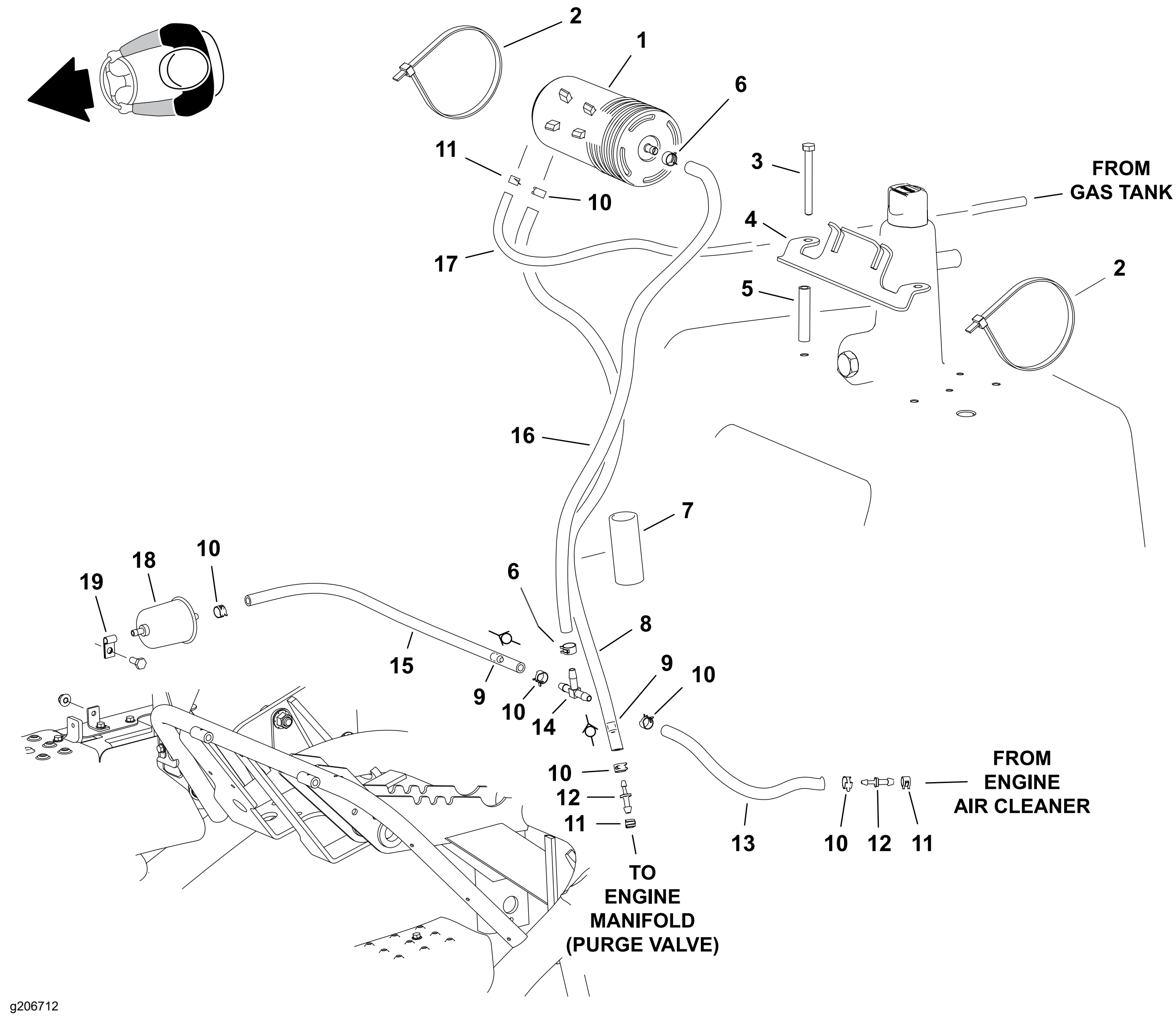

Figure 12

1. Carbon canister
2. Tie wrap (2 each)
3. Cap screw (2 each)
4. Bracket
5. Spacer (2 each)
6. Hose clamp (2 each)
7. Convoluted tubing
8. Vent hose (canister to engine)
9. Check valve (2 each)
10. Hose clamp (5 each)
11. Hose clamp (3 each)
12. Barb fitting (2 each)
13. Vent hose (tee to engine)
14. Tee
15. Vent hose (filter to tee)
16. Vent hose (canister to tee)
17. Vent hose (tank to canister)
18. Fresh air filter
19. Clamp

Greensmaster 3120 machines are equipped with a fuel evaporative control system designed to collect and store evaporative emissions from the fuel tank. The evaporate control system uses a carbon canister and a series of vent hoses to collect these evaporative emissions. The fuel tank uses a non-vented fuel cap. A fuel tank vent fitting is positioned in the top of the tank that allows tank venting through the carbon canister. Fuel vapors from the fuel tank are vented to the canister and consumed by the engine when the engine is running.

Note: If there is restriction in the carbon canister, the fuel tank vent fitting or the vent hose, 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.

Evaporative Control System (continued)

The carbon canister is mounted on the hydraulic tank. The evaporative system includes two (2) connections to the engine: one to the engine purge valve near the intake manifold and one to the air cleaner. The evaporative control system vent hose assembly between the engine purge valve and the carbon canister (item 8 Figure 12) and the vent hose between the fresh air filter and the tee fitting (item 15 Figure 12) include check valves to control the direction of flow.

Note: The purge hose assembly and fresh air hose assembly include a check valve as a component of the hose assembly. The check valve is not available separately. To ensure proper operation of the check valves, do not attempt to remove them from the hose assembly. If either hose assembly is removed, verify the location of the check valve to make sure the hose is installed correctly, ensuring proper evaporative control system operation; refer to Figure 12.

Disassembly

⚠ DANGER ⚠

Gasoline 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 gasoline.**
- **Do not smoke while handling gasoline.**
- **Always wipe up any spilled gasoline before starting the engine.**

1. Inspect carbon canister and attached hoses for damage or obvious leaks. A damaged or leaking canister should be replaced.
2. Remove evaporative system components as necessary.

Assembly

Note: If either vent hose (items 8 or 15 in Figure 12) are removed, verify the location of the check valves to make sure the hoses are installed correctly, ensuring proper evaporative control system operation.

Install all evaporative control system components previously removed. Ensure all evaporative control system hoses are not kinked or pinched and are secured at each end with hose clamps.

Chapter 4

Hydraulic System

Table of Contents

Additional Reference Materials

Hydro-Gear® P Series Hydrostatic Pumps Service 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

Item	Description
Piston (traction) pump (P1) Maximum pump displacement	Hydro Gear variable displacement piston pump 21.8 cc (1.33 in^3/rev) per revolution
Gear pump Front section (P2) displacement Rear Section (P3) displacement	Casappa two section, positive displacement gear type pump 9.5 cc (0.58 in^3) per revolution 5.4 cc (0.33 in^3) per revolution
Wheel motors	Parker TF Series orbital rotor motor, 169 cc (10.3 in^3) per revolution
Cutting unit reel motors	Casappa gear motor, 12 cc (0.73 in^3) per revolution
Steering control valve	Sauer/Danfoss Steering Unit Type OSPM distributor valve with rotary meter
Relief pressures Traction circuit (in piston pump) Steering and cutting unit lift (in steering control valve) Cutting unit lower R2) Cutting unit reels (R1)	 20,000 kPa (2900 psi) 8000 kPa (1160 psi) above charge pressure 1724 kPa (250 psi) above charge pressure 20,700 kPa (3000 psi)
Hydraulic filter	Spin-on cartridge type
Hydraulic fluid	Refer to the *Traction Unit Operator's Manual*
Hydraulic tank	18.9 L (20 US qt.)

General Information

Traction Unit Operator's Manual

The traction unit and cutting unit *Operator's Manuals* provide information regarding the operation, general maintenance and maintenance intervals for the Greensmaster 3120 machine. Refer to these publications for additional information when servicing the machine.

Relieving Pressure from the Hydraulic System

Release all the pressure in the hydraulic system before performing any work on the hydraulic system.

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

1. Move the machine to a level surface.
2. Lower the cutting units fully.
3. Engage the parking brake.
4. Turn the key switch to the OFF position and allow the engine to stop.
5. Make sure all electrically operated control valves are actuated by setting the key switch to the RUN position but Do Not start the engine.
6. Press the traction pedal to the full FORWARD and the full REVERSE positions.
7. Move the joystick to the RAISE and LOWER positions
8. Turn the steering wheel in both the LEFT and the RIGHT directions.
9. Turn the key switch to the OFF position.

Note: Turning the steering wheel with the engine off may unseat the relief valve in the steering control valve. If the steering or the lift circuits appear sluggish or inoperative after the machine is returned to service, repeat relieving the hydraulic system pressure procedure.

Towing the Traction Unit

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

IMPORTANT

Do not tow the machine faster than 2 to 3 mph. Drive system damage may occur it the machine is towed too fast of for too far. If the machine must be moved a considerable distance, transport it on a truck or trailer.

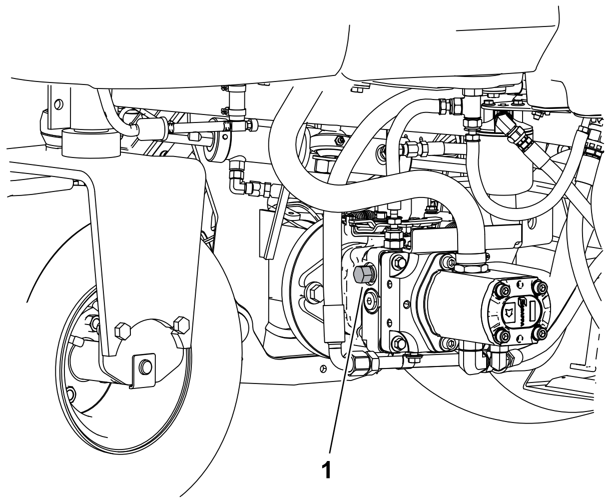

Figure 13

1. By-pass valve

1. Locate the by-pass valve on the rear of the piston pump (access from right side of machine Figure 13) and rotate the valve counter-clockwise 2 full turns.

IMPORTANT

Do not start the engine when the bypass valves are open.

2. After towing and before starting the engine, close the by-pass valve by rotating it clockwise until seated.

Traction Circuit (Closed Loop) Component Failure

The traction circuit of the Greensmaster 3120 machine is a closed loop circuit which includes the piston (traction) pump and two (2) wheel motors. If a component in the traction circuit should fail, unwanted material and contamination from the damaged component will circulate throughout the traction circuit. This contamination can damage other components in the circuit. The contamination must be removed as soon as possible to prevent additional component failure.

The recommended method of removing contamination from the traction circuit is to temporarily install a Toro high flow hydraulic filter into the traction circuit; refer to High Flow Hydraulic Filter Kit (page 4–29). If a traction circuit failure is suspect, the filter should be installed before connecting hydraulic test gauges to test traction circuit components or after replacing a failed traction circuit component. The filter will ensure that contaminates are removed from the closed loop traction circuit and thus, prevent additional component damage.

Once the Toro high flow hydraulic filter kit has been placed in the traction circuit, raise and support the machine with the front wheels off the ground. Then, operate the traction circuit to allow fluid flow throughout the circuit. The filter will remove contamination from the traction circuit during operation. Because the Toro high flow filter is bidirectional, the traction circuit can be operated in both the forward and reverse direction. The filter should be removed from the machine after contamination has been removed from the traction circuit. Refer to Filtering the Closed-Loop Traction Circuit (page 4–76) for additional information on using the Toro high flow hydraulic filter.

Note: If traction circuit contamination exists, the traction pump case drain could allow contaminates to enter other hydraulic circuits on the machine.

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

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 and repair or replace them as necessary. Hoses that move during normal machine operation (cutting unit drive motors for example) should be replaced every 2 years. Check hydraulic hoses for the following signs of deterioration or damage:

- Hydraulic hoses should not be hard, cracked, cut, abraded, charred, leaking, or otherwise damaged.
- Hydraulic hoses should not be kinked, crushed, flattened, or twisted.
- Hydraulic hose covers should not be blistered, soft, degraded, or loose.
- Hydraulic hose fittings should not be cracked, damaged, or badly corroded.

WARNING

Release all pressure in the hydraulic system before performing any work on the hydraulic system; refer to Relieving Pressure from the Hydraulic System (page 4–4).

- **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.**

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 two wrenches, hold the hose straight with one wrench and tighten the hose swivel nut onto the fitting with the other wrench; refer to Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 4–8).

Note: If the hose has an elbow at one 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 the Toro Basics Series Training Book *Hydraulic Hose Servicing* (Part No. 94813SL).

Installing Hydraulic Hoses and Tubes (O-Ring Face Seal)

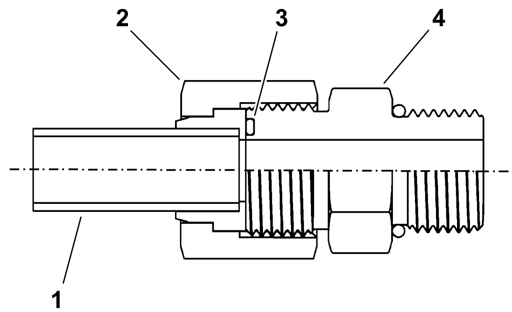

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Figure 14

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

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.
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 14).
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 4–9). 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 2–4).

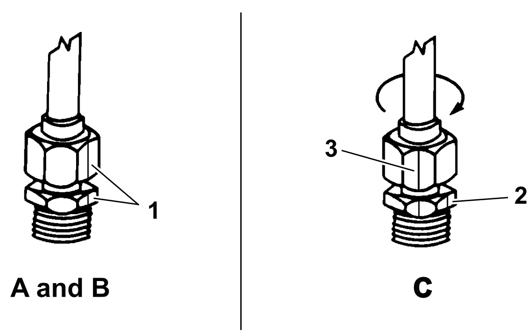

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Figure 15

1.	Mark swivel nut and fitting body	2.	Initial position	3.	Final position

Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (continued)

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

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.

   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 (item 1 Figure 15). If connecting a hose, hold the hose in alignment with a wrench to prevent the hose from turning.

   C. Use a wrench to tighten the nut to the correct Flats From Wrench Resistance (compare items 2 and 3 in Figure 15).

Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings)

Installing a Non-Adjustable Fitting

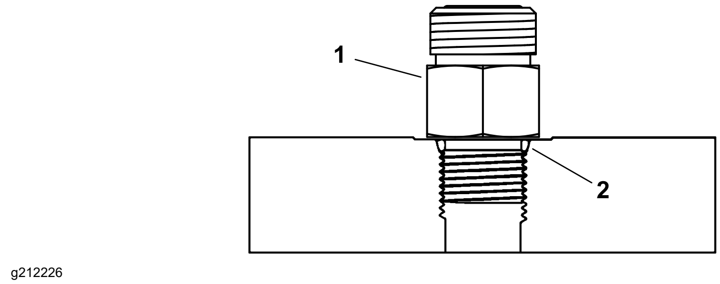

Figure 16

1. Fitting
2. O-ring

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

IMPORTANT

Before tightening the fitting, determine the material used for the port the fitting is being installed in. Installing a fitting into an aluminum port requires reducing the 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 4–12).

   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 2–4).

5. If a torque wrench is not available or if space at the port prevents the use of a torque wrench, use the Flats From Finger Tight (FFFT) procedure 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 value; refer to the Flats From Finger Tight (FFFT) Table (page 4–12).

   C. If the port material is aluminum, tighten the fitting to 60% of the listed value; refer to the Flats From Finger Tight (FFFT) Table (page 4–12).

Installing an Adjustable Fitting

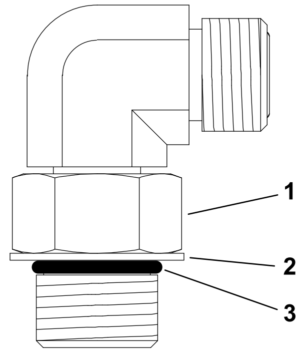

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Figure 17

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

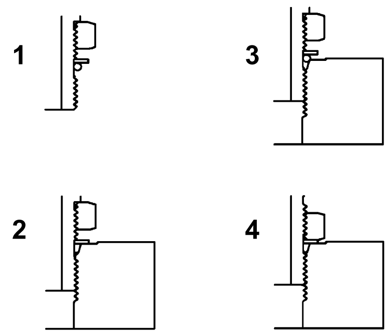

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Figure 18

1. Step 1: clearance the lock nut
2. Step 2: seat the back-up washer
3. Step 3: align the fitting
4. Step 4: tighten the lock nut

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.
3. Lightly lubricate the O-ring with clean hydraulic fluid. Ensure that the threads of the fitting are clean with no lubricant applied.
4. Turn back the lock nut 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 18).
5. Install the adjustable fitting into the port by hand until the washer contacts the face of the port (Step 2 in Figure 18).
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 18). Do not rotate the adjustable fitting more than 1 turn counterclockwise.

IMPORTANT

Before tightening the fitting, determine the material used for the port the fitting is being installed in. Installing a fitting into an aluminum port requires reducing the installation torque.

7. Tighten the fitting lock nut (Step 4 in Figure 18):

Installing an Adjustable Fitting (continued)

A. Hold the fitting in the correct alignment with a wrench and use a torque wrench and tighten the lock nut to the recommended torque value within the specified range of torque values; refer to the Fitting Installation Torque Table (page 4–12). This tightening procedure requires a drive-adapter wrench (e.g., crowfoot wrench); refer to Calculating the Torque Values When Using a Drive-Adapter Wrench (page 2–4).

B. If a torque wrench is not available or if space at the port prevents the use of a torque wrench, hold the fitting in the correct alignment with a wrench and tighten the lock nut with a second wrench.

C. If the port material is steel, tighten the fitting to the listed Flats From Finger Tight (FFFT) value; refer to the Flats From Finger Tight (FFFT) Table (page 4–12).

D. If the port material is aluminum, tighten the fitting to 60% of the listed FFFT value; refer to the Flats From Finger Tight (FFFT) Table (page 4–12).

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)
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)

Flats From Finger Tight (FFFT) 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

Larger versions of the hydraulic schematics can be found in Appendix A (page A–1)

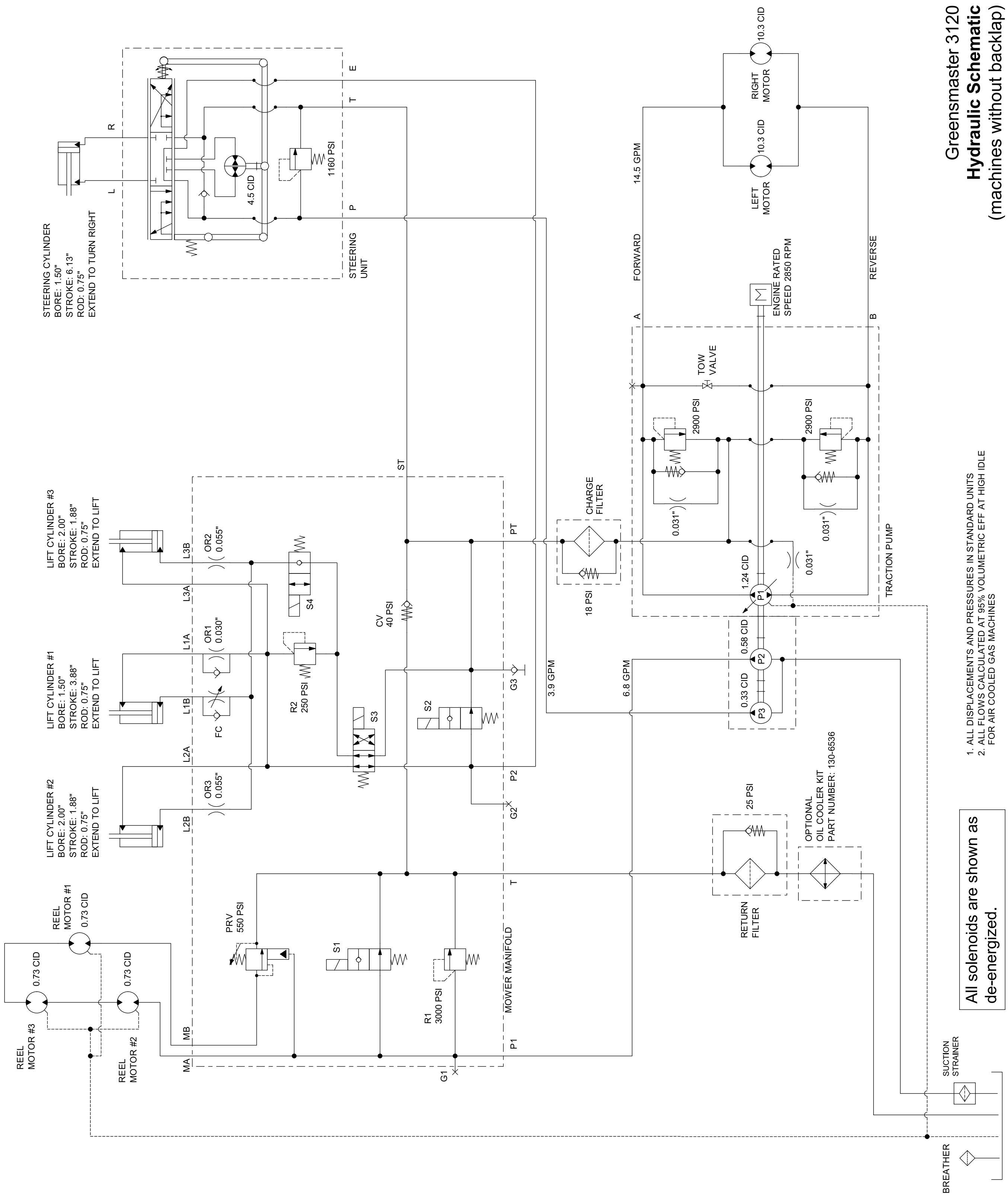

Figure 19

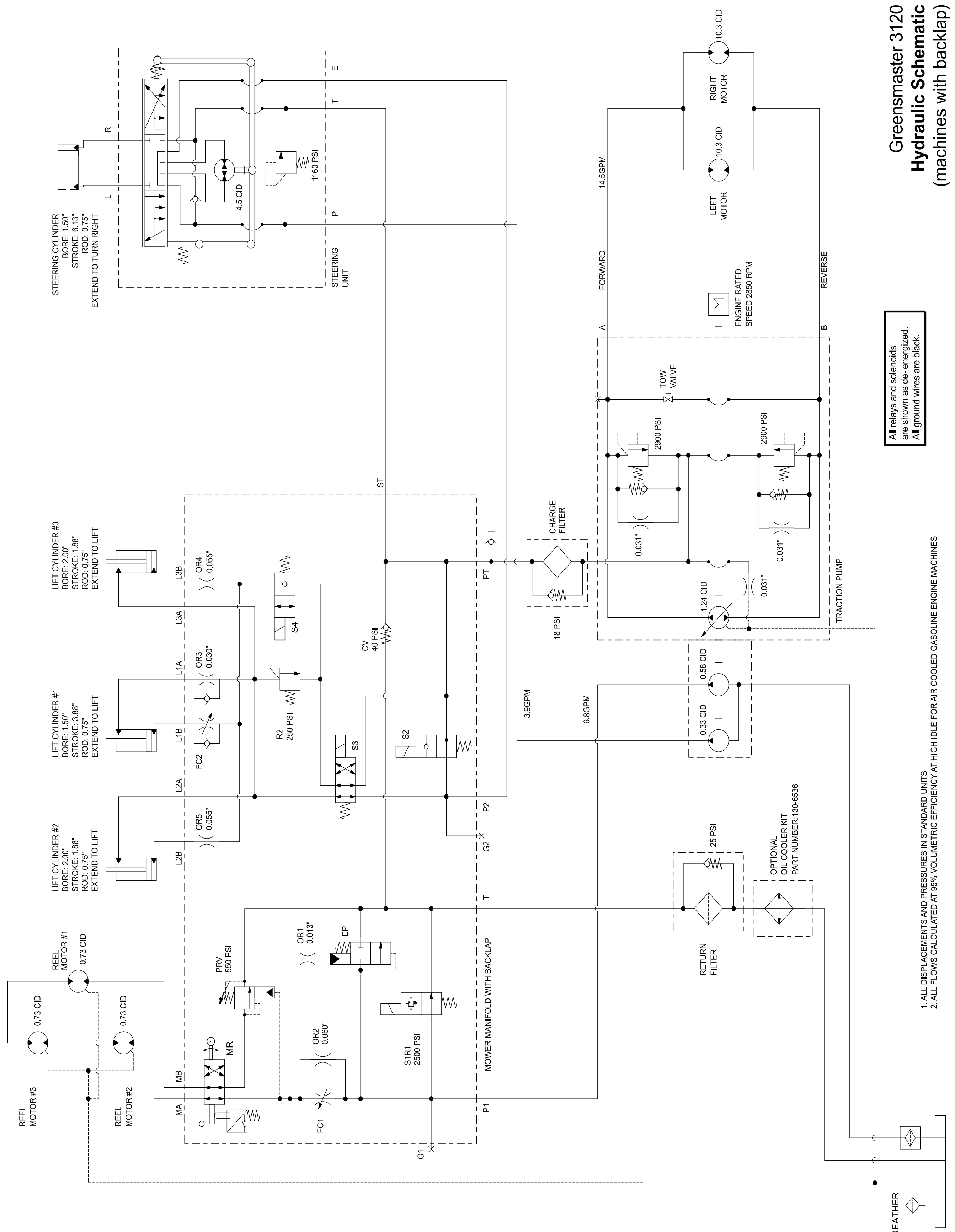

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Figure 20

Hydraulic Flow Diagrams

Traction Circuit

The piston (traction) pump is driven directly by the engine. The traction circuit of the hydraulic system acts essentially as a closed loop. With the engine running and the traction pedal in the neutral position, the swash plate of the piston pump is held in the vertical position, providing no flow in either direction and the machine remains stationary. A pair of 0.031 inch orifices in the traction (piston) pump (one on each side of the swash plate) help keep the system in neutral.

Forward Direction

When the traction pedal is pressed to the forward position, the linkage from the pedal positions the swash plate in the piston pump so fluid flows out the upper port (A) of the pump; refer to Figure 21. Fluid flow out of the upper port goes to the wheel motors and turns them in the forward direction. The fluid flow out of the wheel motors returns to the piston pump lower port (B) and is continuously pumped while the traction lever is in the forward position.

As the traction load increases, the forward traction circuit pressure can increase to the relief-valve setting of 19,994 kPa (2,900 psi). If the circuit pressure is more than the relief-valve setting, fluid flows through the forward relief valve in the transmission to the low-pressure side of the closed-loop traction circuit.

The piston pump uses a small amount of hydraulic fluid for internal lubrication. The fluid is designed to leak across the pump parts into the pump case drain. This leakage results in the loss of hydraulic fluid from the closed-loop traction circuit that must be replaced by the traction charge circuit. Hydraulic fluid is supplied to the traction pump charge circuit from the gear pump section (P3) after servicing the demands of the steering and lift circuits. Charge circuit pressure is maintained by a 276 kPa (40 psi) check valve (CV) located in the mower manifold. A pair of check valves in the traction (piston) pump control the release of charge circuit flow when fluid replacement is required by the closed-loop system. Charge circuit flow in excess of closed-loop system requirements returns to the hydraulic tank via the traction (piston) pump case drain.

Reverse Direction

The traction circuit operates essentially the same in reverse as it does in the forward direction.

When the traction pedal is pressed to the reverse position, the linkage from the pedal positions the swash plate in the piston pump so fluid flows out the lower port (B) of the pump. Fluid flow out of the lower port goes to the wheel motors and turns them in the reverse direction. The fluid flow out of the wheel motors returns to the piston pump upper port (A) and is continuously pumped while the traction lever is in the forward position

As the traction load increases, the reverse traction circuit pressure can increase to the relief-valve setting of 19,994 kPa (2,900 psi). If the circuit pressure is more than the relief-valve setting, fluid flows through the reverse relief valve in the transmission to the low-pressure side of the closed-loop traction circuit.

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

Reverse Direction (continued)

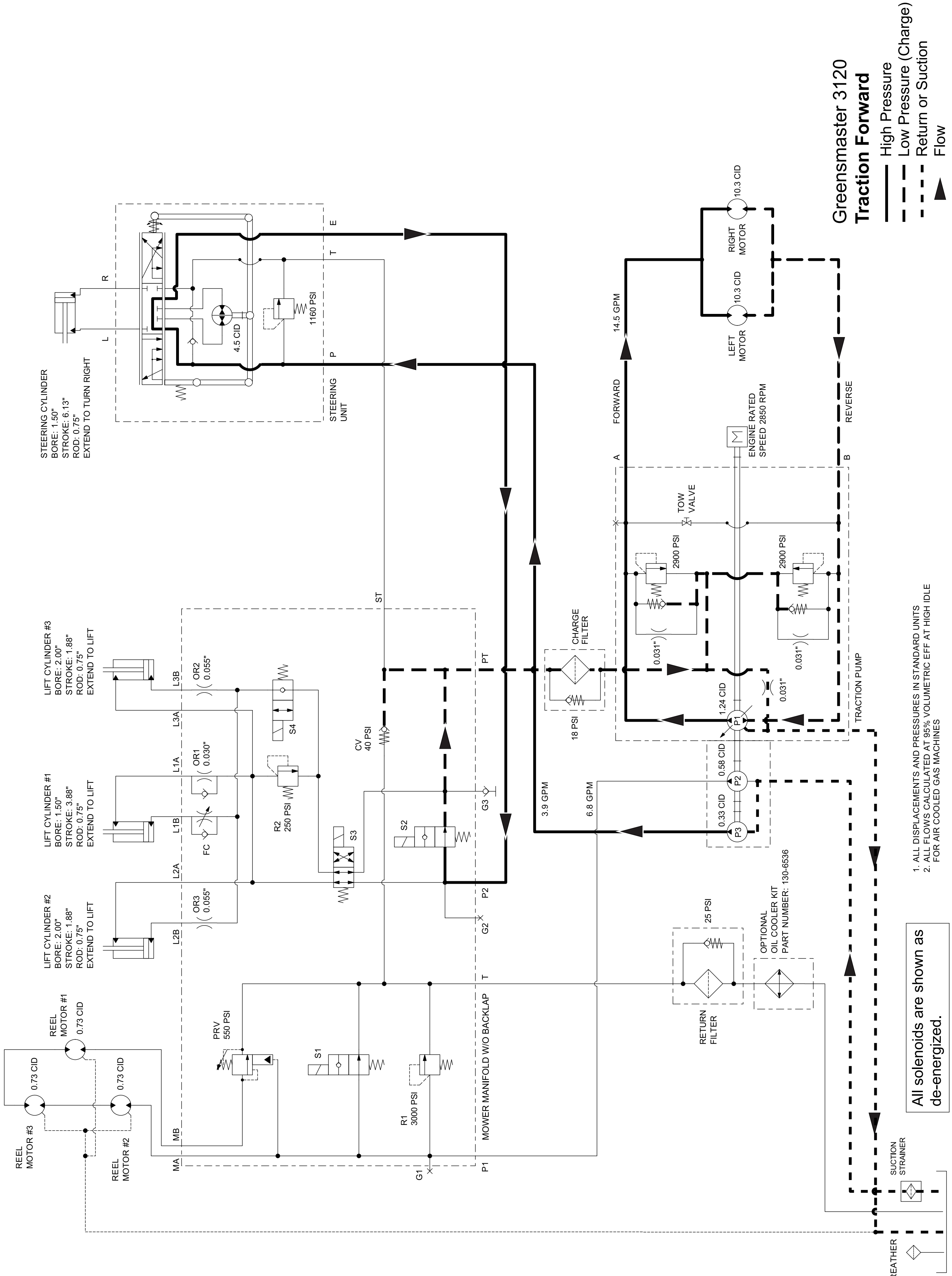

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Figure 21

Lift Circuit

A tandem gear pump is directly coupled to the piston (traction) pump. The rear gear pump section (P3) supplies hydraulic flow for the steering circuit (priority flow), for raising and lowering the cutting units and for the traction system charge circuit. The gear pump takes its suction from the hydraulic tank through a suction strainer. Maximum circuit pressure of 7998 kPa (1160 PSI) is limited by the relief valve located in the steering valve.

During cutting unit hold (not raising or lowering) conditions, flow from the rear gear pump section is by-passed through the steering valve and de-energized solenoid valve (S2) in the mower manifold directly to the traction system charge circuit. Charge circuit flow in excess of closed-loop system requirements returns to the hydraulic tank via the traction (piston) pump case drain.

Raise Cutting Units

When the Rasie/Lower Mow control is moved forward, the mower manifold solenoid valves (S2 and S3) are energized; refer to Figure 22. Energized solenoid valve (S2) blocks the flow of fluid to the traction system charge circuit, and directs the flow to energized solenoid valve (S3). The flow continues through de-energized solenoid valve (S4) and onto the lift cylinders. Hydraulic pressure at the barrel end of the lift cylinder extends the cylinders causing the cutting units to raise. At the same time, the cylinder pistons push hydraulic fluid out of the rod end of the cylinder, through energized solenoid valve (S3) and back into the traction system charge circuit. Raise speed for the front cutting units is controlled by a pair or 0.055 inch orifices in the mower manifold. A 0.030 inch orifice in the mower manifold creates a slight delay in raising the center cutting unit.

When solenoid valves (S2) and (S3) de-energize, spring action returns the valves to their original position and flow is directed back to the traction charge circuit stopping lift cylinder movement. The lift cylinders position is held in place by the check valve feature of de-energized solenoid valve (S4), blocking any return flow from the cylinders.

Lower Cutting Units

When the Rasie/Lower Mow control is moved rearward to lower the cutting units, mower manifold solenoid valves (S2 and S4) are energized; refer to Figure 23. Energized solenoid valve (S2) blocks the flow of fluid to the traction system charge circuit, and directs the flow through de-energized solenoid valve (S3) and onto the lift cylinders. Hydraulic pressure at the rod end of the lift cylinder retracts the cylinders causing the cutting units to lower. At the same time, the cylinder pistons push hydraulic fluid out of the barrel end of the cylinder, through energized solenoid valve (S4), de-energized solenoid valve (S3) and back into the traction system charge circuit. Lower speed for the front cutting units is controlled by a pair or 0.055 inch orifices in mower manifold. An adjustable flow control valve in the mower manifold creates a slight delay in lowering the center cutting unit.

Relief valve (R2) in the mower manifold is incorporated into the lowering circuit in case the cutting units are obstructed during lowering. The relief valve is set to 1,724 kPa (250 psi) at the factory. Once the cutting units are fully lowered, solenoid valve (S2) and (S4) de-energize, spring action returns the valves to their original position and flow is directed back to the traction charge circuit stopping lift cylinder movement.

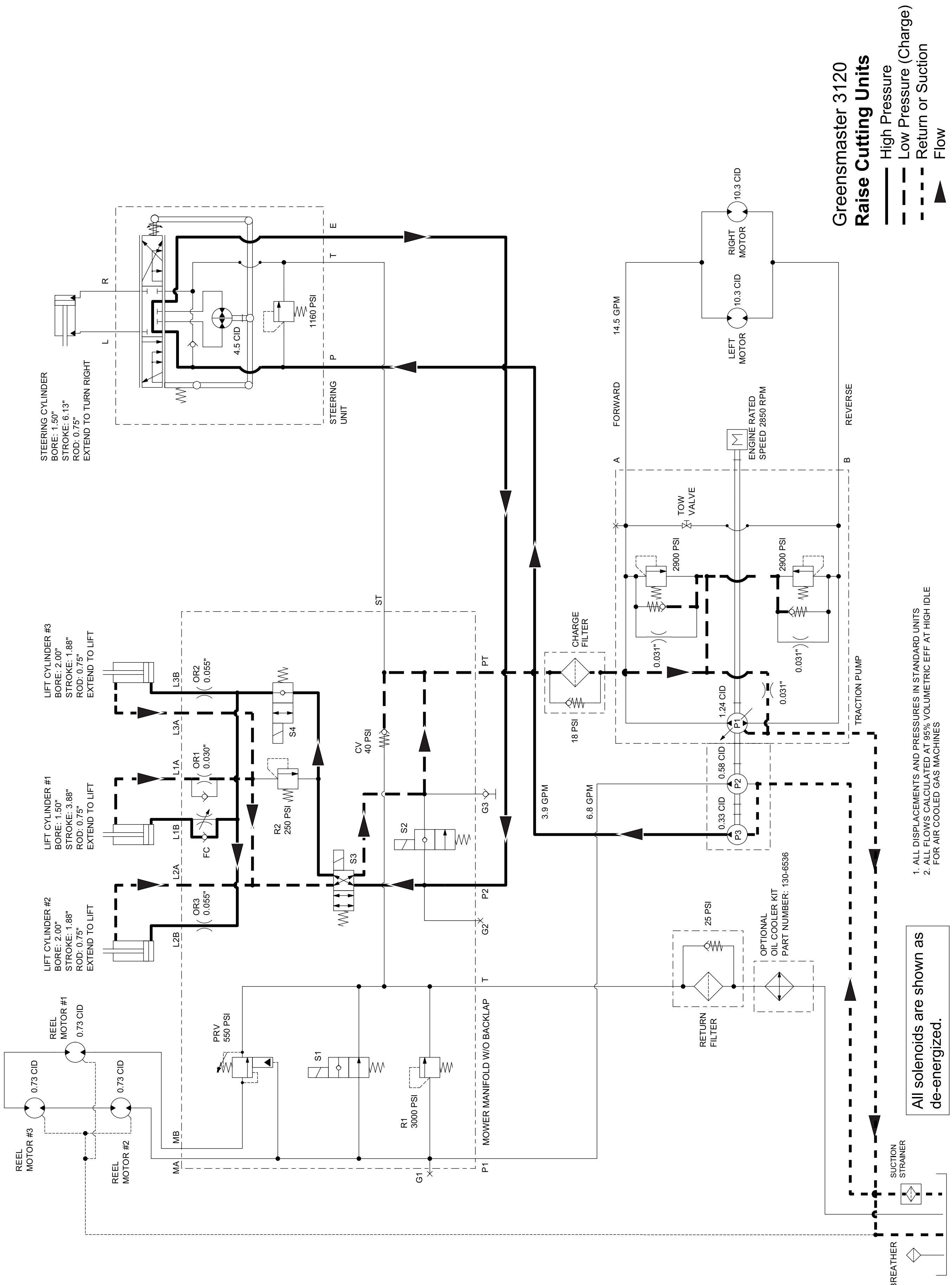
Greensmaster 3120
Raise Cutting Units
High Pressure
Low Pressure (Charge)
Return or Suction
Flow
All solenoids are shown as de-energized.
1. ALL DISPLACEMENTS AND PRESSURES IN STANDARD UNITS
2. ALL FLOWS CALCULATED AT 95% VOLUMETRIC EFF AT HIGH IDLE FOR AIR COOLED GAS MACHINES
STEERING CYLINDER
BORE: 1.50"
STROKE: 6.13"
ROD: 0.75"
EXTEND TO TURN RIGHT
STEERING UNIT
4.5 CID
1160 PSI
R
L
E
T
P
LIFT CYLINDER #3
BORE: 2.00"
STROKE: 1.88"
ROD: 0.75"
EXTEND TO LIFT
LIFT CYLINDER #1
BORE: 1.50"
STROKE: 3.88"
ROD: 0.75"
EXTEND TO LIFT
LIFT CYLINDER #2
BORE: 2.00"
STROKE: 1.88"
ROD: 0.75"
EXTEND TO LIFT
L3B
L3A
L1A
L1B
L2A
L2B
OR2 0.055"
OR1 0.030"
OR3 0.055"
FC
S4
R2 250 PSI
S3
CV 40 PSI
S2
ST
PT
G3
P2
G2
T
P1
G1
MA
MB
REEL MOTOR #1 0.73 CID
REEL MOTOR #2 0.73 CID
REEL MOTOR #3 0.73 CID
PRV 550 PSI
S1
R1 3000 PSI
MOWER MANIFOLD W/O BACKLAP
CHARGE FILTER
18 PSI
3.9 GPM
6.8 GPM
RETURN FILTER
25 PSI
OPTIONAL OIL COOLER KIT PART NUMBER: 130-6536
SUCTION STRAINER
BREATHER
1.24 CID
0.58 CID
0.33 CID
P1
P2
P3
0.031"
2900 PSI
TOW VALVE
TRACTION PUMP
ENGINE RATED SPEED 2850 RPM
A
B
FORWARD
REVERSE
14.5 GPM
LEFT MOTOR 10.3 CID
RIGHT MOTOR 10.3 CID
g213625

Figure 22

Lower Cutting Units (continued)

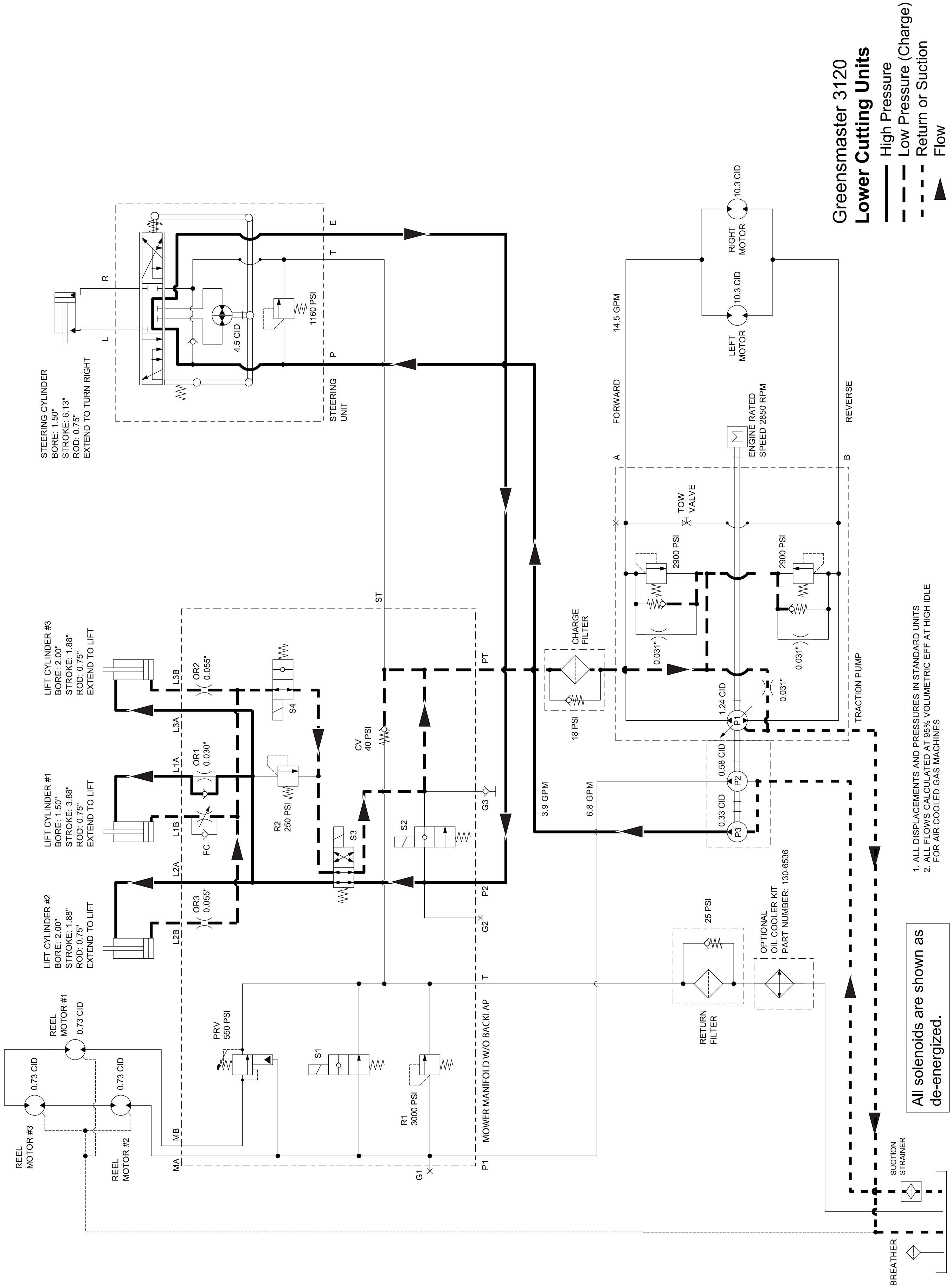

Figure 23

Mow Circuit

The tandem gear pump is directly coupled to the piston (traction) pump. The front gear pump section (P2) supplies fluid flow to the mower manifold and to the cutting reel motors. The gear pump takes its suction directly from the hydraulic tank.

Mow (machines without backlap)

With the engine running and the function control and joystick levers positioned so the reels will not turn; refer to the traction unit *Operator's Manual*, solenoid relief valve (S1) in the mower manifold is de-energized. The de-energized (S1) by-passes flow from the front gear pump section (P2) to the hydraulic filter and back to the tank. Additionally, the pilot operated relief valve (PRV) in the mower manifold will remain seated to prevent the reel motors (and reels) from rotating.

With the engine running and the function control and joystick levers positioned to lower and engage the cutting units; refer to the traction unit *Operator's Manual*, solenoid valve (S1) is energized to direct fluid flow toward the reel motors; refer to Figure 24. Mow circuit pressure will cause the pilot piston under the pilot operated relief valve (PRV) to shift and open the valve. The shifted relief valve allows fluid to exit the reel motors and return to the tank through the mower manifold, hydraulic filter and optional hydraulic fluid cooler (if equipped). The reel motors are connected in series. Fluid flows through the left front reel motor, then the right front reel motor and then the center reel motor to turn the reel motors in the mow direction. Maximum circuit pressure is limited to 20,684 kPa (3000 psi) by relief valve (R1) which is located in the mower manifold.

Mow (machines without backlap) (continued)

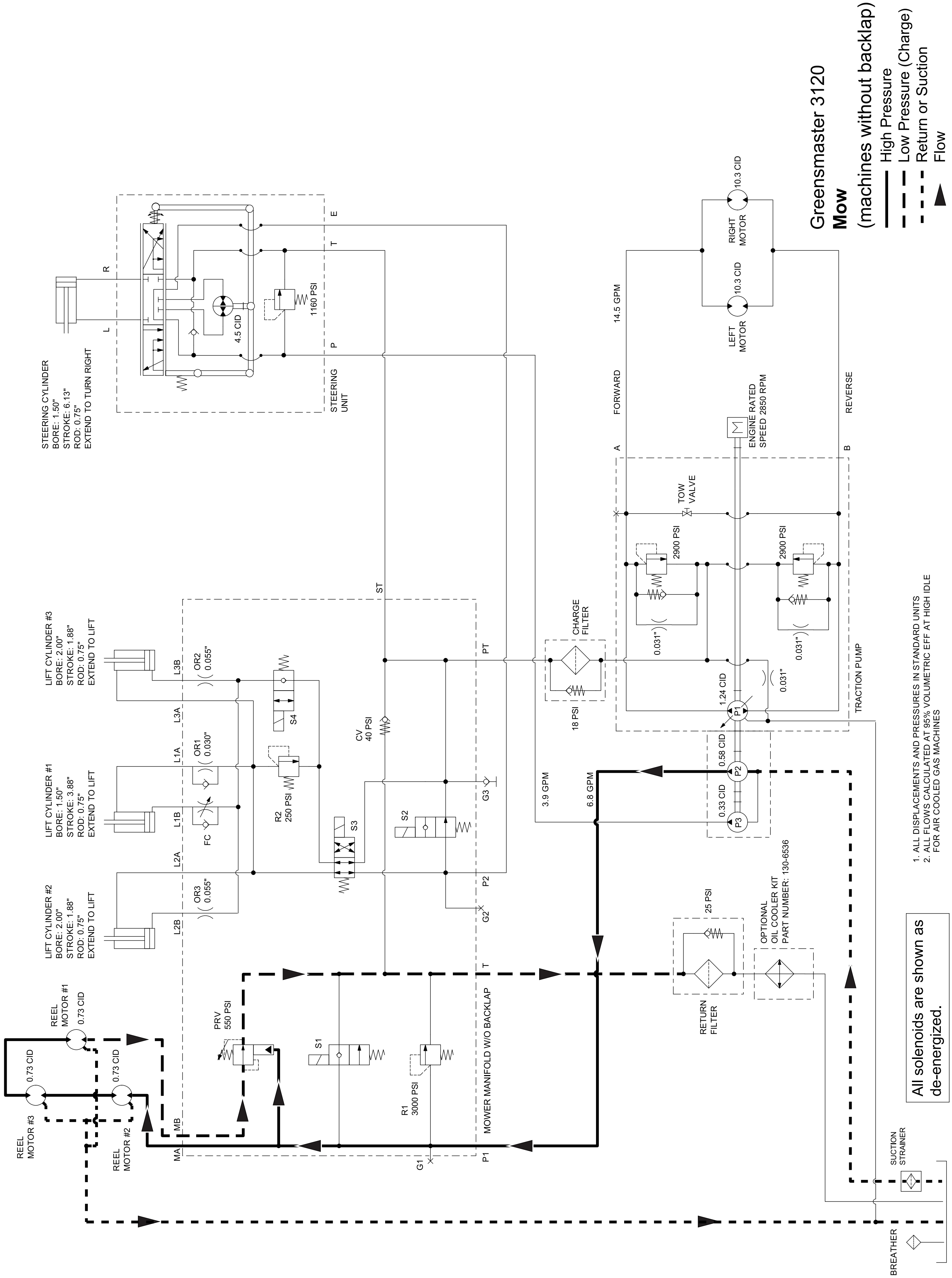

Figure 24

Mow (machines with backlap)

With the engine running and the function control and joystick levers positioned so the reels will not turn (refer to the traction unit *Operator's Manual*), solenoid relief valve (S1R1) in the mower manifold is de-energized. The de-energized (S1R1) by-passes flow from the front gear pump section to the hydraulic filter and tank. Additionally, pilot operated relief valve (PRV) will remain seated to prevent the reel motors (and reels) from rotating.

With the engine running and the function control and joystick levers positioned to lower and engage the cutting units (refer to the traction unit *Operator's Manual*), solenoid relief valve (S1R1) is energized to direct fluid flow toward the reel speed control valve (FC1) and the reel motors; refer to Figure 25. Solenoid relief valve (S1R1) and also functions as the mow circuit relief valve, limiting circuit pressure to 17,236 kPa (2500 psi). To provide precise reel speed control, flow moving across the speed control valve (FC1) is pressure compensated by the logic cartridge valve (LC). The logic cartridge valve maintains a pressure differential of 517 kPa (75 psi) across the speed control valve. Any excess flow above the speed control valve setting is by-passed to the tank through the logic cartridge valve.

With the backlap valve (MR) in the mow position, fluid flows out the (MA) port of the mower manifold and to the reel motors. The reel motors are connected in series. Fluid flows through the left front reel motor, then the right front reel motor and then the center reel motor to turn the reel motors in the mow direction. Mow circuit pressure will cause the pilot piston under the pilot operated relief valve (PRV) to shift and open the valve. The shifted relief valve allows fluid to exit the reel motors and return to the tank through the mower manifold, hydraulic filter and optional hydraulic fluid cooler (if equipped).

Backlap

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

Backlap (continued)

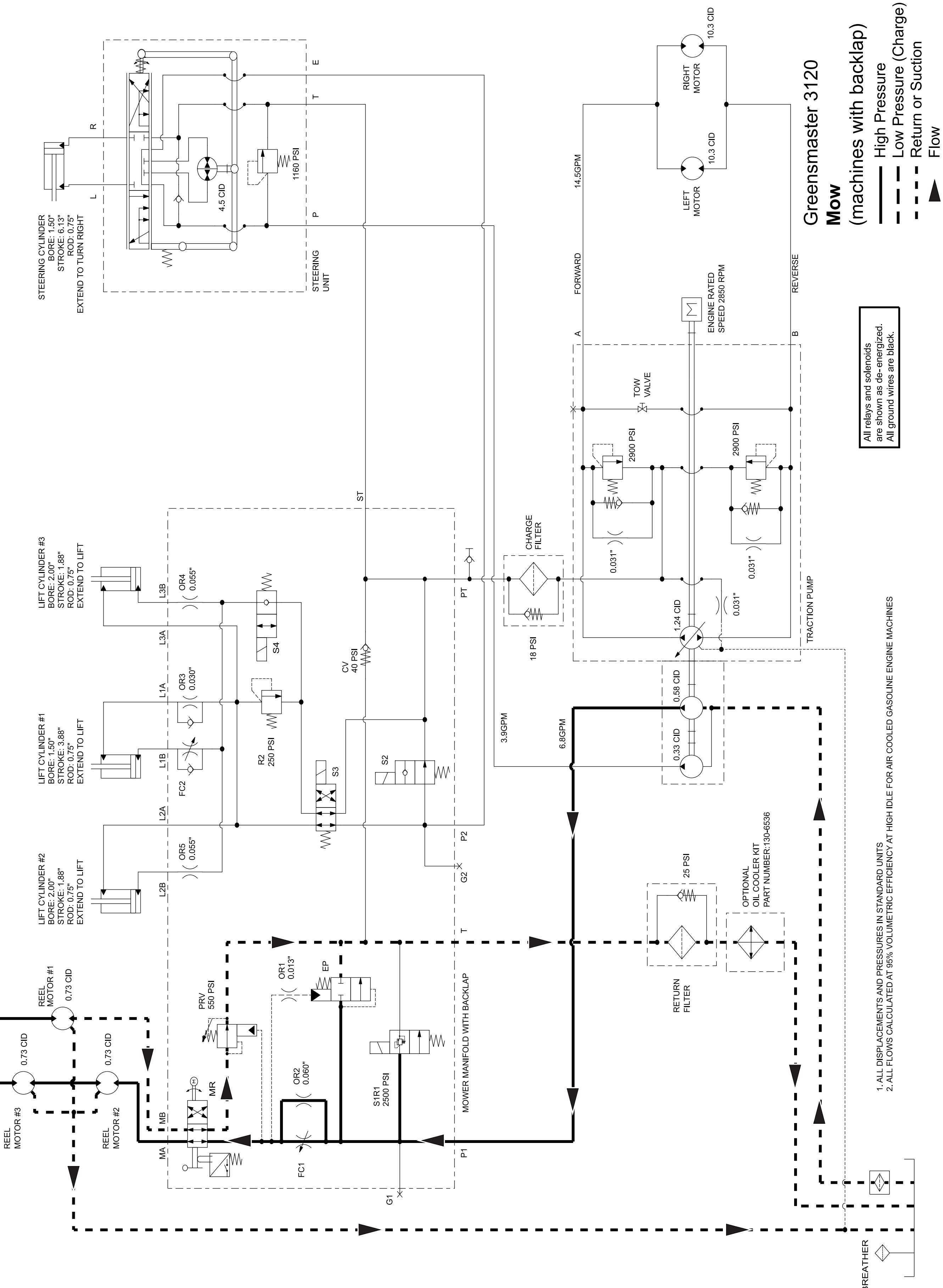

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Figure 25

Steering Circuit

The tandem gear pump is directly coupled to the piston (traction) pump. The rear gear pump section (P2) supplies hydraulic flow for the steering circuit (priority flow), for raising and lowering the cutting units and for the traction charge circuit. The gear pump takes its suction from the hydraulic tank. Maximum circuit pressure of 7,998 kPa (1160 PSI) is limited by the relief valve located in the steering unit.

With the steering wheel in the neutral (not turning) position and the engine running, the spool valve in the steering unit is in the center position; refer to Figure 26. Flow enters the steering unit at port (P) and goes through the spool valve, by-passing the steering cylinder. Flow leaves the control unit out port (E) to be available for the raise/lower and traction charge circuits.

Right Turn

When a right turn is made with the engine running, the turning of the steering wheel positions the spool valve in the steering unit so that flow goes through the bottom of the spool; refer to Figure 26. Flow entering the steering unit at port (P) goes through the spool and is routed to two places. First, most of the flow through the valve is by-passed out steering unit port (E) and is available for raising and lowering the cutting units and for the traction charge circuit. Second, the remainder of the flow is drawn through the steering valve rotary meter and out steering unit port (R). Pressure extends the steering cylinder for a right turn. The rotary meter ensures that the fluid flow to the cylinder is proportional to the amount of turning on the steering wheel. Fluid leaving the cylinder flows back through the spool valve then out steering unit port (T) and then to the traction charge circuit. When turning is complete, the steering unit returns to the neutral position.

Left Turn

When a left turn is made with the engine running, the turning of the steering wheel positions the spool valve in the steering unit so that flow goes through the top of the spool; refer to Figure 26). Flow entering the steering unit at port (P) goes through the spool and is routed to two places. First, most of the flow through the valve is by-passed out steering unit port (E) and is available for raising and lowering the cutting units and for the traction charge circuit. Second, the remainder of the flow is drawn through the steering valve rotary meter and out steering unit port (L). Pressure retracts the cylinder for a left turn. The rotary meter ensures that the fluid flow to the cylinder is proportional to the amount of turning on the steering wheel. Fluid leaving the cylinder flows back through the spool valve then out steering unit port (T) and then to the traction charge circuit. When turning is complete, the steering unit returns to the neutral position.

Left Turn (continued)

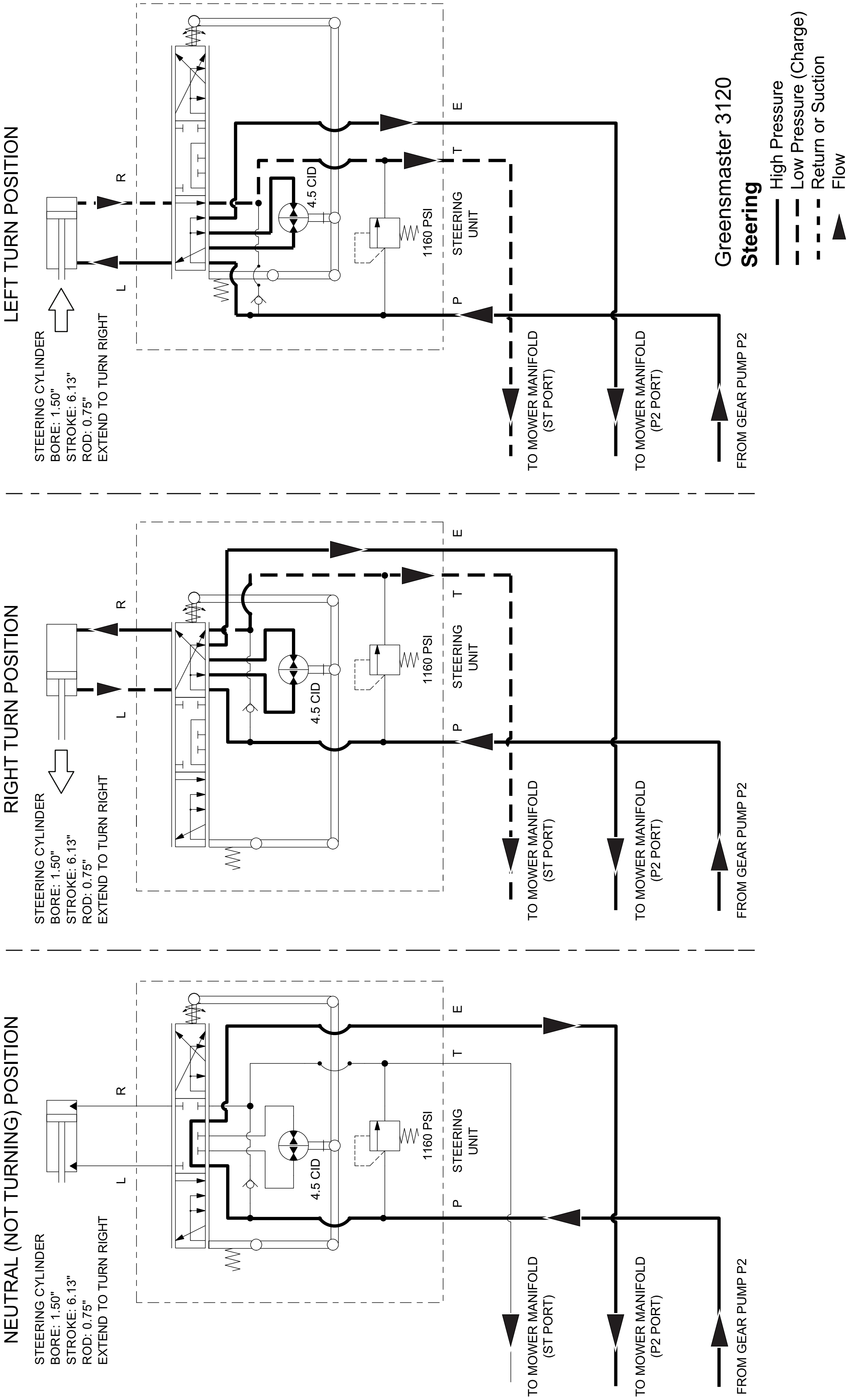

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Figure 26

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.

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).

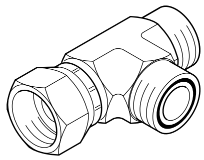
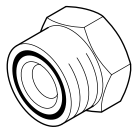
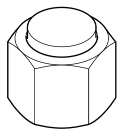
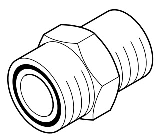
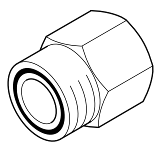
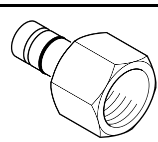
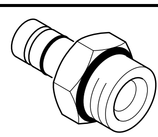
Outlet Hose – A hose from the outlet side of the hydraulic tester that connects to the hydraulic system circuit.

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

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

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.

Measuring Container

Part Number: TOR4077

Use this container (graduated cylinder) for performing hydraulic motor efficiency tests (motors with case drain lines only). Measure efficiency of a hydraulic motor by restricting the outlet flow from the motor and measuring leakage from the case drain line while the motor is pressurized by the hydraulic system. Refer to Cutting Unit Circuit Testing – Cutting Unit Motor Efficiency/Case Drain Test (page 4–50) for additional information.

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 4–28).

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

Troubleshooting

The following chart contains information to troubleshoot hydraulic circuit problems. There can be more than one cause for a machine malfunction.

Refer to Testing the Hydraulic System (page 4–35) for 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.	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. The incompatible hydraulic fluids are mixed in the system. There is water in the hydraulic system.
The hydraulic system operates hot.	The hydraulic-fluid level in the hydraulic tank is low. The suction filter is loose or clogged. The hydraulic fluid is contaminated or the fluid viscosity is too light. Brakes are applied or are incorrectly adjusted. The fluid cooler (if equipped) is damaged or plugged. The fluid cooler air flow is obstructed. Working load of machine (ie: high ambient temperatures, use of verticutter) may require use of fluid cooler. The traction pump bypass valve is open or damaged. The charge pressure is low; refer to Charge Pressure Relief Valve Pressure Test in the Testing section of this chapter. The traction pump, wheel motor(s) or reel motor(s) is worn or damaged. **Note:** If a 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 hydraulic fluid is very cold. The transmission bypass valve(s) is open or damaged. The brake is dragging or binding. The traction pump relief valves are leaking or damaged. The charge pressure is low; refer to Charge Pressure Relief Valve Pressure Test in the Testing section of this chapter. The traction pump or wheel motor(s) is worn or damaged. **Note:** If a 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 machine operates in one direction only.	The external control linkage is incorrectly adjusted, disconnected, binding, or damaged. The orifice in the traction pump check valve(s) is plugged. The traction pump is worn or damaged.
No traction exists in either direction.	The brakes are applied or are incorrectly adjusted. The hydraulic-fluid level in the hydraulic tank is low (other hydraulic circuit performance is affected as well). The transmission bypass valve is open. The charge pressure is low; refer to Charge Pressure Relief Valve Pressure Test in the Testing section of this chapter. The traction pump or wheel motor(s) is worn or damaged. **Note:** If a traction circuit component has internal wear or damage, it is possible that the other traction components are also damaged.
The wheel motor does not turn.	Brakes are binding. Key on wheel motor shaft is sheared or missing. The wheel motor is worn or damaged. **Note:** If a traction circuit component has internal wear or damage, it is possible that the other traction components are also damaged.
While on level ground, the wheel motor does not hold load in the NEUTRAL position.	The make-up fluid from the charge pump is not available. The check valves in the transmission are damaged. The traction pump relief valves are leaking or damaged.

Note: The piston (traction) pump used on Greensmaster 3120 machines is equipped with relief valves for both the forward and reverse direction. Due to engine output, it is unlikely that traction pressure will reach relief valve settings. If, however, a piston pump relief valve is leaking or otherwise faulty, traction performance would be affected.

Mow Circuit Problems

Problem	Possible Causes
Gear pump (P2) is noisy (cavitation).	Hydraulic tank fluid level is low (other hydraulic circuits affected as well). Hydraulic pump suction line is restricted. Hydraulic pump suction line has an air leak.
Cutting reel motors will not turn.	**Machines without Backlap** Mower manifold relief valve R1 is stuck open. An electrical problem exists with solenoid valve S1(see Chapter 5 - Electrical System). Pilot operated relief valve PRV or pilot piston in mower manifold is stuck closed or damaged. Gear pump (P2) is damaged (see Gear Pump (Front Section) Flow Test in the Testing section of this chapter).
	Machines with Backlap Mower manifold solenoid valve S1R1 is stuck open (not shifting to its energized position). An electrical problem exists with solenoid valve S1R1 (see Chapter 5 - Electrical System). Flow control FC1 in mower manifold is stuck open. Pilot operated relief valve PRV or pilot piston in mower manifold is stuck closed or damaged. Gear pump (P2) is damaged; refer to Gear Pump (P2) Flow Test in the Testing section of this chapter.
Cutting reel speed is erratic.	A mechanical problem with the cutting unit exists; refer to Chapter 7 - DPA Cutting Units. Mower manifold cartridge valve In the reel circuit is leaking or damaged. Mower manifold orifice (OR1 or OR2) is plugged (machines with backlap only).
Cutting reel speed is low.	A mechanical problem with the cutting unit exists; refer to Chapter 7 - DPA Cutting Units. Mower manifold cartridge valve In the reel circuit is leaking or damaged. Excessive internal wear in reel motor exists; refer to Reel Motor Case Drain Flow Test in the Testing section of this chapter.

Lift/Lower Circuit Problems

Problem	Possible Causes
Gear pump (P1) is noisy (cavitation).	Hydraulic tank fluid level is low (other hydraulic circuits affected as well). Hydraulic pump suction line is restricted. Hydraulic pump suction line has an air leak.
Cutting units will not lift or lift slowly.	Engine speed is too low. Hydraulic tank fluid level is low. Lift cylinder linkage is binding or broken. Lift cylinder bushings are binding or worn. Charge circuit pressure is low; refer to Charge Relief Valve Pressure Test in the Testing section of this chapter. Lift circuit relief valve (in steering control valve) is leaking or damaged. Mower manifold solenoid valve (S2) is leaking or damaged (not shifting to its energized position). An electrical problem exists with solenoid valve S2 (see Chapter 5 – Electrical System). Relief valve (R2) is leaking or damaged. The lift cylinder(s) is leaking internally. Spool in steering control valve is sticking; refer to Steering Control Valve Test in the Testing section of this chapter. Gear pump (P1) is damaged; refer to Gear Pump (P1) Flow Test in the Testing section of this chapter.
Cutting units raise, but will not stay up.	Mower manifold solenoid valve (S4) leaks or is damaged. The lift cylinder(s) is leaking internally.

Steering Circuit Problems

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

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 Testing the Hydraulic System (page 4–35).

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 Relieving Pressure from the Hydraulic System (page 4–4).

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 a hydraulic test, check the fluid supply, the filter condition, control linkage operation and adjustment, loose fasteners, or mechanical and electrical issues 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 operators seat and the other available to read and record the test results.

1. Use the Hydraulic Schematic, Hydraulic Flow Diagrams and the Troubleshooting section found in this Chapter to assist with problem identification and solution.
2. Always wear the eye protection when you performing hydraulic system tests.
3. 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 wear on hydraulic components.
4. To prevent hydraulic system contamination, put metal caps or plugs on any hydraulic lines left open or exposed during testing or removal of components.
5. The engine must be in good operating condition. Use a phototach (non−contact tachometer) when performing a hydraulic test. Engine speed can affect the accuracy of the test readings. Monitor engine RPM during hydraulic testing. Use the information below when performing hydraulic system tests. If engine RPM is above or below the specified speed during a test, you will need to adjust the expected hydraulic performance parameters (aprox. 3% per 100 engine rpm at full throttle)

IMPORTANT

Hydraulic component output volume relates directly to engine RPM. For every 100 engine rpm the following component output volumes will change by the volume listed.

- Traction Pump: 100 engine RPM = 2.03 LPM (0.54 GPM or 68.7 oz.) of hydraulic fluid displaced per minute
- Gear Pump (P1): 100 engine RPM = 0.95 LPM (0.25 GPM or 32.1oz.) of hydraulic fluid displaced per minute.
- Gear Pump (P2): 100 engine RPM = 0.54 LPM (0.14 GPM or 18.3 oz.) of hydraulic fluid displaced per minute

6. Before you perform a test, check the traction control lever linkages for improper adjustment, binding, or broken parts.
7. 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.
8. 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.
9. Install the hydraulic fittings by hand and ensure that they are not cross-threaded before you tighten them with a wrench.
10. Position any test hoses away from parts that may move during the test procedure.
11. After you connect the test equipment, check the hydraulic-fluid level in the hydraulic tank and ensure that the fluid level is correct.
12. Perform all the hydraulic tests with the hydraulic fluid at normal operating temperature.
13. Record the results of all hydraulic tests performed.

Hydraulic Test Selection

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

If a traction circuit problem exists, consider performing one or more of the following tests: Charge Pressure Test, Wheel Motor Efficiency Test, and/or Traction Pump (P1) Flow and Relief Valve Tests.

If a cutting (mow) circuit problem exists, consider performing one or more of the following tests: Circuit Pressure Test, Reel Motor Efficiency/Case Drain Test, Manifold Relief Pressure Test, and/or Gear Pump (P2) Flow Test.

If a steering or lift circuit problem exists, consider performing one or more of the following tests: Gear Pump (P1) Flow Test, Relief Valve Pressure Test, Lower Cutting Units Relief Valve (R2) Pressure Test, and/or Steering Control Valve and Steering Cylinder Test.

Traction Circuit Testing – Charge Pressure Test

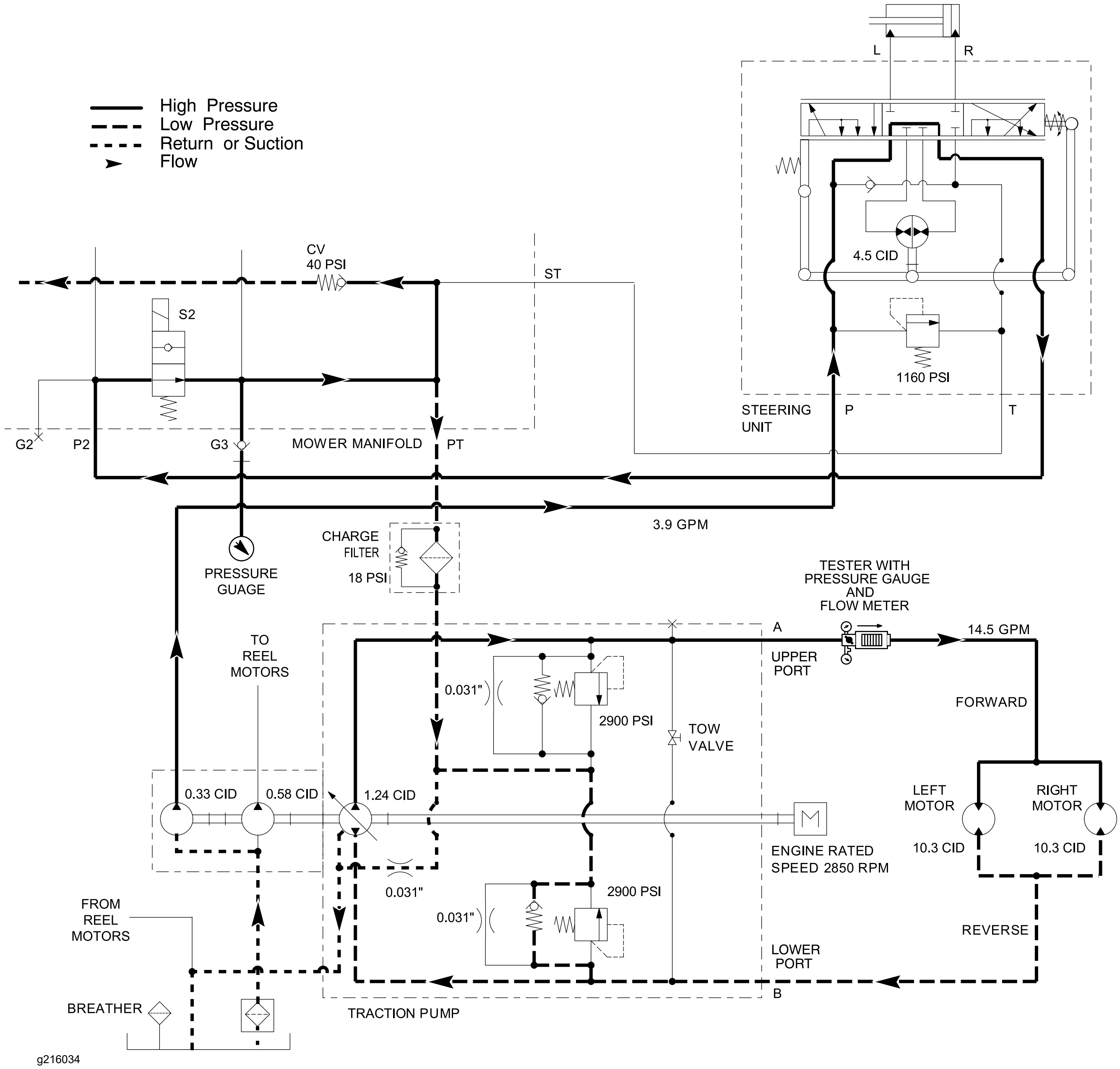


Figure 27

Traction Circuit Testing – Charge Pressure Test (machines without backlap)

Traction Circuit Testing – Charge Pressure Test (continued)

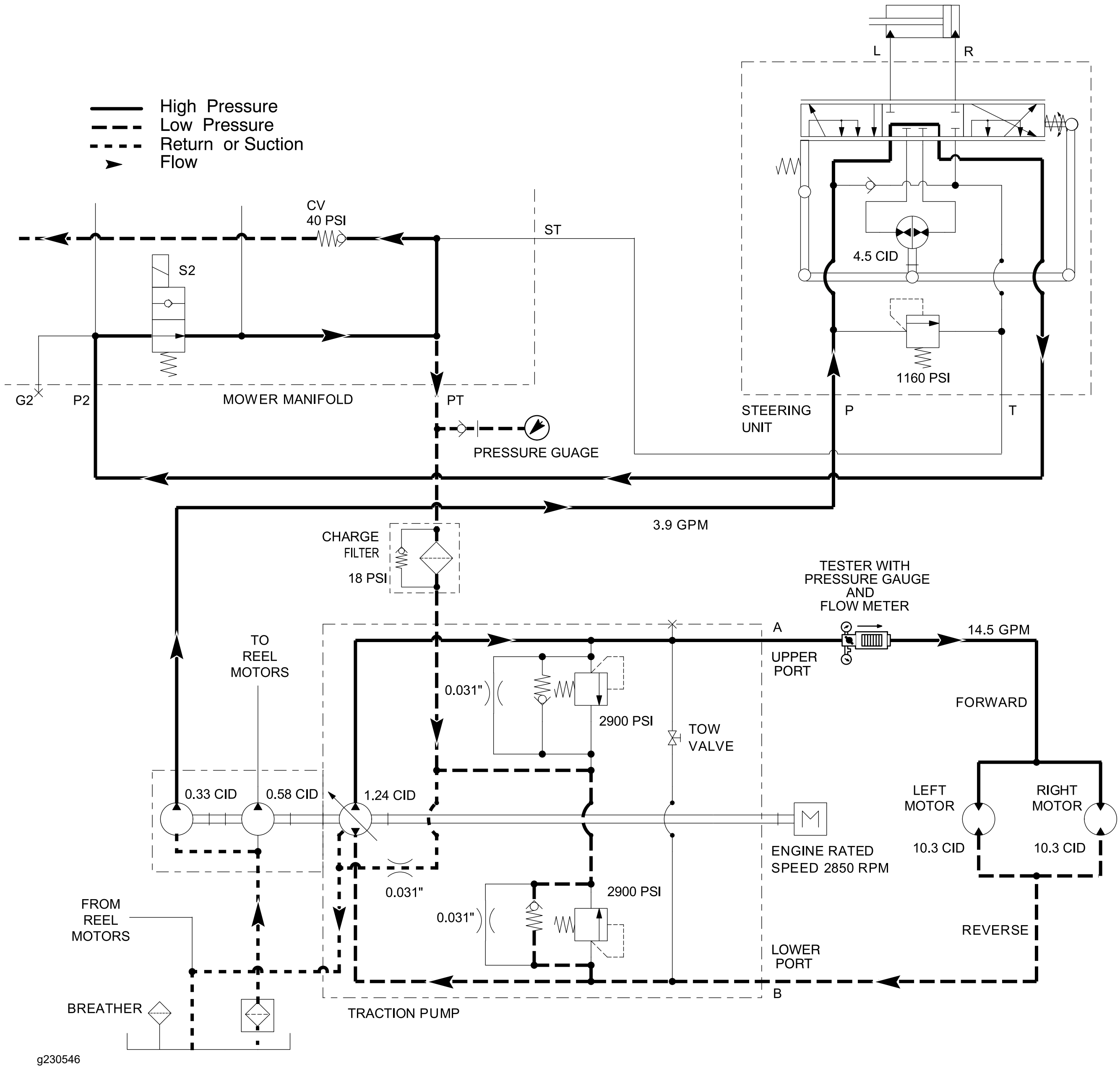


Figure 28

Traction Circuit Testing – Charge Pressure Test (machines with backlap)

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 traction pump. 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 (accurate below 300 psi) with hose and quick disconnect coupling
- Flow Meter with Pressure Gauge that has at least an 68 LPM (18 GPM) capacity.

Traction Circuit Testing – Charge Pressure Test (continued)

- Phototach (non−contact tachometer).
- Hydraulic test fittings (early machines with backlap): swivel tee p/n 340-104, test connector p/n 100-5610, dust cap p/n 354-79.

1. Park machine on a level surface. Make sure engine is OFF.
2. Read and adhere to the information provided in Testing the Hydraulic System (page 4–35).
3. Make sure that traction pedal is adjusted to the neutral position.

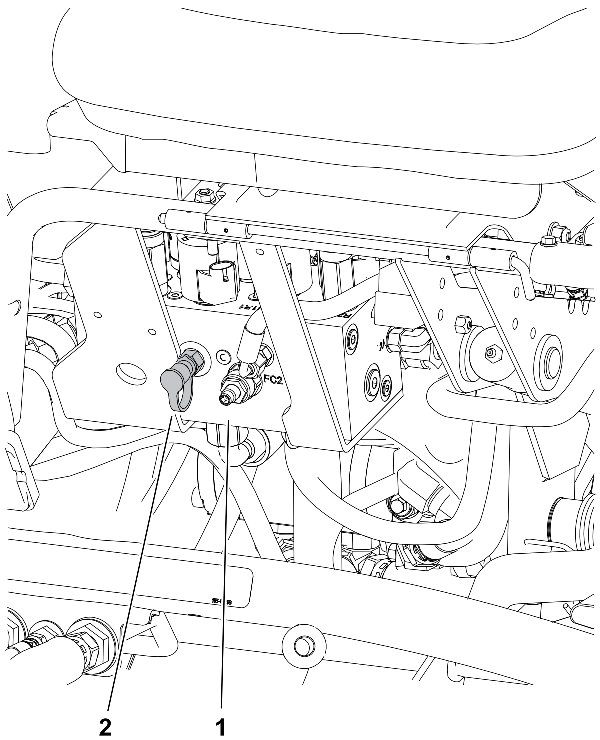


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Figure 29

(machines without backlap)

1. Mower manifold
2. Test connector (G3)

Traction Circuit Testing – Charge Pressure Test (continued)

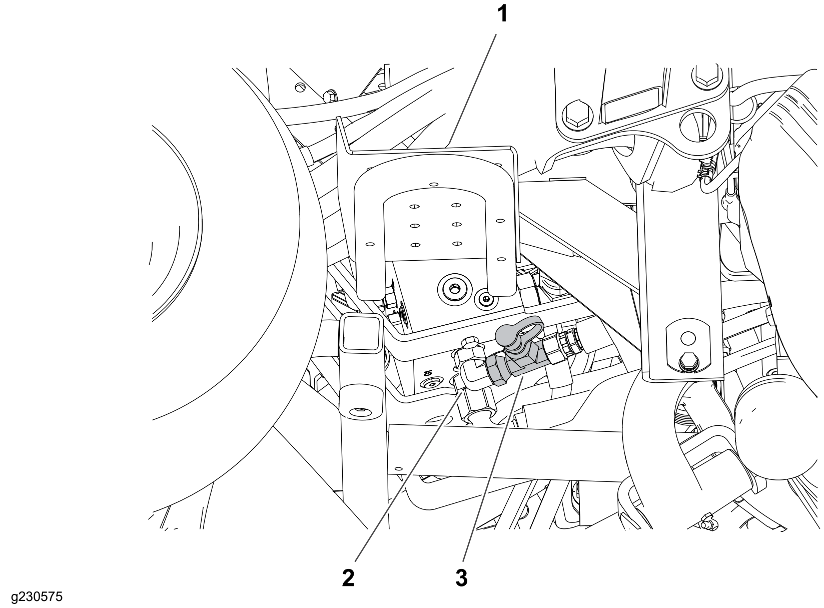

Figure 30
(early machines with backlap)

1. Left step
2. Mower manifold PT port
3. Swivel tee fitting and test connector

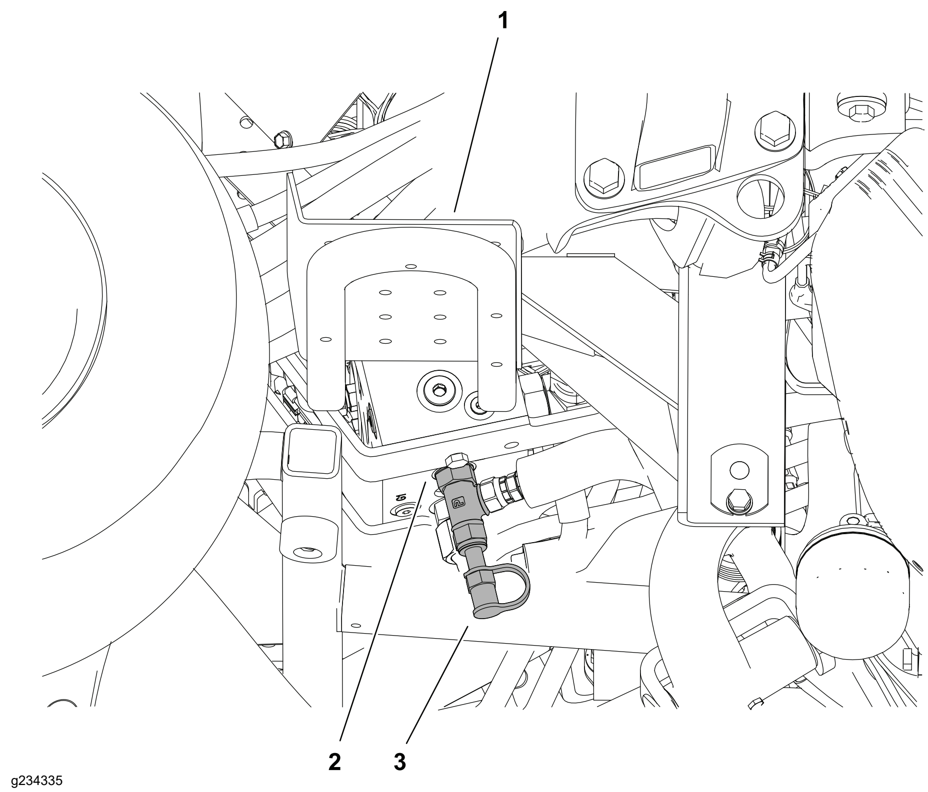

Figure 31

1. Left step
2. Mower manifold PT port
3. Test connector

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4. Install a hydraulic pressure gauge in the charge circuit:

Traction Circuit Testing – Charge Pressure Test (continued)

- For machines without backlap, connect a pressure gauge with hydraulic hose to the test connector in the G3 port of the mower manifold; refer to Figure 29.
- For early machines with backlap, disconnect the hose from the elbow at the PT port of the mower manifold and install a swivel tee and test connector fitting. Connect a pressure gauge with hydraulic hose to the newly installed test connector; refer to Figure 30.
- For later machines with backlap, connect a pressure gauge with hydraulic hose to the test connector at the PT port of the mower manifold; refer to Figure 31.

