Form No. 20252SL Rev A

Count on it.

Service Manual

Reelmaster® 3100-D/3105-D

(Model No. 03170
Serial No. 403430001 and Up)
(Model No. 03171
Serial No. 403430001 and Up)
(Model No. 03174
Serial No. 400000000 and Up)

8111 Lyndale Avenue South
Bloomington, MN 55420

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

Revision History

Revision	Date	Description
A	05/2021	Initial issue.

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

or Mail to:

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NOTES

Preface

The purpose of this publication is to provide the service technician with the information for troubleshooting, testing, and repair of the major systems and components on the Reelmaster 3100-D/3105-D (Models 03170, 03171 and 03174).

Refer to the *Operator's Manuals* and *Installation Instructions* for installing, operating, maintenance, and adjustment instructions. Keep a copy of the *Operator's Manuals*, *Installation Instructions* and *Parts Catalogs* for your machine and its accessories with this *Service Manual* for reference. Additional copies of the *Operator's Manuals*, *Installation Instructions* and *Parts Catalogs* are available at www.toro.com.

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

DANGER

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

WARNING

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

CAUTION

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

IMPORTANT

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

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

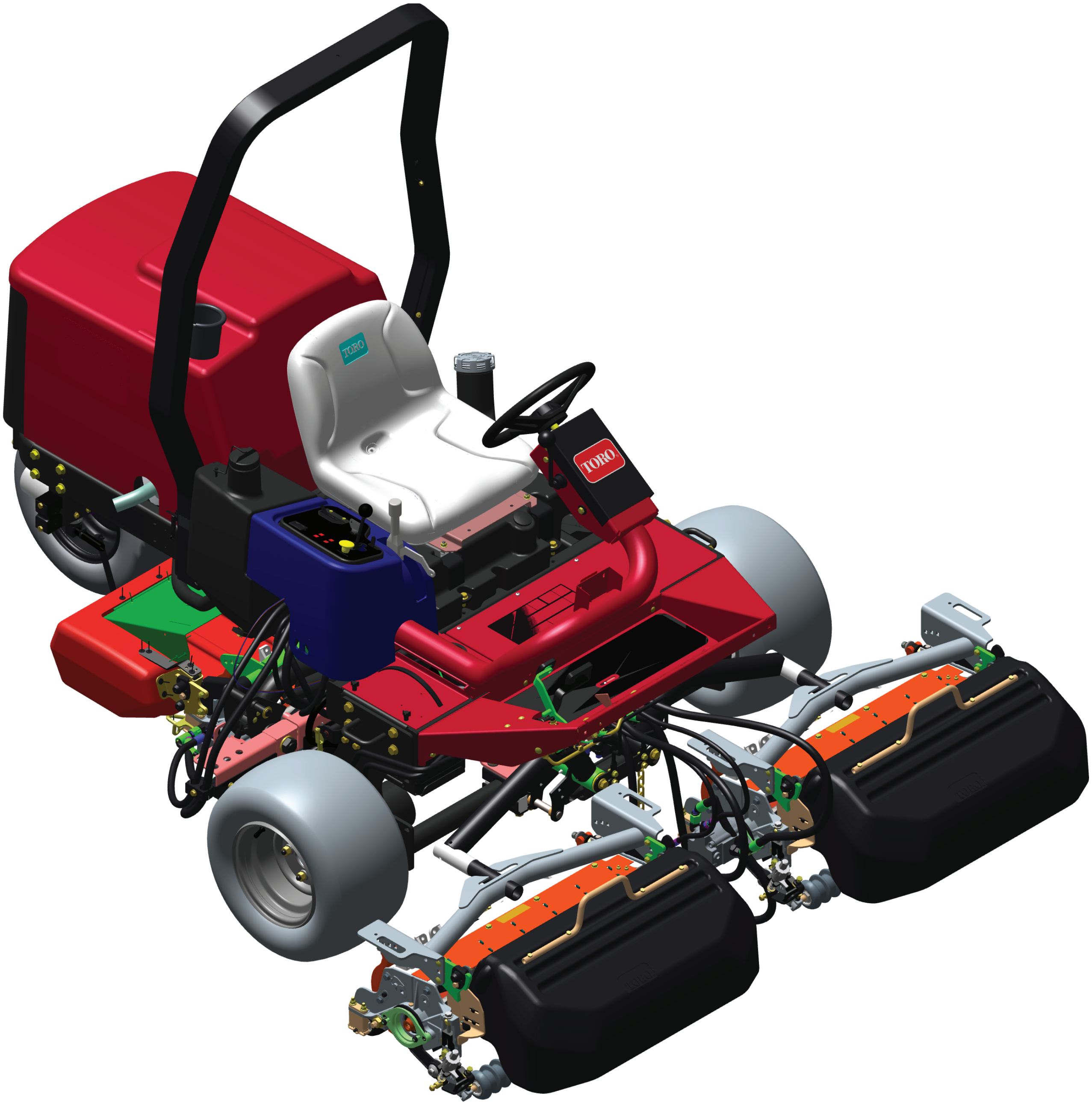
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Figure 1

Service Procedure Icons

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

Critical Process

This icon is used to highlight:

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

Critical Torque

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

Fluid Specifications

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

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

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Additional Reference Materials

KUBOTA 05-E4B SERIES WORKSHOP MANUAL

PARKER TORQMOTOR SERVICE PROCEDURE (TC, TB, TE, TJ, TF, TG, TH AND TL SERIES)

EATON MEDIUM DUTY PISTON PUMP REPAIR INFORMATION MODEL 70160 VARIABLE DISPLACEMENT PISTON PUMP

DANFOSS STEERING UNIT TYPE OSPM SERVICE MANUAL

Safety

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Safety Instructions

The Reelmaster 3100-D/3105-D (Models 03170, 03171 and 03174) machine is tested and certified by Toro for compliance with existing safety standards and specifications. Although hazard control and accident prevention are partially dependent upon the design and configuration of the machine, these factors are also dependent on 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 of the machine can result in injury or death.

WARNING

To reduce the potential of injury or death, comply with the following safety instructions as well as information found in the *Operator's Manuals* and the *Operator and Safety Training Videos* found on www.toro.com.

Supervisor's Responsibilities

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

Before Operating the Machine

- Review and understand the contents of the *Operator's Manuals* before starting and operating the machine. Become familiar with the controls and know how to stop the machine quickly. Additional copies of the *Operator's Manuals* are available at www.toro.com.
- Keep all the shields, safety devices, and decals in place. If a shield, safety device, or decal is illegible or damaged, repair or replace it before operating the machine.
- Tighten any loose nuts, bolts, or screws to ensure that the machine is in safe operating condition.
- Do not carry passengers on the machine. Keep everyone, especially children and pets, away from the areas of operation.
- 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 attachments.
- Keep everyone, especially children and pets, away from the areas of operation.
- Diesel fuel is highly flammable; handle it carefully.
  - Store fuel in containers specifically designed for storing fuel.
  - Do not remove the fuel tank cap of the machine while the engine is hot or running.
  - Do not smoke while handling fuel.
  - Fill the fuel tank outdoors and only to the bottom of the filler neck. Do not overfill the fuel tank.
  - After refueling the machine, install the fuel tank and fuel container caps.
  - If you spill fuel, do not attempt to start the engine but move the machine away from the spill. Avoid creating any source of ignition until fuel vapors have dissipated. Wipe up any spilled fuel.

While Operating the Machine

1. Do not run the engine in a confined area without adequate ventilation. Exhaust fumes are hazardous and could be deadly.
2. Sit on the seat when starting and operating the machine.
3. Check interlock switches daily for proper operation (see Chapter 6: Electrical System (page 6–1)). Do not rely entirely on safety switches: shut off engine before getting off seat. If a switch fails, replace it before operating the machine. The interlock system is for your protection, so do not bypass it.
4. Operator must be skilled and trained in how to drive on hillsides. Failure to use caution on slopes or hills may cause vehicle to tip or roll, possibly resulting in personal injury or death.
5. This triplex mower has a unique drive system for superior traction on hills. The uphill wheel will not spin out and limit traction like conventional triplexes. If operated on a side hill that is too steep, rollover may occur before losing traction.
6. Before backing up, look to the rear and assure no one is behind the machine. Watch out for traffic when near or crossing roads. Always yield the right of way.
7. Keep hands, feet and clothing away from moving parts and the deck discharge area.
8. Establish special procedures and work rules for unusual operating conditions (e.g. slopes, sand traps, water hazards). Survey the mowing site completely to determine which areas can be operated on safely. When performing this site survey, always use common sense and take into consideration the turf condition and the rollover risk. To perform a site survey, follow the procedure outlined in the Operator's Manual.

   Stay alert for holes in terrain and other hidden hazards which can cause a sudden change in side hill angle. Use extreme caution when operating close to sand traps, ditches, creeks, steep hillsides, or other hazards. Reduce speed when making sharp turns. Do not turn on hills. Avoid sudden stops and starts. Use reverse pedal for braking. Cutting units should be lowered when going down slopes.
9. When starting the engine:
   A. Engage parking brake.
   B. Be sure traction pedal is in neutral and blade drive is in disengage position.
   C. After engine starts, release parking brake and keep foot off traction pedal. Machine must not move. If movement is evident, the neutral control linkage is incorrectly adjusted: therefore, shut engine off and adjust until machine does not move when traction pedal is released (see Adjusting the Traction Drive for Neutral in *Operator's Manual*).
10. Before backing up, look to the rear and assure no one is behind the machine. Watch out for traffic when near or crossing roads. Always yield the right of way.
11. Keep hands, feet and clothing away from moving parts and the reel discharge area. Grass baskets, if so equipped, must be in place during reel operation for maximum safety.
12. This product may exceed noise levels of 85 dB(A) at the operator position. Ear protectors are recommended for prolonged exposure to reduce the potential of permanent hearing damage.
13. Raise the cutting units when driving from one work area to another.

While Operating the Machine (continued)

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

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

16. Before getting off the seat:

    A. Move traction pedal to neutral.

    B. Set the parking brake.

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

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

17. Whenever machine is left unattended, make sure key is removed from key switch and parking brake is set.

Maintenance and Service

1. Before servicing or making adjustments to the machine, stop the engine and remove key from switch to prevent accidental starting of the engine.
2. Check performance of all interlock switches daily. Do not defeat interlock system. It is for your protection.
3. To ensure entire machine is in good operating condition, frequently check and keep all nuts, bolts, screws and hydraulic fittings tight.
4. Make sure all hydraulic line connectors are tight, and all hydraulic hoses and lines are in good condition before applying pressure to the system.
5. Keep body and hands away from pin hole leaks or nozzles that eject hydraulic fluid under high pressure. Use paper or cardboard, not hands, to search for leaks. Hydraulic fluid escaping under pressure can have sufficient force to penetrate skin and do serious damage. If fluid is injected into the skin it must be surgically removed within a few hours by a doctor familiar with this form of injury or gangrene may result.
6. Before disconnecting or performing any work on the hydraulic system, all pressure in system must be relieved by stopping engine and lowering cutting units to the ground.
7. If major repairs are ever needed, or if assistance is desired, contact an Authorized Toro Distributor.
8. To reduce potential fire hazard, keep the engine area free of excessive grease, grass, leaves and accumulation of dirt.
9. If the engine must be running to perform a maintenance adjustment, keep hands, feet, clothing, and any other parts of the body away from the cutting units and any moving parts. Keep everyone away.
10. Do not overspeed the engine by changing governor settings. To assure safety and accuracy, have an Authorized Toro Distributor check maximum engine speed with a tachometer.
11. Engine must be shut off before checking oil or adding oil to the crankcase.
12. To insure optimum performance and safety, use genuine TORO replacement parts and accessories. Replacement parts and accessories made by other manufacturers could be dangerous, and such use could void the product warranty of The Toro Company.
13. Disconnect battery before servicing the machine. Disconnect negative battery cable first and positive cable last. If battery voltage is required for troubleshooting or test procedures, temporarily connect the battery. Reconnect positive battery cable first and negative cable last.
14. Battery acid is poisonous and can cause burns. Avoid contact with skin, eyes and clothing. Protect your face, eyes and clothing when working with a battery.
15. Battery gases can explode. Keep cigarettes, sparks and flames away from the battery.
16. When changing attachments, tires or performing other service, use correct jacks, hoists and jack stands. Make sure machine is parked on a solid level surface such as a concrete floor. Prior to raising the machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use appropriate jack stands to support the raised machine. If the machine is not properly supported by jack stands, the machine may move or fall, which may result in personal injury (see Jacking Instructions (page 1–7)).
17. Make sure to dispose of potentially harmful waste (e.g. fuel, oil, engine coolant, filters, battery) in an environmentally safe manner. Follow all local codes and regulations when recycling or disposing of waste.

Jacking Instructions

CAUTION

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

Use the following positions when jacking up the machine:

Jacking the Front End

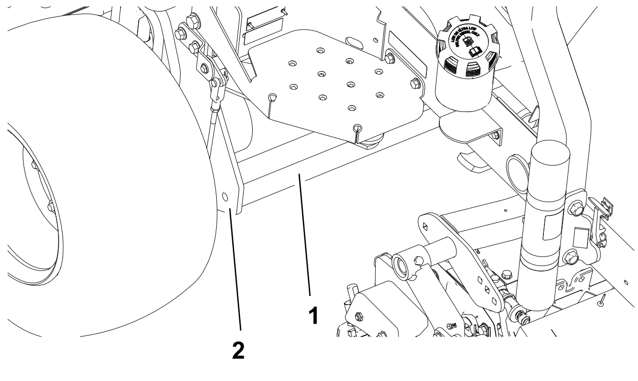

Figure 2

1. Square tube
2. Side plate

1. If the front wheel motor is to be removed, position jack securely under the square tube of the lower frame as closely to the side plate as possible (Figure 2).
2. If the front tire is to be removed, position the jack securely under the front wheel motor.
3. Use jack stands or hardwood blocks under the square tube or wheel motors to support the machine (Figure 2).

Jacking the Rear End

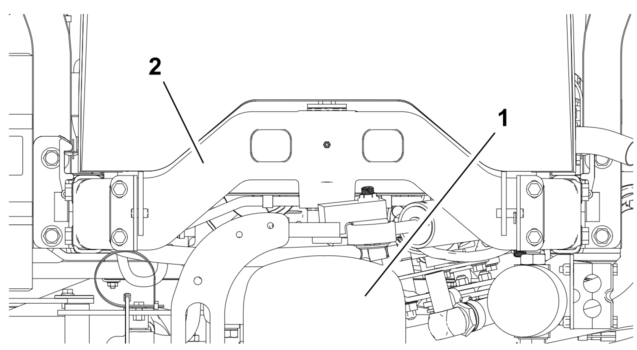

Figure 3

1. Rear tire
2. Rear casting

Jacking the Rear End (continued)

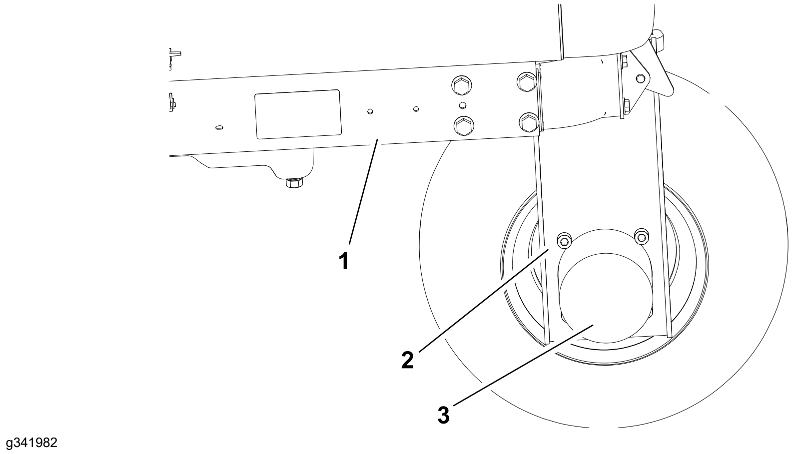

Figure 4

1. Frame
2. Rear wheel motor
3. Rear fork

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1. The preferred method of lifting the rear end of the machine for removing the rear fork or the rear wheel motor:
   A. Secure a chain fall or hoist to the rear casting (Figure 3).
   B. Chock both front tires. Lift rear tire off the ground.
   C. Use jack stands or hardwood blocks under the frame to support the machine (Figure 4).
2. If the rear of the machine can not be lifted from above (Figure 4):

IMPORTANT

Make sure jack is as close to the rear fork as possible when jacking the rear wheel.

   A. Place jack securely under the rear wheel motor.
   B. Chock both front tires. Jack rear tire off the ground.
   C. Use jack stands or blocks under the frame to secure the machine.

Safety and Instructional Decals

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

Chapter 2

Specifications and Maintenance

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Specifications

Overall Dimensions

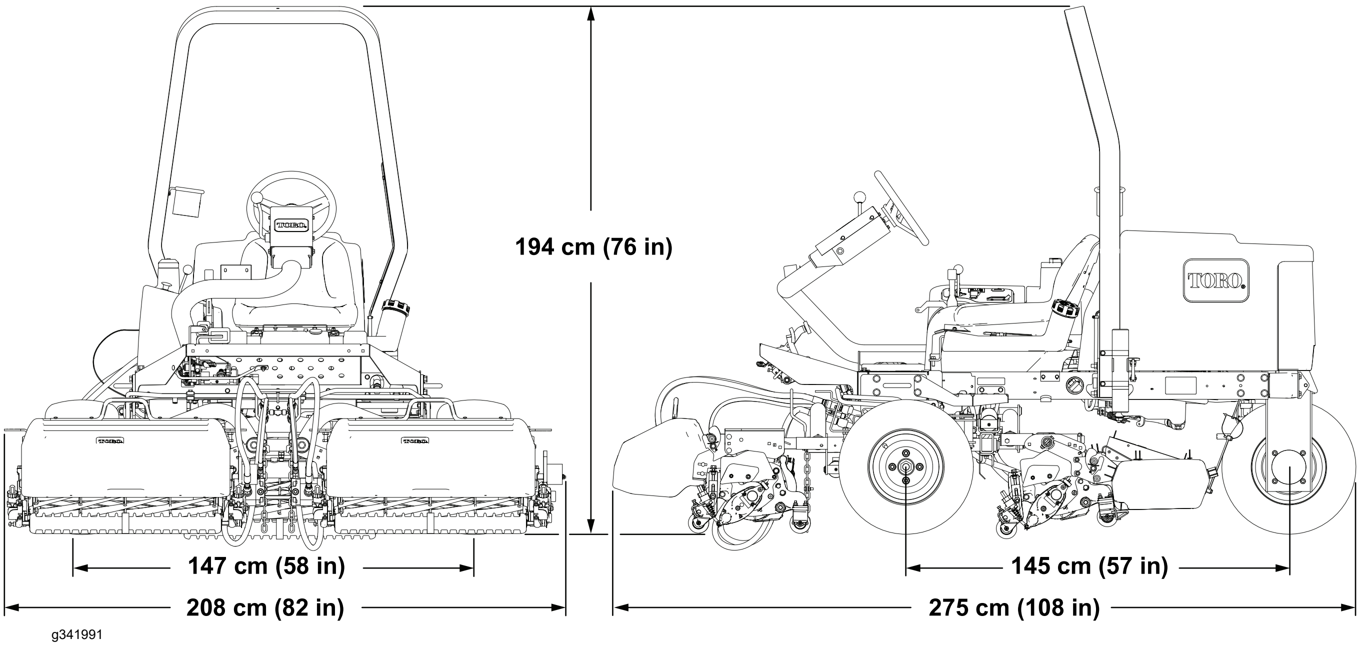


Figure 5

Engine

Item	Description
Make / Designation	Kubota, 4−Cycle, 3 Cylinder, Water Cooled, Diesel Engine
Horse Power	21.5 HP @ 2500 RPM
Bore mm (in.)	78.0 mm (3.07 in)
Stroke mm (in.)	78.4 mm (3.09 in)
Total Displacement cc (cu. in.)	1123 cc (68.53 cu. in.)
Torque N·m (ft−lb)	67.3 N·m (49.6 ft-lb) @ 2000 RPM
Firing Order	1−2−3
Combustion Chamber	Spherical Type
Fuel	No. 2 Diesel Fuel (ASTM D975)
Fuel Capacity liters (gallons)	28.4 L (7.5 gallons)
Fuel Injection Pump	Bosch MD Type Mini Pump
Governor	Centrifugal Mechanical
Low Idle (no load)	1400 + 50 RPM
High Idle (no load)	2650 + 50 RPM
Direction of Rotation	Counterclockwise (Viewed from Flywheel)
Compression Ratio	24:1
Injection Nozzles	Mini Nozzle (DNOPD)
Engine Oil	10W30 Detergent (API CD, CE, CF, CF−4, or CG−4)
Oil Pump	Trochoid Type

Engine (continued)

Item	Description
Crankcase Oil Capacity liters (U.S. qt.)	3.8 L (4.0 qt) with Filter
Starter	12 VDC, 1 KW
Alternator/Regulator	12 VDC 40 AMP
Dry Weight kilograms (U.S. lbs)	93 kg (205 lb)
Coolant Capacity liters (U.S. qt.)	5.7 L (6.0 qt) with 0.9 L (1.0 qt) Reservoir

Hydraulic System

Item	Description
Piston Pump (Hydrostat) Charge Pressure Traction Circuit Relief Pressure (Forward Only) Maximum Displacement	Variable displacement piston pump 6.9 to 10.0 bar (100 to 150 PSI) 241 bar (3500 PSI) 23.6 cc/rev (1.44 cu. in./rev)
Gear Pump Displacement Section 1 (P1) Displacement Section 2 (P2)	2 stage positive displacement gear type pump 8.3 cc/rev (0.5 cu. In./rev) 5.34 cc/rev (0.33 cu. in./rev)
Wheel Motors (Front) Front Wheel Motor Displacement	Orbital rotor motor 195 cc/rev (12 cu. in./rev)
Wheel Motors (Rear) Rear Wheel Motor Displacement	Orbital rotor motor 405 cc/rev (24.7 cu. in./rev)
Hydraulic Manifold Relief Pressure	207 bar (3000 PSI)
Reel Motor Cross−over Relief Pressure Displacement	Gear motor 100 bar (1450 PSI) 27 cc/rev (1.62 cu. in./rev)
Steering Control Valve Implement (Steering and Lift) Relief Valve Pressure	Sauer Danfoss Steering Unit, Type OSPM 69 bar (1000 PSI)
Hydraulic Filter	10 Micron (nominal), spin-on cartridge type
Hydraulic Oil	See *Traction Unit Operator 's Manual*
Hydraulic Reservoir	3.5 gal. U.S. (13.2 L)

Wheels and Brakes

Item	Description
Transport Wheel (Optional) Tire Pressure	83 to 103 kPa (12 to 15 PSI)

DPA Cutting Units

Frame construction:	Precision machined die cast aluminum cross member with bolt-on aluminum side plates.
Reel construction:	Reels are 69 cm (27 inches) or 81 cm (32 inches) in length and 18 cm (7 inch) in diameter. High strength, low alloy steel blades are thru hardened and impact resistant. 27 inch reels are available in 5, 8 and 11 blade configurations. 32 inch reels have 8 blades.
Reel bearings:	Two stainless steel sealed radial ball bearings pressed onto the reel shaft. Reel end play is maintained by an internal wave spring (no adjustment required).
Reel drive:	The reel weldment shaft is a 33.3 mm (1 5/16 inch) diameter tube with drive inserts threaded into both ends. The reel drive inserts have an internal nine (9) tooth spline.
Height-of-cut:	Cutting height is adjusted on the front roller by two (2) vertical screws. Effective HOC may vary depending on turf conditions, type of bedknife, roller type and installed attachments.
Bedknife:	Replaceable, tool steel EdgeMax™ bedknife is fastened to a machined cast iron bedbar with 8 screws. Optional bedknives are available.
Bedknife adjustment	Dual screw adjustment to the reel; detents corresponding to 0.023 mm (0.0009 inch) bedknife movement for each indexed position.
Rollers:	Greaseable through-shaft front and rear rollers are used with these cutting units. All rollers use the same heavy duty, stainless steel ball bearings and seal package.
Counterbalance weight:	A cast iron weight or a groomer and/or a powered rear roller brush accessory is mounted opposite to the hydraulic drive motor to balance the cutting unit.

Cutting unit weight (approximate):

27” Reel, 5 Blade	64 kg (141 lb.)
27” Reel, 8 Blade	67 kg (147 lb.)
27” Reel, 11 Blade	69 kg (152 lb.)
32” Reel, 8 Blade	74 kg (163 lb.)

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

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., Nylocknut), hardness of the surface underneath the head of the fastener, or similar condition which affects the installation.

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

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

Calculating the Torque Values When Using a Drive-Adapter Wrench

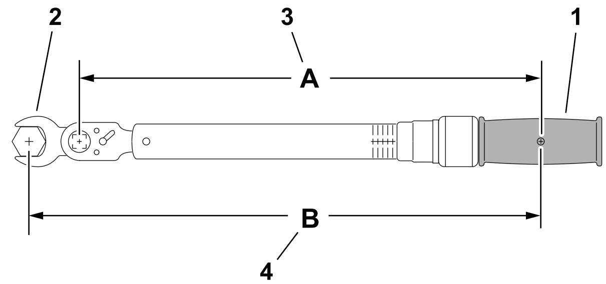


Figure 6

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

Example: The measured effective length of the torque wrench (distance from the center of the handle to the center of the square drive) is 457 mm (18 inches).

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

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

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

Identifying the Fastener

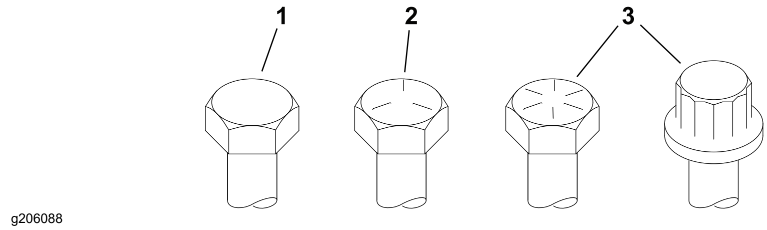


Figure 7

Inch Series Bolts and Screws

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

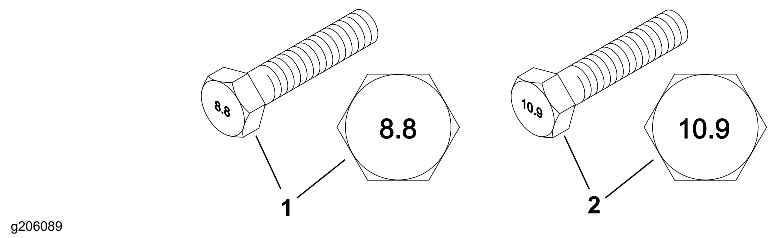


Figure 8

Metric Bolts and Screws

1. Class 8.8
2. Class 10.9

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 during 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 (Inch Series)

Thread Size	Grade 1, 5 and 8 with Thin Height Nuts	SAE Grade 1 Bolts, Screws, Studs, and Sems with Regular Height Nuts (SAE J995 Grade 2 or Stronger Nuts)		SAE Grade 5 Bolts, Screws, Studs, and Sems with Regular Height Nuts (SAE J995 Grade 2 or Stronger Nuts)		SAE Grade 8 Bolts, Screws, Studs, and Sems with Regular Height Nuts (SAE J995 Grade 2 or Stronger Nuts)	
	in-lb	in-lb	N·cm	in-lb	N·cm	in-lb	N·cm
# 6 - 32 UNC	10 ± 2	13 ± 2	147 ± 23	15 ± 2	169 ± 23	23 ± 3	262 ± 34
# 6 - 40 UNF				17 ± 2	192 ± 23	25 ± 3	282 ± 34
# 8 - 32 UNC	13 ± 2	25 ± 5	282 ± 56	29 ± 3	328 ± 34	41± 5	463 ± 56
# 8 - 36 UNF				31 ± 4	350 ± 45	43 ± 5	486 ± 56
# 10 - 24 UNC	18 ± 2	30 ± 5	339 ± 56	42 ± 5	475 ± 56	60 ± 6	678 ± 68
# 10 - 32 UNF				48 ± 5	542 ± 56	68 ± 7	768 ± 79
1/4 - 20 UNC	48 ± 7	53 ± 7	599 ± 79	100 ± 10	1130 ± 113	140 ± 15	1582 ± 169
1/4 - 28 UNF	53 ± 7	65 ± 10	734 ± 113	115 ± 12	1299 ± 136	160 ± 17	1808 ± 192
5/16 - 18 UNC	115 ± 15	105 ± 15	1186 ± 169	200 ± 25	2260 ± 282	300 ± 30	3390 ± 339
5/16 - 24 UNF	138 ± 17	128 ± 17	1146 ± 192	225 ± 25	2542 ± 282	325 ± 33	3672 ± 373
	ft-lb	ft-lb	N·m	ft-lb	N·m	ft-lb	N·m
3/8 - 16 UNC	16 ± 2	16 ± 2	22 ± 3	30 ± 3	41 ± 4	43 ± 5	58 ± 7
3/8 - 24 UNF	17 ± 2	18 ± 2	24 ± 3	35 ± 4	47 ± 5	50 ± 6	68 ± 8
7/16 - 14 UNC	27 ± 3	27 ± 3	37 ± 4	50 ± 5	68 ± 7	70 ± 7	95 ± 9
7/16 - 20 UNF	29 ± 3	29 ± 3	39 ± 4	55 ± 6	75 ± 8	77 ± 8	104 ± 11
1/2 - 13 UNC	30 ± 3	48 ± 7	65 ± 9	75 ± 8	102 ± 11	105 ± 11	142 ± 15
1/2 - 20 UNF	32 ± 4	53 ± 7	72 ± 9	85 ± 9	115 ± 12	120 ± 12	163 ± 16
5/8 - 11 UNC	65 ± 10	88 ± 12	119 ± 16	150 ± 15	203 ± 20	210 ± 21	285 ± 28
5/8 - 18 UNF	75 ± 10	95 ± 15	129 ± 20	170 ± 18	230 ± 24	240 ± 24	325 ± 33
3/4 - 10 UNC	93 ± 12	140 ± 20	190 ± 27	265 ± 27	359 ± 37	375 ± 38	508 ± 52
3/4 - 16 UNF	115 ± 15	165 ± 25	224 ± 34	300 ± 30	407 ± 41	420 ± 43	569 ± 58
7/8 - 9 UNC	140 ± 20	225 ± 25	305 ± 34	430 ± 45	583 ± 61	600 ± 60	813 ± 81
7/8 - 14 UNF	155 ± 25	260 ± 30	353 ± 41	475 ± 48	644 ± 65	667 ± 66	904 ± 89

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

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

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

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

Thread Size	Class 8.8 Bolts, Screws, and Studs with Regular Height Nuts (Class 8 or Stronger Nuts)		Class 10.9 Bolts, Screws, and Studs with Regular Height Nuts (Class 10 or Stronger Nuts)	
M5 X 0.8	57 ± 6 in-lb	644 ± 68 N·cm	78 ± 8 in-lb	881 ± 90 N·cm
M6 X 1.0	96 ± 10 in-lb	1085 ± 113 N·cm	133 ± 14 in-lb	1503 ± 158 N·cm
M8 X 1.25	19 ± 2 ft-lb	26 ± 3 N·m	28 ± 3 ft-lb	38 ± 4 N·m
M10 X 1.5	38 ± 4 ft-lb	52 ± 5 N·m	54 ± 6 ft-lb	73 ± 8 N·m
M12 X 1.75	66 ± 7 ft-lb	90 ± 10 N·m	93 ± 10 ft-lb	126 ± 14 N·m
M16 X 2.0	166 ± 17 ft-lb	225 ± 23 N·m	229 ± 23 ft-lb	310 ± 31 N·m
M20 X 2.5	325 ± 33 ft-lb	440 ± 45 N·m	450 ± 46 ft-lb	610 ± 62 N·m

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

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

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

Other Torque Specifications

SAE Grade 8 Steel Set Screws

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

Thread Cutting Screws
(Zinc Plated Steel)

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

Wheel Bolts and Lug Nuts

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

*For steel wheels and non-lubricated fasteners

Thread Cutting Screws
(Zinc Plated Steel)

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

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

Conversion Factors

in-lb X 11.2985 = N·cm

ft-lb X 1.3558 = N·m

N·cm X 0.08851 = in-lb

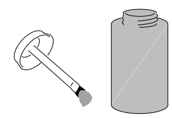
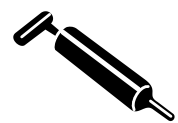
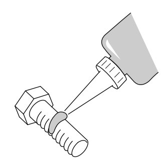
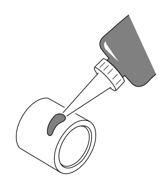
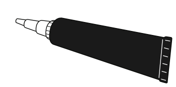
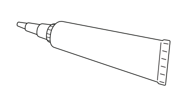
N·m X 0.7376 = ft-lb

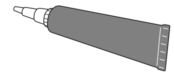
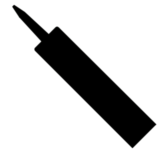
Shop Supplies

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

IMPORTANT

Always follow manufacturers instructions when using or storing shop supplies.

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

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

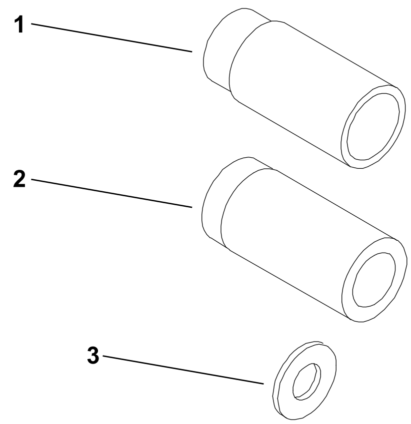
Special Tools

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

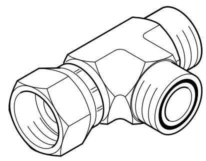
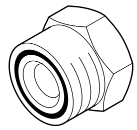
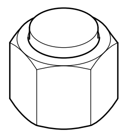
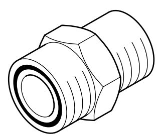
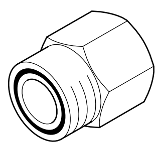
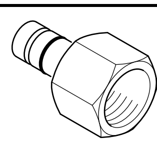
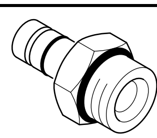
K-Line Part No. TOR6007

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 2–14).

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

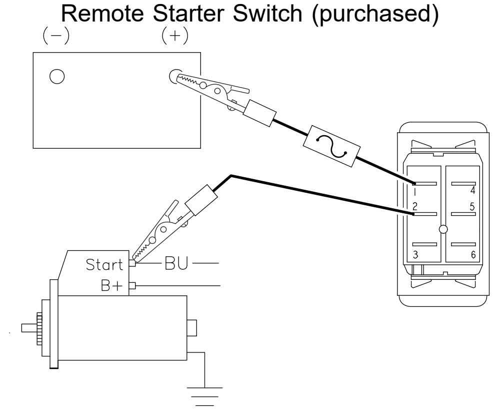
After flushing the hydraulic system or replacing a hydraulic component (e.g. gear pump, piston pump, drive motor), it is necessary to prime the hydraulic pumps. A remote starter switch can be used for this purpose. A remote starter switch can be purchased locally or fabricated as follows.

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.



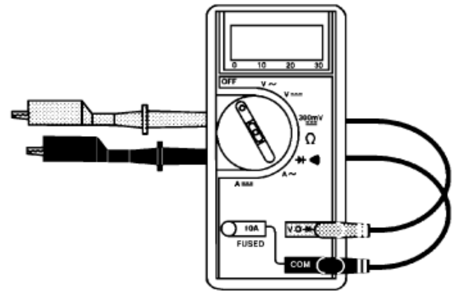
Remote Starter Switch (fabricated)

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.

Battery Hydrometer

Use the battery hydrometer when measuring the specific gravity of the battery electrolyte. You can get this tool locally.

Dielectric Gel

Toro Part No. 107-0342

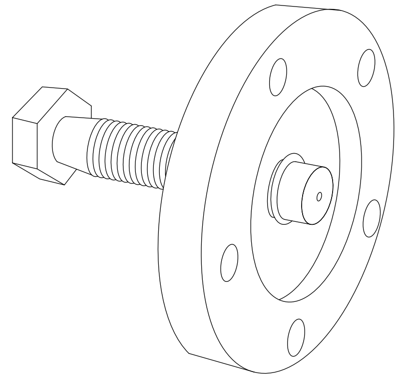
Use the dielectric gel to prevent corrosion of unsealed connection terminals. To ensure complete coating of the terminals, liberally apply the gel to the component and wire harness connector, plug the connector into the component, unplug the connector, apply the gel to both surfaces again, and connect the harness connector to the component again. The connectors must be fully packed with gel for effective results.

Note: Do not use the dielectric gel on the sealed connection terminals as the gel can unseat the connector seals during assembly.

Wheel Hub Puller

K-Line Part No. TOR6004

The wheel hub puller allows you to safely remove the wheel hub from the wheel motor shaft. If the machine is equipped with the optional CrossTrax™ Kit, this wheel hub puller is necessary for removing the rear wheel hub from the rear wheel motor.

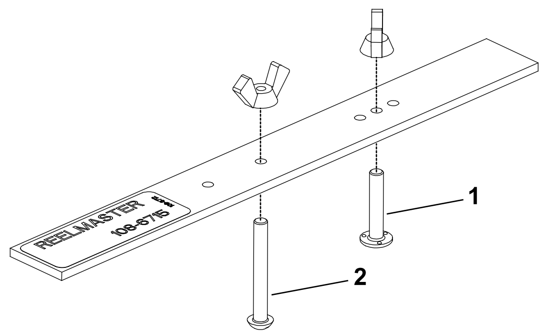


Gauge Bar Assembly

Toro Part No. 108-6715

Use gauge bar to verify height-of-cut adjustment. Also used for adjustment of optional groomer.

1. Used for groomer adjustment
2. Used for height-of-cut adjustment



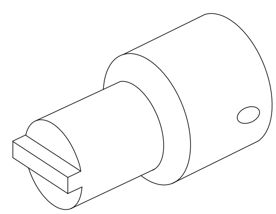
Bedknife Screw Tool

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

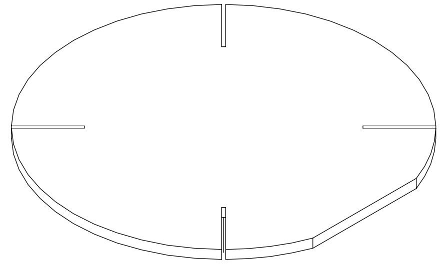
Important: To prevent damage to the bedbar, do not use an air or manual impact wrench with this tool.



Spindle Plug

K-Line Part No. 94-2703

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

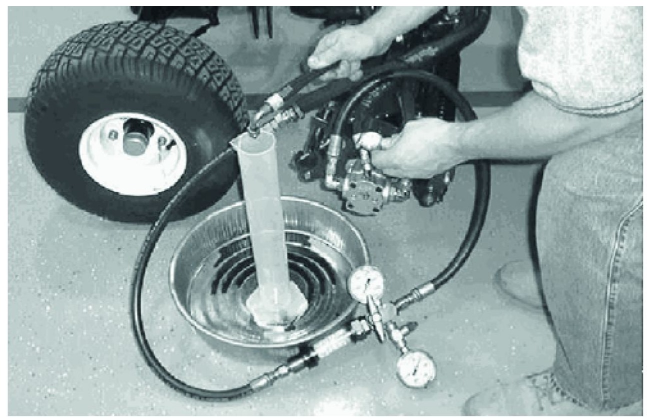


Measuring Container

K-Line Part No. TOR4077

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

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



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

Handle Assembly

K-Line Part No. 29-9100

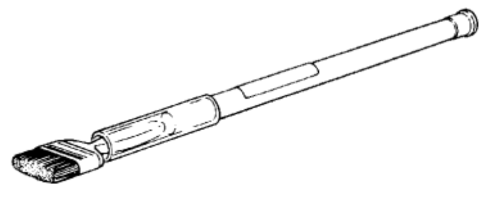
Used to apply lapping compound to cutting units while keeping the operator's hands at a safe distance from the rotating reel.

Components for the handle assembly are available individually as follows:

• Brush 36-4310

• Handle 29-9080

• Handle cap 2410-18

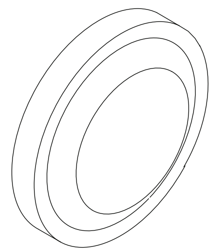


Plastic Plug

K-Line Part No. 94-2703 (for 7 inch reels)

K-Line Part No. 2410-30 (for 5 inch reels)

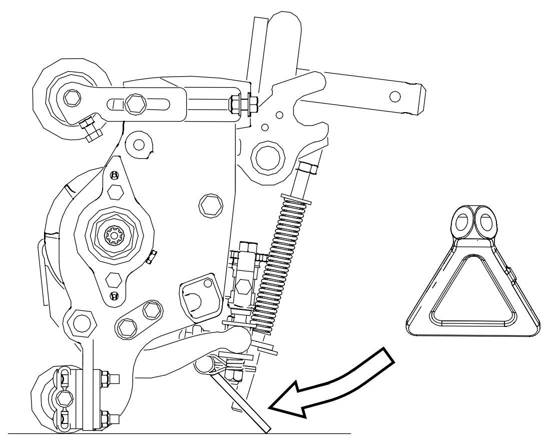
This cap is used for placement into the cutting unit side plate when the cutting reel motor is removed. It prevents dirt and unwanted material from entering the cutting reel bearing area.



Cutting Unit Kickstand

Toro Part No. 119-8010-03

The cutting unit kickstand is used to prop up the rear of the cutting unit during service. Use of this tool stabilizes the cutting unit and prevents the bedbar adjusting screws from resting on the work surface.

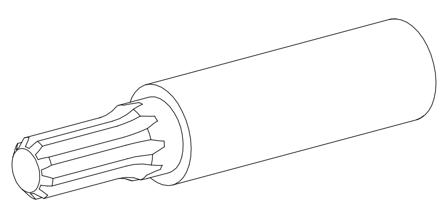


Spline Insert Tool

K-Line Part No. TOR4112 (8 tooth for 5 inch reels)

K-Line Part No. TOR4074 (9 tooth for 7 inch reels)

Use the spline insert tool for rotating the cutting reel when motor is removed. Also use this tool for installation of threaded inserts into the cutting reel shaft.



Roller Bearing and Seal Installation Tools

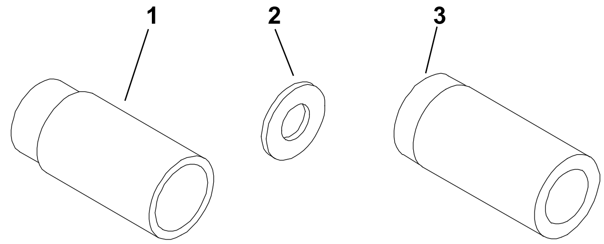
Toro Part No. 115-0803

This tool kit is used to assemble the cutting unit rollers. The tools in this kit are also available individually as follows:

1. Inner seal tool: 115-0852

2. Bearing installation washer: 107-8133

3. Bearing/outer seal tool: 115-0853



Turf Evaluator Tool

Toro Model No. 04399

Many turf discrepancies are subtle and require closer examination. In these instances, the turf evaluator grass viewing tool is helpful. It can assist turf managers and service technicians in determining causes for poor reel mower performance and in comparing the effective height-of-cut of one mowed surface to another. This tool should be used with the Toro Guide to Evaluation Reel Mower Performance and Using the Turf Evaluator (Toro Part No. 97931SL).

Diameter/Circumference Measuring Tape

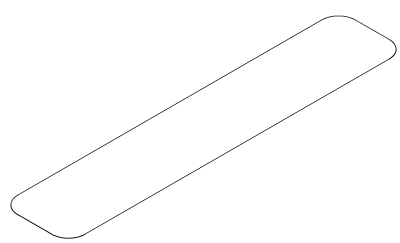
K-Line Part No. TOR6023

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

Cutting Reel Shim

Toro Part No. 125-5611

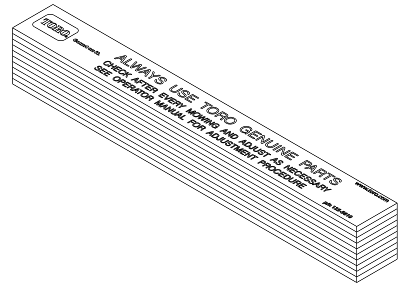
The cutting reel shim (0.05 mm/0.002 inch) is used to help parallel the bedknife and cutting reel.



Cutting Performance Paper

Toro Part No. 125–5610 (300 strips)

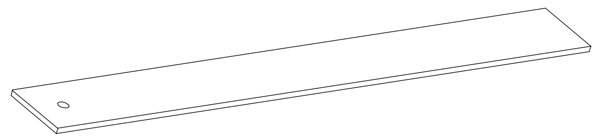
Cutting performance paper is used to test the cutting reel performance after adjusting the reel to bedknife clearance. 10 packs (30 strips per pack) of cutting performance paper are included in this part number.



Pulley Alignment Tool

Toro Part No. 114-5446

Use the pulley alignment tool to verify alignment of groomer and/or rear roller brush drive and driven pulleys.



Angle Indicator and Magnetic Mount

Angle Indicator: Toro Part No. 131–6828

Magnetic Mount: Toro Part No. 131–6829

Because the top grind angle on bedknives is critical for edge retention, and therefore after-cut appearance, Toro has develop these service tools for accurately measuring the top grind angle on all bedknives.

Since there can be variations in the mounting surface of the bedbar, it is necessary to grind the bedknife after installing it to the bedbar.

1. Place the angle indicator on the bottom side of the bedknife with the digital display facing you as shown.

2. Press the Alt Zero button on the angle indicator.

3. Remove the angle indicator and place the magnetic mount on the edge of the bedknife so that the face of the magnet is flat against the top angle of the bedknife.

4. Place the angle indicator on the mount with the digital display facing you as shown. The angle displayed on the indicator is the current bedknife top angle.

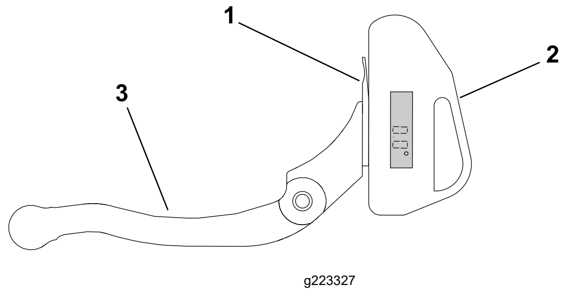


Figure 9

1. Bedknife
2. Angle Indicator
3. Bedbar

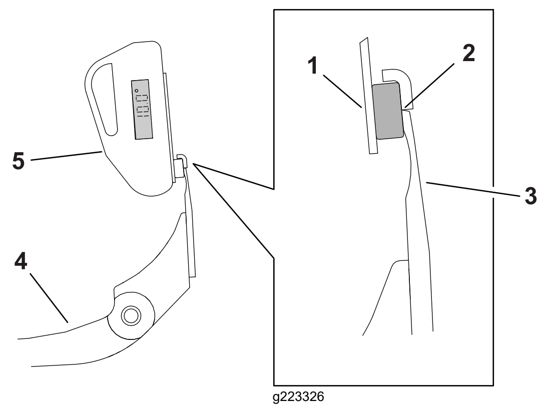


Figure 10

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

Troubleshooting

Table of Contents

GEARS – The Systematic Approach to Defining, Diagnosing and Solving Problems

Gather Information

- Information reported by the customer
- Information observed by you
- Establish the what, where and when of the issue

Evaluate Potential Causes

- Consider possible causes of the problem to develop a hypothesis
- Narrow down the focus of the problem

Assess Performance

- Ensure you have all the necessary tools for testing
- Test all potential causes of the failure
- Reevaluate and create a new hypothesis if necessary

Repair

- Return the unit to service by repairing, rebuilding or replacing

Solution Confirmation

- Did the issue go away
- Was the root cause of the issue correctly repaired
- Are there any other new symptoms

General Hydraulic System Problems

The charts that follow contain suggestions that can be used to assist in diagnosing hydraulic system performance issues. The suggestions are not all−inclusive. Also, consider that there may be more than one cause for a machine problem.

Review the hydraulic schematic and information on hydraulic system operation in the Hydraulic Flow Diagrams in Hydraulic System chapter. This information will be useful during the hydraulic troubleshooting process.

Refer to the Testing (page 5–27) for precautions and specific hydraulic test procedures.

General Hydraulic System Problems

Problem	Possible Causes
Hydraulic oil leaks from machine.	Fitting(s), hose(s) or tube(s) is (are) loose or damaged. O−ring(s) or seal(s) is (are) missing or damaged.
Hydraulic system operates hot.	Transmission pressure is high due to load or brakes applied. Oil level in reservoir is low, or inlet filter is loose or clogged. Oil is contaminated or too light. Heat exchanger (if equipped) is damaged or plugged. By−pass relief is stuck open or air flow is obstructed. Charge pressure is low. Towing by−pass valve is open or defective. Wheel motor(s) or reel motor(s) are worn or damaged. Trump pump is worn or damaged.
Hydraulic fluid foams.	Oil level in reservoir is low. Hydraulic system has wrong type of oil. One of the pump suction lines has an air leak. Incompatible hydraulic oils are mixed in the hydraulic system. Water contamination is in the hydraulic system.

Traction Circuit Problems

Problem	Possible Causes
Traction response is sluggish.	Bypass valve in the traction pump/hydrostat is open or defective. Charge pressure is low. Hydraulic oil is very cold. Towing by−pass valve is open or worn. Brake is not released. Traction pump or wheel motor(s) are worn or damaged.
Neutral is difficult to find, or unit operates in one direction only.	External control linkage is mis-adjusted, disconnected, binding, or damaged. Traction pump is worn or damaged.
No traction exists in either direction.	Brake is not released. Oil level in reservoir is low. Towing by−pass valve is open. Charge pressure is low. Traction pump or wheel motor(s) are worn or damaged. Traction pump drive belt loose or broken.
Wheel motor will not turn.	Internal parts in wheel motor are damaged. Brakes are binding. Key on wheel motor shaft is sheared or missing.
Wheel motor will not hold load in neutral.	Make up fluid from charge pump is not available. Hydrostat ball check valves are damaged.

Mow Circuit Problems

Problem	Possible Causes
Reel motor drive pump is noisy (cavitation).	Reservoir oil level is low. Suction line is restricted. Suction line has an air leak.
Reels will not turn.	Solenoid valve SV is stuck open. An electrical problem exists (see Chapter 6: Electrical System (page 6–1)). Gear pump P1 is damaged.
Reel speed is erratic.	Reel to bedknife adjustment is too tight. Reel bearing(s) are damaged.
Reel(s) turn too slowly.	Reel section of pump is inefficient (see Reel Circuit Testing − Pressure Test (page 5–40)). Reel motor has internal leakage or malfunctioning cross−over relief valve (see Reel Motor Cross−over Relief Pressures Test (Using Pressure Gauge) (page 5–46)). Reel bearing(s) are damaged.

Steering Circuit Problems

Problem	Possible Causes
Steering inoperative or sluggish.	Oil level in hydraulic reservoir is low. **Note:** Other hydraulic systems are affected as well. Steering components (e.g. steering fork assembly, steering cylinder ends) are worn or binding. Relief valve in steering control valve is damaged − open. Steering cylinder leaks internally. See Danfoss steering control service manual. Gear pump (P2) is worn or damaged. **Note:** The lift/lower and traction charge circuits are affected as well.
Turning steering wheel turns machine in the opposite direction.	Hoses to the steering cylinder are reversed.

Lift Circuit Problems

Problem	Possible Causes
Cutting units will not lift or lift slowly.	Engine speed is too low. Charge (gear) pump is damaged. Lift cylinder linkage is binding or broken. Lift cylinder bushings are binding. Reservoir oil level is low. Charge pump pressure or flow is insufficient. Implement relief valve (1000 PSI) is stuck open. Lift cylinders leak internally. Steering control valve is defective.
Cutting units raise, but will not stay up.	Lift circuit hydraulic lines or fittings are leaking. Lift cylinders leak internally. Lift control manifold cartridge valve(s) has damaged seals or is faulty.
Cutting units will not lower. **Note:** To lower the cutting units, the seat must be occupied and the mow/transport switch must be in the MOW position.	Lift arm pivots are binding. Lift cylinder(s) for affected cutting unit(s) is damaged.

Electrical System Problems

⚠ CAUTION ⚠

Remove all the jewelry, especially rings and watches, before doing any electrical troubleshooting or testing.

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 and Wire Harness Drawings/Diagrams in Appendix A (page A–1).

Note: If the machine has any interlock switches by-passed, they must be reconnected for proper troubleshooting and safety.

Starting Problems

Problem	Possible Causes
Starter solenoid clicks, but starter will not crank (if solenoid clicks, problem is not in safety interlock system).	Low battery charge. Loose or corroded battery cables. Loose or corroded ground. Faulty wiring at the starter. Faulty starter solenoid.
Nothing happens when start attempt is made.	The traction pedal is not in neutral position or the neutral switch is faulty. Reel on/off switch is in the ON position or faulty. The engine is too hot or the over temperature shut down relay is faulty. The battery is dead. Fuse F1 or F3 is faulty or blown. Loose or corroded battery or ground cables. Loose or corroded ground. Wiring in the crank circuit (see B Electrical Schematic (page A–6)) is loose, corroded, or damaged. The key switch faulty. Starter solenoid wiring loose, corroded or damaged. Starter solenoid faulty. The interlock relay is faulty.
Engine cranks, but does not start.	Wiring in the crank circuit (see B Electrical Schematic (page A–6)) is loose, corroded, or damaged. Engine run solenoid or fuel pump faulty. The fuel tank is empty. An engine or fuel system problem exists. The glow circuit does not operate properly.

Starting Problems (continued)

Problem	Possible Causes
The glow circuit does not operate properly.	Wiring in the glow circuit (see B Electrical Schematic (page A–6)) is loose, corroded, or damaged. The glow relay or glow plug controller is faulty. Fuse F4 is blown or faulty.
Engine cranks (but should not) with the reel on/off switch in the ON position.	The reel on/off switch is faulty or short circuited. Short circuit in reel drive neutral switch circuit.

General Run and Transport Problems

Problem	Possible Causes
Engine kills during operation (operator sitting on seat).	Operator moved too far forward on seat (seat switch is not depressed). The engine overheated. The parking brake was engaged or the parking brake switch No. 1 failed. The seat relay or seat switch failed. The high temperature shutdown relay failed. Fuse F1 or F3 failed. The run solenoid or fuel pump failed. Wiring in the run circuit (see B Electrical Schematic (page A–6)) broke or disconnected.
Engine kills when the backlap switch is in the BACKLAP position and the parking brake is ON.	The parking brake was released or the backlap switch was moved to MOW. The engine overheated. The traction pedal was moved from the neutral. The high temperature shutdown relay failed. Fuse F1 or F3 failed. The run solenoid or fuel pump failed. Wiring in the run circuit (see B Electrical Schematic (page A–6)) broke or disconnected.
Battery does not charge.	Loose or broken wire(s). Faulty alternator. Dead battery. Alternator warning lamp is faulty or burned out. Alternator warning lamp wiring loose, corroded or damaged.

Cutting Unit Operating Problems

Problem	Possible Causes
The cutting units will not run with the transport mow switch in MOW and the reel on/off switch in ON with the cutting units lowered.	Wiring to the reel drive circuit is (see B Electrical Schematic (page A–6)) is loose, corroded, or damaged. Fuse F4 is faulty or blown. The coil to solenoid valve SV on the hydraulic manifold is faulty or the valve is stuck. The reels on/off is faulty. The reels up limit or transport/mow switch is faulty or misadjusted. There is insufficient hydraulic oil pressure to turn the reels (see Mow Circuit Problems (page 3–4)).
The cutting units run, but should not run when raised.	The coil to solenoid valve S1 on the hydraulic manifold is faulty or the valve is stuck. The reels up limit switch is stuck, faulty, or misadjusted.

Factors That Can Affect Cutting Performance

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

Refer to the *Cutting Unit Operator’s Manual* detailed adjustment procedures. Refer to Chapter 8: DPA Cutting Units (page 8–1) 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.

Factor	Possible Problem/Correction
Tire pressure	Check tire pressure of all traction unit tires. Adjust tire pressure as necessary (see the *Traction Unit Operator’s manual*).
Governed engine speed	For best cutting performance and appearance, engine should be run at maximum governed speed during machine operation. Check maximum governed engine speed. Adjust engine to specifications if necessary. See the *Traction Unit Operator’s Manual* and Chapter 4: Engine (page 4–1) in this manual.
Reel speed	All cutting reels must rotate at the same speed (within 100 rpm) (see Mow Circuit Problems (page 3–4)). All cutting units must have equal bedknife to reel and height-of-cut adjustments. Make sure that reel speed selection is correct (see Clip Chart in *Traction Unit Operator’s Manual*).
Reel bearing condition	Check reel bearings for wear and replace if necessary. See Reel Assembly Service (page 8–26).
Bedknife to reel adjustment	Check bedknife to reel contact daily. The bedknife must have light contact across the entire reel. No contact will dull the cutting edges. Excessive contact accelerates wear of both edges. Quality of cut is adversely affected by both conditions (see Bedknife to Reel Adjustment in the *Cutting Unit Operator’s Manual*).
Reel and bedknife sharpness **Note:** After grinding the reel and/or bedknife, check the reel to bedknife contact again after cutting two (2) fairways. During this initial use, any burrs will be removed from reel and bedknife which may create improper reel to bedknife clearance and thus accelerate wear. This practice of re-checking the reel to bedknife contact after grinding will extend the longevity of the sharpness of the edge of the reel and the bedknife.	A reel and/or bedknife that has rounded cutting edges or “rifling” (grooved or wavy appearance) cannot be corrected by tightening the bedknife to reel contact. Grind cutting reel to remove taper and/or rifling. Grind bedknife to sharpen and/or remove rifling. The most common cause of rifling is bedknife to reel contact that is too tight. Dull cutting edges must be corrected by grinding the bedknife and cutting reel (see Preparing the Reel for Grinding (page 8–29)). **A new bedknife must be ground flat (within 0.002”) after installation to the bedbar. Backlapping may be required to properly mate the reel and bedknife after installation into the cutting unit.** **Note:** On cutting units equipped with optional bedknives, slightly dull cutting edges may be corrected by backlapping (see Backlapping in the Service and Repairs section of this chapter).
Rear roller adjustment	Adjust the rear roller brackets to correct position depending on the height-of-cut range and aggressiveness of cut that is desired. See Rear Roller Adjustment in the *Cutting Unit Operator’s Manual*.

Factor	Possible Problem/Correction
Height-of-cut	“Effective” or actual height-of-cut depends on the cutting unit weight and turf conditions. Effective height-of-cut will be different from the bench set height-of-cut. See Height-of-Cut Adjustment in the *Cutting Unit Operator’s Manual*.
Proper bedknife selection for height-of-cut desired	If the bedknife is incorrect for effective height-of-cut, poor quality of cut will result. See *Cutting Unit Operator’s Manual* for bedknife options.
Stability of bedbar	Make sure bedbar pivot bolts are seated securely. Check condition of the bushings in the side plates. See Bedbar Assembly (page 8–10).
Number of reel blades	Use correct number of reel blades for clip frequency and optimum height-of-cut range. Refer to Clip Chart in *Traction Unit Operator’s Manual*.
Cutting unit alignment and carrier frame ground following	Check carrier frames and lift arms for damage, binding conditions or bushing wear. Repair if necessary.
Roller condition and roller type	Make sure rollers rotate freely. Repair roller bearings as necessary. See Servicing the Roller (page 8–36). Refer to *Cutting Unit Operator’s Manual* for roller options.
Cutting unit accessories	A variety of cutting unit accessories are available that can be used to enhance after-cut appearance. Refer to *Operator’s Manual* for a listing of available accessories.

Factors Affecting Grooming

There are a number of factors that can affect the performance of grooming. These factors vary for different golf courses and from green to green. It is important to inspect the turf frequently and vary the grooming practice with turf needs.

IMPORTANT

Improper or overaggressive use of the grooming reel, such as too deep or frequent grooming, may cause unnecessary stress on the turf leading to severe turf damage. Use the groomer carefully. Read and understand the installation instructions before operating or testing groomer performance.

It is important to remember that factors affecting quality of cut also affect grooming performance.

Variables that Affect the Use and Performance of Grooming Reels:

1. The growing season and weather conditions.
2. General turf conditions.
3. The frequency of grooming/cutting—number of cuttings per week and how many passes per cutting.
4. The blade spacing on the grooming reel.
5. The height-of-cut.
6. The grooming depth.
7. The type of grass on the green.
8. The amount of time that a grooming reel has been in use on a particular turf area.
9. The amount of traffic on the turf.
10. The overall turf management program (e.g., irrigation, fertilizing, weed control, coring, over-seeding, disease control, sand dressing, and pest control).
11. Stress periods for turf (e.g., high temperatures, high humidity, and unusually high traffic).

Grooming Reel Mechanical Problems

Problem	Possible Causes	Correction
No rotation of the grooming reel.	Groomer drive gears are worn or damaged.	Inspect groomer drive assembly and replace damaged drive components.
	The groomer drive is in Neutral.	Engage groomer drive to Forward or Reverse.
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 grooming reel blades are bent, damaged or missing.	Repair or replace blades if necessary.
	The grooming reel shaft is bent or damaged.	Replace grooming reel shaft.
	Grooming depth is not equal on both ends of grooming reel.	Adjust depth if necessary. Check and adjust cutting unit set up (level bed knife to reel, set height-of-cut, etc.).

Engine

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Additional Reference Materials

KUBOTA 05-E4B SERIES WORKSHOP MANUAL

General Information

This chapter gives information about specifications, troubleshooting, testing and repair of the Kubota diesel engine used in Reelmaster 3100-D and 3105-D machines.

Most repairs and adjustments require tools which are commonly available in many service shops. The use of some specialized test equipment is explained in the engine service manual included in this chapter. However, the cost of the test equipment and the specialized nature of some repairs may dictate that the work be done at an engine repair facility.

Service and repair parts for Kubota diesel engines are supplied through your local Toro Distributor. If a parts list is not available, be sure to provide your distributor with the Toro model and serial number.

Operator's Manual

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

Kubota Workshop Manual

The engine that powers your Reelmaster machine is a Kubota model D1105-E4B. The Kubota Workshop Manual is available for this engine. Ensure that the correct engine manual is used when servicing the engine on your Reelmaster.

Service and Repairs

Air Cleaner Assembly

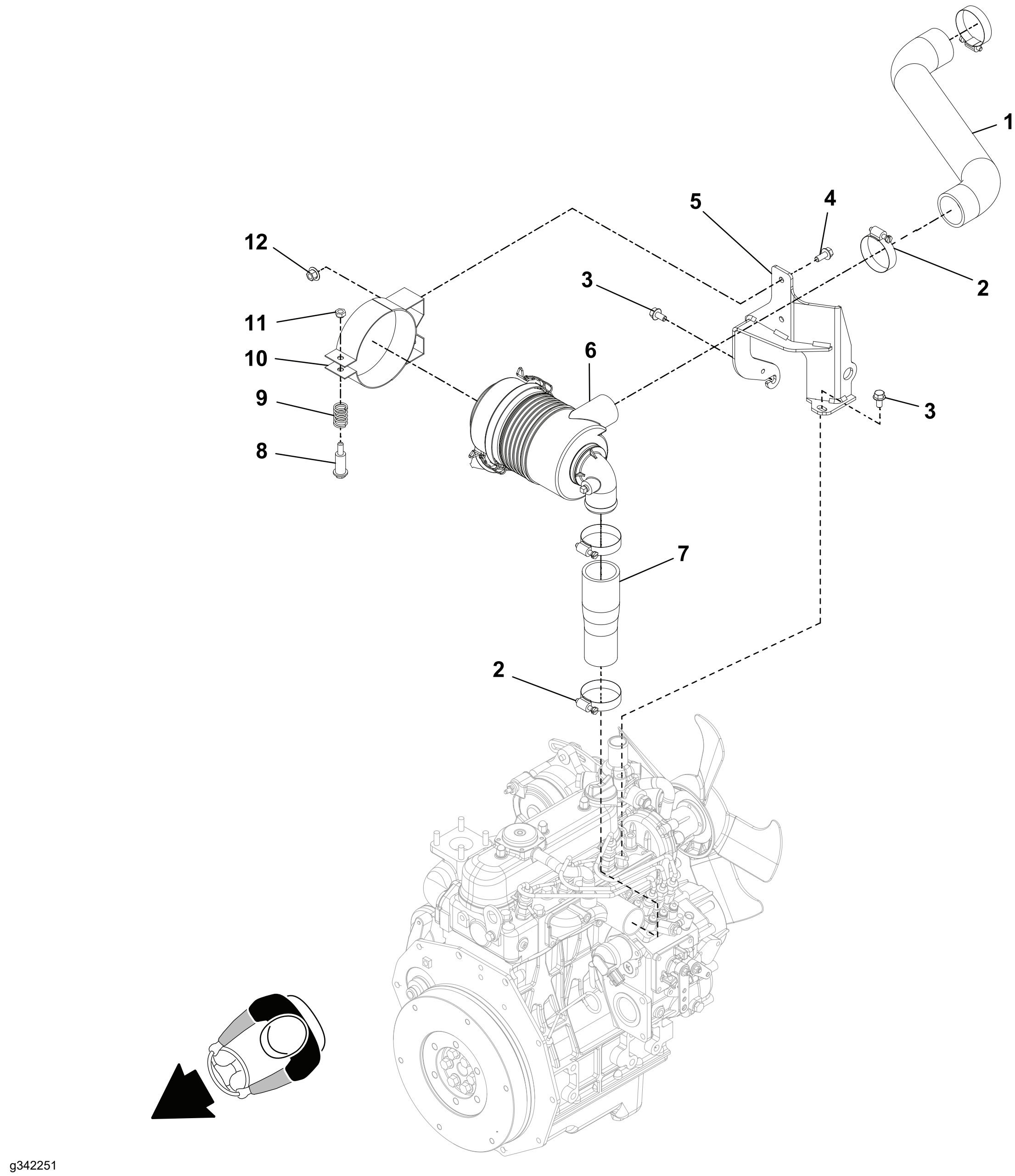

Figure 11

1. Air inlet hose (upper)
2. Hose clamp (4 each)
3. Flange head bolt (3 each)
4. Flange head bolt (2 each)
5. Bracket
6. Air cleaner assembly
7. Air inlet hose (lower)
8. Bolt
9. Compression spring
10. Mounting band assembly
11. Lock nut
12. Flange nut (2 each)

Removing the Air Cleaner Assembly

The air cleaner body, air filter, filter cover, and burp valve should be checked daily, prior to operation.

IMPORTANT

Any leaks in the air cleaner system will cause serious engine damage. Make sure that all air cleaner components are in good condition and are properly secured during operation.

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

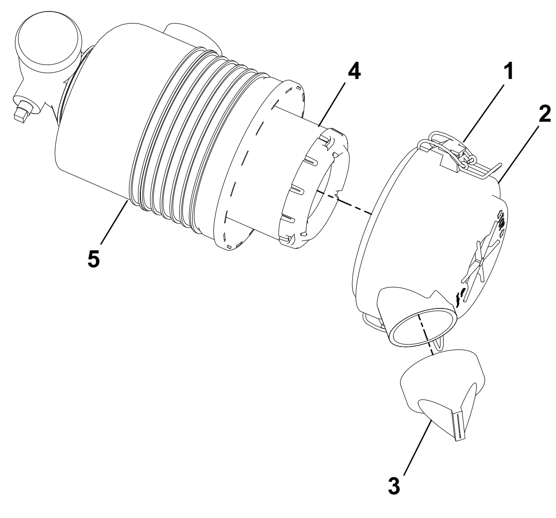

Figure 12

1. Latch
2. Dust cap
3. Burp valve
4. Filter element
5. Body

2. Release latches securing the air cleaner cover to the air cleaner body. Separate the cover from body. Clean inside of the air cleaner cover; refer to Figure 12.
3. Gently slide the filter out of air cleaner body to reduce the amount of dust dislodged. Avoid knocking filter against air cleaner body.
4. Inspect filter and discard if damaged. Do not wash or reuse a damaged filter.

IMPORTANT

Do not over service the air filter element; damage may result.

5. Remove the air cleaner components as necessary; refer to Figure 11.

Installing the Air Cleaner Assembly

1. If removed, install the air cleaner components; refer to Figure 11.

IMPORTANT

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

2. Inspect the filter for damage. Check the sealing end of the filter. Do not install the damaged filter.
3. Insert the filter properly into the air cleaner body. Make sure that the filter is sealed properly by applying pressure to outer rim of filter when installing. Do not press a flexible center of the filter; refer to Figure 12.
4. Install the cover and secure with latches. Make sure that the cover is positioned with TOP side up.
5. After air cleaner has been properly installed, lower and secure hood.

Exhaust System

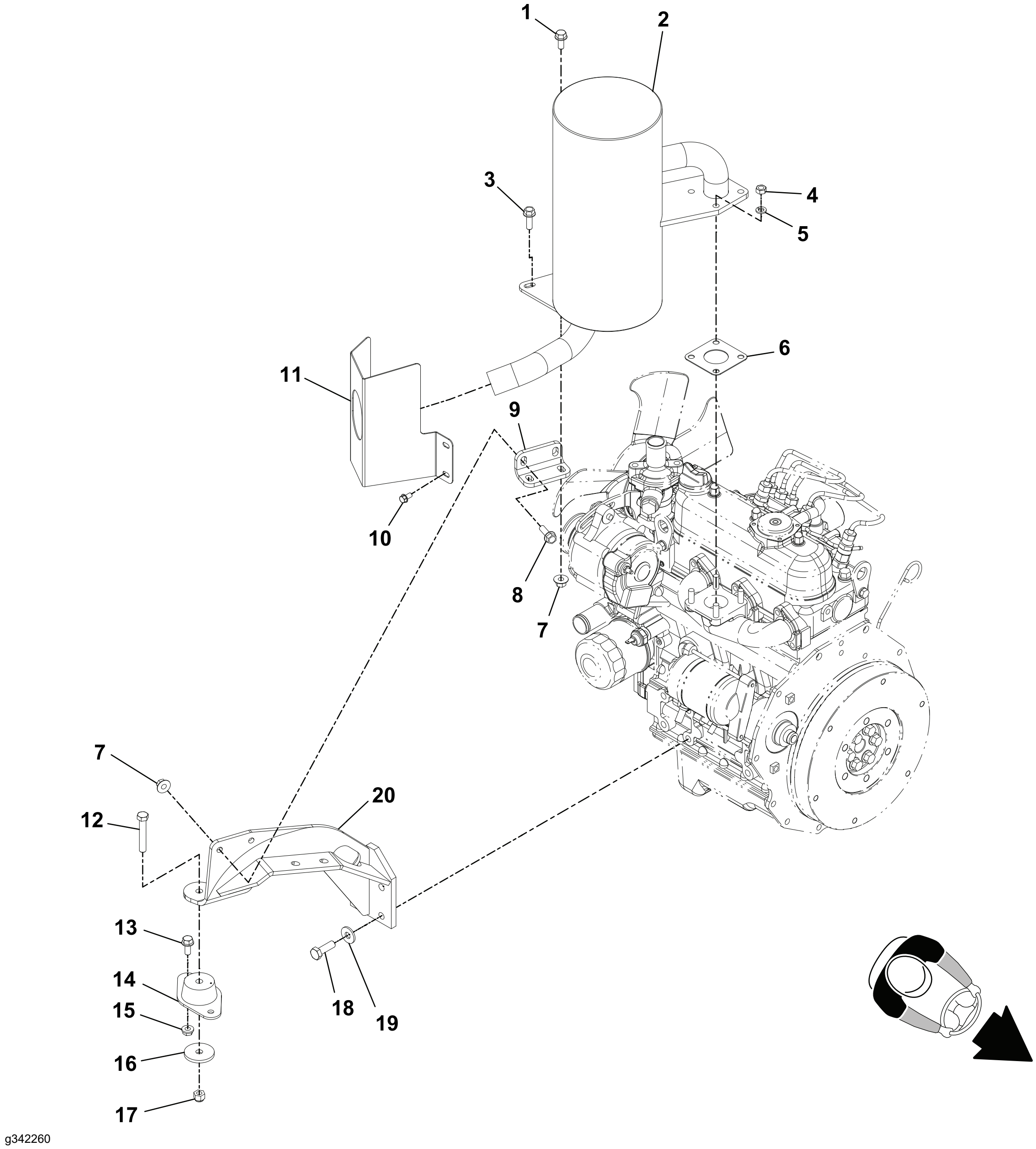

Figure 13

1. Flange head bolt
2. Muffler
3. Flange head bolt (2 each)
4. Nut (4 each)
5. Lock washer (4 each)
6. Gasket
7. Flange nut (4 each)
8. Flange head bolt
9. Muffler bracket
10. Flange head bolt (4 each)
11. Exhaust guard
12. Bolt
13. Flange head bolt (2 each)
14. Engine mount
15. Flange nut
16. Hardened washer
17. Lock nut
18. Bolt (4 each)
19. Washer (4 each)
20. Engine mount

Removing the Exhaust System

⚠ CAUTION ⚠

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

---

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the key switch. Raise and support hood.
2. Remove the four flange head bolts (item 10 in Figure 13) that secures the exhaust guard (11) to the frame.
3. Remove the two flange nuts (7) and bolts (3) that secures the muffler (2) to the muffler bracket (9).
4. Remove the four nuts (4) and lock washers (5) from the exhaust manifold studs. Remove the muffler (2) from the engine.
5. Remove the gasket (6) from the exhaust manifold. Discard the gasket.

Installing the Exhaust System

Note: Make sure that the muffler flange and exhaust manifold sealing surfaces are free of debris or damage that may prevent a tight seal.

1. Place the new gasket (6) on the exhaust manifold.
2. Install the muffler (2) onto the engine and secure with four lock washers (5) and nuts (4).

IMPORTANT

Finger tighten all nuts before securing the muffler (2) to the muffler bracket (9) so there is no preload on the exhaust manifold.

---

3. Secure muffler (2) to the muffler bracket (9) with two flange head bolts (3) and nuts (7).
4. Secure the exhaust guard (11) to the frame with four flange head bolts (10).
5. Lower and secure hood after exhaust system installation is complete.

Fuel System

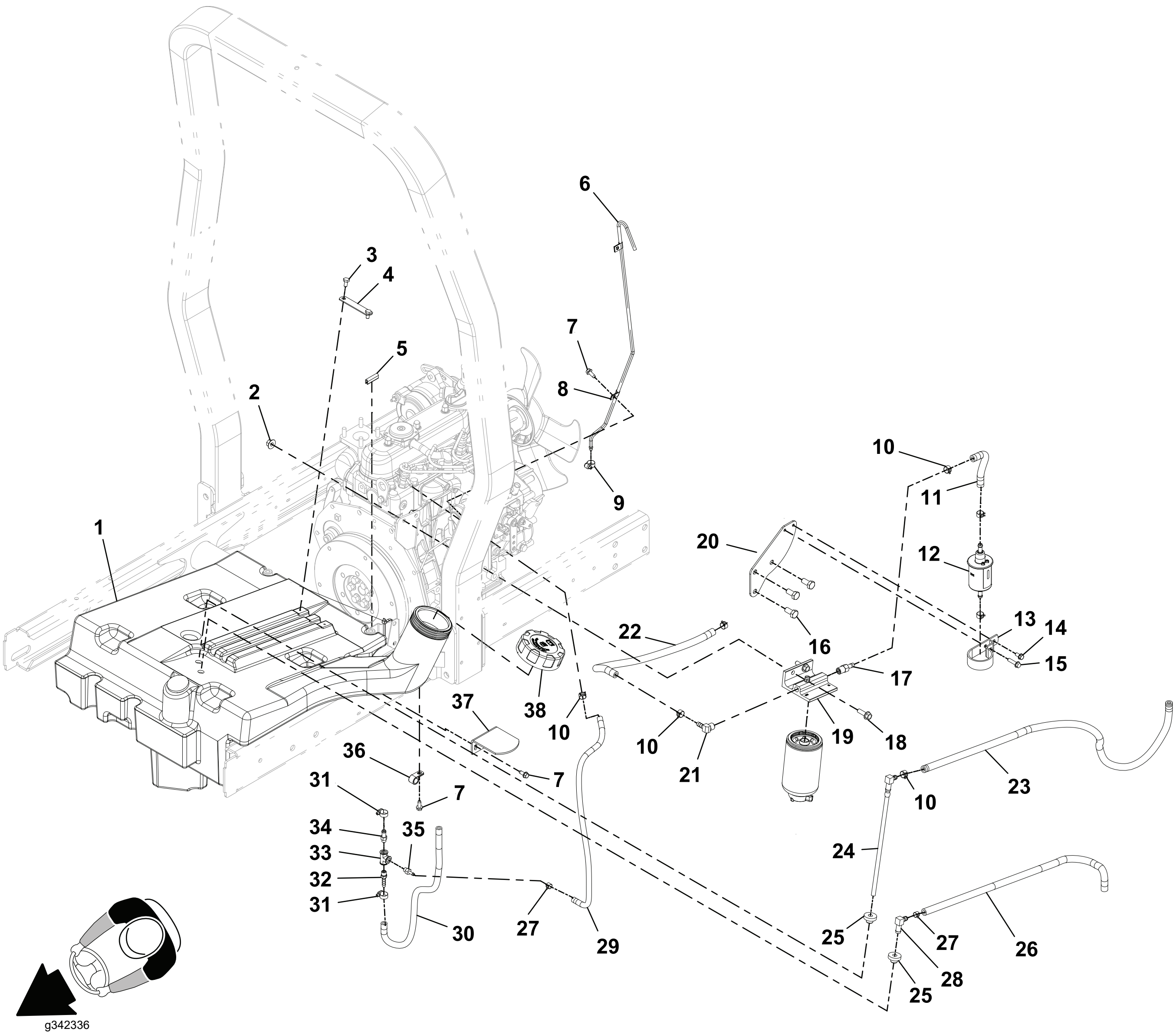

Figure 14

1. Fuel tank
2. Flange nut (2 each)
3. Bolt (2 each)
4. Fuel hose strap
5. Trim
6. Breather tube
7. Bolt (5 each)
8. Closed clip (2 each)
9. Hose clamp
10. Hose clamp (7 each)
11. Fuel hose
12. Fuel pump
13. Fuel pump bracket
14. Bolt
15. Bolt
16. Bolt (3 each)
17. Fitting
18. Flange head bolt (2 each)
19. Fuel filter
20. Fuel pump mount plate
21. Fitting
22. Fuel hose
23. Fuel hose
24. Pipe
25. Bushing (2 each)
26. Fuel hose
27. Hose clamp (2 each)
28. Elbow fitting (2 each)
29. Fuel hose
30. Fuel hose
31. Hose clamp (2 each)
32. Hose clamp (2 each)
33. T fitting
34. Fitting
35. Fitting
36. R clamp
37. Fuel tank support
38. Fuel tank cap

DANGER

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

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

Checking the Fuel Lines and Connections

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

Drain and Clean Fuel Tank

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

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

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

Priming the Fuel System

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

Removing the Fuel Tank

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the key switch. Raise and support hood.
2. Remove the negative battery cable from the negative post of the battery.
3. Allow the engine to completely cool.
4. Drain fuel from the tank into a suitable container. If necessary.
5. Remove seat and seat support straps from the frame. Disconnect seat switch from the electrical harness; refer to Removing the Seat (page 7–7).
6. For assembly purposes, label fuel hoses. Remove the fuel hose strap and both fuel hoses from the fuel tank. Pull the fuel tank from the machine; refer to Figure 14.

Installing the Fuel Tank

1. Position fuel tank into the machine.
2. Using labels placed during fuel tank removal, connect both fuel hoses to the tank and secure with the hose clamps and fuel hose strap; refer to Figure 14.
3. Connect seat switch to the electrical harness. Secure seat support straps and seat to the frame with hex flange head screws; refer to Installing the Seat (page 7–8).
4. Connect the negative battery cable to the negative battery post.
5. Fill the fuel tank with clean fuel; refer to *Operator's Manual*.
6. Prime the fuel system; refer to Priming the Fuel System (page 4–9).
7. Check the fuel hoses and fittings for leaks.

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

Radiator and Oil Cooler Assembly

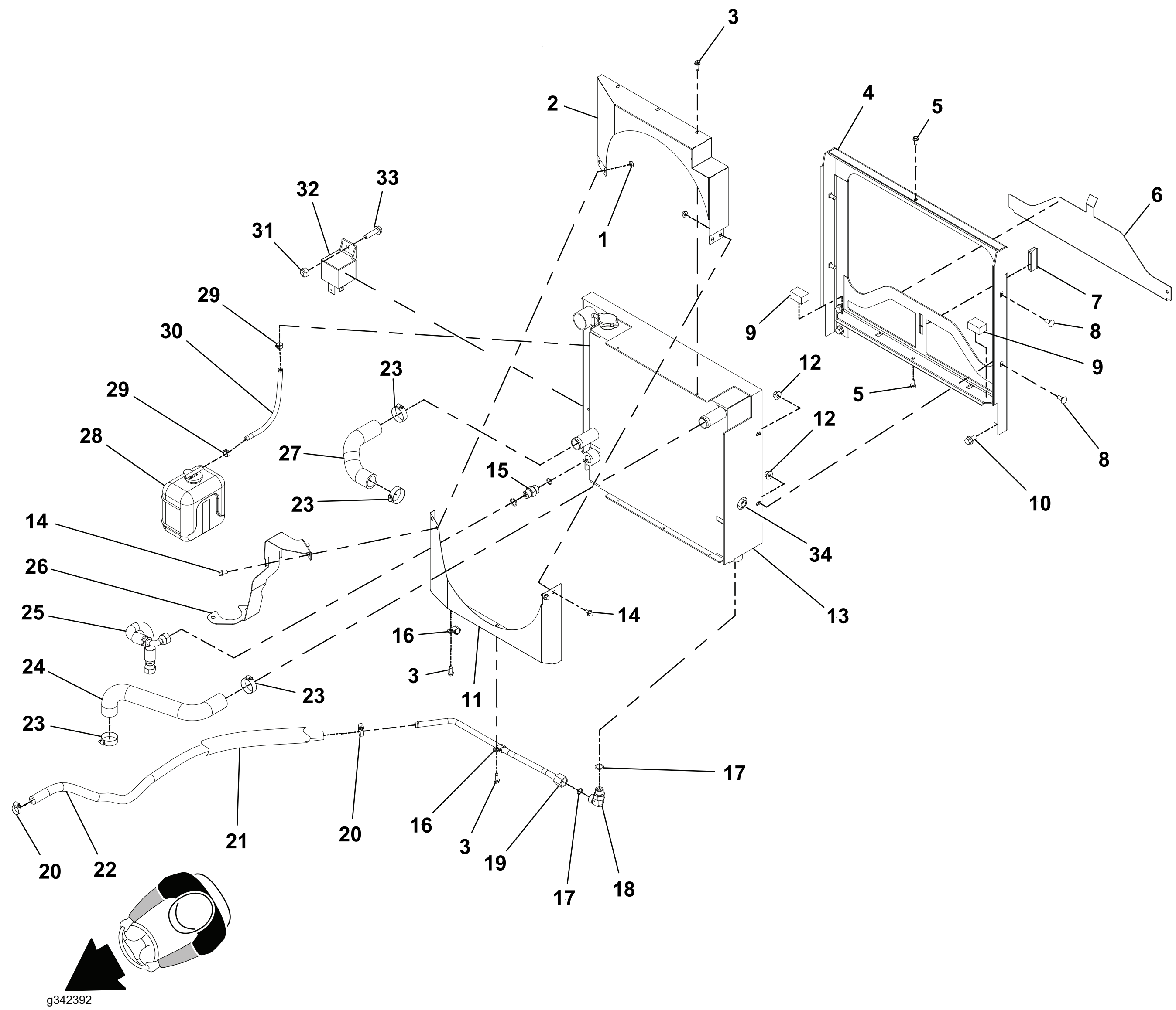

Figure 15

1. Flange head nut (4 each)
2. Top fan shroud
3. Flange head bolts (6 each)
4. Radiator frame assembly
5. Bolt (2 each)
6. Lower radiator shield
7. Magnet
8. Carriage bolt (4 each)
9. Radiator seal (2 each)
10. Flange head bolt (4 each)
11. Bottom fan shroud
12. Flange nut (4 each)
13. Radiator cooler
14. Flange head bolt (4 each)
15. Fitting
16. R clamp (2 each)
17. O-ring (2 each)
18. Elbow fitting
19. Hydraulic tube
20. Hose clamp (2 each)
21. Protective sleeve
22. Hose
23. Hose clamp (4 each)
24. Upper radiator hose
25. Hydraulic hose assembly
26. Reservoir mounting bracket
27. Lower radiator hose
28. Overflow bottle
29. Hose clamp (2 each)
30. Hose
31. Nut
32. Relay
33. Bolt
34. Drain plug

Removing the Radiator and Oil Cooler Assembly

DANGER

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

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

WARNING

- **Ethylene-glycol antifreeze is poisonous.**
- **Keep the coolant away from children and pets.**
- **Keep the coolant in a labelled container.**
- **Discard the coolant in accordance with local hazardous waste ordinances.**

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

IMPORTANT

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

3. Place a suitable container under the radiator to collect the coolant. Open drain plug (item 34 in Figure 15), and completely drain the radiator.
4. Remove glow plug relay (32) from the radiator assembly (13). Position relay away from the radiator.
5. Disconnect following hoses from the radiator:
   A. Upper radiator hose (24) to the water pump.
   B. Lower radiator hose (27) to the engine block.
   C. Coolant hose to the reservoir (30).
   D. Air hose to the air cleaner.
6. To prevent contamination of hydraulic system during radiator/oil cooler removal, thoroughly clean junction of hydraulic hoses and fittings on oil cooler.

   Note: Allow hydraulic components and hoses to drain into a suitable container.
7. Disconnect hydraulic hoses from radiator/oil cooler. Put caps or plugs on open hydraulic hoses and fittings to prevent system contamination. Label the hydraulic hoses to ensure correct installation. Discard the O-rings.
8. Remove the reservoir (28) and bracket (26) from the bottom fan shroud.
9. Remove both fan shrouds (2 and 11) from radiator assembly (13).
10. Remove the flange head bolts (5) securing the top and bottom of the radiator frame (4) to the radiator (13). Remove the four carriage bolts (8) and lock nuts (12) securing the radiator (13) to the radiator frame (4).

Removing the Radiator and Oil Cooler Assembly (continued)

11. Pull the radiator (13) carefully from the radiator frame (4).
12. Plug any openings to prevent contamination.

Installing the Radiator and Oil Cooler Assembly

1. Remove any plugs from the radiator used during the removal procedures.
2. Position the radiator (13) carefully to the radiator frame (4).
3. Secure radiator assembly to the radiator frame with four carriage bolts (8) and lock nuts (12). Secure the top and bottom of radiator to frame with flange head bolts (5).
4. Secure both fan shrouds (2 and 11) to the radiator assembly with flange head bolts.
5. Secure the reservoir bracket (26) and reservoir (28) to the bottom fan shroud (11) with both flange head bolts (14) and flange nuts (1).
6. Connect following hoses to the radiator:
   A. Upper radiator hose (27) to the water pump.
   B. Lower radiator hose (24) to the engine block.
   C. Coolant hose (30) to the reservoir.
   D. Air hose to the air cleaner.
7. Remove all plugs from hydraulic tubes, hoses, and openings used during the removal procedures.
8. Install the new O−rings to the hydraulic fittings (15 and 18). Connect the hydraulic hose (25) to the radiator (13).
9. Connect the hydraulic tube (19) to the radiator (13).
10. Secure the glow plug relay (32) to the radiator assembly with the bolt (33) and nut (31). Connect the wire harness connector to the glow plug relay.
11. Make sure the drain plug (34) is closed. Fill radiator with coolant; refer to *Operator's Manual*.
12. Start the engine and check for coolant and hydraulic fluid leaks. Repair any leaks as required before returning the machine to service.
13. Continue to run the engine to obtain the operating temperature. Check the coolant and hydraulic fluid levels and adjust as necessary.
14. Install engine hood to the machine and close.

Engine

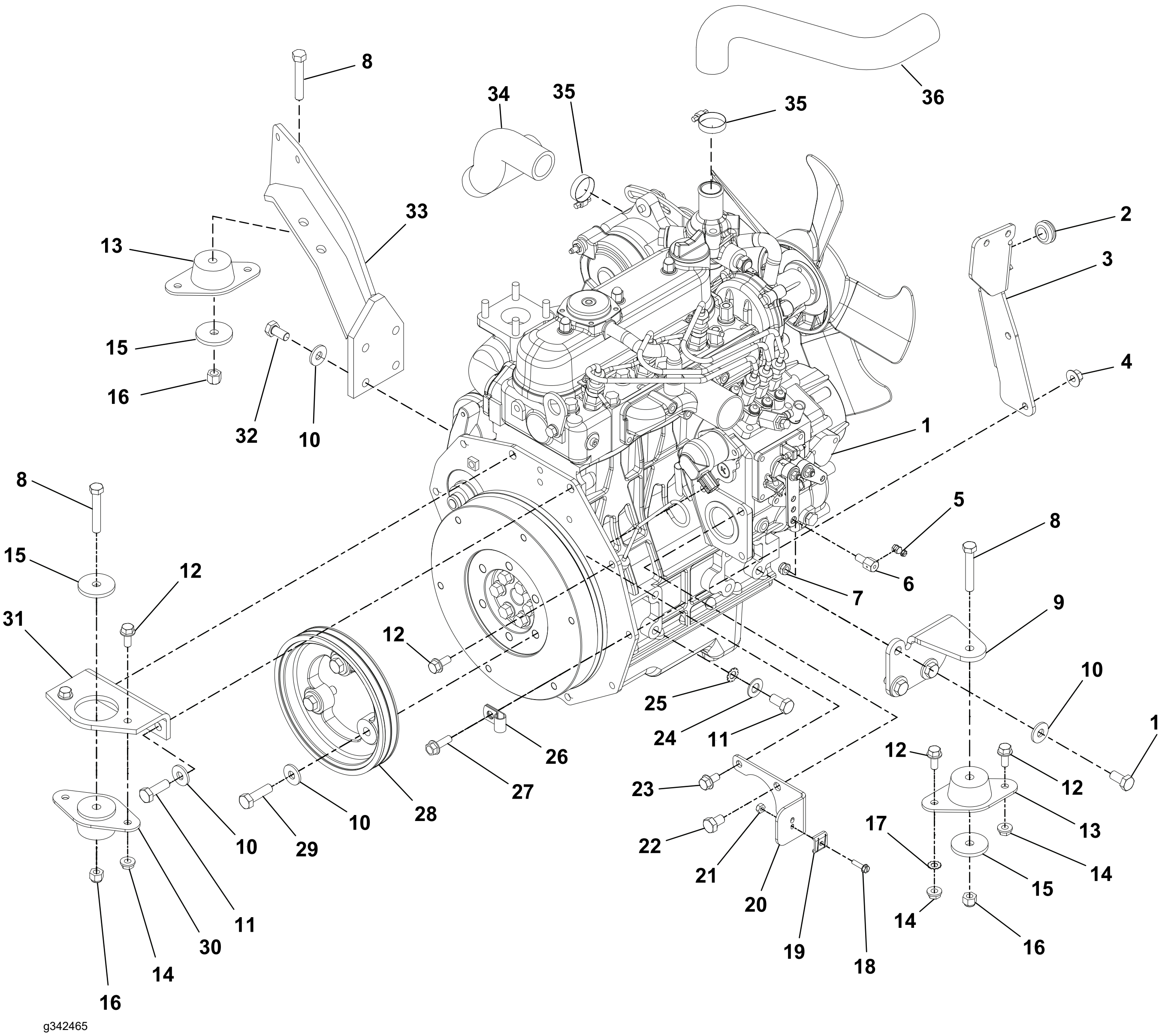

Figure 16

1. Engine	13. Engine mount (2 each)	25. Lock washer
2. Grommet	14. Flange head nut (4 each)	26. Clamp
3. Fuel filter mount bracket	15. Washer (2 each)	27. Flange head bolt
4. Nut (4 each)	16. Flange nut (3 each)	28. Pulley
5. Throttle cable stop	17. Lock washer	29. Bolt (3 each)
6. Throttle swivel	18. Bolt	30. Engine mount
7. Lock nut	19. Cable clamp	31. Front engine mount
8. Cap screw (3 each)	20. Throttle cable bracket	32. Cap screw (4 each)
9. LH engine mount	21. Lock nut	33. Engine mount
10. Washer (11 each)	22. Bolt	34. Lower radiator hose
11. Bolt (4 each)	23. Bolt	35. Hose clamp (2 each)
12. Flange head bolt (7 each)	24. Flat washer	36. Upper radiator hose

Removing the Engine

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the key switch.
2. Open and remove the engine hood from the machine. Slide seat all the way forward.
3. Disconnect the air hose from the air cleaner and radiator. Remove air cleaner from the engine; refer to Removing the Air Cleaner Assembly (page 4–4).
4. Disconnect both battery cables at the battery (see Servicing the Battery (page 6–49)).
5. Remove muffler from the exhaust manifold and muffler bracket; refer to Removing the Exhaust System (page 4–7).

DANGER

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

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

WARNING

- **Ethylene-glycol antifreeze is poisonous.**
- **Keep the coolant away from children and pets.**
- **Keep the coolant in a labelled container.**
- **Discard the coolant in accordance with local hazardous waste ordinances.**

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6. Drain radiator from the drain cock valve into a suitable container. Disconnect coolant hoses from the water pump and engine block; refer to Removing the Radiator and Oil Cooler Assembly (page 4–12).
7. Remove reservoir and bracket from the top fan shroud. Remove top fan shroud from the radiator; refer to Removing the Radiator and Oil Cooler Assembly (page 4–12).

Removing the Engine (continued)

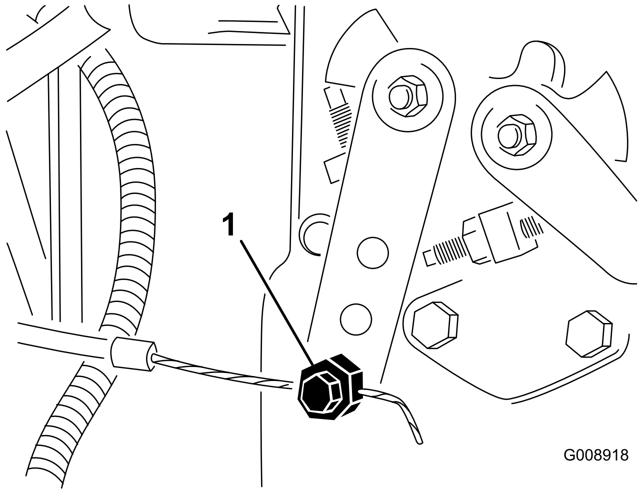

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Figure 17

1. Throttle cable

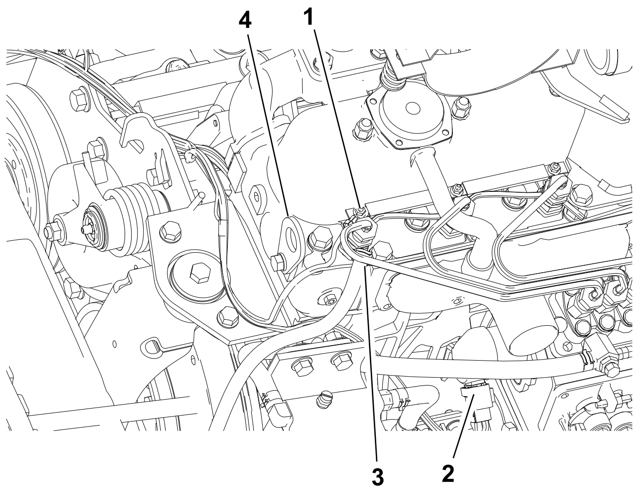

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Figure 18

1. Glow plug wire
2. Fuel stop solenoid
3. Fuel hose
4. Front lift tab

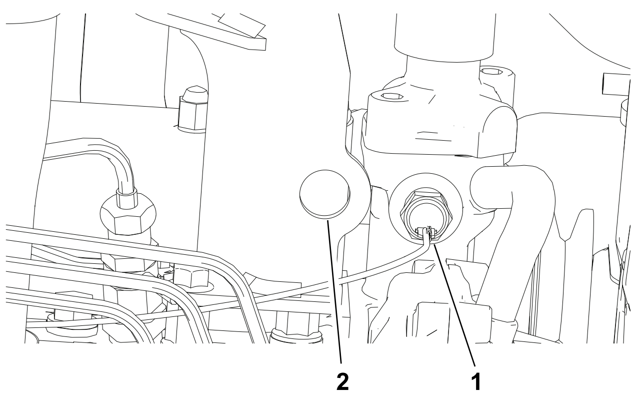

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Figure 19

1. Temp. warning switch
2. Rear lift tab

Removing the Engine (continued)

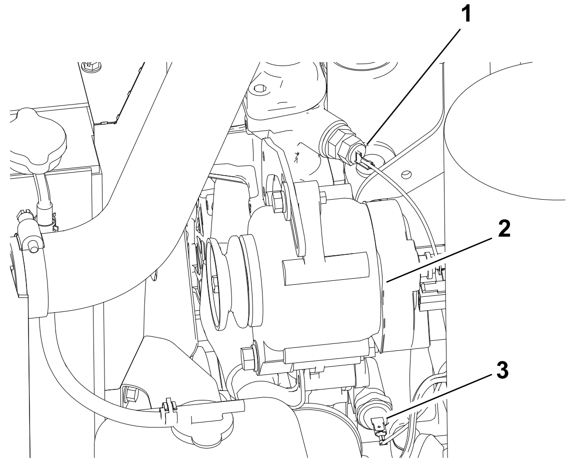

Figure 20

1. Temp. shutdown switch
2. Alternator
3. Low oil press. switch

8. Disconnect wire harness and electrical wires from the following:
   A. Engine grounds to the battery and wire harness.
   B. Glow plug bus and fuel stop solenoid; refer to Figure 18.
   C. High temperature warning switch; refer to Figure 19.
   D. High temperature shutdown switch, alternator, and low oil pressure switch; refer to Figure 20.
9. Disconnect the throttle cable from the support and swivel on the speed control lever; refer to Figure 17.
10. Disconnect the fuel hose from the water/fuel separator and front injector nozzle.
11. Remove traction control cable from the neutral arm assembly on the piston pump. Remove all hydraulic hoses from the piston an gear pumps (see Removing the Piston Pump/Hydrostat (page 5–80)).
12. Remove cable ties securing the wire harness to the front lift tab and other engine parts. Connect hoist or lift to the front and rear lift tabs; refer to Figure 18 and Figure 19.

CAUTION

Make sure lift or hoist can support the total weight of the engine before removing the cap screws from the rear bracket and engine.

13. Remove flange nut, cap screw, and washer securing three engine mounts to the engine mounting brackets; refer to Figure 16.

CAUTION

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

IMPORTANT

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

14. Remove engine slowly from the machine.
15. Separate hydrostat and pump mount plate from the engine as follows:

    Note: The cap screw next to the torsion spring does not have a flat washer with it.

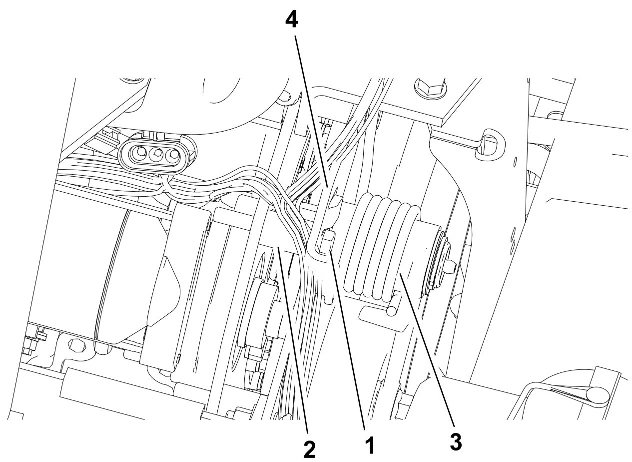

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Figure 21

1. Cap screw
2. Spacer
3. Torsion spring
4. Pump mount plate

    A. Remove hydrostat belt from the engine fly wheel and hydrostat pulleys (see Hydrostat Belt Replacement in *Operator's Manual*).

    B. Remove five cap screws, four washers, and five spacers securing the pump mount plate to the engine; refer to Figure 21.

    C. Remove four cap screws (item 32 in Figure 16) and hardened washers (10) securing the right engine mounting bracket (33) and hydrostat to the engine.

Installing the Engine

1. Install hydrostat and pump mount plate to the engine as follows:

    A. Secure right engine mounting bracket (33) and hydrostat to the engine four hardened washers (10) and cap screws (32).

    Note: Do not install flat washer with cap screw near the torsion spring to prevent the spring from binding.

    B. Secure pump mount plate to the engine with five spacers, four washers, and five cap screws; refer to Figure 21.

    C. Install hydrostat belt to the engine fly wheel and hydrostat pulleys (see Hydrostat Belt Replacement in *Operator's Manual*).

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

Installing the Engine (continued)

CAUTION

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

IMPORTANT

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

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3. Position engine slowly into the machine.
4. Secure all three engine mounts to the engine mounting brackets with cap screw, washer, and flange nut; refer to Figure 16.
5. Secure wire harness to the front lift tab and the engine with cable ties.
6. Install all hydraulic hoses to the piston and gear pumps. Install traction control cable to the neutral arm assembly on the piston pump (see Installing the Piston Pump/Hydrostat (page 5–81)).
7. Connect fuel hose to the water/fuel separator and front injector nozzle.
8. Install top fan shroud to the radiator. Install reservoir and bracket to the top fan shroud; refer to Installing the Radiator and Oil Cooler Assembly (page 4–13).
9. Connect wire harness and electrical wires to the following:
   A. Engine grounds to the battery and wire harness.
   B. Glow plug bus and fuel stop solenoid; refer to Figure 18.
   C. High temperature warning switch; refer to Figure 19.
   D. High temperature shutdown switch, alternator, and low oil pressure switch; refer to Figure 20.
10. Connect coolant hoses to the water pump and engine block. Make sure drain cock valve is closed. Fill radiator with coolant.
11. Install muffler to the exhaust manifold and muffler bracket; refer to Installing the Exhaust System (page 4–7).
12. Connect throttle cable to the support and swivel on the speed control lever; refer to Figure 17.
13. Connect both battery cables at the battery (see Servicing the Battery (page 6–49)).
14. Install air cleaner to the engine. Connect air hose to air cleaner and radiator; refer to Installing the Air Cleaner Assembly (page 4–5).
15. Adjust throttle cable; refer to *Operator's Manual*.
16. Ensure that all the wires, fuel lines, hydraulic hoses, and cables are clear of moving parts and secured to their original locations.
17. Bleed fuel system; refer to *Operator's Manual*.
18. Start the unit and run engine to normal operating temperature. Use all of the hydraulic controls while the engine is running to distribute the hydraulic fluid throughout the system.
19. Stop the engine and check the hydraulic fluid and coolant levels. Adjust as necessary.

