



**Count on it.**

Form No. 14205SL Rev H

**Service Manual**

**Groundsmaster® 4500-D/4700-D**  
**(Models 30873, 30874, 30881 and 30882)**

## Revision History

[illegible]

© THE TORO COMPANY 2021

This document and all information contained herein is the sole property of The Toro Company (and/or its affiliated companies). No intellectual property rights are granted by the delivery of this document or the disclosure of its content. This document shall not be reproduced by a third party without the express written consent of The Toro Company (and/or the appropriate affiliated company).

# 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](mailto:servicemanuals@toro.com)

or Mail to:

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

# NOTES

---





# Service Manual

(Models 30873, 30874, 30881 and 30882)

## Groundsmaster<sup>®</sup> 4500-D/4700-D

### 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 30873 and 30881) and 4700-D (Models 30874 and 30882).

REFER TO THE TRACTION UNIT AND CUTTING UNIT OPERATOR'S MANUALS FOR OPERATING, MAINTENANCE AND ADJUSTMENT INSTRUCTIONS. For reference, insert a copy of the Operator's Manuals and Parts Catalog for your machine into Chapter 2 of this service manual. Additional copies of the Operator's Manuals and Parts Catalog are available on the internet at [www.Toro.com](http://www.Toro.com).

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



**This safety symbol means DANGER, WARNING or CAUTION, PERSONAL SAFETY INSTRUCTION. When you see this symbol, carefully read the instructions that follow. Failure to obey the instructions may result in personal injury.**

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

**IMPORTANT:** The **IMPORTANT** notice will give important instructions which must be followed to prevent damage to systems or components on the machine.

Groundsmaster 4700-D



Groundsmaster 4500-D



This page is intentionally blank.

# Table Of Contents

## Chapter 1 - Safety

General Safety Instructions	1 - 2
Jacking Instructions	1 - 5
Safety and Instruction Decals	1 - 6

## Chapter 2 - Product Records and Maintenance

Product Records	2 - 1
Maintenance	2 - 1
Equivalents and Conversions	2 - 2
Torque Specifications	2 - 3

## Chapter 3 - Yanmar Diesel Engine

Specifications	3 - 2
General Information	3 - 4
Service and Repairs	3 - 12
YANMAR TNV (Tier 4i) SERIES SERVICE MANUAL	
YANMAR TNV (Tier 4i) SERIES TROUBLE- SHOOTING MANUAL	
YANMAR TNV (Tier 4) SERIES SERVICE MANUAL	
YANMAR TNV (Tier 4) SERIES TROUBLESHOOTING MANUAL	

## Chapter 4 - Hydraulic System

Specifications	4 - 2
General Information	4 - 3
Hydraulic Schematics	4 - 10
Hydraulic Flow Diagrams	4 - 12
Special Tools	4 - 32
Troubleshooting	4 - 37
Testing	4 - 44
Adjustments	4 - 72
Service and Repairs	4 - 73
DANFOSS H1 CLOSED CIRCUIT AXIAL PISTON PUMPS SERVICE MANUAL	
DANFOSS H1 CLOSED CIRCUIT AXIAL PISTON PUMPS REPAIR INSTRUCTIONS	
DANFOSS K and L FRAME VARIABLE MOTORS SERVICE MANUAL	
DANFOSS STEERING UNIT TYPE OSPM SERVICE MANUAL	

## Chapter 5 - Electrical System

General Information	5 - 2
Special Tools	5 - 6
InfoCenter Display	5 - 8
Troubleshooting	5 - 15
Electrical System Quick Checks	5 - 23
Adjustments	5 - 24
Component Testing	5 - 27
Service and Repairs	5 - 50

## Chapter 6 - Axles, Planetaries and Brakes

Specifications	6 - 2
General Information	6 - 3
Adjustments	6 - 4
Service and Repairs	6 - 6

## Chapter 7 - Chassis

General Information	7 - 2
Service and Repairs	7 - 4

## Chapter 8 - Cutting Decks

Specifications	8 - 2
General Information	8 - 3
Troubleshooting	8 - 4
Special Tools	8 - 5
Adjustments	8 - 6
Service and Repairs	8 - 8

## Chapter 9 - Foldout Drawings

Electrical Drawing Designations	9 - 2
Hydraulic Schematics	9 - 3
Electrical Schematics	9 - 7
Wire Harness Drawings	9 - 19

Safety

Product Records  
and Maintenance

Yanmar  
Diesel Engine

Hydraulic  
System

Electrical  
System

Axles, Planetaries  
and Brakes

Chassis

Cutting Decks

Foldout  
Drawings

This page is intentionally blank.



# Chapter 1

## Safety

### Table of Contents

GENERAL SAFETY INSTRUCTIONS .....	2
Before Operating .....	2
While Operating .....	3
Maintenance and Service .....	4
JACKING INSTRUCTIONS .....	5
SAFETY AND INSTRUCTION DECALS .....	6

# General Safety Instructions

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



## WARNING

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

---

### Before Operating

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

## While Operating

1. Sit on the seat when starting and operating the machine.
2. Before starting the engine:
  - A. Engage the parking brake.
  - B. Make sure traction pedal is in neutral and the PTO switch is OFF (disengaged).
  - C. 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 the piston (traction) pump that needs to be corrected before using the machine.
3. Do not run engine in a confined area without adequate ventilation. Exhaust fumes are hazardous and could possibly be deadly.
4. Do not touch engine, exhaust system components or radiator while engine is running or soon after it is stopped. These areas could be hot enough to cause burns.
5. Before getting off the seat:
  - A. Ensure that traction pedal is in neutral.
  - B. Fully lower and disengage cutting decks. Wait for deck blades to stop.
  - C. Engage parking brake.
  - D. Stop engine and remove key from switch.
6. Toro recommends that anytime the machine is parked (short or long term), the cutting decks should be lowered to the ground. This relieves pressure from the lift circuit and eliminates the risk of cutting decks accidentally lowering to the ground.
7. Do not park on slopes unless wheels are chocked or blocked.

---

## Maintenance and Service

1. The Traction Unit and Cutting Deck Operator's Manuals 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 cutting decks, stop engine, set parking brake and remove key from the ignition switch.
3. Make sure machine is in safe operating condition by keeping all nuts, bolts and screws tight.
4. Never store the machine or fuel container inside where there is an open flame, such as near a water heater or furnace.
5. Make sure all hydraulic line connectors are tight and all hydraulic hoses and lines are in good condition before applying pressure to the hydraulic system.
6. Keep body and hands away from pin hole leaks in hydraulic lines that eject high pressure hydraulic fluid. Use cardboard or paper to find hydraulic leaks. Hydraulic fluid escaping under pressure can penetrate skin and cause injury. Fluid accidentally injected into the skin must be surgically removed within a few hours by a doctor familiar with this form of injury or gangrene may result.
7. Before disconnecting or performing any work on the hydraulic system, all pressure in system must be relieved by stopping engine and lowering cutting decks to the ground.
8. If major repairs are ever needed or assistance is desired, contact an Authorized Toro Distributor.
9. To reduce potential fire hazard, keep engine area free of excessive grease, grass, leaves and dirt. Clean protective screen on machine frequently.
10. If engine must be running to perform maintenance or an adjustment, keep hands, feet, clothing and other parts of the body away from cutting decks and other moving parts. Keep bystanders away.
11. To assure safety and accuracy, check that maximum engine speed is correct.
12. Shut engine off before checking or adding oil to the crankcase.
13. Disconnect battery before servicing the machine. Disconnect negative battery cable first and positive cable last. If battery voltage is required for troubleshooting or test procedures, temporarily connect the battery. Reconnect positive battery cable first and negative cable last.
14. Battery acid is poisonous and can cause burns. Avoid contact with skin, eyes and clothing. Protect your face, eyes and clothing when working with a battery.
15. Battery gases can explode. Keep cigarettes, sparks and flames away from the battery.
16. 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 jacks, hoists and jack stands. Make sure machine is parked on a solid level surface such as a concrete floor. Prior to raising the machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use appropriate jack stands to support the raised machine. If the machine is not properly supported by jack stands, the machine may move or fall, which may result in personal injury (see Jacking Instructions in this chapter).
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 the TEC controller(s), disconnect and remove the engine ECU 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 Rear End

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.

### Jacking the Front End

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

**IMPORTANT: 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.

# Safety and Instruction Decals

Numerous safety and instruction decals are affixed to the Groundsmaster 4500-D and 4700-D. If any decal becomes illegible or damaged, install a new decal. Decal part numbers are listed in your Parts Catalog.



# Product Records and Maintenance

## Table of Contents

PRODUCT RECORDS .....	1
MAINTENANCE .....	1
EQUIVALENTS AND CONVERSIONS .....	2
Decimal and Millimeter Equivalents .....	2
U.S. to Metric Conversions .....	2
TORQUE SPECIFICATIONS .....	3
Fastener Identification .....	3
Using a Torque Wrench with an Offset Wrench ..	3
Standard Torque for Dry, Zinc Plated and Steel Fasteners (Inch Series) .....	4
Standard Torque for Dry, Zinc Plated and Steel Fasteners (Metric Fasteners) .....	5
Other Torque Specifications .....	6
Conversion Factors .....	6

## Product Records

Insert Operator's Manuals and Parts Catalog for your Groundsmaster 4500-D or 4700-D at the end of this chapter. Additionally, insert Installation Instructions, Operator's Manuals and Parts Catalogs for any accessories that have been installed on your Groundsmaster at the end of this section.

## Maintenance

Maintenance procedures and recommended service intervals for your Groundsmaster are covered in the Traction Unit and Cutting Deck Operator's Manuals. Refer to those publications when performing regular equipment maintenance. Several maintenance procedures have break-in intervals identified in the Operator's Manuals. Refer to the Engine Operator's Manual for additional engine specific maintenance procedures.

# Equivalents and Conversions

## Decimal and Millimeter Equivalents

Fractions		Decimals	mm	Fractions		Decimals	mm
	1/64	0.015625	— 0.397		33/64	0.515625	— 13.097
	1/32	0.03125	— 0.794		17/32	0.53125	— 13.494
	3/64	0.046875	— 1.191		35/64	0.546875	— 13.891
1/16		0.0625	— 1.588	9/16		0.5625	— 14.288
	5/64	0.078125	— 1.984		37/64	0.578125	— 14.684
	3/32	0.09375	— 2.381		19/32	0.59375	— 15.081
	7/64	0.109275	— 2.778		39/64	0.609375	— 15.478
1/8		0.1250	— 3.175	5/8		0.6250	— 15.875
	9/64	0.140625	— 3.572		41/64	0.640625	— 16.272
	5/32	0.15625	— 3.969		21/32	0.65625	— 16.669
	11/64	0.171875	— 4.366		43/64	0.671875	— 17.066
3/16		0.1875	— 4.762	11/16		0.6875	— 17.462
	13/64	0.203125	— 5.159		45/64	0.703125	— 17.859
	7/32	0.21875	— 5.556		23/32	0.71875	— 18.256
	15/64	0.234375	— 5.953		47/64	0.734375	— 18.653
1/4		0.2500	— 6.350	3/4		0.7500	— 19.050
	17/64	0.265625	— 6.747		49/64	0.765625	— 19.447
	9/32	0.28125	— 7.144		25/32	0.78125	— 19.844
	19/64	0.296875	— 7.541		51/64	0.796875	— 20.241
5/16		0.3125	— 7.938	13/16		0.8125	— 20.638
	21/64	0.328125	— 8.334		53/64	0.828125	— 21.034
	11/32	0.34375	— 8.731		27/32	0.84375	— 21.431
	23/64	0.359375	— 9.128		55/64	0.859375	— 21.828
3/8		0.3750	— 9.525	7/8		0.8750	— 22.225
	25/64	0.390625	— 9.922		57/64	0.890625	— 22.622
	13/32	0.40625	— 10.319		29/32	0.90625	— 23.019
	27/64	0.421875	— 10.716		59/64	0.921875	— 23.416
7/16		0.4375	— 11.112	15/16		0.9375	— 23.812
	29/64	0.453125	— 11.509		61/64	0.953125	— 24.209
	15/32	0.46875	— 11.906		31/32	0.96875	— 24.606
	31/64	0.484375	— 12.303		63/64	0.984375	— 25.003
1/2		0.5000	— 12.700	1		1.000	— 25.400
1 mm = 0.03937 in.				0.001 in. = 0.0254 mm			

## U.S.to Metric Conversions

	To Convert	Into	Multiply By
<b>Linear Measurement</b>	Miles	Kilometers	1.609
	Yards	Meters	0.9144
	Feet	Meters	0.3048
	Feet	Centimeters	30.48
	Inches	Meters	0.0254
	Inches	Centimeters	2.54
	Inches	Millimeters	25.4
<b>Area</b>	Square Miles	Square Kilometers	2.59
	Square Feet	Square Meters	0.0929
	Square Inches	Square Centimeters	6.452
	Acre	Hectare	0.4047
<b>Volume</b>	Cubic Yards	Cubic Meters	0.7646
	Cubic Feet	Cubic Meters	0.02832
	Cubic Inches	Cubic Centimeters	16.39
<b>Weight</b>	Tons (Short)	Metric Tons	0.9078
	Pounds	Kilograms	0.4536
	Ounces (Avdp.)	Grams	28.3495
<b>Pressure</b>	Pounds/Sq. In.	Kilopascal	6.895
	Pounds/Sq. In.	Bar	0.069
<b>Work</b>	Foot-pounds	Newton-Meters	1.356
	Foot-pounds	Kilogram-Meters	0.1383
	Inch-pounds	Kilogram-Centimeters	1.152144
<b>Liquid Volume</b>	Quarts	Liters	0.9463
	Gallons	Liters	3.785
<b>Liquid Flow</b>	Gallons/Minute	Liters/Minute	3.785
<b>Temperature</b>	Fahrenheit	Celsius	1. Subtract 32°
			2. Multiply by 5/9

# Torque Specifications

Recommended fastener torque values are listed in the following tables. For critical applications, as determined by Toro, either the recommended torque or a torque that is unique to the application is clearly identified and specified in this Service Manual.

These Torque Specifications for the installation and tightening of fasteners shall apply to all fasteners which do not have a specific requirement identified in this Service Manual. The following factors shall be considered when applying torque: cleanliness of the fastener, use of a thread sealant (e.g. Loctite), degree of lubrication on the fastener, presence of a prevailing torque feature (e.g. Nylock nut), hardness of the surface underneath the fastener's head or similar condition which affects the installation.

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

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

## Fastener Identification

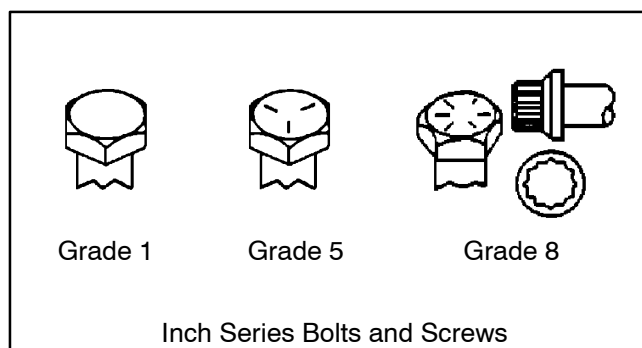


Figure 1

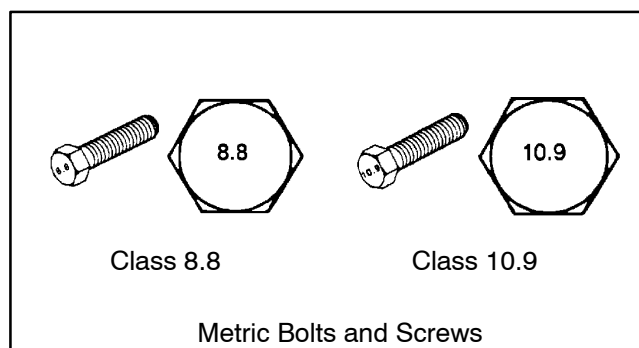


Figure 2

## Using a Torque Wrench with an Offset Wrench

Use of an offset wrench (e.g. crowfoot wrench) will affect torque wrench calibration due to the effective change of torque wrench length. When using a torque wrench with an offset wrench, multiply the listed torque recommendation by the calculated torque conversion factor (Fig. 3) to determine proper tightening torque. Tightening torque when using a torque wrench with an offset wrench will be lower than the listed torque recommendation.

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

The measured effective length of the torque wrench with the offset wrench installed (distance from the center of the handle to the center of the offset wrench) is 19".

The calculated torque conversion factor for this torque wrench with this offset wrench would be  $18 / 19 = 0.947$ .

If the listed torque recommendation for a fastener is from 76 to 94 ft-lb, the proper torque when using this torque wrench with an offset wrench would be from 72 to 89 ft-lb.

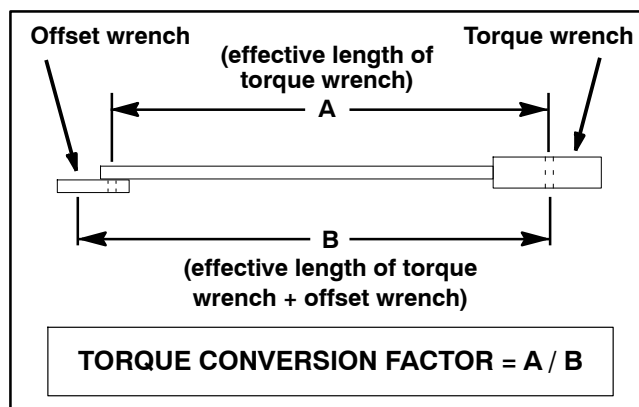


Figure 3

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

Thread Size	Grade 1, 5 & 8 with Thin Height Nuts	SAE Grade 1 Bolts, Screws, Studs & Sems with Regular Height Nuts (SAE J995 Grade 2 or Stronger Nuts)		SAE Grade 5 Bolts, Screws, Studs & Sems with Regular Height Nuts (SAE J995 Grade 2 or Stronger Nuts)		SAE Grade 8 Bolts, Screws, Studs & Sems with Regular Height Nuts (SAE J995 Grade 5 or Stronger Nuts)	
	in-lb	in-lb	N-cm	in-lb	N-cm	in-lb	N-cm
# 6 - 32 UNC	10 ± 2	13 ± 2	147 ± 23	15 ± 2	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 ± 30	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	1446 ± 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 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 thread sealant such as Loctite.

**NOTE:** Torque values may have to be reduced when installing fasteners into threaded aluminum or brass. The specific torque value should be determined based on the fastener size, the aluminum or base material strength, length of thread engagement, etc.

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

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

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 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 thread sealant such as Loctite.

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

**NOTE:** Torque values may have to be reduced when installing fasteners into threaded aluminum or brass. The specific torque value should be determined based on the fastener size, the aluminum or base material strength, length of thread engagement, etc.

## Other Torque Specifications

### SAE Grade 8 Steel Set Screws

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

### Wheel Bolts and Lug Nuts

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

\*\* For steel wheels and non-lubricated fasteners.

### Thread Cutting Screws (Zinc Plated Steel)

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

### Thread Cutting Screws (Zinc Plated Steel)

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

\* Hole size, material strength, material thickness and finish must be considered when determining specific torque values. All torque values are based on non-lubricated fasteners.

## Conversion Factors

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

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

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

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





# Yanmar Diesel Engine

## Table of Contents

SPECIFICATIONS .....	2
Models 30873 and 30874 .....	2
Models 30881 and 30882 .....	3
GENERAL INFORMATION .....	4
Operator's Manuals .....	4
Yanmar Service and Troubleshooting Manuals ..	4
Stopping the Engine .....	4
Engine Electronic Control Unit (ECU) .....	5
Yanmar Engine: Models 30873 and 30874 .....	6
Yanmar Engine: Models 30881 and 30882 .....	7
Diesel Particulate Filter (DPF) .....	7
SERVICE AND REPAIRS .....	12
Air Cleaner System .....	12
Fuel System .....	14
Check Fuel Lines and Connections .....	15
Drain and Clean Fuel Tank .....	15
Priming the Fuel System .....	15
Fuel Tank Removal .....	15
Fuel Tank Installation .....	15
Radiator and Oil Cooler Assembly .....	16
Engine .....	20
Engine Removal .....	21
Engine Installation .....	22
Pump Adapter Plate .....	24
Exhaust System (Models 30881 and 30882) ...	26
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	

# Specifications (Models 30873 and 30874)

Item	Description
Make / Designation	Yanmar Model 4TNV84T-ZMTR: 4-Cycle, 4 Cylinder, Water Cooled, Turbocharged, Tier 4i Diesel Engine
Bore	3.307 in (84 mm)
Stroke	3.543 in (90 mm)
Total Displacement	121.7 in <sup>3</sup> (1995 cc)
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 Capacity	22 U.S. gallons (83 liters)
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	6 U.S. quarts (5.7 liters) with Filter
Oil Pump	Trochoid Type
Coolant Capacity	9 U.S. quarts (8.5 liters)
Alternator/Regulator	12 VDC, 80 amp
Engine Weight (Dry)	420 U.S. pounds (191 kg)

# Specifications (Models 30881 and 30882)

Item	Description
Make / Designation	Yanmar Model 4TNV86CT-DTR: 4-Cycle, 4 Cylinder, Water Cooled, Turbocharged, Tier 4 Diesel Engine
Bore	3.386 in (86 mm)
Stroke	3.543 in (90 mm)
Total Displacement	127.5 in <sup>3</sup> (2090 cc)
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 Capacity	22 U.S. gallons (83 liters)
Fuel Pump	Yanmar Supply Pump
Fuel Injection Type	Common Rail with Direct Injection
Governor	Electronic All Speed
Low Idle (no load)	1200 RPM
High Idle (no load)	2700 RPM
Engine Oil	API CJ-4 or higher
Engine Oil Viscosity	See Operator's Manual
Crankcase Oil Capacity	6 U.S. quarts (5.7 liters) with Filter
Oil Pump	Trochoid Type
Coolant Capacity	9 U.S. quarts (8.5 liters)
Alternator/Regulator	12 VDC, 80 amp
Engine Weight (Dry)	496 U.S. pounds (225 kg)

**NOTE:** Groundsmaster 4500-D (Model 30881) and 4700-D (Model 30882) machines with serial numbers below 314000000 are equipped with a 40 amp alternator.

# 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 Traction Unit Operator's Manual. Information on engine troubleshooting, testing, disassembly and assembly is identified in the Yanmar Workshop Manual.

Most repairs and adjustments require tools which are commonly available in many service shops. Special

tools are described in the Yanmar Workshop Manual. The use of some specialized test equipment is explained. However, the cost of the test equipment and the specialized nature of some repairs may dictate that the work be done at an engine repair facility.

Service and repair parts for 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 Manuals

The Traction Unit and Yanmar Engine Operator's Manuals 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.

---

## Yanmar Service and Troubleshooting Manuals

The engine that powers your Groundsmaster machine is either a Yanmar model 4TNV84T–Z (used on Groundsmaster models 30873 and 30874) (Tier 4i) or a Yanmar model 4TNV86CT (used on Groundsmaster models 30881 and 30882) (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:** Before stopping the engine after mowing or full load operation, cool the turbo-charger by allowing the engine to run at low idle speed for five (5) minutes. Failure to do so may lead to turbo-charger trouble.

## Engine Electronic Control Unit (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 ECU before the machine ignition switch is moved from the OFF position to either the ON or START position.

The engine electrical components (e.g. 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 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 a 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.

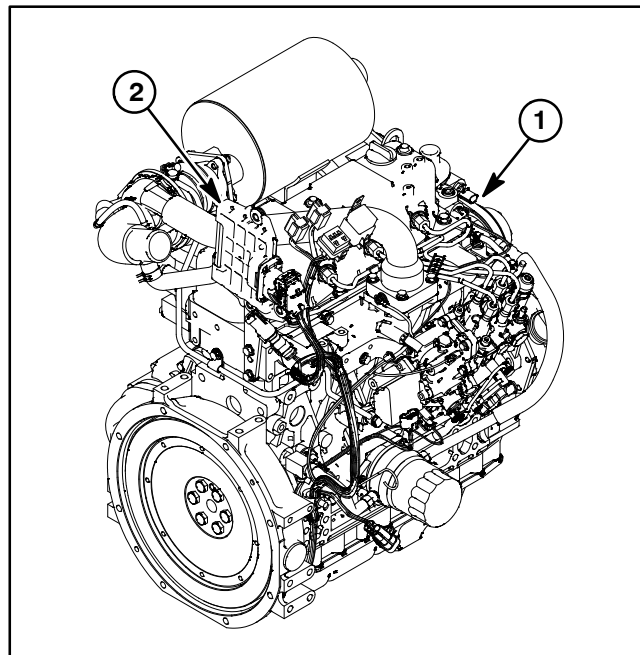


Figure 1

1. Engine (models 30873 and 30874)
2. Engine ECU

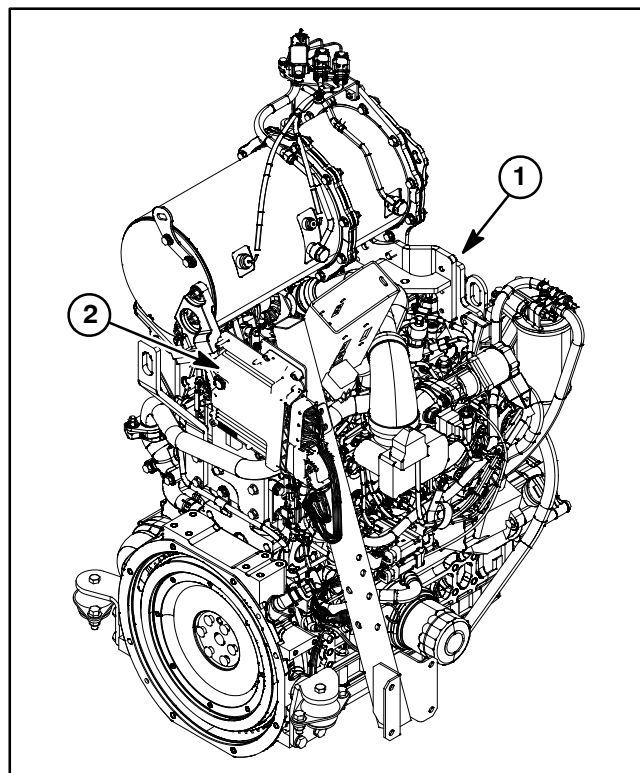


Figure 2

1. Engine (models 30881 and 30882)
2. Engine ECU

---

## Yanmar Engine: Models 30873 and 30874

The engine used on Groundsmaster models 30873 and 30874 is a Yanmar TNV Series, turbocharged, diesel engine that complies with EPA interim Tier 4 emission regulations. 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.

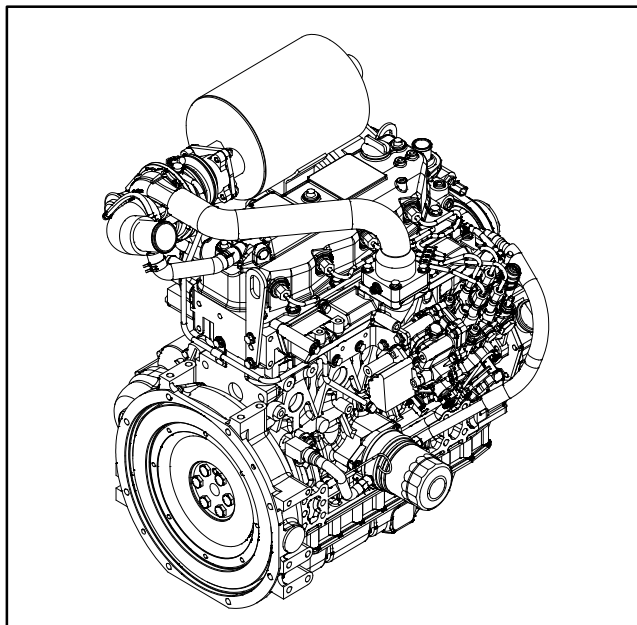


Figure 3

---

## Yanmar Engine: Models 30881 and 30882

The engine used on Groundsmaster models 30881 and 30882 is a Yanmar TNV Series, turbocharged, diesel engine that complies with EPA Tier 4 emission regulations. Engine features include an electronic control unit (ECU) that controls a common rail fuel injection system with direct injection, water-cooled exhaust gas recirculation (EGR), an electronic governor, 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.

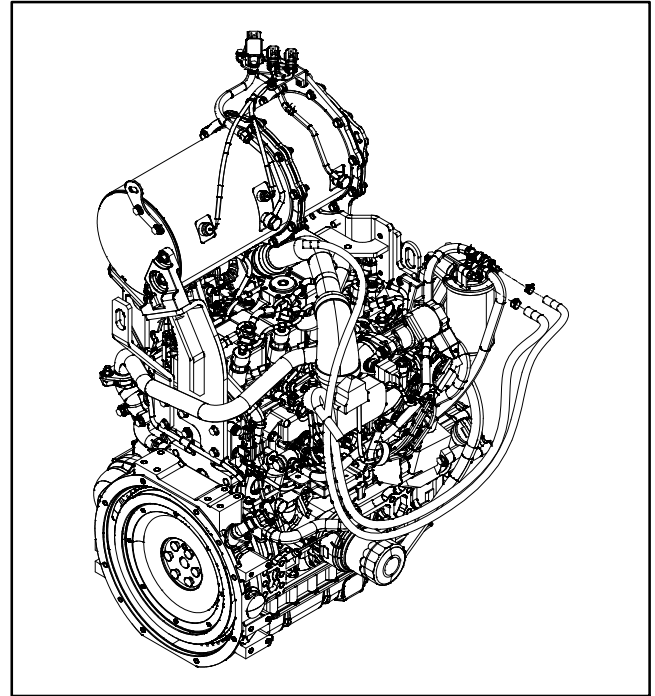


Figure 4

Yanmar  
Diesel Engine

---

### Diesel Particulate Filter (DPF)

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

#### Regeneration



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

**Note:** The user interface and InfoCenter displays for DPF regeneration changed with machine software 120–6373N. Use the InfoCenter About screen to verify the software installed on the machine.

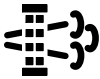

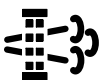
– For machines with software 120–6373A thru M: Complete DPF regeneration instructions can be found in the updated traction unit Operator's Manual for the specific machine. Visit [www.toro.com](http://www.toro.com) to download the updated traction unit Operator's Manual for the machine.

– For machines with software 120–6373N and up: Complete DPF regeneration instructions can be found in the traction unit Operator's Manual. Visit [www.toro.com](http://www.toro.com) to download the traction unit Operator's Manual with the correct DPF regeneration instructions for the machine.

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

Type	Conditions	Description
Passive	Occurs during normal operation of the machine at high engine speed or high engine load.	The DPF processes high heat exhaust gasses, oxidizing harmful emissions and incinerating soot to ash. The InfoCenter does not display an icon during passive regeneration.
Assist	Occurs because of prolonged operation at low engine speed, low engine load, or when the engine ECU detects the soot filter is becoming obstructed.	The engine ECU adjusts the exhaust intake throttle to raise the exhaust temperature.  <b>For software 120–6373A thru M only:</b> the InfoCenter displays the assist regeneration icon.
Reset	Occurs every 100 hours of engine operation.  Occurs after an assist regeneration if the engine ECU determines the assist regeneration did not sufficiently reduce the soot level.  <b>Note:</b> Reset regeneration may be temporarily delayed if high exhaust temperatures would create an unsafe condition (the machine is operating indoors or outdoors around trees, brush, tall grass, or other temperature-sensitive plants or materials). Refer to Setting the Inhibit Regen in the traction unit Operators Manual for additional information.	The engine ECU adjusts the exhaust intake throttle and the injector timing to raise the exhaust temperature.  <b>For all software revisions:</b> the InfoCenter displays the high exhaust temperature icon.

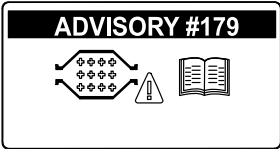
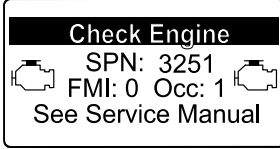


Type	Conditions	Description
Parked	<p>Occurs when exhaust back pressure in the DPF increases due to continued soot buildup. May be caused by prolonged operation at low engine speed, low engine load, or the use of incorrect fuel or engine oil.</p> <p>May occur if the InfoCenter is set to inhibit regen (preventing a Reset Regeneration) and machine operation is continued.</p> <p>Can be initiated when prompted by the engine ECU or after a minimum of 50 hours of engine operation.</p> <p><b>For software 120–6373N and up:</b> if a parked regeneration is ignored, the machine mow function (PTO) will be disabled approximately 2 hours after the first notification.</p>	<p>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.</p> <p>The engine ECU adjusts the exhaust intake throttle to raise the exhaust temperature.</p>  <p><b>For all software revisions:</b> the InfoCenter displays advisory #188 and/or the stationary regeneration icon.</p>
Recovery	<p>Occurs when exhaust back pressure in the DPF increases due to soot buildup reaching a critical level.</p> <p>Can only be initiated when prompted by the engine ECU.</p> <p><b>For software 120–6373N and up:</b> the machine mow function (PTO) will be disabled at first notification.</p>	<p>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.</p> <p>Use the InfoCenter About screen to verify the software installed on the machine.</p> <ul style="list-style-type: none"> <li>• Machines with software 120–6373A thru M: Recovery regeneration must be initiated by an Authorized Toro Distributor service technician using Yanmar SMARTASSIST—Direct</li> <li>• Machines with software 120–6373N and up: Recovery regeneration can be initiated from the machine InfoCenter</li> </ul>  <p><b>For software 120–6373A thru M only:</b> the InfoCenter displays the recovery regeneration icon.</p>  <p><b>For software 120–6373N and up:</b> the InfoCenter displays advisory #190 and/or the stationary regeneration icon.</p> <p><b>Note:</b> Verify the model and serial number of the engine installed in the machine. 4TNV86CT—DTR engines below serial number 03789 cannot run a recovery regeneration without first reprogramming the engine ECU. Contact an Authorized Toro Distributor for assistance.</p>

## Soot Accumulation

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

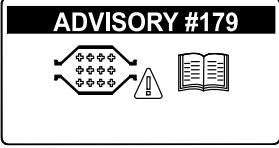
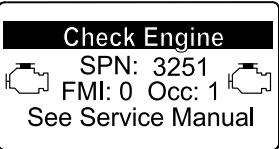
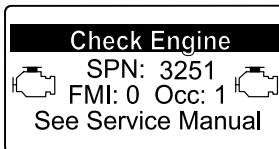
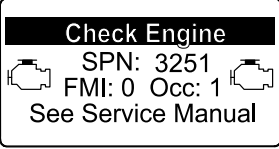
### Soot Accumulation Engine Faults

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

## Ash Accumulation

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

### Ash Accumulation Advisories and Engine Faults

Fault Level	Fault Code	Engine Power Rating	Engine Speed Reduction	Recommended Action
System Advisory (machine software 120–6373A thru M only)	 <b>ADVISORY #179</b>	100%	None	Plan to service the DPF in the future.
Level 1: Engine Warning	 <b>Check Engine</b> SPN: 3251 FMI: 0 Occ: 1 See Service Manual	De-rated to 85%	None	Service DPF
Level 2: Engine Warning	 <b>Check Engine</b> SPN: 3251 FMI: 0 Occ: 1 See Service Manual	De-rated to 50%	None	Service DPF
Level 3: Engine Warning	 <b>Check Engine</b> SPN: 3251 FMI: 0 Occ: 1 See Service Manual	De-rated to 50%	Maximum torque +200 rpm	Service DPF

This page is intentionally left blank.

# Service and Repairs

## Air Cleaner System

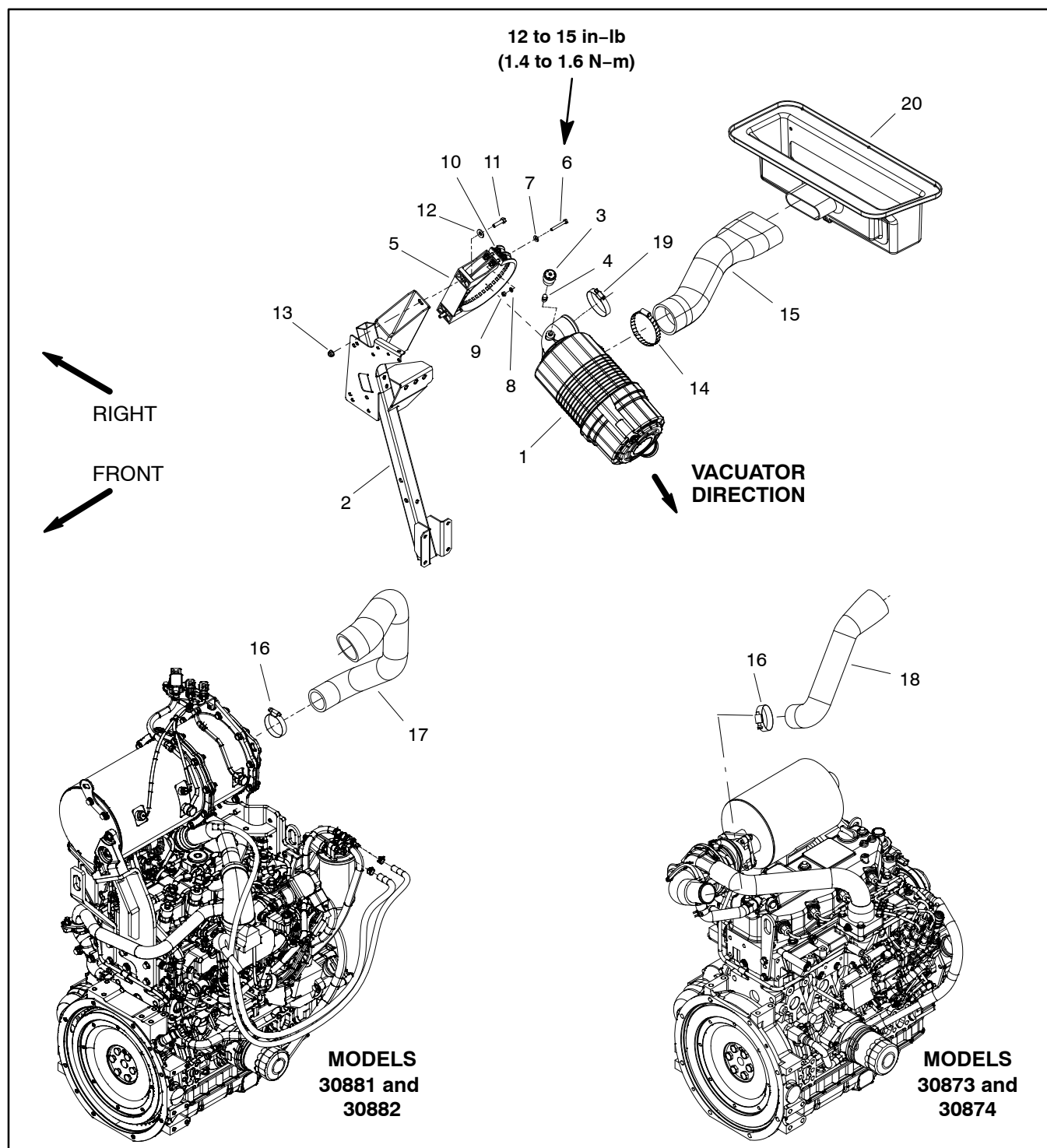


Figure 5

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 (Fig. 5)**

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 5 as a guide.

**Installation (Fig. 5)**

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

1. Assemble air cleaner components using Figure 5 as a guide.

A. If service indicator (item 3 in Figure 5) 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 (Fig. 7). Torque indicator from **12 to 15 in-lb (1.4 to 1.6 N-m)**.

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

C. Make sure that air cleaner outlet hose (item 17 or 18 in Figure 5) 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. Lower and secure hood.

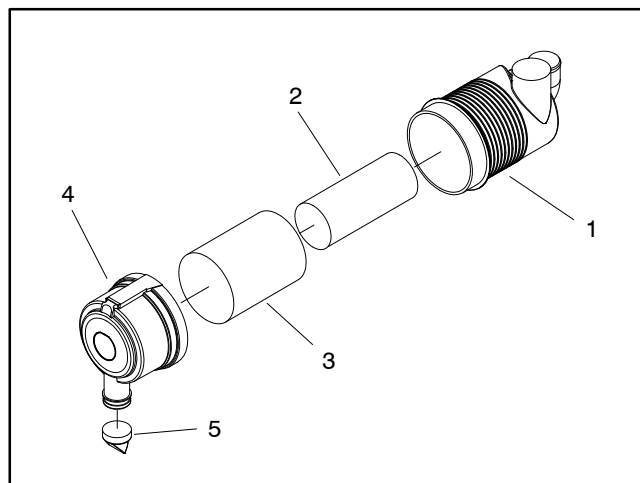


Figure 6

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

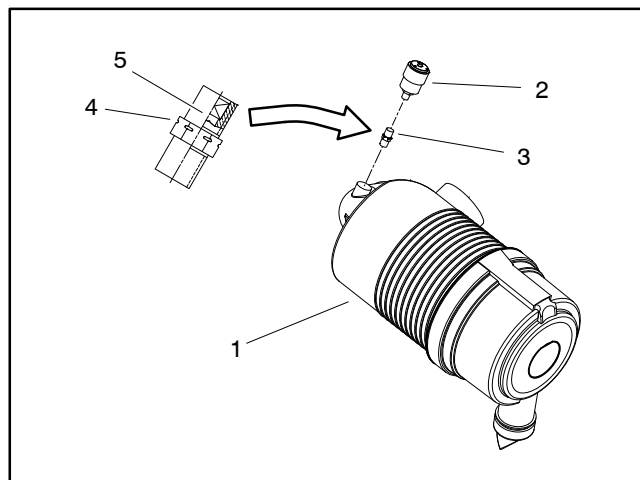


Figure 7

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

## Fuel System

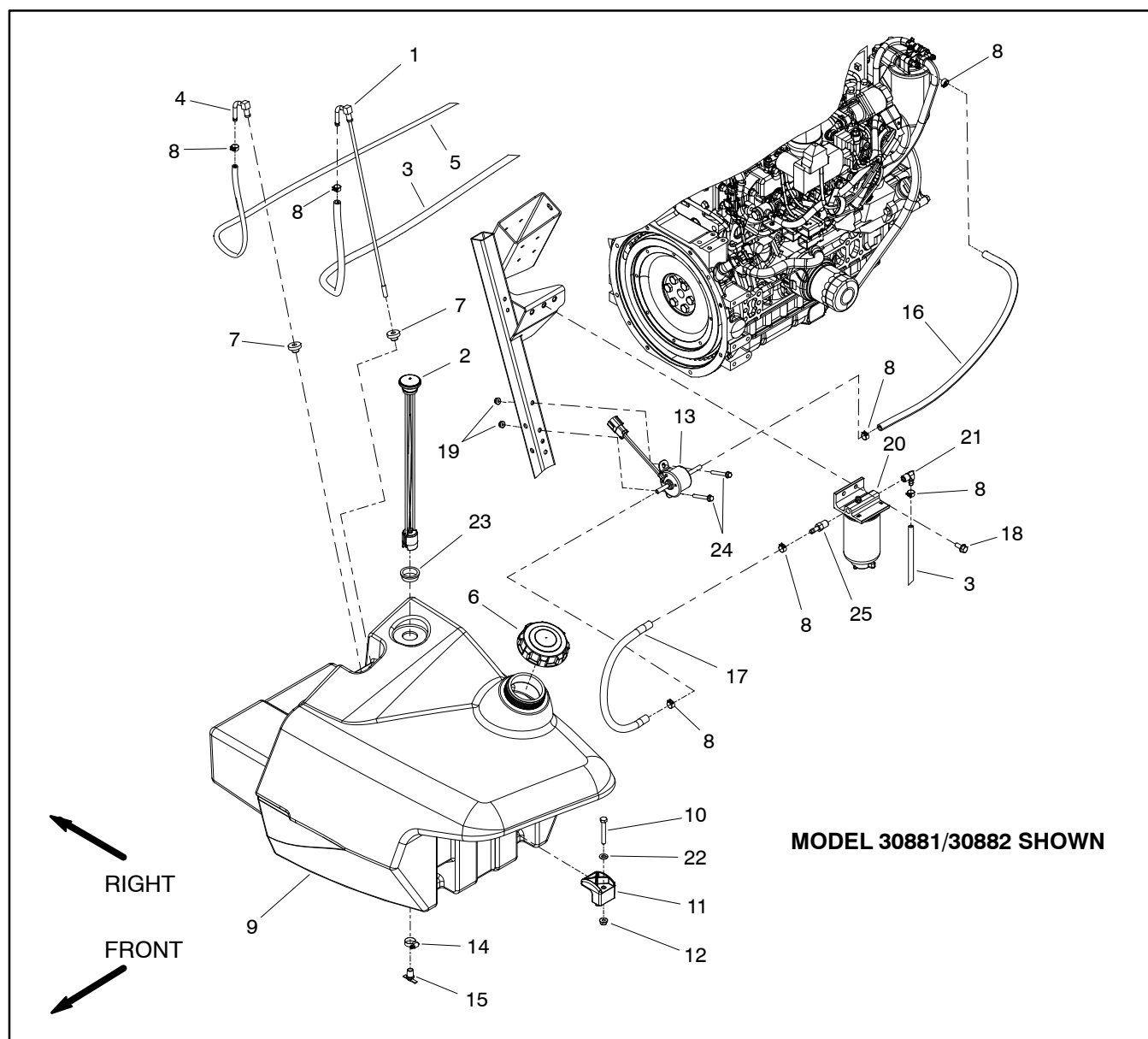


Figure 8

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



## DANGER

**Because diesel fuel is highly flammable, use caution when storing or handling it. Do not smoke while filling the fuel tank. Do not fill fuel tank while engine is running, 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 as recommended in the Traction Unit Operator's Manual. Check lines for deterioration, damage, leaking or loose connections. Replace hoses, clamps and connections as necessary.

### Drain and Clean Fuel Tank

Drain and clean the fuel tank periodically as recommended in the Traction Unit Operator's Manual. Also, drain and clean the fuel tank if the fuel system becomes contaminated or if the machine is to be stored for an extended period. To clean fuel tank, flush tank out with clean diesel fuel. Make sure tank is free of contaminants and debris. Follow all local codes and regulations when recycling or disposing of waste fuel.

### Priming the Fuel System

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

### Fuel Tank Removal (Fig. 8)

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.
4. Remove fuel tank using Figure 8 as a guide.

### Fuel Tank Installation (Fig. 8)

1. Install fuel tank to frame using Figure 8 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.

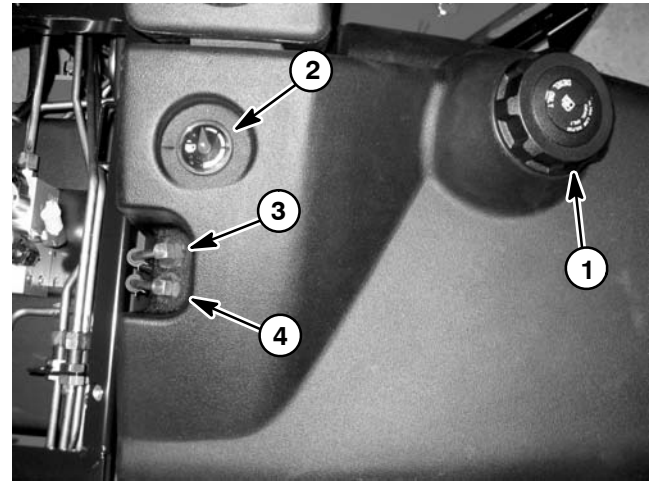


Figure 9

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

## Radiator and Oil Cooler Assembly

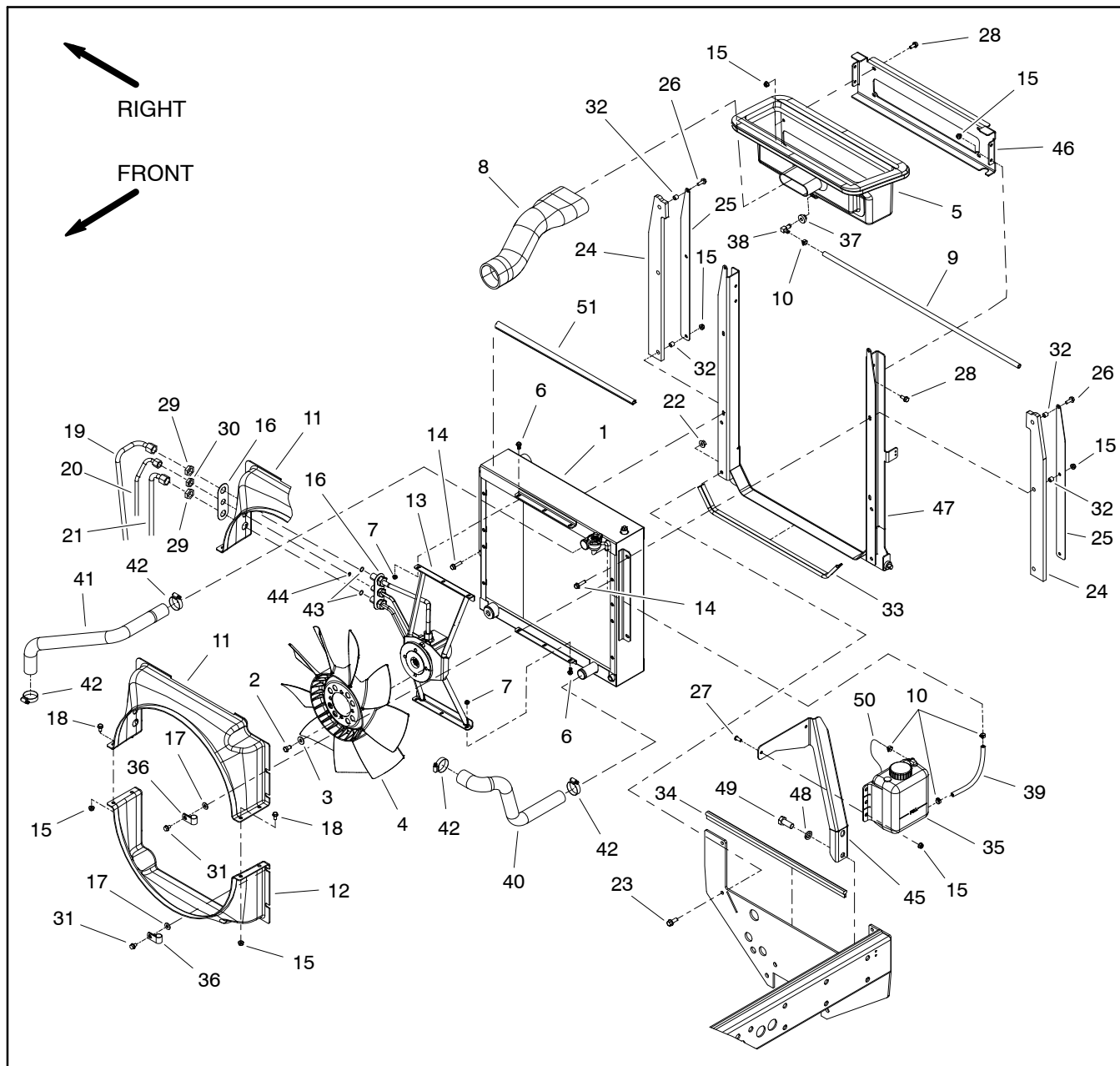


Figure 10

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



## Removal (Fig. 10)

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 Removal in the Service and Repairs section of Chapter 7 – Chassis).



## 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.**

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 in the Service and Repairs section of Chapter 4 – Hydraulic System).

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.

10. Disconnect hydraulic hoses from radiator/oil cooler (Fig. 11). 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.

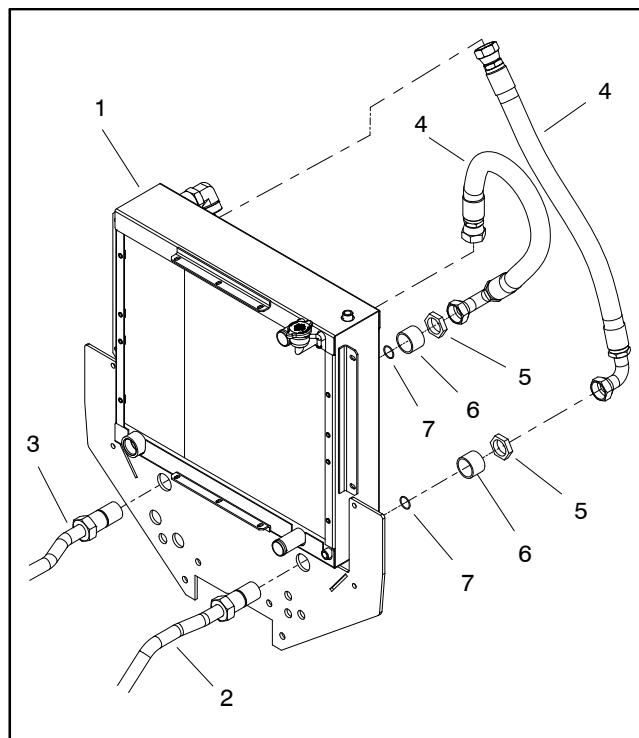


Figure 11

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

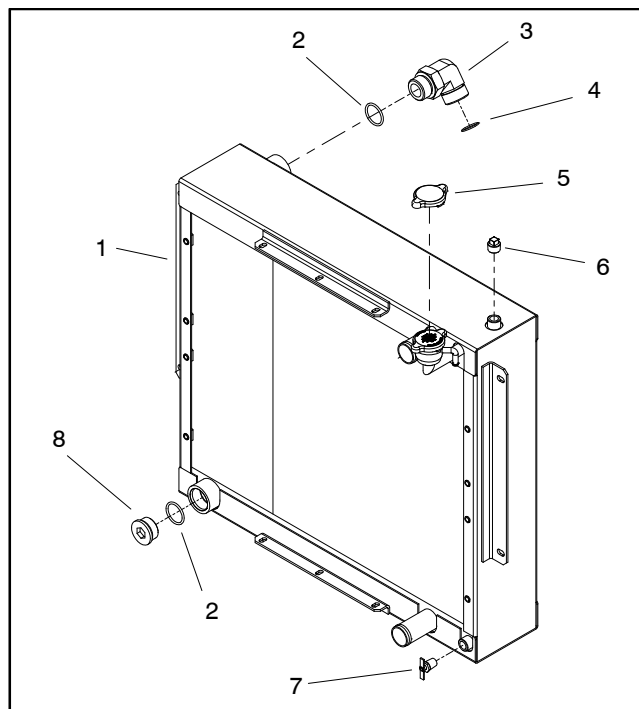


Figure 12

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

13. Plug all radiator/oil cooler and hose openings to prevent contamination.

14. If necessary, remove draincock (item 7 in Fig. 12), plug (item 6 in Fig. 12) and hydraulic plug (item 8 in Fig. 12) from radiator/oil cooler.

15. If hydraulic fittings (item 3 in Fig. 12) are to be removed from oil cooler, mark fitting orientation to allow correct assembly. Remove fittings from cooler and discard O-rings.

### Installation (Fig. 10)

1. If hydraulic fittings (item 3 in Fig. 12) 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 Hydraulic Fitting Installation in the General Information section Chapter 4 – Hydraulic System).

2. If hydraulic plug (item 8 in Fig. 12) was removed from oil cooler, place new O-ring on plug and install into oil cooler port.

3. If draincock (item 7 in Fig. 12) or plug (item 6 in Fig. 12) were removed from radiator, apply thread sealant and install draincock and plug into radiator openings (Fig. 12).

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.

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 in the Service and Repairs section of Chapter 4 – Hydraulic System). Make sure that clearance between shrouds and fan is at least **0.180" (4.6 mm)** 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 Hydraulic Hose and Tube Installation in the General Information section of Chapter 4 – Hydraulic System).

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 Installation in the Service and Repairs section of Chapter 7 – Chassis).

This page is intentionally blank.

# Engine

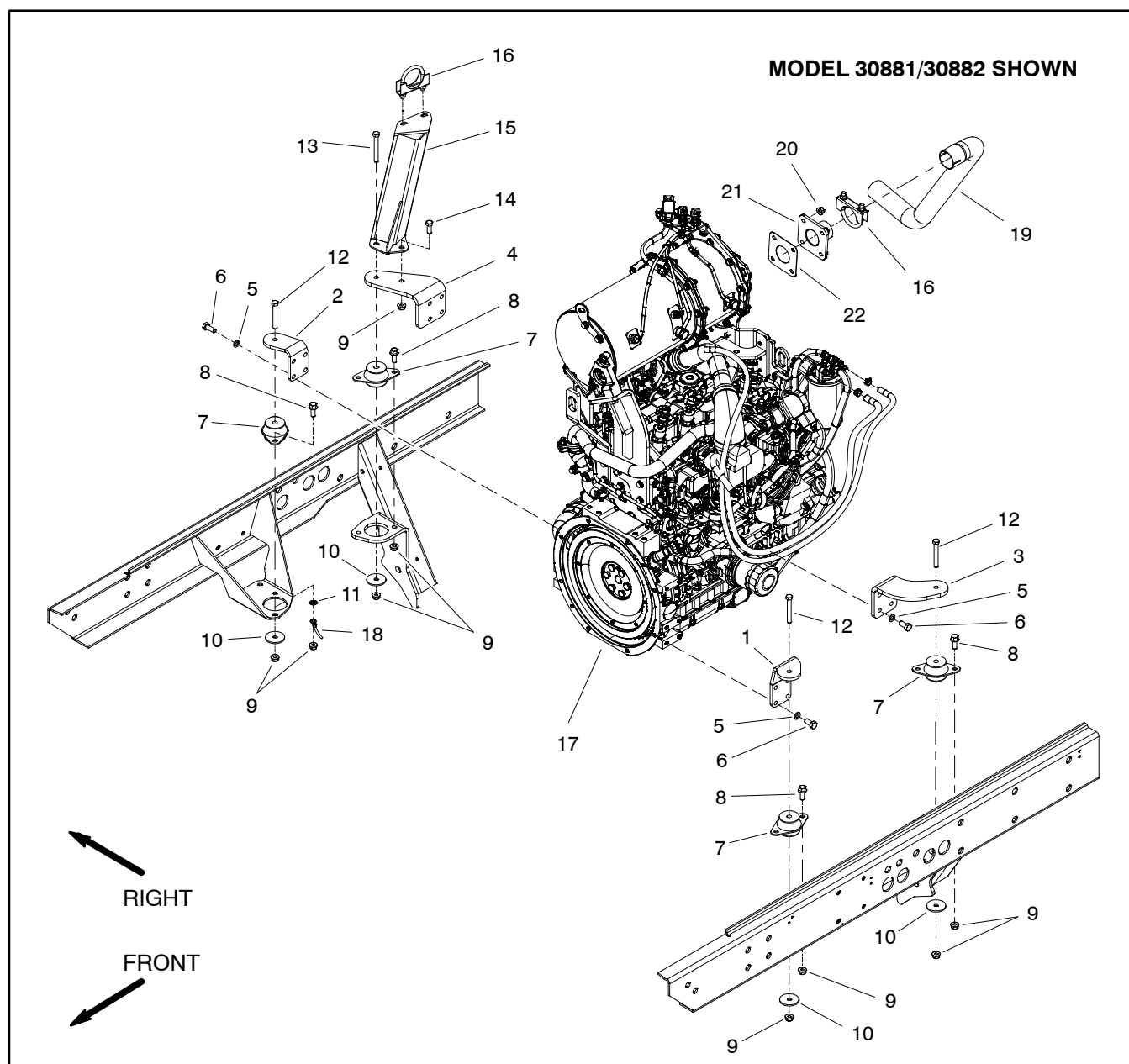


Figure 13

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

## Engine Removal (Fig. 13)

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 Removal in the Service and Repairs section of Chapter 7 – Chassis).
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. Pressurized, hot coolant can escape and cause burns.**

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

4. Drain coolant from radiator into a suitable container (see Radiator and Oil Cooler Assembly in this section). Disconnect upper and lower radiator hoses from the radiator.
5. Remove air cleaner system from engine (see Air Cleaner System in this section).
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.
7. Disconnect fuel supply and return hoses from injection pump (Fig. 14 or 15). 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 in the Service and Repairs section of Chapter 4 – Hydraulic System).

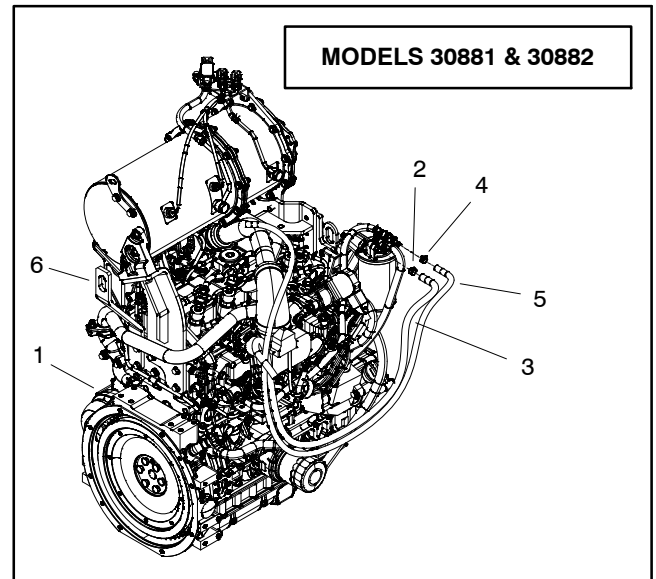


Figure 14

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

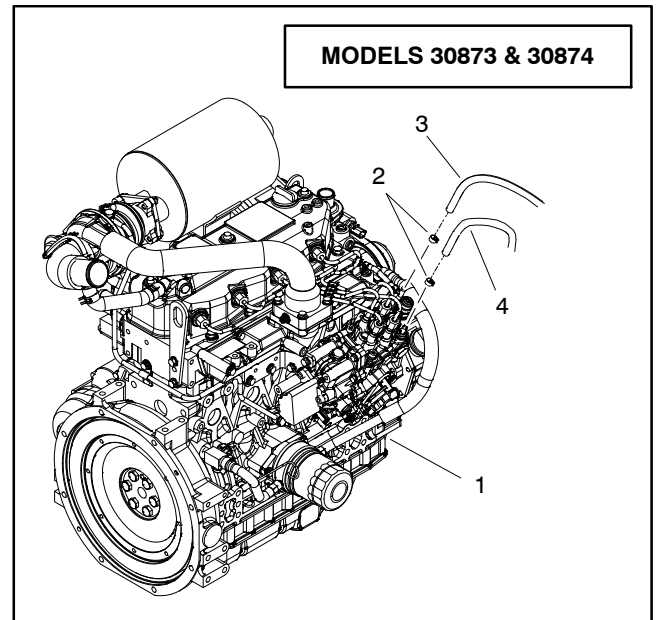


Figure 15

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

9. Remove fasteners that secure lower radiator shroud to radiator (see Radiator and Oil Cooler Assembly in this section). 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 in the Service and Repairs section of Chapter 4 – Hydraulic System).

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.**

**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 13 as a guide.

### Engine Installation (Fig. 13)

1. If removed, install engine mount brackets, tailpipe support and exhaust tailpipe to the engine using Figure 13 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 in the Service and Repairs section of Chapter 4 – Hydraulic System).

6. Position lower radiator shroud to radiator/oil cooler (see Radiator and Oil Cooler Assembly in this section). 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 in the Service and Repairs section of Chapter 4 – Hydraulic System). Make sure that clearance between shrouds and fan is at least **0.180" (4.6 mm)** 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 (Fig. 14 or 15). Secure hoses with hose clamps.

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 in this section).

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. Check and adjust hydraulic reservoir oil level as needed.

17. Prime the fuel system (see Fuel System in this section).

18. Start engine and operate hydraulic controls to properly fill hydraulic system (see Charge Hydraulic System in the Service and Repairs section of Chapter 4 – Hydraulic Systems).

19. Install hood onto the machine (see Hood Installation in the Service and Repairs section of Chapter 7 – Chassis). Close and secure hood.

## Pump Adapter Plate

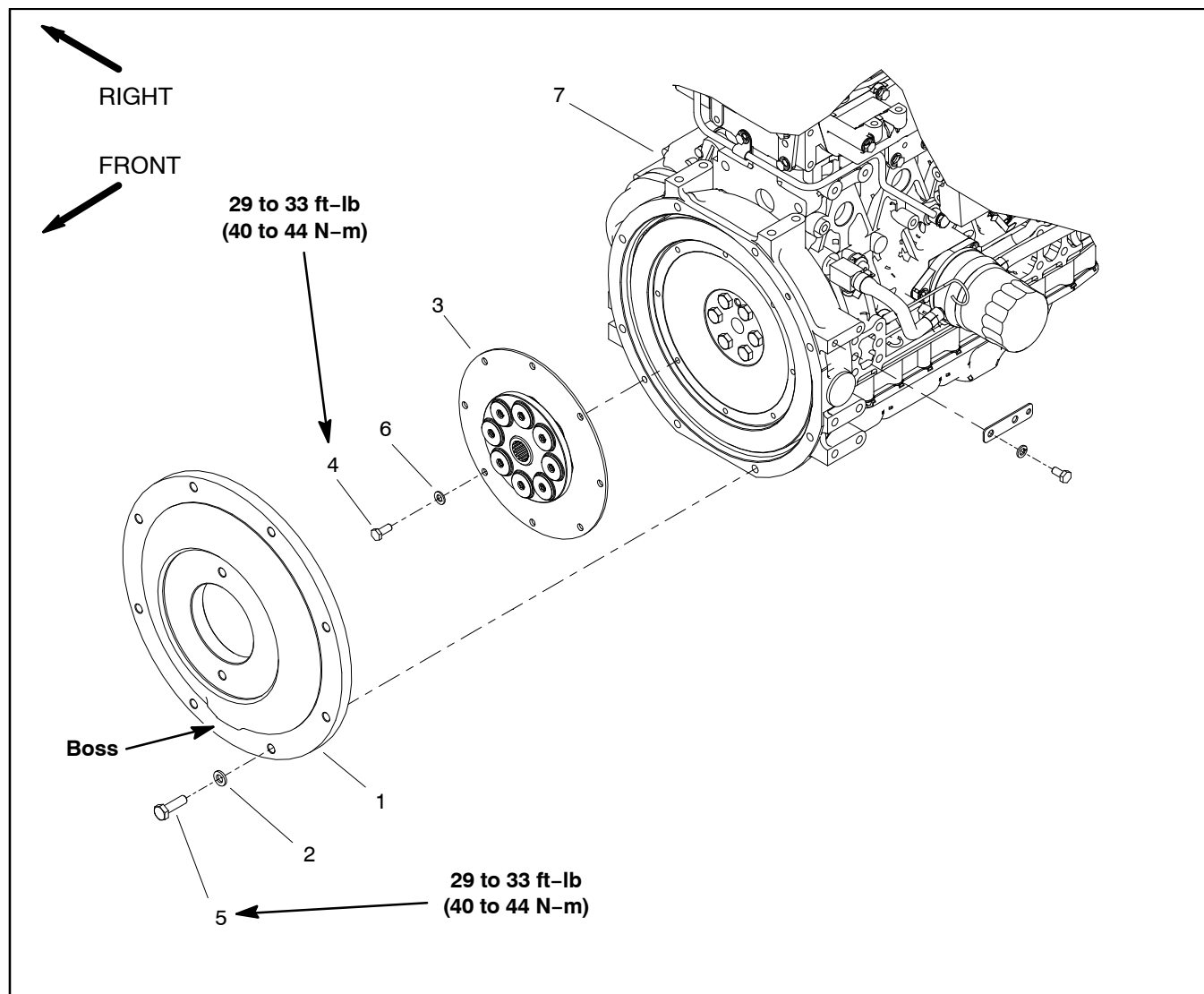


Figure 16

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



### Coupler Removal (Fig. 16)

**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 in the Service and Repairs section of Chapter 4 – Hydraulic System).
2. Remove flywheel plate and spring coupler from engine using Figure 16 as a guide.

### Coupler Installation (Fig. 16)

1. Position spring coupler to engine flywheel and align mounting holes. Make sure that coupling hub is away from engine flywheel (Fig. 17).
2. Secure coupler to flywheel with eight (8) cap screws and hardened washers. Torque cap screws in a crossing pattern from **29 to 33 ft-lb (40 to 44 N-m)**.
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 **29 to 33 ft-lb (40 to 44 N-m)**.
4. If engine is in machine, install hydraulic pump assembly (see Piston (Traction) Pump in the Service and Repairs section of Chapter 4 – Hydraulic System).

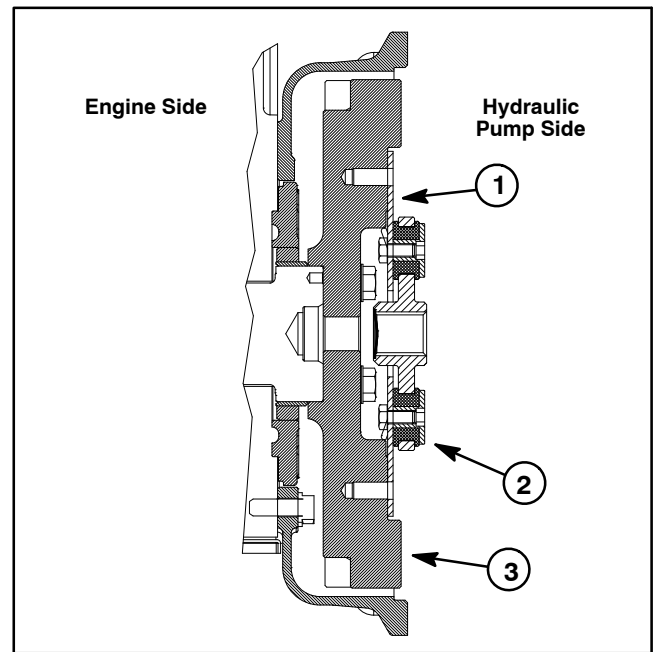


Figure 17

- |                |                    |
|----------------|--------------------|
| 1. Coupler     | 3. Engine flywheel |
| 2. Coupler hub |                    |

## Exhaust System (Models 30881 and 30882)

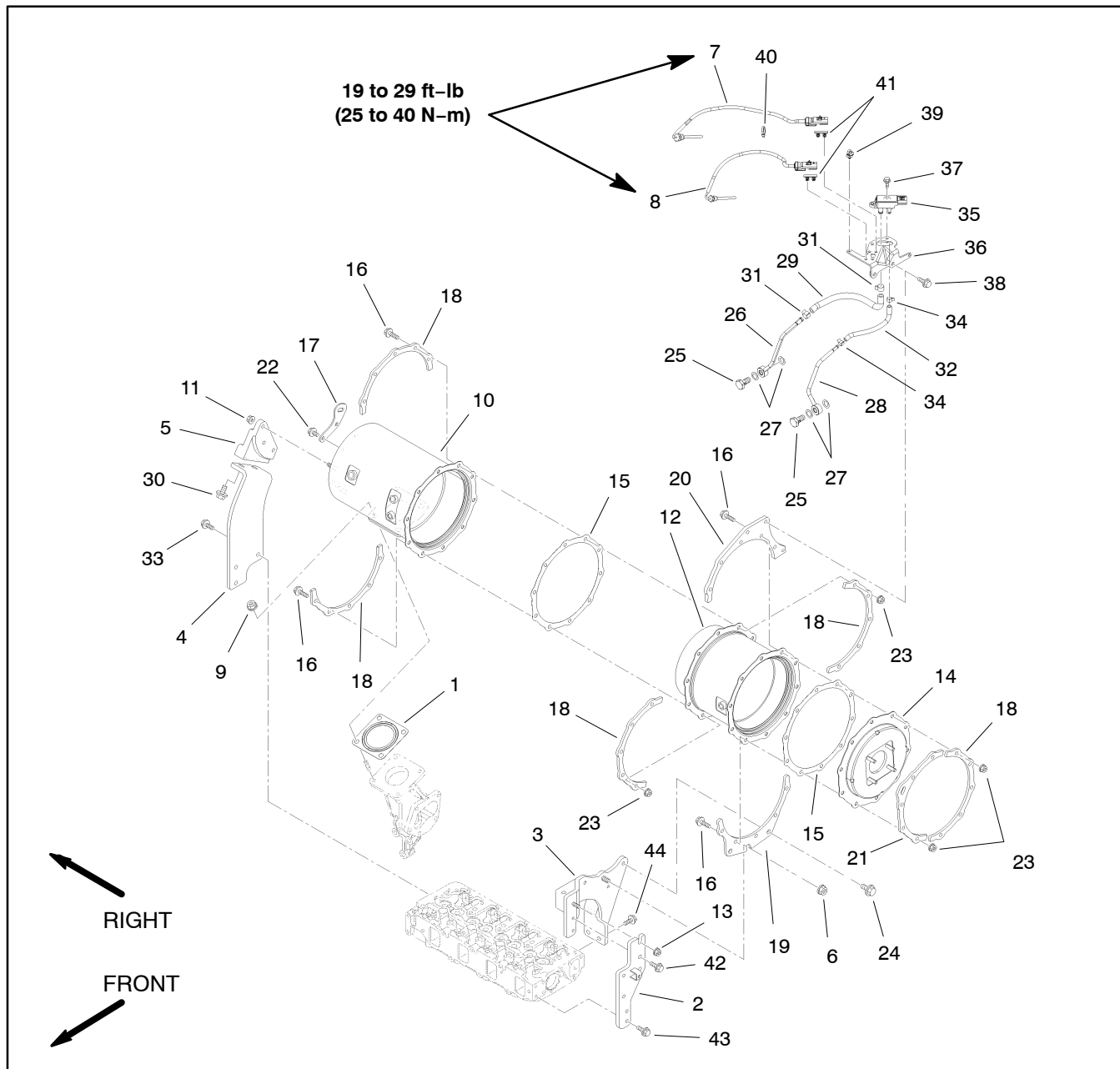


Figure 18

- |                             |  |                             |
|-----------------------------|--|-----------------------------|
| 1. Gasket                   | 16. Bolt (20 used)                     | 31. Hose clip (2 used)      |
| 2. Exhaust assembly stay    | 17. DPF lifter                         | 32. Hose                    |
| 3. Exhaust assembly stay    | 18. DPF stiffener (5 used)             | 33. Bolt (3 used)           |
| 4. Exhaust assembly stay    | 19. DPF stiffener                      | 34. Hose clip (2 used)      |
| 5. Exhaust assembly stay    | 20. DPF stiffener                      | 35. Pressure sensor         |
| 6. Nut                      | 21. DPF stiffener                      | 36. Sensor bracket          |
| 7. DOC temp sensor (inlet)  | 22. Bolt (2 used)                      | 37. Bolt (2 used)           |
| 8. DOC temp sensor (outlet) | 23. Nut (20 used)                      | 38. Bolt (2 used)           |
| 9. Nut (4 used)             | 24. Bolt (2 used)                      | 39. Clip band               |
| 10. DOC assembly            | 25. Pipe joint bolt (2 used)           | 40. Band                    |
| 11. Nut (3 used)            | 26. Exhaust pressure pipe (DPF inlet)  | 41. Connector clip (2 used) |
| 12. DPF assembly            | 27. Sensor gasket (4 used)             | 42. Bolt (2 used)           |
| 13. Nut                     | 28. Exhaust pressure pipe (DPF outlet) | 43. Bolt (2 used)           |
| 14. Outlet flange           | 29. Exhaust hose                       | 44. Bolt (2 used)           |
| 15. DPF gasket (2 used)     | 30. 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 Yanmar Engine: Models 30881 and 30882 in the General Information section of this chapter). 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.

Refer to the Parts Catalog to identify individual components for the exhaust system on your Groundsmaster.

### Removal (Figs. 18 and 19)

**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.



## 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 18 and 19 as guides. Discard all removed gaskets (items 1 and 15 in Fig. 18 or item 6 in Fig. 19).

### Installation (Figs. 18 and 19)

**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 18 and 19 as guides.
  - A. If exhaust sensors (items 7 and 8 in Fig. 18) were removed, torque sensors from **19 to 29 ft-lb (25 to 40 N-m)**.
  - B. If exhaust pressure pipes (items 26 and 28 in Fig. 18) 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 Fig. 18) were loosened or removed, tighten fasteners that secure stiffeners before tightening fasteners that secure exhaust system to DPF stays.

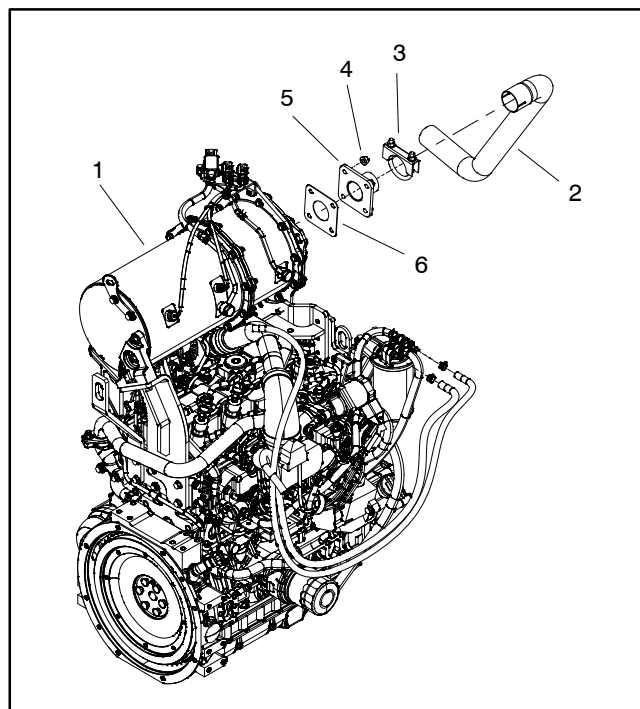


Figure 19

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

This page is intentionally blank.



## Hydraulic System

### Table of Contents

SPECIFICATIONS .....	2	Priming Hydraulic Pumps .....	74
GENERAL INFORMATION .....	3	Flush Hydraulic System .....	75
Operator's Manual .....	3	Filtering Closed-Loop Traction Circuit .....	76
Check Hydraulic Fluid .....	3	Charge Hydraulic System .....	77
Towing Traction Unit .....	4	Gear Pump .....	78
Relieving Hydraulic System Pressure .....	5	Gear Pump Service .....	82
Traction Circuit Component Failure .....	5	Piston (Traction) Pump .....	84
Hydraulic Hoses .....	6	Piston (Traction) Pump Service .....	87
Hydraulic Hose and Tube Installation .....	7	Rear Traction Control Manifold .....	90
Hydraulic Fitting Installation .....	8	Rear Traction Control Manifold Service .....	92
HYDRAULIC SCHEMATICS .....	10	Control Manifold Cartridge Valve Service .....	93
GM 4500-D Hydraulic Schematic .....	10	HI/LOW Range Control Manifold .....	94
GM 4700-D Hydraulic Schematic .....	11	Rear Axle Motor .....	96
HYDRAULIC FLOW DIAGRAMS .....	12	Front Wheel Motors .....	98
Traction Circuit: LOW Speed (Mow) .....	12	Rear Axle and Front Wheel Motor Service ....	100
Traction Circuit: HI Speed (Transport) .....	14	Cutting Deck Motor .....	102
Lower Cutting Decks: Groundsmaster 4500-D .	16	Cutting Deck Motor Service .....	104
Lower Cutting Decks: Groundsmaster 4700-D .	18	Deck Control Manifold .....	108
Raise Cutting Decks: Groundsmaster 4500-D .	20	Deck Control Manifold Service (GM 4500-D) .	110
Raise Cutting Decks: Groundsmaster 4700-D .	22	Deck Control Manifold Service (GM 4700-D) .	112
Mow Circuit .....	24	Steering Control Valve .....	114
Cutting Deck Blade Braking .....	26	Steering Control Valve Service .....	116
Steering Circuit .....	28	Steering Cylinder .....	118
Engine Cooling Fan Circuit .....	30	Steering Cylinder Service .....	120
SPECIAL TOOLS .....	32	Engine Cooling Fan Motor .....	122
TROUBLESHOOTING .....	37	Engine Cooling Fan Motor Service .....	126
TESTING .....	44	Fan Control Manifold .....	128
Traction Circuit Charge Pressure .....	46	Fan Control Manifold Service .....	130
Traction Circuit Relief Pressure .....	48	Lift Control Manifold .....	132
Reverse Traction Circuit Reducing Valve (PR)		Lift Control Manifold Service (GM 4500-D) ...	134
Pressure .....	50	Lift Control Manifold Service (GM 4700-D) ...	136
Rear Traction Circuit Relief (RV) Pressure ....	52	Lift Circuit Junction Manifold .....	138
Piston (Traction) Pump Flow Test .....	54	Lift Cylinders: Decks #1, #4 and #5 .....	140
Cutting Deck Circuit Pressure .....	56	Lift Cylinders: Decks #2 and #3 .....	142
Cutting Deck Circuit Relief Pressure .....	58	Lift Cylinders: Decks #6 and #7 (GM 4700-D) .	144
Deck Motor Case Drain Leakage .....	60	Lift Cylinder Service .....	146
Steering Circuit Relief Pressure .....	62	Hydraulic Reservoir .....	148
Steering Cylinder Internal Leakage .....	64	Radiator and Oil Cooler Assembly .....	150
Lift/Lower Circuit Relief Pressure .....	66	DANFOSS H1 CLOSED CIRCUIT AXIAL PIS-	
Engine Cooling Fan Circuit .....	68	TON PUMPS SERVICE MANUAL	
Gear Pump Flow .....	70	DANFOSS H1 CLOSED CIRCUIT AXIAL PIS-	
ADJUSTMENTS .....	72	TON PUMPS REPAIR INSTRUCTIONS	
Adjust Control Manifold Relief Valves .....	72	DANFOSS K and L FRAME VARIABLE MO-	
SERVICE AND REPAIRS .....	73	TORS SERVICE MANUAL	
General Precautions for Removing and		DANFOSS STEERING UNIT TYPE OSPM	
Installing Hydraulic System Components ....	73	SERVICE MANUAL	
Check Hydraulic Lines and Hoses .....	74		

# Specifications

Item	Description
Piston (Traction) Pump Maximum Displacement (per revolution) System Relief Pressure: Forward System Relief Pressure: Reverse Charge Pressure	Sauer-Danfoss Variable Displacement Axial Piston Pump 2.75 in <sup>3</sup> (45 cc) 4350 PSI (300 bar) 5000 PSI (345 bar) 250 PSI (17 bar)
Front Wheel Motors Displacement (per revolution)	Sauer-Danfoss 2-Position Axial Piston Motors 1.83 in <sup>3</sup> (30 cc) Maximum / 0.89 in <sup>3</sup> (14.6 cc) Minimum
Rear Axle Motor Displacement (per revolution)	Sauer-Danfoss 2-Position Axial Piston Motor with Loop Flushing Valve 2.32 in <sup>3</sup> (38 cc) Maximum / 1.13 in <sup>3</sup> (18.5 cc) Minimum
Gear Pump Section P1/P2 Displacement (per revolution) Section P3/P4 Displacement (per revolution)	Casappa 4 section, positive displacement gear type pump 1.03 in <sup>3</sup> (16.85 cc) 0.56 in <sup>3</sup> (9.16 cc)
Steering Control Valve Displacement (per revolution)	Sauer-Danfoss Steering Unit, Series OSPM 6.1 in <sup>3</sup> (100 cc)
Steering Relief Pressure	1050 PSI (72 bar)
Lift/Lower Relief Pressure	1600 PSI (110 bar)
Cutting Deck Motors Displacement (per revolution)	Casappa Gear Motor 1.16 in <sup>3</sup> (19 cc)
Cutting Deck Circuit Relief Pressure	3500 PSI (241 bar)
Engine Cooling Fan Motor Displacement (per revolution)	Casappa Gear Motor 0.50 in <sup>3</sup> (8.3 cc)
Engine Cooling Fan Circuit Relief Pressure	3000 PSI (207 bar)
Hydraulic Filters In-line Suction Strainer	Spin-on cartridge type 100 mesh (in reservoir)
Hydraulic Reservoir Capacity	7.5 U.S. Gallons (28.4 Liters)
Hydraulic Oil	See Traction Unit 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 the Testing section of this chapter for hydraulic test procedures and expected test results.

# 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

The Groundsmaster 4500-D and 4700-D hydraulic systems are designed to operate on anti-wear hydraulic fluid. The hydraulic reservoir holds approximately 7.5 gallons (28.4 liters) of hydraulic fluid. **Check level of hydraulic fluid daily.** See Operator's Manual for fluid level checking procedure and oil recommendations.

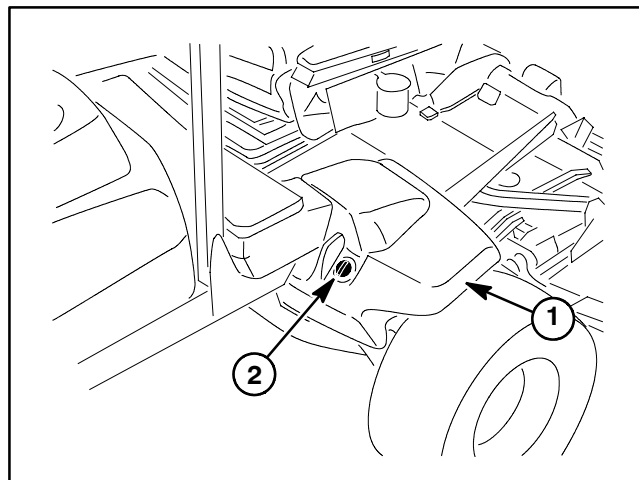


Figure 1

1. Hydraulic reservoir
2. Reservoir cap

Hydraulic  
System

## Towing Traction Unit

**IMPORTANT:** If towing limits are exceeded, severe damage to the piston pump may occur.

If it becomes necessary to tow (or push) the machine, tow (or push) in a **forward direction only**, at a speed **below 3 mph (4.8 kph)** and for a distance **less than 1/4 mile (0.4 km)**. 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 (Fig. 2). Do not turn bypass valves when engine is running.

After the machine has been moved, torque the bypass valves to **52 ft-lb (70 N-m)**.

See Traction Unit Operator's Manual for additional towing procedures.

**IMPORTANT:** If the machine must be pushed or towed in a reverse direction, the check valve in the rear traction control manifold must be bypassed. To bypass this check valve, connect a hydraulic hose between the piston (traction) pump reverse traction pressure test port and the port located between ports M8 and P2 on the rear traction control manifold. Toro part numbers 95-8843 (hydraulic hose), 95-0985 (coupler fitting) (2 required) and 340-77 (hydraulic fitting) (2 required) are needed for this connection.

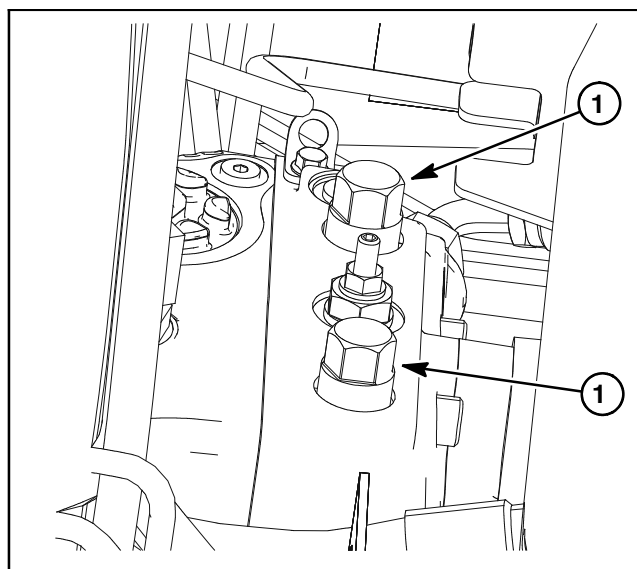


Figure 2

1. Bypass valve location



---

## 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 in this chapter) into the circuit. This filter should be used when connecting hydraulic test gauges in order to test traction circuit components or after replacing a failed traction circuit component (e.g. traction (piston) pump or wheel motor). The filter will ensure that contaminants are removed from the closed loop and thus, do not cause additional component damage.

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

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

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

Hard, cracked, cut, abraded, charred, leaking or otherwise damaged hose.

Kinked, crushed, flattened or twisted hose.

Blistered, soft, degraded or loose hose cover.

Cracked, damaged or badly corroded hose fittings.

When replacing a hydraulic hose, be sure that the hose is straight (not twisted) before tightening the fittings. This can be done by observing the imprint (layline) on the hose. Use two wrenches; hold the hose straight with one wrench and tighten the hose swivel nut onto the fitting with the other wrench (See Hydraulic Hose and Tube Installation in this section). If the hose has an elbow at one end, tighten the swivel nut on that end before tightening the nut on the straight end of the hose.

For additional hydraulic hose information, refer to Toro Service Training Book, Hydraulic Hose Servicing (Part Number 94813SL).



### WARNING

**Before disconnecting or performing any work on hydraulic system, relieve all pressure in system (see Relieving Hydraulic System Pressure in this section).**

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

## Hydraulic Hose and Tube Installation (O-Ring Face Seal Fitting)

1. Make sure threads and sealing surfaces of the hose/tube and the fitting are free of burrs, nicks, scratches or any foreign material.

2. As a preventative measure against leakage, it is recommended that the face seal O-ring be replaced any time the connection is opened. Make sure the O-ring is installed and properly seated in the fitting groove. Lightly lubricate the O-ring with clean hydraulic oil.

3. Place the hose/tube against the fitting body so that the flat face of the hose/tube sleeve fully contacts the O-ring in the fitting.

4. Thread the swivel nut onto the fitting by hand. While holding the hose/tube with a wrench, use a torque wrench to tighten the swivel nut to the recommended installation torque shown in Figure 5. This tightening process will require the use of an offset wrench (e.g. crowfoot wrench). Use of an offset wrench will affect torque wrench calibration due to the effective length change of the torque wrench. Tightening torque when using a torque wrench with an offset wrench will be lower than the listed installation torque (see Using a Torque Wrench with an Offset Wrench in the Torque Specifications section of Chapter 2 – Product Records and Maintenance).

5. If a torque wrench is not available or if space at the swivel nut prevents use of a torque wrench, an alternate method of assembly is the Flats From Wrench Resistance (F.F.W.R.) method (Fig. 2).

A. Using a wrench, tighten the swivel nut onto the fitting until light wrench resistance is reached (approximately 30 in-lb).

B. Mark the swivel nut and fitting body. Hold the hose/tube with a wrench to prevent it from turning.

C. Use a second wrench to tighten the nut to the correct Flats From Wrench Resistance (F.F.W.R.). The markings on the nut and fitting body will verify that the connection has been properly tightened.

Size	F.F.W.R.
4 (1/4 in. nominal hose or tubing)	1/2 to 3/4
6 (3/8 in.)	1/2 to 3/4
8 (1/2 in.)	1/2 to 3/4
10 (5/8 in.)	1/2 to 3/4
12 (3/4 in.)	1/3 to 1/2
16 (1 in.)	1/3 to 1/2

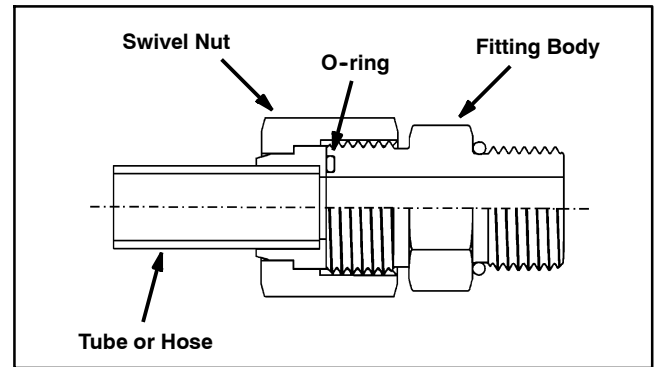


Figure 3

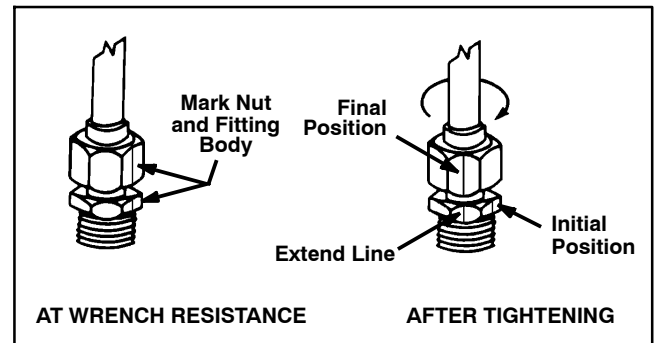


Figure 4

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

Figure 5

## Hydraulic Fitting Installation (SAE Straight Thread O-Ring Fitting into Component Port)

### Non-Adjustable Fitting (Fig. 6)

1. Make sure all threads and sealing surfaces of fitting and component port are free of burrs, nicks, scratches or any foreign material.
2. As a preventative measure against leakage, it is recommended that the O-ring be replaced any time the connection is opened.
3. Lightly lubricate the O-ring with clean hydraulic oil. Fitting threads should be clean with no lubricant applied.

**IMPORTANT: Before installing fitting into port, determine port material. If fitting is to be installed into an aluminum port, installation torque is reduced.**

4. Install the fitting into the port. Then, use a torque wrench and socket to tighten the fitting to the recommended installation torque shown in Figure 7.

**NOTE:** Use of an offset wrench (e.g. crowfoot wrench) will affect torque wrench calibration due to the effective length change of the torque wrench. Tightening torque when using a torque wrench with an offset wrench will be less than the recommended installation torque. See Using a Torque Wrench with an Offset Wrench in the Torque Specifications section of Chapter 2 - Product Records and Maintenance to determine necessary conversion information.

5. If a torque wrench is not available, or if space at the port prevents use of a torque wrench, an alternate method of assembly is the Flats From Finger Tight (F.F.F.T.) method.

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

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

Size	F.F.F.T.
4 (1/4 in. nominal hose or tubing)	1.00 ± 0.25
6 (3/8 in.)	1.50 ± 0.25
8 (1/2 in.)	1.50 ± 0.25
10 (5/8 in.)	1.50 ± 0.25
12 (3/4 in.)	1.50 ± 0.25
16 (1 in.)	1.50 ± 0.25

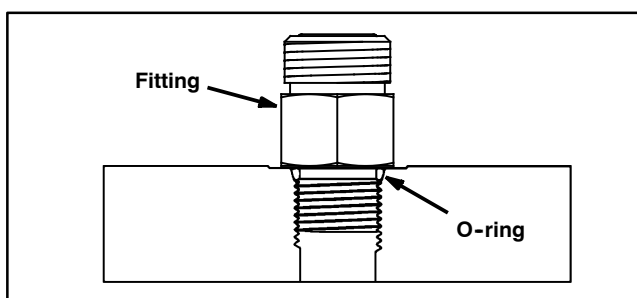


Figure 6

Fitting Dash Size	Fitting Port Side Thread Size	Installation Torque Into Steel Port	Installation Torque Into Aluminum Port
4	7/16 - 20	15 to 19 ft-lb (21 to 25 N-m)	9 to 11 ft-lb (13 to 15 N-m)
5	1/2 - 20	18 to 22 ft-lb (25 to 29 N-m)	11 to 15 ft-lb (15 to 20 N-m)
6	9/16 - 18	34 to 42 ft-lb (47 to 56 N-m)	20 to 26 ft-lb (28 to 35 N-m)
8	3/4 - 16	58 to 72 ft-lb (79 to 97 N-m)	35 to 43 ft-lb (48 to 58 N-m)
10	7/8 - 14	99 to 121 ft-lb (135 to 164 N-m)	60 to 74 ft-lb (82 to 100 N-m)
12	1 1/16 - 12	134 to 164 ft-lb (182 to 222 N-m)	81 to 99 ft-lb (110 to 134 N-m)
14	1 3/16 - 12	160 to 196 ft-lb (217 to 265 N-m)	96 to 118 ft-lb (131 to 160 N-m)
16	1 5/16 - 12	202 to 248 ft-lb (274 to 336 N-m)	121 to 149 ft-lb (165 to 202 N-m)
20	1 5/8 - 12	247 to 303 ft-lb (335 to 410 N-m)	149 to 183 ft-lb (202 to 248 N-m)

Figure 7

## Adjustable Fitting (Fig. 8)

1. Make sure all threads and sealing surfaces of fitting and component port are free of burrs, nicks, scratches or any foreign material.
2. As a preventative measure against leakage, it is recommended that the O-ring be replaced any time the connection is opened.
3. Lightly lubricate the O-ring with clean hydraulic oil. Fitting threads should be clean with no lubricant applied.
4. Turn back the lock nut as far as possible. Make sure the back up washer is not loose and is pushed up as far as possible (Step 1 in Figure 9).

**IMPORTANT: Before installing fitting into port, determine port material. If fitting is to be installed into an aluminum port, installation torque is reduced.**

5. Install the fitting into the port and tighten finger tight until the washer contacts the face of the port (Step 2).
6. To put the fitting in the desired position, unscrew it by the required amount, but no more than one full turn (Step 3).
7. Hold the fitting in the desired position with a wrench and use a torque wrench to tighten the fitting to the recommended installation torque shown in Figure 7. This tightening process will require the use of an offset wrench (e.g. crowfoot wrench). Use of an offset wrench will affect torque wrench calibration due to the effective length change of the torque wrench. Tightening torque when using a torque wrench with an offset wrench will be lower than the listed installation torque (see Using a Torque Wrench with an Offset Wrench in the Torque Specifications section of Chapter 2 – Product Records and Maintenance).
8. If a torque wrench is not available, or if space at the port prevents use of a torque wrench, an alternate method of assembly is the Flats From Finger Tight (F.F.F.T.) method. Hold the fitting in the desired position with a wrench and, if port material is steel, tighten the lock nut with a second wrench to the listed F.F.F.T (Step 4). If port material is aluminum, tighten fitting to 60% of listed F.F.F.T.

