Count on it.

Form No. 19245SL Rev E

Service Manual

Groundsmaster® 4500-D/4700-D

(Models 30885, 30887, 30893, 30893TE, 30899 and 30899TE)

8111 Lyndale Avenue South
Bloomington, MN 55420

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

Revision History

Revision	Date	Description
A	04/2020	Initial issue.
B	01/2021	Service brake switches, 5V bus capacitor, swashplate angle sensor, pressure transducer, updated electrical schematics and main wire harness.
C	06/2021	Updated foldout drawings.
D	07/2021	Updated Hydraulic chapter.
E	10/2021	Updated Electrical chapter.

Reader Comments

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

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NOTES

Preface

The purpose of this publication is to provide the service technician with information for troubleshooting, testing and repair of major systems and components on the Groundsmaster 4500–D (Models 30885, 30893 and 30893TE) and Groundsmaster 47000–D (Models 30887, 30899 and 30899TE).

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

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

DANGER

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

WARNING

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

CAUTION

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

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.

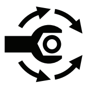
Service Procedure Icons

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 Standard Torque for Dry, Zinc Plated, and Steel Fasteners (Inch Series) (page 2–11) or Standard Torque for Dry, Zinc Plated, and Steel Fasteners (Metric Fasteners) (page 2–12).

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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Yanmar TNV (Tier 4i) Series Service Manual
Yanmar TNV (Tier 4i) Series Troubleshooting Manual
Yanmar TNV (Tier 4) Series Service Manual
Yanmar TNV (Tier 4) Series Troubleshooting Manual
Danfoss K And L Frame Variable Motors Service Manual
Danfoss Steering Unit Type OSPM Service Manual
Danfoss MP1 Closed Circuit Axial Piston Pumps Service Manual

Safety

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Safety Instructions

The Groundsmaster 4500-D and 4700-D are tested and certified by Toro for compliance with existing safety standards and specifications. Although hazard control and accident prevention partially are dependent upon the design and configuration of the machine, these factors are also dependent upon the awareness, concern and proper training of the personnel involved in the operation, transport, maintenance and storage of the machine. Improper use or maintenance of the machine can result in injury or death.

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.

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 and engine quickly. Additional copies of the *Operator's Manuals* are available at www.toro.com.
- Never allow children to operate the machine. Never allow adults to operate the machine without proper instructions.
- Become familiar with the controls and know how to stop the machine and tractor engine quickly.
- Keep all the shields, safety devices, and decals in place. If a shield, safety device, or decal is illegible or damaged, repair or replace it before operating the machine.
- Always wear substantial shoes. Do not operate machine while wearing sandals, tennis shoes or sneakers. Do not wear loose fitting clothing which could get caught in moving parts and cause personal injury.
- Wearing safety glasses, safety shoes, long pants and a helmet is advisable and required by some local safety and insurance regulations.
- Make sure work area is clear of objects which might be picked up and thrown by the attachments.
- Keep everyone, especially children and pets, away from the areas of operation.
- Ensure that the interlock switches are adjusted correctly so the engine cannot be started unless traction pedal is in NEUTRAL and cutting decks are DISENGAGED.
- Since the fuel is highly flammable; handle it carefully.
  - Use an approved fuel container.
  - Do not remove cap from fuel tank when engine is hot or running.
  - Do not smoke while handling fuel.
  - Fill fuel tank outdoors and no higher than to the bottom of filter screen. Do not overfill fuel tank.
  - Wipe up any spilled fuel.

While Operating the Machine

1. Sit on the seat when starting and operating the machine.
2. Before starting the engine:
   A. Apply the parking brake.
   B. Make sure traction pedal is in neutral and the PTO switch is OFF (disengaged).
3. After engine is started, release parking brake and keep foot off traction pedal. Machine must not move. If movement is evident, there may be a problem with traction pedal calibration or the piston (traction) pump that needs to be corrected before using the machine.
4. Do not touch engine, radiator or exhaust system while engine is running or soon after it is stopped. These areas could be hot enough to cause burns.
5. Do not touch the engine, muffler or exhaust pipe while engine is running or soon after it has stopped because these areas are hot enough to cause burns.
6. Before getting off the seat:
   A. Ensure that traction pedal is in neutral.
   B. Fully lower and disengage cutting decks. Wait for blades to stop.
   C. Apply the parking brake.
   D. Stop engine and remove key from switch.
7. Toro recommends that anytime the machine is parked (short or long term), the cutting decks should be lowered to the ground. This relieves hydraulic pressure from the deck lift circuit and eliminates the risk of the cutting decks unexpectedly lowering to the ground.
8. Do not park on slopes unless wheels are chocked or blocked.

Maintenance and Service

1. The Traction Unit and Cutting Deck *Operator's Manual* provide information regarding the operation, general maintenance and maintenance intervals for your Groundsmaster machine. Refer to these publications for additional information when servicing the machine.
2. Before servicing or making adjustments, lower decks, stop engine, apply parking brake and remove key from the ignition switch.
3. Make sure machine is in safe operating condition by keeping all nuts, bolts and screws tight.
4. Never store the machine or fuel container inside where there is an open flame, such as near a water heater or furnace.
5. Make sure all hydraulic connectors are tight and all hydraulic hoses and lines are in good condition before applying pressure to the hydraulic system.
6. Keep body and hands away from pin hole leaks in hydraulic lines that eject high pressure hydraulic fluid. Use cardboard or paper to find hydraulic leaks. Hydraulic fluid escaping under pressure can penetrate skin and cause injury. Fluid accidentally injected into the skin must be surgically removed within a few hours by a doctor familiar with this form of injury or gangrene may result.
7. Before disconnecting or performing any work on the hydraulic system, all pressure in system must be relieved by lowering cutting decks to the ground and stopping engine.
8. If major repairs are ever needed or assistance is desired, contact an Authorized Toro Distributor.
9. To reduce potential fire hazard, keep engine area free of excessive grease, grass, leaves and dirt. Clean protective screen on machine frequently.
10. If engine must be running to perform maintenance or an adjustment, keep hands, feet, clothing and other parts of the body away from cutting decks and other moving parts. Keep bystanders away.
11. To assure safety and accuracy, check maximum engine speed.
12. Shut engine off before checking or adding oil to the crankcase.
13. Disconnect battery before servicing the machine. Disconnect negative cable first and positive cable last. If battery voltage is required for troubleshooting or test procedures, temporarily connect the battery. Reconnect positive 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. At the time of manufacture, the machine conformed to the safety standards for riding mowers. To assure optimum performance and continued safety certification of the machine, use genuine Toro replacement parts and accessories. Replacement parts and accessories made by other manufacturers may result in non-conformance with the safety standards and the warranty may be voided.
17. When changing attachments, tires or performing other service, use correct supports, hoists and jacks. Make sure machine is parked on a solid level surface such as a concrete floor. Prior to raising 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)).

Maintenance and Service (continued)

18. When welding on machine, disconnect all battery cables to prevent damage to machine electronic equipment. Disconnect negative battery cable first and positive cable last. Also, disconnect wire harness connector from both of the TEC controllers, disconnect and remove the engine ECM and disconnect the terminal connector from the alternator. Attach welder ground cable no more than two (2) feet (0.6 meters) from the welding location.
19. 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 jacks and supports. Make sure machine is parked on a solid, level surface such as a concrete floor. Prior to raising machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use jack stands to support the raised machine. If the machine is not properly supported by jack stands, the machine may move or fall, which may result in personal injury.

Jacking the Front End

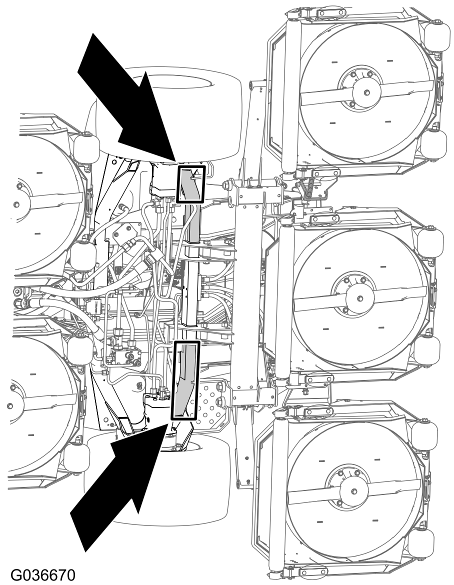

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Figure 1

1. Apply parking brake and chock both rear tires to prevent the machine from moving.

   Note: Do not place jack, jack stands or blocks under the wheel motors. Wheel motors can be damaged if used for jacking or support points.

2. Position jack securely under the frame, just to the inside of the front tire.
3. Jack front wheel off the ground.
4. Position appropriate jack stands under the frame as close to the wheel as possible to support the machine.

Jacking the Rear End

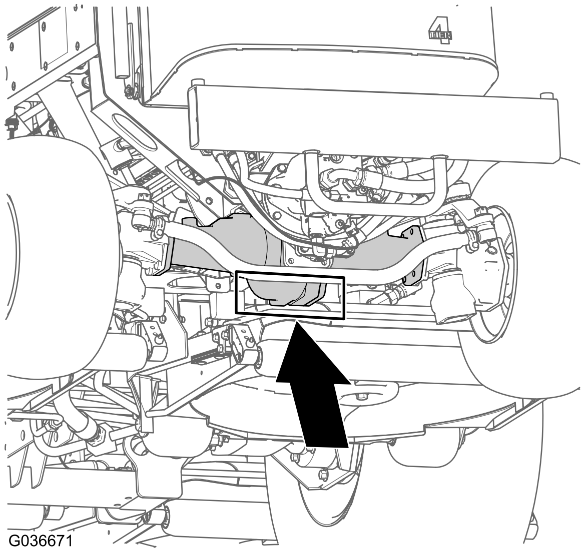

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Figure 2

1. Apply parking brake and chock both front tires to prevent the machine from moving.
2. Place jack securely under the center of rear axle.
3. Jack rear of machine off the ground.
4. Position appropriate jack stands under the rear axle to support the machine.

Safety and Instructional Decals

Numerous safety and instruction decals are affixed to the traction unit and cutting units of your Groundsmaster. 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

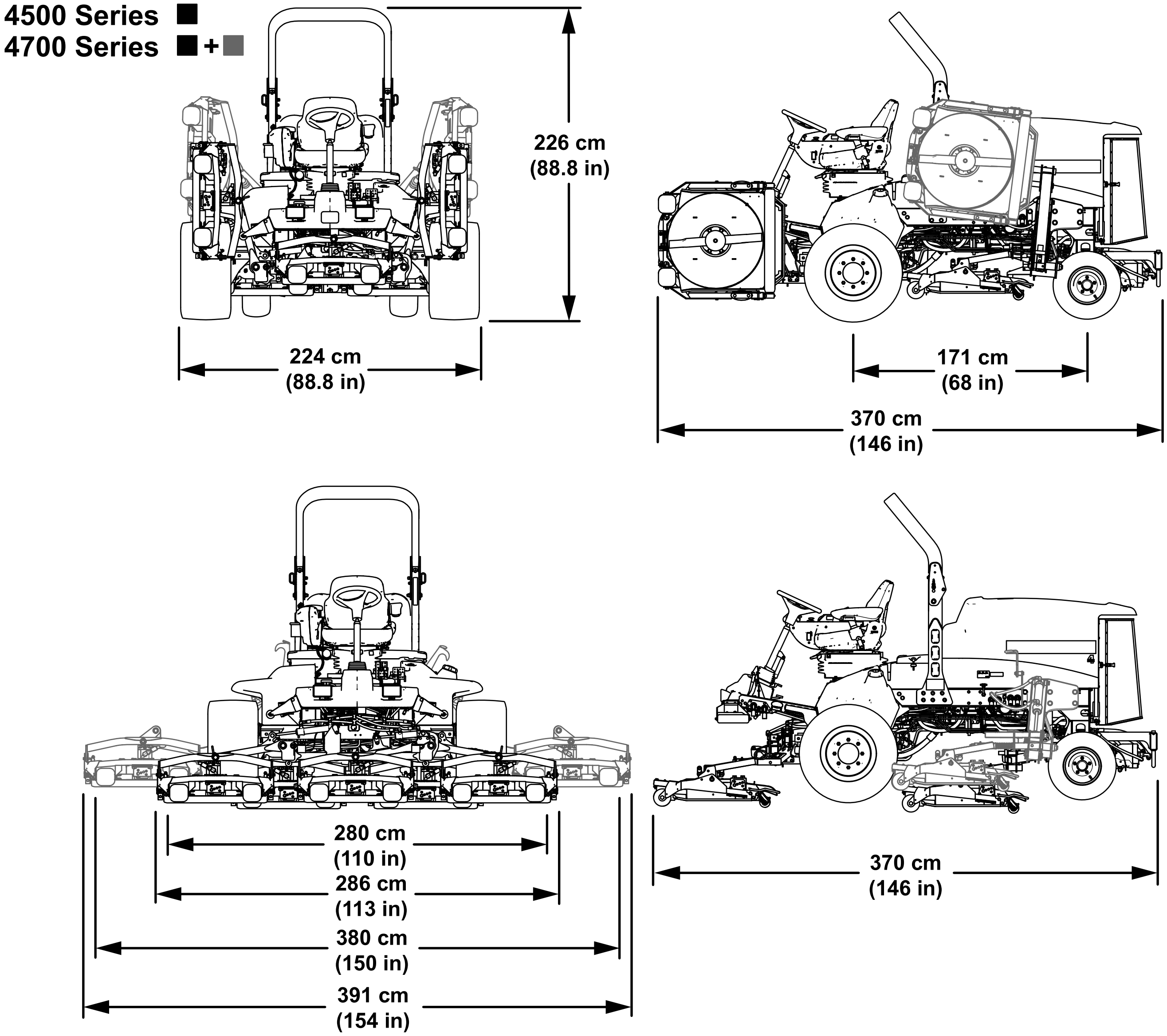

Figure 3

Engine (Models 30893, 30893TE, 30899 and 30899TE)

Item	Description
Make / Designation	Yanmar Model 4TNV84T−ZMTR: 4−Cycle, 4 Cylinder, Water Cooled, Turbocharged, Tier 4i Diesel Engine
Bore	84 mm (3.307 in)
Stroke	90 mm (3.543 in)
Total Displacement	1995 cc (121.7 in^3)
Firing Order	1 (closest to flywheel end) − 3 − 4 (farthest from flywheel) − 2
Direction of Rotation	Counterclockwise (viewed from flywheel)
Fuel	Diesel or Biodiesel (up to B20) Fuel with Low or Ultra Low Sulfur Content
Fuel Tank Capacity	83 liters (22 U.S. gallons)
Fuel Injection Pump	Yanmar MP2 Distributor Type Pump
Fuel Injection Type	Direct Injection
Governor	Centrifugal All Speed
Low Idle (no load)	1200 RPM
High Idle (no load)	2600 RPM
Engine Oil	API CH−4, CI−4 or higher
Engine Oil Viscosity	See *Operator's Manual*
Crankcase Oil Capacity	5.7 liters (6 U.S. quarts) with Filter
Oil Pump	Trochoid Type
Coolant Capacity	8.5 liters (9 U.S. quarts)
Alternator/Regulator	12 VDC, 80 amp
Engine Weight (Dry)	191 kg (420 U.S. pounds)

Engine (Models 30885 and 30887)

Item	Description
Make / Designation	Yanmar Model 4TNV86CT−DTR: 4−Cycle, 4 Cylinder, Water Cooled, Turbocharged, Tier 4 Diesel Engine
Bore	86 mm (3.386 in)
Stroke	90 mm (3.543 in)
Total Displacement	2090 cc (127.5 in^3)
Firing Order	1 (closest to flywheel end) − 3 − 4 (farthest from flywheel) − 2
Direction of Rotation	Counterclockwise (viewed from flywheel)
Fuel	Diesel or Biodiesel (up to B7) Fuel with Ultra Low Sulfur Content
Fuel Tank Capacity	83 liters (22 U.S. gallons)
Fuel Injection Pump	Yanmar Supply Pump
Fuel Injection Type	Common Rail with Direct Injection
Governor	Electronic All Speed
Low Idle (no load)	1000 RPM
High Idle (no load)	2700 RPM
Engine Oil	API CJ−4 or higher
Engine Oil Viscosity	See *Operator’s Manual*
Crankcase Oil Capacity	5.7 liters (6 U.S. quarts) with Filter
Oil Pump	Trochoid Type
Coolant Capacity	8.5 liters (9 U.S. quarts)
Alternator/Regulator	12 VDC, 80 Amp
Engine Weight (Dry)	225 kg (496 U.S. pounds)

Hydraulic System

Item	Description
Piston (Traction) Pump	Sauer−Danfoss Variable Displacement Axial Piston Pump
Maximum Displacement (per revolution)	45 cc (2.75 in^3)
System Relief Pressure: Forward	350 bar (5075 PSI)
System Relief Pressure: Reverse	360 bar (5225 PSI)
Charge Pressure	17 bar (250 PSI)
Front Wheel Motors	Danfoss Variable Displacement Axial Piston Motors
Displacement (per revolution)	26.47 cc (1.62 in^3) Maximum / 14.6 cc (0.89 in^3) Minimum
Rear Axle Motor	Danfoss Variable Displacement Axial Piston Motor with Loop Flushing Valve
Displacement (per revolution)	33.54 cc (2.05 in^3) Maximum / 18.5 cc (1.13 in^3) Minimum
Gear Pump	Casappa 4 Section, Positive Displacement Gear pump
Section P1/P2 Displacement (per revolution)	16.85 cc (1.03 in^3)
Section P3/P4 Displacement (per revolution)	9.16 cc (0.56 in^3)
Steering Control Valve	Sauer-Danfoss Steering Unit, Series OSPM
Displacement (per revolution)	100 cc (6.1 in^3)
Steering Circuit Relief Pressure	72 bar (1050 PSI)
Lift/Lower Circuit Relief Pressure	110 bar (1600 PSI)
Cutting Deck Motors	Gear Motor
Displacement (per revolution)	19 cc (1.16 in^3)
Cutting Deck Circuit Relief Pressure	241 bar (3500 PSI)
Engine Cooling Fan Motor	Casappa Gear Motor
Displacement (per revolution)	8.3 cc (0.5 in^3)
Engine Cooling Fan Circuit Relief Pressure	207 bar (3000 PSI)
Hydraulic Filters	Spin−on Cartridge Type
In−line Suction Strainer	100 Mesh (In Reservoir)
Hydraulic Reservoir Capacity	28.4 Liters (7.5 U.S. Gallons)
Hydraulic Oil	See *Operator's Manual*

Note: The pressure specifications listed above are component settings. When using pressure gauges to measure circuit pressures, values may be different than these specifications. See Testing (page 5–43) of hydraulic test procedures and expected test results.

Axles, Planetaries and Brakes

Item	Description
Tire pressure (front and rear)	138 kPa (20 PSI)
Rear wheel toe−in	3 mm (0.125 in)
Wheel lug nut torque (front and rear)	116 to 135 N·m (85 to 100 ft−lb), front and rear in a crossing pattern
Steering cylinder castle nut torque	136 to 169 N·m (100 to 125 ft−lb)
Planetary, Brake Assembly and Wheel Motor Mounting Screw Torque	
VA02 series planetary	101 to 115 N·m (75 to 85 ft−lb)
Planetary Drive Lubricant	SAE 85W−140 wt. Gear Lube
Capacity (each wheel)	0.65 L (22 fl. oz.)
Rear axle lubricant	SAE 85W−140 wt. gear lube
Rear axle gear lube capacity	2.4 L (80 fl. oz.)
Rear axle gear box lubricant	SAE 85W−140 wt. gear lube
Rear axle gear box gear lube capacity	0.5 L (16 fl. oz.)

Cutting Decks

MOUNTING:	All cutting decks are supported by independent lift arms and are interchangeable to any cutting deck positions. The Groundsmaster 4500-D uses five (5) cutting decks. The Groundsmaster 4700-D uses seven (7) cutting decks.
CONSTRUCTION:	Deck chamber and frame are welded steel construction reinforced with channels and plates.
HEIGHT−OF−CUT RANGE:	19 to 101 mm (3/4 to 4 in) in 6.4 mm (1/4 in) increments. Height-of-cut adjustment is made by repositioning deck on deck frame.
DECK DRIVE:	Closed loop, integrated relief, hydraulic system operates cutting deck hydraulic motors. Blade spindles are 31.7 mm (1-1/4 in) shafts supported by greaseable, tapered roller bearings in a ductile iron housing.
CUTTING BLADE:	Each cutting deck equipped with a 686 mm (27 in) length, 6.4 mm (0.250 in) thick, heat treated, steel blade. Anti-scalp cup installed on cutting blade. The standard blade is optimized for most cutting applications. Optional high lift, angled sail and Atomic blades are available for those situations where the standard blade is not ideal.
DISCHARGE:	Clippings are discharged from the rear of the mowing decks. Pre-drilled mounting holes allow attachment of optional mulching baffle.
CUTTING DECK LIFT:	Cutting decks on the Groundsmaster 4500-D are controlled with one (1) lift switch. The Groundsmaster 4700-D uses three (3) lift switches: one for the right wing deck, one for the left wing deck and the third (center) switch for the remaining five decks.
SUSPENSION SYSTEM:	A fully floating suspension with hydraulic counterbalance. Main center pivot allows side-to-side deck oscillation. Individual decks supported with two (2) front rollers and one, full width, rear roller.
WEIGHT:	Individual cutting deck weighs approximately 89 kg (195 lb).

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

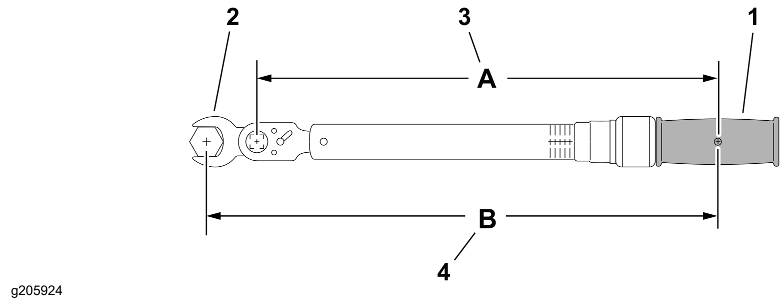

Figure 4

Torque Conversion Factor = A / B

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

Using a drive-adapter wrench (e.g., 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 4) to determine proper tightening torque. When using a torque wrench with a drive-adapter wrench, the calculated torque will be lower than the listed torque recommendation.

Example: The measured effective length of the torque wrench (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

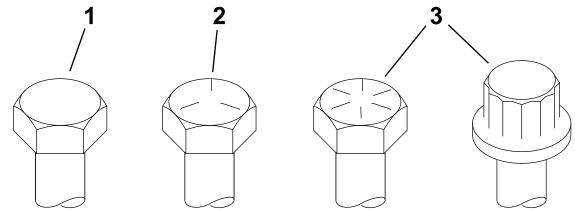

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Figure 5

Inch Series Bolts and Screws

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

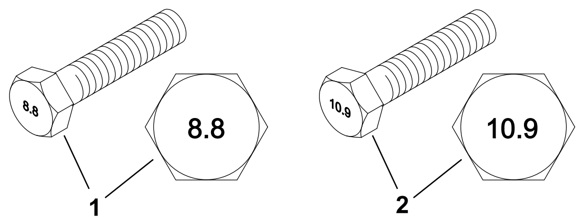

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Figure 6

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

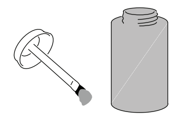
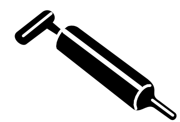
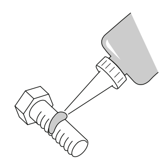
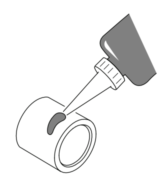
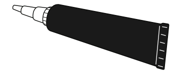
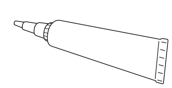
N·m X 0.7376 = ft-lb

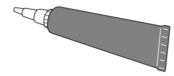
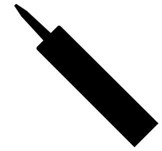
Shop Supplies

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

Special Tools

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

Hydraulic Pressure Testing Kit

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.

---

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 K Line Part No. TOR6007 and Hydraulic Test Fitting Kit K Line Part No. TOR4079.

Traction Circuit Hydraulic Diagnostic Fittings

Toro Part No. 59-7410

To measure traction charge pressure, reverse traction circuit reducing valve pressure or rear traction circuit relief valve pressure, a diagnostic fitting is required. To measure reverse traction relief pressure, two (2) fittings and a diagnostic test fitting are needed. The fittings can be temporarily installed into the appropriate component port to allow pressures to be measured. Refer to the Testing section of this chapter for necessary test procedures when using these diagnostic fittings.

Toro Part Number (traction charge, reverse traction circuit reducing valve or rear traction circuit relief valve):

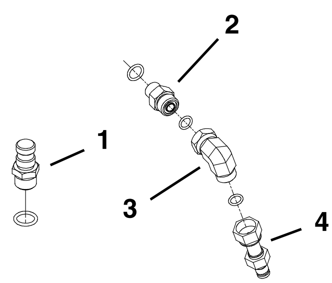
Diagnostic Fitting 59-7410

Toro Part Numbers (reverse traction relief pressure):

Straight Fitting: 340-2

90º Fitting: 340-159

Diagnostic Fitting: 86-5480



1. Diagnostic fitting
2. Straight fitting
3. 90º fitting
4. Diagnostic fitting

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

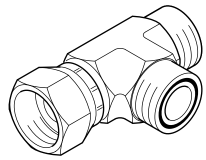
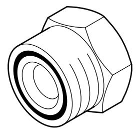
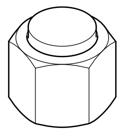
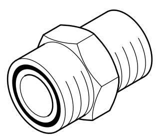
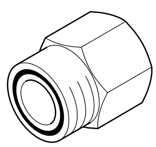
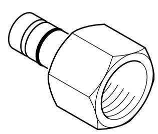
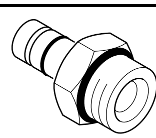
K Line Part No. TOR6007

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	K LINE 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 LPM or 40 GPM) and high pressure (34,500 kPa or 5,000 psi) capabilities. This kit provides for bidirectional 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 2–18).

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

Measuring Container

K Line Part Number: TOR4077

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

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

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

Remote Starter Switch

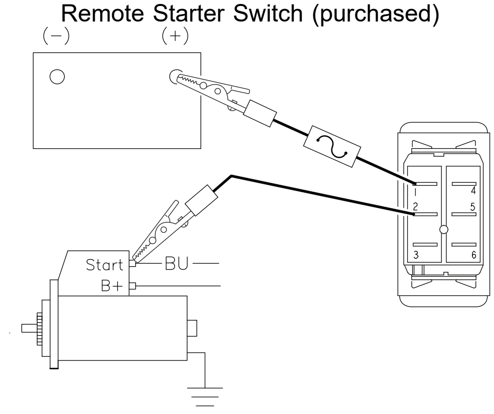
After flushing the hydraulic system or replacing a hydraulic component (e.g. gear pump, piston pump, drive motor), it is necessary to prime the hydraulic pumps. A remote starter switch can be used for this purpose. A remote starter switch can be purchased locally or fabricated as follows.

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 (purchased)



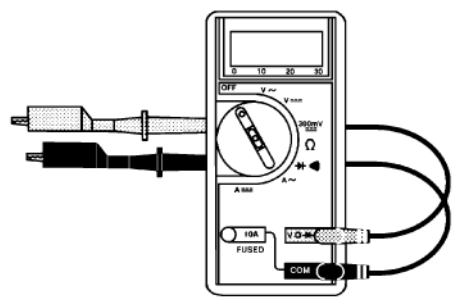
Remote Starter Switch (fabricated)

Multimeter

Obtain this tool locally

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

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



Battery Terminal Protector

Toro Part No. 107-0392

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

Dielectric Gel

Toro Part No. 107-0342

Use the dielectric gel to prevent corrosion of unsealed connection terminals. To ensure complete coating of the terminals, liberally apply the gel to the component and wire harness connector, plug the connector into the component, 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.

Battery Hydrometer

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

Troubleshooting

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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 section of this Chapter. This information will be useful during the hydraulic troubleshooting process.

Refer to the Testing (page 5–43) for precautions and specific hydraulic test procedures.

Problem	Possible Cause
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. **Note:** An indication that the hydraulic system is operating at excessive temperatures would be frequent reversing of the cooling fan and a normal engine coolant temperature.	Engine RPM is too low. Brakes are applied or sticking. Hydraulic reservoir oil level is low. Hydraulic oil is contaminated or the wrong type. Piston pump by-pass valve is open or damaged. Cooling system is not operating properly. Engine cooling fan circuit is malfunctioning. Charge pressure is low. Traction circuit pressure is incorrect. Pump(s) or motor(s) are damaged.
Hydraulic oil in reservoir foams.	Hydraulic reservoir oil level is low. Wrong type of oil is in the hydraulic system. Air is leaking into a pump suction line.

Traction Problems

Note: When troubleshooting traction circuit problems, if a problem exists in both low (mow) and high speeds, consider a faulty component that affects the entire traction circuit (e.g. charge circuit, traction circuit relief valves, piston pump). If the problem exists in LOW speed (mow) but not in HIGH speed, consider a problem that only exists in mow (e.g. swashplate components in front wheel or rear axle motor, solenoid valve in two speed shift manifold).

Problem	Possible Cause
Machine operates in one direction only.	Piston (traction) pump by−pass valve is open or damaged. Traction relief valve is leaking or faulty. Piston (traction) pump servo control valve orifices or screens are plugged or damaged. Problem with TEC output to piston (traction) pump servo control exists (see Chapter 6: Electrical System (page 6–1)).
Traction pedal response is sluggish.	Traction pedal components are stuck or binding. Traction charge pressure is low. Piston (traction) pump servo control valve orifices are plugged or damaged.
Machine travels too far before stopping when the traction pedal is released.	Traction pedal components are stuck or binding. Traction charge pressure is low. Piston (traction) pump servo control valve orifices are plugged or damaged.
Traction power is lost or machine will not operate in either direction.	Hydraulic reservoir oil level is low (Other hydraulic systems are affected as well). Piston (traction) pump by-pass valve is open or damaged. Traction charge pressure is low. Traction circuit pressure is low. Traction pedal position sensor is not plugged in or is faulty (see Chapter 6: Electrical System (page 6–1)). Problem with TEC output to piston (traction) pump servo control exists (see Chapter 6: Electrical System (page 6–1)).

Problem	Possible Cause
LOW traction speed (mow) will not engage. **Note:** LOW (mow) will not engage when the cutting decks are raised.	Electrical problem exists that prevents solenoid valve in two speed shift manifold from being de-energized (see Chapter 6: Electrical System (page 6–1)). Deck lift switch(s) or their circuit wiring is faulty. Use the InfoCenter Diagnostics > Traction > Inputs screen to verify traction input operation. Solenoid valve in two speed shift manifold is faulty.
HIGH traction speed (transport) will not engage. **Note:** HIGH (transport) will not engage when the cutting decks are lowered.	Electrical problem exists that prevents solenoid valve in two speed shift manifold from being energized (see Chapter 6: Electrical System (page 6–1)). Service brake switch(s) or deck lift switch(s) or their circuit wiring is faulty. Use the InfoCenter Diagnostics > Traction > Inputs screen to verify traction input operation. Solenoid valve in two speed shift manifold is faulty.

Mow Problems

Problem	Possible Cause
None of the cutting decks will operate. **Note:** To engage the mow circuit, the seat must be occupied, the cutting deck(s) must be fully lowered the traction speed must be in the LOW (mow) position and the PTO switch must be on.	Cutting decks are not fully lowered to ground. PTO switch is not in engaged position. Operator seat is unoccupied. Engine temperature is excessive causing cutting decks to be disengaged (Fault should be displayed on InfoCenter). Electrical problem exists that prevents deck control manifold solenoid valve operation (see Chapter 6: Electrical System (page 6–1)). Gear pump sections that supply mow circuits are damaged.
One cutting deck will not operate.	Circuit pressure to the affected deck motor is low. Cutting deck problem exists (see Chapter 9: Cutting Decks (page 9–1)). Spline on affected deck motor (or spindle) is damaged. Deck motor relief valve is stuck or damaged. Deck motor is damaged. NOTE: If appropriate, transfer a suspected damaged motor to another cutting deck. If problem follows the motor, motor needs repair or replacement. On Groundsmaster 4700-D, deck is not fully lowered to ground (decks #6 and #7). On Groundsmaster 4700-D, cartridge valve SV1 or SV2 in deck control manifold is damaged or sticking (decks #6 and #7).
Several cutting decks will not operate.	Electrical problem exists that prevents deck control manifold solenoid valve operation (see Chapter 6: Electrical System (page 6–1)). Decks are not fully lowered to ground. Deck control manifold solenoid cartridge valve (PRV1 or PRV2) for affected decks is faulty. Logic cartridge valve (LC1 or LC2) in deck control manifold is stuck or damaged. Gear pump section (first or second section) is worn or damaged.

Problem	Possible Cause
All cutting decks operate slowly.	Engine RPM is low. All deck motors are worn or damaged. First and second gear pump sections are worn or damaged.
Cutting deck stops under load.	Relief valve in deck control manifold is bypassing. Traction speed and cutting conditions (e.g. very tall or wet grass) exceed deck capacity. Deck motor relief valve is stuck or damaged. Deck motor has internal leakage (bypassing oil). Cutting deck gear pump section (first or second section) is worn or damaged.

Steering Problems

Problem	Possible Cause
Steering inoperative or sluggish.	Steering components (e.g. tie rods, steering cylinder ends) are worn or binding. Steering cylinder is binding. Oil level in hydraulic reservoir is low (Note: Other hydraulic systems are affected as well). Steering relief valve in steering control valve is stuck or damaged. Flow divider (FD) in fan control manifold is faulty. Steering cylinder leaks internally. Steering control valve is worn or damaged. Gear pump section is worn or damaged (Note: A worn or damaged third gear pump section will also affect the traction charge and lift circuits).

Lift Problems

Problem	Possible Cause
Cutting decks will not raise. **Note:** Seat must be occupied in order to raise the cutting decks.	Engine RPM is too low. Hydraulic oil level in reservoir is low (NOTE: Other hydraulic systems are affected as well). Electrical problem exists (see Chapter 6: Electrical System (page 6–1)). Lift arm pivots are binding. Lift/lower circuit relief valve in lift control manifold is stuck open. Solenoid valve in lift control manifold is damaged or sticking. Lift cylinder(s) is (are) damaged. Flow divider (FD) in fan control manifold is faulty. The third gear pump section is worn or damaged (NOTE: A worn or damaged third gear pump section will also affect the traction charge and steering circuits).
Cutting decks raise, but will not stay up. **Note:** Lift cylinders cannot provide an absolutely perfect seal. A cutting deck will eventually lower if left in the raised position during storage.	Lift circuit hydraulic lines or fittings are leaking. Cartridge valve in lift control manifold is stuck open. Lift cylinder for affected deck is damaged.
Cutting decks will not lower.	Lift arm pivots are binding. Engine RPM is too low. Electrical problem exists (see Chapter 6: Electrical System (page 6–1)). Proportional relief cartridge valve (TS) in lift control manifold is damaged or sticking. Lift cylinder for affected deck is damaged.

Engine Cooling Fan Problems

Problem	Possible Cause
Cooling fan runs only in forward direction (fan does not run in reverse direction).	Fan control manifold solenoid cartridge valve (S1) is faulty. Electrical problem exists that prevents fan control manifold solenoid valve (S1) operation (see Chapter 6: Electrical System (page 6–1)).
Cooling fan does not rotate.	Cooling fan motor is worn or damaged. Last gear pump section is worn or damaged.
Cooling fan always rotates at slow speed.	Fan control manifold cartridge valve seals are leaking. Check valve in combination manifold is not seating. Fan control manifold proportional relief valve (PRV) is stuck open. Hydraulic fan motor is worn or damaged.
Cooling fan always rotates at fast speed.	Fan control manifold proportional relief valve (PRV) is faulty. Electrical problems exists that prevents correct operation of combination manifold proportional relief valve (PRV) (see Chapter 6: Electrical System (page 6–1)).

Operator Advisories

CAUTION

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

For effective troubleshooting and repairs, you must have a good understanding of the electrical circuits and components used on this machine (see Chapter 6: Electrical System (page 6–1)).

If the machine has any interlock switches by−passed, reconnect the switches for safety and efficient troubleshooting.

Note: Check the InfoCenter Display for possible operator advisories or faults whenever diagnosing machine electrical problems.

The list below identifies the operator advisories that are generated by the TEC controller. An advisory will be displayed on the InfoCenter Display. Typically, an advisory can be eliminated with a change in machine controls by the operator.

Advisory	Advisory Name	Cause	InfoCenter Message | Corrective Action Required
B2004	START DENIED	PTO switch engaged	To start | Disengage PTO
B2005	START DENIED	Out of seat and parking brake disengaged	To start | Must be seated or set parking brake
B2008	START DENIED	Traction pedal engaged	To start | Move traction pedal to neutral
B2009	START DENIED	Engine running	To start | Engine Running
B200D	START DENIED	Teach engaged	Complete teach sequence
B2013	START DENIED	Fault(s) active	To start | Resolve active faults
B2015	START DENIED	Deck switch engaged	To start | Disengage Deck Switch
B2026	ENGINE RPM RESTRICTED	Cold hydraulic fluid	Engine RPM Restricted | Let hydraulic oil warm
B2027	ENGINE SHUTDOWN	Engine too hot	Engine | Let engine cool
B2028	ENGINE DERATE	Engine too hot	Engine | Let engine cool
B2030	COOLING MAXIMIZED	System too hot	Check cooling system
B2031	ENGINE WARM UP	Cold hydraulic fluid	Let hydraulic oil warm
B211D	CRUISE DENIED	Ground speed too slow	To set cruise | Increase ground speed
B211E	CRUISE DENIED	Traction pedal in reverse	Move traction pedal
B211F	CRUISE DENIED	Brake applied	Release brake
B2133	RANGE LO DENIED	Not in neutral	Return traction pedal to neutral
B2155	TRACTION DISABLED	Parking brake engaged	For traction | Release parking brake
B2159	TRACTION DISABLED	Out of seat	For traction | Operator must be seated
B2168	TRACTION TEACH DENIED	Engine running	Traction pedal | Engine running
B216A	TRACTION ADVISORY	Traction pedal sensor needs calibration	Traction pedal | Calibrate
B2403	DECK LOWER DENIED	Not in neutral	Return traction pedal to neutral

Advisory	Advisory Name	Cause	InfoCenter Message | Corrective Action Required
B2409	DECK LOWER DENIED	Out of seat	To lower deck | Operator must be seated
B2507	PTO DENIED	Engine too hot	To engage PTO | Let engine cool
B2509	PTO DENIED	Out of seat	To engage PTO | Operator must be seated
B250A	PTO DENIED	No decks floating	To engage PTO | Lower Decks
B2800	REGEN STATUS	Regen complete	Regen Complete
B2801	REGEN REQUIRED	Inhibit active	Regen Required | Inhibit Active
B2802	REGEN REQUIRED	Low exhaust temp	Set engine to full throttle. Regen Required.
B2804	PARKED REGEN REQUIRED	Engine requested	Parked Regen Required | See Service Menu
B2805	PTO DISABLED	Parked regen required	Parked Regen Required | PTO disabled
B2807	PTO DISABLED	Recovery regen required	Recovery Regen Required | PTO disabled
B280A	REGEN STATUS	Regen failed	Regen Failed

Machine Fault Codes

Machine faults are generated by the machine controllers to identify an electrical system malfunction (fault) that occurs during machine operation. The fault IDs conform to SAE J2012 standards. When a fault occurs, a red warning light will illuminate and a code for the active fault will appear on the InfoCenter display.

Faults can be viewed via the InfoCenter Faults screen. The fault code includes the number of the controller that generated the fault. For example: C1453:T1 is a Solenoid 5 fault generated by the T1 (primary TEC). “Active” or the time the fault last occurred expressed in machine Key On hours will appear next to the fault. Selecting an individual fault displays the current machine Key On hours for reference, the last time (expressed in Key On hours) the specific fault occurred, the first time (expressed in Key On hours) the specific fault occurred, and the number of times the specific fault has occurred.

Recent non-active faults can be cleared from the Faults screen only after the correct PIN has peen entered at the Settings > Protected Menus screen.

Fault ID	Fault Title	Contro-ller(s) Affected	Fault Condition / Circuit Description	Additional Notes	Service Actions
B105C	Left deck Raise/Lower Switch Broken	T2	This fault is reported when the left deck raise and left deck lower inputs are active simultaneously.	No raise or lower action is allowed on the deck. The inputs are ignored.	1. Test the switch. There could be a short in the switch. 2. Check the harness/connector (P76) for a loose wire or corrosion.
B105D	Center deck Raise/Lower Switch Broken	T1	This fault is reported when the center deck raise and center deck lower inputs are active simultaneously.	No raise or lower action is allowed on the deck. The inputs are ignored.	1. Test the switch. There could be a short in the switch. 2. Check the harness/connector (P07) for a loose wire or corrosion.
B105E	Right deck Raise/Lower Switch Broken	T2	This fault is reported when the right deck raise and right deck lower inputs are active simultaneously.	No raise or lower action is allowed on the deck. The inputs are ignored.	1. Test the switch. There could be a short in the switch. 2. Check the harness/connector (P73) for a loose wire or corrosion.
C1013	ETR/RTR/OK to Run - Short to Battery	T1	Low current detected on engine run output indicating a short to a high (+) source. This short could be to battery voltage or to another signal that is in a high state.		1. Test the output circuit for a short. 2. Test for proper resistance in the component connected to the primary TEC (P74, pin 10). 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1014	ETR/RTR/OK to Run - Short to Ground / Overcurrent	T1	Overcurrent detected on engine run output indicating a short to ground.		1. Test the output circuit for a short. 2. Test for proper resistance in the component connected to the primary TEC (P74, pin 10). 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).

Fault ID	Fault Title	Contro-ller(s) Affected	Fault Condition / Circuit Description	Additional Notes	Service Actions
C1015	ETR/RTR/OK to Run - Open Circuit	T1	Open circuit detected on engine run output.		1. Test the output circuit for an open. 2. Test for proper resistance in the component connected to the primary TEC (P74, pin 10). 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1124	Fan Direction - Short to Ground / Overcurrent	T1	Overcurrent detected on fan direction output indicating a short to ground.		1. Test the output circuit for a short. 2. Test for proper resistance in the component connected to the primary TEC (P74, pin 7). 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1125	Fan Direction - Open Circuit	T1	Open circuit detected on fan direction output.		1. Test the output circuit for an open. 2. Test for proper resistance in the component connected to the primary TEC (P74, pin 7). 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1134	Fan Speed - Short to Ground / Overcurrent	T1	Overcurrent detected on fan speed output indicating a short to ground.		1. Test the output circuit for a short. 2. Test for proper resistance in the component connected to the primary TEC (P74, pin 44). 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1135	Fan Speed - Open Circuit	T1	Open circuit detected on fan speed output.		1. Test the output circuit for an open. 2. Test for proper resistance in the component connected to the primary TEC (P74, pin 44). 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1413	Solenoid 1 - Short to Battery	T2	Low current detected on enable S1 output indicating a short to a high (+) source. This short could be to battery voltage or to another signal that is in a high state.		1. Test the output circuit for a short. 2. Test for proper resistance in the component connected to the auxiliary TEC (P75, pin 3). 3. Swap the T2: Auxiliary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1414	Solenoid 1 - Short to Ground / Overcurrent	T2	Overcurrent detected on enable S1 output indicating a short to ground.		1. Test the output circuit for a short. 2. Test for proper resistance in the component connected to the auxiliary TEC (P75, pin 3). 3. Swap the T2: Auxiliary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).

Fault ID	Fault Title	Controller(s) Affected	Fault Condition / Circuit Description	Additional Notes	Service Actions
C1415	Solenoid 1 - Open Circuit	T2	Open circuit detected on enable S1 output.		1. Test the output circuit for an open. 2. Test for proper resistance in the component connected to the auxiliary TEC (P75, pin 3). 3. Swap the T2: Auxiliary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1423	Solenoid 2 - Short to Battery	T2	Low current detected on left deck raise S2 output indicating a short to a high (+) source. This short could be to battery voltage or to another signal that is in a high state.		1. Test the output circuit for a short. 2. Test for proper resistance in the component connected to the auxiliary TEC (P75, pin 8). 3. Swap the T2: Auxiliary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1424	Solenoid 2 - Short to Ground / Overcurrent	T2	Overcurrent detected on left deck raise S2 output indicating a short to ground.		1. Test the output circuit for a short. 2. Test for proper resistance in the component connected to the auxiliary TEC (P75, pin 8). 3. Swap the T2: Auxiliary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1425	Solenoid 2 - Open Circuit	T2	Open circuit detected on left deck raise S2 output.		1. Test the output circuit for an open. 2. Test for proper resistance in the component connected to the auxiliary TEC (P75, pin 8). 3. Swap the T2: Auxiliary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1433	Solenoid 3 - Short to Battery	T2	Low current detected on left deck lower S3 output indicating a short to a high (+) source. This short could be to battery voltage or to another signal that is in a high state.		1. Test the output circuit for a short. 2. Test for proper resistance in the component connected to the auxiliary TEC (P75, pin 10). 3. Swap the T2: Auxiliary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1434	Solenoid 3 - Short to Ground / Overcurrent	T2	Overcurrent detected on left deck lower S3 output indicating a short to ground.		1. Test the output circuit for a short. 2. Test for proper resistance in the component connected to the auxiliary TEC (P75, pin 10). 3. Swap the T2: Auxiliary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1435	Solenoid 3 - Open Circuit	T2	Open circuit detected on left deck lower S3 output.		1. Test the output circuit for an open. 2. Test for proper resistance in the component connected to the auxiliary TEC (P75, pin 10). 3. Swap the T2: Auxiliary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).

Fault ID	Fault Title	Contro-ller(s) Affected	Fault Condition / Circuit Description	Additional Notes	Service Actions
C1443	Solenoid 4 - Short to Battery	T2	Low current detected on left deck float S4 output indicating a short to a high (+) source. This short could be to battery voltage or to another signal that is in a high state.		1. Test the output circuit for a short. 2. Test for proper resistance in the component connected to the auxiliary TEC (P75, pin 7). 3. Swap the T2: Auxiliary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1444	Solenoid 4 - Short to Ground / Overcurrent	T2	Overcurrent detected on left deck float S4 output indicating a short to ground.		1. Test the output circuit for a short. 2. Test for proper resistance in the component connected to the auxiliary TEC (P75, pin 7). 3. Swap the T2: Auxiliary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1445	Solenoid 4 - Open Circuit	T2	Open circuit detected on left deck float S4 output.		1. Test the output circuit for an open. 2. Test for proper resistance in the component connected to the auxiliary TEC (P75, pin 7). 3. Swap the T2: Auxiliary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1453	Solenoid 5 - Short to Battery	T1	Low current detected on center deck up S5 output indicating a short to a high (+) source. This short could be to battery voltage or to another signal that is in a high state.		1. Test the output circuit for a short. 2. Test for proper resistance in the component connected to the primary TEC (P74, pin 4). 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1454	Solenoid 5 - Short to Ground / Overcurrent	T1	Overcurrent detected on center deck up S5 output indicating a short to a high (+) source. This short could be to battery voltage or to another signal that is in a high state.		1. Test the output circuit for a short. 2. Test for proper resistance in the component connected to the primary TEC (P74, pin 4). 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1455	Solenoid 5 - Open Circuit	T1	Open circuit detected on center deck up S5 output.		1. Test the output circuit for an open. 2. Test for proper resistance in the component connected to the primary TEC (P74, pin 4). 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).

Fault ID	Fault Title	Contro-ller(s) Affected	Fault Condition / Circuit Description	Additional Notes	Service Actions
C1463	Solenoid 6 - Short to Battery	T1	Low current detected on center deck float S6 output indicating a short to a high (+) source. This short could be to battery voltage or to another signal that is in a high state.		1. Test the output circuit for a short. 2. Test for proper resistance in the component connected to the primary TEC (P74, pin 3). 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1464	Solenoid 6 - Short to Ground / Overcurrent	T1	Overcurrent detected on center deck float S6 output indicating a short to ground.		1. Test the output circuit for a short. 2. Test for proper resistance in the component connected to the primary TEC (P74, pin 3). 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1465	Solenoid 6 - Open Circuit	T1	Open circuit detected on center deck float S6 output.		1. Test the output circuit for an open. 2. Test for proper resistance in the component connected to the primary TEC (P74, pin 3). 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1473	Solenoid 7 - Short to Battery	T2	Low current detected on right deck raise S7 output indicating a short to a high (+) source. This short could be to battery voltage or to another signal that is in a high state.		1. Test the output circuit for a short. 2. Test for proper resistance in the component connected to the auxiliary TEC (P75, pin 6). 3. Swap the T2: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1474	Solenoid 7 - Short to Ground / Overcurrent	T2	Overcurrent detected on right deck raise S7 output indicating a short to ground.		1. Test the output circuit for a short. 2. Test for proper resistance in the component connected to the auxiliary TEC (P75, pin 6). 3. Swap the T2: Auxiliary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1475	Solenoid 7 - Open Circuit	T2	Open circuit detected on right deck raise S7 output.		1. Test the output circuit for an open. 2. Test for proper resistance in the component connected to the auxiliary TEC (P75, pin 6). 3. Swap the T2: Auxiliary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).

Fault ID	Fault Title	Contro-ller(s) Affected	Fault Condition / Circuit Description	Additional Notes	Service Actions
C1483	Solenoid 8 - Short to Battery	T2	Low current detected on right deck lower S8 output indicating a short to a high (+) source. This short could be to battery voltage or to another signal that is in a high state.		1. Test the output circuit for a short. 2. Test for proper resistance in the component connected to the auxiliary TEC (P75, pin 4). 3. Swap the T2: Auxiliary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1484	Solenoid 8 - Short to Ground / Overcurrent	T2	Overcurrent detected on right deck lower S8 output indicating a short to ground.		1. Test the output circuit for a short. 2. Test for proper resistance in the component connected to the auxiliary TEC (P75, pin 4). 3. Swap the T2: Auxiliary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1485	Solenoid 8 - Open Circuit	T2	Open circuit detected on right deck lower S8 output.		1. Test the output circuit for an open. 2. Test for proper resistance in the component connected to the auxiliary TEC (P75, pin 4). 3. Swap the T2: Auxiliary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1493	Solenoid 9 - Short to Battery	T2	Low current detected on right deck float S9 output indicating a short to a high (+) source. This short could be to battery voltage or to another signal that is in a high state.		1. Test the output circuit for a short. 2. Test for proper resistance in the component connected to the auxiliary TEC (P75, pin 2). 3. Swap the T2: Auxiliary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1494	Solenoid 9 - Short to Ground / Overcurrent	T2	Overcurrent detected on right deck float S9 output indicating a short to ground.		1. Test the output circuit for a short. 2. Test for proper resistance in the component connected to the auxiliary TEC (P75, pin 2). 3. Swap the T2: Auxiliary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1495	Solenoid 9 - Open Circuit	T2	Open circuit detected on right deck float S9 output.		1. Test the output circuit for an open. 2. Test for proper resistance in the component connected to the auxiliary TEC (P75, pin 2). 3. Swap the T2: Auxiliary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).

Fault ID	Fault Title	Contro-ller(s) Affected	Fault Condition / Circuit Description	Additional Notes	Service Actions
C14B3	Transport Solenoid - Short to Battery	T1	Low current detected on range hi SV output indicating a short to a high (+) source. This short could be to battery voltage or to another signal that is in a high state.		1. Test the output circuit for a short. 2. Test for proper resistance in the component connected to the primary TEC (P74, pin 5). 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C14B4	Transport Solenoid - Short to Ground / Overcurrent	T1	Overcurrent detected on range hi SV. Indicates short to ground.		1. Test the output circuit for a short. 2. Test for proper resistance in the component connected to the primary TEC (P74, pin 5). 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C14B5	Transport Solenoid - Open Circuit	T1	Open circuit detected on range hi SV.		1. Test the output circuit for an open. 2. Test for proper resistance in the component connected to the primary TEC (P74, pin 5). 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C14C4	PTO 1 - Short to Ground / Overcurrent	T1	Overcurrent detected on deck PTO 1 PRV-1 output indicating a short to ground.		1. Test the output circuit for a short. 2. Test for proper resistance in the component connected to the primary TEC (P74, pin 41). 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C14C5	PTO 1 - Open Circuit	T1	Open circuit detected on deck PTO 1 PRV-1 output.		1. Test the output circuit for an open. 2. Test for proper resistance in the component connected to the primary TEC (P74, pin 41). 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C14D4	PTO 2 - Short to Ground / Overcurrent	T1	Overcurrent detected on deck PTO 2 PRV-2 output indicating a short to ground.		1. Test the output circuit for a short. 2. Test for proper resistance in the component connected to the primary TEC (P74, pin 42). 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C14D5	PTO 2 - Open Circuit	T1	Open circuit detected on deck PTO 2 PRV-2 output.		1. Test the output circuit for an open. 2. Test for proper resistance in the component connected to the primary TEC (P74, pin 42). 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).

Fault ID	Fault Title	Contro-ller(s) Affected	Fault Condition / Circuit Description	Additional Notes	Service Actions
C14E4	PTO 3 - Short to Ground / Overcurrent	T2	Overcurrent detected on PTO left SV2 output indicating a short to ground.		1. Test the output circuit for a short. 2. Test for proper resistance in the component connected to the auxiliary TEC (P75, pin 42). 3. Swap the T2: Auxiliary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C14E5	PTO 3 - Open Circuit	T2	Open circuit detected on PTO left SV2 output.		1. Test the output circuit for an open. 2. Test for proper resistance in the component connected to the auxiliary TEC (P75, pin 42). 3. Swap the T2: Auxiliary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C14F4	PTO 4 - Short to Ground / Overcurrent	T2	Overcurrent detected on deck PTO right SV1 output indicating a short to ground.		1. Test the output circuit for a short. 2. Test for proper resistance in the component connected to the auxiliary TEC (P75, pin 41). 3. Swap the T2: Auxiliary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C14F5	PTO 4 - Open Circuit	T2	Open circuit detected on deck PTO right SV1 output.		1. Test the output circuit for an open. 2. Test for proper resistance in the component connected to the auxiliary TEC (P75, pin 41). 3. Swap the T2: Auxiliary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1514	Hydraulic Pressure Sensor 1 - Short to Ground	T1	Front hydraulic pressure sensor (traction pressure) is shorted to ground (out of range low).		1. Check for the pressure sensor wiring and connector (P74, pin 11). 2. Test the pressure sensor wiring. 3. Test the pressure sensor. 4. Check the 5V bus capacitor in the main wire harness. 5. Replace the pressure sensor.
C1515	Hydraulic Pressure Sensor 1 - Open Circuit	T1	Front hydraulic pressure sensor (traction pressure) is open (out of range high).		1. Check for the pressure sensor wiring and connector (P74, pin 11). 2. Test the pressure sensor wiring. 3. Test the pressure sensor. 4. Check the 5V bus capacitor in the main wire harness. 5. Replace the pressure sensor.

Fault ID	Fault Title	Contro-ller(s) Affected	Fault Condition / Circuit Description	Additional Notes	Service Actions
P0225	Traction Pedal 1 Analog Sensor 1 - Open Circuit	T1	Traction pedal analog sensor 1 (neutral forward and neutral reverse) is reading a voltage outside the range it was designed to operate, indicating an open circuit.	Traction is disabled.	1. Use the InfoCenter to verify sensor movement. 2. If no voltage is displayed: A. Check the traction pedal wiring and connector (P01, pins D and E). B. Test the sensor wiring. 3. Check the sensor wiring to the TEC controller. (P74, pins 17 and 32). 4. Test the traction pedal assembly. 5. Check the 5V bus capacitor in the main wire harness. 6. Replace the sensor.
P0227	Traction Pedal Analog Sensor 1 - Short to Ground	T1	Traction pedal analog sensor 1 (neutral forward and neutral reverse) is reading a voltage outside the range it was designed to operate, indicating a short to ground.	Traction is disabled.	1. Use the InfoCenter to verify sensor movement. 2. If no voltage is displayed: A. Check the traction pedal wiring and connector (P01, pins D and E). B. Test the sensor wiring. 3. Check the sensor wiring to the TEC controller. (P74, pins 17 and 32). 4. Test the traction pedal assembly. 5. Check the 5V bus capacitor in the main wire harness. 6. Replace the sensor.
P0575	Cruise Control Switch Correlation Fault	T1	Cruise engage input is active but the cruise on input is off.	Cruise is not enabled.	1. Check the switch wiring and connector (P74, pins 15 and 35). 2. Test the cruise control switch.
P0615	Start Output - Open Circuit	T1	Open circuit detected on engine start output.		1. Check the circuit wiring (P74, pin 8). 2. Test the engine start output circuit wiring between the TEC and the engine ECU. 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
P0616	Start Output - Short to Ground / Overcurrent	T1	Overcurrent detected on engine start output indicating a short to ground.		1. Check the circuit wiring (P74, pin 8). 2. Test the engine start output circuit wiring between the TEC and the engine ECU. 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
P0617	Start Output - Short to Battery	T1	Low current detected on engine start output indicating a short to a high (+) source. This short could be to battery voltage or to another signal that is in a high state.		1. Check the circuit wiring (P74, pin 8). 2. Test the engine start output circuit wiring between the TEC and the engine ECU. 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).

Fault ID	Fault Title	Contro-ller(s) Affected	Fault Condition / Circuit Description	Additional Notes	Service Actions
P06E9	Starter Timeout	T1	Starter timeout has occurred.	Disable starter output.	1. Ensure that the key switch is not stuck in start position. 2. Test the key switch and replace if necessary. 3. Test the start relay and replace if necessary.
P0939	Hydraulic Oil Temperature Sensor - Short to Ground	T1	Short to ground detected on hydraulic temperature sender.		1. Check the temperature sender wiring and connector (P74, pin 39). 2. Check the temperature sender.
P0940	Hydraulic Oil Temperature Sensor - Open Circuit	T1	Open circuit detected on hydraulic temperature sender.		1. Check the temperature sender wiring and connector (P74, pin 39). 2. Check the temperature sender.
P100C	Engine Coolant Temperature Above Threshold - PTO Kill	Yanmar ECU	Engine coolant temperature has reached a critical operating level that requires the PTO to be disabled.	Engine temp must be greater than 105 ºC. PTO will be disabled.	1. Check the fan. 2. Check the air flow passages. 3. Check the coolant. 4. Check the temperature sender wiring and connector (P01, pins K79 and K21). 5. Check the temperature sender.
P100D	Engine Coolant Temperature Above Threshold - Engine Kill	Yanmar ECU	Engine coolant temperature has reached a critical operating level that requires the engine to be shut down.	Engine temp must be greater than 115 ºC. Engine will be shut down.	1. Check the fan. 2. Check the air flow passages. 3. Check the coolant. 4. Check the temperature sender wiring and connector (P01, pins K79 and K21). 5. Check the temperature sender.
P1104	Traction Coil 1 FWD - Overcurrent	T1	Overcurrent detected on traction coil 1 FWD (neutral FWD). Indicates short to ground.		1. Use the InfoCenter to verify the traction coil operation. 2. If no amperage reading is displayed: A. Check the traction coil wiring and connector (P74, pin 17). B. Test the traction coil wiring. 3. Test the traction coil. 4. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).

Fault ID	Fault Title	Contro-ller(s) Affected	Fault Condition / Circuit Description	Additional Notes	Service Actions
P110C	Traction Coil 1 FWD - Validation Failure - Current Converge	T1	A current monitor which validates the intended traction coil current is indicating an unexpected variance between the desired level of current to the traction coil and the actual level of current to the traction coil. It is expected that the actual level of coil current will track the desired level of current set by the drive-by-wire module.	Traction is disabled and machine will come to a sudden stop.	1. Use the InfoCenter to verify the traction coil operation. 2. If no amperage reading is displayed: A. Check the traction coil wiring and connector (P74, pin 17). B. Test the traction coil wiring. 3. Test the traction coil. 4. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
P110D	Traction Coil 1 FWD - Validation Failure - PWM Converge	T1	PWM convergence is checking 2 fault conditions. The first check is to confirm that the PWM duty cycle across the coil is decreasing when the desired current to the coil is 0. This ensures the voltage across the coil is approaching 0 when required. The second check to verify that the PWM duty cycle across the coil is not greater than the max allowed limit.	Traction is disabled and machine will come to a sudden stop.	1. Use the InfoCenter to verify the traction coil operation. 2. If no amperage reading is displayed: A. Check the traction coil wiring and connector (P74, pin 17). B. Test the traction coil wiring. 3. Test the traction coil. 4. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
P110E	Traction Coil 1 FWD - Feedback Measurement Validation Failure	T1	The expected circuit feedback (calculated) does not match the measured circuit feedback.	Traction is disabled and machine will come to a sudden stop.	1. Use the InfoCenter to verify the traction coil operation. 2. If no amperage reading is displayed: A. Check the traction coil wiring and connector (P74, pin 17). B. Test the traction coil wiring. 3. Test the traction coil. 4. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).

Fault ID	Fault Title	Contro-ller(s) Affected	Fault Condition / Circuit Description	Additional Notes	Service Actions
P1114	Traction Coil 1 REV - Overcurrent	T1	Overcurrent detected on traction coil 1 REV (Neutral REV). Indicates short to ground.		1. Use the InfoCenter to verify the traction coil operation. 2. If no amperage reading is displayed: A. Check the traction coil wiring and connector (P74, pin 32). B. Test the traction coil wiring. 3. Test the traction coil. 4. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
P111C	Traction Coil 1 REV - Validation Failure - Current Converge	T1	A current monitor which validates the intended traction coil current is indicating an unexpected variance between the desired level of current to the traction coil and the actual level of current to the traction coil. It is expected that the actual level of coil current will track the desired level of current set by the drive-by-wire module.	Traction is disabled and machine will come to a sudden stop.	1. Use the InfoCenter to verify the traction coil operation. 2. If no amperage reading is displayed: A. Check the traction coil wiring and connector (P74, pin 32). B. Test the traction coil wiring. 3. Test the traction coil. 4. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
P111D	Traction Coil 1 REV - Validation Failure - PWM Converge	T1	PWM convergence is checking 2 fault conditions. The first check is to confirm that the PWM duty cycle across the coil is decreasing when the desired current to the coil is 0. This ensures the voltage across the coil is approaching 0 when required. The second check is to verify that the PWM duty cycle across the coil is not greater than the max allowed limit.	Traction is disabled and machine will come to a sudden stop.	1. Use the InfoCenter to verify the traction coil operation. 2. If no amperage reading is displayed: A. Check the traction coil wiring and connector (P74, pin 32). B. Test the traction coil wiring. 3. Test the traction coil. 4. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).

Fault ID	Fault Title	Contro-ller(s) Affected	Fault Condition / Circuit Description	Additional Notes	Service Actions
P111E	Traction Coil 1 REV - Feedback Measurement Validation Failure	T1	The expected circuit feedback (calculated) does not match the measured circuit feedback.	Traction is disabled and machine will come to a sudden stop.	1. Use the InfoCenter to verify the traction coil operation. 2. If no amperage reading is displayed: A. Check the traction coil wiring and connector (P74, pin 32). B. Test the traction coil wiring. 3. Test the traction coil. 4. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
P1164	Swashplate 1 - Signal Shorted to Gnd	T1	Short to ground detected on swashplate sensor signal.	PTO is disabled traction speed is reduced by 50%.	1. Check for shorted wire (P74, pin 28). 2. Check the 5V bus capacitor in the main wire harness.
P1165	Swashplate 1 - Signal Open Circuit	T1	Open circuit detected on swash plate sensor signal.	PTO is disabled traction speed is reduced by 50%.	1. Check for open connector (P74, pin 28). 2. Check the 5V bus capacitor in the main wire harness.
P1167	Swashplate 1 - Validation Failure - Position Converge	T1	The swashplate position is not converging on the swashplate position set point.	Traction is disabled and machine will come to a sudden stop.	1. Check the hydraulic pump, pump controller and swashplate sensor. Current controlling pump is doing what it is supposed to but the pump swashplate angle is not moving to the right position. 2. Check the 5V bus capacitor in the main wire harness. Check the hydraulic pump, pump controller and swashplate sensor. Current controlling pump is doing what it is supposed to but the pump swashplate angle is not moving to the right position.
P1169	Swashplate 1 - Invalid Calibration Data	T1	Integrity check on calibration data failed.	PTO is disabled traction speed is reduced by 50%.	1. Recalibrate the traction system. 2. Check the 5V bus capacitor in the main wire harness.
P116C	Swashplate 1 - Signal Out of Operational Range	T1	Sensor signal is valid but is outside of operational range.	PTO is disabled traction speed is reduced by 50%.	1. Recalibrate the traction system. 2. Check the 5V bus capacitor in the main wire harness. 3. Replace the swashplate sensor.

Fault ID	Fault Title	Contro-ller(s) Affected	Fault Condition / Circuit Description	Additional Notes	Service Actions
P2135	Traction Pedal Sensor 1 Digital vs Digital Conflict	T1	Traction pedal 1 has two digital inputs that independently indicate pedal position relative to neutral in the FWD or REV directions. The two signals are reporting simultaneously, which is not physically possible.	TP is disabled.	1. Check the traction pedal potentiometer. 2. Check the harness wiring (P74, pins 17, 18 and 32). 3. Check the connection points to the potentiometer. 4. Test the traction pedal assembly. 5. Check the 5V bus capacitor in the main wire harness. 6. Replace the sensor.
P2136	Traction Pedal Sensor 1 Analog vs Digital conflict	T1	Traction pedal 1 has one digital input and one analog input that independently indicate pedal position relative to neutral in the FWD or REV directions. The analog and digital signals conflict with one another.	TP is disabled.	1. Check the traction pedal potentiometer. 2. Check the harness wiring (P74, pins 17, 18 and 32). 3. Check the connection points to the potentiometer. 4. Test the traction pedal assembly. 5. Check the 5V bus capacitor in the main wire harness. 6. Replace the sensor.
P2503	Alternator - Charging Too Low	T1	Charging system (alternator) is producing a voltage that the TEC has determined to be out of range on the low side.		1. Test the alternator using the Yanmar TNV (Tier 4) Service Manual. 2. Check and clean the battery connections. 3. Test and charge the battery. 4. Check the alternator belt condition and belt tension. 5. Check wiring and connectors. 6. Test the alternator wiring.
P2504	Alternator - Charging Too High	T1	Charging system (alternator) is producing a voltage that the TEC has determined to be out of range on the high side.		1. Test the alternator using the Yanmar TNV (Tier 4) Service Manual. 2. Check and clean the battery connections. 3. Test and charge the battery. 4. Check the alternator belt condition and belt tension. 5. Check wiring and connectors. 6. Test the alternator wiring.
P2530	Key Start/Run Correlation Fault	T1	Key start input is active but the key run input is off.	Machine will be shut down since key run input is inactive.	1. Check for a loose wire or a loose connector. 2. Check the connector for corrosion. 3. Test the key switch wiring between the key switch and the TEC (P74, pins 25 and 36). 4. Test the key switch.
U0100	CAN Bus Communication Fault - Engine	T1	Lost communication with engine controller.	May disable one or more machine functions.	1. Check the power supply to the engine controller (ECU). 2. Check resistance of CAN network. 3. Test the fuse F-A5 (10A).

Fault ID	Fault Title	Contro-ller(s) Affected	Fault Condition / Circuit Description	Additional Notes	Service Actions
U012A	CAN Bus Communication Fault - Secondary 1	T1	Lost communication with auxiliary TEC controller.	May disable one or more machine functions.	1. Check the resistance of the CAN network. 2. Check the CAN connection at the auxiliary TEC. 3. Verify power to the auxiliary TEC.
U0156	CAN Bus Communication Fault - IC	T1	Lost communication with the InfoCenter.		1. Check the resistance of the CAN network. 2. Check the CAN connection at the InfoCenter. 3. Verify power to the InfoCenter.
U1007	Controller Main Power Relay	T1	A main power relay has failed. Source address to indicate which controller reported this fault.		1. Test all the 7.5-amp fuses. 2. Test the functionality of the main power relay. 3. If the relay test passes, verify that the primary TEC is getting 12 Vdc from the relay. 4. If the relay test passes, verify that the auxiliary TEC controller is getting 12 Vdc from the relay.
U1022	TEC Fuse 2 Failure	T1 T2	Fuse is blown on outputs 1–4 of the TEC. Source address to indicate which controller reported this fault. This fault will not coincide with the controller main power relay fault (U1007).		For T1: Check the 7.5-amp fuse F-A1. For T2: Check the 7.5-amp fuse F-A2.
U1023	TEC Fuse 3 Failure	T1 T2	Fuse is blown on outputs 5–8 on the TEC.		For T1: Check the 7.5-amp fuse F-C1. For T2: Check the 7.5-amp fuse F-C2.
U1024	TEC Fuse 4 Failure	T1 T2	Fuse is blown on outputs 9–12 on the TEC.		For T1: Check the 7.5-amp fuse F-B1. For T2: Check the 7.5-amp fuse F-B2.
U1025	TEC Fuse 5 Failure	T1 T2	Fuse is blown on outputs 13–16 on the TEC.		For T1: Check the 7.5-amp fuse F-D1. For T2: Check the 7.5-amp fuse F-D2.
U1030	5V Supply - Out of Range	T1	5V Supply voltage has been determined to be out of range either on the high or low side.	Disable the controller functionality.	1. Check the 5V out at P74, pin 20. 2. Disconnect the sensors one by one to make sure one of them is not pulling too heavy of a load. 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
U110C	Model Number Unknown	T1	Model number not recognized.	Disable engine.	Reprogram system software (contact your Authorized Toro Distributor for assistance).
U110D	Serial Number Unknown	T1	Serial number not recognized.	Disable engine.	Reprogram system software (contact your Authorized Toro Distributor for assistance).
U1117	Source Address Contention Fault	T1 T2	Controller received a message from another controller on the CAN bus using the same source address.	Disable the machine.	Reprogram system software (contact your Authorized Toro Distributor for assistance).

Fault ID	Fault Title	Contro-ller(s) Affected	Fault Condition / Circuit Description	Additional Notes	Service Actions
U1308	Software Version Incompatibility - Secondary 1	T1	Auxiliary TEC firmware is incompatible.	Disable the machine.	Reprogram system software (contact your Authorized Toro Distributor for assistance).
U130A	Software Version Incompatibility - InfoCenter	T1	InfoCenter software is incompatible.	Disable the machine.	Reprogram system software (contact your Authorized Toro Distributor for assistance).
U130F	Software Version Incompatibility - Unknown	T1	Unknown software version incompatible.	Disable the machine.	Reprogram system software (contact your Authorized Toro Distributor for assistance).
U1701	Board Internal Error - IPE	T1 T2	Inputs or outputs on the controller are not working correctly due to low internal voltage. Inputs can't be trusted.	Disable the controller functionality.	1. Check 12V battery. 2. Swap the TEC controller with a known-good unit (contact an Authorized Toro Distributor for assistance).

Starting Problems

Note: Check InfoCenter Display for possible operator advisories or faults whenever diagnosing machine electrical problems.

Problem	Possible Cause
No electrical power to machine.	The battery is discharged. The battery cables are loose or corroded. Fuse F−B5 (2 Amp) is faulty. Ground connection on the machine is loose or corroded. The ignition switch or circuit wiring is faulty.
Starter solenoid clicks, but starter will not crank. **Note:** If the solenoid clicks, the problem is not in the interlock circuit.	The battery is discharged. The battery cables are loose or corroded. A ground wire or cable is loose or corroded. The wiring at the starter motor is faulty. The starter solenoid is faulty. The starter motor is faulty. The engine crankshaft seized.
No “click”, no “crank”, no ”start” happens when start attempt is made. InfoCenter display operates with the ignition switch in the RUN position. **Note:** Use InfoCenter Display to assist with identifying problem.	Traction pedal position sensor is out of adjustment. Traction pedal position sensor or circuit wiring is faulty. The seat switch or circuit wiring is faulty. The parking brake switch or circuit wiring is faulty. The start relay or circuit wiring is faulty. The PTO switch is ON (engaged). The starter solenoid or starter motor is faulty. The engine or fuel system is malfunctioning (see *Yanmar Service Manual*). The wiring harness connectors, fuses and relays are faulty (see Chapter 6: Electrical System (page 6–1)).
Nothing happens when start attempt is made. InfoCenter display operates with the ignition switch in the ON position. No Operator Advisory displayed on InfoCenter.	Fuse for TEC controller(s) are faulty (fuse B5). Ignition switch or circuit wiring is faulty. Start relay or circuit wiring is faulty. Starter solenoid or starter motor is faulty.
Starter cranks, but should not, when the traction pedal is depressed.	Traction pedal position sensor is out of adjustment. Traction pedal position sensor or circuit wiring is faulty.
Engine cranks, but does not start.	The fuel tank is empty. The battery charge is low, voltage drop in start circuit cables. The fuel pump or circuit wiring is faulty. The engine or fuel system is malfunctioning (see *Yanmar Service Manual*).

General Run and Transport Problems

Note: Check InfoCenter Display for possible operator advisories or faults whenever diagnosing machine electrical problems.

Problem	Possible Cause
Engine continues to run, but should not, when the ignition switch is turned off.	The ignition switch or circuit wiring is faulty. The engine or fuel system is malfunctioning (see *Yanmar Service Manual*).
Machine continues to move without an InfoCenter Advisory, but should not, when the traction pedal is depressed with no operator in the seat.	The seat switch or circuit wiring is faulty. Traction pedal position sensor is out of adjustment. Traction pedal position sensor or circuit wiring is faulty.
Engine stops during operation, but is able to restart. **Note:** Excessive engine coolant temperature will cause the cutting decks to be disengaged and can lead to engine shutdown. If excessive coolant temperature causes engine shutdown, the operator can restart the engine to allow the machine to be moved a short distance. After a restart in this condition, the engine will run for approximately ten (10) seconds before the engine shuts down again.	The operator is lifting off the seat switch while mowing. The seat switch or circuit wiring is faulty. The ignition switch or circuit wiring is faulty. The engine coolant temperature is excessive. Machine is being operated on a slope with a low fuel level. The engine or fuel system is malfunctioning (see *Yanmar Service Manual*).
Battery does not charge. **Note:** Charging system faults will be actively displayed if the charging system voltage is not detected by the Yanmar ECU.	Loose, corroded or broken wire(s) exist in charging circuit. The engine alternator belt is out of adjustment. The battery is faulty. The alternator is faulty.

Cutting Deck Operating Problems

Note: Check InfoCenter Display for possible operator advisories or faults whenever diagnosing machine electrical problems.

Note: To engage the mow circuit, the operator must be in the operator seat, the traction speed must be in the LOW speed (mow) position, the PTO switch must be ON and the cutting deck(s) must be fully lowered and in float.

Problem	Possible Cause
Cutting decks run, but should not, when raised. Decks shut off with PTO switch.	The cutting deck position switch or circuit wiring is faulty. Wire harness connections are incorrectly connected to hydraulic solenoid valve coils on hydraulic deck control manifold. A hydraulic problem in the mow circuit exists (see General Hydraulic System Problems (page 3–3)). The TEC controller is faulty.
Cutting decks run, but should not, when raised. Decks do not shut off with the PTO switch.	The deck position switch or circuit wiring and PTO switch or circuit wiring are faulty. A hydraulic problem in the mow circuit exists (see General Hydraulic System Problems (page 3–3)). The TEC controller is faulty.
Cutting decks run, but should not, when lowered with PTO switch in the OFF (disengage) position.	The PTO switch or circuit wiring is faulty. The TEC controller is faulty.
Cutting deck(s) do not operate and Operator Advisory is displayed on InfoCenter (see Operator Advisories (page 3–11)).	The operator is lifting off the seat switch. The cutting decks are not fully lowered. Traction circuit is not in LOW speed (mow) mode.
Cutting deck(s) do not operate and no Operator Advisory is displayed on InfoCenter.	High temperature of engine coolant or hydraulic oil has disabled the cutting decks. Fuse is faulty preventing PTO manifold solenoids from being energized (fuse B−1 or B−2). The seat switch or circuit wiring is faulty. The PTO switch or circuit wiring is faulty. The deck position switch or circuit wiring is faulty. The HIGH/LOW speed switch or circuit wiring is faulty. Hydraulic valve solenoid(s) or circuit wiring to the affected deck(s) is faulty. A hydraulic problem in the mow circuit exists (see General Hydraulic System Problems (page 3–3)). The TEC controller is faulty.

Cutting Deck Lift/Lower Problems

Note: Check InfoCenter Display for possible operator advisories or faults whenever diagnosing machine electrical problems.

Note: To lower a cutting deck, the operator must be in the operator seat and the traction speed must be in the LOW speed (mow) position. To raise a cutting deck, the operator must be in the operator seat.

Problem	Possible Cause
None of the cutting decks will lower and Operator Advisory is displayed on InfoCenter (see Operator Advisories (page 3–11)).	Operator is not fully depressing the seat switch.
None of the cutting decks will lower and no Operator Advisory is displayed on InfoCenter.	Fuse(s) for TEC controller are faulty. The seat switch or circuit wiring is faulty. The HIGH/LOW speed switch or circuit wiring is faulty. On Groundsmaster 4500−D, lift switch or circuit wiring is faulty. On Groundsmaster 4500−D, lift control manifold solenoid coil S6 or circuit wiring is faulty. On Groundsmaster 4700−D, all lift switches or circuit wiring are faulty. On Groundsmaster 4700−D, lift control manifold solenoid coil S1 or circuit wiring is faulty. A hydraulic problem in the lift/lower circuit exists (see General Hydraulic System Problems (page 3–3)). The TEC controller is faulty.
None of the cutting decks will raise.	Fuse(s) for TEC controller are faulty. The seat switch or circuit wiring is faulty. On Groundsmaster 4500−D, lift switch or circuit wiring is faulty. On Groundsmaster 4500−D, lift control manifold solenoid coil S5 or circuit wiring is faulty. On Groundsmaster 4700−D, all lift switches or circuit wiring are faulty. On Groundsmaster 4700−D, lift control manifold solenoid coil S1 or circuit wiring is faulty. A hydraulic problem in the lift/lower circuit exists (see General Hydraulic System Problems (page 3–3)). The TEC controller is faulty.

Problem	Possible Cause
On Groundsmaster 4700−D, center cutting decks will not raise or lower, but both wing cutting decks will raise and lower.	The center deck lift switch or circuit wiring is faulty. Fuse(s) for TEC controller are faulty (fuse C−1). Lift control manifold solenoid coils S5 or S6 or circuit wiring is faulty. A hydraulic problem in the lift/lower circuit exists (see General Hydraulic System Problems (page 3–3)). The TEC controller is faulty.
On Groundsmaster 4700−D, RH wing cutting deck will not raise or lower, but the center and LH wing cutting decks will raise and lower.	The RH deck lift switch or circuit wiring is faulty. Fuse(s) for TEC controller are faulty (fuses A-2 and C-2). Lift control manifold solenoid coils S7, S8 or S9 or circuit wiring is faulty. A hydraulic problem in the lift/lower circuit exists (see General Hydraulic System Problems (page 3–3)). The TEC controller is faulty.
On Groundsmaster 4700−D, LH wing cutting deck will not raise or lower, but the center and RH wing cutting decks will raise and lower.	The LH deck lift switch or circuit wiring is faulty. Fuse(s) for TEC controller are faulty (fuse A−2). Lift control manifold solenoid coils S2, S3 or S4 or circuit wiring is faulty. A hydraulic problem in the lift/lower circuit exists (see General Hydraulic System Problems (page 3–3)). The TEC controller is faulty.

Aftercut Appearance

There are a number of factors that can contribute to unsatisfactory quality of cut, some of which may be turf conditions. Turf conditions such as excessive thatch, uneven ground conditions, “sponginess” or attempting to cut off too much grass height may not always be overcome by adjusting the machine.

Remember that the “effective” or actual height−of−cut depends on cutting deck weight, tire pressures, hydraulic counterbalance settings and turf conditions. Effective height−of−cut will be different than the bench set height− of−cut.

Factors That Can Affect Quality of Cut

Factor	Possible Problem/Correction
Blade speed.	All deck blades should rotate at the same speed.
Tire pressure.	Check air pressure of each tire. Adjust to pressures specified in *Operator’s Manual*.
Blade condition.	Sharpen blades if their cutting edges are dull or nicked. Inspect blade sail for wear or damage. Replace blade if needed.
Mower housing condition.	Make sure that cutting chambers are in good condition. Keep underside of deck clean. Debris buildup will reduce cutting performance.
Height−of−cut.	Make sure all cutting decks are set at the same height−of−cut. Set decks as specified in the *Operator’s Manual*. Adjust height-of-cut setting to remove only 25 mm (1 in) or 1/3 of the grass blade when cutting.
Cutting deck alignment and ground following.	Check lift arms and cutting deck pivot linkages for wear, damage or binding. Also, inspect for bent or damaged pivot shafts.
Roller and castor wheel condition.	All rollers should rotate freely. Replace bearings if worn or damaged.
Grass conditions.	Mow when grass is dry for best cutting results.

Chapter 4

Yanmar Diesel Engine

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Additional Reference Materials

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

General Information

This Chapter gives information about specifications and repair of the diesel engine used in the Groundsmaster 4500−D and 4700−D.

General maintenance procedures are described in your *Operator's Manual*. Information on engine troubleshooting, testing, disassembly and reassembly is identified in the Yanmar Service Manual.

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

Service and repair parts for Yanmar engines are supplied through your Authorized Toro Distributor. If no parts list is available, be prepared to provide your distributor with the Toro model and serial number of your machine.

Operator's Manual

The *Operator's Manual* provides information regarding the operation, general maintenance and maintenance intervals for your Groundsmaster machine. The *Yanmar Operator's Manual* includes information specific to the engine used in your Groundsmaster. Refer to these publications for additional information when servicing the machine.

Yanmar Service and Troubleshooting Manuals

The engine that powers your Groundsmaster machine is either a Yanmar model 4TNV84T−Z (used on Groundsmaster models 30893, 30893TE, 30899 and 30899TE) (Tier 4i) or a Yanmar model 4TNV86CT (used on Groundsmaster models 30885 and 30887) (Tier 4). Both the *Yanmar Service Manual* and *Yanmar Troubleshooting Manual* are available for these engines. Make sure that the correct engine manuals are used when servicing the engine on your Groundsmaster.

Stopping the Engine

IMPORTANT

After mowing or full load operation on machines with a turbo−charged engine, cool the turbo- charger by allowing the engine to run at low idle speed for five (5) minutes before stopping the engine. Avoid or don't shut down the engine as speeds greater than idle. Failure to do so may lead to premature internal wear/damage to turbo-charger.

Engine Electronic Control Unit (ECU)

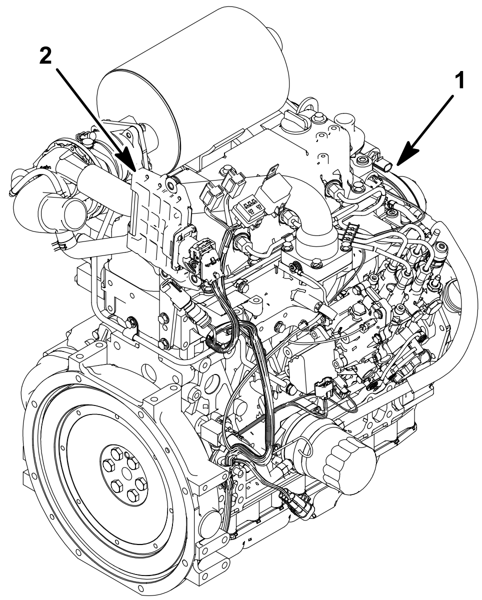

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Figure 7

(Tier 4i)

1. Electronic control unit (30893 / 30893TE / 30899 / 30899TE)
2. Engine ECU

The Yanmar engine that powers your Groundsmaster uses an electronic control unit (ECU) for engine management and also to communicate with the machine TEC controllers and the operator Info Center display on the machine. All wire harness electrical connectors should be plugged into the engine ECU before the machine ignition switch is moved from the OFF position to either the ON or START position.

Engine Electronic Control Unit (ECU) (continued)

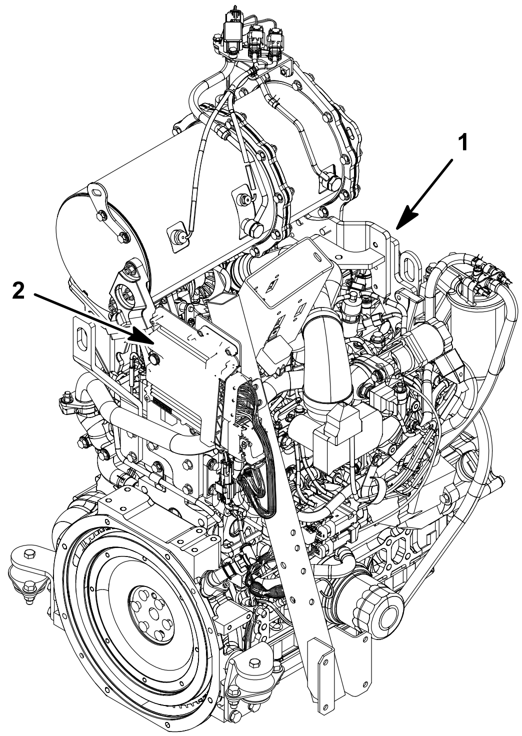

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Figure 8
(Tier 4)

1. Electronic control unit (30885 / 30887)
2. Engine ECU

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

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

IMPORTANT

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

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

Yanmar Engine: Models 30893, 30893TE, 30899 and 30899TE

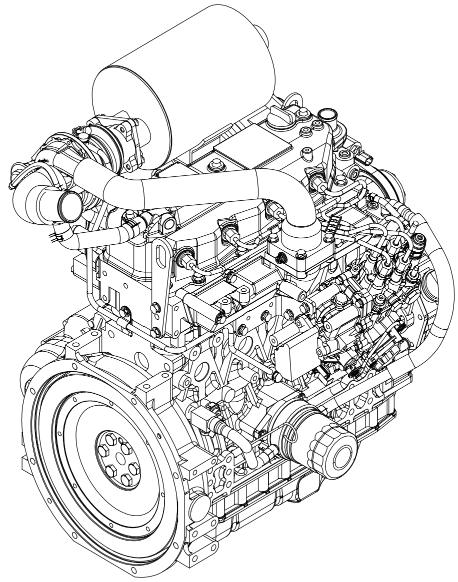

Figure 9

The engine used on Groundsmaster models 30893, 30893TE, 30899 and 30899TE is a Yanmar TNV Series, turbocharged, diesel engine that complies with EPA interim Tier 4 emission regulations. The T4i engine features include an electronic control unit (ECU) controlled direct fuel injection and electronic governor. An air heater in the intake system is used to assist starting the engine. Numerous engine sensors are used to allow the engine electronic control unit (ECU) to monitor and control engine operation for optimum engine performance.

During machine operation, if an engine fault occurs, the machine InfoCenter display can be used to identify the fault. Also, the Yanmar SMARTASSIST−Direct electronic control diagnostics service system is available to confirm real−time engine running status and to offer timely technical services.

Yanmar Engine: Models 30885 and 30887

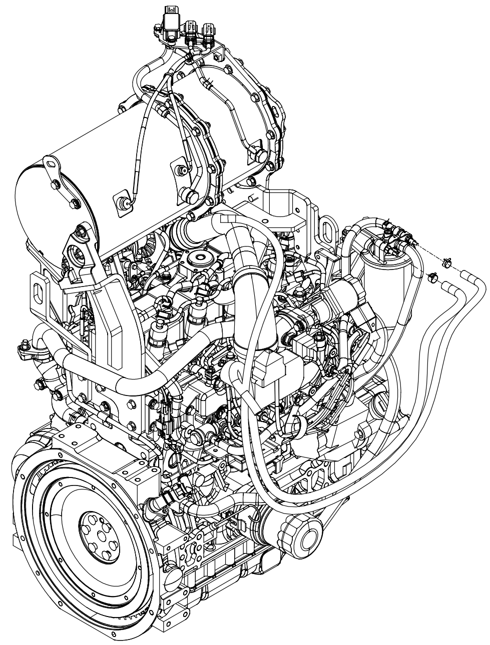

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Figure 10

The engine used on Groundsmaster models 30885 and 30887 is a Yanmar TNV Series, turbocharged, diesel engine that complies with EPA Tier 4 final emission regulations. The T4 engine features include an electronic control unit (ECU) that controls a common rail, direct fuel injection system, water−cooled exhaust gas recirculation (EGR), an exhaust system diesel oxidation catalyst (DOC) and an exhaust diesel particulate filter (DPF) with active regeneration. Glow plugs are used to assist starting the engine. Numerous engine sensors are used to allow the engine ECU to monitor and control engine operation for optimum engine performance.

During the operation of the engine, if conditions warrant, the engine ECU may generate an engine fault. Use the machine InfoCenter to identify the engine fault; refer to the *Yanmar Troubleshooting Manual*, or contact an Authorized Toro Distributor for assistance.

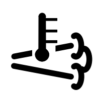
Diesel Particulate Filter

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

Regeneration

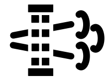
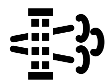
The engine ECU monitors the exhaust pressure before and after the soot filter in the DPF to determine if soot is accumulating. If soot is accumulating during normal engine operation, the pressure differential will increase. The increase in pressure will signal the engine to begin a process called regeneration.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

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

Type	Conditions	Description
Passive	Occurs during normal operation of the machine at high engine speed or high engine load.	The DPF processes high heat exhaust gasses, oxidizing harmful emissions and incinerating soot to ash. Passive regeneration occurs as part of normal engine operation. The InfoCenter does not display an icon during passive regeneration. While operating the machine, run the engine at full-engine speed and high load when possible to promote DPF regeneration.
Assist	Occurs because of prolonged operation at low engine speed, low engine load, or when the engine ECU detects the soot filter is becoming obstructed.	The engine ECU adjusts the exhaust intake throttle to raise the exhaust temperature. The InfoCenter does not display an icon during assist regeneration.
Reset	Occurs every 100 hours of engine operation. Occurs after an assist regeneration if the engine ECU determines the assist regeneration did not sufficiently reduce the soot level.	 The engine ECU adjusts the engine setting to raise the exhaust temperature. The engine ECU adjusts the exhaust intake throttle and the injector timing to raise the exhaust temperature. Do not shut off the engine or reduce the engine speed while the reset regeneration is processing.

Regeneration (continued)

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

Type	Conditions	Description
Parked	Occurs when exhaust back pressure in the DPF increases due to continued soot buildup. May occur because the InfoCenter was set to inhibit reset regeneration and machine operation continued, adding more soot to the DPF after a reset regeneration was requested. May be caused by prolonged operation at low engine speed, low engine load, or the use of incorrect fuel or engine oil. Can be initiated when prompted by the engine ECU or manually after a minimum of 50 hours of engine operation.	 The InfoCenter displays the stationary regeneration icon. Manually initiate a parked regeneration as soon as possible. A parked regeneration will take approximately 30 to 60 minutes and should not be started with less than 1/4 tank of fuel. The machine must remain stationary (cannot be operated) during the entire parked regeneration process.
Recovery	Occurs when exhaust back pressure in the DPF increases due to soot buildup reaching a critical level. May occur because parked regeneration requests were ignored and machine operation continued, adding more soot to the DPF after a parked regeneration was requested. Can only be initiated when prompted by the engine ECU.	 The InfoCenter displays the stationary regeneration icon. Manually initiate a recovery regeneration as soon as possible. A recovery regeneration will take approximately 3 hours and should not be started with less than 1/2 tank of fuel. The machine must remain stationary (cannot be operated) during the entire recovery regeneration process.

Refer to the traction unit *Operator's Manual* for additional DPF regeneration information, and instructions for using the InfoCenter DPF Regeneration Menus.

Soot Accumulation

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

Ash Accumulation

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

Service and Repairs

Air Cleaner System

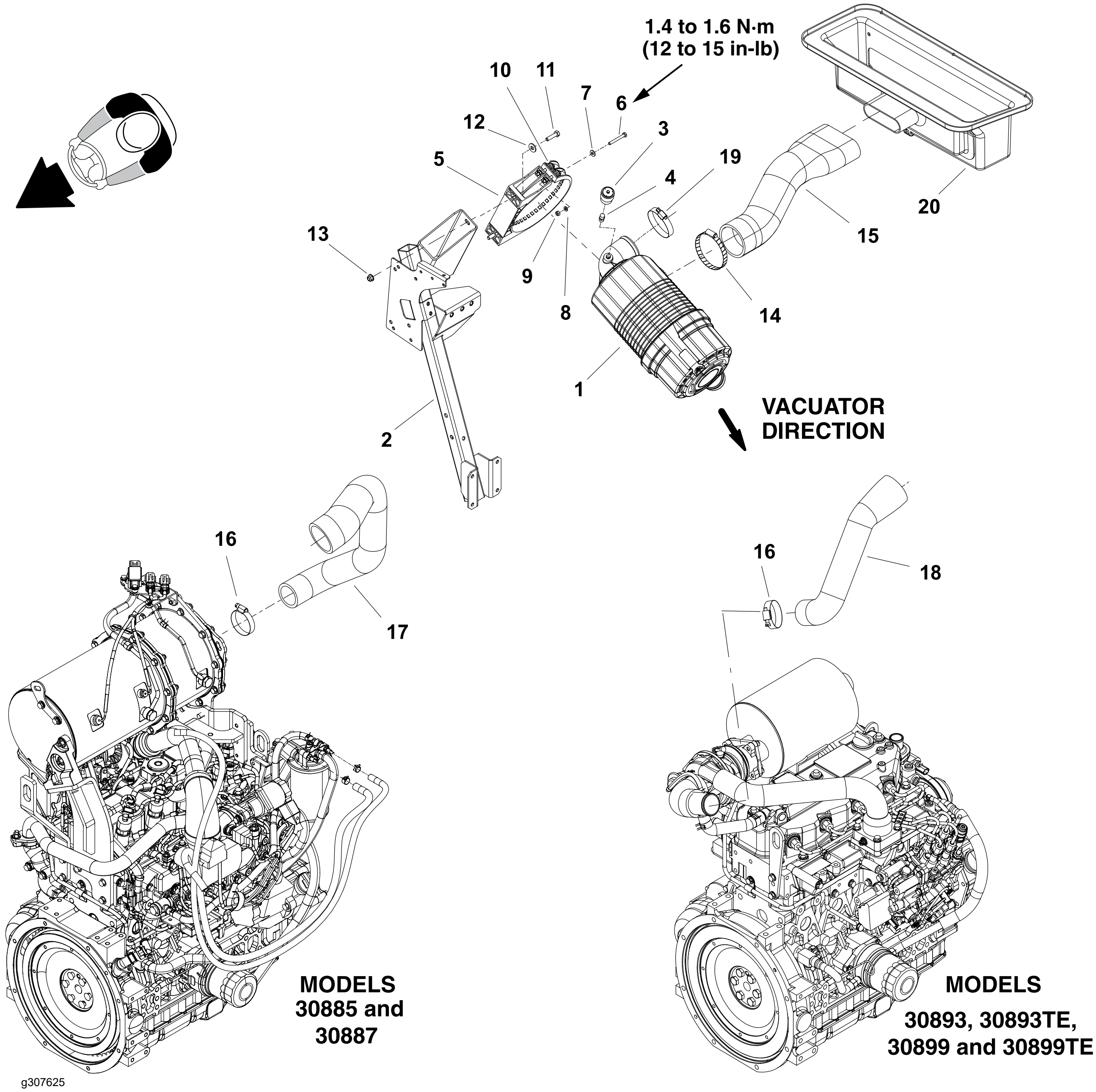


Figure 11

1. Air cleaner assembly
2. Air cleaner mount
3. Indicator
4. Adapter
5. Air cleaner strap
6. Socket head screw (2 used)
7. Flat washer (2 used)
8. Flat washer (2 used)
9. Lock nut (2 used)
10. Spring (2 used)
11. Cap screw (2 used)
12. Flat washer (2 used)
13. Flange nut (2 used)
14. Hose clamp
15. Air cleaner inlet hose
16. Hose clamp
17. Air cleaner outlet hose (tier 4)
18. Air cleaner outlet hose (tier 4i)
19. Hose clamp
20. Plenum

Removal (Figure 11)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.
2. Raise and support hood.
3. Remove air cleaner components as needed using Figure 11 as a guide.

Installation (Figure 11)

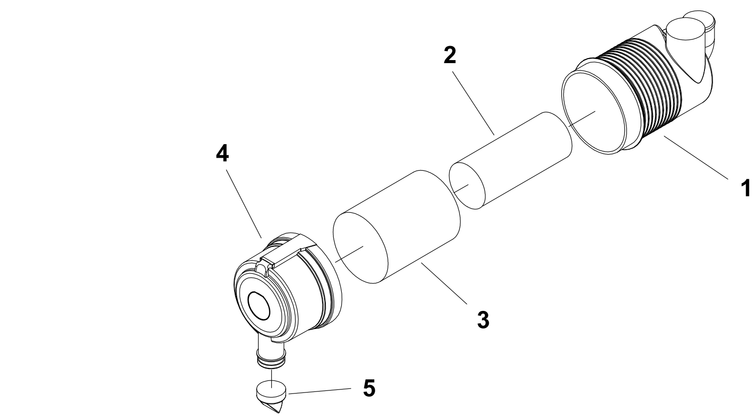


Figure 12

1. Air cleaner housing
2. Safety filter element
3. Air filter element
4. Air cleaner cover
5. Vacuator valve

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 assembly.

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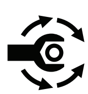
1. Assemble air cleaner system using Figure 11 as a guide.



A. If service indicator (item 3 in Figure 11) was removed from air cleaner housing, apply thread sealant to adapter threads before installing adapter and indicator to housing. Install adapter so that grooves in adapter hex and adapter filter element are installed toward service indicator (Figure 13). Torque indicator from **1.4 to 1.6 N·m (12 to 15 in−lb)**.

Installation (Figure 11) (continued)

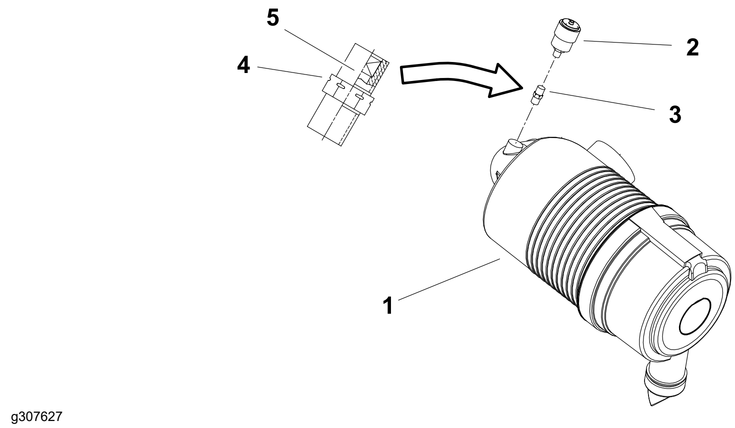


Figure 13

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

B. Orientate vacuator valve on air cleaner cover toward ground.

C. Make sure that air cleaner outlet hose (item 17 or 18 in Figure 11) does not contact any engine or machine components. To modify clearance, move and/ or rotate air cleaner body in air cleaner strap. Verify that tabs in strap mesh fully with slots in air cleaner body.

2. After all air cleaner components have been installed, lower and secure hood.

Fuel System

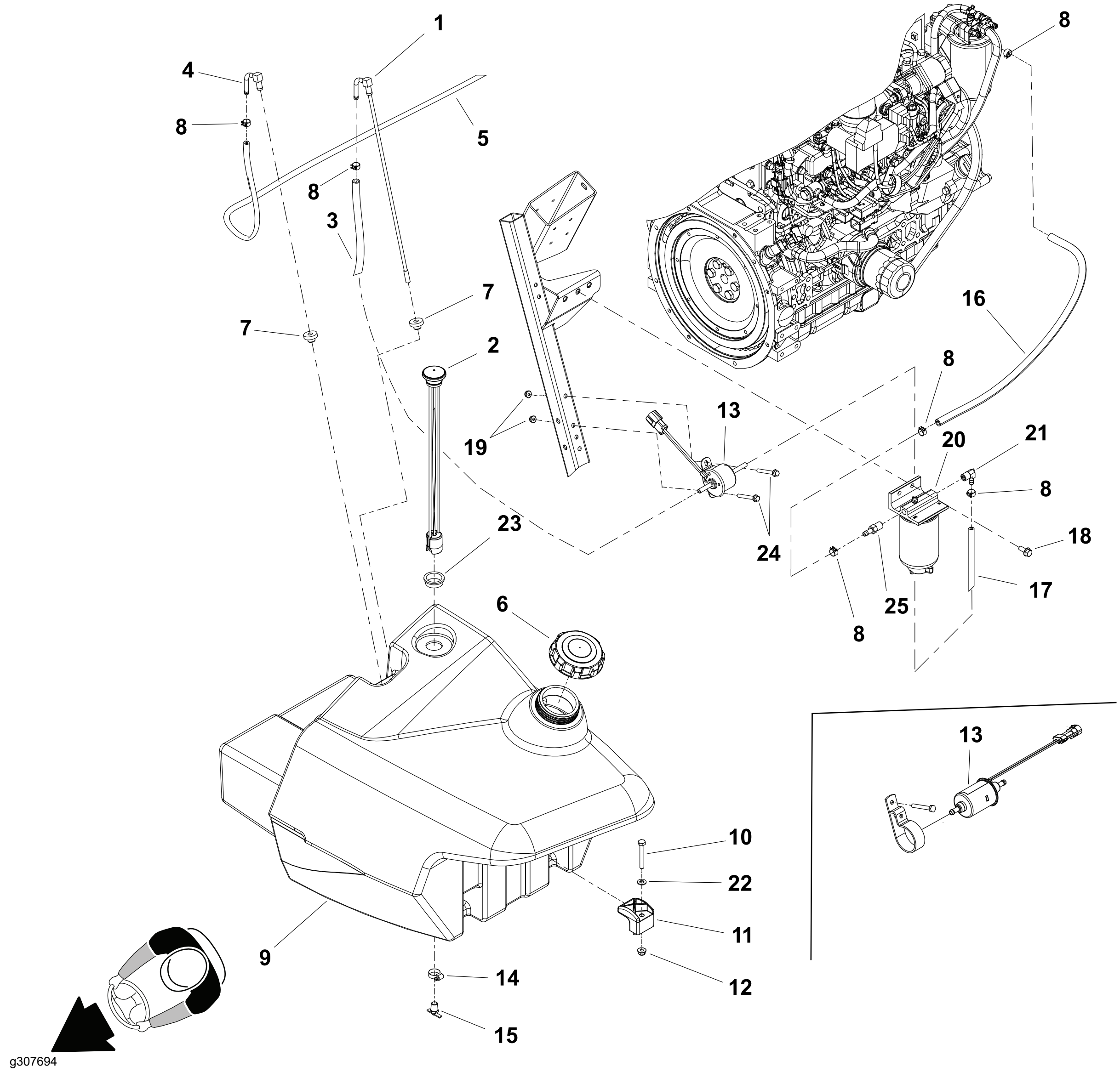


Figure 14

1. Fuel suction tube
2. Fuel gauge
3. Fuel hose (supply)
4. Return fitting
5. Fuel hose (return)
6. Fuel tank cap
7. Bushing (2 used)
8. Hose clamp (6 used)
9. Fuel tank
10. Cap screw (2 used)
11. Clamp (2 used)
12. Flange nut (2 used)
13. Fuel pump
14. Hose clamp
15. Draincock
16. Fuel hose (supply)
17. Fuel hose (supply)
18. Flange head screw (2 used)
19. Flange nut (2 used)
20. Fuel/water separator
21. Elbow fitting
22. Flat washer (2 used)
23. Grommet
24. Flange head screw (2 used)
25. Straight fitting

DANGER

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

Check Fuel Lines and Connections

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

Drain and Clean Fuel Tank

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

IMPORTANT

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

To clean fuel tank, flush tank out with clean diesel fuel. Make sure tank is free of contaminates and debris.

Priming the Fuel System

The fuel system needs to be primed before starting the engine for the first time, after running out of fuel or after fuel system maintenance (e.g. draining the filter/water separator, replacing a fuel hose).

IMPORTANT

Do not turn the key switch to the START position to prime the fuel system.

To prime the fuel system:

1. Enure that the fuel tank has fuel in it.
2. Allow the electric fuel pump to prime the fuel system by turning the key switch to the RUN position for 10 to 15 seconds. Cycle the key switch and repeat if necessary.

Fuel Tank Removal (Figure 14)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.
2. For assembly purposes, label fuel hoses at suction and return fittings in top of tank. Disconnect fuel hoses from fittings.
3. Use draincock to empty fuel tank into a suitable container.

Fuel Tank Removal (Figure 14) (continued)

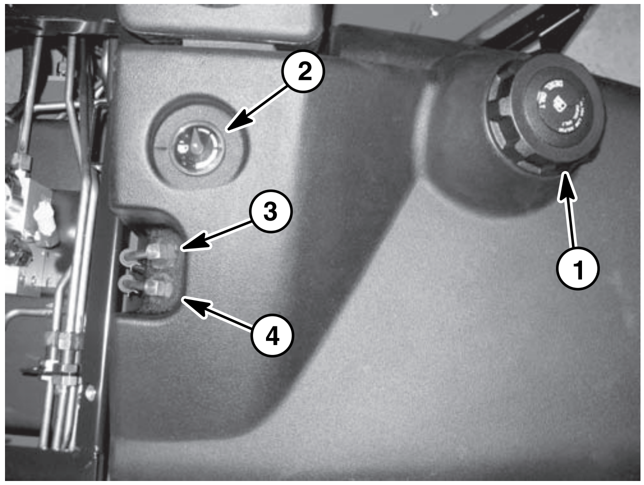


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Figure 15

1. Fuel tank cap	3. Fuel supply hose
2. Fuel gauge	4. Fuel return hose

4. Disconnect wire harness connections from the fuel pump (item 13).
5. Remove fuel tank using Figure 14 as a guide.

Fuel Tank Installation (Figure 14)

1. Install fuel tank to frame using Figure 14 as a guide. If draincock (item 15) was removed from tank, apply thread sealant to threads of draincock before installing it into fuel tank.
2. Using labels placed during fuel tank removal, correctly connect fuel hoses to the suction and return fittings in top of tank. Secure hoses with hose clamps.
3. Make sure that draincock in bottom of fuel tank is closed.
4. Fill fuel tank with clean fuel.

Radiator and Oil Cooler Assembly

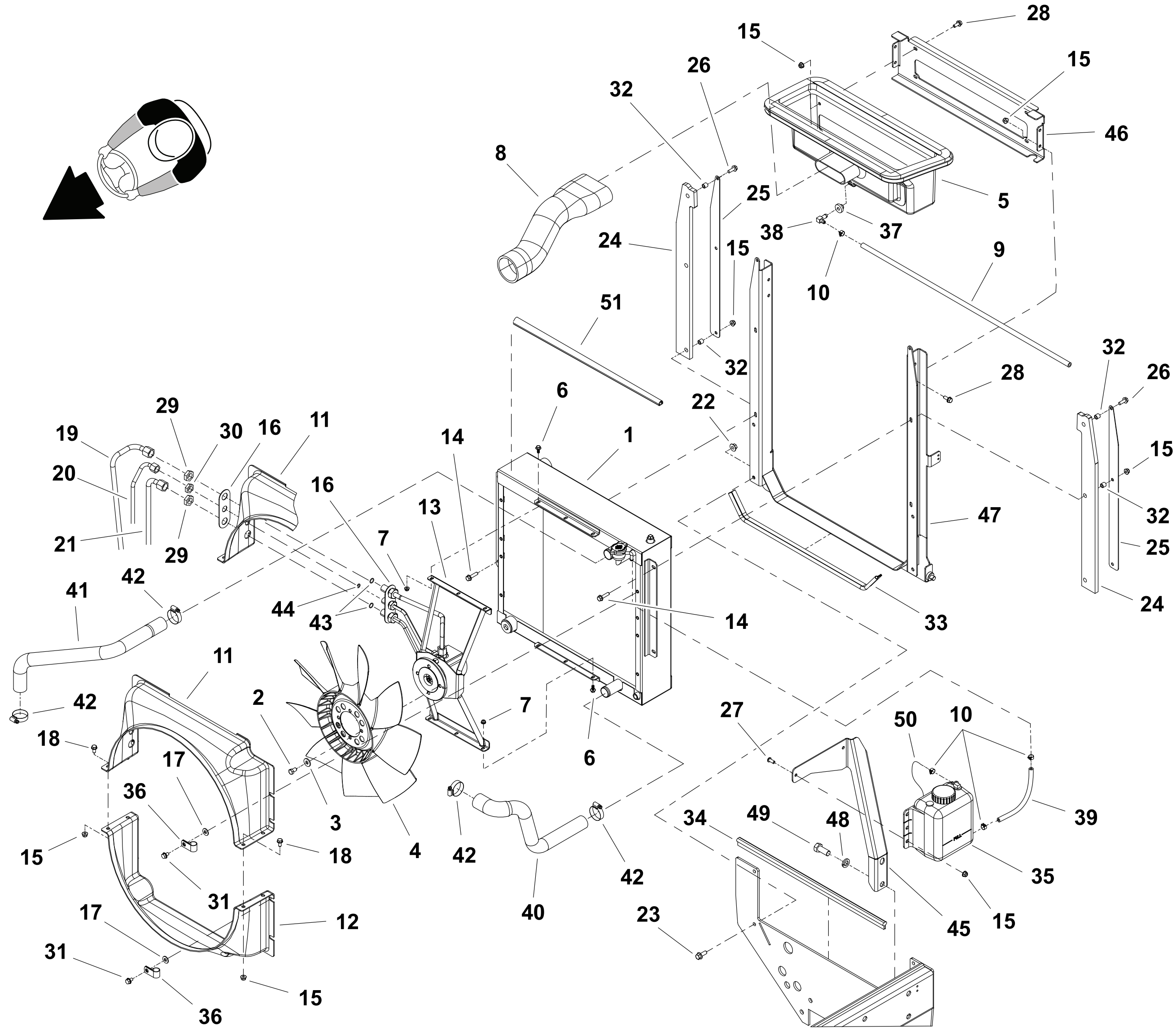

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Figure 16

1. Radiator/oil cooler assembly
2. Cap screw (4 used)
3. Washer (4 used)
4. Fan
5. Plenum assembly
6. Cap screw (6 used)
7. Flange nut (6 used)
8. Air intake hose
9. Hose
10. Hose clamp (4 used)
11. Upper radiator shroud
12. Lower radiator shroud
13. Fan motor and bracket assembly
14. Flange head screw (4 used)
15. Flange nut (22 used)
16. Shim (2 used)
17. Flat washer (8 used)
18. Flange head screw (4 used)
19. Hydraulic tube
20. Hydraulic tube
21. Hydraulic tube
22. Flange nut (4 used)
23. Flange head screw (4 used)
24. Hood seal (2 used)
25. Hood seal bracket (2 used)
26. Screw (2 used)
27. Screw (2 used)
28. Flange head screw (12 used)
29. Bulkhead nut (2 used)
30. Bulkhead nut
31. Flange head screw (8 used)
32. Spacer (6 used)
33. Bulb seal
34. Bulb seal
35. Coolant reservoir
36. R−clamp (2 used)
37. Bushing
38. Elbow fitting
39. Hose
40. Lower radiator hose
41. Upper radiator hose
42. Hose clamp (4 used)
43. O−ring
44. O−ring
45. Mount bracket
46. Crossover plate
47. Radiator mount
48. Lock washer (2 used)
49. Cap screw (2 used)
50. Hose
51. Bulb seal

Removal (Figure 16)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.
2. Remove hood from the machine (see Hood (page 8–26)).

CAUTION

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

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

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3. Remove radiator cap. Use the radiator draincock to drain radiator into a suitable container.
4. Disconnect upper and lower radiator hoses from the radiator.
5. Remove air cleaner intake hose (item 8).
6. Remove four (4) flange head screws and flange nuts that secure plenum assembly (item 5) to crossover plate. Remove plenum assembly from machine.
7. Remove engine cooling fan motor and bracket assembly, upper radiator shroud and cooling fan from machine (see Engine Cooling Fan Motor (page 5–147)).
8. Remove fasteners that secure lower radiator shroud to radiator. Remove lower shroud from machine.
9. To prevent contamination of hydraulic system during radiator/oil cooler removal, thoroughly clean junction of hydraulic hoses and fittings on oil cooler.

Removal (Figure 16) (continued)

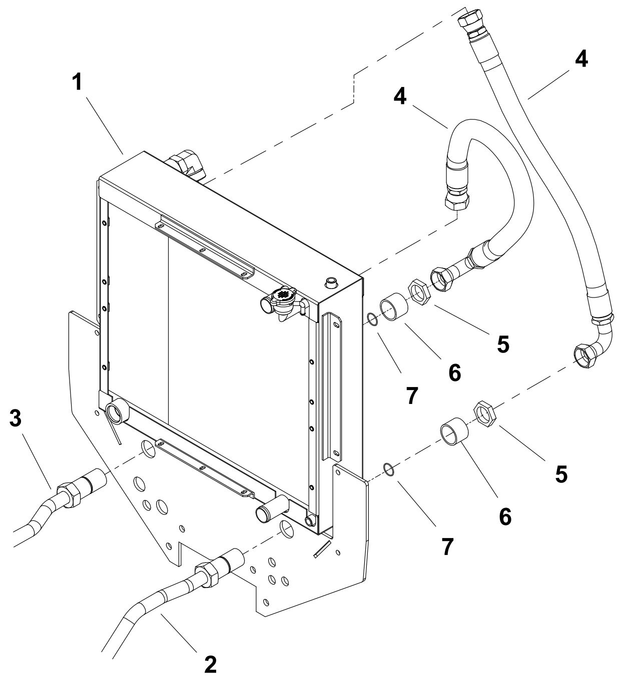

Figure 17

1. Radiator/oil cooler
2. Hydraulic tube
3. Hydraulic tube
4. Hydraulic hose
5. Bulkhead nut
6. Spacer
7. O−ring

10. Disconnect hydraulic hoses from radiator/oil cooler (Figure 17). Put caps or plugs on open hydraulic hoses and fittings to prevent system contamination. Label the hydraulic hoses to show their correct position on the oil cooler for assembly purposes.
11. Disconnect reservoir hose (item 39) from the radiator vent tube.
12. Remove four (4) flange head screws and flange nuts securing the radiator/oil cooler and recirculation barriers (items 24 and 25) to the radiator mount. Carefully remove radiator/oil cooler from the machine. Make sure that spacers (item 32) remain in hood seal.
13. Plug all radiator/oil cooler and hose openings to prevent contamination.

Removal (Figure 16) (continued)

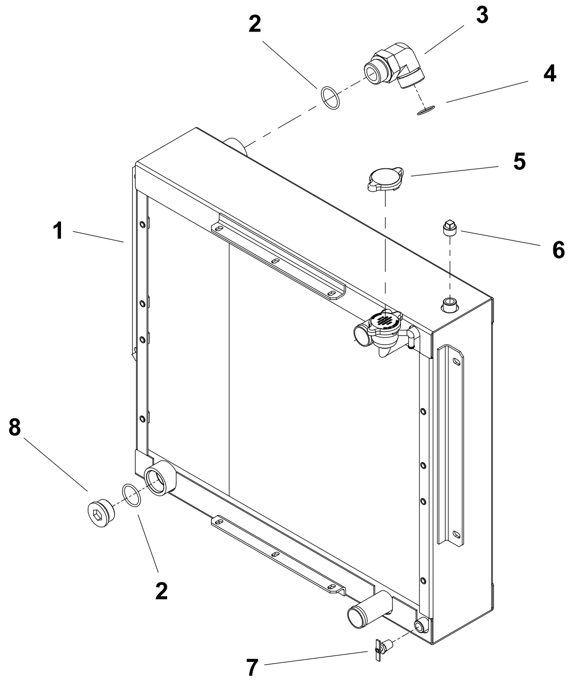

Figure 18

1.	Radiator/oil cooler	5.	Radiator cap
2.	O−ring	6.	Plug
3.	90º fitting (2 used)	7.	Draincock
4.	O−ring	8.	Hydraulic plug

14. If necessary, remove draincock (item 7 in Figure 18), plug (item 6 in Figure 18) and hydraulic plug (item 8 in Figure 18) from radiator/oil cooler.
15. If hydraulic fittings (item 3 in Figure 18) are to be removed from oil cooler, mark fitting orientation to allow correct assembly. Remove fittings from cooler and discard O−rings.

Installation (Figure 16)

1. If hydraulic fittings (item 3 in Figure 18) were removed from oil cooler, lubricate and place new O−rings onto fittings. Install fittings into oil cooler 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 5–9)).
2. If hydraulic plug (item 8 in Figure 18) was removed from oil cooler, place new O−ring on plug and install into oil cooler port.
3. If draincock (item 7 in Figure 18) or plug (item 6 in Figure 18) were removed from radiator, apply thread sealant and install draincock and plug into radiator openings (Figure 18).
4. Remove plugs placed in radiator and hose openings during the removal procedure.
5. Carefully position radiator/oil cooler to the radiator mount. Make sure that spacers (item 32) are positioned in hood seals. Secure radiator/oil cooler and recirculation barriers (items 24 and 25) in place with four (4) flange head screws and flange nuts.

Installation (Figure 16) (continued)

6. Position lower radiator shroud to radiator/oil cooler. Install fasteners to secure lower shroud to radiator. Do not fully tighten fasteners until after engine cooling fan motor, fan and upper shroud are installed.
7. Install engine cooling fan motor and bracket assembly, cooling fan and upper radiator shroud to machine (see Engine Cooling Fan Motor (page 5–147)). Make sure that clearance between shrouds and fan is at least 4.6 mm (0.180 in) at all points. Also, make sure that all fasteners for radiator shrouds are fully tightened.
8. Connect reservoir hose (item 39) to the radiator vent tube.
9. Connect upper and lower radiator hoses to the radiator and secure with hose clamps.
10. Remove caps or plugs from hydraulic hoses and fittings that were placed during disassembly. Connect hydraulic hoses to oil cooler fittings (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–7)).
11. Install plenum assembly (item 5) to crossover plate and secure with flange head screws and flange nuts.
12. Install air cleaner intake hose (item 8) to the air cleaner and plenum.
13. Make sure that radiator draincock is closed. Fill radiator with coolant.
14. Check and adjust hydraulic oil level in hydraulic reservoir.
15. Start engine. Check for fluid leaks and proper engine operation.
16. After running engine for a short time, stop engine and make sure radiator and hydraulic reservoir are full. Add correct fluids if necessary.
17. Install hood on the machine (see Hood (page 8–26)).

Engine

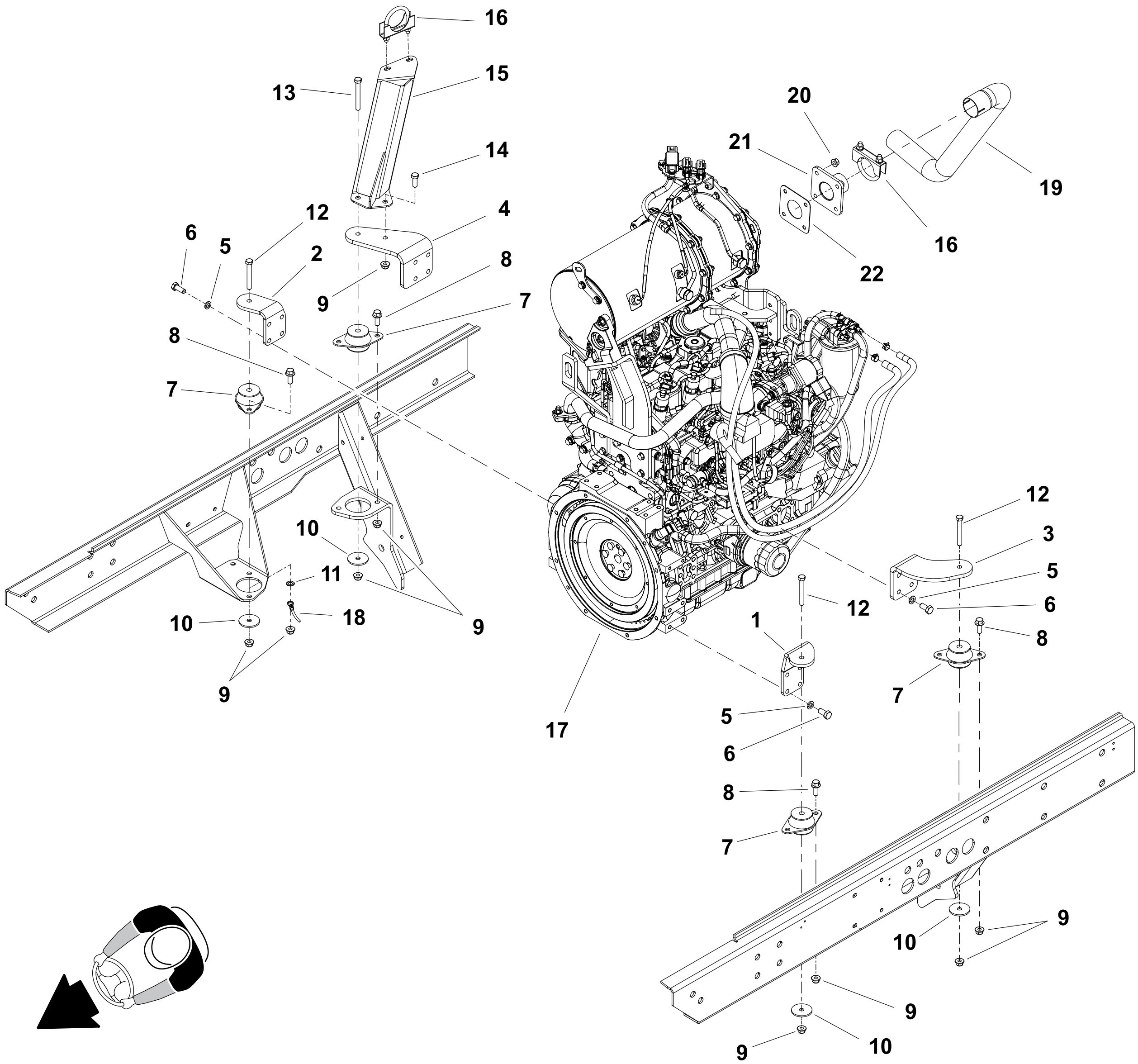

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Figure 19

1. LH front engine mount bracket
2. RH front engine mount bracket
3. LH rear engine mount bracket
4. RH rear engine mount bracket
5. Lock washer (16 used)
6. Cap screw (16 used)
7. Engine mount (4 used)
8. Flange head screw (8 used)
9. Flange nut (13 used)
10. Rebound washer (4 used)
11. Lock washer
12. Cap screw (3 used)
13. Cap screw
14. Cap screw
15. Tailpipe support bracket
16. Clamp
17. Engine
18. Negative battery cable
19. Tailpipe
20. Flange nut (4 used)
21. Exhaust flange
22. Exhaust gasket

Engine Removal (Figure 19)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.
2. Remove hood from the machine (see Hood (page 8–26)).
3. Remove battery cover. Disconnect negative battery cable from the battery first and then disconnect positive battery cable.

CAUTION

Do not open radiator cap or drain coolant if the radiator or engine is hot. Allow the engine and exhaust system to cool before working on the engine. Pressurized, hot coolant can escape and cause burns.

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

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4. Drain coolant from radiator into a suitable container (see Radiator and Oil Cooler Assembly (page 4–15)). Disconnect upper and lower radiator hoses from the radiator.
5. Remove air cleaner system from engine (see Air Cleaner System (page 4–9)).
6. Note location of cable ties used to secure wire harness. Disconnect the following engine electrical connections:
   A. The engine wire harness from the machine wire harness.
   B. The positive battery cable and fusible link harness from the engine starter motor.
   C. The negative battery cable, engine ground cable and main wire harness ground wires secured with a cap screw and external lock washer to the right side of the engine below the starter motor. Note location of lock washer for assembly purposes.

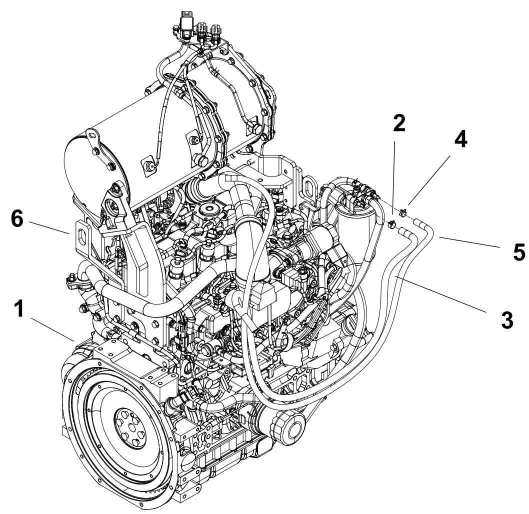

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Figure 20
(Models 30885 and 30887)

1. Engine
2. Hose clamp
3. Fuel supply hose
4. Hose clamp
5. Fuel return hose
6. Front lift bracket

Engine Removal (Figure 19) (continued)

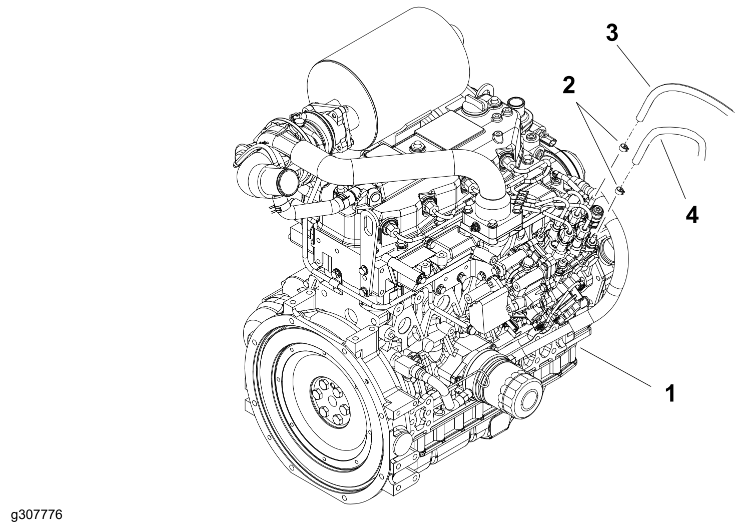

Figure 21

(Models 30893, 30893TE, 30899 and 30899TE)

1. Engine	3. Fuel return hose
2. Hose clamp	4. Fuel supply hose

7. Disconnect fuel supply and return hoses from injection pump (Figure 20 or Figure 21). Cap fuel hoses and injector pump fittings to prevent contamination.
8. Remove engine cooling fan motor and bracket assembly, upper radiator shroud and cooling fan from machine (see Engine Cooling Fan Motor (page 5–147)).
9. Remove fasteners that secure lower radiator shroud to radiator (see Radiator and Oil Cooler Assembly (page 4–15)). Remove lower shroud from machine.

IMPORTANT

The hydraulic pump assembly can remain in machine during engine removal. To prevent pump assembly from shifting or falling, make sure to support pump assembly before piston (traction) pump mounting fasteners are removed.

10. Support hydraulic pump assembly to prevent it from shifting or falling. Remove fasteners that secure piston (traction) pump to engine (see Piston (Traction) Pump (page 5–102)).
11. Make sure all cable ties securing the wire harness, fuel lines and hydraulic hoses to the engine are removed.
12. Connect lift or hoist to the lift brackets on engine.
13. Remove flange nuts, rebound washers and cap screws that secure the engine mount brackets to the engine mounts.

CAUTION

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

Engine Removal (Figure 19) (continued)

IMPORTANT

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

14. Carefully move engine away from the hydraulic pump assembly to disengage the pump input shaft from the coupler on the engine flywheel. Once the engine has cleared the hydraulic pump, carefully lift engine from the machine.
15. If necessary, remove exhaust tailpipe, tailpipe support and engine mount brackets from the engine using Figure 19 as a guide.

Engine Installation (Figure 19)

1. If removed, install engine mount brackets, tailpipe support and exhaust tailpipe to the engine using Figure 19 as a guide.
2. Connect lift or hoist to the lift brackets on engine.

CAUTION

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

IMPORTANT

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

3. Carefully lower engine into the machine and move engine toward the hydraulic pump assembly to engage the pump input shaft with the coupler on the engine flywheel.
4. Align engine mount brackets to the engine mounts (item 7). Secure engine mount brackets to engine mounts with cap screws, rebound washers and flange nuts.
5. Secure hydraulic pump assembly to engine (see Piston (Traction) Pump (page 5–102)).
6. Position lower radiator shroud to radiator/oil cooler (see Radiator and Oil Cooler Assembly (page 4–15)). Install fasteners to secure lower shroud to radiator. Do not fully tighten fasteners until after engine cooling fan motor, fan and upper shroud are installed.
7. Install engine cooling fan motor and bracket assembly, cooling fan and upper radiator shroud to machine (see Engine Cooling Fan Motor (page 5–147)). Make sure that clearance between shrouds and fan is at least 4.6 mm (0.180 in) at all points. Also, make sure that all fasteners for radiator shrouds are fully tightened.
8. Remove caps from fuel hoses and injector pump fittings that were placed during engine removal to prevent contamination. Connect fuel supply and return hoses to injection pump (Figure 20 or Figure 21). Secure hoses with hose clamps.

Engine Installation (Figure 19) (continued)

9. Connect the following engine electrical components:

   A. The engine wire harness to the machine wire harness.

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

   C. The negative battery cable, engine ground cable and main wire harness ground wires to the right side of the engine below the starter motor with external lock washer and cap screw. Lock washer should be positioned next to engine casting.

10. Using notes taken during engine removal, secure wires with cable ties in proper locations.

11. Install air cleaner system to engine (see Air Cleaner System (page 4–9)).

12. Connect coolant hoses to the radiator. Make sure radiator draincock is closed. Fill radiator and reservoir with coolant.

13. Check position of wires, fuel lines and hydraulic hoses for proper clearance with rotating, high temperature and moving components.

14. Connect positive battery cable to battery first and then negative battery cable. Secure battery cover to machine.

15. Check and adjust engine oil level as needed.

16. Bleed air from the cooling system. Check and adjust the coolant levels accordingly.

17. Check and adjust hydraulic reservoir oil level as needed.

18. Prime the fuel system (see Priming the Fuel System (page 4–13)).

19. Start engine and operate hydraulic controls to properly fill hydraulic system (see Charge Hydraulic System (page 5–94)).

20. Install hood onto the machine (see Hood (page 8–26)). Close and secure hood.

Pump Adaptor Plate

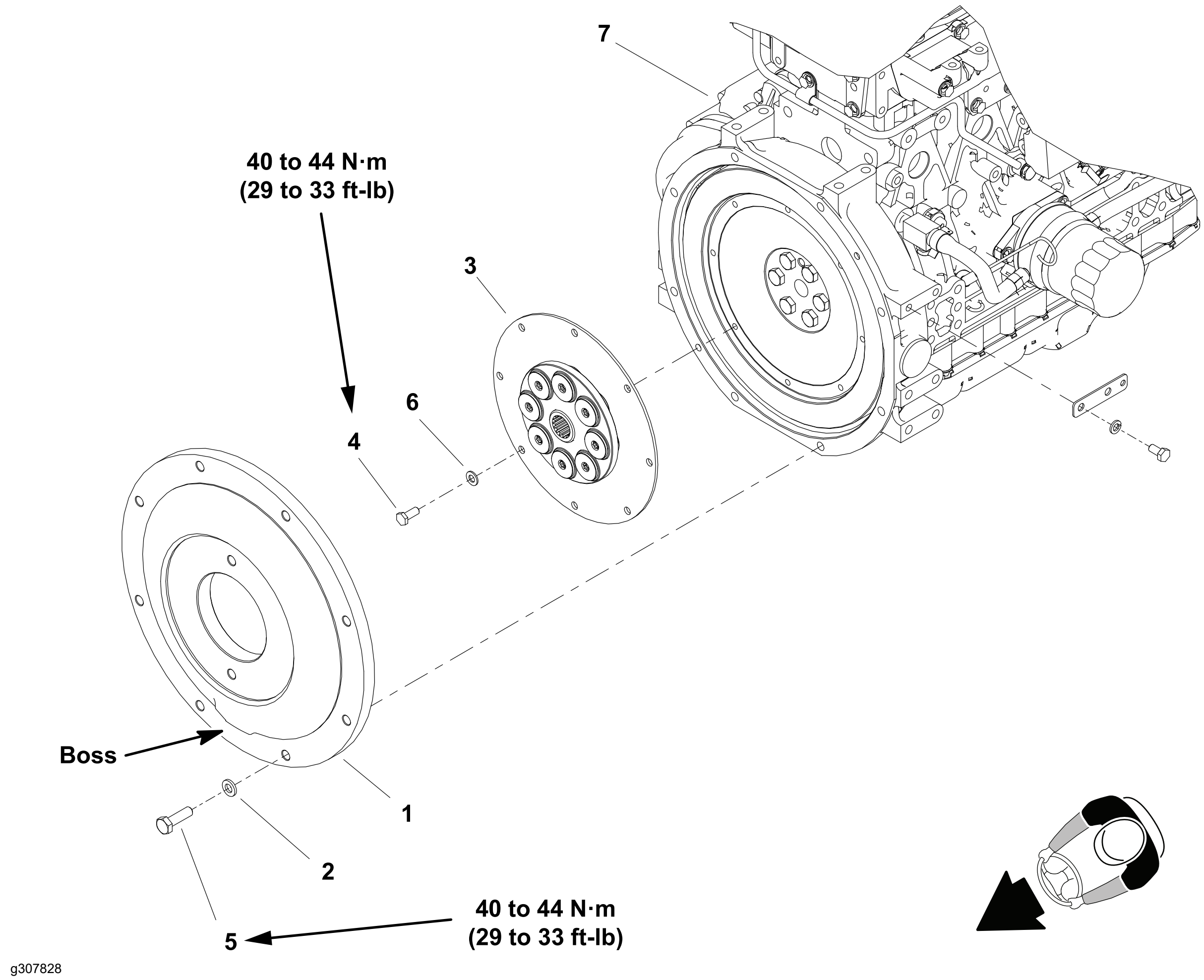

Figure 22

1. Flywheel plate
2. Hardened washer (8 used)
3. Spring coupler
4. Cap screw (8 used)
5. Cap screw with patchlock (8 used)
6. Hardened washer (8 used)
7. Engine assembly

Coupler Removal (Figure 22)

Note: The hydraulic pump assembly needs to be removed from engine before coupler can be removed.