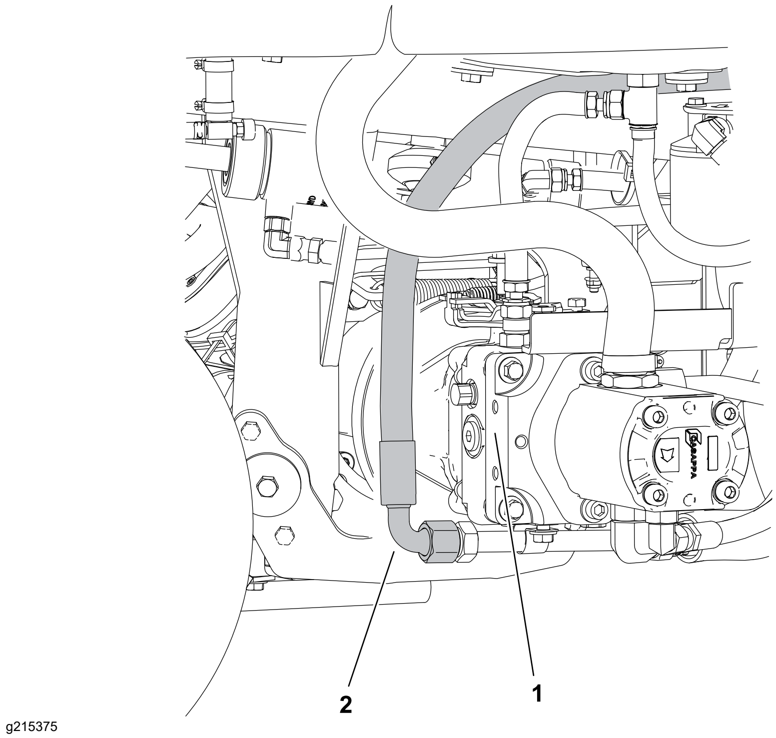

Figure 32

1. Traction pump
2. Hose from traction pump “A” port

5. Disconnect hose from traction pump “A” port; refer to Figure 32.
6. Install tester in series with the pump and the disconnected hose. Make sure the tester is installed in the correct flow direction and the tester flow control valve is fully open.
7. Attach a heavy chain to the rear of the machine frame and an immovable object to prevent the machine from moving during testing.
8. Chock the wheels to prevent wheel rotation during testing.
9. Start engine. Move throttle to full speed **(2850 ± 50 RPM)**.
10. Make sure hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes.
11. Verify and record engine speed with a phototach.
12. Record the reading on pressure gauge from the PT port of the mower manifold (not the pressure gauge on the flow meter). Charge pressure (without load) should read approximately **414 kPa (60 PSI)**. If charge relief pressure specification is not met, consider the following:

A. The charge relief valve (CV) in the mower manifold is faulty. Repair or replace the charge relief valve (CV); refer to Servicing the Mower Manifold (page 4–99).

B. Gear pump (P3) is faulty (steering/lift circuit performance will also be affected). Test gear pump (P3) flow (see Gear Pump (P3) Flow Test in this chapter).

13. Sit in the operator's seat, release the parking brake, and apply a load to the traction pump by slowly depressing the forward traction pedal until **6895 to 10342 kPa (1000 to 1500 PSI)** is reached on the flow meter pressure gauge.

14. Record reading on pressure gauge from the PT port of the mower manifold (not the pressure gauge on the flow meter).

15. Release traction pedal, move throttle to low speed and turn the engine OFF.

16. Charge pressure (under load) should not drop more than **20%** when compared to charge pressure (without load) recorded in step12.

If specifications are not met, perform Traction Pump (P1) Flow and Traction Relief Pressure Test as described in Traction Circuit Testing – Traction Pump (P1) Flow and Relief Pressure Test (page 4–47).

Traction Circuit Testing – Wheel Motor Efficiency Test

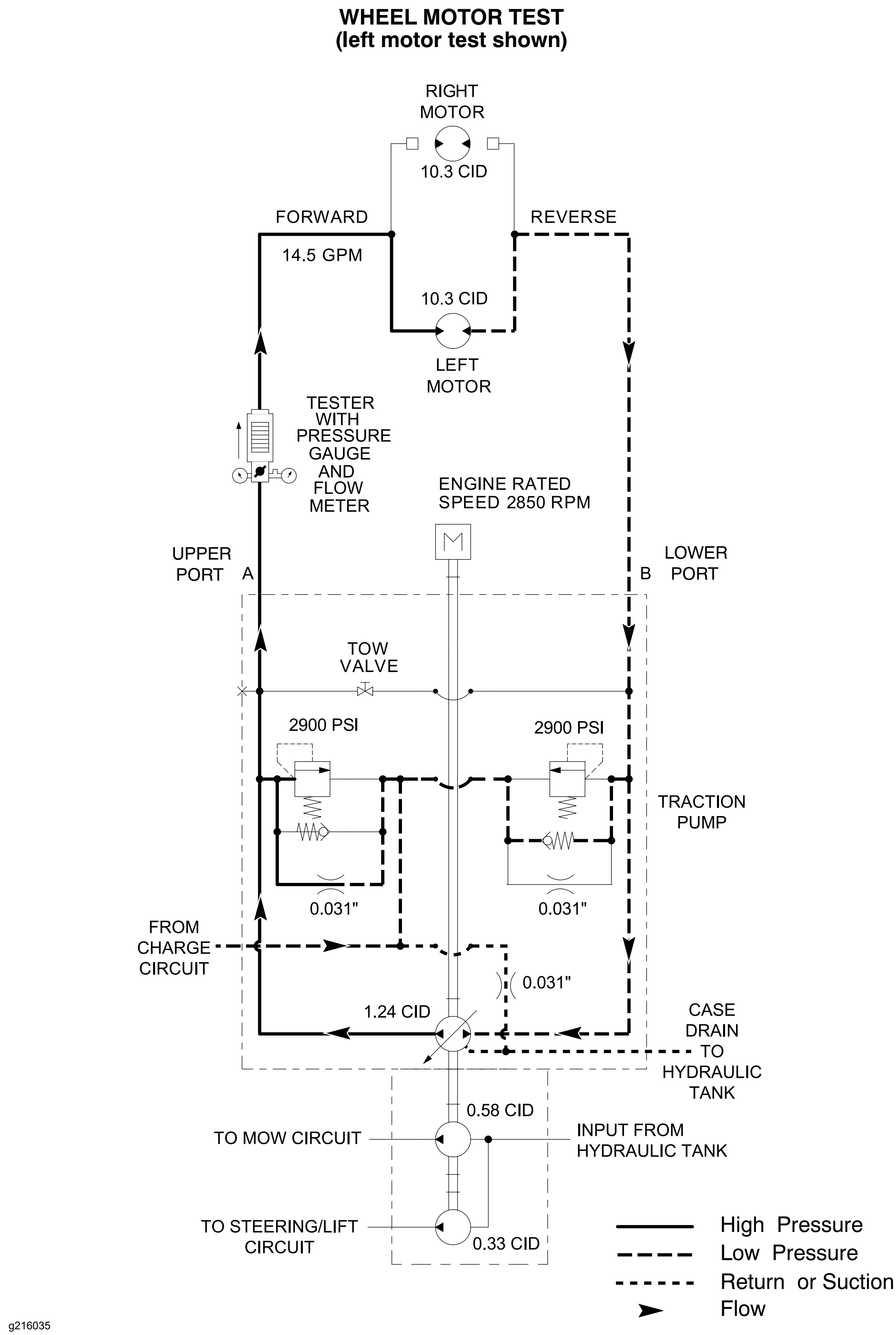

Figure 33

Traction Circuit Testing – Wheel Motor Efficiency Test

Wheel motor efficiency is the second in a series of tests recommended to determine traction circuit performance. Hydraulic fluid flow of 2.4 LPM (0.6

Traction Circuit Testing – Wheel Motor Efficiency Test (continued)

GPM) or more through a single stationary wheel motor under load indicates an internal leak in the wheel motor. A worn wheel motor is less efficient. Eventually, enough fluid by−pass will cause the wheel motor 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.

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 should not be used to determine wheel motor efficiency. Test wheel motors in three (3) different wheel positions to obtain accurate test results. Record test readings for all three (3) wheel positions and use the average for the final test result.

Special Equipment Required:

- Flow Meter with Pressure Gauge that has at least a 57 LPM (15 GPM) capacity.
- Phototach (non−contact tachometer).

1. Park machine on a level surface. The engine should be OFF.
2. Read and adhere to the information provided in Testing the Hydraulic System (page 4–35).
3. Make sure that traction pedal is adjusted to the neutral position.
4. Attach a heavy chain to the rear of the machine frame and an immovable object to prevent the machine from moving during testing.

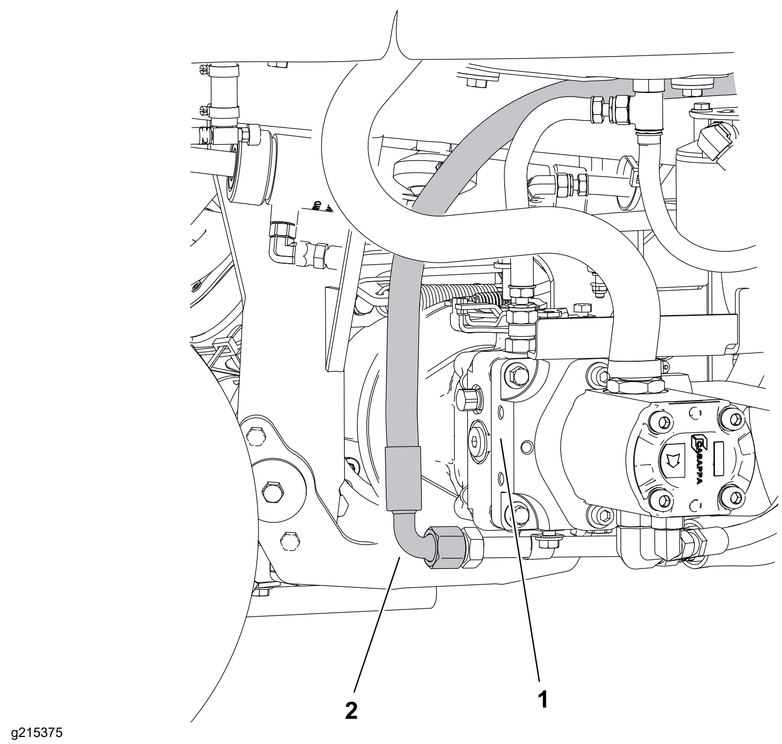

Figure 34

1. Traction pump
2. Hose from traction pump “A” port

5. Disconnect hose from traction pump “A” port; refer to Figure 34.
6. Install tester in series with the pump and the disconnected hose. Make sure the tester is installed in the correct flow direction and the tester flow control valve is fully open.

Traction Circuit Testing – Wheel Motor Efficiency Test (continued)

7. Disconnect hydraulic lines from front wheel motor that is not being tested. Cap disconnected hydraulic lines and plug ports in wheel motor to prevent contamination.
8. Chock front wheel being tested to prevent wheel rotation.
9. Start engine. Move throttle to full speed **(2850 ± 50 RPM)**.
10. Make sure hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes.
11. Verify and record engine speed with a phototach.

CAUTION

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

12. Sit in the operators seat, release the parking brake, and slowly depress forward traction pedal until **6890 to 10340 kPa(1000 to 1500 PSI)** is displayed on the flow meter pressure gauge. The flow meter should read **less than 2.4 LPM (0.6 GPM)**.
13. Release traction pedal, shut engine off, and record test results.
14. Rotate the wheel motor being tested 90 degrees and retest.
15. Rotate the wheel motor being tested 180 degrees and retest.
16. If the wheel motor allows more than the specified flow, the wheel motor is worn and should be repaired or replaced.
17. Reconnect hydraulic lines to front wheel motor and repeat procedure for remaining front wheel motor.
18. Check fluid level in hydraulic tank and adjust as necessary; refer to traction unit *Operator's Manual*.

Traction Circuit Testing – Traction Pump (P1) Flow and Relief Pressure Test

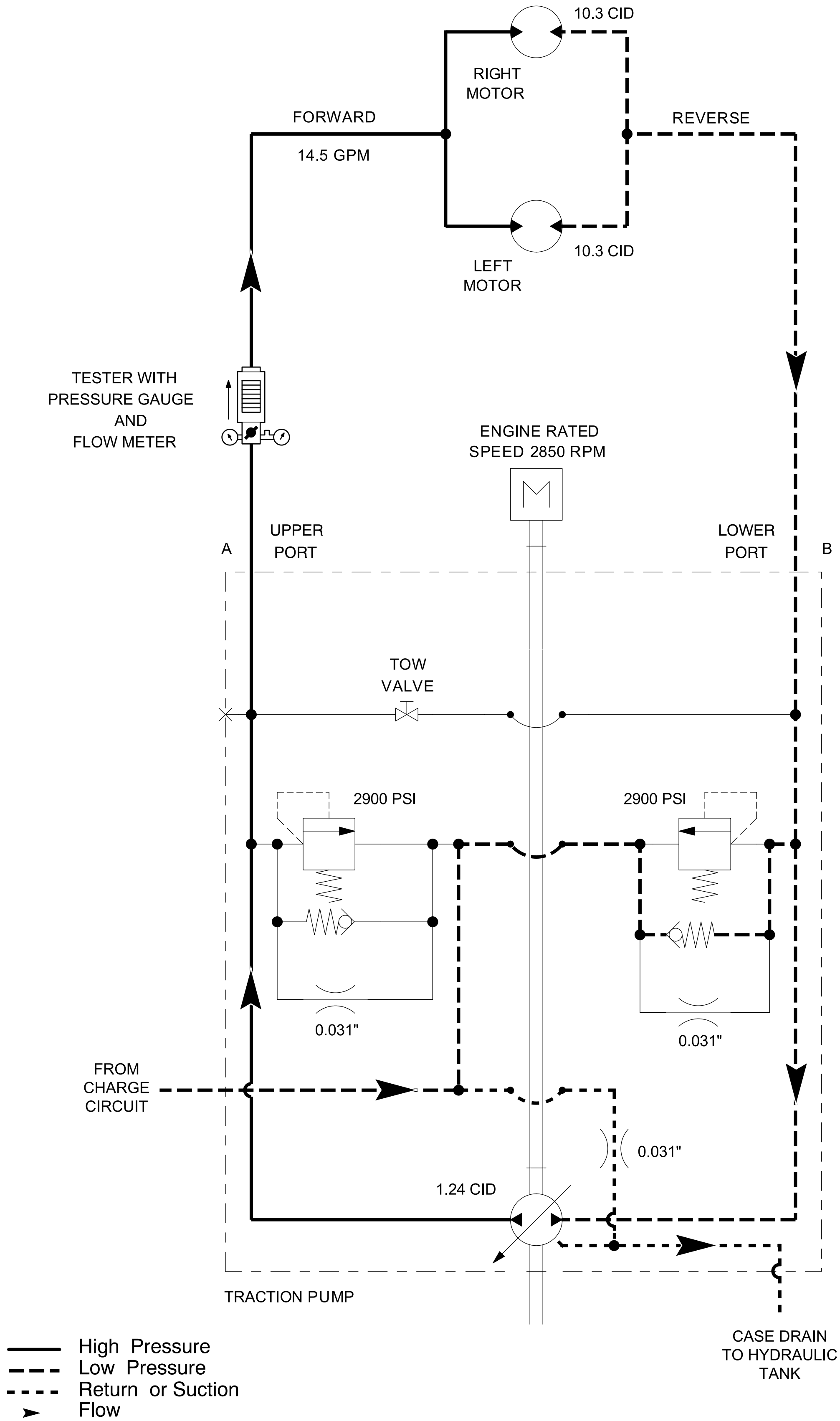

Figure 35

Traction Circuit Testing – Traction Pump (P1) Flow and Relief Pressure Test

Traction Circuit Testing – Traction Pump (P1) Flow and Relief Pressure Test (continued)

The traction pump flow test is the third in a series of tests recommended to determine traction circuit performance. The final traction circuit test is verifying the traction pump relief valve operation. The traction pump flow 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 traction pump. A worn traction pump or malfunctioning relief valve is less efficient. Eventually, enough fluid by−pass 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:

- Flow Meter with Pressure Gauge that has at least a 57 LPM (15 GPM) capacity.
- Phototach (non−contact tachometer).

1. Park machine on a level surface. The engine should be OFF.
2. Read and adhere to the information provided in Testing the Hydraulic System (page 4–35).
3. Make sure that traction pedal is adjusted to the neutral position.

WARNING

Review and follow Jacking Instructions (page 1–7) before jacking up the machine.

4. Raise both front wheels off the floor and support the machine.

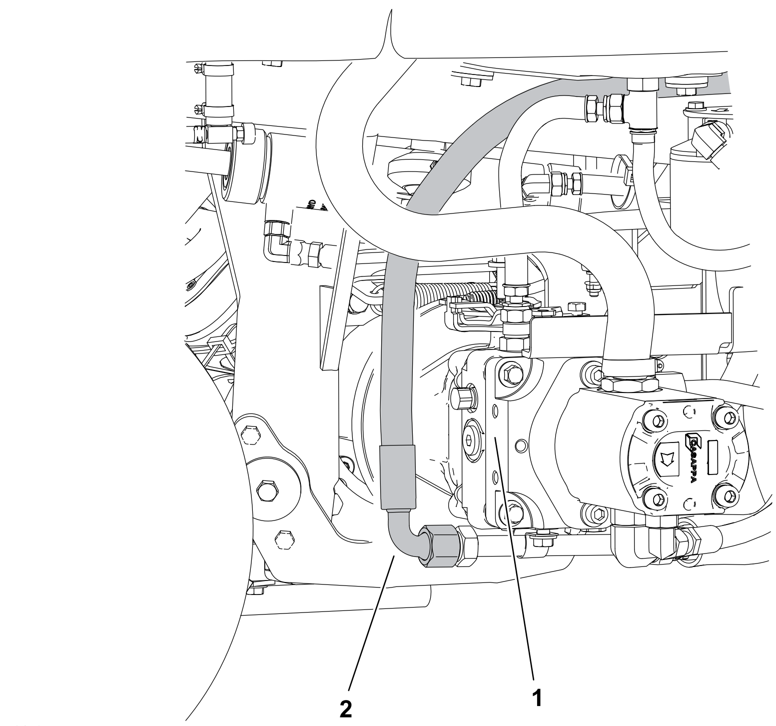

Figure 36

1. Traction pump
2. Hose from traction pump "A" port

Traction Circuit Testing – Traction Pump (P1) Flow and Relief Pressure Test (continued)

5. Disconnect hose from traction pump “A” port; refer to Figure 36.
6. Install tester in series with the pump and the disconnected hose. Make sure the tester is installed in the correct flow direction and the tester flow control valve is fully open.
7. Start engine. Move throttle to full speed **(2850 ± 50 RPM)**.
8. Make sure hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes.
9. Verify and record engine speed with a phototach.

CAUTION

Use extreme caution when performing this test. The traction unit wheels will be rotating during the test.

---

10. Verify pump flow at No Load as follows:
    A. Slowly depress forward traction pedal to full forward position.
    B. Unrestricted pump output should be approximately **54.9 LPM (14.5 GPM)**. Record tester pressure and flow readings.
11. Verify pump flow Under Load as follows:
    A. Slowly depress forward traction pedal to full forward position.
    B. Apply an additional load of **6890 to 10340 kPa (1000 to 1500 PSI)** by slowly closing the flow meter.
    C. Record tester pressure and flow readings.
12. Verify traction pump relief valve operation as follows:
    A. With the traction pedal in the neutral position, fully close the flow meter flow control valve.
    B. Slowly depress the traction pedal toward the forward position.
    C. System pressure should reach approximately **20340 kPa (2950 PSI)** before the relief valve opens. Record tester pressure reading.

       Note: The relief valve setting is **19995 kPa (2900 PSI)**. An additional **345 kPa (50 PSI)** is necessary to overcome system charge pressure before the relief valve opens.

    D. Release traction pedal, open flow control valve fully, move throttle to low speed and turn the engine OFF.
13. If relief pressure can not be met or is greater than specified, the forward direction traction relief valve is faulty and should be replaced.
14. The Under Load test flow reading (step 10) should not drop **more than 12%** when compared to the No Load test flow reading (step 11). A difference of more than 12% may indicate the traction pump is worn and should be repaired or replaced.
15. Remove tester and reconnect hydraulic hose to pump “A” port.
16. Check fluid level in hydraulic tank and adjust as necessary; refer to traction unit *Operator’s Manual*.

Cutting Unit Circuit Testing – Cutting Unit Motor Efficiency/Case Drain Test

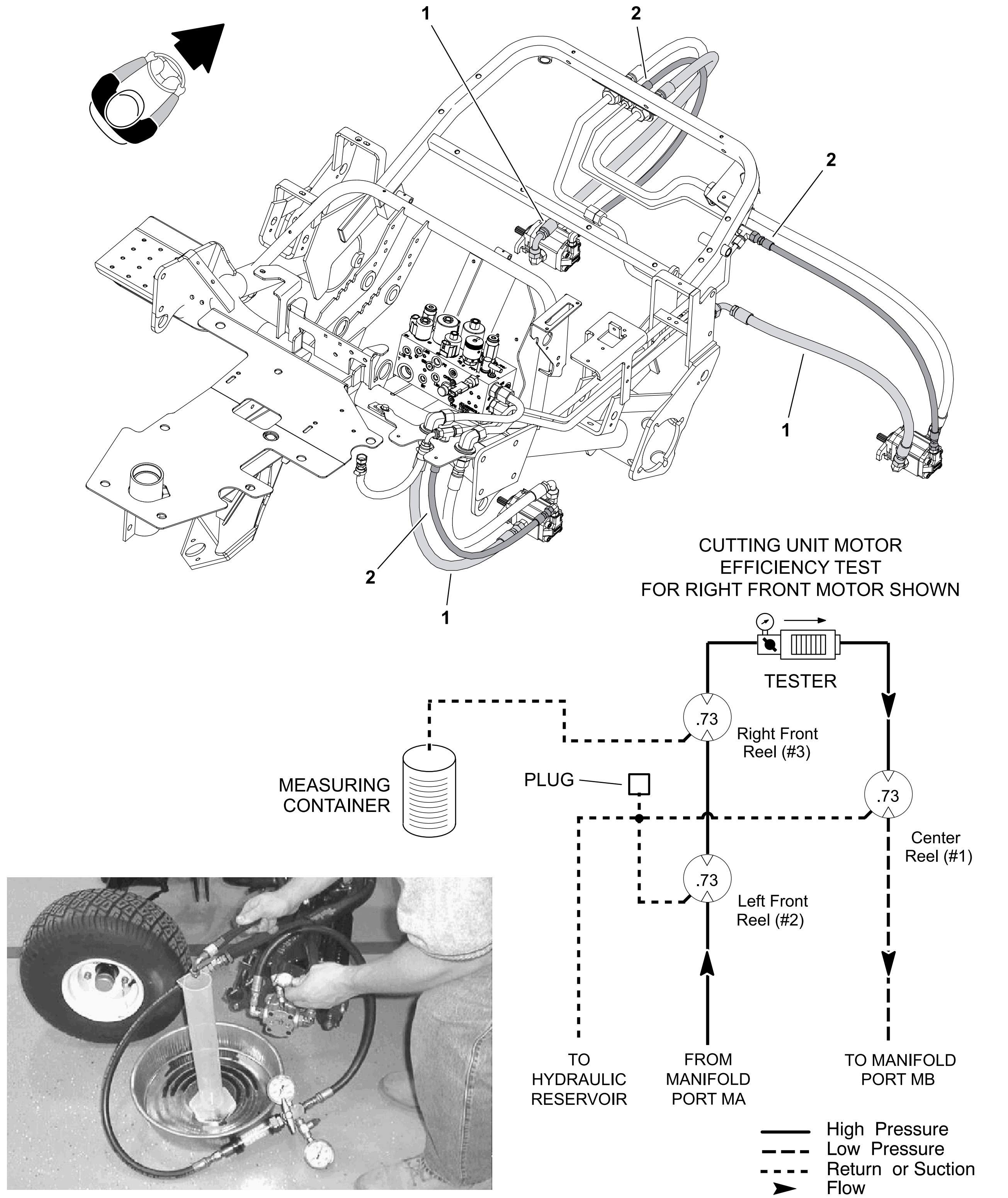

Figure 37

Cutting Unit Circuit Testing – Cutting Unit Motor Efficiency/Case Drain Test

1. Return hose
2. Case drain hose

The cutting unit motor efficiency/case drain test is the first in a series of tests recommended to check cutting unit circuit performance. Over a period of time,

Cutting Unit Circuit Testing – Cutting Unit Motor Efficiency/Case Drain Test (continued)

a cutting unit 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 by−pass hydraulic fluid to its case drain causing the motor to be less efficient. Eventually, enough fluid loss will cause the cutting unit 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: The cutting unit motors are connected in series. If a faulty cutting unit motor is not obvious (based on quality of cut issues) you may have to test all three motors in the circuit. If testing all cutting unit motors, start with the first motor in the series (front left).

Special Equipment Required:

- Flow Meter with Pressure Gauge that has at least a 45 LPM (12 GPM) capacity.
- Phototach (non−contact tachometer).

1. Make sure hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.
2. Park the machine on a level surface with the cutting units lowered. Make sure engine is OFF and the parking brake is disengaged.
3. Read and adhere to the information provided in Testing the Hydraulic System (page 4–35).
4. Disconnect one end of the return hose (fitting at the rear of the motor) for the cutting unit motor being tested.
5. Install the tester in series with the cutting unit motor and the disconnected return hose. Make sure the tester is installed in the correct flow direction and the tester flow control valve is fully open.
6. For machines with backlap, record the current reel speed setting then set the reel speed to the highest speed (fully open). The backlap knob on the mower manifold is in the MOW position.
7. Disconnect the motor case drain (small hose) at the bulkhead fitting for the motor to be tested; refer to Figure 36.
   A. Install a hydraulic cap at the bulkhead fitting.
   B. Place the open end of the disconnected case drain hose in a drain pan
8. Two people are required to complete the following steps. One person should sit in the operator’s seat and operate the machine while another person reads the tester and measures the motor case drain volume.
9. Set the function control lever to NEUTRAL and start the engine. Move throttle to full speed **(2850 ± 50 RPM)**.
10. Verify and record engine speed with a phototach.

CAUTION

Use extreme caution when performing this test. The cutting unit reels will be rotating during the test.

Cutting Unit Circuit Testing – Cutting Unit Motor Efficiency/Case Drain Test (continued)

11. Move the function control lever to the MOW position, engage the cutting units and slowly close tester flow control valve until a pressure of **13789 kPa (2000 PSI)** is obtained.
12. Hold disconnected motor case drain hose into a container graduated in ounces or milliliters (e.g. Toro #TOR4077) and collect hydraulic fluid for 15 seconds. After 15 seconds, remove hose end from container.
13. Disengage the cutting units, Open the tester flow control, set throttle to low speed and stop engine.
14. Record amount of fluid collected in the container.
15. If volume is more than **579 ml (19.5 oz)**, repair or replace the cutting unit motor.
16. Remove tester and reconnect hydraulic hoses.
17. Check hydraulic fluid level (see Traction Unit Operator's Manual).
18. Repeat test with remaining cutting unit motors as needed.
19. If specifications are met and cutting unit performance is still in question, test solenoid valve (S1R1) relief or relief valve (R1) as described in Cutting Unit Circuit Testing – Relief Valve Test (page 4–53).
20. Check fluid level in hydraulic tank and adjust as necessary; refer to traction unit *Operator's Manual*.

Cutting Unit Circuit Testing – Relief Valve Test

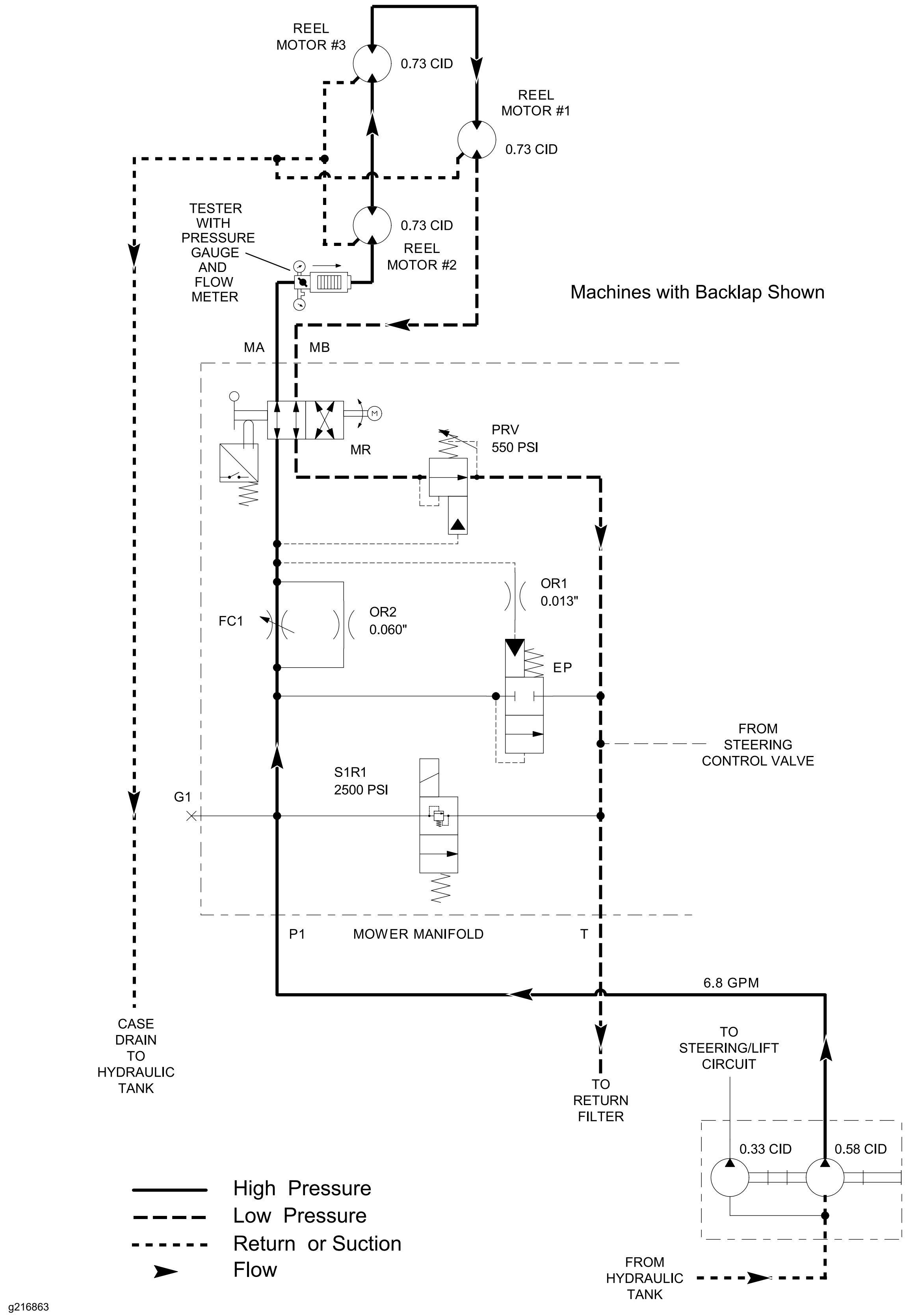

Figure 38

Cutting Unit Circuit Testing – Relief Valve Test

Cutting Unit Circuit Testing – Relief Valve Test (continued)

Cutting unit circuit pressure and relief valve operation is the first in a series of tests recommended to check cutting deck circuit performance. The results from this test will help determine which component(s) are the cause of cutting unit performance issues.

Note: For machines with backlap, the relief valve is part of the solenoid valve (S1R1).

Testing the performance of the solenoid valve (S1R1) relief or relief valve (R1) ensures that the maximum amount of fluid is available to the cutting unit motors up to the set relief pressure. This test also ensures that pump (P2) is capable of generating enough pressure to open a properly functioning relief valve.

Special Equipment Required:

- Flow Meter with Pressure Gauge that has at least a 45 LPM (12 GPM) capacity.
- Phototach (non−contact tachometer).

1. Park the machine on a level surface with the cutting units lowered. Make sure the engine is OFF and the parking brake is engaged.
2. Read and adhere to the information provided in Testing the Hydraulic System (page 4–35).

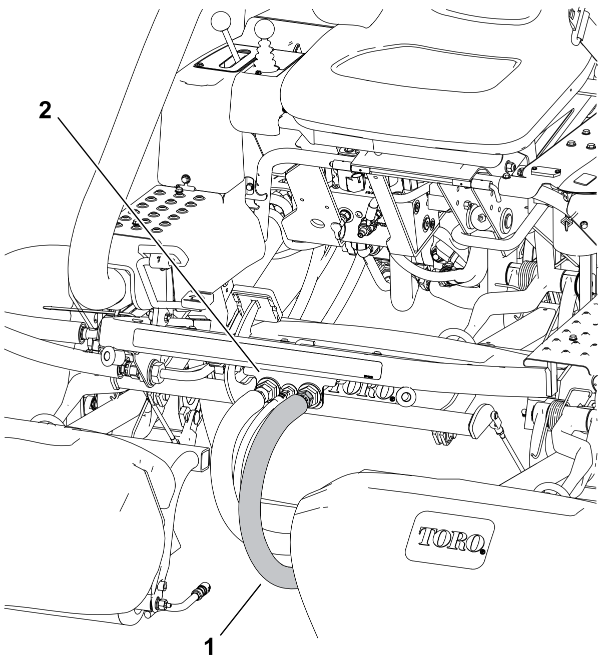

Figure 39

1. Hydraulic hose
2. Bulkhead

3. Disconnect the hydraulic hose from the bulkhead at the front of the machine; refer to Figure 39.
4. Install tester in series with the bulkhead and the disconnected hose. Make sure the tester is installed in the correct flow direction and the tester flow control valve is fully open.
5. To prevent reel damage, temporarily adjust bedknife to allow clearance between bedknife and reel (no contact) on all three cutting units.
6. For machines with backlap, record the current reel speed setting then set the reel speed to the highest speed (fully open). The backlap knob on the mower manifold must be in the MOW position.

Cutting Unit Circuit Testing – Relief Valve Test (continued)

7. Start engine. Move throttle to full speed **(2850 ± 50 RPM)**.
8. Make sure hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes.
9. Verify and record engine speed with a phototach.

⚠ CAUTION ⚠

Use extreme caution when performing this test. The cutting unit reels will be rotating during the test.

---

10. Engage the cutting units and record the unrestricted cutting unit pressure.
11. Watch pressure gauge carefully while slowly closing the flow control valve.
    A. For machines with backlap, system pressure should be approximately **17237 kPa (2500 PSI)** as solenoid valve (S1R1) relief opens. Record test results.
    B. For machines without backlap, system pressure should be approximately **20684 kPa (3000 PSI)** as relief valve (R1) opens. Record test results.
12. Disengage the cutting units. Open the control valve on the tester and shut the engine OFF.
13. If specification is met, test pump (P2) flow as described in Cutting Unit Circuit Testing – Gear Pump (P2) Flow Test (page 4–56). If specification is not met, clean or replace solenoid valve (S1R1) or relief valve (R1) as described in Servicing the Mower Manifold (page 4–99) and retest.
14. Remove the tester and reconnect the hydraulic hose.
15. For machines with backlap, adjust cutting unit bedknife to reel clearance and reel speed as necessary.
16. Check the fluid level in the hydraulic tank and adjust as necessary; refer to traction unit *Operator's Manual*.

Cutting Unit Circuit Testing – Gear Pump (P2) Flow Test

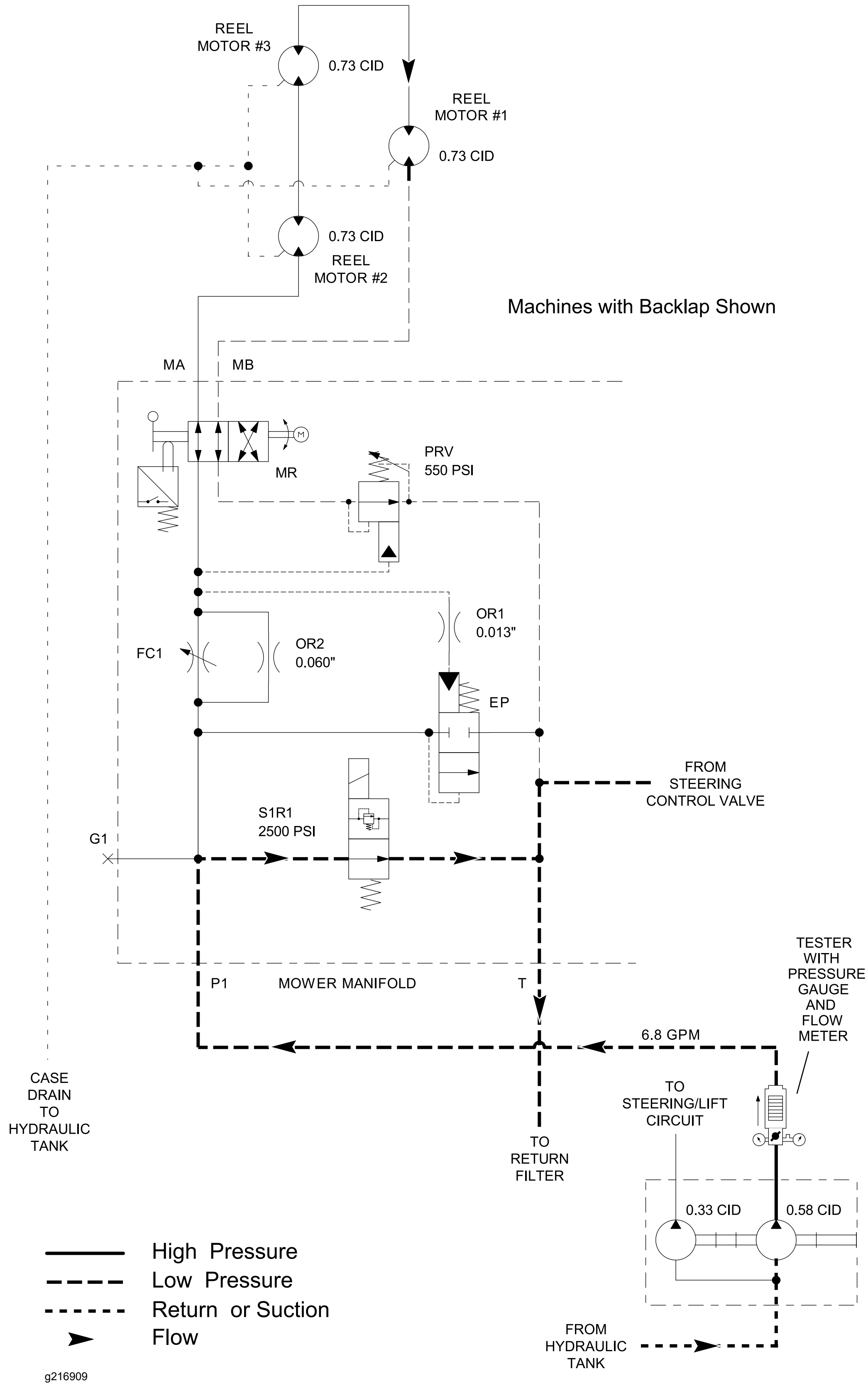

Figure 40

Cutting Unit Circuit Testing – Gear Pump (P2) Flow Test

Cutting Unit Circuit Testing – Gear Pump (P2) Flow Test (continued)

The gear pump (P2) flow test is the last in a series of tests recommended to determine cutting unit circuit performance. 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 will by−pass hydraulic fluid and make the pump less efficient. Eventually, enough fluid loss will occur to cause the cutting unit motors to stall under heavy cutting 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 LPM (12 GPM) capacity.
- Phototach (non−contact tachometer).

1. Park machine on a level surface with the cutting units lowered. Make sure engine is OFF and the parking brake is engaged.
2. Read and adhere to the information provided in Testing the Hydraulic System (page 4–35).

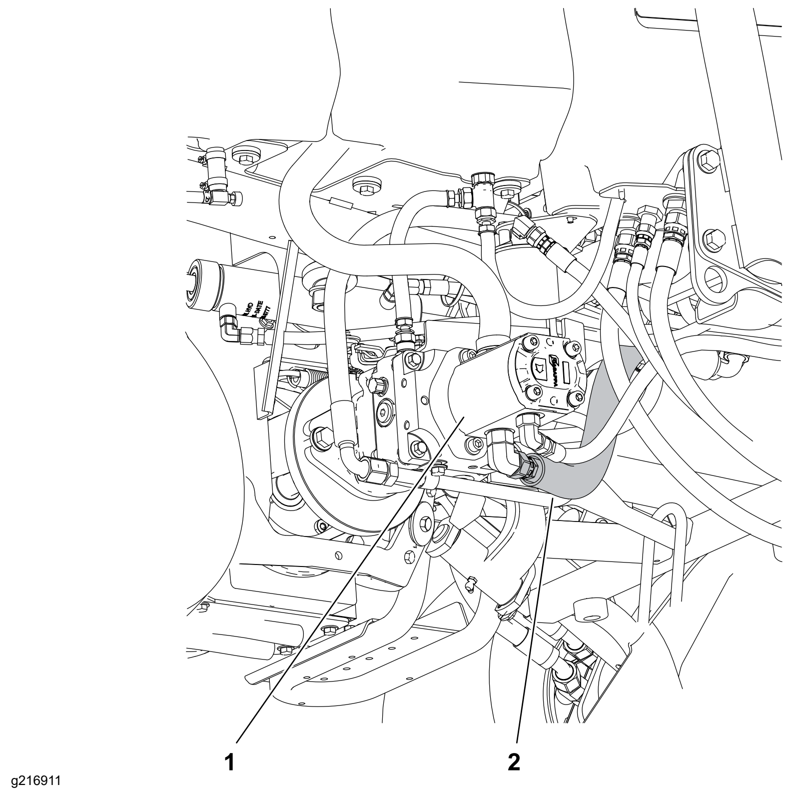

Figure 41

1. Gear pump section (P2)
2. Hydraulic hose

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3. Disconnect hose connection on the bottom of gear pump (P2); refer to Figure 41.
4. Install tester between the gear pump and the disconnected hose. Make sure the tester is installed in the correct flow direction and the tester flow control valve is fully open.
5. For machines with backlap, record the current reel speed setting then set the reel speed to the highest speed (fully open). The backlap knob on the mower manifold must be in the MOW position.

Cutting Unit Circuit Testing – Gear Pump (P2) Flow Test (continued)

CAUTION

Do not engage the cutting units when performing this test.

6. Start engine. Move throttle to full speed **(2850 ± 50 RPM)**.
7. Make sure hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes.
8. Verify and record engine speed with a phototach.
9. Record tester pressure and flow reading with pump At No Load. Unrestricted pump output should be approximately **25.7 LPM (6.8 GPM)**.

CAUTION

Do not close tester valve fully when performing this test. In this test, the hydraulic tester is positioned before the circuit relief valve. Pump damage can occur if the fluid flow is fully restricted by fully closing the tester flow control valve.

10. Verify pump flow Under Load as follows:
    A. Watch flow meter pressure gauge carefully while slowly closing the flow control valve until **12411 kPa (1800 PSI)** is obtained on gauge.
    B. Record tester pressure and flow readings under load.
11. Open flow control valve fully, move throttle to low speed and turn the engine OFF.
12. The under load test flow reading (step 9) should not drop more than 15% when compared to the pump at no load test flow reading (step 10). A difference in flow of more than 15%, or the inability to achieve specified pressure may indicate:
    A. A restriction in the pump intake line
    B. The gear pump (P2) is worn and should be repaired or replaced
13. When testing is complete, remove tester and connect hose to pump fitting.
14. For machines with backlap, return reel speed adjustment knob to original setting.
15. Check fluid level in hydraulic tank and adjust as necessary; refer to traction unit *Operator's Manual*.

Steering/Lift Circuit Testing – Gear Pump (P3) Flow and Circuit Relief Valve Test

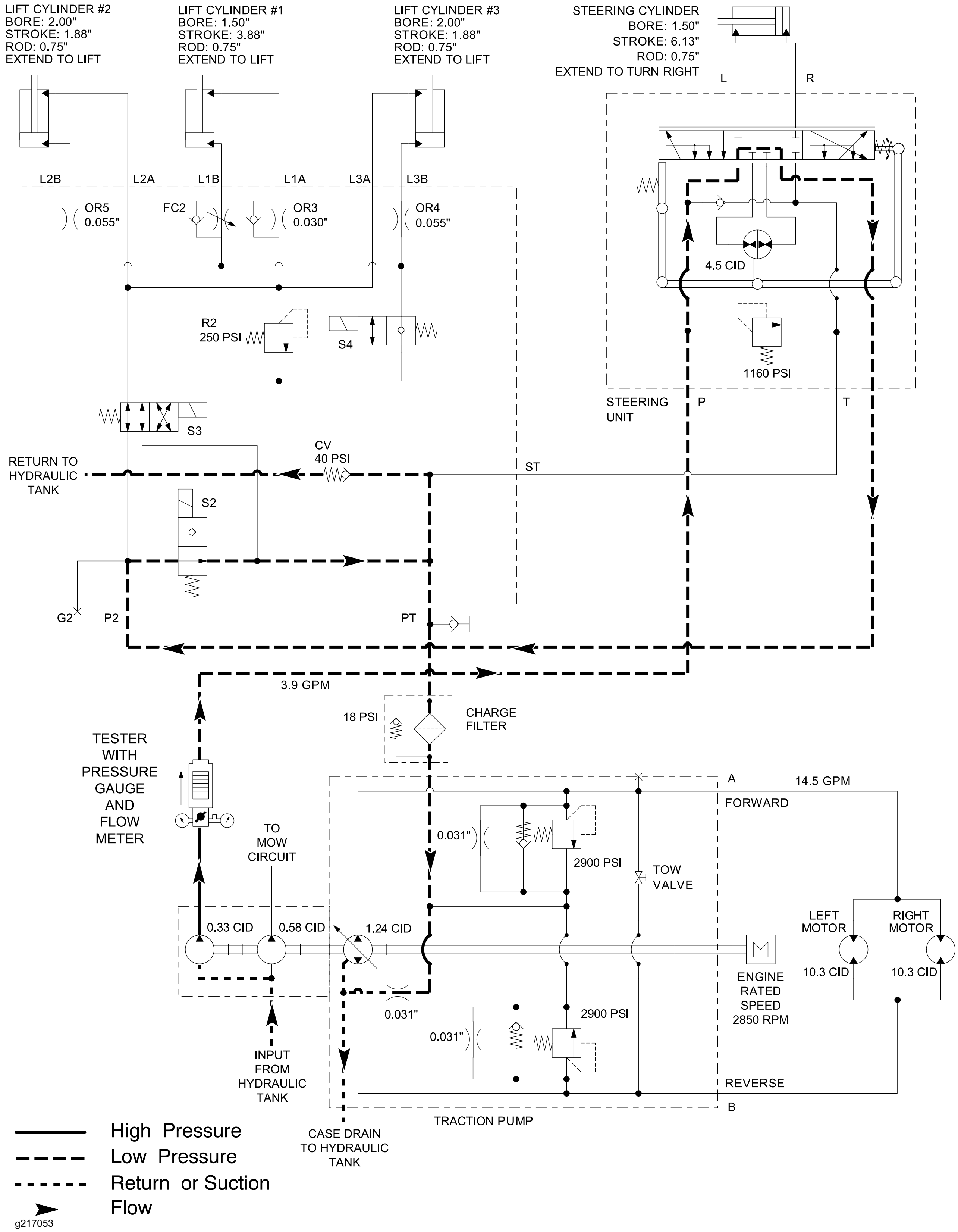

Figure 42

Steering/Lift Circuit Testing – Gear Pump (P3) Flow and Circuit Relief Valve Test

Steering/Lift Circuit Testing – Gear Pump (P3) Flow and Circuit Relief Valve Test (continued)

Gear pump (P3) is designed to satisfy both steering cylinder and lift cylinder needs simultaneously (at full speed throttle). 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.

The relief valve for the steering and lift circuit is integrated into the steering control valve. If both steering and lift operations perform poorly, perform the gear pump (P3) flow test and the circuit relief valve test.

If machine steering is sluggish or otherwise performs poorly, refer to Steering/Lift Circuit Testing – Steering Control Valve and Steering Cylinder Test (page 4–67).

If cutting deck lift operation is unsatisfactory, check lift control cartridge valves and/or lift cylinders. Additional information on these components is available in the Service and Repair section of this chapter.

Special Equipment Required:

- Flow Meter with Pressure Gauge that has at least a 16 LPM (5 GPM) capacity.
- Phototach (non−contact tachometer).

1. Park machine on a level surface with the cutting units lowered. Make sure engine is OFF and the parking brake is engaged.
2. Read and adhere to the information provided in Testing the Hydraulic System (page 4–35).
3. Measure and record the system charge pressure (without load). Refer to Traction Circuit Testing – Charge Pressure Test (page 4–38) for additional information.

Steering/Lift Circuit Testing – Gear Pump (P3) Flow and Circuit Relief Valve Test (continued)

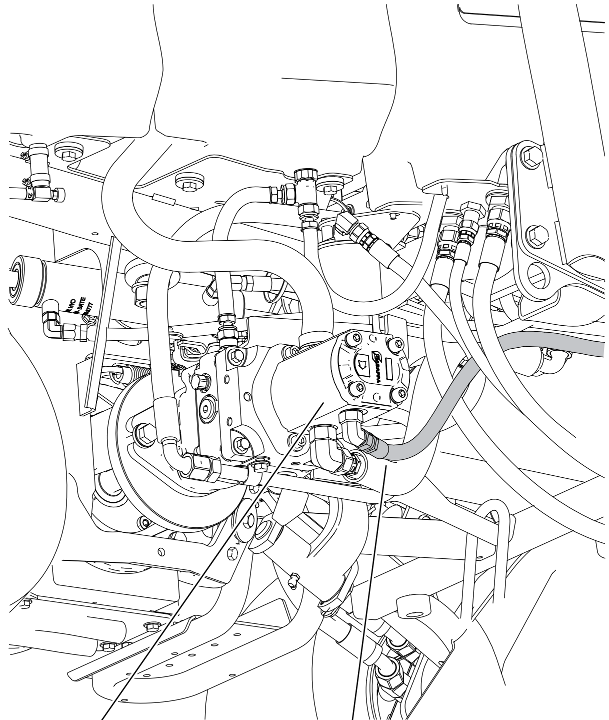

Figure 43

1. Gear pump section (P3)
2. Hydraulic hose

---

4. Disconnect hose connection on the bottom of gear pump (P3); refer to Figure 43.
5. Install tester between the gear pump and the disconnected hose. Make sure the tester is installed in the correct flow direction and the tester flow control valve is fully open.
6. Start engine. Move throttle to full speed **(2850 ± 50 RPM)**.
7. Make sure hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes.
8. Verify and record engine speed with a phototach.
9. Test the gear pump (P3) flow as follows:
   A. Record tester pressure and flow reading with pump At No Load. Unrestricted pump output should be approximately **14.7 LPM (3.9 GPM)**.

CAUTION

Do not close tester valve fully when performing this test. In this test, the hydraulic tester is positioned before the circuit relief valve. Pump damage can occur if the fluid flow is fully restricted by fully closing the tester flow control valve.

   B. To verify the pump flow Under Load, watch flow meter pressure gauge carefully while slowly closing the flow control valve until **5516 kPa (800 PSI)** is obtained on gauge.

Steering/Lift Circuit Testing – Gear Pump (P3) Flow and Circuit Relief Valve Test (continued)

C. Record tester pressure and flow readings under load.

D. Open flow control valve fully.

E. The under load test flow reading (step B) should not drop more than 15% when compared to the pump at no load test flow reading (step A). A difference in flow of more than 15%, or the inability to achieve specified pressure may indicate a restriction in the pump intake line, or that the gear pump (P3) is worn and should be repaired or replaced.

10. Test the circuit relief valve as follows:

CAUTION

When performing the test, do not allow the system pressure to exceed 8300 kPa (1400 PSI).

IMPORTANT

Hold steering wheel at full lock only long enough to obtain a system pressure reading.

A. Open the circuit relief valve via the steering system. Watch the pressure gauge on the tester and turn the steering wheel completely in one direction. The circuit relief valve should open just after the rear wheel gets to the full lock position. Record the pressure at which the relief valve opens.

B. Open the circuit relief valve via the lift system. Watch the pressure gauge on the tester and move the joystick control to the RAISE position. Momentarily hold the joystick with the cutting units fully raised causing the circuit relief valve to open. Record the pressure at which the relief valve opens.

C. Set the joystick to the NEUTRAL position and turn the engine OFF.

Note: The circuit relief valve is in series with charge relief valve. Charge relief pressure will affect the circuit relief pressure.

D. The circuit relief valve pressure should be **7300 to 8600 kPa (1050 to 1250 PSI) higher than the charge relief valve pressure** (e.g. if the charge relief valve pressure is 414 kPa (60 PSI), the circuit relief valve pressure should be from 7653 to 9032 kPa (1110 to 1310 PSI).

Note: The Lowering Cutting Units Relief Valve Test is performed with the tester installed in its current location. Refer to Steering/Lift Circuit Testing – Lowering Cutting Units Relief Valve Test (page 4–63) for additional information.

11. When testing is complete, remove tester and connect hose to pump fitting.

12. Check fluid level in hydraulic tank and adjust as necessary; refer to traction unit *Operator's Manual*.

Steering/Lift Circuit Testing – Lowering Cutting Units Relief Valve Test

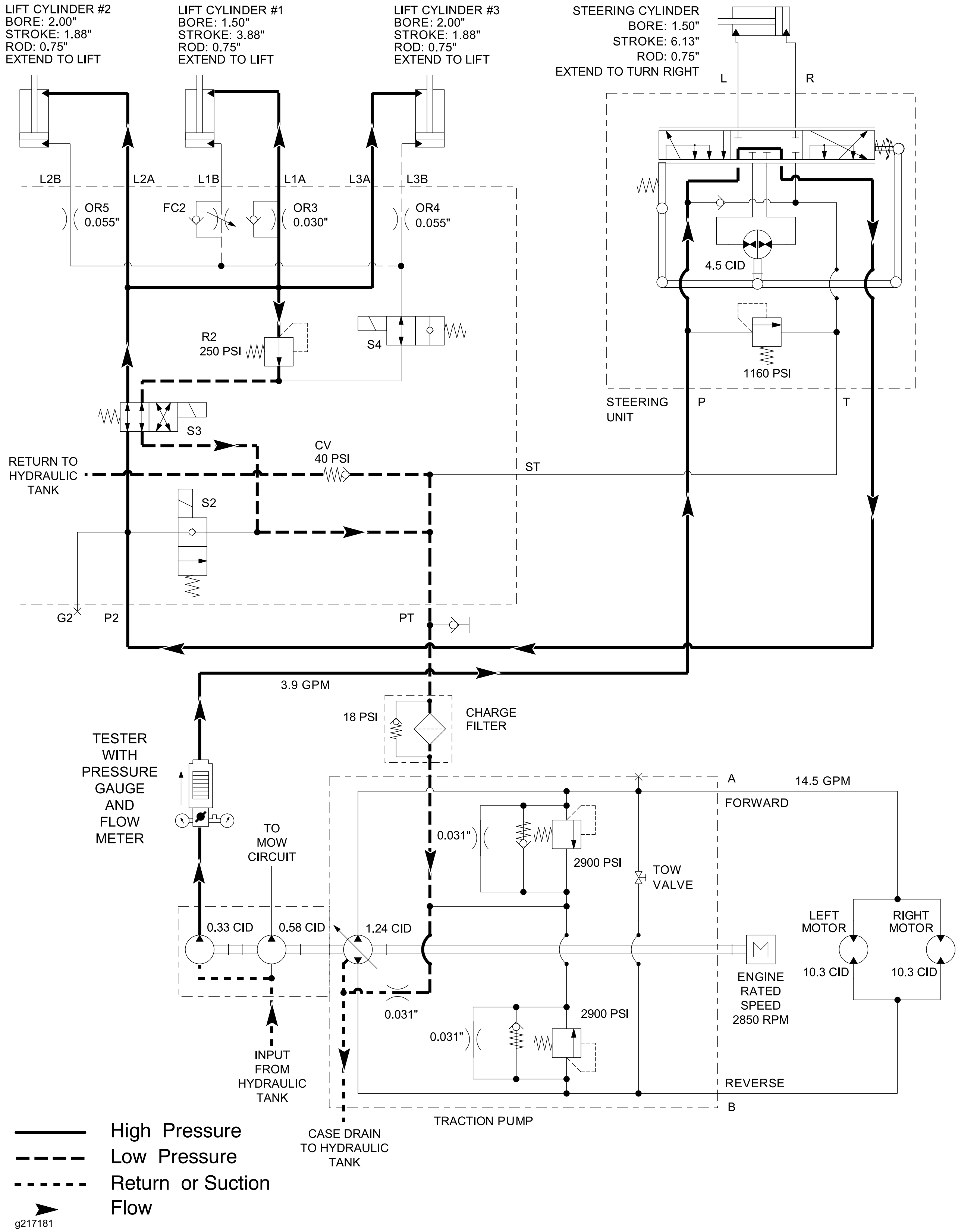

Figure 44

Steering/Lift Circuit Testing – Lowering Cutting Units Relief Valve Test

Steering/Lift Circuit Testing – Lowering Cutting Units Relief Valve Test (continued)

Special Equipment Required:

- Flow Meter with Pressure Gauge that has at least a 16 LPM (5 GPM) capacity.
- Phototach (non−contact tachometer).

1. Park machine on a level surface with the cutting units lowered. Make sure engine is OFF and the parking brake is engaged.
2. Read and adhere to the information provided in Testing the Hydraulic System (page 4–35).
3. Measure and record the system charge pressure (without load). Refer to Traction Circuit Testing – Charge Pressure Test (page 4–38) for additional information.

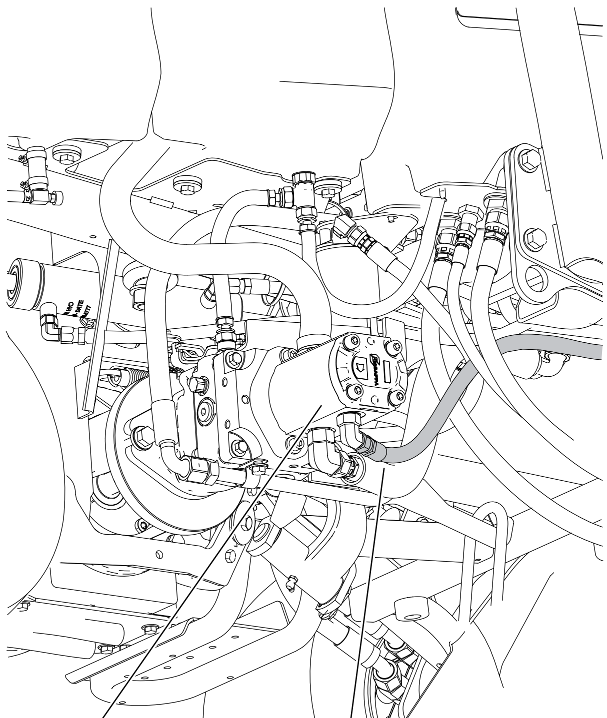

Figure 45

1. Gear pump section (P3)
2. Hydraulic hose

4. Disconnect hose connection on the bottom of gear pump (P3); refer to Figure 45.
5. Install tester between the gear pump and the disconnected hose. Make sure the tester is installed in the correct flow direction and the tester flow control valve is fully open.
6. Start engine. Move throttle to full speed **(2850 ± 50 RPM)**.
7. Make sure hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes.
8. Verify and record engine speed with a phototach.
9. Make sure that cutting units are fully lowered and then engage the cutting units.

Steering/Lift Circuit Testing – Lowering Cutting Units Relief Valve Test (continued)

Note: Lowering the cutting units is an electrically timed function and automatically turns off after approximately six (6) seconds. If the relief pressure cannot be determined within the six (6) second time frame, repeat the test procedure.

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

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

11. The lowering cutting units relief valve pressure should be approximately 1724 kPa (250 PSI) higher than the charge relief pressure (e.g. if the charge relief valve pressure is 414 kPa (60 PSI), the lowering relief valve pressure should be approximately 2137 kPa (310 PSI)).

Steering/Lift Circuit Testing – Lowering Cutting Units Relief Valve Test (continued)

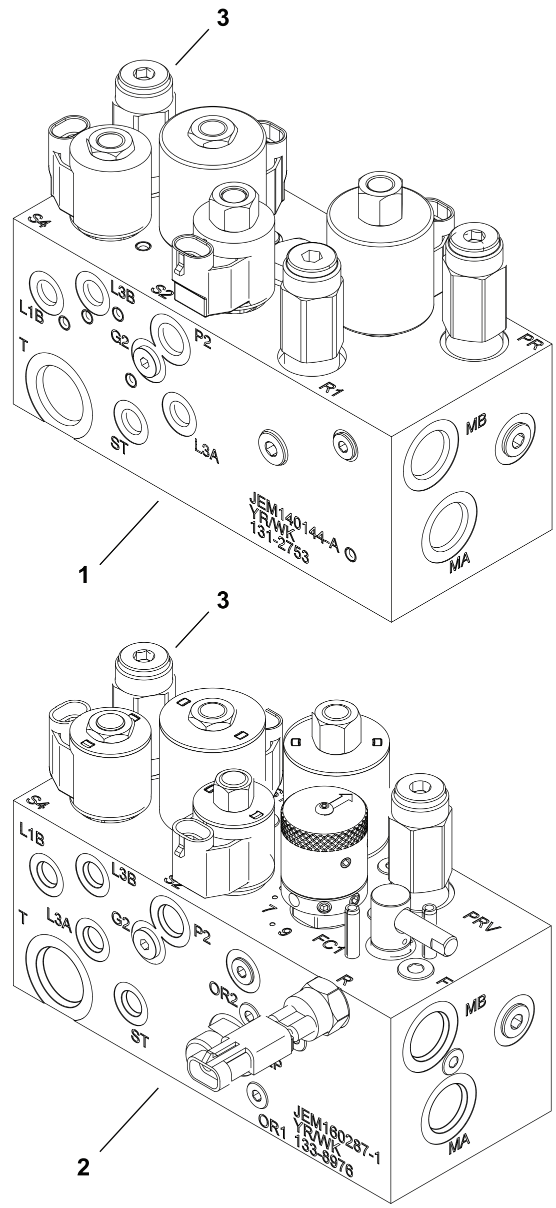

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Figure 46

1. Mower manifold assembly (machines without backlap)
2. Mower manifold assembly (machines with backlap)
3. Lowering cutting units relief valve (R2)

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12. If lowering cutting units relief valve pressure is incorrect, adjust the mower manifold relief valve (R2) (refer to Figure 46) and retest. Refer to Adjusting Relief Valves (page 4–70) in this Chapter for additional information.

    Note: The Gear Pump (P3) Flow and Circuit Relief Valve Test is performed with the tester installed in its current location. Refer to Steering/Lift Circuit Testing – Gear Pump (P3) Flow and Circuit Relief Valve Test (page 4–59) for additional information.
13. When testing is complete, remove tester and connect hose to pump fitting.
14. Check fluid level in hydraulic tank and adjust as necessary; refer to traction unit *Operator's Manual*.

Steering/Lift Circuit Testing – Steering Control Valve and Steering Cylinder Test

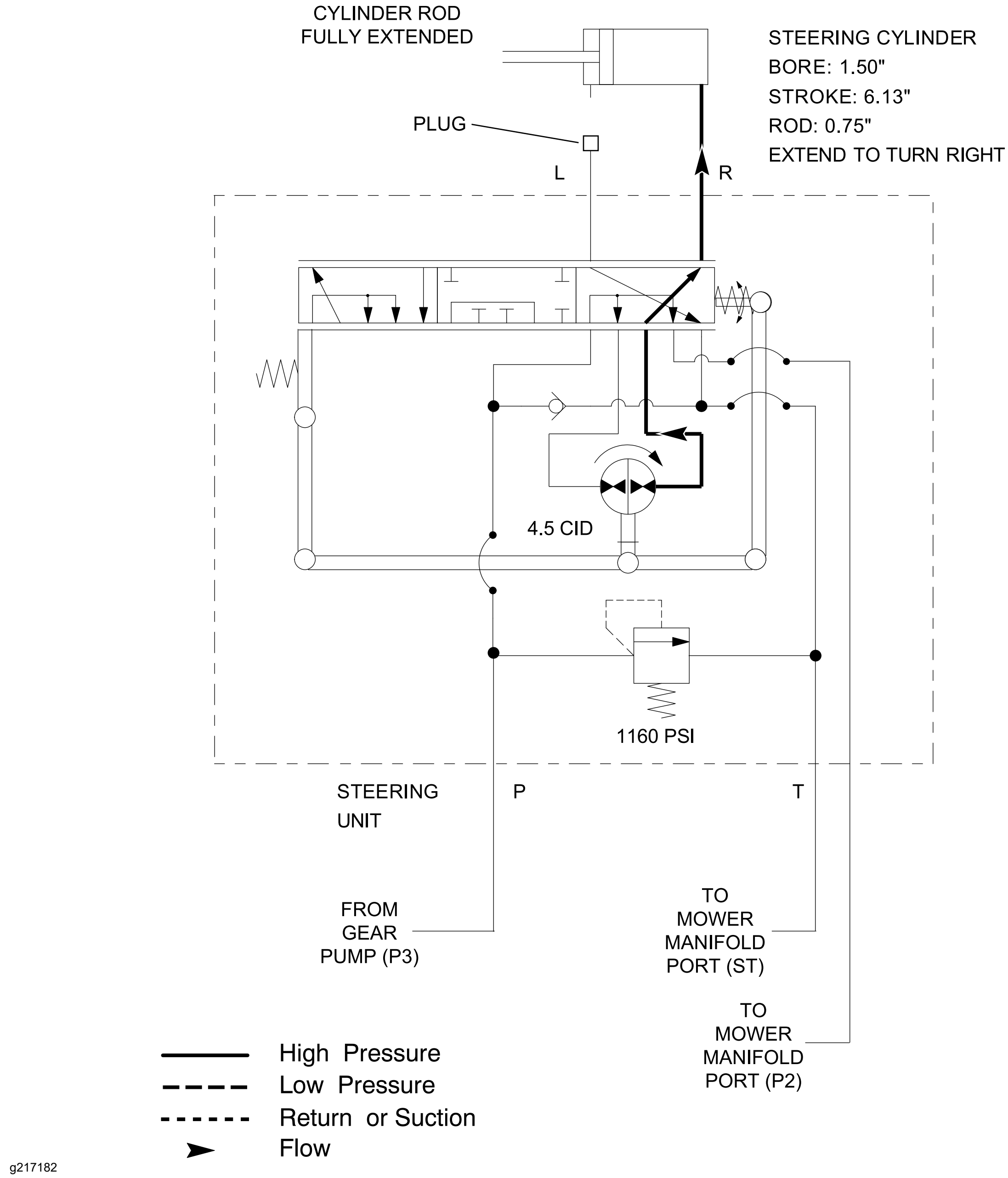

Figure 47

Steering/Lift Circuit Testing – Steering Control Valve and Steering Cylinder Test

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Unit steering performance will be affected by incorrect rear tire pressure, binding in the hydraulic steering cylinder, and/or binding of the steering fork assembly. Make sure that these conditions are checked and functioning properly before proceeding with any steering system hydraulic testing.

1. Make sure the hydraulic tank is full.
2. Make sure hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes.
3. Drive machine slowly in a figure eight on a flat level surface.
   A. There should be no shaking or vibration in the steering wheel or rear wheel.

Steering/Lift Circuit Testing – Steering Control Valve and Steering Cylinder Test (continued)

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

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

   A. The steering 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.

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

   A. Park machine on a level surface with the parking brake engaged.

   B. With the engine running, turn the steering wheel to the right (clockwise) until the steering cylinder rod is fully extended and turn the engine OFF.

   C. Read and adhere to the information provided in Testing the Hydraulic System (page 4–35).

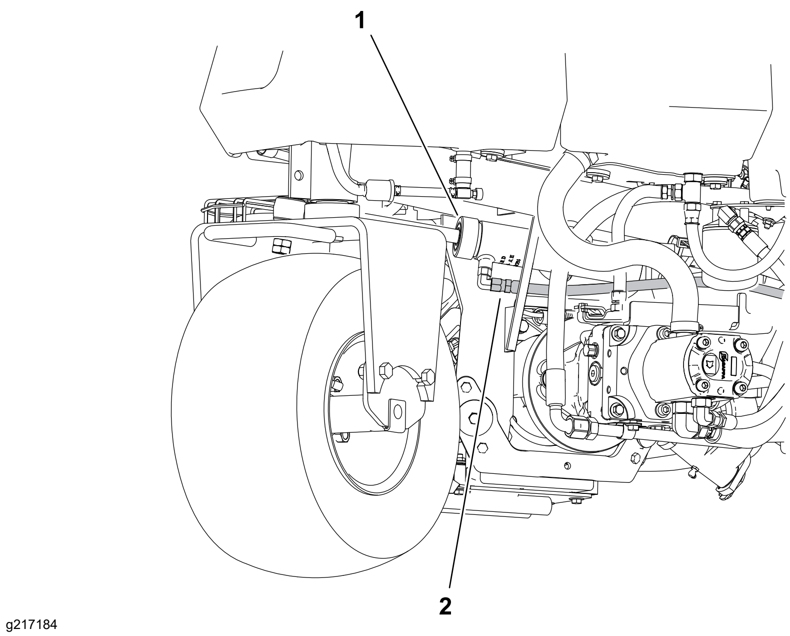

Figure 48

1. Steering cylinder
2. Rod end hydraulic hose

   D. Disconnect the hydraulic hose from the fitting on the rod end of the steering cylinder. Plug the disconnected hose.

   E. With the engine OFF, continue turning the steering wheel to the right (clockwise) with the steering cylinder fully extended. Observe the open fitting on the steering cylinder as the wheel is turned. If hydraulic 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.

   F. Remove plug from the hydraulic hose and reconnect the hose. Make sure the hydraulic hoses do not contact any moving parts as the caster fork moves from stop to stop.

Steering/Lift Circuit Testing – Steering Control Valve and Steering Cylinder Test (continued)

6. If a steering problem exists and the steering cylinder passes testing, perform Steering/Lift Circuit Testing – Gear Pump (P3) Flow and Circuit Relief Valve Test (page 4–59) to make sure the steering control valve and cylinder are receiving adequate fluid flow and pressure. Based on the results of these tests, repair or replace steering control valve as necessary; refer to Steering Control Valve (page 4–127).

Adjustments

Adjusting Relief Valves

The mower manifold includes one or more adjustable relief valves. Use the following procedure if adjusting to a relief valve is necessary.

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

WARNING

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

1. Locate the desired relief valve on the mower manifold; refer to Servicing the Mower Manifold (page 4–99).

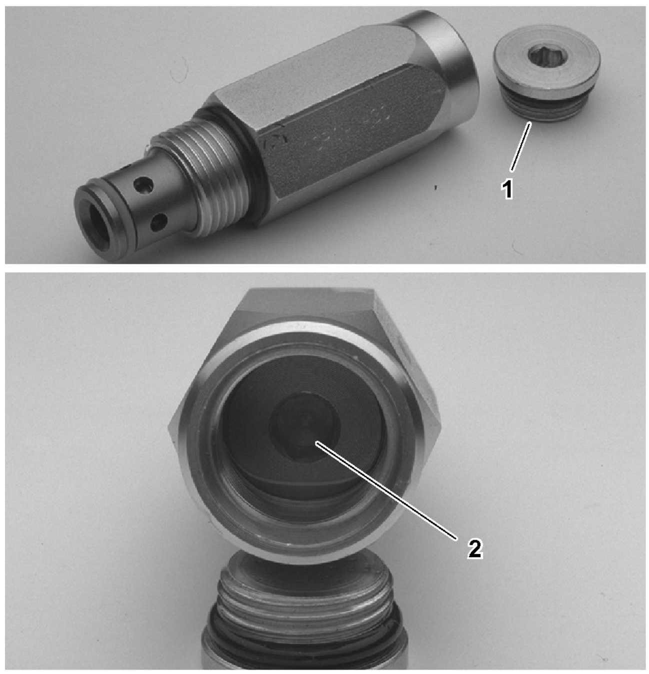

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Figure 49

1. Cap
2. Adjustment hex socket

2. Remove cap on relief valve with a hex wrench; refer to Figure 49.
3. To increase pressure setting, turn the adjustment socket on the valve in a clockwise direction. A 1/8 turn on the socket will make a measurable change in relief pressure.
4. To decrease pressure setting, turn the adjustment socket on the valve in a counterclockwise direction. A 1/8 turn on the socket will make a measurable change in relief pressure.
5. Install and tighten cap on relief valve.
6. Recheck relief pressure and readjust as needed.

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, turn the engine OFF, 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.

WARNING

Before disconnecting or doing any work on the hydraulic system, release all the pressure in the system; refer to Relieving Pressure from the Hydraulic System (page 4–4).

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 traction unit *Operator's Manual*.

IMPORTANT

Drain and fill the hydraulic-system tank and change the hydraulic fluid filters if the component failure is severe or the system is contaminated; refer to the traction unit *Operator's Manual*.

2. Lubricate the O-rings and seals with clean hydraulic fluid before installing the hydraulic components.
3. Remove all the caps or plugs from the hydraulic tubes, hydraulic fittings, and components before connecting them again.
4. Use proper tightening procedures when installing the hydraulic hoses and fittings; refer to Installing Hydraulic Hoses and Tubes (O-Ring Face Seal)

(page 4–8) and Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 4–10).

5. After you complete the repairs, check the control linkages or cables for proper adjustment, binding, or broken parts.
6. Whenever hydraulic fluid has been drained from the pumps (system drain, flush, or pump removal/installation) it is important to properly prime the hydraulic pumps, refer to Priming the Hydraulic Pumps (page 4–78).
7. After you disconnect or replace any hydraulic component, operate the machine functions slowly until the air is out of the system; refer to Charging the Hydraulic System (page 4–79).
8. Check for hydraulic-fluid leaks. Shut off the engine and repair leaks 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, weather deterioration, and chemical deterioration. Repair the damaged hydraulic equipment before operating the machine.

Flushing the Hydraulic System

IMPORTANT

If a component failure occurs in the traction circuit; refer to Filtering the Closed-Loop Traction Circuit (page 4–76) for additional information.

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).

1. Park the machine on a level surface, engage the parking brake, lower the cutting units and stop the engine. Remove key from the ignition switch.
2. Read and adhere to the information provided in General Precautions for Removing and Installing the Hydraulic System Components (page 4–71).

CAUTION

Flush the hydraulic system with the hydraulic fluid as warm as possible, but to prevent additional system damage, Do Not operate a machine with contaminated hydraulic fluid to warm the fluid before draining.

IMPORTANT

Follow all local codes and regulations when recycling or disposing the hydraulic fluid and filters.

Flushing the Hydraulic System (continued)

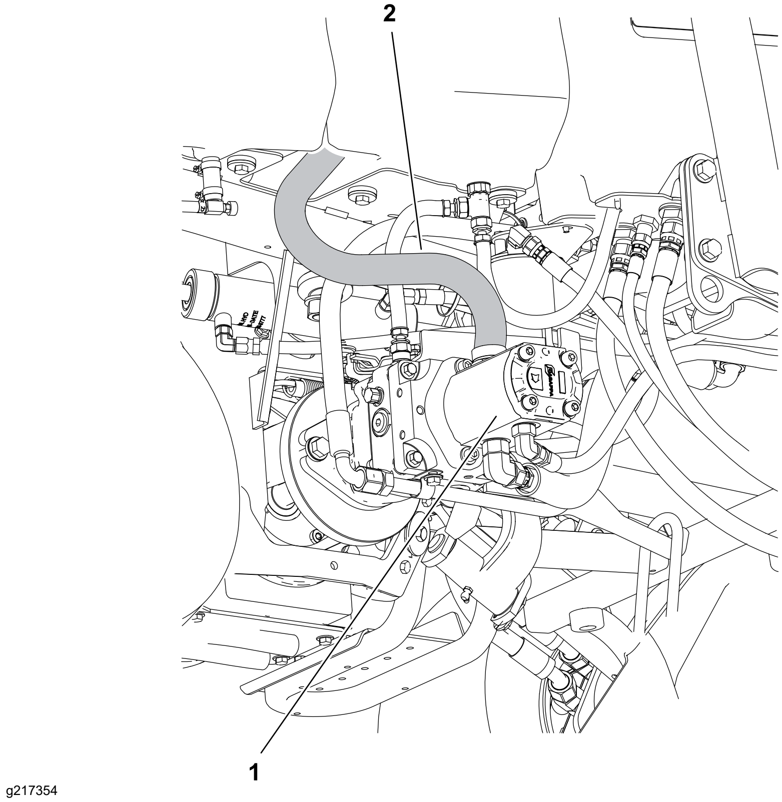


Figure 50

1. Gear pump
2. Inlet hose

3. Clean area around gear pump and pump inlet hose; refer to Figure 50. Clamp pump inlet hose closed and remove hose from gear pump. Release clamp and drain tank into a suitable container.
4. Drain hydraulic system hoses, tubes, lift cylinders and other components from low points in the system.
5. Inspect and clean hydraulic tank; refer to Hydraulic Tank (page 4–137).
6. Remove and replace the hydraulic-fluid filters; refer to the traction unit *Operator's Manual*.
7. Connect all the hydraulic hoses, tubes, and components that were disconnected while draining the system; refer to Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 4–8).

IMPORTANT

Using other hydraulic fluids could damage the hydraulic system. Use the hydraulic fluids that are specified in the traction unit *Operator's Manual*.

8. Fill the hydraulic tank with the correct type and quantity of new hydraulic fluid; refer to the traction unit *Operator's Manual*.
9. Prime the hydraulic pumps; refer to Priming the Hydraulic Pumps (page 4–78).
10. Charge the hydraulic system; refer to Charging the Hydraulic System (page 4–79).

Filtering the Closed-Loop Traction Circuit

Filtering of a closed−loop hydraulic system after a major component failure (e.g. traction (piston) pump or wheel motor) is required to prevent debris from transmitting throughout the system. If a filtering tool is not used (to ensure system cleanliness), repeat failures and subsequent damage to other hydraulic components in the system will occur. To effectively remove contamination from the closed−loop traction circuit, use of a Toro bidirectional high flow hydraulic filter and hydraulic hose kit is recommended; refer to High Flow Hydraulic Filter Kit (page 4–29).

1. Park machine on a level surface with engine stopped and key removed from ignition switch.
2. Read and adhere to the information provided in General Precautions for Removing and Installing the Hydraulic System Components (page 4–71).

WARNING

Review and follow Jacking Instructions (page 1–7) before jacking up the machine.

3. Raise both front wheels off the floor and support the machine.
4. Install the hydraulic filter directly upstream of the new component.

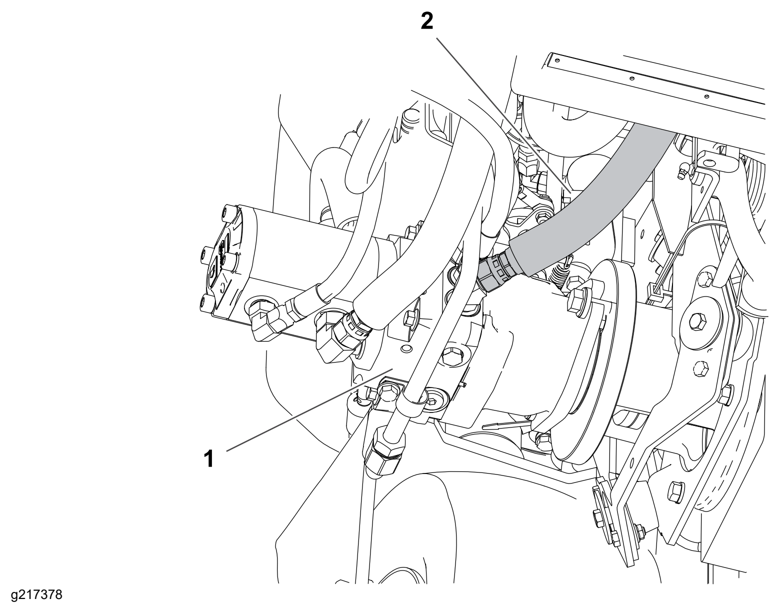


Figure 51

1. Traction pump
2. Hydraulic hose

A. If the traction pump was replaced, thoroughly clean the junction and disconnect the hydraulic hose at the lower fitting of the traction pump; refer to Figure 51.

Filtering the Closed-Loop Traction Circuit (continued)

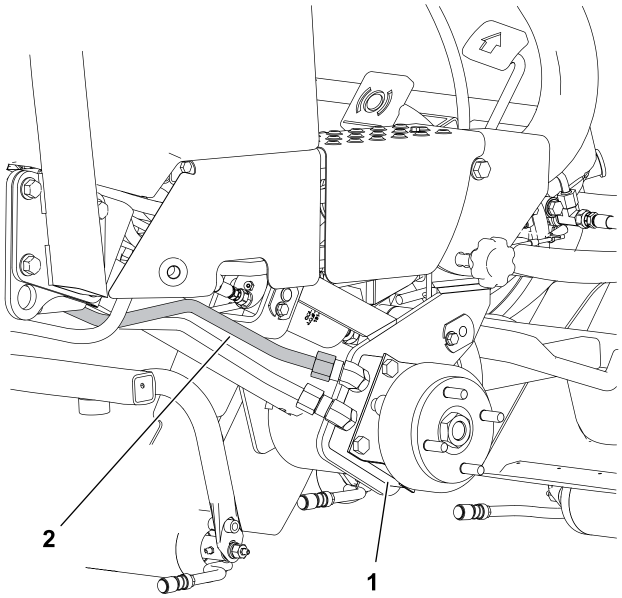


Figure 52

1. Right side wheel motor
2. Hydraulic tube

B. If the right wheel motor was replaced, remove the wheel and thoroughly clean the junction at both ends of the upper hydraulic tube and remove the tube; refer toFigure 52.