Installing the Engine (continued)

20. Install engine hood to the machine. Close and latch hood.
21. Adjust traction drive for neutral (see Adjust traction Drive for Neutral in *Operator's Manual*).

Chapter 5

Hydraulic System

Table of Contents

Additional Reference Materials

PARKER TORQMOTOR SERVICE PROCEDURE (TC, TB, TE, TJ, TF, TG, TH AND TL SERIES)

EATON MEDIUM DUTY PISTON PUMP REPAIR INFORMATION MODEL 70160 VARIABLE DISPLACEMENT PISTON PUMP

DANFOSS STEERING UNIT TYPE OSPM SERVICE MANUAL

General Information

Operator's Manual

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

Relieving Hydraulic System Pressure

Before disconnecting or performing any work on the Reelmaster hydraulic system, all pressure in the hydraulic system must be relieved. Park machine on a level surface with the cutting units lowered and off. Turn key switch to OFF and allow engine to stop.

To relieve hydraulic pressure in traction circuit, move traction lever to both forward and reverse directions. To relieve hydraulic pressure in steering and lift circuits, rotate steering wheel in both directions.

To relieve cutting system pressure, turn key switch to ON (engine not running). Move PTO switch to engage which will energize the solenoid valve on hydraulic manifold to relieve circuit pressure. Move PTO switch to disengage, return key switch to OFF and remove key from the key switch.

To relieve lift circuit system pressure, turn key switch to ON (engine not running), fully lower the cutting units to the ground. Turn key switch to OFF.

Note: Moving steering wheel with engine off may unseat implement relief valve. If steering or lift circuits appear weak or inoperative after machine is returned to service, repeat relieving hydraulic system pressure procedure.

Traction Circuit (Closed Loop) Component Failure

The Reelmaster traction circuit is a closed loop system that includes the hydrostat and two (2) wheel motors. If a component in the traction circuit should fail, debris and contamination from the failed component will circulate throughout the traction circuit. This contamination can damage other components in the circuit so it must be removed to prevent additional component failure.

If a component failure occurs in the traction circuit, it is critical that the entire traction circuit be disassembled, drained and thoroughly cleaned to ensure that all contamination is removed from the circuit. If any debris remains in the traction circuit and the machine is operated, the debris can cause additional component failure.

An additional step for removing all traction circuit contamination would be to temporarily install a high pressure hydraulic oil filter (refer to Special Tools (page 2–13)) into the circuit. The filter could be used when connecting hydraulic test gauges in order to test traction circuit components or after replacing a failed traction circuit component (e.g. hydrostat or wheel motor). The filter will ensure that contaminates are removed from the closed loop and thus, do not cause additional component damage.

Once the Toro high flow hydraulic filter kit has been placed in the circuit, raise and support the machine with all 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 bi-directional, the traction circuit can be operated in both the forward and reverse direction. The filter should be removed from the machine after contamination has been removed from the traction circuit. See Filtering Closed−Loop Traction Circuit (page 5–67) in the Service and Repairs section of this chapter for additional information on using the Toro high flow hydraulic filter.

Traction Circuit (Closed Loop) Component Failure (continued)

IMPORTANT

When operating the traction system with the high pressure filter installed, make sure that flow is always directed through the filter (e.g. do not press the traction pedal in the reverse direction if the filter is placed for forward direction flow). If flow is reversed, debris from the filter will re−enter the traction circuit.

The alternative to using the Toro high flow hydraulic filter kit after a traction circuit component failure would be to disassemble, drain and thoroughly clean all components, hydraulic tubes and 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 failure.

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 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:

- **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 Fittings) (page 5–6).

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 Fittings)

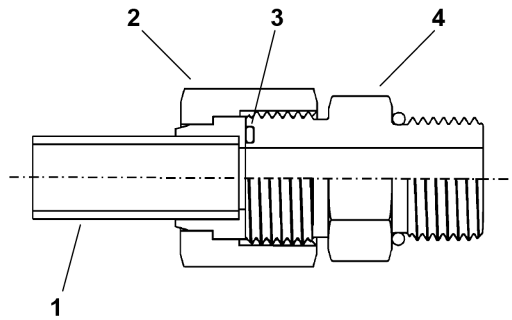

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Figure 22

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 22).
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 5–7). This procedure to tighten the swivel nut requires a drive-adapter wrench (e.g., crowfoot wrench).

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

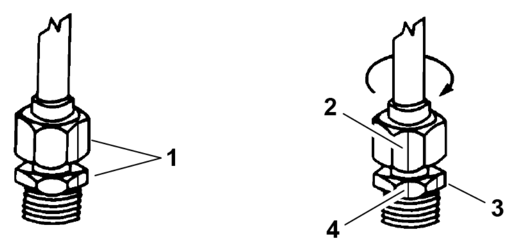

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Figure 23

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

5. If a torque wrench is not available or if space at the swivel nut prevents the use of a torque wrench, use the alternative procedure Flats From Wrench Resistance (FFWR) given below (Figure 23).
   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 in Figure 23). If connecting a hose, hold the hose in alignment with a wrench to prevent the hose from turning.

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

C. Use a second wrench to tighten the nut to the correct Flats From Wrench Resistance (FFWR); refer to the Flats From Wrench Resistance Table (page 5–7).

Hose/Tube Installation Torque Table

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

Flats From Wrench Resistance Table

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

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

Installing a Non-Adjustable Fitting

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

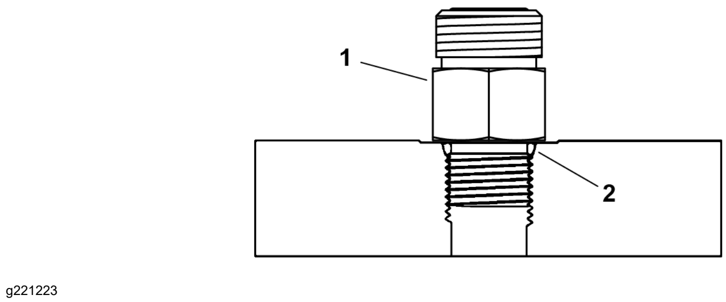


Figure 24

1. Fitting
2. O-ring

3. Lightly lubricate the O-ring with clean hydraulic fluid. Ensure that the threads of the fitting are clean with no lubricant applied (Figure 24).

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 5–10).

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

5. If a torque wrench is not available or if space at the port prevents the use of a torque wrench, use the 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 5–10).

   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 5–10).

Installing an Adjustable Fitting

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

Installing an Adjustable Fitting (continued)

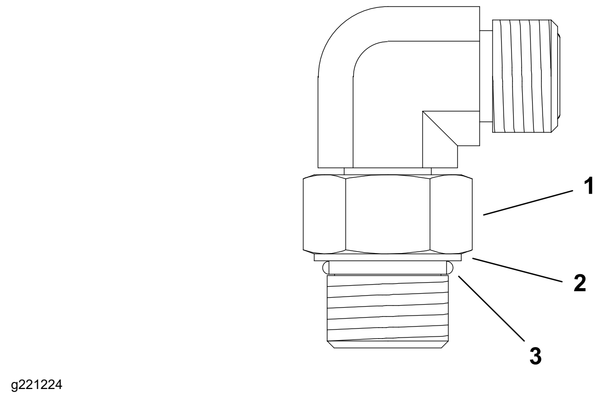


Figure 25

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

3. Lightly lubricate the O-ring with clean hydraulic fluid. Ensure that the threads of the fitting are clean with no lubricant applied (Figure 25).

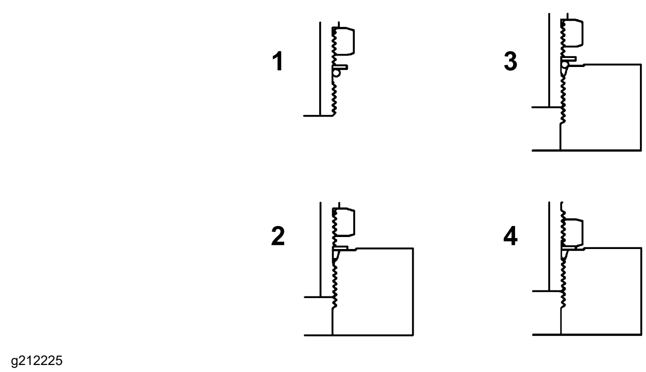


Figure 26

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

4. Turn back the locknut as far as possible. Ensure that the back-up washer is not loose and it is pushed up as far as possible (Step 1 in Figure 26).

IMPORTANT

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

5. Install the adjustable fitting into the port by hand until the washer contacts the face of the port (Step 2 in Figure 26).
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 26). 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 26):
   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 5–10). 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 2–6).
   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 5–10).
   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 5–10).

Fitting Installation Torque Table

Fitting Dash Size	Fitting Port Side Thread Size (inch)—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

Hydraulic Schematic

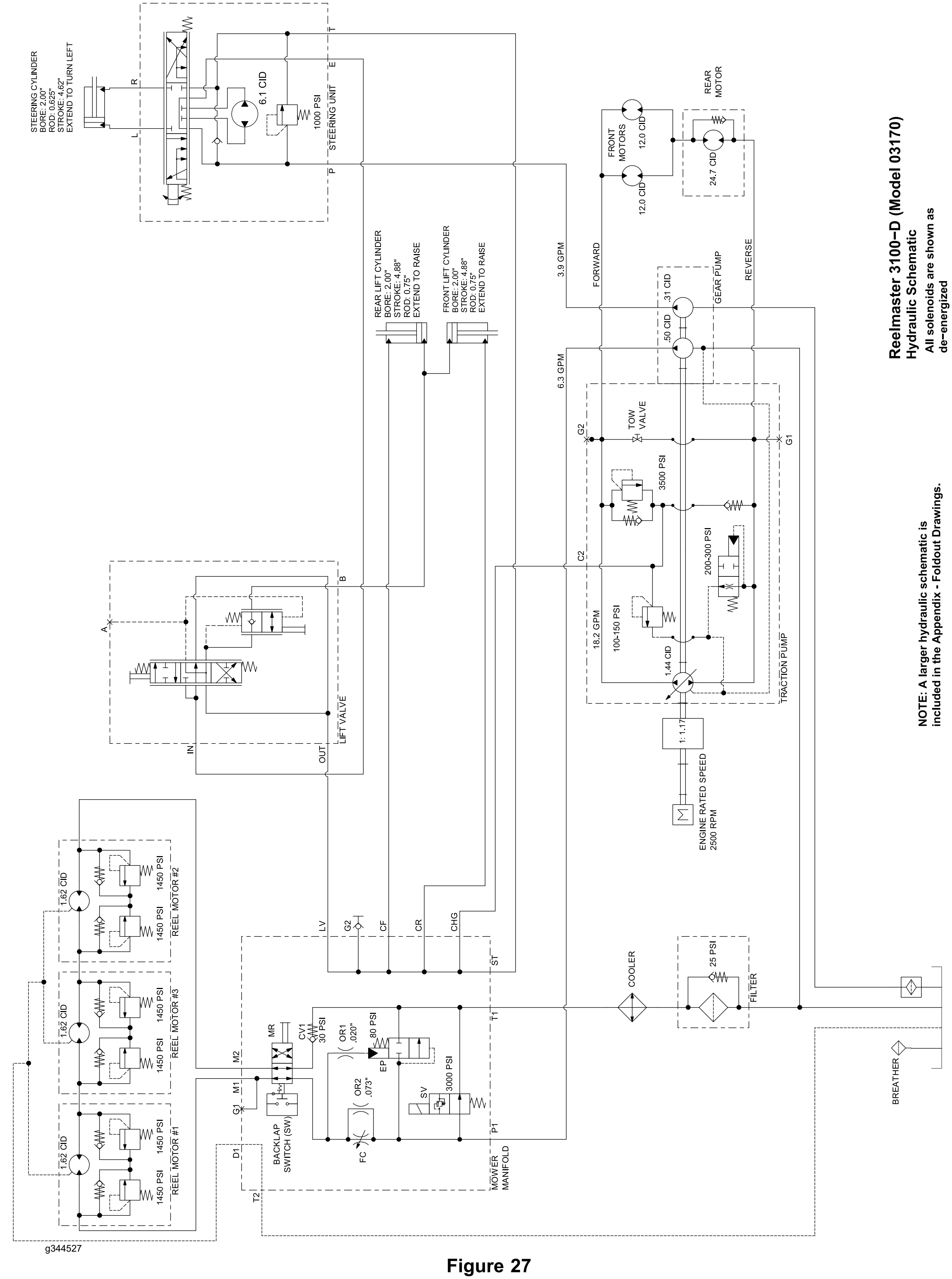
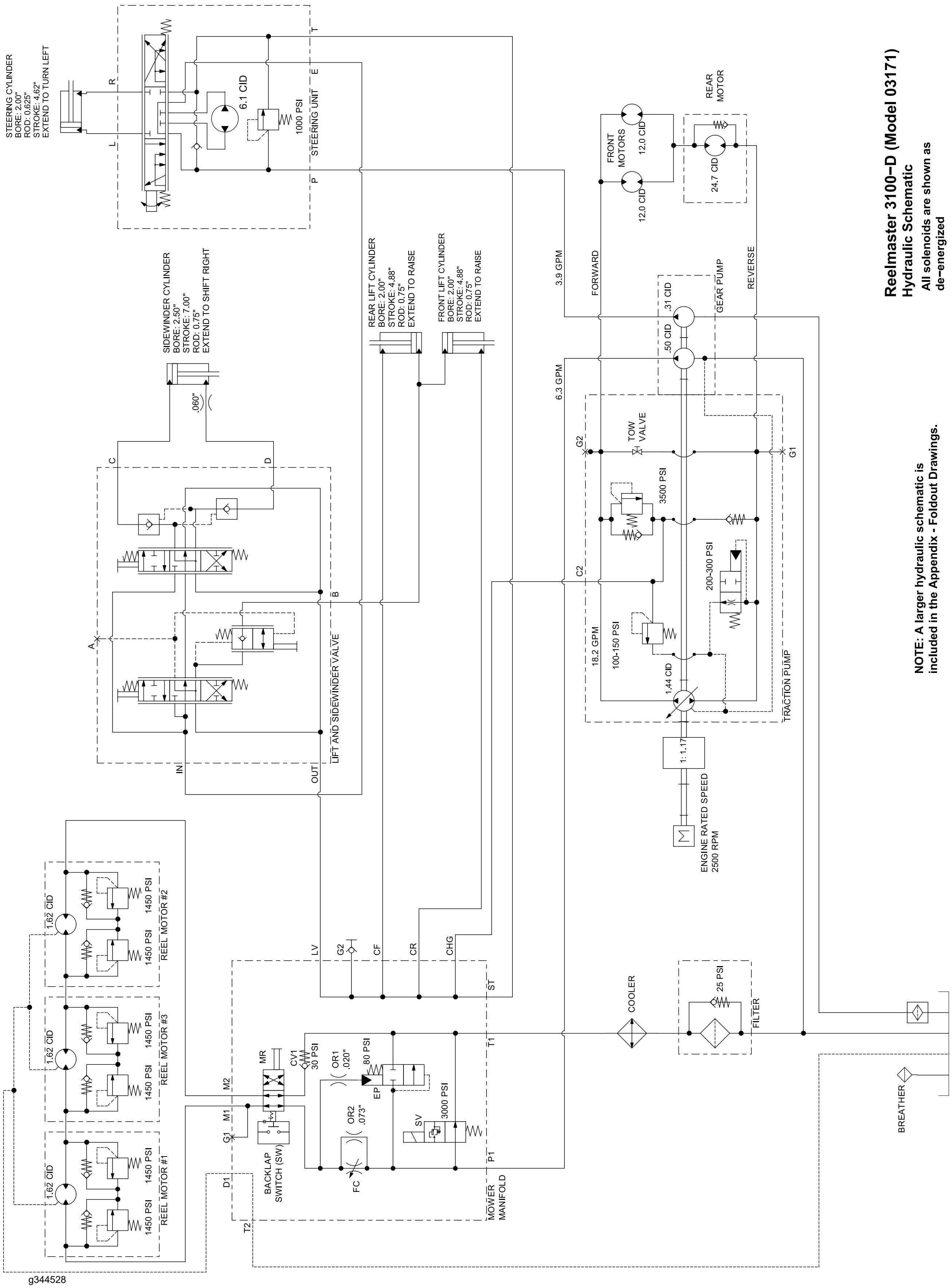


Figure 27



Reelmaster 3100–D (Model 03171)
Hydraulic Schematic
All solenoids are shown as de–energized
NOTE: A larger hydraulic schematic is included in the Appendix - Foldout Drawings.
STEERING CYLINDER
BORE: 2.00"
ROD: 0.625"
STROKE: 4.62"
EXTEND TO TURN LEFT
6.1 CID
1000 PSI
STEERING UNIT
SIDEWINDER CYLINDER
BORE: 2.50"
STROKE: 7.00"
ROD: 0.75"
EXTEND TO SHIFT RIGHT
.060"
REAR LIFT CYLINDER
BORE: 2.00"
STROKE: 4.88"
ROD: 0.75"
EXTEND TO RAISE
FRONT LIFT CYLINDER
BORE: 2.00"
STROKE: 4.88"
ROD: 0.75"
EXTEND TO RAISE
LIFT AND SIDEWINDER VALVE
FRONT MOTORS
12.0 CID
12.0 CID
REAR MOTOR
24.7 CID
3.9 GPM
6.3 GPM
FORWARD
REVERSE
.31 CID
.50 CID
GEAR PUMP
TOW VALVE
3500 PSI
200-300 PSI
100-150 PSI
18.2 GPM
1.44 CID
TRACTION PUMP
1 : 1.17
ENGINE RATED SPEED
2500 RPM
REEL MOTOR #1
REEL MOTOR #2
REEL MOTOR #3
1.62 CID
1450 PSI
MR
CV1
30 PSI
OR1
.020"
80 PSI
EP
OR2
.073"
SV
3000 PSI
FC
BACKLAP SWITCH (SW)
MOWER MANIFOLD
COOLER
25 PSI
FILTER
BREATHER
g344528

Figure 28

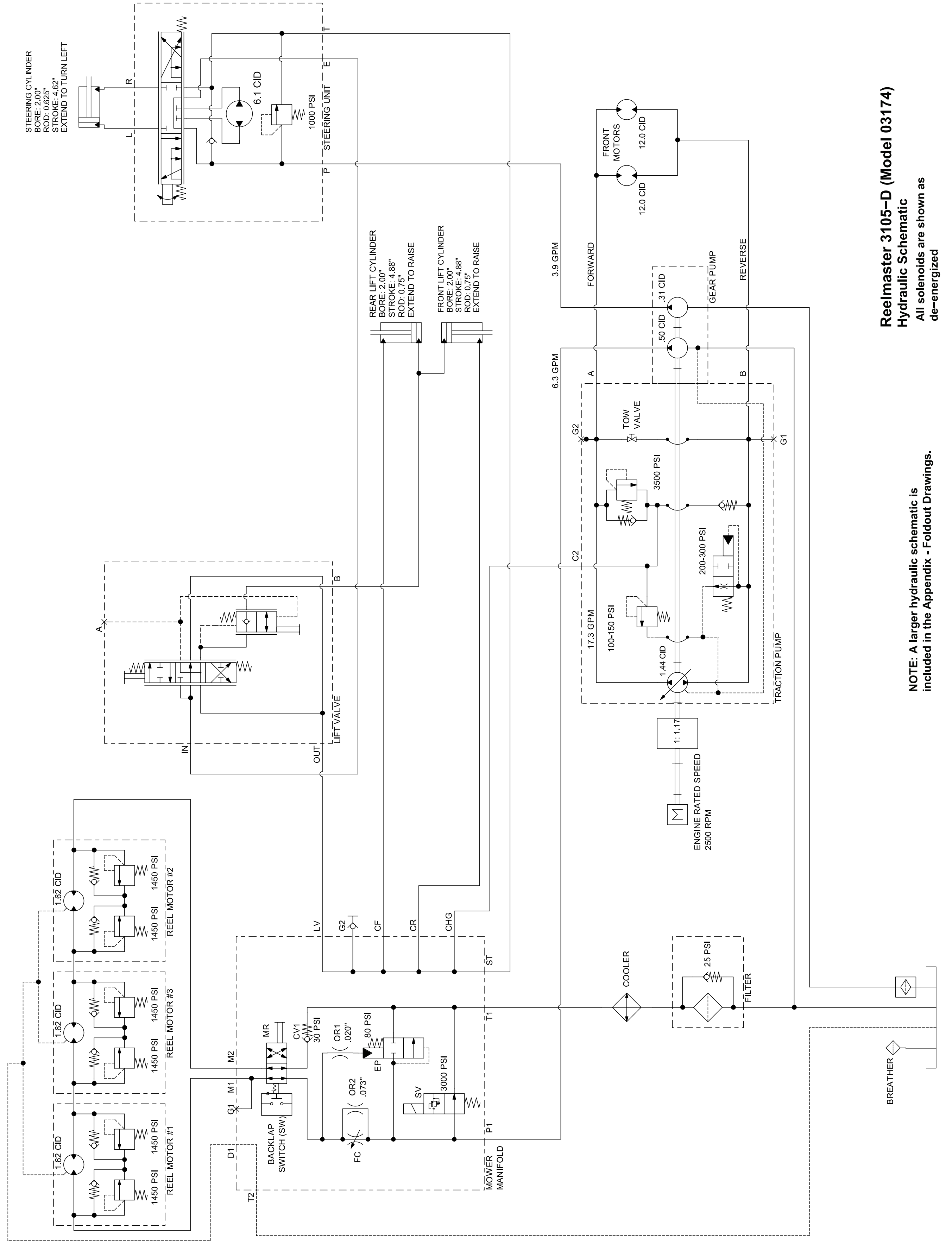

Reelmaster 3105–D (Model 03174)
Hydraulic Schematic
All solenoids are shown as de–energized
NOTE: A larger hydraulic schematic is included in the Appendix - Foldout Drawings.
STEERING CYLINDER
BORE: 2.00"
ROD: 0.625"
STROKE: 4.62"
EXTEND TO TURN LEFT
6.1 CID
1000 PSI
STEERING UNIT
REAR LIFT CYLINDER
BORE: 2.00"
STROKE: 4.88"
ROD: 0.75"
EXTEND TO RAISE
FRONT LIFT CYLINDER
BORE: 2.00"
STROKE: 4.88"
ROD: 0.75"
EXTEND TO RAISE
FRONT MOTORS
12.0 CID
12.0 CID
3.9 GPM
FORWARD
REVERSE
.31 CID
.50 CID
GEAR PUMP
6.3 GPM
TOW VALVE
3500 PSI
200-300 PSI
17.3 GPM
100-150 PSI
1.44 CID
TRACTION PUMP
1: 1.17
ENGINE RATED SPEED
2500 RPM
LIFT VALVE
1.62 CID
1450 PSI
REEL MOTOR #2
REEL MOTOR #3
REEL MOTOR #1
MR
CV1
30 PSI
OR1
.020"
.80 PSI
EP
OR2
.073"
SV
3000 PSI
FC
BACKLAP SWITCH (SW)
MOWER MANIFOLD
COOLER
25 PSI
FILTER
BREATHER
g344526

Figure 29

Hydraulic Flow Diagrams

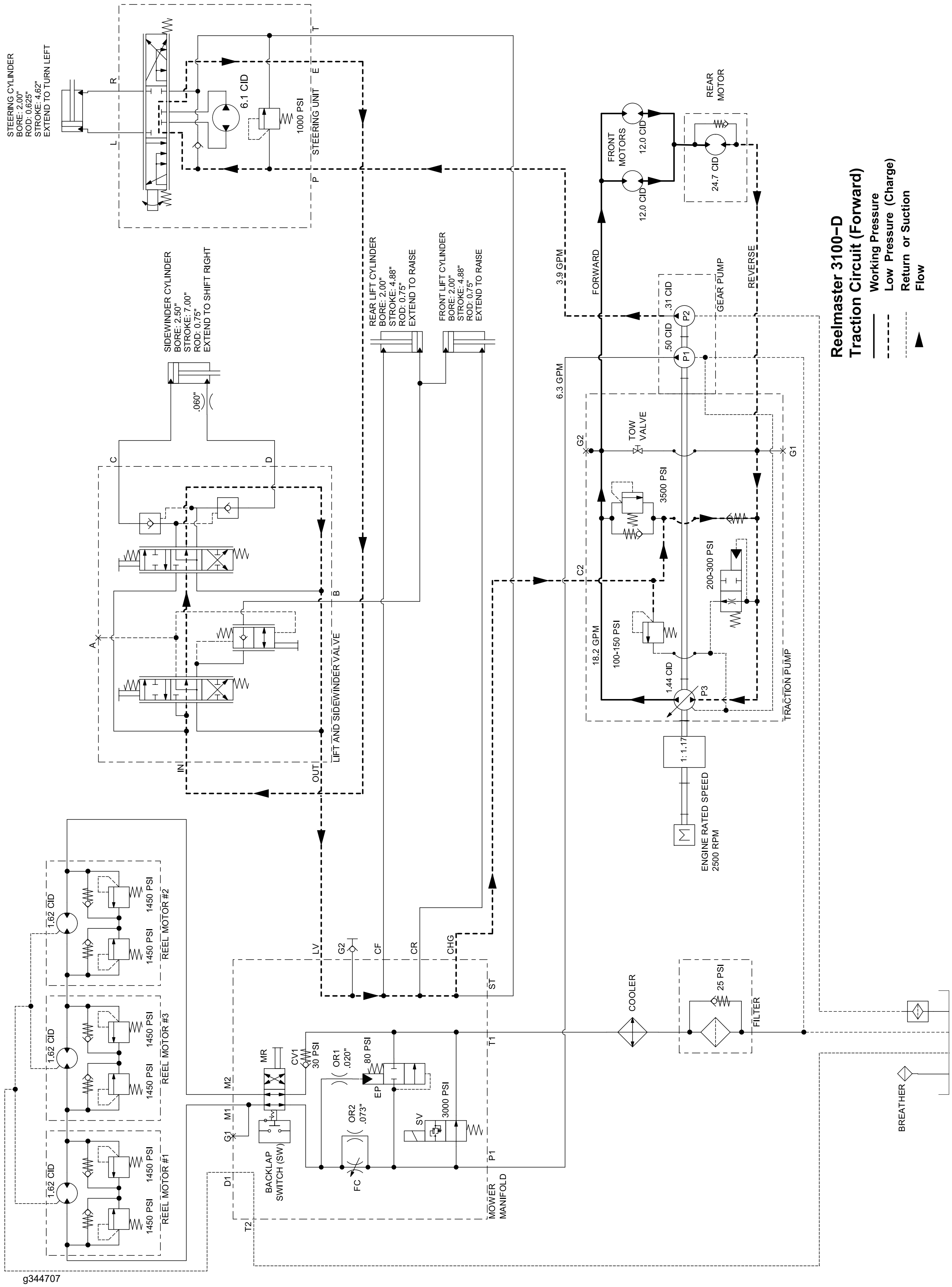


Figure 30

Model 03171 (shown)

Traction Circuits

The traction circuit of the hydraulic system consists of a hydrostat connected in a closed loop circuit to three orbital vane wheel motors.

The mow/transport slide control on the machines has positions for mow and transport. The mow position allows traction pedal inputs that are appropriate for mow speeds by limiting the movement of the traction pedal and the piston pump swash plate. The transport position allows full movement of the traction pedal so complete pump swash rotation is possible.

Forward

The engine drives traction pump (P3) indirectly through pulleys and a V−belt. The traction pump is a variable displacement piston pump. The traction pedal connects through a cable to the trunnion shaft and swash plate of the pump. With the engine running and the traction pedal in the neutral position, P3 supplies no flow to the wheel motors. When the traction pedal is pressed to the forward position, the cable from the pedal positions the swash plate in the traction pump so fluid flows out of the lower port. Fluid flow out of the lower port goes to the wheel motors and turns them in the forward direction. Fluid flowing out of the wheel motors returns to upper port of the hydrostat and is continuously pumped out of the lower port.

Operating pressure in the closed traction circuit is determined by the amount of load developed by the wheel motors. As the load increases, circuit pressure can increase to the relief valve setting of **241.3 bar (3500 PSI)**. In forward operation, fluid flows through the internal hydrostat relief valve to the low pressure side of the traction circuit when circuit pressure exceeds the relief setting.

Reverse

The traction circuit operates essentially the same in reverse as it does in forward. However, there are a few differences in operation.

When the reverse traction pedal is depressed, the cable from the pedal positions the swash plate in the traction pump so fluid flows out of the upper port. Fluid flow out of the upper port goes to the wheel motors and turns them in the reverse direction. Fluid flowing out of the wheel motors returns to the lower port of the hydrostat and is continuously pumped out of the upper port. Fluid by−passes the rear motor in reverse because of the check valve inside the rear motor.

Charge Circuit

The traction pump uses a small amount of hydraulic fluid for internal lubrication. Fluid is designed to leak across pump parts into the case drain. This leakage results in the loss of hydraulic fluid from the closed loop circuit that must be replenished.

The gear pump (P2) is directly coupled to the hydrostat through gear pump (P1) and driven by the engine. Gear pump (P2) supplies hydraulic pressure for operating the power steering system, raising and lowering the cutting units, and operating the sidewinder unit. Gear pump (P2) may also be referred to as the charge pump as flow from the gear pump also replenishes the closed loop traction circuit. Hydraulic fluid exits the lift/sidewinder valve, passes through the mow manifold and continues on to the hydrostat. A relief valve located in the hydrostat provides sufficient resistance so that flow is guided to the low pressure side of the traction circuit through one of two check valves (charge circuit). Pump flow in excess of **6.9 to 10.3 bar (100 to 150 PSI)** is relieved through the relief valve back to the gear pump inlet and hydraulic tank.

Traction Circuit Cooling

The traction circuit is cooled by a bleed off circuit in the piston pump. The piston pump includes an internal bleed valve which allows a small amount of hydraulic fluid to pass from the return side of the pump while operating the traction unit in the forward direction. The charge circuit replenishes fluid that is bled from the traction circuit by the bleed valve.

When operating the traction circuit in the reverse direction, the bleed valve closes once reverse pressure reaches **13.8 to 20.6 bar (200 to 300 PSI)** to allow normal reverse operation.

Note: The bleed valve threads into the piston pump back plate. Access to the bleed valve requires removal of the back plate from the piston pump.

Reel Circuit

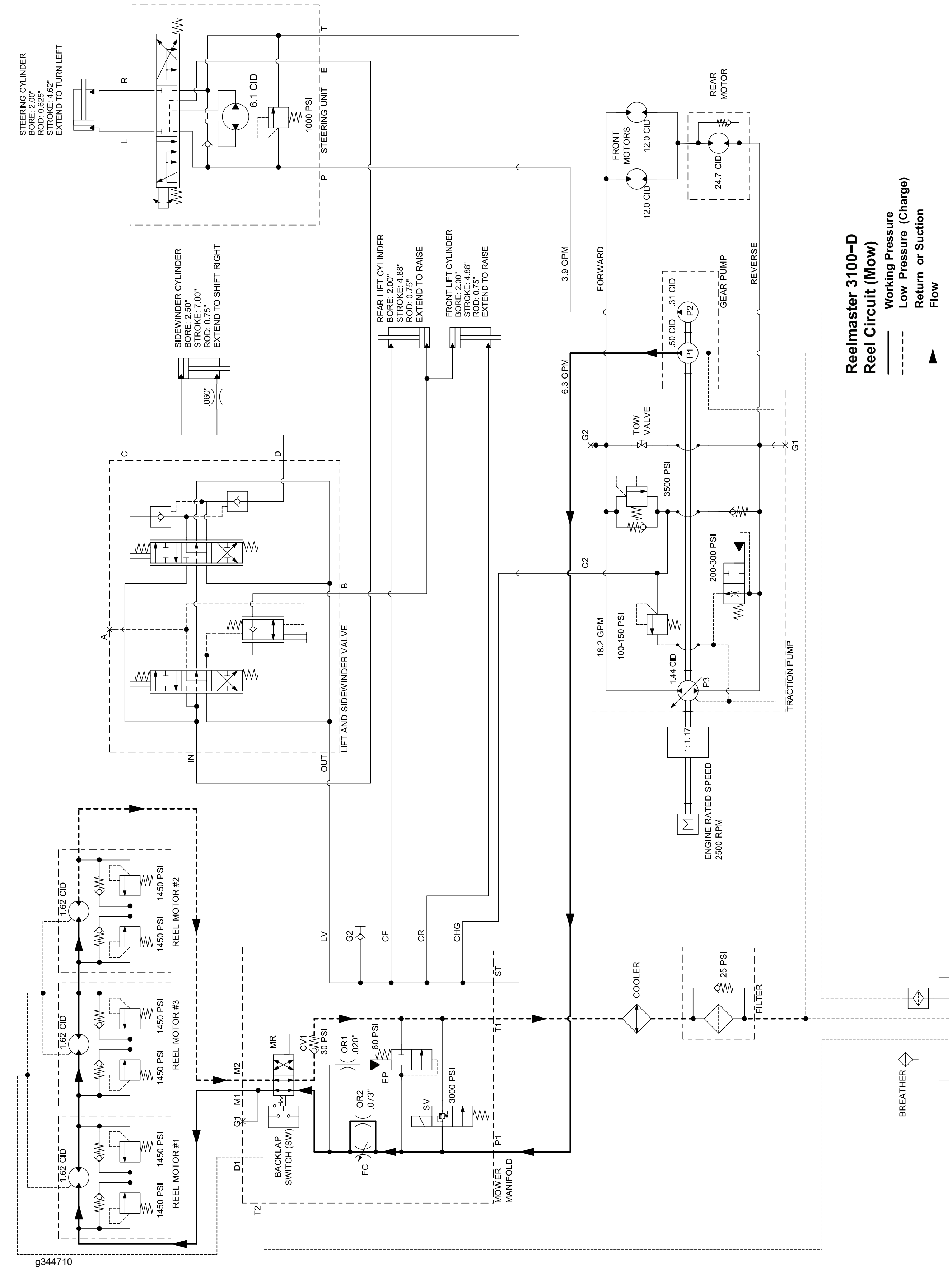


Figure 31

Model 03171 (shown)

Mow

The gear pump (P1) is directly coupled to the hydrostat which is driven by the engine. Taking its suction directly from the hydraulic tank, the gear pump supplies fluid flow to the manifold block and to the reel motors.

Solenoid valve (SV) is de−energized with the engine running when either the reels on/off switch is OFF, the cutting units are up, or the transport/mow switch is in TRANSPORT. SV by−passes flow from the reel motors directly to the hydraulic reservoir.

Solenoid valve (SV) is energized with the engine running when the reels on/off switch is ON, the cutting units are down, and the transport/mow switch is in MOW. Flow is diverted to the reel motors.

Fluid flows from port (P1) across the logic cartridge valve. The logic cartridge valve maintains a pressure differential of **5.5 bar (80 PSI)** across the speed control valve. Any excess flow above what the speed control valve is set for, is by−passed to the reservoir through the logic cartridge valve. With the backlapping valve in the mow position, fluid flows through the valve, out port (M1), and to reel motors that are connected in series.

Fluid flows through the rear, right front, and then left front reel motors as it turns the motors in the mow direction. The fluid then returns into manifold block port (M2) and then to the hydraulic tank.

If cutting unit circuit pressure exceeds relief pressure of **207 bar (3000 PSI)** during deck motor operation, solenoid valve (SV) shifts to allow circuit pressure relief.

Backlap

Backlapping operation is the same as mowing operation, except for the position of the backlap valve (MR). When the backlap valve (MR) is in the backlap position, fluid flows through the left front, right front, and then rear reel motors.

Lift Circuit (Up)

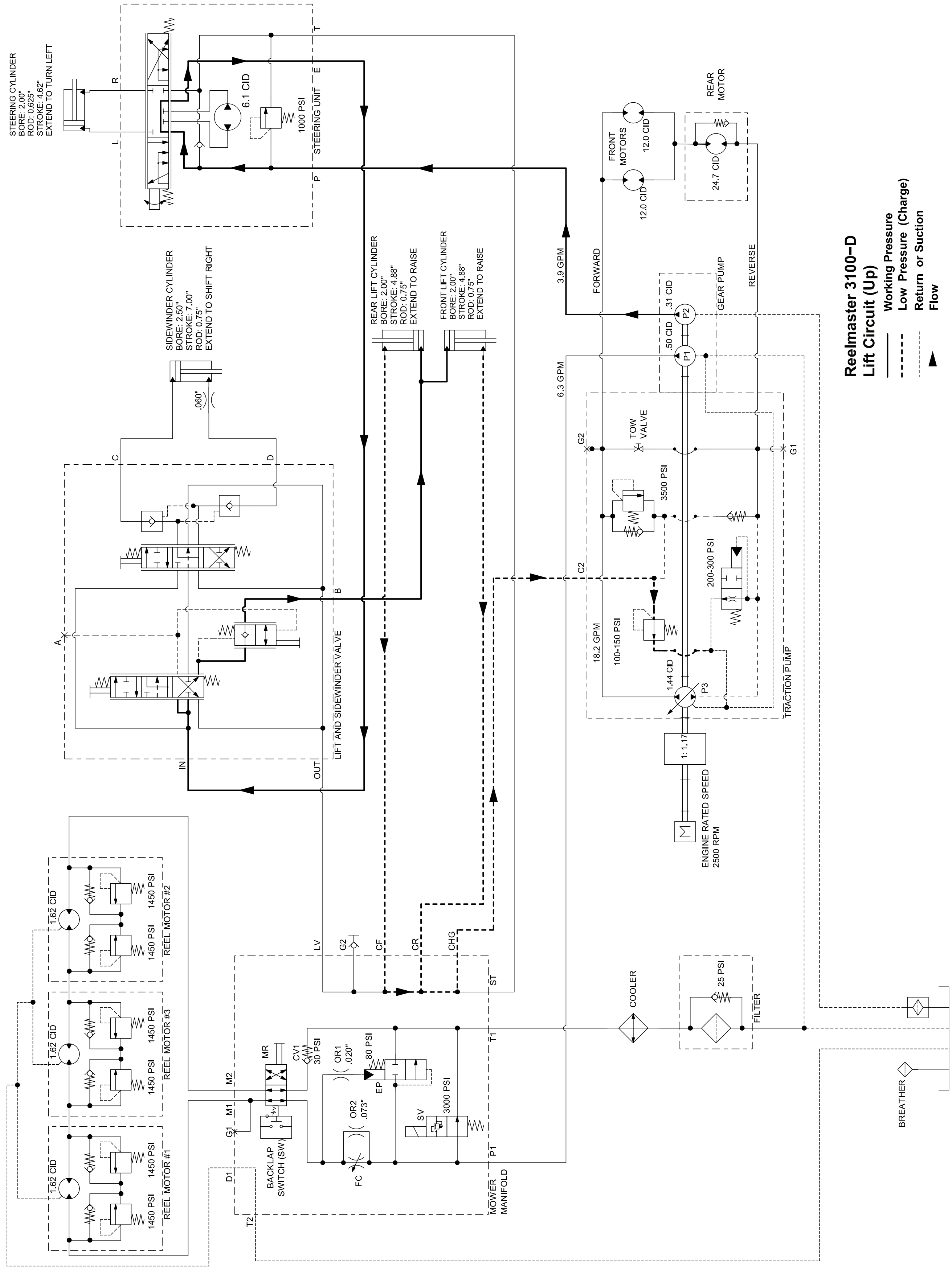


Figure 32

Model 03171 (shown)

Raise Cutting Units

The gear pump (P2) is directly coupled to the hydrostat through gear pump (P1). It supplies hydraulic pressure (charge pressure) for raising and lowering the cutting units, operating the sidewinder unit, and replenishing the closed loop traction circuit (charge pressure). The pump takes its suction directly from the hydraulic tank.

During conditions of not lifting or lowering cutting units, flow from the gear pump (P2) is by−passed through the power steering valve, 2-spool valve, and hydraulic manifold directly to the hydrostat and the charge relief valve. Flow then returns to the hydraulic tank.

When the cutting units are to be raised, the 2-spool valve is positioned by moving the cutting unit shift lever to RAISE. Flow is directed to cap ends of the lift cylinders. Hydraulic pressure against the cylinder pistons moves their shafts causing the cutting units to raise. At the same time, the pistons push the hydraulic fluid out of the lift cylinders and back through the hydraulic manifold to the hydrostat.

When the cutting unit shift lever is released, spring action returns the valve to its original position and by−passes flow back to the hydrostat stopping lift cylinder movement. The cylinder position is locked in place by the load holding checks in the lift control valve.

Lift Circuit (Down)

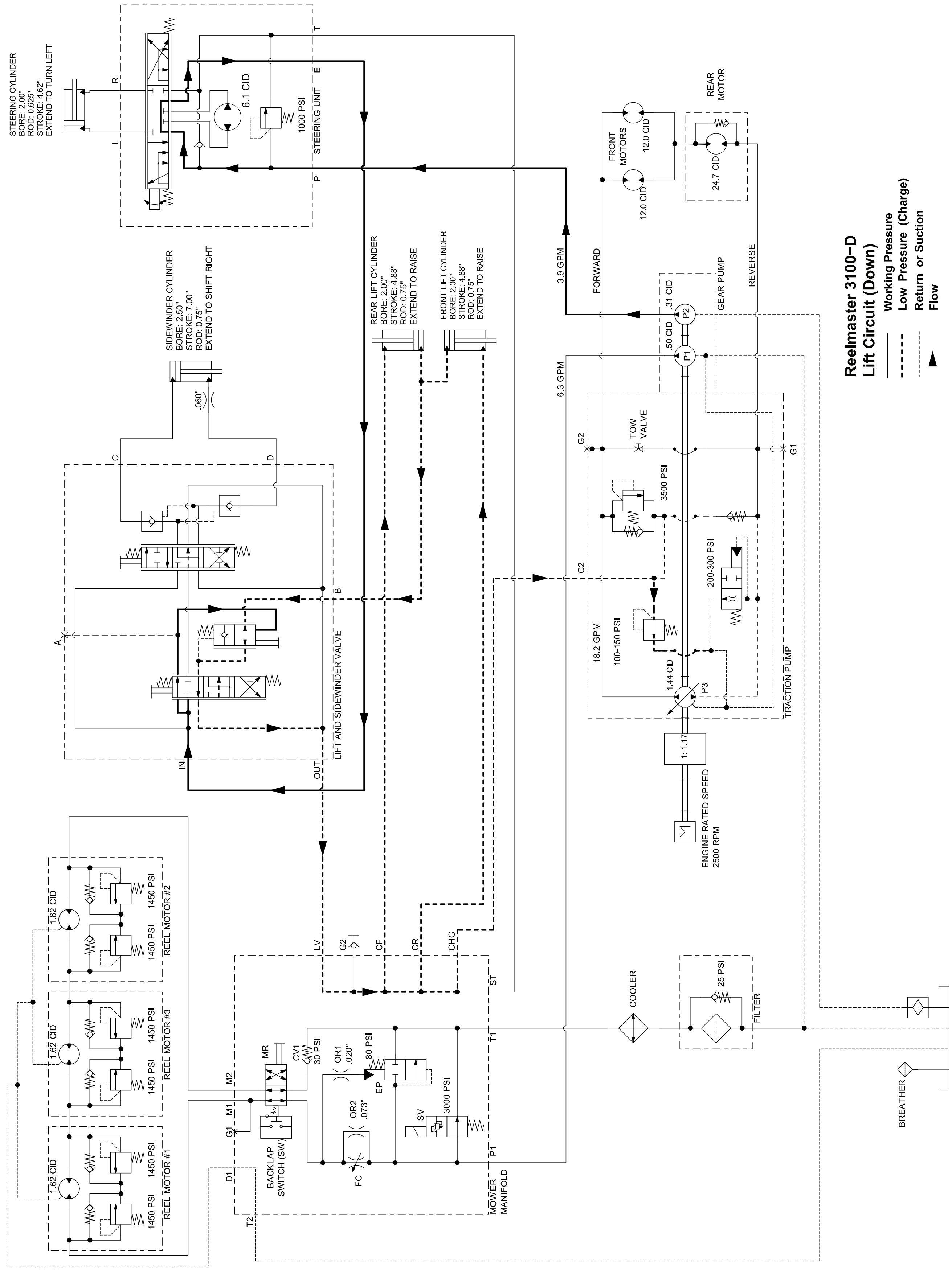


Figure 33

Model 03171 (shown)

Lower Cutting Units

The gear pump (P2) is directly coupled to the hydrostat through gear pump (P1). It supplies hydraulic pressure (charge pressure) for raising and lowering the cutting units, operating the sidewinder unit, and replenishing the closed loop traction circuit (charge pressure). The pump takes its suction directly from the hydraulic tank.

During conditions of not lifting or lowering cutting units, flow from the gear pump (P2) is by−passed through the power steering valve, 2−spool valve, and hydraulic manifold directly to the hydrostat and the charge relief valve. Flow then returns to the hydraulic tank.

Circuit operation for lowering the cutting units is similar to raising them. However, pressure is relieved from the lift cylinders, and this action allows them to lower.

When the cutting units are to be lowered, the 2−spool valve is positioned by moving the cutting unit shift lever to LOWER. Pressure from gear pump (P2) is used to shift the pilot valve in the 2−spool valve. This shifting of the pilot valve allows hydraulic pressure to relieve from the cap end of the lift cylinders. Flow from the cap end of the lift cylinders causes the cutting units to lower. At the same time, the fluid relieved from the cap end of the lift cylinders goes into the rod end of the cylinders and back through the hydraulic manifold to the hydrostat.

When the cutting unit shift lever is released, spring action returns and detents the valve into the float position while by−passing flow back to the hydrostat. The pilot valve then shifts to its original position and stops lift cylinder movement. The cylinder position is locked in place since there is no complete circuit of flow to and from the lift cylinders.

Sidewinder Circuit

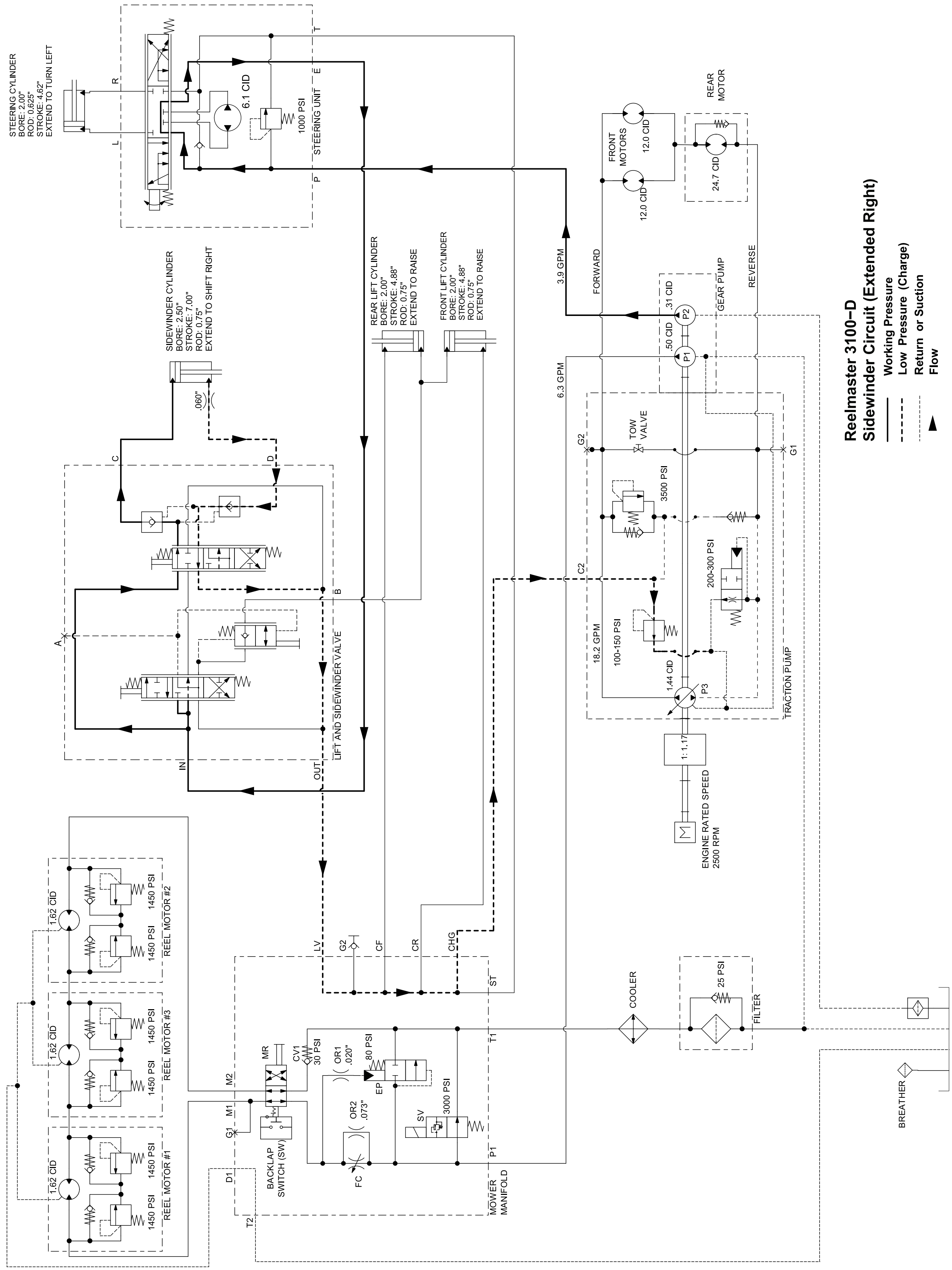


Figure 34

Model 03171 (shown)

The gear pump (P2) is directly coupled to the hydrostat through gear pump (P1). It supplies hydraulic pressure (charge pressure) for raising and lowering the cutting units, operating the sidewinder unit, and replenishing the closed loop traction circuit (charge pressure). The pump takes its suction directly from the hydraulic tank.

During conditions of not lifting or lowering the cutting units, flow from the gear pump is by−passed through the power steering valve, 2−spool valve, and hydraulic manifold directly to the hydrostat and the charge relief valve. Flow then returns to the hydraulic tank.

Shift Sidewinder Right

When the sidewinder is to be shifted right, the 2−spool valve is positioned by moving the cutting unit shift lever to RIGHT. Flow is directed to the cap end of the sidewinder cylinder. Hydraulic pressure against the cylinder piston moves the rod causing the sidewinder cylinder to extend right. At the same time, the piston pushes the hydraulic fluid out of the cylinder, back through the spool and hydraulic manifold, and to the hydrostat. When the cutting unit shift lever is released, spring action returns the valve to its original position and by−passes flow back to the hydrostat and stopping cylinder movement. The cylinder position is locked in place since there is no complete circuit of flow to or from the sidewinder cylinder when the lever is released.

Shift Sidewinder Left

When the sidewinder is to be shifted left, the 2−spool valve is positioned by moving the cutting unit shift lever to LEFT. Flow is directed to the rod end of the sidewinder cylinder. Hydraulic pressure against the cylinder piston moves the rod causing the sidewinder to retract left. At the same time, the piston pushes the hydraulic fluid out of the cylinder, back through the spool and hydraulic manifold, and to the hydrostat. When the cutting unit shift lever is released, spring action returns the valve to its original position and by−passes flow back to the hydrostat stopping cylinder movement. The cylinder position is locked in place since there is no complete circuit of flow to or from the sidewinder cylinder when the lever is released.

Steering Circuit

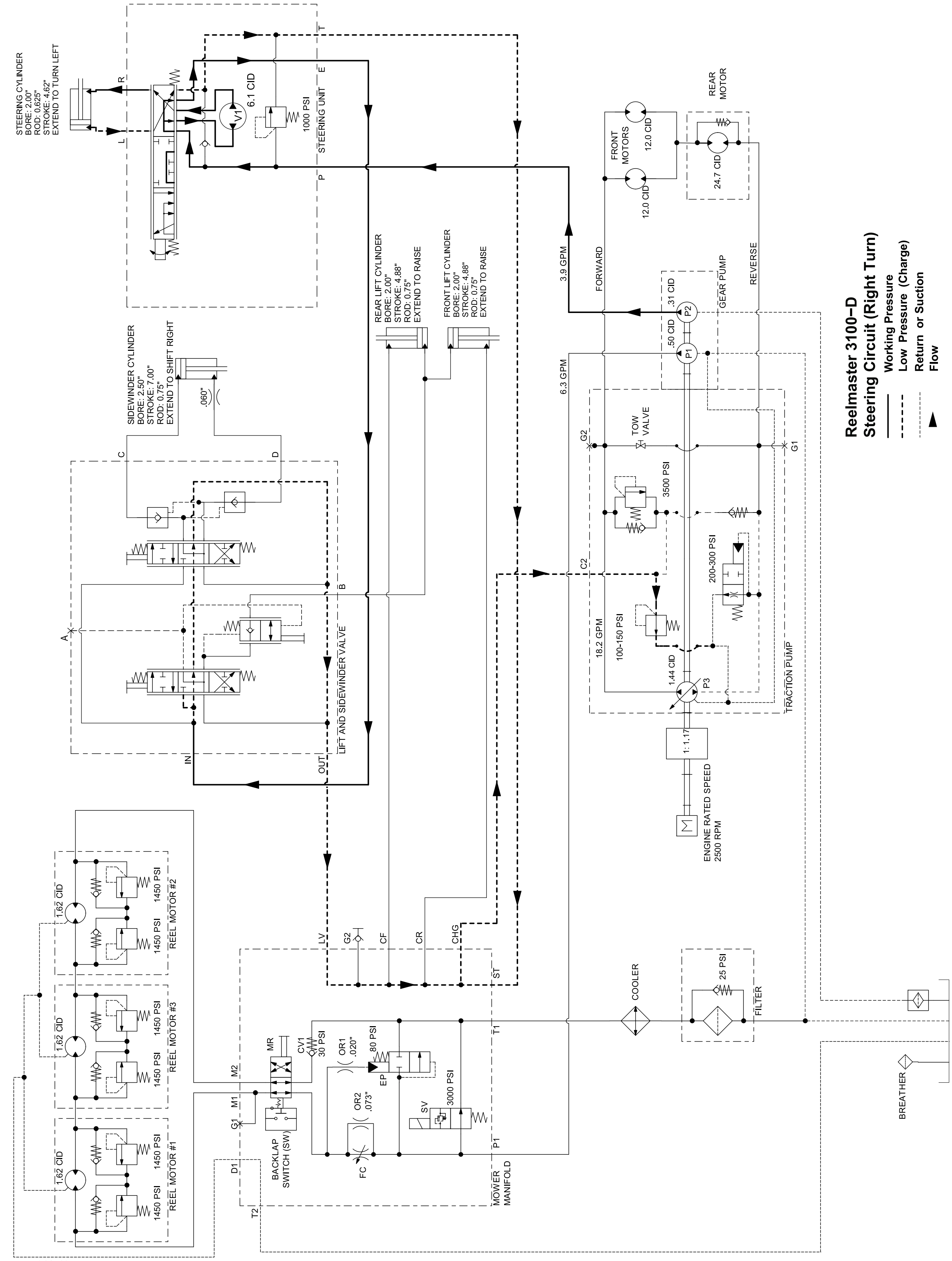


Figure 35

Model 03171 (shown)

The gear pump (P2) is directly coupled to the hydrostat. It supplies hydraulic pressure to the power steering valve for turning the rear wheel and maintaining **6.9 to 10.0 bar (100 to 150 PSI)** to the low pressure side of the traction circuit. The pump takes its suction from the hydraulic tank.

With the steering wheel in the neutral position, the engine running, and the lift/sidewinder spool valve in the center position, flow enters the steering control valve at the P port and goes through the valve, by−passing the rotary meter (V1) and steering cylinder. Flow leaves the steering control valve through the E port, passes through the lift/sidewinder valve, hydraulic manifold, hydrostat and charge relief valve, and continues on to the gear pump inlet and hydraulic tank.

Right Turn

When a right turn is made with the engine running, the turning of the steering wheel positions the steering control spool valve so that flow goes through the bottom of the spool. Flow entering the steering control valve at the P port goes through the spool and is routed to two places. First, most of the flow through the steering control valve is by−passed out the E port back through the lift/sidewinder valve, hydraulic manifold, hydrostat and charge relief valve, and continues on to the gear pump inlet and hydraulic tank. Second, the remainder of the flow is drawn through the rotary meter (V1) and out port (R). Pressure retracts the piston for a right turn. The rotary meter (V1) ensures that the fluid flow to the cylinder is proportional to the amount of steering wheel rotation. Fluid leaving the cylinder flows back through the steering control spool valve and through the T port. Return flow passes through the hydraulic manifold, hydrostat and charge relief valve, and continues on to the gear pump inlet and hydraulic tank.

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

Left Turn

When a left turn is made with the engine running, the turning of the steering wheel positions the steering control spool valve so that flow goes through the top of the spool. Flow entering the steering control valve at the P port goes through the spool and is routed to two places. Most of the flow through the steering control valve is by− passed out the E port back through the lift/sidewinder valve, hydraulic manifold, hydrostat and charge relief valve, and continues on to the gear pump inlet and hydraulic tank (as in a right turn). The remainder of the flow is drawn through rotary meter (V1) but during a left turn the flow goes out port (L). Pressure extends the piston for a left turn. The rotary meter (V1) ensures that the fluid flow to the cylinder is proportional to the amount of steering wheel rotation. Fluid leaving the cylinder flows back through the spool valve then through the T port. Return flow passes through the hydraulic manifold, hydrostat and charge relief valve, and continues on to the gear pump inlet and hydraulic tank.

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

Testing

The most effective method for isolating problems in the hydraulic system is by using hydraulic test equipment such as pressure gauges and flow meters in the various hydraulic circuits to perform various operational checks (refer to the Special Tools (page 2–13)).

Remember that pressure specifications that appear on hydraulic schematics are the design specifications for the specific component. Actual system pressure will vary depending on fluid temperature, the location of the test port, and the specific components used in the hydraulic circuit.

IMPORTANT

The hydraulic test procedures listed in this manual represent actual performance for this machine. To correctly measure product or component performance, be sure to follow the test procedures provided.

Before Performing Hydraulic Tests

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

Precautions for Hydraulic Testing

⚠ WARNING ⚠

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

⚠ CAUTION ⚠

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

⚠ CAUTION ⚠

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

Precautions for Hydraulic Testing (continued)

1. Clean machine thoroughly before disconnecting or disassembling any hydraulic components. Always keep in mind the need for cleanliness when working on hydraulic equipment. Contamination can cause excessive wear or binding of hydraulic components.
2. Before testing, check control linkages for improper adjustment, binding or broken parts.
3. All hydraulic tests should be made with the hydraulic fluid at normal operating temperature.
4. Put metal caps or plugs on any hydraulic lines left open or exposed during testing or component removal.
5. When using hydraulic tester (pressure and flow), the inlet and the outlet hoses must be properly connected and not reversed to prevent damage to the hydraulic tester or components.
6. Install hydraulic fittings finger tight and far enough to make sure that they are not cross-threaded before tightening them with a wrench.
7. Position tester hoses to prevent rotating machine parts from contacting and damaging the hoses or tester.
8. After connecting test equipment, check fluid level in the hydraulic tank to make sure that fluid level is correct.
9. When using hydraulic tester (pressure and flow), open tester load valve completely before starting engine to minimize the possibility of damaging components.
10. The engine must be in good operating condition. Use a phototac when performing a hydraulic test. Engine speed can affect the accuracy of the tester readings. Check actual speed of the pump when performing hydraulic flow tests.
11. If a traction circuit problem exists, consider performing one or more of the following tests: Charge Pressure Test, Wheel Motor Efficiency Test, and/or Piston Pump/ Hydrostat (P3) Flow and Relief Valve Tests.
12. If a cutting (mow) circuit problem exists, consider performing one or more of the following tests: Circuit Pressure Test, Deck Motor Efficiency/Case Drain Test, Manifold Relief Pressure Test, and/or Gear Pump (P1) Flow Test.
13. If a steering or lift/sidewinder circuit problem exists, consider performing one or more of the following tests: Gear Pump (P2) Flow Test, Relief Valve Pressure Test, and/or Steering Control Valve and Steering Cylinder Test.

Traction Circuit Testing − Charge Pressure Test

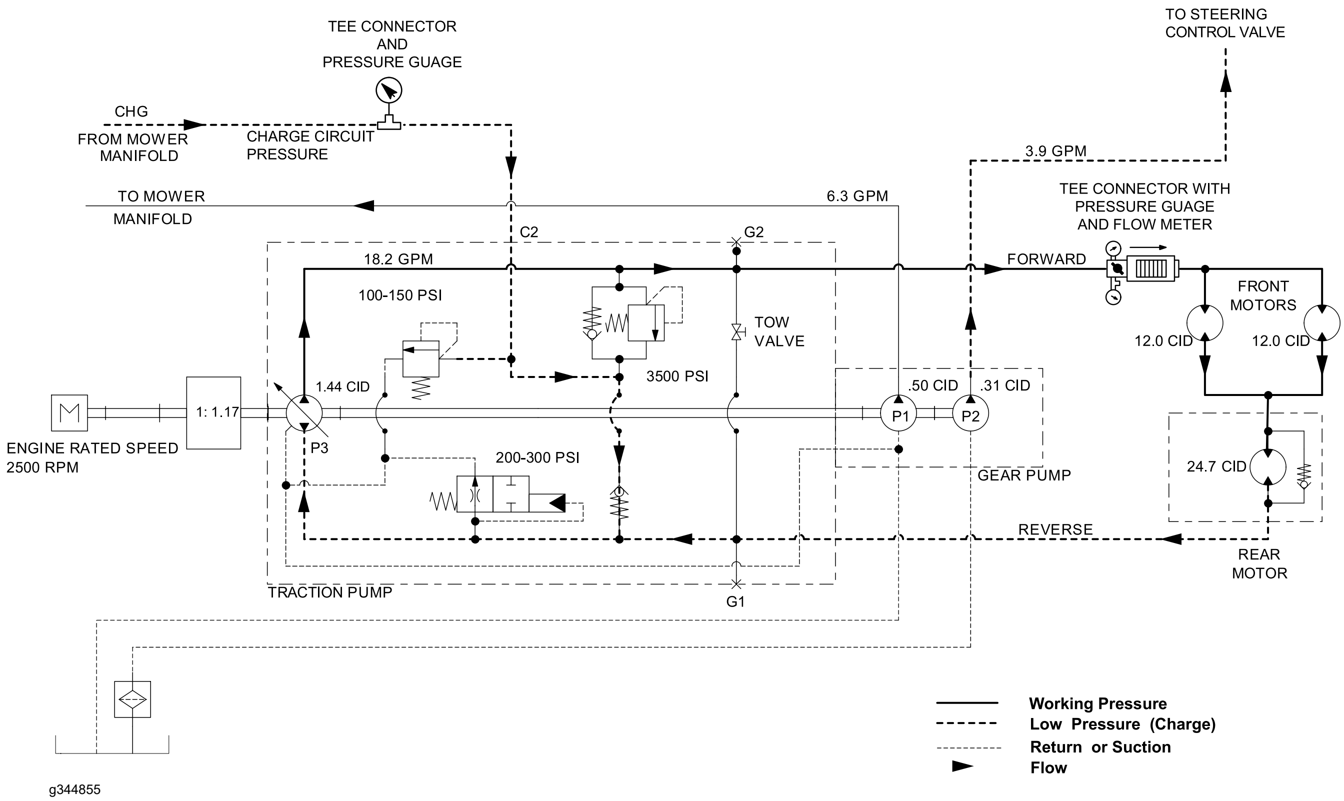


Figure 36

Model 03171 (shown)

The charge pressure test is the first in a series of tests recommended to determine traction circuit performance. A charge pressure drop of more than 20% indicates an internal leak in the piston pump/hydrostat. Continued unit operation can generate excessive heat, cause damage to seals and other components in the hydraulic system, and affect overall machine performance.

Special Equipment Required:

- Pressure Gauge
- Flow Meter with Pressure Gauge that has at least an 68 LPM (18 GPM) capacity
- Phototach (non−contact tachometer)

1. Park the machine on a level surface with the cutting units lowered and the reel engage/disengage switch is in the disengage position. Make sure that the engine is off and the parking brake is engaged.
2. Read Precautions for Hydraulic Testing (page 5–27).
3. Make sure that the traction pedal is adjusted to the neutral position.

Traction Circuit Testing − Charge Pressure Test (continued)

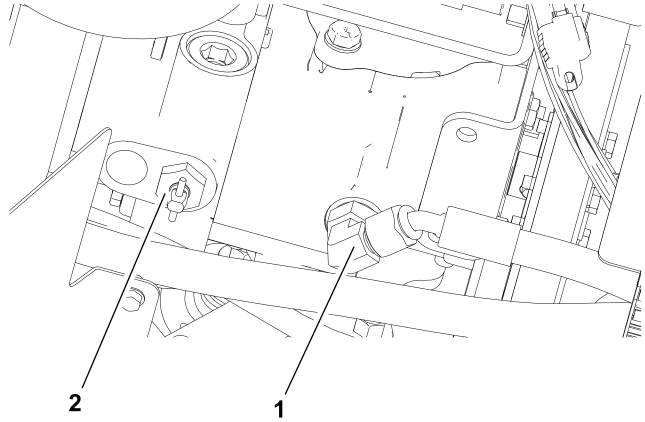


Figure 37

1. Hydraulic hose
2. Piston pump tow valve

4. Disconnect the hydraulic hose at the piston pump/ hydrostat fitting near the tow valve. This hose comes from the mower manifold CHG port (Figure 37).
5. Install a T−connector and pressure gauge between the fitting and disconnected hose.

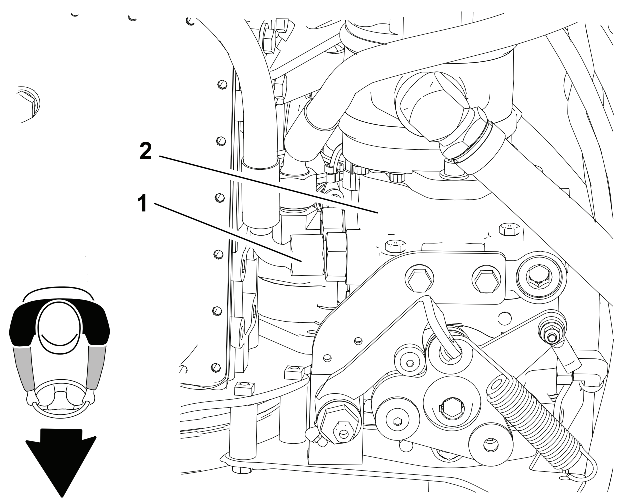


Figure 38

1. Lower hydraulic fitting
2. Piston pump

6. Disconnect hose from the lower hydraulic fitting on the engine side of the hydrostat (Figure 38).
7. Install tester in series with the pump and the disconnected hose. Make sure that the tester flow control valve is fully open.
8. Attach a heavy chain to the rear of the machine frame and an immovable object to prevent the machine from moving during testing.
9. Chock the wheels to prevent wheel rotation during testing.
10. Start engine. Move throttle to full speed (2650 ±50 RPM).
11. Make sure hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes.
12. Verify with a phototach that the pump speed is approximately 3100 RPM.

Traction Circuit Testing − Charge Pressure Test (continued)

13. Record reading on pressure gauge from the mower manifold CHD port. Charge pressure (without load) should read from **10.3 to 13.8 Bar (150 to 200 PSI)**. If charge relief pressure specification is not met, consider the following:

    A. Gear pump (P2) is faulty (steering/lift circuit performance will also be affected). Test gear pump (P2) flow (refer to Steering/Lift/Sidewinder Circuit Testing − Gear Pump (P2) Flow Test (page 5–55)).

    B. The piston pump charge relief valve is faulty. Repair or replace the piston pump charge relief valve (see Piston Pump/Hydrostat Service (page 5–84)).

14. Sit in the operator's seat, release the parking brake, and slowly depress the forward traction pedal until **68.9 to 103.4 Bar (1000 to 1500 PSI)** is reached on the flow meter pressure gauge.

15. Record reading on pressure gauge from mower manifold CHD port (under load). Charge pressure (under load) should not drop more than 20% when compared to charge pressure (without load) recorded in step 13.

    If specifications are not met, perform Traction Circuit Testing − Piston Pump/Hydrostat (P3) Flow and Relief Pressure Test (page 5–37).

16. Release traction pedal, move throttle to low speed and turn the engine off.

Traction Unit Testing − Wheel Motor Efficiency Tests

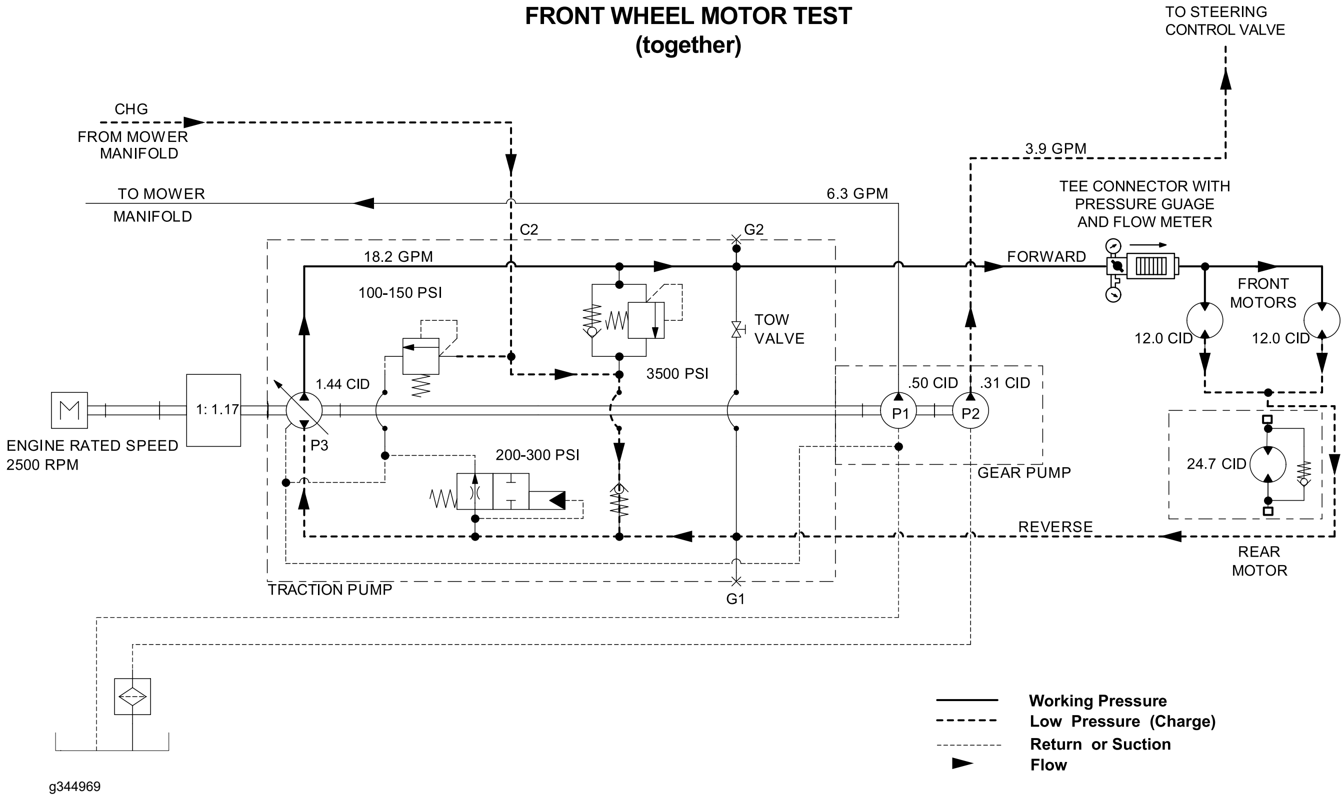


Figure 39

Model 03171 (shown)

Wheel motor efficiency is the second in a series of tests recommended to determine traction circuit performance. Hydraulic fluid flow of **5.7 LPM (1.5 GPM)** or more through a 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.

Hydraulic fluid flows through both front wheel motors (in parallel) before passing through the rear wheel motor (in series). In this configuration, the rear wheel motor can mask front wheel motor performance issues, and the front wheel motors can mask rear wheel motor performance issues. Start by testing both front wheel motors together, then individually if necessary. Finish by testing the rear wheel motor.

Special Equipment Required:

- Pressure Gauge
- Flow Meter with Pressure Gauge that has at least an 68 LPM (18 GPM) capacity
- Phototach (non−contact tachometer)

1. Park machine on a level surface with the cutting units lowered and the reel engage/disengage switch is in the disengage position. The engine should be off and the parking brake engaged.
2. Read Precautions for Hydraulic Testing (page 5–27).
3. Make sure that the 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.

Front Wheel Motor Tests

Hydraulic fluid flows through both front wheel motors (in parallel) before passing through the rear wheel motor (in series). To accurately test the front wheel motors, the rear wheel motor must be removed from the traction circuit.

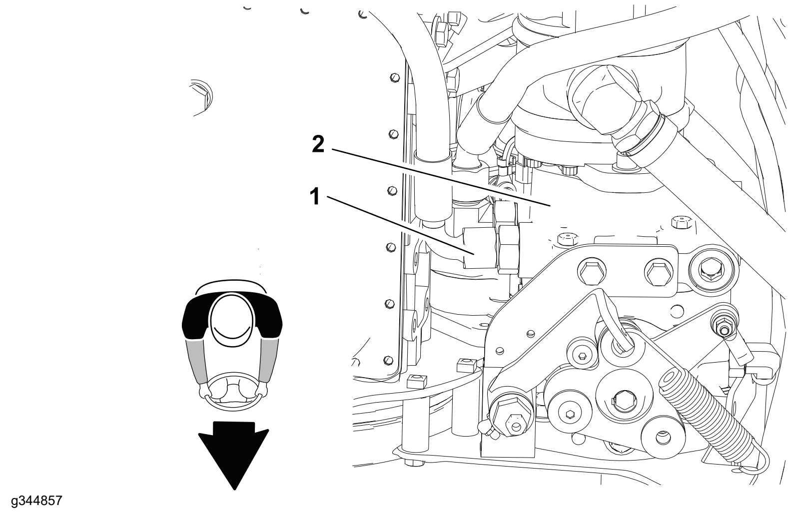


Figure 40

1. Lower hydraulic fitting
2. Piston pump

---

1. Disconnect the hose from the lower hydraulic fitting on the bottom of the hydrostat (Figure 40).

   Note: An alternate testing location would be at the hydraulic tube supplying the front wheel motors under the left floor plate.
2. Install the flow tester between the hydrostat and the disconnected hydraulic line. Make sure that the tester flow control valve is fully open.
3. Disconnect both hydraulic lines from the rear wheel motor, then reconnect the lines to each other. Plug ports in the wheel motor to prevent contamination.
4. Chock the front wheels to prevent wheel rotation.
5. Start the engine. Move throttle to full speed (2650 ± 50 RPM).
6. Make sure that the hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure that the hydraulic tank is full.
7. Verify with a phototach that the pump speed is approximately 3100 RPM.

CAUTION

Use extreme caution when performing wheel motor tests. The wheel motors will be trying to move the machine forward.

Front Wheel Motor Tests (continued)

8. Sit in the operators seat, release the parking brake, and set the Mow/Transport slide to the transport position.
9. Slowly depress forward traction pedal until **68.9 to 103.4 Bar (1000 to 1500 PSI)** is displayed on the pressure gauge.

   Flow meter should read less than **5.7 LPM (1.5 GPM)**.
10. Release traction pedal, shut engine off, and record test results.
11. Rotate each front wheel 120 degrees and retest. Repeat this procedure until each wheel motor has been tested in three (3) different positions.

    Proceed to testing rear wheel motor If test results are within specification. If specifications are not met, test front wheel motors individually as follows:

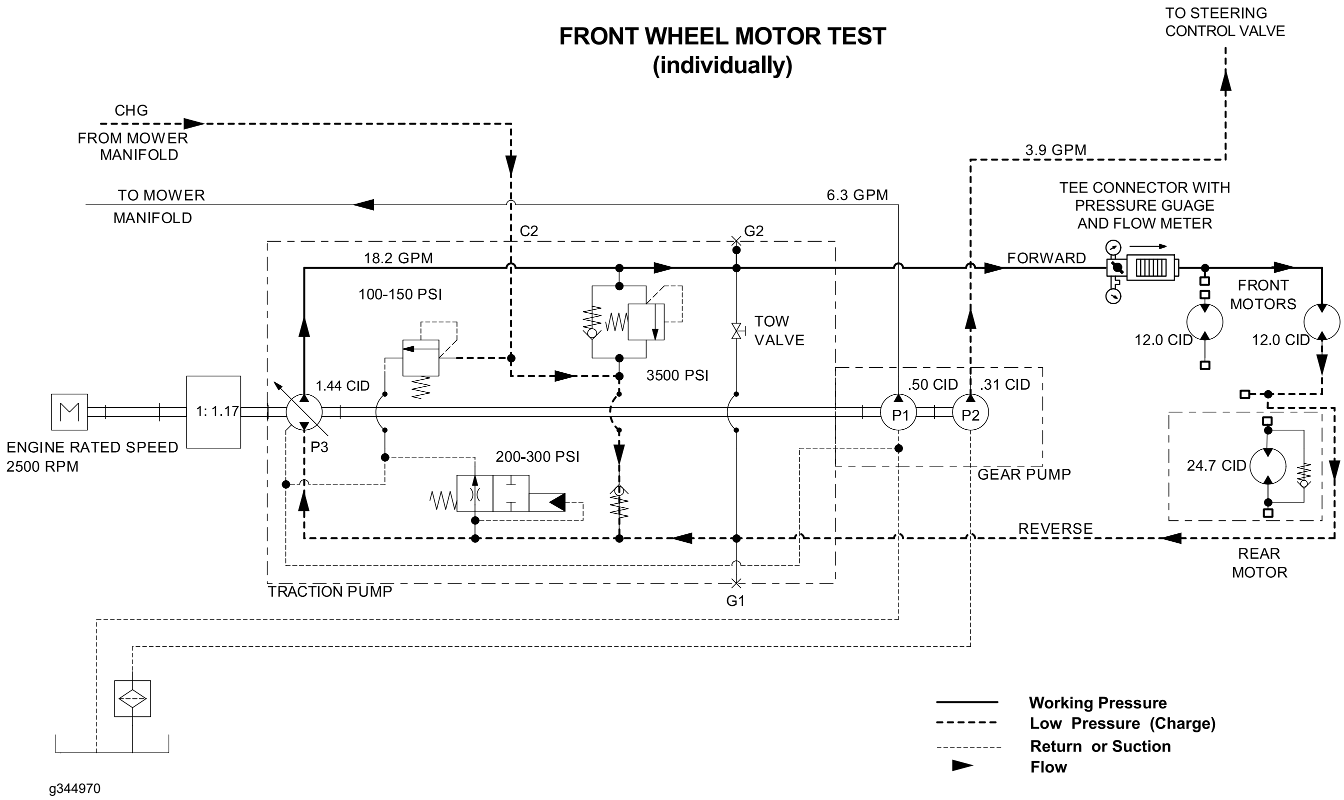


Figure 41

Model 03171 (shown)

12. Disconnect the hydraulic lines from front wheel motor that is not being tested. Cap disconnected hydraulic lines and plug ports in wheel motor to prevent contamination.
13. Chock the front wheel being tested to prevent the wheel rotation.
14. Start the engine. Move throttle to full speed.

CAUTION

Use extreme caution when performing wheel motor tests. The wheel motors will be trying to move the machine forward.

15. Sit in the operators seat, release the parking brake, and set the Mow/Transport slide to the transport position.

Front Wheel Motor Tests (continued)

16. Slowly depress forward traction pedal until **68.9 to 103.4 Bar (1000 to 1500 PSI)** is displayed on the pressure gauge.

    Flow meter should read less than **5.7 LPM (1.5 GPM)**.

17. Release traction pedal, shut engine off, and record test results.
18. Rotate front wheel 120 degrees and retest. Repeat this procedure until wheel motor has been tested in three (3) different positions.
19. Reconnect hydraulic lines to front wheel motor and repeat procedure for remaining front wheel motor.
20. If specifications are not met, repair or replace worn wheel motor.

Rear Wheel Motor Test:

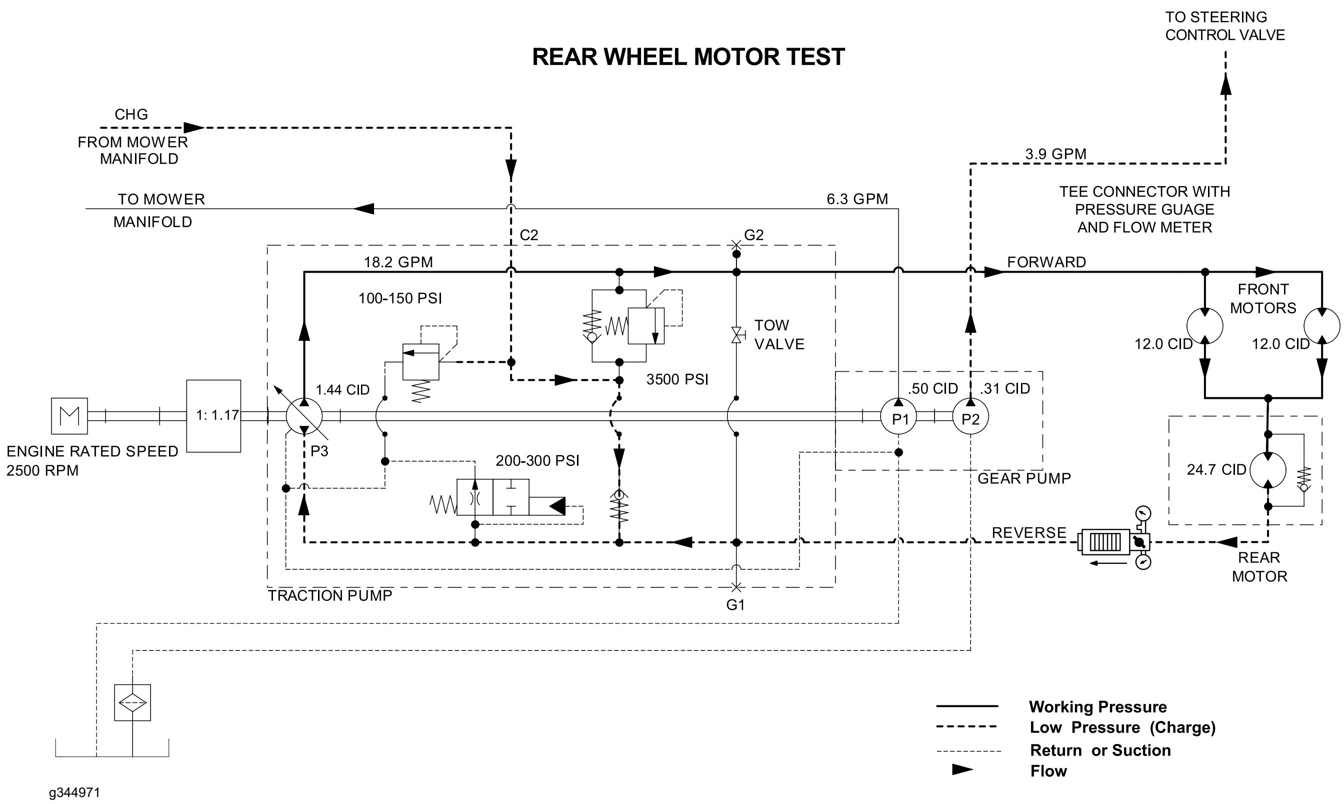


Figure 42

Model 03171 (shown)

Hydraulic fluid flows through both front wheel motors (in parallel) before passing through the rear wheel motor (in series). To accurately test the rear wheel motor, the front wheel motors must be allowed to rotate.

Rear Wheel Motor Test: (continued)

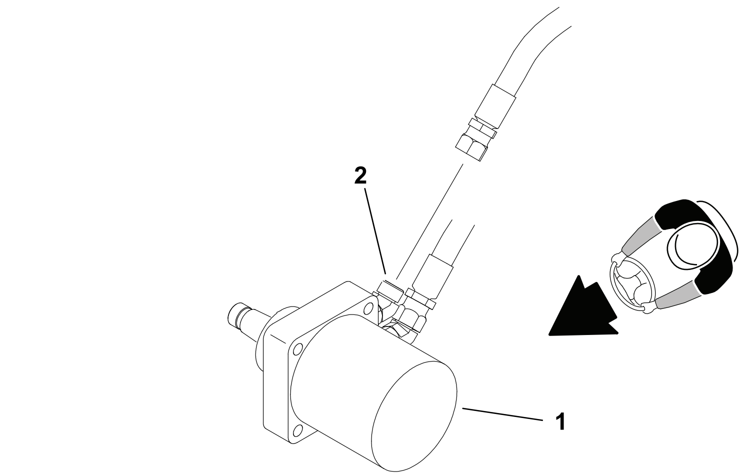


Figure 43

1. Rear wheel motor
2. Upper fitting

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1. Disconnect hose from the upper hydraulic fitting of the rear wheel motor (Figure 43).
2. Install flow tester between the disconnected hydraulic hose and the rear wheel motor. Make sure the tester flow control valve is fully open.

WARNING

Before jacking up the machine, review and follow Jacking Instructions (page 1–7).

3. Raise off the floor and support both front wheels.
4. Chock the rear wheel to prevent wheel rotation.
5. Start the engine. Move throttle to full speed.

CAUTION

Use extreme caution when performing wheel motor tests. The wheel motors will be trying to move the machine forward.

6. Sit in the operators seat, release the parking brake, and set the Mow/Transport slide to the transport position.
7. Slowly depress forward traction pedal until **68.9 to 103.4 Bar (1000 to 1500 PSI)** is displayed on the pressure gauge.

   Flow meter should read less than **5.7 LPM (1.5 GPM)**.
8. Release traction pedal, shut engine off, and record test results.
9. Rotate rear wheel 120 degrees and retest. Repeat this procedure until wheel motor has been tested in three (3) different positions.
10. If specifications are not met, repair or replace worn wheel motor.

Traction Circuit Testing − Piston Pump/Hydrostat (P3) Flow and Relief Pressure Test

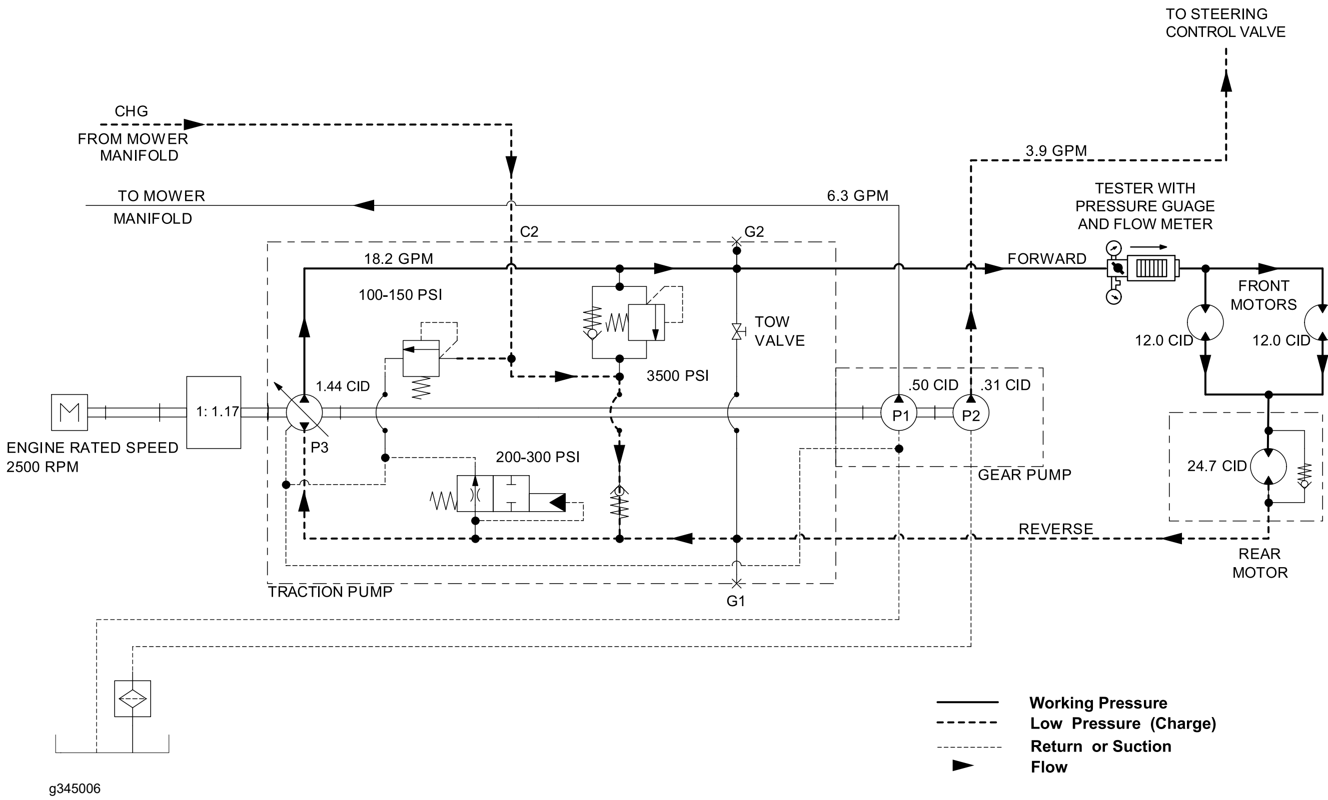


Figure 44

Model 03171 (shown)

The hydrostat flow test is the third in a series of tests recommended to determine traction circuit performance. The final traction circuit test is verifying the hydrostat relief valve operation. This test compares fluid flow at No Load with fluid flow Under Load. A drop in flow under load of more than 12% indicates an internal leak or malfunctioning relief valve in the piston pump/hydrostat. A worn hydrostat or malfunctioning relief valve is less efficient. Eventually, enough fluid 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:

- Pressure Gauge
- Flow Meter with Pressure Gauge that has at least an 68 LPM (18 GPM) capacity
- Phototach (non−contact tachometer)

1. Park machine on a level surface with the cutting units lowered and the reel engage/disengage switch in the disengage position. The engine should be off and the parking brake engaged.
2. Read Precautions for Hydraulic Testing (page 5–27).
3. Make sure that the traction pedal is adjusted to the neutral position.

Traction Circuit Testing − Piston Pump/Hydrostat (P3) Flow and Relief Pressure Test (continued)

WARNING

Before jacking up the machine, review and follow Jacking Instructions (page 1–7).

4. Raise off the floor and support both front wheels and the rear wheel.

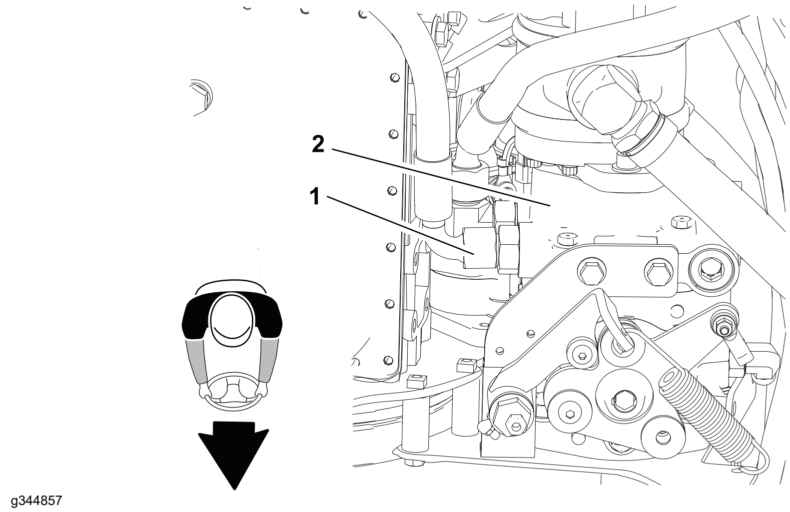


Figure 45

1. Lower hydraulic fitting
2. Piston pump

5. Disconnect hose from the lower hydraulic fitting on the engine side of the hydrostat (Figure 45).
6. Install the tester in series with the pump and the disconnected hose. Make sure the tester flow control valve is fully open.
7. Start the engine. Move throttle to full speed (2650 ±50 RPM).
8. Make sure that the hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.
9. Verify with a phototach that the pump speed is approximately 3100 RPM.
10. Sit in the operator's seat, release the parking brake, and set the Mow/Transport slide to the transport position.

CAUTION

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

11. Verify the pump flow at No Load as follows:
    A. Slowly depress forward traction pedal to full forward position.
    B. Record tester pressure and flow readings. Unrestricted pump output should be approximately **69 LPM (18 GPM)** at **44.8 Bar (650 PSI)**.
12. Verify pump flow Under Load as follows:
    A. Slowly depress forward traction pedal to full forward position.

Traction Circuit Testing − Piston Pump/Hydrostat (P3) Flow and Relief Pressure Test (continued)

B. Apply an additional load of **68.9 to 103.4 Bar (1000 to 1500 PSI)** by slowly closing the flow meter. The flow meter pressure gauge should read **117.2 to 144.8 Bar (1700 to 2100 PSI)**.

C. Record tester pressure and flow readings.

13. Verify traction relief valve operation as follows:

A. Return the traction pedal to neutral.

B. Fully close the flow meter flow control valve.

C. Depress the traction pedal slowly.

System pressure should reach **248 to 251 Bar (3600 to 3650 PSI)** before the relief valve opens.

Note: The relief valve setting is **241 Bar (3500 PSI)**. An additional **6.9 to 10.3 Bar (100 to 200 PSI)** is necessary to overcome system charge pressure before the relief valve opens.

D. Record tester pressure reading.

E. Release traction pedal, open flow control valve fully, move throttle to low speed and turn the engine off.

14. If relief pressure can not be met or is greater than specified, the traction relief valve is faulty and should be replaced.

15. The Under Load test flow reading (12) should not drop more than 12% when compared to the No Load test flow reading (11). A difference of more than 12% may indicate:

A. The hydrostat belt is worn and/or slipping.

B. The piston pump/hydrostat is worn and should be repaired or replaced.

16. Disconnect tester and reconnect hose to pump.

Reel Circuit Testing − Pressure Test

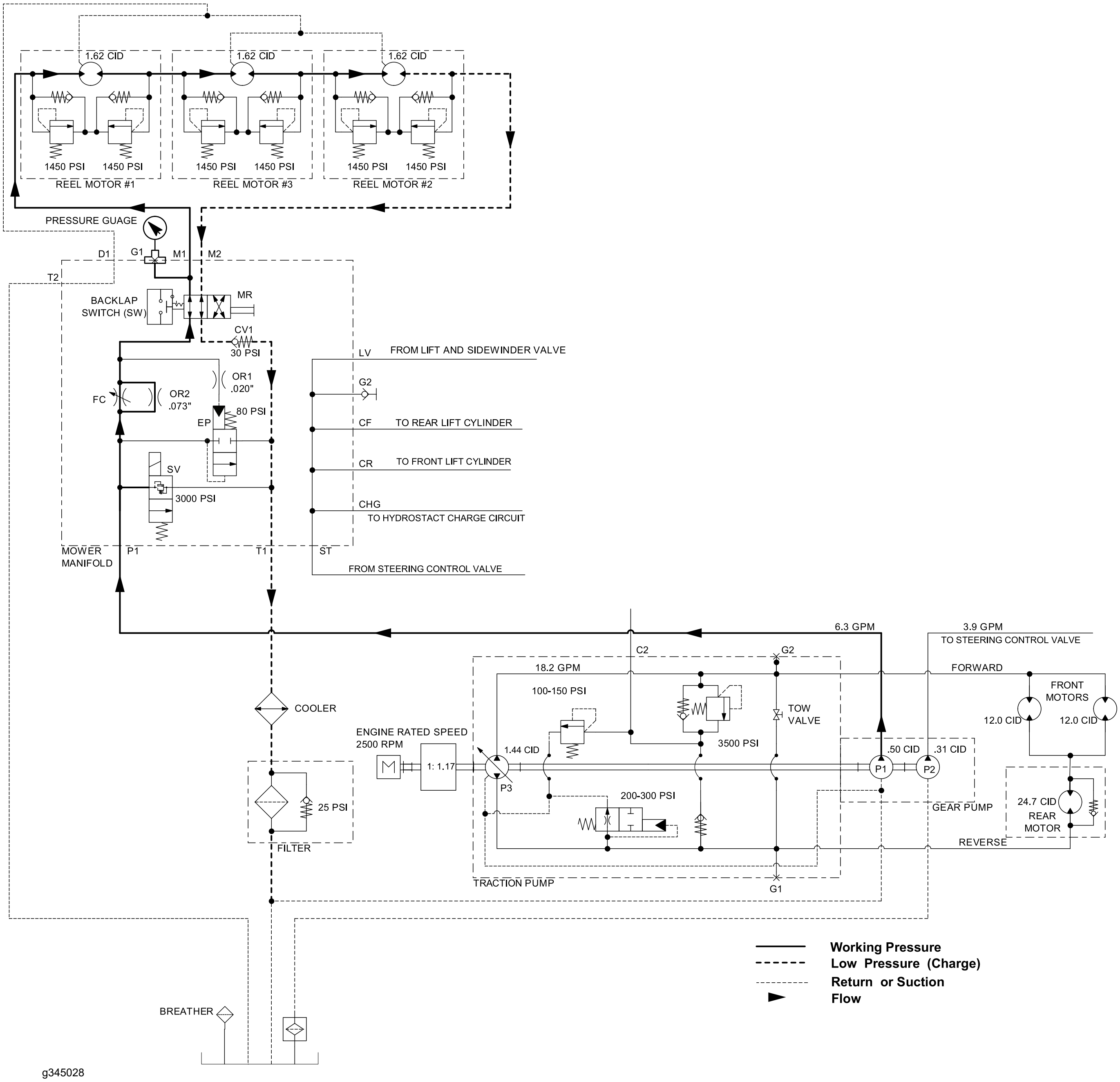


Figure 46

Model 03171 (shown)

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

Special Equipment Required:

- Pressure Gauge
- Phototach (non−contact tachometer)

1. Park machine on a level surface with the cutting units lowered, the reel engage/disengage switch in the DISENGAGE position, and the mow/transport switch in the MOW position. Make sure engine is off and the parking brake is disengaged.

Reel Circuit Testing − Pressure Test (continued)

2. Make sure backlap knob on the hydraulic manifold is in the MOW position. Make sure that the reel speed knob is set for typical mowing conditions.
3. Read Precautions for Hydraulic Testing (page 5–27).

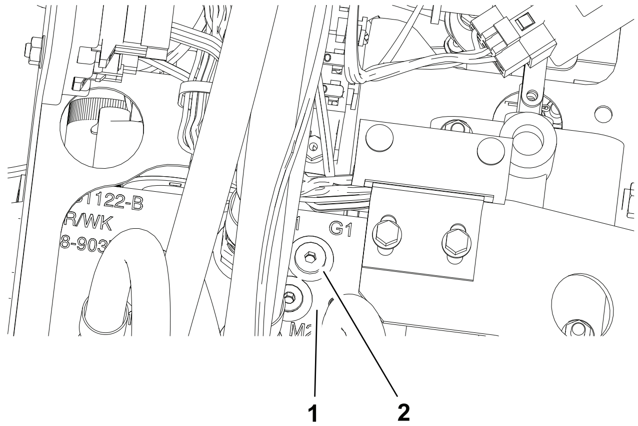


Figure 47

1. Hydraulic manifold
2. Test port (G1)

4. Remove cap from test fitting at mow control manifold port (G1) and install a pressure gauge with hydraulic hose to the test fitting (Figure 47).

CAUTION

Keep away from cutting units during test to prevent personal injury from the cutting blades.

5. Sit in the Operator’s seat, start the engine, and move throttle to full speed (2650 ±50 RPM).
6. Make sure that the hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure that the hydraulic tank is full.
7. Verify with a phototach that the pump speed is approximately 3100 RPM.
8. Set the cutting unit speed control to #9 (maximum) and engage the cutting units.

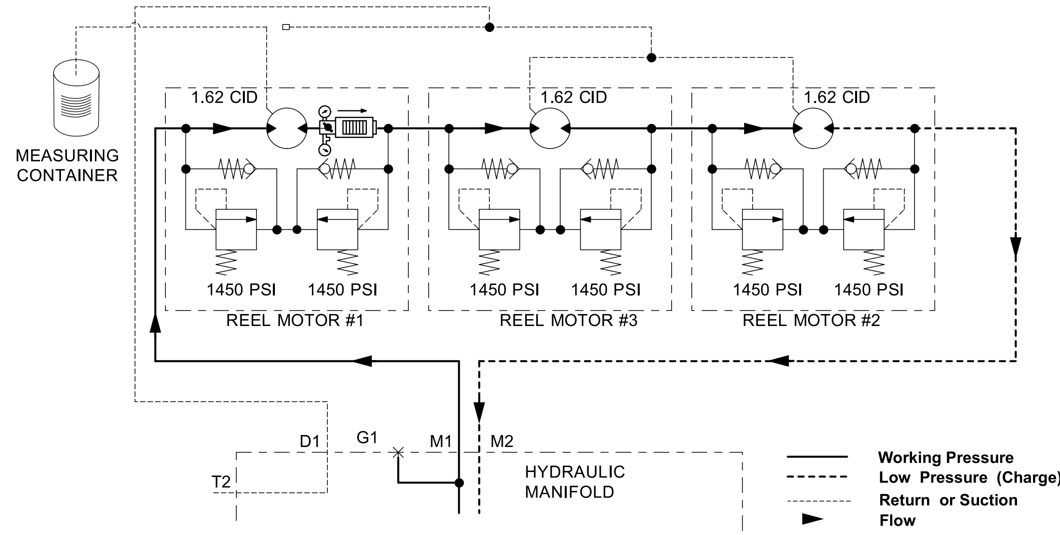
   When engaged, the cutting circuit pressure may exceed manifold relief valve pressure setting of **207 Bar (3000 PSI)** momentarily opening the relief valve. Circuit pressure should then stabilize at approximately **83 Bar (1200 PSI)**.
9. Safely secure the test pressure gauge and operate the machine under your specific mowing conditions. Monitor test gauge while mowing. reel circuit pressure should be approximately: **103 to 138 Bar (1500 to 2000 PSI)** under low to normal load conditions.
10. Disengage cutting units, move throttle to low speed and shut off the engine.
11. If pressure readings are within specifications and cutting unit performance is still in question, test cutting unit motors individually (see Reel Circuit Testing − Reel Motor Efficiency/Case Drain Test (page 5–43)).
12. If pressure specifications are not met, consider the following:
    A. Solenoid valve (SV) is faulty (see Reel Circuit Testing − Manifold Relief Valve (SV) Pressure Test (page 5–49)).