1. If engine is in machine, remove hydraulic pump assembly (see Piston (Traction) Pump (page 5–102)).
2. Remove flywheel plate and spring coupler from engine using Figure 22 as a guide.

Coupler Installation (Figure 22)

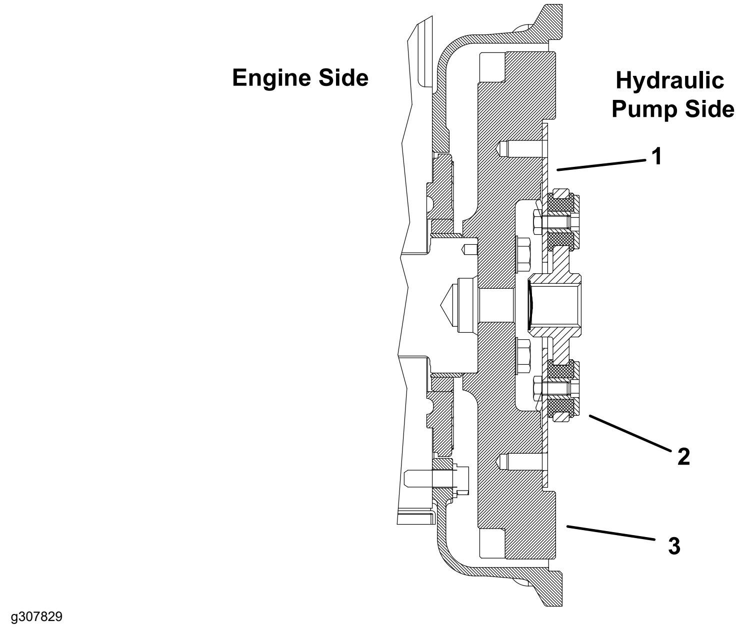

Figure 23

1. Coupler
2. Coupler hub
3. Engine flywheel

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1. Position spring coupler to engine flywheel and align mounting holes. Make sure that coupling hub is away from engine flywheel (Figure 23).
2. Secure coupler to flywheel with eight (8) cap screws and hardened washers. Torque cap screws in a crossing pattern from **40 to 44 N·m (29 to 33 ft−lb)**.
3. Position flywheel plate to engine. Make sure that boss on plate is orientated down. Secure flywheel plate with eight (8) cap screws (item 7) and hardened washers. Torque cap screws in a crossing pattern from **40 to 44 N·m (29 to 33 ft−lb)**.
4. If engine is in machine, install hydraulic pump assembly (see Piston (Traction) Pump (page 5–102)).

Exhaust System (Models 30885 and 30887)

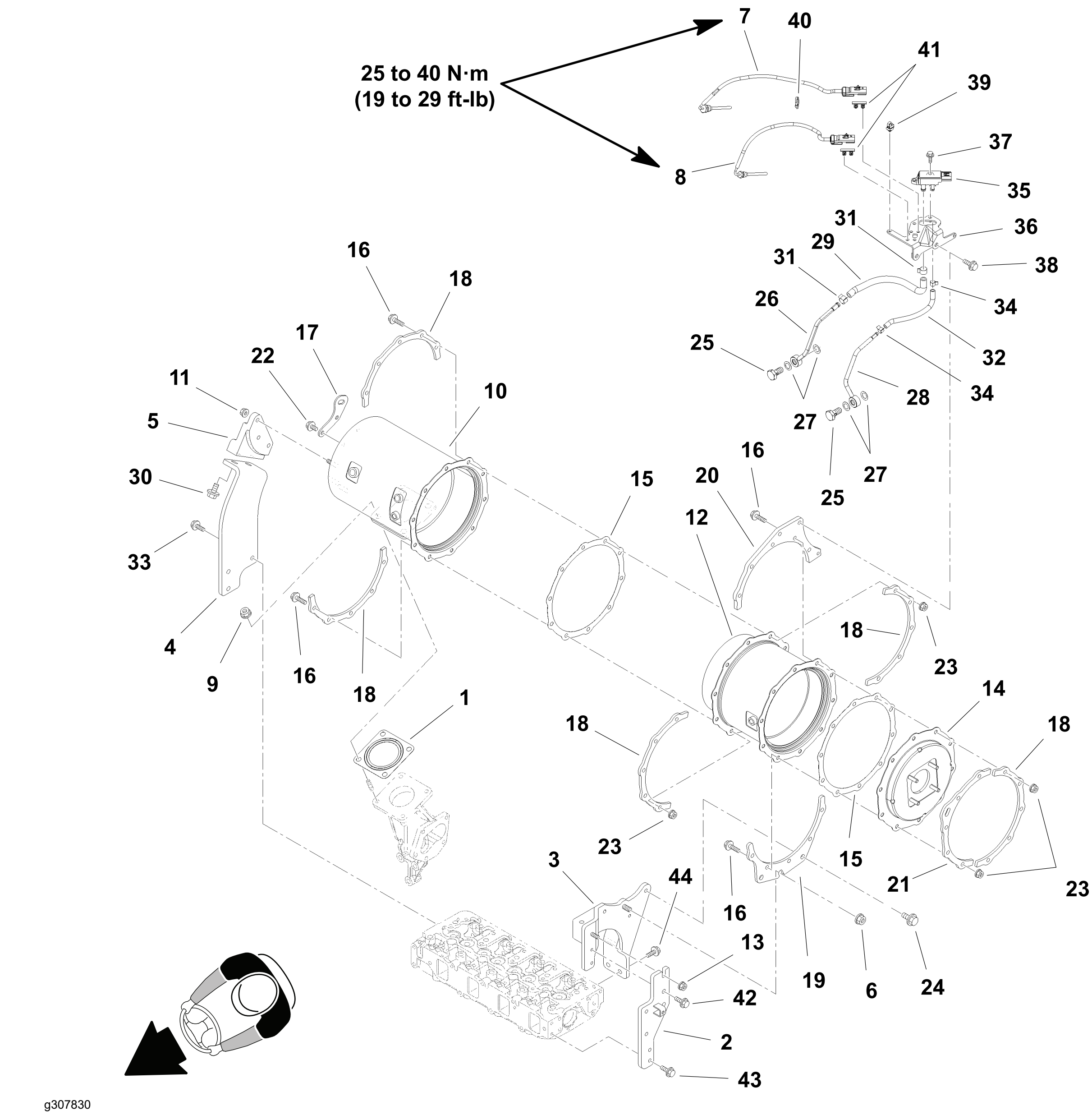

Figure 24

1. Gasket
2. Exhaust assembly stay
3. Exhaust assembly stay
4. Exhaust assembly stay
5. Exhaust assembly stay
6. Nut
7. DOC temp sensor (inlet)
8. DOC temp sensor (outlet)
9. Nut (4 used)
10. DOC assembly
11. Nut (3 used)
12. DPF assembly
13. Nut
14. Outlet flange
15. DPF gasket (2 used)
16. Bolt (20 used)
17. DPF lifter
18. DPF stiffener (5 used)
19. DPF stiffener
20. DPF stiffener
21. DPF stiffener
22. Bolt (2 used)
23. Nut (20 used)
24. Bolt (2 used)
25. Pipe joint bolt (2 used)
26. Exhaust pressure pipe (DPF inlet)
27. Sensor gasket (4 used)
28. Exhaust pressure pipe (DPF outlet)
29. Exhaust hose
30. Bolt (2 used)
31. Hose clip (2 used)
32. Hose
33. Bolt (3 used)
34. Hose clip (2 used)
35. Pressure sensor
36. Sensor bracket
37. Bolt (2 used)
38. Bolt (2 used)
39. Clip band
40. Band
41. Connector clip (2 used)
42. Bolt (2 used)
43. Bolt (2 used)
44. Bolt (2 used)

Groundsmaster models that are powered by a diesel engine that complies with EPA Tier 4 emission regulations are equipped with an exhaust system that includes a diesel oxidation catalyst (DOC) and a diesel particulate filter (DPF). These exhaust components require service or component replacement at intervals identified in your *Operator's Manual*. Additionally, the exhaust assembly uses two (2) temperature sensors and a pressure differential sensor which are used as inputs for the engine ECU to monitor the operation of the exhaust system.

The diesel particulate filter (DPF) is cleaned periodically through a regenerative process that is controlled by the engine ECU (see Engine (Models 30885 and 30887) (page 2–4)). The InfoCenter display will identify the status of DPF regeneration. At recommended intervals, DPF reconditioning is necessary which will require exhaust system disassembly, DPF removal and DPF reconditioning by a company that has the necessary equipment. Once the DPF has gone through the reconditioning process, it can be re−installed in the exhaust system. Contact your Toro Distributor for information on reconditioning the DPF.

The diesel oxidation catalyst (DOC) has a service life expectancy and requires replacement at recommended intervals. Replacement of the DOC will require exhaust system disassembly, removal of the existing DOC and installation of the new DOC. Contact your Toro Distributor for information.

Refer to the *Parts Catalog* to identify individual components for the exhaust system on your Groundsmaster. Contact your Toro Distributor for information.

Removal

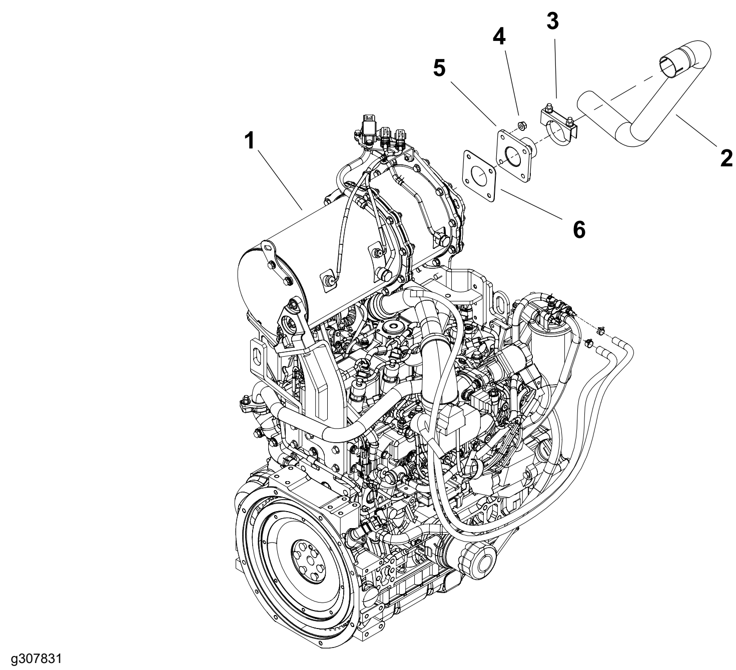

Figure 25

1. Engine
2. Exhaust pipe
3. Clamp assembly
4. Flange nut (4 used)
5. Exhaust flange
6. Exhaust gasket

Note: The exhaust system DPF and DOC can be removed from the exhaust system without removing the entire exhaust from the engine. Certain engine service procedures (e.g. rocker cover removal for valve clearance adjustment) will require removal of the exhaust system assembly.

Removal (continued)

CAUTION

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

1. Raise and support hood to gain access to exhaust system. Allow engine and exhaust to cool before doing any disassembly of exhaust system components.
2. Remove exhaust system components from the engine as necessary using Figure 24 and Figure 25 as guides. Discard all removed gaskets (items 1 and 15 in Figure 24 or item 6 in Figure 25).

Installation

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

1. Make sure to install new gaskets in place of all gaskets that were removed. Do not use any type of gasket sealant on gasket or flange surfaces.
2. Assemble all removed exhaust system components using Figure 24 and Figure 25 as guides.
   A. If exhaust sensors (items 7 and 8 in Figure 24) were removed, torque sensors from **25 to 40 N·m (19 to 29 ft−lb)**.
   B. If exhaust pressure pipes (items 26 and 28 in Figure 24) were removed, replace sensor gaskets (item 27) on both sides of the pressure pipe fitting.
   C. If DPF stiffeners (items 18, 19, 20 and 21 in Figure 24) were loosened or removed, tighten fasteners that secure stiffeners before tightening fasteners that secure exhaust system to DPF stays.

Hydraulic System

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Additional Reference Materials

Danfoss K And L Frame Variable Motors Service Manual
Danfoss Steering Unit Type OSPM Service Manual
Danfoss MP1 Closed Circuit Axial Piston Pumps Service Manual

General Information

Operator's Manual

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

Check Hydraulic Fluid

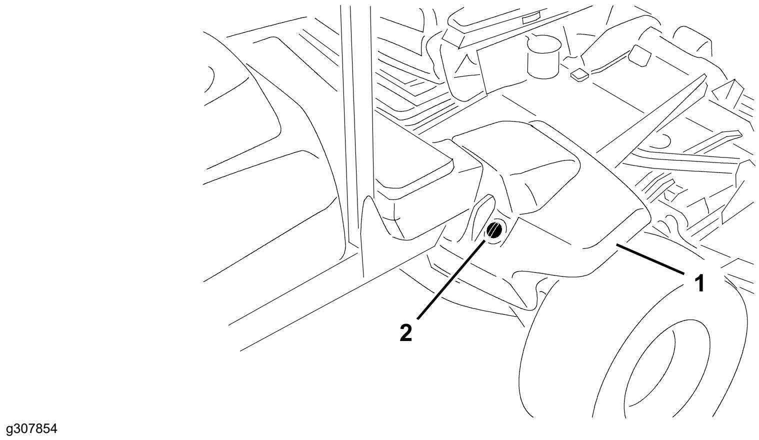

Figure 26

1. Hydraulic reservoir
2. Reservoir cap

The Groundsmaster hydraulic system is designed to operate on anti−wear hydraulic fluid. The hydraulic reservoir located beneath the operator seat holds approximately 28.4 liters (7.5 U.S. gallons) of hydraulic fluid. **Check level of hydraulic fluid daily**. See *Operator's Manual* for fluid level checking procedure and oil recommendations.

Towing Traction Unit

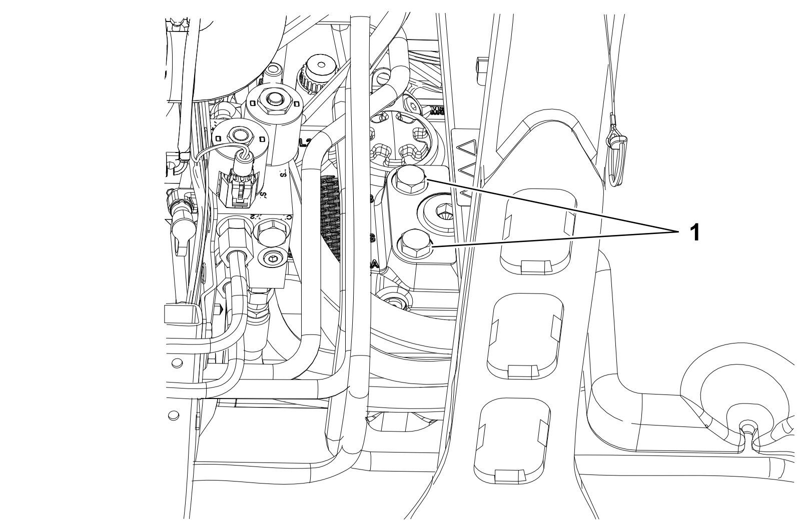

Figure 27

1. Bypass valve location

Towing Traction Unit (continued)

IMPORTANT

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

If it becomes necessary to tow (or push) the machine, tow (or push) in a forward direction only and at a speed below 5 kph (3 mph) and for a distance less than 0.4 km (0.25 mile). The piston (traction) pump is equipped with two (2) bypass valves that need to be turned three (3) turns counterclockwise before towing or pushing the machine. The bypass valves are on the top of the piston pump (Figure 27). Do not turn bypass valves when engine is running.

IMPORTANT

Do not loosen relief valves when engine is running.

Before returning machine to service, tighten both of the relief valves until seated. Then, torque relief valves to **70 N·m (52 ft−lb)**.

IMPORTANT

If the machine must to be pushed or towed in reverse, the check valve in the rear traction manifold must also be bypassed. To bypass this check valve, connect a hydraulic hose assembly to the reverse traction pressure test port, located on the piston (traction) pump, and on the port located in−between ports M8 and P2 on the rear traction manifold which is located behind the front tire. Use Toro part numbers 95−8843 (hydraulic hose), 95−0985 (quantity 2) (coupler fitting) and 340−77 (quantity 2) (hydraulic fitting).

Relieving Hydraulic System Pressure

Before disconnecting or performing any work on the hydraulic system, all pressure in the hydraulic system must be relieved. Park machine on a level surface, make sure that PTO switch is OFF, lower cutting decks fully, stop engine and engage parking brake. Wait for all moving parts to come to a complete stop.

System pressure in lift circuit is relieved when the cutting decks are fully lowered.

System pressure in mow circuit is relieved when the PTO switch is disengaged.

To relieve hydraulic pressure in traction circuit, turn ignition switch to ON (engine not running) and move traction pedal to both forward and reverse directions. Turn ignition switch to OFF after relieving traction circuit pressure.

To relieve hydraulic pressure in steering circuit, rotate steering wheel in both directions.

After all hydraulic system pressures have been relieved, remove key from ignition switch.

Traction Circuit Component Failure

The traction circuit on Groundsmaster 4500−D and 4700−D machines is a closed loop system that includes the piston (traction) pump, two (2) front wheel motors and the rear axle motor. If a component in the traction circuit should fail, debris and contamination from the failed component will circulate throughout the traction circuit. This contamination can damage other components in the circuit so it must be removed to prevent additional component failure.

The recommended method of removing traction circuit contamination would be to temporarily install the Toro high flow hydraulic filter (see Special Tools (page 2–16)) into the circuit. This filter should be used when connecting hydraulic test gauges in order to test traction circuit components or after replacing a failed traction circuit component (e.g. traction (piston) pump 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 oil flow throughout the circuit. The filter will remove contamination from the traction circuit during operation. Because the Toro high flow filter is bi−directional, the traction circuit can be operated in both the forward and reverse direction. The filter should be removed from the machine after contamination has been removed from the traction circuit. See Filtering Closed−Loop Traction Circuit (page 5–92) for additional information on using the Toro high flow hydraulic filter.

The alternative to using the Toro high flow hydraulic filter kit after a traction circuit component failure would be to disassemble, drain and thoroughly clean all components, 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) (page 5–7).

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)

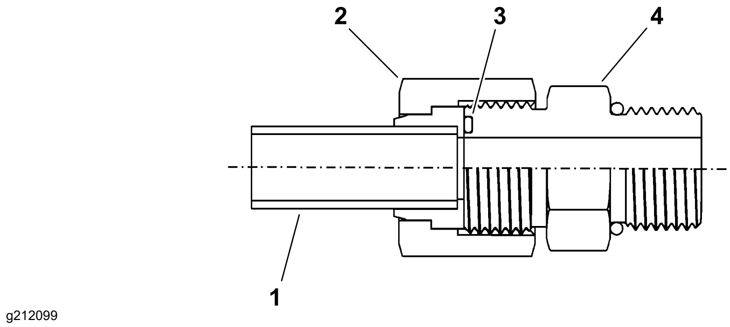

Figure 28

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 28).
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 Torque Specifications (page 2–8). 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 Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–9).

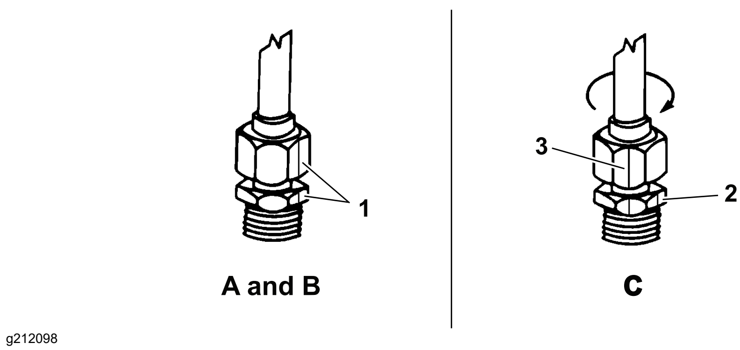

Figure 29

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

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

Hose/Tube Installation Torque Table

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

Flats From Wrench Resistance Table

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

5. If a torque wrench is not available or if space at the swivel nut prevents the use of a torque wrench, use the alternative procedure Flats From Wrench Resistance (FFWR) given below.

   A. Use a wrench to tighten the swivel nut onto the fitting until you feel light resistance with the wrench—approximately **3.39 N·m (30 in-lb)**.

   B. Put a mark on the swivel nut and body of the fitting (item 1 in Figure 29). If connecting a hose, hold the hose in alignment with a wrench to prevent the hose from turning.

   C. Use a wrench to tighten the nut to the correct Flats From Wrench Resistance (compare items 2 and 3 in Figure 29).

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

Installing a Non-Adjustable Fitting

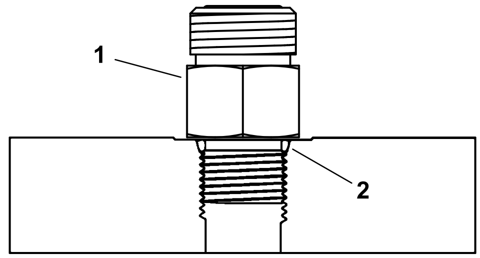

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Figure 30

1. Fitting
2. O-ring

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1. Ensure that all the threads, the sealing surfaces of fitting, and the component port are free of burrs, nicks, scratches, or unwanted material.
2. To help prevent a hydraulic leak, replace the O-ring when you open the connection.
3. Lightly lubricate the O-ring with clean hydraulic fluid. Ensure that the threads of the fitting are clean with no lubricant applied.

IMPORTANT

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

4. Install the fitting into the port, then use a torque wrench and socket to tighten the fitting to the recommended torque value within the specified range of torque values; refer to the Fitting Installation Torque Table (page 5–11).

   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 2–9).

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 5–11).

   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 5–11).

Installing an Adjustable Fitting

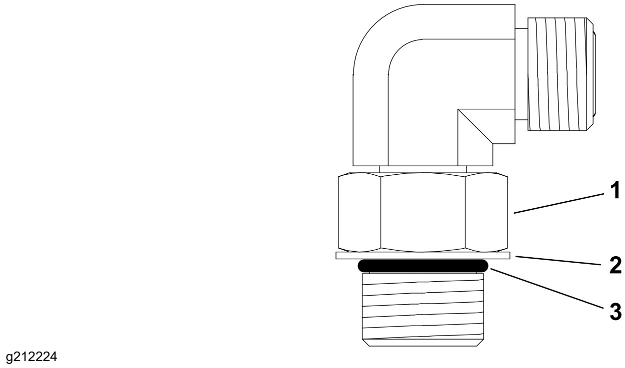


Figure 31

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

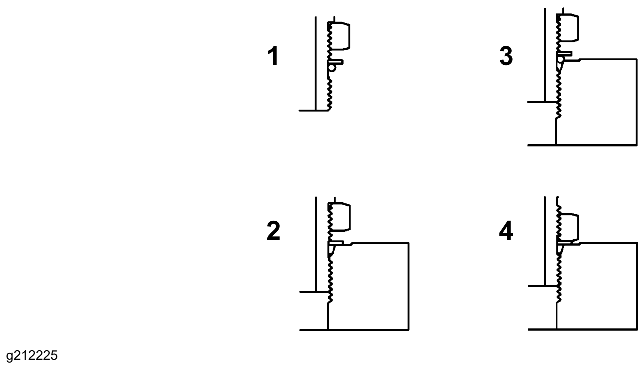


Figure 32

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

1. Ensure that all the threads, the sealing surfaces of fitting, and the component port are free of burrs, nicks, scratches, or unwanted material.
2. To help prevent a hydraulic leak, replace the O-ring when you open the connection.
3. Lightly lubricate the O-ring with clean hydraulic fluid. Ensure that the threads of the fitting are clean with no lubricant applied.
4. Turn back the lock nut as far as possible. Ensure that the back-up washer is not loose and it is pushed up as far as possible (Step 1 in Figure 32).
5. Install the adjustable fitting into the port by hand until the washer contacts the face of the port (Step 2 in Figure 32).
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 32). 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.

Installing an Adjustable Fitting (continued)

7. Tighten the fitting lock nut (Step 4 in Figure 32):

   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 5–11). 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 2–9).

   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 5–11).

   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 5–11).

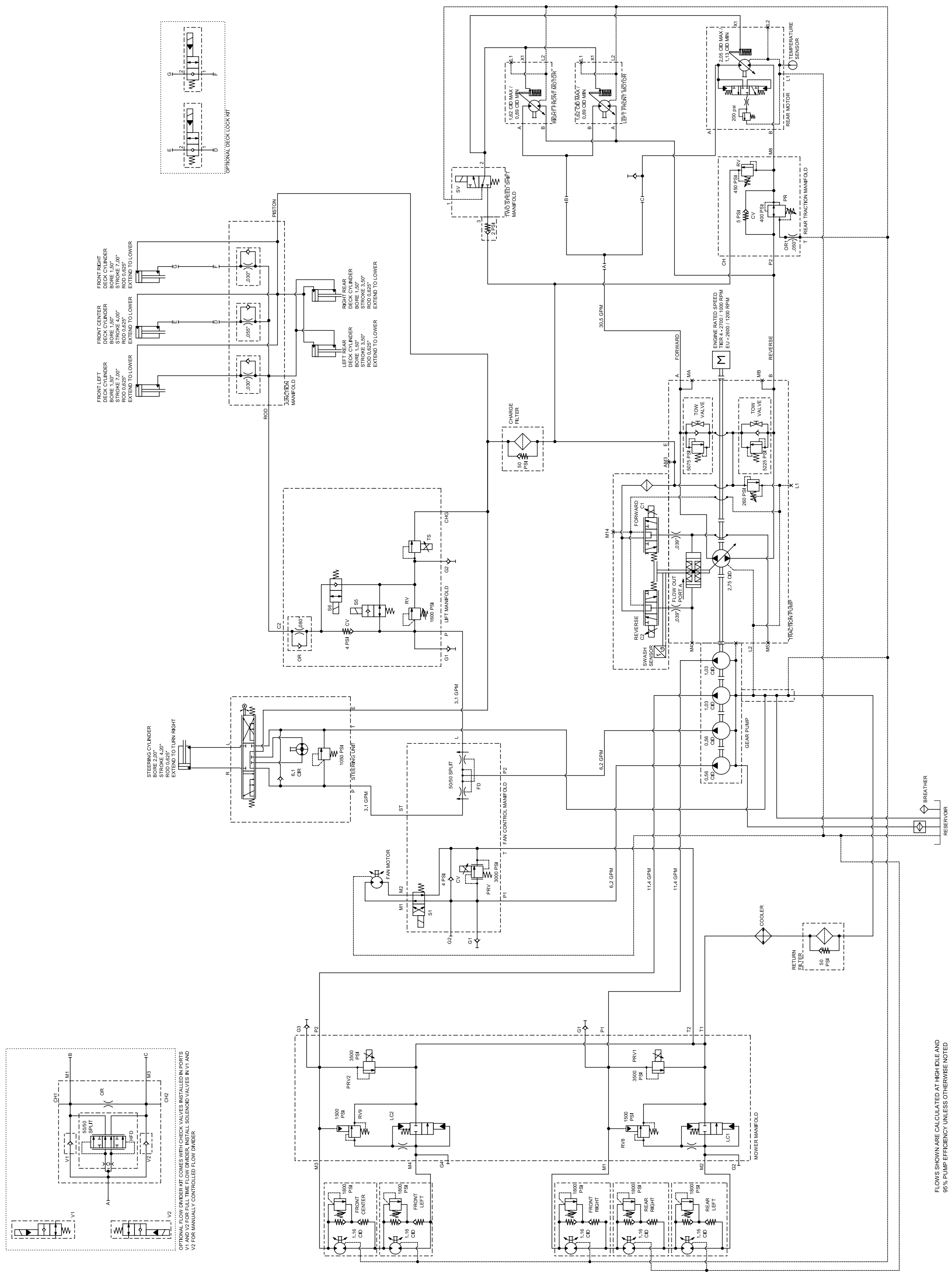
Fitting Installation Torque Table

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



g307891

Figure 33

Groundsmaster 4500-D

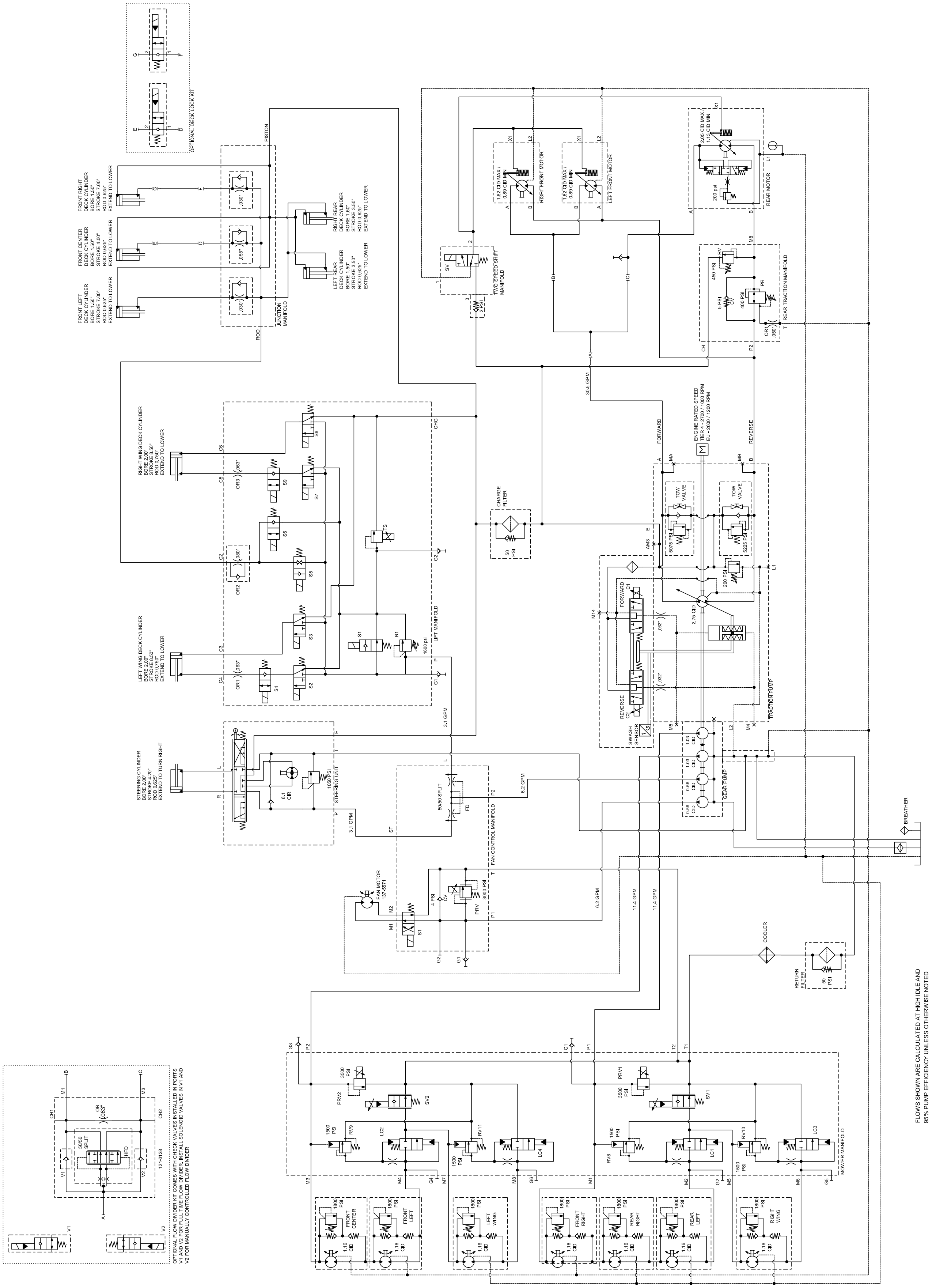


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Figure 34

Groundsmaster 4700-D

Hydraulic Flow Diagrams

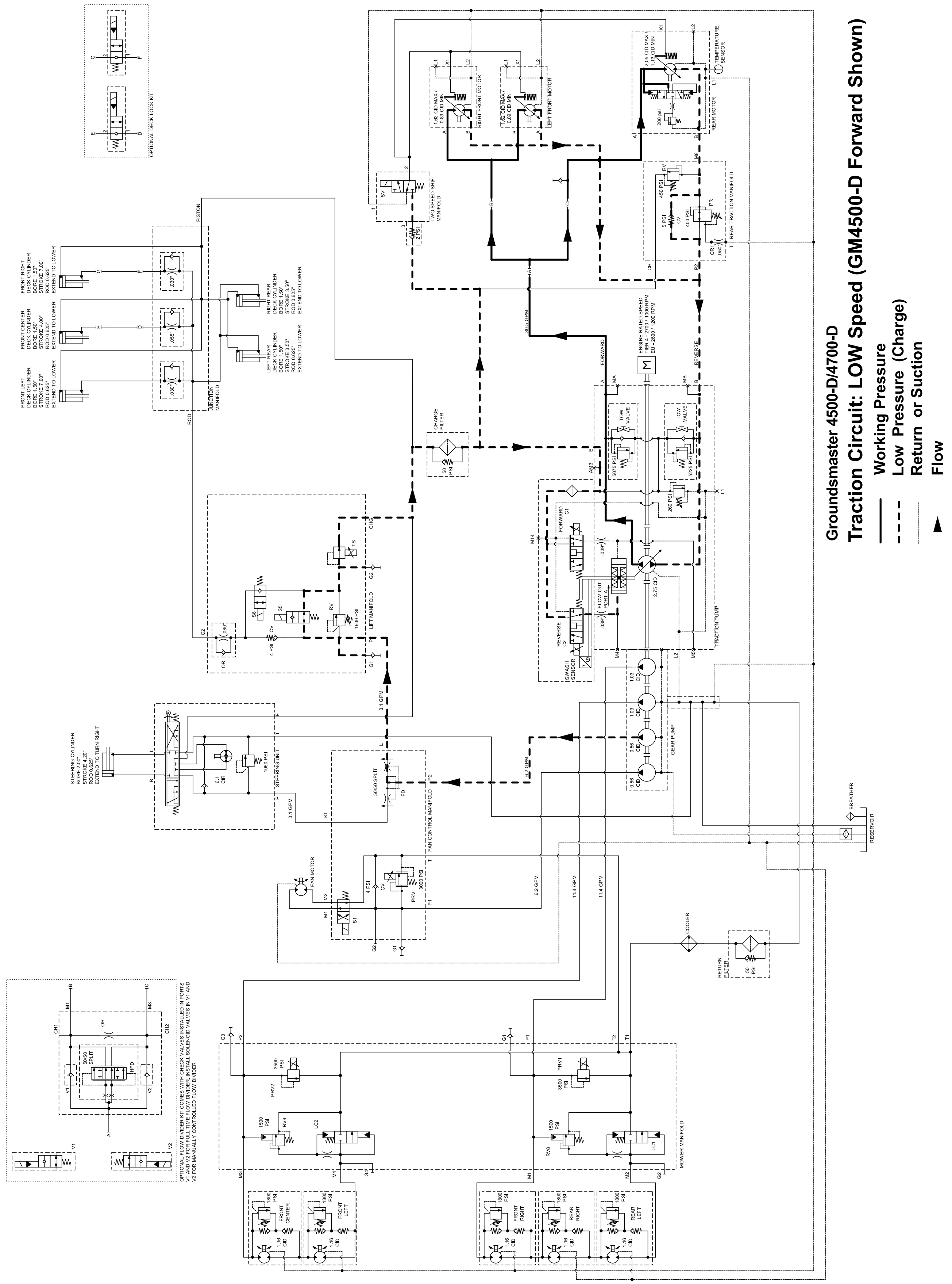


Figure 35

Traction Circuit: LOW Speed

The traction circuit piston pump is a variable displacement pump that is directly coupled to the engine flywheel. This pump utilizes an integral electro−hydraulic servo piston assembly that controls the rate and direction of hydraulic flow. Pressing the traction pedal rotates a potentiometer that provides an input to the machine TEC controller. The controller in turn sends a corresponding PWM (Pulse Width Modulation) output to the electronic pump control to rotate the pump swashplate accordingly to control pump output and direction. The swashplate angle sensor is attached to the pump to provide the position of the swashplate. Traction circuit oil is directed to the dual displacement front wheel and rear axle motors. Operating pressure on the high pressure side of the closed traction circuit loop is determined by the amount of load developed at the wheel and axle motors. As the traction load increases, circuit pressure can increase to relief valve settings: 350 bar (5075 PSI) in forward and 360 bar (5225 PSI) in reverse. If traction circuit pressure exceeds the relief setting, oil flows through the piston pump relief valve to the low pressure side of the closed loop traction circuit.

Front wheel and rear axle motors are positive displacement, two speed variable motors. The dual displacement wheel and axle motors allow operation in either LOW (mow) or High (transport) speed. The motors are spring biased to maximum displacement for LOW speed and are hydraulically shifted to minimum displacement for High speed. The rear axle motor includes a flushing valve that bleeds off a small amount of hydraulic oil for cooling of the closed loop traction circuit. The charge circuit replenishes oil that is bled from the traction circuit by the flushing valve.

The Smart Power™ feature prevents the engine from slowing down in heavy load conditions (e.g. cutting tall grass) by automatically decreasing the traction speed if necessary. With a reduced traction speed, the cutting blades can continue to be at optimum speed.

An optional traction circuit flow divider is available that equally splits traction pump flow between the front wheel motors and rear axle motor to prevent excessive circuit flow going to a spinning wheel. If equipped, the front traction manifold which includes the flow divider is mounted to the right side of the front frame.

The piston pump, front wheel motors and rear axle motor use small amounts of hydraulic fluid for internal lubrication. Fluid is designed to leak across traction pump and motor components into the case drain. This leakage results in the loss of hydraulic fluid from the closed loop traction circuit that must be replaced. The charge circuit is designed to replace this traction circuit leakage. The gear pump section that supplies oil to the steering and lift/lower circuits also provides oil for the charge circuit.

Gear pump flow for the charge circuit is directed through the oil filter and to the low pressure side of the closed loop traction circuit. Charge pressure is limited to 18 bar (260 PSI) by a relief valve located in the piston pump.

Forward Direction

With the armrest console High and Low speed switch in the LOW speed position, the solenoid valve in the two speed shift manifold is not energized. The front wheel motors and rear axle motor are at their maximum displacement when in LOW speed providing a slower traction speed for mowing conditions.

Forward Direction (continued)

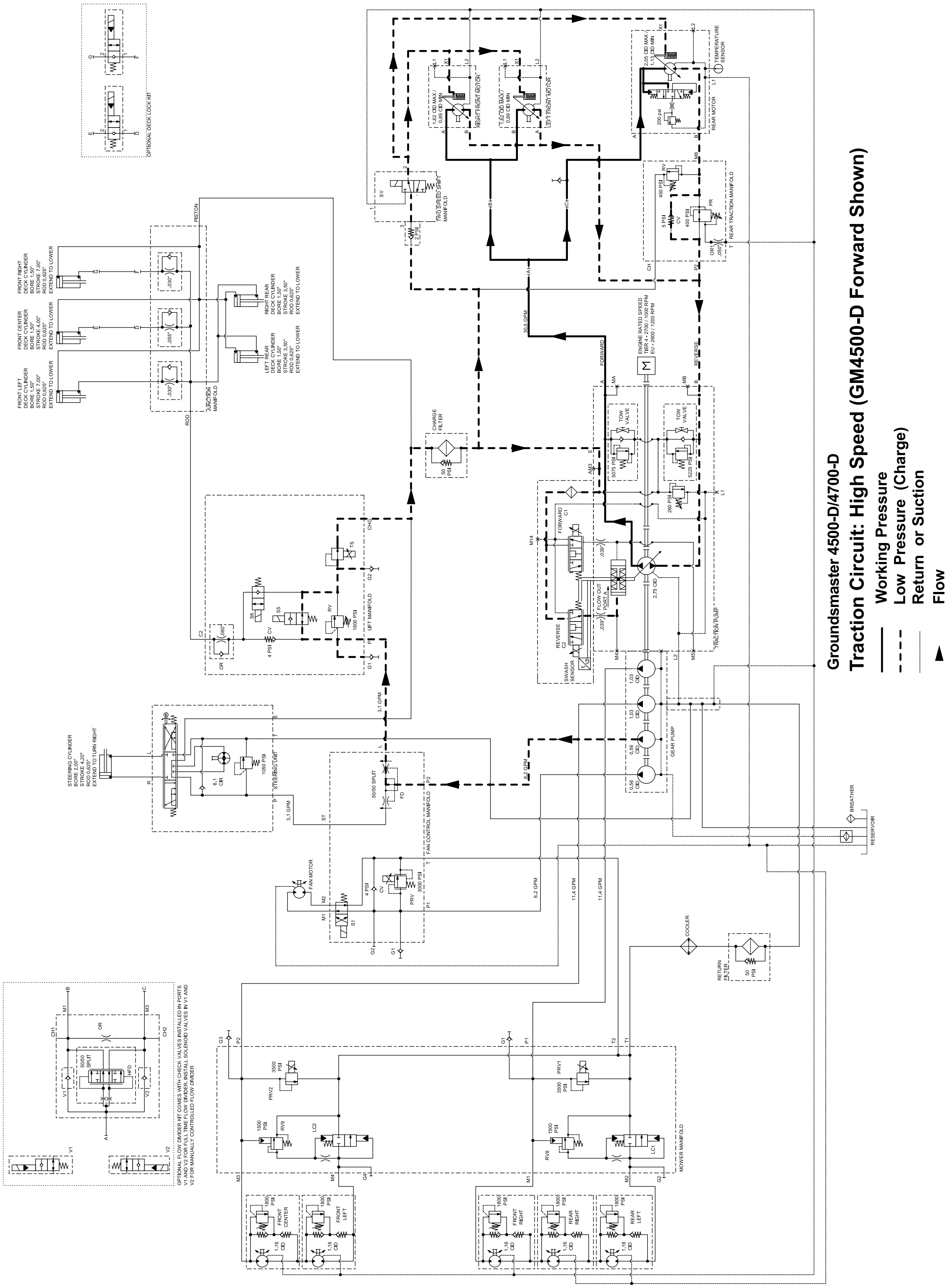
When in LOW speed position with the traction pedal pushed in the forward direction, oil from the piston pump is directed to the front wheel motors and rear axle motor through a parallel system. Oil flow to the front wheel motors drives the motors in the forward direction and then returns to the piston pump. Oil flow to the rear axle motor drives the motor in the forward direction. Oil returning from the axle motor enters the rear traction manifold at the M8 port. Flow bypasses the PR cartridge through the CV check valve, out manifold port P2 and returns to the piston pump.

When going down a hill, the tractor becomes an over-running load that drives the front wheel and rear axle motors. In this condition, the rear axle motor could lock up as the oil pumped from the motor increases pressure as it returns to the piston pump. To prevent rear wheel lock up, an adjustable relief valve (RV) in the rear traction manifold reduces rear axle motor pressure created in down hill, dynamic braking conditions.

Reverse Direction

The traction circuit operates essentially the same in reverse LOW speed as it does in the forward direction. However, the flow through the circuit is reversed. Oil flow from the piston pump is directed to the front wheel motors and also to the rear traction manifold. The oil to the front wheel motors drives them in the reverse direction and then returns to the piston pump. The oil to the rear traction manifold enters the manifold at port P2 and flows through pressure reducing valve (PR) which limits the down stream pressure to the rear axle motor to 27.6 bar (400 PSI) so the rear wheels will not scuff the turf during reverse operation. This reduced pressure flow is directed out rear traction manifold port M8 to drive the rear axle motor in reverse. Return oil from the rear motor returns to the piston pump.

Traction Circuit: HIGH Speed



g307905

Figure 36

The traction circuit piston pump is a variable displacement pump that is directly coupled to the engine flywheel. This pump utilizes an integral electro-hydraulic servo piston assembly that controls the rate and direction of hydraulic flow. Pressing the traction pedal rotates a potentiometer that provides an input to the machine TEC controller. The controller in turn sends a corresponding PWM (Pulse Width Modulation) output to the electronic pump control to rotate the pump swashplate accordingly to control pump output and direction. The swashplate angle sensor is attached to the pump to provide the position of the swashplate. Traction circuit oil is directed to the dual displacement front wheel and rear axle motors. Operating pressure on the high pressure side of the closed traction circuit loop is determined by the amount of load developed at the wheel and axle motors. As the traction load increases, circuit pressure can increase to relief valve settings: 350 bar (5075 PSI) in forward and 360 bar (5225 PSI) in reverse. If traction circuit pressure exceeds the relief setting, oil flows through the piston pump relief valve to the low pressure side of the closed loop traction circuit.

Front wheel and rear axle motors are positive displacement, two speed variable motors. The dual displacement wheel and axle motors allow operation in either LOW or HI range. The motors are spring biased to maximum displacement for LOW speed and are hydraulically shifted to minimum displacement for HI range. The rear axle motor includes a flushing valve that bleeds off a small amount of hydraulic oil for cooling of the closed loop traction circuit. The charge circuit replenishes oil that is bled from the traction circuit by the flushing valve.

An optional traction circuit flow divider is available that equally splits traction pump flow between the front wheel motors and rear axle motor to prevent excessive circuit flow going to a spinning wheel. If equipped, the front traction manifold which includes the flow divider is mounted to the right, rear side of the front frame.

The piston pump, front wheel motors and rear axle motor use small amounts of hydraulic fluid for internal lubrication. Fluid is designed to leak across traction pump and motor components into the case drain. This leakage results in the loss of hydraulic fluid from the closed loop traction circuit that must be replaced. The charge circuit is designed to replace this traction circuit leakage. The gear pump section that supplies oil to the steering and lift/lower circuits also provides oil for the charge circuit.

Gear pump flow for the charge circuit is directed through the oil filter and to the low pressure side of the closed loop traction circuit. Charge pressure is limited to 18 bar (260 PSI) by a relief valve located in the piston pump.

Forward Direction

With the armrest console High and Low speed switch in the High speed position, the TEC controller controls two speed shift manifold solenoid. The solenoid valve in the two speed shift manifold is energized by the TEC controller for HI range. This energized solenoid valve directs charge pressure to shift the front wheel motors and rear axle motor to their minimum displacement. With the motors at their minimum displacements, a faster traction speed is available for transport.

When the high and low speed switch is in high speed position with the traction pedal pushed in the forward direction, oil from the piston pump oil is directed to the front wheel motors and rear axle motor through a parallel system. Oil flow to the front wheel motors drives the motors in the forward direction and then returns to the piston pump. Oil flow to the rear axle motor drives the motor in the forward direction. Oil returning from the axle motor enters the rear traction manifold at the M8 port. Flow bypasses the PR cartridge through the CV check valve, out manifold port P2 and returns to the piston pump.

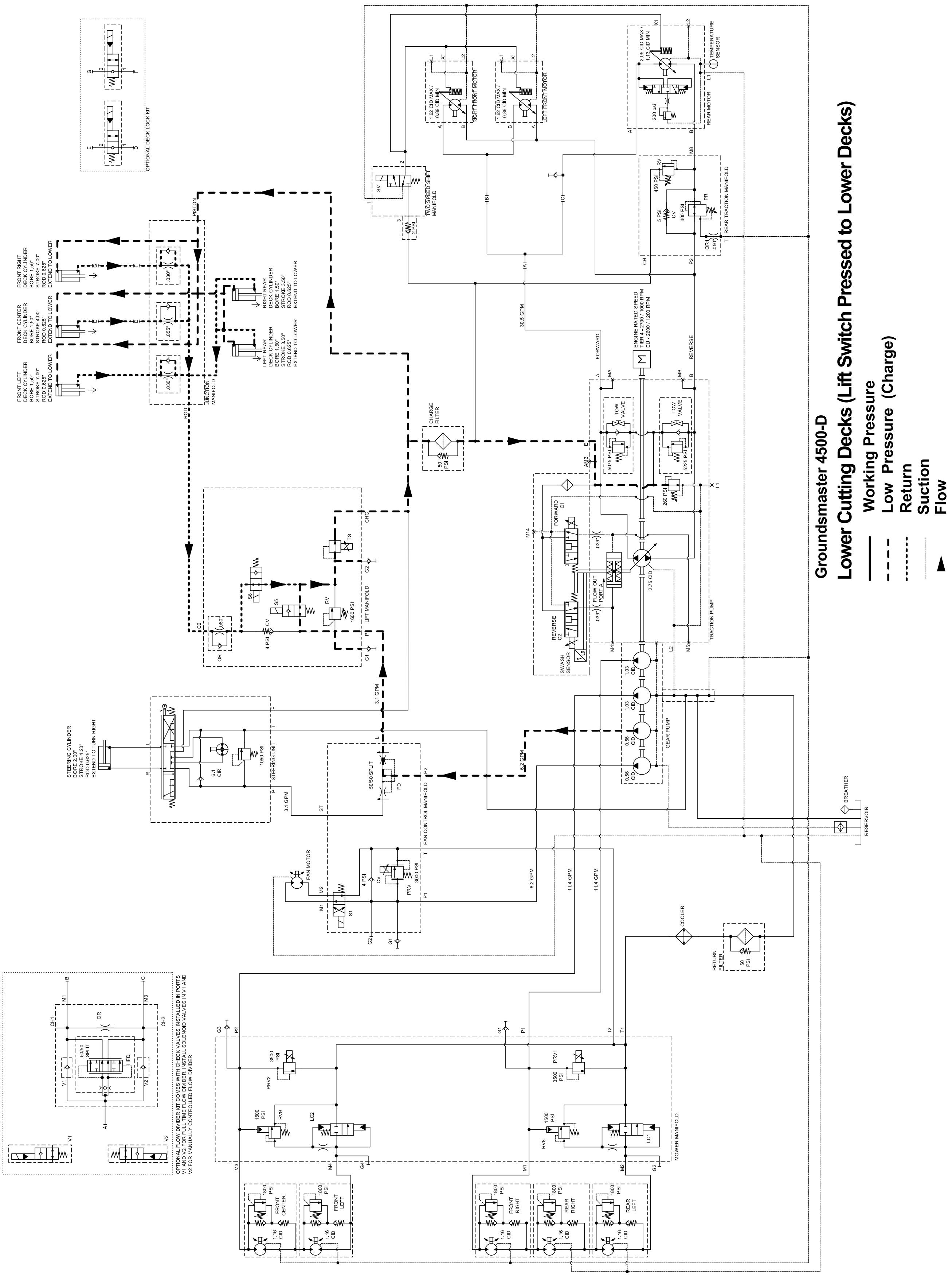
Forward Direction (continued)

When going down a hill, the tractor becomes an over-running load that drives the front wheel and rear axle motors. In this condition, the rear axle motor could lock up as the oil pumped from the motor increases pressure as it returns to the piston pump. To prevent rear wheel lock up, an adjustable relief valve (RV) in the rear traction manifold reduces rear axle motor pressure created in down hill, dynamic braking conditions.

Reverse Direction

The traction circuit operates essentially the same in reverse HI range as it does in the forward direction. However, the flow through the circuit is reversed. Oil flow from the piston pump is directed to the front wheel motors and also to the rear traction manifold. The oil to the front wheel motors drives them in the reverse direction and then returns to the piston pump. The oil to the rear traction manifold enters the manifold at port P2 and flows through pressure reducing valve (PR) which limits the down stream pressure to the rear axle motor to 27.6 bar (400 PSI) so the rear wheels will not scuff the turf during reverse operation. This reduced pressure flow is directed out rear traction manifold port M8 to drive the rear axle motor in reverse. Return oil from the rear motor returns to the piston pump.

Lower Cutting Decks: Groundsmaster 4500-D



g308025

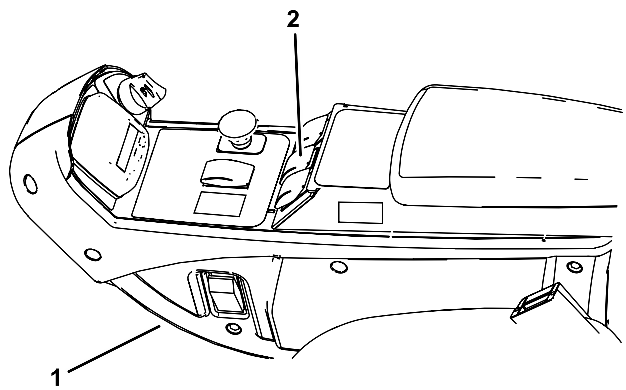
Figure 37

A four section gear pump is coupled to the piston (traction) pump. The third gear pump section supplies hydraulic flow to both the lift control manifold and the steering control valve. Hydraulic flow from this pump section is delivered to the circuits through a proportional flow divider located in the fan control manifold. Maximum lift/ lower circuit pressure is limited to 110 bar (1600 PSI) by a relief valve (RV) in the lift control manifold. Lift circuit pressure can be monitored at lift control manifold test fitting G1.

On the Groundsmaster 4500-D, a single lift switch on the console arm is used to raise and lower the five (5) cutting decks (Figure 38).

When the cutting decks are in a stationary position (not raising or lowering), lift circuit flow from the third gear pump section bypasses the lift cylinders through the lift control manifold solenoid valve S5 (de-energized) and proportional relief valve TS. Return flow from the manifold is routed to the oil filter and traction charge circuit.

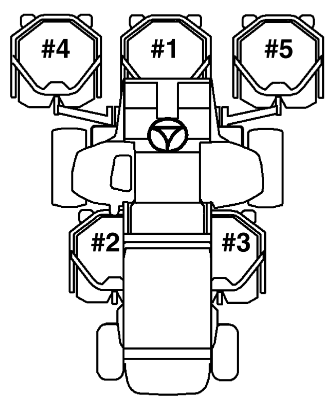
Note: The operator must be in the operator seat in order to lower the cutting decks.



g308047

Figure 38

1. Console arm
2. Lift switch



g308048

Figure 39

GM4500-D Cutting Deck Locations

Cutting Deck Lower

To lower the five (5) cutting decks on a Groundsmaster 4500-D, the front of the lift switch is depressed. The switch acts as an input to the TEC controller (T1) which then provides an electrical output to solenoid valve S6 in the lift control manifold. This energized solenoid valve shifts to allow a passage for oil flow from the rod ends of the five (5) deck lift cylinders. The weight of the cutting decks causes the lift cylinders to extend and lowers all of the cutting decks. An orifice in the lift control manifold C2 port restricts oil flow from the lift cylinders to control deck drop speed. An orifice in the junction manifold further controls the lowering speed of the #1 deck. The junction manifold orifices leading to the #4 and #5 decks are bypassed during deck lowering.

Cutting Deck Float

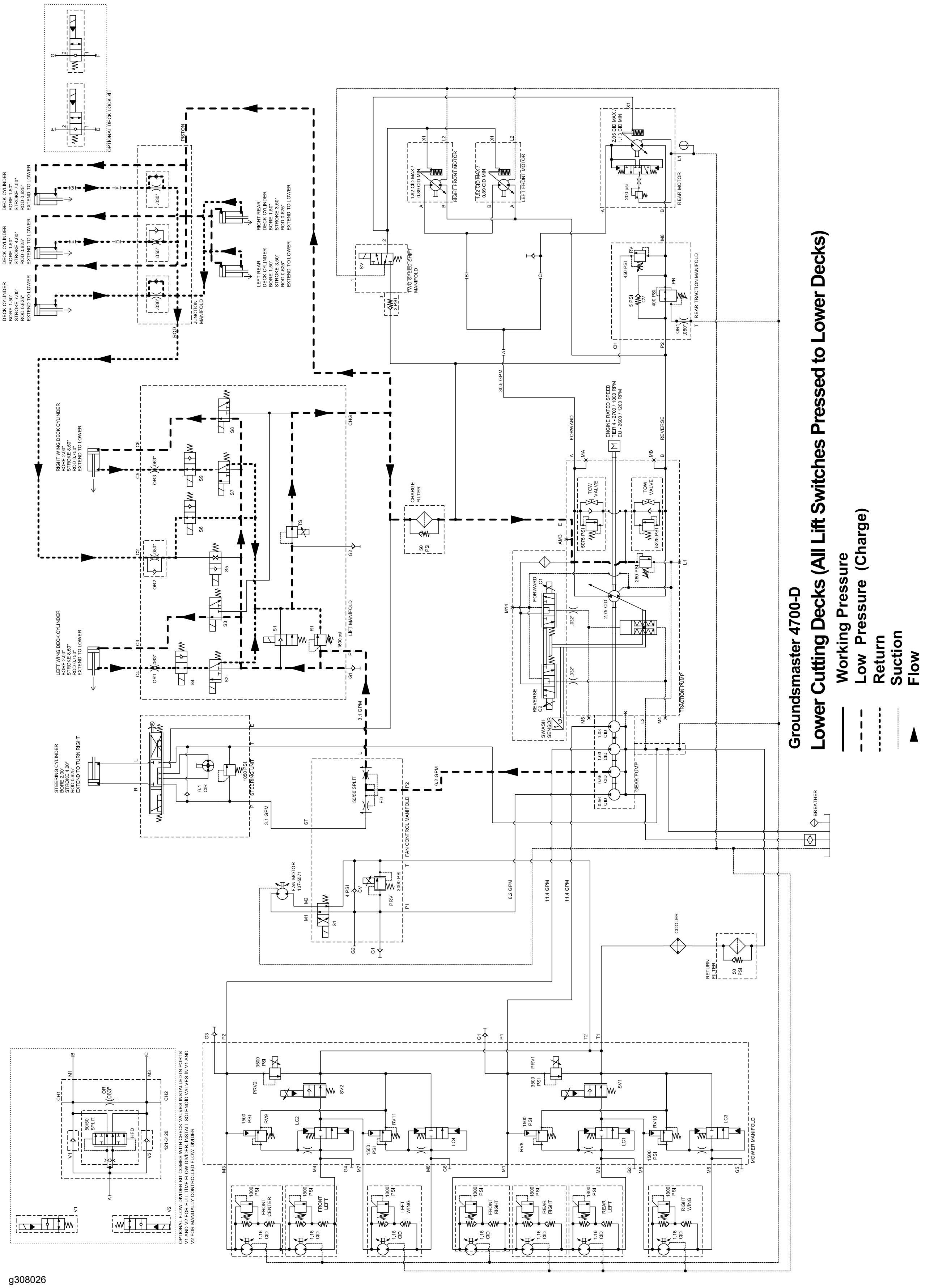
Cutting deck float allows the fully lowered cutting decks to follow ground surface contours. On a Groundsmaster 4500-D, lift control manifold solenoid valve S6 is energized for deck float when the decks are fully lowered. This energized solenoid provides an oil passage to and from the lift cylinders to allow cylinder and cutting deck movement while mowing.

Counterbalance

Once the cutting decks are fully lowered, the lift control manifold proportional relief valve (TS) maintains back pressure (counterbalance) on the deck lift cylinders. This counterbalance pressure transfers cutting deck weight to the machine to improve traction. The counterbalance automatically adjusts according traction circuit pressure. The counterbalance setting in the InfoCenter determines how responsive the system should be.

A pressure sensor located in the hydraulic tube between the front wheel and rear axle motors is used by the TEC controller (T1) as an input to determine traction circuit pressure. Based on this sensor input, a PWM (Pulse Width Modulation) signal from the TEC controller (T1) is provided to the proportional relief valve (TS) to maintain counterbalance pressure.

Lower Cutting Decks: Groundsmaster 4700-D



g308026

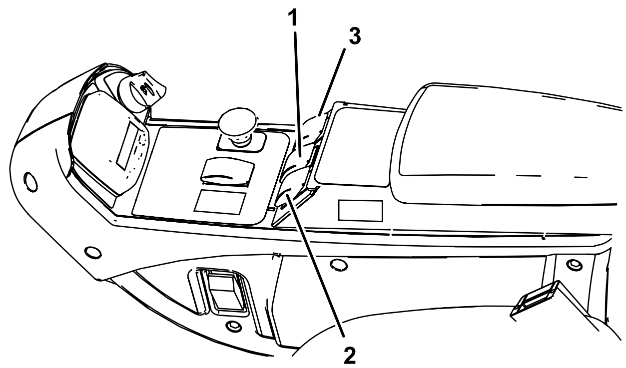
Figure 40

A four section gear pump is coupled to the piston (traction) pump. The third gear pump section supplies hydraulic flow to both the lift control manifold and the steering control valve. Hydraulic flow from this pump section is delivered to the circuits through a proportional flow divider located in the fan control manifold. Maximum lift/ lower circuit pressure is limited to 110 bar (1600 PSI) by a relief valve (R1) in the lift control manifold. Lift circuit pressure can be monitored at lift control manifold test fitting G1.

The Groundsmaster 4700-D has three (3) lift switches to control the cutting decks (Figure 41). The center switch is for the five (5) center decks, the left switch controls the left, rear deck (#6) and the right switch controls the right, rear deck (#7) (Figure 42).

When the cutting decks are in a stationary position (not raising or lowering), lift circuit flow from the third pump section bypasses the lift cylinders through the lift control manifold solenoid valve S1 and proportional relief valve TS which are de-energized. Return flow from the manifold is routed to the oil filter and traction charge circuit.

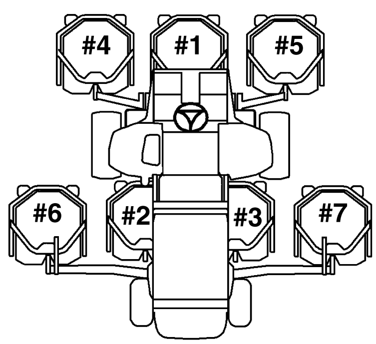
Note: The operator must be in the operator seat in order to lower the cutting decks.



g308049

Figure 41

1. Lift switch (#1 to #5)
2. Lift switch (#6)
3. Lift switch (#7)



g308050

Figure 42

GM4700-D Cutting Deck Locations

Cutting Deck Lower

To lower the center five (5) cutting decks on a Groundsmaster 4700-D, the front of the center lift switch is depressed. The switch acts as an input to the TEC controller (T1) which then provides an electrical output to solenoid valves S1 and S6 in the lift control manifold. These energized solenoid valves shift to allow oil

Cutting Deck Lower (continued)

flow from the rod ends of the center five (5) deck lift cylinders. The weight of the cutting decks cause the lift cylinders to extend and the center decks to lower. An orifice in the lift control manifold restricts oil flow from the lift cylinders to control deck drop speed. Additionally, an orifice in the junction manifold further controls the lowering speed of the #1 deck.

To lower a side cutting deck on the Groundsmaster 4700-D (deck #6 or #7), the front of the appropriate lift switch is depressed. The switch acts as an input to the TEC controller (T2) which then provides electrical output to the appropriate solenoid valves in the lift control manifold: S1, S3 and S4 for deck #6 or S1, S8 and S9 for deck #7. The energized solenoid valves shift to allow pump flow to the barrel end of the deck lift cylinder and a passage for oil from the rod end of the cylinder. The cylinder extends to lower the side cutting deck. An orifice in the lift manifold restricts oil flow from the lift cylinder to control side deck drop speed.

Cutting Deck Float

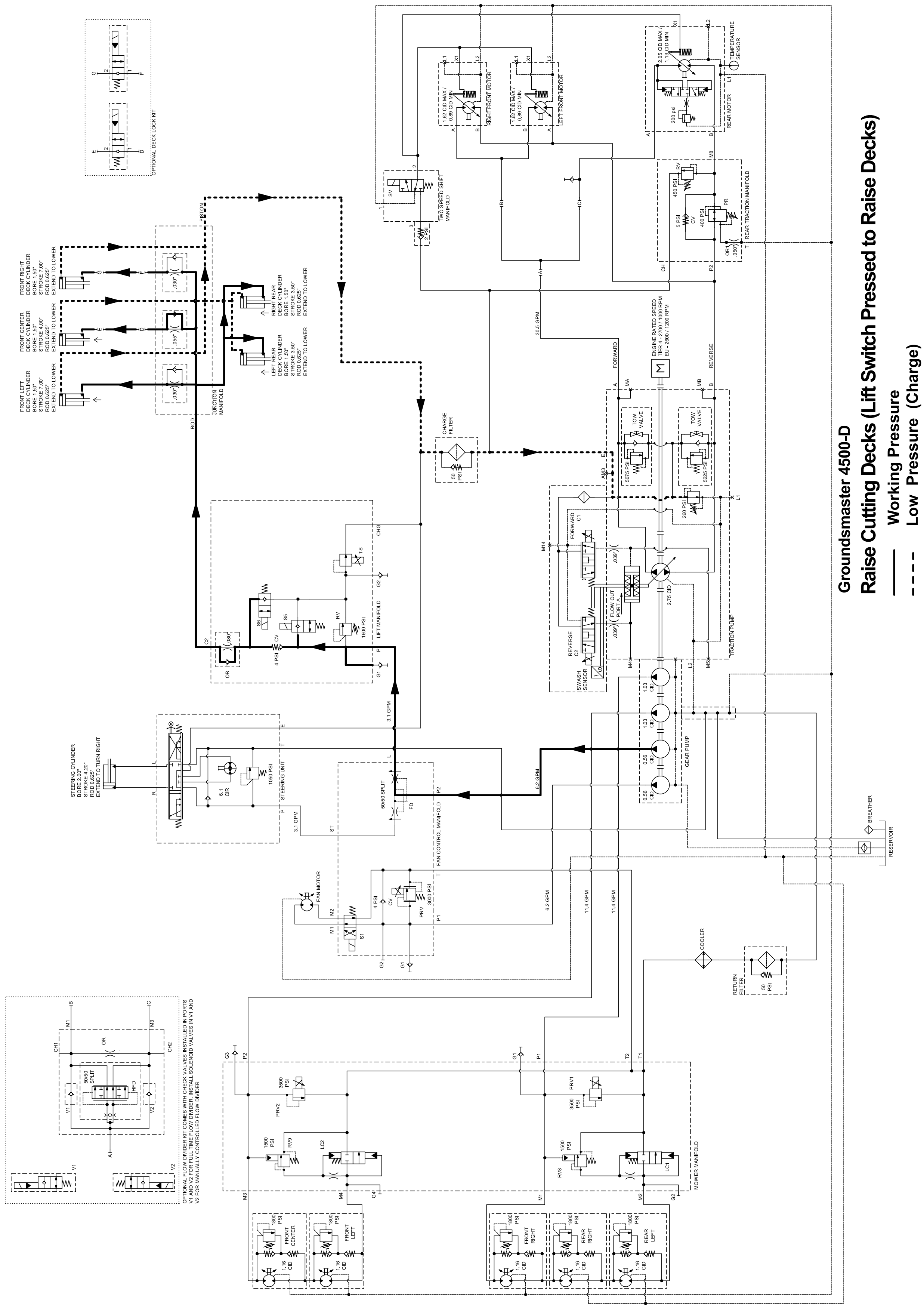
Cutting deck float allows the fully lowered cutting decks to follow ground surface contours. On a Groundsmaster 4700-D, S6 (center decks), S4 (left deck #6) and S9 (right deck #7) are energized for deck float. These energized solenoids provide an oil passage to and from the lift cylinders to allow cylinder and cutting deck movement while mowing.

Counterbalance

Once the cutting decks are fully lowered, the lift control manifold proportional relief valve (TS) maintains back pressure (counterbalance) on the deck lift cylinders. This counterbalance pressure transfers cutting deck weight to the machine to improve traction. The counterbalance automatically adjusts according traction circuit pressure. The counterbalance setting in the InfoCenter determines how responsive the system should be.

A pressure sensor located in the hydraulic tube between the front wheel and rear axle motors is used by the TEC controller (T1) as an input to determine traction circuit pressure. Based on this sensor input, a PWM (Pulse Width Modulation) signal from the TEC controller (T1) is provided to the proportional relief valve (TS) to maintain counterbalance pressure.

Raise Cutting Decks: Groundsmaster 4500-D



g308073

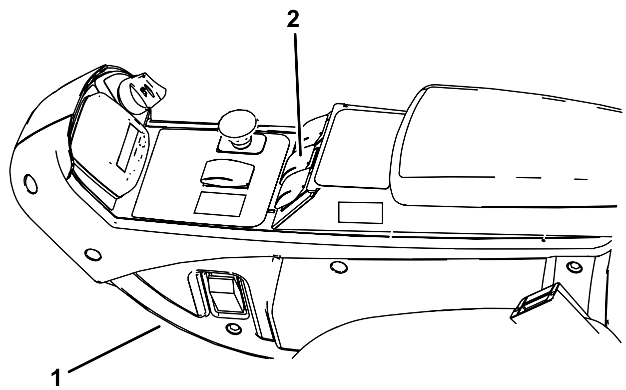
Figure 43

A four section gear pump is coupled to the piston (traction) pump. The third gear pump section supplies hydraulic flow to both the lift control manifold and the steering control valve. Hydraulic flow from this pump section is delivered to the circuits through a proportional flow divider located in the fan control manifold. Maximum lift/ lower circuit pressure is limited to 110 bar (1600 PSI) by a relief valve (RV) in the lift control manifold. Lift circuit pressure can be monitored at test fitting G1 on the lift control manifold.

On the Groundsmaster 4500-D, a single lift switch on the console arm is used to raise and lower the five (5) cutting decks (Figure 44).

When the cutting decks are in a stationary position (not raising or lowering), lift circuit flow from the third gear pump section bypasses the lift cylinders through the lift control manifold solenoid valve S5 and proportional relief valve TS which are de- energized. Return flow from the manifold is routed to the oil filter and traction charge circuit.

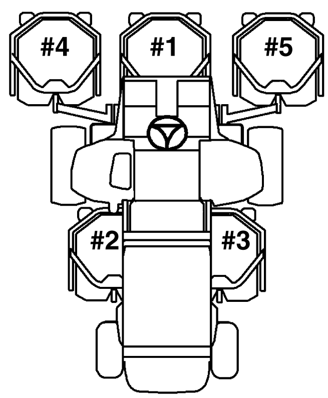
Note: The operator must be in the operator seat in order to raise the cutting decks.



g308047

Figure 44

1. Console arm
2. Lift switch



g308048

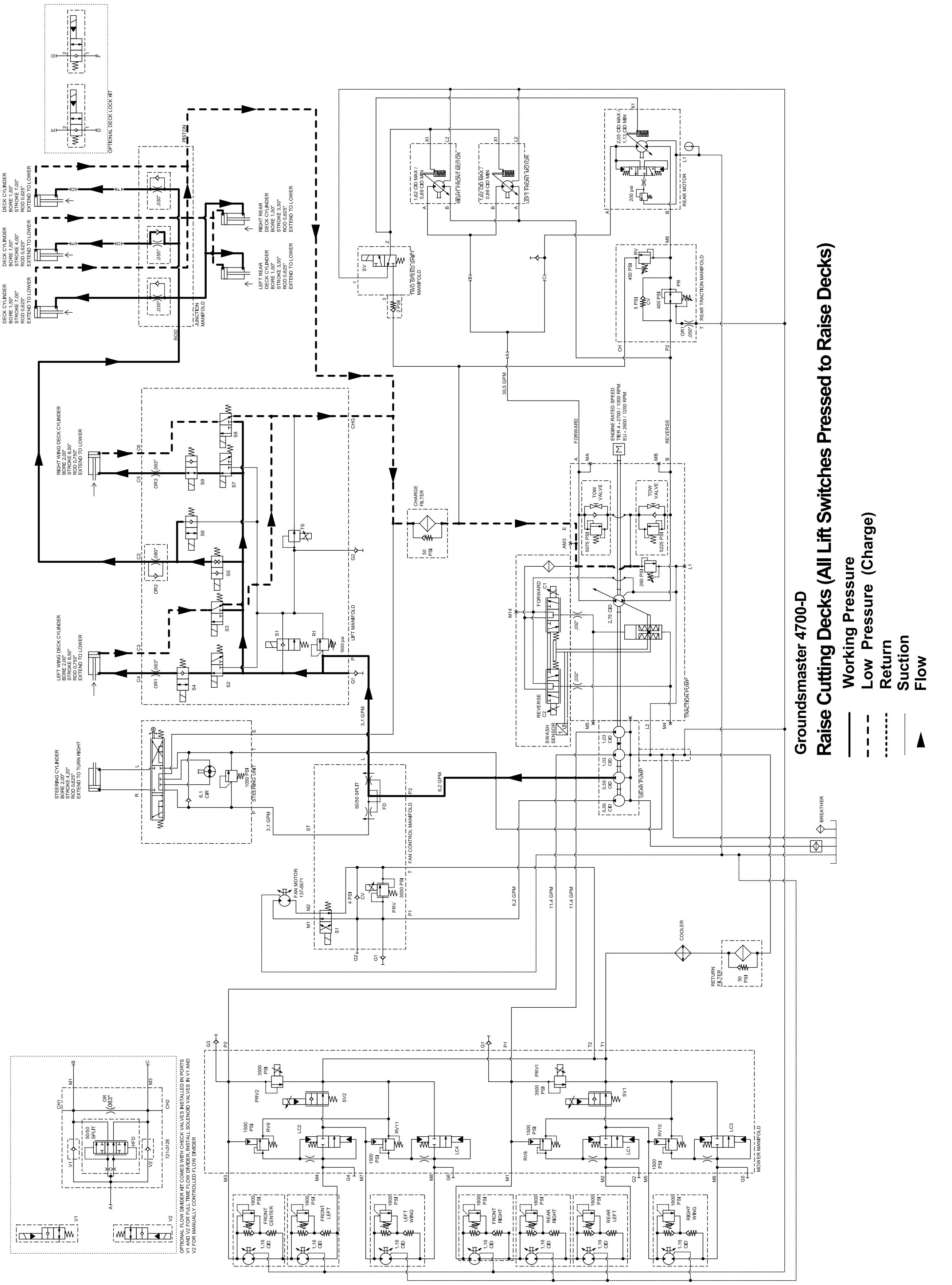
Figure 45

GM4500-D Cutting Deck Locations

Cutting Deck Raise

To raise the five (5) cutting decks on a Groundsmaster 4500-D, the rear of the lift switch is depressed. The switch acts as an input to the TEC controller (T1) which then provides an electrical output to solenoid valve S5 in the lift control manifold. Energized solenoid valve S5 shifts to allow a passage for oil flow to the rod ends of the five (5) deck lift cylinders. The oil flow causes the lift cylinders to retract and raise all of the cutting decks. The junction manifold orifice leading to the #1 deck is bypassed during deck raising.

Raise Cutting Decks: Groundsmaster 4700-D



g308074

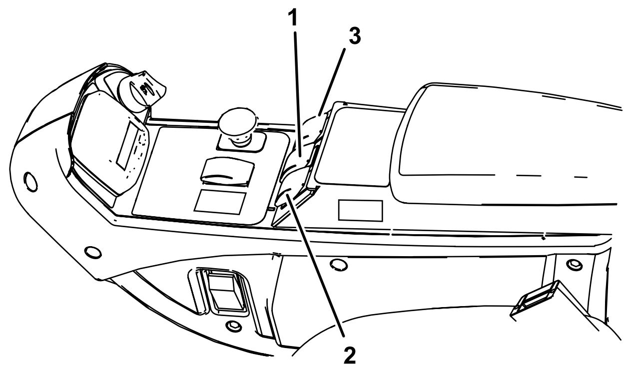
Figure 46

A four section gear pump is coupled to the piston (traction) pump. The third gear pump section supplies hydraulic flow to both the lift control manifold and the steering control valve. Hydraulic flow from this pump section is delivered to the circuits through a proportional flow divider located in the fan control manifold. Maximum lift/ lower circuit pressure is limited to 110 bar (1600PSI) by a relief valve (R1) in the lift control manifold. Lift circuit pressure can be monitored at test fitting G1 in the lift control manifold.

The Groundsmaster 4700-D has three (3) lift switches to control the cutting decks (Figure 47). The center switch is for the five (5) center decks, the left switch controls the left, rear deck (#6) and the right switch controls the right, rear deck (#7) (Figure 48).

When the cutting decks are in a stationary position (not raising or lowering), lift circuit flow from the third pump section bypasses the lift cylinders through the lift control manifold solenoid valve S1 and proportional relief valve TS which are de- energized. Return flow from the manifold is routed to the oil filter and traction charge circuit.

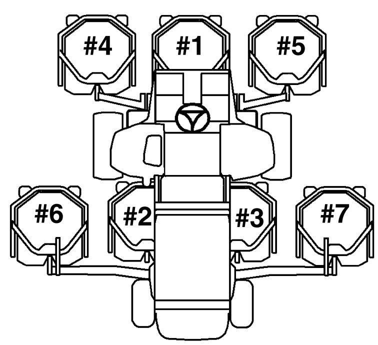
Note: The operator must be in the operator seat in order to raise the cutting decks.



g308049

Figure 47

1. Lift switch (#1 to #5)
2. Lift switch (#6)
3. Lift switch (#7)



g308050

Figure 48

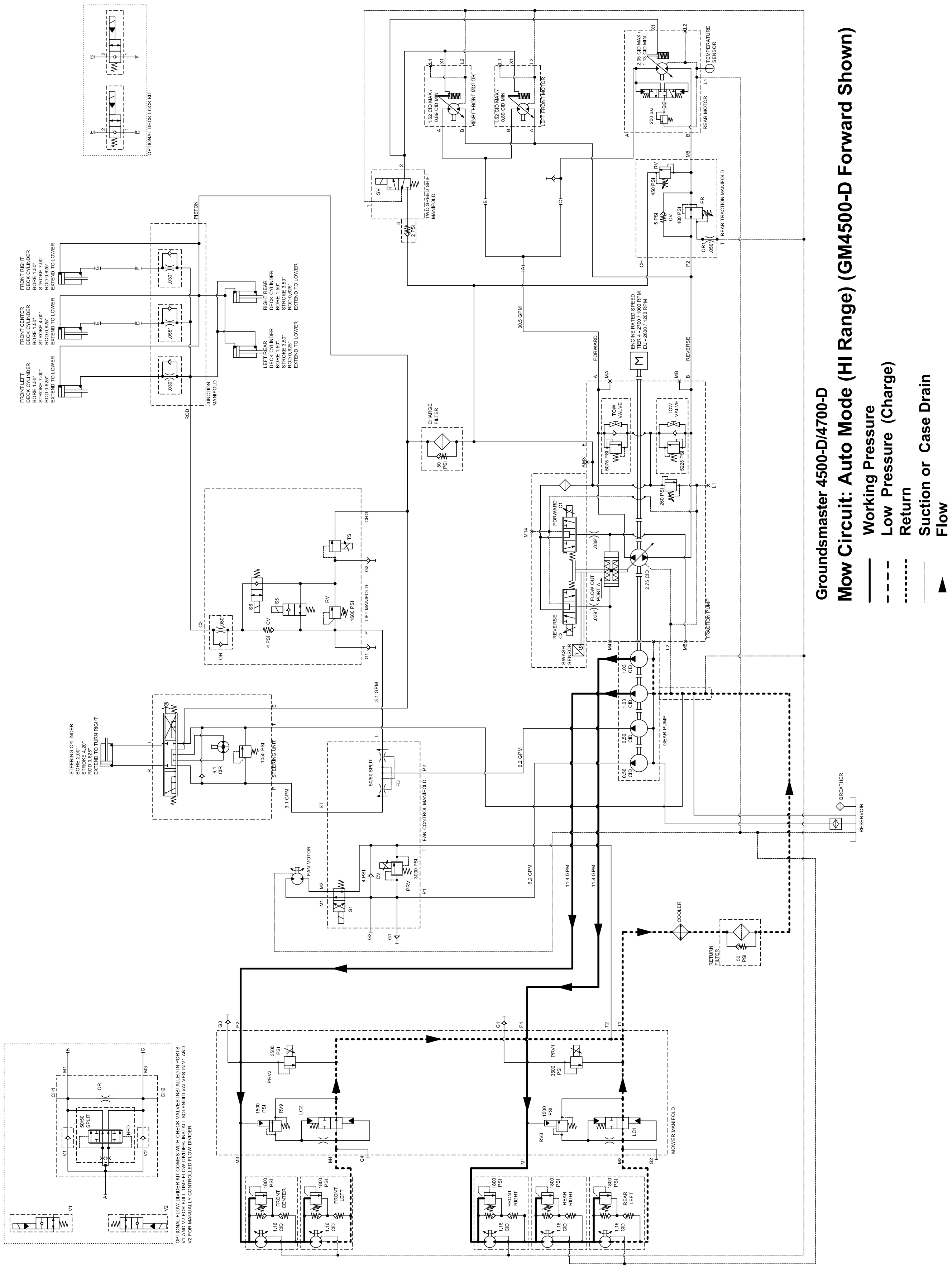
GM4700-D Cutting Deck Locations

Cutting Deck Raise

To raise the center five (5) cutting decks on the Groundsmaster 4700-D, the rear of the center console switch is depressed. The switch acts as an input to the TEC controller (T1) which then provides an electrical output to solenoid valves S1 and S5 in the lift control manifold. The energized solenoid valves shift to allow a passage for oil flow to the rod ends of the center five (5) deck lift cylinders. The oil flow causes the lift cylinders to retract and raises the center five (5) cutting decks. The orifice in lift manifold port C2 is bypassed during deck raising. The junction manifold orifice leading to the #1 deck is bypassed during deck raising.

To raise a side cutting deck on the Groundsmaster 4700-D (deck #6 or #7), the rear of the appropriate console arm lift switch is depressed. The switch acts as an input to the TEC controller (T2) which then provides an electrical output to the appropriate solenoid valves in the lift control manifold: S1 and S2 for deck #6 and S1 and S7 for deck #7. The energized solenoid valves shift to allow a passage for oil flow to the rod ends of the deck lift cylinder. The oil flow causes the lift cylinder to retract and raises the cutting deck. An orifice in the lift manifold restricts oil flow to the lift cylinder to control deck raising speed.

Mow Circuit



g308129

Figure 49

Hydraulic flow for the mow circuit is supplied by the first two (2) sections of the gear pump. The first gear pump section P1 supplies hydraulic flow to decks 5, 3 and 2 (also deck 7 on the GM 4700-D), while the second gear pump section supplies decks 1 and 4 (also deck 6 on the GM 4700-D).

A single deck control manifold is used to control flow from the two (2) pump sections. The manifold includes cartridge valves for control of each of the two (2) pump circuits. Each manifold circuit is equipped with a solenoid controlled, proportional relief valve (PRV1/PRV2), a logic cartridge (LC1/LC2) and a brake relief cartridge (RV8/RV09). The Groundsmaster 4700–D deck manifold includes additional cartridges to control hydraulic flow for decks 6 and 7: an additional logic cartridge (LC3/LC4), a solenoid valve (SV1/SV2) and an additional brake relief cartridge (RV10/RV11).

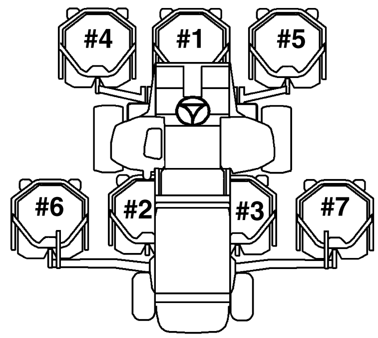


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Figure 50

GM4700-D Cutting Deck Locations

PTO Disengaged

When the PTO switch is OFF (or if the decks are raised), the deck control manifold solenoid valves (PRV1 and PRV2) are not energized, allowing hydraulic flow to bypass the deck motors through the manifold. Return oil from the manifolds is routed to the oil cooler and oil filter.

PTO Disengaged (continued)

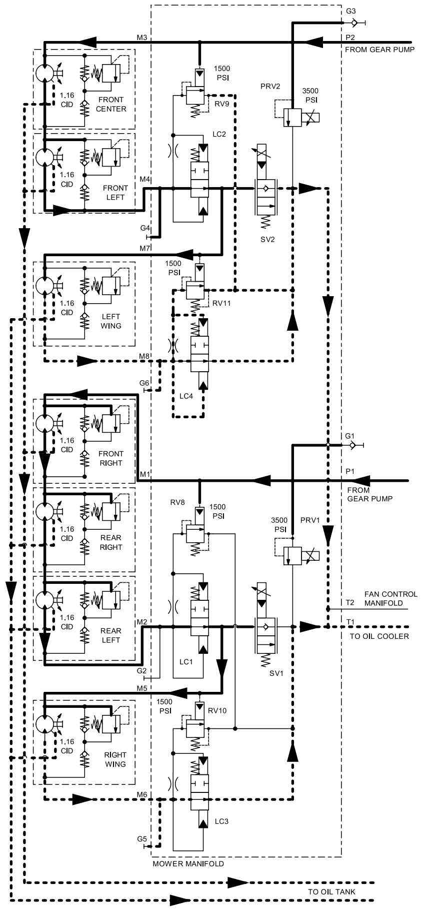

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Figure 51

DECK CONTROL MANIFOLD (GM4700-D)

PTO Engaged

When the PTO switch is turned ON with the decks lowered, the solenoid valves (PRV1 and PRV2) are energized with outputs from the TEC controller (T1). The energized valves shift to direct pump flow toward the deck motors. As circuit pressure to the deck motors increases, the brake relief cartridge (RV) opens which allows an oil flow through the manifold orifice positioned before the logic cartridge (LC). This flow creates a pressure increase at the logic cartridge that will shift the logic cartridge and allow oil return from the deck motors.

On the Groundsmaster 4700-D (Figure 51), if deck 6 or deck 7 is lowered and the PTO switch is ON, the deck control manifold solenoid valve (SV1/SV2) will be energized by the TEC controller. This energized solenoid valve allows oil flow to the appropriate deck motor as described above.

Maximum mow circuit pressure is limited at each deck manifold circuit by the proportional relief valve (PRV1/PRV2). The deck relief valve pressure is 241 bar (3500 PSI). Mow circuit pressure can be measured at port G1 or G3 of the deck control manifold.

The brake relief and logic cartridges control the stopping rate of the blades when the solenoid valves are de-energized as the PTO switch is turned OFF or if the decks are raised (see Cutting Deck Blade Braking (page 5–35)).

Cutting Deck Blade Braking

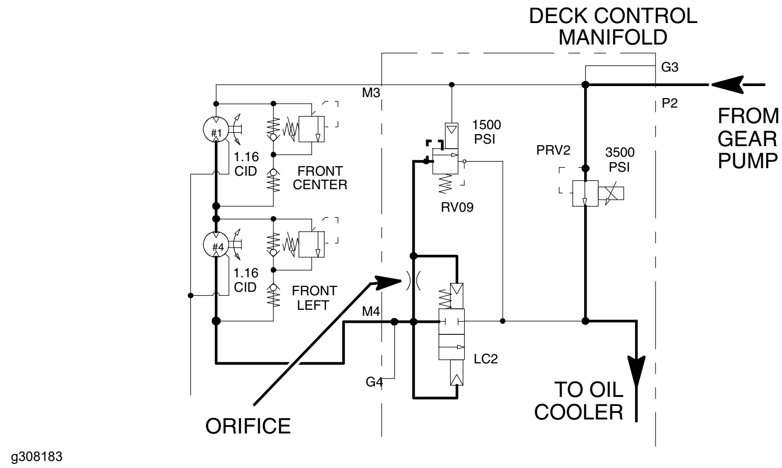

Figure 52

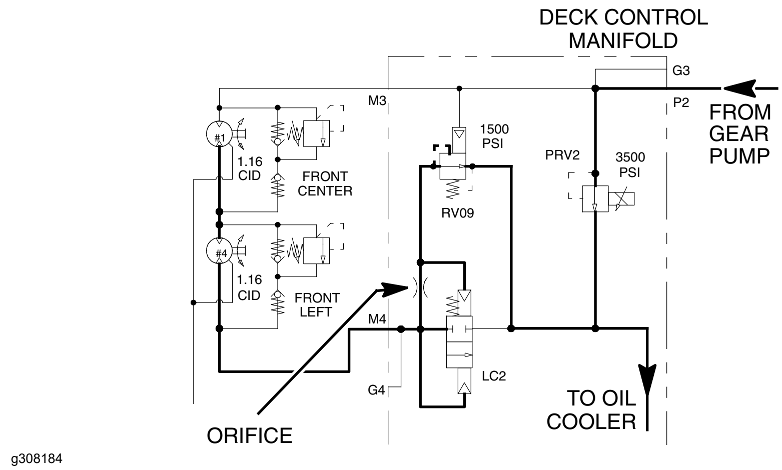

Figure 53

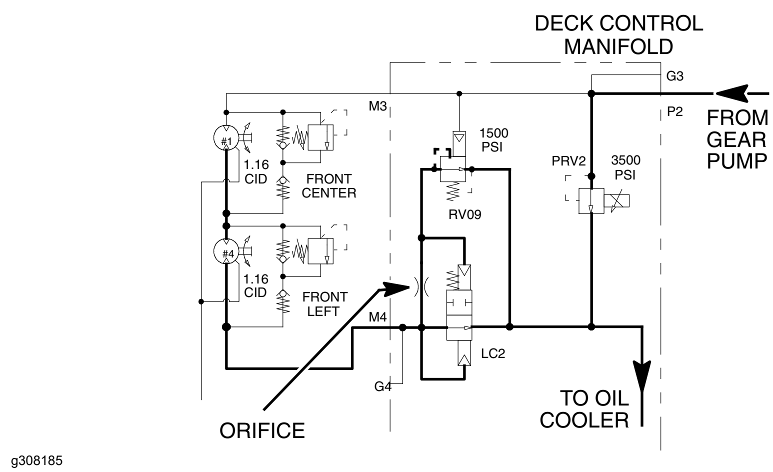

Figure 54

When the operator turns the PTO switch OFF (or if the decks are raised), deck manifold solenoid valves (PRV1, PRV2, SV1 and SV2) are de-energized. The valves will shift to direct oil away from the deck motors and toward the oil cooler and filter. Hydraulic pressure is reduced to the cutting deck motors which slows the cutting blades and also allows the deck manifold relief valve (RV) to shift. The shifted relief valve removes the flow path from the orifice at the logic cartridge, causing the logic cartridge to shift and block the return oil path from the deck motors (Figure 52).

The inertia of the rotating cutting blades, however, effectively turns the deck motors into pumps causing an increase in pressure as the flow from the motors comes up against the closed logic cartridge (LC). When this pressure builds to approximately 104 bar (1500 PSI), the relief valve opens which allows a small amount of hydraulic flow past the relief valve (Figure 53). This flow causes a pressure increase that shifts the logic cartridge to once again allow oil flow from the deck motors (Figure 54). When return pressure drops below 104 bar (1500 PSI), the relief valve re-seats and causes the logic cartridge to close again, blocking return flow from the deck motors to further slow the cutting blades. This action of the relief valve opening and the logic cartridge shifting occurs several times in a very short time frame as the blades finally come to a stop. Once the blades have stopped, the logic cartridge remains in the neutral position to keep the deck motors from rotating.

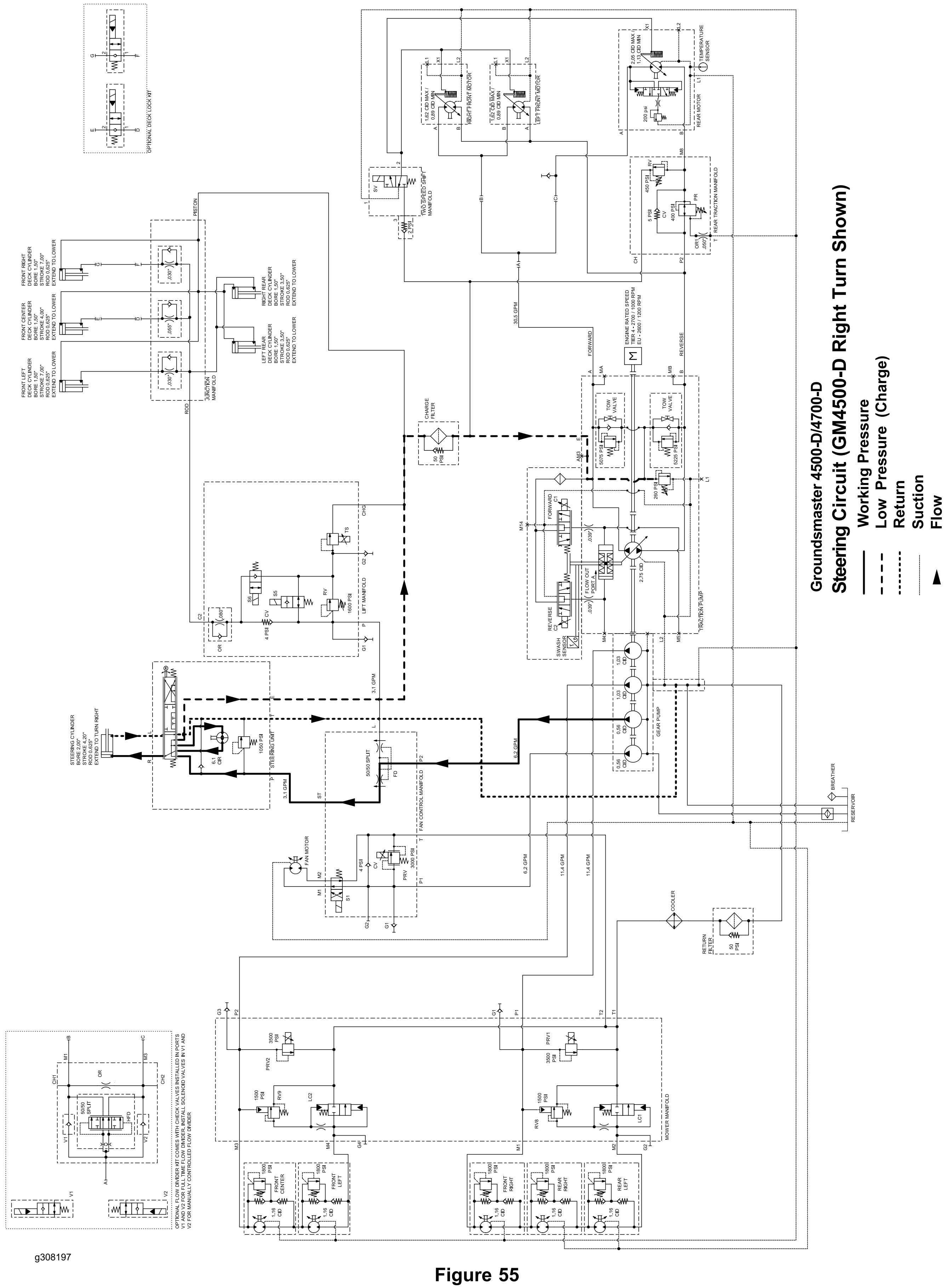

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Figure 55

A four section gear pump is coupled to the piston (traction) pump. The third gear pump section supplies hydraulic flow to the steering control valve and the lift/lower control valve. Pump hydraulic flow is delivered to the two circuits through a proportional flow divider located in the fan control manifold. Steering circuit pressure is limited to 72 bar (1050 PSI) by a relief valve located in the steering control valve.

With the steering wheel in the neutral position and the engine running, gear pump section flow enters the steering control valve at the P port and goes through the steering control spool valve, bypassing the rotary meter and steering cylinder. Flow leaves the control valve through the E port to the oil filter and traction charge circuit.

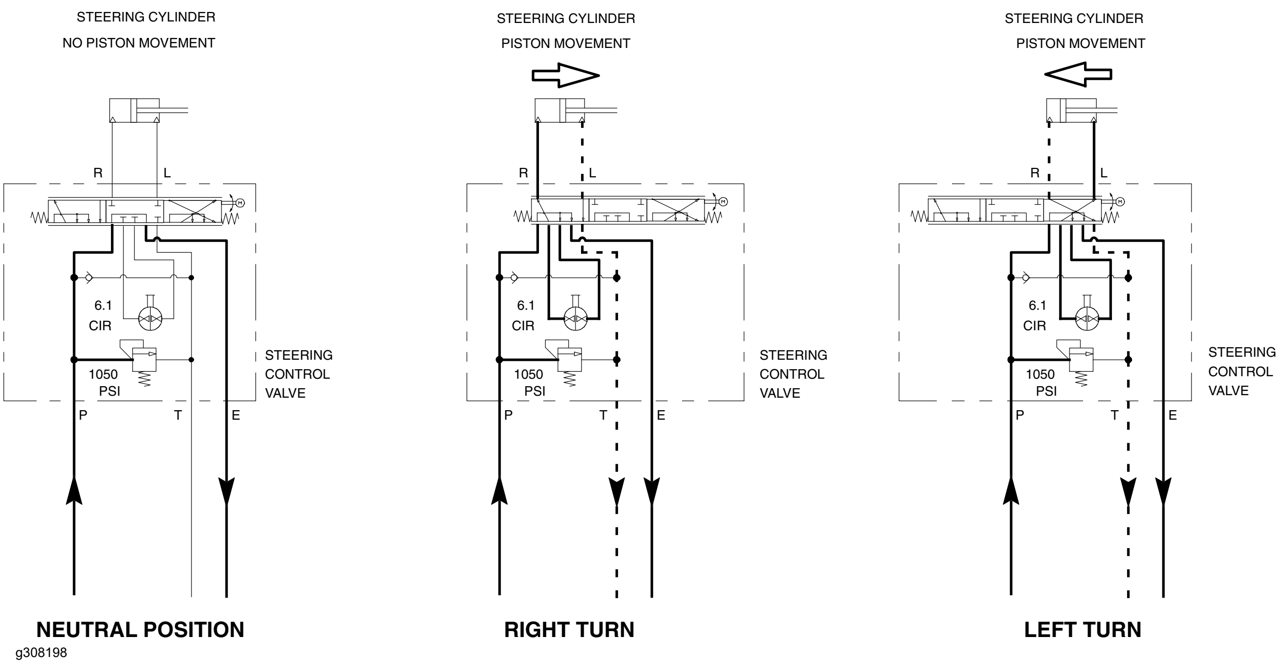

Figure 56

Right Turn

When a right turn is made with the engine running, the turning of the steering wheel positions the 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 valve is bypassed out the E port back to the oil filter and traction charge circuit. The remainder of the flow is drawn through rotary meter and then is directed out port R. Pressure extends the steering cylinder for a right turn. The rotary meter ensures that the oil flow to the cylinder is proportional to the amount of the turning on the steering wheel. Fluid leaving the cylinder flows back through the spool valve then through the T port and to the hydraulic reservoir.

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

Left Turn

When a left turn is made with the engine running, the turning of the steering wheel positions the 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. As in a right turn, most of the flow through the valve is bypassed out the E port back to the oil filter and traction charge circuit. The remainder of the flow is drawn through the rotary meter and out the L port.

Left Turn (continued)

Pressure retracts the lift cylinder for a left turn. The rotary meter ensures that the oil flow to the cylinder is proportional to the amount of the turning on the steering wheel. Fluid leaving the cylinder flows back through the spool valve then through the T port and to the hydraulic reservoir.

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

Engine Cooling Fan Circuit

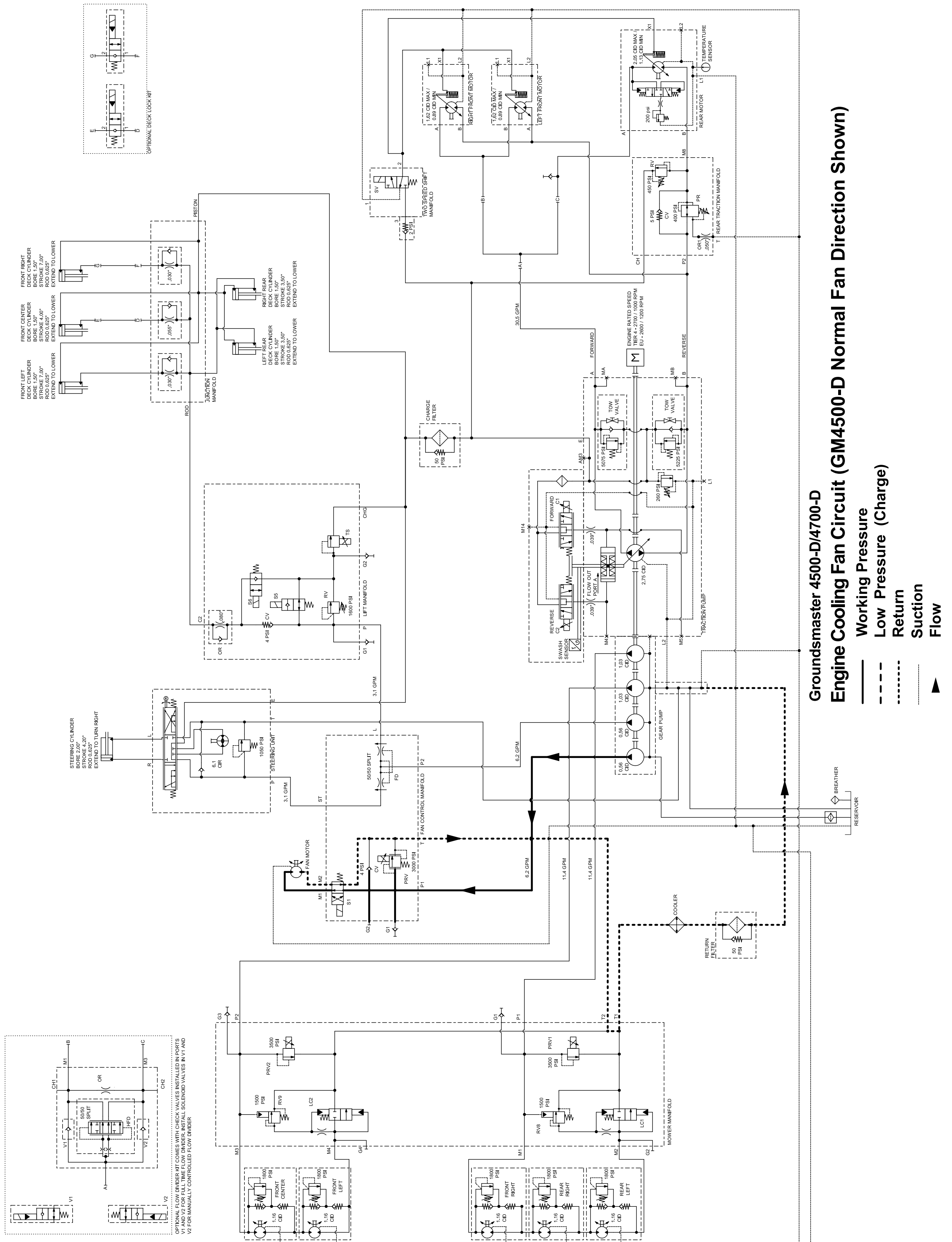

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Figure 57

A four section gear pump is coupled to the piston (traction) pump. The final gear pump section (farthest from the piston pump) supplies hydraulic flow for the hydraulic engine cooling fan motor.

The fan control manifold controls the operation of the hydraulic motor that drives the engine cooling fan in addition to including the flow divider for the steering and lift circuits. The electronically controlled proportional relief valve (PRV) in the manifold controls the oil flow to the fan motor. The fan control manifold controls the speed and direction of the fan motor based on electrical output from the TEC controller (T1).

Oil flow from the gear pump section to the cooling fan motor is controlled by the proportional relief valve (PRV) in the fan control manifold. This valve adjusts fan circuit flow based on a PWM (Pulse Width Modulation) signal from the TEC controller (1). The controller uses engine coolant and hydraulic oil temperatures as inputs to determine the proper PWM signal for the PRV valve. The fan circuit flow determines the speed of the cooling fan motor.

- The fan motor runs at half speed until coolant reaches approximately 74 ºC (165 ºF). The fan motor increases to full speed (approximately 2800 RPM) as coolant reaches 82 ºC (180 ºF).
- The fan motor automatically reverses if coolant reaches 95 ºC (203 ºF) or hydraulic oil reaches 100 ºC (212 ºF).

If the cooling fan motor is stalled for any reason, the manifold proportional relief valve (PRV) has a secondary function as a circuit relief to limit fan motor pressure to 207 bar (3000 PSI).

When the engine is shut off, the over-running inertia load of the fan blades keeps driving the fan motor and turns it into a pump. The check valve (CV) in the fan control manifold will open to keep the motor circuit full of oil so the fan motor will not cavitate.

Note: If PWM current is not available to the fan control manifold proportional relief valve (PRV), the cooling fan motor will run at full speed in the normal (forward) direction.

Forward Direction Fan Operation

Oil flow from the gear pump section is sent through the de-energized solenoid valve S1 to rotate the cooling fan motor. Return flow from the motor re-enters the manifold (port M2), through the de-energized solenoid valve S1, out of the manifold (port T) and then is routed through the deck control manifold, oil cooler and oil filter.

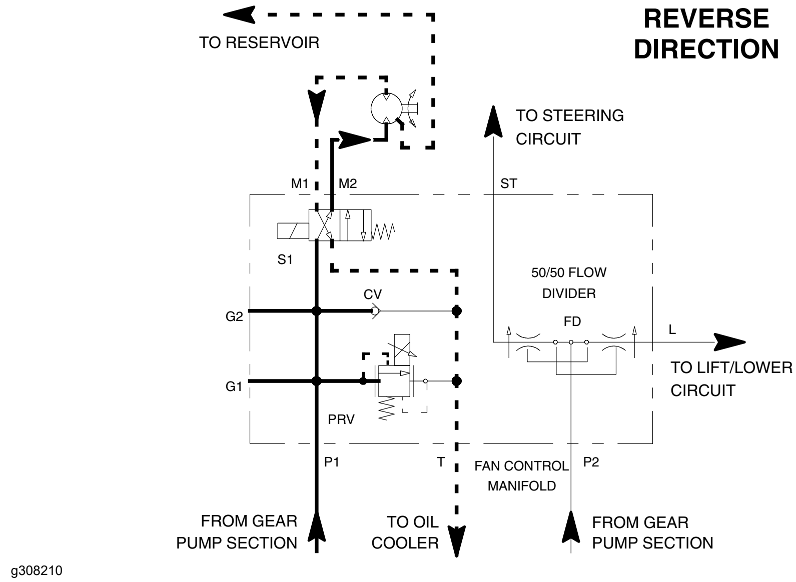

Figure 58

Reverse Direction Fan Operation (Figure 58)

The TEC controller (T1) can reverse the cooling fan to clean debris from the rear intake screen. If hydraulic oil and/or engine coolant temperatures increase to an unsuitable level or if a manual fan reversal is requested via the InfoCenter display, a high PWM signal is sent to the PRV valve to slow the cooling fan and direct pump oil flow away from the fan motor. The controller then energizes solenoid valve S1 in the fan control manifold to reverse cooling fan motor oil flow so that the motor runs in the reverse direction. A lower PWM signal is sent to the PRV valve allowing oil flow to return to the fan motor but in the reverse direction causing the motor and cooling fan to run in reverse for a short time.

Note: The fan reversal process is designed to clean debris from the rear screen but not the radiator. Refer to *Operator's Manual* for radiator cleaning maintenance recommendations.

Testing

The most effective method for isolating problems in the hydraulic system is by using hydraulic test equipment such as pressure gauges and flow meters in the circuits during various operational checks (see the Special Tools (page 2–16)).

IMPORTANT

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

⚠ CAUTION ⚠

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

⚠ 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.

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure (page 5–4).

⚠ CAUTION ⚠

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

Precautions for Hydraulic Testing

1. Clean machine thoroughly before disconnecting or disassembling any hydraulic components. Always keep in mind the need for cleanliness when working on hydraulic equipment. Contamination will cause excessive wear of components.
2. Before conducting a hydraulic test, make sure hydraulic oil is at normal operating temperature by operating the machine under load for approximately ten (10) minutes.
3. Check control linkages for improper adjustment, binding or broken parts.

Precautions for Hydraulic Testing (continued)

4. Put metal caps or plugs on any hydraulic lines left open or exposed during testing or removal of components.
5. The engine must be in good operating condition. Use a phototac to determine engine speed when performing a hydraulic test. Engine speed will affect the accuracy of the tester readings. See Engine (Models 30893, 30893TE, 30899 and 30899TE) (page 2–3) and Engine (Models 30885 and 30887) (page 2–4).
6. When using the hydraulic tester with flow and pressure capabilities, the inlet and the outlet hoses must be properly connected and not reversed to prevent damage to the hydraulic tester or components.
7. When using the hydraulic tester with flow and pressure capabilities, completely open flow control valve on tester before starting the engine to minimize the possibility of damaging components.
8. Install fittings finger tight and far enough to make sure that they are not cross−threaded before tightening them with a wrench.
9. Position tester hoses to prevent rotating machine parts from contacting and damaging the hoses or tester.
10. Check oil level in the hydraulic reservoir. After connecting test equipment, make sure reservoir is full.
11. After installing test gauges, run engine at low idle speed and check for any hydraulic oil leaks. Correct any leaks before proceeding with test procedure.
12. Before returning machine to use, make sure that hydraulic reservoir has correct fluid level.

Which Hydraulic Tests Are Necessary?

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

1. If a traction circuit problem exists, consider performing one or more of the following tests: Traction Circuit Charge Pressure, Traction Circuit Relief Pressure, Counterbalance Pressure, Reverse Traction Circuit Reducing Valve (PR) Pressure, Rear Traction Circuit Relief Valve (RV) Pressure, Piston (Traction) Pump Flow and/ or Gear Pump Flow Tests.

IMPORTANT

Refer to Traction Problems (page 3–4) for information regarding the importance of removing contamination from the traction circuit.

2. If a cutting (mow) circuit problem exists, consider performing one or more of the following tests: Cutting Deck Circuit Pressure, PTO Relief Pressure, Cutting Deck Motor Case Drain Leakage and/or Gear Pump Flow Tests.
3. If a lift/lower circuit problem exists, consider performing one or more of the following tests: Lift/Lower Circuit Relief Pressure and/or Gear Pump Flow Tests.
4. If a steering circuit problem exists, consider performing one or more of the following tests: Steering Circuit Relief Pressure, Steering Cylinder Internal Leakage and/or Gear Pump Flow Tests.
5. If a engine cooling fan circuit problem exists, consider performing one or more of the following tests: Engine Cooling Fan Circuit and/or Gear Pump Flow Tests.

Traction Circuit Charge Pressure (Using Pressure Gauge)

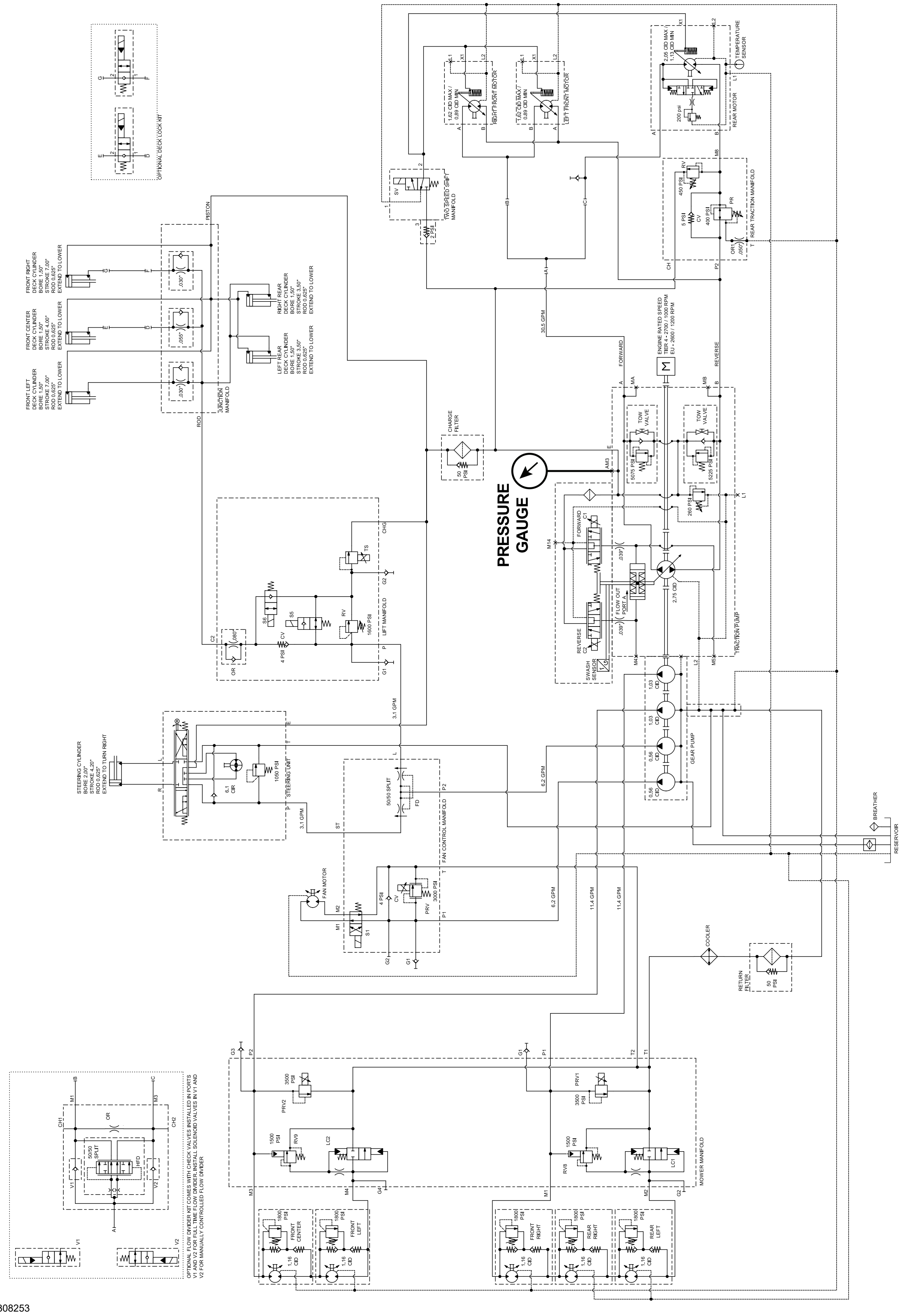

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Figure 59

Note: The traction charge circuit is designed to replace loss of hydraulic fluid from the closed loop traction circuit.

Procedure for Traction Circuit Charge Pressure Test

CAUTION

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

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately ten (10) minutes. Make sure the hydraulic reservoir is full.
2. Park machine on a level surface with the cutting decks lowered and off. Make sure hydraulic oil is at normal operating temperature, engine is OFF, the parking brake is engaged and the hydraulic reservoir is full.

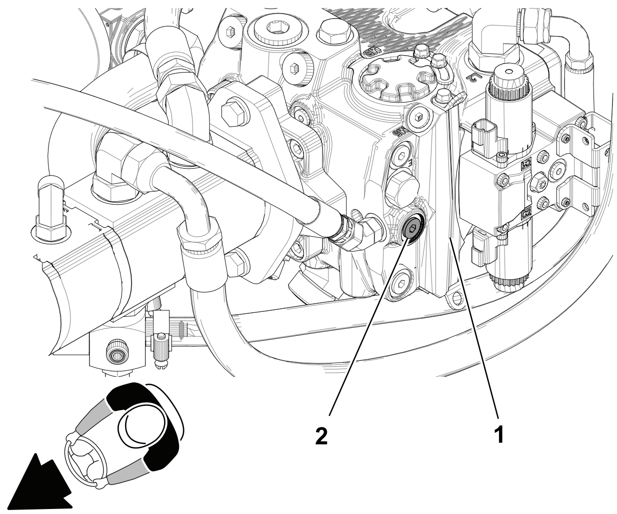

Figure 60

1. Traction pump
2. AM3 port

3. Locate AM3 port plug on the piston (traction) pump (Figure 60). Thoroughly clean the pump surfaces around AM3 plug to prevent system contamination.
4. Remove the AM3 port plug from traction pump and connect a 70 bar (1000 PSI) pressure gauge with hydraulic hose attached to the test fitting in AM3 port of piston pump.
5. Start the engine and increase engine speed to high idle speed with no load on the hydraulic system.

   GAUGE READING TO BE 13.8 to 20.6 bar (200 to 300 PSI).
6. Stop engine and record test results.
7. If there is no pressure or pressure is low, check for the following:
   A. Restriction in gear pump intake line.
   B. Charge relief valve in piston pump is leaking (see Piston (Traction) Pump Service (page 5–107)).
   C. If necessary, check for internal wear or damage in the third gear pump section (see Gear Pump Flow (Using Tester with Pressure Gauge & Flow Meter) (page 5–81)).

Procedure for Traction Circuit Charge Pressure Test (continued)

Note: Steering and lift/lower circuits would also be affected if the third gear pump section is worn or damaged.

8. Next, with the pressure gauge still connected to the diagnostic test fitting, monitor the gauge reading while operating the machine in forward and reverse. Start the engine and increase engine speed to high idle speed. Apply the brakes and push the traction pedal forward, then reverse.

   GAUGE READING TO BE within 20% of no-load charge pressure measured in step 4 above (e.g. if charge pressure in step 6 is 18 bar (260 PSI), charge pressure in forward or reverse should be from 13.8 to 18 bar (200 to 260 PSI).

9. If charge pressure is good under no load (step 5), but drops below specification when under traction load (step 8), the piston (traction) pump, front wheel motors and/or rear axle motor should be suspected of wear and in efficiency. When the pump and/or traction motor(s) are worn or damaged, the charge pump is not able to keep up with internal leakage in traction circuit components.

10. When testing is completed, disconnect pressure gauge from diagnostic test fitting. Remove diagnostic test fitting from piston (traction) pump. Install plug into piston pump port and torque plug to **43 N·m (32 ft-lb)**. Lower and secure hood.

Traction Circuit Relief Pressure (Using Pressure Gauge)

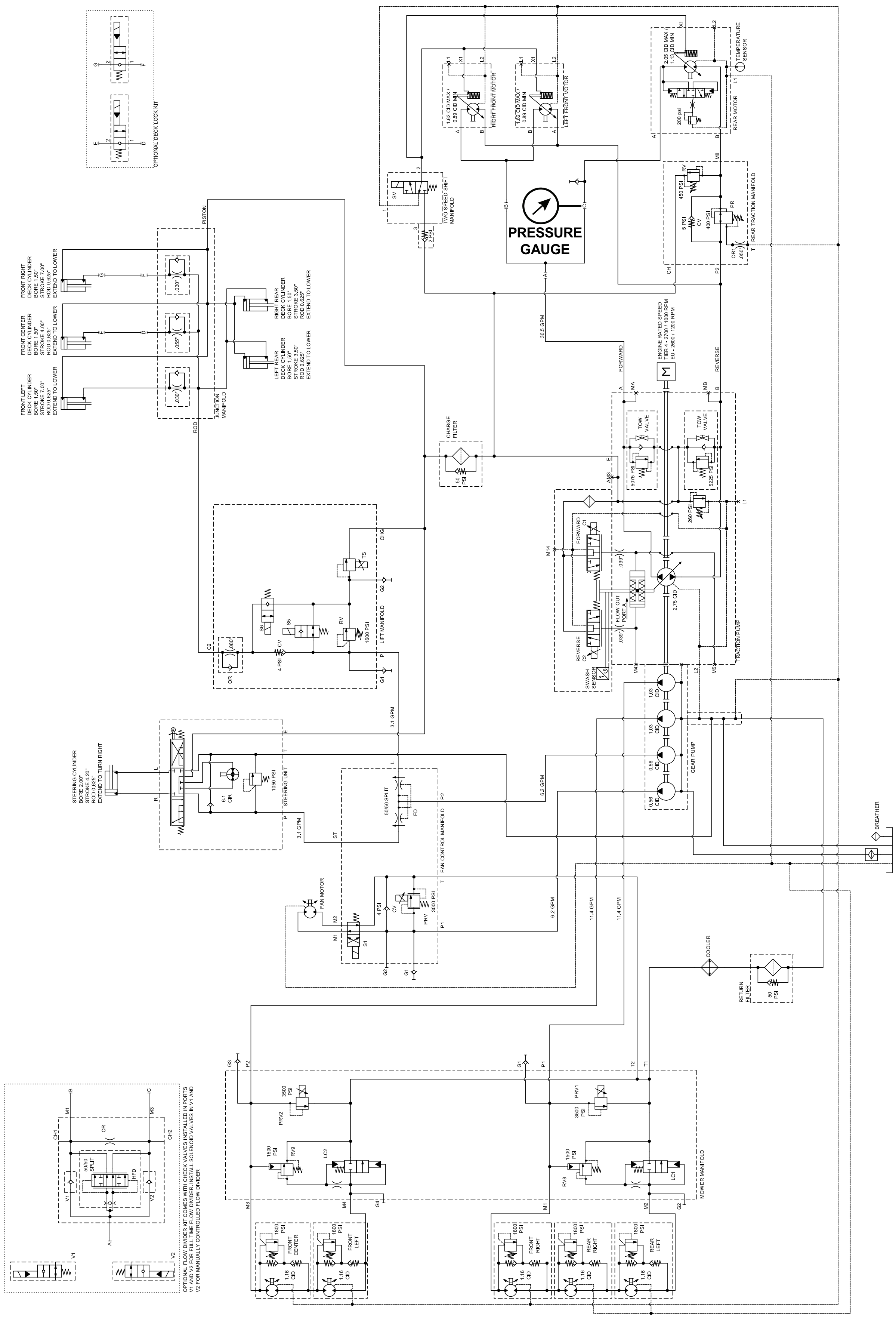

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Figure 61

FORWARD DIRECTION TEST SHOWN

Procedure for Traction Circuit Relief Pressure Test

CAUTION

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

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

CAUTION

Move machine to an open area, away from people and obstructions.

2. Drive machine to an open area, lower cutting decks, turn the engine off and apply parking brake.

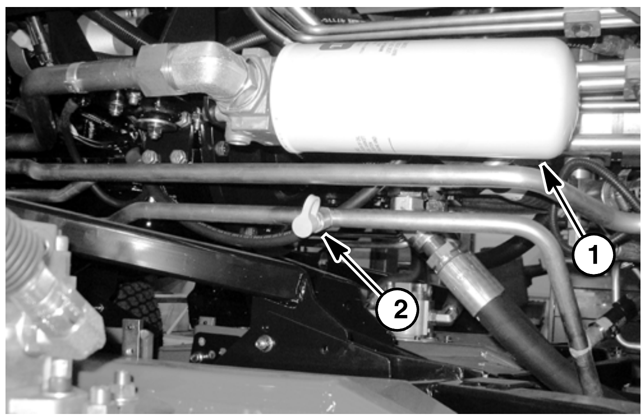

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Figure 62

1. Oil filter
2. Forward traction fitting

Procedure for Traction Circuit Relief Pressure Test (continued)

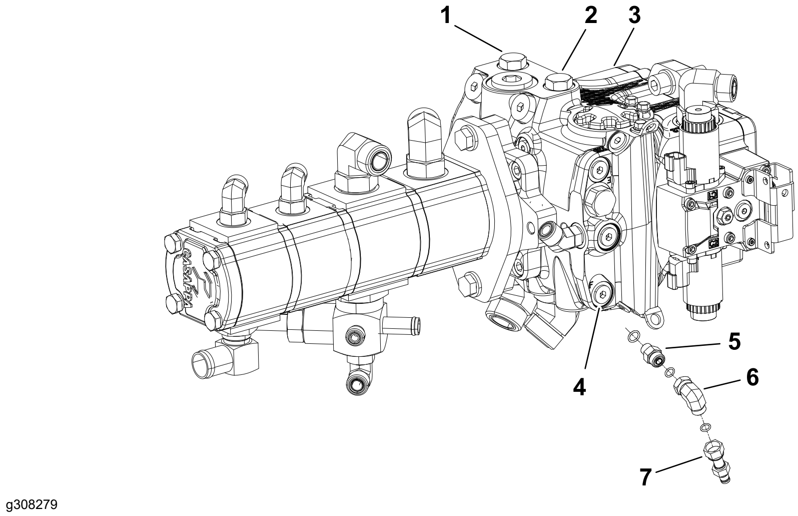

Figure 63

1. Forward relief valve
2. Reverse relief valve
3. Piston (traction) pump
4. Reverse traction port
5. Straight fitting
6. 90º fitting
7. Diagnostic test fitting

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3. Locate traction circuit test fitting for function to be checked (forward or reverse):
   A. For testing the forward traction circuit, a test fitting is located on a hydraulic tube on the right side of the machine below the hydraulic oil filter (Figure 62).
   B. For testing the reverse traction circuit, a test fitting needs to be temporarily installed in the piston (traction) pump reverse traction port on left side of pump (Figure 63). Thoroughly clean side of pump around plug to prevent system contamination. Remove plug from pump reverse traction port and then install straight fitting, 90º fitting and diagnostic test fitting into pump port (see Special Tools (page 2–16) for fitting part numbers).
4. Connect a 700 bar (10,000 PSI) pressure gauge to traction circuit test fitting for function to be checked (forward or reverse).
5. Start the engine and increase engine speed to high idle speed. Make sure that traction speed is in the HI (transport) range. Release parking brake.
6. While sitting on seat, apply brakes fully and slowly depress the traction pedal in the appropriate direction (forward or reverse).While pushing traction pedal, identify pressure reading on gauge as relief valve opens:

   GAUGE READING TO BE:

   Forward: 283 to 317 bar (4100 to 4600 PSI)

   Reverse: 328 to 362 bar (4750 to 5250 PSI)
7. Release traction pedal and stop engine. Record test results.
8. If traction pressure is too low, makes sure that bypass valve on traction pump is fully seated and then inspect traction pump relief valve in piston (traction) pump (Figure 63). Clean or replace valves as necessary. These cartridge type valves are factory set and are not adjustable. If relief valves are in good condition, piston (traction) pump, wheel motors and/or rear axle motor should be suspected of wear and inefficiency.

Procedure for Traction Circuit Relief Pressure Test (continued)

9. When testing is completed, disconnect pressure gauge from diagnostic test fitting. If reverse traction circuit was tested, remove test fitting, 90º fitting and straight fitting from piston (traction) pump. Install plug into piston pump port and torque plug to **43 N·m (32 ft-lb)**.

Reverse Traction Circuit Reducing Valve (PR) Pressure (Using Pressure Gauge)

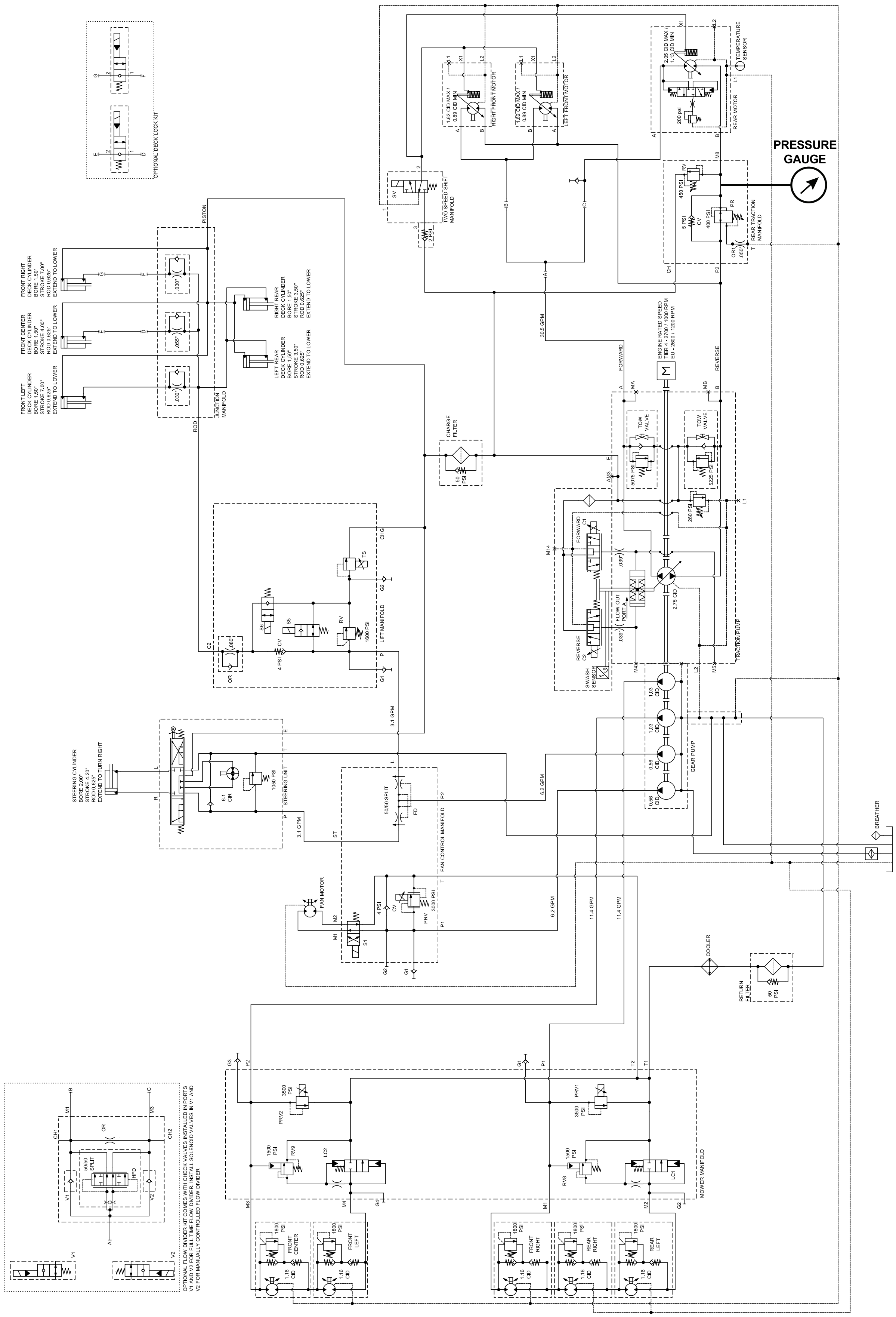

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Figure 64

Procedure for Reverse Traction Circuit Reducing Valve (PR) Pressure Test

Note: When in reverse, pressure reducing valve (PR) limits the pressure to the rear axle motor to 31 bar (450 PSI) so the rear wheels will not scuff the turf.

CAUTION

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

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately ten (10) minutes. Make sure the hydraulic reservoir is full.
2. Park machine on a level surface with the cutting decks lowered and off. Make sure engine is off and the parking brake is engaged.

   Note: The #6 zero leak plug on the inside of rear traction manifold is a zero leak plug that has a tapered sealing surface on the plug head. 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.

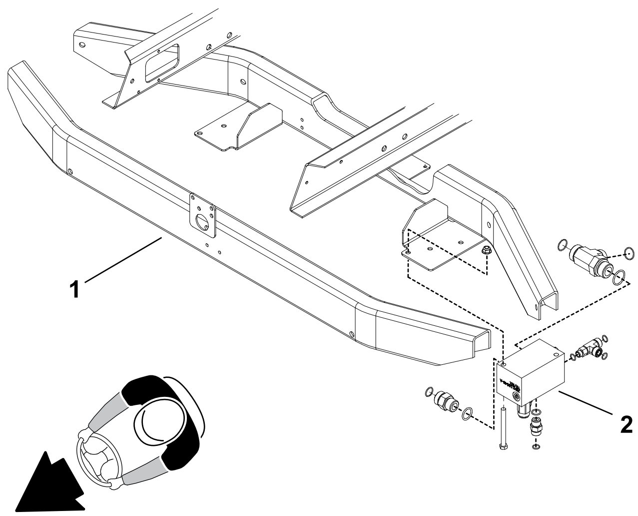

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Figure 65

1. Front frame
2. Rear traction manifold

3. Locate rear traction manifold that is attached to the front frame next to the left side front wheel (Figure 65). Remove #6 zero leak plug on the inside of rear traction manifold and install diagnostic fitting (Toro part number 59-7410) into manifold port.
4. Connect a 70 bar (1000 PSI) pressure gauge with hydraulic hose attached to installed diagnostic fitting.
5. Start engine and increase engine speed to high idle speed. Make sure that HIGH/LOW speed switch is in the LOW speed (mow) position and release parking brake.
6. Sit on seat, apply brakes fully and slowly depress the traction pedal in the reverse direction. While pushing traction pedal, carefully monitor the pressure gauge to identify the opening pressure of the pressure reducing (PR) valve:

   GAUGE READING TO BE 29 to 32 bar (420 to 470 PSI) when the pressure reducing (PR) valve opens.

Procedure for Reverse Traction Circuit Reducing Valve (PR) Pressure Test (continued)

7. Release traction pedal to neutral, stop engine and record test results.

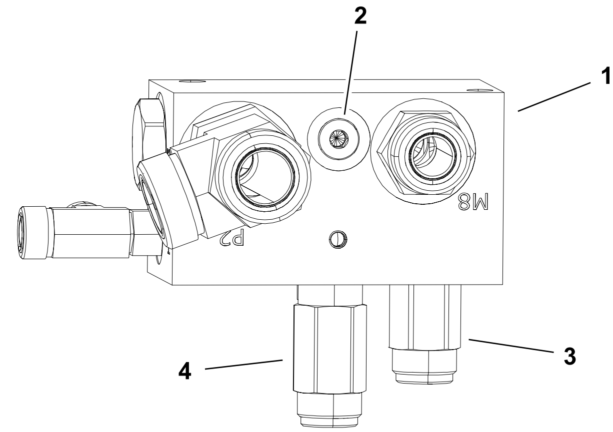

Figure 66

1. Rear traction manifold
2. #6 zero leak plug
3. Relief (RV) valve
4. Reducing (PR) valve

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8. The pressure reducing valve (PR) is located on the bottom of the rear traction manifold (Figure 66). If test pressure is incorrect, adjust pressure reducing valve (PR) (see Adjust Control Manifold Relief Valves in the Adjustments section of this chapter). Recheck pressure reducing valve pressure after any adjustment.

   Note: The rear traction circuit relief valve (RV) pressure test uses the same pressure gauge position as used to measure traction circuit pressure reducing valve (PR) pressure. If necessary, conduct the rear traction circuit relief valve (RV) pressure test before removing pressure gauge from rear traction manifold.

9. When testing is completed, disconnect pressure gauge from the installed diagnostic fitting. Remove diagnostic fitting from manifold and install removed plug into manifold. Torque plug to **34 N·m (25 ft-lb)**.