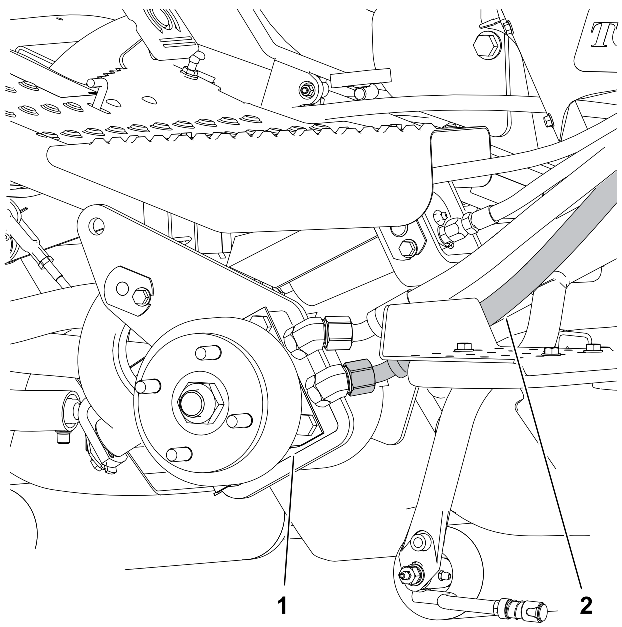


Figure 53

1. Left side wheel motor
2. Hydraulic hose

C. If the left wheel motor was replaced, remove the wheel and thoroughly clean the junction at the end of the hydraulic hose and the lower fitting; refer to Figure 53.

5. Connect the hydraulic filter in series between the disconnected fitting hose. Use a Hydraulic Hose Kit (page 4–28) if necessary and make sure that fittings and hose connections are properly tightened.

Filtering the Closed-Loop Traction Circuit (continued)

6. Fill the hydraulic tank with the correct type and quantity of new hydraulic fluid; refer to the traction unit *Operator's Manual*.
7. Start engine and run at low idle speed. Check for and correct any hydraulic leaks before proceeding.

CAUTION

Use extreme caution when performing this test. The traction unit wheels will be rotating during the test.

IMPORTANT

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

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

IMPORTANT

If using a hydraulic filter that is not bidirectional, do not press the traction pedal in the reverse direction. If flow is reversed when using a filter that is not bidirectional, debris from the filter will re-enter the traction circuit.

9. With a bidirectional hydraulic filter installed and the engine running at high idle speed, alternately move traction pedal from forward to reverse. Continue this process for an additional five (5) minutes while monitoring filter indicator.
10. Shut the engine OFF and remove the key from ignition switch.
11. Remove hydraulic filter from the machine and install disconnected hydraulic hose/tube.
12. Lower machine to ground.
13. Check the hydraulic fluid level in the tank and adjust as necessary; refer to the traction unit *Operator's Manual*.
14. Operate the machine and check for leaks before returning the machine to service.

Priming the Hydraulic Pumps

Whenever hydraulic fluid has been drained from the pumps (system drain, flush, or pump removal/installation) it is important to properly prime the hydraulic pumps. Priming the hydraulic pumps ensures that the gear pumps and piston (traction) pump have sufficient fluid while charging the hydraulic system.

Use the following procedure to prime the hydraulic pumps:

IMPORTANT

If the traction pump was rebuilt or replaced, make sure the traction pump housing is at least half full of clean hydraulic fluid after installation.

1. Make sure all hydraulic connections and lines are secured tightly.
2. Check the hydraulic-fluid level in the hydraulic tank and add correct type and quantity of fluid if necessary; refer to the traction unit *Operator's Manual*.
3. Check control linkage for proper adjustment, binding or broken parts.
4. Disconnect both spark plug wires from the spark plugs to prevent the engine from starting.
5. Make sure function control lever is in neutral, then turn ignition key to engage the starter for ten (10) seconds to prime pumps. Return ignition switch to OFF and wait one (1) minute to allow starter to cool. Engage the starter for ten (10) seconds a second time.
6. Charge the hydraulic system; refer to Charging the Hydraulic System (page 4–79).

Charging the Hydraulic System

When initially starting the hydraulic system with new or rebuilt components such as wheel motors, gear pump, or lift cylinder, it is important that the hydraulic system is charged properly to remove air from the system, its components, and reduce the chance of damage.

IMPORTANT

Flush the hydraulic system whenever there is a severe component failure or the system is contaminated; refer to Flushing the Hydraulic System (page 4–74)

1. Park the machine on a level surface and turn the engine OFF.
2. Ensure that all of the hydraulic connections, lines, and components are secured tightly.
3. Ensure that the hydraulic tank is full. Add the correct quantity and type of hydraulic fluid if necessary; refer to the traction unit *Operator's Manual*.
4. Check the traction control components for proper adjustment, binding, or damaged parts.
5. Prime the hydraulic pumps; refer to Priming the Hydraulic Pumps (page 4–78).

WARNING

Review and follow Jacking Instructions (page 1–7) before jacking up the machine.

6. Raise both front wheels off the floor and support the machine.

Charging the Hydraulic System (continued)

IMPORTANT

Check hydraulic tank fluid level frequently while charging the system and add fluid as necessary.

7. Make sure traction pedal is in neutral. Start the engine and let it idle at low speed.

   Note: The hydraulic pumps should pick up hydraulic fluid and fill the hydraulic system. If there is no indication of the system filling within 30 seconds, stop the engine and determine the cause.

8. After the hydraulic system starts to show signs of filling:

   A. Operate the joystick until the lift cylinders move in and out the full distance several times. If the cylinders do not move after 15 seconds or the pump emits abnormal sounds:

      B. Turn the engine OFF immediately

      C. Make sure one of the hydraulic fluid filters or the suction line is not loose

      D. Check for incorrect hose routing

      E. Ensure the suction line is not blocked

      F. Make sure the charge relief valve (CV) is not blocked or damaged (open)

      G. Test gear pump (P2) for damage

   H. If the traction pump or a wheel motor was replaced or rebuilt:

      I. Operate the traction pedal in the forward and reverse directions. Make sure the wheels are turning in the proper direction and allow the wheels turn slowly for ten (10) minutes.

      J. Adjust the traction for NEUTRAL; refer to the traction unit *Operator's Manual*.

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

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

9. Lower the machine to the ground.

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

11. Stop the machine, check the hydraulic components for leaks and tighten any loose connections.

12. . Check the fluid level in the hydraulic tank if necessary.

13. Check the level and condition of the hydraulic fluid and adjust if necessary; refer to the traction unit *Operator's Manual*.

    Note: If new fluid shows any signs of contamination, flush hydraulic system again until the fluid is clean; refer to Flushing the Hydraulic System (page 4–74).

Gear Pump

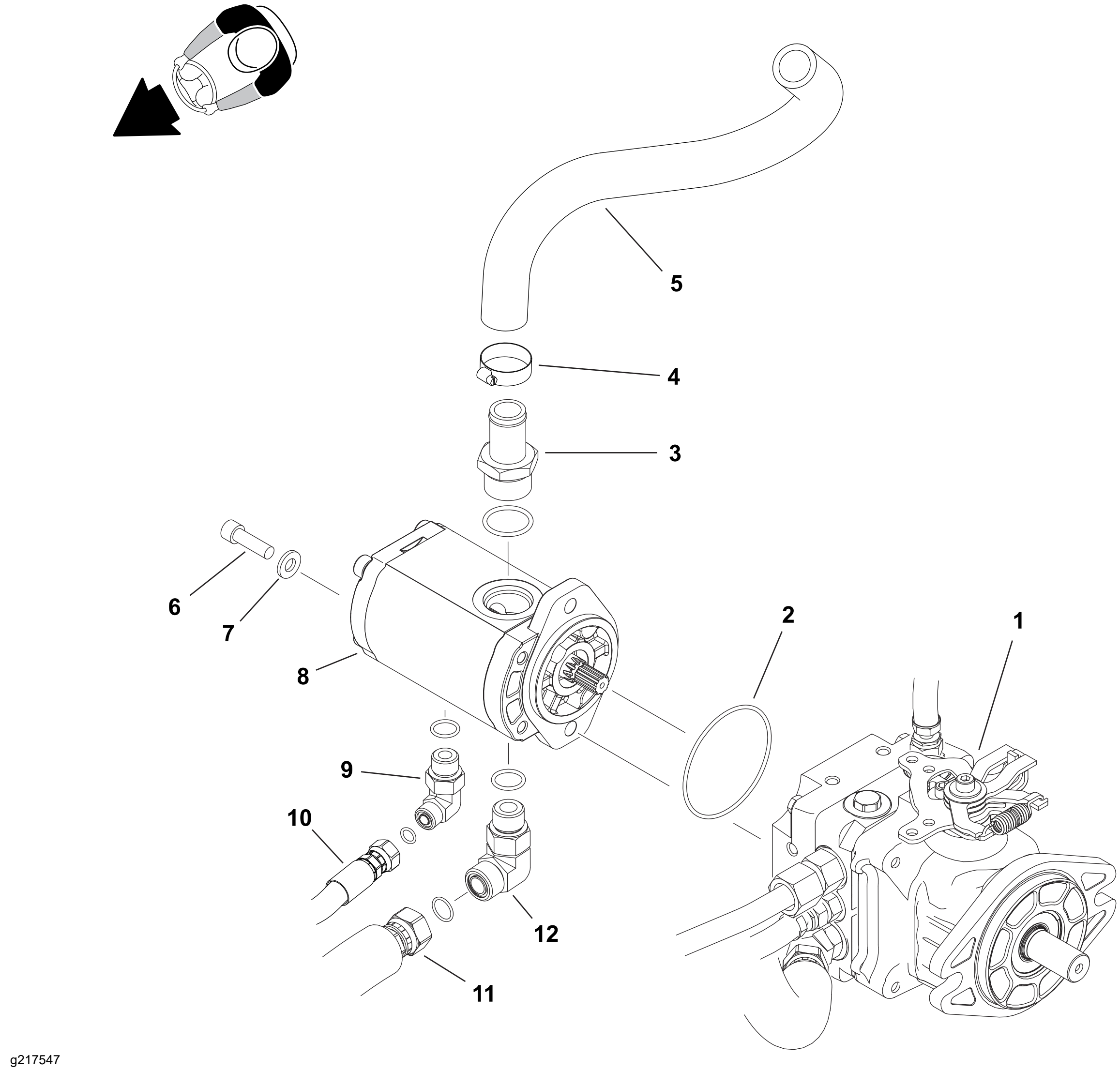


Figure 54

1.	Traction pump assembly	5.	Inlet hose	9.	Elbow fitting
2.	O-ring	6.	Socket head screw (2 each)	10.	Hydraulic hose
3.	Barb fitting	7.	Hardened washer (2 each)	11.	Hydraulic hose
4.	Hose clamp	8.	Gear pump	12.	Elbow fitting

Note: The gear pump is a single assembly that includes both pumps (P2 – input shaft end) and (P3 – cap end)

Removing the Gear Pump

1. Park the machine on a level surface, engage parking brake, lower cutting units and stop engine. Remove key from the ignition switch.
2. Read and adhere to the information provided in General Precautions for Removing and Installing the Hydraulic System Components (page 4–71).
3. Pinch the pump inlet hose closed with a clamp to prevent draining the hydraulic tank prematurely.
4. Remove the inlet hose from the gear pump and drain the hydraulic tank into a suitable container.
5. Disconnect the hydraulic hoses from the gear pump. Allow hoses to drain into a suitable container. Plug hoses and cap fittings to prevent contamination.

IMPORTANT

Follow all local codes and regulations when recycling or disposing the hydraulic fluid and filters.

6. Support the gear pump to prevent it from falling and remove both socket head screws and flat washers. Separate the gear pump from the piston pump.
7. Remove and discard the O-ring from between the gear pump and piston pump.
8. If necessary, mark the hydraulic fitting location and orientation to allow for correct assembly and remove the hydraulic fittings from the gear pump. Remove and discard all O-rings from the hydraulic fittings.

Installing the Gear Pump

Note: Inspect threads and sealing surfaces of hydraulic fittings and hydraulic hose or tube connectors prior to installation. Replace any damaged or worn fittings, hoses or tubes.

1. Lubricate and fit new O-rings onto gear pump hydraulic fittings. Install fittings into pump openings making sure that fitting location and orientation is as noted during removal. Tighten fittings as specified; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 4–10).
2. Make sure traction pump and gear pump mounting and O-ring sealing surfaces are clean.
3. Lubricate and place new O-ring on the gear pump (item 2 in Figure 54).
4. Position gear pump with inlet from hydraulic tank upward, secure with two (2) socket head screws and flat washers.
5. Remove the plugs and the caps from hydraulic hoses and fittings and using labels placed during gear pump removal, connect the hydraulic hoses to the gear pump fittings. Tighten connections as specified; refer to Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 4–8).
6. Install pump inlet hose to the gear pump and secure with hose clamp.
7. Prime the gear pump and charge the hydraulic system; refer to Priming the Hydraulic Pumps (page 4–78)

Servicing the Gear Pump

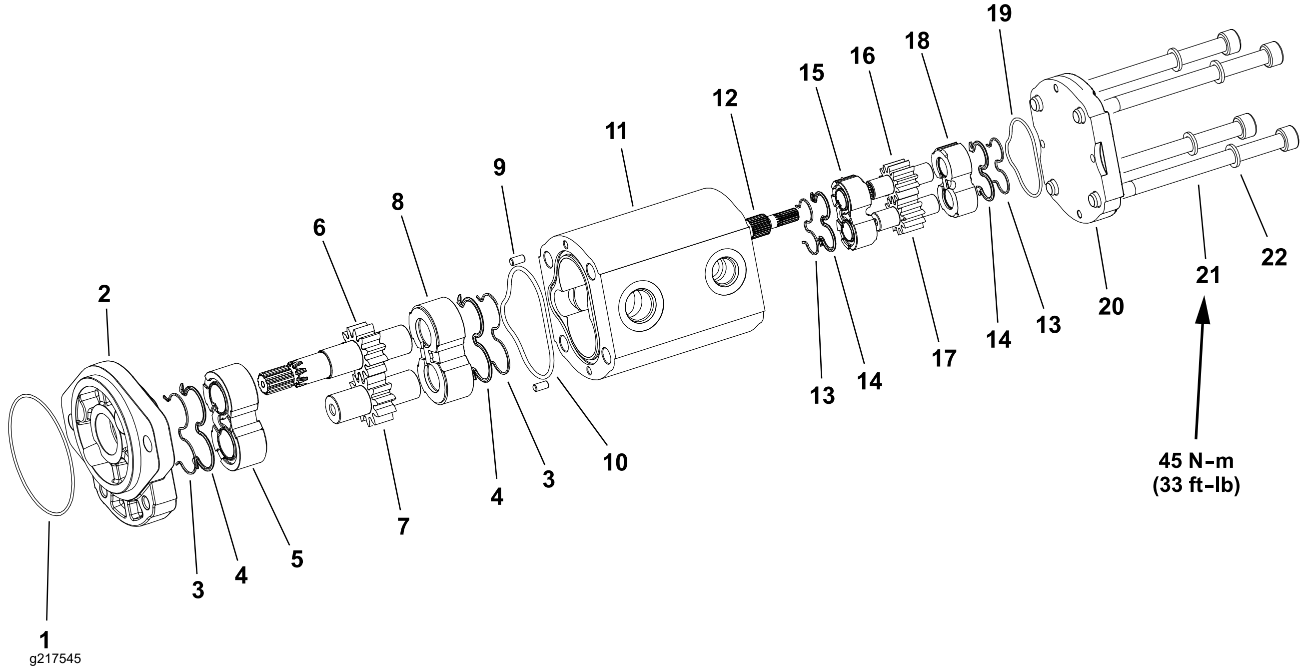


Figure 55

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

Disassembling the Gear Pump

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

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

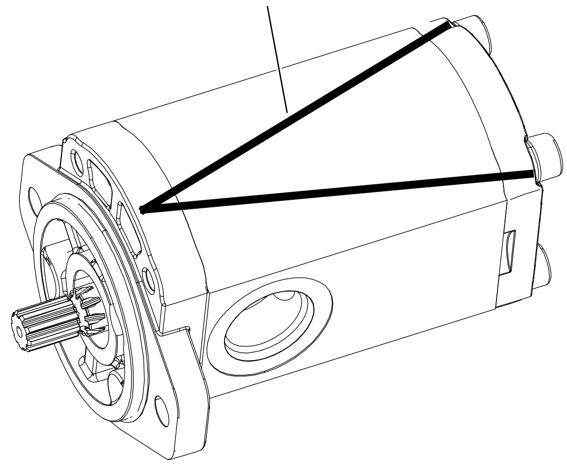


Figure 56

1. "V" mark

2. Use a marker to make a "V" across the front cover, housing and end cover for assembly purposes; refer to Figure 56.

IMPORTANT

Avoid distorting any pump components when clamping gear pump in a vise. Use a vise with soft jaws.

3. Secure the front cover of the pump in a vise with the drive shaft pointing down.
4. Loosen the four (4) socket head screws that secure pump assembly.
5. Remove pump from vise and remove fasteners.
6. Support the pump assembly and gently tap the pump housing with a soft face hammer to loosen the pump sections. Be careful to not drop parts or disengage gear mesh.

IMPORTANT

Keep gears and thrust plates for each pump section together; do not mix parts between pump sections. Mark the relative positions of the gear teeth to the thrust plates so they can be assembled in the same position. Before removing each gear set, apply marking dye to mating teeth to retain "timing". Pump efficiency may be affected if the teeth are not installed in the same position during assembly. Do not touch the gear surfaces as residue on hands may be corrosive to gear finish.

7. Remove the thrust plates, seals and gears from each pump section. Keep the parts for each pump section together; do not mix parts between sections.

Disassembling the Gear Pump (continued)

8. Clean all parts. Check all components for burrs, scoring, nicks and other damage.
9. Replace the entire pump assembly if any pump components are excessively worn or scored.

Inspecting the Gear Pump

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

CAUTION

Use goggles or other appropriate eye protection when using compressed air for drying parts.

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

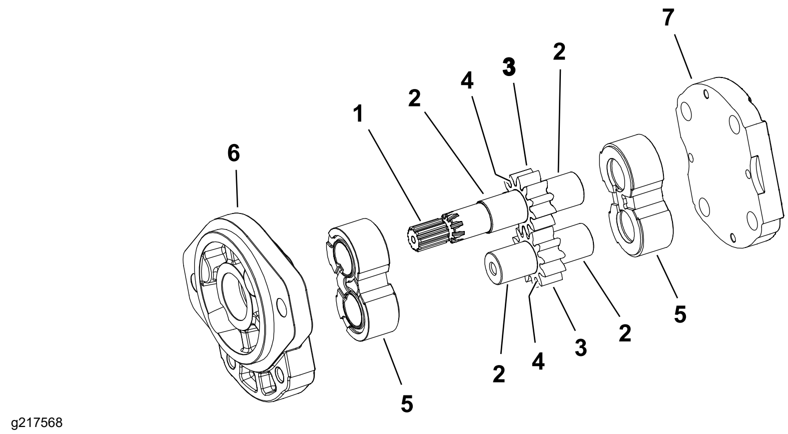


Figure 57

1. Gear shaft spline
2. Gear shaft
3. Gear teeth
4. Gear face edge
5. Thrust plate
6. Front cover
7. End cover

3. Inspect the drive gears and the idler gears; refer to Figure 57:
   A. The gear shafts should be free of rough surfaces and excessive wear at the bushing points and the sealing areas. Scoring, rough surfaces or wear on the gear shafts indicates the need for pump replacement.
   B. The gear teeth should be free of excessive scoring and wear. Broken or nicked gear teeth indicates the need for pump replacement.
   C. Inspect the gear face edge for sharpness. Sharp edges of the gears will cut into wear plates, and therefore, indicate the need for pump replacement.
4. Inspect the thrust plates:
   A. The bearing areas should not have excessive wear or scoring.
   B. The face of the thrust plate that contacts the gears should be free of wear, roughness or scoring.
   C. The thickness of each set of thrust plates should be equal.
5. Inspect the front cover and the rear cover for damage or wear.

Assembling the Gear Pump

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

   Note: Pressure seals and back-up seals fit in grooves machined into the thrust plates. Body O-rings fit in grooves machined into housings.

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

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

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

Traction Pump

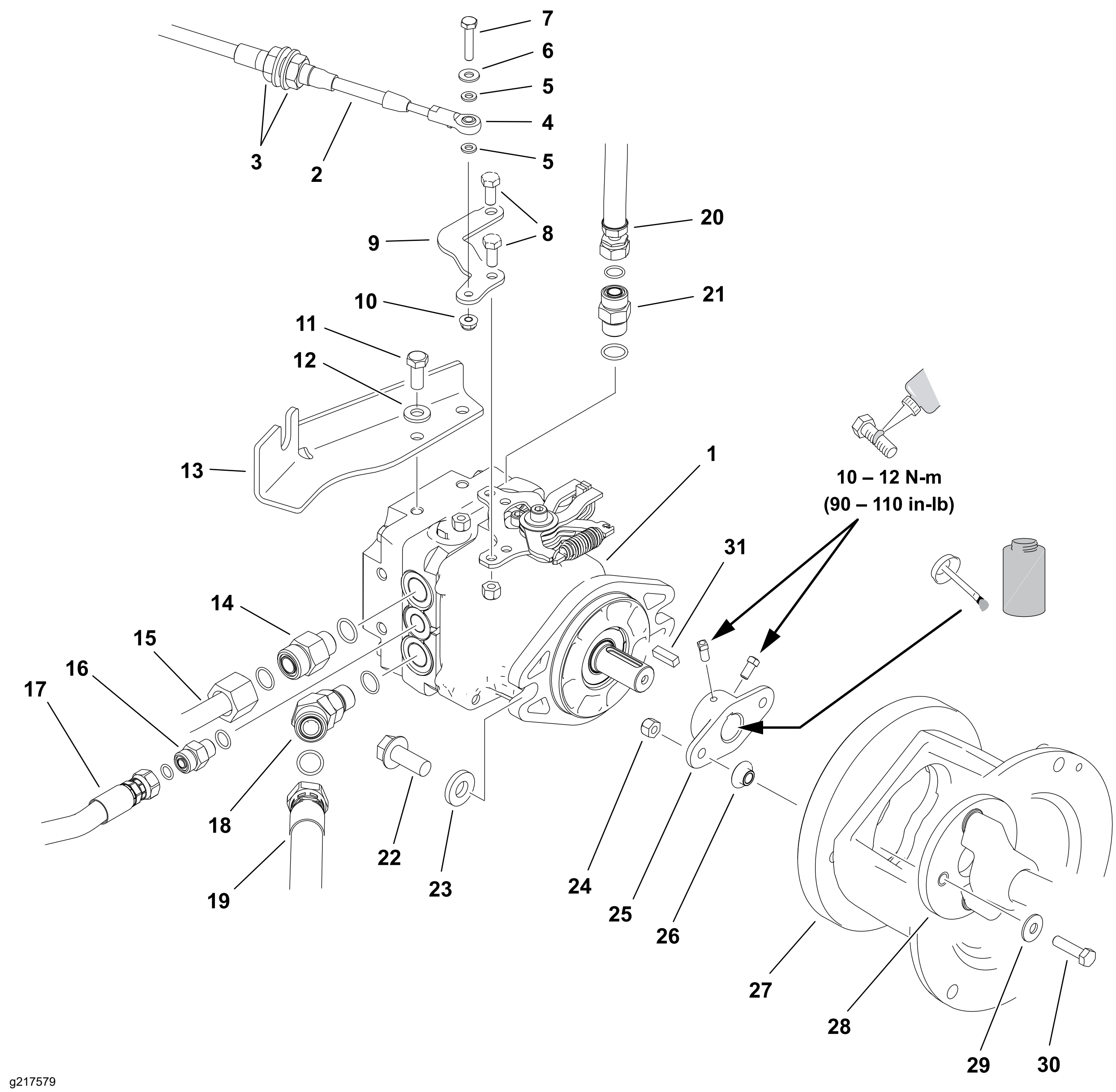


Figure 58

1.	Traction pump	12.	Flat washer (2 each)	23.	Hardened washer (2 each)
2.	Traction cable	13.	Cable support	24.	Hex nut (2 each)
3.	Cable adjuster jam nuts	14.	Straight fitting	25.	Pump hub
4.	Ball joint	15.	Hydraulic tube	26.	Spacer (2 each)
5.	Flat washer (2 each)	16.	Straight fitting	27.	Adapter plate
6.	Flat washer	17.	Hydraulic hose	28.	Rubber coupler
7.	Cap screw	18.	Elbow fitting	29.	Flat washer (2 each)
8.	Cap screw (2 each)	19.	Hydraulic hose	30.	Cap screw (2 each)
9.	Cable bracket	20.	Hydraulic hose	31.	Square key
10.	Flange nut	21.	Straight fitting		
11.	Cap screw (2 each)	22.	Flange head screw (2 each)		

Removing the Traction Pump

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

Removing the Traction Pump (continued)

2. Read and adhere to the information provided in General Precautions for Removing and Installing the Hydraulic System Components (page 4–71).
3. Remove the gear pump; refer to Removing the Gear Pump (page 4–82).
4. Disconnect the traction control cable ball joint (item 4 in Figure 58) from the neutral arm. Loosen the cable adjusting jam nuts and position the traction cable away from the pump assembly.
5. Disconnect the hydraulic hoses from the traction pump. Allow hoses to drain into a suitable container. Plug hoses and cap fittings to prevent contamination.
6. Remove the two (2) hex nuts (item 24 in Figure 58), the flat washers and the cap screws securing the pump hub to the rubber drive coupler.
7. Support the pump assembly and remove the two (2) cap screws and the hardened washers securing the traction pump to the adapter plate. Remove the traction pump from the machine.
8. If necessary, mark the hydraulic fitting location and orientation to allow for correct assembly and remove the hydraulic fittings from the traction pump. Remove and discard all O-rings from the hydraulic fittings.

   Note: Record the position (depth) of the pump hub on the pump shaft prior to removing the pump hub.
9. If necessary, remove the pump hub from the pump input shaft. Locate and retrieve the square key.
10. If necessary, remove the traction cable support and bracket from the traction pump.

Installing the Traction Pump

Note: Inspect threads and sealing surfaces of hydraulic fittings and hydraulic hose or tube connectors prior to installation. Replace any damaged or worn fittings, hoses or tubes.

1. Lubricate and fit new O-rings onto gear pump hydraulic fittings. Install fittings into pump openings making sure that fitting location and orientation is as noted during removal. Tighten fittings as specified; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 4–10).
2. Install the traction cable support and bracket if previously removed.
3. If removed, secure the pump hub to the pump shaft:
   A. Make sure that the pump shaft and the bore of hub are thoroughly cleaned.
   B. Position the square key to the pump shaft.
   C. Apply medium strength thread locker to the threads of the set screws used to secure the hub to pump shaft.
   D. Apply anti-seize lubricant to the bore of the pump hub.
   E. Install the pump hub to the position on the pump shaft recorded during disassembly.
   F. Tighten the pump hub set screws from **10 to 12 N·m (90 to 110 in-lb)**.
4. Position the pump assembly to the adapter plate and align pump hub with the rubber coupler. Secure the pump assembly to the adapter plate with two (2) cap screws and hardened washers.

Installing the Traction Pump (continued)

5. Make sure two (2) spacers (item 26 in Figure 58) are fit into the holes of the rubber coupler and secure the pump hub to the rubber coupler with two (2) hex nuts, flat washers, and lock nuts.
6. Connect the traction control cable:
   A. Secure the traction cable ball joint to the cable bracket.
   B. Secure the control cable to the cable support with the jam nuts on the cable. Make sure that a washer is positioned on each side of the cable support.
7. Remove the plugs and the caps from hydraulic hoses and fittings and using labels placed during traction pump removal, connect the hydraulic hoses to the traction pump fittings. Tighten the connections as specified; refer to Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 4–8).
8. Install the gear pump; refer to Installing the Gear Pump (page 4–82).

Servicing the Traction Pump

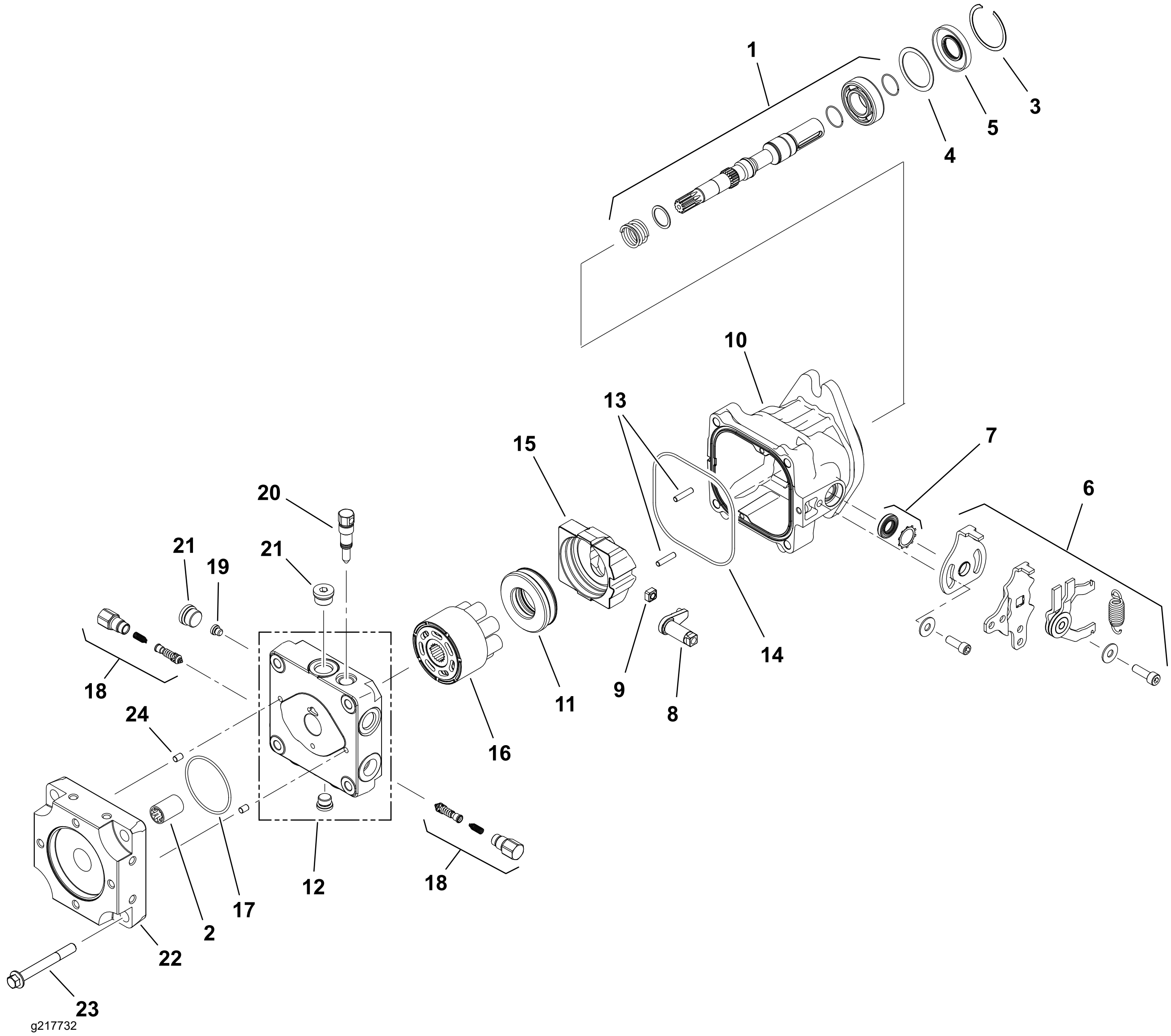


Figure 59

1. Pump shaft kit
2. Coupling
3. Retaining ring
4. Washer
5. Seal
6. Heavy-duty return kit
7. Trunnion seal kit
8. Trunnion arm
9. Guide
10. Front housing kit
11. Thrust bearing
12. End cap kit
13. Pin (2 each)
14. O-ring
15. Swashplate
16. Cylinder block kit
17. O-ring
18. Relief valve kit (2 each)
19. Plug, 5/16 SAE
20. Bypass valve
21. Plug, 3/4-16 (2 each)
22. Adapter plate
23. Flange head screw (4 each)
24. Pin (2 each)

IMPORTANT

If a transmission fails; refer to Filtering the Closed-Loop Traction Circuit (page 4–76) for information regarding removing contamination from the traction circuit.

Servicing the Traction Pump (continued)

The traction pump is a Hydro-Gear® PY series pump. For traction pump repair information, see the Hydro-Gear P Series Hydrostatic Pumps Service and Repair Manual at the end of this chapter. Replacement pump components are available from your Authorized Toro Distributor; refer to the traction unit *Parts Catalog*.

Wheel Motors

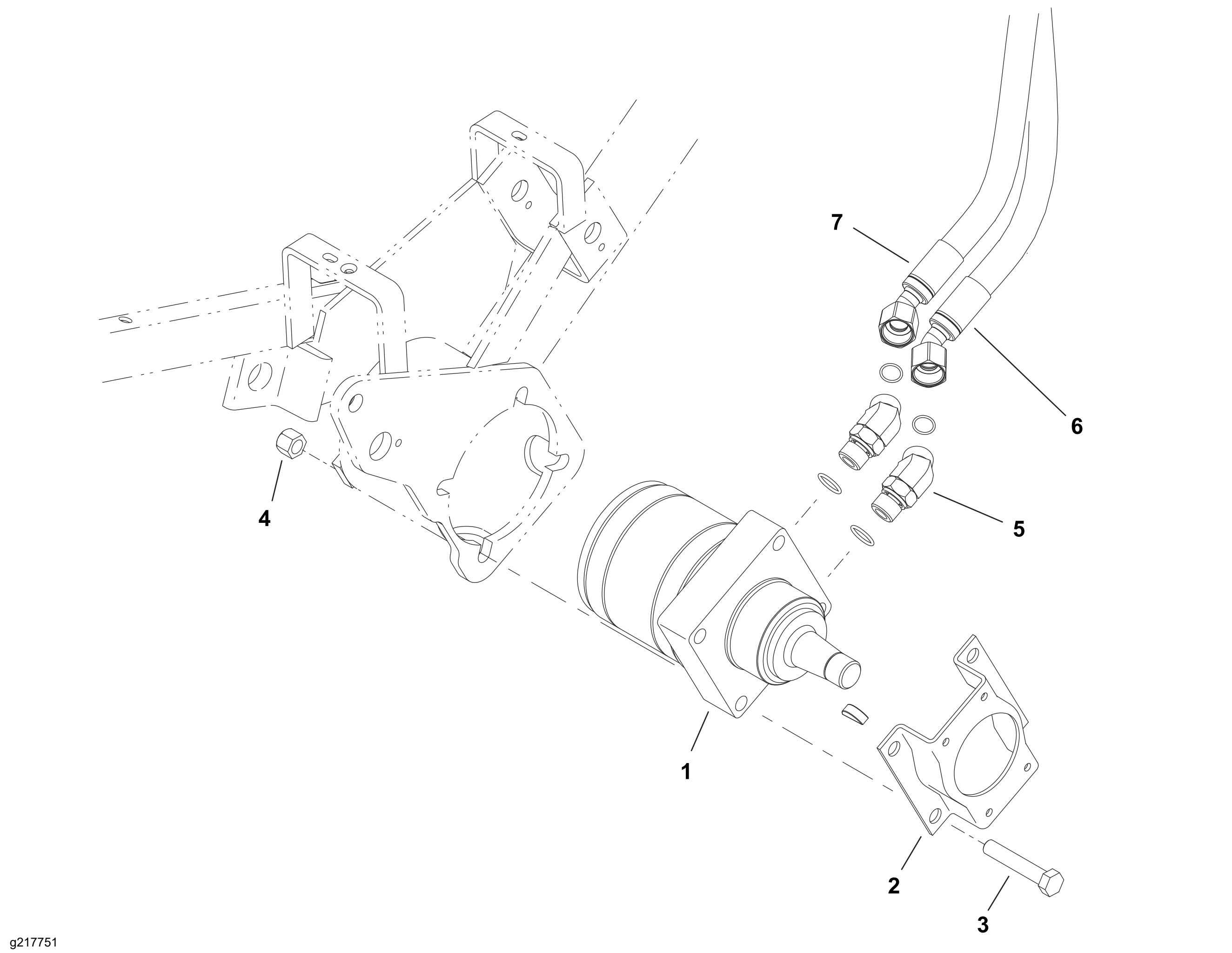


Figure 60
(left wheel motor shown)

1. Wheel motor
2. Brake bracket
3. Hex head screw (4 each)
4. Lock nut (4 each)
5. elbow fitting (2 each)
6. Hydraulic hose
7. Hydraulic hose

Removing the Wheel Motors

1. Park the machine on a level surface. Lower the cutting units, stop the engine and remove the key from the ignition switch.
2. Remove the front wheel and brake assembly; refer to Removing the Front Wheel and Brake Assembly (page 6–4).
3. Read and adhere to the information provided in General Precautions for Removing and Installing the Hydraulic System Components (page 4–71).
4. Disconnect the hydraulic hoses (left wheel motor) or remove the hydraulic tubes (right wheel motor). Allow hoses or tubes to drain into a suitable container. Plug hoses and cap fittings to prevent contamination.

IMPORTANT

Mark the wheel motors right and left prior to removal. Due to the predominant direction of rotation (forward), the right and left wheel motors are not interchangeable.

5. Remove four (4) hex head screws and lock nuts securing the brake bracket and wheel motor to the frame. Remove brake bracket and wheel motor from machine.
6. If necessary, mark the hydraulic fitting location and orientation to allow for correct assembly and remove the hydraulic fittings from the wheel motor. Remove and discard all O-rings from the hydraulic fittings.

Installing the Wheel Motors

Note: Inspect threads and sealing surfaces of hydraulic fittings and hydraulic hose or tube connectors prior to installation. Replace any damaged or worn fittings, hoses or tubes.

1. Lubricate and fit new O-rings onto wheel motor hydraulic fittings. Install fittings into motor openings making sure that fitting location and orientation is as noted during removal. Tighten fittings as specified; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 4–10).
2. Install the wheel motor and the brake bracket to the frame using four (4) hex head screws and lock nuts.
3. Remove the plugs and the caps from hydraulic hoses and fittings and using labels placed during wheel motor removal, connect the hydraulic hoses or tubes to the wheel motor fittings. Tighten the connections as specified; refer to Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 4–8).
4. Install the front wheel and brake assembly; refer to Installing the Front Wheel and Brake Assembly (page 6–5).
5. Charge the hydraulic system; refer to Charging the Hydraulic System (page 4–79).

Servicing the Wheel Motor

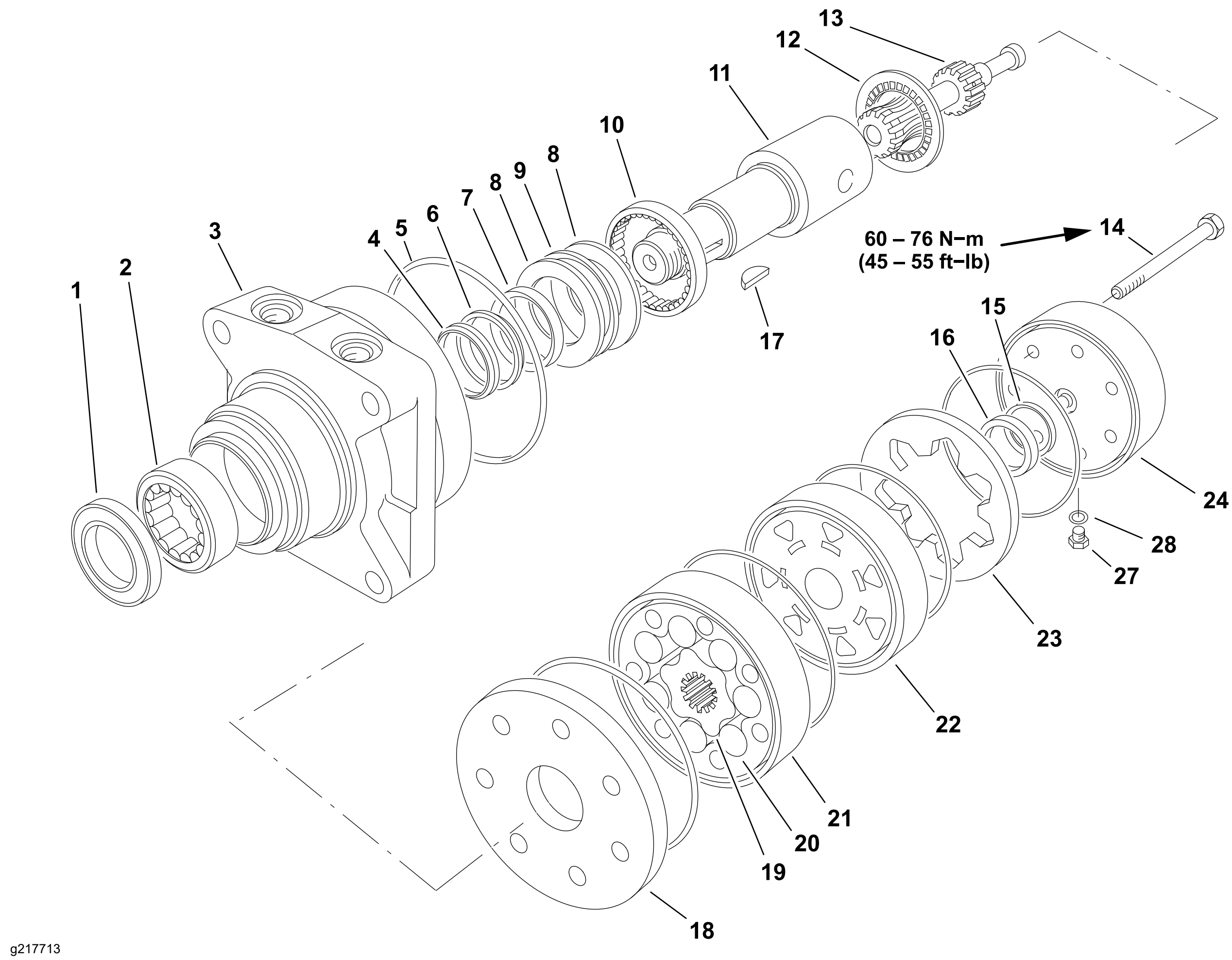


Figure 61

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

IMPORTANT

If a wheel motor fails; refer to Filtering the Closed-Loop Traction Circuit (page 4–76) for information regarding removing contamination from the traction circuit.

Servicing the Wheel Motor (continued)

IMPORTANT

Due to the predominant direction of rotation (forward), the right and left wheel motors are not interchangeable.

For wheel motor repair information, see the Parker Torqmotor™ Service Procedure (TC, TB, TE, TJ, TF, TG, TH and TL Series) at the end of this chapter. Replacement motor components are available from your Authorized Toro Distributor; refer to the traction unit *Parts Catalog*.

Mower Manifold

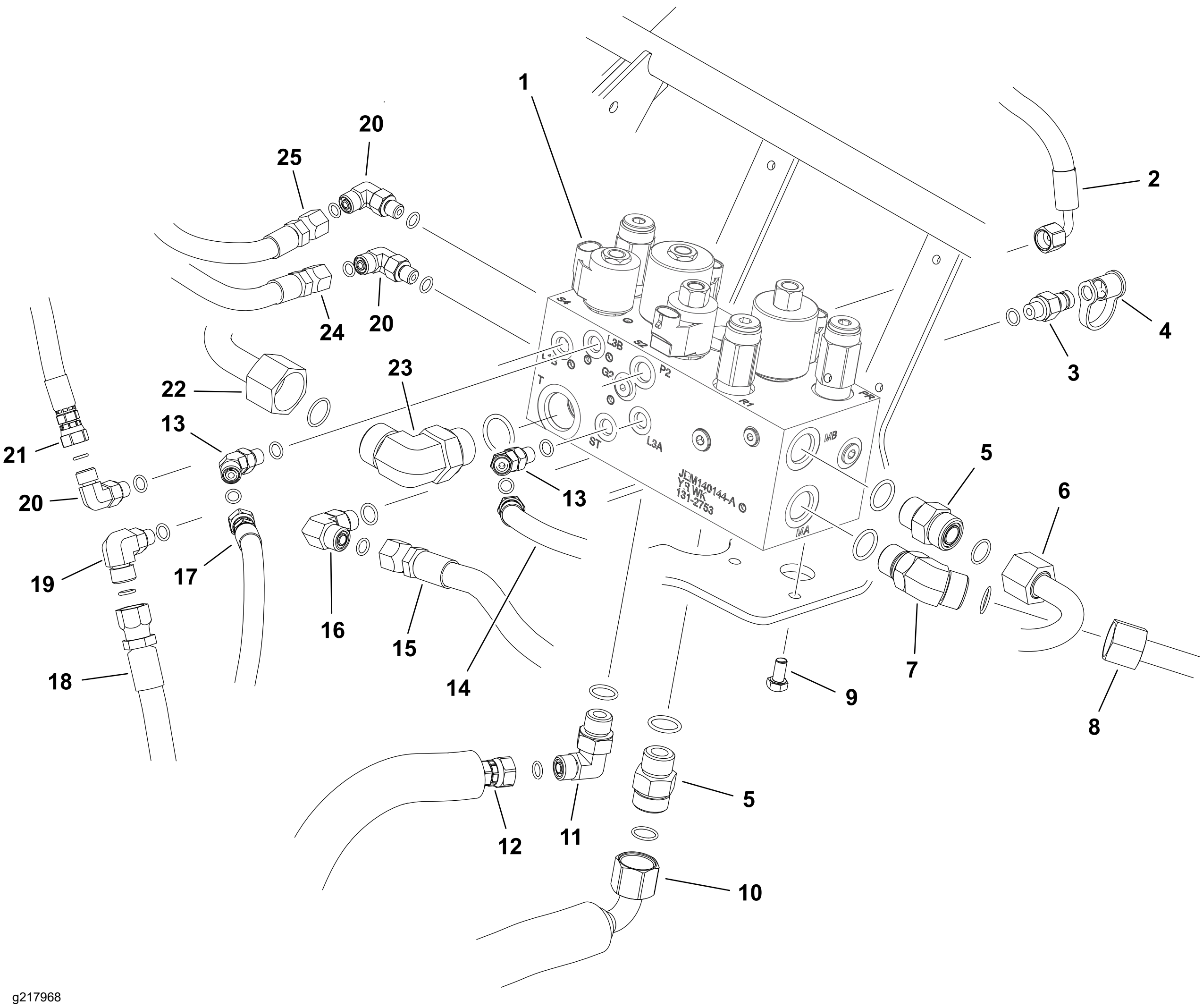


Figure 62

(machines without backlap)

1. Manifold assembly
2. Hydraulic hose, lift cylinder #1 rod end
3. Test fitting
4. Cap
5. Straight fitting (2 each)
6. Hydraulic tube, from reel motor #1
7. Elbow fitting
8. Hydraulic tube, to reel motor #2
9. Cap screw (2 each)
10. Hydraulic hose, from gear pump P2
11. Elbow fitting
12. Hydraulic hose, to charge filter
13. Elbow fitting (2 each)
14. Hydraulic hose, from steering control valve T port
15. Hydraulic hose, lift cylinder #3 rod end
16. Elbow fitting
17. Hydraulic hose, lift cylinder #3 cap end
18. Hydraulic hose, from steering control valve E port
19. Elbow fitting
20. Elbow fitting (3 each)
21. Hydraulic hose, lift cylinder #1 cap end
22. Hydraulic tube, to return filter
23. Elbow fitting
24. Hydraulic hose, lift cylinder #2 rod end
25. Hydraulic hose, lift cylinder #2 cap end

The ports on the manifold are marked for easy identification of components. Example: R1 is the cutting unit circuit relief valve and P1 is the gear pump connection port; refer to the Hydraulic Schematics (page 4–13) to identify the function of the connections and the cartridge valves at each port location).

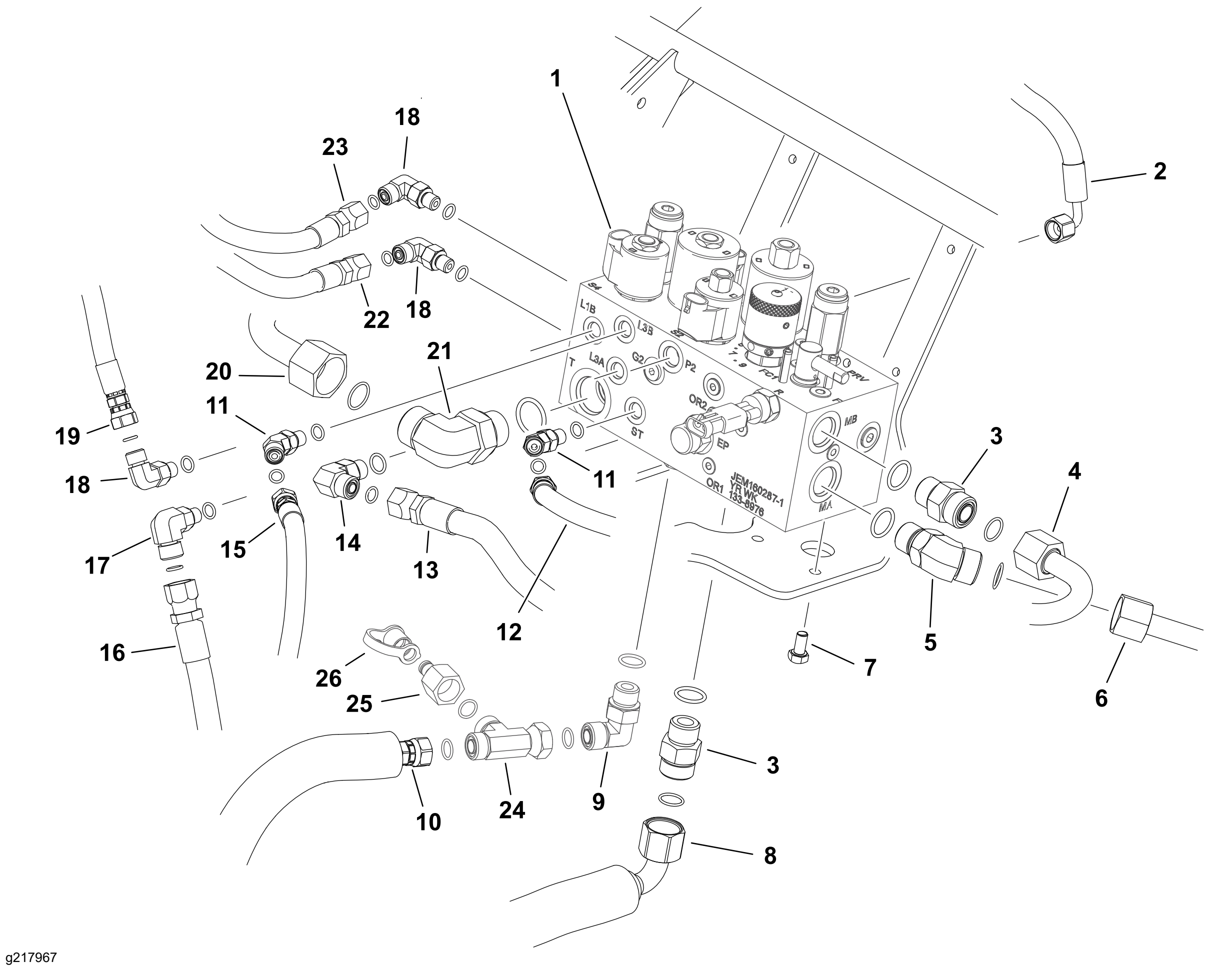


Figure 63

(early machines with backlap)

1.	Manifold assembly	10.	Hydraulic hose, to charge filter	19.	Hydraulic hose, lift cylinder #1 cap end
2.	Hydraulic hose, lift cylinder #1 rod end	11.	Elbow fitting (2 each)	20.	Hydraulic tube, to return filter
3.	Straight fitting (2 each)	12.	Hydraulic hose, from steering control valve T port	21.	Elbow fitting
4.	Hydraulic tube, from reel motor #1	13.	Hydraulic hose, lift cylinder #3 rod end	22.	Hydraulic hose, lift cylinder #2 rod end
5.	Elbow fitting	14.	Elbow fitting	23.	Hydraulic hose, lift cylinder #2 cap end
6.	Hydraulic tube, to reel motor #2	15.	Hydraulic hose, lift cylinder #3 cap end	24.	Swivel tee fitting (add for testing)
7.	Cap screw (2 each)	16.	Hydraulic hose, from steering control valve E port	25.	Test connector (add for testing)
8.	Hydraulic hose, from gear pump P2	17.	Elbow fitting	26.	Cap
9.	Elbow fitting	18.	Elbow fitting (3 each)		

The ports on the manifold are marked for easy identification of components. Example: FC1 is the cutting unit circuit flow control valve and P1 is the gear pump connection port; refer to the Hydraulic Schematics (page 4–13) to identify the function of the connections and the cartridge valves at each port location).

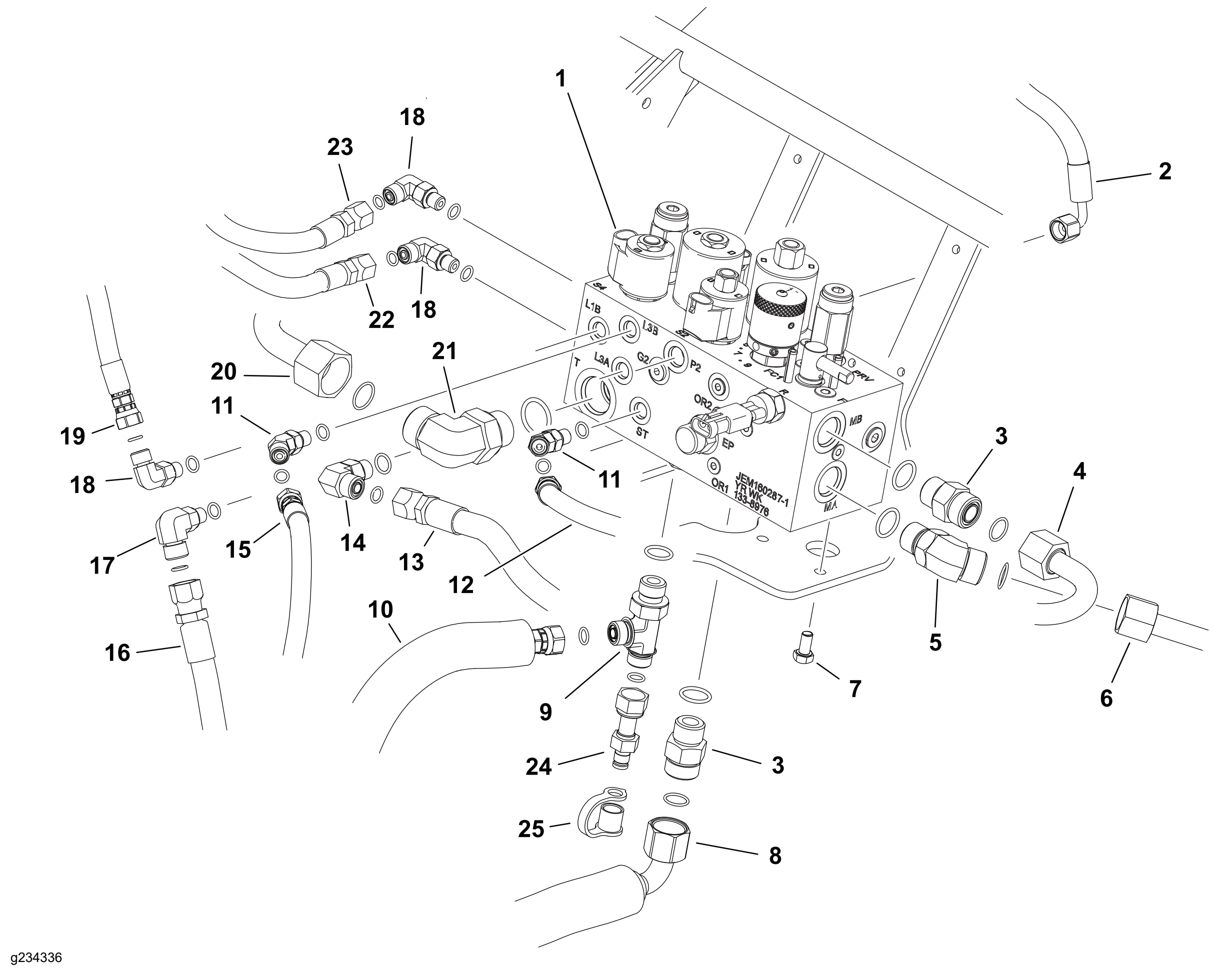


Figure 64

(later machines with backlap)

1. Manifold assembly
2. Hydraulic hose, lift cylinder #1 rod end
3. Straight fitting (2 each)
4. Hydraulic tube, from reel motor #1
5. Elbow fitting
6. Hydraulic tube, to reel motor #2
7. Cap screw (2 each)
8. Hydraulic hose, from gear pump P2
9. Tee fitting
10. Hydraulic hose, to charge filter
11. Elbow fitting (2 each)
12. Hydraulic hose, from steering control valve T port
13. Hydraulic hose, lift cylinder #3 rod end
14. Elbow fitting
15. Hydraulic hose, lift cylinder #3 cap end
16. Hydraulic hose, from steering control valve E port
17. Elbow fitting
18. Elbow fitting (3 each)
19. Hydraulic hose, lift cylinder #1 cap end
20. Hydraulic tube, to return filter
21. Elbow fitting
22. Hydraulic hose, lift cylinder #2 rod end
23. Hydraulic hose, lift cylinder #2 cap end
24. Test connector
25. Cap

The ports on the manifold are marked for easy identification of components. Example: FC1 is the cutting unit circuit flow control valve and P1 is the gear pump connection port; refer to the Hydraulic Schematics (page 4–13) to identify the function of the connections and the cartridge valves at each port location).

Removing the Mower Manifold

1. Park the machine on a level surface. Lower the cutting units, stop the engine, engage the parking brake and remove the key from the ignition switch.
2. Read and adhere to the information provided in General Precautions for Removing and Installing the Hydraulic System Components (page 4–71).
3. Label all hydraulic connections and electrical connections for proper assembly.
4. Disconnect the wire harness connectors from the manifold solenoid coils. For machines with backlap, disconnect the wire harness connector from the backlap switch.
5. Disconnect the hydraulic hose and tube assemblies from the hydraulic fittings. Allow the hoses and tubes to drain into a suitable container. Cap and plug the hydraulic hoses, tubes and fittings to prevent system contaminations.
6. Remove the two (2) cap screws from under the hydraulic manifold and remove manifold assembly from the machine.

IMPORTANT

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

---

7. If necessary, mark the hydraulic fitting location and orientation to allow for correct assembly and remove the hydraulic fittings from the manifold. Remove and discard all O-rings from the hydraulic fittings.

Installing the Mow Control Manifold

Note: Inspect threads and sealing surfaces of hydraulic fittings and hydraulic hose or tube connectors prior to installation. Replace any damaged or worn fittings, hoses or tubes.

1. Lubricate and fit new O-rings onto the manifold hydraulic fittings. Install the fittings making sure that the fitting location and orientation is as noted during removal. Tighten fittings as specified; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 4–10).
2. Position the manifold assembly to the machine frame and secure the manifold to the frame with two (2) cap screws.
3. Remove the plugs and the caps from the hydraulic hoses, tubes and fittings. Using the labels placed during manifold removal, connect the hydraulic hoses or tubes to the manifold fittings. Tighten the connections as specified; refer to Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 4–8).
4. Connect the wire harness connectors to the manifold solenoid coils. For machines with backlap, connect the wire harness connector to the backlap switch.
5. Charge the hydraulic system; refer to Charging the Hydraulic System (page 4–79).

Servicing the Mower Manifold

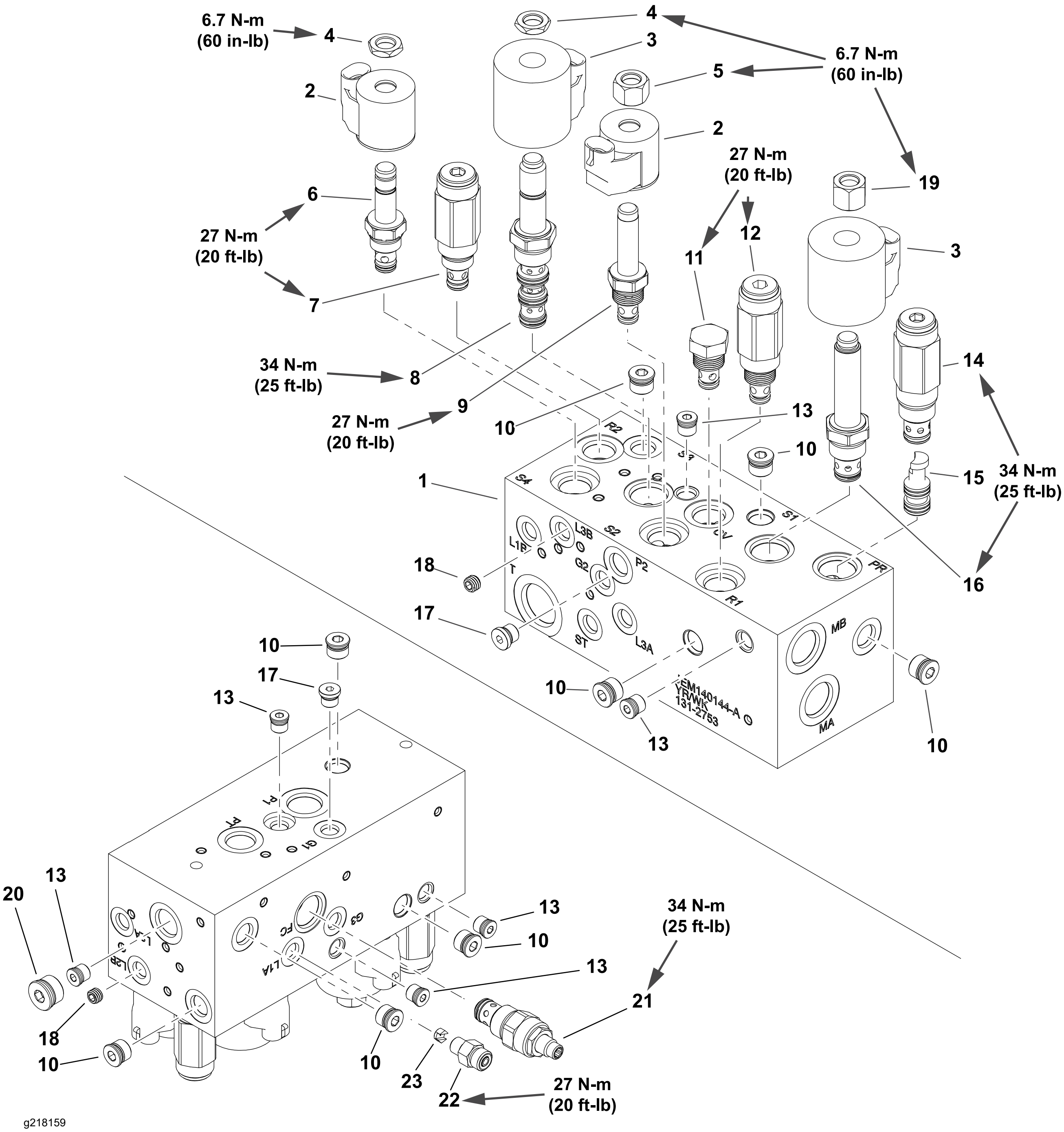


Figure 65

(machines without backlap)

1. Manifold block
2. Solenoid coil (2 each)
3. Solenoid coil (2 each)
4. Coil nut (2 each)
5. Coil nut
6. Solenoid cartridge valve S4
7. Relief valve R2
8. Solenoid cartridge valve S3
9. Solenoid cartridge valve S2
10. Zero leak plug #6 (8 each)
11. Check valve CV
12. Relief valve R1
13. Zero leak plug #4 (6 each)
14. Pilot operated relief valve PRV
15. Pilot piston
16. Solenoid cartridge valve S1
17. SAE Plug #4 (2 ea)
18. Orifice 0.055 inch (2 each)
19. Coil nut
20. Zero leak plug #8
21. Flow control valve FC
22. Straight fitting
23. Orifice disc 0.030 inch

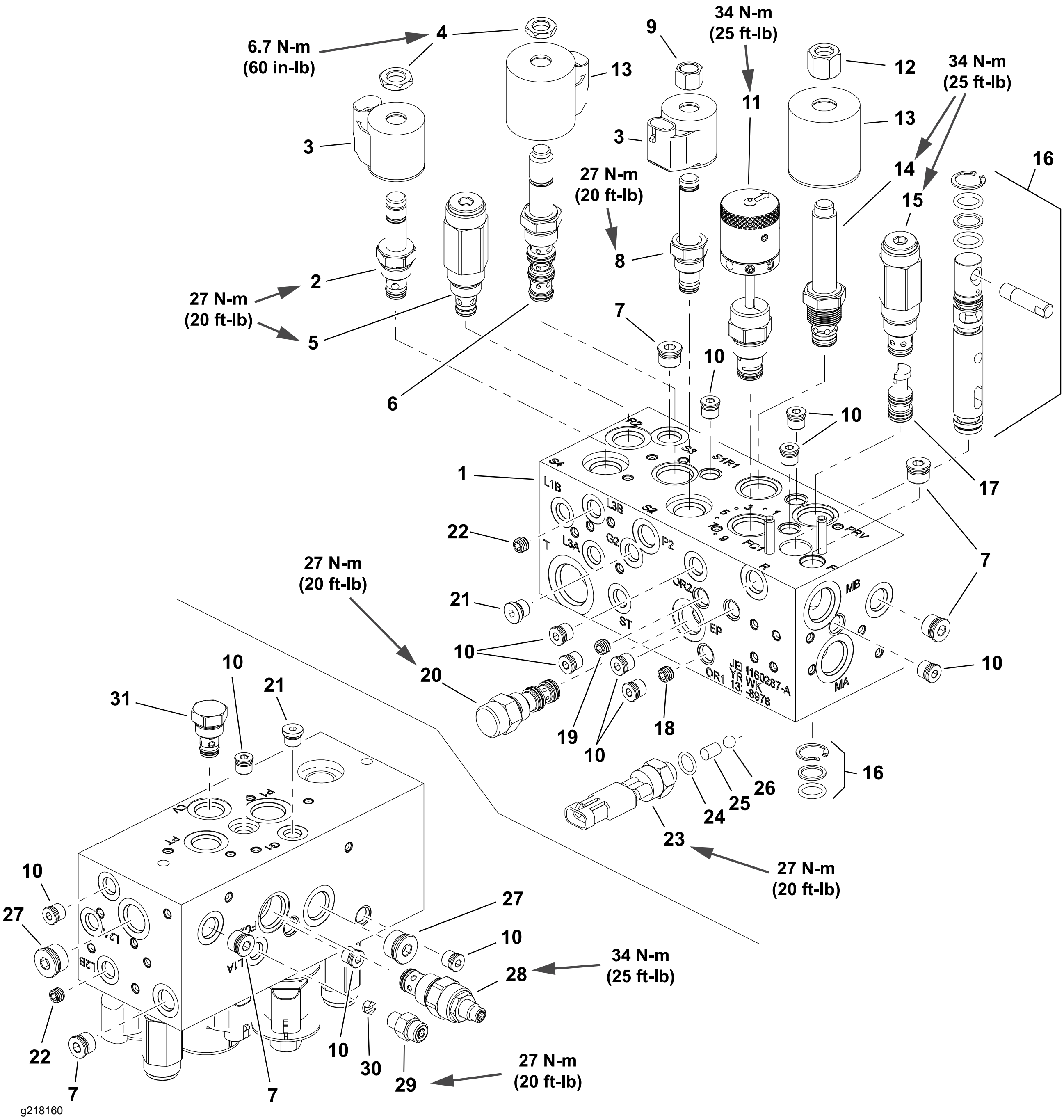


Figure 66
(machines with backlap)

1. Manifold block
2. Solenoid cartridge valve S4
3. Solenoid coil (2 each)
4. Coil nut (2 each)
5. Relief valve R2
6. Solenoid cartridge valve S3
7. Zero leak plug #6 (5 each)
8. Solenoid cartridge valve S2
9. Coil nut
10. Zero leak plug #4 (13 each)
11. Rotary valve
12. Coil nut
13. Solenoid coil (2 each)
14. Solenoid relief valve S1R1
15. Pilot operated relief valve PRV
16. Spool valve
17. Pilot piston
18. Orifice 0.013 inch
19. Orifice 0.060 inch
20. Pressure compensator EP
21. SAE Plug #4 (2 each)
22. Orifice 0.055 inch (2 each)
23. Backlap switch N.O.
24. O-ring
25. Pin
26. Ball
27. Zero leak plug #8 (2 each)
28. Flow control valve FC
29. Straight fitting
30. Orifice disc 0.030 inch
31. Check valve CV

The ports on the mower manifold are marked for easy identification of components. Example: FC1 is the flow control valve and P1 is the gear pump connection port; refer to the Hydraulic Schematics in Appendix A (page A–1) to identify the function of the hydraulic lines and cartridge valves at each port location).

The mower 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 to provide a secondary seal. If zero leak plug removal is necessary, lightly rap the plug head using a punch and hammer before using an hex wrench to remove the plug: the impact will allow plug removal with less chance of damage to the socket head of the plug. When installing plugs into the manifold, torque the plugs to the values specified.

PLUG TORQUE		
SIZE	**THREAD**	**TORQUE**
#4	7/16–20	27 N·m (20 ft-lb)
#6	9/16–18	34 N·m (25 ft-lb)
#8	3/4–16	68 N·m (50 ft-lb)

IMPORTANT

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

Cartridge Valves

Note: For solenoid style cartridge valve coil testing information; refer to Testing a Solenoid Valve Coil (page 5–27).

1. Park the machine on a level surface. Lower the cutting units, stop the engine, engage the parking brake and remove the key from the ignition switch.
2. Read and adhere to the information provided in General Precautions for Removing and Installing the Hydraulic System Components (page 4–71).
3. Ensure that the mower manifold is clean before you remove the cartridge valve from the manifold.
4. Remove the cartridge valve:

   A. For solenoid style valves, remove the nut that secures the solenoid coil to the cartridge valve. Carefully slide the coil off the valve.

IMPORTANT

Carefully handle the cartridge valve. Slight bending or distortion of the stem tube can cause binding and malfunction. When removing the cartridge valve from the manifold, ensure that the deep well socket fully engages the valve base.

   B. Use a deep socket wrench to remove the cartridge valve from the manifold.

5. Record the correct location of the O-rings, the sealing rings, and the back-up rings. Remove and discard the seal kit from the cartridge valve.
6. Visually inspect the manifold port and the cartridge valve:

   A. Check for damaged threads on the cartridge valve and in the manifold block.

   B. If valve sealing surfaces appear pitted or damaged, the hydraulic system may be overheating or there may be water in the system.

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

CAUTION

Use eye protection such as goggles when using compressed air.

Note: Particles as fine as talcum powder can affect the operation of high pressure hydraulic valves.

7. Clean the cartridge valve.

   A. For non-solenoid operated valves: Submerge the valve in clean mineral spirits to flush out contamination. If the valve design allows, use a non–metallic probe to push the internal spool in and out 20 to 30 times to flush out contamination. Clean and dry the cartridge valve with compressed air.

   B. For solenoid operated valves: Temporarily install the solenoid on the cartridge valve and connect a 12 volt power source to the solenoid. While energized, flush out any contamination with a nonflammable aerosol brake cleaner. De-energize the solenoid. Repeat the flush while energized procedure 5 or 6 times. Remove the solenoid from the cartridge.

Cartridge Valves (continued)

8. Install the cartridge valve:

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

   IMPORTANT

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

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

   C. Tighten the cartridge valve using a deep well socket to the torque specification shown.

   D. For solenoid valves, slide the solenoid coil onto the cartridge valve. Tighten the coil nut to **6.7 N·m (60 in-lb)**.

9. If a problem still exists, remove the valve and clean it again or replace the valve.

Rotary Valve (machines with backlap)

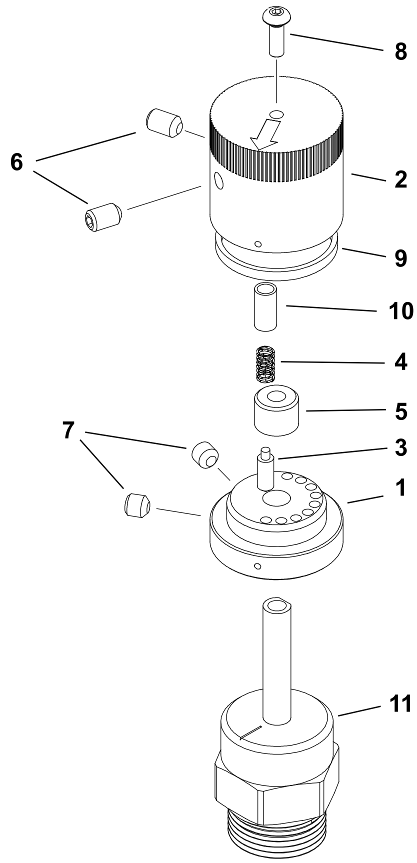


Figure 67

1. Handle base
2. Handle cap
3. Detent pin
4. Compression spring
5. Bushing
6. Set screw (2 each)
7. Set screw (2 each)
8. Screw
9. Lip seal
10. Sleeve bearing
11. Flow control cartridge valve

---

1. Park the machine on a level surface. Lower the cutting units, stop the engine, engage the parking brake and remove the key from the ignition switch.
2. Read and adhere to the information provided in General Precautions for Removing and Installing the Hydraulic System Components (page 4–71).
3. Ensure that the mower manifold is clean before you remove the rotary valve from the manifold.
4. Remove the rotary valve:
   A. Loosen the two (2) set screws that secure the handle cap.
   B. Remove the screw and then lift the handle cap from valve.
   C. Locate and retrieve the detent pin, compression spring, bushing and the lip seal. The sleeve bearing should stay in the cap.
   D. Loosen the two (2) set screws that secure the handle base to the flow control valve and remove the base.

IMPORTANT

Carefully handle the rotary valve. Slight bending or distortion of the stem tube can cause binding and malfunction. When removing the rotary valve from the manifold, ensure that the deep well socket fully engages the valve base.

E. Remove the rotary valve from the manifold with a deep well socket.

5. Record location of the O-rings and the backup rings on the valve. Remove and discard the seal kit from the rotary valve.
6. Visually inspect the manifold port and the cartridge valve:
   A. Check for damaged threads on the cartridge valve and in the manifold block.
   B. If valve sealing surfaces appear pitted or damaged, the hydraulic system may be overheating or there may be water in the system.
   C. Contamination may cause valves to stick or hang up. Contamination can become lodged in small valve orifices or seal areas causing valve malfunction.

CAUTION

Use eye protection such as goggles when using compressed air.

Note: Particles as fine as talcum powder can affect the operation of high pressure hydraulic valves.

7. Clean the rotary valve. Submerge the valve in clean mineral spirits to flush out contamination. If the valve design allows, use a non–metallic probe to push the internal spool in and out 20 to 30 times to flush out contamination. Clean and dry the cartridge valve with compressed air.
8. Install the rotary valve:
   A. Lubricate the new O-rings and the backup rings of the seal kit with clean hydraulic fluid and install them on the rotary valve. The O-rings and the backup rings must be arranged properly on the rotary valve for proper operation and sealing.

IMPORTANT

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

   B. Lubricate the threads on the cartridge valve with clean hydraulic fluid. Thread the cartridge valve carefully into the correct manifold port. The valve should thread in easily without binding.
   C. Tighten the cartridge valve using a deep well socket to the torque specification shown.
   D. Place the handle base on the flow control valve and position the alignment mark on the base with the number 1 on manifold. Secure the base with the two (2) set screws. Apply a light coating of grease to chamfer on top of the base to ease the lip seal installation.

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

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

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

9. If a problem still exists, remove the valve and clean it again or replace the valve.

Spool Valve (machines with backlap)

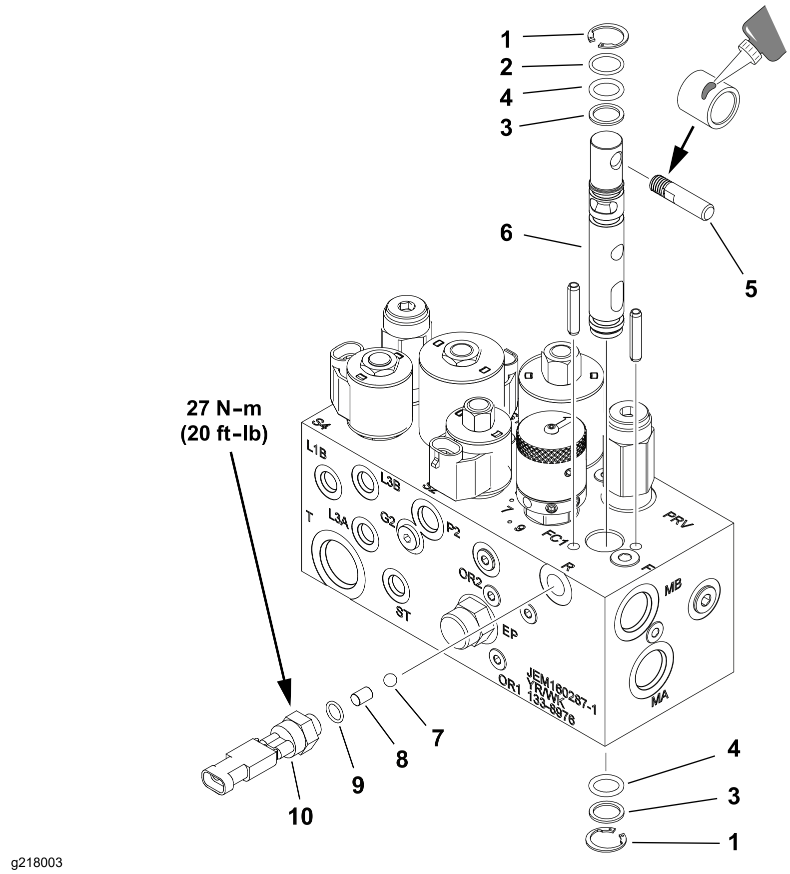


Figure 68

1.	Retaining ring	5.	Handle	9.	O-ring
2.	O-ring	6.	Spool	10.	Backlap switch
3.	Back-up ring	7.	Ball		
4.	O-ring	8.	Dowel pin		

1. Park the machine on a level surface. Lower the cutting units, stop the engine, engage the parking brake and remove the key from the ignition switch.
2. Read and adhere to the information provided in General Precautions for Removing and Installing the Hydraulic System Components (page 4–71).
3. Ensure that the mower manifold is clean before you remove the spool valve from the manifold.
4. Remove the spool valve:
   A. Remove the backlap switch from the manifold before removing the spool valve. Remove the dowel pin and the 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 spool valve. Raise the spool to allow access to the retaining ring on the upper end of the spool. Remove the upper retaining ring.
   C. Push the spool down until the lower O-ring and the back-up ring are exposed on the bottom of the manifold. Remove the lower O-ring and the back-up ring from the spool.
   D. Pull the spool up and out of the manifold. Remove the O-rings and the back-up ring from the spool.
   E. Discard the removed O-rings and the back-up rings.

Spool Valve (machines with backlap) (continued)

5. Visually inspect the manifold port and the spool valve:

   A. If valve sealing surfaces appear pitted or damaged, the hydraulic system may be overheating or there may be water in the system.

   B. Contamination may cause the valve to stick or hang up. Contamination can become lodged in small valve orifices or seal areas causing valve malfunction.

6. Install the spool valve:

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

   B. Carefully push the spool down into the manifold port until the lower O-ring and back-up ring groove is exposed on 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. Install the lower retaining ring to the spool.

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

   E. If the handle was removed from the spool, position the spool so the handle location is between the stop pins in the manifold. Apply a high strength retaining compound (Loctite® #603 or equivalent) to the threads on the handle and install the handle into the spool.

   F. Place the ball and the dowel pin in the backlap switch manifold port. Install a new O-ring onto the backlap switch. Thread the backlap switch into the port and tighten to **27 N·m (20 ft-lb)**.

Reel Motors

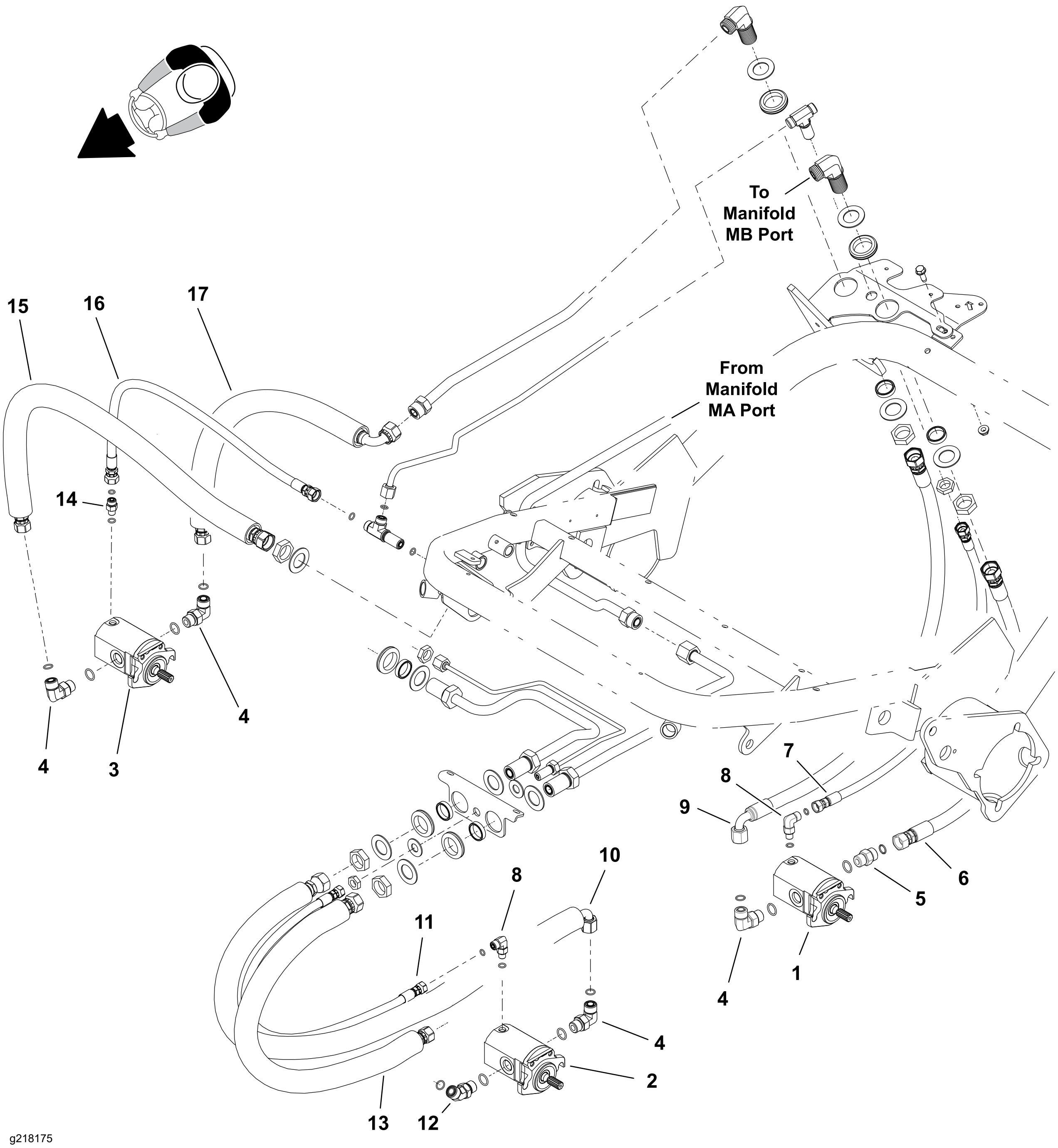


Figure 69

1. Reel motor #1
2. Reel motor #2
3. Reel motor #3
4. Elbow fitting (4 each)
5. Straight fitting
6. Hydraulic hose, return
7. Hydraulic hose, case drain
8. Elbow fitting (2 each)
9. Hydraulic hose, inlet
10. Hydraulic hose, return
11. Hydraulic hose, case drain
12. Elbow fitting
13. Hydraulic hose, inlet
14. Straight fitting
15. Hydraulic hose, inlet
16. Hydraulic hose, case drain
17. Hydraulic hose, return

Removing the Reel Motors

1. Park the machine on a level surface. Lower the cutting units, stop the engine, engage the parking brake and remove the key from the ignition switch.
2. Read and adhere to the information provided in General Precautions for Removing and Installing the Hydraulic System Components (page 4–71).
3. Label all hydraulic connections for proper assembly.