Size	F.F.F.T.
4 (1/4 in. nominal hose or tubing)	1.00 ± 0.25
6 (3/8 in.)	1.50 ± 0.25
8 (1/2 in.)	1.50 ± 0.25
10 (5/8 in.)	1.50 ± 0.25
12 (3/4 in.)	1.50 ± 0.25
16 (1 in.)	1.50 ± 0.25

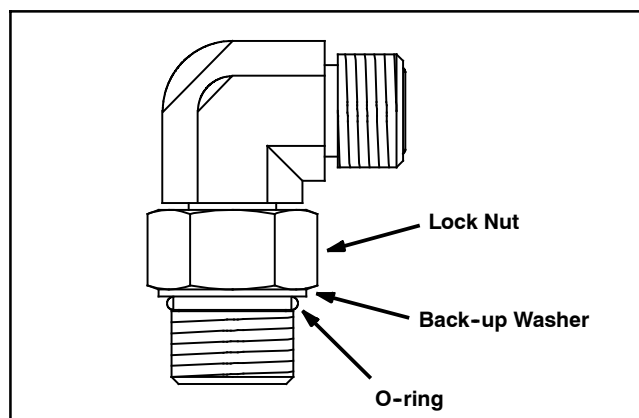


Figure 8

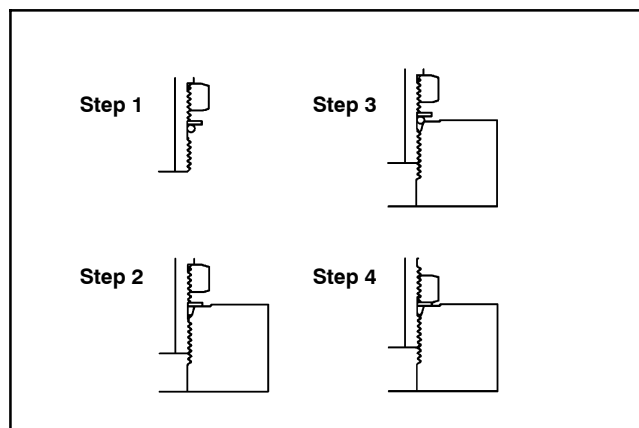
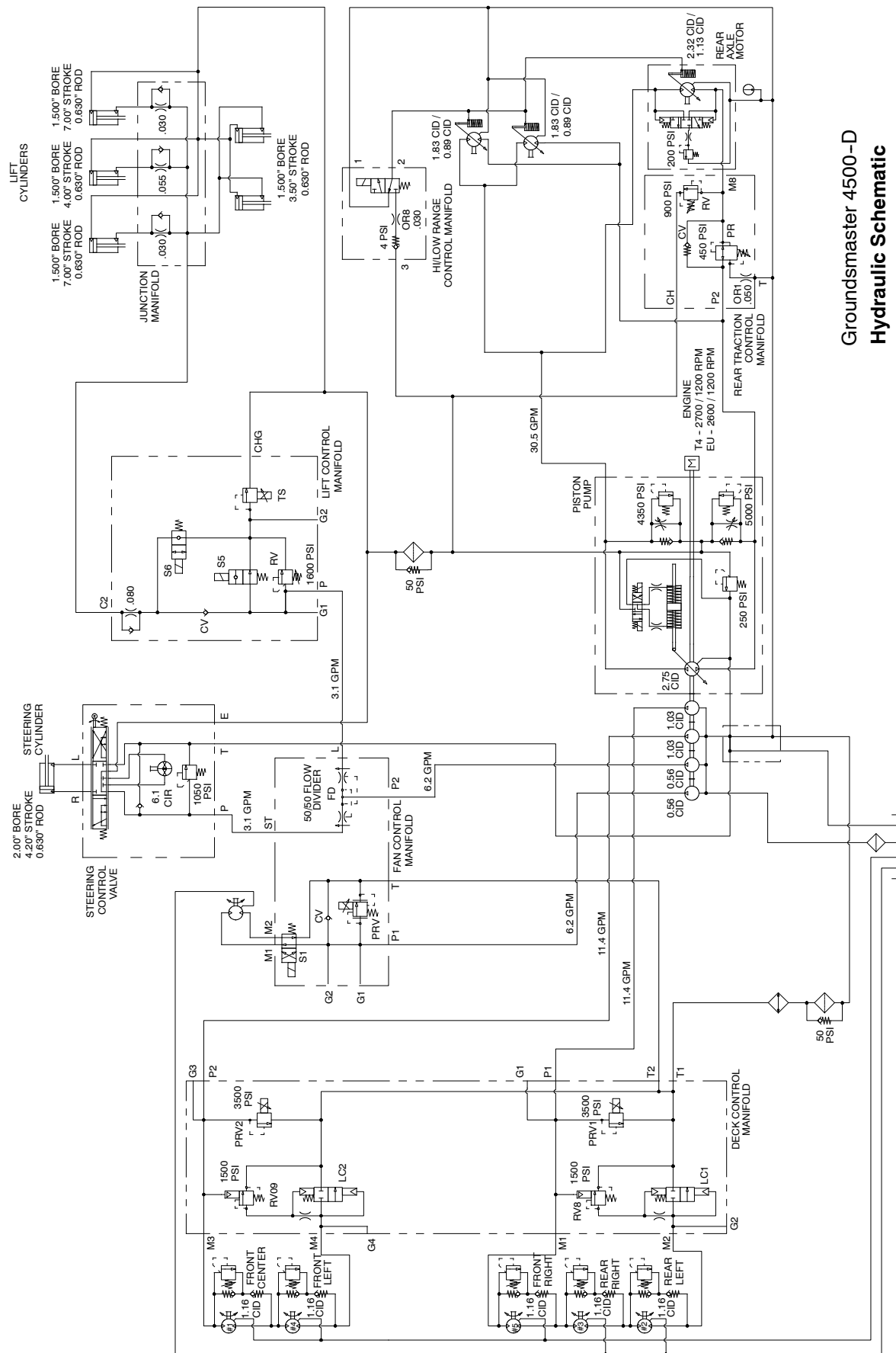


Figure 9

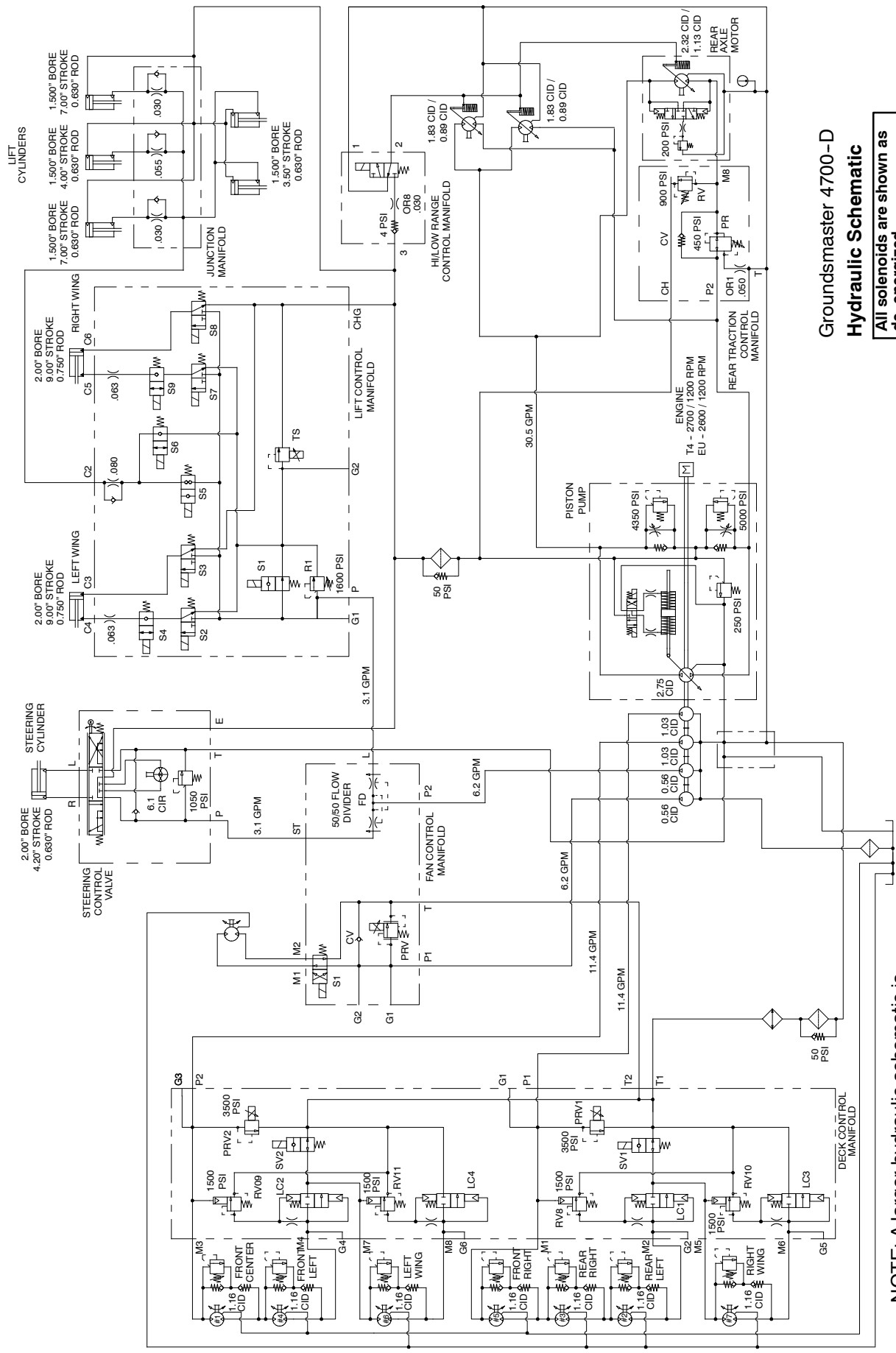
# Hydraulic Schematics



Groundsmaster 4500-D  
Hydraulic Schematic

All solenoids are shown as  
de-energized

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

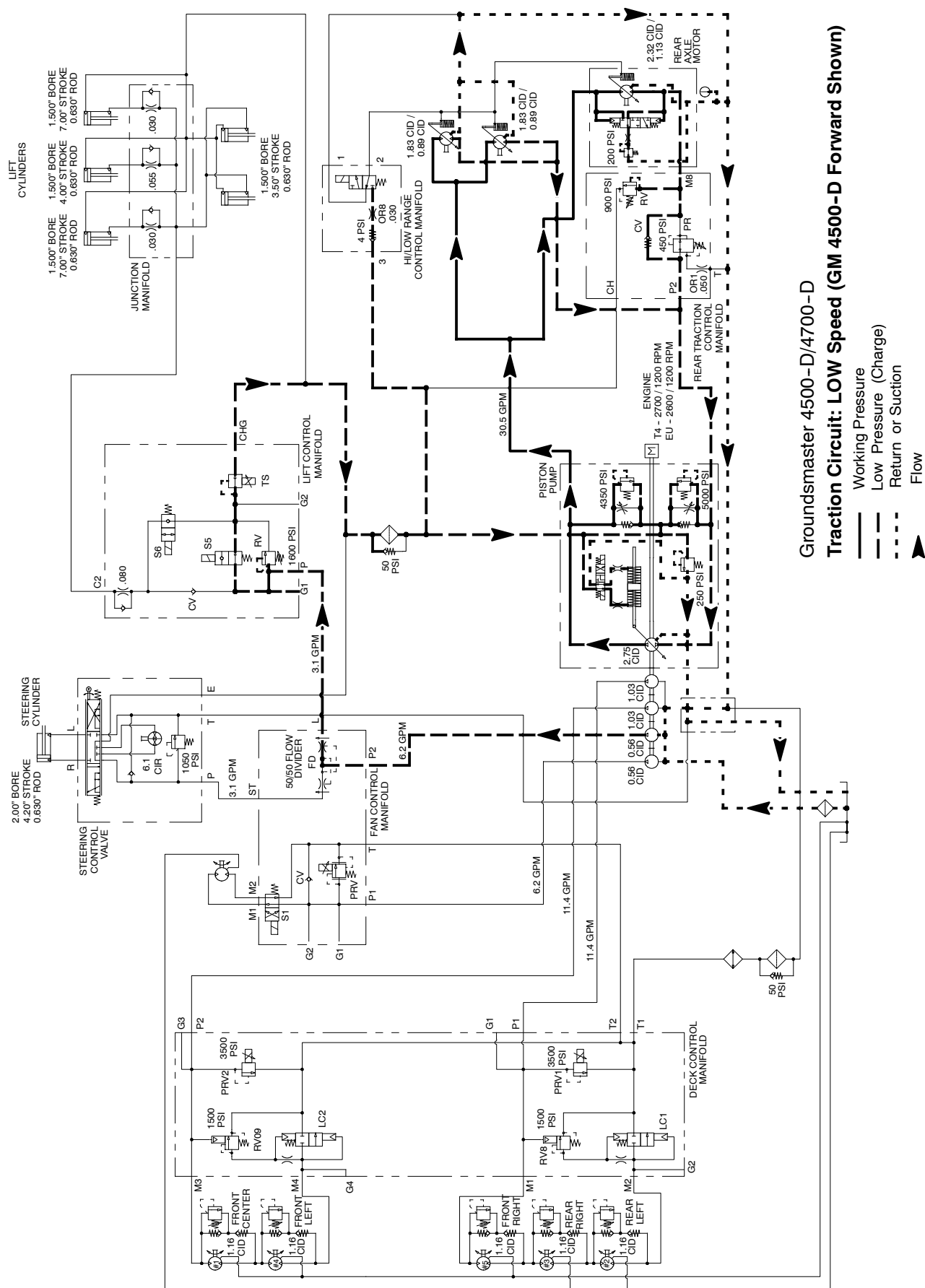


Groundsmaster 4700-D  
Hydraulic Schematic

All solenoids are shown as de-energized

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

# Hydraulic Flow Diagrams





## Traction Circuit: LOW Speed (Mow)

The traction circuit piston pump is a variable displacement pump that is directly coupled to the engine fly-wheel. 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-5002 controller. The controller in turn sends a corresponding PWM (Pulse Width Modulation) output to the electronic pump control to rotate the pump swash plate accordingly to control pump output and direction. 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: 4350 PSI (300 bar) in forward and 5000 PSI (345 bar) 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 HI (transport) speed. The motors are spring biased to maximum displacement for LOW speed and are hydraulically shifted to minimum displacement for HI 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 250 PSI (17 bar) by a relief valve located in the piston pump.

### Forward Direction

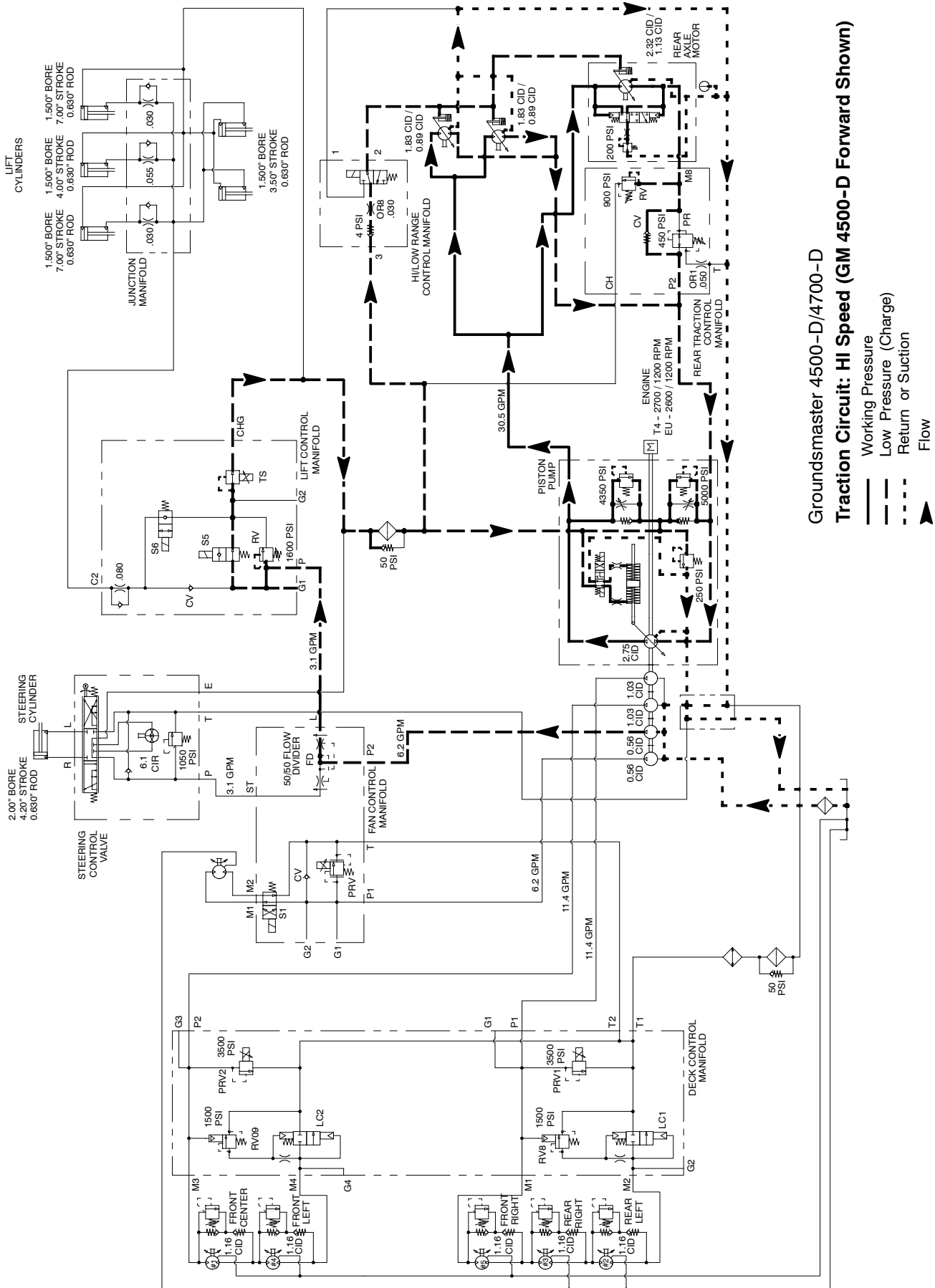
With the armrest console HI/LOW speed switch in the LOW speed (mow) position, the solenoid valve in the HI/LOW range control manifold is not energized. The front wheel motors and rear axle motor are at their maximum displacement when in LOW speed providing a slower traction speed for mowing conditions.

When in LOW speed (mow) 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, a 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 (mow) 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 downstream pressure to the rear axle motor to 450 PSI (31 bar) 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.



Groundmaster 4500-D/4700-D  
Traction Circuit: HI Speed (GM 4500-D Forward Shown)

## Traction Circuit: HI Speed (Transport)

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-5002 controller. The controller in turn sends a corresponding PWM (Pulse Width Modulation) output to the electronic pump control to rotate the pump swash plate accordingly to control pump output and direction. 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: 4350 PSI (300 bar) in forward and 5000 PSI (345 bar) 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 HI (transport) speed. The motors are spring biased to maximum displacement for LOW speed and are hydraulically shifted to minimum displacement for HI 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.

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 250 PSI (17 bar) by a relief valve located in the piston pump.

### Forward Direction

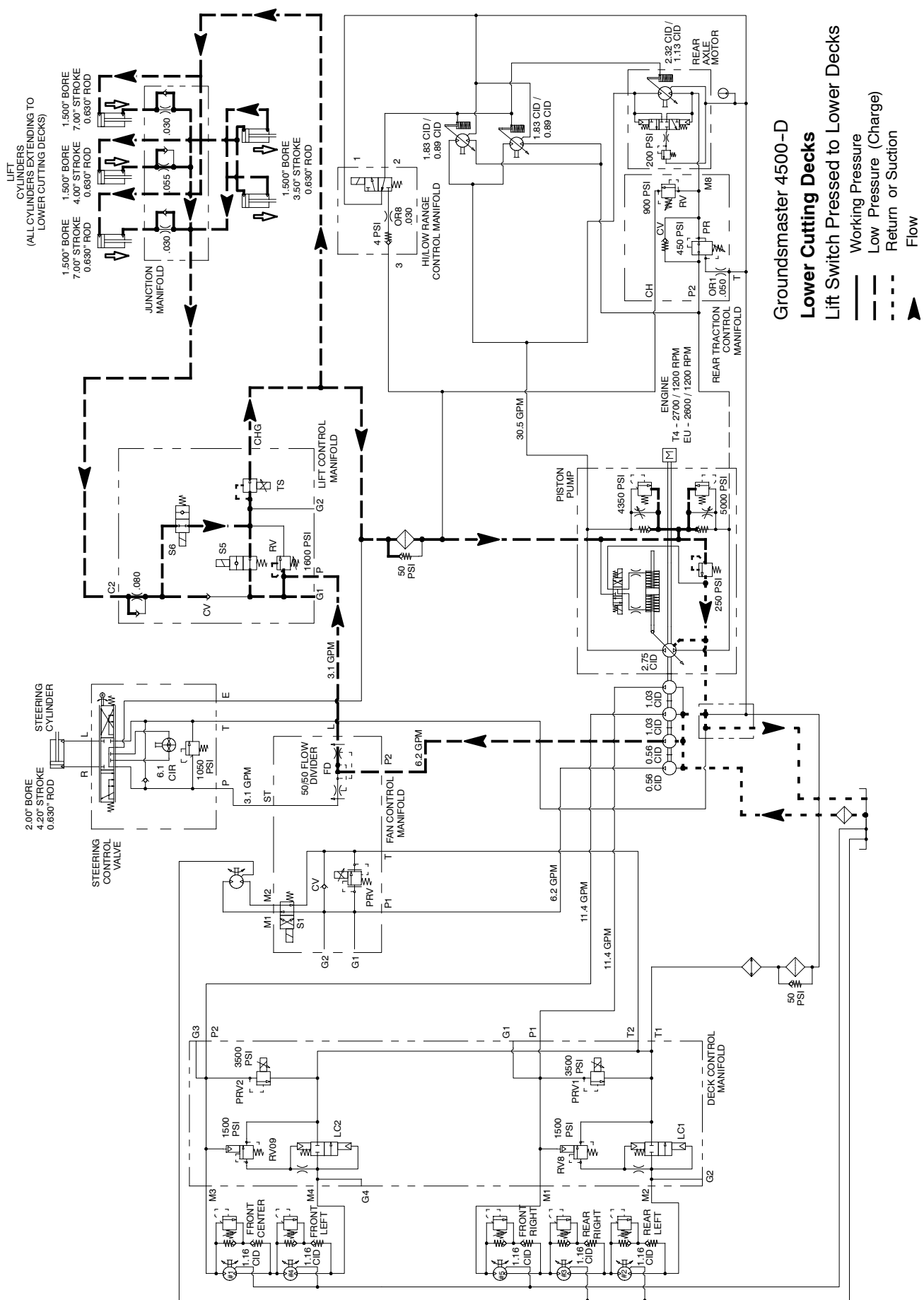
With the armrest console HI/LOW speed switch in the HI speed (transport) position, the solenoid valve in the HI/LOW range control manifold is energized. This energized solenoid valve directs charge pressure to shift the front wheel motors and rear axle motor to their minimum displacement. With the motors at their minimum displacements, a faster traction speed is available for transport.

When in HI speed (transport) 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, a 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 speed (transport) 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 450 PSI (31 bar) 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.



**Groundsmaster 4500-D**  
**Lower Cutting Decks**  
 Lift Switch Pressed to Lower Decks

## Lower Cutting Decks: Groundsmaster 4500-D

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 1600 PSI (110 bar) 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 (Fig. 10).

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. Also, when in HI speed (transport), the cutting decks will not lower.

### 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-5002 controller 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.

A pressure sensor located in the hydraulic tube between the front wheel and rear axle motors is used by the TEC-5002 controller as an input to determine traction circuit pressure. Based on this sensor input, a PWM (Pulse Width Modulation) signal from the TEC-5002 controller is provided to the proportional relief valve (TS) to maintain counterbalance pressure.

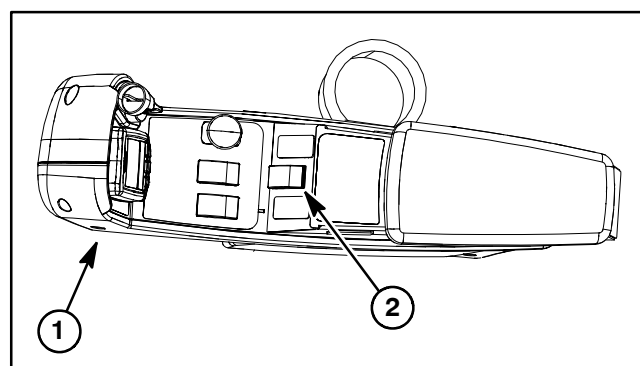


Figure 10

1. Console arm                      2. Lift switch

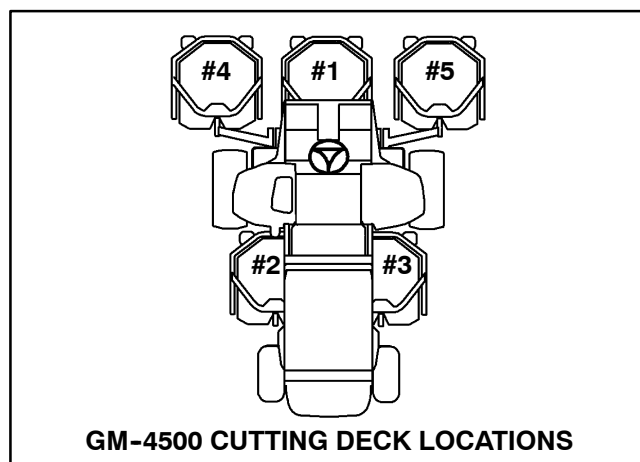
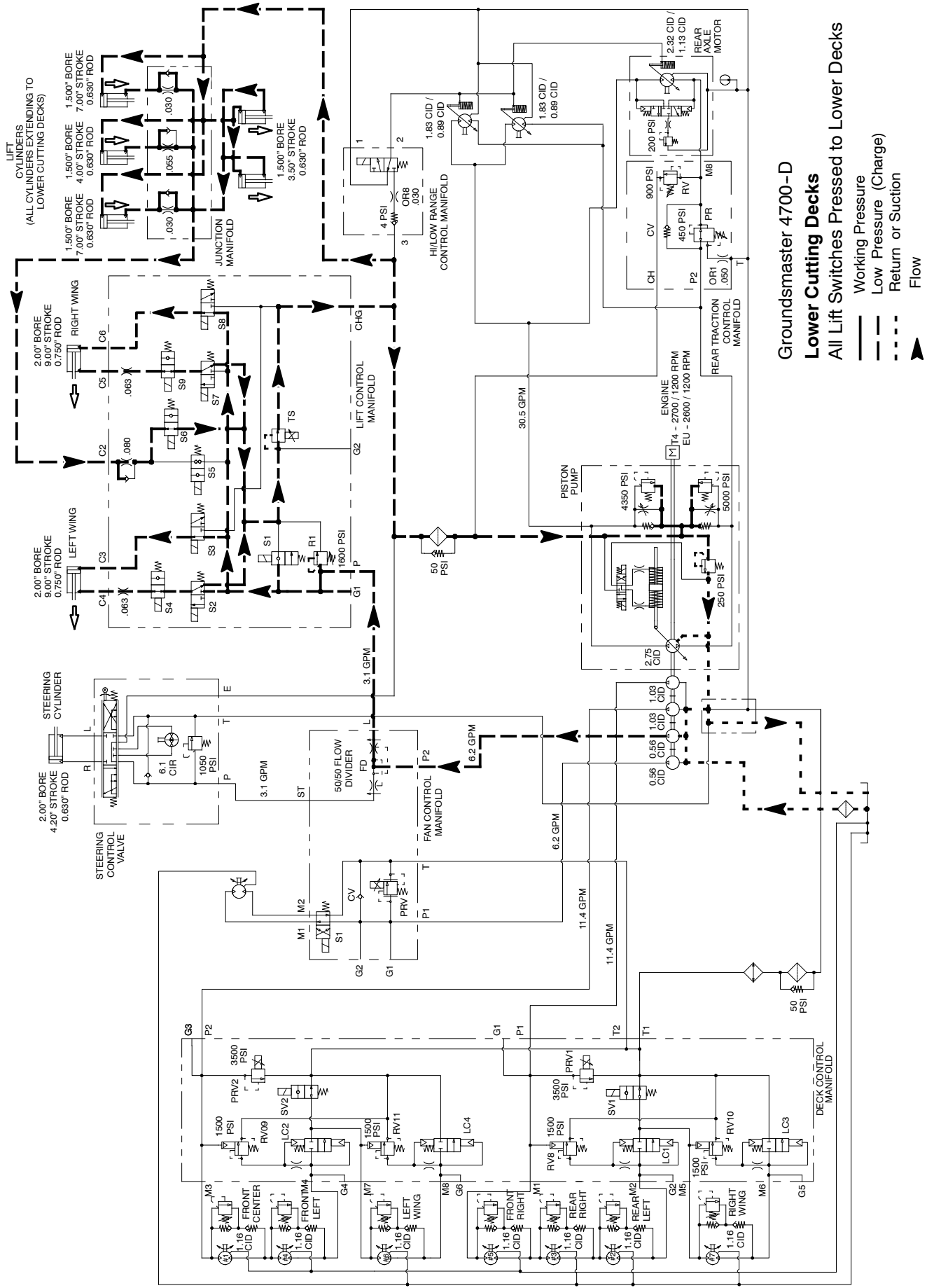


Figure 11



Groundsmaster 4700-D  
**Lower Cutting Decks**  
 All Lift Switches Pressed to Lower Decks

— Working Pressure  
 - - - Low Pressure (Charge)  
 - - - Return or Suction  
 ➤ Flow

## Lower Cutting Decks: Groundsmaster 4700-D

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 1600 PSI (110 bar) 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 (Fig. 12). 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) (Fig. 13).

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. Also, when in HI speed (transport), the cutting decks will not lower.

### 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-5002 controller 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 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-5001 controller 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.

A pressure sensor located in the hydraulic tube between the front wheel and rear axle motors is used by the TEC-5002 controller as an input to determine traction circuit pressure. Based on this sensor input, a PWM (Pulse Width Modulation) signal from the TEC-5002 controller is provided to the proportional relief valve (TS) to maintain counterbalance pressure.

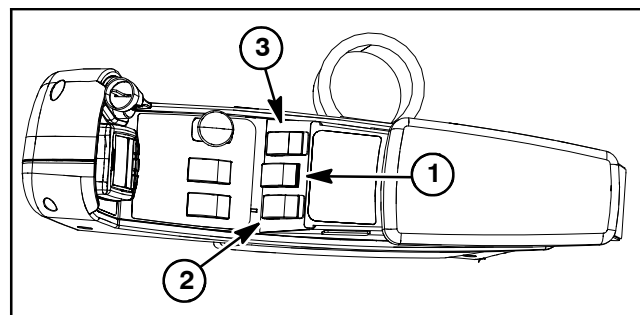


Figure 12

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

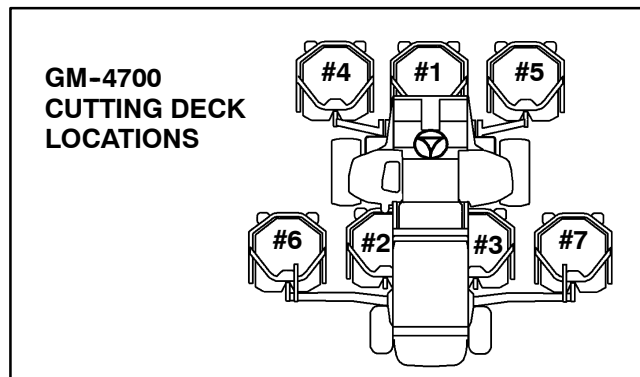
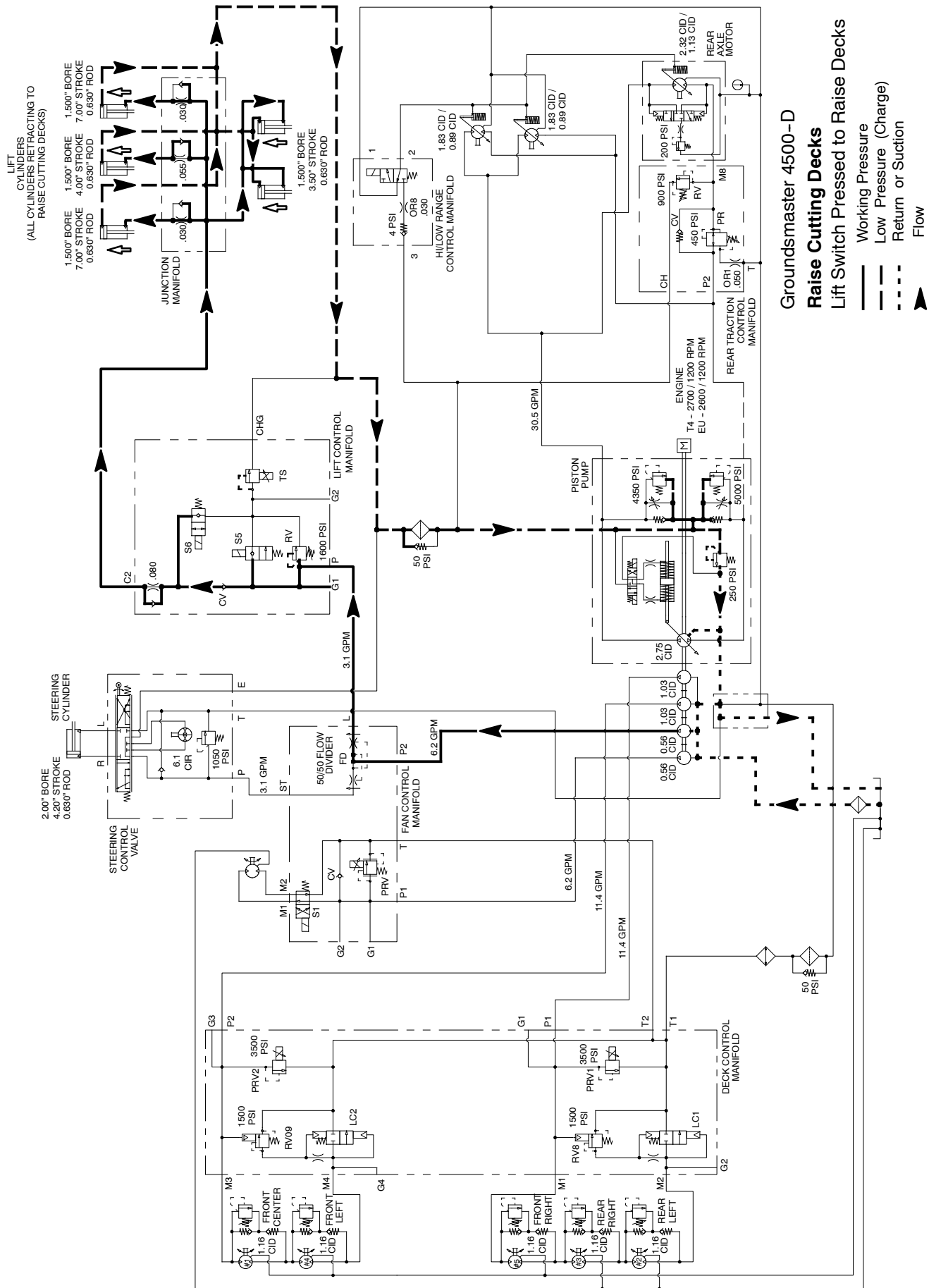


Figure 13



## Groundsmaster 4500-D

### Raise Cutting Decks

Lift Switch Pressed to Raise Decks

Working Pressure  
Low Pressure (Charge)  
Return or Suction  
Flow



## Raise Cutting Decks: Groundsmaster 4500- D

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 1600 PSI (110 bar) 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 (Fig. 14).

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.

### 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- 5002 controller 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.

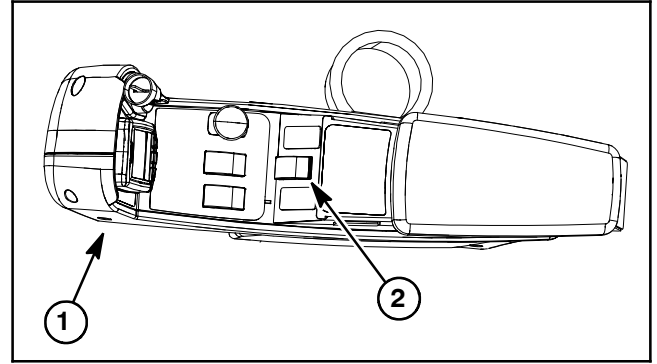


Figure 14

1. Console arm

2. Lift switch

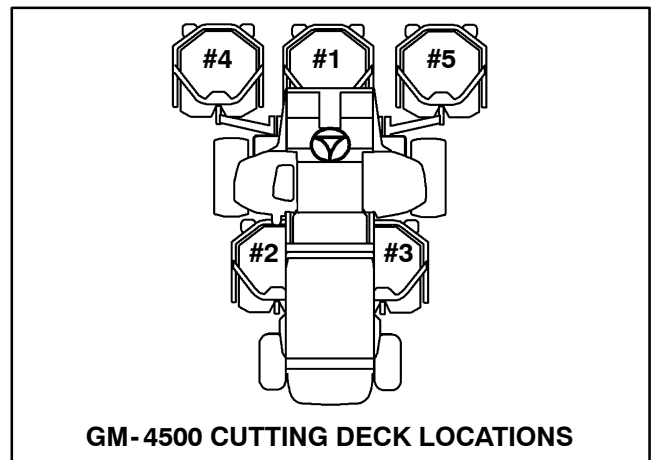


Figure 15



## Raise Cutting Decks: Groundsmaster 4700- D

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 1600 PSI (110 bar) 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 (Fig. 16). 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) (Fig. 17).

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.

### 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- 5002 controller 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- 5001 controller 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.

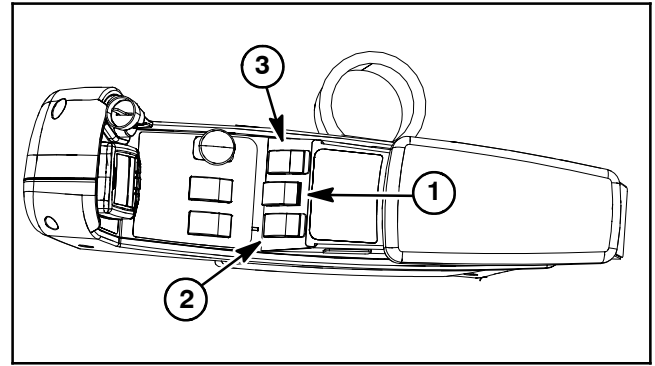


Figure 16

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

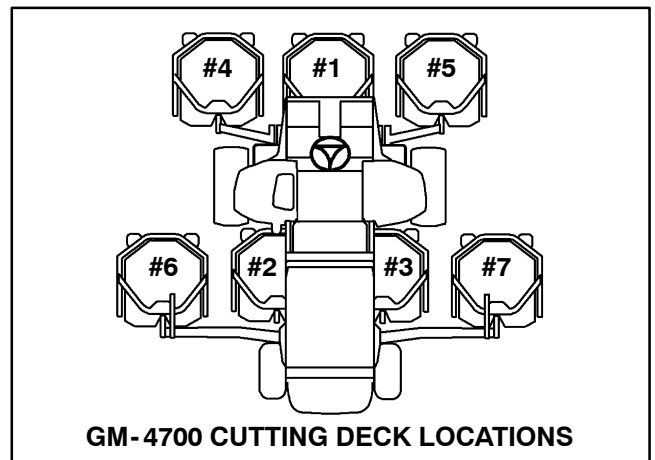
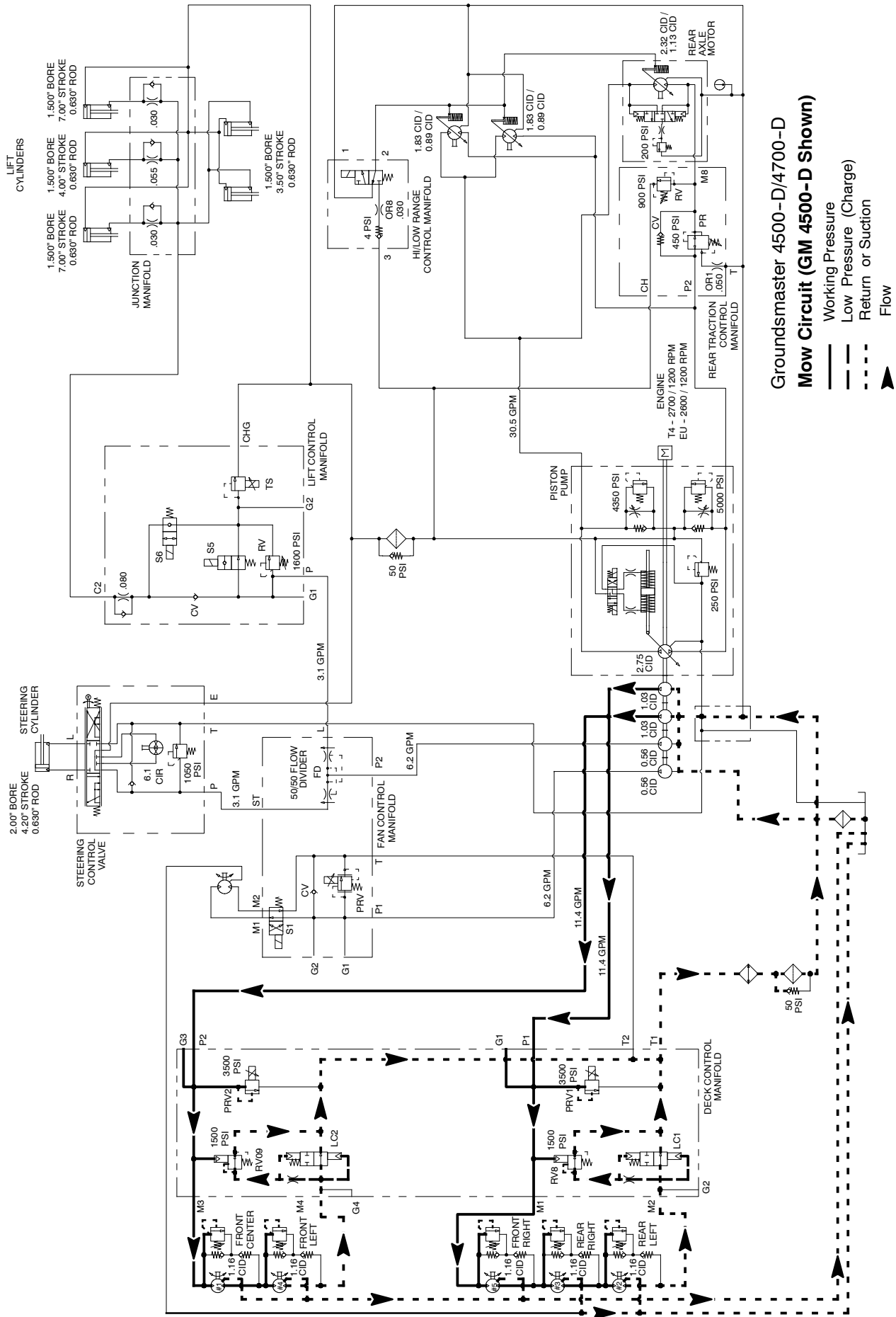


Figure 17



## Mow Circuit

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).

### 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 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-5002 controller. 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 (Fig. 19), 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-5001 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 3500 PSI (241 bar). 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 in this section).

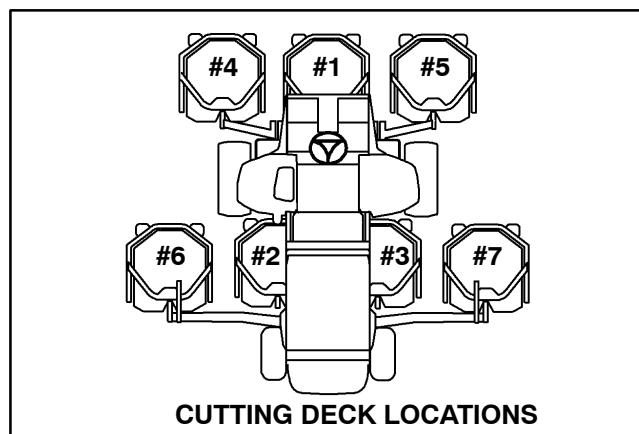


Figure 18

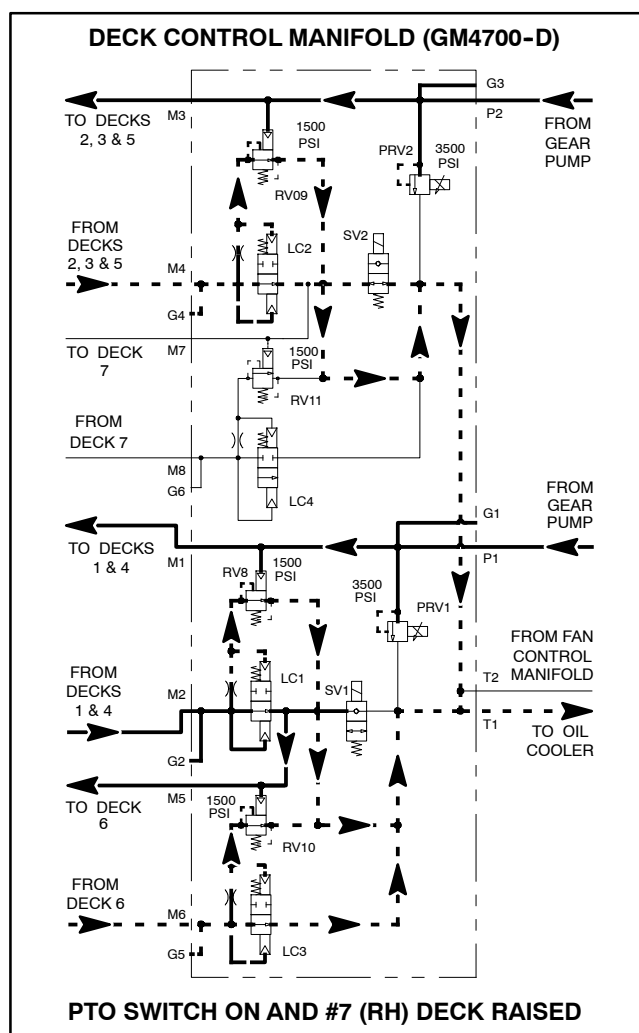


Figure 19

## Cutting Deck Blade Braking

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 (Fig. 20).

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 1500 PSI (104 bar), the relief valve opens which allows a small amount of hydraulic flow past the relief valve (Fig. 21). This flow causes a pressure increase that shifts the logic cartridge to once again allow oil flow from the deck motors (Fig. 22). When return pressure drops below 1500 PSI (104 bar), the relief valve reseats 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.

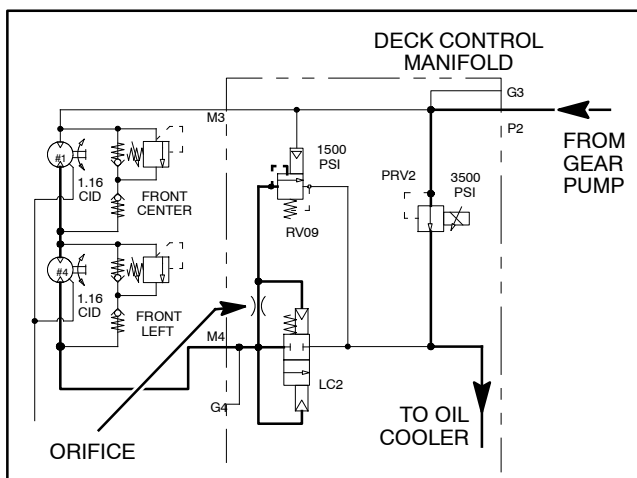


Figure 20

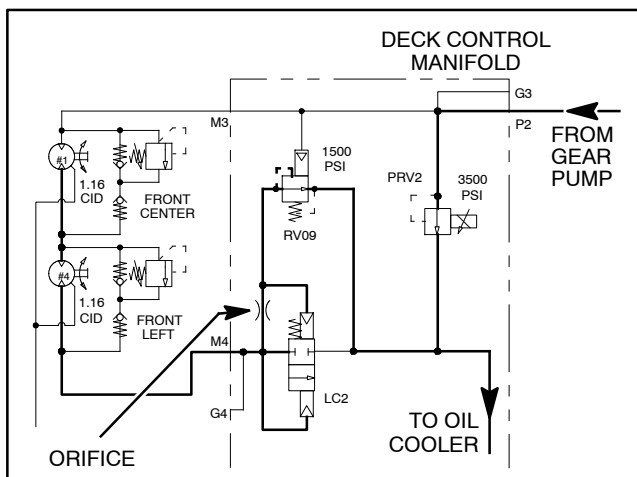


Figure 21

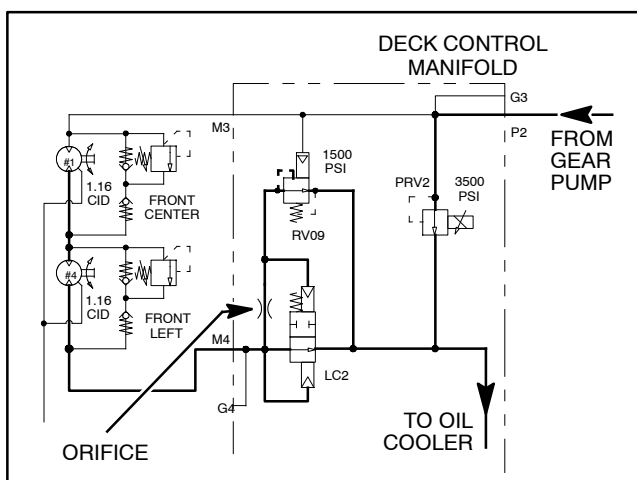


Figure 22

This page is intentionally blank.





## Steering Circuit

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 1050 PSI (72 bar) 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.

### 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 steer-

ing 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. 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.

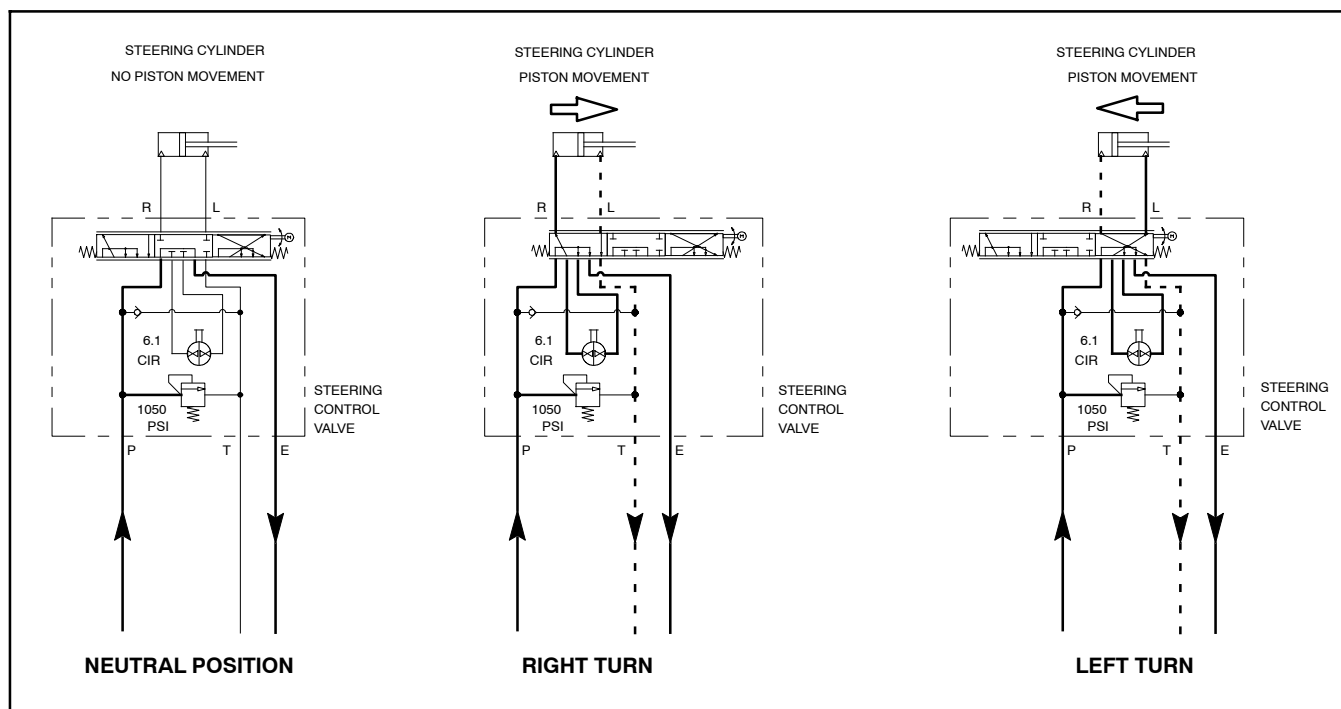
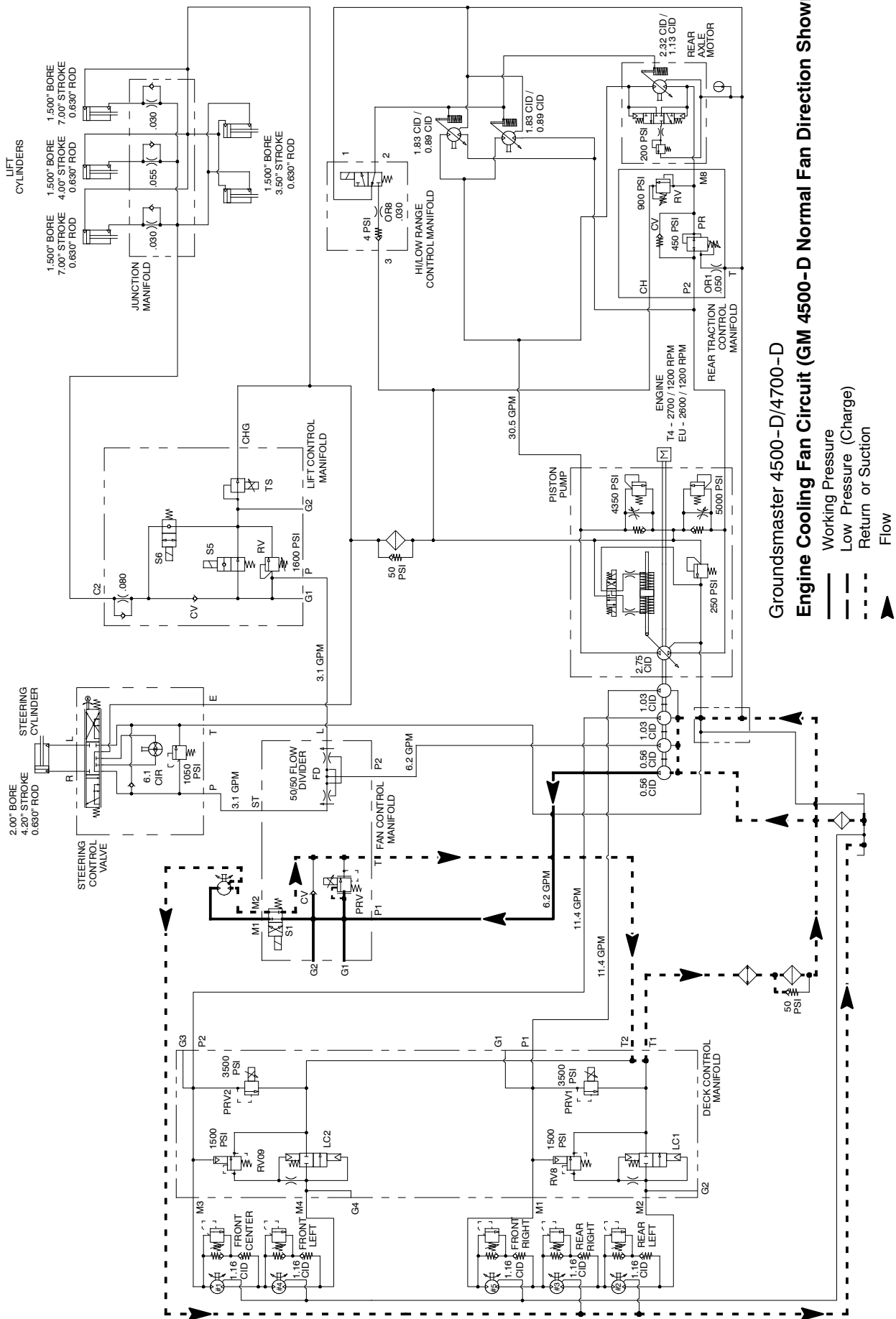


Figure 23



Groundmaster 4500-D/4700-D  
**Engine Cooling Fan Circuit (GM 4500-D Normal Fan Direction Shown)**

## Engine Cooling Fan Circuit

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-5002 controller.

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-5002 controller. 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 165°F (74°C). The fan motor increases to full speed (approximately 2800 RPM) as coolant reaches 180°F (82°C).

The fan motor automatically reverses if coolant reaches 203°F (95°C) or hydraulic oil reaches 212°F (100°C).

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 3000 PSI (207 bar).

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.

### Reverse Direction Fan Operation (Fig. 24)

The TEC-5002 controller 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.

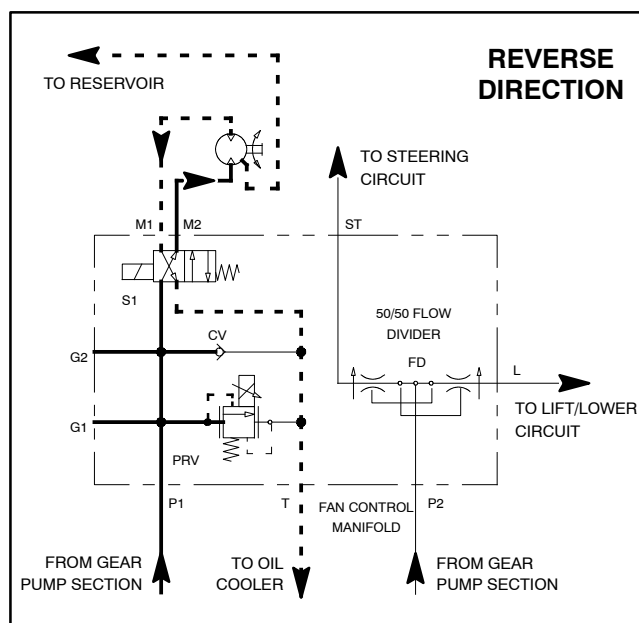


Figure 24

# Special Tools

Order these special tools from your Toro Distributor.

---

## Hydraulic Pressure Test Kit

Use to take various pressure readings for diagnostic tests. Quick disconnect fittings provided attach directly to mating fittings on machine test ports without tools. A high pressure hose is provided for remote readings. Contains one each: 1000 PSI (70 Bar), 5000 PSI (350 Bar) and 10000 PSI (700 Bar) gauges. Use gauges as recommended in Testing section of this chapter.

Toro Part Number: **TOR47009**



Figure 25

---

## Hydraulic Tester (Pressure and Flow)

This tester requires O-ring Face Seal (ORFS) adapter fittings for use on this machine (see Hydraulic Test Fitting Kit (TOR4079) in this section).

1. **INLET HOSE:** Hose connected from the system circuit to the inlet side of the hydraulic tester.
2. **LOAD VALVE:** A simulated working load is created in the circuit by turning the valve to restrict flow.
3. **PRESSURE GAUGE:** 0 to 5000 PSI gauge to provide operating circuit pressure.
4. **FLOW METER:** This meter measures actual oil flow in the operating circuit with a gauge rated at 15 GPM.
5. **OUTLET HOSE:** A hose from the outlet side of the hydraulic tester connects to the hydraulic system circuit.

Toro Part Number: **TOR214678**



Figure 26

## 40 GPM Hydraulic Tester (Pressure and Flow)

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

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

Toro Part Number: **AT40002**

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



Figure 27

## Traction Circuit Hydraulic Diagnostic Fittings

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**

90° Fitting **340-159**

Diagnostic Fitting **86-5480**

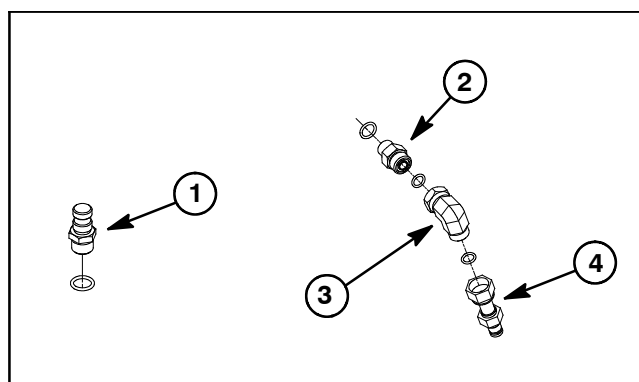


Figure 28

1. Diagnostic fitting
2. Straight fitting

3. 90° fitting
4. Diagnostic fitting

## Hydraulic Hose Kit

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

Toro Part Number: **TOR6007**

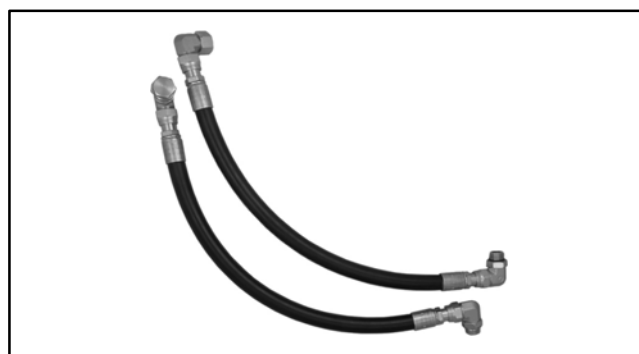


Figure 29

---

## High Flow Hydraulic Filter Kit

The high flow hydraulic filter kit is designed with large flow (40 GPM/150 LPM) and high pressure (5000 PSI/345 bar) capabilities. This kit provides for bi-directional filtration which prevents filtered debris from being allowed back into the circuit regardless of flow direction.

If a component failure occurs in the closed loop traction circuit, contamination from the failed part will remain in the circuit until removed. When connecting hydraulic test gauges in order to test traction circuit components or after replacing a failed traction circuit component (e.g. piston pump or wheel motor), the high flow hydraulic filter can be installed in the traction circuit. The filter will ensure that contaminants are removed from the closed loop and thus, do not cause additional component damage.

Toro Part Number: **TOR6011**

**NOTE:** This kit does not include hoses (see Hydraulic Hose Kit TOR6007 above).

**NOTE:** Replacement filter element is Toro part number TOR6012. Filter element cannister tightening torque is **25 ft-lb (34 N-m)**.



Figure 30

---

## O-Ring Kit

The O-ring kit includes O-rings in a variety of sizes for face seal and port seal hydraulic connections. It is recommended that O-rings be replaced whenever a hydraulic connection is loosened.

Toro Part Number: **117-2727**



Figure 31

Hydraulic Test Fitting Kit

This kit includes a variety of O-ring Face Seal fittings to enable you to connect test gauges into the system.

The kit includes: tee's, unions, reducers, plugs, caps and male test fittings.

Toro Part Number: **TOR4079**





Toro Test Fitting Kit TOR4079		
Fitting	Tool Number	
	Swivel Nut Run Tee 2 Each	Union 1 Each Toro Tool Number
	Size	Size
	No 4	No 4 to No 8
	No 6	No 10 to No 8
	Plug 2 Each	Reducer 1 Each Toro Tool Number
	Size	Size
	No 4	No 10 to No 8
	No 6	No 12 to No 8
	Cap 2 Each	Test Cap Fitting 2 Each Toro Tool Number
	Size	Size
	No 4	No 4
	No 6	No 6
	Toro Tool Number	Test Fitting 2 Each Toro Tool Number
		Size
		7/16 - 20
		1/8 Pipe Thread

Figure 32

Measuring Container

Use this container for doing hydraulic motor efficiency testing (motors with case drain lines only). Measure efficiency of a hydraulic motor by restricting the outlet flow from the motor and measuring leakage from the case drain line while the motor is pressurized by the hydraulic system.

The table in Figure 34 provides gallons per minute (GPM) conversion for measured milliliter or ounce motor case drain leakage.

Toro Part Number: **TOR4077**



Figure 33

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

Figure 34

## Remote Starter Switch

After flushing the hydraulic system or replacing a hydraulic component (e.g. gear pump, piston pump, wheel motor), it is necessary to prime the hydraulic pumps. A remote starter switch (Fig. 35) can be used for this purpose. Obtain a remote starter switch locally.

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

A remote starter 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 (Fig. 36).

**NOTE:** For information on using the remote starter switch to prime the hydraulic pumps, see Flush Hydraulic System in the Service and Repairs section of this chapter.



Figure 35

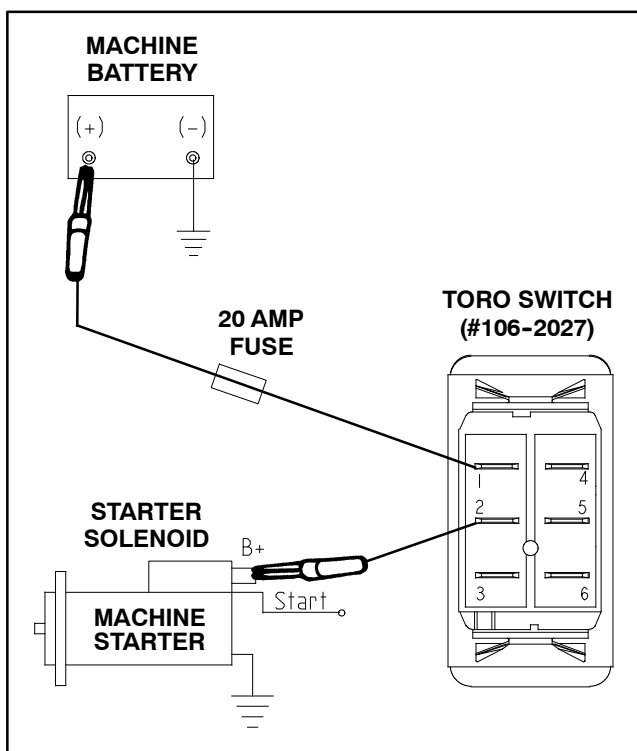


Figure 36

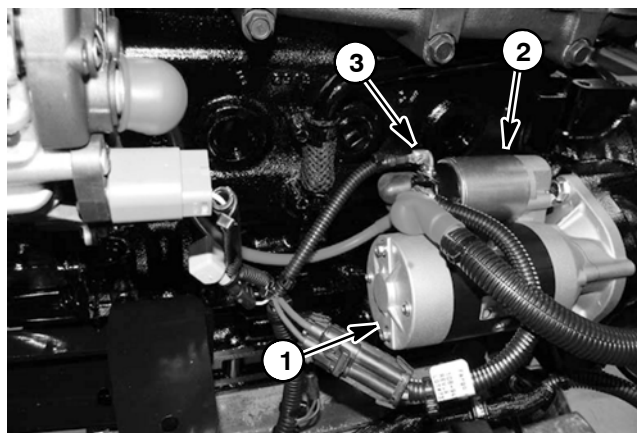


Figure 37

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



# Troubleshooting

The charts that follow contain information to assist in hydraulic system troubleshooting. There may possibly be more than one cause for a machine malfunction.

Refer to the Testing section of this Chapter for precautions and specific testing procedures.

## General Hydraulic System Problems

Problem	Possible Cause
Hydraulic system operates hot.  <b>NOTE:</b> 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.  Hydraulic reservoir oil level is low.  Hydraulic oil is contaminated or the wrong type.  Brakes are applied or sticking.  Piston pump bypass valve(s) is open or damaged.  Cooling system is not operating properly.  Charge pressure is low.  Engine cooling fan circuit is malfunctioning (see Engine Cooling Fan Circuit Problems in this section).  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 in suction line.
Hydraulic oil leak(s).	Fitting(s), hose or tube loose or damaged.  Missing or damaged O-ring in fitting.

## Traction Circuit Problems

**NOTE:** When troubleshooting traction circuit problems, if a problem exists in both low (mow) and high (transport) 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 HI speed (transport), consider a problem that only exists in mow (e.g. swashplate components in front wheel or rear axle motor, solenoid valve in HI/LOW range control manifold).

Problem	Possible Cause
Machine operates in one direction only.	<p>Piston (traction) pump by-pass valve is open or damaged.</p> <p>Traction relief valve in piston pump is leaking or faulty.</p> <p>Piston (traction) pump servo control valve orifices or screens are plugged or damaged.</p> <p>Problem with TEC output to piston (traction) pump servo control exists (see Chapter 5 – Electrical System).</p>
Traction pedal reaction is sluggish.	<p>Traction pedal components are stuck or binding.</p> <p>Traction charge pressure is low.</p> <p>Piston (traction) pump servo control valve orifices are plugged or damaged.</p>
Machine travels too far before stopping when the traction pedal is released.	<p>Traction pedal components are stuck or binding.</p> <p>Traction charge pressure is low.</p> <p>Piston (traction) pump servo control valve orifices are plugged or damaged.</p>
Traction power is lost or machine will not operate in either direction.	<p>Hydraulic reservoir oil level is low (NOTE: Other hydraulic systems are affected as well).</p> <p>Piston (traction) pump by-pass valve is open or damaged.</p> <p>Traction charge pressure is low.</p> <p>Traction circuit pressure is low.</p> <p>Problem with TEC output to servo control (see Chapter 5 – Electrical System).</p>
<p>LOW traction speed (mow) will not engage.</p> <p><b>NOTE:</b> LOW (mow) will not engage when the cutting decks are lowered.</p>	<p>Electrical problem exists that prevents solenoid valve in HI/LOW range control manifold from being de-energized (see Chapter 5 – Electrical System).</p> <p>Solenoid valve in HI/LOW range control manifold is faulty.</p>
LOW traction speed (mow) will not disengage.	<p>Electrical problem exists that prevents solenoid valve in HI/LOW range control manifold from being energized (see Chapter 5 – Electrical System).</p> <p>Solenoid valve in HI/LOW range control manifold is faulty.</p>

## Mow Circuit Problems

Problem	Possible Cause
<p>None of the cutting decks will operate.</p> <p><b>NOTE:</b> 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.</p>	<p>Cutting decks are not fully lowered to ground.</p> <p>PTO switch is not in engaged position.</p> <p>Operator seat is unoccupied.</p> <p>Traction system is in HI speed (transport).</p> <p>Engine temperature is excessive causing cutting decks to be disengaged (Fault should be displayed on InfoCenter).</p> <p>Electrical problem exists that prevents deck control manifold solenoid valve operation (see Chapter 5 – Electrical System).</p> <p>Gear pump sections that supply mow circuits are damaged.</p>
<p>One cutting deck will not operate.</p>	<p>Circuit pressure to the affected deck motor is low.</p> <p>Cutting deck problem exists (see Chapter 8 – Cutting Decks).</p> <p>Spline on affected deck motor (or spindle) is damaged.</p> <p>Deck motor relief valve is stuck or damaged.</p> <p>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.</p> <p>On Groundsmaster 4700-D, deck is not fully lowered to ground (decks #6 and #7).</p> <p>On Groundsmaster 4700-D, cartridge valve SV1 or SV2 in deck control manifold is damaged or sticking (decks #6 and #7).</p>
<p>Several cutting decks will not operate.</p>	<p>Electrical problem exists that prevents deck control manifold solenoid valve operation (see Chapter 5 – Electrical System).</p> <p>Decks are not fully lowered to ground.</p> <p>Deck control manifold solenoid cartridge valve (PRV1 or PRV2) for affected decks is faulty.</p> <p>Logic cartridge valve (LC1 or LC2) in deck control manifold is stuck or damaged.</p> <p>Gear pump section (first or second section) is worn or damaged.</p>

---

## Mow Circuit Problems (Continued)

Problem	Possible Cause
All cutting decks operate slowly.	Engine RPM is low.  Deck motor is 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 Circuit 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 (other hydraulic systems 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.  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 lift circuits).

## Lift/Lower Circuit Problems

Problem	Possible Cause
<p>Cutting decks will not raise.</p> <p><b>NOTE:</b> Operator must be in seat in order to raise the cutting decks.</p>	<p>Operator seat is unoccupied.</p> <p>Hydraulic oil level in reservoir is low.</p> <p>Electrical problem exists that prevents lift control manifold solenoid valve operation (see Chapter 5 – Electrical System).</p> <p>Lift cylinder(s) is (are) damaged.</p> <p>Lift arm pivots are binding.</p> <p>Lift/lower circuit relief valve in lift control manifold is stuck open.</p> <p>Solenoid valve in lift control manifold is damaged or sticking.</p> <p>Flow divider (FD) in fan control manifold is faulty.</p> <p>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).</p>
<p>Cutting decks raise, but will not stay up.</p> <p><b>NOTE:</b> Lift cylinders cannot provide an absolutely perfect seal. The lift arms will eventually lower if left in the raised position during storage.</p>	<p>Lift circuit hydraulic lines or fittings are leaking.</p> <p>Cartridge valve in lift control manifold is stuck open.</p> <p>Air exists in lift circuit.</p> <p>Lift cylinder is damaged.</p>
<p>Cutting decks will not lower.</p> <p><b>NOTE:</b> Operator must be in seat and traction system must be in LOW speed (mow) in order to lower the cutting decks.</p>	<p>Operator seat is unoccupied.</p> <p>Traction system is in HI speed (transport).</p> <p>Lift arm pivots are binding.</p> <p>Lift cylinder is damaged.</p> <p>Electrical problem exists that prevents lift control manifold solenoid valve operation (see Chapter 5 – Electrical System).</p> <p>Proportional relief cartridge valve (TS) in lift control manifold is damaged or sticking.</p>

---

## Engine Cooling Fan Circuit 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 5 – Electrical System).
Cooling fan does not rotate.	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 fan control 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 problem exists that prevents fan control manifold proportional relief valve (PRV) operation (see Chapter 5 – Electrical System).

This page is intentionally blank.

# Testing

The most effective method for isolating problems in the hydraulic system is by using hydraulic test equipment such as pressure gauges and flow meters in the circuits during various operational checks (See the Special Tools section in this chapter).

**IMPORTANT:** All obvious areas such as 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 (PSI) rating as listed in test procedures could result in damage to the gauge and possible personal injury from leaking hot oil.



## CAUTION

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



## WARNING

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



## WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved and all rotating machine parts must be stopped. See Relieving Hydraulic System Pressure in the General Information section of this chapter.

## 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. Hydraulic system contamination will cause excessive wear of hydraulic 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. Also, make sure the hydraulic reservoir is full.
3. Check control linkages for improper adjustment, binding or broken parts.
4. Put metal caps or plugs on all 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 Chapter 3 – Yanmar Diesel Engine for engine speed specifications.
6. When using hydraulic tester with pressure and flow capabilities, the inlet and the outlet hoses must be properly connected and not reversed to prevent damage to the hydraulic tester or machine components.
7. When using hydraulic tester with pressure and flow capabilities, open load valve in the tester completely 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. To prevent damage, position tester hoses so that rotating or moving machine parts do not contact the hoses or tester.
10. After connecting test equipment, make sure hydraulic reservoir is full.
11. After installing test equipment, start engine and run at idle speed. Check for hydraulic leakage and correct before proceeding with test.
12. Before returning machine to use after testing, 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, Traction Circuit Reducing Valve (PR) Pressure, Rear Traction Circuit Relief Valve (RV) Pressure, Gear Pump Flow and/or Piston (Traction) Pump Flow Tests.

**IMPORTANT: Refer to Traction Circuit Component Failure in the General Information section of this chapter for information regarding the importance of removing contamination from the traction circuit.**

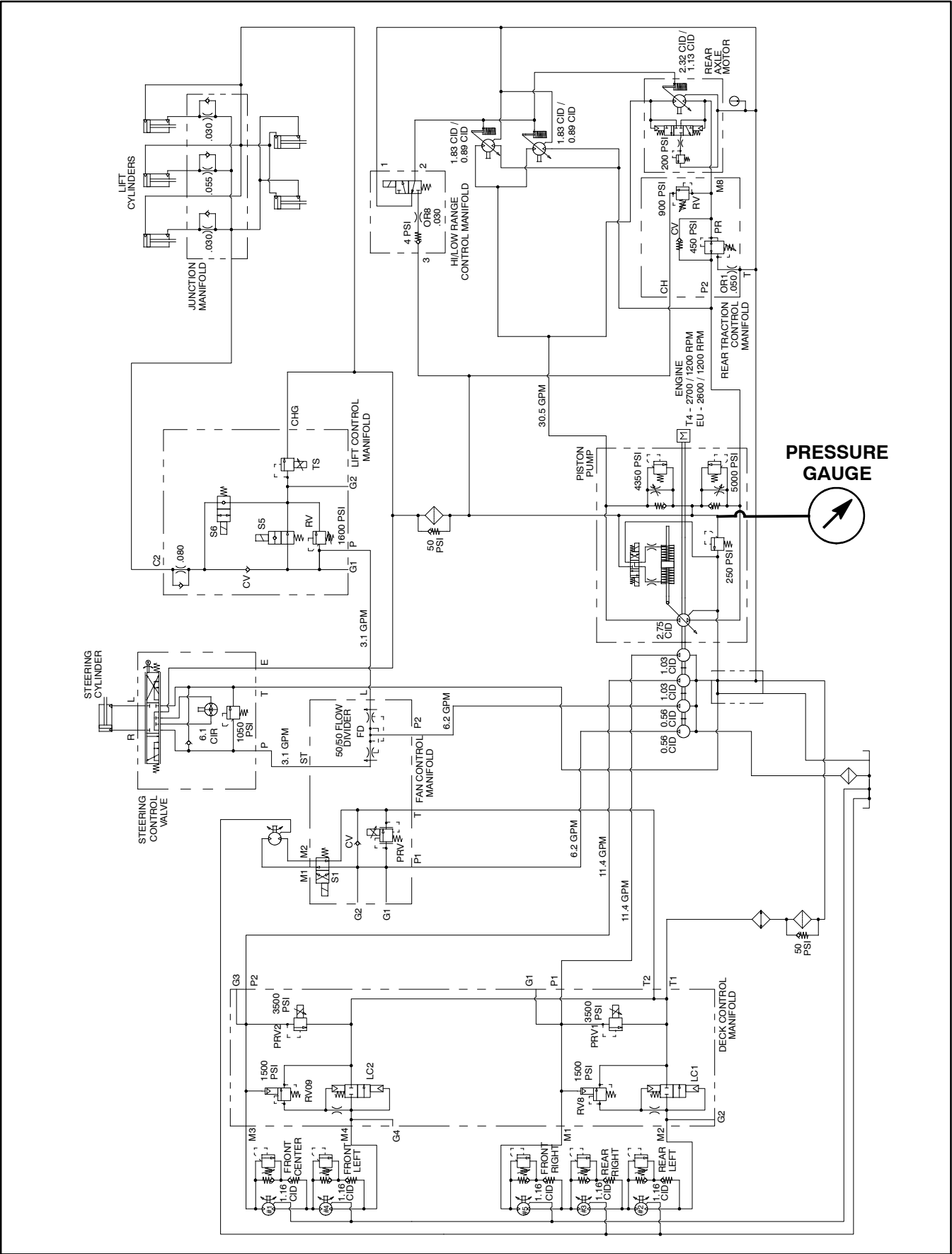
2. If a cutting (mow) circuit problem exists, consider performing one or more of the following tests: Cutting Deck Circuit Pressure, Cutting Deck Circuit Relief Pressure, Deck Motor Case Drain Leakage and/or Gear Pump Flow Tests.

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)



**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.
3. Raise hood and locate piston (traction) pump charge port plug on top of pump (Fig. 38). Thoroughly pump surfaces around plug to prevent system contamination.
4. Remove plug from pump traction charge port and then install diagnostic test fitting (Toro part number 59-7410) into charge port.
5. Connect a 1000 PSI (70 bar) pressure gauge onto diagnostic test fitting.
6. Start the engine and increase engine speed to high idle speed with no load on the hydraulic system.

**GAUGE READING TO BE 200 to 300 PSI (13.8 to 20.6 bar)**

7. Stop engine and record test results.
8. 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 in the Service and Repairs section of this chapter).
  - C. If necessary, check for internal wear or damage in the third gear pump section (see Gear Pump Flow Test in this section). **NOTE:** Steering and lift/lower circuits would also be affected if the third gear pump section is worn or damaged.

9. 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 250 PSI (17.2 bar), charge pressure in forward or reverse should be from 200 to 250 PSI (13.8 to 17.2 bar)

10. If charge pressure is good under no load (step 6), but drops below specification when under traction load (step 9), the piston (traction) pump, front wheel motors and/or rear axle motor should be suspected of wear and inefficiency. When the pump and/or traction motor(s) are worn or damaged, the charge pump is not able to keep up with internal leakage in traction circuit components.

11. 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 **32 ft-lb (43 N-m)**. Lower and secure hood.

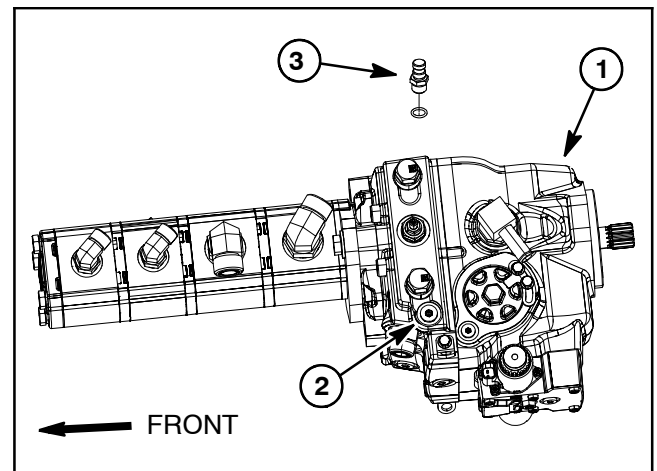
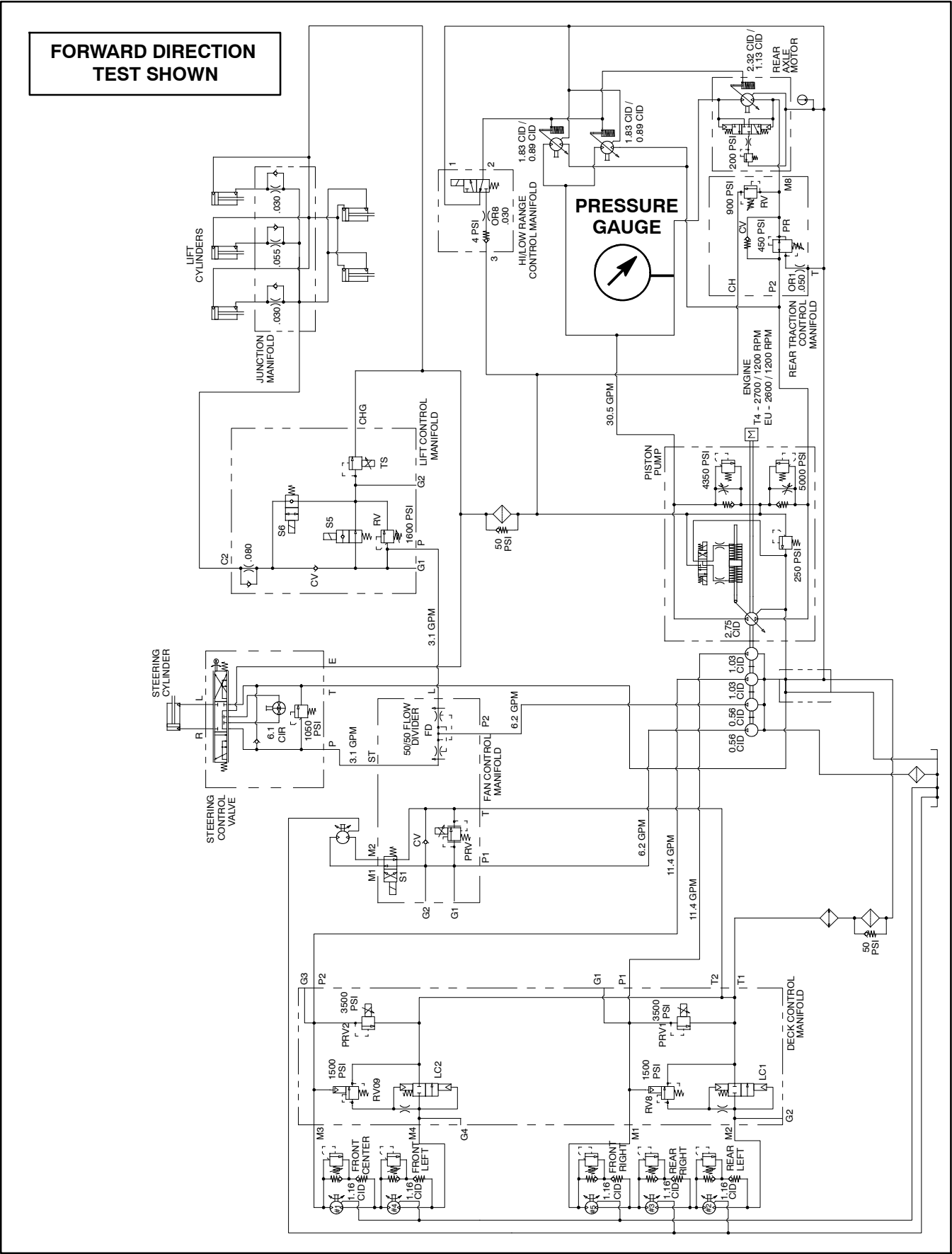


Figure 38

- |                         |                            |
|-------------------------|----------------------------|
| 1. Traction pump        | 3. Diagnostic test fitting |
| 2. Traction charge port |                            |

Traction Circuit Relief Pressure (Using Pressure Gauge)



## 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.
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 (Fig. 39).

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 (Fig. 40). Thoroughly clean side of pump around plug to prevent system contamination. Remove plug from pump reverse traction port and then install straight fitting, 90° fitting and diagnostic test fitting into pump port (see Special Tools in this chapter for fitting part numbers).

4. Connect a 10,000 PSI (700 bar) 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: **4100 to 4600 PSI (283 to 317 bar)**

Reverse: **4750 to 5250 PSI (328 to 362 bar)**

7. Release traction pedal and stop engine. Record test results.

8. If traction pressure is too low, make sure that bypass valve on traction pump is fully seated and then inspect traction pump relief valve in piston (traction) pump (Fig. 40). 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.

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

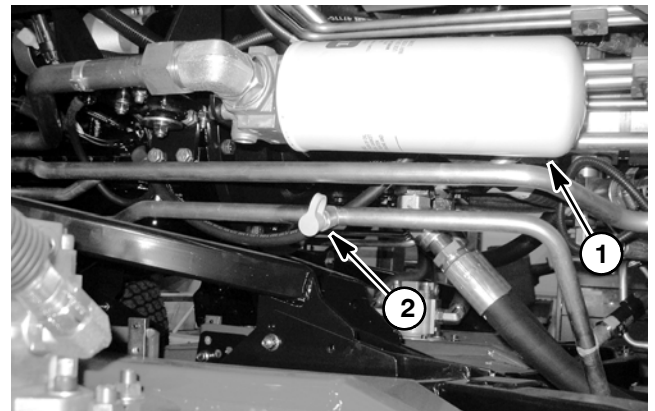


Figure 39

1. Oil filter

2. Forward traction fitting

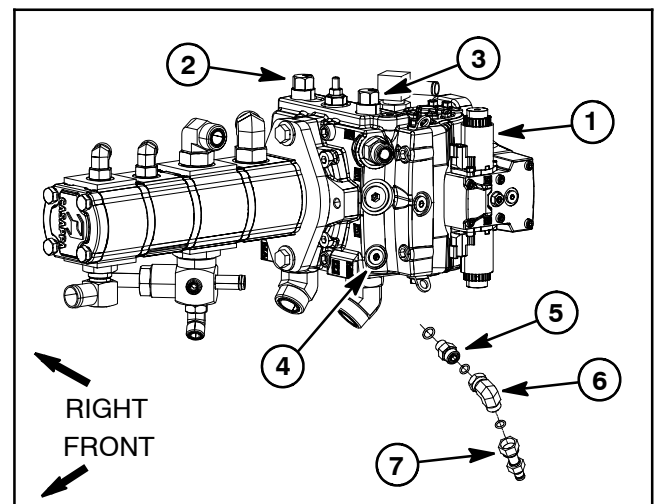


Figure 40

1. Traction pump

2. Forward relief valve

3. Reverse relief valve

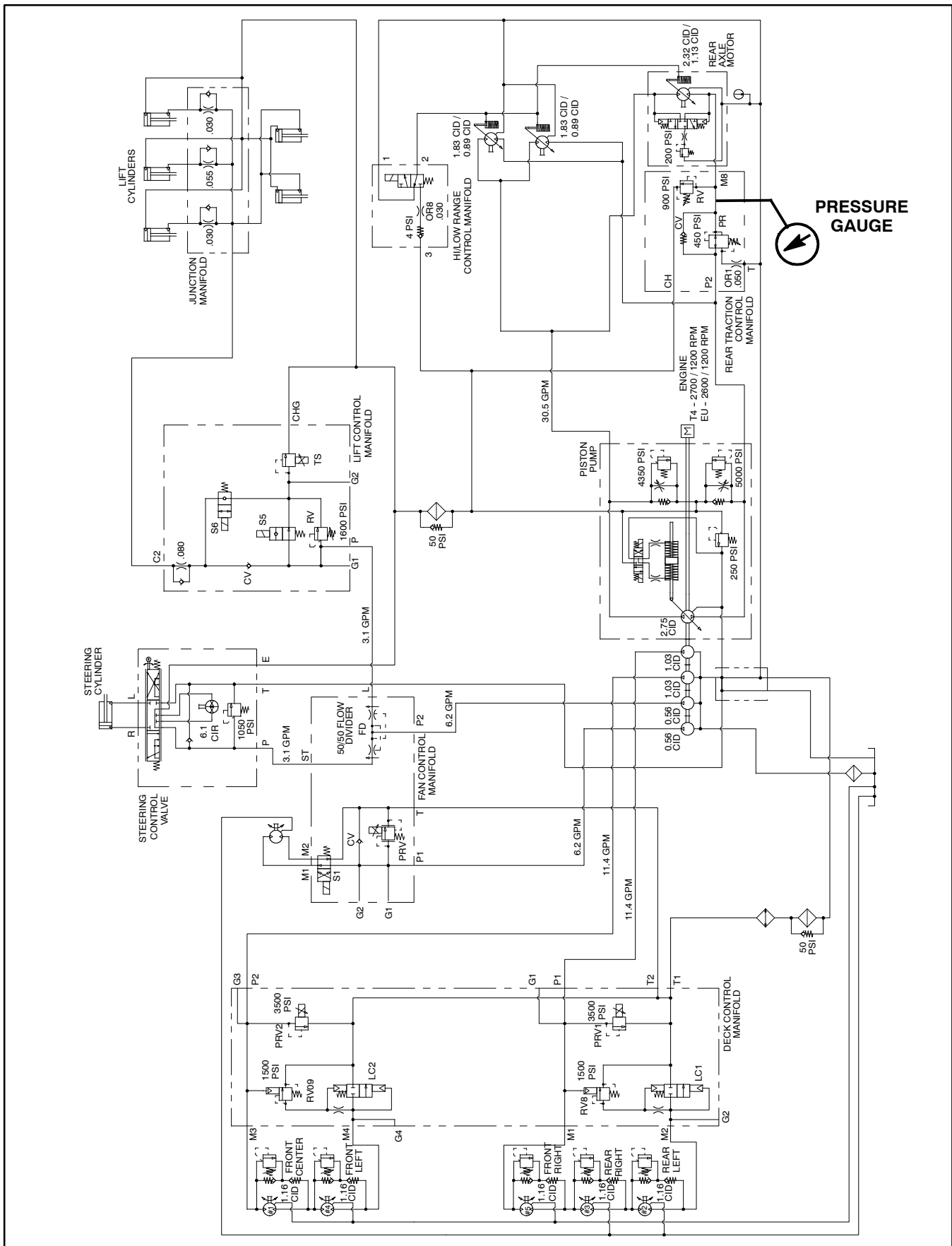
4. Reverse traction port

5. Straight fitting

6. 90° fitting

7. Diagnostic test fitting

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



## 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 450 PSI (31 bar) 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.

3. Locate rear traction manifold that is attached to the front frame next to the left side front wheel (Fig. 41). 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 1000 PSI (70 bar) pressure gauge with hydraulic hose attached to installed diagnostic fitting.

5. Start engine and increase engine speed to high idle speed. Make sure that HI/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 420 to 470 PSI (29 to 32 bar) when the pressure reducing (PR) valve opens.**

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

8. The pressure reducing valve (PR) is located on the bottom of the rear traction manifold (Fig. 42). 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 **25 ft-lb (34 N-m)**.

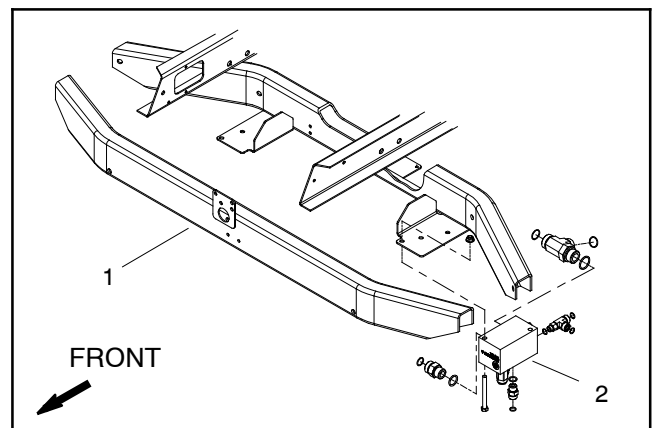


Figure 41

1. Front frame

2. Rear traction manifold

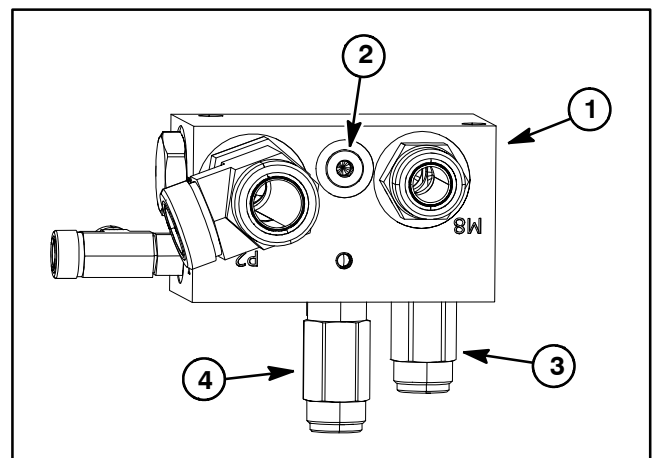


Figure 42

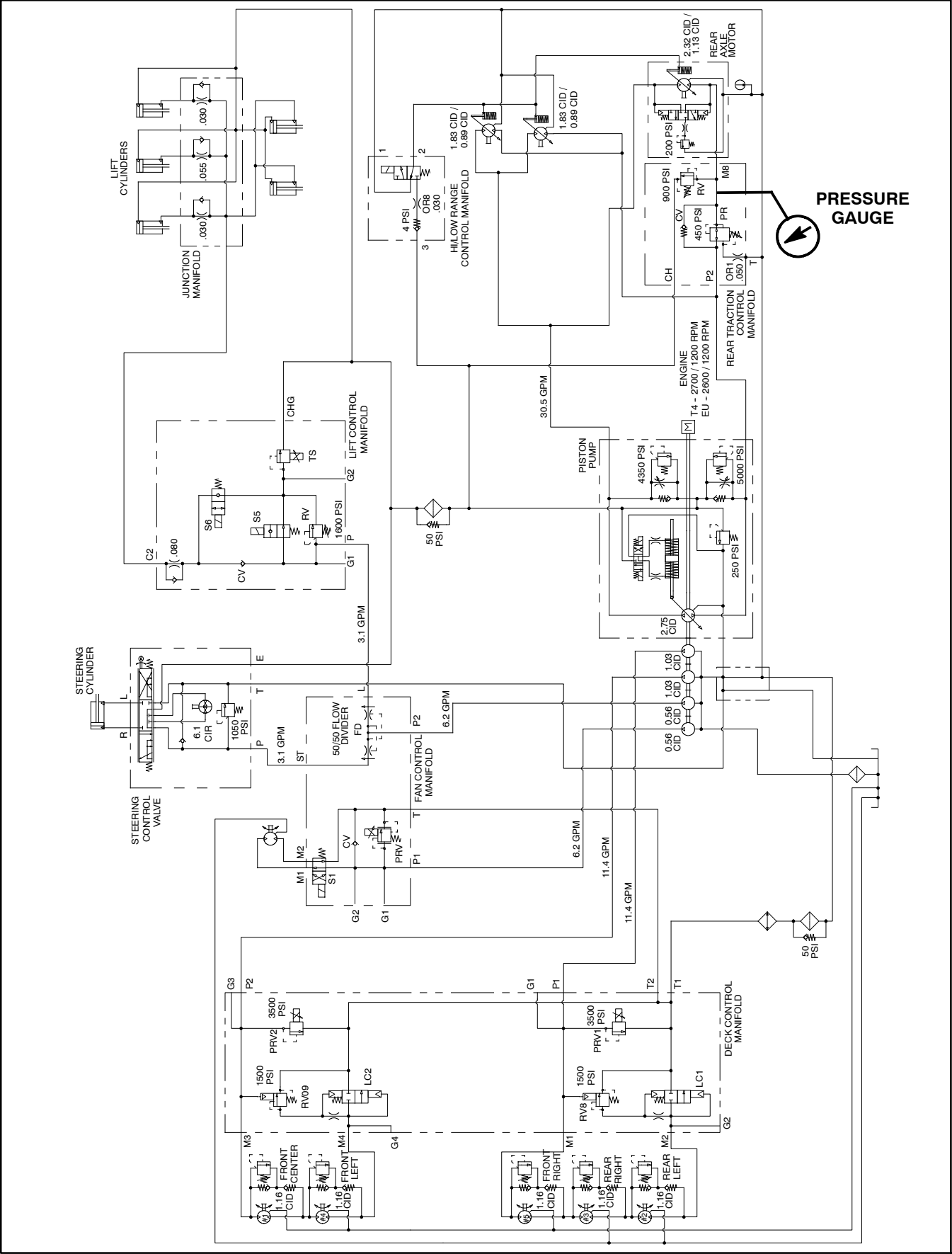
1. Rear traction manifold

2. #6 zero leak plug

3. Relief (RV) valve

4. Reducing (PR) valve

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





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

**NOTE:** A relief valve (RV) in the rear traction control manifold reduces rear axle motor pressure created in down hill, dynamic braking conditions to pre-vent 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.**

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.