Rear Traction Circuit Relief (RV) Pressure (Using Pressure Gauge)

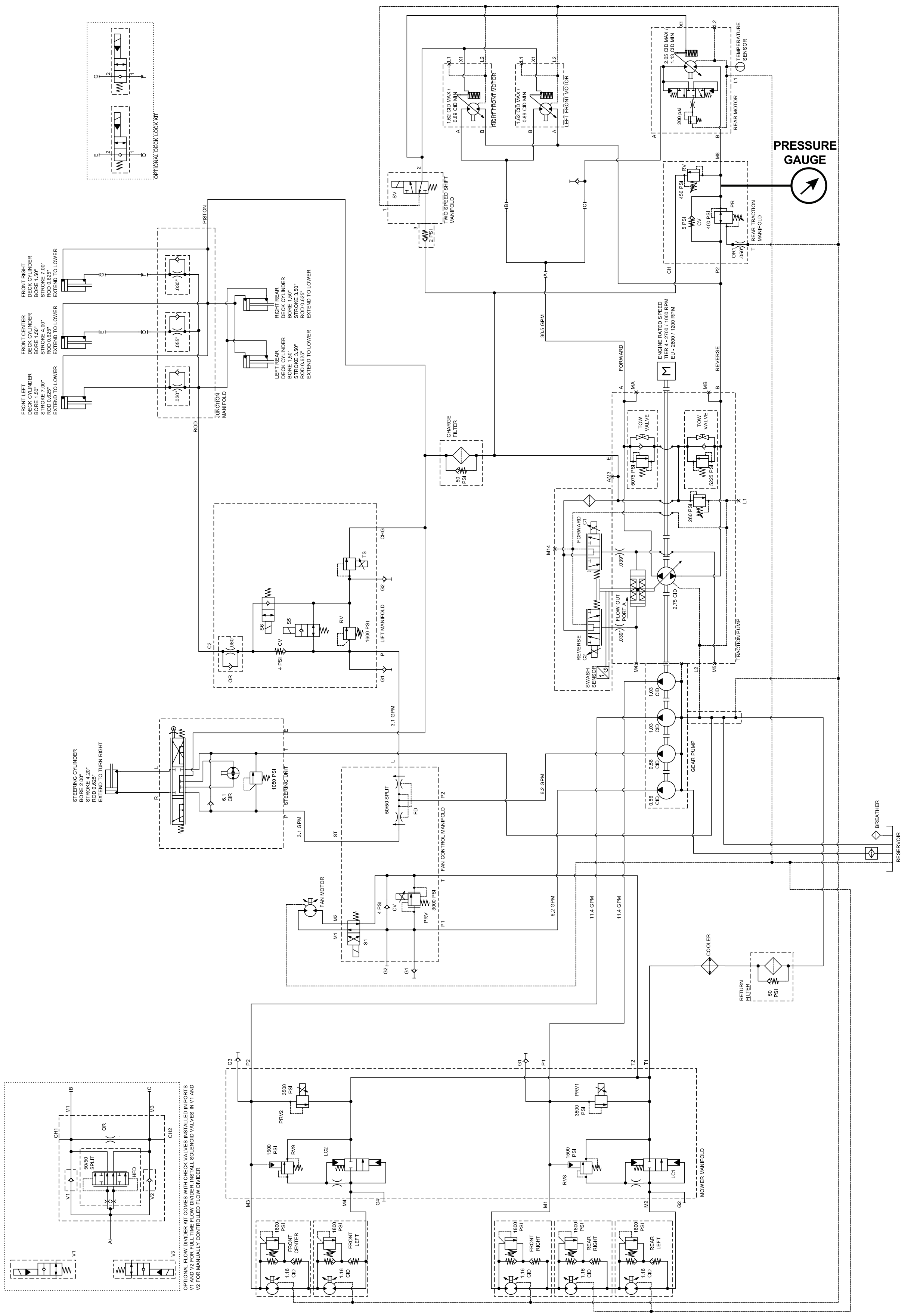

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Figure 67

Procedure for Rear Traction Circuit Relief Valve (RV) Pressure Test

Note: Adjustable relief valve (RV) in the rear traction control manifold reduces rear axle motor pressure created in down hill, dynamic braking conditions to prevent rear wheel lock up.

CAUTION

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

Note: If the rear traction circuit pressure reducing valve (PR) pressure is excessive, operation of the rear traction relief valve (RV) may be affected. Before adjusting rear traction relief valve (RV), make sure that pressure reducing valve (PR) pressure is correct.

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately ten (10) minutes. Make sure the hydraulic reservoir is full.
2. Park machine on a level surface with the cutting decks lowered and off. Make sure engine is off and the parking brake is engaged.

   Note: This test uses the same pressure gauge position as used to measure traction circuit pressure reducing valve (PR) pressure.

   Note: The #6 zero leak plug on the inside of rear traction manifold is a zero leak plug that has a tapered sealing surface on the plug head. 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.

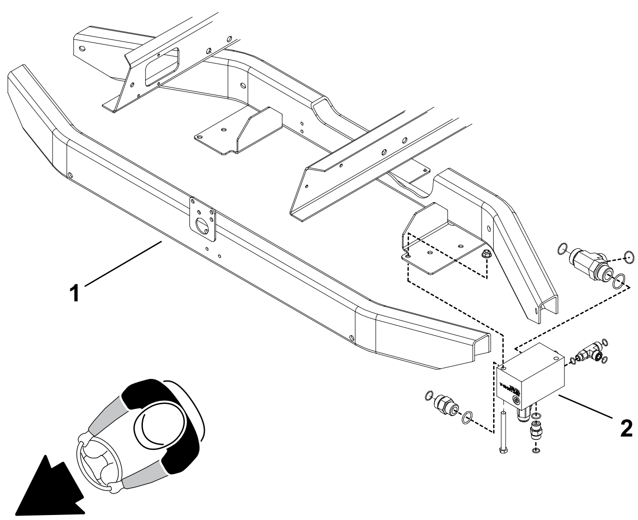

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Figure 68

1. Front frame
2. Rear traction manifold

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3. Locate rear traction manifold that is attached to the front frame next to the left side front wheel (Figure 68). Remove #6 zero leak plug on inside of rear traction manifold and install diagnostic fitting (Toro part number 59-7410) into manifold port.
4. Connect a 70 bar (1000 PSI) pressure gauge with hydraulic hose attached to installed diagnostic fitting.

Procedure for Rear Traction Circuit Relief Valve (RV) Pressure Test (continued)

5. Start engine and increase engine speed to high idle speed. Make sure that HIGH/LOW speed switch is in the LOW (mow) position and release the parking brake.
6. Measure and record reverse traction circuit reducing valve (PR) pressure (see Reverse Traction Circuit Reducing Valve (PR) Pressure (Using Pressure Gauge) (page 5–52)).
7. Operate the machine in LOW speed (mow) with the cutting decks lowered. Drive down a slope in a forward direction, decrease pressure on the traction pedal and monitor the pressure gauge. Pressure should increase until the rear traction circuit relief valve (RV) lifts.

   GAUGE READING TO BE approximately 38 bar (550 PSI) and at least 7 bar (100 PSI) higher than the traction circuit pressure reducing valve (PR) pressure (e.g. if the pressure reducing valve (PR) pressure is 31 bar (450 PSI), relief (RV) pressure should be at least 38 bar (550 PSI) but not much higher).
8. Stop engine and record test results.

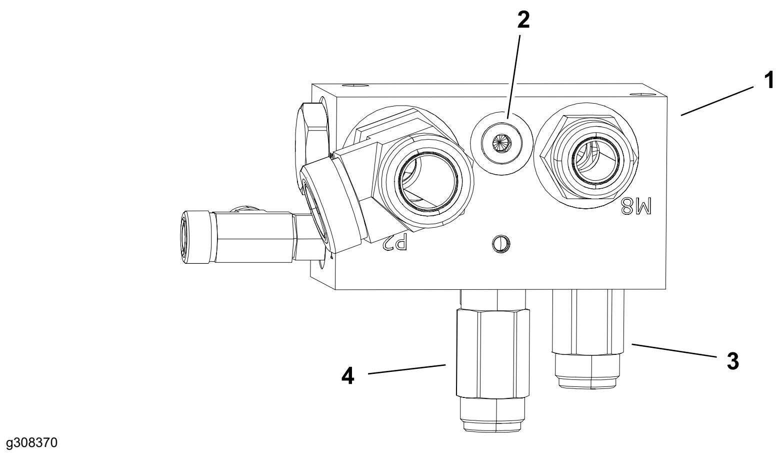

Figure 69

1. Rear traction manifold
2. #6 zero leak plug
3. Relief (RV) valve
4. Reducing (PR) valve

9. The rear traction circuit relief valve (RV) is located on the bottom of the rear traction manifold (Figure 69). If test pressure is incorrect, adjust relief valve (RV) (see Adjust Control Manifold Relief Valves (page 5–85)).
10. When testing is completed, disconnect pressure gauge from the installed diagnostic fitting. Remove diagnostic fitting from manifold and install removed plug into manifold. Torque plug to **34 N·m (25 ft-lb)**.

Piston (Traction) Pump Flow (Using Tester with Pressure Gauge & Flow Meter)

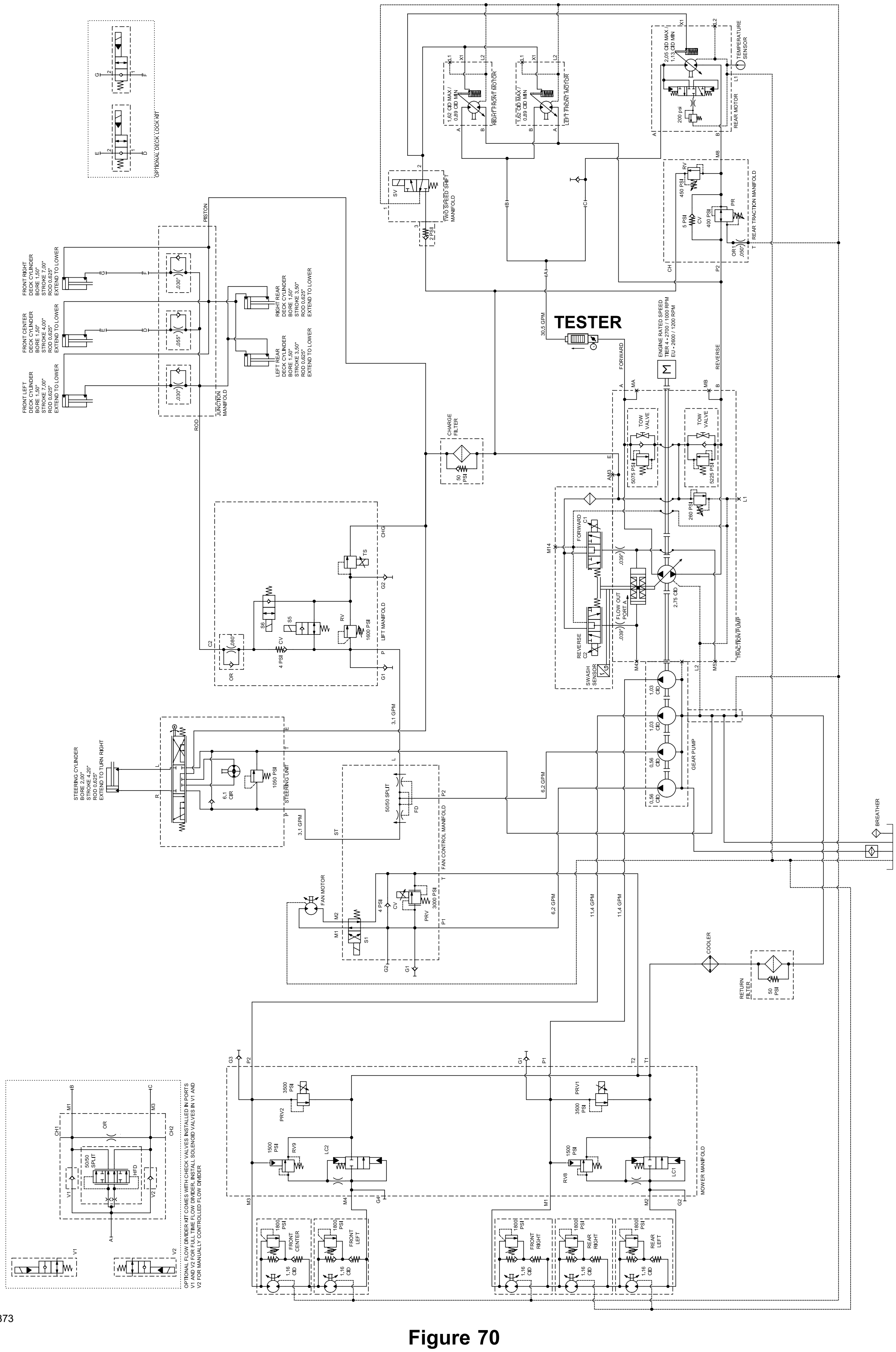

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Figure 70

Procedure for Piston (Traction) Pump Flow Test

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

Note: Before performing piston pump flow test, make sure that traction speed is set to 100% using the InfoCenter settings menu.

IMPORTANT

Traction circuit flow for the Groundsmaster 4500/4700 is approximately 113.5 LPM (30 GPM). Use 40 GPM Hydraulic Tester #AT40002 (pressure and flow) for this test (see Special Tools (page 2–16)).

CAUTION

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

1. Park machine on a level surface with the cutting decks lowered and off. Make sure hydraulic oil is at normal operating temperature, engine is off and the parking brake is applied.

CAUTION

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

2. Raise and support machine so all wheels are off the ground (see Jacking Instructions (page 1–7)).

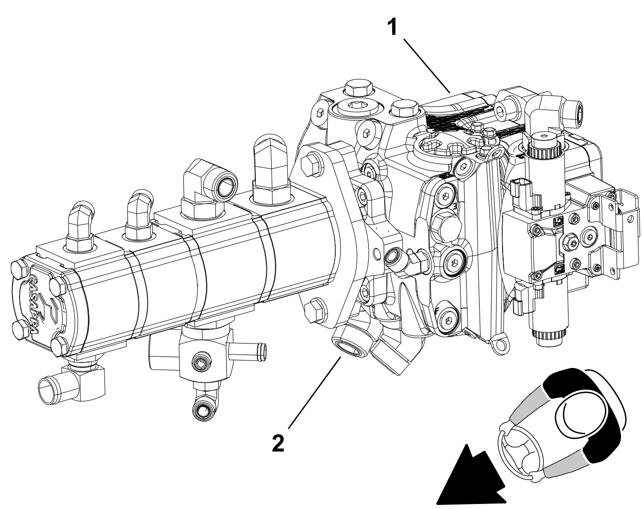

Figure 71

1. Piston (traction) pump
2. Forward port fitting

Procedure for Piston (Traction) Pump Flow Test (continued)

3. Thoroughly clean junction of hydraulic hose and right side fitting on bottom of piston pump (forward port) (Figure 71). Disconnect hose from right side pump fitting.
4. Install tester with pressure gauge and flow meter in series between piston pump fitting and disconnected hose to allow flow from traction pump to tester. Use hydraulic hose kit (see Special Tools (page 2–16)) to connect tester to machine. Make sure that fitting and hose connections are properly tightened. Also, make sure the flow control valve on tester is fully open.
5. Start engine and increase engine speed to high idle speed.
6. Slowly push traction pedal to fully forward position. Keep pedal fully depressed in the fully forward position.
7. Have second person watch pressure gauge on tester carefully while slowly closing the flow control valve until 69 bar (1000 PSI) is obtained. Verify with the InfoCenter display that the engine speed is still at the correct high idle speed.

   Note: If engine speed drops during testing, pump flow will decrease and flow test results will be inaccurate.
8. Observe flow gauge. Flow indication should be approximately 113 LPM (30 GPM).
9. Release traction pedal to the neutral position, open flow control valve on tester and shut off engine. Record test results.
10. If flow is less than 91 LPM (24 GPM), consider the following:
    A. The traction pedal is not calibrated correctly (see Traction Pedal Position Sensor Calibration (page 6–23)).
    B. The piston pump swashplate is not being rotated fully (e.g. traction speed is not set to 100%).
    C. The forward traction relief valve is leaking or faulty.
    D. The piston pump needs to be repaired or replaced as necessary.
11. Make necessary repairs before performing any additional traction circuit tests.
12. When testing is complete, disconnect tester from pump fitting and machine hydraulic hose. Reconnect hose to pump fitting. Lower machine to ground.

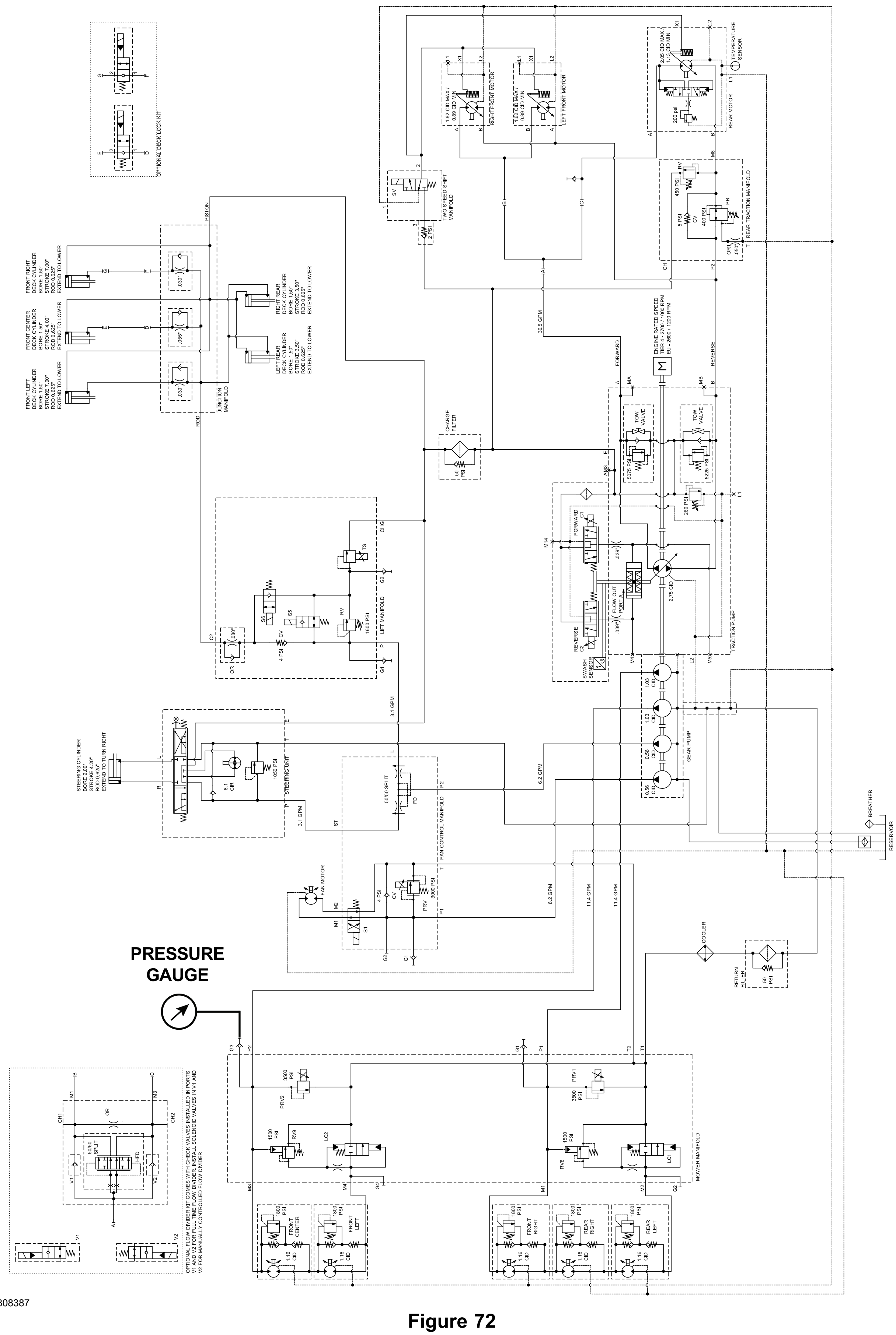

Figure 72

TEST FOR GM4500-D DECKS 1 AND 4 SHOWN

Procedure for Cutting Deck Circuit Pressure Test

CAUTION

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

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately ten (10) minutes. Make sure the hydraulic reservoir is full.
2. Park machine on a level surface with the cutting decks lowered and off. Make sure engine is off and the parking brake is engaged.
3. Raise hood to allow access to deck control manifold.

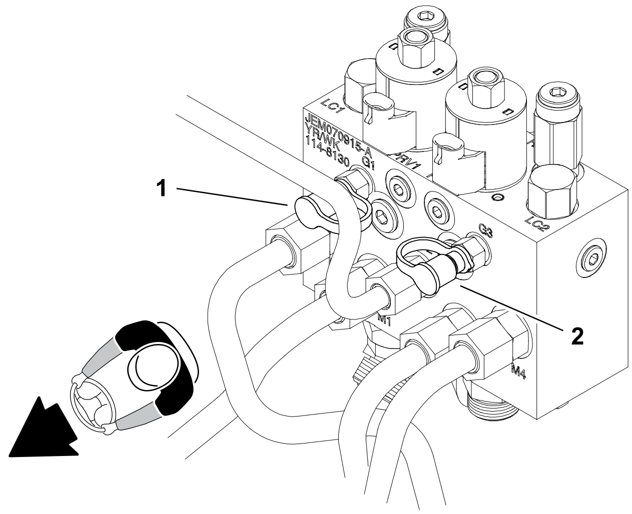

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Figure 73

1. Test port G1 (decks 2, 3, & 5)
2. Test port G3 (decks 1 & 4)

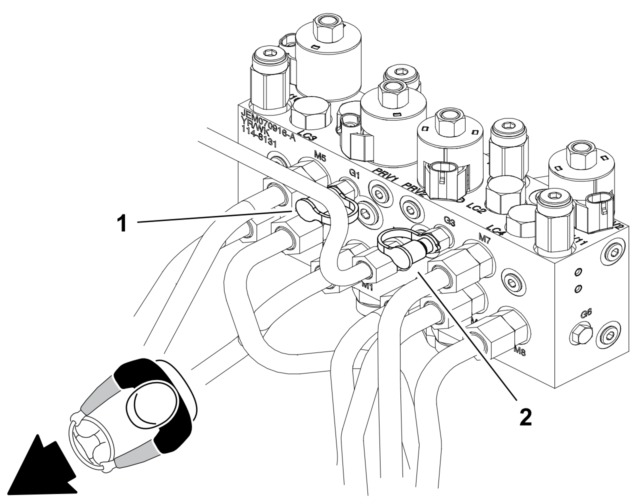

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Figure 74

1. Test port G1 (decks 2, 3, 5 & 7)
2. Test port G3 (decks 1, 4 & 6)

4. Install 350 bar (5000 PSI) pressure gauge with hydraulic hose attached to deck control manifold test port for the cutting deck circuit to be tested (Figure 73 or Figure 74).

Procedure for Cutting Deck Circuit Pressure Test (continued)

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

CAUTION

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

6. Increase engine speed to high idle speed. Engage the cutting decks.

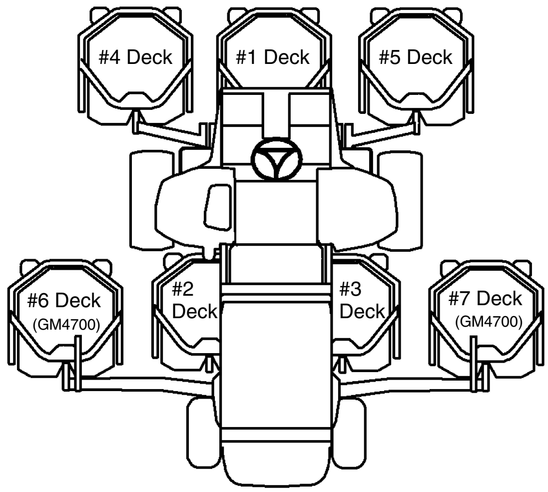


Figure 75
CUTTING DECK LOCATIONS

7. Watch pressure gauge carefully while mowing with the machine.
8. Cutting deck circuit pressure should be from 69 to 241 bar (1000 to 3500 PSI) and will vary depending on mowing conditions.
9. Disengage cutting decks. Shut off engine. Record test results.
10. After testing is complete, disconnect pressure gauge from manifold test port.
11. Lower and secure hood.

Cutting Deck Circuit Relief Pressure (Using Tester with Pressure Gauge & Flow Meter)

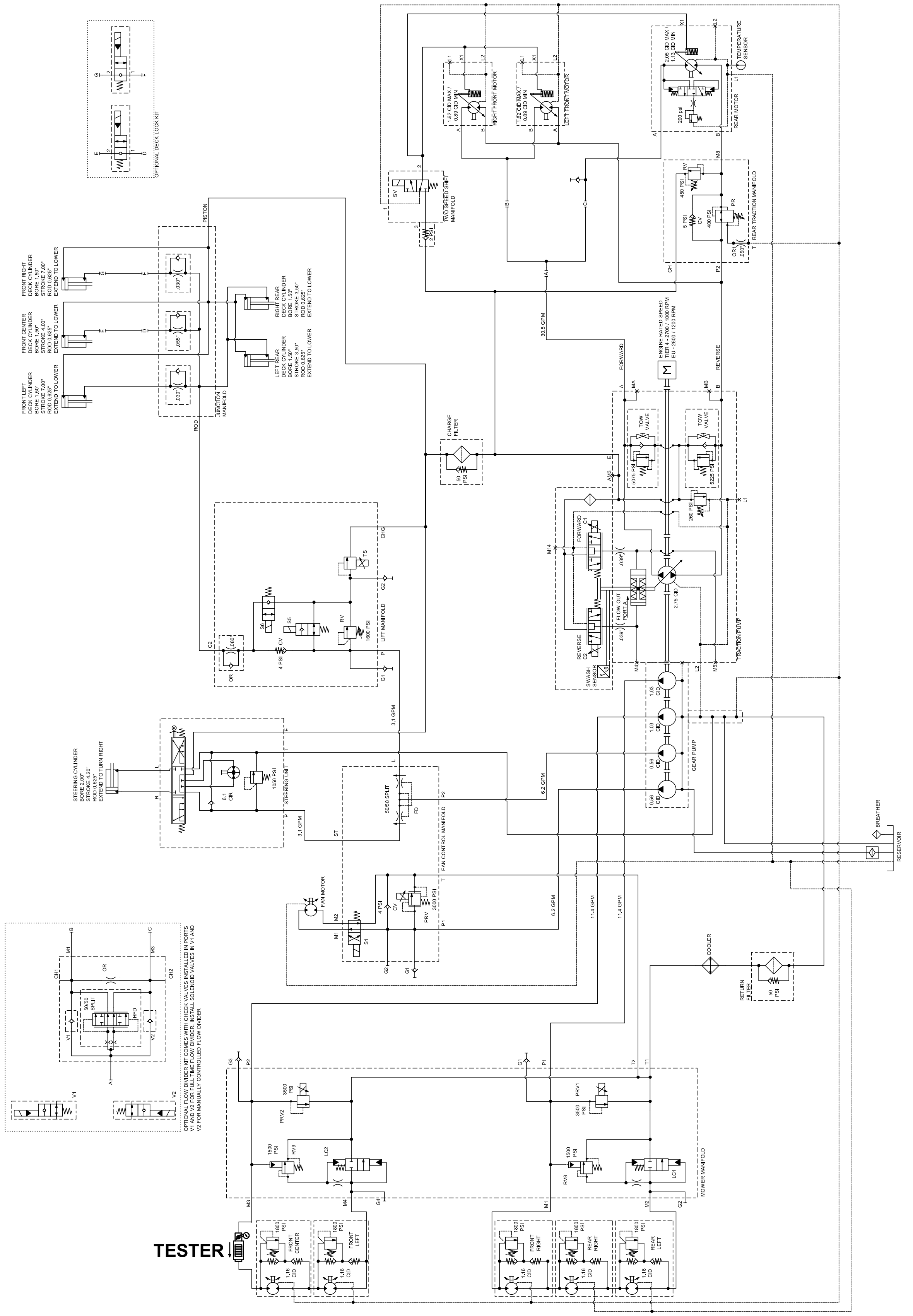


Figure 76

TEST FOR GM4500-D SECOND PUMP SECTION SHOWN

Procedure for Cutting Deck Circuit Relief Pressure Test

CAUTION

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

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately ten (10) minutes. Make sure the hydraulic reservoir is full.
2. Park machine on a level surface with the cutting decks lowered and off. Make sure engine is off and the parking brake is engaged.

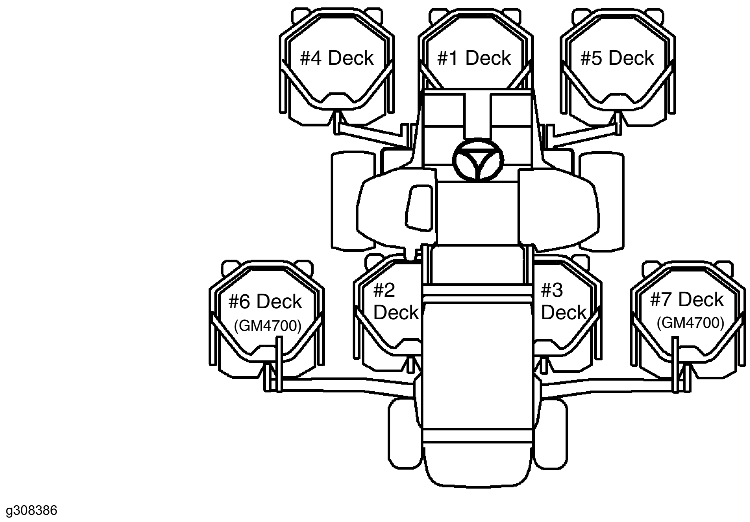


Figure 77

CUTTING DECK LOCATIONS

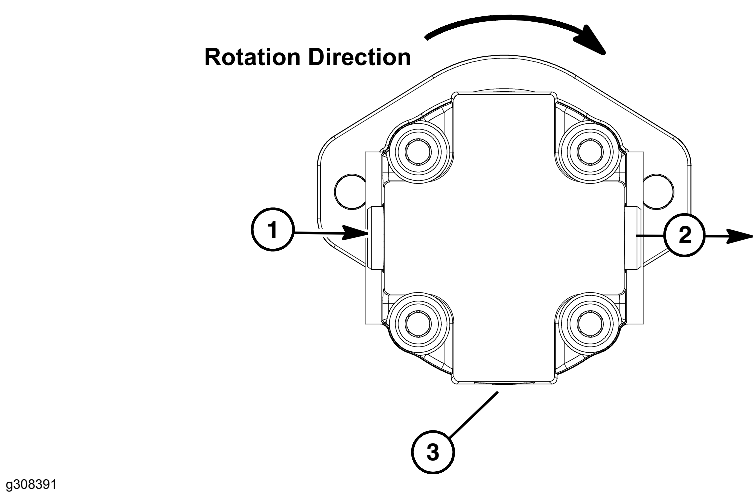


Figure 78

1. Flow IN
2. Flow OUT
3. Case drain

3. Determine cutting deck circuit relief pressure to be tested:
   A. For the first gear pump section (decks #2, #3, #5 and #7), cutting deck circuit relief (PRV2) is tested at the inlet to the deck #5 motor (Figure 77).

B. For second gear pump section (decks #1, #4 and #6), cutting deck circuit relief (PRV1) is tested at the inlet to the deck #1 motor (Figure 77).

4. Thoroughly clean junction of appropriate hydraulic inlet hose and deck motor fitting (Figure 78). Disconnect the hydraulic inlet hose from the deck motor.

IMPORTANT

Make sure that the oil flow indicator arrow on the tester is showing that the oil will flow from the disconnected hose, through the tester and into the deck motor.

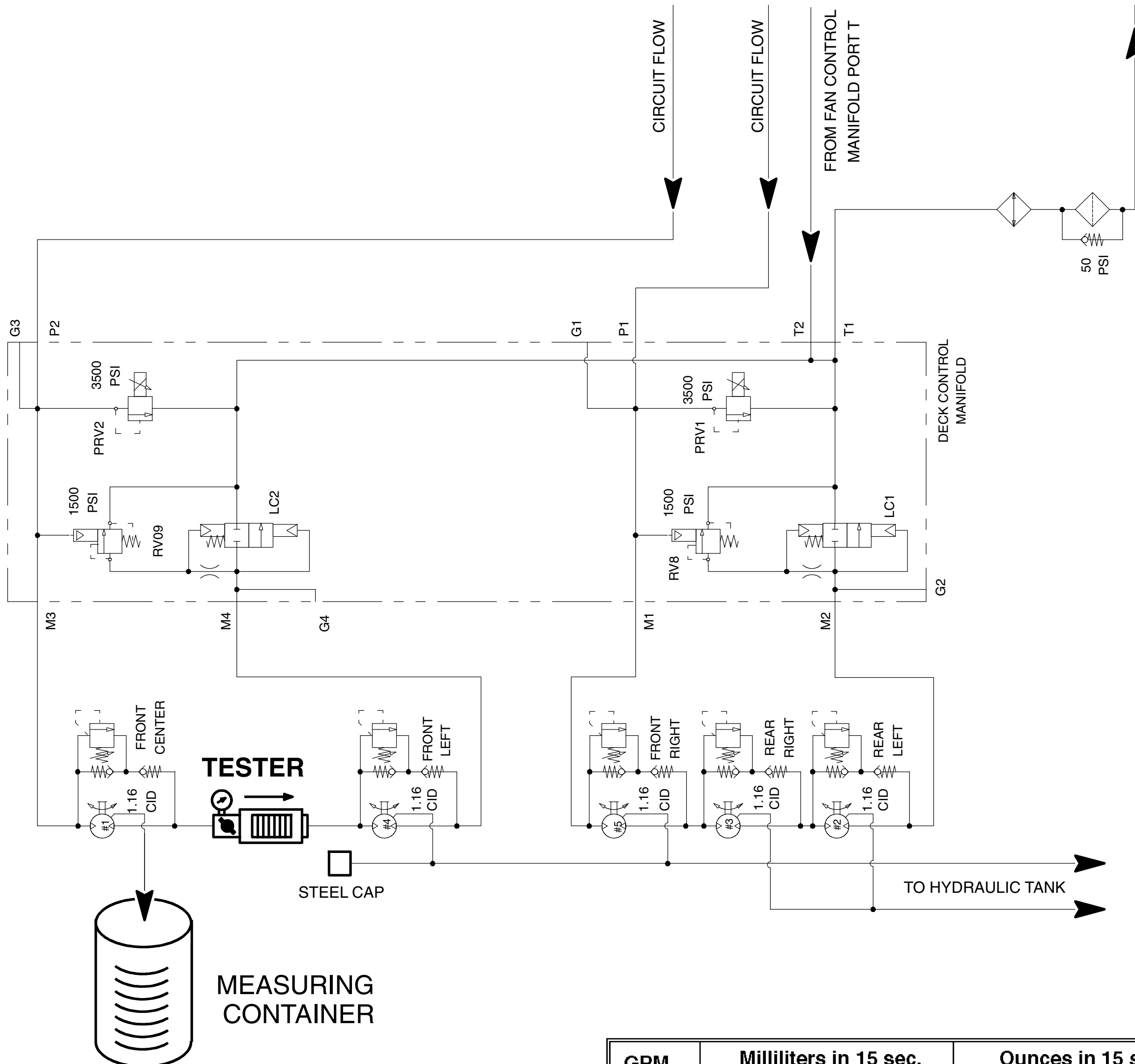
5. Install tester with pressure gauge and flow meter in series with the disconnected hose and deck motor inlet. Make sure the tester flow control valve is fully open.
6. After installing pressure gauge, start engine and run at low idle speed. Check for hydraulic leakage and correct before proceeding with test.

CAUTION

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

7. Increase engine speed to high idle speed. Engage the cutting decks.
8. Watch tester pressure gauge carefully while slowly closing the flow control valve on tester.
9. As the circuit relief valve lifts, system pressure should be from 235 to 258 bar (3400 to 3750 PSI).
10. Open the tester flow control valve, disengage cutting decks and stop the engine. Record test results.
11. If specification is not met, make sure that electrical connections at deck control manifold are secure and then clean or replace relief valve (PRV1 or PRV2) in the deck control manifold (see Deck Control Manifold (page 5–130)). Also, if pressure is still low after relief valve service, check for restriction in pump intake line. The first or second gear pump section could also be suspected of wear or damage (see Gear Pump Flow (Using Tester with Pressure Gauge & Flow Meter) (page 5–81)).
12. After testing is complete, disconnect tester from deck motor and hose. Connect hydraulic hose to motor.

Deck Motor Case Drain Leakage (Using Tester with Pressure Gauge & Flow Meter)



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

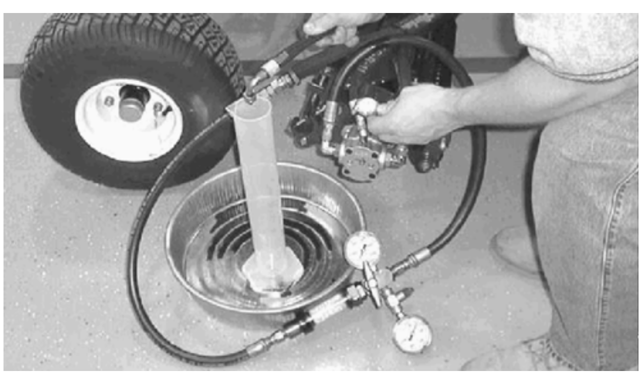


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Figure 79

TEST FOR GM4500-D DECK MOTOR #1 SHOWN

Procedure for Deck Motor Case Drain Leakage Test

Note: Over a period of time, a deck motor can wear internally. A worn motor may bypass oil to its case drain causing the motor to be less efficient. Eventually, enough oil loss will cause the deck 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 deck 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.

CAUTION

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

---

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately ten (10) minutes. Make sure the hydraulic reservoir is full.
2. Park machine on a level surface with the cutting decks lowered and off. Make sure engine is off and the parking brake is engaged.

   Note: The deck 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 circuit (see Appendix A (page A–1)).

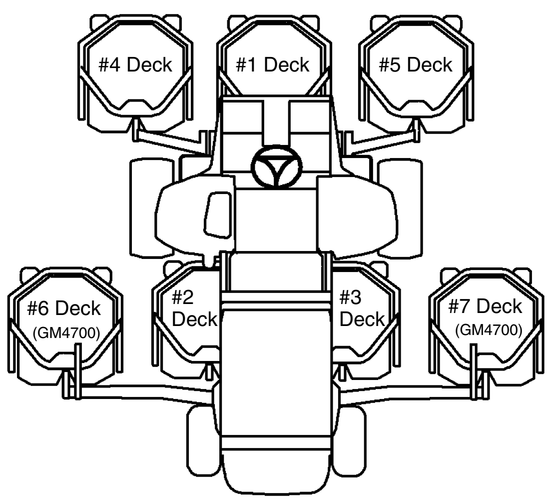

Figure 80
CUTTING DECK LOCATIONS

Procedure for Deck Motor Case Drain Leakage Test (continued)

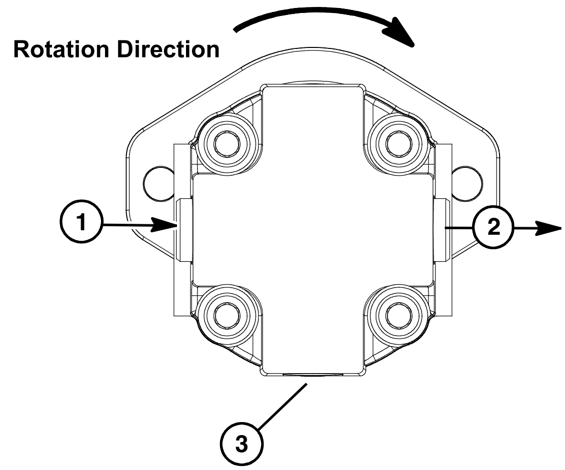

Figure 81

1. Flow IN
2. Flow OUT
3. Case drain

---

3. Disconnect pressure return hose from the motor to be tested (Figure 81). Install tester with pressure gauge and flow meter in series with the motor and the disconnected return hose. Make sure the flow control valve on tester is fully open.
4. Disconnect the motor case drain hose (small diameter hose) where it connects to bulkhead fitting at the frame rail (not at the motor). Put a steel cap on the bulkhead fitting; leave the case drain hose open.

CAUTION

Cutting deck blades will rotate when lowered with PTO switch in ON position. Keep away from cutting decks during test to prevent personal injury from rotating blades. Do not stand in front of the machine during test.

---

5. Sit on seat and start the engine. Increase engine speed to high idle speed. Engage cutting decks.
6. While watching tester pressure gauge, have second person slowly close flow control valve on tester until a pressure of 83 bar (1200 PSI) is obtained.

   Note: Use a graduated container, special tool TOR4077, to measure case drain leakage.
7. Have a second person measure flow from the case drain line for fifteen (15) seconds, then disengage the cutting decks and stop the engine. Record test results.

   TEST RESULTS: Case drain leakage less than 662 ml (22.4 ounces) of hydraulic fluid in fifteen (15) seconds (0.7 GPM / 2.7 LPM)
8. If case drain flow is more than 662 ml (22.4 ounces), the deck motor is worn or damaged and should be repaired or replaced.
9. When testing is complete, disconnect tester from motor and hose. Reconnect hose to the deck motor. Remove cap from bulkhead fitting and reconnect case drain hose.
10. Repeat test for additional motors if required.

Steering Circuit Relief Pressure (Using Pressure Gauge)

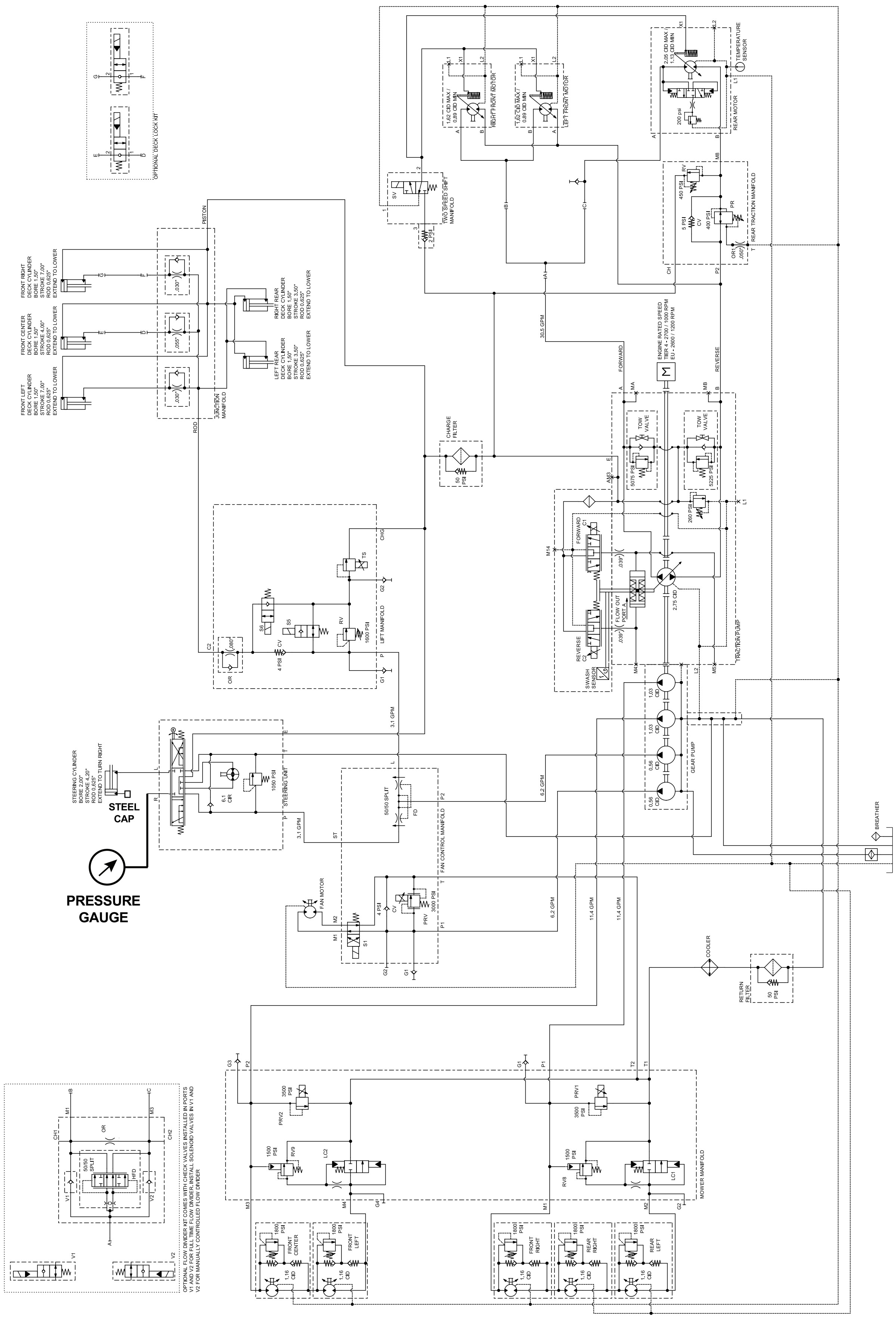

Figure 82

TEST FOR GM4500-D SHOWN (STEERING WHEEL TURNED FOR RIGHT TURN)

Procedure for Steering Circuit Relief Pressure Test

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

CAUTION

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

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately ten (10) minutes. Make sure the hydraulic reservoir is full.
2. Park machine on a level surface with the cutting decks lowered and off. Make sure engine is off and the parking brake is engaged.

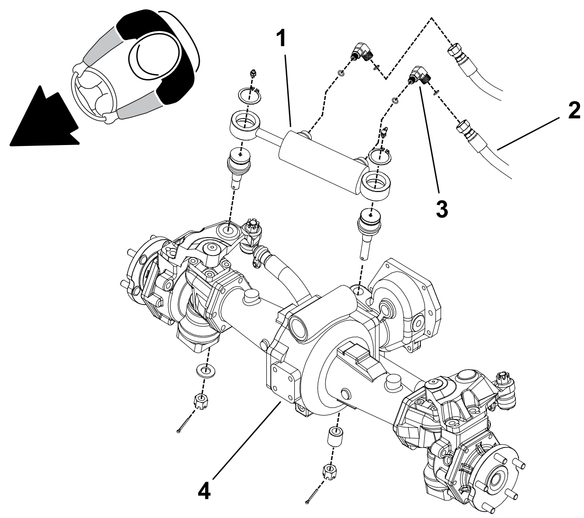

Figure 83

1.	Steering cylinder	3.	Barrel end fitting
2.	Barrel end hose	4.	Rear axle

3. Thoroughly clean junction of hydraulic hose and steering cylinder fitting at the barrel end of the steering cylinder (Figure 83). Disconnect hose from fitting in barrel end of steering cylinder.
4. Install 350 bar (5000 PSI) pressure gauge with hydraulic hose attached to disconnected hose. Install steel cap on steering cylinder fitting to prevent any leakage from cylinder.
5. After installing pressure gauge, start engine and run at low idle speed. Check for hydraulic leakage and correct before proceeding with test.
6. Increase engine speed to high idle speed.

IMPORTANT

While testing, rotate steering wheel only long enough to get a system relief pressure reading. Holding the steering circuit at relief pressure for an extended period may damage the steering control valve.

7. Turn steering wheel to the right while monitoring the pressure gauge. When steering circuit pressure reaches the relief pressure setting, pressure should

stabilize briefly and then may continue to increase. The steering circuit relief pressure is the gauge reading when pressure stabilizes.

GAUGE READING TO BE 80 to 103 bar (1150 TO 1500 PSI).

8. Stop the engine. Record test results.
9. If steering relief pressure is incorrect, inspect steering relief valve located in the steering control valve (see Steering Control Valve Service (page 5–141)). If relief valve is operating properly and if lift/lower and traction charge circuit problems also exist, the third gear pump section should be suspected of wear or damage. If steering wheel continues to turn at end of cylinder travel (with lower than normal effort), steering cylinder or steering control valve may be worn or damaged.
10. When testing is complete, turn steering wheel to both the right and the left with the engine not running to relieve steering circuit pressure. Remove pressure gauge from hydraulic hose and steel cap from steering cylinder fitting. Connect hydraulic hose to steering cylinder fitting.

Steering Cylinder Internal Leakage

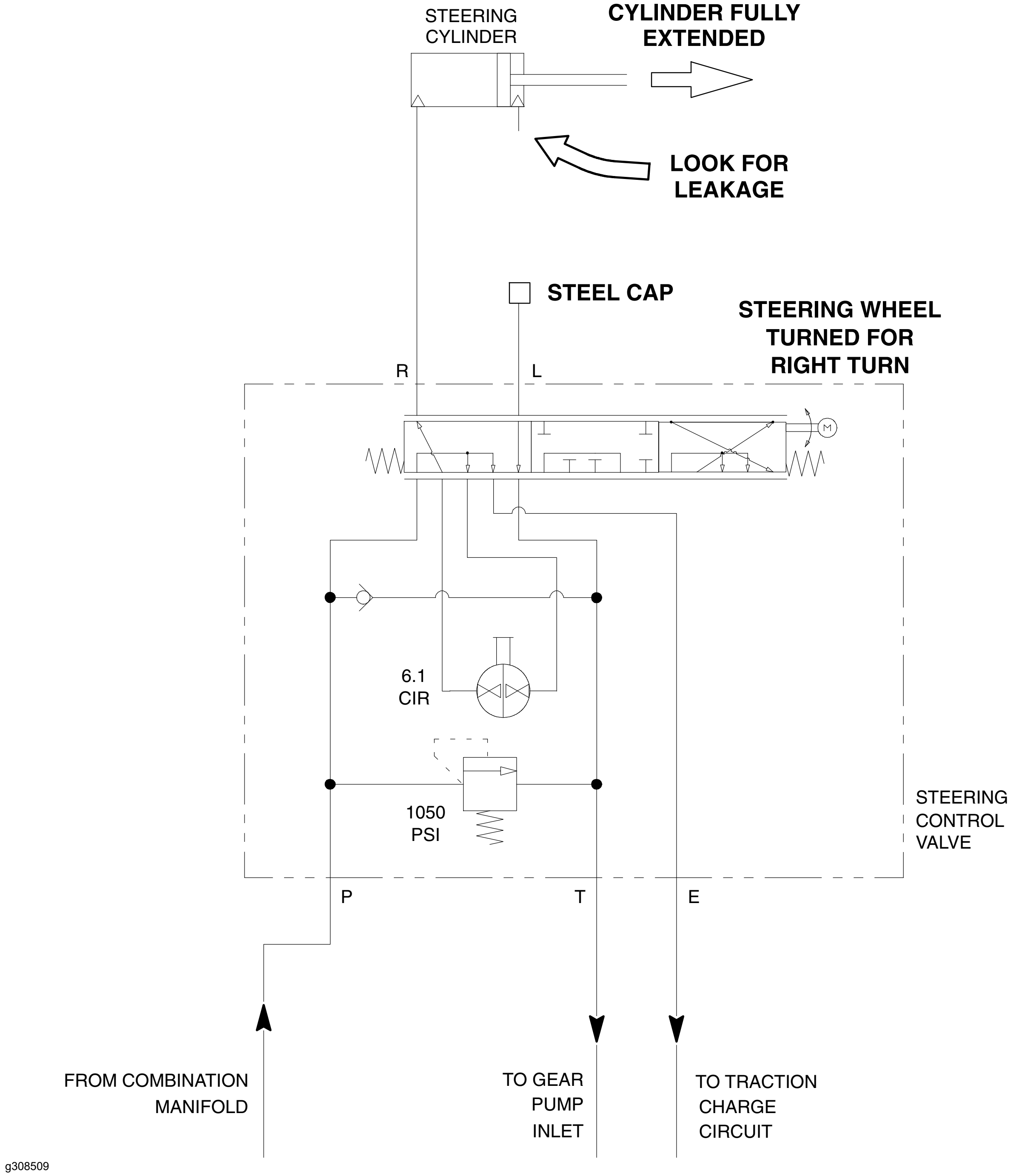

Figure 84

The steering cylinder internal leakage test should be performed if a steering problem is identified. This test will determine if the steering cylinder is faulty.

Procedure for Steering Cylinder Internal Leakage Test

Note: Steering circuit operation will be affected by rear tire pressure, binding of steering cylinder, extra weight on the vehicle and/or binding of rear axle steering components. Make sure that these items are checked before proceeding with steering cylinder internal leakage test.

Procedure for Steering Cylinder Internal Leakage Test (continued)

⚠ CAUTION ⚠

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

---

1. Park machine on a level surface with the cutting decks lowered and off. Make sure hydraulic oil is at normal operating temperature, engine is off and the parking brake is applied.
2. Turn the steering wheel for a right turn so that the steering cylinder rod is fully extended.
3. Thoroughly clean the area around the hydraulic hose at the rod end of the steering cylinder.
4. Place a drain pan under the steering cylinder. Remove hydraulic hose from the fitting on the rod end of the steering cylinder. Install a steel plug in the disconnected hose. Leave cylinder fitting open.
5. Remove all hydraulic oil from drain pan. Make sure that empty drain pan remains under the open fitting of the steering cylinder.
6. With the engine off, turn the steering wheel for a right turn. Observe the open fitting on the extended steering cylinder as the steering wheel is turned. If oil comes out of the fitting while turning the steering wheel, the steering cylinder has internal leakage and must be repaired (see Steering Cylinder Service (page 5–144)). Check drain pan for any evidence of oil that would indicate cylinder leakage.
7. If a steering problem exists and the steering cylinder tested acceptably, the steering control valve requires service (see Steering Control Valve Service (page 5–141)).
8. After testing is completed, remove plug from the hydraulic hose. Connect hose to the steering cylinder fitting.
9. Check oil level in hydraulic reservoir and adjust if needed.

Lift/Lower Circuit Relief Pressure (Using Pressure Gauge)

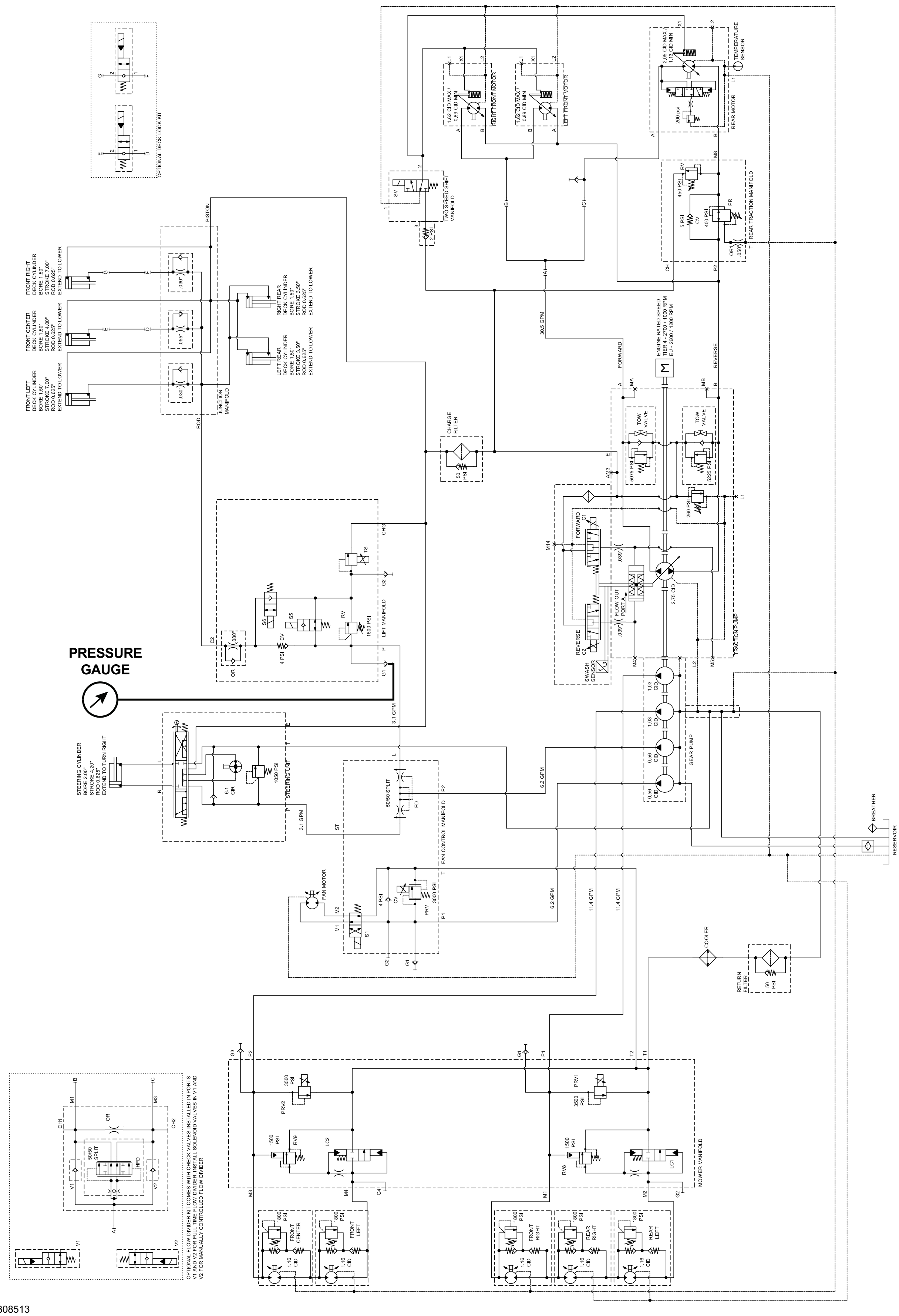

Figure 85

GM4500-D SHOWN

Procedure for Lift/Lower Circuit Relief Pressure Test

The lift/lower circuit relief pressure test should be performed to make sure that the cutting unit lift and lower circuit relief pressure is correct.

CAUTION

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

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately ten (10) minutes. Make sure the hydraulic reservoir is full.
2. Park machine on a level surface with the cutting decks fully raised. Apply the parking brake and stop engine.

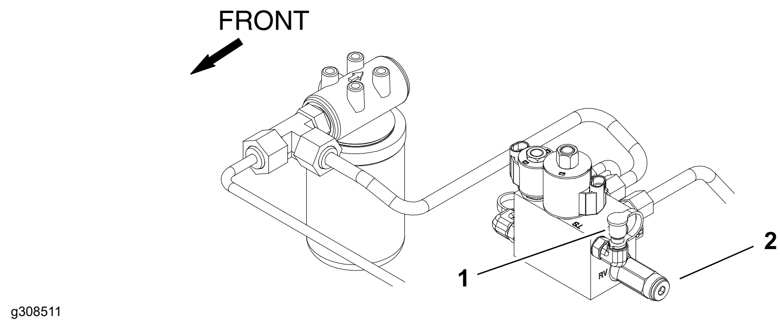

Figure 86

GM4500-D

1. Test port G1
2. Relief valve

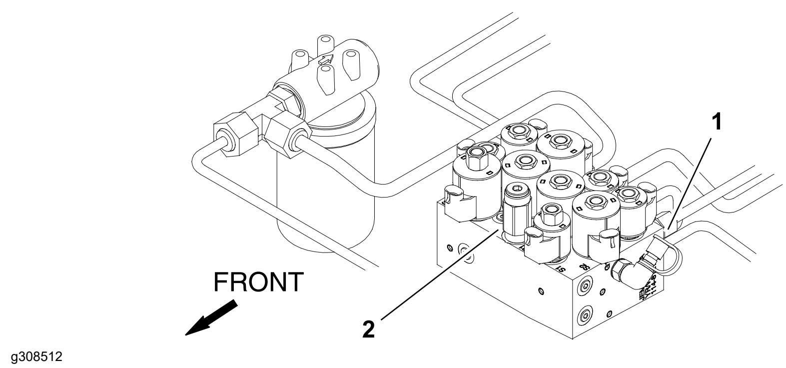

Figure 87

GM4700-D

1. Test port G1
2. Relief valve

3. Raise and support seat to gain access to lift control manifold (Figure 86 or Figure 87). Connect a 350 bar (5000 PSI) pressure gauge with hydraulic hose attached to lift manifold test port G1. Route gauge hose to allow hood to be safely lowered.
4. Sit on the seat and start the engine. Increase engine speed to high idle speed.
5. While sitting on the seat, with the cutting decks fully raised, monitor the pressure gauge to identify lift/lower circuit pressure with no load. Record this pressure.

Procedure for Lift/Lower Circuit Relief Pressure Test (continued)

6. While remaining on the seat, depress rear of lift switch (raise) to allow lift/lower circuit pressure to increase. Momentarily hold the switch with the lift cylinders fully retracted while looking at the pressure gauge as the lift/lower relief valve opens.

   GAUGE READING TO BE approximately 110 bar (1600 PSI) higher than measured lift/lower circuit pressure with no load from step 5 above (e.g. if circuit no load pressure is 21 bar (300 PSI), lift/lower relief pressure should be approximately 131 bar (1900 PSI)).

7. Release the lift switch and stop the engine. Record test results.

8. If specification is not met, adjust or clean relief valve located in the lift control manifold (see Lift Control Manifold (page 5–155)).

   A. If pressure is too high, adjust the relief valve (see Adjust Control Manifold Relief Valves (page 5–85)).

   B. If pressure is too low, check for restriction in gear pump intake line. Check the lift cylinders for internal leakage. If pump intake line is not restricted and lift cylinders are not leaking, adjust the relief valve (see Adjust Control Manifold Relief Valves (page 5–85)).

   C. If pressure is still too low after relief valve adjustment, pump P4 or lift cylinder(s) should be suspected of wear or damage.

9. Lower and secure seat after testing is completed.

Engine Cooling Fan Circuit (Using Pressure Gauge and Phototac)

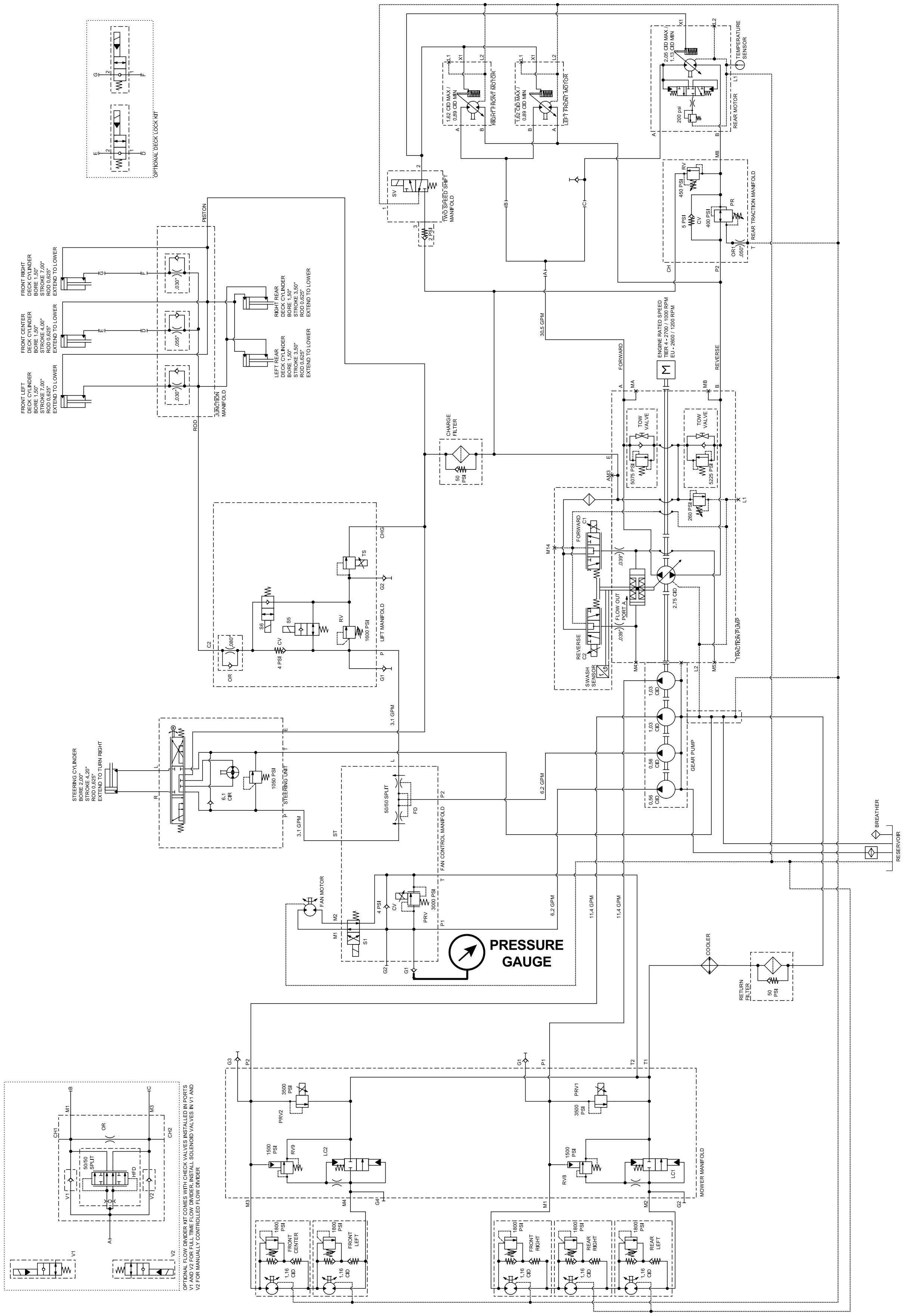

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Figure 88

GM4500-D SHOWN

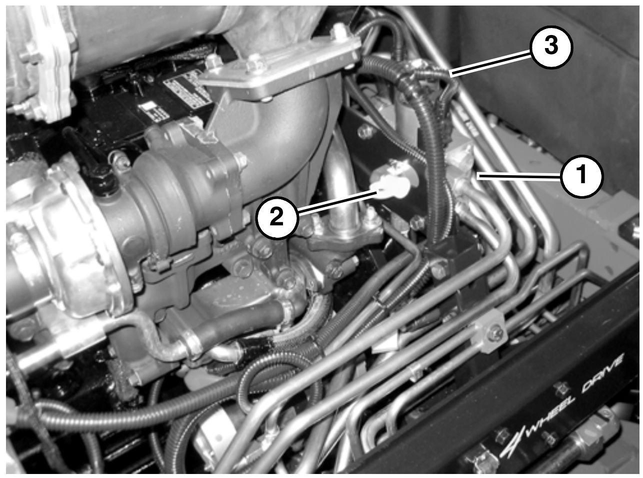
Procedure for Engine Cooling Fan Circuit Test

The engine cooling fan circuit test should be performed to make sure that the engine cooling fan circuit has the correct system pressure and fan speed.

CAUTION

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

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately ten (10) minutes. Make sure the hydraulic reservoir is full.
2. Park machine on a level surface with the cutting decks lowered and off. Make sure engine is off and the parking brake is applied.



g308527

Figure 89

1. Fan control manifold
2. Test fitting (port G1)
3. PRV solenoid

3. Raise and support hood to gain access to fan control manifold (Figure 89). Connect a 345 bar (5,000 PSI) gauge with hydraulic hose attached to test fitting in port G1 on rear of manifold.
4. Start the engine and increase engine speed to high idle speed.
5. While monitoring the pressure gauge and using a phototac to identify the cooling fan speed, disconnect the wire harness connector (white/violet and black wires) from the proportional relief valve solenoid at fan control manifold (port TS). Both fan speed and pressure should increase and stabilize after the solenoid is disconnected.

   PRESSURE GAUGE READING TO BE approximately 207 bar (3000 PSI).

   PHOTOTAC (fan speed) READING TO BE approximately 2800 RPM.
6. Stop engine and record test results.
7. If pressure rises to approximately 207 bar (3000 PSI) but fan speed is low, consider that the hydraulic fan motor is worn or damaged. If pressure and fan speed are both low, consider that final gear pump section is worn or damaged (see Gear Pump Flow (Using Tester with Pressure Gauge & Flow Meter) (page 5–81)).

Procedure for Engine Cooling Fan Circuit Test (continued)

Note: If pressure and fan speed are both low and the final gear pump section flow proves to be correct (see Gear Pump Flow (Using Tester with Pressure Gauge & Flow Meter) (page 5–81)), suspect that seals in fan control manifold are leaking or faulty (see Fan Control Manifold Service (page 5–154)) or that fan motor is worn or damaged.

8. When testing is complete, remove pressure gauge from manifold fitting and reconnect wire harness to proportional relief valve solenoid. Lower and secure hood.

Gear Pump Flow (Using Tester with Pressure Gauge & Flow Meter)

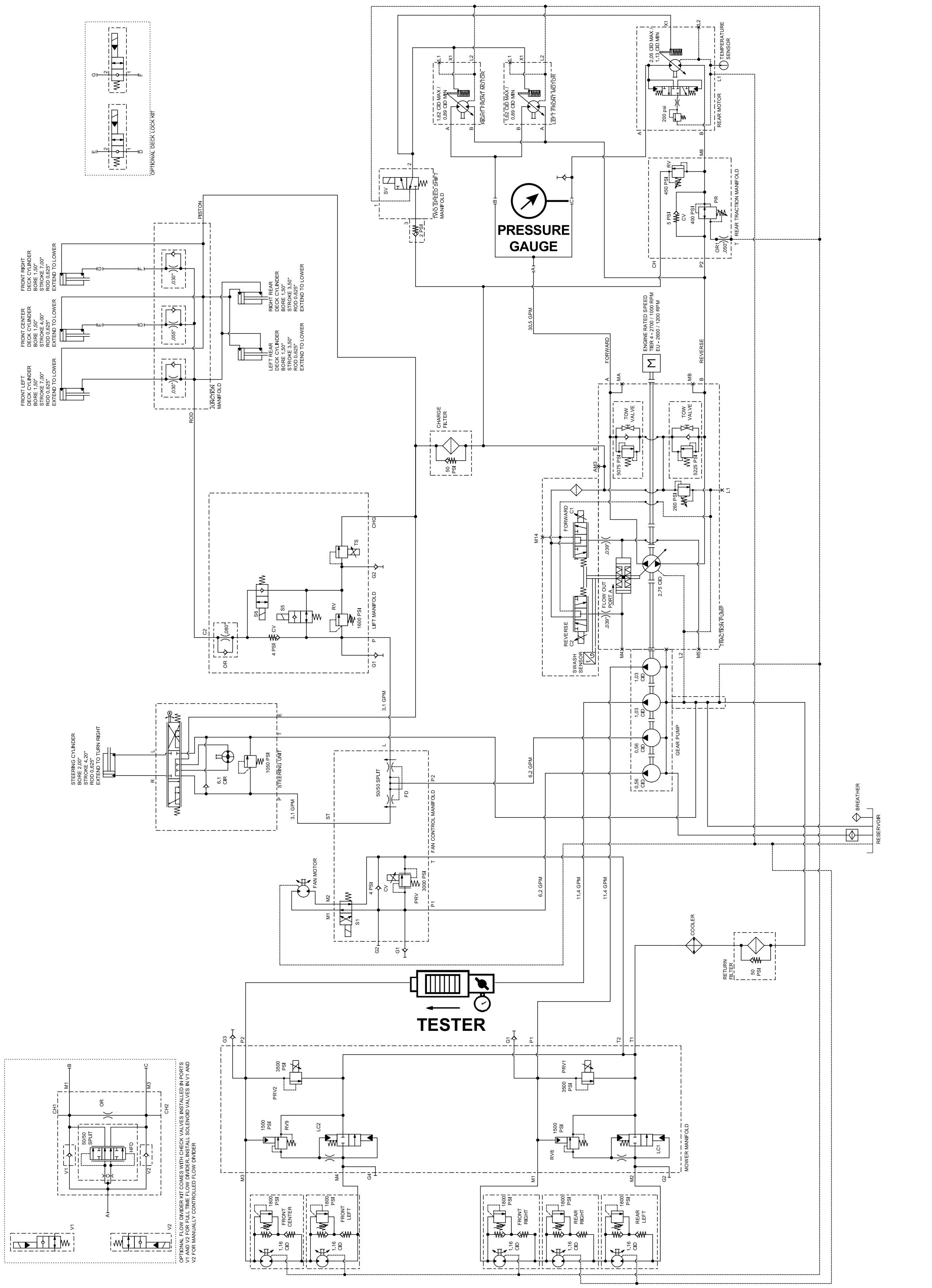


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Figure 90

GM4500-D and SECOND GEAR PUMP SECTION FLOW TEST SHOWN

Gear Pump Flow (Using Tester with Pressure Gauge & Flow Meter) (continued)

The gear pump flow test should be performed to make sure that the mow, steering, lift/lower, cooling fan and traction charge circuits have adequate hydraulic flow. Gear pump sections are illustrated in Figure 91. The first gear pump section provides hydraulic flow for cutting decks 2, 3 and 5 (also deck 7 on the GM4700-D). The second gear pump section provides hydraulic flow for cutting decks 1 and 4 (also deck 6 on the GM4700-D). The third gear pump section provides hydraulic flow for the steering, lift/lower and traction charge circuits. The fourth gear pump section provides hydraulic flow for the engine cooling fan circuit.

Note: Over a period of time, the gears and wear plates in the gear pump can wear. A worn pump will by pass oil and make the pump less efficient. Eventually, enough oil loss will occur to cause circuit problems (e.g. cutting deck motors stalling under heavy cutting conditions, lift or steering problems). Continued operation with a worn, inefficient gear pump can generate excessive heat and cause damage to the seals and other components in the hydraulic system.

Procedure for Gear Pump Flow Test

CAUTION

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

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately ten (10) minutes. Make sure the hydraulic reservoir is full.
2. Park machine on a level surface with the cutting decks lowered and off. Make sure engine is off and the parking brake is applied.
3. Raise and support operator seat to gain access to gear pump.

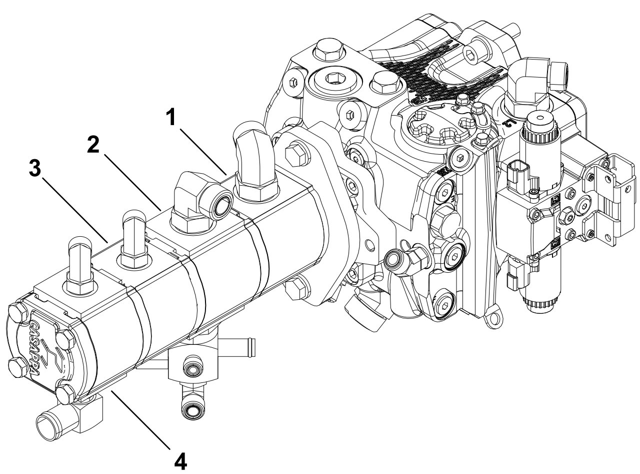

Figure 91

1. First gear pump section (decks 2, 3, 5 and 7)
2. 2nd gear pump section (decks 1, 4 and 6)
3. 3rd gear pump section (steering, lift/lower and charge)
4. 4th gear pump section (engine cooling fan)

Procedure for Gear Pump Flow Test (continued)

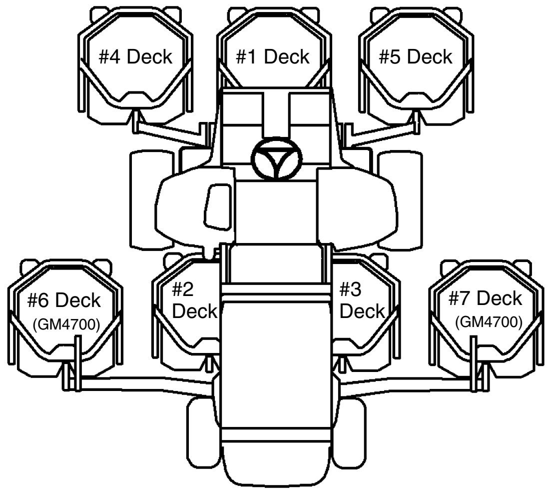

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Figure 92
CUTTING DECK LOCATIONS

4. Determine which gear pump section is to be tested. Disconnect hydraulic hose from fitting in gear pump section that is to be tested (Figure 91).
5. Install tester (flow and pressure) in series with the disconnected hose and hydraulic fitting in gear pump section.
6. Make sure the flow control valve on tester is fully open.
7. Start engine and increase engine speed to high idle speed. Do not engage the cutting decks.

IMPORTANT

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

8. Watch pressure gauge carefully while slowly closing the flow control valve until 69 bar (1000 PSI) is obtained. Verify with the InfoCenter display that the engine is still running at the correct high idle speed.

   Note: If engine speed drops during testing, pump flow will decrease and flow test results will be inaccurate.
9. Normal flow indication for the four (4) gear pump sections is listed in below table:

PUMP SECTION	NORMAL FLOW	MINIMUM FLOW
FIRST SECTION	41.6 LPM (11 GPM)	34 LPM (9 GPM)
SECOND SECTION	41.6 LPM (11 GPM)	34 LPM (9 GPM)
THIRD SECTION	22.7 LPM (6 GPM)	18 LPM (4.8 GPM)
FOURTH SECTION	22.7 LPM (6 GPM)	18 LPM (4.8 GPM)

10. Shut off engine and record test results.
11. If a pressure of 69 bar (1000 PSI) cannot be obtained or flow was less than the minimum flow listed in above table, check for restriction in the pump

Procedure for Gear Pump Flow Test (continued)

intake line. If line is not restricted, consider that the tested gear pump section is worn or damaged.

12. After testing is completed, disconnect flow tester from hydraulic hose and fitting in gear pump section. Reconnect hose to the pump fitting.

13. Lower and secure operator seat.

Adjustments

Adjust Control Manifold Relief Valves

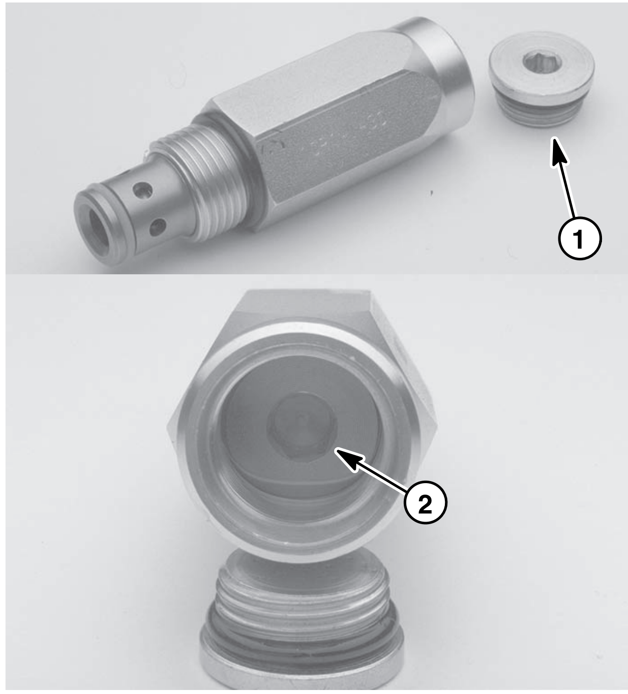

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Figure 93

1. Relief valve cap
2. Adjustment socket

Several of the hydraulic control manifolds on your Groundsmaster include adjustable relief valves. The following procedure can be used to adjust these relief valves. Refer to the Testing (page 5–43) section of this chapter for information on testing relief pressure.

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

1. Locate relief valve on control manifold.
2. Remove cap on relief valve with an allen wrench.
3. To increase pressure setting, turn the adjustment socket on the valve in a clockwise direction. A 1/8 turn on the socket will make a measurable change in relief pressure.
4. To decrease pressure setting, turn the adjustment socket on the valve in a counterclockwise direction. A 1/8 turn on the socket will make a measurable change in relief pressure.
5. Install and tighten cap on relief valve.
6. Recheck relief pressure and readjust as needed.

Service and Repairs

General Precautions for Removing and Installing Hydraulic System Components

Before Repair or Replacement of Components

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

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 5–4).

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

After Repair or Replacement of Components

1. Check oil level in the hydraulic reservoir and add correct oil if necessary. Drain and refill hydraulic system reservoir and change oil filters if component failure was severe or system is contaminated (see Flush Hydraulic System (page 5–90)).

IMPORTANT

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

2. Lubricate O−rings and seals with clean hydraulic oil before installing hydraulic components.
3. Make sure caps or plugs are removed from the hydraulic lines, hydraulic fittings and components before reconnecting.
4. Use proper tightening methods when installing hydraulic lines and fittings (see Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–9) and Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–7)).
5. After repairs, check control linkages or cables for proper adjustment, binding or broken parts.
6. If piston (traction) pump, front wheel motors or rear axle motor was removed from machine for service, fill housing through case drain with new hydraulic

oil before starting engine. This will ensure that internal components have adequate lubrication during initial operation.

7. After disconnecting or replacing any hydraulic components, operate machine functions slowly until air is out of system (see Charge Hydraulic System (page 5–94)).

8. Before returning machine to regular operation, check for hydraulic oil leaks. Shut off engine and correct leaks if necessary. Check oil level in hydraulic reservoir and add correct oil if necessary.

Check Hydraulic Lines and Hoses

WARNING

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

IMPORTANT

Check hydraulic lines and hoses daily for leaks, kinked lines, loose mounting supports, wear, loose fittings or any hose 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 installed, it is important to properly prime the hydraulic pumps. Hydraulic pump priming ensures that the gear pump and piston (traction) pump have adequate oil during initial start−up and running. The pumps can be primed by using a remote starter switch (see Special Tools (page 2–16)) to crank engine which allows the pumps to prime.

Use the following procedure to prime the hydraulic pumps:

1. Make sure that ignition switch is in the OFF position and key is removed from switch.

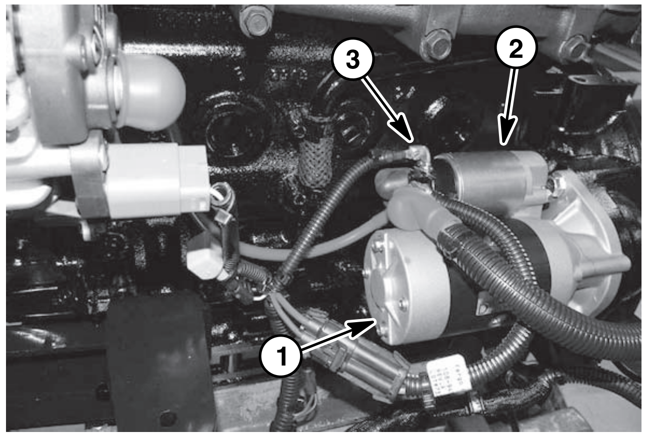

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Figure 94

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

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2. Check hydraulic reservoir oil level and adjust if necessary.

   Note: A blue wire connects to the starter motor solenoid B+ terminal (Figure 94). It is not necessary to remove this blue wire from the solenoid terminal for hydraulic pump priming.

3. Connect remote starter switch electrical leads to the starter motor solenoid B+ terminal and the positive post of the 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 the system is contaminated. Contaminated oil may appear milky or black or may contain metal particles.

IMPORTANT

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

IMPORTANT

If a component failure occurred in the closed loop traction circuit (e.g. piston pump or wheel motor), filtering the traction circuit is recommended. See Filtering Closed−Loop Traction Circuit (page 5–92).

1. Park machine on a level surface. Lower cutting decks to the ground, stop engine and apply parking brake. Remove key from the ignition switch.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure (page 5–4).

IMPORTANT

Make sure to clean around any hydraulic connections that will be disconnected for draining.

2. Drain hydraulic reservoir. Remove suction screen from reservoir and clean thoroughly. Consider removing and cleaning reservoir if necessary.
3. Drain hydraulic system. Drain all hoses, tubes and components while the system is warm.
4. Remove and replace both hydraulic oil filters.

IMPORTANT

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

5. Inspect and clean hydraulic reservoir (see Hydraulic Reservoir (page 5–176)).

Flush Hydraulic System (continued)

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

IMPORTANT

When filling hydraulic reservoir, use only hydraulic fluids specified in *Operator's Manual*. Other fluids could cause system damage.

7. Fill hydraulic reservoir with new hydraulic fluid.
8. Prime hydraulic pumps (see Priming Hydraulic Pumps (page 5–89)).
9. Start engine and let it run at low idle speed for a minimum of two (2) minutes. Increase engine speed to high idle for minimum of one (1) minute under no load.
10. Raise and lower cutting decks several times. Turn steering wheel fully left and right several times.
11. With cutting decks fully lowered and the operator seat occupied, engage cutting decks and let them run for several minutes. Move PTO switch to OFF.
12. Shut off engine and check for hydraulic oil leaks. Check oil level in hydraulic reservoir and add correct amount of oil if necessary.
13. Operate machine for two (2) hours under normal operating conditions.
14. Check condition of hydraulic oil. If the new fluid shows any signs of contamination, repeat steps 1 through 13 again until oil 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 front wheel motor) is a requirement to prevent debris from transmitting throughout the system. If a closed−loop hydraulic system filtering tool is not used to ensure system cleanliness, repeat failures, as well as subsequent damage to other hydraulic components in the affected system, will occur. To effectively remove contamination from closed−loop traction circuit, use of the Toro high flow hydraulic filter and hydraulic hose kits are recommended (see Special Tools (page 2–16)).

1. Park machine on a level surface with engine stopped and key removed from ignition switch.
2. Raise and support machine so all wheels are off the ground (see Jacking Instructions (page 1–7)).

   Note: If front wheel or rear axle motor was replaced, install high flow filter to the inlet of new motor instead of to the traction pump fitting. This will prevent system contamination from entering and damaging the new motor.

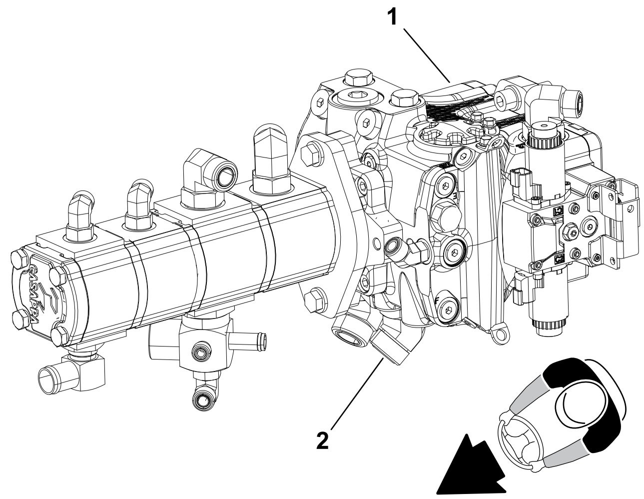

Figure 95

1. Piston (traction) pump
2. Left side fitting

3. Thoroughly clean junction of hydraulic hose and left side fitting on bottom of piston (traction) pump (Figure 95). Disconnect hose from left side pump fitting.
4. Connect Toro high flow hydraulic filter in series between piston pump fitting and disconnected hose. Use hydraulic hose kit (see Special Tools (page 2–16)) to connect filter to machine. Make sure that fitting and hose connections are properly tightened.

IMPORTANT

When filling hydraulic reservoir, 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 oil as required.
6. Start engine and run at idle speed. Check for any hydraulic leakage from filter and hose connections. Correct any leaks before proceeding.

Filtering Closed−Loop Traction Circuit (continued)

CAUTION

All wheels will be off the ground and rotating during this procedure. Make sure machine is well supported so it will not move and accidentally fall to prevent injuring anyone around machine.

IMPORTANT

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

IMPORTANT

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

9. With engine running at high idle speed, alternately move traction pedal from forward to reverse. While monitoring filter indicator, continue this process for an additional five (5) minutes.
10. Shut engine off and remove key from ignition switch.
11. Remove high flow hydraulic filter and hydraulic hose kit from machine. Connect hydraulic hose to right side piston (traction) pump fitting. Make sure to properly tighten hose (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–7)).
12. Lower machine to ground.
13. Check oil level in hydraulic reservoir and add correct oil 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 to reduce the chance of component damage.

IMPORTANT

Change hydraulic oil filters whenever hydraulic components are repaired or replaced.

1. Park machine on a level surface. Lower cutting decks, stop engine and apply parking brake. Remove key from the ignition switch.
2. Make sure all hydraulic connections, lines and components are secured tightly.
3. If hydraulic component failure was severe or the hydraulic system is contaminated, flush and refill hydraulic system and hydraulic reservoir (see Flush Hydraulic System (page 5–90)).

IMPORTANT

When filling hydraulic reservoir, use only hydraulic fluids specified in *Operator's Manual*. Other fluids could cause system damage.

4. Make sure hydraulic reservoir is full. Add correct hydraulic oil to reservoir if necessary.
5. Prime hydraulic pumps (see Priming Hydraulic Pumps (page 5–89)).

WARNING

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

6. Raise machine so that all wheels are off the ground and place appropriate jack stands under the frame to support the machine.

IMPORTANT

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

7. Make sure traction pedal and lift switches are in neutral. Start engine and run at low idle speed. The gear pump should pick up oil and fill the hydraulic system. If there is no indication of fill in thirty (30) seconds, stop the engine and determine the cause.
8. After the hydraulic system starts to show signs of fill, actuate a lift switch until the lift cylinder rod moves in and out several times. If the lift cylinder does not move after ten (10) to fifteen (15) seconds, or if 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. Blocked suction line.

Charge Hydraulic System (continued)

C. Faulty charge relief valve.

D. Faulty gear pump.

9. Once the lift cylinder does move in ten (10) to fifteen (15) seconds, proceed to step 10.

10. Operate the traction pedal in the forward and reverse directions. The wheels should rotate in the proper direction.

    A. If the wheels rotate in the wrong direction, stop engine and check for proper hydraulic hose and electrical connections at traction pump and motors. Correct as needed.

    B. If the wheels rotate in the proper direction, stop the engine.

11. Make sure that traction pedal returns to the neutral position when released from the forward or reverse direction.

12. Check operation of the traction interlock switch (see Check Operation of Interlock Switches (page 6–27)).

13. With engine not running and ignition switch in the OFF position, remove jack stands that are supporting the machine and lower the machine to the ground.

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

15. Operate machine by gradually increasing its work load to full over a ten (10) minute period.

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

Gear Pump

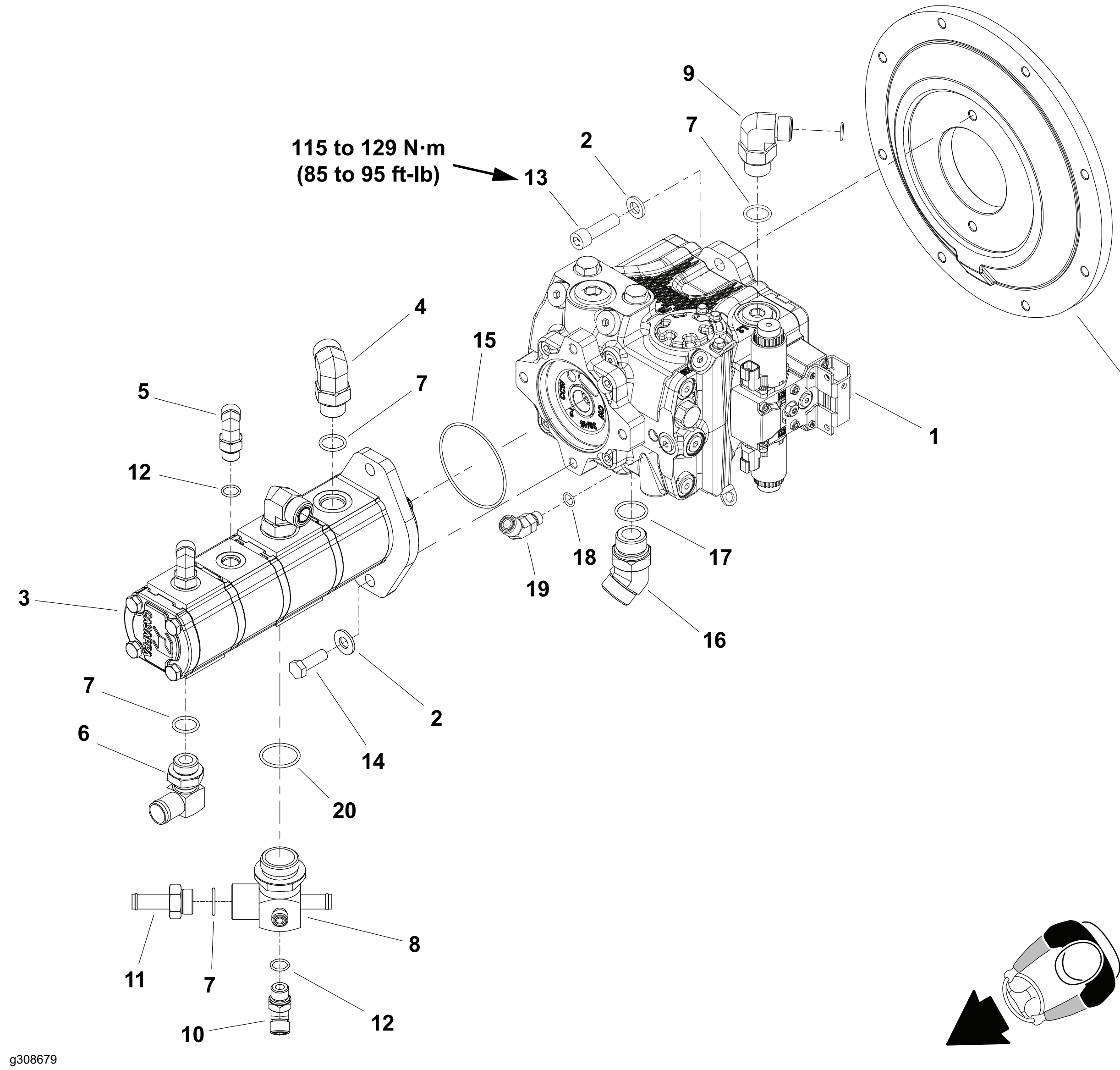

Figure 96

1. Piston pump assembly
2. Flat washer (4 used)
3. Gear pump assembly
4. 90º hydraulic fitting (2 used)
5. 90º hydraulic fitting (2 used)
6. 90º hydraulic fitting
7. O-ring
8. Hydraulic tee fitting
9. 90º hydraulic fitting
10. 45º hydraulic fitting
11. Straight fitting
12. O-ring
13. Cap screw (2 used)
14. Cap screw (2 used)
15. O-ring
16. 45º hydraulic fitting (2 used)
17. O-ring
18. O-ring
19. Hydraulic adapter
20. O-ring
21. Engine flywheel plate

Removal (Figure 96)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.
2. Gain access to gear pump from below the machine.
3. Drain the hydraulic reservoir into a suitable container (see Hydraulic Reservoir (page 5–176)).
4. To prevent contamination of hydraulic system during gear pump removal, thoroughly clean exterior of gear pump, fittings and ends of hydraulic lines.

Removal (Figure 96) (continued)

5. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–86).
6. For assembly purposes, label all hydraulic lines connected to gear pump fittings.
7. Disconnect hydraulic lines from gear pump and put caps or plugs on open hydraulic lines and fittings.
8. Support gear pump assembly to prevent it from falling.
9. Remove two (2) cap screws and washers that secure gear pump to piston pump. Slide gear pump away from piston pump until gear pump shaft is removed from piston pump coupler. Lower gear pump and remove from machine.

   Note: A case drain exists in the piston (traction) pump and a suction port is near the input shaft of the gear pump (Figure 97). When the gear pump is removed from the piston pump, plug piston pump case drain hole to prevent draining the piston pump.

10. Remove O-ring (item 15) from gear pump flange. Discard O-ring.
11. If hydraulic fittings are to be removed from gear pump, mark fitting orientation to allow correct assembly. Remove fittings from pump and discard O-rings.

Installation (Figure 96)

1. If fittings were removed from gear pump, lubricate and place new O-rings onto fittings. Install fittings into pump ports 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 5–9)).
2. Make sure mounting and O-ring sealing surfaces on the gear pump and piston pump are clean.
3. Lubricate new O-ring (item 15) with clean hydraulic oil. Position O-ring on gear pump flange.

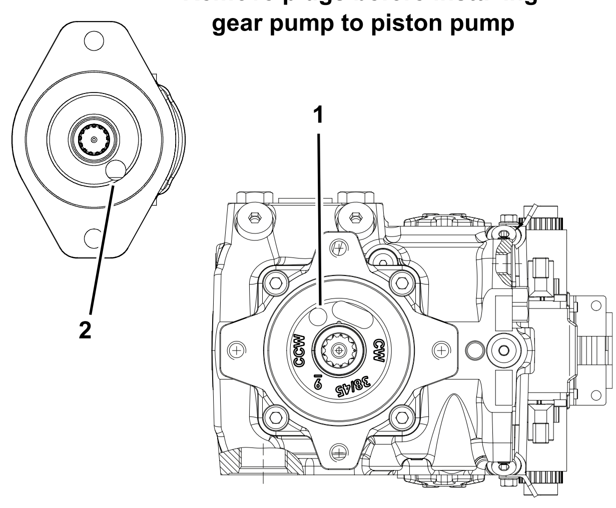

Figure 97

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

4. Align gear teeth on gear pump input shaft with piston pump shaft. Slide gear pump input shaft into piston pump shaft. Secure gear pump to piston pump with two (2) cap screws and flat washers.

Installation (Figure 96) (continued)

IMPORTANT

Position gear pump to the piston (traction)pump so that the gear pump inlet (suction) ports are facing down.

IMPORTANT

A case drain exists in the piston (traction) pump and a suction port is near the input shaft of the gear pump (Figure 97). 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 securing gear pump to piston pump, fill piston pump housing with clean hydraulic oil through case drain hole.

5. Remove caps and plugs from hydraulic lines and fittings. Install hydraulic lines to gear pump (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–7)).
6. Replace hydraulic oil filter and fill hydraulic reservoir with new hydraulic oil.

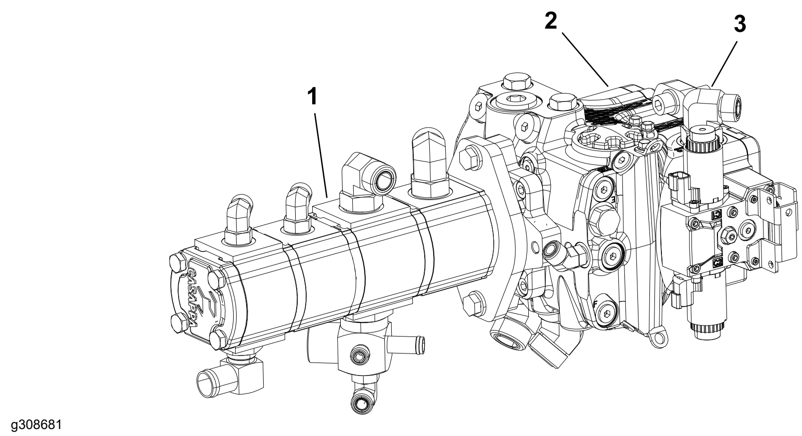

Figure 98

1. Gear pump
2. Piston pump
3. Piston pump case drain

7. Fill piston pump housing through case drain (90º barbed fitting) with new hydraulic oil (Figure 98). This will ensure that internal pump components have adequate lubrication during initial operation.
8. Prime hydraulic pumps (see Priming Hydraulic Pumps (page 5–89)).
9. Properly fill hydraulic system (see Charge Hydraulic System (page 5–94)).
10. Stop engine and check for hydraulic oil leaks. Check hydraulic reservoir oil level and adjust if necessary.

Gear Pump Service

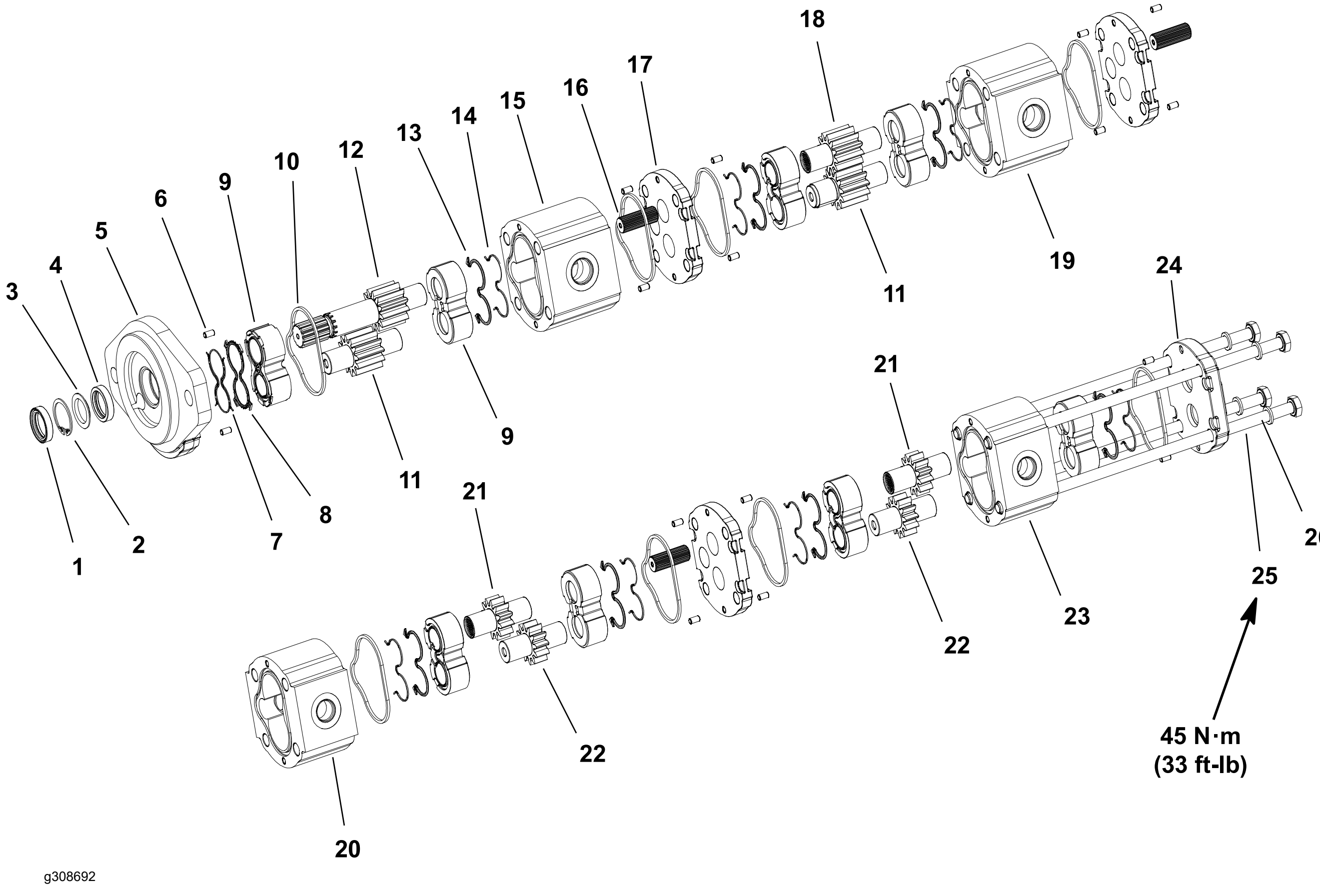

Figure 99

1. Dust seal
2. Retaining ring
3. Flange washer
4. Shaft seal
5. Front cover
6. Dowel pin (16 used)
7. Pressure seal
8. Back-up gasket
9. Thrust plate (8 used)
10. Seal (8 used)
11. Idler gear
12. Drive shaft
13. Back-up gasket
14. Pressure seal
15. Front body (first pump section)
16. Splined connecting shaft (3 used)
17. Flange
18. Drive gear
19. Body (2nd pump section)
20. Body (3rd pump section)
21. Drive gear
22. Idler gear
23. Rear body (4th pump section)
24. Rear cover
25. Cap screw (4 used)
26. Washer (4 used)

Disassembly (Figure 99)

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.

IMPORTANT

Keep bodies, gears, flanges and thrust plates for each pump section together; do not mix parts between pump sections.

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

Disassembly (Figure 99) (continued)

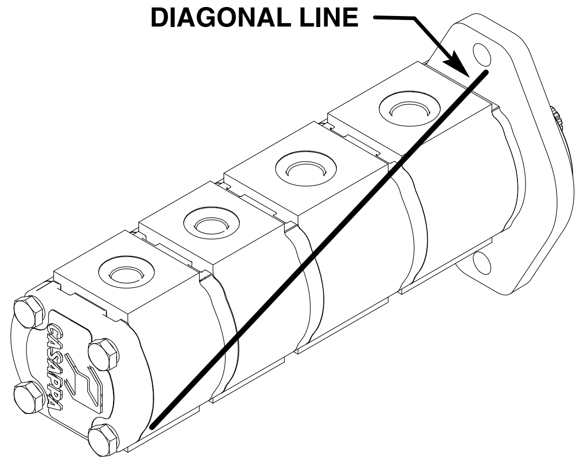

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Figure 100

2. Use a marker to make a diagonal line across the gear pump for assembly purposes (Figure 100).

IMPORTANT

Use caution when clamping gear pump in a vise to avoid distorting any pump components.

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

IMPORTANT

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

7. Remove the thrust plates and seals from each pump section. Before removing each gear set, apply marking dye to mating teeth to retain "timing". Pump efficiency may be affected if the teeth are not installed in the same position during assembly. Keep the parts for each pump section together; do not mix parts between sections.
8. Clean all parts. Check all components for burrs, scoring, nicks and other damage.
9. Replace the entire pump assembly if parts are excessively worn or scored.

Assembly (Figure 99)

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

   Note: Pressure seals and back-up gaskets fit in grooves machined into thrust plates. Body seals fit in grooves machined in body faces.

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

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

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

Piston (Traction) Pump

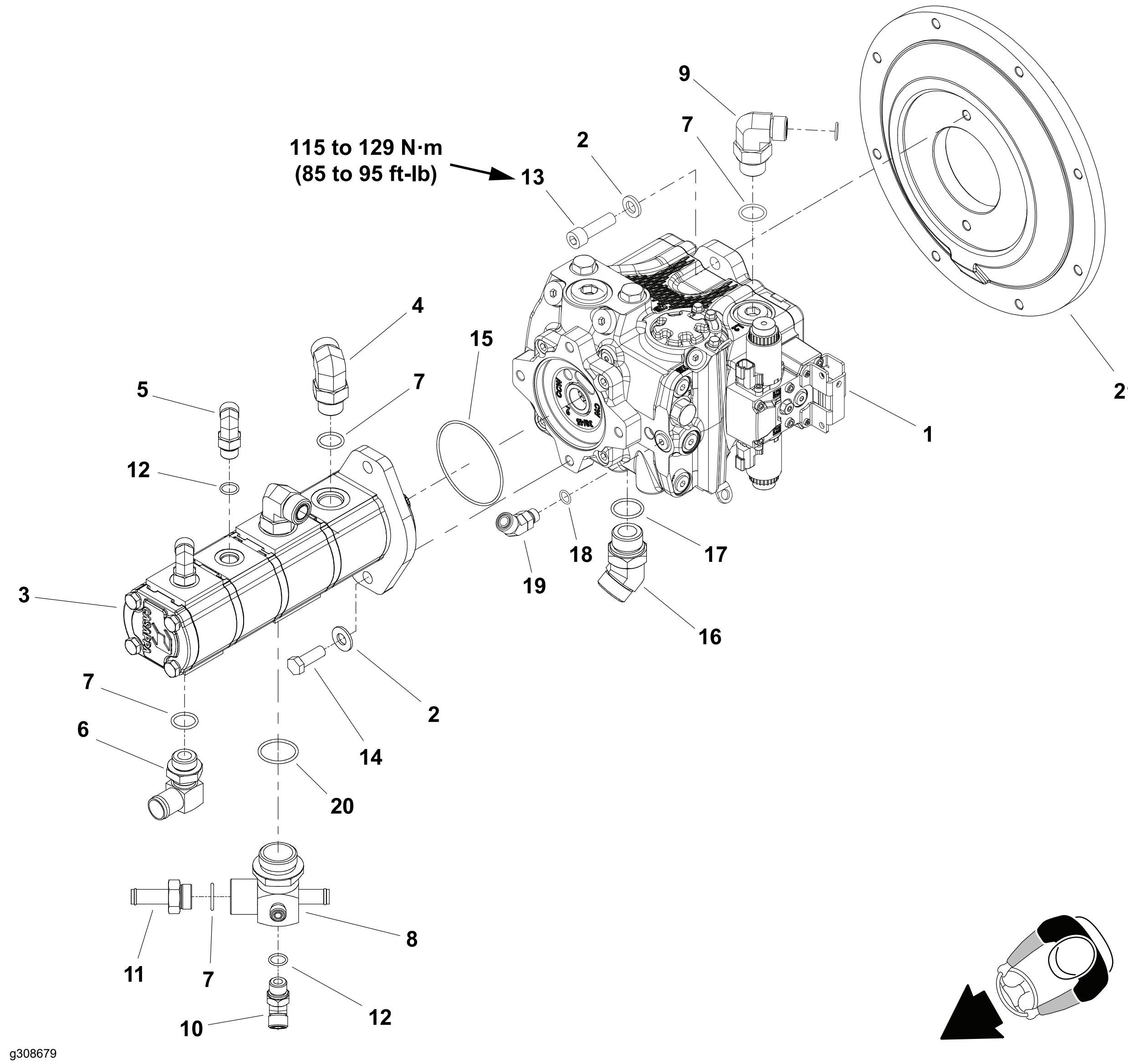

Figure 101

1. Piston pump assembly
2. Flat washer (4 used)
3. Gear pump assembly
4. 90º hydraulic fitting (2 used)
5. 90º hydraulic fitting (2 used)
6. 90º hydraulic fitting
7. O-ring
8. Hydraulic tee fitting
9. 90º hydraulic fitting
10. 45º hydraulic fitting
11. Straight fitting
12. O-ring
13. Cap screw (2 used)
14. Cap screw (2 used)
15. O-ring
16. 45º hydraulic fitting (2 used)
17. O-ring
18. O-ring
19. Hydraulic adapter
20. O-ring
21. Engine flywheel plate

Removal (Figure 101)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.
2. To prevent contamination of hydraulic system during removal, thoroughly clean exterior of pump assembly.

Removal (Figure 101) (continued)

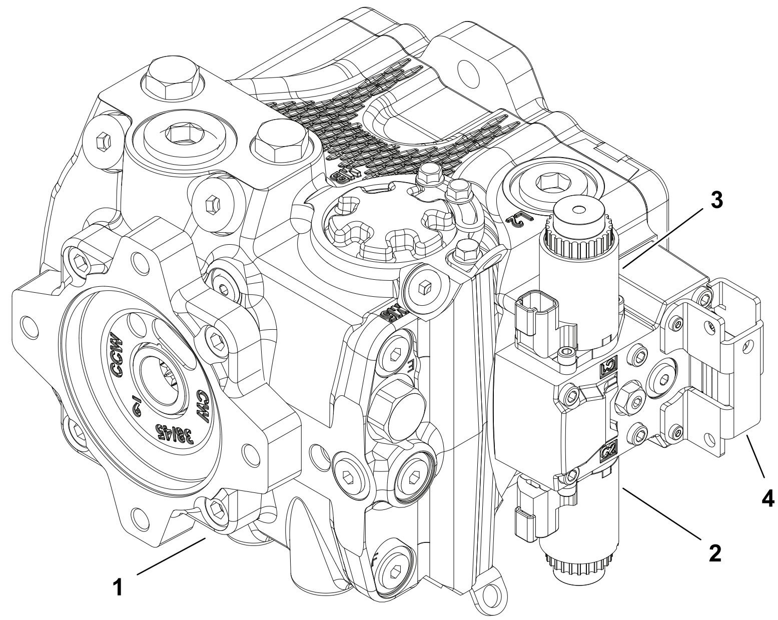

Figure 102

1. Piston pump	3. Solenoid coil (forward)
2. Solenoid coil (reverse)	4. Swashplate angle sensor

3. Label wire harness connectors that attach to the two (2) solenoid coils on left side of piston pump (Figure 102). Disconnect harness connectors from solenoid coils on piston pump.
4. Disconnect harness connector from swashplate angle sensor on piston pump.
5. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–86).
6. For assembly purposes, label all hydraulic lines connected to gear pump and traction pump fittings.
7. Put a drain pan below the pump assembly. Remove hydraulic hoses connected to piston and gear pumps. Put plugs or caps on disconnected hydraulic hoses and fittings to prevent contamination of the system.

Removal (Figure 101) (continued)

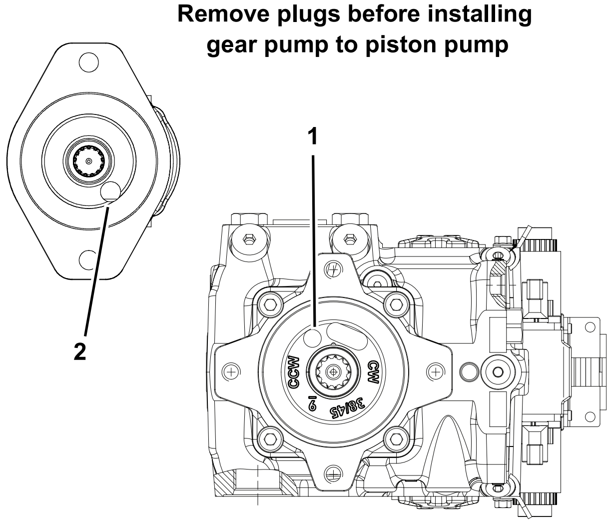

Figure 103

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

8. Remove gear pump from machine (see Gear Pump (page 5–96)).

   Note: A case drain exists in the piston (traction) pump and a suction port is near the input shaft of the gear pump (Figure 103). When the gear pump is removed from the piston pump, plug piston pump case drain hole to prevent draining the piston pump.

IMPORTANT

Dry weight of piston (traction) pump is 41 kg (90 lbs).

9. Support the piston pump to prevent it from falling while removing two (2) cap screws and washers retaining pump assembly to engine flywheel plate. Carefully pull pump assembly from flywheel plate and lower it out of the machine.
10. If hydraulic fittings are to be removed from piston pump, mark fitting orientation to allow correct assembly. Remove fittings from pump and discard O- rings.

Installation (Figure 101)

1. If fittings were removed from piston pump, lubricate and place new O- rings onto fittings. Install fittings into pump ports 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 5–9)).

IMPORTANT

To prevent spring coupler damage, make sure that piston pump is properly supported and does not put side load into coupler during pump installation.

2. Carefully raise piston pump into the machine, align pump input shaft to spring coupler on engine and position it to the engine flywheel plate. Support pump

Installation (Figure 101) (continued)

to prevent it from producing any side load into coupler and also to align pilot diameter of pump to flywheel plate bore.

3. While maintaining pump alignment with spring coupler and flywheel plate, install two (2) cap screws and washers to secure piston pump to engine.

IMPORTANT

A case drain exists in the piston (traction) pump and a suction port is near the input shaft of the gear pump (Figure 103). Before the gear pump is installed to the piston pump, make sure that plugs placed in both of these ports are removed. Failure to remove plugs will cause excessive pressure in the piston pump and damage seals. Also, before securing gear pump to piston pump, fill piston pump housing with clean hydraulic oil through case drain hole.

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4. Remove plugs that were placed in piston pump case drain and gear pump suction port. Fill piston pump housing with new hydraulic oil through case drain hole.
5. Install gear pump to piston pump (see Gear Pump (page 5–96)).
6. Using labels placed during pump removal, connect wire harness connectors to the two (2) solenoid coils on left side of piston (traction) pump.
7. Connect wire harness connector to the swashplate angle sensor on left side of piston (traction) pump.

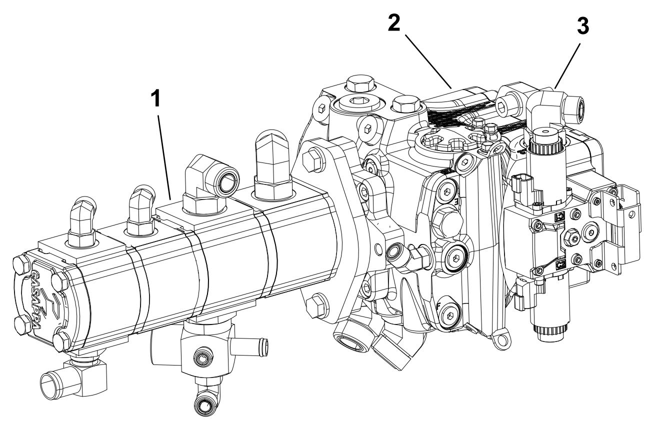

Figure 104

1. Gear pump
2. Piston pump
3. Piston pump case drain

8. Fill piston (traction) pump housing with new hydraulic oil through the case drain (90º barbed fitting) at the top of the pump (Figure 104). This will ensure that internal pump components have adequate lubrication during initial operation.
9. Remove plugs and caps from disconnected hydraulic lines and fittings of the pump assembly. Install hydraulic lines to correct location on gear and piston pumps (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–7)).
10. Fill hydraulic reservoir with correct oil.
11. Install new hydraulic filter and fill hydraulic reservoir with correct oil.

Installation (Figure 101) (continued)

IMPORTANT

Refer to Traction Problems (page 3–4) for information regarding the importance of removing contamination from the traction circuit.

12. Prime hydraulic pumps (see Priming Hydraulic Pumps (page 5–89)).
13. Properly fill hydraulic system (see Charge Hydraulic System (page 5–94)).
14. Stop engine and check for hydraulic oil leaks. Check hydraulic reservoir oil level and adjust if necessary.

Piston (Traction) Pump Service

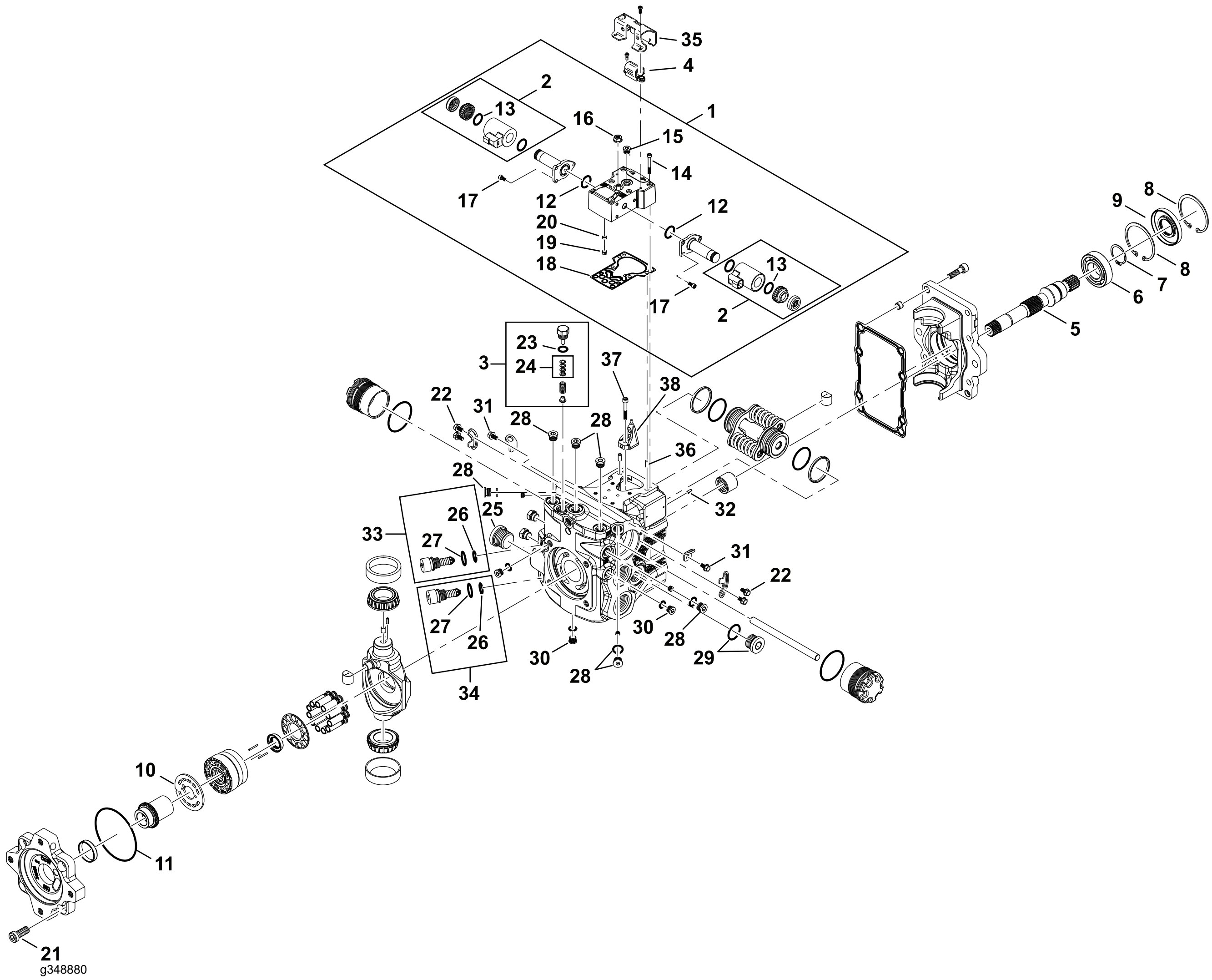

Figure 105

1. Control kit (12 volt)
2. Coil kit
3. Charge relief kit
4. Swashplate angle sensor
5. Shaft
6. Bearing-ball
7. Ring-retaining
8. Ring-retaining
9. Seal-lip
10. Valve plate
11. O-ring
12. O-ring
13. O-ring
14. Screw
15. Plug asm
16. Nut-seal
17. Screw
18. Gasket-control
19. Ring-locking
20. Screen
21. Screw
22. Screw
23. O-ring
24. Shim kit
25. Plug asm
26. O-ring
27. O-ring
28. Plug
29. Plug
30. Plug-thread, straight
31. Screw
32. Pin-slotted
33. Valve-relief, high pressure (345 bar)
34. Valve-relief, high pressure (300 bar)
35. Guard
36. Pin
37. Screw
38. Link - Swashplate Feedback

For service of the piston (traction) pump, see the **Danfoss MP1 Closed Circuit Axial Piston Pumps Service Manual**.

Rear Traction Control Manifold

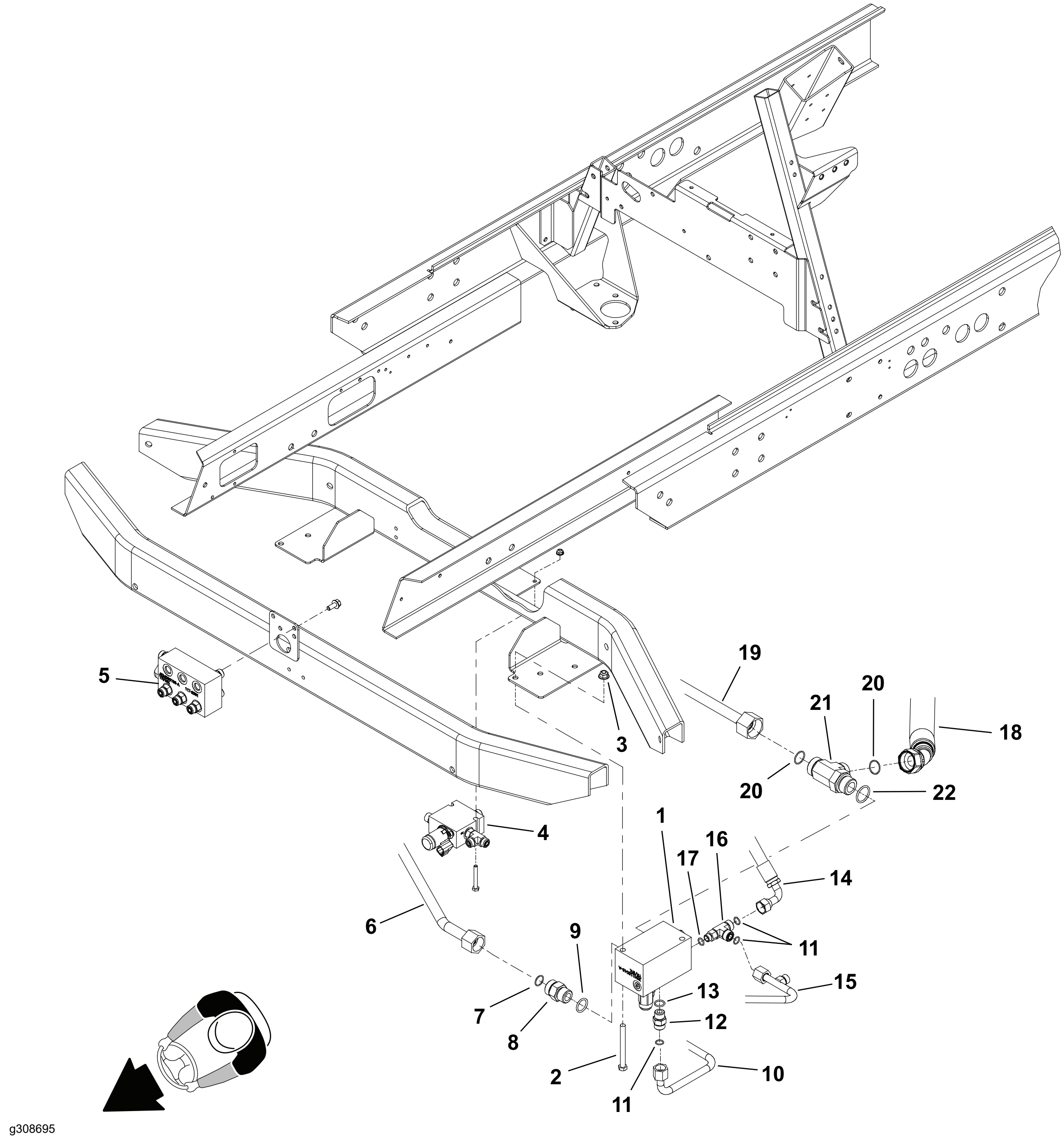

Figure 106

1. Rear traction control manifold
2. Cap screw (2 used)
3. Flange nut (2 used)
4. Two speed shift manifold
5. Lift circuit junction manifold
6. Hydraulic tube
7. O-ring
8. Hydraulic straight fitting
9. O-ring
10. Hydraulic tube
11. O-ring
12. Hydraulic straight fitting
13. O-ring
14. Hydraulic hose
15. Hydraulic tube
16. Hydraulic tee fitting
17. O-ring
18. Hydraulic hose
19. Hydraulic tube
20. O-ring
21. Hydraulic tee fitting
22. O-ring

Removal (Figure 106)

Note: The ports on the rear traction control manifold are marked for easy identification of components. Refer to the Appendix A (page A–1).

1. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–86).
2. To prevent contamination of hydraulic system during manifold removal, thoroughly clean exterior of manifold.
3. Label all hydraulic lines for assembly purposes.
4. Disconnect hydraulic lines from manifold and put caps or plugs on open hydraulic lines and fittings.
5. Remove rear traction control manifold from the frame using Figure 106 as guide.
6. If hydraulic fittings are to be removed from control manifold, mark fitting orientation to allow correct assembly. Remove fittings from manifold and discard O-rings.

Installation (Figure 106)

1. If fittings were removed from control manifold, lubricate and place new O-rings onto fittings. Install fittings into manifold ports 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 5–9)).
2. Install rear traction control manifold to the frame using Figure 106 as guide.
3. Remove 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) (page 5–7)).
4. Fill hydraulic reservoir with hydraulic fluid as required.

Rear Traction Manifold Service

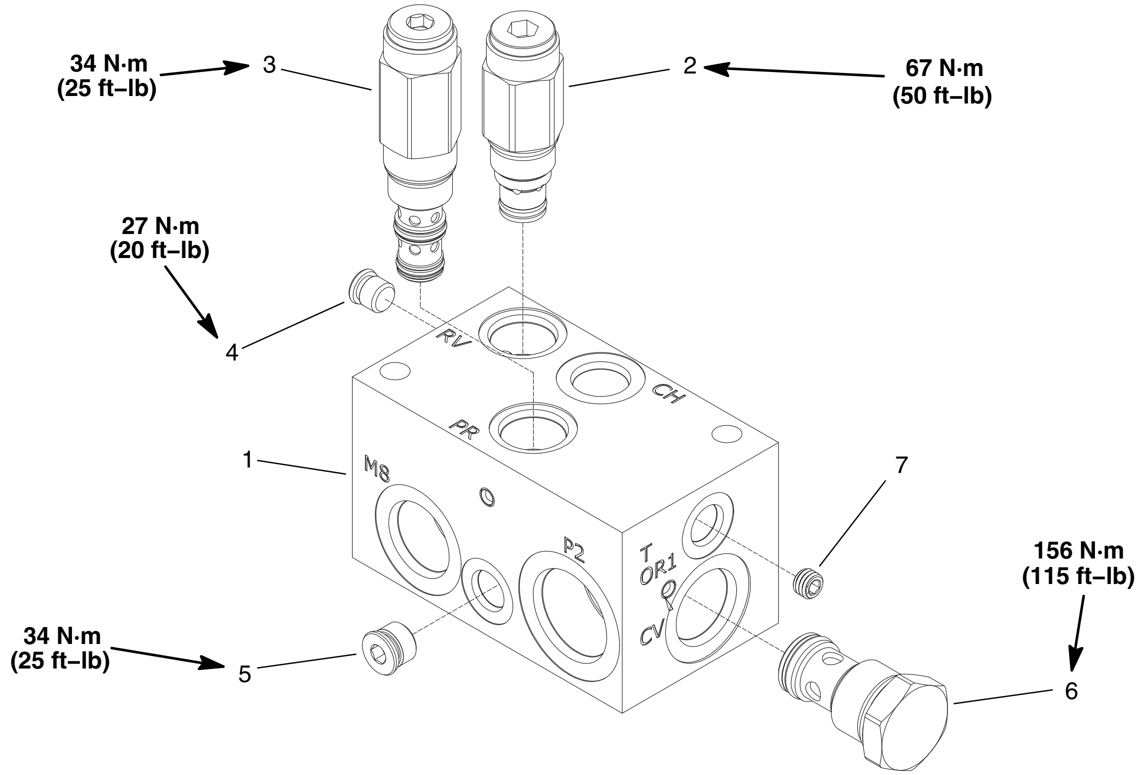

Figure 107

1. Rear traction manifold body
2. Relief valve (port RV)
3. Pressure reducing valve (port PR)
4. #4 zero leak plug with O−ring
5. #6 zero leak plug with O−ring
6. Check valve (port CV)
7. Orifice (0.050) (port OR1)

Note: The ports on the rear traction manifold are marked for easy identification of components. Example: P2 is a piston pump connection port and RV is the location for the relief valve (seeAppendix A (page A–1) to identify the function of the hydraulic lines and cartridge valves at each port).

Note: The rear traction manifold uses several zero leak plugs. These plugs have a tapered sealing surface on the plug head that is designed to resist vibration induced plug loosening. The zero leak plugs also have an O−ring as a secondary seal. If zero leak plug removal is necessary, lightly rap the plug head using a punch and hammer before using an allen wrench to remove the plug: the impact will allow plug removal with less chance of damage to the socket head of the plug.

For rear traction manifold cartridge valve service procedures, see Control Manifold Cartridge Valve Service (page 5–111). Refer to Figure 107 for rear traction manifold cartridge valve and plug installation torque.

IMPORTANT

A flow control orifice (item 7) is located beneath the hydraulic fitting in rear traction manifold port T/OR1. If the orifice is removed from this manifold port, make sure to label its position for assembly purposes. When installing the orifice in the manifold, make sure that the orifice is properly tightened in the port.

Control Manifold Cartridge Valve Service

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

IMPORTANT

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

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

CAUTION

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

6. Clean cartridge valve using clean mineral spirits. Submerge valve in clean mineral spirits to flush out contamination. Particles as fine as talcum powder can affect the operation of high pressure hydraulic valves. If cartridge design allows, use a wood or plastic probe to push the internal spool in and out 20 to 30 times to flush out contamination. Be extremely careful not to damage cartridge. Use compressed air for cleaning.
7. Install the cartridge valve into the manifold:
   A. Lubricate new seal kit components with clean hydraulic oil and install on valve. The O−rings, sealing rings and backup rings must be arranged properly on the cartridge valve for proper operation and sealing.
   B. Dip assembled cartridge into clean hydraulic oil.

IMPORTANT

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

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

Control Manifold Cartridge Valve Service (continued)

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

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

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

Two Speed Shift Manifold

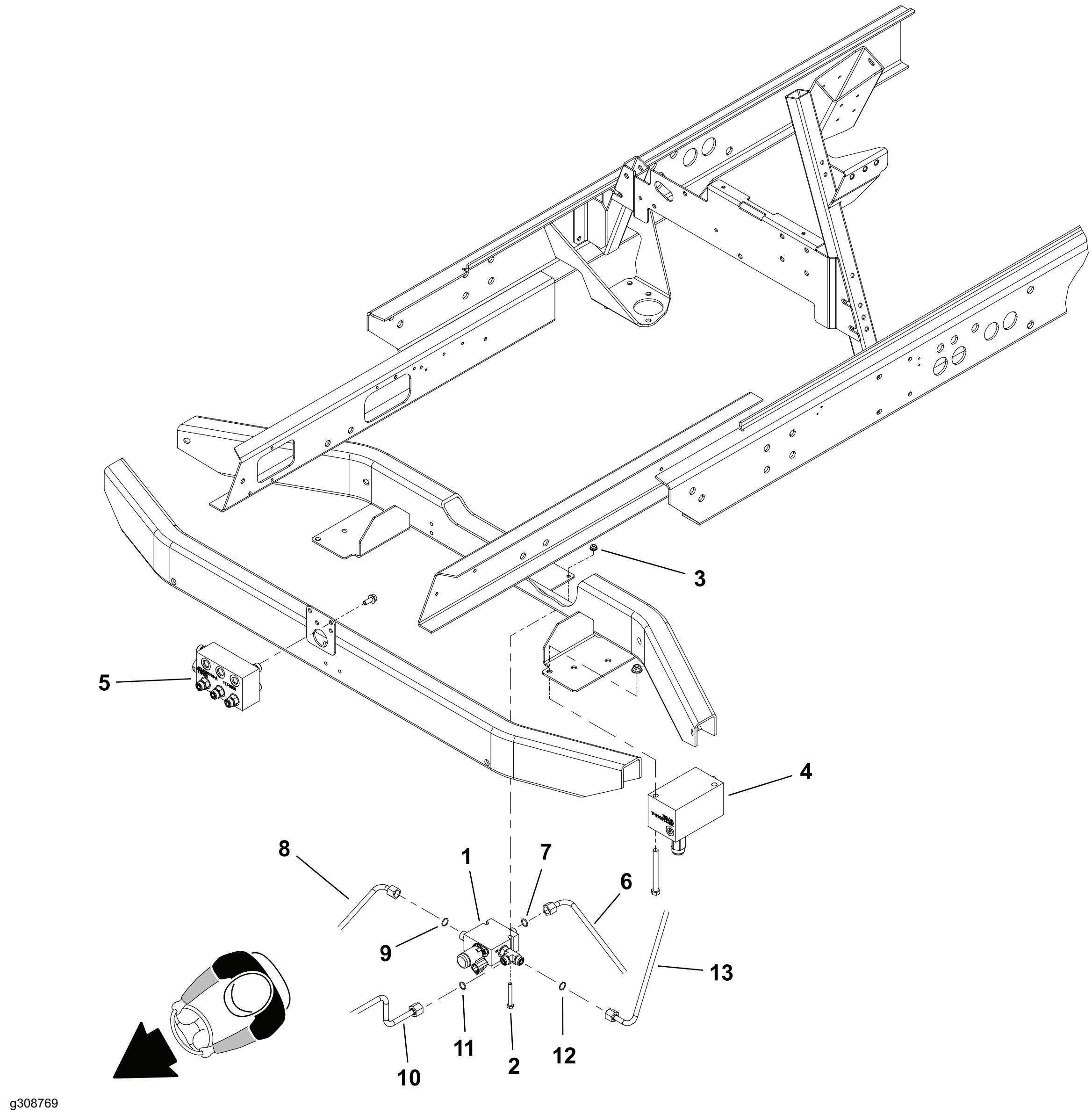

Figure 108

1. Two speed shift manifold
2. Cap screw (2 used)
3. Flange nut (2 used)
4. Rear traction control manifold
5. Lift circuit junction manifold
6. Hydraulic tube
7. O-ring
8. Hydraulic tube
9. O-ring
10. Hydraulic tube
11. O-ring
12. O-ring
13. Hydraulic tube

Note: The ports on the two speed shift manifold are marked for easy identification of components. Refer to the Appendix A (page A–1).