CAUTION

Before opening the hydraulic system, relieve the hydraulic system pressure to avoid injury from pressurized hydraulic fluid; refer to Relieving Pressure from the Hydraulic System (page 4–4).

4. Disconnect the hydraulic hos assemblies from the hydraulic fittings. Allow the hoses to drain into a suitable container. Cap and plug the hydraulic hoses and fittings to prevent system contaminations.

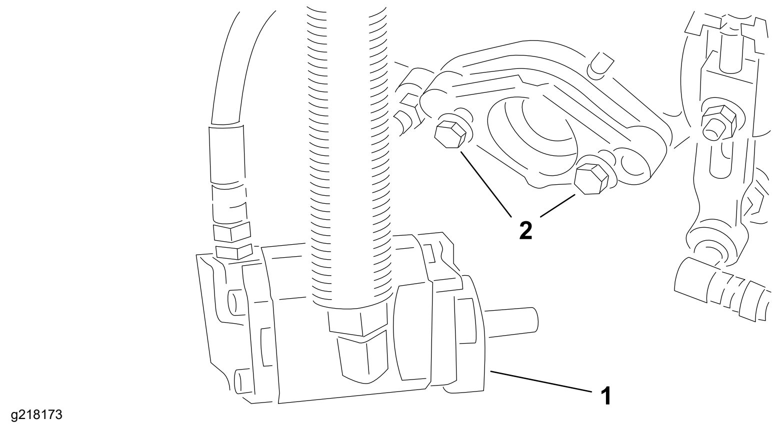


Figure 70

1. Reel motor
2. Flange head screw (2 each)
3. Cutting unit

5. Loosen the two (2) flange head screws that secure the reel motor to the cutting unit side plate; refer to Figure 70. Rotate the reel motor clockwise and remove the motor from the cutting unit.
6. Inspect the O−ring on the reel motor flange and replace the O−ring if worn or damaged.
7. If hydraulic fittings are to be removed from the motor, mark the fitting location and orientation to allow for correct assembly. Remove the fittings and discard the O−rings.

Installing the Reel Motors

Note: Inspect threads and sealing surfaces of the hydraulic fittings and the hydraulic hoses prior to installation. Replace any damaged or worn fittings or hoses.

1. Lubricate and fit new O-rings onto the reel motor fittings. Install the fittings making sure that the fitting location and orientation is as noted during removal. Tighten fittings as specified; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 4–10).
2. Coat the reel motor shaft splines with No. 2 multipurpose lithium base grease. Lubricate the O−ring on the motor flange with clean fluid.
3. Rotate the motor clockwise so the motor flanges clear the flange head screws 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.
4. Rotate the motor counterclockwise until the motor flanges encircle the cap screws in the side plates. While holding the motor, tighten the two (2) flange head screws securing the reel motor to the cutting unit; refer to Figure 70.

IMPORTANT

When installing the hydraulic hoses, make sure that hydraulic hoses are straight (not twisted) before tightening the hoses to the motor fittings.

5. Remove the plugs and the caps from the hydraulic hoses and fittings. Using the labels placed during removal, connect the hydraulic hoses to the reel motor fittings. Tighten the connections as specified; refer to Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 4–8).
6. Charge the hydraulic system; refer to Charging the Hydraulic System (page 4–79).

Servicing the Reel Motor

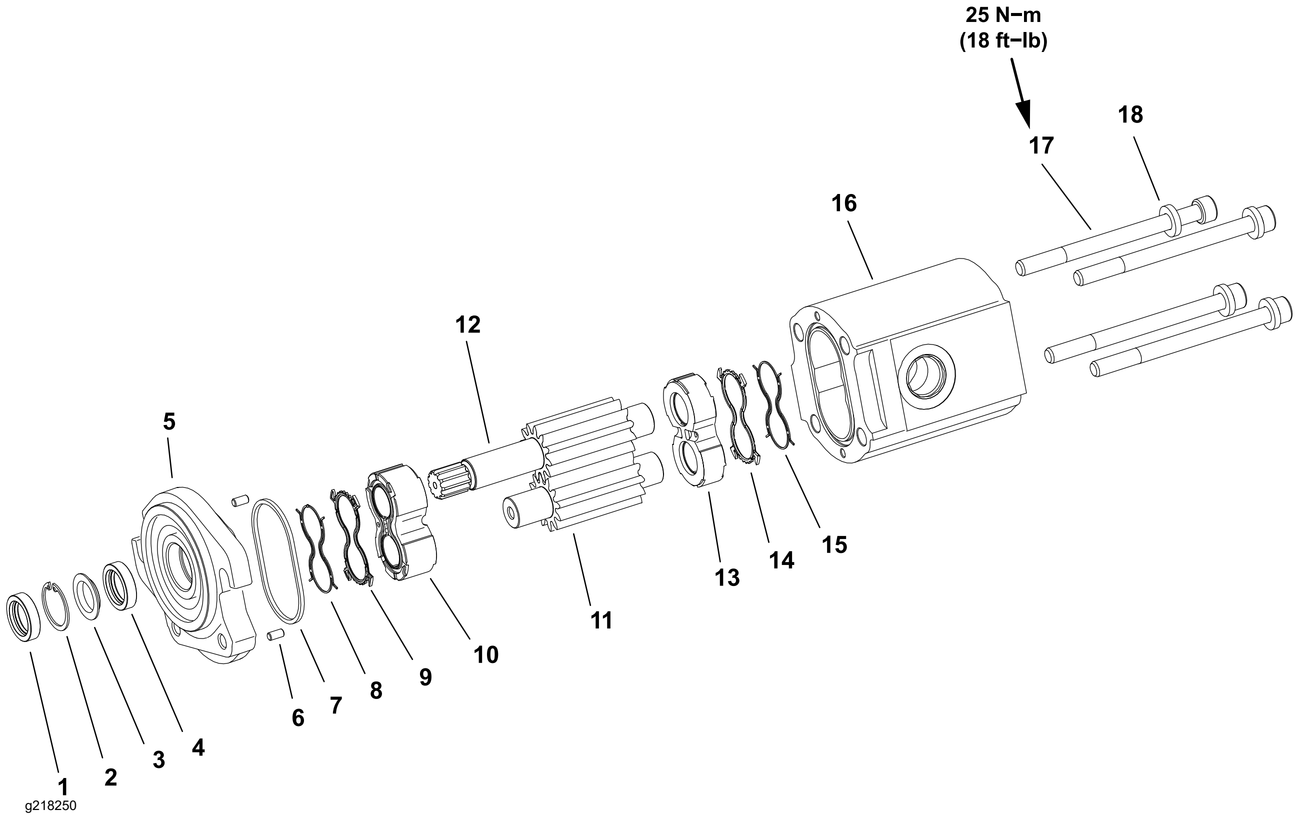


Figure 71

1. Dust seal
2. Retaining ring
3. Backup washer
4. Shaft seal
5. Front flange
6. Dowel pin (2 each)
7. O-ring
8. Pressure seal, outer
9. Backup gasket, outer
10. Wear plate, outer
11. Idler gear
12. Drive gear
13. Wear plate, inner
14. Backup gasket, inner
15. Pressure seal, inner
16. Body
17. Cap screw (4 each)
18. Washer (4 each)

Disassembling the Reel Motor

1. Plug the motor ports and clean the outside of the motor thoroughly. After cleaning the motor, remove the plugs and drain any fluid out of the motor.

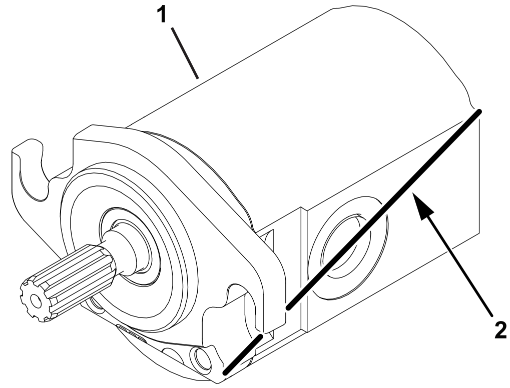


Figure 72

1. Reel motor
2. Marker line

2. Use a marker to make a diagonal line across the front flange and the body for assembly purposes; refer to Figure 72.

IMPORTANT

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

3. Clamp the front flange of the motor in a vise with soft jaws with the shaft end down.
4. Loosen the cap screws from the body.
5. Remove the motor from the vise. Turn the motor so that the shaft end is facing down and remove the cap screws.
6. Carefully remove the body by lifting the body straight up. Make sure the rear wear plate remains on the drive and idler gear shafts. Remove and discard the O–ring from the body. Locate and retrieve the dowel pins.

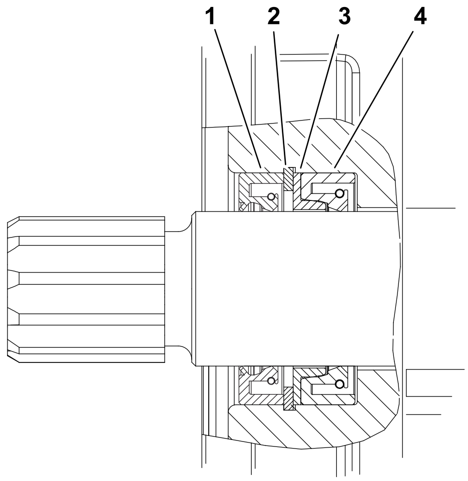
IMPORTANT

Record the position of the open and closed side of the wear plates before removing. Identify the wear plates (inner and outer, drive gear and idler gear) with a marker for proper assembly.

Mark the relative positions of the gear teeth so they can be reassembled in the same (mated) position. Do not touch the gear surfaces as residue on hands may be corrosive to the gear finish.

7. Carefully disassemble the inner wear plate, the idler gear, the drive gear and the outer wear plate.
8. Remove and discard the back−up gaskets and the pressure seals from the wear plates.
9. Turn the front flange over, with the seal side up.

Disassembling the Reel Motor (continued)



g218253

Figure 73

1. Dust seal
2. Retaining ring
3. Backup washer
4. Shaft seal

IMPORTANT

Make sure to not damage the front flange counter bore when removing the seals from the front flange.

10. Carefully remove the dust seal, the retaining ring, the backup washer and the shaft seal from the front flange; refer to Figure 73. Discard the removed seals.

Inspecting the Reel Motor

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

CAUTION

Use goggles or other appropriate eye protection when using compressed air for drying parts.

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

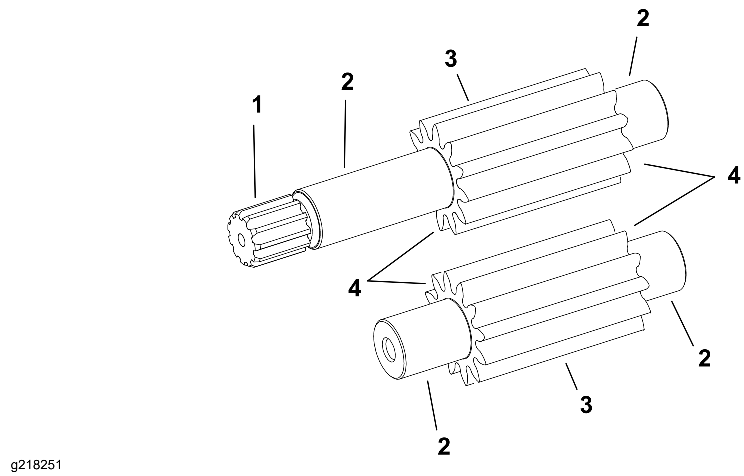


Figure 74

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

3. Inspect the drive gears and the idler gears for the following; refer to Figure 74.
   A. The gear shafts should be free of rough surfaces and excessive wear at the bushing points and the sealing areas. Scoring, rough surfaces or wear on the gear shafts indicates the need for replacement.
   B. The gear teeth should be free of excessive scoring and wear. Any broken or nicked gear teeth must be replaced.
   C. Inspect the gear face edge for sharpness. Sharp edges on the gears will damage the wear plates and should be replaced.
4. 4. Inspect the wear plates for the following:
   A. The bearing areas should not have excessive wear or scoring.
   B. The face of the wear plates that are in contact with the gears should be free of wear, roughness or scoring.
   C. The thickness of the wear plates should be equal.
5. Inspect the front flange and the rear cover for damage or wear.
6. If the internal parts are found to be worn or damaged, replacing the reel motor is necessary.

Assembling the Reel Motor

1. Lubricate the O–rings, the pressure seals, the back−up gaskets and the wear plate grooves with a thin coat of petroleum jelly. Lubricate all the other internal parts freely with clean hydraulic fluid.
2. Install the new seals into the front flange; refer to Figure 73.
   A. Press a new shaft seal into the front flange until it reaches the bottom of the bore.
   B. Install the backup washer into the front flange and then install the retaining ring into the groove of the front flange. Make sure the retaining ring is fully seated in the front flange groove.
   C. Install a new dust seal into the front flange.
3. Place the front flange, seal side down, on a flat surface.
4. Install the outer pressure seal, flat side outward, into the grooves in the outer wear plate. Follow by carefully placing the outer backup gasket, flat side outward, between the pressure seal and the grooves in the outer 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. Insert the drive end of the drive shaft through the outer wear plate with the pressure seal side down and the open side of the pressure seal pointing to the inlet side of the motor. Carefully install the shaft into the front flange.
7. Lubricate the idler gear shaft with clean hydraulic fluid. Install the idler gear shaft into the remaining position in the outer wear plate with the gear teeth in the mated position recorded during disassembly. Apply a light coating of clean hydraulic fluid to the gear faces.
8. Install the inner pressure seal, flat side outward, into the grooves in the inner wear plate. Follow by carefully placing the inner backup gasket, flat side outward, between the pressure seal and the grooves in the inner wear plate.
9. Install the inner wear plate with the pressure seal side up and the open side of the pressure seal pointing to the inlet side of the motor.
10. Apply a light coating of petroleum jelly to a new O–ring and the O–ring grooves in the body. Install the new O–ring to the body.

    Note: When assembling the motor, check the marker line on each part to make sure the parts are properly aligned during assembly.
11. Install the locating dowels in the body. Align the marker line on the body and the front flange.

IMPORTANT

Do not dislodge the seals during installation.

12. Gently slide the body onto the assembly. Firm hand pressure should be sufficient to engage the dowels.
13. Check to make sure that the surface of the body contacts the front flange. If the body does not contact the front flange, check assembly for a shifted pressure seal, backup gasket or O–ring. Correct before proceeding.
14. Install the four (4) cap screws with the washers and hand tighten the screws.

IMPORTANT

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

Assembling the Reel Motor (continued)

15. Place the front flange of the motor into a vise with soft jaws and alternately torque the cap screws **25 N−m (18 ft−lb)**.
16. Remove the motor from the vise.
17. Place a small amount of clean hydraulic fluid in the inlet of the motor and rotate the drive shaft away from the inlet one revolution. If any binding is evident, disassemble the motor and check for assembly problems.

Front Lift Cylinders

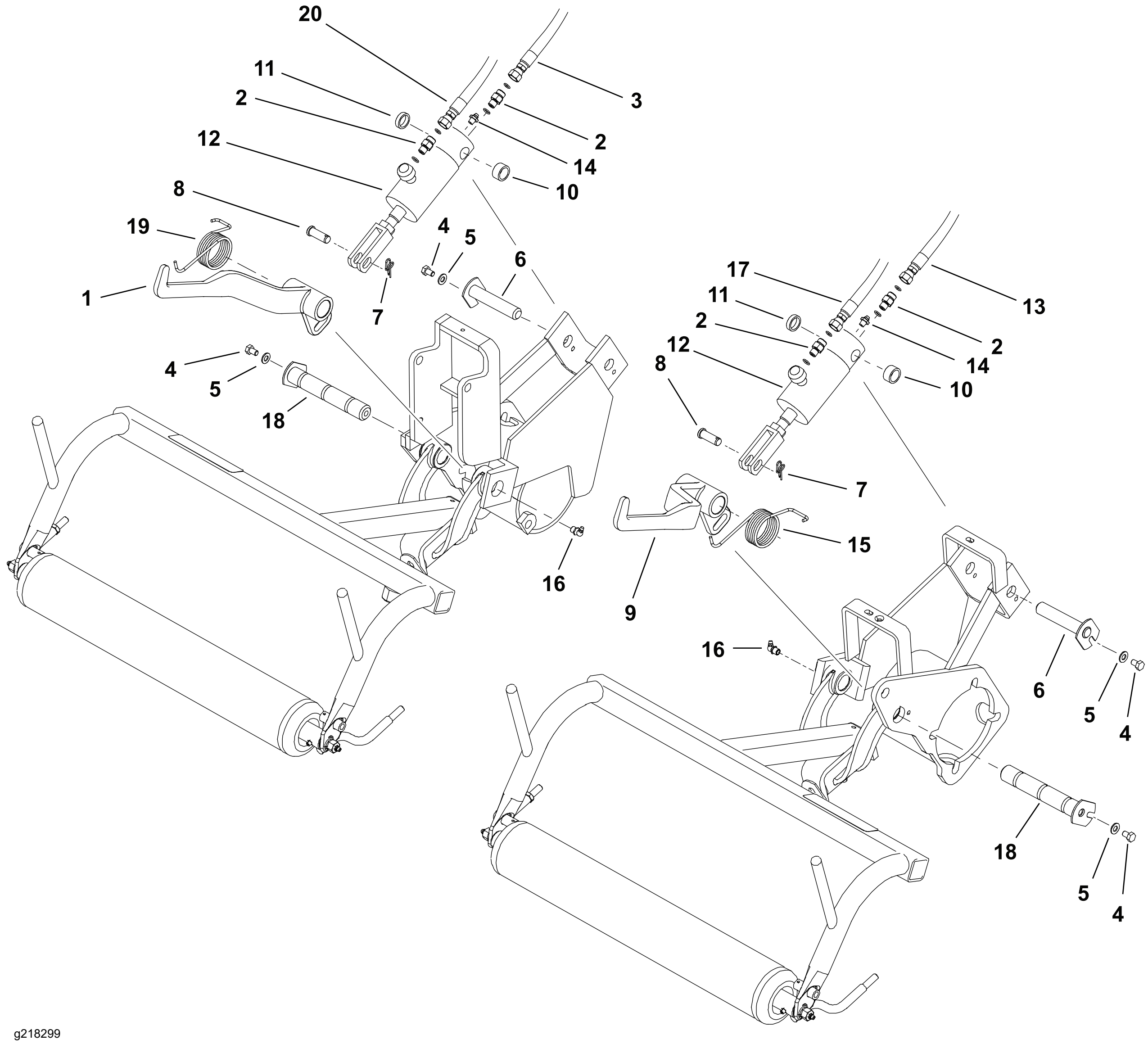


Figure 75

1. Lift arm, right
2. Straight fitting (4 each)
3. Hydraulic hose, right lift
4. Cap screw (4 each)
5. Flat washer (2 each)
6. Pivot pin (2 each)
7. Cotter pin (2 each)
8. Clevis pin (2 each)
9. Lift arm, left
10. Spacer, thick (2 each)
11. Spacer, thin (2 each)
12. Lift cylinder (2 each)
13. Hydraulic hose, left lift
14. Grease fitting (2 each)
15. Torsion spring, left
16. Grease fitting (2 each)
17. Hydraulic hose, left raise
18. Hinge pin (2 each)
19. Torsion spring, right
20. Hydraulic hose, right raise

Removing the Front Lift Cylinders

1. Park the machine on a level surface. Lower the cutting units, stop the engine, engage the parking brake and remove the key from the ignition switch.
2. Read and adhere to the information provided in General Precautions for Removing and Installing the Hydraulic System Components (page 4–71).
3. Label all hydraulic connections for proper assembly.

CAUTION

Before opening the hydraulic system, relieve the hydraulic system pressure to avoid injury from pressurized hydraulic fluid; refer to Relieving Pressure from the Hydraulic System (page 4–4).

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4. Disconnect the hydraulic hose assemblies from the hydraulic fittings. Allow the hoses to drain into a suitable container. Cap and plug the hydraulic hoses and fittings to prevent system contaminations.
5. Remove the cotter pin and the clevis pin that secure the lift cylinder clevis to the lift arm.
6. Support the lift cylinder to prevent it from dropping.
   A. Remove the cap screw and the washer from the pivot pin (item 6 in Figure 75).
   B. Pull the pivot pin from the frame, the spacers and the lift cylinder. Note that the thicker spacer is toward the center of the machine.
   C. Remove the hydraulic cylinder from the frame.
7. If hydraulic fittings are to be removed from the cylinder, mark the fitting location and orientation to allow for correct assembly. Remove the fittings and discard the O−rings.

Installing the Front Lift Cylinders

Note: Inspect the threads and the sealing surfaces of the hydraulic fittings and the hydraulic hoses prior to installation. Replace any damaged or worn fittings or hoses.

1. Lubricate and fit new O-rings onto the cylinder fittings. Install the fittings making sure that the fitting location and orientation is as noted during removal. Tighten fittings as specified; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 4–10).
2. Position the lift cylinder to the machine.
3. Insert the pivot pin (item 6 in Figure 75) through the outer frame bracket, the thinner spacer, the lift cylinder, the thicker spacer and the inner frame bracket. Secure the pin to the frame with the cap screw and the washer.
4. Position the clevis of the lift cylinder to the lift arm. Secure the lift cylinder clevis to the lift arm with the clevis pin and the cotter pin.
5. Remove the plugs and the caps from the hydraulic hoses and fittings. Using the labels placed during removal, connect the hydraulic hoses to the cylinder fittings. Tighten the connections as specified; refer to Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 4–8).
6. Charge the hydraulic system; refer to Charging the Hydraulic System (page 4–79).

Servicing the Front Lift Cylinders

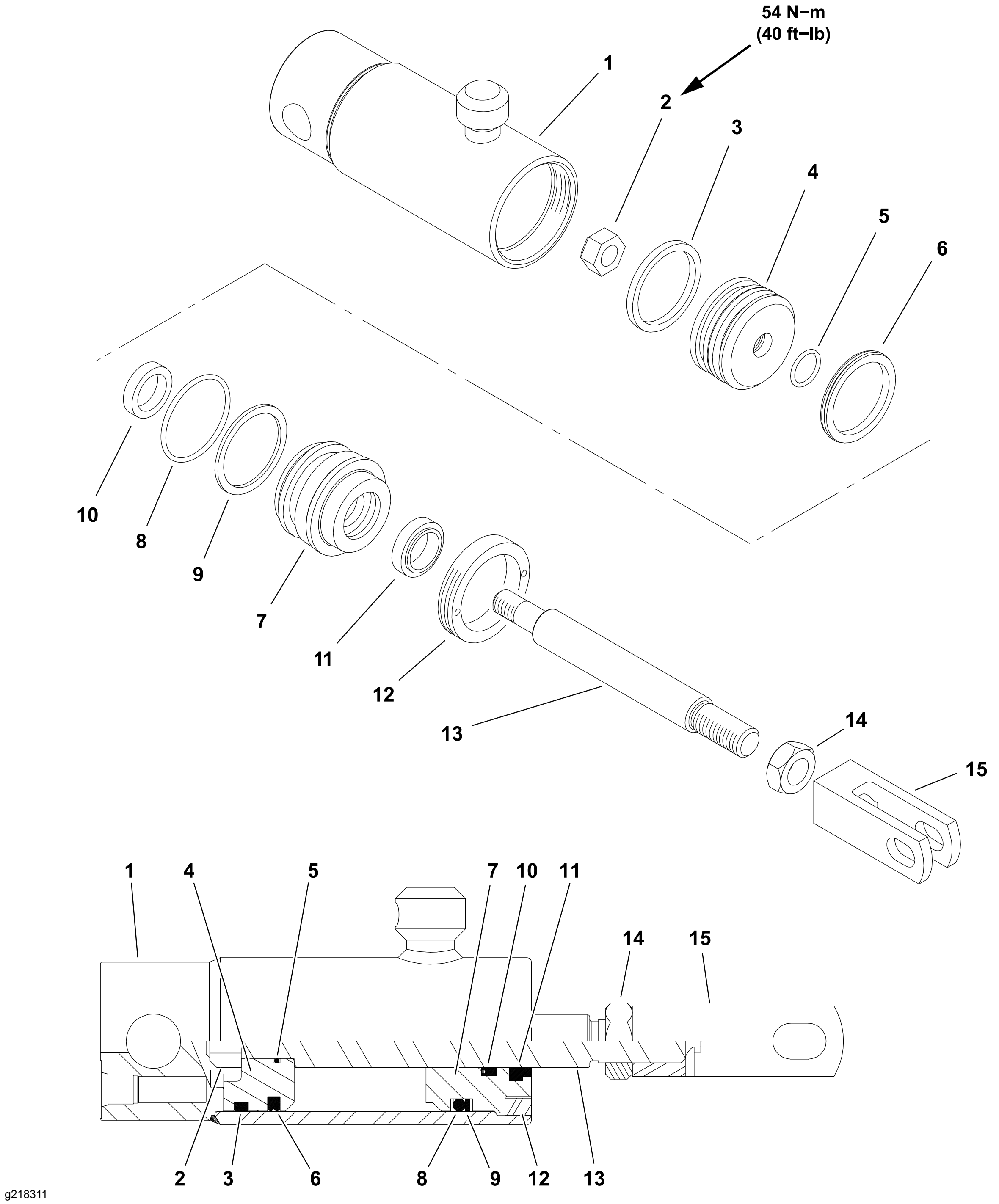

Figure 76

1. Barrel
2. Lock nut
3. Wear ring
4. Piston
5. O-ring
6. Seal
7. Head
8. O-ring
9. Back-up ring
10. Seal
11. Dust seal
12. Internal collar
13. Rod
14. Jam nut
15. Rod clevis

Disassembling the Front Lift Cylinder

1. Remove any fluid from the cylinder by slowly pumping the cylinder rod while holding the cylinder over a drain pan.
2. Plug both cylinder ports and clean the outside of the cylinder.

IMPORTANT

Do not clamp vise jaws against the cylinder barrel. Clamp on the clevis ONLY.

3. Mount the cylinder securely in a vise by clamping on the clevis end of the barrel. Using a vise with soft jaws is recommended.
4. Use a spanner wrench to rotate the internal collar counterclockwise until it is free of the cylinder barrel.
5. Remove the plugs from the ports. Extract the rod, the head and the piston assembly from the barrel by carefully twisting and pulling on the rod.

IMPORTANT

Do not clamp vise jaws against the cylinder rod surface. Clamp on the clevis ONLY.

6. Mount the cylinder rod securely in a vise by clamping on the clevis of the rod. Using a vise with soft jaws is recommended.
7. Remove the lock nut from the rod. Slide the piston and the head off the rod.
8. Remove the wear ring, the seals, the back−up ring and the O−rings from the piston and the head.

Assembling the Front Lift Cylinder

1. Make sure all the cylinder components are clean before assembly.
2. Coat the new wear rings, the O−rings, the seals and the back−up ring with clean hydraulic fluid.
   A. Install the wear ring and the seal to the outside of the piston.
   B. Install the O−ring to the inner bore of the piston.
   C. Install the O−ring, the back−up ring and the rod seals to the cylinder head.

IMPORTANT

Do not clamp vise jaws against the cylinder rod surface. Clamp on the clevis ONLY.

3. Mount the cylinder rod securely in a vise by clamping on the clevis of the rod. Using a vise with soft jaws is recommended.
   A. Coat the rod with a light layer of clean hydraulic fluid.
   B. Carefully slide the head assembly and then the piston assembly onto the rod. Install the lock nut onto the rod and tighten to **54 N−m (40 ft−lb)**.
   C. Remove the rod assembly from the vise.
4. Coat all the internal parts with a light layer of clean hydraulic fluid. Slide the piston, the rod and head assembly into the barrel being careful to not damage the seals.

IMPORTANT

Do not clamp vise jaws against the cylinder barrel. Clamp on the clevis ONLY.

5. Mount the cylinder securely in a vise by clamping on the clevis end of the barrel. Using a vise with soft jaws is recommended.
6. Use a spanner wrench to rotate the internal collar clockwise until it is tight against the cylinder barrel.

Rear Lift Cylinder

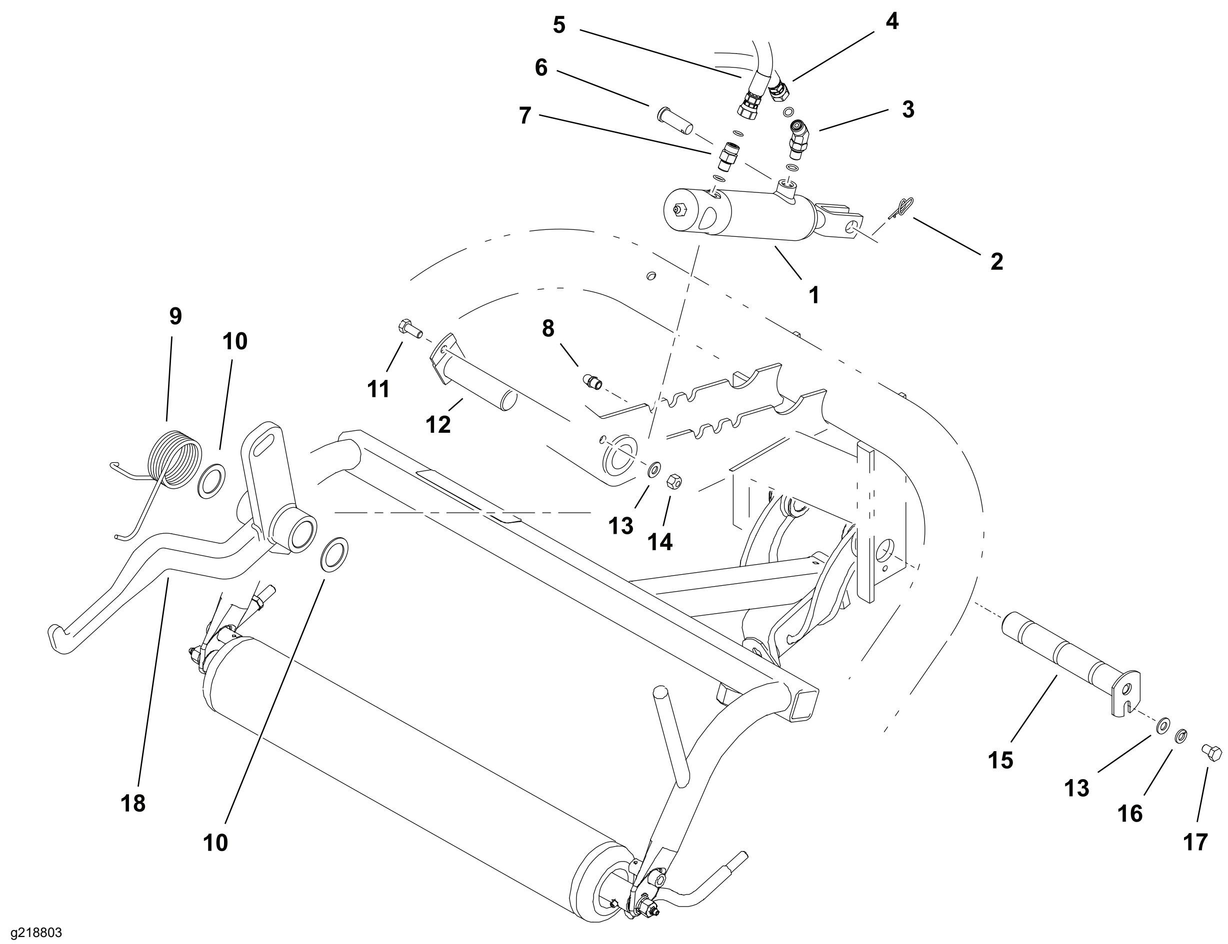

Figure 77

1. Rear lift cylinder
2. Cotter pin
3. Elbow fitting
4. Hydraulic hose, lower
5. Hydraulic hose, raise
6. Clevis pin
7. Straight fitting
8. Grease fitting
9. Torsion spring
10. Thrust washer (2 each)
11. Cap screw
12. Pivot pin
13. Flat washer (2 each)
14. Lock nut
15. Hinge pin
16. Lock washer
17. Cap screw
18. Lift arm

Removing the Rear Lift Cylinder

1. Park the machine on a level surface. Lower the cutting units, stop the engine, engage the parking brake and remove the key from the ignition switch.
2. Read and adhere to the information provided in General Precautions for Removing and Installing the Hydraulic System Components (page 4–71).
3. Label all hydraulic connections for proper assembly.

CAUTION

Before opening the hydraulic system, relieve the hydraulic system pressure to avoid injury from pressurized hydraulic fluid; refer to Relieving Pressure from the Hydraulic System (page 4–4).

4. Disconnect the hydraulic hose assemblies from the hydraulic fittings. Allow the hoses to drain into a suitable container. Cap and plug the hydraulic hoses and fittings to prevent system contaminations.
5. Support the lift cylinder to prevent it from dropping.
   A. Remove the cap screw, the flat washer and the lock nut from the pivot pin (item 12 in Figure 77). Pull the pivot pin from the frame and the lift cylinder.
   B. Remove the cotter pin from clevis pin (item 6 in Figure 77). Slide the clevis pin from the lift cylinder and the lift arm.
   C. Separate the hydraulic cylinder from the frame and the lift arm. Remove the cylinder from the machine.
6. If hydraulic fittings are to be removed from the cylinder, mark the fitting location and orientation to allow for correct assembly. Remove the fittings and discard the O−rings.

Installing the Rear Lift Cylinder

Note: Inspect the threads and the sealing surfaces of the hydraulic fittings and the hydraulic hoses prior to installation. Replace any damaged or worn fittings or hoses.

1. Lubricate and fit new O-rings onto the cylinder fittings. Install the fittings making sure that the fitting location and orientation is as noted during removal. Tighten fittings as specified; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 4–10).
2. Position the lift cylinder to the machine.
3. Insert the pivot pin (item 12 in Figure 77) through the frame brackets and the lift cylinder. Secure the pin to the frame with the cap screw, the flat washer and the lock nut.
4. Position the clevis of the lift cylinder to the lift arm. Secure the lift cylinder clevis to the lift arm with the clevis pin (item 6 in Figure 77) and the cotter pin.
5. Remove the plugs and the caps from the hydraulic hoses and fittings. Using the labels placed during removal, connect the hydraulic hoses to the cylinder fittings. Tighten the connections as specified; refer to Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 4–8).
6. Charge the hydraulic system; refer to Charging the Hydraulic System (page 4–79).

Servicing the Rear Lift Cylinder

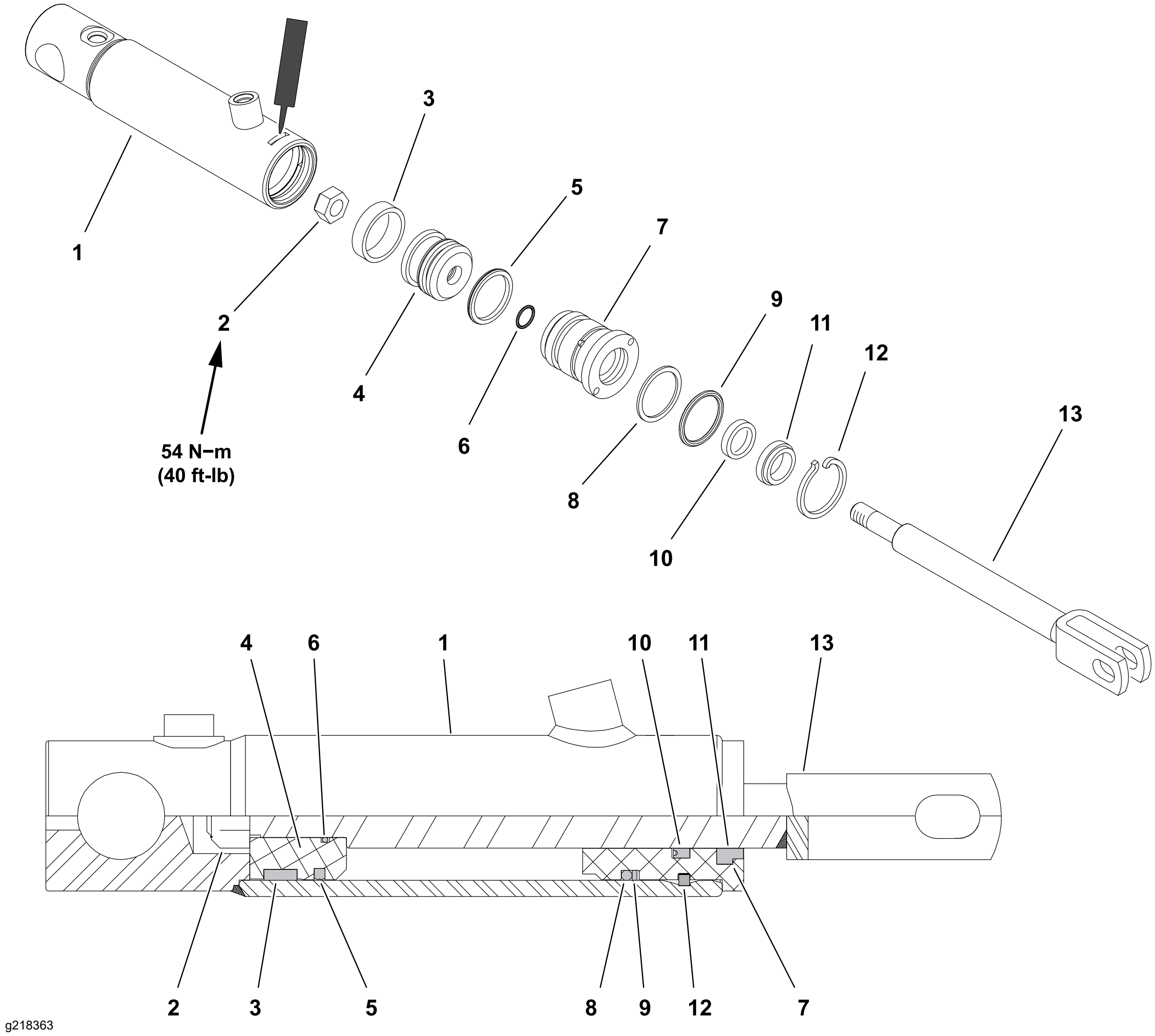

Figure 78

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

Disassembling the Lift Cylinder

1. Remove any fluid from the cylinder by slowly pumping the cylinder rod while holding the cylinder over a drain pan.
2. Plug both cylinder ports and clean the outside of the cylinder.

IMPORTANT

Do not clamp vise jaws against the cylinder barrel. Clamp on the clevis ONLY.

3. Mount the cylinder securely in a vise by clamping on the clevis end of the barrel. Using a vise with soft jaws is recommended.
4. Loosen the head from the cylinder barrel.
   A. Use a spanner wrench to rotate the head clockwise until the edge of the retaining ring appears in the barrel opening.
   B. Insert a screwdriver under the beveled edge of the retaining ring to start the retaining ring through the opening.
   C. Rotate the head counter−clockwise to remove the retaining ring from the barrel and the head.
5. Remove the plugs from the ports. Extract the rod, the head and the piston assembly from the barrel by carefully twisting and pulling on the rod.

IMPORTANT

Do not clamp vise jaws against the cylinder rod surface. Clamp on the clevis ONLY.

6. Mount the cylinder rod securely in a vise by clamping on the clevis of the rod. Using a vise with soft jaws is recommended.
7. Remove the lock nut from the rod. Slide the piston and the head off the rod.
8. Remove the wear ring, the seals, the back−up ring and the O−rings from the piston and the head.

Assembling the Lift Cylinder

1. Make sure all the cylinder components are clean before assembly.
2. Coat the new wear rings, the O−rings, the seals and the back−up ring with clean hydraulic fluid.
   A. Install the wear ring and the seal to the outside of the piston.
   B. Install the O−ring to the inner bore of the piston.
   C. Install the O−ring, the back−up ring and the rod seals to the cylinder head.

IMPORTANT

Do not clamp vise jaws against the cylinder rod surface. Clamp on the clevis ONLY.

3. Mount the cylinder rod securely in a vise by clamping on the clevis of the rod. Using a vise with soft jaws is recommended.
   A. Coat the rod with a light layer of clean hydraulic fluid.

B. Carefully slide the head assembly and then the piston assembly onto the rod. Install the lock nut onto the rod and tighten to **54 N−m (40 ft−lb)**.

C. Remove the rod assembly from the vise.

4. Coat all the internal parts with a light layer of clean hydraulic fluid. Slide the piston, the rod and head assembly into the barrel being careful to not damage the seals.

IMPORTANT

Do not clamp vise jaws against the cylinder barrel. Clamp on the clevis ONLY.

5. Mount the cylinder securely in a vise by clamping on the clevis end of the barrel. Using a vise with soft jaws is recommended.

   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 barrel access slot.

Steering Control Valve

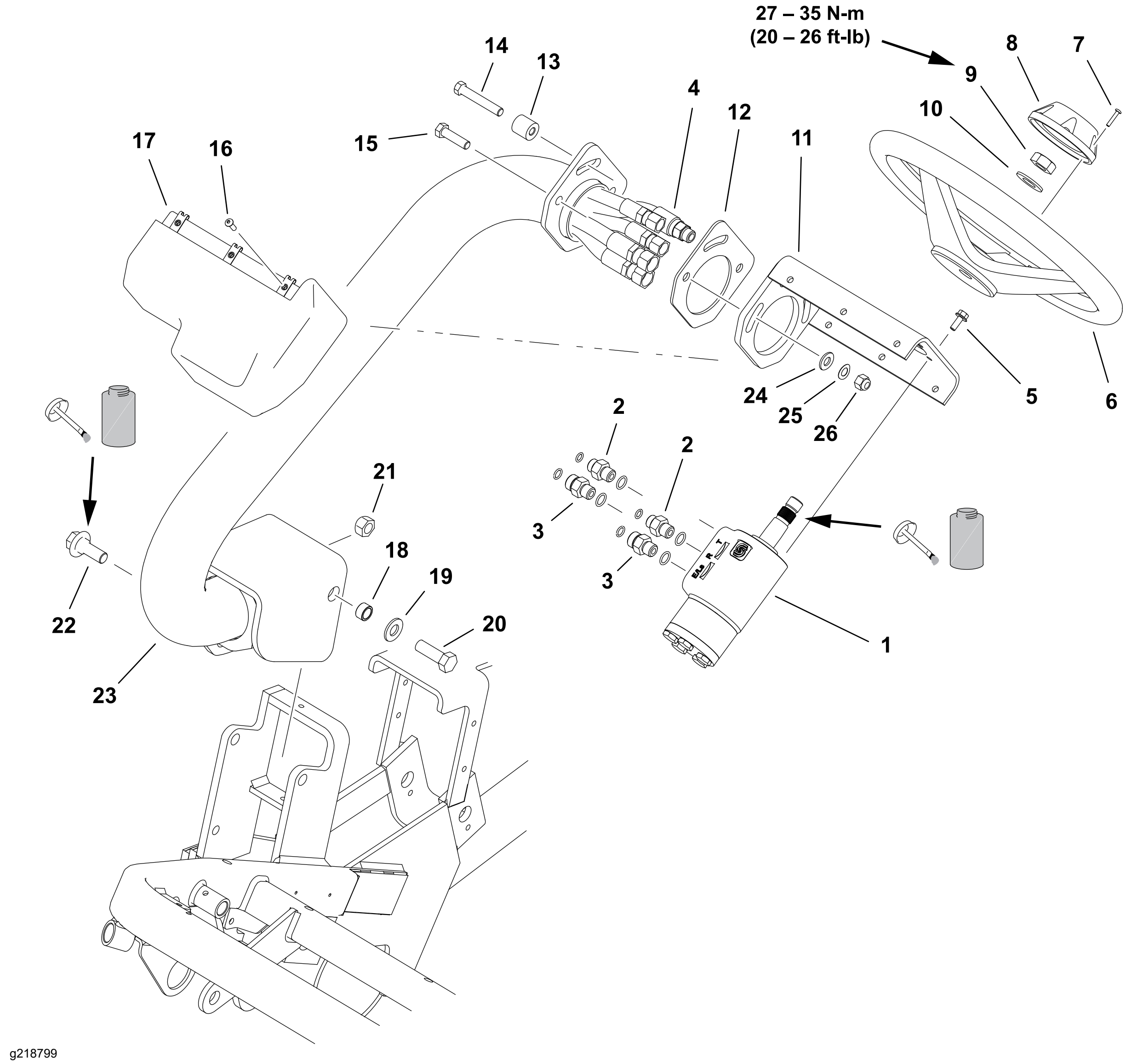

Figure 79

1.	Steering control valve	10.	Flat washer	19.	Flat washer (2 each)
2.	Straight fitting (2 each)	11.	Steering mount	20.	Cap screw (2 each)
3.	Straight fitting (2 each)	12.	Friction plate	21.	Lock nut (2 each)
4.	Hydraulic hose, T port	13.	Spacer	22.	Shoulder bolt
5.	cap screw (4 each)	14.	Cap screw	23.	Steering arm
6.	Steering wheel	15.	Cap screw (2 each)	24.	Flat washer (2 each)
7.	Screw (2 each)	16.	Screw (6 each)	25.	Wave washer (2 each)
8.	Steering wheel cover	17.	Steering valve cover	26.	Lock nut (2 each)
9.	Lock nut	18.	Bushing (2 each)		

Removing the Steering Control Valve

1. Park the machine on a level surface. Lower the cutting units, stop the engine, engage the parking brake and remove the key from the ignition switch.
2. Read and adhere to the information provided in General Precautions for Removing and Installing the Hydraulic System Components (page 4–71).
3. Remove the two (2) screws and the steering wheel cover from the steering wheel.
4. Remove the lock nut and the flat washer from the steering control valve shaft.
5. Remove the six (6) screws and the steering control valve cover.
6. Remove the four (4) cap screws that secure the steering control valve to the steering mount and lower the steering control valve (with the hydraulic hoses attached) from the steering mount.

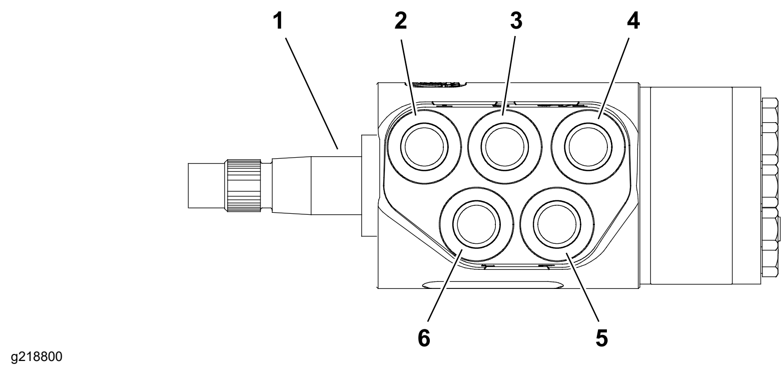

Figure 80

1.	Steering control valve	3.	R port	5.	P port
2.	T port	4.	E/Ls port	6.	L port

7. The ports of the steering control valve are marked as shown in . Label all hydraulic connections for proper assembly.

CAUTION

Before opening the hydraulic system, relieve the hydraulic system pressure to avoid injury from pressurized hydraulic fluid; refer to Relieving Pressure from the Hydraulic System (page 4–4).

8. Disconnect the hydraulic hose assemblies from the hydraulic fittings. Allow the hoses to drain into a suitable container. Cap and plug the hydraulic hoses and fittings to prevent system contaminations.
9. If hydraulic fittings are to be removed from the valve, mark the fitting location to allow for correct assembly. Remove the fittings and discard the O−rings.

Installing the Steering Control Valve

Note: Inspect the threads and the sealing surfaces of the hydraulic fittings and the hydraulic hoses prior to installation. Replace any damaged or worn fittings or hoses.

1. Lubricate and fit new O-rings onto the valve fittings. Install the fittings making sure that the fitting location and orientation is as noted during removal. Tighten fittings as specified; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 4–10).
2. Position steering control valve to steering mount.
3. Remove any plugs and caps from the hydraulic hoses and fittings. Using the labels placed during removal, connect the hydraulic hoses to the valve fittings. Tighten the connections as specified; refer to Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 4–8).
4. Slide the steering control valve (with the hydraulic hoses attached) into the steering mount and secure it with the four (4) cap screws.
5. Install the steering valve cover.
6. Secure the steering wheel cover with the two (2) screws.
7. Apply a small amount of anti-seize lubricant to the splines and the taper of the steering control valve shaft and install the steering wheel, the flat washer and the lock nut. Tighten lock nut from **28 to 35 N·m (20 to 26 ft-lb)**.
8. Charge the hydraulic system; refer to Charging the Hydraulic System (page 4–79).

Servicing the Steering Control Valve

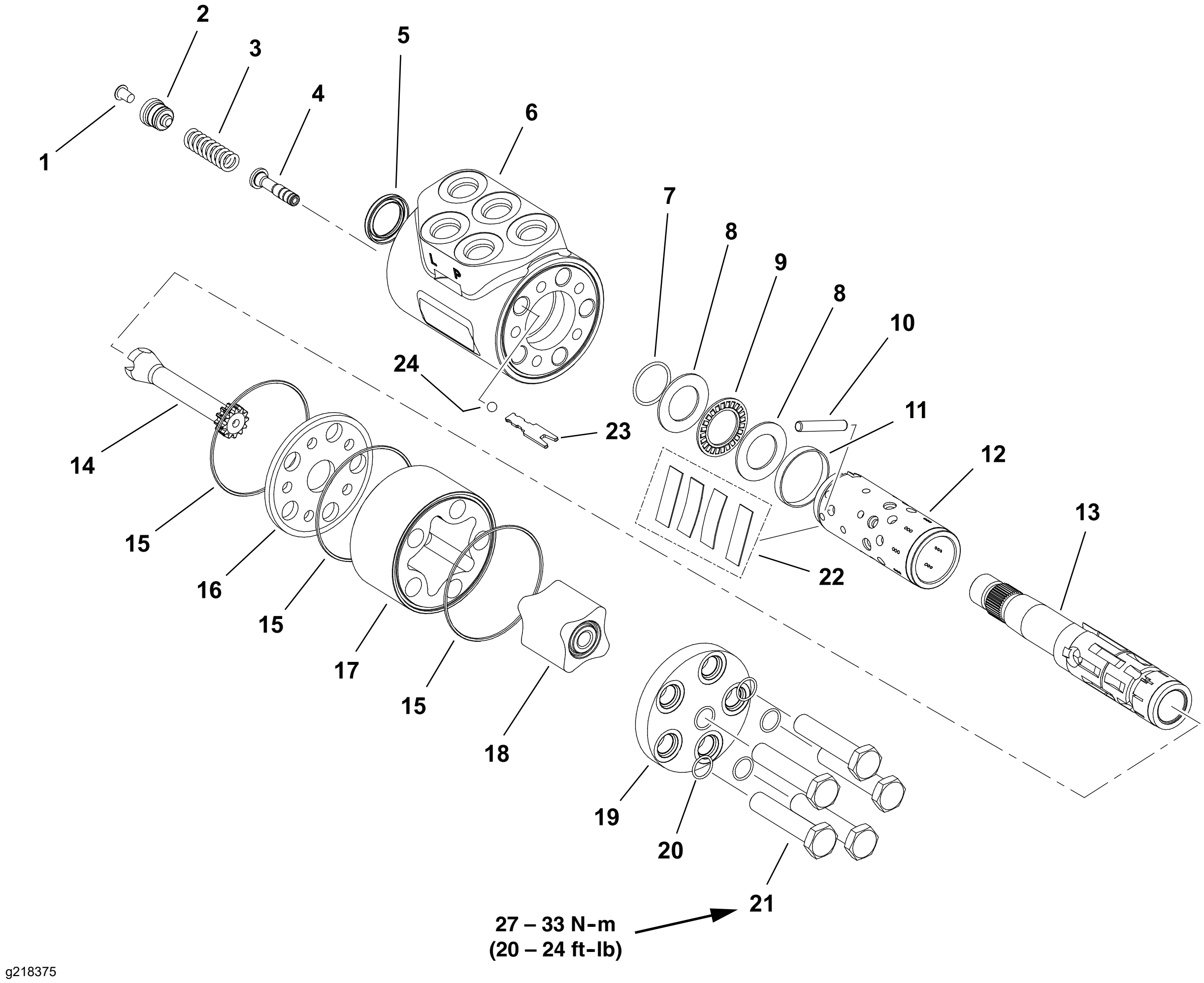

Figure 81

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

Note: For servicing the steering control valve, see the Danfoss Steering Unit Type OSPM Service Manual.

Steering Cylinder

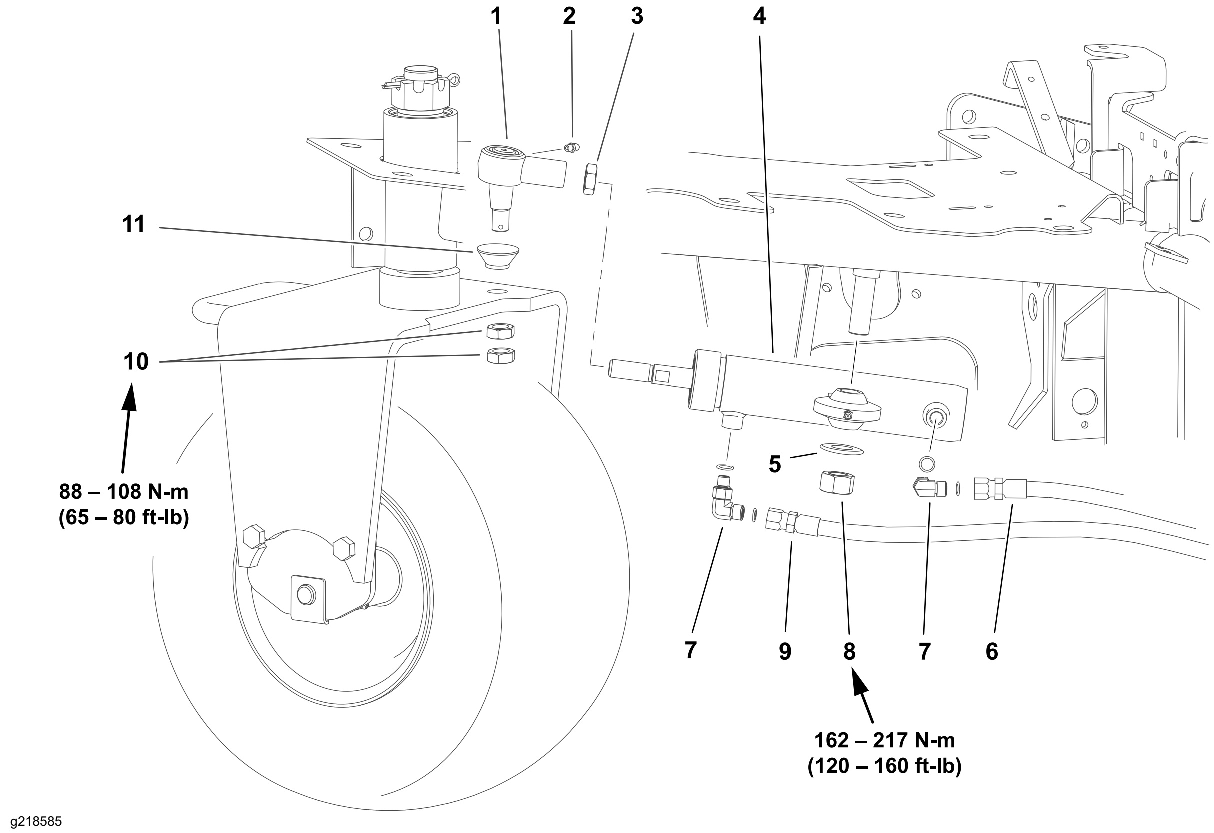

Figure 82

1. Rod end
2. Grease fitting
3. Jam nut
4. Steering cylinder
5. Flat washer
6. Hydraulic hose, right turn
7. Elbow fitting (2 each)
8. Lock nut
9. Hydraulic hose, left turn
10. Jam nut (2 each)
11. Dust seal

Removing the Steering Cylinder

1. Park the machine on a level surface. Lower the cutting units, stop the engine, engage the parking brake and remove the key from the ignition switch.
2. Read and adhere to the information provided in General Precautions for Removing and Installing the Hydraulic System Components (page 4–71).
3. Label all hydraulic connections for proper assembly.

CAUTION

Before opening the hydraulic system, relieve the hydraulic system pressure to avoid injury from pressurized hydraulic fluid; refer to Relieving Pressure from the Hydraulic System (page 4–4).

4. Disconnect the hydraulic hose assemblies from the hydraulic fittings. Allow the hoses to drain into a suitable container. Cap and plug the hydraulic hoses and fittings to prevent system contaminations.
5. Remove the two (2) jam nuts and the flat washer from the rod end at the rear wheel caster fork. Use a suitable tool (pickle fork) to separate the rod end from the caster fork.
6. Remove the lock nut and the flat washer from the barrel mounting stud and remove the steering cylinder from the machine.
7. If hydraulic fittings are to be removed from the cylinder, mark the fitting location and orientation to allow for correct assembly. Remove the fittings and discard the O−rings.
8. If the rod end (item 1 in Figure 82) is to be removed from the cylinder rod, fully retract the cylinder rod and measure and record the distance from the rod end to the cylinder for assembly purpose. Loosen the jam nut and remove the rod end and the jam nut from the cylinder rod.

Installing the Steering Cylinder

1. If rod the rod end was removed from the cylinder rod, fully retract the cylinder rod and thread the jam nut and the rod end onto shaft so to the distance recorded during removal. Tighten the jam nut to retain the rod end.

   Note: Inspect the threads and the sealing surfaces of the hydraulic fittings and the hydraulic hoses prior to installation. Replace any damaged or worn fittings or hoses.
2. Lubricate and fit new O-rings onto the cylinder fittings. Install the fittings making sure that the fitting location and orientation is as noted during removal. Tighten fittings as specified; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 4–10).
3. Thoroughly clean the tapered surfaces of the rod end and the tapered bore on the caster fork.
4. Secure the rod end to the caster fork with a flat washer and two jam nuts. Tighten the first jam nut from **88 to 108 N·m (65 to 80 ft-lb)**. While holding the first jam nut stationary, tighten the second jam nut from **88 to 108 N·m (65 to 80 ft-lb)**.
5. Fit the steering cylinder over the barrel mounting stud and install the flat washer and the lock nut. Tighten lock nut from **162 to 217 N·m (120 to 160 ft-lb)**.
6. Remove the plugs and the caps from the hydraulic hoses and fittings. Using the labels placed during removal, connect the hydraulic hoses to the cylinder

fittings. Tighten the connections as specified; refer to Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 4–8).

7. Charge the hydraulic system; refer to Charging the Hydraulic System (page 4–79).

Servicing the Steering Cylinder

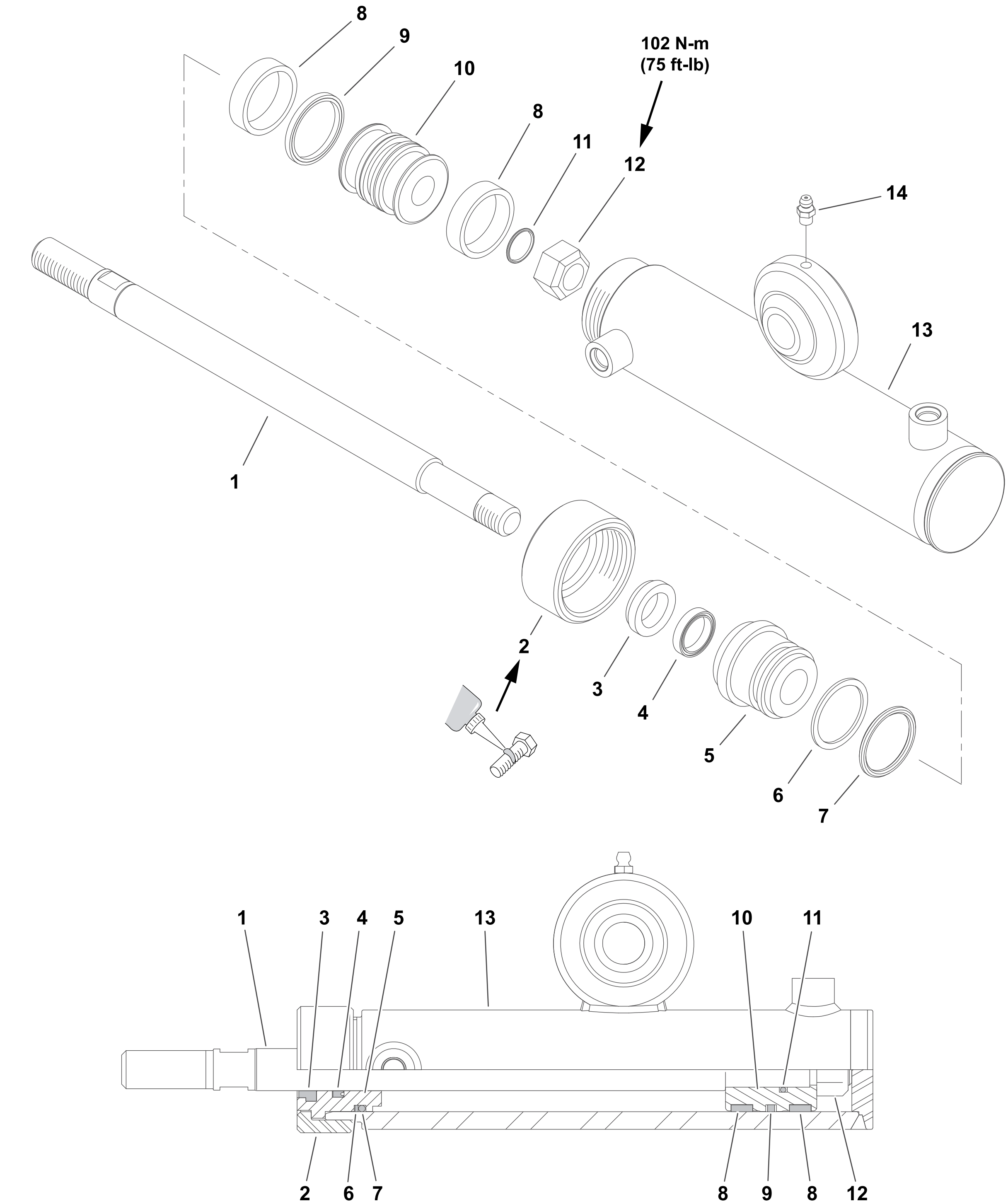

Figure 83

1. Rod
2. External collar
3. Dust seal
4. Seal
5. Head
6. Back-up ring
7. O-ring
8. Wear ring (2 each)
9. Seal
10. Piston
11. O-ring
12. Lock nut
13. Barrel
14. Grease Fitting

Disassembling the Steering Cylinder

1. Remove any fluid from the cylinder by slowly pumping the cylinder rod while holding the cylinder over a drain pan.
2. Plug both cylinder ports and clean the outside of the cylinder.

IMPORTANT

Do not clamp vise jaws against the center of the cylinder barrel. Clamp on the cap end of the barrel ONLY.

3. Mount the cylinder securely in a vise by clamping on the cap end of the barrel. Using a vise with soft jaws is recommended.

   Note: A high strength thread locker was used on the external collar during cylinder assembly. Slowly heating the external collar will ease collar removal.
4. Use a pipe wrench to rotate the external collar counterclockwise until it is free of the cylinder barrel.
5. Remove the plugs from the ports. Extract the rod, the head and the piston assembly from the barrel by carefully twisting and pulling on the rod.

IMPORTANT

Do not clamp vise jaws against the cylinder rod surface. Use the wrench flats provided on the cylinder rod ONLY.

6. Slide the piston off the rod.
7. Remove the wear ring, the seals, the back−up ring and the O−rings from the piston and the head.

Assembling the Steering Cylinder

1. Make sure all the cylinder components are clean before assembly.
2. Coat the new wear rings, the O−rings, the seals and the back−up ring with clean hydraulic fluid.
   A. Install the wear rings and the seal to the outside of the piston.
   B. Install the O−ring to the inner bore of the piston.
   C. Install the O−ring, the back−up ring and the rod seals to the cylinder head.
3. Coat the rod with a light layer of clean hydraulic fluid and carefully slide the piston assembly onto the rod.

IMPORTANT

Do not clamp vise jaws against the cylinder rod surface. Use the wrench flats provided on the cylinder rod ONLY.

4. Install the lock nut on the cylinder rod. Hold the cylinder rod securely and tighten the lock nut to **102 N−m (75 ft−lb)**.
5. Coat the rod with a light layer of clean hydraulic fluid and carefully slide the head assembly onto the rod.
6. Coat all the internal parts with a light layer of clean hydraulic fluid. Slide the rod assembly into the barrel being careful to not damage the seals.

IMPORTANT

Do not clamp vise jaws against the center of the cylinder barrel. Clamp on the cap end of the barrel ONLY.

7. Mount the cylinder securely in a vise by clamping on the cap end of the barrel. Using a vise with soft jaws is recommended.
8. Apply a few drops of high strength thread locker to the threads of the cylinder barrel and install the external collar. Use a pipe wrench to tighten the external collar.

Hydraulic Tank

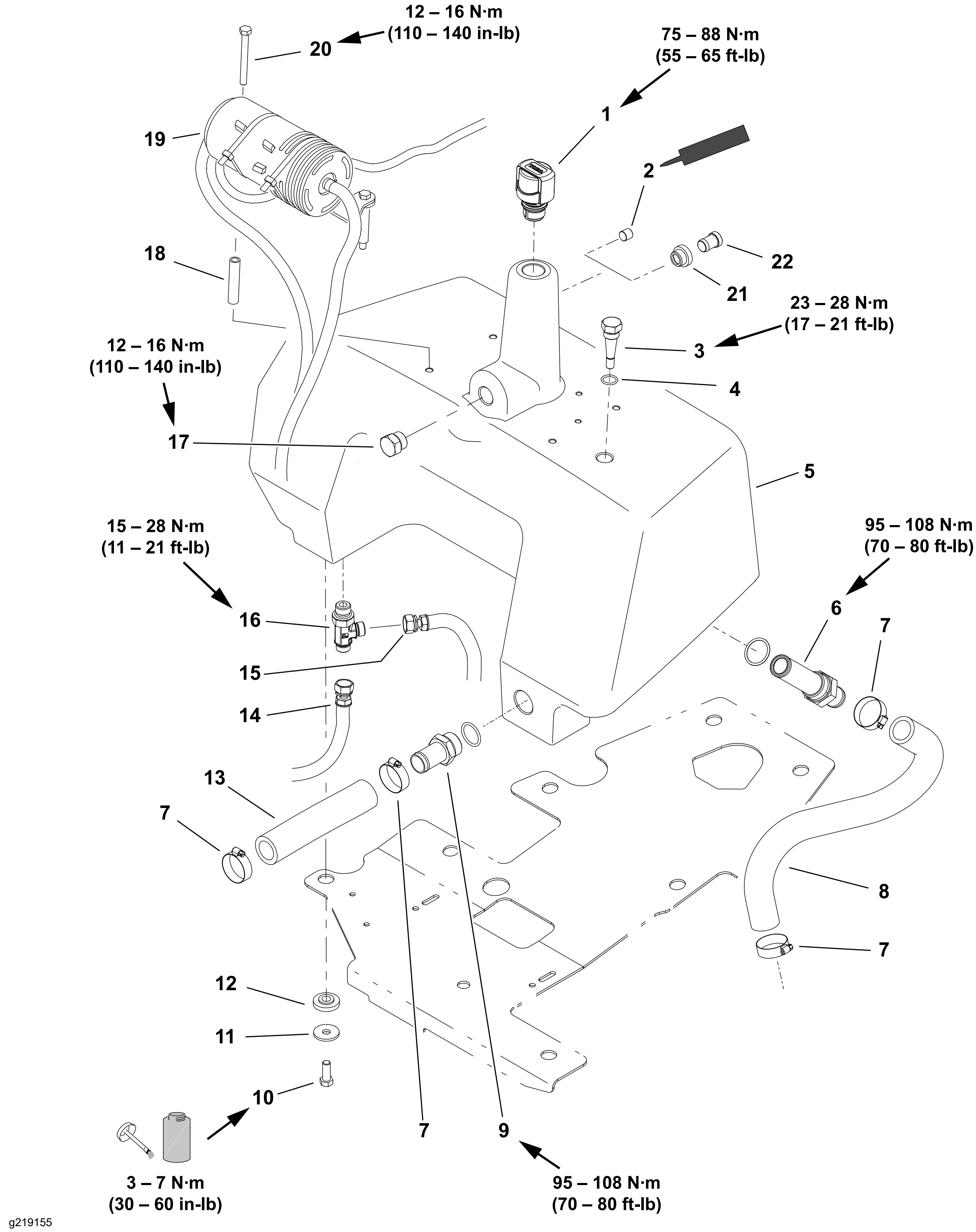

Figure 84

Figure 84 (continued)

1. Breather	9. Barb fitting	17. Plug
2. Plug (machine serial numbers before 400000000)	10. cap screw (3 each)	18. Spacer (2 each)
3. Dipstick	11. Flat washer (3 each)	19. Carbon canister assembly
4. O-ring	12. Rubber bushing (3 each)	20. Cap screw (2 each)
5. Hydraulic tank	13. Hose, return from filter	21. Grommet (machine serial numbers after 400000000)
6. Inlet strainer	14. Hydraulic hose, case drain from traction pump	22. Plug (machine serial numbers after 400000000)
7. Hose clamp (4 each)	15. Hydraulic hose, case drain from reel motors	
8. Hose, inlet to pump	16. Tee fitting	

Removing the Hydraulic Tank

1. Park the machine on a level surface. Lower the cutting units, stop the engine, engage the parking brake and remove the key from the ignition switch.
2. Read and adhere to the information provided in General Precautions for Removing and Installing the Hydraulic System Components (page 4–71).
3. Drain hydraulic fluid from the tank through the pump inlet hose into a suitable container.
4. Label all the hydraulic connections for proper assembly.
5. Disconnect the hydraulic hose assemblies from the hydraulic fittings. Allow the hoses to drain into a suitable container. Cap and plug the hydraulic hoses and fittings to prevent system contaminations.

IMPORTANT

Follow all local codes and regulations when recycling or disposing the hydraulic fluid and filters.

6. Remove the cap screws securing the carbon canister assembly to the hydraulic tank.
7. Remove the three (3) cap screws, flat washers and bushings securing the hydraulic tank to the machine frame. Support the carbon canister assembly and remove the hydraulic tank from the machine.
8. If hydraulic fittings are to be removed from the tank, mark the fitting location and orientation to allow for correct assembly. Remove the fittings and discard the O−rings.

Inspecting the Hydraulic Tank

1. Clean the hydraulic tank and the filler screen with solvent.
2. Inspect the hydraulic tank for leaks, cracks or other damage.
3. Replace any worn or damaged hydraulic hoses.

Installing the Hydraulic Tank

Note: Inspect the threads and the sealing surfaces of the hydraulic fittings and the hydraulic hoses prior to installation. Replace any damaged or worn fittings or hoses.

If the hydraulic tank is being installed, replace the spout in the breather neck with a grommet style plug.

Installing the Hydraulic Tank (continued)

1. Lubricate and fit new O-rings onto the tank fittings. Install the fittings making sure that the fitting location and orientation is as noted during removal. Tighten fittings as specified; refer to Figure 84.
2. Fit the hydraulic tank onto the machine frame.

IMPORTANT

After the hydraulic tank is installed, a 3.2 to 9.5 mm (0.125” to 0.375”) clearance should exist between the hydraulic tank and the fuel tank.

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3. Apply anti-seize lubricant to the threads of the three (3) cap screws and secure the hydraulic tank to the machine frame with the cap screws, the flat washers and the bushings. Tighten the cap screws from **3.4 to 6.7 N·m (30 to 60 in-lb)**.
4. Install the carbon canister assembly to the hydraulic tank with the two (2) cap screws and the spacers. Tighten the cap screws from **12 to 16 N·m (110 to 140 in-lb)**.
5. Remove the plugs and the caps from the hydraulic hoses and fittings. Using the labels placed during removal, connect the hydraulic hoses to the tank fittings. Tighten the connections as specified; refer to Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 4–8).
6. Charge the hydraulic system; refer to Charging the Hydraulic System (page 4–79).

Chapter 5

Electrical System

Table of Contents

General Information

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

Electrical Schematics and Diagrams

Refer to the Electrical Schematics and Wire Harness Drawings/Diagrams in Appendix A (page A–1).

Special Tools

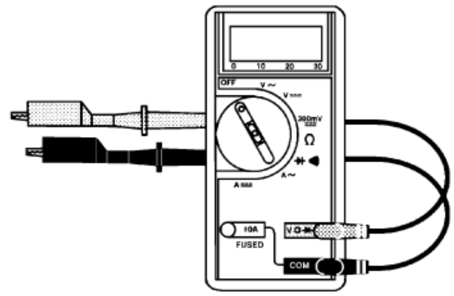
You can order these special tools from your Authorized Toro Distributor. Some tools are also available from a local supplier.

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.

Battery Hydrometer

Obtain this tool locally

Use the battery hydrometer when measuring the specific gravity of the battery electrolyte.

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.

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 Schematics 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.

Starting Problems

Problem	Possible Causes
Starter solenoid clicks, but starter will not crank. **Note:** If solenoid clicks, problem is not in safety interlock system.	Battery charge is low. Battery cables are loose or corroded. Battery ground to frame is loose or corroded. Wiring at starter is faulty. Starter solenoid is faulty. Starter mounting bolts are loose or not supplying a sufficient ground for starter operation. Starter is faulty.
Nothing happens when start attempt is made.	Function control lever is not in the neutral position. Battery cables are loose or corroded. Battery ground to frame is loose or corroded. Fuse F1 (20 amp) is loose or faulty. Fuse F3 (10 amp) is loose or faulty. Fusible link at starter solenoid (included in main wire harness) is faulty. Wiring to the start circuit components is loose, corroded or damaged; refer to Electrical Schematics and Wire Harness Drawings/Diagrams in Appendix A (page A–1). Start safety relay (K2) is faulty. Neutral switch is out of adjustment or faulty. Starter solenoid fusible link is faulty. Ignition switch is faulty. Starter solenoid is faulty. Fuse block is faulty. Battery is faulty.

Starting Problems (continued)

Problem	Possible Causes
Engine cranks, but does not start.	Wiring to the start circuit components is loose, corroded or damaged; refer to Electrical Schematics and Wire Harness Drawings/Diagrams in Appendix A (page A–1). Engine wiring is loose, corroded or damaged; refer to Electrical Schematics and Wire Harness Drawings/Diagrams in Appendix A (page A–1). Diode D1-A circuit is open. Engine or fuel system is malfunctioning; refer to Chapter 3: Engine (page 3–1). Kill relay (K1) is faulty. Engine and fuel may be too cold. Engine and fuel may be too cold.
Engine cranks (but should not) with the function control lever in the MOW or TRANSPORT position.	Neutral switch is out of adjustment, faulty or its wiring is shorted.

General Run and Transport Problems

Problem	Possible Causes
Engine kills when the function control lever is in the MOW or TRANSPORT position with the operator in the seat.	Operator is sitting too far forward on the seat (seat switch not depressed). Parking brake is set. Parking brake sensor is faulty. Seat switch is faulty. Seat switch wiring is loose, corroded or damaged.
Battery does not charge.	Wiring to the charging circuit components is loose, corroded or damaged; refer to Electrical Schematics and Wire Harness Drawings/Diagrams inAppendix A (page A–1). Voltage regulator is loose or not grounded to engine. Voltage regulator is faulty. Alternator stator (under engine flywheel) is faulty. Alternator fusible link (included in engine wire harness) is open. Ignition switch is faulty. Battery is faulty.
Engine stops during operation (operator sitting on seat).	Operator moved too far forward on the seat (seat switch not depressed). Wiring to the run circuits components are faulty or disconnected; refer to Electrical Schematics and Wire Harness Drawings/Diagrams inAppendix A (page A–1). Engine or fuel system is malfunctioning; refer to Chapter 3: Engine (page 3–1).

Cutting Unit Operating Problems

Cutting Unit Operating Problems (continued)

Problem	Possible Causes
Cutting units run (but should not) when raised.	Joystick relay (K3) is faulty. Mow relay (K4) is faulty. Mow switch is out of adjustment or faulty. A hydraulic problem exists; refer to Chapter 4: Hydraulic System (page 4–1).
Cutting units do not run when lowered with the function control lever in the MOW position.	Wiring to run/mow/backlap circuits components is loose, corroded or damaged; refer to Electrical Schematics and Wire Harness Drawings/Diagrams in Appendix A (page A–1). Fuse block or fuse is faulty. Solenoid coil S1 (machines without backlap) or S1R1 (units with backlap) is faulty. Mow switch and/or mow relay (K4) is faulty. Raise or lower switch and/or joystick relay (K3) is faulty. A hydraulic problem exists; refer to Chapter 4: Hydraulic System (page 4–1).
Cutting units will not raise.	Wiring to raise circuit components is loose, corroded or damaged; refer to Electrical Schematics and Wire Harness Drawings/Diagrams in Appendix A (page A–1). Fuse block or fuse is faulty. Diode D3 is open. Raise switch is faulty. Raise relay (K6) is faulty. Solenoid coil S3 and/or S2 is faulty. A hydraulic problem exists; refer to Chapter 4: Hydraulic System (page 4–1).
Cutting units will not lower.	Wiring to lower circuit components is loose, corroded or damaged; refer to Electrical Schematics and Wire Harness Drawings/Diagrams in Appendix A (page A–1). Fuse block or fuse is faulty. Diode D2 is open. Raise switch is faulty. Lower switch is faulty. Joystick relay (K3) is faulty. Lower relay (K5) is faulty. 6 second delay timer is faulty. Solenoid coil S2 or S4 is faulty.

Electrical System Quick Checks

Testing the Battery (Open Circuit Test)

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

Measure the voltage between the battery terminals.

Tools required: Digital multimeter to set the DC volts.

1. The battery temperature should be 16°C to 38°C (60°F to 100°F).
2. Ensure that the key is in the OFF position and all the accessories are turned off.
3. Connect the positive (+) meter lead to the positive battery post and negative (-) meter lead to the negative battery post.
4. Measure and record the battery voltage. Refer to the Battery Test Table (page 5–8) 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 Inspecting, Maintaining, and Testing the Battery (page 5–33).

Testing the Charging System

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

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.

Tool required: Digital multimeter to set the DC volts.

1. Connect the positive (+) multimeter lead to the positive battery post and negative (-) multimeter lead to the negative battery post and record the battery voltage.
2. Start the engine and run it at high-idle speed **(2,850 rpm)**. Allow the battery to charge for a minimum time of 3 minutes.
3. Connect the positive (+) multimeter lead to the positive battery post and negative (-) multimeter lead to the negative battery post and record the battery voltage.
4. After running the engine for a minimum time of 3 minutes, the battery voltage must be at east 0.50 V higher than that of the initial battery voltage.

   Note: Depending upon the condition of the battery, its current charge and the battery temperature, the battery voltage increases at different rates as the battery charges.

Refer to the Battery Voltage Table (page 5–9) for an example of a charging system that is functioning.

Checking the Interlock System Operation

CAUTION

The interlock system is for the operator’s protection; do not disconnect any of the interlock system components. Check the operation of the interlock system daily to assure the system is operating correctly. If an interlock system component is out of adjustment or defective, replace it before operating the machine.

The purpose of the interlock system is to:

- Prevent the engine from cranking or starting unless the function control lever is in NEUTRAL.
- Prevent operating the traction pedal with the function control lever in NEUTRAL.
- Shut off the reels if the function control lever is moved to NEUTRAL or TRANSPORT.

To test the interlock system:

1. Sit on the seat, engage the parking brake and move the function control lever to NEUTRAL. Try to depress the traction pedal. If the pedal does not depress, the interlock system is operating correctly.
2. Sit on the seat, engage the parking brake, keep the traction pedal in neutral and place the function control lever in MOW or TRANSPORT. Try to start the engine. If the engine does not crank, the interlock system is operating correctly.
3. Sit on the seat and start the engine. Move the function control lever to MOW. Raise off the seat. If the engine stops, the interlock system is operating correctly.
4. Sit on the seat and start the engine. Move the function control lever to TRANSPORT. Raise off the seat. If the engine stops, the interlock system is operating correctly.
5. Sit on the seat, engage the parking brake, keep the traction pedal in neutral and place the function control lever in NEUTRAL. Start the engine. Move the Raise/Lower - Mow Control Lever forward to lower the cutting units. If the cutting units do not start rotating, the interlock system is operating correctly.
6. Sit on the seat and set the parking brake. Start the engine and move the function control lever to MOW. If the engine stops, the interlock system is operating correctly.

IMPORTANT

Adjust or repair any of the interlock system components as necessary so all of the interlock system operations function correctly.

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: For the engine component testing information; refer to the Briggs & Stratton Engine Repair Manual.

IMPORTANT

When testing the electrical components for continuity with a multimeter (ohms setting), ensure that you disconnect the power to the circuit.

Fusible Links

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Figure 85

The electrical system includes two (2) fusible links for protecting the machine circuits. One of these fusible links is included in the main wire harness and is connected to the same terminal of the starter solenoid as the battery positive cable (main harness terminal J3). The second fusible link is included in the engine wire harness and connects to the engine at the output lead of the regulator/rectifier (engine harness terminal P19). If either of these links should fail, current to the protected circuits will be interrupted. Refer to the electrical schematics and wire harness drawings inAppendix A (page A–1) for fusible link location and additional circuit information.

Testing a Fusible Link

1. Make sure that key switch is in the OFF position.
2. Disconnect the negative (-) cable from the battery and then disconnect the positive (+) cable from the battery.
3. Locate the fusible link in the wire harness and use a multimeter to make sure that continuity exists across the fusible link. If continuity does not exist across the fusible link (open circuit), replace the fusible link.
4. After testing is complete, make sure that all the wire harness connectors are secured. Connect the positive (+) cable to the battery first and then connect the negative (-) cable to the battery. Coat the wire and cable connections at the battery and at the starter solenoid with Battery Terminal Protector (page 5–3).