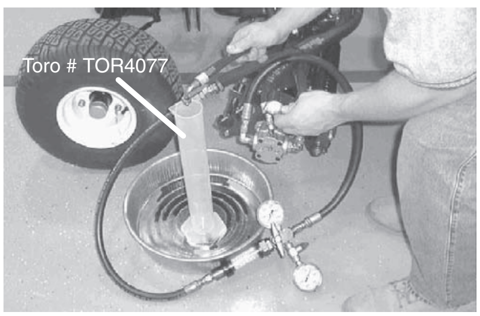
Reel Circuit Testing − Pressure Test (continued)

B. Gear pump (P1) is faulty (see Reel Circuit Testing − Gear Pump (P1) Flow Test (page 5–52)).

13. Disconnect test equipment from hydraulic manifold.

Reel Circuit Testing − Reel Motor Efficiency/Case Drain Test





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

g345040

Figure 48

Model 03171 (shown)

The reel motor efficiency/case drain test is the second in a series of tests recommended to check cutting unit circuit performance. Over a period of time, a reel motor can wear internally. This test measures case drain volume while restricting flow across the motor ports. Case drain volume under load of more than 9% of total motor flow indicates the gears and wear plates in the motor have worn. A worn motor may by−pass hydraulic fluid to its case drain causing the motor to be less efficient. Eventually, enough fluid loss will cause the reel motor to stall under heavy cutting conditions. Continued operation with a worn, inefficient motor can generate excessive heat, cause damage to seals and other components in the hydraulic system, and affect quality of cut.

Note: One method to find a failing or malfunctioning cutting unit motor is to have another person observe the machine while mowing in dense turf. A bad motor will run slower, produce fewer clippings and may cause a different appearance on the turf.

Special Equipment Required:

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

1. Make sure that the 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 and the PTO switch in the disable position. Make sure engine is off and the parking brake is disengaged.
3. Read Precautions for Hydraulic Testing (page 5–27).
4. Make sure that the traction pedal is adjusted to the neutral position.

   Note: The cutting unit motors are connected in series. If a faulty reel motor is not obvious (based on quality of cut issues) you may have to test all the reel motors in the circuit. If testing all reel motors, start with the first motor.
5. Hydraulic fluid passes through each reel motor from the front to the rear. Disconnect the return hose from the motor (hose at the rear of the reel motor).
6. Install hydraulic tester between the motor and the disconnected return hose. Make sure the tester flow control valve is fully open.
7. Make sure backlap knob on the hydraulic manifold is in the MOW position.

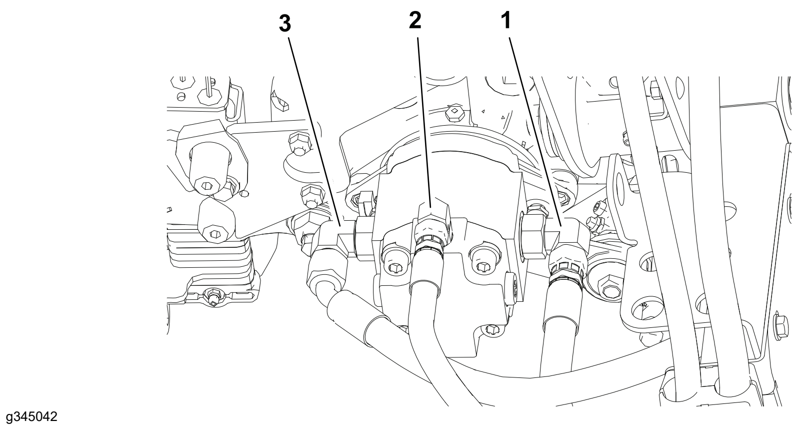


Figure 49

1. Inlet hose
2. Case drain hose
3. Outlet hose

8. Disconnect hose from reel motor case drain at the hydraulic tube (#1 cutting unit), or from the bulkhead fitting (#2 and 3). Cap the hydraulic tube or bulkhead fitting to prevent system contamination.
9. Place open end of disconnected case drain hose into a drain pan.
10. 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 reel motor case drain volume.
11. Start the engine, and move throttle to full speed (2650 ±50 RPM).
12. Verify with a phototach that the pump speed is approximately 3100 RPM.

CAUTION

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

13. Engage cutting units and slowly close tester flow control valve until **82.7 Bar (1200 PSI)** is obtained.

Reel Circuit Testing − Reel Motor Efficiency/Case Drain Test (continued)

14. Hold disconnected motor case drain hose into a container graduated in ounces or milliliters (e.g. Toro #TOR4077) and collect hydraulic fluid for 30 seconds. After 30 seconds, remove hose end from container.
15. Record the amount of fluid collected in the container.
16. Disengage the cutting units, set the throttle to low speed, and stop engine.
17. If volume is more than **1265 milliliters (43 oz)**, repair or replace the tested reel motor.
18. Remove tester and reconnect hydraulic hoses.
19. Check hydraulic fluid level (see *Traction Unit Operator's Manual*).
20. Repeat test for remaining reel motors as needed.

Reel Motor Cross−over Relief Pressures Test (Using Pressure Gauge)

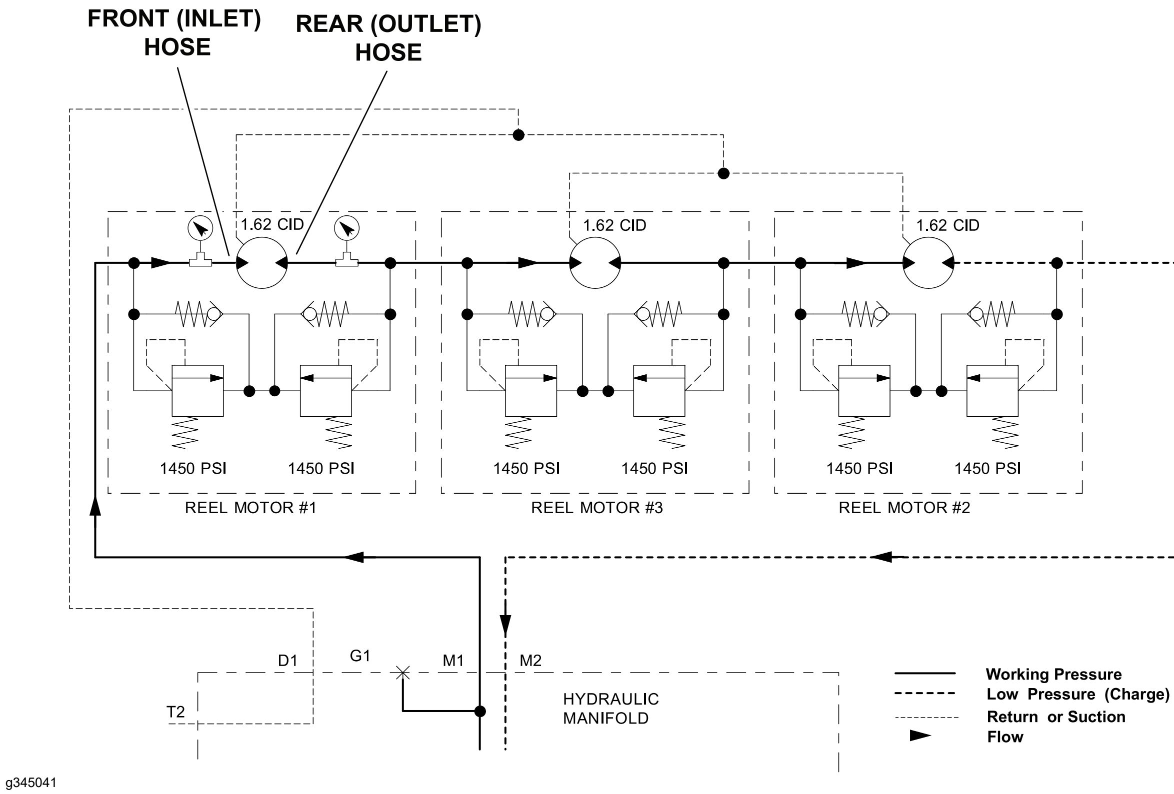


Figure 50

Model 03171 (shown)

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

Note: Before testing the cutting reel motor cross−over relief pressure, make sure that the reel motor is in good condition by performing the Cutting Reel Motor Efficiency Test (see Reel Circuit Testing − Reel Motor Efficiency/Case Drain Test (page 5–43)).

1. Determine which cutting reel motor needs to be tested by observing the machine during mowing.
2. Park machine on a level surface with the cutting units lowered and reel engage switch OFF. Make sure engine is off and mow/transport lever is in mow. Apply the parking brake.
3. Read Precautions for Hydraulic Testing (page 5–27).

CAUTION

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil. See Relieving Hydraulic System Pressure (page 5–3).

Reel Motor Cross−over Relief Pressures Test (Using Pressure Gauge) (continued)

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

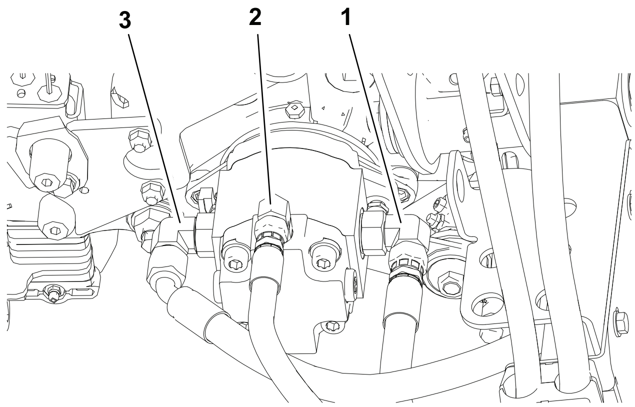


Figure 51

1. Inlet hose
2. Case drain hose
3. Outlet hose

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4. On the reel motor to be tested, thoroughly clean motor inlet and outlet fittings and hydraulic hoses (Figure 51). Loosen and remove both hoses from fittings. Install a tee fitting with a **350 bar (5000 PSI)** pressure gauge between the fitting and hose for both the motor inlet and outlet.
5. Make sure that the backlap knob on the hydraulic manifold is in the MOW position.
6. Insert a block of wood between cutting unit reel blades and carrier frame of cutting unit being tested to prevent reel from turning.
7. Start the engine and run at low idle speed. Check for any hydraulic leakage from test connections and correct before proceeding with test.
8. Make sure that the hydraulic fluid is at normal operating temperature by operating the machine under load for approximately ten (10) minutes. DO NOT engage cutting units.

CAUTION

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

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9. One person should sit on the seat and operate the machine while a second person closely monitors both pressure gauges connected to the reel motor. Make sure that engine speed is at low idle position (1400 ±50 RPM) and engage the cutting units.
10. There should be a slight hesitation in pressure increase on the inlet side of motor as the cross−over relief valve opens. Record the pressure reading on both the inlet and outlet side pressure gauges.
11. Disengage the cutting units and stop the engine.

Reel Motor Cross−over Relief Pressures Test (Using Pressure Gauge) (continued)

12. Calculate the pressure differential between the two gauges. If the pressure differential is not approximately **100 bar (1450 PSI)**, the cross-over relief valves on the tested motor may be leaking or damaged. Inspect relief valves in the reel motor and replace if necessary (see Servicing the Reel Motor (page 5–106)).
13. After testing is completed, relieve cutting unit hydraulic system pressure (see Relieving Hydraulic System Pressure (page 5–3)). Remove pressure gauges and tee fittings from machine. Connect hydraulic hoses to reel motor fittings.
14. If necessary, test cross−over relief pressure on other cutting reel motors.
15. Operate machine and check for leaks before returning machine to service.

Reel Circuit Testing − Manifold Relief Valve (SV) Pressure Test

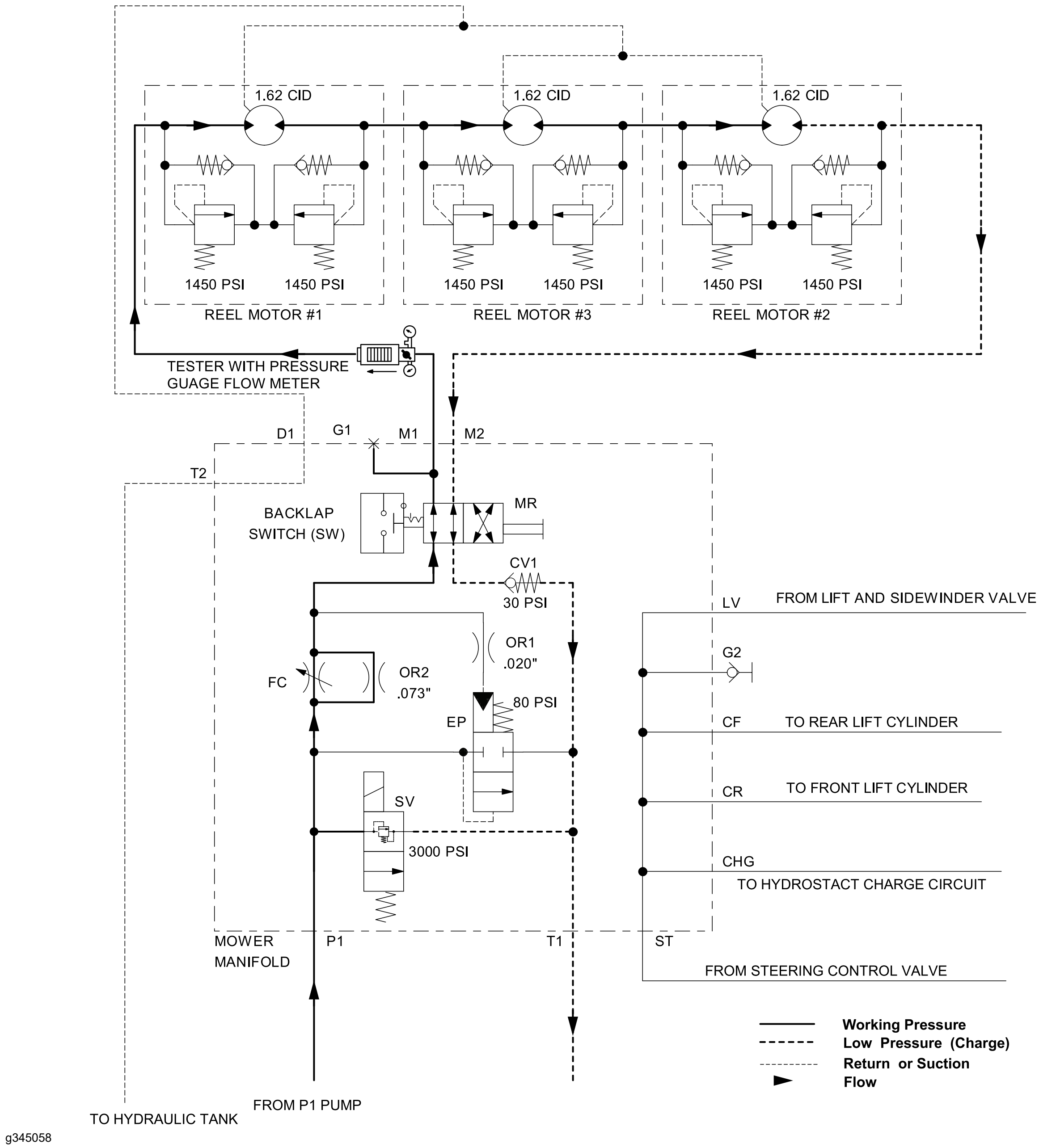

Figure 52

Model 03171 (shown)

Test the performance of the mow control manifold relief valve (SV) to make sure 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 (P1) 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)

Reel Circuit Testing − Manifold Relief Valve (SV) Pressure Test (continued)

1. Park the machine on a level surface with the cutting units lowered, reel engage/disengage switch in the disengage position, and the mow/transport switch in the MOW position. Engine should be off and the parking brake disengaged.
2. Read Precautions for Hydraulic Testing (page 5–27).
3. Make sure that the reel speed adjuster knob (FC) is set to the highest speed setting (fully open).

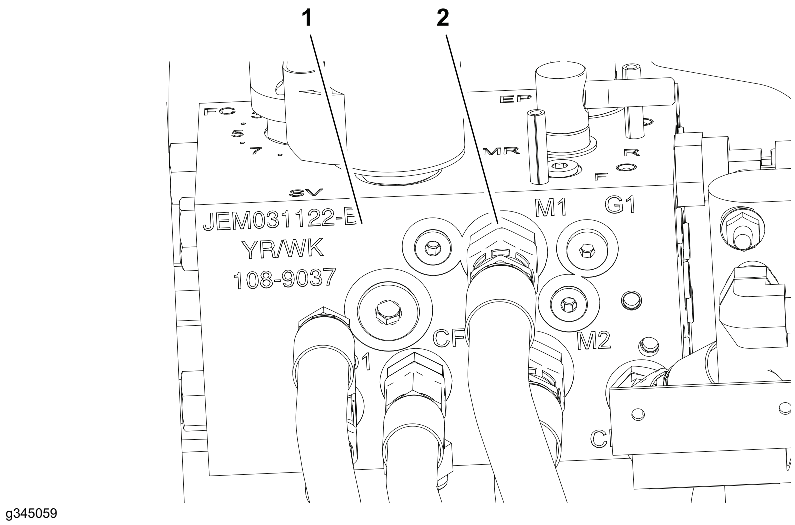

Figure 53

1. Hydraulic manifold
2. Hydraulic fitting (M1)

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure (page 5–3).

4. Disconnect the hose connection from hydraulic fitting on manifold port (M1).
5. Install the tester in series with the hose and hydraulic fitting. Make sure that the flow control valve on tester is fully open.
6. Make sure that the backlap knob on the hydraulic manifold is in the mow position.

CAUTION

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

7. Start the engine, and move throttle to full speed (2650 ±50 RPM).
8. Make sure that the hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes.
9. Verify with a phototach that the pump speed is approximately 3100 RPM.

Reel Circuit Testing − Manifold Relief Valve (SV) Pressure Test (continued)

10. Engage cutting units.
11. Watch pressure gauge carefully while slowly closing the flow control valve.
12. System pressure should reach **207 Bar (3000 PSI)** before the relief valve opens.
13. Set throttle to low speed and shut off engine.
14. If specification is met, test pump (P1) flow (see Reel Circuit Testing − Gear Pump (P1) Flow Test (page 5–52)). If specification is not met, test relief valve (EV) solenoid, clean or replace valve (see Servicing the Hydraulic Manifold (page 5–113)) and retest.
15. Disconnect tester from manifold and hose. Reconnect hydraulic hose to manifold fitting for port (M1).

Reel Circuit Testing − Gear Pump (P1) Flow Test

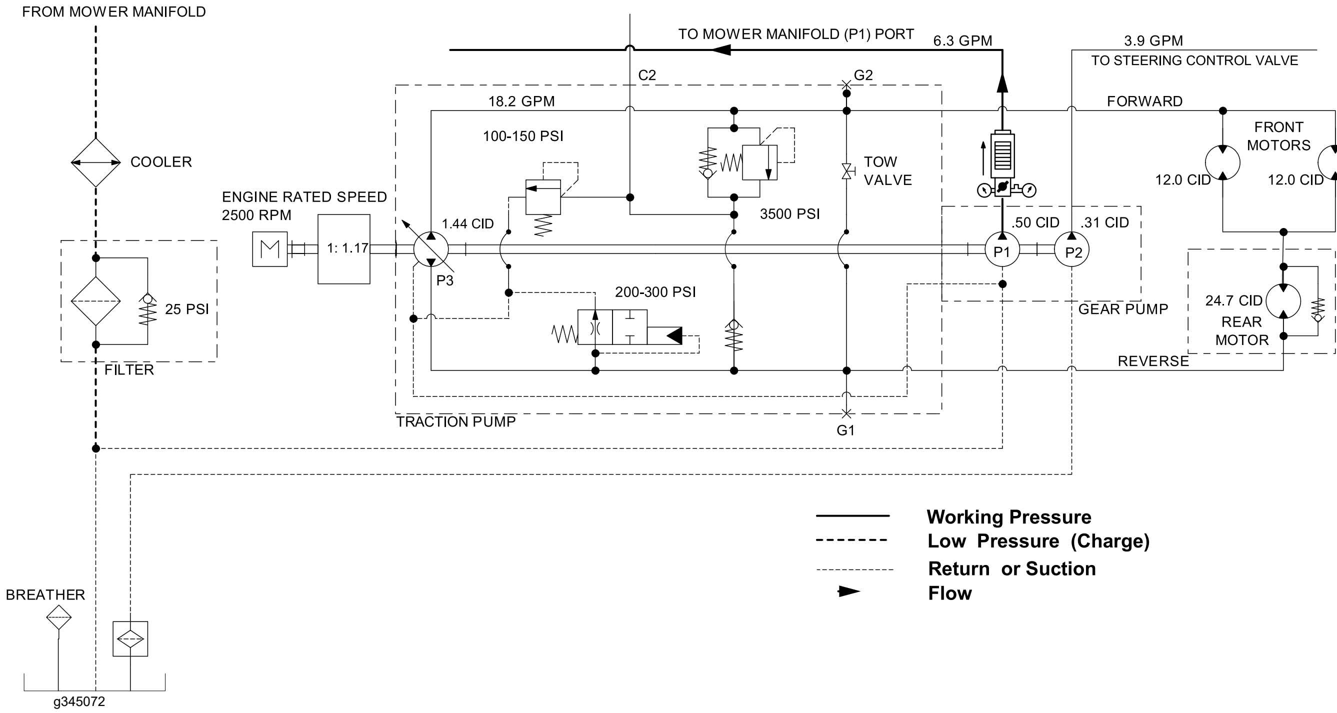

Figure 54

Model 03171 (shown)

The gear pump (P1) 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 the machine on a level surface with the cutting units lowered and PTO switch in the disengage position. Make sure engine is off and the parking brake is engaged.
2. Read Precautions for Hydraulic Testing (page 5–27).

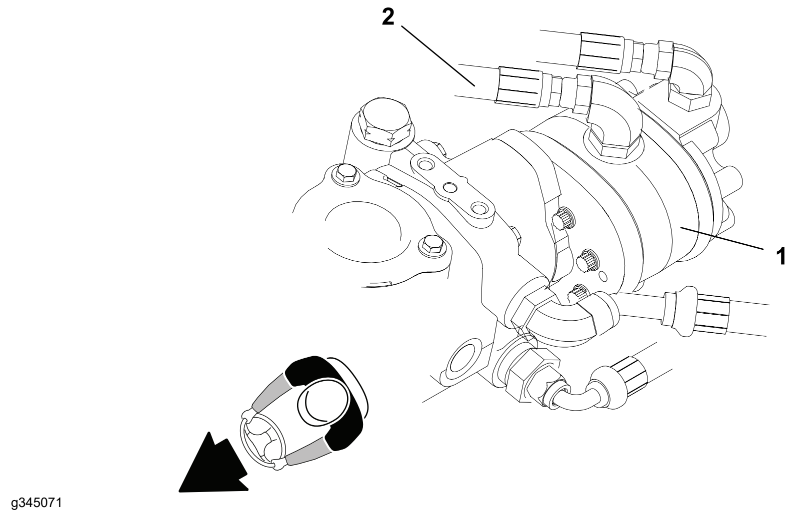

Figure 55

1. Gear pump (P1)
2. To manifold port (P1)

3. Disconnect the hose connection on the gear pump (P1) leading to port (P1) on the mow control manifold (Figure 55).
4. Install the tester in series with reel drive pump and the disconnected hose leading to port (P1) of the hydraulic manifold.
5. Make sure that the flow control valve on the tester is fully open.
6. Make sure backlap knob on the hydraulic manifold is in the mow position and reel speed is set to maximum.
7. Sit in the operator's seat and start the engine. Move the throttle to full speed (2650 ±50 RPM).
8. Make sure hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes.
9. Verify with a phototach that the pump speed is approximately 3100 RPM.
10. Verify pump flow at No Load as follows:

    Record tester pressure and flow reading at no load. Unrestricted pump output should be approximately **23.8 LPM (6.3 GPM)**.
11. Verify pump flow Under Load as follows:

CAUTION

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

    A. Watch flow meter pressure gauge carefully while slowly closing the flow control valve until **137.9 Bar (2000 PSI)** is obtained on gauge.
    B. Record the tester pressure and flow readings under load.
12. Set throttle to low speed and shut off engine.

Reel Circuit Testing − Gear Pump (P1) Flow Test (continued)

13. The under load test flow reading (step 11.B.) should not drop more than 15% when compared to 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. A worn and/or slipping hydrostat belt.

    C. The gear pump (P1) is worn and should be repaired or replaced.

14. Disconnect tester and reconnect hose to pump.

Steering/Lift/Sidewinder Circuit Testing − Gear Pump (P2) Flow Test

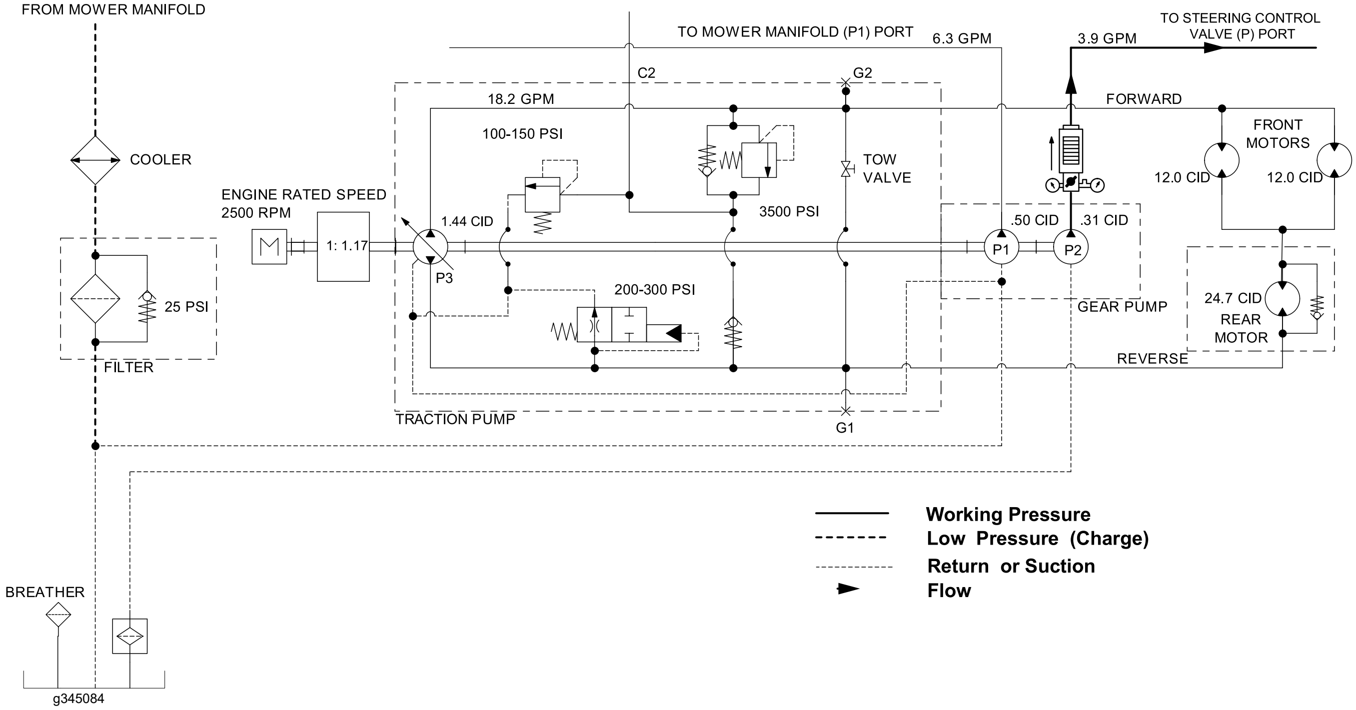

Figure 56

Gear pump (P2) is designed to satisfy both steering cylinder and lift cylinder needs simultaneously (at full speed throttle). The Gear Pump (P2) 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.

If unit steering is sluggish or otherwise performs poorly, see Steering/Lift/Sidewinder Circuit Testing − Steering Control Valve and Steering Cylinder Test (page 5–60).

If cutting unit lift operation is unsatisfactory, check lift control manifold solenoid valves and/or lift cylinders. Additional information on these components is available in this chapter.

If both steering and lift operations perform poorly, perform the gear pump (P2) flow test and circuit relief valve pressure test (see Steering/Lift/Sidewinder Circuit Testing − Relief Valve Pressure Test (page 5–58)).

Special Equipment Required:

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

1. Park the machine on a level surface with the cutting units lowered and PTO switch in the disable position. The engine should be off and the parking brake engaged.
2. Read Precautions for Hydraulic Testing (page 5–27).

Steering/Lift/Sidewinder Circuit Testing − Gear Pump (P2) Flow Test (continued)

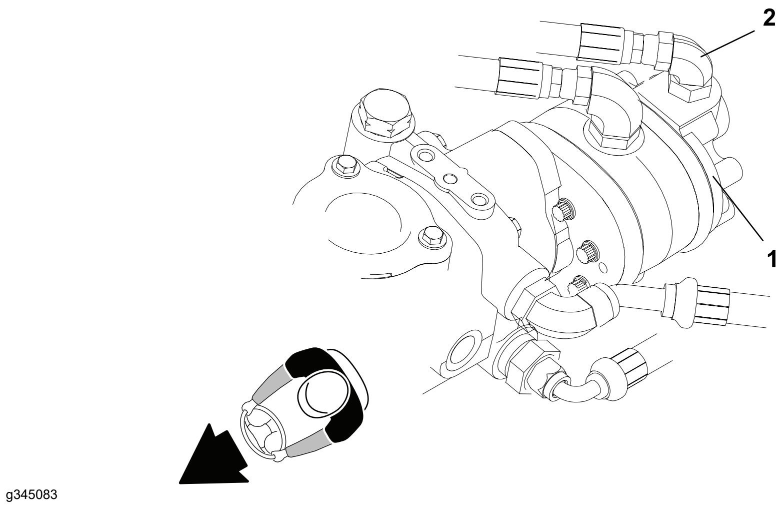

Figure 57

1. Gear pump
2. To steering control valve

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure (page 5–3).

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3. Disconnect the hose connection on the reel gear pump leading to the steering control valve.
4. Install the tester in series with reel drive pump and the disconnected hose leading to the steering control valve.
5. Make sure that the flow control valve on the tester is fully open.
6. Sit in the operator's seat and start the engine. Move the throttle to full speed (2650 ±50 RPM).
7. Make sure that the hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes.
8. Verify with a phototach that the pump speed is approximately 3100 RPM.
9. Verify pump flow at No Load as follows:

   Record tester pressure and flow readings 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 manifold relief valve. Pump damage can occur if the fluid flow is fully restricted by fully closing the tester flow control valve.

Steering/Lift/Sidewinder Circuit Testing − Gear Pump (P2) Flow Test (continued)

10. Verify pump flow Under Load as follows:
    A. Watch pressure gauge carefully while slowly closing the flow control valve until **55.2 bar (800 PSI)** is obtained on gauge.
    B. Record tester pressure and flow readings under load.
11. Set throttle to low speed and shut off engine.
12. The under load test flow reading (step 10.B) should not drop more than 15% when compared to the no load test flow reading (step 9). 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. A worn and/or slipping drive belt.
    C. The gear pump (P2) is worn and should be repaired or replaced.
13. Disconnect tester and reconnect hose to pump.

Steering/Lift/Sidewinder Circuit Testing − Relief Valve Pressure Test

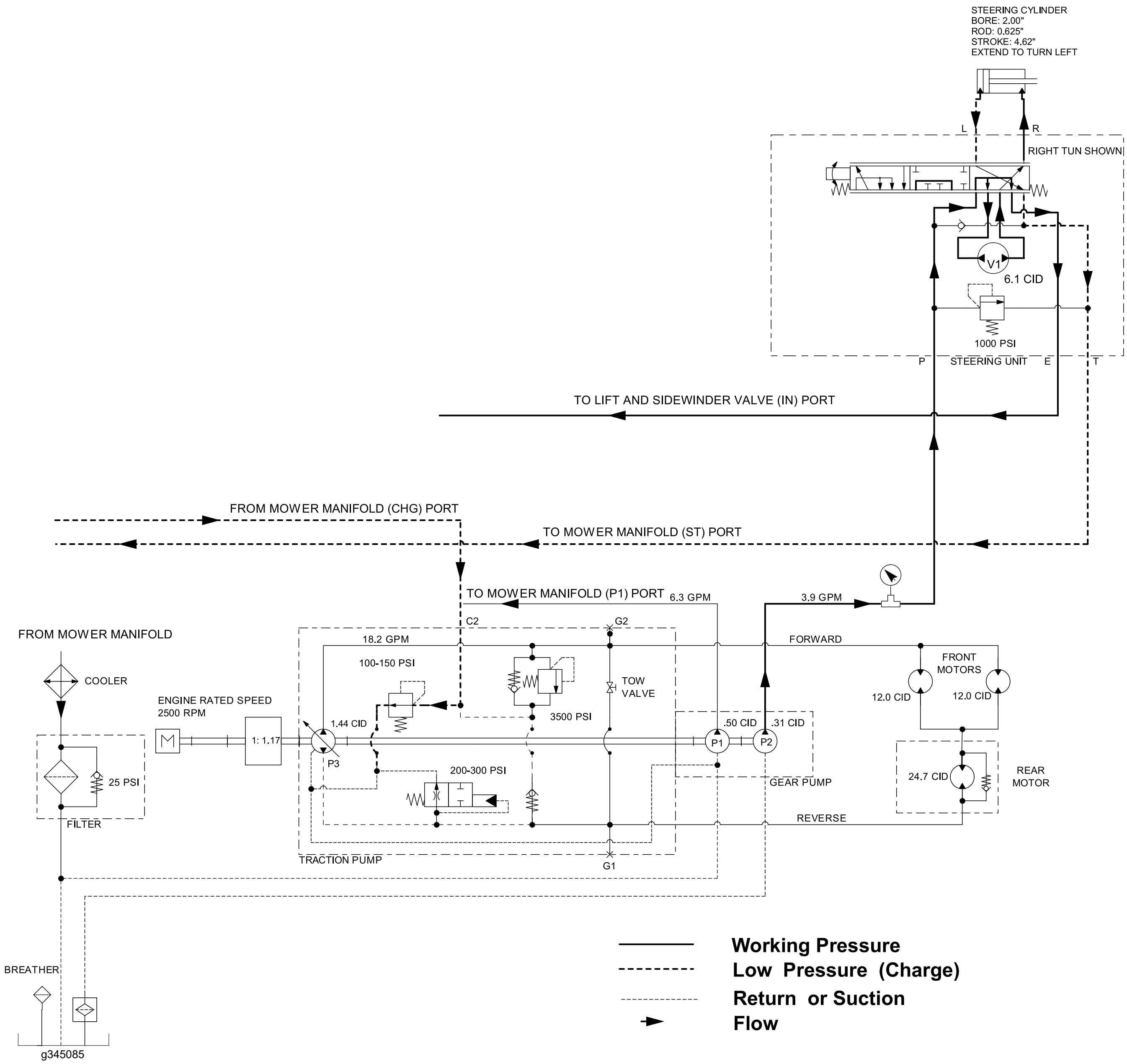

Figure 58

The relief valve for the steering, lift, and sidewinder circuits is integrated into the steering control valve. If both steering and lift operations perform poorly, perform the relief valve pressure test and gear pump (P2) flow test (see Steering/Lift/Sidewinder Circuit Testing − Gear Pump (P2) Flow Test (page 5–55)).

1. Park the machine on a level surface with the cutting units lowered and reel engage/disengage switch in the disengage position. Make sure the engine is off and the parking brake is engaged.

2. Read Precautions for Hydraulic Testing (page 5–27).

Steering/Lift/Sidewinder Circuit Testing − Relief Valve Pressure Test (continued)

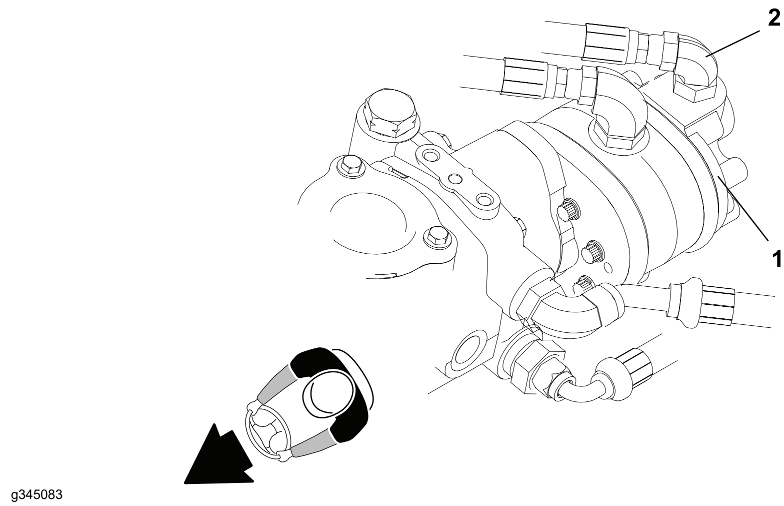

Figure 59

1. Gear pump
2. To steering control valve

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3. Install a T−connector with a pressure gauge between the gear pump and the hydraulic hose connection on the gear pump (P2) (Figure 59).
4. Make sure that the steering wheel is positioned so the rear wheel points directly ahead.
5. Start the engine, and move throttle to full speed (2650 ±50 RPM).
6. Make sure that the hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes.
7. Watch the pressure gauge carefully while turning the steering wheel completely in one direction and holding.

CAUTION

Do not allow pressure to exceed 1500 PSI. Hold steering wheel at full lock only long enough to get a system pressure reading. Holding the steering wheel against the stop for an extended period may damage the steering control valve.

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8. System pressure should reach **65 to 70 Bar (940 to 1015 PSI)** as the relief valve opens.
9. Return the steering wheel to the center position and shut off the engine.
10. If specification is not met, repair or replace steering control valve.
11. Disconnect the T−connector with pressure gauge and reconnect hydraulic hose to gear pump (P2).

Steering/Lift/Sidewinder Circuit Testing − Steering Control Valve and Steering Cylinder Test

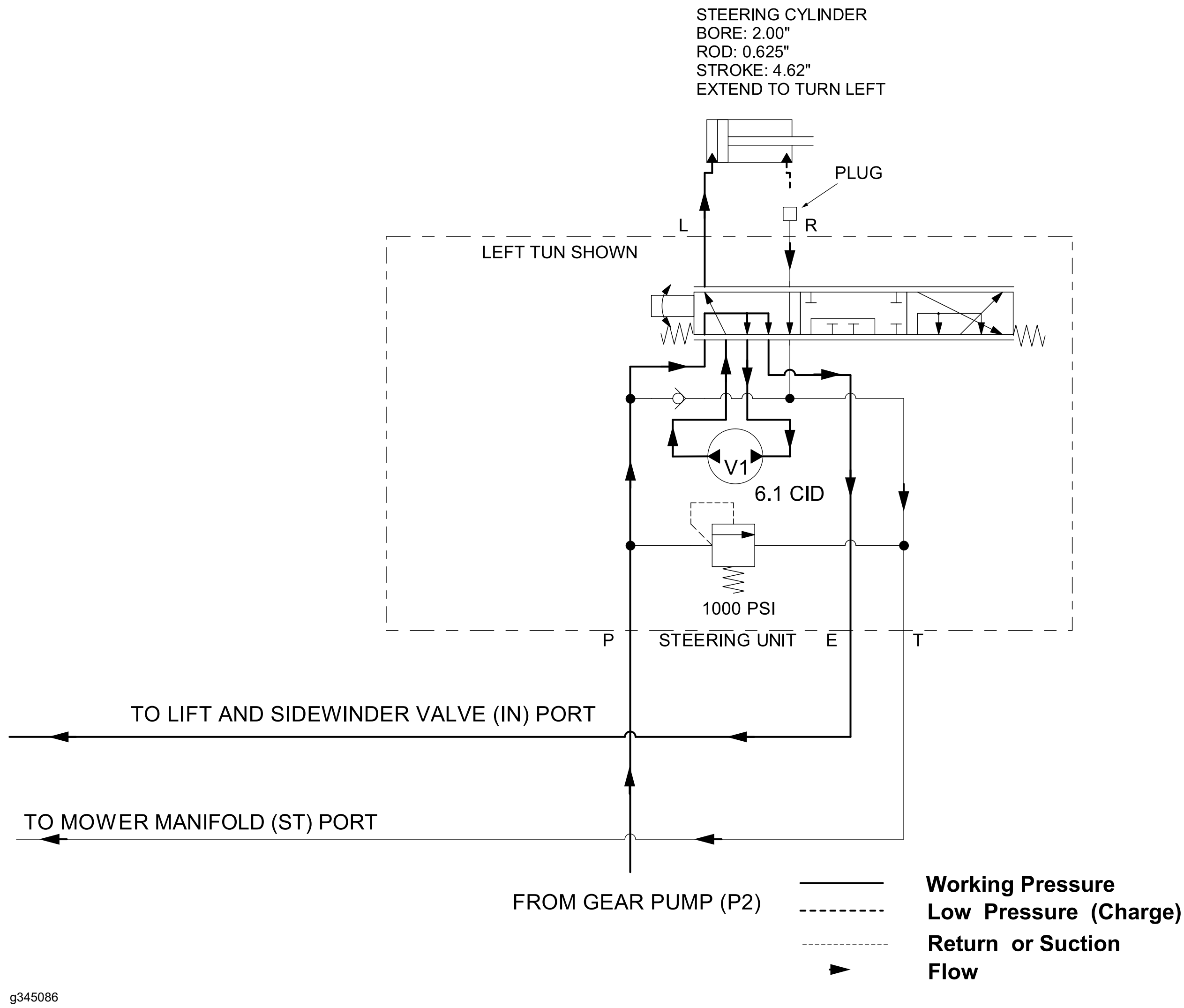

Figure 60

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

1. Make sure that the hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes.
2. Drive the machine slowly in a figure eight on a flat level surface.
   A. There should be no shaking or vibration in the steering wheel or rear wheel.
   B. Steering wheel movements should be followed immediately by a corresponding rear wheel movement without the steering wheel continuing to turn.
3. Stop unit with the engine running. Turn 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.

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

B. When steering wheel is released, steering control should return to the neutral position with no additional turning.

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

   A. Park the machine on a level surface with the cutting units lowered, PTO switch in the disable position, and the parking brake engaged.

   B. With the engine running, turn the steering wheel to the left (counterclockwise) until the steering cylinder rod is fully extended and turn the engine off.

   C. Read Precautions for Hydraulic Testing (page 5–27).

   D. Remove the hydraulic hose from the fitting on the rod end of the steering cylinder. Plug the end of the hose removed.

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

   F. Remove plug from the hydraulic hose and reconnect the hose.

5. If steering problem exists and steering cylinder passed test, perform the Steering/Lift/Sidewinder Circuit Testing − Gear Pump (P2) Flow Test (page 5–55) and Steering/Lift/Sidewinder Circuit Testing − Relief Valve Pressure Test (page 5–58) to make sure that 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 (see Steering Control Valve (page 5–133) and Servicing the Steering Control Valve (page 5–135)).

Service and Repairs

General Precautions for Removing and Installing Hydraulic System Components

Before Repair or Replacement of Hydraulic Components

1. Before removing any parts from the hydraulic system, park machine on a level surface, engage parking brake, lower cutting units and stop engine. Remove key from the key switch.
2. Clean machine before disconnecting, removing or disassembling any hydraulic components. Make sure hydraulic components, hoses connections and fittings are cleaned thoroughly. Always keep in mind the need for cleanliness when working on hydraulic equipment.

CAUTION

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

3. Put caps or plugs on any hydraulic lines, hydraulic fittings and components left open or exposed to prevent system contamination.
4. Put labels on disconnected hydraulic lines and hoses for proper installation after repairs are completed.
5. Record the position of hydraulic fittings (especially elbow fittings) on hydraulic components before removal. Mark parts if necessary to make sure they will be aligned properly when installing hydraulic hoses and tubes.

After Repair or Replacement of Hydraulic Components

1. Check fluid level in the hydraulic tank and add correct fluid if necessary. Drain and refill hydraulic tank and change fluid filter if component failure was severe or system is contaminated (see Flush Hydraulic System (page 5–65)).
2. Lubricate O−rings and seals with clean hydraulic fluid before installing hydraulic components.
3. Make sure caps or plugs are removed from the hydraulic tubes, hydraulic fittings and components before reconnecting.
4. Use proper tightening methods when installing hydraulic hoses and fittings (see Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–8)).
5. After repairs, check control linkages or cables for proper adjustment, binding or broken parts.
6. After disconnecting or replacing any hydraulic components, operate machine functions slowly until air is out of system (see Charge Hydraulic System (page 5–69)).
7. Check for hydraulic fluid leaks. Shut off engine and correct leaks if necessary. Check fluid level in hydraulic tank and add correct fluid if necessary.

Check 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 hydraulic lines and hoses daily for leaks, kinked lines, loose mounting supports, wear, loose fittings or deterioration. Make all necessary repairs before operating the machine.

Priming Hydraulic Pumps

Whenever the hydraulic system is flushed, the hydraulic system is charged or hydraulic components are removed, it is important to properly prime the hydraulic pumps. Hydraulic pump priming ensures that the gear pump and piston (traction) pump have adequate fluid during initial start−up and running. The pumps can be primed by using a remote starter switch (see Special Tools (page 2–13)) to crank engine which allows the pumps to prime.

Use the following procedure to prime the hydraulic pumps:

1. Make sure that key switch is in the OFF position and key is removed from switch.
2. Check hydraulic reservoir fluid level and adjust if necessary.

   Note: It may not be necessary to remove the wire from the starter solenoid B+ terminal when connecting a remote starter switch.

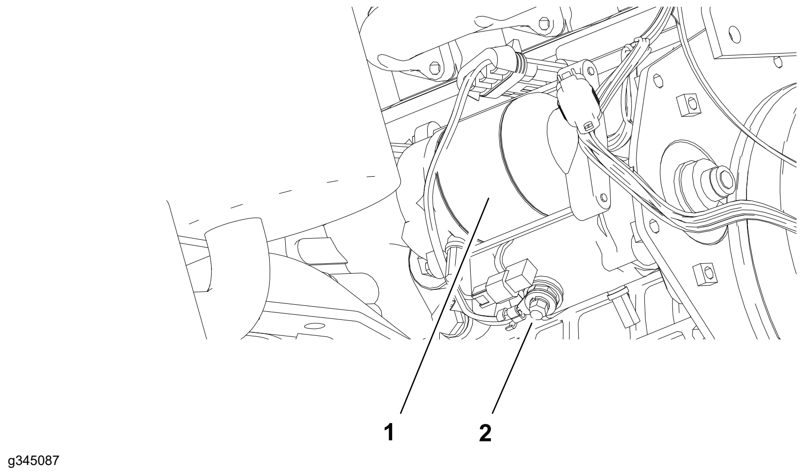

Figure 61

1. Starter motor
2. B+ terminal

3. Connect remote starter switch electrical leads to the starter motor solenoid B+ terminal (Figure 61) and the positive (+) terminal at the starter or battery.
4. Engage remote starter switch and crank starter for thirty (30) seconds to prime hydraulic pumps. Wait thirty (30) seconds to allow the starter motor and starter solenoid to cool. Repeat cranking procedure a second time.
5. Disconnect remote starter switch leads from starter motor solenoid terminal and positive post of the battery.

Flush Hydraulic System

IMPORTANT

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

IMPORTANT

Flush hydraulic system when changing from petroleum base hydraulic fluid to a biodegradable fluid such as Toro Biodegradable Hydraulic Fluid. Operate machine under normal operating conditions for at least four (4) hours before draining.

IMPORTANT

If a component failure occurred in the traction circuit, refer to Traction Circuit (Closed Loop) Component Failure (page 5–3) for information regarding the importance of removing contamination from the traction circuit.

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

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure (page 5–3).

IMPORTANT

Make sure to clean around any hydraulic connections that will be disassembled.

2. Drain hydraulic tank.
3. Drain hydraulic system. Drain all hoses, tubes, and components while the system is warm.
4. Change and replace hydraulic fluid filter.
5. Inspect and clean hydraulic fluid tank (see Hydraulic Tank Inspection (page 5–72)).

IMPORTANT

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

Flush Hydraulic System (continued)

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

   Note: Use only hydraulic fluids specified (see *Traction Unit Operator's Manual*). Other fluids may cause system damage.

7. Fill hydraulic tank with new hydraulic fluid.
8. Prime hydraulic pumps (see Priming Hydraulic Pumps (page 5–64)).
9. Start engine and let it idle at low speed for a minimum of 2 minutes. Increase engine speed to high speed for a minimum of 1 minute under no load.
10. Raise and lower cutting units several times. Turn steering wheel fully left and right several times.
11. Move PTO switch to ENABLE to engage cutting units and let them run for several minutes. Move PTO switch to DISABLE.
12. Shut off engine and check for hydraulic fluid leaks. Check fluid level in hydraulic tank and add correct amount of hydraulic fluid if necessary.
13. Operate the machine for 2 hours under normal operating conditions.
14. Check condition of hydraulic fluid. If the new fluid shows any signs of contamination, repeat steps 1 through 14 again until fluid is clean. If changing to biodegradable fluid, repeat steps 1 through 13 again at least once and until the fluid is clean.
15. Assume normal operation and follow recommended maintenance intervals.

Filtering 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 a requirement to prevent debris from transmitting throughout the system. If a closed−loop hydraulic system filtering tool is not used (to ensure system cleanliness) repeat failures and subsequent damage to other hydraulic components in the system will occur. To effectively remove contamination from closed−loop traction circuit, use of the Toro high flow hydraulic filter and hydraulic hose kit are recommended (see Special Tools (page 2–13)).

1. Park machine on a level surface, stop engine and remove key from key switch.

WARNING

Before jacking up the machine, review and follow Jacking Instructions (page 1–7).

2. Raise and support machine so all wheels are off the ground.

   Note: If a wheel motor was replaced, install high flow filter to the inlet (when traveling forward) of new wheel motor instead of to the inlet (when traveling forward) of the traction pump. This will prevent system contamination from entering and damaging the new motor.

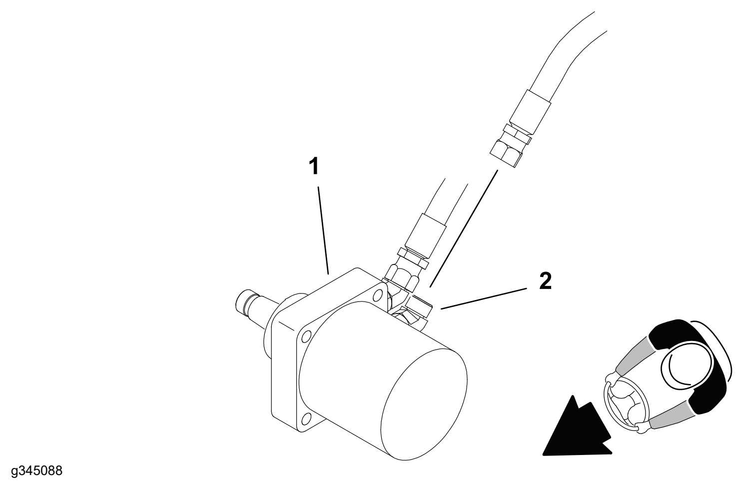

Figure 62

1. Rear wheel motor
2. Lower fitting

3. Thoroughly clean junction of hydraulic hose and lower fitting on rear wheel motor (Figure 62). Disconnect hose from lower fitting on wheel motor.
4. Connect Toro high flow hydraulic filter in series between wheel motor fitting and disconnected hose. Use hydraulic hose kit (see Special Tools (page 2–13)) to connect filter to machine. Make sure that fitting and hose connections are properly tightened.

IMPORTANT

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

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

Filtering Closed−Loop Traction Circuit (continued)

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

IMPORTANT

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

---

7. With engine running at low idle speed, slowly depress the forward traction pedal to the full forward position to allow flow through the traction circuit and high flow filter. Keep traction circuit engaged for five (5) minutes while gradually increasing both forward pressure on traction pedal and engine speed. Monitor filter indicator to make sure that green color is showing during operation.
8. With engine running at high idle speed and traction pedal moved to the forward direction, periodically apply brakes to increase pressure in traction circuit. While monitoring filter indicator, continue this process for an additional five (5) minutes.

IMPORTANT

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

---

9. With engine running at high idle speed, alternately move traction pedal from forward to reverse. While monitoring filter indicator, continue this process for an additional five (5) minutes.
10. Shut engine off and remove key from key switch.
11. Remove high flow hydraulic filter and hydraulic hose kit from machine. Reconnect hydraulic hose to rear wheel motor fitting. Make sure to properly tighten hose (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal Fittings) (page 5–6)).
12. Lower machine to ground.
13. Check fluid level in hydraulic reservoir and add correct fluid if necessary.

Charge Hydraulic System

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

IMPORTANT

Change hydraulic fluid filter whenever hydraulic components are repaired or replaced.

1. Park machine on a level surface. Lower cutting units, disengage PTO switch. stop engine, and engage parking brake. Remove key from the key switch.
2. Make sure all hydraulic connections, lines, and components are secured tightly.
3. If component failure was severe or the system is contaminated, flush and refill hydraulic system and tank (see Flush Hydraulic System (page 5–65)).
4. Make sure hydraulic tank is full. Add correct hydraulic fluid if necessary.
5. Prime hydraulic pumps (see Priming Hydraulic Pumps (page 5–64)).

⚠ WARNING ⚠

Before jacking up the machine, review and follow Jacking Instructions (page 1–7).

6. Raise all 3 wheels off the floor and safely support the traction unit.

IMPORTANT

During initial operation, check hydraulic reservoir fluid level frequently and add fluid as necessary.

7. Make sure traction pedal is in neutral. Sit in the operator’s seat and start engine and let it idle at low speed. The hydraulic pumps should pick up hydraulic fluid and fill the hydraulic system. If there is no indication of fill in 30 seconds, stop the engine and determine the cause.
8. After the hydraulic system starts to show signs of fill, actuate lift control switch until the lift cylinders move in and out several times. If the cylinders do not move after 15 seconds or the pump emits abnormal sounds, shut the engine off immediately and determine cause or problem. Inspect for the following:
    A. Loose filter or suction lines.
    B. Incorrect hydraulic hose routing.
    C. Blocked suction line.
    D. Faulty charge relief valve in traction pump.
    E. Faulty gear pump.
9. Operate the traction pedal in the forward and reverse directions. The wheels should rotate in the proper direction. If the wheels rotate in the wrong direction, stop engine, remove lines from rear of hydrostat pump, and reverse the connections.
10. Make sure that traction pedal returns to the neutral position when released from the forward or reverse direction.

Charge Hydraulic System (continued)

11. Check operation of the traction interlock switches (see Check Operation of Interlock Switches (page 6–4)).
12. Stop the engine and lower machine.
13. If the traction (traction) pump or a wheel motor was replaced or rebuilt, run the traction unit so all wheels turn slowly for 10 minutes.
14. Operate traction unit by gradually increasing its work load to full over a 10 minute period.
15. Stop the machine. Check hydraulic tank and fill if necessary. Check hydraulic components for leaks and tighten any loose connections.

Hydraulic Tank and Hydraulic Fluid Filter

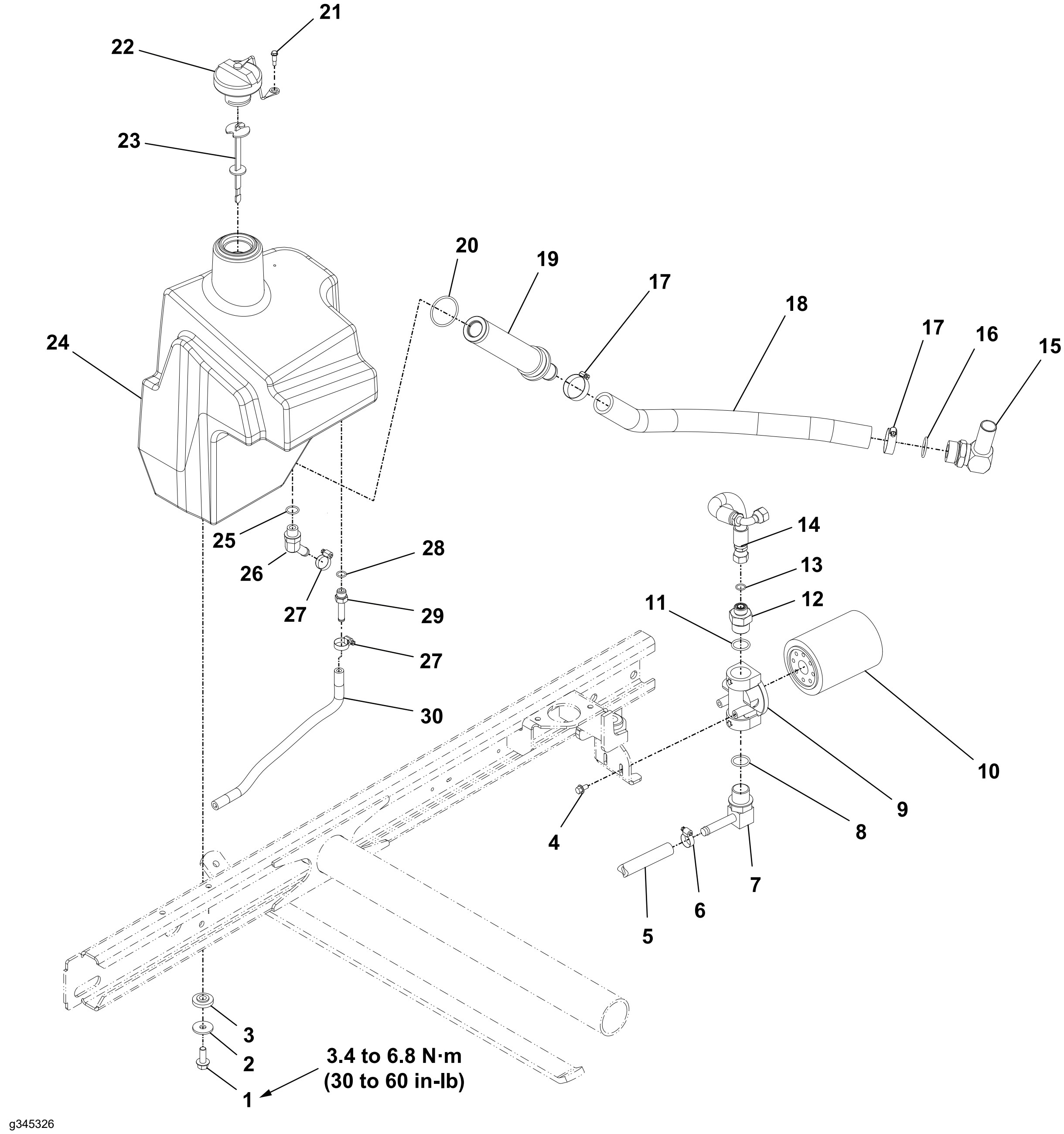

Figure 63

1. Flange head bolt (4 each)
2. Flat washer (4 each)
3. Grommet (4 each)
4. Flange head bolt (2 each)
5. Hose
6. Hose clamp
7. Barb fitting
8. O-ring
9. Filter head
10. Oil filter element
11. O-ring
12. Hydraulic fitting
13. O-ring
14. Hydraulic tube
15. Barb fitting
16. O-ring
17. Hose clamp (2 each)
18. Suction hose
19. Suction strainer
20. O-ring
21. Shoulder screw
22. Hydraulic tank cap
23. Dipstick
24. Hydraulic tank
25. O-ring
26. Barb fitting
27. Clamp
28. O-ring
29. Hydraulic fitting
30. Hose

Removing the Hydraulic Tank (Figure 63)

1. Park the machine on a level surface. Lower cutting units, stop engine and engage parking brake. Remove key from the key switch.
2. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–62).
3. To prevent contamination of hydraulic system during hydraulic tank removal, thoroughly clean exterior of tank.
4. To allow draining of hydraulic tank, disconnect the suction hose from the tank strainer in the bottom of the tank. Drain tank into a suitable container.
5. Disconnect hydraulic lines from tank and put caps or plugs on open hydraulic lines and fittings. Label disconnected hydraulic lines for proper assembly.
6. Remove tank strainer from hydraulic tank. Discard O−ring from strainer.
7. Remove four (4) flange head bolts, flat washers and grommets that secure hydraulic tank to machine. Remove hydraulic tank from machine.
8. If fittings are to be removed from tank, mark fitting orientation to allow correct assembly. Remove the fittings from tank and discard O−rings from fittings.

Hydraulic Tank Inspection

1. Clean the hydraulic tank and suction strainer with solvent.
2. Inspect the hydraulic tank for leaks, cracks or other damage.

Installing the Hydraulic Tank (Figure 63)

1. If the fittings were removed from hydraulic tank, lubricate and place new O−rings onto fittings. Install fittings into tank openings using marks made during the removal process to properly orientate fittings. Tighten fittings (see Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–8).
2. Position hydraulic tank to machine. Apply anti−seize lubricant or equivalent to the four (4) flange head bolts that secure the hydraulic tank. Secure the tank to frame with flange head bolts, flat washers and grommets. Torque the bolts from **3.4 to 6.8 N·m (30 to 60 in−lb)**.
3. Lubricate and install the new O−ring on suction strainer.
4. Thread suction strainer into hydraulic tank. Using a wrench, turn suction strainer into tank port at least 1−1/2 to 2 full turns beyond finger tight.
5. Remove caps and plugs from fittings and hydraulic lines. Properly connect hydraulic lines to hydraulic tank (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal Fittings) (page 5–6)).
6. Fill hydraulic tank with new hydraulic fluid.
7. Operate machine. Check hydraulic fluid level and adjust if necessary. Check hydraulic components for leaks. Tighten any loose connections.

Radiator and Oil Cooler Assembly

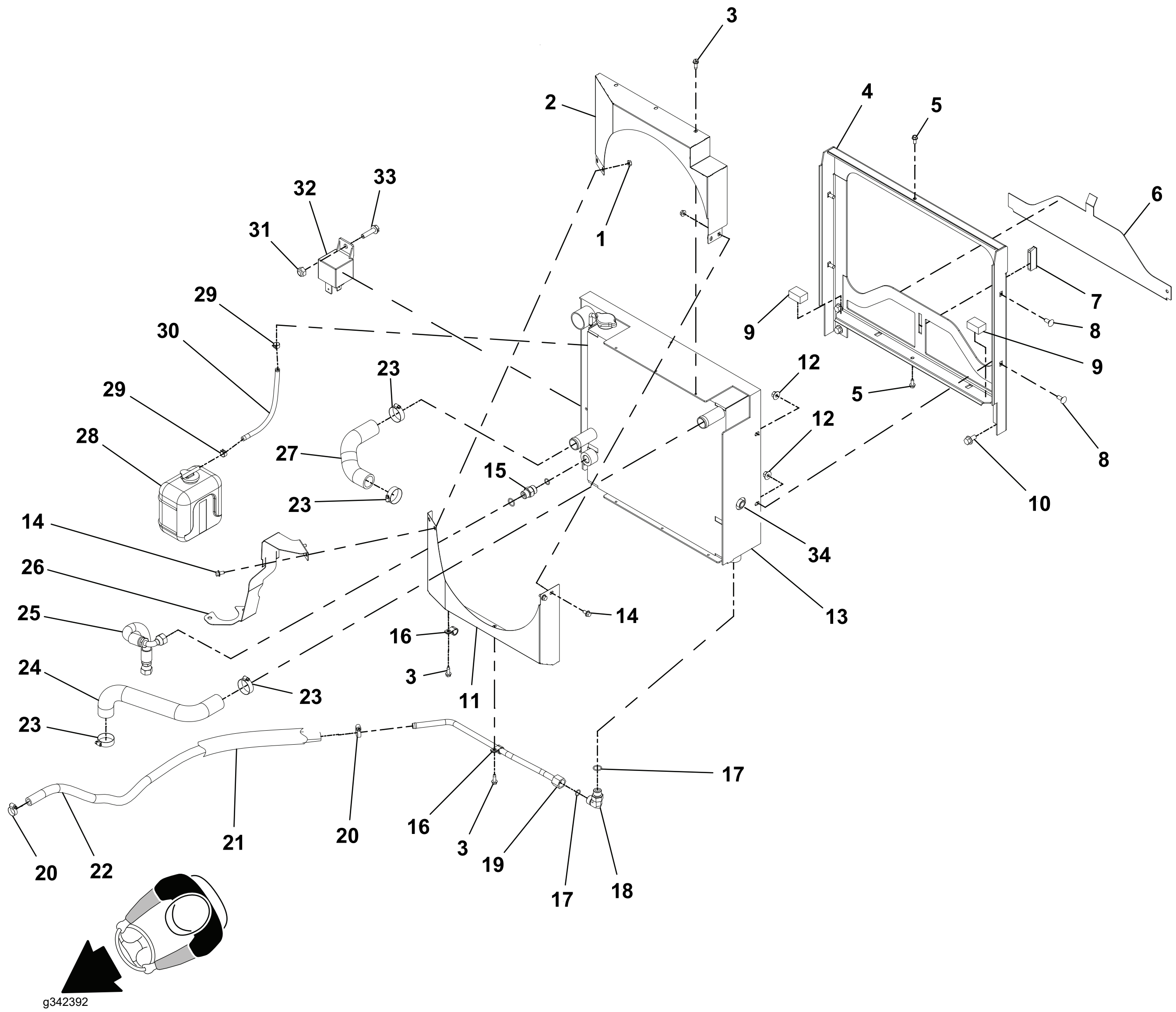

Figure 64

1. Flange head nut (4 each)
2. Top fan shroud
3. Flange head bolts (6 each)
4. Radiator frame assembly
5. Bolt (2 each)
6. Lower radiator shield
7. Magnet
8. Carriage bolt (4 each)
9. Radiator seal (2 each)
10. Flange head bolt (4 each)
11. Bottom fan shroud
12. Flange nut (4 each)
13. Radiator cooler
14. Flange head bolt (4 each)
15. Fitting
16. R clamp (2 each)
17. O-ring (2 each)
18. Elbow fitting
19. Hydraulic tube
20. Hose clamp (2 each)
21. Protective sleeve
22. Hose
23. Hose clamp (4 each)
24. Upper radiator hose
25. Hydraulic hose assembly
26. Reservoir mounting bracket
27. Lower radiator hose
28. Overflow bottle
29. Hose clamp (2 each)
30. Hose
31. Nut
32. Relay
33. Bolt
34. Drain plug

Note: The hydraulic oil cooler on your Reelmaster is combined with the radiator. See Radiator and Oil Cooler Assembly (page 4–11) for information on removal and installation of the radiator/oil cooler assembly.

Hydraulic Pump Assembly

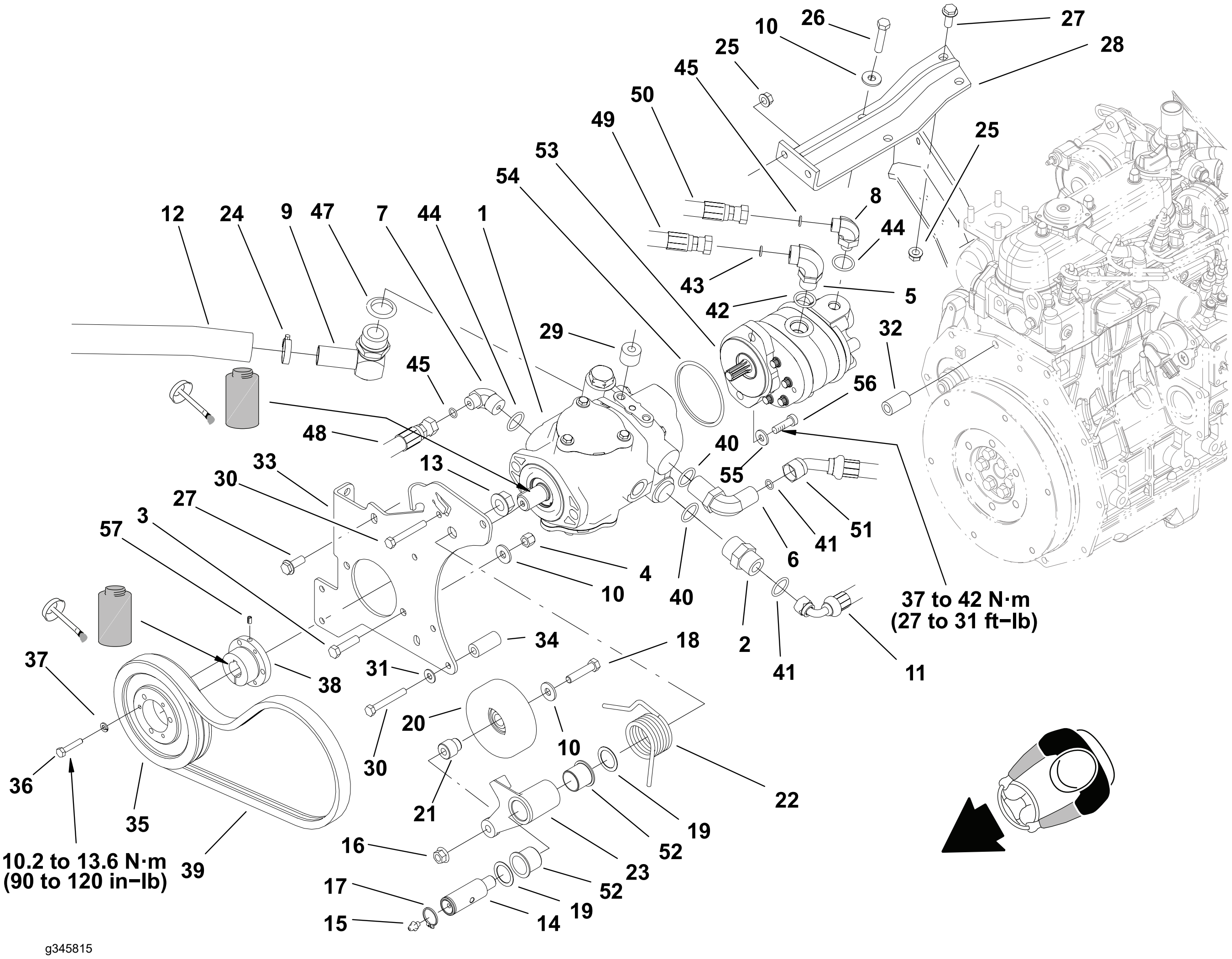

Figure 65

1. Piston pump
2. Straight hydraulic fitting
3. Cap screw
4. Lock nut
5. 90º hydraulic fitting
6. 90º hydraulic fitting
7. 90º hydraulic fitting
8. 90º hydraulic fitting
9. 90º hydraulic fitting
10. Washer
11. Hydraulic hose
12. Suction hose
13. Flange nut
14. Idler pivot pin
15. Grease fitting
16. Flange nut
17. Retaining ring
18. Cap screw
19. Thrust washer
20. Idler pulley
21. Spacer
22. Torsion spring
23. Idler arm
24. Hose clamp
25. Flange nut
26. Cap screw
27. Flange head screw
28. Pump support
29. Spacer
30. Cap screw
31. Flat washer
32. Spacer
33. Pump mount plate
34. Pump mount spacer
35. Pulley
36. Cap screw
37. Lock washer
38. Taper lock bushing
39. V−belt
40. O−ring
41. O−ring
42. O−ring
43. O−ring
44. O−ring
45. O−ring
46. O−ring
47. O−ring
48. Hydraulic hose
49. Hydraulic hose
50. Hydraulic hose
51. Hydraulic hose
52. Bushing
53. Gear pump
54. O−ring
55. Flat washer
56. Socket head screw
57. Set screw

Removing the Drive Belt (Figure 65)

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

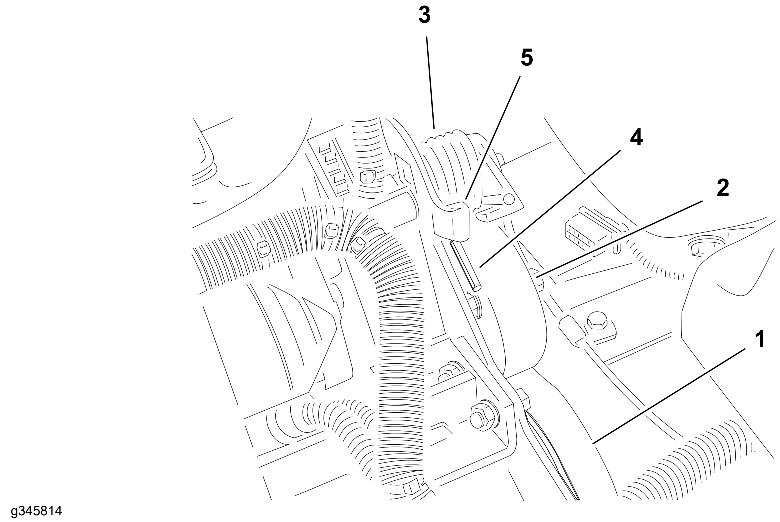

Figure 66

1. Pump drive belt
2. Idler pulley
3. Torsion spring
4. Spring end
5. Pump mount plate tab

CAUTION

The torsion spring that tensions the idler assembly is under tension and may cause personal injury during removal. Use caution when removing spring end from the pump mount plate.

3. Remove pump drive belt tension from torsion spring on idler arm (Figure 66).
   A. Insert nut driver or small piece of pipe onto the end of the torsion spring that is secured on the pump mount plate tab.
   B. Push down and forward on the spring end to unhook the spring from the tab on the pump mount plate.
4. Rotate idler pulley away from pump drive belt and remove drive belt from pulleys. Make sure that drive belt is in good condition if it is to be re−installed. Replace drive belt if worn or damaged.
5. Remove drive belt idler components as needed.

Installing the Drive Belt (Figure 65)

1. Install all removed drive belt idler components. Make sure that the idler pulley and idler arm rotate freely after assembly.
2. Install drive belt onto pulleys. Position idler pulley toward the pump drive belt.
3. Using a straight edge across the lower face of the pump pulley, verify pump drive belt alignment across engine and pump pulleys. If pulleys are not in alignment, adjust location of pump pulley on pump shaft so alignment is correct (see Piston Pump/Hydrostat (page 5–79)).

Installing the Drive Belt (Figure 65) (continued)

CAUTION

Use caution when installing torsion spring end onto the pump mount plate. Applying tension to the spring may cause personal injury during installation.

4. Apply pump drive belt tension with torsion spring on idler arm (Figure 66).
   A. Insert nut driver or small piece of pipe onto the end of the torsion spring.
   B. Push down on the spring end and then hook the spring under the tab on the pump mount plate.
5. Lubricate the grease fitting on end of idler pivot shaft.
6. Lower and secure hood.

Removing the Neutral Arm

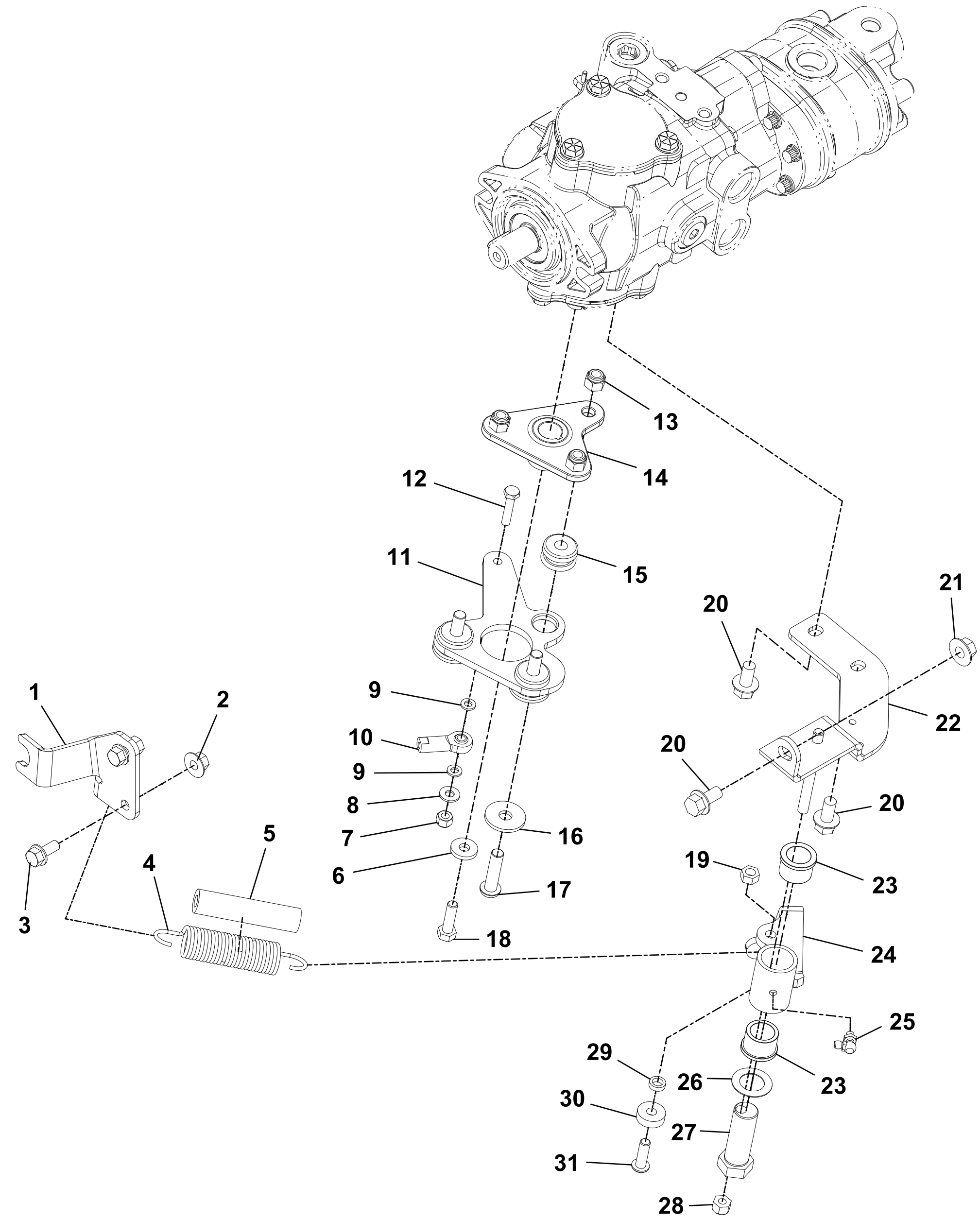

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Figure 67

1. Cable support bracket
2. Flange nut
3. Flange head bolt
4. Extension spring
5. Hose
6. Flat washer
7. Lock nut
8. Flat washer
9. Flat washer
10. Ball joint
11. Pump lever
12. Cap screw
13. Lock nut
14. Hub assembly
15. Mount
16. Flat washer
17. Screw
18. Cap screw
19. Nut
20. Flange head bolt
21. Flange nut
22. Neutral bracket
23. Flange bushing
24. Neutral arm
25. 90º grease fitting
26. Thrust washer
27. Traction stud
28. Lock nut
29. Spacer
30. Ball bearing
31. Screw

Removing the Neutral Arm (continued)

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

CAUTION

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

3. Remove extension spring from the cable support bracket and neutral arm.
4. Disconnect traction control cable from the pump lever. Locate and retrieve three (3) flat washers and record their position for assembly purposes.
5. Remove both flange head bolts securing the neutral bracket to the piston pump. Remove flange nut and flange head bolt securing the neutral bracket to the pump mount plate.
6. Remove cap screw and flat washer that secure the pump lever and hub assembly to the piston pump trunnion.
7. Separate pump lever and hub assembly from pump trunnion and neutral bracket from mount plate. Locate and retrieve key from trunnion.

Installing the Neutral Arm

1. Install key into trunnion slot. Position neutral bracket to the mount plate and the pump lever and hub assembly to the pump trunnion.
2. Secure pump lever and hub assembly to the piston pump trunnion with flat washer and cap screw.
3. Secure neutral bracket to the pump mount plate with flange head bolt and flange nut. Secure neutral bracket to the piston pump with both flange head bolts.
4. Position three (3) flat washers to traction control cable end. Secure traction control cable to the pump lever with cap screw and lock nut.

CAUTION

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

5. Install extension spring to the cable support bracket and neutral arm.
6. Adjust the traction drive for neutral; refer to *Operator's Manual*.
7. Lower and secure the hood.

Piston Pump/Hydrostat

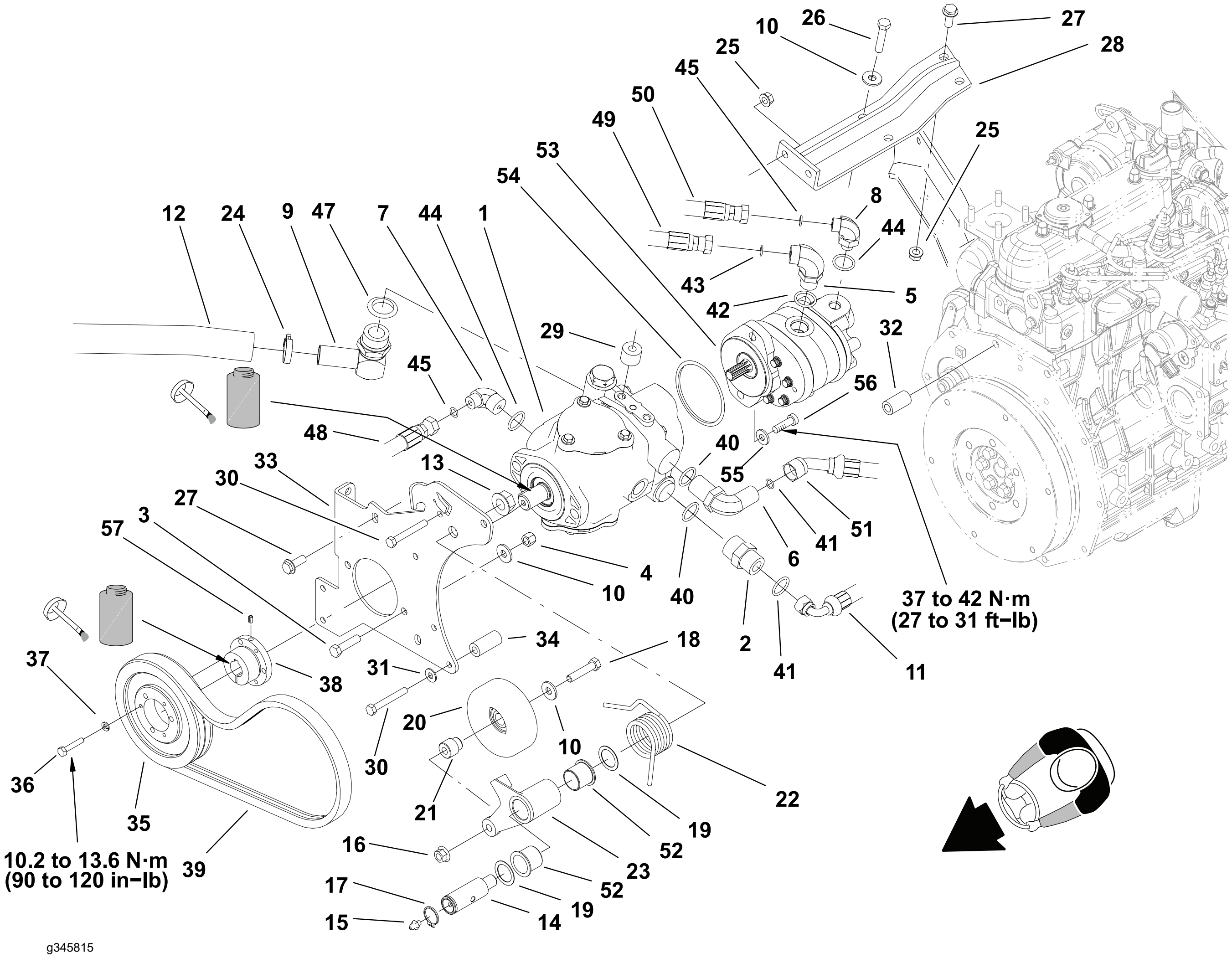

Figure 68

1. Piston pump
2. Straight hydraulic fitting
3. Cap screw
4. Lock nut
5. 90º hydraulic fitting
6. 90º hydraulic fitting
7. 90º hydraulic fitting
8. 90º hydraulic fitting
9. 90º hydraulic fitting
10. Washer
11. Hydraulic hose
12. Suction hose
13. Flange nut
14. Idler pivot pin
15. Grease fitting
16. Flange nut
17. Retaining ring
18. Cap screw
19. Thrust washer
20. Idler pulley
21. Spacer
22. Torsion spring
23. Idler arm
24. Hose clamp
25. Flange nut
26. Flange head screw
27. Flange head screw
28. Pump support
29. Spacer
30. Cap screw
31. Flat washer
32. Spacer
33. Pump mount plate
34. Pump mount spacer
35. Pulley
36. Cap screw
37. Lock washer
38. Taper lock bushing
39. V−belt
40. O−ring
41. O−ring
42. O−ring
43. O−ring
44. O−ring
45. O−ring
46. O−ring
47. O−ring
48. Hydraulic hose
49. Hydraulic hose
50. Hydraulic hose
51. Hydraulic hose
52. Bushing
53. Gear pump
54. O−ring
55. Flat washer
56. Socket head screw
57. Set screw

Removing the Piston Pump/Hydrostat

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

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure (page 5–3).

3. Remove pump drive belt (see Removing the Drive Belt (Figure 65) (page 5–75)).
4. Remove neutral arm assembly (see Removing the Neutral Arm (page 5–77)).
5. Thoroughly clean the hydraulic hose ends and fittings on piston pump/hydrostat and gear pumps to prevent hydraulic system contamination.
6. Disconnect the suction hose from the barbed fitting on the bottom of the gear pump and drain hydraulic tank into a suitable container.
7. Label all hydraulic hoses and fittings for assembly purposes.
8. Disconnect all hydraulic hoses connected to the hydraulic fittings on the piston pump/hydrostat and gear pump. Allow hoses to drain into a suitable container. Plug hose and fitting openings to prevent contamination.

CAUTION

Support pump assembly during removal to prevent them from falling and causing personal injury or component damage.

9. Support hydraulic pump assembly to prevent it from shifting.
10. Remove both flange head screws and flange nuts that secure pump support to engine mount.
11. Remove fasteners and spacers securing the pump mount plate to the engine (Figure 68). Record location of cap screws, washers and spacers for assembly purposes.
12. Carefully remove pump mount plate with pumps, pulley, pump support and idler assembly from the machine.

    Note: A case drain exists in the piston pump/hydrostat and a suction port is near the input shaft of the gear pump (Figure 69). When the gear pump is removed from the piston pump/hydrostat, plug both case drain holes to prevent draining the pumps.

Removing the Piston Pump/Hydrostat (continued)

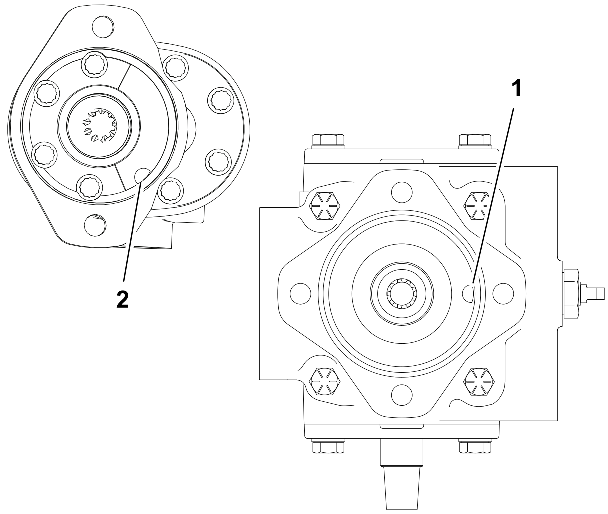

Figure 69

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

13. Remove both socket head screws and flat washers securing gear pump to the piston pump. Separate gear pump from the piston pump. Locate and retrieve O−ring. Plug openings of gear pump to prevent contamination.
14. Remove pump pulley from the taper lock bushing on the piston pump shaft:
    A. Remove three (3) cap screws and lock washers securing pulley to the taper lock bushing.

IMPORTANT

Excessive or unequal pressure on the cap screws can break the bushing flange.

    B. Insert cap screws into threaded removal holes of the pulley. Tighten screws progressively and evenly until the pulley is loose on the bushing. Remove pulley from the bushing.
15. Loosen set screw that secures taper lock bushing to piston pump shaft. Remove bushing from the pump shaft. Locate and retrieve key from pump shaft.
16. Remove both cap screws and washers that secure piston pump to pump support. Locate and retrieve spacers.
17. Remove lock nuts, flat washers and cap screws that secure the piston pump to the pump mount plate. Remove pump from plate.
18. If hydraulic fittings are to be removed from piston pump, mark fitting orientation to allow correct assembly. Remove hydraulic fittings and O−rings from the piston pump as needed. Discard removed O−rings.

Installing the Piston Pump/Hydrostat

1. Position and secure piston pump to the pump mount plate with cap screws, flat washers and lock nuts.
2. Lubricate and place new O−rings onto all removed pump fittings. Install fittings into pump openings using marks made during the removal process to properly orientate fittings. Tighten fittings (see Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–8)).

Installing the Piston Pump/Hydrostat (continued)

IMPORTANT

A case drain exists in the piston pump/hydrostat and a suction port is near the input shaft of the gear pump (Figure 69). Before the gear pump is installed to the piston pump, make sure that plugs placed in either of these ports are removed. Failure to remove plugs will cause excessive pressure in the piston pump and damage seals. Also, before installing gear pump to piston pump, fill piston pump housing with clean hydraulic fluid through case drain hole.

3. Install and secure gear pump to the piston pump (see Gear Pump (page 5–88)).
4. Place key into piston pump shaft slot. Slide taper lock bushing onto the piston pump shaft with bushing flange toward pump housing.
5. Make sure that tapered surfaces of pump pulley and taper lock bushing are thoroughly clean (no oil, grease, dirt, rust, etc.).
6. Position pump pulley to taper lock bushing and align non−threaded holes of pulley with threaded holes of bushing. Loosely install three (3) cap screws with lock washers to bushing and pulley.

⚠ CAUTION ⚠

Support pump assembly during installation to prevent them from falling and causing personal injury or component damage.

7. Position pump assembly to the machine. Install fasteners and spacers securing the pump mount plate to the engine and pump support (Figure 68). Tighten fasteners securely.
8. Position and secure pump support to pump mount plate, piston pump and engine mount with removed fasteners and spacers.
9. Install pump drive belt (see Installing the Drive Belt (Figure 65) (page 5–75)).
10. Using a straight edge across the lower face of the pump pulley, verify pump drive belt alignment across engine and pump pulleys. Slide pulley and taper lock bushing on pump shaft so that drive belt and straight edge are aligned indicating correct position of pump pulley. Secure taper lock bushing in position with set screw.

IMPORTANT

When tightening taper lock bushing cap screws, tighten in three (3) equal steps and in a circular pattern.

11. Secure taper lock bushing and pump pulley by tightening three (3) cap screws to a torque from **10.2 to 13.6 N·m (90 to 120 in−lb)** in three (3) equal steps and in a circular pattern.
12. Check that pump drive belt alignment is still correct. If needed, loosen and re−adjust pulley and taper lock bushing location on pump shaft to allow for correct belt alignment.

13. Remove caps and plugs from all fittings and hydraulic hoses. Using labels placed during pump removal, properly connect hydraulic lines to pump assembly (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal Fittings) (page 5–6)).
14. Install neutral arm assembly to the piston pump (see Installing the Neutral Arm (page 5–78)).
15. Fill hydraulic tank with new hydraulic fluid.
16. Properly charge hydraulic system (see Charge Hydraulic System (page 5–69)).
17. Adjust the traction drive for neutral; refer to *Operator's Manual*.
18. Lower and secure hood.

Piston Pump/Hydrostat Service

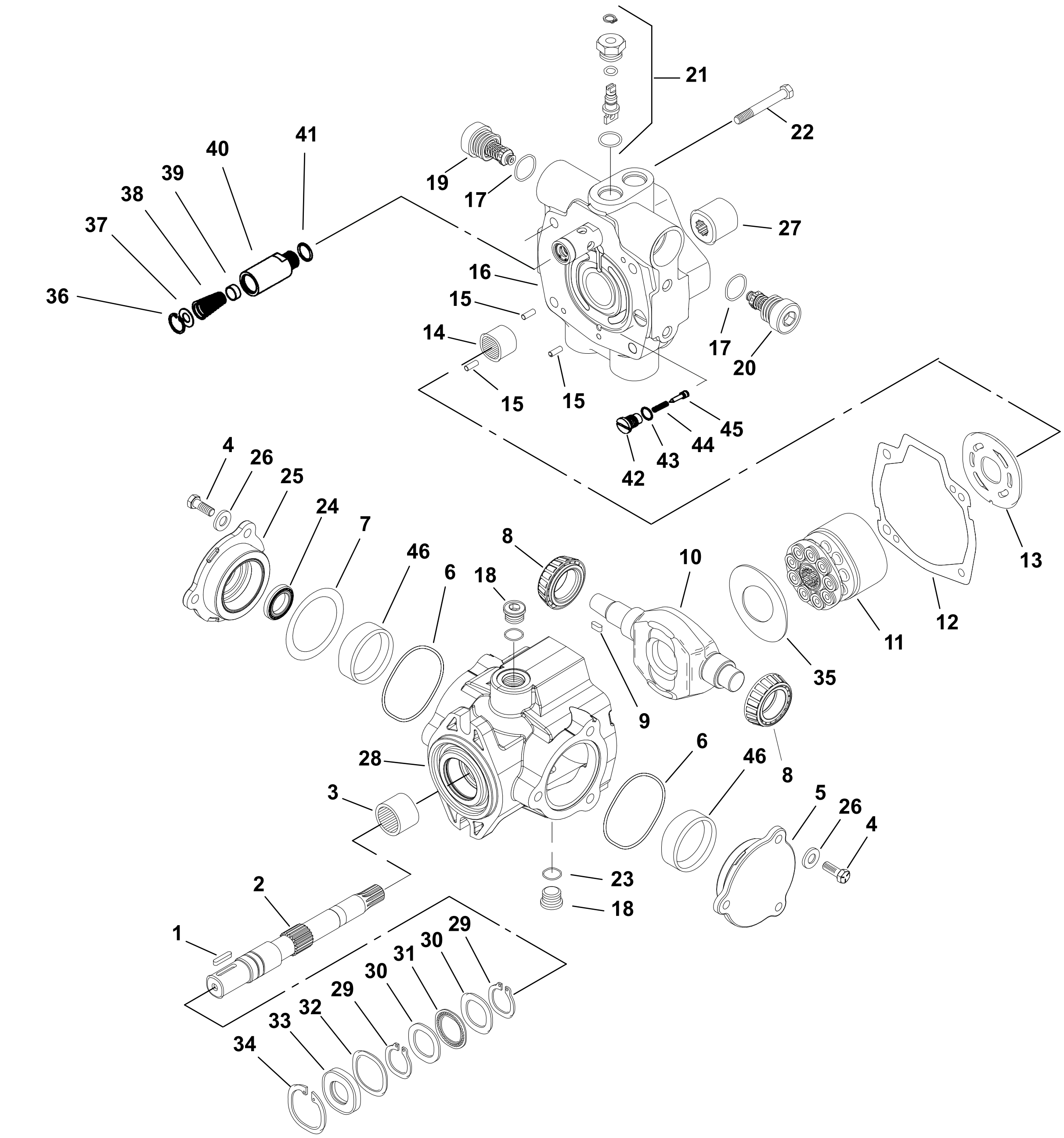

Figure 70

Figure 70 (continued)

1. Key
2. Drive shaft
3. Bearing
4. Cap screw (3 used per plate)
5. Cover plate
6. O–ring
7. Shim kit
8. Bearing cone
9. Key
10. Swashplate
11. Rotating kit
12. Gasket
13. Valve plate
14. Bearing
15. Dowel pin
16. Back plate
17. O–ring
18. Plug
19. Relief valve asm.
20. Check valve asm.
21. Bypass valve asm.
22. Cap screw
23. O–ring
24. Shaft seal
25. Cover plate
26. Washer (3 per plate)
27. Coupler
28. Housing
29. Retaining ring
30. Thrust washer
31. Thrust bearing
32. Washer
33. Shaft seal
34. Retaining ring
35. Cam plate insert
36. Retaining ring
37. Washer
38. Charge relief spring
39. Charge relief poppet
40. Charge relief housing
41. O–ring
42. Cartridge
43. O–ring
44. Bleed−off spring
45. Bleed−off valve poppet
46. Bearing cup

IMPORTANT

If a piston pump failure occurred, refer to Traction Circuit (Closed Loop) Component Failure (page 5–3) for information regarding the importance of removing contamination from the traction circuit.

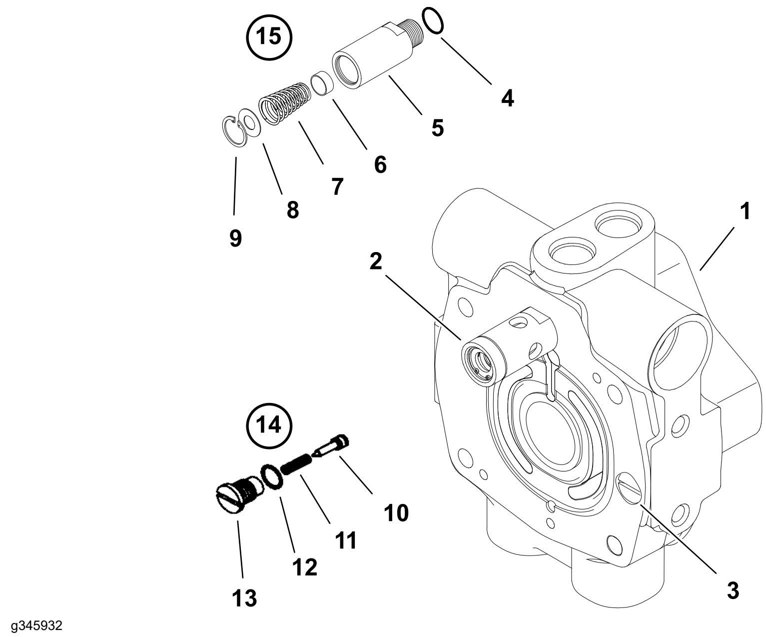

Figure 71

1. Back plate assembly
2. Charge relief valve
3. Bleed off valve
4. O−ring
5. Housing
6. Poppet
7. Spring
8. Washer
9. Retaining ring
10. Bleed off valve
11. Spring
12. O−ring
13. Cartridge
14. Bleed-off valve
15. Charge relief valve

Note: The traction circuit charge relief valve and the bleed off valve for traction circuit cooling are attached to the piston pump back plate assembly (Figure 71). The back plate assembly must be removed from the piston pump/hydrostat to service either the relief valve or the bleed off valve.

IMPORTANT

The shim kit is used to replace the original crush ring (not shown) in the cover plate. If the swash plate, cover plate or housing is replaced during servicing, the old crush ring must be replaced. See Piston Pump/Hydrostat Crush Ring Replacement (page 5–87) in conjunction with the Eaton service manual for additional information.

Note: For repair of the piston pump, see the Eaton service manual for Repair Information Model 70160 Variable Displacement Piston Pump.

Piston Pump/Hydrostat Crush Ring Replacement

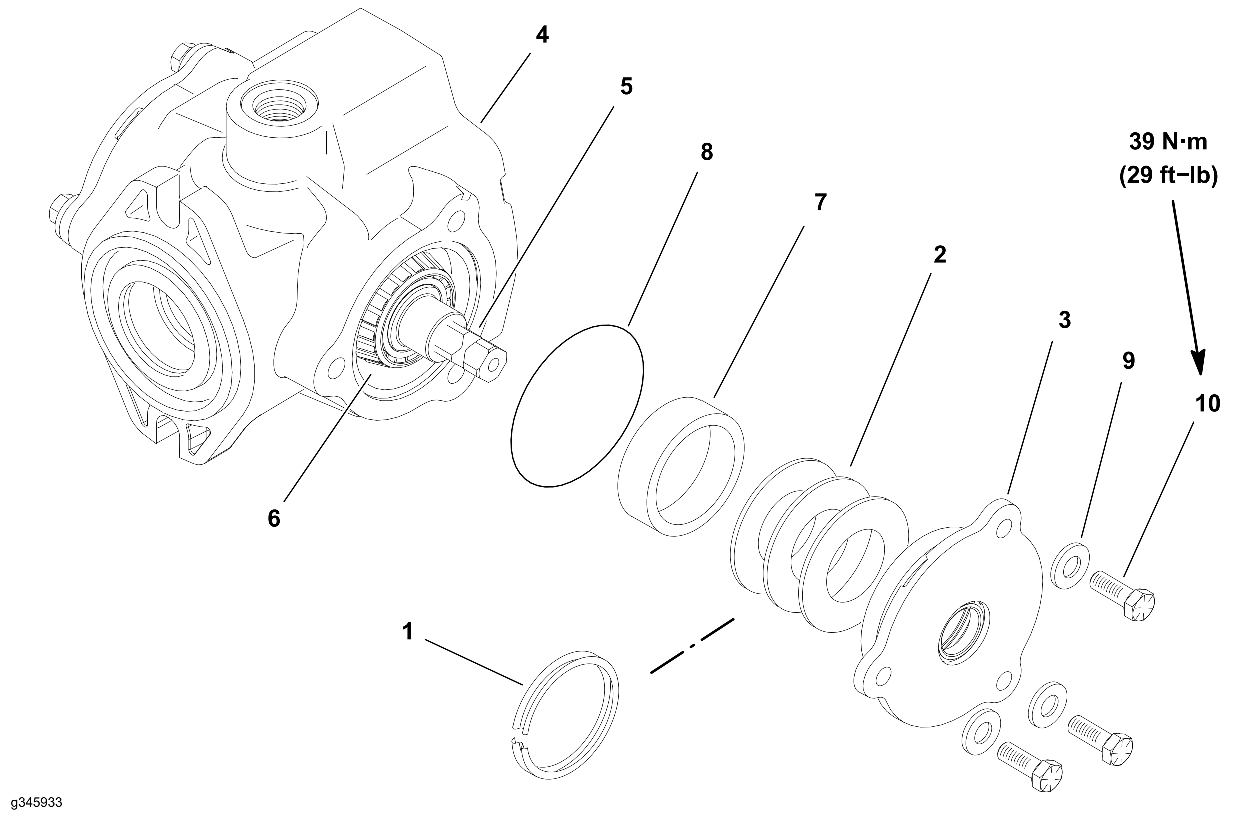

Figure 72

1. Crush ring
2. Shims
3. Cover plate
4. Housing
5. Camplate (control shaft)
6. Bearing cone
7. Bearing cup
8. O−ring
9. Washer (3)
10. Cap screw (3)

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

1. Remove the crush ring from the cover plate. Measure thickness of crush ring.
2. Stack shims to the thickness of the crush ring.
3. Insert shims into the cover plate in the same location that the crush ring was removed from.
4. Assemble housing sub assembly consisting of the housing, camplate, bearing cone, bearing cup and cover plate (see Eaton service manual for Repair Information, Model 70160 Variable Displacement Piston Pump).
5. Install the washers and cap screws to the cover plate and housing. Torque cap screws to **39 N·m (29 ft−lbs)**.
6. Check torque required to rotate control shaft. Torque should be from **1.7 to 2.8 N·m (15 to 25 in−lbs)**.
   A. If torque is too low, add additional shims and repeat steps 3 through 6 until the specified torque is achieved.
   B. If torque is too high, remove shims and repeat steps 3 through 6 until the specified torque is achieved.
7. Complete assembly of the pump (see Eaton service manual for Repair Information, Model 70160 Variable Displacement Piston Pump).