3. Locate rear traction manifold that is attached to the front frame next to the left side front wheel (Fig. 43). 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 1000 PSI (70 bar) pressure gauge with hydraulic hose attached to installed diagnostic fitting.

5. Start engine and increase engine speed to high idle speed. Make sure that HI/LOW 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 Test in this section).

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 900 PSI (62 bar)**.

8. Stop engine and record test results.

**NOTE:** If the rear traction circuit pressure reducing valve (PR) pressure is excessive, operation of the rear traction relief valve (RV) may be affected. Ensure that pressure reducing valve (PR) pressure is correct .

9. The rear traction circuit relief valve (RV) is located on the bottom of the rear traction manifold (Fig. 44). If test pressure is incorrect, replace relief valve (RV).

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 **25 ft-lb (34 N-m)**.

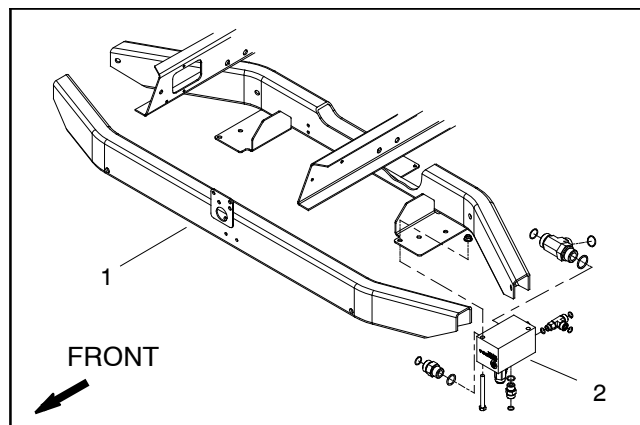


Figure 43

1. Front frame

2. Rear traction manifold

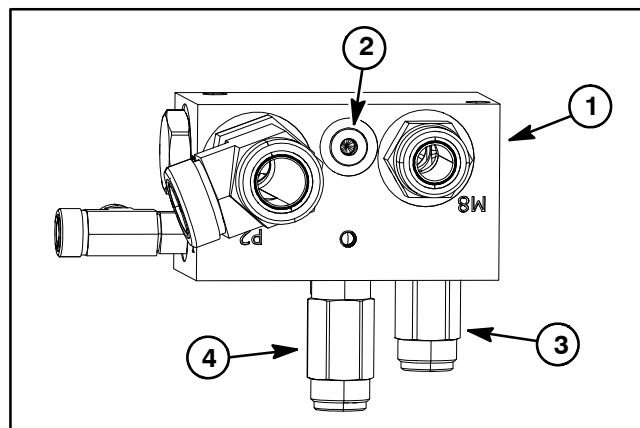


Figure 44

1. Rear traction manifold

2. #6 zero leak plug

3. Relief (RV) valve

4. Reducing (PR) valve

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

## 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 In-foCenter settings menu.

**IMPORTANT:** Traction circuit flow for the Groundsmaster 4500/4700 is approximately 30 GPM (113.5 LPM). Use 40 GPM Hydraulic Tester #AT40002 (pressure and flow) for this test (see Special Tools in this chapter).



### 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 in Chapter 1 – Safety).

3. Thoroughly clean junction of hydraulic hose and **right** side fitting on bottom of piston pump (forward port) (Fig. 45). 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 in this chapter) to connect tester to machine. Make sure that fitting and hose connections are properly tightened. Also, make sure the flow control valve on tester is fully open.

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 **1000 PSI (69 bar)** is obtained. Verify with the In-foCenter 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 **30 GPM (113 LPM)**.

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 **24 GPM (91 LPM)**, consider the following:

A. The traction pedal is not calibrated correctly (see Traction Pedal Calibration in the Adjustments section of Chapter 5 – Electrical System).

B. The piston pump swash plate 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.

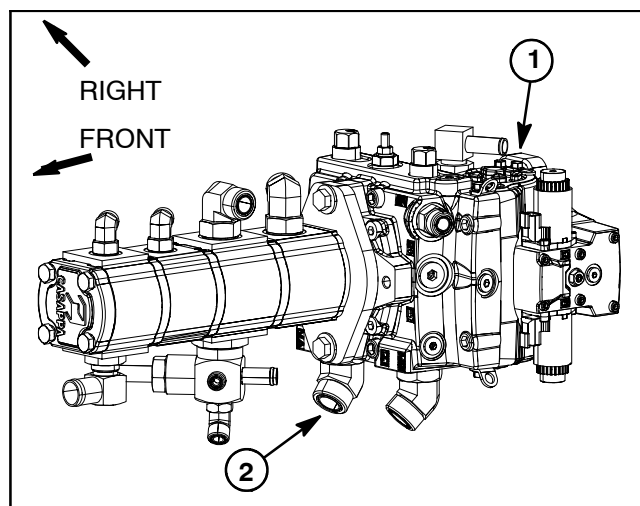
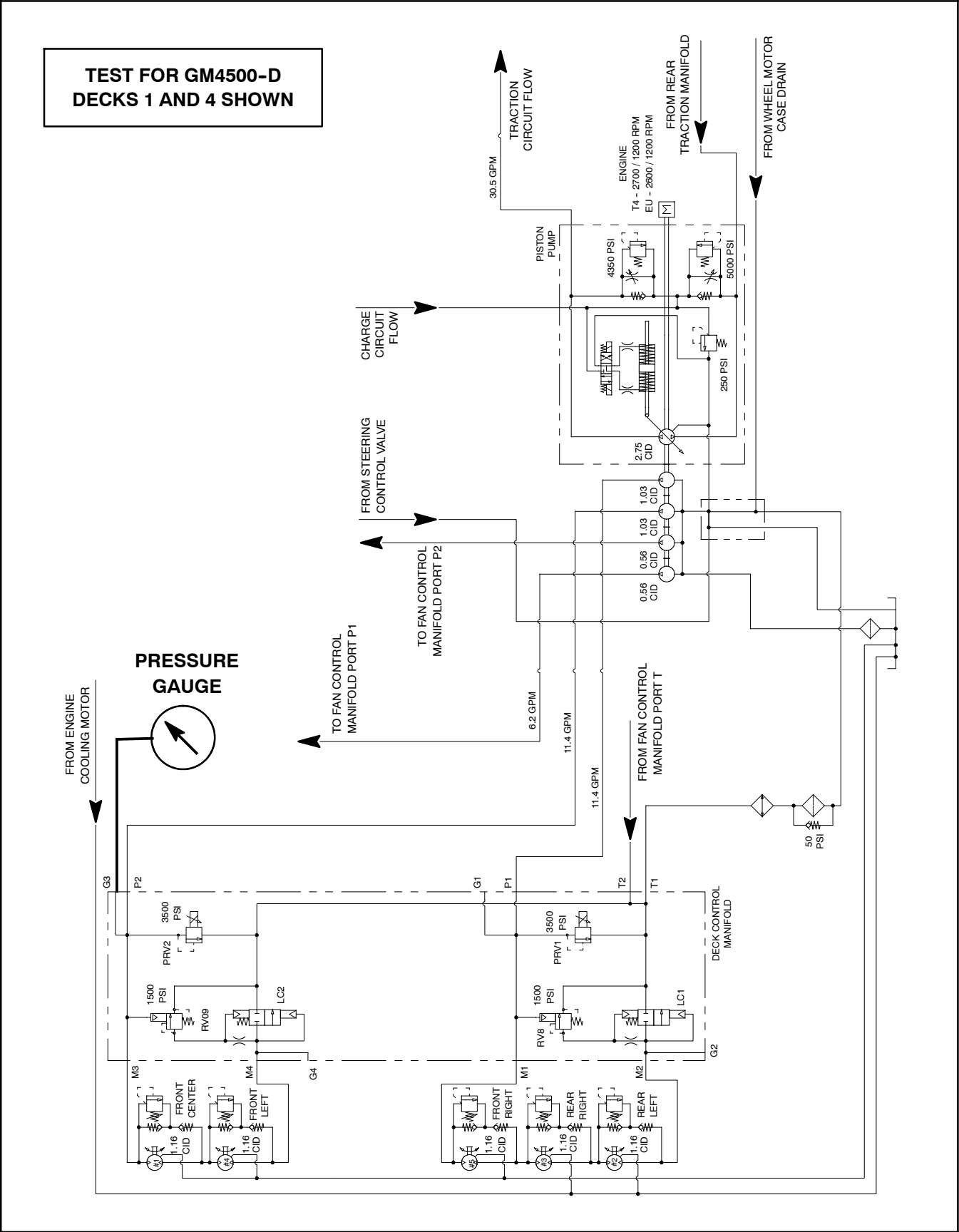


Figure 45

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

Cutting Deck Circuit Pressure (Using Pressure Gauge)



## 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.
4. Install 5000 PSI (350 bar) pressure gauge with hydraulic hose attached to deck control manifold test port for the cutting deck circuit to be tested (Fig. 46 or 47).
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.
7. Watch pressure gauge carefully while mowing with the machine.
8. Cutting deck circuit pressure should be from **1000 to 3500 PSI (69 to 241 bar)** 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.

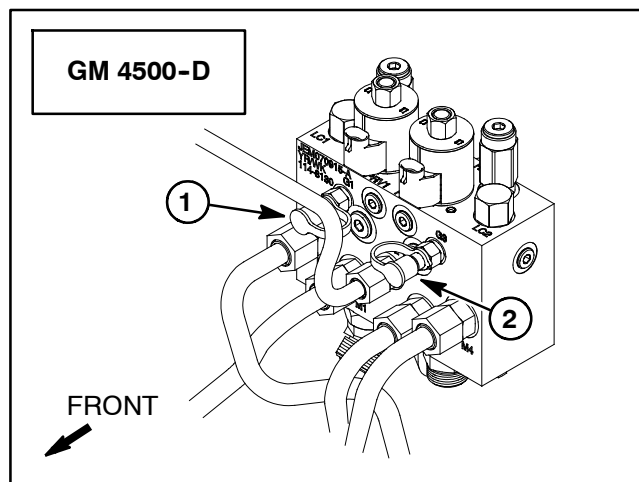


Figure 46

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

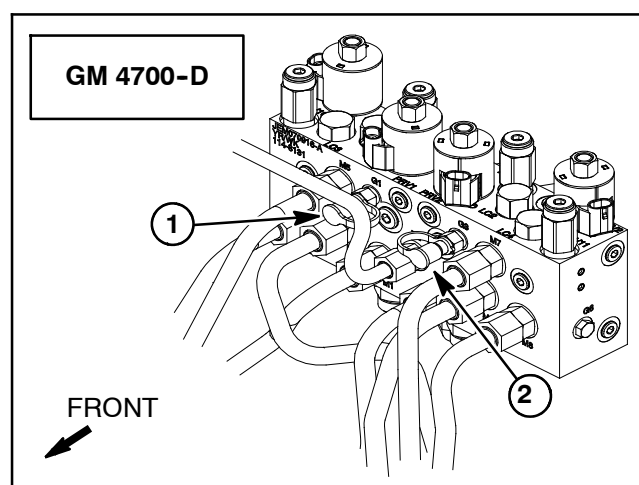


Figure 47

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

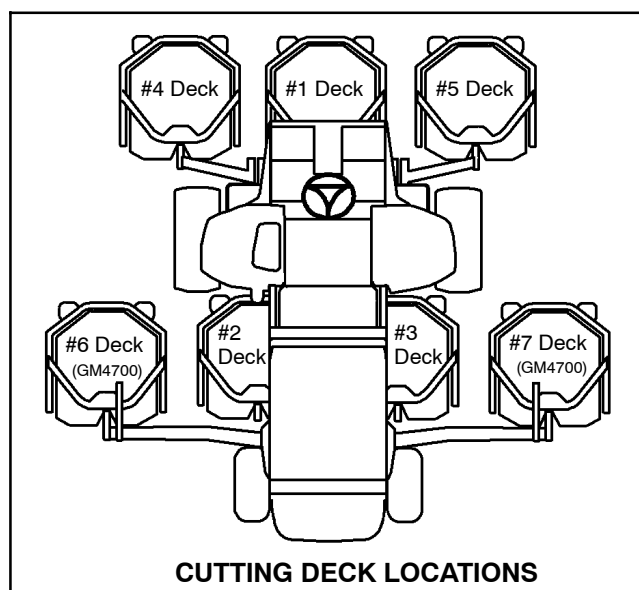
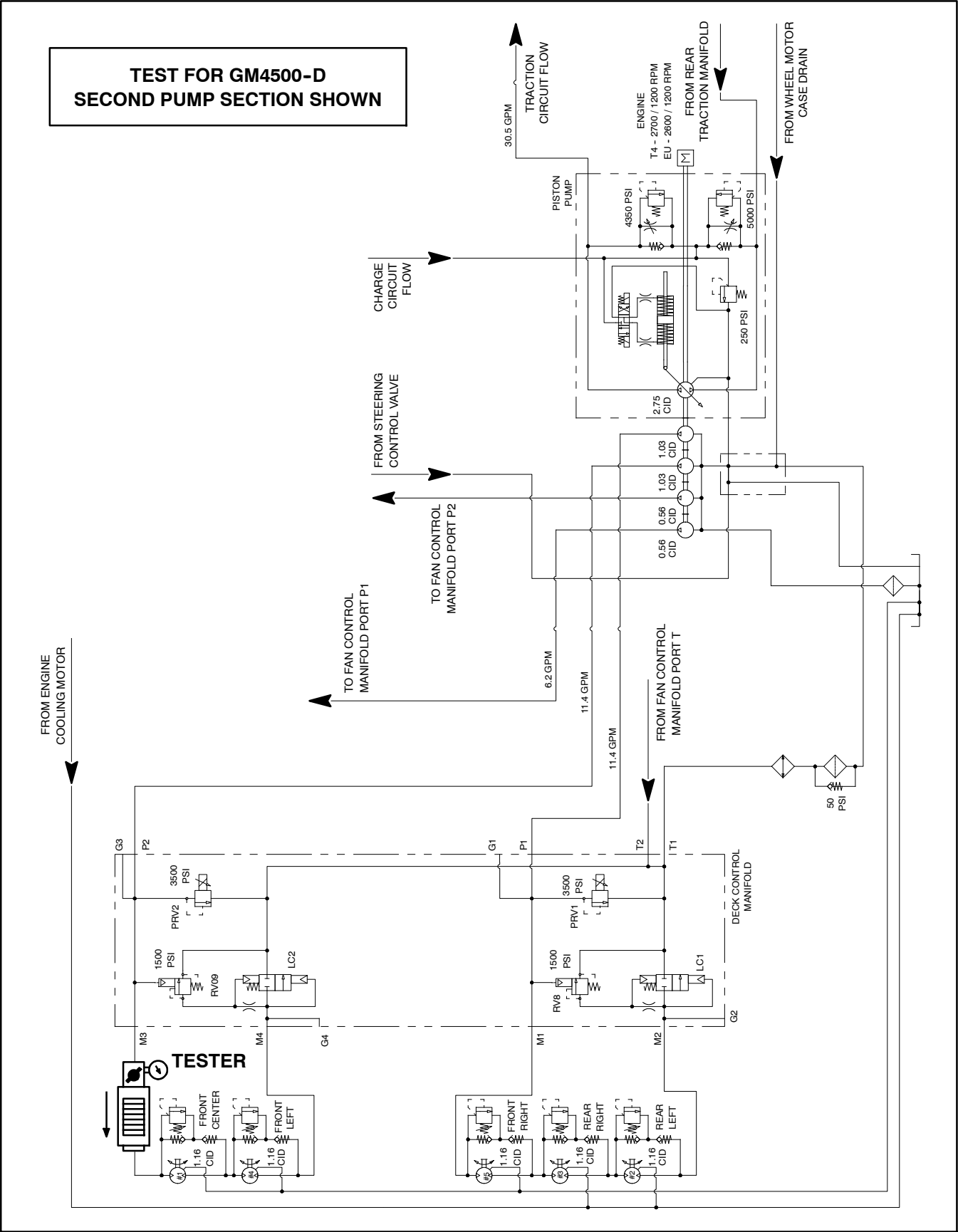


Figure 48

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



## 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.
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 (Fig. 49).

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 (Fig. 49).

4. Thoroughly clean junction of appropriate hydraulic inlet hose and deck motor fitting (Fig. 50). 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 **3400 to 3750 PSI (235 to 258 bar)**.

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 Service in the Service and Repairs section of this chapter). 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 Test in this section).

12. After testing is complete, disconnect tester from deck motor and hose. Connect hydraulic hose to motor.

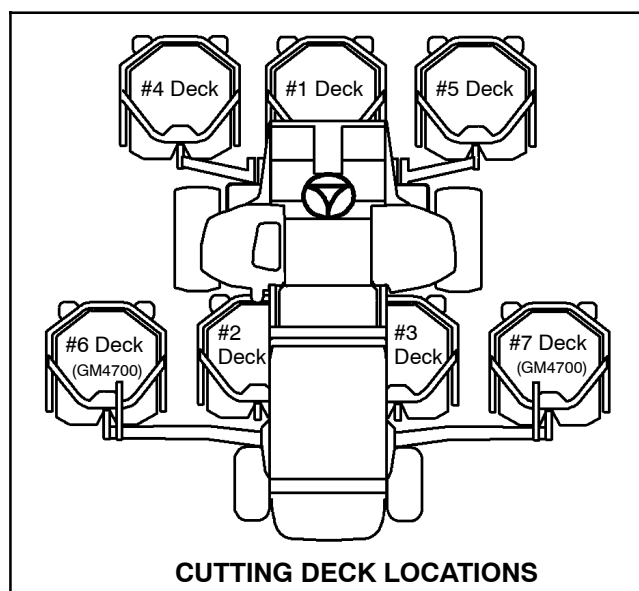


Figure 49

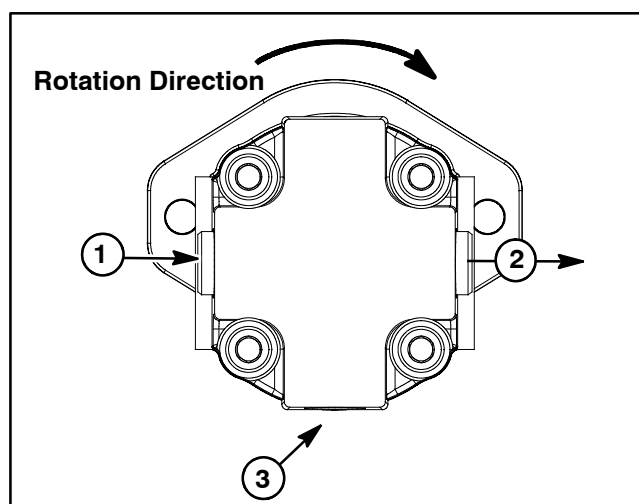
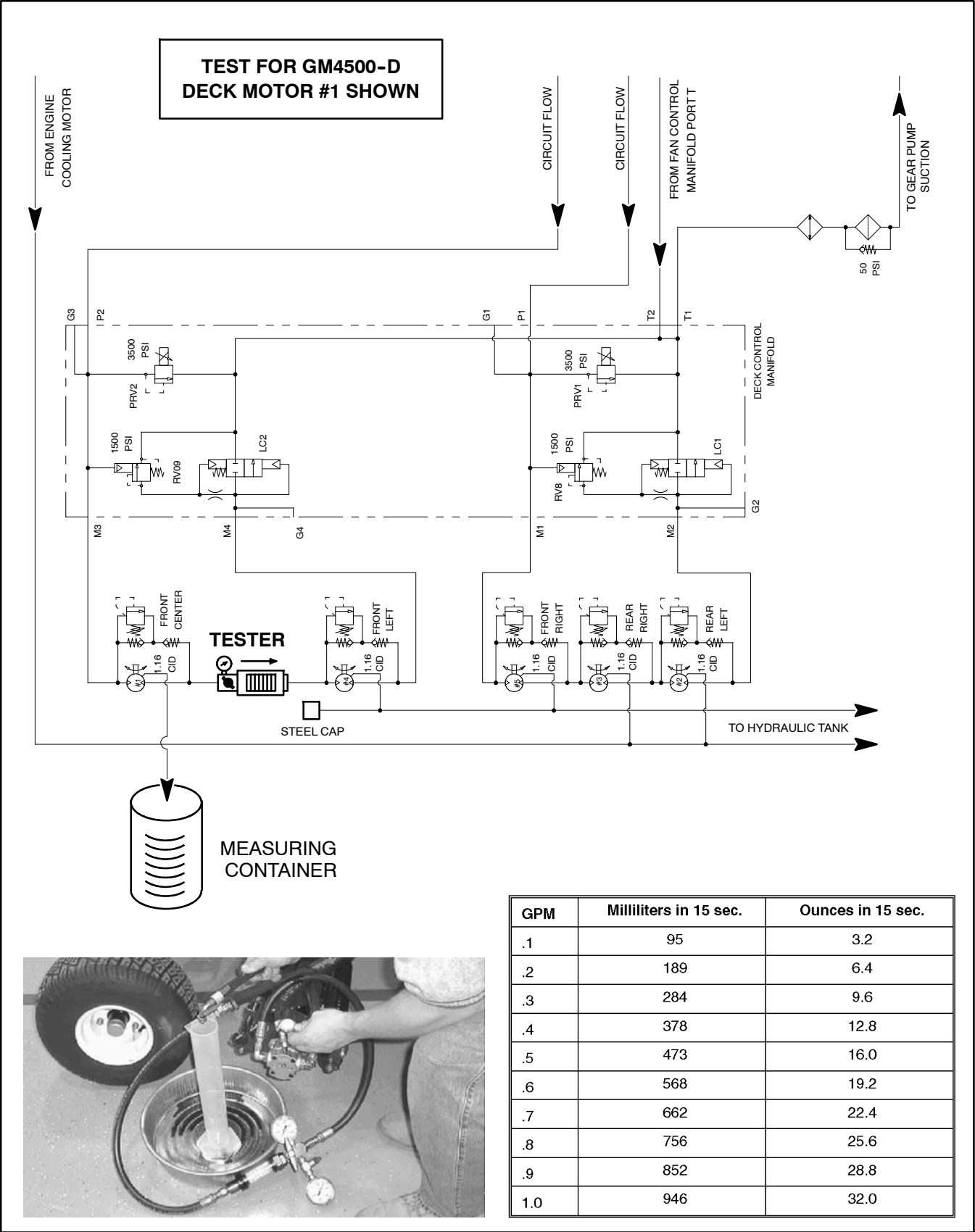


Figure 50

1. Flow IN
2. Flow OUT

3. Case drain

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





## 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 Hydraulic Schematic).

3. Disconnect pressure return hose from the motor to be tested (Fig. 52). 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 **1200 PSI (83 bar)** 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 **22.4 ounces (662 ml)** of hydraulic fluid in fifteen (15) seconds (0.7 GPM / 2.7 LPM)

8. If case drain flow is more than **22.4 ounces (662 ml)**, 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.

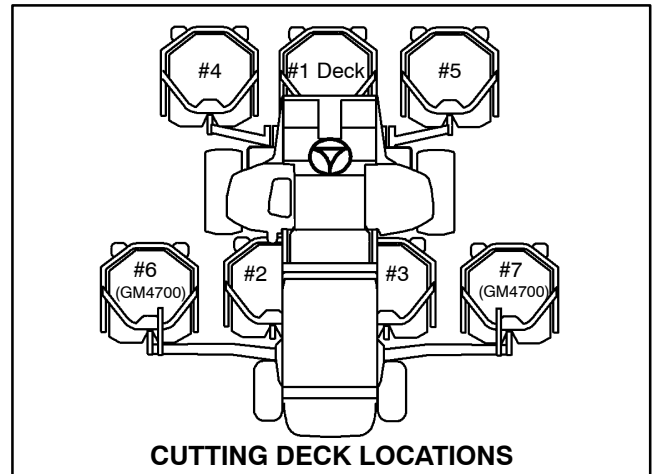


Figure 51

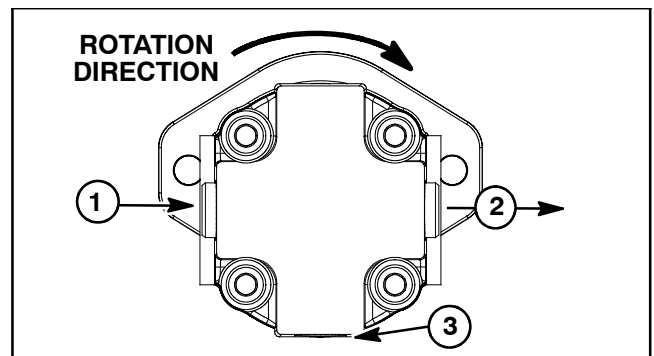
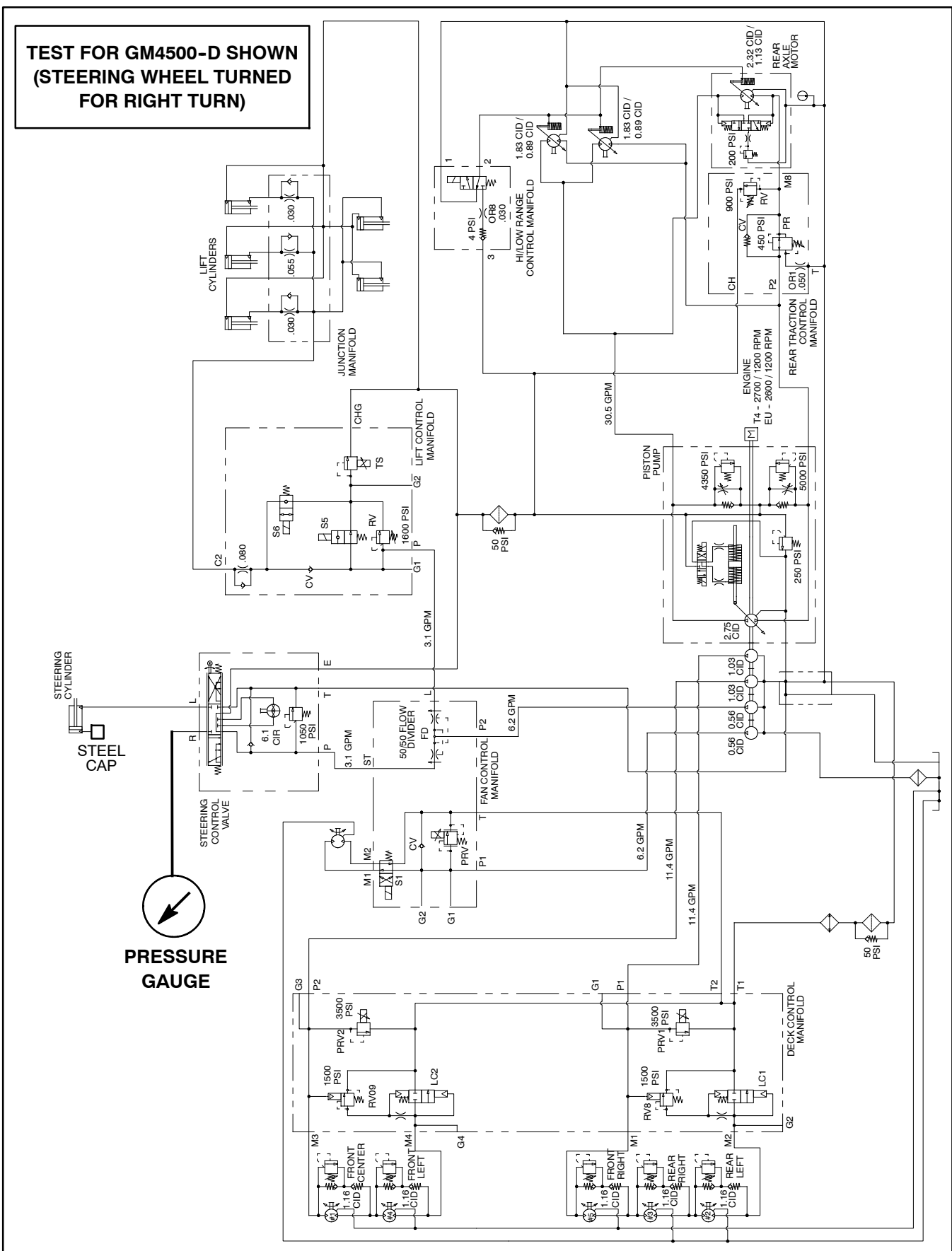


Figure 52

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



## 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.
3. Thoroughly clean junction of hydraulic hose and steering cylinder fitting at the barrel end of the steering cylinder (Fig. 53). Disconnect hose from fitting in barrel end of steering cylinder.
4. Install 5000 PSI (350 bar) 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 1150 TO 1500 PSI (80 to 103 bar)**

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 in the Service and Repairs section of this chapter). 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.

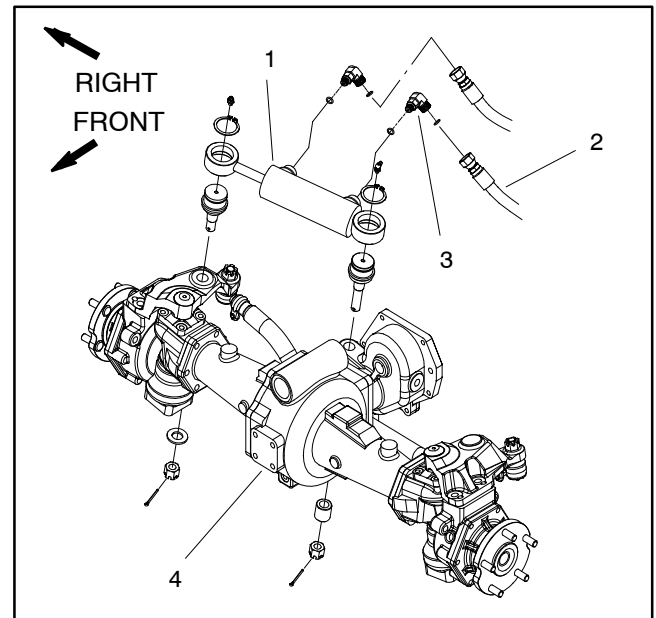
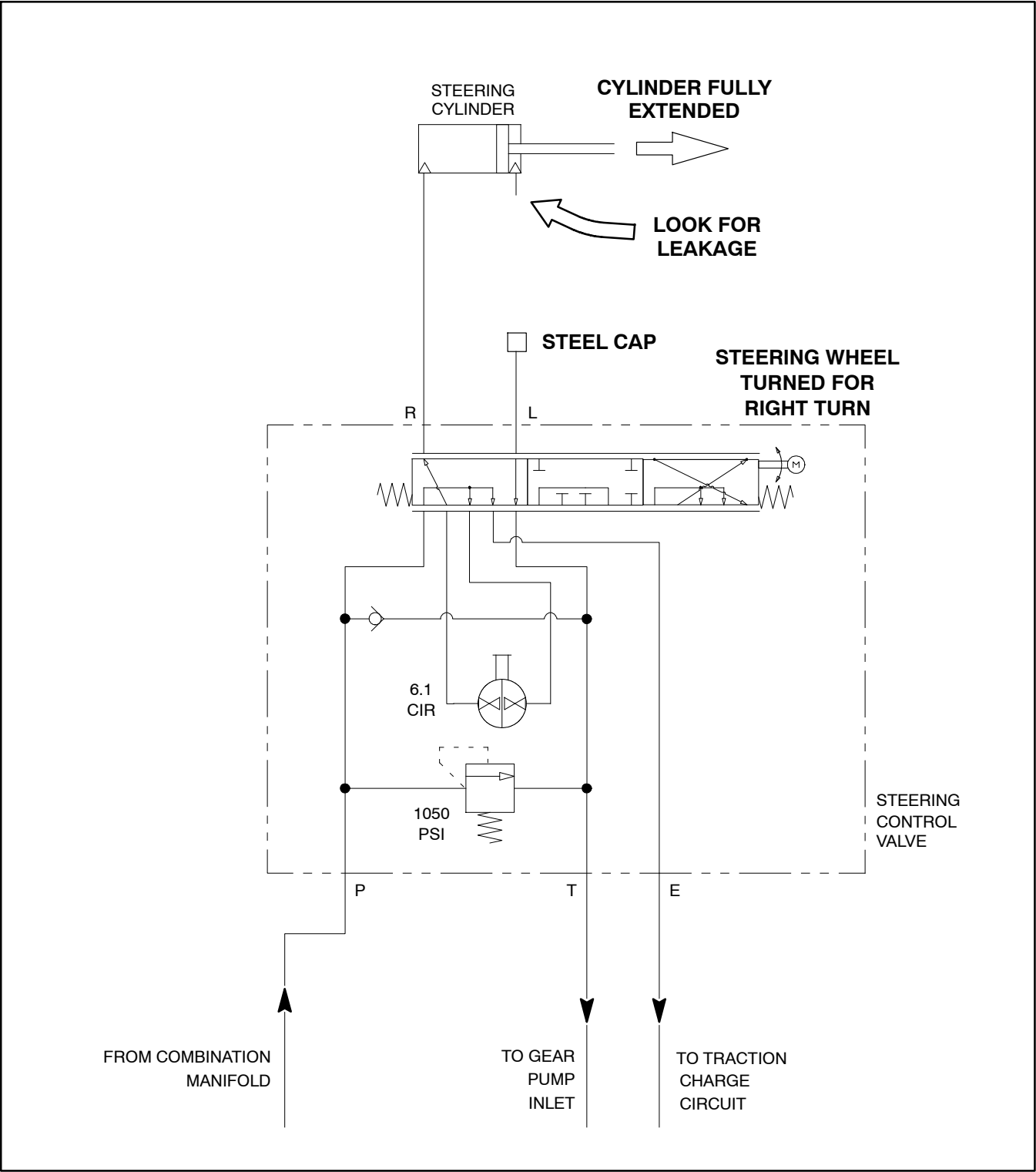


Figure 53

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

Steering Cylinder Internal Leakage



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.



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.

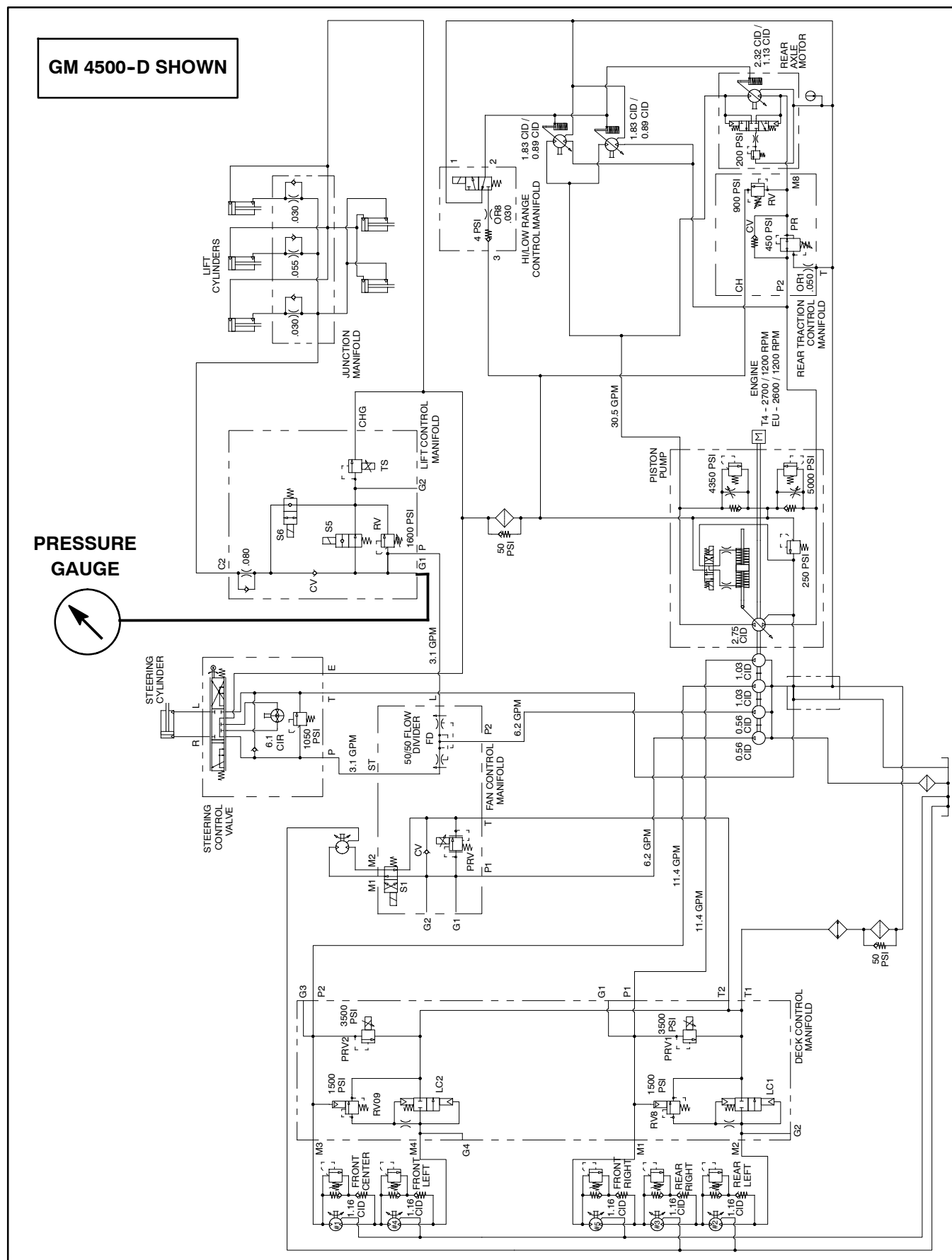
6. With the engine off, turn the steering wheel for a right turn. Observe the open fitting on the extended steering cylinder as the steering wheel is turned. If oil comes out of the fitting while turning the steering wheel, the steering cylinder has internal leakage and must be repaired (see Steering Cylinder and Steering Cylinder Service in the Service and Repairs section of this chapter). 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 and Steering Control Valve Service in the Service and Repairs section of this chapter).

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)



## 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.
3. Raise and support seat to gain access to lift control manifold (Fig. 54 or 55). Connect a 5000 PSI (350 bar) 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.
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 1600 PSI (110 bar) higher than measured lift/lower circuit pressure with no load from step 5 above** (e.g. if circuit no load pressure is 300 PSI (21 bar), lift/lower relief pressure should be approximately 1900 PSI (131 bar))

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 Service in the Service and Repairs section of this chapter).

A. If pressure is too high, adjust the relief valve (see Adjust Control Manifold Relief Valves in the Adjustments section of this chapter).

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 in the Adjustments section of this chapter).

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.

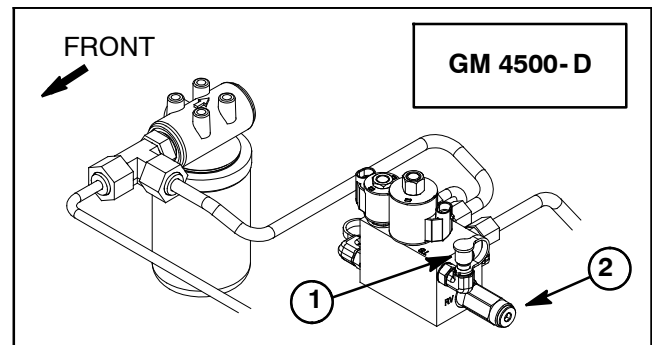


Figure 54

1. Test port G1

2. Relief valve

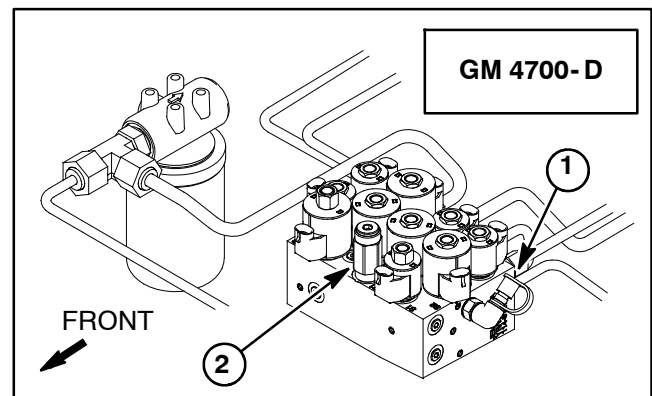
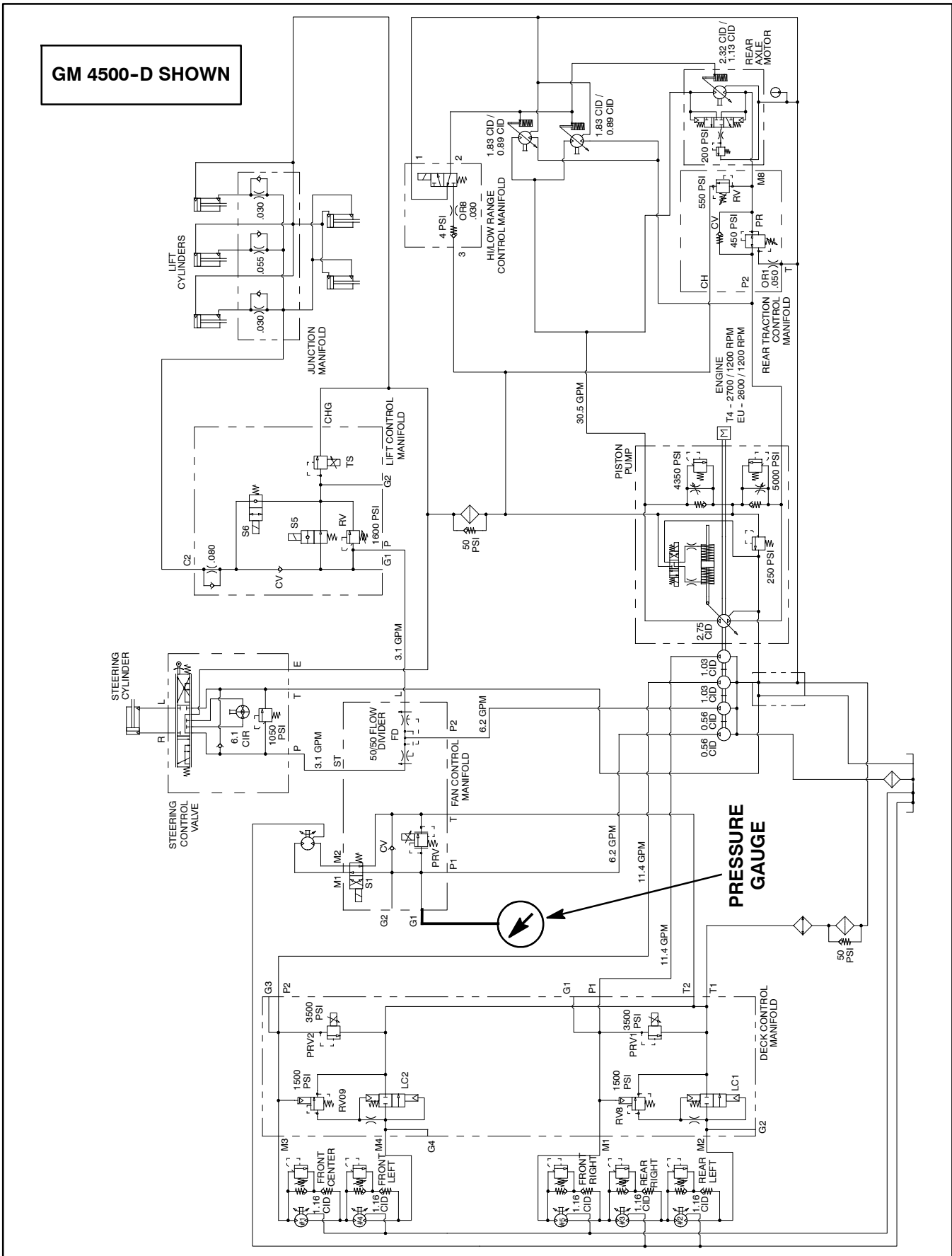


Figure 55

1. Test port G1

2. Relief valve

### Engine Cooling Fan Circuit (Using Pressure Gauge and Phototac)





## 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.
3. Raise and support hood to gain access to fan control manifold (Fig. 56). Connect a 5,000 PSI (345 bar) 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 **3000 PSI (207 bar)**

PHOTOTAC (fan speed) READING TO BE approximately **2800 RPM**

6. Stop engine and record test results.

7. If pressure rises to approximately **3000 PSI (207 bar)** 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 Test in this section).

**NOTE:** If pressure and fan speed are both low and the final gear pump section flow proves to be correct (see Gear Pump Flow Test in this section), suspect that seals in fan control manifold are leaking or faulty (see Fan Control Manifold Service in the Service and Repairs section of this chapter) 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.

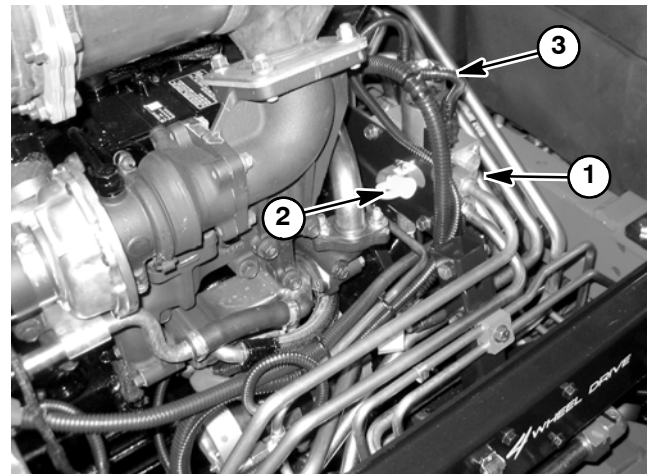
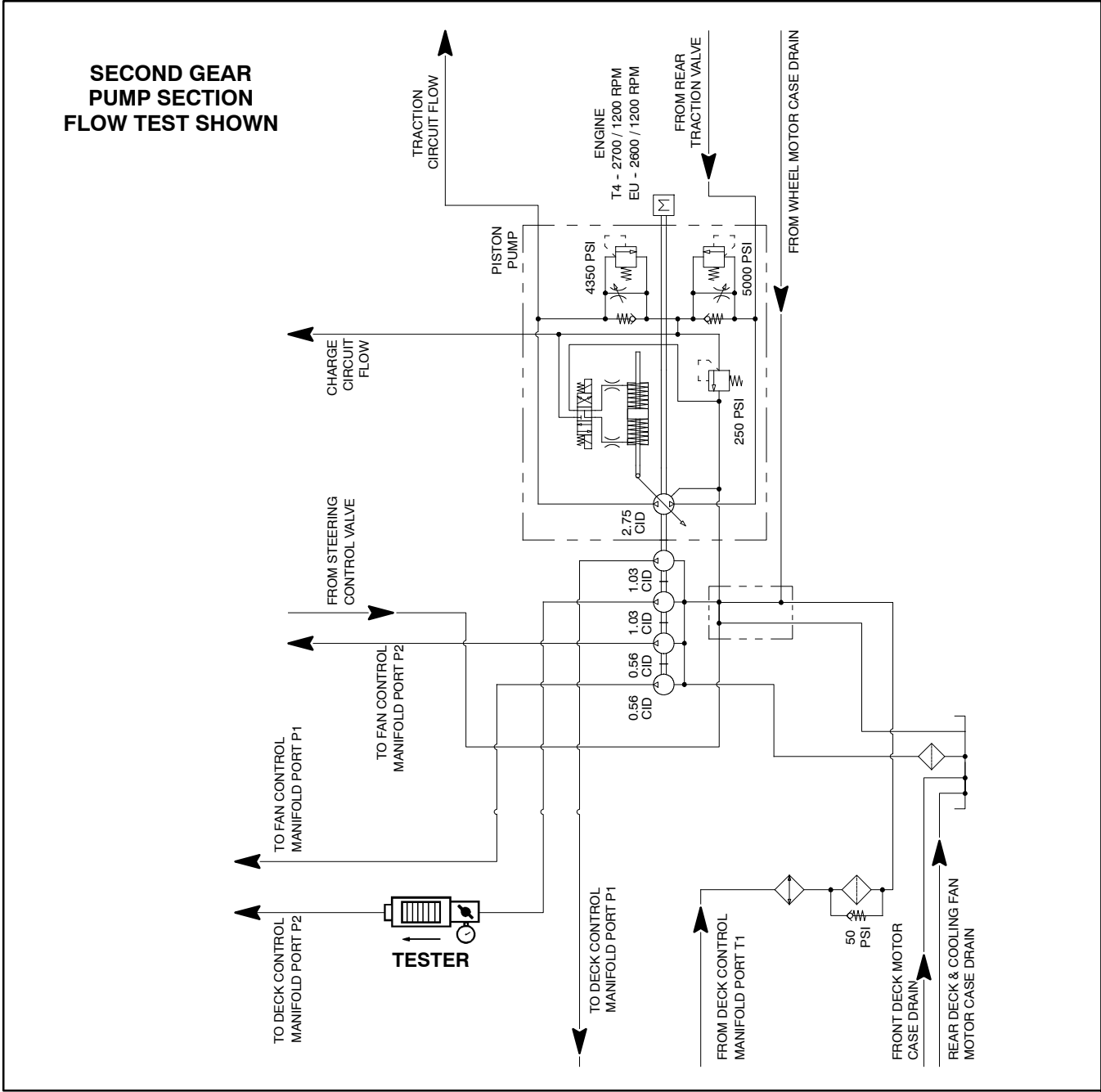


Figure 56

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



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 57. The first gear pump section provides hydraulic flow for cutting decks 2, 3 and 5 (also deck 7 on the GM 4700-D). The second gear pump section provides hydraulic flow for cutting decks 1 and 4 (also deck 6 on the GM 4700-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.
4. Determine which gear pump section is to be tested. Disconnect hydraulic hose from fitting in gear pump section that is to be tested (Fig. 57).
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 **1000 PSI (69 bar)** 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 Figure 59.

10. Shut off engine and record test results.

11. If a pressure of **1000 PSI (69 bar)** cannot be obtained or flow was less than the minimum flow listed in Figure 59, check for restriction in the pump 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.

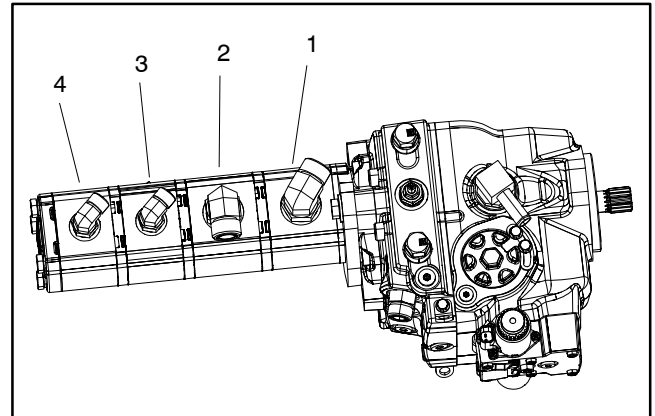


Figure 57

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

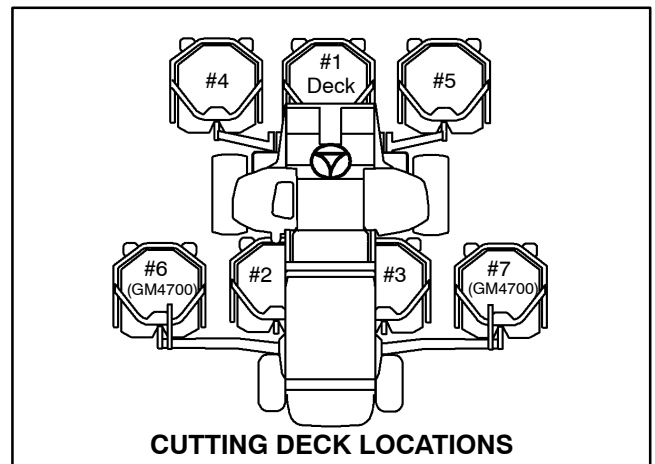


Figure 58

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

Figure 59

# Adjustments

## Adjust Control Manifold Relief Valves

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 section of this chapter for information on testing relief pressure.

**NOTE:** Adjusting the Rear Traction Circuit Relief Valve (RV) located in the rear traction control manifold is not recommended.

**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.

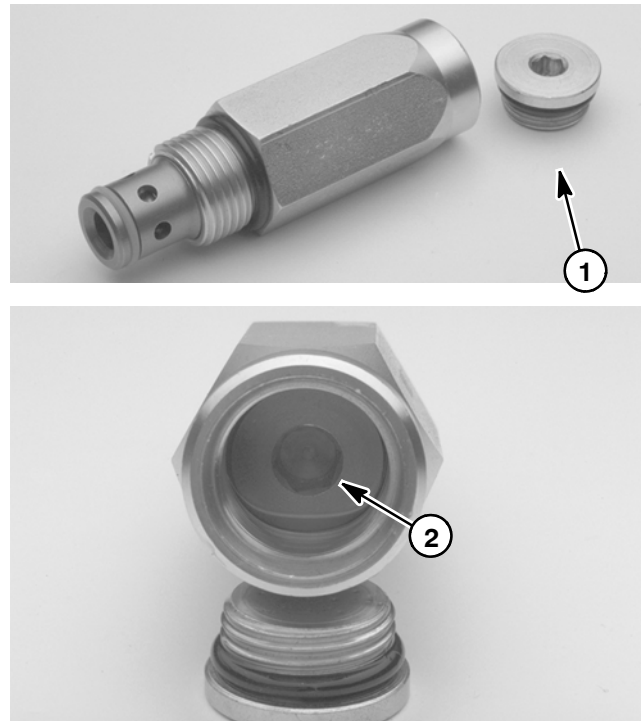


Figure 60

1. Relief valve cap

2. Adjustment socket

# 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, engage parking brake, lower cutting decks and stop engine. Remove key from the ignition switch.
2. Clean machine before disconnecting, removing or disassembling any hydraulic components. Make sure hydraulic components, hose connections and fittings are cleaned thoroughly. Always keep in mind the need for cleanliness when working on hydraulic equipment.



### WARNING

**Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure in the General Information section in this chapter.**

3. Put caps or plugs on any hydraulic lines, hydraulic fittings and components left open or exposed to prevent system contamination.
4. Put labels on disconnected hydraulic lines and hoses for proper installation after repairs are completed.
5. 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 in this section).

**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 tubes, hydraulic fittings and components before reconnecting.
4. Use proper tightening methods when installing hydraulic hoses and fittings (see Hydraulic Fitting Installation and Hydraulic Hose and Tube Installation in the General Information section of this chapter).
5. After repairs, check control linkages and 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 in this section).
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 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 in this chapter) 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.
2. Check hydraulic reservoir oil level and adjust if necessary.

**NOTE:** A blue wire connects to the starter motor solenoid B+ terminal (Fig. 61). 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.

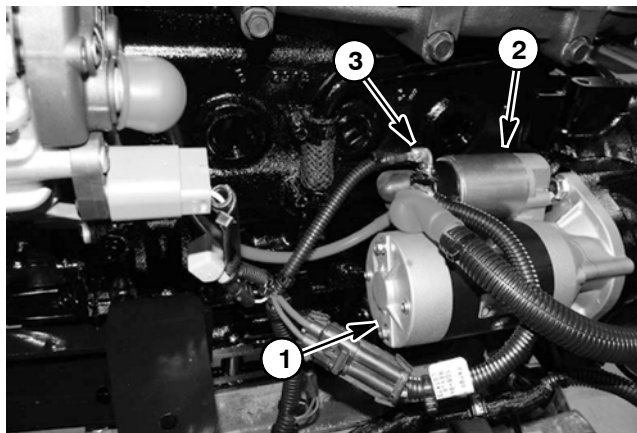


Figure 61

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

## Flush Hydraulic System

**IMPORTANT:** Flush the hydraulic system any time there is a severe component failure or the system is contaminated (oil appears milky, black or contains 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.

1. Park machine on a level surface. Lower cutting decks, stop engine and engage 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 in the General Information section in this chapter.

**IMPORTANT:** Make sure to clean around all hydraulic connections that will be disconnected for draining.

2. Drain hydraulic reservoir into a suitable container.
3. Drain hydraulic system. Drain all hydraulic hoses, tubes and components while the system is warm.
4. Remove and replace both hydraulic oil filters.
5. Inspect and clean hydraulic reservoir (see Hydraulic Reservoir in this section).

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

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

**NOTE:** Use only hydraulic fluids specified in the Traction Unit Operator's Manual. Other fluids may cause system damage.

7. Fill hydraulic reservoir with **new** hydraulic fluid.
8. Prime hydraulic pumps (see Priming Hydraulic Pumps in this section).
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. If changing to biodegradable fluid, repeat steps 1 through 13 again at least once and until the 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, front wheel motor or rear axle 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 kit are recommended (see Special Tools in this chapter).

1. Park machine on a level surface with engine stopped and key removed from ignition switch.

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

**NOTE:** If 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.

3. Thoroughly clean junction of hydraulic hose and **left** side fitting on bottom of piston (traction) pump (Fig. 62). 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 in this chapter) to connect filter to machine. Make sure that fitting and hose connections are properly tightened.

**IMPORTANT:** Use only hydraulic fluids specified in **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 low idle speed. Check for any hydraulic leakage from filter and hose connections. Correct any leaks before proceeding.



### CAUTION

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

**IMPORTANT:** While engaging the traction circuit, monitor the 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.

Hydraulic System

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

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

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

9. With engine running at high idle speed, alternately move traction pedal from forward to reverse. While monitoring filter indicator, continue this process for an additional five (5) minutes.

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

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

12. Lower machine to ground.

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

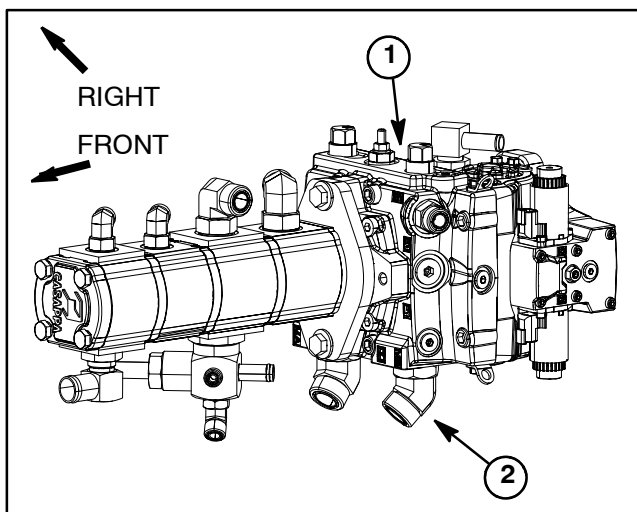


Figure 62

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

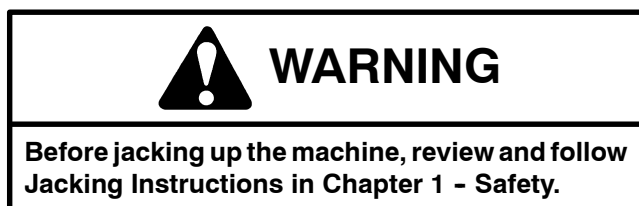


## Charge Hydraulic System

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

**IMPORTANT:** Change hydraulic oil filter whenever hydraulic components are repaired or replaced.

1. Park machine on a level surface. Lower cutting decks, stop engine and engage parking brake. Remove key from the ignition switch.
2. Make sure all hydraulic connections, lines and components are secured tightly.
3. If component failure was severe or the system is contaminated, flush and refill hydraulic system and reservoir (see Flush Hydraulic System in this section).
4. Make sure hydraulic reservoir is full. Add correct hydraulic oil if necessary.
5. Prime hydraulic pumps (see Priming Hydraulic Pumps in this section).



6. Raise one front and one rear wheel off the ground and place appropriate jack stands under the frame to support machine. Chock remaining wheels to prevent movement of the machine.

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

7. Make sure traction pedal is in **neutral**. Start engine and run it at low idle speed. The hydraulic pumps should pick up oil and fill the hydraulic system. If there is no indication of fill in **30 seconds**, stop the engine and determine the cause.

8. After the hydraulic system starts to show signs of fill, actuate lift control switch until the lift cylinders move in and out several times. If the cylinders do not move after **15 seconds** or the pump emits abnormal sounds, shut the engine off immediately and determine cause or problem. Inspect for the following:

- A. Loose hydraulic filter or suction lines.
- B. Blocked suction line.
- C. Faulty charge relief valve in traction pump.
- D. Faulty gear pump.

9. Once lift cylinders do move, proceed to step 10.

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

- A. If the wheels rotate in the wrong direction, stop engine and inspect hydraulic line placement at piston (traction) pump and wheel motors. Correct hydraulic line installation before proceeding.
- B. If the wheels rotate in the proper direction, proceed to step 11.

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.

13. Stop engine, remove jack stands from frame and lower machine. Remove chocks from remaining wheels.

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

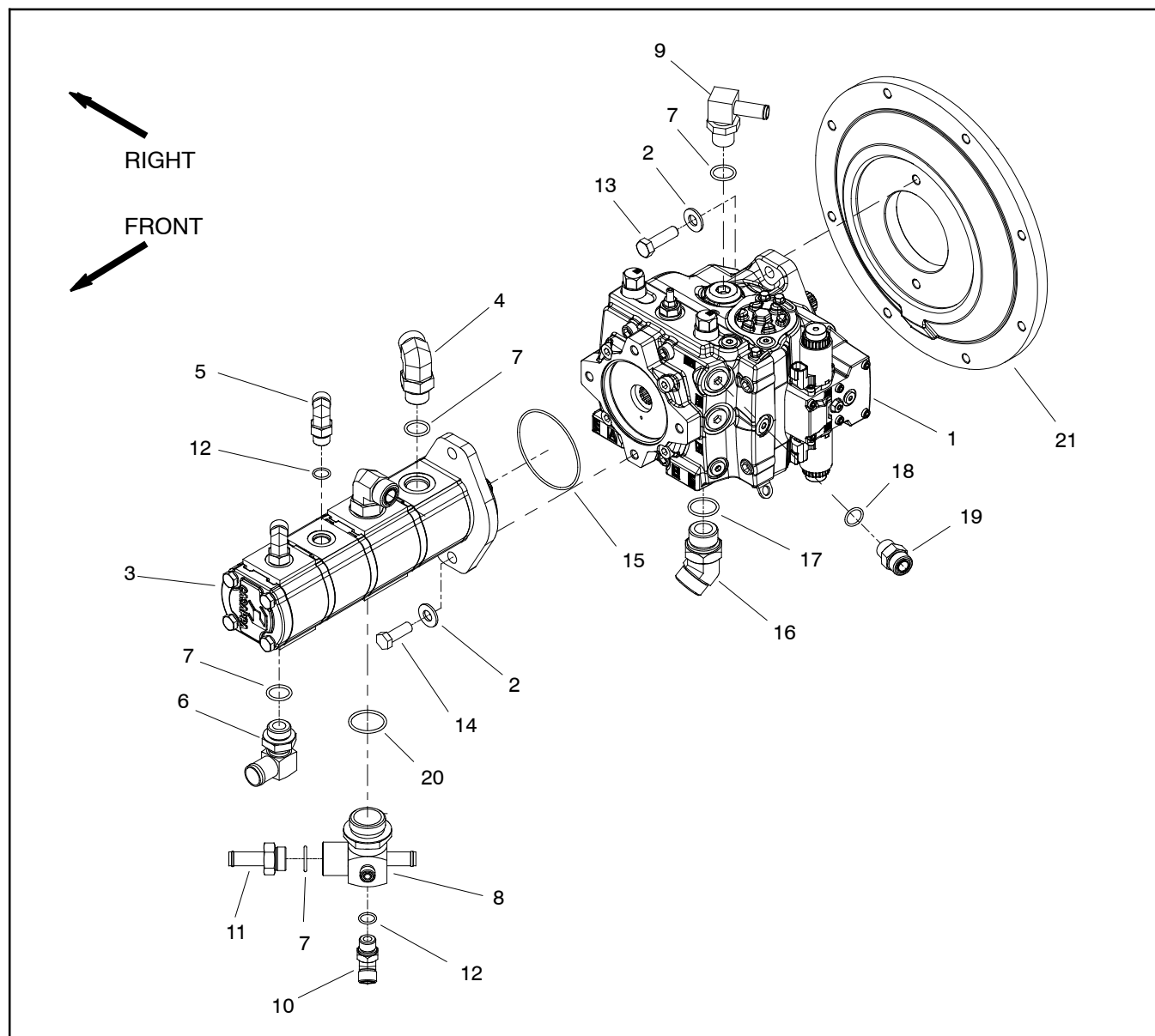


Figure 63

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

### Removal (Fig. 63)

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 in this section).
4. To prevent contamination of hydraulic system during gear pump removal, thoroughly clean exterior of gear pump, fittings and ends of hydraulic lines.
5. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.
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 (Fig. 64). 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 (Fig. 63)

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 Hydraulic Fitting Installation in the General Information section of this chapter).
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.

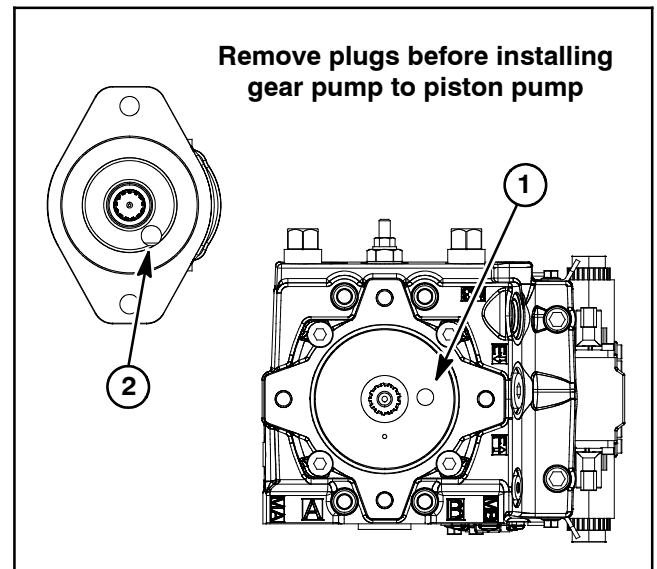


Figure 64

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

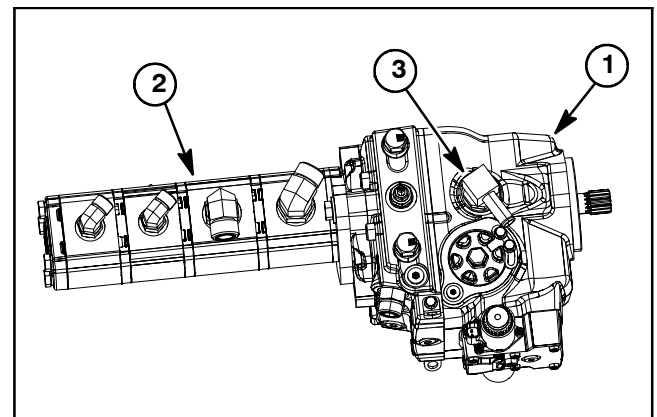


Figure 65

1. Piston (traction) pump      2. Gear pump      3. Piston pump case drain

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.

**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 (Fig. 64). 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 Hydraulic Hose and Tube Installation in the General Information section of this chapter).

6. Replace hydraulic oil filter and fill hydraulic reservoir with new hydraulic oil.

7. Fill piston pump housing through case drain (90° barbed fitting) with new hydraulic oil (Fig. 65). This will ensure that internal pump components have adequate lubrication during initial operation.

8. Prime hydraulic pumps (see Priming Hydraulic Pumps in this section).

9. Properly fill hydraulic system (see Charge Hydraulic System in this section).

10. Stop engine and check for hydraulic oil leaks. Check hydraulic reservoir oil level and adjust if necessary.

This page is intentionally blank.

## Gear Pump Service

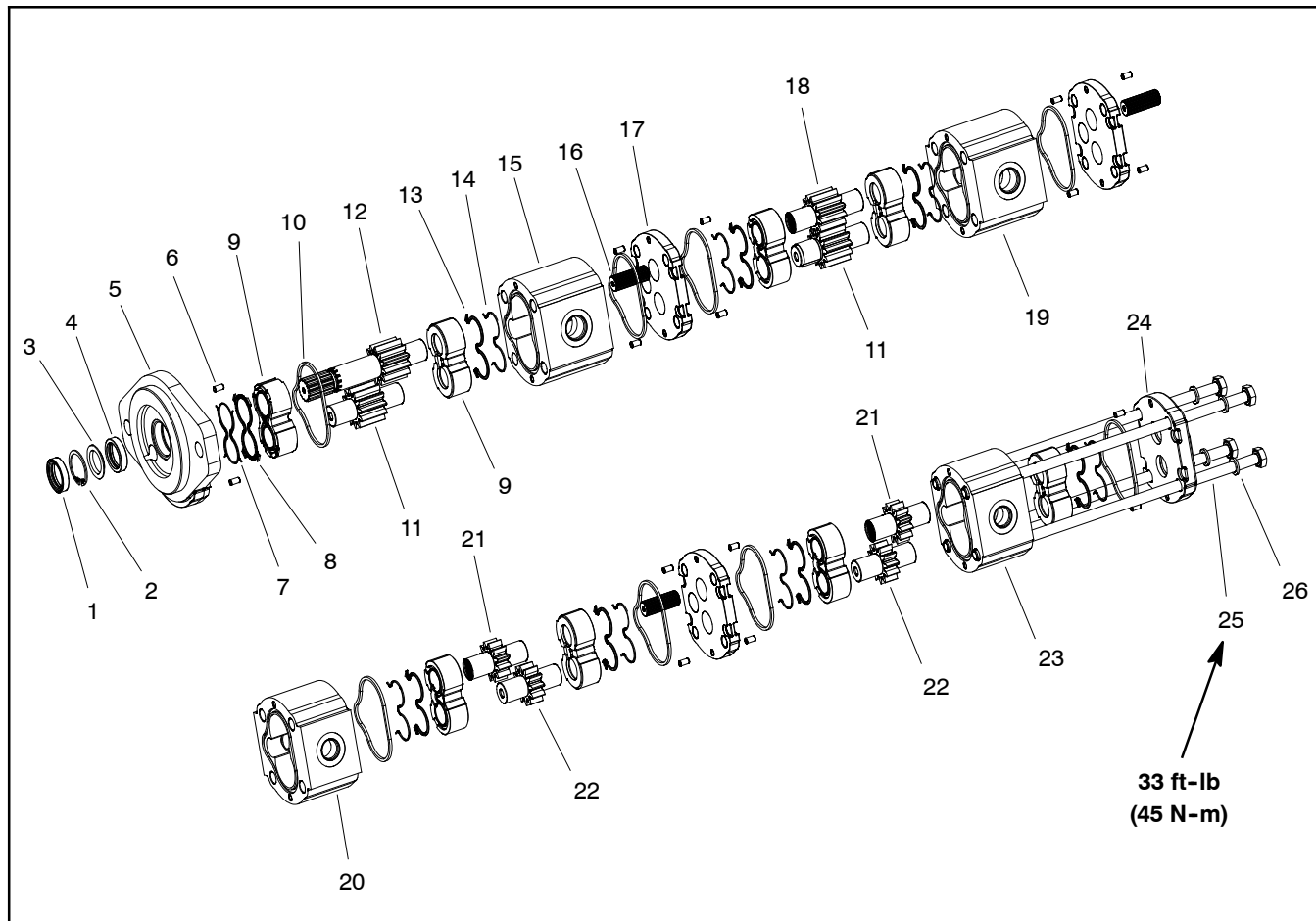


Figure 66

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

### Disassembly (Fig. 66)

**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.

2. Use a marker to make a **diagonal** line across the gear pump for assembly purposes (Fig. 67).

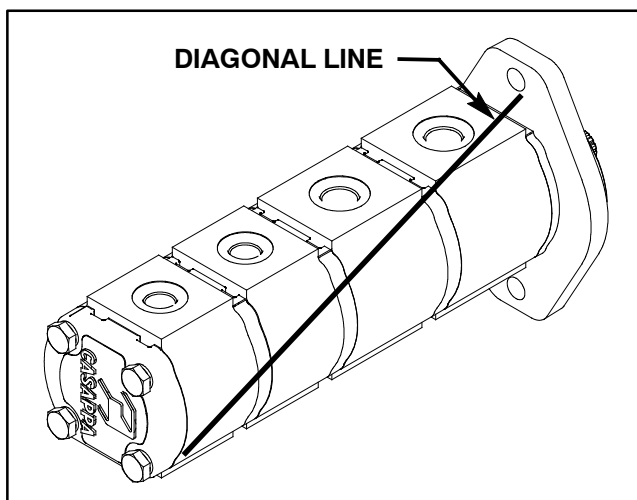


Figure 67

**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 (Fig. 66)**

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 **33 ft-lb (45 N-m)**.

## Piston (Traction) Pump

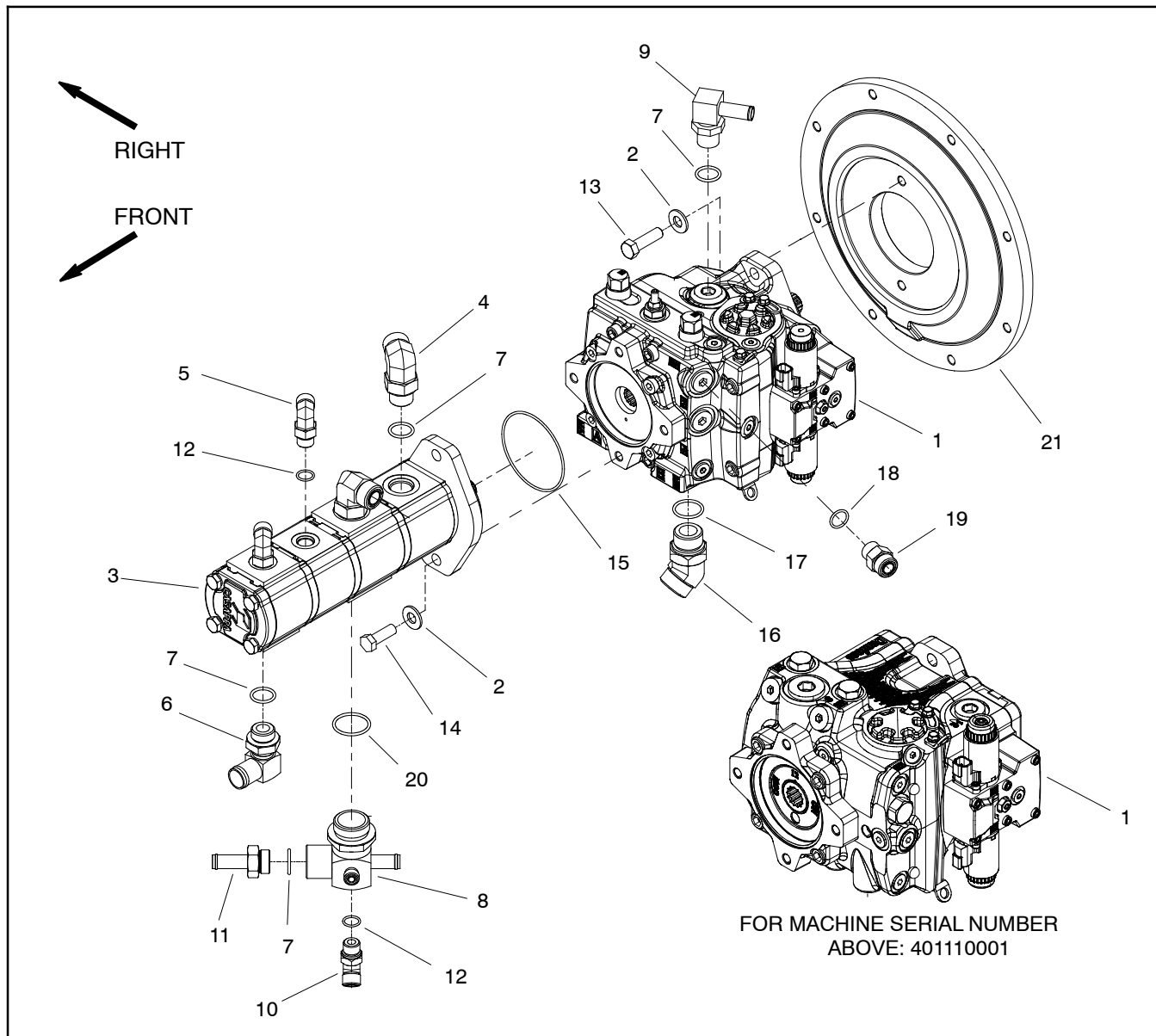


Figure 68

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

### Removal (Fig. 68)

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.

3. Label wire harness connectors that attach to the two (2) solenoid coils on left side of piston pump (Fig. 69). Disconnect harness connectors from solenoid coils on piston pump.

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



5. For assembly purposes, label all hydraulic lines connected to gear pump and traction pump fittings.

6. 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.

7. Remove gear pump from machine (see Gear Pump in this section).

**NOTE:** A case drain exists in the piston (traction) pump and a suction port is near the input shaft of the gear pump (Fig. 70). 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 90 pounds (41 kg).

8. 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.

9. 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 (Fig. 68)

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 Hydraulic Fitting Installation in the General Information section of this chapter).

**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 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.

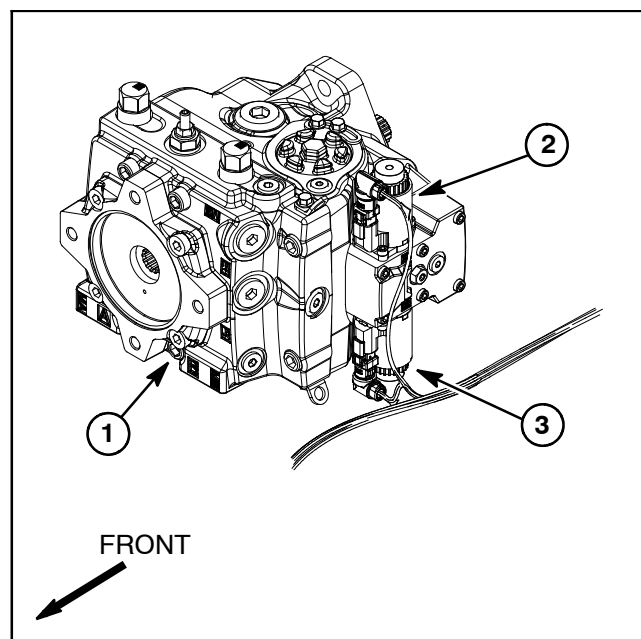


Figure 69

- |                            |                            |
|----------------------------|----------------------------|
| 1. Piston pump             | 3. Solenoid coil (reverse) |
| 2. Solenoid coil (forward) |                            |

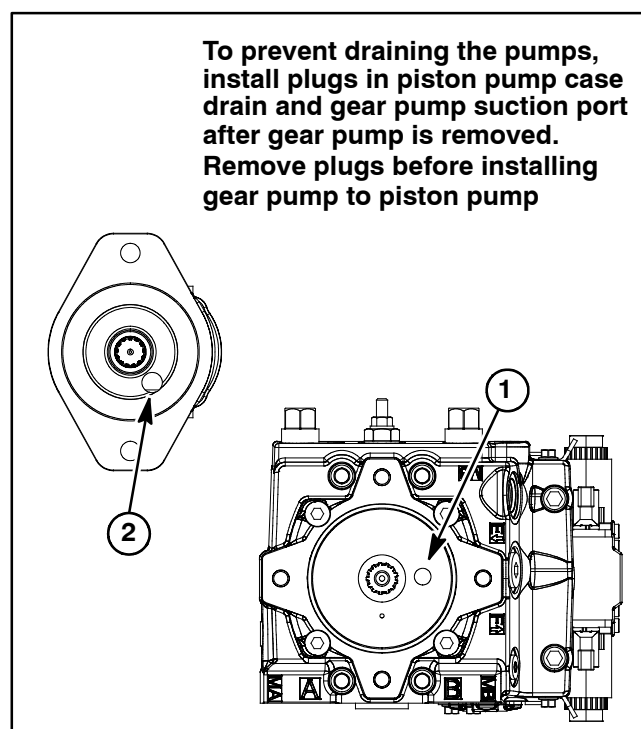


Figure 70

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

**IMPORTANT:** A case drain exists in the piston (traction) pump and a suction port is near the input shaft of the gear pump (Fig. 70). 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.

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 in this section).

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. Fill piston (traction) pump housing with new hydraulic oil through the case drain (90° barbed fitting) at the top of the pump (Fig. 71). This will ensure that internal pump components have adequate lubrication during initial operation.

8. 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 Hydraulic Hose and Tube Installation in the General Information section of this chapter).

9. Fill hydraulic reservoir with correct oil.

10. Install new hydraulic filter and fill hydraulic reservoir with correct oil.

**IMPORTANT:** Refer to Traction Circuit Component Failure in the General Information section of this chapter for information regarding the importance of removing contamination from the traction circuit.

11. Prime hydraulic pumps (see Priming Hydraulic Pumps in this section).

12. Properly fill hydraulic system (see Charge Hydraulic System in this section).

13. Stop engine and check for hydraulic oil leaks. Check hydraulic reservoir oil level and adjust if necessary.

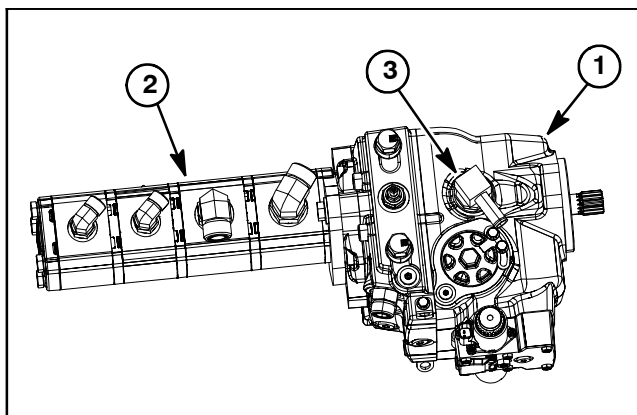


Figure 71

- |                           |                           |
|---------------------------|---------------------------|
| 1. Piston (traction) pump | 3. Piston pump case drain |
| 2. Gear pump              |                           |

**Piston (Traction) Pump Service (For machine serial number below: 401110001)**

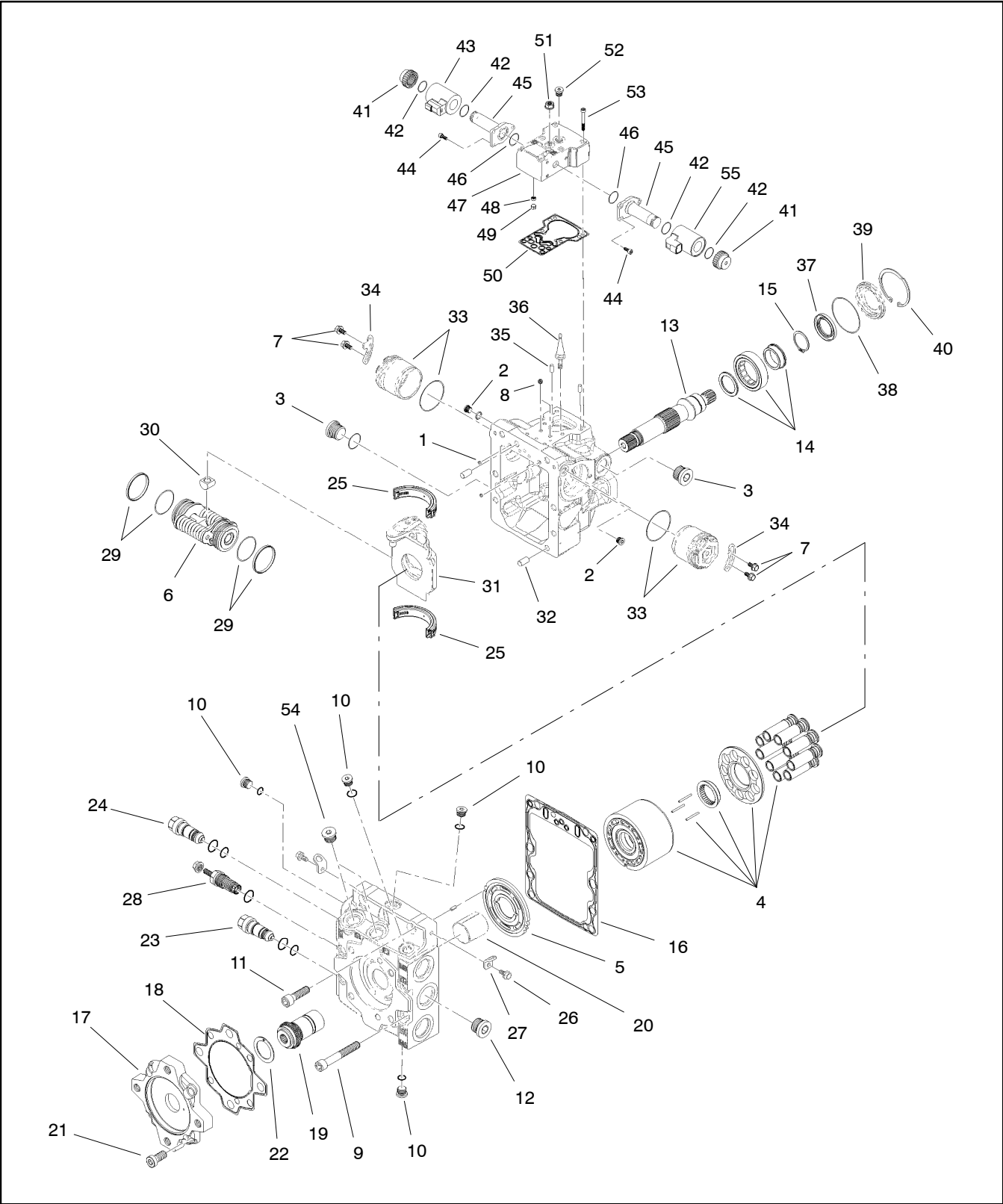


Figure 72

Figure 72 (Continued)

- |                               |                                      |                                 |
|-------------------------------|--------------------------------------|---------------------------------|
| 1. Screen (2 used)            | 20. Bearing                          | 38. O-ring                      |
| 2. Plug with O-ring (2 used)  | 21. Screw (4 used)                   | 39. Seal carrier                |
| 3. Plug with O-ring (2 used)  | 22. Thrust plate                     | 40. Retaining ring              |
| 4. Cylinder block assembly    | 23. Forward relief valve assembly    | 41. Coil nut (2 used)           |
| 5. Valve plate                | 24. Reverse relief valve assembly    | 42. O-ring                      |
| 6. Servo piston               | 25. Swash plate bearing assembly     | 43. Forward solenoid coil       |
| 7. Screw (4 used)             | 26. Screw (2 used)                   | 44. Screw (3 used per solenoid) |
| 8. Orifice (2 used)           | 27. Bracket (2 used)                 | 45. Solenoid (2 used)           |
| 9. Screw (4 used)             | 28. Charge relief valve assembly     | 46. O-ring                      |
| 10. Plug with O-ring (4 used) | 29. Servo piston seal assembly       | 47. Control housing             |
| 11. Screw (2 used)            | 30. Piston follower                  | 48. Screen (2 used)             |
| 12. Plug                      | 31. Swashplate                       | 49. Retaining ring (2 used)     |
| 13. Shaft                     | 32. Dowel pin (2 used)               | 50. Gasket                      |
| 14. Bearing assembly          | 33. Servo cylinder assembly (2 used) | 51. Lock nut                    |
| 15. Retaining ring            | 34. Locking plate (2 used)           | 52. Plug                        |
| 16. Gasket                    | 35. Dowel pin (2 used)               | 53. Screw (6 used)              |
| 17. Adapter                   | 36. Feedback pin                     | 54. Plug (2 used)               |
| 18. Adapter seal              | 37. Seal                             | 55. Reverse solenoid coil       |
| 19. Coupling                  |                                      |                                 |

### Piston (Traction) Pump Service (Fig. 72)

For service of the piston (traction) pump, see the Sauer-Danfoss H1 Closed Circuit Axial Piston Pumps Service Manual and Repair Instructions at the end of this chapter.

**NOTE:** The forward (item 43) and reverse (item 55) solenoid coils are identical.

## Piston (Traction) Pump Service (For machine serial number above: 401110001)

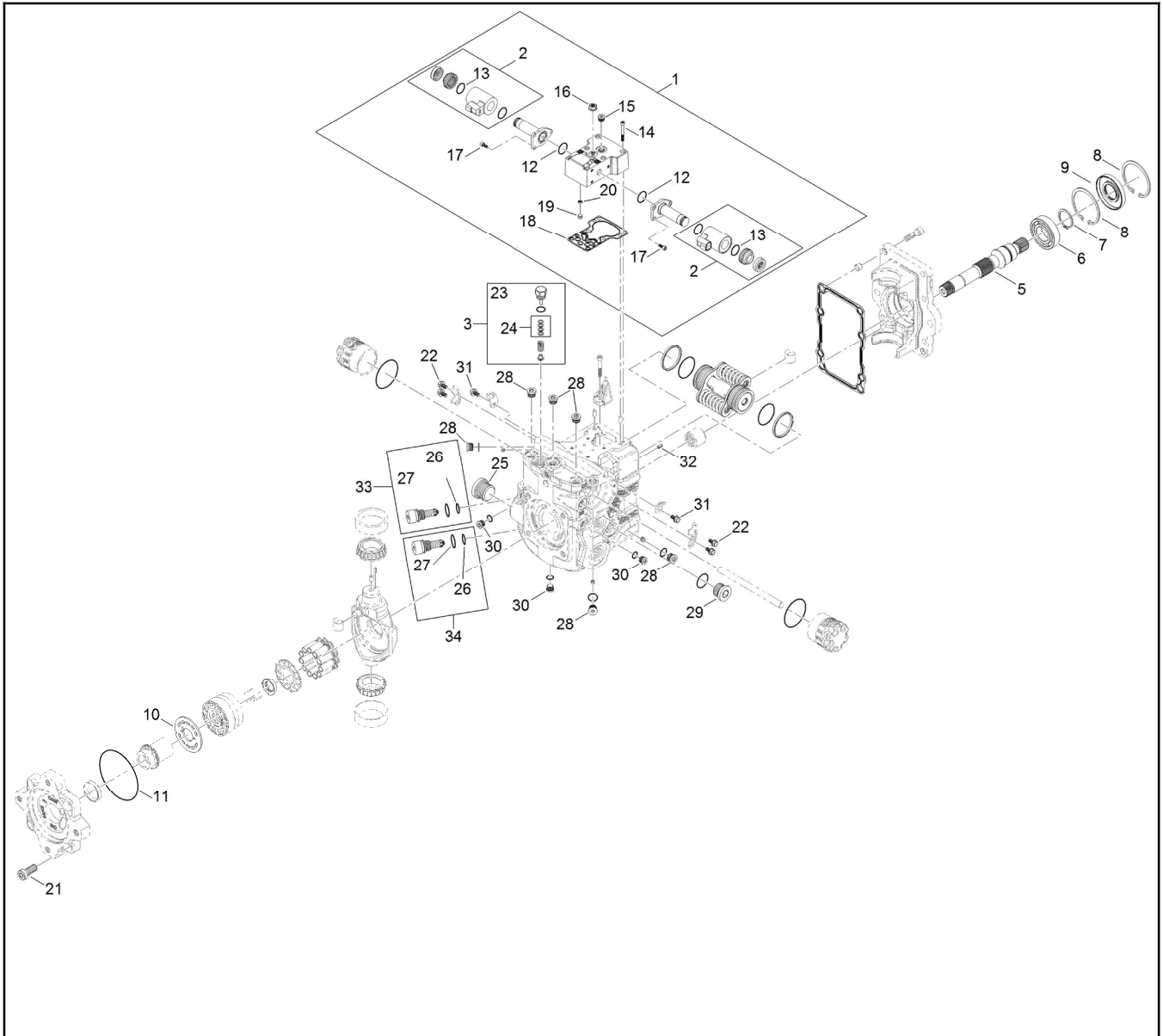


Figure 73

- |                          |                    |  |
|--------------------------|--------------------|--|
| 1. Control kit (12 volt) | 13. O-ring         | 25. Plug assembly                        |
| 2. Coil kit              | 14. Screw          | 26. O-ring                               |
| 3. Charge relief kit     | 15. Plug assembly  | 27. O-ring                               |
| 4.                       | 16. Seal nut       | 28. Plug                                 |
| 5. Shaft                 | 17. Screw          | 29. Plug                                 |
| 6. Ball bearing          | 18. Control gasket | 30. Straight plug-thread                 |
| 7. Retaining ring        | 19. Locking ring   | 31. Screw                                |
| 8. Retaining ring        | 20. Screen         | 32. Slotted pin                          |
| 9. Lip seal              | 21. Screw          | 33. High pressure relief valve (345 bar) |
| 10. Valve plate          | 22. Screw          | 34. High pressure relief valve (300 bar) |
| 11. O-ring               | 23. O-ring         | 35. Overhaul seal kit                    |
| 12. O-ring               | 24. Shim kit       |  |

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

## Rear Traction Control Manifold

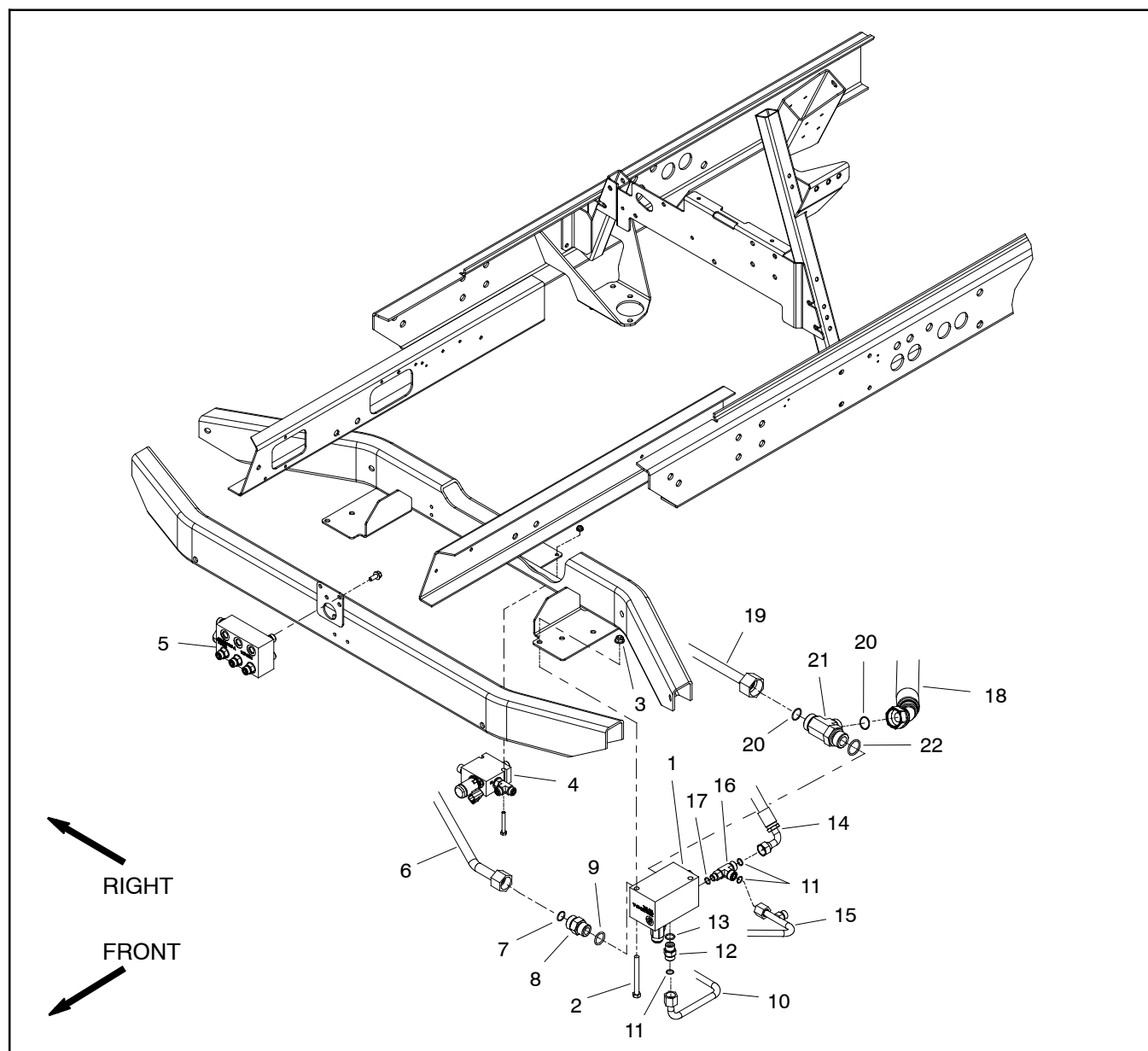


Figure 73

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

**Removal (Fig. 73)**

**NOTE:** The ports on the rear traction control manifold are marked for easy identification of components. Refer to the Hydraulic Schematics in Chapter 9 – Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port.

1. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.
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 73 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 (Fig. 73)**

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 Hydraulic Fitting Installation in the General Information section of this chapter).
2. Install rear traction control manifold to the frame using Figure 73 as guide.
3. Remove caps and plugs from fittings and hoses. Using labels placed during manifold removal, properly connect hydraulic lines to manifold (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).
4. Fill hydraulic reservoir with hydraulic fluid as required.

## Rear Traction Control Manifold Service

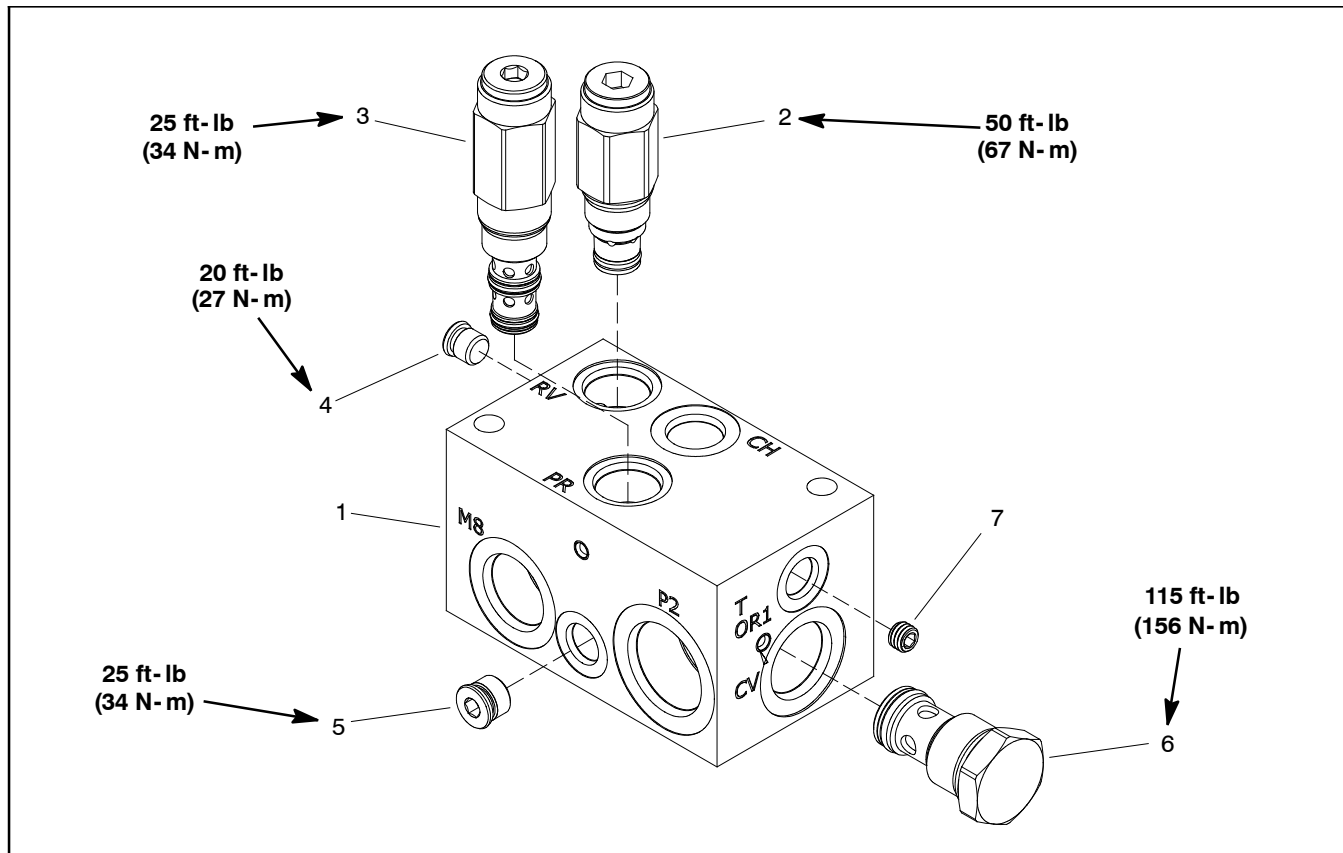


Figure 74

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

**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 (see Hydraulic Schematic in Chapter 10 - Foldout Drawings 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 in this section. Refer to Figure 74 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.

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

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

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

## HI/LOW Range Control Manifold

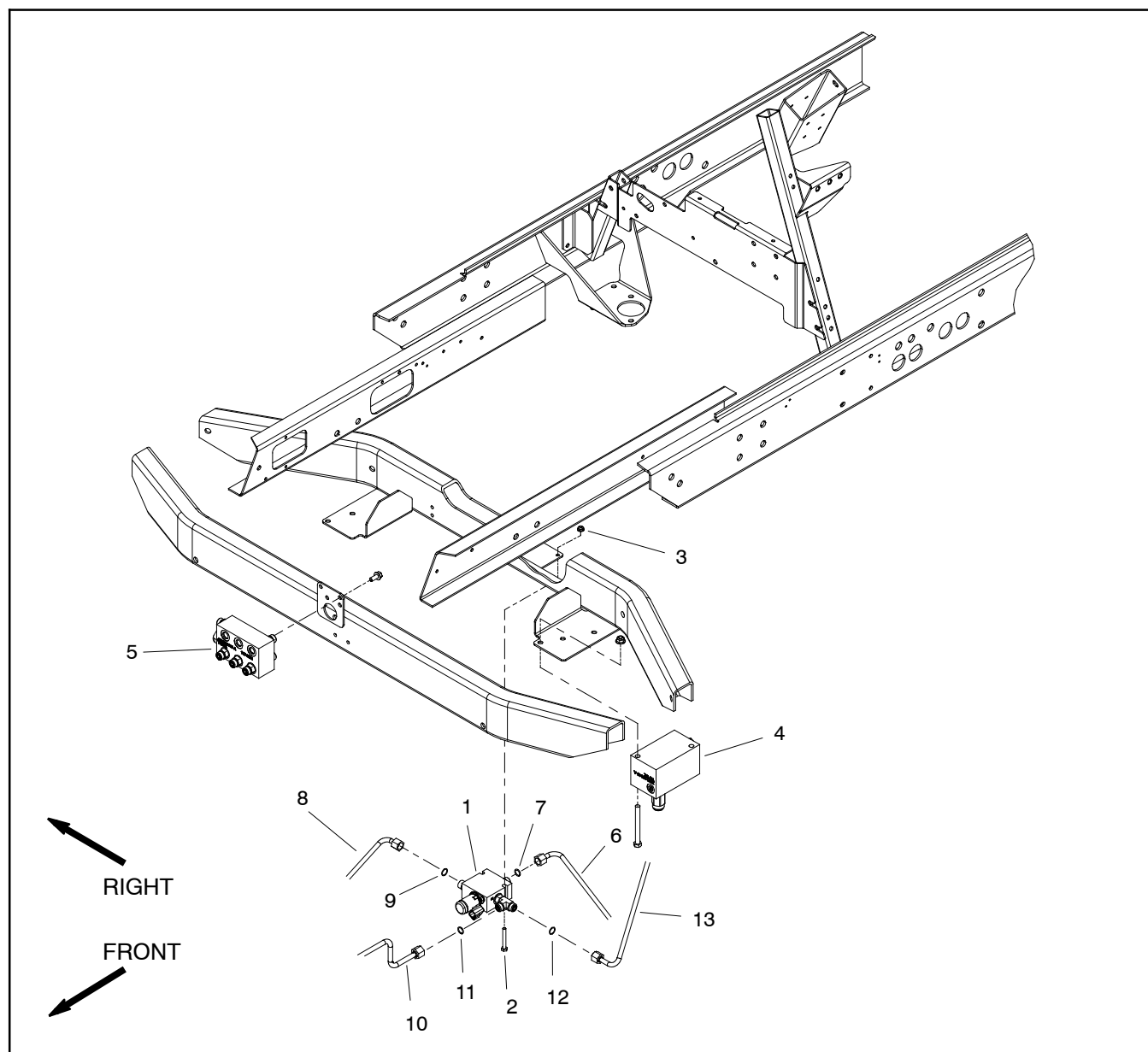


Figure 75

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

**NOTE:** The ports on the HI/LOW range control manifold are marked for easy identification of components. Refer to the Hydraulic Schematics in Chapter 9 - Fold-out Drawings to identify the function of the hydraulic lines and cartridge valves at each port.

### Removal (Fig. 75)

1. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.
2. To prevent contamination of hydraulic system during manifold removal, thoroughly clean exterior of HI/LOW range control 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 HI/LOW range control manifold from the frame using Figure 75 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

For cartridge valve service procedures, see Control Manifold Cartridge Valve Service in this section. Refer to Figure 76 for cartridge valve and hydraulic fitting installation torque.

**NOTE:** The check valve adapter used in the HI/LOW range control manifold allows free flow toward the manifold and prevents flow away from the manifold (Fig. 77).

### Installation (Fig. 75)

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 Hydraulic Fitting Installation in the General Information section of this chapter).
2. Install HI/LOW range control manifold to the frame using Figure 75 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 Hydraulic Hose and Tube Installation in the General Information section of this chapter).
4. Fill hydraulic reservoir with hydraulic fluid as required.

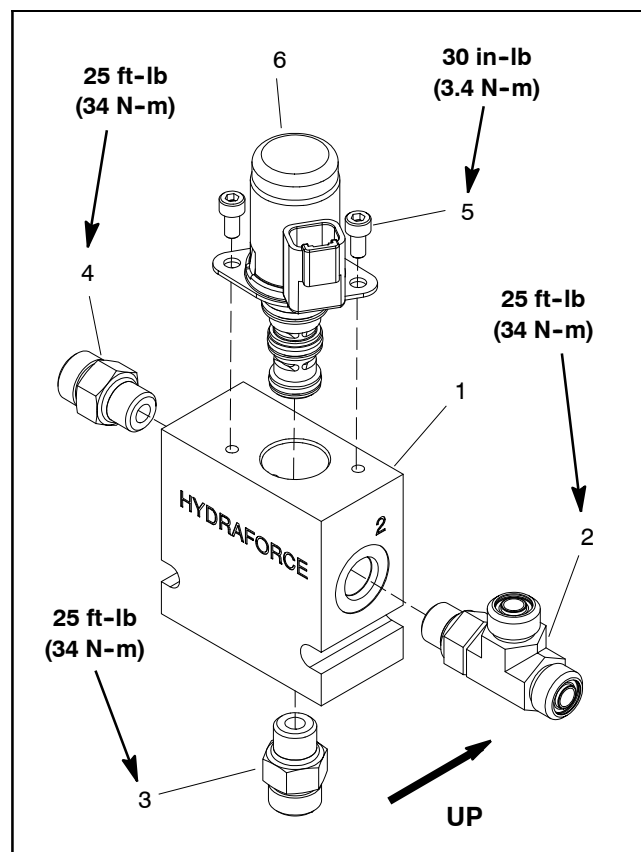


Figure 76

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

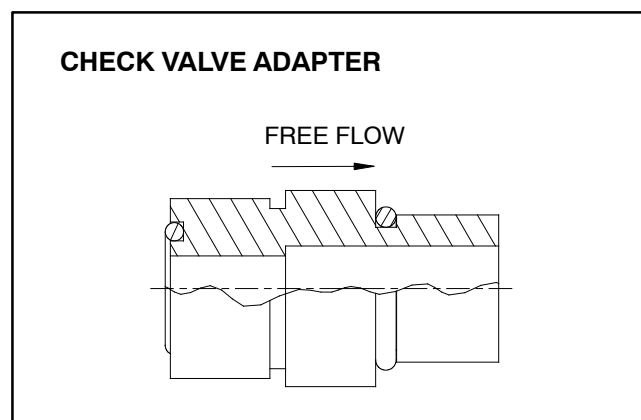


Figure 77

## Rear Axle Motor

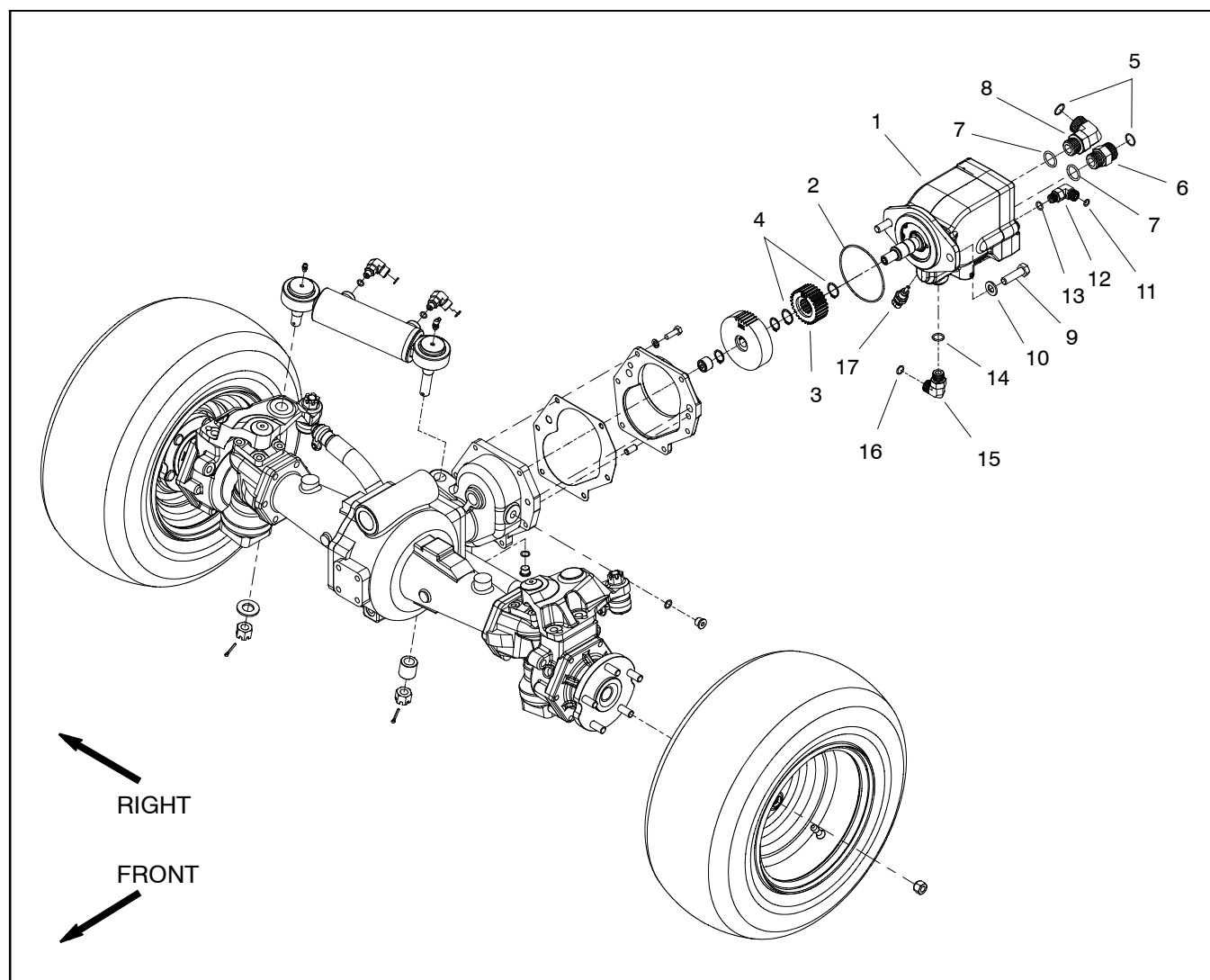


Figure 78

- |                                |                           |                                    |
|--------------------------------|---------------------------|------------------------------------|
| 1. Rear axle motor             | 7. O-ring                 | 13. O-ring                         |
| 2. O-ring                      | 8. 90° hydraulic fitting  | 14. O-ring                         |
| 3. Pinion gear                 | 9. Cap screw (2 used)     | 15. 90° 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. 90° hydraulic fitting |                                    |

**Removal (Fig. 78)**

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 at the beginning of the Service and Repairs section of this chapter.
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.

**IMPORTANT: Support axle motor to prevent motor from falling during removal.**

6. Remove motor using Figure 78 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 (Fig. 78)**

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 Hydraulic Fitting Installation in the General Information section of this chapter).
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 Hydraulic Hose and Tube Installation in the General Information section of this chapter).
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

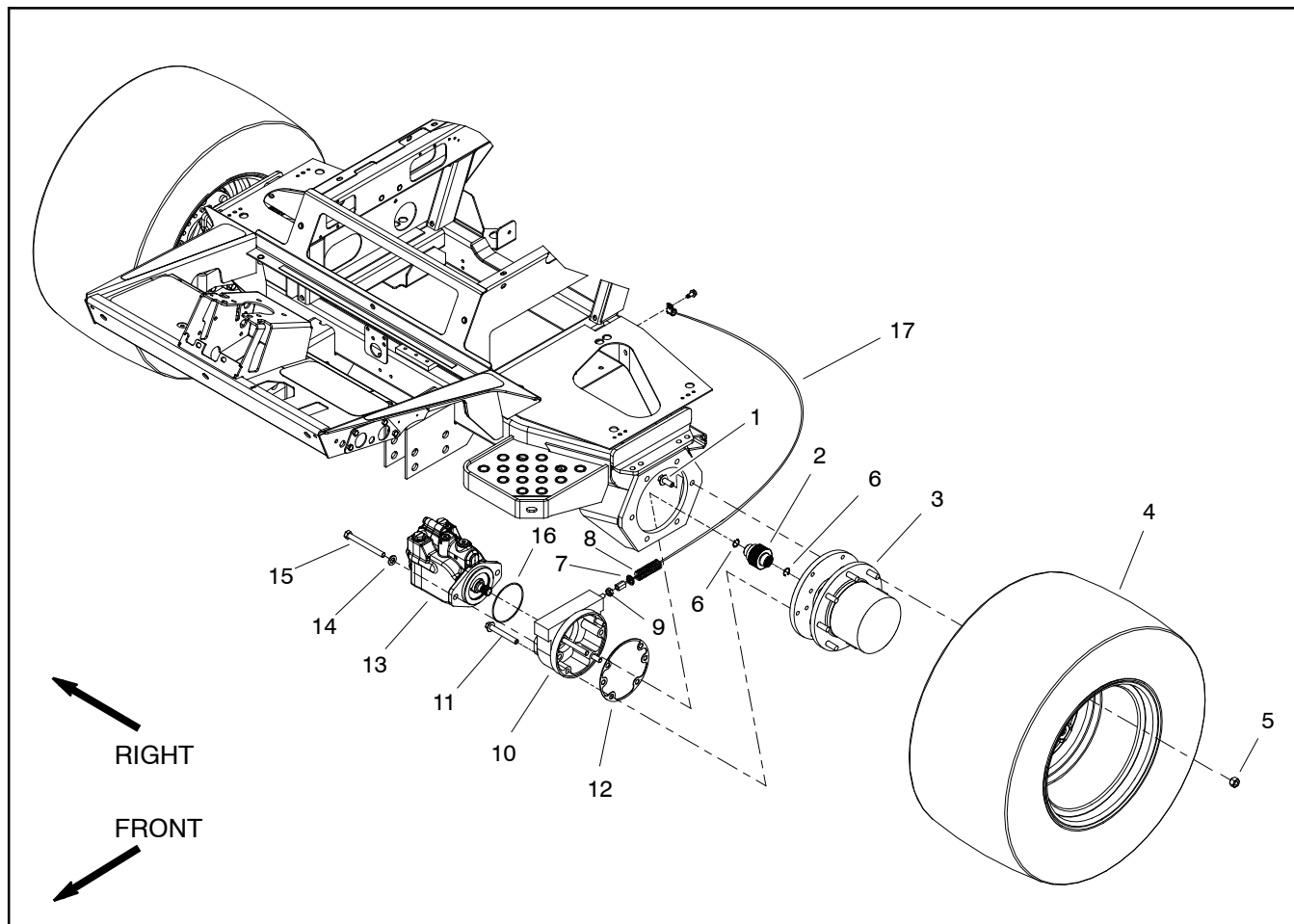


Figure 79

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

### Removal (Fig. 79)

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 in Chapter 2 - Safety for additional information and precautions.**

2. Raise front of machine and support with jack stands.

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

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 79 as a guide.

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 (Figs. 80 and 81). Remove fittings from motor and discard O-rings.

### Installation (Fig. 79)

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 (Figs. 80 and 81). Tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).

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 Hydraulic Hose and Tube Installation in the General Information section of this chapter).

7. Lower machine to ground.

8. Fill reservoir with hydraulic fluid as required.

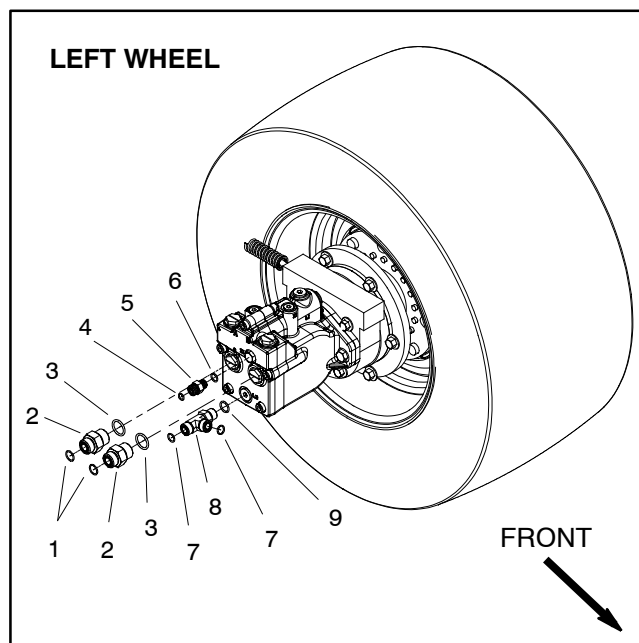


Figure 80

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

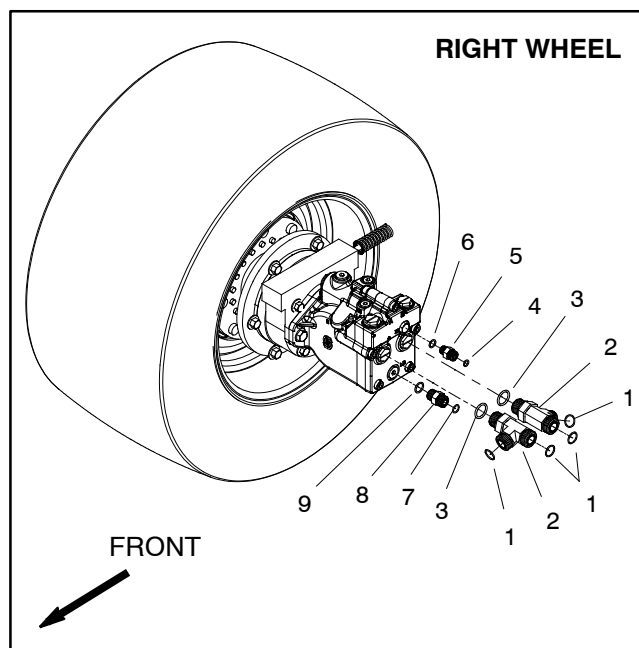


Figure 81

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

## Rear Axle and Front Wheel Motor Service

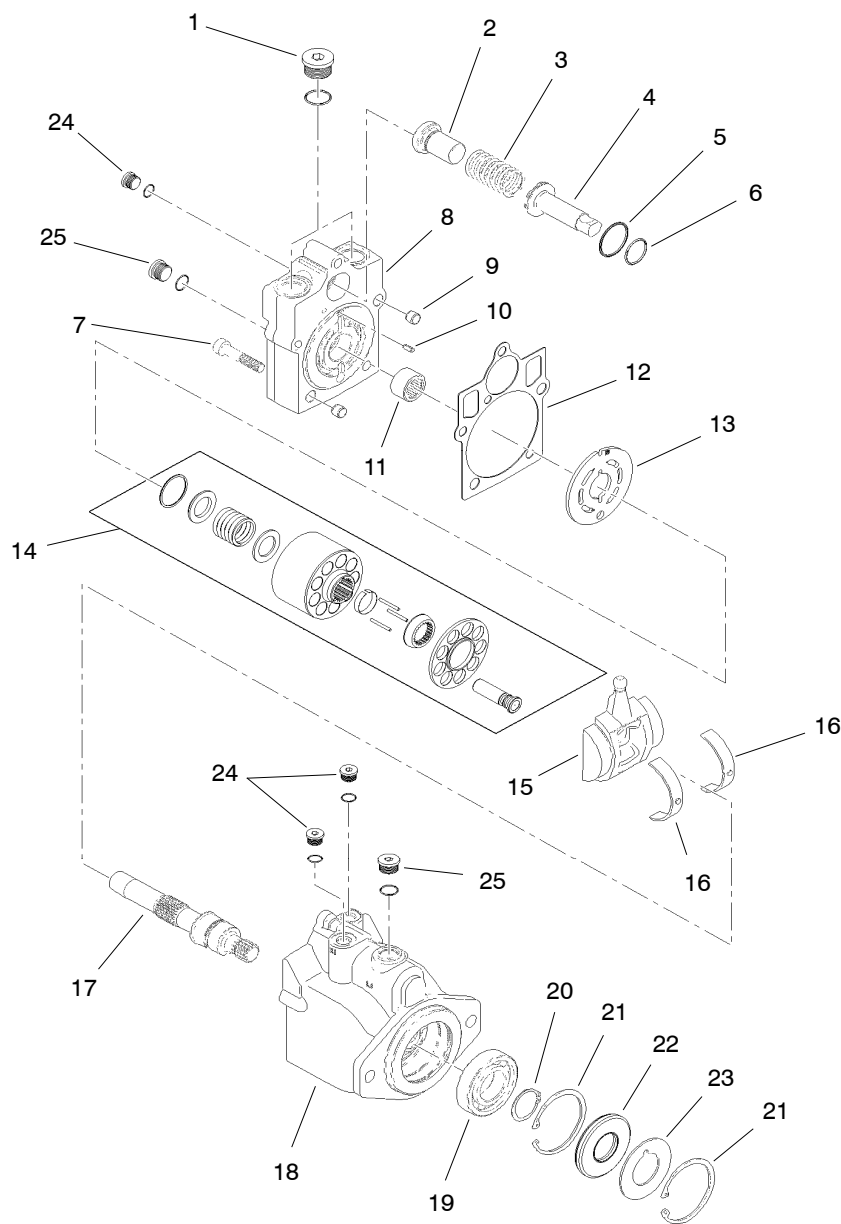


Figure 82

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



**NOTE:** The front wheel motors are identical (shown in Figure 82). 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 (Fig. 83). Service of the wheel and axle motors uses the same procedure.

**NOTE:** For service of the wheel motors, see the Sauer-Danfoss K and L Frame Variable Motors Service Manual at the end of this chapter.

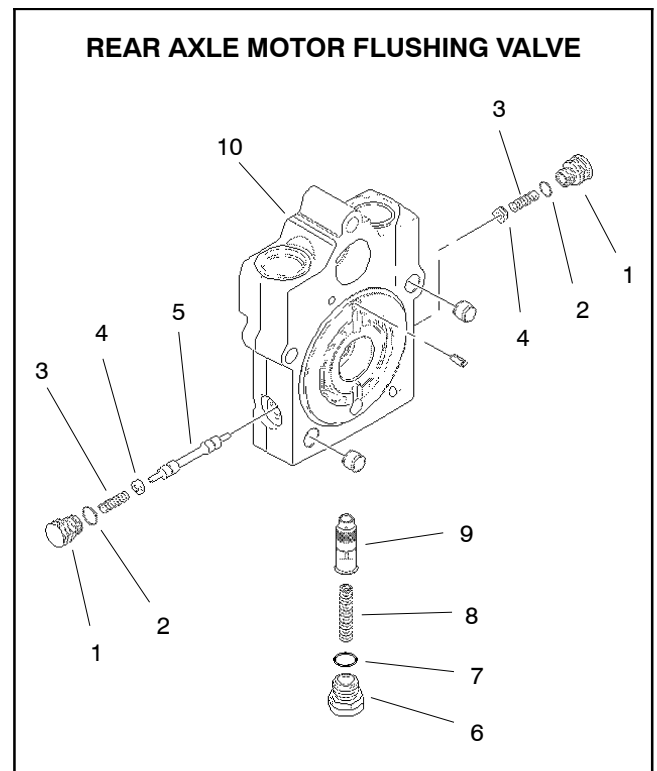


Figure 83

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

## Cutting Deck 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 at the beginning of the Service and Repairs section of this chapter.
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.
5. Remove two (2) socket head screws and flat washers that secure hydraulic motor to cutting deck (Fig. 84).
6. Lift hydraulic motor from cutting deck.
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 Hydraulic Fitting Installation in the General Information section of this chapter).
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 (Fig. 84).
5. Remove caps or plugs from hydraulic fittings and hoses. Connect hydraulic hoses to deck motor (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).
6. After assembly is completed, verify that hydraulic hoses and fittings are not contacted by any moving components.

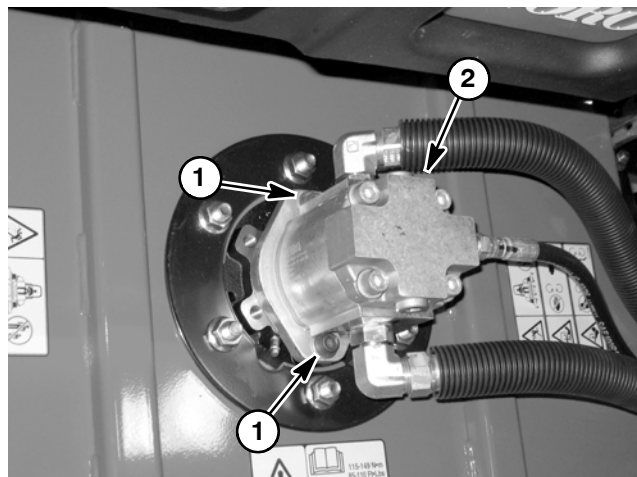


Figure 84

1. Socket head screw      2. Hydraulic motor

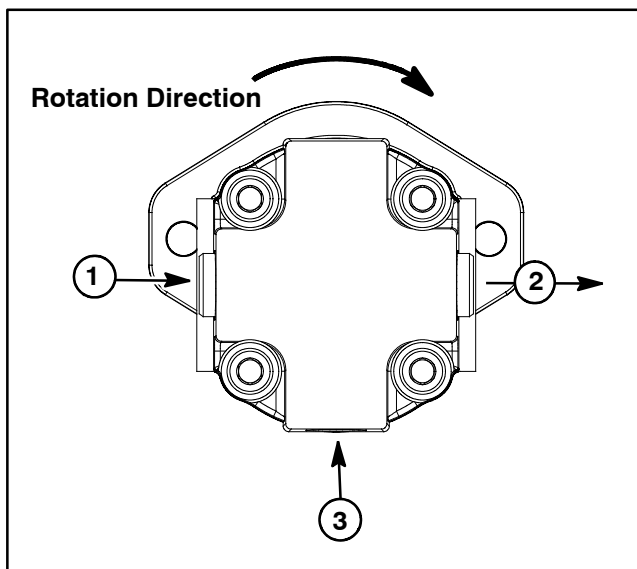


Figure 85

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

This page is intentionally blank.

## Cutting Deck Motor Service

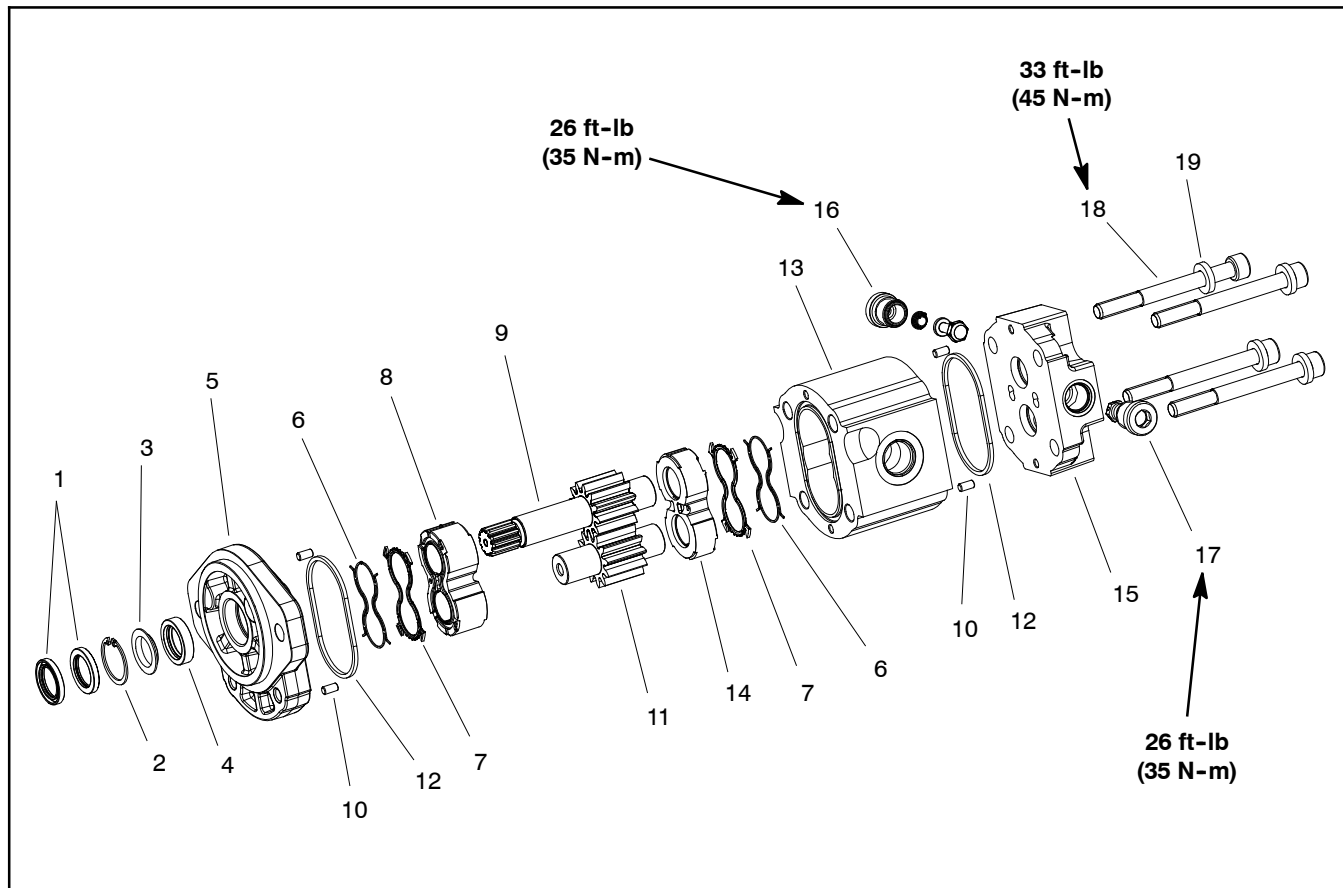


Figure 86

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)

### Disassembly (Fig. 86)

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 (Fig. 87).

**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.

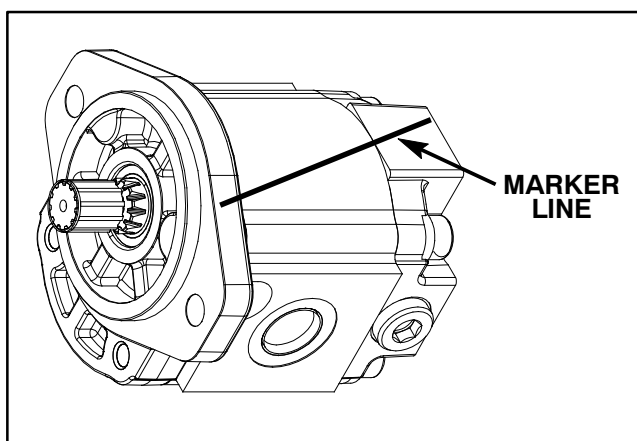


Figure 87

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

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

11. Carefully remove dust seals, retaining ring, flange washer and shaft seal from the front flange (Fig. 88). Discard removed seals.

### Inspection

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



2. Clean all parts with solvent. Dry all parts with compressed air.
3. Inspect drive gears and idler gears for the following (Fig. 89):

- A. Gear shafts should be free of rough surfaces and excessive wear at bushing points and sealing areas. Scoring, rough surfaces or wear on gear shafts indicates need for replacement.

- B. Gear teeth should be free of excessive scoring and wear. Any broken or nicked gear teeth must be replaced.

- C. Inspect gear face edge for sharpness. Sharp edges of gears will mill into wear plates and, thus, must be replaced.

4. Inspect wear plates for the following:

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

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

- C. Thickness of wear plates should be equal.

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

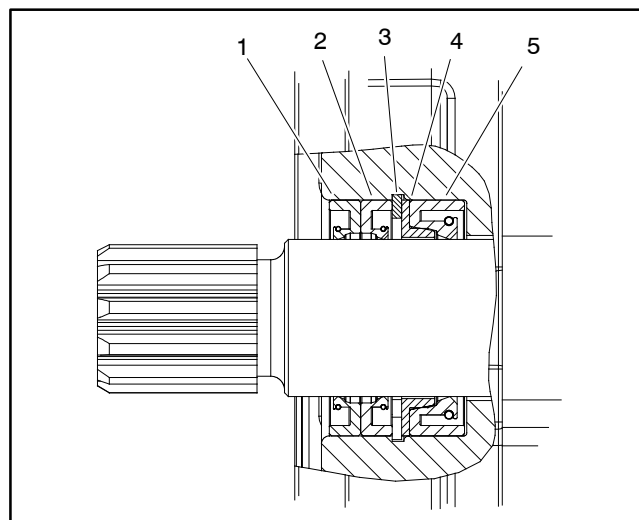


Figure 88

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

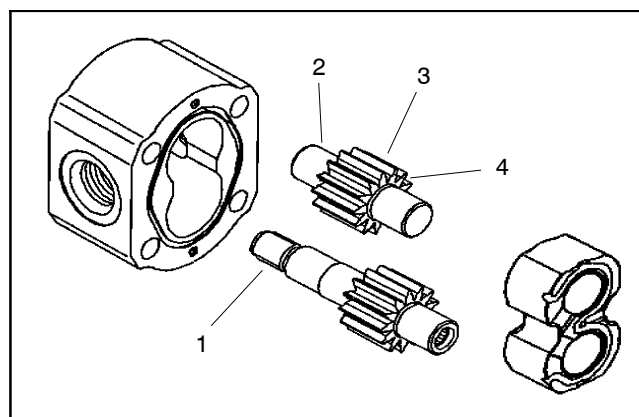


Figure 89

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

## Assembly (Fig. 86)

**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 (Fig. 88):
  - 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.

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 **33 ft-lb (45 N-m)**.

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.

This page is intentionally blank.

## Deck Control Manifold

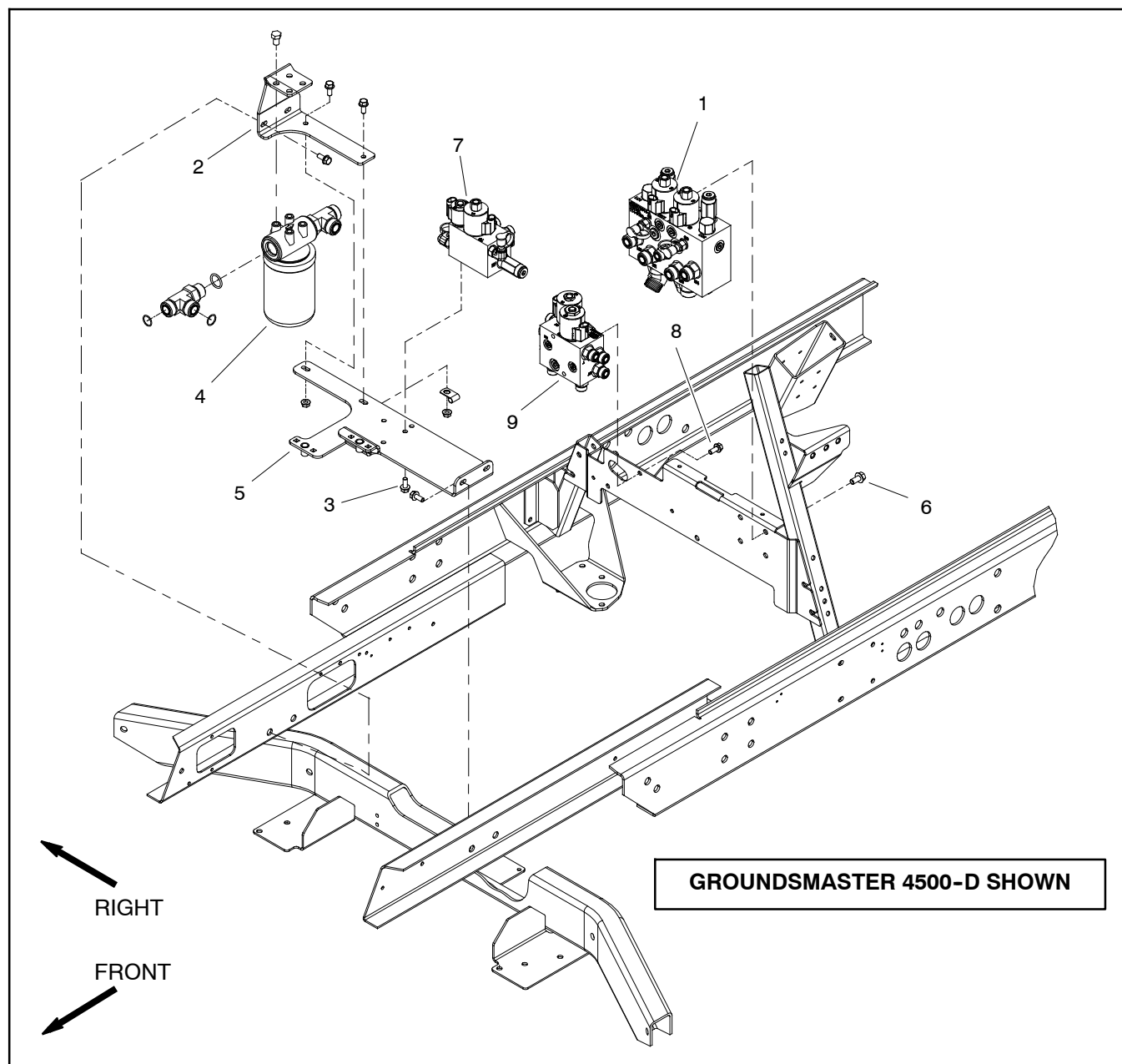


Figure 90

- |                               |                                  |                               |
|-------------------------------|----------------------------------|-------------------------------|
| 1. Deck control manifold      | 4. Hydraulic oil filter assembly | 7. Lift control manifold      |
| 2. Filter mount bracket       | 5. Valve mount bracket           | 8. Flange head screw (2 used) |
| 3. Flange head screw (2 used) | 6. 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 90.



## Removal (Fig. 90)

**NOTE:** The ports on the deck control manifold are marked for easy identification of components. Example: P1 is the gear pump connection port (see Hydraulic Schematics in Chapter 9 – Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each 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 at the beginning of the Service and Repairs section of this chapter.
3. Unlatch and raise hood.
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 90 as guide.
8. If hydraulic fittings are to be removed from control manifold, mark fitting orientation to allow correct assembly (Fig. 91 or 92). Remove fittings from manifold and discard O-rings.

## Installation (Fig. 90)

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 Hydraulic Fitting Installation in the General Information section of this chapter). Refer to Figure 91 or 92 for fitting installation torque.
2. Install hydraulic manifold to the frame using Figure 90 as guide.
3. Remove caps and plugs from fittings and hydraulic lines. Properly connect hydraulic lines to manifold (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).
4. Connect wire harness electrical connectors to the solenoid valve coils.
5. Lower and secure hood.

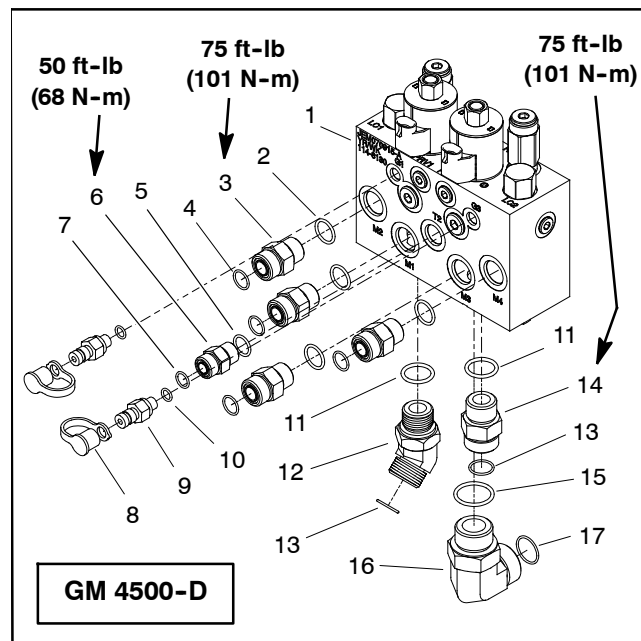


Figure 91

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

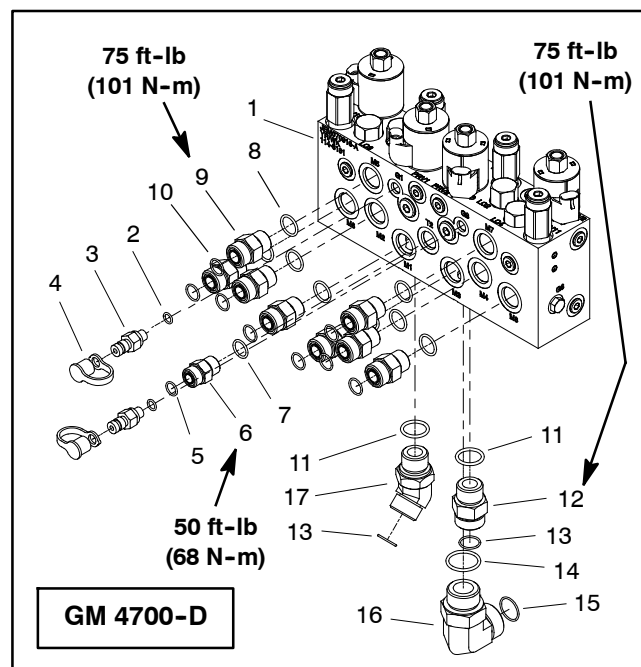


Figure 92

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

## Deck Control Manifold Service (GM 4500-D)

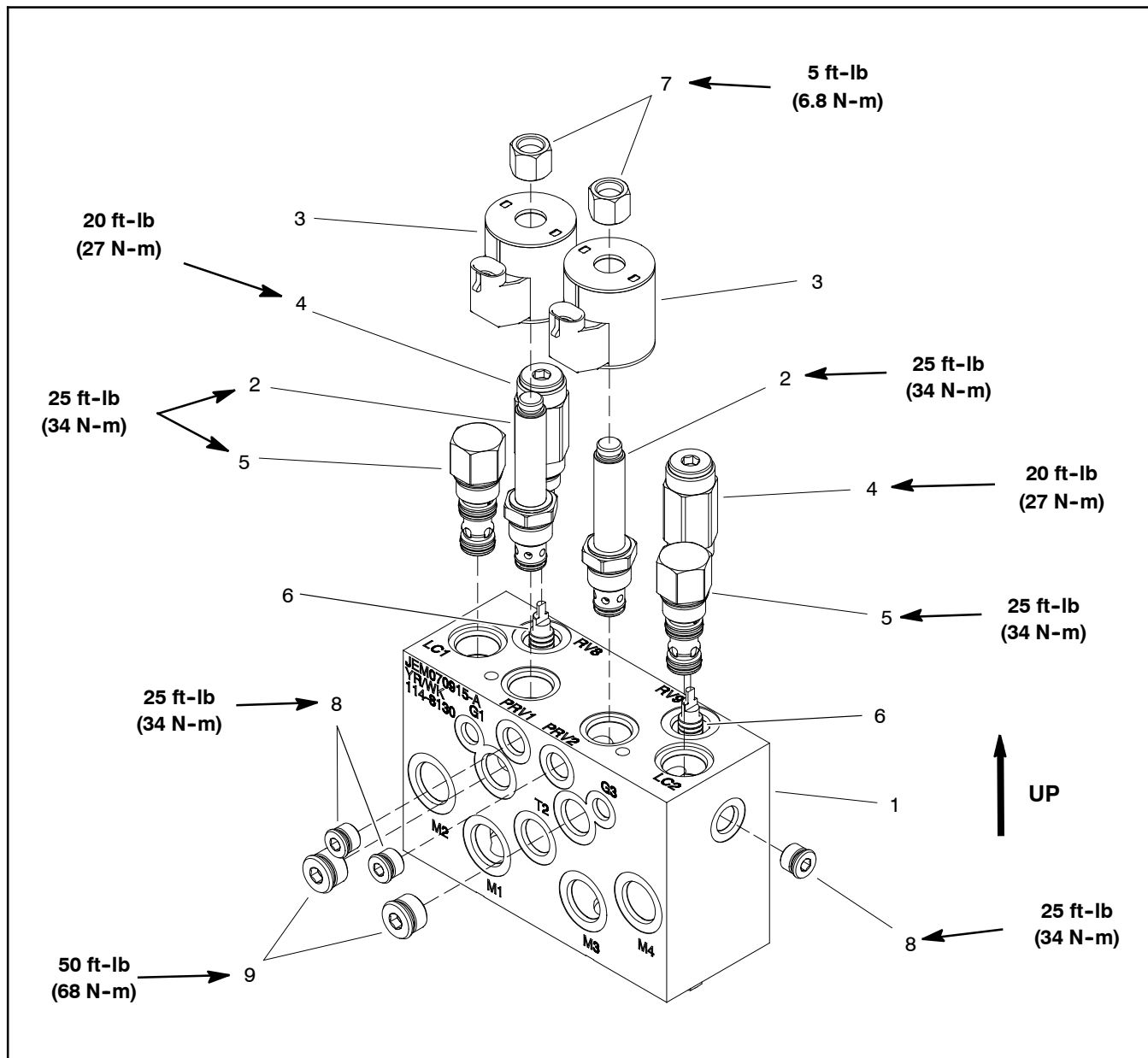


Figure 93

- |                                      |                             |                        |
|--------------------------------------|-----------------------------|------------------------|
| 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 Hydraulic Schematics in Chapter 9 – Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port location.

**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 Control Manifold Cartridge Valve Service in this section. Refer to Figures 93 and 94 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 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.

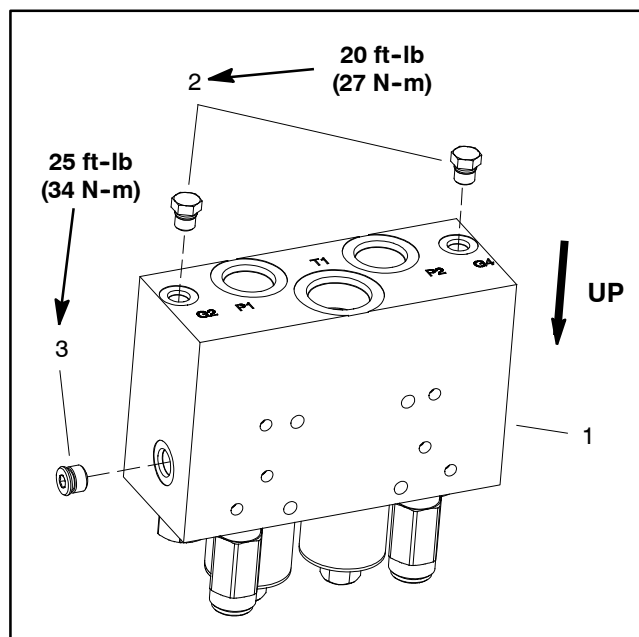


Figure 94

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

## Deck Control Manifold Service (GM 4700-D)

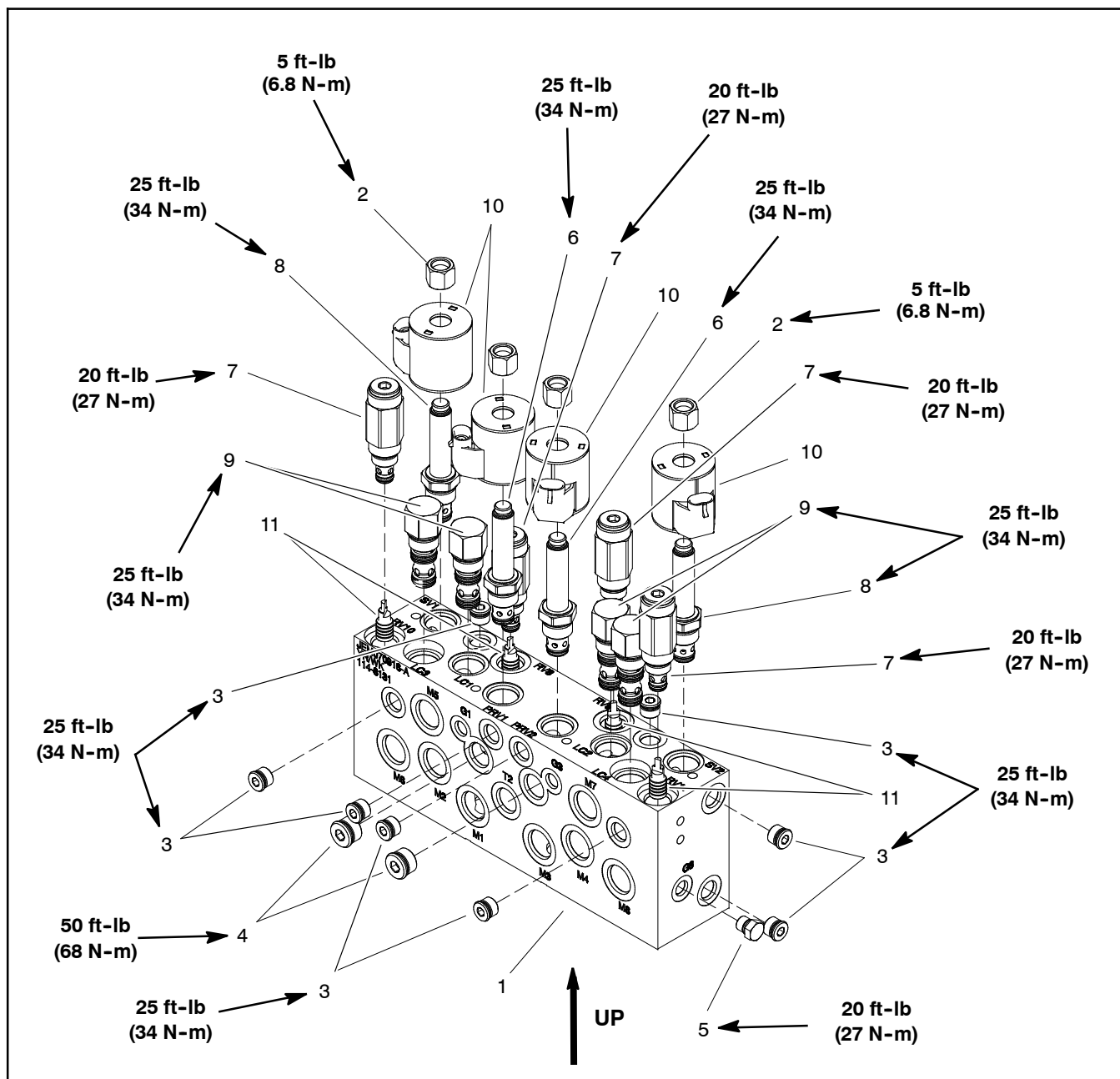


Figure 95

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

**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 Hydraulic Schematics in Chapter 9 – Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port location.

**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 Control Manifold Cartridge Valve Service in this section. Refer to Figures 95 and 96 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.

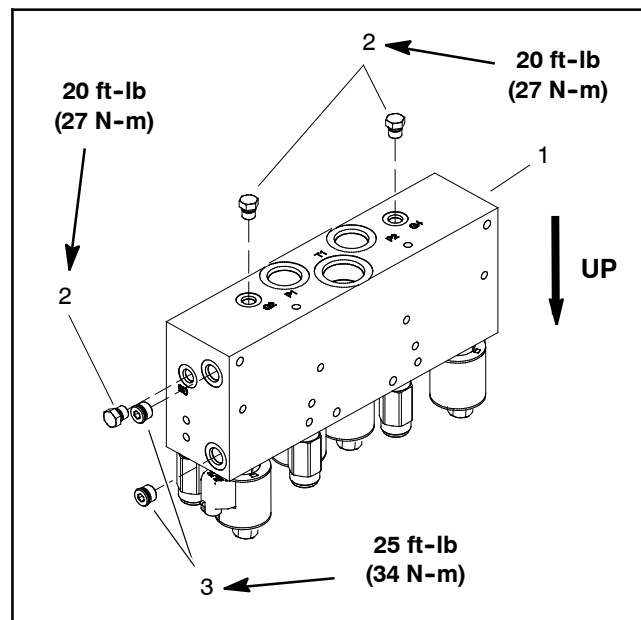


Figure 96

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

## Steering Control Valve

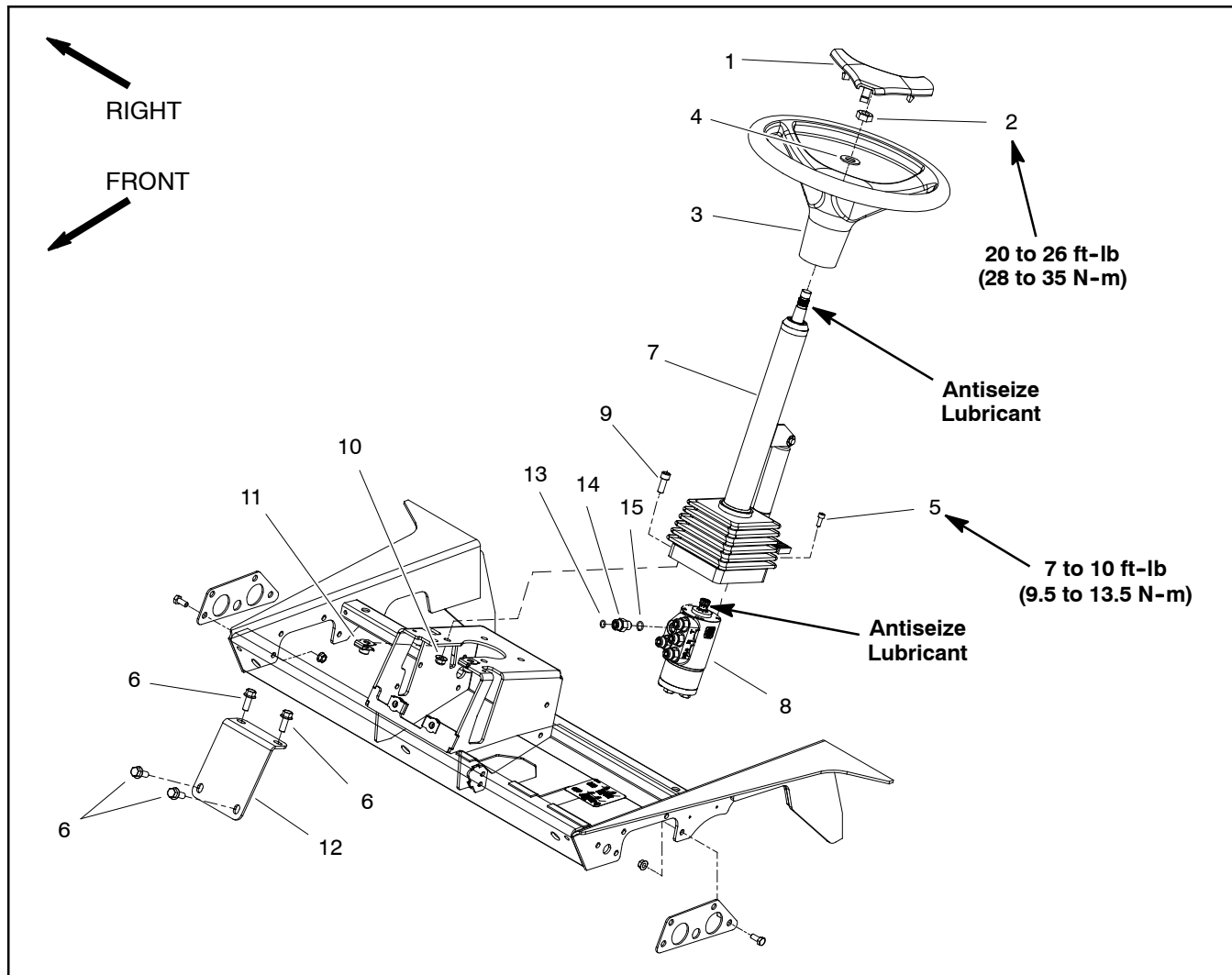


Figure 97

- |                               |                               |                               |
|-------------------------------|-------------------------------|-------------------------------|
| 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 (Fig. 97)

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 (Fig. 98). 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.

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 at the beginning of the Service and Repairs section of this chapter.

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 (Fig. 99).



## CAUTION

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

8. Disconnect hydraulic lines from steering control valve. Allow lines to drain into a suitable container.
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 (Fig. 97)

1. If fittings were removed, lubricate new O-rings with clean hydraulic oil and install fittings to steering control valve (see Hydraulic Fitting Installation in the General Information section of this chapter).
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 **7 to 10 ft-lb (9.5 to 13.5 N-m)**.
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 Hydraulic Hose and Tube Installation in the General Information section of this chapter).

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 (Fig. 98).

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

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

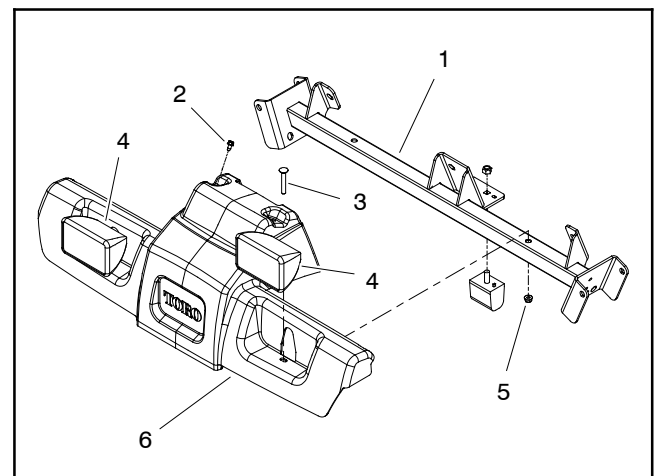


Figure 98

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

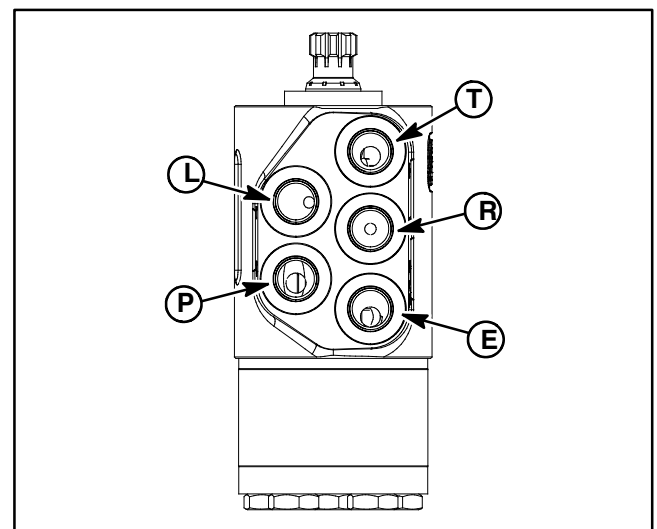


Figure 99

## Steering Control Valve Service

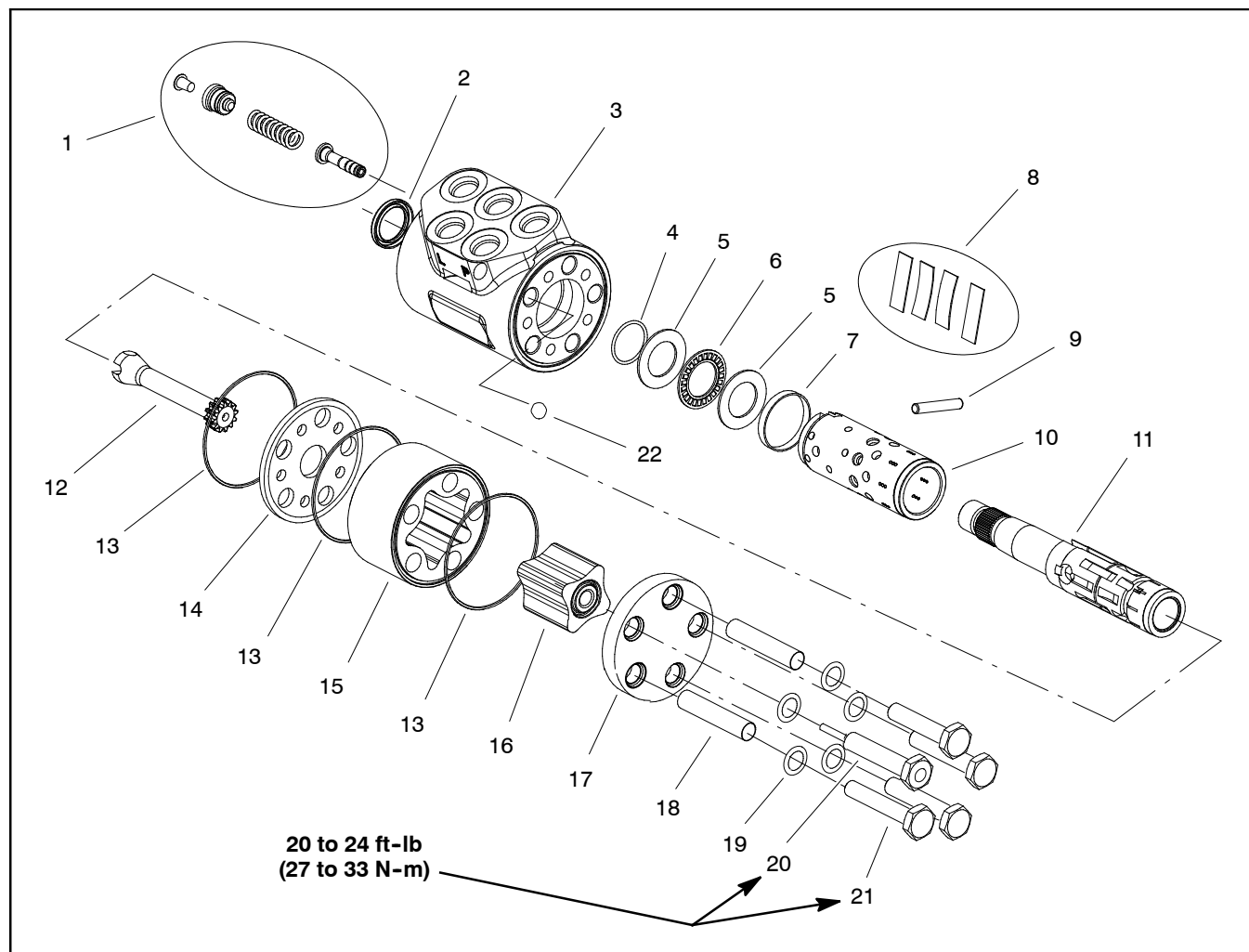


Figure 100

- |                           |                       |                        |
|---------------------------|-----------------------|------------------------|
| 1. Relief valve assembly  | 9. Cross pin          | 16. Inner gearwheel    |
| 2. Dust seal ring         | 10. Sleeve            | 17. End cover          |
| 3. Steering valve housing | 11. Spool             | 18. Tube (2 used)      |
| 4. Shaft seal             | 12. Cardan shaft      | 19. Washer (5 used)    |
| 5. Thrust washer          | 13. O-ring            | 20. Pin bolt           |
| 6. Bearing race           | 14. Distributor plate | 21. Cap screw (4 used) |
| 7. Ring                   | 15. Outer gearwheel   | 22. Ball               |
| 8. Spring set             |                       |                        |

**NOTE:** For repair of the steering control valve, see the Sauer-Danfoss Steering Unit Type OSPM Service Manual at the end of this chapter.



This page is intentionally blank.

## Steering Cylinder

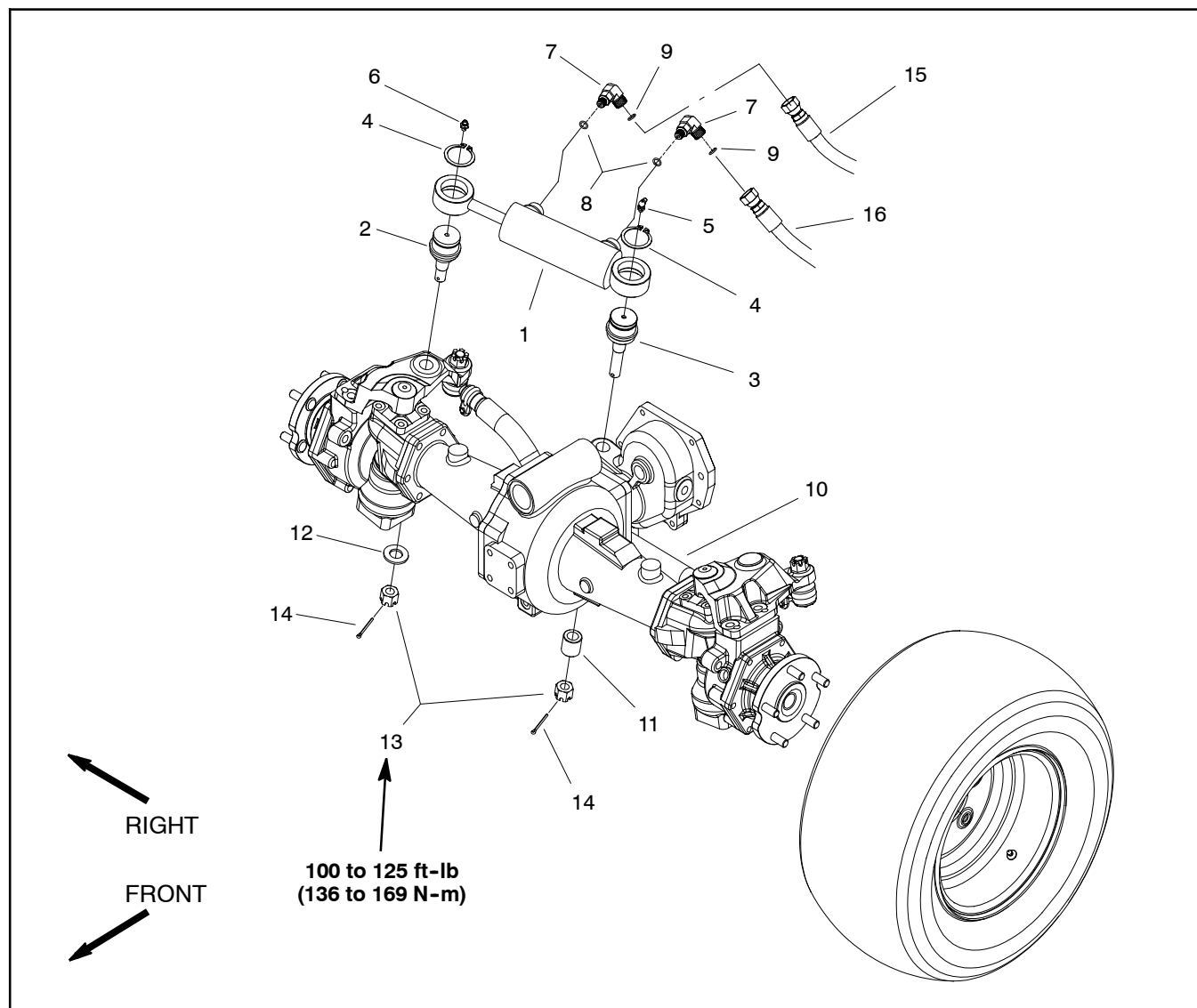


Figure 101

- 1. Steering cylinder
- 2. Ball joint
- 3. Ball joint
- 4. Retaining ring
- 5. Grease fitting
- 6. Grease fitting

- 7. 90° 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 (Fig. 101)**

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 at the beginning of the Service and Repairs section of this chapter.
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.
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 (Fig. 101)**

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 Hydraulic Fitting Installation in the General Information section of this chapter).
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 **100 to 125 ft-lbs (136 to 169 N-m)** prior to inserting cotter pins.
4. Remove caps and plugs from disconnected hoses and fittings.
5. Install hydraulic hoses to steering cylinder (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).
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

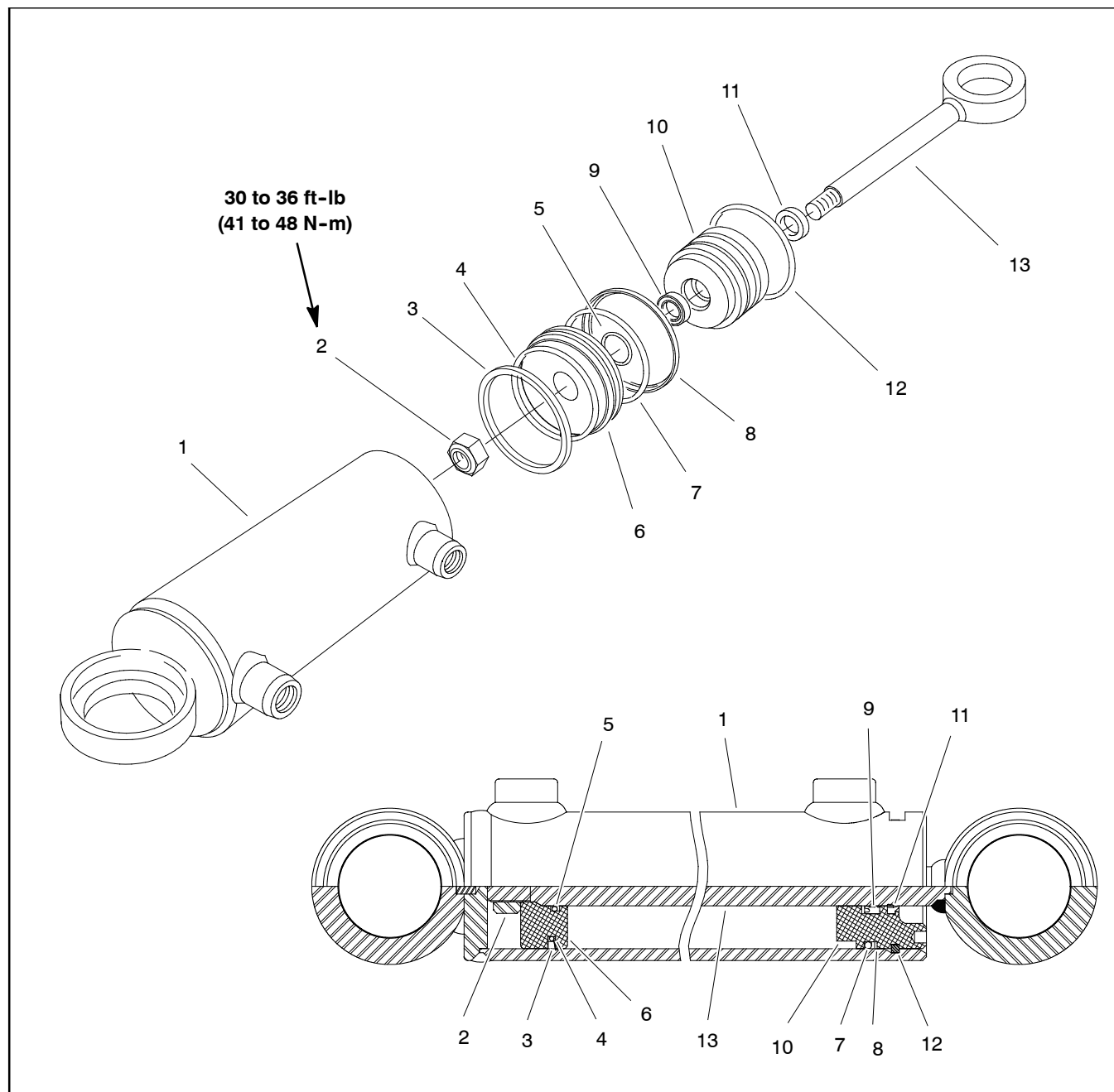


Figure 102

- 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 (Fig. 102)**

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.**

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 (Fig. 102)**

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 **30 to 36 ft-lb (41 to 48 N-m)**.

4. 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.**

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

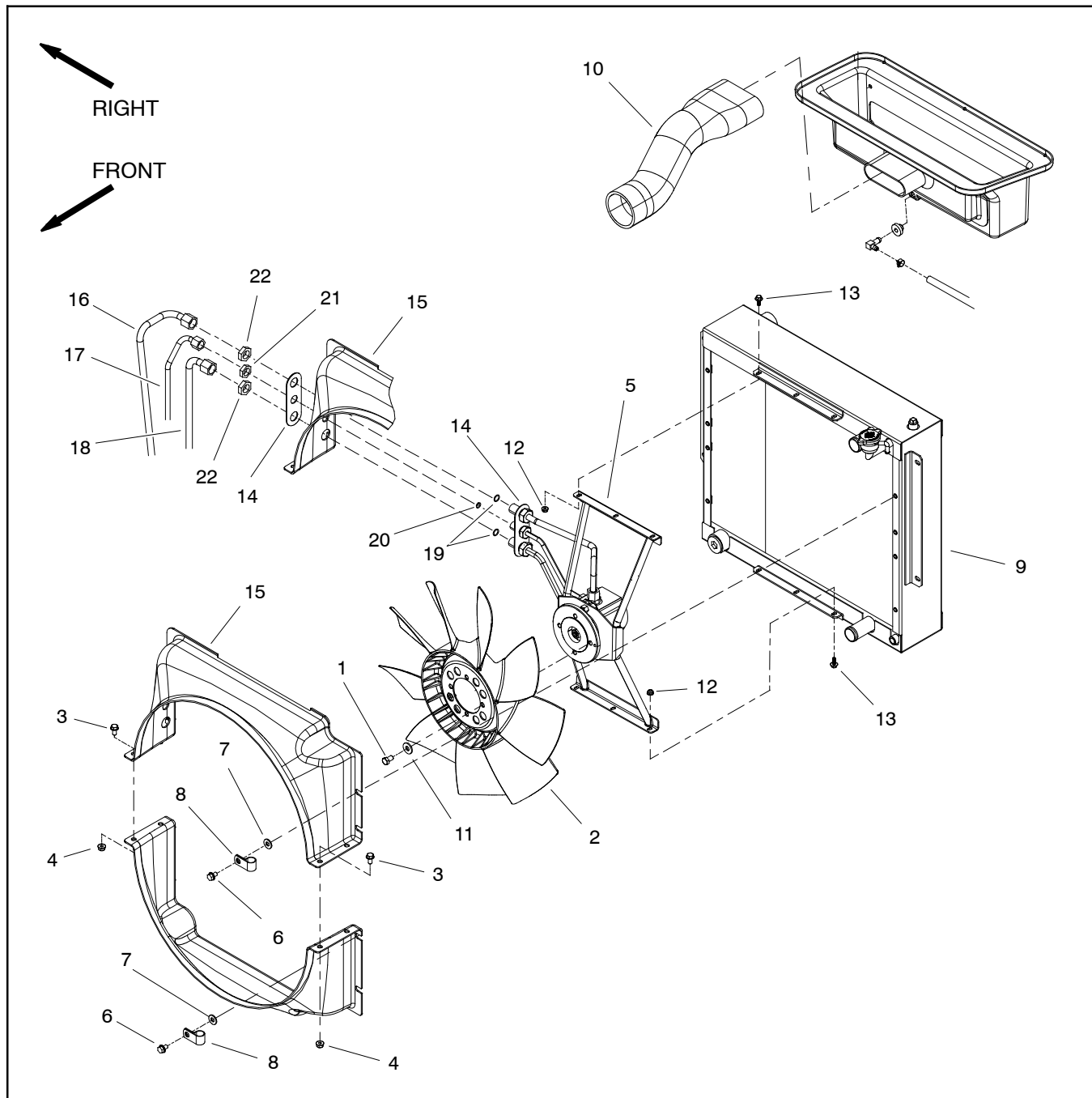


Figure 103

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

## Removal (Fig. 103)

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 at the beginning of the Service and Repairs section of this chapter.
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.

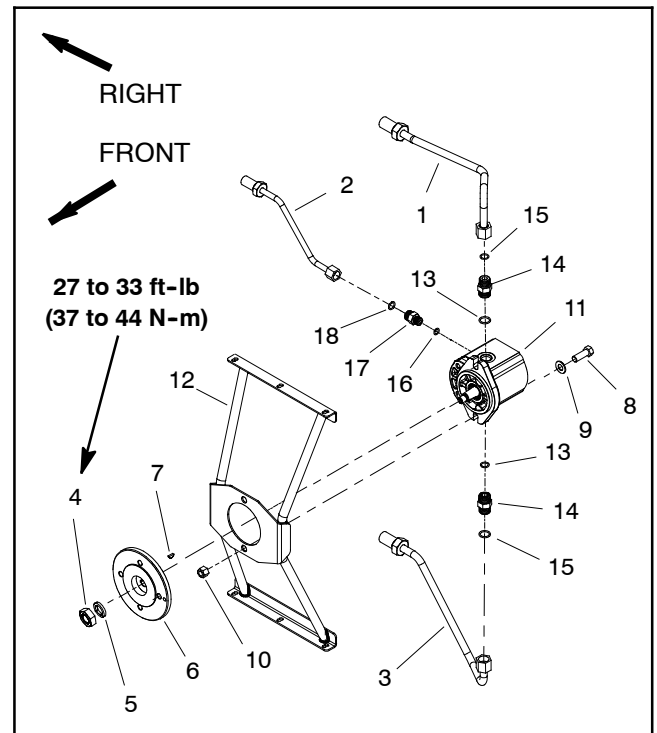


Figure 104

- |                         |                       |
|-------------------------|-----------------------|
| 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 (Fig. 104):

- 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 (Fig. 103)

1. If fittings were removed from fan motor, lubricate and place new O-rings onto fittings. Install fittings into port openings. Tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).
2. Secure fan motor to bracket (Fig. 104):
  - 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.
  - C. Position fan hub onto motor shaft and secure with washer (item 5) and hex nut (item 4). Torque nut from **27 to 33 ft-lb (37 to 44 N-m)**.
  - D. Connect hydraulic tubes (items 1, 2 and 3) to fan motor fittings. Use support shim (item 14 in Fig. 103) 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 (Fig. 103):

- 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 0.180" (4.6 mm) 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 Hydraulic Hose and Tube Installation in the General Information section of this chapter).

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.



This page is intentionally blank.

## Engine Cooling Fan Motor Service

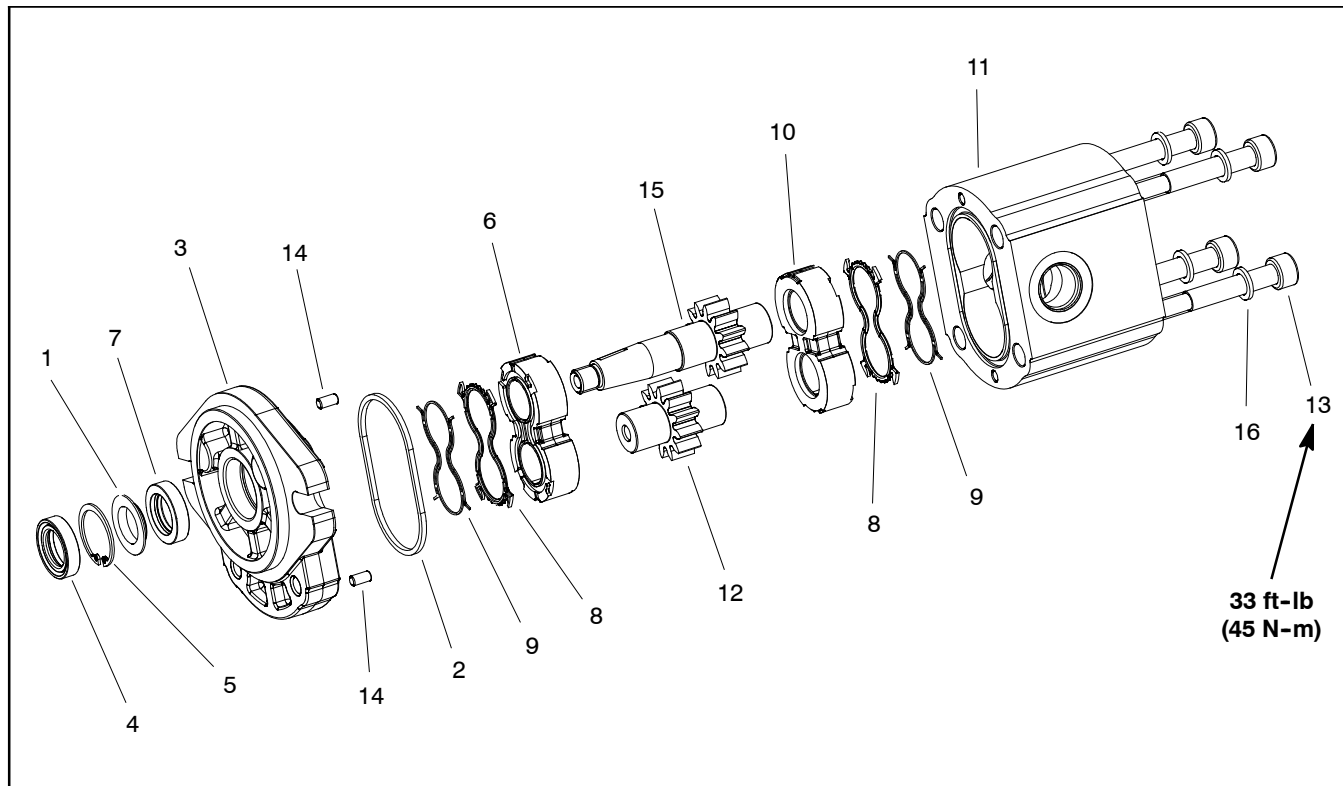


Figure 105

1. Flange washer
2. O-ring
3. Front flange
4. Dust seal
5. Retaining ring
6. Front wear plate

7. Shaft seal
8. Backup gasket
9. Pressure seal
10. Rear wear plate
11. Body

12. Idler gear
13. Cap screw (4 used)
14. Dowel (2 used)
15. Drive gear
16. Washer (4 used)

The engine cooling fan motor has similar construction as the cutting deck motors. The body of the cooling fan motor (item 11 in Fig. 105) includes the rear cover which is a difference from the deck motors which have a separate rear cover. Orientation of the dust seal (item 4 in Fig. 105) is different in the cooling fan motor than in the deck motors.

For disassembly, inspection and assembly procedures of the cooling fan motor, refer to Cutting Deck Motor Service in this section. When installing the seals into the front flange in the cooling fan motor, use the orientation shown in Figure 106.

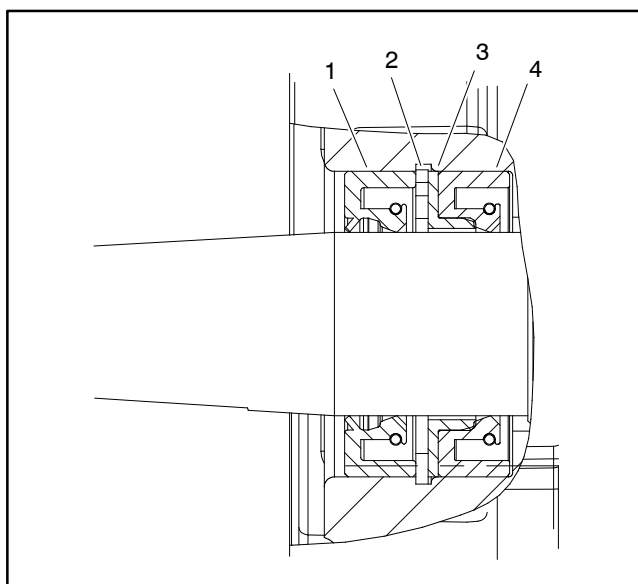


Figure 106

1. Dust seal
2. Retaining ring

3. Flange washer
4. Shaft seal

This page is intentionally blank.

## Fan Control Manifold

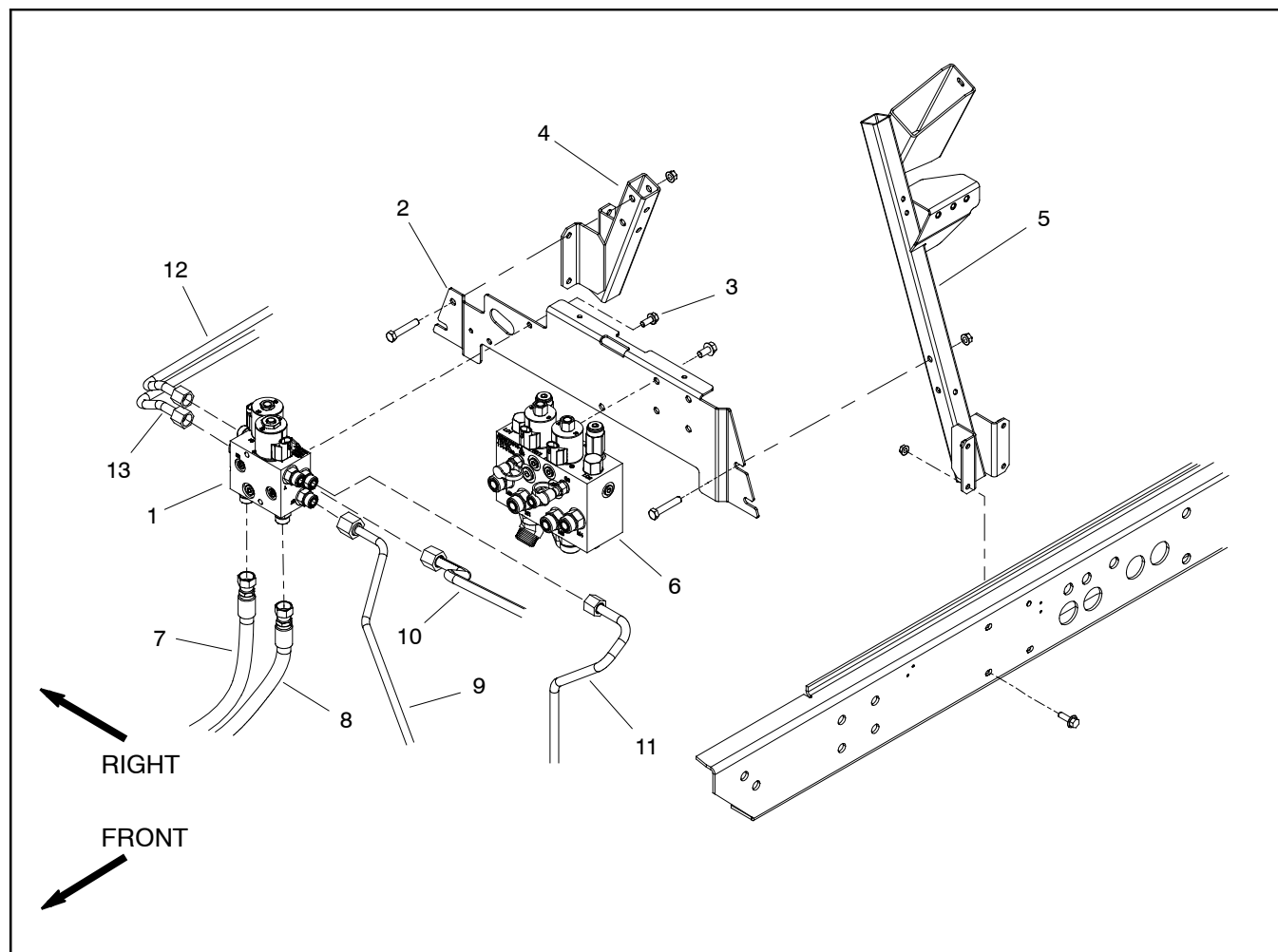


Figure 107

- |                               |                                    |                    |
|-------------------------------|------------------------------------|--------------------|
| 1. Fan control manifold       | 6. Deck manifold (GM 4500-D shown) | 10. Hydraulic tube |
| 2. Support bracket            | 7. Hydraulic hose                  | 11. Hydraulic tube |
| 3. Flange head screw (2 used) | 8. Hydraulic hose                  | 12. Hydraulic tube |
| 4. Battery support            | 9. Hydraulic tube                  | 13. Hydraulic tube |
| 5. Air cleaner mount          |                                    |                    |

## Removal (Fig. 107)

**NOTE:** The ports on the fan control manifold are marked for easy identification of components. Example: P1 is the gear pump connection port (see Hydraulic Schematics in Chapter 9 – Foldout Drawings 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 at the beginning of the Service and Repairs section of this chapter.

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.

7. Remove hydraulic manifold from the frame using Figure 107 as guide.

8. If hydraulic fittings are to be removed from fan control manifold, mark fitting orientation to allow correct assembly (Fig. 108). Remove fittings from manifold and discard O-rings.

## Installation (Fig. 107)

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 Hydraulic Fitting Installation in the General Information section of this chapter). Refer to Figure 108 for fitting installation torque.

2. Install hydraulic manifold to the frame using Figure 107 as guide.

3. Remove caps and plugs from fittings and hydraulic lines. Properly connect hydraulic lines to manifold (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

4. Connect wire harness electrical connectors to the manifold solenoid valves.

5. Lower and secure hood.

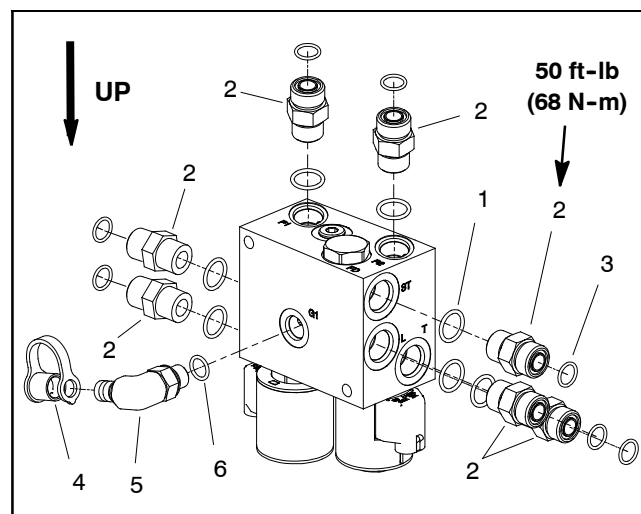


Figure 108

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

## Fan Control Manifold Service

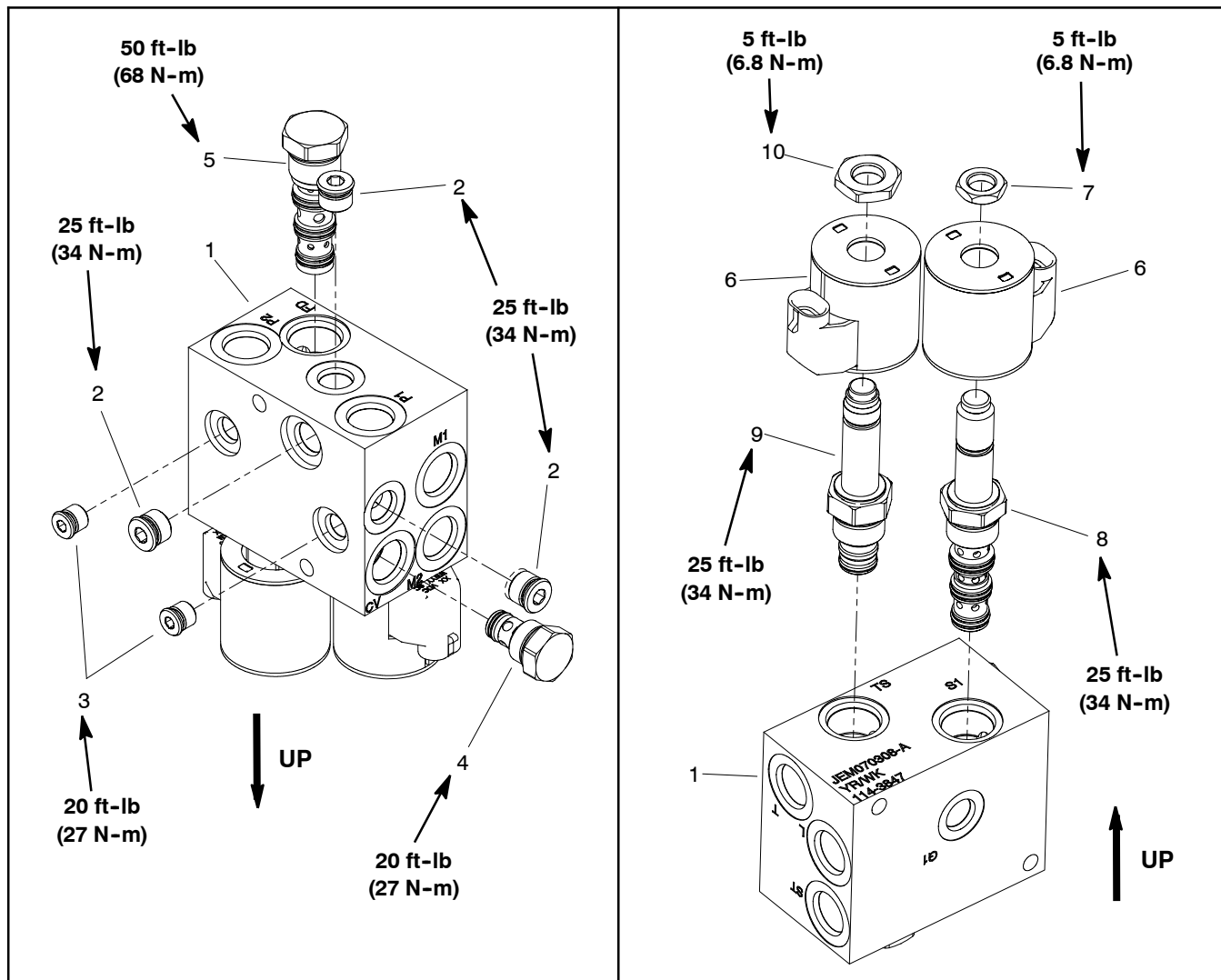


Figure 109

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 Hydraulic Schematics in Chapter 9 – Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port location.