Fuses

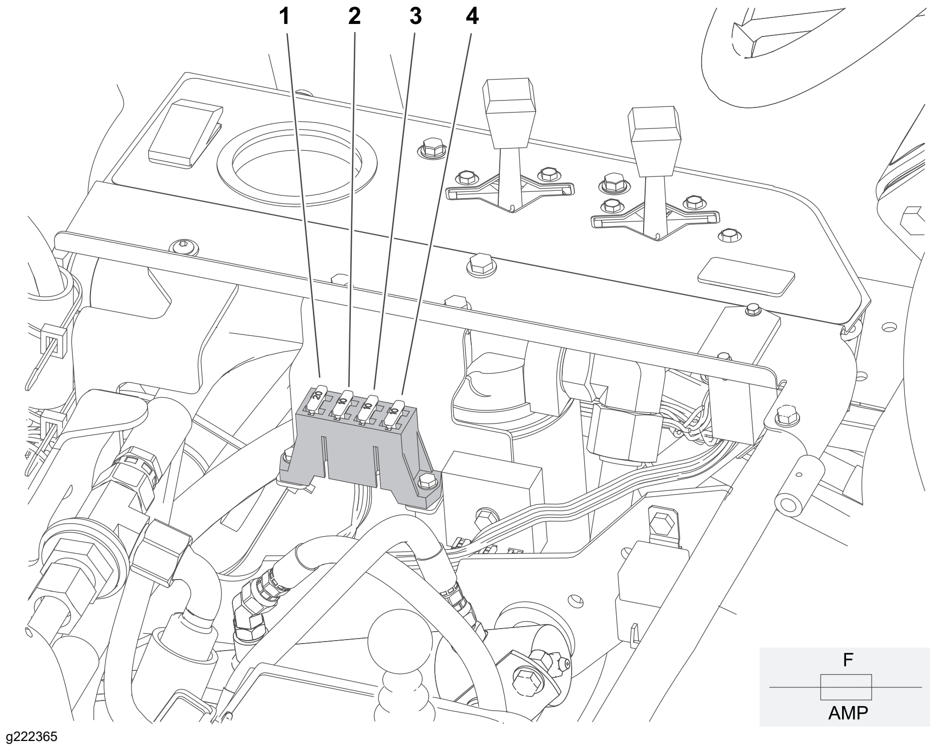


Figure 86

1. Fuse block
2. Fuse F1 (20 Amp)
3. Fuse F2 (10 Amp)
4. Fuse F3 (10 Amp)
5. Fuse F4 (10 Amp)

The fuse block is located on the left side of the machine under the operator seat; refer to Figure 86.

Identifying the Fuses and their Functions

Fuse F1 (20 Amp) supplies power to the key switch and protects the starter solenoid coil circuit

Fuse F2 (10 Amp) supplies power to the optional light circuit

Fuse F3 (10 Amp) supplies power to the engine start and run circuits, and to the hydraulic solenoid coils

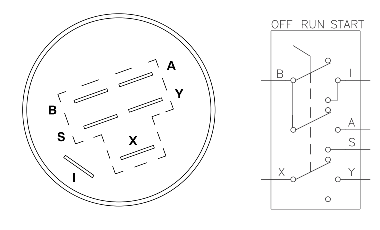
Fuse F24 (10 Amp) supplies power to the cutting unit cutting unit control circuits

Testing a Fuse

1. Turn the key switch to the RUN position (do not start the engine).
2. 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.
3. If the fuse removal is necessary, ensure that the key switch is in the OFF position and the key is removed from the key switch. Remove the fuse from the fuse block and check that the fuse has continuity across the fuse terminals.
4. If the fuse tests correctly and a circuit problem still exists, check the wire harnesses; refer to Appendix A (page A–1).

Key Switch

POSITION	CIRCUIT
OFF	NONE
RUN	B + I + A, X + Y
START	B + I + S



The key (ignition) switch located on the control panel has three (3) positions (OFF, RUN and START).

Testing the Key Switch

1. Park the machine on a level surface, lower the cutting units and stop the engine.
2. Disconnect the wire harness from the key switch and remove the key switch from the control panel if necessary.
3. Use a multimeter (ohms setting) and the preceding table to determine whether continuity exists between the various terminals for each switch position.
4. Replace the switch if necessary.
5. If the switch tests correctly and a circuit problem still exists, check the wire harnesses; refer to Appendix A (page A–1).
6. Connect the wire harness to the key switch after testing.

Starter Solenoid

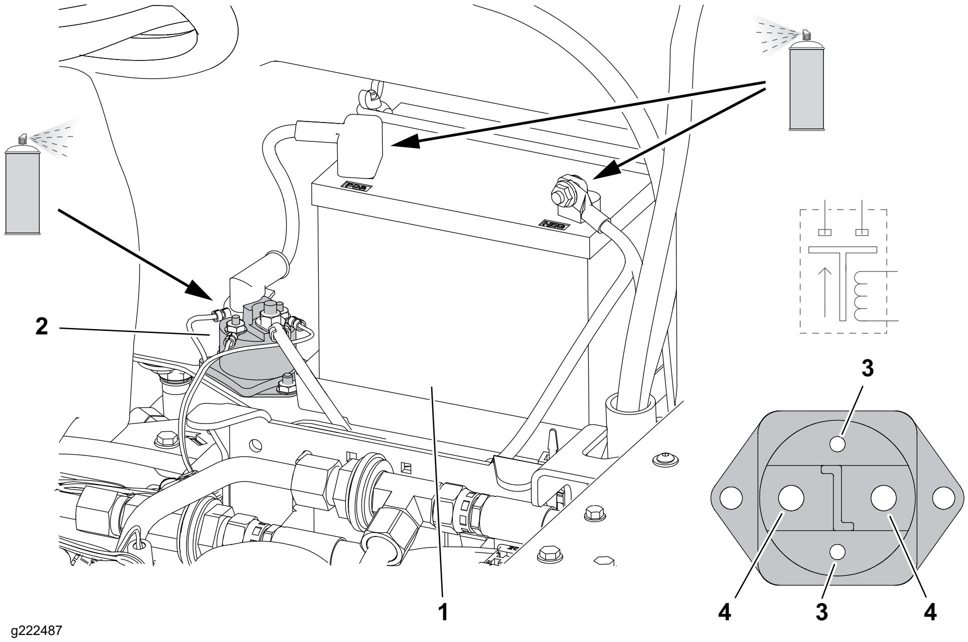


Figure 87

1. Battery
2. Starter solenoid
3. Main contact post (2 each)
4. Solenoid coil post (2 each)

The starter solenoid used on the Greensmaster 3120 allows current flow from the battery to the engine starter motor when energized. The starter solenoid coil should energize when both the kill relay (K1) and the start safety relay (K2) are energized. The starter solenoid is attached to the rear frame in front of the battery; refer to Figure 87.

Testing the Starter Solenoid

1. Park the machine on a level surface and lower the cutting units. Make sure the engine is off and the key switch is in the OFF position.
2. Disconnect the negative (-) cable from the battery and then disconnect the positive (+) cable from the battery; refer to Servicing the Battery (page 5–31).
3. Record the wire and cable connections at the starter solenoid for assembly purposes. Disconnect the wires and cables from the starter solenoid.

   Note: Prior to taking small resistance readings with a digital multimeter, short the meter test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from the measured value of the component you are testing.

4. Apply 12 VDC directly across the solenoid coil posts; refer to item 3 in Figure 87. The solenoid should click as the solenoid coil is energized. When energized, resistance across the main contact posts should be **less than 1 ohm**.
5. Remove voltage from solenoid coil posts. The solenoid should click as the solenoid coil is de-energized. When de-energized, resistance across the main contact posts should be infinite ohms. Replace the starter solenoid if necessary.
6. If the starter solenoid tests correctly and a circuit problem still exists, check the wire harnesses; refer to Appendix A (page A–1).

Testing the Starter Solenoid (continued)

7. When testing is complete, secure the cables and wires to the solenoid. Tighten the nuts on the solenoid coil posts from **15 to 20 in-lb (1.7 to 2.3 N·m)**. Tighten the nuts on the main contact posts from **50 to 60 in-lb (5.7 to 6.8 N·m)**.

8. Connect the positive (+) cable to the battery first and then connect the negative (-) cable to the battery. Coat the wire and cable connections at the battery and at the starter solenoid with Battery Terminal Protector (page 5–3).

Hour Meter

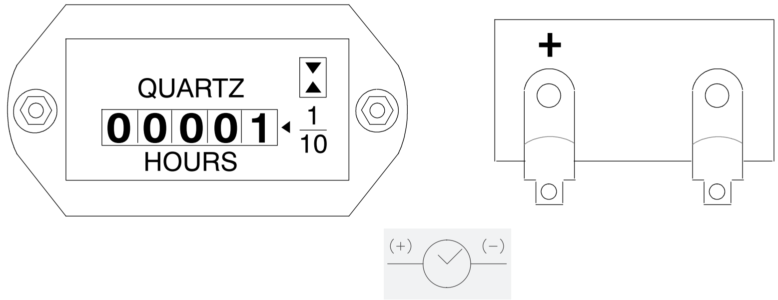


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Figure 88

The hour meter is located on the operator control panel.

Testing the Hour Meter

1. Park the machine on a level surface and lower the cutting units. Make sure the engine is off and the key switch is in the OFF position.
2. Record the wire connections at the hour meter for assembly purposes. Disconnect the wire harness from the hour meter.
3. Connect the positive (+) terminal of a 12 VDC power source to the positive terminal of the hour meter; refer to Figure 88.
4. Connect the negative (-) terminal of the 12 VDC power source to the other terminal of the hour meter.
5. The hour meter should move a 1/10 of an hour in six (6) minutes.
6. Disconnect the voltage source from the hour meter and replace the hour meter if necessary.
7. If the hour meter tests correctly and a circuit problem still exists, check the wire harnesses; refer to Appendix A (page A–1).
8. Connect the wire harness to the hour meter before returning the machine to service.

Seat Switch

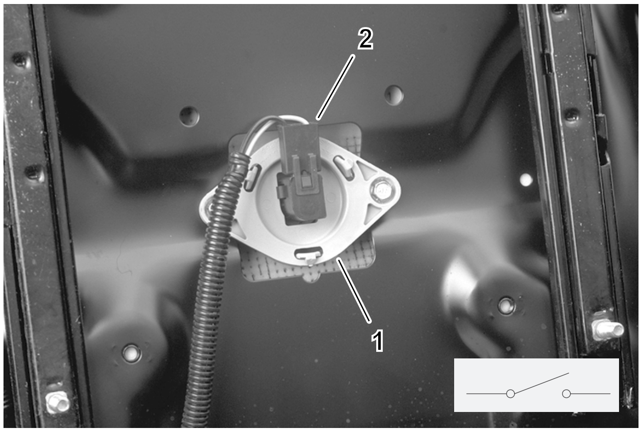

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Figure 89

1. Seat switch
2. Harness connector

The seat switch is a normally open switch that closes when the operator is on the seat. If the function control lever is moved out of NEUTRAL (the neutral switch opens) when the operator raises out of the seat, the engine magneto will divert the ignition circuit to ground and the engine will stop. The seat switch is mounted to the seat pan directly under the seat.

Testing the Seat Switch

1. Park the machine on a level surface and lower the cutting units. Make sure the engine is off and the key switch is in the OFF position.
2. Raise the seat and disconnect the wire harness connector from the seat switch; refer to Figure 89.
3. Check the continuity of the switch by connecting a multimeter (ohms setting) across the switch terminals.
   A. With no operator in the seat, there should be no continuity between the terminals.
   B. Press directly onto the seat switch through the seat cushion. There should be continuity as the seat cushion approaches the bottom of its travel.
4. Replace the switch if necessary.
5. If the seat switch tests correctly and a circuit problem still exists, check the wire harnesses; refer to Appendix A (page A–1).
6. Connect the wire harness to the switch before returning the machine to service.

Neutral and Mow Switches

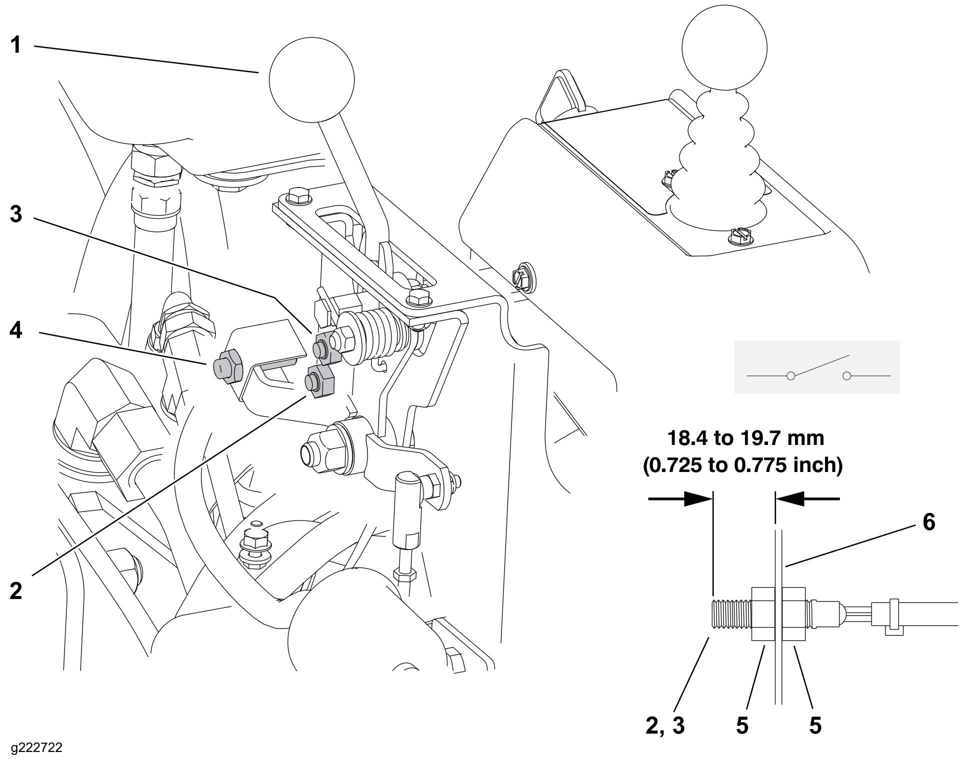

Figure 90

1. Function control lever
2. Neutral switch
3. Mow switch
4. Actuator
5. Jam nut (2 each)
6. Function control lever bracket

The neutral and mow switches are attached to the function control lever bracket under the console cover; refer to Figure 90. The actuator is attached to the function control lever. The switches are used to determine when the function control lever is in the NEUTRAL or MOW position. The switches are identical normally open proximity switches that close when the actuator comes in close proximity to the switch. If the function control lever is moved out of NEUTRAL (the neutral switch opens) when the parking brake is engaged or the operator is not in the seat, the engine magneto will divert the ignition circuit to ground and the engine will stop. Both of the switches and the actuator are adjustable.

Testing the Neutral and Mow Switches

1. Park the machine on a level surface and lower the cutting units. Make sure the engine is off and the key switch is in the OFF position.
2. Remove the console from the right side of the operator seat.
3. Disconnect the wire harness from the switch. Check the continuity of the switch by connecting a multimeter (ohms setting) across the switch terminals.
   A. Place the function control lever in the NEUTRAL position. The neutral switch should be closed (continuity between the switch terminals) and the mow switch should be open (no continuity between the switch terminals).
   B. Place the function control lever in the MOW position. The mow switch should be closed (continuity between the switch terminals) and the neutral switch should be open (no continuity between the switch terminals).

Testing the Neutral and Mow Switches (continued)

4. If the switch does not function as described:

   A. Adjust the distance between the sensing end of each switch and the function control lever bracket from **18.4 to 19.7 mm (0.725 to 0.775 inch)**; refer to Figure 90. Tighten the switch jam nuts from **4.5 to 6.7 N·m (40 to 60 in-lb)**.

   B. Use a multimeter (ohms setting) across the switch terminals and adjust the actuator so the opposing switch just closes. Continue to turn the actuator in toward the switch two (2) additional revolutions. Tighten the actuator jam nuts from **4.5 to 6.7 N·m (40 to 60 in-lb)**.

   C. Repeat step 3.

5. Replace the switch if necessary.

6. If the switch tests correctly and a circuit problem still exists, check the wire harnesses; refer to Appendix A (page A–1).

7. Connect the wire harness to the switch and install the console before returning the machine to service.

Parking Brake Switch

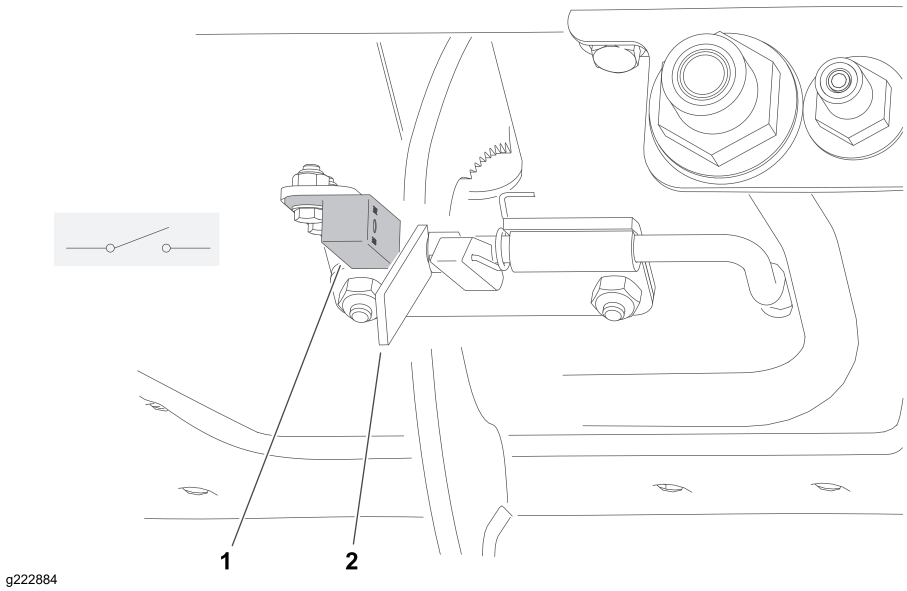

Figure 91

(view from under foot panel)

1. Parking brake switch
2. Latch assembly

The switch is located directly under the operator foot panel. The parking brake switch is used to determine when the parking brake is engaged or disengaged. The switch is a normally closed proximity switch that opens when the operator sets the parking brake (the parking brake latch comes in close proximity to the switch). If the function control lever is moved out of NEUTRAL (the neutral switch opens) when the parking brake is engaged, the engine magneto will divert the ignition circuit to ground and the engine will stop. The parking brake switch should not require adjustment.

Testing the Parking Brake Switch

1. Park the machine on a level surface and lower the cutting units. Make sure the engine is off and the key switch is in the OFF position.
2. Disconnect the wire harness from the parking brake switch.
3. Check the continuity of the switch by connecting a multimeter (ohms setting) across the switch terminals.
   A. With the parking brake disengaged, there should be continuity (switch contacts closed) across the switch terminals.
   B. Engage the parking brake. There should be no continuity (switch contacts open) across the switch terminals.
4. Replace the switch if necessary.
5. If the switch tests correctly and a circuit problem still exists, check the wire harnesses; refer to Appendix A (page A–1).
6. Connect the wire harness to the switch before returning the machine to service.

Cutting Unit Raise and Lower Joystick Switches

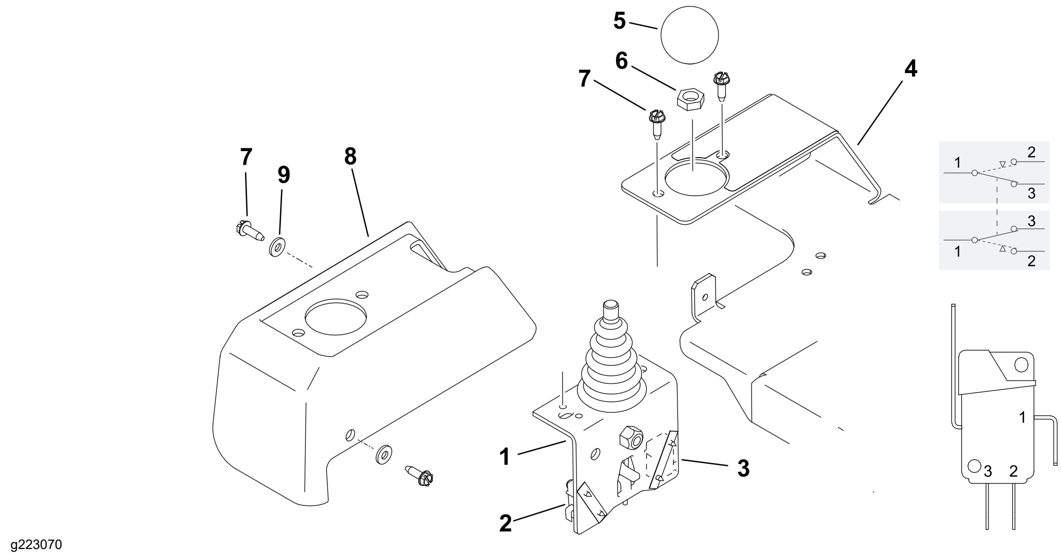

Figure 92

1. Joystick assembly
2. Lower switch
3. Raise switch
4. Bracket
5. Knob
6. Jam nut
7. Thread forming screw (4 each)
8. Pod
9. Flat washer (2 each)

Joystick Switch Testing Reference

JOYSTICK POSITION	RAISE SWITCH CIRCUIT	LOWER SWITCH CIRCUIT
RAISE	1 + 2	1 + 3
CENTER	1 + 3	1 + 3
LOWER	1 + 3	1 + 2

The cutting unit raise and lower switches are located on the joystick bracket. The rear switch is used to lower the cutting units and the front switch is used to raise the cutting units. The switches are identical. Each switch includes a common terminal, a normally open terminal and a normally closed terminal.

Testing the Joystick Switches

1. Park the machine on a level surface and lower the cutting units. Make sure the engine is off and the key switch is in the OFF position.
2. Raise the operator seat and access the switch from under the pod (cover).
3. Disconnect the wire harness from the switch and use a multimeter (ohms setting) to determine whether continuity exists between the various terminals for each switch position: refer to the Joystick Switch Testing Reference (page 5–21).
4. Replace the switch if necessary.
5. If the switch tests correctly and a circuit problem still exists, check the wire harnesses; refer to Appendix A (page A–1).
6. Connect the wire harness to the switch before returning the machine to service.

Backlap Switch (machines with backlap)

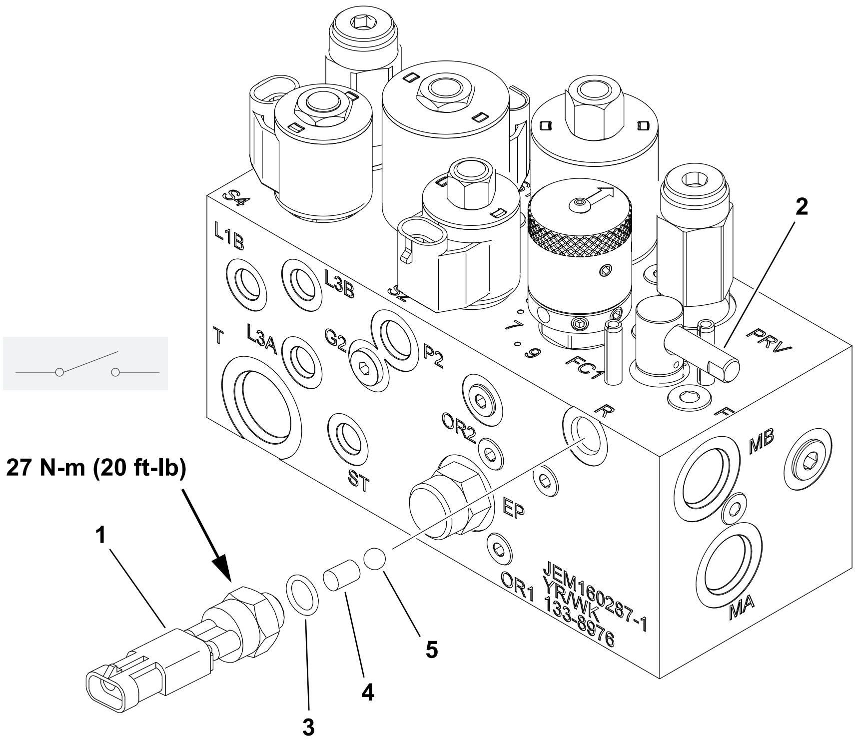

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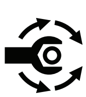
Figure 93

1.	Backlap switch	3.	O-ring	5.	Ball
2.	Backlap lever	4.	Dowel		

The backlap switch is located on the front of the mower hydraulic manifold on machines with the backlap feature. The backlap switch is a normally open ball switch. The switch contacts are open when the backlap lever is in the F (forward – mow) position, and closed when the backlap lever is in the R (reverse – backlap) position.

Testing the Backlap Switch

1. Park the machine on a level surface and lower the cutting units. Make sure the engine is off and the key switch is in the OFF position.
2. Raise the operator seat and disconnect the wire harness from the switch.
3. Check the continuity of the switch by connecting a multimeter (ohms setting) across the switch terminals.
   A. With the backlap lever in the F position, there should be no continuity (switch contacts open) across the switch terminals.
   B. With the backlap lever in the R position, there should be continuity (switch contacts closed) across the switch terminals.



4. Replace the backlap switch if necessary. Make sure that the dowel and the ball are placed in the manifold port before installing the new switch. Tighten the switch to **27 N·m (20 ft-lb)**.
5. If the switch tests correctly and a circuit problem still exists, check the wire harnesses; refer to Appendix A (page A–1).
6. Connect the wire harness to the switch before returning the machine to service.

Relays

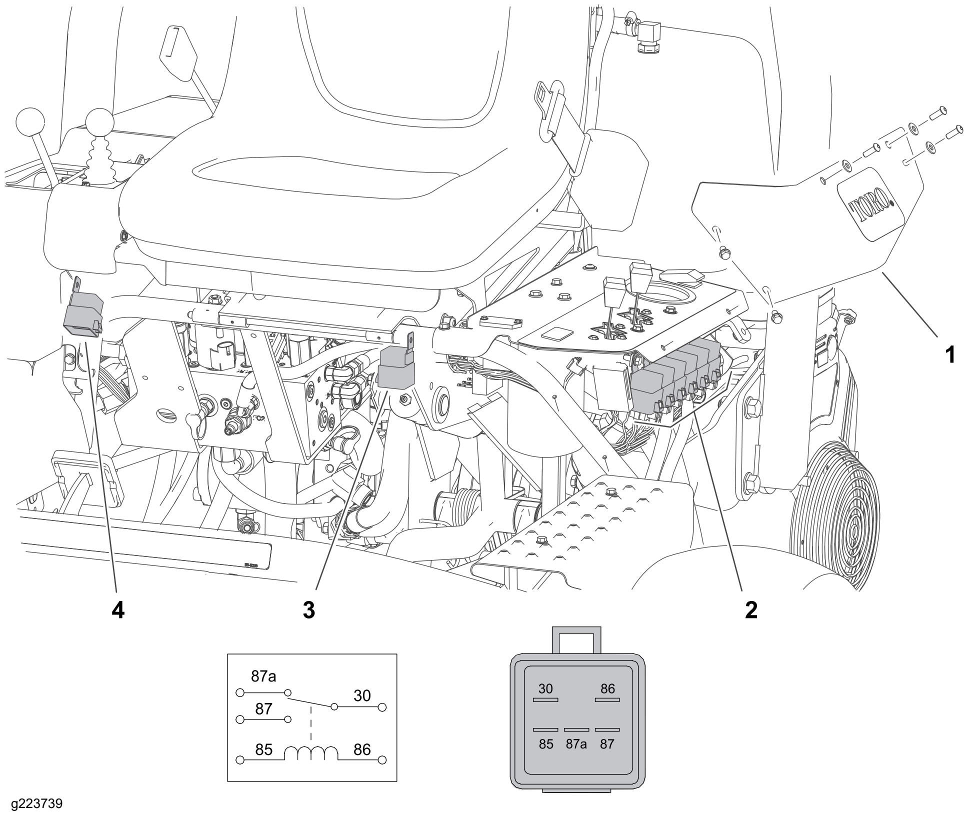


Figure 94

1. Control panel shield
2. Relays K1 – K6
3. Relay K8
4. Relay K7

Several relays are used on the Greensmaster 3120 machine. The relays are identical five (5) terminal relays that are located toward the front of the machine; refer to Figure 94).

Identifying the Relays and their Functions

Note: Refer to the Electrical Schematics and Wire Harnesses in Appendix A (page A–1) for additional relay circuit information.

Kill Relay (K1) When energized, the kill relay provides a path to ground so the starter solenoid coil can be energized. When de-energized, the kill relay provides a path to ground for the engine magneto to stop the engine. The kill relay is located under the control panel on the left side of the operator seat.

Start Safety Relay (K2) The start safety relay ensures that the function control lever is in neutral before the engine can be started. Both the start safety relay and the kill relay must be energized for the engine to crank. The start relay is located under the control panel on the left side of the operator seat.

Joystick relay (K3) The joystick relay is energized by the joystick lower switch. The relay supplies power to the solid state timer used when lowering the cutting units. The joystick relay is located under the control panel on the left side of the operator seat.

Mow Relay (K4) When energized, the mow relay supplies power to the reel engage solenoid valve coil (S1 for machines without backlap or S1R1 for machines with backlap) to be energized for cutting unit operation. The mow relay is located under the control panel on the left side of the operator seat.

Identifying the Relays and their Functions (continued)

Lower Relay (K5) When energized by the solid state timer, the lower relay allows current flow to the hydraulic solenoid valve coils S2 and S4 causing the cutting units to lower. The lower relay is located under the control panel on the left side of the operator seat.

Raise Relay (K6) When energized by the joystick raise switch, the raise relay allows current flow to hydraulic solenoid valve coils S2 and S3 causing the cutting units to raise. The raise relay is located under the control panel on the left side of the operator seat.

Backlap Relay (K7) (machines with backlap only) The backlap relay is only installed on machines with the backlap feature. The relay is energized by the backlap switch when the backlap lever is in the R position. The backlap relay prevents the cutting units from engaging while the engine is cranking if the backlap lever is in the R position. The backlap relay is located near the functional control lever.

Charge Circuit Relay (K8) The charge circuit relay is energized when the key switch is in the Run or Start position. The charge circuit relay allows output from the engine alternator to reach the machine electrical circuits. The charge circuit relay is located under the front of the operator seat.

Testing the Relays

1. Park the machine on a level surface and lower the cutting units. Make sure the engine is off and the key switch is in the OFF position.
2. Remove the control panel shield.

   Note: Since all of the relays used on the machine are identical, use the tag on the wire harness at the relay connector to help locate the desired relay.
3. Locate the relay to be tested and disconnect wire harness connector from the relay. If desired, remove the relay from the machine for testing.
4. Use a multimeter (ohms setting) to measure the resistance between the following relay terminals; refer to Figure 94.

   A. Continuity should exist between terminals 87a and 30.

   B. There should not be continuity between terminals 87 and 30.

   C. Resistance between terminals 86 and 85 (relay coil) should be from **80 to 90 ohms**.
5. Connect a multimeter (ohms setting) to relay terminals 30 and 87. Ground terminal 86 and apply +12 VDC to terminal 85. The relay should make and break continuity between terminals 30 and 87 as 12 VDC is applied and removed from terminal 85.
6. Connect a multimeter (ohms setting) to relay terminals 30 and 87a. Ground terminal 86 and apply +12 VDC to terminal 85. The relay should make and break continuity between terminals 30 and 87a as 12 VDC is applied and removed from terminal 85.
7. Replace the relay if necessary.
8. If the relay tests correctly and a circuit problem still exists, check the wire harnesses; refer to Appendix A (page A–1).
9. If previously removed for testing, install the relay and connect the wire harness to the relay.
10. Install the control panel shield before returning the machine to service.

Delay Timer (Lower Cutting Units)

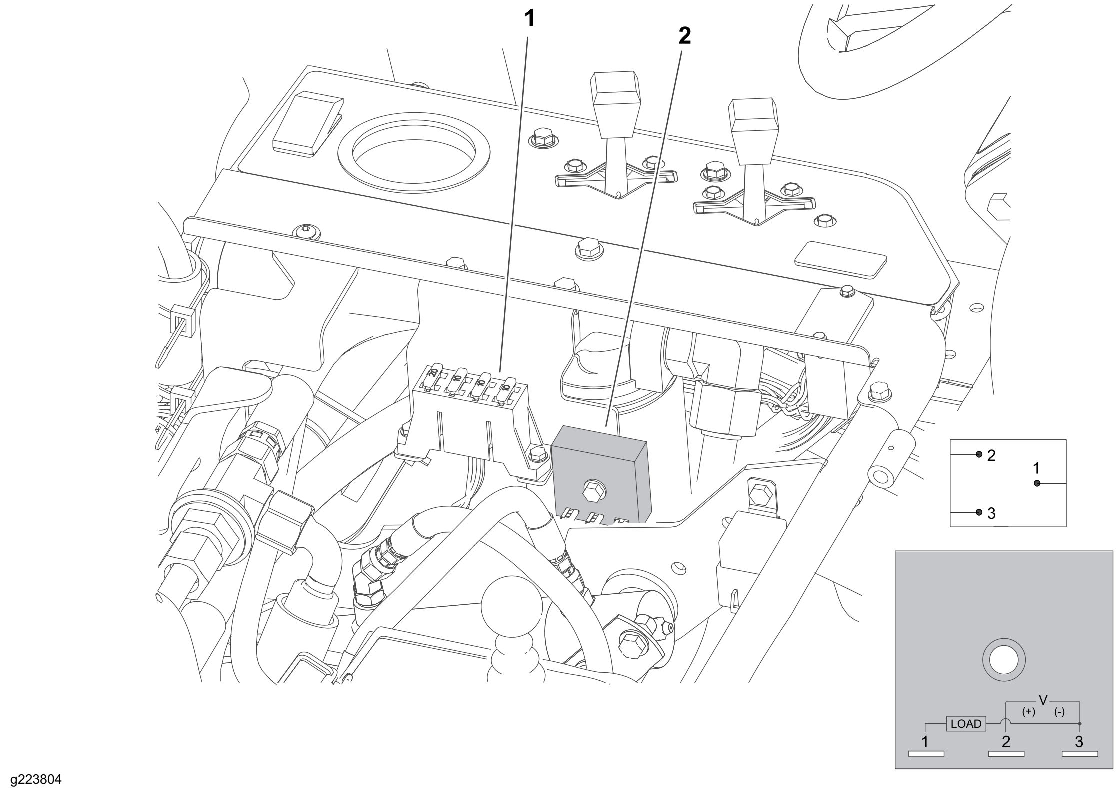


Figure 95

1. Fuse block
2. Delay timer

The delay timer is located on the left side of the machine under the operator seat; refer to Figure 95. The delay timer is a solid state timer used to energize the lower relay (K5) long enough to make sure that the cutting units will fully lower. When the joystick is moved to the LOWER position, the joystick lower switch supplies power to the delay timer. The timer energizes lower relay (K5). Hydraulic manifold solenoid valves S2 and S4 are energized causing the cutting unit lift cylinders to retract and lower the cutting units. After six (6) seconds the delay timer de-energizes the relay.

Testing the Delay Timer

1. Park the machine on a level surface and lower the cutting units. Make sure the engine is off and the key switch is in the OFF position.
2. Raise seat to allow access to lower cutting unit delay timer.
3. Record the wire harness connections at the delay timer for proper assembly and disconnect the harness from the timer.
4. Connect a multimeter (DC V setting) to the delay timer terminals 1 and 3; refer to Figure 95. Ground terminal 3 and apply +12 VDC to terminal 2. The multimeter should display 12 VDC for 6 seconds. After 6 seconds there should be no voltage displayed on the multimeter as long as +12 VDC remains connected to terminal 2. Removing the +12 VDC connection from terminal 2 resets the delay timer.
5. Replace the timer if necessary.
6. If the timer tests correctly and a circuit problem still exists, check the wire harnesses; refer to Appendix A (page A–1).
7. Connect the wire harness to the timer before returning the machine to service.

Hydraulic Solenoid Valve Coils

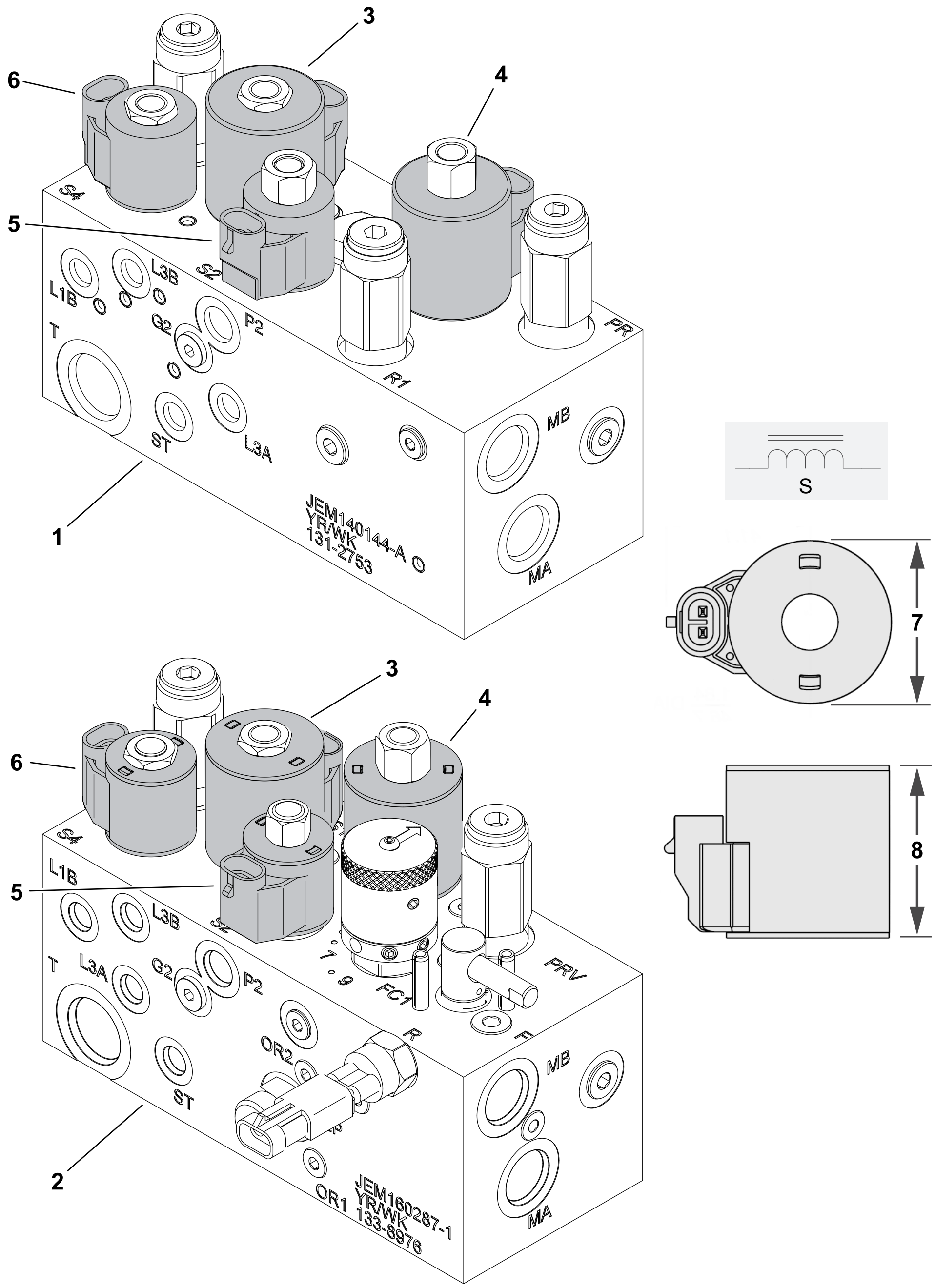


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Figure 96

1. Manifold assembly (machines without backlap)
2. Manifold assembly (machines with backlap)
3. Solenoid S3 (reels raise)
4. Solenoid S1 (reels engage)
5. Solenoid S2 (reels raise/lower)
6. Solenoid S4 (reels lower)
7. Coil diameter
8. Coil height

Solenoid Valve Coil Specifications

Coil Diameter	Coil Height	Coil Resistance
46.7 mm (1.84 inch)	49.9 mm (1.96 inch)	7.1 ohm
35.8 mm (1.41 inch)	36.3 mm (1.43 inch)	8.8 ohm

The Greensmaster 3120 hydraulic manifold uses several solenoid actuated cartridge valve for system control. When the solenoid coil is energized, hydraulic cartridge valve shifts and changes the hydraulic circuit flow. Testing a solenoid coil can be done with the coil installed on the hydraulic cartridge valve.

Testing a Solenoid Valve Coil

1. Park the machine on a level surface and lower the cutting units. Make sure the engine is off and the key switch is in the OFF position.
2. Disconnect the wire harness electrical connector from the solenoid coil that is to be tested; refer to Figure 96.
3. Two (2) different size solenoid coils are used on the machine. Identify the coil resistance specification by measuring the height and the diameter of the coil; refer toFigure 96 and the Solenoid Valve Coil Specifications (page 5–26). To assist in troubleshooting, identical solenoid coils can be exchanged. If the problem follows the exchanged coil, a problem with the coil likely exists.

   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.

4. Use a multimeter (ohms setting) and measure the resistance between the solenoid valve coil terminals.

   Note: Solenoid coil resistance should be measured with the solenoid at approximately **20° C (68° F)**. Resistance may be slightly different than listed at different temperatures. Typically, a failed solenoid coil will either be shorted (very low or no resistance) or open (infinite resistance)

5. If the solenoid coil resistance is incorrect, replace the solenoid coil; refer to the Cartridge Valves (page 4–102).
6. If the solenoid coil tests correctly and a circuit problem still exists, check the wire harness; refer to Appendix A (page A–1).
7. After testing the coils, connect the wire harness electrical connector to the solenoid valve coil.

Diodes

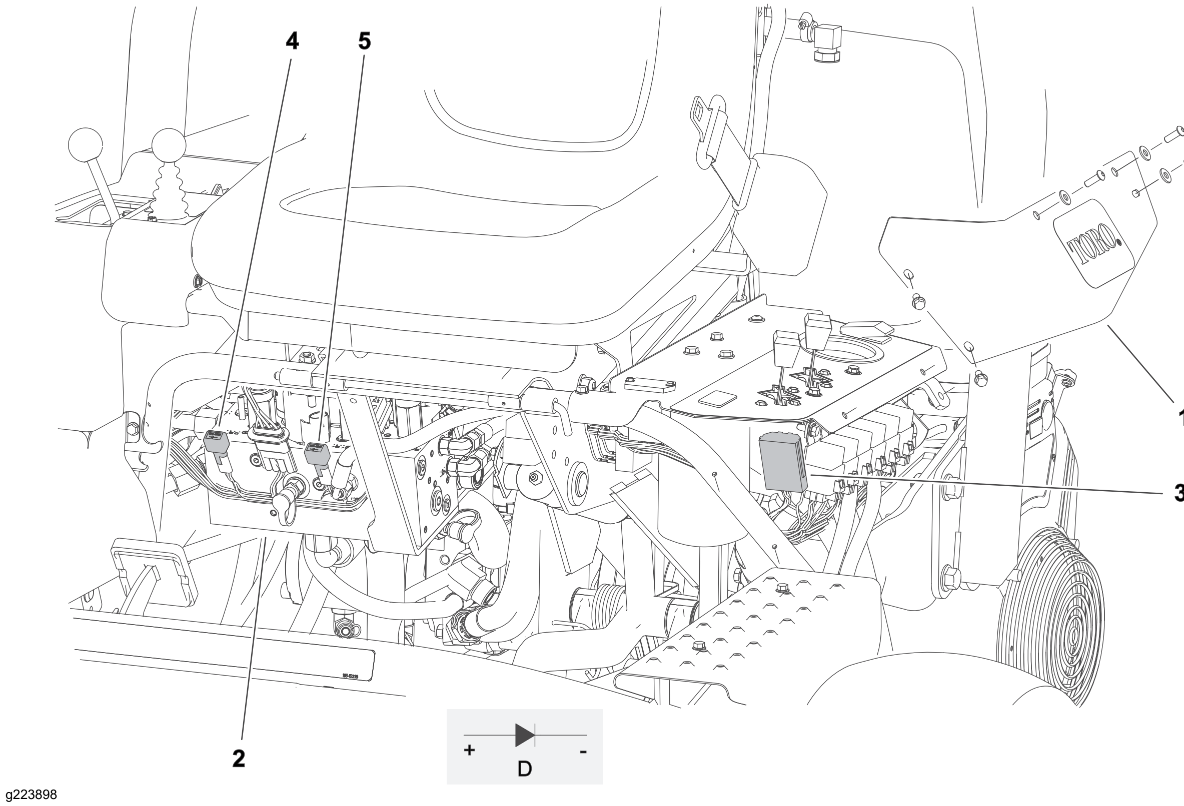
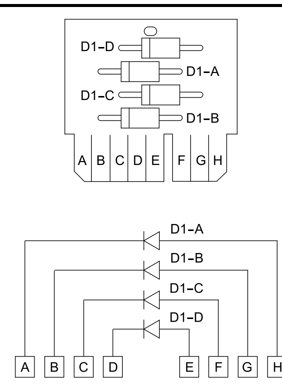
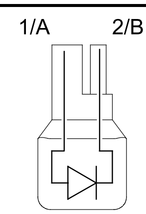


Figure 97

1. Control panel shield
2. Mower hydraulic manifold
3. Diodes D1-A, D1-B, D1-C and D1-D
4. Diode D2
5. Diode D3

Diode Testing Reference

Diode	Multimeter Red (+) Probe	Multimeter Black (-) Probe	Continuity	Type
D1-A	H	A	YES	 Diode Circuit Board
	A	H	NO	
D1-B	G	B	YES	
	B	G	NO	
D1-C	F	C	YES	
	C	F	NO	
D1-D	E	D	YES	
	D	E	NO	
D2	1/A	2/B	YES	 Plug-In Diode
	2/B	1/A	NO	
D3	1/A	2/B	YES	
	2/B	1/A	NO	

The main wiring harness contains six (6) diodes. The diodes are used for circuit protection from inductive voltage spikes and for safety circuit logic. Diodes D1-A, D1-B, D1-C and D1-D are attached to a circuit board that plugs into the main wire harness located under the control panel shield ;refer to Figure 97. Diodes D2 and D3 are individual plug-in diodes connected to the main harness near the front of the mower hydraulic manifold.

Identifying the Diodes and their Functions

Diode D1-A allows the engine to start only with the function control lever in the NEUTRAL position (neutral switch closed). The diode also allows the engine to continue to run with either the function control lever in the NEUTRAL position or the operator sitting in the seat (seat switch closed).

Diode D1-B prevents a negative voltage spike from damaging the neutral switch and seat switch by allowing a path to ground for the start safety relay (K2) when it de-energizes.

Diode D1-C maintains current flow to the joystick relay (K3) after the joystick is released from the LOWER position (joystick lower switch opens).

Diode D1-D prevents a negative voltage spike from damaging the mow and backlap switches by allowing a path to ground for the mow relay (K4) when it de-energizes.

Diode D2 prevents current flow to solenoid valve coil S4 when solenoid valves S2 and S3 are energized through by the raise relay (K6).

Diode D3 prevents current flow to solenoid valve coil S3 when solenoid valves S2 and S4 are energized through by the lower relay (K5).

Testing the Diodes

1. Park the machine on a level surface and lower the cutting units. Make sure the engine is off and the key switch is in the OFF position.
2. Access the diode to be tested and disconnect the diode from the main wire harness.
3. Use a multimeter (ohms setting) and check the continuity across the diode terminals in both directions; refer to the Diode Testing Reference (page 5–28).

   Note: If diodes D1-A, D1-B, D1-C or D1-D are damaged, the entire circuit board should be replaced.
4. Replace the diode if necessary.
5. If the diode tests correctly and a circuit problem still exists, check the wire harnesses; refer to Appendix A (page A–1).

   Note: Apply dielectric gel to the circuit board contacts whenever the circuit board is installed into the wire harness; refer to Dielectric Gel (page 5–4).
6. Connect the diode(s) to the wire harness before returning the machine to service.

Service and Repairs

Caring for the Battery

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 fill caps while cleaning.

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2. Clean the top of the battery by washing at the intervals with a brush dipped in ammonia or bicarbonate of soda solution. Flush the top surface with water after cleaning.
3. Tighten the battery cables on the battery terminals to provide a good electrical contact.

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.

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4. If corrosion occurs at the battery terminals, disconnect the battery cables. Always disconnect the negative (-) cable first. Clean the cable clamps and terminals separately. Connect the battery cables. Always connect the positive (+) cable first. Apply a coating of Toro Part No. 107-0392 battery terminal protector or a light coat of grease to the terminals to reduce corrosion after you make the connections; refer to Special Tools (page 5–3).
5. Check the battery-electrolyte level every 25 operating hours and every 30 days if machine is in storage.

   Note: Do not fill the cells above the fill line.
6. Maintain the cell level with the distilled or demineralized water.

Storing the Battery

If you store the machine for more than 30 days:

1. Ensure that the key switch is in the OFF position.
2. Disconnect the ground (-) cable from the battery terminal first, then disconnect the positive (+) cable from the battery terminal.
3. Charge the battery fully before storage; refer to Charging the Battery (page 5–35).
4. Store the battery in the appropriate environment:
   - If temperatures are expected to drop below freezing for an extended period, remove the battery from the machine and store the battery on a shelf in an environment above freezing.
   - If temperatures are expected to remain above freezing, you may leave the battery on the machine with the battery cables disconnected.

Servicing the Battery

Battery Specifications

Battery-electrolyte specific gravity	Fully Charged: 1.25 to 1.28 at 27°C (80°F) Discharged: less than 1.24
Battery specifications	BCI Group Size U1 300 CCA at -18°C (0°F) Reserve Capacity of 28 minutes at 27°C (80°F)
Battery dimensions (including terminal posts and caps)	Length 19.6 cm (7.7 inches) Width 13.2 cm (5.2 inches) Height 18.3 cm (7.2 inches)

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 safety goggles and a face shield while working with batteries.

Removing the Battery

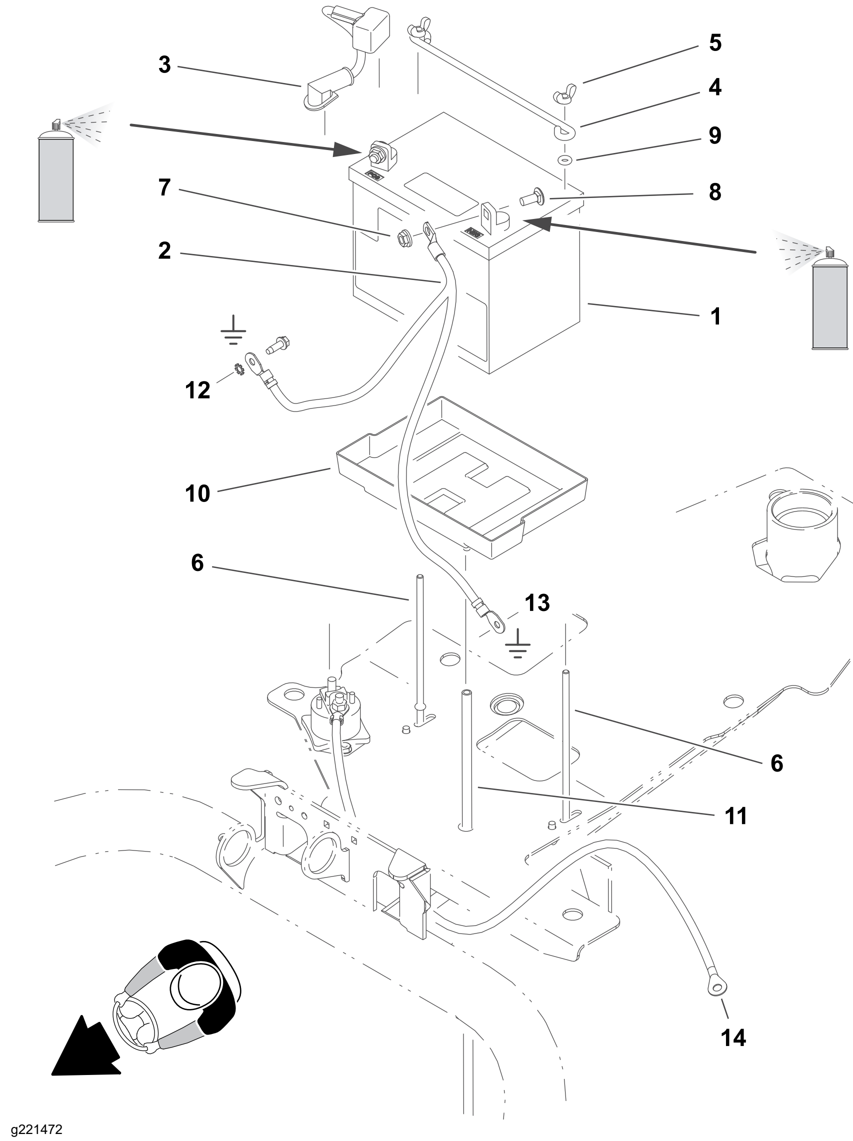


Figure 98

1.	Battery	6.	Hold down post (2 each)	11.	Drain tube
2.	Negative (-) cable	7.	Hex nut (2 each)	12.	To frame – ground
3.	Positive (+) cable	8.	Cap screw (2 each)	13.	To engine – ground
4.	Hold down rod	9.	O-ring (2 each)	14.	To starter motor
5.	Wing nut (2 each)	10.	Battery tray		

IMPORTANT

Be careful when removing the battery cables and ensure that you do not damage the terminal posts or cable connectors.

1. Disconnect the ground (-) cable from the battery terminal, then disconnect the positive (+) cable from the battery terminal.
2. Remove the two (2) wing nuts and the battery hold down rod.
3. Make sure that the battery filler caps are secure and remove the battery from the battery compartment.

Installing the Battery

IMPORTANT

To prevent possible electrical problems, install only a fully charged battery.

1. Ensure that the key switch and all accessories are in the OFF position.
2. Ensure that the battery tray is clean and place the battery tray in position.
3. Ensure that all the battery terminals, battery cables and battery hold down components are in good condition.
4. Place the battery into the battery tray. Make sure the battery is level and flat. Connect the positive (+) cable connector onto the positive (+) battery terminal. Use 2 wrenches to attach the cable bolt and lock nut.
5. Install and secure battery hold down rod with two (2) wing nuts. Do not overtighten to prevent cracking or distorting the battery case.
6. Connect a digital multimeter (set to A) between the negative (-) battery post and the negative (-) cable connector. Ensure that the reading is less than 0.1 A. A reading of more than 0.1 A usually indicates a damaged switch, a shorted circuit, or grounded wire. Identify and repair the electrical faults before returning the machine to service.
7. Connect the negative (-) cable connector to the negative (-) battery terminal. Use the 2 wrenches to attach the cable bolt and lock nut.
8. After you make the connections, apply battery terminal protector Toro Part No. 107-0392 or a light layer of grease to the battery terminals and cable connectors to reduce corrosion; refer to Special Tools (page 5–3).

Inspecting, Maintaining, and Testing the Battery

Temperature Correcting Specific Gravity

Cell Temperature	100°F
Cell Specific Gravity	1.245
38°C minus 27°C equals 11.0°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

Minimum Voltage

Minimum Voltage	Battery-Electrolyte Temperature	
9.6	70°F (and up)	21°C (and up)
9.5	60°F	15°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

1. Inspect the battery as follows:
   A. Check for cracks. Replace the battery if cracked or leaking.
   B. Check the battery terminals 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 secure.

   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 (sodium bicarbonate) and water, then rinse it with clean water.
   D. Check that the cover seal is not broken away. Replace the battery if the seal is broken or leaking.

IMPORTANT

Make sure the area around the battery caps is clean before opening the caps.

   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.
2. Perform the hydrometer test of the battery-electrolyte.

IMPORTANT

Make sure the area around the battery caps is clean before opening the 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 6°C (10°F) above 27°C (80°F) add 0.004 to the specific gravity reading. For each 6°C (10°F) below 27°C (80°F) subtract 0.004 from the specific gravity reading; refer to Temperature Correcting Specific Gravity (page 5–33).
   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 Battery Charge Rate (page 5–35) or until all cells specific gravity is 1.225 or greater with the difference

in specific gravity between the highest and lowest cell being 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 a very reliable means of testing a battery as it simulates the battery cold-cranking capacity. 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 12.0 VDC, charge the battery before continuing the test.

B. If you charge the battery, apply a 150 A load for 15 seconds to remove the surface charge. Use a battery load tester following the manufacturer's instructions.

C. Ensure that the battery terminals are free of corrosion.

D. Measure the electrolyte temperature of the center cell.

E. Connect a battery load tester to the battery terminals following the manufacturer's instructions. Connect a digital multimeter to the battery terminals

F. Apply a test load of 1/2 the cold cranking amperage rating of the battery; refer to Battery Specifications (page 5–31).

G. Take a test voltage reading while still under load after 15 seconds, then immediately remove the load.

H. Use Minimum Voltage (page 5–33) to determine the minimum voltage for the center cell electrolyte temperature reading.

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.

Charging the Battery

Battery Charge Level

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

Battery Charge Rate

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

To minimize damage to the battery and allow the battery to charge fully, use the following slow charging procedure. You can accomplish this charging procedure with a constant current battery charger that is available locally.

IMPORTANT

Follow the manufacturer's instructions when using a battery charger.

Note: Using the specific gravity of the battery cells is the most accurate procedure of determining the battery condition.

1. Use Battery Charge Level (page 5–35) to determine the battery charge level from the specific gravity of the battery cells or open circuit voltage.
2. Use the manufacturer's battery charger instructions or Battery Charge Rate (page 5–35) to determine the charging time and rate.

CAUTION

Charging a frozen battery can cause explosion and can cause personal injury. Let the battery warm to 15°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 terminals.**

3. Follow the battery charger manufacturer's instructions, connect the charger cables to the battery terminals. 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 the charge rate or temporarily stop charging the battery.
6. Beginning three hours before the end of the scheduled charge, 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.

Chapter 6

Chassis

Table of Contents

Specifications

Chassis

Item	Description
Front tire	18 x 9.50 x 8, 4 ply Smooth 55 to 83 kPa (8 to 12 psi)
Rear tire	18 x 9.50 x 8, 4 ply Smooth 55 to 103 kPa (8 to 15 psi)
Front wheel lug nut torque	95 to 122 N·m (70 to 90 ft-lb)
Front wheel hub nut torque	339 to 542 N·m (250 to 400 ft-lb)

General Information

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

Service and Repairs

Front Wheels and Brakes

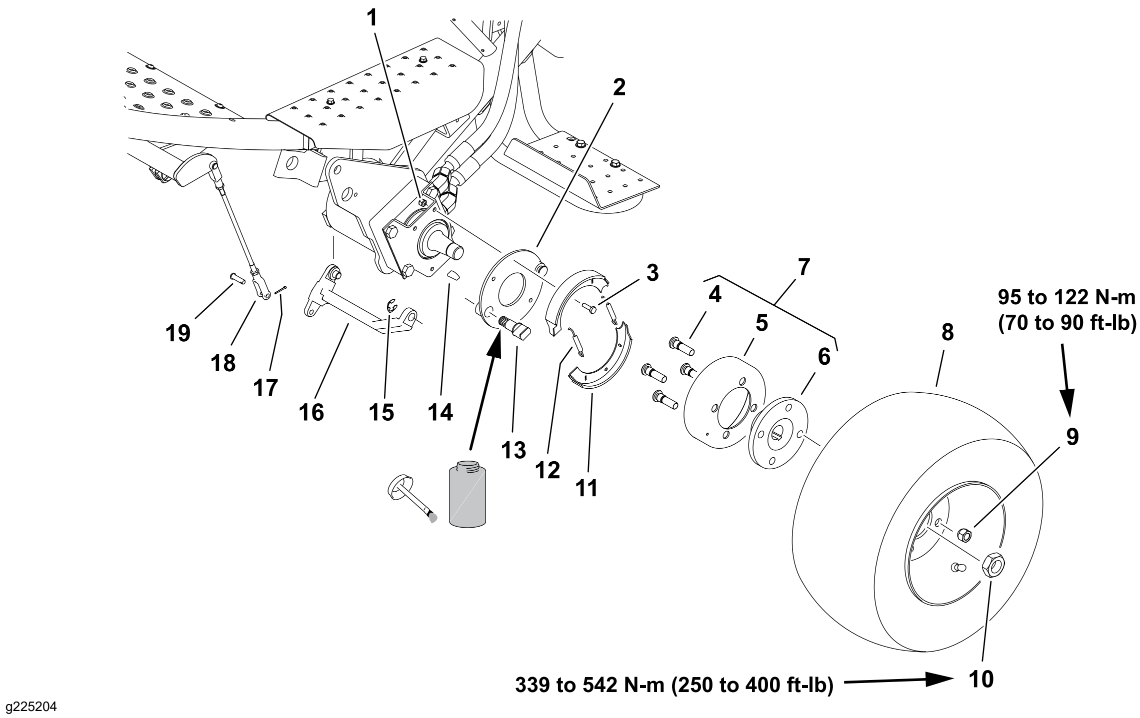


Figure 99

1.	Lock nut (4 each)	8.	Wheel and tire assembly	15.	Retaining clip
2.	Brake backing plate	9.	Lug nut (4 each)	16.	Brake lever
3.	Cap screw (4 each)	10.	Wheel hub nut	17.	Cotter pin
4.	Drive stud (4 each)	11.	Brake shoe (2 each)	18.	Brake rod
5.	Brake drum	12.	Return spring (2 each)	19.	Clevis pin
6.	Wheel hub	13.	Brake cam		
7.	Wheel hub assembly	14.	Woodruff key		

Removing the Front Wheel and Brake Assembly

1. Park the machine on a level surface, lower the cutting units and stop the engine. Remove the key from the ignition switch.
2. Loosen, but do not remove the lug nuts. If the wheel hub assembly is being removed, loosen but do not remove the wheel hub nut.
3. Raise the front of the machine off the ground; refer to Jacking Instructions (page 1–7).
4. Remove the lug nuts and the wheel and tire assembly.

IMPORTANT

DO NOT hit the wheel hub and brake drum assembly with a hammer during removal or installation. Hammering the assembly may cause damage to the hydraulic wheel motor.

5. Make sure that the wheel hub lock nut is loosened at least two revolutions. Use the hub puller to loosen the wheel hub assembly from the wheel motor; refer to Wheel Hub Puller (page 2–15).

Removing the Front Wheel and Brake Assembly (continued)

6. Remove the wheel hub lock nut and the wheel hub assembly. Locate and retrieve the woodruff key.

   If wheel hub, brake drum or drive studs need replacement, press the drive studs from the wheel hub to separate the hub from the brake drum.

7. Disconnect the brake rod from the brake lever and discard the cotter pin.

8. Remove the return springs and remove the brake shoes from the backing plate.

   The brake parts should be clean and free of rust. Inspect the contact surfaces of the brake shoes and the brake drum for excessive wear. Replace worn or damaged parts as necessary.

9. Remove the brake backing plate if necessary.

   A. Mark the brake cam and the brake lever to assure proper alignment during reassembly.

   B. Remove the retaining clip from the brake cam and pull the brake lever from the cam and machine frame.

   C. Remove the brake cam from the backing plate.

   D. Remove the cap screws, lock nuts and the brake backing plate from the brake bracket.

Installing the Front Wheel and Brake Assembly

1. Install the brake backing plate if necessary.

   A. Secure the backing plate to the brake bracket with four cap screws and lock nuts.

   B. Apply anti-seize lubricant to spline area of the brake cam and install the brake cam into the backing plate.

   C. Slide the brake lever onto the brake cam making sure that the brake lever pivot is inserted into the machine frame. Secure the brake lever to the brake cam with the retaining clip.

2. Position the brake shoes on the backing plate and install the return springs.

   Note: If the brake rod was disassembled, apply anti-seize lubricant to the threads of the brake rod prior to assembly.

3. Connect the brake rod to the brake lever with a new cotter pin.

4. Make sure the wheel hub bore and the wheel motor shaft are clean. Install the wheel hub assembly with the woodruff key and the hub lock nut.

5. Install the front wheel and secure it with four lug nuts. Tighten the lug nuts evenly in a crossing pattern.

WARNING

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

6. Lower machine to ground and tighten hub lock nut from **339 to 542 N·m (250 to 400 ft-lb)**. Tighten wheel lug nuts from **95 to 122 N·m (70 to 90 ft-lb)**.

7. Check and adjust brakes as necessary; refer to *Traction Unit Operator's Manual*.

Rear Wheel

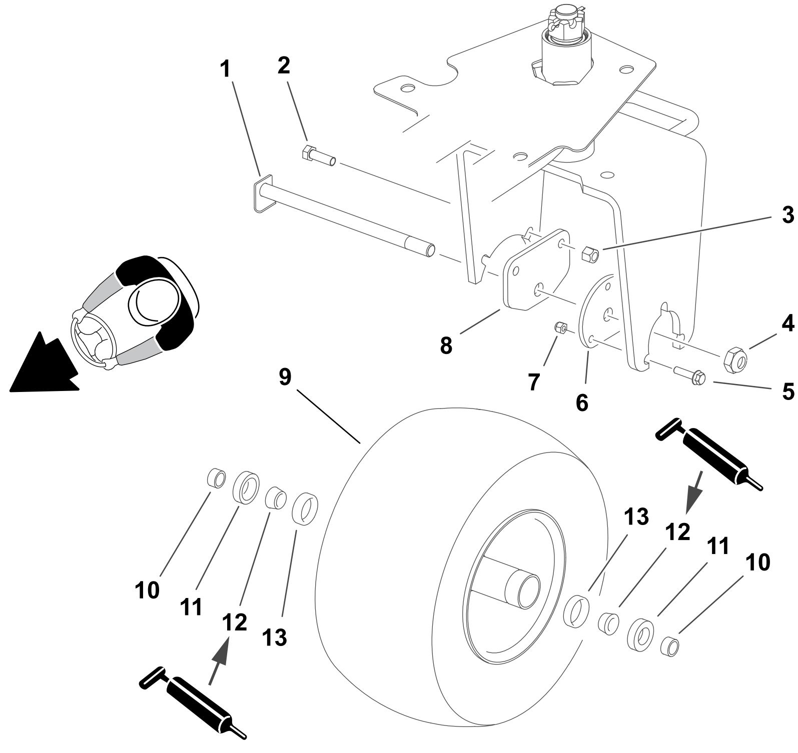


Figure 100

1.	Caster bolt	6.	Adapter plate LH	11.	Seal (2 each)
2.	Cap screw (2 each)	7.	Lock nut (3 each)	12.	Bearing cone (2 each)
3.	Lock nut (2 each)	8.	Adapter plate RH	13.	Bearing cup (2 each)
4.	Lock nut	9.	Wheel and hub assembly		
5.	Flange head screw (3 each)	10.	Spindle spacer (2 each)		

Removing the Rear Wheel

1. Park the machine on a level surface, engage the parking brake, lower the cutting units and stop the engine. Remove the key from the ignition switch.
2. Raise the rear of the machine off the ground; refer to Jacking Instructions (page 1–7).
3. Remove the lock nut from the caster bolt. Pull the caster bolt from both adapter plates and the spindle spacers to remove the wheel and hub assembly from the caster fork.
4. Disassemble the rear wheel hub If necessary.

   A. Remove the seals and bearing cones.

   B. Press the bearing cups from the wheel hub.

   Note: If rear caster fork removal is necessary, refer to Caster Fork (page 6–8).

Installing the Rear Wheel

1. Assembly the rear wheel hub if necessary.

   A. Press new bearing cups into the hub until seated.

   B. Pack new bearing cones with #2 multi-purpose lithium base grease and fit in bearing cup.

Installing the Rear Wheel (continued)

C. Press new bearing seals into hub until seated.

2. Install the wheel and hub assembly into the caster fork.
3. Insert caster bolt into motor adapter plate. Install one spacer and slide the bolt through the wheel and hub assembly.
4. Install a second spindle spacer onto the caster bolt and pass the bolt through the adapter plate.
5. Position bent lip of the caster bolt head under the bottom edge of the motor adapter plate. Install and tighten lock nut to secure caster bolt. Do not overtighten the lock nut; the wheel must rotate freely.
6. Clean grease fitting on hub and pump grease into the hub until grease is seen at both bearing seals. Wipe away excess grease.
7. Lower machine to ground.

Caster Fork

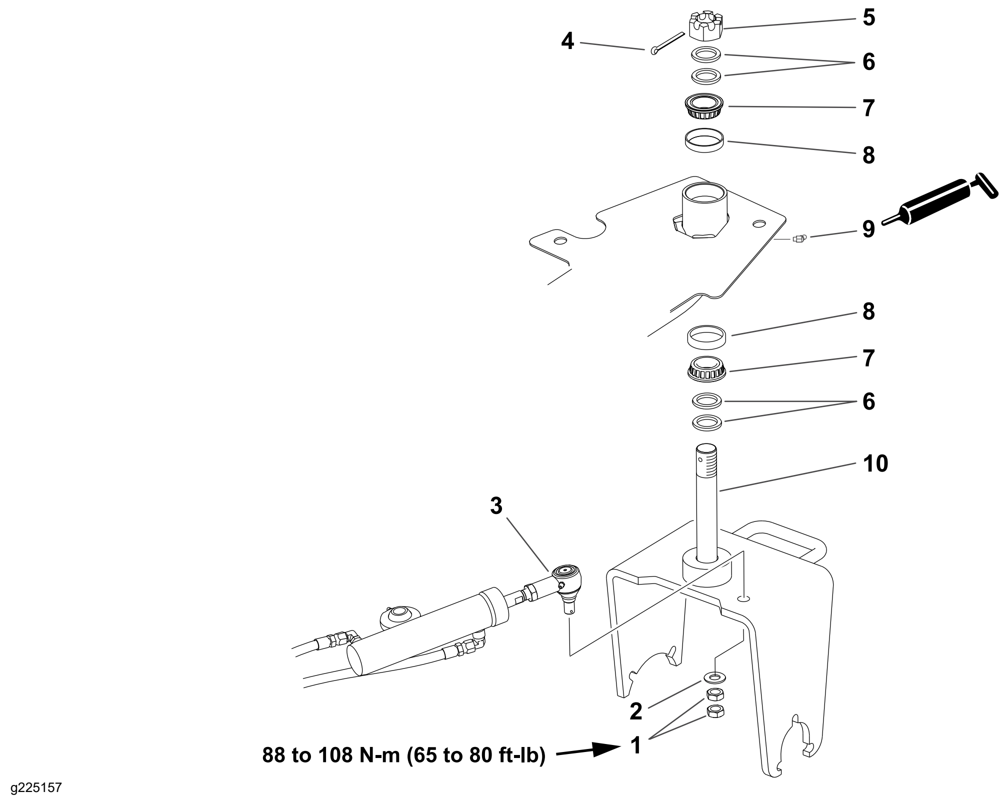


Figure 101

1. Jam nut (2 each)
2. Flat washer
3. Steering cylinder rod end
4. Cotter pin
5. Slotted hex nut
6. Washer (4 each)
7. Bearing cone (2 each)
8. Bearing cup (2 each)
9. Grease fitting
10. Caster fork

Removing the Caster Fork

1. Park the machine on a level surface, engage the parking brake, lower the cutting units and stop the engine. Remove the key from the ignition switch.
2. Remove the rear wheel; refer to Removing the Rear Wheel (page 6–6).
3. Remove the fuel tank; refer to Removing the Fuel Tank (page 3–5).
4. Remove the two jam nuts and the flat washer from the steering cylinder rod end at the caster fork. Use a suitable tool (pickle fork) to separate the rod end from the caster fork.

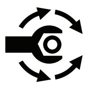
CAUTION

Support caster fork while removing the slotted hex nut to prevent the fork from dropping and causing personal injury.

5. Remove the cotter pin, slotted hex nut and washers from the caster fork stem and lower caster fork from frame.
6. Remove the bearing cones and washers from the caster fork and frame.
7. Inspect the upper and lower bearing cups in the frame for wear or damage and replace them if necessary.

Installing the Caster Fork

1. If the bearing cups were removed from the frame, press new cups into the frame making sure that they are fully seated against the shoulder of the frame housing.
2. Pack the bearing cones with #2 multi-purpose lithium base grease.
3. Place two washers and a bearing cone onto the caster fork stem and insert the caster fork stem up through the bottom of the frame.
4. Place the remaining bearing cone and two washers onto the caster fork stem.
5. Thread the slotted hex nut onto the caster fork stem until drag is felt while rotating the caster fork. Loosen the hex nut only enough to align the hex nut with the hole in the stem and install a new cotter pin.
6. Thoroughly clean the tapered surfaces of the steering cylinder rod end and the tapered bore on the caster fork.



7. Secure the rod end to the caster fork with the flat washer and two jam nuts. Tighten the first jam nut from **88 to 108 N·m (65 to 80 ft-lb)**. While holding the first jam nut stationary, tighten the second jam nut from **88 to 108 N·m (65 to 80 ft-lb)**.
8. Install the rear wheel; refer to Installing the Rear Wheel (page 6–6).
9. Install the fuel tank; refer to Installing the Fuel Tank (page 3–6).
10. Clean grease fitting and lubricate steering stem until grease is seen at both ends of the housing. Wipe up excess grease.

Cutting Unit Pull Frame Rollers, Pivot Hinges and Lift Arms

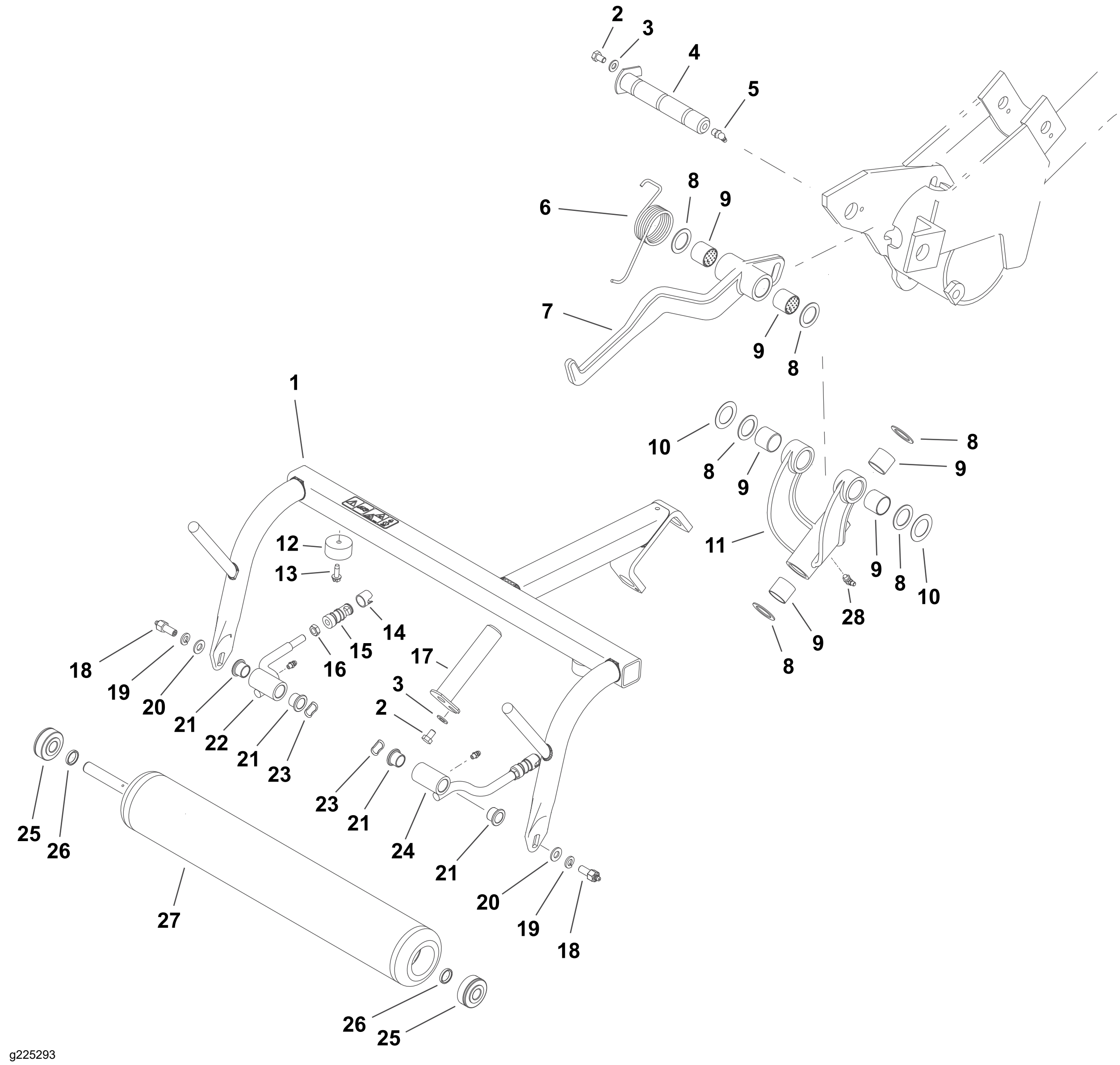


Figure 102
(front right assembly shown)

1. Pull frame
2. Cap screw (2 each)
3. Flat washer (2 each)
4. Hinge pin
5. Grease fitting
6. Torsion spring
7. Lift arm
8. Thrust washer (6 each)
9. Bushing (6 each)
10. Shim – 0.8 mm (0.032 in)
11. Pivot Hinge
12. Bumper (2 each)
13. Flange head screw (2 each)
14. Sleeve (2 each)
15. Ball joint receiver (2 each)
16. Jam nut (2 each)
17. Pivot pin
18. Roller shaft screw (2 each)
19. Lock washer (2 each)
20. Flat washer (2 each)
21. Flange bushing (4 each)
22. Pull arm – RH
23. Spring washer
24. Pull arm – LH
25. Ball bearing (2 each)
26. Shaft seal (2 each)
27. Roller assembly
28. Grease fitting

The pull frame assemblies, pivot hinges and lift arms used on Greensmaster 3120 machines are slightly different depending on location (right front, left front and center positions). Servicing the components is similar regardless of their position on the machine.

Servicing the Cutting Unit Pull Frame Rollers, Pivot Hinges and Lift Arms

1. Park machine on a level surface with cutting units lowered to the ground. Make sure engine is off. Engage parking brake.
2. Remove the cutting unit from the machine; refer to the *Traction Unit Operator's Manual*.

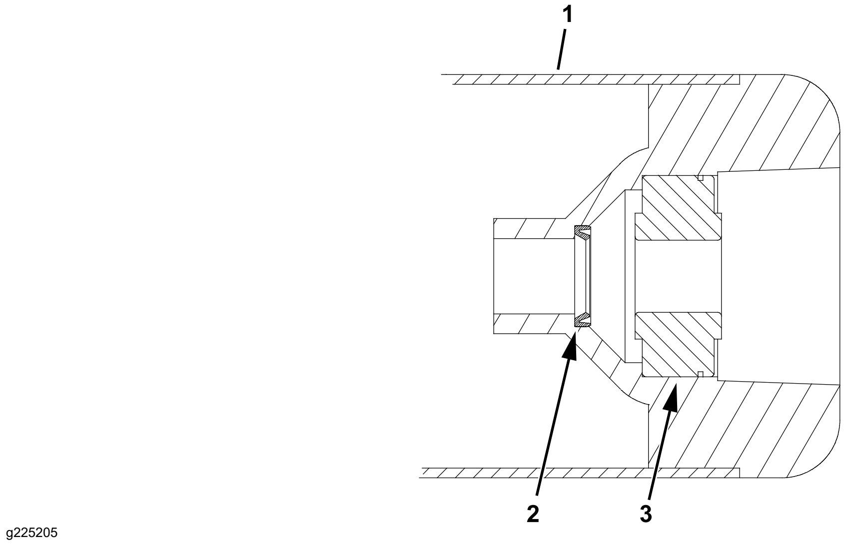


Figure 103

1. Roller
2. Shaft seal (2 each)
3. Ball bearing (2 each)

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3. Service the pull frame rollers as necessary; refer to Figure 103.
   A. Install shaft seal with seal lip toward end of roller.
   B. Install roller ball bearing with seal toward end of roller.

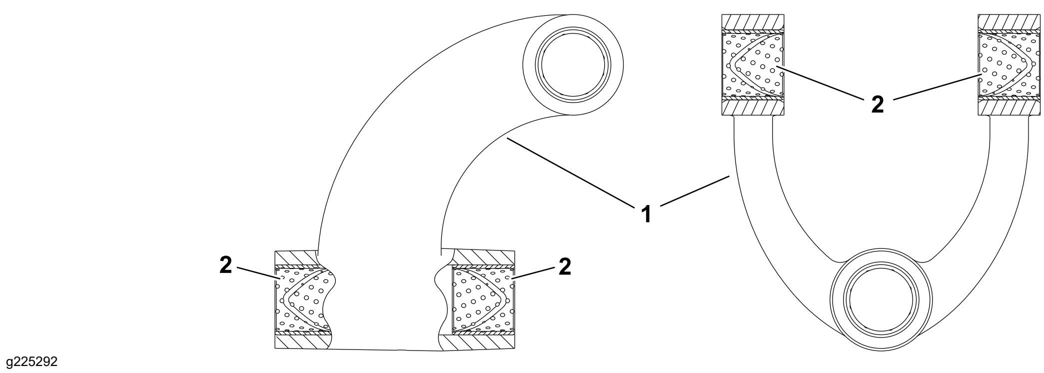

Figure 104

1. Pivot hinge
2. Bushing (4 each)

---

4. Service the pivot hinges as necessary; refer to Figure 104.
   A. Install new bushings so the grease groove opening is orientated inward.

Servicing the Cutting Unit Pull Frame Rollers, Pivot Hinges and Lift Arms (continued)

B. Make sure the side play clearance between the pivot hinge and the machine frame is less than **1.5 mm (0.060”)**. Adjust the clearance with shims and thrust washers as required.

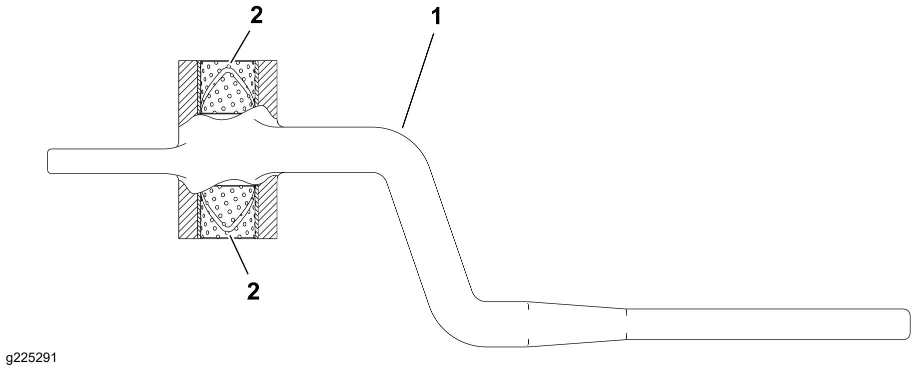

Figure 105

1. Lift arm
2. Bushing (2 each)

5. Service the lift arms as necessary. Install new bushings so the grease groove opening is orientated inward; refer to Figure 105.

Chapter 7

DPA Cutting Units

Table of Contents

Specifications

DPA Cutting Units

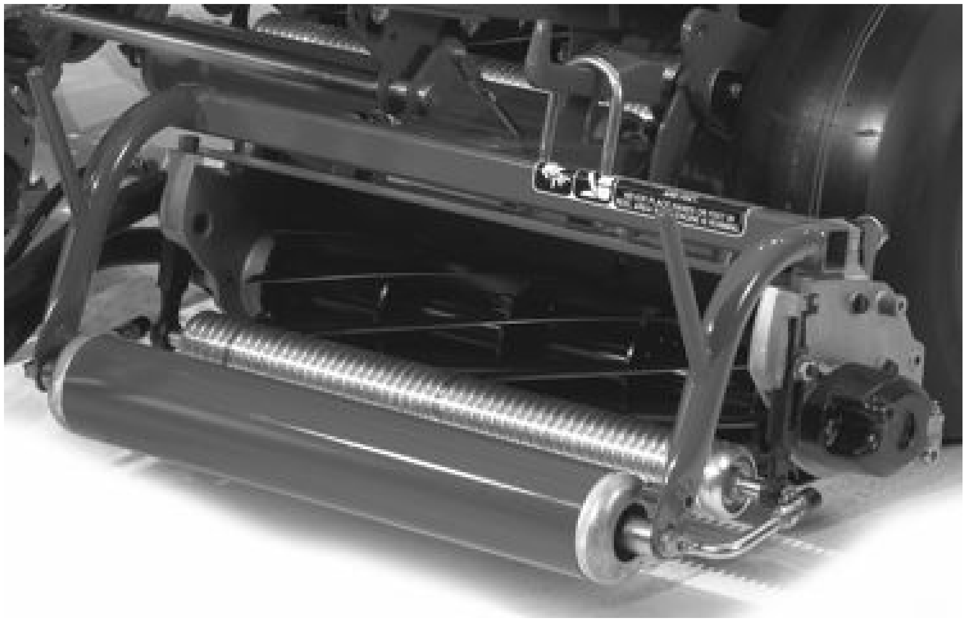

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Figure 106

Frame construction: Precision machined die cast aluminum crossmember with two bolt-on die-cast aluminum side plates.