Gear Pump

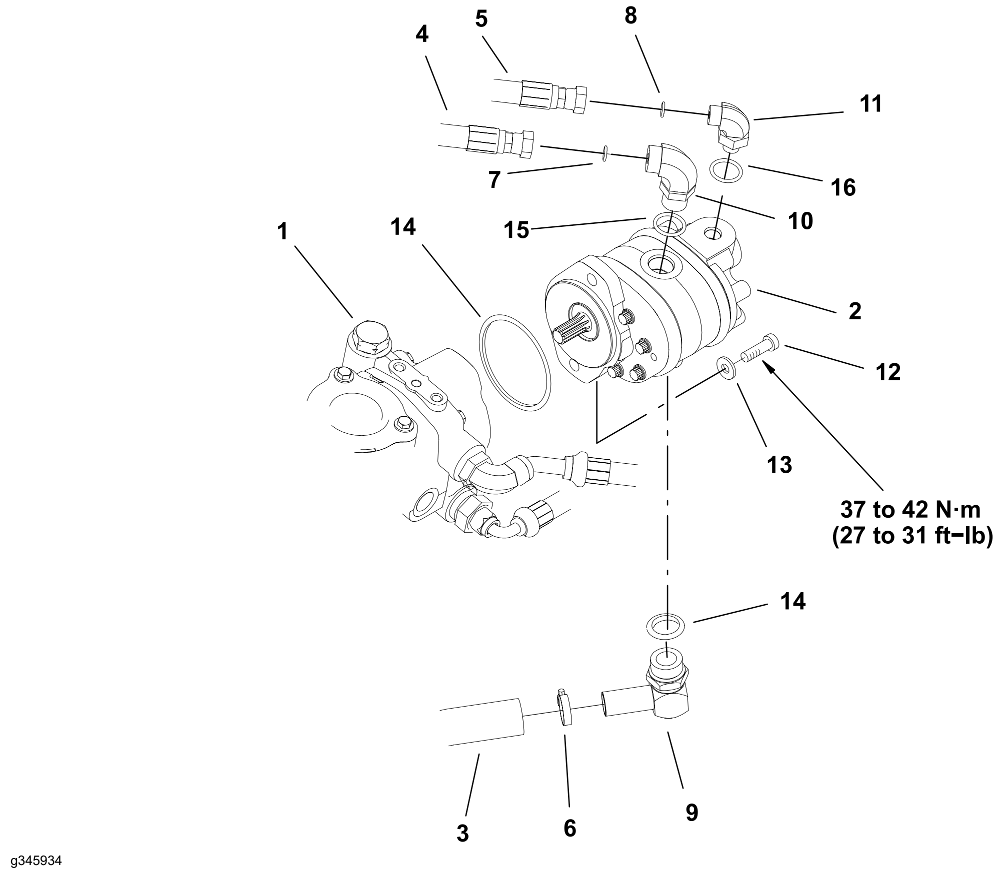

Figure 73

1.	Piston pump	7.	O–ring	13.	Flat washer
2.	Gear pump	8.	O–ring	14.	O–ring
3.	Hydraulic hose (tank suction)	9.	Hydraulic barb fitting	15.	O–ring
4.	Hydraulic hose (hydraulic manifold)	10.	90° hydraulic fitting	16.	O–ring
5.	Hydraulic hose (steering valve)	11.	90° hydraulic fitting		
6.	Hose clamp	12.	Cap screw		

Removing the Gear Pump

1. Park the machine on a level surface. Lower cutting units, stop engine and engage parking brake. Remove key from the key switch. Raise and support hood.
2. Remove muffler from the engine to gain access to the gear pump (see Removing the Exhaust System (page 4–7)).

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure (page 5–3).

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

Removing the Gear Pump (continued)

4. Drain the hydraulic fluid from hydraulic tank by disconnecting the suction hose from the barbed fitting in the bottom of the gear pump. Drain tank into a suitable container.
5. Label the hydraulic hoses and fittings on gear pump for assembly purposes.

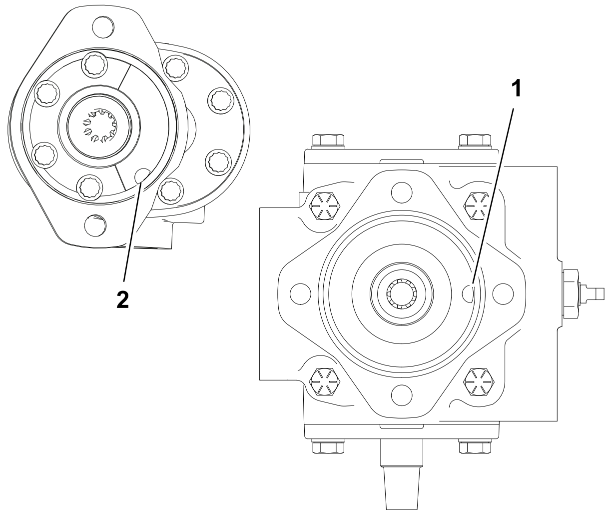

Figure 74

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

6. Disconnect the hydraulic hoses connected to the hydraulic fittings on the gear pump. Allow hoses to drain into a suitable container. Plug hose openings to prevent contamination.

   Note: A case drain exists in the piston pump/hydrostat and a suction port is near the input shaft of the gear pump (Figure 74). When the gear pump is removed from the piston pump, plug piston pump case drain hole to prevent draining the piston pump.

7. Remove both cap screws and flat washers securing gear pump to the piston pump. Separate gear pump from the piston pump. Locate and retrieve O−ring. Plug openings of gear pump to prevent contamination.
8. If hydraulic fittings are to be removed from gear pump, mark fitting orientation to allow correct assembly. Remove the hydraulic fittings and O−rings from the gear pump as needed. Discard removed O−rings.

Installing the Gear Pump

1. If fittings were removed from gear pump, lubricate and place new O−rings onto fittings. Install fittings into pump openings using marks made during the removal process to properly orientate fittings. Tighten fittings (see Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–8)).
2. Make sure that the mounting and O−ring sealing surfaces on the gear pump and piston pump are clean.
3. Apply clean hydraulic fluid to gear pump flange O−ring. Place the O−ring on the gear pump.

Installing the Gear Pump (continued)

IMPORTANT

A case drain exists in the piston pump/hydrostat and a suction port is near the input shaft of the gear pump (Figure 74). Before the gear pump is installed to the piston pump, make sure that the plugs placed in either of these ports are removed. Failure to remove plugs will cause excessive pressure in the piston pump and damage seals. Also, before installing gear pump to piston pump, fill piston pump housing with clean hydraulic fluid through case drain hole.

4. Remove the plugs that were placed in piston pump case drain and gear pump suction port. Fill piston pump housing with clean hydraulic fluid through case drain hole.

IMPORTANT

The gear pump suction fitting must be on the same side as the trunnion of the piston pump.

5. Align gear teeth and slide gear pump input shaft into piston pump coupler. Secure gear pump to piston pump with two (2) cap screws and flat washers.
6. Remove the caps and plugs from gear pump fittings and hoses. Using labels placed during gear pump removal, properly connect hydraulic lines to pump (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal Fittings) (page 5–6)).
7. Fill the hydraulic tank with new hydraulic fluid.
8. Install the muffler to the engine (see Installing the Exhaust System (page 4–7)).
9. Properly fill hydraulic system (see Charge Hydraulic System (page 5–69)).
10. Lower and secure hood.

Servicing the Gear Pump

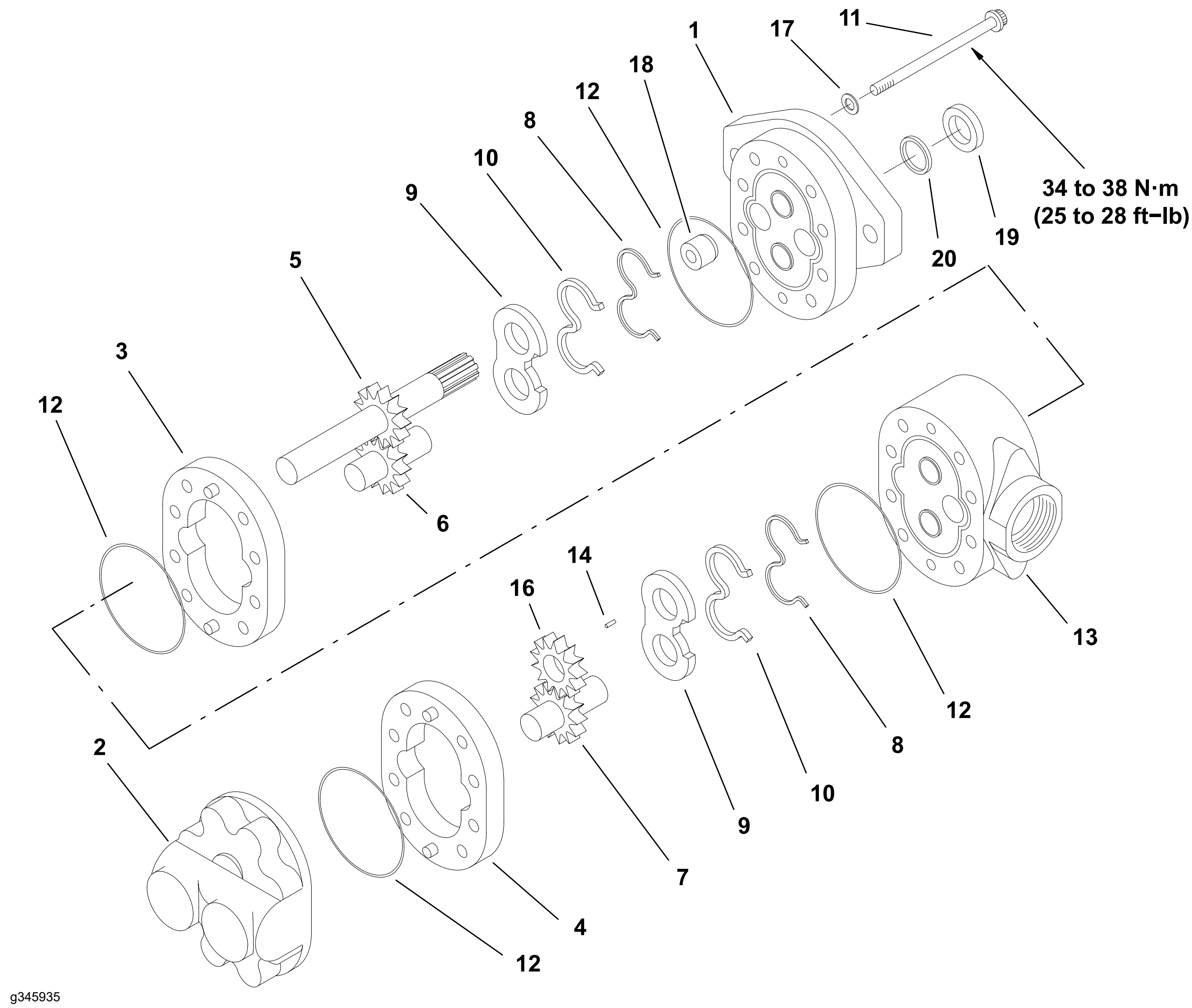

Figure 75

1. Front plate	8. Back−up gasket	15. Not used
2. Back plate	9. Wear plate	16. Drive gear
3. Front body	10. Pressure seal	17. Washer
4. Rear body	11. Cap screw	18. Plug
5. Drive gear	12. O−ring	19. Shaft seal
6. Idler gear	13. Adapter plate	20. Washer
7. Idler gear	14. Key	

Disassembling the Gear Pump (Figure 75)

Note: The gear pump must be replaced as a complete assembly. Individual gears, housings and thrust plates are not available separately. Disassemble gear pump for cleaning, inspection and seal replacement only.

1. Plug the pump ports and clean the outside of the pump thoroughly. After cleaning, remove plugs and drain any fluid out of the pump.
2. Make sure that the key is removed from the shaft of the drive gear.

Disassembling the Gear Pump (Figure 75) (continued)

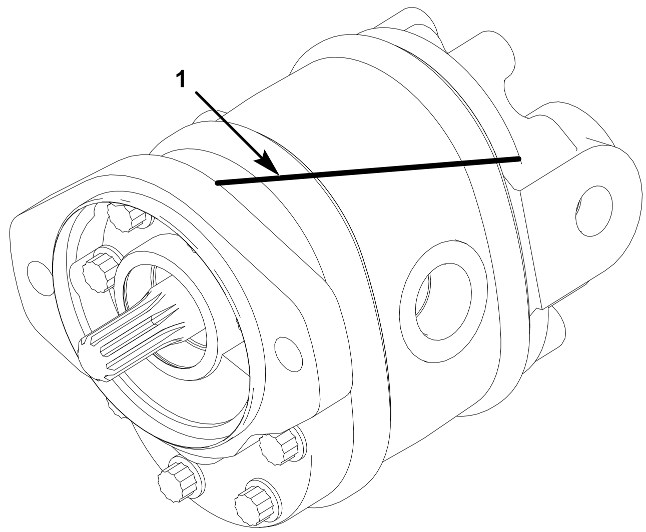

Figure 76

1. Marker line

3. Use a marker to make a diagonal line across the front plate, front body, adapter plate, rear body, and back plate for assembly purposes (Figure 76).

IMPORTANT

Avoid using excessive clamping pressure on the pump housing to prevent distorting the housing.

4. Clamp the pump in a vise with the shaft end up.
5. Remove the cap screws and washers from the front plate.
6. Remove the pump from the vise. Turn the pump so that the shaft end is facing down.
7. Remove the back plate from the rear body by tapping with a soft face hammer. Remove and discard O−ring from the back plate.
8. Loosen the rear body from the adapter plate by tapping with a soft face hammer. Lift body straight up to remove.
9. Remove the idler gear from the wear and adapter plates. Remove drive gear from the drive gear shaft.

IMPORTANT

Note position of the open and closed side of the wear plate before removing from the adapter plate.

10. Remove the wear plate and O−ring from the adapter plate.
11. Remove the key from the drive gear shaft using a pencil magnet.
12. Remove the O−ring from the adapter plate using an O− ring pick.
13. Loosen the adapter plate from the from the front body using a soft face hammer. Remove plate from the body. Turn the plate over and remove O−ring using an O−ring pick.
14. Remove the front pump body from the front plate.

Disassembling the Gear Pump (Figure 75) (continued)

15. Remove the idler gear and drive gear from the front plate.

IMPORTANT

Note position of the open and closed side of the wear plate before removing from the front plate.

16. Remove the wear plate from front plate. Remove O−ring from front plate using O−ring pick.
17. Remove the back−up gasket and pressure seal from both wear plates.

IMPORTANT

Make sure not to damage the counter bore when removing the shaft seal from the front plate.

18. Remove the shaft seal from the front plate using a drift punch.

Inspecting the Gear Pump (Figure 75)

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

CAUTION

Use eye protection such as goggles when using compressed air.

2. Clean all parts with solvent. Dry all parts with compressed air.
3. Inspect gear, drive gear, and idler gears for the following:
   A. Drive gear shaft spline should be free of twisted or broken teeth.
   B. Gear shafts should be free of rough surfaces and excessive wear at bushing points and sealing areas.
   C. Gear shaft diameter in the bushing area should not be less than **19.0 mm (0.748 inch)**.
   D. Gears should be free of excessive scoring and wear.
   E. Make sure that the drive and idler gears have their snap rings in the grooves on each side.
   F. Break sharp edges of gear teeth with emery cloth.
   G. Gear width on the drive gear and front idler gear should not be less than **9.75 mm (0.384 inch)**. Gear width on the back gear and back idler gear should not be less than **6.20 mm (0.244 inch)**.
4. Inspect body for the following:
   A. Gear pockets should be free of excessive scoring and wear.
   B. Inside diameter of gear pockets should not exceed **43.7 mm (1.719 inches)**.
5. Inspect front plate, back plate, and adapter plate as follows:
   A. Inside diameter of all bushings should not exceed **19.2 mm (0.755 inch)**.
   B. Bushings in the front plate should extend **3.20 mm (0.126 inch)** from the plate surface.

Inspecting the Gear Pump (Figure 75) (continued)

C. Bushings on the wear plate side of the adapter plate should extend **3.20 mm (0.126 inch)** from the plate surface.

D. Scoring on the face of the back plate or the back plate side of the adapter plate should not exceed **0.038 mm (0.0015 inch)**.

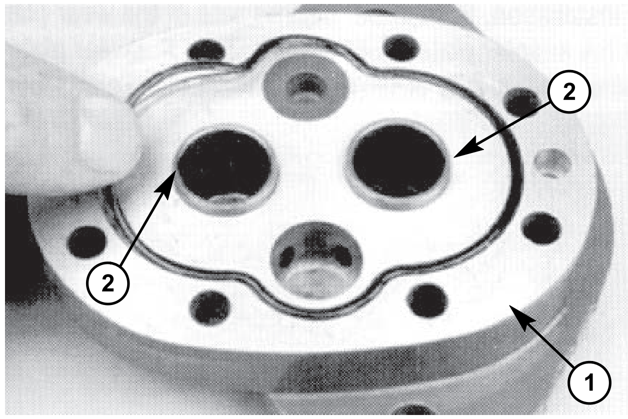

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Figure 77

1. Front plate
2. Oil groove

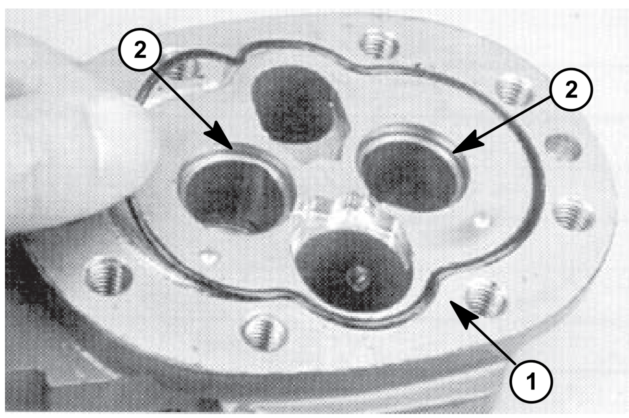

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Figure 78

1. Back plate
2. Oil groove

E. The oil groove in the bushings of the front plate should be opposite each other and in line with the dowel pin holes. The oil groove in the bushings of the back plate should be about 37º to the pressure port (Figure 77 and Figure 78).

Assembling the Gear Pump (Figure 75)

Note: When reassembling the pump, check the marker line on each part to make sure the parts are properly aligned during reassembly.

1. Lubricate new O−rings, pressure seals, back−up gaskets, and wear plates with a thin coat of petroleum jelly. Lubricate all other internal parts freely with clean hydraulic oil.
2. Install the O−ring into the groove of the front plate.
3. Lubricate the gear pockets of front body with a thin coat of petroleum jelly. Place front body onto front plate so the half moon port cavities face away from the front plate.

Assembling the Gear Pump (Figure 75) (continued)

4. Install new pressure seal and back−up gasket into both new wear plates. The flat section in the middle of the back−up gasket must face away from the wear plate inside the seal.
5. Install wear plate into the gear pocket with the pressure seal and back−up gasket against the front plate. Make sure mid section cut−away of the wear plate is on the suction side of the pump.
6. Dip drive gear and front idler gear into clean hydraulic oil. Install gear shafts into the front plate bushings so that the gears set inside the gear pockets.
7. Install new O−ring into the groove of the adapter plate on the side with the bushings below the surface.
8. Align marker line on the body and adapter plate. Install adapter plate onto the body and gear shafts.
9. Install second new O−ring to the other side of the adapter plate.
10. Coat key lightly with petroleum jelly to hold it in place. Install key into the slot in the drive gear shaft.
11. Align marker line on back body and adapter plate. Install body onto adapter plate and drive gear shaft.

IMPORTANT

Do not dislodge seals during installation.

12. Install the wear plate into the gear pocket of back body with the pressure seal and back−up gasket against the adapter plate. Make sure mid section cut−away of the wear plate is on the suction side of the pump.
13. Lubricate the back gear with clean hydraulic oil. Install the gear onto the drive gear shaft and key.
14. Lubricate the back idler gear with clean hydraulic oil. Install the idler gear into the gear pocket of back body and the adapter plate.
15. Install new O−ring into the groove of the back plate.
16. Align marker line on the back plate and body. Install back plate onto the body and gear shafts.
17. Secure pump together with cap screws and new washers on cap screws external of the flange cavity. Torque cap screws in a criss−cross pattern from **34 to 38 N·m (25 to 28 ft−lb)**.

Front Wheel Motors

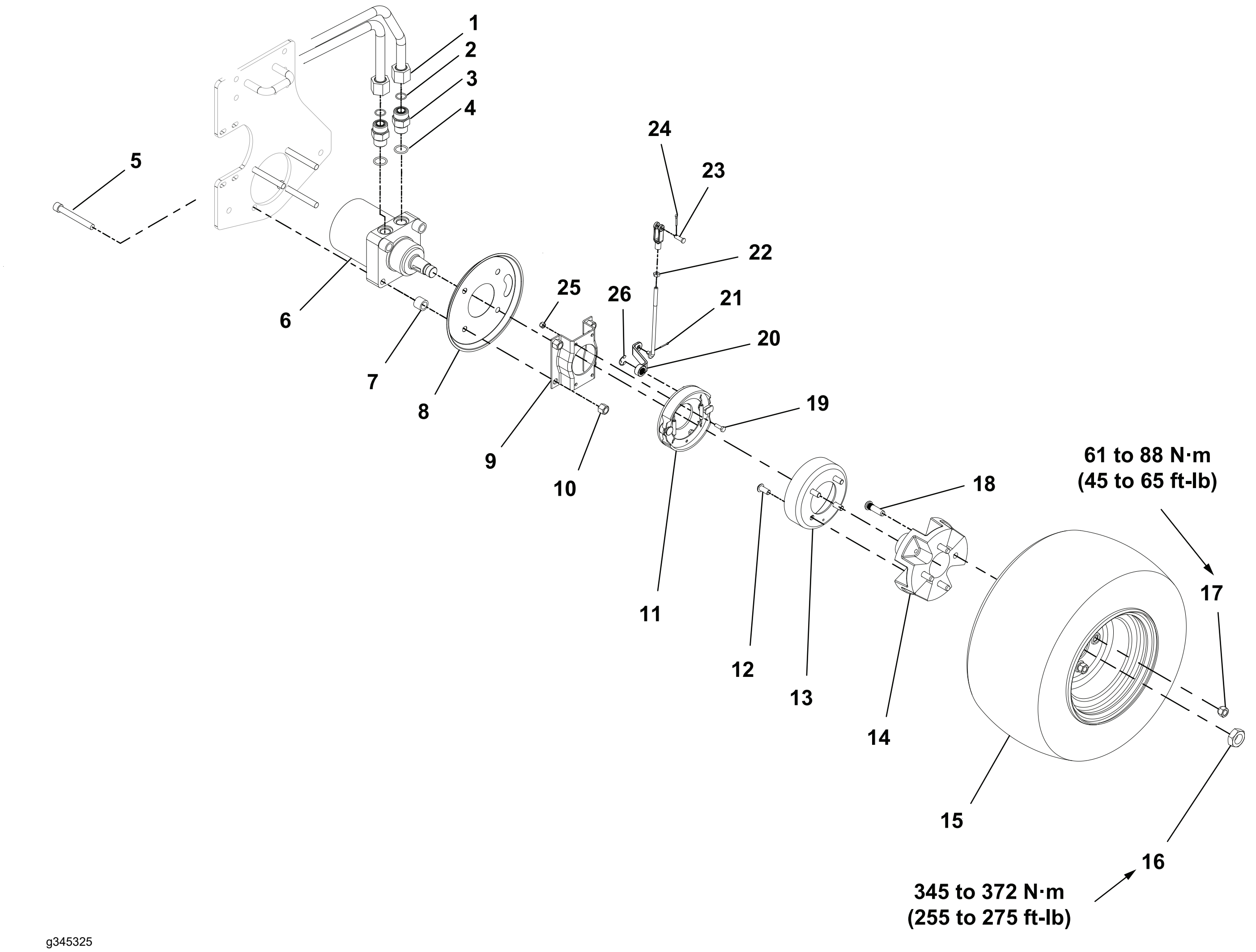


Figure 79

1. Hydraulic tube
2. O-ring
3. Hydraulic fitting
4. O-ring
5. Socket head screw
6. Hydraulic motor assembly
7. Pulley deck spacer
8. Wheel shield
9. Brake bracket
10. Lock nut
11. Brake assembly
12. Bolt
13. Brake drum
14. Wheel hub
15. Wheel assembly
16. Lock nut
17. Lug nut
18. Drive stud
19. Bolt
20. Brake lever
21. Cotter pin
22. Adjustment rod
23. Clevis pin
24. Cotter pin
25. Lock nut
26. Retaining ring

Removing the Front Wheel (Figure 79)

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

WARNING

Before jacking up the machine, review and follow Jacking Instructions (page 1–7).

Removing the Front Wheel (Figure 79) (continued)

2. Jack up front of machine enough to allow the removal of the front wheel. Support machine with appropriate jackstands.

IMPORTANT

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

3. Remove the wheel assembly, wheel hub and brake drum from the hydraulic motor. Remove the brake assembly from the brake bracket (see Removing the Front Wheel and Brake (page 7–9)).
4. Thoroughly clean the hydraulic line ends and wheel motor fittings to prevent hydraulic system contamination.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure (page 5–3).

5. Disconnect the hydraulic tubes from adapters on the wheel motors. Plug the hose openings to prevent contamination.
6. Remove four (4) socket head screws and lock nuts that secure brake bracket and wheel motor to frame. Located and retrieve the spacers. Remove the brake bracket and wheel motor from machine.
7. If necessary, remove the hydraulic adapters and O−rings from the wheel motor. Discard removed the O−rings.

Installing the Front Wheel (Figure 79)

1. If adapters were removed from wheel motor, lubricate and place new O−rings onto fittings. Install adapters into motor openings and tighten fittings (see Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–8)).
2. Install the wheel motor and brake bracket to frame using four (4) socket head screws, spacers and lock nuts.
3. Remove the caps and plugs from wheel motor fittings and hoses. Using labels placed during motor removal, properly connect hydraulic lines to motor (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal Fittings) (page 5–6)).
4. Install the brake assembly to the brake bracket. Install the brake drum, wheel hub and wheel assembly to the hydraulic motor (see Installing the Front Wheel and Brake (page 7–11)).
5. Lower the machine to the ground.
6. Make sure that lock nut is torqued from **345 to 372 N·m (255 to 275 ft−lb)**. Also, make sure that the wheel lug nuts are torqued from **61 to 88 N·m (45 to 65 ft−lb)**.
7. Make sure that the hydraulic tank is full. Add correct fluid if necessary.

Rear Wheel Motor

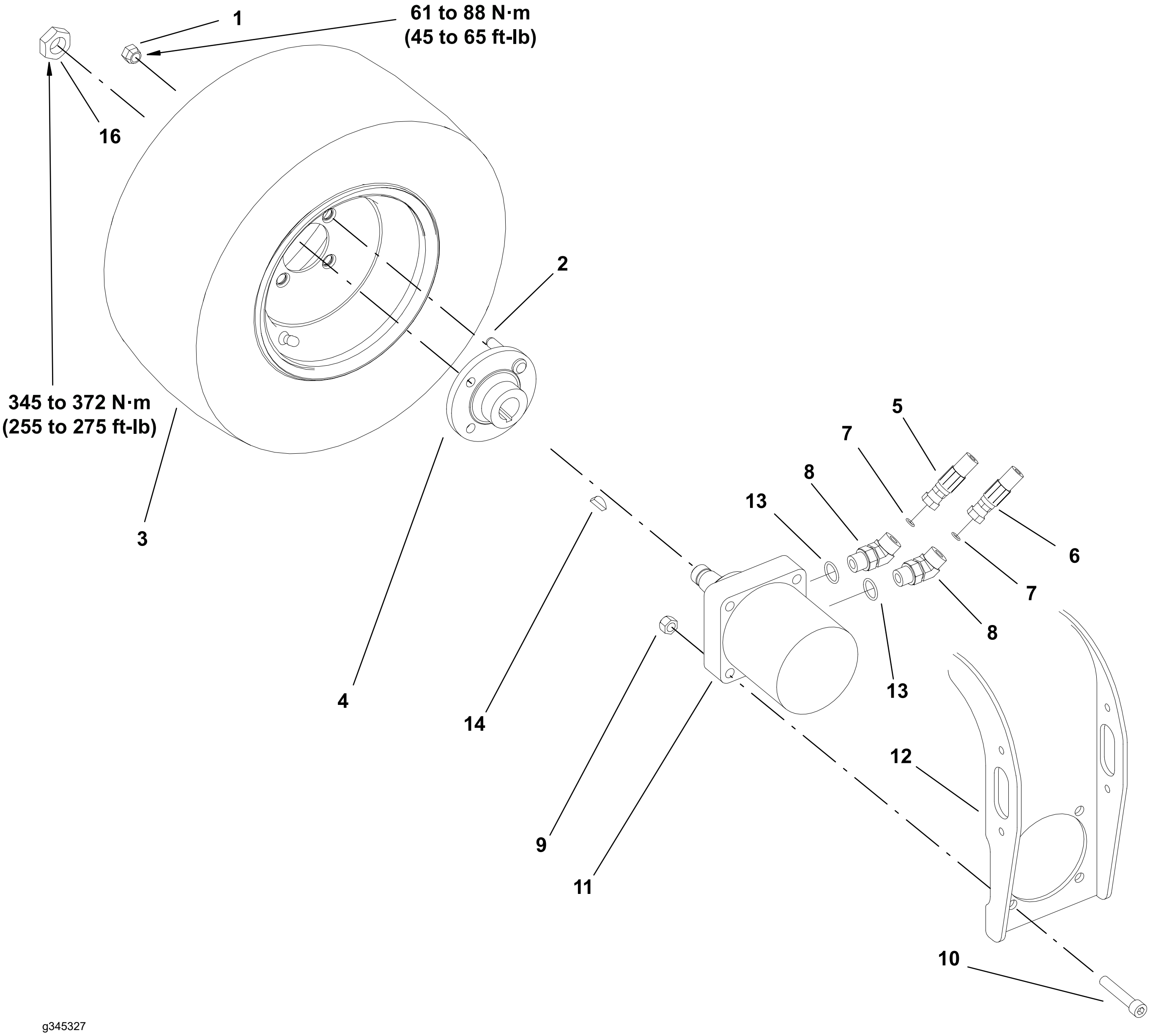


Figure 80

1. Lug nut
2. Drive stud
3. Tire and rim
4. Wheel hub
5. Hydraulic hose
6. Hydraulic hose
7. O−ring
8. 45º hydraulic fitting
9. Lock nut
10. Socket head screw
11. Hydraulic motor
12. Rear fork
13. O−ring
14. Woodruff key

Removing the Rear Wheel Motor (Figure 80)

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

WARNING

Before jacking up the machine, review and follow Jacking Instructions (page 1–7).

Removing the Rear Wheel Motor (Figure 80) (continued)

2. Jack up the rear of equipment enough to allow the removal of the rear wheel.
3. Remove the rear wheel assembly from the machine; refer to Removing the Rear Fork and Wheel (page 7–14).
4. Thoroughly clean the hydraulic hose ends and rear wheel motor fittings to prevent hydraulic system contamination.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure (page 5–3).

5. Disconnect the hydraulic hoses from fittings on wheel motor. Plug the hose openings to prevent contamination.
6. Remove four (4) socket head screws and lock nuts that secure rear wheel motor to rear fork. Remove the wheel motor with wheel hub attached from the rear fork.
7. Secure the wheel hub in a vise. Loosen but do not remove lock nut that secures the wheel hub to wheel motor.

IMPORTANT

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

8. Using hub puller (see Special Tools (page 2–13)), loosen wheel hub from wheel motor.
9. Remove the wheel hub and motor from vise. Remove the lock nut and wheel hub from motor shaft. Locate and retrieve the woodruff key.
10. If hydraulic fittings are to be removed from the wheel motor, mark fitting orientation to allow correct assembly. Discard the O−rings from removed fittings.

Installing the Rear Wheel Motor (Figure 80)

1. If fittings were removed from the rear wheel motor, lubricate and place new O−rings onto fittings. Install the fittings into motor openings using marks made during the removal process to properly orientate fittings. Tighten fittings (see Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–8)).
2. Thoroughly clean the wheel motor shaft and wheel hub taper.
3. Lock the wheel hub in a vise. Install woodruff key into the wheel motor shaft. Slide the motor shaft into hub and secure with lock nut. Torque lock nut from **345 to 372 N·m (255 to 275 ft−lb)**. Remove the wheel motor and hub from vise.
4. Position the wheel motor with wheel hub attached to the rear fork. Secure the rear wheel motor to rear fork with four (4) socket head screws and lock nuts.

Installing the Rear Wheel Motor (Figure 80) (continued)

5. Remove caps and plugs from wheel motor fittings and hoses. Using labels placed during motor removal, properly connect hydraulic lines to motor (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal Fittings) (page 5–6)).
6. Install the wheel assembly to machine and secure with four (4) lug nuts.
7. Lower the machine to the ground.
8. Make sure that the lock nut is torqued from **345 to 372 N·m (255 to 275 ft−lb)**. Also, make sure that the wheel lug nuts are torqued from **61 to 88 N·m (45 to 65 ft−lb)**.
9. Make sure hydraulic tank is full. Add correct fluid if necessary.

Servicing the Wheel Motor

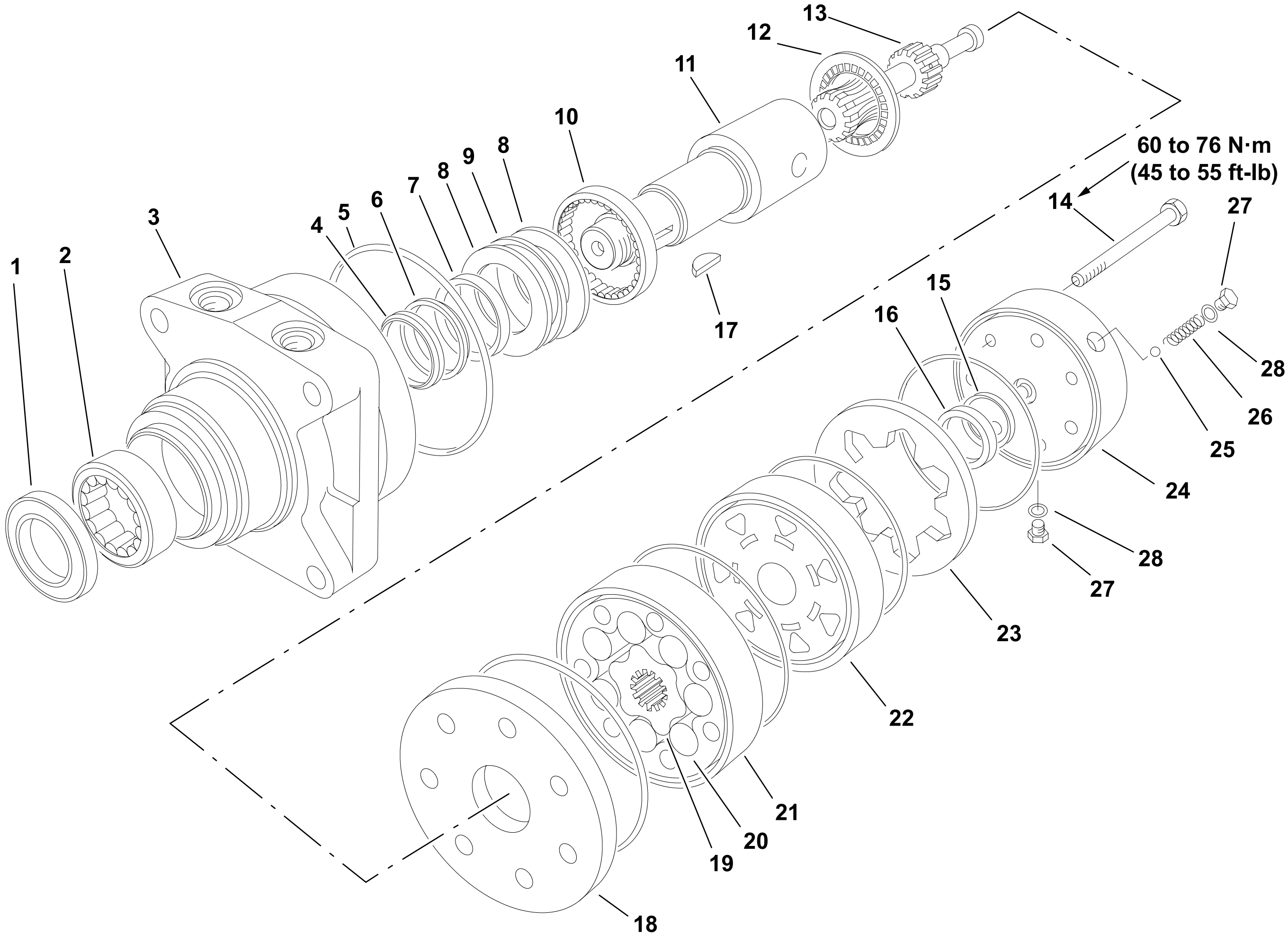


Figure 81

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

Note: The three wheel motors used on the Reelmaster 3100-D and 3105-D are similar in construction but do have some differences. The right front and left front motors are the same basic design but the right side motor has a reverse timed manifold to allow correct rotation direction for forward and reverse. The end cover of the rear motor has a check valve consisting of a ball and spring, and both front motors lack this feature. The wheel motor shown in Figure 81 is a rear motor.

Note: If a wheel motor failure occurred, refer to Traction Circuit (Closed Loop) Component Failure (page 5–3) for information regarding the importance of removing contamination from the traction circuit.

Servicing the Wheel Motor (continued)

Note: For repair of the wheel motors, see the Parker Torqmotor Service Procedure (TC, TB, TE, TJ, TF, TG, TH and TL Series).

Reel Motors

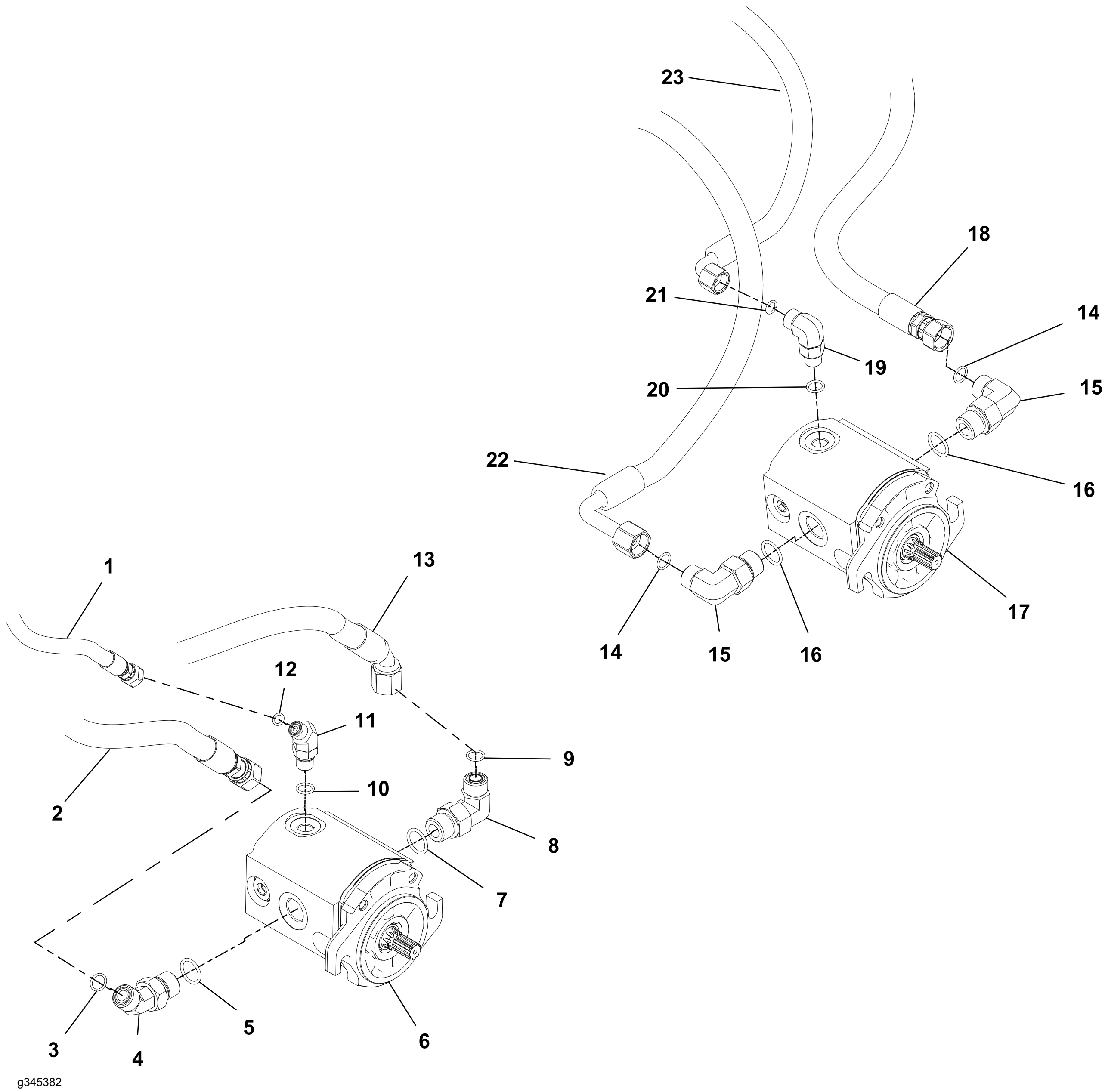


Figure 82

1.	Hydraulic hose	9.	O-ring	17.	Hydraulic motor (rear)
2.	Hydraulic hose	10.	O-ring	18.	Hydraulic hose
3.	O-ring	11.	Hydraulic fitting	19.	90º hydraulic fitting
4.	45º hydraulic fitting	12.	O-ring	20.	O-ring
5.	O-ring	13.	Hydraulic hose	21.	O-ring
6.	Hydraulic motor (front)	14.	O-ring	22.	Hydraulic hose
7.	O-ring	15.	90º hydraulic fitting	23.	Hydraulic hose
8.	90º hydraulic fitting	16.	O-ring		

Removing the Reel Motors

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

Removing the Reel Motors (continued)

2. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–62).
3. Label all hydraulic connections for assembly purposes (Figure 82). Thoroughly clean hydraulic connections prior to loosening hydraulic lines from reel motor to prevent hydraulic system contamination.

CAUTION

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil. See Relieving Hydraulic System Pressure (page 5–3).

4. Disconnect the hydraulic hoses from fittings in reel motor. Allow lines to drain into a suitable container. Remove and discard the O−rings.
5. Put caps or plugs on disconnected hoses and fittings to prevent contamination.

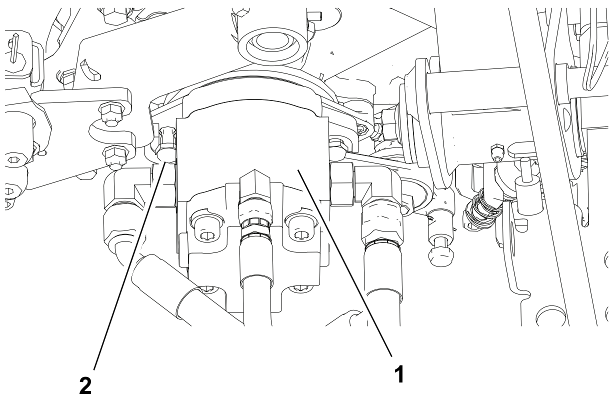


Figure 83

1. Hydraulic reel motor
2. Cap screw

6. Loosen two cap screws that secure the hydraulic reel motor to the cutting unit side plate (Figure 83). Rotate motor clockwise and remove motor from cutting unit.
7. Inspect the O−ring on the reel motor flange and replace O−ring if damaged.
8. If hydraulic fittings are to be removed from motor, mark fitting orientation to allow correct assembly. Remove fittings from motor and discard O−rings.

Installing the Reel Motors

1. If hydraulic fittings were removed from motor, lubricate new O−rings, position O−rings to fittings and install fittings into motor ports (see Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–8)). Make sure that fittings are orientated correctly.
2. Coat spline shaft of the reel motor with No. 2 multipurpose lithium base grease. Lubricate the O−ring on the motor flange with clean oil.
3. Install the cap screws for the reel drive motor into the cutting unit side plate and leave approximately 12.7 mm (1/2 inch) of threads exposed on each screw.
4. Rotate the motor clockwise so the motor flanges clear the cap screws in the cutting unit side plates. Align reel motor shaft splines with cutting reel insert splines. Slide motor shaft into reel insert.

Installing the Reel Motors (continued)

5. Rotate the motor counter-clockwise until the motor flanges are encircling the cap screws. Tighten two (2) cap screws to secure reel motor to cutting unit (Figure 83).

6. Remove the caps or plugs from fittings and hoses.

IMPORTANT

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

7. Lubricate and install new O−rings on motor fittings. Correctly connect hydraulic hoses to the motor using labels placed during removal procedure (Figure 82).

8. Check the fluid level in hydraulic reservoir and add correct fluid if necessary.

Servicing the Reel Motor

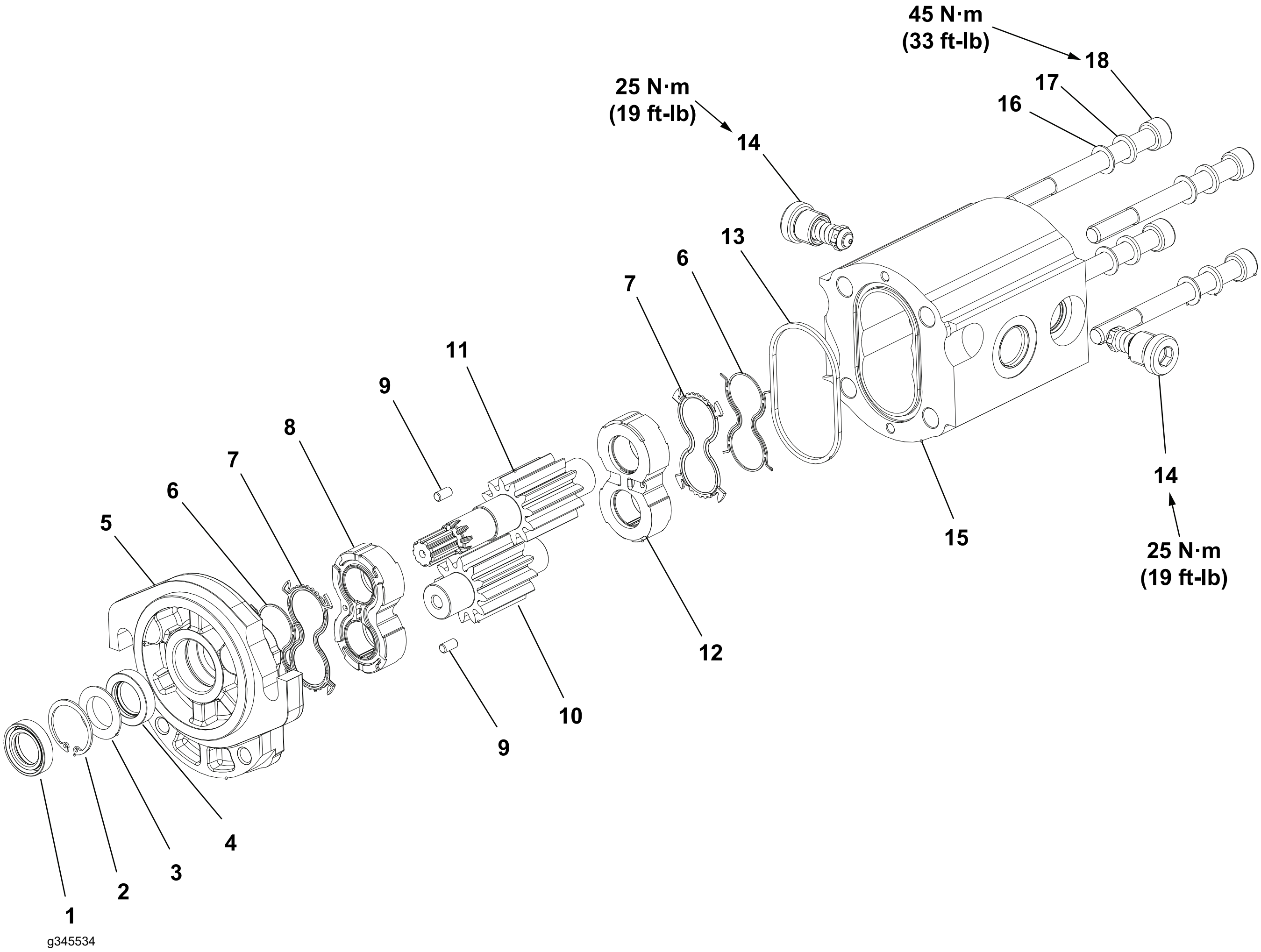


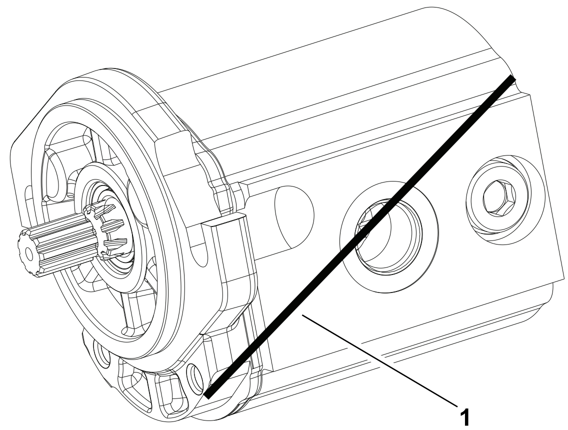
Figure 84

1.	Dust seal	7.	Back-up gasket	13.	O-ring
2.	Retaining ring	8.	Front wear plate	14.	Relief valve
3.	Flange washer	9.	Dowel pin	15.	Body
4.	Shaft seal	10.	Idler gear	16.	Washer (4 each)
5.	Front flange	11.	Drive shaft	17.	Lock washer (4 each)
6.	Pressure seal	12.	Rear wear plate	18.	Cap screw (4 each)

Disassembling the Reel Motor (Figure 84)

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

Disassembling the Reel Motor (Figure 84) (continued)



g345531

Figure 85

1. Marker line

2. Use a marker to make a diagonal line across the front flange, body and rear cover for assembly purposes (Figure 85).

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

IMPORTANT

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

IMPORTANT

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 gear finish.

8. Carefully disassemble the inner wear plate, idler gear, drive gear and outer wear plate.

Disassembling the Reel Motor (Figure 84) (continued)

9. Remove and discard the back−up gaskets and pressure seals from wear plates.
10. Turn the front flange over, with seal side up.

IMPORTANT

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

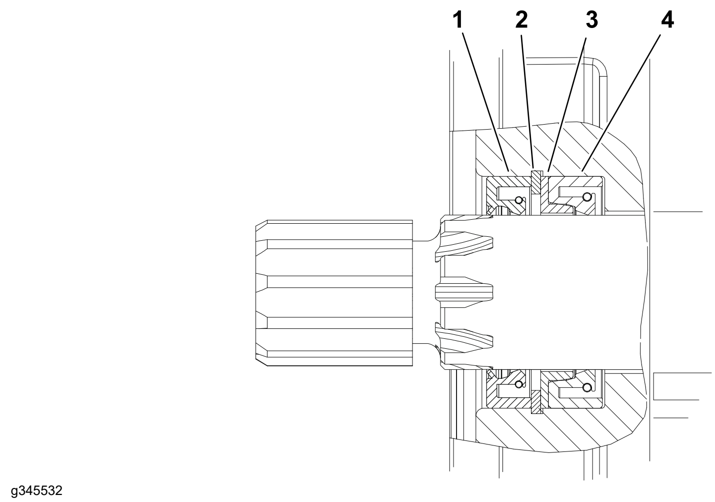


Figure 86

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

11. Carefully remove the dust seal, retaining ring, backup washer and shaft seal from the front flange (Figure 86). Discard removed seals.
12. Remove the cross−over relief valves from rear cover if necessary.

Inspecting the Reel Motor

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.

Inspecting the Reel Motor (continued)

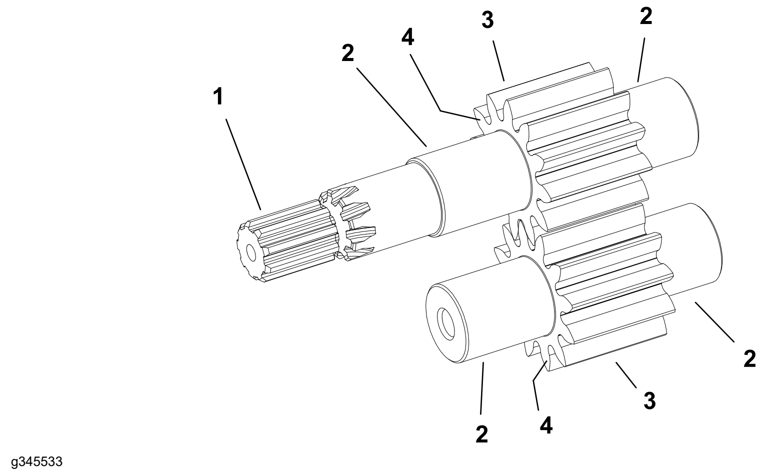


Figure 87

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

3. Inspect drive gears and idler gears for the following (Figure 86):
   A. Gear shafts should be free of rough surfaces and excessive wear at bushing points and sealing areas. Scoring, rough surfaces or wear on gear shafts indicates need for replacement.
   B. Gear teeth should be free of excessive scoring and wear. Any broken or nicked gear teeth must be replaced.
   C. Inspect gear face edge for sharpness. Sharp edges of gears will damage wear plates and should be replaced.
4. Inspect wear plates for the following:
   A. Bearing areas should not have excessive wear or scoring.
   B. Face of wear plates that are in contact with gears should be free of wear, roughness or scoring.
   C. Thickness of wear plates should be equal.
5. Inspect front flange and rear cover for damage or wear.
6. If internal parts are found to be worn or damaged, reel motor replacement is necessary.

Assembling the Reel Motor (Figure 84)

1. Lubricate the O–rings, pressure seals, back−up gaskets and wear plate grooves with a thin coat of petroleum jelly. Lubricate all other internal parts freely with clean hydraulic fluid.
2. Install new seals into front flange (Figure 86):
   A. Press new shaft seal into front flange until it reaches the bottom of the bore.
   B. Install backup washer into front flange and then install retaining ring into the groove of the front flange. Make sure retaining ring is fully seated in front flange groove.
   C. Install new dust seal into front flange.
3. Place 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.

Assembling the Reel Motor (Figure 84) (continued)

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 shaft into front flange.
7. Lubricate the idler gear shaft with clean hydraulic fluid. Install idler gear shaft into the remaining position in the outer wear plate with gear teeth in the mated position recorded during dis−assembly. Apply a light coating of clean hydraulic fluid to gear faces.
8. Install rear wear plate with pressure seal side up and open side of the pressure seal pointing to the inlet side of the motor.
9. Install inner wear plate with pressure seal side up and open side of the pressure seal pointing to the inlet side of the motor.
10. Apply a light coating of petroleum jelly to new O–ring and O–ring grooves in the body. Install 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 locating dowels in body. Align marker line on the body and front flange.

IMPORTANT

Do not dislodge 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. Make sure that lubricated O−ring and located dowels are installed in rear of body.
15. Place rear cover onto the assembly. Firm hand pressure should be sufficient to engage the dowels.
16. Install the four (4) cap screws with washers and hand tighten screws.

IMPORTANT

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

17. Place front flange of the motor into a vise with soft jaws and alternately torque the cap screws to **45 N·m (33 ft−lb)**.
18. Install cross−over relief valves into rear flange if they were removed. Torque relief valves **25 N·m (19 ft−lb)**.
19. Remove the motor from vise.
20. 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.

Hydraulic Manifold Assembly

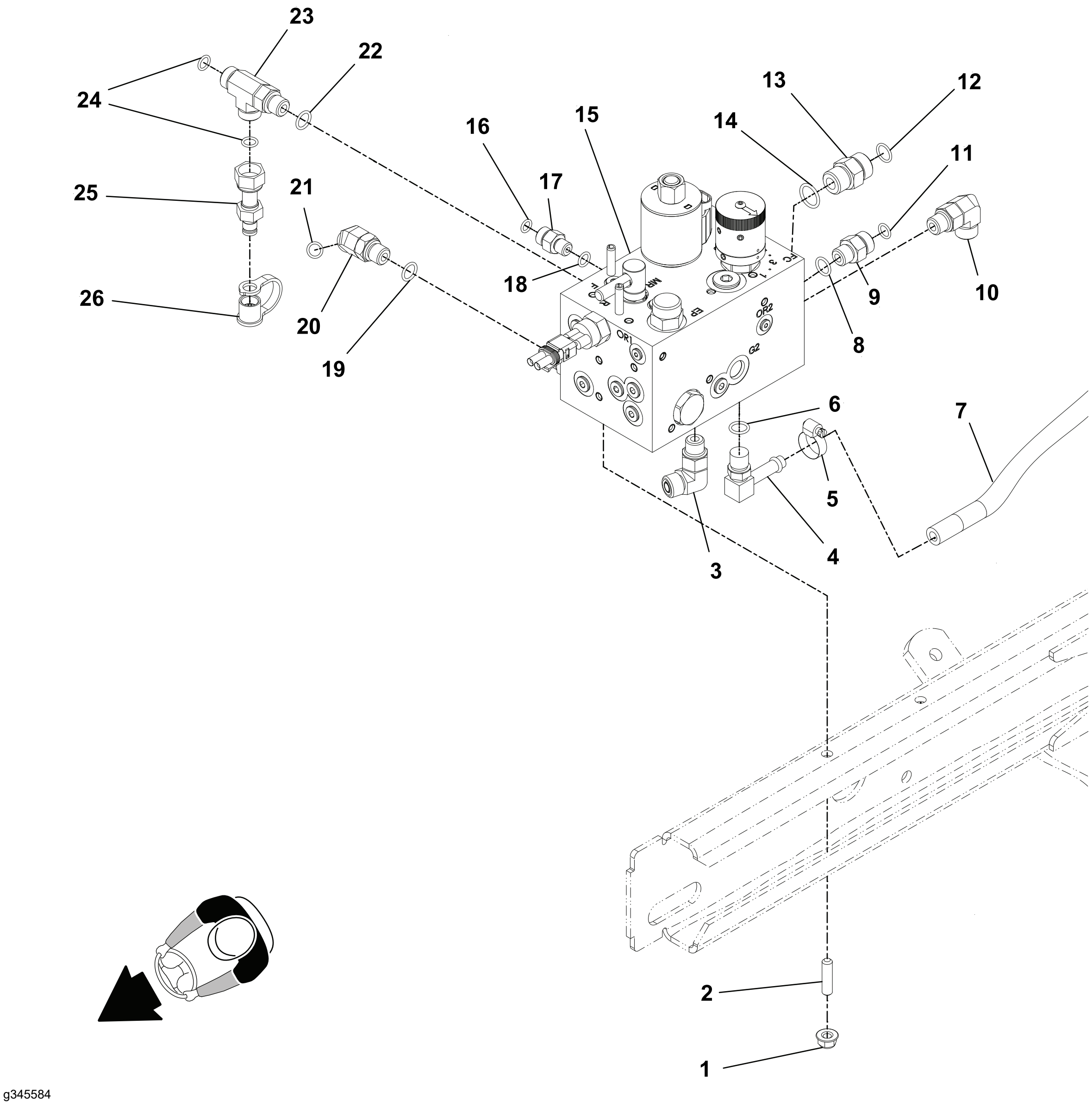


Figure 88

1. Flange nut (2 each)
2. Stud (2 each)
3. 90º hydraulic fitting
4. Elbow fitting
5. Hose clamp
6. O-ring
7. Hydraulic hose
8. O-ring
9. Hydraulic fitting
10. 90º hydraulic fitting
11. O-ring
12. O-ring
13. Hydraulic fitting
14. O-ring
15. Hydraulic manifold assembly
16. O-ring
17. Hydraulic fitting
18. O-ring
19. O-ring
20. 45º hydraulic fitting
21. 90º hydraulic fitting
22. O-ring
23. Tee hydraulic fitting
24. O-ring
25. Test nipple
26. Dust cap

Removing the Hydraulic Manifold Assembly

Note: The ports on the manifold are marked for easy identification of components. Example: P1 is the gear pump connection port (See Hydraulic Schematic (page 5–11) to identify the function of the hydraulic lines and cartridge valves at each port location).

Removing the Hydraulic Manifold Assembly (continued)

1. Park the machine on a level surface. Lower cutting units, stop engine and engage parking brake. Remove key from the key switch.
2. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–62).
3. To prevent contamination of the hydraulic system during manifold removal, thoroughly clean exterior of mow control manifold and fittings.
4. Disconnect the wire harness connector from the hydraulic manifold.
5. Disconnect the hydraulic lines from manifold and put caps or plugs on open hydraulic lines and fittings. Label disconnected hydraulic lines for proper installation.
6. Remove the two (2) nuts under the manifold that secure the manifold to the frame.
7. If hydraulic fittings are to be removed from manifold, mark fitting orientation to allow correct assembly. Remove fittings from manifold and discard O−rings.

Installing the Hydraulic Manifold Assembly

1. If fittings were removed from mow control manifold, lubricate and place new O−rings onto fittings. Install fittings into manifold openings using marks made during the removal process to properly orientate fittings. Tighten fittings (see Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–8)).
2. Install the mow control manifold to the frame.
3. Remove the caps and plugs from fittings and hoses. Using labels placed during manifold removal, properly connect hydraulic lines to manifold (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal Fittings) (page 5–6)).
4. Connect wire harness connector to the hydraulic manifold.
5. Make sure hydraulic tank is full. Add correct fluid if necessary before returning machine to service.

Servicing the Hydraulic Manifold

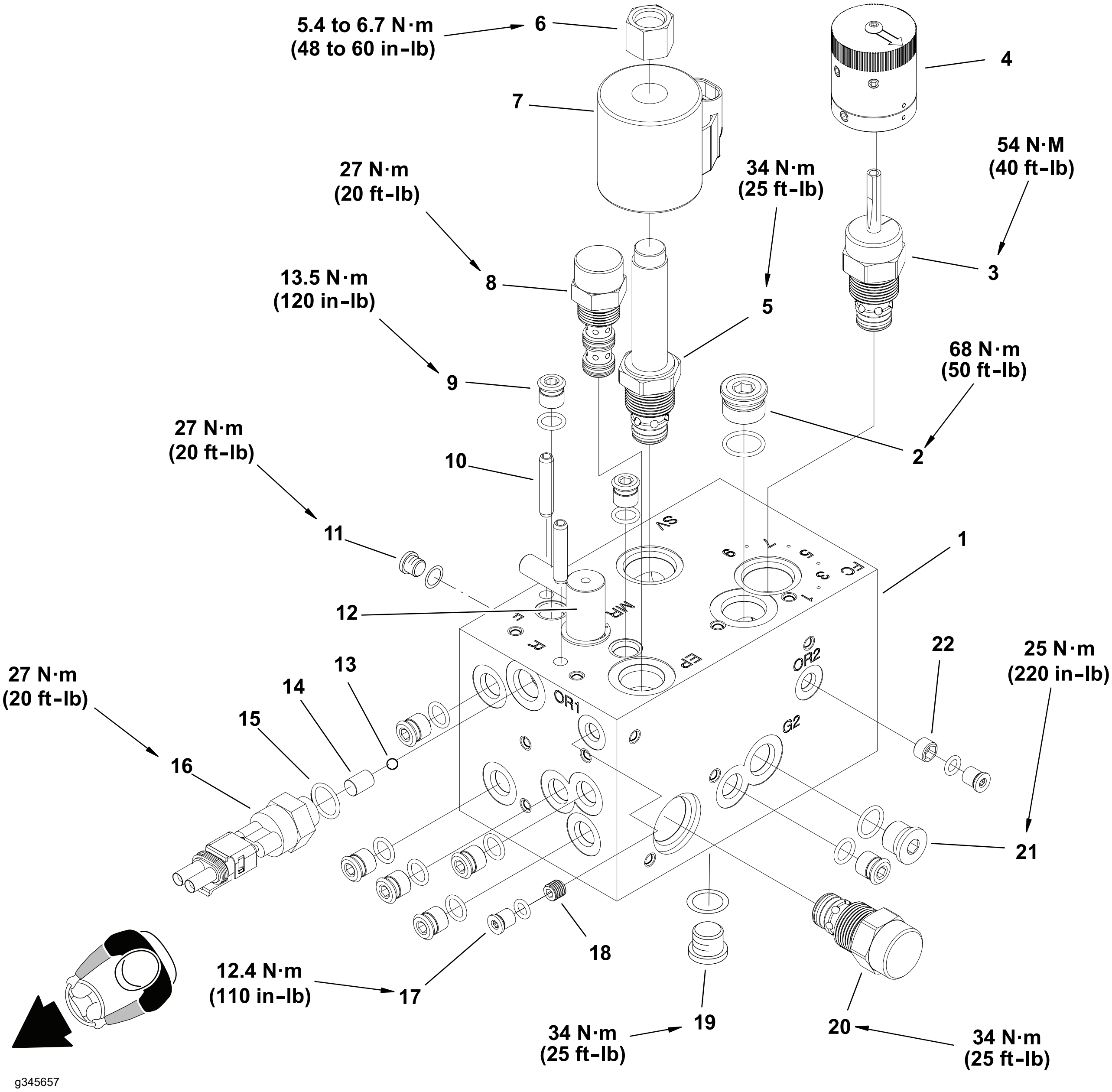


Figure 89

1. Manifold body
2. Plug (Zero Leak #8)
3. Rotary cartridge valve (flow control)
4. Rotary handle assembly
5. Solenoid relief cartridge valve
6. Nut
7. Solenoid coil
8. Logic control cartridge
9. Plug (Zero Leak #4) (10 each)
10. Spring pin (2 each)
11. Plug (SAE #4)
12. Mow/backlap spool
13. Ball
14. Dowel pin
15. O-ring
16. Ball switch (N.C.)
17. Plug (Zero Leak #2) (2 each)
18. Orifice (.020)
19. Plug (Zero Leak #6)
20. Check valve
21. Plug (SAE #6) (2 each)
22. Orifice (.073)

Note: The ports on the hydraulic manifold are marked for easy identification of components. Example: FC is the flow control valve and P1 is the gear pump connection port (See Hydraulic Schematic (page 5–11) to identify the function of the hydraulic lines and cartridge valves at each port location).

Note: The hydraulic manifold shown in Figure 89 uses several zero leak plugs. These plugs have a tapered sealing surface on the plug head that is designed to resist vibration induced plug loosening. The zero leak plugs also have an O-ring to provide a secondary seal. If zero leak plug removal is necessary, lightly rap the plug head using a punch and hammer before using an allen wrench to remove the plug: the impact will allow plug removal with less chance of damage to the socket head of the plug. When installing plugs into the manifold, torque plugs to the values identified in Figure 89.

Solenoid Operated, Relief and Logic Control Cartridge Valves

1. Make sure that the manifold is clean before removing the cartridge valve and seal kit.
2. If solenoid valve is to be removed from manifold, remove nut securing solenoid to the cartridge valve. Carefully slide solenoid and O-rings (if equipped) off the valve.

IMPORTANT

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

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

CAUTION

Use eye protection such as goggles when using compressed air.

5. Cleaning cartridge valves:
   A. For non-solenoid operated valves:

      Submerge valve in clean mineral spirits to flush out contamination. If valve design allows, use a probe to push the internal spool in and out 20 to 30 times to flush out contamination. Particles as fine as talcum powder can affect the operation of high pressure hydraulic valves. Clean and dry cartridge with compressed air.
   B. For solenoid operated valves:

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

Solenoid Operated, Relief and Logic Control Cartridge Valves (continued)

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

IMPORTANT

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

   B. Lubricate threads on cartridge valve with clean hydraulic oil. Thread cartridge valve carefully into correct manifold port. The valve should go in easily without binding.
   C. Torque cartridge valve using a deep well socket to specification shown in manifold illustration.
7. For solenoid valve, install solenoid coil and O-rings (if equipped) to the cartridge valve. Torque nut to specification shown in manifold illustration.
8. If problems still exist, remove valve and clean again or replace valve.

Rotary Cartridge Valves

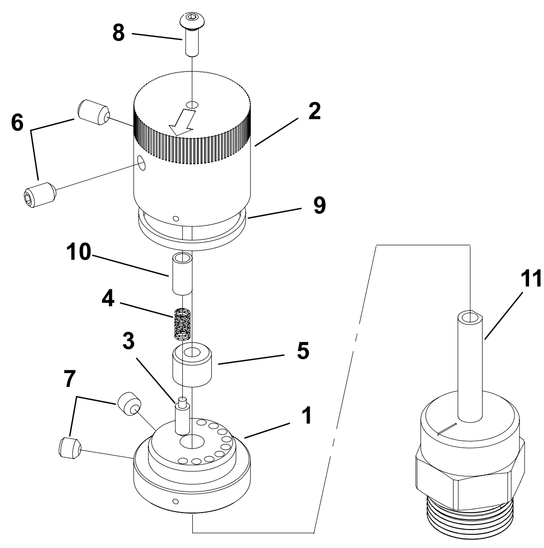


Figure 90

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

1. Remove rotary handle (manifold shown in Figure 89 and Figure 90):
   A. Loosen two (2) set screws that secure handle cap. Remove screw and then lift handle cap from valve.
   B. Locate and retrieve detent pin, compression spring, bushing and lip seal. The sleeve bearing should stay in the cap.

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

2. Make sure manifold is clean before removing the rotary cartridge valve. Remove the valve and seal kit.

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

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

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

CAUTION

Use eye protection such as goggles when using compressed air.

4. If necessary, clean cartridge valve using clean mineral spirits. Submerge valve in clean mineral spirits to flush out contamination. Particles as fine as talcum powder can affect the operation of high pressure hydraulic valves. Clean and dry with compressed air.

5. Reinstall rotary cartridge valve into manifold port:

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

IMPORTANT

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

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

6. Install rotary handle (manifold shown in Figure 89 and Figure 90):

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

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

   C. Place bushing onto cartridge valve stem. Use a small amount of grease to keep bushing toward the top of the valve stem.

   D. Place compression spring and detent pin into handle cap. Use a small amount of grease to hold detent pin in place.

   E. Make sure that flow control valve is closed by rotating valve stem fully clockwise. During handle installation, DO NOT rotate valve stem or speed adjustment will be incorrect.

F. Press handle cap onto valve stem with arrow on cap pointing to number 9 on manifold. Make sure that the detent pin and spring stay positioned in cap.

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

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

Mow/Backlap Spool (Figure 89 and Figure 91)

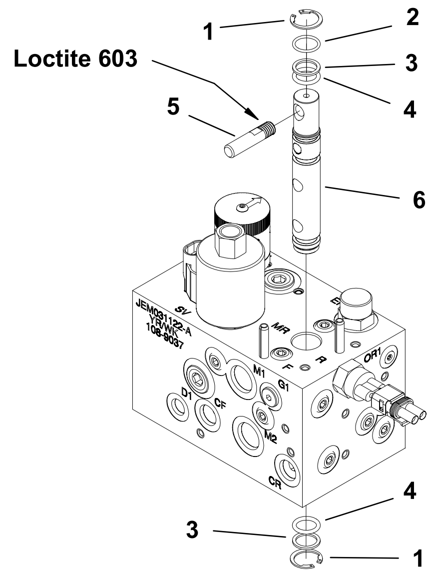


Figure 91

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

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1. Remove spool from mow manifold:

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

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

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

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

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

3. Install spool into mow manifold:

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

Mow/Backlap Spool (Figure 89 and Figure 91) (continued)

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

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

D. Push mow/backlap spool down and install lower retaining ring to spool.

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

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

Control Valve (Models 03170 and 03174)

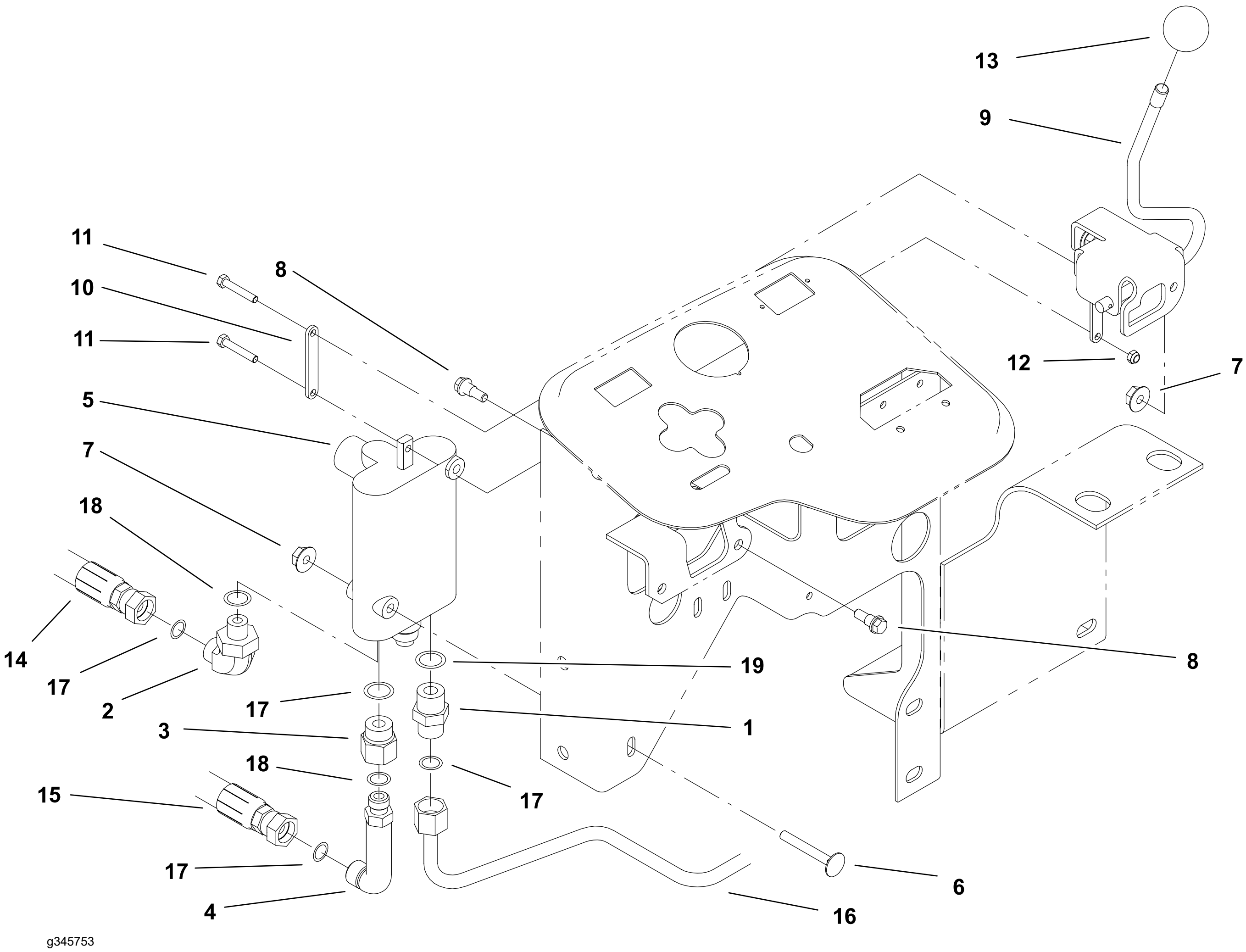

Figure 92

1. Straight hydraulic fitting
2. 90º hydraulic fitting
3. Hydraulic fitting
4. 90º hydraulic fitting
5. Control valve (single spool)
6. Carriage screw (2 each)
7. Flange nut
8. Shoulder bolt
9. Valve lever assembly
10. Link (2 each)
11. Bolt
12. Lock nut (2 each)
13. Knob
14. Hydraulic hose
15. Hydraulic hose
16. Hydraulic tube
17. O-ring
18. O-ring
19. O-ring

Removing the Control Valve

1. Thoroughly clean hydraulic hose ends and fittings on lift cylinder to prevent hydraulic system contamination.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See **Relieving Hydraulic System Pressure (page 5–3)****.**

Removing the Control Valve (continued)

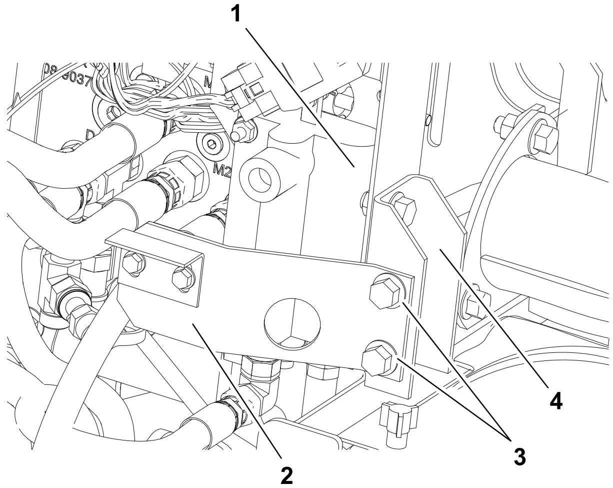

Figure 93

1. Lift control valve
2. Support bracket
3. Flange head screws
4. Frame

2. Remove control valve from the frame using Figure 92 and Figure 93 as guides.
3. If hydraulic fittings are to be removed from control valve, mark fitting orientation to allow correct assembly.

Installing the Control Valve

1. If fittings were removed, install fittings to control valve using marks made during the removal process to properly orientate fittings.
2. Install control valve to the frame using Figure 92 and Figure 93 as guides.
3. Make sure hydraulic tank is full. Add correct fluid if necessary (see *Operator 's Manual*).

Servicing the Control Valve (Models 03170 and 03174)

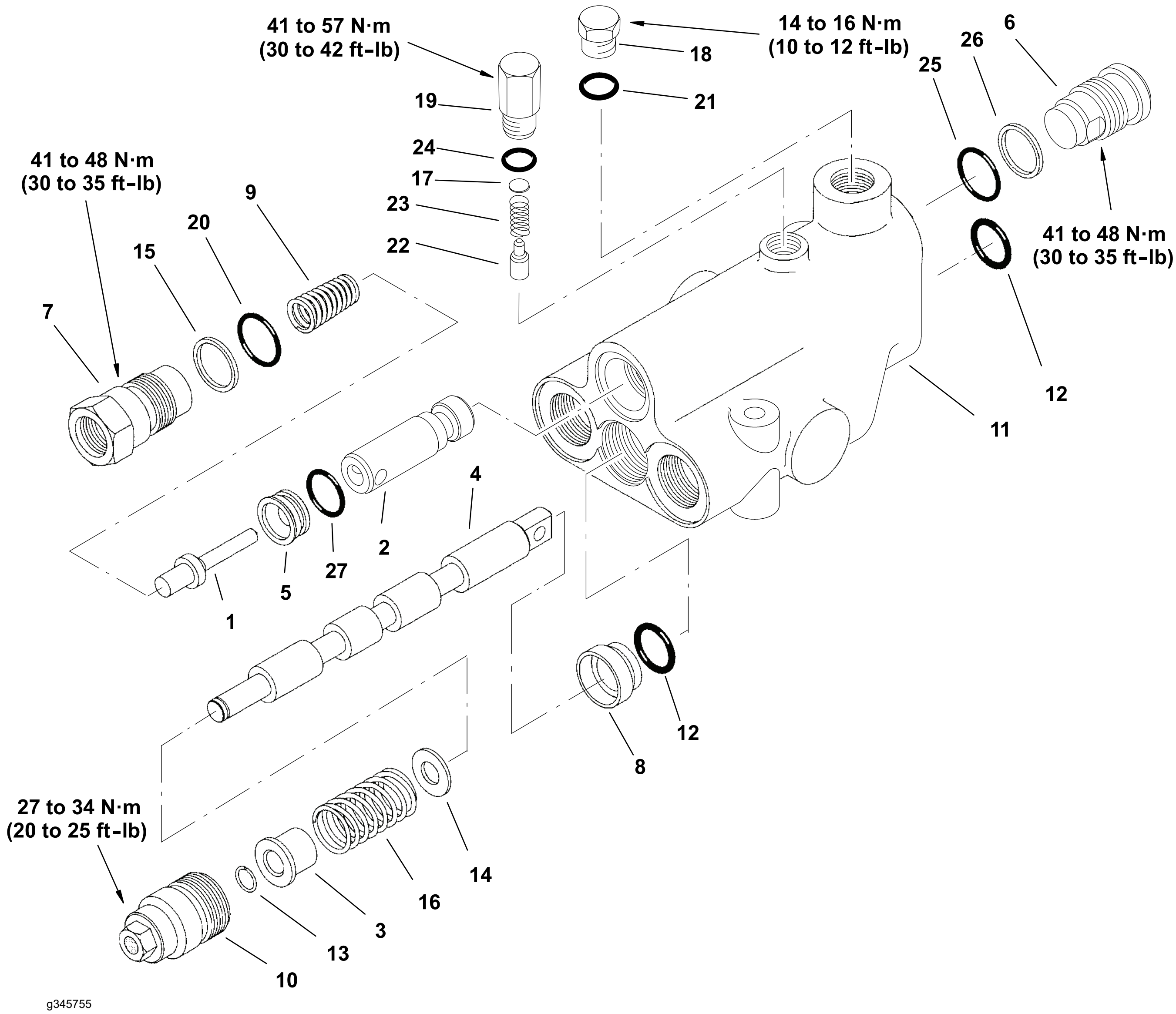

Figure 94

1. Check poppet
2. Plunger
3. Spacer
4. Spool
5. Seat
6. Plug (solid)
7. Seat retaining plug
8. Bushing
9. Check spring
10. Spool cap
11. Valve body
12. O-ring
13. Retaining ring
14. Washer
15. Back-up washer
16. Spool spring
17. Disc
18. Plug
19. Detent plug
20. O-ring
21. O-ring
22. Detent plunger
23. Spring
24. O-ring
25. O-ring
26. Back-up washer
27. O-ring

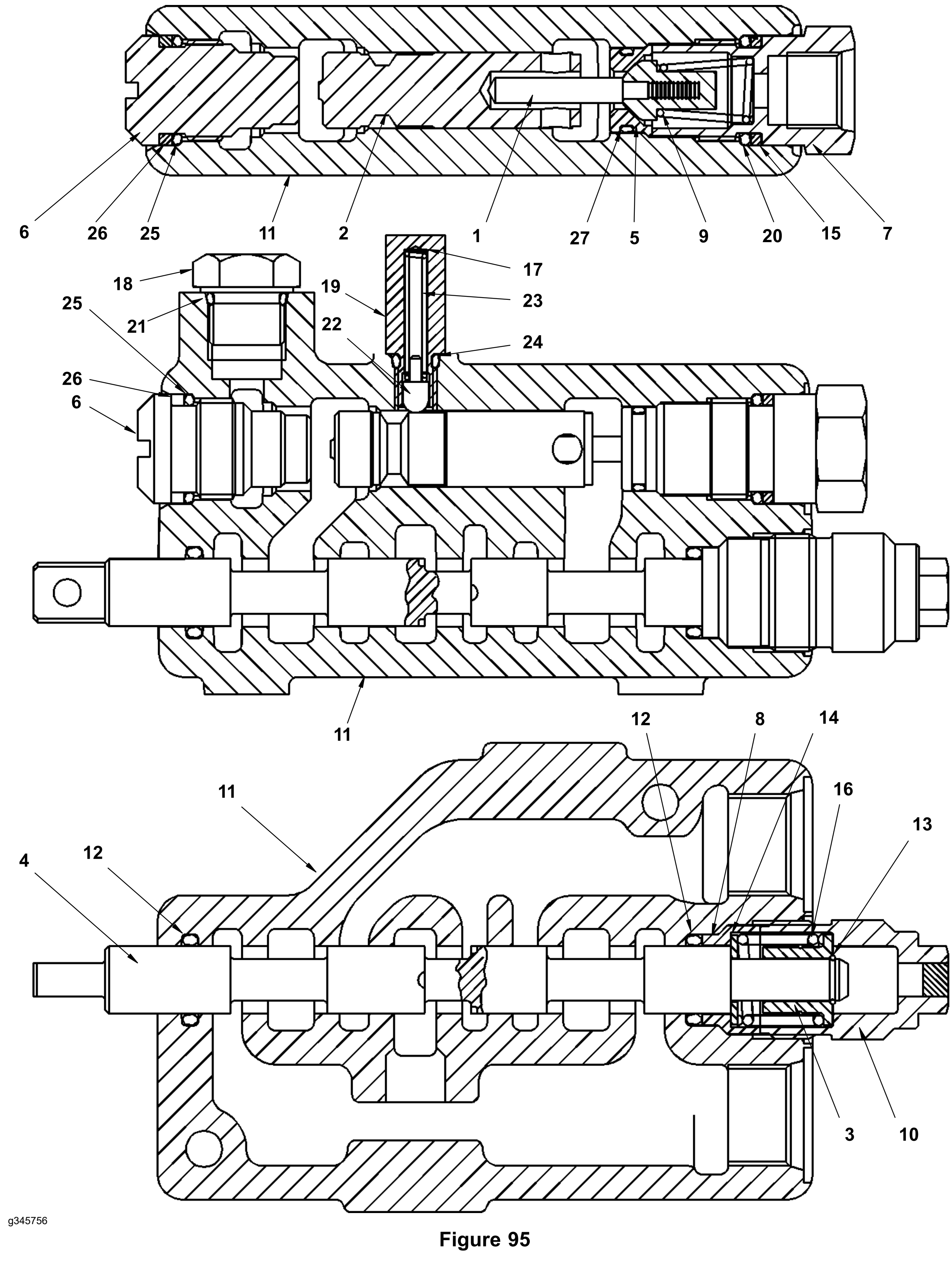

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Figure 95

Figure 95 (continued)

1. Check poppet
2. Plunger
3. Spacer
4. Spool
5. Seat
6. Plug (solid)
7. Seat retaining plug
8. Bushing
9. Check spring
10. Spool cap
11. Valve body
12. O-ring
13. Retaining ring
14. Washer
15. Back-up washer
16. Spool spring
17. Disc
18. Plug
19. Detent plug
20. O-ring
21. O-ring
22. Detent plunger
23. Spring
24. O-ring
25. O-ring
26. Back-up washer
27. O-ring

Disassembling the Control Valve

1. Plug all ports and clean the outside of the valve thoroughly.
2. Remove spool cap and slide the spool assembly from its bore.
3. Remove O−ring and bushing from the spool assembly.
4. Remove O−ring from the spool bore end that is opposite the spool cap.

   Note: Disassemble spool assembly only if the retaining ring, spacer, spring, or washer need replacing.
5. Remove seat retaining plug, back−up washer, O− ring, and check spring from the valve body.
6. Remove check poppet, seat, O−ring, and plunger from the valve body.
7. Remove solid plug, back−up washer, and O−ring from the opposite end of the plunger.
8. Remove plug and O−ring from the top of the valve body next to the detent plug.
9. Remove detent plug and O−ring from the valve body. Remove disc spring, and detent plunger from the body.

Inspecting the Control Valve

1. Inspect spool and spool bore for wear. If wear is excessive, replace valve with new one.
2. Inspect springs and replace as necessary.
3. Inspect plunger, detent plunger, and check poppet for wear. Replace as necessary.
4. Inspect seat, spacer, and bushing for wear. Replace as necessary.
5. Inspect disc and washer. Replace as necessary.
6. Inspect cap and plugs for damaged threads and O− ring sealing surfaces. Replace as necessary.

Assembling the Control Valve

Note: Do not wipe parts with paper towels or rags. Lint free cloth must be used to prevent lint from causing damage to the hydraulic system.

CAUTION

Use eye protection such as goggles when using compressed air.

1. Clean all metal parts with solvent and blow dry with compressed air.

Assembling the Control Valve (continued)

2. Replace check poppet, O−rings, and back−up washers with new ones.
3. Install new O−rings into the valve body.
4. Slide bushing and new O−ring over the spool.
5. If the spool was disassembled, install washer, spool spring, spacer, and retaining ring to the spool.
6. Lubricate spool liberally with clean hydraulic fluid and install into its proper bore.
7. Install spool cap into valve body. Torque cap from **27 to 34 N·m (20 to 25 ft−lb)**.
8. Install O−ring, back−up washer, and solid plug into the bore on the opposite end of the plunger. Torque plug from **41 to 48 N·m (30 to 35 ft−lb)**.
9. Lubricate plunger liberally with clean hydraulic fluid and install into its valve body bore.
10. Install new O−ring, seat, check poppet, and check spring into the plunger bore.
11. Install O−ring, back−up washer, and seat retaining plug into the plunger bore. Torque plug from **41 to 48 N·m (30 to 35 ft−lb)**.
12. Install O−ring and plug into the top of the valve body next to the detent plug bore. Torque plug from **14 to 16 N·m (10 to 12 ft−lb)**.
13. Lubricate plunger detent, spring, and disc liberally with clean hydraulic fluid and install into its valve body bore.
14. Install O−ring and detent plug into its proper bore. Torque plug from **41 to 57 N·m (30 to 42 ft−lb)**.

Control Valve (Model 03171)

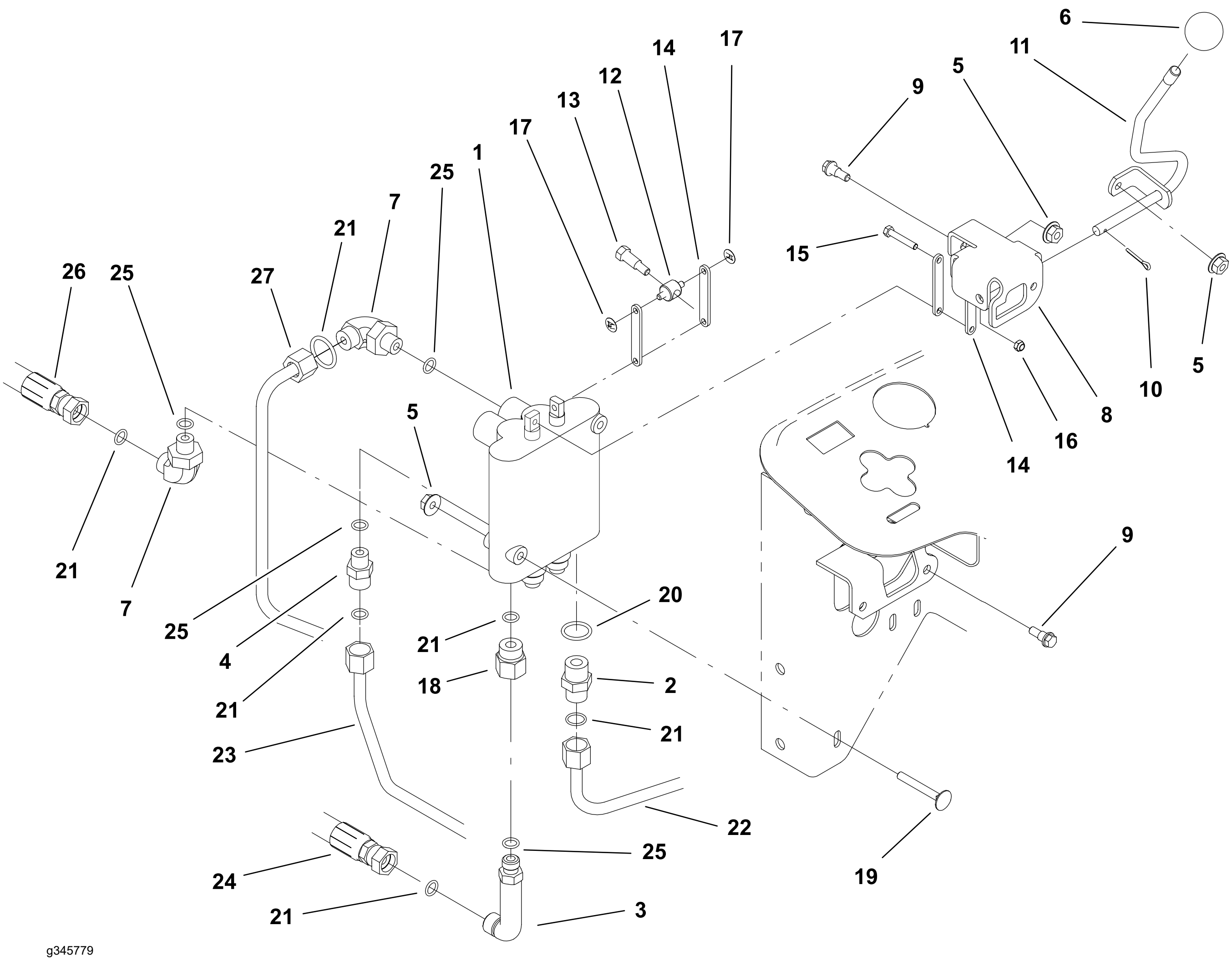

Figure 96

1. Control valve (2-spool)	10. Cotter pin	19. Carriage screw (2 each)
2. Hydraulic fitting (straight)	11. Valve lever	20. O-ring
3. 90º hydraulic fitting	12. Valve actuator trunnion	21. O-ring
4. Hydraulic fitting (straight)	13. Shoulder bolt	22. Hydraulic tube
5. Flange nut	14. Link (4 each)	23. Hydraulic tube
6. Knob	15. Bolt	24. Hydraulic hose
7. 90º hydraulic fitting	16. Lock nut	25. O-ring
8. Valve actuator bracket	17. Push nut	26. Hydraulic hose
9. Shoulder bolt	18. Hydraulic fitting	27. Hydraulic tube

Removing the Control Valve

1. Thoroughly clean hydraulic hose ends and fittings on lift cylinder to prevent hydraulic system contamination.

Removing the Control Valve (continued)

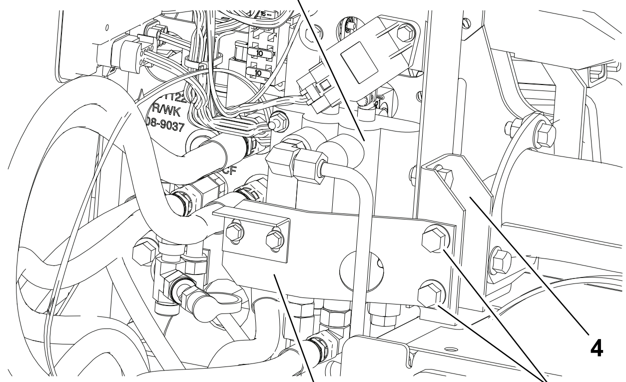

Figure 97

1. Spool valve
2. Magnet support bracket
3. Flange head screws
4. Frame

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure (page 5–3).

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2. Remove the control valve from the frame using Figure 96 and Figure 97 as guides.
3. If hydraulic fittings are to be removed from control valve, mark fitting orientation to allow correct assembly.

Installing the Control Valve

1. If fittings were removed, install fittings to control valve using marks made during the removal process to properly orientate fittings.
2. Install the control valve to the frame using Figure 96 and Figure 97 as guides.
3. Make sure hydraulic tank is full. Add correct fluid if necessary (see *Operator 's Manual*).

Servicing the Control Valve (Model 03171)

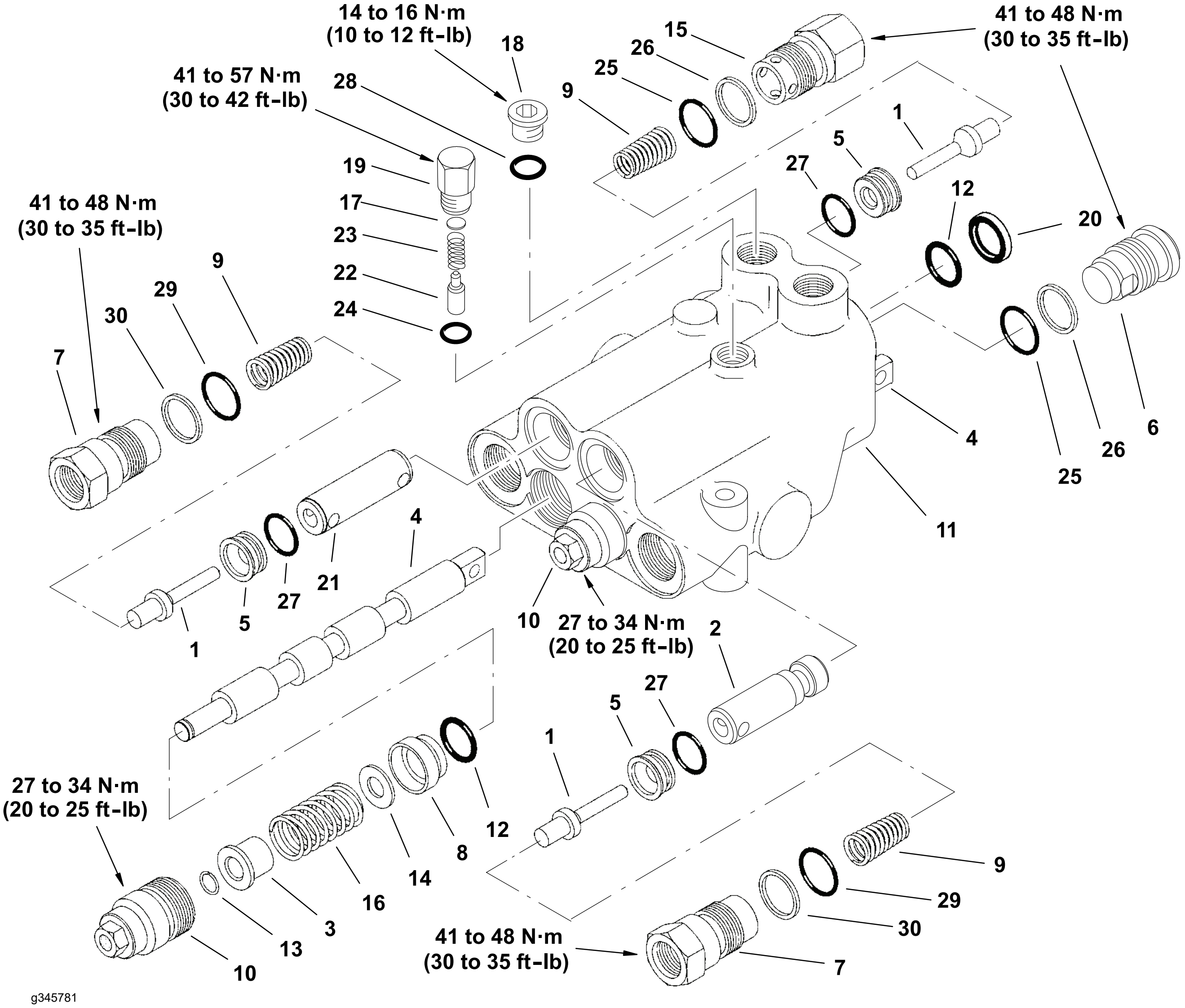

Figure 98

1. Check poppet
2. Grooved plunger
3. Spacer
4. Spool
5. Seat
6. Solid plug
7. Seat retaining plug with port
8. Bushing
9. Check spring
10. Spool cap
11. Valve body
12. O-ring
13. Retaining ring
14. Washer
15. Seat retaining plug
16. Spool spring
17. Disc
18. Plug
19. Detent plug
20. Wiper seal
21. Plunger
22. Plunger detent
23. Detent spring
24. O-ring
25. O-ring
26. Back-up washer
27. O-ring
28. O-ring
29. O-ring
30. Back-up washer

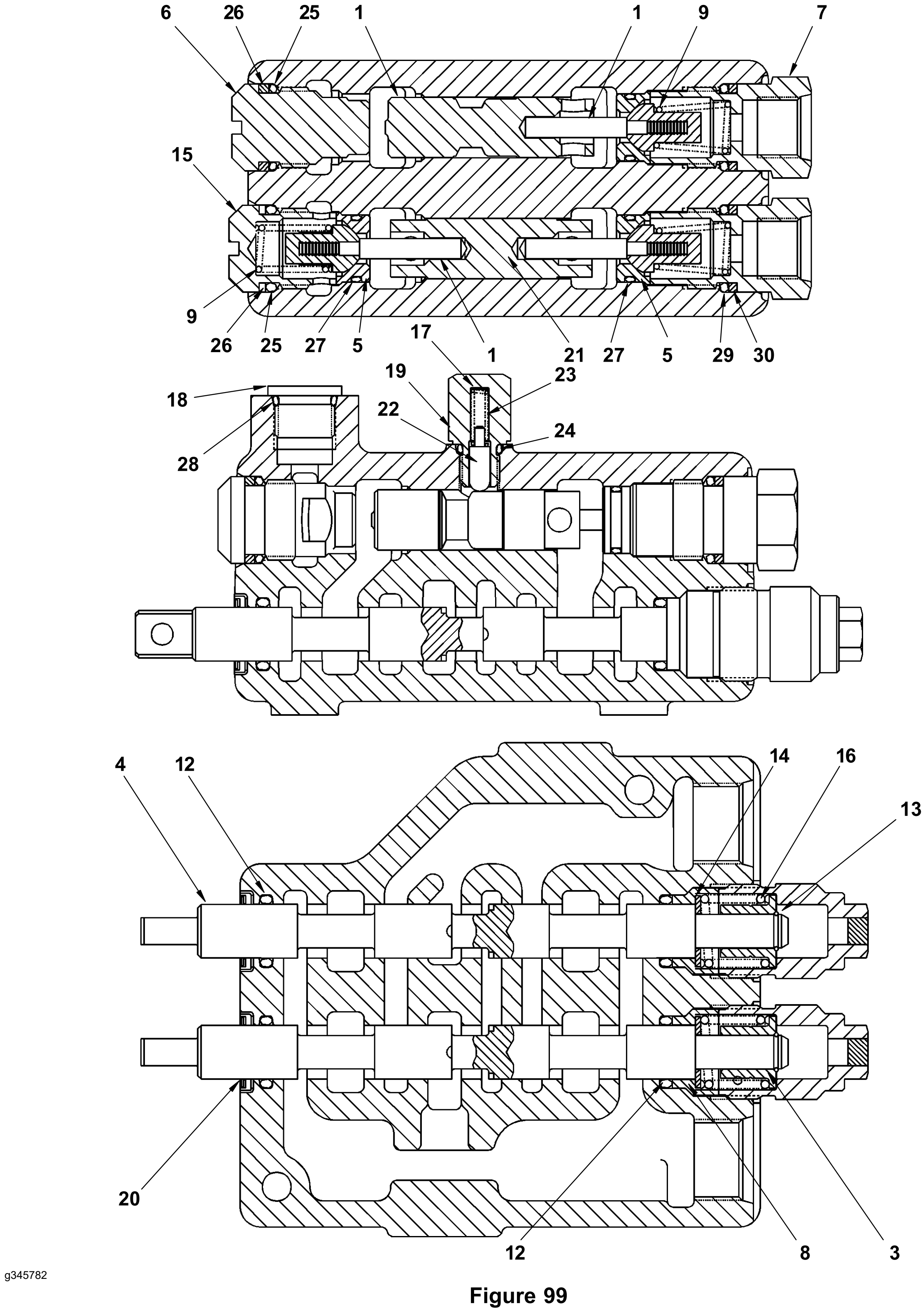
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Figure 99

Figure 99 (continued)

1.	Check poppet	11.	Valve body	21.	Plunger
2.	Grooved plunger	12.	O-ring	22.	Plunger detent
3.	Spacer	13.	Retaining ring	23.	Detent spring
4.	Spool	14.	Washer	24.	O-ring
5.	Seat	15.	Seat retaining plug	25.	O-ring
6.	Solid plug	16.	Spool spring	26.	Back-up washer
7.	Seat retaining plug with port	17.	Disc	27.	O-ring
8.	Bushing	18.	Plug	28.	O-ring
9.	Check spring	19.	Detent plug	29.	O-ring
10.	Spool cap	20.	Wiper seal	30.	Back-up washer

Disassembling the Control Valve

1. Plug all ports and clean the outside of the valve thoroughly.

IMPORTANT

Match mark spools to their associated bores. Spools must be reinstalled to the bore from which they were removed.