Removal (Figure 108)

1. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–86).
2. To prevent contamination of hydraulic system during manifold removal, thoroughly clean exterior of two speed shift manifold.
3. Label all hydraulic lines for assembly purposes.

Removal (Figure 108) (continued)

4. Disconnect hydraulic lines from manifold and put caps or plugs on open hydraulic lines and fittings.
5. Remove two speed shift manifold from the frame using Figure 108 as guide.
6. If hydraulic fittings are to be removed from control manifold, mark fitting orientation to allow correct assembly. Remove fittings from manifold and discard O-rings.

Manifold Service

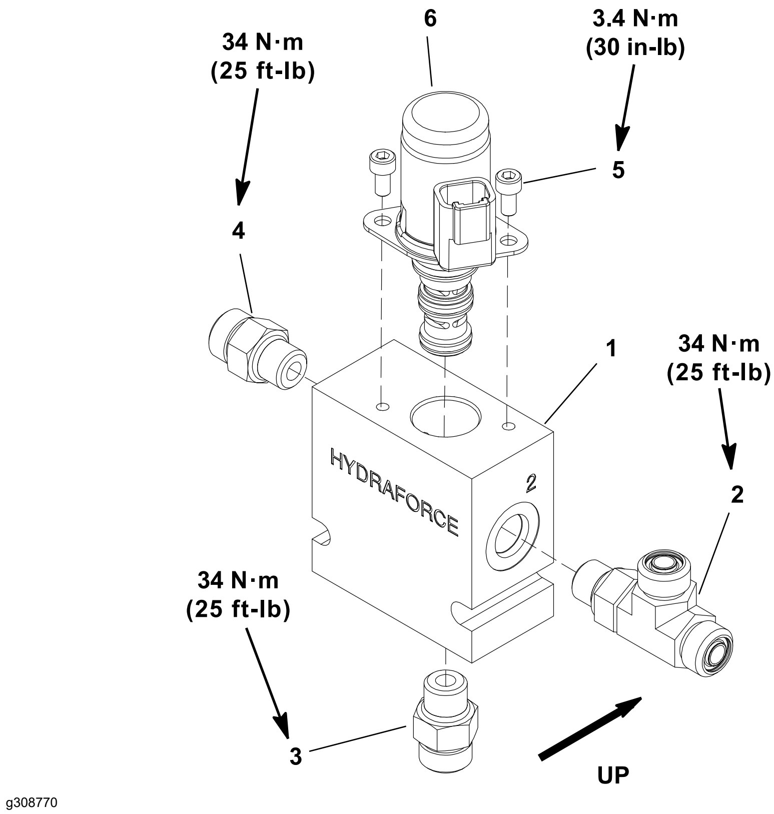

Figure 109

1. Manifold body
2. Tee fitting w/O-ring
3. Straight fitting w/O-ring
4. Check adapter w/O-ring
5. Screw (2 used)
6. Solenoid valve

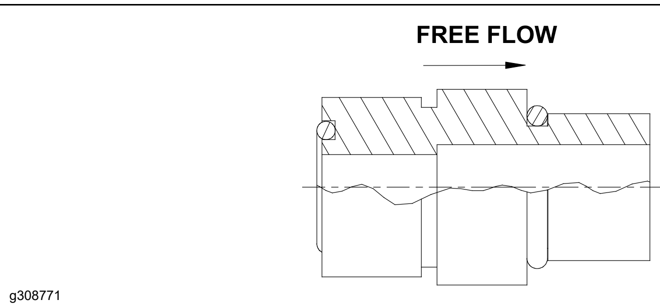

Figure 110
CHECK VALVE ADAPTER

For cartridge valve service procedures, see Control Manifold Cartridge Valve Service in this section. Refer to Figure 109 for cartridge valve and hydraulic fitting installation torque.

Note: The check valve adapter used in the two speed shift manifold allows free flow toward the manifold and prevents flow away from the manifold (Figure 110).

Installation (Figure 108)

1. If fittings were removed from control manifold, lubricate and place new O-rings onto fittings. Install fittings into manifold ports 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 5–9)).
2. Install two speed shift manifold to the frame using Figure 108 as guide.
3. Remove caps and plugs from fittings and hydraulic lines. Using labels placed during manifold removal, properly connect hydraulic lines to manifold (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–7)).
4. Fill hydraulic reservoir with hydraulic fluid as required.

Rear Axle Motor

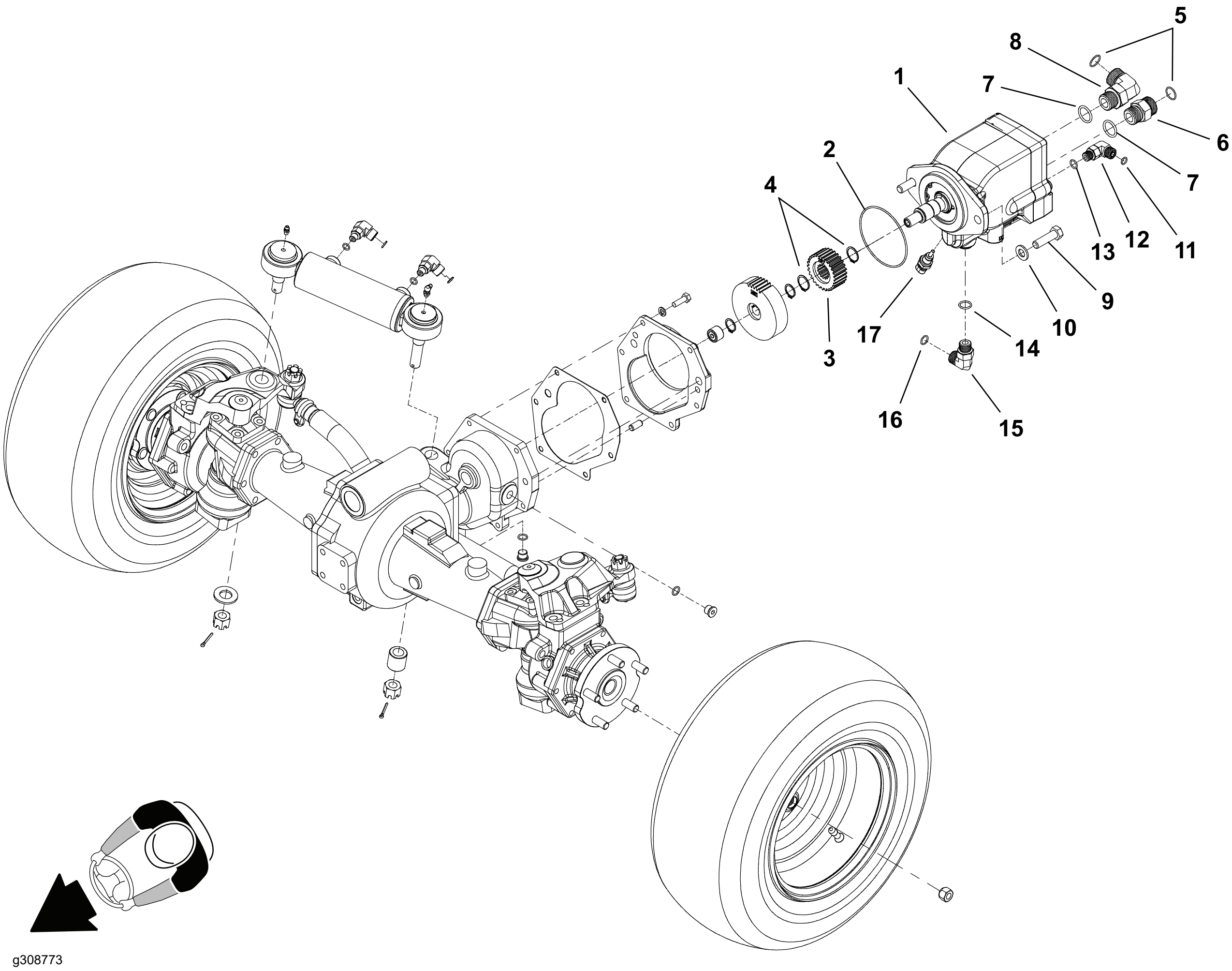

Figure 111

1.	Rear axle motor	7.	O-ring	13.	O-ring
2.	O-ring	8.	90º hydraulic fitting	14.	O-ring
3.	Pinion gear	9.	Cap screw (2 used)	15.	90º hydraulic fitting
4.	External snap ring (2 used)	10.	Flat washer (2 used)	16.	O-ring
5.	O-ring	11.	O-ring	17.	Temperature sender with O-ring
6.	Hydraulic fitting	12.	90º hydraulic fitting		

Removal (Figure 111)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.
2. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–86).
3. To prevent contamination of hydraulic system during rear axle motor removal, thoroughly clean exterior of motor.
4. Disconnect wire harness connector from the temperature sender (item 17) on the rear axle motor.
5. Disconnect hydraulic lines from motor. Put caps or plugs on lines and fittings to prevent contamination. Label the hydraulic hoses to show their correct position on the axle motor for assembly purposes.

Removal (Figure 111) (continued)

IMPORTANT

Support axle motor to prevent motor from falling during removal.

6. Remove motor using Figure 111 as a guide.
7. If hydraulic fittings are to be removed from axle motor, mark fitting orientation to allow correct assembly. Remove fittings from motor and discard O-rings.

Installation (Figure 111)

1. If fittings were removed from axle motor, lubricate and place new O-rings onto fittings. Install fittings into motor ports using marks made during the removal process to properly orientate fittings. Tighten fittings (see Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–9)).
2. If removed, install pinion gear to axle motor. Make sure that snap rings are fully seated into the motor shaft grooves.
3. Install O-ring (item 2) onto motor. Position motor to rear axle assembly, align gear teeth and slide motor into place.
4. Secure motor to axle with cap screws and flat washers.
5. Remove plugs from lines and fittings. Attach hydraulic lines to rear axle motor (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–7)).
6. Connect wire harness connector to the temperature sender (item 17) on the rear axle motor.
7. Fill hydraulic reservoir with hydraulic fluid as required.
8. After assembly is completed, verify that hydraulic lines and fittings do not contact anything.

Front Wheel Motors

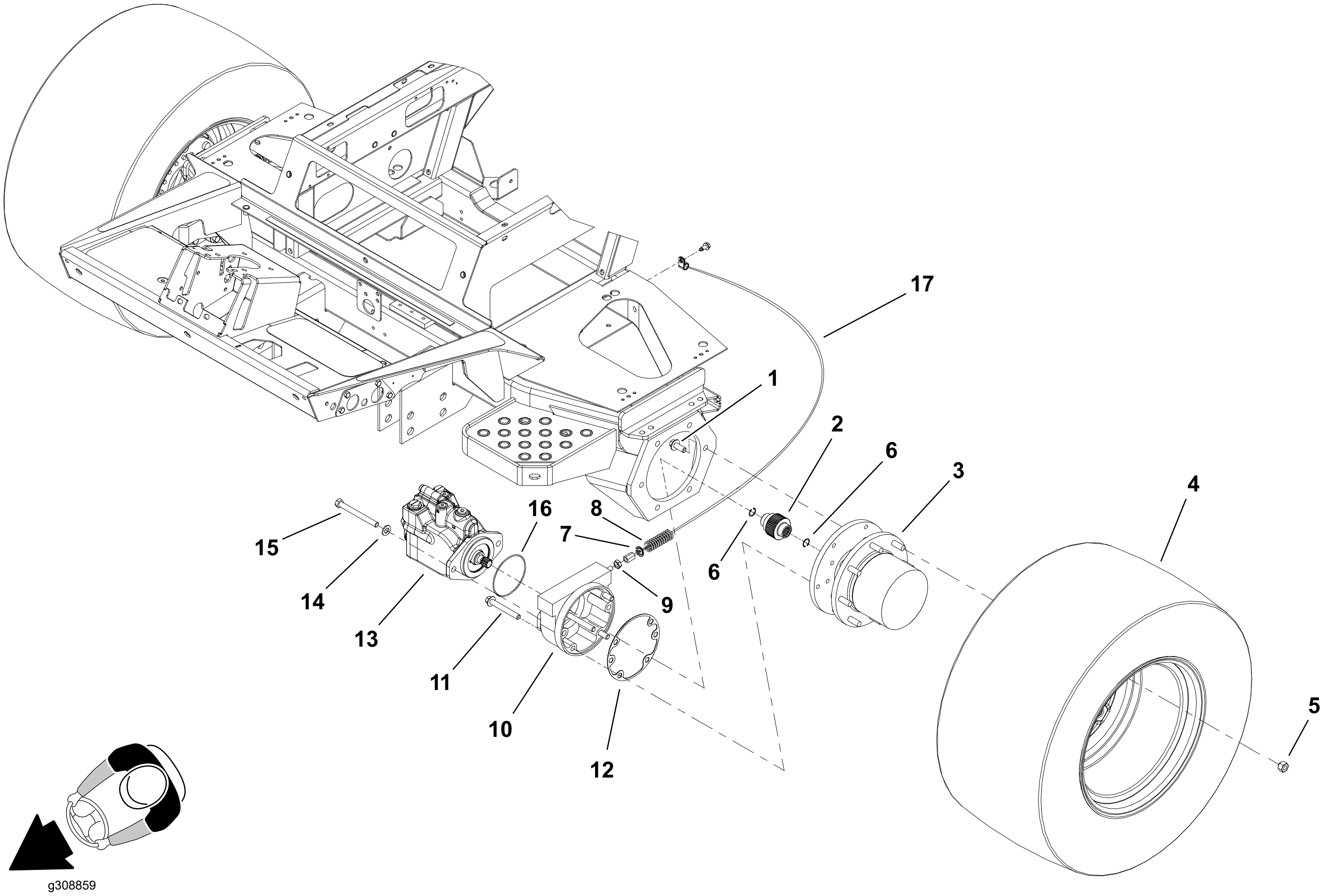

Figure 112

1. Flange head screw (6 per planetary)
2. Splined brake shaft
3. Planetary assembly
4. Wheel assembly
5. Lug nut (8 per wheel)
6. Retaining ring
7. Spring plate
8. Compression spring
9. Jam nut
10. Brake assembly (LH shown)
11. Flange head screw (4 per brake)
12. Gasket
13. Piston wheel motor (2 used)
14. Flat washer (2 per motor)
15. Cap screw (2 per motor)
16. O-ring
17. Brake cable

Removal (Figure 112)

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

CAUTION

When changing attachments, tires or performing other service, use correct blocks, hoists and jacks to raise and support machine. See Jacking Instructions (page 1–7).

2. Raise front of machine and support with jack stands.
3. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–86).

Removal (Figure 112) (continued)

4. To prevent contamination of hydraulic system during wheel motor removal, thoroughly clean exterior of motor.
5. Disconnect hydraulic lines from wheel motor. Put caps or plugs on lines and fittings to prevent contamination. Label the hydraulic lines to show their correct position on the wheel motor for assembly purposes.

IMPORTANT

Support wheel motor to prevent motor from falling during removal.

6. Remove wheel motor using Figure 112 as a guide.

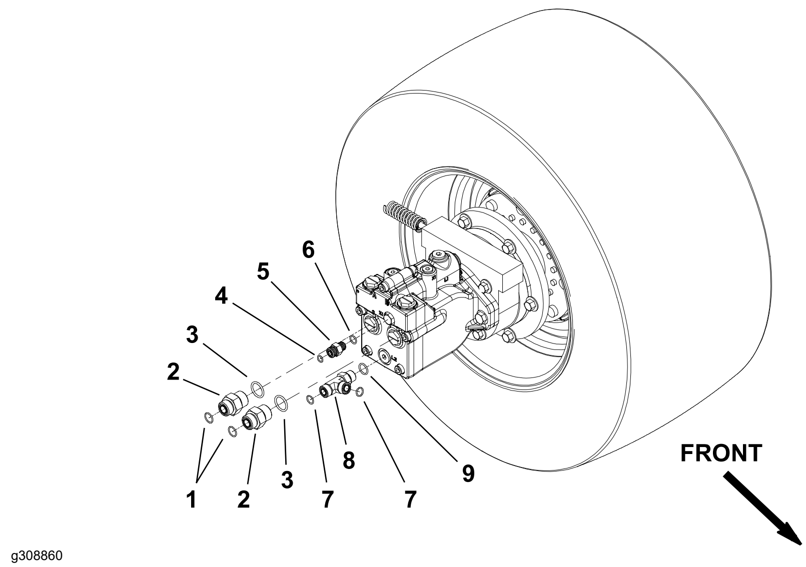

Figure 113
LEFT WHEEL

1. O-ring
2. Straight fitting
3. O-ring
4. O-ring
5. Straight fitting
6. O-ring
7. O-ring
8. Tee fitting
9. O-ring

Removal (Figure 112) (continued)

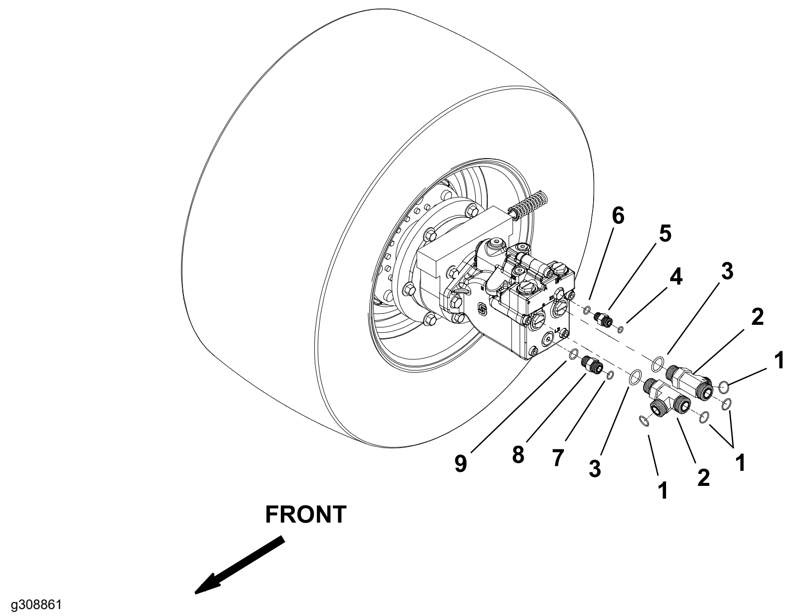

Figure 114

RIGHT WHEEL

1. O-ring
2. Tee fitting
3. O-ring
4. O-ring
5. Straight fitting
6. O-ring
7. O-ring
8. Straight fitting
9. O-ring

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7. Remove and discard O-ring (item 16) from flange of wheel motor.
8. If hydraulic fittings are to be removed from wheel motor, mark fitting orientation to allow correct assembly (Figure 113 and Figure 114). Remove fittings from motor and discard O-rings.

Installation (Figure 112)

1. If fittings were removed from wheel motor, lubricate and place new O-rings onto fittings. Install fittings into motor ports using marks made during the removal process to properly orientate fittings (Figure 113 and Figure 114). Tighten fittings (see Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–9)).
2. Place new O-ring (item 16) into flange of wheel motor.
3. Position wheel motor to brake assembly.
4. Align splines on motor shaft and splined brake shaft. Slide motor into brake assembly.
5. Secure motor to brake assembly with cap screws and flat washers.
6. Remove plugs from lines and fittings. Attach hydraulic lines to wheel motor (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–7)).
7. Lower machine to ground.
8. Fill reservoir with hydraulic fluid as required.

Rear Axle and Front Wheel Motor Service

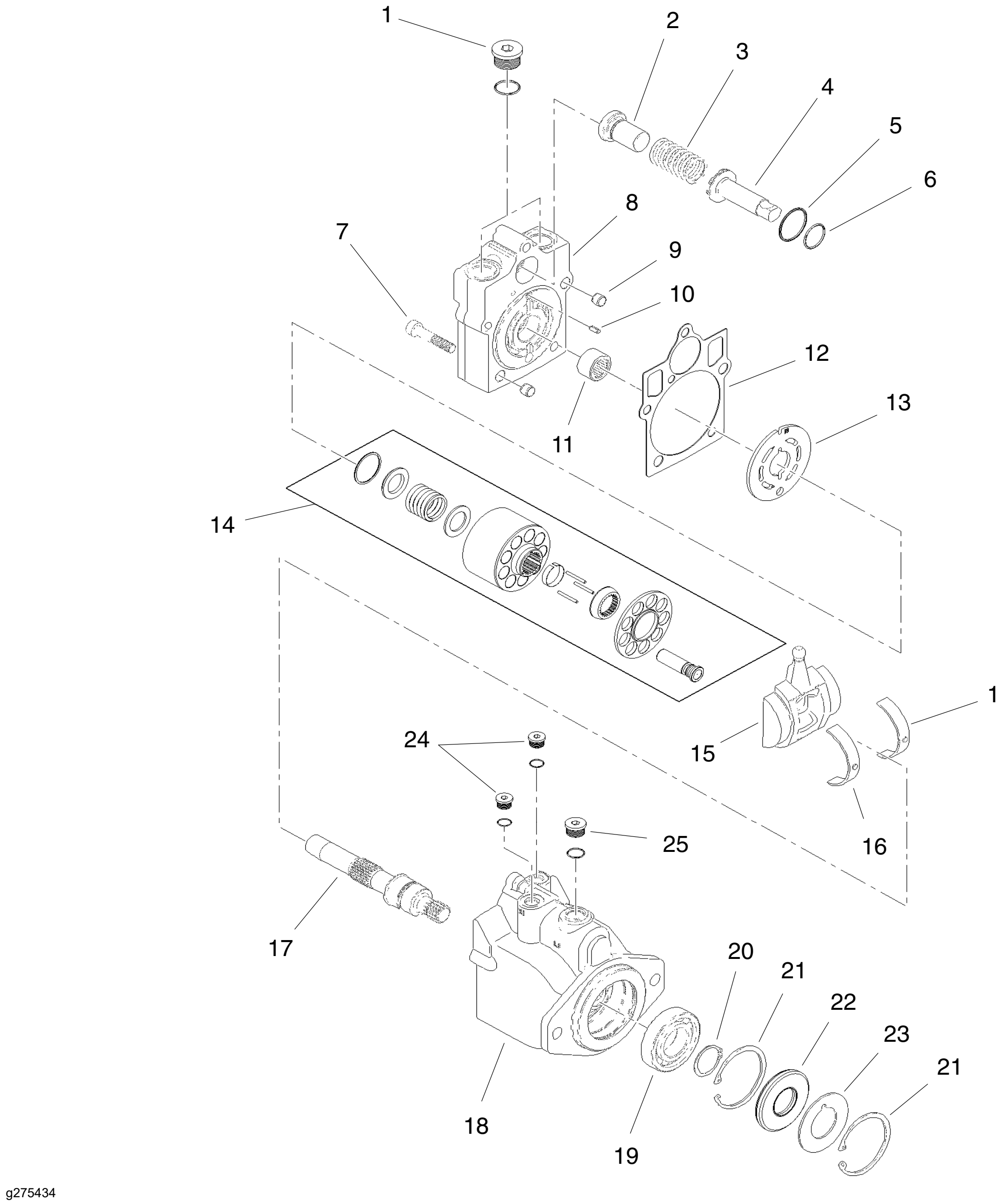

Figure 115

1. Plug with O−ring	10. Dowel pin	19. Bearing
2. Minimum angle stop	11. Bearing	20. Retaining ring
3. Bias spring	12. Gasket	21. Retaining ring (2 used)
4. Servo piston	13. Valve plate	22. Seal
5. O−ring	14. Cylinder block kit	23. Support washer
6. O−ring	15. Swashplate	24. Plug with O−ring (3 used)
7. Socket head screw (5 used)	16. Swashplate bearing assembly	25. Plug with O−ring (2 used)
8. Endcap	17. Output shaft	
9. Dowel	18. Housing	

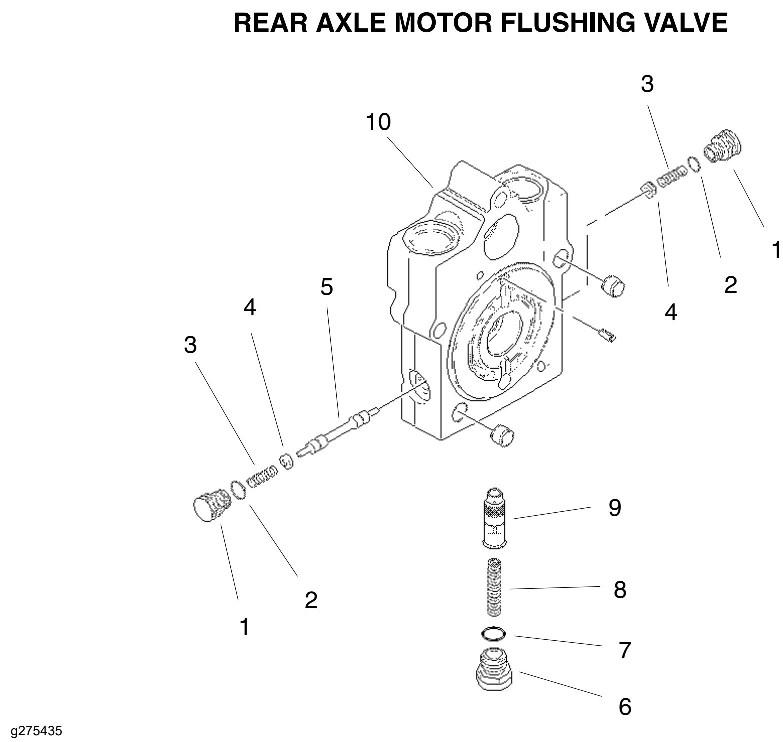

Figure 116

1. Plug
2. O−ring
3. Centering spring
4. Spring retaining washer
5. Shift spool
6. Plug
7. O−ring
8. Centering spring
9. Orifice poppet
10. Endcap

Note: The front wheel motors on your Groundsmaster are identical (Figure 115). The rear axle motor includes a flushing valve for cooling of the closed loop traction circuit and therefore has some differences from the front motors (Figure 116). Service of the wheel and axle motors uses the same procedure.

Note: For service of the front wheel and rear axle motors, see the Sauer−Danfoss K and L Frame Variable Motors Service Manual.

Cutting Deck Motor

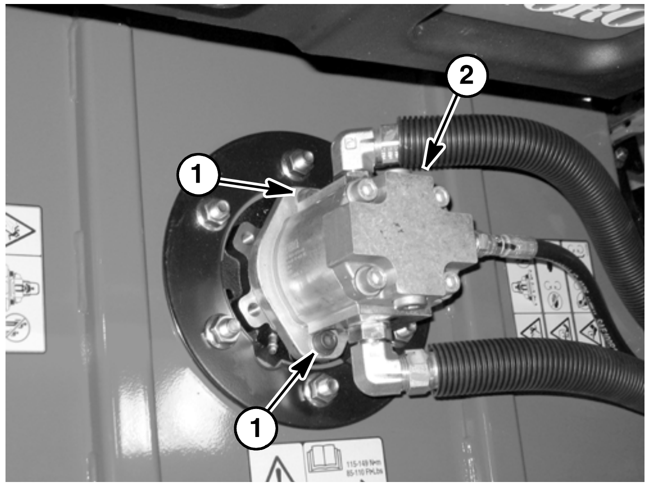

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Figure 117

1. Socket head screw
2. Hydraulic motor

The hydraulic motors used on all cutting decks are the same.

Removal

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.
2. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–86).
3. To prevent contamination of hydraulic system during deck motor removal, thoroughly clean exterior of motor.
4. Disconnect hydraulic lines from deck motor. Put caps or plugs on fittings and hoses to prevent contamination of hydraulic system. Label hydraulic lines for proper assembly.

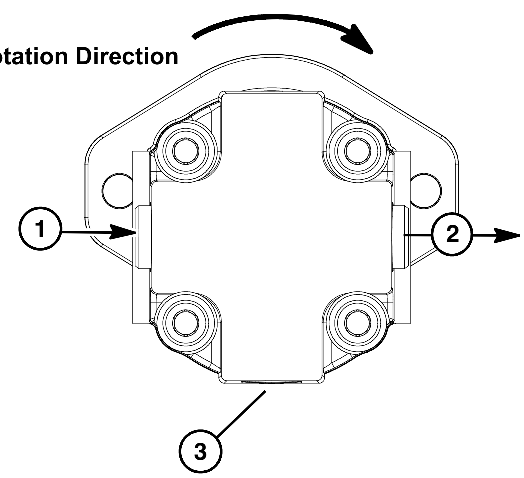

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Figure 118

1. Flow IN
2. Flow OUT
3. Case drain

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5. Remove two (2) socket head screws and flat washers that secure hydraulic motor to cutting deck (Figure 117).
6. Lift hydraulic motor from cutting deck.

Removal (continued)

7. Place cover on deck spindle opening to prevent contamination.
8. If hydraulic fittings are to be removed from deck motor, mark fitting orientation to allow correct assembly. Remove fittings from motor and discard O-rings.

Installation

1. If fittings were removed from deck motor, lubricate and place new O-rings onto fittings. Install fittings into motor ports using marks made during the removal process to properly orientate fittings. Tighten fittings (see Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–9)).
2. Remove cover from deck spindle opening.
3. Align splines on motor shaft and spindle shaft. Position hydraulic motor to the cutting deck.
4. Secure motor to cutting deck with two (2) socket head screws and flat washers (Figure 117).
5. Remove caps or plugs from hydraulic fittings and hoses. Connect hydraulic hoses to deck motor (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–7)).
6. After assembly is completed, verify that hydraulic hoses and fittings are not contacted by any moving components.

Cutting Deck Motor Service

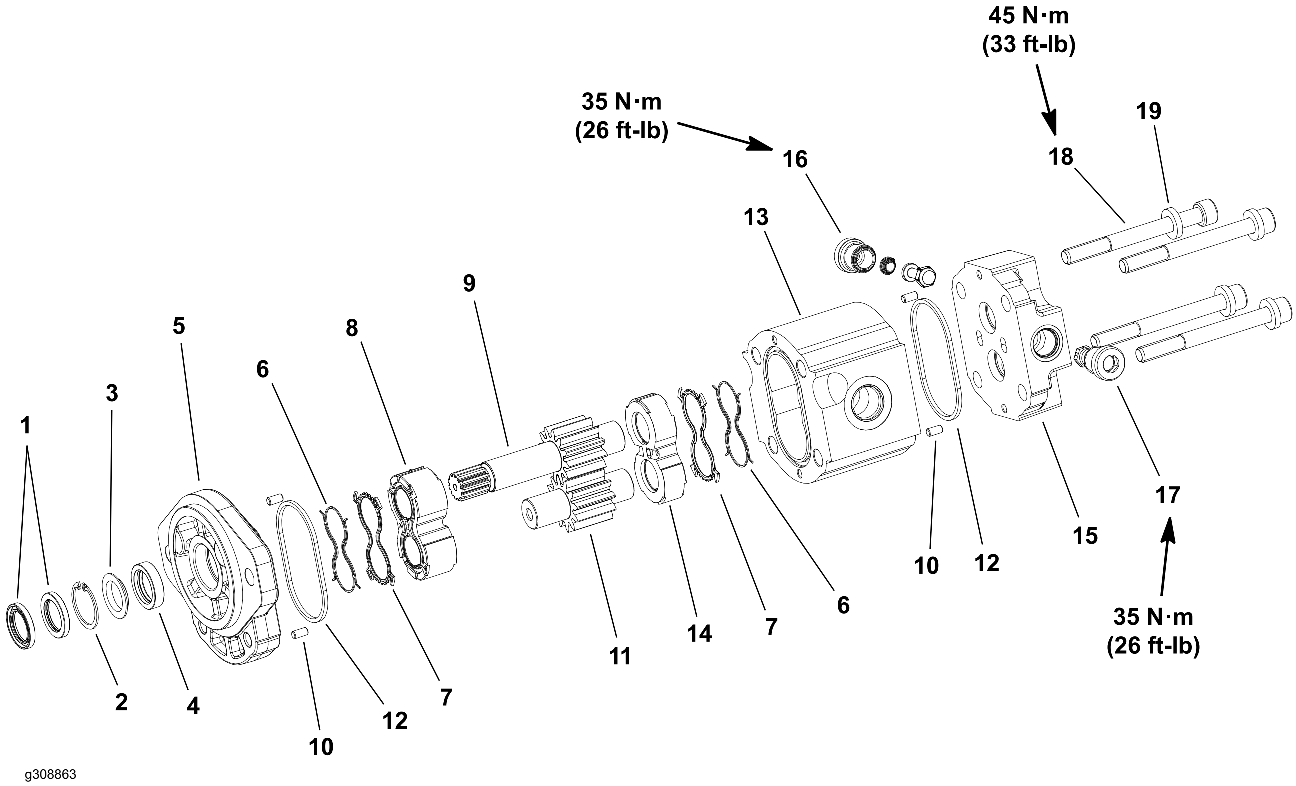

Figure 119

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

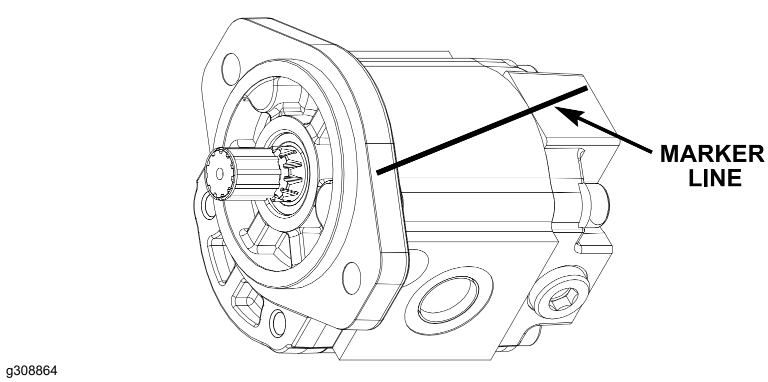

Figure 120

Disassembly (Figure 119)

1. Plug motor ports and clean the outside of the motor thoroughly. After cleaning, remove plugs and drain any oil out of the motor.
2. Use a marker to make a diagonal line across the front flange, body and rear cover for assembly purposes (Figure 120).

Disassembly (Figure 119) (continued)

IMPORTANT

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

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

IMPORTANT

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

IMPORTANT

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

8. Carefully remove rear wear plate, idler gear, drive gear and front wear plate from the front flange.
9. Remove and discard back-up gaskets and pressure seals from wear plates.

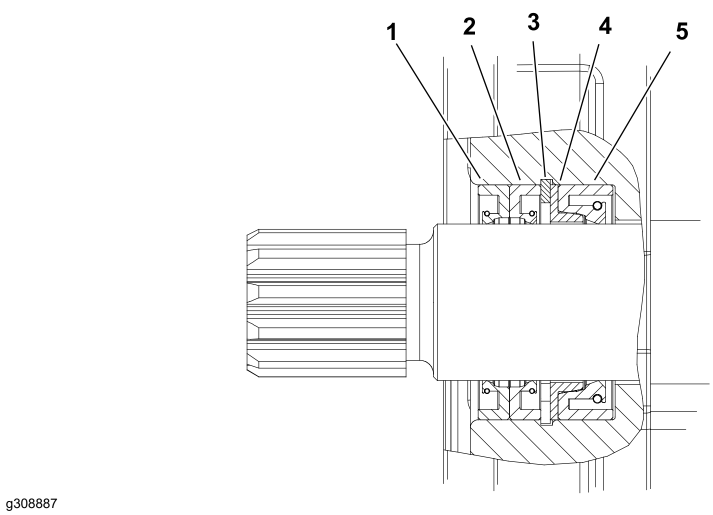

Figure 121

1. Outer dust seal
2. Inner dust seal
3. Retaining ring
4. Flange washer
5. Shaft seal

10. Turn front flange over, with seal side up.

Disassembly (Figure 119) (continued)

IMPORTANT

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

11. Carefully remove dust seals, retaining ring, flange washer and shaft seal from the front flange (Figure 121). Discard removed seals.

Inspection

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

CAUTION

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

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

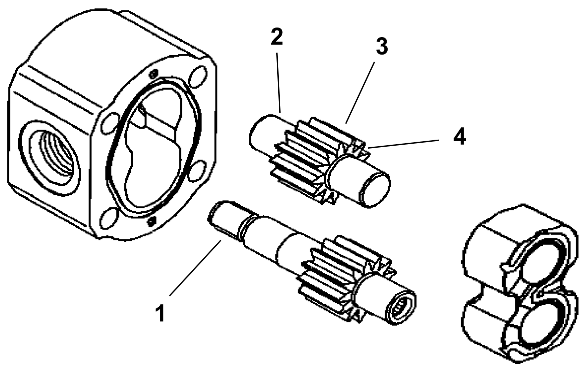

Figure 122

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 122):
   A. Gear shafts should be free of rough surfaces and excessive wear at bushing points and sealing areas. Scoring, rough surfaces or wear on gear shafts indicates need for replacement.
   B. Gear teeth should be free of excessive scoring and wear. Any broken or nicked gear teeth must be replaced.
   C. Inspect gear face edge for sharpness. Sharp edges of gears will mill into wear plates and, thus, must be replaced.
4. Inspect wear plates for the following:
   A. Bearing areas should not have excessive wear or scoring.
   B. Face of wear plates that are in contact with gears should be free of wear, roughness or scoring.
   C. Thickness of wear plates should be equal.
5. Inspect front flange and rear cover for damage or wear.

Assembly (Figure 119)

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

1. Lubricate O-rings, pressure seals, back-up gaskets and wear plate grooves with a thin coat of petroleum jelly. Lubricate all other internal parts freely with clean hydraulic oil.
2. Install new seals into front flange (Figure 121):
   A. Press shaft seal into front flange until it reaches the bottom of the bore.
   B. Install flange washer into front flange and then install retaining ring into the groove of the front flange.
   C. Install new dust seals into front flange.
3. Place front flange, seal side down, on a flat surface.
4. Install the pressure seals, flat side outward, into the grooves in the wear plates. Follow by carefully placing the backup gaskets, flat side outward, between the pressure seals and the grooves in the wear plate.
5. Apply a light coating of petroleum jelly to the exposed side of the front flange.
6. Lubricate the drive gear shaft with clean hydraulic oil. Insert the drive end of the drive shaft through the wear plate with the pressure seal side down and the open side of the pressure seal pointing to the inlet side of the motor. Carefully install shaft into front flange.
7. Lubricate the idler gear shaft with clean hydraulic oil. Install idler gear shaft into the remaining position in the front wear plate. Apply a light coating of clean hydraulic oil 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. Apply a light coating of petroleum jelly to new O-rings and O-ring grooves in the body. Install new O-rings to the body.
10. Install locating dowels in body. Align marker line on the body and front flange.

IMPORTANT

Do not dislodge seals during installation.

11. Gently slide the body onto the assembly. Firm hand pressure should be sufficient to engage the dowels.
12. Check to make sure that the surface of the rear wear plate is slightly below the face of the body. If the wear plate is not below the body, check assembly for a shifted pressure seal, backup gasket or O-ring. Correct before proceeding.
13. Apply a light coating of petroleum jelly to the exposed side of the rear cover.
14. Place rear cover on assembly using marker line for proper location. Firm hand pressure should be sufficient to engage the dowel pins.

Assembly (Figure 119) (continued)

15. Install the four (4) cap screws with washers and hand tighten screws.

IMPORTANT

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

---

16. Place front flange of the motor into a vise with soft jaws and alternately torque the cap screws **45 N·m (33 ft-lb)**.
17. Remove motor from vise.
18. Place a small amount of clean hydraulic oil in the inlet of the motor and rotate the drive shaft away from the inlet one revolution. If any binding is noted, disassemble the motor and check for assembly problems.

Deck Control Manifold

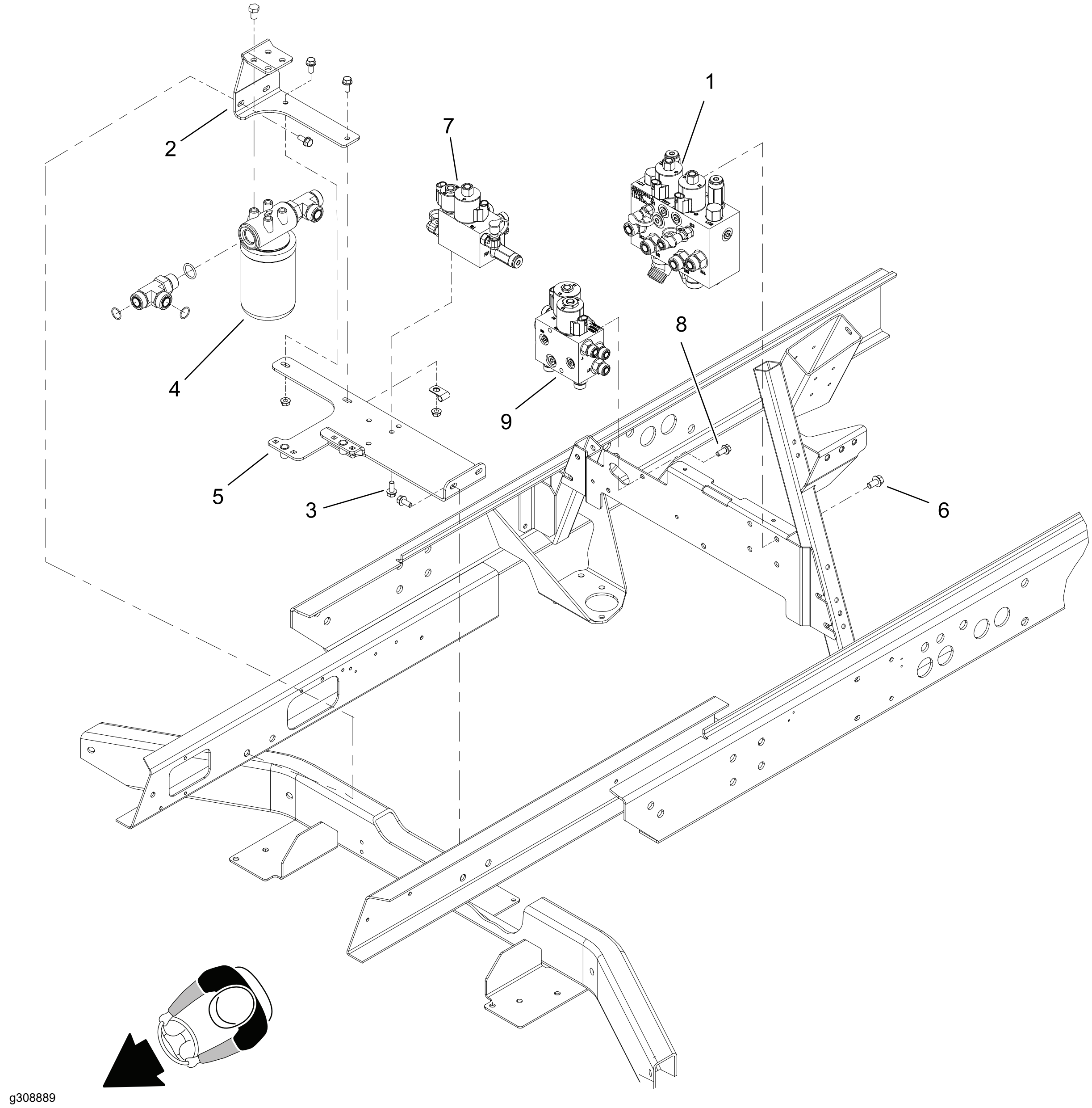

Figure 123

GROUNDSMASTER 4500-D SHOWN

1. Deck control manifold
2. Filter mount bracket
3. Flange head screw (2 used)
4. Hydraulic oil filter assembly
5. Valve mount bracket
6. Flange head screw (2 used)
7. Lift control manifold
8. Flange head screw (2 used)
9. Fan drive manifold

Note: The deck control manifolds used on Groundsmaster 4500-D and 4700-D are different but they mount to the machine in the same location. The control manifolds used on the Groundsmaster 4500-D are shown in Figure 123.

Removal (Figure 123)

Note: The ports on the deck control manifold are marked for easy identification of components. Example: P1 is the gear pump connection port (see Appendix A (page A–1)).

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

Removal (Figure 123) (continued)

2. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–86).

3. Unlatch and raise hood.

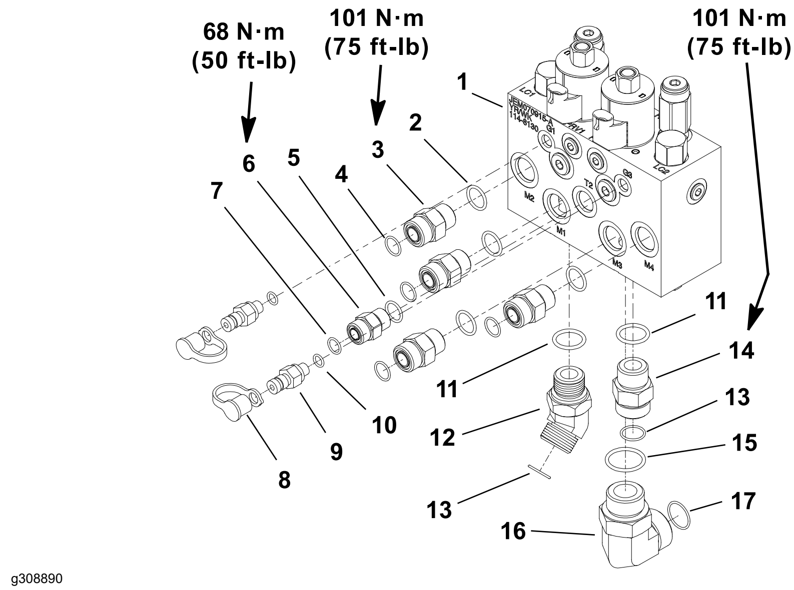

Figure 124

GM4500-D

1. Deck manifold
2. O-ring
3. Straight fitting (8 used)
4. O-ring
5. O-ring
6. Straight fitting
7. O-ring
8. Dust cover
9. Test fitting
10. O-ring
11. O-ring
12. 45º fitting
13. O-ring
14. Straight fitting
15. O-ring
16. 90º fitting
17. O-ring

Removal (Figure 123) (continued)

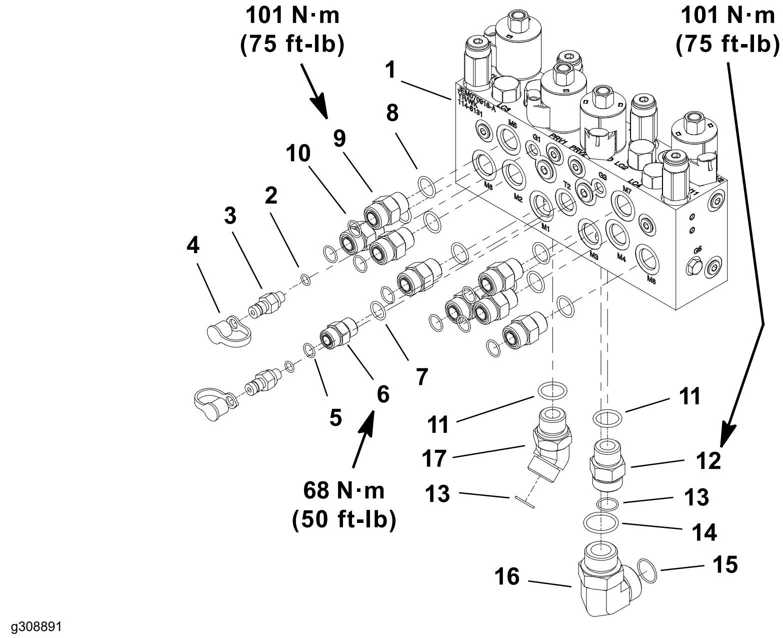

Figure 125

GM4700-D

1. Deck manifold
2. O-ring
3. Test fitting
4. Dust cap
5. O-ring
6. Straight fitting
7. O-ring
8. O-ring
9. Straight fitting (8 used)
10. O-ring
11. O-ring
12. Straight fitting
13. O-ring
14. O-ring
15. O-ring
16. 90º fitting
17. 45º fitting

---

4. To prevent contamination of hydraulic system during manifold removal, thoroughly clean exterior of manifold.
5. Label wire harness electrical connectors that attach to manifold solenoid coils. Disconnect connectors from the solenoid coils.
6. Disconnect hydraulic lines from manifold and put caps or plugs on open hydraulic lines and fittings. Label disconnected hydraulic lines for proper assembly.
7. Remove hydraulic manifold from the frame using Figure 123 as guide.
8. If hydraulic fittings are to be removed from control manifold, mark fitting orientation to allow correct assembly (Figure 124 or Figure 125). Remove fittings from manifold and discard O-rings.

Installation (Figure 123)

1. If fittings were removed from control manifold, lubricate and place new O-rings onto fittings. Install fittings into manifold ports 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 5–9)). Refer to Figure 124 or Figure 125 for fitting installation torque.
2. Install hydraulic manifold to the frame using Figure 123 as guide.

Installation (Figure 123) (continued)

3. Remove caps and plugs from fittings and hydraulic lines. Properly connect hydraulic lines to manifold (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–7)).
4. Connect wire harness electrical connectors to the solenoid valve coils.
5. Lower and secure hood.

Deck Control Manifold Service (GM4500-D)

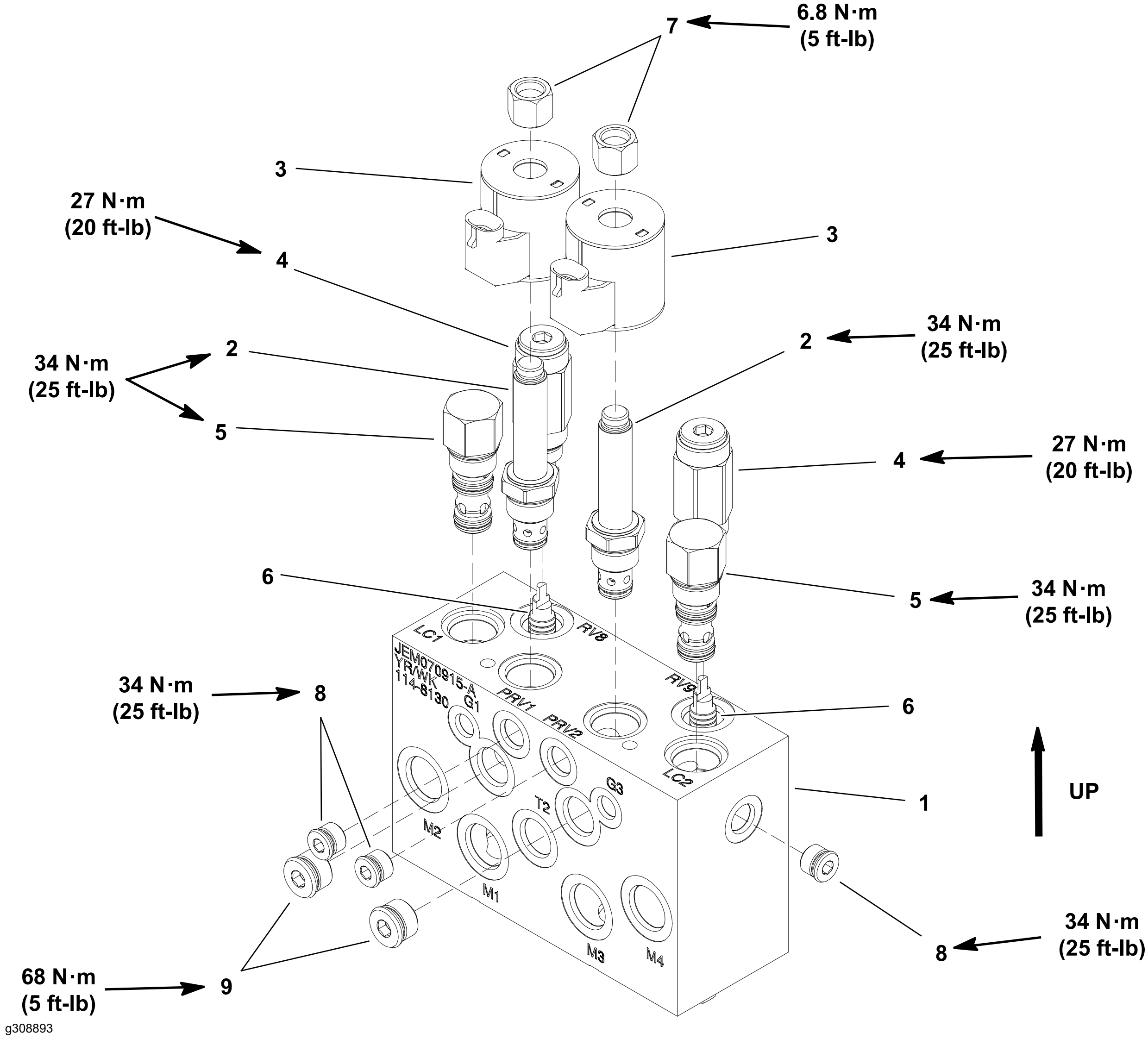

Figure 126

1.	Manifold body	4.	Relief valve (RV8 & RV9)	7.	Nut
2.	Proportional relief (PRV1 & PRV2)	5.	Logic valve (LC1 & LC2)	8.	Zero leak plug (#6)
3.	Solenoid coil	6.	Pilot piston	9.	Zero leak plug (#8)

Note: The ports on the deck control manifold are marked for easy identification of components (e.g. P1 is a gear pump connection port and PRV1 is the location for a proportional relief valve). See Appendix A (page A–1) to identify the function of the hydraulic lines and cartridge valves at each port location.

Deck Control Manifold Service (GM4500-D) (continued)

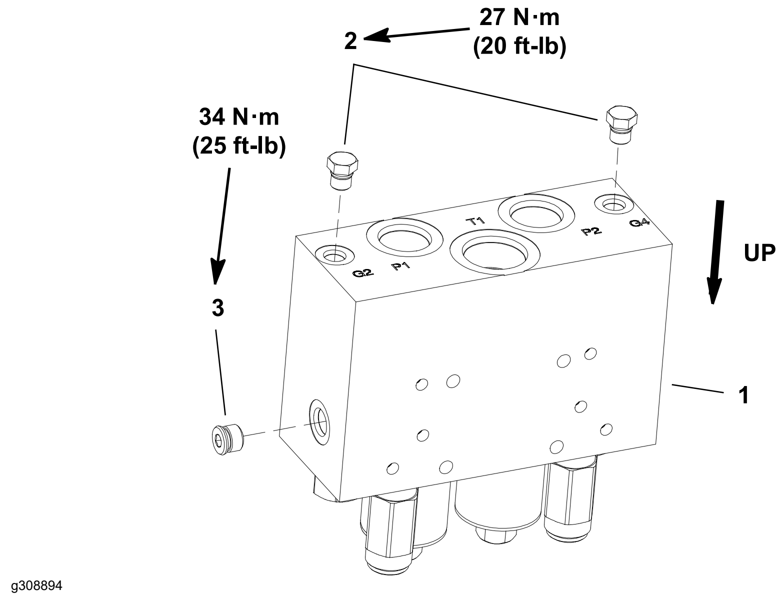

Figure 127

1. Manifold body
2. Zero leak plug (#4)
3. Zero leak plug (#6)

Note: The deck control manifold uses several zero leak plugs. These plugs have a tapered sealing surface on the plug head that is designed to resist vibration induced plug loosening. The zero leak plugs also have an O-ring as a secondary seal. If zero leak plug removal is necessary, lightly rap the plug head using a pin 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 head of the plug.

For solenoid and control valve service procedures, see Deck Control Manifold Service (GM4500-D) (page 5–134). Refer to Figure 126 and Figure 127 for cartridge valve and plug installation torque.

Note: A pilot piston (item 6) is placed beneath each of the relief valves in deck control manifold ports RV8 and RV9. If a relief valve is removed from the manifold, make sure to remove pilot piston and label its position for assembly purposes. When installing the pilot piston in the manifold, make sure that the pilot piston slides fully into the port before installing relief valve.

Deck Control Manifold Service (GM4700-D)

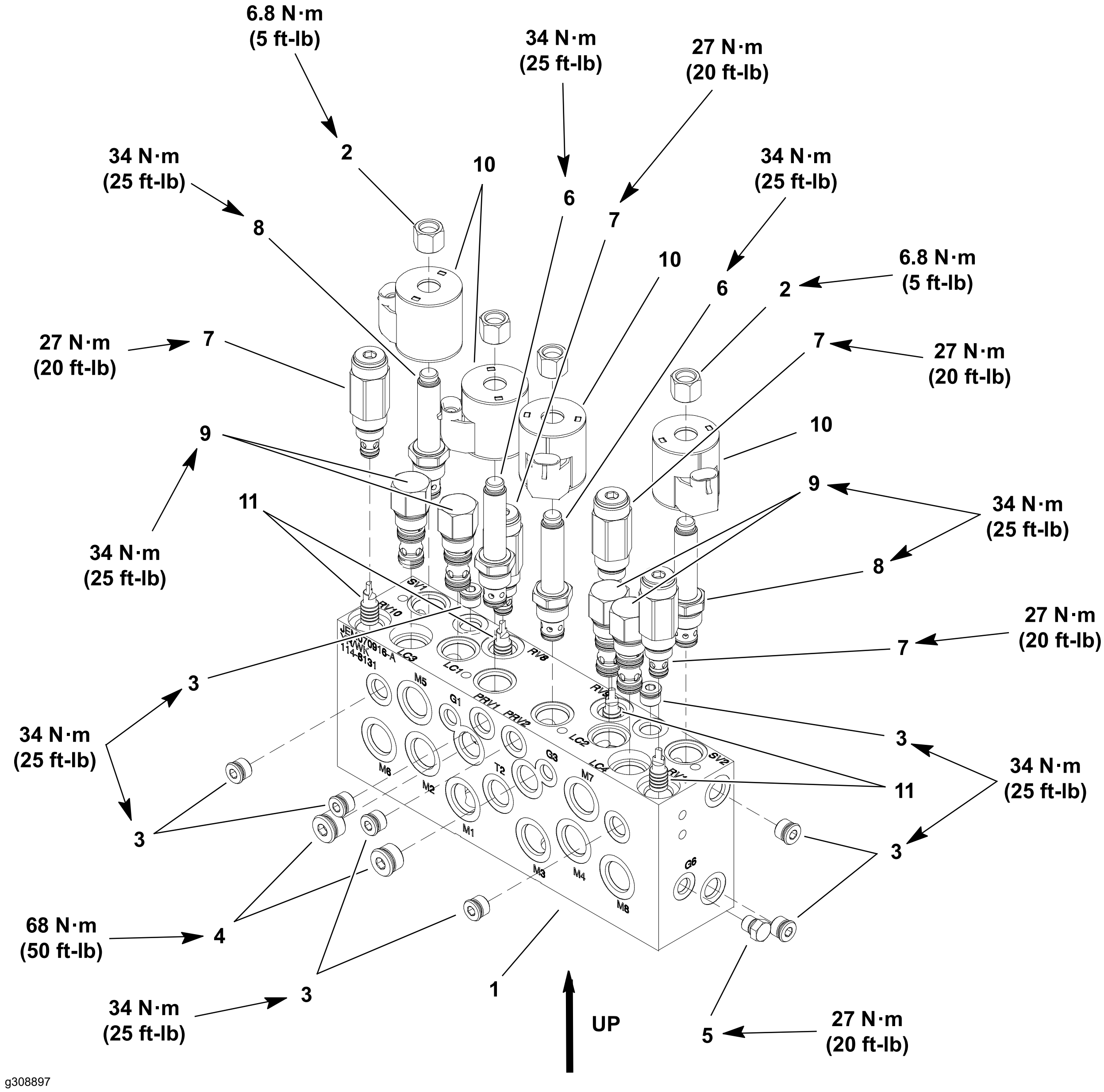

Figure 128

1. Manifold body
2. Nut (4 used)
3. Zero leak plug (#6)
4. Zero leak plug (#8)
5. Zero leak plug (#4)
6. Proportional relief (PRV2 & PRV2)
7. Relief valve (RV8, RV9, RV10 & RV11)
8. Solenoid valve (SV1 & SV2)
9. Logic valve (LC1, LC2, LC3 & LC4)
10. Solenoid coil (4 used)
11. Pilot piston (4 used)

Note: The ports on the deck control manifold are marked for easy identification of components (e.g. P1 is a gear pump connection port and RV8 is the location for a relief valve). See Appendix A (page A–1) to identify the function of the hydraulic lines and cartridge valves at each port location.

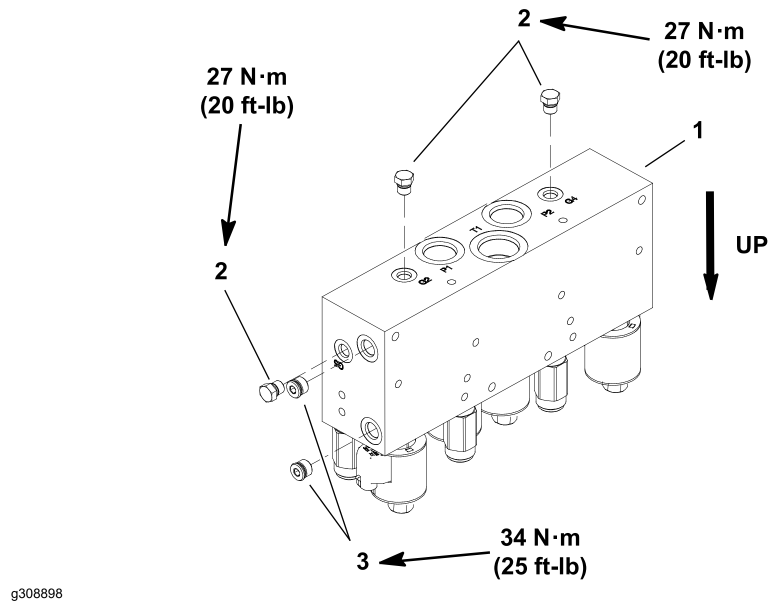

Figure 129

1. Manifold body
2. Zero leak plug (#6)
3. Zero leak plug (#4)

Note: The deck control manifold uses several zero leak plugs. These plugs have a tapered sealing surface on the plug head that is designed to resist vibration induced plug loosening. The zero leak plugs also have an O-ring as a secondary seal. If zero leak plug removal is necessary, lightly rap the plug head using a punch and hammer before using an allen wrench to remove the plug: the impact will allow plug removal with less chance of damage to the head of the plug.

For solenoid and control valve service procedures, see Deck Control Manifold Service (GM4500-D) (page 5–134). Refer to Figure 128 and Figure 129 for cartridge valve and plug installation torque.

IMPORTANT

A pilot piston (item 6) is placed beneath each of the relief valves in deck control manifold ports RV8, RV9, RV10 and RV11. If a relief valve is removed from the manifold, make sure to remove pilot piston and label its position for assembly purposes. When installing the pilot piston in the manifold, make sure that the pilot piston slides fully into the port before installing relief valve.

Steering Control Valve

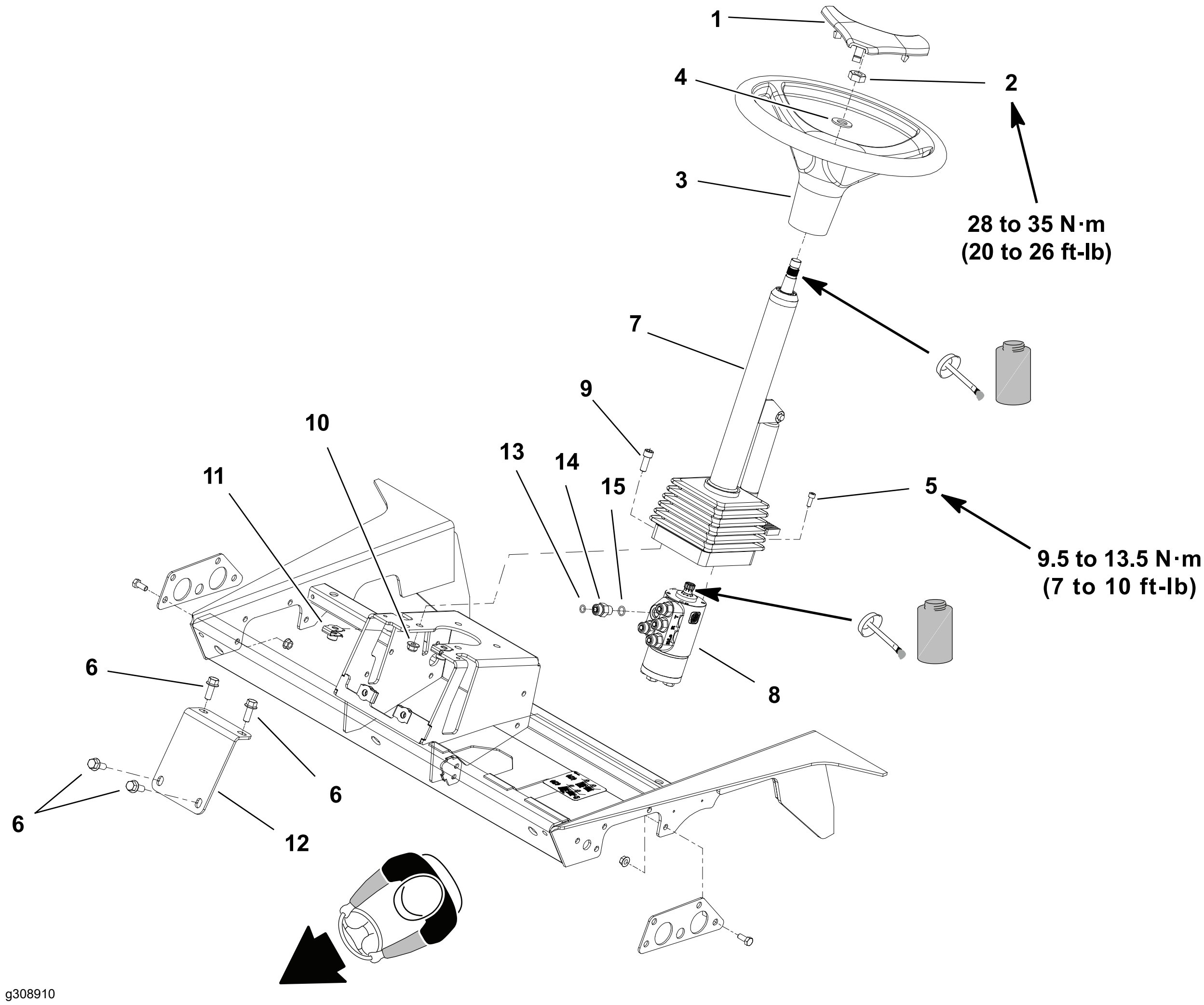

Figure 130

1. Steering wheel cover
2. Lock nut
3. Steering wheel
4. Flat washer
5. Socket head screw (4 used)
6. Flange head screw (4 used)
7. Steering column
8. Steering control valve
9. Socket head screw (4 used)
10. Flange nut (4 used)
11. Tinnerman nut (4 used)
12. Column brace
13. O-ring
14. Straight fitting (5 used)
15. O-ring

Removal (Figure 130)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.
2. Remove fasteners that secure platform shroud to front of machine (Figure 131). Remove shroud from machine to allow access to steering control valve.
3. Remove four (4) flange head screws that secure column brace (item 12) to frame platform. Remove brace from machine to allow access to steering column fasteners.

Removal (Figure 130) (continued)

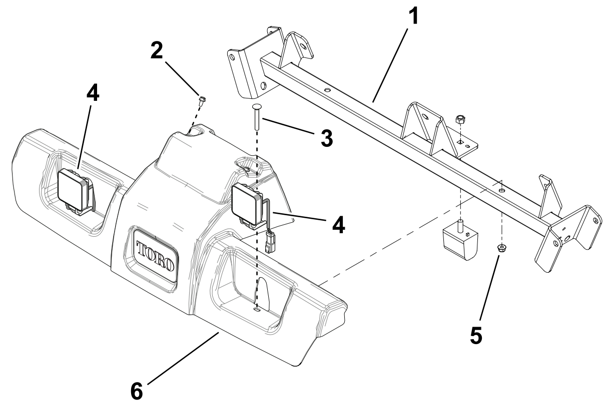

Figure 131

1. Roller support
2. Screw (2 used)
3. Carriage screw (2 used)
4. Headlight assembly
5. Flange nut (2 used)
6. Platform shroud

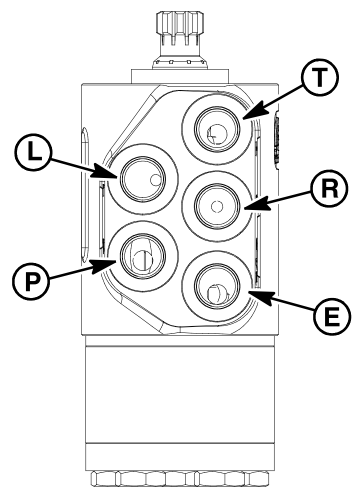

Figure 132

4. Slide rubber bellows up from bottom of steering column. Support steering column to prevent it from falling.
5. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–86).
6. Thoroughly clean hydraulic connections prior to loosening hydraulic lines.
7. Label all hydraulic connections for assembly purposes. Note port designations on steering control valve (Figure 132).

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 5–4).

8. Disconnect hydraulic lines from steering control valve. Allow lines to drain into a suitable container.

Removal (Figure 130) (continued)

9. Put caps or plugs on disconnected lines and fittings to prevent contamination.
10. Loosen and remove four (4) socket head screws and flange nuts that secure steering column to machine.
11. Remove steering column assembly with steering control valve attached from machine.
12. Loosen and remove four (4) socket head screws that secure steering control valve to steering column. When removing screws, tilt steering column for easier screw access.
13. Remove steering control valve from steering column.
14. If necessary, remove fittings and O-rings from steering control valve. Discard all removed O-rings.

Installation (Figure 130)

1. If fittings were removed, lubricate new O-rings with clean hydraulic oil and install fittings to steering control valve (see Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–9)).
2. Apply antiseize lubricant to splines of steering control valve shaft.
3. Slide steering control valve shaft into steering column universal joint. Position control valve with ports toward front of machine. Secure steering control valve to steering column with four (4) socket head screws. Torque screws in a criss-cross pattern from **9.5 to 13.5 N·m (7 to10 ft-lb)**.
4. Position steering column assembly to machine. Secure steering column in place with four (4) socket head screws and flange nuts.
5. Remove caps and plugs from disconnected lines and fittings.
6. Lubricate new O-rings and connect hydraulic lines to fittings on steering control valve (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–7)).
7. Position steering column brace (item 12) to machine and secure with four (4) flange head screws.
8. Slide rubber bellows to bottom of steering column.
9. Position platform shroud in place and secure with removed fasteners (Figure 131).
10. Check oil level in hydraulic reservoir and add correct oil if necessary.
11. Follow Hydraulic System Start-up procedures (see Priming Hydraulic Pumps (page 5–89)).

Steering Control Valve Service

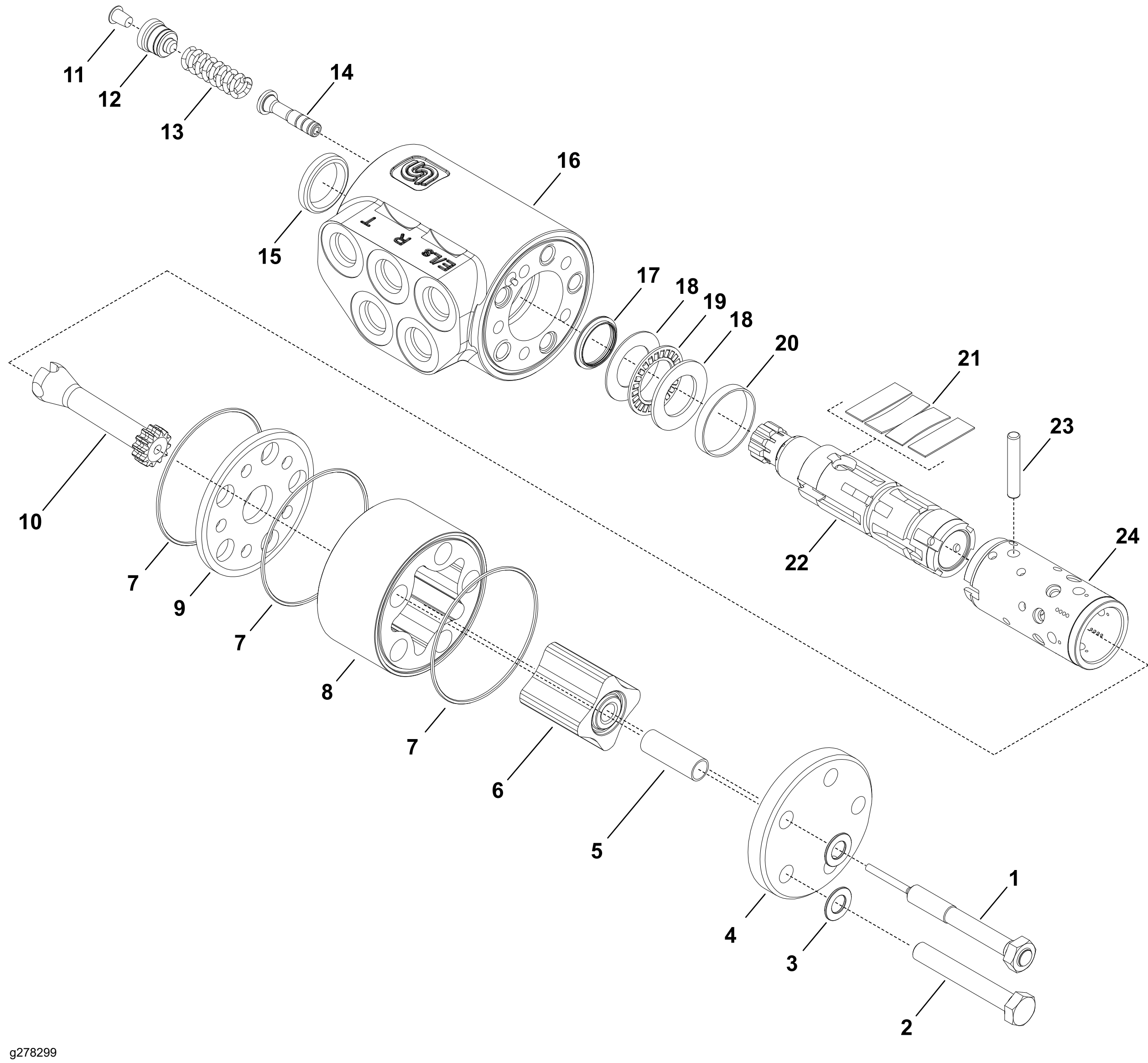

Figure 133

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

Note: For the steering control valve repair procedures, refer to the Danfoss Steering Unit Type OSPM Service Manual.

Steering Cylinder

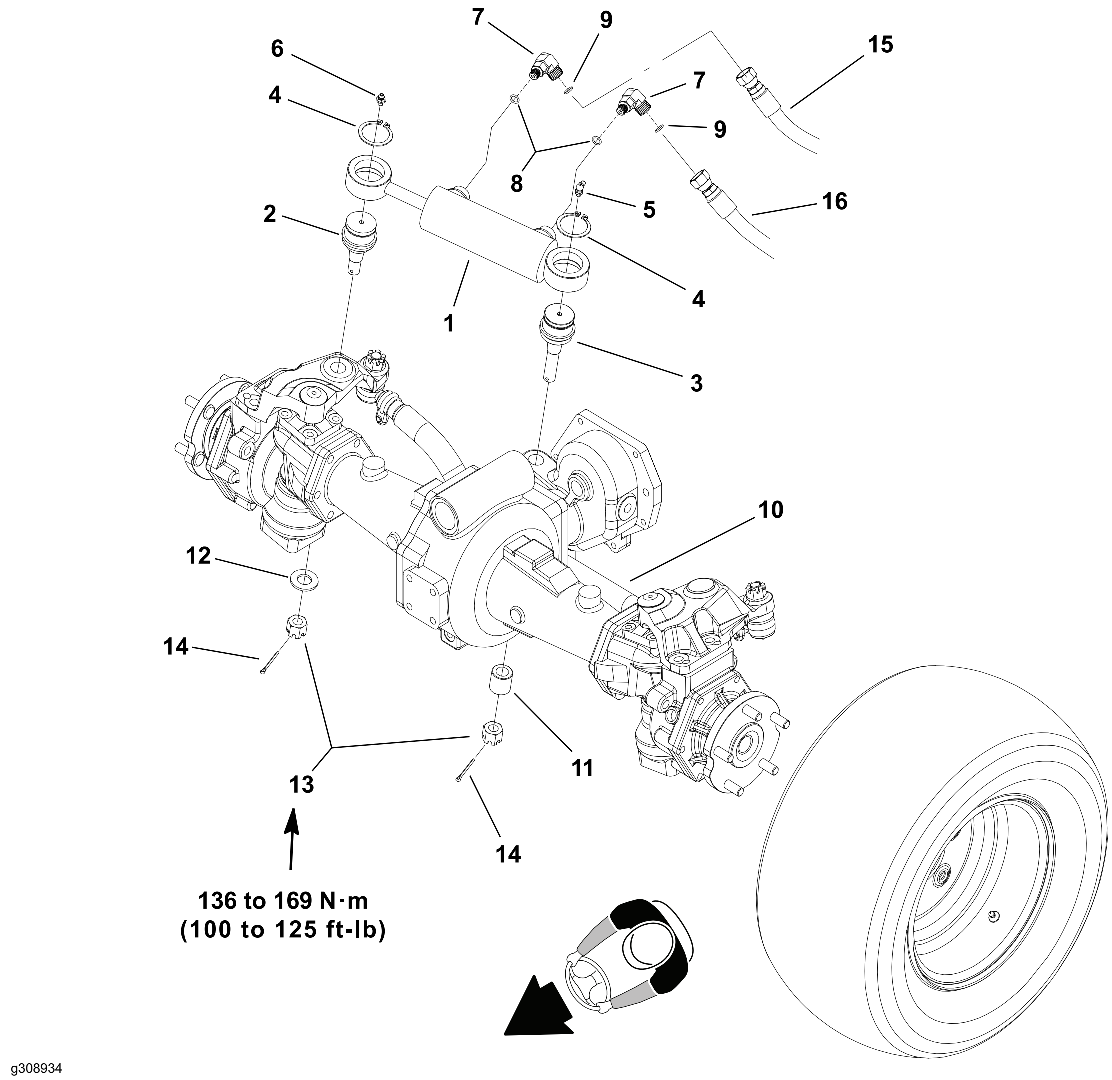

Figure 134

1. Steering cylinder
2. Ball joint
3. Ball joint
4. Retaining ring
5. Grease fitting
6. Grease fitting
7. 90º hydraulic fitting
8. O-ring
9. O-ring
10. Drive axle assembly
11. Ball joint spacer
12. Axle washer
13. Slotted hex nut
14. Cotter pin
15. Hydraulic hose
16. Hydraulic hose

Removal (Figure 134)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.
2. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–86).
3. To prevent contamination of hydraulic system during steering cylinder removal, thoroughly clean exterior of steering cylinder.
4. Remove hydraulic hoses from steering cylinder. Label the hydraulic hoses to show their correct position on the steering cylinder for assembly purposes.
5. Put caps or plugs on disconnected hoses and fittings to prevent contamination.

Removal (Figure 134) (continued)

6. Remove cotter pins, slotted hex nuts, axle washer and ball joint spacer from the threaded ends of ball joints. Remove steering cylinder with ball joints from machine.
7. If necessary, remove ball joints from steering cylinder.
8. If hydraulic fittings are to be removed from steering cylinder, mark fitting orientation to allow correct assembly. Remove fittings from cylinder and discard O-rings.

Installation (Figure 134)

1. If fittings were removed from steering cylinder, lubricate and place new O-rings onto fittings. Install fittings into cylinder ports 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 5–9)).
2. If removed, press ball joints into lift cylinder and secure with retaining ring.
3. Slide ram end ball joint through hole on steering arm. Secure with axle washer and slotted hex nut. Slide fixed end of cylinder through hole on axle. Install spacer onto ball joint and secure with slotted hex nut. Torque slotted hex nuts from **136 to 169 N·m (100 to 125 ft-lbs)** prior to inserting cotter pins.
4. Remove caps and plugs from disconnected hoses and fittings.
5. Install hydraulic hoses to steering cylinder (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–7)).
6. Fill reservoir with hydraulic fluid as required.
7. After assembly is completed, operate steering cylinder to verify that hydraulic hoses and fittings are not contacted by anything.

Steering Cylinder Service

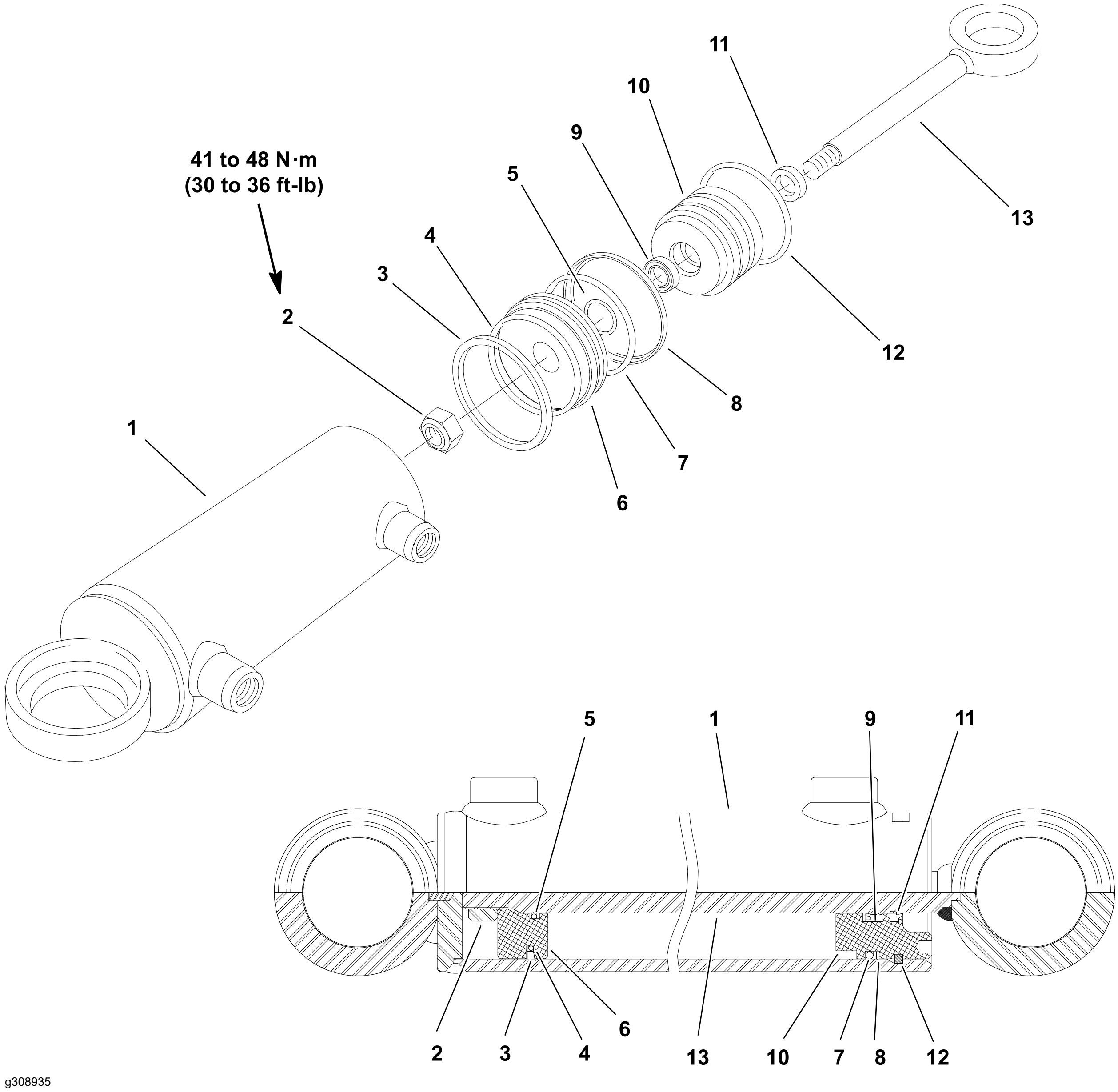

Figure 135

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

Disassembly (Figure 135)

1. Remove oil from steering 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 cylinder in a vise; clamp on the clevis only. Do not close vise enough to distort the barrel.

Disassembly (Figure 135) (continued)

2. Mount steering cylinder securely in a vise by clamping on the clevis end of the barrel. Use of a vise with soft jaws is recommended.
3. Loosen head from barrel:
   A. Use a spanner wrench to rotate head clockwise until the edge of the retaining ring appears in the barrel opening.
   B. Insert a screwdriver under the beveled edge of the retaining ring to start the retaining ring through the opening.
   C. Rotate the head counter-clockwise to remove retaining ring from barrel and head.
4. Extract shaft with head and piston by carefully twisting and pulling on the shaft.

IMPORTANT

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

5. Mount shaft securely in a vise by clamping on the clevis of the shaft. Remove lock nut and piston from the shaft. Slide head off the shaft.
6. Remove and discard all seals and O-rings from the piston and the head.
7. Wash parts in clean solvent. Dry parts with compressed air. Do not wipe parts dry with paper towels or cloth. Lint in a hydraulic system will cause damage.
8. Carefully inspect internal surface of barrel for damage (deep scratches, out-of-round, etc.). Replace entire cylinder if barrel is damaged. Inspect piston rod and piston for evidence of excessive scoring, pitting or wear. Replace any damaged parts.

Assembly (Figure 135)

1. Make sure all cylinder components are clean before assembly.
2. Coat new seal kit components with clean hydraulic oil.
   A. Install new seals and O-rings to the piston.
   B. Install new seals, O-ring and back-up seal to the head.

IMPORTANT

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

3. Mount shaft securely in a vise by clamping on the clevis of the shaft.
   A. Coat shaft with clean hydraulic oil.
   B. Carefully slide head and piston onto the shaft. Secure piston to shaft with lock nut.
   C. Torque lock nut from **41 to 48 N·m (30 to 36 ft-lb)**.
4. Lubricate head and piston with hydraulic oil. Carefully slide shaft assembly into cylinder barrel.

Assembly (Figure 135) (continued)

IMPORTANT

Prevent damage when clamping the cylinder's barrel into a vise; clamp on the clevis only. Do not close vise enough to distort the barrel.

5. Mount steering cylinder in a vise with soft jaws. Secure head in barrel:

   A. Align retaining ring hole in the head with the access slot in the barrel.

   B. Insert the retaining ring hook into the hole and rotate head clockwise until the retaining ring is completely pulled into the barrel and the ring ends are covered.

   C. Apply silicone sealer to barrel access slot.

Engine Cooling Fan Motor

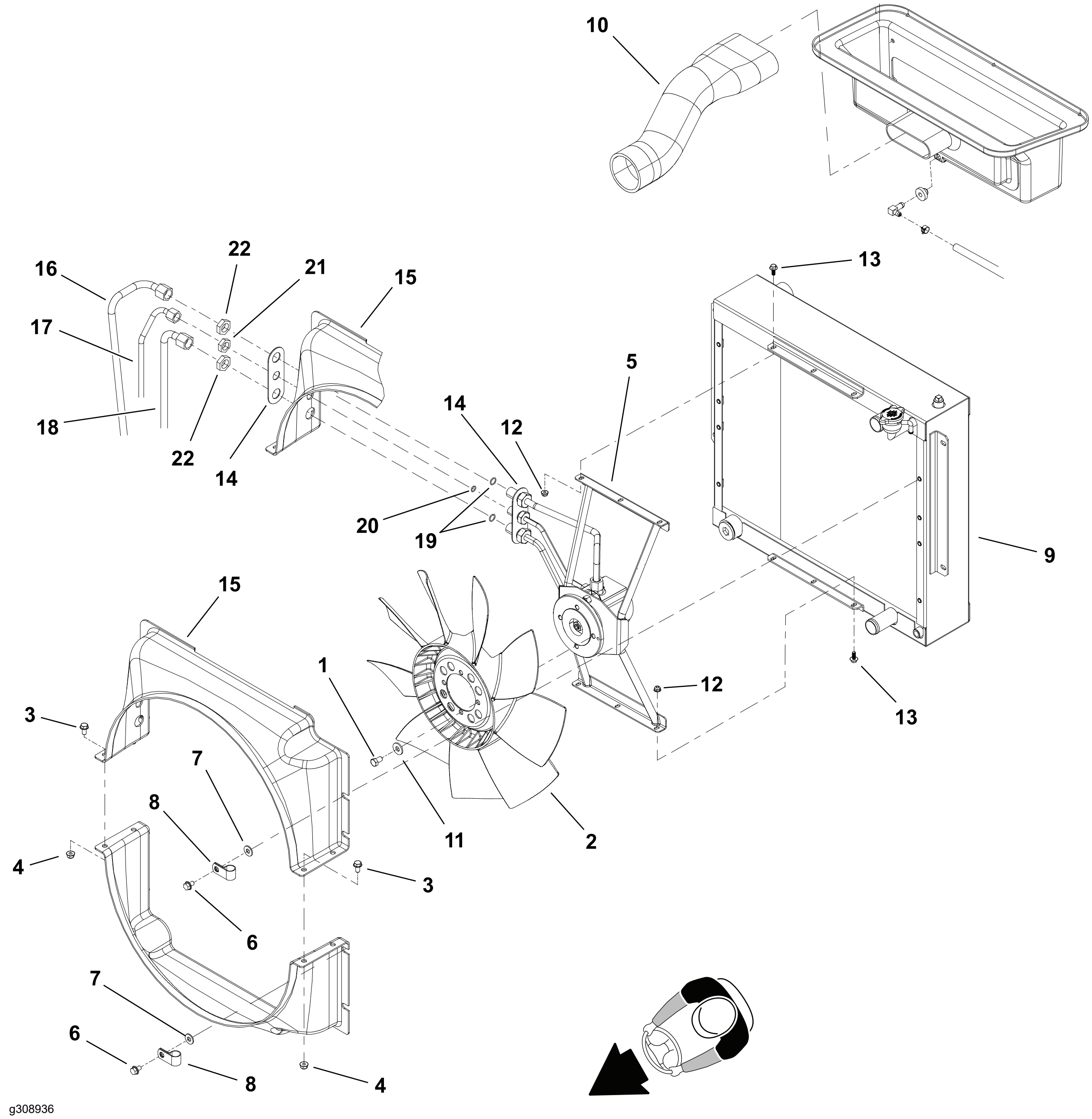

Figure 136

1. Cap screw (4 used)
2. Fan
3. Flange head screw (4 used)
4. Flange nut (4 used)
5. Fan motor and bracket assembly
6. Flange head screw (8 used)
7. Flat washer (8 used)
8. R-clamp (2 used)
9. Radiator/oil cooler assembly
10. Air intake hose
11. Washer (4 used)
12. Flange nut (6 used)
13. Cap screw (6 used)
14. Support shim (2 used)
15. Upper fan shroud
16. Hydraulic tube
17. Hydraulic tube
18. Hydraulic tube
19. O-ring
20. O-ring
21. Bulkhead nut
22. Bulkhead nut (2 used)

Removal (Figure 136)

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

Removal (Figure 136) (continued)

2. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–86).
3. Unlatch and raise hood.
4. Remove four (4) cap screws and washers used to secure fan (item 2) to fan hub. Remove fan.

CAUTION

The radiator and engine may be hot. To avoid possible burns, allow the engine and cooling systems to cool before removing fan motor.

5. Remove upper radiator shroud to allow access to hydraulic fan motor:
   A. Remove air cleaner intake hose (item 10) from air cleaner and plenum on top of radiator.
   B. Clean junction of hydraulic tubes on right side of upper radiator shroud. Loosen and separate hydraulic tubes (items 16, 17 and 18) that lead to hydraulic fan motor.
   C. Remove bulkhead nuts (items 21 and 22) that secure hydraulic tubes to upper radiator shroud. Slide support shim (item 14) from tubes.
   D. Remove fasteners that secure upper radiator shroud to lower radiator shroud and radiator. Carefully lift upper shroud from machine.
   E. Put caps or plugs on disconnected hydraulic tubes to prevent contamination.

IMPORTANT

Make sure to not damage the radiator or other machine components while loosening and removing the fan motor and bracket assembly.

6. Remove six (6) cap screws and flange nuts that secure fan motor bracket to radiator. Carefully remove fan motor, hydraulic tubes and bracket assembly from machine and place on suitable work surface.

Removal (Figure 136) (continued)

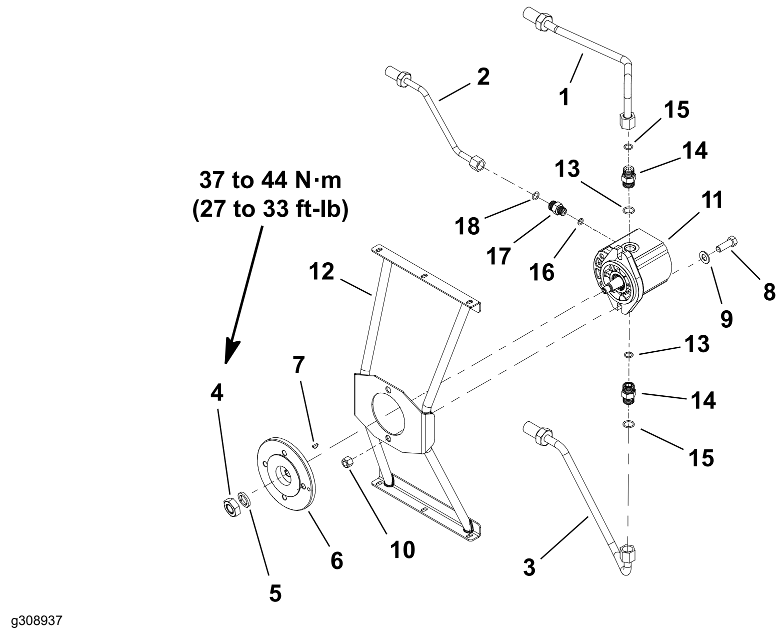

Figure 137

1.	Hydraulic tube	10.	Lock nut (2 used)
2.	Hydraulic tube	11.	Fan motor
3.	Hydraulic tube	12.	Fan motor bracket
4.	Hex nut	13.	O-ring
5.	Flat washer	14.	Hydraulic fitting
6.	Fan hub	15.	O-ring
7.	Woodruff key	16.	O-ring
8.	Cap screw (2 used)	17.	Hydraulic fitting
9.	Flat washer (2 used)	18.	O-ring

7. Remove fan motor from bracket (Figure 137):
   A. Disconnect hydraulic tubes (items 1, 2 and 3) from fan motor fittings. Label hydraulic tubes for proper assembly.
   B. Remove hex nut (item 4) and washer (item 5) that secure fan hub to fan motor. Use suitable puller to carefully remove fan hub from fan motor shaft. Locate and retrieve woodruff key (item 7).
   C. Remove two (2) cap screws (item 8), flat washers (item 9) and lock nuts (item 10) that secure fan motor to fan motor bracket. Remove fan motor from bracket.
   D. If necessary, remove hydraulic fittings from fan motor and discard O-rings.

Installation (Figure 136)

1. If fittings were removed from fan motor, lubricate and place new O-rings onto fittings. Install fittings into port openings. Tighten fittings (see Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–9)).
2. Secure fan motor to bracket (Figure 137):
   A. Position fan motor to fan motor bracket and secure with two (2) cap screws (item 8), flat washers (item 9) and lock nuts (item 10).
   B. Thoroughly clean tapered surfaces of fan motor shaft and fan hub. Place woodruff key (item 7) in slot in motor shaft.

Installation (Figure 136) (continued)

C. Position fan hub onto motor shaft and secure with washer (item 5) and hex nut (item 4). Torque nut from **37 to 44 N·m (27 to 33 ft-lb)**.

D. Connect hydraulic tubes (items 1, 2 and 3) to fan motor fittings. Use support shim (item 14 in Figure 136) to help orientate tubes during assembly.

IMPORTANT

Make sure to not damage the radiator or other machine components while installing the fan motor and bracket assembly.

3. Carefully position fan motor and bracket assembly to radiator and secure with six (6) cap screws and flange nuts.
4. Install upper radiator shroud (Figure 136):
   A. Place support shim (item 10) on hydraulic tubes connected to fan motor.
   B. Carefully install upper shroud to machine. Make sure that upper shroud mounting holes properly align with hydraulic tubes and fastener locations in radiator and lower shroud.
   C. Secure upper radiator shroud to lower shroud and radiator with removed fasteners. Make sure that clearance between shroud and cooling fan is at least 4.6 mm (0.180 in) at all points.
   D. Slide support shim (item 10) onto hydraulic tubes and secure tubes to upper shroud with bulkhead nuts (items 21 and 22).
   E. Make sure that lubricated O-rings (items 19 and 28) are placed in hydraulic tubes.
   F. Remove caps and plugs placed in hydraulic tubes during removal to prevent contamination. Connect and secure hydraulic tubes (items 16, 17 and 18) (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–7)).
5. Position fan (item 2) to fan hub and secure with four (4) cap screws and washers.
6. Install air cleaner hose (item 10) to air cleaner and plenum on top of radiator.
7. Lower and secure hood.

Engine Cooling Fan Motor Service

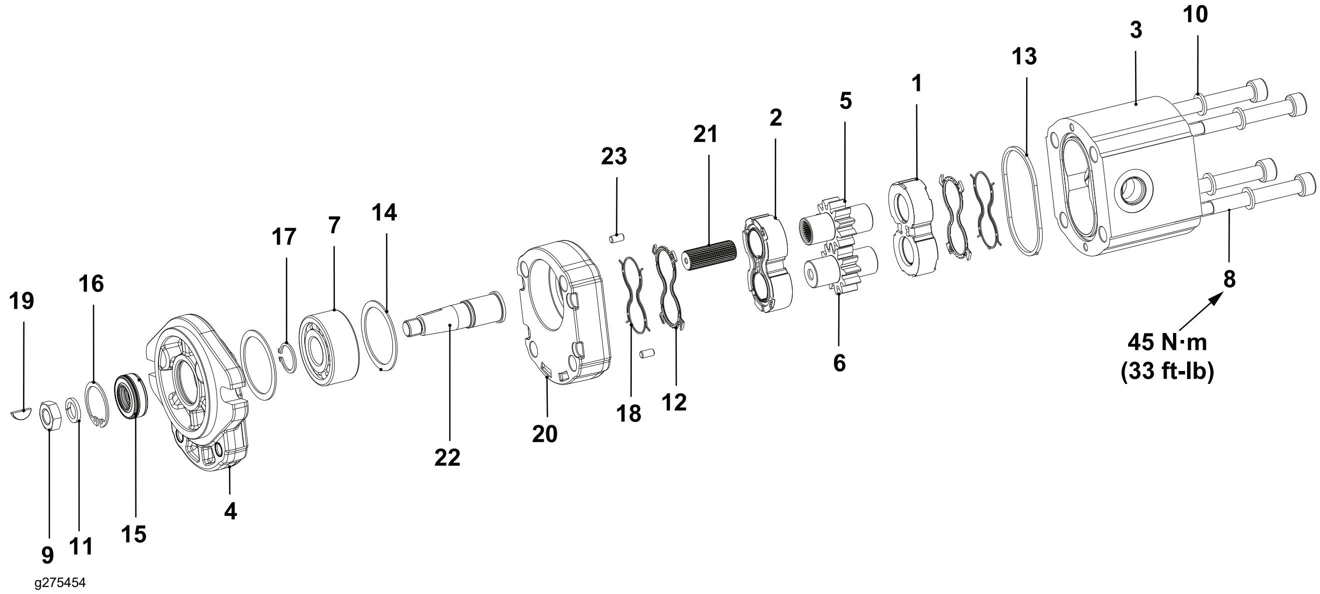

Figure 138

1. Thrust plate
2. Thrust plate
3. Body
4. Front cover
5. Drive gear
6. Driven gear
7. Ball bearing
8. Screw
9. Nut
10. Washer
11. Washer
12. Seal
13. Standard seal
14. Square seal
15. Shaft seal
16. Ring
17. Ring
18. Anti-extrusion
19. Key
20. Flange
21. Hub
22. Support
23. Dowel pin

The engine cooling fan motor has similar construction as the cutting deck motors. The body of the cooling fan motor (item 3 in Figure 138) includes the rear cover which is a difference from the deck motors which have a separate rear cover.

For disassembly, inspection and assembly procedures of the cooling fan motor, refer to Cutting Deck Motor Service (page 5–125).

Fan Control Manifold

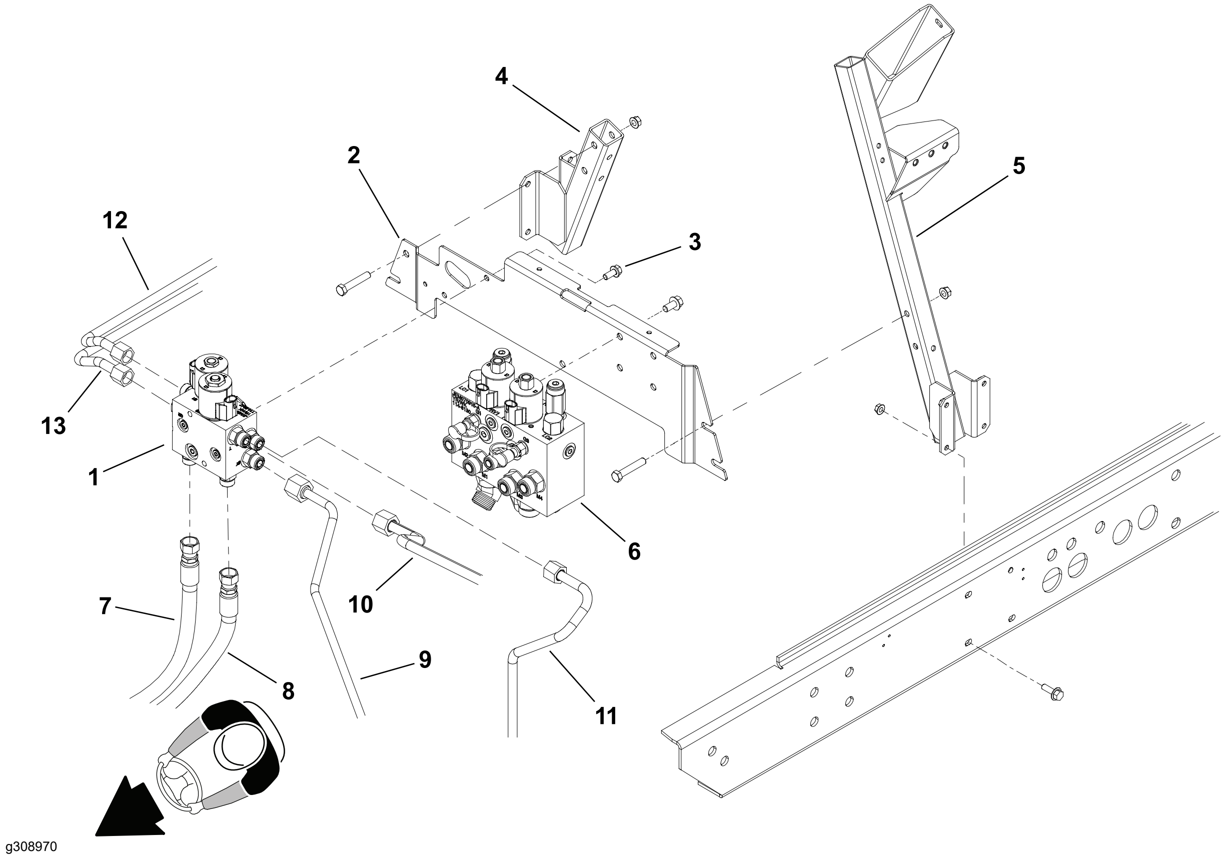

Figure 139

1. Fan control manifold
2. Support bracket
3. Flange head screw (2 used)
4. Battery support
5. Air cleaner mount
6. Deck manifold (GM4500-D shown)
7. Hydraulic hose
8. Hydraulic hose
9. Hydraulic tube
10. Hydraulic tube
11. Hydraulic tube
12. Hydraulic tube
13. Hydraulic tube

Removal (Figure 139)

The ports on the fan control manifold are marked for easy identification of components. Example: P1 is the gear pump connection port (see Appendix A (page A–1) to identify the function of the hydraulic lines and cartridge valves at each manifold port).

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.
2. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–86).
3. Unlatch and raise hood.
4. To prevent contamination of hydraulic system during fan control manifold removal, thoroughly clean exterior of manifold.
5. Label wire harness electrical connectors that attach to manifold solenoid coils. Disconnect connectors from the solenoid coils.
6. Disconnect hydraulic lines from manifold and put caps or plugs on open hydraulic lines and fittings. Label disconnected hydraulic lines for proper assembly.

Removal (Figure 139) (continued)

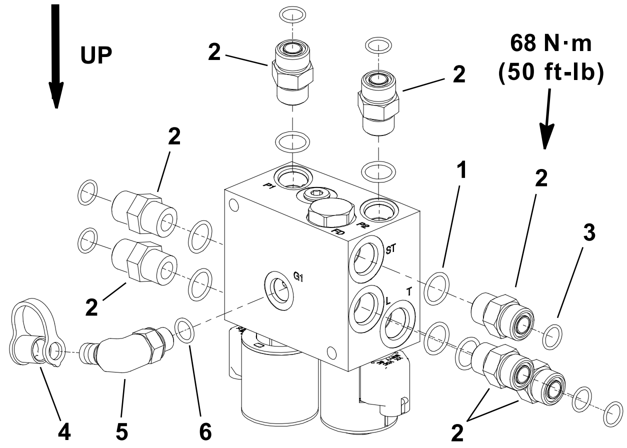

Figure 140

1. O-ring
2. Straight fitting (7 used)
3. O-ring
4. Dust cap
5. Test fitting
6. O-ring

---

7. Remove hydraulic manifold from the frame using Figure 139 as guide.
8. If hydraulic fittings are to be removed from fan control manifold, mark fitting orientation to allow correct assembly (Figure 140). Remove fittings from manifold and discard O-rings.

Installation (Figure 139)

1. If fittings were removed from fan control manifold, lubricate and place new O-rings onto fittings. Install fittings into manifold ports 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 5–9)). Refer to Figure 140 for fitting installation torque.
2. Install hydraulic manifold to the frame using Figure 139 as guide.
3. Remove caps and plugs from fittings and hydraulic lines. Properly connect hydraulic lines to manifold (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–7)).
4. Connect wire harness electrical connectors to the manifold solenoid valves.
5. Lower and secure hood.

Fan Control Manifold Service

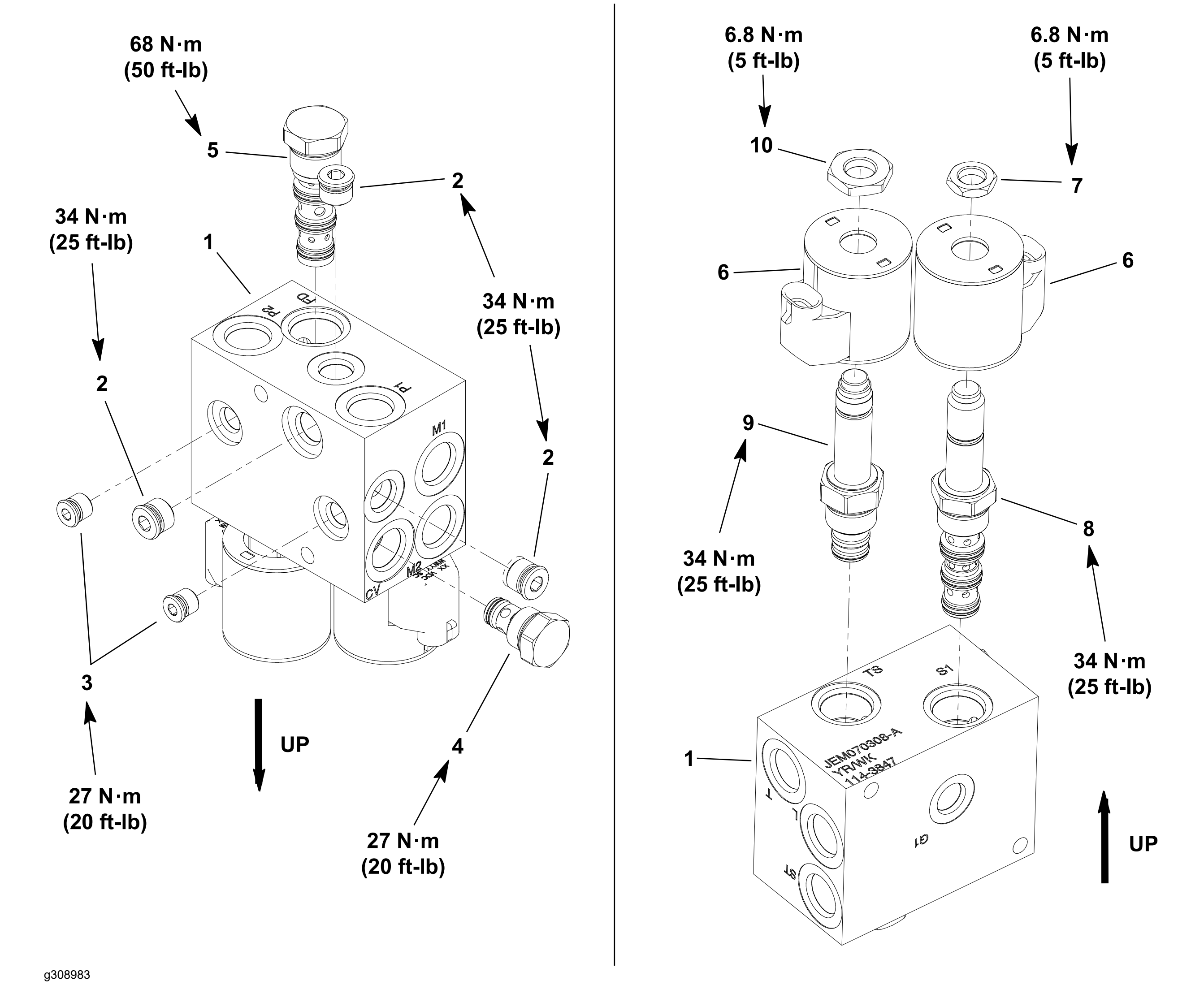

Figure 141

1. Manifold body
2. Zero leak plug (#6) (3 used)
3. Zero leak plug (#4) (2 used)
4. Check valve (port CV)
5. Flow divider cartridge (port FD)
6. Solenoid coil (2 used)
7. Nut
8. Solenoid valve (port S1)
9. Proportional relief cartridge (port TS)
10. Nut

Note: The ports on the fan control manifold are marked for easy identification of components (e.g. ST is the supply to the steering control valve and FD is the location of the flow divider cartridge valve). See Appendix A (page A–1) to identify the function of the hydraulic lines and cartridge valves at each port location.

For solenoid and control valve service procedures, see Deck Control Manifold Service (GM4500-D) (page 5–134). Refer to Figure 141 for cartridge valve and plug installation torque.

Note: The fan control manifold includes several zero leak plugs. These plugs have a tapered sealing surface on the plug head that is designed to resist vibration induced plug loosening. The zero leak plugs also have an O-ring as a secondary seal. If zero leak plug removal is necessary, lightly rap the plug head using a punch and hammer before using an allen wrench to remove the plug: the impact will allow plug removal with less chance of damage to the socket head of the plug.

Lift Control Manifold

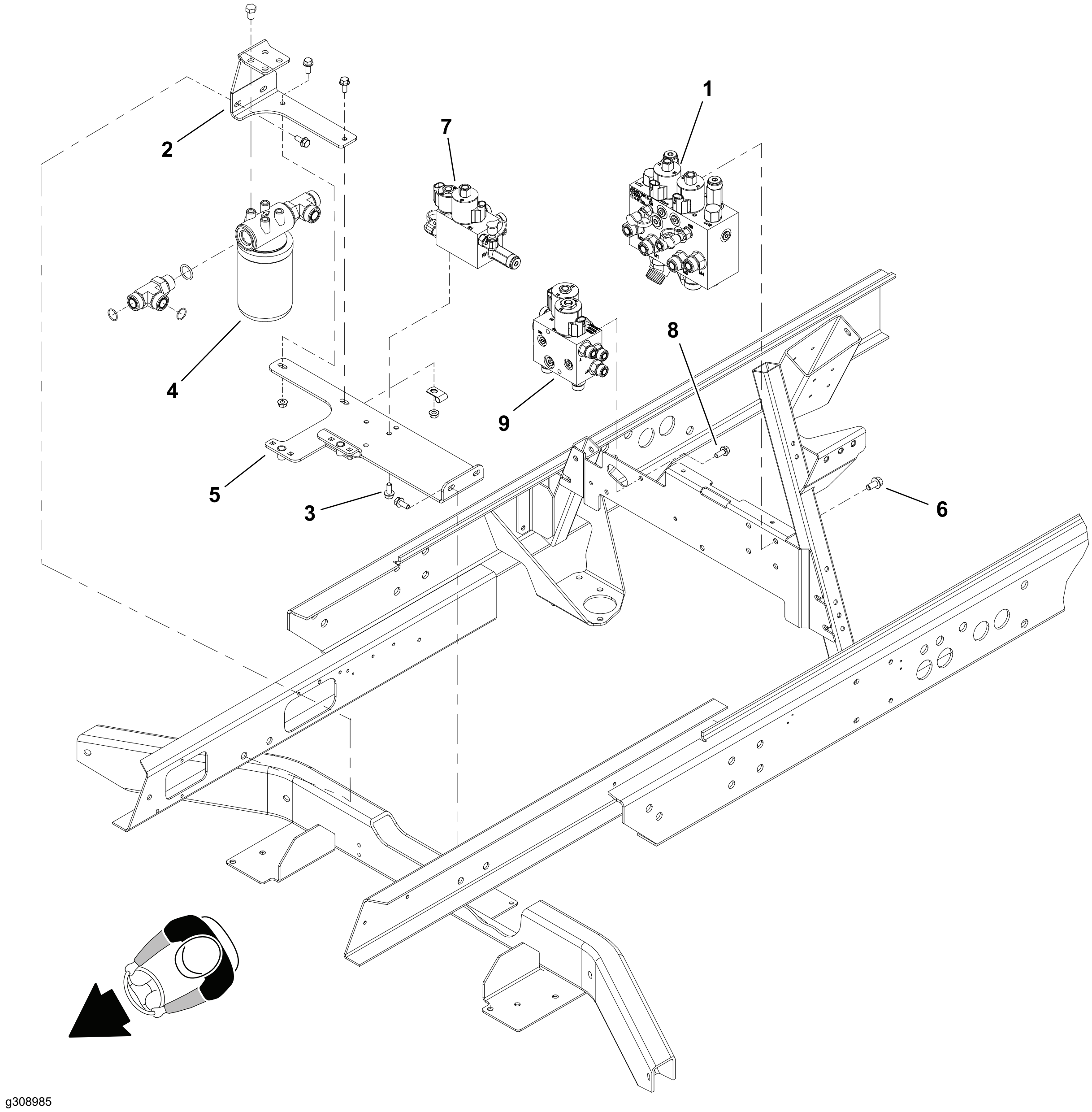

Figure 142

GROUNDSMASTER 4500-D SHOWN

1. Deck control manifold
2. Filter mount bracket
3. Flange head screw (2 used)
4. Hydraulic oil filter assembly
5. Valve mount bracket
6. Flange head screw (2 used)
7. Lift control manifold
8. Flange head screw (2 used)
9. Fan drive manifold

Note: The lift control manifolds used on Groundsmaster 4500-D and 4700-D machines are different but they mount to the machine in the same location. The Groundsmaster 4500-D control manifolds are shown in Figure 142.

Note: The ports on the lift control manifold are marked for easy identification of components. Example: P1 is the gear pump connection port (see Appendix A (page A–1) to identify the function of the hydraulic lines and cartridge valves at each port).

Removal (Figure 142)

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

IMPORTANT

To prevent unexpected deck lowering, make sure that cutting decks are fully lowered before loosening hydraulic lines from lift manifold.

2. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–86).
3. Raise and support the operator seat.
4. To prevent contamination of hydraulic system during manifold removal, thoroughly clean exterior of manifold.
5. Label wire harness electrical connectors that attach to manifold solenoid coils. Disconnect wire harness electrical connectors from the solenoid valve coils.

WARNING

Make sure that cutting decks are fully lowered before loosening hydraulic lines from lift manifold. If decks are raised as hydraulic lines are loosened, decks may drop unexpectedly.

6. Disconnect hydraulic lines from manifold and put caps or plugs on open hydraulic lines and fittings. Label disconnected hydraulic lines for proper assembly.

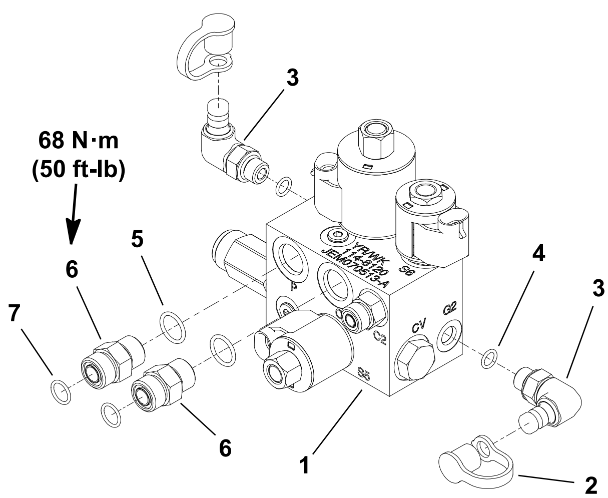

Figure 143
GROUNDSMASTER 4500-D

1. Lift manifold (GM4500-D)
2. Dust cap
3. Test fitting (2 used)
4. O-ring
5. O-ring
6. Straight fitting (2 used)
7. O-ring

Removal (Figure 142) (continued)

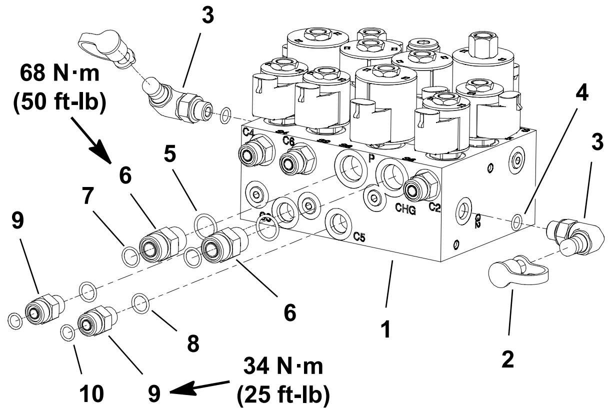

Figure 144

GROUNDSMASTER 4700-D

1. Lift manifold (GM4700-D)
2. Dust cap
3. Test fitting (2 used)
4. O-ring
5. O-ring
6. Straight fitting (2 used)
7. O-ring
8. O-ring
9. Straight fitting (2 used)
10. O-ring

---

7. Remove hydraulic manifold from the frame using Figure 142 as guide.
8. If hydraulic fittings are to be removed from lift control manifold, mark fitting orientation to allow correct assembly (Figure 143 or Figure 144). Remove fittings from manifold and discard O-rings.

Installation (Figure 142)

1. If fittings were removed from lift 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 5–9)). Refer to Figure 143 or Figure 144 for fitting installation torque.
2. Install hydraulic manifold to the frame using Figure 142 as guide.
3. Remove caps and plugs from fittings and hoses. Properly connect hydraulic lines to manifold (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–7)).
4. Connect wire harness electrical connectors to the solenoid valve coils.
5. Lower and secure operator seat.

Lift Control Manifold Service (GM4500-D)

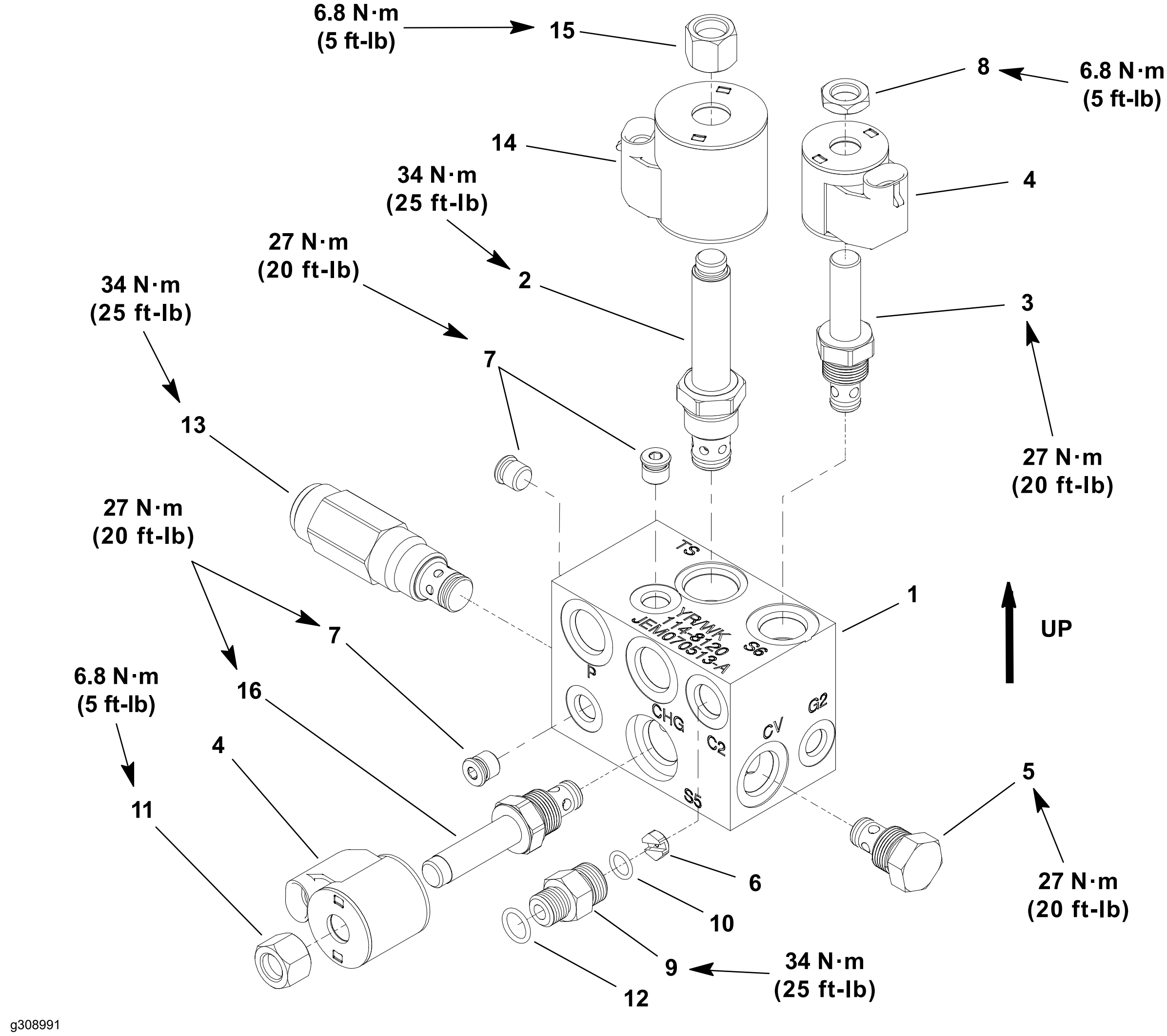

Figure 145

1. Manifold body
2. Proportional relief valve (port TS)
3. Solenoid valve (port S6)
4. Solenoid coil (2 used)
5. Check valve (port CV)
6. Orifice (0.080)
7. Zero leak plug (#4)
8. Nut
9. Straight fitting
10. O-ring
11. Nut
12. O–ring
13. Relief valve (port RV)
14. Solenoid coil
15. Nut
16. Solenoid valve (port S5)

Note: The ports on the lift control manifold are marked for easy identification of components (e.g. P is the supply connection port and R7 is the location for the lift relief valve). See Appendix A (page A–1) to identify the function of the hydraulic lines and cartridge valves at each port location.

Note: The lift control manifold includes several zero leak plugs. These plugs have a tapered sealing surface on the plug head that is designed to resist vibration induced plug loosening. The zero leak plugs also have an O-ring as a secondary seal. If zero leak plug removal is necessary, lightly rap the plug head using a punch and hammer before using an allen wrench to remove the plug: the impact will allow plug removal with less chance of damage to the socket head of the plug.

Lift Control Manifold Service (GM4500-D) (continued)

WARNING

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

For solenoid and control valve service procedures, see Deck Control Manifold Service (GM4500-D) (page 5–134). Refer to Figure 145 for cartridge valve and plug installation torque.

IMPORTANT

A flow control orifice (item 6) is placed beneath the hydraulic fitting in lift control manifold port C2. If this fitting is removed from the manifold, make sure to remove orifice and label its position for assembly purposes. Also note location of groove in orifice for assembly purposes. When installing the orifice in the manifold, make sure that the orifice is flat in the base of the port. Manifold damage is possible if the orifice is cocked in the port.

Lift Control Manifold Service (GM4700-D)

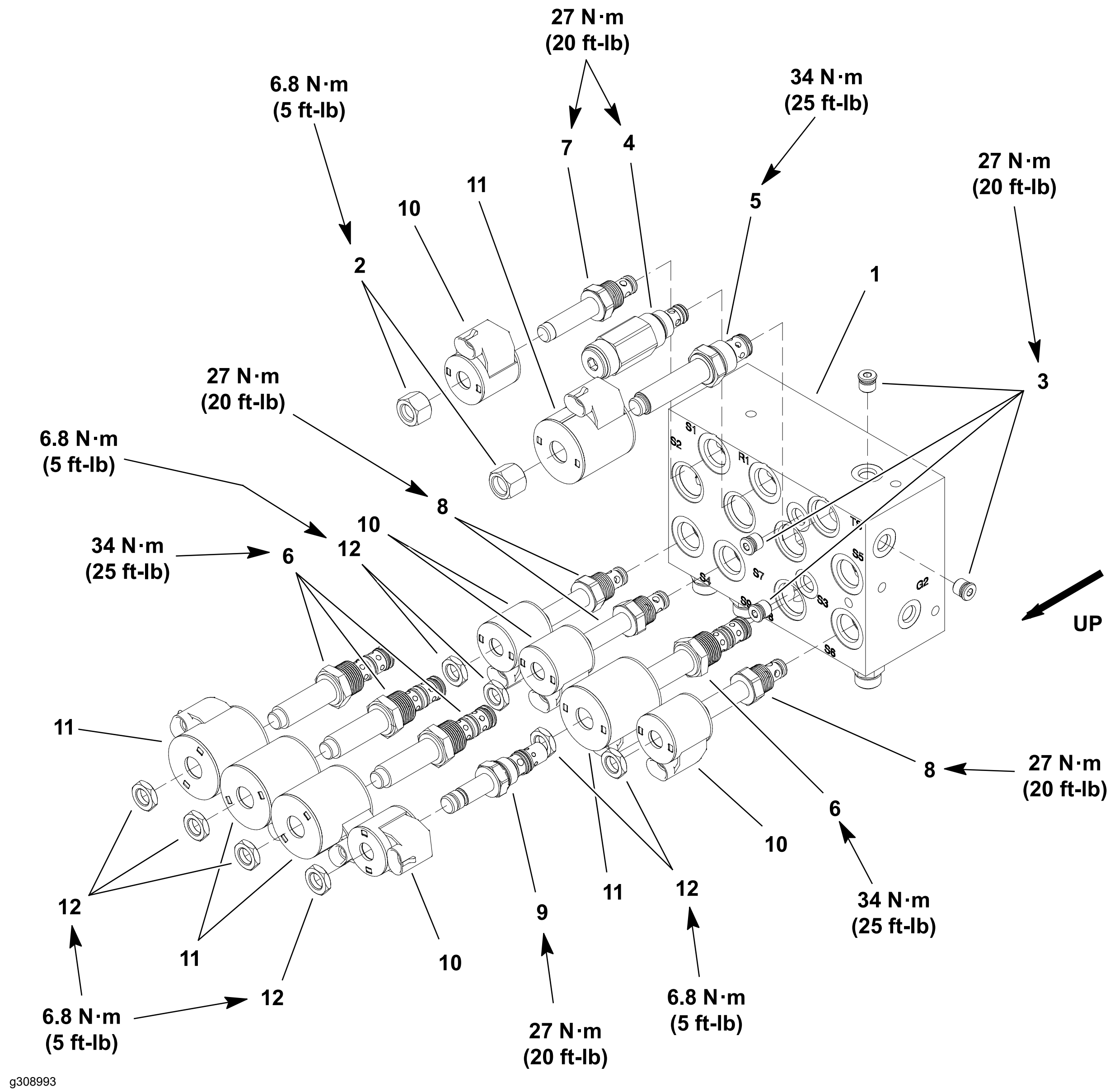

Figure 146

1.	Manifold body	5.	Proportional relief valve (port TS)	9.	Solenoid valve (port S5)
2.	Nut	6.	Solenoid valve (ports S2, S3, S7, S8)	10.	Solenoid coil (5 used)
3.	Zero leak plug (#4)	7.	Solenoid valve (port S1)	11.	Solenoid coil (5 used)
4.	Relief valve (port R1)	8.	Solenoid valve (ports S4, S6, S9)	12.	Nut

Note: The ports on the lift control manifold are marked for easy identification of components (e.g. P is the gear pump connection port and R1 is the relief valve port). See Appendix A (page A–1) to identify the function of the hydraulic lines and cartridge valves at each port location.

Note: The lift control manifold uses several zero leak plugs. These plugs have a tapered sealing surface on the plug head that is designed to resist vibration induced plug loosening. The zero leak plugs also have an O-ring as a secondary seal. If zero leak plug removal is necessary, lightly rap the plug head using a punch and hammer before using an allen wrench to remove the plug: the impact will allow plug removal with less chance of damage to the socket head of the plug.

Lift Control Manifold Service (GM4700-D) (continued)

WARNING

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

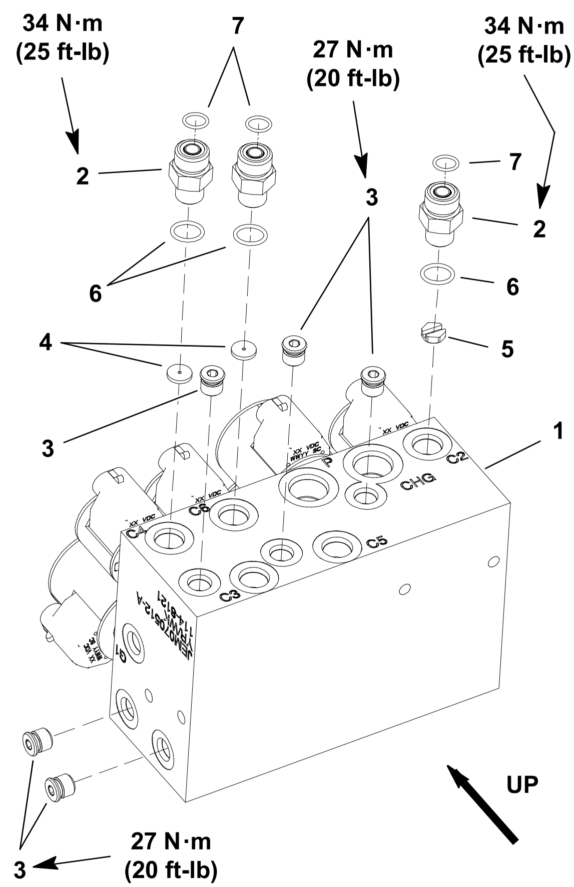

Figure 147

1. Manifold body
2. Straight fitting (3 used)
3. Zero leak plug (#4)
4. Orifice (0.063)
5. Orifice (0.080)
6. O-ring
7. O-ring

For solenoid and control valve service procedures, see Deck Control Manifold Service (GM4500-D) (page 5–134). Refer to Figure 146 and Figure 147 for cartridge valve and plug installation torque.

IMPORTANT

A flow control orifice is placed beneath several of the hydraulic fittings on the lift control manifold (Figure 147). The lift manifold uses two (2) different orifice sizes. If a fitting is removed from the lift control manifold and an orifice is in the manifold port, make sure to remove orifice and label its position for assembly purposes. Also note location of groove in orifice for assembly purposes.

IMPORTANT

When installing orifice in manifold (Figure 147), make sure that orifice is flat in the base of the manifold port. Manifold damage is possible if the orifice is cocked in the cavity.