Reel construction: Reels are 53.3 cm (21 inches) in length and 12.7 cm (5 inch) in diameter. High strength, low alloy steel blades are thru hardened and impact resistant. Reels are available in 8, 11 and 14 blade configurations.

Reel bearings: Two stainless steel ball bearings are press fit onto the reel shaft and retained by a threaded insert. Low drag seals/slingers for added protection with an O-ring sealed counterweight mounting surface. Reel position is maintained by a wave washer with no end play adjustment required.

Reel drive: The reel shaft is 35 mm (1.375 inch) diameter tube with an internally splined threaded nut on each end

Height-of-cut: Cutting height is adjusted on the front roller by two vertical screws. Standard bench height of cut range is 1.6 to 1.1 mm (0.062 to 0.438 inch) depending on type of bedknife installed. An optional high height-of-cut kit is available to obtain a cut range of 11.1 to 25.4 mm (0.438 to 1.0 inch). Effective HOC may vary depending on turf conditions, type of bedknife, rollers, and attachments installed.

Bedknife and bedbar: Replaceable single edged Edgemax™ bedknife (solid tool steel construction) is standard. Bedknife is fastened to the bedbar with thirteen bedknife screws. A variety of optional bedknives and a more aggressive bedbar are available.

Bedknife adjustment Dual adjustment (one on each side of the bedbar) with 0.018 mm (0.0007 inch) bedknife movement for each detent.

Rollers: The front roller is a 6.3 cm (2.5 inches) diameter roller that is available in full, wide spaced Wiehle and narrow spaced Wiehle configurations (narrow spaced Wiehle roller is shown in Figure 106).The rear roller is a 5.1 cm (2 inches) diameter full roller.

DPA Cutting Units (continued)

Grass shield: Non-adjustable shield with adjustable cut-off bar to improve grass discharge from reel in varying moisture conditions.

Counterbalance weight: A cast iron weight mounted on left end of the cutting unit compensates for the hydraulic drive motor mounted on the right end of the cutting unit.

Cutting unit weight (approximate):

8 blade*	32.7 kg (72 lb)
11 blade*	34 kg (75 lb)
14 blade*	35 kg (78 lb)

*Cutting unit weights include a narrow spaced aluminum Wiehle front roller

Options: Refer to the *Cutting Unit Parts Catalog* or contact your local Authorized Toro Distributor for available cutting unit options.

General Information

Cutting Unit Operator's Manual

The *Cutting Unit Operator's Manual* provides information regarding the operation, general maintenance, and maintenance intervals for the cutting units on your machine. Additionally, if optional kits have been installed on the cutting units (e.g. groomer or rear roller brush), the *Installation Instructions* for the kit includes set-up, operation and maintenance information. Refer to the *Cutting Unit Operator's Manual* and the kit *Installation Instructions* for additional information when servicing the cutting units.

Supporting the Cutting Unit when Servicing

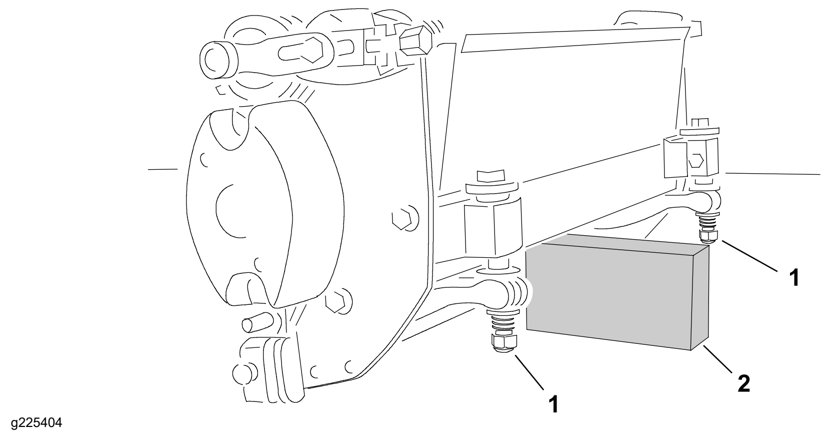

Figure 107

1. Bedbar adjuster screws
2. Support

Whenever the cutting unit has to be tipped to expose the bedknife or cutting reel, support the rear of the cutting unit making sure the back of the bedbar adjuster screws are not resting on the work surface.

Aftercut Appearance

There are a number of factors that can contribute to unsatisfactory quality of cut, some of which may be turf conditions. Turf conditions such as excessive thatch, "sponginess" or attempting to cut off too much grass height may not always be overcome by adjusting the cutting unit. It is important to remember that the lower the height-of-cut, the more critical these factors are.

Refer to the *Cutting Unit Operator's Manual* detailed adjustment procedures. Refer to Service and Repairs (page 7–10) for cutting unit repair information.

Note: For additional information regarding cutting unit troubleshooting, a number of Reel Mower and Aftercut Appearance General Training Books can be found on the Service Reference Set available from your Authorized Toro Distributor.

Factors That Can Affect Quality of Cut

Factor	Possible Problem/Correction
Tire pressure	Check tire pressure of all traction unit tires. Adjust tire pressure as necessary.
Engine RPM and mow speed	For best cutting performance and appearance, the engine should be run at high idle speed while cutting. Check and adjust the high idle speed as necessary; refer to the *Traction Unit Operator's Manual*. Use the traction pedal linkage to adjust the actual mow speed; refer to *Traction Unit Operator's Manual*.
Reel speed	All cutting reels must rotate at the same speed ± 100 rpm. Use a non-contact tachometer (phototach) to verify reel speed. Make sure that the reel speed setting is correct for the number of blades and mow speed used; refer to the *Traction Unit Operator's Manual*. **Note:** The reel speed is related to the engine RPM on machines with hydraulically driven cutting units. Reducing the engine RPM in low mow speed situations (clean-up passes for example) will help match the clip to the green and reduce the appearance of a triplex ring.
Reel bearing condition	Check and replace the reel bearings if necessary; refer to Reel Assembly (page 7–19).
Bedknife to reel adjustment	Check the bedknife to reel contact daily. The bedknife must have light contact across the entire reel. No contact will dull the cutting edges. Excessive contact accelerates wear of both edges. Quality of cut is adversely affected by both conditions.
Reel and bedknife sharpness	A reel and/or bedknife that has rounded cutting edges or rifling (grooved or wavy appearance) cannot be corrected by tightening the bedknife to reel contact. Grind the 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. A new bedknife must be ground or backlapped after installation to the bedbar. Refer to Grinding the Bedknife (page 7–17) for grinding information or the *Traction Unit Operator's Manual* for backlapping information.
Rear roller level	Reel and rear roller should be parallel for proper cutting performance; refer to Leveling the Rear Roller (page 7–8).
Height-of-cut	Effective or actual height-of-cut depends on the mower weight and turf conditions. Effective height-of-cut will be different than the bench set height-of-cut.
Proper bedknife for height-of-cut desired	If the bedknife is too thick for effective height-of-cut, poor quality of cut will result.

Factors That Can Affect Quality of Cut (continued)

Factor	Possible Problem/Correction
Stability of bedbar	Ensure that the bedbar pivot bolts are securely seated; refer to Bedbar Assembly (page 7–10).
Number of reel blades	Use correct number of blades for clip frequency and optimum height-of-cut range.
Cutting unit alignment and ground following	Check pull frames and lift arms for damage, binding conditions or bushing wear. Repair if necessary.
Roller type and condition	A variety of cutting unit rollers are available. Refer to the *Cutting Unit Parts Manual* for a listing of available accessories, or contact your local Authorized Toro Distributor for additional information. Ensure that the rollers rotate freely. Repair the roller bearings if necessary; refer to Roller Assemblies (page 7–26).
Cutting unit accessories	A variety of cutting unit accessories are available that can be used to enhance aftercut appearance. Refer to the *Cutting Unit Parts Manual* for a listing of available accessories, or contact your local Authorized Toro Distributor for additional information.

Adjustments

DPA Cutting Unit Characteristics

CAUTION

Never install or work on or near a cutting unit or cutting unit suspension with the engine running. Always stop the engine and remove the key before working on or near a cutting unit.

The dual point adjust (DPA) bedknife-to-reel adjustment system incorporated in this cutting unit simplifies the adjustment procedure needed to deliver optimum mowing performance. The precise adjustment possible with this design gives the necessary control to provide a continual self-sharpening action. This feature maintains sharp cutting edges, assures good quality of cut and greatly reduces the need for routine backlapping. In addition, the rear roller positioning system allows for various height-of-cut ranges and aggressiveness of cut selections.

If a cutting unit is determined to be out of adjustment, complete the following procedures in the specified order to adjust the cutting unit properly.

1. Adjust the bedknife to reel contact; refer to the *Cutting Unit Operator's Manual*.

   Note: If one of the cutting unit side plates is removed during cutting unit service or maintenance, check to make sure the rear roller is level (parallel to the reel) before adjusting the rear roller; refer to Leveling the Rear Roller (page 7–8).
2. Determine desired height-of-cut range and adjust the rear roller accordingly; refer to the *Cutting Unit Operator's Manual*.
3. Adjust the height-of-cut; refer to the *Cutting Unit Operator's Manual*.
4. Adjust the cut-off bar; refer to the *Cutting Unit Operator's Manual*

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 a limited amount of side plate adjustment is possible to make sure that the rear roller and cutting reel remain parallel.

Note: Use a pie tape to measure the reel diameter taper; service limit 0.25 mm (0.01 inch). Leveling the rear roller of a cutting unit with a reel that exceeds the reel diameter taper limit is not recommended.

1. Make sure the cutting unit bedknife is properly adjusted to the reel; refer to the *Cutting Unit Operator's Manual*.

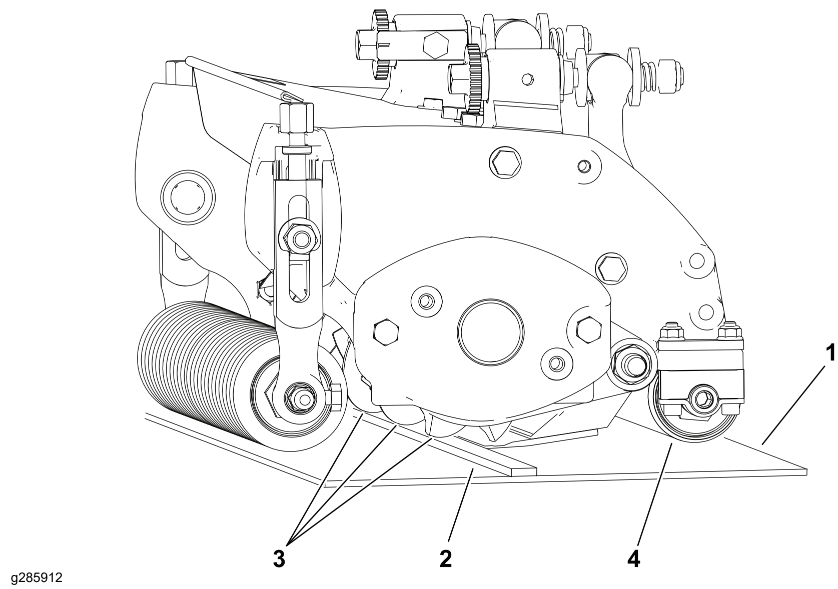

Figure 108

1. Bench plate
2. Bench plate rib
3. Reel blade contacting rid
4. Rear roller

---

2. Place the assembled cutting unit on a cutting unit bench plate so at least three of the reel blades contact the bench plate rib; refer to Figure 108.
3. Check if the rear roller is parallel to the cutting reel by trying to fit a **0.13 mm (0.005 in)** shim between the rear roller and the bench plate at each end of rear roller. Rotate the roller and recheck the clearance at each end a few times to account for any roller run-out. If the shim will pass under the roller through the rollers entire rotation, the rear roller is not parallel to the reel or is high on one side and an adjustment should be made.

Leveling the Rear Roller (continued)

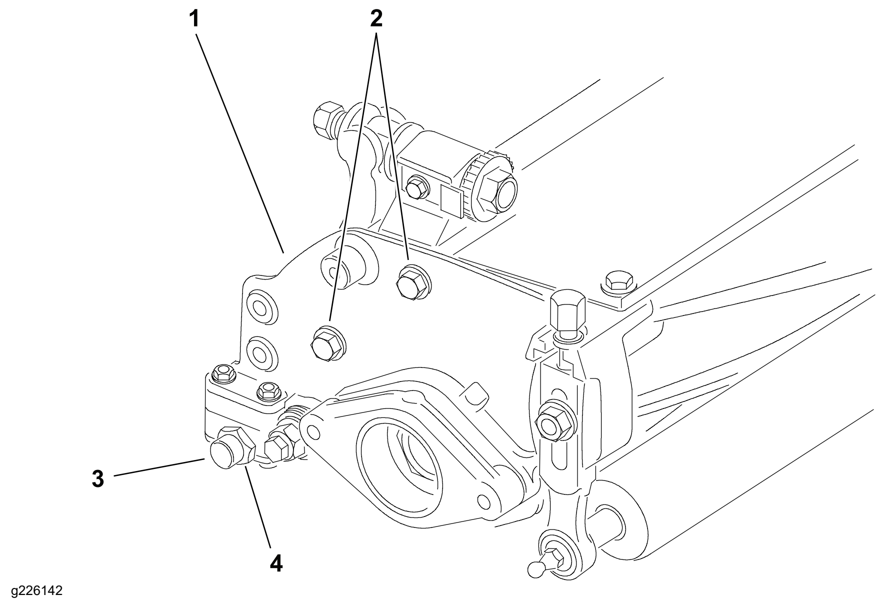

Figure 109

1. Side plate
2. Shoulder bolt (2 each)
3. Rear roller
4. Rear roller adjustment kit (optional)

Note: If the cutting unit has an optional rear roller adjustment kit (eccentric roller shaft bushing), loosening the cutting unit side plate should not be necessary. Adjust the rear roller by loosening the rear roller clamp fasteners and rotating the eccentric bushing as necessary; refer to the kit *Installation Instructions* for additional information.

4. Loosen, but do not remove, the two shoulder bolts that secure the side plate to the frame on the side of the cutting unit where the rear roller is high (not contacting the bench plate).
5. Adjust the position of the side plate so the rear roller contacts the bench plate at both ends, making the rear roller parallel to the reel. Tighten the shoulder bolts from **24 to 27 N·m (210 to 240 in-lb)**.
6. Recheck the clearance between the rear roller and the bench plate. If necessary, loosen and adjust second side plate on the side of the cutting unit where the rear roller is low (contacting the bench plate).
7. Complete the cutting unit set-up and adjustment procedure.

Service and Repairs

Bedbar Assembly

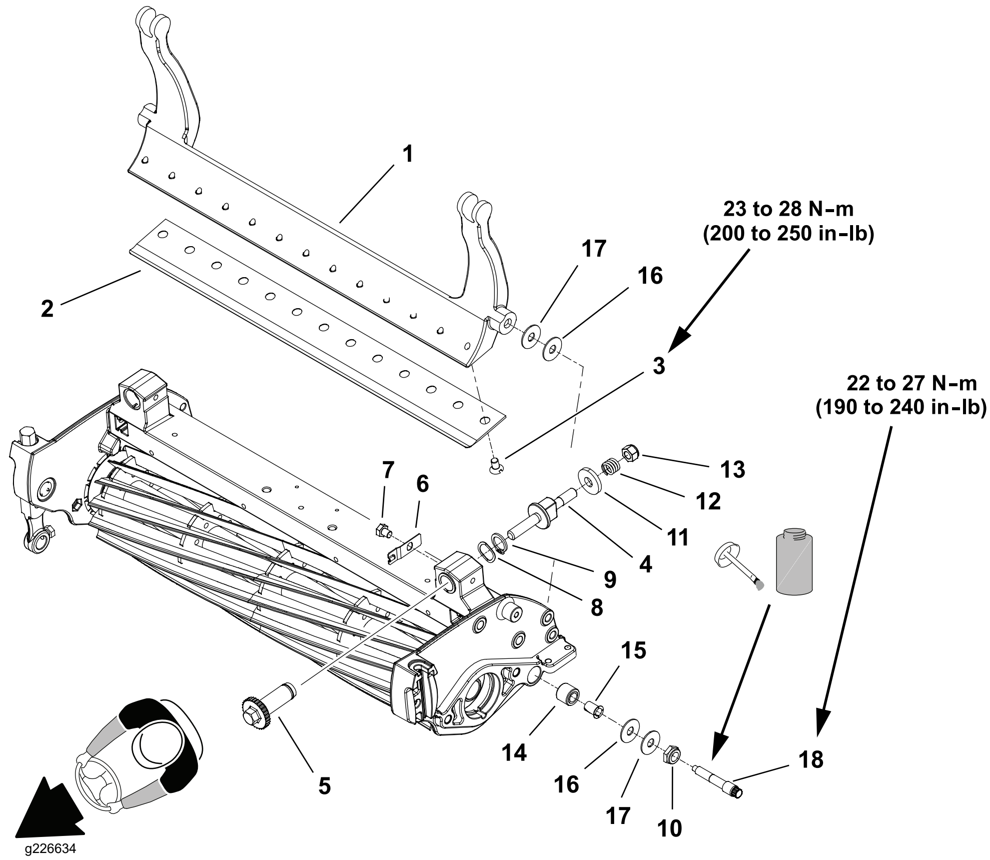

Figure 110

1. Bedbar
2. Bedknife
3. Bedknife screw (13 each)
4. Bedbar adjuster screw (2 each)
5. Bedbar adjuster shaft (2 each)
6. cap screw (2 used)
7. Detent (2 each)
8. Wave washer (2 each)
9. Retaining ring (2 each)
10. Lock nut (2 each)
11. Washer (2 each)
12. Compression spring (2 each)
13. Lock nut (2 each)
14. Rubber bushing (2 each)
15. Nylon bushing (2 each)
16. Plastic washer (4 each)
17. Metal washer (4 each)
18. Bedbar pivot bolt (2 each)

Removing the Bedbar

1. Position the machine on a clean and level surface, lower the cutting units, stop the engine, engage the parking brake and remove the key from the ignition switch.
2. Remove the cutting unit from the machine and place the cutting unit on a flat work surface.
3. Loosen the lock nuts (item 13 in Figure 110) on the end of each bedbar adjuster screw until the washers (item 11 in Figure 110) are loose.
4. Tip the cutting unit to expose the bedknife and support the rear of the cutting unit; refer to Supporting the Cutting Unit when Servicing (page 7–4).
5. Loosen the lock nuts (item 10 in Figure 110) on each bedbar pivot bolt.
6. Remove the two bedbar pivot bolts, two metal washers and four 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.

7. Remove the bedbar assembly from the cutting unit.
8. Inspect the nylon bushings and rubber bushings in the side plates for wear or damage. Replace the bushings if necessary.

Installing the Bedbar

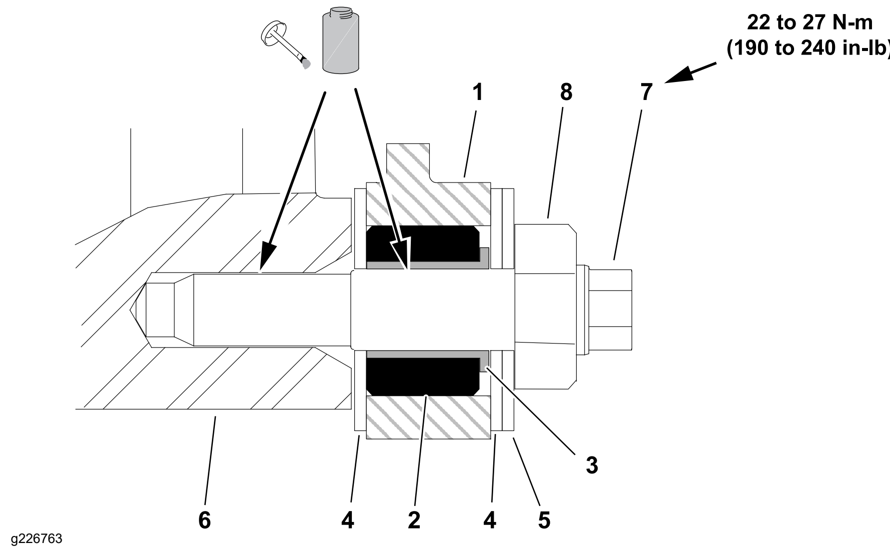

Figure 111

1. Side plate
2. Rubber bushing
3. Nylon bushing
4. Plastic washer (2 each)
5. Metal washer
6. Bedbar
7. Bedbar pivot bolt
8. Lock nut

1. If rubber bushing was removed from either side plate, apply grease to outside surface of new bushing and install into side plate. The bushing should be installed flush with the inside surface of the side plate; refer to Figure 111.
2. If removed, install the nylon bushings with flange facing outward.
3. Apply anti-seize lubricant to the threads and shank of each bedbar pivot bolt; refer to Figure 111.

CAUTION

Contact with the reel, bedknife or other cutting unit parts can result in personal injury. Use heavy gloves when handling the bedbar.

Note: If a new bedknife is attached to the bedbar, there may be interference between the bedknife and the reel when installing the bedbar. Turn the bedbar adjusting screws counterclockwise to increase bedknife clearance if necessary.

4. Position the bedbar into the cutting unit. Make sure that the top of each bedbar arm is between the washer (item 11 in Figure 110) and adjuster screw flange.

IMPORTANT

When installing the washers, make sure that the plastic washers are positioned against the side plate.

5. Slide one metal washer and then one plastic washer onto each bedbar pivot bolt.
6. Position one plastic washer between the bedbar and each side plate.

Installing the Bedbar (continued)

7. Install the bedbar pivot bolt assemblies. Make sure the washers are not caught on the threads of the pivot bolts. Tighten each bedbar pivot bolt from **22 to 27 N·m (190 to 240 in-lb)**.

IMPORTANT

Do not over tighten the lock nuts as this can distort the side plates and affect reel bearing alignment. When the lock nut is correctly tightened, the inside washers may be loose.

8. Tighten both lock nuts (item 10 in Figure 110) until outside washers do not have any end play and can still can be rotated.
9. Tighten the lock nut (item 13 in Figure 110) on each bedbar adjuster assembly until the adjuster spring is fully compressed, then loosen the lock nut 1/2 turn.
10. Adjust the bedknife to reel contact; refer to the *Cutting Unit Operator's Manual*.

Removing the Bedbar Adjuster

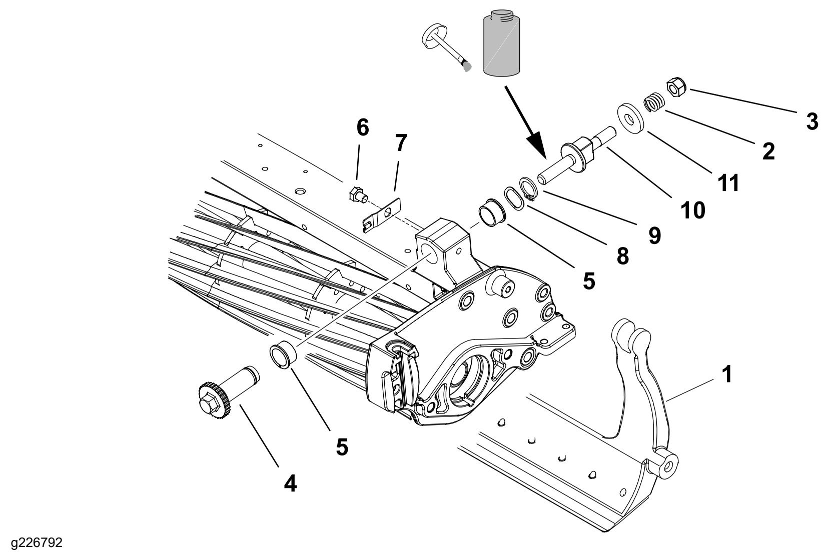

Figure 112

1. Bedbar assembly
2. Compression spring
3. Lock nut
4. Bedbar adjuster shaft
5. Flange bushing
6. Cap screw
7. Detent
8. Wave washer
9. Retaining ring
10. Bedbar adjuster screw
11. Washer

---

1. Remove bedbar; refer to Removing the Bedbar (page 7–11).
2. Remove the lock nut, compression spring and washer from the bedbar adjuster screw.

   Note: The bedbar adjuster shaft has left-hand threads.
3. Unscrew the bedbar adjuster shaft from the bedbar adjuster screw.
4. Remove the retaining ring and wave washer from the adjuster shaft and remove the adjuster shaft.
5. Inspect the flange bushings in the cutting unit side plate and replace them if necessary.
6. Inspect the detent and replace it if necessary.

Installing the Bedbar Adjuster

1. If previously removed, secure the detent to the side plate.
2. If previously removed, align the key on the flange bushings to the slots in the cutting unit frame and install.
3. Slide adjuster shaft into flange bushings and secure with wave a washer and a retaining ring.

   Note: The bedbar adjuster shaft has left-hand threads.
4. Apply anti-seize lubricant to the threads of the bedbar adjuster screw that fit into adjuster shaft (the left hand threads) and thread the bedbar adjuster screw into the adjuster shaft.
5. Install the washer, spring and lock nut onto the adjuster screw.
6. Install the bedbar; refer to Installing the Bedbar (page 7–12).

Bedknife

Removing the Bedknife

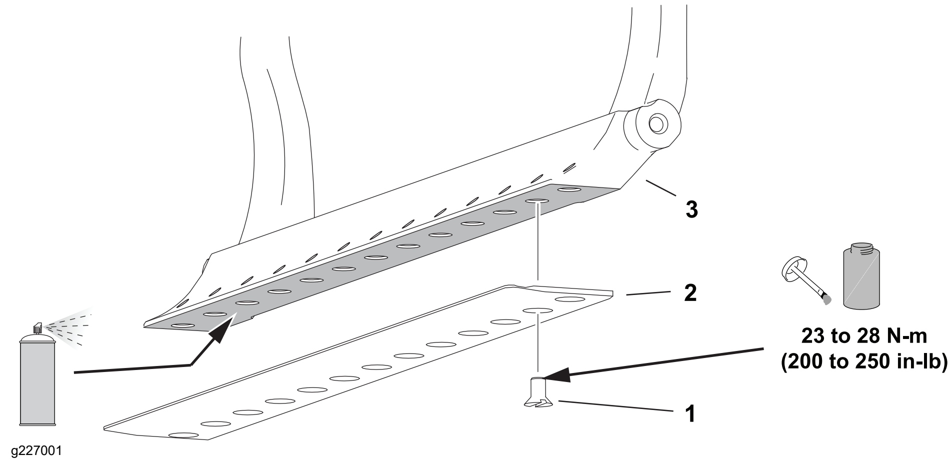

Figure 113

1. Bedknife screw (13 used)
2. Bedbar
3. Bedknife

1. Remove the bedbar from the cutting unit; refer to Removing the Bedbar (page 7–11).
2. Remove screws from bedbar using a socket wrench and bedknife screw tool; refer to Bedknife Screw Tool (page 2–18). Discard the screws. Remove bedknife from the bedbar.
3. Refer to Grinding the Bedknife (page 7–17) for additional information.

Installing the Bedknife

1. Use a scraper to remove all rust, scale and corrosion from the bedbar surface under the bedknife. Lightly oil the bedbar surface before installing the bedknife.
2. Make sure that screw threads in bedbar (5/16-18UNC-2A) are clean.

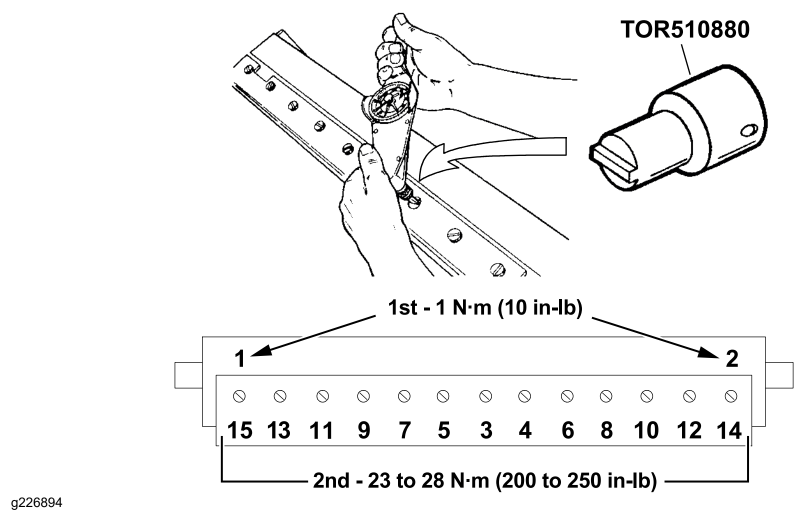

Figure 114

Installing the Bedknife (continued)

IMPORTANT

Do not use an impact wrench to tighten 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.
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 bedbar, grind the bedknife.

Grinding the Bedknife

Bedknife Grinding Specifications

Standard Bedknife Relief Angle	3° minimum
Fairway Bedknife Relief Angle	3° minimum
Extended Bedknife Relief Angle	7° minimum
Front Angle Range	13° to 17°

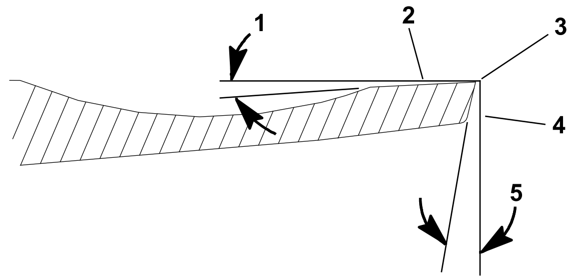

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Figure 115

1. Top angle
2. Top surface
3. Remove burr
4. Front surface
5. Front angle

Since there can be variations in the mounting surface of the bedbar, it is necessary to grind the bedknife after installing it to the bedbar. Follow the bedknife grinding specifications provided; refer to Bedknife Grinding Specifications (page 7–17). Grind only enough so the top surface of the bedknife is true; refer to Figure 115.

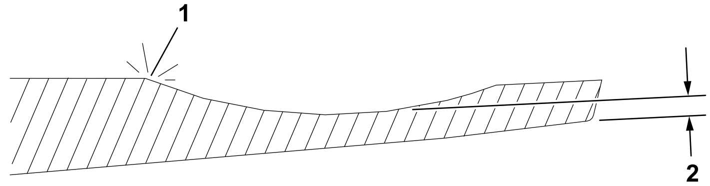

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Figure 116

1. Service limit (reel contacts back of bedknife scallop during operation)
2. Service limit (bottom of bedknife scallop reached when grinding)

IMPORTANT

Do Not grind the bedknife below it's service limit; refer to Figure 116. Operating the cutting unit with the bedknife below the service limit may result in poor after-cut appearance and reduce the structural integrity of the bedknife.

The bedknife service limit occurs when the reel contacts the back of the bedknife scallop during operation. Check for reel contact marks at the back of the bedknife scallop prior to grinding. The bedknife service limit may also occur when the bottom of the bedknife scallop is reached when grinding the bedknife.

When grinding the bedknife, be careful to not overheat the bedknife. Remove small amounts of material with each pass of the grinder. **Also, clean and dress grinding stone often during the grinding process.**

IMPORTANT

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 Angle Indicator and Magnetic Mount (page 2–17).

1. Use Toro General Service Training Book, Reel Mower Basics (part no. 09168SL) and grinder manufacturer's instructions for bedknife grinding information.
2. After grinding the bedknife, install the bedbar assembly in the cutting unit; refer to Installing the Bedbar (page 7–12).

   Note: Always adjust the cutting unit after grinding the reel and/or bedknife; refer to the Cutting Unit *Operator's Manual*. If a properly adjusted cutting unit does not cut paper cleanly after grinding, the grind angle may be incorrect. To extend the cutting unit performance by allowing the reel and the bedknife to hold their edge longer, an additional adjustment may be required after the first few minutes of operation as the reel and bedknife conform to each other.

Reel Assembly

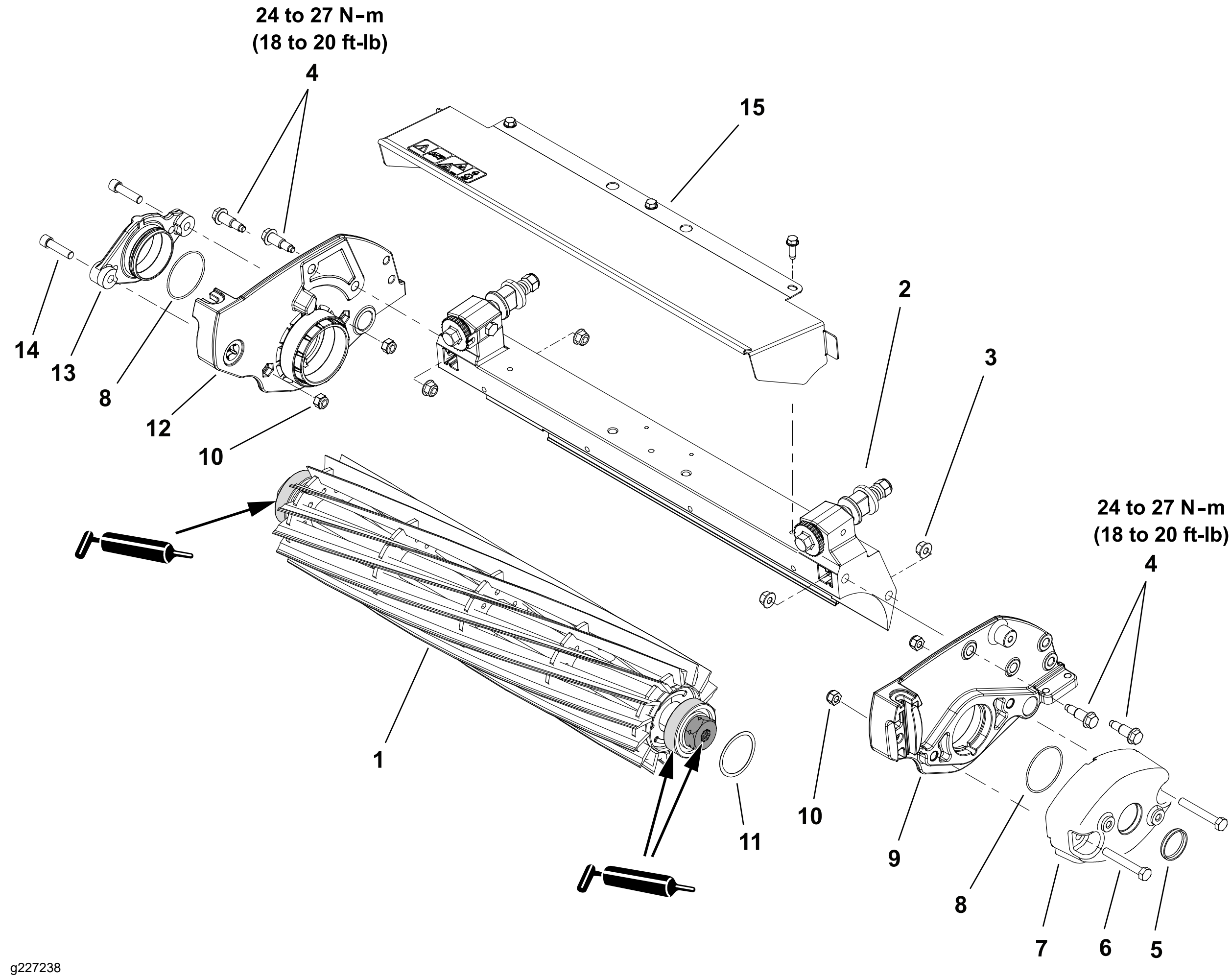


Figure 117

1. Cutting reel assembly
2. Frame assembly
3. Flange nut (4 each)
4. Shoulder bolt (4 used)
5. Plug
6. Cap screw (2 each)
7. Counterweight
8. O-ring (2 each)
9. Left side plate
10. Lock nut (4 each)
11. Flat wire spring
12. Right side plate
13. Motor adapter
14. Socket head screw (2 each)
15. Grass shield

Removal of the cutting reel requires removal of the left or right side plate from the cutting unit frame. The opposite side plate does not have to be removed from the frame to service the cutting reel.

Removing the Reel Assembly

Refer to Figure 117 for this procedure.

1. Position the machine on a clean and level surface, lower the cutting units, stop the engine, engage the parking brake and remove the key from the ignition switch.
2. Remove the cutting unit from the machine and place the cutting unit on a flat work surface.

Removing the Reel Assembly (continued)

3. If the cutting unit is equipped with an optional groomer or rear roller brush, remove the drive components for those options from cutting unit. Refer to Removing the Drive Plate (page 8–8) for belt drive groomer, Removing the Gear Box Assembly (page 9–6) for universal groomer, and Rear Roller Brushes (Optional) (page 7–33) for additional information.
4. Remove the two cap screws and nuts that secure counterweight to the left side plate, and remove the counterweight from the cutting unit. Remove and discard the O-ring.

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 nuts must be removed. Use the following procedure to restrain the reel and loosen the reel nuts before removing the rollers.

---

5. Loosen the reel nuts:
   A. Tip up the cutting unit to access the bottom of the reel.

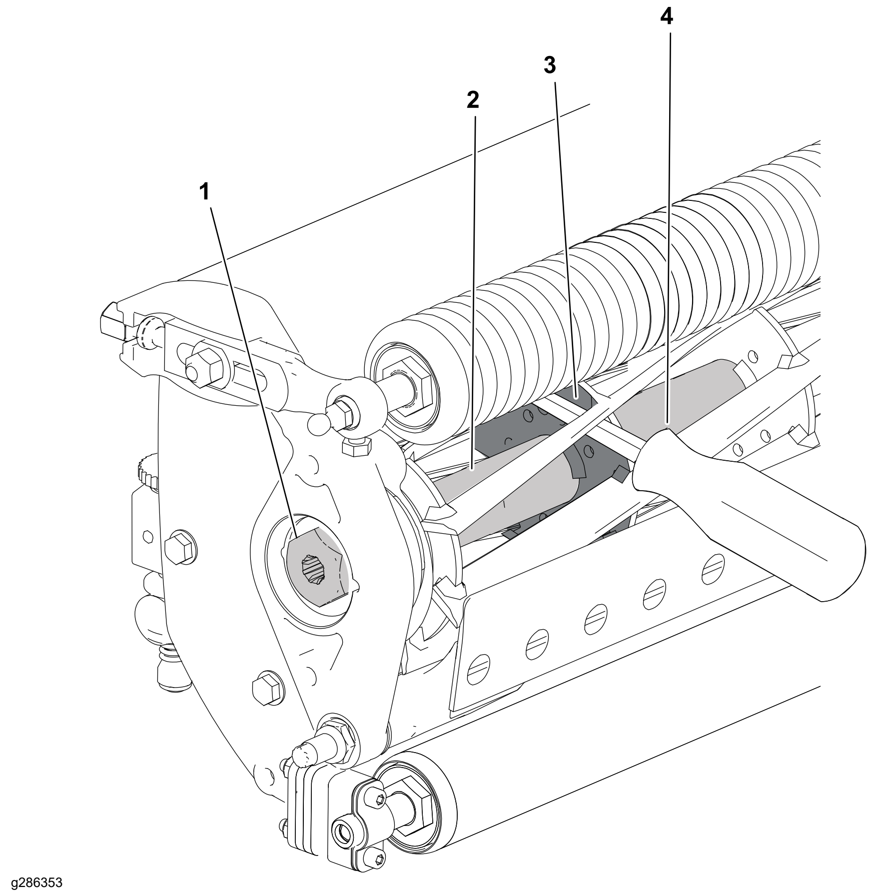


Figure 118

1. Reel nut (right end shown)
2. Reel shaft
3. Weld side of reel support plate
4. Pry bar

B. Insert a long-handled pry bar (3/8 x 12 inch with screwdriver handle recommended) through the bottom of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

IMPORTANT

To avoid grinding the reel, do not contact the cutting edge of any blade with the pry bar as this may damage the cutting edge and/or cause a high blade.

C. Move the pry bar against the weld side of the reel support plate closest to the reel nut being loosened.

IMPORTANT

The reel nut on the left end of the cutting reel has a black finish and has left-hand threads. The reel nut on the right end of the cutting reel has a silver finish and has right-hand threads.

D. Rest the handle of the pry bar against the front roller and loosen the reel nut closest to the pry bar.

Removing the Reel Assembly (continued)

E. Position the pry bar in the same manner on the opposite end of the reel and loosen the remaining reel nut.

F. Tip the cutting unit back onto its rollers.

6. Remove the bedbar; refer to Removing the Bedbar (page 7–11).
7. Remove the front roller; refer to Removing the Front Roller (page 7–26).
8. Remove the rear roller; refer to Removing the Rear Roller (page 7–28).
9. Support the cutting reel to prevent it from shifting or falling and remove the two shoulder bolts and two flange nuts that secure the side plate to the cutting unit frame. Remove the side plate from the cutting unit.
10. Carefully slide the cutting reel assembly (with seals, bearings and reel nuts) from the opposite side plate. Retrieve the flat wire spring from the reel bearing bore of the left side plate.
11. Thoroughly clean any grease and corrosion from the reel bearing bores in the side plates.
12. Inspect the remaining cutting unit components for corrosion, wear, or damage and replace the components as necessary.

Inspecting the Reel Assembly

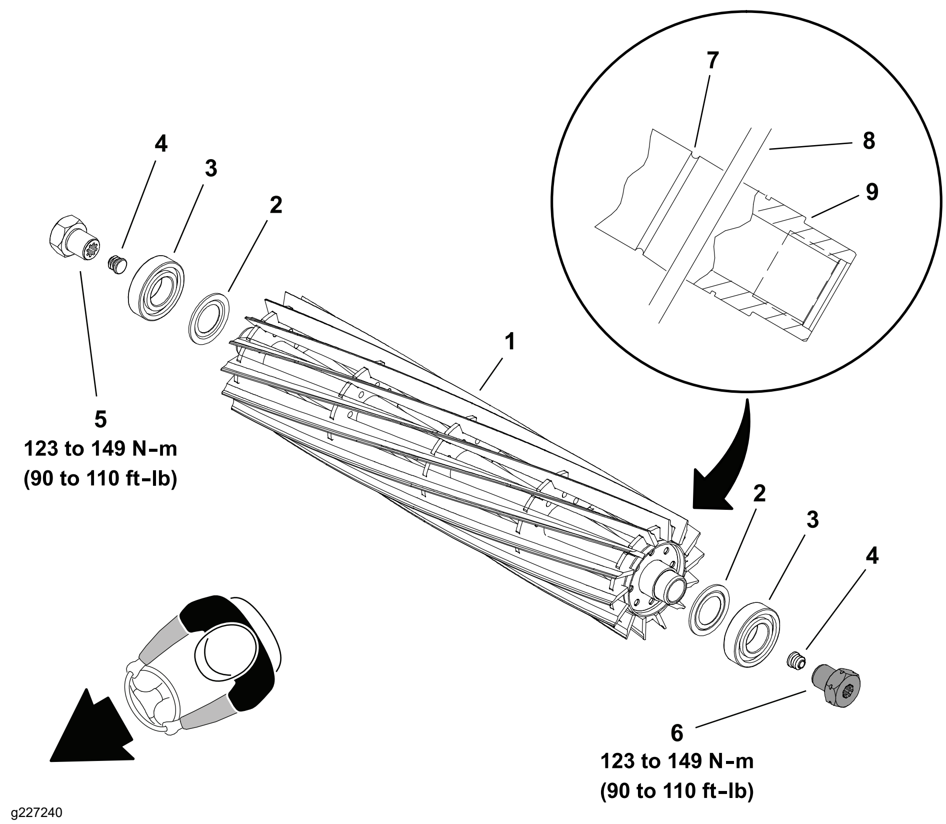


Figure 119

1. Cutting reel
2. Flocked seal (2 each)
3. Bearing (2 each)
4. Plug (2 each)
5. reel nut (right hand thread)
6. Reel nut (black – left hand thread)
7. Groove indication left hand threads
8. Left-most reel spider
9. Bearing shoulder

Inspecting the Reel Assembly (continued)

1. Remove the reel nuts from the cutting reel. Check the splines in the reel nuts for excessive wear or distortion and replace them if necessary.
2. Slide the bearings and seals from the reel shaft. Discard the seals and inspect the reel bearings to insure that they spin freely and have a minimal amount of axial play.
3. Inspect the reel as follows:

   A. Place the reel shaft ends in V-blocks and check the reel shaft for distortion.

   B. Check the threads in the ends of the reel shaft.

   C. Check the reel blades for bending or cracking.

   D. Check the service limit of the reel diameter; refer to Preparing the Reel for Grinding (page 7–25).

   Replace the reel if damage is evident.

IMPORTANT

The seal must be installed with the flocked side of the seal toward the bearing.

---

4. Slide the new flocked seals and the bearings onto the reel shaft until they contact the shoulder of the reel shaft.

   Note: The reel nut on the left end of the cutting reel has a black finish and has left-hand threads. The left end of the cutting reel shaft is identified with a groove cut just inside of the left-most reel spider. Tighten the reel nuts to the specified torque once the cutting reel is installed in the cutting unit.
5. Install the reel nuts finger tight.

Installing the Reel Assembly

Refer to Figure 117 for this procedure.

1. Position the cutting unit on a flat work area.
2. If previously removed; attach the right side plate to the cutting unit frame. Tighten the shoulder bolts from **24 to 27 N·m (18 to 20 ft-lb)**.

CAUTION

Contact with the reel, bedknife or other cutting unit parts can result in personal injury. Use heavy gloves when installing the cutting reel.

---

3. Apply a thin coat of grease to the outside of the cutting reel bearings and carefully slide the cutting reel assembly into the right side plate. Make sure that the reel bearing is fully seated in the right side plate, and that the real nut on the left (exposed) end of the cutting reel has a black finish.
4. Place the flat wire spring into bearing bore of left side plate and carefully slide the left side plate onto the cutting reel assembly as far as possible.
5. Install the shoulder bolts and flange nuts that secure the left side plate to the cutting unit frame. Tighten the shoulder bolts from **24 to 27 N·m (18 to 20 ft-lb)**.

Installing the Reel Assembly (continued)

6. Install the rear roller; refer to Installing the Rear Roller (page 7–28).
7. Install the front roller; refer to Installing the Front Roller (page 7–27).
8. Install the bedbar assembly; refer to Installing the Bedbar (page 7–12).
9. Tighten the reel nuts:

   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.

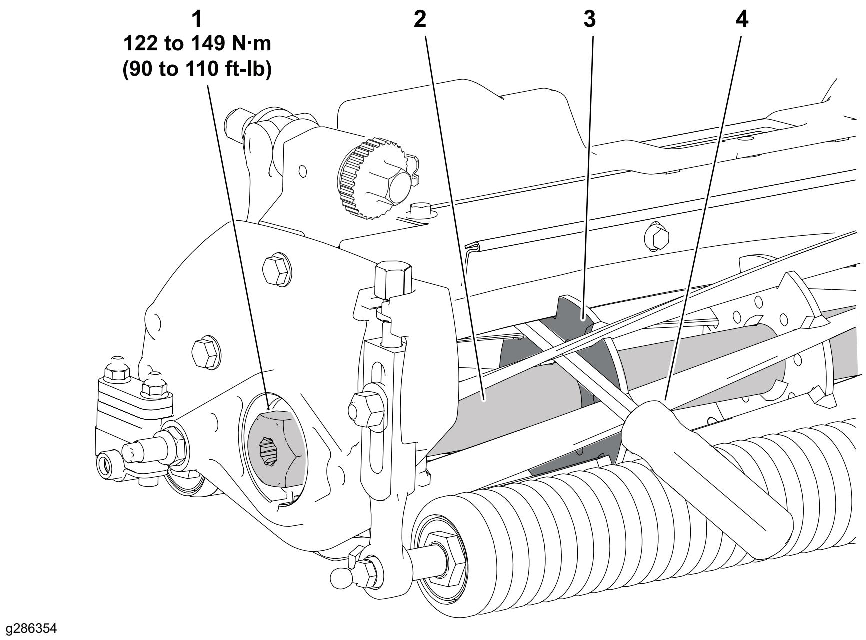


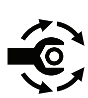
Figure 120

1. Reel nut (right end shown)
2. Reel shaft
3. Weld side of reel support plate
4. Pry bar

   B. Move the pry bar against the weld side of the reel support plate closest to the reel nut being tightened.

IMPORTANT

The reel nut on the left end of the cutting reel has a black finish and has left-hand threads. The reel nut on the right end of the cutting reel has a silver finish and has right-hand threads.



   C. Rest the handle of the pry bar against the front roller and tighten the reel nut closest to the pry bar. Tighten the reel nut from **123 to 149 N·m (90 to 110 ft-lb)**.

Installing the Reel Assembly (continued)

D. Position the pry bar in the same manner on the opposite end of the reel and tighten the remaining reel nut.

E. Fill the reel nut splines with high temp Mobil XHP−222 grease or equivalent.

10. Check to make sure the rear roller and cutting reel are parallel; refer to Leveling the Rear Roller (page 7–8).

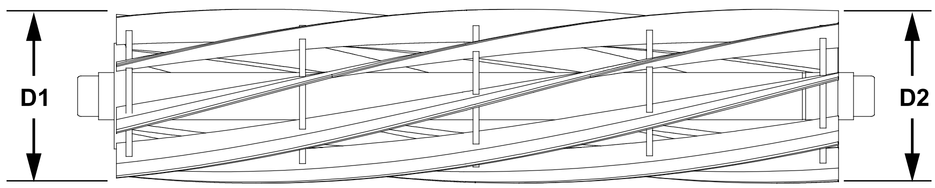
11. Install a new O-ring on the counterweight and secure the counterweight to the left side plate with two cap screws and nuts.

12. If the cutting unit is equipped with an optional groomer or optional rear roller brush, install the components for those options. Refer to Installing the Drive Plate (page 8–15) for belt drive groomer, Installing the Gear Box Assembly (page 9–13) for universal groomer, and Rear Roller Brushes (Optional) (page 7–33) for additional information.

Preparing the Reel for Grinding

Reel Grinding Specifications

Reel Diameter New (D)	128.5 mm (5.06 inch)
Reel Diameter Service Limit	114.3 mm (4.50 inch)
Reel Diameter Taper Limit (D1 – D2)	0.25 mm (0.01 inch)
Blade Land Width	0.8 to 1.2 mm (0.03 to 0.05 inch)
Blade Relief Angle	30° ±2°
Reel Shaft Diameter	34.9 mm (1.375 inch)



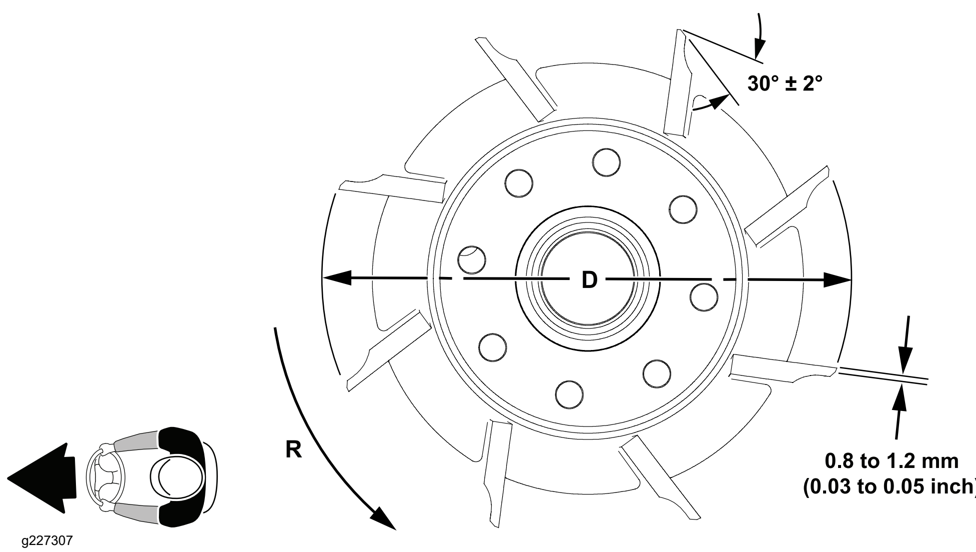


Figure 121

(R = Direction of Rotation)

Preparing the Reel for Grinding (continued)

Before grinding a cutting reel, make sure that all the cutting unit components are in good condition. Depending on the type of grinder used, faulty cutting unit components can affect the 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 reel grinder manufacturer's instructions to grind cutting reel to Toro specifications; refer to Reel Grinding Specifications (page 7–25). Additional reel grinding information can be found in the *Cutting Unit Operator's Manual*. An additional resource is the Toro Basics Series Training Book, Reel Mower Basics (part no. 09168SL) found on the Service Reference Set available from your Authorized Toro Distributor.

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 establish the specified blade land width or to restore the reel's cylindrical shape.

Note: Always adjust the cutting unit after grinding the reel and/or bedknife; refer to the *Cutting Unit Operator's Manual*. To extend the cutting unit performance by allowing the reel and the bedknife to hold their edge longer, an additional adjustment may be required after the first few minutes of operation as the reel and bedknife conform to each other.

Roller Assemblies

Removing the Front Roller

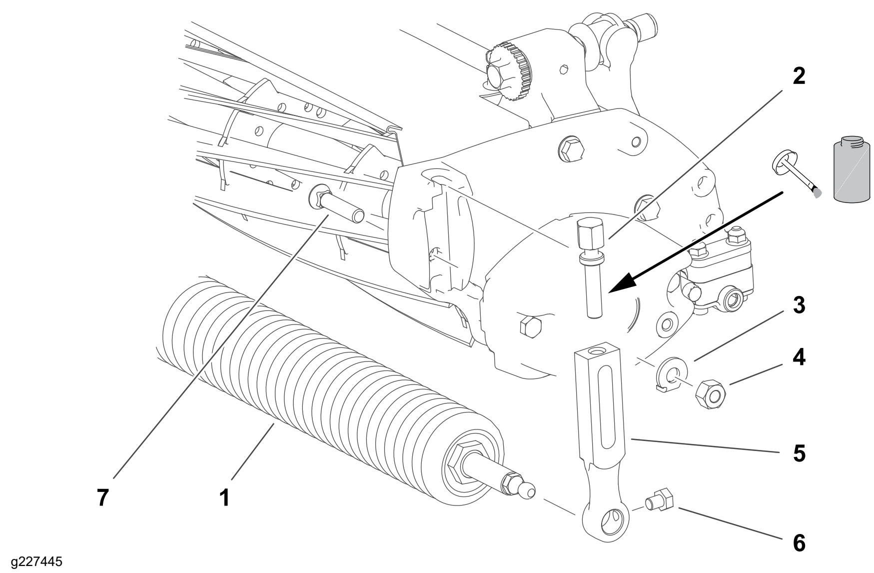


Figure 122

1. Front roller assembly
2. Height-of-cut screw (2 each)
3. Height-of-cut washer (2 each)
4. Lock nut (2 each)
5. Height-of-cut arm (2 each)
6. Pinch bolt (2 each)
7. Plow bolt (2 each)

---

1. Remove the cutting unit from the machine and place it on a level work surface. Use an appropriate support to raise the front roller off of the work surface.
2. Loosen the pinch bolts that secure the front roller shaft to the front height-of-cut arms.

Removing the Front Roller (continued)

3. Remove the lock nut, height-of-cut washer and plow bolt that secures one of the height-of-cut arms to the cutting unit side plate and remove the height-of-cut arm.
4. Slide the front roller assembly from the remaining height-of-cut arm.
5. Remove the remaining height-of-cut arm from the cutting unit if necessary.

Installing the Front Roller

1. Place the cutting unit on a level work surface. Use an appropriate support to raise the front of the cutting unit off of the work surface.
2. Inspect the condition of both height-of-cut screws and replace them if necessary. Apply anti-seize lubricant to the threads of a new height-of-cut screw.

   Note: When installing the height-of-cut arms, make sure tab of the side plate fits between the head and the washer of the height-of-cut screw.
3. Secure one of the height-of-cut arms to the side plate with a plow bolt, height-of-cut washer and lock nut. The tab on the height-of-cut washer should be oriented downward and fit into the slot of the height-of-cut arm.
4. Slide the front roller shaft into the height-of-cut arm attached to the cutting unit.
5. Slide the remaining height-of-cut arm onto the other end of roller shaft. Secure the remaining height-of-cut arm to the side plate with a plow bolt, height-of-cut washer and lock nut.
6. Center the front roller in the cutting unit and tighten the pinch bolts that secure the front roller shaft to the height-of-cut arms.
7. Adjust the cutting unit height-of-cut; refer to the *Cutting Unit Operator's Manual*.

Removing the Rear Roller

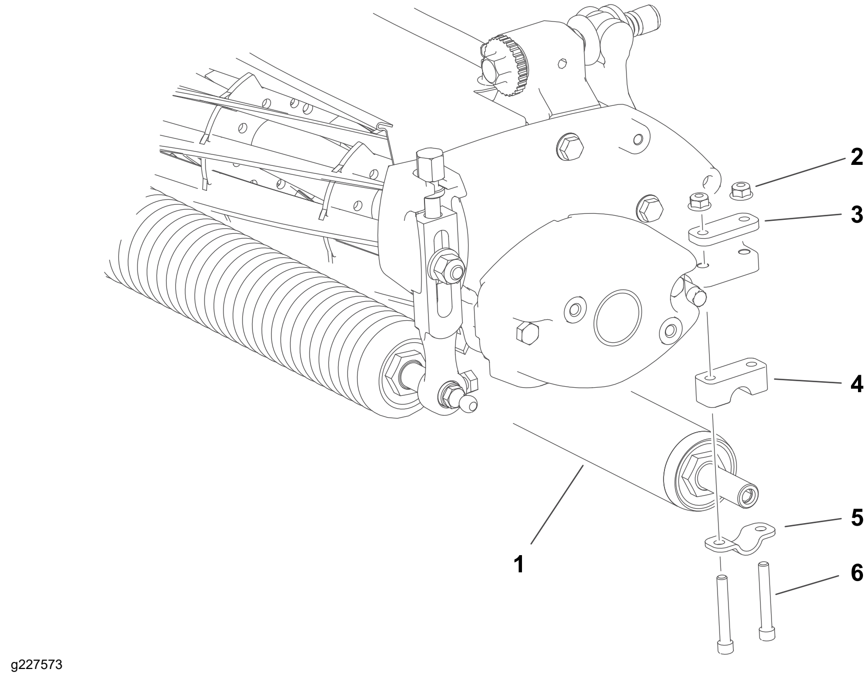


Figure 123

1. Rear roller assembly
2. Flange nut (2 each)
3. Shim
4. Spacer
5. Shaft retainer
6. Socket head screw (2 each)

---

1. Remove the cutting unit from the machine and place it on a level work surface. Place blocks under the bedbar to raise the rear roller off of the work surface.
2. Loosen the flange nuts that secure the rear roller retainer assemblies (flange nuts, socket head screws, shaft retainer, spacer and shims) to the cutting unit.

   Note: On cutting units equipped with the optional High Height-of-Cut Kit, there will be additional roller shims installed between the rear roller and the cutting unit side plate.
3. Remove one of the rear roller retainer assemblies.
4. Slide the rear roller assembly from the remaining retainer assembly.
5. Remove the remaining retainer assembly from the cutting unit if necessary.

Installing the Rear Roller

1. Place the cutting unit on a level work surface. Place blocks under the bedbar to raise the rear of the cutting unit off of the work surface.

   Note: Refer to the *Cutting Unit Operator's Manual* to determine the number of shims required for the desired height-of-cut range.
2. If previously removed, install one of the rear roller retainer assemblies (flange nuts, socket head screws, shaft retainer, spacer and shims) to the cutting unit.
3. Slide the rear roller shaft into the retainer assembly attached to the cutting unit.
4. Install the remaining rear roller retainer assembly.
5. Center the rear roller in the cutting unit and tighten the flange nuts at each of the retainer assemblies.
6. Check to make sure the rear roller and the cutting reel are parallel; refer to Leveling the Rear Roller (page 7–8).

Disassembling the Roller

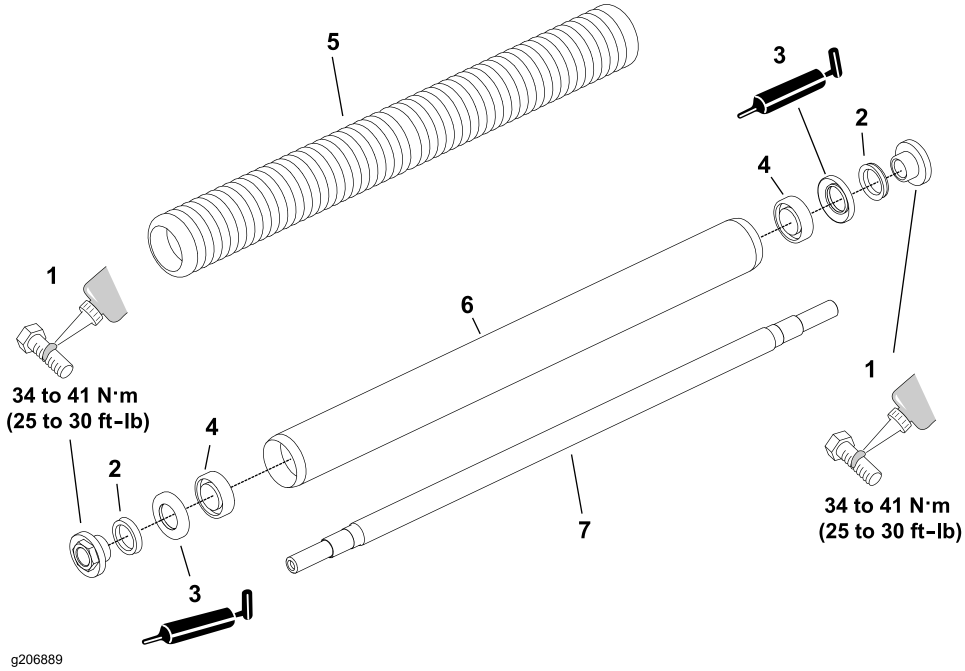


Figure 124

1. Bearing lock nut
2. V-ring
3. Seal
4. Ball bearing
5. Wiehle roller
6. Smooth roller
7. Roller shaft

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1. To hold the roller shaft stationary while removing the bearing lock nut, install a 3/8-24 UNF 2B screw with a jam nut into the threaded end of the roller shaft and tighten the jam nut against the roller shaft. Remove the bearing lock nuts.
2. Carefully inspect the seating surface and threads of the bearing lock nuts and replace them if damaged.
3. Remove the and discard the V-rings.
4. Loosely secure the roller assembly in a bench vise and lightly tap on the roller shaft to remove the seals and bearings. Discard the seals.
5. Clean and carefully remove any corrosion from the bearing cavities of the roller.

Assembling the Roller

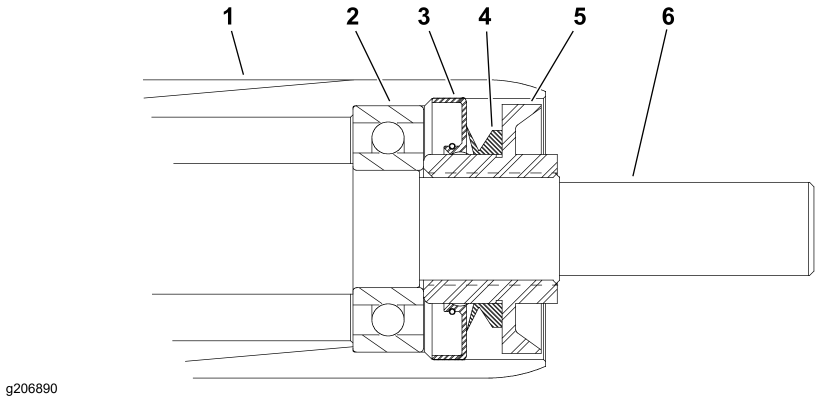

Figure 125

1. Roller
2. Ball bearing
3. Seal
4. V-ring
5. Bearing lock nut
6. Roller shaft

Note: Special tools are required to assemble the rollers; refer to Roller Rebuilding Tools (page 2–19). The following procedure describes the assembling the rollers using the set of assembly washers and spacers.

1. Place the roller shaft into the roller

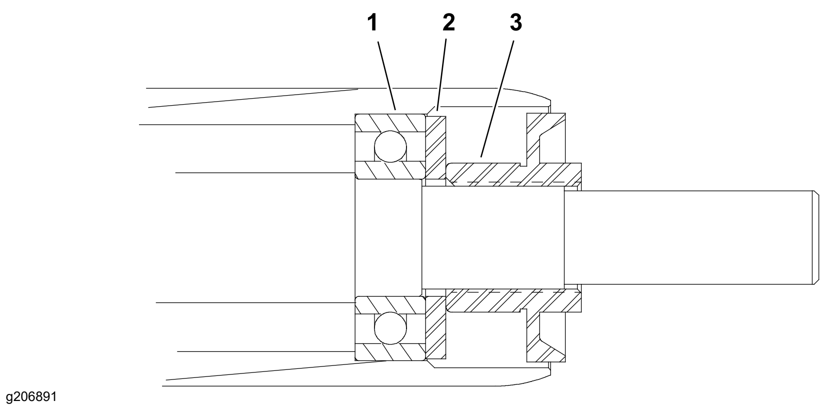

Figure 126

1. Bearing
2. Black assembly washer
3. Bearing lock nut

IMPORTANT

If the bearing lock nuts are being replaced, use the original lock nuts for installing the bearings and seals, if possible, to preserve the patch lock feature of the new lock nuts. Use the new nuts only after the bearings and seals have been installed.

2. Position a new bearing, black assembly washer and a bearing lock nut onto each end of the roller shaft.
3. Tighten the bearing lock nuts until both bearings are seated in the roller.
4. Remove the bearing lock nuts and the black assembly washers.

Assembling the Roller (continued)

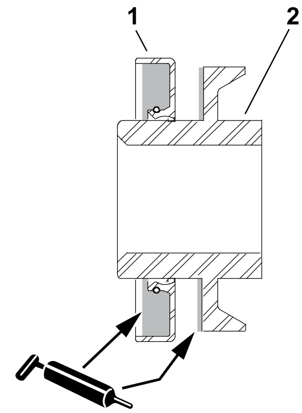

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Figure 127

1. Seal
2. Bearing lock nut

IMPORTANT

Failure to grease bearing lock nut before seal installation may result in seal damage.

5. Fill the seal 75 to 90% full with #2 grease and apply a coating of grease to the underside of the bearing lock nut to prevent damaging the seal damage during installation. Carefully fit a seal onto each bearing lock nut.

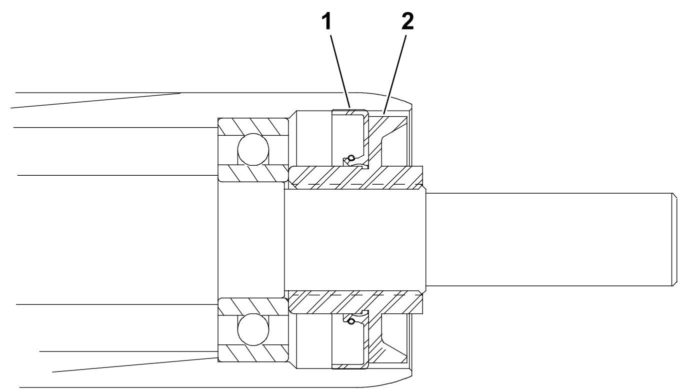

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Figure 128

1. Seal
2. Bearing lock nut

6. Install a bearing lock nut with seal onto each end of the roller shaft. Tighten the bearing lock nuts until they bottom against the bearings. Remove and clean any grease from the bearing lock nuts.

Assembling the Roller (continued)

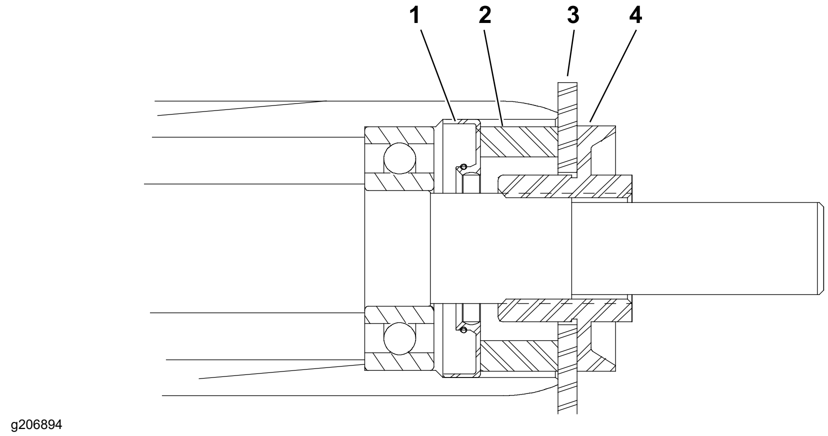


Figure 129

1. Seal
2. Assembly spacer
3. Yellow assembly washer
4. Bearing lock nut

7. Position an assembly spacer and yellow assembly washer on each end of the roller shaft
8. Tighten the bearing lock nuts until the yellow assembly washers bottom out against the roller housing. Remove the bearing lock nuts, assembly washers, and assembly spacers.

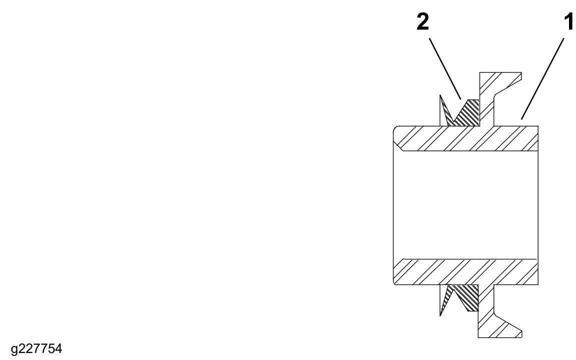


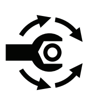
Figure 130

1. Bearing lock nut
2. V-ring

Note: The V-rings should be installed without any lubrication.

9. Carefully fit a dry V-ring onto each bearing lock nut.
10. Lubricate the lips of the installed seals with #2 general purpose grease.

    Note: If an original bearing lock nut is being used, apply a medium strength thread locker (Loctite #242 or equivalent) to the threads of the lock nut.



11. Install the bearing lock nut with V-ring onto each end of the roller shaft. Tighten the lock nuts to **34 to 41 N·m (25 to 30 ft-lb)**.

Rear Roller Brushes (Optional)

There are two different types of rear roller brush kits for Greensmaster 3120 cutting units. The earlier type of kit is designed to fit on cutting units with or without a belt driven groomer. A later type of kit is designed to fit on cutting units with or without a universal groomer. Please take a moment to determine which type of rear roller brush kit is installed on the cutting unit as the service information is different for each rear roller brush type.

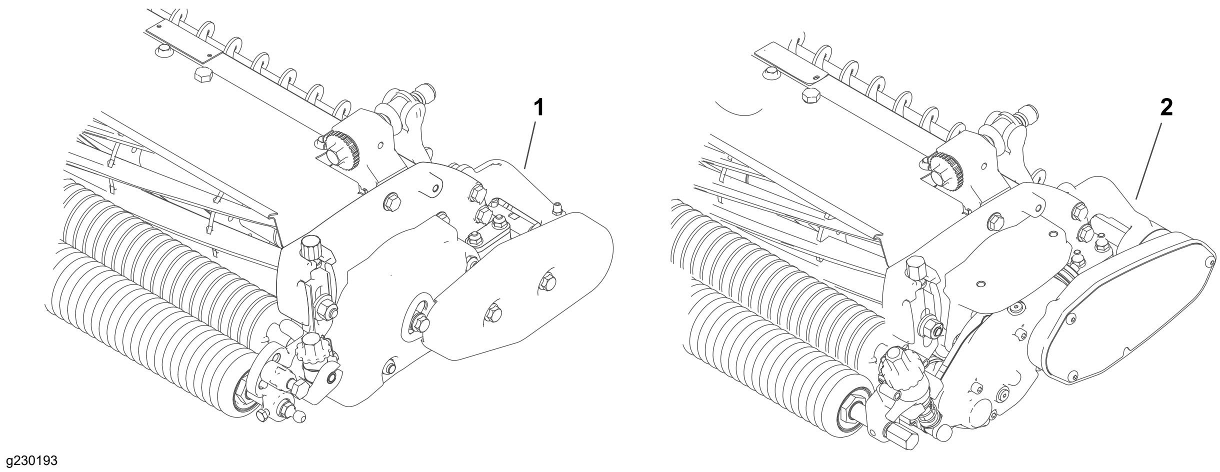


Figure 131

1. Rear roller brush for cutting units with or without a belt driven groomer
2. Rear roller brush for cutting units with or without a universal groomer

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Note: The *Installation Instructions* for the rear roller brush kit has detailed information regarding assembly and adjustment. Use the *Installation Instructions* along with this *Service Manual* when servicing the rear roller brush.

Drive components for the rear roller brush are located on the left side of the cutting unit (opposite from the hydraulic cutting unit motor).

Servicing the Rear Roller Brush (with or without a belt driven groomer)

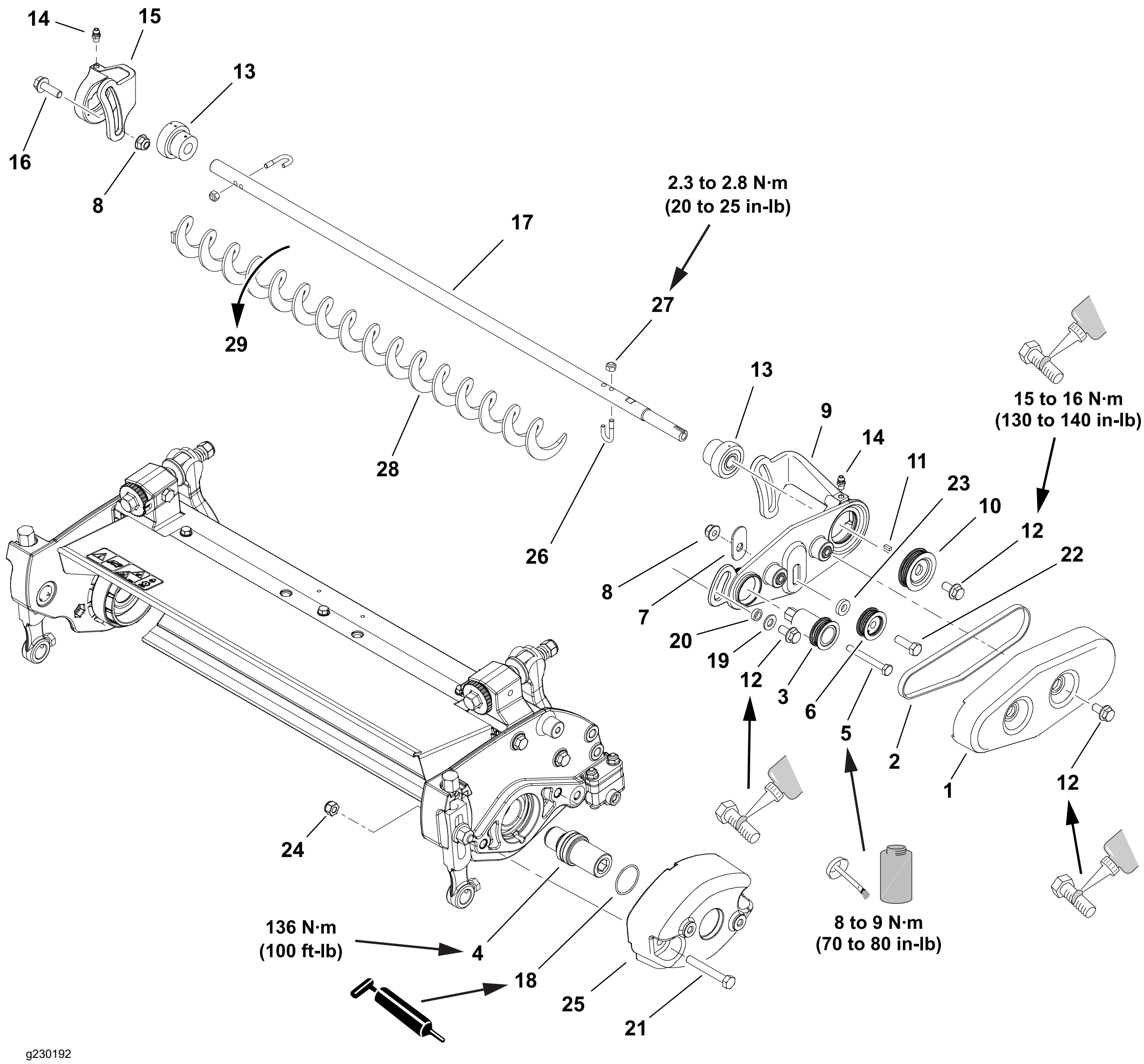

Figure 132

1.	Cover	11.	Square key	21.	Cap screw (2 each)
2.	Drive belt	12.	Flange head screw (4 each)	22.	Cap screw
3.	Drive pulley	13.	Roller bearing assembly (2 each)	23.	Bearing spacer
4.	Pulley driver (used without groomer)	14.	Grease fitting (2 each)	24.	Hex nut (2 each)
5.	Cap screw	15.	Brush support – RH	25.	Counterweight (used without groomer)
6.	Idler pulley assembly	16.	Flange head screw (4 each)	26.	J-bolt (2 each)
7.	Cover plate	17.	Brush shaft	27.	Lock nut (2 each)
8.	Flange nut (5 each)	18.	O-ring	28.	Brush element
9.	Drive plate	19.	Flat washer	29.	Direction of brush rotation
10.	Driven pulley	20.	Bearing spacer		

Servicing the Rear Roller Brush (with or without a belt driven groomer) (continued)

⚠ CAUTION ⚠

Contact with the reel or other cutting unit parts can result in personal injury. Use heavy gloves when handling the cutting reel.

Replacing the Roller Brush Element

1. Remove the cutting unit from the machine and place it on a level work surface.
2. Loosen the set screw in the bearing locking collar on right side of brush shaft.
3. Using the blind hole in the bearing locking collar as an impact point, unlock the collar by striking it with a punch in the opposite direction of brush rotation.
4. Remove the RH brush support, bearing and locking collar.
5. Remove the brush element from the shaft.
6. Slide the new brush element onto the shaft while rotating the brush.
7. Install the J-bolts and lock nuts making sure the threaded portion of the J-bolts are installed on the outside of the brush element. Tighten the lock nuts from **2.3 to 2.8 N·m (20 to 25 in-lb)**.
8. Install the RH bearing support.
9. Tighten the bearing locking collar.
    A. Slide the locking collars outward onto the bearing collars. Rotate the locking collars by hand in the direction of normal brush rotation until the collars are tight on the shaft.
    B. Using the blind hole in the bearing locking collar as an impact point, lock the collar by striking it with a punch in the normal direction of the brush rotation.
    C. Tighten the set screw in the locking collar.

IMPORTANT

If brush to roller contact is incorrect, brush operation will be adversely affected.

---

10. Check that the roller brush is parallel to the rear roller within **0.25 mm (0.010 inch) clearance to light contact**. Adjust the roller support or drive plate as necessary.

Replacing the Drive Belt

1. Remove the cover.
2. Loosen the idler pulley assembly from the drive plate to relieve the belt tension.
3. Replace the drive belt making sure that the belt and the pulley grooves are aligned and the belt is centered in the pulleys.
4. Push down on the idler pulley and secure it to the drive plate. Make sure the cover plate (item 7 in Figure 132) is positioned to prevent debris from entering the drive area.

Servicing the Rear Roller Brush (with or without a belt driven groomer) (continued)

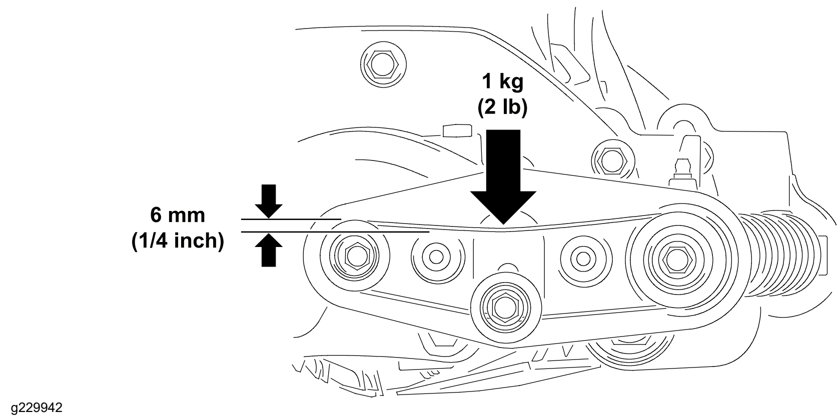

Figure 133

5. The drive belt should deflect approximately **6 mm (1/4 inch) when 1 kg (2 lb)** of force is applied to the belt halfway between the pulleys. Adjust the idler puller as necessary.

Drive and Support Components

Refer to Figure 132 for this procedure.

1. Disassemble the roller brush components as necessary. Retrieve and discard the drive plate O-ring.
2. Clean and inspect all components for wear or damage and replace as necessary.
3. If the pulley driver (item 4) requires replacement (machines without a belt driven groomer):
   A. Tip up the cutting unit to access the bottom of the reel to remove the pulley driver.

Servicing the Rear Roller Brush (with or without a belt driven groomer) (continued)

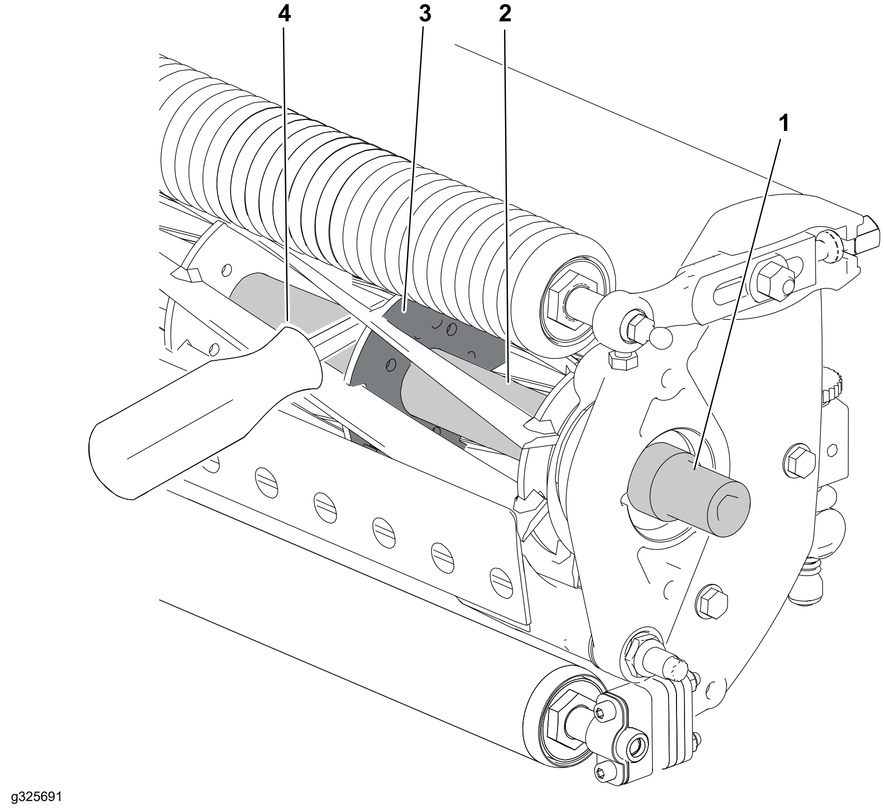

Figure 134

1. Pulley driver
2. Reel shaft
3. Weld side of reel support plate
4. Pry bar

B. Insert a long-handled pry bar (3/8 x 12 inch with screwdriver handle recommended) through the bottom of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

IMPORTANT

To avoid grinding the reel, do not contact the cutting edge of any blade with the pry bar as this may damage the cutting edge and/or cause a high blade.