2. Remove both spool caps and slide the spool assemblies from their bores.
3. Remove O−ring and bushing from each spool assembly.
4. Remove wiper seals O−rings from the spool bore ends that are opposite the spool caps.

   Note: Disassemble spool assemblies only if the retaining ring, spacer, spring, or washer need replacing.
5. Remove seat retaining plugs, back−up washers, O− rings, and check springs from the valve body.
6. Remove check poppets, seats, O−rings, and plungers from the valve body.
7. Remove solid plug, back−up washer, and O−ring from the opposite end of the plunger.
8. Remove plug and O−ring from the top of the valve body next to the detent plug.
9. Remove detent plug and O−ring from the valve body. Remove disc spring, and detent plunger from the body

Inspecting the Control Valve

1. Inspect spools and spool bores for wear. If wear is excessive, replace valve with new one.
2. Inspect springs and replace as necessary.
3. Inspect plunger, detent plunger, and check poppet for wear. Replace as necessary.
4. Inspect seat, spacer, and bushing for wear. Replace as necessary.
5. Inspect disc and washer. Replace as necessary.
6. Inspect cap and plugs for damaged threads and O− ring sealing surfaces. Replace as necessary.

Assembling the Control Valve

IMPORTANT

Do not wipe parts with paper towels or rags. Lint may cause damage to the hydraulic system.

CAUTION

Use eye protection such as goggles when using compressed air.

1. Clean all metal parts with solvent and blow dry with compressed air.
2. Replace check poppets, O−rings, and back−up washers with new ones.
3. Install new O−rings into the valve body.
4. Slide bushings and new O−rings over the spools.
5. If a spool was disassembled, install washer, spool spring, spacer, and retaining ring to the spool.
6. Lubricate spools liberally with clean hydraulic fluid and install into their proper bore.
7. Install spool caps into valve body. Torque caps from **27 to 34 N·m (20 to 25 ft−lb)**.
8. Lubricate both plungers liberally with clean hydraulic fluid and install into their proper bore.
9. Install new O−rings, seats, check poppets, and check springs into the plunger bores.
10. Install O−rings, back−up washers, and seat retaining plugs into their plunger bores. Torque both plugs from **41 to 48 N·m (30 to 35 ft−lb)**.
11. Install new O−ring, back−up washer, and solid plug into the bore with the grooved plunger. Torque plug from **41 to 48 N·m (30 to 35 ft−lb)**.
12. Install new O−ring, seat, check poppet, check spring, new O−ring, back−up washer, and seat retaining plug into the bore with the plunger. Torque plug from **41 to 48 N·m (30 to 35 ft−lb)**.
13. Install O−ring and plug into the top of the valve body next to the detent plug bore. Torque plug from **14 to 16 N·m (10 to 12 ft−lb)**.
14. Lubricate plunger detent, spring, and disc liberally with clean hydraulic fluid and install into its valve body bore.
15. Install O−ring and detent plug into its proper bore. Torque plug from **41 to 57 N·m (30 to 42 ft−lb)**.

Sidewinder (Model 03171)

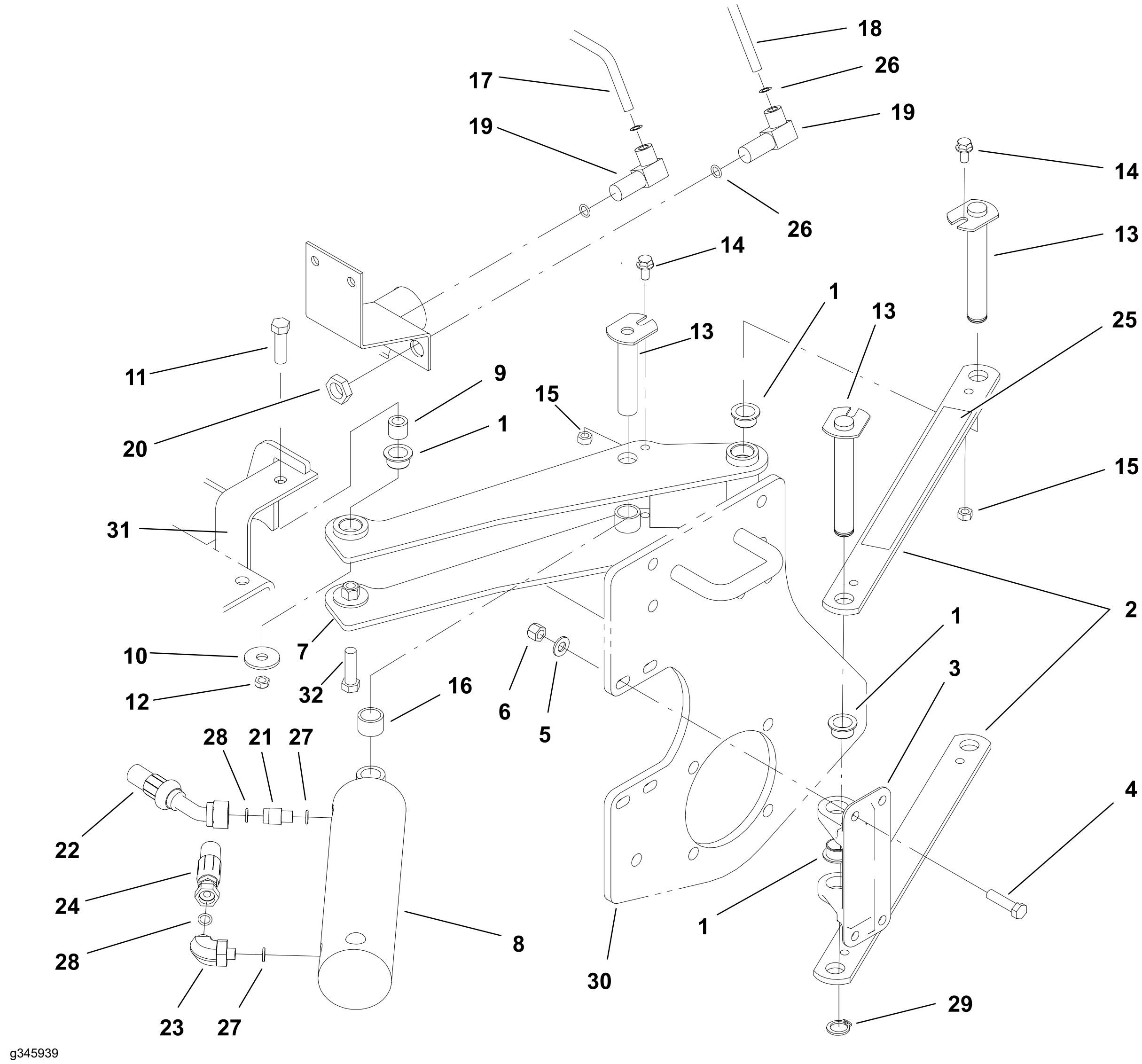

Figure 100

1.	Plastic bushing	12.	Lock nut	23.	90º hydraulic fitting
2.	Scissor link	13.	Welded pin	24.	Hydraulic hose
3.	Scissor mount	14.	Flange head screw	25.	Pinch point decal
4.	Cap screw	15.	Lock nut	26.	O-ring
5.	Flat washer	16.	Spacer	27.	O-ring
6.	Lock nut	17.	Hydraulic tube	28.	O-ring
7.	Scissor frame	18.	Hydraulic tube	29.	Retaining ring
8.	Hydraulic cylinder	19.	90º hydraulic fitting	30.	Lower frame (LH)
9.	Spacer	20.	Bulkhead lock nut	31.	Frame
10.	Flat washer	21.	Straight hydraulic fitting	32.	Bolt
11.	Cap screw	22.	Hydraulic hose		

Removing the Sidewinder

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure (page 5–3).

The hydraulic cylinder used in the Reelmaster sidewinder assembly is a non−serviceable cylinder. Replace the cylinder if it becomes worn or damaged.

1. Remove the hydraulic cylinder from the frame using Figure 100 as guide.
2. If hydraulic fittings are to be removed from cylinder, mark fitting orientation to allow correct assembly.

Installing the Sidewinder

1. If hydraulic fittings were removed from cylinder, install fittings to cylinder using marks made during the removal process to properly orientate fittings.
2. Install hydraulic cylinder to the frame using Figure 100 as guide.
3. Adjust scissors mount as follows:
   A. Shift sidewinder fully to the left (fully retract cylinder).
   B. Loosen four cap screws securing mount to lower frame.
   C. The gap between the scissor frame and lower frame and the gap between the scissor frame and the sidewinder carrier must be equal distances within **1.5 mm (0.060 inch)**.
   D. Tighten four cap screws and lock nuts.

Steering Control Valve

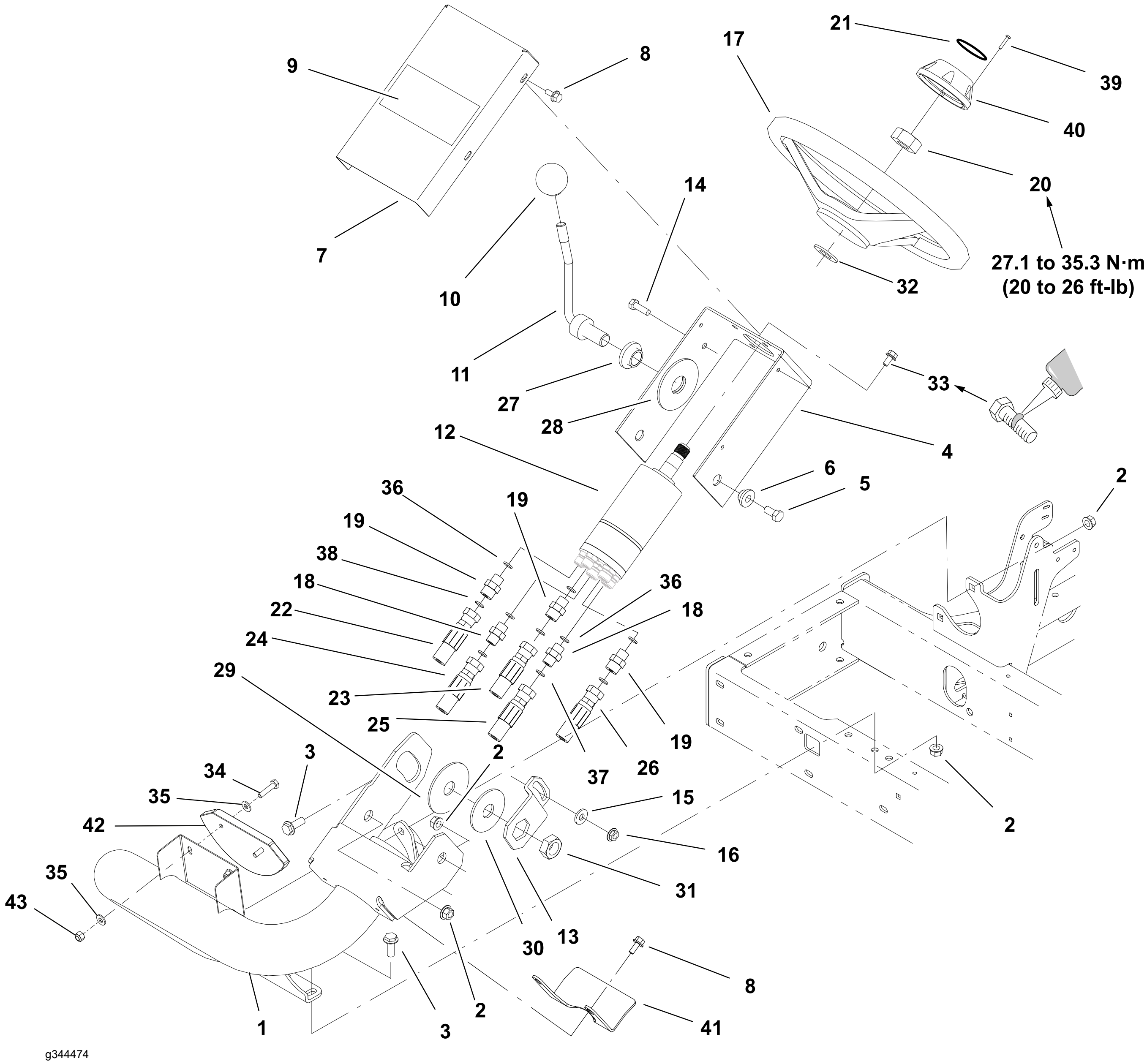

Figure 101

1. Steering arm
2. Flange hex nut
3. Hex flange head bolt
4. Steering control valve bracket
5. Bolt
6. Pivot hub
7. Steering cover
8. Bolt
9. Decal
10. Ball knob
11. Lever
12. Steering control valve
13. Tilt bracket
14. Bolt
15. Flat washer
16. Flange hex nut
17. Steering wheel
18. Hydraulic fitting
19. Hydraulic fitting
20. Steering wheel nut
21. Decal
22. Hose assembly
23. Hose assembly
24. Hose assembly
25. Hose assembly
26. Hose assembly
27. Tilt steering boss
28. Friction disc
29. Friction disc
30. Flat washer
31. Jam nut
32. Flat washer
33. Flange head bolt
34. Bolt
35. Washer
36. O−ring
37. O−ring
38. O−ring
39. Phillips pan head screw
40. Steering wheel cap
41. Steering shield
42. Slope indicator assembly
43. Nut

Removing the Steering Control Valve

1. Park the machine on a level surface. Lower cutting units, stop engine and engage parking brake. Remove key from the key switch.
2. Thoroughly clean the hydraulic hose ends and fittings on steering control valve to prevent hydraulic system contamination.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure (page 5–3).

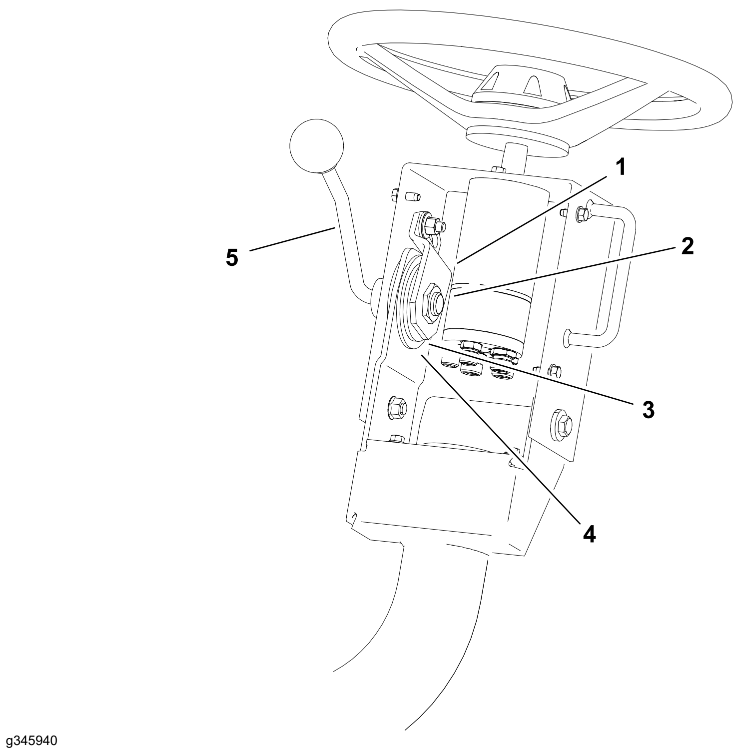

Figure 102

1. Tilt bracket
2. Jam nut
3. Flat washer
4. Friction disc
5. Steering tilt lever

3. Label all hydraulic hoses and fittings for assembly purposes. Note port identification on steering control valve.
4. Remove the steering control valve from the steering column using the Figure 101 and Figure 102.

Installing the Steering Control Valve

1. Install the steering control valve to the steering column using the Figure 101 and Figure 102.
2. Use labels placed during the removal process to properly install hydraulic hoses to control valve.
3. Adjust location of steering shield so that it just contacts hydraulic hoses when the steering wheel is tilted to its lowest position.
4. Make sure hydraulic tank is full. Add correct fluid if necessary.

Servicing the Steering Control Valve

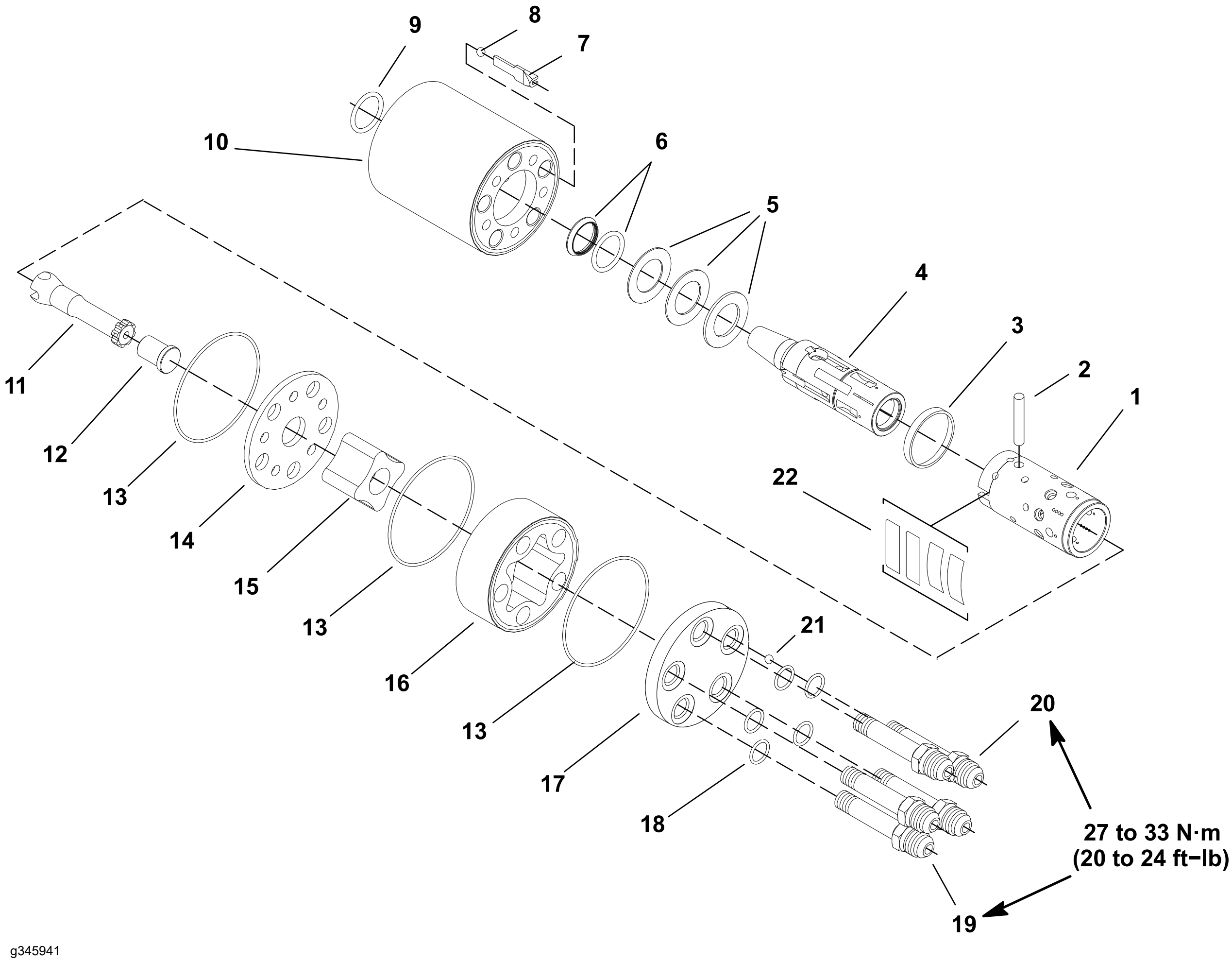

Figure 103

1. Sleeve
2. Cross pin
3. Ring
4. Spool
5. Bearing assembly
6. Shaft seal
7. Ball stop
8. Ball
9. Dust seal ring
10. Housing
11. Cardan shaft
12. Spacer
13. O–ring
14. Distribution plate
15. Inner gearwheel
16. Outer gearwheel
17. End cover
18. O–ring (5 used)
19. Screw/fitting (ports L and R)
20. Screw/fitting (ports P, T and E)
21. P port check ball
22. Spring set

Note: For service of the steering control valve, see the Sauer/Danfoss Steering Unit Type OSPM Service Manual.

Steering Cylinder

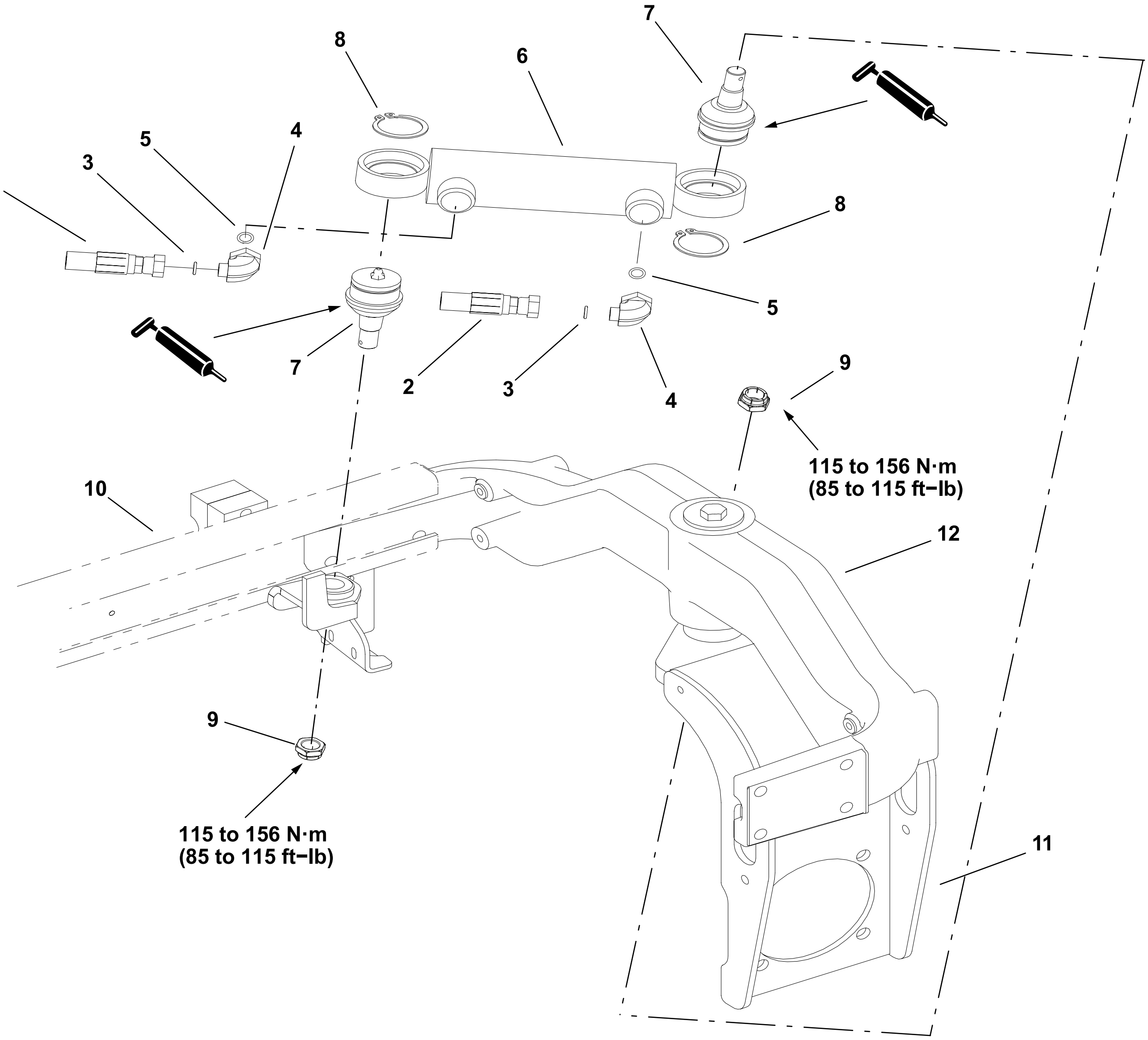

Figure 104

1.	Hydraulic hose	5.	O−ring	9.	Flextop lock nut
2.	Hydraulic hose	6.	Steering cylinder	10.	Frame
3.	O−ring	7.	Ball joint	11.	Rear fork
4.	Hydraulic fitting	8.	Retaining ring	12.	Rear casting

Removing the Steering Cylinder

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

   Note: The rear tire must be removed to allow sufficient clearance to remove the steering cylinder from the machine.

Removing the Steering Cylinder (continued)

⚠ WARNING ⚠

Before jacking up the machine, review and follow Jacking Instructions (page 1–7).

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2. Jack or lift rear wheel off the ground.
3. Remove the rear wheel from the machine.
4. Thoroughly clean hydraulic hose ends and fittings on steering cylinder to prevent hydraulic system contamination.

⚠ WARNING ⚠

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure (page 5–3).

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5. Label the hydraulic hoses to show their correct position on the steering cylinder. Remove the hydraulic hoses from steering cylinder.
6. Remove the flextop lock nut from both steering cylinder ball joints.
7. Use a suitable tool (pickle fork) to separate the ball joints from the machine.
8. If hydraulic fittings are to be removed from steering cylinder, mark fitting orientation to allow correct assembly. Discard the O−rings from removed fittings.
9. If needed, remove the ball joints from steering cylinder.

Installing the Steering Cylinder

1. If removed, install ball joints into steering cylinder.
2. Lubricate and place new O−rings onto removed steering cylinder fittings. Install fittings into cylinder openings using marks made during the removal process to properly orientate fittings. Tighten fittings (see Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–8)).
3. Install the steering cylinder to machine. When securing cylinder ball joints to machine, torque tighten the flextop lock nut from **115 to 156 N·m (85 to 115 ft−lb)**.
4. Remove caps and plugs from steering cylinder fittings and hoses. Using labels placed during cylinder removal, properly connect hydraulic lines to steering cylinder (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal Fittings) (page 5–6)).
5. Secure the rear wheel to the machine with four (4) lug nuts. Lower machine to the ground. Torque wheel lug nuts in a crossing pattern from **61 to 88 N·m (45 to 65 ft−lb)**.
6. Make sure that the hydraulic tank is full. Add correct fluid if necessary.
7. After assembly is completed, operate steering cylinder to verify that hydraulic hoses and fittings are not contacted by anything.

Servicing the Steering Cylinder

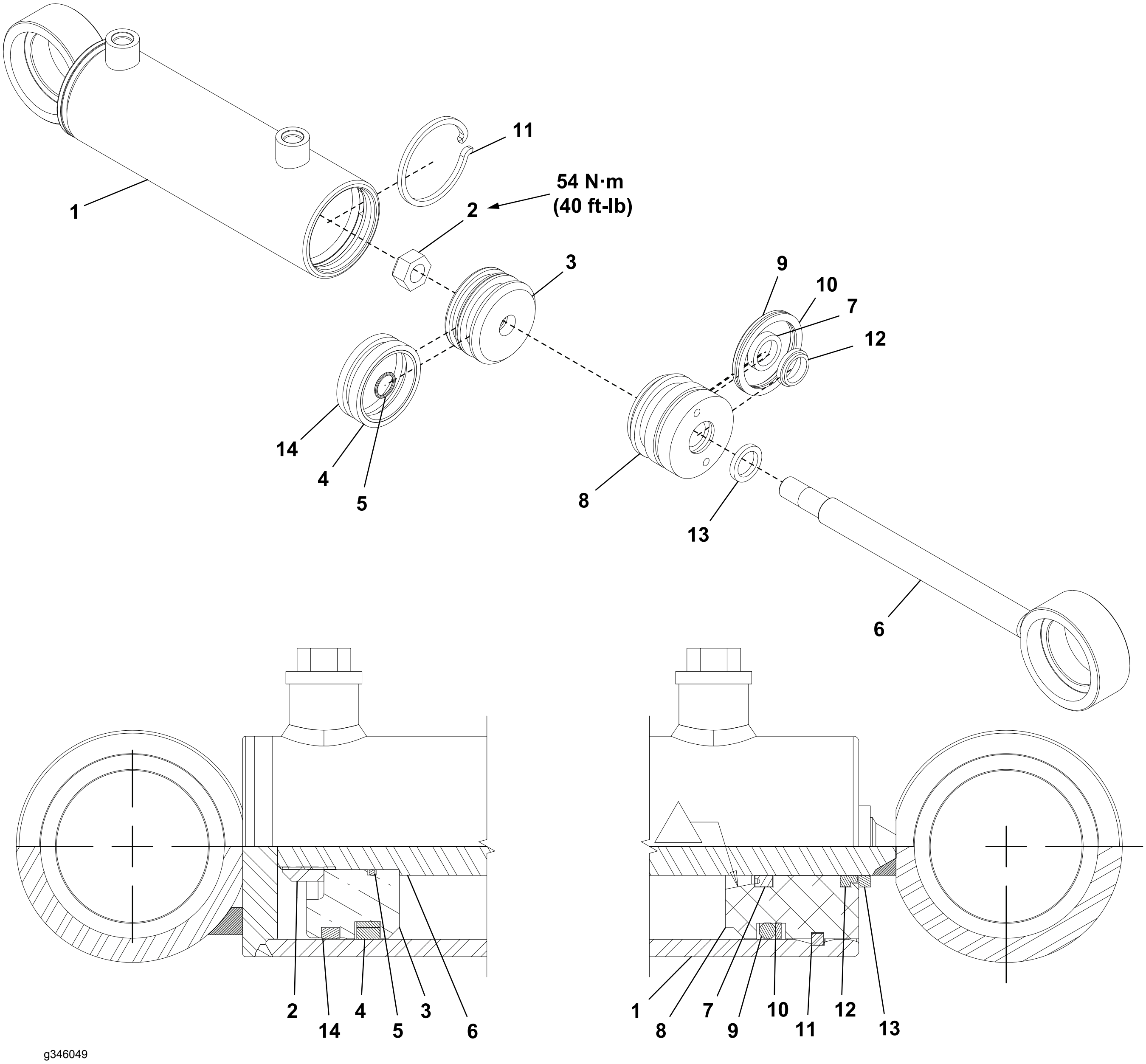

Figure 105

1.	Barrel with clevis	6.	Piston rod	11.	Retaining ring
2.	Lock nut	7.	Rod seal	12.	Dust seal
3.	Piston	8.	Cylinder gland	13.	Square O-ring
4.	Seal	9.	O-ring	14.	Wear ring
5.	O-ring	10.	Back−up ring		

Disassembling the Steering Cylinder

1. Remove the hydraulic fluid from the steering cylinder into a drain pan by slowly pumping the cylinder shaft. Plug both ports and clean the outside of the cylinder.

Disassembling the Steering Cylinder (continued)

IMPORTANT

Prevent damage when clamping the hydraulic cylinder into a vise; clamp on the clevis only.

2. Mount clevis end of steering cylinder in a vice. Remove the retaining ring.
3. Remove plugs from ports. Extract shaft, cylinder gland, and piston by carefully twisting and pulling on the shaft.

IMPORTANT

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

4. Mount shaft securely in a vise by clamping on the clevis of the shaft. Remove lock nut and piston from the shaft. Slide cylinder gland off the shaft.
5. Remove the wear ring, seal and O–ring from the piston.
6. Remove back−up ring, O–rings, rod seal and dust seal from the cylinder gland.

Assembling the Steering Cylinder

Carefully inspect internal surface of cylinder barrel for damage (deep scratches, out−of−round, etc.). Inspect piston rod for straightness, excessive scoring, and pitting or wear. Inspect piston and head for evidence of excessive scoring and pitting or wear. Replace entire cylinder assembly if necessary.

1. Make sure all parts are clean before reassembly.
2. Coat new O–rings, wear ring, seal, rod seal, and back−up ring with clean hydraulic fluid.
   A. Install seal, wearing and O–ring to the piston.
   B. Install dust seal, rod seal, O–rings and back−up ring to the cylinder gland.

IMPORTANT

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

3. Mount shaft securely in a vise by clamping on the clevis of the shaft.
   A. Coat shaft with a light coat of clean hydraulic fluid.
   B. Slide cylinder gland assembly onto the shaft. Install piston and lock nut onto the shaft. Torque nut from **54 N·m (40 ft−lb)**.
   C. Remove shaft from the vise.

IMPORTANT

Prevent damage when clamping the hydraulic cylinder into a vise; clamp on the clevis only.

4. Mount clevis of the barrel in a vice.

Assembling the Steering Cylinder (continued)

5. Coat all internal parts with a light coat of clean hydraulic fluid. Slide piston, shaft, and cylinder gland assembly into the barrel being careful not to damage the seals.
6. Secure head into the barrel with the retaining ring.

Front Lift Cylinder

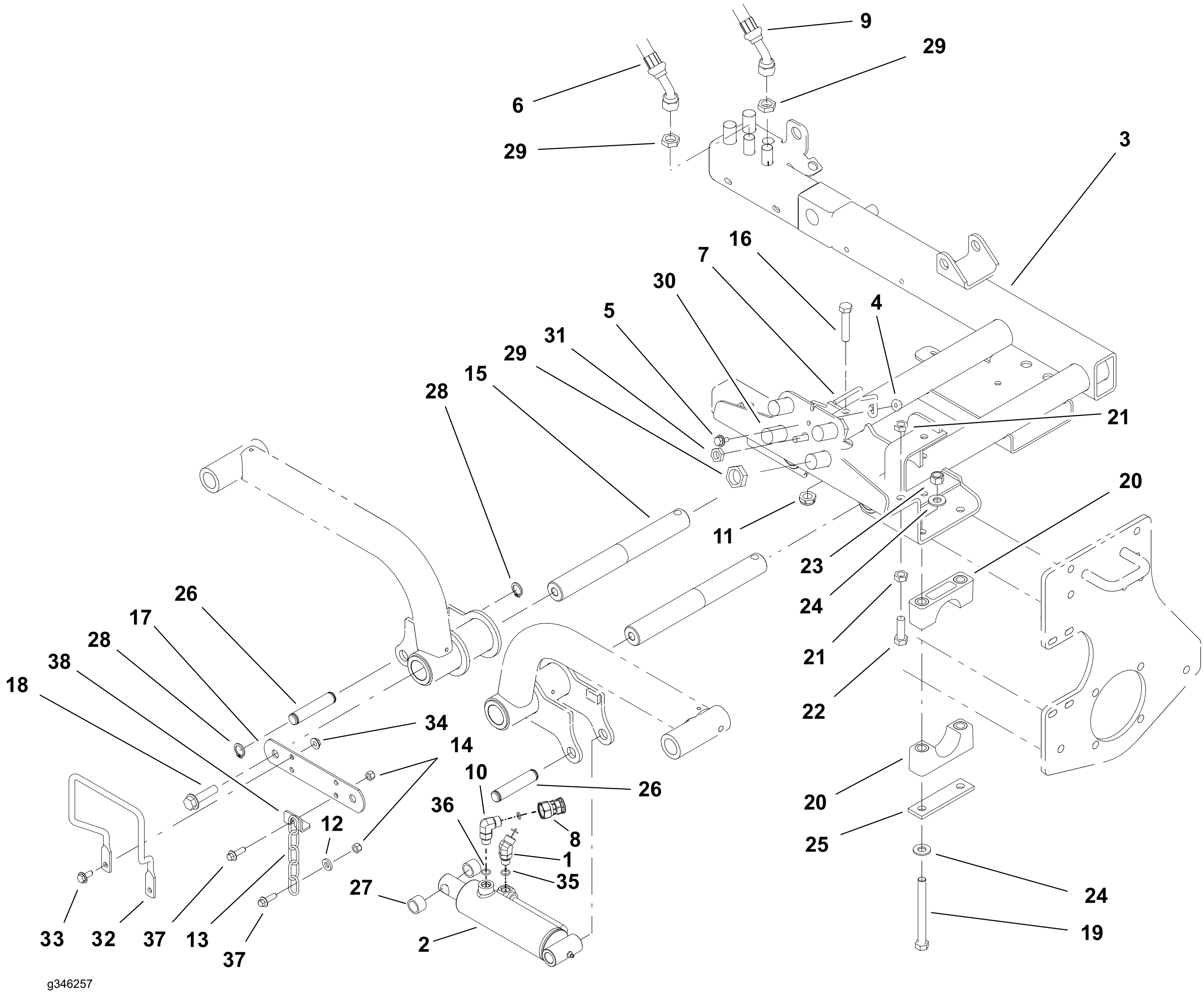

Figure 106

Model 03171 (shown)

1. 45º hydraulic fitting
2. Hydraulic cylinder
3. Carrier assembly
4. Flange nut
5. Flange head screw
6. Hydraulic hose
7. Centering wire
8. Hydraulic hose
9. Hydraulic hose
10. 90º hydraulic fitting
11. Flange nut
12. Flat washer
13. Straight link chain
14. Hex nut
15. Lift arm pivot shaft
16. Bolt
17. Pivot shaft link
18. Flange head screw
19. Cap screw
20. Bearing cap
21. Jam nut
22. Cap screw
23. Lock nut
24. Hardened washer
25. Slide support bar
26. Pin
27. Spacer
28. External retaining ring
29. Bulkhead nut
30. Hydraulic tube
31. Bulkhead nut
32. Hose rod
33. Flange head screw
34. Flange nut
35. O−ring
36. O−ring
37. Flange head screw
38. Link clip

Removing the Front Lift Cylinder

1. Park machine on a level surface. Lower cutting units, stop engine and engage parking brake. Remove key from the key switch.
2. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–62).
3. To prevent contamination of hydraulic system during lift cylinder removal, thoroughly clean exterior of cylinder and fittings.

WARNING

Make sure that the cutting units are fully lowered before loosening hydraulic lines from lift cylinders. If cutting units are not fully lowered as hydraulic lines are loosened, cutting units may drop unexpectedly.

Note: To ease installation, label the hydraulic hoses to show their correct position on the lift cylinder.

4. Disconnect the hydraulic hoses from lift cylinder and plug hydraulic hoses to prevent contamination.
5. Remove front lift cylinder from the frame and lift arm using Figure 106 as guide.
6. If hydraulic fittings are to be removed from lift cylinder, mark fitting orientation to allow correct assembly. Remove fittings from the cylinder and discard O−rings.

Installing the Front Lift Cylinder

1. If fittings were removed from lift cylinder, lubricate and place new O−rings onto fittings. Install fittings into cylinder port openings using marks made during the removal process to properly orientate fittings. Tighten fittings (see Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–8)).
2. Install the front lift cylinder to the frame and lift arm using Figure 106 as guide.

   Torque tighten the cap screws (19) as below:

   A. For Models 03170 and 03174: **75 to 88 N·m (55 to 65 ft-lb)**

   B. For Model 03171: **91 to 112 N·m (67 to 83 ft-lb)**
3. Attach the hydraulic hoses to lift cylinder (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal Fittings) (page 5–6)).
4. Fill the reservoir with hydraulic fluid as required.
5. Adjust the front lift arm; refer to *Operator's Manual*.
6. After installation is completed, operate lift cylinder to verify cylinder, hydraulic hose and fitting clearance.

Rear Lift Cylinder

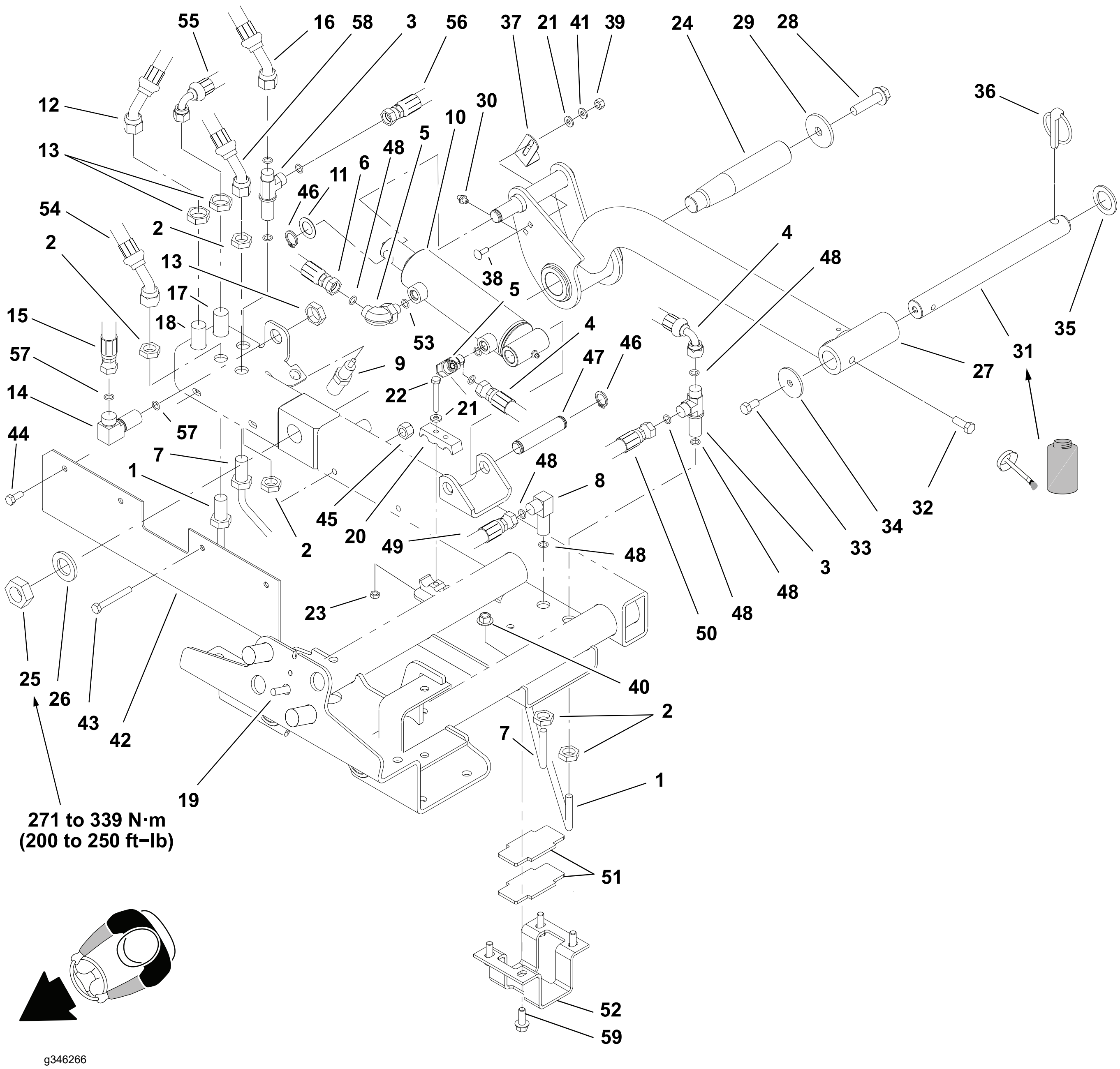

Figure 107

Model 03171 (shown)

Figure 107 (continued)

1. Hydraulic tube
2. Lock nut
3. Hydraulic T−fitting
4. Hydraulic hose
5. 90° hydraulic fitting
6. Hydraulic hose
7. Hydraulic tube
8. 90° hydraulic fitting
9. Push button switch
10. Hydraulic cylinder
11. Thrust washer
12. Hydraulic hose
13. Bulkhead nut
14. Hydraulic fitting
15. Hydraulic hose
16. Hydraulic hose
17. Hydraulic tube
18. Hydraulic tube
19. Hydraulic tube
20. Tube clamp
21. Flat washer
22. Cap screw
23. Lock nut
24. Rear pivot shaft
25. Jam nut
26. Washer
27. Rear lift arm assembly
28. Flange head screw
29. Thrust washer
30. Grease fitting
31. Cutting unit pivot shaft
32. Cap screw
33. Cap screw
34. Rebound washer
35. Washer
36. Lynch pin
37. Switch bracket
38. Carriage screw
39. Nut
40. Flange nut
41. Lock washer
42. Guard
43. Cap screw
44. Cap screw
45. Lock nut
46. External retaining ring
47. Pin
48. O−ring
49. Hydraulic hose
50. Hydraulic hose
51. Plastic slide
52. Bracket
53. O−ring
54. Hydraulic hose
55. Hydraulic hose
56. Hydraulic hose
57. O−ring
58. Hydraulic hose
59. Flange head bolt

Removing the Rear Lift Cylinder

1. Park machine on a level surface. Lower cutting units, stop engine and engage parking brake. Remove key from the key switch.
2. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–62).
3. To prevent contamination of hydraulic system during lift cylinder removal, thoroughly clean exterior of cylinder and fittings.

WARNING

Make sure that the cutting units are fully lowered before loosening hydraulic lines from lift cylinders. If cutting units are not fully lowered as hydraulic lines are loosened, cutting units may drop unexpectedly.

Note: To ease installation, label the hydraulic hoses to show their correct position on the lift cylinder.

4. Disconnect the hydraulic hoses from the rear lift cylinder.
5. Remove the rear lift cylinder from the frame and lift arm using Figure 107 as guide.
6. If hydraulic fittings are to be removed from lift cylinder, mark fitting orientation to allow correct assembly. Discard O−rings.

Installing the Rear Lift Cylinder

1. If fittings were removed from lift cylinder, lubricate and place new O−rings onto fittings. Install fittings into cylinder port openings using marks made during the removal process to properly orientate fittings. Tighten fittings (see Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–8)).
2. Install the rear lift cylinder to the frame and lift arm using Figure 107 as guide.
3. Attach hydraulic hoses to lift cylinder (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal Fittings) (page 5–6)).
4. Fill the reservoir with hydraulic fluid as required.
5. Adjust the rear lift arm; refer to *Operator's Manual*.
6. After installation is completed, operate lift cylinder to verify cylinder, hydraulic hose and fitting clearance.

Servicing the Lift Cylinder

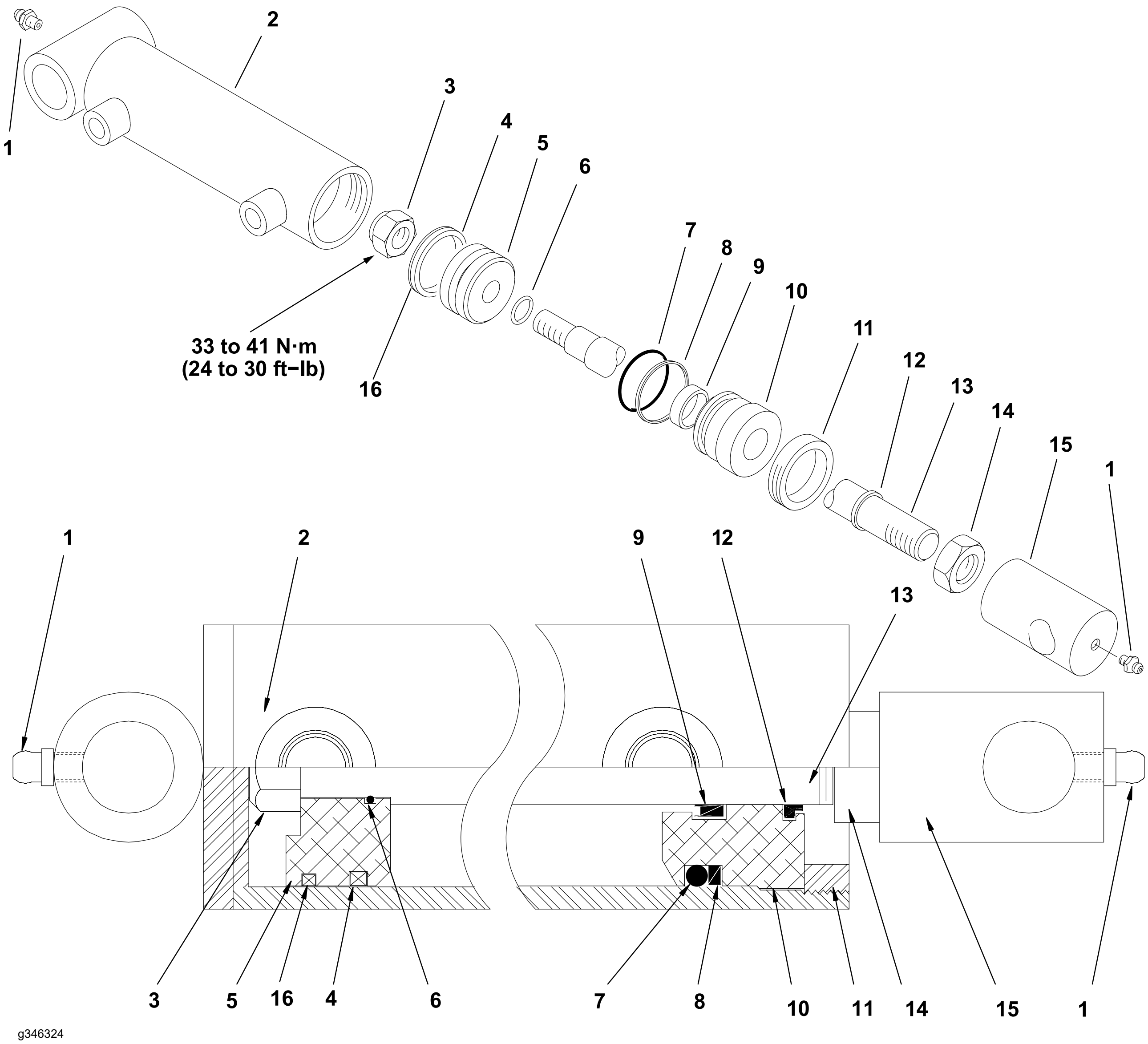

Figure 108

1. Grease fitting
2. Barrel with clevis
3. Nut
4. Seal
5. Piston
6. O−ring
7. O−ring
8. Back−up ring
9. Rod seal
10. Head
11. Internal collar
12. Dust seal
13. Shaft
14. Jam nut
15. Clevis
16. Wear ring

Disassembling the Lift Cylinder

1. Remove fluid from lift cylinder into a drain pan by slowly pumping the cylinder shaft. Plug both ports and clean the outside of the cylinder.

IMPORTANT

Prevent damage when clamping the hydraulic cylinder into a vise; clamp on the clevis only.

Disassembling the Lift Cylinder (continued)

2. Mount lift cylinder in a vice. Remove the internal collar with a spanner wrench.
3. Extract the shaft, head, and piston by carefully twisting and pulling on the shaft.

IMPORTANT

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

4. Mount shaft securely in a vise by clamping on the clevis of the shaft. Remove lock nut and piston from the shaft. Slide head off the shaft.
5. Remove wear ring, seal and O−ring from the piston. Remove O−ring, back−up ring, rod seal, and dust seal from the head.

Assembling the Lift Cylinder

1. Make sure all parts are clean before reassembly.
2. Coat new O−rings, seal, wear ring, rod seal, back−up ring, and dust seal with clean hydraulic oil.
   A. Install the seal, wear ring and O−ring to the piston.
   B. Install the dust seal, O−ring, back−up ring, and dust seal to the head.

IMPORTANT

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

3. Mount shaft securely in a vise by clamping on the clevis of the shaft.
   A. Coat shaft with clean hydraulic oil.
   B. Slide head onto the shaft. Install rod seal onto shaft and into head.
   C. Install piston and nut onto the shaft. Torque nut from **33 to 41 N·m (24 to 30 ft−lb)**.
   D. Remove the shaft from the vise.

IMPORTANT

Prevent damage when clamping the hydraulic cylinder into a vise; clamp on the clevis only.

4. Mount the barrel in a vice.
5. Coat all internal parts with a light coat of clean hydraulic oil. Slide piston, shaft, and head assembly into the barrel being careful not to damage the seals.
6. Secure head in the barrel with internal collar using a spanner wrench. Tighten the collar until snug and the outer end of the collar is flush with end of the barrel.

Chapter 6

Electrical System

Table of Contents

General Information

Operator's Manual

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

Electrical Drawings

The electrical schematic and wire harness drawings for the Reelmaster 3100−D and the Reelmaster 3105−D are located in Chapter 9 − Foldout Drawings.

Standard Control Module (SCM)

All Reelmaster 3100–D and 3105–D machines are equipped with a Standard Control Module (SCM) to monitor and control electrical components required for safe operation. The SCM can be used to check operation of machine switches by monitoring the SCM LED's. Detailed information on the Standard Control Module can be found later in this chapter.

Diesel Engine − Electrical Components

The engine used in the Reelmaster incorporates the following electrical components to start and run properly:

- Glow plug controller and relay
- Fuel stop Solenoid
- High Temp Warning and Shutdown Switches
- Oil Pressure Switch
- Alternator

Additional information on troubleshooting and servicing engine electrical components can be found in the appropriate Kubota Workshop Manual.

Electrical System Quick Checks

Battery Test (Open Circuit Test)

Use a multimeter to measure the voltage between the battery terminals.

Set the multimeter to the DC volts setting. The battery should be at a temperature of 16º to 38ºC (60º to 100ºF). The key switch should be off and all accessories turned off. Connect the positive (+) meter lead to the positive battery post and the negative (−) meter lead to the negative battery post.

Note: This test provides a relative condition of the battery. Load testing of the battery will provide additional and more accurate information (see Servicing the Battery (page 6–49)).

Voltage Measured	Battery Charge Level
12.68 V (or higher)	Fully charged (100%)
12.45 V	75% charged
12.24 V	50% charged
12.06 V	25% charged
11.89 V	0% charged

Charging System Test

This is a simple test used to determine if a charging system is functioning. It will tell you if the charging system has an output, but not its capacity.

Use a digital multimeter set to DC volts. Connect the positive (+) multimeter lead to the positive battery post and the negative (−) multimeter lead to the negative battery post. Keep the test leads connected to the battery posts and record the battery voltage.

Note: Upon starting the engine, the battery voltage will drop and then should increase once the engine is running.

Note: Depending upon the condition of the battery charge and battery temperature, the battery voltage will increase at different rates as the battery charges.

Start the engine and run at high idle (2650 RPM). Allow the battery to charge for at least three (3) minutes. Record the battery voltage.

After running the engine for at least three (3) minutes, battery voltage should be at least 0.50 volt higher than initial battery voltage.

An example of a charging system that is functioning:

At least 0.50 volt over initial battery voltage	
Initial Battery Voltage	= 12.30 v
Battery Voltage after 3 Minute Charge	= 12.85 v
Difference	= +0.55 v

Glow Plug System Test

This is a fast, simple test that can help to determine the integrity and operation of your Reelmaster glow plug system. The test should be run anytime hard starting (cold engine) is encountered on a diesel engine equipped with a glow plug system.

Use a digital multimeter and/or inductive Ammeter (AC/ DC Current Transducer). Properly connect the ammeter to the digital multimeter (refer to manufacturers’

Glow Plug System Test (continued)

instructions) and set the multimeter to the correct scale. With the key switch in the OFF position, place the ammeter pickup around the main glow plug power supply wire and read the meter prior to activating the glow plug system. Adjust the meter to read zero (if applicable). Activate the glow plug system by turning the key switch to ON and record the multimeter results.

The Reelmaster glow plug system should have a reading of approximately 27 Amps.

Check Operation of Interlock Switches

The interlock switches are for the operator's protection; do not disconnect them. Check the operation of the interlock switches daily for proper operation. Replace any malfunctioning switches before operating the machine.

CAUTION

The machine is equipped with a number of interlock switches. The engine will not start, or if the engine is running, the engine will stop if one or more of the interlock conditions are met.

To start the engine:

1. The PTO switch must be in the DISENGAGE position.
2. The traction pedal must be in neutral (with pedal and switch properly adjusted).
3. An operator must be in the seat or the parking brake must be engaged.

When the engine is running, the engine should stop in 1−3 seconds if:

1. The operator leaves the seat without engaging the parking brake.
2. The traction pedal is depressed with the parking brake engaged.

Use the Standard Control Module (SCM) to check operation of the interlocks:

1. Remove the cover over the control panel to get access to the Standard Control Module (SCM).
2. Turn the ignition switch to the on RUN position.
3. Sit in the operators seat and the In Seat LED on the SCM should be on. Remove your weight from the seat and the In Seat LED on the SCM should be off.
4. The Parking Brake LED on the SCM should be on when the parking is disengaged and go off when the parking brake is engaged.
5. The PTO LED on the SCM should be off when the PTO switch is in the DISENGAGED position and go on when the PTO switch is in the ENGAGED position.
6. The Neutral LED on the SCM should be on when the traction pedal in in the neutral position and off when the traction pedal in the forward or reverse position.
7. Take corrective action immediately if any of the interlocks do not perform as described.

Adjustments

Neutral Switch

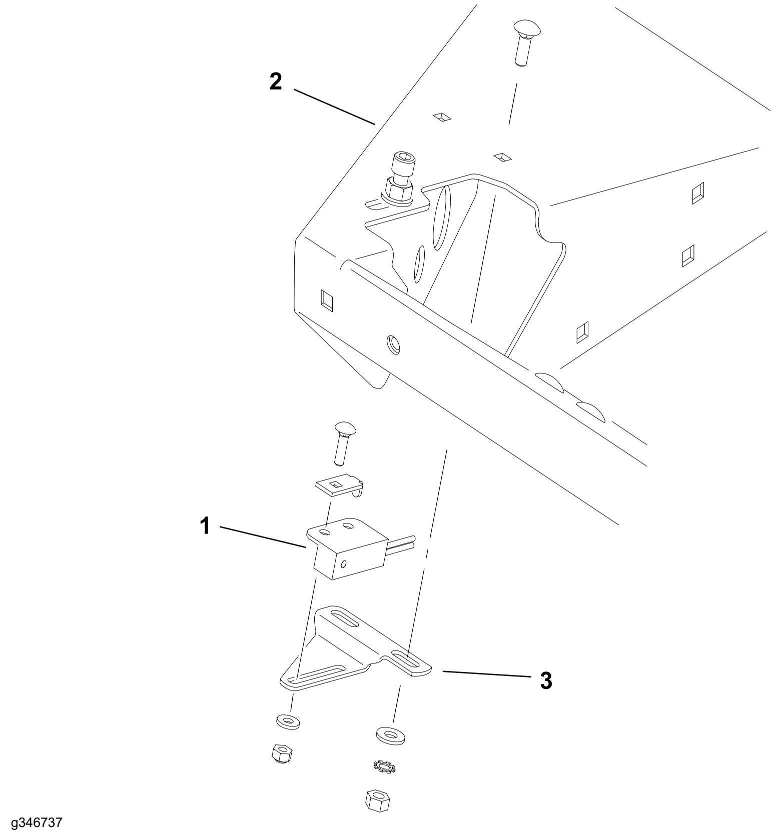

Figure 109

1. Neutral switch
2. Floor plate
3. Switch bracket

The neutral switch is a normally open proximity switch that closes when the traction pedal is in the neutral position. The neutral switch is located under the floor plate near the traction pedal.

Adjusting

1. Before adjusting the traction neutral switch, check and adjust traction system neutral position (refer to *Traction Unit Operator's Manual*).

IMPORTANT

To prevent traction neutral switch damage, make sure that no components contact switch through entire traction pedal movement.

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

Adjusting (continued)

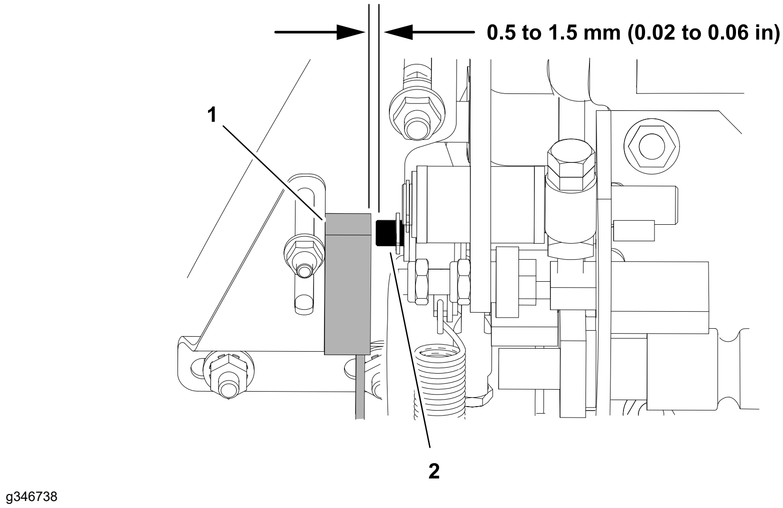

Figure 110

1. Neutral switch
2. Traction pedal pin

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3. When the traction pedal is in the neutral position, the pin on the traction pedal should be centered with the switch eye. With the traction pushed all the way to the right, the clearance between the pin on the traction pedal and the switch should be **0.5 to 1.5 mm (0.02 to 0.06 in)** (Figure 110).
4. To adjust the switch, loosen the nut securing the switch to the switch bracket or the nuts securing the switch bracket to the floor plate and adjust the switch position as needed.
5. After adjusting the switch, use the Standard Control Module (see Standard Control Module (SCM) (page 6–45)) to verify that the switch and circuit wiring are functioning correctly. The switch should open when the traction pedal is moved in either direction **6.3 to 25.4 mm (0.25 to 1.0 in)** when measured at the top of the traction pedal.

Mow/Transport Switch

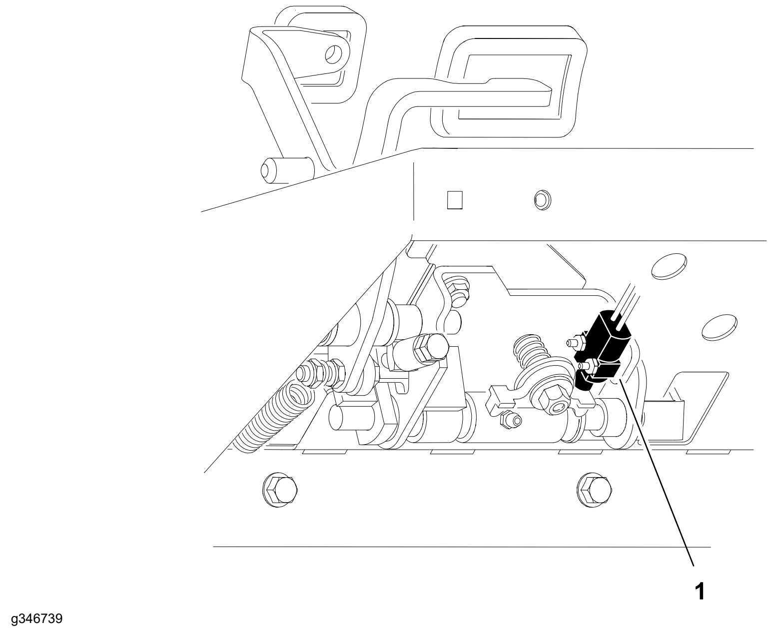


Figure 111

1. Mow/Transport switch

The switch used for the mow/transport slide is a normally closed switch. The switch opens when the mow/ transport slide is in the transport position. The switch is located under the floor plate (Figure 111).

Adjusting

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 key switch.

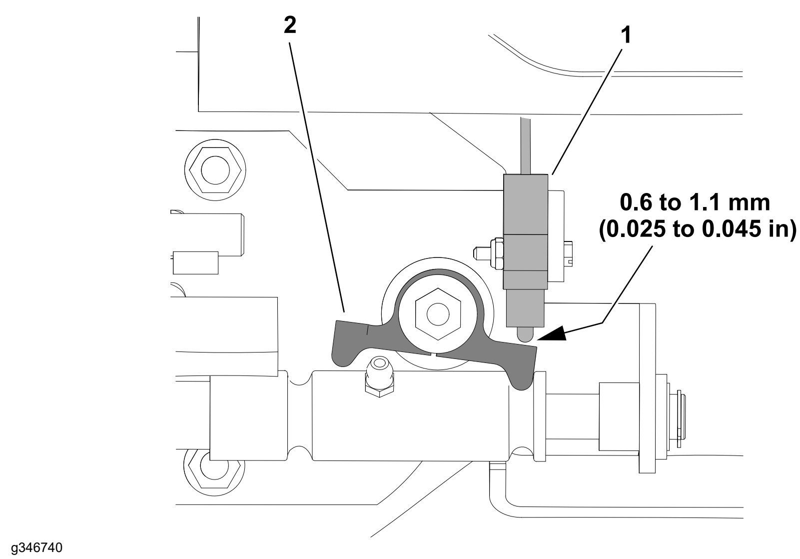


Figure 112

1. Mow/Transport switch
2. Rocker arm

2. When the mow/transport lever is on the transport position, the clearance between the rocker arm and the switch should be **0.6 to 1.1 mm (0.025 to 0.045 in)** at the closest point (Figure 112).

Adjusting (continued)

3. To adjust switch, loosen fasteners that secure switch to bracket and position switch to allow correct clearance between switch and rocker arm. Tighten switch fasteners and recheck switch to rocker arm clearance.

Component Testing

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).

Note: For engine component testing information (starter solenoid and motor, alternator, glow plugs) see the Kubota Workshop Manual.

CAUTION

When testing electrical components for continuity with a multimeter (ohms setting), make sure that power to the circuit has been disconnected.

Fusible Link Harness

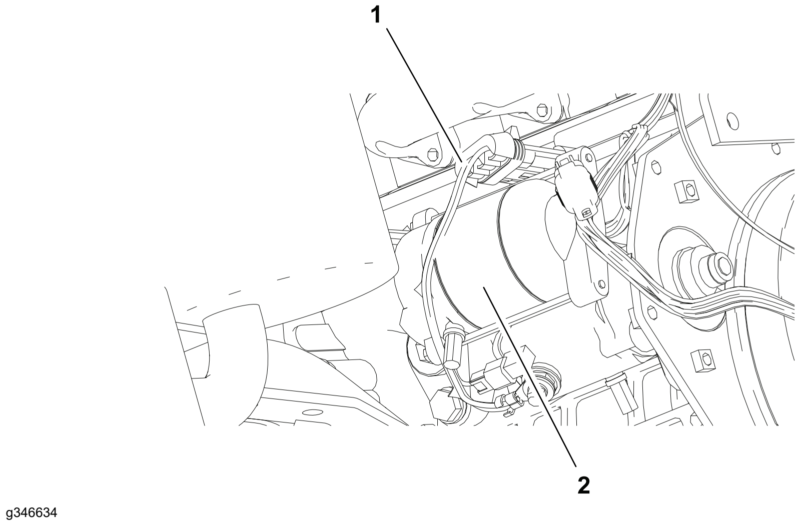


Figure 113

1. Fusible link harness
2. Starter motor

The Reelmaster machines use 3 fusible links for the circuit protection. These fusible links are located in a harness that connects the starter B+ terminal to the wire harness (Figure 113 and Figure 114). If any of these links fail, current to the protected circuit stops; refer to the Electrical Schematics in Appendix A (page A–1) for additional circuit information.

Testing

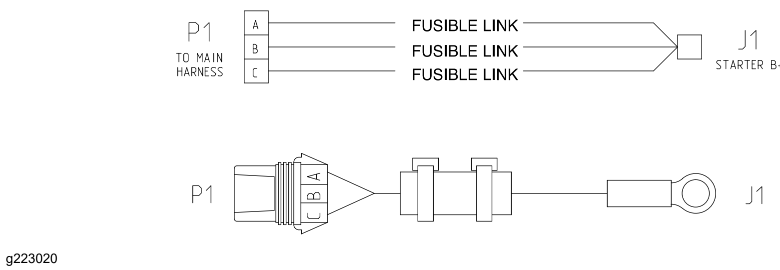


Figure 114

1. Ensure that the key switch is in the OFF position, disconnect the negative battery cable from the battery terminal, and then disconnect the positive cable from the battery; refer to Servicing the Battery (page 6–49).
2. Locate and unplug the fusible link connector P1 from the machine wire harness.
3. Use a multimeter to ensure that the continuity exists between each terminal pin in the connector P1 and connector J1 at the starter (Figure 114).
4. If any of the fusible links are open, replace the fusible link harness.

   Note: Do not replace individual fusible link conductors of the fusible link harness. If any of the harness links are open (failed), replace the entire fusible link harness.

5. After you complete the testing, ensure that the fusible link harness connectors are correctly attached to the starter and machine wire harness. Connect the positive battery cable to the battery terminal and then connect the negative cable to the battery.

Fuses

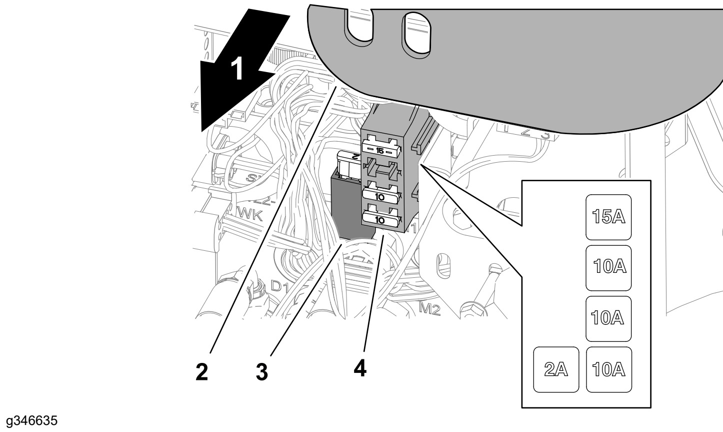


Figure 115

The fuse blocks are located under the control panel (Figure 115).

Identification and Function

The fuses are held in the fuse blocks. Use Figure 115 to identify each individual fuse and its correct amperage. Each fuse holder has the following function.

F1 (15 A): Protects main power circuit to the key switch terminal B.

F2 (10 A): Protects main power circuit to the key switch terminal X and telematics connector.

F3 (10 A): Protects power circuit from the key switch terminal I.

F4 (10 A): Protects power circuit from the key switch terminal S.

F5 (2 A): Protects power supply to the Standard Control Module.

Testing

1. Turn the key switch to the ON position (do not start the engine) and remove the control panel. 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.
2. If necessary, remove the fuse from the fuse block for testing. The fuse should have continuity between the fuse terminals.
   A. Ensure that the key switch is in the OFF position and the key is removed from the key switch.
   B. Locate the fuse(s) to be tested under the control panel.
   C. Remove the fuse(s) from the fuse holder for testing. The fuse should have continuity between the fuse terminals.

IMPORTANT

If fuse replacement is necessary, ensure that replacement fuse has the correct amp rating.

   D. Replace the fuse if testing determines that it is damaged.
   E. After you complete the fuse testing, install the control panel.

Key Switch

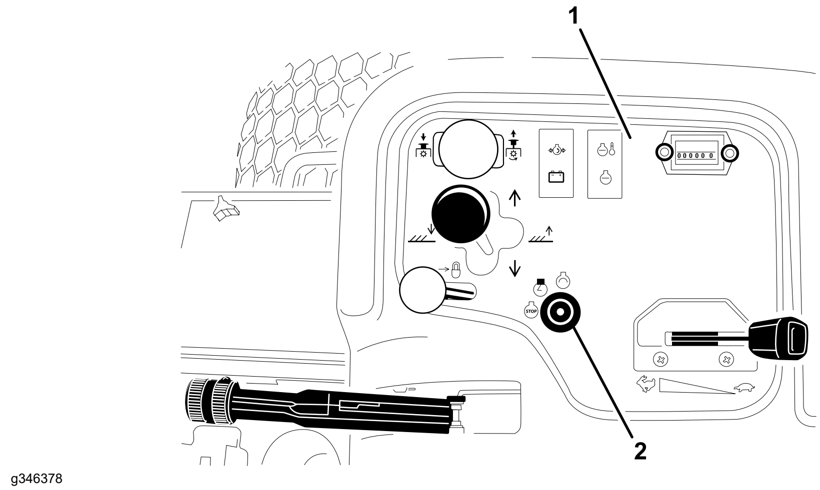


Figure 116

1. Control panel
2. Key switch

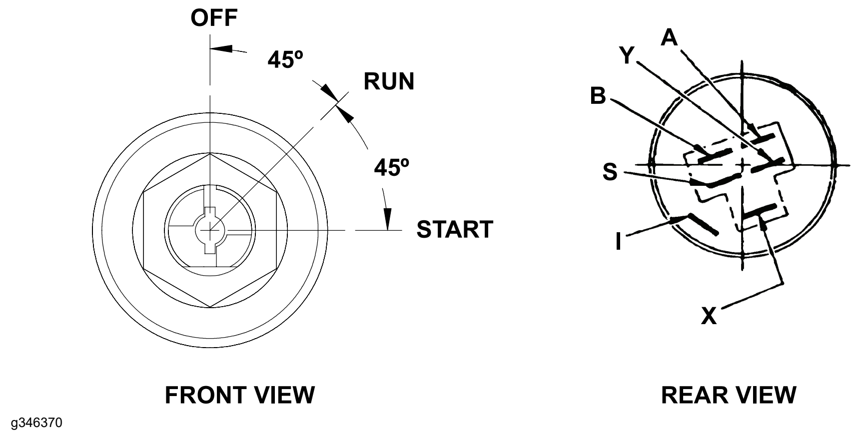


Figure 117

The key switch is located on the control panel and has three (3) positions: OFF, RUN and START (Figure 117). The Standard Control Module (SCM) monitors the operation of the key switch and reacts to the various key switch positions.

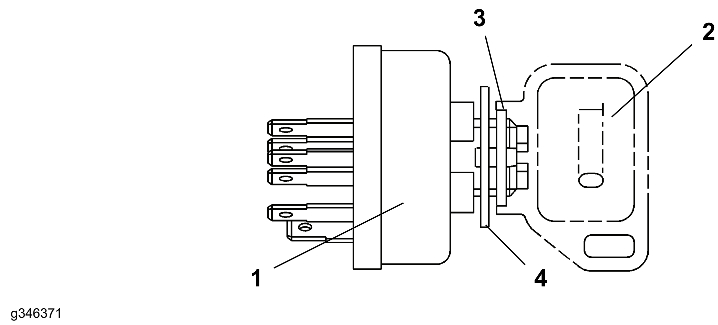


Figure 118

1. Switch
2. Key
3. Hex nut
4. Lock washer

Testing

1. Park machine on a level surface, lower cutting units, engage parking brake and stop engine. Remove key from key switch.
2. Remove the cover from control panel to access key switch.
3. Make sure that the key switch is in the OFF position. Disconnect wire harness connector from key switch.
4. The key switch terminals are identified in Figure 117 and the circuitry of the switch is shown in below table. With the use of a multimeter (ohms setting), the switch functions can be tested to determine whether continuity exists between the various terminals for each switch position. Verify continuity between switch terminals.

SWITCH POSITION	NORMAL CIRCUITS	OTHER CIRCUITS
OFF	NONE	NONE
RUN	B + A + I	X + Y
START	B + S + I	NONE

5. Replace key switch if testing determines that it is faulty.
6. If the key switch tests correctly and a circuit problem still exists, check wire harness.
7. After testing is complete, connect the machine wire harness connector to key switch. Install cover onto control panel.

Indicator Lights

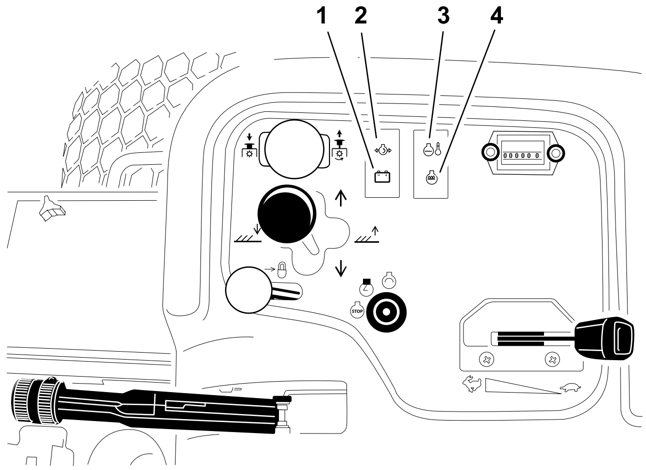


Figure 119

1. Charge indicator
2. Engine oil pressure
3. High temp shutdown
4. Glow plug indicator

Charge Indicator Light

The charge indicator light should come on when the key switch is in the ON position with the engine not running. Also, it should illuminate with an improperly operating charging circuit while the engine is running.

Engine Oil Pressure Light

The engine oil pressure light should come on when the key switch is in the ON position with the engine not running. Also, it should illuminate with the engine running if the engine oil pressure drops to an unsafe level.

IMPORTANT

If the oil pressure indicator light is illuminated with the engine running, shut off the engine immediately.

To test the oil pressure light and circuit wiring, ground the wire attached to oil pressure switch located on the engine near the oil filter. Turn key switch to the ON position; the engine oil pressure light should come on indicating correct operation of the indicator light and circuit wiring.

High Temperature Warning Light

If the engine coolant temperature reaches 105ºC (221ºF) (approximate), the high temperature warning light should come on.

To test the high temperature warning light and circuit wiring, turn key switch to the ON position and ground the wire attached to high temperature sender located on the engine water pump housing (see High Temperature Warning Switch (page 6–29)). The high temperature warning light should illuminate.

Glow Plug Indicator Light

The glow plug light should come on when the key switch is placed in the ON position prior to placing the key switch in START. The light should stay lit for approximately 6 seconds while the key switch is left in the ON position.

Testing Indicator Lights

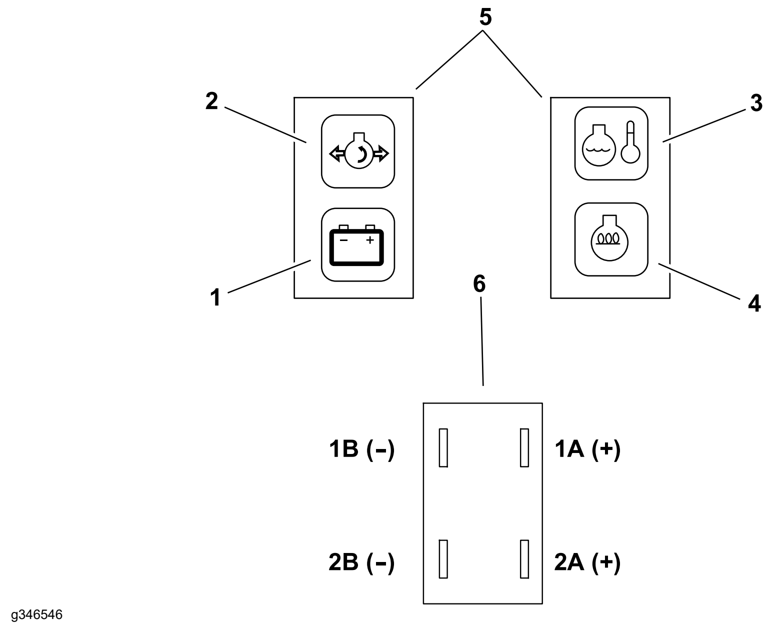


Figure 120

1. Apply 12 VDC to terminals 1A and 2A (Figure 120).
2. Ground terminals 1B and 2B (Figure 120).
3. Both indicator lights should illuminate.

Hour Meter

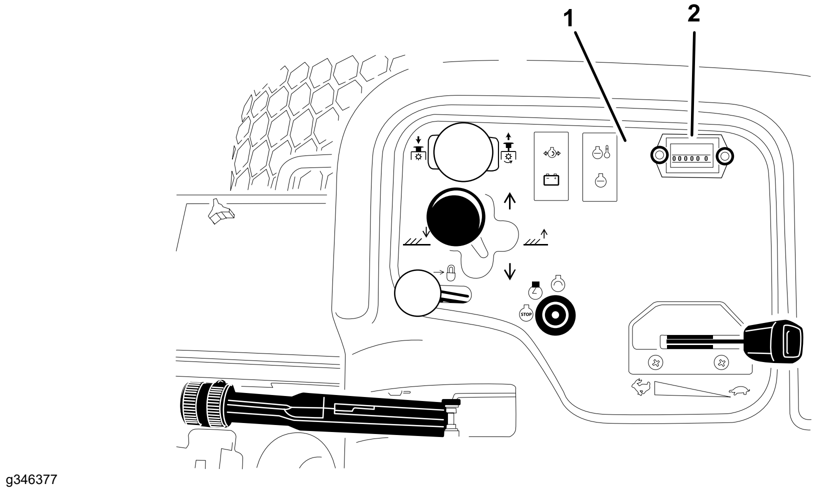


Figure 121

1. Control panel
2. Hour meter

The hour meter (Figure 121) indicates the total hours of machine operation. The hour meter starts to function whenever the key switch is on.

Testing

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the key switch.
2. Locate the wire harness connector at the rear of the hour meter. Unplug the harness connector from the hour meter.

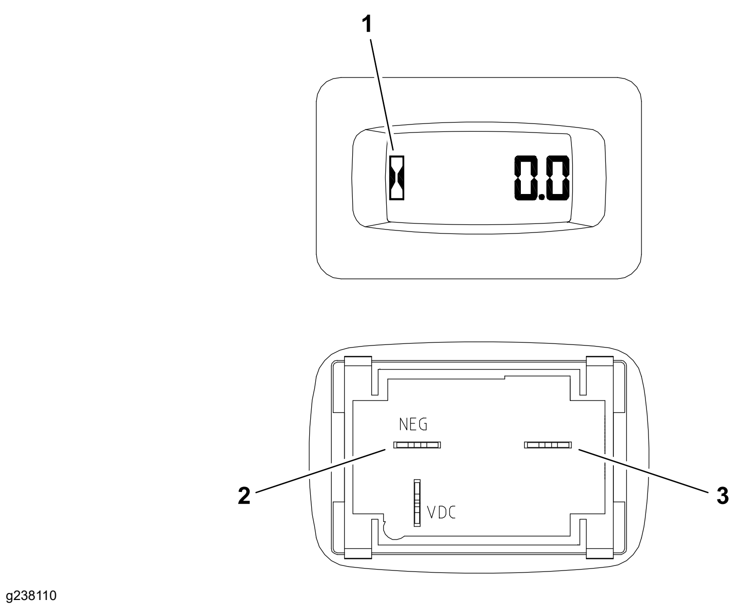


Figure 122

1. Hourglass icon
2. Negative terminal (BK)
3. Positive terminal (PK)

3. Connect the positive (+) terminal of a 12 VDC source to the positive (+) terminal of the hour meter.
4. Connect the negative (-) terminal of the voltage source to the other terminal of the hour meter.

Testing (continued)

5. The hour meter should move 1/10 of an hour in 6 minutes.
6. Disconnect the voltage source from the hour meter.
7. Replace the hour meter if necessary.
8. Connect the wire harness connector to the hour meter.

PTO Switch

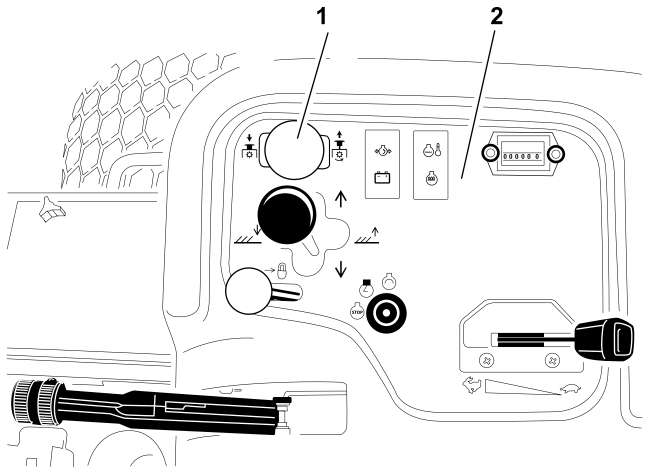


Figure 123

1. PTO switch
2. Control panel

The PTO switch is located on the control panel (Figure 123). This switch is pulled out to engage the cutting units and pushed in to disengage the cutting units.

The Standard Control Module (SCM) monitors the position of the PTO switch (up or down). Using the inputs from the PTO switch and other switches in the interlock system, the SCM controls the energizing of the reel drive solenoid and thus, the PTO. If the key switch is in the ON position and the PTO switch is engaged, the SCM PTO switch input LED should be illuminated.

IMPORTANT

During the operation of the machine, if the PTO shuts down and the console temperature warning light is illuminated because of excessive engine coolant temperature, avoid shutting off the engine. Under this condition, push the PTO knob down, slowly drive to a safe flat area, move the throttle lever to the SLOW position, press the traction pedal, and set the parking brake. Allow the engine to be idle for several minutes while it cools to a safe level, and check the cooling system before returning the machine to service.

Testing

1. Park the machine on a level surface, lower the cutting deck, set the parking brake, and shut off the engine.
2. Before you disconnect the PTO switch for testing, ensure that you test the switch and its circuit wiring as a SCM input; refer to Standard Control Module (SCM) (page 6–45).
3. If the SCM verifies that the PTO switch and circuit wiring are functioning correctly, no further switch testing is necessary.

Testing (continued)

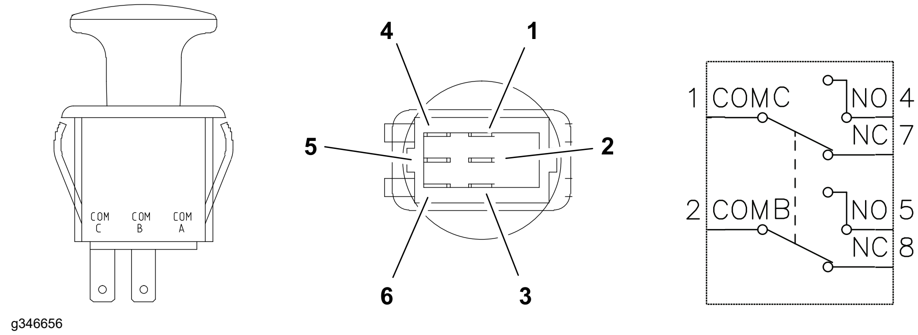


Figure 124

1. COM B terminal
2. NO B terminal
3. NC B terminal
4. COM C terminal
5. NO C terminal
6. NC C terminal

---

4. If the SCM determines that the PTO switch and circuit wiring are not functioning correctly, then test the PTO switch as follows:

   A. Remove cover from control panel to gain access to PTO switch.

   B. Ensure that the key switch is in the OFF position. Disconnect the wire harness connector from the PTO switch.

   C. The PTO switch terminals are identified in Figure 124 and the circuitry of the PTO switch is shown in the Circuit Logic Table (page 6–19). With the use of a multimeter (ohms setting), test the switch functions to determine if the continuity exists between the various terminals for each switch position. Check the continuity between the switch terminals.

Circuit Logic Table

Switch Position	Closed Circuits	Open Circuits
OFF (DOWN)	COM B + NC B COM C + NC C	COM B + NO B COM C + NO C
ON (UP)	COM B + NO B COM C + NO C	COM B + NC B COM C + NC C

   D. Replace the PTO switch if testing determines that the switch is damaged.

   E. If the PTO switch testing is correct and a circuit problem still exists, check the wire harness; refer to the Electrical Schematics and Wire Harness Drawings/Diagrams in Appendix A (page A–1).

   F. After you complete the testing, connect the machine wire harness connector to the PTO switch. Install control panel cover.

Seat Switch

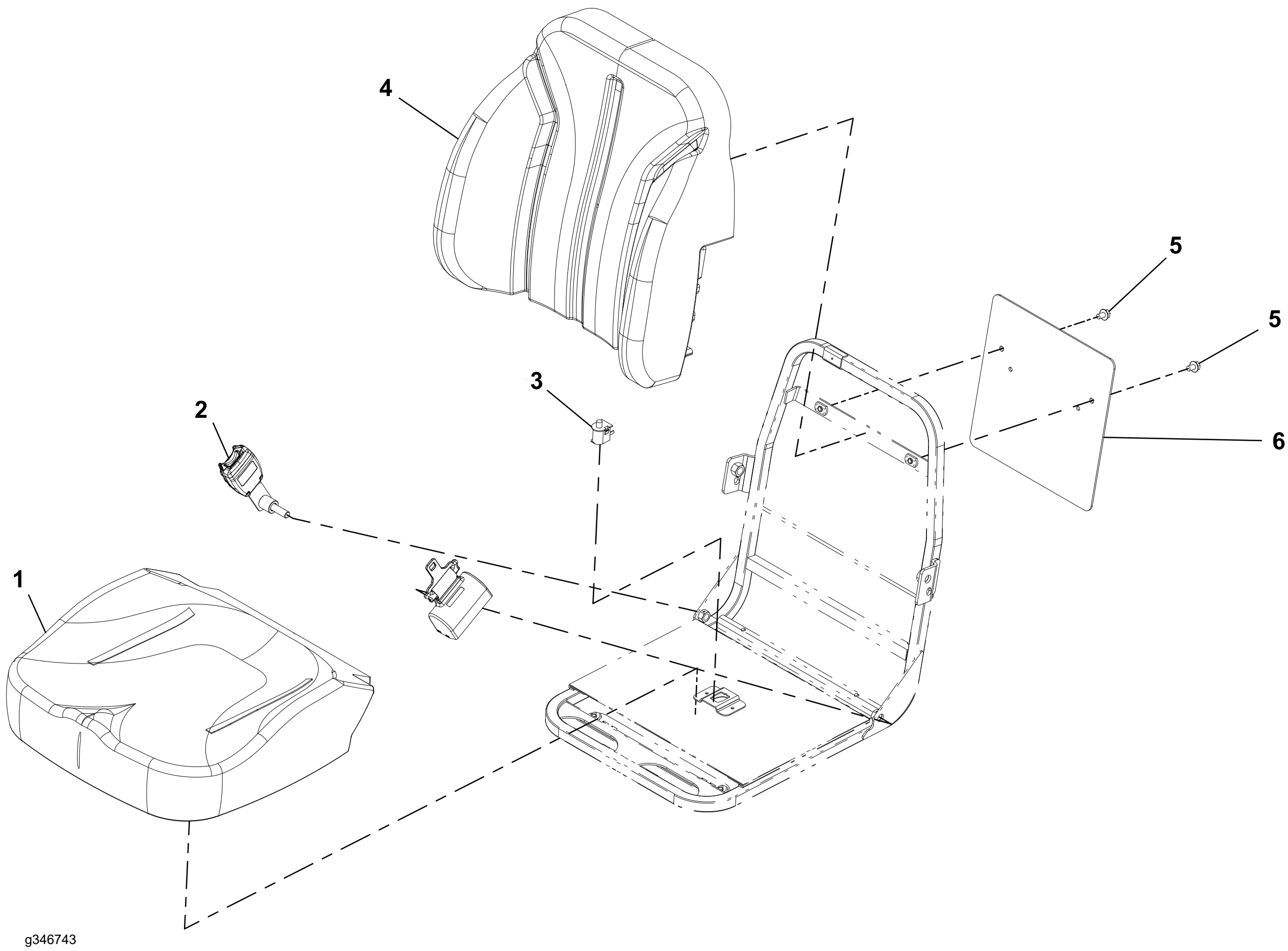


Figure 125

1.	Seat bottom	3.	Seat switch	5.	Flange head screws
2.	Seat belt kit	4.	Seat back	6.	Decal

The seat switch is normally open and closes when the operator is on the seat. If the traction system or PTO switch is engaged when the operator raises out of the seat, the engine shuts off. The seat switch and its electrical connector are located directly under the seat (Figure 124). Testing of the switch can be done without seat removal by disconnecting the seat wire from the machine wire harness.

The Standard Control Module (SCM) monitors the operation of the seat switch. If the key switch is in the ON position and the seat is occupied, the SCM in seat input LED should be illuminated.

Testing

1. Park the machine on a level surface, lower the cutting deck, set the parking brake, and shut off the engine.
2. Before you disconnect the seat switch for testing, ensure that you test the switch and its circuit wiring as a SCM input; refer to Standard Control Module (SCM) (page 6–45).
3. If the SCM verifies that the seat switch and circuit wiring are functioning correctly, no further switch testing is necessary.
4. If the SCM determines that the seat switch and circuit wiring are not functioning correctly, proceed with the following switch testing procedure.

Testing (continued)

5. Ensure that the key switch is in the OFF position. Locate the switch for testing.
6. Disconnect the machine wire harness electrical connector from the seat switch (Figure 124).
7. Connect a multimeter (ohms setting) across the seat switch harness connector terminals to check the continuity of the seat switch.
   A. With no pressure on the seat, ensure that there is no continuity between the harness terminals of the seat switch.
   B. Press directly onto the seat switch through the seat cushion. Ensure that there is continuity between the harness terminals of the seat switch as the seat cushion approaches the bottom of its travel indicating that the seat switch is functioning.
8. Replace the seat switch if testing determines that the switch is damaged.
9. If the seat switch testing is correct and the circuit problem still exists, check the machine wire harness; refer to the Electrical Schematics and Wire Harness Drawings/Diagrams in Appendix A (page A–1).
10. After you complete the seat switch testing, connect the machine wire harness connector to the seat switch. Check the operation of the seat switch.

Parking Brake Switch

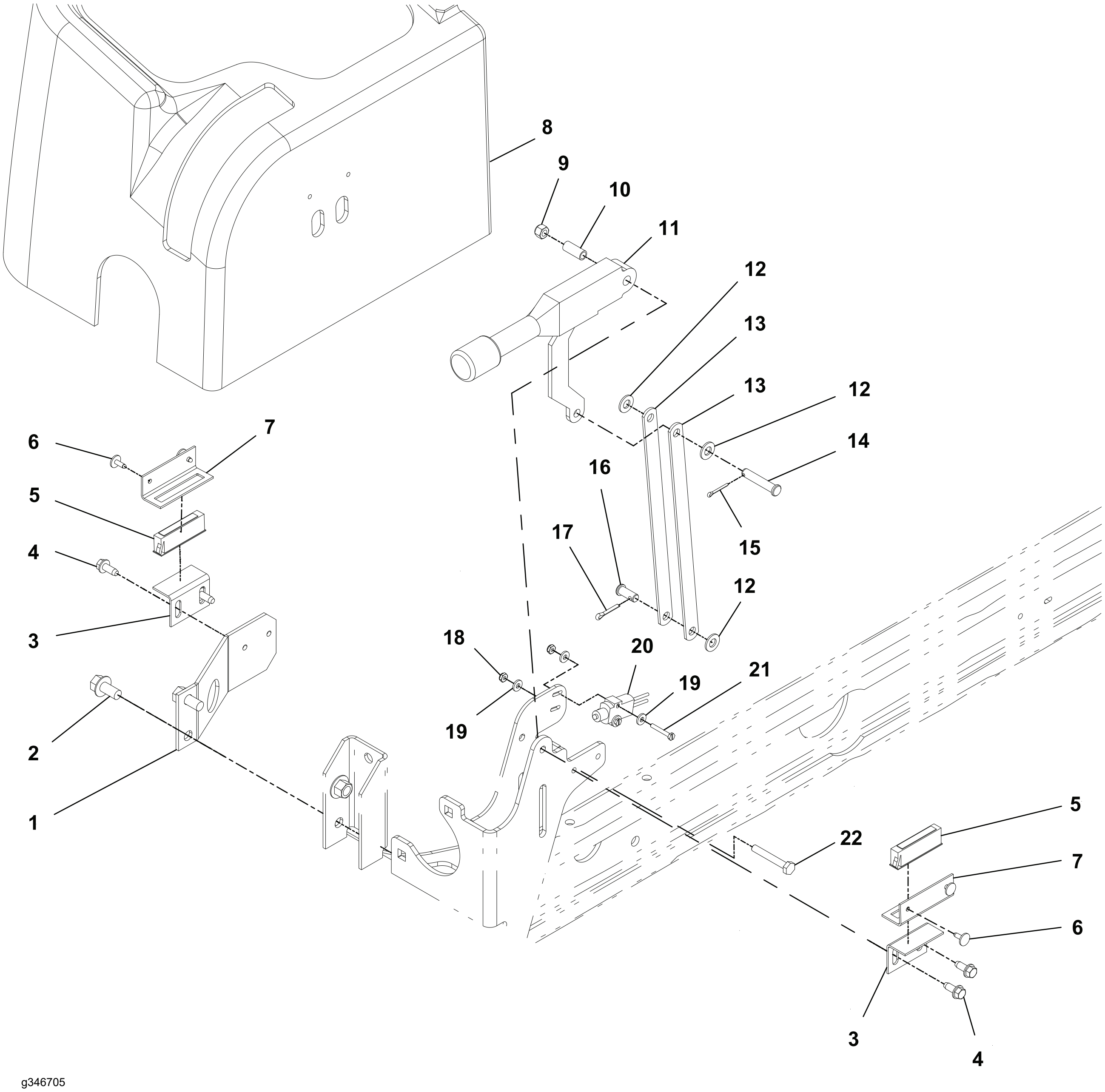


Figure 126

1. Magnet support
2. Washer head bolt
3. Strike bracket
4. Washer head bolt
5. Magnet catch
6. Rivet
7. Cover bracket
8. Control panel cover
9. Lock nut
10. Parking brake spacer
11. Lever assembly
12. Flat washer
13. Parking brake link
14. Clevis pin
15. Cotter pin
16. Clevis pin
17. Cotter pin
18. Lock nut
19. Flat washer
20. Switch
21. Slotted hex head screw
22. Bolt

The switch used for the parking brake is a normally open switch. The switch closes when the parking brake is not set. The parking brake switch is located under the steering tower cover (Figure 126).

The Standard Control Module (SCM) monitors the operation of the parking brake switch. If the key switch is in the ON position and the parking brake is released, the SCM parking brake off input LED should be illuminated.

Testing

1. Park the machine on a level surface, lower the cutting unit, and shut off the engine.
2. Before you disconnect the parking brake switch for testing, ensure that you test the parking brake switch and its circuit wiring as a SCM input; refer to Standard Control Module (SCM) (page 6–45).
3. If the SCM verifies that the switch and circuit wiring are functioning correctly, then no more switch testing is necessary.
4. If the SCM determines that the parking brake switch and circuit wiring are not functioning correctly, proceed with the test.
5. Remove cover from control panel to gain access to parking brake switch.
6. Locate the parking brake switch.
7. Make sure key switch is OFF and disconnect the parking brake switch connector from machine wire harness.
8. Connect a multimeter (ohms setting) across the switch connector terminals to check the continuity of the switch as follows:
   - A. When the switch plunger is extended, there should not be continuity between the switch terminals.
   - B. When the switch plunger is pressed, there should be continuity between the switch terminals.
9. Replace the switch if testing determines that the switch is damaged.
10. If the parking brake switch testing is correct and a circuit problem still exists, check the main wire harness; refer to the Electrical Schematics and Wire Harness Drawings/Diagrams in Appendix A (page A–1).
11. After you complete the parking brake switch testing, connect the switch connector to the machine wire harness.
12. Install cover to control panel.

Neutral Switch

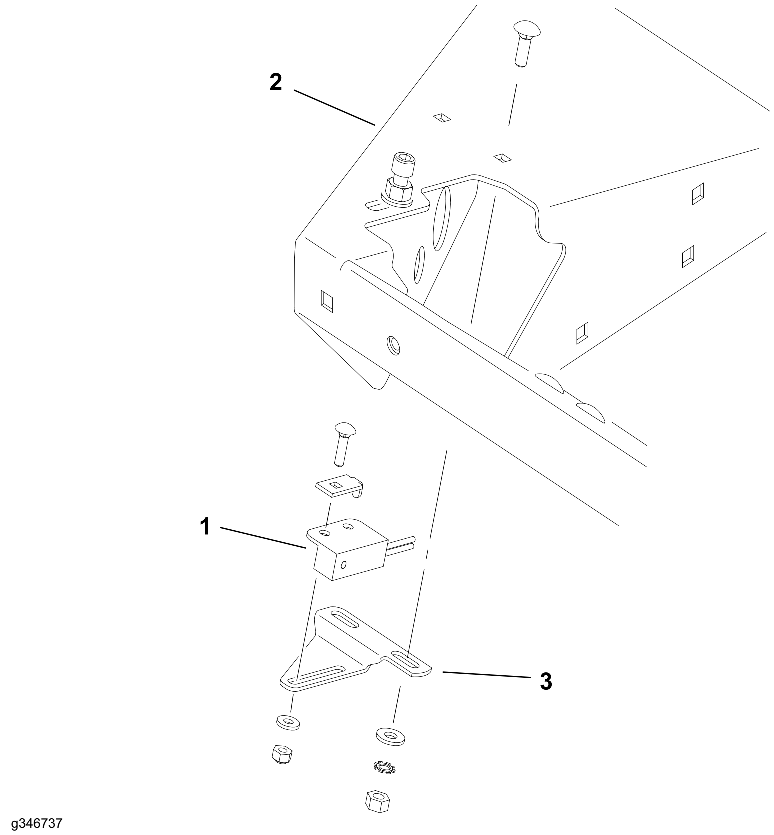


Figure 127

1. Neutral switch
2. Floor plate
3. Switch bracket

The neutral switch is a normally open proximity switch that closes when the traction pedal is in the neutral position. The neutral switch is located under the floor plate (Figure 115).

The Standard Control Module (SCM) monitors the position of the neutral switch (open or closed). Using inputs from the neutral switch and other switches in the interlock system, the SCM controls the energizing of the engine start relay, and the fuel stop solenoid and fuel pump.

Testing

1. Park machine on level surface, lower cutting units, stop engine, apply parking brake and remove key from key switch.
2. Make sure the neutral switch is properly adjusted (see Neutral Switch (page 6–5)).
3. Before disconnecting the switch for testing, the switch and its circuit wiring should be tested as a SCM input. (see Standard Control Module (SCM) (page 6–45)). If input testing verifies that the switch and circuit wiring are functioning correctly, no further switch testing is necessary. If, however, input testing determines that the switch and circuit wiring are not functioning correctly, proceed with the following switch testing procedure.
4. Make sure key switch is in the OFF position. Disconnect electrical connector from the neutral switch.
5. Check the continuity of the switch by connecting a multimeter (ohms setting) across the connector terminals.

Testing (continued)

6. With the traction pedal in the neutral position, there should be continuity between the two (2) switch leads.
7. Slowly depress the traction pedal. The continuity tester should show no continuity as the pedal is moved to the full forward or full reverse direction.
8. Replace and readjust the switch if necessary.
9. Reconnect switch after testing.