Lift Circuit Junction Manifold

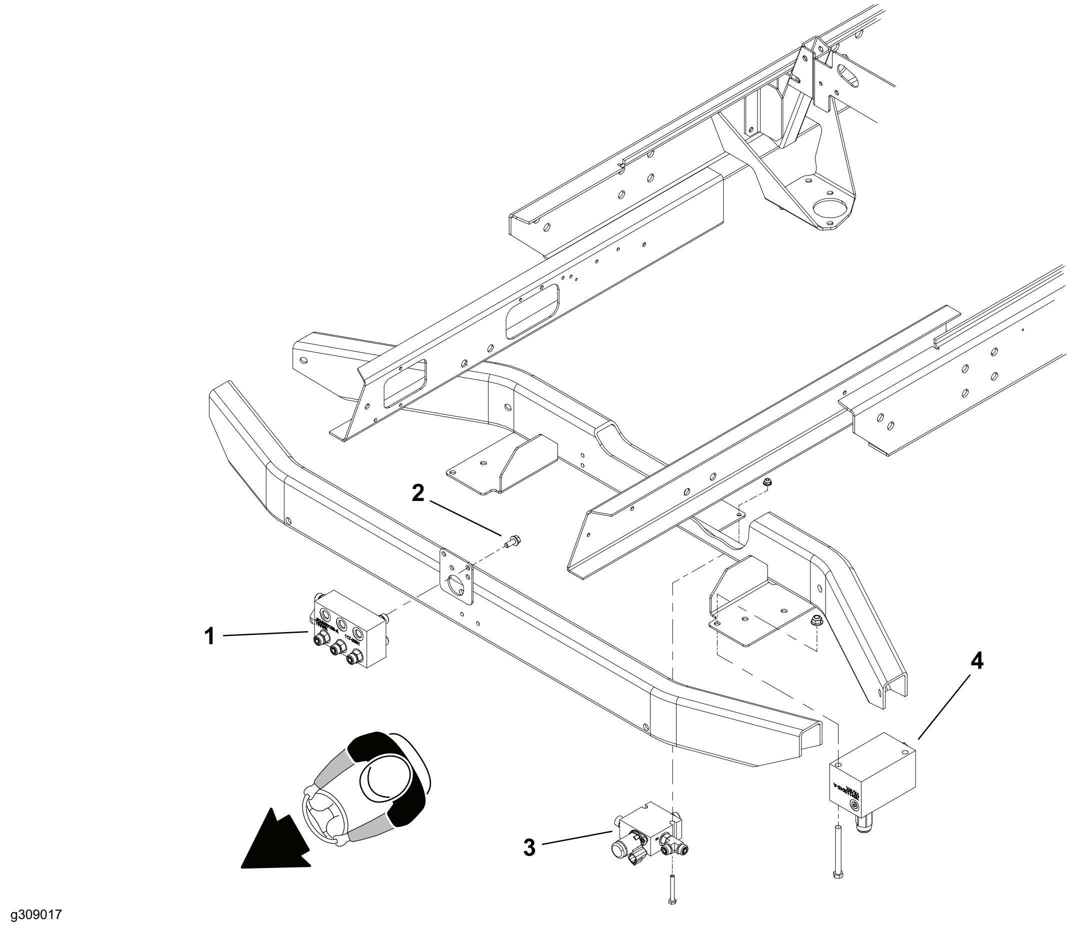

Figure 148

1. Lift circuit junction manifold
2. Flange head screw (2 used)
3. Two speed shift manifold
4. Rear traction control manifold

Removal (Figure 148)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.
2. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–86).
3. To prevent contamination of hydraulic system during manifold removal, thoroughly clean exterior of manifold.

WARNING

Make sure that cutting decks are fully lowered before loosening hydraulic lines from lift circuit junction manifold. If decks are raised as hydraulic lines are loosened, decks may drop unexpectedly.

Note: Upper three (3) hydraulic hoses on the front of the junction manifold thread into manifold ports. Loosen or remove opposite end of these hoses at lift cylinder fittings to allow hose removal from the manifold.

4. Disconnect hydraulic lines from manifold and put caps or plugs on open hydraulic lines and fittings. Label disconnected hydraulic lines for proper assembly.

Removal (Figure 148) (continued)

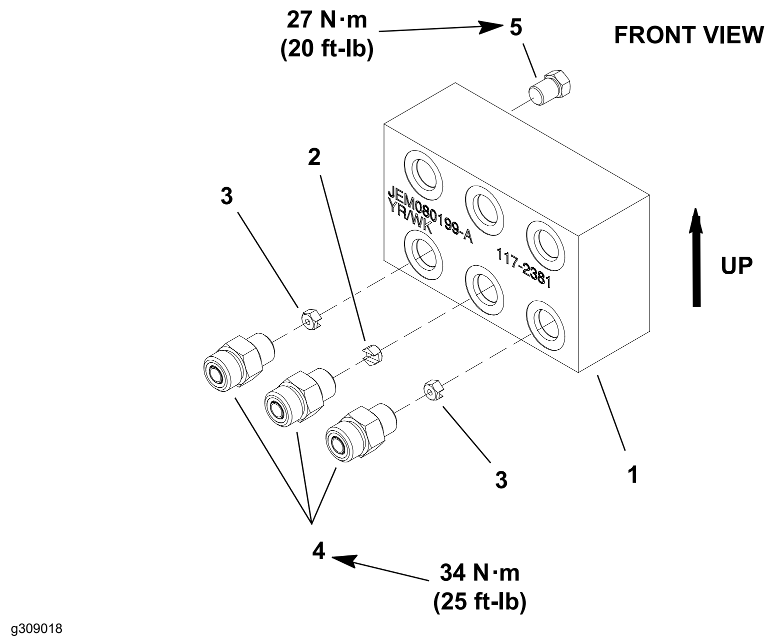

Figure 149

1. Manifold body
2. Orifice (0.055)
3. Orifice (0.030)
4. Straight fitting (3 used)
5. Zero leak plug

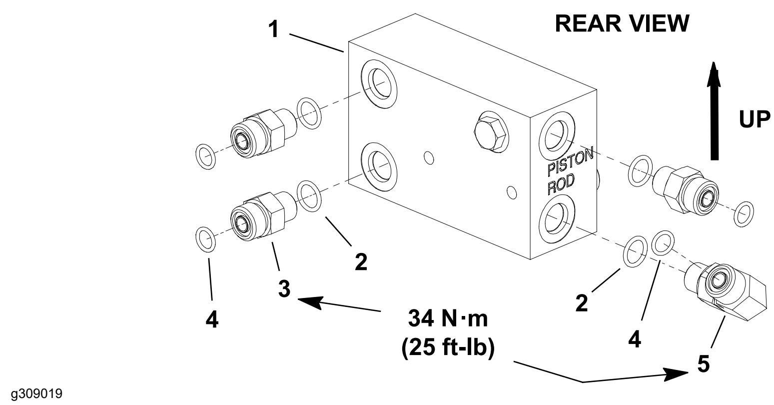

Figure 150

1. Manifold body
2. O-ring
3. Straight fitting (3 used)
4. O-ring
5. 90º hydraulic fitting

5. Remove hydraulic manifold from the frame using Figure 148 as guide.

IMPORTANT

A flow control orifice is placed beneath several of the hydraulic fittings on the lift circuit junction manifold (Figure 149). The manifold uses two (2) different orifice sizes. If a fitting is removed from the lift junction manifold and an orifice is in the manifold port, make sure to remove orifice and label its position for assembly purposes. Also note location of groove in orifice for assembly purposes.

Removal (Figure 148) (continued)

6. If necessary, remove fittings from manifold and discard O-rings (Figure 149 and Figure 150).

Installation (Figure 148)

IMPORTANT

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

1. If fittings were removed from junction manifold, lubricate and place new O-rings onto fittings. Install fittings into manifold openings making sure that orifice is correctly placed before threading fitting into manifold. Tighten fittings (see Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–9)). Refer to Figure 149 and Figure 150 for fitting installation torque.
2. Install hydraulic manifold to the frame using Figure 148 as guide.
3. Remove caps and plugs from fittings and hydraulic lines. Properly connect hydraulic lines to manifold (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–7)).

Lift Cylinders: Decks #1, #4 and #5

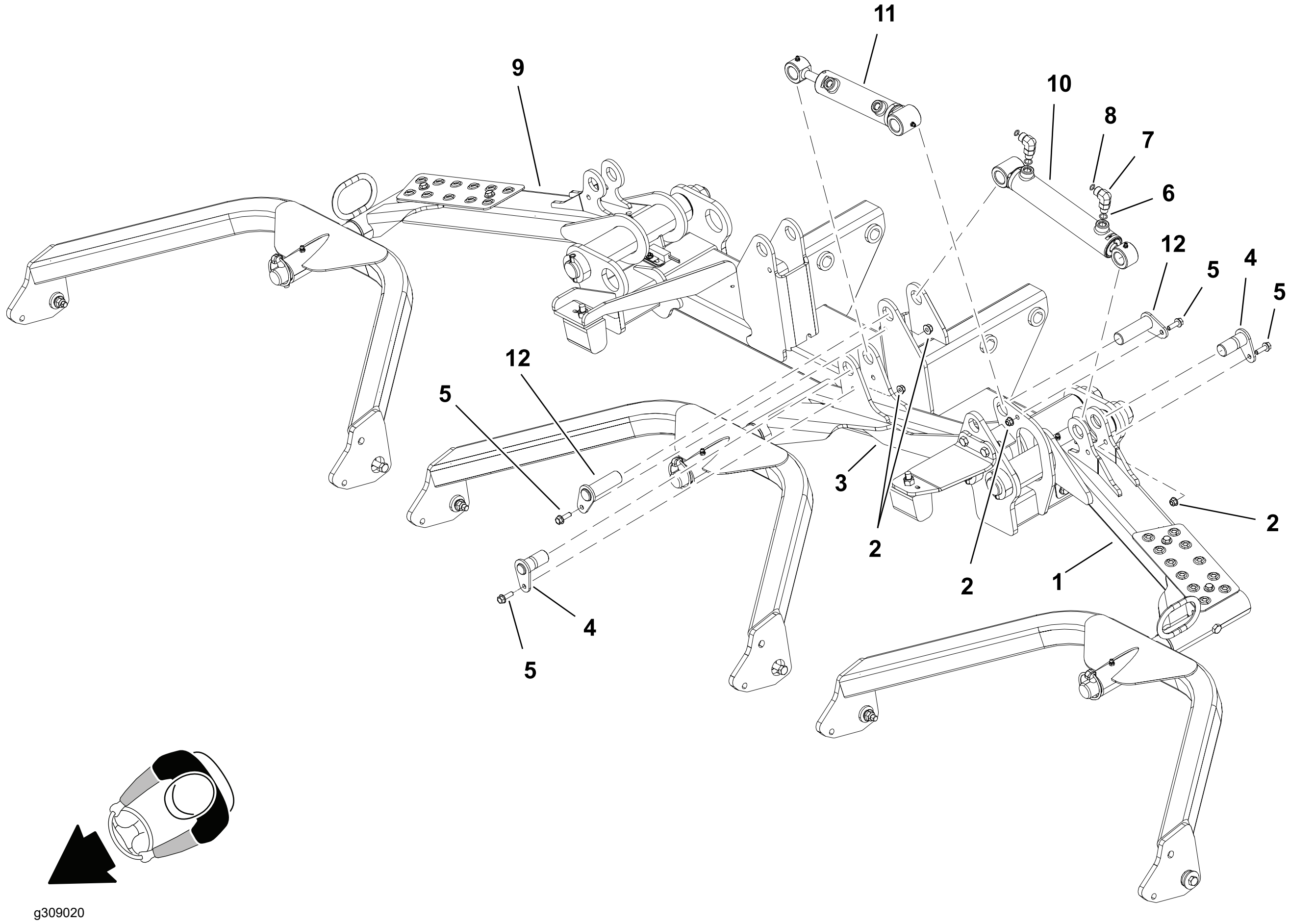

Figure 151

1.	Lift arm (deck #4)	5.	Flange head screw	9.	Lift arm (deck #5)
2.	Flange nut	6.	O-ring	10.	Lift cylinder (decks #4 and #5)
3.	Lift arm (deck #1)	7.	90º hydraulic fitting (2 per cylinder)	11.	Lift cylinder (deck #1)
4.	Cylinder pin (3 used)	8.	O-ring	12.	Cylinder pin (3 used)

Note: The lift cylinders for deck 1 and 4 are shown in Figure 151. The lift cylinder for deck 5 is identical to the cylinder for deck 4.

Removal (Figure 151)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.
2. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–86).
3. To prevent contamination of hydraulic system during lift cylinder removal, thoroughly clean exterior of lift cylinder.

WARNING

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

Removal (Figure 151) (continued)

4. Disconnect hydraulic hoses from lift cylinder. Put caps or plugs on open hoses and fittings to prevent system contamination. Label disconnected hydraulic hoses for proper assembly.
5. Remove flange nut and flange head screw that secure the cylinder pin (item 4) to the lift arm. Remove pin from lift arm and cylinder shaft clevis which will free lift cylinder from lift arm.
6. Remove flange nut and flange head screw that secure the cylinder pin (item 12) to the frame. Pull pin from frame and cylinder barrel clevis.

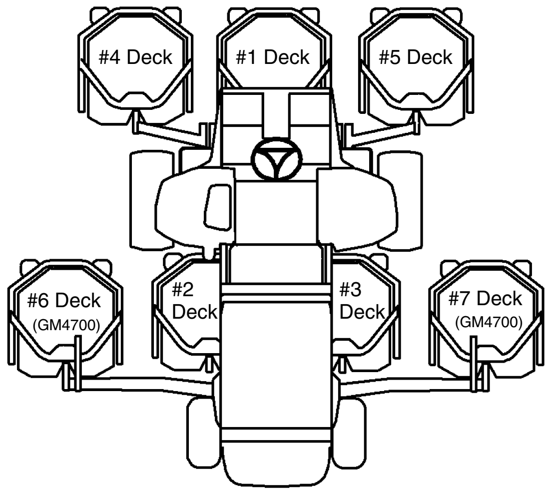

Figure 152
CUTTING DECK LOCATIONS

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

   Note: For lift cylinder disassembly and assembly procedures, see Lift Cylinder Service (page 5–173).

Installation (Figure 151)

1. If fittings were removed from lift cylinder, lubricate and place new O-rings onto 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 5–9)).
2. Position cylinder barrel clevis to frame and insert cylinder pin (item 12) into frame and clevis. Secure pin with flange nut and flange head screw.
3. Insert cylinder pin (item 4) through lift arm and cylinder shaft clevis. Secure pin to lift arm with flange nut and flange head screw.
4. Remove caps and plugs from hydraulic hoses and fittings. Attach hydraulic hoses to lift cylinder (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–7)).
5. Fill reservoir with hydraulic fluid as required.
6. Lubricate lift cylinder grease fittings.
7. After assembly is completed, operate lift cylinder to verify that lift cylinder, hydraulic hoses and fittings do not contact any machine components during operation.

Lift Cylinders: Decks #2 and #3

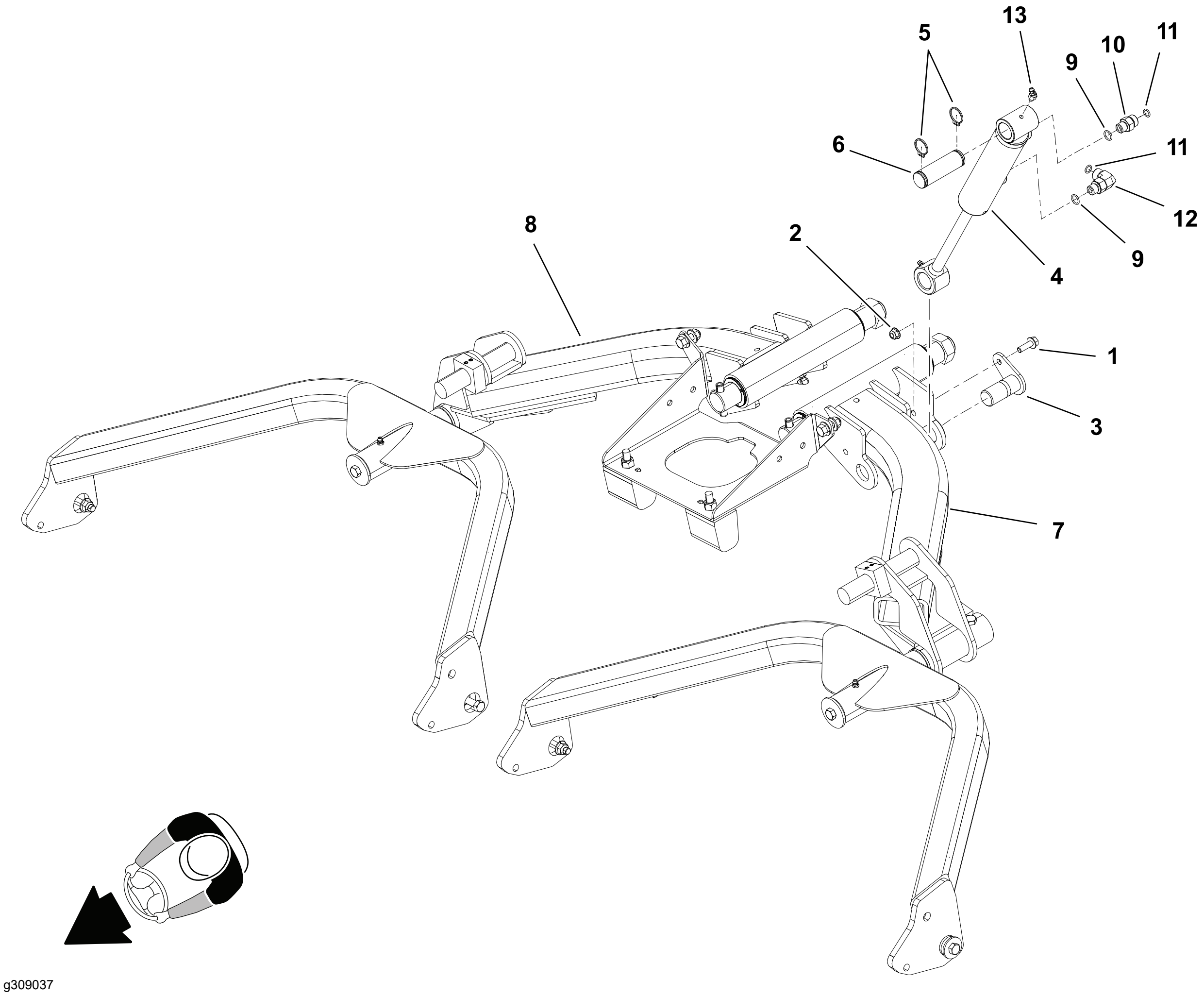

Figure 153

1. Flange head screw
2. Flange nut
3. Cylinder pin
4. Lift cylinder
5. Retaining ring
6. Cylinder pin
7. Lift arm (deck #2)
8. Lift arm (deck #3)
9. O-ring
10. Hydraulic fitting
11. O-ring
12. 90º hydraulic fitting
13. Grease fitting

Removal (Figure 153)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.
2. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–86).
3. To prevent contamination of hydraulic system during lift cylinder removal, thoroughly clean exterior of lift cylinder.

WARNING

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

Removal (Figure 153) (continued)

4. Disconnect hydraulic hoses from lift cylinder. Put caps or plugs on open hydraulic hoses and fittings to prevent system contamination. Label the hydraulic hoses to show their correct position on the lift cylinder for assembly purposes.
5. Remove flange head screw and flange nut that secure the cylinder pin (item 3) to the lift arm. Remove pin from lift arm and cylinder shaft clevis.
6. Remove one (1) retaining ring from the cylinder pin (item 6). Remove cylinder pin from the frame and cylinder barrel clevis.

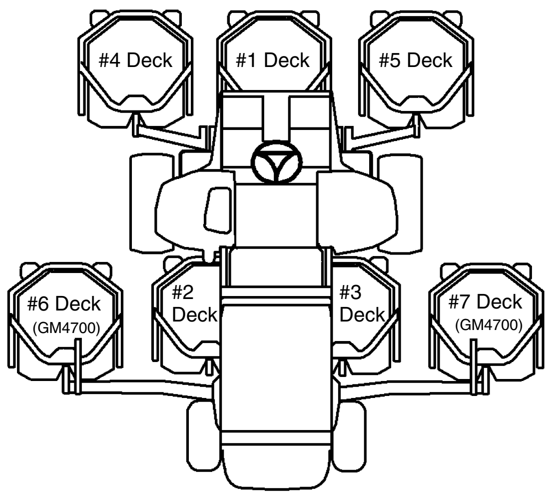

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Figure 154
CUTTING DECK LOCATIONS

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

   Note: For lift cylinder disassembly and assembly procedures, see Lift Cylinder Service (page 5–173).

Installation (Figure 153)

1. If fittings were removed from lift cylinder, lubricate and place new O-rings onto 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 5–9)).
2. Position cylinder barrel clevis to frame and insert cylinder pin (item 6) with one (1) retaining ring installed through the frame and cylinder clevis. Secure pin with second retaining ring.
3. Insert cylinder pin (item 3) through the lift arm and cylinder shaft clevis. Secure pin to lift arm with flange head screw and flange nut.
4. Remove caps and plugs from hydraulic hoses and fittings. Attach hoses to lift cylinder (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–7)).
5. Fill reservoir with hydraulic fluid as required.
6. Lubricate lift cylinder grease fittings.
7. After assembly is completed, operate lift cylinder to verify that lift cylinder, hydraulic hoses and fittings do not contact any machine components during operation.

Lift Cylinders: Decks #6 and #7 (GM4700-D)

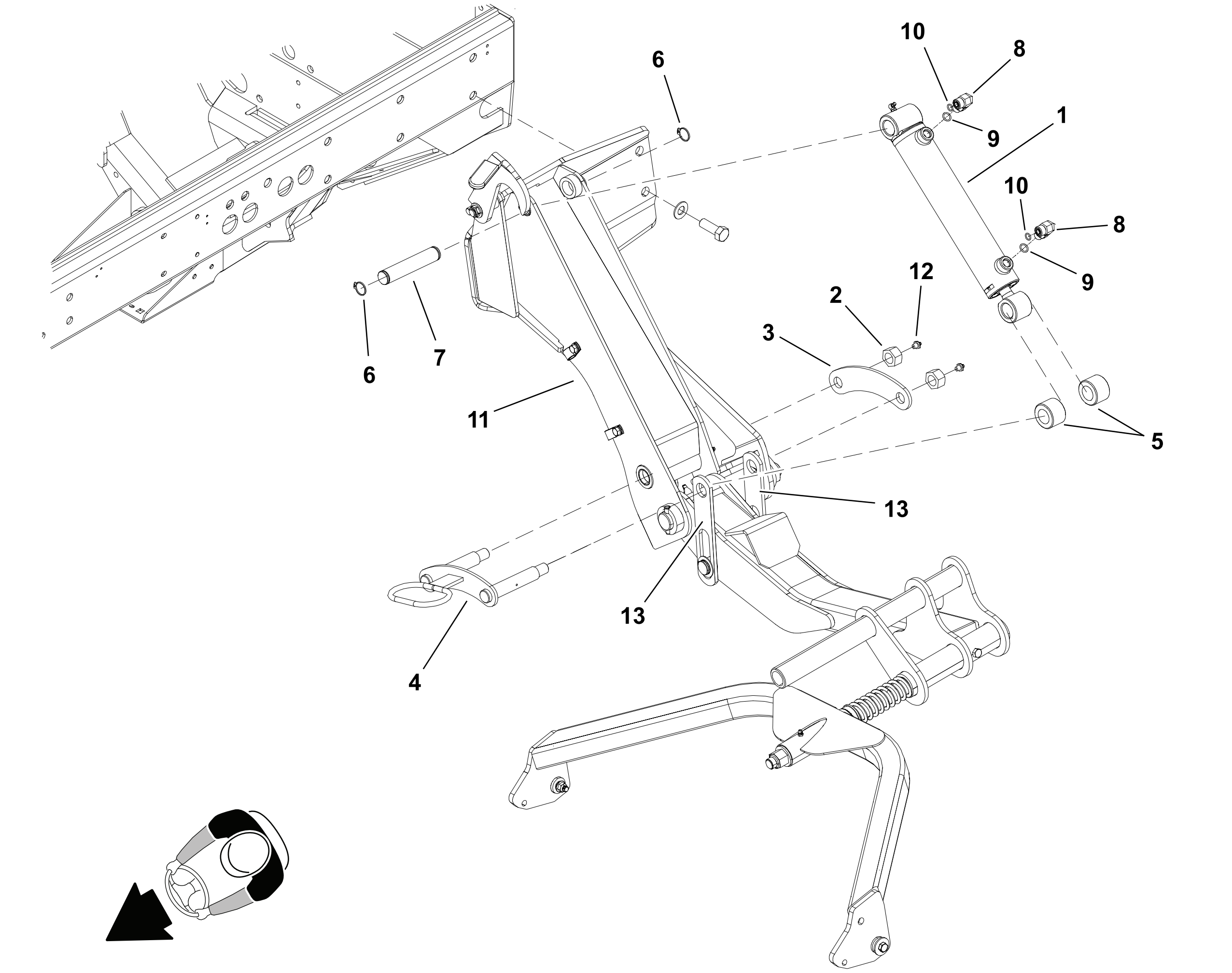


Figure 155

1.	Lift cylinder	6.	Retaining ring	11.	Lift arm assembly (deck #6 shown)
2.	Lock nut (2 used per side)	7.	Cylinder pin	12.	Grease fitting
3.	Rear link	8.	90° hydraulic fitting	13.	Lift link
4.	Link assembly	9.	O-ring		
5.	Plastic roller	10.	O-ring		

Removal (Figure 155)

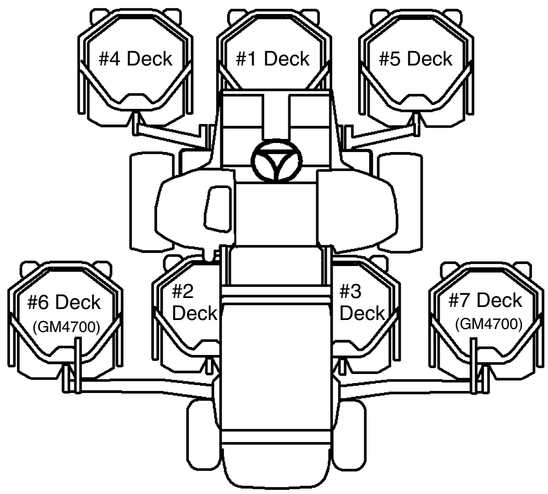
1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.
2. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–86).
3. To prevent contamination of hydraulic system during lift cylinder removal, thoroughly clean exterior of lift cylinder.

WARNING

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

Removal (Figure 155) (continued)

4. Disconnect hydraulic hoses from lift cylinder. Put caps or plugs on open hydraulic hoses and fittings to prevent system contamination. Label the hydraulic hoses to show their correct position on the lift cylinder for assembly purposes.
5. Remove lock nuts (item 2) that secure link assembly (item 4). Remove rear link (item 3) from link assembly. Pull link assembly from lift arm assembly, lift links (item 13) and cylinder shaft clevis which will free lift cylinder from lift arm. Locate and remove plastic rollers (item 5) positioned on both sides of cylinder clevis.
6. Remove one retaining ring that secures the cylinder pin (item 7) to the lift arm support. Pull pin from lift arm and cylinder barrel clevis.



g308386

Figure 156
CUTTING DECK LOCATIONS

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

   Note: For lift cylinder disassembly and assembly procedures, see Lift Cylinder Service (page 5–173).

Installation (Figure 155)

1. If fittings were removed from lift cylinder, lubricate and place new O-rings onto 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 5–9)).
2. Position cylinder barrel clevis to lift arm and insert cylinder pin (item 7) into lift arm support and cylinder clevis. Secure pin with retaining ring (item 6).Make sure that retaining ring is fully installed in groove in pin.
3. Position plastic rollers (item 5) to cylinder shaft clevis. Insert link assembly (item 4) through lift arm assembly, lift links (item 13), plastic rollers and cylinder shaft clevis. Install rear link (item 3) to link assembly and secure assembly with lock nuts (item 2).
4. Remove caps and plugs from hydraulic hoses and fittings. Attach hoses to lift cylinder fittings (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–7)).
5. Fill reservoir with hydraulic fluid as required.

Installation (Figure 155) (continued)

6. Lubricate lift cylinder grease fittings.
7. After assembly is completed, operate lift cylinder to verify that lift cylinder, hydraulic hoses and fittings do not contact any machine components during operation.

Lift Cylinder Service

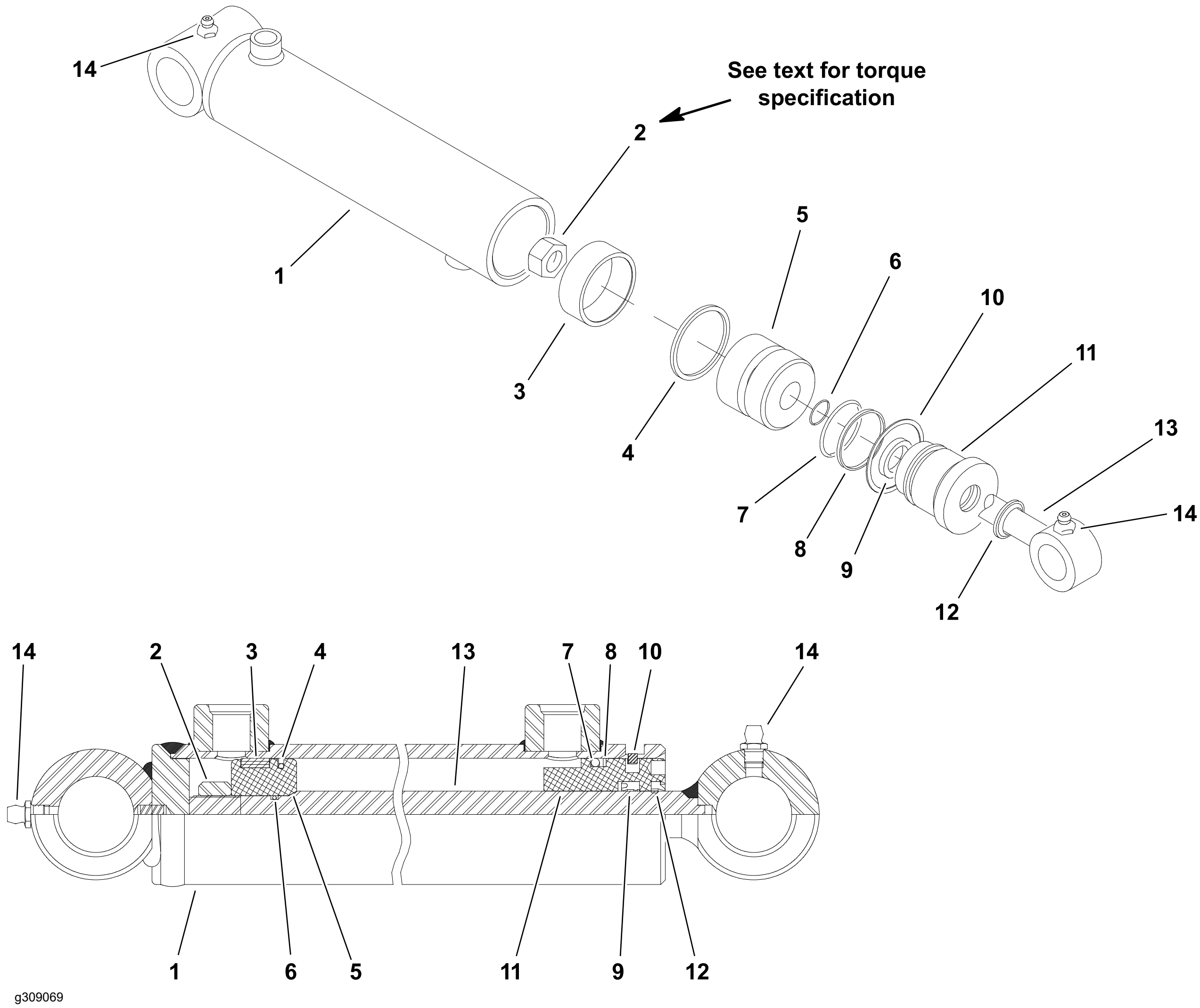


Figure 157

1. Tube assembly	6. O–ring	11. Head
2. Lock nut	7. O–ring	12. Wiper
3. Wear ring	8. Back–up ring	13. Rod assembly
4. Seal	9. Seal	14. Grease fitting (2 used)
5. Piston	10. Retaining ring	

Note: The lift cylinders used on the Groundsmaster are all very similar regardless of the location on the machine. The lift cylinders used on Groundsmaster 4700-D #6 and #7 lift arms have a 19 mm (0.750 in) diameter rod. All other lift cylinders used on Groundsmaster 4500-D and 4700-D have a 16 mm (0.630 in) diameter rod. The disassembly and assembly procedure is the same for all lift cylinders.

Disassembly (Figure 157)

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

Disassembly (Figure 157) (continued)

IMPORTANT

Prevent damage when clamping the cylinder in a vise; clamp on the clevis only. Do not close vise enough to distort the barrel.

2. Mount lift cylinder securely in a vise by clamping on the clevis end of the barrel. Use of a vise with soft jaws is recommended.
3. Loosen head from barrel:
   A. Use a spanner wrench to rotate head clockwise until the edge of the retaining ring appears in the barrel opening.
   B. Insert a screwdriver under the beveled edge of the retaining ring to start the retaining ring through the opening.
   C. Rotate the head counter-clockwise to remove retaining ring from barrel and head.
4. Extract shaft with head and piston by carefully twisting and pulling on the shaft.

IMPORTANT

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

5. Mount shaft securely in a vise by clamping on the clevis of the shaft. Remove lock nut and piston from the shaft. Slide head off the shaft.
6. Remove and discard all seals and O-rings from the piston and the head.
7. Wash parts in clean solvent. Dry parts with compressed air. Do not wipe parts dry with paper towels or cloth. Lint in a hydraulic system will cause damage.
8. Carefully inspect internal surface of barrel for damage (deep scratches, out-of-round, etc.). Replace entire cylinder if barrel is damaged. Inspect piston rod and piston for evidence of excessive scoring, pitting or wear. Replace any damaged parts.

Assembly (Figure 157)

1. Make sure all cylinder components are clean before assembly.
2. Coat new seal kit components with clean hydraulic oil.
   A. Install new seals and O-rings to the piston.
   B. Install new seals, O-ring and back-up seal to the head.
3. Coat shaft with clean hydraulic oil. Carefully slide head and piston onto the shaft.

IMPORTANT

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

4. Mount shaft securely in a vise by clamping on the clevis of the shaft. Secure piston to shaft with lock nut.

Assembly (Figure 157) (continued)

A. If rod diameter is 16 mm (0.630 in), torque lock nut from **41 to 47 N·m (30 to 35 ft-lb)**.

B. If rod diameter is 19 mm (0.750 in), torque lock nut from **82 to 94 N·m (60 to 70 ft-lb)**.

5. Lubricate head and piston with hydraulic oil. Carefully slide shaft assembly into cylinder barrel.

IMPORTANT

Prevent damage when clamping the cylinder's barrel into a vise; clamp on the clevis only. Do not close vise enough to distort the barrel.

6. Mount lift cylinder in a vise with soft jaws. Secure head in barrel:

   A. Align retaining ring hole in the head with the access slot in the barrel.

   B. Insert the retaining ring hook into the hole and rotate head clockwise until the retaining ring is completely pulled into the barrel and the ring ends are covered.

   C. Apply silicone sealer to barrel access slot.

Hydraulic Reservoir

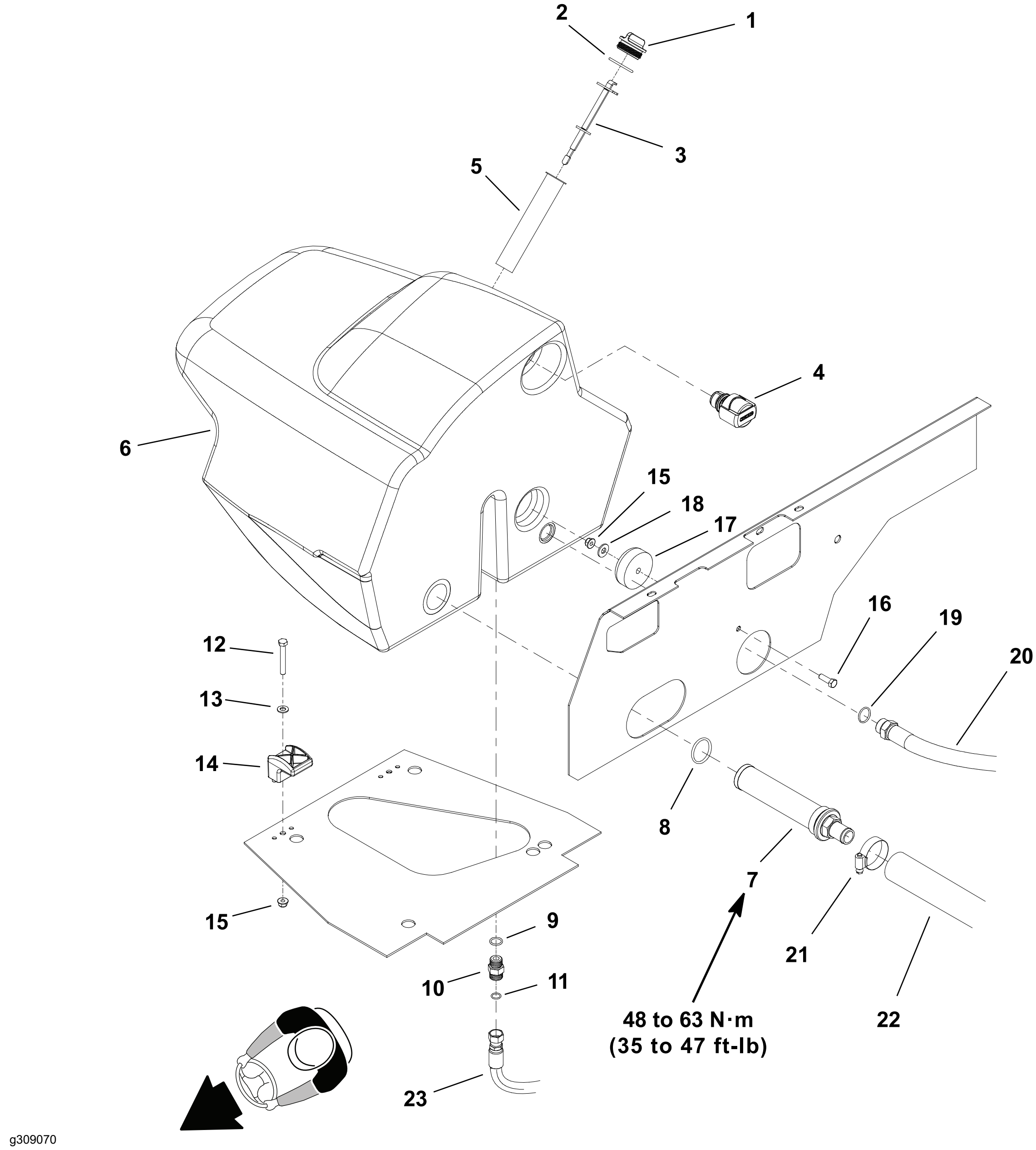


Figure 158

1. Plug
2. O-ring
3. Dipstick
4. Breather
5. Screen filter
6. Hydraulic reservoir
7. Reservoir strainer
8. O-ring
9. O-ring
10. Straight hydraulic fitting
11. O-ring
12. Cap screw (2 used)
13. Flat washer (2 used)
14. Clamp (2 used)
15. Flange nut (3 used)
16. Cap screw
17. Bumper
18. Flat washer
19. O-ring
20. Hydraulic hose
21. Hose clamp
22. Suction hose
23. Hydraulic hose

Removal (Figure 158)

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

Removal (Figure 158) (continued)

2. Read the General Precautions for Removing and Installing Hydraulic System Components (page 5–86).
3. To prevent contamination of hydraulic system during hydraulic reservoir removal, thoroughly clean exterior of reservoir.
4. To allow draining of hydraulic reservoir, disconnect the hydraulic hose (item 23) from the fitting in the bottom of the reservoir. Drain reservoir into a suitable container.
5. Disconnect remaining hydraulic hoses from reservoir. Label the hydraulic hoses to show their correct position on the reservoir for assembly purposes.
6. Remove hydraulic reservoir using Figure 158 as a guide.
7. If necessary, remove fittings from reservoir and discard O-rings.

Inspection

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

Installation (Figure 158)

1. If fittings were removed from reservoir, lubricate and place new O-rings onto fittings. Install fittings into reservoir openings. If reservoir strainer (item 7) was removed from reservoir, torque strainer from **48 to 63 N·m (35 to 47 ft-lb)**.
2. Install reservoir using Figure 158 as a guide.

IMPORTANT

When tightening hoses to reservoir fittings, hold fitting with wrench to prevent over-tightening of fitting and potential reservoir damage.

3. Connect hydraulic hoses to reservoir fittings (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–7)).
4. Fill reservoir with hydraulic fluid to proper level.

Radiator and Oil Cooler Assembly

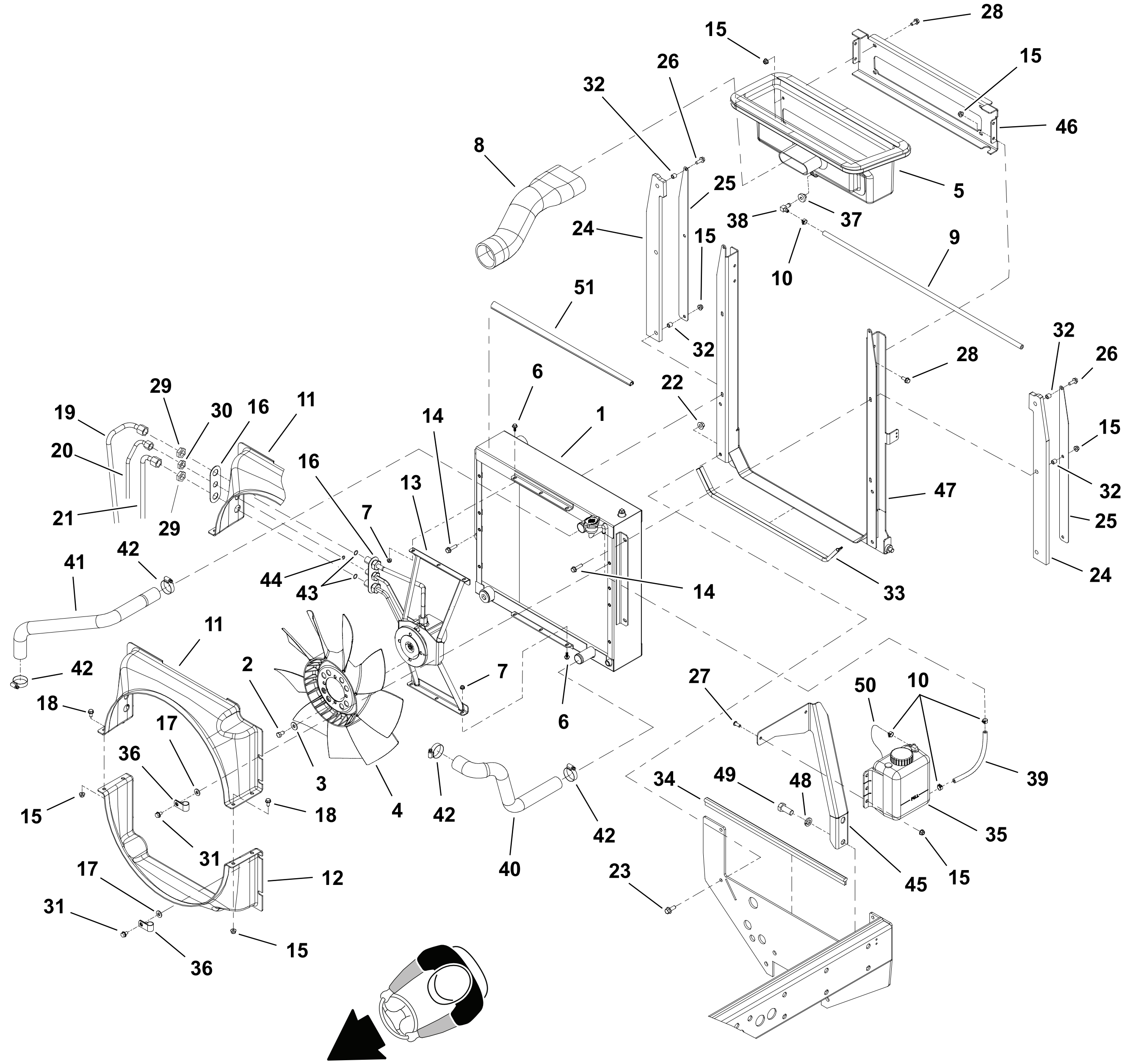


Figure 159

Radiator and Oil Cooler Assembly (continued)

Figure 159 (continued)

1. Radiator/oil cooler assembly
2. Cap screw (4 used)
3. Washer (4 used)
4. Fan
5. Plenum assembly
6. Cap screw (6 used)
7. Flange nut (6 used)
8. Air intake hose
9. Hose
10. Hose clamp (4 used)
11. Upper radiator shroud
12. Lower radiator shroud
13. Fan motor and bracket assembly
14. Flange head screw (4 used)
15. Flange nut (22 used)
16. Shim (2 used)
17. Flat washer (8 used)
18. Flange head screw (4 used)
19. Hydraulic tube
20. Hydraulic tube
21. Hydraulic tube
22. Flange nut (4 used)
23. Flange head screw (4 used)
24. Hood seal (2 used)
25. Hood seal bracket (2 used)
26. Screw (2 used)
27. Screw (2 used)
28. Flange head screw (12 used)
29. Bulkhead nut (2 used)
30. Bulkhead nut
31. Flange head screw (8 used)
32. Spacer (6 used)
33. Bulb seal
34. Bulb seal
35. Coolant reservoir
36. R-clamp (2 used)
37. Bushing
38. Elbow fitting
39. Hose
40. Lower radiator hose
41. Upper radiator hose
42. Hose clamp (4 used)
43. O-ring
44. O-ring
45. Mount bracket
46. Crossover plate
47. Radiator mount
48. Lock washer (2 used)
49. Cap screw (2 used)
50. Hose
51. Bulb seal

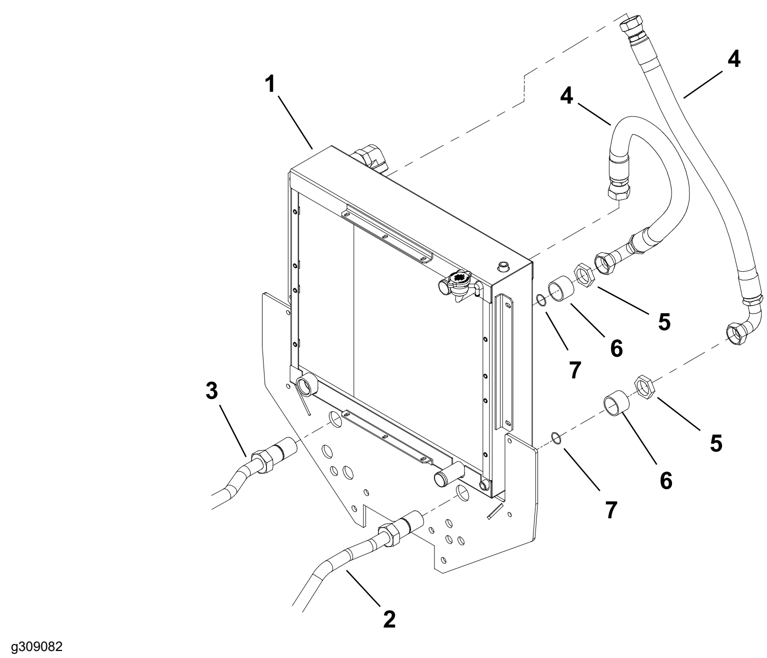


Figure 160

1. Radiator/oil cooler
2. Hydraulic tube
3. Hydraulic tube
4. Hydraulic hose
5. Bulkhead nut
6. Spacer
7. O-ring

Radiator and Oil Cooler Assembly (continued)

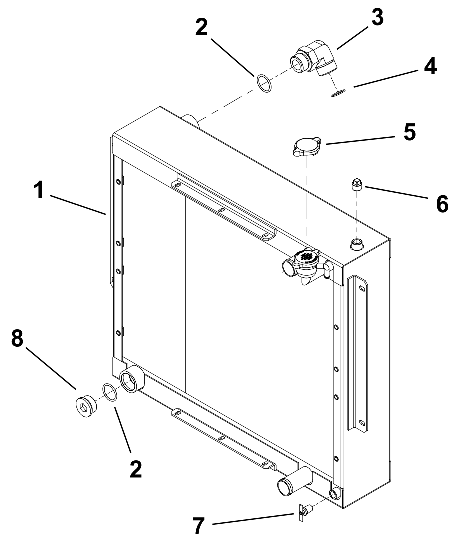


Figure 161

1. Radiator/oil cooler
2. O-ring
3. 90º fitting (2 used)
4. O-ring
5. Radiator cap
6. Plug
7. Draincock
8. Plug

Note: The hydraulic oil cooler on your Groundsmaster is combined with the radiator. See Radiator and Oil Cooler Assembly (page 4–15).

Electrical System

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General Information

Operator's Manual

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

Electrical Drawings

The electrical schematic and wire harness drawings for Groundsmaster 4500-D and 4700-D machines are located in Appendix A (page A–1).

Toro Electronic Controllers (TEC)

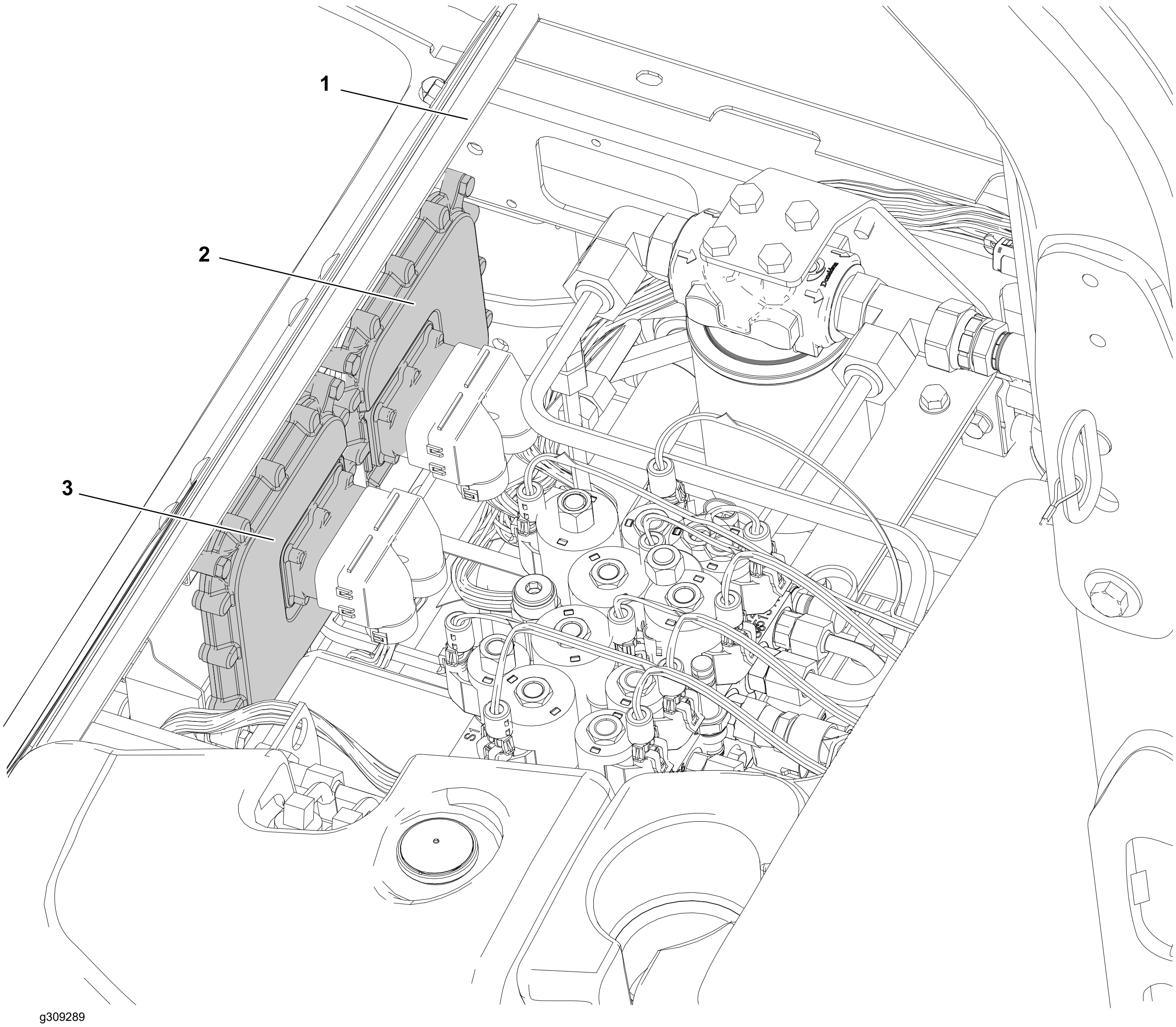

Figure 162

1. Operator platform
2. TEC-5004 (T1)
3. TEC-5004 (T2) (GM4700-D only)

The Groundsmaster 4500-D machines use a single Toro Electronic Controller (TEC-5004) to manage machine electrical functions. Groundsmaster 4700-D machines uses two (2) TEC controllers (TEC-5004) for machine operations. The TEC controllers are microprocessor controlled that sense the condition of various switches and sensors (inputs). The controllers then direct electrical power to control appropriate machine functions (outputs) based on the input state. The communication between the two (2) TEC controllers, the Yanmar engine electronic control unit (ECU) and the machine InfoCenter display is provided with a CAN-bus system. The status of inputs to the controllers as well as outputs from the controllers can be monitored with the InfoCenter display.

Toro Electronic Controllers (TEC) (continued)

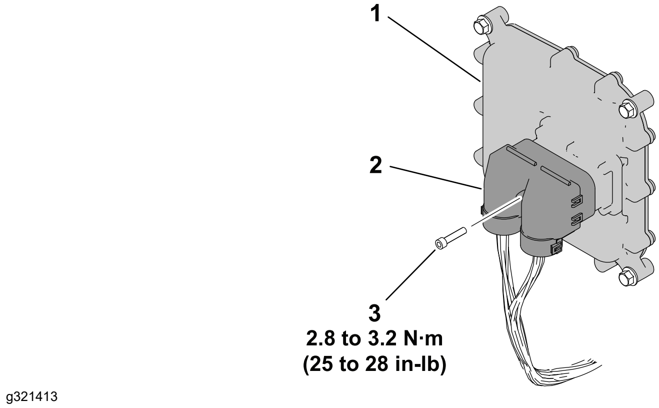

Figure 163

1. TEC controller
2. Machine harness connector
3. Socket head screw

The TEC controllers are attached to the machine under the operator seat.

Note: To prevent machine electrical system damage while welding on the machine, disconnect the battery cables from the batteries, disconnect the wire harness connectors from both TEC controllers, disconnect the wire harness connectors from the engine ECU and disconnect the terminal connector from the alternator. Also, disconnect and remove the engine ECU from the machine before welding.

Engine Electronic Control Unit (ECU)

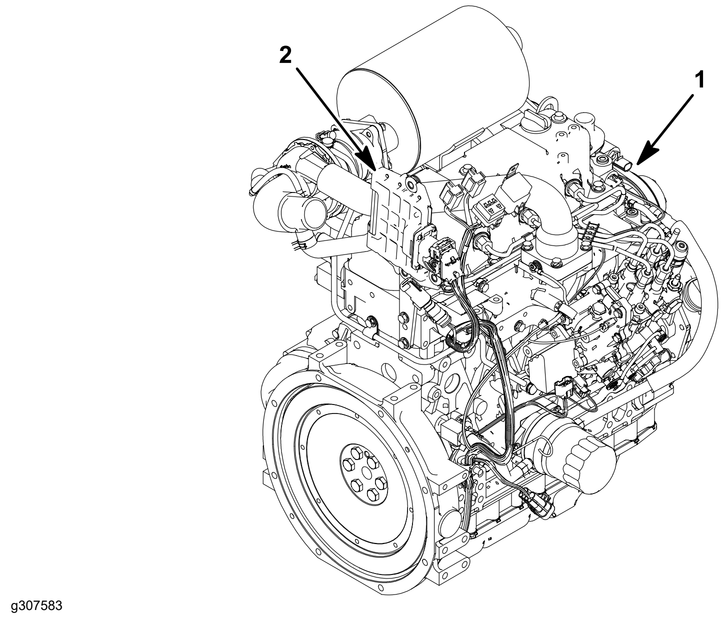

Figure 164

1. Engine (models 30893, 30893TE, 30899 and 30899TE)
2. Engine ECU

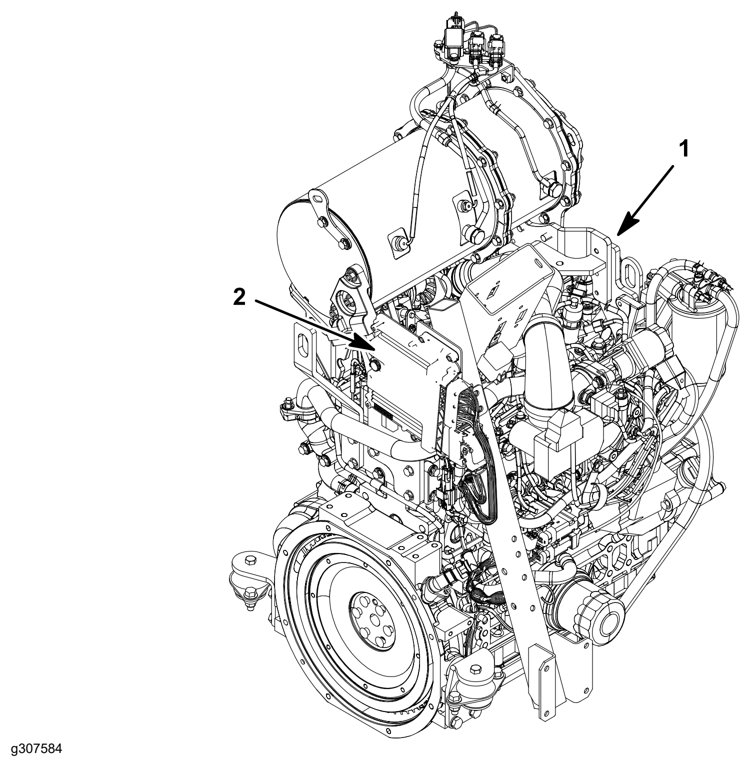

Figure 165

1. Engine (models 30885 and 30887)
2. Engine ECU

The Yanmar engine that powers the Groundsmaster 4500−D and 4700−D uses an electronic control unit (ECU) for engine management and also to communicate with the TEC controllers and the InfoCenter Display on the machine. All engine ECU electrical connectors should be plugged into the controller before the machine ignition switch is moved from the OFF position to either the ON or START position. If the engine ECU is to be disconnected for any reason, make sure that the ignition switch is in the OFF position with the key removed before disconnecting the engine ECU. See Engine Electronic Control Unit (ECU) (page 4–3).

IMPORTANT

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

Yanmar Engine Electrical Components

When servicing or troubleshooting the engine electrical components, use the correct engine service manual and troubleshooting manual. Also, the Yanmar SMARTASSIST− Direct electronic control diagnostics service system is available to support the error diagnosis and maintenance services of engine electrical control devices.

CAN−bus Communications

The Toro TEC controller(s), the Yanmar Engine Controller and the InfoCenter Display used on the Groundsmaster 4500−D and 4700−D communicate with each other on a CAN−bus system. Using this system allows the traction unit to fully integrate all the different electrical components of the traction unit and bring them together as one. The CAN−bus system reduces the number of electrical components and connections used on the machine and allows the number of wires in the wire harness to be significantly reduced. The integration of electrical functions also allows the InfoCenter Display to assist with electrical system diagnostics.

CAN identifies the Controller Area Network that is used between the controllers on the Groundsmaster. Two (2) specially designed, twisted wires form the bus. These wires provide the data pathways between the controllers (the TEC controllers and the Yanmar electronic control unit) and the InfoCenter Display used on the machine. The engineering term for these wires are CAN High and CAN Low. At the ends of the twisted pair of bus wires are 120 ohm termination resistors. One of these resistors is included in the wire harness and the second is inside the engine ECU.

Each of the components that is controlled by the CAN− bus link needs only four (4) wires to operate and communicate to the system: CAN High, CAN Low, B+ (power) and ground. The CAN−bus needs the ignition switch ON input for both the TEC and engine ECU to be activated.

Electrical Drawings

Refer to Appendix A (page A–1) for the electrical schematics and wire harness drawings for Groundsmaster 4500−D and 4700−D machines.

InfoCenter Display

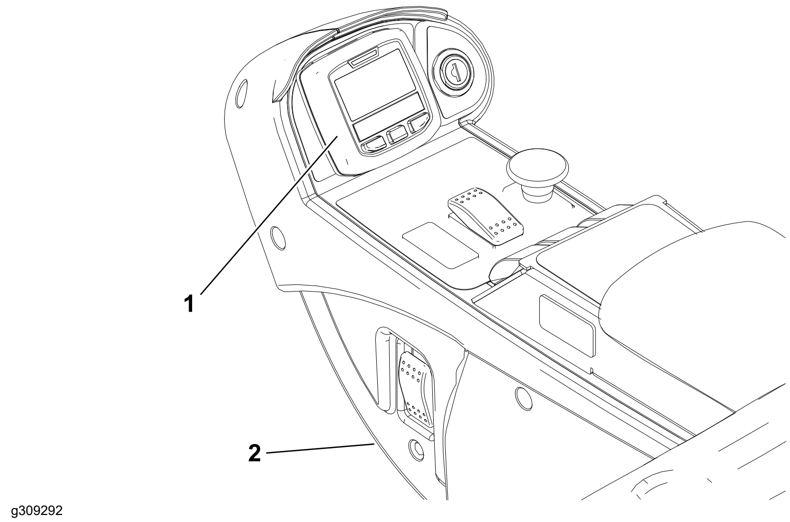

Figure 166

1. InfoCenter display
2. Console arm

The InfoCenter Display used on your Groundsmaster is a LCD device that is located on the console. The InfoCenter provides information for the machine operator during machine operation, provides electrical system diagnostic assistance for technicians and allows inputs for adjustable machine settings.

Power for the InfoCenter is available when energized by the main power relay (ignition switch in the RUN or START position). A CAN−bus system involving the machine TEC controllers, the Yanmar engine electronic control unit and the InfoCenter is used to provide necessary machine communication for InfoCenter operation.

Note: Icons that are used on the InfoCenter display are identified in the Traction Unit *Operator's Manual*.

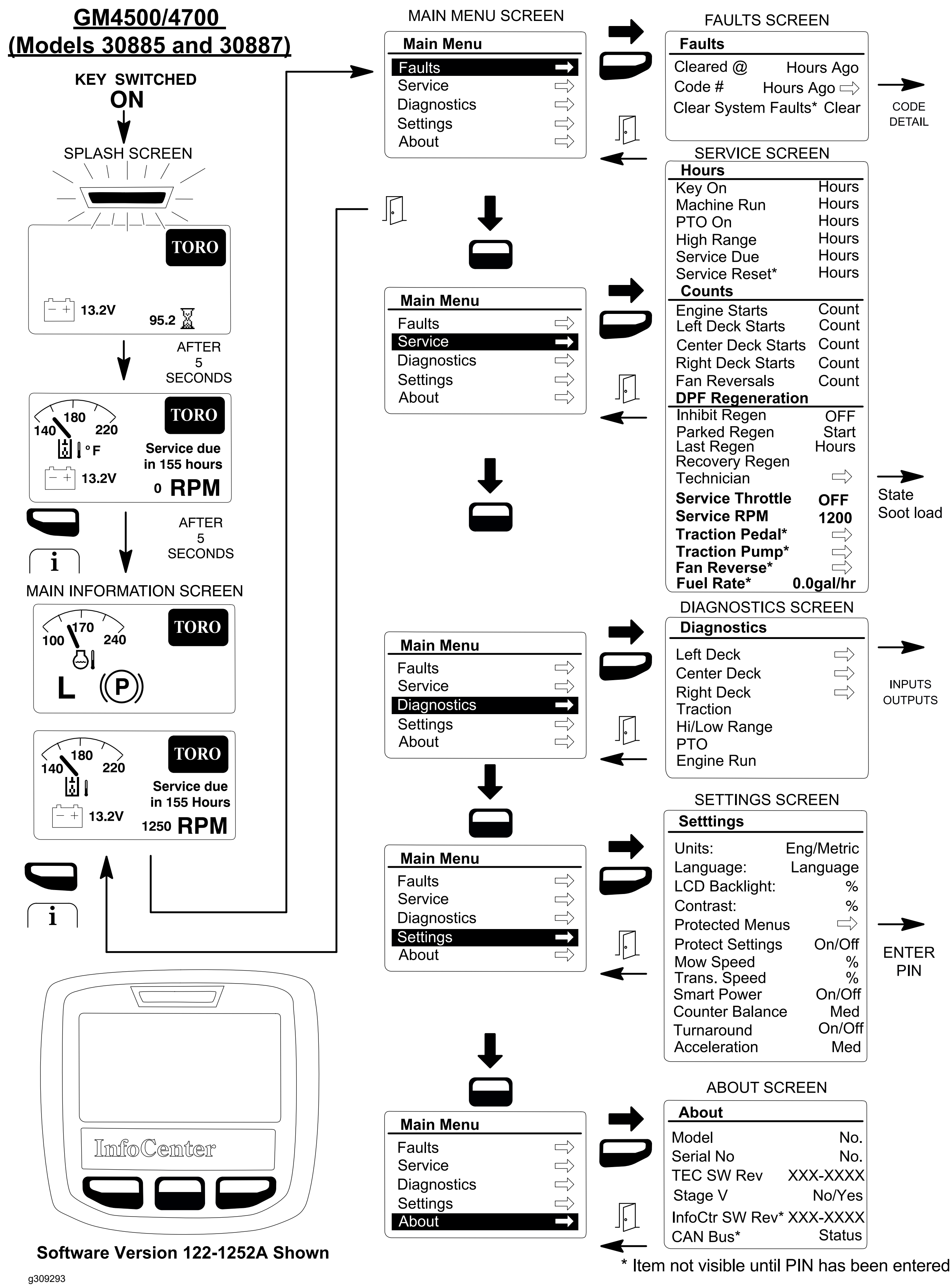
GM4500/4700
(Models 30885 and 30887)
KEY SWITCHED
ON
SPLASH SCREEN
TORO
13.2V
95.2
AFTER
5
SECONDS
180
140
220
°F
Service due
in 155 hours
0 RPM
AFTER
5
SECONDS
MAIN INFORMATION SCREEN
170
100
240
L
P
Service due
in 155 Hours
1250 RPM
InfoCenter
Software Version 122-1252A Shown
g309293
MAIN MENU SCREEN
Main Menu
Faults
Service
Diagnostics
Settings
About
FAULTS SCREEN
Faults
Cleared @ Hours Ago
Code # Hours Ago
Clear System Faults* Clear
CODE
DETAIL
SERVICE SCREEN
Hours
Key On Hours
Machine Run Hours
PTO On Hours
High Range Hours
Service Due Hours
Service Reset* Hours
Counts
Engine Starts Count
Left Deck Starts Count
Center Deck Starts Count
Right Deck Starts Count
Fan Reversals Count
DPF Regeneration
Inhibit Regen OFF
Parked Regen Start
Last Regen Hours
Recovery Regen
Technician
Service Throttle OFF
Service RPM 1200
Traction Pedal*
Traction Pump*
Fan Reverse*
Fuel Rate* 0.0gal/hr
State
Soot load
DIAGNOSTICS SCREEN
Diagnostics
Left Deck
Center Deck
Right Deck
Traction
Hi/Low Range
PTO
Engine Run
INPUTS
OUTPUTS
SETTINGS SCREEN
Setttings
Units: Eng/Metric
Language: Language
LCD Backlight: %
Contrast: %
Protected Menus
Protect Settings On/Off
Mow Speed %
Trans. Speed %
Smart Power On/Off
Counter Balance Med
Turnaround On/Off
Acceleration Med
ENTER
PIN
ABOUT SCREEN
About
Model No.
Serial No No.
TEC SW Rev XXX-XXXX
Stage V No/Yes
InfoCtr SW Rev* XXX-XXXX
CAN Bus* Status
* Item not visible until PIN has been entered

Figure 167

Splash Screen

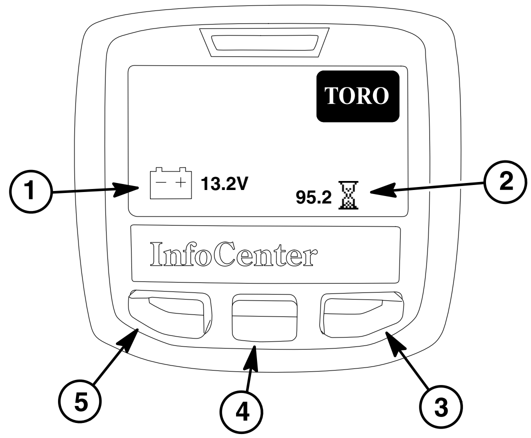

Figure 168

1. Battery voltage
2. Hour meter
3. Right button
4. Down button
5. Menu/back button

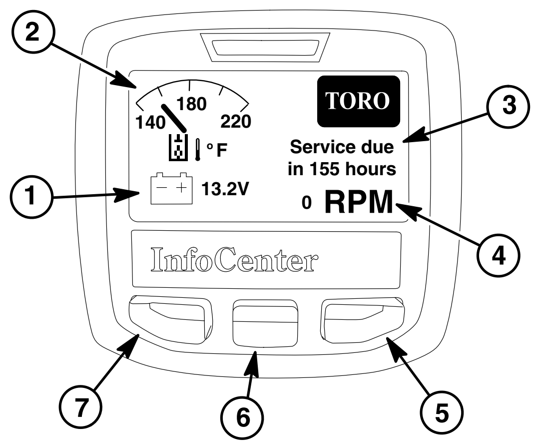

Figure 169

1. Battery voltage
2. Hydraulic oil temperature
3. Time to next service
4. Engine RPM
5. Right button
6. Down button
7. Menu/back button

The two (2) InfoCenter splash screens (Figure 168 and Figure 169) are displayed when the ignition switch is initially turned to the RUN or START position. The splash screens allow basic machine information to be reviewed by the operator. After each of the splash screens has been on the InfoCenter for several seconds, the main information screen will be displayed on the InfoCenter.

The splash screens can be used to identify machine battery voltage, hour meter reading, hydraulic oil temperature and engine status.

Main Information Screens

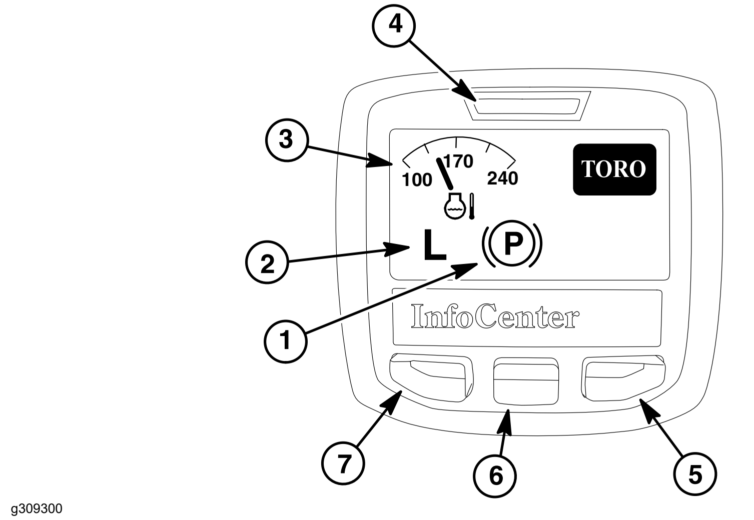

Figure 170

1. Parking brake applied
2. Traction speed
3. Coolant temperature
4. Fault indicator
5. Right button
6. Down button
7. Menu/back button

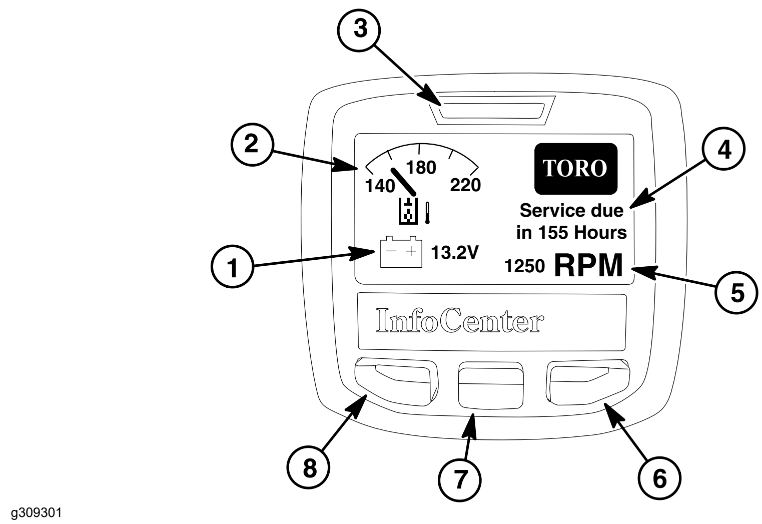

Figure 171

1. Battery voltage
2. Hydraulic oil temperature
3. Fault indicator
4. Time to next service
5. Engine RPM
6. Right button
7. Down button
8. Menu/back button

The two (2) InfoCenter main information screens (Figure 170 and Figure 171) are displayed after the initial splash screens have been displayed for several seconds. During normal machine operation, the main information screens provide machine information for the operator. Toggling between the main information screens is done by pressing the right button on the InfoCenter.

The main information screens can be used to monitor engine coolant temperature, hydraulic oil temperature, battery voltage, engine RPM and traction speed range. The screens will also identify if the parking brake is applied or if the PTO is engaged.

Main Information Screens (continued)

The main information screens will display arrows whenever the cutting decks are either raising (up arrows) or lowering (down arrows).

If controls are not selected properly to allow certain machine operations, an advisory will be displayed on the InfoCenter Display. Typically, an advisory can be eliminated with a change in controls by the operator.

If an electrical machine fault occurs during machine operation, the InfoCenter fault indicator will blink to notify the operator. Accessing the fault log is described below in Faults Screen.

If an electrical engine fault occurs during machine operation, the fault will be displayed on the InfoCenter to notify the operator. The engine fault will be retained in the engine electronic control unit (ECU) and can be viewed using the engine diagnostic tool. Engine faults are not stored in the TEC controller so they cannot be viewed using the InfoCenter Faults Screen.

The main menu and additional information screens can be accessed from the InfoCenter main information screen by pressing and releasing the menu/back button (left button) on the display. Information on the main menu and menu item screens is included below.

Main Menu Screen

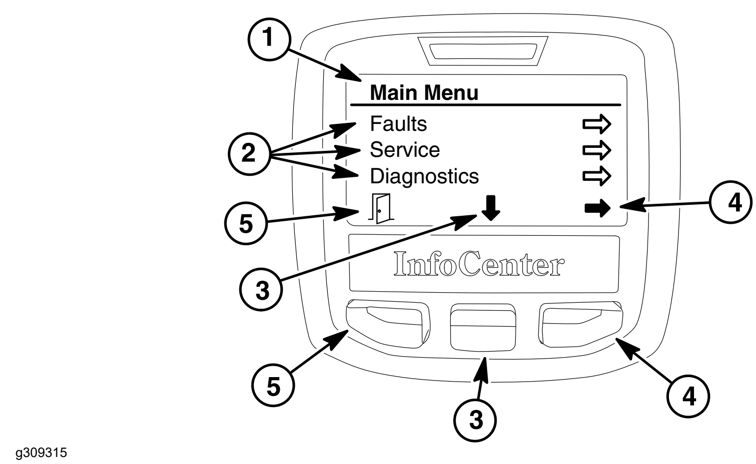

Figure 172

1. Main menu
2. Menu items
3. Move to menu items
4. Choose menu item
5. Back button

The main menu screen can be accessed from the Info- Center main information or splash screen by pressing and releasing the menu/back button (left button) on the display. Once to the main menu screen (Figure 172), navigation to the five (5) different menu items can occur. Pressing the move to menu item button (center button) allows a different menu item to be highlighted. Selection of the highlighted item is completed by pressing the choose item button (right button).

The main menu items include faults, service, diagnostics, settings and about. These menu items are described below.

To return to the main information screen from the main menu screen, press the back button (left button).

Faults Screen

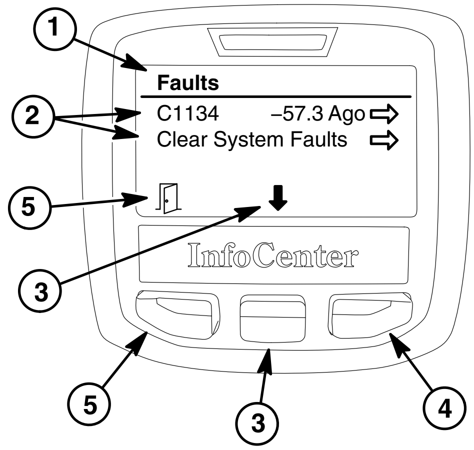

Figure 173

1. Fault menu
2. Fault items
3. Move to menu items
4. Choose menu item
5. Back button

The faults screen (Figure 173) will list all machine electrical faults that have occurred since the faults were last cleared from the InfoCenter. The faults will be identified by a fault number and when the fault occurred. Faults that might occur on the machine are listed in Fault Codes in the Troubleshooting section of this chapter.

After entry of the PIN code, the InfoCenter fault log can be cleared by selecting the clear system faults menu item. The cleared faults will be removed from the Info- Center list but will be retained in the TEC controller memory.

If a fault occurs during machine use, there may be a change in machine functionality due to the fault. Should there be machine operation issues due to a fault, a first step to remedy the issue would be to disengage the cutting decks, release the traction pedal, turn the ignition switch OFF and allow all machine functions to stop. Then, attempt to restart the machine to see if operation has returned to normal. Some faults will be reset during the restart and will then allow normal function. If a fault continues to occur, further system evaluation and possible component repair or replacement will be necessary.

To return to the main menu screen from the faults screen, press the back button (left button).

Service Screen

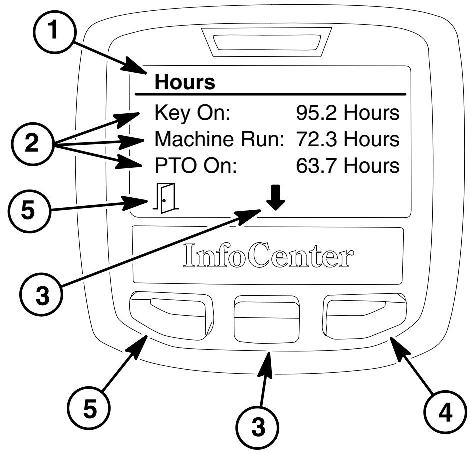

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Figure 174

1. Service menu
2. Service items
3. Move to menu items
4. Choose menu item
5. Back button

The service screen (Figure 174) contains machine operational information including hours and counts. Values listed for these service menu items cannot be changed. If the machine PIN has been entered to allow access to protected menu items in the settings screen, the protected service menu items will also be listed and available in the service screen.

Note: If the protected menu items are available, PIN will be shown in the upper right corner of the InfoCenter display.

The options listed for hours include the following:

- **Key On** identifies the number of hours that the ignition switch has been in the ON position.
- **Machine Run** identifies the number of hours that the engine has been running.
- **PTO On** identifies the number of hours that the machine has been operated with the cutting decks engaged.
- **High Range** identifies the number of hours that the machine has been operated in high range speed (transport).
- **Service Due** identifies the number of hours before the next scheduled maintenance is due.

The options listed for counts include the following:

- **Starts** identifies the number of times that the engine has been started.
- **Left Deck** (Groundsmaster 4700−D) identifies the number of times that the left side cutting deck has been energized.
- **Center Deck** identifies the number of times that the center cutting deck has been energized.
- **Right Deck** (Groundsmaster 4700−D) identifies the number of times that the right side cutting deck has been energized.
- **Fan Reversals** identifies the number of times that the engine cooling fan has been operated in the reverse direction.
- **Fan − Coolant** identifies the number of times that engine coolant temperature caused the fan speed to change.
- **Fan − Oil** identifies the number of times that hydraulic oil temperature caused the fan speed to change.

- **DPF Regeneration** provides the necessary procedure for stationary regeneration for the exhaust system DPF (diesel particulate filter) on machines with a Tier 4 engine (models 30885 and 30887). If the engine ECU identifies that a stationary DPF regeneration is necessary, an advisory will occur on the InfoCenter and the necessary steps will be listed in the service screen menu.
- **Service Throttle** allows the user to ON/OFF the feature. The ON mode allows the user to vary the max engine RPM.
- **Service RPM** allows the user to set the service RPM.

The protected menu items include the following:

- **Traction Pedal** allows the traction pedal sensor to be calibrated (see Traction Pedal Position Sensor Calibration (page 6–23)).
- **Traction Pump** allows the traction pump sensor to be calibrated.
- **Fan Reverse** provides the necessary inputs to cause the cooling fan to reverse direction. This protected menu item allows the demonstration of the fan reversal and would never be necessary to use on a normally functioning machine.
- **Fuel Rate** indicates the user to rate of fuel flow in gal/hour.

To return to the main menu screen from the service screen, press the back button (left button).

Diagnostics Screen

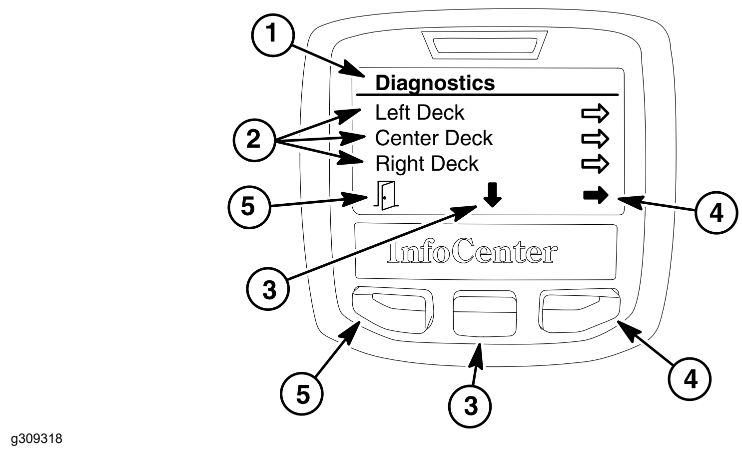

Figure 175

1. Diagnostics menu
2. Diagnostics items
3. Move to menu items
4. Choose menu item
5. Back button

The diagnostics screen (Figure 175) lists the various states of machine electrical components. The diagnostics screen should be used to check operation of machine controls and to verify that switches and circuit wiring are functioning correctly.

For each of the diagnostics screen items, inputs, qualifiers and outputs are identified.

The diagnostics screen includes the following:

- **Left Deck** (Groundsmaster 4700−D) identifies machine requirements to allow the left deck to raise and lower.

    Left Deck Inputs include:

- Left deck lift/lower switch
- HIgh/Low speed switch
- Seat switch
- Parking brake switch

Left Deck Outputs indicate whether the TEC is sending voltage to energize the primary, lower, raise, or float solenoid valves.

- **Center Deck** identifies machine requirements to allow the center deck to raise and lower.
  - Center deck lift/lower switch
  - HIgh/Low speed switch
  - Seat switch
  - Parking brake switch

  Center Deck Outputs indicate whether the TEC is sending voltage to energize the primary, raise, or float solenoid valves.
- **Right Deck** (Groundsmaster 4700−D) identifies machine requirements to allow the right deck to raise and lower.

  Right Deck Inputs include:
  - Right deck lift/lower switch
  - HIgh/Low speed switch
  - Seat switch
  - Parking brake switch

  Right Deck Outputs indicate whether the TEC is sending voltage to energize the primary, lower, raise, or float solenoid valves.
- **Traction** identifies machine requirements to allow the traction system to be engaged.

  Traction Inputs include:
  - Traction pedal position (Fwd or Rev)
  - Traction pedal position (sensor output voltage)
  - Traction pedal position (% of movement)
  - Piston (traction) pump swashplate position (sensor output voltage)
  - Piston (traction) pump swashplate (% of movement)
  - Parking brake switch
  - Service brake switches
  - Seat switch
  - Cruise control switch (On or Off)
  - Cruise control (engaged or disengaged)

  Traction Outputs indicate whether the TEC is sending PWM voltage to the piston (traction) pump forward or reverse control solenoid.
- **High/Low speed** identifies machine requirements to allow high or low speed range to be engaged.

  High/Low speed Inputs include:
  - PTO switch
  - HIgh/Low speed switch
  - Cutting deck position switches (decks raised or lowered)

  High/Low speed Outputs indicate whether the TEC is sending voltage to energize the two speed shift solenoid valve (SV).

Diagnostics Screen (continued)

- **PTO** identifies machine requirements to allow the PTO to be engaged.

  PTO Inputs include:

  – PTO switch

  – HIgh/Low speed switch

  – Seat switch

  – Cutting deck position switches (decks raised or lowered)

  PTO Outputs indicate whether the TEC is sending voltage to energize the PTO solenoid valves.

- **Engine Run** identifies whether necessary TEC outputs exists to allow the engine to run.

  Engine Run Inputs include:

  – Ignition switch

  – PTO switch

  – Traction pedal position

  – Seat switch

  – Parking brake switch

  – Cutting deck lift/lower switches

  Engine Run Outputs indicate whether the TEC is sending voltage to energize the engine ECU Start or Run inputs.

  Note: The components for engine operation (e.g. glow plugs, starter) are controlled by the Yanmar engine control unit (ECU).

To return to the main menu screen from the diagnostics screen, press the back button (left button).

Settings Screen

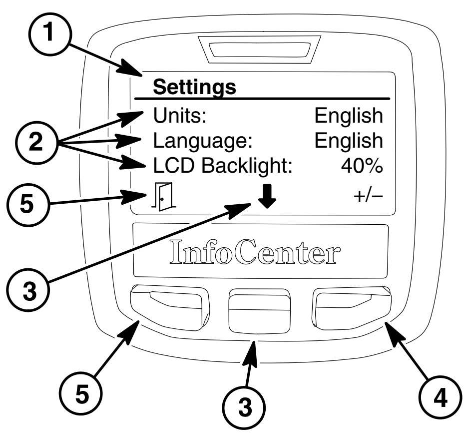

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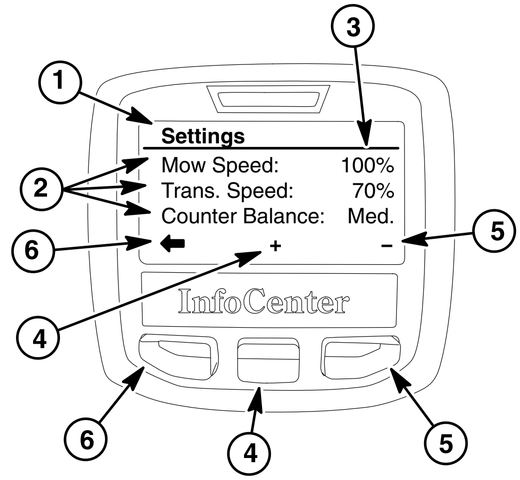
Figure 176

1. Settings menu
2. Settings items
3. Move to menu items
4. Change menu item
5. Back button

Settings Screen (continued)



g309320

Figure 177

1. Settings menu
2. Settings items
3. Current setting
4. Increase setting
5. Decrease setting
6. Back button

The settings screen identifies the InfoCenter language and decks (English or Metric). The settings screen also allows the operator to customize the backlight (brightness) and contrast settings for the InfoCenter display.

If either the backlight (brightness) or contrast items are selected, the center button (−) or right button (+) can be used to change the display settings.

Protected menus allows the machine PIN to be entered so that hidden machine service screen items can be viewed and modified. The protected service items includes service intervel reset, traction pedal sensor calibration, traction pump calibration, cooling fan reversal demonstration and exhaust system DPF regeneration (Tier 4 engines). If the protect settings is ON (see below), auto idle, mow speed, transport speed and counterbalance are also included in the protected menu.

To allow access to the protected menu items, enter the four (4) digit pin PIN using the center and right InfoCenter buttons. After PIN has been entered, a check mark should be visible above center InfoCenter button. Press center button and the InfoCenter display screen should indicate PIN in the upper right hand corner if the correct PIN number was entered. Use back button to return to Settings menu. The protected menu items should be available in the Service menu and can be changed as long as the ignition switch remains in RUN.

Note: The initial PIN will either be 1234 or 0000. If the PIN has been changed and is forgotten, a temporary PIN can be obtained from your Toro distributor.

Protect settings allows the settings for auto idle, mow speed, transport speed and counterbalance to be hidden so they cannot be changed unless the PIN is entered. If the protect settings is ON, these settings will not be seen when using the InfoCenter until the protected menus is selected and the chosen PIN is entered. If protect settings is OFF (default setting), settings for these functions will be visible on the InfoCenter and can be adjusted by the operator.

Mow Speed allows the maximum traction speed to be adjusted when in LOW (mow) speed. Adjustments will be listed as a percent.

Trans. (Transport) Speed allows the maximum traction speed to be adjusted when in HI (transport) speed. Adjustments will be listed as a percent.

Settings Screen (continued)

Smart Power allows the user to enable or disable the Smart Power feature.

Counter Balance allows counterbalance pressure applied by the cutting decks to be adjusted. Options for counterbalance are low, medium and high.

Turnaround allows the user to set ON/OFF. The ON feature allows the decks to be raised in turnaround position. The OFF feature allows the decks be able to hover off the ground with PTO engaged until it is at or above the deck limit switch.

Acceleration allows the user to vary the aggressiveness of the acceleration of the machine.

To return to the main menu screen from the settings screen, press the back button (left button).

About Screen

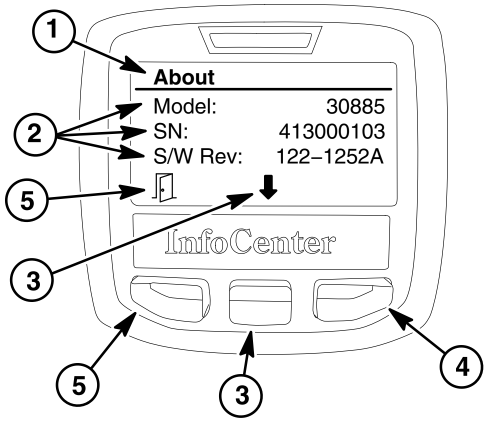


Figure 178

1. About menu
2. About items
3. Move to menu items
4. Choose menu item
5. Back button

The about screen (Figure 178) identifies the machine model number, serial number and software revisions for the TEC controllers, InfoCenter and engine electronic control unit (if available). The about screen also lists the CAN−bus status. Additional information is identified if the about screen is accessed after the protected menus have been accessed by entering the PIN.

To return to the main menu screen from the about screen, press the back button (left button).

Adjustments

Traction Pedal Adjustment

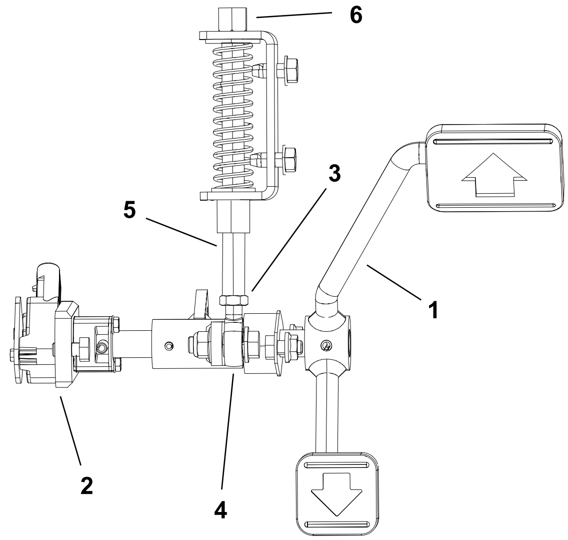


Figure 179

1. Traction pedal	4. Rod end bearing
2. Pedal position sensor	5. Spring shaft
3. Hex nut	6. Spring shaft hex

The traction pedal includes a neutral assembly that is used to adjust the traction neutral position (Figure 179). Traction pedal adjustment may be necessary to make sure that traction pedal movement provides the correct full reverse and full forward positions for the traction pedal position sensor. The InfoCenter display can be used to check traction pedal adjustment using the following procedure.

1. Park machine on a level surface, lower cutting decks, engage parking brake and stop engine.
2. Turn ignition switch to RUN but do not start engine.

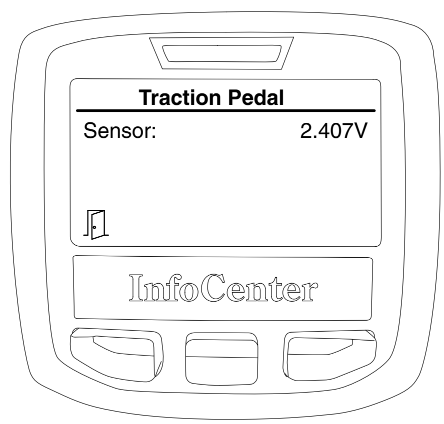


Figure 180

3. Use the InfoCenter Display Diagnostics menu (see InfoCenter Display (page 6–9)) to obtain and select the Traction Pedal menu item. Choose Inputs and the InfoCenter display should identify sensor voltage (Figure 180).
4. Move traction pedal from full reverse to full forward positions while noting the range of voltage displayed on the InfoCenter.

Traction Pedal Adjustment (continued)

A. Voltage in full reverse should be from 0.5 to 1.75V (approximate).

B. Voltage in full forward should be from 3.5 to 4.5V (approximate).

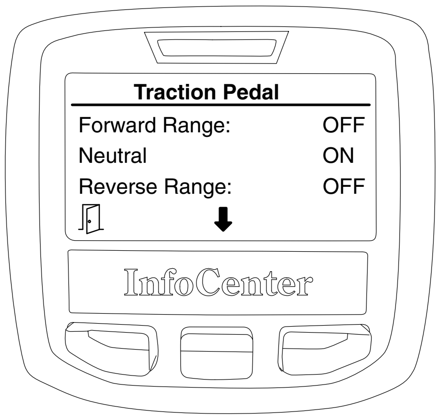
5. If voltage range from full reverse to full forward is incorrect, adjustment of the spring shaft and rod end bearing is necessary (Figure 179).

   A. Loosen hex nut that secures rod end bearing in spring shaft. Hex nut can be accessed through slot in frame bracket next to traction pedal.

   B. Use hex on front end of spring shaft to rotate spring shaft which changes traction pedal position in relation to traction pedal position sensor. The spring shaft hex nut can be accessed from below the machine.

   C. Check range of voltage as described in step 4 above and make additional adjustments to the spring shaft until range of voltage is within specifications.

   D. Tighten hex nut to secure rod end bearing in spring shaft. Check that traction pedal range of voltage is still correct after hex nut is tightened.



g309422

Figure 181

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6. After any adjustment of the spring shaft and rod end bearing, use the InfoCenter Display Diagnostics menu to obtain and select the Traction Pedal menu item (see InfoCenter Display (page 6–9)). Choose Outputs and the InfoCenter display will identify the traction pedal position (Figure 181).

   A. When the traction pedal is in the neutral position, the InfoCenter should display Neutral as ON and both Forward Range and Reverse Range as OFF.

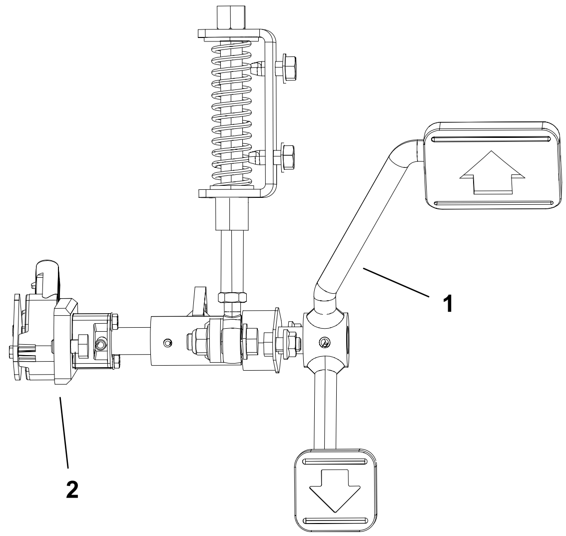
   B. Move traction pedal in the forward direction and the InfoCenter should display the Forward Range as ON and both Neutral and Reverse Range as OFF.

   C. Return the traction pedal to neutral and then move pedal in the reverse direction. The InfoCenter should display the Reverse Range as ON and both Neutral and Forward Range as OFF.

   D. If outputs are incorrect, additional adjustment of the spring shaft and rod end bearing are necessary.

7. After completing all adjustments and before returning the machine to operation, calibrate traction pedal position sensor (see Traction Pedal Position Sensor Calibration (page 6–23)).

Traction Pedal Position Sensor Calibration



g309423

Figure 182

1. Traction pedal
2. Pedal position sensor

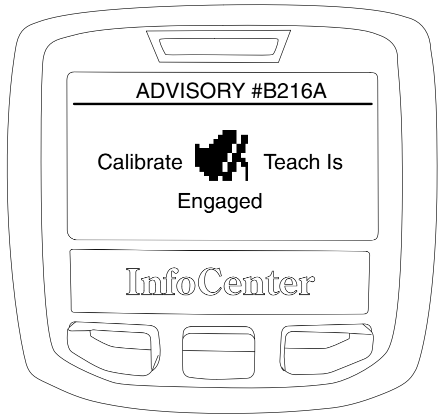
IMPORTANT

A properly installed and calibrated traction pedal position sensor is critical to accurate traction system response and for reliable sensor life. Use care when removing, installing and calibrating the traction pedal position sensor.

Calibration of the traction pedal position sensor ensures that the TEC controller can identify the traction neutral, forward and reverse positions.

1. Park machine on a level surface, lower cutting decks, engage parking brake and stop engine.
2. Turn ignition switch to RUN but do not start engine.
3. Use the InfoCenter Display Settings menu (see InfoCenter Display (page 6–9)) to obtain and select Protected Menus. Enter valid PIN for the machine to allow access to protected menu items including calibration of the traction pedal position sensor. The InfoCenter display screen should indicate PIN in the upper right hand corner when the correct PIN number has been entered.

Traction Pedal Position Sensor Calibration (continued)



g309424

Figure 183

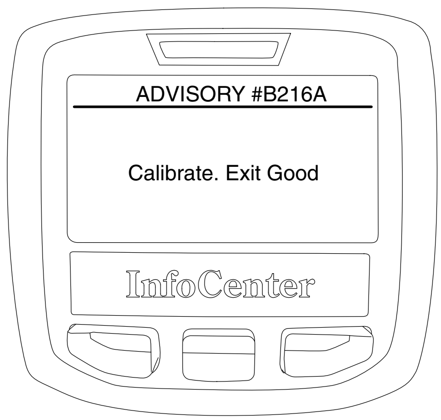


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Figure 184

4. Use the InfoCenter Display Service menu (see InfoCenter Display (page 6–9)) to obtain and select the Traction Pedal menu item. The InfoCenter display should indicate that the traction pedal calibration process is engaged (Figure 183).
5. Follow the prompts on the InfoCenter display screen to calibrate the Traction Pedal.
6. When finished, check that InfoCenter display indicates a successful calibration process (Figure 184).
7. Turn ignition switch to OFF which exits the traction pedal calibration menu.

Traction Pump Swashplate Angle Sensor Calibration

IMPORTANT

A properly installed and calibrated traction pump swashplate angle sensor is critical to accurate traction system response.

Calibration of the traction pump swashplate angle sensor ensures that the piston (traction) pump is reacting appropriately to the demands made by the traction control system.

1. Park machine on a level surface, lower cutting decks, engage parking brake and stop engine.
2. Turn ignition switch to RUN but do not start engine.
3. Use the InfoCenter Display Settings menu (see Settings Screen (page 6–18)) to obtain and select Protected Menus. Enter valid PIN for the machine to allow access to protected menu items including calibration of the traction pump swashplate angle sensor. The InfoCenter display screen should indicate PIN in the upper right hand corner when the correct PIN number has been entered.
4. Follow the prompts on the InfoCenter display screen to calibrate the Traction Pump.
5. When finished, check that InfoCenter display indicates a successful calibration process Figure 185

g309425

Figure 185

6. Turn ignition switch to OFF which exits the traction pump calibration menu.

Electrical System Quick Checks

Battery Test (Open Circuit)

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

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

Note: This test provides a relative condition of the battery. Load testing of the battery will provide additional and more accurate information.

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

Charging System Test

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

Note: The InfoCenter display can be used to identify battery voltage during machine operation.

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

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

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

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

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

An example of a charging system that is functioning:

At least 0.50 volt over initial battery voltage.	
Initial Battery Voltage	= 12.30 v
Battery Voltage after 3 Minute Charge	= 12.95 v
Difference	= +0.65 v

Check Operation of Interlock Switches

CAUTION

Do not disconnect safety switches. They are for the operator's protection. Check the operation of the interlock switches daily for proper operation. Replace any malfunctioning switches before operating the machine.

Interlock switch operation is described in the Traction Unit *Operator's Manual*. Your Groundsmaster is equipped with one (1) (Groundsmaster 4500-D) or two (2) (Groundsmaster 4700-D) Toro Electronic Controllers (TEC) which monitor interlock switch operation. Testing of individual interlock switches and relays is included in the Component Testing (page 6–28) section of this Chapter.

Note: Use the InfoCenter Display when troubleshooting an electrical problem on your Groundsmaster.

Component Testing

For accurate resistance and/or continuity checks, electrically disconnect the component being tested from the circuit (e.g. unplug the ignition switch connector before checking continuity on the switch terminals).

For engine component testing information, see the *Yanmar Workshop Manual* and *Yanmar Troubleshooting Manual*.

CAUTION

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

Ignition Switch

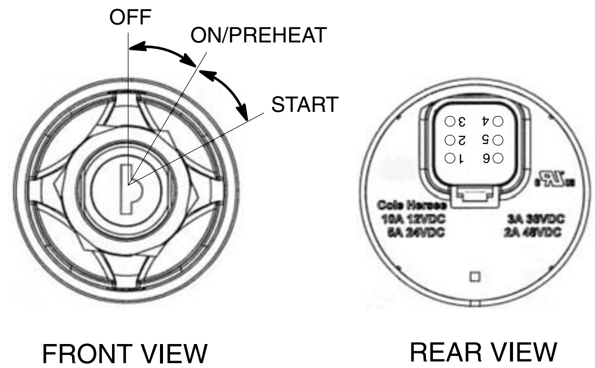

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Figure 186

The ignition (key) switch on the console arm has three (3) positions (OFF, ON/PREHEAT and START).

Testing

Note: Before disconnecting the ignition switch for testing, the switch and its circuit wiring should be tested as a TEC electrical input using the InfoCenter Display (see InfoCenter Display (page 6–9)). If input testing verifies that the ignition switch and circuit wiring are functioning correctly, no further ignition switch testing is necessary. If, however, input testing determines that the ignition switch and circuit wiring are not functioning correctly, proceed with the following ignition switch testing procedure.

1. Park machine on a level surface, lower cutting decks, engage parking brake and stop engine. Remove key from ignition switch.
2. Remove console arm covers to gain access to ignition switch (see Console Arm (page 8–10)).
3. Disconnect wire harness connector from ignition switch.
4. The ignition switch terminals are identified in Figure 186 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	CIRCUITS
OFF	1 + 6, 4 + 5
ON/PREHEAT	1 + 3 + 4 + 5 + 6
START	1 + 2 + 4 + 5 + 6

Note: Ignition switch terminals 1 and 6 are connected internally. Terminals 4 and 5 are also connected internally. These terminals should have continuity regardless of switch position.

5. Replace ignition switch if testing determines that it is faulty.
6. If the ignition switch tests correctly and a circuit problem still exists, check wire harness (see Appendix A (page A–1)).
7. After testing is complete, connect machine wire harness connector to ignition switch. Secure console arm covers to machine with removed fasteners (see Console Arm (page 8–10)).

Fuses

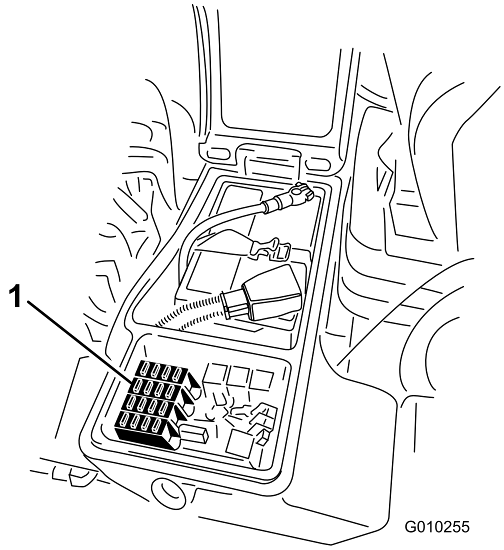

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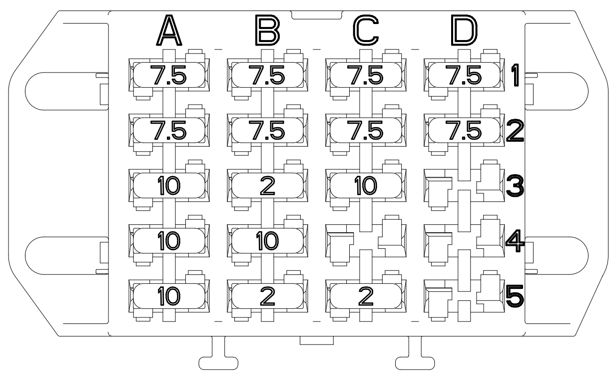
Figure 187

1. Fuses



g309470

Figure 188

The fuse block is located in the right storage box back of the operator seat (Figure 187).

In addition to the fuses in the fuse block, a 60 Amp fuse is included in the storage box to protect the power circuit for the operator cab (if equipped).

Fuse Identification and Function

Use Figure 188 to identify each individual fuse and its correct amperage in the fuse block. The fuses have the following functions.

Fuse A−1 (7.5 Amp) protects TEC controller 1 power supply output for engine start, engine run, fuel pump, cooling fan directional solenoid (S1) and brake light kit.

Fuse A−2 (7.5 Amp) protects TEC controller 2 power supply output for the left deck raise solenoid (S2), left deck lower solenoid (S3), left deck float solenoid (S4) and right deck raise solenoid (S7) on Groundsmaster 4700−D machines.

Fuse A−3 (10 Amp) protects power supply to the main power circuits, hour meter, front bypass and rear bypass solenoid.

Fuse A−4 (10 Amp) protects power supply to the headlight circuits.

Fuse Identification and Function (continued)

Fuse A−5 (10 Amp) protects power supply to the engine control unit (ECU).

Fuse B−1 (7.5 Amp) protects TEC controller 1 output power supply for the two (2) PTO solenoids (PRV1 and PRV2), the cooling fan speed solenoid (TS) and counterbalance solenoid valve (TS).

Fuse B−2 (7.5 Amp) protects TEC controller 2 output power supply for right deck engage solenoid (SV1) and left deck engage solenoid (SV2) on Groundsmaster 4700−D machines.

Fuse B−3 (2 Amp) protects the power supply to the InfoCenter display.

Fuse B−4 (10 Amp) protects the power supply to the operator air ride seat circuit.

Fuse B−5 (2 Amp) protects power supply for the logic power circuits for TEC controller 1.

Fuse C−1 (7.5 Amp) protects TEC controller 1 output power supply for center decks raise solenoid (S5), center decks float solenoid (S6) and two speed shift solenoid (SV).

Fuse C−2 (7.5 Amp) protects TEC controller 2 output power supply for right deck lower solenoid (S8), right deck float solenoid (S9) and enable solenoid (S1) on Groundsmaster 4700−D machines.

Fuse C−3 (10 Amp) protects the power supply to the powerpoint.

Fuse C−4 position available for optional kit.

Fuse C−5 (2 Amp) protects power supply for the logic power circuits for TEC controller 2 on Groundsmaster 4700−D machines.

Fuse D−1 (7.5 Amp) protects TEC controller 1 output power supply for hydrostat forward solenoid (C1) and hydrostat reverse solenoid (C2).

Fuse D−2 (7.5 Amp) protects TEC controller 2 output power supply on Groundsmaster 4700-D machines.

Fuse D−3 position available for optional kit.

Fuse D−4 position available for optional kit.

Fuse D−5 (10 Amp) protects the power supply to telematics.

Maxi Fuse M1 (60 Amp) supplies the power to the operator cab (if equipped).

Fuse Testing

Turn ignition switch to the RUN position (do not start engine). With the fuse installed in the fuse block, use a multimeter to verify that 12 VDC exists at both of the terminal test points on the fuse. If 12 VDC exists at one of the fuse test points but not at the other, the fuse is faulty.

1. Ensure that the key switch is in OFF position and the key is removed from the key switch.
2. Open power center cover from operator platform to access fuses.
3. Remove fuse from fuse block for testing. Fuse should have continuity across the terminals.
4. After fuse testing is completed, install known good fuse into fuse block.
5. Replace the fuse if testing determines that it is damaged.

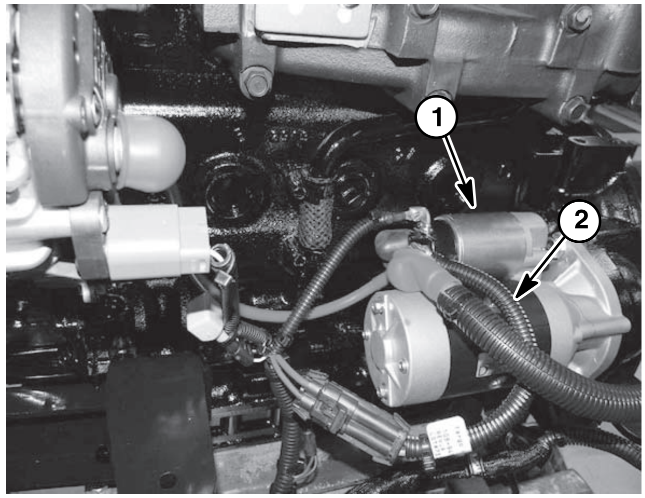
Fuse Testing (continued)

IMPORTANT

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

6. Close and secure power center cover.

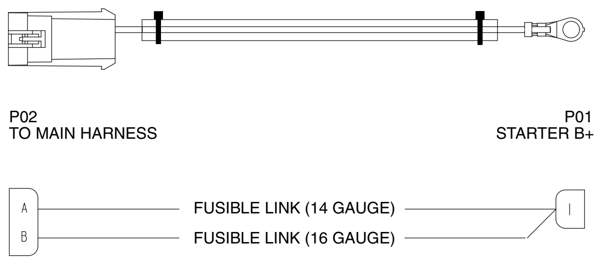
Fusible Link Harness



g275996

Figure 189

1. Starter motor
2. Fusible link harness



g275997

Figure 190

Your Groundsmaster uses two (2) fusible links for circuit protection. These fusible links are located in a harness that connects the starter B+ terminal to the wire harness (Figure 189). If either of these links should fail, current to the protected circuits will cease. Refer to Appendix A (page A–1) for wire harness drawings for additional fusible link information.

Testing

Make sure that ignition switch is OFF. Disconnect negative battery cable from battery terminal and then disconnect positive cable from battery (see Battery Service (page 6–83)). Locate and unplug fusible link connector from machine wire harness. Use a multimeter to make sure that continuity exists between the fusible link terminals. If either fusible link is open, replace the fusible link harness.

Note: It is not recommended to 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.

After fusible link testing is complete, make sure that fusible link harness is securely attached to starter B+ terminal and wire harness. Connect positive battery cable to battery terminal first and then connect negative cable to battery.

PTO Switch

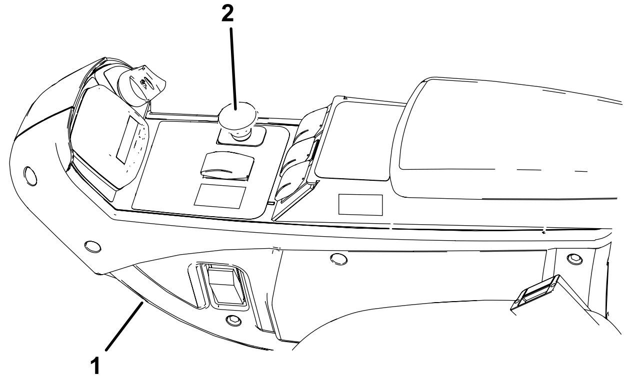


Figure 191

1. Console arm
2. PTO switch

The two position PTO switch is located on the console arm (Figure 191). The PTO switch is pulled up to engage the PTO and pushed in to disengage the PTO.

Note: To engage the PTO, the seat has to be occupied, traction speed has to be in low range (mow) and the cutting decks have to be fully lowered.

Testing

Note: Before disconnecting the PTO switch for testing, the switch and its circuit wiring should be tested as a TEC electrical input using the InfoCenter Display (see InfoCenter Display (page 6–9)). If input testing verifies that the PTO switch and circuit wiring are functioning correctly, no further PTO switch testing is necessary. If, however, input testing determines that the PTO switch and circuit wiring are not functioning correctly, proceed with the following PTO switch testing procedure.

1. Park machine on a level surface, lower cutting decks, engage parking brake and stop engine. Remove key from ignition switch.
2. Remove console arm covers to gain access to PTO switch (see Console Arm (page 8–10)).
3. Disconnect wire harness electrical connector from the PTO switch.

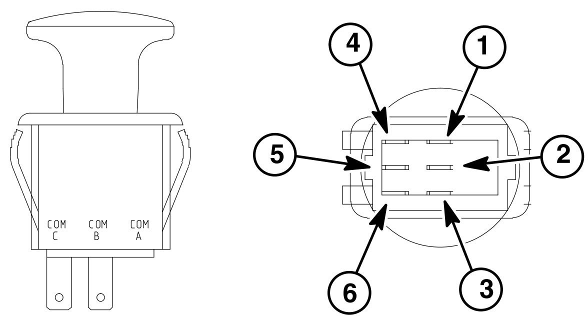


Figure 192

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. The switch terminals are marked as shown in Figure 192. The circuit logic of the PTO switch is shown in the chart below. 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.

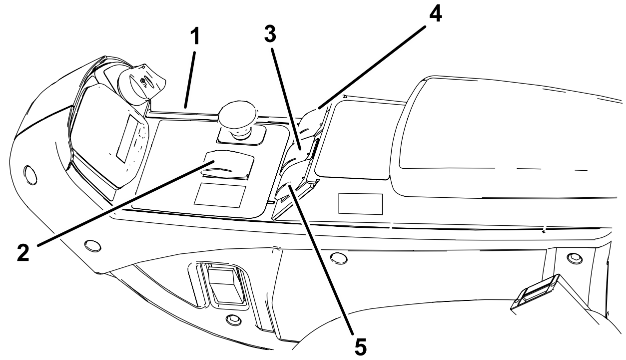
Testing (continued)

Verify continuity between switch terminals. Replace switch if testing identifies that switch is faulty.

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

5. If PTO switch tests correctly and circuit problem still exists, check wire harness (see Appendix A (page A–1)).
6. After testing is completed, connect the wire harness connector to the PTO switch.
7. Assemble console arm (see Console Arm (page 8–10)).

High/Low Speed, Engine Speed Request and Cutting Deck Lift Switches



g309581

Figure 193

1. Console arm
2. High/Low speed switch
3. Lift switch (#1 to #5)
4. Lift switch (GM4700 #7)
5. Lift switch (GM4700 #6)

The High/Low speed and cutting deck lift switches are all identical. These switches are located on the console arm (Figure 193).

The High/Low speed switch is used as an input for the TEC controller to select either the High speed or Low speed traction speed.

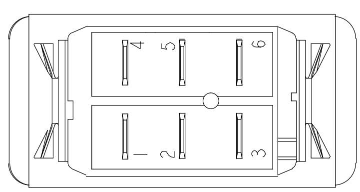
The cutting deck lift switches are used as inputs for the TEC controller to raise or lower the cutting decks. When the front of a lift switch is depressed, the controlled decks will lower. When the rear of a lift switch is depressed and held, the controlled decks will raise.

Note: To raise or lower the decks, the operator seat has to be occupied. Also, to lower the cutting decks, the traction speed has to be in Low speed.

Testing

Note: Before disconnecting a switch for testing, the switch and its circuit wiring should be tested as a TEC electrical input using the InfoCenter Display (see InfoCenter Display (page 6–9)). 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.

1. Park machine on a level surface, lower cutting decks, engage parking brake and stop engine. Remove key from ignition switch.
2. Remove console arm covers to gain access to switch that is to be tested (see Console Arm (page 8–10)).
3. Disconnect wire harness electrical connector from the switch that is to be tested.



BACK OF SWITCH

g276001

Figure 194

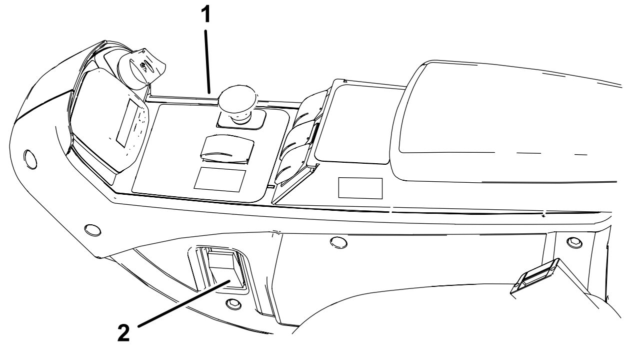
Testing (continued)

4. The switch terminals are marked as shown in Figure 194. The circuit logic of the switch is shown in the chart below. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each position. Verify continuity between switch terminals. Replace switch if testing identifies a faulty switch.

SWITCH POSITION	CLOSED CIRCUITS	OPEN CIRCUITS
FRONT OF SWITCH PRESSED	2 + 3 5 + 6	2 + 1 5 + 4
NEUTRAL	NONE	ALL
REAR OF SWITCH PRESSED	2 + 1 5 + 4	2 + 3 5 + 6

5. If switch tests correctly and circuit problem still exists, check wire harness (see Appendix A (page A–1)).
6. After testing is completed, connect wire harness connector to the switch.
7. Assemble console arm (see Console Arm (page 8–10)).

Headlight Switch



g309584

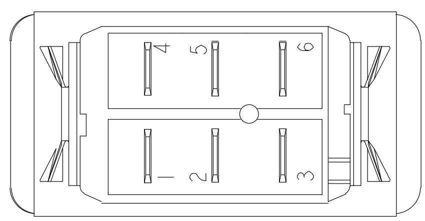
Figure 195

1. Console arm
2. Headlight switch

The headlight switch is located on the operator side of the console arm (Figure 195). This two (2) position rocker switch allows the headlights to be turned on and off.

Testing

1. Park machine on a level surface, lower cutting decks, engage parking brake and stop engine. Remove key from ignition switch.
2. Remove console arm covers to gain access to headlight switch (see Console Arm (page 8–10)).
3. Disconnect wire harness electrical connector from the headlight switch.



BACK OF SWITCH

g276008

Figure 196

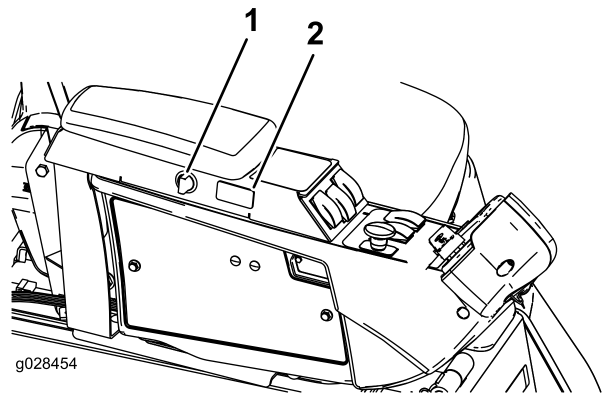
Note: Headlight switch terminals 1, 4, 5 and 6 are not used on Groundsmaster 4500−D and 4700−D machines.

4. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each switch position. The switch terminals are marked as shown in Figure 196. The circuitry of the switch is shown in the chart below. Verify continuity between switch terminals. Replace switch if testing identifies a faulty switch.

SWITCH POSITION	CIRCUIT 1	CIRCUIT 2
ON	2 + 3	5 + 6
OFF	2 + 1	5 + 4

5. If switch tests correctly and headlight circuit problem still exists, check wire harness (see Appendix A (page A–1)).
6. After testing is completed, connect wire harness connector to the headlight switch.
7. Assemble console arm (see Console Arm (page 8–10)).

Cruise Control Switch



g028454

Figure 197

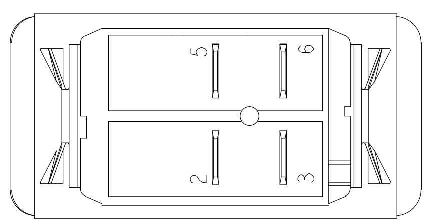
1. Power-point switch
2. Cruise control switch

The cruise control switch is used as an input for the TEC controller to maintain ground speed when engaged. The cruise control function is enabled when the switch is in the ON (center) position. Pressing the front of the switch to the momentary position sets the desired ground speed. The cruise control function is disengaged when the rear of the cruise control switch is depressed.

Note: The cruise control function can also be disengaged if either brake pedal is pressed or if the traction pedal is pressed and held in the reverse direction.

Testing

1. Before disconnecting the cruise control switch for testing, the switch and its circuit wiring should be tested as a TEC input with the InfoCenter Display (see InfoCenter Display (page 6–9)). If the InfoCenter Display verifies that switch and circuit wiring are functioning correctly, no further switch testing is necessary. If, however, the Display determines that the switch and circuit wiring are not functioning correctly, proceed with test.
2. Make sure ignition switch is OFF. Remove key from ignition switch.
3. Disassemble console arm to gain access to the cruise control switch (see Console Arm (page 8–10)).
4. Disconnect harness electrical connector from the switch.



BACK OF SWITCH

g276003

Figure 198

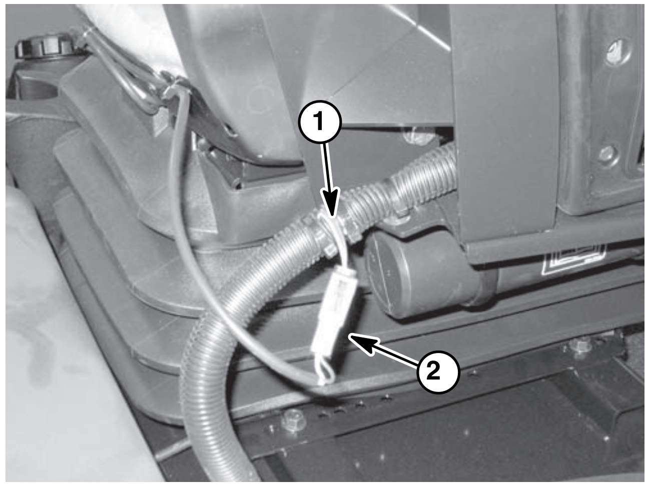
5. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each position. The switch terminals are marked as shown in Figure 198. The circuitry of the cruise control switch is shown in the chart below. Verify continuity between switch terminals.

Testing (continued)

SWITCH POSITION	CLOSED CIRCUITS	OPEN CIRCUITS
CRUISE DISENGAGE	NONE	ALL
CRUISE ON (CENTER)	2 + 3	5 + 6
SPEED SET (MOMENTARY)	2 + 3 5 + 6	NONE

6. If switch tests correctly and circuit problem still exists, check wire harness (see Appendix A (page A–1)).
7. After testing is completed, connect wire harness connector to the cruise control switch.
8. Assemble console arm (see Console Arm (page 8–10)).

Seat Switch



g309585

Figure 199

1. Wire harness connector
2. Seat switch connector

The seat switch is normally open and closes when the operator is on the seat. The seat switch and its electrical connector are located in the seat assembly. If the traction system or PTO switch is engaged when the operator raises out of the seat, an operator advisory will be displayed on the InfoCenter. Testing of the switch can be done without seat removal by disconnecting the switch wire from the machine wire harness (Figure 197).

Testing

Note: Before disconnecting the seat switch for testing, the switch and its circuit wiring should be tested as a TEC electrical input using the InfoCenter Display (see InfoCenter Display (page 6–9)). If input testing verifies that the seat switch and circuit wiring are functioning correctly, no further seat switch testing is necessary. If, however, input testing determines that the seat switch and circuit wiring are not functioning correctly, proceed with the following seat switch testing procedure.

1. Park machine on a level surface, lower cutting decks, engage parking brake and stop engine. Remove key from ignition switch.
2. Disconnect seat switch connector from the machine wire harness connector.
3. Check the continuity of the switch by connecting a multimeter (ohms setting) across the seat switch connector terminals.
4. With no pressure on the seat, there should be no continuity between the seat switch terminals.
5. Press directly onto the seat switch through the seat cushion. There should be continuity as the seat cushion approaches the bottom of its travel.
6. If testing determines that seat switch is faulty, replace seat switch (see Operator Seat Service (page 8–22)).
7. Connect seat switch connector to wire harness connector after testing is complete.

Parking Brake Switch

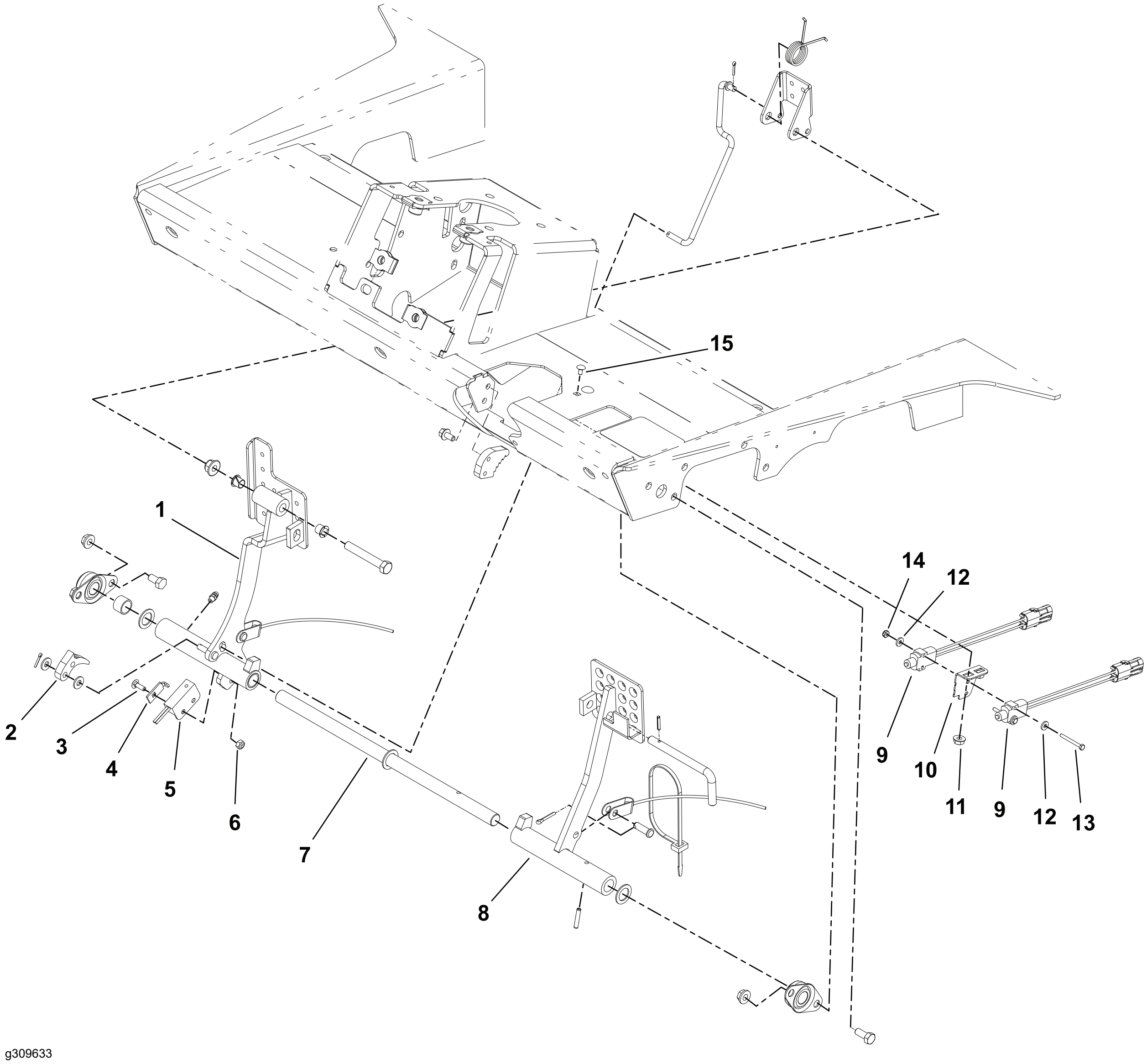


Figure 200

1. RH brake pedal
2. Brake detent
3. Carriage screw
4. Switch plate
5. Brake switch
6. Lock nut
7. Brake pivot pin
8. LH brake pedal
9. Service brake switch (2 used)
10. Switch bracket
11. Flange nut (2 each)
12. Flat washer (4 each)
13. Bolt (2 each)
14. Nut (2 each)
15. Carriage bolt (2 each)

The parking brake switch is a normally open proximity switch. The parking brake switch is attached to the bottom of the RH brake pedal (Figure 200).

When the parking brake is not applied, the parking brake detent is positioned near the target end of the parking brake switch so the switch is closed. The parking brake detent is moved away from the switch when the parking brake is applied causing the switch to open.

Testing the Parking Brake Switch

Note: Before disconnecting the parking brake switch for testing, the switch and its circuit wiring should be tested as a TEC electrical input using the InfoCenter Display; refer to Main Information Screens (page 6–12) or Diagnostics Screen (page 6–16) > Traction. If input testing verifies that the parking brake switch and circuit wiring are functioning correctly, no further brake switch testing is necessary. If, however, input testing determines that the brake switch and circuit wiring are not functioning correctly, proceed with the following parking brake switch testing procedure.

1. Park machine on a level surface, lower cutting decks, stop the engine and remove the key from the ignition switch.
2. Inspect the parking brake detent operation.
3. Ensure the parking brake switch body is not damaged, and that the switch is securely mounted.
4. Disconnect wire harness electrical connector from the parking brake switch. Check the switch and the harness connector for damage or corrosion and clean or repair as necessary.
5. Check the continuity of the switch by connecting a multimeter (ohms setting) across the switch connector terminals.
6. When the parking brake is released (brake not applied), there should be continuity (closed) between the switch terminals.
7. When the parking brake pedal is depressed (brake applied), there should not be continuity (open) between the switch terminals.
8. Replace parking brake switch if testing determines that it is faulty.
9. After testing is complete, connect wire harness to the brake switch and verify switch operation before returning the machine to service.
10. Perform the parking brake switch check as below:
    A. Engage the parking brake and remove the foot from the brake pedals.
    B. Press the traction pedal.
    C. The wheels will not move and the InfoCenter Display should show the message “For Traction | Release Parking Brake”.
    D. If not, readjust the parking brake switch as necessary to achieve para C.

Service Brake Switches

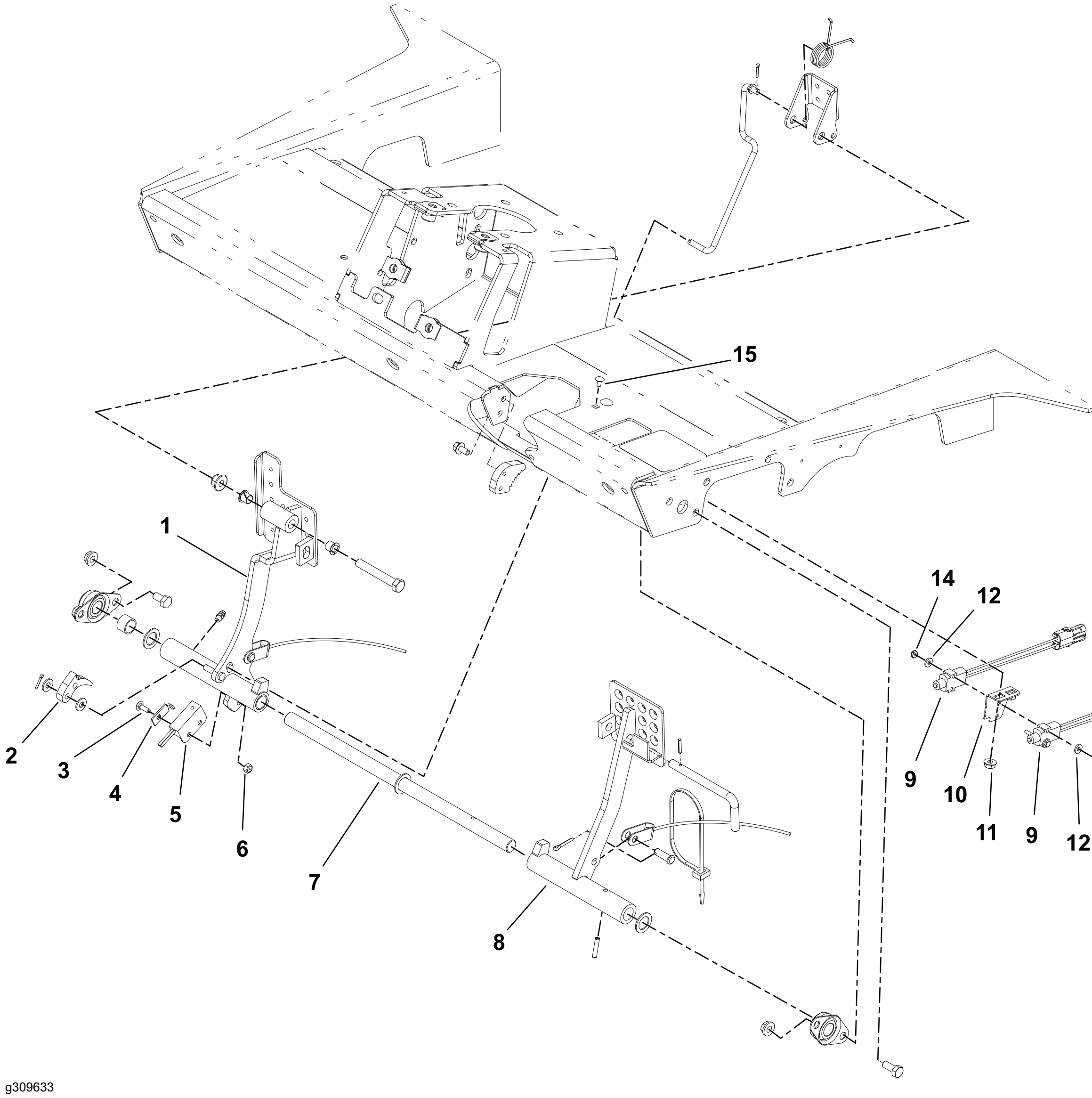


Figure 201

1. RH brake pedal	6. Lock nut	11. Flange nut (2 each)
2. Brake detent	7. Brake pivot pin	12. Flat washer (4 each)
3. Carriage screw	8. LH brake pedal	13. Bolt (2 each)
4. Switch plate	9. Service brake switch (2 used)	14. Nut (2 each)
5. Brake switch	10. Switch bracket	15. Carriage bolt (2 each)

There are 2 service brake switches on the machine; one switch is for the right brake pedal and one for the left brake pedal. Both service brake switches are normally open plunger switches. The switches are mounted to a single bracket which is attached to the underside of the left floor plate behind the service brakes.