C. Move the pry bar against the weld side of the reel support plate closest to the rear roller brush pulley driver.

IMPORTANT

The pulley driver and drive adapter have left-hand threads. Turn the pulley driver or drive adapter clockwise to loosen.

D. Rest the handle of the pry bar against the front roller and loosen the pulley driver.

E. Tip the cutting unit back onto its rollers.

Servicing the Rear Roller Brush (with or without a belt driven groomer) (continued)

F. Clean the threads in the end of the reel shaft. A left-hand thread tap is available to clean or repair the threads if necessary; refer to Reel Thread Repair Taps (page 2–17).

G. To install the pulley driver, insert a long-handled pry bar through the front of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

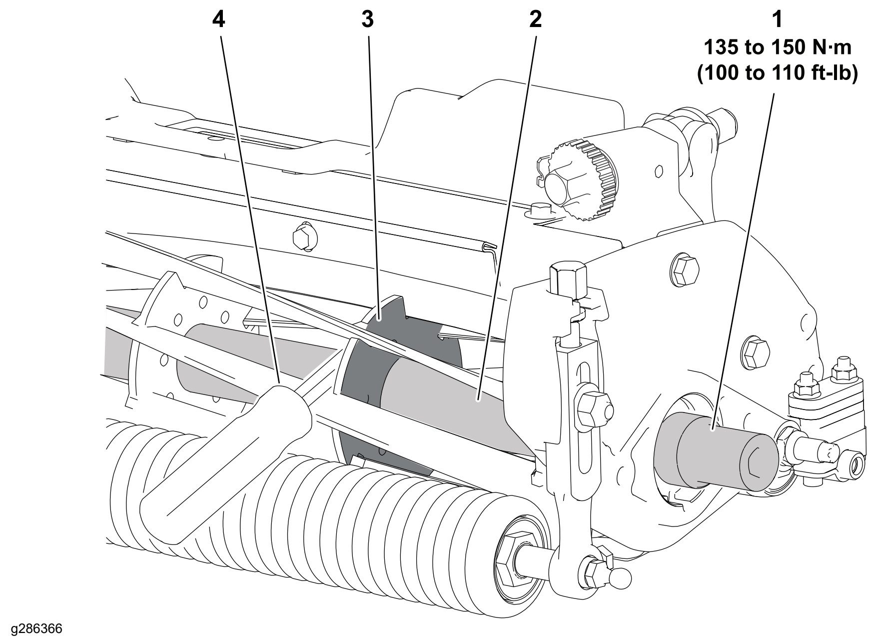

Figure 135

1. Pulley driver
2. Reel shaft
3. Weld side of reel support plate
4. Pry bar

H. Move the pry bar against the weld side of the reel support plate closest to the pulley driver.

IMPORTANT

The pulley driver and drive adapter have left-hand threads. Turn the pulley driver or drive adapter counterclockwise to tighten.

I. Rest the handle of the pry bar against the front roller and tighten the pulley driver from **135 to 150 N·m (100 to 110 ft-lb)**.

4. For machines without a belt driven groomer, install the counterweight.

   Note: The screws used to secure the cover, driven pulley and the front of the drive plate have a locking feature to prevent the screws from loosening. If the original screws are being re-used, apply a medium strength thread locker (Loctite #242 or equivalent).

5. For machines with a belt driven groomer, apply a light coating of grease to a new drive plate O-ring and install the O-ring and the drive plate.

6. Install the roller brush with the bearings and locking collars loose on the brush shaft.

7. Install the driven pulley and key. Tighten the flange head screw from **15 to 16 N·m (130 to 140 in-lb)**.

8. Install the brush support.
9. Install the drive pulley. Apply anti-seize lubricant the cap screw threads and tighten from **8 to 9 N·m (70 to 80 in-lb)**.

IMPORTANT

The brush drive belt may fail prematurely if the pulleys are not properly aligned.

10. Using a straight edge, move the roller brush as necessary to align the pulleys.

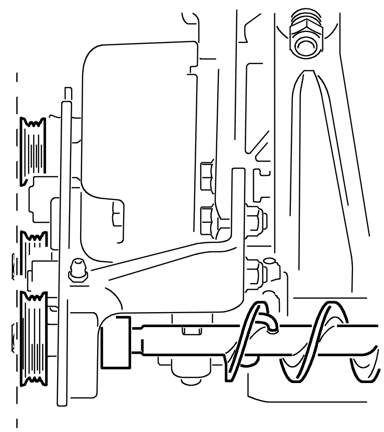

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Figure 136

11. Tighten the roller brush bearing locking collars.
    A. Slide the locking collars outward onto the bearing collars. Rotate the locking collars by hand in the direction of normal brush rotation until the collars are tight on the shaft.
    B. Using the blind hole in the bearing locking collar as an impact point, lock each collar by striking it with a punch in the normal direction of the brush rotation.
    C. Tighten the set screw in the locking collars to secure the bearing assembly to the brush shaft.
    D. Check the brush assembly for end-play and adjust the bearings if necessary.

IMPORTANT

If brush to roller contact is incorrect, brush operation will be adversely affected.

12. Check that the roller brush is parallel to the rear roller within **0.25 mm (0.010 inch) clearance to light contact**. Adjust the roller support or drive plate as necessary.
13. Install and adjust the drive belt and install the cover.
14. Lubricate the grease fittings on the brush support and the drive plate until grease is visible. Wipe up any excess grease.

Servicing the Rear Roller Brush (with or without a universal groomer)

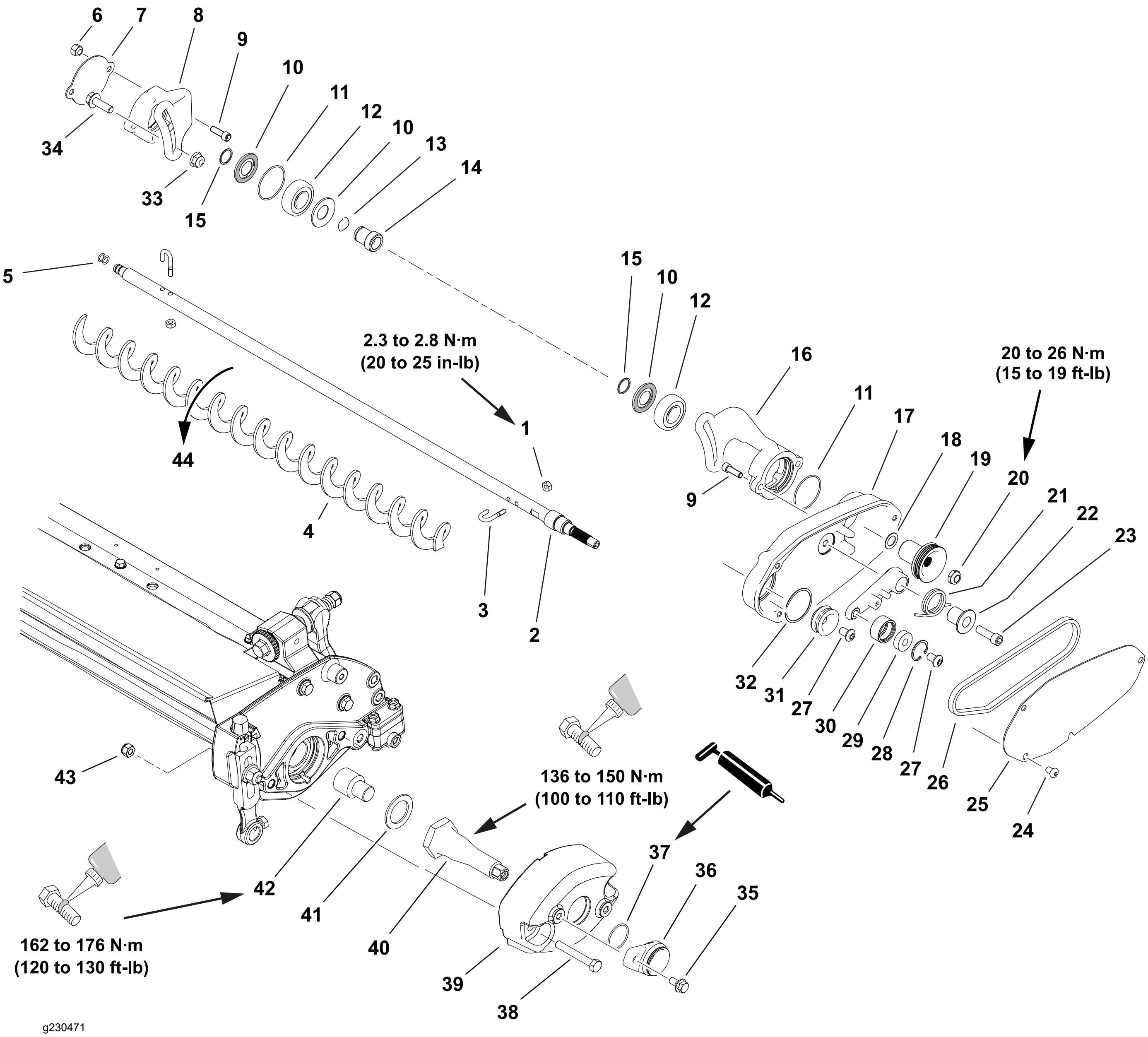

Figure 137

(shown without Universal Groomer installed)

Figure 137 (continued)

1. Lock nut (2 each)
2. Brush shaft
3. J-bolt (2 each)
4. Brush element
5. O-ring (2 each)
6. Lock nut (2 each)
7. Cover
8. Bearing bracket RH
9. Socket head screw (4 each)
10. Flocked seal (3 each)
11. O-ring (2 each)
12. Bearing (2 each)
13. Retaining ring
14. Collar
15. Retaining ring (2 each)
16. Bearing bracket LH
17. Drive housing
18. Spacer (as required)
19. Driven pulley
20. Lock nut
21. Torsion spring
22. Idler bushing
23. Socket head screw
24. Socket head screw (3 each)
25. Cover
26. Drive belt
27. Socket head screw (2 each)
28. Retaining ring
29. Bearing
30. Idler pulley
31. Drive pulley
32. Retaining ring
33. Flange nut (4 each)
34. Flange head screw (4 each)
35. Flange head screw
36. Adapter housing (used without groomer)
37. O-ring
38. Cap screw (2 each)
39. Counterweight
40. Drive shaft (used without groomer)
41. Shim (used without groomer)
42. Drive adapter (used without groomer)
43. Lock nut (2 each)
44. Direction of brush rotation

CAUTION

Contact with the reel or other cutting unit parts can result in personal injury. Use heavy gloves when handling the cutting reel.

Replacing the Roller Brush Element

Refer to Figure 137 for this procedure.

1. Remove the cutting unit from the machine and place it on a level work surface.
2. Remove the RH bearing bracket assembly.
3. Remove the brush element from the shaft.
4. Slide the new brush element onto the shaft while rotating the brush.
5. Install the J-bolts and lock nuts making sure the threaded portion of the J-bolts are installed on the outside of the brush element. Tighten the lock nuts from **2.3 to 2.8 N·m (20 to 25 in-lb)**.
6. Apply a thin coating of grease to the O-rings on the brush shaft and install the RH bearing bracket.

IMPORTANT

If brush to roller contact is incorrect, brush operation will be adversely affected.

7. Check that the roller brush is parallel to the rear roller within **0.25 mm (0.010 inch) clearance to light contact**. Adjust the bearing brackets as necessary.

Drive and Support Components

Refer to Figure 137 for this procedure.

Servicing the Rear Roller Brush (with or without a universal groomer) (continued)

1. Disassemble the roller brush components as necessary. Retrieve and discard the adapter housing O-ring (machines without a universal groomer).
2. Clean and inspect all components for wear or damage and replace as necessary.
3. If the drive shaft and drive adapter (items 40 or 42) require replacement (machines without a universal groomer):
   A. Tip up the cutting unit to access the bottom of the reel to remove the drive shaft assembly.

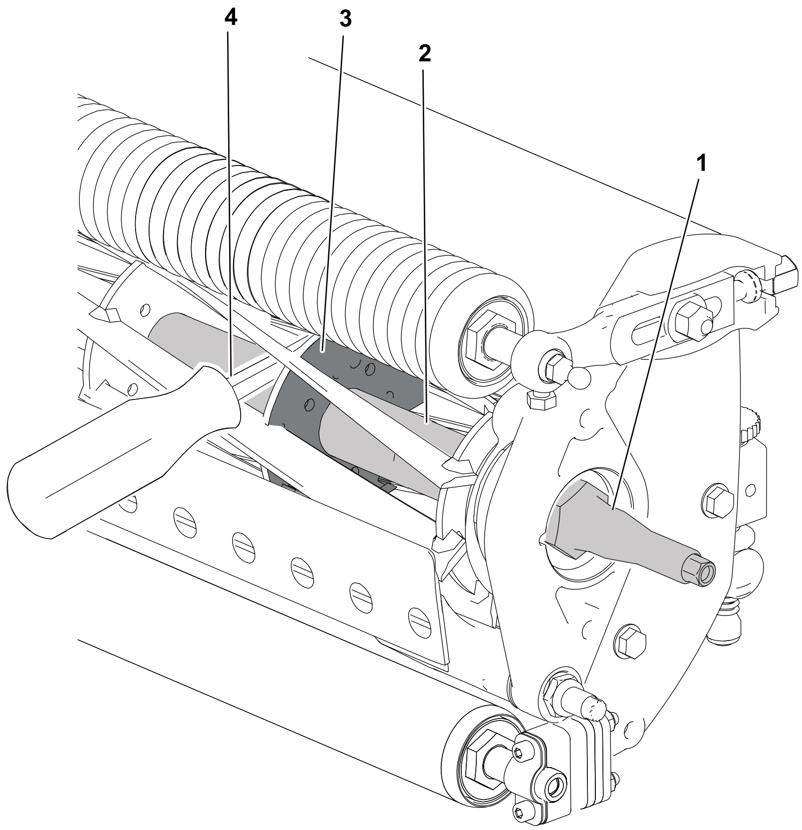

Figure 138

1.	Drive shaft assembly	3.	Unwelded side of reel support plate
2.	Reel shaft	4.	Pry bar

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. Insert a long-handled pry bar (3/8 x 12 inch with screwdriver handle recommended) through the bottom of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.
   C. Move the pry bar against the weld side of the reel support plate closest to the rear roller brush drive shaft.

IMPORTANT

The drive shaft and drive adapter have left-hand threads. Turn the drive shaft or drive adapter clockwise to loosen.

D. Rest the handle of the pry bar against the front roller and use the large hex (1.375 inch) to loosen the drive shaft assembly.

E. Retrieve the shim (item 41 in Figure 137).

F. Tip the cutting unit back onto its rollers.

G. Clean the threads in the end of the reel shaft. A right-hand thread and left-hand thread tap is available to clean or repair the threads if necessary; refer to Reel Thread Repair Taps (page 2–17).

H. Install the shim and assemble the drive shaft and drive adapter (machines without a universal groomer) with a medium strength thread locking compound (Loctite 243 or equivalent) and tighten from **150 to 163 N·m (110 to 120 ft-lb)**.

I. Insert a long-handled pry bar through the front of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

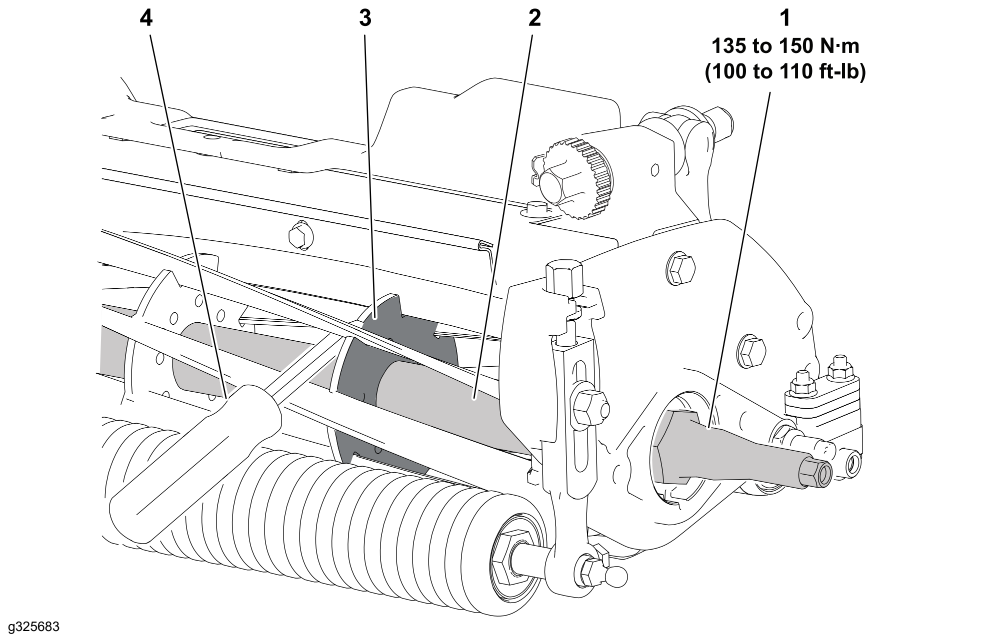

Figure 139

1. Drive shaft assembly
2. Reel shaft
3. Unwelded side of reel support plate
4. Pry bar

J. Move the pry bar against the weld side of the reel support plate closest to the drive shaft assembly.

IMPORTANT

The drive shaft and drive adapter have left-hand threads. Turn the drive shaft or drive adapter counterclockwise to tighten.

Servicing the Rear Roller Brush (with or without a universal groomer) (continued)

K. Rest the handle of the pry bar against the front roller. Use the large hex (1.375 inch) and tighten the drive shaft from **135 to 150 N·m (100 to 110 ft-lb)**.

4. For units without a universal groomer, install the counterweight.

   Note: The screw used to secure the adapter housing has a locking feature to prevent the screw from loosening. If the original screw is being re-used, apply a medium strength thread locker (Loctite #242 or equivalent).
5. Install and apply a light coating of grease to a new O-ring and install the adapter housing (machines without a universal groomer).
6. Install the drive housing and LH bearing bracket.
7. Apply a thin coating of grease to the O-rings on the brush shaft and fit the RH bearing bracket over the brush shaft.

   Note: Install all flocked seals with the flocked surface against the bearing.
8. Install a flocked seal and the retaining ring onto the brush shaft.
9. Install the brush and RH bearing bracket assembly.
10. Install the drive pulley.

IMPORTANT

The brush drive belt may fail prematurely if the pulleys are not properly aligned.

11. Using a straight edge, determine the number of spacers necessary under the driven pulley to align the pulleys. Tighten the lock nut securing the driven pulley from **20 to 26 N·m (15 to 19 ft-lb)**.

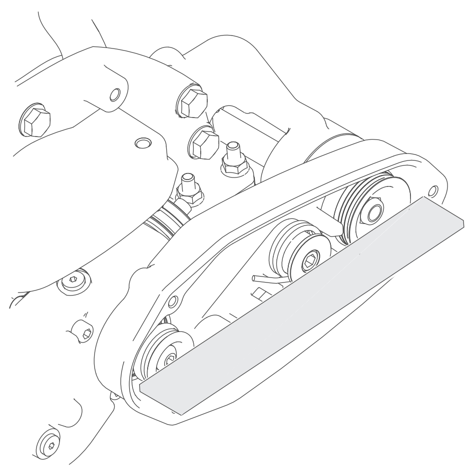

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Figure 140
(shown with Universal Groomer installed)

12. Install and adjust the drive belt and install the cover.

IMPORTANT

If brush to roller contact is incorrect, brush operation will be adversely affected.

13. Check that the roller brush is parallel to the rear roller within **0.25 mm (0.010 inch) clearance to light contact**. Adjust the bearing brackets as necessary.

Chapter 8

Belt Driven Groomer (Optional)

Table of Contents

Specifications

Belt Driven Groomer (Optional)

Item	Description
Grooming reel diameter	6 cm (2.375 inches)
Groomer blade type	**Spring Steel:** 42 steel blades with 1/2 inch blade spacing. **Carbide:** 42 steel blades with 1/2 inch blade spacing. **Thin blade:** 82 steel blades with 1/4 inch blade spacing. A soft or stiff groomer brush can be installed in place of the grooming reel.
Groomer mounting	The groomer is mounted to the cutting unit side plates. The drive assembly for the grooming reel is located on the opposite side of the cutting unit from the hydraulic cutting reel motor.
Groomer height setting	**Mowing:** 0.8 to 15.7 mm (0.030 to 0.620 inch). **HOC range:** 1.5 to 19.1 mm (0.060 to 0.750 inch).
Width-of-groomer	49.2 cm (19.38 inches).
Height adjustment knob	Allows a 0.003 inch (0.08 mm) increment of height adjustment for each click of the adjuster.
Quick-up feature	Allows grooming reel to be raised above the height/depth adjustment for no grooming reel action while mowing.
Groomer drive	The groomer drive assembly is attached to the right side of the cutting unit.

General Information

Installation Instructions

The *Installation Instructions* for the groomer provides information regarding the set-up, operation, general maintenance procedures, and maintenance intervals for the groomer assembly on your Greensmaster machine. Refer to the *Installation Instructions* for additional information when servicing the groomer assembly.

Grooming Performance

There are a number of factors that can affect the performance of grooming. These factors vary for different golf courses and from fairway to fairway. It is important to inspect the turf frequently and vary the grooming practice with turf needs.

IMPORTANT

Improper or overaggressive use of the groomer (e.g., too deep or too frequent grooming) may cause unnecessary stress on the turf leading to severe turf damage. Use the groomer carefully. Read and understand the groomer operation instructions before operating or testing the groomer performance.

It is important to remember that the same factors that affect quality of cut also affect grooming performance.

Variables that Affect the Use and Performance of the Groomer:

1. The growing season and weather conditions.
2. General turf conditions.
3. The frequency of grooming/cutting–number of cuttings per week and how many passes per cutting.
4. The height-of-cut.
5. The grooming depth.
6. The type of grass.
7. The amount of time that a groomer reel has been in use on a particular turf area.
8. The amount of traffic on the turf.
9. The overall turf management program–irrigation, fertilizing, weed control, coring, over-seeding, sand dressing, disease control, and pest control.
10. Stress periods for turf–high temperatures, high humidity, and unusually high traffic.

Troubleshooting

Problem	Possible Causes	Correction
The groomer reel does not rotate.	Seized grooming reel or idler bearing(s) in groomer side plate(s).	Identify and replace faulty bearing(s).
	Broken or damaged drive belt idler spring.	Replace idler .
	The groomer drive belt is worn, broken or damaged.	If the belt slips, it probably is worn and must be replaced. Repair or replace belt if necessary. A broken or worn belt could be the result of improper belt routing or seized bearings in groomer assembly.
The turf is damaged or has uneven grooming.	The groomer is set too aggressively.	Refer to groomer Installation Instructions for groomer set-up information.
	The groomer reel blades are bent, damaged, or missing.	Repair or replace the blades if necessary.
	The groomer reel shaft is bent or damaged.	Replace the groomer reel shaft.
	Grooming depth is not equal on both ends of the groomer reel.	Adjust the depth if necessary. Check and adjust the cutting unit set up (level bed knife to reel, level rear roller to reel, set the height-of-cut, etc.).

Service and Repairs

Replacing the Groomer Drive Belt

1. Park the machine on a clean and level surface, lower the cutting units completely to the ground, stop the engine, engage the parking brake and remove the key from the ignition switch.
2. If equipped, remove rear roller brush from cutting unit; refer to Servicing the Rear Roller Brush (with or without a belt driven groomer) (page 7–34).

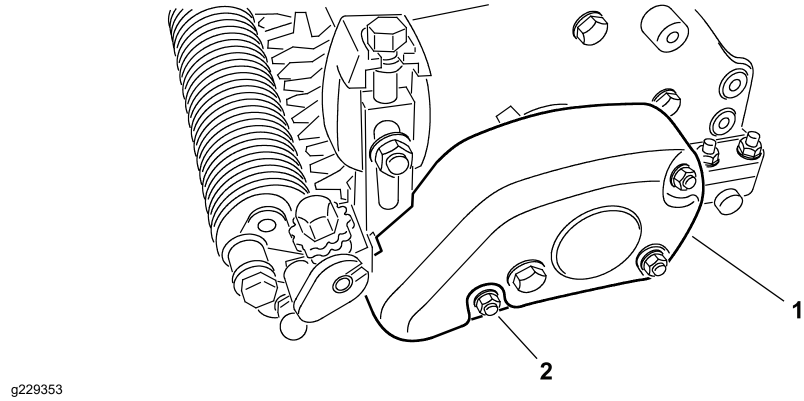

Figure 141

1. Groomer drive cover
2. Lock nut (3 each)

3. Remove the three lock nuts that secure the groomer drive cover, then remove the cover.

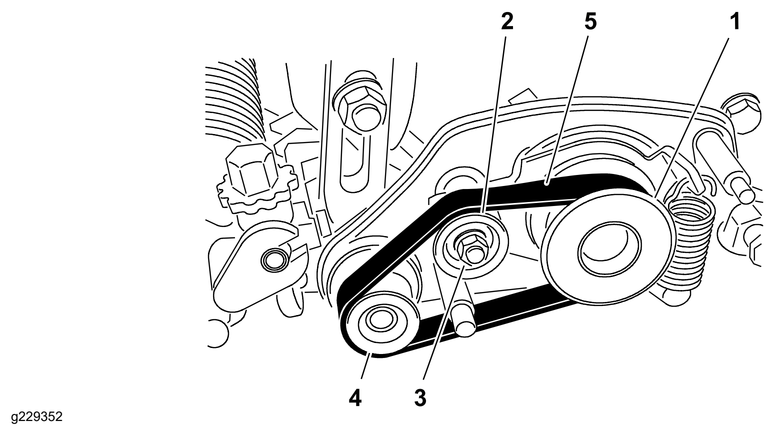

Figure 142

1. Drive pulley
2. Idler pulley
3. Idler pulley nut
4. Driven pulley
5. Groomer drive belt

4. Pivot the idler pulley by placing a 12 mm wrench on the pulley nut and rotating the idler bracket to relax the belt tension. Slip the groomer drive belt off the pulleys and carefully release the idler bracket.

IMPORTANT

Make sure that the drive belt is centered on the pulleys and correctly aligned with pulley grooves after installation.

5. Install a new drive belt to the drive pulley, idler pulley and the driven pulley observing correct belt routing.

Replacing the Groomer Drive Belt (continued)

6. Secure the belt cover to the machine with three lock nuts.
7. If equipped, install the rear roller brush to the cutting unit; refer to Servicing the Rear Roller Brush (with or without a universal groomer) (page 7–40)

The Groomer Plate Assemblies

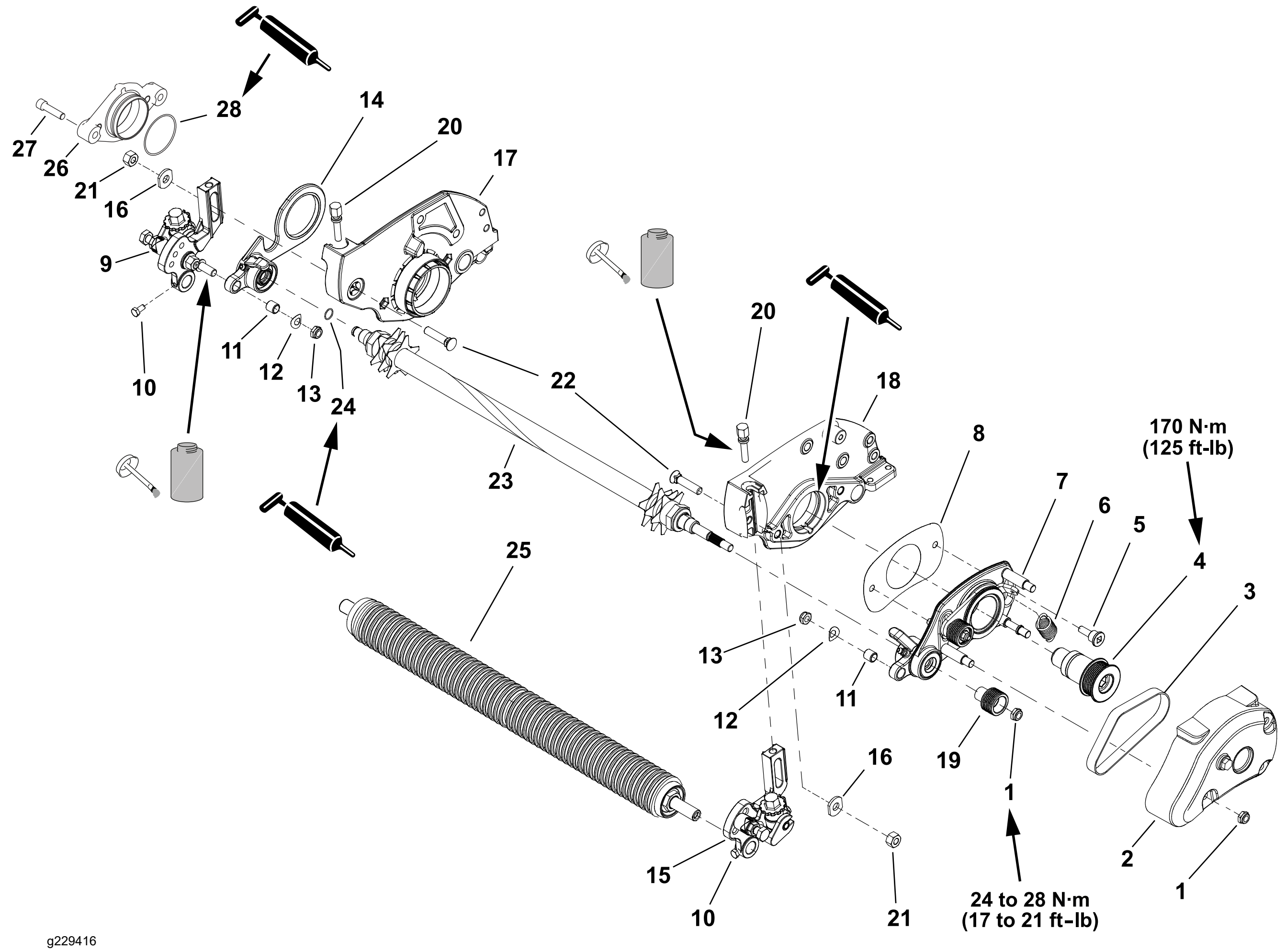

Figure 143

1. Lock nut (4 each)
2. Drive cover
3. Drive belt
4. Drive pulley
5. Shoulder bolt (2 each)
6. Extension spring
7. Drive plate assembly
8. Shim
9. Groomer arm – RH
10. Pinch bolt (2 each)
11. Bushing (2 each)
12. Spring washer (2 each)
13. Lock nut (2 each)
14. Support plate assembly
15. Groomer arm – LH
16. Tabbed washer (2 each)
17. Cutting unit side plate – RH
18. Cutting unit side plate – LH
19. Driven pulley
20. Height adjustment bolt (2 each)
21. Lock nut (2 each)
22. Plow bolt (2 each)
23. Grooming reel assembly
24. O-ring
25. Front roller assembly
26. Motor adapter
27. Socket head screw (2 each)
28. O-ring

Removing the Drive Plate

Refer to Figure 143 for this procedure.

1. Park the machine on a clean and level surface, lower the cutting units completely to the ground, stop the engine, engage the parking brake and remove the key from the ignition switch.
2. Remove the cutting unit from the machine and place cutting unit on a flat work surface.
3. If equipped, remove rear roller brush from cutting unit; refer to Servicing the Rear Roller Brush (with or without a belt driven groomer) (page 7–34).
4. Remove the groomer drive cover and drive belt.
5. Loosen and remove the drive pulley from the cutting reel:

   A. Tip up the cutting unit to access the bottom of the reel.

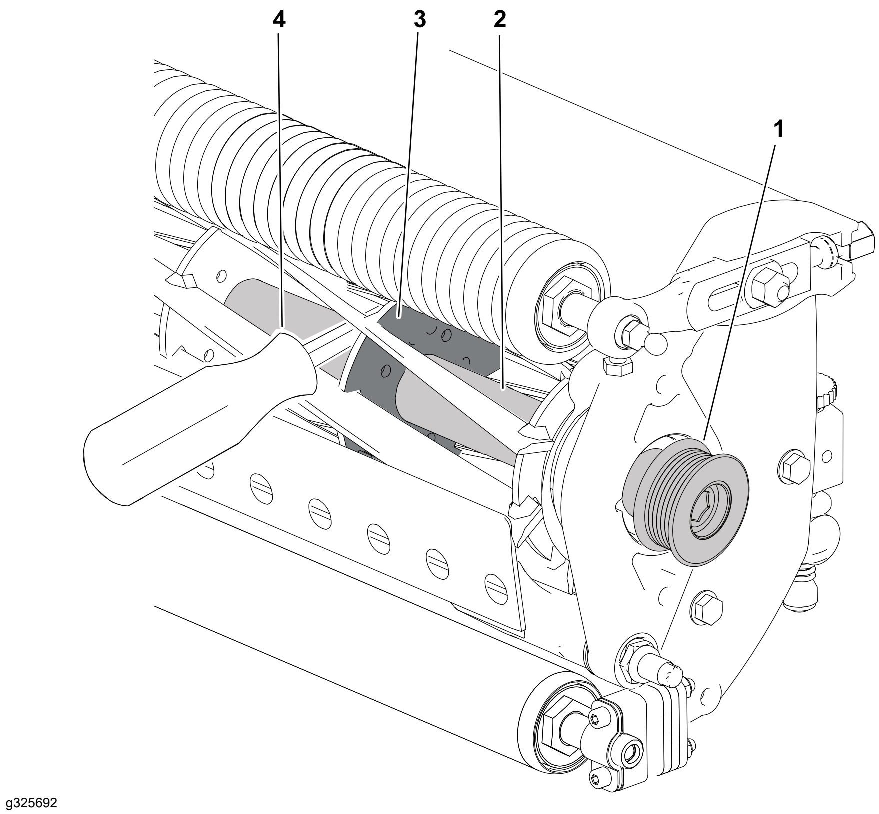

Figure 144

1.	Drive pulley	3.	Unwelded side of reel support plate
2.	Reel shaft	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.

Removing the Drive Plate (continued)

C. Move the pry bar against the weld side of the reel support plate closest to the drive pulley.

IMPORTANT

The drive pulley has left-hand threads. Turn the pulley driver or drive adapter clockwise to loosen.

D. Rest the handle of the pry bar against the front roller and loosen the drive pulley.

E. Tip the cutting unit back onto its rollers.

F. Clean the threads in the end of the reel shaft. A left-hand thread tap is available to clean or repair the threads if necessary; refer to Reel Thread Repair Taps (page 2–17).

6. Loosen pinch bolts that secure the front roller shaft to the groomer arms.

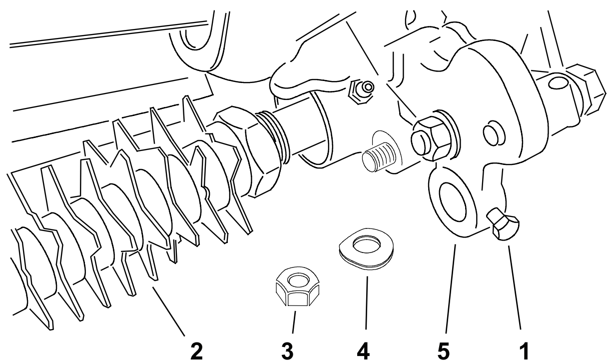

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Figure 145

1. Pinch bolt
2. Groomer reel
3. Lock nut
4. Spring washer
5. Groomer arm – LH

7. Remove the lock nut and spring washer that secure the LH groomer arm to the drive plate assembly.

   Note: To speed cutting unit setup after installing the groomer reel, do not change the height adjustment bolt or the groomer adjuster setting.

8. Remove the lock nut, special washer and plow bolt that secure the LH groomer arm assembly to the cutting unit side plate.

9. Remove the LH groomer arm and the front roller from the cutting unit.

10. Using the flats provided on the groomer reel shaft to prevent the groomer reel from turning, remove the locknut that secures the driven pulley to the groomer reel and remove the driven pulley.

Removing the Drive Plate (continued)

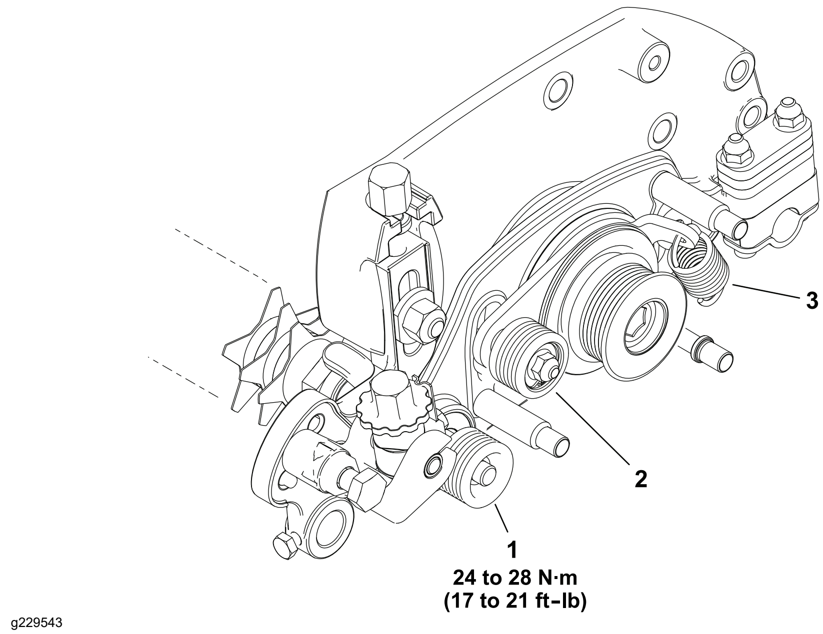


Figure 146

1. Driven pulley
2. Idler pulley
3. Idler arm extension spring

11. Remove the idler arm extension spring.
12. Remove the two shoulder bolts that secure the drive plate assembly to the cutting unit and remove the groomer drive plate assembly. Locate and retrieve the shim.
13. Inspect the seals, bushings and bearings in the drive plate, support plate and groomer arms for wear or damage. Replace components as needed.

Removing the Support Plate

Refer to Figure 143 for this procedure.

1. Park the machine on a clean and level surface, lower the cutting units completely to the ground, stop the engine, engage the parking brake and remove the key from the ignition switch.
2. Remove the cutting unit from the machine and place cutting unit on a flat work surface.
3. If equipped, remove rear roller brush from cutting unit; refer to Servicing the Rear Roller Brush (with or without a belt driven groomer) (page 7–34).
4. Loosen pinch bolts that secure the front roller shaft to the groomer arms.

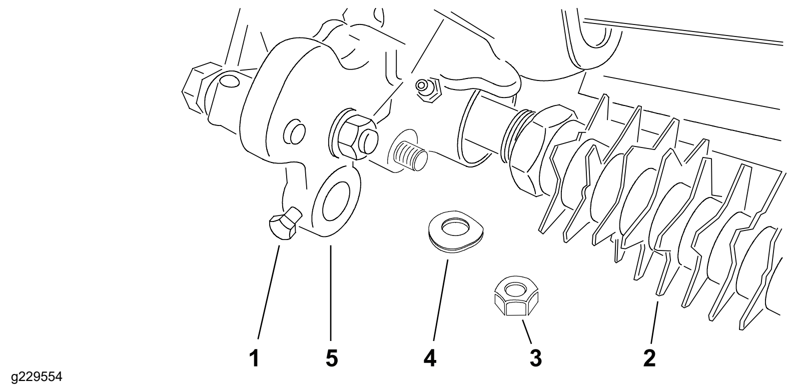


Figure 147

1. Pinch bolt	3. Lock nut	5. Groomer arm – RH
2. Groomer reel	4. Spring washer	

5. Remove the lock nut and spring washer that secure the RH groomer arm to the drive plate assembly.

   Note: To speed cutting unit setup after installing the groomer reel, do not change the height adjustment bolt or the groomer adjuster setting.
6. Remove the lock nut, tabbed washer and plow bolt that secure the RH groomer arm assembly to the cutting unit side plate.
7. Remove the RH groomer arm and the front roller from the cutting unit.
8. Remove the motor adapter and support plate.

Servicing the Drive and Support Plates

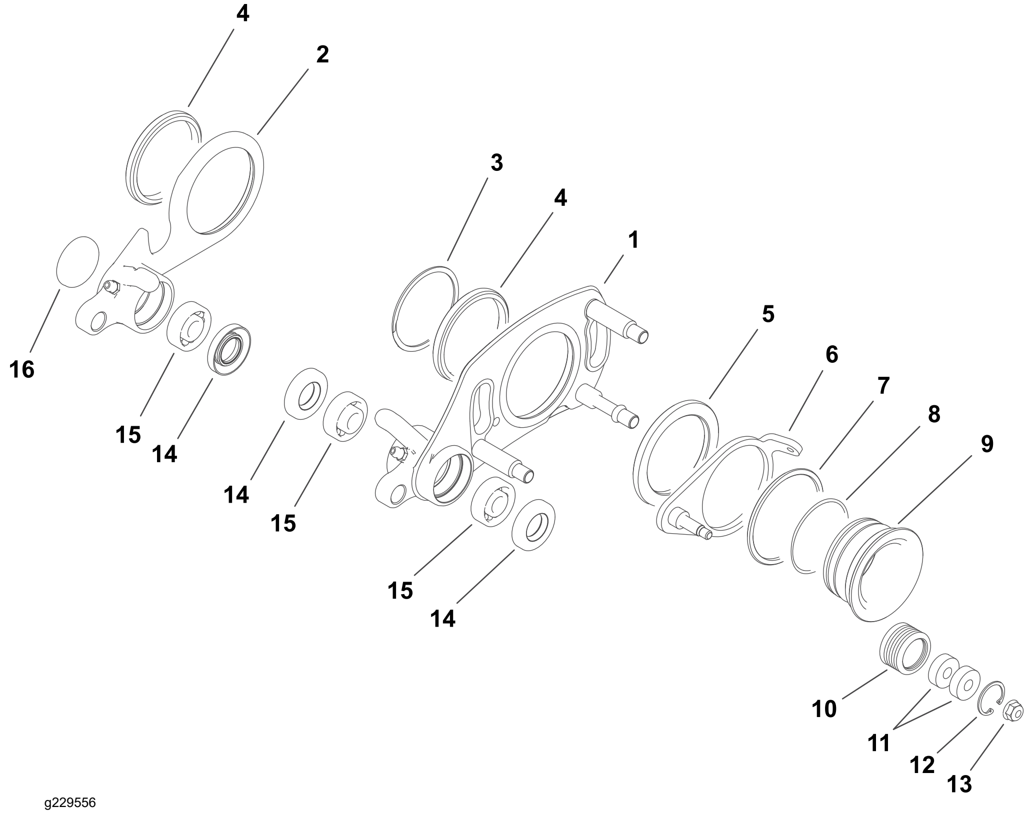


Figure 148

1. Drive plate
2. Support plate
3. Retaining ring
4. Bushing (2 each)
5. Spacer
6. Idler arm
7. Spacer
8. O-ring
9. Reel hub
10. Idler pulley
11. Bearing (2 each)
12. Retaining ring
13. Flange nut
14. Shaft seal (3 each)
15. Shaft bearing (3 each)
16. Expansion plug

---

1. Remove the retaining ring and separate the reel hub, spacers and idler arm from the drive plate.
2. Replace idler pulley bearings if necessary.
3. Remove and discard the O-ring and the groomer shaft seals.

   Note: Remove the expansion plug from the support plate to access the groomer shaft bearing.
4. Remove and discard the groomer shaft bearings.
5. Clean and inspect bearing bores in the drive and support plates. Inspect the drive and support plate bushings and replace as necessary.

Servicing the Drive and Support Plates (continued)

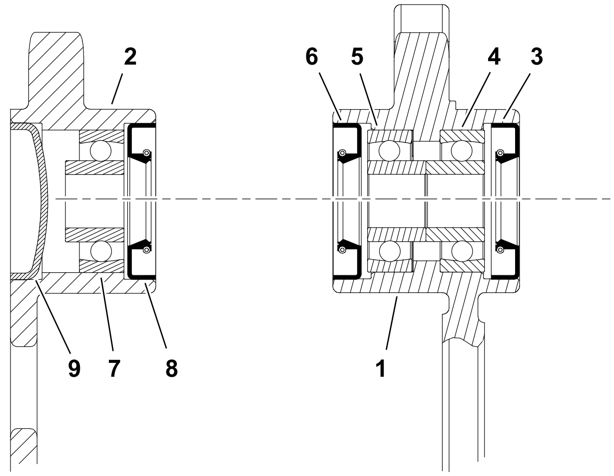


Figure 149

1. Drive plate
2. Support plate
3. Outer shaft seal
4. Outer bearing
5. Inner bearing
6. Inner shaft seal
7. Bearing
8. Seal
9. Expansion plug

IMPORTANT

Bearings should be installed with extended inner races toward center of plate. Apply pressure equally to inner and outer bearing races when installing bearings. Seals should be installed with the face of the seal toward the outside of the plate.

---

6. Install new groomer shaft bearings and seals:
   A. Press the outer bearing fully to the shoulder of the drive plate bore. Install the outer shaft seal as shown.
   B. Press the inner bearing into the drive plate until the inner race contacts the outer bearing. Install the inner shaft seal as shown.
   C. Press the bearing into the support plate until it is flush with shoulder of the bearing bore. Install the shaft seal and the expansion plug as shown.
7. Assemble the reel hub, spacers and idler arm to the drive plate and install the retaining ring.
8. Install a new O-ring on the reel hub.

Installing the Support Plate

Refer toFigure 143 for this procedure.

1. Fit the support plate over the motor adapter.
2. Apply a light coating of grease to the support plate end of the groomer reel shaft and to the seal lip in the support plate.
3. Apply a light coating of grease to the O-ring on the motor adapter and the pilot bore of the cutting unit side plate.
4. Carefully fit the support plate and motor adapter onto the groomer shaft and into the pilot bore of the cutting unit side plate. Secure the motor adapter to the cutting unit side plate with two socket head screws and lock nuts. Make sure the groomer reel and the support plate rotate freely after installation.
5. Insert the front roller into the LH groomer arm.
6. Install the RH groomer arm:
   A. Apply anti-seize lubricant to the shoulder of the groomer arm lift rod.
   B. Position the groomer arm over the front roller, through the support plate bushing and against the cutting unit side plate. Make sure the cutting unit side plate fits between the height adjustment bolt head and shoulder.
   C. Secure the groomer arm to the cutting unit side plate with the plow bolt, special washer and lock nut.

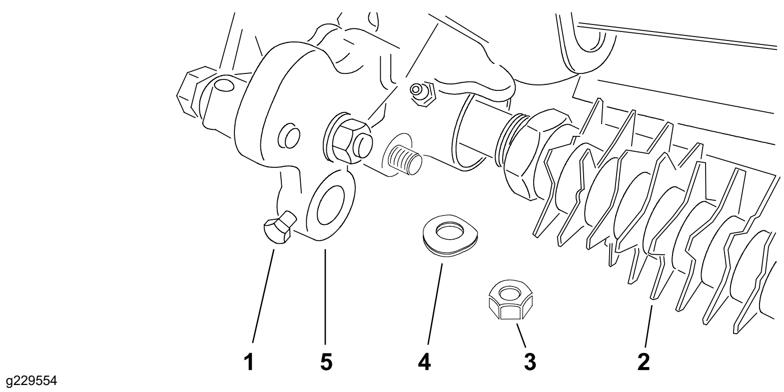


Figure 150

1. Pinch bolt
2. Groomer reel
3. Lock nut
4. Spring washer
5. Groomer arm – RH

   D. Secure the groomer arm to the drive plate with the spring washer and lock nut.

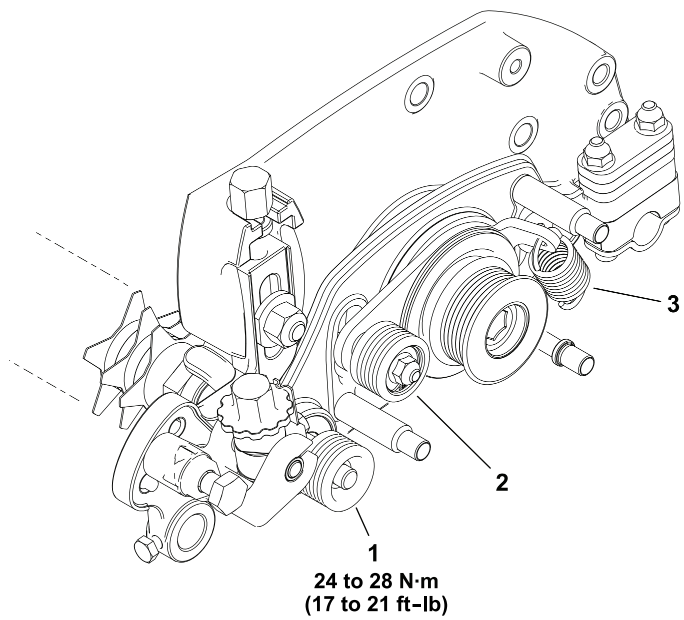
7. Center the front roller in the cutting unit and tighten both pinch bolts.
8. If equipped, install rear roller brush to cutting unit; refer to Servicing the Rear Roller Brush (with or without a universal groomer) (page 7–40).
9. Check and adjust cutting unit height-of-cut and groomer height settings; refer to the *Cutting Unit Operators Manual* and the *Groomer Installation Instructions*.
10. Lubricate the groomer bearings; refer to the *Groomer Installation Instructions*.

    Note: After greasing the groomer bearings, operate the groomer for 30 seconds, stop the machine and wipe any excess grease from the groomer shaft and seals.

Installing the Drive Plate

Refer to Figure 143 for this procedure.

1. Make sure that all drive plate bearings, bushings and seals are in good condition and properly installed.
2. Apply a light coating of grease to the drive end of the groomer reel shaft and to the seal lips in the drive plate.
3. Position the shim on the drive plate assembly.
4. Apply a light coating of grease to the O-ring on the drive plate pivot hub and the pilot bore of the cutting unit side plate.
5. Carefully fit the drive plate assembly onto the groomer shaft and into the pilot bore of the cutting unit side plate. Secure the drive plate to the cutting unit side plate with two shoulder bolts. Make sure the groomer reel, the drive plate and the idler arm rotate freely after installation.
6. Install the idler arm extension spring.



g229543

Figure 151

1. Driven pulley
2. Idler pulley
3. Idler arm extension spring

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7. Install the driven pulley and lock nut onto the grooming reel shaft. Using the flats provided on the groomer reel shaft to prevent the groomer reel from turning, tighten the locknut from **24 to 28 N·m (17 to 21 ft-lb)**.
8. Insert the front roller into the RH groomer arm.
9. Install the LH groomer arm:
   A. Apply anti-seize lubricant to the shoulder of the groomer arm lift rod.
   B. Position the groomer arm over the front roller, through the drive plate bushing and against the cutting unit side plate. Make sure the cutting unit side plate fits between the height adjustment bolt head and shoulder.
   C. Secure the groomer arm to the cutting unit side plate with the plow bolt, special washer and lock nut.

Installing the Drive Plate (continued)

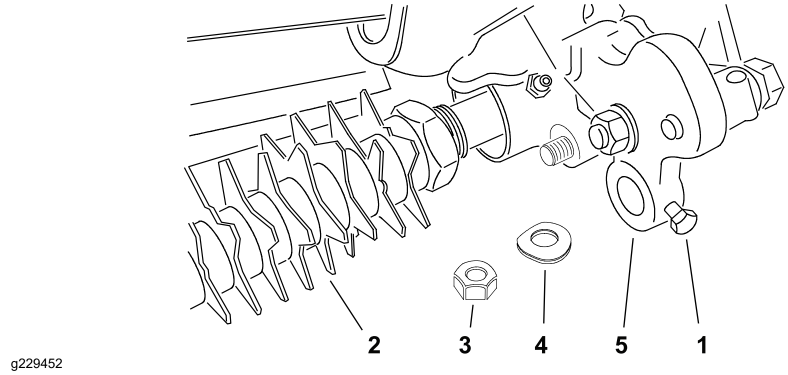


Figure 152

1. Pinch bolt
2. Groomer reel
3. Lock nut
4. Spring washer
5. Groomer arm – LH

D. Secure the groomer arm to the drive plate with the spring washer and lock nut.

10. Center the front roller in the cutting unit and tighten both pinch bolts.

11. Install the drive pulley:

A. Insert a long-handled pry bar through the front of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

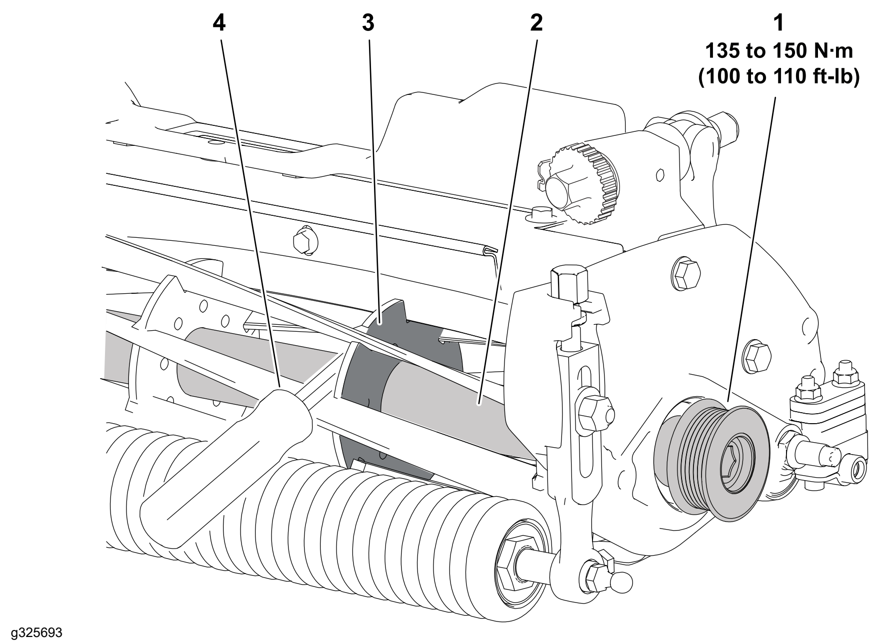


Figure 153

1. Drive pulley
2. Reel shaft
3. Unwelded side of reel support plate
4. Pry bar

B. Move the pry bar against the weld side of the reel support plate closest to the drive pulley.

IMPORTANT

The drive pulley has left-hand threads. Turn the drive pulley counterclockwise to tighten.

C. Rest the handle of the pry bar against the front roller and tighten the drive pulley from **135 to 150 N·m (100 to 110 ft-lb)**.

12. Install the groomer drive belt and drive cover.
13. If equipped, install rear roller brush to cutting unit; refer to Servicing the Rear Roller Brush (with or without a universal groomer) (page 7–40).
14. Check and adjust cutting unit height-of-cut and groomer height settings; refer to the *Cutting Unit Operators Manual* and the *Groomer Installation Instructions*.
15. Lubricate the groomer bearings; refer to the *Groomer Installation Instructions*.

    Note: After greasing the groomer bearings, operate the groomer for 30 seconds, stop the machine and wipe any excess grease from the groomer shaft and seals.

The Groomer Reel

Removing the Groomer Reel

1. Remove the groomer drive plate; refer to Removing the Drive Plate (page 8–8).
2. Carefully pull the grooming reel from the support plate on the right side of the cutting unit.
3. Retrieve and discard the O-ring from the support plate end of the groomer reel shaft.

Servicing the Groomer Reel

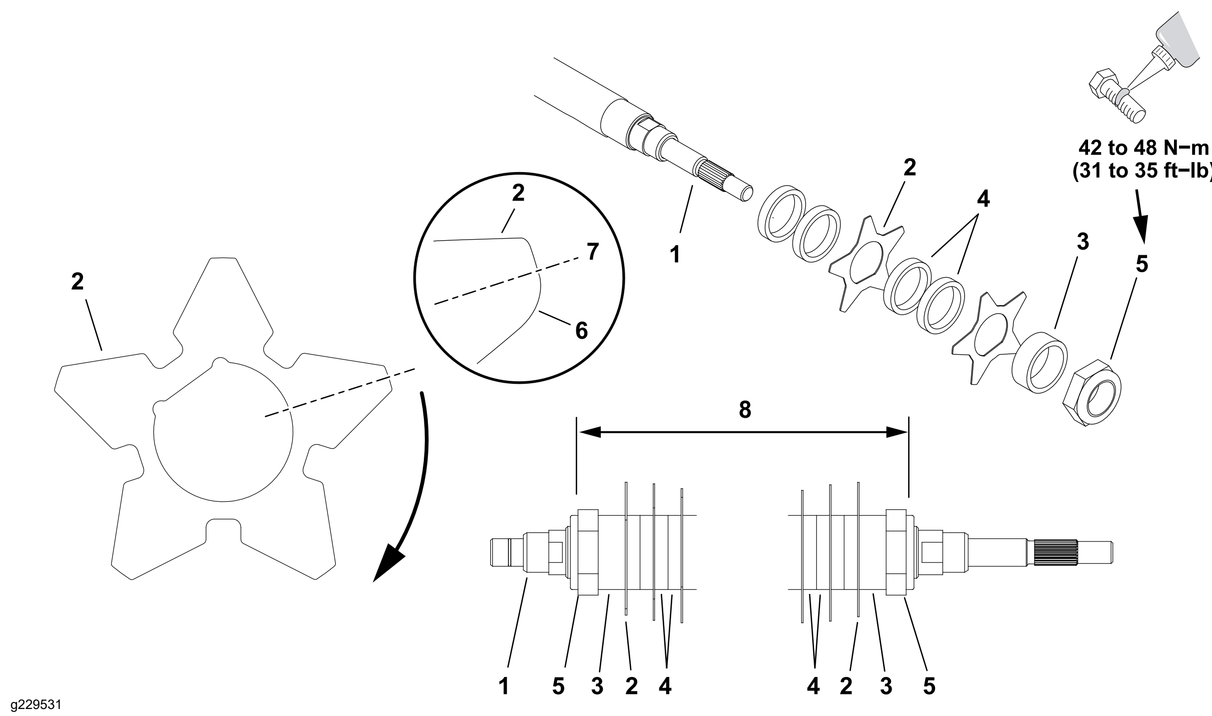


Figure 154

1. Groomer reel shaft
2. Groomer blade (42 each)
3. Spacer – thick (2 each)
4. Spacer – thin (82 each)
5. Locknut (2 each)
6. Rounded edge
7. Midpoint
8. Centered on shaft

Inspect the groomer reel blades frequently for any damage and wear. Straighten the bent blades. Either replace the worn blades or reverse the individual blades to put the sharpest blade edge forward. The blades that are rounded to the midpoint of the blade tip must be reversed or replaced for best groomer performance: refer to Figure 154.

1. Park the machine on a clean and level surface, lower the cutting units completely to the ground, set the parking brake, and remove the key from the key switch.
2. Remove the groomer reel from the cutting unit; refer to Removing the Groomer Reel (page 8–18).
3. Remove the lock nut from either end of the groomer reel shaft.
4. Remove the blades and from the groomer shaft. If necessary, remove second lock nut from the shaft.
5. Inspect and replace worn or damaged components.
6. Assemble the groomer reel as follows:

Servicing the Groomer Reel (continued)

Note: New lock nuts have an insert to prevent the lock nut from loosening. If a used lock nut is being installed, apply a medium strength thread locker (Loctite #242 or equivalent) to the threads of the lock nut.

A. Install a lock nut on one end of the groomer reel shaft.

B. Install a single 12 mm (0.46 inch) spacer against the lock nut. Then, place the first blade against the spacer installed.

Note: For standard 13 mm (1/2 inch) spacing, fit two 5.6 mm (0.22 inch) spacers between each blade.

C. Install the remaining spacers and blades in an alternating manner making sure that all blades are separated by one or more spacers.

D. When all the blades have been installed, install the second lock nut onto the shaft. Center the blades and spacers on the shaft by adjusting the lock nuts.

E. Use the flats provided on the groomer reel shaft to prevent the shaft from rotating and tighten the second lock nut to **42 to 48 N·m (31 to 35 ft-lb)**. After tightening the lock nut, spacers should not be free to rotate and the groomer blades should be centered on the shaft.

7. Install the groomer reel back onto the cutting unit; refer to Installing the Groomer Reel (page 8–19).

Installing the Groomer Reel

1. Make sure that all support plate bearings, bushings and seals are in good condition and properly installed.
2. Install a new O-ring on the support plate end of the groomer reel shaft.
3. Apply a light coat of grease to the O-ring, the support plate end of the groomer reel shaft and to the seal lip in the support plate.
4. Carefully fit the groomer reel into the support plate.
5. Install the groomer drive plate; refer to Installing the Drive Plate (page 8–15).

The Groomer Arm Assemblies

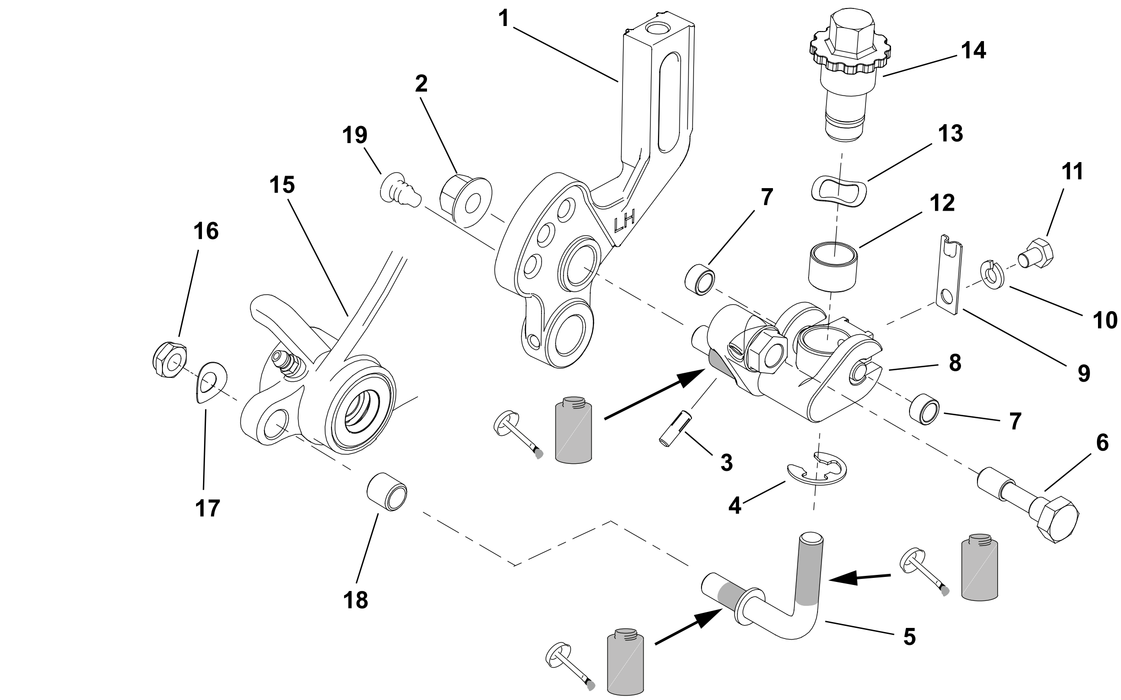


Figure 155

1. Groomer arm – LH	8. Lift arm assembly	15. Drive plate
2. Flange nut	9. Detent spring	16. Lock nut
3. Grooved pin	10. Lock washer	17. Spring washer
4. E-ring	11. Cap screw	18. Bushing
5. Lift rod	12. Bushing	19. Plastic plug
6. Lock screw	13. Wave washer	
7. Bushing (2 each)	14. Adjuster	

The right side and left side groomer arms and lift arm assemblies are unique, the remaining components are the same on both side of the groomer.

Removing the Groomer Arms

1. Loosen pinch bolts that secure the front roller shaft to the groomer arms.
2. Remove the lock nut and spring washer that secure the either groomer arm to the plate assembly.
3. Remove the lock nut, special washer and plow bolt that secure the groomer arm to the cutting unit side plate.
4. Remove the groomer arm and the front roller from the cutting unit.
5. Repeat the procedure for the remaining groomer arm.
6. Disassemble the groomer arm as necessary. Clean and inspect all components and replace items as necessary.

Installing the Groomer Arms

1. Paying attention to the orientation of the components for either the left side or the right side application, assemble the groomer arm as necessary.
   A. Install the lock screw before installing the grooved pin. The grooved pin is used to retain the lock screw.
   B. Apply anti-seize lubricant to the threads of the lift rods before installing the adjusters.

Installing the Groomer Arms (continued)

2. Apply anti-seize lubricant to the shoulder of the groomer arm lift rods and the shoulder of the lift arm studs.
3. Position either groomer arm through the drive plate bushing and against the cutting unit side plate. Make sure the cutting unit side plate fits between the height adjustment bolt head and shoulder.
4. Secure the groomer arm to the cutting unit side plate with the plow bolt, special washer and lock nut.
5. Secure the groomer arm to the plate with the spring washer and lock nut.
6. Insert the front roller into the installed groomer arm.
7. Repeat the procedure for the remaining groomer arm.
8. Center the front roller in the cutting unit and tighten both pinch bolts.

The Grooming Brushes (Optional)

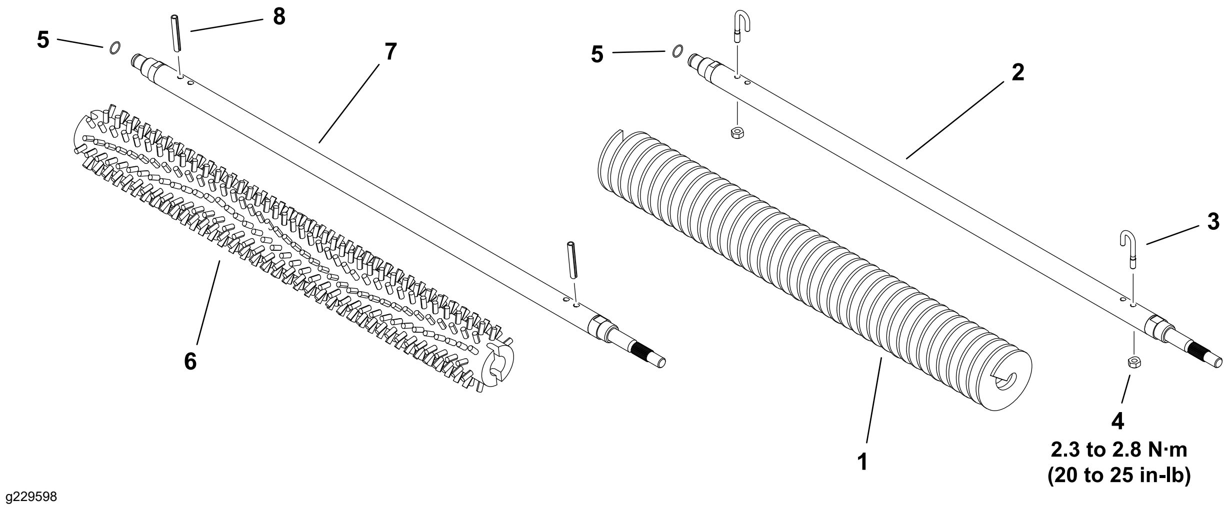


Figure 156

1. Spiral brush
2. Spiral brush shaft
3. J-bolt (2 each)
4. Lock nut (2 each)
5. O-ring
6. Grooming brush
7. Grooming brush shaft
8. Roll pin (2 each)

The optional grooming brush attaches to the groomer in place of the groomer reel. The grooming brush is removed and installed from the groomer in the same manner as the groomer reel; refer to The Groomer Reel (page 8–18).

The grooming brush elements or shafts can be serviced separately.

To remove the spiral grooming brush from the shaft, remove the lock nut and J-bolt from both ends of the brush assembly and slide the brush from the shaft. When assembling the spiral brush to the shaft, make sure that the J-bolts are installed with the threaded portion on the outside of the brush (as shown) and tighten the lock nuts from **2.3 to 2.8 N·m (20 to 25 in-lb)**.

Chapter 9

Universal Groomer (Optional)

Table of Contents

Specifications

Universal Groomer

Item	Description
Grooming reel diameter	6 cm (2.375 inches)
Groomer blade type	**Spring Steel:** 40 steel blades with 1/2 inch blade spacing. **Carbide:** 40 steel blades with 1/2 inch blade spacing. **Thin blade:** 81 steel blades with 1/4 inch blade spacing. The groomer brush can be installed in place of grooming reel.
Groomer mounting	The groomer is mounted to the cutting unit side plates. The drive assembly for the grooming reel is located on the opposite side of the cutting unit from the hydraulic cutting reel motor.
Groomer height setting	**Mowing:** 0.8 to 15.7 mm (0.030 to 0.620 inch). **HOC range:** 1.5 to 19.1 mm (0.060 to 0.750 inch).
Width-of-groomer	54.6 cm (21.5 inches).
Height adjustment knob	Allows a 0.003 inch (0.08 mm) increment of height adjustment for each click of the adjuster.
Quick-up feature	Allows grooming reel to be raised above the height/depth adjustment for no grooming reel action while mowing.
Groomer drive	The groomer drive assembly is attached to the right side of the cutting unit.

General Information

Installation Instructions

The *Installation Instructions* for the groomer provides information regarding the set-up, operation, general maintenance procedures, and maintenance intervals for the groomer assembly on your Greensmaster machine. Refer to the *Installation Instructions* for additional information when servicing the groomer assembly.

Grooming Performance

There are a number of factors that can affect the performance of grooming. These factors vary for different golf courses and from fairway to fairway. It is important to inspect the turf frequently and vary the grooming practice with turf needs.

IMPORTANT

Improper or overaggressive use of the groomer (e.g., too deep or too frequent grooming) may cause unnecessary stress on the turf leading to severe turf damage. Use the groomer carefully. Read and understand the groomer operation instructions before operating or testing the groomer performance.

It is important to remember that the same factors that affect quality of cut also affect grooming performance.

Variables that Affect the Use and Performance of the Groomer:

1. The growing season and weather conditions.
2. General turf conditions.
3. The frequency of grooming/cutting–number of cuttings per week and how many passes per cutting.
4. The height-of-cut.
5. The grooming depth.
6. The type of grass.
7. The amount of time that a groomer reel has been in use on a particular turf area.
8. The amount of traffic on the turf.
9. The overall turf management program–irrigation, fertilizing, weed control, coring, over-seeding, sand dressing, disease control, and pest control.
10. Stress periods for turf–high temperatures, high humidity, and unusually high traffic.

Troubleshooting

Problem	Possible Causes	Correction
The groomer reel does not rotate.	The groomer drive is in neutral.	Engage the groomer drive to forward or reverse.
	The groomer drive gears are damaged or seized.	Repair the groomer drive.

Troubleshooting (continued)

Problem	Possible Causes	Correction
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

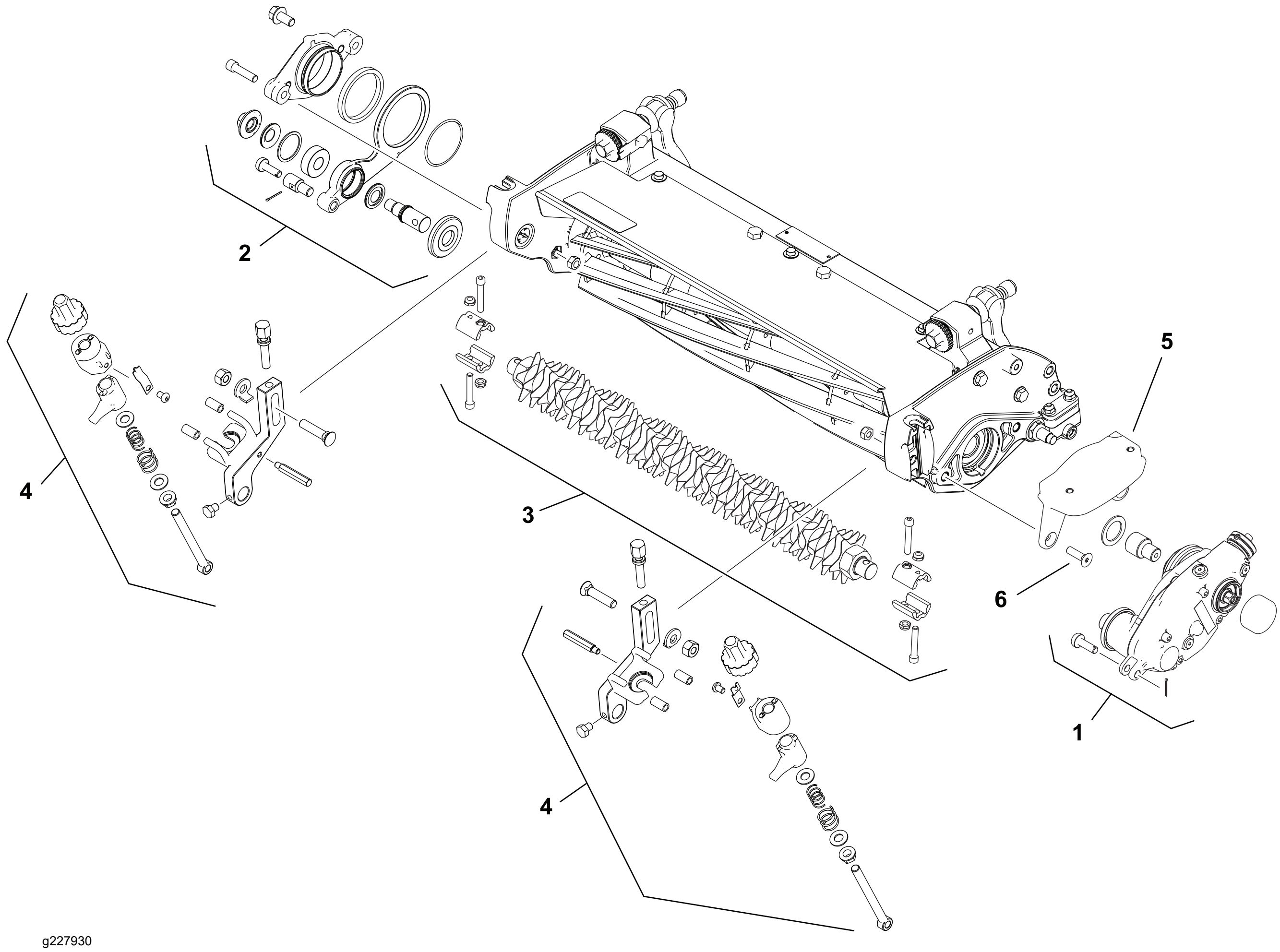


Figure 157

1. Gear box assembly
2. Idler assembly
3. Groomer reel
4. Height adjuster assembly (2 each)
5. Weight
6. Flat head screw (2 each)

CAUTION

Never work on the groomer with the engine running. Always stop the engine, remove the key from the ignition switch and wait for all machine movement to stop before working on the groomer.

The Gear Box Assembly

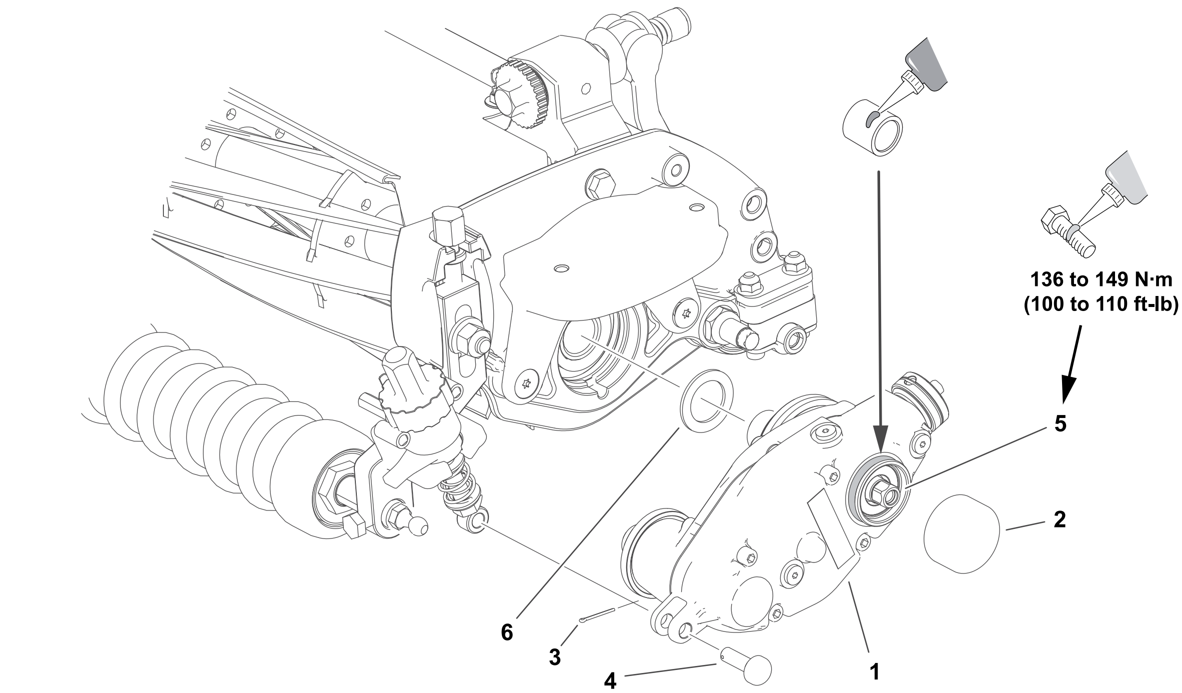


Figure 158

1. Gear box assembly
2. Drive shield
3. Cotter pin
4. Clevis pin
5. Input shaft
6. Shim

The groomer gear box assembly is located on the opposite side of the cutting unit from the cutting unit hydraulic motor.

Removing the Gear Box Assembly

IMPORTANT

All of the groomer gear boxes for this machine are installed on the left side of the cutting unit. Groomer gear boxes installed on the left side of the cutting unit use a left hand thread. Turn the input shaft (rear roller brush drive shaft) clockwise to remove the gear box.

1. Park the machine on a clean and level surface, lower the cutting units completely to the ground, set the parking brake, and remove the key from the key switch.
2. Remove the groomer reel assembly; refer to Removing the Groomer Reel (page 9–17).
3. Remove the drive shield, or, if the cutting unit is equipped with an optional powered rear roller brush, remove the rear roller brush drive assembly to service the groomer drive; refer to Servicing the Rear Roller Brush (with or without a universal groomer) (page 7–40).
4. Install a 5/16–18 X 5/8 inch square head set screw (Toro p/n 1-803022) in the end of the drive shaft and tighten to **13 N·m (120 in-lb)**; refer to Figure 159.
5. Remove the cotter pin and clevis pin from the height adjustment rod at the front of the groomer gear box. Discard the cotter pin.

Removing the Gear Box Assembly (continued)

6. Tip up the cutting unit to access the bottom of the reel to remove the drive shaft assembly.

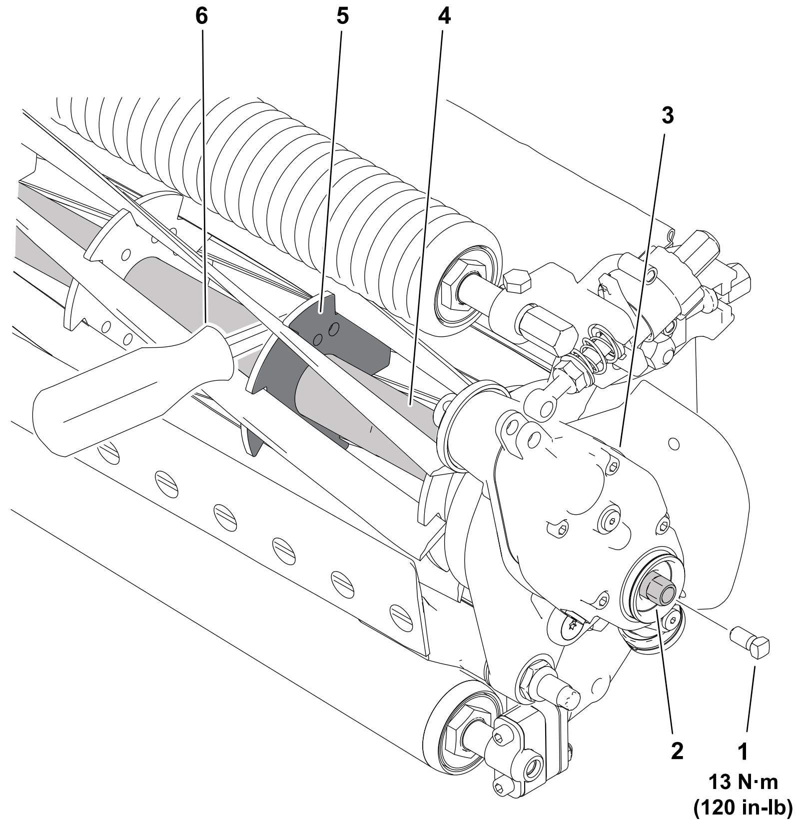


Figure 159

1. 5/16–18 X 5/8 inch square head set screw
2. Input shaft assembly
3. Groomer gear box assembly
4. Reel shaft
5. Unwelded side of reel support plate
6. Pry bar

7. Insert a long-handled pry bar (3/8 x 12 inch with screwdriver handle recommended) through the bottom of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

IMPORTANT

To avoid grinding the reel, do not contact the cutting edge of any blade with the pry bar as this may damage the cutting edge and/or cause a high blade.

8. Move the pry bar against the weld side of the reel support plate closest to the groomer gear box.

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 clockwise to remove the gear box.

9. Rest the handle of the pry bar against the front roller and turn the drive shaft clockwise to loosen it from the reel. Continue to unscrew the drive shaft and remove the gear box from the cutting unit.
10. Retrieve the shim (item 6 in Figure 158).
11. If the hex head on the end of the drive shaft is damaged during removal:
    A. Remove the drain/fill plug and drain the oil from the gear box.