Mow/Transport Switch

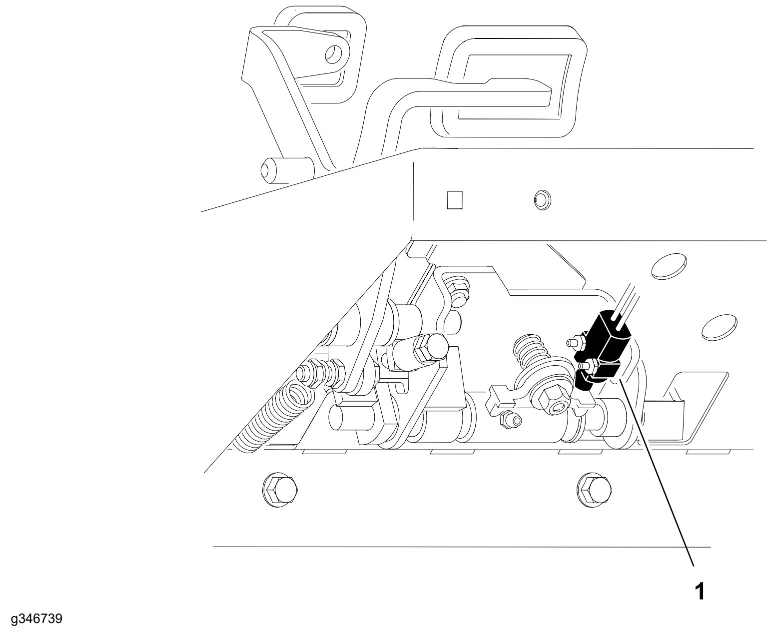


Figure 128

1. Mow/Transport switch

The switch used for the mow/transport slide is a normally closed switch. The switch opens when the mow/ transport slide is in the transport position. The switch is located under the floor plate (Figure 123).

The Standard Control Module (SCM) monitors the position of the mow/ transport switch (open or closed). Using inputs from the mow/transport switch and other switches in the interlock system, the SCM control the energizing of the reel drive solenoid.

Testing

1. Park vehicle on a level surface, stop engine, apply parking brake and remove key from key switch.
2. Make sure the mow/transport switch is properly adjusted (see Mow/Transport Switch (page 6–7)).
3. Locate the switch and disconnect electrical connector from the switch.
4. Check the continuity of the switch by connecting a multimeter (ohms setting) across the connector terminals.
5. When the switch plunger is extended (mow/transport slide in MOW position) there should be continuity between the switch terminals.
6. When the switch plunger is depressed (mow/transport slide in TRANSPORT position) there should be no continuity between the switch terminals.
7. Replace switch if testing determines that it is faulty.
8. Reconnect switch after testing.

Backlap Switch

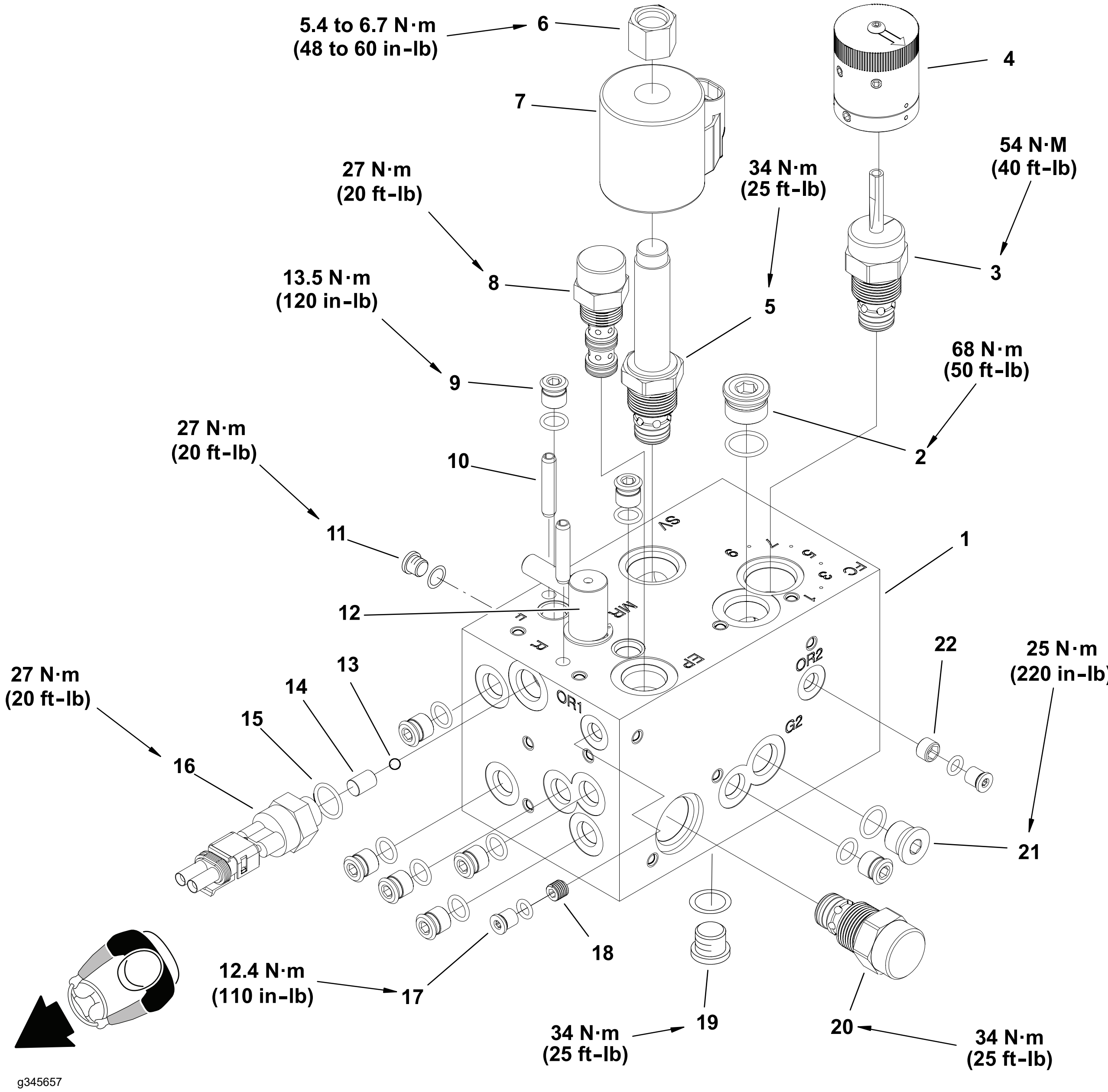


Figure 129

1. Manifold body
2. Plug (Zero Leak #8)
3. Rotary cartridge valve (flow control)
4. Rotary handle assembly
5. Solenoid relief cartridge valve
6. Nut
7. coil
8. Logic control cartridge
9. Plug (Zero Leak #4) (10 each)
10. Spring pin (2 each)
11. Plug (SAE #4)
12. Mow/backlap spool
13. Ball
14. Dowel pin
15. O-ring
16. Backlap switch
17. Plug (Zero Leak #2) (2 each)
18. Orifice (.020)
19. Plug (Zero Leak #6)
20. Check valve
21. Plug (SAE #6) (2 each)
22. Orifice (.073)

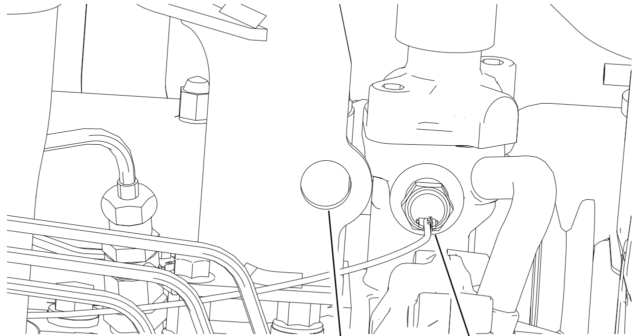
The backlap switch is a normally open ball switch that is in the normal, open state when the backlap lever is in the mow position. When the backlap lever is in the backlap position, the switch closes. The backlap switch is attached to the hydraulic mow control manifold (Figure 126).

The Standard Control Module (SCM) monitors the operation of the backlap switch. If the backlap switch is in the ON position, the SCM in backlap input LED should be illuminated.

Testing

1. Park vehicle on a level surface, stop engine, apply parking brake and remove key from key switch.
2. Before you disconnect the backlap switch for testing, ensure that you test the switch and its circuit wiring as a SCM input; refer to Standard Control Module (SCM) (page 6–45).
3. If the SCM verifies that the backlap switch and circuit wiring are functioning correctly, no further switch testing is necessary.
4. If the SCM determines that the backlap switch and circuit wiring are not functioning correctly, proceed with the following switch testing procedure.
5. Get access to reel drive manifold. Disconnect the harness electrical connector from the backlap switch.
6. Check the continuity of the switch by connecting a multimeter (ohms setting) across the switch connector terminals.
7. With the key switch in the OFF position, turn the backlap lever to the backlap position while watching the multimeter. Continuity should be made as the switch closes.
8. Turn the backlap lever to the mow position while watching the multimeter. Continuity should be broken as the switch opens.
9. If backlap switch is faulty, replace switch. Make sure that dowel and ball are placed in the manifold port before installing new switch in manifold. Torque switch to **27 N- m (20 ft-lb)**.
10. If the backlap switch tests correctly and a circuit problem still exists, check wire harness (see Electrical Schematic and Wire Harness Drawings in Appendix A (page A–1)).
11. After testing is completed, connect harness electrical connector to the backlap switch and close access panel.

High Temperature Warning Switch



g342502

Figure 130

1. Temp. warning switch
2. Rear lift tab

The high temperature warning switch (Figure 130) is attached to the water pump housing on the engine and has a gray wire attached to it. This switch is normally open and closes when the engine coolant temperature reaches approximately 105°C (220°F). The closed switch causes the high temperature warning light on the console to illuminate and also provides an input to the Standard Control Module (SCM).

This input causes the SCM high temperature warning LED to illuminate and the cutting unit to shut down. The high temperature warning switch and circuit wiring should be tested as a SCM input before performing the following testing procedure.

Testing

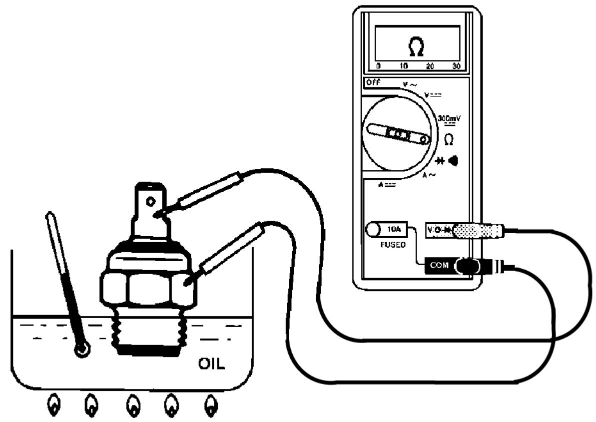
1. Park the machine on a level surface, lower the cutting deck, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Unlatch the hood and raise it.

DANGER

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

Do not open the radiator cap or drain the radiator when the coolant is hot. Ensure that the engine is cool before removing the high temperature warning switch from the engine.

3. Lower the coolant level in the engine.
4. Remove the wire harness connector from the high temperature warning switch, and remove the switch from the engine.



g226814

Figure 131

5. Put the end of the switch in a container of fluid with a thermometer and then slowly heat the fluid (Figure 131).

CAUTION

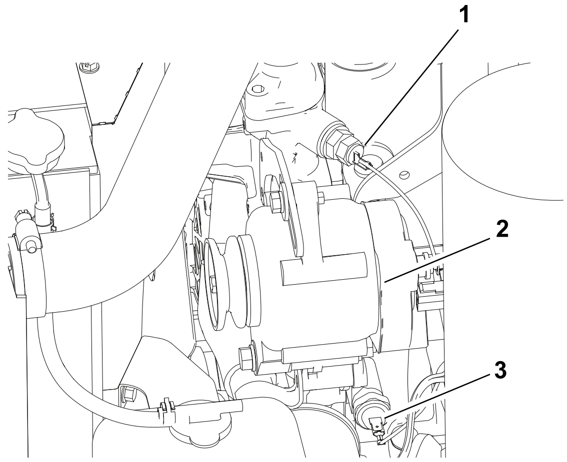
The fluid is hot and could cause personal injury or fire.

Handle the hot fluid with extreme care.

Note: Before taking the small resistance readings with a digital multimeter, short the multimeter test leads together. The meter will display 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 you are testing.

6. Check the resistance of the switch with a multimeter (ohms setting) as the fluid temperature increases.
7. The high temperature warning switch is normally open and should close between 102 to 108ºC (216 to 226ºF).
8. Allow fluid to cool while observing temperature.
9. The high temperature warning switch should open at about 98ºC (208ºF).
10. If the switch does not meet the specifications, replace the switch.
11. After you complete the testing, install the temperature switch to the engine housing, do the following steps:
    A. Clean the threads of the housing and switch. Apply thread sealant to the threads of the switch.
    B. Thread the switch into the housing; torque the switch to **29.4 to 39.2 N·m (22 to 28 ft-lb)**.
    C. Connect the harness wires to the temperature switch.
12. Fill the engine cooling system; refer to the *Traction Unit Operator's Manual*.
13. Lower the hood and secure it with the latches.

High Temperature Shutdown Switch



g342503

Figure 132

1. Temp. shutdown switch
2. Alternator
3. Low oil press. switch

The high temperature shutdown switch (Figure 132) is attached to the water pump housing on the engine and has a blue/white wire attached to it. This switch is normally open and closes when engine coolant temperature reaches approximately 110°C (230°F). The closed switch provides an input to the Standard Control Module (SCM).

This input causes the SCM high temperature shutdown LED to illuminate and the cutting deck to shut down. The high temperature shutdown switch and circuit wiring should be tested as a SCM input before performing the following testing procedure.

Testing

1. Park the machine on a level surface, lower the cutting deck, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Unlatch the hood and raise it.

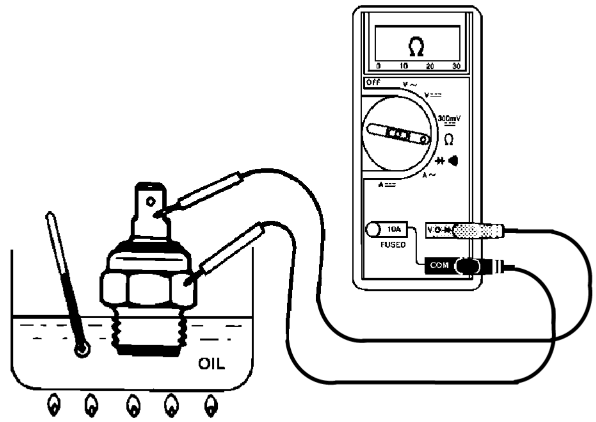
DANGER

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

Do not open the radiator cap or drain the radiator when the coolant is hot. Ensure that the engine is cool before removing the high temperature shutdown switch from the engine.

3. Lower the coolant level in the engine.
4. Remove the wire harness connector from the high temperature shutdown switch, and remove the switch from the engine.

Testing (continued)



g226814

Figure 133

5. Put the end of the switch in a container of fluid with a thermometer and then slowly heat the fluid (Figure 133).

CAUTION

The fluid is hot and could cause personal injury or fire.

Handle the hot fluid with extreme care.

6. Check the resistance of the switch with a multimeter (ohms setting) as the oil temperature increases. The high-temperature shutdown switch is normally open.
7. The high temperature shutdown switch should close between 107° and 113°C (225° and 235°F).
8. Allow oil to cool while observing temperature.
9. The high temperature shutdown switch should open at approximately 104°C (219°F).
10. If the switch does not meet the specifications, replace the switch.
11. After you complete the testing, install the temperature switch to the engine housing, do the following steps:
    A. Clean the threads of the housing and switch. Apply thread sealant to the threads of the switch.
    B. Thread the switch into the housing; torque the switch to **29.4 to 39.2 N·m (22 to 28 ft-lb)**.
    C. Connect the harness wires to the temperature switch.
12. Fill the engine cooling system; refer to the *Traction Unit Operator's Manual*.
13. Lower the hood and secure it with the latches.

Oil Pressure Switch

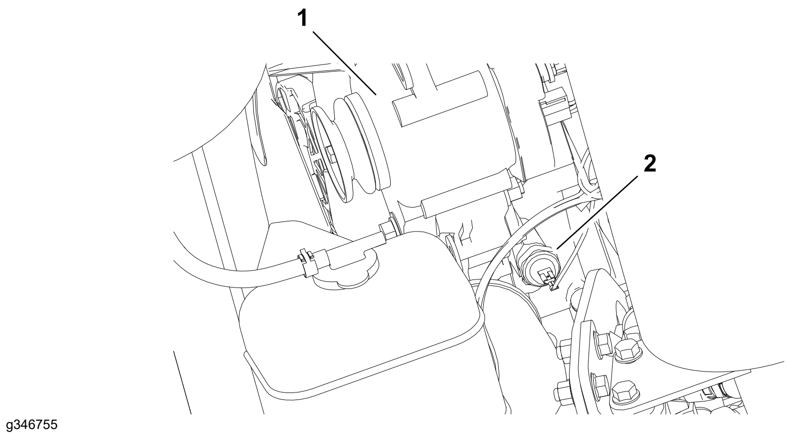


Figure 134

1. Alternator
2. Oil pressure switch

The engine oil pressure switch is located on the engine below the alternator (Figure 127). The oil pressure switch is a normally closed switch that opens with pressure. The oil pressure switch should open at approximately 8 PSI.

If low engine oil pressure allows the oil pressure switch to close during engine operation, the engine oil pressure light should illuminate.

IMPORTANT

If the oil pressure indicator light is illuminated with the engine running, shut off the engine immediately. Check the indicator light, circuit wiring, pressure switch, and engine lubrication system to identify the cause of the illuminated indicator light.

Testing

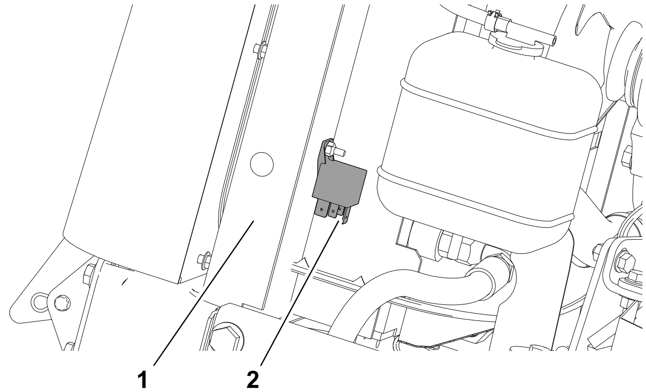
Note: Refer to Engine Service Manual for information regarding engine lubrication system and testing.

1. Park the machine on a level surface, lower the cutting deck, set the parking brake, and shut off the engine.
2. Turn the key switch to the ON position. The oil pressure indicator light on the control panel should be illuminated.
3. If the indicator light is not illuminated:
   A. Unlatch the hood and raise it.
   B. Locate the engine oil pressure switch on the engine and disconnect the wire harness connector from the switch.
   C. Connect a multimeter (ohms setting) across the switch harness connector terminals to check the continuity of the switch:
      - With the engine shut off, there should be no continuity between the switch harness terminals.
      - With the engine running, there should be continuity between the switch harness terminals.
4. If the testing determines that the oil pressure switch is not operating correctly, check the pressure switch and/or pressure switch harness for continuity. Repair or replace the components as necessary.

Testing (continued)

5. If the switch testing is correct and the circuit problem still exists, check the machine wire harness; refer to the Electrical Schematics and Wire Harness Drawings/Diagrams in Appendix A (page A–1).
6. After you complete the oil pressure switch testing, connect the wire harness connector to the oil pressure switch.
7. Lower the hood and secure it with the latches.

Glow Relay



g346376

Figure 135

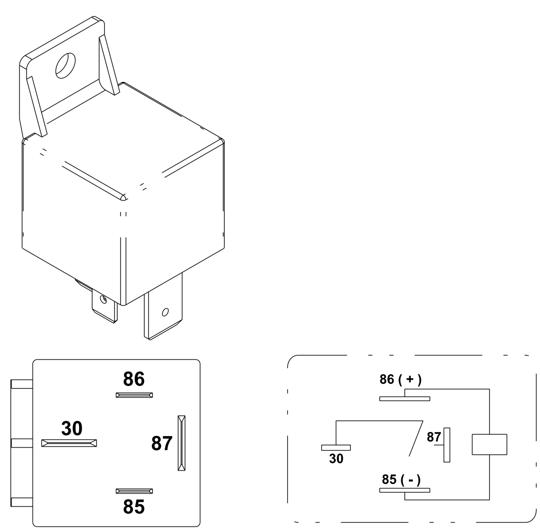
1. Radiator assembly
2. Glow relay

The glow relay is attached to the radiator assembly (Figure 135). When energized, the glow relay allows electrical current to the engine glow plugs.

Testing

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the key switch.
2. Open the hood and get access to the glow relay.
3. To ensure that the machine operation does not occur unexpectedly, disconnect the negative (-) cable from the battery and then disconnect the positive (+) cable from the battery; refer to Servicing the Battery (page 6–49).
4. Disconnect the wire harness connectors from the relay.

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



g214499

Figure 136

Testing (continued)

5. Check the coil resistance between terminals the 85 and 86 with a multimeter (ohms setting). The resistance should be approximately 72 ohms (Figure 136).
6. Connectmultimeter (ohms setting) leads to relay terminals 30 and 87. Ground terminal 86 and apply +12 VDC to terminal 85. The relay should make and break continuity between terminals 30 and 87 as 12VDCis applied and removed from terminal 85.
7. Disconnect the voltage and leads from the relay terminals.
8. Replace the relay if testing determines that the relay is damaged.
9. If the relay testing is correct and a circuit problem still exists, check the main wire harness; refer to the Electrical Schematics and Wire Harness Drawings/Diagrams in Appendix A (page A–1).
10. Connect the wire harness electrical connectors to the relay after you complete the testing.
11. Connect the positive (+) cable to the battery and then connect the negative (-) cable to the battery; refer to Servicing the Battery (page 6–49).
12. Lower and secure the hood.

Diode Assembly

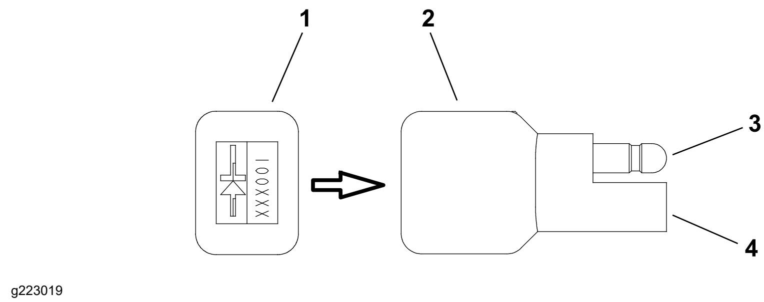


Figure 137

1. End of the diode body
2. Diode assembly
3. Male terminal
4. Female terminal

The diode assembly can be identified by a black color, diode symbol, and Toro Part Number on the end of the diode assembly body (Figure 137). The diode assembly can be located between the operator seat and hydraulic tank.

Testing

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. Locate the diode assembly that is to be tested and remove the cable tie that secures the diode to the wire harness. Unplug the diode from the wire harness for testing.
3. The diode (Figure 137) can be tested by using a digital multimeter (diode test or ohms setting) and the Diode Test Table (page 6–37).
4. Replace the diode assembly if testing determines that the diode is damaged.
5. After you complete the testing, ensure that the diode is fully installed into the wire harness connector and secured to the harness with cable tie.

Diode Test Table

Multimeter Red Lead (+) on Terminal	Multimeter Black Lead (-) on Terminal	Continuity
Female	Male	Yes
Male	Female	No

Fuel Stop Solenoid

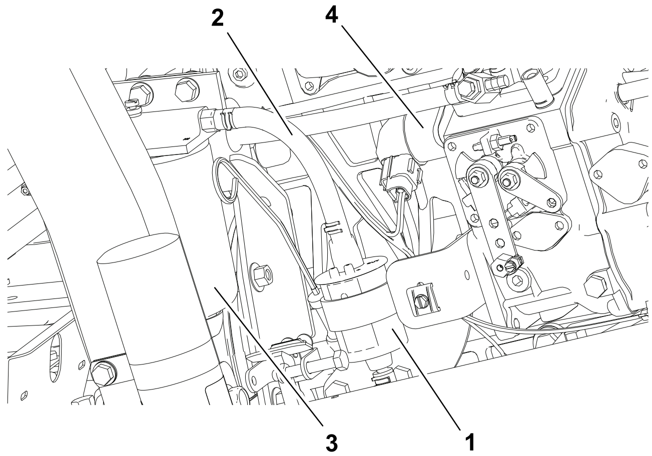


Figure 138

1. Fuel pump
2. Fuel hose (discharge)
3. Fuel filter
4. Fuel stop solenoid

The fuel stop solenoid used on the Reelmaster must be energized for the diesel engine to run. The solenoid is mounted to the injection pump on the engine (Figure 138).

The fuel stop solenoid includes two coils for operation: the pull coil and the hold coil. When the key switch is turned to START, the fuel stop solenoid is initially energized and the pull coil retracts the solenoid plunger. Once the plunger is retracted, the hold coil will keep it retracted for continued engine operation. When the solenoid is de-energized, the plunger extends to shut off fuel supply to the engine causing the engine to stop running. The fuel stop solenoid is grounded through the solenoid housing.

Testing the Fuel Stop Solenoid (In Place)

Note: Before taking the small resistance readings with a digital multimeter, short the multimeter test leads together. The meter will display 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 you are testing.

1. Park the machine on a level surface, lower the cutting deck, set the parking brake, shut off the engine, and remove the key from the key switch.
2. Unlatch the hood and raise it.
3. Locate the fuel stop solenoid on the engine and disconnect the wire harness connector from the solenoid.

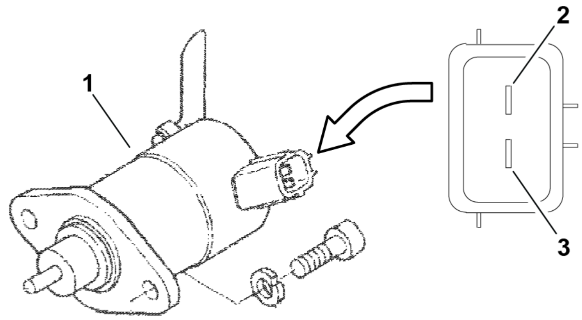


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Figure 139

1. Fuel stop solenoid
2. Pull coil terminal
3. Hold coil terminal

4. Use a digital multimeter, touch 1 test lead to the pull coil terminal and the other test lead to the fuel stop solenoid frame (ground) (Figure 139). The resistance of the pull coil should be less than 1 ohm (but not zero).
5. Use a digital multimeter, touch 1 test lead to the hold coil terminal and the other test lead to the fuel stop solenoid frame (ground) (Figure 139). The resistance of the hold coil should be approximately 15 ohms.
6. Replace the fuel stop solenoid if the testing determines that it is damaged.
7. Connect the wire harness connector to the fuel stop solenoid.
8. Lower the hood and latch it.

Testing the Fuel Stop Solenoid (Live)

1. Park the machine on a level surface, lower the cutting deck, set the parking brake, shut off the engine, and remove the key from the key switch.
2. Unlatch the hood and raise it.
3. Locate the fuel stop solenoid on the engine and disconnect the wire harness connector from the solenoid.

   Note: The solenoid can be removed from the engine or tested in place.
4. If the solenoid is removed from the engine, ensure that the solenoid plunger moves freely and is free of dirt, unwanted material, and corrosion.

   Note: When testing the run solenoid, use test leads with at least 14 gauge wire.
5. Connect a positive (+) test lead from a 12 VDC source to the pull coil and hold coil terminals.
6. Touch a negative (-) test lead from the 12 VDC source to the fuel stop solenoid frame (ground) (Figure 139). The solenoid should engage, making an audible click, and the plunger should retract.
7. Remove positive (+) voltage from the pull coil terminal. The solenoid should stay engaged.
8. Remove positive (+) voltage from the hold coil terminal. The solenoid should release.
9. Replace the fuel stop solenoid if the testing determines that it is damaged.
10. Connect the wire harness connector to the fuel stop solenoid.
11. Lower the hood and latch it.

Reel Drive Solenoid

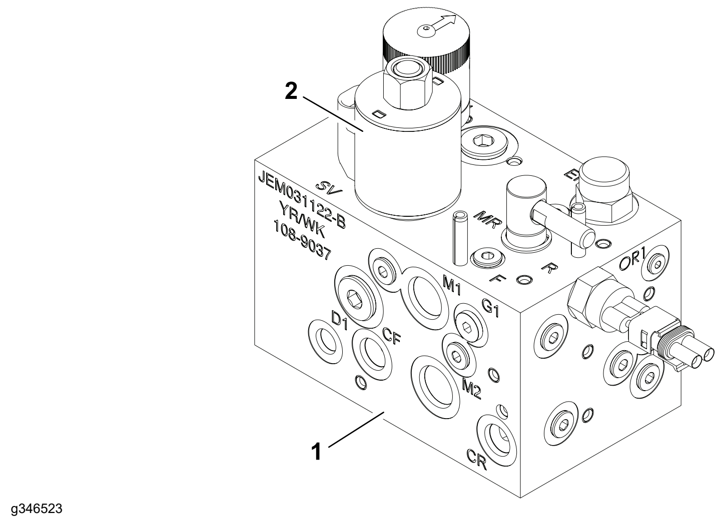

Figure 140

1. Hydraulic manifold
2. Solenoid

The hydraulic system on the Reelmaster uses a solenoid valve coil on the hydraulic manifold (Figure 140). When the solenoid valve coil (SV) is energized, hydraulic flow is directed to the cutting decks.

The standard control module provides current to the solenoid valve coil based on the position of several inputs. A LED on the standard control module will be illuminated when the solenoid valve coil is energized.

Testing

Note: The solenoid does not have to be removed from the cartridge valve for testing.

1. Make sure key switch is in the OFF position. Unplug wire harness electrical connector from solenoid valve coil.

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

2. Apply 12 VDC source directly to the solenoid. Listen for solenoid to switch on.
3. Remove 12 VDC source from the solenoid. Listen for solenoid to switch off.
4. Measure resistance between the two connector terminals. The resistance should be about 7.2 ohms.
5. Install new solenoid if necessary.

   A. Make sure O-ring is installed at each end of coil. Apply ”Loctite 242” or equivalent to threads on end of valve stem before installing nut.

   B. Tighten nut to a torque of **34 N·m (25 ft-lb)**. Over-tightening may damage the solenoid or cause the valve to malfunction.

6. Reconnect electrical connector to the solenoid.

Glow Controller

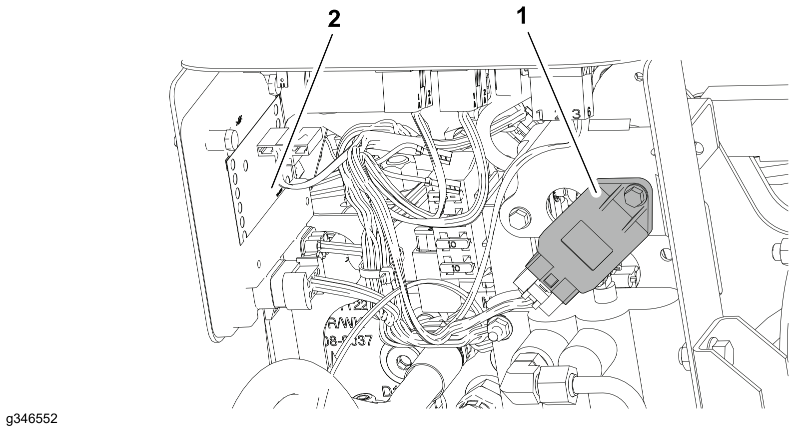

Figure 141

1. Glow controller
2. SCM

The controller is located under the right lower corner of the control panel (Figure 141).

Note: Refer to the Electrical Schematics in Appendix A (page A–1) when troubleshooting the glow controller circuit.

Controller Operation

1. When the key switch is turned to the RUN position, the controller energizes the glow plugs and lights up the glow lamp for approximately 6 seconds.
2. When the key switch is held in the START position, the glow plugs will energize while the switch is held in START and the glow lamp will not light.
3. When the key switch is released from START to RUN, the glow plugs will de-energize and the glow lamp will remain off.

Controller Checks

1. Ensure that there is power from the battery.
2. Disconnect the electrical connector to the fuel stop solenoid to prevent the engine from starting.
3. Turn the key switch to the RUN position. Check the following while in the RUN position:
   A. Glow indicator lamp is on.
   B. Glow relay is energized.
   C. Glow plugs are energized.
   D. Glow indicator lamp goes out and glow plugs de-energize after approximately 6 seconds.
4. Turn the key switch to the START position. Check the following while in the START position:
   A. Glow indicator lamp is out.
   B. Glow relay is energized.
   C. Glow plugs are energized.
   D. Power exists at terminal 1 of the glow controller.

   Note: If there is no power to terminal 1 of the glow controller, check the continuity of the circuitry from the key switch to the glow controller and perform step 4 again; refer to the Electrical Schematics in Appendix A (page A–1).

Controller Checks (continued)

5. If any of the conditions in step 3 are not met or power to terminal 1 exists and any of the other conditions in step 4 are not met:

   A. Check the continuity of the circuitry from the battery to the glow relay and glow plugs; refer to the Electrical Schematics in Appendix A (page A–1).

   B. Check the continuity of the circuitry from the battery to key switch, glow controller, glow lamp, glow relay, and ground; refer to the Electrical Schematics in Appendix A (page A–1).

   C. Replace the parts as necessary.

6. Connect the electrical connector to the fuel stop solenoid.

Fuel Pump

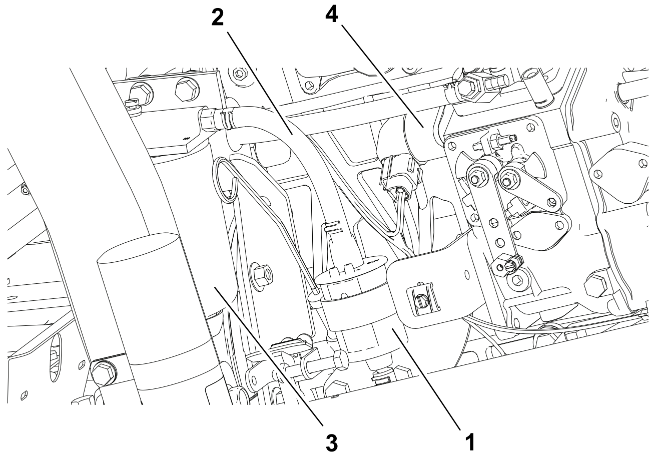

Figure 142

1. Fuel pump
2. Fuel hose (discharge)
3. Fuel filter
4. Fuel stop solenoid

The fuel pump is attached to the frame just outboard of the fuel injection pump.

IMPORTANT

When testing the fuel pump, ensure that the pump is not operated without fuel.

DANGER

Diesel fuel is highly flammable.

- **Use caution whenever you handle diesel fuel.**
- **Do not smoke while testing the fuel pump.**
- **Do not test the fuel pump while the engine is hot.**
- **Ensure that there is adequate ventilation when testing.**
- **Always wipe up any spilled diesel fuel before starting the engine.**

Testing the Fuel Pump Capacity

1. Park the machine on a level surface, lower the cutting deck, set the parking brake, and shut off the engine. Ensure that the key switch is in the OFF position.
2. Unlatch the hood and raise it.
3. Disconnect electrical connector from the fuel stop solenoid to prevent the engine from firing.
4. Disconnect fuel hose (pump discharge) from the fuel filter.
5. Make sure fuel hoses attached to the fuel pump are free of obstructions.
6. Place fuel hose (pump discharge) into a large, graduated cylinder sufficient enough to collect 1 liter (33.8 fluid ounces).

Testing the Fuel Pump Capacity (continued)

IMPORTANT

When testing the fuel pump output, do not turn the key switch to the START position.

7. Turn the key switch to the ON position and collect the fuel in the graduated cylinder. Allow the pump to run for 15 seconds and then turn the switch to the OFF position.

   Note: The amount of fuel pumped in 15 seconds must be approximately **475 ml (16 fl oz)**.

8. Replace the fuel pump if output specification is not met.

IMPORTANT

If the fuel pump is replaced, ensure that replacement pump is the correct pump for your Reelmaster by using your Parts Catalog. If incorrect pump is used, the fuel system damage can occur.

9. Connect the fuel pump discharge hose to the fuel/water separator or filter. Ensure to secure the hose with the hose clamp.
10. Reconnect electrical connector to the fuel stop solenoid.
11. Prime the fuel system; refer to *Operator's Manual*.

Fuel Pump Specifications

Pump Capacity	1.9 L/minute (64 fl oz/minute)
Pressure	48.3 kPa (7 psi)
Maximum Current Draw	2.0 A

Standard Control Module (SCM)

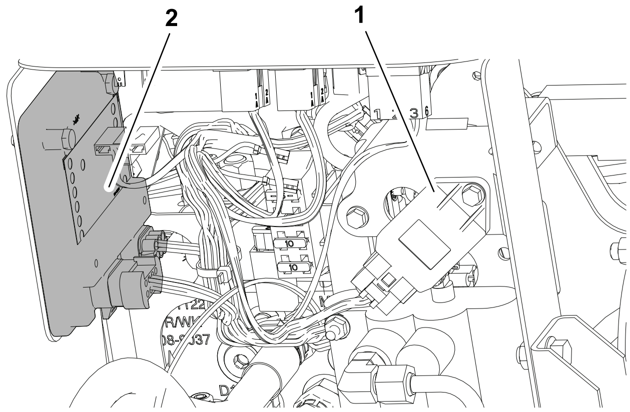

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Figure 143

1. Glow controller
2. SCM

The Reelmaster 3100-D and 3105-D machines are equipped with a Standard Control Module (SCM) to monitor and control electrical components required for safe operation. This Module is attached to the back of the control panel (Figure 143).

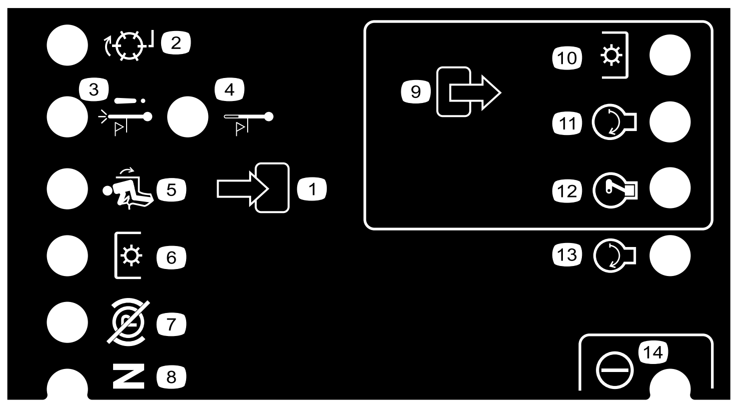

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Figure 144

1. Inputs
2. Reels-active
3. High temperature shutdown
4. High temperature warning
5. In seat
6. PTO
7. Parking brake-Off
8. Neutral
9. Outputs
10. PTO
11. Engine-Start (output)
12. Engine-Run
13. Engine-Start (input)
14. Power

SCM monitor the inputs from the neutral, parking brake, PTO, start (ignition), backlap, high temperature warning switch and high temperature shutdown switch. Output to the PTO (reel drive solenoid), fuel pump, and engine run solenoid are controlled based on the inputs received by the Module.

The Standard Control Module does not connect to an external computer or hand held device, can not be re-programmed, and does not record intermittent fault data.

The Standard Control Module can be used to check operation of machine switches by monitoring the LED of the module. If a Module LED does not illuminate (e.g. the in seat input LED does not illuminate with the seat occupied

Standard Control Module (SCM) (continued)

and the key switch in the run position), testing of the switch and circuit wiring would be required.

Refer to the *Traction Unit Operator's Manual* for operation and troubleshooting of the Standard Control Module.

Service and Repairs

Note: Refer to the Kubota Workshop Manual for additional component repair information.

Battery Storage

If you store the machine for more than 30 days:

1. Ensure that the key switch is in the OFF position. Remove the battery and charge it fully; refer to Servicing the Battery (page 6–49).
2. Either store the battery on a shelf or on the machine.
3. Disconnect the cables if the battery is kept on the machine.
4. Store the battery in a cool atmosphere to avoid quick deterioration of the battery charge.
5. To prevent the battery from freezing during storage, ensure that you charge it fully; refer to Servicing the Battery (page 6–49).

Battery Care

1. The battery-electrolyte level must be properly maintained. The top of the battery must be kept clean. If the machine is stored in a location where the temperatures are extremely high, the battery will discharge more rapidly than if the machine is stored in a location where the temperatures are cool.

WARNING

The gases are explosive; also, they can cause nausea.

- **Wear safety goggles and rubber gloves when working with electrolyte. Charge the battery in a well ventilated place so that the gasses produced while charging can dissipate.**
- **Keep open flames and electrical sparks away from the battery; do not smoke.**
- **Disconnect the charger from the electrical outlet before connecting or disconnecting charger leads to or from the battery posts.**

IMPORTANT

Do not remove battery fill caps while cleaning.

2. Check the battery condition weekly or after every 50 hours of operation. Keep the terminals and entire battery case clean because a dirty battery will discharge slowly.
   A. Clean the battery by washing entire case with a solution of baking soda and water. Flush the battery case with clear water.
   B. Coat the battery posts and cable connectors with the battery terminal protector (refer to Special Tools (page 2–13)) or petroleum jelly to prevent corrosion.
3. Tighten the battery cables on the battery terminals to provide a good electrical contact.

Battery Care (continued)

WARNING

Connecting the cables to the wrong battery post could result in personal injury and/or damage to the electrical system.

Ensure that the cables are properly connected to the correct battery posts before operating the machine.

---

4. If corrosion occurs at the battery terminals, disconnect the cables. Always disconnect the negative (-) cable first. Clean the cable clamps and terminals separately. Connect the cables with the positive (+) cable first. Apply a layer of terminal protector (Toro Part No. 107-0392) or a light coat of petroleum jelly to the terminals to reduce corrosion after you make the connections.
5. Check the battery-electrolyte level every 25 operating hours and every 30 days if machine is in storage.
6. Maintain the cell level with the distilled or demineralized water.

   Note: Do not fill the cells above the fill line.

Servicing the Battery

The battery is the heart of the electrical system. With the regular and correct service, the battery life can be extended. Additionally, the battery and electrical component failure can be prevented.

CAUTION

Battery-electrolyte is corrosive and can burn skin and eyes and damage clothing.

While working with the batteries, use extreme caution to avoid splashing or spilling of the electrolyte. Always wear the safety goggles and a face shield while working with batteries.

Battery Specifications

Battery-electrolyte specific gravity	Fully Charged: 1.250 to 1.280 Discharged: less than 1.240
Battery specifications	BCI Group Size: 26 525 CCA at -18°C (0°F) Reserve Capacity of 80 minutes at 27°C (80°F)
Battery dimensions (including terminal posts and caps)	Length 20.8 cm (8.2 inches) Width 17.3 cm (6.8 inches) Height 20.3 cm (8.0 inches)

Removing and Installing the Battery

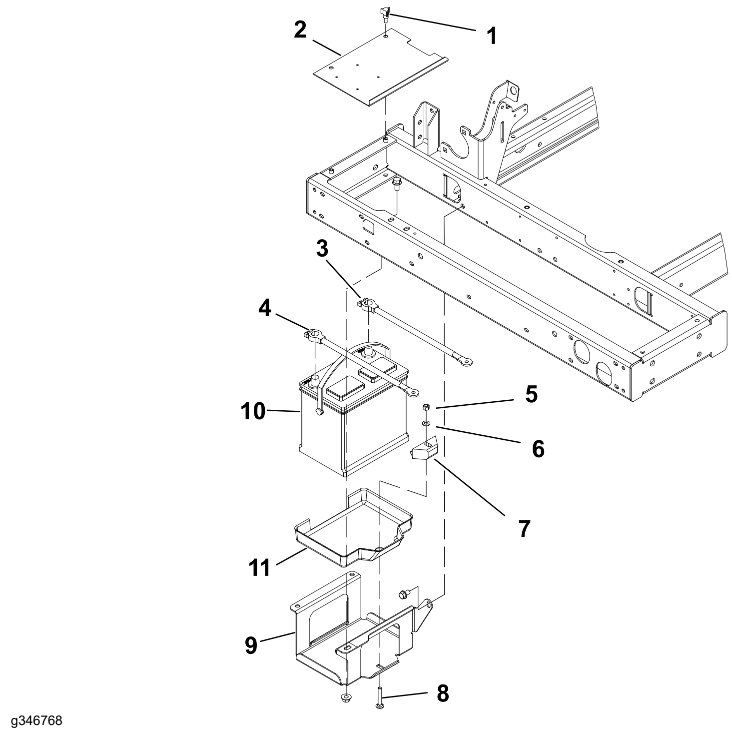

Figure 145

1. Knob (2)
2. Battery cover
3. Negative cable
4. Positive cable
5. Lock nut
6. Flat washer
7. Battery retainer
8. Carriage screw
9. Battery support
10. Battery
11. Battery tray

---

1. Remove battery cover from the frame. Loosen battery retainer securing the back of the battery to the battery support.
2. Note battery cable routing and loosen nut on ground cable (−) post and remove cable from battery. This should prevent short circuiting the battery, other components, or the operators hands.
3. Note battery cable routing and loosen nut on positive (+) cable post and remove cable from battery.
4. Carefully remove battery from machine.
5. Install battery in reverse order making sure to connect and tighten positive cable to battery before connecting the negative cable. Route battery cables as noted during removal.

   Note: Before connecting the negative (ground) cable, connect a digital multimeter (set to amps) between the negative battery post and the negative (ground) cable connector. The reading should be less than 0.1 amp. If the reading is 0.1 amp or more, the machine's electrical system should be tested for short circuits or faulty components and repaired.
6. Make sure that rubber boot is properly placed over positive cable end and positive battery post.
7. Secure battery cover after installing battery.

Inspecting, Maintaining, and Testing the Battery

1. Do the following inspections and maintenance:
   A. Check for cracks. Replace the battery if cracked or leaking.
   B. Check the battery terminal posts for corrosion. Use the wire brush to clean corrosion from the posts.

IMPORTANT

Before cleaning the battery, tape or block the vent holes of the filler caps and ensure that the caps are tight.

   C. Check for the signs of wetness or leakage on the top of the battery which might indicate a loose or missing filler cap, overcharging, loose terminal post, or overfilling. Also, check the battery case for dirt and oil. Clean the battery with a solution of baking soda and water, then rinse it with clean water.
   D. Check that the cover seal is not broken away. Replace the battery if the seal is broken or leaking.
   E. Check the electrolyte level in each cell. If the level is below the tops of the plates in any cell, fill all the cells with distilled water between the minimum and maximum fill lines. Charge at 15 to 25 A for 15 minutes to allow sufficient mixing of the electrolyte; refer to Charging the Battery (page 6–53).
2. Perform the hydrometer test of the battery-electrolyte.

IMPORTANT

Ensure that the area around the cells is clean before opening the battery caps.

   A. Use a hydrometer to measure the specific gravity of each cell. Pull the electrolyte in and out of the hydrometer barrel before taking a reading to warm-up the hydrometer. At the same time, take the temperature of the cell.
   B. Temperature correct each cell reading. For each 5.5°C (10°F) above 27°C (80°F) add 0.004 to the specific gravity reading. For each 5.5°C (10°F) below 27°C (80°F) subtract 0.004 from the specific gravity reading; refer to the Cell Specific Gravity Example (page 6–51).

Cell Specific Gravity Example

Cell Temperature	100°F
Cell Specific Gravity	1.245
38°C minus 27°C equals 11°C (100°F minus 80°F equals 20°F)	
11°C multiply by 0.004/5.5°C equals 0.008 (20°F multiply by 0.004/10°F equals 0.008)	
ADD (conversion above)	0.008
Correction to 27°C (80°F)	1.253

C. If the difference between the highest and lowest cell specific gravity is 0.050 or more or the lowest cell specific gravity is less than 1.225, charge the battery.

D. Charge at the rate and time given in Charging the Battery (page 6–53) or until all cells specific gravity is 1.225 or greater with the difference in specific gravity between the highest and lowest cell is less than 0.050. If you can not meet these charging conditions, replace the battery.

3. Do a high-discharge test with an adjustable load tester. This is 1 of the most reliable means of testing a battery as it simulates the cold-cranking test. A commercial battery load tester is required to do this test.

CAUTION

Follow the manufacturer's instructions when using a battery load tester.

A. Check the voltage across the battery terminals before testing the battery. If the voltage is less than 12.4 VDC, charge the battery before continuing the test; refer to Charging the Battery (page 6–53).

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

C. Measure the electrolyte temperature of the center battery cell.

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

E. If you charge the battery, apply a 150 A load for 15 seconds to remove the surface charge. Wait for 10 minutes before proceeding with load test.

F. Apply a test load of 270 A (1/2 the cranking performance rating of the battery) for 15 seconds.

G. After test load has been applied for 15 seconds, take a test voltage reading and then remove the load. Record the test voltage reading.

H. Use the Minimum Voltage Table (page 6–52), determine the minimum voltage for the center cell electrolyte temperature reading.

Minimum Voltage Table

Minimum Voltage	Battery-Electrolyte Temperature	
9.6	70°F (and up)	21.1°C (and up)
9.5	60°F	16°C
9.4	50°F	10°C
9.3	40°F	4°C
9.1	30°F	-1°C
8.9	20°F	-7°C
8.7	10°F	-12°C
8.5	0°F	-18°C

I. If the test voltage is below the minimum, replace the battery. If the test voltage is at or above the minimum, return the battery to service.

4. After you make the connections, apply terminal protector (Toro Part No. 107-0392) or a light layer of grease on all the battery posts and cable connectors to reduce corrosion.

Charging the Battery

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

IMPORTANT

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

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

1. Determine the battery charge level from either its specific gravity or open circuit voltage.

Battery Charge Level	Specific Gravity	Open Circuit Voltage
100%	1.265	12.68
75%	1.225	12.45
50%	1.190	12.24
25%	1.155	12.06
0%	1.120	11.89

2. Determine the charging time and rate using the manufacturer's battery charger instructions or the following Battery Charge Level Table (page 6–53).

Battery Charge Level Table

Battery Reserve Capacity (Minutes)	Battery Charge Level (Percent of Fully Charged)			
	75%	**50%**	**25%**	**0%**
80 or less	3.8 hrs @ 3 A	7.5 hrs @ 3 A	11.3 hrs @ 3 A	15 hrs @ 3 A
81 to 125	5.3 hrs @ 4 A	10.5 hrs @ 4 A	15.8 hrs @ 4 A	21 hrs @ 4 A
126 to 170	5.5 hrs @ 5 A	11 hrs @ 5 A	16.5 hrs @ 5 A	22 hrs @ 5 A
171 to 250	5.8 hrs @ 6 A	11.5 hrs @ 6 A	17.3 hrs @ 6 A	23 hrs @ 6 A
above 250	6 hrs @ 10 A	12 hrs @ 10 A	18 hrs @ 10 A	24 hrs @ 10 A

Charging the Battery (continued)

⚠ CAUTION ⚠

Charging a frozen battery can cause explosion and can cause personal injury. Let the battery warm to 15.5°C (60°F) before connecting to a charger.

- **Charge the battery in a well-ventilated place to dissipate the gases produced from the charging.**
- **These gases are explosive; keep open flame and electrical spark away from the battery. Do not smoke.**
- **Inhaling the battery gases can cause nausea.**
- **Unplug the charger from the electrical outlet before connecting or disconnecting the charger leads from the battery posts.**

---

3. Follow the battery charger manufacturer's instructions, connect the charger cables to the battery posts. Ensure that you make a good connection.
4. Charge the battery following the manufacturer's instructions.
5. Occasionally check the temperature of the battery-electrolyte. If the temperature is more than 52 ºC (125 ºF) or the electrolyte is violently gassing or spewing, lower and temporarily stop the charging rate.
6. Three hours before the end of the charging, measure the specific gravity of a battery cell once per hour.

   Note: The battery is fully charged when the cells are gassing freely at a low charging rate and there is less than a 0.003 change in specific gravity for 3 consecutive readings.

Chapter 7

Wheels, Brakes and Chassis

Table of Contents

General Information

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

Adjustments

Adjusting the Brake

⚠ CAUTION ⚠

Before and after adjusting the brakes, always check the brakes in a wide open area that is flat and free of other persons and obstructions.

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

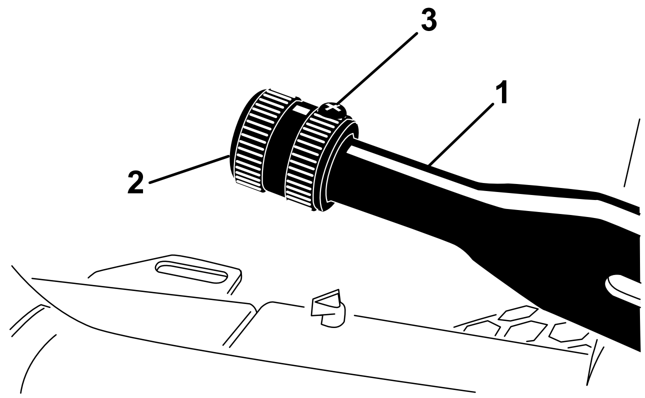

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Figure 146

1. Set screw
2. Adjustment knob
3. Brake lever

2. Adjust parking brake lever until a force of **133 to 178 N (30 to 40 lb)** is required to actuate lever. To adjust:
   A. Loosen set screw on adjustment knob (Figure 146).
   B. Turn adjustment knob clockwise to increase force and counterclockwise to decrease force.
   C. Tighten set screw after adjustment.

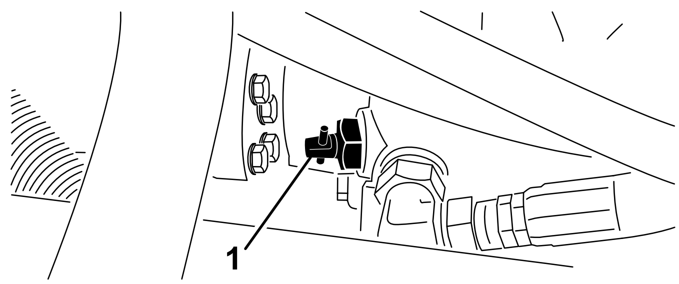

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Figure 147

1. Piston pump
2. By−pass valve

3. Check brake adjustment as follows:
   A. Rotate by−pass valve on the piston pump 90 degrees to allow front wheels to turn freely (Figure 147).

Adjusting the Brake (continued)

CAUTION

Before jacking up the machine, review and follow Jacking Instructions (page 1–7).

B. Chock rear wheel. Jack up both front wheels and support the machine with hardwood blocks.

C. With the parking brake applied, use a torque wrench on the wheel hub lock nut to identify the break away torque at each front wheel. The minimum break away torque with the parking applied should be **366 N·m (270 ft–lb)**.

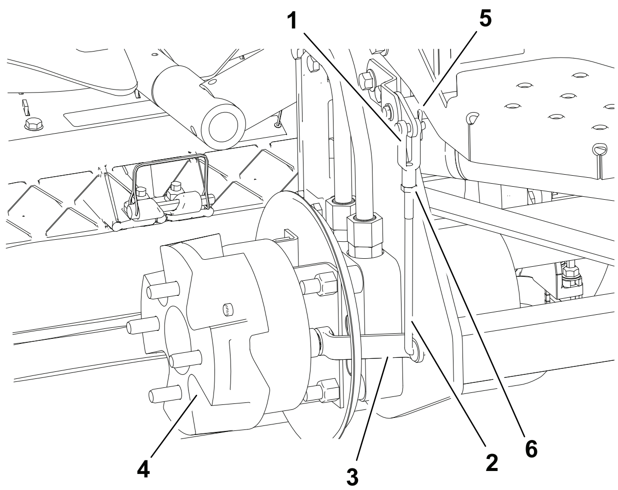

Figure 148

1. Clevis
2. Adjustment rod
3. Brake lever
4. Wheel hub
5. Cotter pin
6. Jam nut

4. If adjustment is necessary, adjust brakes as follows:

A. Remove both front wheel assemblies from the machine (see Removing the Front Wheel and Brake (page 7–9)).

B. Adjust brakes by turning clevis to increase or decrease shoe pressure on the brake drum (Figure 148). Make sure that the brake shoes do not drag against drums with the parking brake lever released.

C. If brakes can not be adjusted properly, repair or replace brake components as necessary.

D. After adjustment is complete, install front wheel assemblies to the machine (see Installing the Front Wheel and Brake (page 7–11)).

E. Lower front wheels to the ground.

F. Before starting engine, close by-pass valve on pump by rotating it 90 degrees (Figure 147).

Service and Repairs

Standard Seat

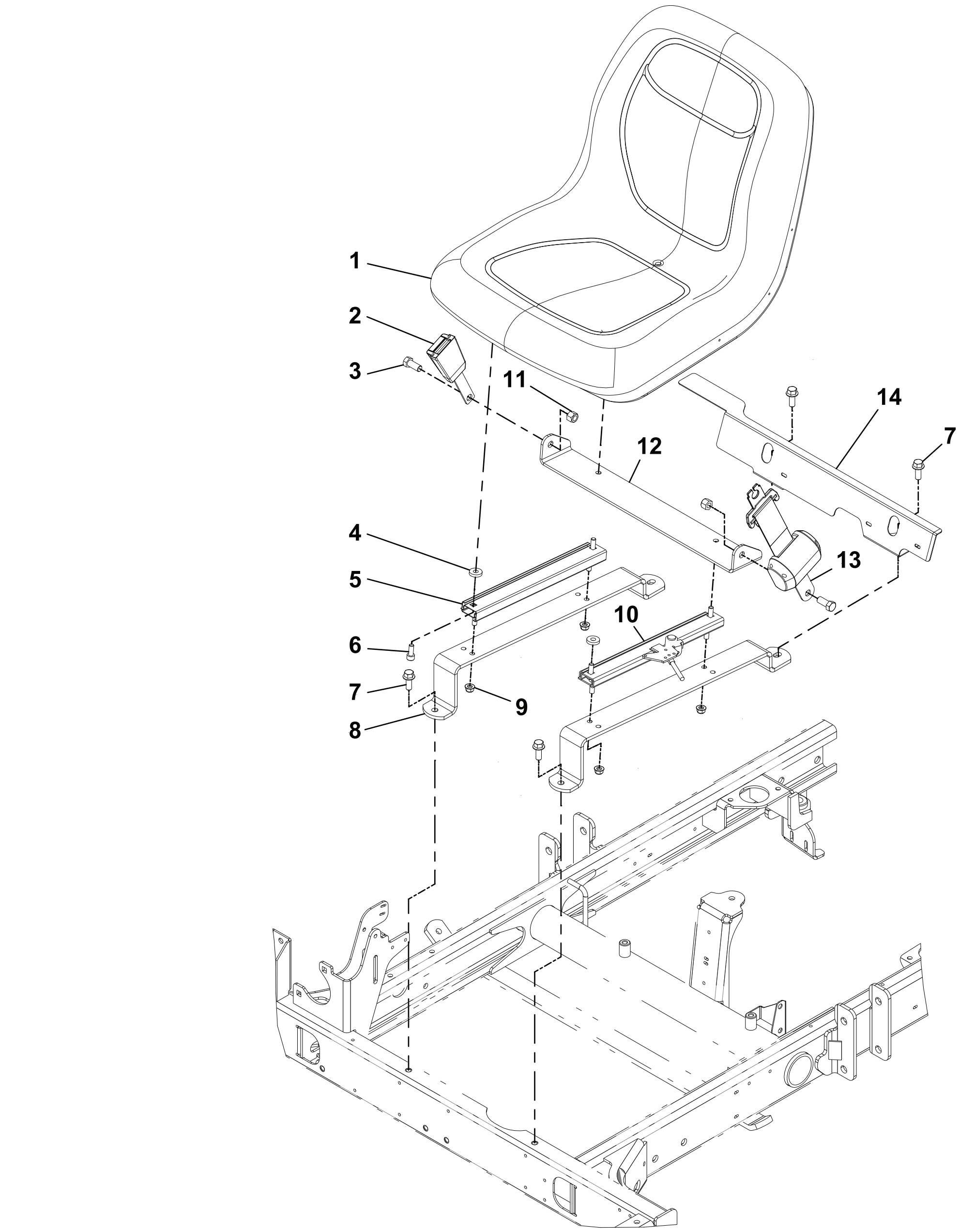

Figure 149

1. Seat assembly
2. Seat belt buckle
3. Bolt (2 each)
4. Spacer (2 each)
5. Seat slider
6. Socket head screw (4 each)
7. Flange head bolt (4 each)
8. Seat support strap (2 each)
9. Flange nut (4 each)
10. Seat adjuster
11. Lock nut (2 each)
12. Seat belt bracket
13. Seat belt
14. Heat shield

Removing the Seat

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the key switch.
2. Remove the four flange head bolts securing the seat support straps to the frame.
3. Disconnect the electrical connector from the seat switch. Separate the seat from the frame.
4. Remove seat parts as necessary to make repairs using Figure 149 as a guide.

Installing the Seat

1. Install any new seat parts using Figure 149 as a guide.
2. Position the seat and support straps to the fuel tank and frame.
3. Connect the electrical connector to the seat switch.
4. Secure the seat support straps to the frame with four flange head bolts.

Deluxe Seat

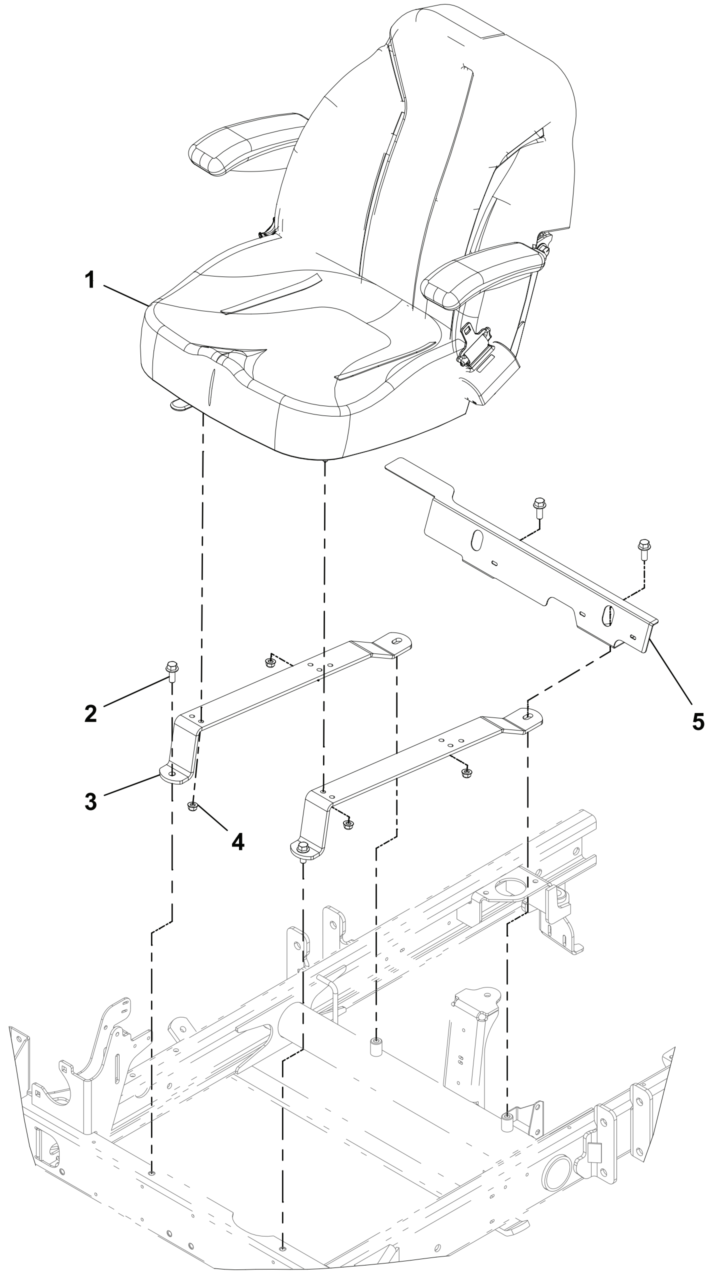

Figure 150

1. Seat and track assembly
2. Flange head bolt (4 each)
3. Seat support strap (2 each)
4. Flange nut (4 each)
5. Heat shield

Removing the Seat

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the key switch.
2. Remove the four flange head bolts securing the seat support straps to the frame; refer to Figure 150.
3. Disconnect the electrical connector from the seat switch. Separate the seat from the frame.

Removing the Seat (continued)

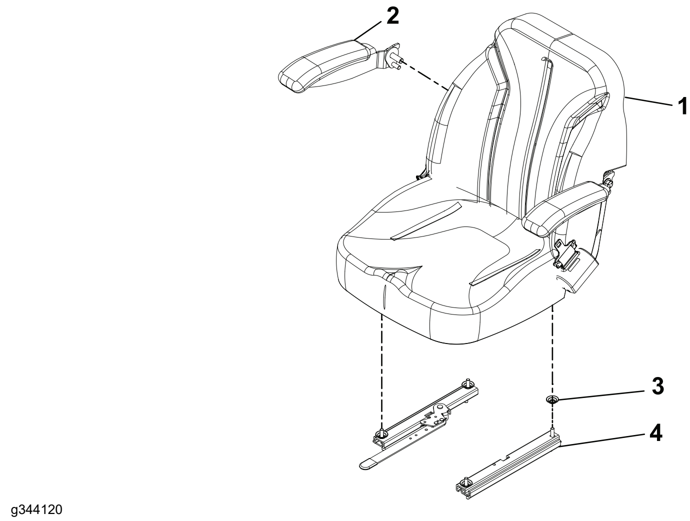

Figure 151

1. Seat assembly
2. Arm rest
3. Mounting spacer (4 each)
4. Seat track

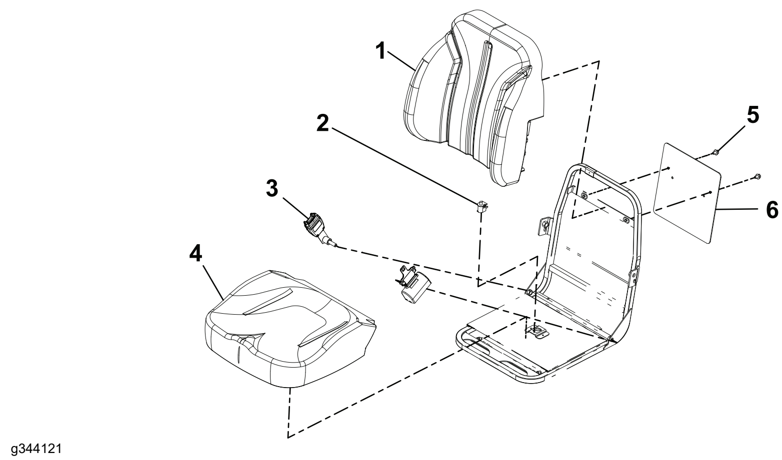

Figure 152

1. Seat-back
2. Seat switch
3. Seat belt
4. Seat-bottom
5. Flange head bolt (2 each)
6. Decal

4. Remove seat parts as necessary to make repairs using Figure 151 and Figure 152 as a guide.

Installing the Seat

1. Install any new seat parts using Figure 151 and Figure 152 as a guide.
2. Position the seat and support straps to the fuel tank and frame.
3. Connect the electrical connector to the seat switch.
4. Secure the seat support straps to the frame with four flange head bolts; refer to Figure 150.

Front Wheel and Brake

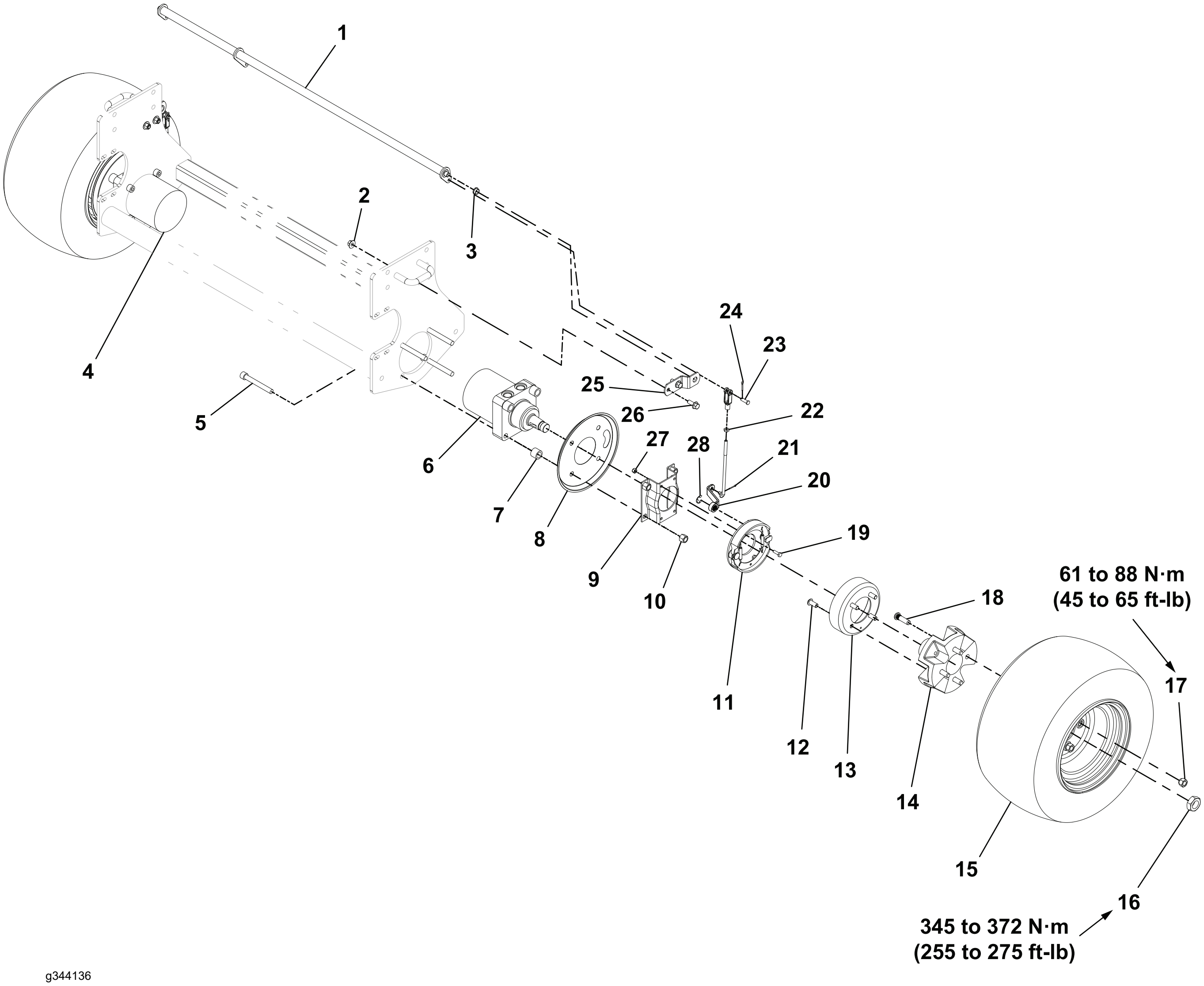

Figure 153

1. Brake pivot shaft
2. Flange nut (4 each)
3. Flange bush (2 each)
4. Hydraulic motor assembly (CW)
5. Socket head screw (8 each)
6. Hydraulic motor assembly (CCW)
7. Pulley deck spacer (8 each)
8. Wheel shield (2 each)
9. Brake bracket (2 each)
10. Lock nut (8 each)
11. Brake assembly (2 each)
12. Bolt (8 each)
13. Brake drum (2 each)
14. Wheel hub (2 each)
15. Wheel assembly (2 each)
16. Lock nut (2 each)
17. Lug nut (8 each)
18. Drive stud (8 each)
19. Bolt (8 each)
20. Brake lever (2 each)
21. Cotter pin (2 each)
22. Adjustment rod (2 each)
23. Clevis pin (2 each)
24. Cotter pin (2 each)
25. Brake pivot bracket (2 each)
26. Flange head bolt (2 each)
27. Lock nut (10 each)
28. Retaining ring (2 each)

Removing the Front Wheel and Brake

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

CAUTION

Before jacking up the machine, review and follow Jacking Instructions (page 1–7).

2. Jack up front wheel and use wood blocks to keep the rear tire off the floor.
3. Remove the lug nuts (item 17 in Figure 153) from drive studs (18). Pull wheel from drive studs (18) and wheel hub (14).

   Note: The installation torque of the locknut (16) is from **345 to 372 N·m (255 to 275 ft-lb)**. Use impact wrench to remove lock nut from the hydraulic motor shaft.
4. Loosen, but do not remove, lock nut (16) from the hydraulic motor shaft. Release parking brake.

IMPORTANT

Do not hit wheel hub, wheel hub puller or wheel motor with a hammer during removal or installation. Hammering may cause damage to the hydraulic wheel motor.

5. Using the hub puller (refer to Special Tools (page 2–13)), loosen wheel hub (14) from wheel motor.
6. Remove lock nut (16), hub, and brake drum (13) from motor shaft. Locate and retrieve woodruff key.
7. Remove cotter pin (21) from the adjustment rod (22). Separate adjustment rod from the brake lever (20).

   Note: The brake lever, backing plate, retaining clip, return springs, brake shoes, and cam shaft can be removed as a complete brake assembly.
8. If it is desired to remove the brake assembly (11) from the brake bracket (9), remove four bolts (19) and lock nuts (27) securing the assembly to the bracket.

Removing the Front Wheel and Brake (continued)

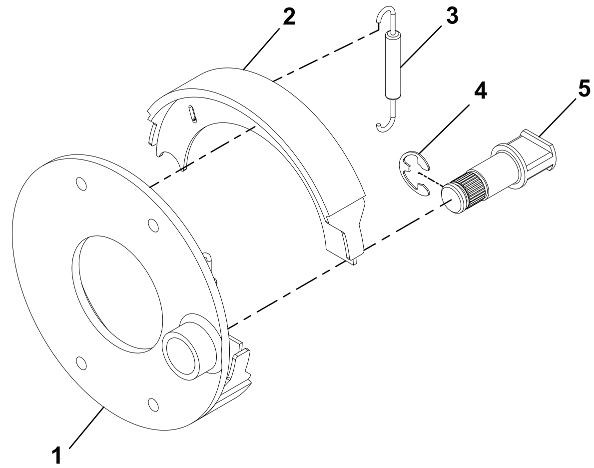

Figure 154

1. Backing plate
2. Brake shoe
3. Return spring
4. Retaining ring
5. Cam shaft

9. Disassemble brake assembly as follows (Figure 154):
   A. Remove return springs (3) from the brake shoes (2). Remove brake shoes from the backing plate (1).
   B. Matchmark brake cam and brake lever to assure proper alignment during reassembly. Remove retaining ring (4) from the brake cam. Pull brake lever from the cam (5). Remove cam from backing plate.
10. The brake bracket (9) and wheel shield (8) can be removed as follows:
    A. Remove lock nuts (10), spacers (7), and socket head screws (5) securing the brake bracket, wheel shield, and hydraulic motor to the frame.
    B. Separate bracket (9) and shield (8) from the frame.

Installing the Front Wheel and Brake

1. Insert four socket head screws (item 5 in Figure 153) through the frame, hydraulic motor (6), spacers (7), wheel shield (8), and brake bracket (9). Secure with lock nuts (10), but do not fully tighten.
2. Assemble brake assembly as follows (Figure 154):
   A. Secure backing plate to the brake bracket with four cap screws and lock washers.
   B. Apply antiseize lubricant to cam shaft splines. Insert cam shaft through the backing plate.
   C. Attach brake lever to the cam shaft. Make sure matchmarks are aligned properly. Secure lever to shaft with retaining clip.
   D. Lubricate brake shoe pivot points with a light coating of grease.
   E. Position both brake shoes on the backing plate so that the concave heels attach to the anchor pin.
   F. Insert both return springs into the holes of both brake shoes. Make sure shoes fit snuggly against the anchor pin and cam.
3. If the brake lever, backing plate, retaining clip, return springs, brake shoes, and cam shaft were removed as a complete brake assembly, secure backing plate to the brake bracket with four bolts and lock nuts. Tighten fasteners.

Installing the Front Wheel and Brake (continued)

4. Attach adjustment (20) rod to the brake lever (22). Secure adjustment rod with cotter pin (21).
5. Thoroughly clean wheel motor shaft and wheel hub taper.
6. Install the woodruff key to the slot on the hydraulic motor shaft. Slide the wheel hub and brake drum assembly onto the shaft.
7. Secure the wheel hub and brake drum to the hydraulic motor shaft with lock nut (16).

   Note: For proper brake operation, the brake shoes and backing plate must be concentrically aligned with the brake drum.
8. To align brake shoes and drum, apply parking brake. Then tighten four socket head screws (5) and lock nuts (10) that secure the brake bracket and wheel motor to the frame.
9. Place wheel onto drive studs (18) and wheel hub. Secure wheel with lug nuts (17) on drive studs.
10. Lower wheel to ground. Torque the lug nuts (17) from **61 to 88 N·m (45 to 65 ft-lb)** in a criss-cross pattern. Torque the lock nut (16) from **345 to 372 N·m (255 to 275 ft-lb)**.
11. Check and adjust brakes (see Adjusting the Brake (page 7–3)).

Burnish Brake Pads

After brake pad replacement, burnish (break- in) the brakes before use.

1. Bring the machine to full speed and apply the brakes to rapidly stop the machine without skidding or locking up the wheels.
2. Repeat this procedure 10 times. To avoid overheating the brakes, wait 1 minute between each stop.

Rear Fork and Wheel with Hydraulic Motor

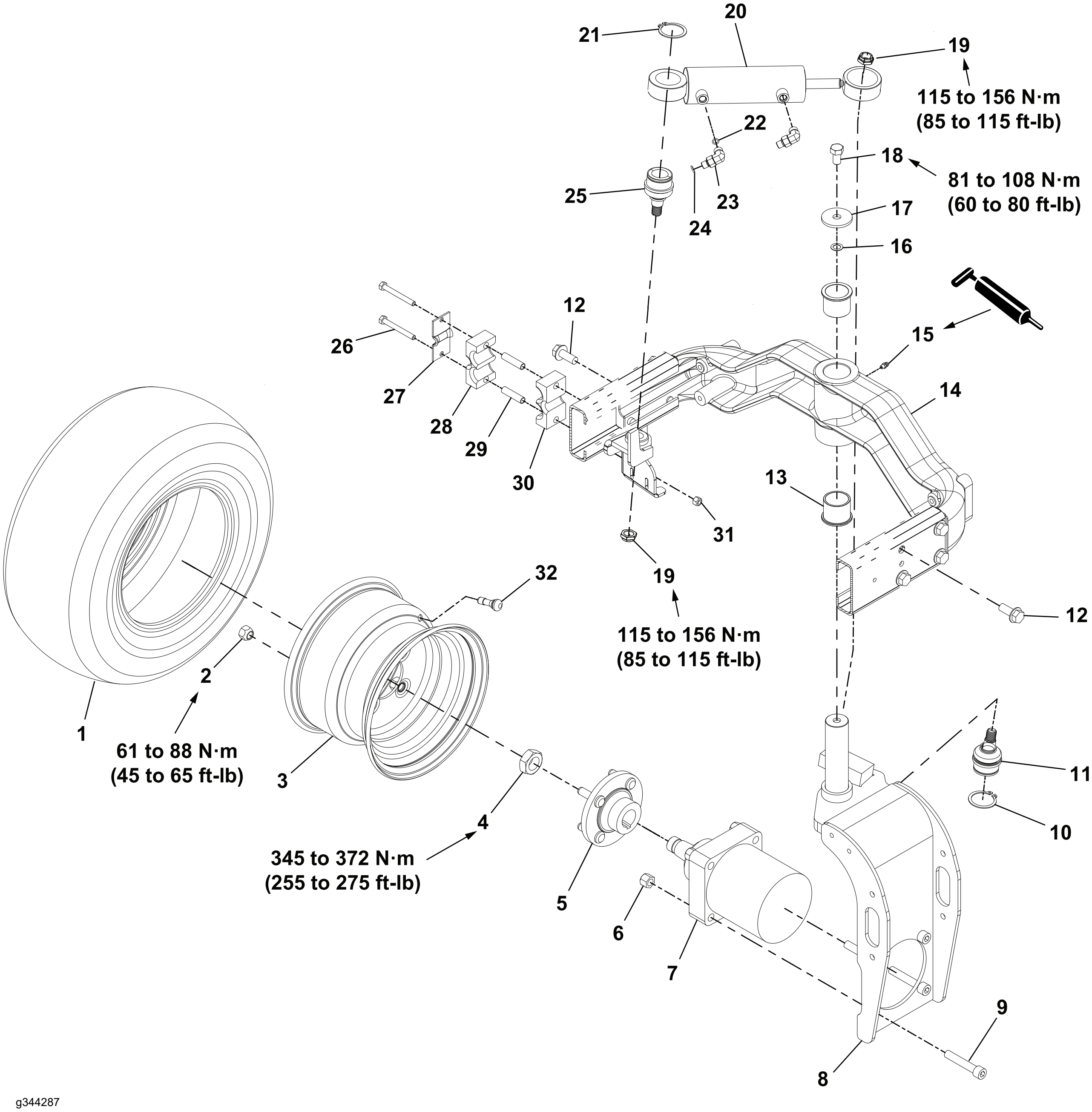

Figure 155

1. Tire
2. Lug nut (4 each)
3. Wheel rim
4. Lock nut
5. Wheel hub
6. Lock nut (4 each)
7. Hydraulic motor
8. Rear fork
9. Socket head screw (4 each)
10. External retaining ring
11. Ball joint
12. Flange head bolt (8 each)
13. Bushing (2 each)
14. Rear casting
15. Grease fitting
16. Lock washer
17. Thrust washer
18. Bolt
19. Flex-top nut (2 each)
20. Hydraulic cylinder
21. External retaining ring
22. O-ring (2 each)
23. Hydraulic fitting (2 each)
24. O-ring (2 each)
25. Ball joint
26. Bolt (2 each)
27. Case drain clamp
28. Clamp
29. Spacer (2 each)
30. Clamp
31. Lock nut (2 each)
32. Valve stem

Removing the Rear Fork and Wheel

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the key switch.
2. Remove the hood from the machine.
3. Separate the hydraulic cylinder from the rear fork as follows:
   A. Remove both jam nuts securing the ball joint to the rear fork.
   B. Separate the ball joint from the rear fork.
   C. Swing cylinder clear of the rear fork.

CAUTION

Before jacking up the machine, review and follow Jacking Instructions (page 1–7).

4. Jack up rear wheel enough to allow the removal of the rear fork.
5. Remove lug nuts from drive studs. Remove tire with wheel rim from wheel hub.
6. Remove four lock nuts and socket head screws securing the hydraulic motor to the rear fork. Remove the motor from the fork and position it away from the fork.

CAUTION

Support the front fork to prevent its falling during removal and installation. Personal injury or damage to the fork may result from improper handling.

7. Remove the bolt, thrust washer, and lock washer from the rear fork shaft.
8. Lower the rear fork from machine.
9. Check the bushings for wear and damage. Replace if necessary.

Installing the Rear Fork and Wheel

1. If removed, install the bushings into the rear fork.
2. Position the rear fork through the frame.
3. Install the lock washer, thrust washer, and bolt to the rear fork shaft. Torque the bolt from **81 to 108 N·m (60 to 80 ft−lb)**. Make sure that the fork turns freely.
4. Install the hydraulic motor to the rear fork. Secure the motor to the fork with four hex socket head screws and lock nuts.
5. Secure wheel rim to the wheel hub with four lug nuts. Torque the nuts from **61 to 88 N·m (45 to 65 ft-lb)**.
6. Lower the rear wheel to the ground.
7. Secure the hydraulic cylinder to the rear fork as follows:
   A. Swing cylinder to the rear fork.
   B. Install the ball joints to the rear fork.
   C. Secure ball joint to the rear fork with both jam nuts. Torque the nuts from **115 to 156 N·m (85 to 115 ft-lb)**.

Rear Fork and Wheel without Hydraulic Motor

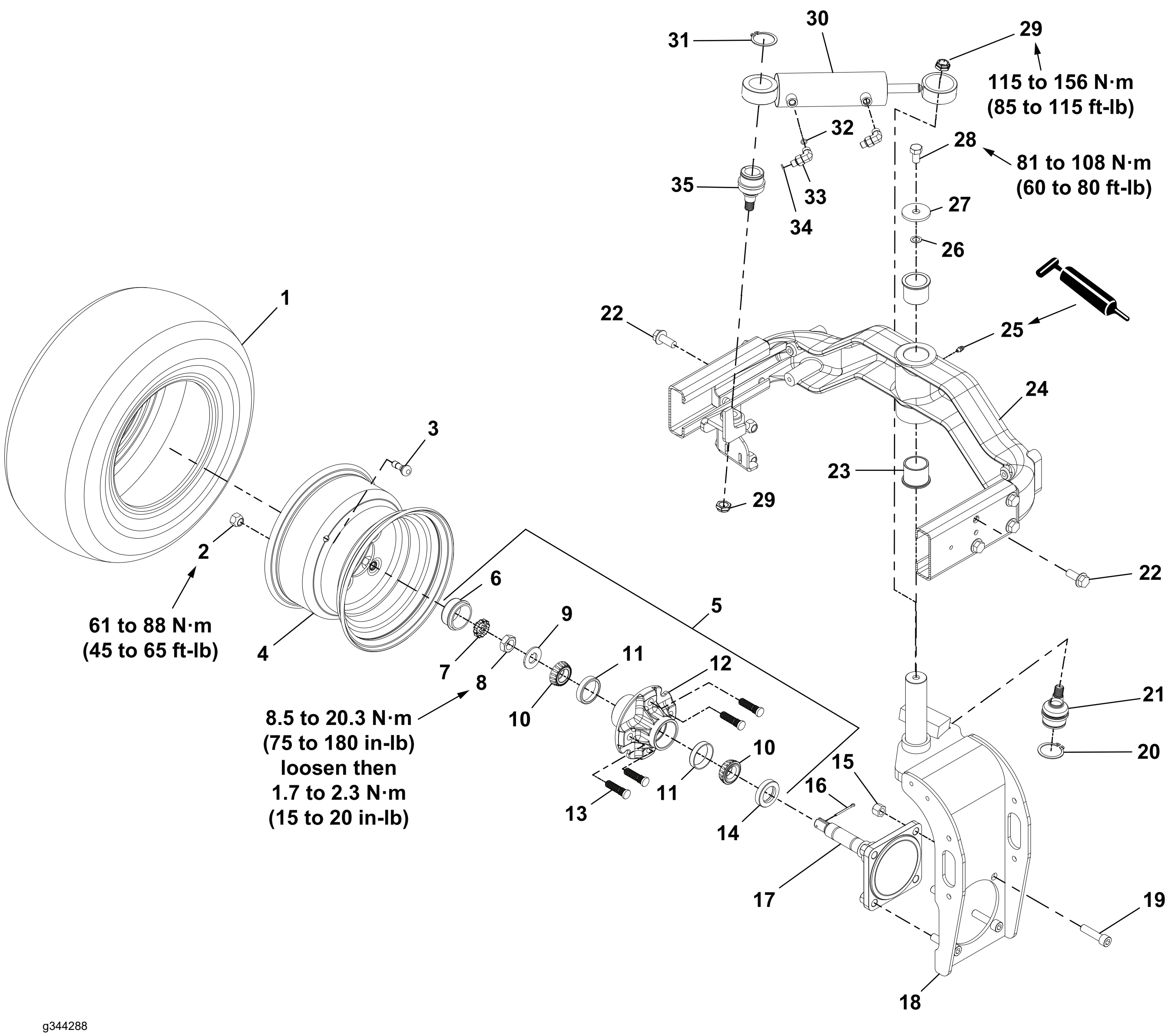

Figure 156

1. Tire
2. Lug nut (4 each)
3. Valve stem
4. Wheel rim
5. Hub and bearing assembly
6. Dust cap
7. Lock nut retainer
8. Jam nut
9. Tab washer
10. Tapered bearing (2 each)
11. Bearing cup (2 each)
12. Wheel hub
13. Drive studs (4 each)
14. Oil seal
15. Lock nut (4 each)
16. Cotter pin
17. Spindle
18. Rear fork
19. Socket head screw (4 each)
20. External retaining ring
21. Ball joint
22. Flange head bolt (8 each)
23. Bushing (2 each)
24. Rear casting
25. Grease fitting
26. Lock washer
27. Thrust washer
28. Bolt
29. Flex-top nut (2 each)
30. Hydraulic cylinder
31. External retaining ring
32. O-ring (2 each)
33. Hydraulic fitting (2 each)
34. O-ring (2 each)
35. Ball joint

Removing the Rear Fork and Wheel

1. Park the machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the key switch.
2. Remove the hood from the machine.
3. Separate the hydraulic cylinder from the rear fork as follows:
   A. Remove both jam nuts securing the ball joint to the rear fork.
   B. Separate the ball joint from the rear fork.
   C. Swing cylinder clear of the rear fork.

CAUTION

Before jacking up the machine, review and follow Jacking Instructions (page 1–7).

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4. Jack up rear wheel enough to allow the removal of the rear fork.
5. Remove lug nuts from drive studs. Remove tire with wheel rim from wheel hub.
6. Carefully remove the dust cap from the wheel hub.
7. Remove and discard the cotter pin from the spindle.
8. Remove the nut retainer, nut, and tab washer that secure the wheel hub to the spindle. Slide the wheel hub with the bearings from the spindle.
9. Disassemble the wheel hub as follows:

   Note: Ensure that you do not damage the hub bore.

   A. Remove and discard the oil seal from the wheel hub.
   B. Remove the bearing cones from both sides of the wheel hub. Clean the inner surface of the wheel hub.
   C. Clean and inspect the wheel bearing cups and cones. Check the bearing cones and cups for wear, pitting, or other damage. Replace the parts that are worn or damaged.
   D. If necessary, press the drive studs from the wheel hub.
10. Remove four lock nuts and socket head screws securing the spindle to the rear fork. Remove the spindle from the fork.

CAUTION

Support the front fork to prevent its falling during removal and installation. Personal injury or damage to the fork may result from improper handling.

---

11. Remove the bolt, thrust washer and lock washer from the rear fork shaft.
12. Lower the rear fork from machine.
13. Check the bushings for wear and damage. Replace if necessary.

Installing the Rear Fork and Wheel

1. If removed, install the bushings into the rear fork.
2. Position the rear fork through the frame.
3. Install the lock washer, thrust washer, and bolt to the rear fork shaft. Torque the bolt from **81 to 108 N·m (60 to 80 ft−lb)**. Make sure that the fork turns freely.
4. Install the spindle to the rear fork. Secure the spindle to the fork with four socket head screws and lock nuts.
5. Assemble the wheel hub as follows:

   A. If the drive studs were removed from the wheel hub, press the drive studs fully into the hub. Ensure that the drive studs flange is pressed fully to the hub surface.

   B. If the bearing cups were removed from the wheel hub, press the inner and outer cups into the wheel hub until they seat against the wheel hub shoulder.

   C. Fill the wheel hub approximately 50% full of grease.

   D. Pack both bearing cones with grease. Install greased inner bearing cone into the cup on inboard side of the wheel hub.

   IMPORTANT

   The oil seal should be pressed in so that it is flush with the end of the wheel hub. The lip of the oil seal must be toward the inner bearing.

   E. Lubricate the inside of new oil seal and press it into the wheel hub.

   Note: Ensure that you do not damage the oil seal in the wheel hub.

6. Install the wheel hub onto the spindle.
7. Install greased outer bearing cone, tab washer, and nut onto the spindle shaft.
8. While rotating the wheel hub by hand, torque the nut to **8.5 to 20.3 N·m (75 to 180 in-lb)** to seat bearings. Loosen the nut until it is away from the tab washer and the wheel hub has end-play. Finally, while rotating the wheel hub, tighten the nut to **1.7 to 2.3 N·m (15 to 20 in-lb)**.
9. Install the nut retainer and a new cotter pin to secure the nut. Install the dust cap.
10. Secure wheel rim to the wheel hub with four lug nuts. Torque the nuts from **61 to 88 N·m (45 to 65 ft-lb)**.
11. Lower the rear wheel to the ground.
12. Secure the hydraulic cylinder to the rear fork as follows:

    A. Swing cylinder to the rear fork.

    B. Install the ball joints to the rear fork.

    C. Secure ball joint to the rear fork with both jam nuts. Torque the nuts from **115 to 156 N·m (85 to 115 ft-lb)**.

Brake Linkages

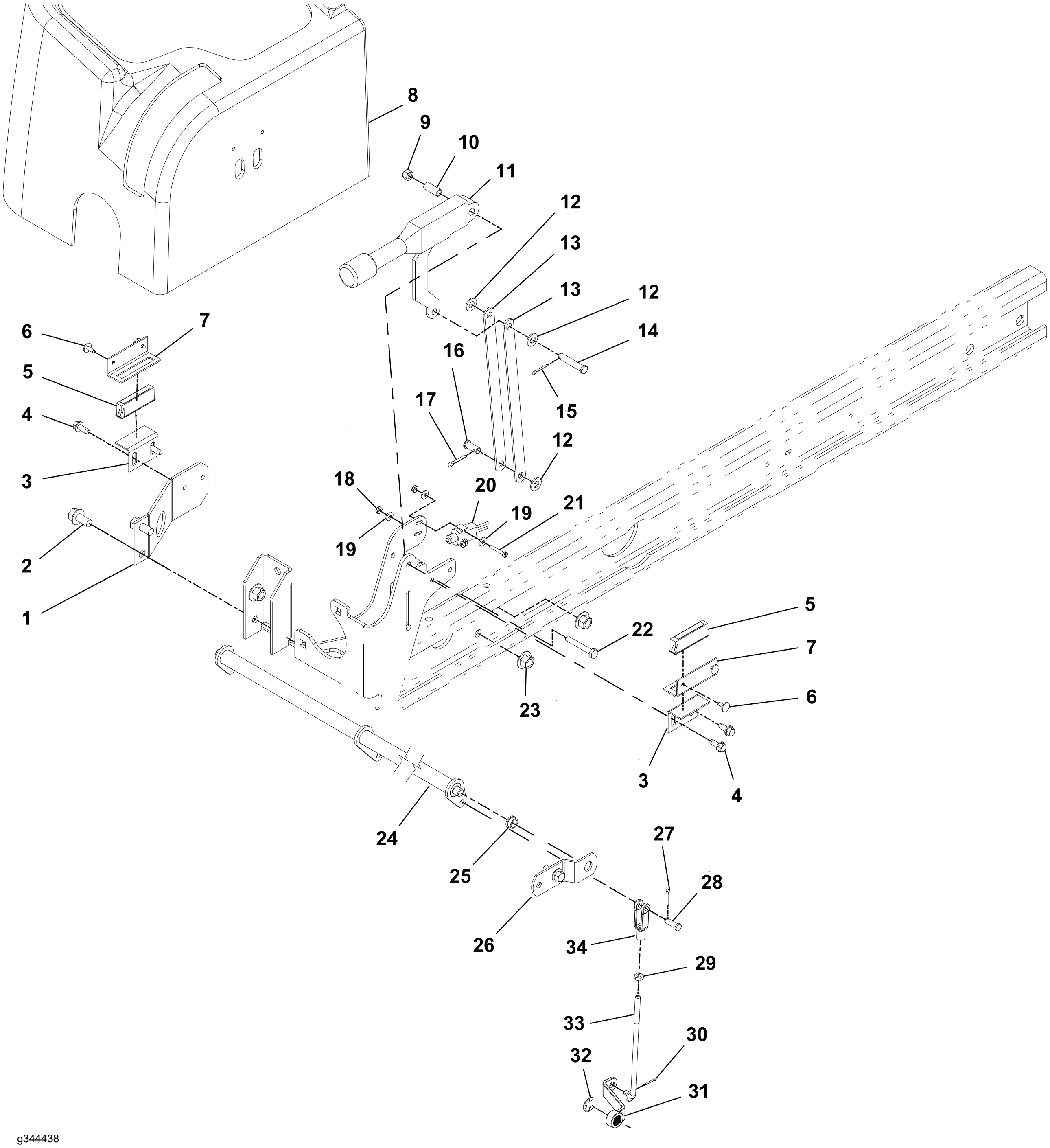

Figure 157

Figure 157 (continued)

1.	Magnet support	13.	Parking brake link	25.	Flange bushing
2.	Washer head bolt	14.	Clevis pin	26.	Brake pivot bracket
3.	Strike bracket	15.	Cotter pin	27.	Cotter pin
4.	Washer head bolt	16.	Clevis pin	28.	Clevis pin
5.	Magnet catch	17.	Cotter pin	29.	Jam nut
6.	Rivet	18.	Lock nut	30.	Cotter pin
7.	Cover bracket	19.	Flat washer	31.	Brake lever
8.	Control panel cover	20.	Switch	32.	Retaining ring
9.	Lock nut	21.	Slotted hex head screw	33.	Adjustment rod
10.	Parking brake spacer	22.	Bolt	34.	Adjustable clevis
11.	Lever assembly	23.	Nut		
12.	Flat washer	24.	Brake pivot shaft		

Removing the Brake Linkages

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the key switch.
2. Remove the control panel cover from the machine.

IMPORTANT

When removing the adjustable clevis from either the brake pivot shaft or adjustment rod or the brake lever from the cam shaft on the brake assembly, make sure to match mark both parts. Marking both parts will make reassembly and brake adjustment easier.

3. Remove the parts as necessary to repair brake linkages using Figure 157 as a guide.

Installing the Brake Linkages

1. Install the removed parts onto the brake linkages using Figure 157 as a guide.
2. Install the control panel cover to the machine.

IMPORTANT

Always check and adjust the brakes anytime brake linkages are disassembled or repaired.

3. Adjust the brake linkages (refer to Adjusting the Brake (page 7–3)).

Steering Column

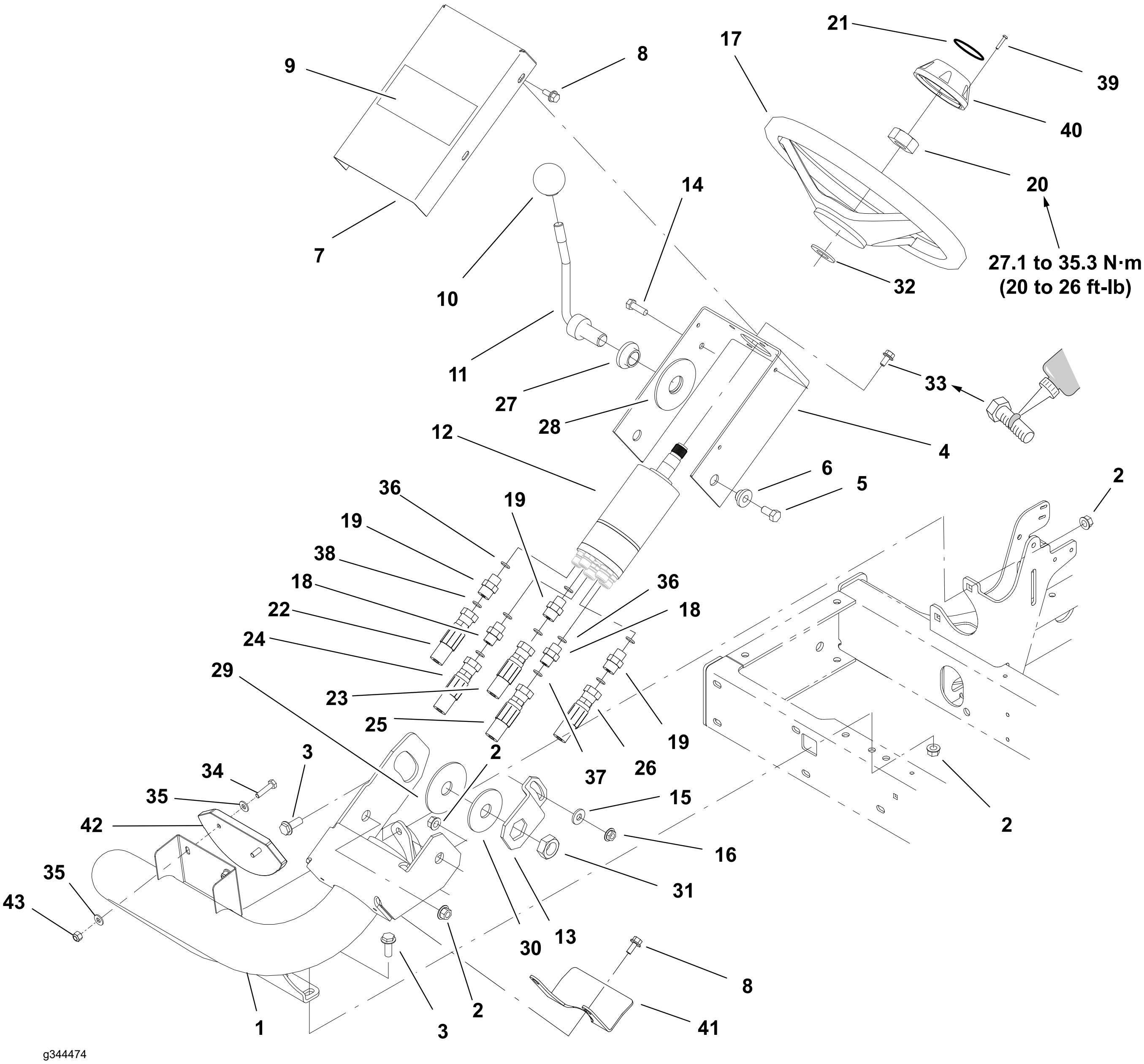

Figure 158

1. Steering arm
2. Flange hex nut
3. Hex flange head bolt
4. Steering control valve bracket
5. Bolt
6. Pivot hub
7. Steering cover
8. Bolt
9. Decal
10. Ball knob
11. Lever
12. Steering control valve
13. Tilt bracket
14. Bolt
15. Flat washer
16. Flange hex nut
17. Steering wheel
18. Hydraulic fitting
19. Hydraulic fitting
20. Steering wheel nut
21. Decal
22. Hose assembly
23. Hose assembly
24. Hose assembly
25. Hose assembly
26. Hose assembly
27. Tilt steering boss
28. Friction disc
29. Friction disc
30. Flat washer
31. Jam nut
32. Flat washer
33. Flange head bolt
34. Bolt
35. Washer
36. O−ring
37. O−ring
38. O−ring
39. Philips pan head screw
40. Steering wheel cap
41. Steering shield
42. Slope indicator assembly
43. Nut

Disassembling the Steering Column

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the key switch.
2. Remove the philips pan head screws and steering wheel cap from the steering wheel.
3. Remove steering wheel nut from the steering control valve. Pull steering wheel from the control valve.
4. Remove steering cover from the steering control valve bracket.
5. Remove four bolts that securing the steering control valve to the steering control valve bracket.