For solenoid and control valve service procedures, see Control Manifold Cartridge Valve Service in this section. Refer to Figure 109 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.

This page is intentionally blank.

## Lift Control Manifold

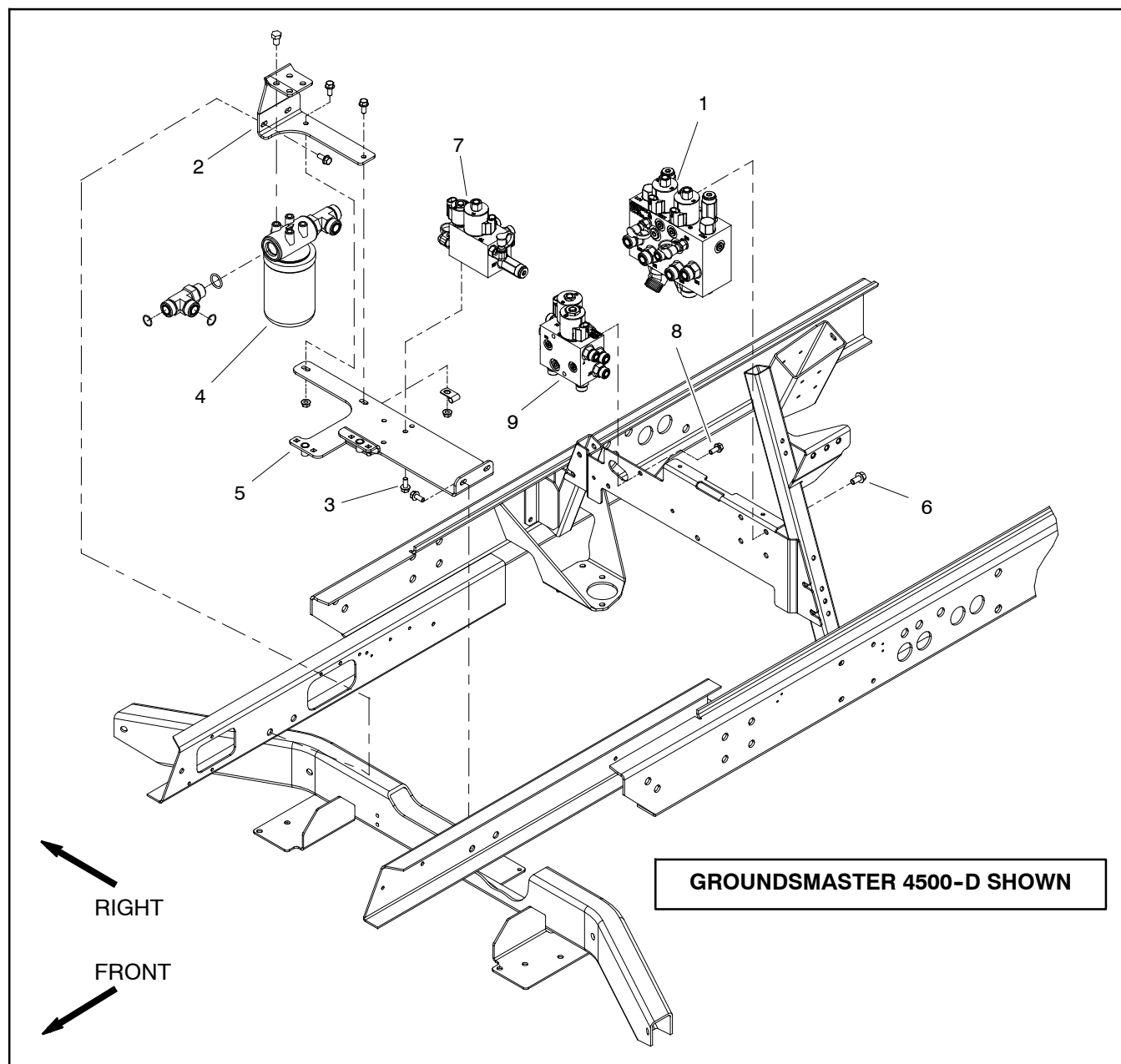


Figure 110

- 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 110.

**NOTE:** The ports on the lift control manifold are marked for easy identification of components. Example: P1 is the gear pump connection port (see Hydraulic Schematics in Chapter 9 - Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port).



## Removal (Fig. 110)

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 at the beginning of the Service and Repairs section of this chapter.

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.

7. Remove hydraulic manifold from the frame using Figure 110 as guide.

8. If hydraulic fittings are to be removed from lift control manifold, mark fitting orientation to allow correct assembly (Fig. 111 or 112). Remove fittings from manifold and discard O-rings.

## Installation (Fig. 110)

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 Hydraulic Fitting Installation in the General Information section of this chapter). Refer to Figure 111 or 112 for fitting installation torque.

2. Install hydraulic manifold to the frame using Figure 110 as guide.

3. Remove caps and plugs from fittings and hoses. Properly connect hydraulic lines to manifold (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

Groundsmaster 4500-D/4700-D

4. Connect wire harness electrical connectors to the solenoid valve coils.

5. Lower and secure operator seat.

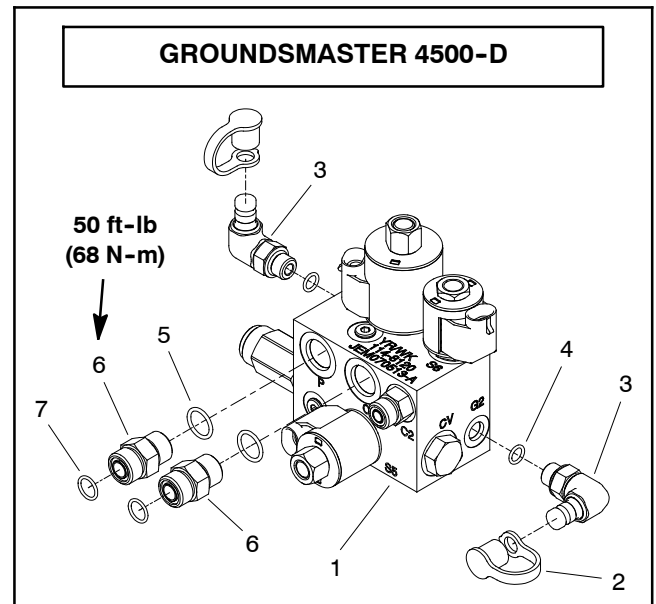


Figure 111

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

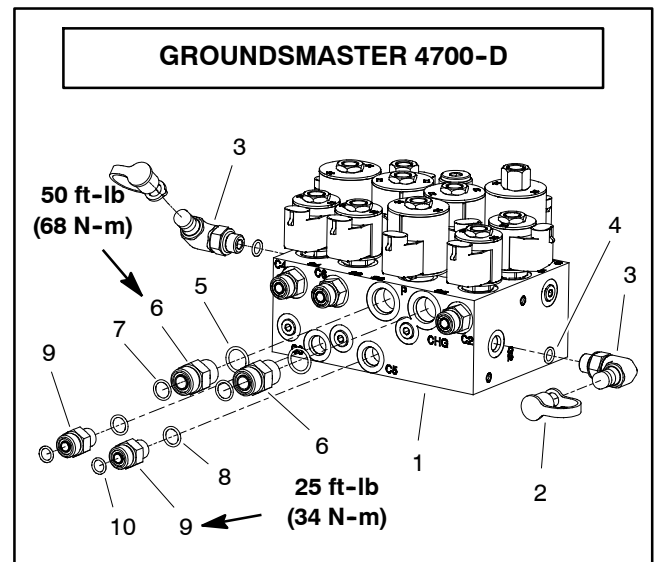


Figure 112

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

## Lift Control Manifold Service (GM 4500-D)

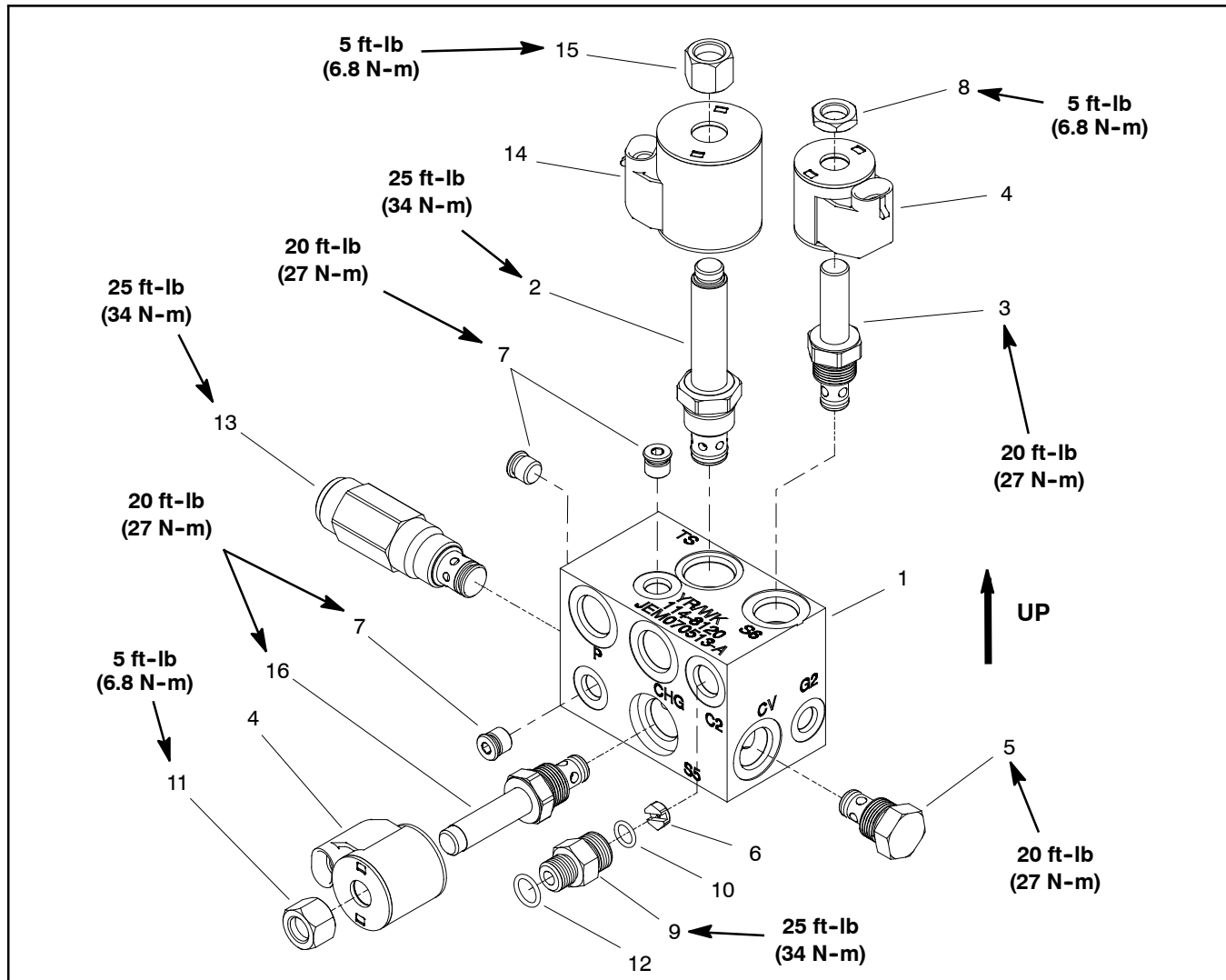


Figure 113

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

**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 Hydraulic Schematics in Chapter 9 - Fold-out Drawings 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.



## 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 Control Manifold Cartridge Valve Service in this section. Refer to Figure 113 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 (GM 4700-D)

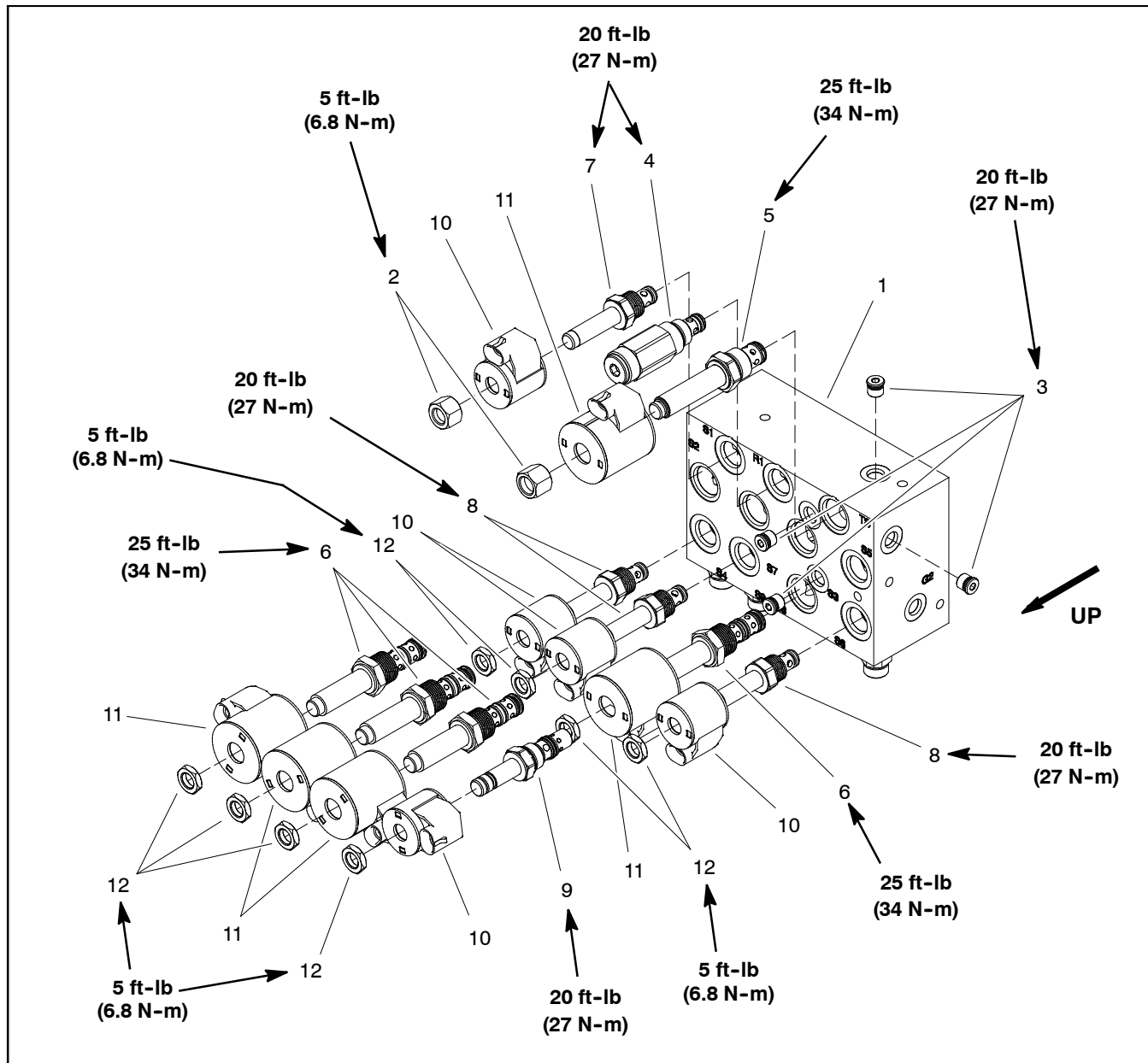


Figure 114

- |                           |  |                             |
|---------------------------|--|-----------------------------|
| 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 Hydraulic Schematics in Chapter 9 - Foldout Drawings 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.



## 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 Control Manifold Cartridge Valve Service in this section. Refer to Figures 114 and 115 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 (Fig. 115). 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 (Fig. 115), 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.

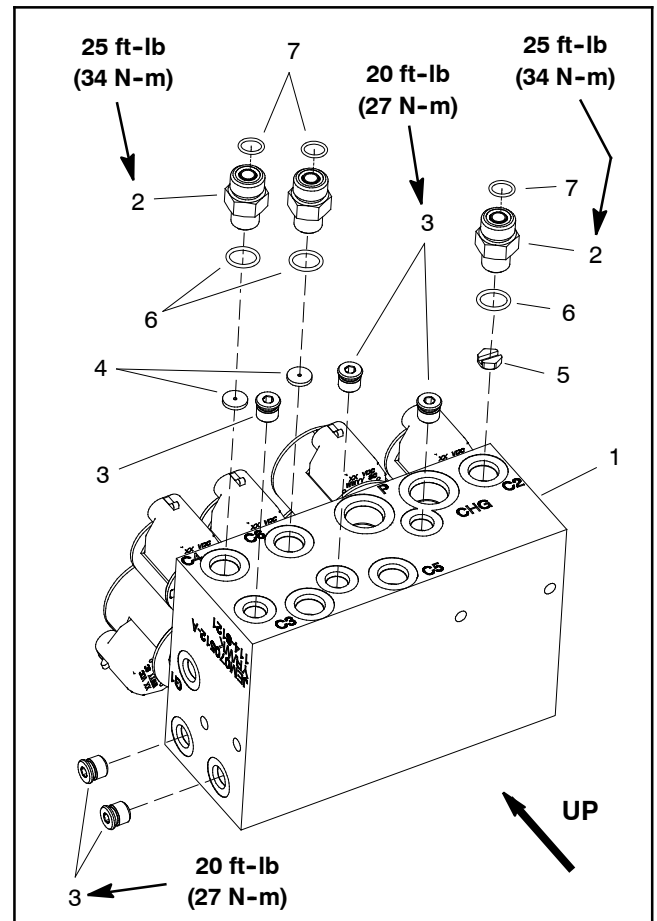


Figure 115

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

## Lift Circuit Junction Manifold

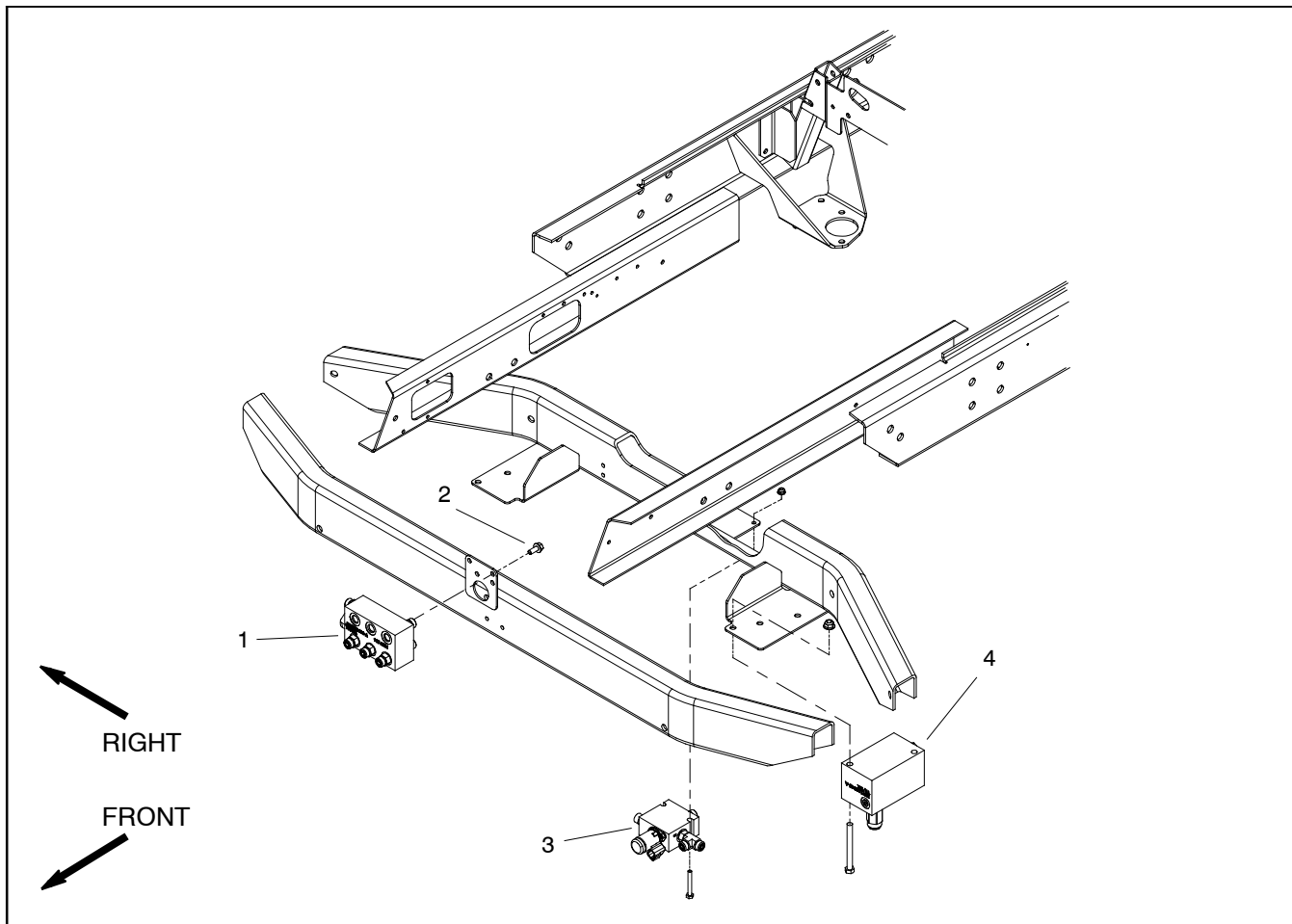


Figure 116


- 1. Lift circuit junction manifold
- 2. Flange head screw (2 used)

- 3. HI/LOW range control manifold

- 4. Rear traction control manifold

## Removal (Fig. 116)

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 at the beginning of the Service and Repairs section of this chapter.
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.
5. Remove hydraulic manifold from the frame using Figure 116 as guide.

**IMPORTANT:** A flow control orifice is placed beneath several of the hydraulic fittings on the lift circuit junction manifold (Fig. 117). 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.

6. If necessary, remove fittings from manifold and discard O-rings (Figs. 117 and 118).

## Installation (Fig. 116)

**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 Hydraulic Fitting Installation in the General Information section of this chapter). Refer to Figures 117 and 118 for fitting installation torque.

2. Install hydraulic manifold to the frame using Figure 116 as guide.
3. Remove caps and plugs from fittings and hydraulic lines. Properly connect hydraulic lines to manifold (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

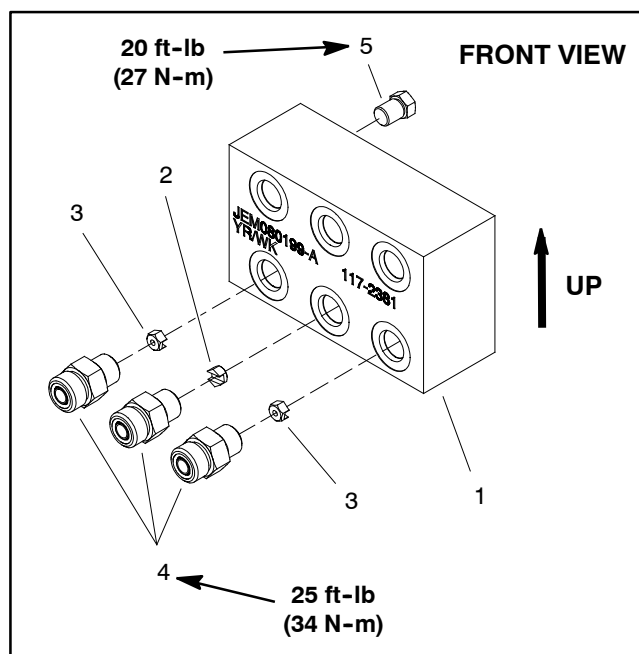


Figure 117

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

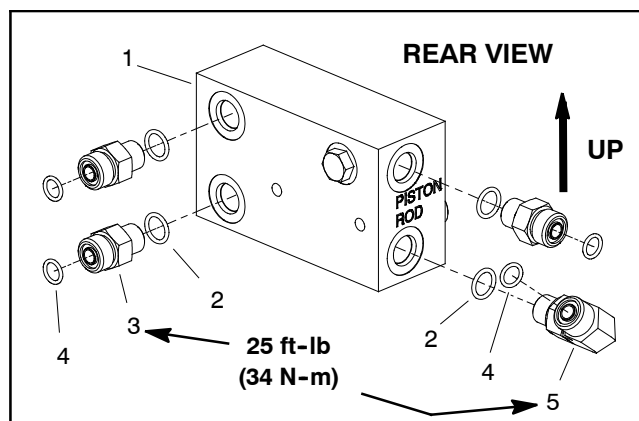


Figure 118

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

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

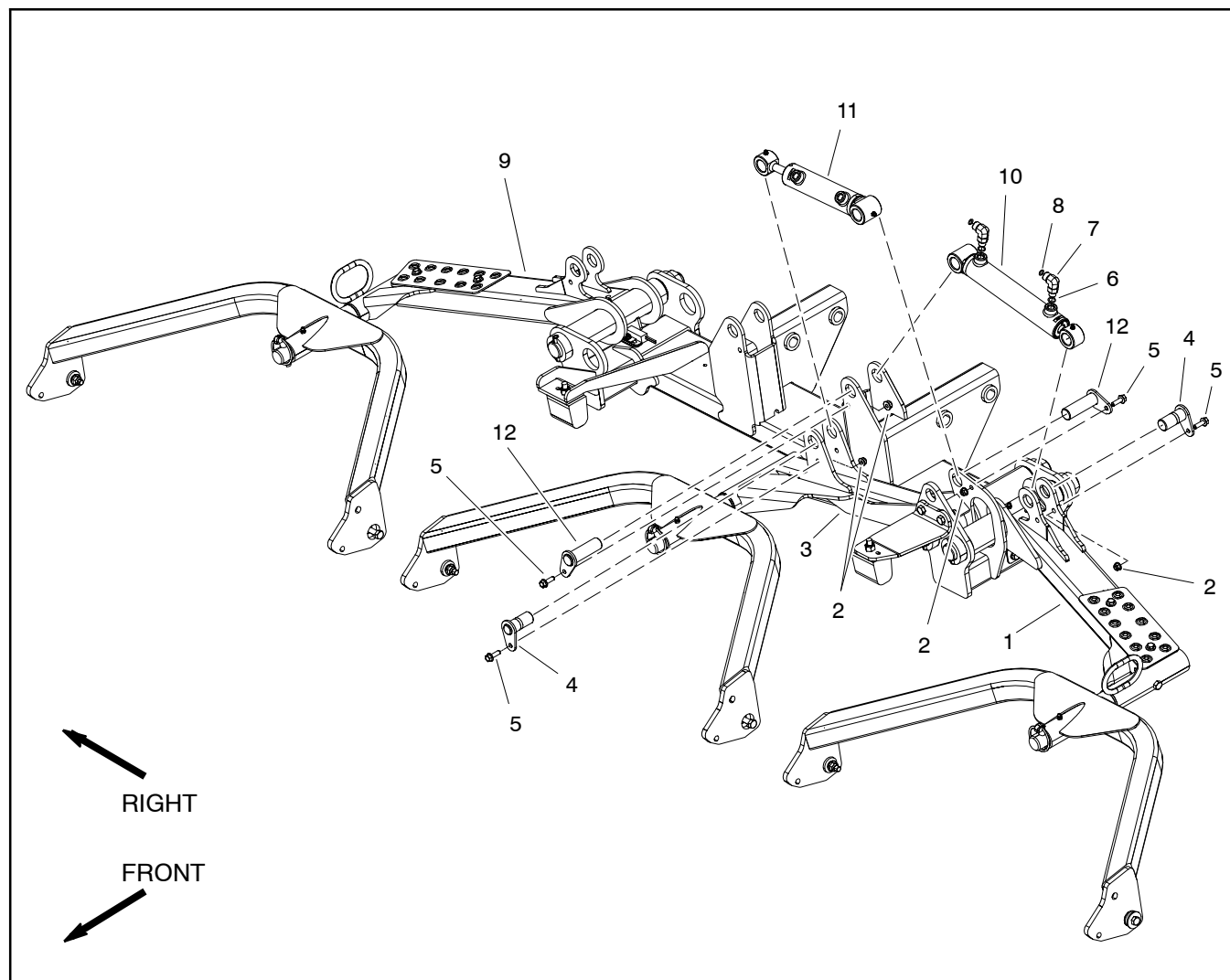


Figure 119

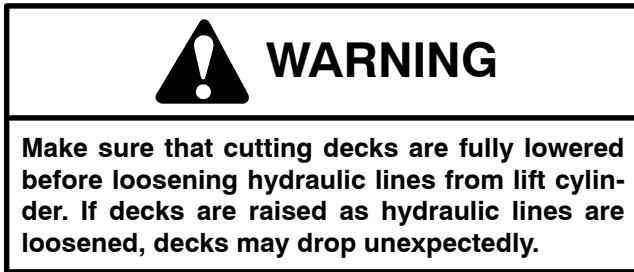
- |                          |   |                                     |
|--------------------------|---|-------------------------------------|
| 1. Lift arm (deck #4)    | 5. Flange head screw                      | 9. Lift arm (deck #5)               |
| 2. Flange nut            | 6. O-ring                                 | 10. Lift cylinder (decks #4 and #5) |
| 3. Lift arm (deck #1)    | 7. 90° 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 119. The lift cylinder for deck 5 is identical to the cylinder for deck 4.



## Removal (Fig. 119)

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 at the beginning of the Service and Repairs section of this chapter.
3. To prevent contamination of hydraulic system during lift cylinder removal, thoroughly clean exterior of lift cylinder.



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.
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 in this section.

## Installation (Fig. 119)

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 Hydraulic Fitting Installation in the General Information section of this chapter).
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 Hydraulic Hose and Tube Installation in the General Information section of this chapter).
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.

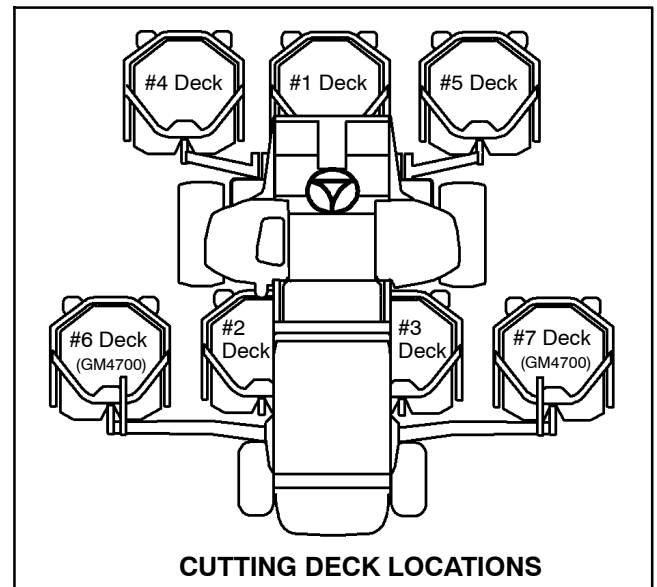


Figure 120

## Lift Cylinders: Decks #2 and #3

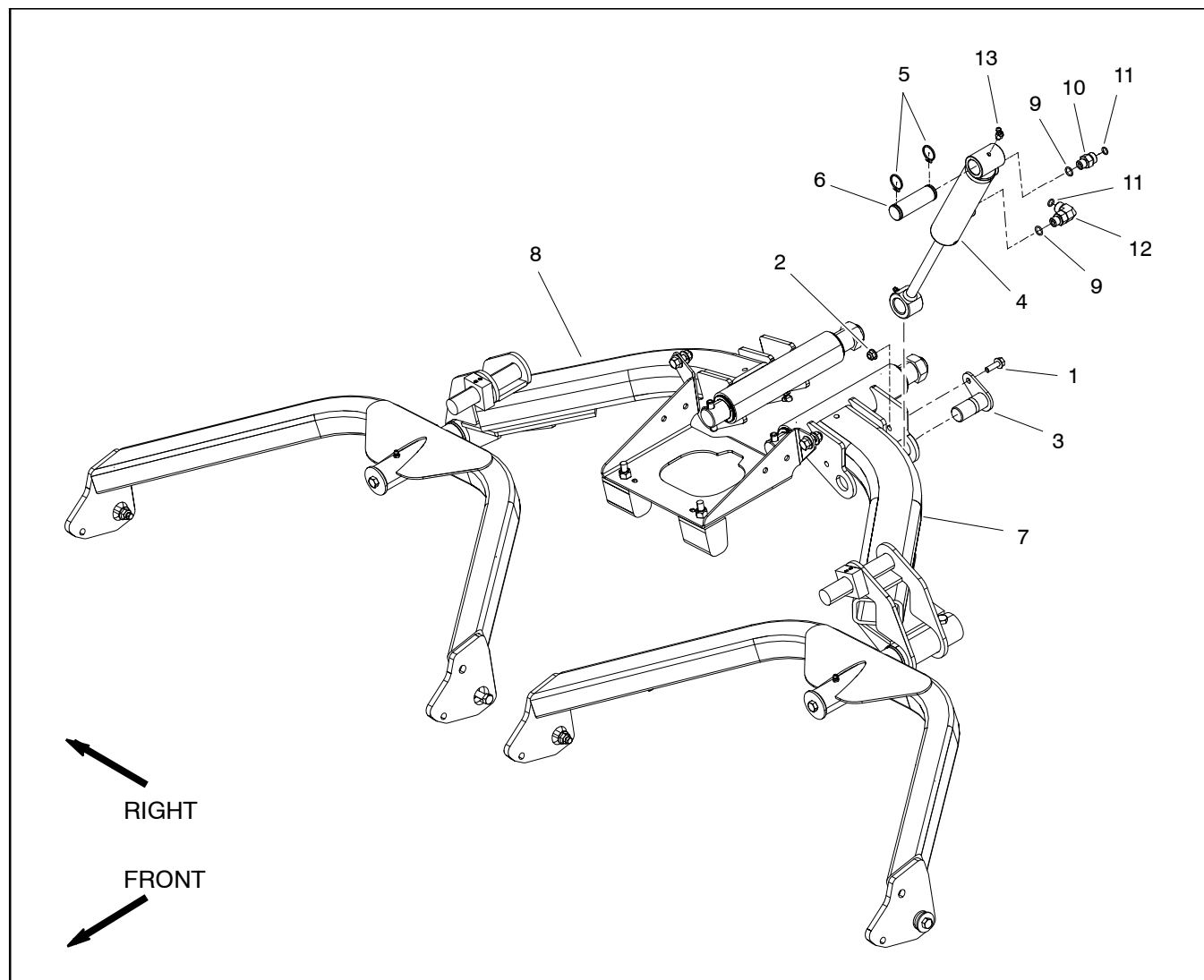


Figure 121


- 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. 90° hydraulic fitting
- 13. Grease fitting

## Removal (Fig. 121)

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 at the beginning of the Service and Repairs section of this chapter.
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.**

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.
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 in this section.

## Installation (Fig. 121)

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 Hydraulic Fitting Installation in the General Information section of this chapter).

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 Hydraulic Hose and Tube Installation in the General Information section of this chapter).

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.

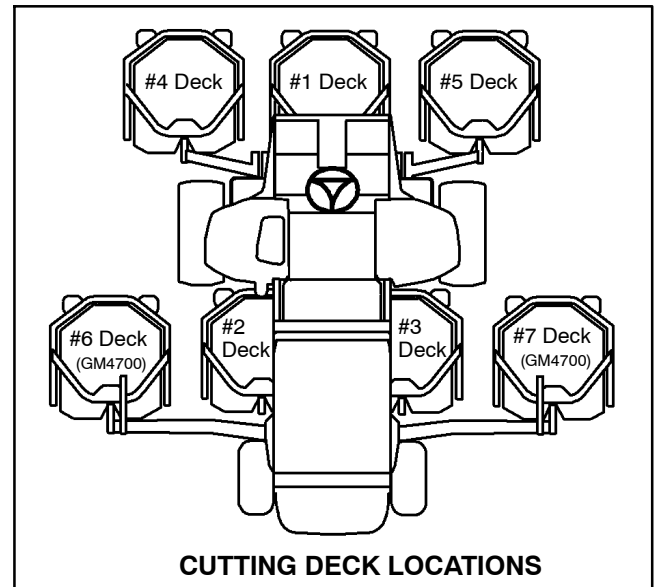


Figure 122

## Lift Cylinders: Decks #6 and #7 (GM 4700-D)

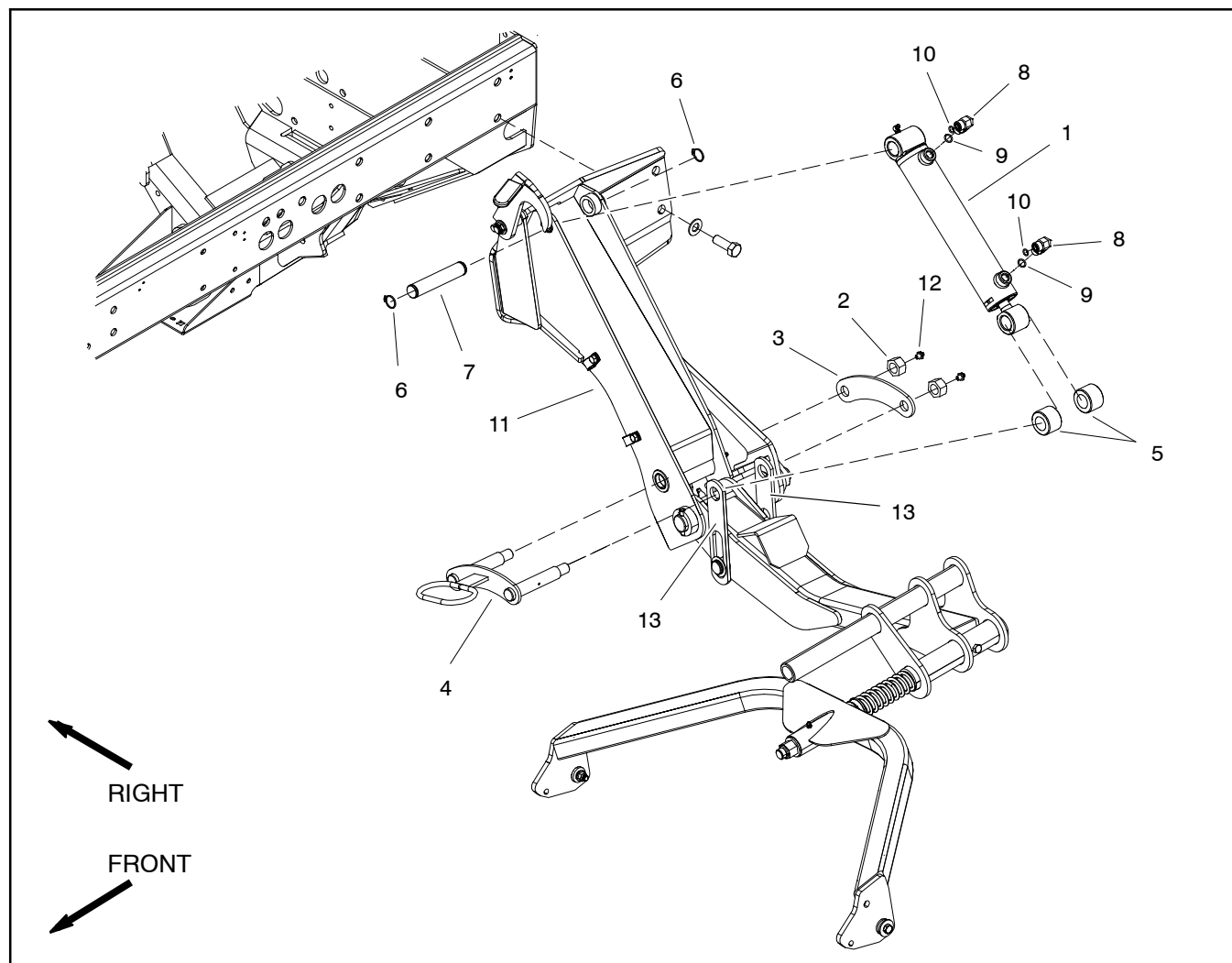
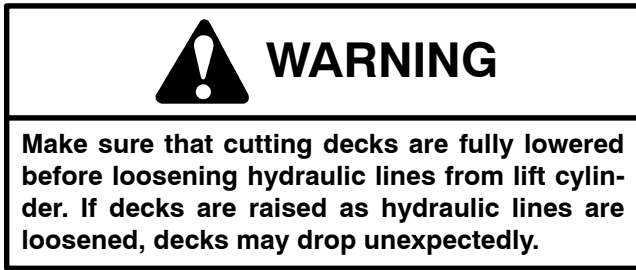


Figure 123

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

## Removal (Fig. 123)

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 at the beginning of the Service and Repairs section of this chapter.
3. To prevent contamination of hydraulic system during lift cylinder removal, thoroughly clean exterior of lift cylinder.



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.
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 in this section.

## Installation (Fig. 123)

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 Hydraulic Fitting Installation in the General Information section of this chapter).

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 Hydraulic Hose and Tube Installation in the General Information section of this chapter).
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.

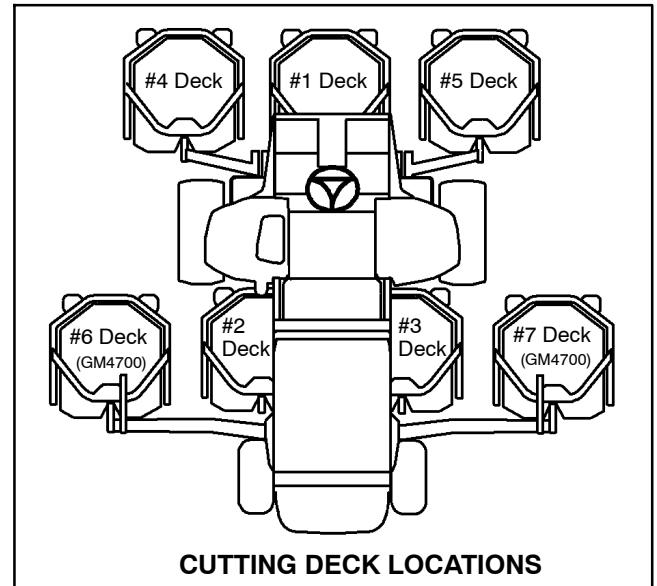


Figure 124

## Lift Cylinder Service

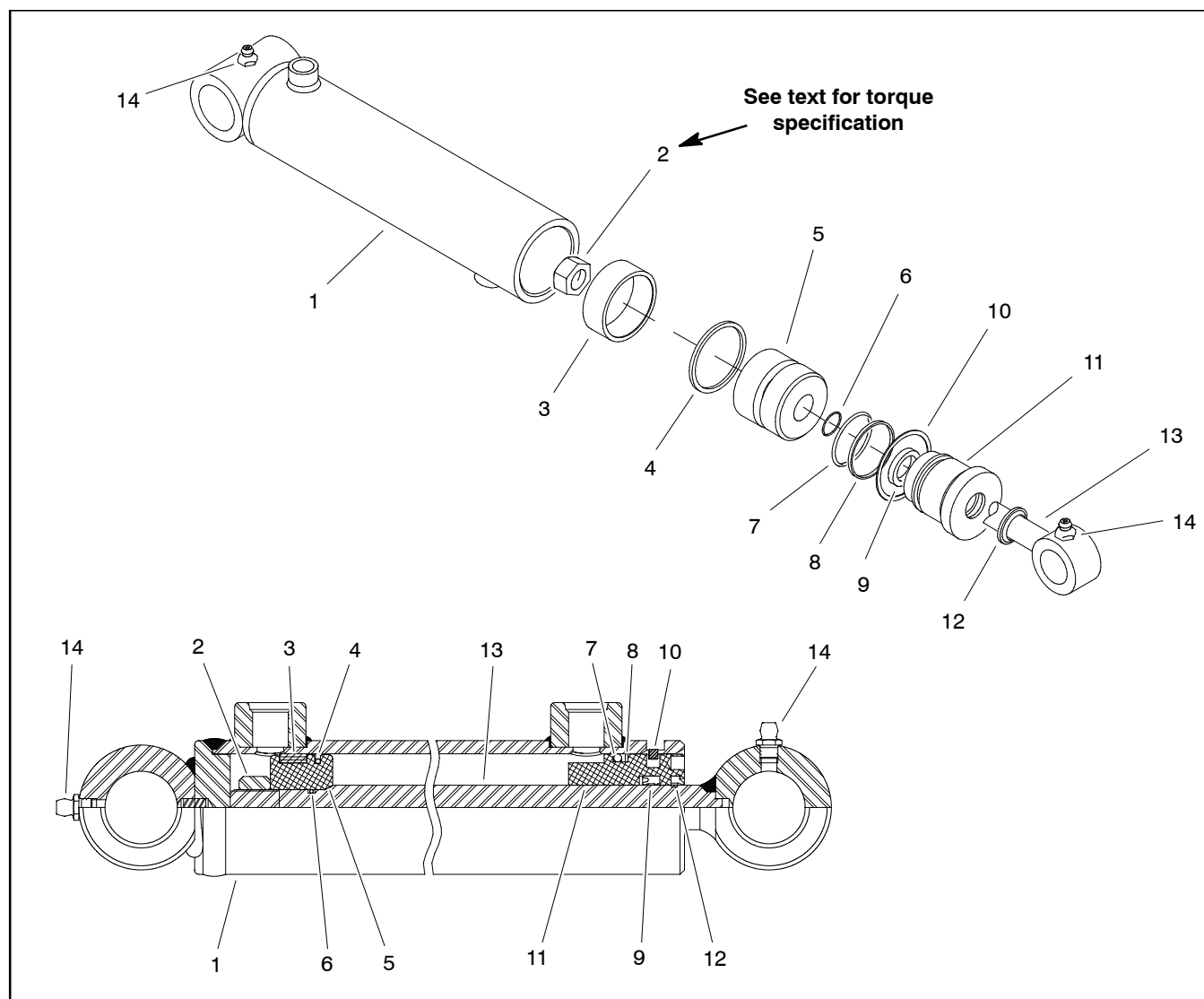


Figure 125

- |                  |                    |                             |
|------------------|--------------------|-----------------------------|
| 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 0.750" (19 mm) diameter rod. All other lift cylinders used on Groundsmaster 4500-D and 4700-D have a 0.630" (16 mm) diameter rod. The disassembly and assembly procedure is the same for all lift cylinders.

**Disassembly (Fig. 125)**

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.

**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 (Fig. 125)**

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.

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

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

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

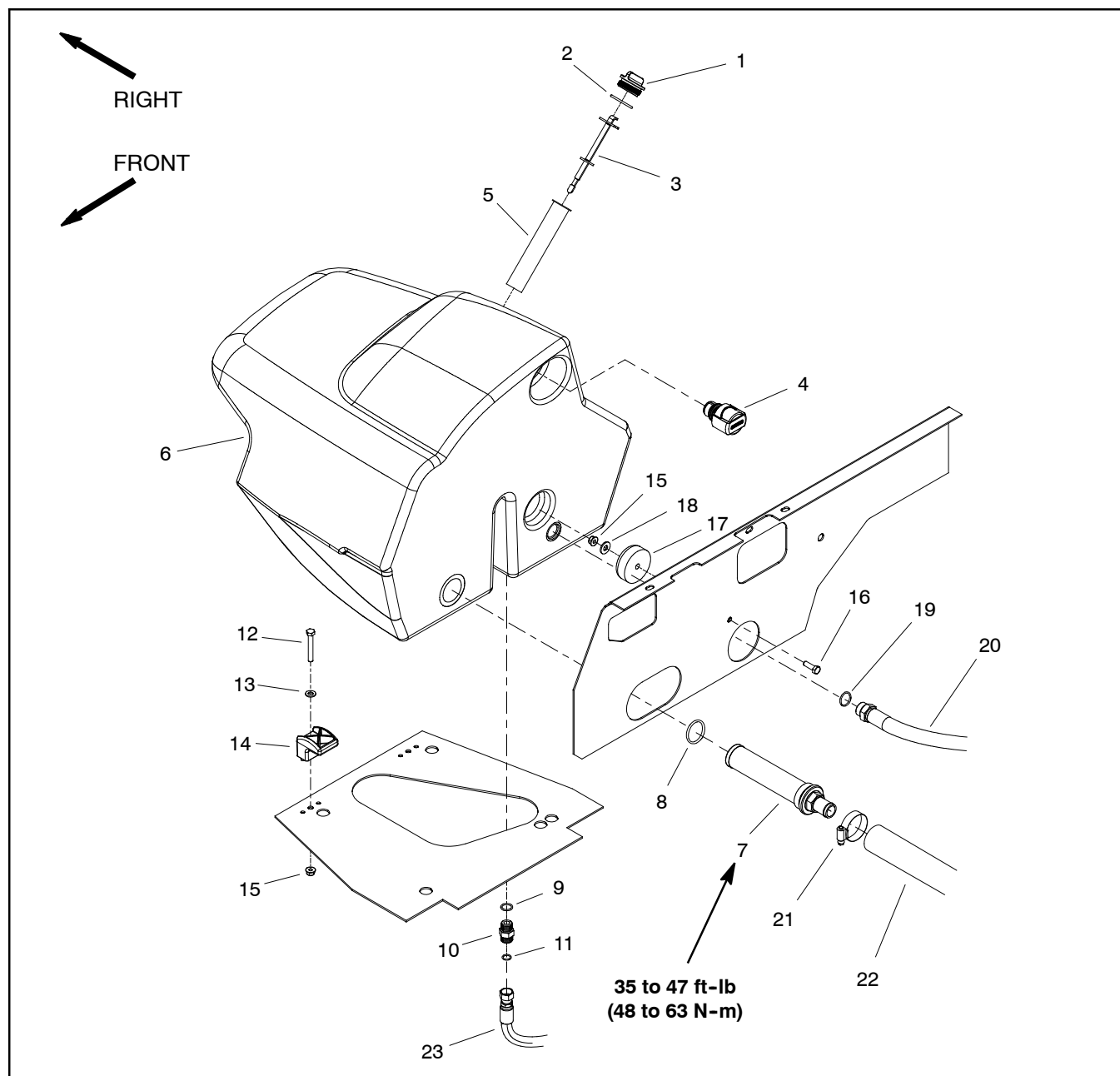


Figure 126

- |                        |                                |                    |
|------------------------|--------------------------------|--------------------|
| 1. Plug                | 9. O-ring                      | 17. Bumper         |
| 2. O-ring              | 10. Straight hydraulic fitting | 18. Flat washer    |
| 3. Dipstick            | 11. O-ring                     | 19. O-ring         |
| 4. Breather            | 12. Cap screw (2 used)         | 20. Hydraulic hose |
| 5. Screen filter       | 13. Flat washer (2 used)       | 21. Hose clamp     |
| 6. Hydraulic reservoir | 14. Clamp (2 used)             | 22. Suction hose   |
| 7. Reservoir strainer  | 15. Flange nut (3 used)        | 23. Hydraulic hose |
| 8. O-ring              | 16. Cap screw                  |                    |



**Removal (Fig. 126)**

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 at the beginning of the Service and Repairs section of this chapter.
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 126 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 (Fig. 126)**

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 **35 to 47 ft-lb (48 to 63 N-m)**.

2. Install reservoir using Figure 126 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 Hydraulic Hose and Tube Installation in the General Information section of this chapter).
4. Fill reservoir with hydraulic fluid to proper level.

## Radiator and Oil Cooler Assembly

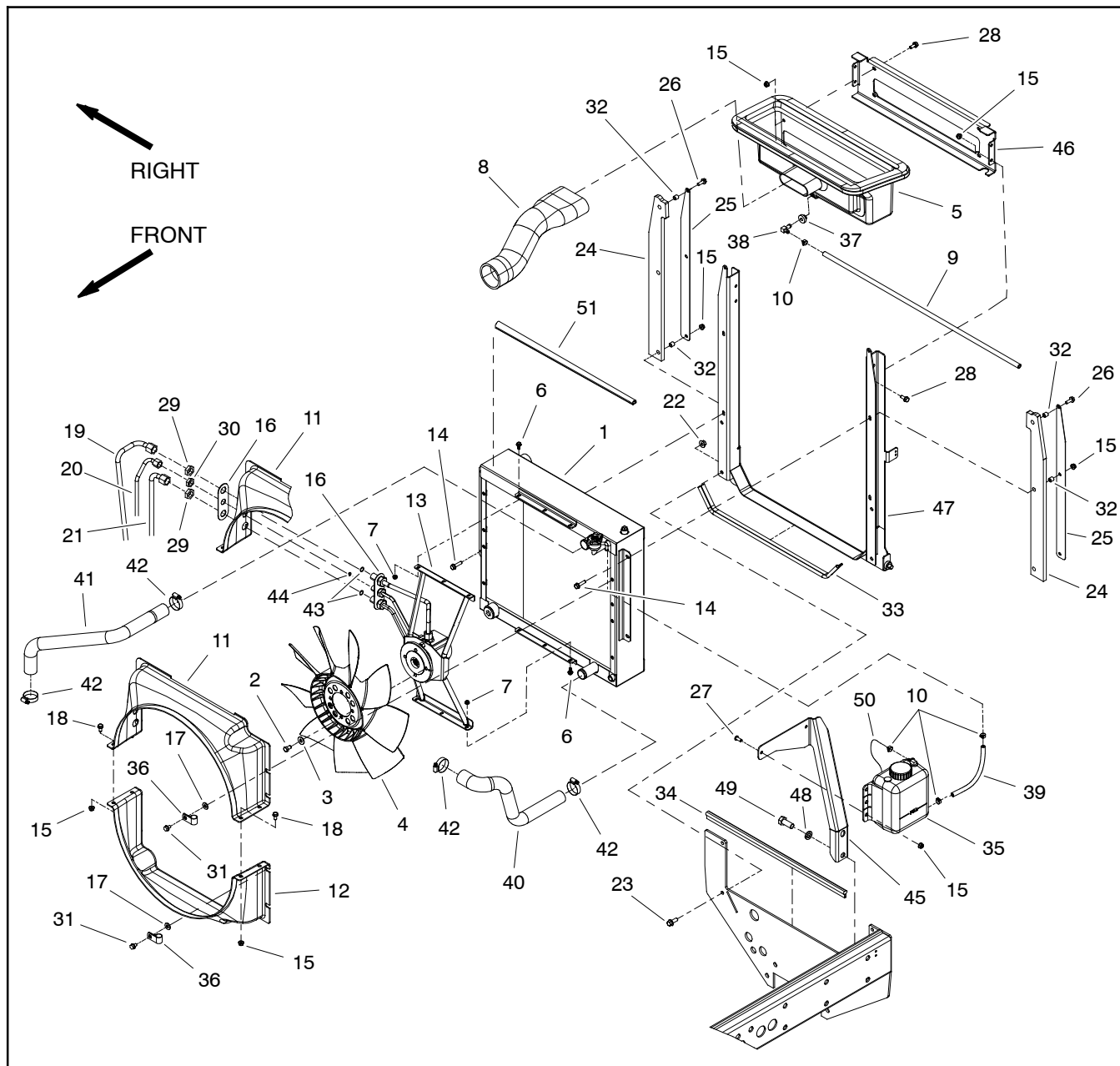


Figure 127

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

**NOTE:** The hydraulic oil cooler on your Groundsmaster is combined with the radiator. See Radiator and Oil Cooler Assembly in the Service and Repairs section of Chapter 3 - Diesel Engine for information on removal and installation of the radiator/oil cooler assembly.

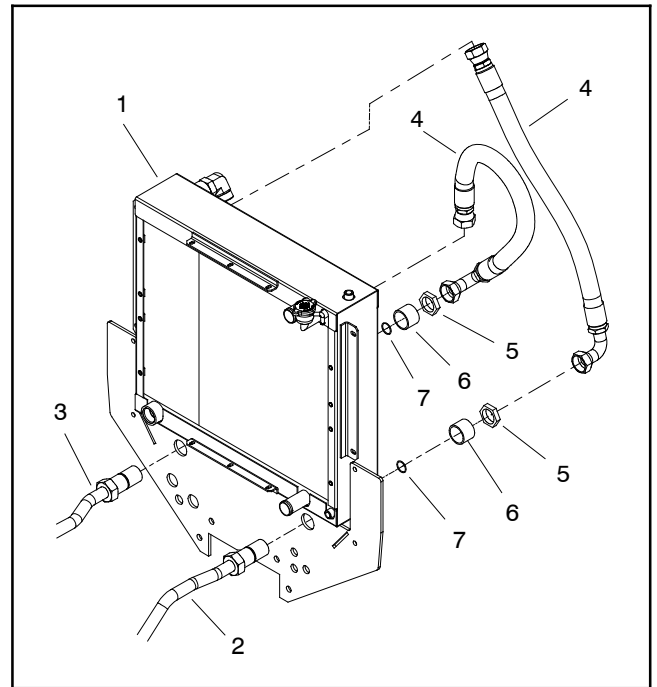


Figure 128

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

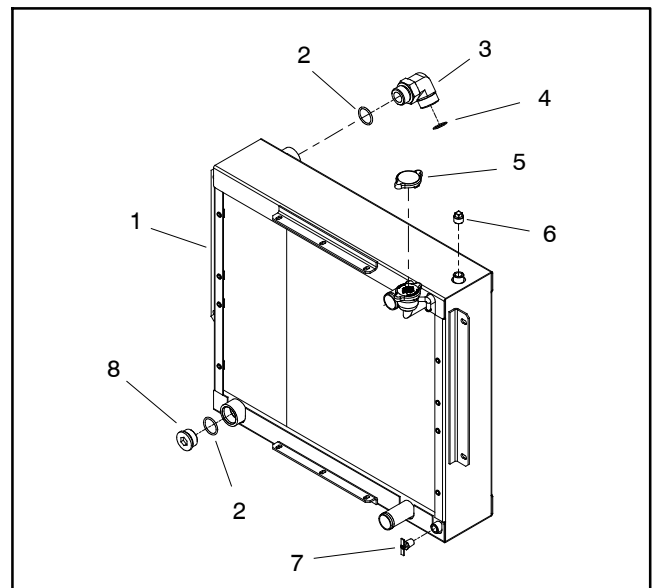


Figure 129

- |                         |                 |
|-------------------------|-----------------|
| 1. Radiator/oil cooler  | 5. Radiator cap |
| 2. O-ring               | 6. Plug         |
| 3. 90° fitting (2 used) | 7. Draincock    |
| 4. O-ring               | 8. Plug         |

This page is intentionally blank.



# Electrical System

## Table of Contents

GENERAL INFORMATION .....	2	Headlight Switch .....	32
Operator's Manual .....	2	Seat Switch .....	33
Electrical Drawings .....	2	Parking Brake Switch .....	34
Toro Electronic Controllers (TEC) .....	2	Cutting Deck Position Switches .....	35
Yanmar Engine Electronic Control Unit (ECU) ...	3	Relays with Four (4) Terminals .....	36
Yanmar Engine Electrical Components .....	4	Relays with Five (5) Terminals .....	38
CAN-bus Communications .....	4	Traction Pedal Position Sensor .....	39
SPECIAL TOOLS .....	6	Toro Electronic Controllers (TEC) .....	40
INFOCENTER DISPLAY .....	8	Hydraulic Solenoid Valve Coils .....	42
TROUBLESHOOTING .....	15	Piston (Traction) Pump Control Solenoid Coils .	44
Operator Advisories .....	15	Hydraulic Oil Temperature Sender .....	45
Fault Codes .....	16	Fuel Pump (Models 30873 and 30874) .....	46
Starting Problems .....	18	Fuel Pump (Models 30881 and 30882) .....	47
General Run & Transport Problems .....	19	CAN-bus Termination Resistor .....	48
Cutting Deck Operating Problems .....	20	Diode Assemblies .....	49
Cutting Deck Lift/Lower Problems .....	21	Resistor Assemblies .....	49
ELECTRICAL SYSTEM QUICK CHECKS .....	23	Fan Speed Switch (Machines with Two-Post	
Battery Test (Open Circuit) .....	23	ROPS Extension Operator Fan Kit) .....	50
Charging System Test .....	23	Resistor Module (Machines with Two-Post	
Check Operation of Interlock Switches .....	23	ROPS Extension Operator Fan Kit) .....	51
ADJUSTMENTS .....	24	SERVICE AND REPAIRS .....	52
Traction Pedal Adjustment .....	24	Battery Care .....	52
Traction Pedal Position Sensor Calibration ....	26	Battery Storage .....	52
COMPONENT TESTING .....	27	Battery Service .....	53
Ignition Switch .....	27	Battery Removal and Installation .....	53
Fuses .....	28	Battery Inspection and Maintenance .....	53
Fusible Link Harness .....	29	Battery Testing .....	54
PTO Switch .....	30	Battery Charging .....	55
Hi/Low Speed, Engine Speed Request and			
Cutting Deck Lift Switches .....	31		

# 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 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 Chapter 9 - Foldout Drawings.

---

## Toro Electronic Controllers (TEC)

Groundsmaster 4500-D machines use a single Toro Electronic Controller (TEC-5002) to manage machine electrical functions. Groundsmaster 4700-D machines uses two (2) TEC controllers for machine operation (TEC-5002 and TEC-5001). The TEC controllers are attached to a bracket under the operator seat (Fig. 1).

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. Communication between the TEC controller(s), 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.

The TEC controllers used on the Groundsmaster 4700-D appear identical but they are different in terms of internal hardware and therefore cannot be interchanged.

**IMPORTANT:** 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 Toro Electronic Controllers, disconnect the wire harness connectors from the engine controller and disconnect the terminal connector from the alternator. Also, disconnect and remove the engine ECU from the machine before welding.

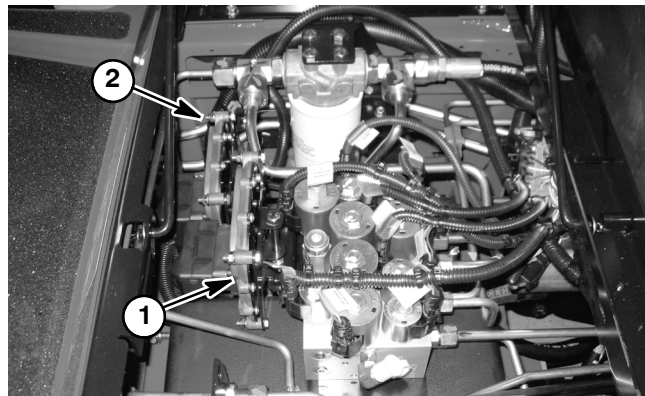


Figure 1

1. TEC-5002 controller      2. TEC-5001 controller

If the wire harness connector is removed from the TEC controller for any reason, tighten the harness connector screw from **25 to 28 in-lb (2.8 to 3.2 N·m)**.

## Yanmar Engine Electronic Control Unit (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 Chapter 3 – Yanmar Diesel Engine for additional engine ECU information.

**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.

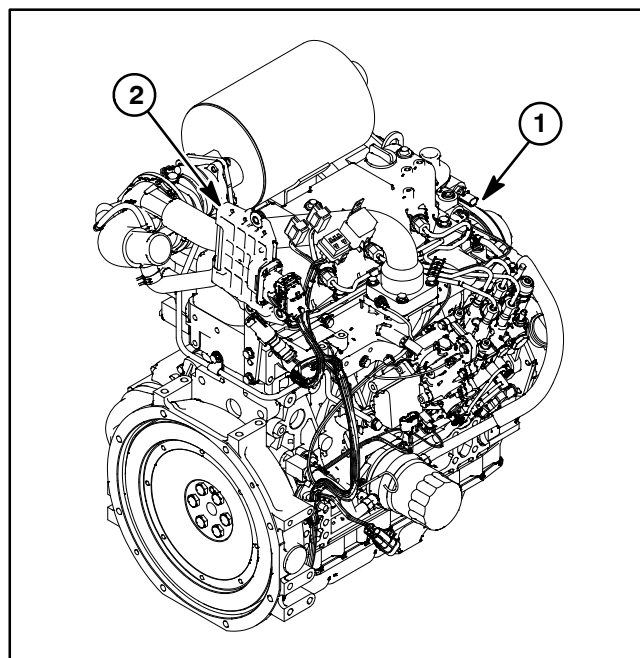


Figure 2

1. Engine (models 30873 and 30874)
2. Engine ECU

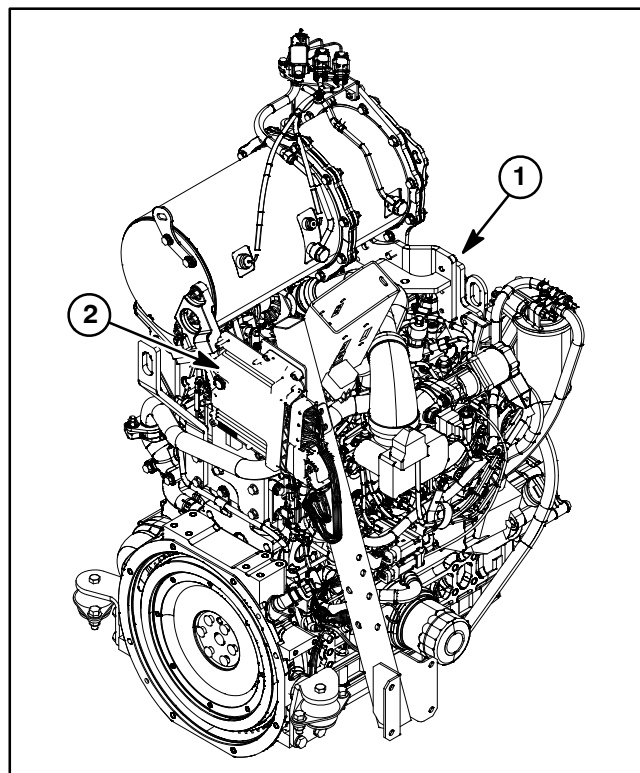


Figure 3

1. Engine (models 30881 and 30882)
2. Engine ECU

---

## Yanmar Engine Electrical Components

When servicing or troubleshooting the engine electrical components, use the correct engine service manual and troubleshooting manual. Also, the Yanmar SMART-ASSIST-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 tractor 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.



This page is intentionally blank.

# Special Tools

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

---

## Multimeter

The multimeter can test electrical components and circuits for current (amps), resistance (ohms) or voltage. Obtain this tool locally.

**NOTE:** Toro recommends the use of a DIGITAL Volt-Ohm-Amp multimeter when testing electrical circuits. The high impedance (internal resistance) of a digital meter in the voltage mode will make sure that excess current is not allowed through the meter. This excess current can cause damage to circuits not designed to carry it.

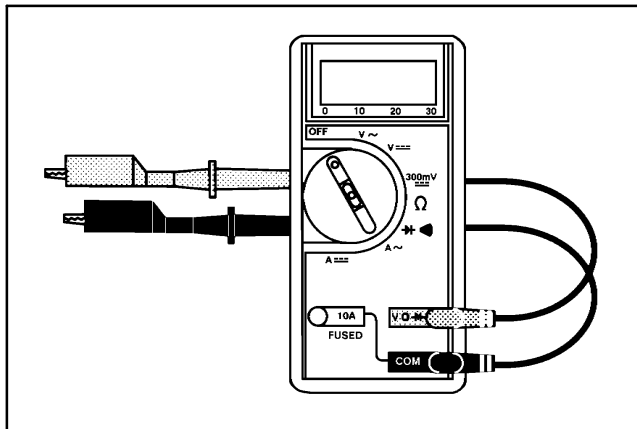


Figure 4

---

## Dielectric Lubricant/Sealant

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

Toro Part Number: **107-0342**



Figure 5

---

## Battery Terminal Protector

Aerosol spray that should be used on battery terminals to reduce corrosion problems. Apply battery terminal protector after the battery cable has been secured to the battery terminal.

Toro Part Number: **107-0392**



Figure 6

---

## Battery Hydrometer

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



Figure 7

# InfoCenter Display

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 TEC controller (ignition switch in the START or ON position). A CAN-bus system involving the TEC controllers, the Yanmar engine electronic control unit and the InfoCenter is used to provide necessary machine communication for InfoCenter operation.

## Splash Screens

The two (2) InfoCenter splash screens (Figs. 8 and 9) 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.

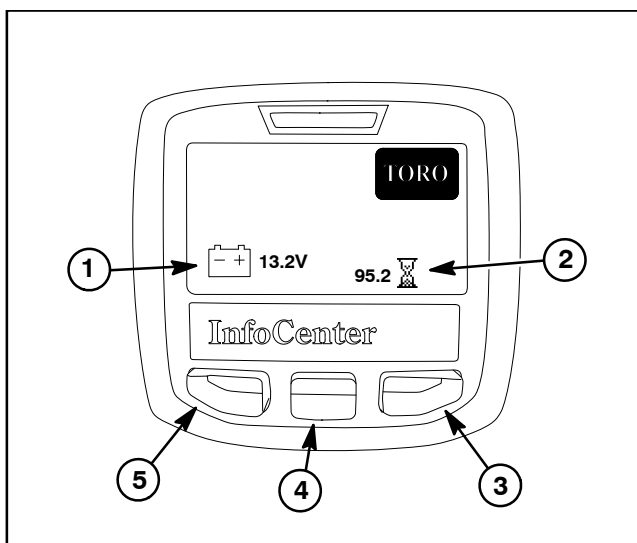


Figure 8

- |                    |                     |
|--------------------|---------------------|
| 1. Battery voltage | 4. Down button      |
| 2. Hour meter      | 5. Menu/back button |
| 3. Right button    |                     |

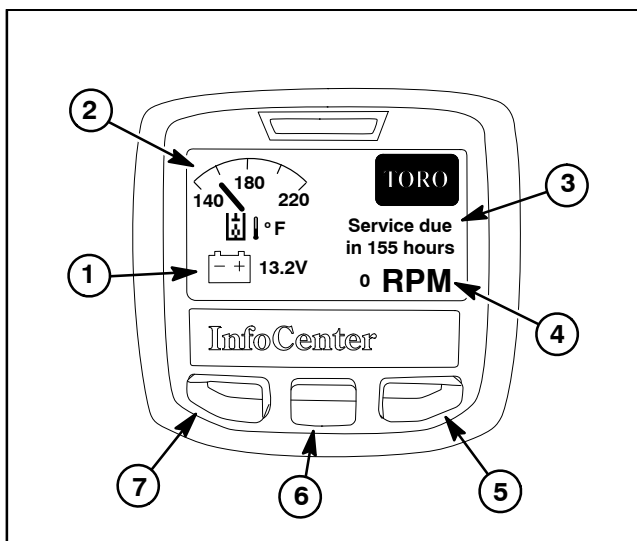


Figure 9

- |                              |                     |
|------------------------------|---------------------|
| 1. Battery voltage           | 5. Right button     |
| 2. Hydraulic oil temperature | 6. Down button      |
| 3. Time to next service      | 7. Menu/back button |
| 4. Engine RPM                |                     |

## Main Information Screens

The two (2) InfoCenter main information screens (Figs. 10 and 11) 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.

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.

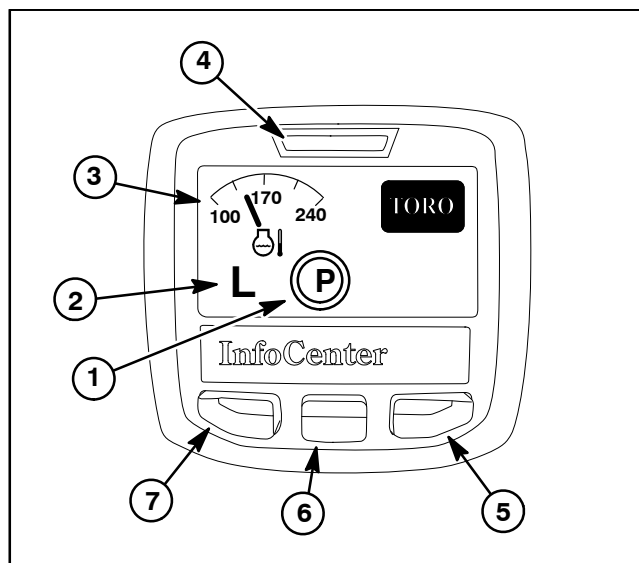


Figure 10

- |                          |                     |
|--------------------------|---------------------|
| 1. Parking brake applied | 5. Right button     |
| 2. Traction speed        | 6. Down button      |
| 3. Coolant temperature   | 7. Menu/back button |
| 4. Fault indicator       |                     |

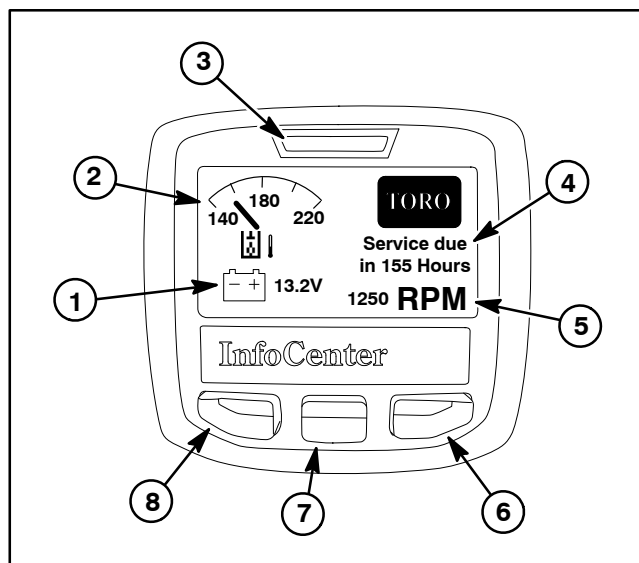


Figure 11

- |                              |                     |
|------------------------------|---------------------|
| 1. Battery voltage           | 5. Engine RPM       |
| 2. Hydraulic oil temperature | 6. Right button     |
| 3. Fault indicator           | 7. Down button      |
| 4. Time to next service      | 8. Menu/back button |

## Main Menu Screen

The main menu screen can be accessed from the InfoCenter main information or splash screen by pressing and releasing the menu/back button (left button) on the display. Once to the main menu screen (Fig. 12), 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).

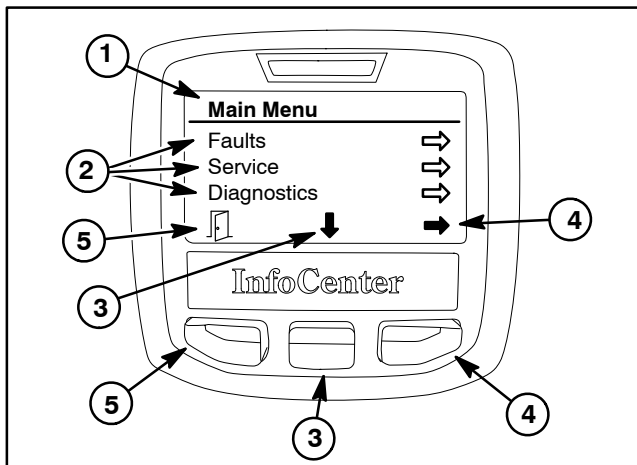


Figure 12

- |                       |                     |
|-----------------------|---------------------|
| 1. Main menu          | 4. Choose menu item |
| 2. Menu items         | 5. Back button      |
| 3. Move to menu items |                     |

## Faults Screen

The faults screen (Fig. 13) 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 InfoCenter 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).

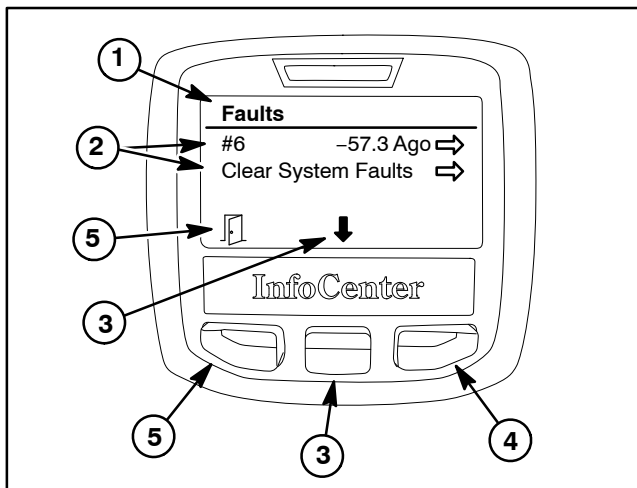


Figure 13

- |                       |                     |
|-----------------------|---------------------|
| 1. Fault menu         | 4. Choose menu item |
| 2. Fault items        | 5. Back button      |
| 3. Move to menu items |                     |

## Service Screen

The service screen (Fig. 14) 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.

The protected menu items include the following:

- **Reset Service Due** allows the service due hours to be reset after a scheduled maintenance item is performed. The Reset Service Due is listed with the other hours options when the protected items are visible.
- **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 30881 and 30882). 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.
- **Traction Pedal** allows the traction pedal sensor to be calibrated (see Traction Pedal Position Sensor Calibration in the Adjustments section of this chapter for calibration procedure).
- **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.

To return to the main menu screen from the service screen, press the back button (left button).

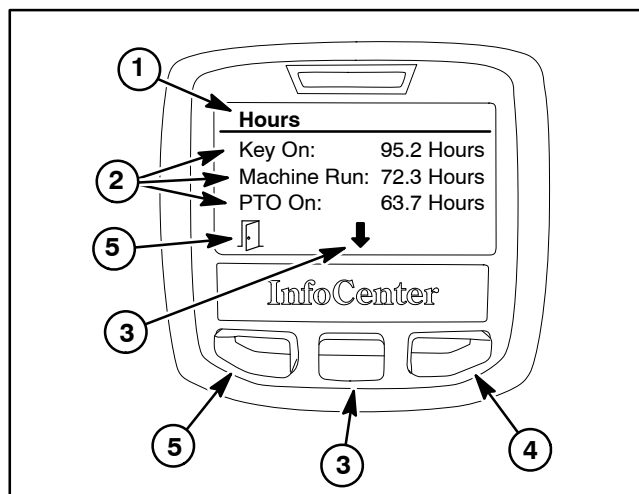


Figure 14

- |                       |                     |
|-----------------------|---------------------|
| 1. Service menu       | 4. Choose menu item |
| 2. Service items      | 5. Back button      |
| 3. Move to menu items |                     |

## Diagnostics Screen

The diagnostics screen (Fig. 15) 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. Inputs indicate the state of the left deck lift/lower switch and whether the machine is in low range speed. Qualifiers include the low range speed, seat switch and parking brake position. Identified outputs consist of master, lower, raise and float solenoids.

- **Center Deck** identifies machine requirements to allow the center deck to raise and lower. Inputs indicate the state of the center deck lift/lower switch. Qualifiers include the low range speed, seat switch and parking brake position. Identified outputs consist of master, raise and float solenoids.

- **Right Deck** (Groundsmaster 4700–D) identifies machine requirements to allow the right deck to raise and lower. Inputs indicate the state of the right deck lift/lower switch. Qualifiers include the low range speed, seat switch and parking brake position. Identified outputs consist of master, lower, raise and float solenoids.

- **Traction Pedal** identifies position of the traction pedal. Inputs indicate the state of the traction pedal potentiometer. Outputs indicate whether the traction circuit is in forward, neutral or reverse.

- **Traction** identifies machine requirements to allow the traction system to be engaged. Inputs indicate the state of the traction pedal. Qualifiers include the seat switch and parking brake position. Outputs indicate whether the piston (traction) pump is engaged in forward or reverse.

- **Hi/Low Range** identifies machine requirements to allow high or low speed range to be engaged. Inputs indicate whether the PTO is off and the state of the hi/low switch. Qualifiers identify the position of the cutting decks (raised or lowered). Outputs indicate whether high range is engaged (solenoid S12 is energized).

- **PTO** identifies machine requirements to allow the PTO to be engaged. Inputs indicate the state of the PTO switch. Qualifiers identify whether low speed range is selected, if the seat is occupied and if the cutting decks are lowered. Outputs indicate which cutting decks are engaged.

- **Engine Run** identifies whether necessary TEC outputs exist to allow the engine to run. Inputs indicate the state of the ignition switch. Qualifiers identify whether the PTO is off, if the traction pedal is in neutral, if the seat is occupied (or parking brake is applied) and if all deck lift switches are not activated. Outputs indicate that requirements have been met to allow engine to run or start. **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).

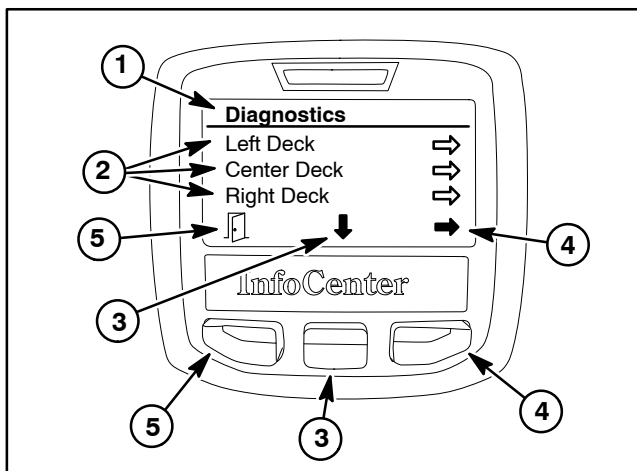


Figure 15

- |                       |                     |
|-----------------------|---------------------|
| 1. Diagnostics menu   | 4. Choose menu item |
| 2. Diagnostics items  | 5. Back button      |
| 3. Move to menu items |                     |



## Settings Screen

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 include traction pedal sensor calibration, cooling fan reversal demonstration and exhaust system DPF regeneration (Tier4 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.

**Auto Idle** causes the engine speed to decrease to low idle after the machine has not been in use for the set time delay in seconds. Auto idle can be adjusted to 8, 10, 15, 20 or 30 seconds or the auto idle feature can be turned OFF.

**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.

**Counter Balance** allows counterbalance pressure applied by the cutting decks to be adjusted. Options for counterbalance are low, medium and high.

To return to the main menu screen from the settings screen, press the back button (left button).

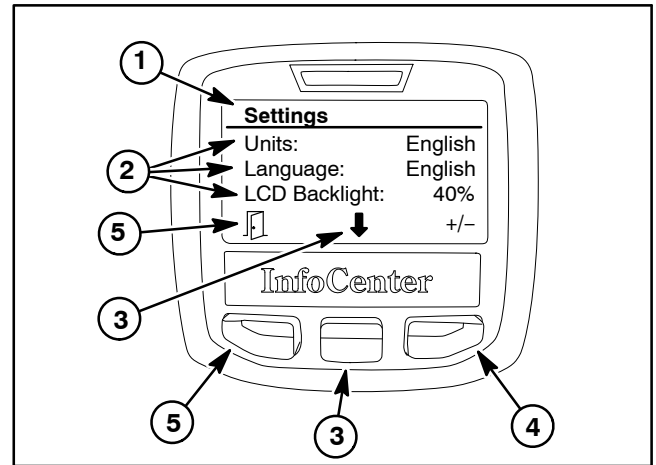


Figure 16

1. Settings menu
2. Settings items
3. Move to menu items
4. Change menu item
5. Back button

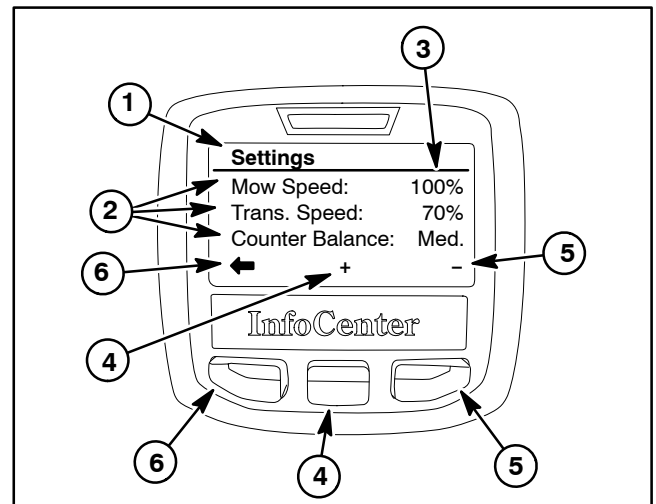


Figure 17

1. Settings menu
2. Settings items
3. Current setting
4. Increase setting
5. Decrease setting
6. Back button

## About Screen

The about screen (Fig. 18) 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).

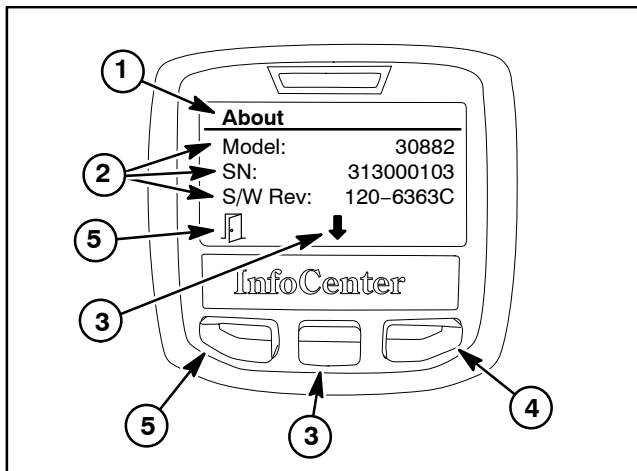


Figure 18

- |                       |                     |
|-----------------------|---------------------|
| 1. About menu         | 4. Choose menu item |
| 2. About items        | 5. Back button      |
| 3. Move to menu items |                     |

# Troubleshooting



## CAUTION

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

For effective troubleshooting and repairs, there must be a good understanding of the electrical circuits and components used on this machine.

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

**NOTE:** Use the InfoCenter Display (see InfoCenter Display in this chapter) to test TEC inputs and outputs when troubleshooting an electrical problem on your Groundsmaster.

## Operator Advisories

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 Description
160	Inhibit start
161	Inhibit PTO
162	Inhibit cutting unit lower
163	Inhibit traction HIGH speed range
164	Inhibit traction LOW speed range
165	Inhibit traction
167	Derate traction setting
168	Inhibit traction teach (traction pedal calibration)
169	Engine shutdown
170	Recycle keyswitch (ignition switch)
171	Auto idle engaged
172	Calibrate (traction pedal)
173	Master address claim (TEC-5002 controller)
174	Slave address claim (TEC-5001 controller)
175	Derate engine

## Fault Codes

The list below identifies the fault codes that are generated by the TEC controller to identify an electrical system malfunction (fault) that occurred during machine operation. Use the InfoCenter Display for fault retrieval.

**NOTE:** The following list of fault codes identifies electrical problems that typically will prevent normal machine operation. The InfoCenter Display will identify existing faults if they should occur. Fault codes 13 through 25 identify problems with inputs (e.g. switches, sensors) to the TEC controllers. For input problems, use the InfoCenter Display to check the different switch positions before removing or replacing the component.

**NOTE:** Fault codes 26 through 62 identify problems with outputs (e.g. solenoid coils, light bulbs) from the TEC controllers. These output problems might involve issues with the wire harness or the actual output device (solenoid coil or bulb).

Fault Code	Fault Description
1	Excessive engine coolant temperature (above 105°C) caused PTO to disengage
2	Excessive engine coolant temperature (above 115°C) caused engine to stop
3	One of the TEC output fuses (7.5 Amp) is faulty
4	TEC controller is faulty
5	Main power relay is faulty
6	Ignition switch was held in the START position for more than 30 seconds or the ignition switch is faulty
7	TEC software needs to be reprogrammed (contact Toro Distributor)
8	Alternator charging is too high
9	Alternator charging is too low
10	Engine has not been seen on CAN-bus for 10 seconds
11	TEC-5001 controller has not been seen on CAN-bus for 1 second
12	InfoCenter has not been seen on CAN-bus for 1 second
13	Ignition switch is faulty (check ignition switch)
14	Traction pedal neutral switch is faulty (check traction pedal position sensor)
15	Engine speed switch is faulty (check engine speed switch)
16	Traction system HI/LOW speed switch is faulty (check HI/LOW speed switch)
17	Traction pedal position sensor is out of range
18	Hydraulic temperature sensor circuit has open or short
20	Counterbalance pressure sensor has open or short
21	Center deck lift switch is faulty (check center lift switch)
22	Left deck lift switch is faulty on Groundsmaster 4700-D (check left lift switch)
23	Right deck lift switch is faulty on Groundsmaster 4700-D (check right lift switch)
26	Engine START output has open or short to ground
27	Engine RUN output has open or short to ground
28	Traction system HIGH has open or short to ground

<b>Fault Code</b>	<b>Fault Description</b>
33	Forward piston (traction) pump output has open or short to ground
34	Reverse piston (traction) pump output has open or short to ground
35	Reverse engine cooling fan output has open or short to ground
39	LH PTO output has open or short to ground
40	RH PTO output has open or short to ground
41	Solenoid valve S1 (GM 4700–D lift/lower enable) output has open or short to ground
42	Solenoid valve S2 (GM 4700–D LH deck raise) output has open or short to ground
43	Solenoid valve S3 (GM 4700–D LH deck lower) output has open or short to ground
44	Solenoid valve S4 (GM 4700–D LH deck float) output has open or short to ground
45	Solenoid valve S5 (center deck raise) output has open or short to ground
46	Solenoid valve S6 (center deck float) output is faulty
47	Solenoid valve S7 (GM 4700–D RH deck raise) output is faulty
48	Solenoid valve S8 (GM 4700–D RH deck lower) output is faulty
49	Solenoid valve S9 (GM 4700–D RH deck float) output has open or short to ground
50	Mow circuit PRV1 output has open or short to ground
51	Mow circuit PRV2 output has open or short to ground
52	Engine cooling fan output has open or short to ground
62	Counterbalance solenoid has open or short to ground
63	Traction pedal position sensor is returning a voltage higher than 4.75V or lower than 0.25V (replace the traction pedal position sensor)
64	Traction pedal position sensor neutral switches do not align with calibrated sensor values (recalibrate traction pedal position sensor)
65	Traction pedal position sensor forward/reverse switches are indicating the pedal is in both positions at the same time (replace the traction pedal position sensor)
66	TEC controller overcurrent in traction circuit
67	Traction current validation failure: make sure TEC forward traction output is connected to the piston pump forward traction solenoid coil. If circuit is connected, replace the TEC–5002 controller.

## Starting Problems

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

Problem	Possible Causes
No electrical power to machine (including gauges).	Battery is discharged. Battery cables are loose or corroded. Fuse D-1 (2 Amp) is faulty. Fuse D-2 (2 Amp) is faulty. Ground connection on machine is loose or corroded. The ignition switch or circuit wiring is faulty.
Starter solenoid clicks, but starter will not crank. <b>NOTE:</b> If the solenoid clicks, the problem is <b>not</b> in the interlock circuit.	Battery is discharged. Battery cables are loose or corroded. Ground connection on machine is loose or corroded. Wiring at the engine starter motor is faulty. Starter solenoid is faulty. Starter motor is faulty.
Nothing happens when start attempt is made but Operator Advisory is displayed on InfoCenter (see Operator Advisory list in this section).	The traction pedal is not in neutral position. Operator seat is unoccupied OR the parking brake is not applied. The PTO switch is ON (engaged). Traction pedal position sensor is out of adjustment. Traction pedal position sensor or circuit wiring is faulty. Seat switch or circuit wiring is faulty. Parking brake switch or circuit wiring is faulty. Engine or fuel system is malfunctioning (see Yanmar Service Manual).
Nothing happens when start attempt is made. InfoCenter display operates with the ignition switch in the ON position. No Operator Advisory displayed on InfoCenter.	Fuses for TEC controller(s) are faulty (fuse D-1 and/or D-2). Ignition switch or circuit wiring is faulty. Start relay or circuit wiring is faulty. Starter solenoid or starter motor is faulty.

## Starting Problems (continued)

Problem	Possible Causes
Engine cranks, but does not start.	Fuel tank is empty. Engine is not cranking fast enough. Fuel pump or circuit wiring is faulty. Engine or fuel system is malfunctioning (see Yanmar Service Manual).
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.

## General Run and Transport Problems

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

Problem	Possible Causes
Engine continues to run, but should not, when the ignition switch is turned off.	The ignition switch or circuit wiring is faulty. The alternator circuit is faulty (machines with 80 Amp alternator) The engine or fuel system is malfunctioning (see Yanmar Service Manual).
Machine continues to run 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. <b>NOTE:</b> 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.	Loose, corroded or broken wire(s) in charging circuit. The engine alternator belt is out of adjustment. 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.

Problem	Possible Causes
Cutting decks run, but should not, when raised. Decks shut off with PTO switch.	<p>The cutting deck position switch or circuit wiring is faulty.</p> <p>Wire harness connections are incorrectly connected to hydraulic solenoid valve coils on hydraulic deck control manifold.</p> <p>A hydraulic problem in the mow circuit exists (see Troubleshooting Section of Chapter 4 – Hydraulic System).</p> <p>TEC controller is faulty.</p>
Cutting decks run, but should not, when raised. Decks do not shut off with the PTO switch.	<p>The deck position switch or circuit wiring AND PTO switch or circuit wiring are faulty.</p> <p>A hydraulic problem in the mow circuit exists (see Troubleshooting Section of Chapter 4 – Hydraulic System).</p>
Cutting decks run, but should not, when lowered with PTO switch in the OFF (disengage) position.	<p>The PTO switch or circuit wiring is faulty.</p> <p>TEC controller is faulty.</p>
Cutting deck(s) do not operate and Operator Advisory is displayed on InfoCenter (see Operator Advisory list in this section).	<p>The operator is lifting off the seat switch.</p> <p>The cutting decks are not fully lowered.</p> <p>Traction circuit is not in LOW speed (mow) mode.</p>
Cutting deck(s) do not operate and no Operator Advisory is displayed on InfoCenter.	<p>High temperature of engine coolant or hydraulic oil has disabled the cutting decks.</p> <p>Fuse is faulty preventing PTO manifold solenoids from being energized (fuse B-1 or B-2).</p> <p>The seat switch or circuit wiring is faulty.</p> <p>The PTO switch or circuit wiring is faulty.</p> <p>The deck position switch or circuit wiring is faulty.</p> <p>The HI/LOW speed switch or circuit wiring is faulty.</p> <p>Hydraulic valve solenoid(s) or circuit wiring to the affected deck(s) is faulty.</p> <p>A hydraulic problem in the mow circuit exists (see Troubleshooting section of Chapter 4 – Hydraulic System).</p> <p>TEC controller is faulty.</p>



## 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 Causes
None of the cutting decks will lower and Operator Advisory is displayed on InfoCenter (see Operator Advisory list in this section).	The HI/LOW speed switch is in the HI speed position. 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 HI/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 Troubleshooting section in Chapter 4 - Hydraulic System). The TEC–5002 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 Troubleshooting section in Chapter 4 - Hydraulic System). The TEC–5002 controller is faulty.

## Cutting Deck Lift/Lower Problems (Continued)

Problem	Possible Causes
On Groundsmaster 4700–D, center cutting decks <b>will not</b> raise or lower, but both wing cutting decks <b>will</b> raise and lower.	<p>The center deck lift switch or circuit wiring is faulty.</p> <p>Fuse(s) for TEC controller are faulty (fuse C–1).</p> <p>Lift control manifold solenoid coils S5 or S6 or circuit wiring is faulty.</p> <p>A hydraulic problem in the lift/lower circuit exists (see Troubleshooting section in Chapter 4 - Hydraulic System).</p> <p>TEC controller is faulty.</p>
On Groundsmaster 4700–D, RH wing cutting deck <b>will not</b> raise or lower, but the center and LH wing cutting decks <b>will</b> raise and lower.	<p>The RH deck lift switch or circuit wiring is faulty.</p> <p>Fuse(s) for TEC controller are faulty.</p> <p>Lift control manifold solenoid coils S7, S8 or S9 or circuit wiring is faulty.</p> <p>A hydraulic problem in the lift/lower circuit exists (see Troubleshooting section in Chapter 4 - Hydraulic System).</p> <p>The TEC–5001 controller is faulty.</p>
On Groundsmaster 4700–D, LH wing cutting deck <b>will not</b> raise or lower, but the center and RH wing cutting decks <b>will</b> raise and lower.	<p>The LH deck lift switch or circuit wiring is faulty.</p> <p>Fuse(s) for TEC controller are faulty (fuse A–2).</p> <p>Lift control manifold solenoid coils S2, S3 or S4 or circuit wiring is faulty.</p> <p>A hydraulic problem in the lift/lower circuit exists (see Troubleshooting section in Chapter 4 - Hydraulic System).</p> <p>The TEC–5001 controller is faulty.</p>

# Electrical System Quick Checks

## Battery Test (Open Circuit Test)

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 60° to 100°F (16° to 38°C). The ignition key should be off and all accessories turned off. Connect the positive (+) meter lead to the positive battery post and the negative (-) meter lead to the negative battery post.

**NOTE:** This test provides a relative condition of the battery. Load testing of the battery will provide additional and more accurate information.

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 monitors interlock switch operation. Testing of individual interlock switches and relays is included in the Component Testing section of this Chapter.

**NOTE:** Use the InfoCenter Display (see InfoCenter Display in this chapter) to test Toro Electronic Controller inputs and outputs before further troubleshooting of an electrical problem on your Groundsmaster.