When a service brake pedal is at rest (parking brake not engaged) the switch plunger is depressed and the switch contacts are closed. When a service brake pedal is applied, the switch plunger extends causing the switch contacts open.

Testing the Service Brake Switches

Note: Before disconnecting a service brake switch for testing, the switch and its circuit wiring should be tested as a TEC electrical input using the InfoCenter Display; refer to Diagnostics Screen (page 6–16) > Traction. If input testing verifies that the service brake switch and circuit wiring are functioning correctly, no further service brake switch testing is necessary. If, however, input testing determines that the service brake switch and circuit wiring are not functioning correctly, proceed with the following service brake switch testing procedure.

1. Park machine on a level surface, lower cutting decks, stop the engine and remove the key from the ignition switch.
2. Ensure each service brake switch body is not damaged, and that the switches are securely mounted.
3. Check the position of the service brake switches and adjust if necessary:

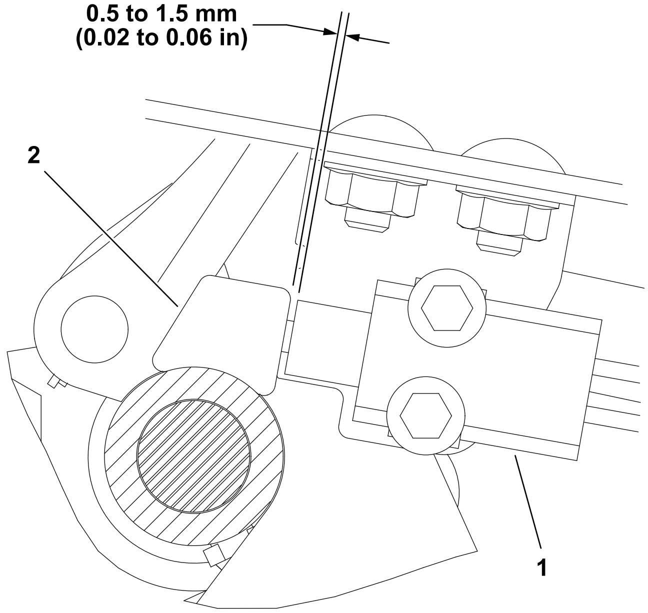


Figure 202

1. Service brake switch
2. Lug on brake pedal

   A. When the brake pedals are at rest (parking brake not engaged), each of the switch plungers should be depressed and a **0.5 to 1.5 mm (0.02 to 0.06 inch)** gap should exist between each switch body and the lugs on the brake pedals.

   B. Loosen the fasteners securing the switch bracket to the floor plate and move the bracket to adjust the switches if necessary.

4. Disconnect wire harness electrical connector from the service brake switch. Check the switch and the harness connector for damage or corrosion and clean or repair as necessary.
5. Check the continuity of the switch by connecting a multimeter (ohms setting) across the switch connector terminals.
6. When the service brake pedals are at rest (parking brake not applied), there should be continuity (closed) between the switch terminals.
7. When the service brake pedal is depressed, there should not be continuity (open) between the switch terminals.
8. Repeat steps to for the opposite service brake switch.
9. Replace the service brake switch if testing determines that it is faulty; refer to Replacing the Service Brake Switches (page 6–46).

Testing the Service Brake Switches (continued)

10. After testing is complete, connect wire harness to the service brake switch and verify switch operation before returning the machine to service.

Replacing the Service Brake Switches

1. Remove and replace the service brake switches using the Figure 201 as a guide.
2. After replacing the service brake switches, connect the wire harness to the service brake switches.
3. Adjust the service brake switches as below:
   A. When the brake pedals are at rest (parking brake not engaged), each of the switch plungers should be depressed and a **0.5 to 1.5 mm (0.02 to 0.06 inch)** gap should exist between each switch body and the lugs on the brake pedals; refer to Figure 202.
   B. Loosen the fasteners securing the switch bracket to the floor plate and move the bracket to adjust the switches if necessary.
4. Perform the service brake switches check as below:

   Note: The service brake switches output should be checked as a TEC electrical input using the InfoCenter Display; refer to Diagnostics Screen (page 6–16) > Traction > Inputs; refer to Figure 203.

   A. Press and release both the brake pedals multiple times.

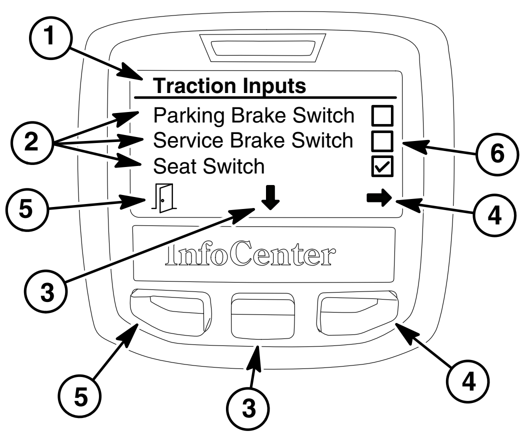


Figure 203

1. Diagnostics menu
2. Diagnostics items
3. Move to menu items
4. Choose menu item
5. Back button
6. Brake switch indicator

   B. With both the brake pedals released, confirm that the brake switches are closed and the InfoCenter display should show service brake switch OFF; refer to Figure 203.

Replacing the Service Brake Switches (continued)

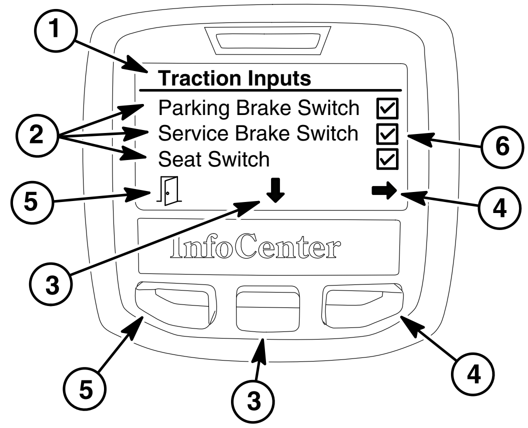


Figure 204

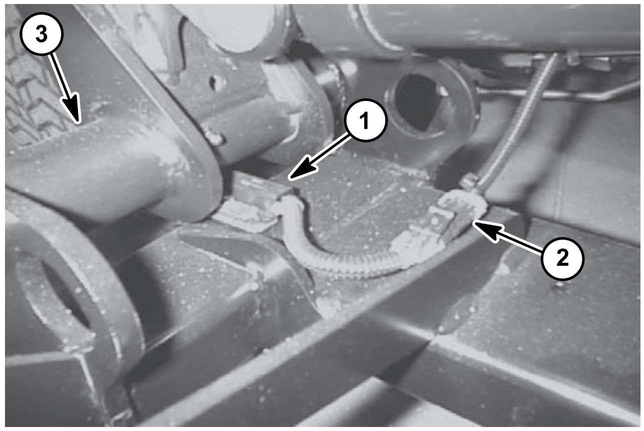
1. Diagnostics menu
2. Diagnostics items
3. Move to menu items
4. Choose menu item
5. Back button
6. Brake switch indicator

C. With both the brake pedals engaged, confirm that the brake switches are open and the InfoCenter display should show service brake switch ON; refer to Figure 204.

Note: Perform this check with brake pedal locking latch both engaged and disengaged.

D. If any problem exist, troubleshoot by re-adjusting the brake switches and checking the connectors between the electrical harness. When properly adjusted, both the switches will have a closed output when the brake pedals are not engaged; refer to Testing the Service Brake Switches (page 6–45).

Cutting Deck Position Switches



g309635

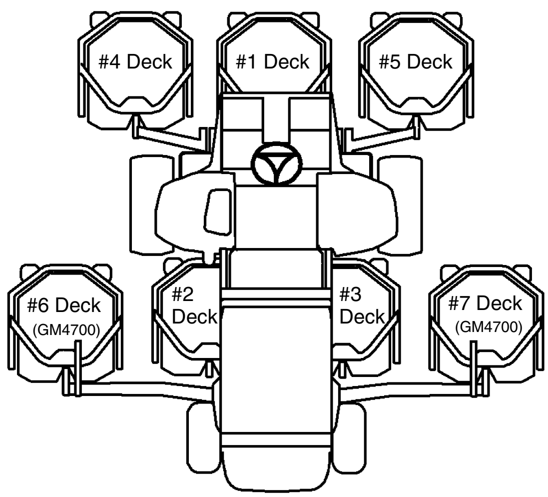
Figure 205

1. Position switch
2. Switch connector
3. Lift arm (#5 shown)

The cutting deck position switches are normally open proximity switches that are located on the traction unit frame (Figure 205). The sensing plate is located on the cutting deck lift arm. The Groundsmaster 4500−D uses two (2) cutting deck position switches: for decks 4 and 5. There are four (4) deck position switches on the Groundsmaster 4700−D: for decks 4, 5, 6 and 7.

When a cutting deck is lowered, the sensing plate is located near the position switch and the switch closes. This closed switch provides an input for the TEC controller to allow the lowered cutting decks to operate.

Switch Testing



g308386

Figure 206
CUTTING DECK LOCATIONS

Switch Testing (continued)

Note: Before disconnecting the deck position switch for testing, the switch and its circuit wiring should be tested as a TEC electrical input using the InfoCenter Display (see InfoCenter Display (page 6–9)). If input testing verifies that the deck position switch and circuit wiring are functioning correctly, no further position switch testing is necessary. If, however, input testing determines that the deck position switch and circuit wiring are not functioning correctly, proceed with the following deck position switch testing procedure.

1. Park machine on a level surface, lower cutting decks, engage parking brake and stop engine. Remove key from ignition switch.
2. Disconnect deck position switch that requires testing from machine wire harness.
3. Check the continuity of the switch by connecting a multimeter (ohms setting) across the switch connector terminals.
4. With the cutting deck in the lowered position, there should be continuity across the switch terminals.
5. Raise the cutting deck. There should be no continuity across the switch terminals.
6. Replace position switch if testing determines that it is faulty.
7. After testing is complete, connect wire harness electrical connector to the position switch.

Switch Adjustment

Adjust switch to have 1.6 mm (1/16 in) clearance between switch and sensing plate on the lift arm.

Relays with Four (4) Terminals

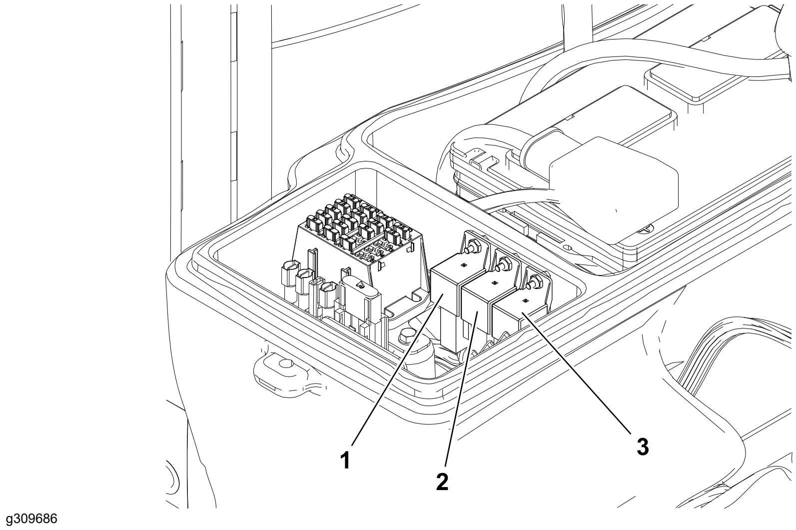


Figure 207

1. TEC 1 power relay
2. TEC 2 power relay
3. Cab power relay

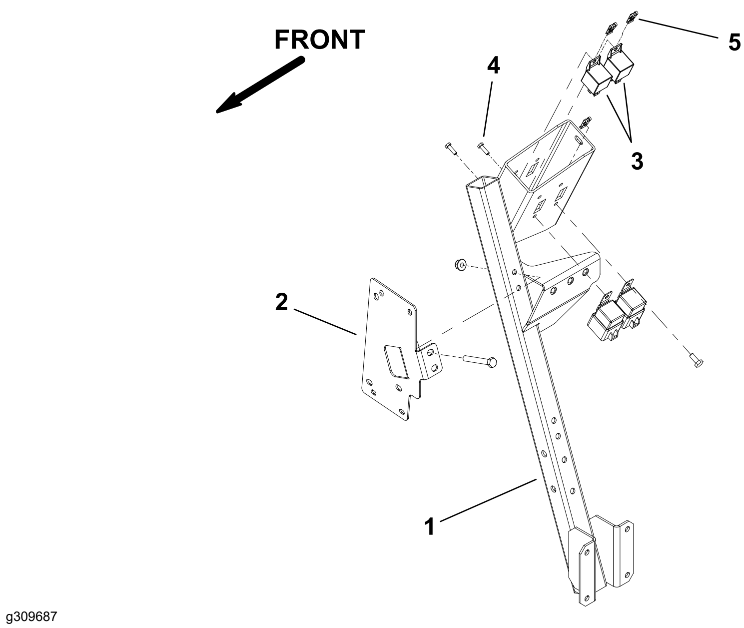


Figure 208

1. Air cleaner mount
2. Engine ECU mount
3. 4 terminal relay
4. Screw
5. Tinnerman nut

Your Groundsmaster uses a number of electrical relays that have four (4) terminals. A tag near the wire harness relay connector can be used to identify each relay.

The TEC 1 and TEC 2 power relays are used to provide current to most of the fuse protected circuits (system power, InfoCenter display, head lights, power point and optional electric equipment). The TEC 1 and TEC 2 power relays are energized when the ignition switch is in the ON or START position.

The start relay is used to provide current to the engine starter motor solenoid. The start relay is energized by the engine ECU.

The air heater relay is used on models 30893, 30893TE, 30899 and 30899TE to provide current for the engine air heater used for starting a cold engine. When necessary, the air heater relay is energized by the engine ECU.

The glow relay is used on models 30885 and 30887 to provide current to the engine glow plugs when energized by the engine ECU.

If machine is equipped with a operator cab, the cab power relay provides current to the operator cab electrical components. The cab power relay is energized when the ignition switch is in the ON or START position.

The TEC 1, TEC 2 and operator cab power (if equipped) relays reside in the power center behind the operator's seat (Figure 207). The start, air heater and glow relays are attached to the air cleaner mount bracket near the engine ECU (Figure 208).

Testing

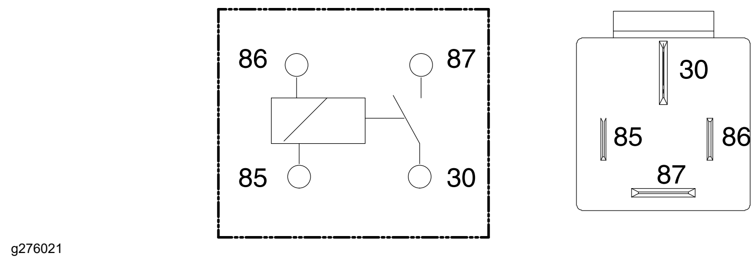


Figure 209

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.
2. To make sure that machine operation does not occur unexpectedly, disconnect negative (−) cable from battery and then disconnect positive (+) cable from battery (see Battery Service (page 6–83)).
3. Locate relay that is to be tested.
4. Disconnect wire harness connector from relay. Remove relay from mounting bracket for testing.
5. Using a multimeter, verify that coil resistance between terminals 86 and 85 is approximately 72 ohms.
6. Connect multimeter (ohms setting) leads to relay terminals 30 and 87. Ground terminal 86 and apply +12 VDC to terminal 85. The relay should make and break continuity between terminals 30 and 87 as +12 VDC is applied and removed from terminal 85.
7. Disconnect voltage and test leads from the relay terminals.
8. Secure relay to mounting bracket and connect wire harness connector to relay.
9. Secure all removed components to machine.
10. Connect positive (+) cable to battery and then connect negative (−) cable to battery (see Battery Service (page 6–83)).

Relays with Five (5) Terminals

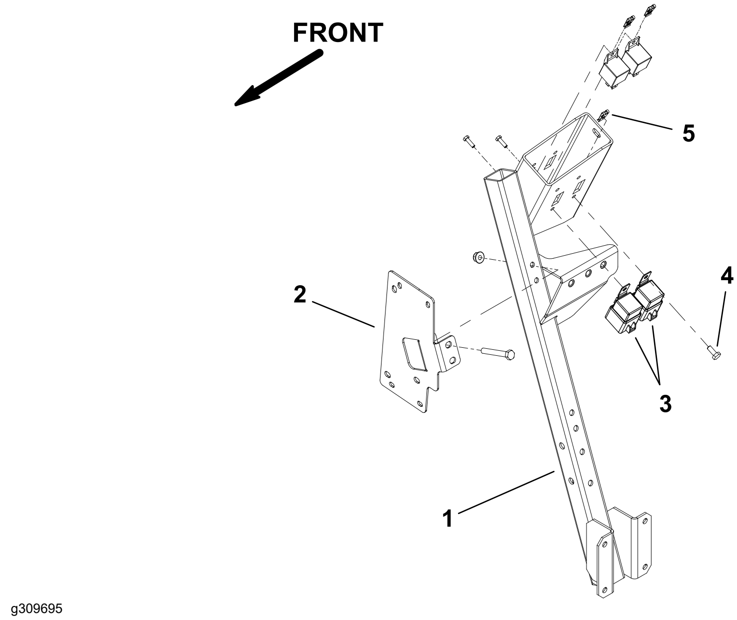


Figure 210

1. Air cleaner mount
2. Engine ECU mount
3. 5 terminal relay
4. Cap screw
5. Flange nut

Your Groundsmaster uses a number of electrical relays that have five (5) terminals. A tag near the wire harness relay connector can be used to identify each relay.

The main relay is used on models 30893, 30893TE, 30899 and 30899TE to provide current for several engine components when energized by the engine electronic control unit (ECU).

The rack actuator relay is used on models 30893, 30893TE, 30899 and 30899TE to provide current for the engine rack actuator when energized by the engine ECU.

The EGR relay is used on models 30885 and 30887 to provide current to the engine EGR valve when energized by the engine ECU.

The main, rack actuator and EGR relays are attached to the air cleaner mount bracket near the engine ECU (Figure 210).

Testing

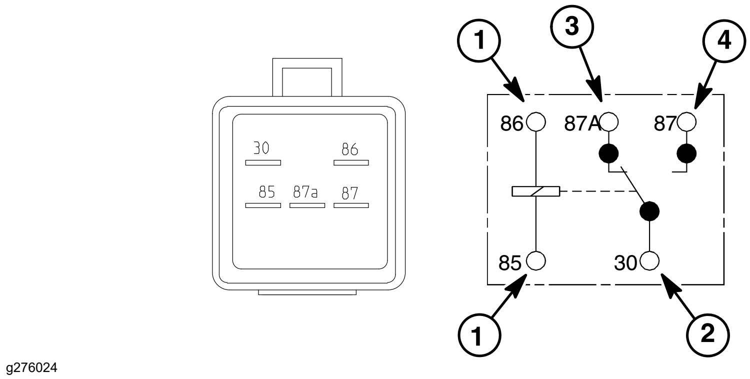


Figure 211

1. Coil terminal
2. Common terminal
3. Normally closed terminal
4. Normally open terminal

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.
2. To make sure that machine operation does not occur unexpectedly, disconnect negative (−) cable from battery and then disconnect positive (+) cable from battery (see Battery Service (page 6–83)).
3. Locate relay that is to be tested.
4. Disconnect wire harness connector from relay. Remove relay from mounting bracket for testing.
5. Using a multimeter, verify that coil resistance between terminals 85 and 86 is from 71 to 88 ohms.
6. Connect multimeter (ohms setting) leads to relay terminals 30 and 87. Ground terminal 86 and apply +12 VDC to terminal 85. The relay should make and break continuity between terminals 30 and 87 as +12 VDC is applied and removed from terminal 85.
7. Disconnect voltage from terminal 85 and multimeter lead from terminal 87.
8. Connect multimeter (ohms setting) leads to relay terminals 30 and 87A. Apply +12 VDC to terminal 85. The relay should make and break continuity between terminals 30 and 87A as +12 VDC is applied and removed from terminal 85.
9. After testing, disconnect voltage and multimeter test leads from the relay terminals. Secure relay to mounting bracket and connect wire harness connector to relay.
10. Secure all removed components to machine.
11. Connect positive (+) cable first to battery and then connect negative (−) cable to battery (see Battery Service (page 6–83)).

Traction Pedal Position Sensor

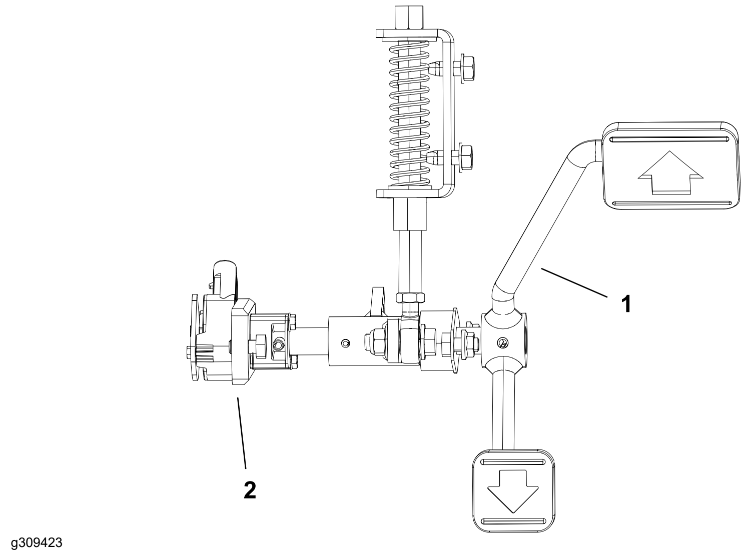


Figure 212

1. Traction pedal
2. Pedal position sensor

The traction pedal position sensor is connected to the traction pedal assembly (Figure 212). This position sensor determines the neutral band for the traction pedal, the direction of travel desired by the operator and the traction speed. The position sensor is a single analog, dual digital signal electronic device. The position sensor portion is a variable resistor that provides an analog signal for the TEC controller to determine the desired ground speed based on how far the traction pedal is moved. The traction pedal position sensor also houses two (2) switches that are used to determine the neutral position (deadband) and the indicated direction of travel (forward or reverse). As the traction pedal is depressed, the internal wiper of the position sensor moves and sends the analog signal to the TEC controller to determine machine direction and speed.

The traction pedal position sensor must be calibrated with the TEC controller to determine the neutral and full speed set points for both the forward and reverse directions. The position sensor calibration process can be completed using the InfoCenter display.

A properly installed and calibrated traction pedal position sensor is critical to accurate traction response and position sensor life. Use care when installing and calibrating the position sensor.

Before suspecting a faulty position sensor, the sensor and its circuit wiring should be tested as a TEC input with the InfoCenter Display (see InfoCenter Display (page 6–9)). If necessary, follow calibration procedures for the traction pedal position sensor found in the Adjustments section of this chapter. If the position sensor tests correctly and a circuit problem still exists, check the capacitor assembly; refer to Capacitor Assembly (page 6–76). If position sensor replacement is necessary, refer to Traction Pedal (page 8–7).

Swashplate Angle Sensor

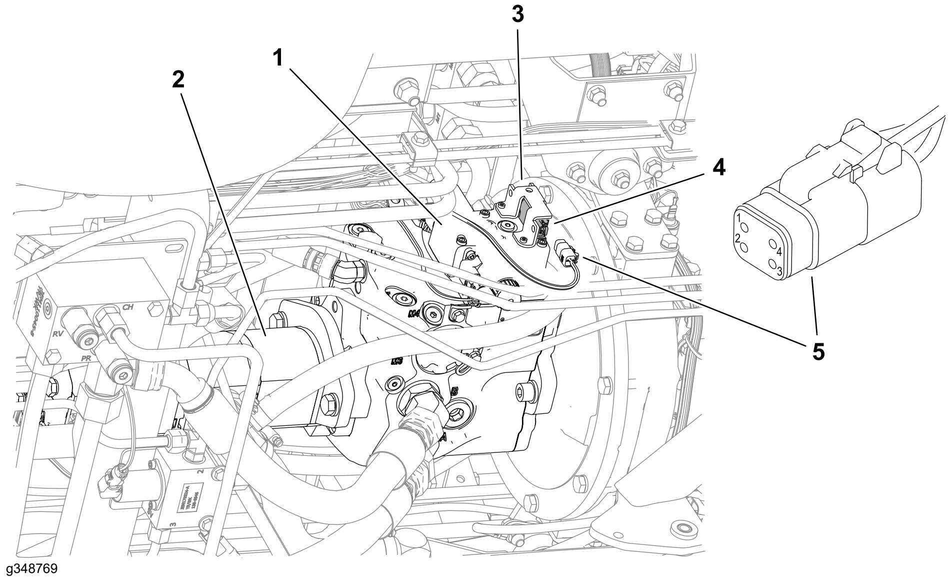


Figure 213

1. Piston (traction) pump
2. Gear pump
3. Guard
4. Swashplate angle sensor
5. Wire harness connector

The swashplate angle sensor is a hall-effect sensor mounted to the left side of the piston (traction) pump. The sensor is triggered by a link attached to the piston (traction) pump swashplate shaft and reports the current position of the swashplate to the TEC (T1) to aid in traction control.

Testing the Swashplate Angle Sensor

It is difficult to test the angle sensor accurately in the field. Rule out any wiring issues by using the following procedure to test the wire harness elements that support the angle sensor before replacing the sensor.

1. Move the machine outdoors in an open secure area.
2. Set the InfoCenter display to the Service>Diagnostics>Traction>Inputs screen.
3. The sensor output voltage and percentage of sensor movement readings should increase and decrease consistently while operating the machine in both forward and reverse directions.
4. If no readings are displayed or the signals displayed are erratic, check the sensor wiring:
   A. Disconnect the machine wire harness from the angle sensor.
   B. Inspect the wire harness and connector for corrosion or damage.
   C. With the key switch in the RUN position, approximately 5VDC should be present at the wire harness connector pin 4 (power).
   D. Check the wire harness connector pin 1 (ground) connection to ground.
   E. Check the continuity exists from wire harness pin 3 (signal) to the TEC (T1) connector pin 28; refer to Appendix A (page A–1). Wire harness pin 3 should not connect to ground.
   F. Repair the wire harness if necessary.
5. If the wire harness tests correctly and a circuit problem still exists, check the capacitor assembly; refer to Capacitor Assembly (page 6–76).

Testing the Swashplate Angle Sensor (continued)

6. Replace the swashplate angle sensor if necessary and calibrate the traction pump; refer to Traction Pump Swashplate Angle Sensor Calibration (page 6–25).

Toro Electronic Controllers (TEC)

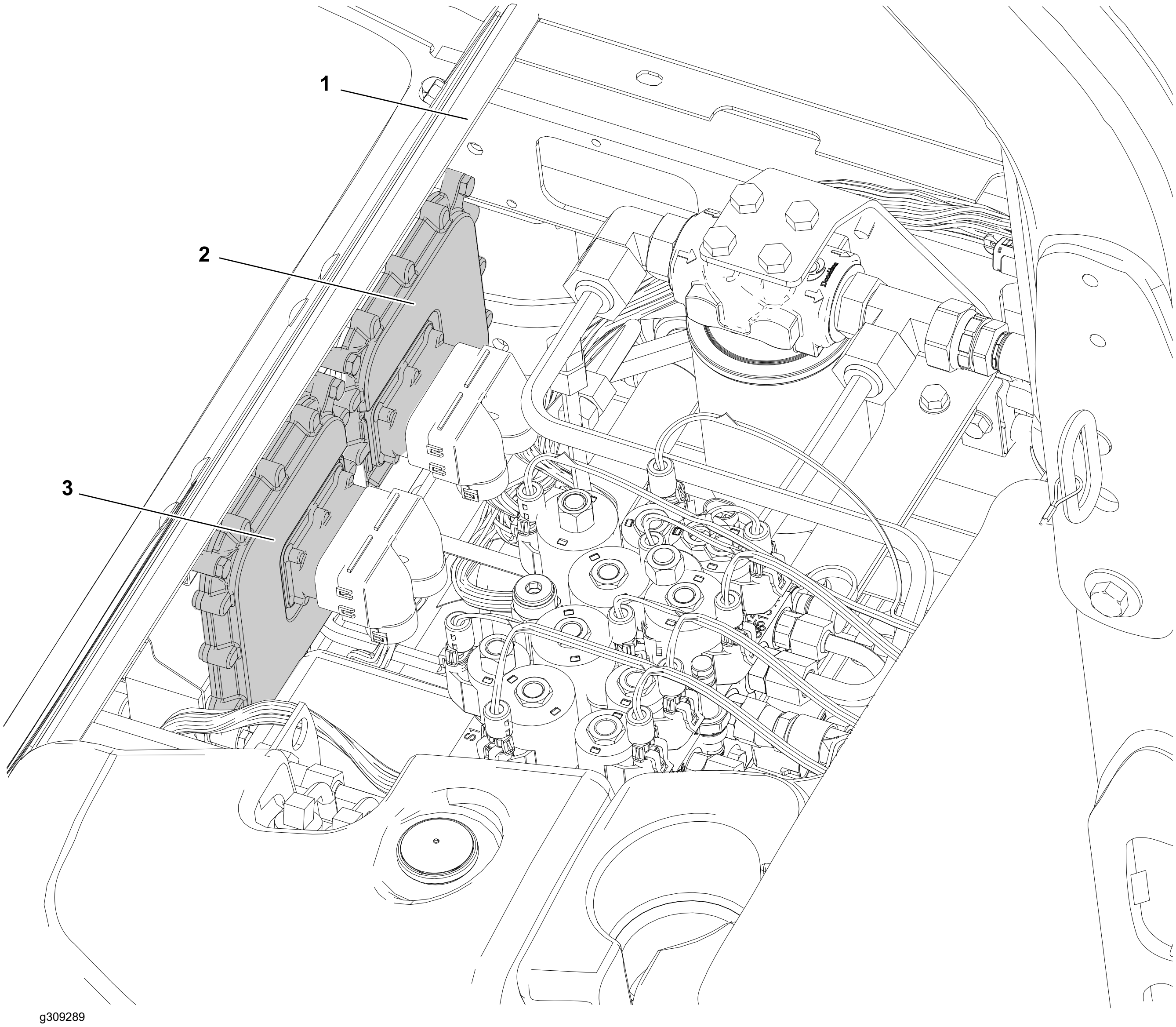


Figure 214

1. Operator platform
2. TEC-5004 (TEC 1)
3. TEC-5004 (TEC 2) (GM4700-D only)

Groundsmaster 4500−D and 4700−D machines use a Toro Electronic Controller (TEC−5004) to control electrical system operation. Groundsmaster 4700−D machines use an additional TEC−5004 controller for electrical control of the rear cutting decks (PTO and lift/ lower functions). The controllers are microprocessor controlled that sense the condition of various switches and sensors (inputs). The controllers then direct electrical power to control appropriate machine functions (outputs) based on the input state. The controllers are attached to the operator platform under the operator seat (Figure 214).

Logic power is provided to the controllers as long as the battery cables are connected to the battery. A pair of 2 amp fuses (B5 for TEC 1 and C5 for TEC 2) provide circuit protection for this logic power to the controllers.

Toro Electronic Controllers (TEC) (continued)

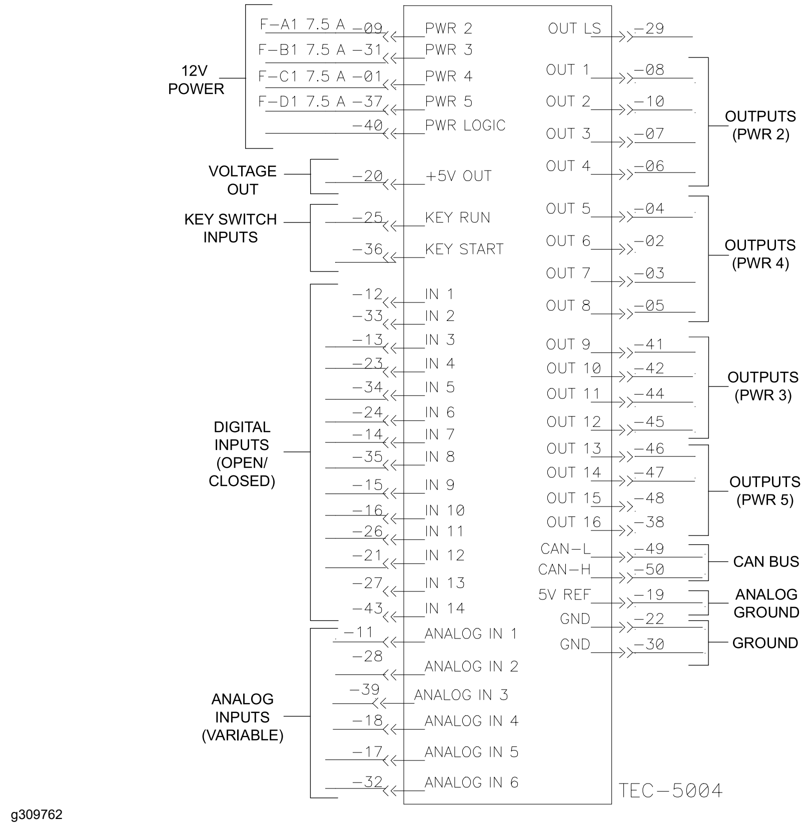


Figure 215

TEC 1 Controller

The TEC 1 controller monitors the states of the following components as inputs: ignition switch, traction pedal position sensor, parking brake switch, automatic switch, seat switch, swashplate sensor, cruise control switch, PTO switch, center cutting deck lift switch, cutting deck position switches (decks 1 and 2), hydraulic temperature sender and hydraulic pressure transducer.

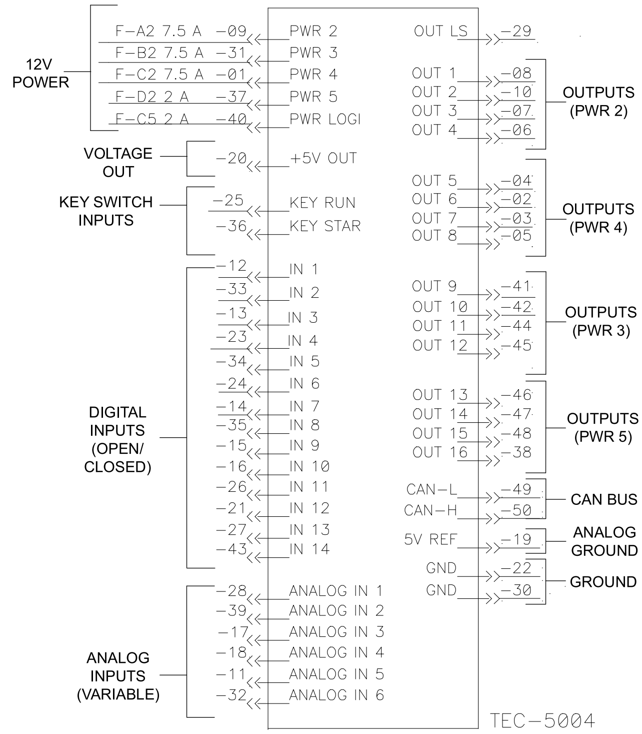
The TEC 1 controller controls electrical output to the engine electronic control unit (ECU) (start and run functions), fan drive solenoid coils (direction and speed), traction (piston) pump solenoids (forward and reverse), traction solenoid coil (HIGH/LOW speed), PTO solenoid coils (decks 1 through 5), center cutting decks raise/lower/float (decks 1 through 5) and counterbalance. Circuit protection for front TEC outputs is provided by four (4) 7.5 amp fuses (A−1, B−1, C–1 and D−1).

On Groundsmaster 4700−D machines, the TEC 2 controller monitors the states of the following components as inputs: ignition switch, cutting deck lift switches (decks 6 and 7) and cutting deck position switches (decks 6 and 7).

The TEC 2 controller controls electrical output to the PTO solenoid coils (decks 6 and 7), cutting decks raise/lower/float (decks 6 and 7). Circuit protection for rear TEC outputs is provided by four (4) 7.5 amp fuses (A−2, B−2, C–2 and D−2).

The InfoCenter display should be used to check inputs and outputs of the TEC controllers. Information on using the InfoCenter is included in the InfoCenter Display section of this chapter.

Toro Electronic Controllers (TEC) (continued)



g309763

Figure 216

TEC 2 Controller

The connection terminal functions for the TEC controllers are shown in Figure 215 and Figure 216. Note that electrical power for controller outputs is provided through 4 (4) connector terminals (PWR 2, PWR 3, PWR 4 and PWR 5) each protected with a 7.5 amp fuse. A fifty (50) pin wire harness connector attaches to each controller. The wire harness connector pins are identified in the diagram in Figure 215 and Figure 216. The layout of the wire harness connectors that plug into the TEC controllers is shown in Figure 217.

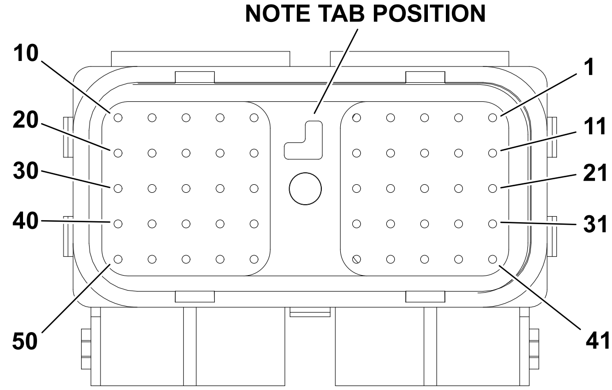


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Figure 217

IMPORTANT

When testing for wire harness continuity at the connector for the TEC controller, take care to not damage the connector pins with multimeter test leads. If connector pins are enlarged or damaged during testing, connector repair will be necessary for proper machine operation.

The machine electrical schematic and wire harness drawings in Chapter 9 − Foldout Drawings can be used to identify possible circuit problems between the controllers and the input/output devices (e.g. switches and solenoid coils).

Because of the solid state circuitry built into the TEC controllers, there is no method to test a controller directly. A controller may be damaged if an attempt is made to test it with an electrical test device (e.g. digital multimeter or test light).

Note: The two (2) TEC controllers used on the Groundsmaster 4700−D are matched for correct machine operation. If either of these components are replaced for any reason, system software needs to be reprogrammed by your Toro Distributor.

IMPORTANT

Before performing welding on the machine, disconnect both positive and negative battery cables from the battery, disconnect the wire harness connector from the TEC controllers and disconnect the terminal connector from the alternator. Also, disconnect and remove the engine ECU from the machine before welding. These steps will prevent damage to the machine electrical system when welding.

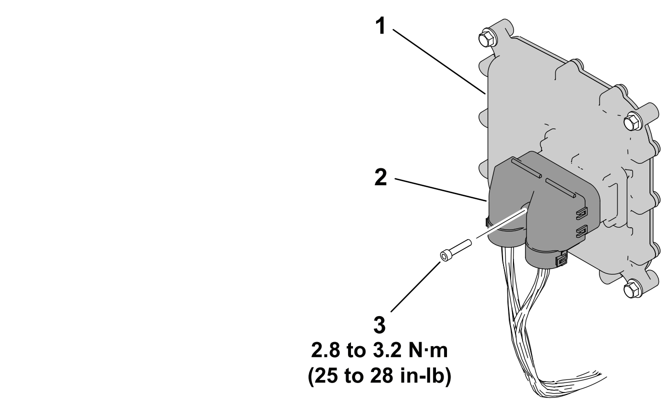


Figure 218

1. TEC controller
2. Machine harness connector
3. Socket head screw

If the wire harness connector is removed from the TEC controller for any reason, tighten the harness connector screw from **2.8 to 3.2 N·m (25 to 28 in-lb)**.

Hydraulic Solenoid Valve Coils

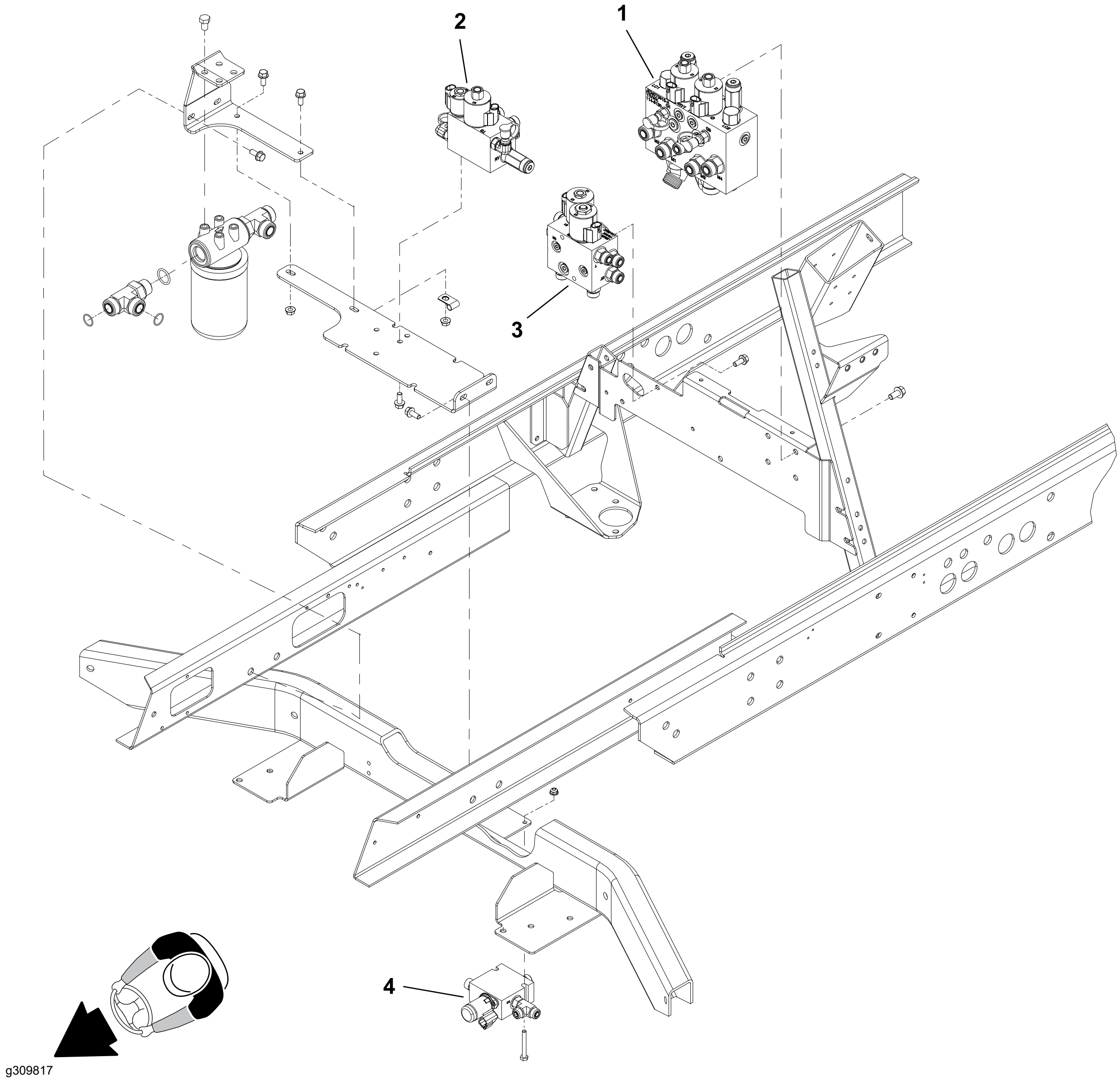


Figure 219

GROUNDSMASTER 4500−D SHOWN

1. Deck control manifold
2. Lift control manifold
3. Fan control manifold
4. Two speed shift manifold

Numerous hydraulic solenoid valve coils are used on the hydraulic control manifolds of Groundsmaster 4500−D and 4700−D machines. When energized by the TEC controller, these coils provide hydraulic circuit control.

Three (3) different solenoid valve coils are used on your Groundsmaster. Two (2) of these coils slide onto the solenoid valve and are secured with a nut. Additionally, the two speed shift manifold (item 4 in Figure 219) includes a solenoid valve with an integral solenoid coil. Testing of all of these coils can be done with the coil remaining on the hydraulic valve.

Note: To assist in troubleshooting, identical solenoid coils can be exchanged. If the problem follows the exchanged coil, a problem with the coil likely exists. If the problem remains unchanged, something other than the solenoid coil is the problem source (e.g. switch, circuit wiring, hydraulic problem).

Solenoid Coil Testing

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.
2. Locate hydraulic solenoid valve coil to be tested (Figure 219).
3. Disconnect wire harness connector from solenoid valve coil.

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

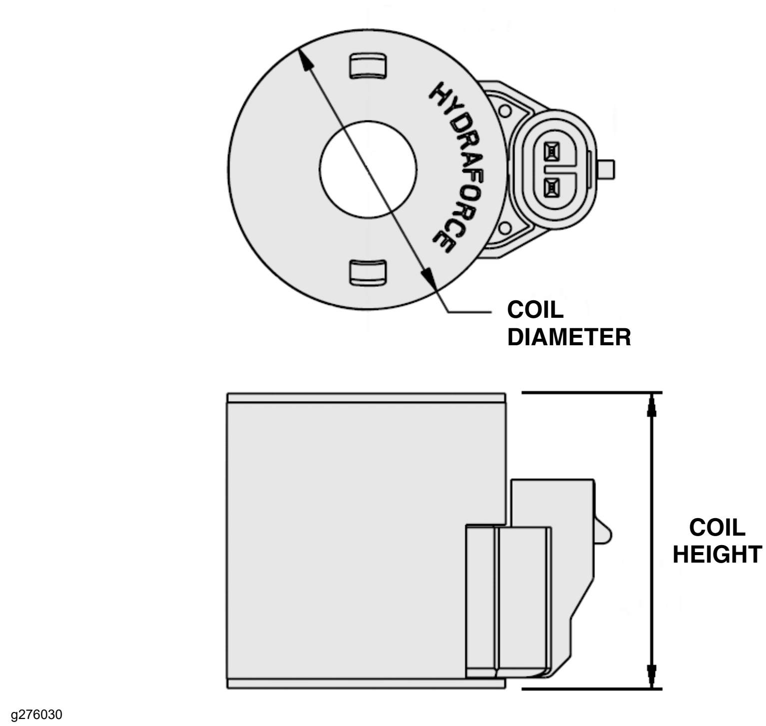


Figure 220

4. Using a multimeter (ohms setting), measure resistance between the two (2) connector terminals on the solenoid valve coil.

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

   A. If coil is secured to valve with a nut, identify coil by measuring the coil diameter and coil height (Figure 220). The correct resistance for the solenoid coil is identified in the table below.

COIL DIAMETER	COIL HEIGHT	COIL RESISTANCE
46.7 mm (1.84 in)	49.9 mm (1.96 in)	7.1 ohm
35.8 mm (1.41 in)	36.3 mm (1.43 in)	8.8 ohm

   B. The resistance of the solenoid valve coil in the HI/ LOW range control manifold (item 4 in Figure 219) is 7.1 ohms.

5. If solenoid coil resistance is incorrect, replace coil (see Deck Control Manifold Service (GM4500-D) (page 5–134)).
6. After testing is completed, connect wire harness connector to the solenoid valve coil.

Piston (Traction) Pump Control Solenoid Coils

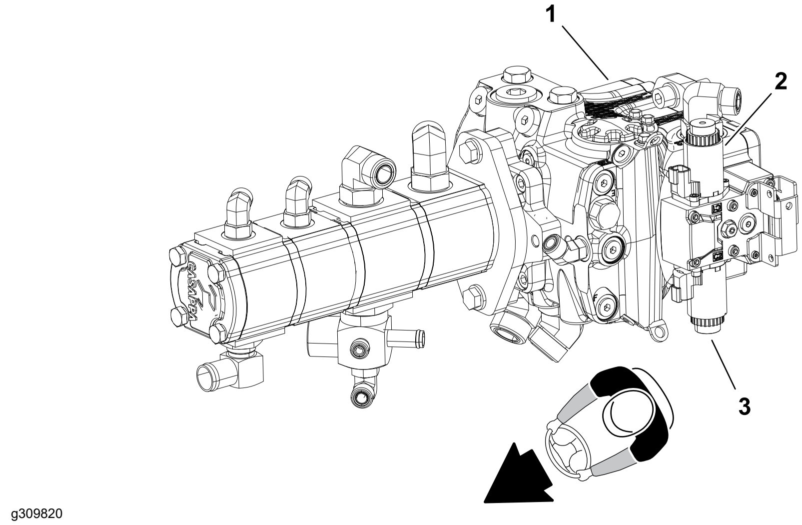


Figure 221

1. Piston pump
2. Forward solenoid coil
3. Reverse solenoid coil

The piston (traction) pump uses an electronic control assembly for swashplate rotation. Electrical outputs from the machine TEC controller are provided to two (2) solenoid coils for pump control. The piston pump control assembly is attached to the left side of the piston pump (Figure 221).

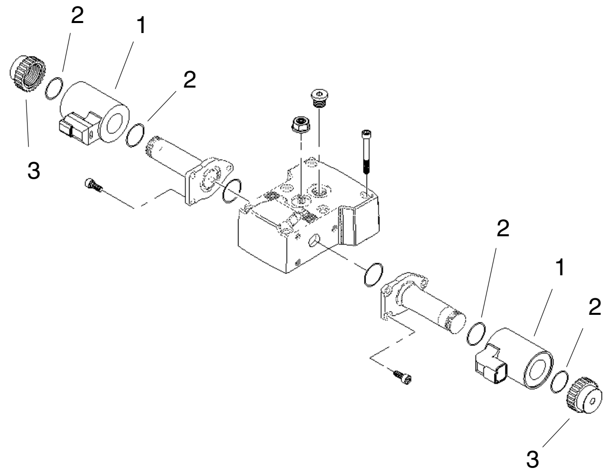
Note: To assist in troubleshooting, the piston pump solenoid coils can be exchanged because they are identical. If the problem follows the exchanged coil, a problem with the coil likely exists. If the problem remains unchanged, something other than the solenoid coil is the problem source (e.g. traction pedal, circuit wiring, hydraulic problem).

Solenoid Coil Testing

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.
2. Locate piston pump solenoid coil to be tested (Figure 221). Disconnect wire harness connector from solenoid coil.

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

Solenoid Coil Testing (continued)



g276033

Figure 222

1. Solenoid coil
2. O−ring
3. Coil nut

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3. Using a multimeter (ohms setting), measure resistance between the two (2) connector terminals on the solenoid coil. Solenoid coil resistance should be 3.66 ohms.

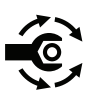
   Note: Solenoid coil resistance should be measured with solenoid at approximately 20 ºC (68 ºF). Resistance may be slightly different than listed at different temperatures. Typically, a failed solenoid coil will either be shorted (very low or no resistance) or open (infinite resistance).

4. If solenoid coil resistance is incorrect, replace coil:

   A. Use a 12 point, 26 mm socket to loosen and remove the coil nut that secures solenoid coil.

   B. Slide solenoid coil and O−rings from valve stem. Clean all corrosion or dirt from the valve.

   C. Slide new coil with O−rings onto the solenoid stem.

   D. Use a 12 point, 26 mm socket to install and torque coil nut to **5 N·m (44 in−lb)** (do not over tighten).

5. After testing is completed, connect wire harness connector to the solenoid coil.

Hydraulic Oil Temperature Sender

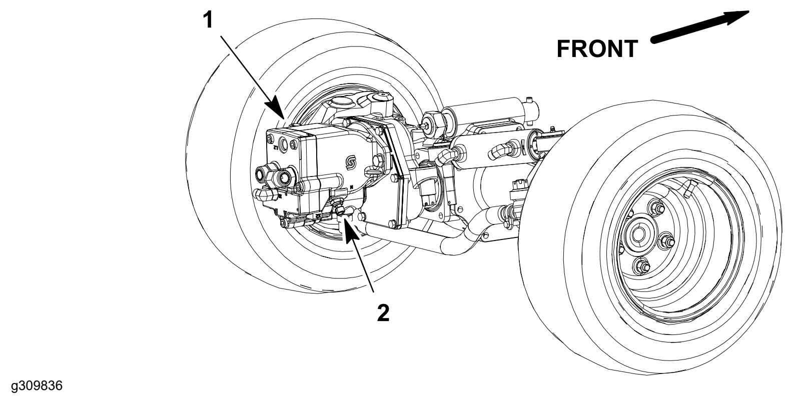


Figure 223

1. Rear axle motor
2. Oil temperature sender

A temperature sender is used as an input for the TEC controller to identify if the hydraulic oil temperature has reached an excessive level. The hydraulic oil temperature sender is attached to the rear axle motor at the rear of the machine (Figure 223).

The InfoCenter will display fault code 18 if the hydraulic oil temperature sender inputs to the TEC controller are not in the normal range.

Testing

Note: Before disconnecting the hydraulic oil temperature sender for testing, the sender and its circuit wiring should be tested as a TEC electrical input using the InfoCenter Display (see InfoCenter Display (page 6–9)). If input testing verifies that the temperature sender and circuit wiring are functioning correctly, no further sender testing is necessary. If, however, input testing determines that the temperature sender and circuit wiring are not functioning correctly, proceed with the following temperature sender testing procedure.

1. Park machine on a level surface, lower cutting decks, engage parking brake and stop engine. Remove key from ignition switch.
2. Locate hydraulic oil temperature sender on bottom of rear axle motor. Disconnect wire harness connector from sender and inspect for connector or wiring damage.
3. Thoroughly clean area around temperature sender and remove sender from rear axle motor.

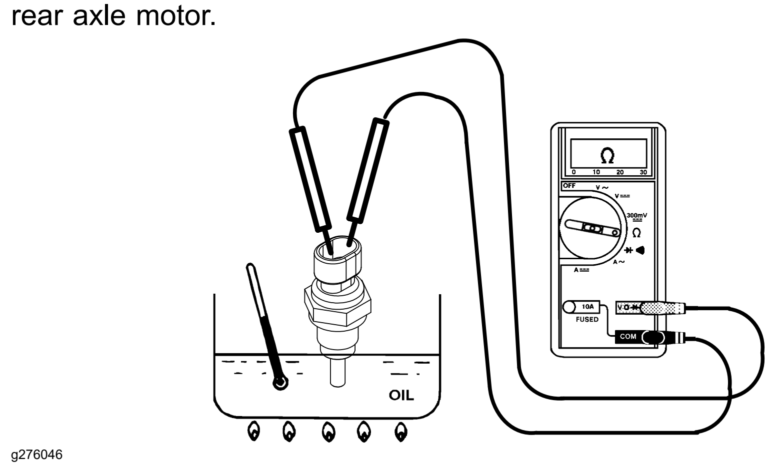


Figure 224

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4. Put sensing end of sender in a container of oil with a thermometer and slowly heat the oil (Figure 224).

CAUTION

Handle the hot oil with extreme care to prevent personal injury or fire.

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

Note: Use a infrared temperature instrument to measure the oil temperature.

5. Check resistance of the sender with a multimeter (ohms setting) as the oil temperature increases.

   A. The meter should indicate from 11.6 to 13.5 kilo ohms at 20 ºC (68 ºF).

   B. The meter should indicate from 2.3 to 2.5 kilo ohms at 60 ºC (140 ºF).

   C. The meter should indicate from 605 to 669 ohms at 100 ºC (212 ºF).

   D. Replace sender if specifications are not met.

6. After allowing the sender to cool, install sender into axle motor:

   A. Install new O−ring on sender and thread sender into motor port. Torque sender from **12.3 to 14.9 N·m (9 to 11 ft−lb)**.

   B. Connect wire harness connector to sender.

7. Check and fill hydraulic system to proper level.

Traction Pressure Sensor

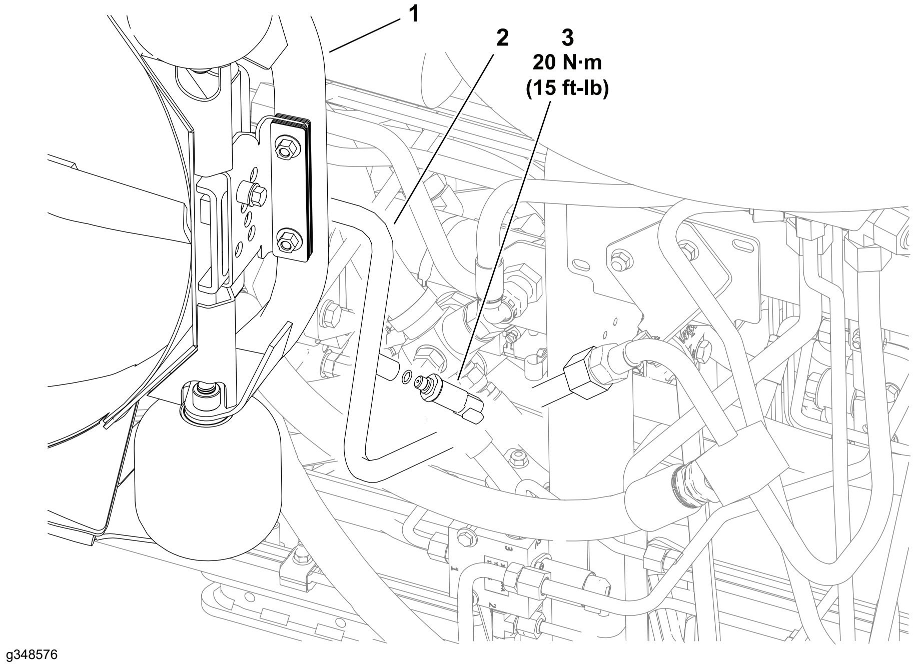

Figure 225

1. Rear right side cutting unit (#3)
2. Hydraulic tube assembly
3. Pressure transducer

A pressure sensor is used to monitor the traction circuit hydraulic pressure when the machine is moving in the forward direction. The pressure sensor is located in the hydraulic tube between the front wheel and rear axle motors. The TEC (T1) uses information from the sensor to adjust the counterbalance pressure by sending a PWM (Pulse Width Modulation) signal to the proportional relief valve (TS) located in the lift manifold.

Testing the Traction Pressure Sensor

1. Park the machine on a level surface, lower the cutting units and stop the engine.
2. Disconnect the wire harness connector from the sensor and clean any corrosion from the sensor and wire harness connector contacts.
3. Test the pressure sensor:

   A. Remove the pressure sensor.

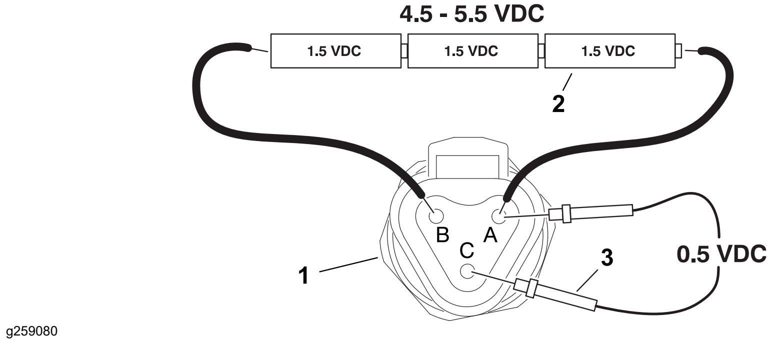

Figure 226

1. Pressure sensor
2. 4.5 to 5.5 VDC power supply
3. Multimeter probe

Testing the Traction Pressure Sensor (continued)

B. Connect a 4.5 to 5.5 VDC power supply to the supply (+) pin A and ground (−) pin B of the sensor.

C. Connect a multimeter set to DC voltage to the signal (+) pin C and ground (−) pin B of the sensor. A small amount of voltage (0.5 VDC) should be present on the multimeter display.

4. Replace pressure sensor if necessary. Apply thread sealant to the sensor threads prior to installation and tighten to **20 N·m (15 ft-lb)**.

5. If the pressure sensor tests correctly and a circuit problem still exists, check the capacitor assembly and the wire harness; refer to Capacitor Assembly (page 6–76) and Appendix A (page A–1).

6. Connect the wire harness to the pressure sensor after testing.

Fuel Pump (Models 30893, 30893TE, 30899 and 30899TE)

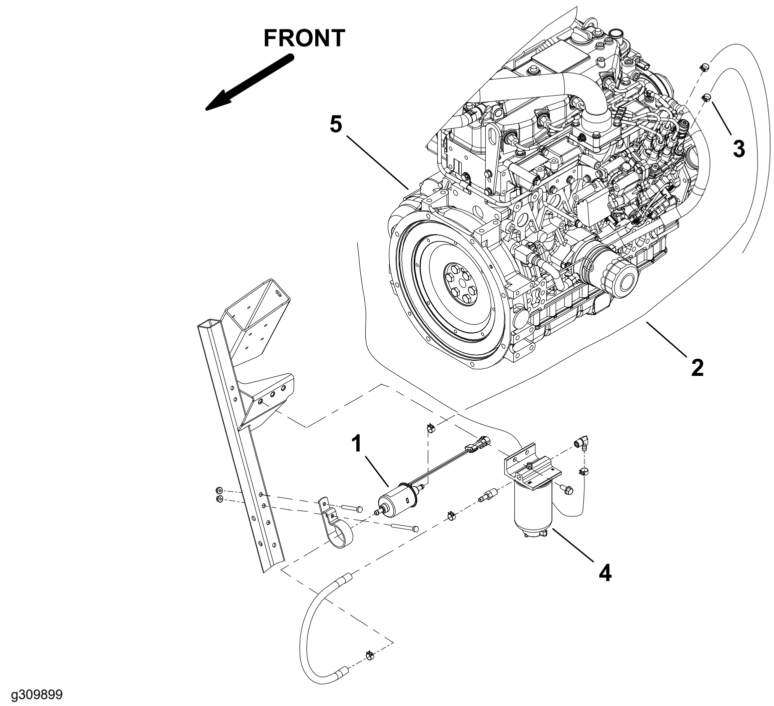

Figure 227

1. Fuel pump
2. Fuel supply hose
3. Hose clamp
4. Fuel water separator
5. Engine

The fuel pump is attached to the air cleaner mount below the fuel water separator (Figure 227).

Operational Test

1. Park machine on a level surface, lower cutting decks, stop engine and apply parking brake. Raise hood to access fuel pump.
2. Disconnect fuel supply hose from the fuel injection pump fitting on the engine (Figure 227). This hose is the fuel pump discharge.
3. Make sure fuel hoses attached to the fuel pump are free of obstructions.
4. Place disconnected end of supply hose into a large, graduated cylinder sufficient enough to collect 0.95 liter (1 quart).

IMPORTANT

When testing fuel pump output, do not turn ignition switch to the START position.

5. Collect fuel in the graduated cylinder by turning ignition switch to the ON position. Allow pump to run for fifteen (15) seconds, then turn switch to OFF.
6. The amount of fuel collected in the graduated cylinder should be approximately 475 ml (16 fl oz) after fifteen (15) seconds.
7. Replace fuel pump as necessary.

Operational Test (continued)

IMPORTANT

If fuel pump is replaced, make sure that replacement pump is the correct pump for your Groundsmaster by using your Parts Catalog. If incorrect pump is used, fuel system components can be damaged.

8. Install fuel supply hose to the fuel injection pump fitting on the engine and secure with hose clamp.
9. Prime fuel system (see Fuel System (page 4–12)).
10. Lower and secure hood.

Fuel Pump Specifications

Pump Capacity	1.9 l/min (64 fl oz/min)
Pressure	48.3 kPa (7 PSI)
Current Draw	2.0 Amp

Fuel Pump (Models 30885 and 30887)

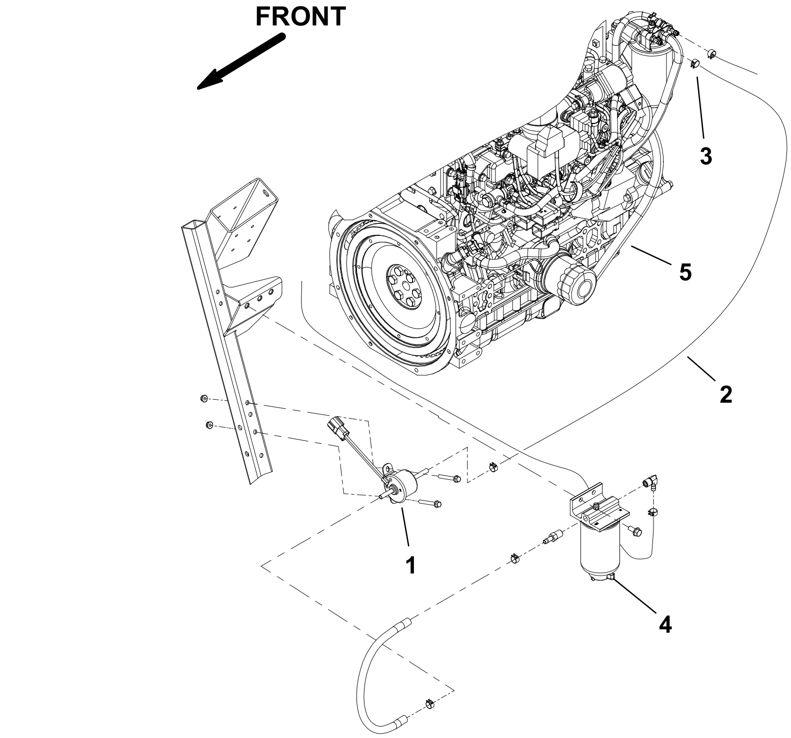

Figure 228

1. Fuel pump
2. Pump discharge hose
3. Hose clamp
4. Fuel water separator
5. Engine

The fuel pump is attached to the air cleaner mount below the fuel water separator (Figure 228).

Operational Test

1. Park machine on a level surface, lower cutting decks, stop engine and apply parking brake. Raise hood to access fuel pump.
2. Disconnect fuel pump discharge hose from the fuel filter attached to the engine (Figure 228).
3. Make sure fuel hoses attached to the fuel pump are free of obstructions.
4. Place disconnected end of pump discharge hose into a large, graduated cylinder sufficient enough to collect 0.95 liter (1 quart).

IMPORTANT

When testing fuel pump output, do not turn ignition switch to the START position.

5. Collect fuel in the graduated cylinder by turning ignition switch to the ON position. Allow pump to run for thirty (30) seconds, then turn switch to OFF.
6. The amount of fuel collected in the graduated cylinder should be approximately 350 ml (11.8 fl oz) after thirty (30) seconds.
7. Replace fuel pump as necessary.

Operational Test (continued)

IMPORTANT

If fuel pump is replaced, make sure that replacement pump is the correct pump for your Groundsmaster by using your Parts Catalog. If incorrect pump is used, fuel system components can be damaged.

8. Install fuel pump discharge hose to the fuel filter fitting on the engine and secure with hose clamp.
9. Prime fuel system (see Fuel System (page 4–12)).
10. Lower and secure hood.

Fuel Pump Specifications

Pump Capacity	700 ml/min (23.5 fl oz/min)
Pressure	22.8 kPa (3.3 PSI)
Current Draw	0.9 Amp

CAN−bus Termination Resistor

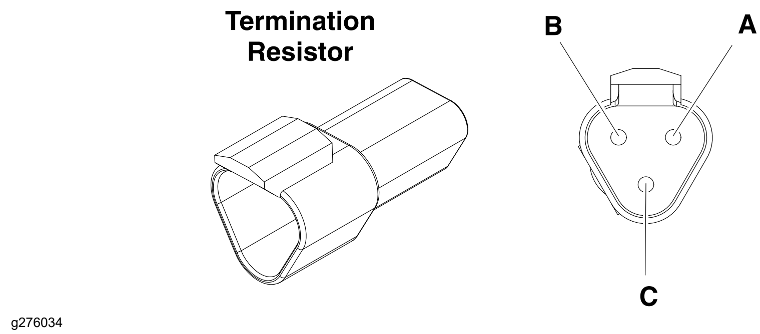

Figure 229

System communication between electrical components on Groundsmaster 4500−D and 4700−D machines is accomplished on a CAN−bus communication system. Two (2) specially designed, twisted cables form the bus for the network used on the machine. These wires provide the data pathways between machine components. At the end of the twisted pair of bus cables near the InfoCenter display is a 120 ohm termination resistor.

The CAN−bus termination resistor plugs into the platform wire harness in the console arm. The resistor can be accessed by removing the cover plate on the right side of the console arm. The wire harness connector has a blue insert to identify the proper location for the termination resistor.

Note: The Groundsmaster 4500−D and 4700−D engine ECU includes the second CAN−bus system termination resistor. This resistor cannot be accessed for testing.

Note: Refer to Appendix A (page A–1) for additional information on termination resistor location and wire connections.

IMPORTANT

The termination resistor is required for proper electrical system operation.

Termination Resistor Test

The termination resistor (Figure 229) can be tested using a digital multimeter (ohms setting). There should be 120 ohms resistance between terminals A and B of the termination resistor. There is not a terminal in cavity C on Groundsmaster 4500−D and 4700−D machines.

Diode Assemblies

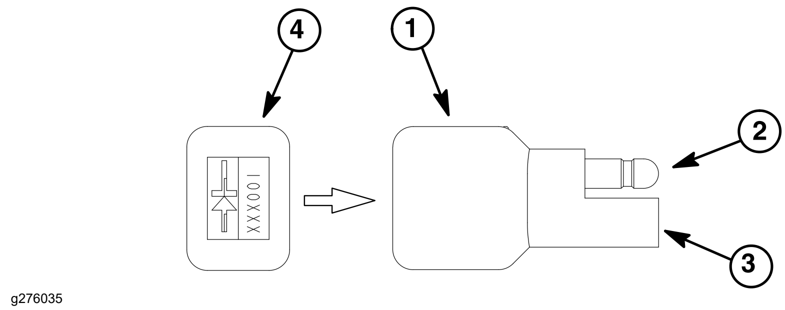

Figure 230

1. Diode assembly
2. Male terminal
3. Female terminal
4. End of diode body

The Groundsmaster engine wire harness contains a diode assembly that is used for circuit protection from voltage spikes when the engine starter solenoid is de-energized. This diode assembly plugs into the engine wire harness near the engine starter motor.

Groundsmaster models 30885 and 30887 use an additional diode assembly in the engine wire harness that protects the engine EGR circuit from reverse polarity. This diode assembly plugs into the engine wire harness near the engine electronic control unit (ECU).

The diode assemblies can be identified by a black color and a diode symbol on the end of the diode assembly body. Refer Appendix A (page A–1) for additional information on diode assembly location.

Testing

A diode assembly can be tested using a digital multimeter (diode test or ohms setting) and the table to the right.

Multimeter Red Lead (+) on Terminal	Multimeter Black Lead (−) on Terminal	Continuity
Female	Male	YES
Male	Female	NO

Resistor Assembly

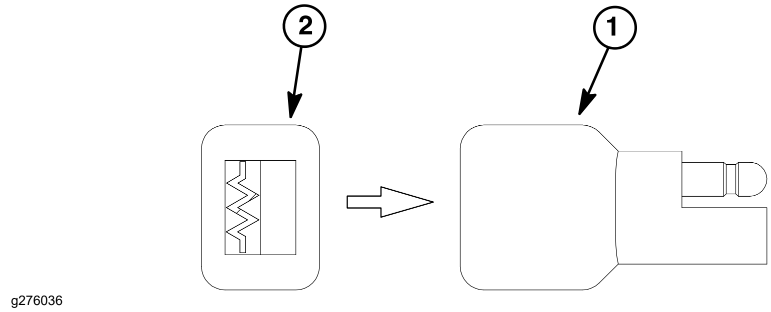

Figure 231

1. Resistor assembly
2. End of resistor body

The engine wire harness also contains a 1.6K ohm resistor that is necessary for ignition switch operation. The resistor plugs into the wiring harness near the engine starter motor (see Appendix A (page A–1)).

The resistor assemblies can be identified by their gray color, resistor symbol and Toro part number on the end of the resistor assembly body.

Testing

The resistor can be tested using a digital multimeter (ohms setting). The resistance across the resistor terminals should be 1.6K ohms.

Capacitor Assembly

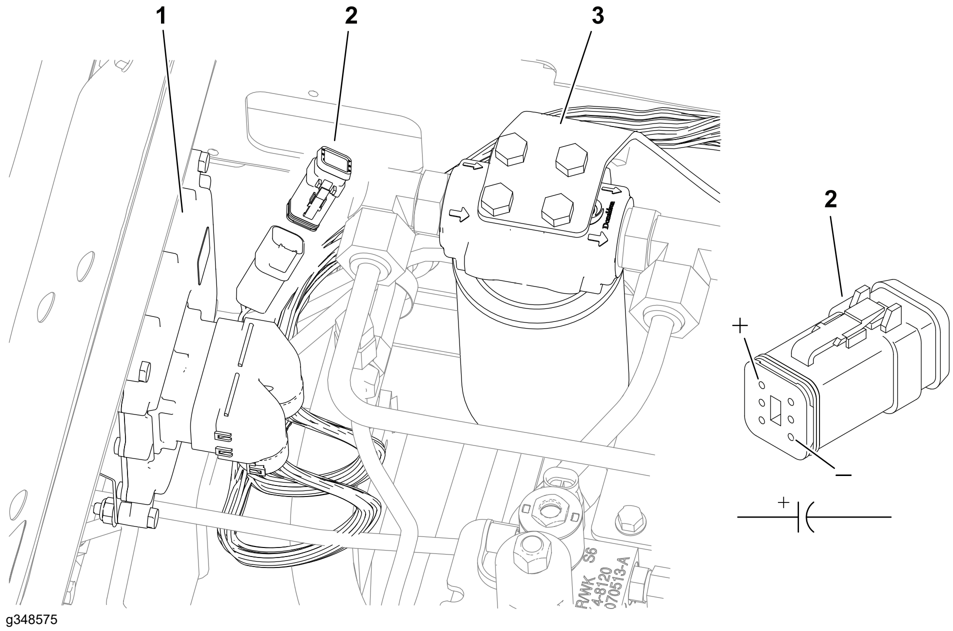

Figure 232

1. TEC (T1)
2. Capacitor
3. Hydraulic charge filter

The traction pedal position sensor, traction pressure sensor, and the swashplate angle sensor are connected to a 5V power bus supplied by the TEC (T1). A 33µF capacitor is incorporated into the main wire harness to stabilize the 5V power bus circuit. The capacitor is located under the operator's seat near the TEC (T1).

Testing the Capacitor

1. Park the machine on a level surface, lower the cutting decks, and shut off the engine. Remove the key from the key switch.
2. Disconnect the capacitor from the main wire harness.
3. Use a digital multimeter set to the maximum fixed (not automatic ranging) ohms setting. Connect the multimeter negative (-) probe to the capacitor negative (-) terminal and the multimeter positive (+) probe to the capacitor positive (+) terminal. The resistance across the capacitor terminals should start low then climb while the multimeter probes are held in contact.
4. Replace the capacitor if necessary.
5. If the capacitor tests correctly and a circuit problem still exists, check the wire harness; refer to Appendix A (page A–1).

Fan Speed Switch (Machines with Two−Post ROPS Extension Operator Fan Kit)

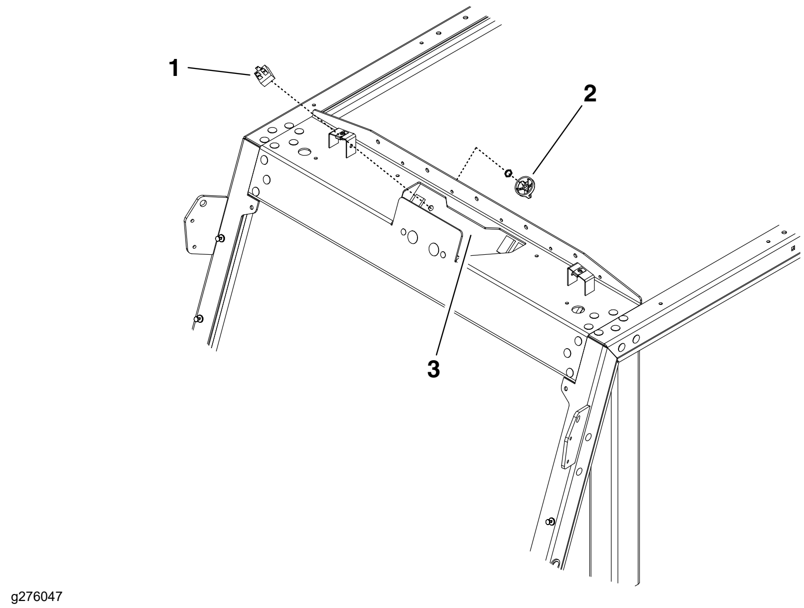

Figure 233

1. Fan speed switch
2. Control knob
3. Control panel

The fan speed switch is attached to the overhead control panel (Figure 233). The switch is used to select the fan speed (off, low, medium, or high).

Testing

1. Park the machine on a level surface, lower the cutting decks, and shut off the engine. Remove the key from the key switch.
2. To access the switch, remove the sunshade from the top of the ROPS extension.
3. Disconnect the machine wire harness from the fan speed switch.

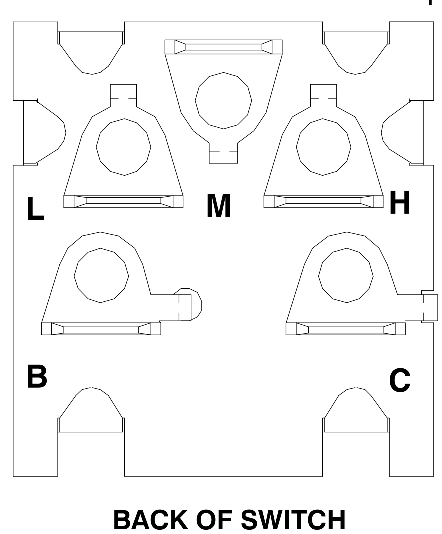

Figure 234

Testing (continued)

4. The switch terminals are identified in (Figure 234). With the use of a multimeter (ohms setting), test the switch functions to determine if continuity exists between only the terminals listed for each switch position. Check the continuity between the switch terminals.

Switch Position	Closed Circuits
OFF	L+H
LOW	B+C+L
MEDIUM	B+C+M
HIGH	B+C+H

5. Replace the fan speed switch if testing determines that the switch is damaged.
6. If the fan speed switch testing is correct and a circuit problem still exists, check the wire harness; refer to Appendix A (page A–1).
7. After you complete the testing, connect the machine wire harness to the switch and install the sunshade.

Resistor Module (Machines with Two−Post ROPS Extension Operator Fan Kit)

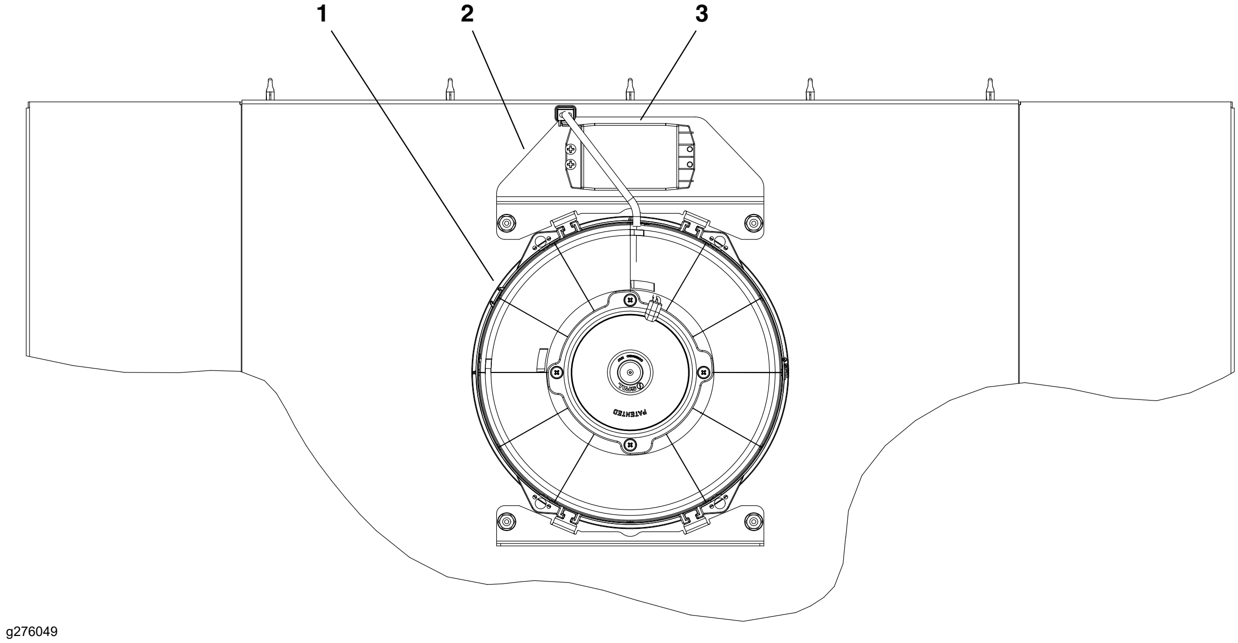

Figure 235

1. Operator’s fan
2. Fan mount bracket
3. Resistor module

The resistor module is attached to the rear of the fan mounting bracket (Figure 235). The resistor module is used for operation of the operator’s fan.

Testing

1. Park the machine on a level surface, lower the cutting decks, and shut off the engine. Remove the key from the key switch.
2. To access the resistor, remove the sunshade from the top of the ROPS extension.
3. Disconnect the wire harness connectors from the resistor module terminals.

Testing (continued)

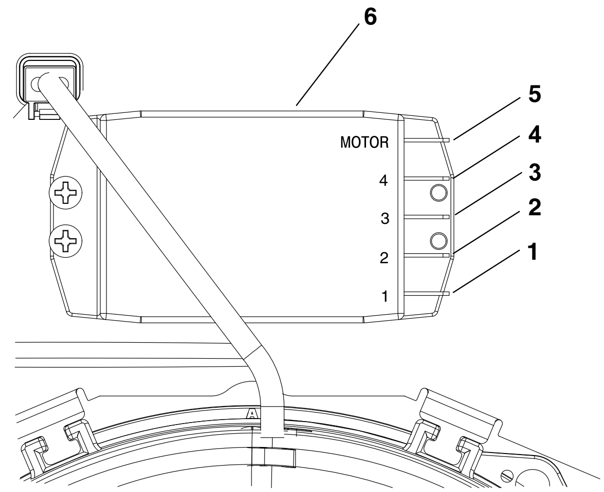

Figure 236

1. Pin 1 (Violet wire)
2. Pin 2 (Brown wire)
3. Pin 3 (Orange wire)
4. Pin 4 (Not used)
5. Motor pin
6. Resistor module

4. Use a multimeter to check that the resistance values of the resistor module as below (Figure 236).

Test Point 1	Test Point 2	Expected Reading
Motor Pin	Pin 1	Less than 9 ohms
Motor Pin	Pin 2	Less than 6 ohms
Motor Pin	Pin 3	Less than 3 ohms

5. Replace the resistor module if it fails the test.
6. If the resistor module testing is correct and a circuit problem still exists, check the wire harness; refer to Appendix A (page A–1).
7. After you complete the testing, connect the wire harness connectors to the resistor module terminals (Figure 236) and install the sunshade.

Service and Repairs

Note: For engine component repair information (e.g. starter motor), refer to the *Yanmar Workshop Manual* that is correct for your Groundsmaster model.

Battery Care

1. The top of the battery must be kept clean. If the machine is stored in a location where temperatures are extremely high, the battery will discharge more rapidly than if the machine is stored in a location where temperatures are cool.

WARNING

Wear safety goggles and rubber gloves when working with electrolyte. Charge battery in a well ventilated place so gasses produced while charging can dissipate. Since the gases are explosive, keep open flames and electrical sparks away from the battery; do not smoke. Nausea may result if the gases are inhaled. Unplug charger from electrical outlet before connecting or disconnecting charger leads to or from battery posts.

IMPORTANT

Do not remove fill caps (if equipped) while cleaning the battery.

2. Check battery condition weekly or after every 50 hours of operation. Keep terminals and entire battery case clean because a dirty battery will discharge slowly.
   A. Clean battery by washing entire case with a solution of baking soda and water. Rinse with clear water.
   B. Coat battery posts and cable connectors with battery terminal protector (Toro Part No. 107−0392) or petroleum jelly to prevent corrosion.
3. Battery cables must be tight on terminals to provide good electrical contact.

WARNING

Connecting battery cables to the wrong battery post could result in personal injury and/or damage to the electrical system.

4. If corrosion occurs at terminals, disconnect cables. Always disconnect negative (−) cable first. Clean clamps and terminals separately. Reconnect cables with positive (+) cable first. Coat battery posts and cable connectors with battery terminal protector (Toro Part No. 107−0392) or petroleum jelly to prevent corrosion.
5. If the battery electrolyte is accessible, check electrolyte level every 25 operating hours and every 30 days if machine is in storage. Maintain cell level with distilled water. Do not fill cells above the fill line.

Battery Storage

If the machine will be stored for more than 30 days:

1. Remove the battery and charge it fully (see Battery Service (page 6–83)).
2. Either store battery on a shelf or on the machine.
3. Leave battery cables disconnected if the battery is stored on the machine.
4. Store battery in a cool atmosphere to avoid quick deterioration of the battery charge.
5. To help prevent the battery from freezing, make sure it is fully charged (see Battery Service (page 6–83)).

Battery Service

The battery is the heart of the electrical system. With regular and proper service, battery life can be extended. Additionally, battery and electrical component failure can be prevented.

CAUTION

When working with batteries, use extreme caution to avoid splashing or spilling electrolyte. Electrolyte can destroy clothing and burn skin or eyes. Always wear safety goggles and a face shield when working with batteries.

Battery Specifications	BCI Group Size 34 690 CCA at −18 ºC (0 ºF) 110 minutes reserve capacity at 27 ºC (80 ºF)
Electrolyte Specific Gravity	Fully charged: 1.265 corrected to 27 ºC (80 ºF) Discharged: less than 1.240

Battery Removal and Installation (Figure 237)

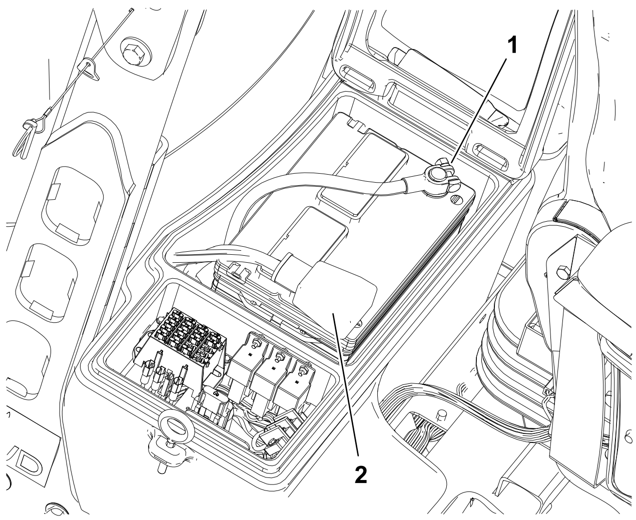

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Figure 237

1. Negative cable
2. Positive cable

1. Unlatch and raise operator’s console panel behind the operator seat to access battery.
2. Loosen and remove negative cable from battery. After negative cable is removed, loosen and remove positive cable from battery.
3. Loosen strap that secures battery to machine.
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.

   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.

Battery Removal and Installation (Figure 237) (continued)

6. Make sure that rubber boot is properly placed over positive cable end and positive battery post.
7. Lower and secure operator's console panel.

Battery Inspection and Maintenance

1. Replace battery if case is cracked or leaking.
2. Check battery terminal posts for corrosion. Use wire brush to clean corrosion from posts.

IMPORTANT

Before cleaning the battery, tape or block vent holes to the filler caps and make sure the caps are on tightly.

3. Check for signs of wetness or leakage on the top of the battery which might indicate a loose or missing filler cap, overcharging, loose terminal post or overfilling. Also, check battery case for dirt and oil. Clean the battery with a solution of baking soda and water, then rinse it with clean water.
4. Check that the cover seal is not broken away. Replace the battery if the seal is broken or leaking.
5. Check the electrolyte level in each cell, if possible. If the level is below the tops of the plates in any cell, fill all cells with distilled water between the minimum and maximum fill lines. Charge at 15 to 25 amps for fifteen (15) minutes to allow sufficient mixing of the electrolyte.

Battery Testing

1. Perform a high−discharge test with an adjustable load tester. This is one of the most reliable means of testing a battery as it simulates the cold−cranking test. A commercial battery load tester is required to perform this test.

CAUTION

Follow the manufacturer's instructions when using a battery load tester.

A. Check the voltage across the battery terminals prior to testing the battery. If the voltage is less than 12.4 VDC, charge the battery before performing a load test.

B. If the battery has recently been charged, use a battery load tester following the manufacturer's instructions to apply a 150 Amp load for fifteen (15) seconds. This step will remove the surface charge.

C. Make sure battery terminals are free of corrosion.

D. Estimate the internal temperature of the battery to the nearest 10 ºF.

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

F. Apply a test load of 345 Amps (one half the cranking performance rating of the battery) to the battery for fifteen (15) seconds.

G. Take a battery voltage reading at fifteen (15) seconds, then remove the load.

H. Using the table in the column to the right, determine the minimum voltage for the battery temperature reading. If the test voltage is below the minimum voltage for the battery temperature, replace the battery. If the test voltage is at or above the minimum, return the battery to service.

Minimum Voltage	Battery Temperature	
9.6	70ºF (and up)	21ºC (and up)
9.5	60ºF	16ºC
9.4	50ºF	10ºC
9.3	40ºF	4ºC
9.1	30ºF	-1ºC
8.9	20ºF	-7ºC
8.7	10ºF	-12ºC
8.5	0ºF	-18ºC

2. If the battery electrolyte is accessible, the specific gravity of the electrolyte can be used to determine the battery condition.

IMPORTANT

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

A. Measure the specific gravity of each cell with a hydrometer. Draw electrolyte in and out of the hydrometer barrel prior to taking a reading to warm-up the hydrometer. At the same time take the temperature of the cell.

B. Temperature correct each cell reading. For each 5.5 ºC (10 ºF) above 26.7 ºC (80 ºF) add 0.004 to the specific gravity reading. For each 5.5 ºC (10 ºF) below 26.7 ºC (80 ºF) subtract 0.004 from the specific gravity reading.

Example:

Cell Temperature: 100 ºF

Cell Gravity: 1.245

100 ºF minus 80 ºF equals 20 ºF

(37.7 ºC minus 26.7 ºC equals 11.0 ºC)

20 ºF multiply by 0.004/10 ºF equals 0.008

(11 ºC multiply by 0.004/5.5 ºC equals 0.008)

ADD (conversion above): 0.008

Correction to 26.7 ºC (80 ºF): 1.253

C. If the difference between the highest and lowest cell specific gravity is 0.050 or greater or the lowest cell specific gravity is less than 1.225, charge the battery. Charge at the recommended rate and time given in **Charging** or until all cells specific gravity is 1.225 or greater with the difference in specific gravity between the highest and lowest cell less than 0.050. If these charging conditions can not be met, replace the battery.

Battery Charging

To minimize possible damage to the battery and allow the battery to be fully charged, the slow charging method is presented here. This charging method can be accomplished with a constant current battery charger which is readily available.

CAUTION

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

Note: Using specific gravity of the battery electrolyte is the most accurate method of determining battery condition.

1. Determine the battery charge level from either its open circuit voltage or electrolyte specific gravity (if electrolyte is accessible).

Battery Charge Level	Open Circuit Voltage	Specific Gravity
100%	12.6	1.265
75%	12.4	1.225
50%	12.2	1.190
25%	12.0	1.155
0%	11.8	1.120

2. Determine the charging time and rate **using the battery charger manufacturer's instructions** or the following table.

Battery Reserve Capacity (Minutes)	Battery Charge Level (Percent of Fully Charged)			
	75%	50%	25%	0%
80 or less	3.8 hrs @ 3 Amps	7.5 hrs @ 3 Amps	11.3 hrs @ 3 Amps	15 hrs @ 3 Amps
81 to 125	5.3 hrs @ 4 Amps	10.5 hrs @ 4 Amps	15.8 hrs @ 4 Amps	21 hrs @ 4 Amps
126 to 170	5.5 hrs @ 5 Amps	11 hrs @ 5 Amps	16.5 hrs @ 5 Amps	22 hrs @ 5 Amps
171 to 250	5.8 hrs @ 6 Amps	11.5 hrs @ 6 Amps	17.3 hrs @ 6 Amps	23 hrs @ 6 Amps
above 250	6 hrs @ 10 Amps	12 hrs @ 10 Amps	18 hrs @ 10 Amps	24 hrs @ 10 Amps

CAUTION

Do not charge a frozen battery because it can explode and cause injury. Let the battery warm to 16ºC (60ºF) before connecting to a charger.

Charge the battery in a well−ventilated place to dissipate gases produced from charging. These gases are explosive; keep open flame and electrical spark away from the battery. Do not smoke. Nausea may result if the gases are inhaled. Unplug the charger from the electrical outlet before connecting or disconnecting the charger leads from the battery posts.

Battery Charging (continued)

3. Following the battery charger manufacturer's instructions, connect the charger cables to the battery. Make sure a good connection is made.
4. Charge the battery following the battery charger manufacturer's instructions.
5. While charging, occasionally check the battery. If the electrolyte is violently gassing or spewing or if the battery case feels hot to the touch, the charging rate must be lowered or temporarily stopped.
6. Determine if battery is fully charged before removing battery from charger. Either of the following procedures can be used:

   A. Continue charging and reduce charging rate as needed until a two (2) hour period results in no increase in voltage. Open circuit voltage should be approximately 12.6 volts for a fully charged battery.

   B. If the battery electrolyte is accessible, three (3) hours prior to the end of the charging, measure the specific gravity of a battery cell once per hour. The battery is fully charged when the cells are gassing freely at a low charging rate and there is less than a 0.003 change in specific gravity for three (3) consecutive readings.

Axles, Planetaries and Brakes

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General Information

Operator’s Manual

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

Adjustments

Planetary Drive Assembly Endplay

A front planetary drive assembly that is properly operating should have no endplay. Any endplay in a planetary assembly indicates that there are potential problems with the planetary. Check planetary endplay at intervals specified in your *Operator's Manual*.

Endplay Checking Procedure

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

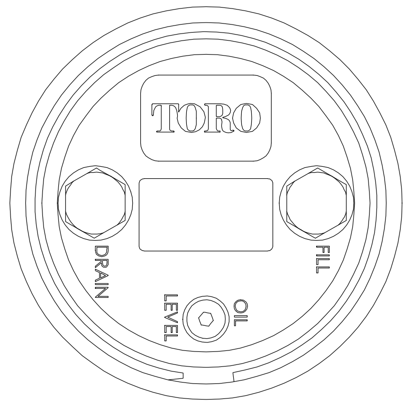

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Figure 238

CAUTION

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

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2. Chock rear wheels and jack up front of machine (see Jacking Instructions (page 1–7)). Support machine with jack stands.
3. Grasp front wheel and check for endplay in the planetary assembly as indicated by axial wheel movement. Make sure that there is no endplay in assembly.
4. If any endplay is detected, the planetary should be disassembled, inspected and serviced as necessary (see Planetary Drive Assembly (page 7–8)).
5. After planetary endplay checking is completed, lower machine to ground.

Service and Repairs

Brake Assembly

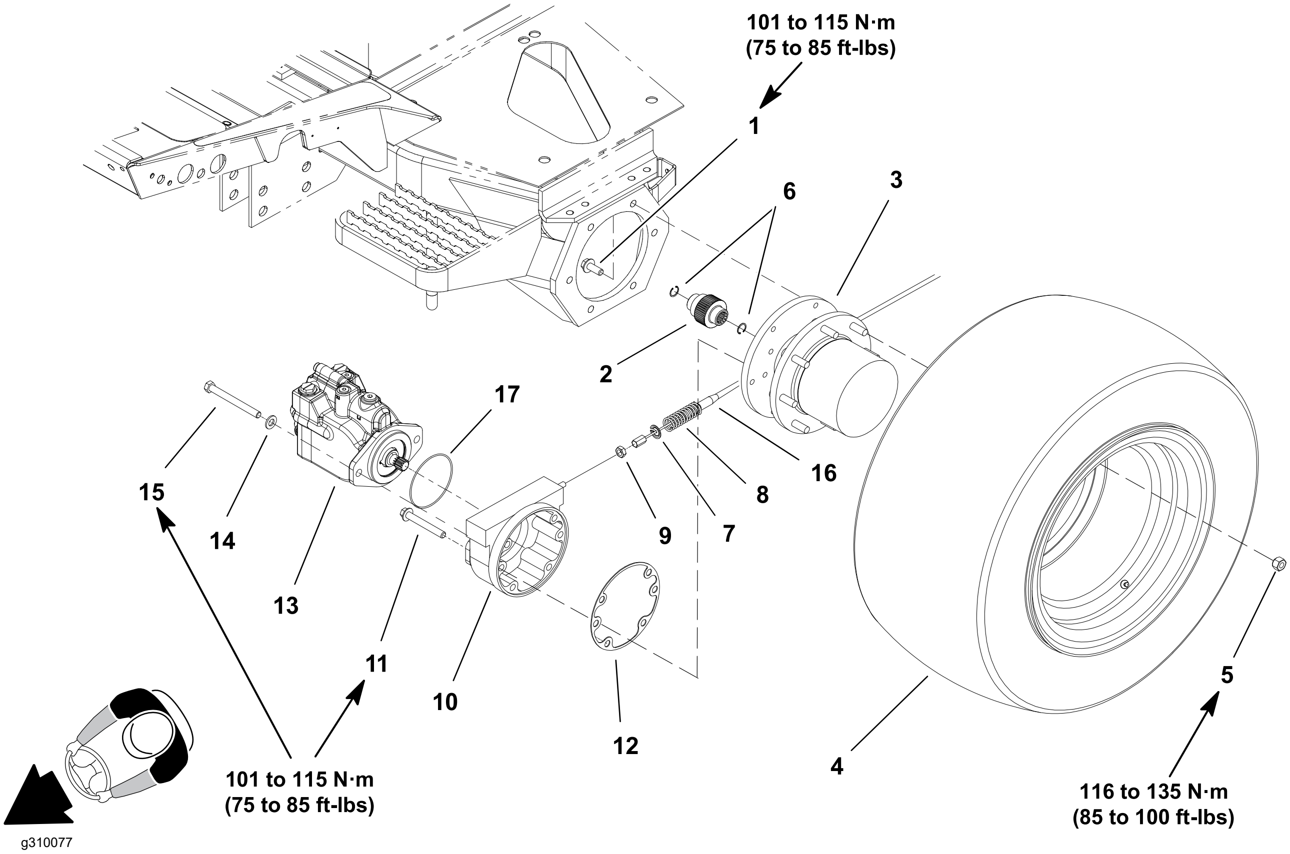

Figure 239

1. Flange head screw (6 per planetary)
2. Splined brake shaft
3. Planetary assembly (2 used)
4. Front wheel assembly (2 used)
5. Lug nut (8 per wheel)
6. Retaining ring
7. Spring plate
8. Compression spring
9. Jam nut
10. Brake assembly (LH shown)
11. Flange head screw (4 per brake)
12. Gasket
13. Piston motor (2 used)
14. Flat washer (2 per motor)
15. Cap screw (2 per motor)
16. Brake cable (LH shown)

Brake Assembly Removal (Figure 239)

1. Park machine on a level surface and raise cutting decks to allow easier access to front brake assembly. Stop engine, engage parking brake and remove key from the ignition switch.
2. Drain oil from planetary drive and brake assembly; refer to traction unit *Operator's Manual*.

CAUTION

When changing attachments, tires or performing other service, use correct jacks, hoists and jack stands to raise and support machine. See Jacking Instructions (page 1–7).

3. Chock rear wheels and jack up front of machine (see Jacking Instructions (page 1–7)). Support machine with appropriate jack stands.

Brake Assembly Removal (Figure 239) (continued)

4. Remove front wheel assembly.
5. Remove hydraulic wheel motor (see Front Wheel Motors (page 5–118)).
6. Disconnect brake cable from pull rod on brake (Figure 241).

   Note: Be careful to not drop splined brake shaft as brake assembly is removed.

7. Support brake assembly and remove flange head cap screws (item 11) securing brake assembly to frame. Remove brake assembly.
8. Remove splined brake shaft.
9. Remove and discard gasket (item 12). Make sure that all gasket material and sealant is removed from both the brake and the planetary assembly.
10. Complete brake inspection and repair (see Brake Inspection and Repair (page 7–7)).

Brake Assembly Installation (Figure 239)

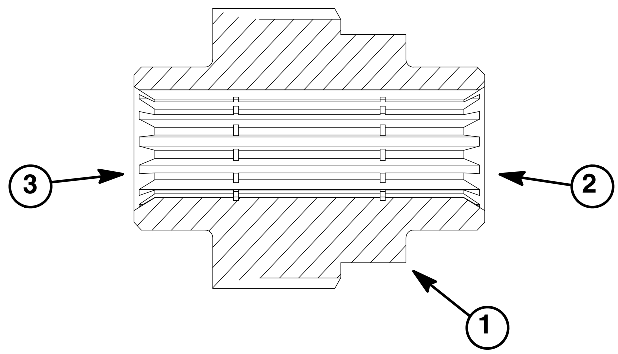

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Figure 240

1. Splined brake shaft step
2. Hydraulic motor end
3. Planetary assembly end

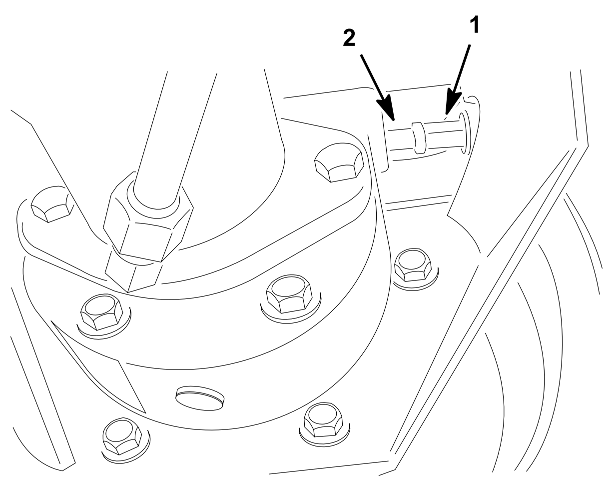

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Figure 241

1. Brake cable
2. Brake pull rod

Note: The stepped end of the splined brake shaft must be aligned toward the hydraulic wheel motor (Figure 240).

Brake Assembly Installation (Figure 239) (continued)

1. Install splined brake shaft into brake assembly. Make sure that splines engage rotating discs in brake assembly.
2. Apply gasket sealant (Loctite #2 or equivalent) to sealing surfaces of new gasket (item 12). Align gasket and secure brake assembly to planetary with screws (item 11). Torque tighten the screw from **101 to 115 N·m (75 to 85 ft−lb)**.
3. Install brake cable to pull rod on brake assembly (Figure 241). Brake cable end should be completely threaded onto pull rod before tightening jam nut.
4. Make sure wheel motor O−ring (item 4) is in position and secure wheel motor to planetary with two (2) cap screws and flat washers. Torque tighten the screws from **101 to 115 N·m (75 to 85 ft−lb)**.
5. Install front wheel assembly.
6. Fill planetary drive with gear lube; refer to traction unit *Operator's Manual*. A portion of the gear lube will pass into the brake assembly automatically.
7. Check and adjust brake cables for proper brake operation (see traction unit *Operator's Manual*).

WARNING

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

8. Lower machine to ground. Torque wheel lug nuts from **116 to 135 N·m (85 to 100 ft−lb)**.

Brake Inspection and Repair

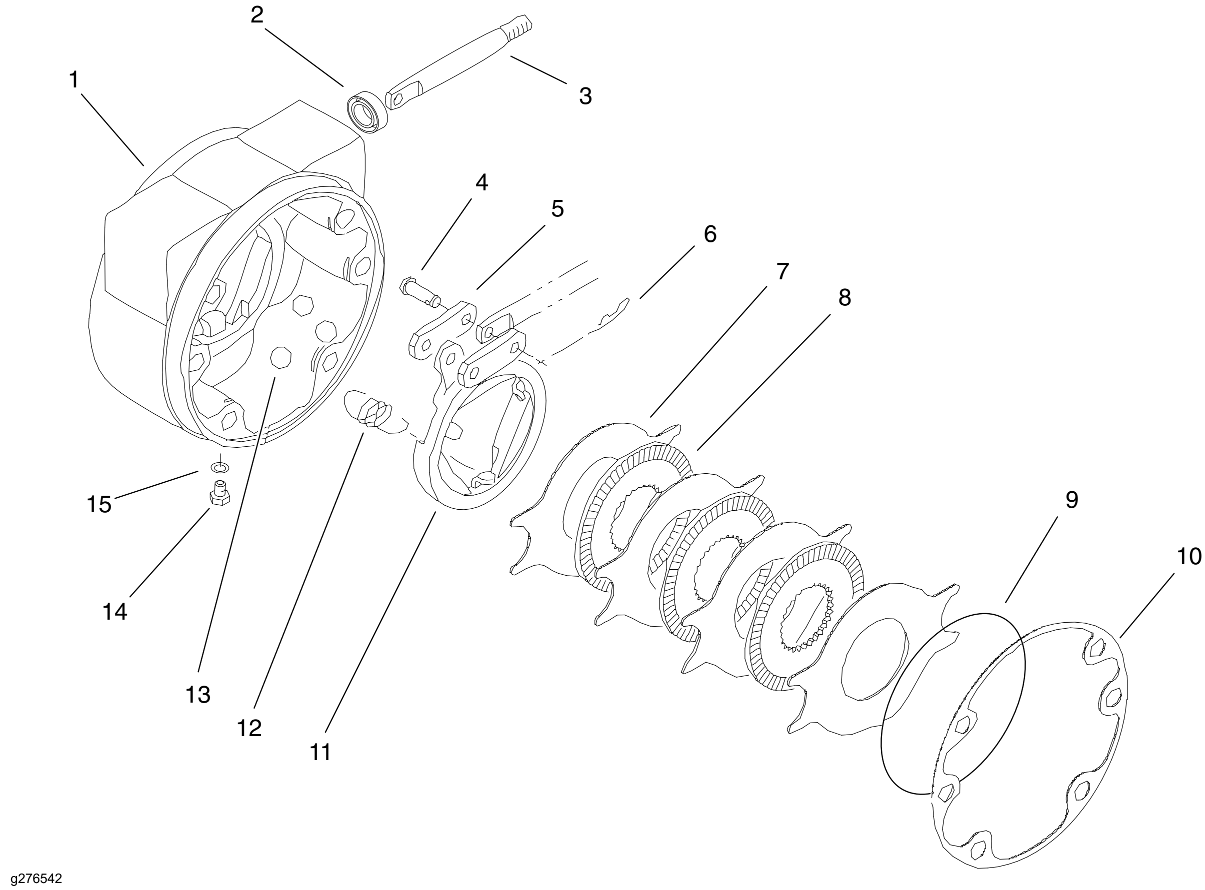

Figure 242

1.	Brake housing (LH shown)	6.	Hitch pin (2 used)	11.	Rotating actuator
2.	Seal	7.	Stationary disc (4 used)	12.	Extension spring (3 used)
3.	Pull rod	8.	Rotating disc (3 used)	13.	Ball (3 used)
4.	Clevis pin (2 used)	9.	Retaining ring	14.	Plug
5.	Link (2 used)	10.	Gasket	15.	O−ring

Brake Inspection and Repair (Figure 242)

1. Scrape gasket material (item 10) from brake housing and planetary drive mounting surfaces.
2. Remove retaining ring (item 9) from brake housing groove.
3. Remove stationary discs (item 7) and rotating discs (item 8).
4. Remove extension springs (item 12).
5. Remove actuator assembly (items 11, 6, 5, 4 and 3) and balls (item 13).
6. Remove seal (item 2) from brake housing.
7. Wash parts in cleaning solvent. Inspect components for wear or damage.
8. Reverse steps 2 through 6 to assemble brakes, installing new parts as necessary. Install a new seal (item 2).
9. Use a new gasket (item 10) when installing brake assembly to machine.

Planetary Drive Assembly

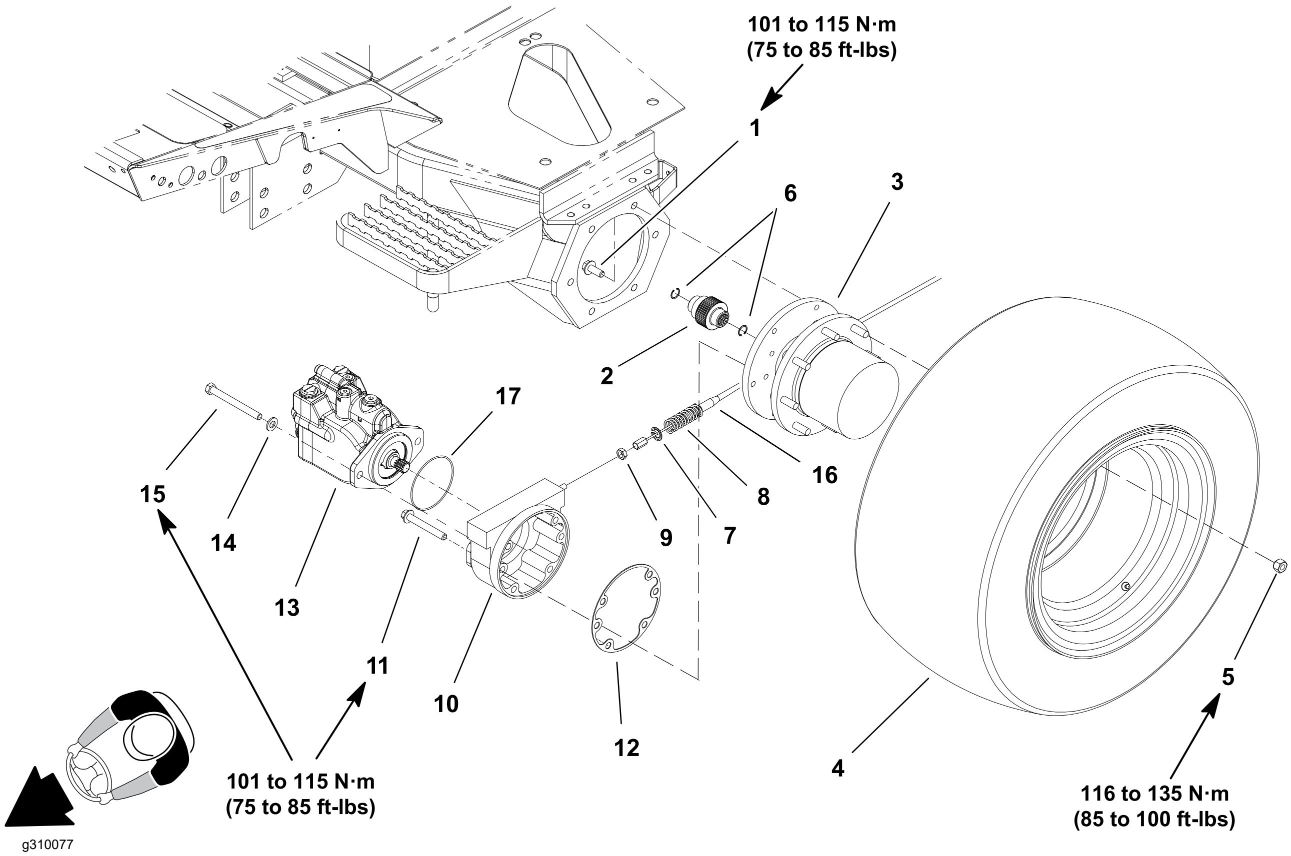

Figure 243

1. Flange head screw (6 per planetary)
2. Splined brake shaft
3. Planetary assembly (2 used)
4. Front wheel assembly (2 used)
5. Lug nut (8 per wheel)
6. Retaining ring
7. Spring plate
8. Compression spring
9. Jam nut
10. Brake assembly (LH shown)
11. Flange head screw (4 per brake)
12. Gasket
13. Piston motor (2 used)
14. Flat washer (2 per motor)
15. Cap screw (2 per motor)
16. Brake cable (LH shown)

Note: The planetary drive assembly can be serviced with the planetary installed to machine (see VA02 Series Planetary Drive Service (page 7–11)). Use the following procedure to remove and install the planetary drive assembly from the machine.

Removal (Figure 243)

1. Park machine on a level surface, lower cutting decks, stop engine and remove key from the ignition switch.
2. Drain the oil from the brake assembly and the Planetary drive; refer to the traction unit *Operator's Manual*.

Removal (Figure 243) (continued)

CAUTION

When removing front wheel, use correct jacks and supports. Make sure machine is parked on a solid, level surface such as a concrete floor. Prior to raising machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use jack stands to support the raised machine. If the machine is not properly supported by jack stands, the machine may move or fall, which may result in personal injury.

3. Chock rear wheels and jack up front of machine (see Jacking Instructions (page 1–7)). Support machine with jack stands.
4. Remove front wheel assembly.
5. Support wheel motor and brake assembly to prevent them from shifting during planetary removal.

   Note: The wheel motor and brake assembly fasteners thread into the planetary housing, and must be removed prior to removing the planetary drive from the machine.
6. Remove hydraulic wheel motor fasteners.
7. Remove brake assembly fasteners.
8. Support planetary assembly to prevent it from falling. Loosen and remove six (6) flange head screws that secure planetary assembly to frame. Remove planetary assembly from machine.
9. Remove and discard gasket (item 12). Make sure that all gasket material and sealant is removed from both the brake and the planetary assembly.

Installation (Figure 243)

1. Position planetary assembly to machine making sure to engage splined brake shaft with planetary drive shaft. Secure planetary assembly to frame with six (6) flange head screws. Torque tighten screws from **101 to 115 N·m (75 to 85 ft−lb)**.
2. Apply gasket sealant (Loctite #2 or equivalent) to sealing surfaces of new gasket (item 12). Align gasket and secure brake assembly to planetary (see Brake Assembly (page 7–4)). Torque tighten screws from **101 to 115 N·m (75 to 85 ft−lb)**.
3. Make sure wheel motor O−ring (item 4) is in position and secure wheel motor to planetary with two (2) cap screws and flat washers. Torque tighten screws from **101 to 115 N·m (75 to 85 ft−lb)**.
4. Install front wheel assembly.
5. Fill planetary drive with gear lube; refer to traction unit *Operator's Manual*. A portion of the gear lube will pass into the brake assembly automatically.
6. Check and adjust the brake cables for proper brake operation.

WARNING

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

Installation (Figure 243) (continued)

7. Lower machine from jack stands. Tighten lug nuts from **115 to 135 N·m (85 to 100 ft−lb)** in a crossing pattern.

VA02 Series Planetary Drive Service

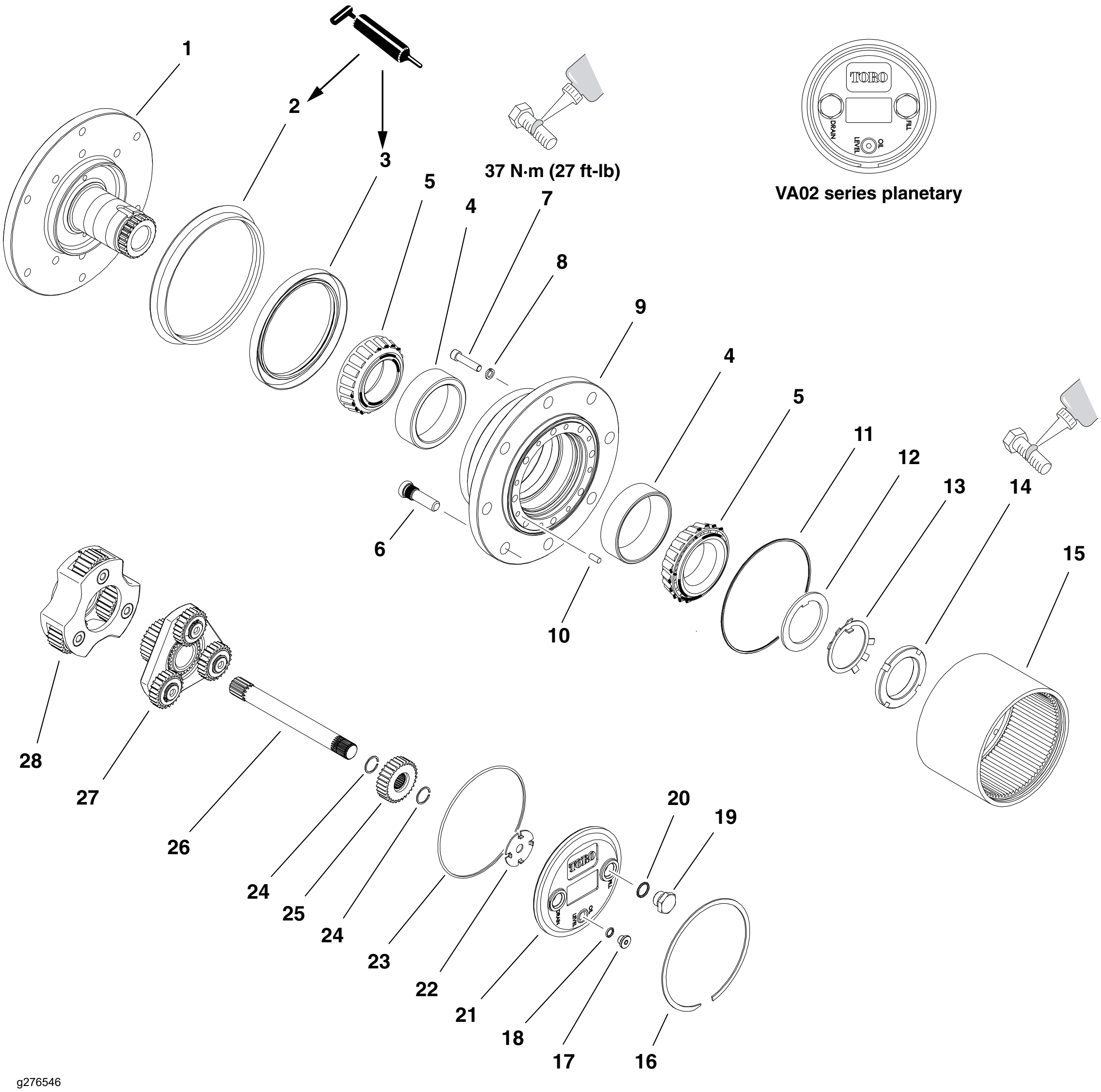

Figure 244

1.	Spindle	11.	O−ring	21.	End cap
2.	Boot seal	12.	Spacer	22.	Thrust plate
3.	Lip seal	13.	Locking washer	23.	O−Ring
4.	Inner bearing cup (2)	14.	Lock nut	24.	Retaining ring (2)
5.	Inner bearing cone (2)	15.	Ring gear	25.	Primary gear
6.	Wheel stud (8)	16.	Retaining ring	26.	Drive shaft
7.	Socket head screw (8)	17.	Plug	27.	Primary carrier assembly
8.	Lock washer (8)	18.	O−ring	28.	Secondary carrier assembly
9.	Housing	19.	Plug (2)		
10.	Dowel pin (4)	20.	O−Ring (2)		

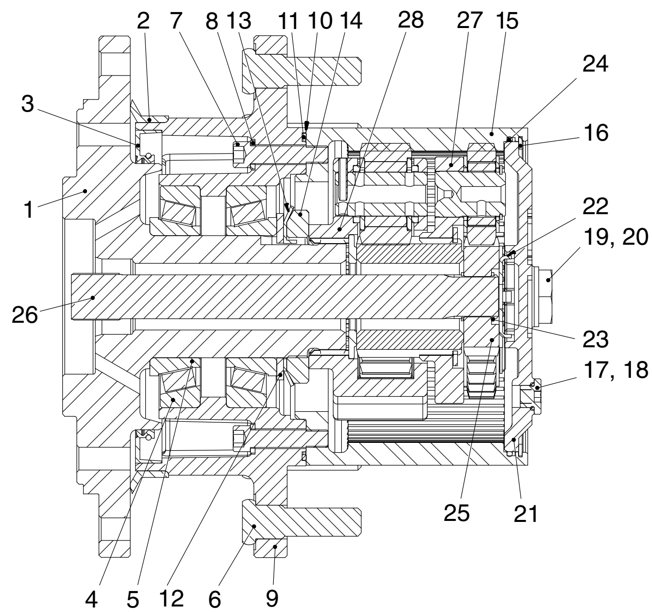

Figure 245

1. Spindle
2. Boot seal
3. Lip seal
4. Inner bearing cup (2)
5. Inner bearing cone (2)
6. Wheel stud (8)
7. Socket head screw (8)
8. Lock washer (8)
9. Housing
10. Dowel pin (4)
11. O−ring
12. Spacer
13. Locking washer
14. Lock nut
15. Ring gear
16. Retaining ring
17. Plug
18. O−ring
19. Plug (2)
20. O−Ring (2)
21. End cap
22. Thrust plate
23. O−Ring
24. Retaining ring (2)
25. Primary gear
26. Drive shaft
27. Primary carrier asm
28. Secondary carrier asm

Note: The planetary drive assembly is best serviced with the planetary installed to machine or the spindle firmly secured to a fixture or workbench. If the spindle (item 1) needs to be removed from machine, see Planetary Drive Assembly (page 7–8).

Disassembly

1. Park machine on a level surface, stop engine and remove key from the ignition switch.
2. Drain oil from planetary drive and brake assembly; refer to traction unit *Operator's Manual*.
3. Chock rear wheels and jack up front of machine (see Jacking Instructions (page 1–7)). Support machine with jack stands and remove rear wheel assembly.
4. Remove retaining ring (16).
5. Remove end cap and thrust plate . Retrieve and discard O−ring from ring gear bore.
6. Remove primary gear and drive shaft assembly (items 24−26).

Disassembly (continued)

7. Remove primary carrier and secondary carrier from ring gear.
8. Bend the locking washer tab away from the lock nut. Use a TMFS12 spanner socket to remove the 55 x 1.5 mm lock nut. Remove the locking washer and spacer. Discard the locking washer.
9. Carefully remove housing and bearing cones from spindle.
10. Remove and discard seals from housing.
11. If necessary, remove bearing cups from housing.
12. If wheel stud removal is necessary, use a press to remove the stud(s) from the housing.
13. If necessary, remove the ring gear from the housing:

    Note: High strength thread locking compound was used during assembly. It may be necessary to heat the ring gear near the mounting screws to release the screws.

    A. Remove socket head screws (item 7) and lock washers that secure the ring gear to the housing.

    B. Remove the ring gear and retrieve the four (4) dowel pins (item 10) from housing.

    C. Remove the O−ring from the housing bore and discard.

Assembly

Note: Use new seals, O−rings and locking washer when assembling the planetary drive.

1. Thoroughly clean parts in solvent and dry completely after cleaning. Inspect parts for damage or excessive wear and replace as necessary.
2. If any wheel studs were removed, use a press to install new studs into housing. Make sure that stud shoulder is fully pressed against housing surface.
3. If ring gear was removed from housing:

    A. Fit four (4) dowel pins in housing.

    B. Apply a light coat of grease to a new O−ring and install it in the housing bore.

    C. Apply high strength thread locking compound and secure ring gear to housing with lock washers and socket head screws. Tighten screws to **37 N·m (27 ft−lb)**.

4. If previously removed, press bearing cups into housing. Cups should be pressed fully to shoulder of the housing bore.
5. Fit inner bearing cone onto spindle. Make sure inner bearing cone seats fully against spindle shoulder. If inner bearing is not seated fully, lightly tap bearing cone on inner hub until it seats properly.
6. Make sure that seal bore in housing is thoroughly cleaned. If OD of seal is not rubber or does not have a sealant coating, apply a light coating of silicone sealant to seal bore in housing. Install seal into housing so it is flush with housing face.
7. Install boot seal. Cover surface of lip seal and boot seal with grease.
8. Lightly oil bearing cups then place housing assembly over spindle and inner bearing cone. Take care to not damage seals or spindle during installation.
9. Fit outer bearing cone onto spindle.

10. Align key on spacer and install spacer onto spindle shaft.
11. Align key on locking washer and install locking washer onto spindle shaft.

IMPORTANT

Perform the following steps without interruption. Once the thread locking compound is applied, you have only a few minutes before the curing process will influence the bearing lock nut torque.

---

12. Install the bearing lock nut:
    A. Apply high strength thread locking compound (Loctite 263 or equivalent) and install the lock nut.
    B. Tighten the lock nut to **150 N·m (110 ft−lb)**.
    C. Rotate the housing on the spindle a few revolutions to align the bearings.
    D. Tighten the lock nut to **200 N·m (150 ft−lb)**.
    E. Rotate the housing on the spindle a few revolutions to seat the bearings.

IMPORTANT

If installing the bearing nut with the spindle installed on machine, have an assistant hold the housing firmly in position during the following step.

    F. Loosen the lock nut completely, then tighten to **122 N·m (90 ft−lb)**.

IMPORTANT

Continue to tighten the lock nut until it aligns with one of the locking washer tabs. Do Not loosen the lock nut to align it with the locking washer tabs.

    G. Secure the lock nut by bending one of the locking washer tabs into a slot in the lock nut.
13. Install secondary carrier and primary carrier making sure that carrier gear teeth align with ring gear and spline on spindle shaft.
14. If primary gear (item 25) was removed from drive shaft, slide gear onto shaft and secure with retaining rings.
15. Install drive shaft assembly (items 24−26) making sure that drive shaft spline aligns with carrier gears.
16. Cover the outer face of the thrust plate with grease and fit thrust plate onto end cap. Make sure that thrust plate tabs are captive in end cap.
17. Apply a light coat of grease to a new O−ring and install it in the ring gear bore. Avoid pinching or cutting the O−ring and install the end cap. Use a soft mallet to fully seat the end cap.
18. Secure the end cap with the retaining ring. Make sure the retaining ring is fully seated in the ring groove.
19. Check operation of planetary drive by hand. With a constant turning force applied, rotation of the planetary should be consistent. If there is more drag

Assembly (continued)

at certain points, gears are not rolling freely and the planetary should be examined for improper assembly or damaged components.

20. Install front wheel assembly.

21. Fill planetary drive with gear lube; refer to traction unit *Operator's Manual*. A portion of the gear lube will pass into the brake assembly automatically.

22. Test planetary drive operation.

WARNING

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

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23. Remove jack stands and lower machine to ground. Tighten wheel lug nuts in a crossing pattern from **116 to 135 N·m (85 to 100 ft−lb)**.

Rear Axle Assembly

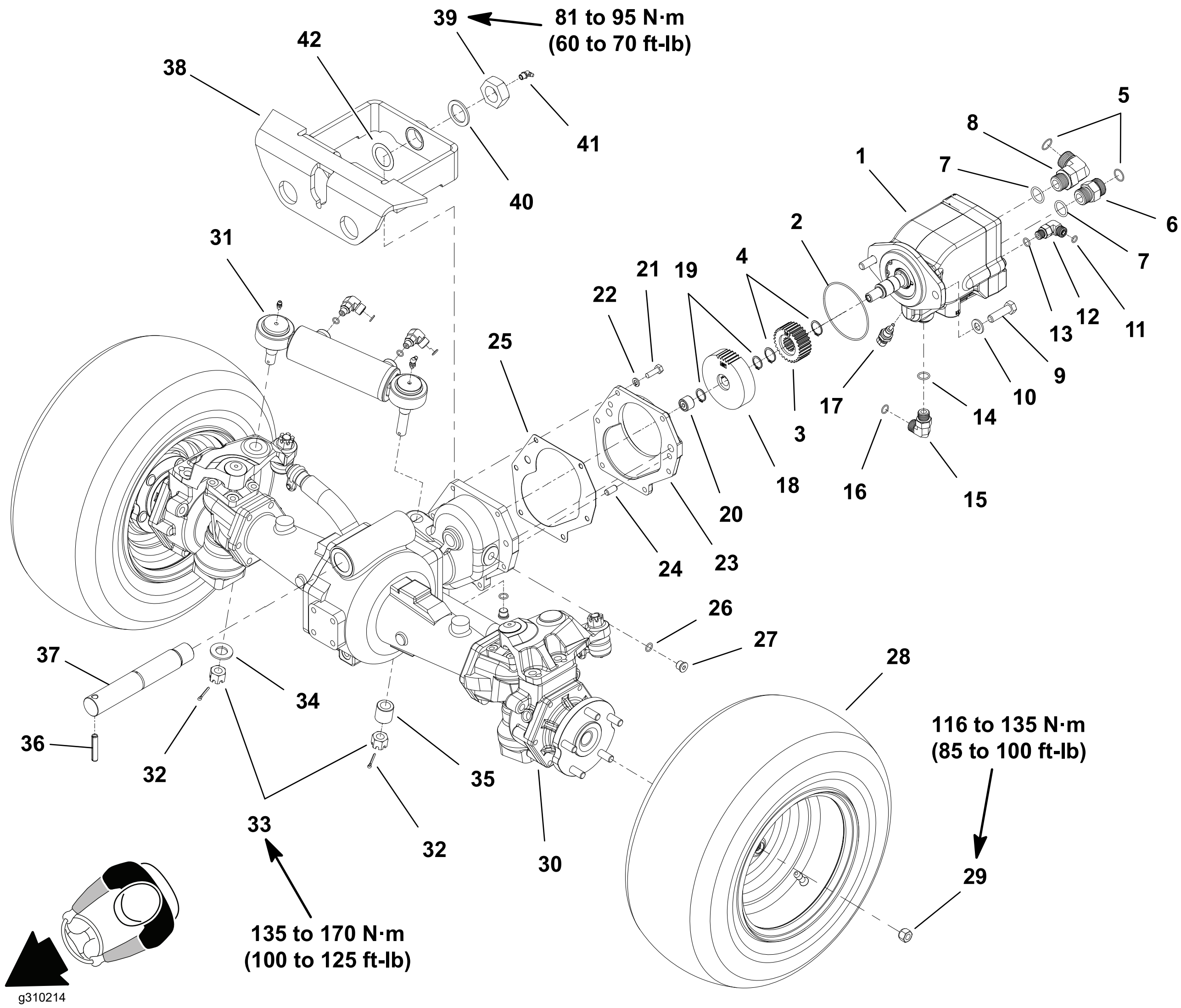

Figure 246

1. Rear axle motor
2. O−ring
3. Pinion gear
4. External snap ring (2 used)
5. O−ring
6. Hydraulic fitting
7. O−ring
8. 90o hydraulic fitting
9. Cap screw (2 used)
10. Flat washer (2 used)
11. O−ring
12. 90o hydraulic fitting
13. O−ring
14. O−ring
15. 90o hydraulic fitting
16. O−ring
17. Temperature sender with O−ring
18. Gear
19. External snap ring (2 used)
20. Needle bearing
21. Cap screw (6 used)
22. Lock washer (6 used)
23. Cover plate
24. Dowel pin (2 used)
25. Gasket
26. O−ring
27. Plug
28. Rear wheel assembly
29. Lug nut (5 used per wheel)
30. Rear axle assembly
31. Steering cylinder assembly
32. Cotter pin (2 used)
33. Slotted hex nut (2 used)
34. Flat washer
35. Spacer
36. Slotted roll pin
37. Rear axle pivot pin
38. Machine frame
39. Lock nut
40. Thrust washer
41. Grease fitting
42. Thrust washer (2 used)

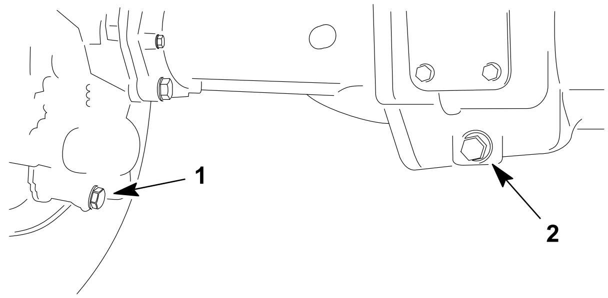

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Figure 247

1. Outside plug (2 used)
2. Center axle drain plug

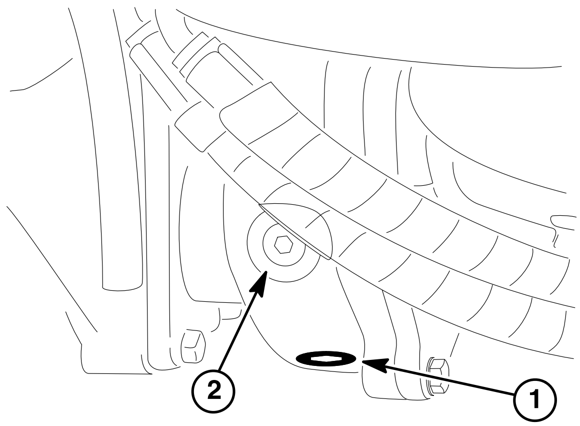

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Figure 248

1. Gearbox drain plug
2. Gearbox fill plug

Remove Rear Axle (Figure 246)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.
2. Drain oil from rear axle and rear axle gearbox (Figure 247 and Figure 248).