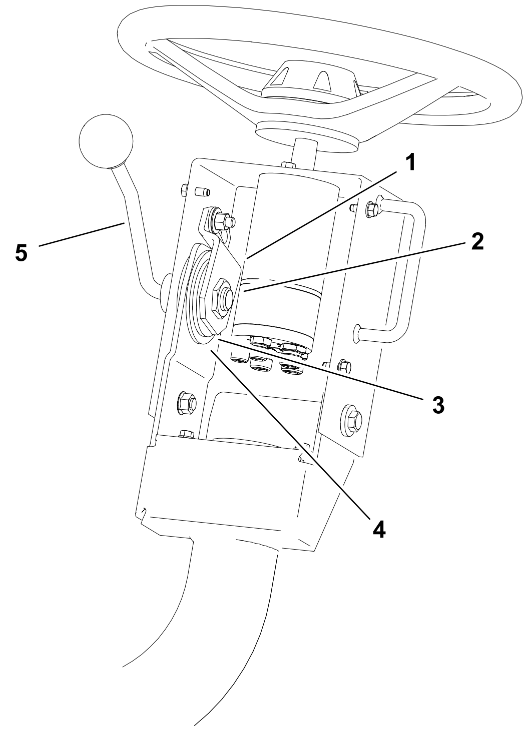

Figure 159

1. Tilt bracket
2. Jam nut
3. Flat washer
4. Friction disc
5. Steering tilt lever

6. Remove both hex flange nuts, bolts, and pivot hubs securing the steering control valve bracket to the steering arm. Slide bracket from the steering control valve and steering arm.
7. Remove and replace parts as necessary to repair steering column using Figure 158 and Figure 159 as a guide.

Assembling the Steering Column

1. Make sure lever and friction discs are properly assembled to the steering control valve bracket using Figure 158 and Figure 159 as a guide.
2. Position steering control bracket to the steering control valve and steering arm. Secure bracket to the steering arm with pivot hubs, bolts, and hex flange nuts.
3. Secure steering control valve bracket to the steering control valve with four bolts.
4. Secure steering cover to the steering control valve bracket with cap screws.

Assembling the Steering Column (continued)

5. Install steering wheel to the steering control valve. Secure steering wheel nut to the steering control valve. Torque steering wheel nut from **27.1 to 35.3 N·m (20 to 26 ft−lb)**.

6. Secure steering wheel cap to the steering wheel with six philips pan head screws.

Front Lift Arms

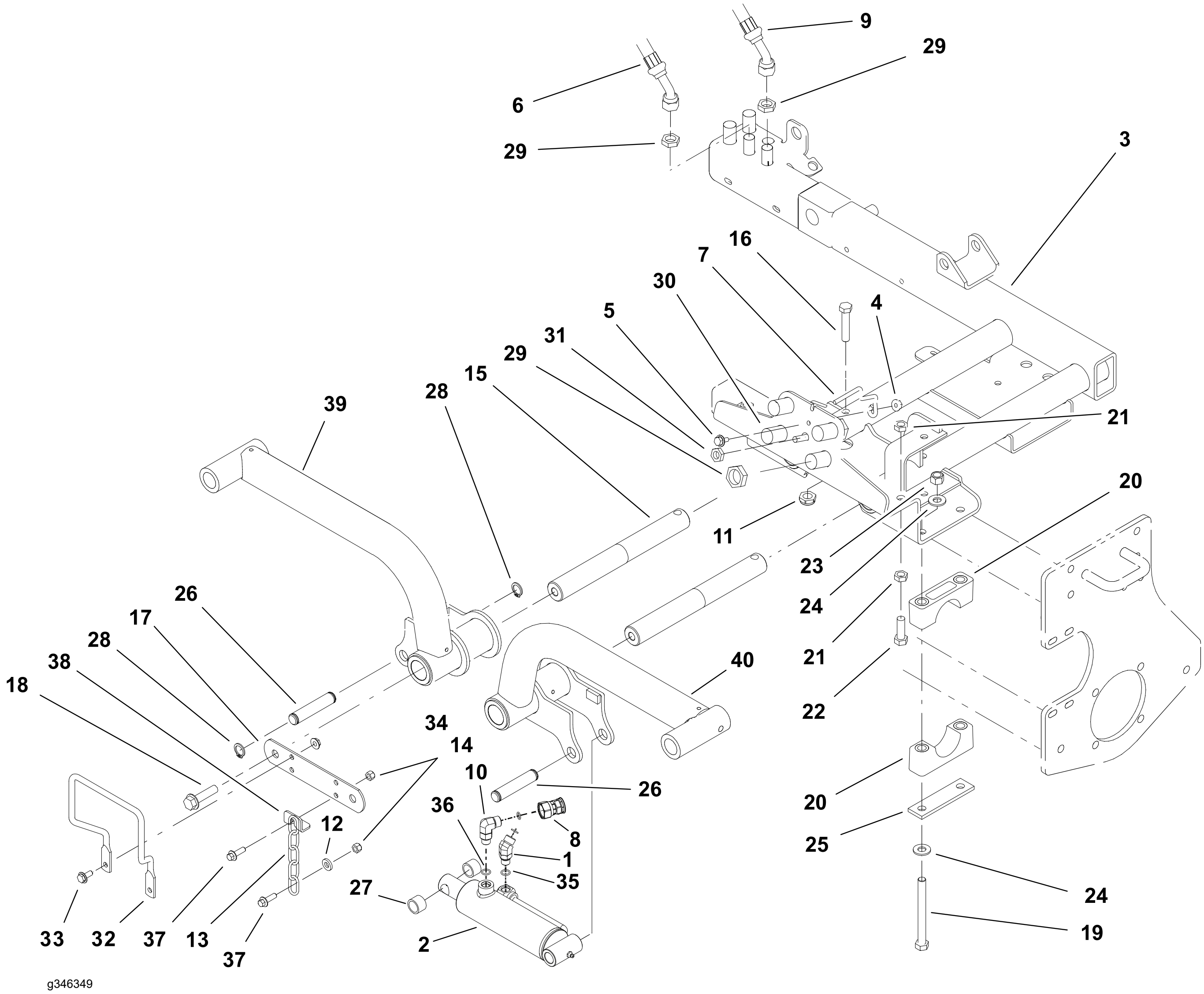

Figure 160

Model 03171 (shown)

1. 45º hydraulic fitting
2. Hydraulic cylinder
3. Carrier assembly
4. Flange nut
5. Flange head screw
6. Hydraulic hose
7. Centering wire
8. Hydraulic hose
9. Hydraulic hose
10. 90º hydraulic fitting
11. Flange nut
12. Flat washer
13. Straight link chain
14. Hex nut
15. Lift arm pivot shaft
16. Bolt
17. Pivot shaft link
18. Flange head screw
19. Cap screw
20. Bearing cap
21. Jam nut
22. Cap screw
23. Lock nut
24. Hardened washer
25. Slide support bar
26. Pin
27. Spacer
28. External retaining ring
29. Bulkhead nut
30. Hydraulic tube
31. Bulkhead nut
32. Hose rod
33. Flange head screw
34. Flange nut
35. O−ring
36. O−ring
37. Flange head screw
38. Link clip
39. RH lift arm
40. LH lift arm

Removing the Front Lift Arms

1. Park the machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the key switch.
2. Remove the cutting units from the pivot shaft of the front lift arms (see *Cutting Unit Operator s Manual*).

   Note: Remove both spacers from the hydraulic cylinder shaft clevis when removing the right, front lift arm.
3. Disconnect the hydraulic cylinder from the front lift arms by removing external retaining rings and pins.
4. Remove both flange head screws and pivot shaft link from the lift arm pivot shafts.
5. Slide the lift arm off the pivot shaft.
6. Disassemble lift arm as necessary using Figure 160 as a guide.
7. Inspect bushings in lift arm and carrier frame. If bushings are worn or damaged, replace bushings.

Installing the Front Lift Arms

1. Assemble the lift arm using Figure 160 as a guide.
2. Slide the lift arm onto the lift arm pivot shaft.
3. Secure the pivot shaft link with both flange head screws to the lift arm pivot shafts.

   Note: Install both spacers to the hydraulic cylinder shaft clevis when installing the right, front lift arm.
4. Secure the hydraulic cylinder to the lift arm with pins and external retaining rings.
5. Adjust lift arms (see *Traction Unit Operator s Manual*).
6. Install cutting unit to the front lift arm pivot shaft (see *Cutting Unit Operator s Manual*).
7. Grease front lift arms (see *Traction Unit Operator s Manual*).

Rear Lift Arm

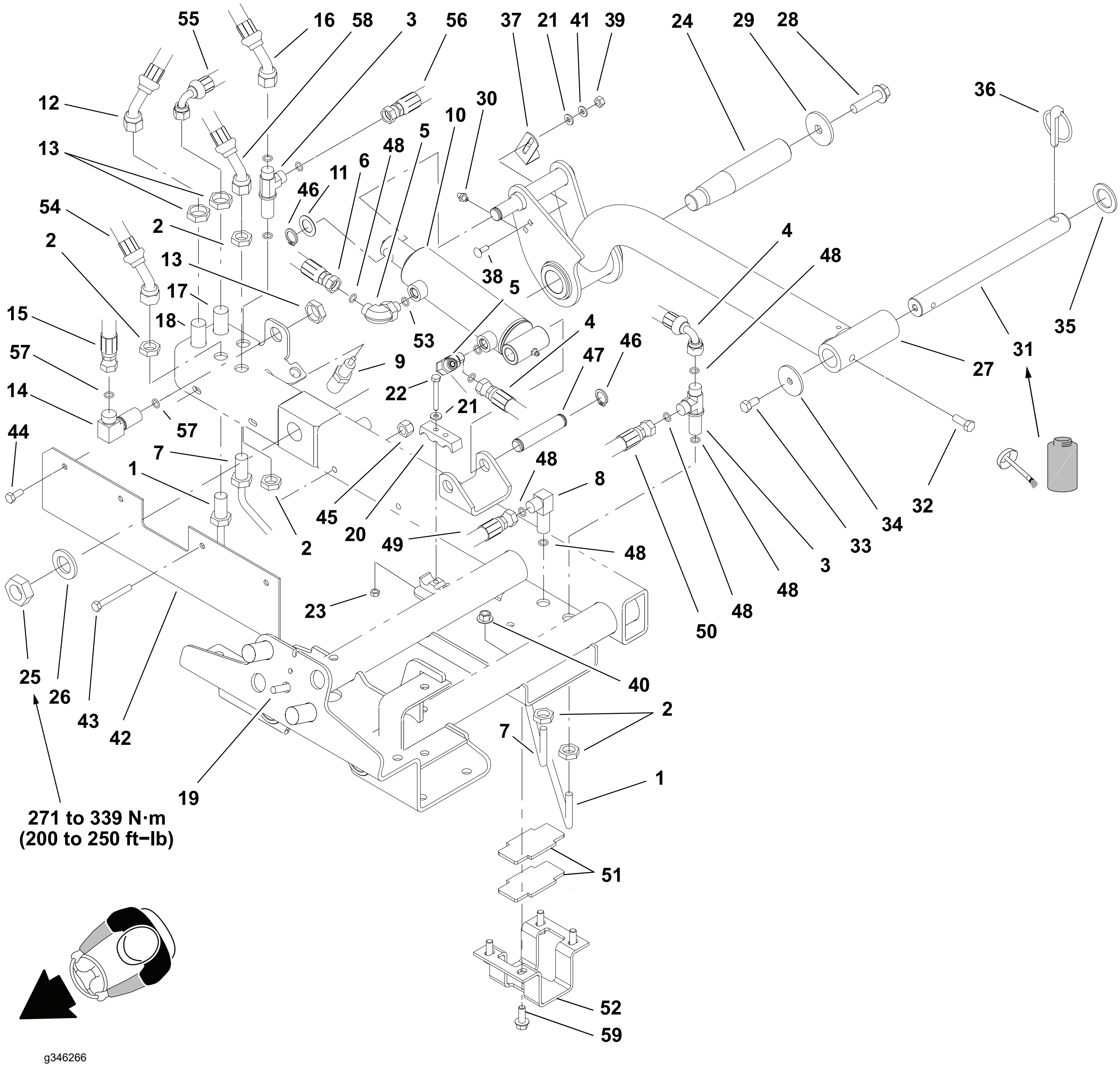

Figure 161

Model 03171 (shown)

Figure 161 (continued)

1. Hydraulic tube
2. Lock nut
3. Hydraulic T−fitting
4. Hydraulic hose
5. 90º hydraulic fitting
6. Hydraulic hose
7. Hydraulic tube
8. 90º hydraulic fitting
9. Push button switch
10. Hydraulic cylinder
11. Thrust washer
12. Hydraulic hose
13. Bulkhead nut
14. Hydraulic fitting
15. Hydraulic hose
16. Hydraulic hose
17. Hydraulic tube
18. Hydraulic tube
19. Hydraulic tube
20. Tube clamp
21. Flat washer
22. Cap screw
23. Lock nut
24. Rear pivot shaft
25. Jam nut
26. Washer
27. Rear lift arm assembly
28. Flange head screw
29. Thrust washer
30. Grease fitting
31. Cutting unit pivot shaft
32. Cap screw
33. Cap screw
34. Rebound washer
35. Washer
36. Lynch pin
37. Switch bracket
38. Carriage screw
39. Nut
40. Flange nut
41. Lock washer
42. Guard
43. Cap screw
44. Cap screw
45. Lock nut
46. External retaining ring
47. Pin
48. O−ring
49. Hydraulic hose
50. Hydraulic hose
51. Plastic slide
52. Bracket
53. O−ring
54. Hydraulic hose
55. Hydraulic hose
56. Hydraulic hose
57. O−ring
58. Hydraulic hose
59. Flange head bolt

Removing the Rear Lift Arm

1. Park the machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the key switch.
2. Remove the cutting unit from the pivot shaft of the rear lift arm (see *Cutting Unit Operator s Manual*).
3. Remove the external retaining ring and thrust washer from the hydraulic lift cylinder shaft of the rear lift arm.
4. Remove the flange head screw and thrust washer from the rear pivot shaft.
5. Slide the rear lift arm from rear pivot shaft and hydraulic lift cylinder.
6. Disassemble lift arm as necessary using Figure 161 as a guide.
7. Inspect the bushings in lift arm and carrier frame. If bushings are worn or damaged, replace bushings.

Installing the Rear Lift Arm

1. Assemble lift arm using Figure 161 as a guide.

   A. If the rear lift arm pivot shaft (item 24) was removed from frame, thoroughly clean tapered surfaces of shaft and frame. Position pivot shaft to frame and secure with washer and jam nut. Torque jam nut from **271 to 339 N·m (200 to 250 ft-lb)**.

   B. If the cutting unit pivot shaft (item 31) was removed from the lift arm, apply antiseize lubricant to pivot shaft before inserting into lift arm. Secure pivot shaft with two (2) cap screws (items 32 and 33) and washer (item 34).
2. Slide the rear lift arm onto rear pivot shaft making sure that the lift cylinder shaft of the rear lift arm slides into the clevis of the hydraulic lift cylinder.
3. Secure the hydraulic cylinder clevis to the lift cylinder shaft of the rear lift arm with the thrust washer and external retaining ring.

Installing the Rear Lift Arm (continued)

4. Install the rear cutting unit to the pivot shaft of the rear lift arm (see *Cutting Unit Operator s Manual*).
5. Adjust the lift arm (see *Traction Unit Operator s Manual*).

IMPORTANT

Make sure hydraulic hoses are free of twists and sharp bends. Raise cutting units and make sure that rear cutting unit hoses do not contact the traction cable bracket. If required, reposition fittings and hoses.

6. Grease the rear lift arm (see *Traction Unit Operator s Manual*).

Traction Pedal

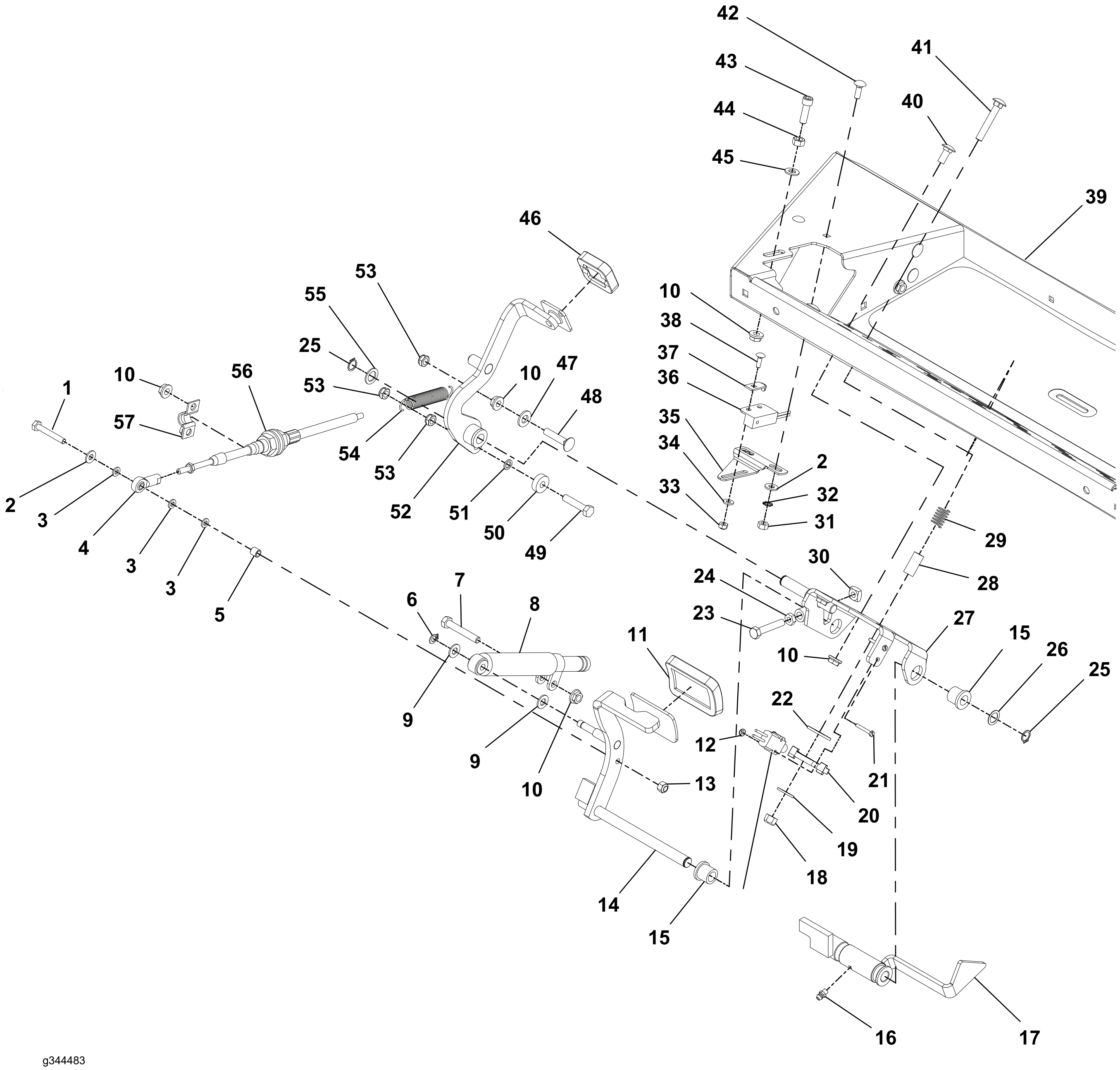

Figure 162

Figure 162 (continued)

1. Bolt
2. Flat washer
3. Flat washer (3 each)
4. Rod end ball joint
5. Spacer
6. Grip ring
7. Bolt
8. Lever damper
9. Plain washer (2 each)
10. Flange head nut (8 each)
11. Forward pedal pad
12. Nut (2 each)
13. Lock nut
14. Traction pedal
15. Flange bushing (2 each)
16. Grease fitting
17. Slide
18. Lock nut
19. Flat washer
20. Rocker arm
21. Bolt (2 each)
22. Flat washer
23. Bolt
24. Jam nut
25. Retaining ring (2 each)
26. Thrust washer
27. Traction pedal bracket
28. Rocker arm tube
29. Spring
30. Square nut
31. Nut (2 each)
32. Lock washer(2 each)
33. Lock nut
34. Flat washer
35. Neutral switch bracket
36. Proximity switch
37. Switch plate
38. Carriage bolt
39. Floor plate assembly
40. Carriage bolt (4 each)
41. Carriage bolt
42. Carriage bolt
43. Socket head screw
44. Nut
45. Plain washer
46. Reverse pedal pad
47. Flat washer
48. Carriage bolt
49. Bolt
50. Ball bearing
51. Retaining ring
52. Reverser pedal
53. Lock nut (3 each)
54. Spring
55. Washer
56. Traction control cable
57. Cable clamp

---

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the key switch.
2. Remove and replace parts as necessary to repair traction pedal using Figure 162 as a guide.
3. Adjust the traction drive for neutral; refer to *Operator's Manual*.

Chapter 8

DPA Cutting Units

Table of Contents

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), 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.

Adjustments

Cutting Unit Characteristics

CAUTION

Do not install or work on the cutting units or lift arms with the engine running. Always shut off the engine and remove the key from the key switch.

The dual knob bedknife-to-reel adjustment system incorporated in this cutting unit simplifies the adjustment procedure 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*.
2. Determine desired height-of-cut range and install rear roller mounting shim(s) accordingly.; refer to the *Cutting Unit Operator's Manual*.
3. Adjust the height-of-cut; refer to the *Cutting Unit Operator's Manual*.

Leveling Rear Roller

The precision machined components of the cutting unit frame keep the rear roller and cutting reel in alignment (parallel). If the side plates are disassembled or as the cutting reel wears, a limited amount of side plate adjustment is possible to make sure that the cutting unit is properly aligned.

1. Place the assembled cutting unit on a surface plate.
2. Make sure that the bedknife is properly adjusted to the cutting reel.
3. Check if the rear roller is level to the cutting reel by using a 0.13 mm (0.005 in) feeler gauge to determine the clearance between the surface plate and the rear roller at each end of the roller. As the rear roller is rotated one full turn, check if the feeler gauge will consistently pass under the roller at one end but will not pass under the opposite end. Check rear roller with the feeler gauge just inside the machined ends of the roller. A frame adjustment should be made if there is consistently more than 0.13 mm (0.005 in) clearance under the roller on one end but not on the other.

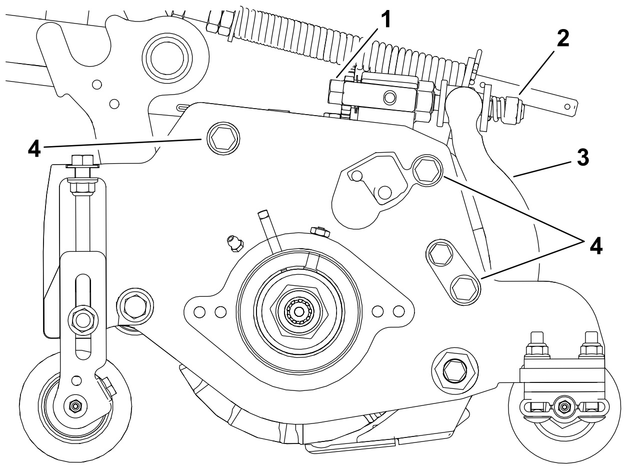

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Figure 163

1. Bedbar adjuster screw
2. Spring tension locknut
3. Bedbar
4. Shoulder bolt

4. Loosen, but do not remove, the three (3) shoulder bolts that secure the side plate to the frame opposite the side that is not level (Figure 163).
5. Adjust the position of the side plate to parallel the rear roller and cutting reel. Then, tighten the shoulder bolts to a torque from **37 to 44 N-m (27 to 33 ft-lb)**.
6. After tightening the side plate, recheck the rear roller. If necessary, loosen and adjust second side plate.

Leveling Rear Roller (continued)

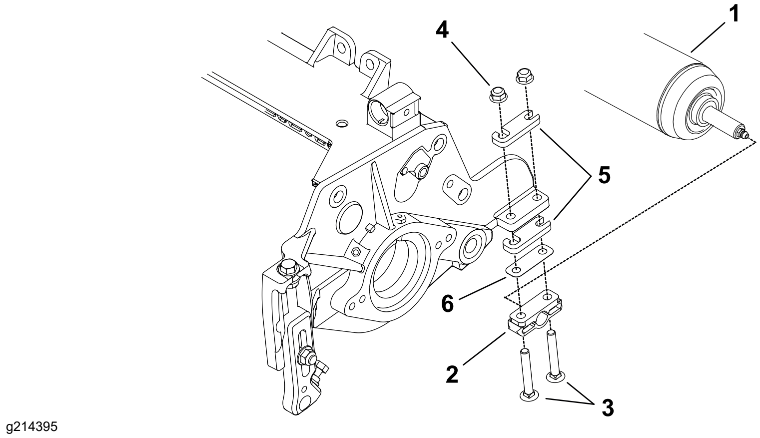

Figure 164

1. Rear roller assembly
2. Rear roller bracket
3. Carriage screw
4. Flange nut
5. Roller shim
6. 0.010” shim (if needed)

---

7. If rear roller is still not level after adjusting both side plates, check to see if cutting reel is tapered (refer to Preparing the Reel for Grinding (page 8–29)). If cutting reel is not tapered and rear roller is not level, a 0.010” shim (part number 107-4001) is available to allow additional rear roller adjustment. The shim would be used on one side of the rear roller and should be installed between the rear roller bracket and roller shim (Figure 164).
8. After leveling rear roller, complete the cutting unit set-up and adjustment sequence.

Service and Repairs

Hydraulic Reel Motor

IMPORTANT

When performing the maintenance procedures on the cutting units, carefully position the cutting unit reel motors to prevent damage to the motors or hydraulic hoses.

Removing the Hydraulic Reel Motor

1. Park the machine on a clean and level surface, lower the cutting units completely to the ground, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Loosen the two (2) cap screws that secure the hydraulic reel motor to the cutting unit side plate. Rotate the motor clockwise and remove the motor from the cutting unit.
3. Inspect the reel insert splines for wear. Replace if necessary (refer to Reel Assembly (page 8–19)).
4. Place protective plastic cap (refer to Special Tools (page 2–13)) into the hole in the cutting unit side plate to prevent debris entry into reel bearing area.

Installing the Hydraulic Reel Motor

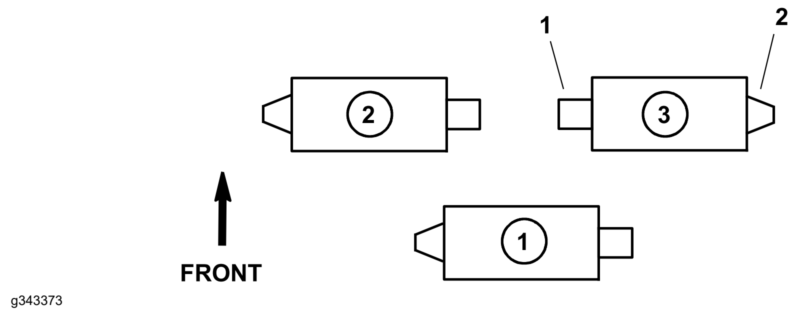

Figure 165

1. Reel motor location
2. Weight location

Note: Refer to Figure 165 for correct placement of the cutting unit reel motors and weights.

1. Coat spline shaft of the reel motor with No. 2 multipurpose lithium base grease.
2. Install the cap screws for the reel drive motor into the cutting unit side plate and leave approximately 12.7 mm (1/2 inch) of threads exposed on each screw.

Installing the Hydraulic Reel Motor (continued)

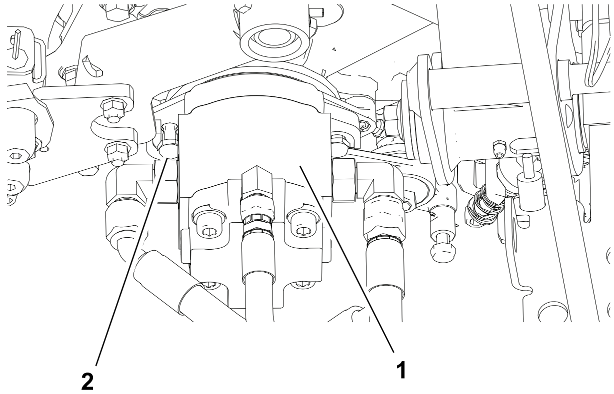

Figure 166

1. Hydraulic reel motor
2. Cap screw

3. Rotate the motor clockwise so the motor flanges clear the cap screws in the cutting unit side plates. Align reel motor shaft splines with cutting reel insert splines. Slide motor shaft into reel insert.
4. Rotate the motor counter-clockwise until the motor flanges are encircling the cap screws. Tighten two (2) cap screws to secure reel motor to cutting unit.

Backlapping

⚠ DANGER ⚠

TO AVOID PERSONAL INJURY OR DEATH:

- **Never place hands or feet in the reel area while the engine is running. Stay away from the cutting reels when backlapping.**
- **When backlapping, run engine at idle speed only.**
- **While backlapping, the reels may stall and then restart.**
- **Do not attempt to restart reels by hand or foot.**
- **Do not adjust reels while the engine is running.**
- **If a reel stalls, stop engine before attempting to clear the reel.**
- **Reel motors are connected in series: rotating one motor causes rotation in other motors.**

1. Park the machine on a clean and level surface, lower the cutting units completely to the ground, shut off the engine, set the parking brake, and remove the key from the key switch.
2. On all cutting units, make initial reel to bedknife adjustments appropriate for backlapping.

IMPORTANT

Do not attempt to rotate the directional valve lever on the hydraulic manifold when the engine or reels are running.

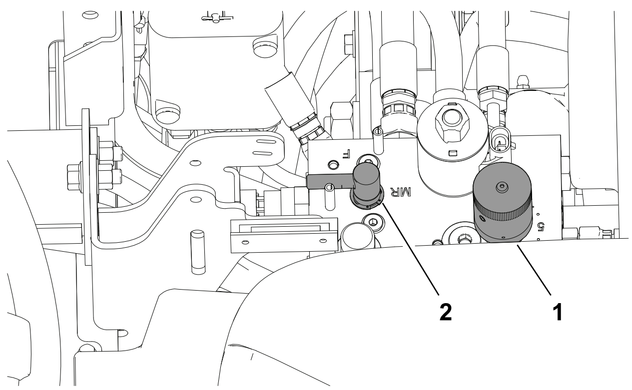

Figure 167

1. Reel Speed Selector Knob
2. Backlap Lever

3. Remove the console cover and locate the reel speed selector knob and backlap lever on the hydraulic manifold (Figure 167). Rotate the reel speed selector knob to position “1” and the backlap lever to the R (backlap) position.
4. Start the engine and run at low idle speed.
5. With the mow speed limiter in the mow position, move the PTO switch to the ON position. Press the lift switch to start the backlapping operation on the designated reels.
6. Apply lapping compound to cutting reels with a long handle brush (refer to Special Tools (page 2–13)). Never use a short handled brush to apply lapping compound.

CAUTION

Be careful when backlapping the reel because contact with the reel or other moving parts can result in personal injury.

7. To make a cutting unit adjustment while backlapping, turn reels OFF, shut off engine and wait for all machine and cutting unit motion to completely stop. Then, after cutting unit adjustments have been completed, repeat steps 4 through 6.
8. When the backlap operation is completed, shut off engine and rotate directional valve lever fully (90º from the backlap position) to the F (forward) position. Also, rotate the flow control valve knob to correct mowing position.
9. Wash all lapping compound from the cutting units.

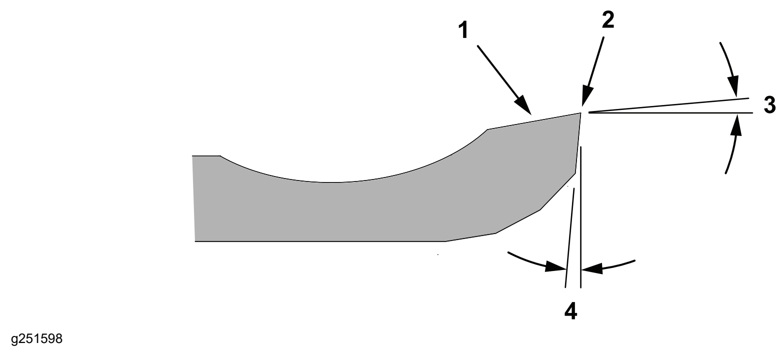

Figure 168

1. Top surface
2. Remove burr (without dulling sharp corner)
3. Top angle
4. Front angle

10. For a better cutting edge, run a file across the front face of the bedknife when the lapping operation is completed (Figure 168). This will remove any burrs or rough edges that may have built up on the cutting edge.

    Note: Additional instructions and procedures on backlapping are available in the *Toro General Service Training Book, Reel Mower Basics (part no. 09168SL)*.

Bedbar Assembly

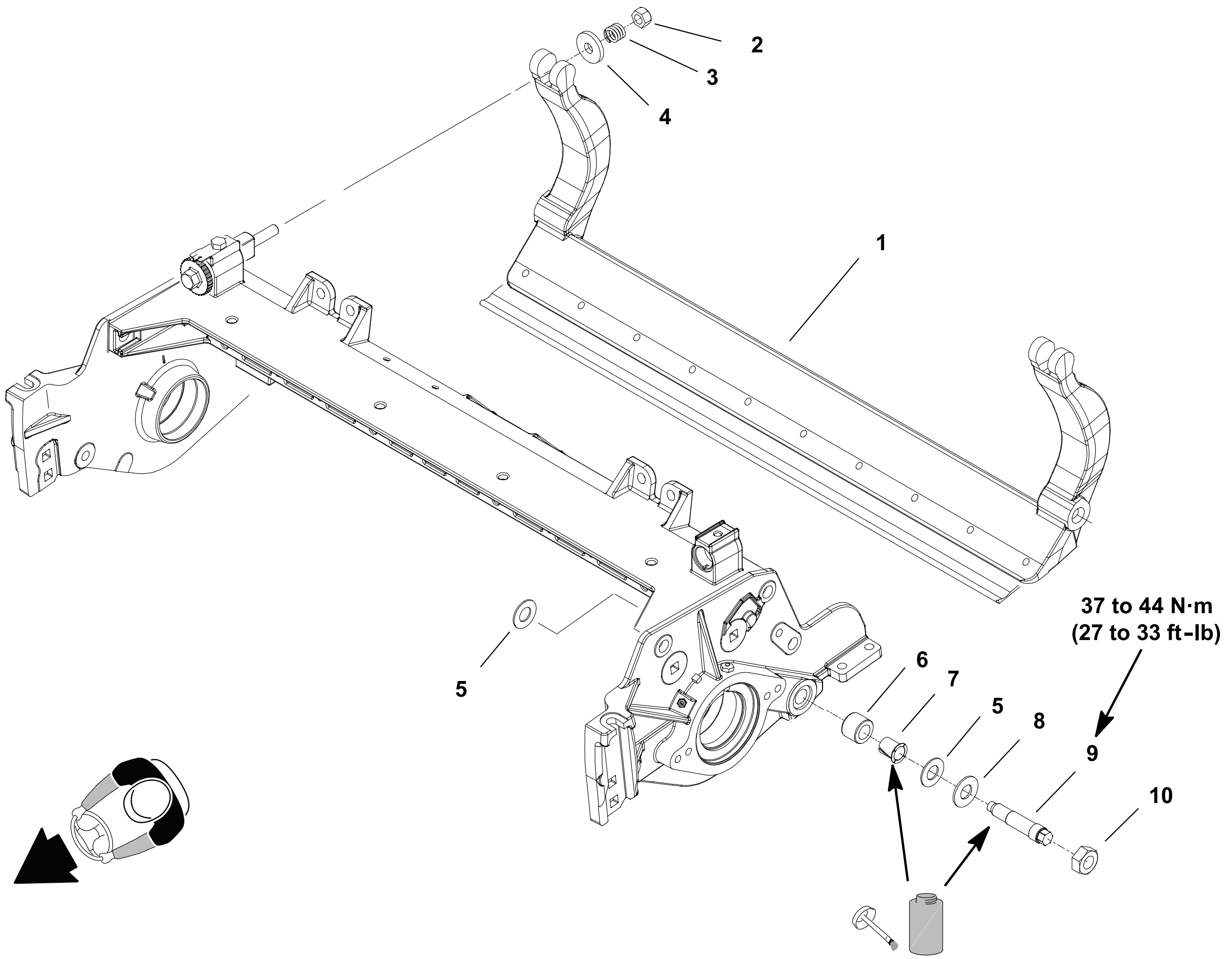

Figure 169

1. Bedbar assembly
2. Lock nut (2 each)
3. Compression spring (2 each)
4. Washer (2 each)
5. Plastic washer (4 each)
6. Rubber bushing (2 each)
7. Flange bushing (2 each)
8. Metal washer (2 each)
9. Bedbar pivot bolt (2 each)
10. Lock nut (2 each)

Removing the Bedbar Assembly

CAUTION

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

1. Park the machine on a clean and level surface, lower the cutting units completely to the ground, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the cutting unit from the machine. Use the cutting unit kickstand to support the cutting unit (refer to Special Tools (page 2–13)).
3. Loosen the lock nuts (item 2 in Figure 169) on the end of each bedbar adjuster assembly until washer (item 2) is loose.

Removing the Bedbar Assembly (continued)

4. Loosen the lock nuts (item 10) on each bedbar pivot bolt.
5. Remove two (2) bedbar pivot bolts (item 9), two (2) metal washers and four (4) plastic washers from the cutting unit side plates.
6. Remove the bedbar assembly from cutting unit.
7. Inspect flange bushings (item 7) and rubber bushings (item 6) in side plates for wear or damage. Remove bushings and replace if necessary.

Installing the Bedbar Assembly

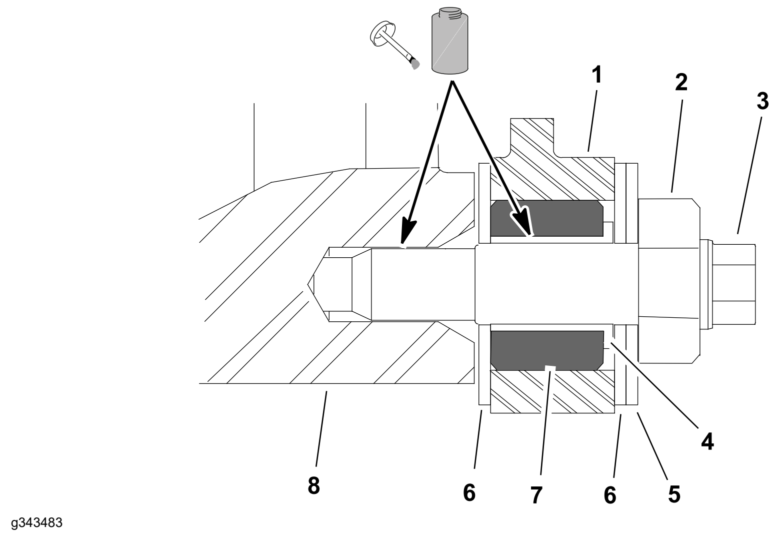

Figure 170

1. Cutting unit side plate
2. Locknut
3. Bedbar pivot bolt
4. Flange bushing
5. Metal washer
6. Plastic washer
7. Rubber bushing
8. Bedbar

---

1. If rubber bushing was removed from either cutting unit side plate, install a new bushing. The bushing should be installed flush with the inside of the side plate (Figure 170).
2. If removed, install the flange bushings with flange facing outward. Apply anti-seize lubricant to inside of flange bushing.
3. Apply anti-seize lubricant to the bedbar threads and the shoulder area of each bedbar pivot bolt.
4. Slide one metal washer and one plastic washer onto each bedbar pivot bolt.

CAUTION

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

5. Position bedbar into cutting unit. Make sure that the top of each bedbar arm is between washer (item 4) and adjuster screw flange.
6. Position a plastic washer between bedbar and each cutting unit side plate (Figure 170).

Installing the Bedbar Assembly (continued)

7. Install the bedbar pivot bolt assemblies:

   A. Push each bedbar pivot bolt through the side plate and into the bedbar enough to hold the bedbar in position.

IMPORTANT

Do Not use a powered wrench or an impact wrench to install the bedbar pivot bolts.

   B. Start threading of one of the pivot bolts into the bedbar and continue until the pivot bolt bottoms out. Repeat for remaining pivot bolt.

   C. Make sure that plastic washers are not caught on the threads of the pivot bolts.

   D. Tighten each bedbar pivot bolt from **37 to 44 N·m (27 to 33 ft- lbs)**.

8. Tighten both lock nuts (item 10 in Figure 169) until outside metal washer just rotates. Do not over tighten the lock nuts as this can distort the side plates and affect reel to bedknife contact, or in the case of cutting units with painted side plates, reel bearing adjustment. The plastic washer between the bedbar and side plate should be loose.

9. Tighten the lock nut (item 2) on each bedbar adjuster assembly until the adjuster spring is fully compressed, then loosen lock nut 1/2 turn.

10. Adjust cutting unit (refer to *Cutting Unit Operator's Manual*).

11. Install cutting unit to machine.

Bedknife Replacement and Grinding

Removing the Bedknife

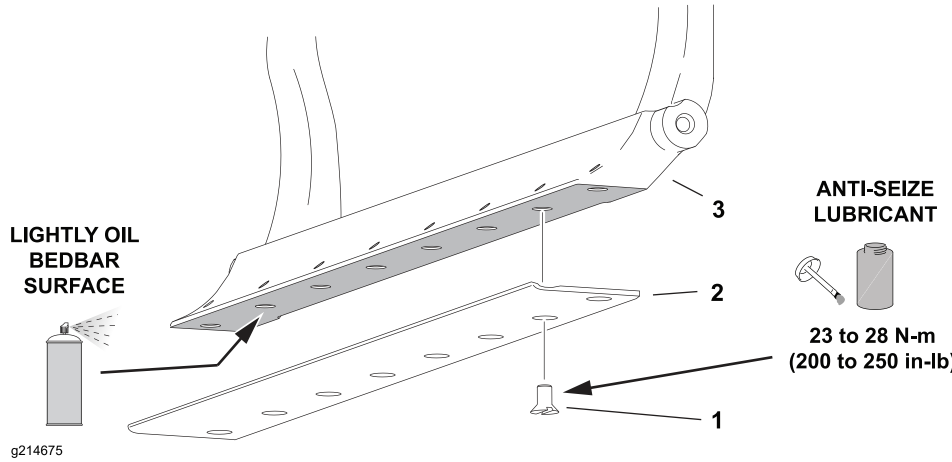

Figure 171

1. Screw (8 each)
2. Bedknife
3. Bedbar

---

1. Remove the bedbar from cutting unit (refer to Removing the Bedbar Assembly (page 8–10)).

   Note: 18” cutting units use 6 screws to secure bedknife to bedbar. 22” cutting units use 8 screws to secure bedknife to bedbar.

2. Remove the screws from bedbar using a socket wrench and bedknife screw tool (refer to Special Tools (page 2–13)). Discard screws. Remove bedknife from the bedbar (refer to Figure 171).
3. Refer to Grinding the Bedknife (page 8–14).

Installing the Bedknife

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

IMPORTANT

Do not use an impact wrench to tighten screws into the bedbar.

3. Use new screws to secure the bedknife to bedbar. Apply antiseize lubricant to the threads of new screws. Do not apply antiseize lubricant to the taper of the screw heads.
4. Install all screws but do not tighten.

Installing the Bedknife (continued)

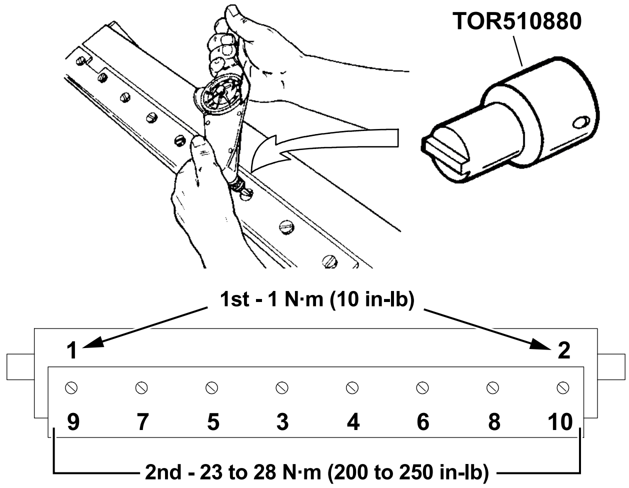

Figure 172

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 (refer to Figure 172), tighten screws from **23 to 28 N·m (200 to 250 in-lb)**.
7. After installing bedknife to bedbar, grind bedknife.

Grinding the Bedknife

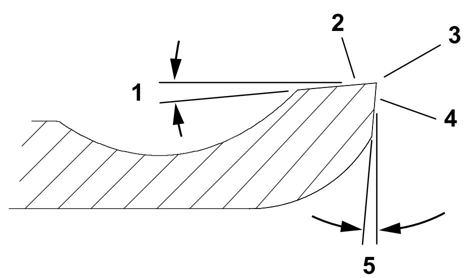

Figure 173

1. Top angle
2. Top surface
3. Remove burr (without dulling sharp corner)
4. Front surface
5. Front angle

Grinding the Bedknife (continued)

Bedknife Grinding Specifications

<table>
<tr><th>Bedknife</th><th>Lip Height Service Limit</th><th>Top Angle</th><th>Front Angle</th></tr>
<tr><td>EdgeMax® Low HOC</td><td rowspan="8">4.8 mm (0.190 inch)</td><td rowspan="8">10°</td><td rowspan="3">5°</td></tr>
<tr><td>Premium Low HOC</td></tr>
<tr><td>Standard Low HOC</td></tr>
<tr><td>Extended EdgeMax® Low HOC</td><td rowspan="2">10°</td></tr>
<tr><td>Extended Low HOC</td></tr>
<tr><td>EdgeMax® Standard HOC</td><td rowspan="3">5°</td></tr>
<tr><td>Standard Standard HOC</td></tr>
<tr><td>Heavy Duty Standard HOC</td></tr>
</table>

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 and grind only enough to make sure the top surface of the bedknife is true (Figure 173).

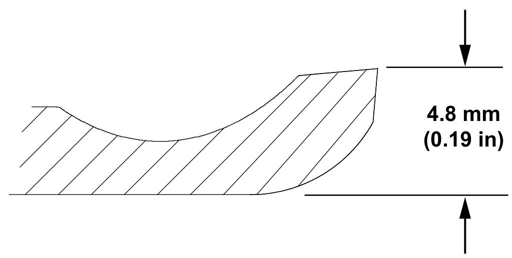

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Figure 174

Lip Height Service Limit

IMPORTANT

Do Not grind the bedknife below it's service limit (Figure 174). Operating the cutting unit with the bedknife below the service limit may result in poor after-cut appearance and reduce the structural integrity of the bedknife for impacts.

When grinding the bedknife, be careful to not overheat the bedknife. Remove small amounts of material with each pass of the grinder. Also, clean and dress grinding stone often during the grinding process.

Note: EdgeMax® bedknives are extremely hard. Using a diamond grinding wheel is recommended to prevent overheating or damaging the bedknife edge while grinding.

Because the top grind angle on bedknives is critical for edge retention, and therefore after-cut appearance, Toro has developed special service tools for accurately measuring the top grind angle on all bedknives; refer to the Angle Indicator and Magnetic Mount in the Special Tools (page 2–13).

Note: Some bedknives were produced with a 5º top angle. Use a 10º top angle when regrinding all bedknives.

Grinding the Bedknife (continued)

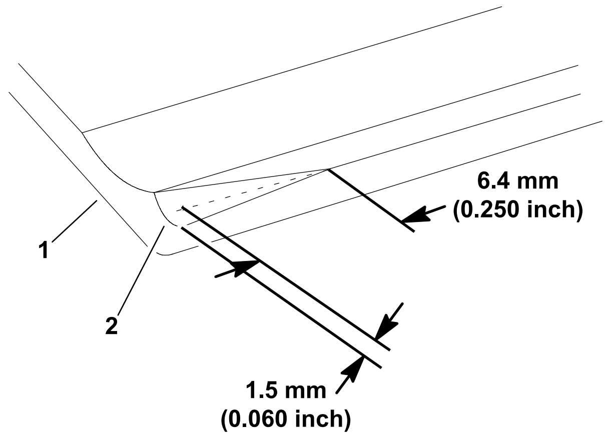

Figure 175

1. Bedknife
2. Lead-in chamfer

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1. Use *Toro General Service Training Book, Reel Mower Basics (part no. 09168SL)* and grinder manufacturer's instructions for bedknife grinding information.
2. lead-in chamfer is ground into all new bedknives (Figure 175). The original chamfer should last for the first 40% of the bedknife service life. Check and re-grind the lead-in chamfer as necessary.
3. After bedknife grinding is complete, install bedbar to cutting unit (refer to Installing the Bedbar Assembly (page 8–11)).

Servicing the Bedbar Adjuster

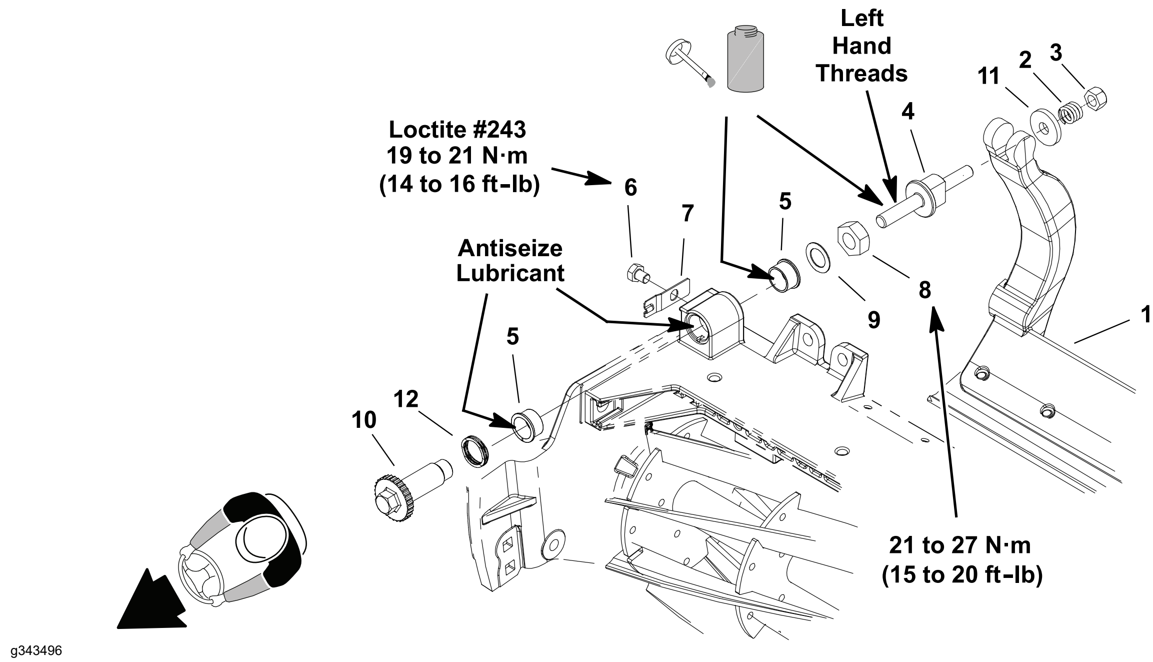

Figure 176

1. Bedbar assembly	5. Flange bushing	9. Flat washer
2. Compression spring	6. Cap screw	10. Bedbar adjuster shaft
3. Lock nut	7. Detent	11. Washer
4. Bedbar adjuster screw	8. Lock nut	12. Wave washer

Removing the Bedbar Adjuster

1. Remove the lock nut (item 3 in Figure 176), compression spring and washer from bedbar adjuster screw (item 4).
2. Remove the bedbar assembly (refer to Removing the Bedbar Assembly (page 8–10)).
3. Remove the bedbar adjuster screw (left hand threads) from the bedbar adjuster shaft (item 10).
4. Remove lock nut and flat washer from adjuster shaft. Slide adjuster shaft and wave washer from cutting unit frame.
5. Inspect the flange bushings (item 5) in cutting unit frame and remove if necessary.
6. If detent is damaged, remove it from cutting unit side plate by removing the cap screw.

Installing the Bedbar Adjuster

1. If the detent (item 7 Figure 176) was removed, apply Loctite #243 (or equivalent) to threads of cap screw and secure detent to cutting unit side plate with cap screw. Tighten cap screw from **19 to 21 N·m (14 to 16 ft-lb)**.
2. If the flange bushings (item 5) were removed, apply antiseize lubricant to bore of cutting unit frame. Align key on bushing to slot in frame and install bushings into frame. Apply antiseize lubricant to bore of each flange bushing.
3. Slide wave washer onto adjuster shaft and then slide adjuster shaft into flange bushings in cutting unit frame. Secure adjuster shaft with flat washer

and lock nut. Tighten lock nut to shoulder of adjuster shaft and then torque lock nut from **21 to 27 N·m (15 to 20 ft-lb)**.

Note: Inside threads in bedbar adjuster shaft (item 4) are left-hand threads.

4. Apply antiseize lubricant to left hand threads threads of bedbar adjuster screw (item 4). Thread bedbar adjuster screw into adjuster shaft (item 10).
5. Install the washer (item 11), compression spring and lock nut onto adjuster screw.
6. Install the bedbar assembly (refer to Installing the Bedbar Assembly (page 8–11)).
7. Adjust the cutting unit (refer to *Cutting Unit Operator's Manual*).

Reel Assembly

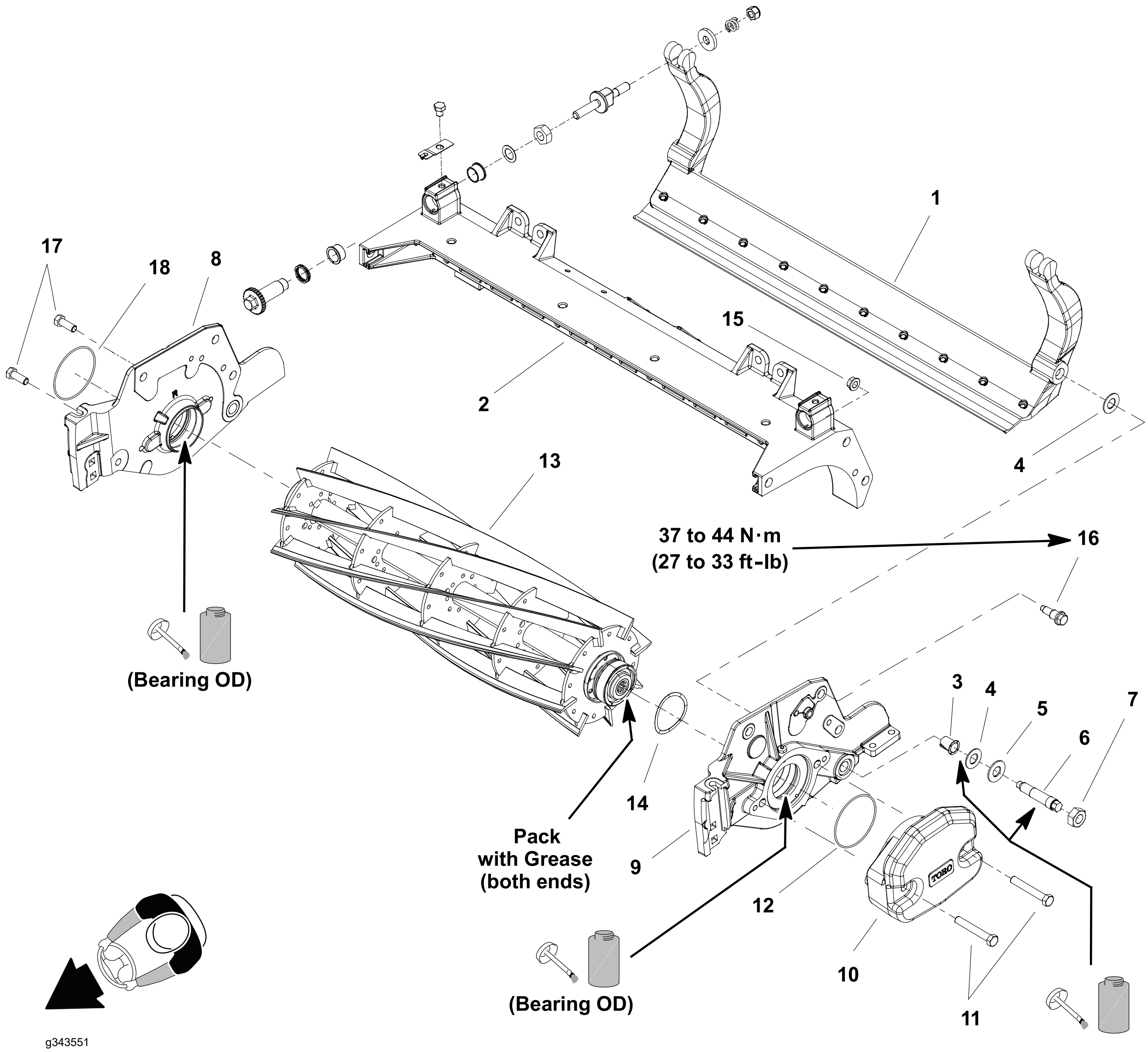

Figure 177

1.	Bedbar assembly	7.	Lock nut (2 each)	13.	Cutting reel assembly
2.	Cutting unit frame	8.	RH side plate	14.	Wire spring
3.	Flange bushing (2 each)	9.	LH side plate	15.	Flange nut (3 each per side plate)
4.	Plastic washer (4 each)	10.	Weight	16.	Shoulder bolt (3 each per side plate)
5.	Metal washer (2 each)	11.	Cap screw (2 each)	17.	Cap screw (2 each)
6.	Bedbar pivot bolt (2 each)	12.	O-ring	18.	O-ring

Note: This section provides the procedure for removing and installing the cutting reel assembly (cutting reel, spline inserts, grease seals and bearings) from the cutting unit.

Note: Refer to Reel Assembly Service (page 8–26) for information on replacing cutting reel seals and bearings.

Note: Removal of the cutting reel requires removal of the left side plate from the cutting unit frame. The right side plate does not have to be removed from the frame.

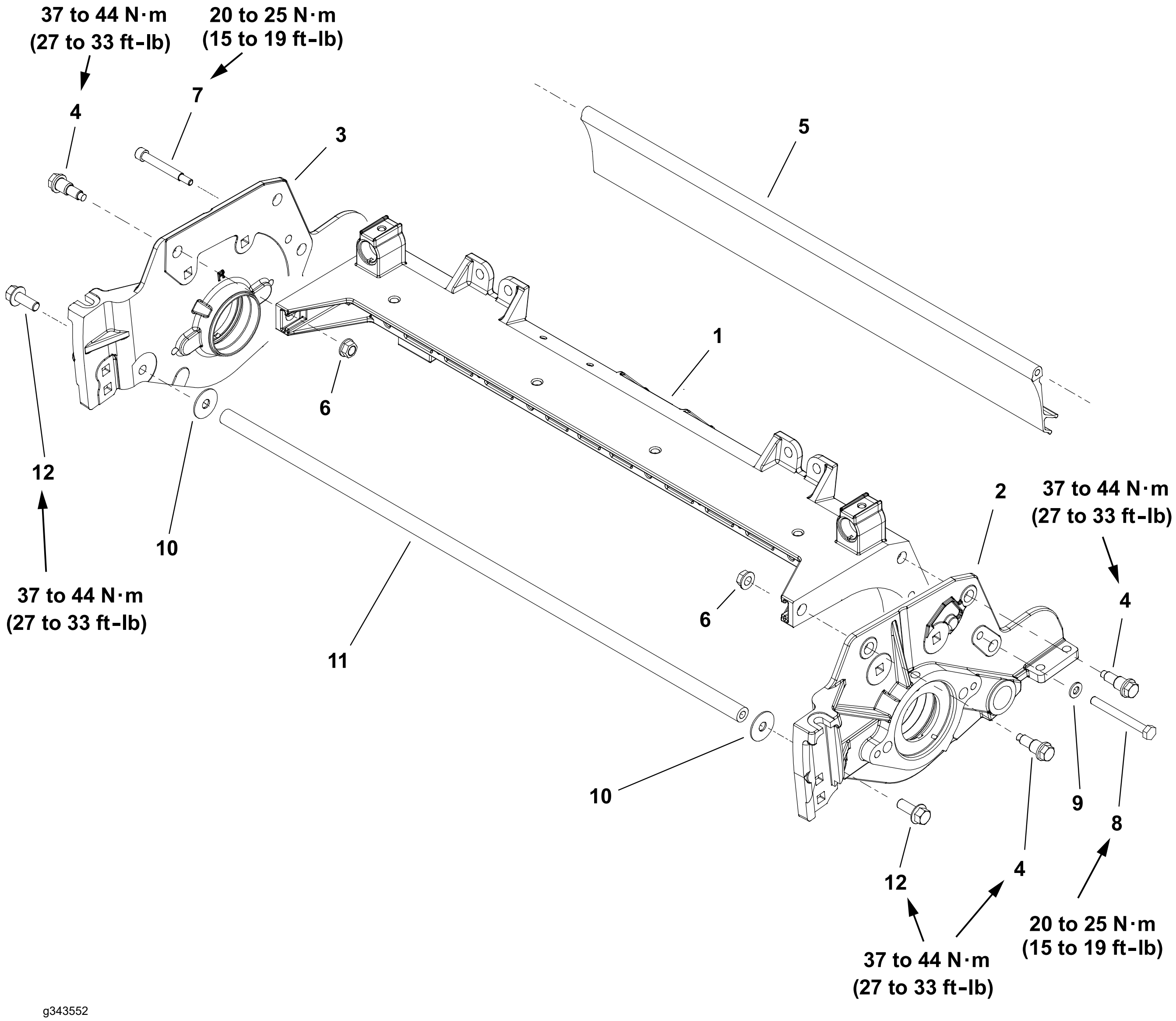

Figure 178

1. Frame
2. LH side plate
3. RH side plate
4. Shoulder bolt (6 each)
5. Rear grass shield
6. Flange nut (6 each)
7. Special screw
8. Cap screw
9. Flat washer
10. Washer (2 each)
11. Support rod
12. Flange head screw (2 each)

Removing the Reel Assembly

1. Position the machine on a clean and level surface, lower cutting units, stop engine, engage parking brake and remove key from the key switch.
2. Remove the cutting unit from the machine and place on a flat work area.

CAUTION

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

3. If cutting unit is equipped with a counterweight or accessory on LH side plate, remove the counter weight or accessory from the cutting unit. Remove and discard O-ring from counter weight. Refer to Chapter 9: Universal Groomer (Optional) (page 9–1) for additional Groomer information. Refer to Rear Roller (page 8–34) for information on rear roller brush.

IMPORTANT

If the reel bearings or seals are being replaced, the reel spline inserts must be removed. Use the following procedure to restrain the reel and loosen the spline insert before removing the rollers.

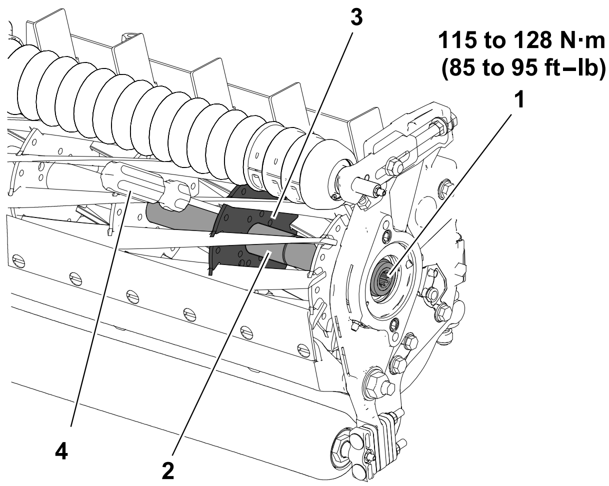

Figure 179

1. Spline insert (LH)
2. Reel shaft
3. Reel support plate
4. Pry bar

4. Loosen the spline inserts:
   A. Tip the cutting unit to access the bottom of the reel.
   B. Insert a long-handled pry bar (3/8 x 12 inch with screwdriver handle recommended) through the bottom of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

   IMPORTANT

   To avoid grinding the reel, do not contact the cutting edge of any blade with the pry bar as this may damage the cutting edge and/or cause a high blade.

   C. Move the pry bar against the weld side of the reel support plate closest to the spline insert being loosened. Use correct spline insert tool (refer to Special Tools (page 2–13)).

IMPORTANT

The spline insert on the left end of the cutting reel has left hand threads and the spline insert on the right end of the cutting reel has right hand threads.

D. Rest the handle of the pry bar against the front roller and loosen the spline insert closest to the pry bar.

E. Position the pry bar in the same manner on the opposite end of the reel and loosen the remaining spline insert.

F. Tip the cutting unit back onto its rollers.

5. Remove the bedbar assembly (refer to Removing the Bedbar Assembly (page 8–10)).
6. Remove the front and rear rollers (refer to Removing the Front Roller (page 8–31) and Removing the Rear Roller (Figure 188) (page 8–34)).
7. Remove the cap screw and flat washer that secure rear grass shield to LH side plate.
8. Remove flange head screw and washer that secures support rod to LH side plate.

   Note: The reel bearings and grease seals are press fit on the cutting reel shaft and should remain on the reel when removing the LH side plate.
9. Remove three (3) shoulder bolts and flange nuts that secure the LH side plate to the cutting unit frame. Remove the LH side plate from the reel shaft and cutting unit frame.
10. Carefully pull the cutting reel assembly from the RH side plate.
11. Inspect and service cutting reel assembly as required (refer to Reel Assembly Service (page 8–26)).

Installing the Reel Assembly

1. Thoroughly clean side plates and other cutting unit components. Inspect side plates for wear or damage and replace if needed.
2. Make sure that the grease seals and bearings are properly installed on cutting reel (refer to Reel Assembly Service (page 8–26)).
3. The cutting unit has O-rings in the reel bearing bore of each side plate. Make sure that the O-rings are in good condition and properly installed in the side plates.

Installing the Reel Assembly (continued)

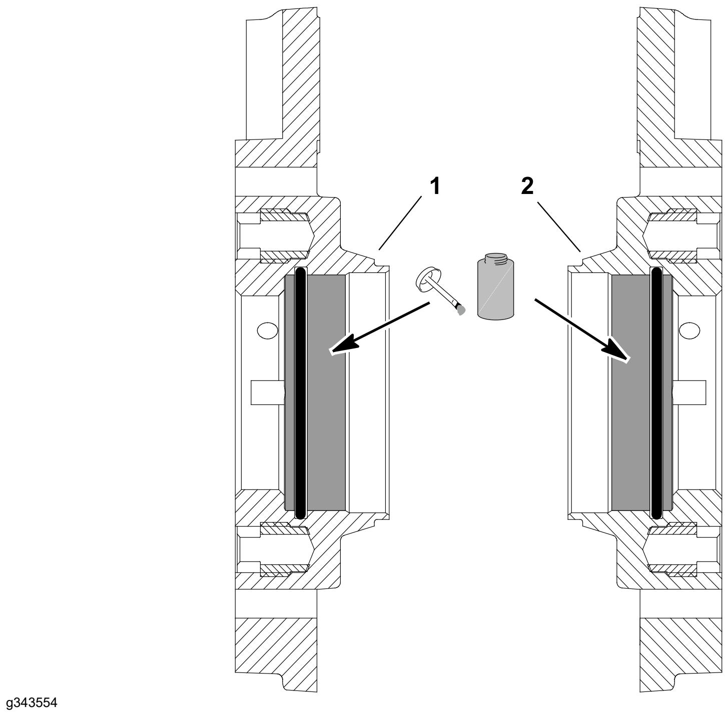

Figure 180

1. Side plate - RH
2. Side plate - LH

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4. Apply a thin coat of antiseize lubricant to the reel bearing bore of each side plate (Figure 180).

CAUTION

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

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5. Make sure that the flat wire spring (item 14 in Figure 177) is installed into LH side plate.
6. Carefully slide the RH end of the cutting reel assembly (no groove in reel shaft or on face of threaded insert) into the RH side plate. Make sure that bearing is fully seated into side plate.
7. Slide the LH side plate onto the cutting reel assembly.
8. Install shoulder bolts and flange nuts that secure the LH side plate to the cutting unit frame. Torque the shoulder bolts from **37 to 44 N·m (27 to 33 ft-lbs)**.
9. Apply Loctite #243 (or equivalent) to threads of flange head screw that secures support rod to LH side plate. Install screw and torque from **37 to 44 N·m (27 to 33 ft-lbs)**.
10. Install cap screw and flat washer that secure rear grass shield to LH side plate. Torque screw from **20 to 25 N·m (15 to 19 ft-lbs)**.
11. Install the bedbar assembly (refer to Installing the Bedbar Assembly (page 8–11)).
12. Install front and rear rollers (refer to Installing the Front Roller (page 8–31) and Installing the Rear Roller (Figure 188) (page 8–34)).

Installing the Reel Assembly (continued)

13. Adjust the cutting unit (refer to *Cutting Unit Operator's Manual*).

    Note: The parallel position of the rear roller to the cutting reel is controlled by the precision machined frame and side plates of the cutting unit. If necessary, the cutting unit side plates can be loosened and a slight adjustment can be made to parallel the rear roller with the cutting reel (refer to Leveling Rear Roller (page 8–4)).

14. Install accessories if equipped. refer to Chapter 9: Universal Groomer (Optional) (page 9–1) in this manual for additional Groomer information. Refer to Rear Roller Brush – Optional (page 8–40) information on rear roller brush.

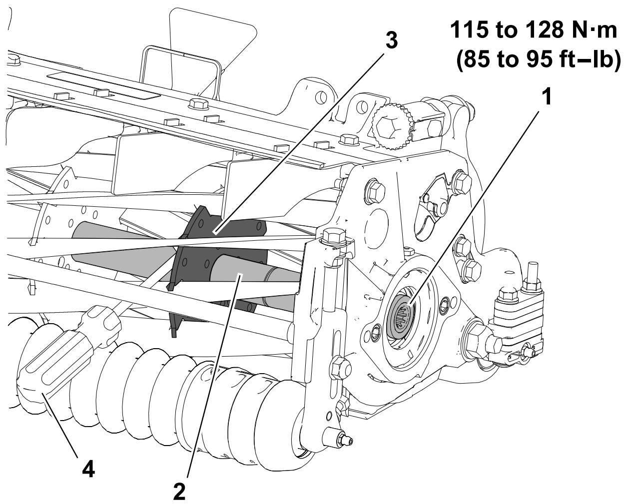

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Figure 181

1. Spline insert (LH)
2. Reel shaft
3. Reel support plate
4. Pry bar

15. Tighten the spline inserts:

    A. Insert a long-handled pry bar (3/8 x 12 inch with a screwdriver handle recommended) through the front of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

IMPORTANT

To avoid grinding the reel, do not contact the cutting edge of any blade with the pry bar as this may damage the cutting edge and/or cause a high blade.

    B. Move the pry bar against the weld side of the reel support plate closest to the spline insert being tightened.

IMPORTANT

The spline insert on the left end of the cutting reel has left hand threads and the spline insert on the right end of the cutting reel has right hand threads.

Installing the Reel Assembly (continued)

C. Rest the handle of the pry bar against the front roller and tighten the spline insert closest to the pry bar. The spline inserts are installed with thread locking compound (Loctite #243 or equivalent). Tighten the spline insert from **115 to128 N·m (85 to 95 ft-lb)**. Use correct spline insert tool (refer to Special Tools (page 2–13)).

D. Position the pry bar in the same manner on the opposite end of the reel and tighten the remaining spline insert.

16. If counterweight was removed from cutting unit, install new O-ring on counter weight. Secure counter weight to cutting unit side plate with two (2) flange nuts. Torque screws from **37 to 44 N·m (27 to 33 ft-lbs)**.

17. Install the cutting unit to the machine.

Reel Assembly Service

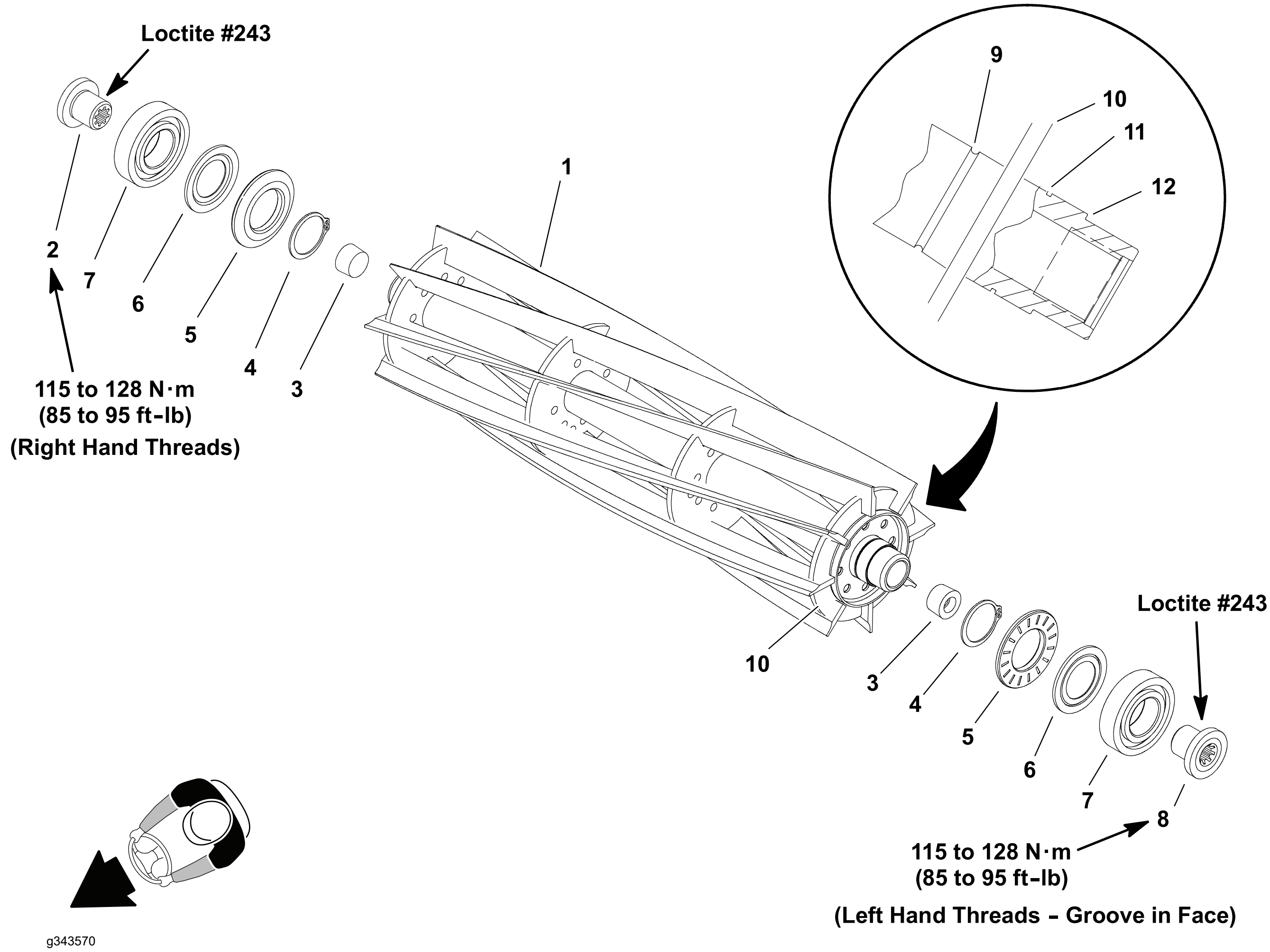

Figure 182

1. Cutting reel
2. Threaded insert (RH thread)
3. Plastic plug (2)
4. Retaining ring
5. Special washer
6. Flocked seal
7. Sealed bearing
8. Threaded insert (LH thread)
9. Groove indicating LH threads
10. Reel spider
11. Retaining ring groove
12. Bearing shoulder

Inspecting the Cutting Reel

1. Inspect the reel bearings to insure that they spin freely and have minimal axial play.
2. Inspect the reel shaft as follows. If the reel damage is detected, replace reel.
   A. Check the reel shaft for bending and distortion by placing the shaft ends in V-blocks.
   B. Check the reel blades for bending or cracking.
   C. Check the service limit of the reel diameter (refer to Preparing the Reel for Grinding (page 8–29)).
3. Check the threaded inserts in the reel shaft for excessive wear or distortion. Replace the inserts if damage is evident.
   A. One insert has LH threads and the other insert has RH threads. The insert with LH threads has a groove on the insert face. A groove is cut in the end of the reel shaft that has LH threads.

B. Use correct spline insert tool to remove threaded inserts (refer to Special Tools (page 2–13)).

Assembling the Cutting Reel

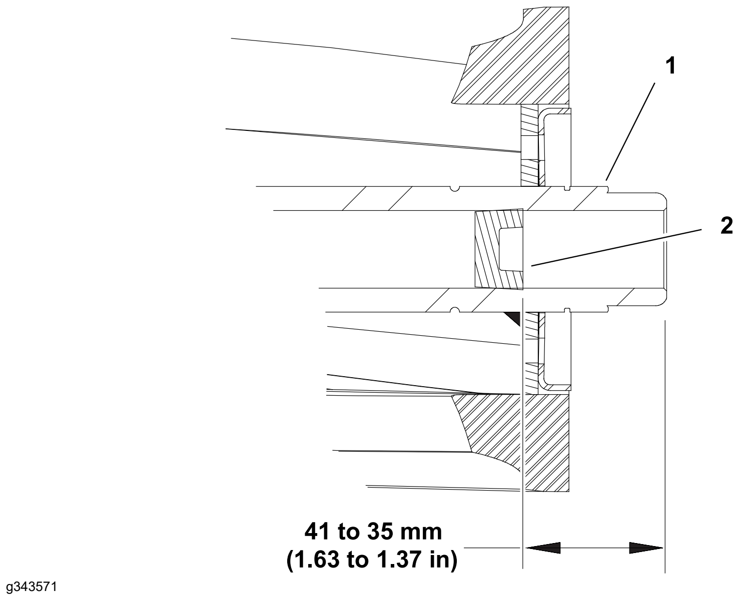

Figure 183

1. Reel shaft
2. Plastic plug (2 each)

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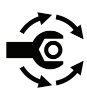
1. If removed, install new reel shaft plugs into cutting reel shaft. For cutting unit serial no. prior to 315000001, make sure plastic plug is pressed flush into end of threaded insert. For cutting unit serial no. 315000001 & Up, make sure plastic plug is pressed unto reel shaft 41 to 35 mm (1.63 to 1.37 in.) below the end of the shaft (Figure 183).

   Note: One insert has LH threads and the other insert has RH threads. The insert with LH threads has a groove on the insert face. A groove is cut in the end of the reel shaft that has LH threads.



2. If previously removed, use correct spline insert tool to install threaded inserts (refer to Special Tools (page 2–13)). Apply thread locking compound (Loctite #243 or equivalent) to threaded portion of insert. Tighten threaded insert from **115 to 128 N·m (85 to 95 ft-lb)**.

3. Make sure that the two (2) retaining rings are fully seated into the grooves on the cutting reel shaft.

4. Carefully drive special washers onto reel shaft with tapered side of washers toward reel (flat side toward bearing location). Installed washers should be tight against retaining ring and should not wobble as the reel is rotated.

IMPORTANT

The flocked seal should be installed so the flocked (red) side of the seal is toward the bearing location.

5. Slide flocked seals (flocked (red) side orientated toward bearing location) and bearings fully onto reel shaft. Flocked seals and bearings should bottom on reel shaft shoulder.

Assembling the Cutting Reel (continued)

6. Fill threaded insert splines with high temp Mobil XHP-222 grease or equivalent.

Preparing the Reel for Grinding

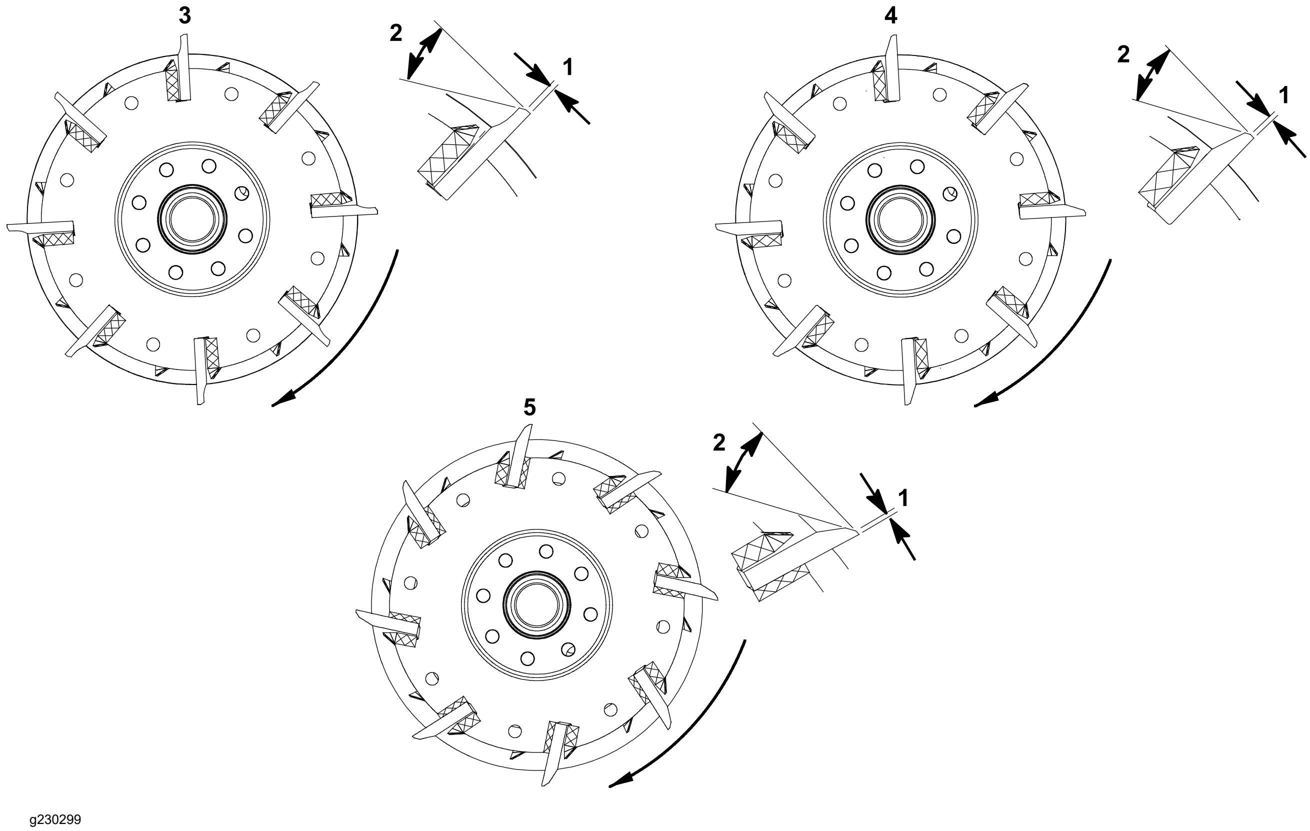


Figure 184

1. Blade land width
2. Blade relief angle
3. Scalloped radial reel
4. Tapered radial reel
5. Tapered forward sweep reel

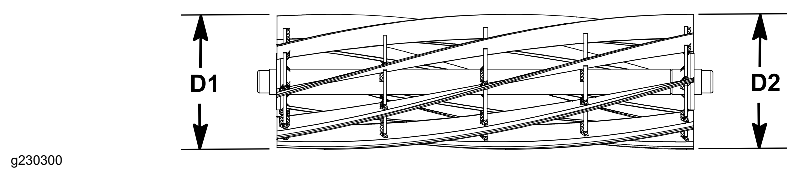


Figure 185

Reel diameter taper = D1 - D2

Three (3) types of reel designs are used in Reelmaster cutting units: scalloped radial reel, tapered radial reel and tapered forward swept reel (Figure 184). The radial reel designs have blades that are placed in line with the center of the reel shaft. The rear of the blades either have a scalloped relief or a tapered relief. The forward swept reel have blades that have a slight forward slant. The rear of the forward swept reel blades have a tapered relief. Before grinding a reel, identify the type of reel design to make sure that grinding is correctly done.

Before grinding a cutting reel, make sure that all cutting unit components are in good condition. Depending on type of grinder used, faulty cutting unit components can affect grinding results. 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 Table (page 8–30)). Additional reel grinding information can be found in your 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.

Reel Grinding Specifications Table

Reel diameter (new)	179.3 mm (7.060 inches)
Service limit-reel diameter	168 mm (6.600 inches)
Reel shaft diameter (outer diameter)	33.3 mm (1.313 in)
Service limit-reel diameter taper (Figure 185)	0.025 mm (0.001 in) Service Limit: 0.25 mm (0.010 in)
Blade land width	1.3 to 1.8 mm (0.050 to 0.060 in) Service Limit: 3.0 mm (0.120 in)
Blade relief angle	30º +/- 5º

Relief grind the reel blades to the minimum blade land width if the reel blade land width exceeds the service limit. Spin grind the reel to restore its cylindrical shape.

Note: Spin grind the reel and establish the specified blade land width after relief grinding.

After grinding the reel and/or bedknife, adjust the cutting unit (refer to *Cutting Unit Operator's Manual*). Check the reel to bedknife contact again after cutting two (2) fairways. During this initial use, any burrs will be removed from reel and bedknife which may create improper reel to bedknife clearance and thus accelerate wear. This practice of re-checking the reel to bedknife contact after grinding will extend the longevity of the sharpness of the edge of the reel and the bedknife.

Front Roller

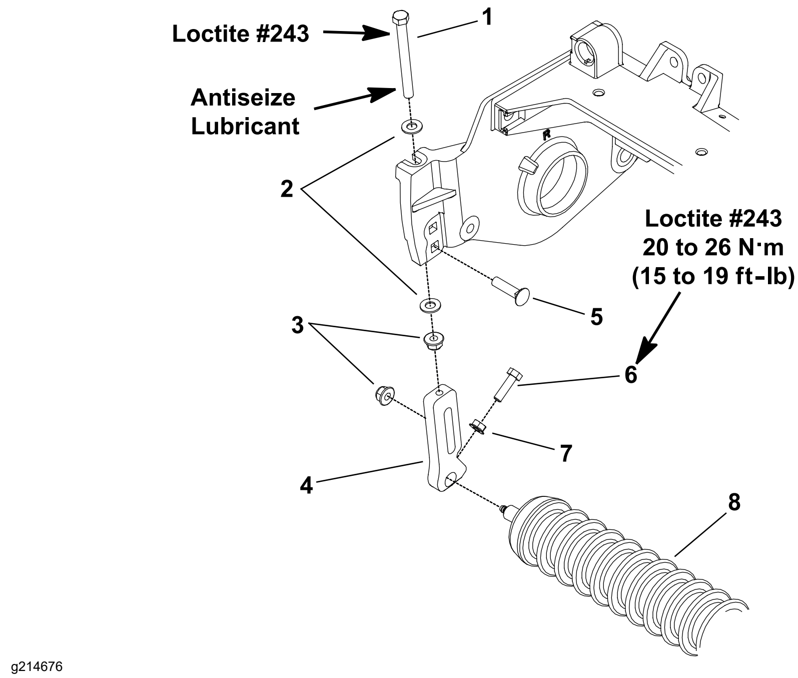


Figure 186

1. Cap screw
2. Flat washer
3. Flange nut
4. HOC (roller) bracket
5. Carriage screw
6. Cap screw
7. Flange nut
8. Front roller assembly

Removing the Front Roller

1. Position machine on a clean and level surface, lower cutting units, stop engine, engage parking brake and remove key from the key switch.
2. Remove the cutting unit from the machine and place on a level working surface. Use cutting unit kickstand (refer to Special Tools (page 2–13)) to raise front roller from work surface.
3. Loosen flange nut and cap screw securing the front roller shaft to each front height-of-cut (roller) bracket.
4. On one of the height-of-cut (roller) brackets:
   A. Remove flange lock nut and carriage screw that secure bracket to the cutting unit side plate.
   B. Remove the height-of-cut (roller) bracket from the cutting unit.
5. Slide the front roller assembly from the remaining height-of-cut (roller) bracket on the cutting unit.
6. If necessary, remove the second height-of-cut (roller) bracket from the cutting unit.

Installing the Front Roller

1. Place cutting unit on a level working surface and use cutting unit kickstand (refer to Special Tools (page 2–13)) to support cutting unit.
2. Inspect condition of cap screws (item 1) in both height-of-cut (roller) brackets. Replace cap screw(s) if necessary:
   A. Place two (2) flat washers on cap screw and thread flange lock nut onto cap screw to a position **19 mm (0.750 in)** from screw head.

Installing the Front Roller (continued)

B. Apply anti-seize lubricant to cap screw threads that will extend into height-of-cut (roller) bracket.

C. Thread cap screw into bracket.

Note: When assembling height-of-cut (roller) brackets to side plate, make sure that the cap screw head and one washer are above adjustment flange on side plate and second washer and flange lock nut are below flange.

3. If both front height-of-cut (roller) brackets were removed from cutting unit side plate, position one of the brackets to side plate. Secure bracket to side plate with carriage screw and flange lock nut.
4. Slide front roller shaft into bracket attached to the cutting unit. Slide second height-of-cut (roller) bracket onto the other end of roller shaft. Secure second bracket to cutting unit side plate with carriage screw and flange nut.
5. Apply Loctite #243 (or equivalent) to exposed threads of cap screw (item 1) between flange of side plate and position of flange lock nut (item 3) on cap screw. Tighten flange lock nut on cap screw and then loosen nut 1/4 to 1/2 turn. Cap screw should rotate freely with little (if any) endplay after lock nut installation.
6. Apply Loctite #243 (or equivalent) to threads of two (2) cap screws (item 6). Center front roller to the cutting reel and secure in place with two (2) cap screws. Torque cap screws from **20 to 26 N·m (15 to 19 ft-lb)**. Secure cap screws with flange nuts.
7. Lubricate the front roller.
8. Adjust the cutting unit; refer to *Cutting Unit Operator's Manual*.

Shop Roller Assembly (Model 03192)

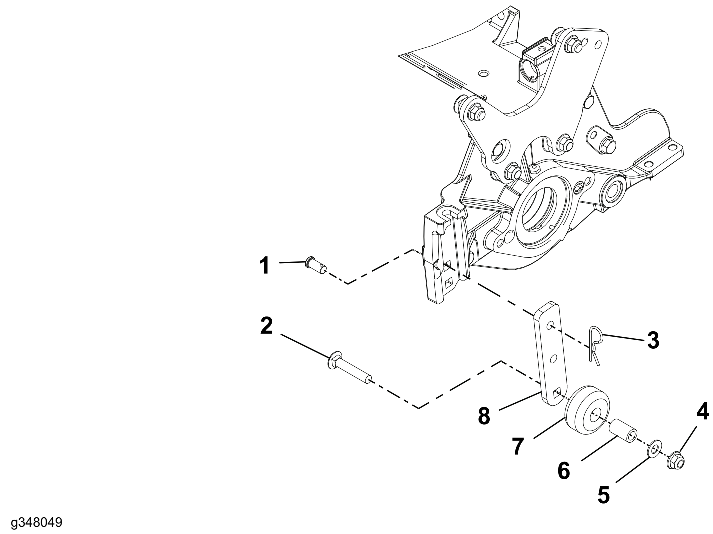


Figure 187

1.	Clevis pin	5.	Washer
2.	Carriage bolt	6.	Spacer
3.	Cotter hairpin	7.	Roller
4.	Flange head nut	8.	Roller bracket

Removing the Shop Roller Assembly

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

IMPORTANT

Before the cutting units are lowered to the shop floor or removed from the traction unit, lower the shop roller assemblies to protect the reel and bedknife blades from hard surface contact.

2. Remove the cotter hairpin from the clevis pin that secures the shop roller bracket to the side plate.
3. Remove the shop roller assembly from the cutting unit.
4. Disassemble the shop roller assembly by using the Figure 187 as a guide.

Installing the Shop Roller Assembly

1. Assemble the shop roller assembly by using the Figure 187 as a guide.
2. Install the shop roller assembly onto the side plate of the cutting unit.
3. Secure the shop roller assembly with clevis pin and cotter hairpin.

IMPORTANT

Ensure that the clevis pin is always installed in the top square hole in the side plate.

4. Adjust the shop roller assembly; refer to *Cutting Unit Operator's Manual*.

Rear Roller

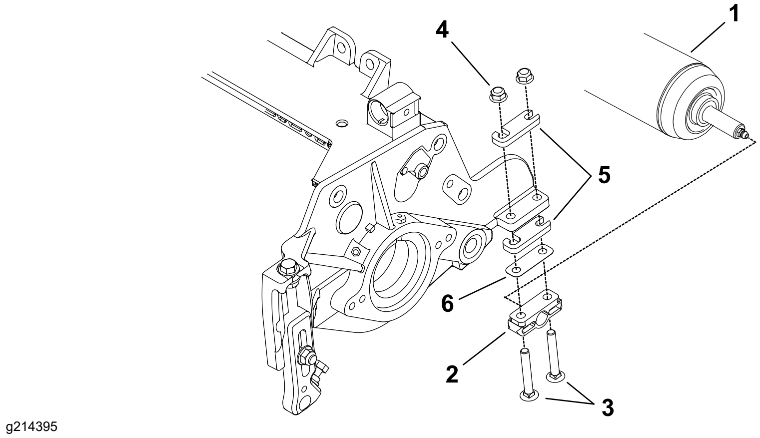


Figure 188

1.	Rear roller assembly	4.	Flange nut (2 each)
2.	Rear roller bracket	5.	Roller shim (2 each)
3.	Carriage screw (2 each)	6.	0.010 inch shim (if necessary)

Removing the Rear Roller (Figure 188)

1. Position machine on a clean and level surface, lower cutting units, stop engine, engage parking brake and remove key from the key switch.
2. Remove the cutting unit from the machine and place on a level working surface. Place support blocks under bedbar to raise rear roller from work surface.
3. Loosen two (2) flange nuts that secure the rear roller shaft to each rear roller bracket.
4. On one of the rear roller brackets:

   Note: On cutting units equipped with optional High Height of Cut Kit, there will be additional roller shims installed between rear roller bracket and cutting unit side plate.

   A. Remove flange nuts and carriage screws that secure rear roller bracket and roller shims to the cutting unit side plate.

   B. Remove the roller bracket and roller shims from the rear roller and cutting unit.
5. Slide the rear roller assembly from the remaining rear roller bracket on the cutting unit.
6. If necessary, remove the second rear roller bracket and roller shims from the cutting unit.

Installing the Rear Roller (Figure 188)

1. Place cutting unit on a level working surface.

   Note: Refer to *Cutting Unit Operator's Manual* for number of roller shims required for various height of cut settings.

   Note: A 0.010" shim (part number 107-4001) is available to allow for leveling of the rear roller (refer to Leveling Rear Roller (page 8–4)). If necessary, this shim would be used on one side of the rear roller and should be installed between the rear roller bracket and roller shim.
2. If both rear roller brackets were removed from the cutting unit side plate, position brackets and roller shims to one of the side plates. Install two (2)

Installing the Rear Roller (Figure 188) (continued)

carriage screws and flange nuts to retain bracket in position. Do not fully tighten flange nuts.

3. Slide rear roller shaft into the rear roller bracket attached to the cutting unit. Slide second rear roller bracket onto the other end of roller shaft. Secure second roller bracket and shims to cutting unit side plate with two (2) carriage screws and flange nuts. Do not fully tighten flange nuts.
4. Center rear roller to the cutting reel and secure in place by tightening four (4) flange nuts.
5. Lubricate the rear roller.
6. Adjust the cutting unit; refer to *Cutting Unit Operator's Manual*.

Servicing the Roller

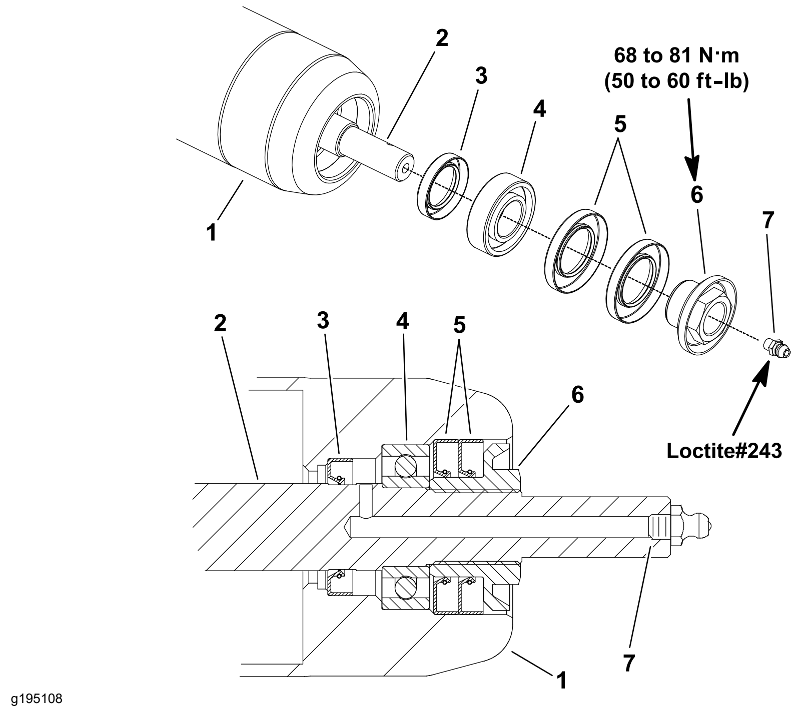


Figure 189

1. Roller tube
2. Roller shaft
3. Inner seal
4. Bearing
5. Outer seal
6. Bearing lock nut
7. Grease fitting

Disassembling the Roller (Figure 189)

1. Remove the bearing lock nut from each end of roller shaft.
2. Loosely secure roller assembly in bench vise and lightly tap one end of roller shaft until outer seals and bearing are removed from opposite end of roller tube. Remove second set of outer seals and bearing from roller tube by tapping on opposite end of shaft. Remove the shaft from roller tube.
3. Carefully remove the inner seal from both ends of roller tube taking care to not damage tube surfaces.
4. Discard the removed seals and bearings.
5. Clean the roller shaft and all surfaces on the inside of the roller tube. Inspect components for wear or damage. Also, carefully inspect seating surface and threads of bearing lock nuts. Replace all damaged components.

Assembling the Roller (Figure 189)

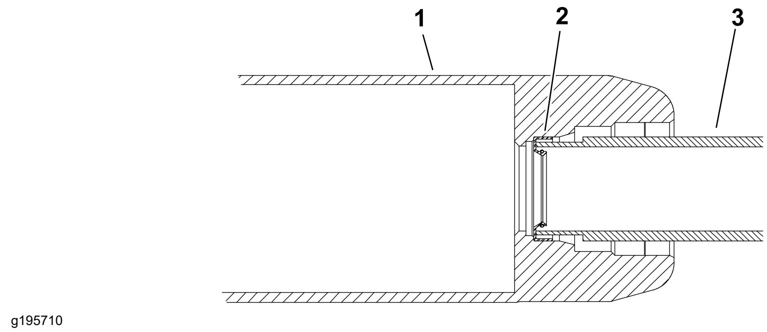


Figure 190

1. Roller tube
2. Inner seal
3. Inner seal tool

1. Install inner seals into roller tube making sure that seal lip (and garter spring) faces end of tube. Use inner seal tool (refer to Special Tools (page 2–13)) and soft face hammer to fully seat seals against roller shoulder (Figure 190). Apply a small amount of grease around the lip of both inner seals after installation.

IMPORTANT

During assembly process, frequently check that bearings rotate freely and do not bind. If any binding is detected, consider component removal and reinstallation.

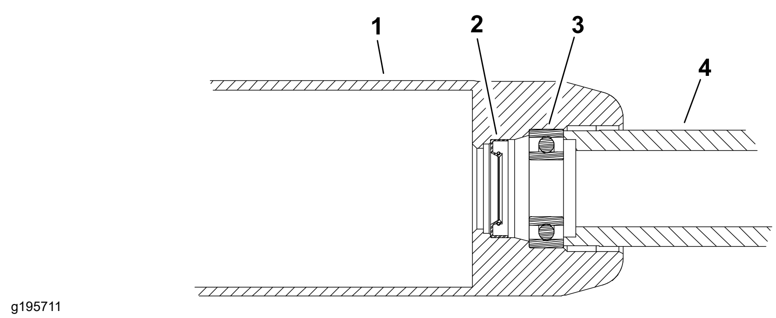


Figure 191

1. Roller tube
2. Inner seal
3. Bearing
4. Bearing/outer seal tool

2. Install new bearing and outer seals into one end of roller tube:
   A. Position a new bearing into one end of roller tube. Use bearing/outer seal tool (refer to Special Tools (page 2–13)) with a soft face hammer to fully seat bearing against roller shoulder (Figure 191). After bearing installation, make sure that it rotates freely with no binding.
   B. Apply a small amount of grease around the lip of both outer seals.

Assembling the Roller (Figure 189) (continued)

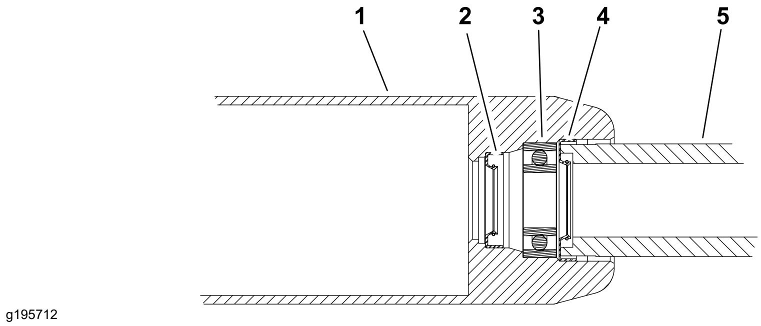


Figure 192

1. Roller tube
2. Inner seal
3. Bearing
4. Outer seal
5. Bearing/outer seal tool

C. Install first outer seal into roller tube making sure that seal lip (and garter spring) faces end of tube. Use bearing/outer seal tool (refer to Special Tools (page 2–13)) and soft face hammer to lightly seat seal against roller shoulder (Figure 192). Make sure that bearing still freely rotates after seal installation.

D. Using the same process, install second outer seal making sure to not crush the installed outer seal. Again, make sure that bearing still freely rotates.

3. From the roller tube end with only the inner seal installed, carefully install the roller shaft into the roller tube. Make sure that seals are not damaged as shaft is installed.

4. Install new bearing and outer seals into second end of roller tube:

A. Position a second new bearing to roller shaft and tube. Position washer (refer to Special Tools (page 2–13)) on bearing to allow pressing on both inner and outer bearing races simultaneously.

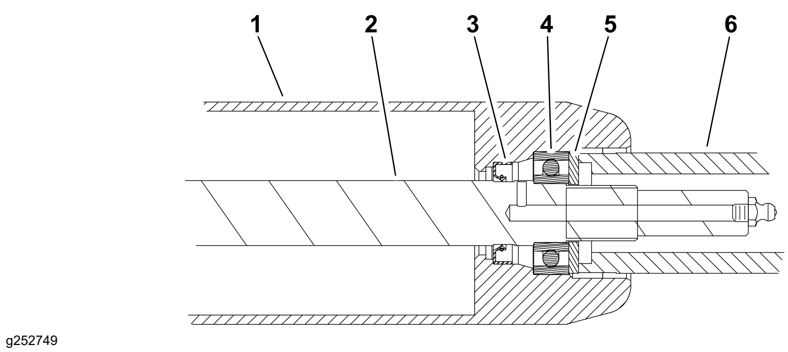


Figure 193

1. Roller tube
2. Roller shaft
3. Inner seal
4. Bearing
5. Washer
6. Bearing/outer seal tool

B. Use washer and bearing/outer seal tool (refer to Special Tools (page 2–13)) with a soft face hammer to fully seat bearing (Figure 193). After bearing installation, make sure that shaft freely rotates and that no binding is detected. If necessary, lightly tap bearing and/or shaft ends to align shaft and bearings. Remove washer from roller.