# Adjustments

## Traction Pedal Adjustment

The traction pedal includes a neutral assembly that is used to adjust the traction neutral position (Fig. 19). 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.
3. Use the InfoCenter Display Diagnostics menu (see InfoCenter Display in this chapter) to obtain and select the Traction Pedal menu item. Choose Inputs and the InfoCenter display should identify sensor voltage (Fig. 20).

4. Move traction pedal from full reverse to full forward positions while noting the range of voltage displayed on the InfoCenter.

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 (Fig. 19).

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.

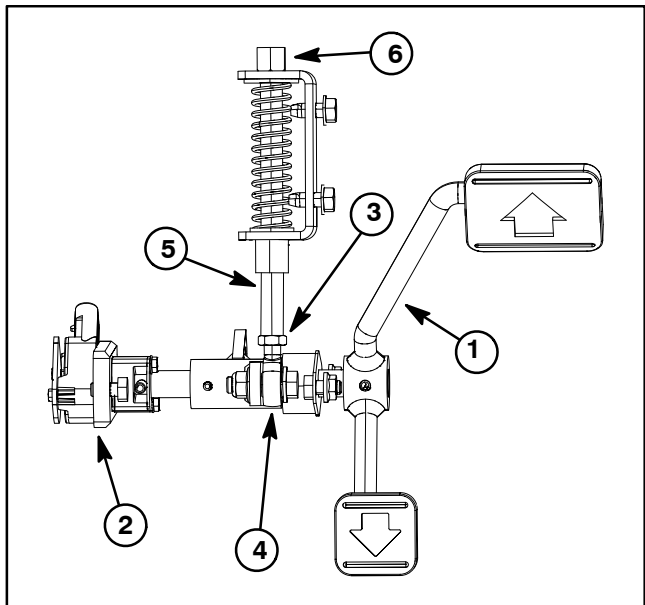


Figure 19

- |                          |                     |
|--------------------------|---------------------|
| 1. Traction pedal        | 4. Rod end bearing  |
| 2. Pedal position sensor | 5. Spring shaft     |
| 3. Hex nut               | 6. Spring shaft hex |

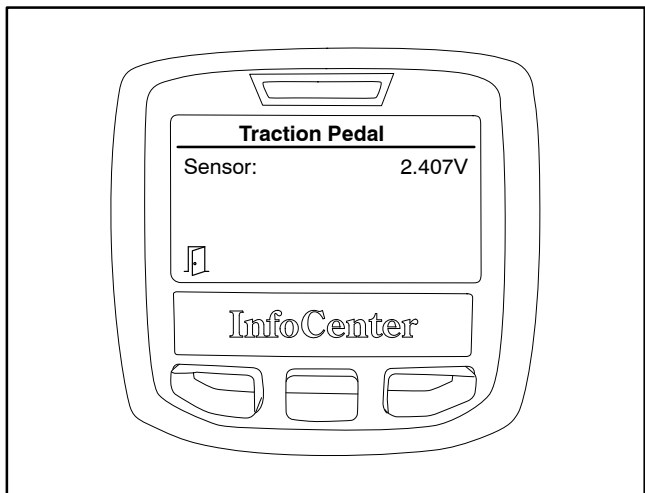


Figure 20

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 in this chapter). Choose Outputs and the InfoCenter display will identify the traction pedal position (Fig. 21).

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 in this section of this chapter).

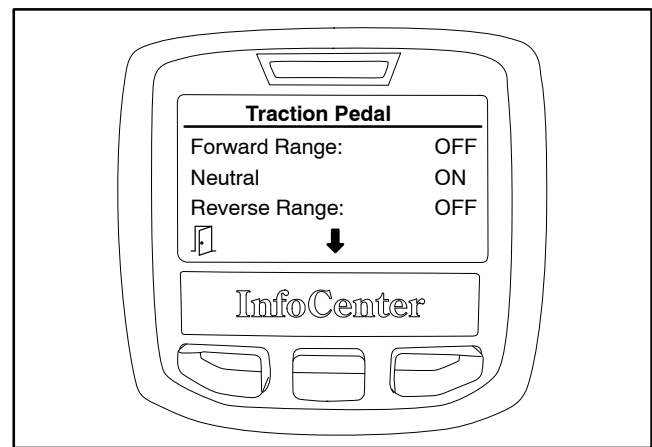


Figure 21

## Traction Pedal Position Sensor Calibration

**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 in this chapter) 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.

4. Use the InfoCenter Display Service menu (see InfoCenter Display in this chapter) to obtain and select the Traction Pedal menu item. The InfoCenter display should indicate that the traction pedal calibration process is engaged (Fig. 23).

5. Follow the prompts on the InfoCenter display screen to calibrate the traction pedal position sensor. The calibration steps are listed below:

- A. Slowly press traction pedal to the forward direction.
- B. Press and hold traction pedal to the full forward position.
- C. Allow traction pedal to return to the neutral position.
- D. Slowly press traction pedal to the reverse direction.
- E. Press and hold traction pedal to the full reverse position.
- F. Check that InfoCenter display indicates a successful calibration process (Fig. 24).

6. Turn ignition switch to OFF which exits the traction pedal calibration menu.

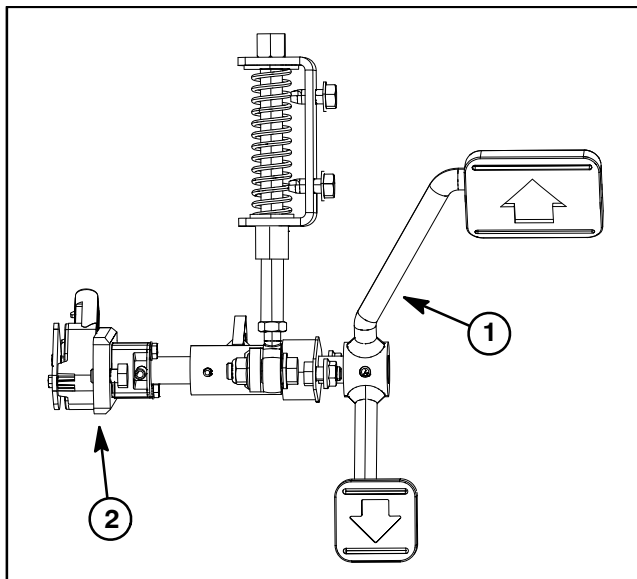


Figure 22

1. Traction pedal                      2. Pedal position sensor



Figure 23

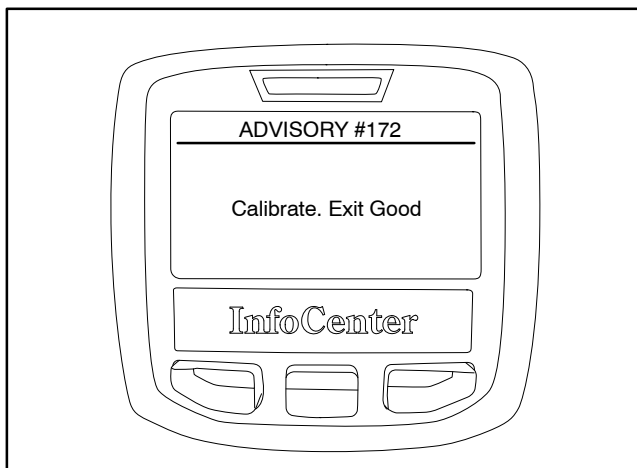


Figure 24

# 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 of the switch terminals).

**NOTE:** For engine component testing information, see the Yanmar Service Manual and Yanmar Troubleshooting Manual.

## Ignition Switch

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 in this chapter). If input testing verifies that the ignition switch and circuit wiring **are** functioning correctly, no further ignition switch testing is necessary. If, however, input testing determines that the ignition switch and circuit wiring **are not** functioning correctly, proceed with the following ignition switch testing procedure.

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 in the Service and Repairs section of Chapter 7 – Chassis).
3. Disconnect wire harness connector from ignition switch.
4. The ignition switch terminals are identified in Figure 25 and the circuitry of the switch is shown in the chart in Figure 26. 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.
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 Electrical Schematics and Wire Harness Drawings in Chapter 9 – Foldout Drawings).



## CAUTION

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

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 in the Service and Repairs section of Chapter 7 – Chassis).

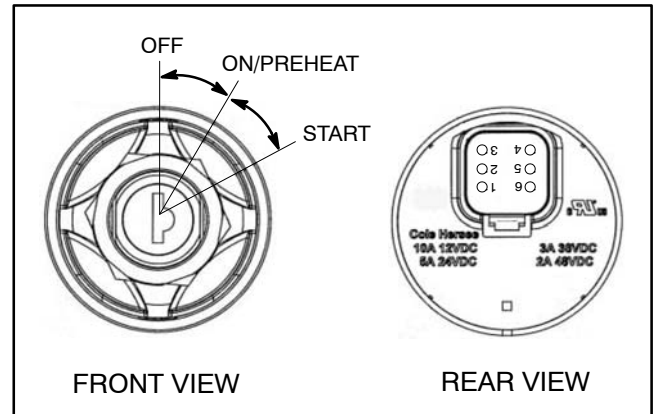


Figure 25

SWITCH POSITION	CIRCUITS
OFF	1 + 6, 4 + 5
ON/PREHEAT	1 + 3 + 4 + 5 + 6
START	1 + 2 + 4 + 5 + 6

Figure 26

**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.

## Fuses

Groundsmaster 4500-D and 4700-D use numerous fuses for circuit protection. The fuses reside in the power center behind the operator's seat.

### Fuse Identification and Function (Fig. 27)

Fuse A-1 (7.5 Amp) protects TEC-5002 output power supply for engine start, engine run, fuel pump and cooling fan directional solenoid (S1).

Fuse A-2 (7.5 Amp) protects TEC-5001 output power supply for 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 the power supply to the main power circuits.

Fuse A-4 (10 Amp) protects the power supply to the headlight circuits.

Fuse B-1 (7.5 Amp) protects TEC-5002 output power supply for the two (2) PTO solenoids (PRV1 and PRV2), the cooling fan speed solenoid (PRV), counterbalance valve (TS) and the piston (traction) pump forward and reverse solenoids.

Fuse B-2 (7.5 Amp) protects TEC-5001 output power supply for right deck lower solenoid (S8), right deck float solenoid (S9), 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 C-1 (7.5 Amp) protects TEC-5002 output power supply for center decks raise solenoid (S5), center decks float solenoid (S6) and the HI/LOW range solenoid.

Fuse C-2 (7.5 Amp) protects TEC-5001 output power supply for lift/lower solenoid enable (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 D-1 (2 Amp) protects logic power circuits for the ignition switch and TEC-5002 controller.

Fuse D-2 (2 Amp) protects logic power circuits for the TEC-5001 controller on Groundsmaster 4700-D machines.

Fuse D-3 (10 Amp) protects the power supply to the engine control unit (ECU).

Fuse D-4 position available for optional kit.

Maxi-fuse M1 (60A) supplies power to the operator cab (if equipped).

### Fuse Testing

1. Make sure that ignition switch is OFF and key is removed from 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. Close and secure power center cover.

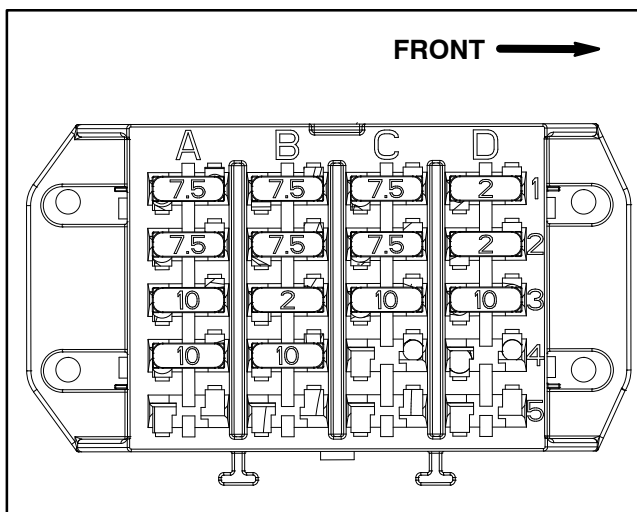


Figure 27



## Fusible Link Harness

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 (Fig. 28). If either of these links should fail, current to the protected circuits will cease. Refer to wire harness drawings in Chapter 9 – Foldout 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 in the Service and Repairs section of this chapter). 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.

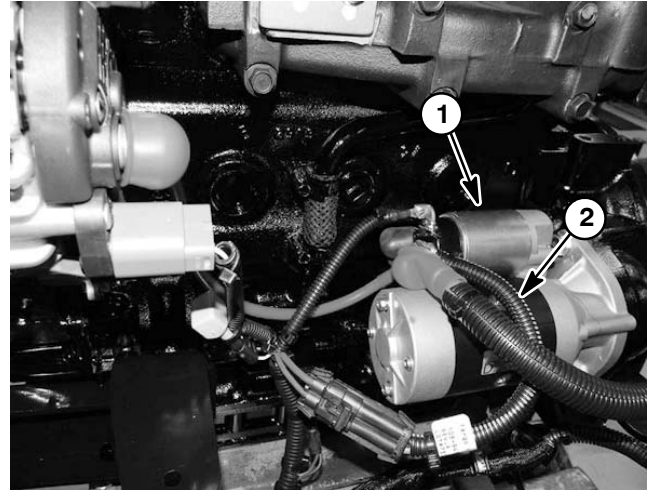


Figure 28

1. Starter motor

2. Fusible link harness

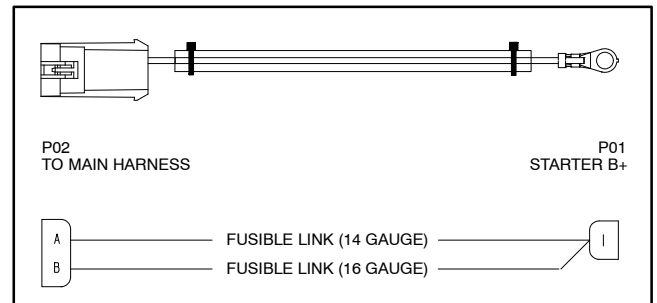


Figure 29

# PTO Switch

The two position PTO switch is located on the console arm (Fig. 30). 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 in this chapter). 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 in the Service and Repairs section of Chapter 7 – Chassis).
3. Disconnect wire harness electrical connector from the PTO switch.
4. The switch terminals are marked as shown in Figure 31. 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. 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 Electrical Schematics and Wire Harness Drawings in Chapter 9 – Foldout Drawings).
6. After testing is completed, connect the wire harness connector to the PTO switch.
7. Assemble console arm (see Console Arm Assembly in the Service and Repairs section of Chapter 7 – Chassis).

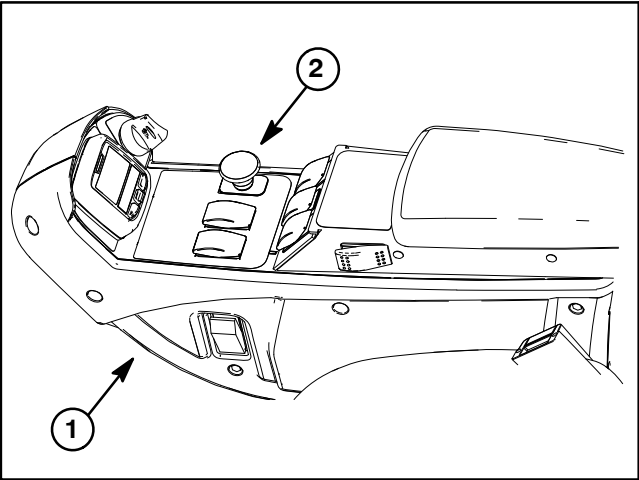


Figure 30

1. Console arm                      2. PTO switch

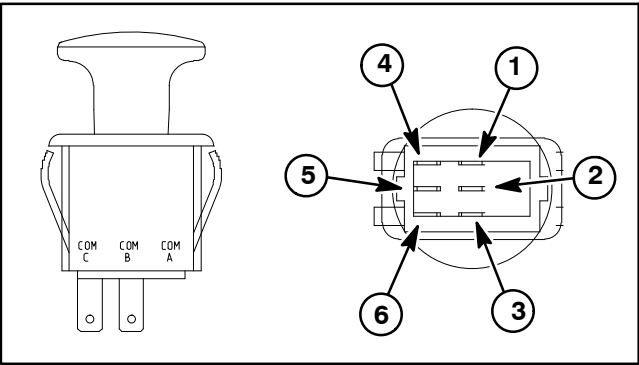


Figure 31

1. COM B terminal                      4. COM C terminal  
2. NO B terminal                      5. NO C terminal  
3. NC B terminal                      6. NC C terminal

## Hi/Low Speed, Engine Speed Request and Cutting Deck Lift Switches

The Hi/Low speed, engine speed request and cutting deck lift switches are all identical. These switches are located on the console arm (Fig. 32).

The Hi/Low speed switch is used as an input for the TEC controller to select either the Hi (transport) or Low (mow) traction speed.

The engine speed request switch is used as an input for the engine control unit (ECU) to raise or lower the engine speed. When the switch is depressed and held in the forward position, the engine speed will increase. Conversely, when the rear of the switch is depressed, engine speed will decrease.

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 (mow) range.

### 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 in this chapter). If input testing verifies that the switch and circuit wiring **are** functioning correctly, no further switch testing is necessary. If, however, input testing determines that the switch and circuit wiring **are not** functioning correctly, proceed with the following switch testing procedure.

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 in the Service and Repairs section of Chapter 7 – Chassis).
3. Disconnect wire harness electrical connector from the switch that is to be tested.
4. The switch terminals are marked as shown in Figure 33. 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 Electrical Schematics and Wire Harness Drawings in Chapter 9 – Foldout Drawings).

6. After testing is completed, connect wire harness connector to the switch.

7. Assemble console arm (see Console Arm in the Service and Repairs section of Chapter 7 – Chassis).

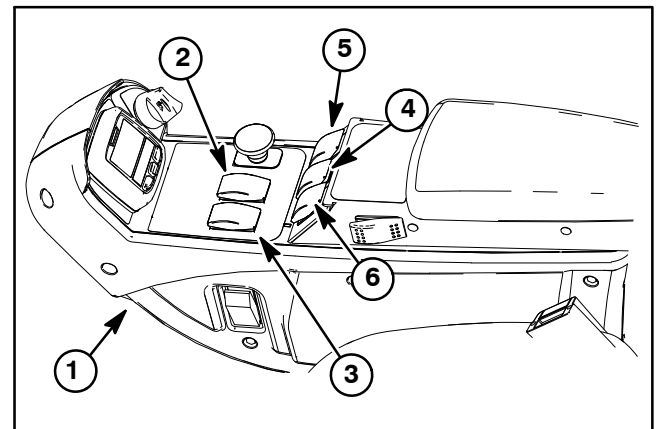


Figure 32

- |                        |                            |
|------------------------|----------------------------|
| 1. Console arm         | 4. Lift switch (#1 to #5)  |
| 2. Engine speed switch | 5. Lift switch (GM4700 #7) |
| 3. Hi/Low speed switch | 6. Lift switch (GM4700 #6) |

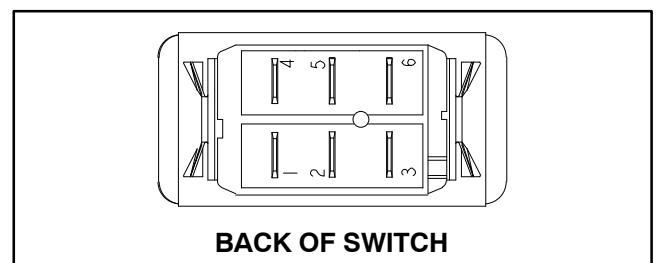


Figure 33

## Headlight Switch

The headlight switch is located on the operator side of the console arm (Fig. 34). 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 in the Service and Repairs section of Chapter 7 – Chassis).
3. Disconnect wire harness electrical connector from the headlight switch.
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 35. 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
OFF	2 + 1	5 + 4
ON	2 + 3	5 + 6

5. If switch tests correctly and headlight circuit problem still exists, check wire harness (see Electrical Schematics and Wire Harness Drawings in Chapter 9 – Foldout Drawings).
6. After testing is completed, connect wire harness connector to the headlight switch.
7. Assemble console arm (see Console Arm Assembly in the Service and Repairs section of Chapter 7 – Chassis).

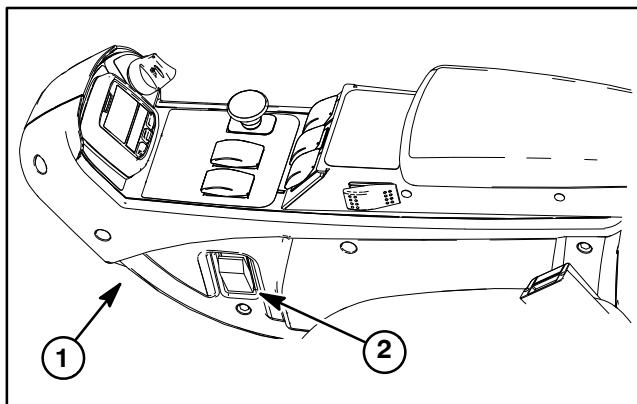


Figure 34

1. Console arm

2. Headlight switch

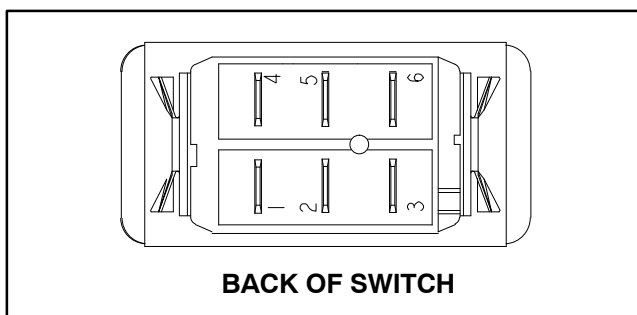


Figure 35

**NOTE:** Headlight switch terminals 1, 4, 5 and 6 are not used on Groundsmaster 4500-D and 4700-D machines.

## Seat Switch

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 (Fig. 36).

### 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 in this chapter). If input testing verifies that the seat switch and circuit wiring **are** functioning correctly, no further seat switch testing is necessary. If, however, input testing determines that the seat switch and circuit wiring **are not** functioning correctly, proceed with the following seat switch testing procedure.

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 in the Service and Repairs section of Chapter 7 – Chassis).
7. Connect seat switch connector to wire harness connector after testing is complete.

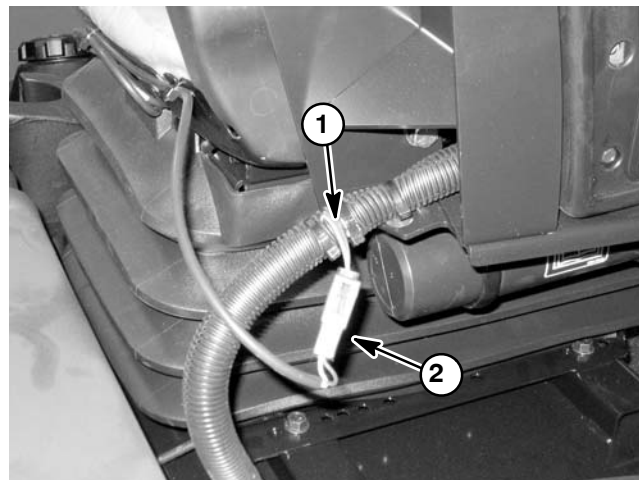


Figure 36

1. Wire harness connector      2. Seat switch connector

## Parking Brake Switch

The parking brake switch is a normally open proximity switch. The parking brake switch is attached to the bottom of the RH brake pedal (Fig. 37).

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.

### Switch Testing

**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 (see InfoCenter Display in this chapter). 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, engage parking brake and stop engine. Remove key from ignition switch.
2. Disconnect wire harness electrical connector from the parking brake switch.
3. Check the continuity of the switch by connecting a multimeter (ohms setting) across the connector terminals.
4. When the parking brake is released (brake not applied), there should be continuity (closed) between the switch terminals.
5. When the parking brake pedal is depressed (brake applied), there should not be continuity (open) between the switch terminals.
6. Replace parking brake switch if testing determines that it is faulty.

**NOTE:** When installing the parking brake switch to the brake pedal, place switch plate tab into switch mounting hole that is closest to target end of switch (Fig. 38).

7. After testing is complete, connect wire harness electrical connector to the brake switch.

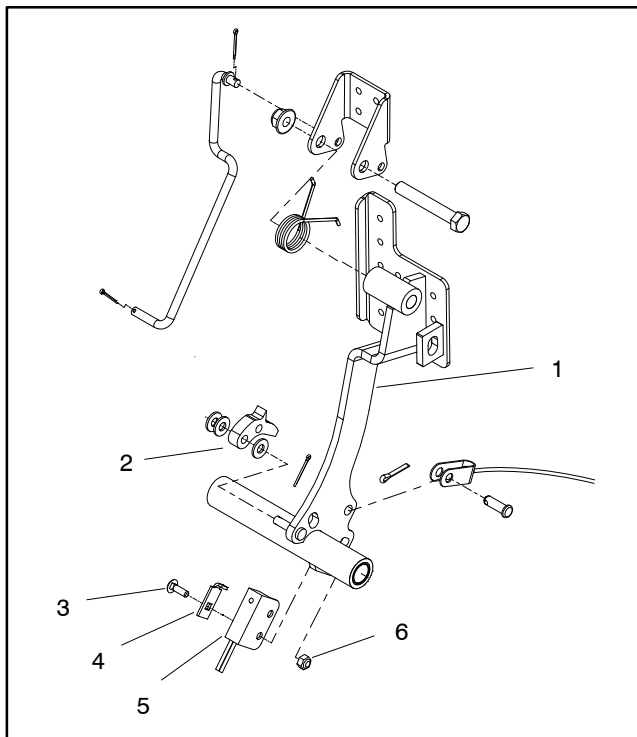


Figure 37

- |                   |                 |
|-------------------|-----------------|
| 1. RH brake pedal | 4. Switch plate |
| 2. Brake detent   | 5. Brake switch |
| 3. Carriage screw | 6. Lock nut     |

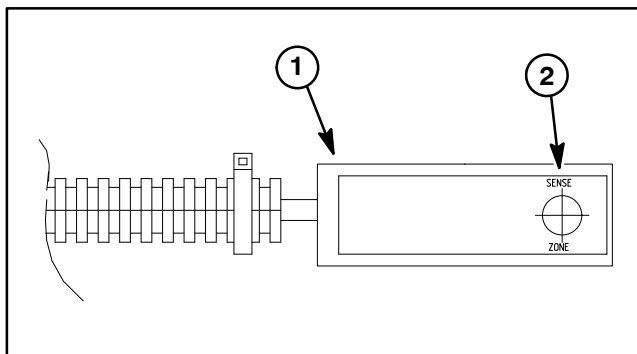


Figure 38

- |                 |                       |
|-----------------|-----------------------|
| 1. Brake switch | 2. Switch target area |
|-----------------|-----------------------|

## Cutting Deck Position Switches

The cutting deck position switches are normally open proximity switches that are located on the traction unit frame (Fig. 39). 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

**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 in this chapter). 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

1. Adjust switch to have **1/16 in (1.6 mm)** clearance between switch and sensing plate on the lift arm.

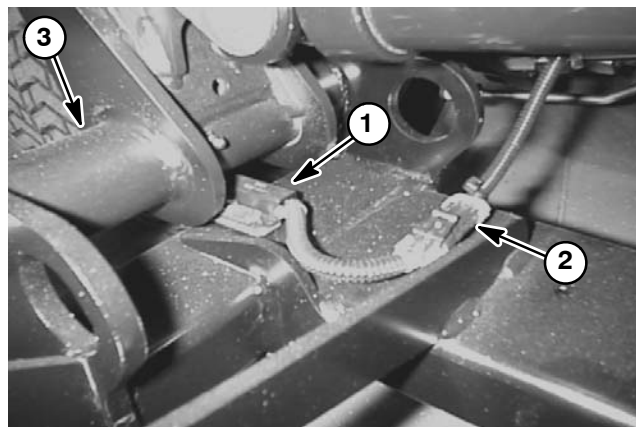


Figure 39

1. Position switch
2. Switch connector
3. Lift arm (#5 shown)

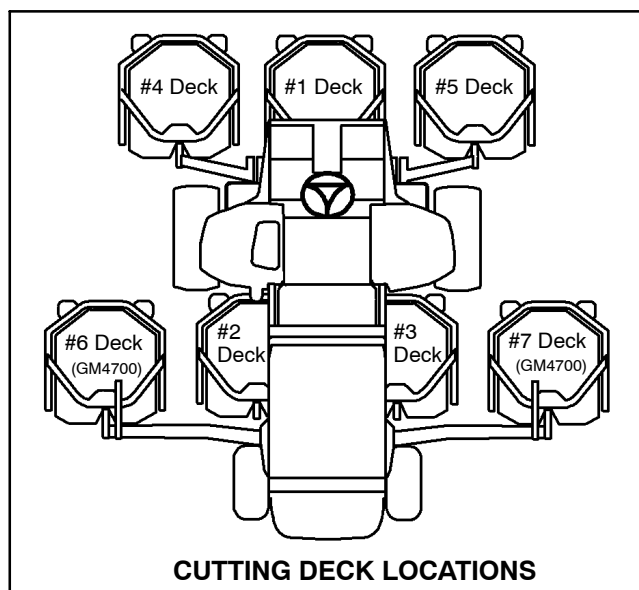


Figure 40

## Relays with Four (4) Terminals

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 main power relay is used to provide current to most of the fuse protected circuits (operator seat, InfoCenter display, engine electronic control unit (ECU), power point and optional electric equipment). The main power relay is 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 30873 and 30874 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 30881 and 30882 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 main power and operator cab power (if equipped) relays reside in the power center behind the operator's seat (Fig. 41). The start, air heater and glow relays are attached to the air cleaner mount bracket near the engine ECU (Fig. 42).

### Testing

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 in the Service and Repairs section of this chapter).
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.

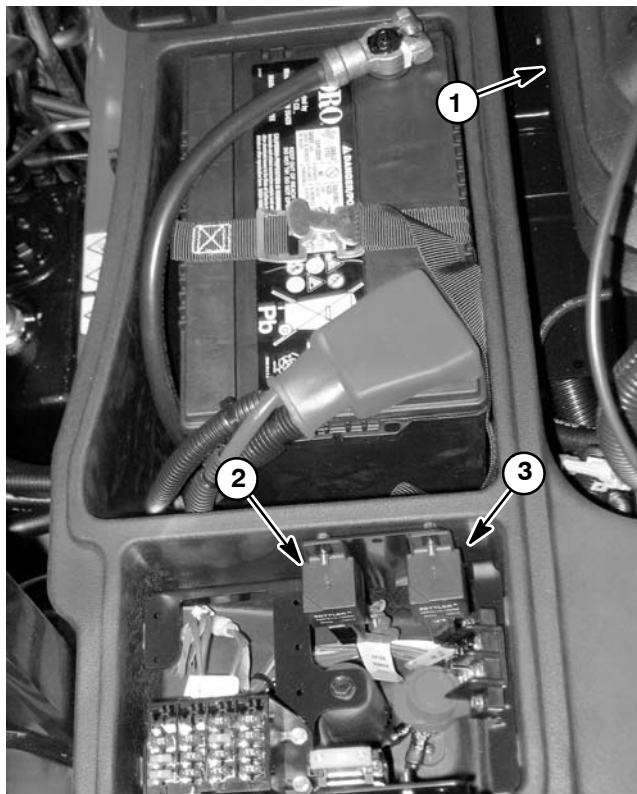


Figure 41

- |                     |                    |
|---------------------|--------------------|
| 1. Operator seat    | 3. Cab power relay |
| 2. Main power relay |                    |

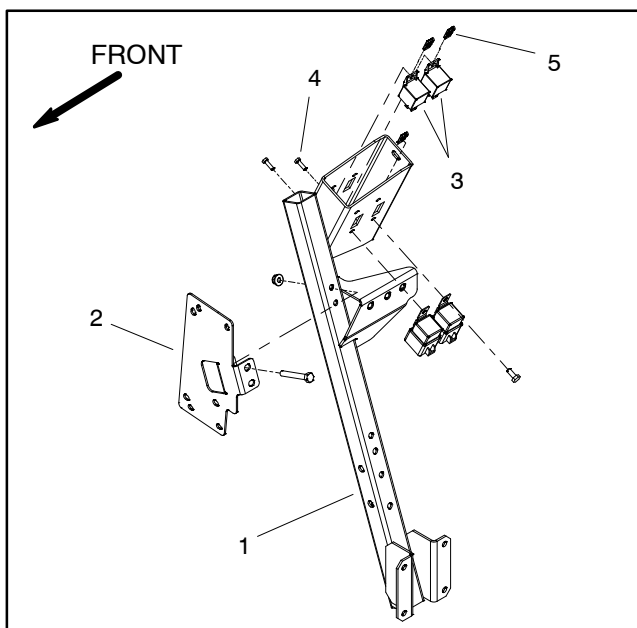


Figure 42

- |                      |                  |
|----------------------|------------------|
| 1. Air cleaner mount | 4. Screw         |
| 2. Engine ECU mount  | 5. Tinnerman nut |
| 3. 4 terminal relay  |                  |



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 in the Service and Repairs section of this chapter).

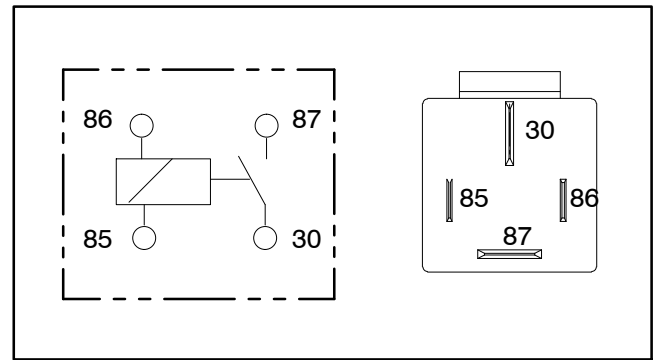


Figure 43

## Relays with Five (5) Terminals

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 30873 and 30874 to provide current for several engine components when energized by the engine electronic control unit (ECU).

The rack actuator relay is used on models 30873 and 30874 to provide current for the engine rack actuator when energized by the engine ECU.

The EGR relay is used on models 30881 and 30882 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 (Fig. 42).

### Testing

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 in the Service and Repairs section of this chapter).

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 in the Service and Repairs section of this chapter).

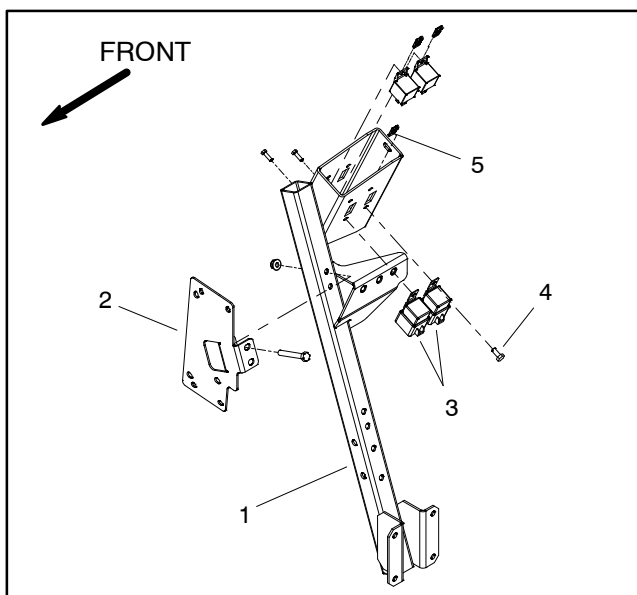


Figure 44

- |                      |               |
|----------------------|---------------|
| 1. Air cleaner mount | 4. Cap screw  |
| 2. Engine ECU mount  | 5. Flange nut |
| 3. 5 terminal relay  |               |

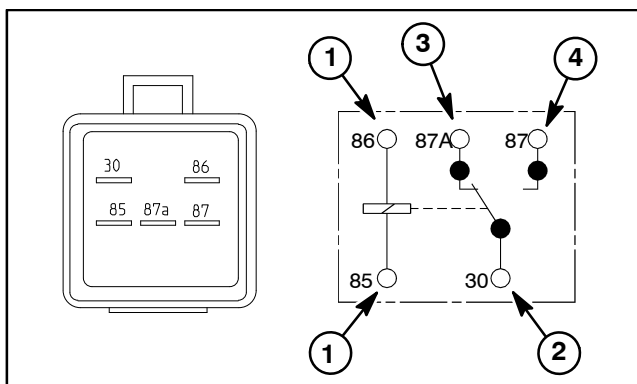


Figure 45

- |                    |                          |
|--------------------|--------------------------|
| 1. Coil terminal   | 3. Normally closed term. |
| 2. Common terminal | 4. Normally open term.   |

## Traction Pedal Position Sensor

The traction pedal position sensor is connected to the traction pedal assembly (Fig. 46). 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 in this chapter). If necessary, follow calibration procedures for the traction pedal position sensor found in the Adjustments section of this chapter. If position sensor replacement is necessary, refer to Traction Pedal in the Service and Repairs section of Chapter 7 – Chassis.

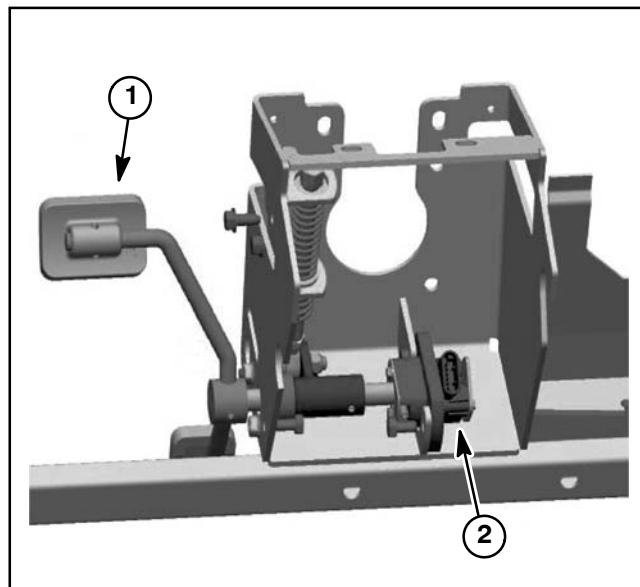


Figure 46

1. Traction pedal

2. Pedal position sensor

## Toro Electronic Controllers (TEC)

Groundsmaster 4500-D and 4700-D machines use a Toro Electronic Controller (TEC-5002) to control electrical system operation. Groundsmaster 4700-D machines use an additional TEC-5001 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 a bracket under the operator seat (Fig. 47).

Logic power is provided to the controllers as long as the battery cables are connected to the battery. A pair of 2 amp fuses (D-1 for TEC-5002 and D-2 for TEC-5001) provide circuit protection for this logic power to the controllers.

The TEC-5002 controller monitors the states of the following components as inputs: ignition switch, traction pedal position sensor, parking brake switch, HI/LOW speed switch, seat switch, engine speed switch, PTO switch, center cutting deck lift switch, cutting deck position switches (decks 4 and 5), hydraulic temperature sender and hydraulic pressure transducer.

The TEC-5002 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 (HI/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 three (3) 7.5 amp fuses (A-1, B-1 and C-1).

On Groundsmaster 4700-D machines, the TEC-5001 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-5001 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 three (3) 7.5 amp fuses (A-2, B-2 and C-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.

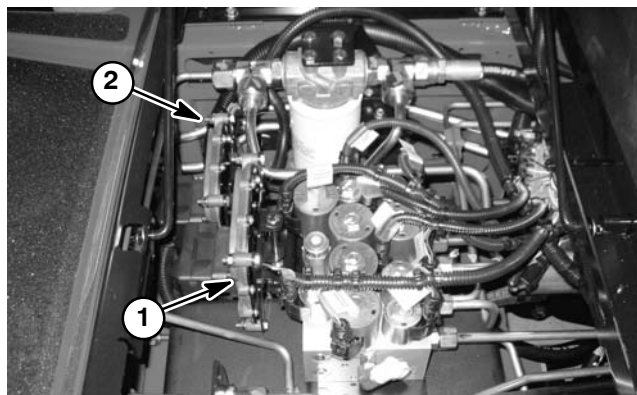


Figure 47

1. TEC-5002 controller      2. TEC-5001 controller

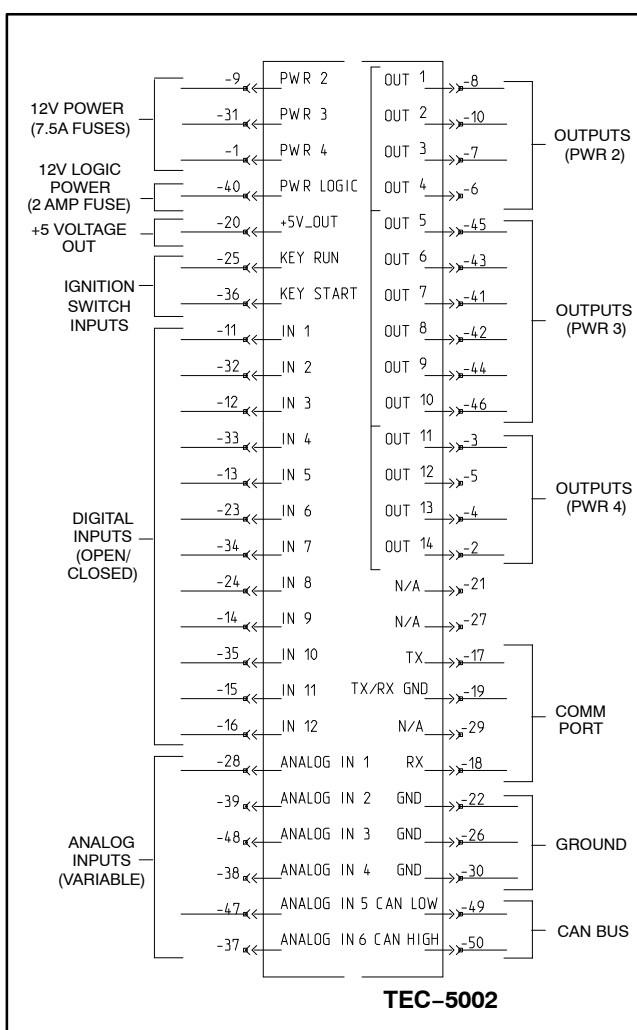


Figure 48

The connection terminal functions for the TEC controllers are shown in Figures 48 (TEC-5002) and 49 (TEC-5001). Note that electrical power for controller outputs is provided through three (3) connector terminals (PWR 2, PWR 3 and PWR 4) 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 Figures 48 and 49. The layout of the wire harness connectors that plug into the TEC controllers is shown in Fig. 50.

**IMPORTANT: When testing for wire harness continuity at the connector for the TEC controller, take care to not damage the connector pins with multi-meter 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 multi-meter 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.**

If the wire harness connector is removed from the TEC controller for any reason, tighten the harness connector screw from **25 to 28 in-lb (2.8 to 3.2 N·m)**.

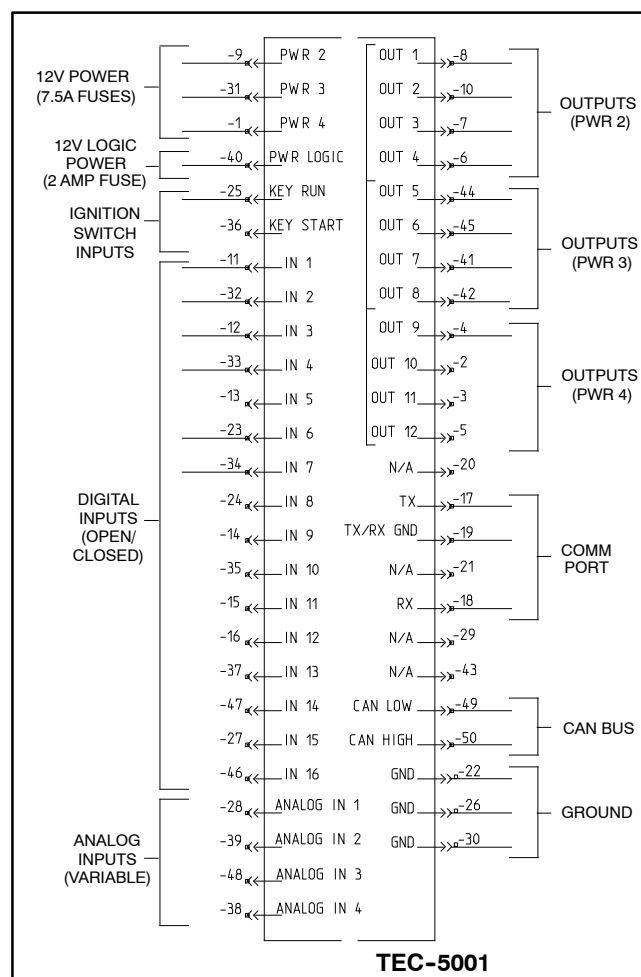


Figure 49

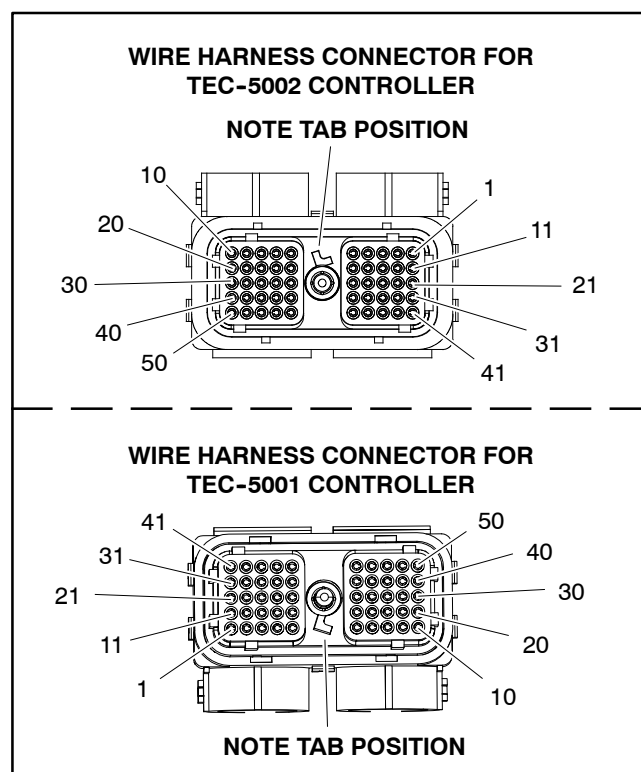


Figure 50

## Hydraulic Solenoid Valve Coils

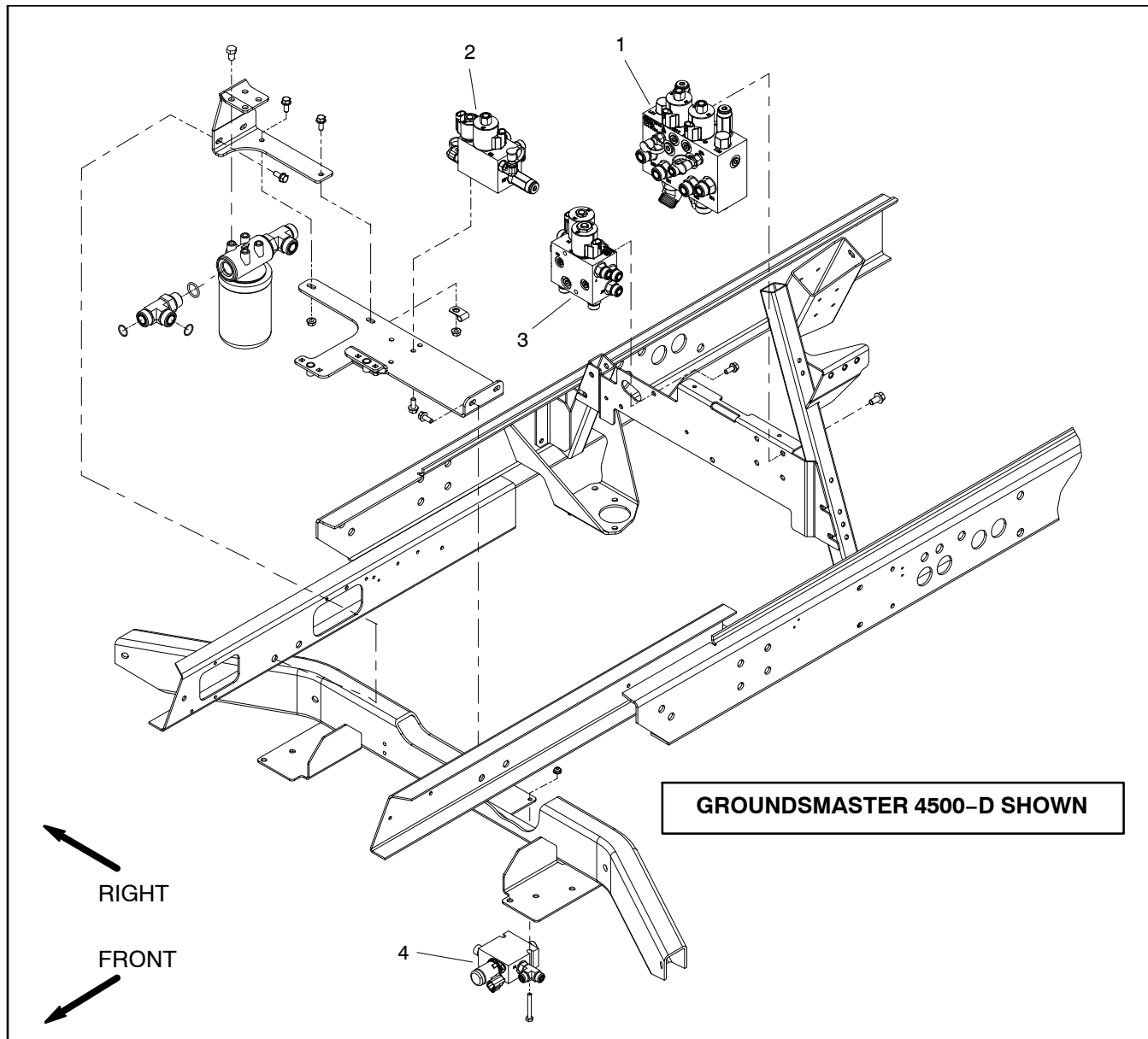


Figure 51

1. Deck control manifold  
2. Lift control manifold

3. Fan control manifold

4. HI/LOW range control 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 HI/LOW range control manifold (item 4 in Figure 51) 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 (Fig. 51).

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.

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 68°F (20°C). Resistance may be slightly different than listed at different temperatures. Typically, a failed solenoid coil will either be shorted (very low or no resistance) or open (infinite resistance).

A. If coil is secured to valve with a nut, identify coil by measuring the coil diameter and coil height (Fig. 52). The correct resistance for the solenoid coil is identified in the table below.

COIL DIAMETER	COIL HEIGHT	COIL RESISTANCE
1.84 in (46.7 mm)	1.96 in (49.9 mm)	7.1 ohms
1.41 in (35.8 mm)	1.43 in (36.3 mm)	8.8 ohms

B. The resistance of the solenoid valve coil in the HI/LOW range control manifold (item 4 in Figure 51) is 7.1 ohms.

5. If solenoid coil resistance is incorrect, replace coil (see appropriate control manifold information in the Service and Repairs section of Chapter 4 – Hydraulic System).

6. After testing is completed, connect wire harness connector to the solenoid valve coil.

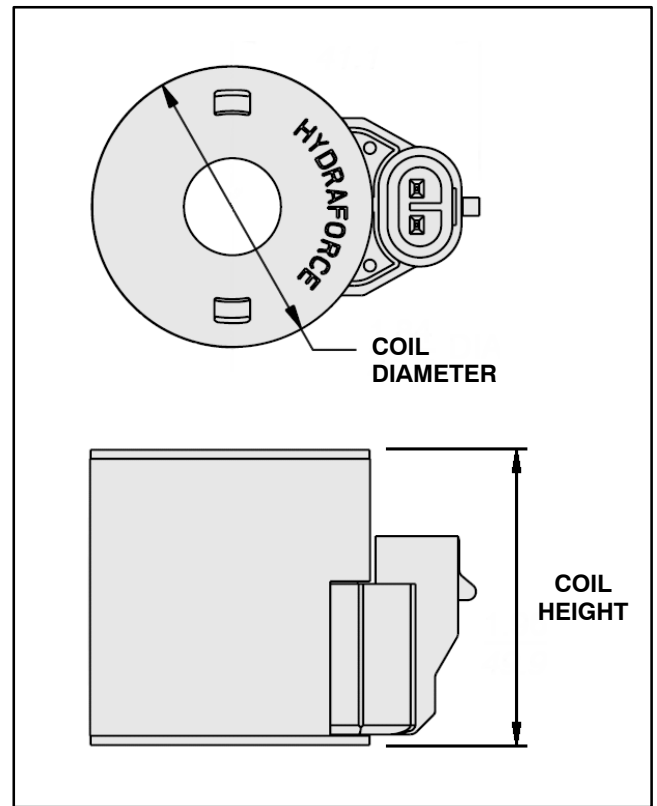


Figure 52

## Piston (Traction) Pump Control Solenoid Coils

The piston (traction) pump uses an electronic control assembly for swash plate 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 (Fig. 53).

**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 (Fig. 53). 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.

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 68°F (20°C). Resistance may be slightly different than listed at different temperatures. Typically, a failed solenoid coil will either be shorted (very low or no resistance) or open (infinite resistance).

4. 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 **44 in-lb (5 N-m)** (do not over tighten).

5. After testing is completed, connect wire harness connector to the solenoid coil.

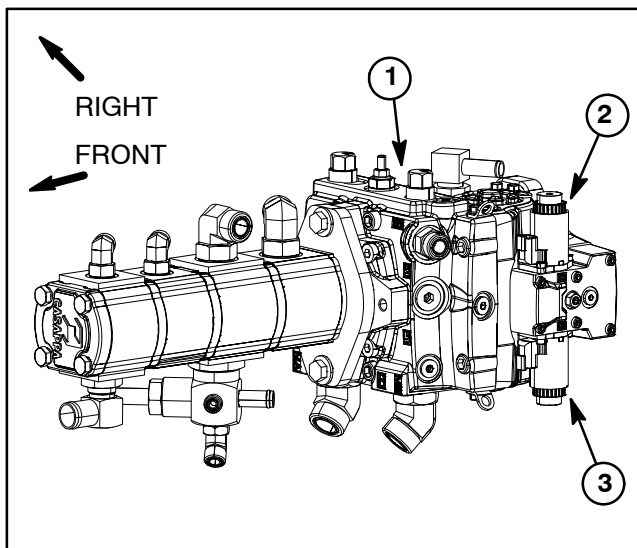


Figure 53

- 1. Piston pump
- 2. Forward solenoid coil
- 3. Reverse solenoid coil

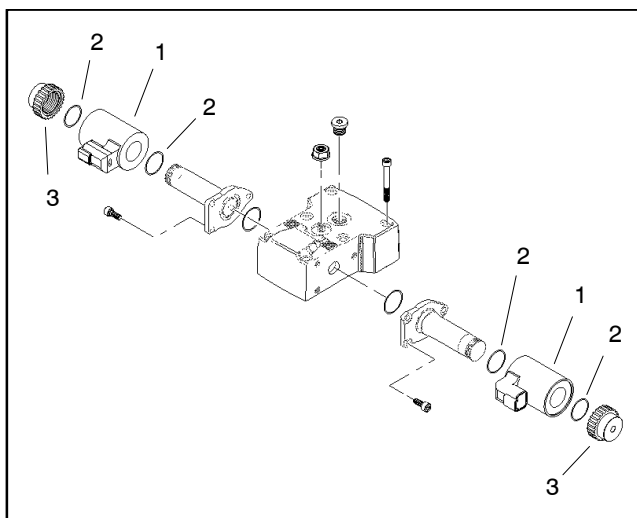


Figure 54

- 1. Solenoid coil
- 2. O-ring
- 3. Coil nut



## Hydraulic 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 (Fig. 55).

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 in this chapter). 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.
3. Thoroughly clean area around temperature sender and remove sender from rear axle motor.
4. Put sensing end of sender in a container of oil with a thermometer and slowly heat the oil (Fig. 56).



### 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.

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 68°F (20°C).

B. The meter should indicate from 2.3 to 2.5 kilo ohms at 140°F (60°C).

C. The meter should indicate from 605 to 669 ohms at 212°F (100°C).

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 **9 to 11 ft-lb (12.3 to 14.9 N-m)**.

B. Connect wire harness connector to sender.

7. Check and fill hydraulic system to proper level.

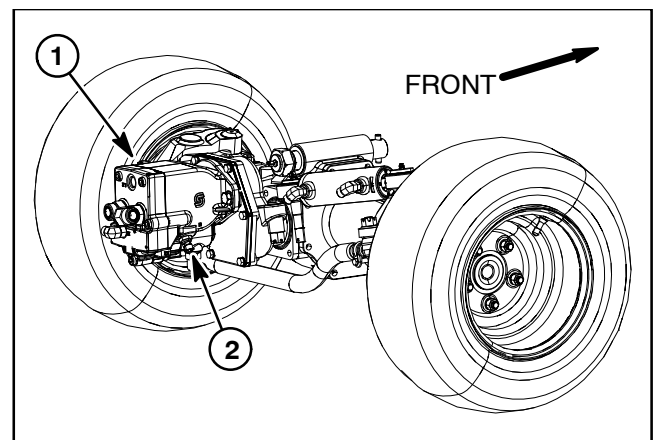


Figure 55

1. Rear axle motor

2. Oil temp sender

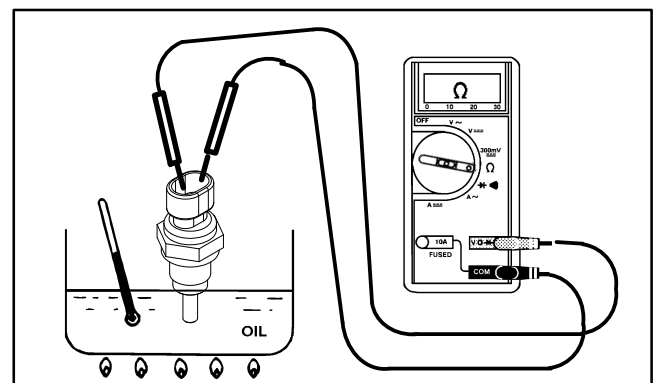


Figure 56

## Fuel Pump (Models 30873 and 30874)

The fuel pump is attached to the air cleaner mount below the fuel water separator (Fig. 57).

### 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 (Fig. 57). 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 1 quart (0.95 liter).

**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 **16 fl oz (475 ml) after fifteen (15) seconds.**

7. Replace fuel pump as necessary.

**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 in the Service and Repairs section of Chapter 3 – Yanmar Diesel Engine).

10. Lower and secure hood.

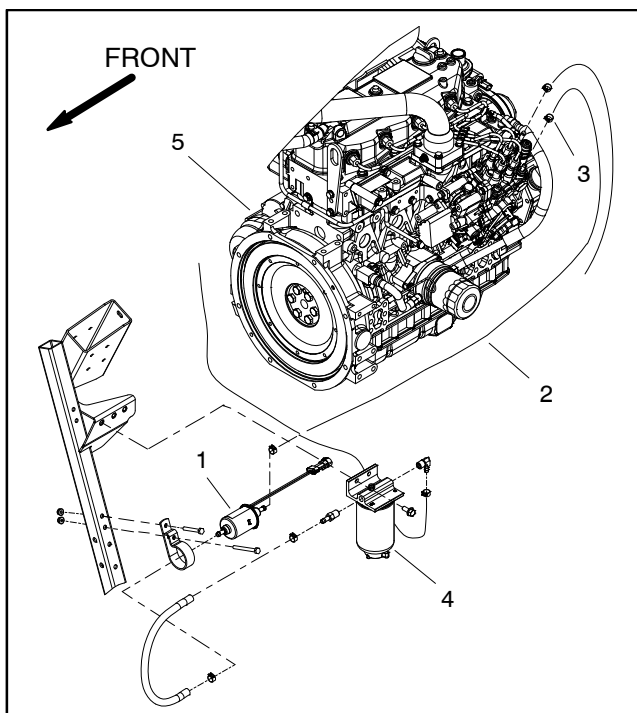


Figure 57

- |                     |                         |
|---------------------|-------------------------|
| 1. Fuel pump        | 4. Fuel water separator |
| 2. Fuel supply hose | 5. Engine               |
| 3. Hose clamp       |                         |

### Fuel Pump Specifications

Pump Capacity	64 fl oz/min (1.9 l/min)
Pressure	7 PSI (48.3 kPa)
Current Draw	2.0 amp

## Fuel Pump (Models 30881 and 30882)

The fuel pump is attached to the air cleaner mount below the fuel water separator (Fig. 58).

### 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 (Fig. 58).
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 1 quart (0.95 liter).

**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 **11.8 fl oz (350 ml) after thirty (30) seconds**.
7. Replace fuel pump as necessary.

**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 in the Service and Repairs section of Chapter 3 – Yanmar Diesel Engine).
10. Lower and secure hood.

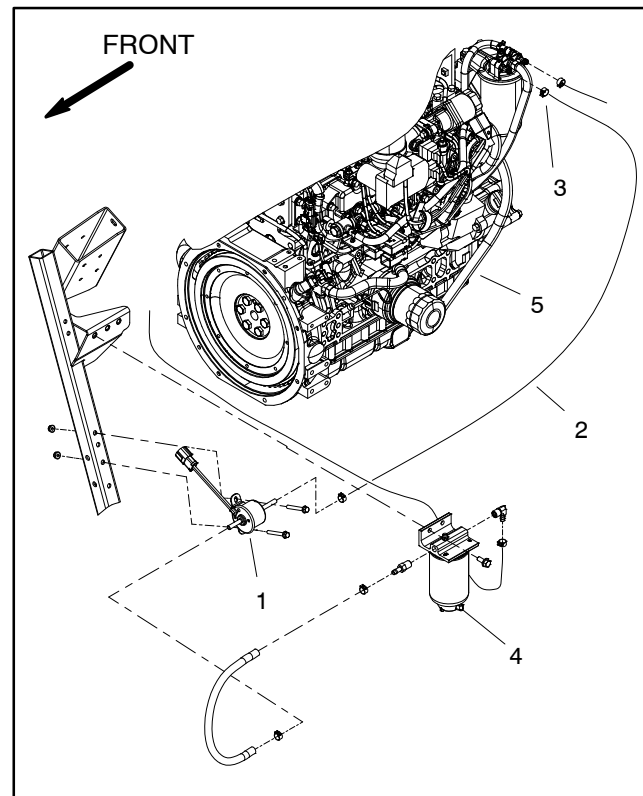


Figure 58

- |                        |                         |
|------------------------|-------------------------|
| 1. Fuel pump           | 4. Fuel water separator |
| 2. Pump discharge hose | 5. Engine               |
| 3. Hose clamp          |                         |

### Fuel Pump Specifications

Pump Capacity	23.5 fl oz/min (700 ml/min)
Pressure	3.3 PSI (22.8 kPa)
Current Draw	0.9 amp

## CAN-bus Termination Resistor

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 control arm. The resistor can be accessed by removing the cover plate on the right side of the control 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 the Electrical Schematics and Wire Harness Drawings in Chapter 9 – Foldout Drawings 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 (Fig. 59) 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.

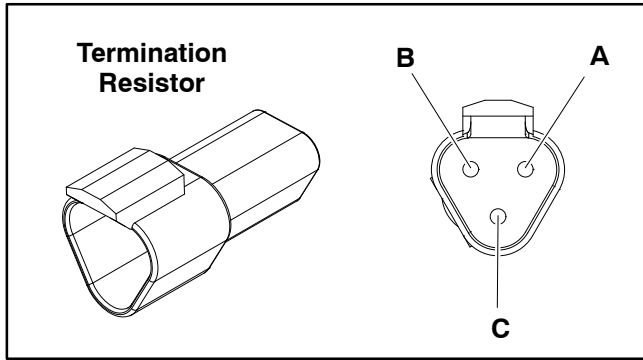


Figure 59

# Diode Assemblies

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 30873 and 30874 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 to the engine wire harness drawing in Chapter 9 – Foldout Drawings 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.

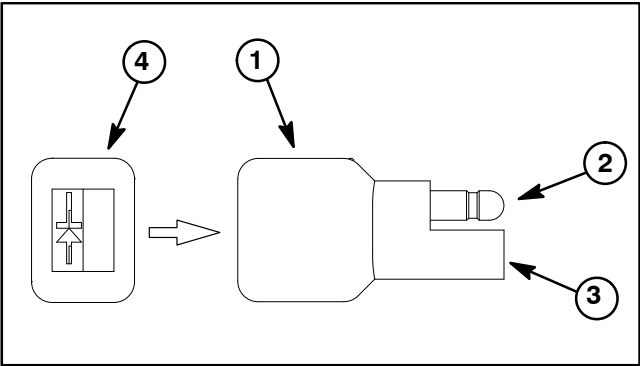


Figure 60

1. Diode

2. Male terminal
3. Female terminal

4. End of diode body

Multimeter Red Lead (+) on Terminal	Multimeter Black Lead (-) on Terminal	Continuity
Female	Male	YES
Male	Female	NO

# Resistor Assemblies

A 75 ohm resistor plugs into the console wire harness near the ignition switch connector (see seat and console wire harness drawing in Chapter 9 – Foldout Drawings). This resistor is necessary for proper ignition switch operation.

The engine wire harness also contains a 1.6K ohm resistor. On Groundsmaster machines with an 80 Amp alternator (see Engine Specifications in Chapter 3 – Yanmar Diesel Engine), this resistor is necessary for ignition switch operation. On Groundsmaster machines with a 40 amp alternator, the resistor is in the engine wire harness but it is not included in any operating circuit. The 1.6K ohm resistor plugs into the wiring harness near the engine starter motor (see engine wire harness drawing in Chapter 9 – Foldout Drawings).

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 either 75 ohms or 1.6K ohms depending on which resistor is tested.

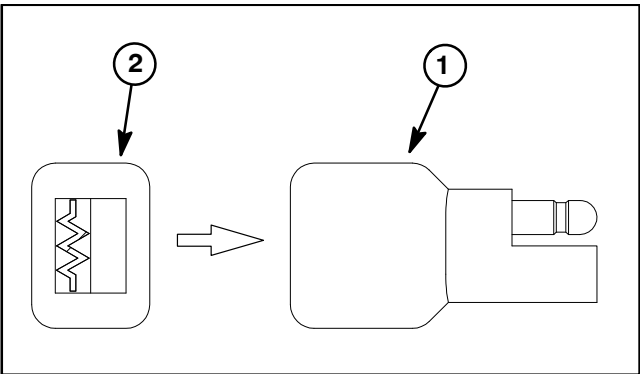


Figure 61

1. Resistor assembly
2. End of resistor body

## Fan Speed Switch (Machines with Two-Post ROPS Extension Operator Fan Kit)

The fan speed switch is attached to the overhead control panel (Fig. 62). 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.
4. The switch terminals are identified in (Fig. 63). 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 Electrical Schematics and Wire Harness Drawings in chapter 9-Foldout Drawings.
7. After you complete the testing, connect the machine wire harness to the switch and install the sunshade.

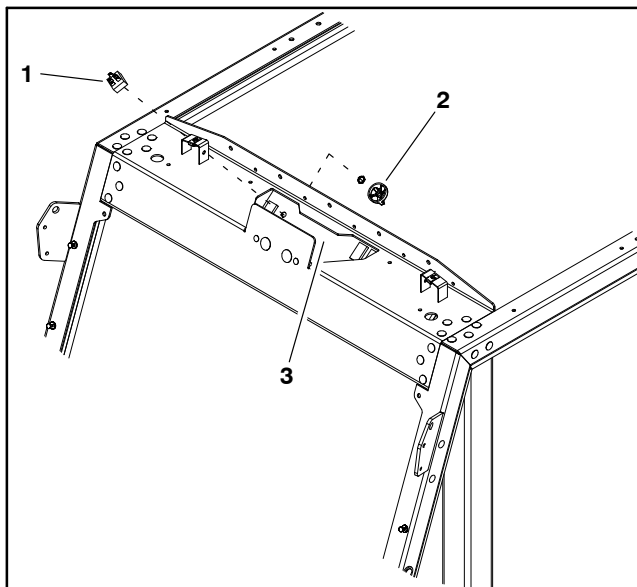


Figure 62

1. Fan speed switch                      3. Control panel  
2. Control knob

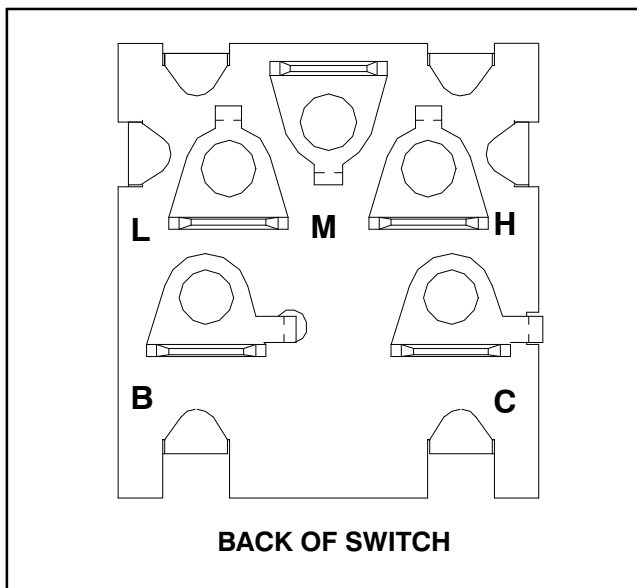


Figure 63

Resistor Module (Machines with Two-Post ROPS Extension Operator Fan Kit)

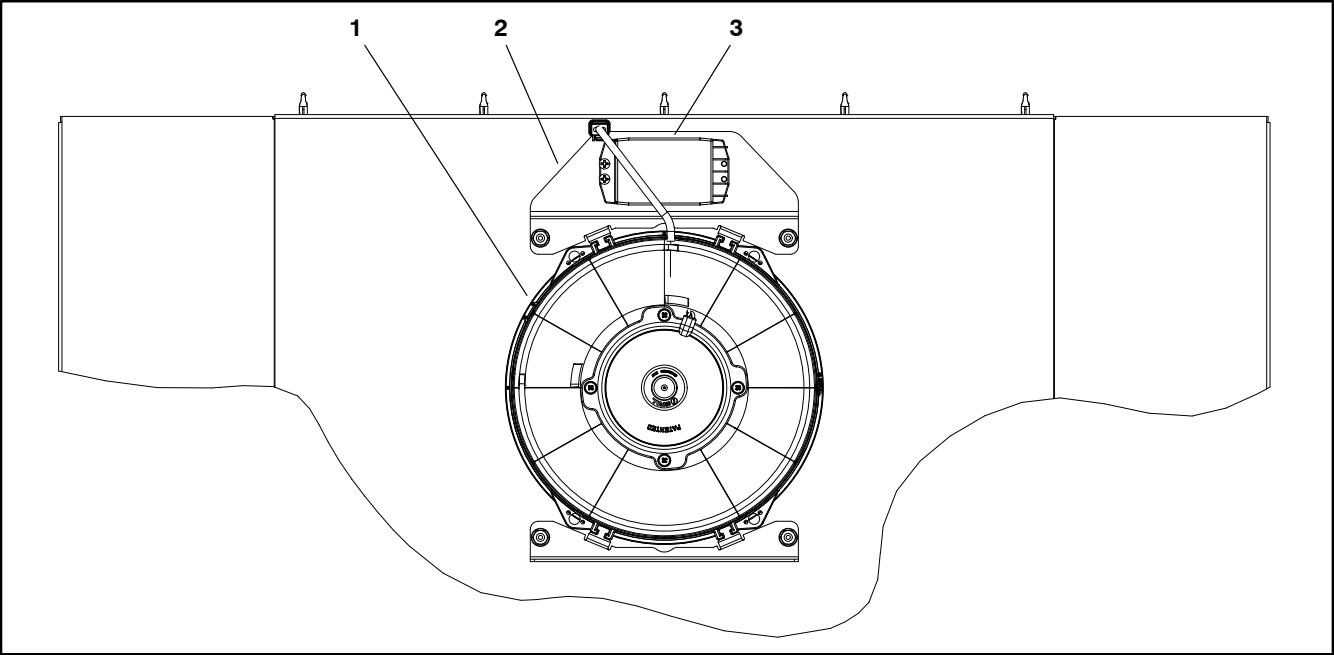


Figure 64

1. Operator’s fan
2. Fan mount bracket
3. Resistor module

The resistor module is attached to the rear of the fan mounting bracket (Fig. 64). 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.
4. Use a multimeter to check that the resistance values of the resistor module as below (Fig. 65).

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

Electrical Schematics and Wire Harness Drawings in Chapter 9-Foldout Drawings.

7. After you complete the testing, connect the wire harness connectors to the resistor module terminals (Fig. 65) and install the sunshade.

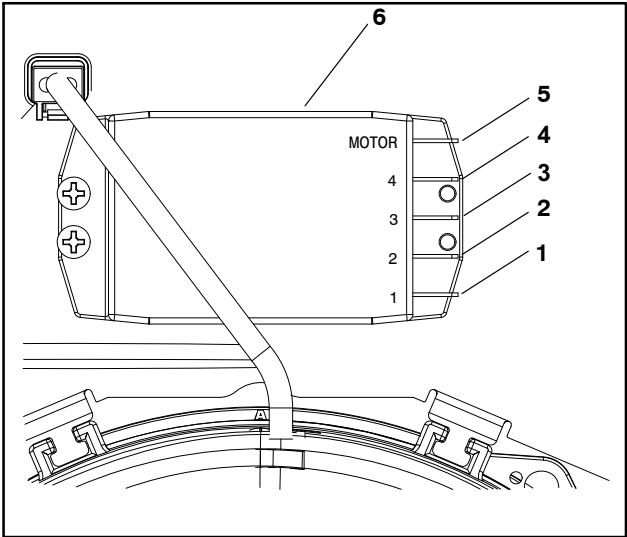


Figure 65

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

# Service and Repairs

**NOTE:** For engine component repair information (e.g. starter motor), refer to the Yanmar Service 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 in this section).

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 in this section).



## 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 (maintenance free with height adapter) or 24 (without height adapter)  
690 CCA at 0°F (-18°C)  
110 minutes reserve capacity at 80°F (27°C)

#### Electrolyte Specific Gravity

Fully charged: 1.265 corrected to 80°F (27°C)  
Discharged: less than 1.240

#### Battery Removal and Installation (Fig. 66)

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.

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.

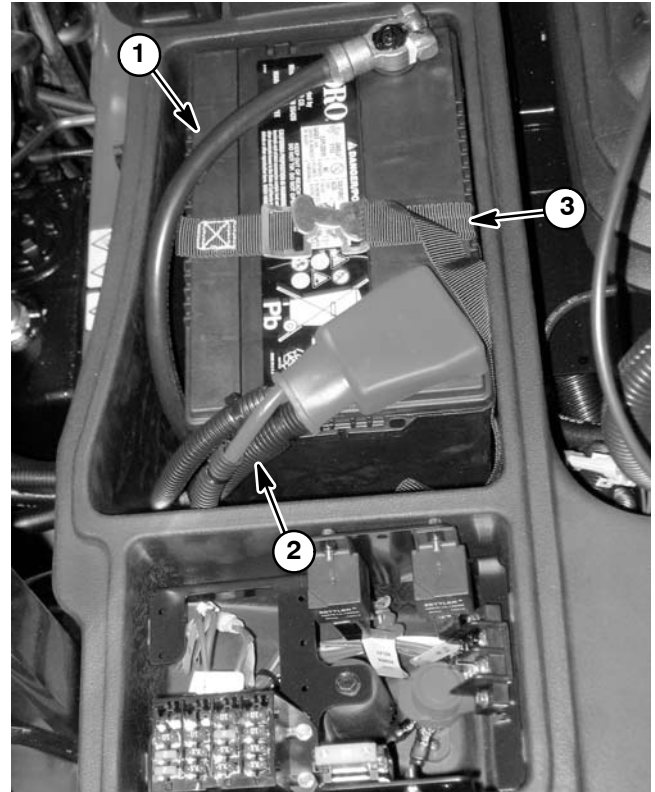


Figure 66

1. Negative cable
2. Positive cable
3. Battery strap

#### 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. Conduct a hydrometer test of the battery electrolyte.

**IMPORTANT: Make sure the area around the cells is clean before opening the battery caps.**

A. Measure the specific gravity of each cell with a hydrometer. Draw electrolyte in and out of the hydrometer barrel prior to taking a reading to warm-up the hydrometer. At the same time take the temperature of the cell.

B. Temperature correct each cell reading. For each 10°F (5.5°C) above 80°F (26.7°C) add 0.004 to the specific gravity reading. For each 10°F (5.5°C) below 80°F (26.7°C) subtract 0.004 from the specific gravity reading.

Example: Cell Temperature                      100°F  
Cell Gravity                                        1.245  
100°F minus 80°F equals 20°F  
(37.7°C minus 26.7°C equals 11.0°C)  
20°F multiply by 0.004/10°F equals 0.008  
(11°C multiply by 0.004/5.5°C equals 0.008)  
ADD (conversion above)                      0.008  
Correction to 80°F (26.7°C)                      1.253

C. If the difference between the highest and lowest cell specific gravity is 0.050 or greater or the lowest cell specific gravity is less than 1.225, charge the battery. Charge at the recommended rate and time given in Battery Charging (in this section) or until the specific gravity for all cells is 1.225 or greater with the difference in specific gravity between the highest and lowest cell less than 0.050. If these charging conditions can not be met, replace the battery.

2. Perform a high-discharge test with an adjustable load tester.

This is one of the most reliable means of testing a battery as it simulates the cold-cranking test. A commercial battery load tester is required to perform this test.



## CAUTION

**Follow the battery load tester manufacturer's instructions when using a load tester.**

A. Check the voltage across the battery terminals prior to testing the battery. If the voltage is less than 12.4 VDC, recharge the battery.

B. If the battery has been charged, apply a 150 amp load for fifteen (15) seconds to remove the surface charge. Use a battery load tester following the manufacturer's instructions.

- C. Make sure battery terminals are free of corrosion.

- D. Measure the temperature of the center battery cell.

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

- F. Apply a test load of 325 amps (one half the Cranking Performance rating of the battery) for fifteen (15) seconds.

- G. Take a battery voltage reading after the load has been applied to the battery for fifteen (15) seconds, then remove the load. Record the voltage reading.


- H. Using the table below, determine the minimum voltage for the cell temperature reading:

Minimum Voltage	Battery Electrolyte Temperature	
9.6	70°F (and up)	21.1°C (and up)
9.5	60°F	15.6°C
9.4	50°F	10.0°C
9.3	40°F	4.4°C
9.1	30°F	-1.1°C
8.9	20°F	-6.7°C
8.7	10°F	-12.2°C
8.5	0°F	-17.8°C

- I. If the test voltage is below the minimum, replace the battery. If the test voltage is at or above the minimum, return the battery to service.

## Battery Charging

To minimize possible damage to the battery and allow the battery to be fully charged, the slow charging method is presented here. This charging method can be accomplished with a constant current battery charger which is available in most locations.

**CAUTION**

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

**NOTE:** Using specific gravity of the battery cells is the most accurate method of determining battery condition.

1. Determine the battery charge level from either its specific gravity or open circuit voltage.

Battery Charge Level	Specific Gravity	Open Circuit Voltage
100%	1.265	12.68
75%	1.225	12.45
50%	1.190	12.24
25%	1.155	12.06
0%	1.120	11.89

2. Determine the charging time and rate using the battery charger manufacturer's instructions or the following table.

Battery Reserve Capacity (Minutes)	Battery Charge Level (Percent of Fully Charged)			
	75%	50%	25%	0%
80 or less	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 60°F (16°C) before connecting to a charger.**

**Charge the battery in a well-ventilated place to dissipate gases produced from charging. These gases are explosive; keep open flame and electrical spark away from the battery. Do not smoke. Nausea may result if the gases are inhaled. Unplug the charger from the electrical outlet before connecting or disconnecting the charger leads from the battery posts.**

3. Following the battery charger manufacturer's instructions, connect the charger cables to the battery. Make sure a good connection is made.

4. Charge the battery following the battery charger manufacturer's instructions.

5. Occasionally check the temperature of the battery electrolyte. If the temperature exceeds 125°F (51.6°C) or the electrolyte is violently gassing or spewing, the charging rate must be lowered or temporarily stopped.

6. Three (3) hours prior to the end of the charging, measure the specific gravity of a battery cell once per hour. The battery is fully charged when the cells are gassing freely at a low charging rate and there is less than a 0.003 change in specific gravity for three (3) consecutive readings.

This page is intentionally blank.



# Axles, Planetaries and Brakes

## Table of Contents

SPECIFICATIONS .....	2
GENERAL INFORMATION .....	3
Operator's Manual .....	3
ADJUSTMENTS .....	4
Planetary Drive End Play (OPH-2 series planetary drives) .....	4
SERVICE AND REPAIRS .....	6
Brake Assembly .....	6
Brake Inspection and Repair .....	9
Planetary Drive Assembly .....	10
OPH-2 Series Planetary Drive Service .....	12
VH02 Series Planetary Drive Service .....	16
Rear Axle Assembly .....	20
Rear Axle Service .....	24
Bevel Gear Case and Axle Case .....	26
Differential Shafts .....	31
Axle Shafts .....	32
Input Shaft/Pinion Gear .....	34
Differential Gear .....	36
Pinion Gear to Ring Gear Engagement .....	39

# Specifications

Item	Specification
Tire pressure (front and rear)	20 psi (138 kPa)
Rear wheel toe-in	0.125 in (3 mm)
Wheel lug nut torque (front and rear)	85 to 100 ft-lb (116 to 135 N-m)
Steering cylinder bolt torque	100 to 125 ft-lb (136 to 169 N-m)
Planetary, Brake Assembly and Wheel Motor Mounting Screw Torque OPH-2 series planetary VA02 series planetary	60 ft-lb (81 N-m) 75 to 85 ft-lb (101 to 115 N-m)
Planetary Drive Lubricant Capacity (each wheel)	SAE 85W-140 wt. Gear Lube 16 to 20 fl oz (0.47 to 0.59 L)
Rear axle lubricant Rear axle gear lube capacity	SAE 85W-140 wt. gear lube 80 fl oz (2.4 l)
Rear axle gear box lubricant Rear axle gear box gear lube capacity	SAE 85W-140 wt. gear lube 16 fl oz (0.5 l)

# General Information

---

## Operator's Manual

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

# Adjustments

## Planetary Drive Endplay (OPH-2 series planetary drives)

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.



### 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.**

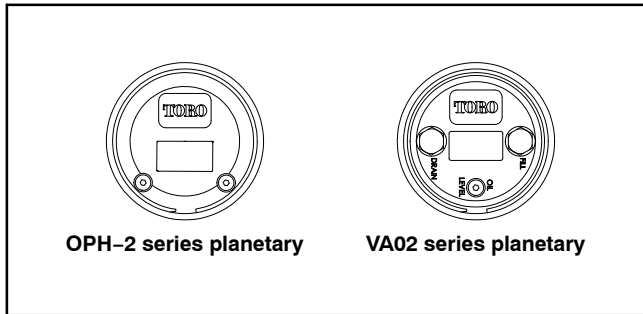


Figure 1

2. Chock rear wheels and jack up front of machine (see Jacking Instructions in Chapter 1 – Safety). 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 in the Service and Repairs section of this chapter).
5. After planetary endplay checking is completed, lower machine to ground.



This page is intentionally blank.

# Service and Repairs

## Brake Assembly

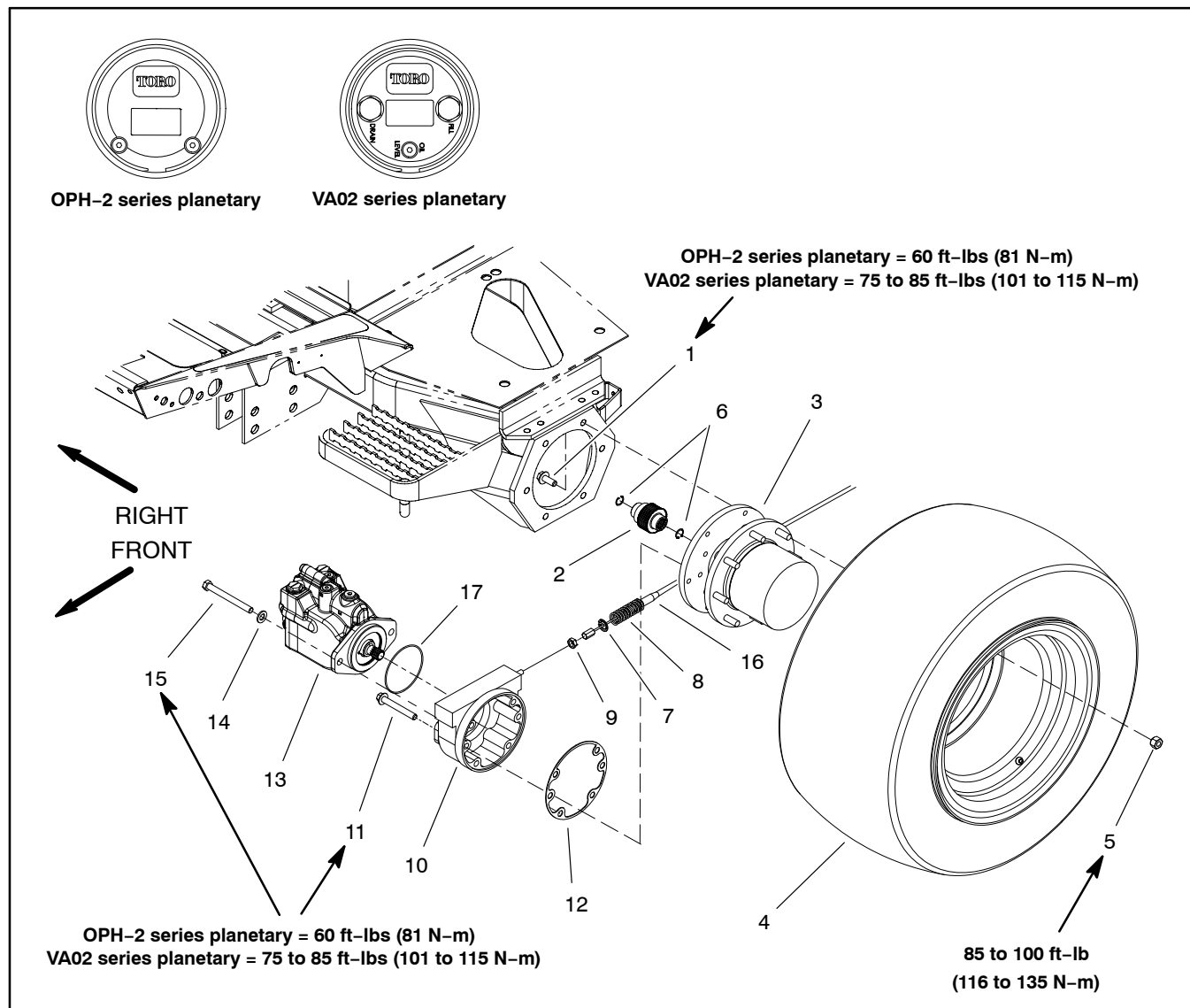


Figure 2

- |  |                                     |                               |
|--|-------------------------------------|-------------------------------|
| 1. Flange head screw (6 per planetary) | 8. Compression spring               | 13. Piston motor (2 used)     |
| 2. Splined brake shaft                 | 9. Jam nut                          | 14. Flat washer (2 per motor) |
| 3. Planetary assembly (2 used)         | 10. Brake assembly (LH shown)       | 15. Cap screw (2 per motor)   |
| 4. Front wheel assembly (2 used)       | 11. Flange head screw (4 per brake) | OPH-2 planetary = 120 mm lg   |
| 5. Lug nut (8 per wheel)               | OPH-2 planetary = 90 mm lg          | VA02 planetary = 110 mm lg    |
| 6. Retaining ring                      | VA02 planetary = 80 mm lg           | 16. Brake cable (LH shown)    |
| 7. Spring plate                        | 12. Gasket                          |                               |

## Brake Assembly Removal (Fig. 2)

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 in Chapter 1 – Safety for additional information and precautions.**

3. Chock rear wheels and jack up front of machine (see Jacking Instructions in Chapter 1 – Safety). Support machine with appropriate jack stands.
4. Remove front wheel assembly.
5. Remove hydraulic wheel motor (see Front Wheel Motors in the Service and Repairs section of Chapter 4 – Hydraulic System).
6. Disconnect brake cable from pull rod on brake (Fig. 4).

**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 in this section).

## Brake Assembly Installation (Fig. 2)

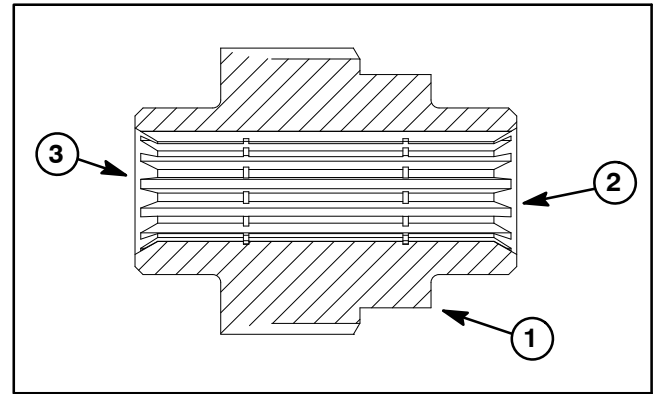


Figure 3

1. Splined brake shaft step
2. Hydraulic motor end
3. Planetary assembly end

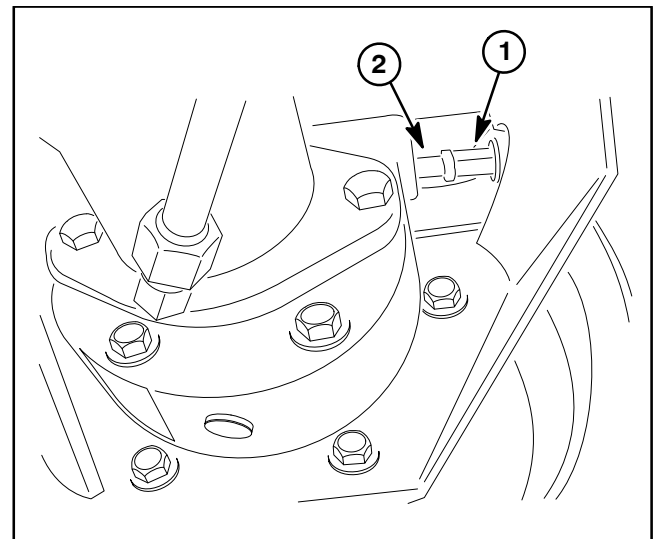


Figure 4

1. Brake cable
2. Brake pull rod

**NOTE:** The stepped end of the splined brake shaft must be aligned toward the hydraulic wheel motor (Fig. 3).

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.

For OPH-2 series planetary drives: tighten screws from **60 ft-lb (81 N-m)**.

For VA02 series planetary drives: tighten screws from **75 to 85 ft-lb (101 to 115 N-m)**.

3. Install brake cable to pull rod on brake assembly (Fig. 4). 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.

For OPH-2 series planetary drives: tighten screws from **60 ft-lb (81 N-m)**.

For VA02 series planetary drives: tighten screws from **75 to 85 ft-lb (101 to 115 N-m)**.

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 machine 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 **85 to 100 ft-lb (116 to 135 N-m)**.

## Brake Inspection and Repair

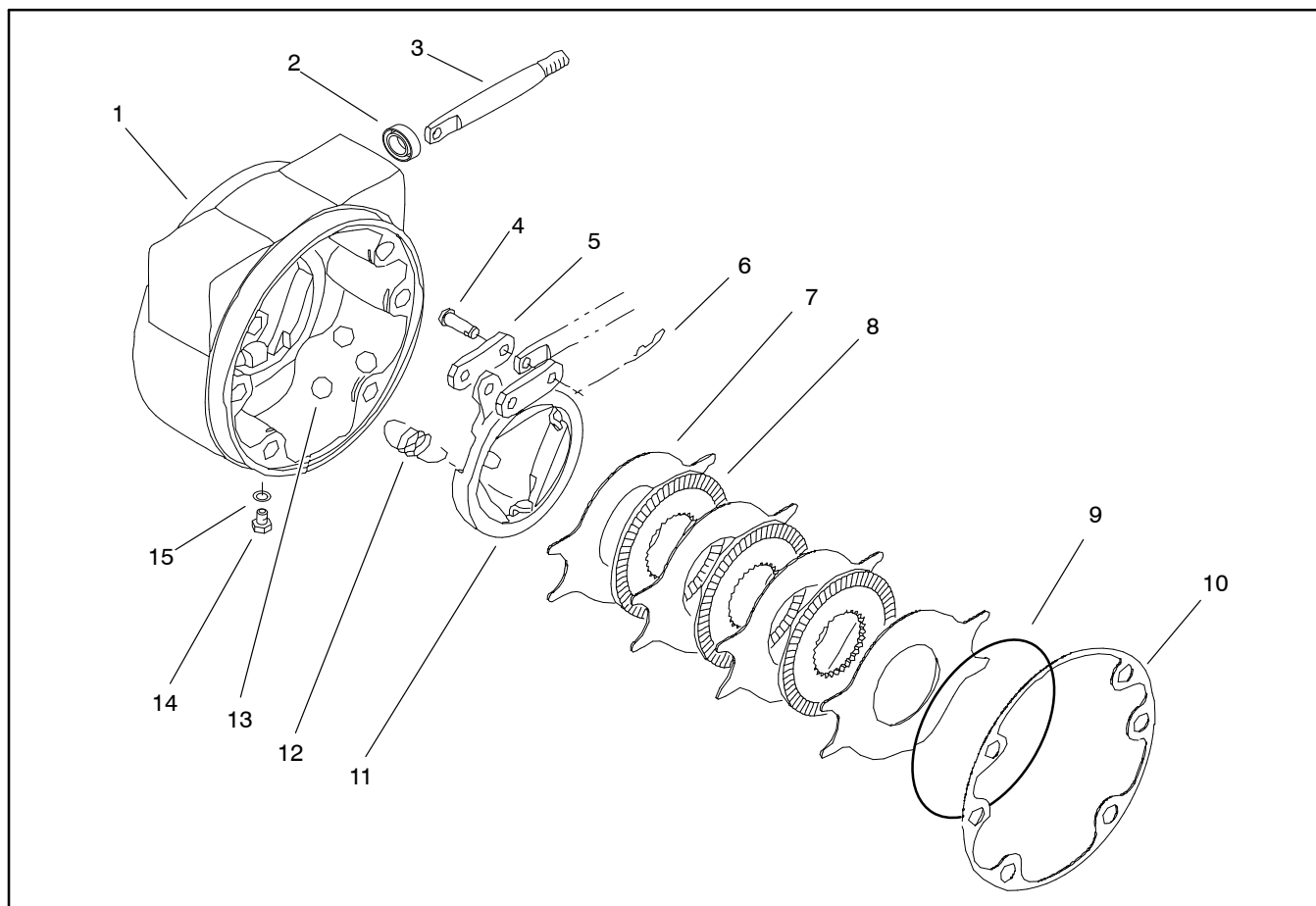


Figure 5

- |                             |                             |                               |
|-----------------------------|-----------------------------|-------------------------------|
| 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 (Fig. 5)

- Carefully scrape gasket material (item 10) from brake housing and planetary drive mounting surfaces.
- Remove retaining ring (item 9) from brake housing.
- Remove stationary discs (item 7) and rotating discs (item 8).
- Remove extension springs (item 12).
- Remove actuator assembly (items 3, 4, 5, 6 and 11) and balls (item 13).
- Remove seal (item 2) from brake housing.
- Wash parts in cleaning solvent. Inspect all brake components for wear or damage.
- Reverse steps 2 – 6 to assemble brakes, installing new parts as necessary. Install a new seal (item 2).
- Use a new gasket (item 10) when installing brake assembly to machine.