CAUTION

When changing attachments, tires or performing other service, use correct jacks, hoists and jack stands to raise and support machine. See Jacking Instructions (page 1–7).

3. Chock front wheels and jack up rear of machine (see Jacking Instructions (page 1–7)). Support machine with appropriate jack stands.
4. Remove both wheel assemblies from rear axle.
5. Remove hydraulic motor from axle assembly (see Rear Axle Motor (page 5–116)).
6. Remove hydraulic hoses from steering cylinder. Put caps or plugs on hoses and cylinder fittings to prevent contamination.
7. Remove lock nut (item 39) and thrust washer (item 40) from rear axle pivot pin.
8. Support rear axle to prevent it from falling. Remove pivot pin from frame and rear axle. Lower rear axle from machine. Note location of thrust washer (item 42) on both ends of axle mounting boss.

Remove Rear Axle (Figure 246) (continued)

9. If needed for further axle disassembly, remove steering cylinder from axle (see Steering Cylinder (page 5–142)).
10. If required, remove tie rod ends from steering arms on rear axle (Figure 249). Remove the cotter pins and castle nuts from the tie rod ball joints. Use a ball joint fork and remove the tie rod ends from the axle steering arms.
11. Clean the rear axle pivot pin and pivot bushings. Inspect the pin and bushings for wear or damage. Replace components as necessary.

Install Rear Axle (Figure 246)

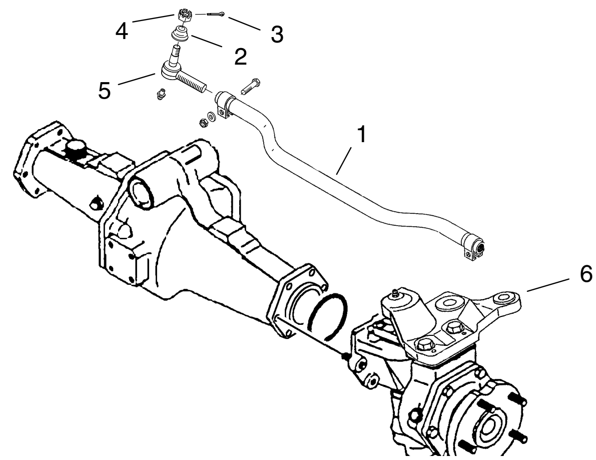

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Figure 249

1. Tie rod
2. Dust cover
3. Cotter pin
4. Castle nut
5. Tie rod end
6. Steering arm (LH)

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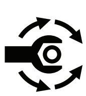
1. If removed, install steering cylinder to axle assembly (see Steering Cylinder (page 5–142)).
2. If removed, install the tie rod to rear axle (Figure 249). Tighten ball joint castle nuts and install new cotter pins.
3. Support axle under machine with a jack. Position axle assembly to rear frame mount.
4. Install rear axle pivot pin to secure axle to frame. Make sure to install thrust washer (item 42) between axle pivot and frame on both ends of the pivot. With thrust washers installed, there should be from 0.05 to 0.51 mm (0.002 to 0.020 inch) clearance between rear frame mount and axle mounting boss. Add additional thrust washers if needed to adjust clearance.



5. Install thrust washer (item 40) and lock nut (item 39) onto axle pivot pin. Lock nut should be tightened enough to allow pivot pin to rotate (**81 to 95 N·m (60 to 70 ft–lb)** maximum).
6. Install hydraulic motor to axle assembly (see Rear Axle Motor (page 5–116)).
7. Remove caps and plugs from hydraulic hoses and steering cylinder fittings. Secure hydraulic hoses to steering cylinder (see Installing Hydraulic Hoses and Tubes (O-Ring Face Seal) (page 5–7)).

WARNING

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

8. Install wheel assemblies to rear axle. Lower machine to ground. Torque wheel lug nuts from **116 to 135 N·m (85 to 100 ft−lb)**.

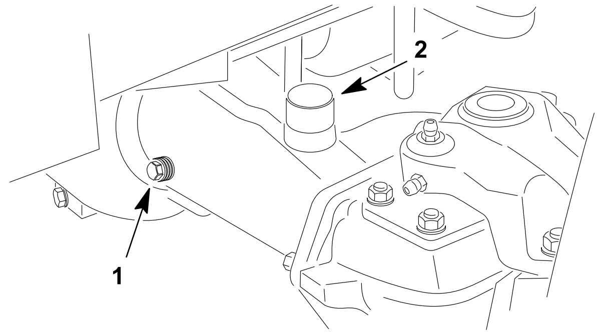


Figure 250

1. Axle check plug
2. Axle fill plug

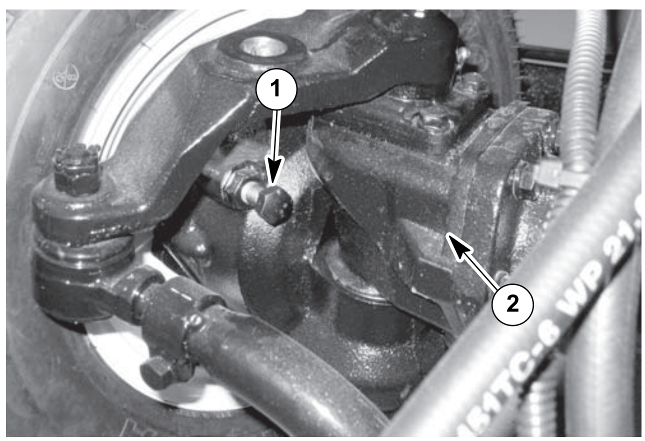


Figure 251

1. Steering stop bolt
2. Bevel gear case (LH)

9. Fill rear axle (Figure 250) and rear axle gearbox (Figure 248) with SAE 85W−140 weight gear lube. Lubricant capacity is approximately 2.37 liters (80 fl. oz.) for the rear axle and 0.47 liters (16 fl. oz.) for the gearbox.
10. Check rear wheel toe−in and adjust if necessary (see Traction Unit *Operator's Manual*).
11. Check steering stop bolt adjustment. When the steering cylinder is fully contracted (left turn), a gap of 1.6 mm (1/16 in) should exist between bevel gear case casting and stop bolt on left axle case. Figure 251 shows stop bolt location.

Rear Axle Service

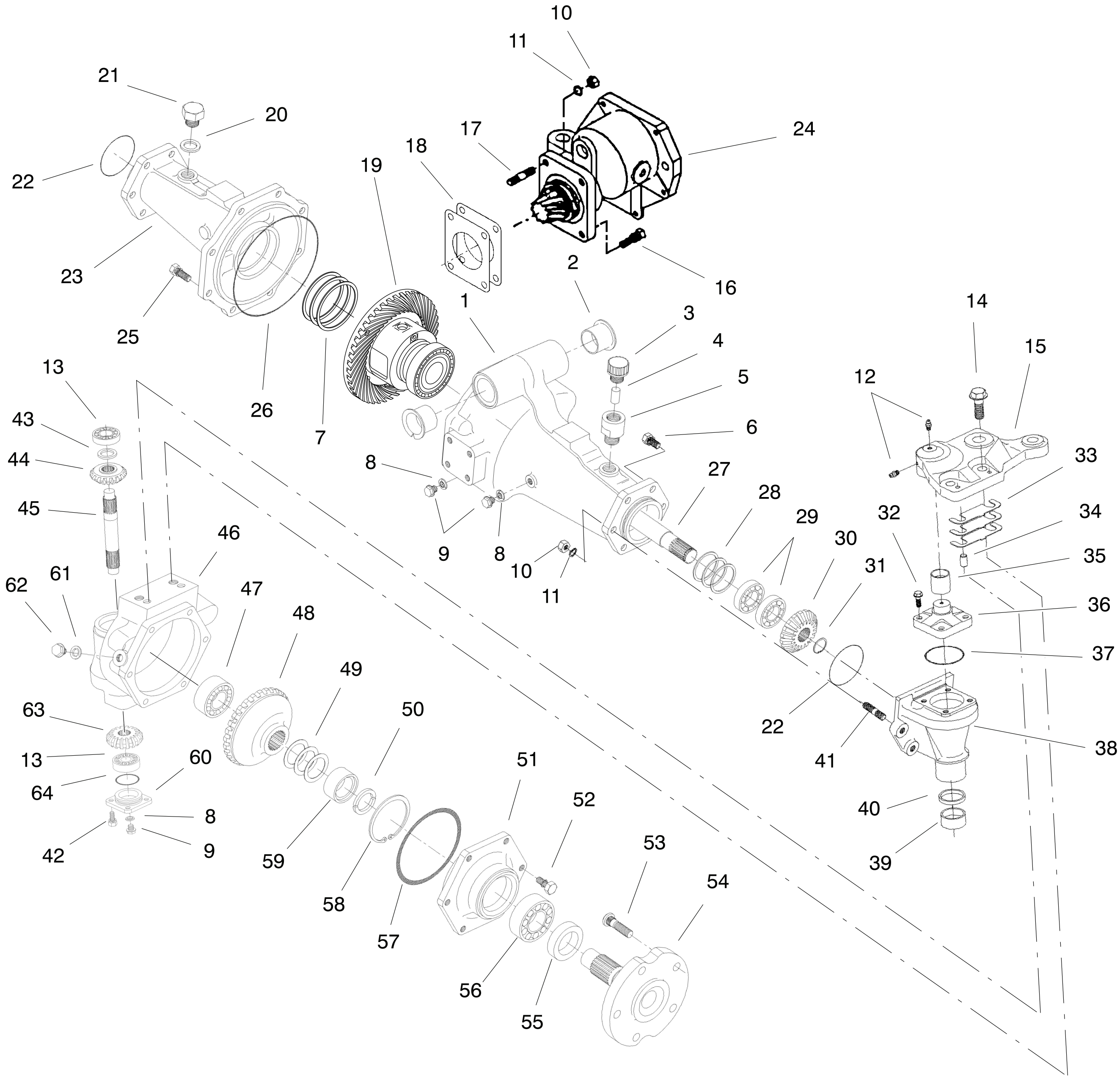


Figure 252

Figure 252 (continued)

1. LH axle support
2. Flange bushing (2 used)
3. Axle vent
4. Filter
5. Vent extension
6. Cap screw (4 used per gear case)
7. Shim set
8. Seal washer
9. Plug
10. Lock nut
11. Lock washer
12. Grease fitting
13. Ball bearing
14. Screw (2 used per steering arm)
15. Axle case support (LH shown)
16. Bolt (2 used)
17. Stud (2 used)
18. Shim set
19. Differential assembly
20. O−ring
21. Plug
22. O−ring
23. RH axle support
24. Input shaft assembly
25. Bolt (8 used)
26. O−ring
27. Differential shaft (LH shown)
28. Shim set
29. Ball bearing
30. Bevel gear (15 tooth)
31. Retaining ring
32. Bolt (4 used per knuckle)
33. Shim set
34. Dowel pin (2 used per axle case)
35. Bushing
36. Knuckle pin
37. O−ring
38. Bevel gear case (LH shown)
39. Bushing
40. Shaft seal
41. Stud (2 used per gear case)
42. Bolt (4 used per cover)
43. Collar
44. Bevel gear (17 tooth)
45. Bevel gear shaft
46. Axle case (LH shown)
47. Ball bearing
48. Bevel gear (29 tooth)
49. Shim set
50. Clip (2 used per axle case)
51. Axle cover
52. Screw (6 used per cover)
53. Wheel stud (5 used per axle)
54. Axle
55. Oil seal
56. Ball bearing
57. O−ring
58. Retaining ring
59. Spacer
60. Axle case cover
61. Seal washer
62. Plug
63. Bevel gear (17 tooth)
64. O−ring

Note: Figure 252 illustrates the rear axle used on the Groundsmaster 4500−D and 4700−D. Service procedures for the rear axle is on the following pages of this section.

Bevel Gear Case and Axle Case

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

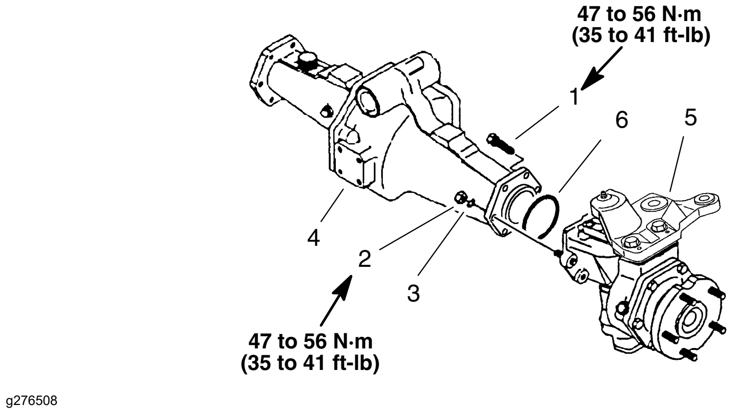


Figure 253

1. Cap screw (4 used)
2. Lock nut (2 used)
3. Lock washer (2 used)
4. Axle support
5. Bevel gear case/axle case assembly
6. O-ring

1. Remove the mounting screws, nuts and lock washers. Remove the bevel gear case/axle case assembly and O-ring from the axle support (Figure 253).
2. Mark both right and left bevel gear case/axle case assemblies.

IMPORTANT

Do not interchange right and left bevel gear case/axle case assemblies.

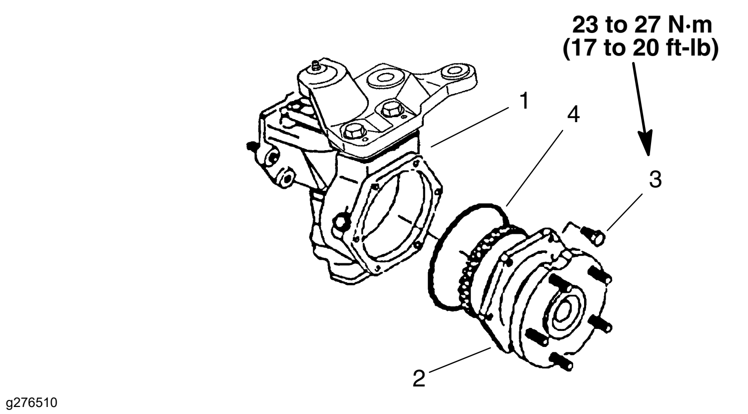


Figure 254

1. Axle case
2. Axle cover assembly
3. Screw (6 used)
4. O-ring

3. Remove the axle cover mounting screws. Remove the axle cover from the axle case as an assembly (Figure 254).

Removal (continued)

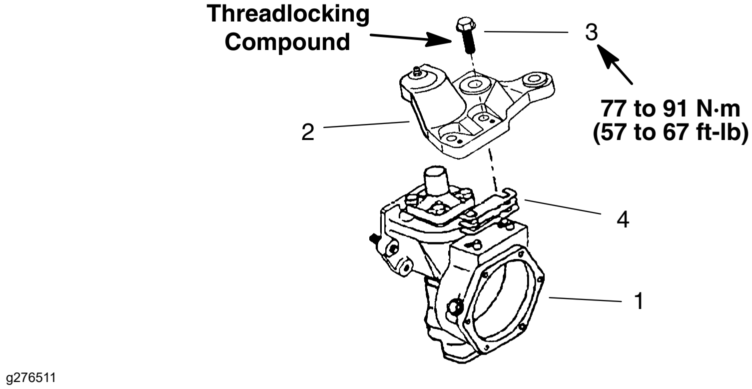


Figure 255

1. Axle case
2. Axle case support
3. Screw (2 used)
4. Support shim

4. Remove the axle case support mounting screws, the axle case support and the support shims (Figure 255).

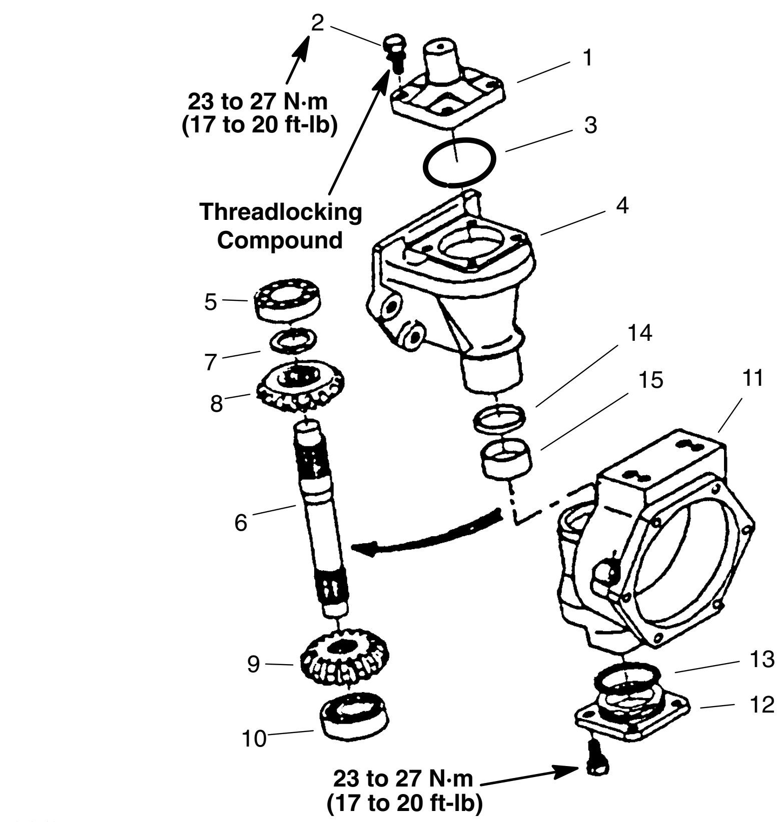


Figure 256

1. Knuckle pin
2. Mounting screw (4 used)
3. O−ring
4. Bevel gear case
5. Upper bearing
6. Bevel gear shaft
7. Collar
8. Upper bevel gear
9. Lower bevel gear
10. Lower bearing
11. Axle case
12. Axle case cover
13. O-ring
14. Shaft seal
15. Bushing

Removal (continued)

5. Remove the knuckle pin mounting screws and the knuckle pin. Remove the gasket and any remaining gasket material from either mating surface (Figure 256).
6. While holding the bevel gear case, tap the upper end of the bevel gear shaft out of the upper bearing and upper bevel gear.
7. Pull the bevel gear case from the axle case and remove the upper bevel gear and collar from the gear case.
8. Remove the axle case cover screws, cover and the O-ring from the axle case.
9. Remove the plug and sealing washer from the center of the axle case cover. While holding the axle case cover, lightly tap the lower end of the bevel gear shaft out of the lower bearing and lower bevel gear.
10. Remove and discard bevel gear shaft seal from axle case (Figure 256).

Inspection

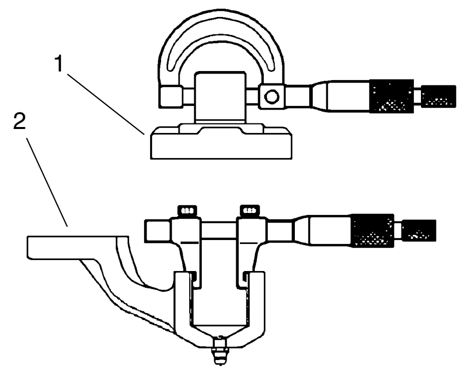


Figure 257

1. Knuckle pin
2. Axle case support

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1. Measure the knuckle pin O.D. and the axle case support bushing I.D. to determine the bushing to pin clearance (Figure 257). Replace components as necessary.

   BUSHING TO PIN CLEARANCE: **0.05 to 0.40 mm (0.002 to 0.016 in)**

   KNUCKLE PIN O.D. (Factory Spec.): **24.95 to 24.98 mm (0.982 to 0.983 in)**

   AXLE CASE SUPPORT BUSHING I.D. (Factory Spec.): **25.00 to 25.08 mm (0.984 to 0.987 in)**
2. Inspect all gears, shafts, bearings, cases and covers for damage and wear. Replace components as necessary.

Installation

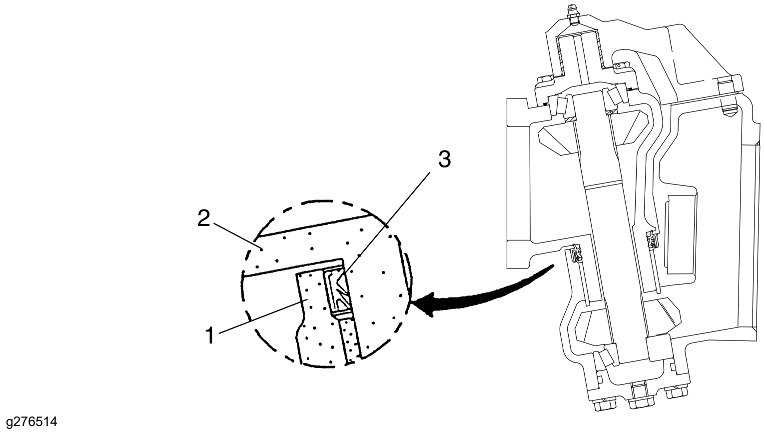

Figure 258

1. Axle case
2. Bevel gear case
3. Shaft seal

1. Coat new shaft seal with grease and install in axle case as shown (Figure 258).

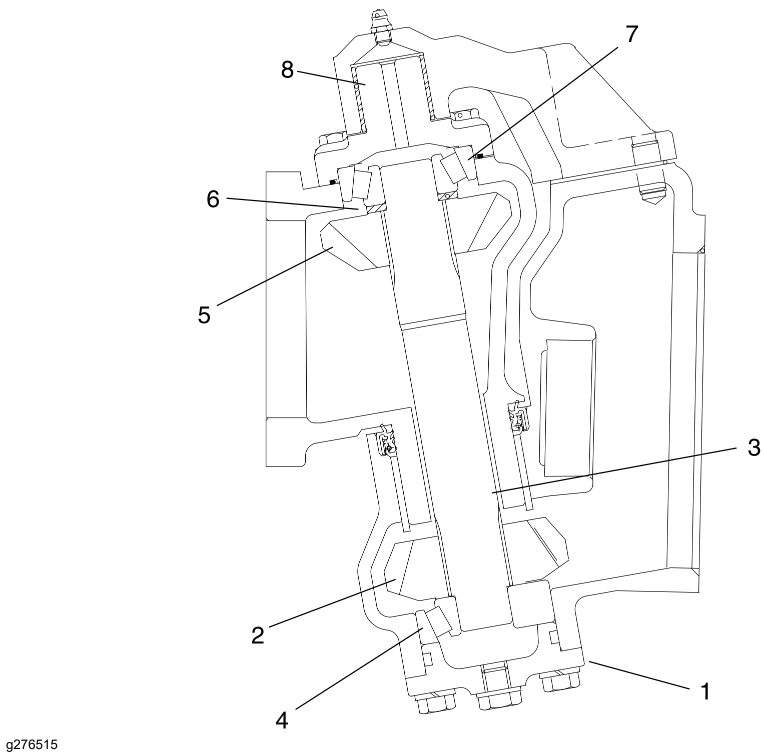

Figure 259

1. Axle case cover
2. Lower bevel gear
3. Bevel gear shaft
4. Lower bearing
5. Upper bevel gear
6. Collar
7. Upper bearing
8. Knuckle pin

2. Install the lower bevel gear and bevel gear shaft in the axle case cover. Coat a new O-ring with grease and install the axle case cover (Figure 259). Tighten cover screws from **23 to 27 N·m (17 to 20 ft-lb)**.
3. Slide the bevel gear case over the bevel gear shaft and install the bevel gear and collar. Make sure the bevel gear shaft is completely seated in the upper and lower bearings (Figure 259).

Installation (continued)

4. Install the knuckle pin. Use medium strength threadlocking compound and tighten the knuckle pin mounting screws from **23 to 27 N·m (17 to 20 ft-lb)**.

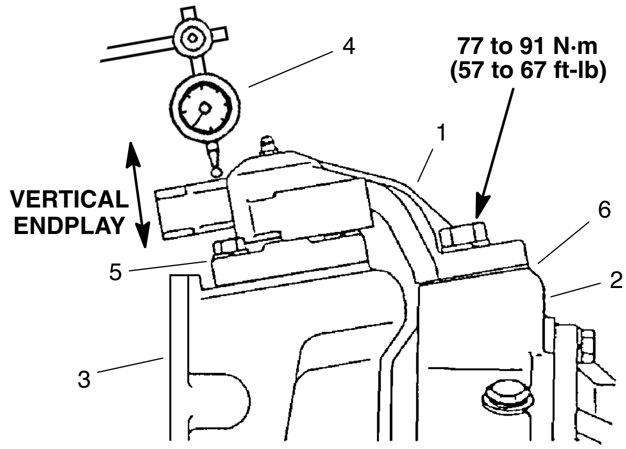

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Figure 260

1. Axle case support
2. Axle case
3. Bevel gearcase
4. Dial indicator
5. Knuckle pin
6. Support shim location

5. Determine necessary quantity of support shims.
   A. Lubricate the axle case support bushing with a thin coat of grease and slide axle case support onto knuckle pin.
   B. Position support shims that were removed during disassembly between axle case support and axle case. Install mounting screws into axle case. Slowly tighten screws while frequently checking for clearance (vertical endplay) between axle case support and knuckle pin. If binding of components is noted before screws are fully tightened, add additional support shims. Torque screws from **77 to 91 N·m (57 to 67 ft−lb)**.
   C. Use dial indicator to measure vertical endplay of axle case (Figure 260).

      AXLE CASE ASSEMBLY ENDPLAY: **0.02 to 0.20 mm (0.001 to 0.008 in)**
   D. Adjust endplay by increasing or reducing number of axle case support shims.

   Note: Axle case support shims are available in **0.1 mm (0.004 in), 0.2 mm (0.008 in)** and **0.4 mm (0.016 in)** thickness.
6. After correct support shims have been determined, remove mounting screws, apply heavy strength thread-locking compound to screw threads, reinstall screws and torque from **77 to 91 N·m (57 to 67 ft−lb)**.

IMPORTANT

Correct engagement between bevel gears is critical to axle performance and durability.

Installation (continued)

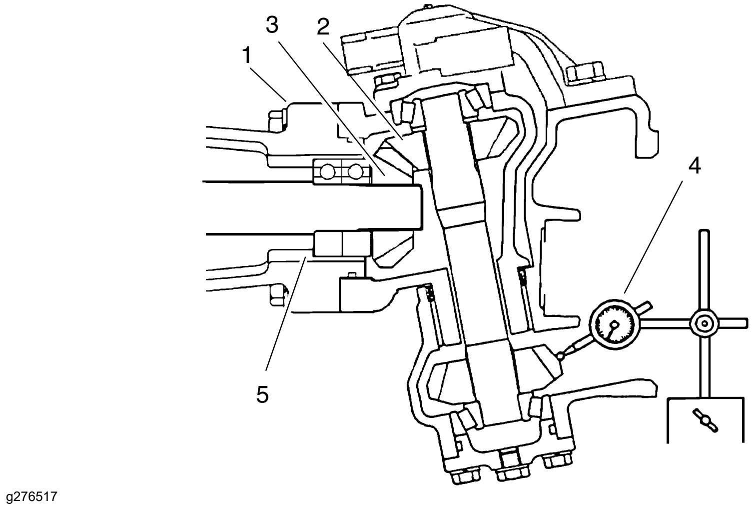

Figure 261

1. Axle support
2. Upper bevel gear
3. Differential shaft gear
4. Dial indicator
5. Axle bearing shims

7. Temporarily install the bevel gear case/axle case assembly on the axle support. Position a dial indicator at the tooths center. Prevent the axle from turning and measure the upper bevel gear to differential shaft gear backlash (Figure 261).

   UPPER BEVEL GEAR BACKLASH: **0.10 to 0.40 mm (0.004 to 0.016 in)**

8. Adjust backlash by increasing or reducing axle bearing shim thickness (see Differential Shafts (page 7–29)).

   Note: Axle bearing shims are available in **0.1 mm (0.004 in), 0.2 mm (0.008 in)** and **0.5 mm (0.020 in)** thickness.

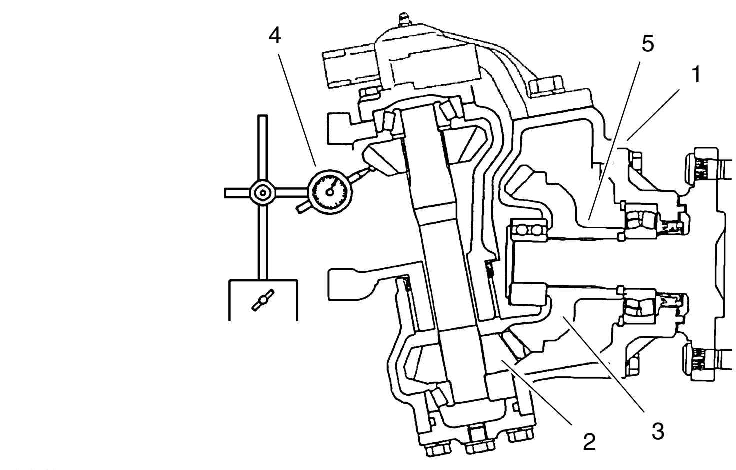

Figure 262

1. Axle cover assembly
2. Lower bevel gear
3. Axle gear
4. Dial indicator
5. Axle bearing shims

9. Remove the bevel gear case/axle case assembly from the axle support. Coat a new O-ring with grease and temporarily install the axle cover assembly.

Position a dial indicator at the tooths center. Prevent the axle from turning and measure the lower bevel gear to axle gear backlash (Figure 262).

LOWER BEVEL GEAR BACKLASH: **0.10 to 0.40 mm (0.004 to 0.016 in)**

10. Adjust backlash by increasing or reducing axle bearing shim thickness (see Axle Shafts (page 7–31)).

    Note: Axle bearing shims are available in **0.2 mm (0.008 in), 0.3 mm (0.012 in)** and **0.5 mm (0.020 in)** thickness.

11. Tighten axle cover screws from **23 to 27 N·m (17 to 20 ft-lb)**.
12. Coat a new O-ring with grease and install the bevel gear case/axle case assembly on the axle support. Tighten mounting screws and nuts from **47 to 56 N·m (35 to 41 ft-lb)** (Figure 253).

Differential Shafts

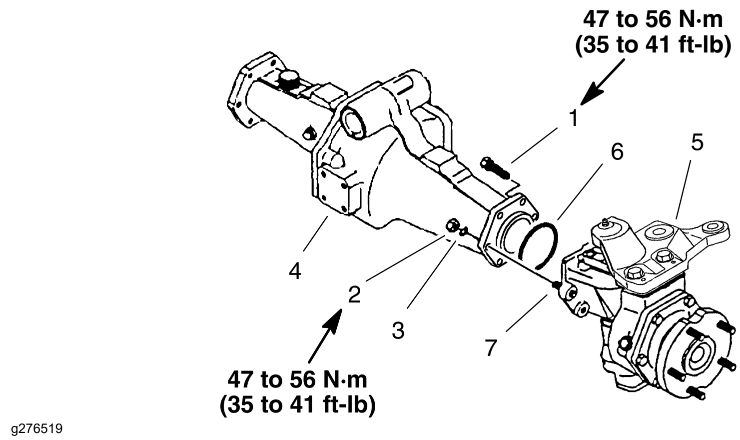

Figure 263

1. Cap screw (4 used)
2. Lock nut (2 used)
3. Lock washer (2 used)
4. Axle support
5. Bevel gear/axle case assembly
6. O-ring
7. Stud (2 used)

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

IMPORTANT

Do not interchange right and left differential shaft assemblies.

1. Remove the mounting screws, nuts and lock washers. Remove the bevel gear case/axle case assembly and O-ring from the axle support (Figure 263).
2. Mark and pull the differential shaft assembly from the axle support.

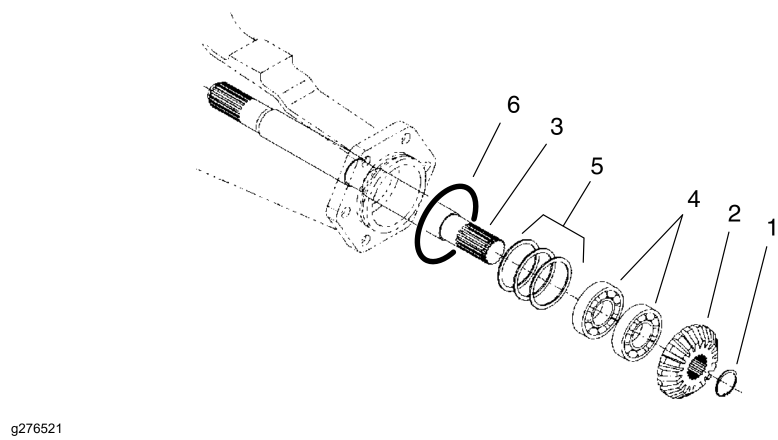

Figure 264

1. Retaining ring
2. Bevel gear
3. Differential shaft
4. Bearing
5. Bearing shims
6. O-ring

3. Remove the retaining ring and bevel gear (Figure 264).
4. Drive the differential shaft out of the bearings. Remove the bearings and bearing shims.

Removal (continued)

5. Inspect all gears, shafts, bearings and cases for damage and wear. Replace components as necessary.

Installation

1. Press bearings onto differential shaft. Place correct combination of bearing shims in axle support and drive differential shaft and bearing assembly into axle support.
2. Install bevel gear and retaining ring.
3. Coat new O-ring with grease. Align differential shaft splines with differential gear assembly and slide differential shaft assembly onto axle support.
4. Install bevel gear case/axle case assembly (see Bevel Gear Case and Axle Case (page 7–22)).

Axle Shafts

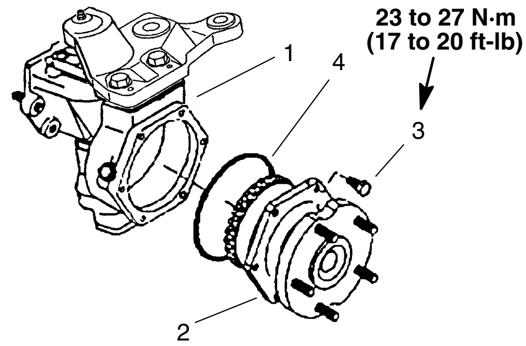

Figure 265

1. Axle case
2. Axle cover assembly
3. Screw (6 used)
4. O-ring

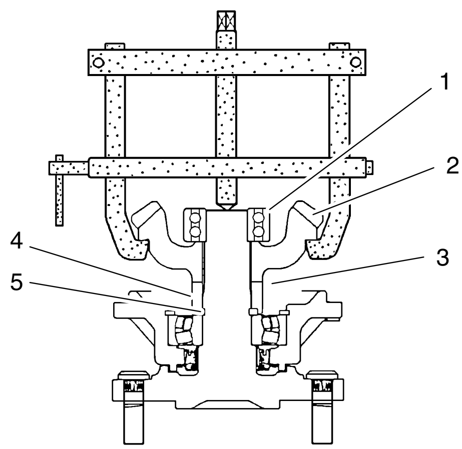

Figure 266

1. Bearing
2. Bevel gear
3. Shims
4. Spacer
5. Retaining ring

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

1. Remove the axle cover mounting screws. Remove the axle cover from the axle case as an assembly (Figure 265).
2. Use a bearing puller to remove the bearing and bevel gear as shown (Figure 266).
3. Remove the shims, spacer and retaining ring. Drive the axle out of the bearing and cover. Remove and discard the axle shaft seal.
4. Inspect all gears, shafts, bearings, spacers and cases for damage and wear. Replace components as necessary.

Installation

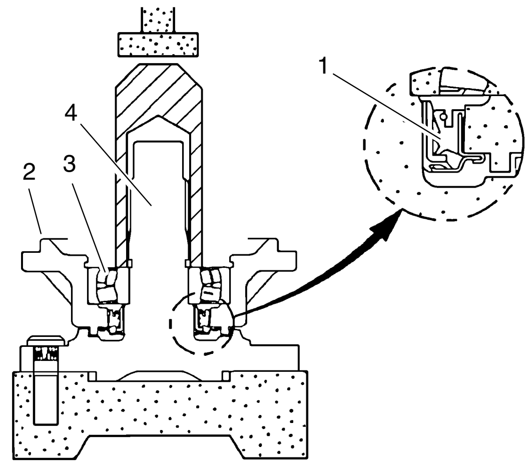

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Figure 267

1. Axle shaft seal
2. Axle cover
3. Bearing
4. Axle shaft

---

1. Coat new axle shaft seal with grease and install in axle cover as shown (Figure 267).
2. Press the axle cover and bearing assembly onto the axle shaft. Press only on the inner race of the cover bearing (Figure 267).
3. Install retaining ring, spacer and correct combination of bearing shims. Install bevel gear and bearing.
4. Coat a new O-ring with grease and install the axle cover assembly. Tighten axle cover screws from **23 to 27 N·m (17 to 20 ft-lb)**.

Input Shaft/Pinion Gear

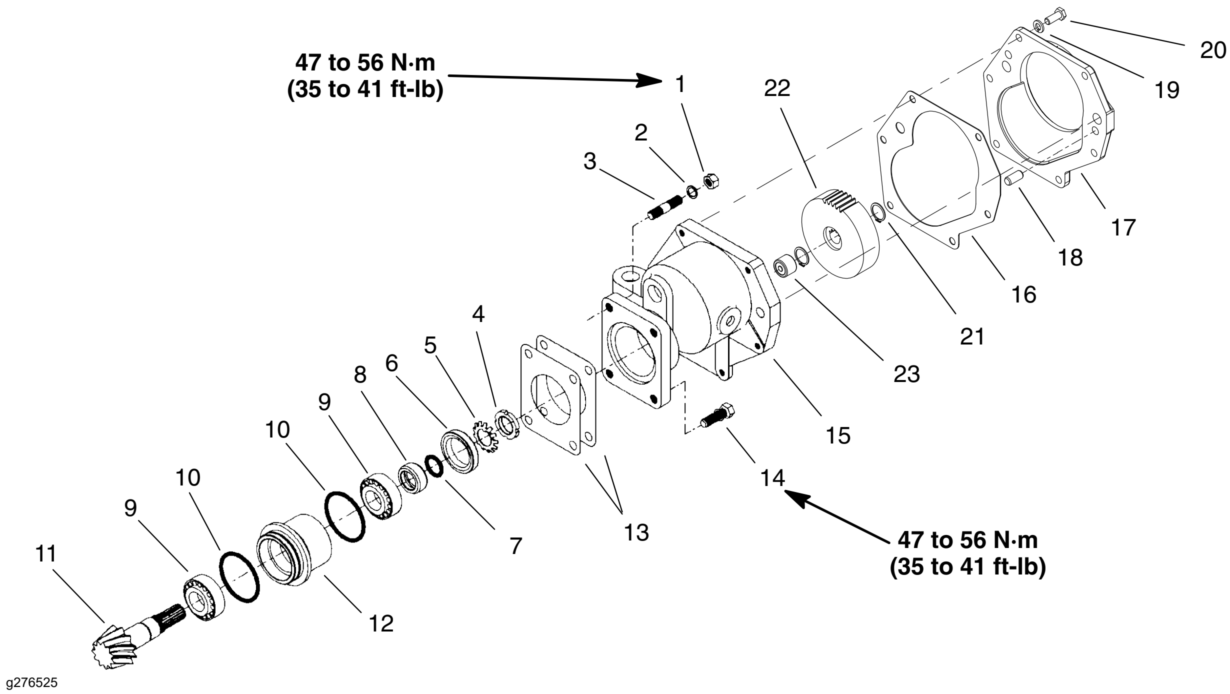

Figure 268

1. Nut (2 used)
2. Lock washer (2 used)
3. Stud (2 used)
4. Lock nut
5. Stake washer
6. Oil seal
7. O-ring
8. Seal collar
9. Bearing
10. O-ring
11. Input shaft/pinion gear
12. Bearing case
13. Shim
14. Screw (2 used)
15. Gear case
16. Gasket
17. Cover plate
18. Dowel pin (2 used)
19. Lock washer (6 used)
20. Cap screw (6 used)
21. Retaining ring (2 used)
22. Driven gear (45 tooth)
23. Needle bearing

The following procedures assume the rear axle assembly has been removed from the machine.

Removal (Figure 268)

1. Remove the cover plate, gasket and gear case assembly from the axle assembly. Remove the gasket and any remaining gasket material.
2. Remove the retaining rings, the driven gear and the needle bearing from the input shaft/pinion gear.
3. Remove input shaft/pinion gear assembly from the gear case. Remove the shims and bearing case O-rings.
4. Release the stake washer and remove the lock nut. Remove and discard the stake washer.
5. Drive the input shaft/pinion gear out from the outer bearing cone and bearing case. Remove and discard the oil seal and O-ring.
6. Inspect all gears, shafts, bearings, spacers and cases for damage and wear. Replace components as necessary.

   Note: Replacement input shaft/pinion gear (item 11) is only available in matched set with differential ring gear.

Installation (Figure 268)

Note: When installing bearing cones onto the input shaft/pinion gear, press only on the inner race of the bearing cone.

1. If the inner bearing cone was removed, press a new bearing cone all the way onto the input shaft/pinion gear.
2. Place the shaft and bearing assembly in the bearing case and install the outer bearing cone.

   Note: The bearings must be completely seated. There should be no input shaft/pinion gear end play.

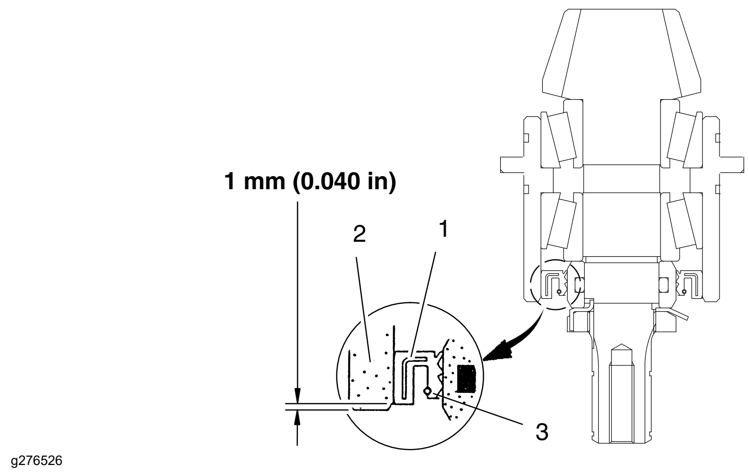

Figure 269

1. Oil seal
2. Bearing case
3. Seal garter spring

---

3. Coat a new oil seal with grease and install as shown in Figure 269. The seal should be installed with the garter spring towards the hydraulic motor location.
4. Coat new O-ring with grease. Install O-ring in the oil seal collar and install the collar.
5. Install a new stake washer. Install the lock nut finger tight.
6. Set the bearing preload by securing the bearing case in a vise. Thread a M12 x 1.5 hex head cap screw into the splined end of the input shaft/pinion gear and slowly tighten the lock nut until **0.4 to 0.7 N·m (4 to 6 in-lb)** of force is required to rotate the input shaft/pinion gear in the bearing case.
7. Secure the lock nut with the stake washer.

Installation (Figure 268) (continued)

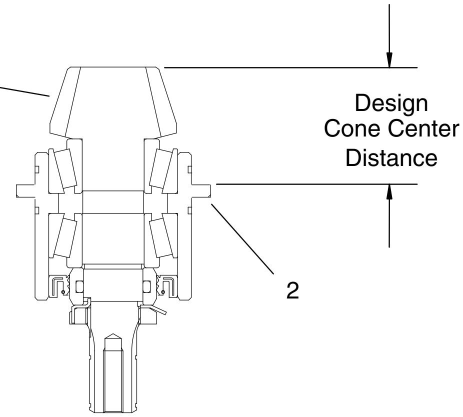

Figure 270

1. Input shaft/pinion gear
2. Bearing case

8. Use a depth gauge to measure the distance from the end face of the input shaft/pinion gear to the mating surface of the bearing case. Subtract the "Design Cone Center Distance" from this distance to determine initial shim thickness (Figure 270).

   DESIGN CONE CENTER DISTANCE (distance from mating surface of axle support to end face of pinion gear): **47.5 + 0.05 mm (1.870 + 0.002 in)**.

   Note: Bearing case shims are available in **0.1 mm (0.004 in)** and **0.2 mm (0.008 in)** thickness.

9. Coat new O-rings with grease and install the bearing case in the gear case. Place shims on the gear case and temporarily install gear case assembly into axle case. Tighten mounting nuts and screws from **47 to 56 N·m (35 to 41 ft-lb)**.

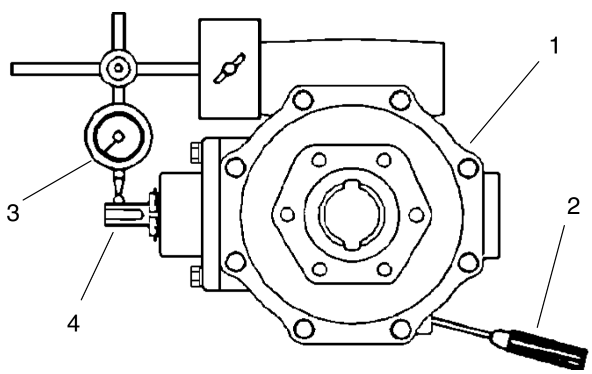

Figure 271

1. Axle case
2. Screwdriver
3. Dial indicator
4. Input shaft/pinion gear

10. Insert a screwdriver through the drain plug hole to hold ring gear and measure the pinion gear to ring gear backlash (Figure 271).

    PINION GEAR TO RING GEAR BACKLASH: **0.10 to 0.40 mm (0.004 to 0.016 in)**

11. Adjust backlash by increasing or reducing gear case shim thickness.

12. Check pinion gear to ring gear engagement (see Pinion Gear to Ring Gear Engagement (page 7–43)).

Installation (Figure 268) (continued)

13. Place the correct combination of shims on the gear case. Tighten mounting nuts and screws from **47 to 56 N·m (35 to 41 ft-lb)**.
14. Install retaining rings and driven gear on input shaft/ pinion gear.
15. If the drive gear (on drive motor shaft) was removed, install the retaining rings and drive gear on the motor shaft.
16. Use a new gasket and install the cover plate. Use a new O-ring and install the drive motor.

Differential Gear

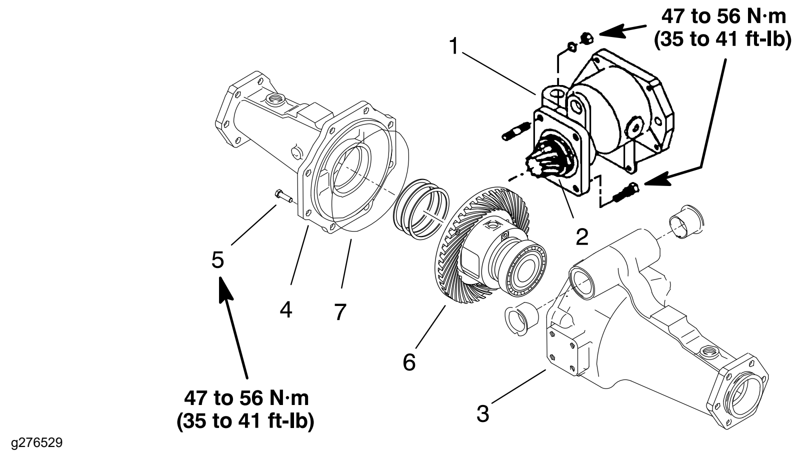

Figure 272

1. Gear case
2. Pinion gear
3. Axle support (left)
4. Axle support (right)
5. Case screw (8 used)
6. Differential gear
7. O-ring

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

1. Remove bevel gear case/axle case assemblies (see Bevel Gear Case and Axle Case (page 7–22)).

IMPORTANT

Do not interchange right and left differential shafts assemblies.

2. Mark and pull the differential shaft assemblies from the axle support.
3. Remove input shaft/pinion gear assembly, shims and O-ring from the axle support (Figure 272).
4. Remove the axle support case screws. Separate the axle support halves and remove the O-ring.
5. Remove the differential gear assembly, bearings and adjusting shims from the axle case.

Removal (continued)

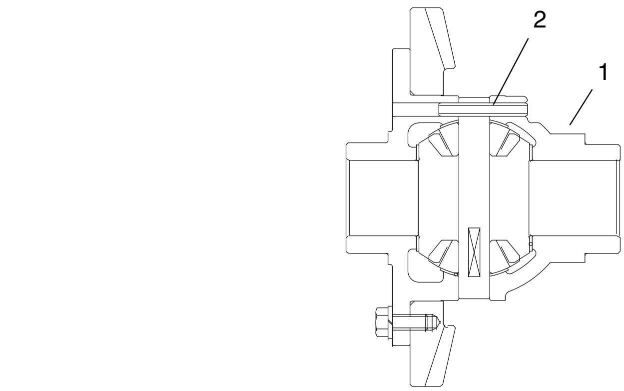

Figure 273

1. Differential case
2. Spring pin

6. Drive the spring pin from the differential case with a punch and hammer. Discard the spring pin (Figure 273).

   Note: Mark and arrange all components so they can be reassembled in their original position.

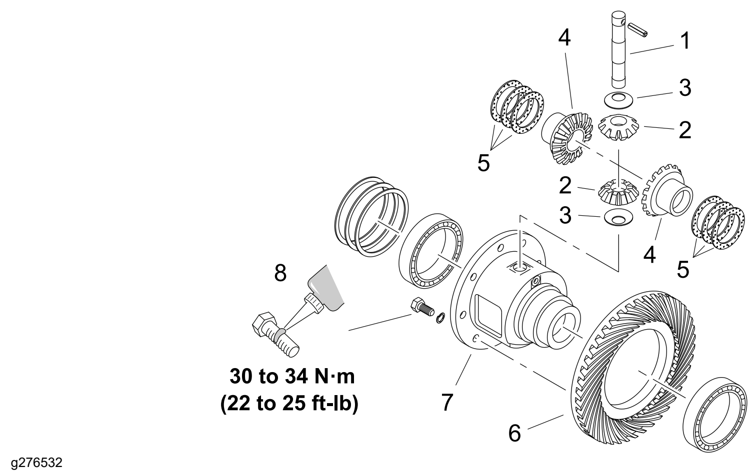

Figure 274

1. Differential pinion shaft
2. Pinion gear
3. Pinion washer
4. Side gear
5. Side gear shims
6. Ring gear
7. Differential case
8. Bolt/washer (8 used)

7. Remove the differential pinion shaft, pinion gears and pinion washers. Remove the differential side gears and side gear shims. Remove the ring gear only if it will be replaced (Figure 274).

   Note: Replacement ring gears are only available in matched ring and pinion sets.

Inspection

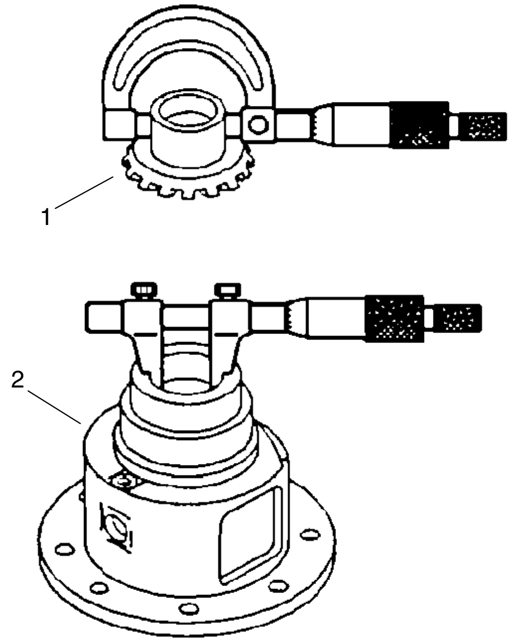

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Figure 275

1. Side gear
2. Differential case

---

1. Measure the differential side gear O.D. and the differential case I.D. to determine the side gear to case clearance (Figure 275). Replace components as necessary.

   SIDE GEAR TO CASE CLEARANCE: **0.05 to 0.30 mm (0.002 to 0.012 in)**

   SIDE GEAR O.D. (Factory Spec.): **33.91 to 33.95 mm (1.335 to 1.337 in)**

   DIFFERENTIAL CASE I.D. (Factory Spec.): **34.00 to 34.06 mm (1.339 to 1.341 in)**

Inspection (continued)

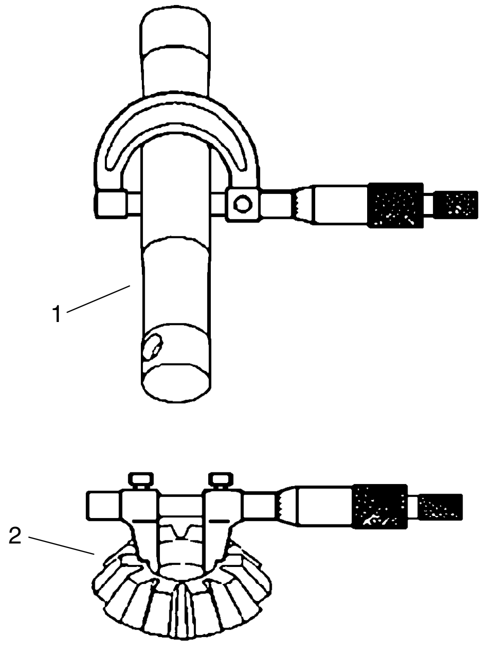

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Figure 276

1. Pinion shaft
2. Pinion gear

---

2. Measure the differential pinion shaft O.D. and the pinion gear I.D. to determine the pinion shaft to pinion gear clearance (Figure 276). Replace components as necessary.

   PINION SHAFT TO PINION GEAR CLEARANCE: **0.03 to 0.25 mm (0.001 to 0.010 in)**

   PINION SHAFT O.D. (Factory Spec.): **13.97 to 13.10 mm (0.550 to 0.551 in)**

   PINION GEAR I.D. (Factory Spec.): **13.10 to 14.02 mm (0.551 to 0.552 in)**

3. Inspect all gears, shafts, bearings, cases and covers for damage and wear. Replace components as necessary.

Installation

1. If the ring gear was removed from the differential case, use medium strength Loctite thread locker and tighten the mounting screws from **30 to 34 N·m (22 to 25 ft-lb)**.

2. Apply molybdenum di-sulfide lubricant (Three Bond 1901 or equivalent) to the splines and bearing surfaces of the differential pinion gears, pinion washers and side gears.

3. Install the side gear shims and side gears in their original location in the differential case.

4. Place the differential pinion gears and pinion washers in their original location in the differential case. Temporarily install the differential pinion shaft.

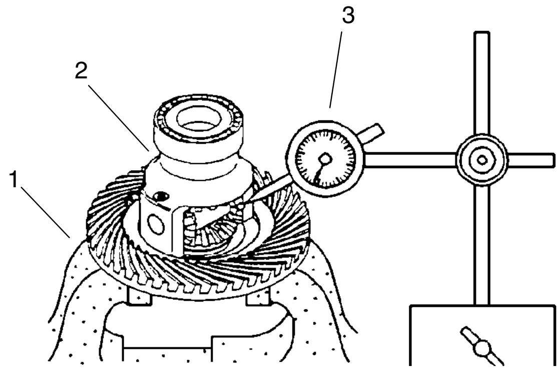

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Figure 277

1. Vise
2. Differential gear case
3. Dial indicator

5. Secure the differential case in a soft jawed vise. Position a dial indicator on a tooth of the differential pinion gear. Press the pinion and side gear against the differential case and measure the pinion gear to side gear backlash (Figure 277).

   PINION GEAR TO SIDE GEAR BACKLASH: **0.10 to 0.40 mm (0.004 to 0.016 in)**

6. Adjust backlash by increasing or reducing side gear shim thickness.

   Note: Side gear shims are available in **1.10 mm (0.043 in)**, **1.20 mm (0.047 in)** and **1.30 mm (0.051 in)** thickness.

7. Apply gear marking compound, such as DyKem Steel Blue lightly over several gear teeth.

8. While applying a light load to either side gear, rotate either pinion gear until the side gears have made one complete revolution.

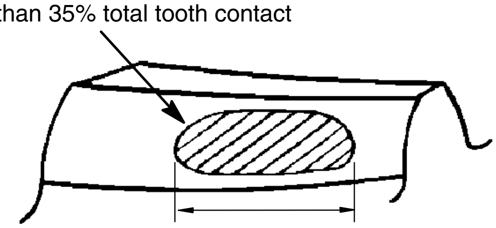

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Figure 278

9. Ideal tooth contact should cover more than 35% of each tooth surface. The contact area should be in the center of each tooth and extend 1/3 to 1/2 way across each tooth from the toe (small) end (Figure 278).

10. Adjust side gear shims if necessary to correct tooth contact. Recheck differential pinion gear to side gear backlash if any changes are made.

11. After backlash and tooth contact have been adjusted, align the hole in the differential pinion shaft with the hole in the differential case and install a new spring pin.

12. Install differential gear assembly in right side axle support half.

Installation (continued)

13. Coat a new O-ring with grease and install left side axle support half. Tighten axle support case screws from **47 to 56 N·m (35 to 41 ft-lb)**.

14. Install input shaft/pinion gear assembly (see Input Shaft/Pinion Gear (page 7–33)).

15. Coat new O-rings with grease, align differential shaft splines with differential gear assembly and slide differential shaft assemblies onto axle support.

16. Install bevel gear case/axle case assemblies (see Bevel Gear Case and Axle Case (page 7–22)).

Pinion Gear to Ring Gear Engagement

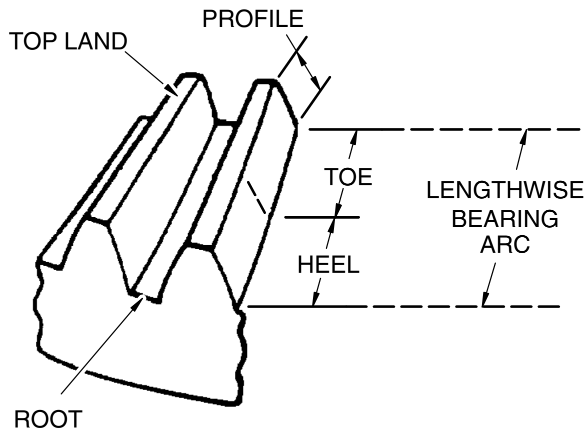

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Figure 279

The final position of the pinion gear is verified by using the gear contact pattern method as described in the following procedure.

GEAR TOOTH DEFINITIONS (Figure 279):

Toe − the portion of the tooth surface at the end towards the center.

Heel − the portion of the gear tooth at the outer end.

Top Land − top surface of tooth.

1. Paint the teeth of the ring gear, both drive and coast side, with a gear marking compound, such as DyKem Steel Blue.
2. Install the input shaft/pinion gear assembly into axle case.

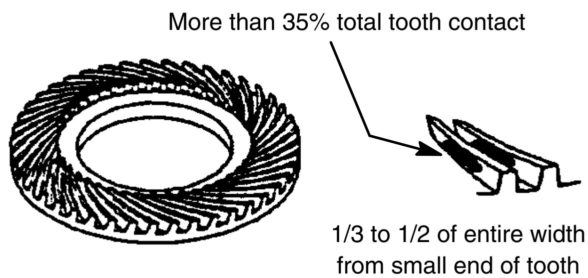

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Figure 280

Pinion Gear to Ring Gear Engagement (continued)

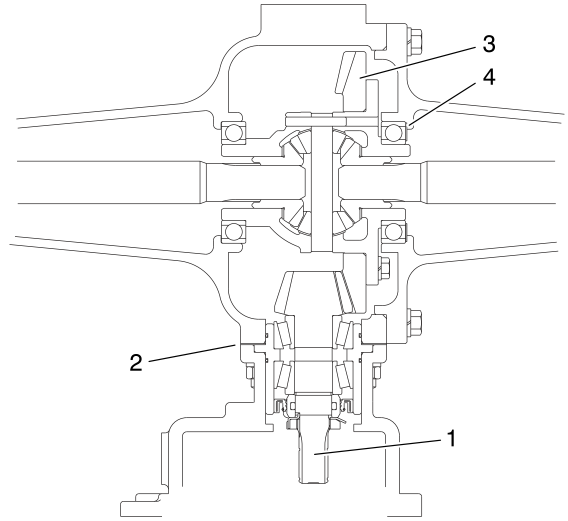

Figure 281

1. Input shaft/pinion gear
2. Bearing case shims
3. Differential gear case
4. Differential bearing shims

3. While applying a light load to the ring gear, rotate the pinion gear in the direction of forward travel until the ring gear has made one complete revolution.

   Ideal tooth contact observed on the ring gear should cover more than 35% of each tooth surface. The contact area should be in the center of each tooth and extend 1/3 to 1/2 way across each tooth from the toe end (Figure 280).

   Adjustments to the gear contact position are made by moving the input shaft/pinion gear (bearing case shims) or by moving the differential gear case (differential bearing shims) (Figure 281).

   Note: Bearing case shims are available in **0.10 mm (0.004 in)** and **0.20 mm (0.008 inch)** thickness.

   Note: Differential bearing shims are available in **0.10 mm (0.004 in), 0.20 mm (0.008 in)** and **0.40 mm (0.016 in)** thickness.

   Study the different contact patterns (Figure 282 and Figure 283) and correct gear engagement as necessary.

   Note: When making changes, note that two variables are involved (see Gear Pattern Movement Summary (page 7–45)).

   Example: If the pinion gear to ring gear backlash is set correctly to specifications and the bearing case shim is changed to adjust tooth contact, it may be necessary to readjust backlash to the correct specification before checking the contact pattern.

Gear Pattern Movement Summary

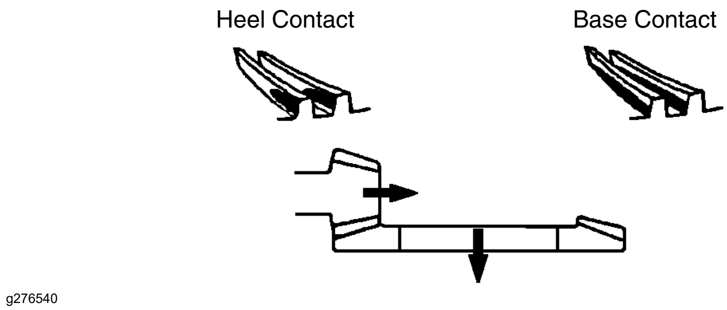

Figure 282

Every gear has a characteristic pattern. The illustrations show typical patterns only and explain how patterns shift as gear location is changed.

1. If contact is toward the heel or base of the gear (Figure 282):
   A. Install thicker or additional bearing case shim(s) to move pinion shaft toward ring gear.
   B. Install thinner or remove differential bearing shim(s) to move ring gear backward.
   C. Repeat until proper tooth contact and pinion gear to ring gear backlash are correct.

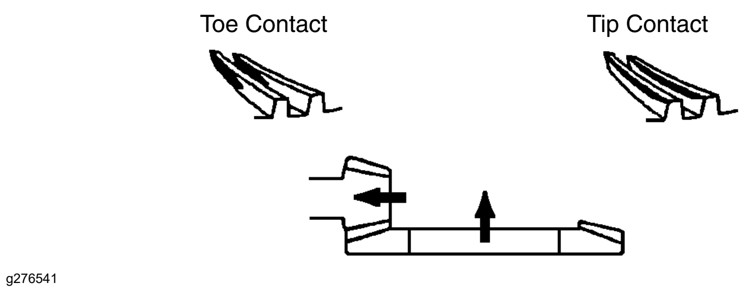

Figure 283

2. If contact is toward the toe or tip of the gear (Figure 283):
   A. Install thinner or remove bearing case shim(s) to move pinion shaft away from ring gear.
   B. Install thicker or additional differential bearing shim(s) to move ring gear forward.
   C. Repeat until proper tooth contact and pinion gear to ring gear backlash are correct.

Chassis

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General Information

Operator’s Manual

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

Cutting Deck Identification

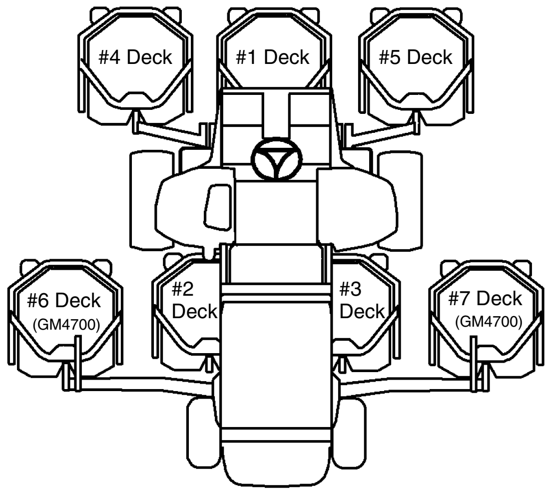

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Figure 284
CUTTING DECK LOCATIONS

Cutting decks on the Groundsmaster 4500-D and 4700-D are identified as shown in Figure 284.

Service and Repairs

Steering Column

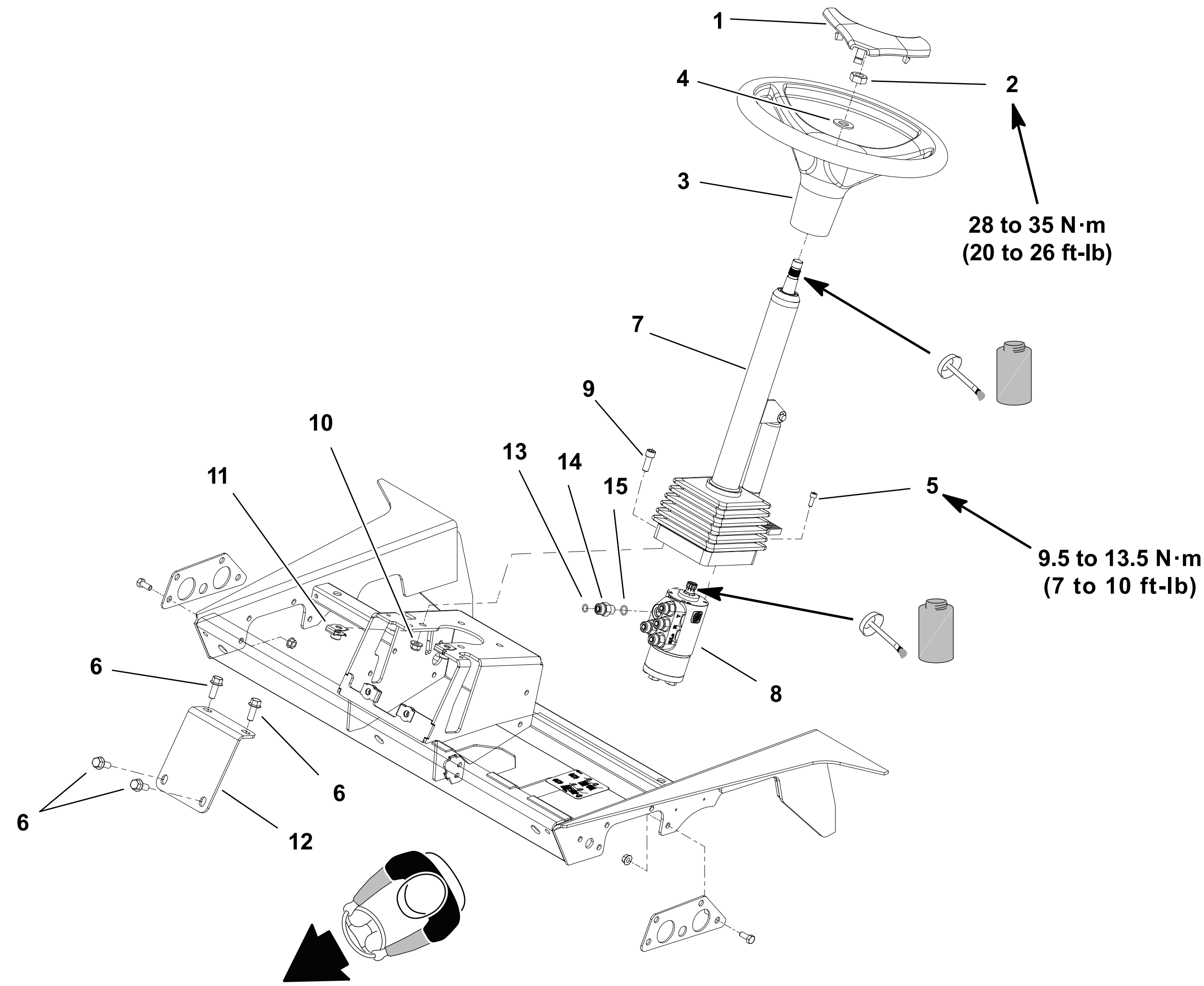

Figure 285

1.	Steering wheel cover	6.	Flange head screw (4 used)	11.	Tinnerman nut (4 used)
2.	Lock nut	7.	Steering column	12.	Column brace
3.	Steering wheel	8.	Steering control valve	13.	O-ring
4.	Flat washer	9.	Socket head screw (4 used)	14.	Straight fitting (5 used)
5.	Socket head screw (4 used)	10.	Flange nut (4 used)	15.	O-ring

Removal (Figure 285)

1. Park the machine on a level surface, engage the parking brake, lower the cutting decks and stop the engine. Remove the key from the ignition switch.
2. Remove platform shroud from machine to allow access to steering column fasteners (Figure 286).

Removal (Figure 285) (continued)

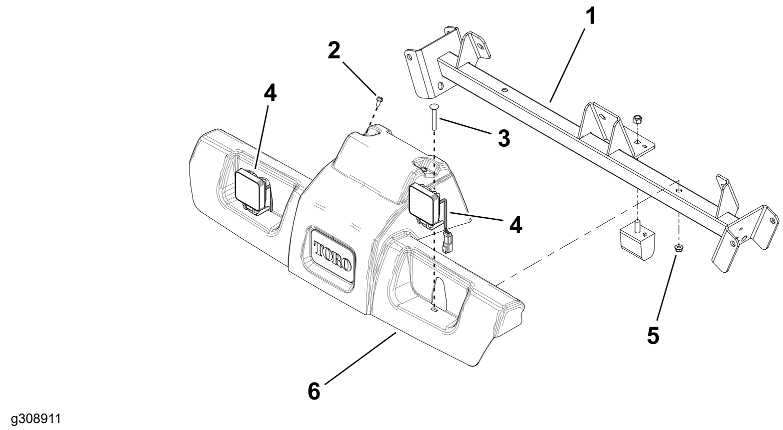

Figure 286

1. Roller support
2. Screw (2 used)
3. Carriage screw (2 used)
4. Headlight assembly
5. Flange nut (2 used)
6. Platform shroud

3. Remove cover from steering wheel by carefully prying up on one of the cover spokes.
4. Remove lock nut and flat washer that secure steering wheel to steering column.
5. Use a suitable puller to remove steering wheel from steering column.
6. Remove four (4) flange head screws that secure column brace (item 12) to frame platform. Remove brace from machine to allow access to steering column fasteners.
7. Slide rubber bellows up steering column to allow access to fasteners that secure steering control valve and steering column to machine.
8. Support steering control valve to prevent it from shifting during steering column removal.
9. Loosen and remove four (4) socket head screws (item 5) that secure steering control valve to steering column.
10. Loosen and remove four (4) socket head screws (item 9) and flange nuts (item 10) that secure steering column to machine.
11. Carefully raise steering column assembly from steering control valve and machine.
12. Disassemble steering column assembly as needed using Figure 287 as a guide.

Removal (Figure 285) (continued)

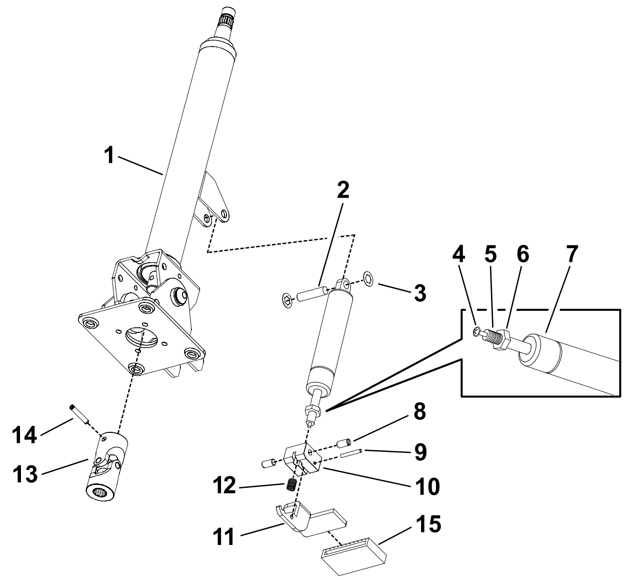

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Figure 287

1. Steering column
2. Pin
3. Lock washer (2 each)
4. Release pin
5. Cylinder shaft
6. Jam nut
7. Cylinder
8. Bolt (2 each)
9. Pin
10. Pedal block
11. Pedal
12. Spring
13. Universal joint
14. Pin
15. Pedal cover

Installation (Figure 285)

1. Assemble steering column using Figure 287 as a guide. After assembly, make sure that release pin on end of cylinder shaft is positioned against the pedal. Jam nut on cylinder shaft can be used to adjust location of release pin.
2. Apply antiseize lubricant to input shaft of steering control valve.
3. Carefully slide steering column onto steering control valve. Secure steering column in place with four (4) socket head screws (item 9) and flange nuts (item 10).
4. Secure steering control valve to steering column with four (4) socket head screws (item 5). Torque screws from **9.5 to 13.5 N·m (7 to 10 ft-lb)**.
5. Slide rubber bellows to bottom of steering column.
6. Position column brace (item 12) in place and secure with four (4) flange head screws.
7. Thoroughly clean tapered surfaces of steering wheel and steering column.
8. Apply antiseize lubricant to splines of steering column taking care to keep antiseize lubricant from column taper. Slide steering wheel onto steering column.
9. Secure steering wheel to steering column with flat washer and lock nut. Torque hex nut from **28 to 35 N·m (20 to 26 ft-lb)**.
10. Install steering wheel cover to steering wheel.

Installation (Figure 285) (continued)

11. Install and secure platform shroud to machine (Figure 286).

Traction Pedal

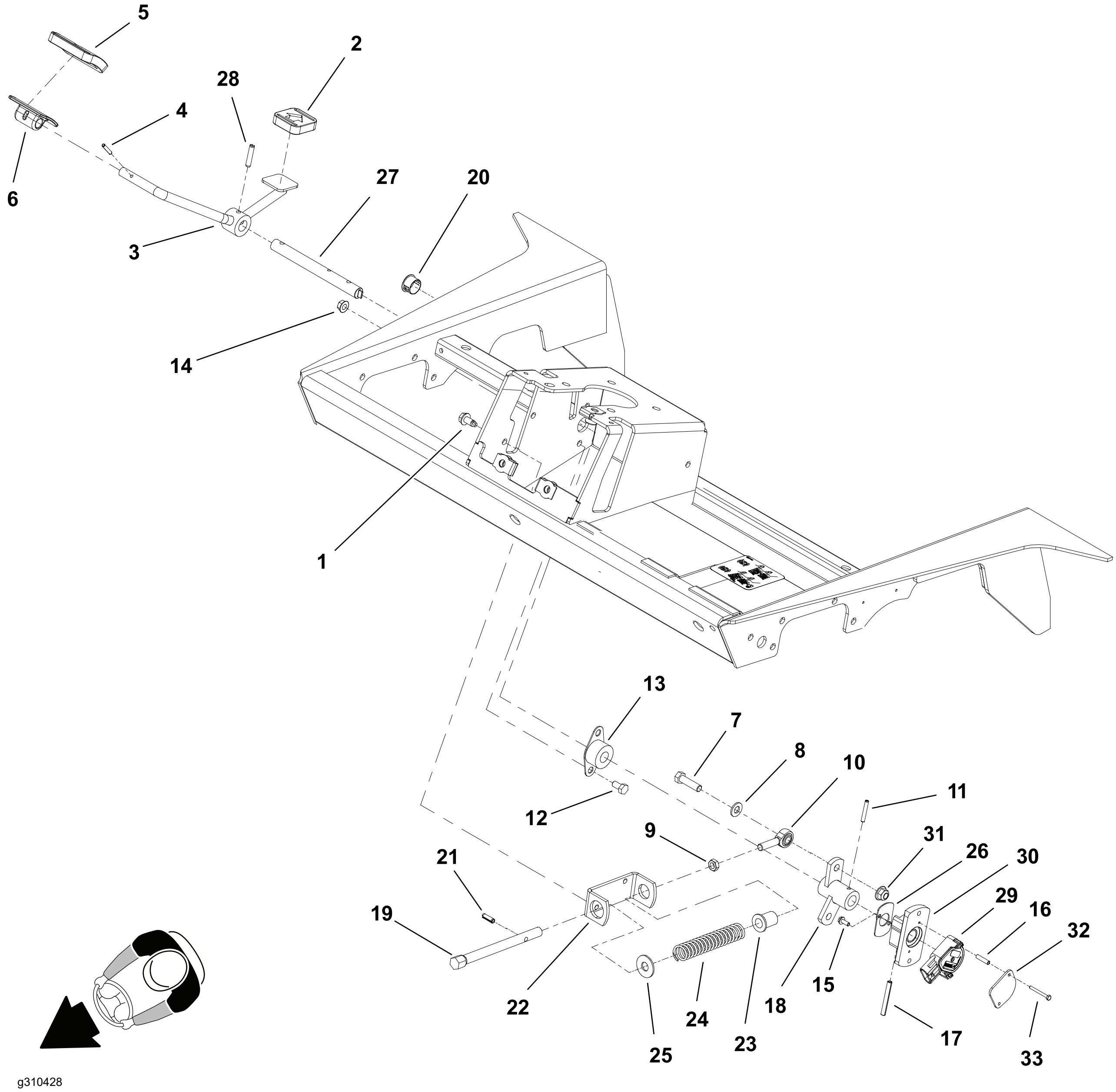
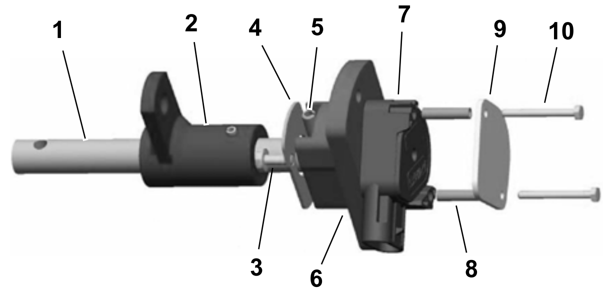


Figure 288

1. Washer head screw (2 used)
2. Reverse pedal pad
3. Pedal assembly
4. Spring pin
5. Forward pedal pad
6. Accelerator pedal
7. Cap screw
8. Flat washer
9. Jam nut
10. Rod end bearing
11. Slotted roll pin
12. Cap screw (4 used)
13. Flange bearing mount
14. Flange nut (2 used)
15. Washer head screw (2 used)
16. Standoff spacer (2 used)
17. Roll pin
18. Pivot hub
19. Spring shaft
20. Plastic plug
21. Roll pin
22. Spring bracket
23. Spring retainer
24. Compression spring
25. Flat washer
26. Sensor cover plate
27. Traction pivot shaft
28. Spring pin
29. Position sensor
30. Hub
31. Flange nut
32. Capture plate
33. Cap screw (2 used)

IMPORTANT

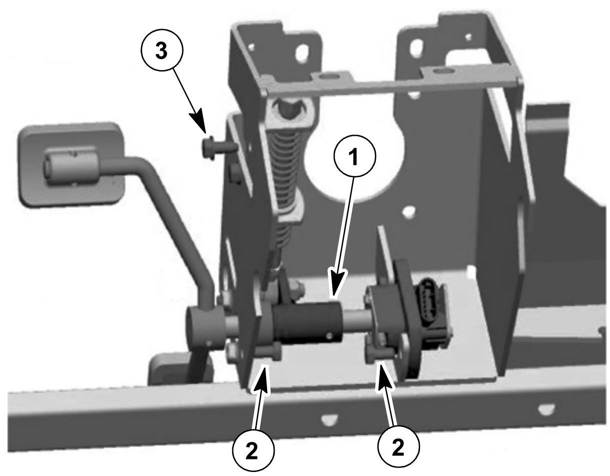
A properly assembled and calibrated traction pedal position sensor is critical to accurate traction system response and for reliable sensor life. Use care when removing, assembling and calibrating the traction pedal position sensor.



g310429

Figure 289

1. Pivot shaft
2. Pivot hub
3. Screw (2 used)
4. Cover plate
5. Roll pin
6. Hub
7. Position sensor
8. Spacer (2 used)
9. Capture plate
10. Cap screw (2 used)



g310430

Figure 290

1. Traction pedal assembly
2. Cap screw (4 used)
3. Screw (2 used)

Disassembly (Figure 288)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.
2. Disconnect machine wire harness connector from position sensor (item 29) on traction pedal.
3. Disassemble traction pedal as needed using Figure 288, Figure 289 and Figure 290 as guides. When removing roll pins (items 11, 17, 21 and 28 in Figure 288), make sure to support shaft to prevent component damage.

Assembly (Figure 288)

1. Assemble traction pedal using Figure 288, Figure 289 and Figure 290 as guides noting the following items:
   A. Apply grease to both the OD and ID of the spring retainer (item 23 in Figure 288) before installation. Take care to not get grease on threads of spring shaft (19) or jam nut (9).
   B. If traction pivot shaft (27) was removed, apply grease to the shaft areas that will be inside the bearings after assembly.
   C. When installing roll pins (11, 17, 21 and 28),make sure to support shaft to prevent component damage. Use a press to install roll pins. Also, take care to not distort roll pins during assembly.
   D. Make sure that roll pin (17) is fully inside the butterfly groove of the hub (30). The roll pin should not contact the hub throughout the operating range.
   E. To install the traction pedal position sensor (29), align the slot on the end of the traction pivot shaft with the slot in the position sensor. Hold position sensor in position while installing standoff spacers (16), capture plate (32) and cap screws (33).
   F. Leave the jam nut (9) loose so that the position sensor can be calibrated.
2. After traction pedal assembly, make sure that there is no binding in pedal movement and also that pedal returns to the centered position when released. Correct any sticking or binding before machine operation.
3. Plug machine wire harness connector into traction pedal position sensor (29).
4. After assembly of the traction pedal, calibrate the traction pedal position sensor using the InfoCenter display (see Traction Pedal Position Sensor Calibration (page 6–23)).
5. Make sure that jam nut (9) is tightened after position sensor adjustment.

Console Arm

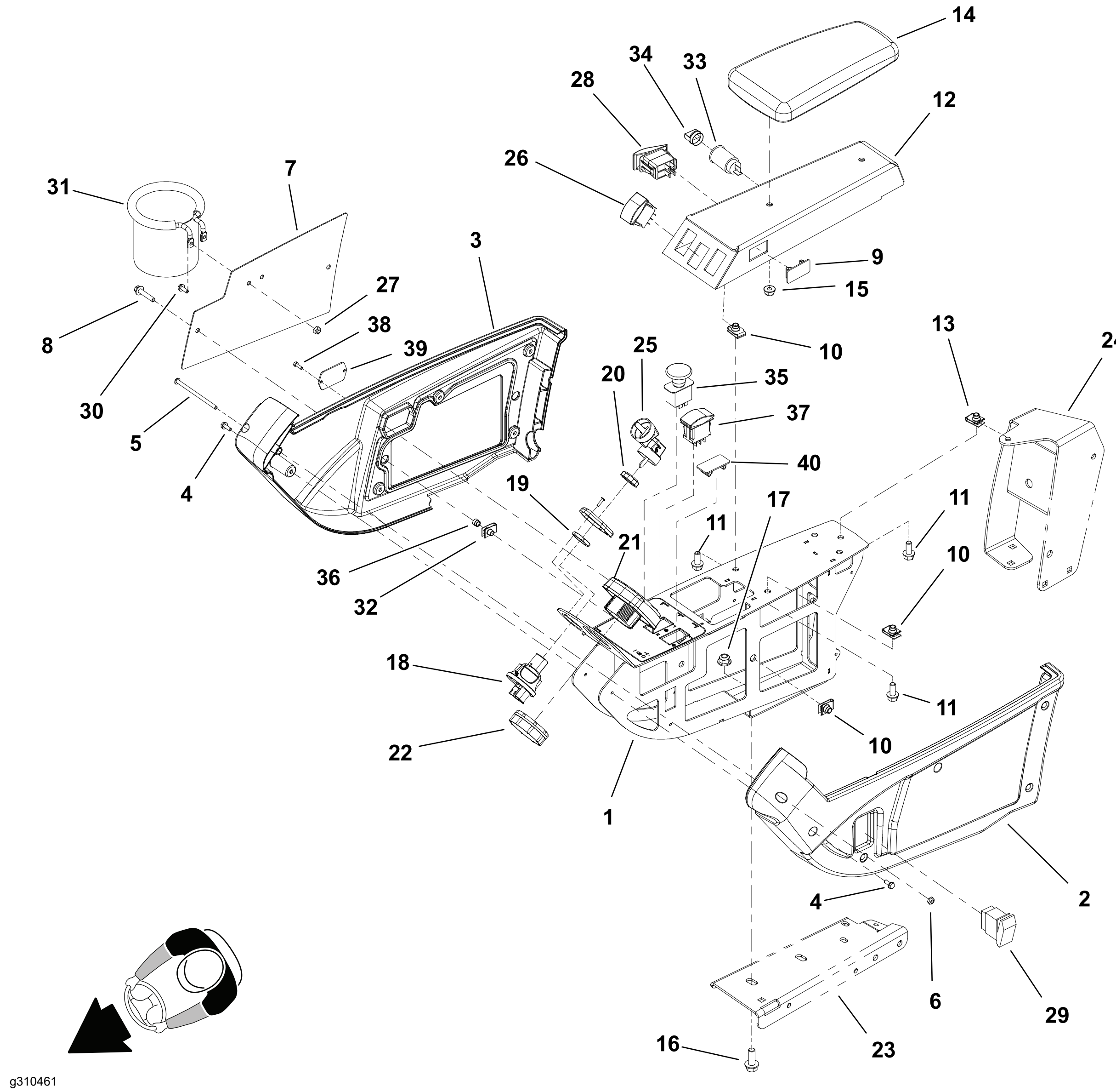


Figure 291

1. Console arm frame
2. LH cover
3. RH cover
4. Washer head screw (10 used)
5. Phillips head screw
6. Lock nut
7. Cover plate
8. Flange head screw (2 used)
9. Plug
10. U-nut (4 used)
11. Flange head screw (5 used)
12. Switch panel
13. U-nut
14. Arm rest
15. Flange nut (2 used)
16. Flange head screw (2 used)
17. Flange nut (2 used)
18. Ignition switch
19. Hex nut
20. Face nut
21. InfoCenter display
22. Nut
23. Support channel
24. Arm support
25. Ignition keys
26. Deck lift switch (1 or 3 used)
27. Lock nut (2 used)
28. Cruise switch
29. Headlight switch
30. Screw (2 used)
31. Bag holder
32. Clip (2 used)
33. Power point
34. Cap
35. PTO switch
36. Flange spacer (2 used)
37. High/Low speed switch
38. Cap screw (2 used)
39. Cover plate
40. Plug

Disassembly (Figure 291)

1. Park machine on a level surface, lower cutting decks, stop engine and engage parking brake. Remove key from ignition switch.
2. Remove two (2) flange head screws (item 8) and then cover plate (item 7) from outside of console arm. Locate and retrieve two (2) flange spacers (item 36).
3. At front of console arm, remove screw (item 5) and lock nut (item 6) that secure console arm covers to each other.
4. Remove five (5) washer head screws (item 4) that secure each cover to console arm panel.
5. Remove console arm covers from machine. As LH cover (item 2) is removed from console arm, unplug wire harness connector from headlight switch.
6. Remove electrical components from console arm as needed using Figure 291 as a guide.
7. If necessary, remove console panel and supports from machine using Figure 291 and Figure 292 as guides.

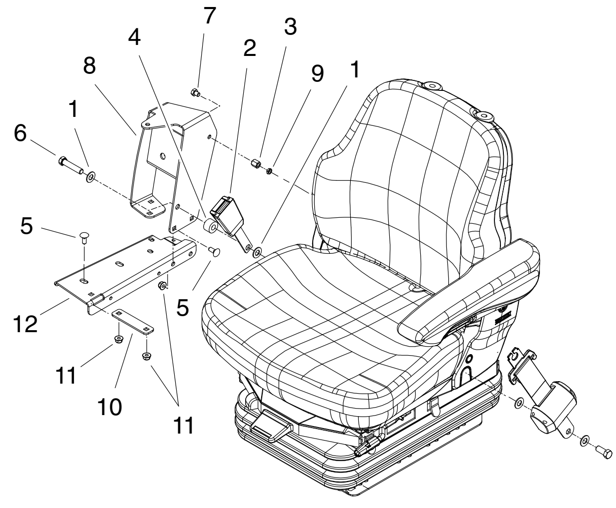


Figure 292

1.	Flat washer	7.	Screw
2.	Seat belt buckle	8.	Arm support
3.	Coupling nut	9.	Hex nut
4.	Spacer	10.	Support bracket
5.	Carriage screw (5 used)	11.	Flange nut (5 used)
6.	Cap screw	12.	Support channel

Assembly (Figure 291)

1. Install all removed electrical and console arm components using Figure 291 and Figure 292 as guides.
2. Position covers to console arm. As LH cover (item 2) is placed, plug wire harness connector to headlight switch.
3. Secure each cover to console arm with five (5) washer head screws (item 4). Install screw (item 5) and lock nut (item 6) to secure covers at front of console arm.
4. Position cover plate and flange spacers to outside of console arm. Secure with two (2) flange head screws.

Lift Arms for Cutting Decks #1, #4 and #5

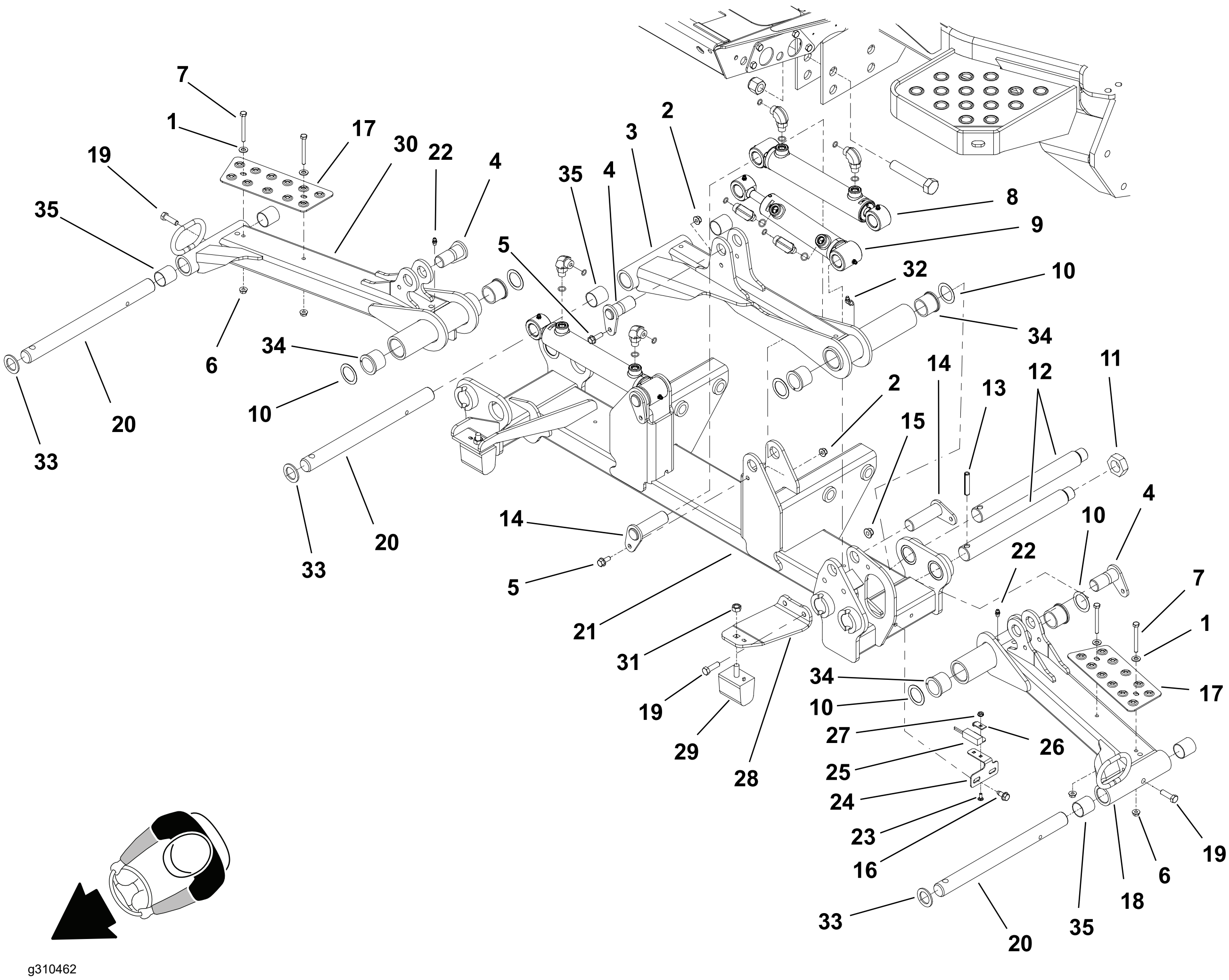


Figure 293

1. Flat washer
2. Flange nut
3. Lift arm (#1 deck)
4. Lift cylinder pin
5. Flange head screw
6. Flange nut
7. Cap screw
8. Lift cylinder (#4 and #5 decks)
9. Lift cylinder (#1 deck)
10. Thrust washer (2 used per arm)
11. Lock nut
12. Pivot pin
13. Slotted roll pin
14. Lift cylinder pin
15. Flange nut
16. Washer head screw
17. Skid plate
18. Lift arm (#4 deck)
19. Cap screw
20. Carrier pivot shaft
21. Front carrier frame
22. Grease fitting
23. Carriage bolt
24. Switch bracket
25. Deck position switch
26. Switch plate
27. Lock nut
28. Bumper support bracket
29. Bumper
30. Lift arm (#5 deck)
31. Lock nut
32. Grease fitting
33. Thrust washer
34. Flange bushing (2 used per arm)
35. Bushing (2 used per arm)

Removal (Figure 293)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.
2. Remove cutting deck assembly from lift arm (see *Cutting Deck Operator's Manual*).

Removal (Figure 293) (continued)

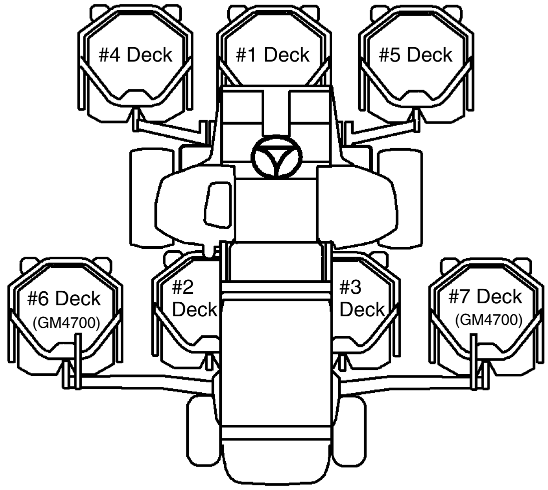


Figure 294

CUTTING DECK LOCATIONS

3. If lift arm for either deck #4 or #5 (Figure 294) is to be removed, clean, label and remove hydraulic hoses from the deck motor (Figure 295). Place plugs or caps on open fittings and hoses. Slide hoses out of the hose retaining loop on the lift arm.
4. Remove lift cylinder pin (item 4) that secures hydraulic lift cylinder to lift arm.
5. Loosen and remove lock nut (item 11) from lift arm pivot pin.
6. Support lift arm and pull lift arm pivot pin from lift arm and frame. Locate and remove thrust washers from both sides of lift arm during pivot pin removal.
7. Remove lift arm from machine.
8. Disassemble lift arm as needed using Figure 293 as a guide.
9. Clean lift arm and pivot pin. Inspect lift arm bushings and pivot pin for damage or wear. Replace worn or damaged components.

Installation (Figure 293)

1. Assemble lift arm using Figure 293 as a guide.
2. Position lift arm to frame. Fit thrust washer (item 10) between both sides of lift arm and frame. Slide pivot pin into frame and lift arm. Align roll pin in pivot pin with slot in frame flange.
3. Install and tighten lock nut (item 11) to secure lift arm pivot pin.
4. Install hydraulic lift cylinder to lift arm with cylinder pin. Secure cylinder pin to lift arm with flange head screw and flange nut.

   Note: Install thrust washer (item 33) on carrier pivot shaft before installing cutting deck on pivot shaft.

5. Position and install cutting deck to lift arm (see *Cutting Deck Operator's Manual*).

Installation (Figure 293) (continued)

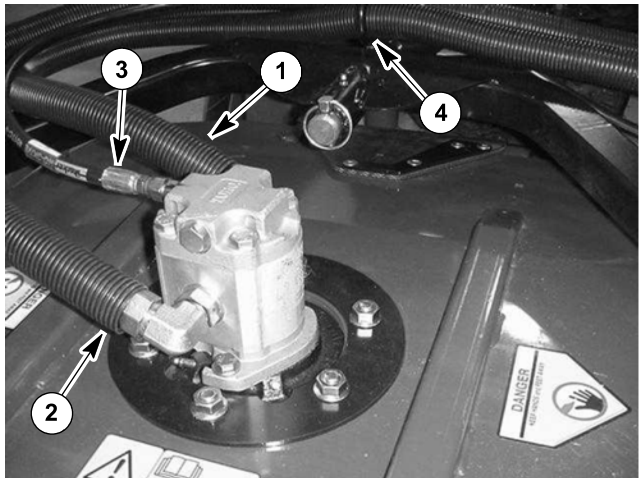


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Figure 295

1. Supply hose
2. Return hose
3. Case drain hose
4. Hose retaining loop

6. If lift arm for either deck #4 or #5 was removed, slide hydraulic hoses through the hose retaining loop on the lift arm. Remove caps and plugs from hydraulic hoses and fittings and install hoses to the deck motor (Figure 295). Make sure that deck is fully lowered to the ground before tightening hoses.
7. Lubricate lift arm and lift cylinder grease fittings after assembly is complete.
8. After assembly, raise and lower the cutting deck to verify that hydraulic hoses and fittings do not contact anything.

Lift Arms for Cutting Decks #2 and #3

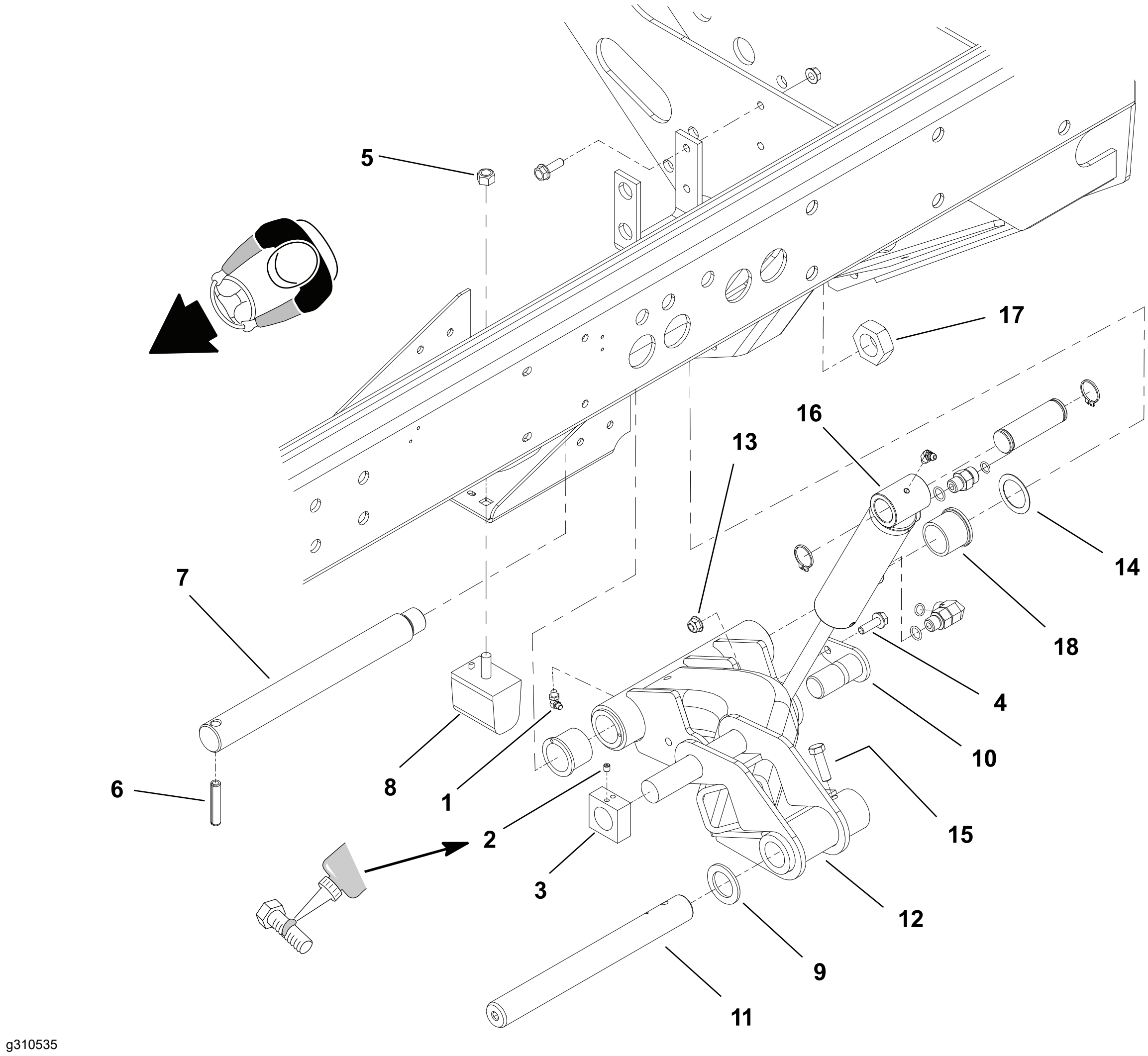

Figure 296

1. Grease fitting
2. Set screw (2 used per stop)
3. Rotation stop
4. Flange head screw
5. Lock nut
6. Slotted roll pin
7. Pivot pin
8. Bumper
9. Thrust washer
10. Lift cylinder pin
11. Deck pivot shaft
12. Lift arm (#2 deck shown)
13. Flange nut
14. Thrust washer
15. Cap screw
16. Lift cylinder
17. Lock nut
18. Flange bushing (2 used per arm)

Removal (Figure 296)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.
2. Remove cutting deck from lift arm (see *Cutting Deck Operator's Manual*).

Removal (Figure 296) (continued)

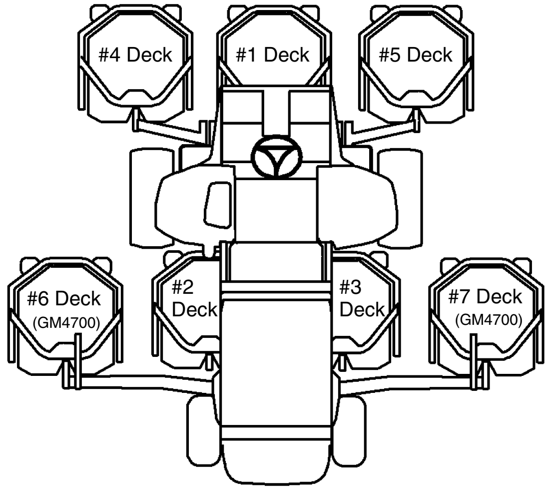

Figure 297
CUTTING DECK LOCATIONS

3. Remove lift cylinder pin (item 10) that secures lift cylinder to lift arm.
4. Loosen and remove lock nut (item 17) from pivot pin.
5. Support lift arm and pull lift arm pivot pin from lift arm and frame. Locate and remove thrust washer (item 14) from rear of lift arm during pivot pin removal.
6. Remove lift arm from machine.
7. Disassemble lift arm as needed using Figure 296 as a guide.
8. Clean lift arm and pivot pin. Inspect lift arm bushings and pivot pin for damage or wear. Replace worn or damaged components.

Installation (Figure 296)

1. Assemble lift arm using Figure 296 as a guide.
2. Position lift arm to frame. Fit thrust washer (item 14) between rear of lift arm and frame. Slide pivot pin into frame and lift arm. Align roll pin in pivot pin with slot in frame flange.
3. Install and tighten lock nut (item 17) to secure lift arm pivot pin.
4. Secure lift cylinder to lift arm with cylinder pin (item 10). Secure cylinder pin to lift arm with flange head screw and flange nut.

   Note: Install thrust washer (item 9) on deck pivot shaft before installing cutting deck on pivot shaft.

5. Position and install cutting deck to lift arm (see *Cutting Deck Operator's Manual*).

   Note: The lift arms for cutting decks #2 and #3 are fitted with a lift arm rotation stop block (item 3). This stop is to keep the deck stable while raised. To adjust rotation stop, remove two (2) set screws from stop and fully raise cutting deck to position the stop. Apply Loctite #242 (or equivalent) to set screws and install set screws to secure stop. The rotation stop should contact the lift arm across the full width of the stop.

6. Lubricate lift arm and lift cylinder grease fittings after assembly is complete.
7. After assembly, raise and lower the cutting deck to verify that hydraulic hoses and fittings do not contact anything.

Lift Arms for Cutting Decks #6 and #7 (Groundsmaster 4700-D)

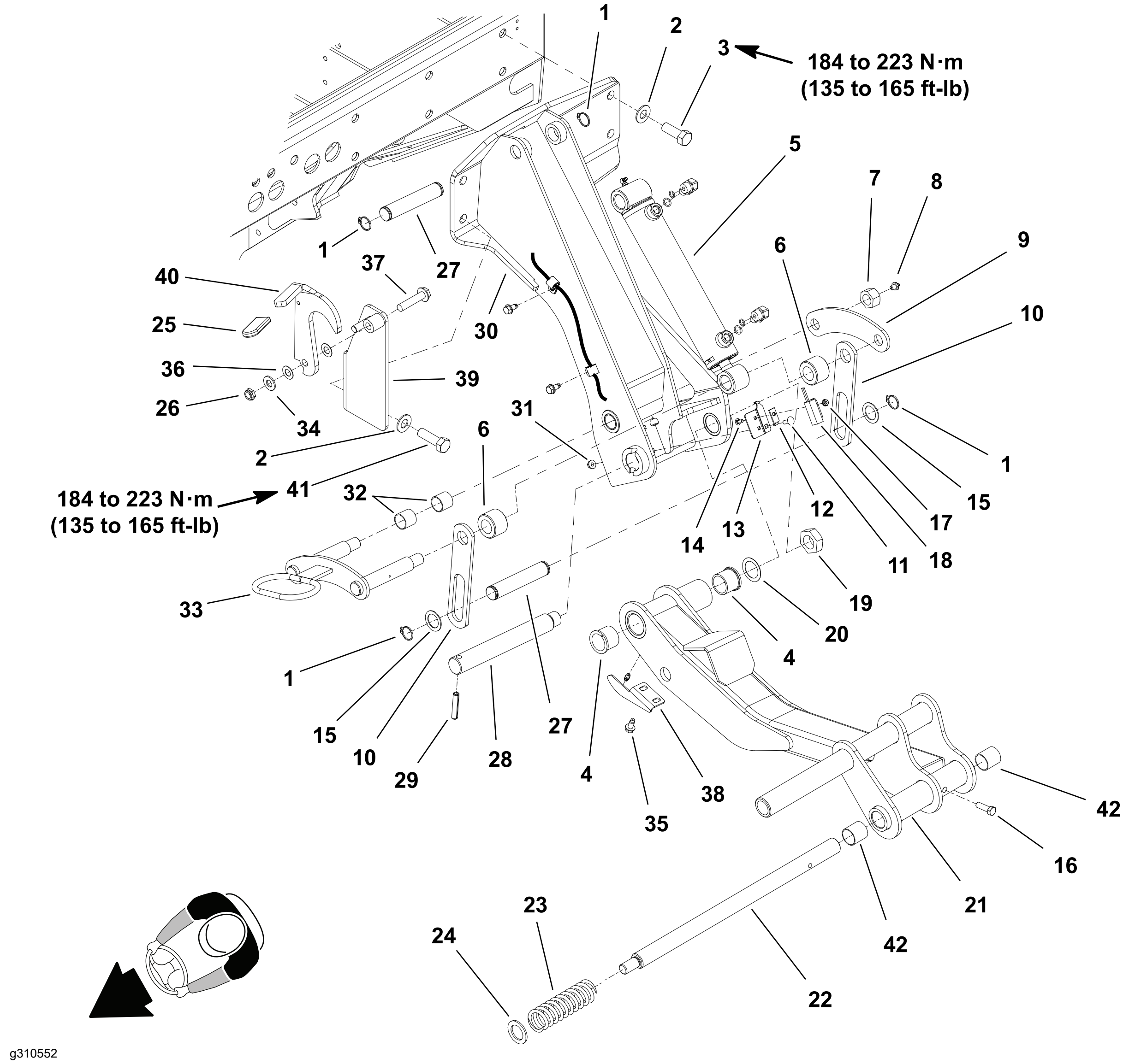

Figure 298

1. Retaining ring
2. Flat washer (4 used per support arm)
3. Cap screw (4 used per support arm)
4. Flange bushing
5. Lift cylinder
6. Plastic roller
7. Lock nut
8. Grease fitting
9. Rear link
10. Lift link
11. Carriage screw
12. Switch plate
13. Switch bracket
14. Carriage bolt
15. Thrust washer
16. Cap screw
17. Lock nut
18. Deck position switch
19. Lock nut
20. Thrust washer
21. Lift arm (deck #6 shown)
22. Carrier pivot pin
23. Compression spring
24. Thrust washer
25. Plastic grip
26. Lock nut
27. Pin
28. Pivot pin
29. Slotted roll pin
30. Support arm (deck #6 shown)
31. Flange nut
32. Bushing
33. Link
34. Flat washer
35. Self tapping screw
36. Washer
37. Flange head screw
38. Switch actuator
39. Latch arm (LH shown)
40. Latch (LH shown)
41. Cap screw
42. Bushing

Removal (Figure 298)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.
2. Remove cutting deck from lift arm (see *Cutting Deck Operator's Manual*).

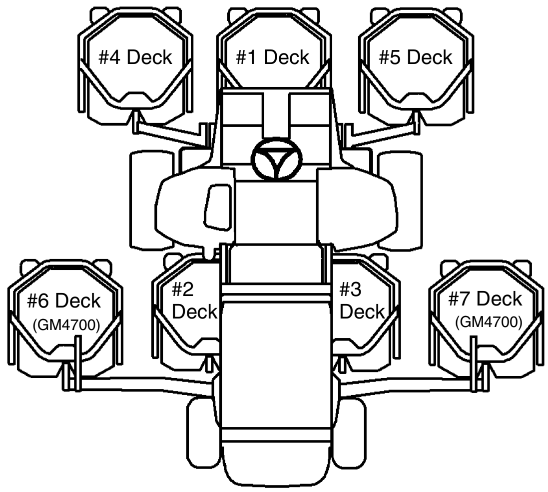

Figure 299
CUTTING DECK LOCATIONS

3. Remove pin (item 27) that secures lift links (item 10) to lift arm.
4. Loosen and remove lock nut (item 19) from pivot pin (item 28).
5. Support lift arm and pull lift arm pivot pin from lift arm and support arm. Locate and remove thrust washer (item 20) from rear of lift arm during pivot pin removal.
6. Remove lift arm from machine.
7. Disassemble lift arm as needed using Figure 298 as a guide.
8. Clean lift arm and pivot pin. Inspect lift arm bushings and pivot pin for damage or wear. Replace worn or damaged components.

Installation (Figure 298)

1. Assemble lift arm using Figure 298 as a guide.
2. Position lift arm to support arm. Fit thrust washer (item 20) between rear of lift arm and support arm. Slide pivot pin into support arm and lift arm. Align roll pin in pivot pin with slot in support arm flange.
3. Install and tighten lock nut (item 19) to secure lift arm pivot pin.
4. Secure lift links (item 10) to lift arm with pin (item 27). Make sure that thrust washer (item 15) and retaining ring (item 1) are on both ends of pin.

   Note: Install compression spring (item 23) and thrust washer (item 24) on carrier pivot pin before installing cutting deck on pivot pin.

5. Position and install cutting deck to lift arm (see *Cutting Deck Operator's Manual*).
6. Lubricate lift arm grease fittings after assembly is complete.
7. After assembly, raise and lower the cutting deck to verify that hydraulic hoses and fittings do not contact anything.

Operator Seat

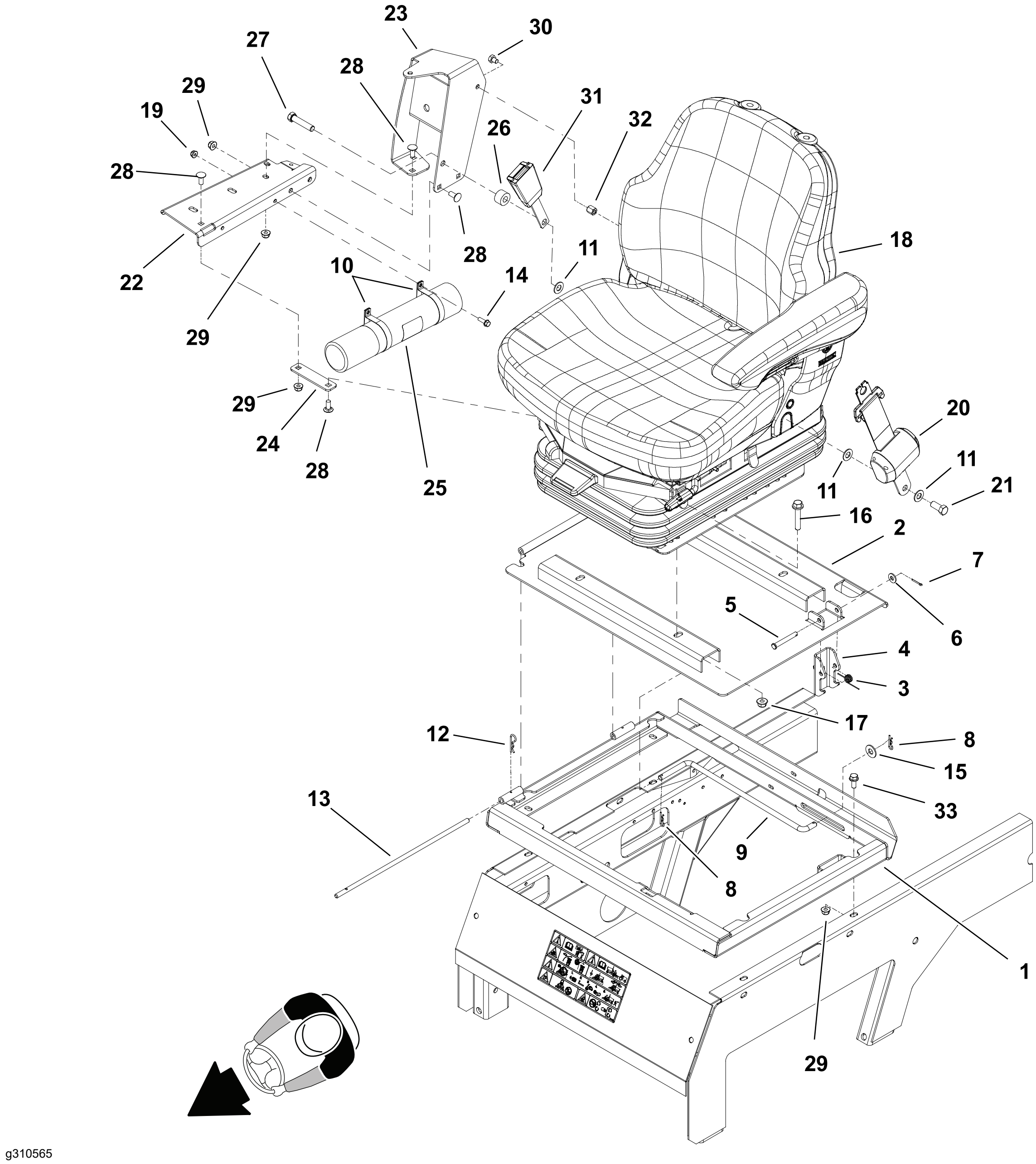

Figure 300

1. Seat frame
2. Seat plate
3. Torsion spring
4. Seat plate latch
5. Clevis pin
6. Flat washer
7. Cotter pin
8. Hair pin (4 used)
9. Seat frame rod (2 used)
10. R-clamp (2 used)
11. Flat washer (3 used)
12. Hair pin
13. Seat pivot shaft
14. Screw (2 used)
15. Flat washer (2 used)
16. Flange head screw (4 used)
17. Flange nut (4 used)
18. Seat assembly
19. Flange nut (2 used)
20. Seat belt
21. Cap screw
22. Support channel
23. Arm support
24. Support bracket
25. Manual tube
26. Spacer
27. Cap screw
28. Carriage screw (6 used)
29. Flange nut (9 used)
30. Cap screw
31. Seat belt latch
32. Hex nut
33. Flange head screw (4 used)

Removal (Figure 300)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.
2. Disconnect seat electrical connector from machine wire harness.
3. Support console arm assembly to prevent it from shifting.
4. Remove flange nut (item 29) and carriage screw (item 28) that secure support bracket (item 24) to support channel (item 22).
5. Remove cap screw (item 30) that secures console arm support (item 23) to coupling nut (item 32).
6. Remove cap screw (item 27), flat washer (item 11), spacer (item 26) and seat belt buckle (item 31) from seat and console arm support (item 23).

IMPORTANT

Make sure to not damage the electrical harness or other parts while moving the console arm assembly.

7. Carefully move console arm assembly away from seat.
8. Remove four (4) torx head screws that secure seat to seat suspension (Figure 301). Note that the screw near the seat adjustment handle is longer than the other three (3) screws.
9. Lift seat from seat suspension and remove from machine.

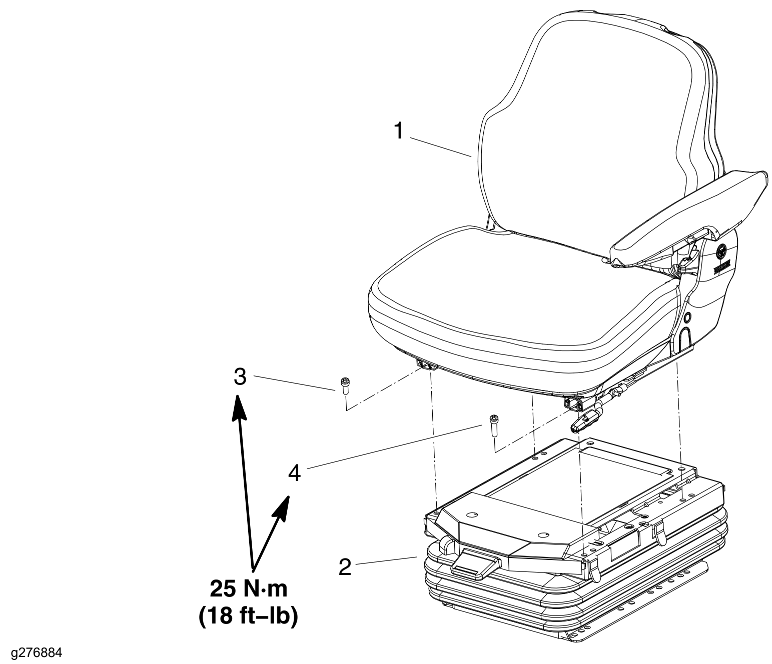

Figure 301

1.	Seat	3.	Screw (M8x12) (3 used)
2.	Suspension assembly	4.	Screw (M8x16)

Installation (Figure 300)

1. Carefully position seat to seat suspension.
2. Secure seat to seat suspension with four (4) torx head screws (Figure 301). Make sure that longer screw is positioned near the seat adjustment handle. Torque screws **25 N·m (18 ft-lb)**.

Installation (Figure 300) (continued)

IMPORTANT

Make sure to not damage the electrical harness or other parts while moving the console arm assembly.

3. Position and secure console arm assembly to seat. Install all fasteners before fully tightening them.
   A. Secure support bracket (item 24) and support channel (item 22) with flange nut (item 29) and carriage screw (item 28).
   B. Secure console arm support (item 23) to coupling nut with cap screw (item 30).
   C. Place flat washer (item 11), seat belt buckle (item 31) and spacer (item 26) between seat and console arm support (item 23). Secure with cap screw (item 27).
   D. Fully tighten all fasteners to secure console arm assembly to seat.
4. Connect seat electrical connector to machine wire harness.

Operator Seat Service

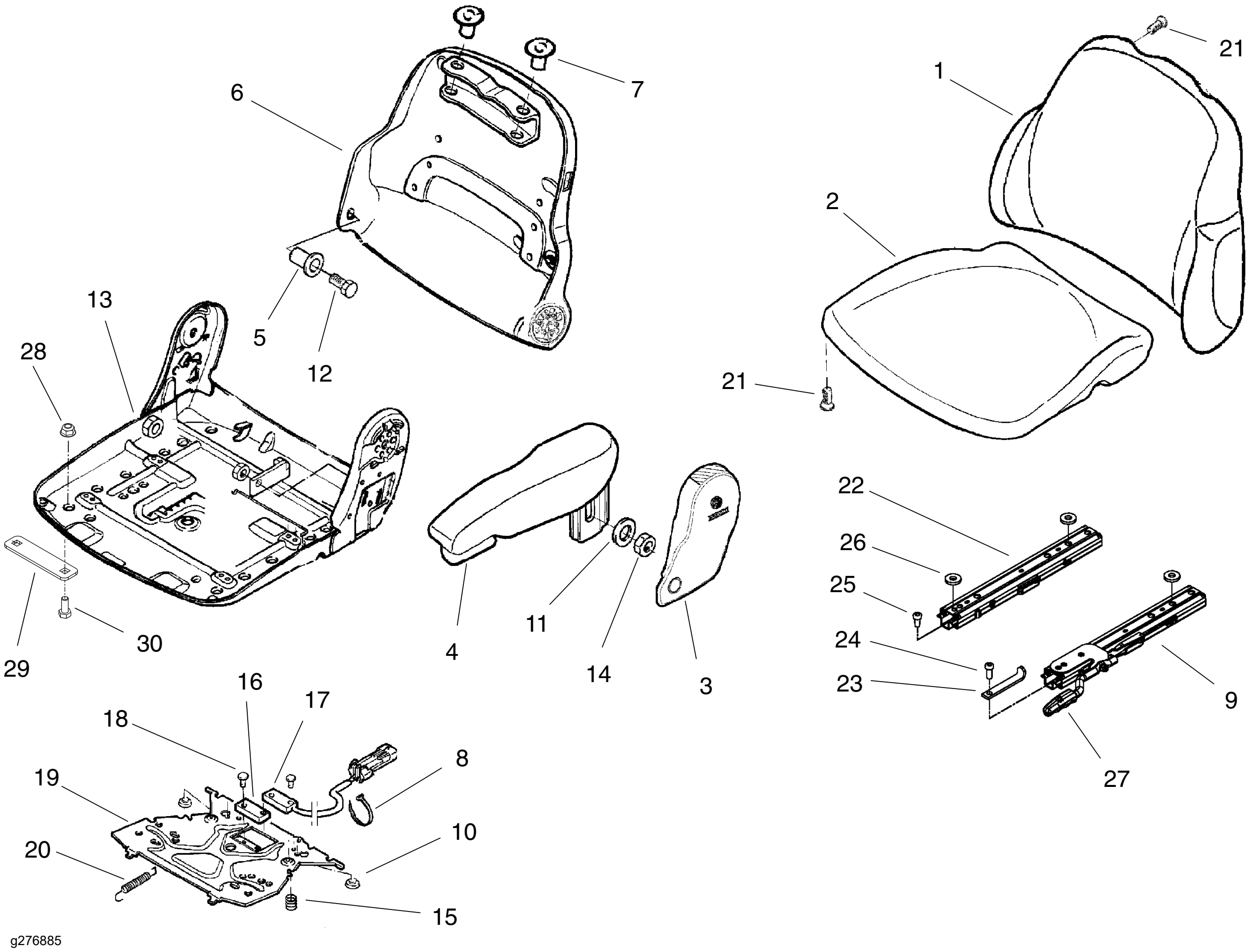

Figure 302

1. Backrest cushion
2. Seat cushion
3. Armrest cover
4. LH armrest
5. Bushing (2 used)
6. Backrest
7. Plug (2 used)
8. Cable tie (3 used)
9. LH adjustment rail
10. Bumper (2 used)
11. Washer
12. Cap screw (2 used)
13. Seat
14. Nut
15. Spring (2 used)
16. Magnet
17. Seat switch
18. Rivet (4 used)
19. Mounting plate
20. Return spring
21. Torx screw (5 used)
22. RH adjustment rail
23. Rail stop
24. Torx screw
25. Torx screw (3 used)
26. Washer (3 used)
27. Handle
28. Nut
29. Support bracket
30. Cap screw

Disassembly (Figure 302)

1. Remove seat from machine for service (see Operator Seat (page 8–19)).
2. Disassemble operator seat as necessary using Figure 302 as a guide.

Assembly (Figure 302)

1. Assemble operator seat using Figure 302 as a guide.
2. Install seat to machine (see Operator Seat (page 8–19)).

Operator Seat Suspension

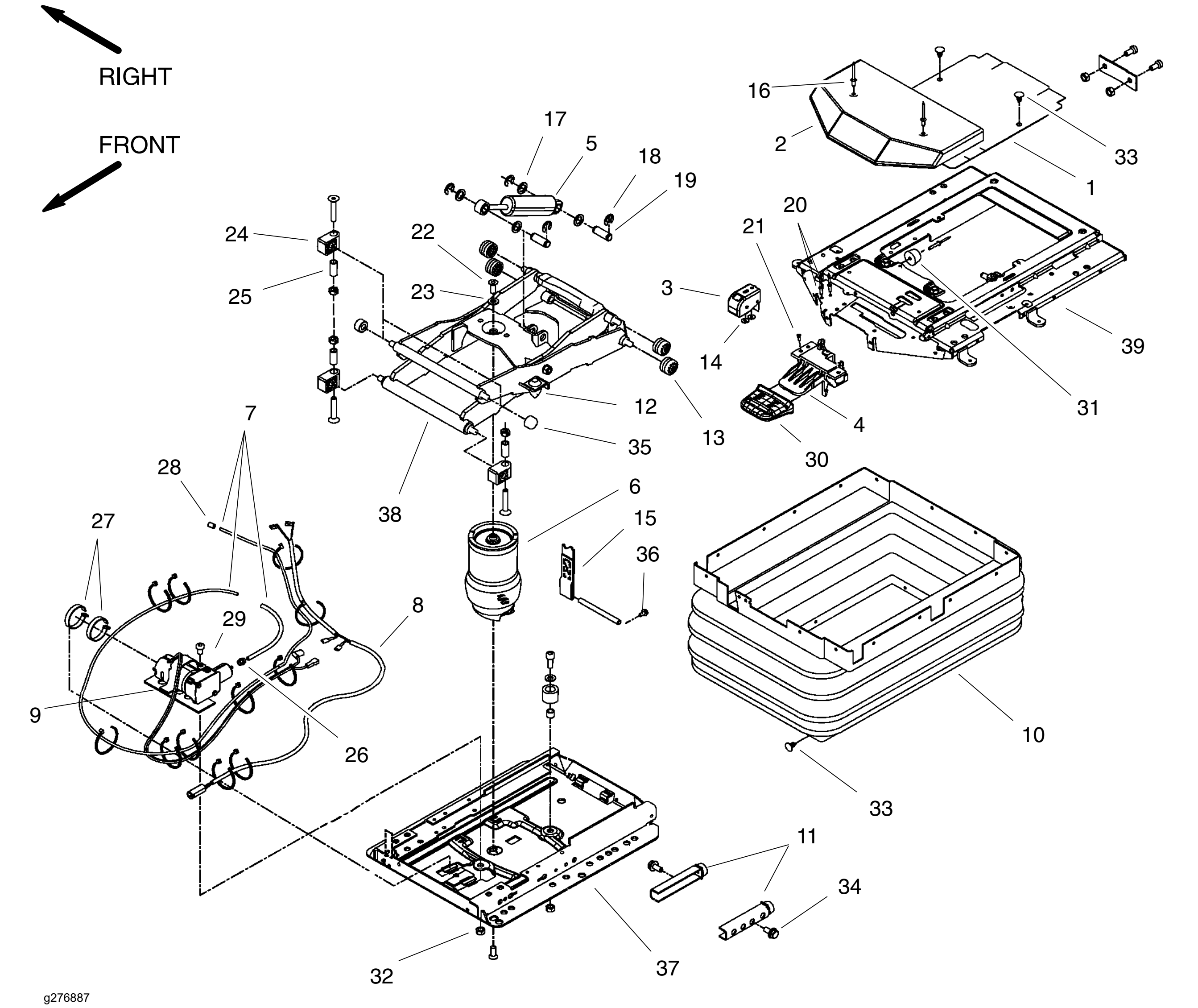

Figure 303

1. Cover
2. Cover
3. Level control
4. Air control valve
5. Shock absorber
6. Air spring
7. Air tube assembly
8. Wire harness
9. Compressor
10. Bellows
11. Stop
12. Bumper set (2 used)
13. Roller (4 used)
14. Washer (2 used)
15. Tether
16. Rivet (2 used)
17. Washer (4 used)
18. C−clip (4 used)
19. Pin (2 used)
20. Rivet (2 used)
21. Washer (3 used)
22. Screw (2 used)
23. Washer
24. Housing support (4 used)
25. Spacer (4 used)
26. Hose nipple
27. Clamp (2 used)
28. Hose nipple
29. Screw
30. Handle
31. Bumper
32. Nut
33. Plastic plug (23 used)
34. Screw (2 used)
35. Roller (2 used)
36. Screw (4 used)
37. Base plate
38. Suspension frame
39. Upper plate

Note: Most of the seat suspension components can be serviced with the seat suspension base mounted to the seat plate. If the air spring assembly (item 6) requires removal, the seat suspension base will have to be removed from the seat plate.

Disassembly (Figure 303)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.
2. Remove operator seat from seat suspension (see Operator Seat (page 8–19)).
3. Disconnect seat suspension electrical connector from machine wire harness.

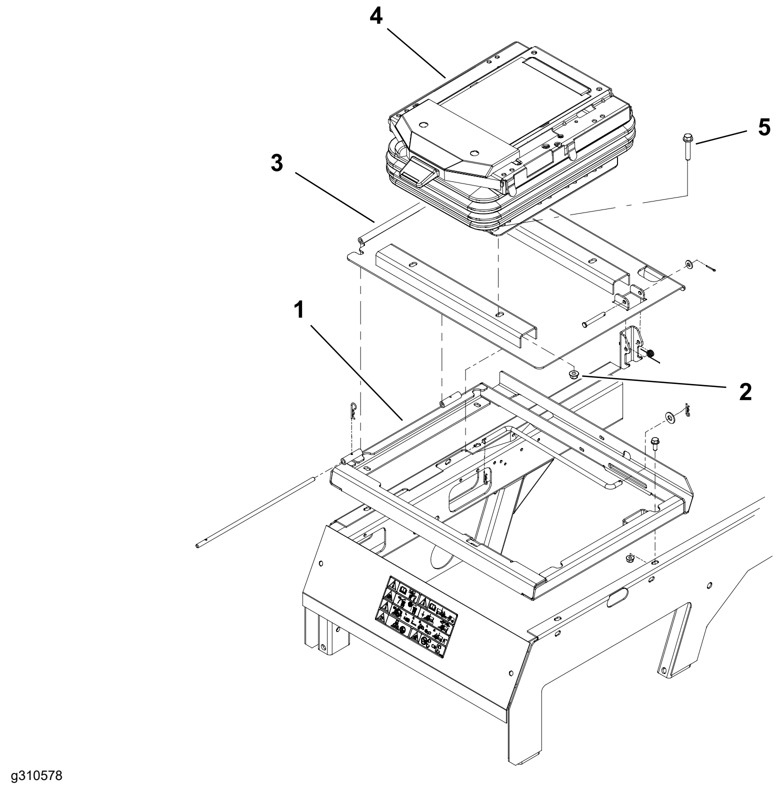

Figure 304

1. Seat frame
2. Flange nut (4 used)
3. Seat plate
4. Seat suspension
5. Flange screw (4 used)

---

4. If the air spring assembly (item 6) or base plate (item 37) requires removal, remove seat suspension from seat plate (Figure 304):
   A. Raise and support seat plate assembly.
   B. Remove four (4) flange head screws and flange nuts that secure seat suspension to seat plate.
   C. Remove seat suspension from machine.
5. Remove seat suspension components as needed using Figure 303 as a guide.

Assembly (Figure 303)

1. Install all removed seat suspension components using Figure 303 as a guide.
2. If seat suspension was removed from seat platform (Figure 304):
   A. Position seat suspension onto seat plate.
   B. Secure seat suspension to seat plate with four (4) flange head screws and flange nuts.
3. Install operator seat to seat suspension (see Operator Seat (page 8–19)).