C. Apply a small amount of grease around the lip of both outer seals.

Assembling the Roller (Figure 189) (continued)

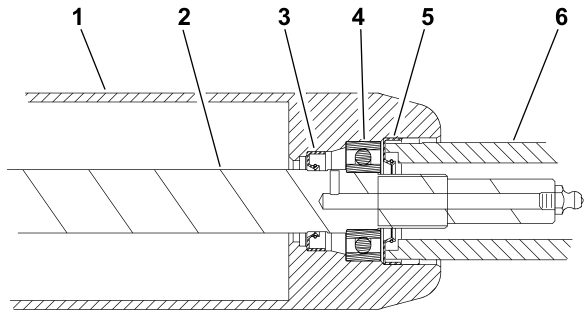


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Figure 194

1. Roller tube
2. Roller shaft
3. Inner seal
4. Bearing
5. Outer seal
6. Bearing/outer seal tool

D. Carefully install first outer seal into roller tube making sure that seal lip (and garter spring) faces end of tube. Use bearing/outer seal tool (refer to Special Tools (page 2–13)) and soft face hammer to lightly seat seal (Figure 194). Make sure that shaft and bearings still freely rotate after seal installation.

E. Using the same process, install second outer seal making sure to not crush the installed outer seal. Again, make sure that shaft and bearings still freely rotate.

IMPORTANT

Make sure that all grease is removed from shaft threads to prevent bearing lock nut loosening.

5. Thoroughly clean threads on both ends of roller shaft.

   Note: If original bearing lock nut(s) are being used, apply Loctite #243 (or equivalent) to threads of lock nut(s).

6. Install bearing lock nut onto each end of the roller shaft. Make sure that outer seals are not damaged during nut installation. Torque lock nuts from **68 to 81 N·m (50 to 60 ft-lb)**.

7. If grease fittings were removed from end of roller shaft, install fittings in shaft.

   Note: After roller is installed to cutting unit, lubricate roller grease fittings, rotate roller to properly distribute grease in bearings and clean excess grease from roller ends. A properly assembled roller should rotate with less than **0.68 N·m (5 in-lb)** resistance.

Rear Roller Brush – Optional

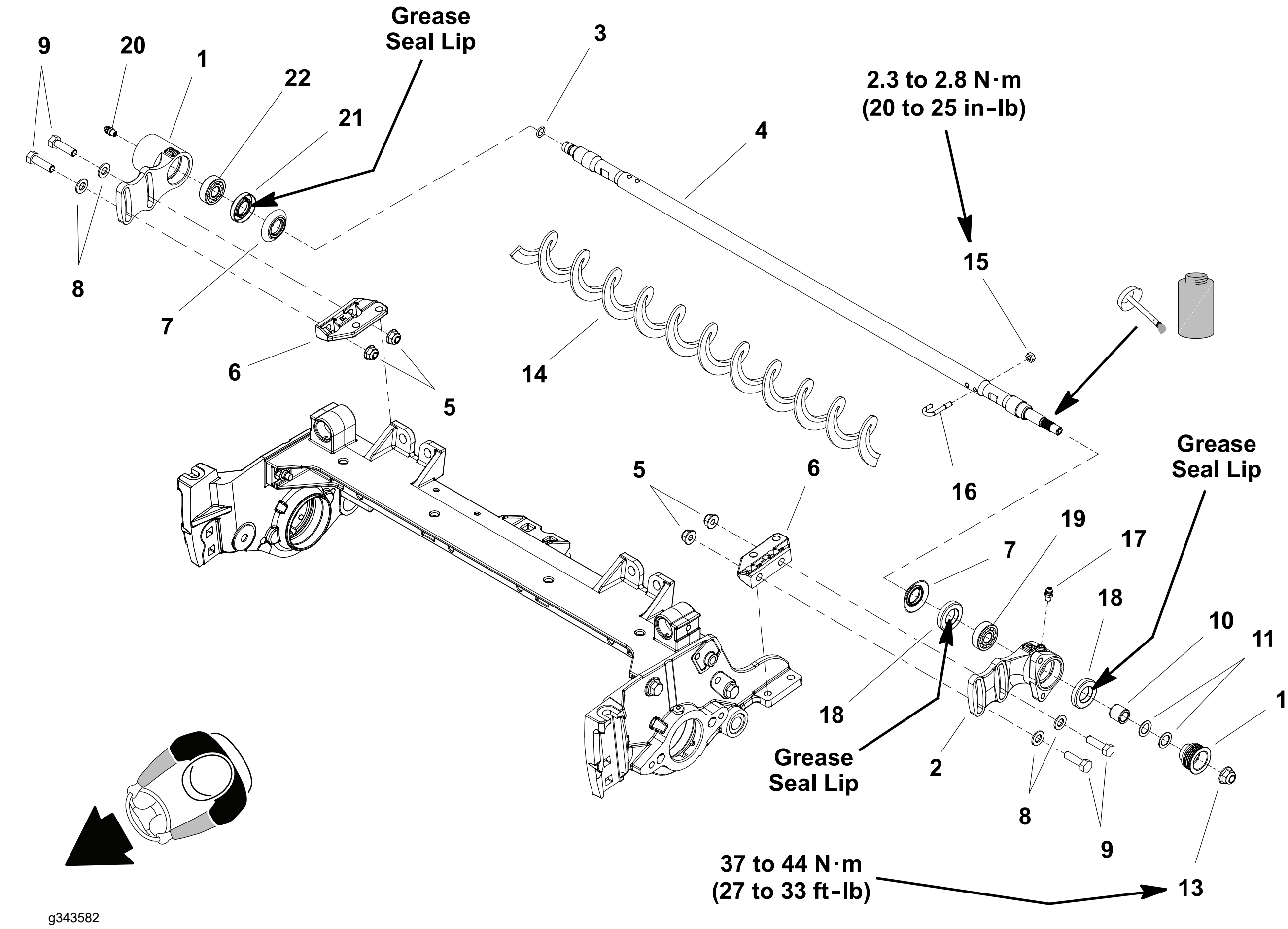

Figure 195

1. Brush bearing housing (non-drive)
2. Brush bearing housing (drive)
3. O-ring
4. Roller brush shaft
5. Flange nut (4 each)
6. Mounting bracket (2 each)
7. Excluder seal (2 each)
8. Flat washer (4 each)
9. Cap screw (4 each)
10. Spacer
11. Flat washer (for pulley alignment)
12. Driven pulley
13. Flange nut
14. Roller brush
15. Lock nut
16. J-bolt (2 each)
17. Grease fitting
18. Grease seal
19. Ball bearing
20. Grease fitting
21. Grease seal
22. Ball bearing

Note: Drive components for the rear roller brush are located on the opposite side of the cutting unit from the cutting reel motor. Figure 55 shows components used when the brush drive is on the left side of the cutting unit.

Note: The Installation Instructions for the rear roller brush kit has detailed information regarding assembly and adjustment. Use those Instructions along with this Service Manual when servicing the rear roller brush.

Disassembling the Rear Roller Brush (Figure 195)

1. Position machine on a clean and level surface, lower cutting units, stop engine, engage parking brake and remove key from the key switch.
2. To remove the roller brush from brush shaft:
   A. Remove the non-drive brush bearing housing (item 1) from cutting unit.
   B. Slide excluder seal from roller brush shaft.

Disassembling the Rear Roller Brush (Figure 195) (continued)

C. Remove lock nut and J-bolt from both ends of the brush.

D. While rotating brush, slide brush from the shaft.

3. Disassemble roller brush components as necessary using Figure 195 as a guide. If drive brush bearing housing (item 2) or driven pulley (item 12) need to be removed, brush cover and drive belt removal will be necessary (refer to Disassembling the Drive System (page 8–43)).

Assembling the Rear Roller Brush (Figure 195)

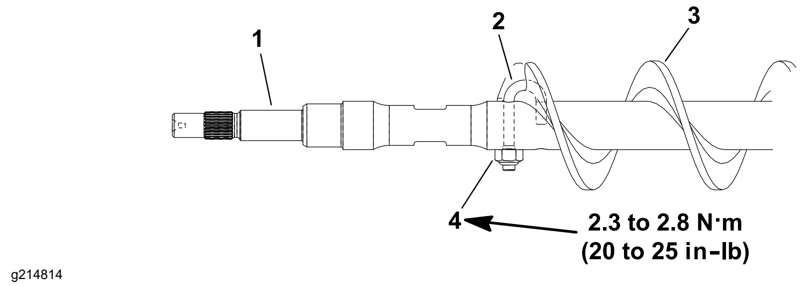

Figure 196

1. Roller brush shaft
2. J-bolt
3. Roller brush
4. Locknut

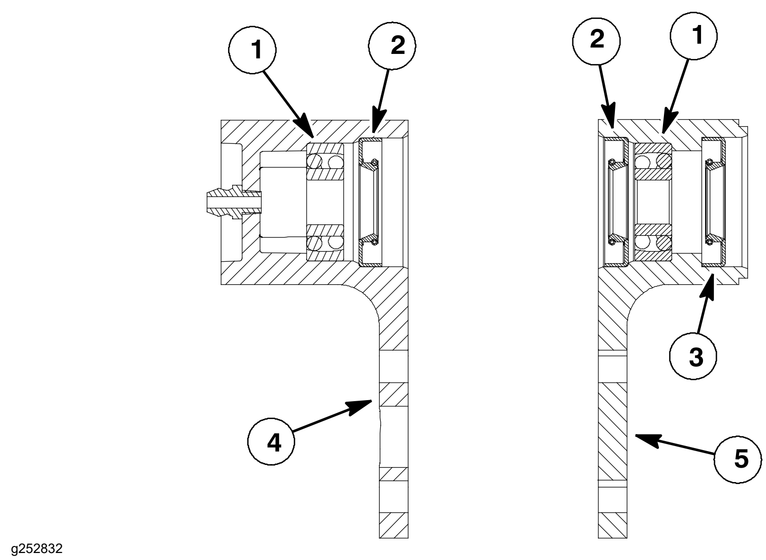

Figure 197

1. Bearing
2. Inner grease seal
3. Outer grease seal
4. Housing (non-driven)
5. Housing (driven)

1. If seals or bearings were removed from brush bearing housings, install new components noting proper orientation as shown in Figure 197.

   A. Pack bearings with high temp Mobil XHP-222 grease (or equivalent) before installation.

   B. Press bearing into bearing housing so that bearing contacts shoulder in housing bore.

   C. Install grease seals so that seal lips are positioned toward the brush location as shown in Figure 197. Press seals into housing so that seal contacts bore shoulder.

Assembling the Rear Roller Brush (Figure 195) (continued)

2. If roller brush was removed from roller shaft, slide brush onto shaft while rotating brush. Secure brush to shaft with two (2) J-bolts and lock nuts. Make sure that the J-bolts are installed with the threaded portion on the outside of the brush (Figure 196). Torque lock nuts from **2.3 to 2.8 N·m (20 to 25 in-lb)**.

3. Assemble the roller brush components using Figure 195 as a guide noting the following items:

   A. Apply the coating of grease to lips of grease seals in brush bearing housing before inserting brush shaft into housing.

   B. If driven pulley (item 12) was removed from roller brush shaft, apply anti-seize lubricant to splines of pulley bore and slide pulley onto shaft. Install and tighten flange nut until pulley is seated onto shaft and then torque flange nut from **37 to 44 N·m (27 to 33 ft-lb)**. Use a ½ wrench on roller brush shaft flats to prevent shaft from rotating when tightening nut.

   C. Position excluder seals on brush shaft so that seals just touch bearing housings.

   D. If driven pulley (item 12) was removed, check and adjust alignment of drive and driven pulleys (refer to Assembling the Drive System (page 8–45)).

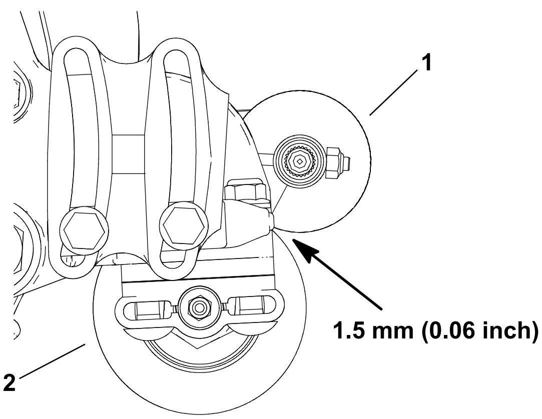

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Figure 198

1. Rear roller brush
2. Rear roller

4. Check that brush is parallel to rear roller with 1.5 mm (0.060 in) clearance to light contact with rear roller (Figure 198). If contact is incorrect, brush operation will be adversely affected.

5. Lubricate grease fittings on brush housings until grease purges past inboard seals. Wipe excess grease from seals and fittings.

Disassembling the Drive System

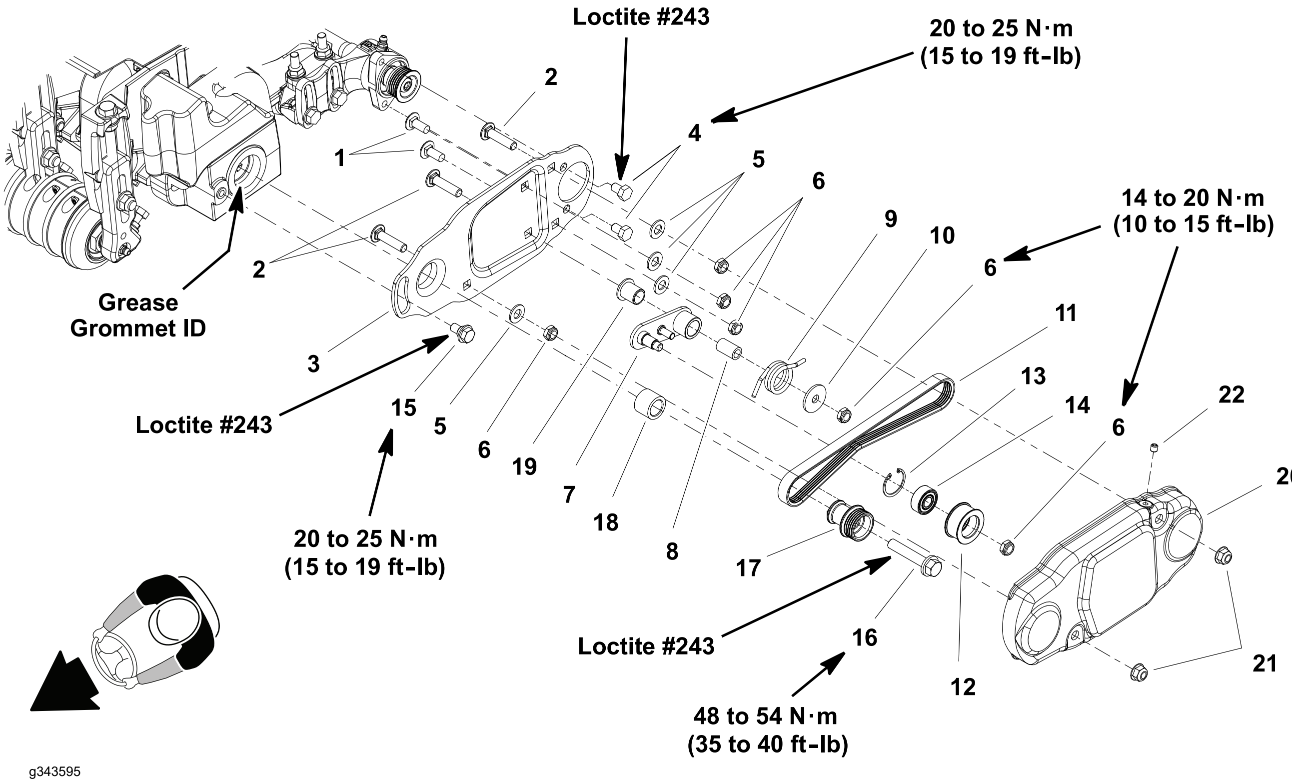

Figure 199

1. Carriage screw (2 used)
2. Carriage screw (3 used)
3. Brush plate
4. Cap screw (2 used)
5. Flat washer (4 used)
6. Lock nut (6 used)
7. Idler arm
8. Idler spacer
9. Idler spring
10. Pivot washer
11. Drive belt
12. Idler pulley
13. Retaining ring
14. Bearing
15. Shoulder screw
16. Flange head screw
17. Drive pulley
18. Spacer
19. Flange bushing
20. Cover
21. Flange nut (2 used)
22. Set screw (top of cover only)

Note: Drive components for the rear roller brush are located on the opposite side of the cutting unit from the cutting reel motor. Figure 199 shows components used when the brush drive is on the left side of the cutting unit.

Note: The Installation Instructions for the rear roller brush kit has detailed information regarding assembly and adjustment. Use those Instructions along with this Service Manual when servicing the rear roller brush.

1. Position machine on a clean and level surface, lower cutting units, stop engine, engage parking brake and remove key from the key switch.
2. Remove cover (item 20) to access rear roller brush drive components.
3. Remove roller brush drive components as necessary using Figure 199 as a guide.

Disassembling the Drive System (continued)

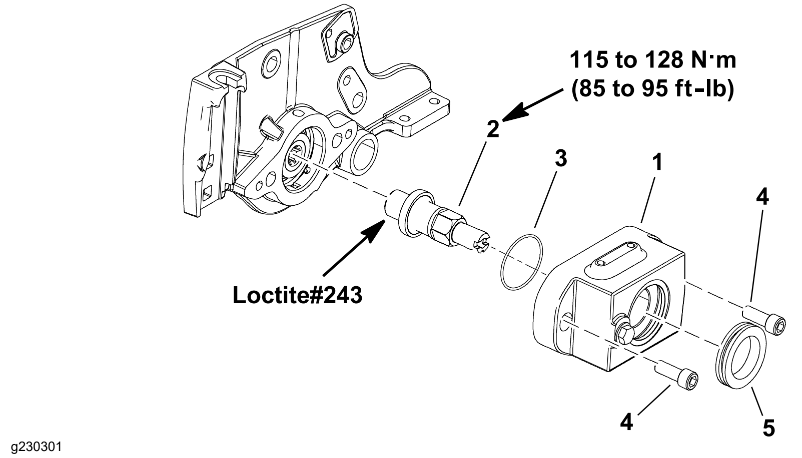

Figure 200

1. Drive housing
2. Drive shaft
3. O-ring
4. Socket-head screw
5. Grommet

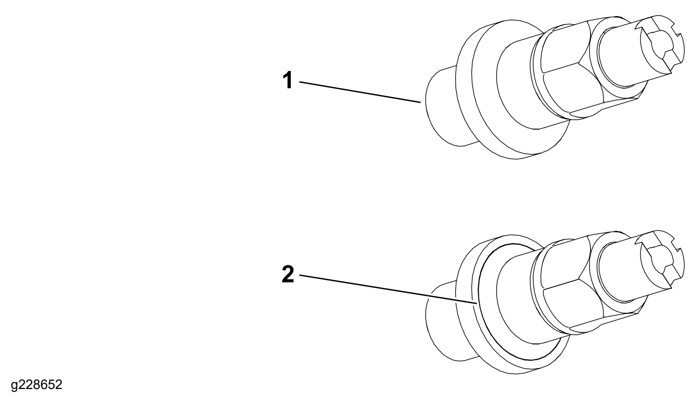

Figure 201

1. Drive shaft with right-hand threads (no groove)
2. Drive shaft with left-hand threads (with groove)

4. Remove roller brush drive shaft if needed:

   A. Remove socket head screws that secure drive housing to cutting unit side plate and remove housing from the cutting unit.

IMPORTANT

If rear roller brush drive is on left side of cutting unit, drive shaft has left hand threads and can be identified by a groove on the flange. If the rear roller brush drive is on right side of cutting unit, drive shaft has right hand threads and does not have a groove on the flange (Figure 201).

   B. Loosen and remove drive shaft from the cutting reel.

Assembling the Drive System

1. Install drive shaft if it was removed:

IMPORTANT

If rear roller brush drive is on left side of cutting unit, drive shaft has left hand threads and can be identified by a groove on the flange. If the rear roller brush drive is on right side of cutting unit, drive shaft has right hand threads and does not have a groove on the flange (Figure 201).

   A. Apply Loctite #243 (or equivalent) to threads of drive shaft. Thread drive shaft into cutting reel and torque from **115 to 128 N·m (85 to 95 ft-lb)**.

   B. Make sure that the O-ring is placed on inner flange of drive housing.

   C. Position housing to cutting unit side plate and secure to cutting unit with two (2) socket head screws.

   D. Make sure that grommet groove is correctly seated on flange in drive housing bore.

2. Assemble roller brush components using Figure 199 as a guide.

   A. During assembly, apply Loctite #243 (or equivalent) to threads of fasteners and torque fasteners as shown in Figure 199.

   B. Apply a light coating of grease to inner diameter of the grommet in drive bearing housing before installing brush plate.

   C. Brush plate should be installed so that idler pulley assembly is toward the bottom of the plate. Also, the shoulder bolt (item 15) should not clamp the brush plate to the drive housing during assembly.

   D. When installing drive pulley (item 17), make sure that tabs on pulley engage slot in drive shaft.

   E. Idler arm (item 7) should be free to rotate after assembly to brush plate. Make sure that idler spring is installed so that it can rotate the idler arm and pulley and apply tension to the drive belt.

   F. After drive belt installation, make sure that the ribs on the belt are properly seated in the grooves of both the drive and driven pulleys and that the belt is in the center of the idler pulley.

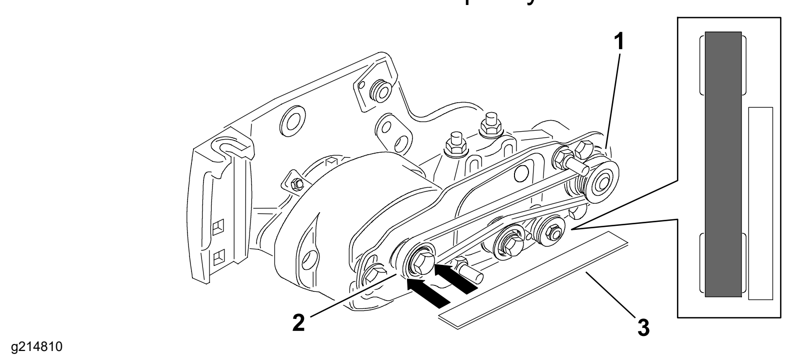

Figure 202

1. Driven pulley
2. Drive pulley
3. Pulley alignment tool

3. After assembly (including drive belt installation), check alignment of pulleys with a straight edge placed along the outer face of the drive pulley (Figure 202).

Assembling the Drive System (continued)

A. The outer faces of the drive and driven pulleys (not the idler pulley) should be in-line within 0.76 mm (0.030 in).

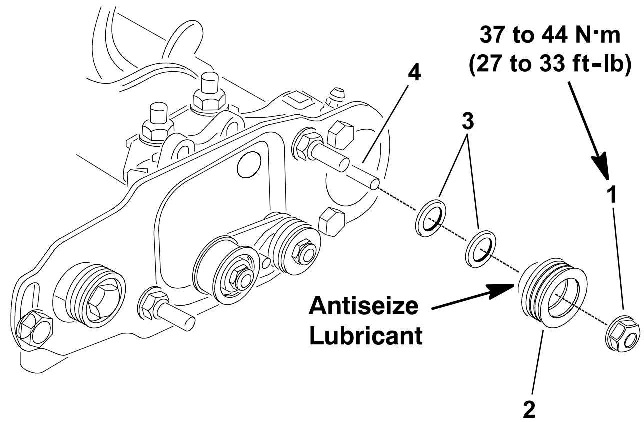

Figure 203

1. Flange nut
2. Driven pulley
3. Flat washer
4. Roller brush shaft

B. If necessary to align pulleys, remove driven pulley from brush shaft and add or remove flat washer(s) until drive and driven pulleys are correctly aligned (Figure 203).

C. If driven pulley was removed from roller brush shaft, apply anti-seize lubricant to splines of pulley bore and slide pulley onto shaft. Install and tighten flange nut until pulley is seated onto shaft and then torque flange nut from **37 to 44 N·m (27 to 33 ft-lb)**. Use a ½ wrench on roller brush shaft flats to prevent shaft from rotating when tightening nut.

IMPORTANT

The roller brush shaft must nor contact the cutting unit side plate. Also, heavy brush contact on the rear roller will cause premature brush wear.

4. Check that brush is parallel to rear roller with 1.5 mm (0.060 in)clearance to light contact with rear roller. If contact is incorrect, brush operation will be adversely affected.
5. Install cover (item 20).There should not be a set screw installed in the bottom of the cover.
6. Lubricate grease fittings on brush housings until grease purges past inboard seals. Wipe excess grease from seals and fittings.

Universal Groomer (Optional)

Table of Contents

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 Reelmaster machine. Refer to the *Installation Instructions* for additional information when servicing the groomer assembly.

Service and Repairs

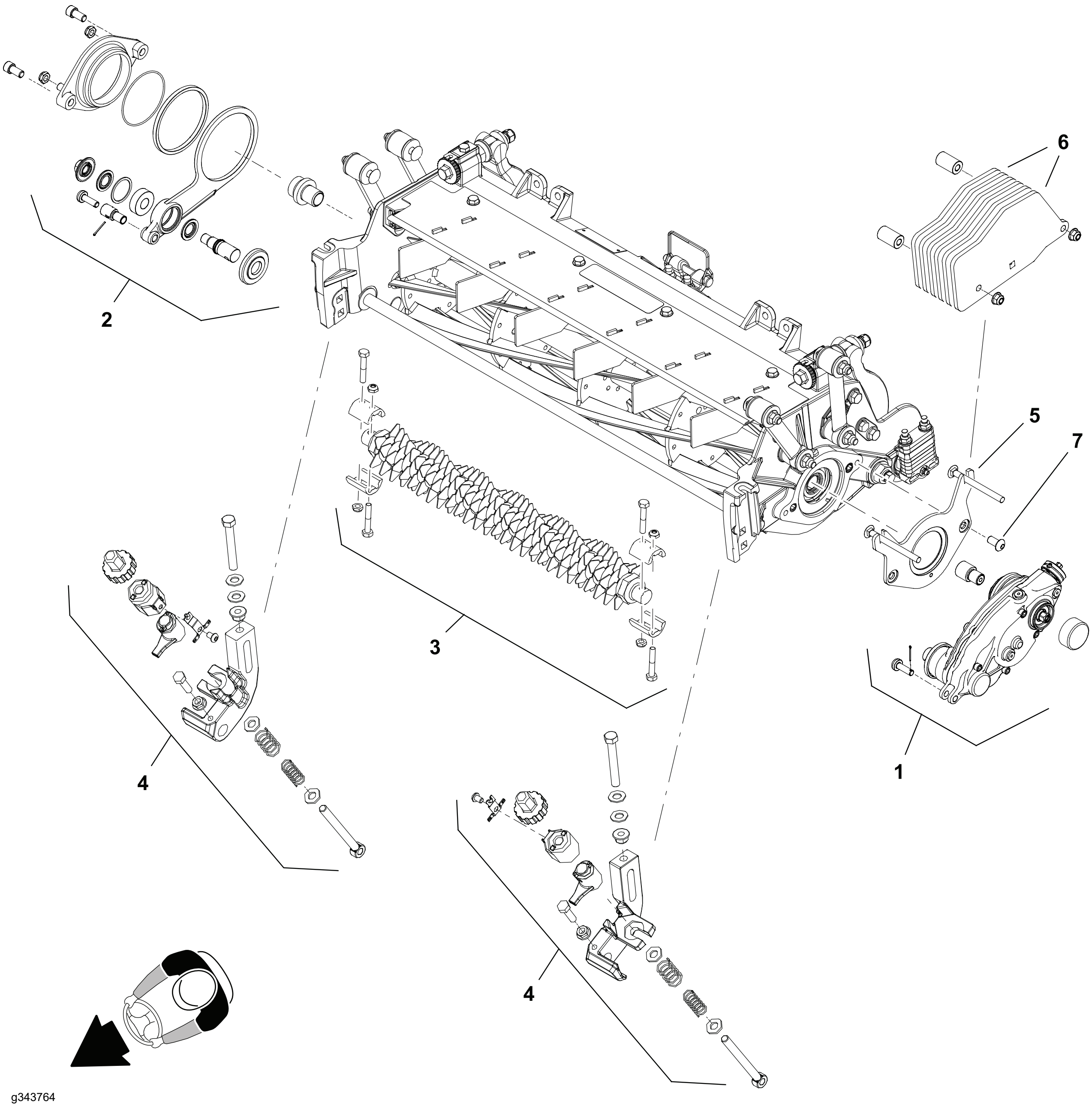

Figure 204

1. Gear box assembly
2. Idler assembly
3. Groomer reel
4. Height adjuster assembly (2)
5. Plate
6. Weights
7. Button head screw (2)

CAUTION

Never work on the groomer with the engine running. Always stop the engine, remove the key from the key switch and wait for all machine movement to stop before working on the groomer.

Note: The *Groomer Operator's Manual* provides information regarding the installation, set-up, operation and maintenance of the universal groomer on your Reelmaster machine. Refer to these instructions for additional information when servicing the groomer.

Gear Box Assembly

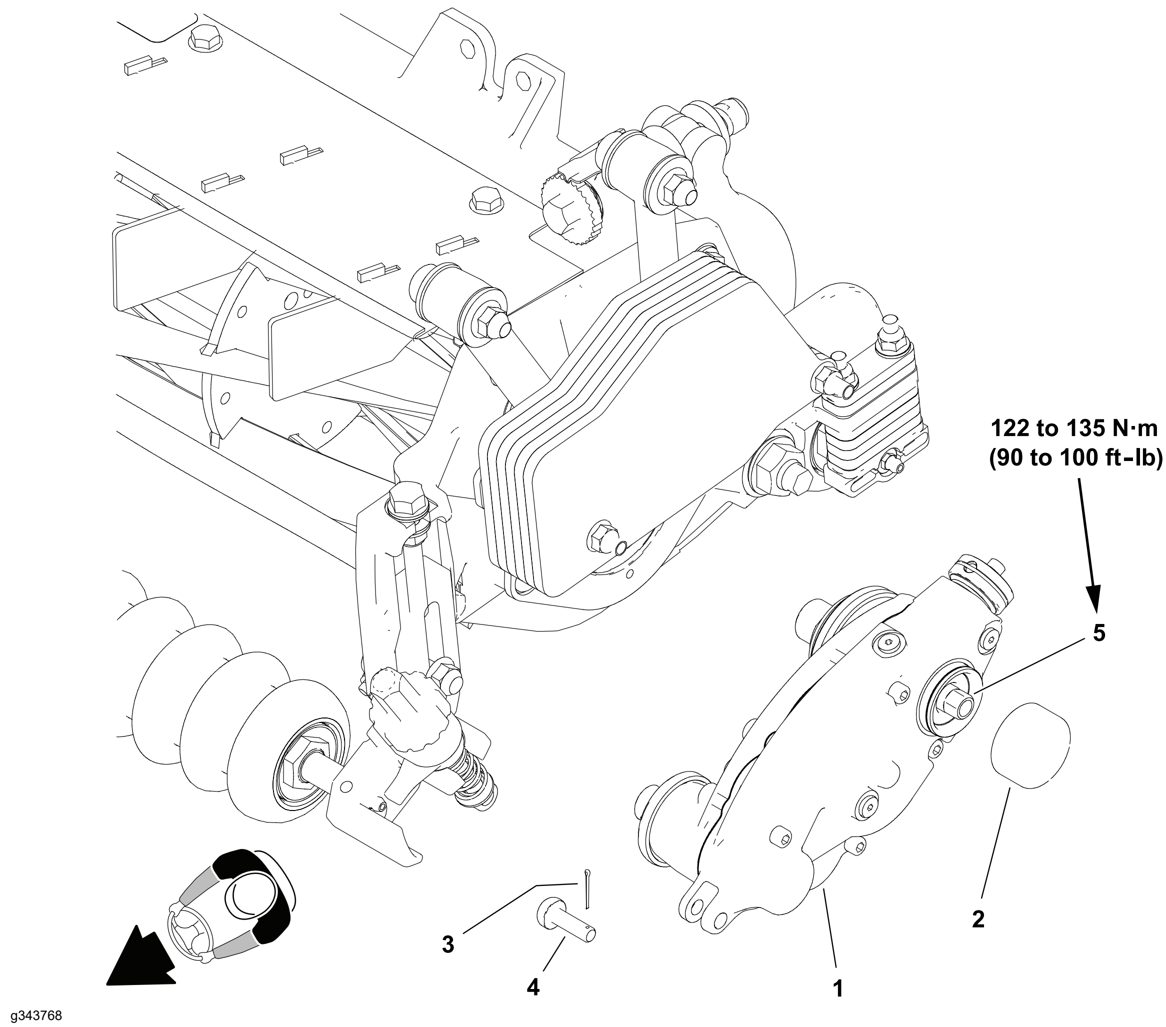

Figure 205

1. Gear box assembly
2. Rear roller brush drive shield
3. Cotter pin
4. Clevis pin
5. Input shaft

Note: The groomer gear box assembly is located on the opposite side of the cutting unit from the cutting unit hydraulic motor.

Removing the Gear Box Assembly

1. Park machine on a clean and level surface, lower cutting units completely to the ground, stop engine, engage parking brake and remove key from the key switch.
2. Remove the groomer reel assembly (refer to Groomer Reel (page 9–15)).

   Note: If cutting unit is equipped with an optional powered rear roller brush, remove the rear roller brush cover, drive belt and drive housing assembly to service the groomer drive (refer to Removing the Rear Roller (Figure 188) (page 8–34) for additional information).

CAUTION

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

Removing the Gear Box Assembly (continued)

3. Safely prevent reel from rotating by blocking the cutting reel with piece of wood near one of the reel spiders.
4. If installed, remove the rear roller brush drive shield from the gear box.

IMPORTANT

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. Groomer gear boxes installed on the right side of the cutting unit use a right hand thread. Turn the input shaft counterclockwise to remove the gear box.

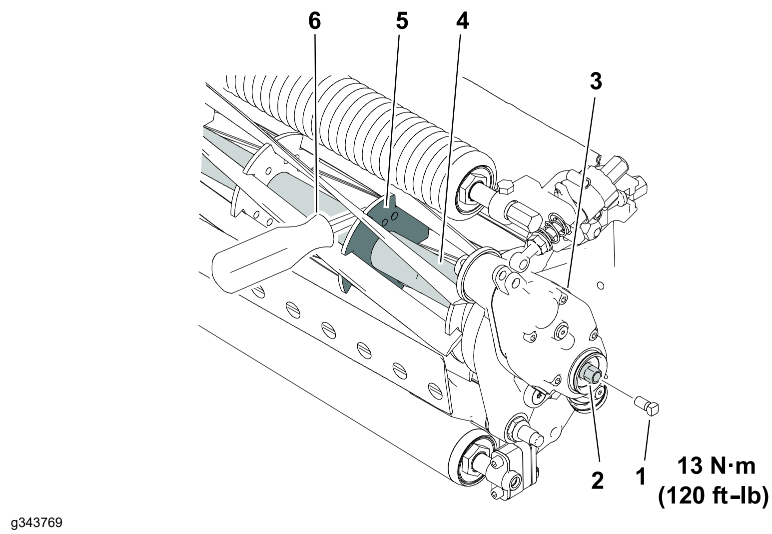

Figure 206

1. Square head set screw
2. Input shaft assembly
3. Gear box assembly
4. Reel shaft
5. Reel support plate
6. Pry bar

5. Install a 5/16–18 X 5/8 inch square head set screw (Toro p/n 1-803022) in the end of the drive shaft and tighten to **13 N·m (120 in-lb)**; refer to (Figure 206).
6. Remove the cotter pin and clevis pin from the height adjustment rod at the front of the groomer gear box. Discard cotter pin.
7. Tip up the cutting unit to access the bottom of the reel to remove the drive shaft assembly.
8. Insert a long-handled pry bar (3/8 x 12 inch with screwdriver handle recommended) through the bottom of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

IMPORTANT

To avoid grinding the reel, do not contact the cutting edge of any blade with the pry bar as this may damage the cutting edge and/or cause a high blade.

9. Move the pry bar against the weld side of the reel support plate closest to the groomer gear box.

Removing the Gear Box Assembly (continued)

IMPORTANT

You must use a 6-point socket with a heavy wall to remove the gear box from the reel. Do not use an impact wrench. Groomer gear boxes installed on the left side of the cutting unit use a left hand thread; turn the drive shaft in correct direction to remove the gear box.

10. Rest the handle of the pry bar against the front roller and turn the drive shaft in correct direction to loosen it from the reel. Continue to unscrew the drive shaft and remove the gear box from the cutting unit.

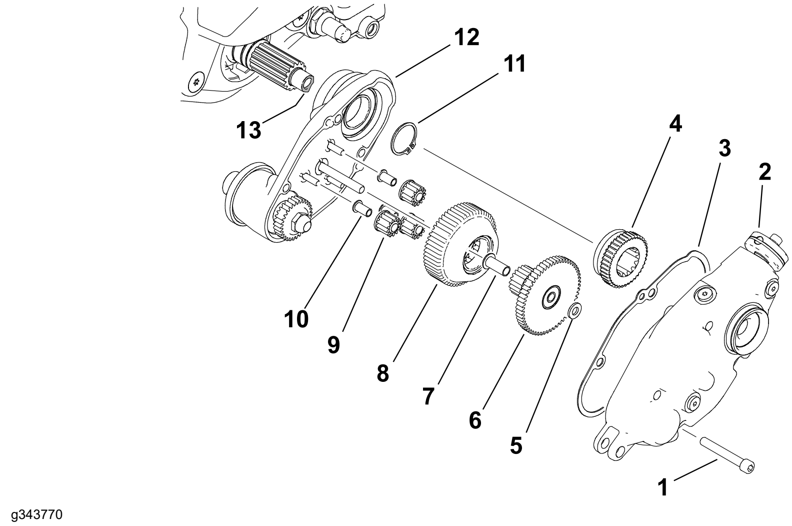

Figure 207

1. Socket head screw (4)
2. Gear box cover assembly
3. Cover gasket
4. Driven gear
5. Thrust washer
6. Ring gear
7. Flange bushing
8. Sun gear
9. Planet gear (3)
10. Flange bushing
11. Retaining ring
12. Gear box housing assembly
13. Damaged drive shaft

11. If the hex head on the end of the drive shaft is damaged during removal:
    A. Remove the drain/fill plug and drain the oil from the gear box.
    B. Remove the 4 socket-head screws and remove the gear box cover assembly and driven gear. Remove and discard the cover gasket.
    C. Slide the thrust washer, ring gear and bushing from the gear box housing.
    D. Slide the sun gear, and planet gears and bushings from the pins on the gear box housing.
    E. Remove the retaining ring from the drive shaft.
    F. Slide the groomer housing assembly from the drive shaft.
    G. Tip up the cutting unit to access the bottom of the reel to remove the drive shaft assembly.
    H. Insert a long-handled pry bar (3/8 x 12 inch with screwdriver handle recommended) through the bottom of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

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.

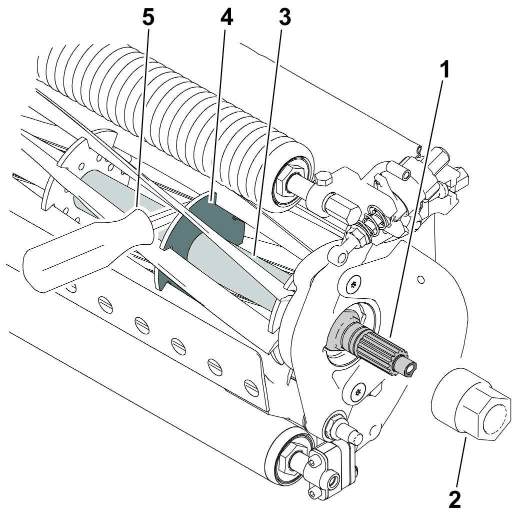

Figure 208

1. Damaged input shaft assembly
2. Drive shaft removal tool
3. Reel shaft
4. Reel support plate
5. Pry bar

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 (Toro p/n 137-0920) on the large flats of the drive shaft assembly; refer to Figure 208.

K. Rest the handle of the pry bar against the front roller and turn the drive shaft in correct direction to loosen it from the reel.

12. Tip the cutting unit back onto its rollers.
13. Clean the threads in the end of the reel shaft. A right- hand thread and left-hand thread tap is available to clean or repair the threads if necessary:

    A. 15/16–16 Right-Hand Thread – Toro p/n. 137-0926

    B. 15/16–16 Left-Hand Thread – Toro p/n. 137-0927

Disassembling the Gear Box Assembly

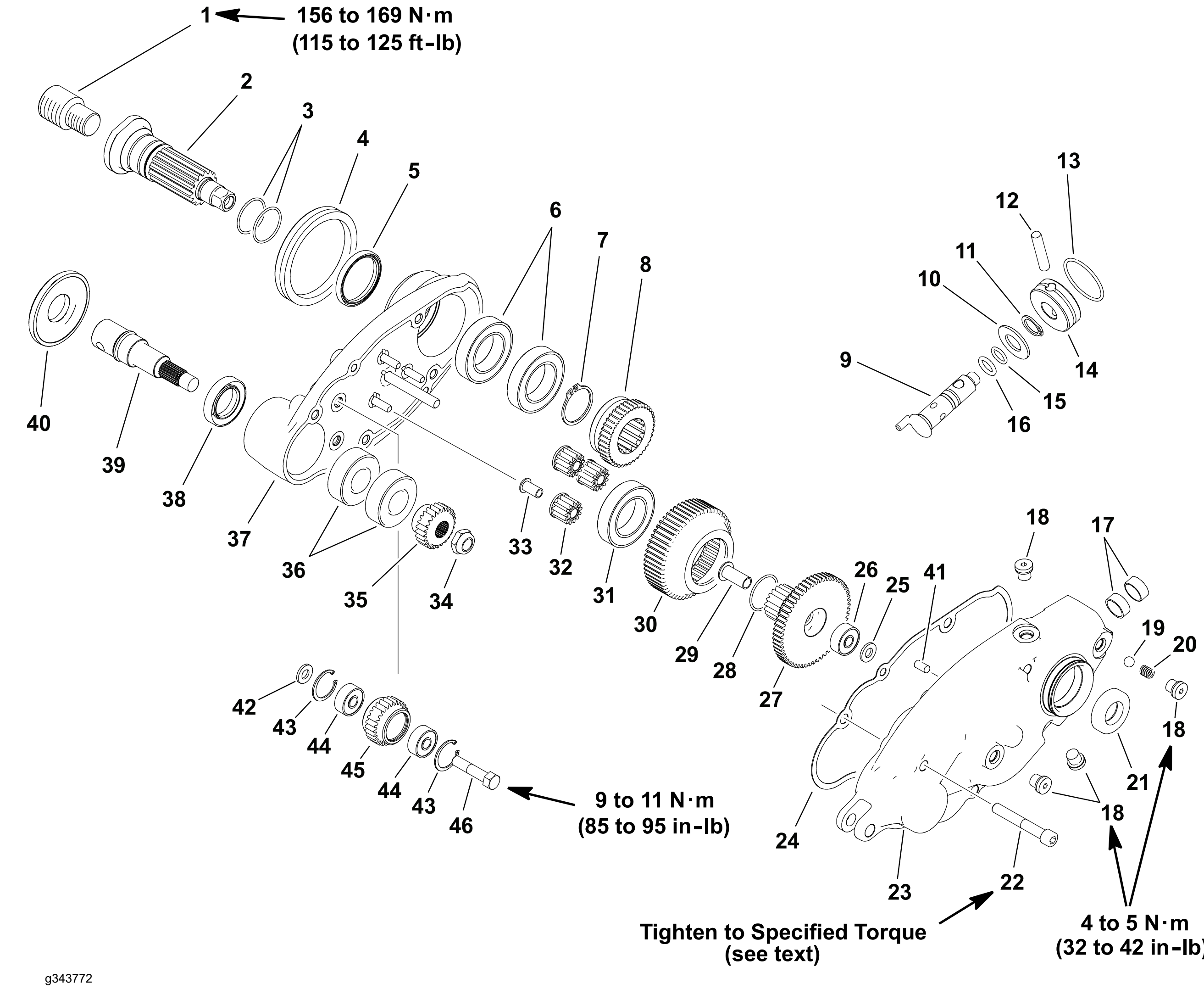

Figure 209

1. Threaded adapter
2. Input shaft
3. O-Ring (2)
4. V-Ring
5. Seal
6. Bearing (2)
7. Retaining ring
8. Slider gear
9. Shifter shaft
10. Thrust washer
11. Retaining ring
12. Dowel pin
13. O-ring
14. Knob
15. O-ring
16. O-ring
17. Bushing (2)
18. Drain/fill plug (4)
19. Ball
20. Detent spring
21. Seal
22. Socket head screw (4)
23. Cover
24. Gasket
25. Thrust washer
26. Bearing
27. Sun gear
28. O-ring
29. Bushing
30. Ring gear
31. Bearing
32. Planet gear (3)
33. Bushing (3)
34. Lock nut
35. Output gear
36. Bearing (2)
37. Housing
38. Seal
39. Output shaft
40. Shield
41. Dowel pin (2)
42. Thrust washer (2)
43. Retaining ring (2)
44. Bearing (4)
45. Idler gear (2)
46. Cap screw (2)

Disassembling the Gear Box Assembly (continued)

⚠ CAUTION ⚠

Use the 1-3/8” flats on the input shaft to prevent the input shaft from rotating during adapter removal. DO NOT use the 1/2” hex on the input shaft to secure the shaft during adapter removal or input shaft damage may occur.

1. Remove input shaft adapter (item 1 in Figure 209) if necessary.
2. Remove the drain/fill plug and drain the oil from the gear box.
3. Remove four (4) socket head cap screws (item 22) and separate the gear box cover and housing.
4. Remove and discard the cover gasket.
5. Slide the sun gear, ring gear and planet gears from the pins on the gear box housing.
6. Continue to disassemble the gear box as necessary.
7. Carefully clean any gasket material from gear box housing and cover.
8. Inspect V-ring, seals, bearings, gears and bushings in gear box assembly. Replace damaged or worn components as necessary.

Assembling the Gear Box Assembly

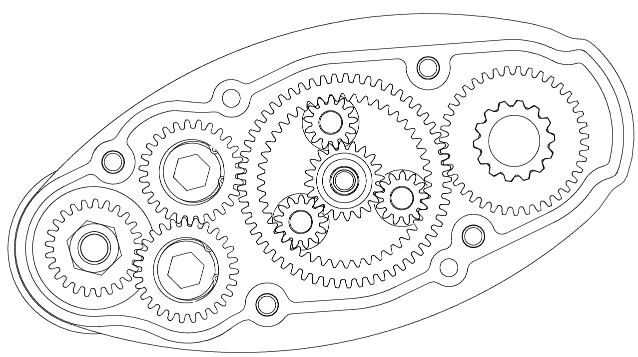

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Figure 210

1. If sun gear, ring gear or gear box housing bearings are replaced, press bearings all the way to shoulder in part.
2. If flange bushings are replaced, ensure bushing flange is fully seated against part.
3. Ensure all retaining rings and O-rings are fully seated in ring groove.
4. Lubricate seal lips and O-rings before installing shafts.
5. If idler gear assemblies were removed (Gear box for 7 in. reel cutting units only) tighten idler gear cap screw from **9 to 11 N·m (85 to 95 in-lb)**.
6. Lubricate planet gear and sun gear pins in gear box housing with gear oil and install planet, ring and sun gears.
7. Clean gasket surface on gear box housing and cover with solvent and install new gasket.

Assembling the Gear Box Assembly (continued)

8. Fit gear box cover over dowel pins and install four (4) socket head screws. Tighten screws from **2 to 4 N·m (15 to 40 in-lb)**. In an alternating cross pattern, tighten four (4) socket head screws from **8 to 9 N-m (75 to 85 in-lb)**.

9. Fill the gear box with 80W-90 gear oil and tighten drain/fill plug from **4 to 5 N·m (32 to 52 in-lb)**.

   Gear box oil capacity for 7 in. reel cutting units = 90 cc (3 oz.)

CAUTION

Use the 1-3/8” flats on the input shaft to prevent the input shaft from rotating during adapter installation. DO NOT use the 1/2” hex on the input shaft to secure the shaft during adapter installation or input shaft damage may occur.

10. If removed, install the threaded adapter in the input shaft. If reusing a previously installed threaded adapter, apply medium strength thread locker to the smaller (5/8-11) threads only. Tighten threaded adapter from **156-196 N·m (115-125 ft-lb)**.

11. Operate groomer gear box by hand to check for proper operation prior ro installation.

Installing the Gear Box Assembly

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

CAUTION

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

2. Safely prevent reel from rotating by blocking the cutting reel with piece of wood near one of the reel spiders.

IMPORTANT

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) counterclockwise to install the gear box. Groomer gear boxes installed on the right side of the cutting unit use a right hand thread. Turn the input shaft clockwise to install the gear box.

Installing the Gear Box Assembly (continued)

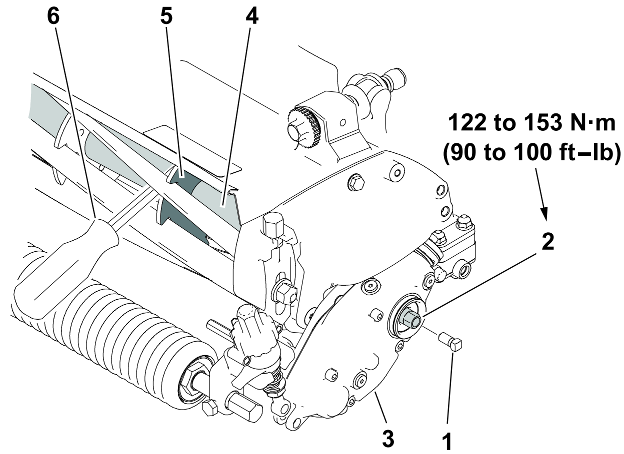

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Figure 211

1. Square head set screw
2. Input shaft assembly
3. Gear box assembly
4. Reel shaft
5. Reel support plate
6. Pry bar

3. Insert a long-handled pry bar through the front of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.
4. Move the pry bar against the weld side of the reel support plate closest to the gear box assembly and rest the handle of the pry bar against the front roller.
5. Position the gear box assembly against the cutting unit and turn the drive shaft assembly in correct direction until it is seated against the reel.

IMPORTANT

You must use a 6-point socket with a heavy wall to install the gear box to the reel. Do not use an impact wrench. Groomer gear boxes installed on the left side of the cutting unit use a left hand thread; turn the drive shaft in correct direction to install the gear box.

6. Tighten the input shaft from **122 to 153 N-m (90 to 100 ft-lb)**.
7. Remove the square head set screw from the end of the drive shaft.
8. Use a new cotter pin and install the cotter pin and clevis pin securing the height adjustment rod to the front of the groomer gear box.
9. Install the rear roller brush drive shield if previously removed.

   Note: If cutting unit is equipped with an optional powered rear roller brush, install the rear roller brush drive housing assembly, drive belt and cover (refer to Rear Roller Brush – Optional (page 8–40) for additional information).

10. Install the groomer reel assembly (refer to Installing the Groomer Reel (page 9–16)).

Idler Assembly

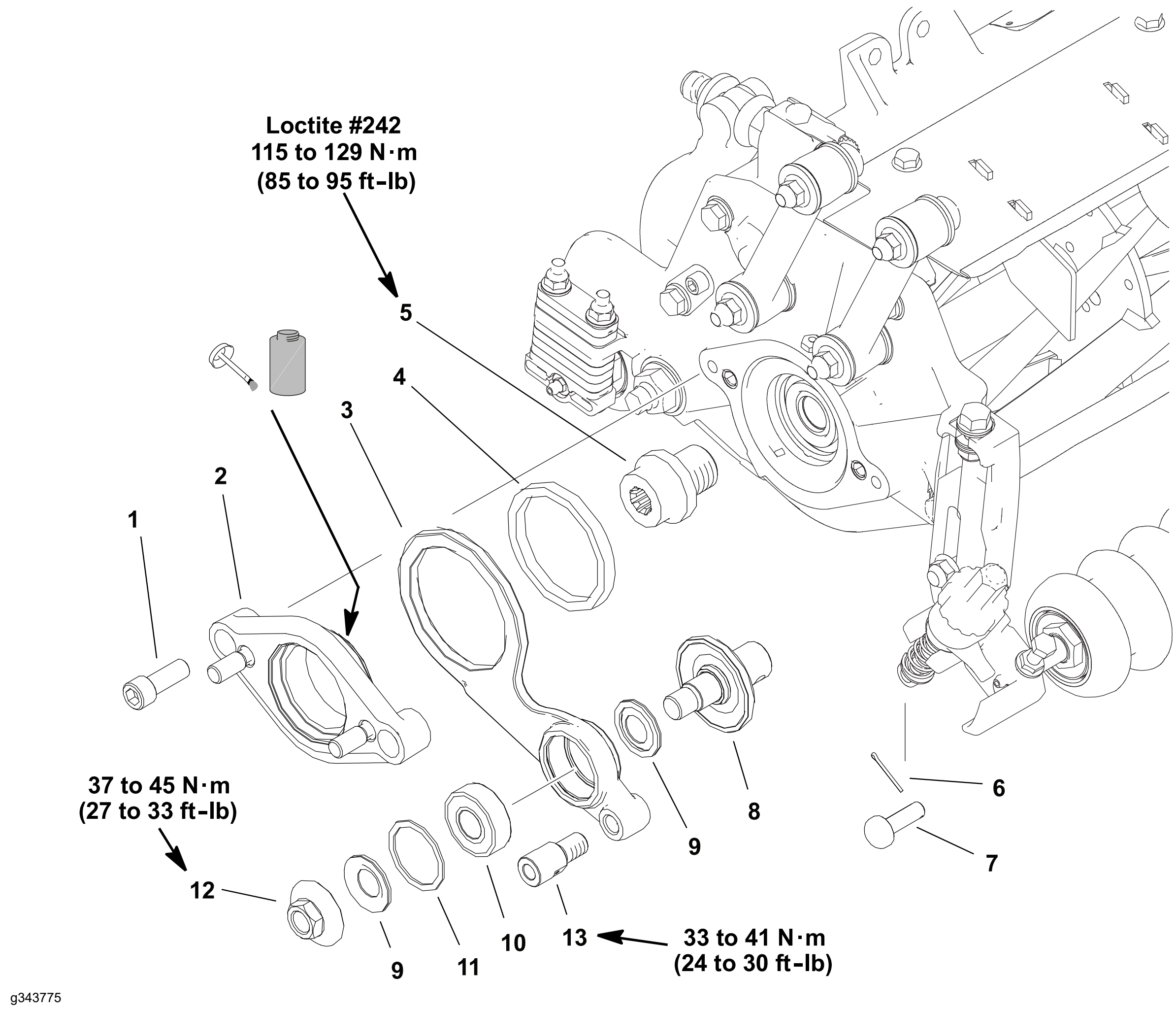


Figure 212

1. Socket head screw (2)
2. Pivot hub
3. Idler arm
4. Bushing
5. Threaded insert
6. Cotter pin
7. Clevis pin
8. Stub shaft and shield
9. Bearing shield (2)
10. Bearing
11. Retaining ring
12. Flange nut
13. Collar

Note: The groomer idler assembly is located on the same side of the cutting unit as the cutting unit hydraulic motor.

Removing the Idler Assembly

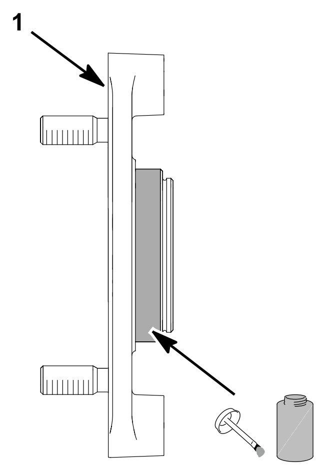
1. Park machine on a clean and level surface, lower cutting units completely to the ground, stop engine, engage parking brake and remove key from the key switch.
2. Remove hydraulic reel motor from cutting unit (refer to Removing the Hydraulic Reel Motor (page 8–6)).
3. Remove the groomer reel assembly (refer to Removing the Groomer Reel (page 9–15)).
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 socket head cap screws securing the pivot hub to the cutting unit and remove the pivot hub and idler assembly from the cutting unit.

Removing the Idler Assembly (continued)

6. Inspect shields, bearing and bushing in idler assembly. Remove and discard damaged or worn components.

Installing the Idler Assembly

1. If shields, bearing or bushing was removed from idler arm, install new components.
   A. Press bushing into groomer plate until the bushing is centered in the idler arm bore.
   B. Press bearing into idler arm so that bearing contact shoulder in idler arm bore and install bearing retaining ring.
   C. Install bearing shields with flocked side of shield toward bearing.
   D. Verify idler arm orientation (LH or RH cutting unit) and insert stub shaft through shields and bearing. Using through hole in shaft to prevent shaft from rotating, tighten flange nut from **37 to 45 N·m (27 to 33 ft-lb)**.
   E. If collar was removed from idler arm, install collar and tighten from **33 to 41 N·m (24 to 30 ft-lb)**.



g343765

Figure 213

1. Pivot hub

2. Apply anti-sieze lubricant to the outside diameter of the pivot hub (Figure 213). Position idler arm over pivot hub.
3. Apply Loctite to two (2) socket head screws and secure pivot hub and idler arm to cutting unit side plate.
4. Use a new cotter pin and install the cotter pin and clevis pin securing the height adjustment rod to the front of the idler arm.
5. Install the groomer reel assembly (refer to Installing the Groomer Reel (page 9–16)).
6. Install the hydraulic reel motor to cutting unit (refer to Installing the Hydraulic Reel Motor (page 8–6)).

Groomer Reel

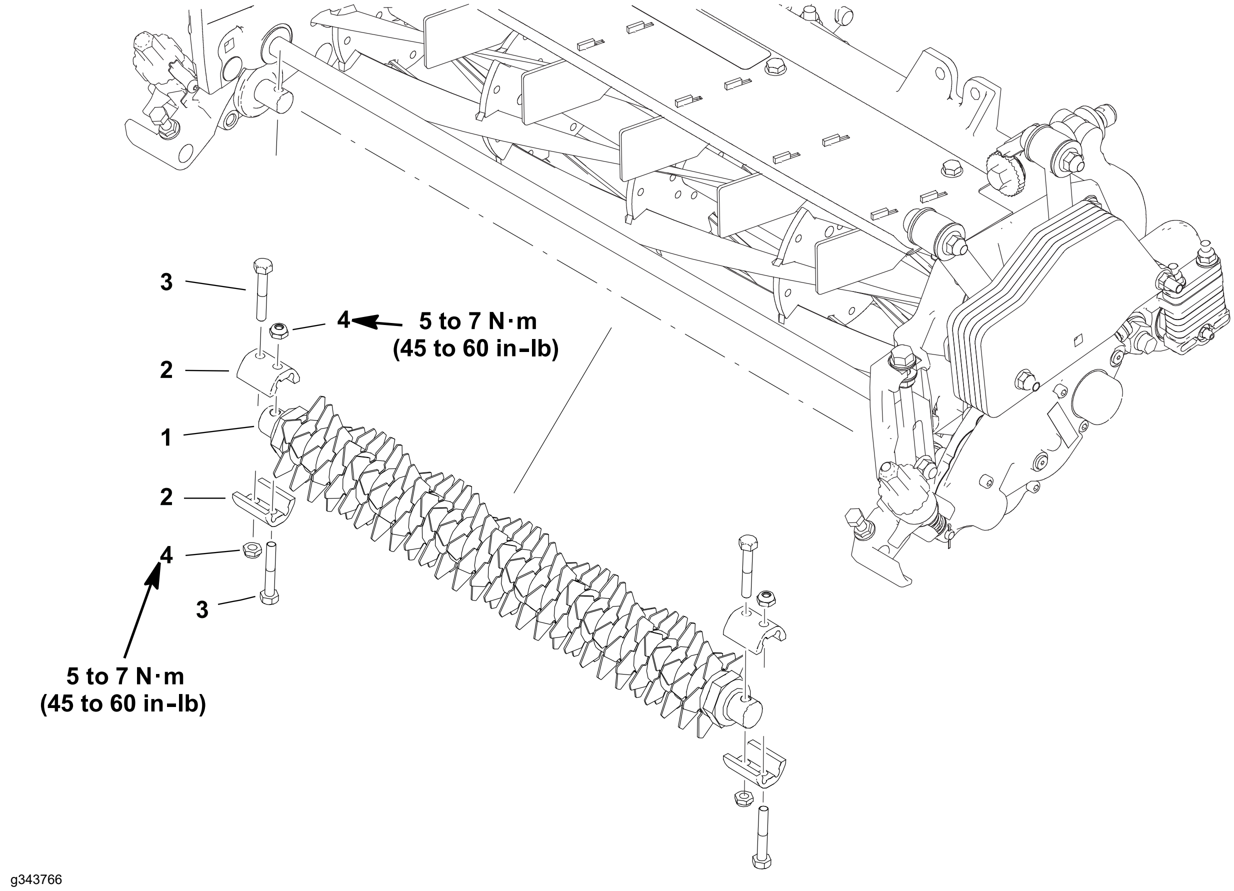


Figure 214

1. Groomer reel
2. Shaft clamp (4)
3. Cap screw (4)
4. Jam nut (4)

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 machine on a clean and level surface, lower cutting units completely to the ground, stop engine, engage parking brake and remove key from the key switch. If desired, remove cutting unit from machine (refer to *Traction Unit Operator's Manual*).

CAUTION

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

2. Carefully remove the four (item 4 in Figure 214) jam nuts, cap screws and shaft clamps securing the groomer reel to the output and stub shafts.
3. Lift the groomer reel from the cutting unit.
4. Inspect seal, shields, bushing and bearings for wear or damage. Replace components as needed (refer to Gear Box Assembly (page 9–5) and Idler Assembly (page 9–13)).

Installing the Groomer Reel

1. Position cutting unit on a level surface. If cutting unit is attached to traction unit, make sure to stop engine, engage parking brake and remove key from the key switch.
2. Position the groomer reel between the groomer output and stub shafts.
3. Secure the groomer reel to the cutting unit with four (4) jam nuts, cap screws and shaft clamps. Tighten the cap screws to **5 to 7 N·m (46 to 60 in-lb)**.
4. Check groomer reel height and mower height-of-cut settings. Adjust as needed.

Groomer Reel Service

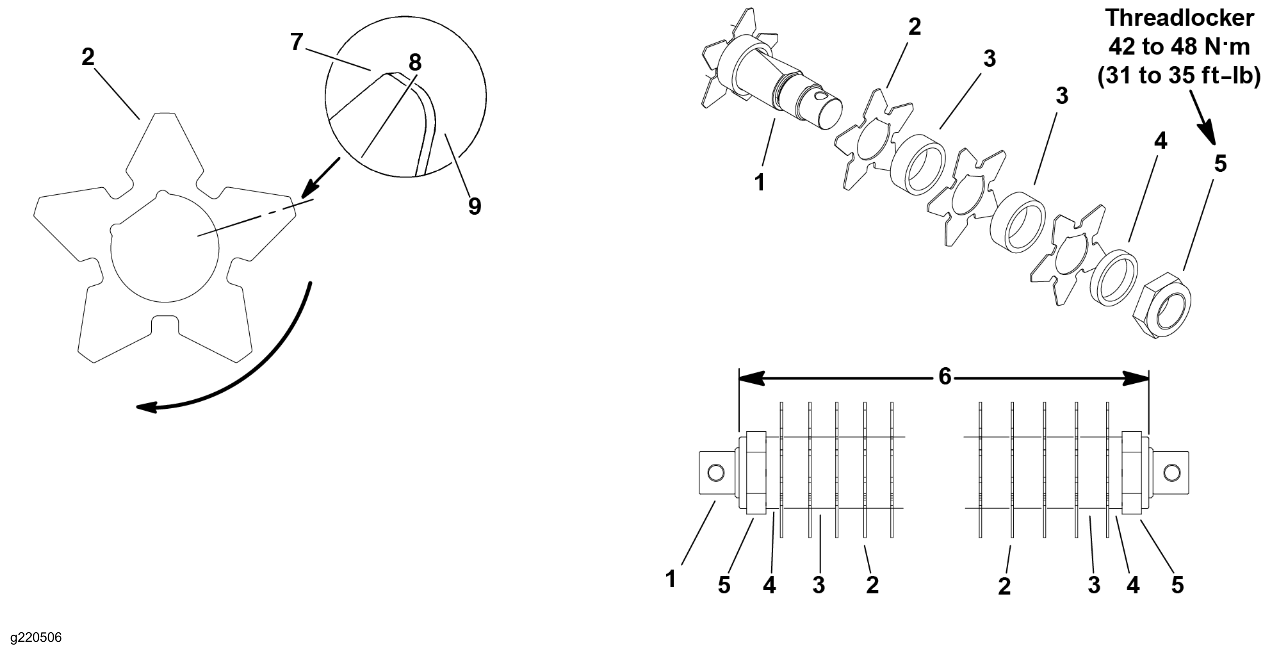


Figure 215

1. Groomer reel shaft
2. Groomer blade (40 each)
3. 31.7 mm (1–1/4 inch) spacer (39 each)
4. 6.3 mm (1/4 inch) spacer (2 each)
5. Locknut (2 each)
6. Centered on shaft
7. Sharp edge
8. Midpoint
9. Dull (rounded) edge

Inspect groomer reel blades frequently for damage and wear. Straighten bent blades. Either replace worn blades or reverse the individual blades to put the sharpest blade edge forward (Figure 215). Blades that are rounded to the midpoint of the blade tip must be reversed or replaced for best groomer performance.

Disassembling the Groomer Reel

1. Park machine on a clean and level surface, lower cutting units completely to the ground, stop engine, engage parking brake and remove key from the key switch.
2. Remove groomer reel from cutting unit (refer to Removing the Groomer Reel (page 9–15)).
3. If groomer reel is equipped with broomer kit, remove straps and broomer brushes from reel (Figure 216).
4. Remove lock nut from either end of the shaft (Figure 215).
5. Remove spacers and blades from groomer shaft. If needed, remove second lock nut from shaft.

Assembling the Groomer Reel

1. Install lock nut on drive end of groomer shaft. Place a 6.3 mm (1/4 in) spacer on the groomer shaft followed by the first groomer blade.
2. Alternately install 31.7 mm (1-1/4 in) spacers and blades making sure that all blades are separated by a spacer.
3. When all blades have been installed, place remaining 6.3 mm (1/4 in) on shaft. Thread second lock nut onto the shaft. Center blades on shaft by adjusting lock nuts.

Assembling the Groomer Reel (continued)

4. Using through holes in shaft to prevent shaft from rotating, tighten second lock nut from **42 to 48 N·m (31 to 35 in-lb)**. After tightening lock nut, spacers should not be free to rotate and groomer blades should be centered on shaft.
5. If groomer reel is equipped with broomer kit:
   A. Loosen the groomer blade retaining nuts on each end of the groomer shaft.

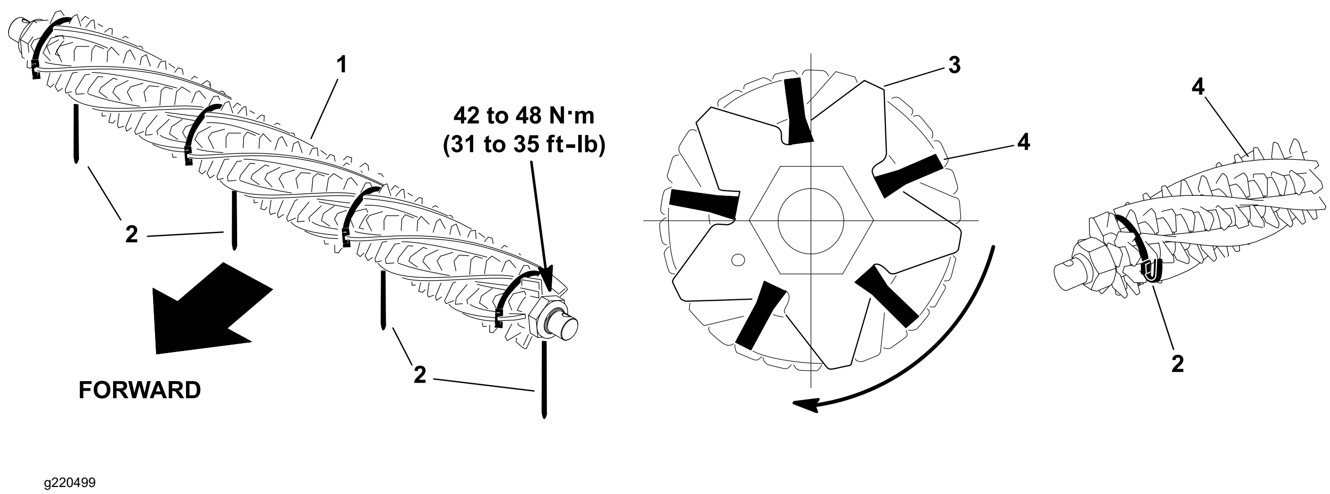


Figure 216

1. Groomer reel
2. Broomer strap (4 each)
3. Blade
4. Brush

   B. Slide a brush into each groove around the full length of the groomer reel (Figure 216). Make sure that the brushes are seated in groomer blade slots (Figure 216).

IMPORTANT

The straps must be wrapped around the groomer blade and brush assembly in the correct direction.

   C. Loosely wrap the straps around the groomer reel shaft and brushes as shown (Figure 216). Straps should be positioned in the pre-cut notches of each brush and at the following locations on the broomer shaft:

   18” reels - between blades 2-3, 11-12, 21-22 and 30-31.

   22” reels - between blades 2-3, 14-15, 26-27 and 38-39.

   Position the broomer brushes properly in the blade slots, and tighten the groomer blade-retaining nuts from **42 to 48 N·m (31 to 35 ft-lb)**.

   D. While holding strap buckle in place, pull straps tight into the pre-cut notches of each brush.

   E. Cut off strap extension approximately 6mm (1/4 in) beyond retainer and fold the excess strap over the buckle (Figure 216).

6. Install O-ring on non-drive end of groomer shaft.
7. Install groomer reel back on cutting unit (refer to Installing the Groomer Reel (page 9–16)).

Grooming Brush (Optional) Service

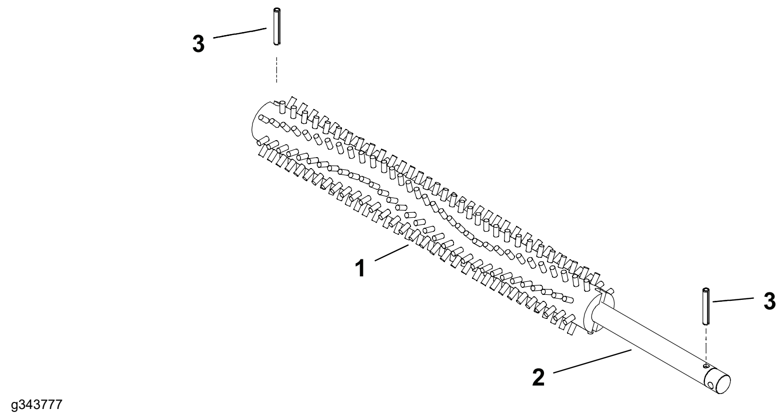


Figure 217

The optional grooming brush is removed and installed from the groomer in the same manner as the groomer reel (refer to Groomer Reel (page 9–15)).

The grooming brush element or shaft can be serviced separately (Figure 217).

Height Adjuster Assembly

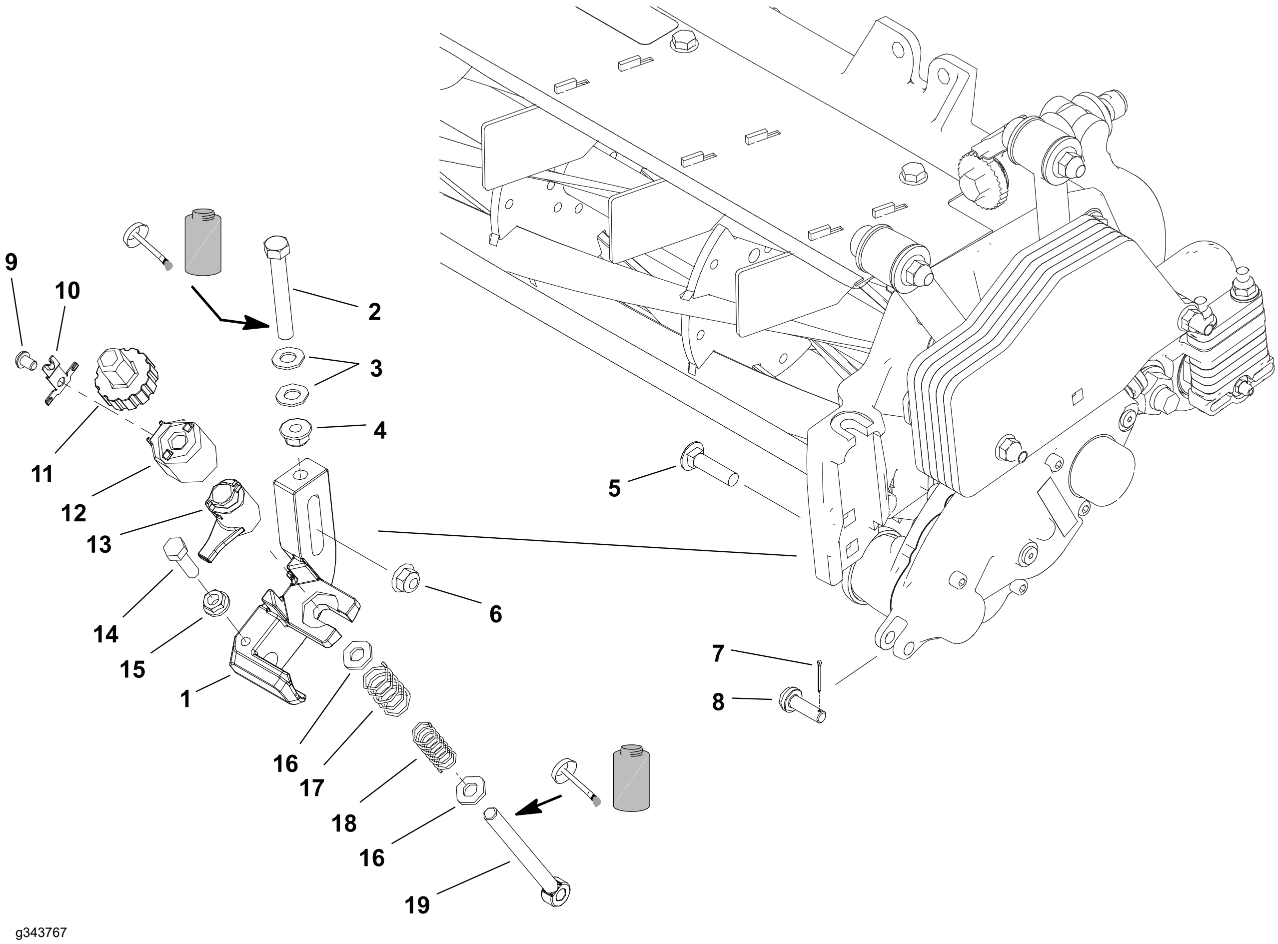


Figure 218

1. Height of cut bracket
2. Height adjustment bolt
3. Washer (2)
4. Lock nut
5. Carriage bolt
6. Flange nut
7. Cotter pin
8. Clevis pin
9. Button head screw
10. Detent spring
11. Groomer height adjuster knob
12. Quick up cover
13. Quick up lever
14. Pinch bolt (front roller)
15. Lock nut
16. Washer (2)
17. Outer spring
18. Inner spring
19. Height adjustment rod

Disassembly of Height Adjuster Assembly

1. Park machine on a clean and level surface, lower cutting units completely to the ground, stop engine, engage parking brake and remove key from the key switch.
2. Remove the cotter pins and clevis pins securing the height adjustment rods to the groomer gear box and idler arm. Discard cotter pins.
3. Loosen the two (item 2 in Figure 218) height adjustment bolt lock nuts.
4. Loosen the two (2) front roller pinch bolt lock nuts and cap screws.
5. Remove the flange nut and carriage bolt securing the height adjuster assembly to the cutting unit side plate and remove the front roller and height adjuster from the cutting unit.
6. Disassemble height adjuster assembly; refer to Figure 218.
7. Clean all components and inspect for wear or damage. Replace all worn or damaged components.

Assembly of Height Adjuster Assembly

1. Apply anti-seize lubricant to upper threads of adjustment rod and lower threads of height adjusters. Assemble height adjuster assembly as shown.
2. If both height adjusters were removed, fit one height adjuster assembly to the cutting unit side plate and secure with carriage bolt and flange nut. Do Not tighten the flange nut at this time. Ensure the height adjustment bolt and one (1) washer is above slot in side plate and one (1) washer and lock nut is below slot in side plate.
3. Position front roller between height adjuster assemblies and secure height adjuster assembly to cutting unit side plate with carriage bolt and flange nut. Do Not tighten the flange nut at this time. Ensure the height adjustment bolt and one (1) washer is above slot in side plate and one (1) washer and lock nut is below slot in side plate.
4. Use new cotter pins and install the cotter pins and clevis pins securing the height adjustment rods to the groomer gear box and idler arm.
5. Adjust the cutting unit height of cut: refer to *Cutting Unit Operators Manual*.
6. Check groomer reel height and adjust as needed.

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

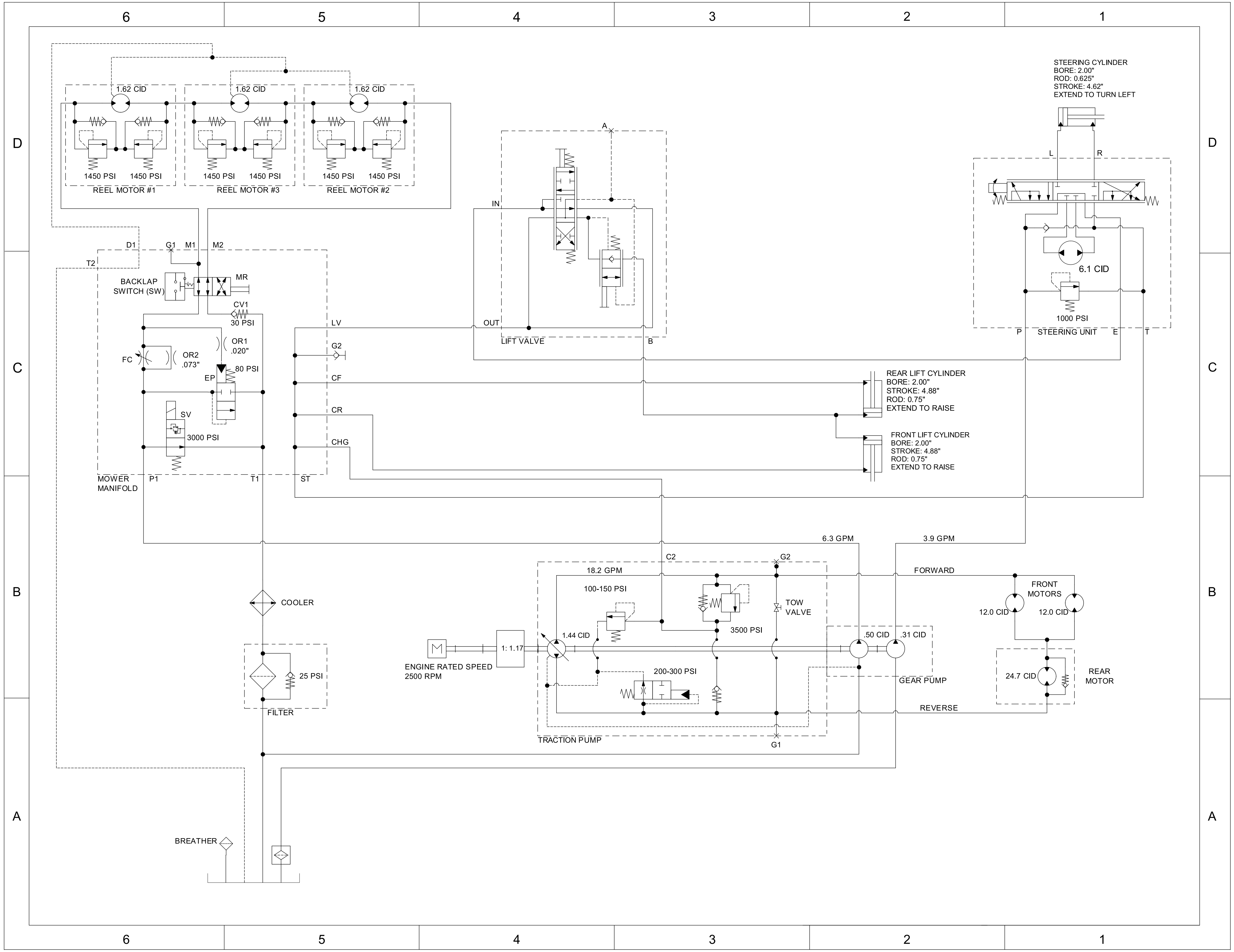
The individual wires of the electrical harness diagrams in this chapter identify both the wire color and the wire size.

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-3100-D (Model 03170)



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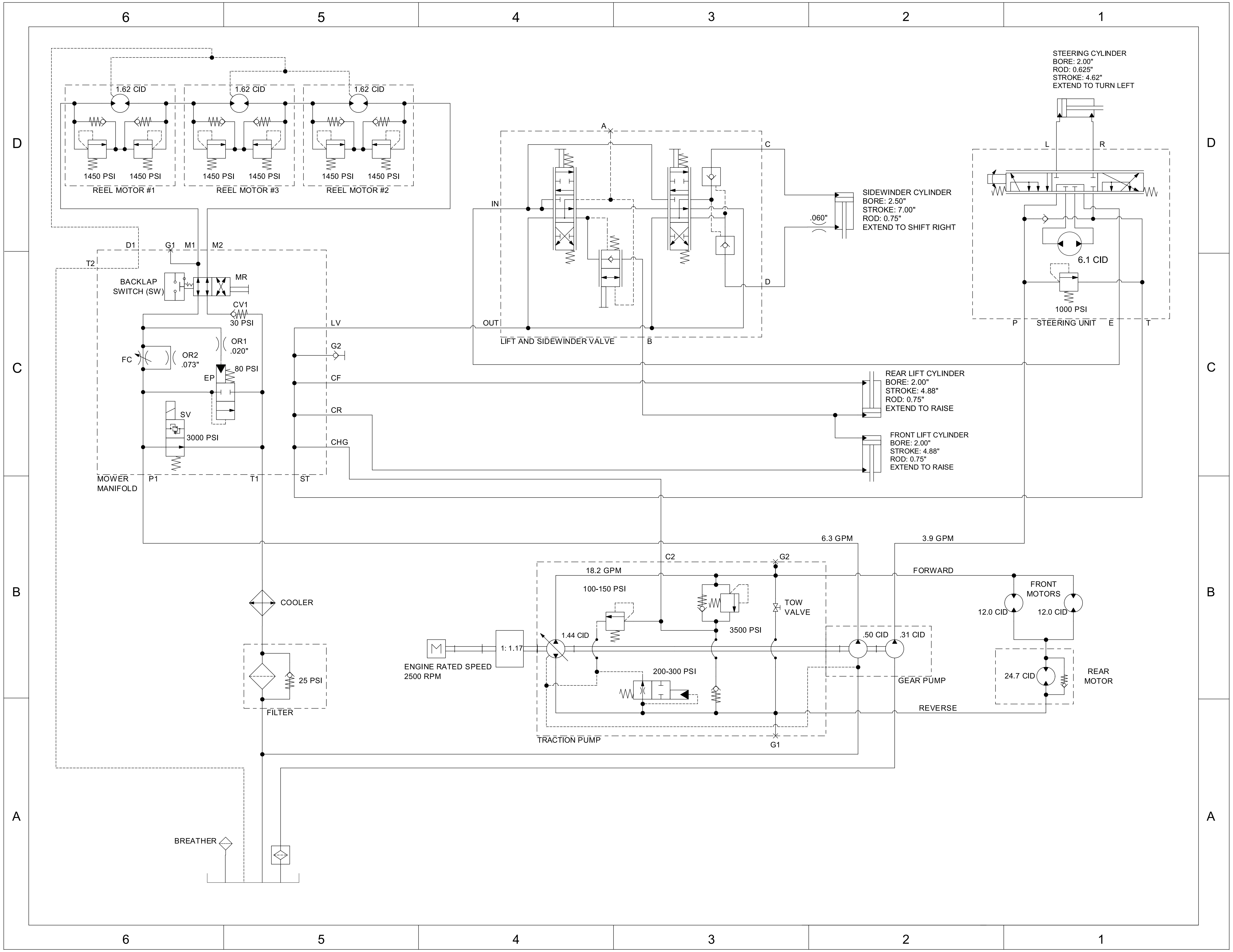

STEERING CYLINDER
BORE: 2.00"
ROD: 0.625"
STROKE: 4.62"
EXTEND TO TURN LEFT
1.62 CID
1450 PSI
REEL MOTOR #1
REEL MOTOR #3
REEL MOTOR #2
SIDEWINDER CYLINDER
BORE: 2.50"
STROKE: 7.00"
ROD: 0.75"
EXTEND TO SHIFT RIGHT
.060"
6.1 CID
1000 PSI
STEERING UNIT
LIFT AND SIDEWINDER VALVE
BACKLAP SWITCH (SW)
MR
CV1
30 PSI
OR1
.020"
OR2
.073"
FC
EP
80 PSI
SV
3000 PSI
MOWER MANIFOLD
REAR LIFT CYLINDER
BORE: 2.00"
STROKE: 4.88"
ROD: 0.75"
EXTEND TO RAISE
FRONT LIFT CYLINDER
BORE: 2.00"
STROKE: 4.88"
ROD: 0.75"
EXTEND TO RAISE
6.3 GPM
3.9 GPM
18.2 GPM
100-150 PSI
3500 PSI
TOW VALVE
FORWARD
FRONT MOTORS
12.0 CID
COOLER
ENGINE RATED SPEED
2500 RPM
1: 1.17
1.44 CID
.50 CID
.31 CID
GEAR PUMP
200-300 PSI
24.7 CID
REAR MOTOR
25 PSI
FILTER
REVERSE
TRACTION PUMP
BREATHER

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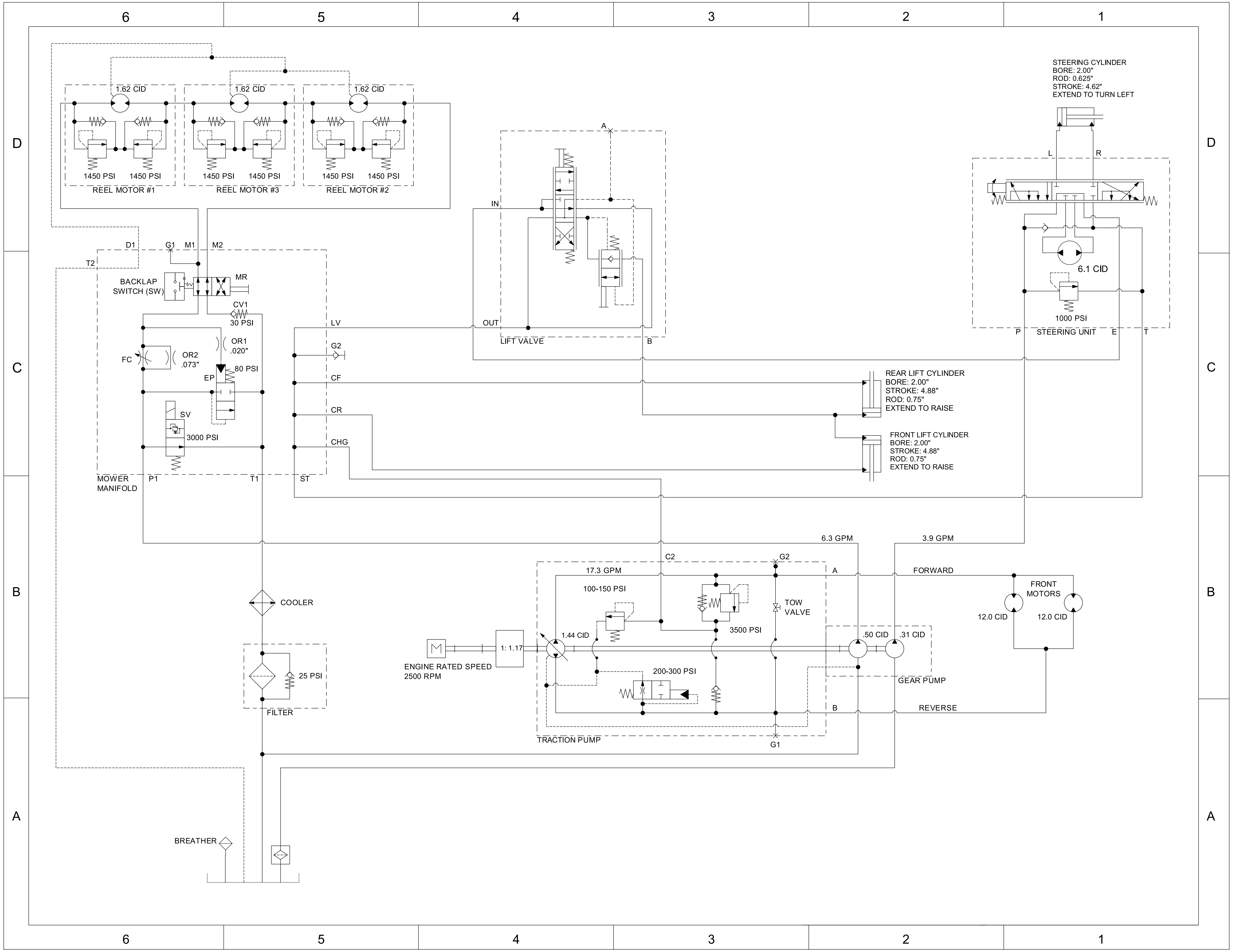
Hydraulic Schematic-3105-D (Model 03174)



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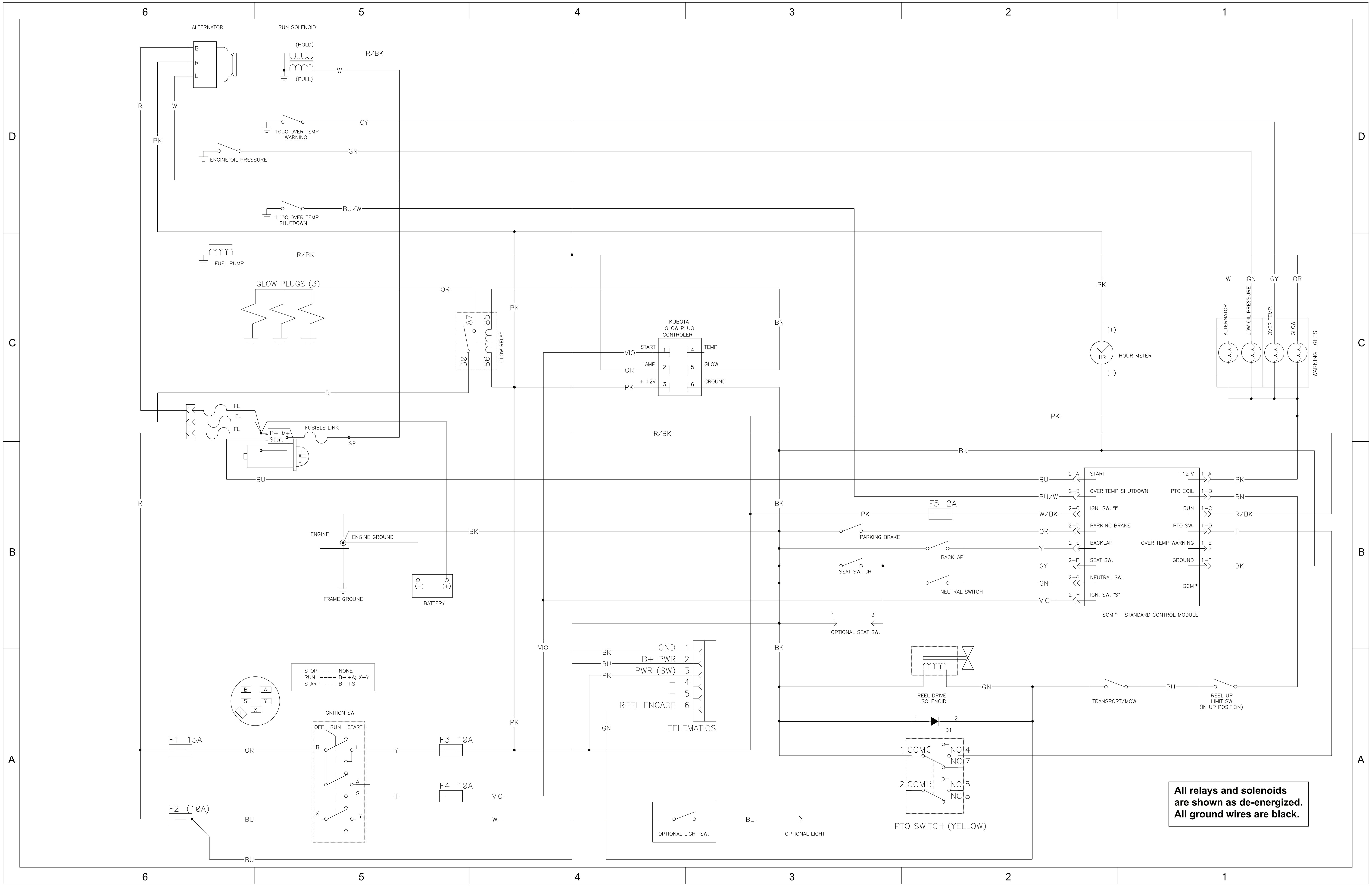
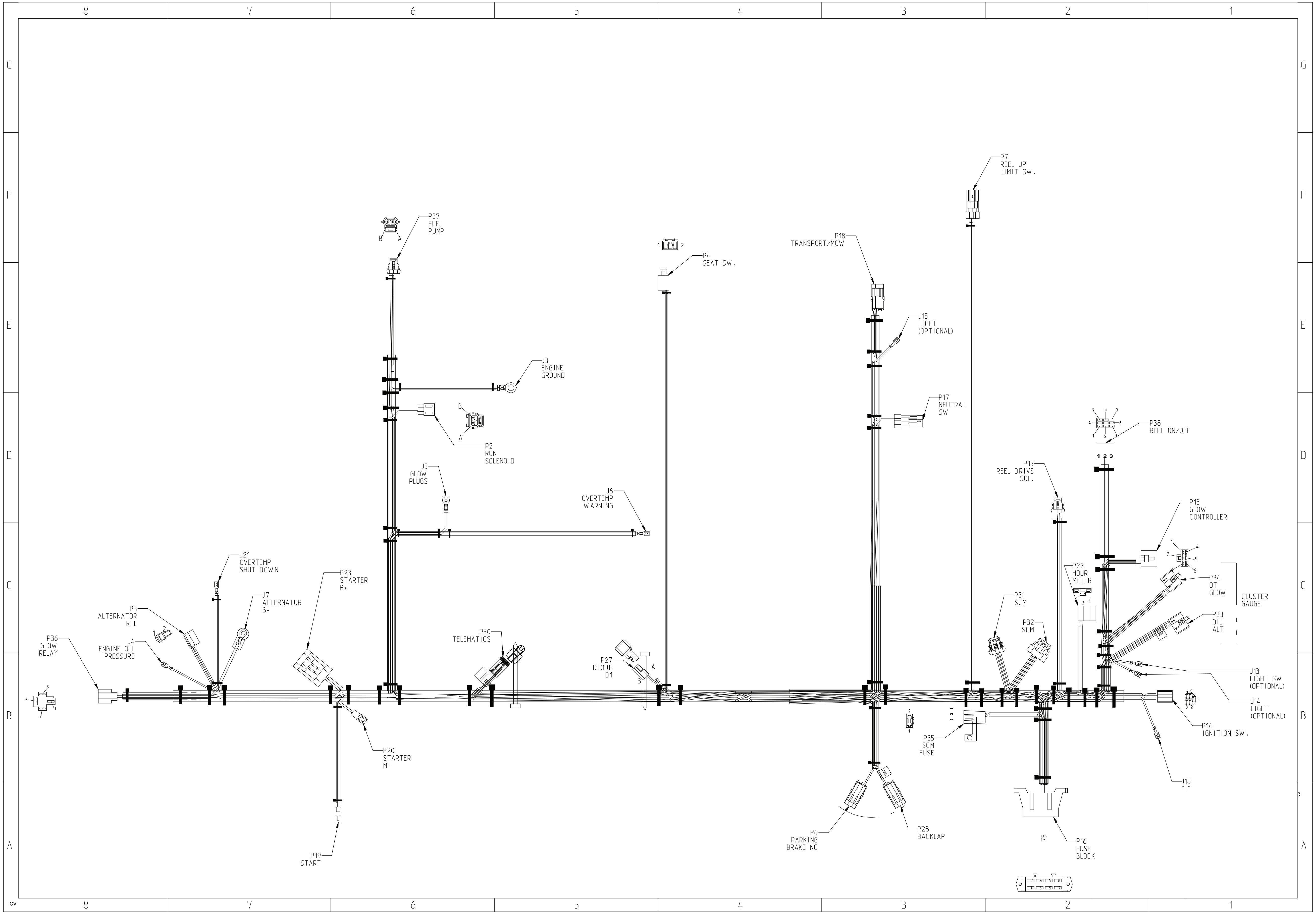


All relays and solenoids are shown as de-energized.
All ground wires are black.

Wire Harness Drawing



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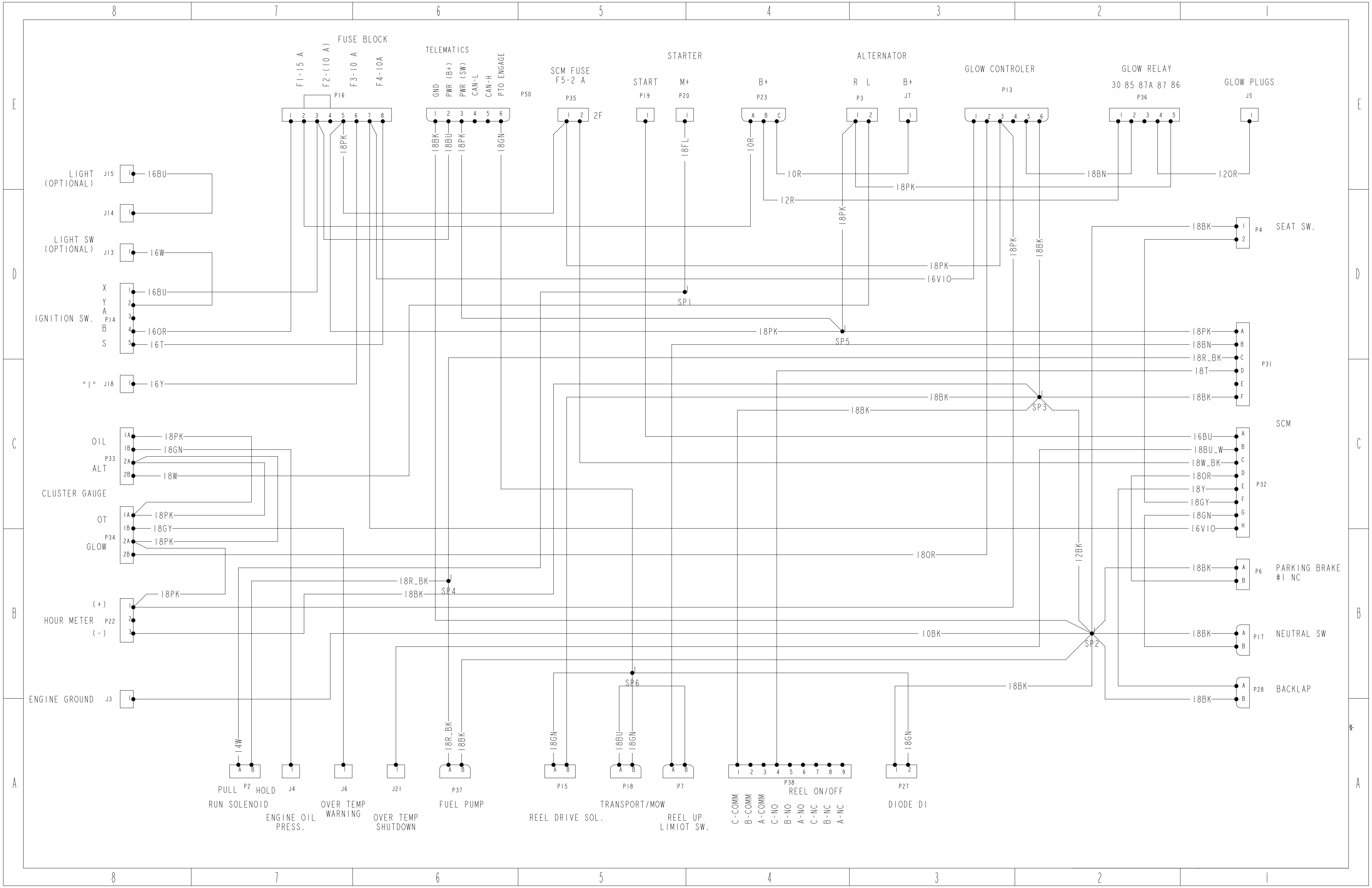
FUSE BLOCK
F1-15 A
F2-(10 A)
F3-10 A
F4-10A
P16
TELEMATICS
GND
PWR (B+)
PWR (SW)
CAN-L
CAN-H
PTO ENGAGE
P50
SCM FUSE
F5-2 A
P35
STARTER
START
M+
P19
P20
B+
P23
ALTERNATOR
R L
B+
P3
J7
GLOW CONTROLER
P13
GLOW RELAY
30 85 87A 87 86
P36
GLOW PLUGS
J5
LIGHT (OPTIONAL)
J15
J14
LIGHT SW (OPTIONAL)
J13
IGNITION SW.
P14
X
Y
A
B
S
"I" J18
OIL
ALT
P33
CLUSTER GAUGE
OT
GLOW
P34
(+)
HOUR METER
P22
(-)
ENGINE GROUND
J3
SEAT SW.
P4
P31
SCM
P32
PARKING BRAKE #1 NC
P6
NEUTRAL SW
P17
BACKLAP
P28
SP1
SP2
SP3
SP4
SP5
SP6
PULL
HOLD
P2
RUN SOLENOID
J4
ENGINE OIL PRESS.
J6
OVER TEMP WARNING
J21
OVER TEMP SHUTDOWN
P37
FUEL PUMP
P15
REEL DRIVE SOL.
P18
TRANSPORT/MOW
P7
REEL UP LIMIOT SW.
P38
REEL ON/OFF
C-COMM
B-COMM
A-COMM
C-NO
B-NO
A-NO
C-NC
B-NC
A-NC
P27
DIODE D1
g346833

Count on it.