## Planetary Drive Assembly

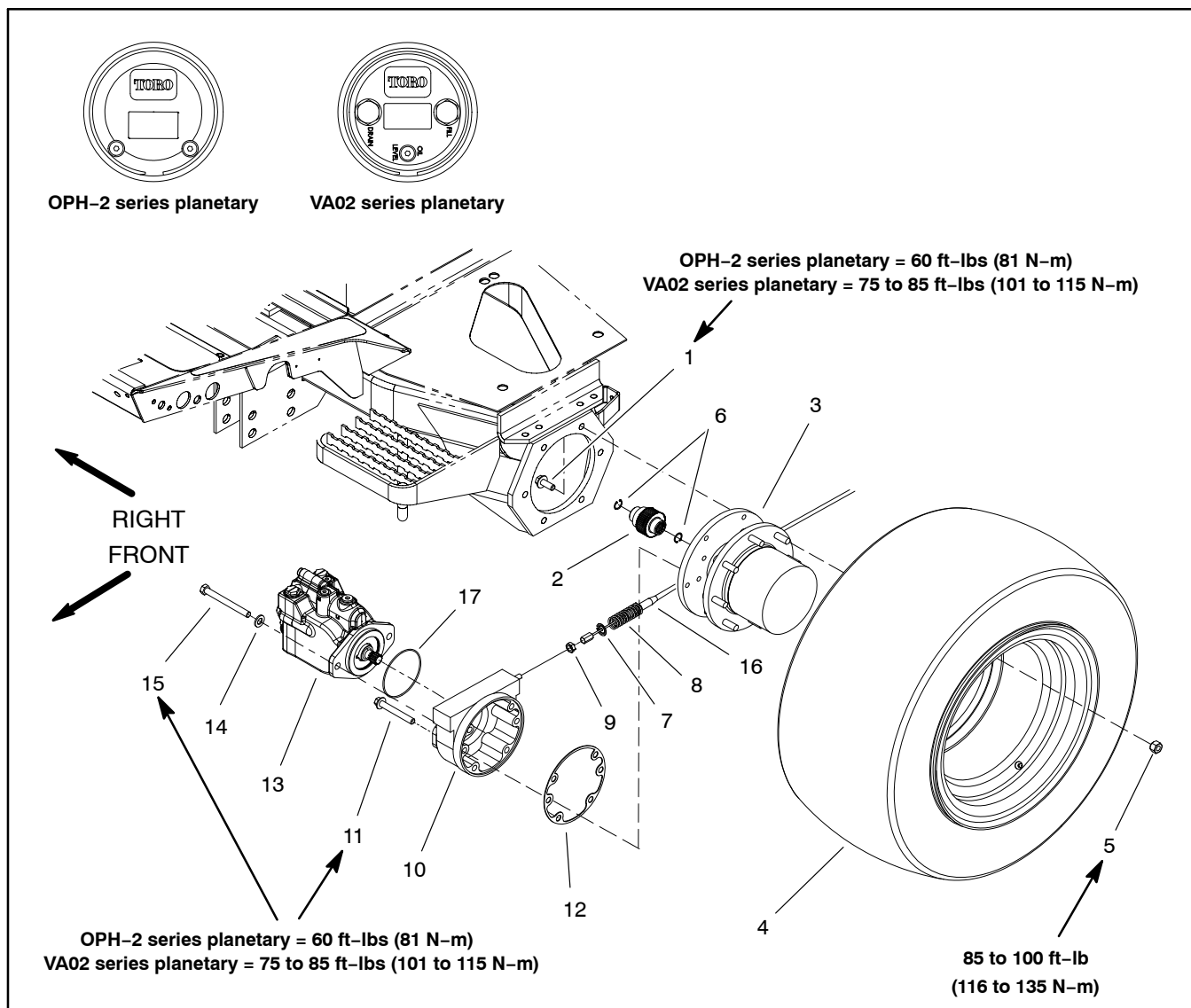


Figure 6

- |  |                                     |                               |
|--|-------------------------------------|-------------------------------|
| 1. Flange head screw (6 per planetary) | 8. Compression spring               | 13. Piston motor (2 used)     |
| 2. Splined brake shaft                 | 9. Jam nut                          | 14. Flat washer (2 per motor) |
| 3. Planetary assembly (2 used)         | 10. Brake assembly (LH shown)       | 15. Cap screw (2 per motor)   |
| 4. Front wheel assembly (2 used)       | 11. Flange head screw (4 per brake) | OPH-2 planetary = 120 mm lg   |
| 5. Lug nut (8 per wheel)               | OPH-2 planetary = 90 mm lg          | VA02 planetary = 110 mm lg    |
| 6. Retaining ring                      | VA02 planetary = 80 mm lg           | 16. Brake cable (LH shown)    |
| 7. Spring plate                        | 12. Gasket                          |                               |

**NOTE:** The planetary drive assembly can be serviced with the planetary installed to machine (see Planetary Drive Service in this section). Use the following procedure to remove and install the planetary drive assembly from machine.

## Planetary Drive Removal (Fig. 6)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake 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.



### CAUTION

**When changing attachments, tires or performing other service, use correct jacks, hoists and jack stands to raise and support machine. See Jacking Instructions in Chapter 1 – Safety for additional information and precautions.**

3. Chock rear wheels and jack up front of machine (see Jacking Instructions in Chapter 1 – Safety). Support machine with appropriate 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.

## Planetary Drive Installation (Fig. 6)

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.

For OPH-2 series planetary drives: tighten screws to **60 ft-lb (81 N-m)**.

For VA02 series planetary drives: tighten screws from **75 to 85 ft-lb (101 to 115 N-m)**.

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 in this section of this chapter).

For OPH-2 series planetary drives: tighten screws to **60 ft-lb (81 N-m)**.

For VA02 series planetary drives: tighten screws from **75 to 85 ft-lb (101 to 115 N-m)**.

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.

For OPH-2 series planetary drives: tighten screws from **60 ft-lb (81 N-m)**.

For VA02 series planetary drives: tighten screws from **75 to 85 ft-lb (101 to 115 N-m)**.

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 for proper brake operation and adjust brake cables if necessary.



### WARNING

**Failure to maintain proper wheel lug nut torque could result in failure or loss of wheel and may result in personal injury.**

7. Lower machine to ground. Torque wheel lug nuts from **85 to 100 ft-lb (116 to 135 N-m)**.

## OPH-2 Series Planetary Drive Service

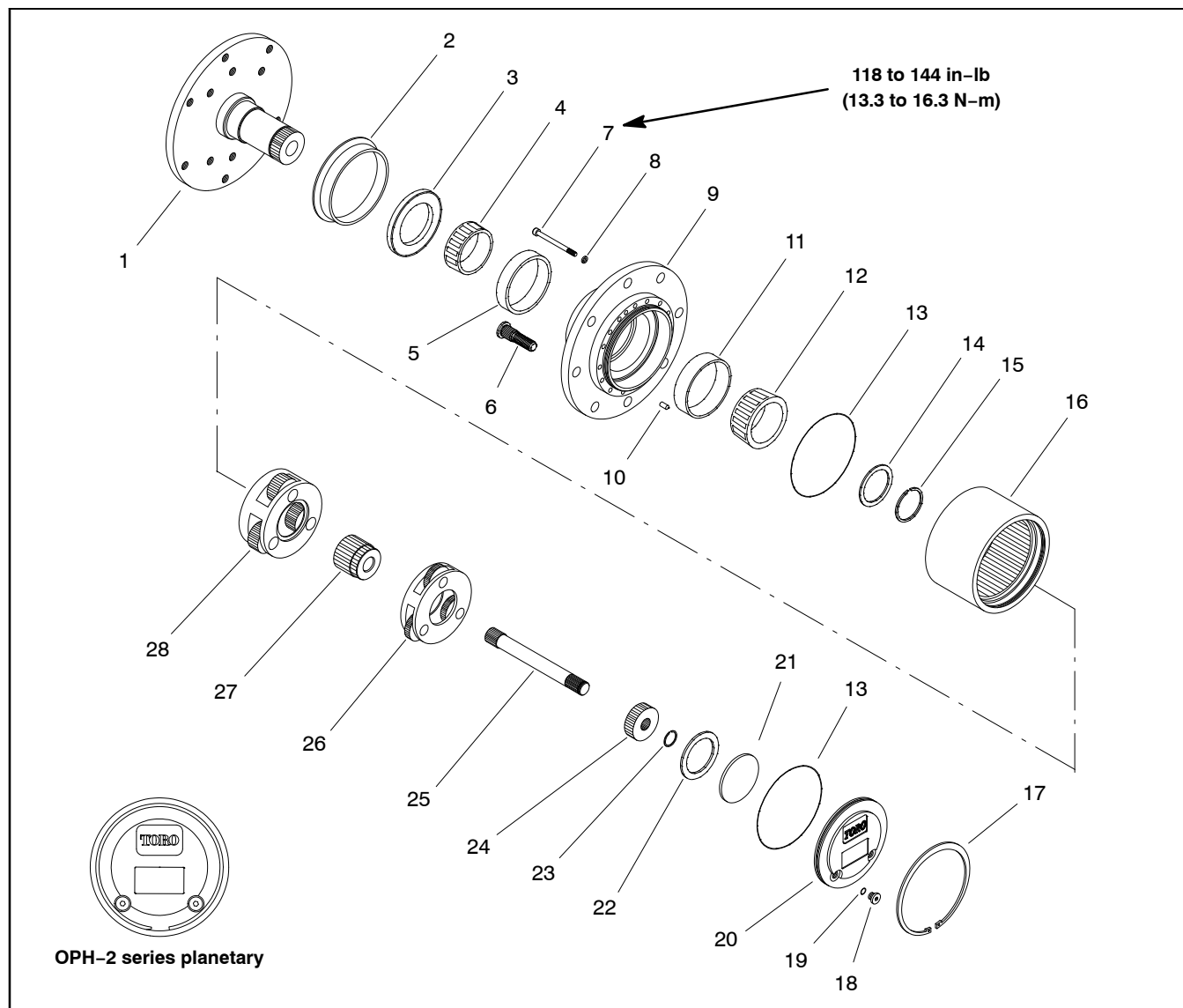


Figure 7

- |                                |                               |                                |
|--------------------------------|-------------------------------|--------------------------------|
| 1. Spindle                     | 11. Outer bearing cup         | 20. End cap                    |
| 2. Boot seal                   | 12. Outer bearing cone        | 21. Thrust plug                |
| 3. Oil seal                    | 13. O-ring                    | 22. Thrust washer              |
| 4. Inner bearing cone          | 14. Thrust washer             | 23. Retaining ring             |
| 5. Inner bearing cup           | 15. Retaining ring (external) | 24. Primary gear               |
| 6. Wheel stud (8 used)         | 16. Ring gear                 | 25. Drive shaft                |
| 7. Socket head screw (16 used) | 17. Retaining ring (internal) | 26. Primary carrier assembly   |
| 8. Lock washer (16 used)       | 18. Plug (2 used)             | 27. Secondary gear             |
| 9. Housing                     | 19. O-ring (2 used)           | 28. Secondary carrier assembly |
| 10. Dowel pin (2 used)         |                               |                                |



**NOTE:** The planetary drive assembly can be serviced with the planetary installed to machine. If the spindle (item 1) needs to be removed, see Planetary Drive Assembly in this chapter.

### Disassembly (Figs. 7 and 8)

1. Park machine on a level surface, stop engine and remove key from the ignition switch.
2. Drain oil from planetary drive/brake assembly; refer to traction unit Operator's Manual.
3. Chock rear wheels and jack up front of machine (see Jacking Instructions in Chapter 1 – Safety). Support machine with jack stands and remove front wheel assembly.
4. Remove retaining ring (item 17).
5. Remove end cap (item 20). Thrust plug (item 21) and thrust washer (item 22) usually remain in end cap bore and should be removed for cleaning and inspection.

6. Remove drive shaft assembly (items 23, 24 and 25). If necessary, remove retaining ring and primary gear from shaft.

7. Remove primary carrier (item 26), secondary gear (item 27) and secondary carrier (item 28).

**NOTE:** Steps 6 through 10 are necessary only if inspecting or replacing bearings and/or seals.

**IMPORTANT: Do not reuse retaining ring (item 10) after it has been removed.**

8. Remove retaining ring (item 15) and thrust washer (item 14). Discard retaining ring.

9. Carefully remove housing (item 9) from spindle (item 1). Remove outer bearing cone (item 12).

10. Remove and discard seals (items 2 and 3) and O-rings (item 13) from housing.

11. Remove inner bearing cone (item 4) from housing. If necessary, remove bearing cups (items 5 and 11) from housing.

12. If wheel stud (item 6) removal is necessary, use press to extract stud(s) from housing.

13. If necessary, remove socket head screws (item 7) with lock washers (item 8) that secure ring gear (item 16) to housing. Remove ring gear and two (2) dowel pins (item 10) from housing.

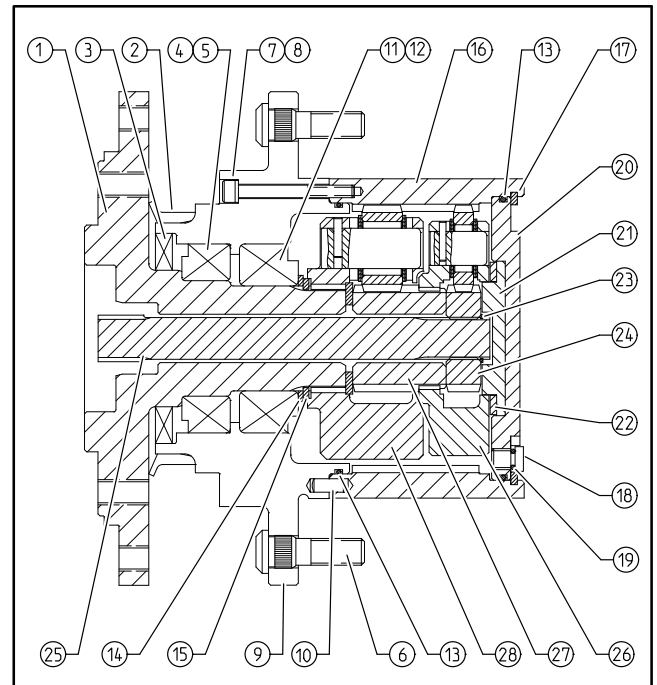


Figure 8

- |                           |                               |
|---------------------------|-------------------------------|
| 1. Spindle                | 15. Retaining ring (external) |
| 2. Boot seal              | 16. Ring gear                 |
| 3. Oil seal               | 17. Retaining ring (internal) |
| 4. Inner bearing cone     | 18. Plug (2)                  |
| 5. Inner bearing cup      | 19. O-ring (2)                |
| 6. Wheel stud (8)         | 20. End cap                   |
| 7. Socket head screw (16) | 21. Thrust plug               |
| 8. Lock washer (16)       | 22. Thrust washer             |
| 9. Housing                | 23. Retaining ring            |
| 10. Dowel pin (2)         | 24. Primary gear              |
| 11. Outer bearing cup     | 25. Drive shaft               |
| 12. Outer bearing cone    | 26. Primary carrier assy.     |
| 13. O-ring                | 27. Secondary gear            |
| 14. Thrust washer         | 28. Secondary carrier assy.   |

### Assembly (Figs. 7 and 8)

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.

**NOTE:** Use new seal and shim kits when assembling planetary drive.

3. If spindle and housing were separated:

A. Press bearing cups (items 5 and 11) into housing (item 9). Cups should be pressed fully to shoulder of the housing bore.

B. Set inner bearing cone (item 4) into inner bearing cup.

C. Make sure that seal bore in housing is thoroughly cleaned. If OD of seal (item 3) is not rubber or does not have a sealant coating, apply light coating of silicone sealant to seal bore in housing. Install seal into housing so it is flush with housing face. Lightly grease seal lips.

D. Pack boot seal (item 2) with grease and install on housing.

E. If ring gear was removed from housing, place dowel pins (item 10) in housing. Secure ring gear to housing with lock washers (item 8) and socket head screws (item 7). Torque socket head screws from **118 to 144 in-lb (13.3 to 16.3 N-m)**.

F. Lightly oil bearing journals on spindle shaft. Slide housing assembly onto spindle (item 1) taking care to not damage seal or spindle. Make sure that inner bearing in housing fully seats against spindle shaft shoulder.

G. Install outer bearing cone (item 12) onto spindle.

**NOTE:** The planetary shim kit includes the retaining ring and several thrust washers with thickness in incremental steps of 0.004 in. (0.10 mm).

H. Measure thickness of thrust washer (item 14) that was removed during disassembly. Choose new thrust washer of equal thickness or the next available thickness from thrust washers in the shim kit.

I. Apply a light coating of oil to spindle shaft, thrust washer (item 14) and new retaining ring (item 15). Install thrust washer onto spindle shaft.



## WARNING

**If retaining ring (item 15) is not fully installed in spindle groove, loss of wheel and personal injury may result.**

J. Carefully install new retaining ring (item 15) into the spindle shaft groove taking care to not distort ring. If the proper thrust washer has been installed, the retaining ring should fit tightly between the thrust washer and spindle groove. Tap the OD of the retaining ring starting in the center and working out toward each end to ensure that the retaining ring is properly seated into the spindle groove. Make sure that retaining ring ID is fully seated to spindle shaft groove.

K. After retaining ring is installed, make sure that there is no endplay in assembly. If required, remove retaining ring and install a thrust washer of different thickness to adjust endplay.

L. Install new O-ring (item 13) into groove in housing.

4. Install secondary carrier (item 28), secondary gear (item 27) and primary carrier (item 26) making sure that carrier gear teeth align with ring gear and spline on spindle shaft.

5. If primary gear (item 24) was removed from drive shaft, slide gear onto shaft and secure with retaining ring (item 23).

6. Install drive shaft assembly (items 25, 24 and 23) making sure that drive shaft spline aligns with carrier gears.

7. Install thrust plug (item 21) and thrust washer (item 22) into end cap (item 20). Make sure that thrust plug and thrust washer are captive on inside of end cap (item 20).

8. Install new O-ring (item 13) to end cap and then install end cap. Secure cap with retaining ring (item 17).

9. Check operation of planetary drive. With a constant turning force applied, rotation of the planetary should be consistent. If there is more drag at certain points, gears are not rolling freely and the planetary should be examined for improper assembly or damaged components.

10. Install front wheel assembly.

11. 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.

12. 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.**

13. Remove jack stands and lower machine to ground. Tighten wheel lug nuts in a crossing pattern from **85 to 100 ft-lb (116 to 135 N-m)**.

This page is intentionally blank.

## VA02 Series Planetary Drive Service

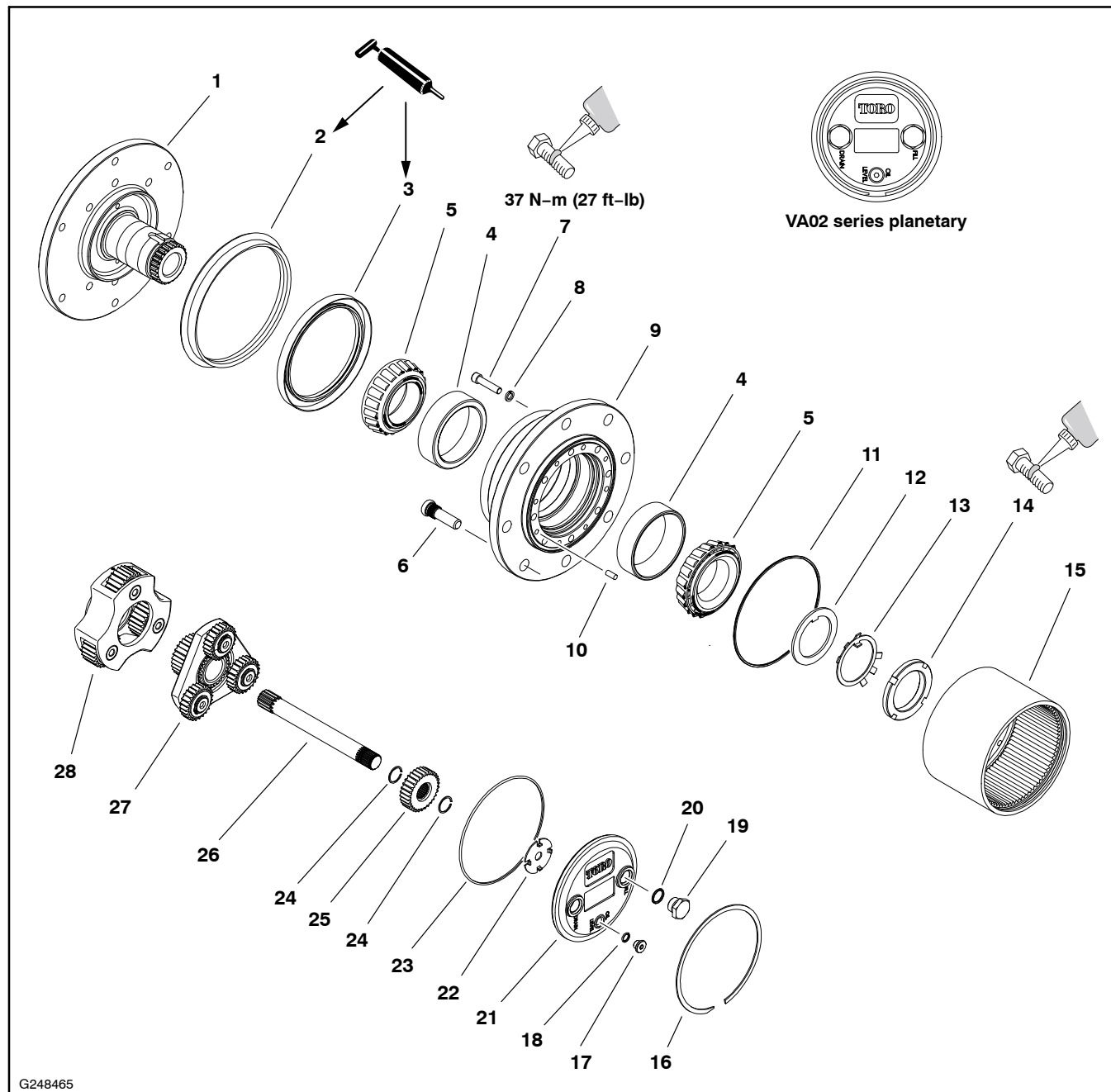


Figure 9

- |                           |                    |                                |
|---------------------------|--------------------|--------------------------------|
| 1. Spindle                | 11. O-ring         | 20. O-Ring (2)                 |
| 2. Boot seal              | 12. Spacer         | 21. End cap                    |
| 3. Lip seal               | 13. Locking washer | 22. Thrust plate               |
| 4. Inner bearing cup (2)  | 14. Lock nut       | 23. O-Ring                     |
| 5. Inner bearing cone (2) | 15. Ring gear      | 24. Retaining ring (2)         |
| 6. Wheel stud (8)         | 16. Retaining ring | 25. Primary gear               |
| 7. Socket head screw (8)  | 17. Plug           | 26. Drive shaft                |
| 8. Lock washer (8)        | 18. O-ring         | 27. Primary carrier assembly   |
| 9. Housing                | 19. Plug (2)       | 28. Secondary carrier assembly |
| 10. Dowel pin (4)         |                    |                                |

**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 in this chapter.

### 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/front** wheels and jack up **front/rear** of machine (see Jacking Instructions in Chapter 1 – Safety). Support machine with jack stands and remove rear wheel assembly.
4. Remove retaining ring (item 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).
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.

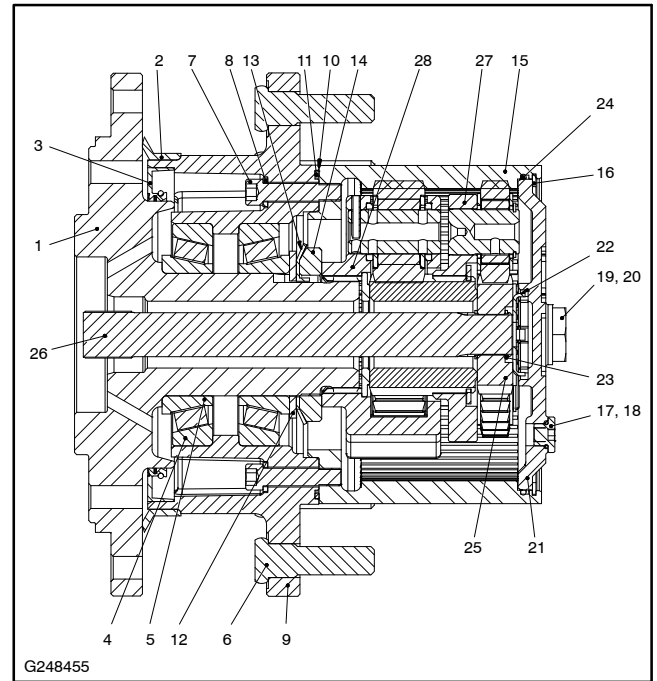


Figure 10

- |                           |                           |
|---------------------------|---------------------------|
| 1. Spindle                | 15. Ring gear             |
| 2. Boot seal              | 16. Retaining ring        |
| 3. Lip seal               | 17. Plug                  |
| 4. Inner bearing cup (2)  | 18. O-ring                |
| 5. Inner bearing cone (2) | 19. Plug (2)              |
| 6. Wheel stud (8)         | 20. O-Ring (2)            |
| 7. Socket head screw (8)  | 21. End cap               |
| 8. Lock washer (8)        | 22. Thrust plate          |
| 9. Housing                | 23. O-Ring                |
| 10. Dowel pin (4)         | 24. Retaining ring (2)    |
| 11. O-ring                | 25. Primary gear          |
| 12. Spacer                | 26. Drive shaft           |
| 13. Locking washer        | 27. Primary carrier asm   |
| 14. Lock nut              | 28. Secondary carrier asm |

### 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 **27 ft-lb (37 N-m)**.

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 **110 ft-lb (150 N-m)**.

C. Rotate the housing on the spindle a few revolutions to align the bearings.

D. Tighten the lock nut to **150 ft-lb (200 N-m)**.

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 **90 ft-lb (122 N-m)**.

**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 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.**

23. Remove jack stands and lower machine to ground. Tighten wheel lug nuts in a crossing pattern from **85 to 100 ft-lb (116 to 135 N-m)**.

This page is intentionally blank.

## Rear Axle Assembly

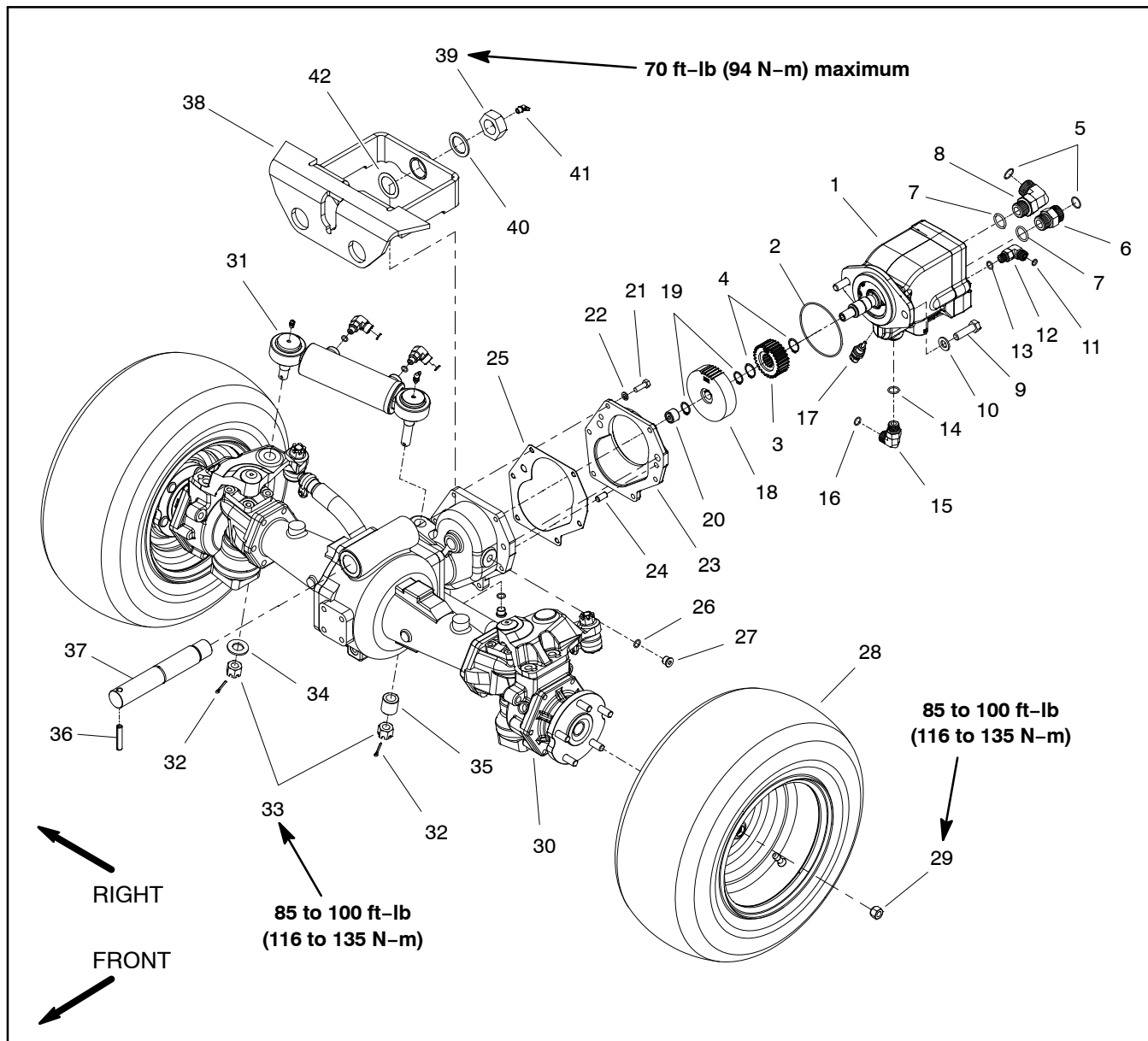


Figure 11

- |                                |                                    |                                |
|--------------------------------|------------------------------------|--------------------------------|
| 1. Rear axle motor             | 15. 90° hydraulic fitting          | 29. Lug nut (5 used per wheel) |
| 2. O-ring                      | 16. O-ring                         | 30. Rear axle assembly         |
| 3. Pinion gear                 | 17. Temperature sender with O-ring | 31. Steering cylinder assembly |
| 4. External snap ring (2 used) | 18. Gear                           | 32. Cotter pin (2 used)        |
| 5. O-ring                      | 19. External snap ring (2 used)    | 33. Slotted hex nut (2 used)   |
| 6. Hydraulic fitting           | 20. Needle bearing                 | 34. Flat washer                |
| 7. O-ring                      | 21. Cap screw (6 used)             | 35. Spacer                     |
| 8. 90° hydraulic fitting       | 22. Lock washer (6 used)           | 36. Slotted roll pin           |
| 9. Cap screw (2 used)          | 23. Cover plate                    | 37. Rear axle pivot pin        |
| 10. Flat washer (2 used)       | 24. Dowel pin (2 used)             | 38. Machine frame              |
| 11. O-ring                     | 25. Gasket                         | 39. Lock nut                   |
| 12. 90° hydraulic fitting      | 26. O-ring                         | 40. Thrust washer              |
| 13. O-ring                     | 27. Plug                           | 41. Grease fitting             |
| 14. O-ring                     | 28. Rear wheel assembly            | 42. Thrust washer (2 used)     |



## Remove Rear Axle (Fig. 11)

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 (Figs. 12 and 13).



## CAUTION

**When changing attachments, tires or performing other service, use correct jacks, hoists and jack stands to raise and support machine. See Jacking Instructions in Chapter 1 – Safety for additional information and precautions.**

3. Chock front wheels and jack up rear of machine (see Jacking Instructions in Chapter 1 – Safety). 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 in the Service and Repairs section of Chapter 4 – Hydraulic System).
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.
9. If needed for further axle disassembly, remove steering cylinder from axle (see Steering Cylinder in the Service and Repairs section of Chapter 4 – Hydraulic System).

10. If required, remove tie rod ends from steering arms on rear axle (Fig. 14). 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 (Fig. 11)

1. If removed, install steering cylinder to axle assembly (see Steering Cylinder in the Service and Repairs section of Chapter 4 – Hydraulic System).

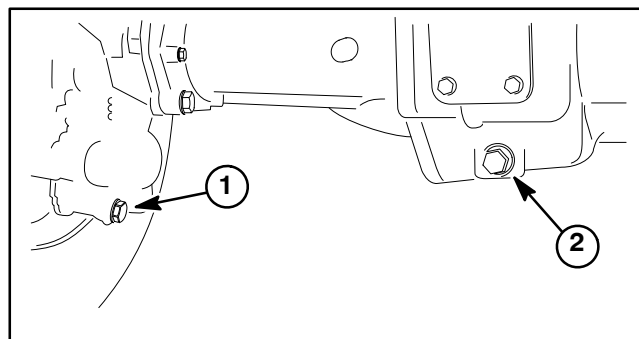


Figure 12

1. Outside plug (2 used)      2. Center axle drain plug

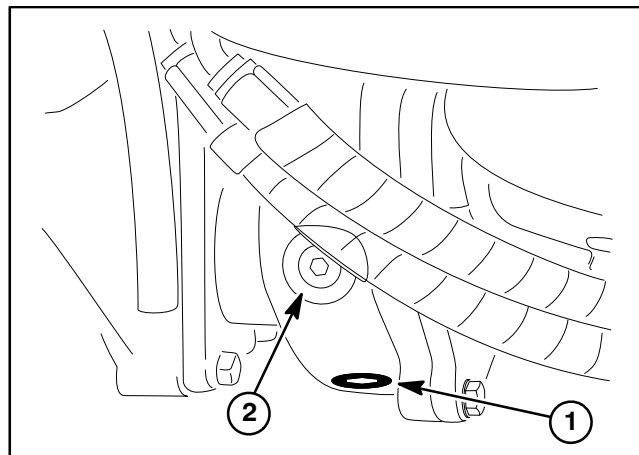


Figure 13

1. Gearbox drain plug      2. Gearbox fill plug

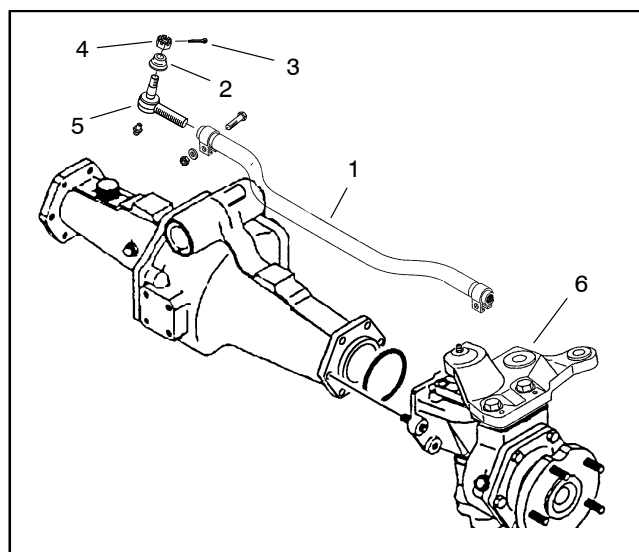


Figure 14

1. Tie rod      4. Castle nut  
2. Dust cover      5. Tie rod end  
3. Cotter pin      6. Steering arm (LH)

2. If removed, install the tie rod to rear axle (Fig. 14). 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 **0.002 to 0.020 inch (0.05 to 0.51 mm)** 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 (**70 ft-lb (94 N-m) maximum**).

6. Install hydraulic motor to axle assembly (see Rear Axle Motor in the Service and Repairs section of Chapter 4 – Hydraulic System).

7. Remove caps and plugs from hydraulic hoses and steering cylinder fittings. Secure hydraulic hoses to steering cylinder (see Hydraulic Hose and Tube Installation in the General Information section of Chapter 4 – Hydraulic System).



## 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 **85 to 100 ft-lb (116 to 135 N-m)**.

9. Fill rear axle (Fig. 15) and rear axle gearbox (Fig. 13) with SAE 85W-140 weight gear lube. Lubricant capacity is approximately 80 fl. oz. (2.37 liters) for the rear axle and 16 fl. oz. (0.47 liters) 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 **1/16" (1.6 mm)** should exist between bevel gear case casting and stop bolt on left axle case. Figure 16 shows stop bolt location.

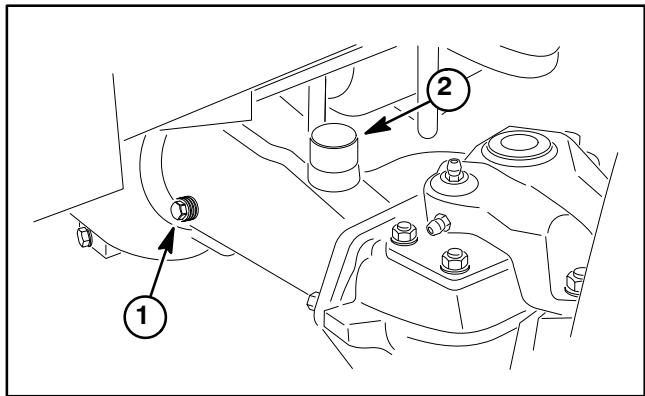


Figure 15

1. Axle check plug

2. Axle fill plug

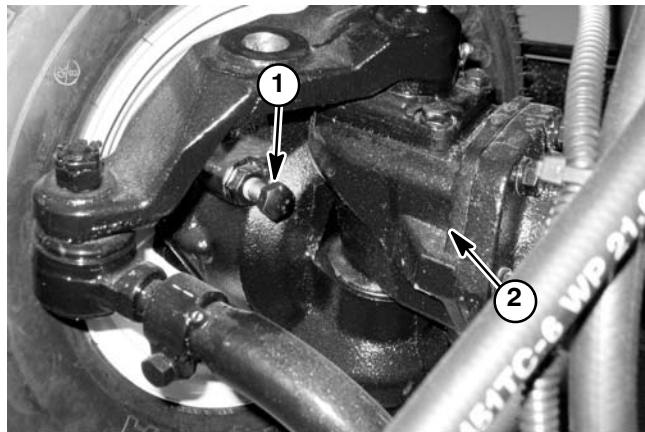


Figure 16

1. Steering stop bolt

2. Bevel gear case (LH)

This page is intentionally blank.

Rear Axle Service

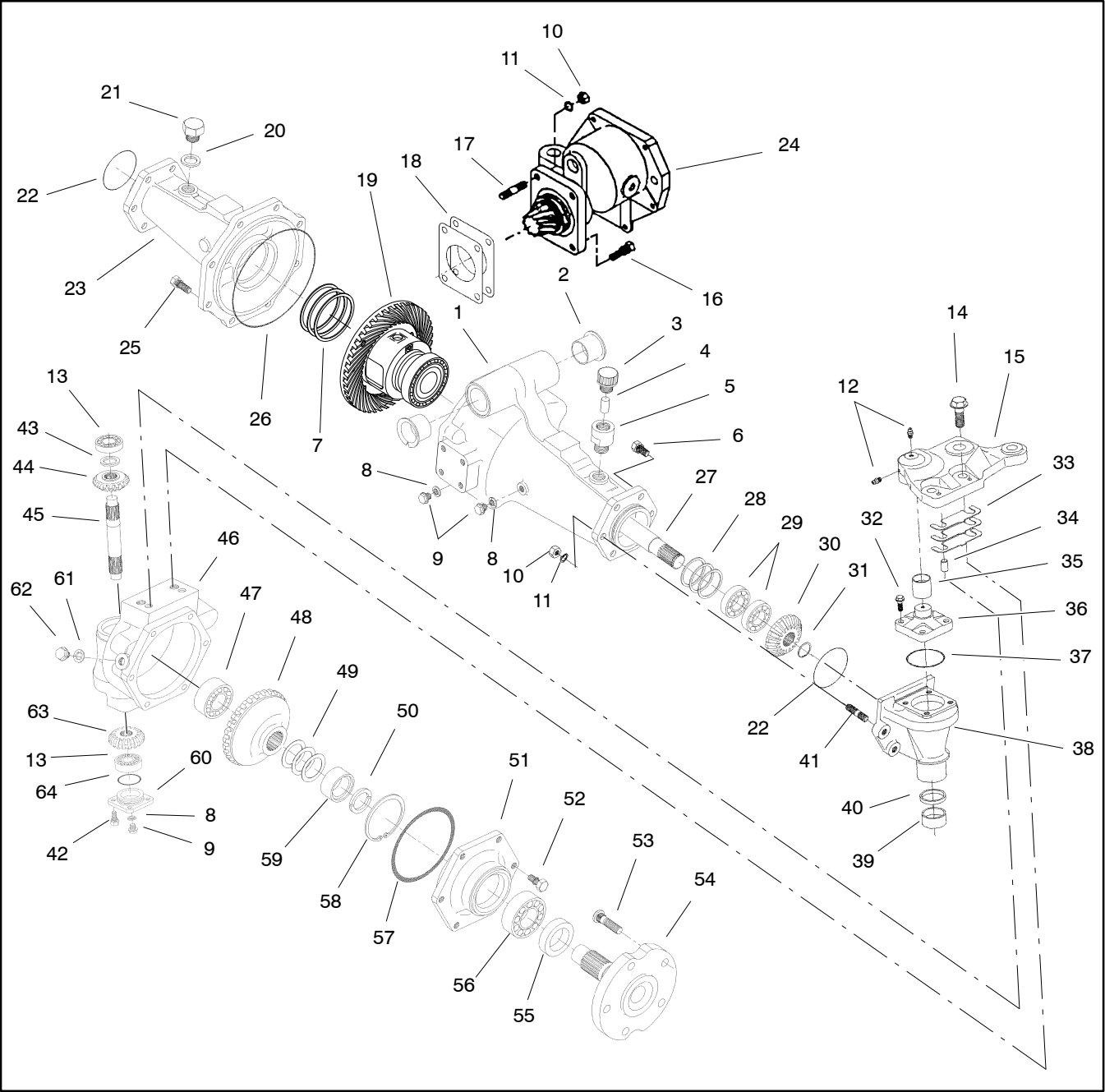


Figure 17

Figure 12 (Continued)

- |                                     |                                      |                                  |
|-------------------------------------|--------------------------------------|----------------------------------|
| 1. LH axle support                  | 23. RH axle support                  | 44. Bevel gear (17 tooth)        |
| 2. Flange bushing (2 used)          | 24. Input shaft assembly             | 45. Bevel gear shaft             |
| 3. Axle vent                        | 25. Bolt (8 used)                    | 46. Axle case (LH shown)         |
| 4. Filter                           | 26. O-ring                           | 47. Ball bearing                 |
| 5. Vent extension                   | 27. Differential shaft (LH shown)    | 48. Bevel gear (29 tooth)        |
| 6. Cap screw (4 used per gear case) | 28. Shim set                         | 49. Shim set                     |
| 7. Shim set                         | 29. Ball bearing                     | 50. Clip (2 used per axle case)  |
| 8. Seal washer                      | 30. Bevel gear (15 tooth)            | 51. Axle cover                   |
| 9. Plug                             | 31. Retaining ring                   | 52. Screw (6 used per cover)     |
| 10. Lock nut                        | 32. Bolt (4 used per knuckle)        | 53. Wheel stud (5 used per axle) |
| 11. Lock washer                     | 33. Shim set                         | 54. Axle                         |
| 12. Grease fitting                  | 34. Dowel pin (2 used per axle case) | 55. Oil seal                     |
| 13. Ball bearing                    | 35. Bushing                          | 56. Ball bearing                 |
| 14. Screw (2 used per steering arm) | 36. Knuckle pin                      | 57. O-ring                       |
| 15. Axle case support (LH shown)    | 37. O-ring                           | 58. Retaining ring               |
| 16. Bolt (2 used)                   | 38. Bevel gear case (LH shown)       | 59. Spacer                       |
| 17. Stud (2 used)                   | 39. Bushing                          | 60. Axle case cover              |
| 18. Shim set                        | 40. Shaft seal                       | 61. Seal washer                  |
| 19. Differential assembly           | 41. Stud (2 used per gear case)      | 62. Plug                         |
| 20. O-ring                          | 42. Bolt (4 used per cover)          | 63. Bevel gear (17 tooth)        |
| 21. Plug                            | 43. Collar                           | 64. O-ring                       |
| 22. O-ring                          |                                      |                                  |

**NOTE:** Figure 17 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

1. Remove the mounting screws, nuts and lock washers. Remove the bevel gear case/axle case assembly and O-ring from the axle support (Fig. 18).

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.**

3. Remove the axle cover mounting screws. Remove the axle cover from the axle case as an assembly (Fig. 19).

4. Remove the axle case support mounting screws, the axle case support and the support shims (Fig. 20).

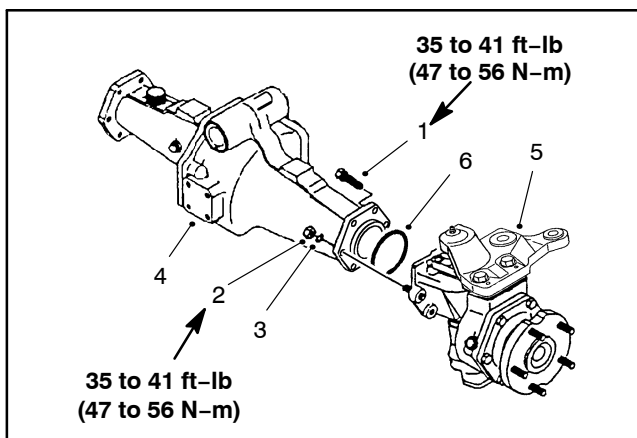


Figure 18

- |                         |                                       |
|-------------------------|---------------------------------------|
| 1. Cap screw (4 used)   | 5. Bevel gear case/axle case assembly |
| 2. Lock nut (2 used)    | 6. O-ring                             |
| 3. Lock washer (2 used) |                                       |
| 4. Axle support         |                                       |

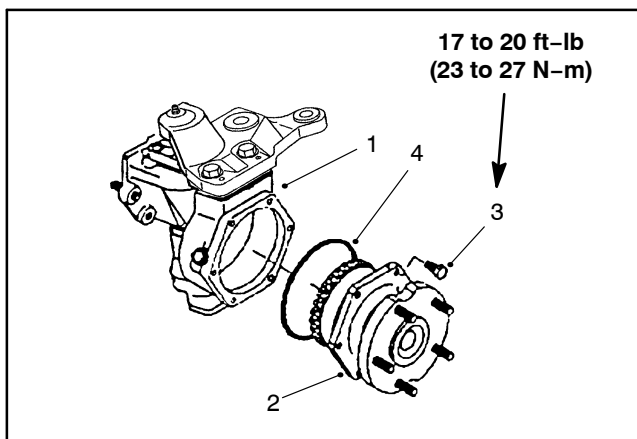


Figure 19

- |                        |                   |
|------------------------|-------------------|
| 1. Axle case           | 3. Screw (6 used) |
| 2. Axle cover assembly | 4. O-ring         |

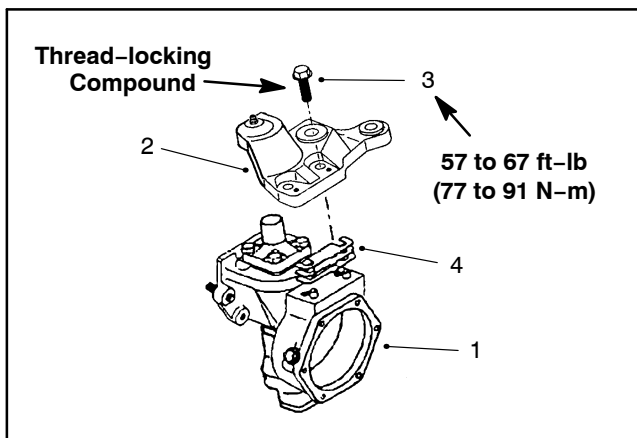


Figure 20

- |                      |                   |
|----------------------|-------------------|
| 1. Axle case         | 3. Screw (2 used) |
| 2. Axle case support | 4. Support shim   |

5. Remove the knuckle pin mounting screws and the knuckle pin. Remove the gasket and any remaining gasket material from either mating surface (Fig. 21).

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 (Fig. 21).

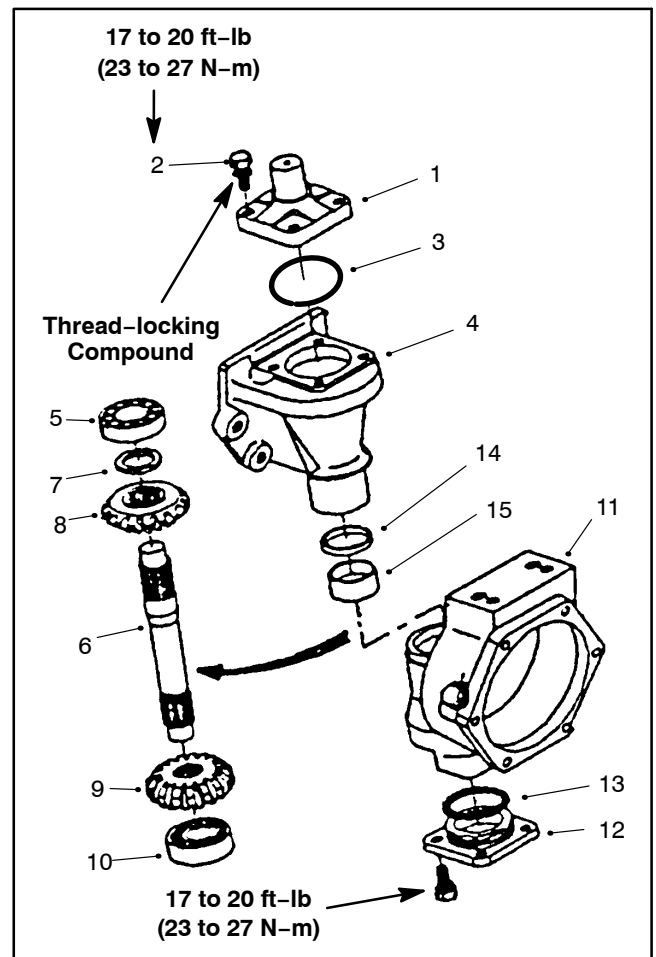


Figure 21

- |                            |                     |
|----------------------------|---------------------|
| 1. Knuckle pin             | 9. Lower bevel gear |
| 2. Mounting screw (4 used) | 10. Lower bearing   |
| 3. O-ring                  | 11. Axle case       |
| 4. Bevel gear case         | 12. Axle case cover |
| 5. Upper bearing           | 13. O-ring          |
| 6. Bevel gear shaft        | 14. Shaft seal      |
| 7. Collar                  | 15. Bushing         |
| 8. Upper bevel gear        |                     |

## Inspection

1. Measure the knuckle pin O.D. and the axle case support bushing I.D. to determine the bushing to pin clearance (Fig. 22). Replace components as necessary.

### BUSHING TO PIN CLEARANCE:

**0.002 to 0.016 in. (0.05 to 0.40 mm)**

### KNUCKLE PIN O.D. (Factory Spec.):

**0.982 to 0.983 in. (24.95 to 24.98 mm)**

### AXLE CASE SUPPORT BUSHING I.D.

(Factory Spec.):

**0.984 to 0.987 in. (25.00 to 25.08 mm)**

2. Inspect all gears, shafts, bearings, cases and covers for damage and wear. Replace components as necessary.

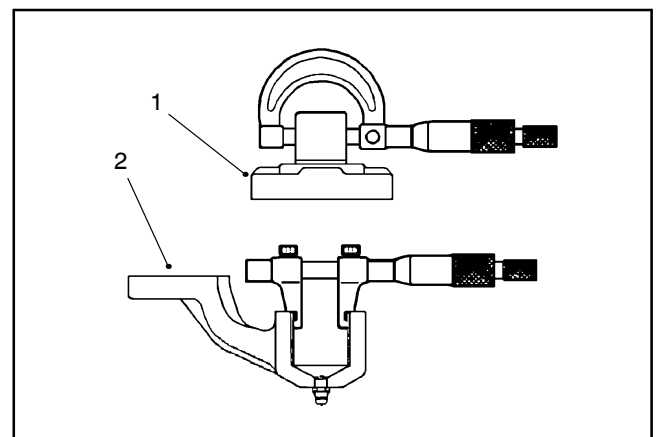


Figure 22

- |                |                      |
|----------------|----------------------|
| 1. Knuckle pin | 2. Axle case support |
|----------------|----------------------|

## Installation

1. Coat new shaft seal with grease and install in axle case as shown (Fig. 23).

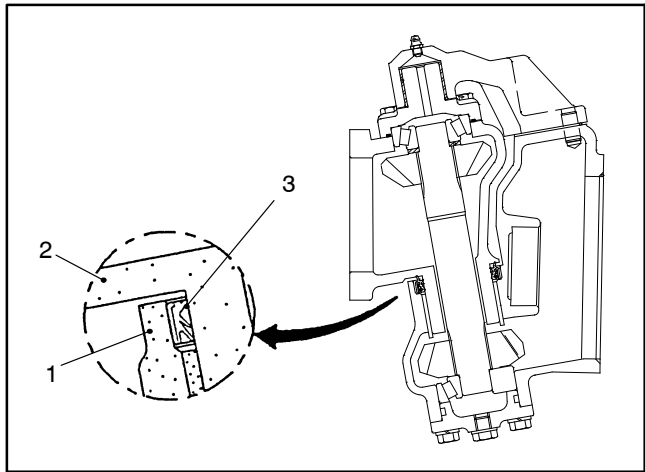


Figure 23

- |                    |               |
|--------------------|---------------|
| 1. Axle case       | 3. Shaft seal |
| 2. Bevel gear case |               |

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 (Fig. 24). Tighten cover screws from **17 to 20 ft-lb (23 to 27 N-m)**.

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 (Fig. 24).

4. Install the knuckle pin. Use medium strength thread-locking compound and tighten the knuckle pin mounting screws from **17 to 20 ft-lb (23 to 27 N-m)**.

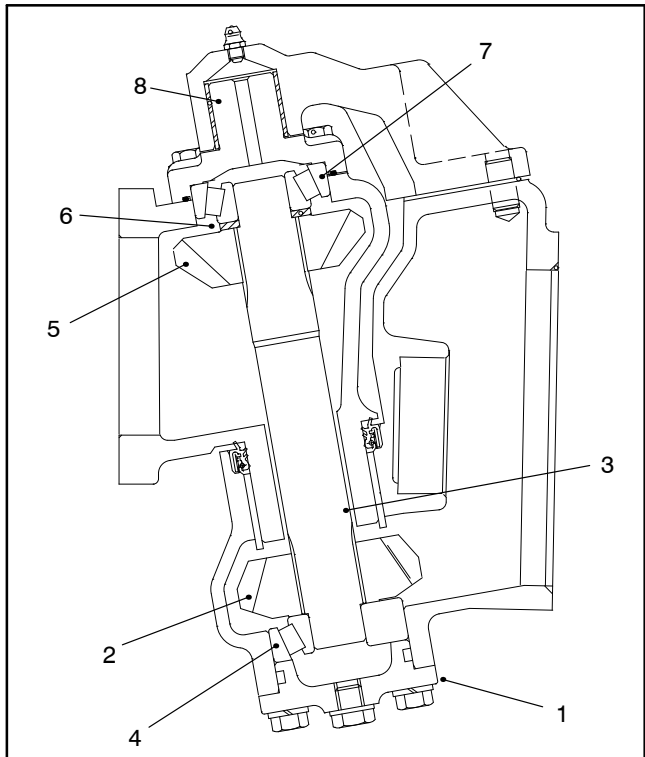


Figure 24

- |                     |                     |
|---------------------|---------------------|
| 1. Axle case cover  | 5. Upper bevel gear |
| 2. Lower bevel gear | 6. Collar           |
| 3. Bevel gear shaft | 7. Upper bearing    |
| 4. Lower bearing    | 8. Knuckle pin      |



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 **57 to 67 ft-lb (77 to 91 N-m)**.

C. Use dial indicator to measure vertical endplay of axle case (Fig. 25).

**AXLE CASE ASSEMBLY ENDPLAY:**  
**0.001 to 0.008 in. (0.02 to 0.20 mm)**

D. Adjust endplay by increasing or reducing number of axle case support shims.

**NOTE:** Axle case support shims are available in 0.004 in. (0.1 mm), 0.008 in. (0.2 mm) and 0.016 in. (0.4 mm) 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 **57 to 67 ft-lb (77 to 91 N-m)**.

**IMPORTANT: Correct engagement between bevel gears is critical to axle performance and durability.**

7. Temporarily install the bevel gear case/axle case assembly on the axle support. Position a dial indicator at the teeth center. Prevent the axle from turning and measure the upper bevel gear to differential shaft gear backlash (Fig. 26).

**UPPER BEVEL GEAR BACKLASH:**  
**0.004 to 0.016 in. (0.10 to 0.40 mm)**

8. Adjust backlash by increasing or reducing axle bearing shim thickness (see Differential Shafts in this section of this manual).

**NOTE:** Axle bearing shims are available in 0.004 in. (0.1 mm), 0.008 in. (0.2 mm) and 0.020 in. (0.5 mm) thickness.

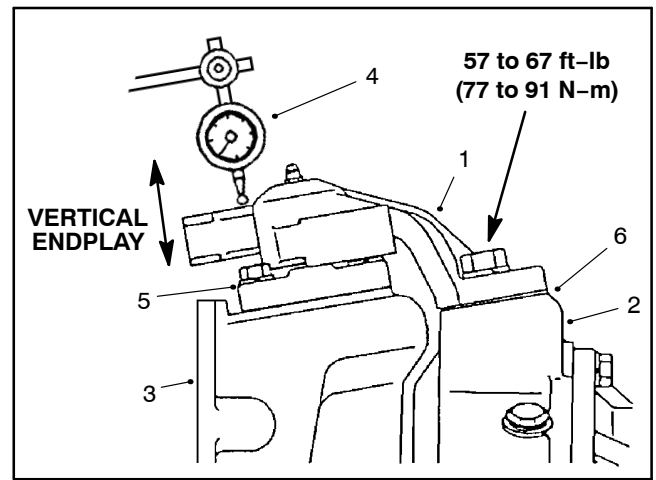


Figure 25

- |                      |                          |
|----------------------|--------------------------|
| 1. Axle case support | 4. Dial indicator        |
| 2. Axle case         | 5. Knuckle pin           |
| 3. Bevel gearcase    | 6. Support shim location |

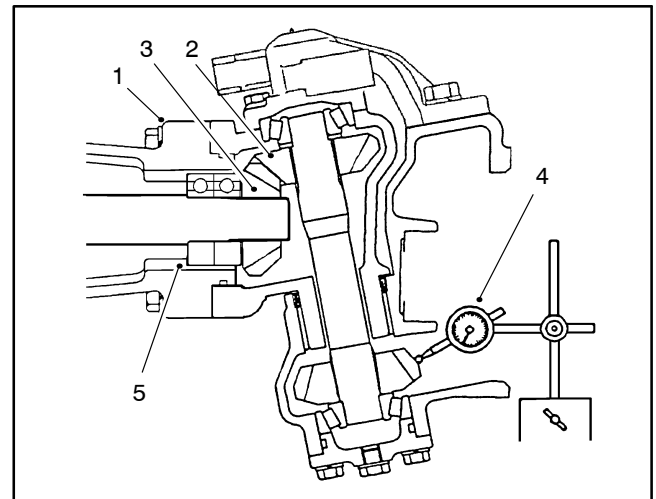


Figure 26

- |                            |                       |
|----------------------------|-----------------------|
| 1. Axle support            | 4. Dial indicator     |
| 2. Upper bevel gear        | 5. Axle bearing shims |
| 3. Differential shaft gear |                       |

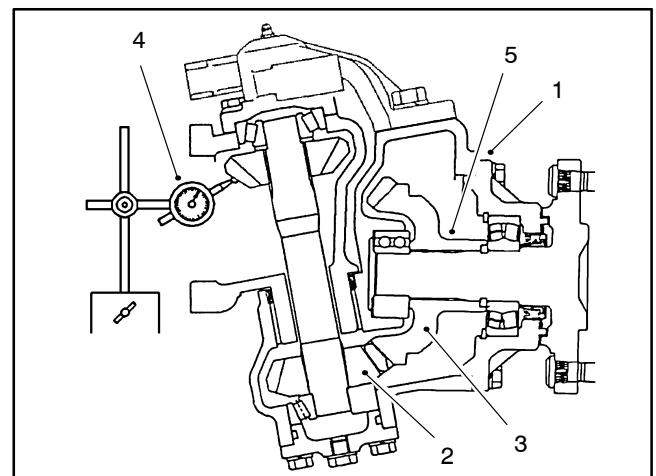


Figure 27

- |                        |                       |
|------------------------|-----------------------|
| 1. Axle cover assembly | 4. Dial indicator     |
| 2. Lower bevel gear    | 5. Axle bearing shims |
| 3. Axle gear           |                       |

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 tooth's center. Prevent the axle from turning and measure the lower bevel gear to axle gear backlash (Fig. 27).

**LOWER BEVEL GEAR BACKLASH:**

**0.004 to 0.016 in. (0.10 to 0.40 mm)**

10. Adjust backlash by increasing or reducing axle bearing shim thickness (see Axle Shafts in this section of this manual).

**NOTE:** Axle bearing shims are available in 0.008 in. (0.2 mm), 0.012 in. (0.3 mm) and 0.020 in. (0.5 mm) thickness.

11. Tighten axle cover screws from **17 to 20 ft-lb (23 to 27 N-m)**.

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 **35 to 41 ft-lb (47 to 56 N-m)** (Fig. 18).

## Differential Shafts

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 (Fig. 28).

2. Mark and pull the differential shaft assembly from the axle support.

3. Remove the retaining ring and bevel gear (Fig 29).

4. Drive the differential shaft out of the bearings. Remove the bearings and bearing shims.

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/Axle Case Assembly in this section of this manual).

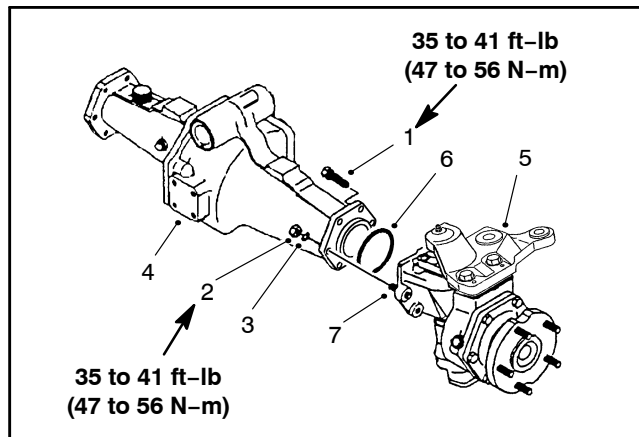


Figure 28

- |                         |                                  |
|-------------------------|----------------------------------|
| 1. Cap screw (4 used)   | 5. Bevel gear/axle case assembly |
| 2. Lock nut (2 used)    | 6. O-ring                        |
| 3. Lock washer (2 used) | 7. Stud (2 used)                 |

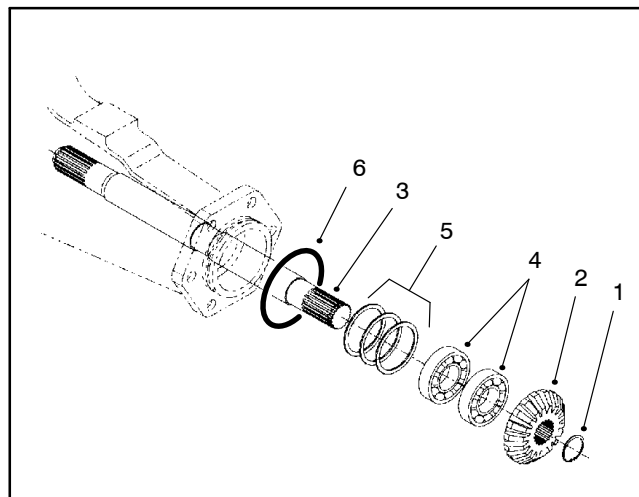


Figure 29

- |                       |                  |
|-----------------------|------------------|
| 1. Retaining ring     | 4. Bearing       |
| 2. Bevel gear         | 5. Bearing shims |
| 3. Differential shaft | 6. O-ring        |

## Axle Shafts

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 (Fig. 30).
2. Use a bearing puller to remove the bearing and bevel gear as shown (Fig. 31).
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

1. Coat new axle shaft seal with grease and install in axle cover as shown (Fig. 32).
2. Press the axle cover and bearing assembly onto the axle shaft. Press only on the inner race of the cover bearing (Fig. 32).
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 **17 to 20 ft-lb (23 to 27 N-m)**.

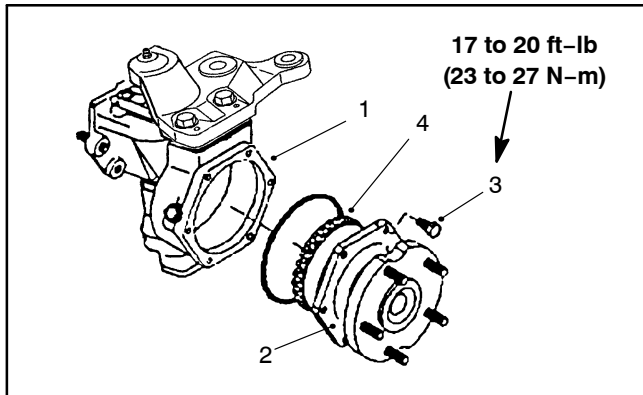


Figure 30

- |                        |                   |
|------------------------|-------------------|
| 1. Axle case           | 3. Screw (6 used) |
| 2. Axle cover assembly | 4. O-ring         |

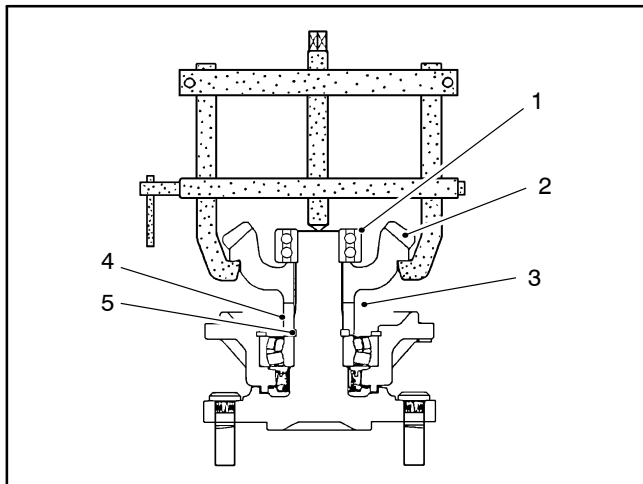


Figure 31

- |               |                   |
|---------------|-------------------|
| 1. Bearing    | 4. Spacer         |
| 2. Bevel gear | 5. Retaining ring |
| 3. Shims      |                   |

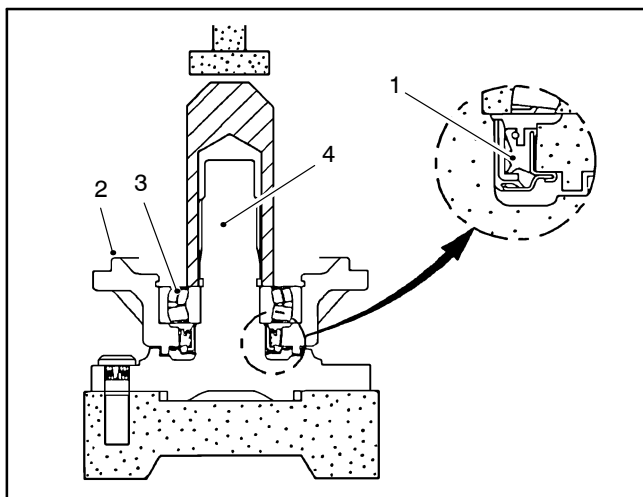


Figure 32

- |                    |               |
|--------------------|---------------|
| 1. Axle shaft seal | 3. Bearing    |
| 2. Axle cover      | 4. Axle shaft |

This page is intentionally left blank.

## Input Shaft/Pinion Gear

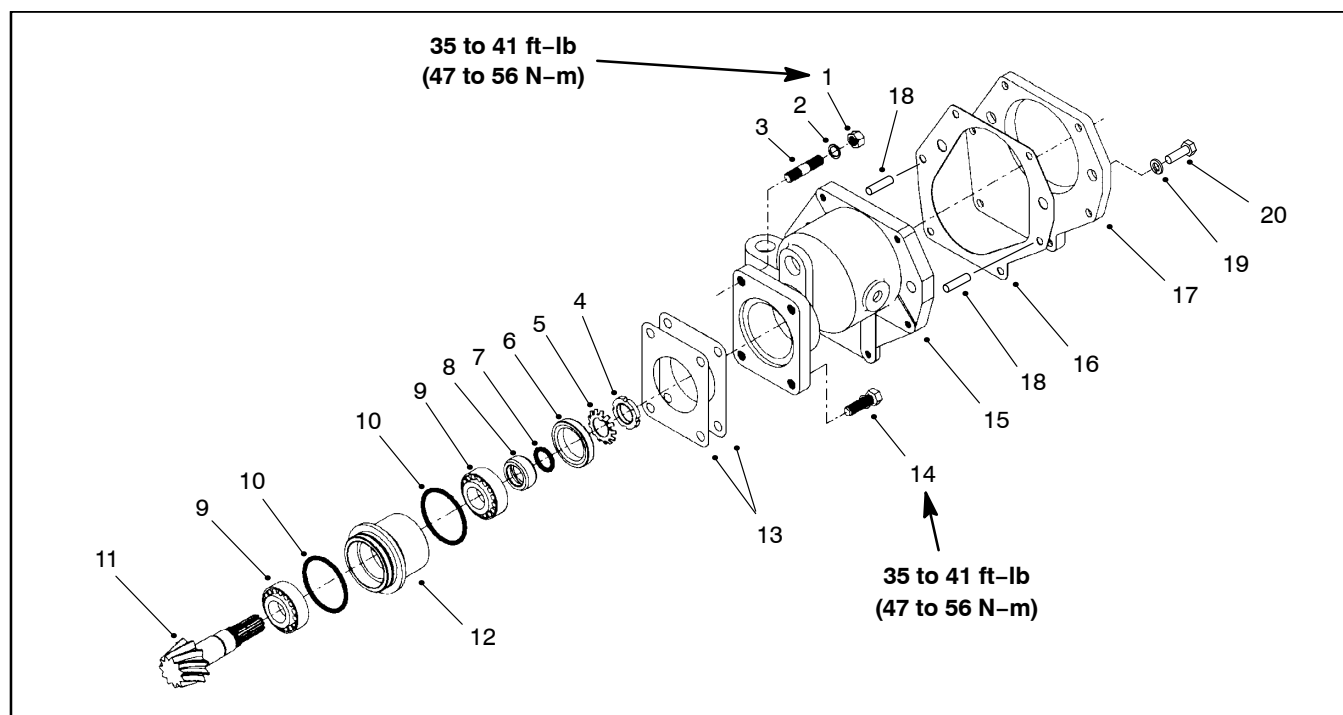


Figure 33

- |                         |                             |                          |
|-------------------------|-----------------------------|--------------------------|
| 1. Nut (2 used)         | 8. Seal collar              | 15. Gear case            |
| 2. Lock washer (2 used) | 9. Bearing                  | 16. Gasket               |
| 3. Stud (2 used)        | 10. O-ring                  | 17. Cover plate          |
| 4. Lock nut             | 11. Input shaft/pinion gear | 18. Dowel pin            |
| 5. Stake washer         | 12. Bearing case            | 19. Lock washer (6 used) |
| 6. Oil seal             | 13. Shim                    | 20. Cap screw (6 used)   |
| 7. O-ring               | 14. Screw (2 used)          |                          |

The following procedures assume the rear axle assembly has been removed from the machine.

### Removal (Fig. 33)

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 and the driven gear 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 (Fig. 33)

**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.

3. Coat a new oil seal with grease and install as shown (Fig. 34). 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 4 to 6 in-lb (0.4 to 0.7 N-m) of force is required to rotate the input shaft/pinion gear in the bearing case.

7. Secure the lock nut with the stake washer.

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 (Fig. 35).

#### DESIGN CONE CENTER DISTANCE

(distance from mating surface of axle support to end face of pinion gear):

**1.870 ± 0.002 in. (47.5 ± 0.05 mm)**

**NOTE:** Bearing case shims are available in 0.004 in. (0.1 mm) and 0.008 in. (0.2 mm) 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 **35 to 41 ft-lb (47 to 56 N-m)**.

10. Insert a screwdriver through the drain plug hole to hold ring gear and measure the pinion gear to ring gear backlash (Fig. 36).

#### PINION GEAR TO RING GEAR BACKLASH:

**0.004 to 0.016 in. (0.10 to 0.40 mm)**

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 in this section of this manual).

13. Place the correct combination of shims on the gear case. Tighten mounting nuts and screws from **35 to 41 ft-lb (47 to 56 N-m)**.

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.

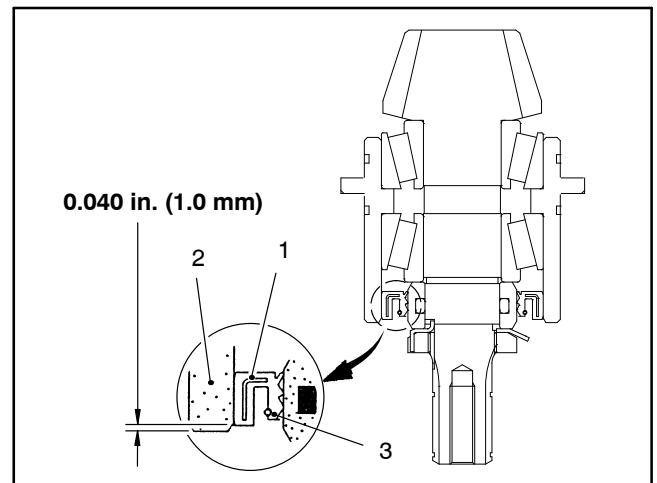


Figure 34

1. Oil seal  
2. Bearing case

3. Seal garter spring

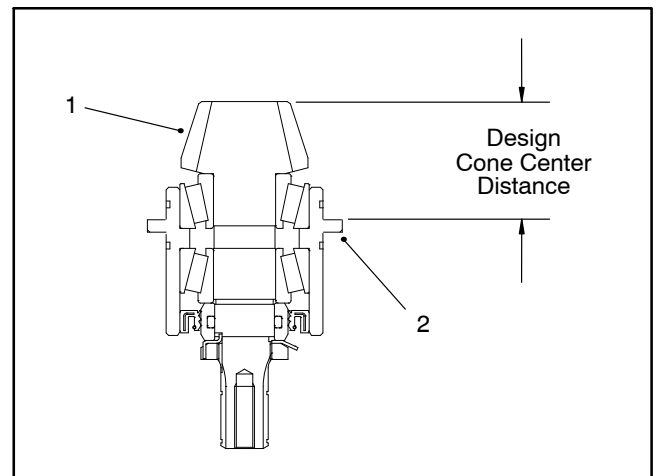


Figure 35

1. Input shaft/pinion gear

2. Bearing case

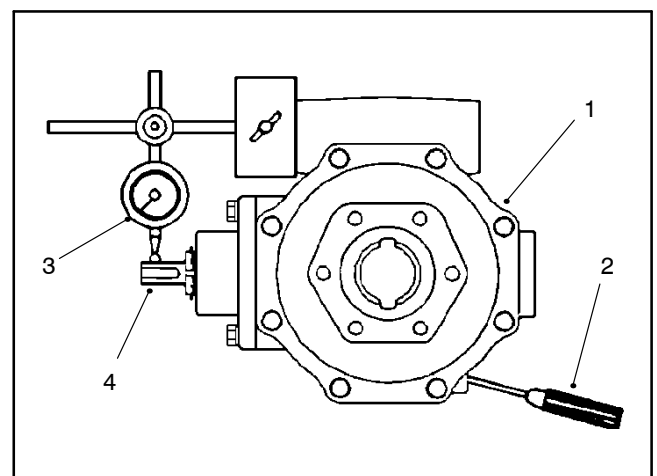


Figure 36

1. Axle case  
2. Screwdriver

3. Dial indicator  
4. Input shaft/pinion gear

## Differential Gear

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/Axle Case Assembly in this section of this manual).

**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 (Fig. 37).

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.

6. Drive the spring pin from the differential case with a punch and hammer. Discard the spring pin (Fig. 38).

**NOTE:** Mark and arrange all components so they can be reassembled in their original position.

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 (Fig. 39).

**NOTE:** Replacement ring gears are only available in matched ring and pinion sets.

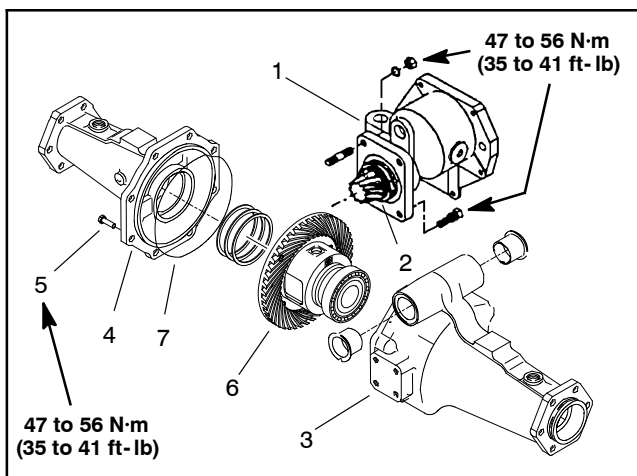


Figure 37

- |                         |                        |
|-------------------------|------------------------|
| 1. Gear Case            | 5. Case screw (8 used) |
| 2. Pinion Gear          | 6. Differential gear   |
| 3. Axle support (left)  | 7. O-ring              |
| 4. Axle support (right) |                        |

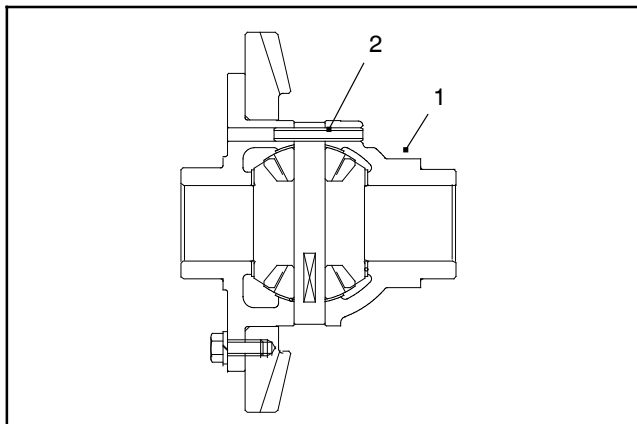


Figure 38

- |                      |               |
|----------------------|---------------|
| 1. Differential case | 2. Spring pin |
|----------------------|---------------|

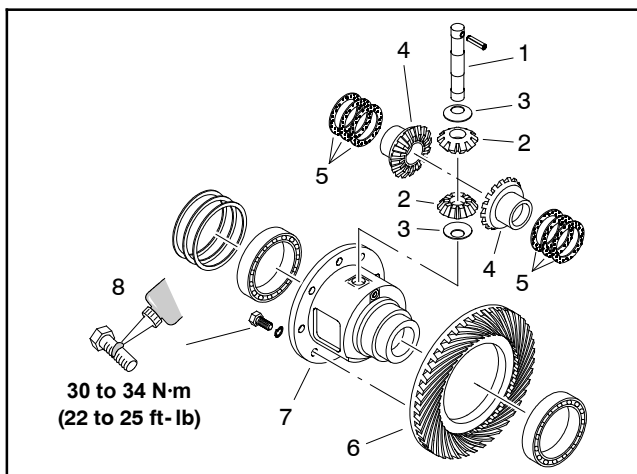


Figure 39

- |                              |                         |
|------------------------------|-------------------------|
| 1. Differential pinion shaft | 5. Side gear shims      |
| 2. Pinion gear               | 6. Ring gear            |
| 3. Pinion washer             | 7. Differential case    |
| 4. Side gear                 | 8. Bolt/washer (8 used) |



## Inspection

1. Measure the differential side gear O.D. and the differential case I.D. to determine the side gear to case clearance (Fig. 40). Replace components as necessary.

**SIDE GEAR TO CASE CLEARANCE:**  
**0.002 to 0.012 in. (0.05 to 0.30 mm)**

**SIDE GEAR O.D. (Factory Spec.):**  
**1.335 to 1.337 in. (33.91 to 33.95 mm)**

**DIFFERENTIAL CASE I.D. (Factory Spec.):**  
**1.339 to 1.341 in. (34.00 to 34.06 mm)**

2. Measure the differential pinion shaft O.D. and the pinion gear I.D. to determine the pinion shaft to pinion gear clearance (Fig. 41). Replace components as necessary.

**PINION SHAFT TO PINION GEAR CLEARANCE:**  
**0.001 to 0.010 in. (0.03 to 0.25 mm)**

**PINION SHAFT O.D. (Factory Spec.):**  
**0.550 to 0.551 in. (13.97 to 13.10 mm)**

**PINION GEAR I.D. (Factory Spec.):**  
**0.551 to 0.552 in. (13.10 to 14.02 mm)**

3. Inspect all gears, shafts, bearings, cases and covers for damage and wear. Replace components as necessary.

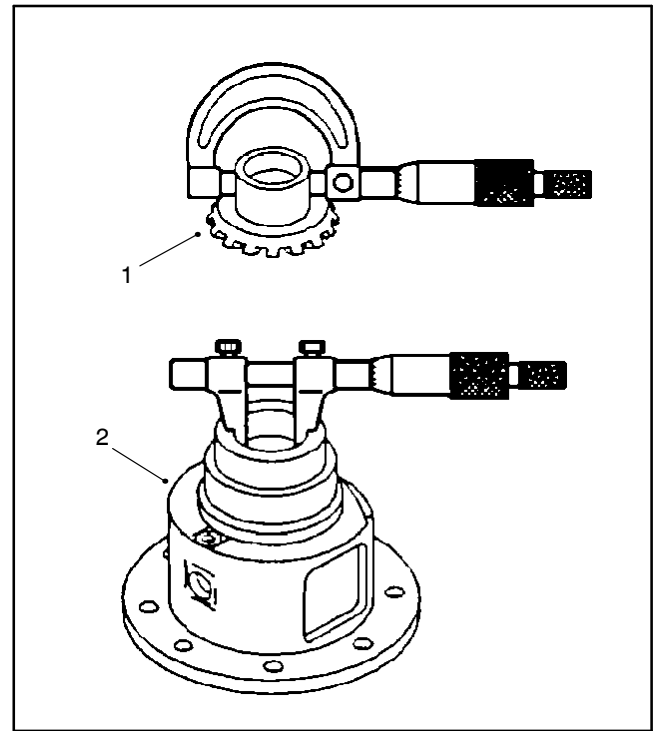


Figure 40

1. Side gear

2. Differential case

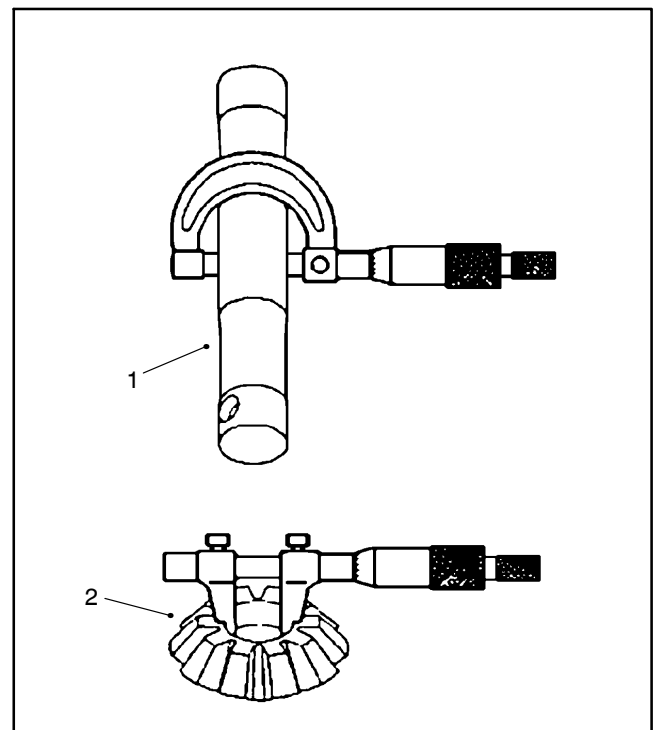


Figure 41

1. Pinion shaft

2. Pinion gear

## Installation

1. If the ring gear was removed from the differential case, use medium strength Loctite thread locker and tighten the mounting screws from **22 to 25 ft-lb (30 to 34 N-m)**.

2. Apply molybdenum disulfide 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.

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 (Fig. 42).

**PINION GEAR TO SIDE GEAR BACKLASH:**  
**0.004 to 0.016 in. (0.10 to 0.40 mm)**

6. Adjust backlash by increasing or reducing side gear shim thickness.

**NOTE:** Side gear shims are available in 0.043 in. (1.10 mm), 0.047 in. (1.20 mm) and 0.051 in. (1.30 mm) 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.

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 (Fig. 43).

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.

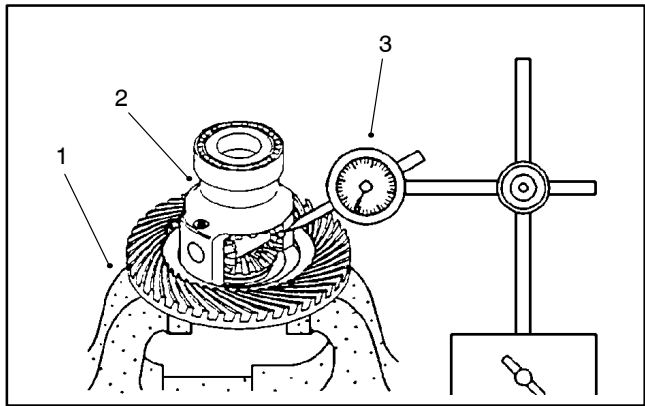


Figure 42

- 1. Vise
- 2. Differential gear case
- 3. Dial indicator

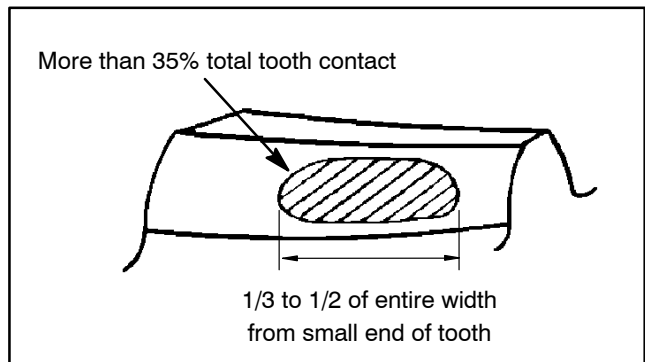


Figure 43

12. Install differential gear assembly in right side axle support half.

13. Coat a new O-ring with grease and install left side axle support half. Tighten axle support case screws from **35 to 41 ft-lb (47 to 56 N-m)**.

14. Install input shaft/pinion gear assembly (see Input Shaft/Pinion Gear in this section of this manual).

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/Axle Case Assembly in this section of this manual).

## Pinion Gear to Ring Gear Engagement

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 (Fig. 44):

**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.

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 (Fig. 45).

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) (Fig. 46).

**NOTE:** Bearing case shims are available in 0.004 in. (0.10 mm) and 0.008 in. (0.20 mm) thickness.

**NOTE:** Differential bearing shims are available in 0.004 in. (0.10 mm), 0.008 in. (0.20 mm) and 0.016 in. (0.40 mm) thickness.

Study the different contact patterns (Figs. 47 and 48) and correct gear engagement as necessary.

**NOTE:** When making changes, note that two variables are involved (see Gear Pattern Movement Summary in this section of this manual).

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.

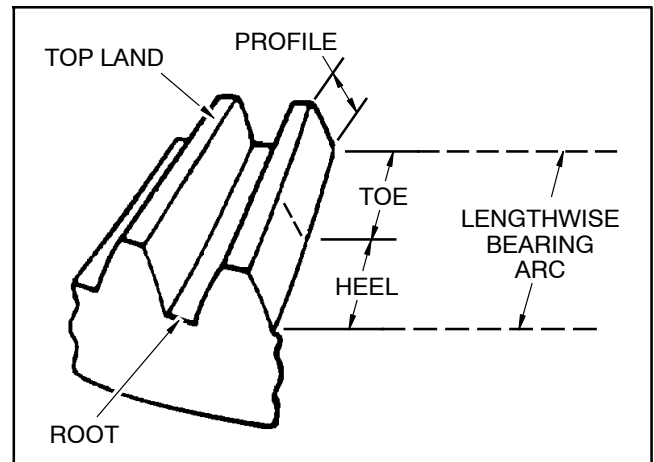


Figure 44

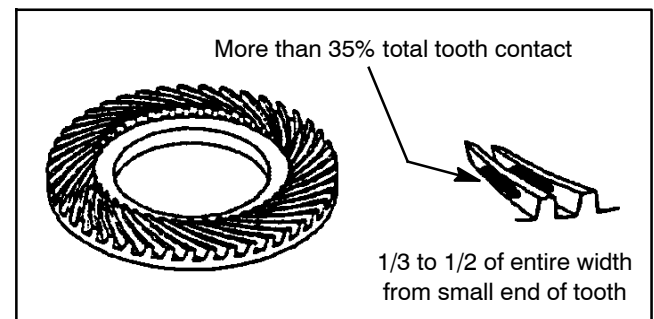


Figure 45

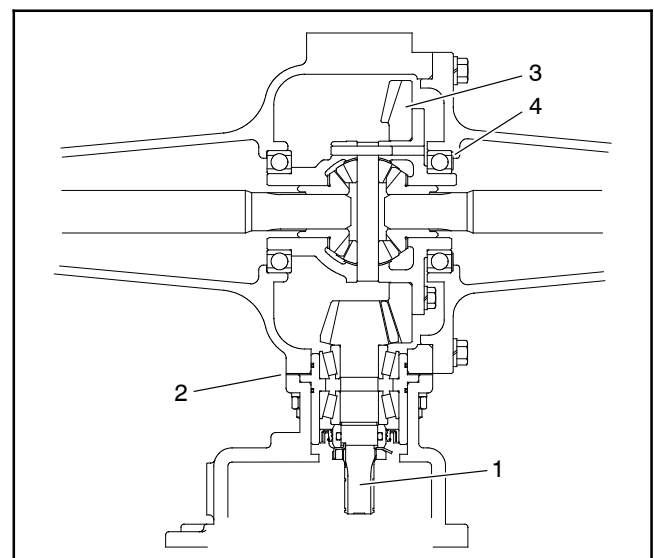


Figure 46

- |                            |                               |
|----------------------------|-------------------------------|
| 1. Input shaft/pinion gear | 4. Differential bearing shims |
| 2. Bearing case shims      |                               |
| 3. Differential gear case  |                               |

## Gear Pattern Movement Summary

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 (Fig. 47):

- 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.

2. If contact is toward the toe or tip of the gear (Fig. 48):

- 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.

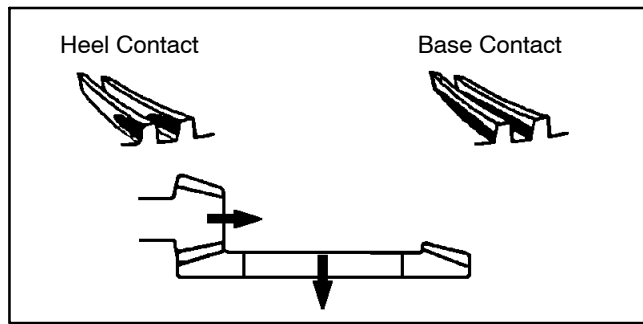


Figure 47

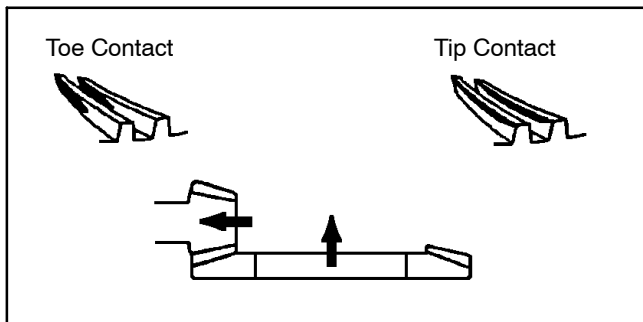


Figure 48



## Chapter 7

# Chassis

### Table of Contents

GENERAL INFORMATION .....	2
Operator's Manual .....	2
Cutting Deck Identification .....	2
SERVICE AND REPAIRS .....	4
Steering Column .....	4
Traction Pedal .....	6
Console Arm .....	8
Lift Arms For Cutting Decks #1, #4 and #5 .....	10
Lift Arms For Cutting Decks #2 and #3 .....	12
Lift Arms For Cutting Decks #6 and #7 (Groundsmaster 4700-D) .....	14
Operator Seat .....	16
Operator Seat Service .....	18
Operator Seat Suspension .....	20
Hood .....	22

# General Information

## Operator's Manual

The Traction Unit and Cutting Deck Operator's Manuals 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.

## Cutting Deck Identification

Cutting decks on the Groundsmaster 4500-D and 4700-D are identified as shown in Figure 1.

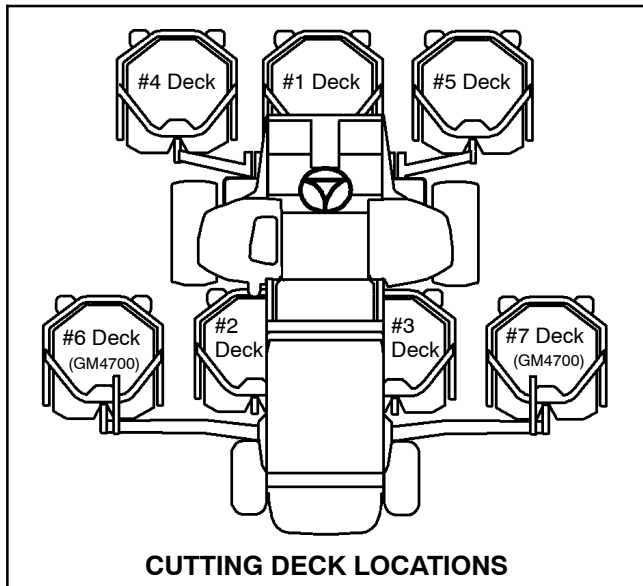


Figure 1

This page is intentionally blank.

# Service and Repairs

## Steering Column

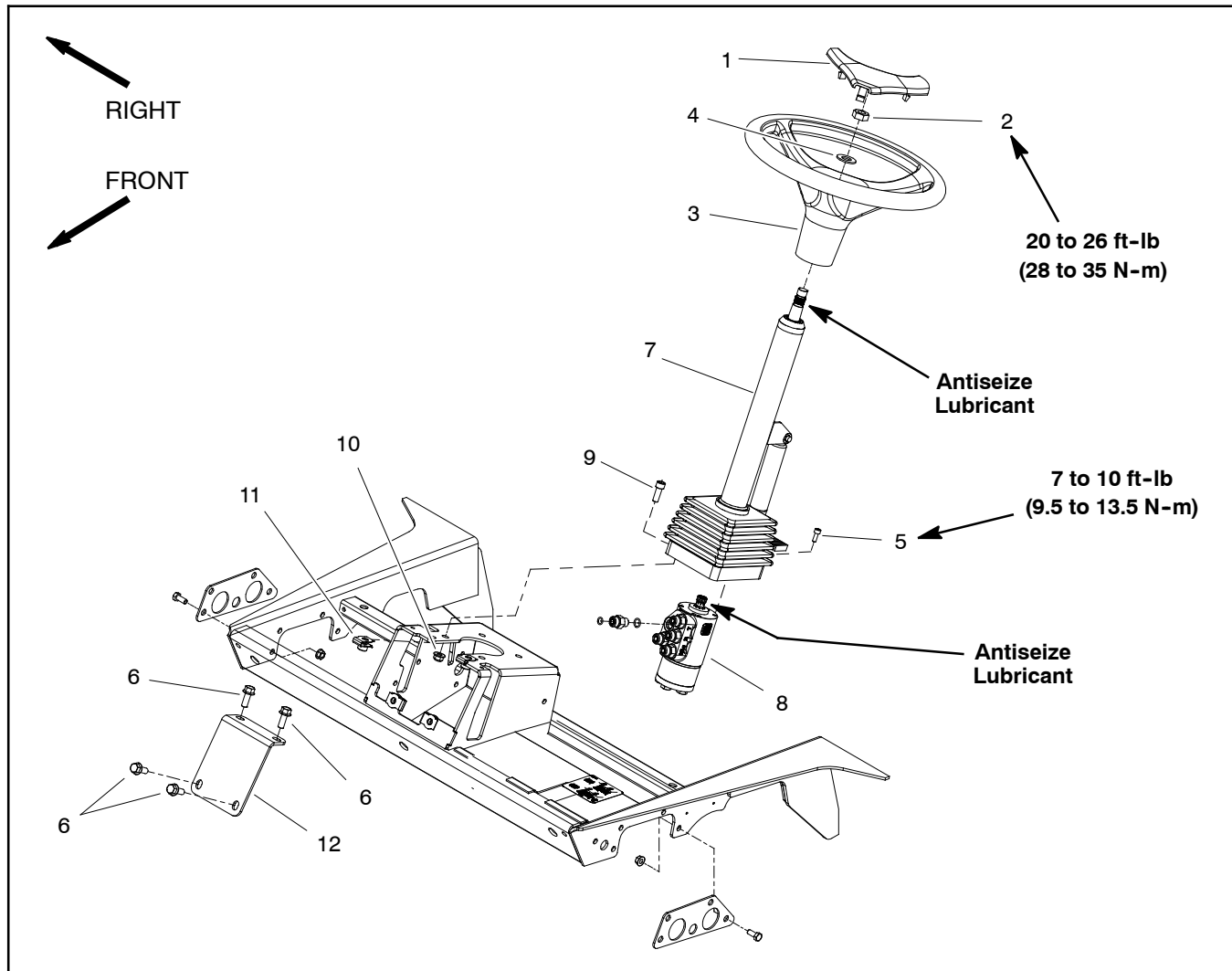


Figure 2

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

### Removal (Fig. 2)

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 (Fig. 3).
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 4 as a guide.

## Installation (Fig. 2)

1. Assemble steering column using Figure 4 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 **7 to 10 ft-lb (9.5 to 13.5 N-m)**.

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 **20 to 26 ft-lb (28 to 35 N-m)**.