Assembly (Figure 303) (continued)

4. Make sure that seat electrical connectors are secured to machine wire harness.

Hood

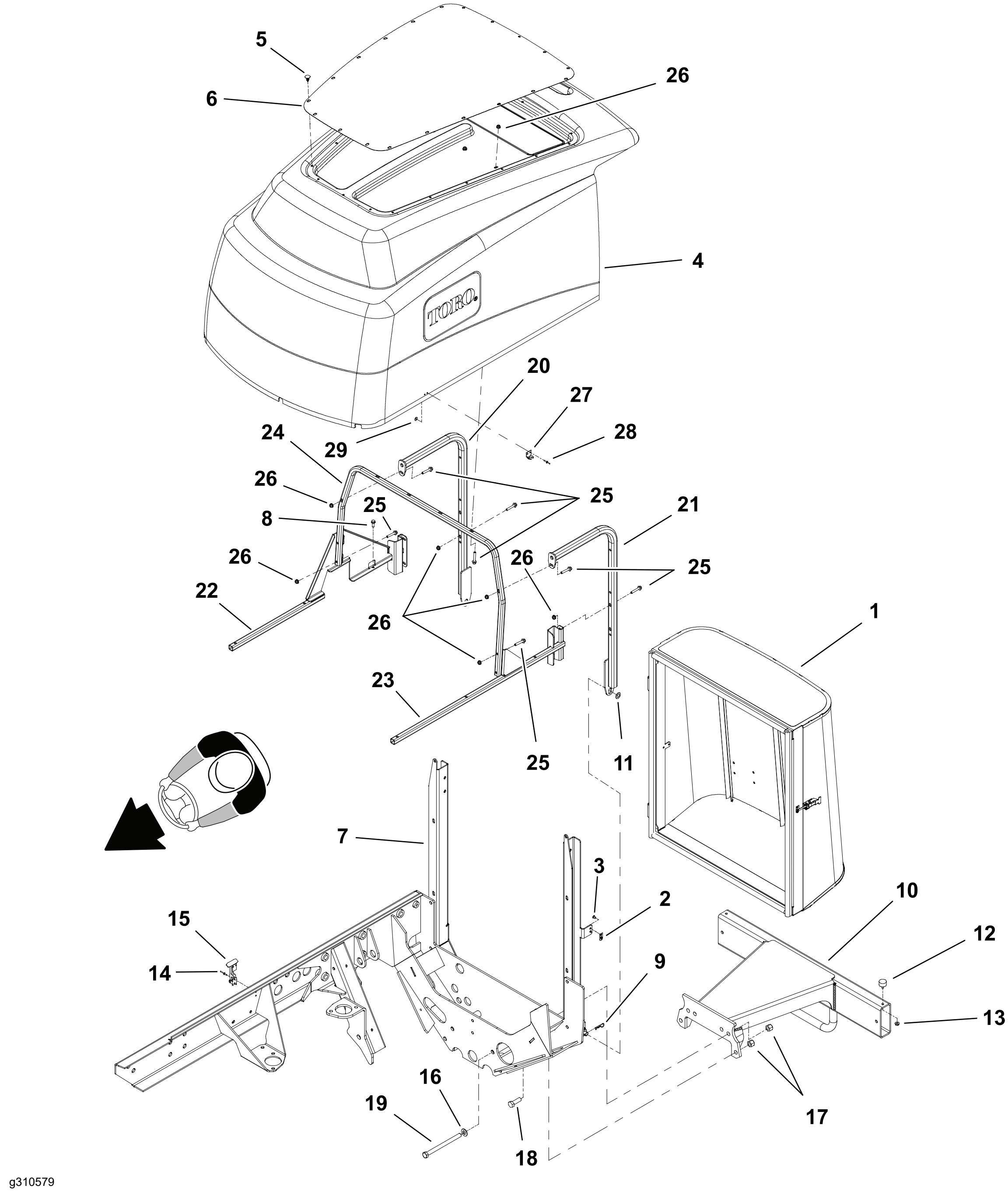

Figure 305

1. Screen
2. Latch keeper
3. Pop rivet (2 used)
4. Hood
5. Plastic plug (20 used)
6. Hood screen
7. Radiator mount
8. Flange head screw
9. Hair pin (2 used)
10. Rear bumper
11. Washer (2 used)
12. Rubber bumper (2 used)
13. Flange nut (2 used)
14. Pop rivet (4 used)
15. Flex draw latch (2 used)
16. Flat washer (2 used)
17. Lock nut (4 used)
18. Cap screw (2 used)
19. Cap screw (2 used)
20. RH hood frame tube
21. LH hood frame tube
22. RH hood frame tube
23. LH hood frame tube
24. Hood frame tube
25. Flange head screw (25 used)
26. Flange nut (26 used)
27. Latch keeper (2 used)
28. Pop rivet (4 used)
29. Back washer (4 used)

Removal (Figure 305)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.
2. Release hood latches and raise hood.
3. Remove hair pins and washers from pivot pins on radiator frame.
4. Remove hood from pivot pins and machine.
5. If necessary, disassemble hood using Figure 305 as a guide.
6. Check bulb seals on screen (item 1) and replace seals if damaged.

Installation (Figure 305)

1. If components were removed from hood, assemble hood using Figure 305 as a guide.
2. Slide hood frame onto radiator frame pivot pins.
3. Secure hood to frame with hair pins and washers.
4. Check hood alignment for correct operation of hood latches and dust seals.

Chapter 9

Cutting Decks

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General Information

CAUTION

Never install or work on the cutting decks or lift arms with the engine running. Always stop engine and remove key from ignition switch first.

Operator’s Manual

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

Adjustments

CAUTION

Never install or work on the cutting decks or lift arms with the engine running. Always stop engine and remove key from ignition switch first.

See the *Cutting Deck Operator's Manual* for adjustment procedures for cutting decks on the Groundsmaster 4500-D and Groundsmaster 4700-D.

Blade Stopping Time

The blades of the cutting decks are to come to a complete stop in approximately five (5) seconds after the PTO is disengaged.

Note: Make sure the decks are lowered onto a clean section of turf or hard surface to avoid dust and debris.

To verify this stopping time, have a second person stand back from the machine at least twenty (20) feet and watch the blade on one of the cutting decks. Have the machine operator disengage the PTO and record the time it takes for the cutting deck blade to come to a complete stop. If this time is greater than seven (7) seconds, the deck control manifold braking valve (RV) may need adjustment.

Service and Repairs

CAUTION

Never install or work on the cutting decks or lift arms with the engine running. Always stop engine and remove key from ignition switch first.

Blade Spindle Assembly

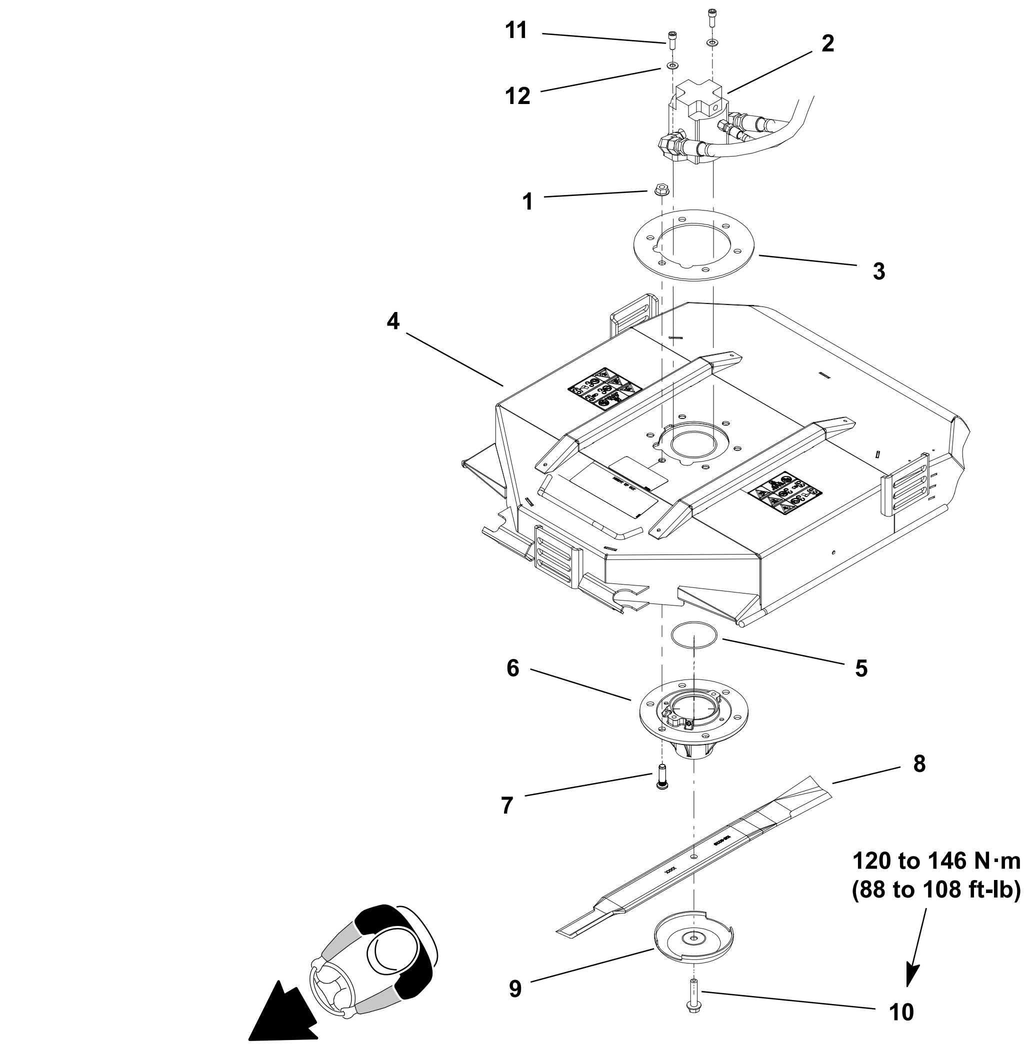

Figure 306

1. Flange nut (6 used)
2. Hydraulic deck motor
3. Spindle plate
4. Cutting deck
5. O-ring
6. Spindle assembly
7. Drive stud (6 used)
8. Cutting blade
9. Anti-scalp cup
10. Blade bolt
11. Socket head screw (2 used)
12. Flat washer (2 used)

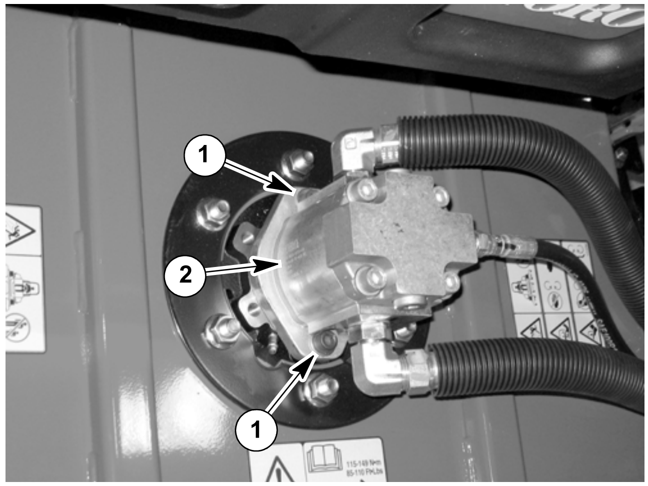

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Figure 307

1. Socket head screw
2. Hydraulic motor

Removal (Figure 306)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.
2. Remove two (2) socket head screws and flat washers that secure hydraulic motor to the cutting deck (Figure 307). Remove hydraulic motor and O-ring from deck.
3. Cover top of spindle to prevent debris from entering spindle. A spindle plug (see Special Tools (page 2–16)) can be used to cover spindle.

   Note: If desired, cutting deck can be removed from machine for spindle removal from cutting deck.

4. If spindle is to be removed with cutting deck attached to the machine, start the engine and raise the cutting deck. Stop engine and remove key from the ignition switch. Support the cutting deck so it cannot fall accidentally.
5. Remove blade bolt, anti-scalp cup and cutting blade.
6. Remove flange nuts that secure spindle assembly to cutting deck. Slide spindle assembly out the bottom of the deck. Remove spindle plate from top of deck.
7. If necessary, press drive studs (item 7) from spindle assembly.

Installation (Figure 306)

1. If drive studs (item 7) were removed from spindle assembly, press new drive studs into spindle. Make sure that stud heads are fully pressed against spindle surface.
2. Position spindle assembly and spindle plate to cutting deck. Notches on cutting deck and spindle plate should be aligned to front of deck.
3. Secure spindle assembly and spindle plate to cutting deck with flange nuts. Tighten flange nuts in a star pattern.
4. Install cutting blade, anti-scalp cup and bolt. Tighten blade bolt from **120 to 146 N·m (88 to 108 ft-lb)**.
5. Remove cover from top of spindle that was placed to prevent debris from entering spindle.

Installation (Figure 306) (continued)

6. Position O-ring to top of spindle housing. Secure hydraulic motor to the cutting deck with two (2) socket head screws and flat washers.
7. After assembly, raise and lower the cutting deck to verify that hydraulic hoses and fittings do not contact anything.

Blade Spindle Service

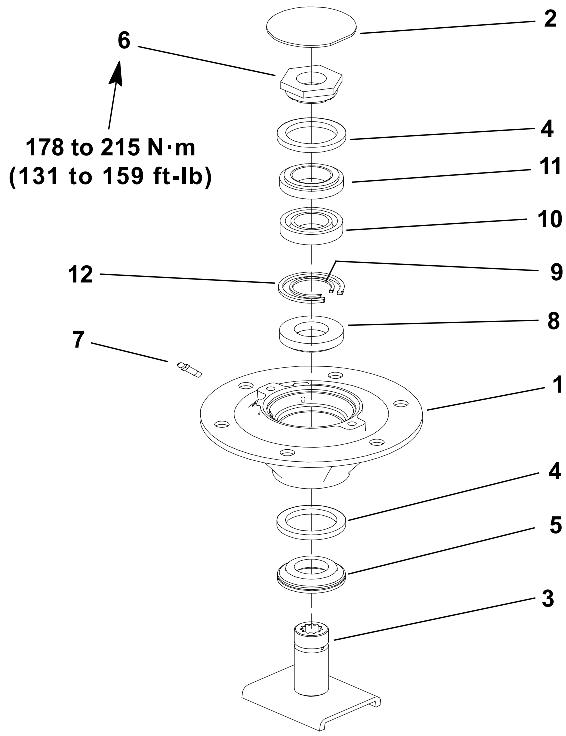

Figure 308

1. Spindle housing
2. Spindle plug
3. Spindle shaft
4. Oil seal
5. Shaft spacer
6. Spindle nut
7. Grease fitting
8. Bearing
9. Spacer ring
10. Spacer set (2 piece)
11. Bearing
12. Large snap ring

Disassembly (Figure 308)

1. Remove blade spindle from cutting deck (see Blade Spindle Assembly (page 9–4)).
2. Loosen and remove spindle nut from top of spindle shaft.
3. Remove the spindle shaft from the spindle housing which may require the use of an arbor press. The spindle shaft spacer should remain on the spindle shaft as the shaft is being removed.
4. Carefully remove oil seals from spindle housing noting direction of seal lips.
5. Allow the bearing cones, inner bearing spacer and spacer ring to drop out of the spindle housing.
6. Using an arbor press, remove both of the bearing cups and the outer bearing spacer from the housing.
7. The large snap ring can remain inside the spindle housing. Removal of this snap ring is very difficult.

Disassembly (Figure 308) (continued)

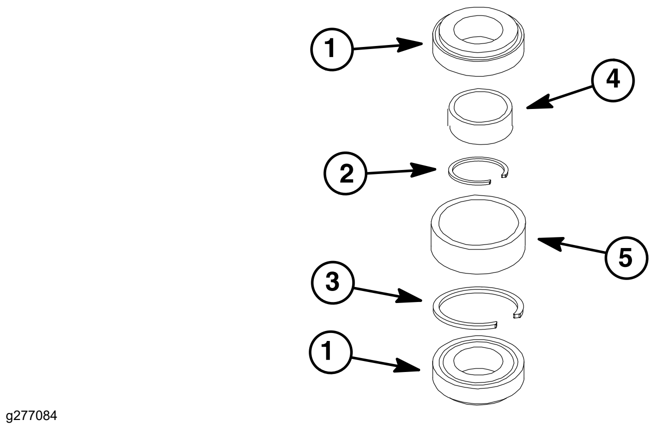

Figure 309

1. Bearing
2. Spacer ring
3. Large snap ring
4. Inner bearing spacer
5. Outer bearing spacer

Assembly (Figure 308)

Note: A replacement spindle bearing set contains two (2) bearings, a spacer ring and a large snap ring (items 1, 2 and 3 in Figure 309). These parts cannot be purchased separately. Do not mix bearing set components from one deck spindle to another.

Note: A replacement bearing spacer set includes the inner spacer and outer spacer (items 4 and 5 in Figure 309). Do not mix bearing spacers from one deck spindle to another.

IMPORTANT

If new bearings are installed into a used spindle housing, it may not be necessary to replace the original large snap ring. If the original large snap ring is in good condition with no evidence of damage (e.g. spun bearing), leave the snap ring in the housing and discard the large snap ring that comes with the new bearings. If the large snap ring is found to be damaged, replace the snap ring.

1. If large snap ring was removed from spindle housing, install snap ring into housing groove. Make sure snap ring is fully seated in groove.
2. Install outer bearing spacer into top of spindle housing. The spacer should fit against the large snap ring.

Assembly (Figure 308) (continued)

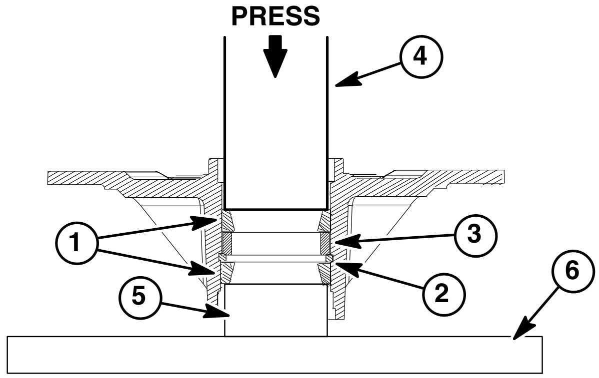

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Figure 310

1. Bearing cups
2. Large snap ring
3. Outer bearing spacer
4. Arbor press
5. Support
6. Arbor press base

3. Using an arbor press, push the bearing cups into the top and bottom of the spindle housing. The top bearing cup must contact the outer bearing spacer previously installed, and the bottom bearing cup must contact the large snap ring. Make sure that the assembly is correct by supporting the first bearing cup and pressing the second cup against it (Figure 310).
4. Pack the bearing cones with grease. Apply a film of grease on lips of oil seals.

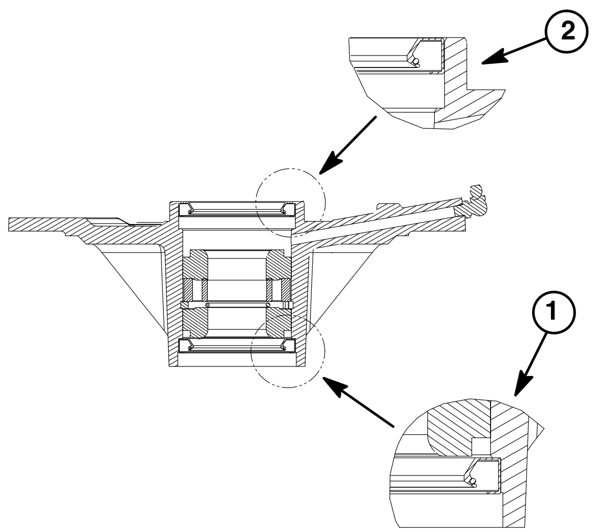

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Figure 311

1. Bottom seal installation
2. Upper seal installation

5. Install lower bearing cone and greased oil seal into bottom of spindle housing. NOTE: The bottom seal must have the lip facing out (down) (Figure 311). This seal installation allows grease to purge from the spindle during the lubrication process.

IMPORTANT

If bearings are being replaced, make sure to use the spacer ring that is included with the new bearing set (Figure 309).

Assembly (Figure 308) (continued)

6. Slide spacer ring and inner bearing spacer into spindle housing, then install upper bearing cone and greased oil seal into top of housing. NOTE: The upper seal must have the lip facing out (up) (Figure 311).
7. Inspect the spindle shaft and shaft spacer to make sure there are no burrs or nicks that could possibly damage the oil seals. Lubricate the shaft and spacer with grease.
8. Install spindle shaft spacer onto shaft. Place thin sleeve or tape on spindle shaft splines to prevent seal damage during shaft installation.
9. Carefully slide spindle shaft with spacer up through spindle housing. The bottom oil seal and spindle spacer should fit together when the spindle is fully installed.
10. Thread spindle nut onto shaft and tighten nut from **178 to 215 N·m (131 to 159 ft-lb)**.

IMPORTANT

Pneumatic grease guns can produce high pressure inside spindle housing that can damage spindle seals. Pneumatic grease guns, therefore, are not recommended to be used for greasing of spindle housings.

---

11. Attach a hand pump grease gun to one of the grease fittings on housing and fill housing cavity with grease until grease starts to come out of lower seal.
12. Rotate spindle shaft to make sure that it turns freely.
13. Install blade spindle assembly to cutting deck (see Blade Spindle Assembly (page 9–4)).

Rear Roller

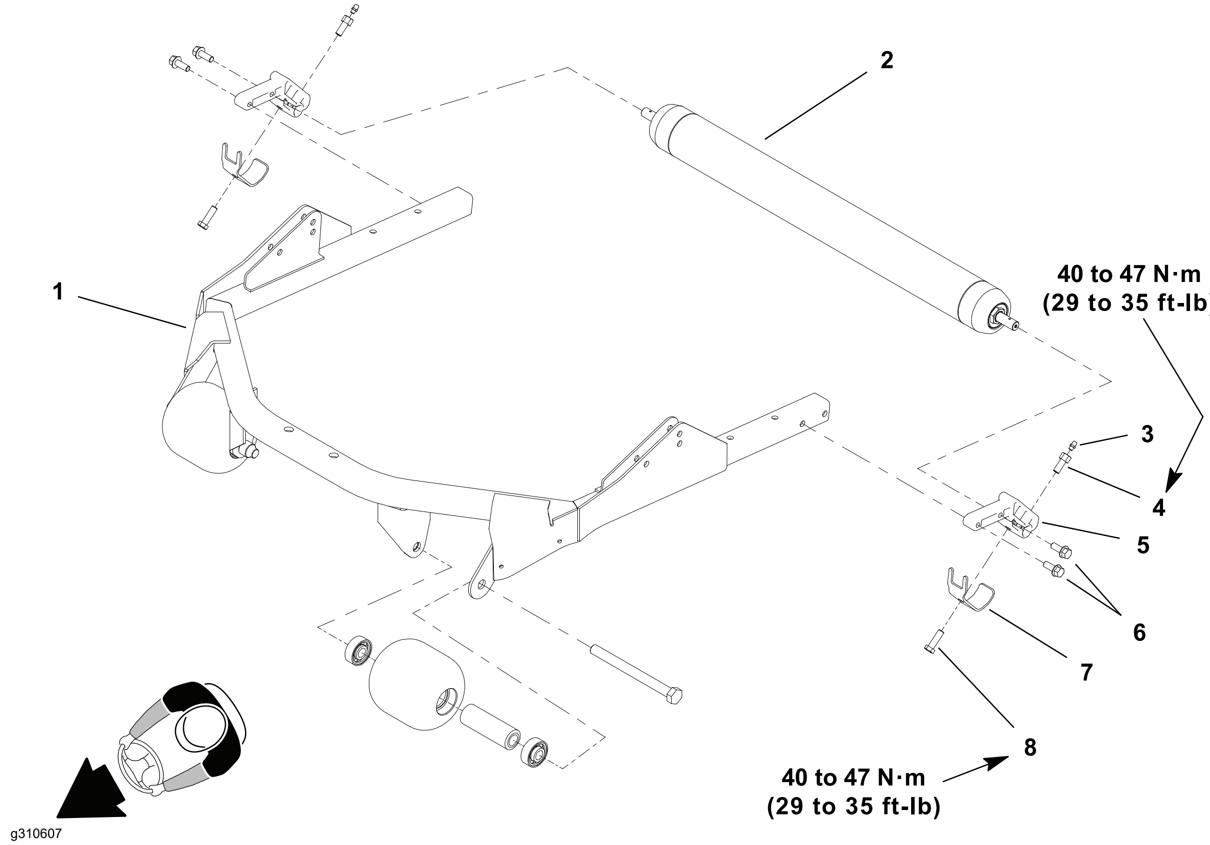

Figure 312

1. Deck frame
2. Rear roller assembly
3. Grease fitting
4. Roller shaft screw
5. Roller mount
6. Flange head screw
7. Skid bracket
8. Cap screw

Removal (Figure 312)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.
2. If cutting deck is equipped with a roller scraper (Figure 313), remove fasteners securing left and right scraper rod brackets to roller mounts. Remove scraper rod assembly.

Removal (Figure 312) (continued)

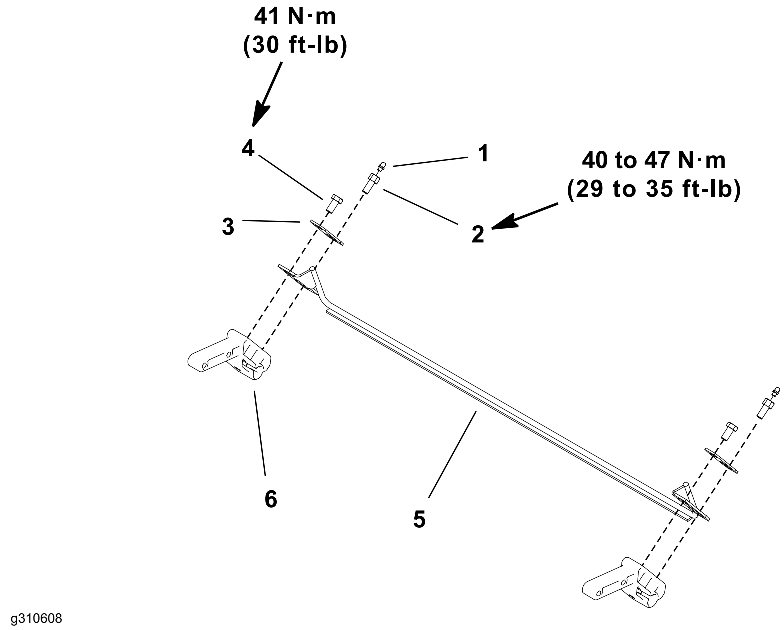

Figure 313

1. Grease fitting
2. Roller shaft screw
3. Scraper plate
4. Cap screw
5. Roller scraper
6. Roller mount

3. Remove four (4) flange head screws securing roller mounts to rear of deck frame. Remove roller mounts and rear roller assembly from deck frame.
4. Loosen fasteners securing each end of roller to roller mounts. Remove mounts and skid brackets from roller.

Installation (Figure 312)

1. Slide roller mounts onto roller shaft.
2. Install roller and roller mount assembly into rear of deck frame. Secure assembly to deck frame with four (4) flange head screws.

IMPORTANT

During assembly, make sure the grease groove in each roller mount aligns with the grease hole in each end of the roller shaft.

3. Align roller shaft grease hole with the roller mount grease groove. Use alignment mark on end of roller shaft to assist with alignment.
4. Position skid brackets to roller mounts and install cap screws to retain brackets in place.
5. If equipped with scraper rod, install and adjust scraper rod assembly to roller mounts (Figure 313). The gap between the scraper rod and roller should be from 0.5 to 1.0 mm (0.020 to 0.040 in). Torque cap screws **41 N·m (30 ft-lb)**.
6. Install and tighten fasteners that secure each end of roller to roller mounts. Torque roller shaft screws (item 4) and cap screws (item 8) from **40 to 47 N·m (29 to 35 ft-lb)**.
7. After assembly, raise and lower the cutting deck to verify that hydraulic hoses and fittings do not contact anything.

Rear Roller Service

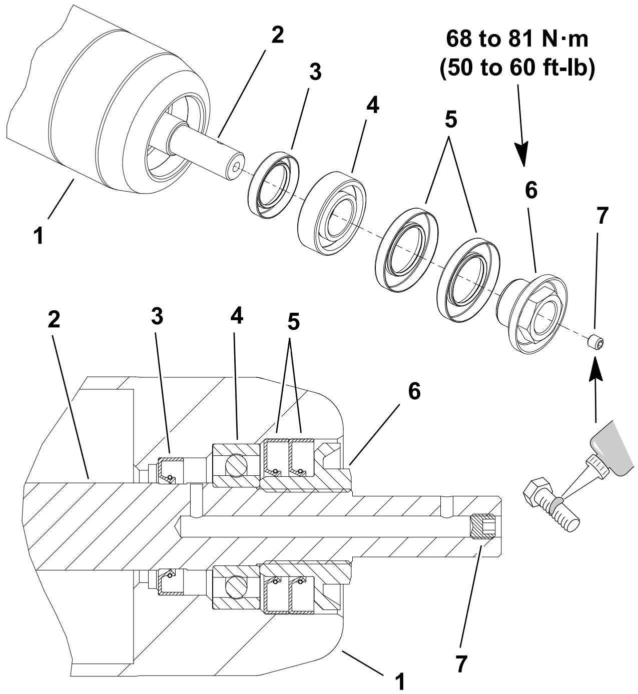

Figure 314

1. Roller tube
2. Roller shaft
3. Inner seal
4. Bearing
5. Outer seal
6. Bearing lock nut
7. Set screw

Disassembly (Figure 314)

1. Remove 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 shaft from roller tube.
3. Carefully remove inner seal from both ends of roller tube taking care to not damage tube surfaces.
4. Discard removed seals and bearings.
5. Clean 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.

Assembly (Figure 314)

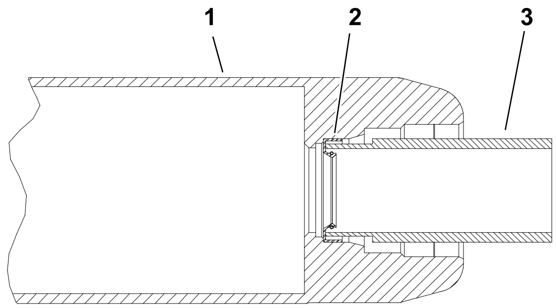

Figure 315

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 (see Special Tools (page 2–16)) and soft face hammer to fully seat seals against roller shoulder (Figure 315). 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.

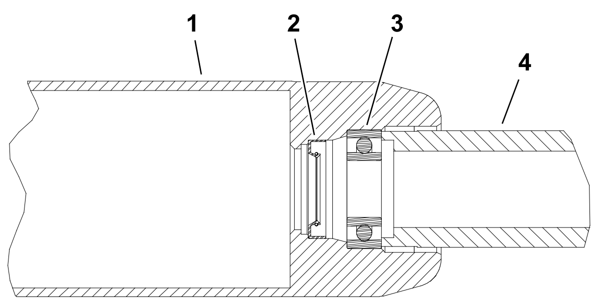

Figure 316

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 (see Special Tools (page 2–16)) with a soft face hammer to fully seat bearing against roller shoulder (Figure 316). 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.

Assembly (Figure 314) (continued)

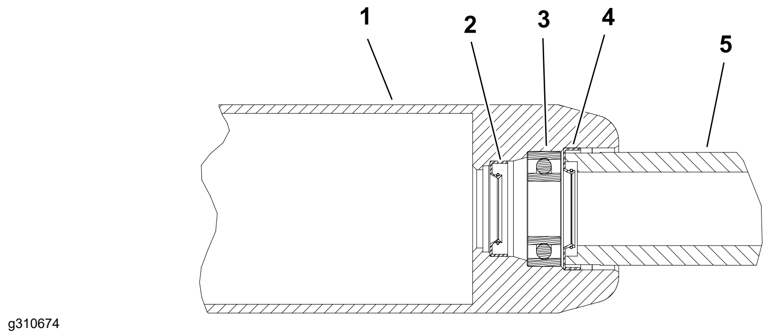

Figure 317

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 (see Special Tools (page 2–16)) and soft face hammer to lightly seat seal against roller shoulder (Figure 317). 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.

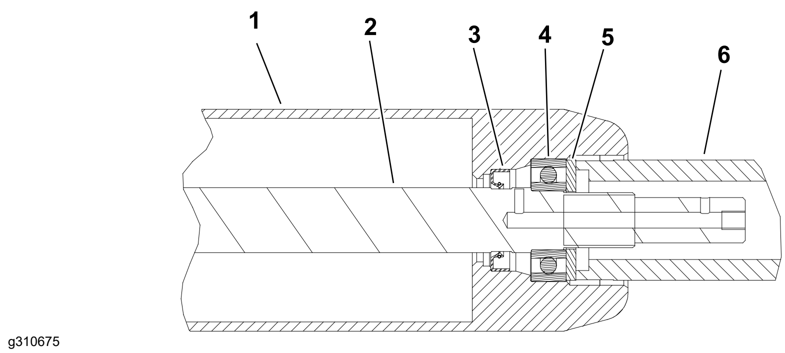

Figure 318

1. Roller tube
2. Roller shaft
3. Inner seal
4. Bearing
5. Washer
6. Bearing/outer seal tool

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 (see Special Tools (page 2–16)) on bearing to allow pressing on both inner and outer bearing races simultaneously.

B. Use washer and bearing/outer seal tool (see Special Tools (page 2–16)) with a soft face hammer to fully seat bearing (Figure 318). 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.

Assembly (Figure 314) (continued)

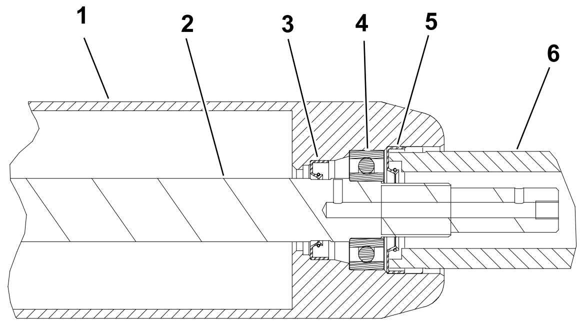

Figure 319

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 (see Special Tools (page 2–16)) and soft face hammer to lightly seat seal (Figure 319). 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 #242 (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 set screw was removed from either end of roller shaft, apply Loctite #242 (or equivalent) to threads of removed set screw and install into roller shaft. Tighten set screw until it bottoms in shaft and is recessed in shaft.

IMPORTANT

When roller assembly is installed to cutting deck, make sure that grease groove in each roller mount aligns with the grease hole in each end of roller shaft.

Note: After roller is installed to cutting deck, 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-lbs)** resistance.

Front Roller Service

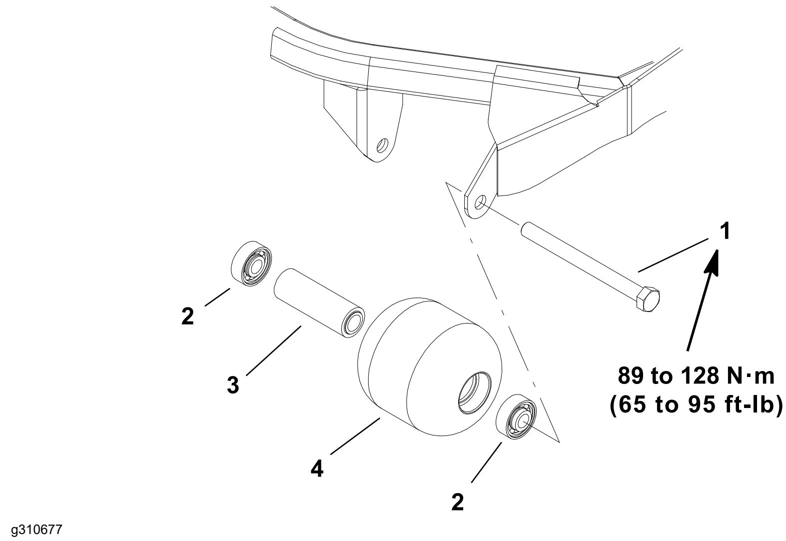

Figure 320

1. Mounting bolt
2. Bearing
3. Bearing spacer
4. Front roller

Disassembly (Figure 320)

1. Remove roller mounting bolt.
2. Remove roller assembly from carrier frame.
3. To remove bearings and bearing spacer:
   A. Insert punch through end of roller and drive opposite bearing out by alternating taps to opposite side of inner bearing race. There should be a lip of inner race exposed for this process.
   B. Remove bearing spacer. Remove second bearing from roller using a press.
4. Inspect roller housing, bearings and bearing spacer for damage or wear. Replace components as needed.

Assembly (Figure 320)

1. Install bearings and bearing spacer into roller:

IMPORTANT

Use Front Roller Bearing Installation Tool (see Special Tools (page 2–16)) when installing bearings into roller. This tool ensures that no side load is applied to the bearings during installation into the front rollers.

   A. Press first bearing into housing. Press equally on inner and outer races during installation.
   B. Insert bearing spacer.
   C. Press second bearing into roller housing pressing equally on inner and outer races until the inner race comes in contact with the bearing spacer.
2. Install roller assembly to deck frame.

   Note: Securing roller assembly with a gap larger than 1.5 mm (0.060 inch) creates a side load on bearings and can lead to premature bearing failure.

Assembly (Figure 320) (continued)

3. Verify that there is no more than a 1.5 mm (0.060 inch) gap between roller assembly and the roller mount brackets of the deck frame. If this gap is larger than 1.5 mm (0.060 inch), shim excess clearance with 5/8” washers.

4. Insert mounting bolt and tighten to **89 to 128 N·m (65 to 95 ft-lb)**.

Cutting Deck Carrier Frame

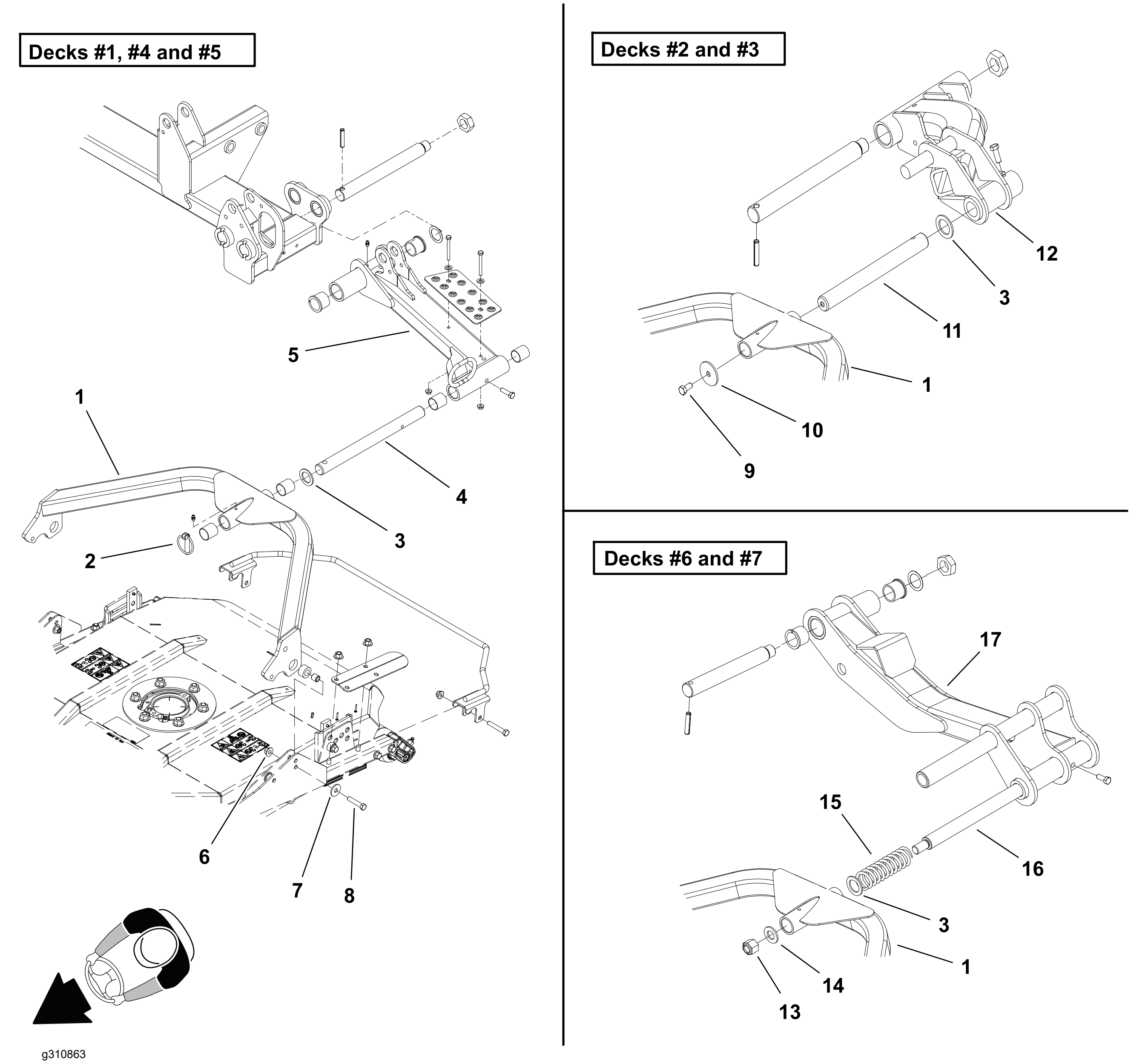

Figure 321

1. Carrier frame
2. Lynch pin
3. Thrust washer
4. Pivot shaft
5. Lift arm (#4 shown)
6. Flange nut (2 used per deck)
7. Hardened washer (2 used per deck)
8. Cap screw (2 used per deck)
9. Cap screw
10. Rebound washer
11. Pivot shaft
12. Lift arm (#2 shown)
13. Lock nut
14. Flat washer
15. Compression spring
16. Pivot shaft
17. Lift arm (#6 shown)

Removal and Installation (Figure 321)

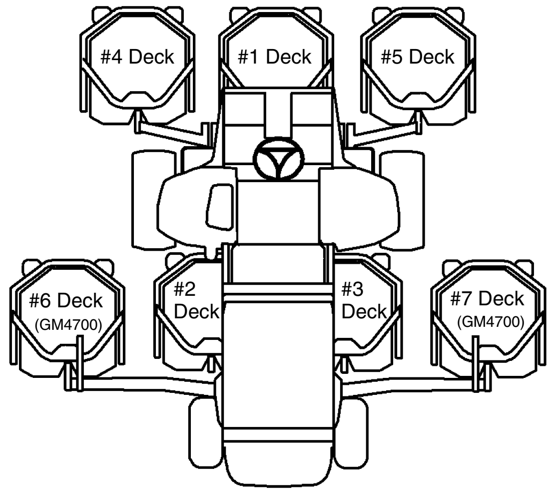

Figure 322
CUTTING DECK LOCATIONS

Each cutting deck is suspended from a carrier frame. The cutting deck carrier frame is attached to the lift arm and allows the cutting deck to pivot on the lift arm pivot shaft. Cutting deck positions are identified in Figure 322.

Cutting deck carrier frames are secured to lift arms as follows:

1. Carrier frames for the front three cutting decks (#1, #4 and #5) have a thrust washer between the carrier frame and the lift arm. The frame is secured to the lift arm pivot shaft with a lynch pin.
2. Carrier frames for the center two cutting decks (#2 and #3) have a thrust washer between the carrier frame and the lift arm. The frame is secured to the lift arm pivot shaft with a rebound washer and cap screw.
3. On Groundsmaster 4700-D machines, carrier frames for the rear two cutting decks (#6 and #7) have a compression spring and thrust washer between the carrier frame and the lift arm. The frame is secured to the lift arm pivot shaft with a flat washer and lock nut.

Foldout Drawings

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Electrical Drawing Designations

Note: A splice used in a wire harness will be identified on the wire harness diagram by SP. The manufacturing number of the splice is also identified on the wire harness diagram (e.g., SP01 is splice number 1).

Wire Color

The following abbreviations are used for wire harness colors on the electrical schematics and wire harness drawings in this chapter.

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

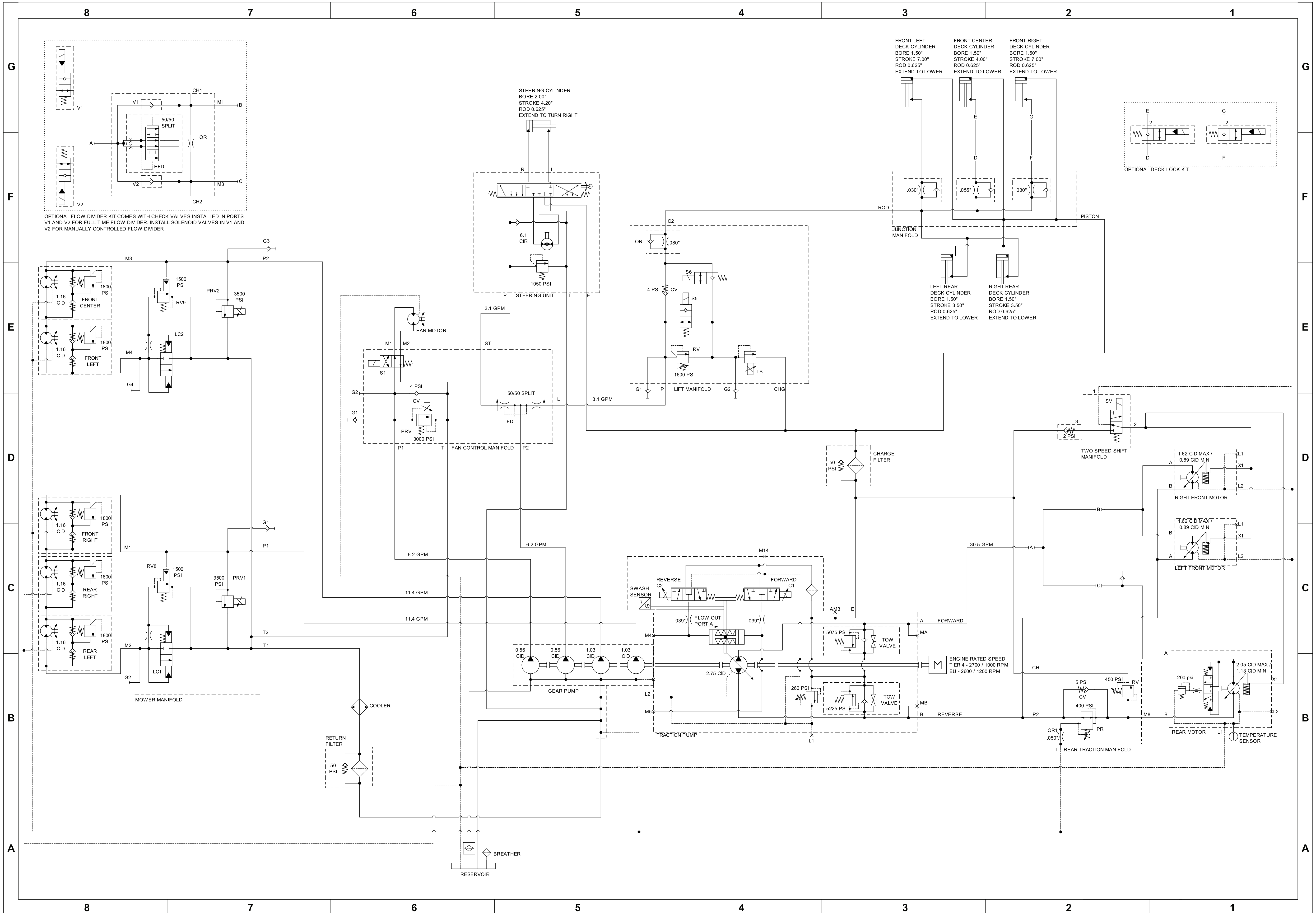
The individual wires of the electrical harness diagrams in this chapter identify both the wire color and the wire size.

Examples:

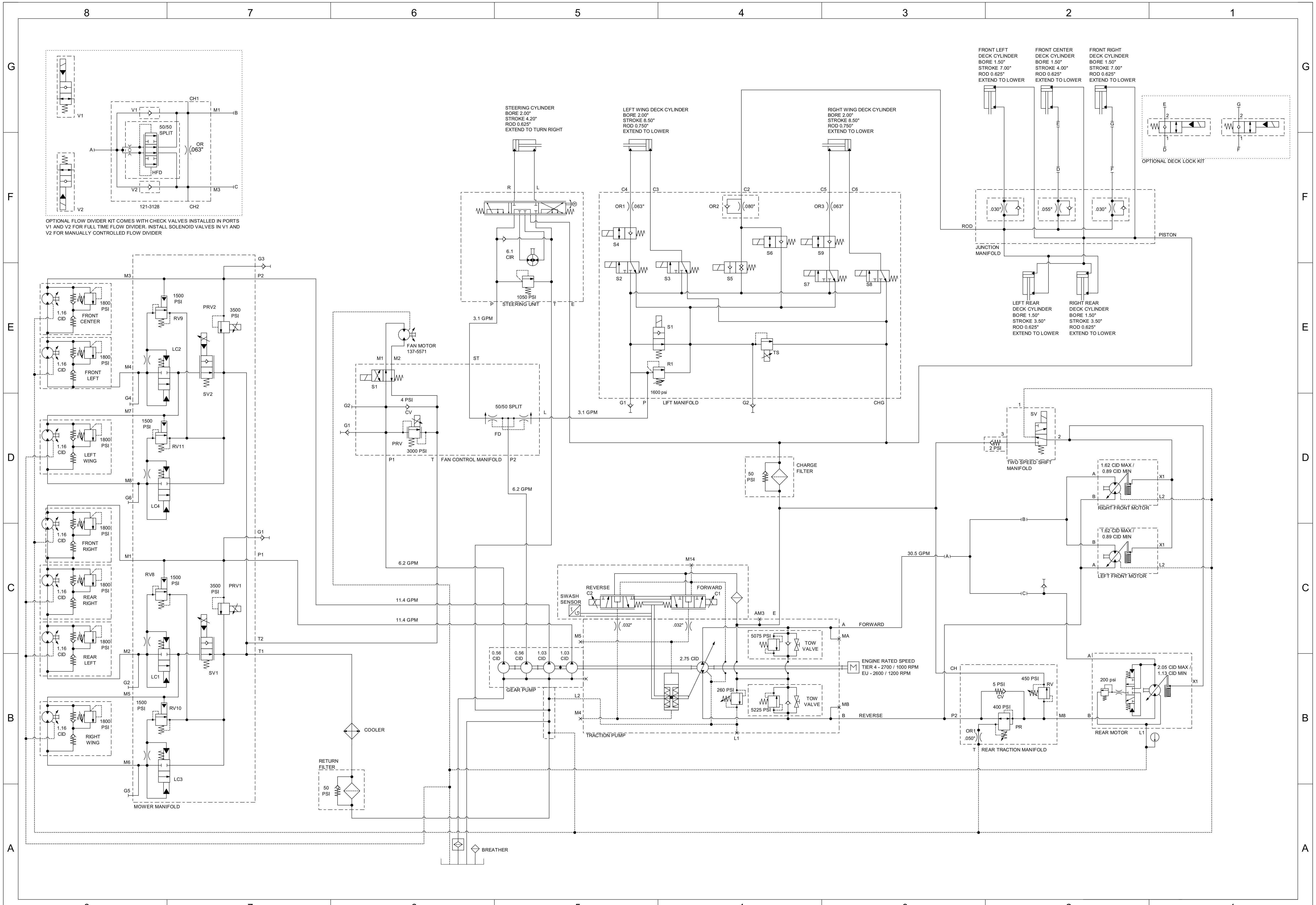
- 16 BK = 16 AWG (American Wire Gauge) wire that has a black insulator
- 050 R = 0.5 mm metric wire that has a red insulator (AWG equivalents for metric wire appear in the following table)

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

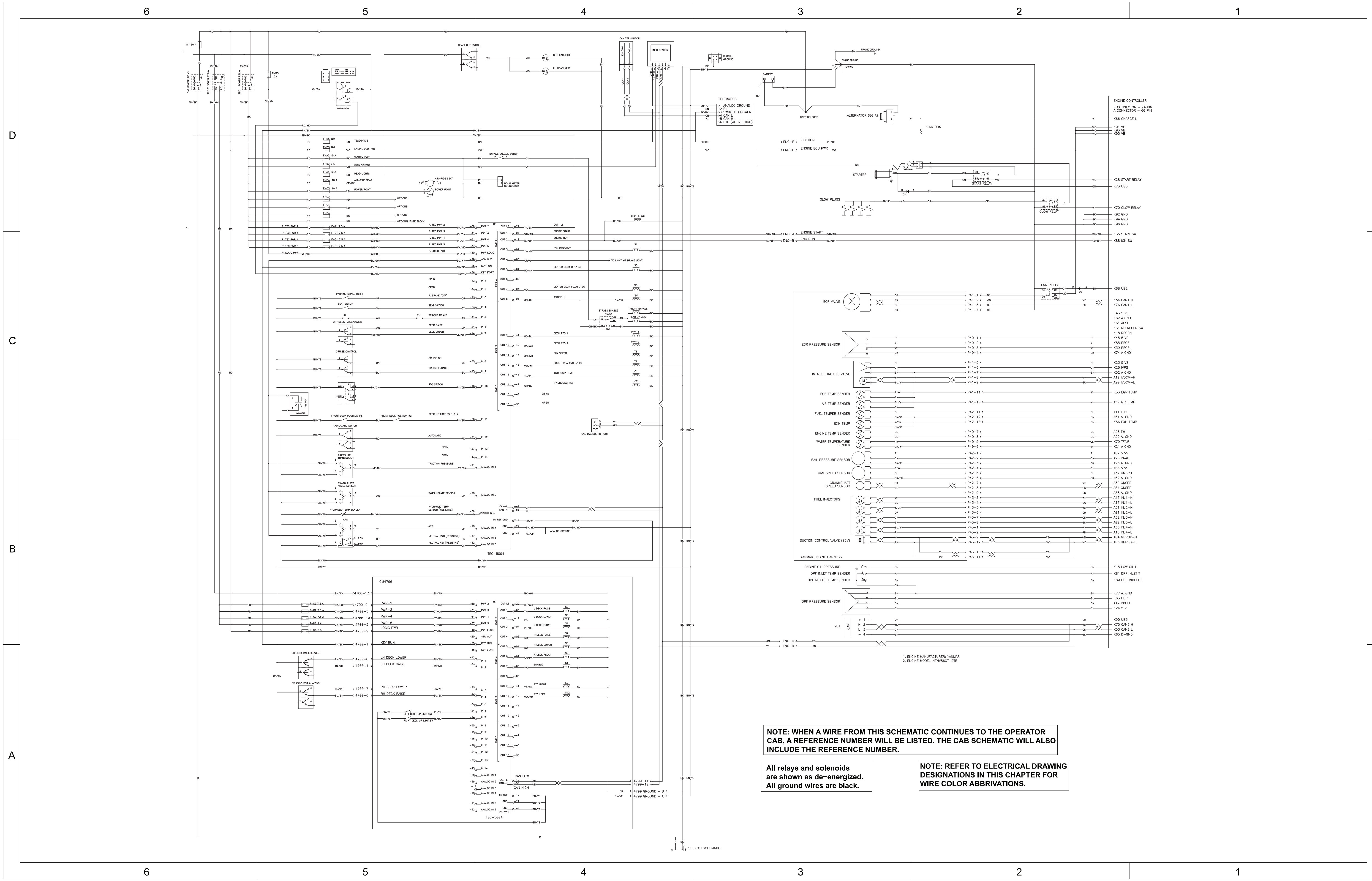
Hydraulic Schematic - Groundsmaster 4500-D



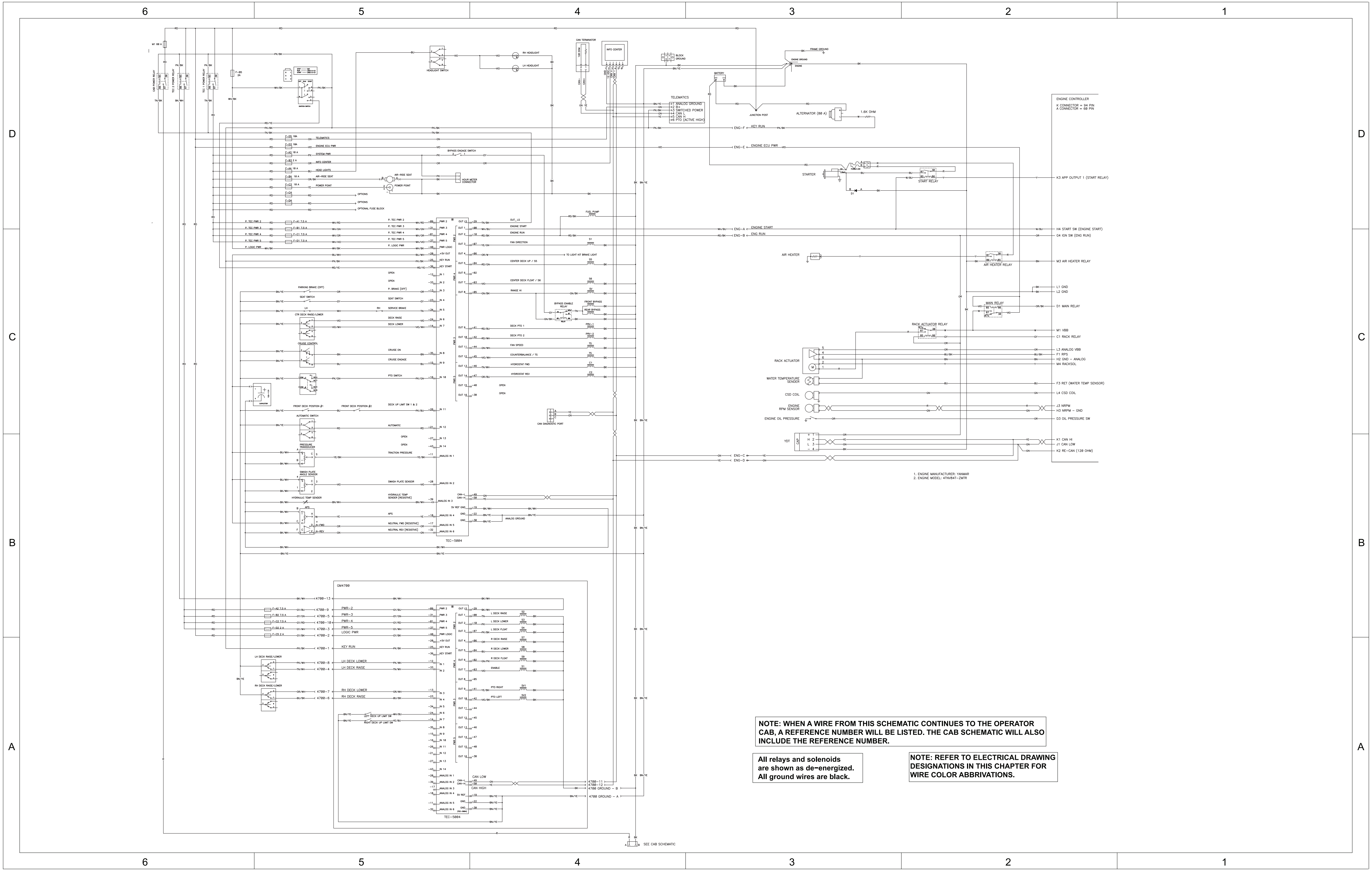
Hydraulic Schematic - Groundsmaster 4700-D



Electric Schematic - Groundsmaster 4500-D/4700-D (Models 30885 and 30887)

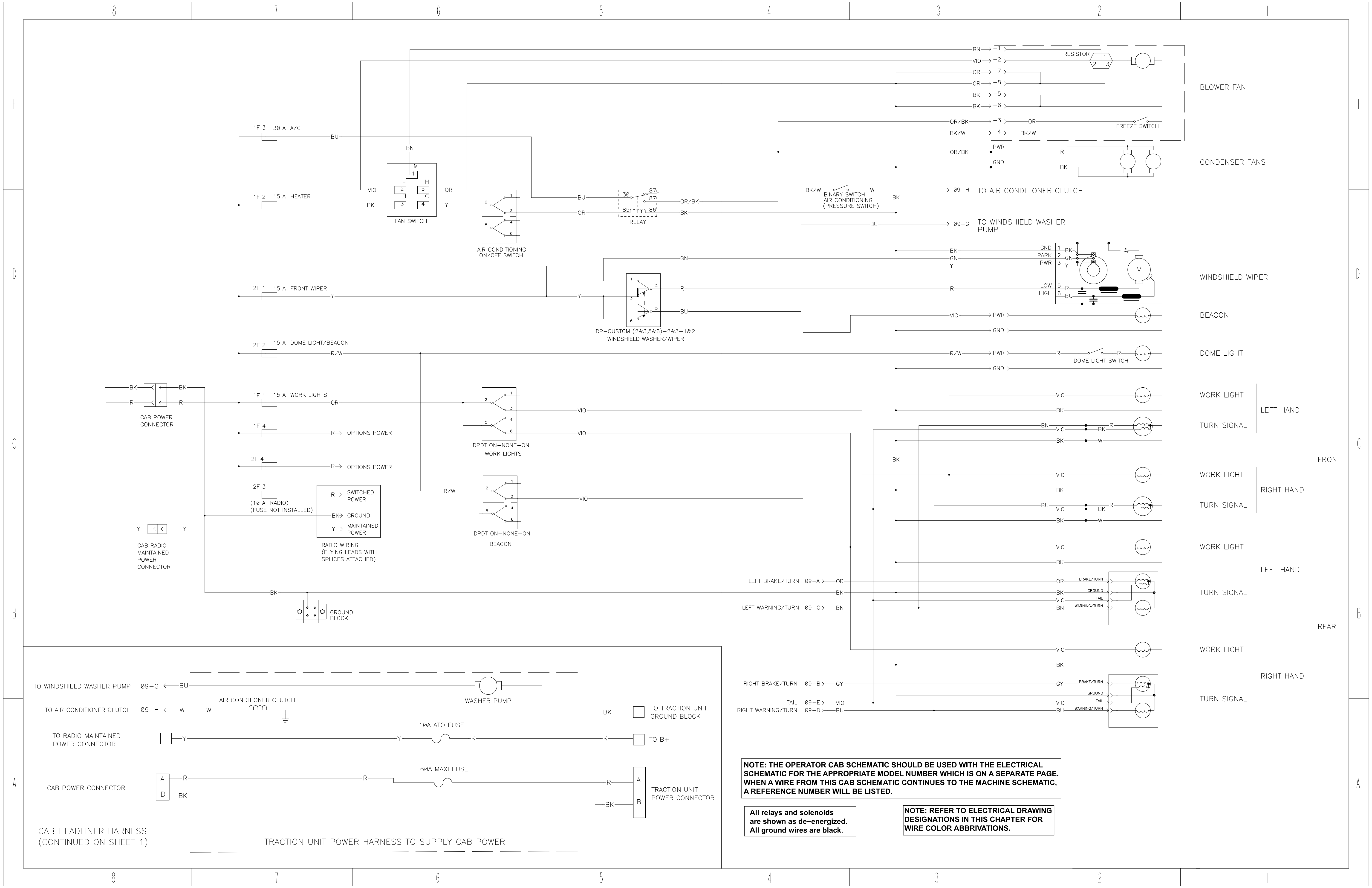


g310872


NOTE: WHEN A WIRE FROM THIS SCHEMATIC CONTINUES TO THE OPERATOR CAB, A REFERENCE NUMBER WILL BE LISTED. THE CAB SCHEMATIC WILL ALSO INCLUDE THE REFERENCE NUMBER.
All relays and solenoids are shown as de-energized. All ground wires are black.
NOTE: REFER TO ELECTRICAL DRAWING DESIGNATIONS IN THIS CHAPTER FOR WIRE COLOR ABBRIVATIONS.
1. ENGINE MANUFACTURER: YANMAR
2. ENGINE MODEL: 4TNV84T-ZMTR
ENGINE CONTROLLER
TEC-5004
GM4700
SEE CAB SCHEMATIC

g310873

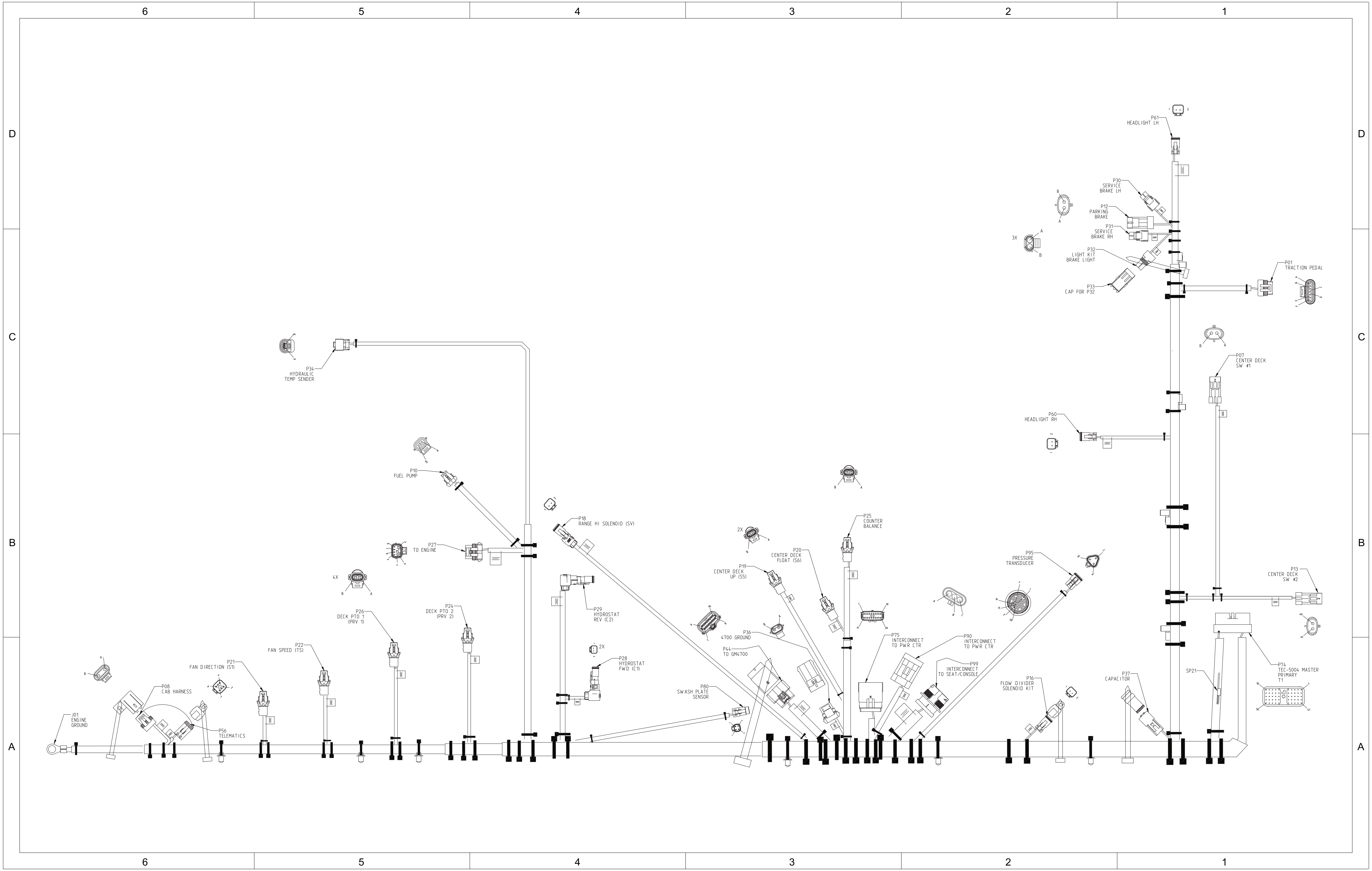
Optional Operator Cab Electrical Schematic - Groundsmaster 4500-D/4700-D



NOTE: THE OPERATOR CAB SCHEMATIC SHOULD BE USED WITH THE ELECTRICAL SCHEMATIC FOR THE APPROPRIATE MODEL NUMBER WHICH IS ON A SEPARATE PAGE. WHEN A WIRE FROM THIS CAB SCHEMATIC CONTINUES TO THE MACHINE SCHEMATIC, A REFERENCE NUMBER WILL BE LISTED.

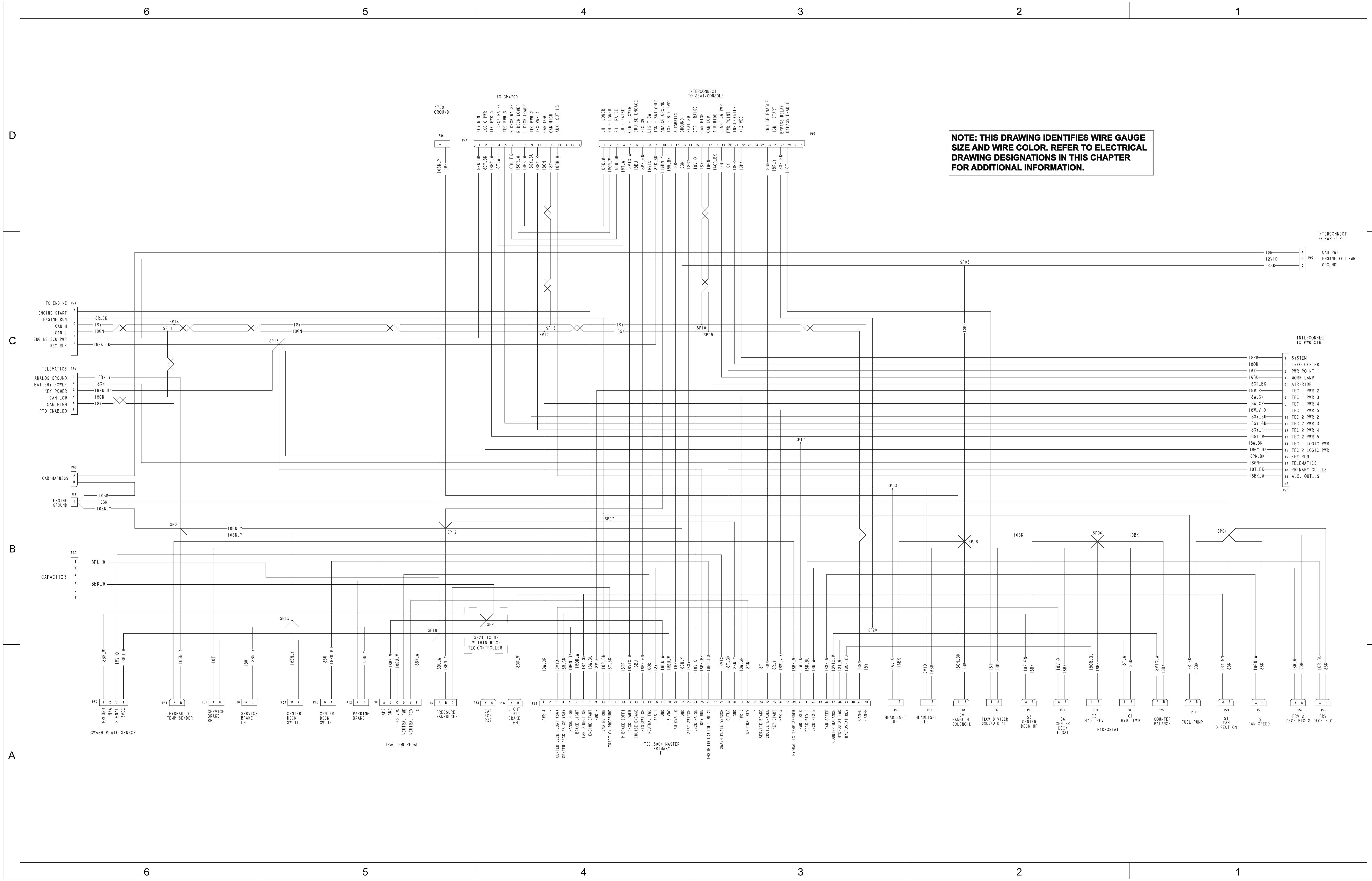
All relays and solenoids are shown as de-energized. All ground wires are black.

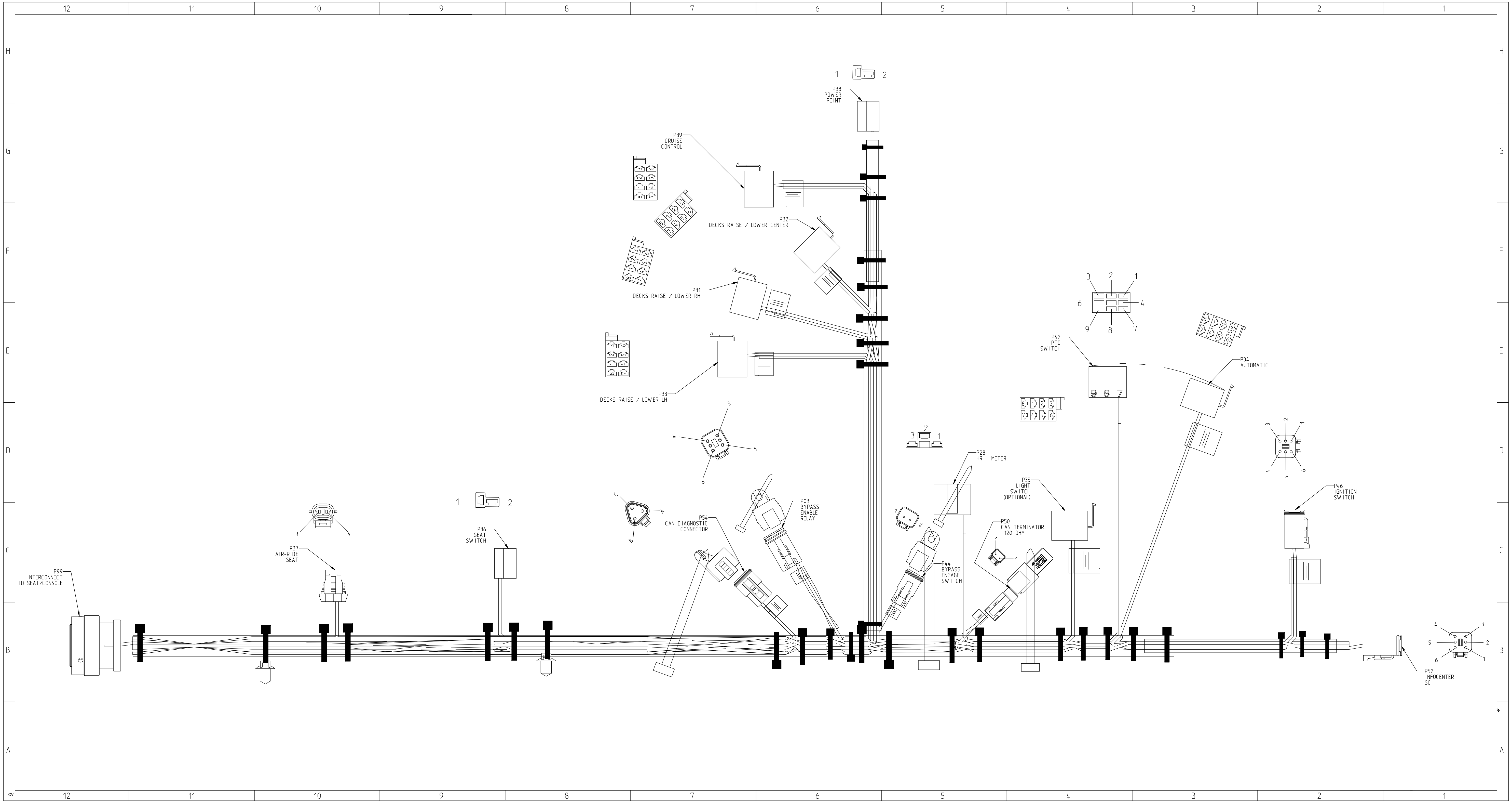
NOTE: REFER TO ELECTRICAL DRAWING DESIGNATIONS IN THIS CHAPTER FOR WIRE COLOR ABBRIVATIONS.


P61 HEADLIGHT LH
P30 SERVICE BRAKE LH
P12 PARKING BRAKE
P31 SERVICE BRAKE RH
P32 LIGHT KIT BRAKE LIGHT
P33 CAP FOR P32
P01 TRACTION PEDAL
P07 CENTER DECK SW #1
P60 HEADLIGHT RH
P34 HYDRAULIC TEMP SENDER
P10 FUEL PUMP
P18 RANGE HI SOLENOID (SV)
P27 TO ENGINE
P25 COUNTER BALANCE
P20 CENTER DECK FLOAT (S6)
P19 CENTER DECK UP (S5)
P95 PRESSURE TRANSDUCER
P13 CENTER DECK SW #2
P29 HYDROSTAT REV (C2)
P26 DECK PTO 1 (PRV 1)
P24 DECK PTO 2 (PRV 2)
P22 FAN SPEED (TS)
P21 FAN DIRECTION (S1)
P28 HYDROSTAT FWD (C1)
P36 4700 GROUND
P44 TO GM4700
P75 INTERCONNECT TO PWR CTR
P90 INTERCONNECT TO PWR CTR
P99 INTERCONNECT TO SEAT/CONSOLE
P74 TEC-5004 MASTER PRIMARY T1
SP21
P37 CAPACITOR
P16 FLOW DIVIDER SOLENOID KIT
P80 SWASH PLATE SENSOR
P08 CAB HARNESS
P56 TELEMATICS
J01 ENGINE GROUND
4X
3X
2X

g310950

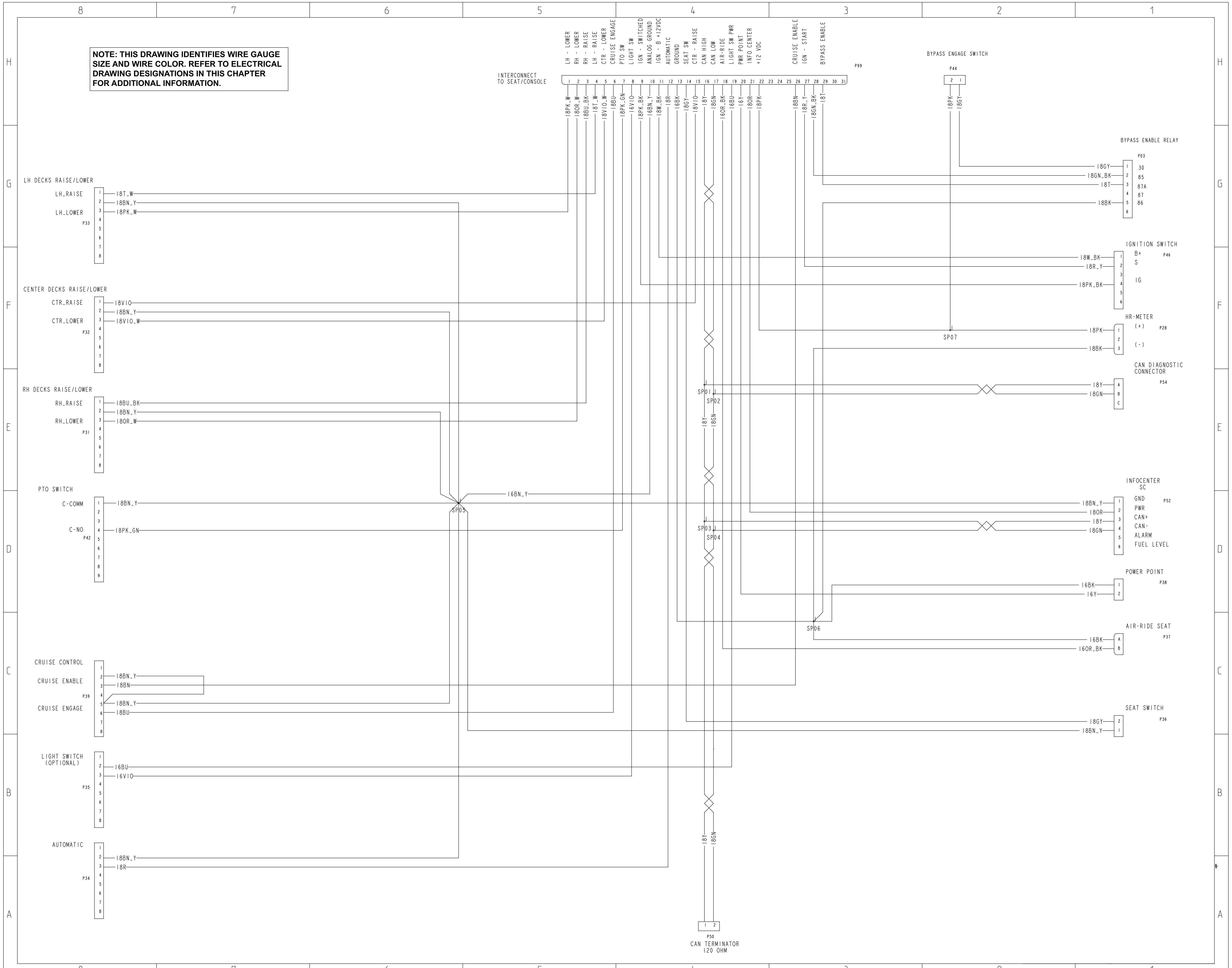
Main Wire Harness - Groundsmaster 4500-D/4700-D

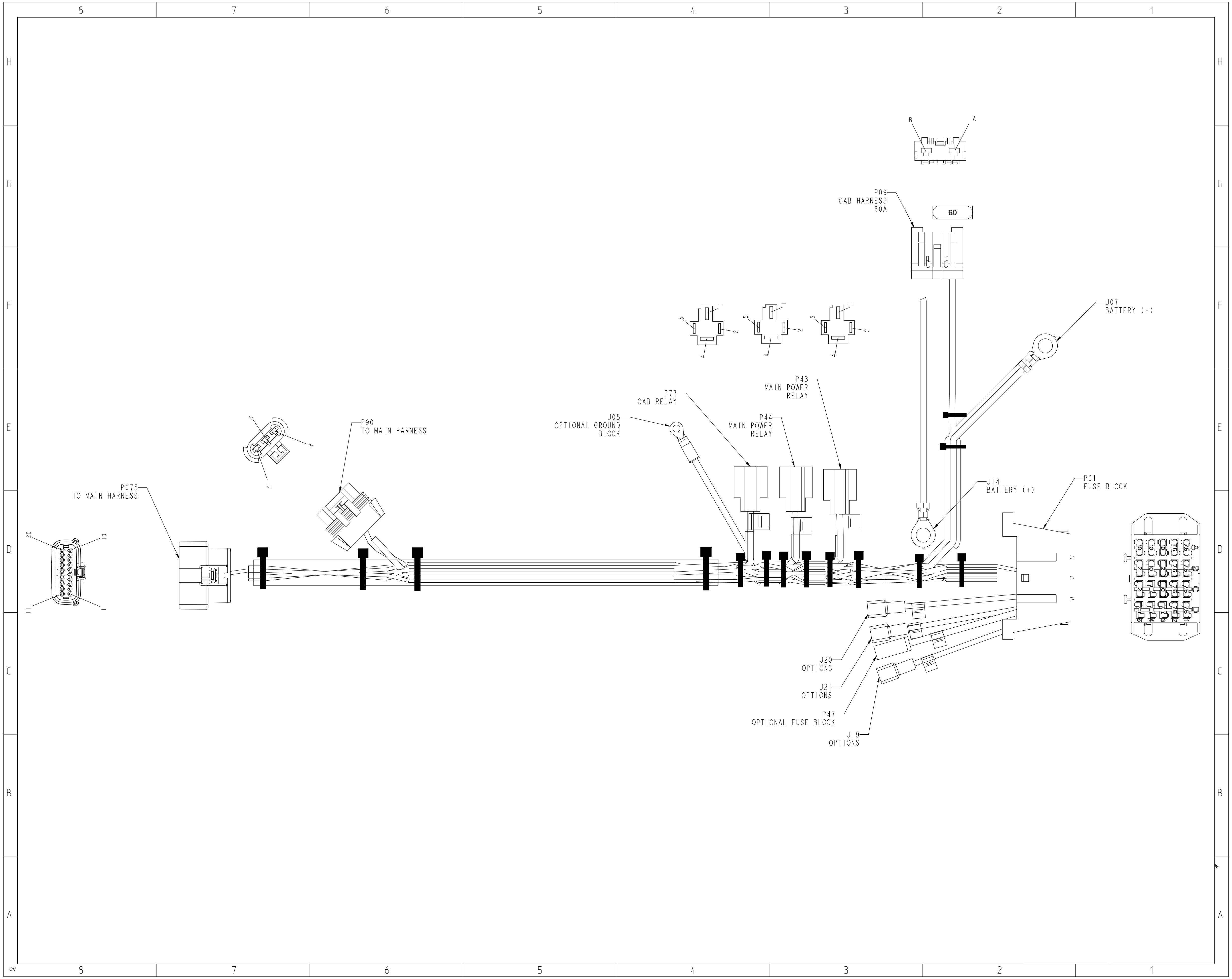



P38 POWER POINT
P39 CRUISE CONTROL
P32 DECKS RAISE / LOWER CENTER
P31 DECKS RAISE / LOWER RH
P33 DECKS RAISE / LOWER LH
P42 PTO SWITCH
P34 AUTOMATIC
P28 HR - METER
P35 LIGHT SWITCH (OPTIONAL)
P50 CAN TERMINATOR 120 OHM
P46 IGNITION SWITCH
P03 BYPASS ENABLE RELAY
P54 CAN DIAGNOSTIC CONNECTOR
P44 BYPASS ENGAGE SWITCH
P36 SEAT SWITCH
P37 AIR-RIDE SEAT
P99 INTERCONNECT TO SEAT/CONSOLE
P52 INFOCENTER SC

g310972

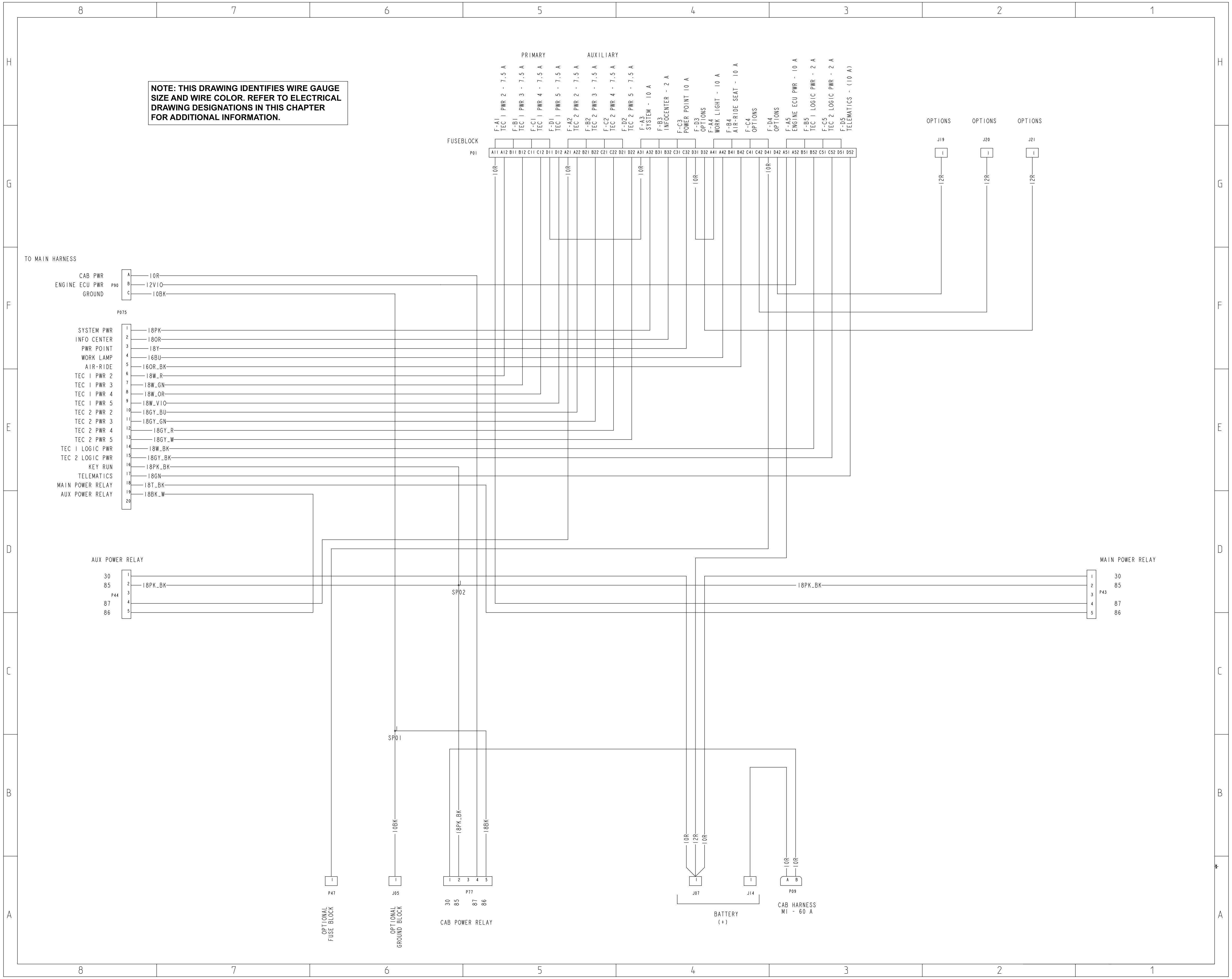
Seat and Console Wire Harness - Groundsmaster 4500-D/4700-D



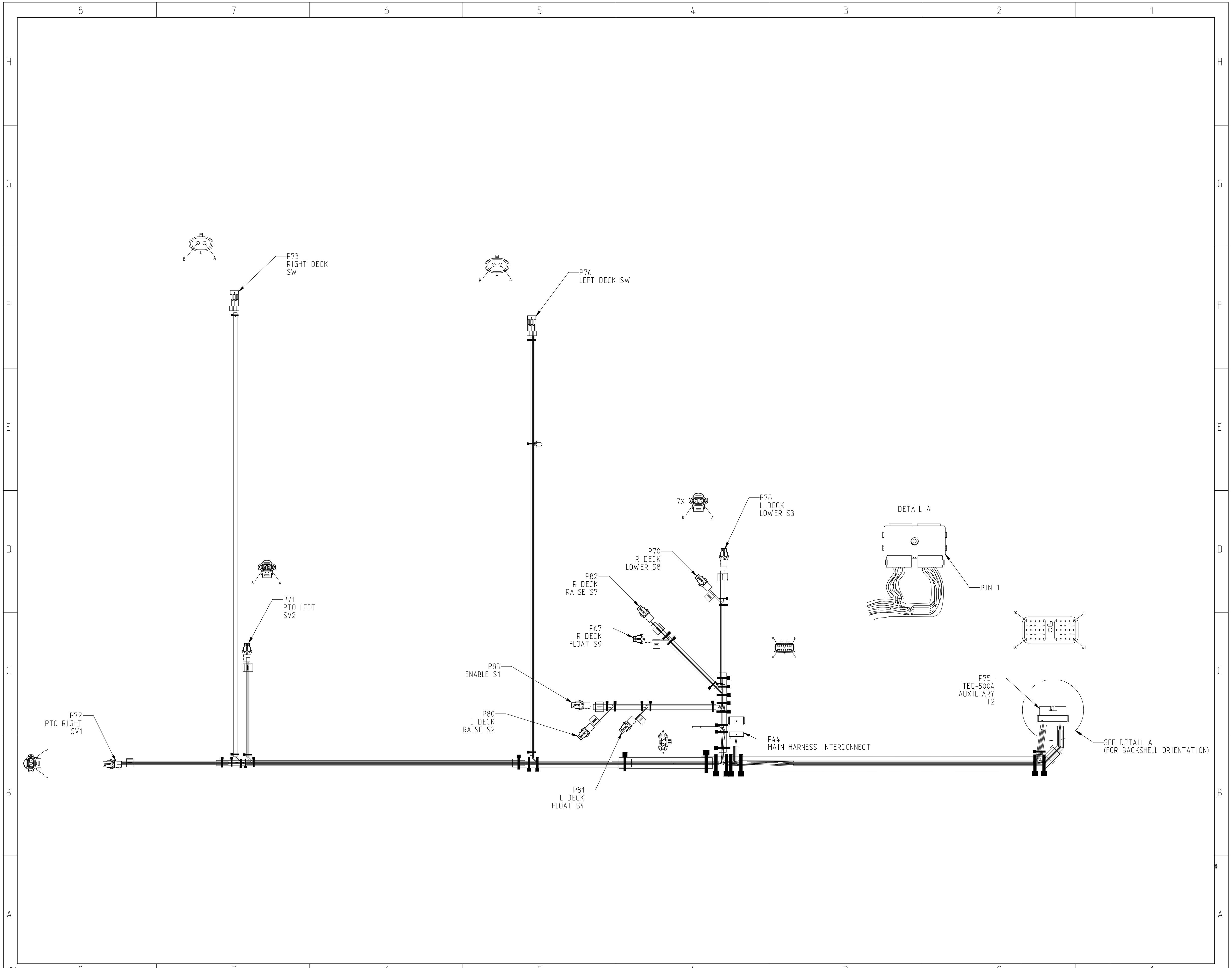

P09
CAB HARNESS
60A
60
J07
BATTERY (+)
P43
MAIN POWER
RELAY
P77
CAB RELAY
P44
MAIN POWER
RELAY
J05
OPTIONAL GROUND
BLOCK
P90
TO MAIN HARNESS
P075
TO MAIN HARNESS
J14
BATTERY (+)
P01
FUSE BLOCK
J20
OPTIONS
J21
OPTIONS
P47
OPTIONAL FUSE BLOCK
J19
OPTIONS

g310974

Power Center Wire Harness - Groundsmaster 4500-D/4700-D

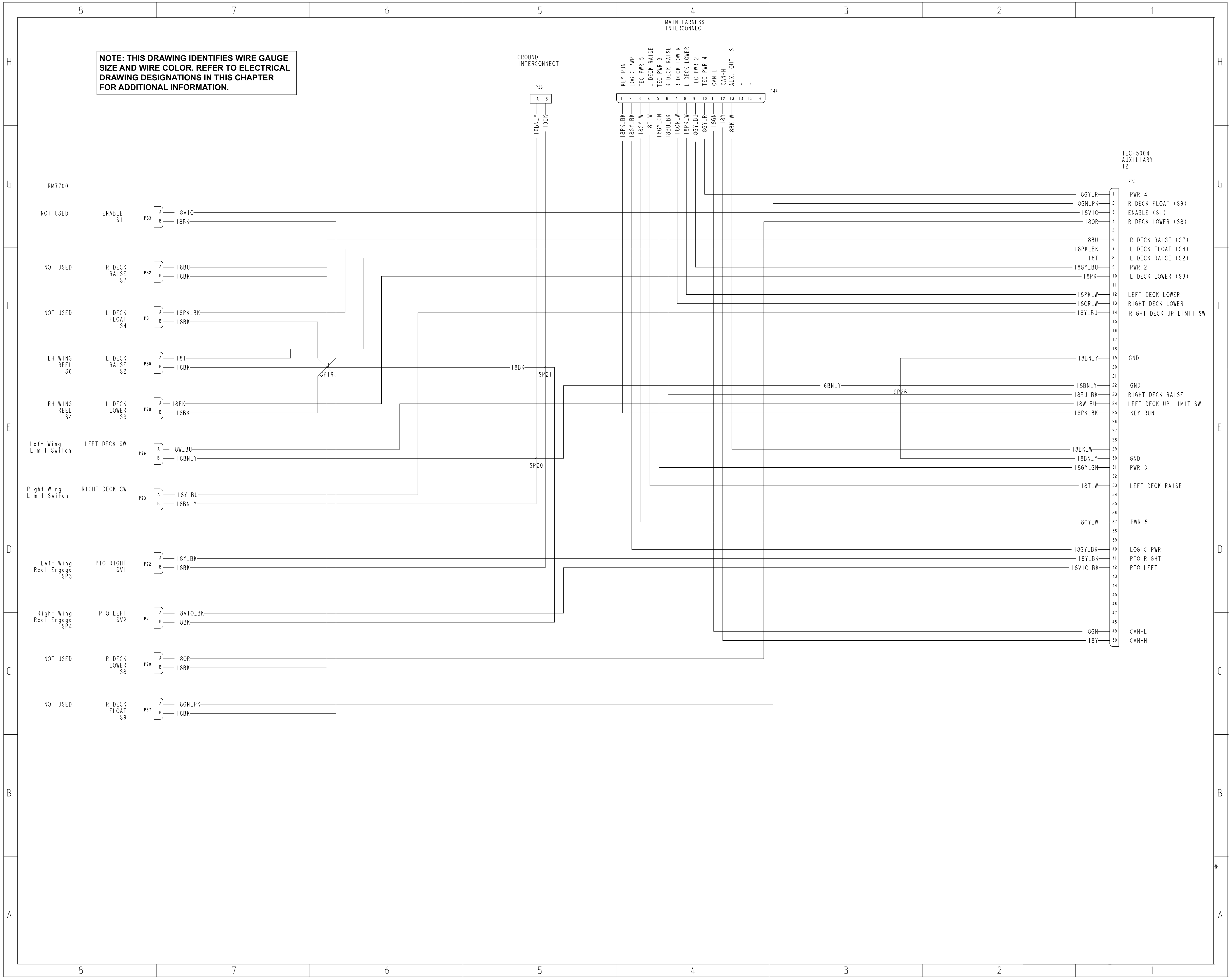


g310975


P73
RIGHT DECK
SW
P76
LEFT DECK SW
7X
P78
L DECK
LOWER S3
DETAIL A
P70
R DECK
LOWER S8
P82
R DECK
RAISE S7
PIN 1
P71
PTO LEFT
SV2
P67
R DECK
FLOAT S9
P83
ENABLE S1
P75
TEC-5004
AUXILIARY
T2
P72
PTO RIGHT
SV1
P80
L DECK
RAISE S2
P44
MAIN HARNESS INTERCONNECT
SEE DETAIL A
(FOR BACKSHELL ORIENTATION)
P81
L DECK
FLOAT S4

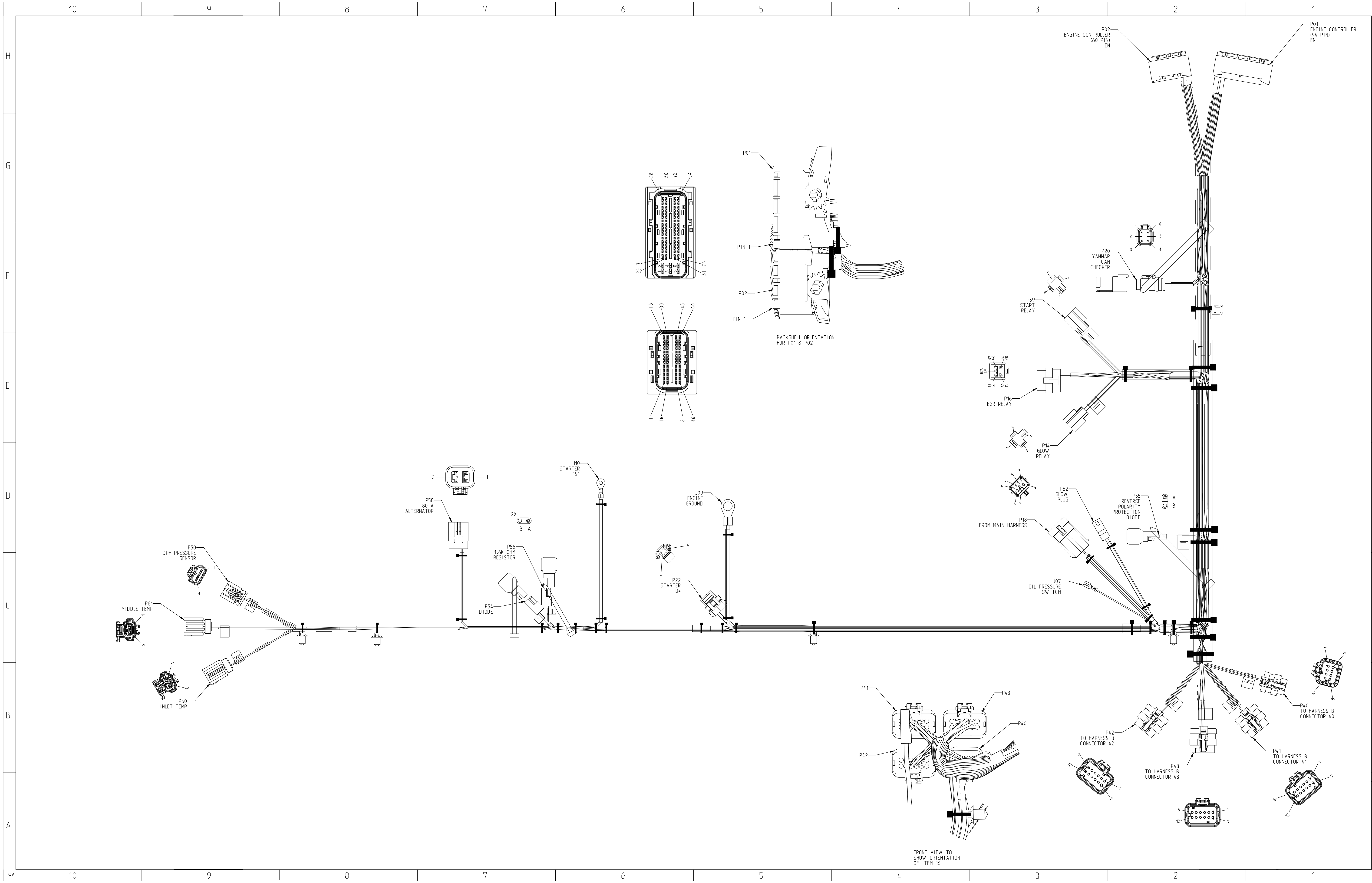
g310991

Deck 6 and 7 Wire Harness - Groundsmaster 4700-D



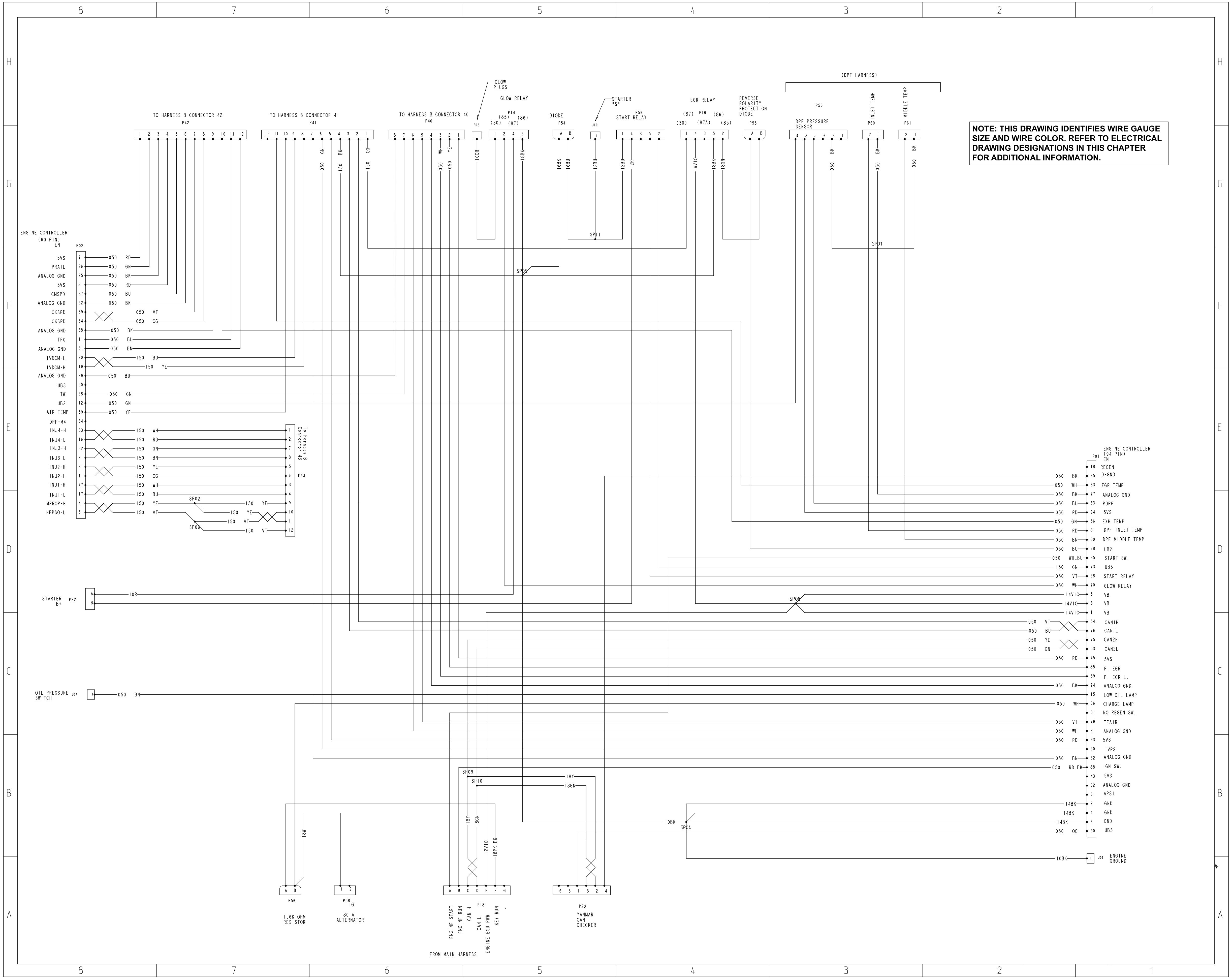
g310992

Engine Wire Harness Drawing - Groundsmaster 4500−D/4700−D (Models 30885 and 30887) (Serial Numbers Below 408000000)



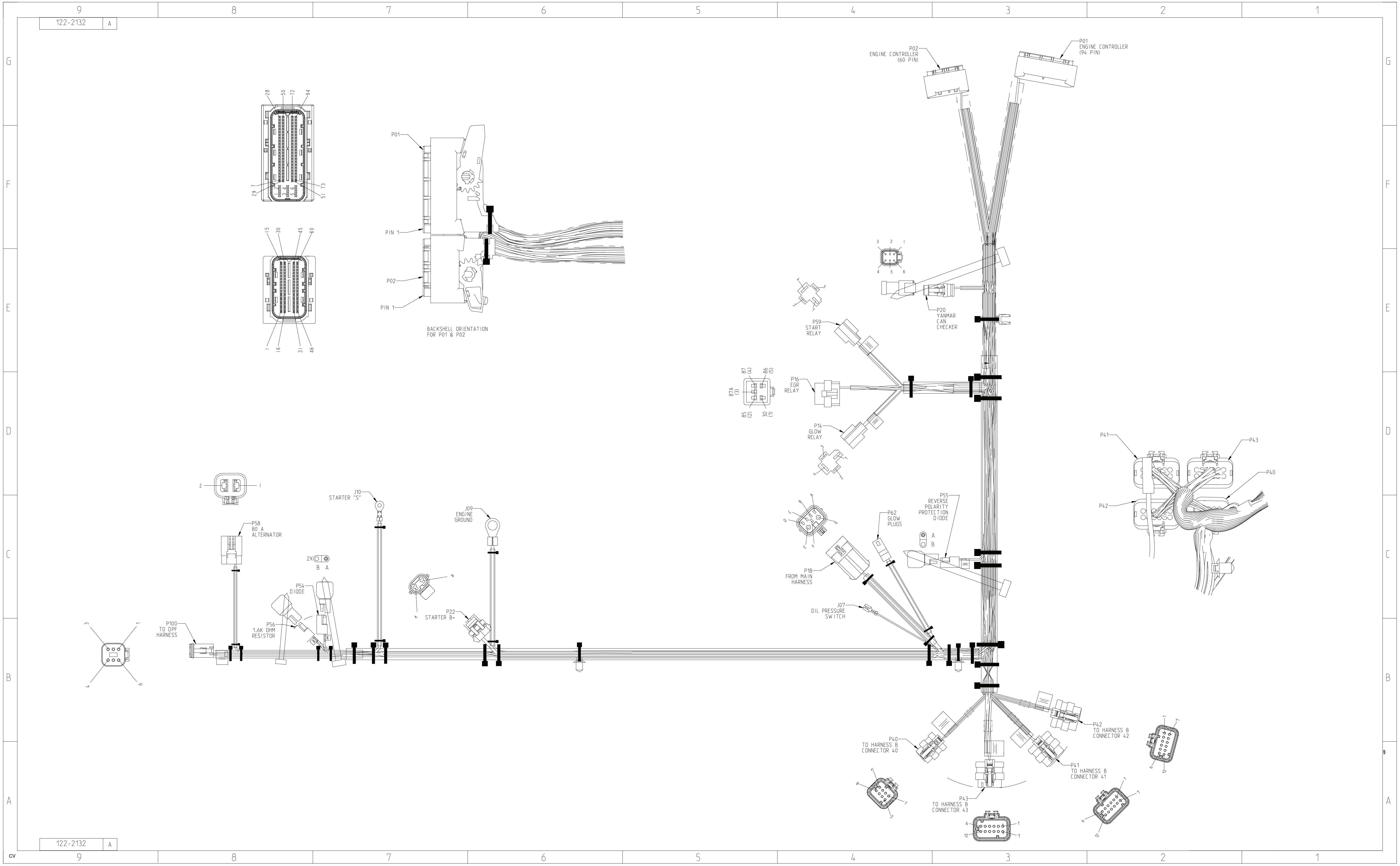
g311045

Engine Wire Harness Drawing - Groundsmaster 4500−D/4700−D (Models 30885 and 30887) (Serial Numbers Below 408000000)

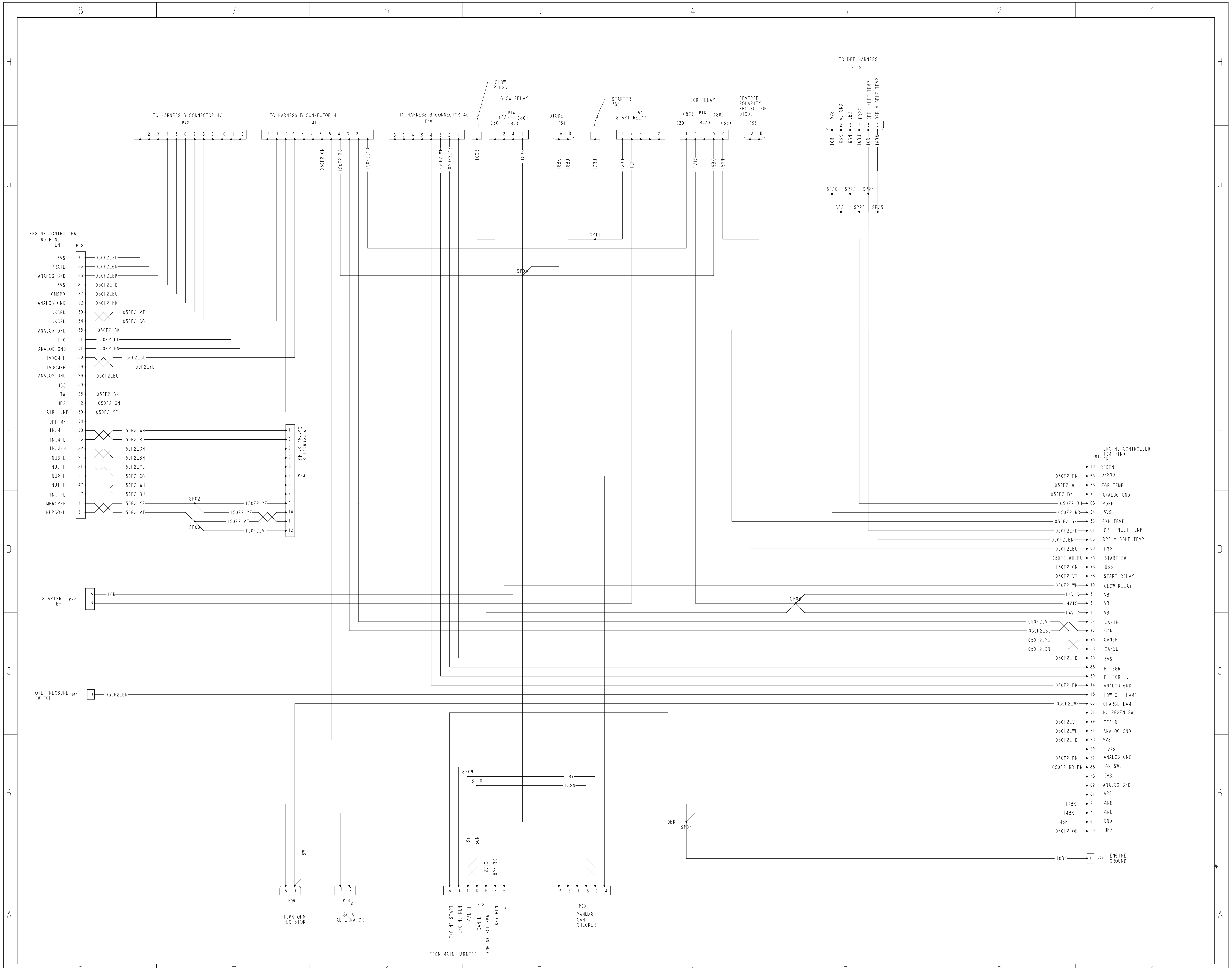


g311046

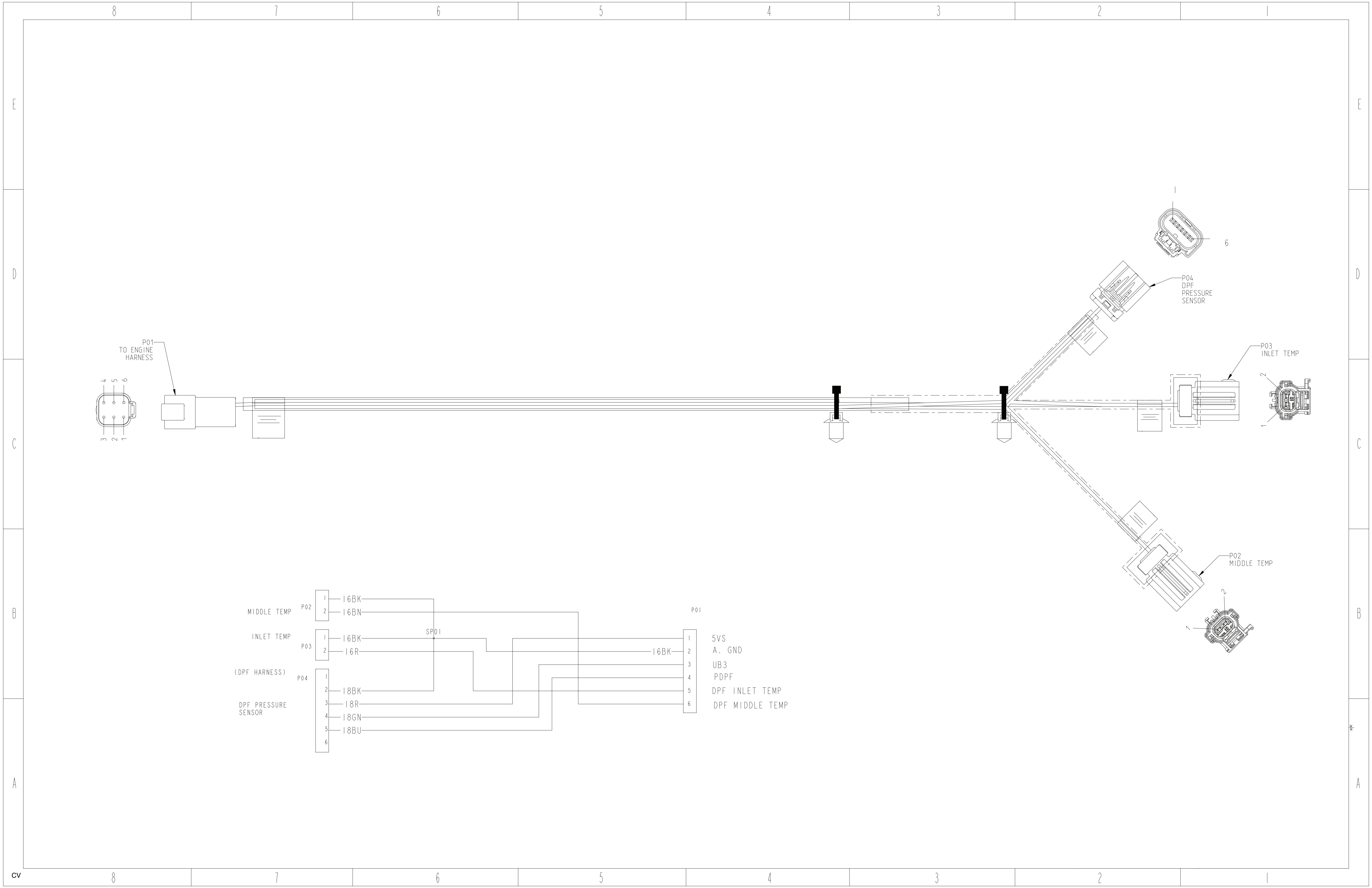
Engine Wire Harness Drawing - Groundsmaster 4500–D/4700–D (Models 30885 and 30887) (Serial Numbers Above 408000000)



Engine Wire Harness Drawing - Groundsmaster 4500−D/4700−D (Models 30885 and 30887) (Serial Numbers Above 408000000)



g362566


P01
TO ENGINE
HARNESS
P04
DPF
PRESSURE
SENSOR
P03
INLET TEMP
P02
MIDDLE TEMP
MIDDLE TEMP
P02
16BK
16BN
INLET TEMP
P03
16BK
16R
SP01
(DPF HARNESS)
P04
18BK
18R
18GN
18BU
DPF PRESSURE
SENSOR
P01
16BK
5VS
A. GND
UB3
PDPF
DPF INLET TEMP
DPF MIDDLE TEMP
CV
g362567

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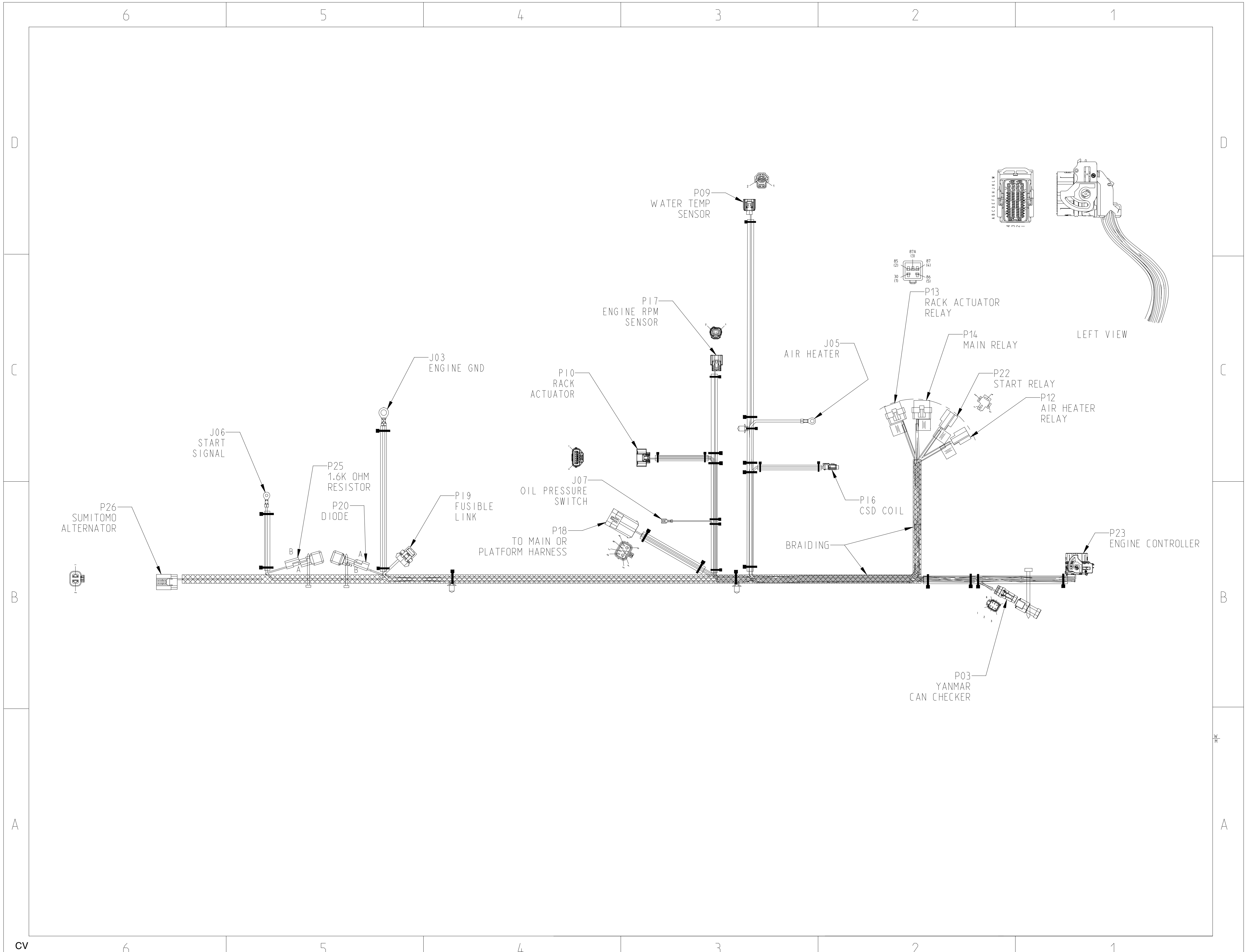
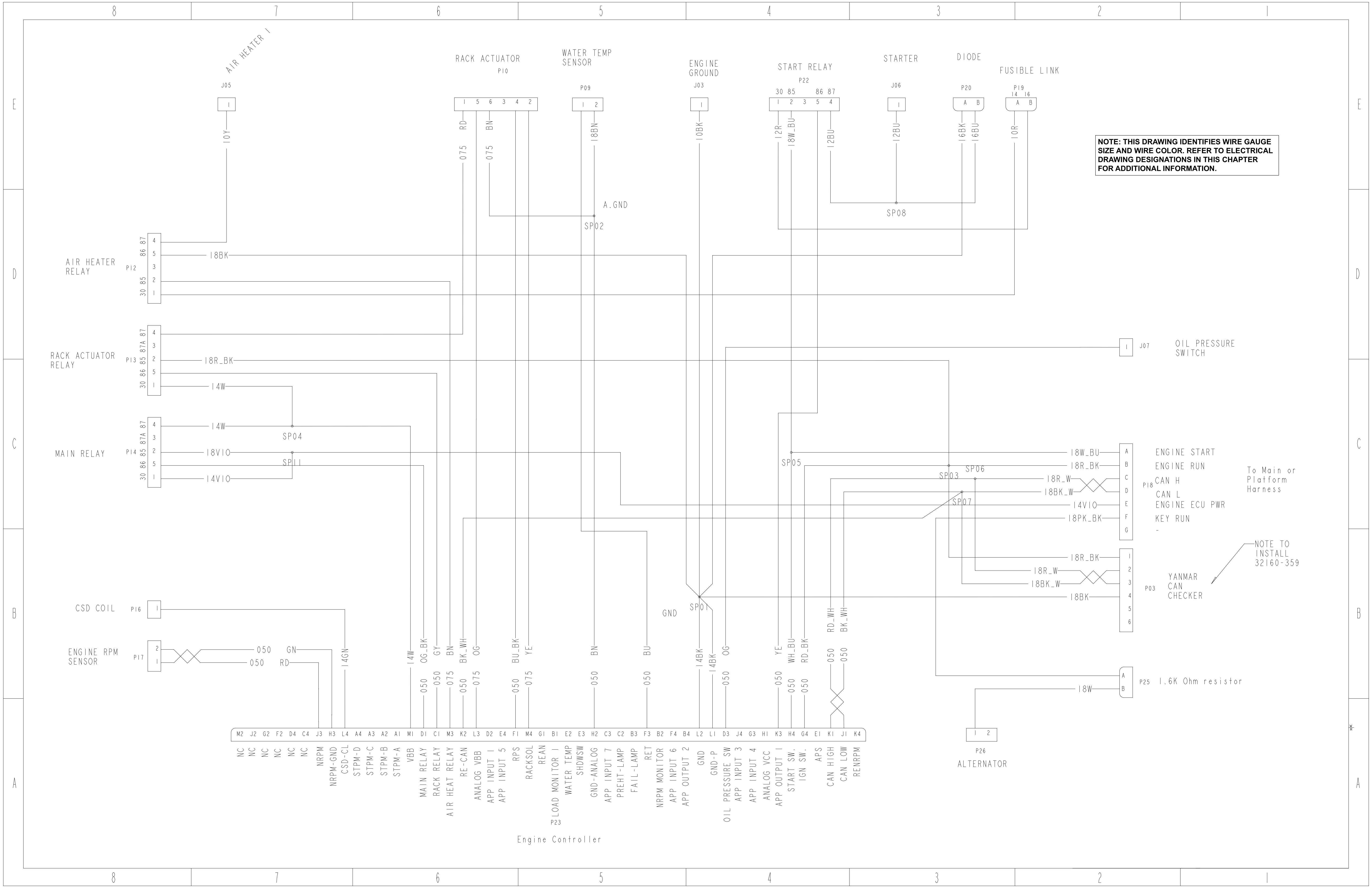
g326106

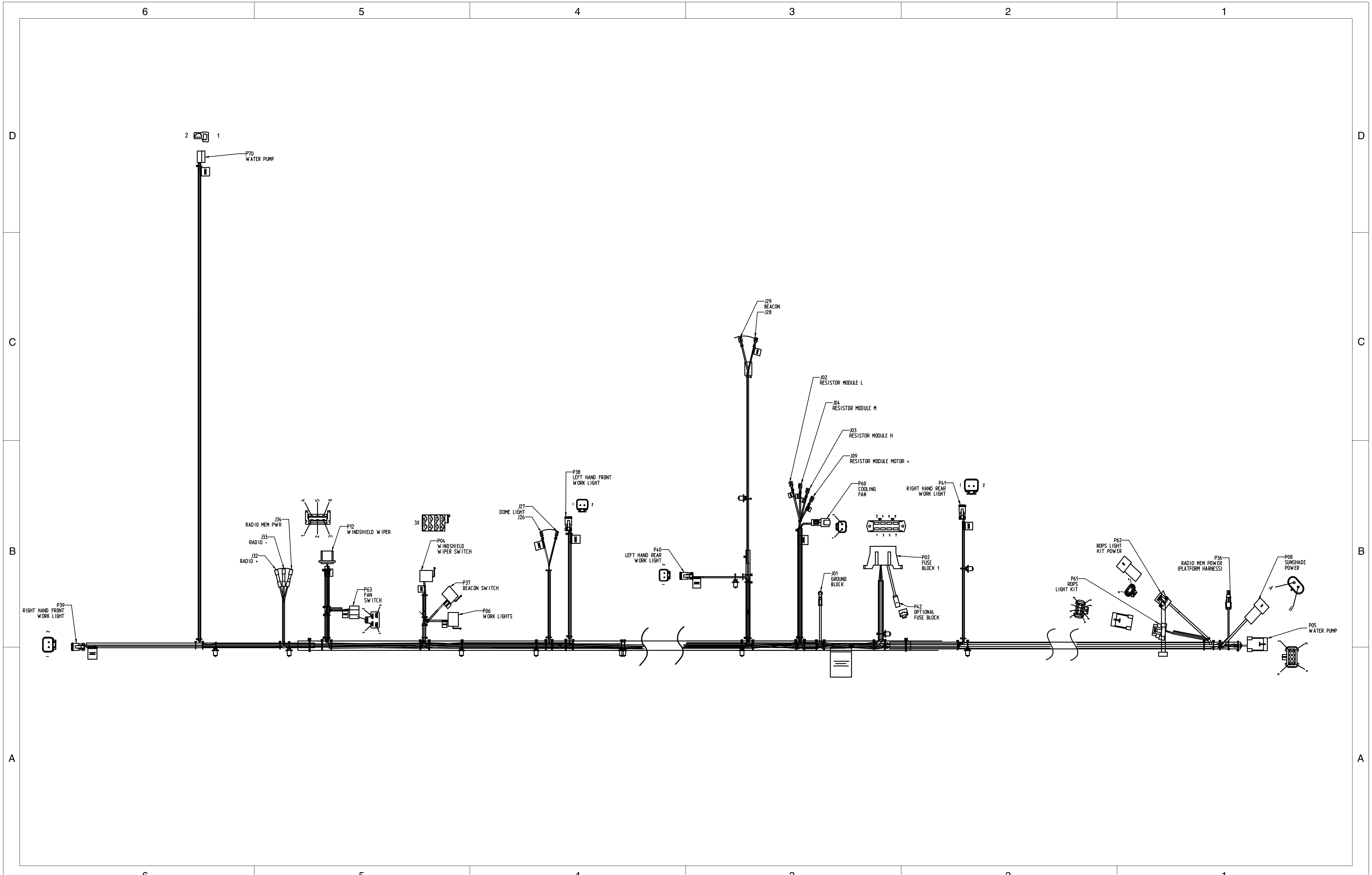

P09
WATER TEMP
SENSOR
P17
ENGINE RPM
SENSOR
P13
RACK ACTUATOR
RELAY
P14
MAIN RELAY
LEFT VIEW
J05
AIR HEATER
J03
ENGINE GND
P10
RACK
ACTUATOR
P22
START RELAY
P12
AIR HEATER
RELAY
J06
START
SIGNAL
P25
1.6K OHM
RESISTOR
P20
DIODE
P26
SUMITOMO
ALTERNATOR
P19
FUSIBLE
LINK
J07
OIL PRESSURE
SWITCH
P18
TO MAIN OR
PLATFORM HARNESS
P16
CSD COIL
BRAIDING
P23
ENGINE CONTROLLER
P03
YANMAR
CAN CHECKER
CV

g311126

Engine Wire Harness Drawing - Groundsmaster 4500–D/4700–D (Models 30893, 30893TE, 30899 and 30899TE)

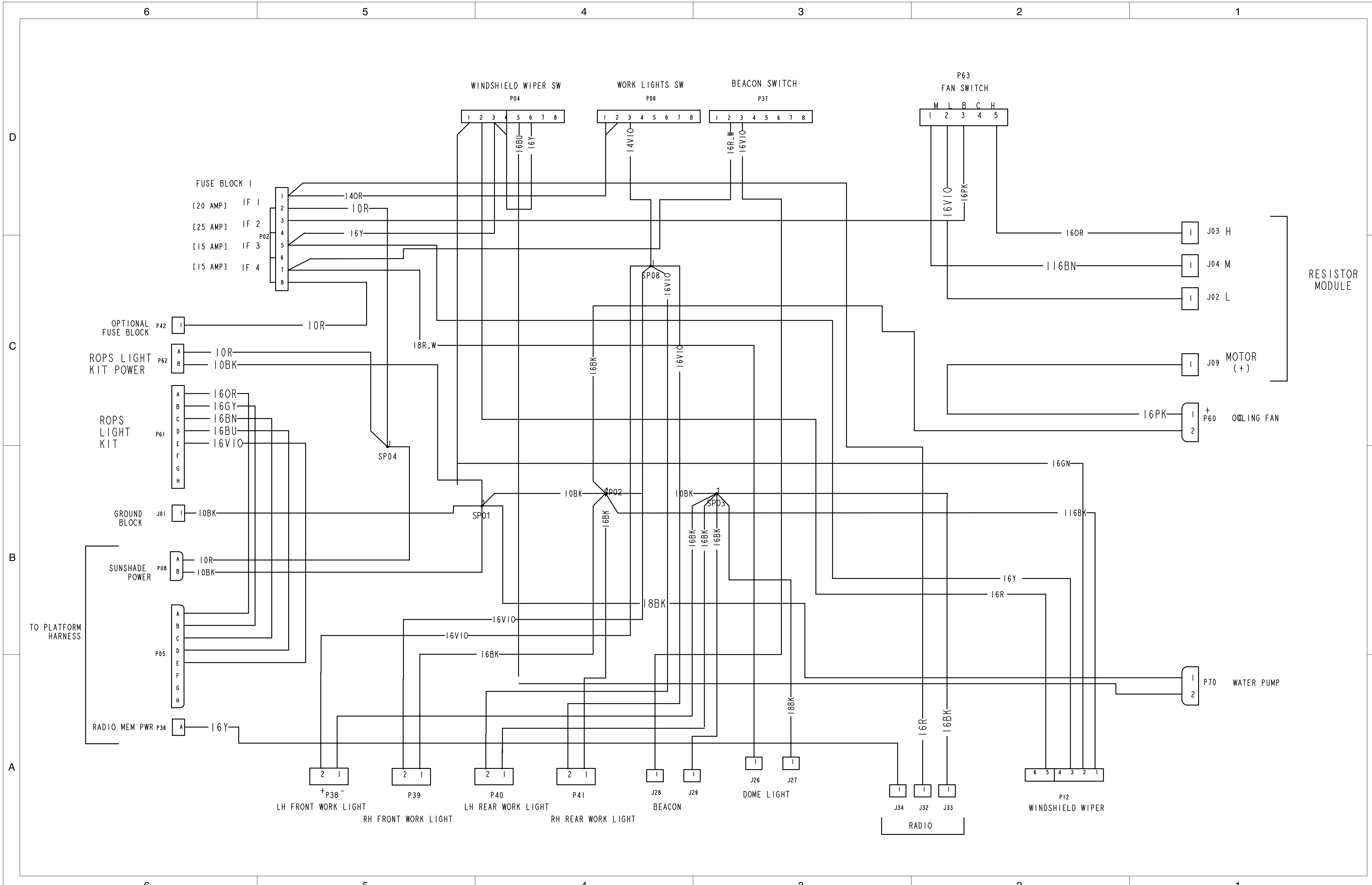


g311127


P70
WATER PUMP
J34
RADIO MEM PWR
J33
RADIO -
J32
RADIO +
P12
WINDSHIELD WIPER
P04
WINDSHIELD
WIPER SWITCH
P63
FAN
SWITCH
P37
BEACON SWITCH
P06
WORK LIGHTS
J27
DOME LIGHT
J26
P38
LEFT HAND FRONT
WORK LIGHT
P40
LEFT HAND REAR
WORK LIGHT
J29
BEACON
J28
J02
RESISTOR MODULE L
J04
RESISTOR MODULE M
J03
RESISTOR MODULE H
J09
RESISTOR MODULE MOTOR +
P60
COOLING
FAN
J01
GROUND
BLOCK
P02
FUSE
BLOCK 1
P42
OPTIONAL
FUSE BLOCK
P41
RIGHT HAND REAR
WORK LIGHT
P62
ROPS LIGHT
KIT POWER
P61
ROPS
LIGHT KIT
P36
RADIO MEM POWER
(PLATFORM HARNESS)
P08
SUNSHADE
POWER
P05
WATER PUMP
P39
RIGHT HAND FRONT
WORK LIGHT

g277230

Wire Harness Diagram - Two–Post ROPS Extension



g277231

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