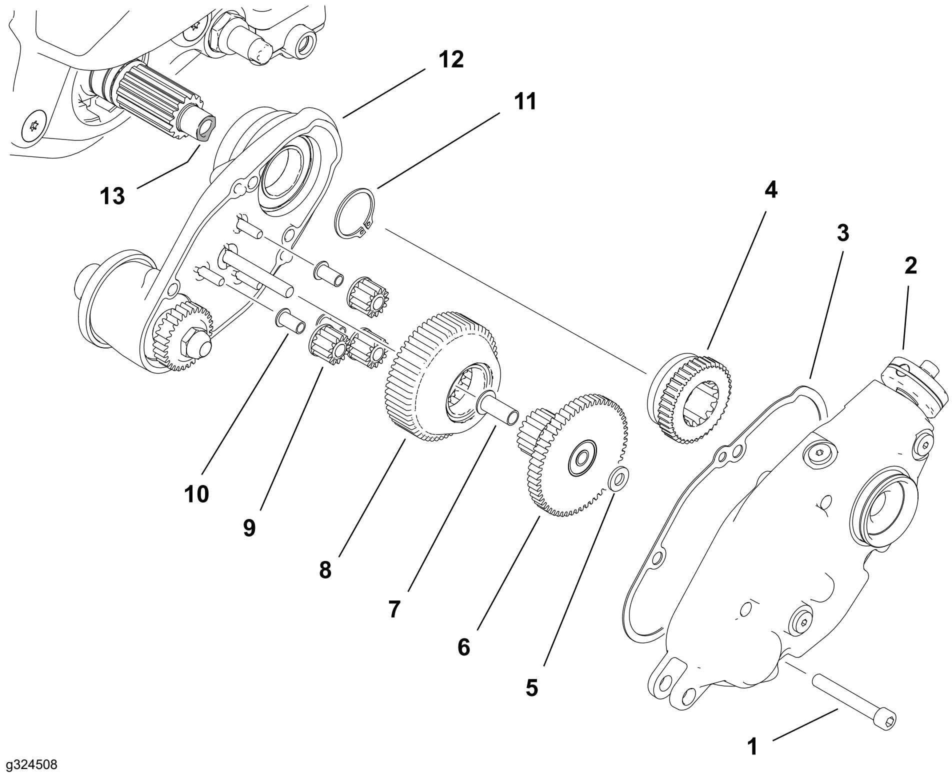


Figure 160

1. Socket head screw (4 each)
2. Gear box cover assembly
3. Cover gasket
4. Driven gear
5. Thrust washer
6. Ring gear
7. Flange bushing
8. Sun gear
9. Planet gear (3 each)
10. Flange bushing (3 each)
11. Retaining ring
12. Gear box housing assembly
13. Damaged drive shaft

    B. Remove the 4 socket-head screws and remove the gear box cover assembly and driven gear. Remove and discard the cover gasket.
    C. Slide the thrust washer, ring gear and bushing from the gear box housing.
    D. Slide the sun gear, and planet gears and bushings from the pins on the gear box housing.

Removing the Gear Box Assembly (continued)

E. Remove the retaining ring from the drive shaft.

F. Slide the groomer housing assembly from the drive shaft.

G. Tip up the cutting unit to access the bottom of the reel to remove the drive shaft assembly.

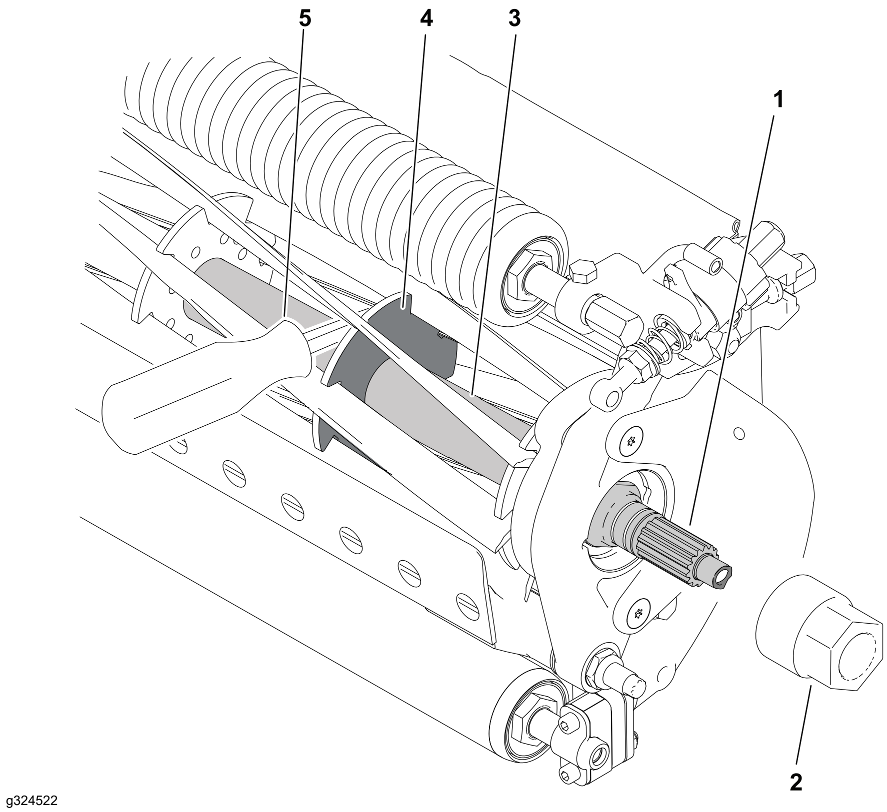


Figure 161

1. Damaged input shaft assembly
2. Drive shaft removal tool
3. Reel shaft
4. Unwelded side of reel support plate
5. Pry bar

H. Insert a long-handled pry bar (3/8 x 12 inch with screwdriver handle recommended) through the bottom of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

IMPORTANT

To avoid grinding the reel, do not contact the cutting edge of any blade with the pry bar as this may damage the cutting edge and/or cause a high blade.

I. Move the pry bar against the weld side of the reel support plate closest to the drive shaft assembly.

J. Use the drive shaft removal tool on the large flats of the drive shaft assembly; refer to Drive Shaft Removal Tool (page 2–19).

Removing the Gear Box Assembly (continued)

IMPORTANT

The drive shaft for groomer gear boxes installed on the left side of the cutting unit use a left hand thread.

K. Rest the handle of the pry bar against the front roller and turn the drive shaft clockwise to loosen it from the reel.

12. Retrieve the shim (item 6 in Figure 158.
13. Tip the cutting unit back onto its rollers.
14. Clean the threads in the end of the reel shaft. A right-hand thread and left-hand thread tap is available to clean or repair the threads if necessary; refer to Reel Thread Repair Taps (page 2–17).

Servicing the Gear Box

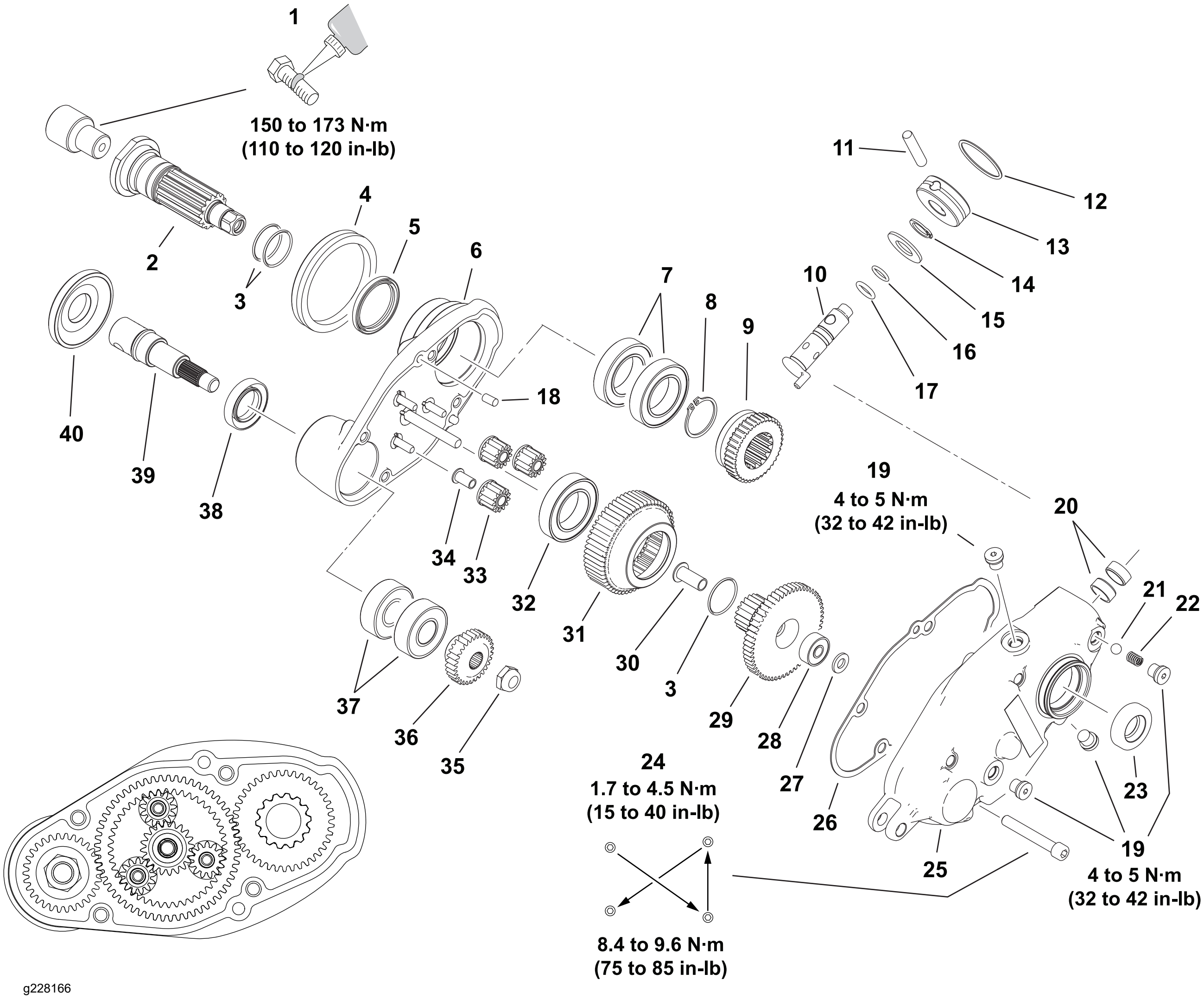


Figure 162

1. Drive adapter
2. Input shaft
3. O-ring (3 each)
4. V-ring
5. Oil seal
6. Groomer housing
7. Ball bearing (2 each)
8. Retaining ring
9. Driven gear
10. Actuator shaft
11. Pin
12. O-ring
13. Knob
14. Retaining ring
15. Thrust washer
16. O-ring
17. O-ring
18. Dowel pin (2 each)
19. Drain/fill plug (4 each)
20. Straight bushing (2 each)
21. Detent ball
22. Detent spring
23. Oil seal
24. Socket-head screw(4 each)
25. Groomer cover
26. Gasket
27. Thrust washer
28. Ball bearing
29. Ring gear
30. Flange bushing
31. Sun gear
32. Bearing
33. Planet gear (3 each)
34. Flange bushing (3 each)
35. Locknut
36. Driver gear
37. Bearing (2 each)
38. Oil seal
39. Driven shaft
40. Shield

Servicing the Gear Box (continued)

1. Remove the drain/fill plug and drain the oil from the gear box.
2. Remove the 4 socket-head screws and separate the gear box cover and housing. Remove and discard the cover gasket.
3. Slide the sun gear, ring gear, and planet gears from the pins on the gear box housing.
4. Continue to disassemble the gear box as necessary.
5. If the drive adapter requires replacement, apply medium strength thread locking compound (Loctite 243 or equivalent) to the internal threads of the drive shaft and the larger threads of the drive adapter (reel end). Allow the thread locking compound to cure for 15 minutes before continuing this procedure.

CAUTION

Use the large 1.375 inch flats on the drive shaft to prevent the drive shaft from rotating during drive adapter removal and installation. DO NOT use the 0.5 inch hex head on the drive shaft for drive adapter removal or installation as drive shaft damage may occur.

Note: A special tool is available to hold the drive shaft if necessary; refer to Adapter Wrench (page 2–20).

6. Tighten the drive adapter from **150 to 163 N·m (110 to 120 ft-lb)**.
7. Carefully clean all the gasket material from the gear box housing and cover.
8. Inspect the V-ring, seals, bearings, gears, and bushings in the gear box assembly. Replace the damaged or worn components as necessary.
9. If the sun gear, ring gear, or the gear box housing bearings are replaced, press the bearings all the way to shoulder into the part.
10. If the flange bushings are replaced, ensure that the flange bushing is fully seated against the part.
11. Assembly the gearbox.
    - Ensure that all the retaining rings and O-rings are fully seated in the ring groove during assembly.
    - Lubricate the seal lips and O-rings before installing the shafts.
    - Lubricate the planet gear and sun gear pins in the gear box housing with the gear oil prior to installing the gears.
12. Clean the gasket surface on the gear box housing and cover with the solvent and install new gasket.
13. Fit the gear box cover over dowel pins and install the 4 socket-head screws. Tighten the screws from **1.7 to 4.5 N·m (15 to 40 in-lb)**. In an alternating cross pattern, tighten the screws from **8.4 to 9.6 N·m (75 to 85 in-lb)**.
14. Fill the gear box with 80W−90 gear oil and tighten the drain/fill plug from **4 to 5 N·m (32 to 42 in-lb)**.

    The gear box oil capacity is **50 ml (1.7 fluid ounces)**.
15. Operate the groomer gear box by hand to check for proper operation prior to installation.

Installing the Gear Box Assembly

IMPORTANT

All of the groomer gear boxes for this machine are installed on the left side of the cutting unit. Groomer gear boxes installed on the left side of the cutting unit use a left hand thread. Turn the input shaft (rear roller brush drive shaft) counter-clockwise to install the gear box.

Refer to Figure 158 for this procedure.

1. Apply medium strength thread locking compound (Loctite 243 or equivalent) to the threads in the reel and allow the thread locking compound to cure for 15 minutes before continuing this procedure.
2. Fit the shim (item 6 in Figure 158) over the input shaft.
3. Insert a long-handled pry bar through the front of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

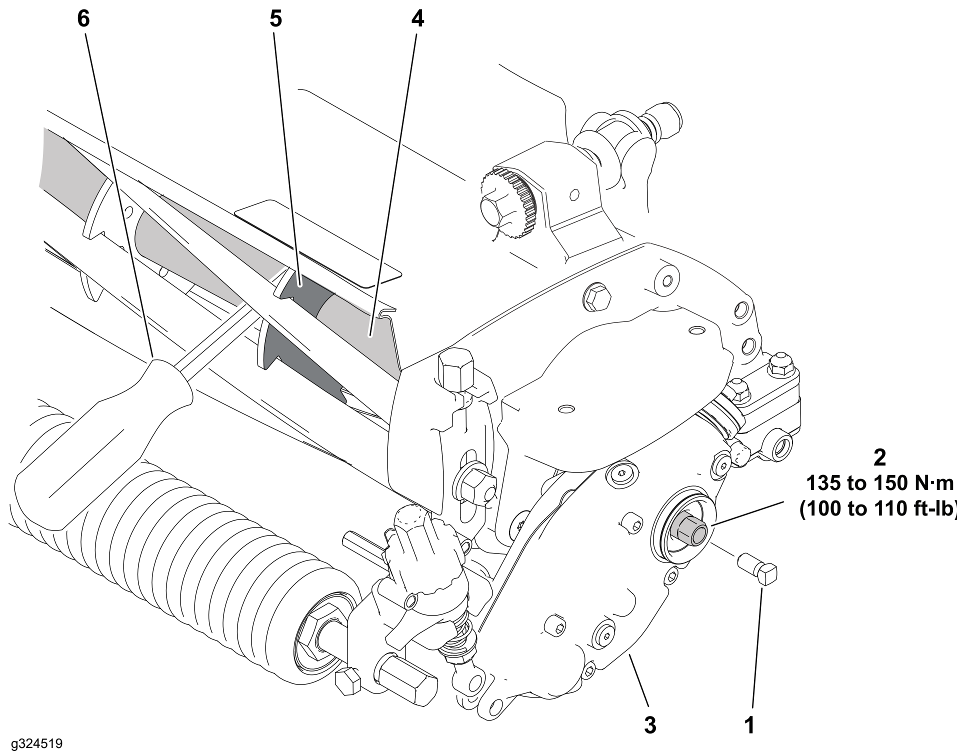


Figure 163

1.	5/16–18 X 5/8 inch square head set screw	4.	Reel shaft
2.	Input shaft assembly	5.	Unwelded side of reel support plate
3.	Groomer gear box assembly	6.	Pry bar

4. Move the pry bar against the weld side of the reel support plate closest to the gear box assembly and rest the handle of the pry bar against the front roller.

Installing the Gear Box Assembly (continued)

IMPORTANT

Groomer gear boxes installed on the left side of the cutting unit use a left hand thread; turn the drive shaft counterclockwise to install the gear box.

5. Position the gear box assembly against the cutting unit and turn the drive shaft assembly counterclockwise until it is seated against the reel.

IMPORTANT

You must use a 6-point socket with a heavy wall to install the gear box to the reel. Do not use an impact wrench.

6. Tighten the drive shaft assembly from **135 to 150 N·m (100 to 110 ft-lb)**.
7. Remove the square head set screw from the end of the drive shaft.
8. Install the clevis pin and a new cotter pin to secure the height adjustment rod to the front of the groomer gear box.
9. Apply a retaining compound (Loctite 609 or equivalent) to the lip of the drive housing and install the drive shield, or, if the cutting unit is equipped with an optional powered rear roller brush, install the rear roller brush drive assembly; refer to Rear Roller Brush (Optional) in Chapter 7 – DPA Cutting Units.
10. Install the groomer reel assembly; refer to Installing the Groomer Reel (page 9–19).

The Idler Assembly

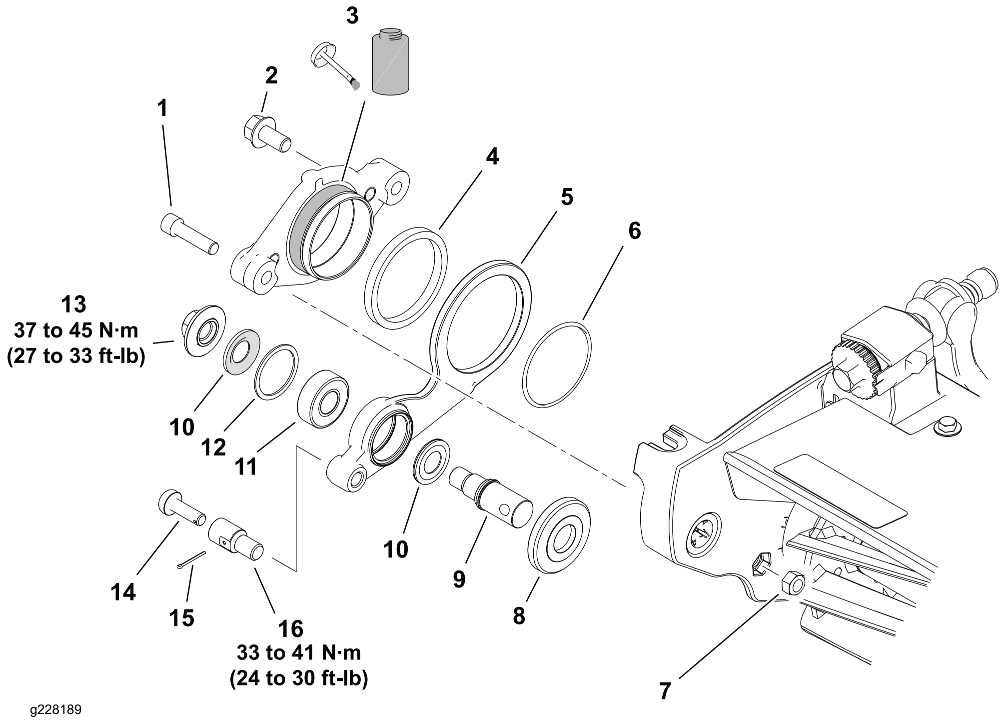


Figure 164

1. Socket-head screw (2 each)
2.
3. Motor adapter
4. Bushing
5. Idler arm
6. O-ring
7. Lock nut (2 each)
8. Shield
9. Stub shaft
10. Flocked seal (2 each)
11. Bearing
12. Retaining ring
13. Flange nut
14. Clevis pin
15. Cotter pin
16. Collar

The groomer idler assembly is located on the opposite side of the groomer gear box.

Removing the Idler Assembly

1. Park the machine on a clean and level surface, lower the cutting units completely to the ground, set the parking brake, and remove the key from the key switch.
2. Remove the reel motor from the cutting unit; refer to Removing the Reel Motors (page 4–110).
3. Remove the groomer reel assembly; refer to Removing the Groomer Reel (page 9–17).
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 two socket-head screws that secure the motor adapter to the cutting unit, and remove the adapter and idler assembly. Retrieve and discard the O-ring and lock nuts.
6. Inspect the shields, bearing, and bushing in the idler assembly. Replace any components that are worn or damaged.

Installing the Idler Assembly

1. If the shields, bearing, or bushing was removed from the idler arm:
   A. Press the bushing into a groomer plate until the bushing is centered in the idler arm bore.
   B. Press the bearing into the idler arm so that the bearing contacts the shoulder in idler arm bore and install the bearing retaining ring.
   C. Install the bearing shields with the flocked side of the shield toward the bearing.
   D. Insert the stub shaft through the shields and bearing. Use the through hole in the shaft to prevent the shaft from rotating and tighten the flange nut from **37 to 45 N·m (27 to 33 ft-lb)**.
   E. If the collar was removed from the idler arm, install the collar and tighten from **33 to 41 N·m (24 to 30 ft-lb)**.
2. Fit a new O-ring to the motor adapter.
3. Apply anti-seize lubricant to the outside diameter of the motor adapter and position the idler arm over the adapter.
4. Use new lock nuts and secure the motor adapter and idler arm to the cutting unit side plate.
5. Install the clevis pin and a new cotter pin to secure the height adjustment rod to the front of the idler arm.
6. Install the reel motor; refer to Installing the Reel Motors (page 4–111).

The Groomer Reel

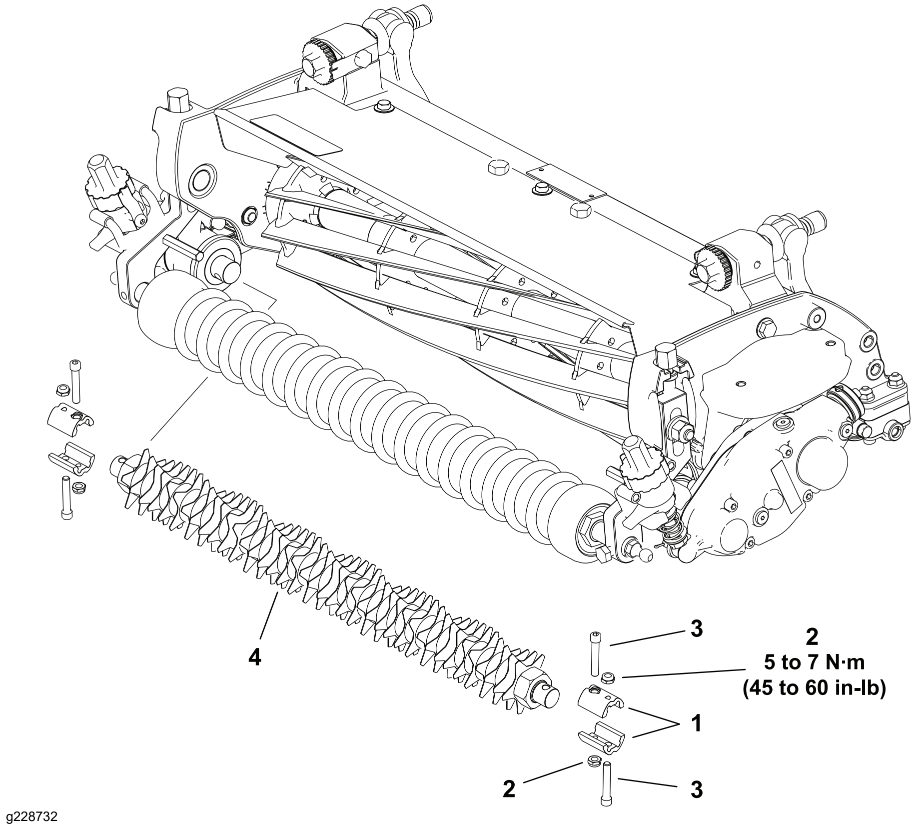


Figure 165

1. Shaft clamp (4 each)
2. Jam nut (4 each)
3. Bolt (4 each)
4. Groomer reel

Remove the groomer reel to replace individual groomer blades or replace the shaft. The groomer reel can be reversed to provide additional blade life.

Removing the Groomer Reel

1. Park the machine on a clean and level surface, lower the cutting units completely to the ground, set the parking brake, and remove the key from the key switch.

CAUTION

Contact with the reel or other cutting unit parts can result in personal injury.

Use heavy gloves when handling the groomer reel.

---

2. Carefully remove the 4 jam nuts, 4 bolts, and 4 shaft clamps that secure the groomer reel to the output and stub shafts.
3. Lift the groomer reel from the cutting unit.
4. Inspect the shields, stub shaft, driven shaft and shaft bearings for wear or damage and replace components as necessary; refer to The Gear Box Assembly (page 9–6) and The Idler Assembly (page 9–15).

Servicing the Groomer Reel

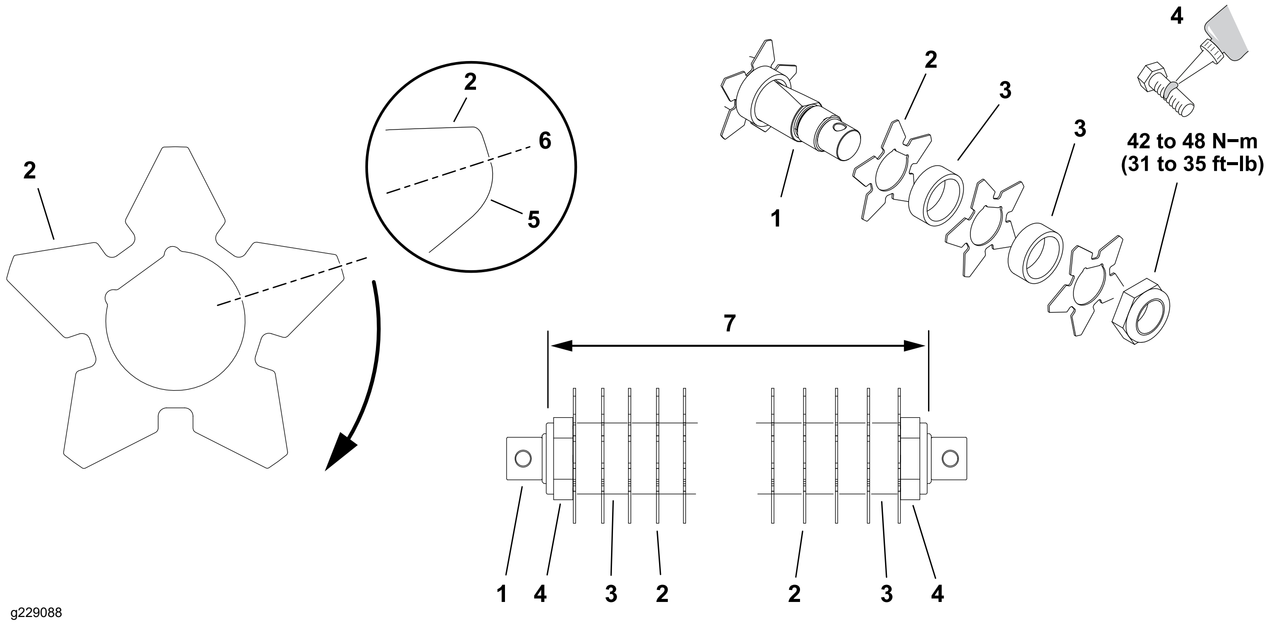


Figure 166

1. Groomer reel shaft
2. Groomer blade (40 each)
3. Spacer (39 each)
4. Locknut (2 each)
5. Rounded edge
6. Midpoint
7. Centered on shaft

Inspect the groomer reel blades frequently for any damage and wear. Straighten the bent blades. Either replace the worn blades or reverse the individual blades to put the sharpest blade edge forward. The blades that are rounded to the midpoint of the blade tip must be reversed or replaced for best groomer performance: refer to Figure 166.

1. Park the machine on a clean and level surface, lower the cutting units completely to the ground, set the parking brake, and remove the key from the key switch.
2. Remove the groomer reel from the cutting unit; refer to Removing the Groomer Reel (page 9–17).
3. Remove the lock nut from either end of the groomer reel shaft.
4. Remove the blades and from the groomer shaft. If necessary, remove second lock nut from the shaft.
5. Inspect and replace worn or damaged components.
6. Assemble the groomer reel as follows:

   Note: New lock nuts have an adhesive patch to prevent the lock nut from loosening. If a used lock nut is being installed, apply a medium strength thread locker (Loctite #242 or equivalent) to the threads of the lock nut.

   A. Install a lock nut on one end of the groomer reel shaft.

   B. Install a groomer blade against the lock nut.

   C. Install the remaining spacers and blades in an alternating manner making sure that all blades are separated by a spacer.

   D. When all the blades have been installed, install the second lock nut onto the shaft. Center the blades and spacers on the shaft by adjusting the lock nuts.

Servicing the Groomer Reel (continued)

E. Use the through holes in shaft to prevent the shaft from rotating and tighten the second lock nut to **42 to 48 N·m (31 to 35 ft-lb)**. After tightening the lock nut, spacers should not be free to rotate and the groomer blades should be centered on the shaft.

7. Install the groomer reel back onto the cutting unit; refer to Installing the Groomer Reel (page 9–19).

Installing the Groomer Reel

1. Position the cutting unit on a level surface. If the cutting unit is attached to the traction unit, set the parking brake, and remove the key from the key switch.
2. Position the groomer reel between the groomer driven and stub shafts.
3. Secure the groomer reel to the cutting unit with the 4 jam nuts, 4 bolts, and 4 shaft clamps. Tighten the bolts from **5 to 7 N·m (45 to 60 in-lb)**.
4. Check the groomer reel height and mower height-of-cut settings and adjust as necessary.

The Height Adjuster Assembly

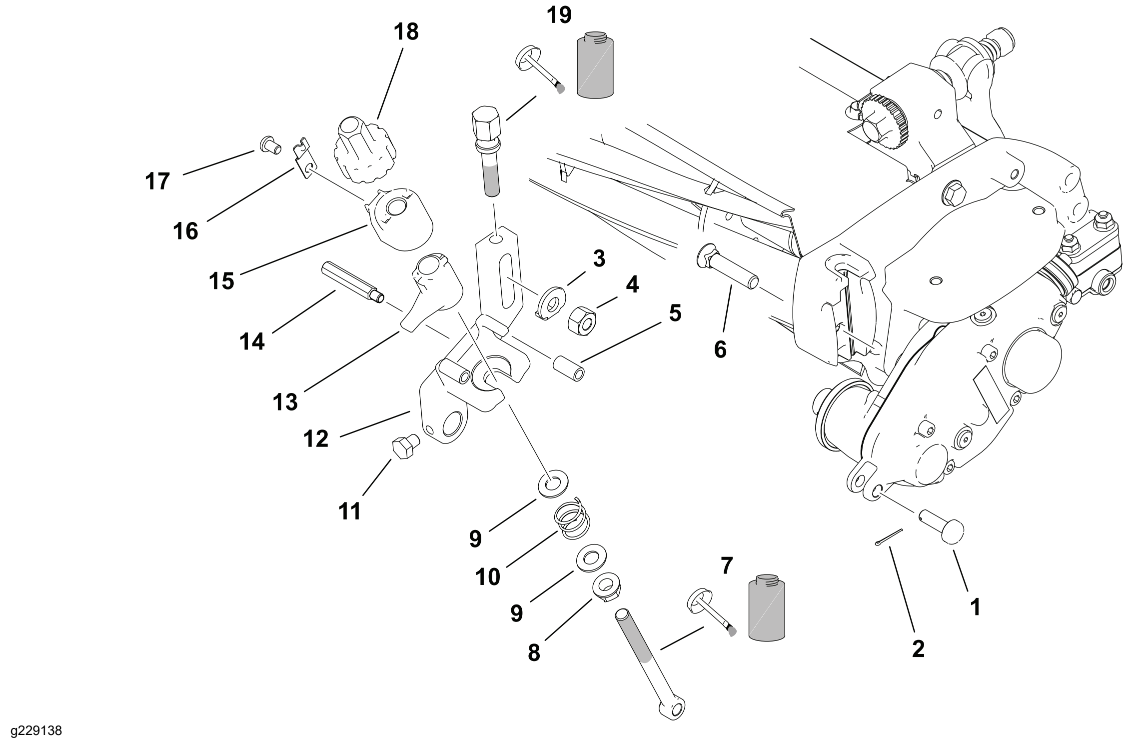


Figure 167

1. Clevis pin
2. Cotter pin
3. Tabbed washer
4. Lock nut
5. Bumper
6. Plow bolt
7. Height adjustment rod
8. Flange nut
9. Washer (2 each)
10. Compression spring
11. Pinch bolt
12. Height-of-cut bracket
13. Quick up lever
14. Groomer pin
15. Quick up cover
16. Detent spring
17. Button-head screw
18. Height adjuster knob
19. Height adjustment bolt

Note: Early universal groomers used 2 compression springs on non-adjustable height adjustment rods. Retrofitting the assemblies on each side of the cutting unit with new compression springs, height adjustment rods, and adding flange nuts to enable spring adjustment is recommended; refer to Figure 167.

Disassembling the Height Adjuster

1. Park the machine on a clean and level surface, lower the cutting units completely to the ground, set the parking brake, and remove the key from the key switch.
2. Remove the cutting unit from the machine.
3. Remove the cotter pins and clevis pins that secure the height adjustment rods to the groomer gear box and idler arm. Discard the cotter pins.
4. Loosen the pinch bolts that secure the front roller to the height-of-cut brackets.
5. Remove the hex nuts, tabbed washers and plow bolts that secure the height-of-cut brackets to the cutting unit side plates, and remove the height adjusters and front roller from the cutting unit.
6. Disassemble the height adjuster assembly as necessary.
7. Replace components that are worn or damaged.

Assembling the Height Adjuster

1. Apply anti-seize lubricant to the upper threads of the adjustment rod and lower threads of the height adjusters. Assemble the height adjuster assembly.
2. If both the height adjusters are removed, fit 1 height adjuster assembly to the cutting unit side plate and secure it with a plow bolt, tabbed washer and lock nut. Tighten the lock nut finger tight.
3. Position front roller between the height adjuster assemblies and secure the remaining height adjuster assembly to the cutting unit side plate with a plow bolt, tabbed washer and lock nut. Tighten the lock nut finger tight.
4. center the front roller between the height-of-cut brackets and tighten the front roller pinch bolts
5. Install new cotter pins and clevis pins and secure the height adjustment rods to the groomer gear box and idler arm.
6. Adjust the cutting unit height-of-cut; refer to *Cutting Unit Operators Manual*.
7. Check the groomer reel height and adjust as necessary.

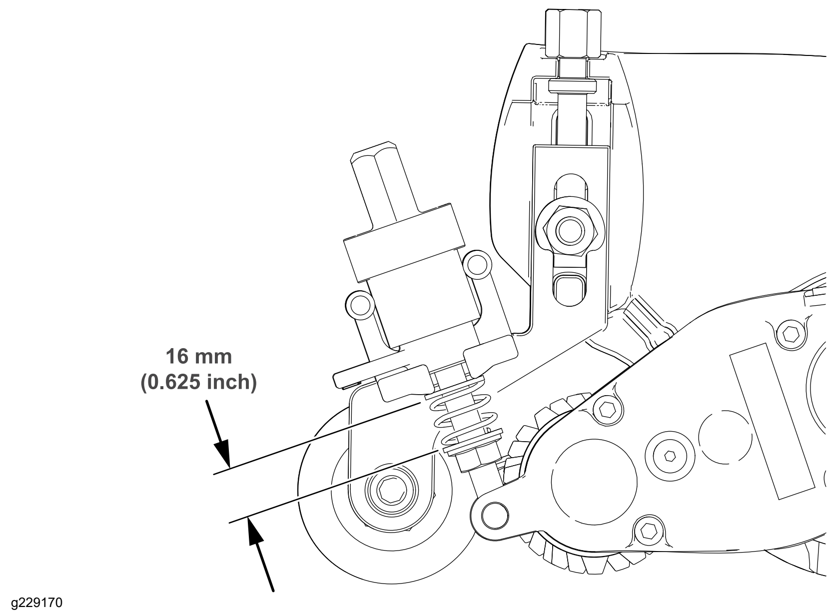


Figure 168

8. Adjust the flange nuts on the groomer height adjustment rods until the springs are compressed to **16 mm (0.625 inch)**.

The Grooming Brush (Optional)

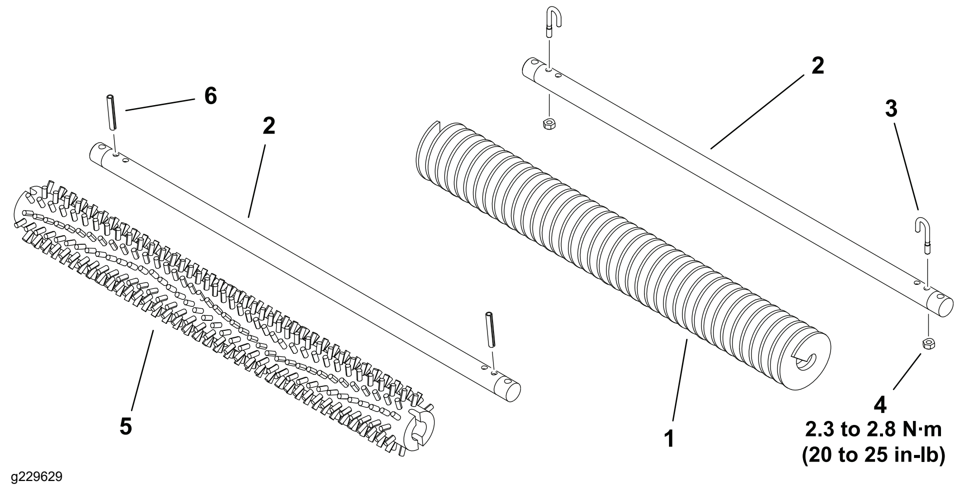


Figure 169

1. Spiral brush
2. Brush shaft
3. J-bolt (2 each)
4. Lock nut (2 each)
5. Grooming brush
6. Roll pin (2 each)

The optional grooming brush attaches to the groomer in place of the groomer reel. The grooming brush is removed and installed from the groomer in the same manner as the groomer reel; refer to The Groomer Reel (page 9–17).

The grooming brush element or shaft can be serviced separately.

To remove the spiral grooming brush from the shaft, remove the lock nut and J-bolt from both ends of the brush assembly and slide the brush from the shaft. When assembling the spiral brush to the shaft, make sure that the J-bolts are installed with the threaded portion on the outside of the brush and tighten the lock nuts from **2.3 to 2.8 N·m (20 to 25 in-lb)**.

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

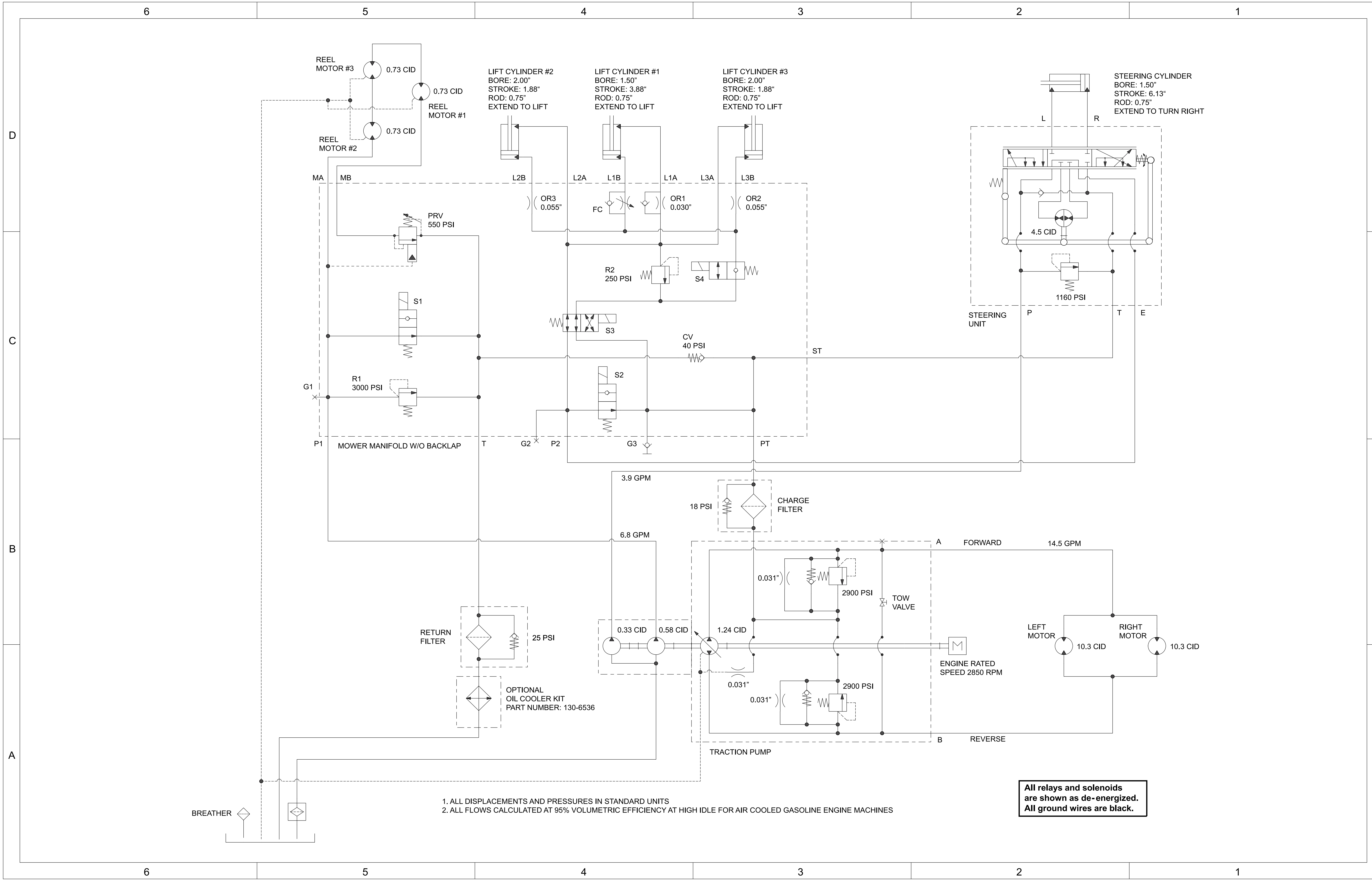
The individual wires of the electrical harness diagrams in this chapter identify both the wire color and the wire size.

Examples:

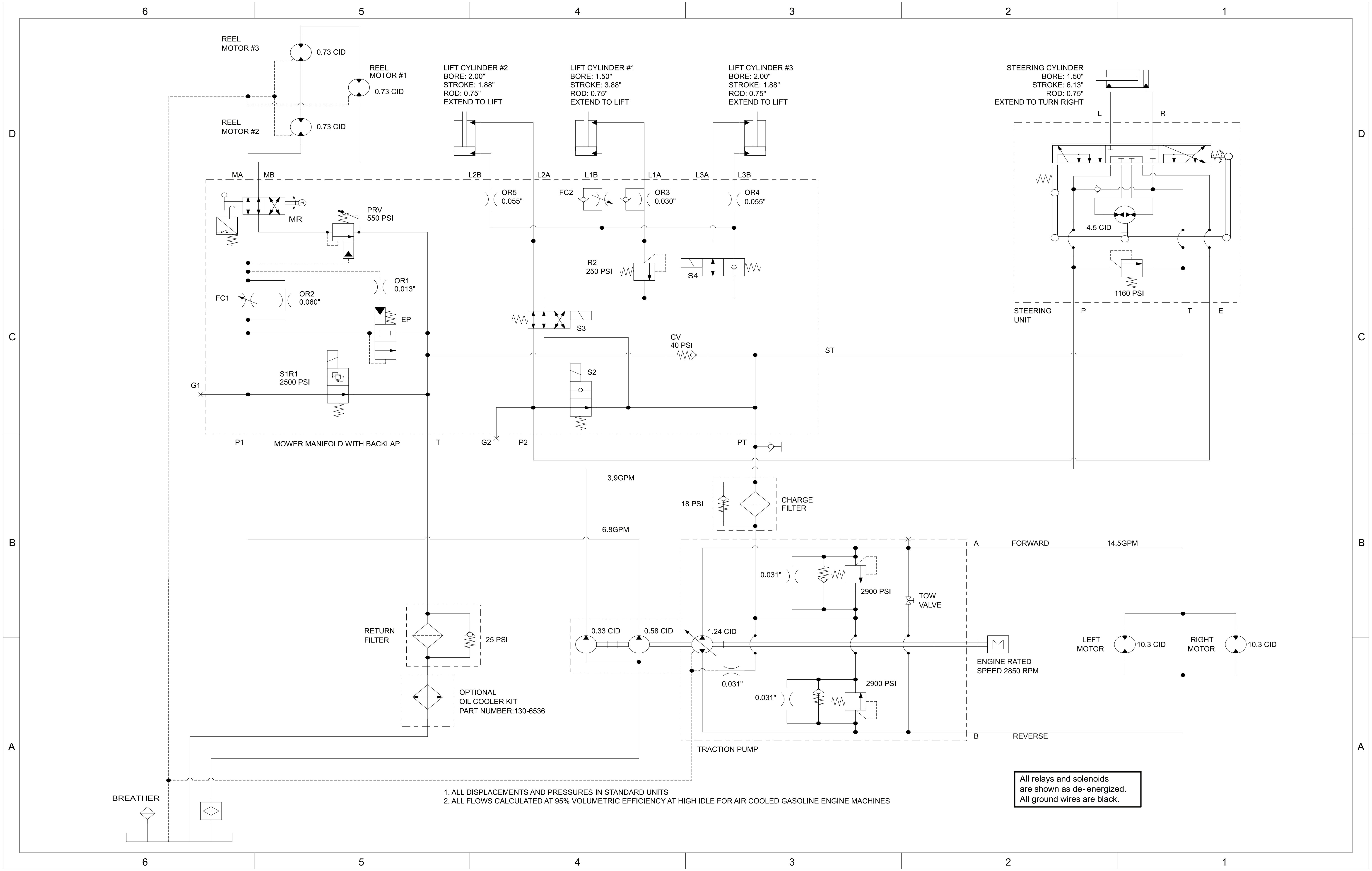
- 16 BK = 16 AWG (American Wire Gauge) wire that has a black insulator
- 050 R = 0.5 mm metric wire that has a red insulator (AWG equivalents for metric wire appear in the following table)

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

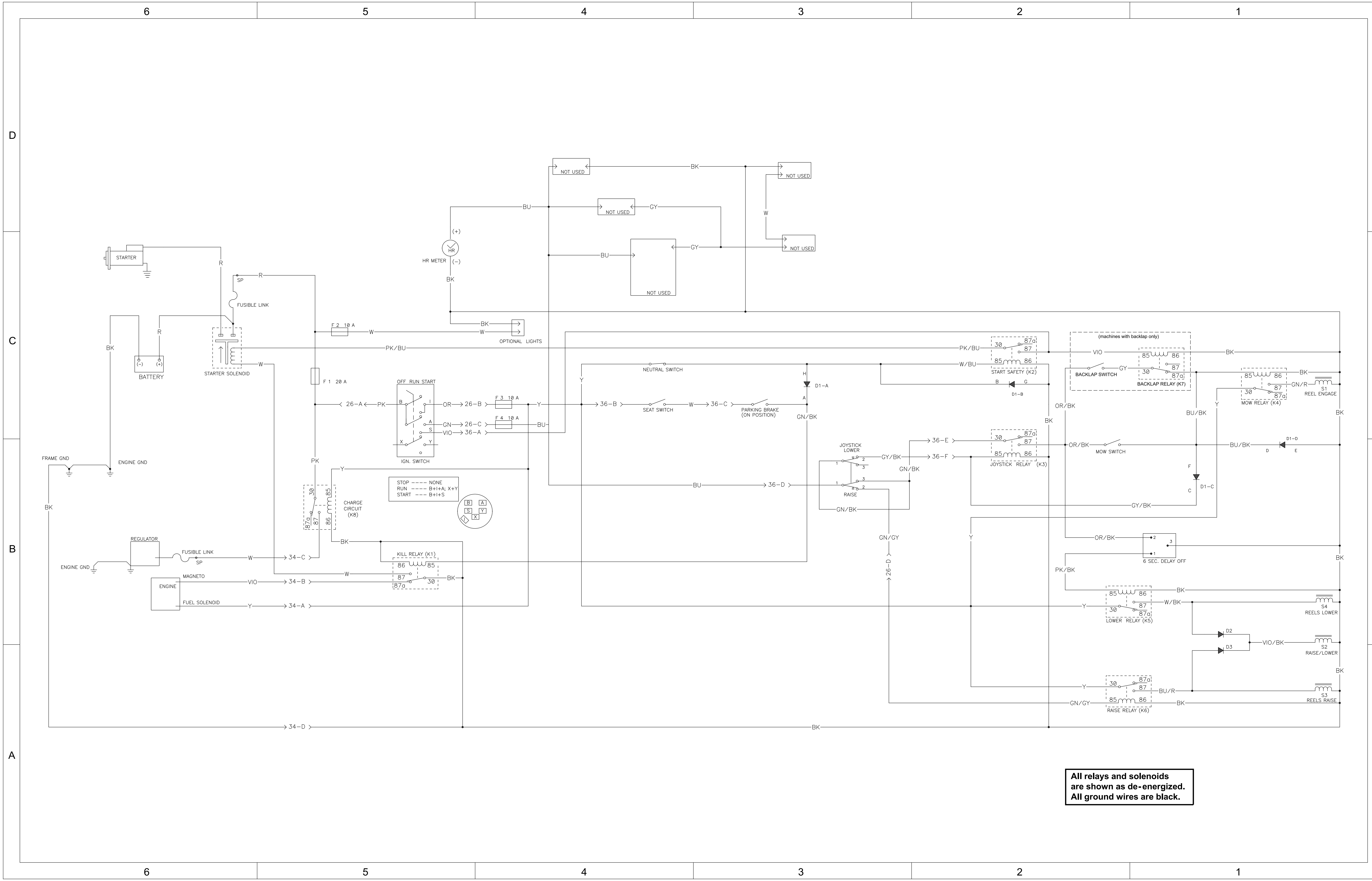
Hydraulic Schematic (machines without backlap)



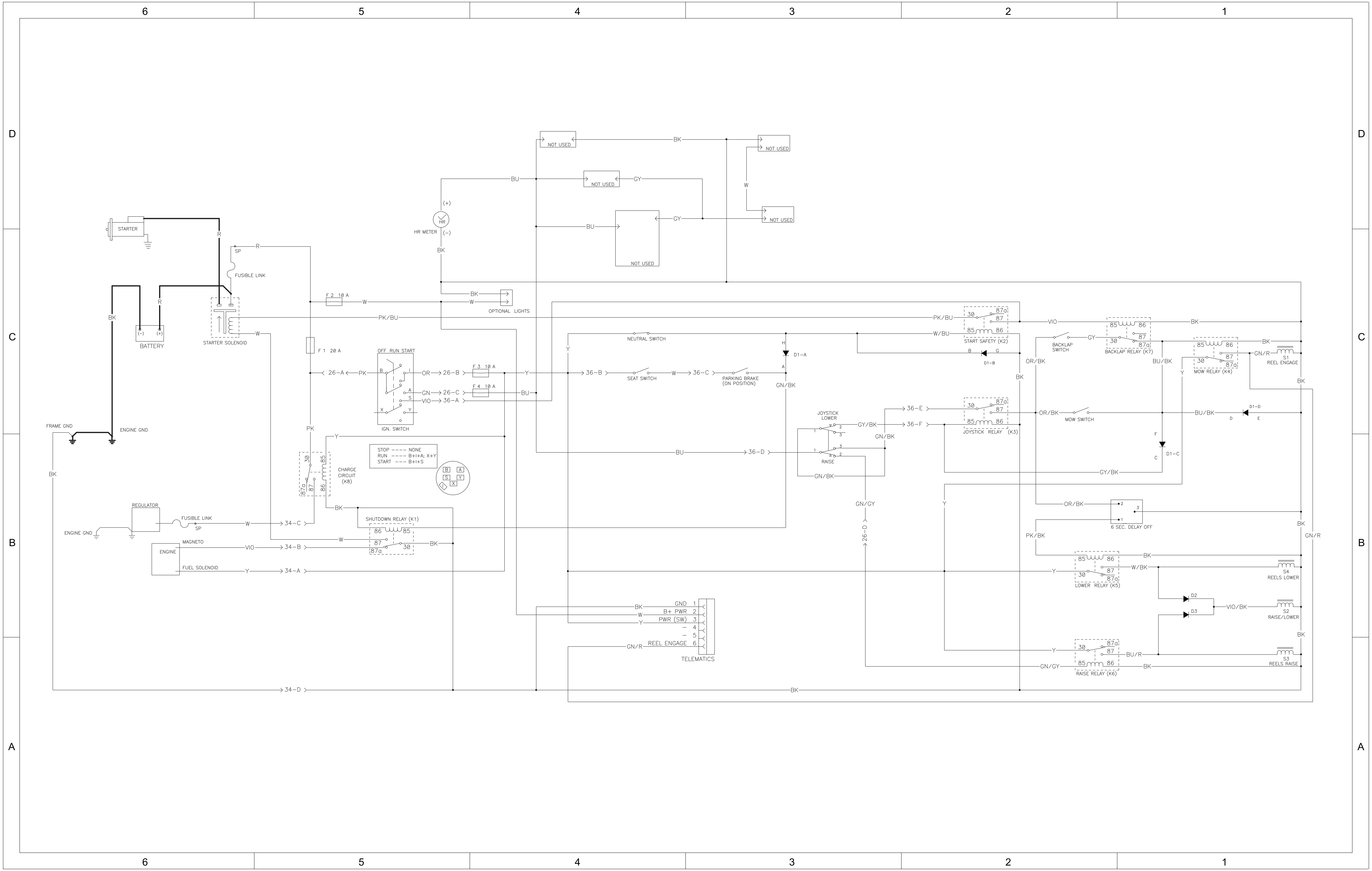
g205802


REEL MOTOR #3
0.73 CID
REEL MOTOR #1
0.73 CID
REEL MOTOR #2
0.73 CID
LIFT CYLINDER #2
BORE: 2.00"
STROKE: 1.88"
ROD: 0.75"
EXTEND TO LIFT
LIFT CYLINDER #1
BORE: 1.50"
STROKE: 3.88"
ROD: 0.75"
EXTEND TO LIFT
LIFT CYLINDER #3
BORE: 2.00"
STROKE: 1.88"
ROD: 0.75"
EXTEND TO LIFT
STEERING CYLINDER
BORE: 1.50"
STROKE: 6.13"
ROD: 0.75"
EXTEND TO TURN RIGHT
L
R
MA
MB
L2B
L2A
L1B
L1A
L3A
L3B
MR
PRV 550 PSI
OR5 0.055"
FC2
OR3 0.030"
OR4 0.055"
4.5 CID
R2 250 PSI
S4
1160 PSI
OR1 0.013"
FC1
OR2 0.060"
EP
S3
STEERING UNIT
P
T
E
CV 40 PSI
ST
S2
S1R1 2500 PSI
G1
P1
MOWER MANIFOLD WITH BACKLAP
T
G2
P2
PT
3.9GPM
18 PSI
CHARGE FILTER
6.8GPM
A
FORWARD
14.5GPM
0.031"
2900 PSI
TOW VALVE
RETURN FILTER
25 PSI
0.33 CID
0.58 CID
1.24 CID
LEFT MOTOR
10.3 CID
RIGHT MOTOR
10.3 CID
ENGINE RATED SPEED 2850 RPM
0.031"
0.031"
2900 PSI
OPTIONAL OIL COOLER KIT PART NUMBER:130-6536
B
REVERSE
TRACTION PUMP
All relays and solenoids are shown as de-energized. All ground wires are black.
BREATHER
1. ALL DISPLACEMENTS AND PRESSURES IN STANDARD UNITS
2. ALL FLOWS CALCULATED AT 95% VOLUMETRIC EFFICIENCY AT HIGH IDLE FOR AIR COOLED GASOLINE ENGINE MACHINES
g213435

Electrical Schematic (serial numbers below 403410000)

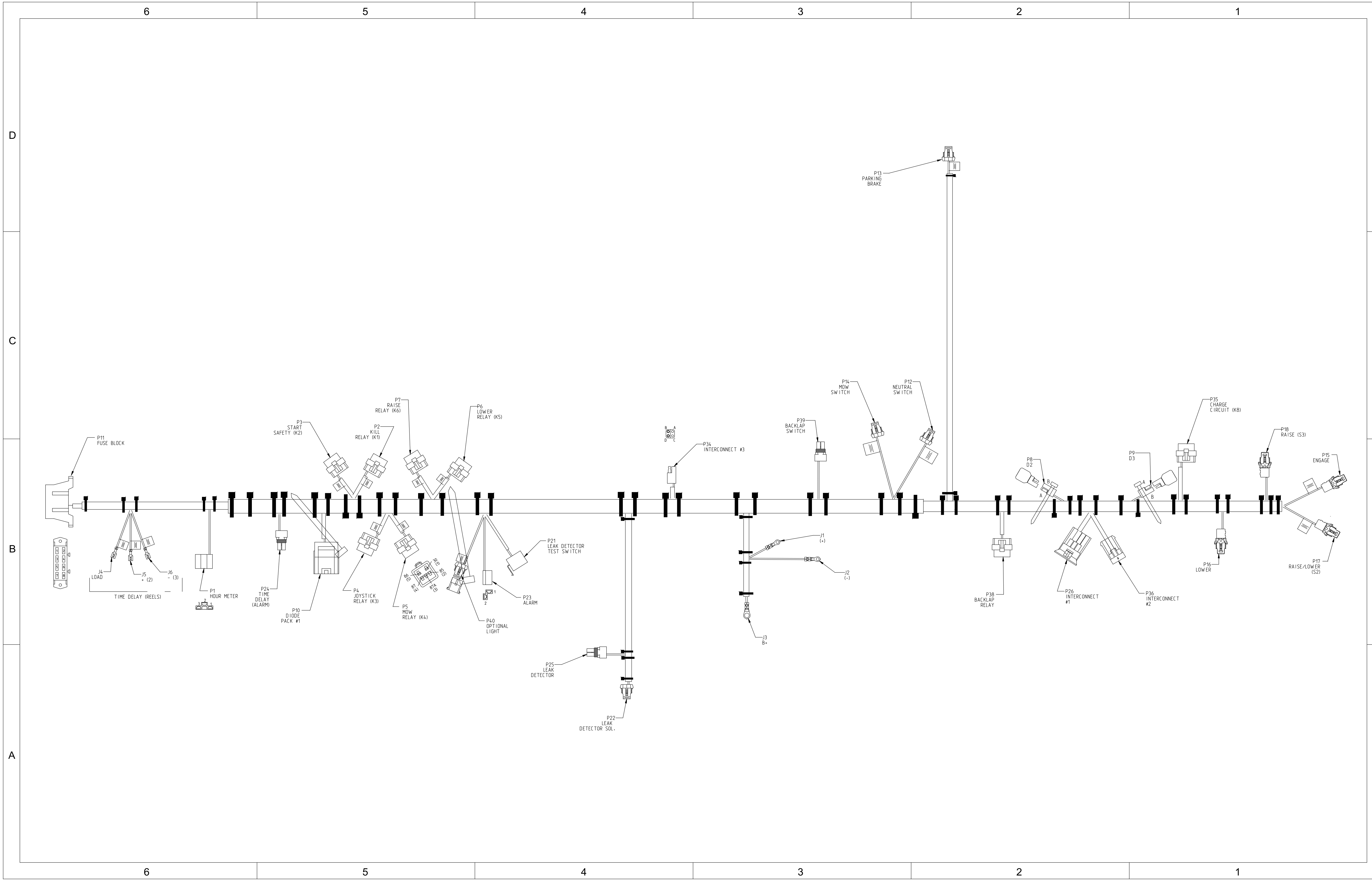


g205801

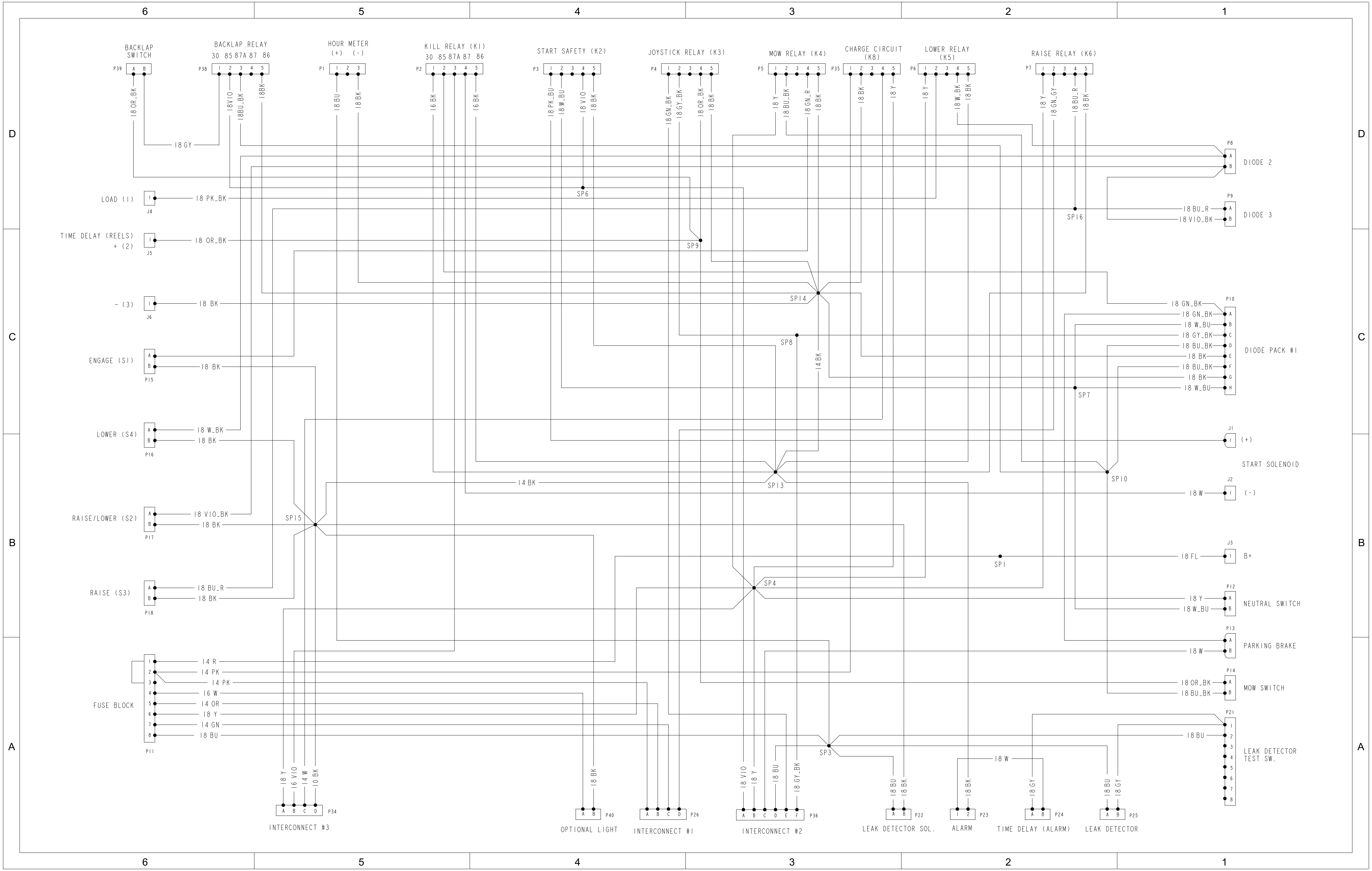


STARTER
FUSIBLE LINK
BATTERY
STARTER SOLENOID
HR METER
NOT USED
OPTIONAL LIGHTS
NEUTRAL SWITCH
SEAT SWITCH
PARKING BRAKE (ON POSITION)
START SAFETY (K2)
BACKLAP SWITCH
BACKLAP RELAY (K7)
MOW RELAY (K4)
S1 REEL ENGAGE
IGN. SWITCH
OFF RUN START
FRAME GND
ENGINE GND
CHARGE CIRCUIT (K8)
STOP ---- NONE
RUN ---- B+I+A; X+Y
START --- B+I+S
JOYSTICK LOWER
RAISE
JOYSTICK RELAY (K3)
MOW SWITCH
REGULATOR
SHUTDOWN RELAY (K1)
ENGINE
MAGNETO
FUEL SOLENOID
6 SEC. DELAY OFF
LOWER RELAY (K5)
S4 REELS LOWER
S2 RAISE/LOWER
S3 REELS RAISE
RAISE RELAY (K6)
GND 1
B+ PWR 2
PWR (SW) 3
– 4
– 5
REEL ENGAGE 6
TELEMATICS

g325786

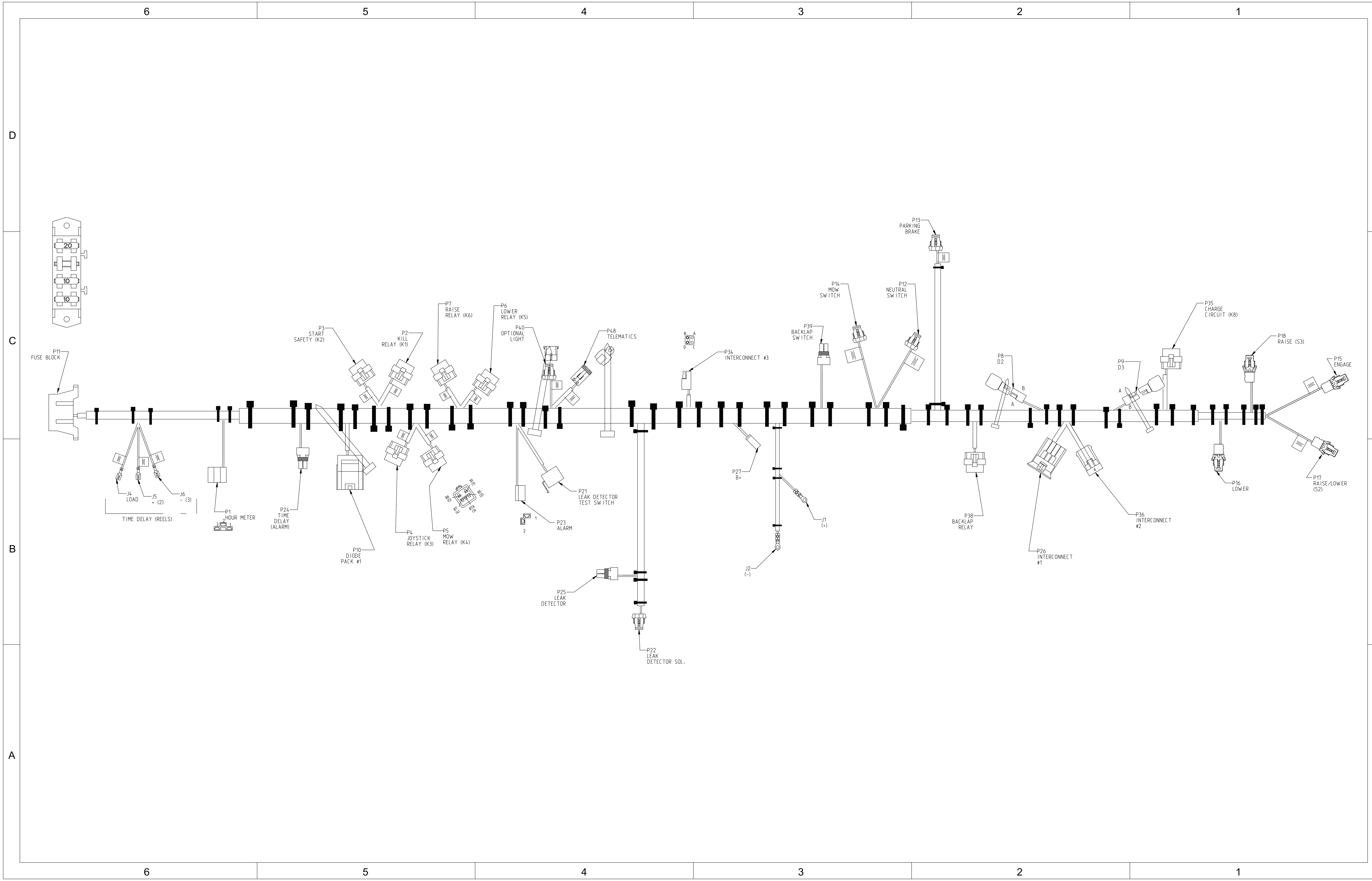

6
5
4
3
2
1
D
C
B
A
P13
PARKING
BRAKE
P11
FUSE BLOCK
J4
LOAD
J5
+ (2)
J6
- (3)
TIME DELAY (REELS)
P1
HOUR METER
P24
TIME
DELAY
(ALARM)
P10
DIODE
PACK #1
P3
START
SAFETY (K2)
P2
KILL
RELAY (K1)
P7
RAISE
RELAY (K6)
P6
LOWER
RELAY (K5)
P4
JOYSTICK
RELAY (K3)
P5
MOW
RELAY (K4)
P40
OPTIONAL
LIGHT
P21
LEAK DETECTOR
TEST SWITCH
P23
ALARM
P25
LEAK
DETECTOR
P22
LEAK
DETECTOR SOL.
P34
INTERCONNECT #3
J1
(+)
J2
(-)
J3
B+
P39
BACKLAP
SWITCH
P14
MOW
SWITCH
P12
NEUTRAL
SWITCH
P38
BACKLAP
RELAY
P8
D2
P9
D3
P26
INTERCONNECT
#1
P36
INTERCONNECT
#2
P35
CHARGE
CIRCUIT (K8)
P16
LOWER
P18
RAISE (S3)
P15
ENGAGE
P17
RAISE/LOWER
(S2)

g205799

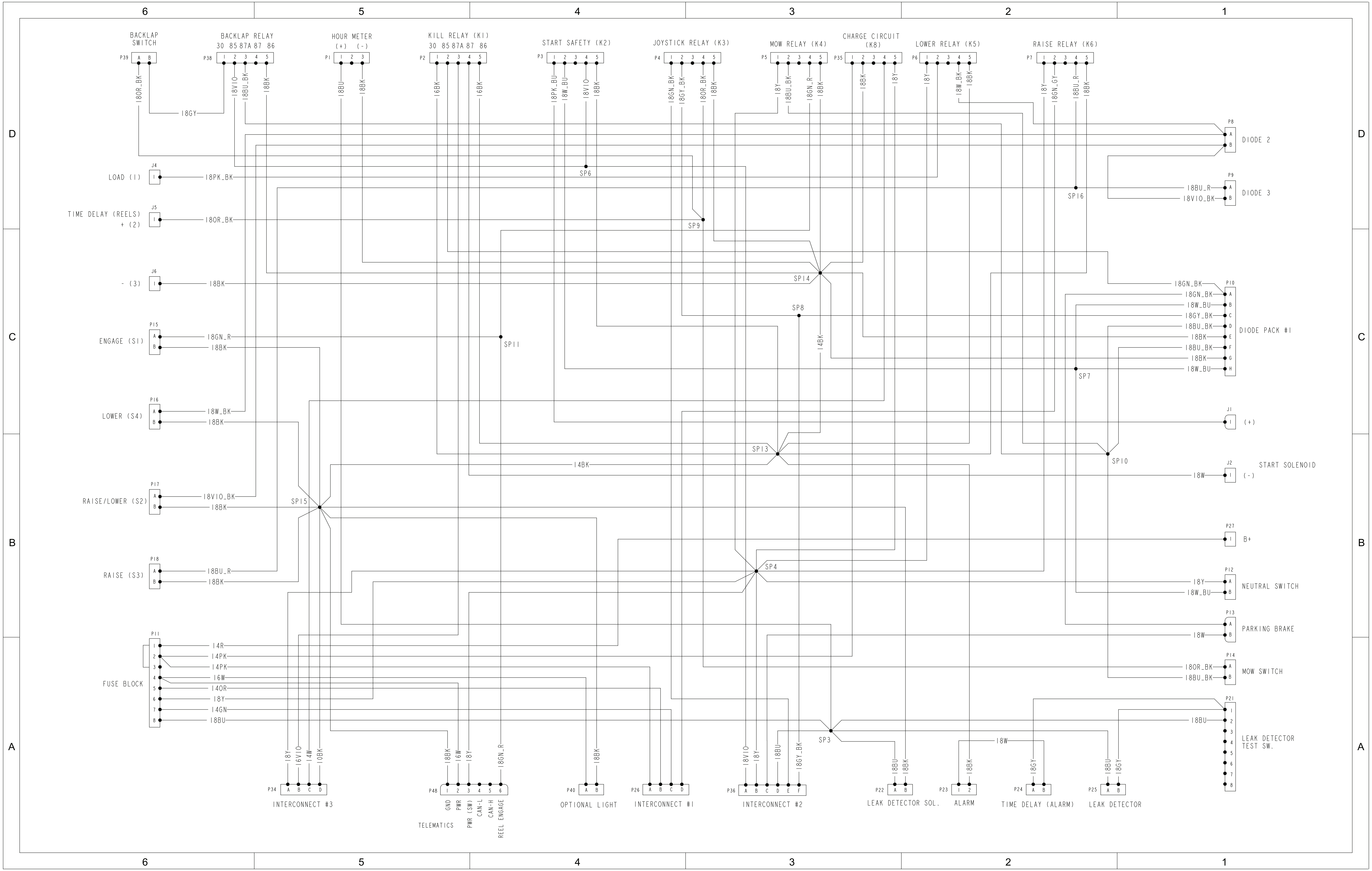


BACKLAP SWITCH
BACKLAP RELAY
HOUR METER
KILL RELAY (K1)
START SAFETY (K2)
JOYSTICK RELAY (K3)
MOW RELAY (K4)
CHARGE CIRCUIT (K8)
LOWER RELAY (K5)
RAISE RELAY (K6)
DIODE 2
DIODE 3
DIODE PACK #1
START SOLENOID
NEUTRAL SWITCH
PARKING BRAKE
MOW SWITCH
LEAK DETECTOR TEST SW.
LOAD (1)
TIME DELAY (REELS) + (2)
- (3)
ENGAGE (S1)
LOWER (S4)
RAISE/LOWER (S2)
RAISE (S3)
FUSE BLOCK
INTERCONNECT #3
OPTIONAL LIGHT
INTERCONNECT #1
INTERCONNECT #2
LEAK DETECTOR SOL.
ALARM
TIME DELAY (ALARM)
LEAK DETECTOR
g205798

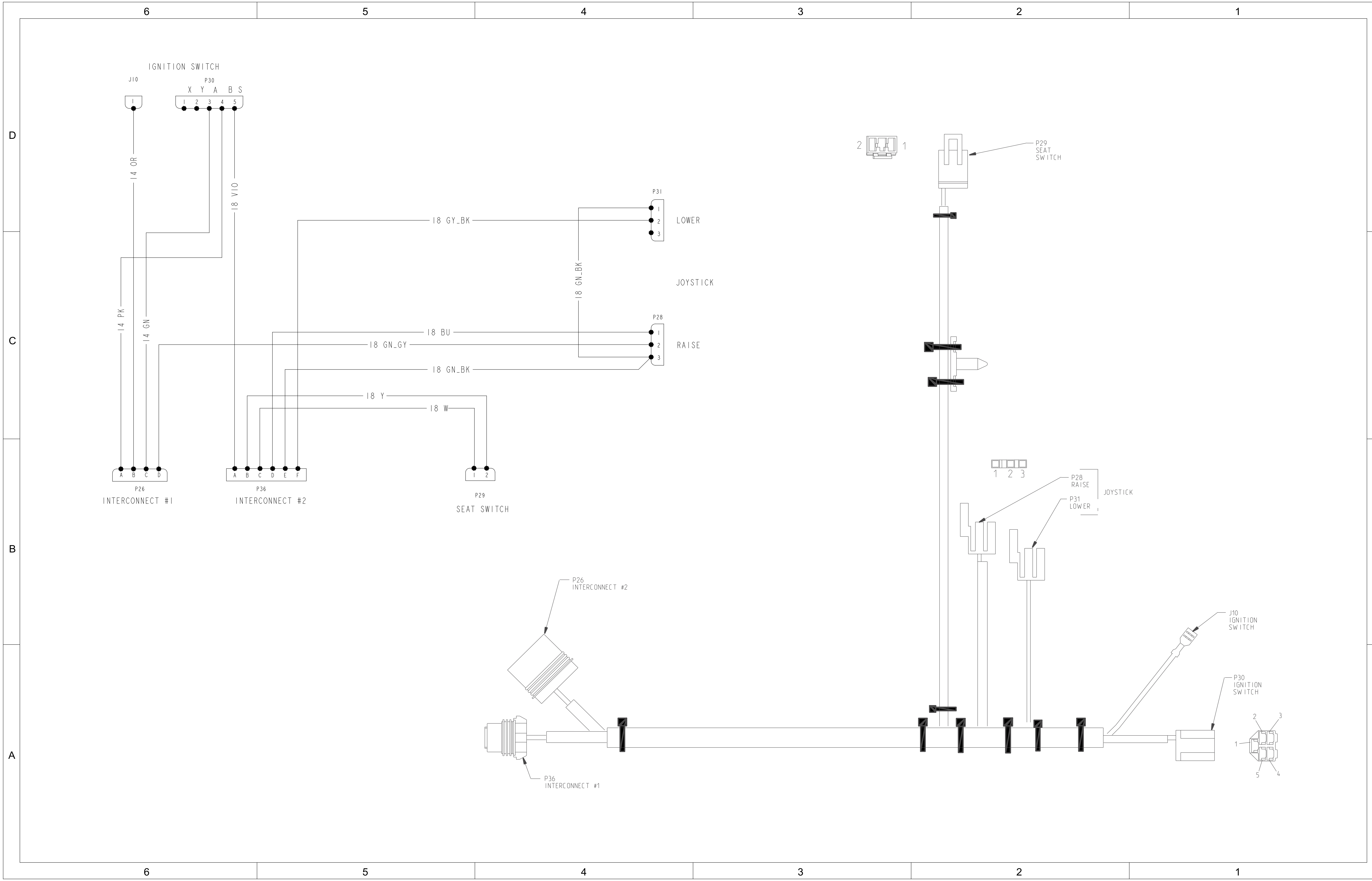
Wire Harness Drawing - Main (serial numbers above 403410000)



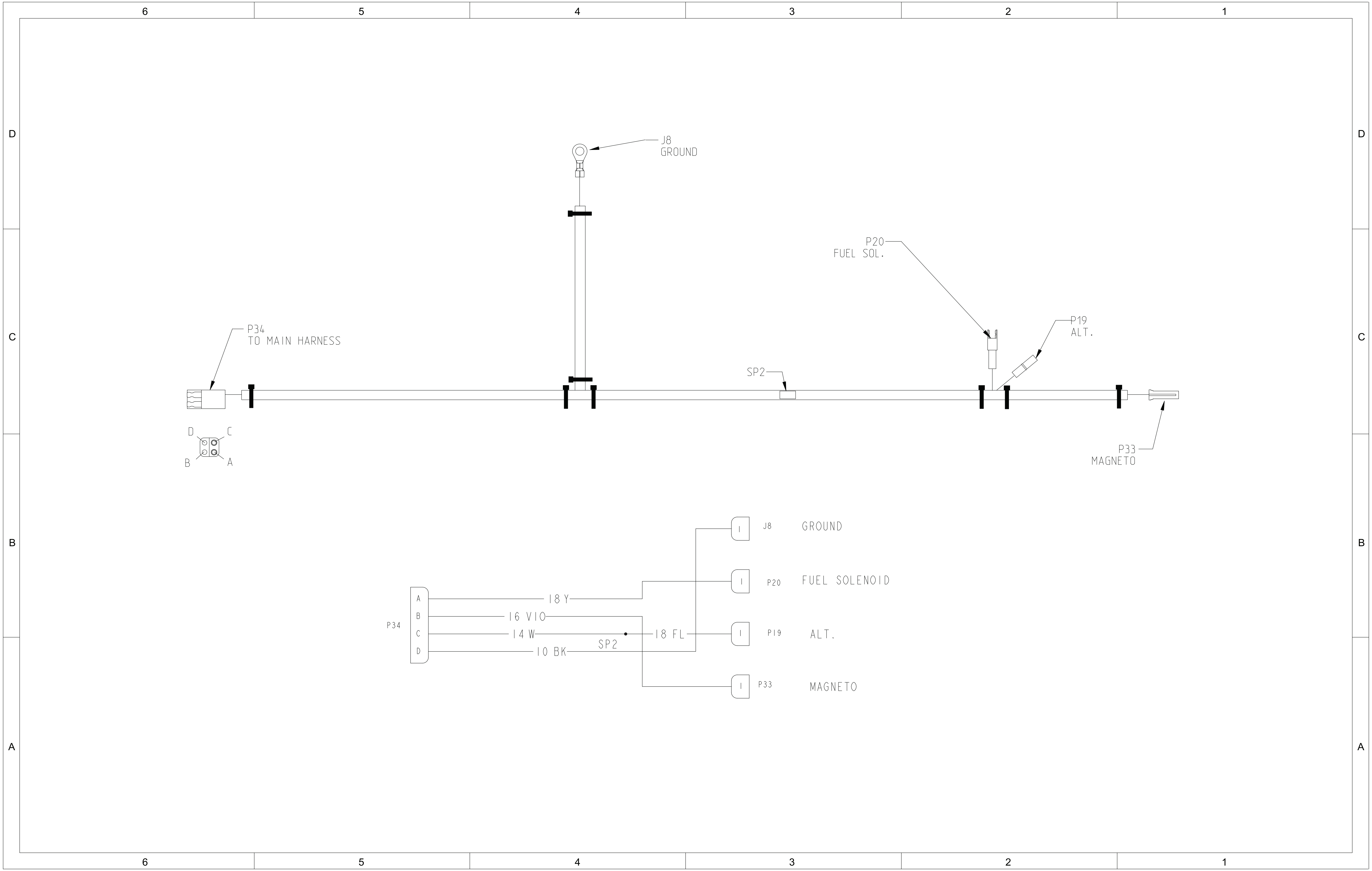
g324321


BACKLAP SWITCH
BACKLAP RELAY
HOUR METER
KILL RELAY (K1)
START SAFETY (K2)
JOYSTICK RELAY (K3)
MOW RELAY (K4)
CHARGE CIRCUIT (K8)
LOWER RELAY (K5)
RAISE RELAY (K6)
DIODE 2
DIODE 3
LOAD (1)
TIME DELAY (REELS) + (2)
- (3)
ENGAGE (S1)
DIODE PACK #1
LOWER (S4)
START SOLENOID
RAISE/LOWER (S2)
RAISE (S3)
NEUTRAL SWITCH
PARKING BRAKE
MOW SWITCH
FUSE BLOCK
LEAK DETECTOR TEST SW.
INTERCONNECT #3
TELEMATICS
GND
PWR
PWR (SW)
CAN-L
CAN-H
REEL ENGAGE
OPTIONAL LIGHT
INTERCONNECT #1
INTERCONNECT #2
LEAK DETECTOR SOL.
ALARM
TIME DELAY (ALARM)
LEAK DETECTOR
g324320

Wire Harness - Seat



g205800


J8
GROUND
P20
FUEL SOL.
P19
ALT.
P34
TO MAIN HARNESS
SP2
D C
B A
P33
MAGNETO
J8 GROUND
P20 FUEL SOLENOID
P19 ALT.
P33 MAGNETO
P34
A
B
C
D
18 Y
16 VIO
14 W
10 BK
SP2
18 FL

g205797

Count on it.