10. Install steering wheel cover to steering wheel.

11. Install and secure platform shroud to machine (Fig. 3).

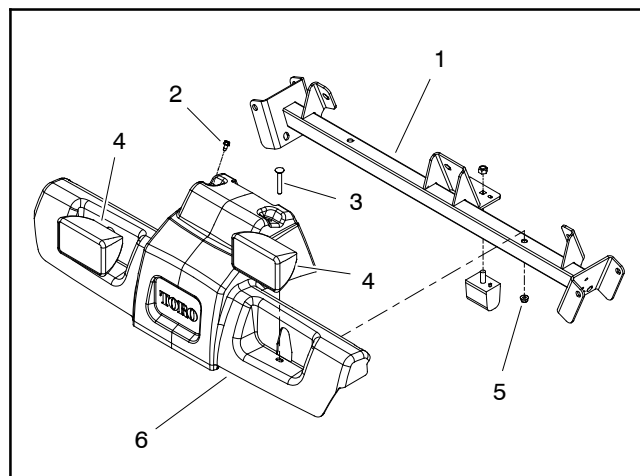


Figure 3

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

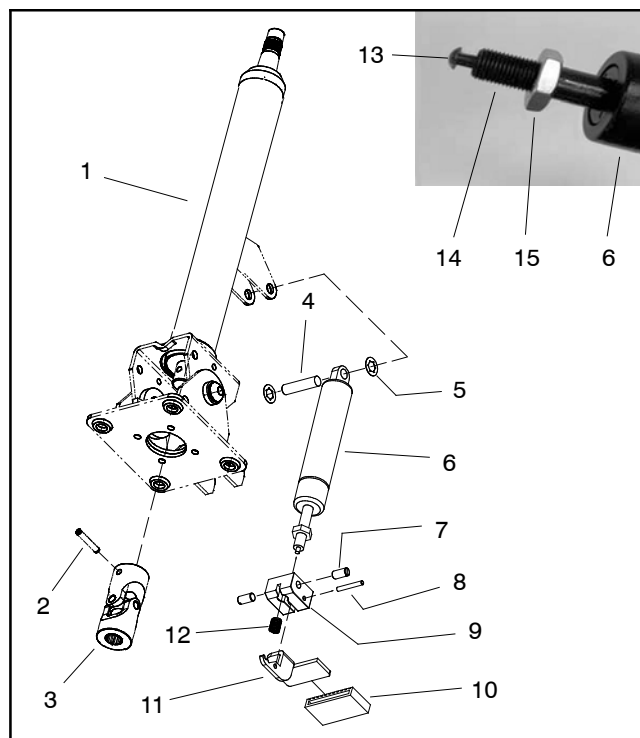


Figure 4

- |                         |                    |
|-------------------------|--------------------|
| 1. Steering column      | 9. Pedal block     |
| 2. Pin                  | 10. Pedal cover    |
| 3. Universal joint      | 11. Pedal          |
| 4. Pin                  | 12. Spring         |
| 5. Lock washer (2 used) | 13. Release pin    |
| 6. Cylinder             | 14. Cylinder shaft |
| 7. Bolt (2 used)        | 15. Jam nut        |
| 8. Pin                  |                    |

## Traction Pedal

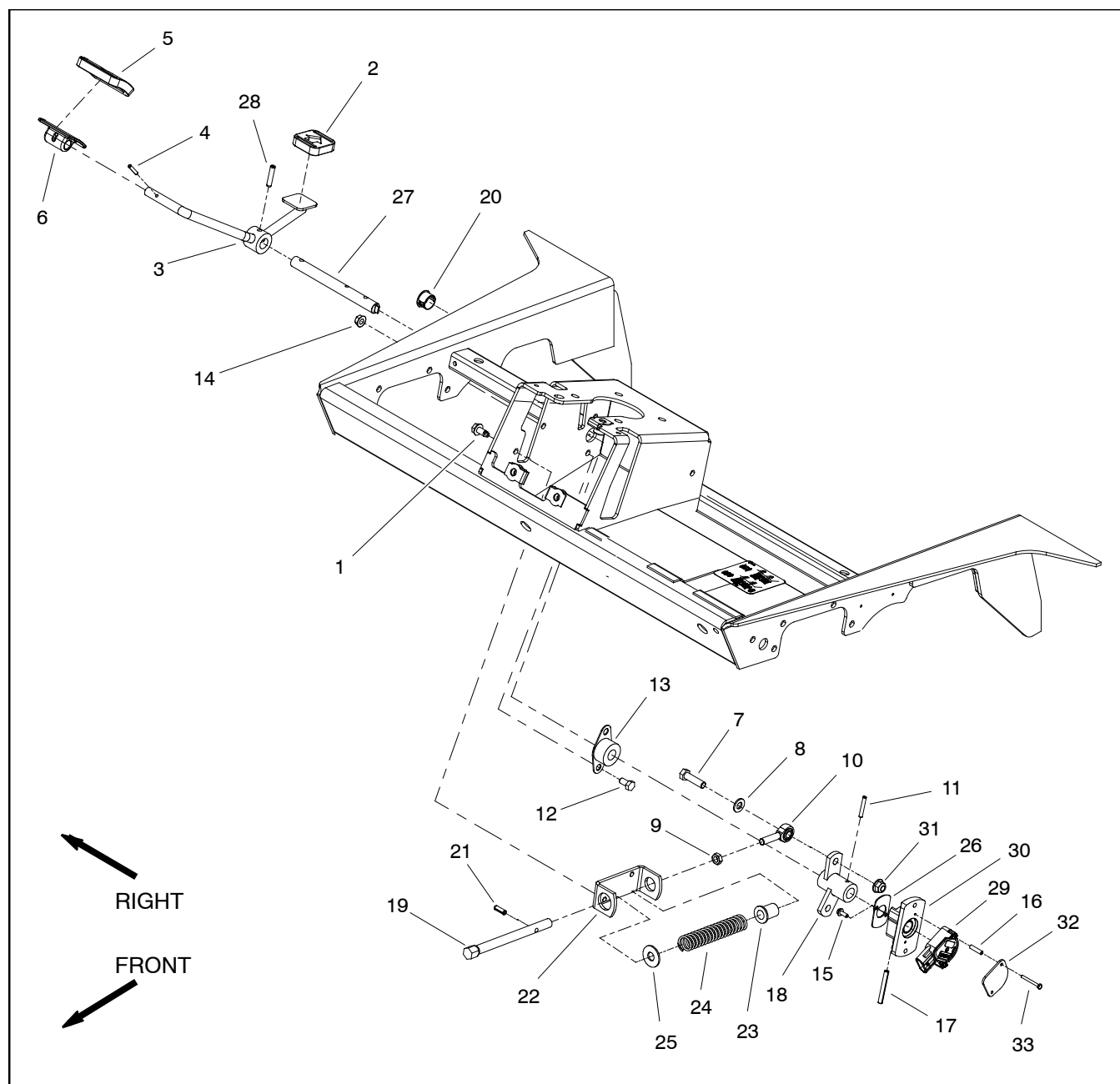


Figure 5

- |                               |                                |                          |
|-------------------------------|--------------------------------|--------------------------|
| 1. Washer head screw (2 used) | 12. Cap screw (4 used)         | 23. Spring retainer      |
| 2. Reverse pedal pad          | 13. Flange bearing mount       | 24. Compression spring   |
| 3. Pedal assembly             | 14. Flange nut (2 used)        | 25. Flat washer          |
| 4. Spring pin                 | 15. Washer head screw (2 used) | 26. Sensor cover plate   |
| 5. Forward pedal pad          | 16. Standoff spacer (2 used)   | 27. Traction pivot shaft |
| 6. Accelerator pedal          | 17. Roll pin                   | 28. Spring pin           |
| 7. Cap screw                  | 18. Pivot hub                  | 29. Position sensor      |
| 8. Flat washer                | 19. Spring shaft               | 30. Hub                  |
| 9. Jam nut                    | 20. Plastic plug               | 31. Flange nut           |
| 10. Rod end bearing           | 21. Roll pin                   | 32. Capture plate        |
| 11. Slotted roll pin          | 22. Spring bracket             | 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.**

#### Disassembly (Fig. 5)

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 Figures 5, 6 and 7 as guides. When removing roll pins (items 11, 17, 21 and 28 in Fig. 5), make sure to support shaft to prevent component damage.

#### Assembly (Fig. 5)

1. Assemble traction pedal using Figures 5, 6 and 7 as guides noting the following items:
  - A. Apply grease to both the OD and ID of the spring retainer (item 23 in Fig. 5) before installation. Take care to not get grease on threads of spring shaft (item 19 in Fig. 5) or jam nut (item 9 in Fig. 5).
  - B. If traction pivot shaft (item 27 in Fig. 5) was removed, apply grease to the shaft areas that will be inside the bearings after assembly.
  - C. When installing roll pins (items 11, 17, 21 and 28 in Fig. 5), 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 (item 17 in Fig. 5) is fully inside the butterfly groove of the hub (item 30 in Fig. 5). The roll pin should not contact the hub throughout the operating range.
  - E. To install the traction pedal position sensor (item 29 in Fig. 5), 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 (item 16 in Fig. 5), capture plate (item 32 in Fig. 5) and cap screws (item 33 in Fig. 5).
  - F. Leave the jam nut (item 9 in Fig. 5) 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 (item 29 in Fig. 5).
4. After assembly of the traction pedal, calibrate the traction pedal position sensor using the InfoCenter display (see Traction Pedal Calibration in the Adjustments section of Chapter 5 – Electrical System).
5. Make sure that jam nut (item 9 in Fig. 5) is tightened after position sensor adjustment.

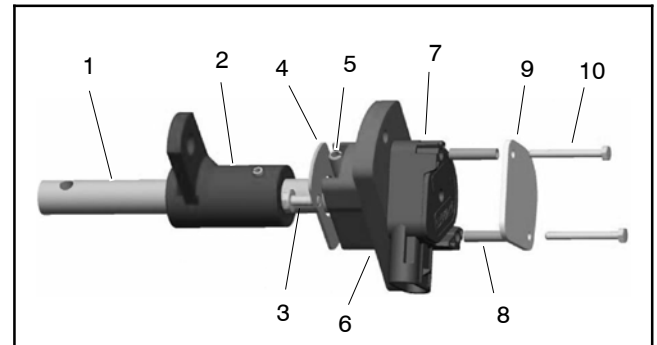


Figure 6

- |                   |                        |
|-------------------|------------------------|
| 1. Pivot shaft    | 6. Hub                 |
| 2. Pivot hub      | 7. Position sensor     |
| 3. Screw (2 used) | 8. Spacer (2 used)     |
| 4. Cover plate    | 9. Capture plate       |
| 5. Roll pin       | 10. Cap screw (2 used) |

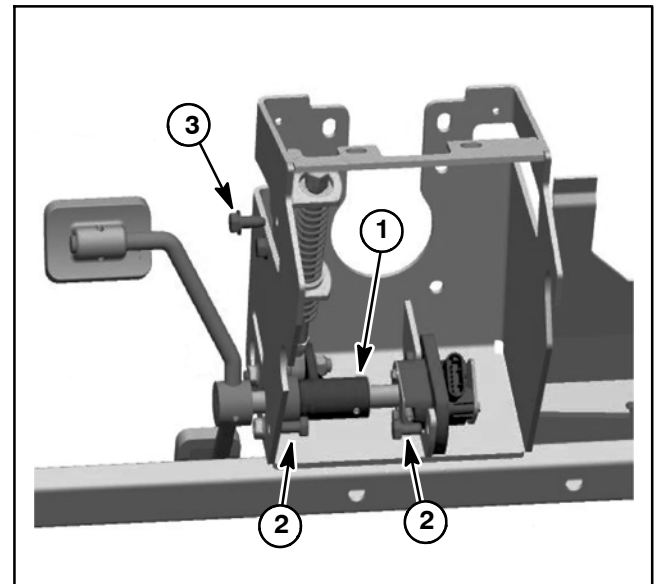


Figure 7

- |                            |                   |
|----------------------------|-------------------|
| 1. Traction pedal assembly | 3. Screw (2 used) |
| 2. Cap screw (4 used)      |                   |

## Console Arm

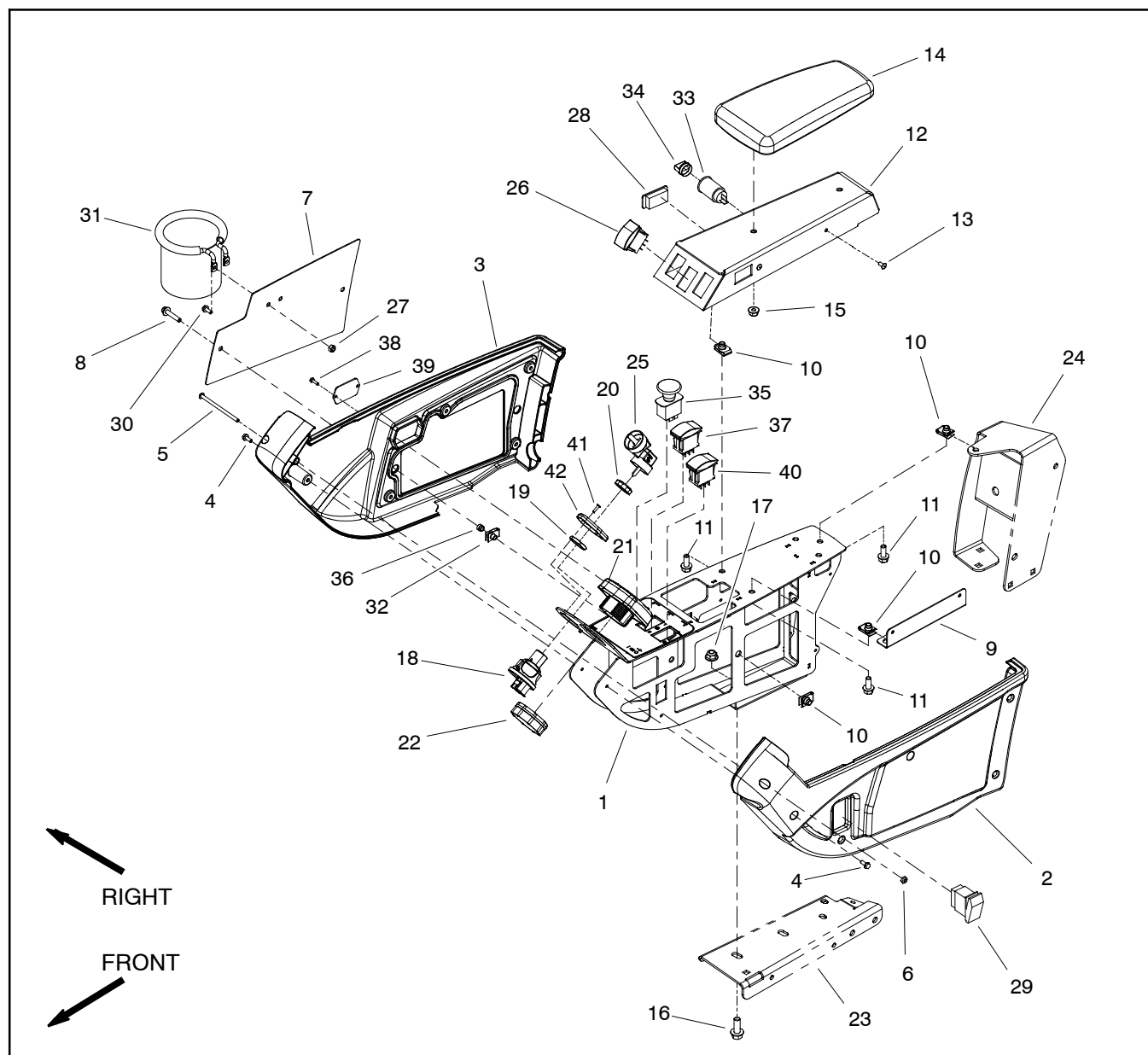


Figure 8

- |                                |                                    |                            |
|--------------------------------|------------------------------------|----------------------------|
| 1. Console arm frame           | 15. Flange nut (2 used)            | 29. Headlight switch       |
| 2. LH cover                    | 16. Flange head screw (2 used)     | 30. Screw (2 used)         |
| 3. RH cover                    | 17. Flange nut (2 used)            | 31. Bag holder             |
| 4. Washer head screw (10 used) | 18. Ignition switch                | 32. Clip (2 used)          |
| 5. Phillips head screw         | 19. Hex nut                        | 33. Power point            |
| 6. Lock nut                    | 20. Face nut                       | 34. Cap                    |
| 7. Cover plate                 | 21. InfoCenter display             | 35. PTO switch             |
| 8. Flange head screw (2 used)  | 22. Nut                            | 36. Flange spacer (2 used) |
| 9. Mount                       | 23. Support channel                | 37. Hi/Low speed switch    |
| 10. U-nut (5 used)             | 24. Arm support                    | 38. Cap screw (2 used)     |
| 11. Flange head screw (5 used) | 25. Ignition keys                  | 39. Cover plate            |
| 12. Switch panel               | 26. Deck lift switch (1 or 3 used) | 40. Engine speed switch    |
| 13. Rivet (2 used)             | 27. Lock nut (2 used)              | 41. Rivet (2 used)         |
| 14. Arm rest                   | 28. Hole plug                      | 42. Switch step            |

### Disassembly (Fig. 8)

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 8 as a guide.

7. If necessary, remove console panel and supports from machine using Figures 8 and 9 as guides.

### Assembly (Fig. 8)

1. Install all removed electrical and console arm components using Figure 8 and 9 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.

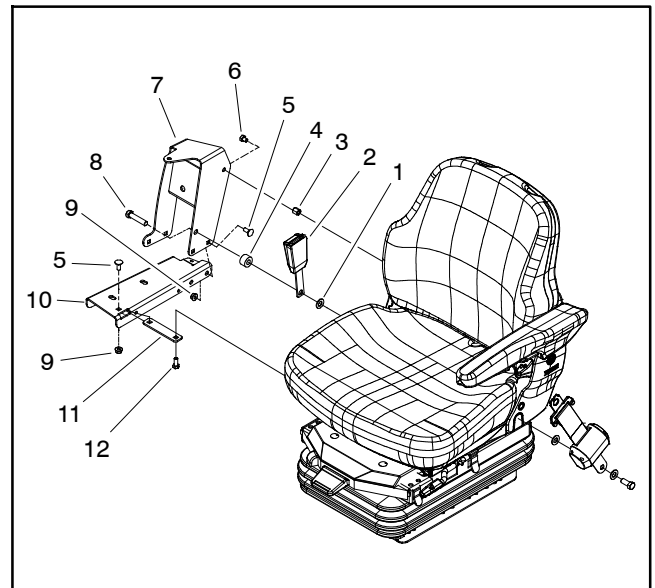


Figure 9

- |                            |                     |
|----------------------------|---------------------|
| 1. Flat washer             | 7. Arm support      |
| 2. Seat belt buckle        | 8. Cap screw        |
| 3. Coupling nut            | 9. Flange nut       |
| 4. Spacer                  | 10. Support channel |
| 5. Carriage screw (5 used) | 11. Support bracket |
| 6. Cap screw               | 12. Cap screw       |

## Lift Arms for Cutting Decks #1, #4 and #5

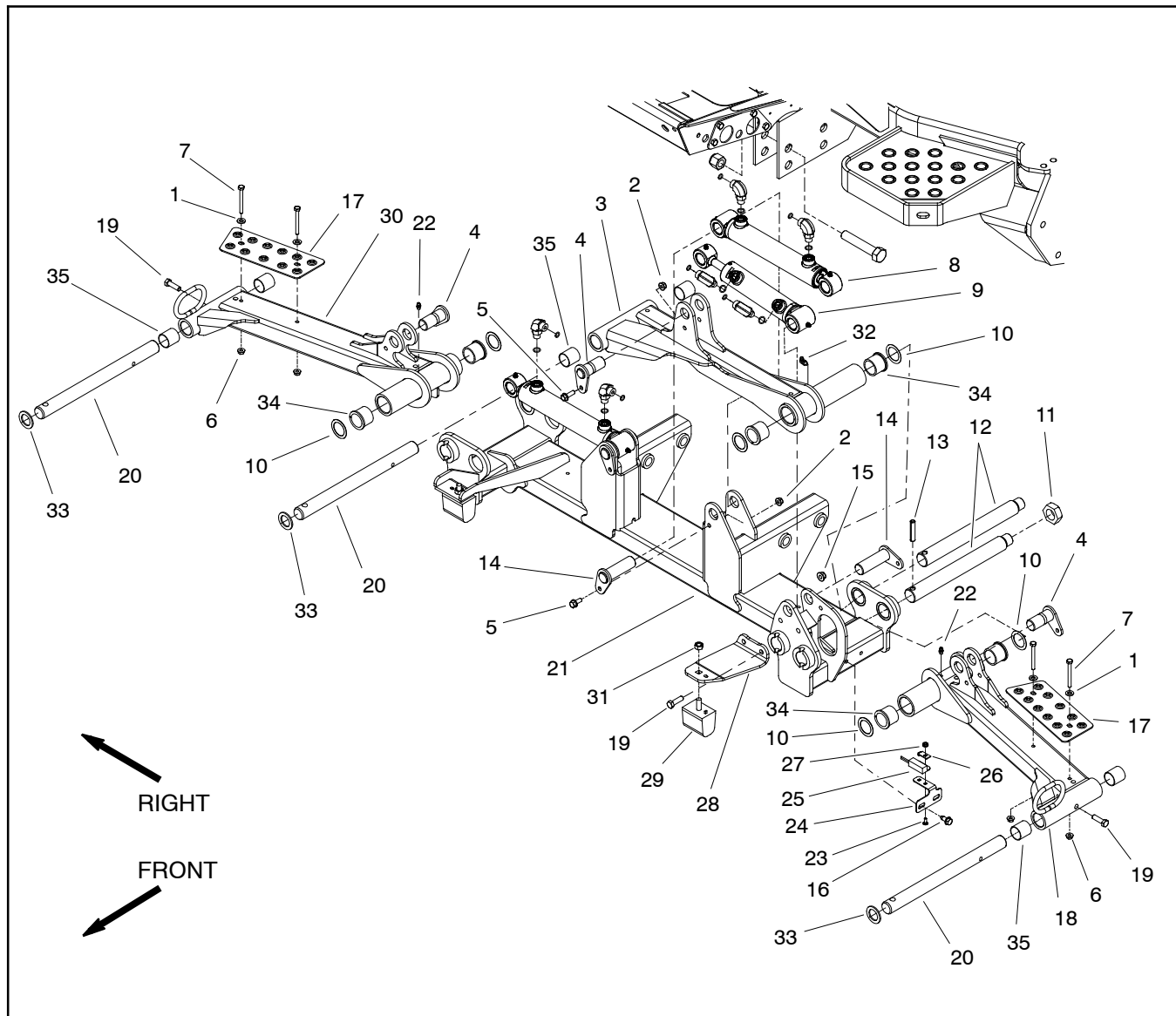


Figure 10

- |                                    |                         |                                     |
|------------------------------------|-------------------------|-------------------------------------|
| 1. Flat washer                     | 13. Slotted roll pin    | 25. Deck position switch            |
| 2. Flange nut                      | 14. Lift cylinder pin   | 26. Switch plate                    |
| 3. Lift arm (#1 deck)              | 15. Flange nut          | 27. Lock nut                        |
| 4. Lift cylinder pin               | 16. Washer head screw   | 28. Bumper support bracket          |
| 5. Flange head screw               | 17. Skid plate          | 29. Bumper                          |
| 6. Flange nut                      | 18. Lift arm (#4 deck)  | 30. Lift arm (#5 deck)              |
| 7. Cap screw                       | 19. Cap screw           | 31. Lock nut                        |
| 8. Lift cylinder (#4 and #5 decks) | 20. Carrier pivot shaft | 32. Grease fitting                  |
| 9. Lift cylinder (#1 deck)         | 21. Front carrier frame | 33. Thrust washer                   |
| 10. Thrust washer (2 used per arm) | 22. Grease fitting      | 34. Flange bushing (2 used per arm) |
| 11. Lock nut                       | 23. Carriage bolt       | 35. Bushing (2 used per arm)        |
| 12. Pivot pin                      | 24. Switch bracket      |                                     |

### Removal (Fig 10)

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).
3. If lift arm for either deck #4 or #5 (Fig. 11) is to be removed, clean, label and remove hydraulic hoses from the deck motor (Fig. 12). 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 10 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 (Fig 10)

1. Assemble lift arm using Figure 10 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).
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 (Fig. 12). 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.

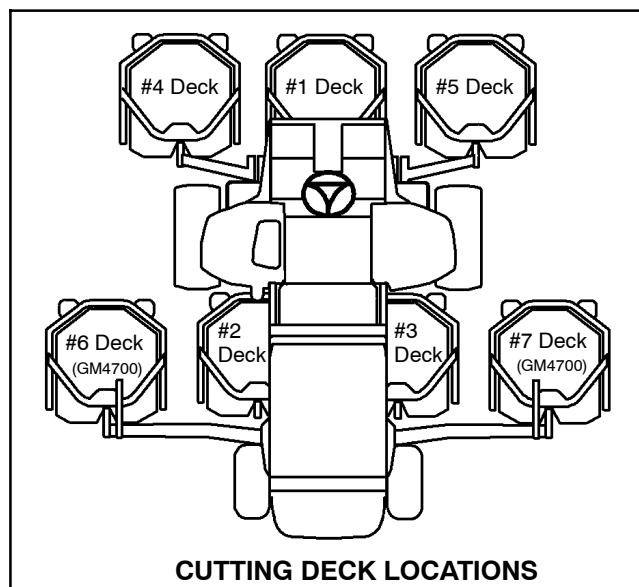


Figure 11

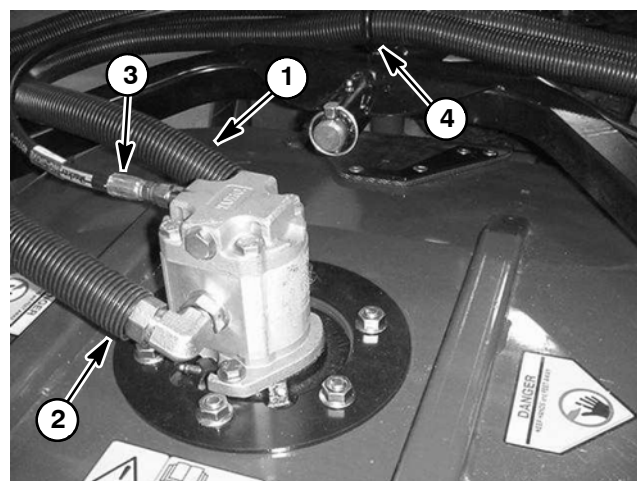


Figure 12

- |                |                        |
|----------------|------------------------|
| 1. Supply hose | 3. Case drain hose     |
| 2. Return hose | 4. Hose retaining loop |

## Lift Arms for Cutting Decks #2 and #3

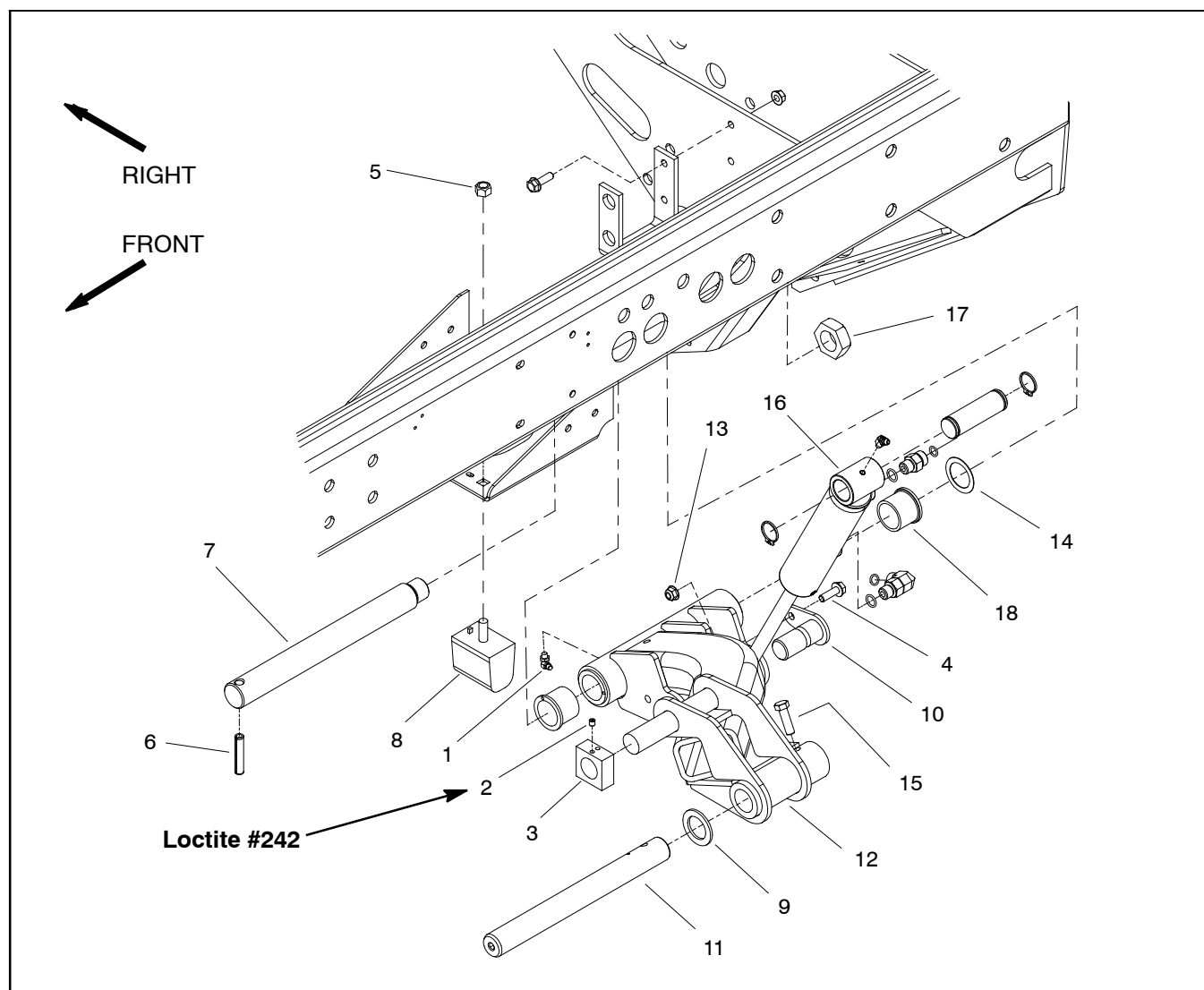


Figure 13

- |                                |                              |                                     |
|--------------------------------|------------------------------|-------------------------------------|
| 1. Grease fitting              | 7. Pivot pin                 | 13. Flange nut                      |
| 2. Set screw (2 used per stop) | 8. Bumper                    | 14. Thrust washer                   |
| 3. Rotation stop               | 9. Thrust washer             | 15. Cap screw                       |
| 4. Flange head screw           | 10. Lift cylinder pin        | 16. Lift cylinder                   |
| 5. Lock nut                    | 11. Deck pivot shaft         | 17. Lock nut                        |
| 6. Slotted roll pin            | 12. Lift arm (#2 deck shown) | 18. Flange bushing (2 used per arm) |



### Removal (Fig. 13)

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).
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 13 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 (Fig. 13)

1. Assemble lift arm using Figure 13 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.

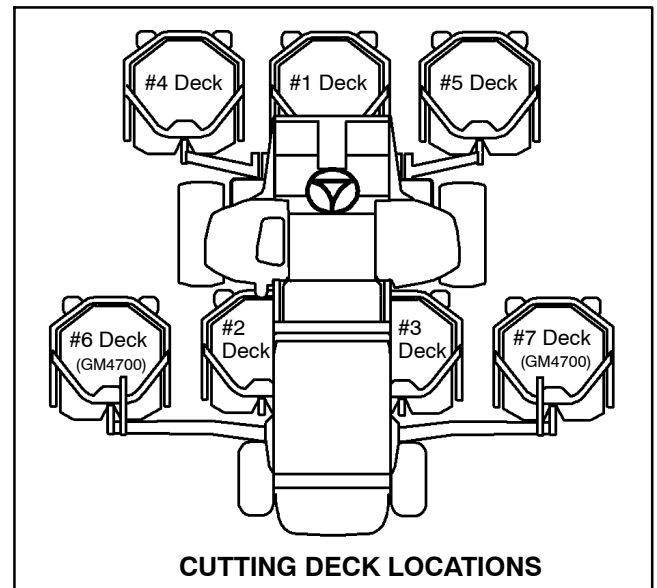


Figure 14

## Lift Arms for Cutting Decks #6 and #7 (Groundsmaster 4700-D)

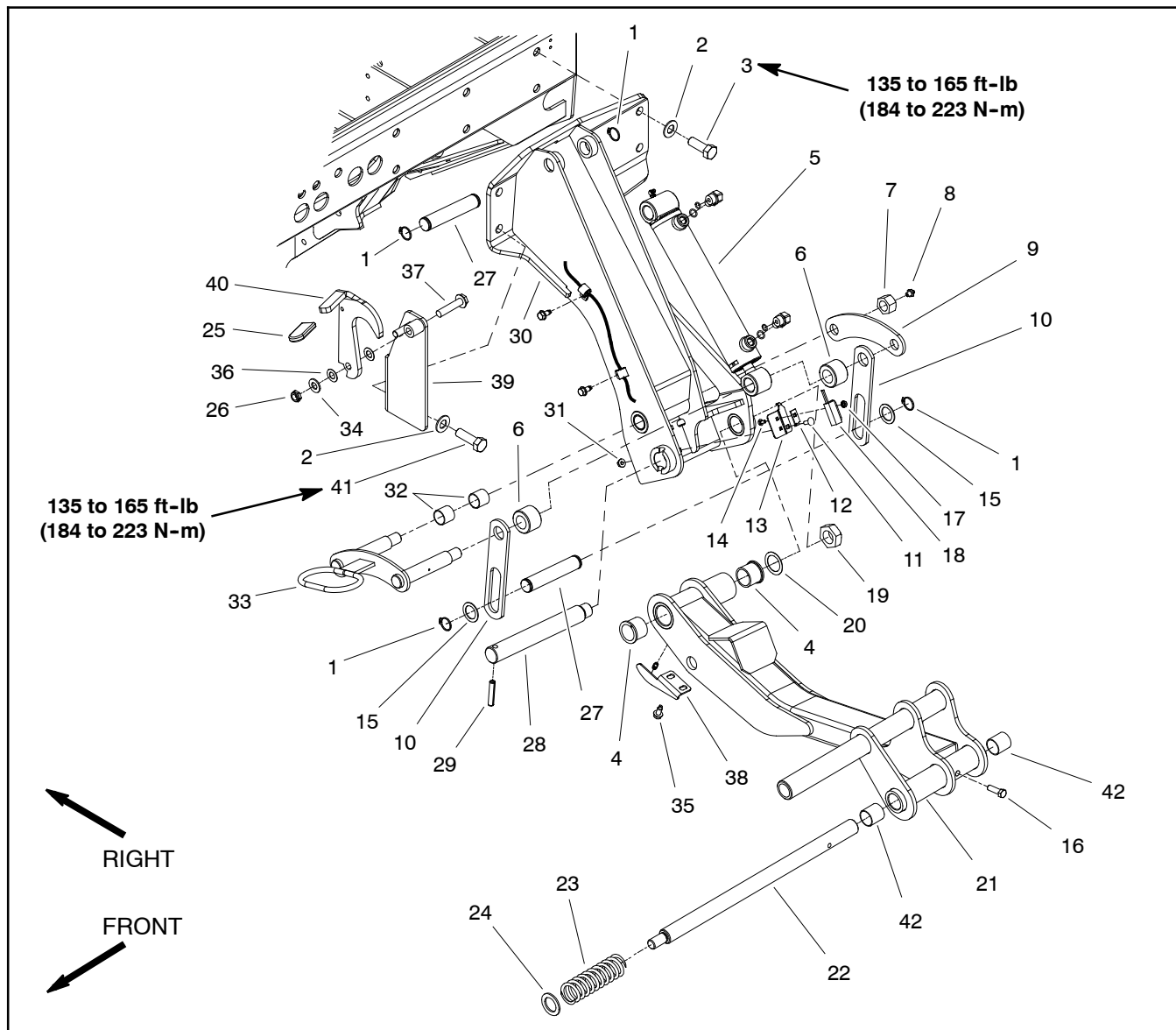


Figure 15

- |   |                              |                                 |
|---|------------------------------|---------------------------------|
| 1. Retaining ring                       | 15. Thrust washer            | 29. Slotted roll pin            |
| 2. Flat washer (4 used per support arm) | 16. Cap screw                | 30. Support arm (deck #6 shown) |
| 3. Cap screw (4 used per support arm)   | 17. Lock nut                 | 31. Flange nut                  |
| 4. Flange bushing                       | 18. Deck position switch     | 32. Bushing                     |
| 5. Lift cylinder                        | 19. Lock nut                 | 33. Link                        |
| 6. Plastic roller                       | 20. Thrust washer            | 34. Flat washer                 |
| 7. Lock nut                             | 21. Lift arm (deck #6 shown) | 35. Self tapping screw          |
| 8. Grease fitting                       | 22. Carrier pivot pin        | 36. Washer                      |
| 9. Rear link                            | 23. Compression spring       | 37. Flange head screw           |
| 10. Lift link                           | 24. Thrust washer            | 38. Switch actuator             |
| 11. Carriage screw                      | 25. Plastic grip             | 39. Latch arm (LH shown)        |
| 12. Switch plate                        | 26. Lock nut                 | 40. Latch (LH shown)            |
| 13. Switch bracket                      | 27. Pin                      | 41. Cap screw                   |
| 14. Carriage bolt                       | 28. Pivot pin                | 42. Bushing                     |

### Removal (Fig. 15)

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).
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 15 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 (Fig. 15)

1. Assemble lift arm using Figure 15 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.

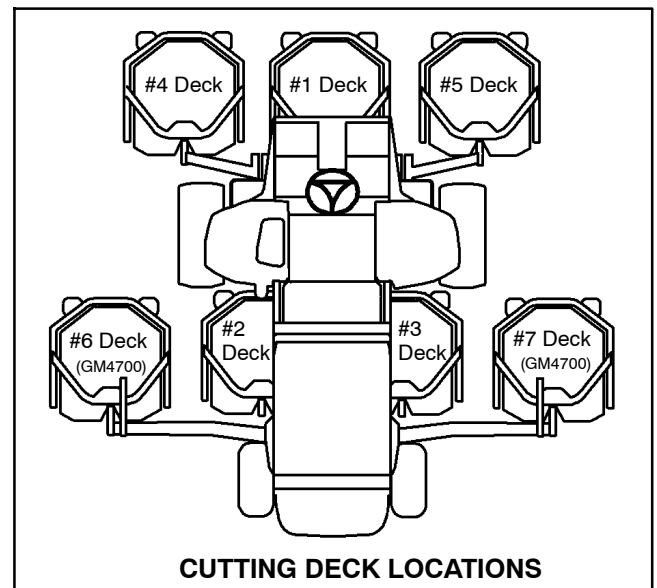


Figure 16

## Operator Seat

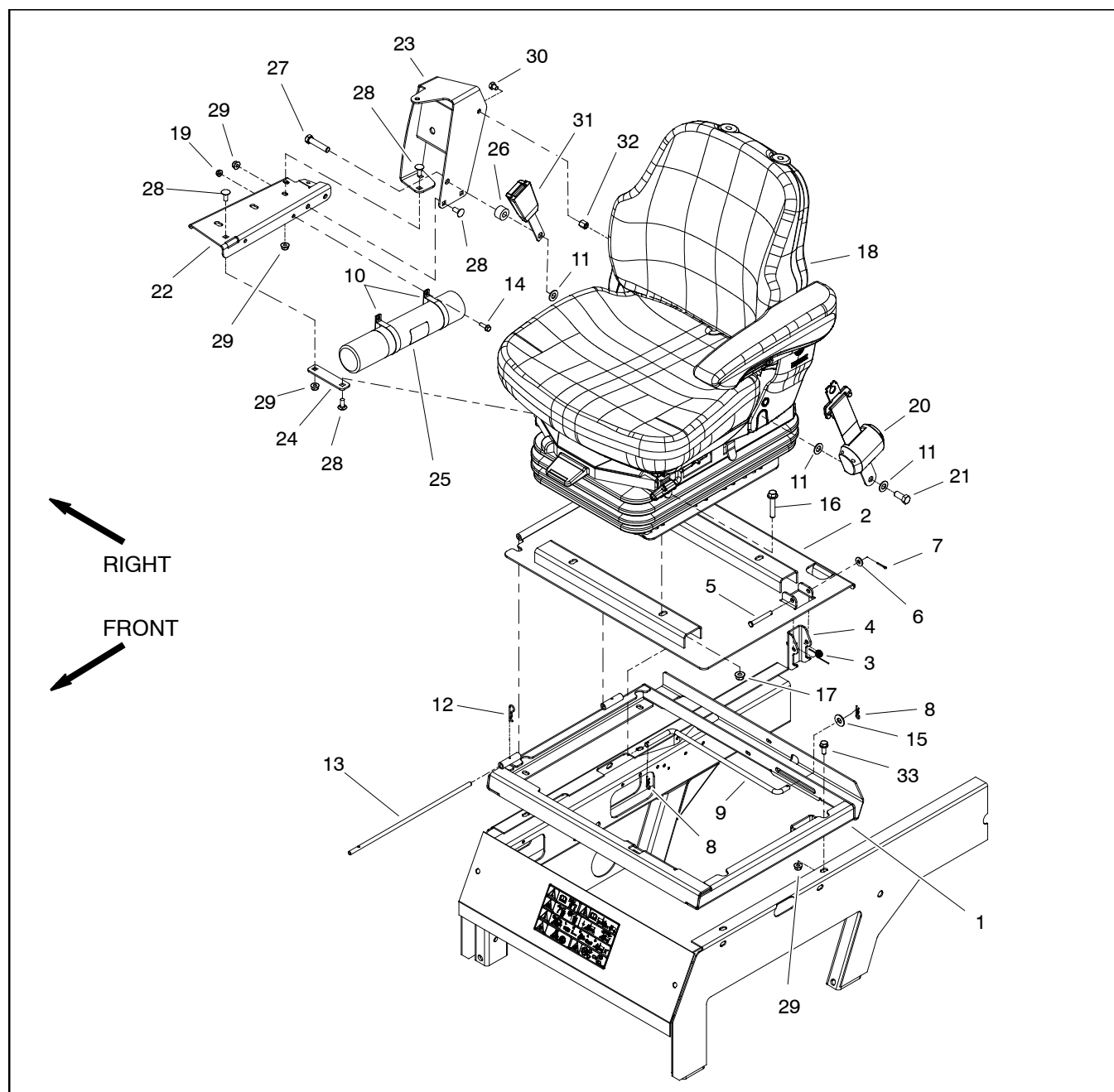


Figure 17

- |                            |                                |                                |
|----------------------------|--------------------------------|--------------------------------|
| 1. Seat frame              | 12. Hair pin                   | 23. Arm support                |
| 2. Seat plate              | 13. Seat pivot shaft           | 24. Support bracket            |
| 3. Torsion spring          | 14. Screw (2 used)             | 25. Manual tube                |
| 4. Seat plate latch        | 15. Flat washer (2 used)       | 26. Spacer                     |
| 5. Clevis pin              | 16. Flange head screw (4 used) | 27. Cap screw                  |
| 6. Flat washer             | 17. Flange nut (4 used)        | 28. Carriage screw (6 used)    |
| 7. Cotter pin              | 18. Seat assembly              | 29. Flange nut (9 used)        |
| 8. Hair pin (4 used)       | 19. Flange nut (2 used)        | 30. Cap screw                  |
| 9. Seat frame rod (2 used) | 20. Seat belt                  | 31. Seat belt latch            |
| 10. R-clamp (2 used)       | 21. Cap screw                  | 32. Hex nut                    |
| 11. Flat washer (3 used)   | 22. Support channel            | 33. Flange head screw (4 used) |

### Removal (Fig. 17)

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 (Fig. 18). 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.

### Installation (Fig. 17)

1. Carefully position seat to seat suspension.
2. Secure seat to seat suspension with four (4) torx head screws (Fig. 18). Make sure that longer screw is positioned near the seat adjustment handle. Torque screws **18 ft-lb (25 N-m)**.

**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.

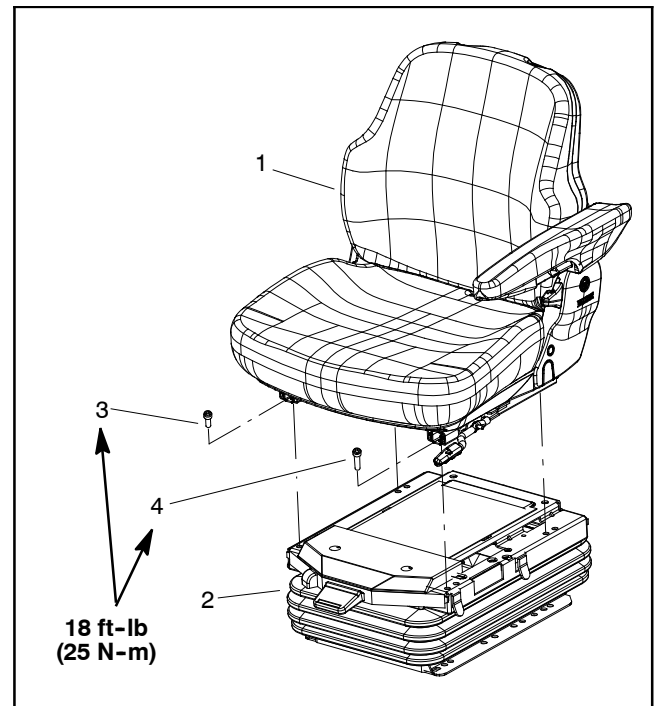


Figure 18

- |                        |                           |
|------------------------|---------------------------|
| 1. Seat                | 3. Screw (M8x12) (3 used) |
| 2. Suspension assembly | 4. Screw (M8x16)          |

## Operator Seat Service

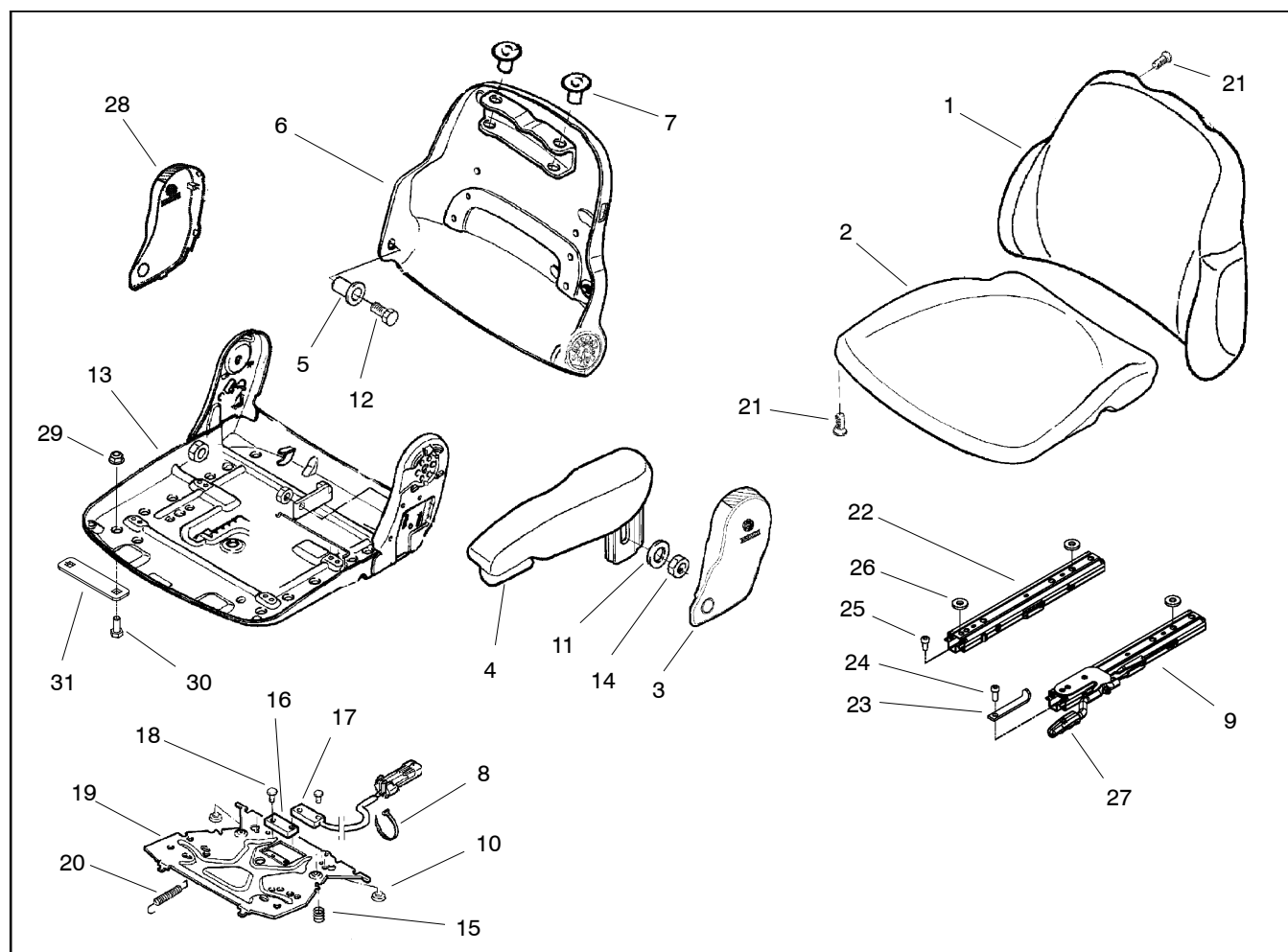


Figure 19

- |                       |                         |                         |
|-----------------------|-------------------------|-------------------------|
| 1. Backrest cushion   | 12. Cap screw (2 used)  | 22. RH adjustment rail  |
| 2. Seat cushion       | 13. Seat                | 23. Rail stop           |
| 3. LH armrest cover   | 14. Nut                 | 24. Torx screw          |
| 4. LH armrest         | 15. Spring (2 used)     | 25. Torx screw (3 used) |
| 5. Bushing (2 used)   | 16. Magnet              | 26. Washer (3 used)     |
| 6. Backrest           | 17. Seat switch         | 27. Handle              |
| 7. Plug (2 used)      | 18. Rivet (4 used)      | 28. RH armrest cover    |
| 8. Cable tie (3 used) | 19. Mounting plate      | 29. Nut                 |
| 9. LH adjustment rail | 20. Return spring       | 30. Cap screw           |
| 10. Bumper (2 used)   | 21. Torx screw (5 used) | 31. Support bracket     |
| 11. Washer            |                         |                         |

### **Disassembly (Fig. 19)**

1. Remove seat from machine for service (see Operator Seat Removal in this section).
2. Disassemble operator seat as necessary using Figure 19 as a guide.

### **Assembly (Fig. 19)**

1. Assemble operator seat using Figure 19 as a guide.
2. Install seat to machine (see Operator Seat Installation in this section).

## Operator Seat Suspension

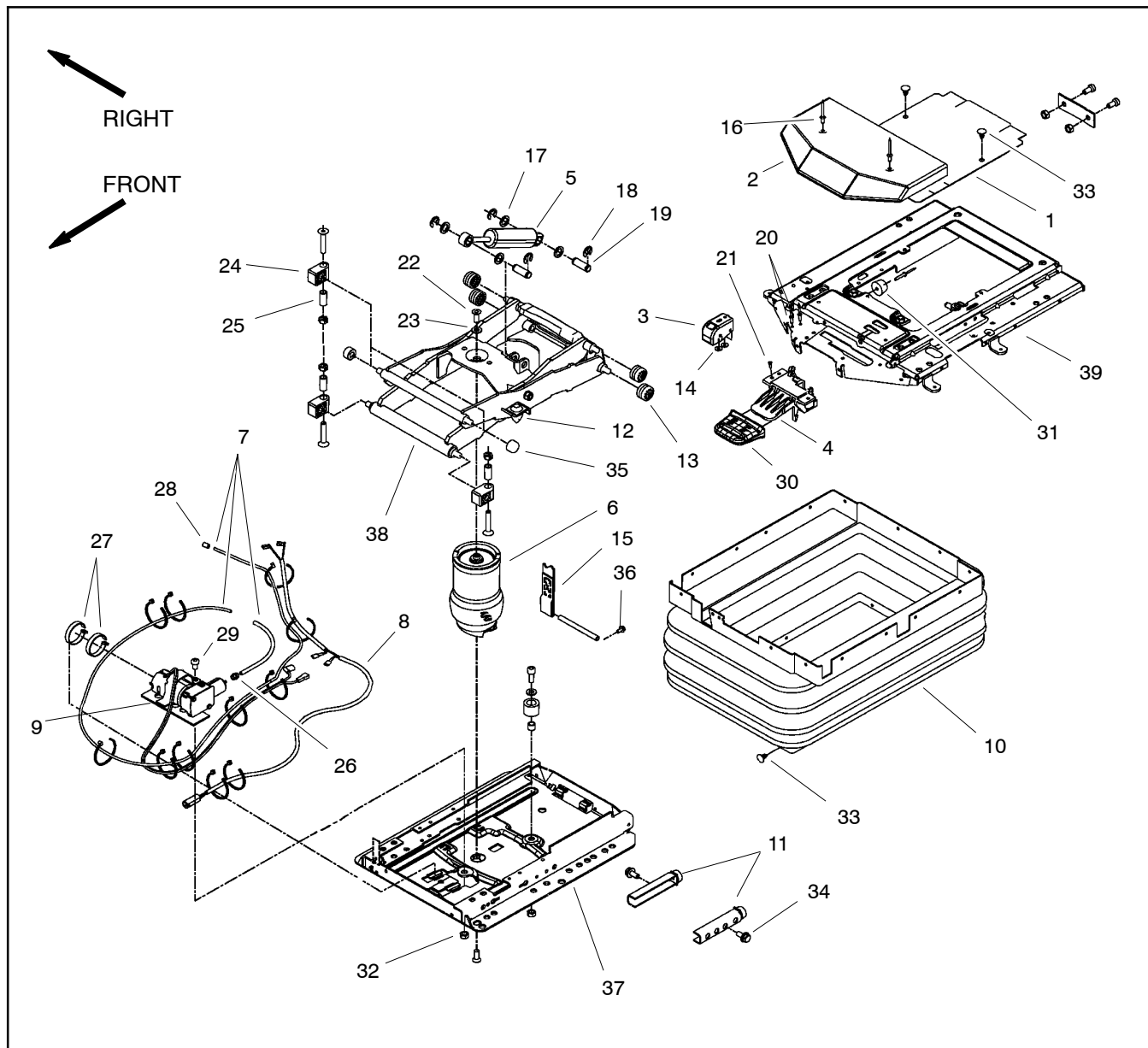


Figure 20

- |                         |                              |                            |
|-------------------------|------------------------------|----------------------------|
| 1. Cover                | 14. Washer (2 used)          | 27. Clamp (2 used)         |
| 2. Cover                | 15. Tether                   | 28. Hose nipple            |
| 3. Level control        | 16. Rivet (2 used)           | 29. Screw                  |
| 4. Air control valve    | 17. Washer (4 used)          | 30. Handle                 |
| 5. Shock absorber       | 18. C-clip (4 used)          | 31. Bumper                 |
| 6. Air spring           | 19. Pin (2 used)             | 32. Nut                    |
| 7. Air tube assembly    | 20. Rivet (2 used)           | 33. Plastic plug (23 used) |
| 8. Wire harness         | 21. Washer (3 used)          | 34. Screw (2 used)         |
| 9. Compressor           | 22. Screw (2 used)           | 35. Roller (2 used)        |
| 10. Bellows             | 23. Washer                   | 36. Screw (4 used)         |
| 11. Stop                | 24. Housing support (4 used) | 37. Base plate             |
| 12. Bumper set (2 used) | 25. Spacer (4 used)          | 38. Suspension frame       |
| 13. Roller (4 used)     | 26. Hose nipple              | 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 (Fig. 20)

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 Removal in this section).

3. Disconnect seat suspension electrical connector from machine wire harness.

4. If the air spring assembly (item 6) or base plate (item 37) requires removal, remove seat suspension from seat plate (Fig. 21):

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 20 as a guide.

### Assembly (Fig. 20)

1. Install all removed seat suspension components using Figure 20 as a guide.

2. If seat suspension was removed from seat platform (Fig. 21):

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 Installation in this section).

4. Make sure that seat electrical connectors are secured to machine wire harness.

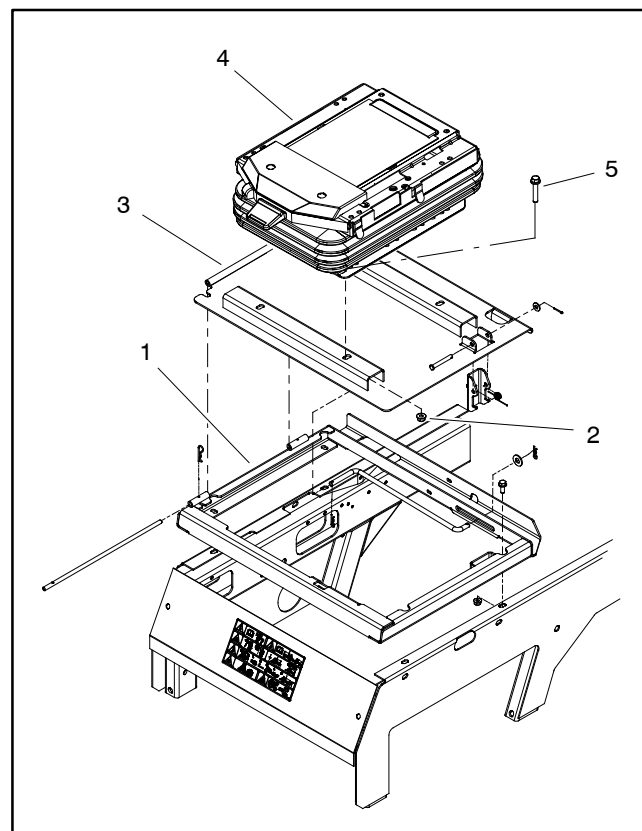


Figure 21

- |                        |                          |
|------------------------|--------------------------|
| 1. Seat frame          | 4. Seat suspension       |
| 2. Flange nut (4 used) | 5. Flange screw (4 used) |
| 3. Seat plate          |                          |

## Hood

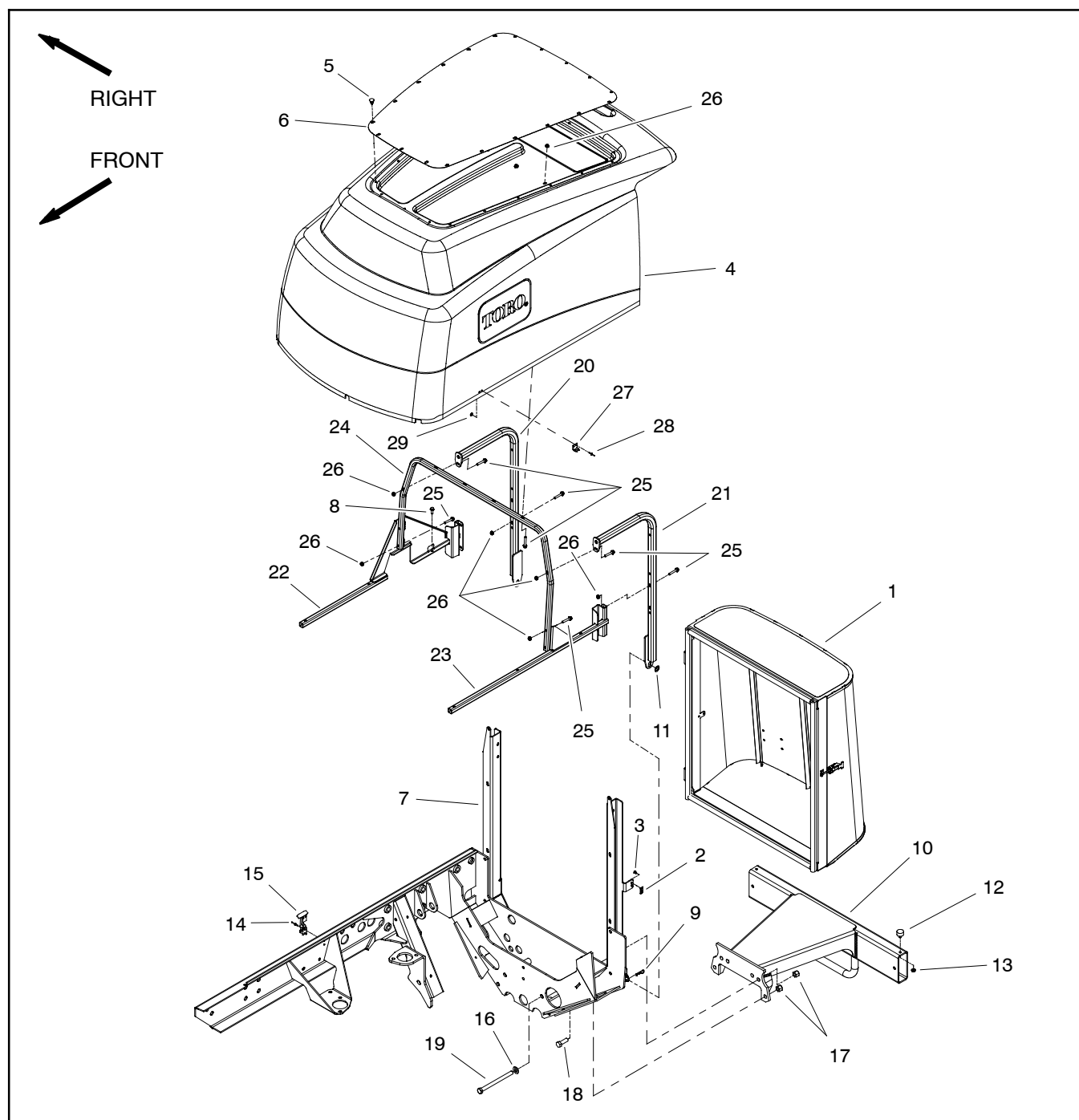


Figure 22

- |                           |                              |                                 |
|---------------------------|------------------------------|---------------------------------|
| 1. Screen                 | 11. Washer (2 used)          | 21. LH hood frame tube          |
| 2. Latch keeper           | 12. Rubber bumper (2 used)   | 22. RH hood frame tube          |
| 3. Pop rivet (2 used)     | 13. Flange nut (2 used)      | 23. LH hood frame tube          |
| 4. Hood                   | 14. Pop rivet (4 used)       | 24. Hood frame tube             |
| 5. Plastic plug (20 used) | 15. Flex draw latch (2 used) | 25. Flange head screw (25 used) |
| 6. Hood screen            | 16. Flat washer (2 used)     | 26. Flange nut (26 used)        |
| 7. Radiator mount         | 17. Lock nut (4 used)        | 27. Latch keeper (2 used)       |
| 8. Flange head screw      | 18. Cap screw (2 used)       | 28. Pop rivet (4 used)          |
| 9. Hair pin (2 used)      | 19. Cap screw (2 used)       | 29. Back washer (4 used)        |
| 10. Rear bumper           | 20. RH hood frame tube       |                                 |

**Removal (Fig. 22)**

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 22 as a guide.
6. Check bulb seals on screen (item 1) and replace seals if damaged.

**Installation (Fig. 22)**

1. If components were removed from hood, assemble hood using Figure 22 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.

This page is intentionally blank.

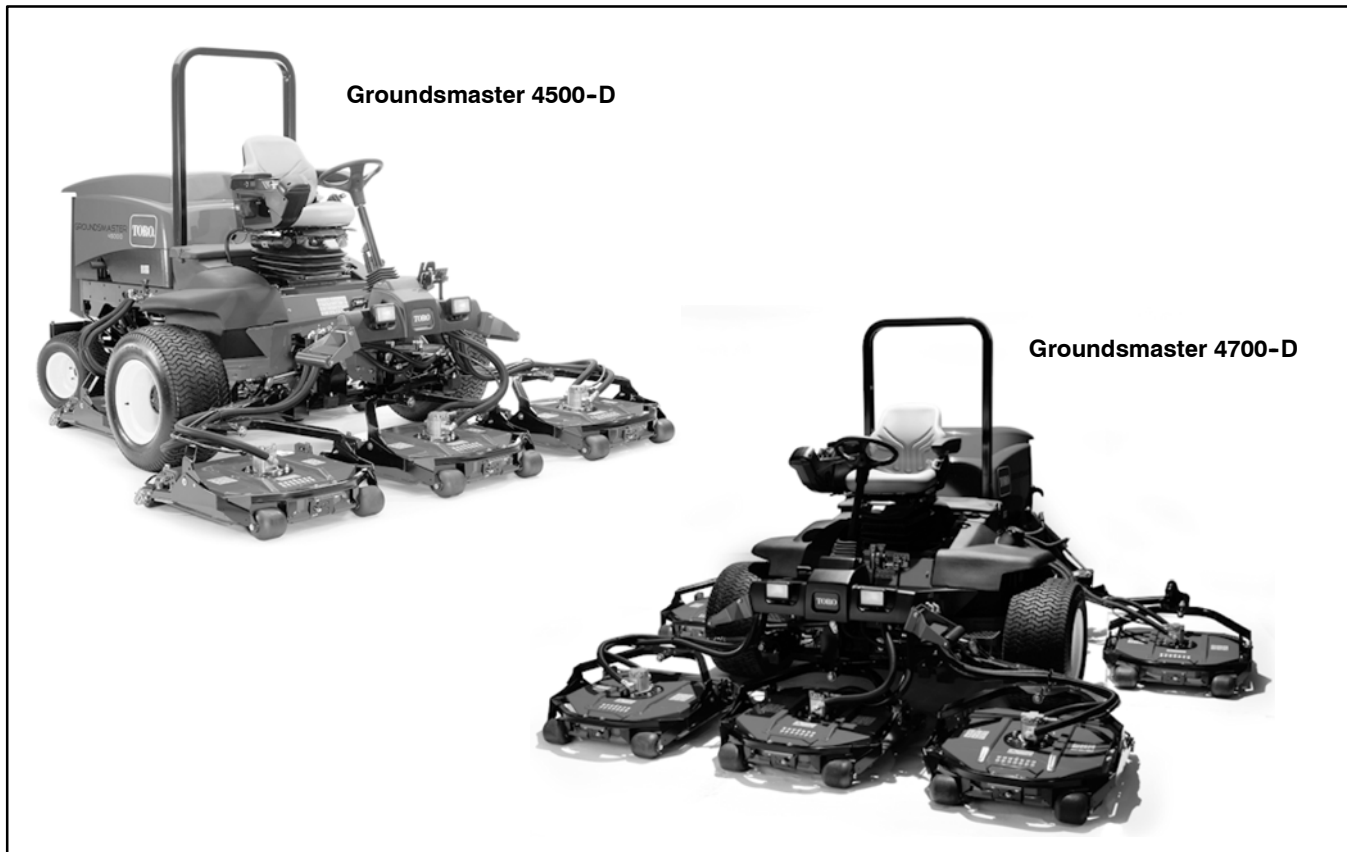


# Cutting Decks

## Table of Contents

SPECIFICATIONS .....	2
GENERAL INFORMATION .....	3
Operator's Manual .....	3
TROUBLESHOOTING .....	4
Factors That Can Affect Quality of Cut .....	4
SPECIAL TOOLS .....	5
ADJUSTMENTS .....	6
Blade Stopping Time .....	6
SERVICE AND REPAIRS .....	8
Blade Spindle Assembly .....	8
Blade Spindle Service .....	10
Rear Roller .....	12
Rear Roller Service .....	14
Front Roller Service .....	16
Cutting Deck Carrier Frame .....	18

# Specifications



**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:** 3/4 to 4 inch (19 to 101 mm) in 1/4 inch (6.4 mm) 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 1-1/4 inch (31.7 mm) shafts supported by greaseable, tapered roller bearings in a ductile iron housing.

**CUTTING BLADE:** Each cutting deck equipped with a 27 inch (686 mm) length, 0.250 inch (6.4 mm) 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 195 lb (89 kg).

# 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 Cutting Deck Operator's Manual provides information regarding the operation, general maintenance and maintenance intervals for the cutting deck on your Groundsmaster machine. Refer to that publication for additional information when servicing the cutting deck.

# Troubleshooting

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

Remember that the “effective” or actual height-of-cut depends on cutting deck weight, counterbalance setting 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
1. Maximum governed engine speed.	Check maximum governed engine speed. Adjust speed to specifications if necessary.
2. Blade speed.	All deck blades should rotate at the same speed.  See items in Troubleshooting Section of Chapter 4 - Hydraulic System.
3. Tire pressure.	Check air pressure of each tire. Adjust to pressures specified in Traction Unit Operator's Manual.
4. Blade condition.	Sharpen blades if their cutting edges are dull or nicked.  Inspect blade sail for wear or damage. Replace blade if needed.
5. Mower housing condition.	Make sure that cutting chambers are in good condition.  Keep underside of deck clean. Debris buildup will reduce cutting performance.
6. Height-of-cut.	Make sure all cutting decks are set at the same height-of-cut. Adjust cutting decks as specified in the Cutting Deck Operator's Manual.  Adjust height-of-cut setting to remove only 1 inch (25 mm) or 1/3 of the grass blade when cutting.
7. 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.
8. Roller condition.	All rollers should rotate freely. Replace bearings if worn or damaged.
9. Grass Conditions.	Mow when grass is dry for best cutting results.



# Special Tools

Order special tools from your Toro Distributor.

## Rear Roller Bearing and Seal Installation Tools

These tools are used to assemble the cutting deck rear roller.

Toro Part Numbers:

Inner Seal Tool	<b>115-0852</b>
Bearing/Outer Seal Tool	<b>115-0853</b>
Bearing Installation Washer	<b>107-8133</b>

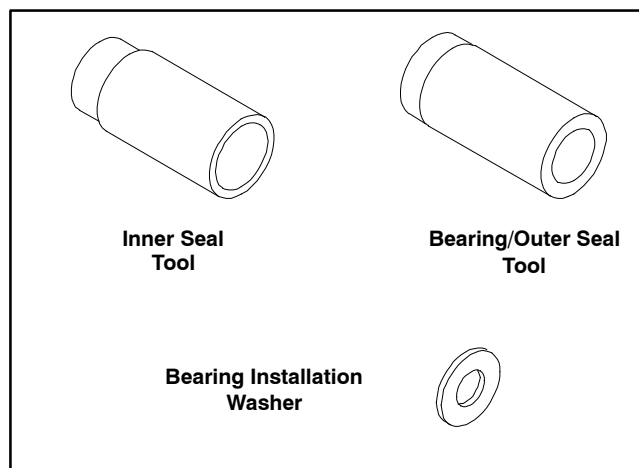


Figure 1

## Front Roller Bearing Installation Tool

The front roller bearing installation tool should be used when installing bearings into the front rollers. This tool presses equally against both the inner and outer bearing races to ensure that no side load is applied to the bearings during installation into the front rollers.

Toro Part Number: **TOR6018**



Figure 2

## Spindle Plug

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

Toro Part Number: **94-2703**

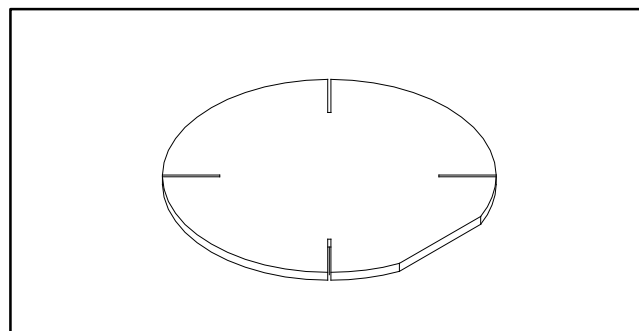


Figure 3

# 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.

This page is intentionally blank.

# 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

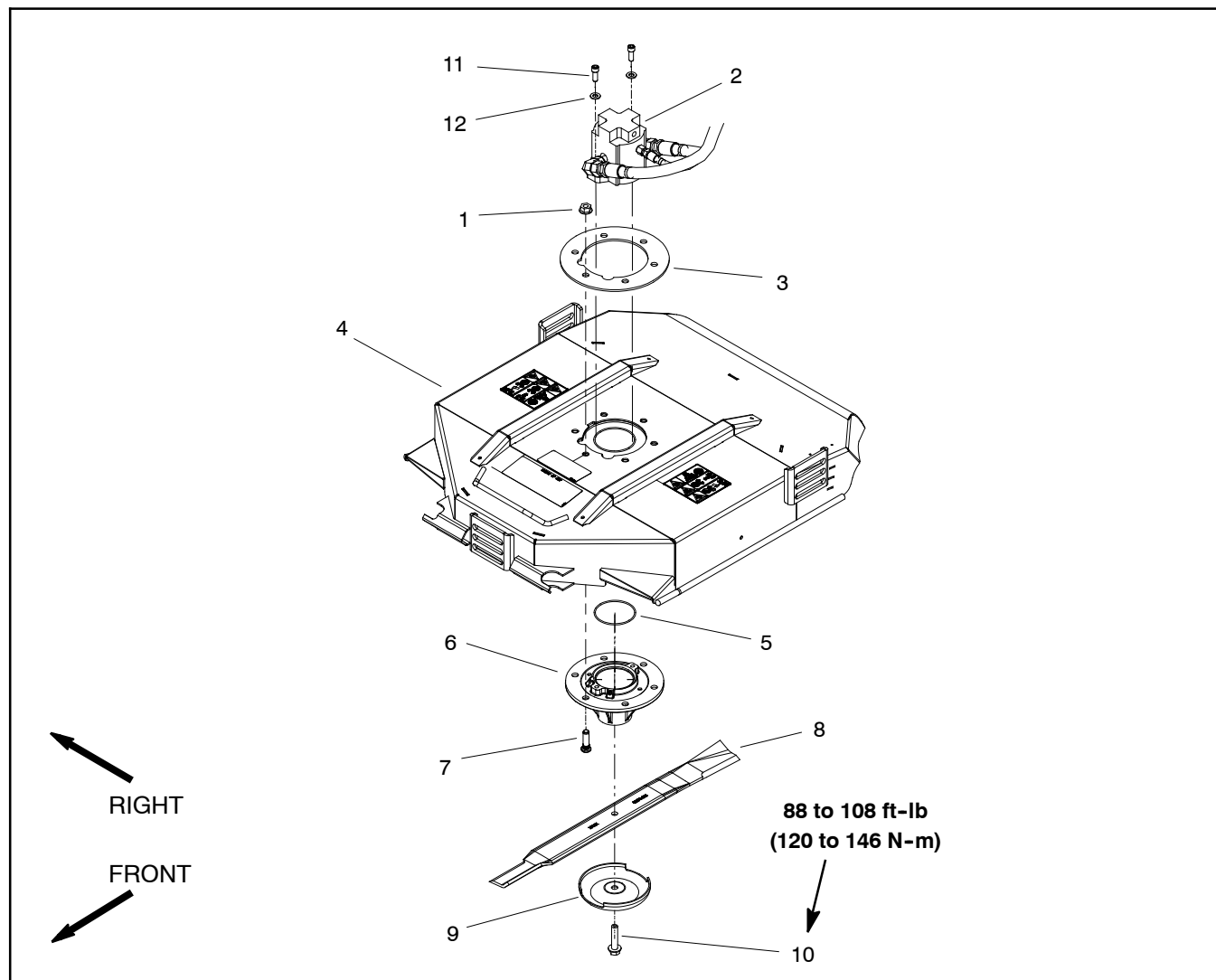


Figure 4

- 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)

### Removal (Fig. 4)

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 (Fig. 5). 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 in this chapter) 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 (Fig. 4)

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 **88 to 108 ft-lb (120 to 146 N-m)**.

5. Remove cover from top of spindle that was placed to prevent debris from entering spindle.

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.

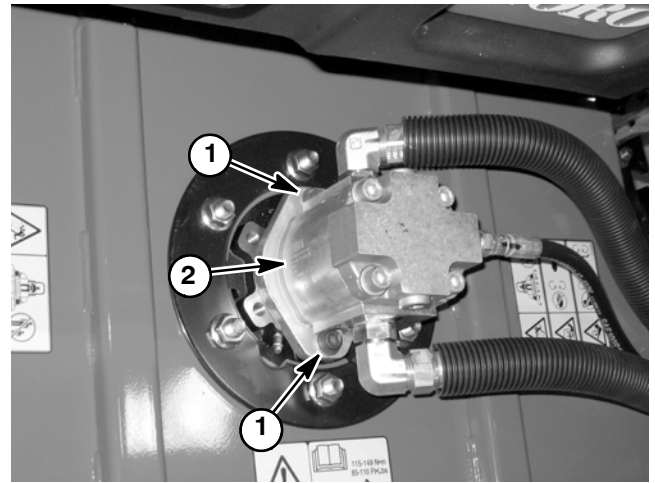


Figure 5

1. Socket head screw

2. Hydraulic motor

## Blade Spindle Service

### Disassembly (Fig. 6)

1. Remove blade spindle from cutting deck (see Blade Spindle Removal in this section).
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.

### Assembly (Fig. 6)

**NOTE:** A replacement spindle bearing set contains two (2) bearings, a spacer ring and a large snap ring (items 1, 2 and 3 in Fig. 7). 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 Fig. 7). 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.

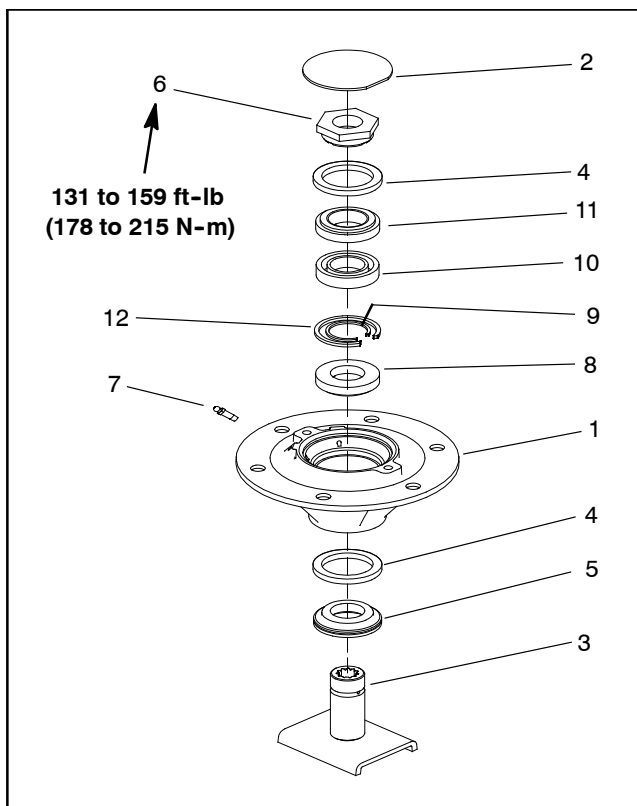


Figure 6

- |                    |                          |
|--------------------|--------------------------|
| 1. Spindle housing | 7. Grease fitting        |
| 2. Spindle plug    | 8. Bearing               |
| 3. Spindle shaft   | 9. Spacer ring           |
| 4. Oil seal        | 10. Spacer set (2 piece) |
| 5. Shaft spacer    | 11. Bearing              |
| 6. Spindle nut     | 12. Large snap ring      |

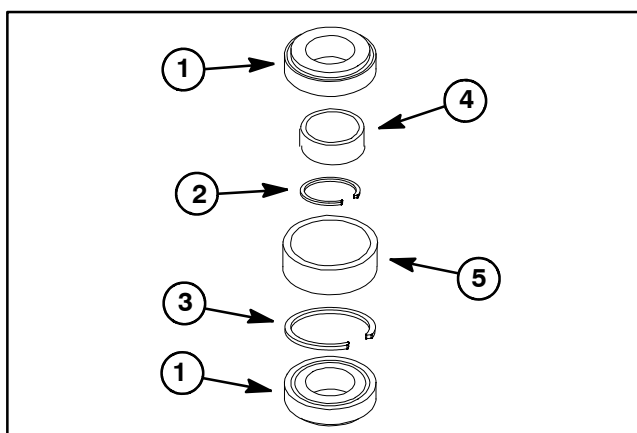


Figure 7

- |                    |                         |
|--------------------|-------------------------|
| 1. Bearing         | 4. Inner bearing spacer |
| 2. Spacer ring     | 5. Outer bearing spacer |
| 3. Large snap ring |                         |

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 (Fig 8).

4. Pack the bearing cones with grease. Apply a film of grease on lips of oil seals.

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) (Fig. 9). 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 (Fig. 7).**

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) (Fig. 9).

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 **131 to 159 ft-lb (178 to 215 N-m)**.

**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 Installation in this section).

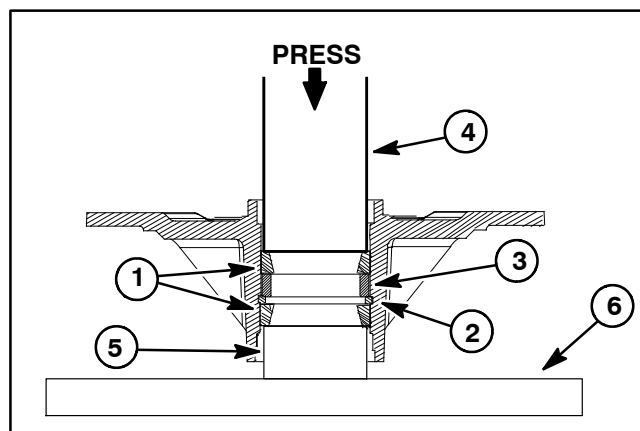


Figure 8

- |                    |                     |
|--------------------|---------------------|
| 1. Bearing cup     | 4. Arbor press      |
| 2. Large snap ring | 5. Support          |
| 3. Large spacer    | 6. Arbor press base |

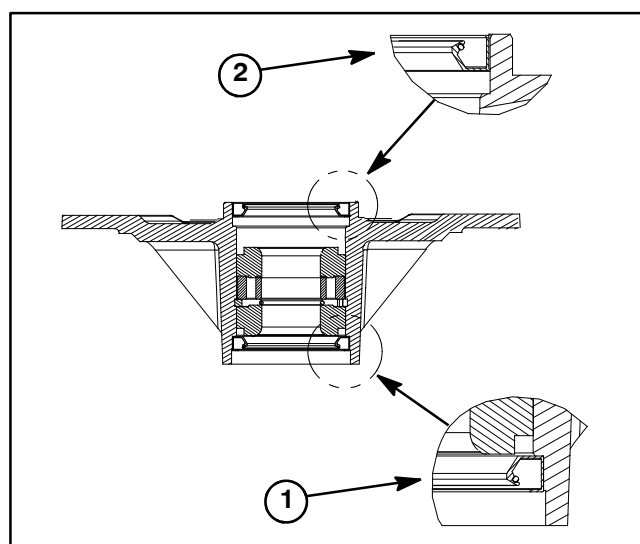


Figure 9

- |                             |                            |
|-----------------------------|----------------------------|
| 1. Bottom seal installation | 2. Upper seal installation |
|-----------------------------|----------------------------|

## Rear Roller

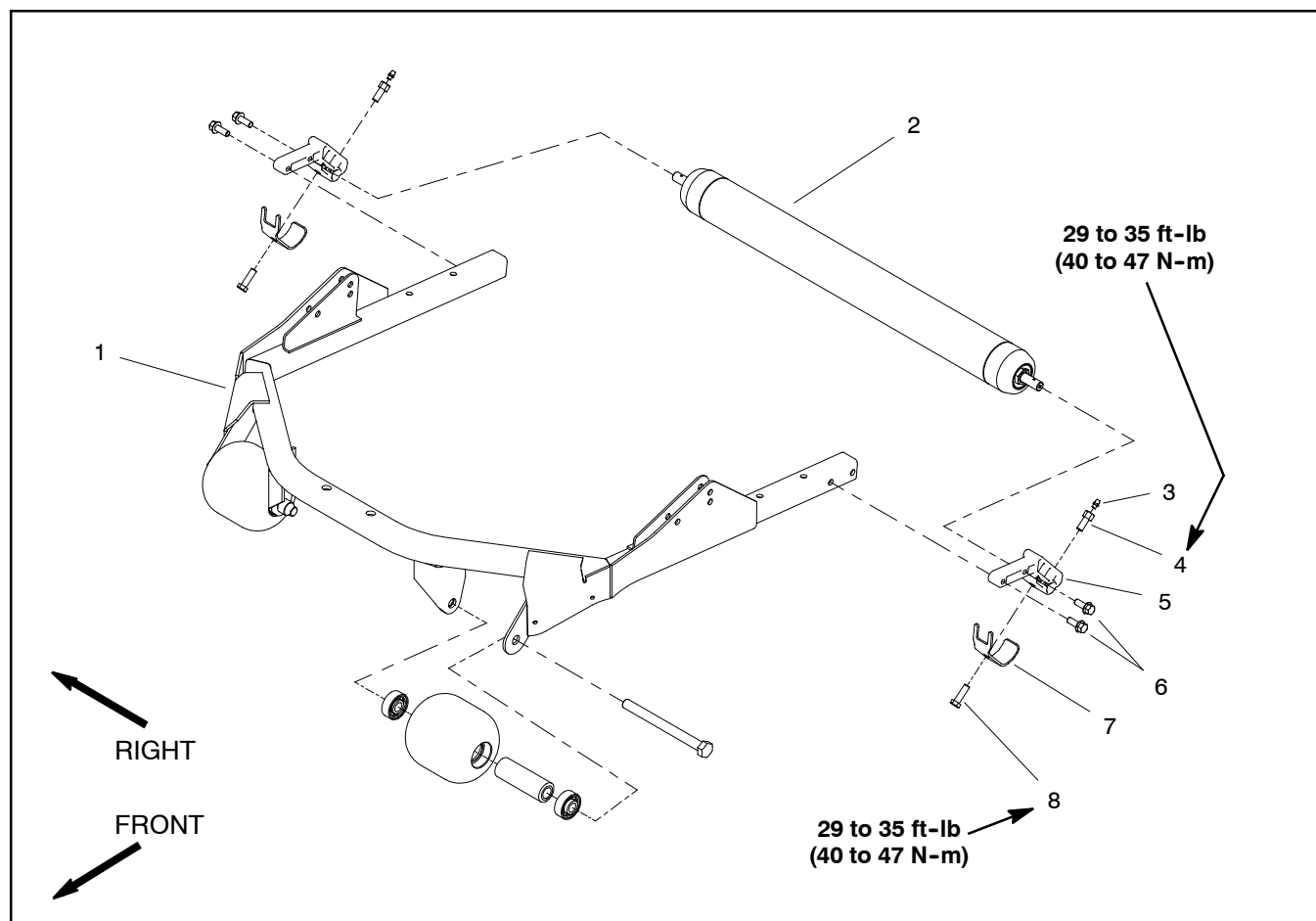


Figure 10

- 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 (Fig. 10)

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 (Fig. 11), remove fasteners securing left and right scraper rod brackets to roller mounts. Remove scraper rod assembly.
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 (Fig. 10)

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 (Fig. 11). The gap between the scraper rod and roller should be from 0.020 to 0.040 in (0.5 to 1.0 mm). Torque cap screws **30 ft-lb (41 N-m)**.
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 **29 to 35 ft-lb (40 to 47 N-m)**.
7. After assembly, raise and lower the cutting deck to verify that hydraulic hoses and fittings do not contact anything.

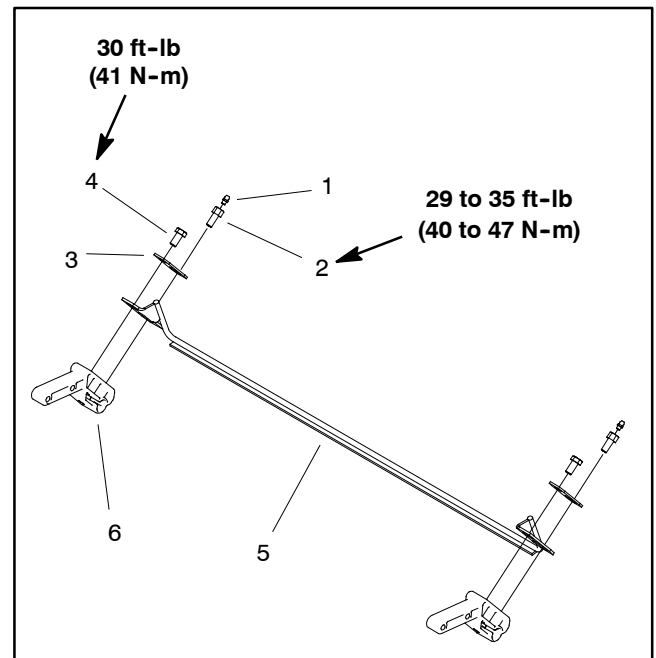


Figure 11

- |                       |                   |
|-----------------------|-------------------|
| 1. Grease fitting     | 4. Cap screw      |
| 2. Roller shaft screw | 5. Roller scraper |
| 3. Scraper plate      | 6. Roller mount   |

## Rear Roller Service

### Disassembly (Fig. 12)

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 (Fig. 12)

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) and soft face hammer to fully seat seals against roller shoulder (Fig. 13). 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.**

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) with a soft face hammer to fully seat bearing against roller shoulder (Fig. 14). 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.

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) and soft face hammer to lightly seat seal against roller shoulder (Fig. 15). 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.

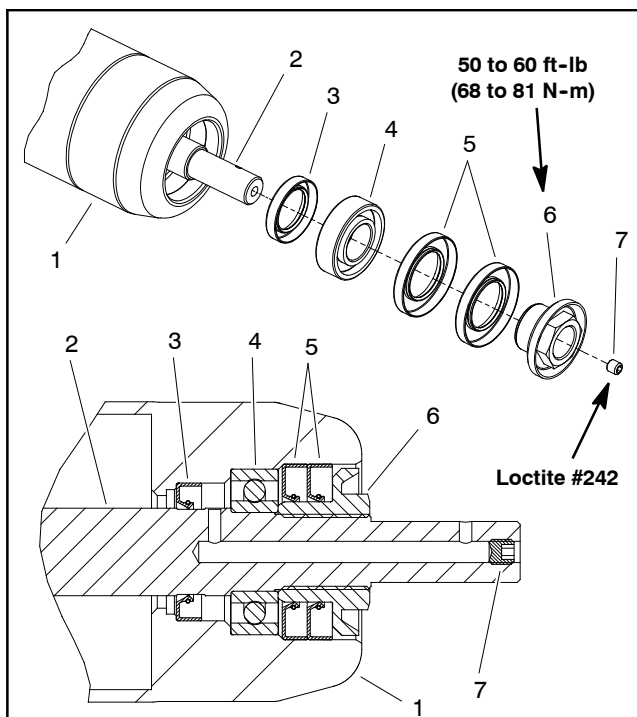


Figure 12

- |                 |                     |
|-----------------|---------------------|
| 1. Roller tube  | 5. Outer seal       |
| 2. Roller shaft | 6. Bearing lock nut |
| 3. Inner seal   | 7. Set screw        |
| 4. Bearing      |                     |

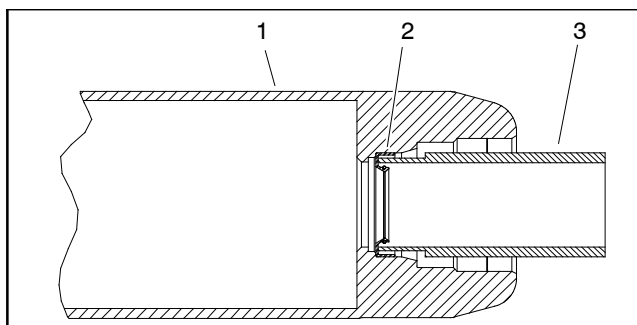


Figure 13

- |                |                    |
|----------------|--------------------|
| 1. Roller tube | 3. Inner seal tool |
| 2. Inner seal  |                    |

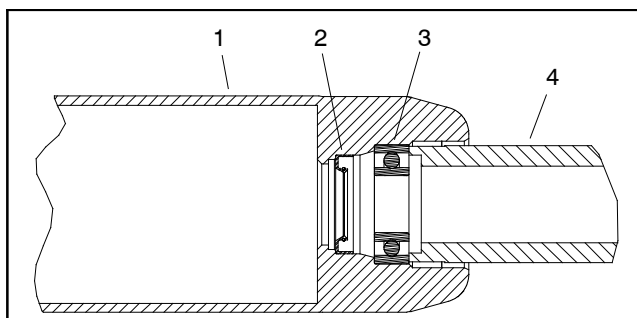


Figure 14

- |                |                            |
|----------------|----------------------------|
| 1. Roller tube | 3. Bearing                 |
| 2. Inner seal  | 4. Bearing/outer seal tool |

3. From the roller tube end with only the inner seal installed, carefully install the roller shaft into the roller tube. Make sure that seals are not damaged as shaft is installed.

4. Install new bearing and outer seals into second end of roller tube:

A. Position a second new bearing to roller shaft and tube. Position washer (see Special Tools) on bearing to allow pressing on both inner and outer bearing races simultaneously.

B. Use washer and bearing/outer seal tool (see Special Tools) with a soft face hammer to fully seat bearing (Fig. 16). 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.

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) and soft face hammer to lightly seat seal (Fig. 17). 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 **50 to 60 ft-lb (68 to 81 N-m)**.

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 5 in-lbs (0.68 N-m) resistance.

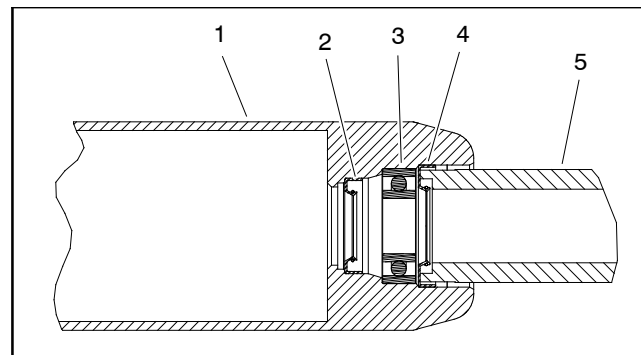


Figure 15

- |                |                            |
|----------------|----------------------------|
| 1. Roller tube | 4. Outer seal              |
| 2. Inner seal  | 5. Bearing/outer seal tool |
| 3. Bearing     |                            |

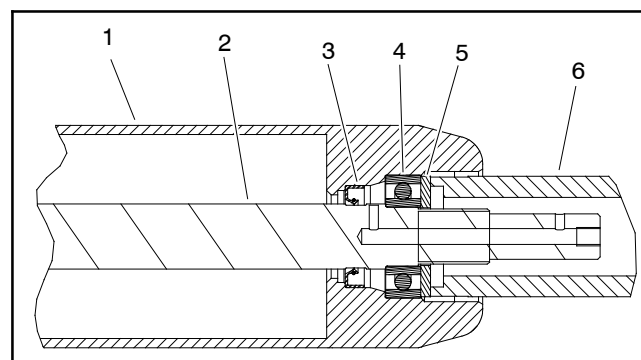


Figure 16

- |                 |                            |
|-----------------|----------------------------|
| 1. Roller tube  | 4. Bearing                 |
| 2. Roller shaft | 5. Washer                  |
| 3. Inner seal   | 6. Bearing/outer seal tool |

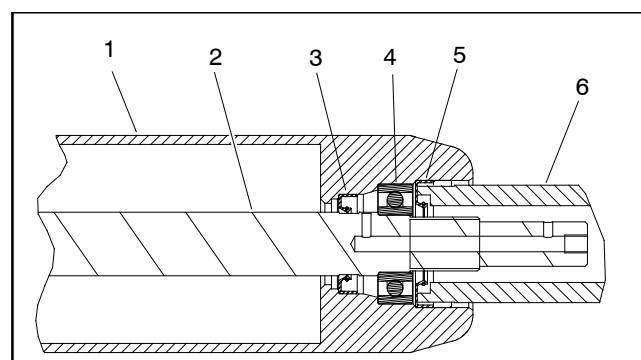


Figure 17

- |                 |                            |
|-----------------|----------------------------|
| 1. Roller tube  | 4. Bearing                 |
| 2. Roller shaft | 5. Outer seal              |
| 3. Inner seal   | 6. Bearing/outer seal tool |

## Front Roller Service

### Disassembly (Fig. 18)

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 (Fig. 18)

1. Install bearings and bearing spacer into roller:

**IMPORTANT: Use Front Roller Bearing Installation Tool (see Special Tools in this chapter) 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 0.060 inch (1.5 mm) creates a side load on bearings and can lead to premature bearing failure.
  3. Verify that there is no more than a 0.060 inch (1.5 mm) gap between roller assembly and the roller mount brackets of the deck frame. If this gap is larger than 0.060 inch (1.5 mm), shim excess clearance with 5/8" washers.
  4. Insert mounting bolt and tighten to **65 to 95 ft-lb (89 to 128 N-m)**.

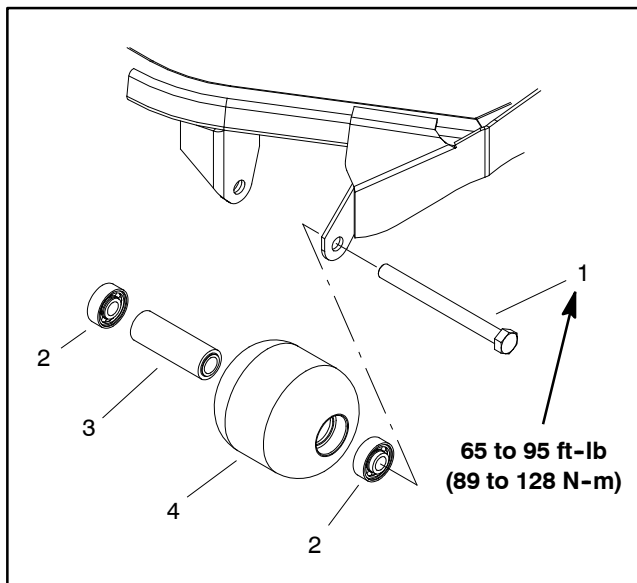


Figure 18

- |                  |                   |
|------------------|-------------------|
| 1. Mounting bolt | 3. Bearing spacer |
| 2. Bearing       | 4. Front roller   |

This page is intentionally blank.

## Cutting Deck Carrier Frame

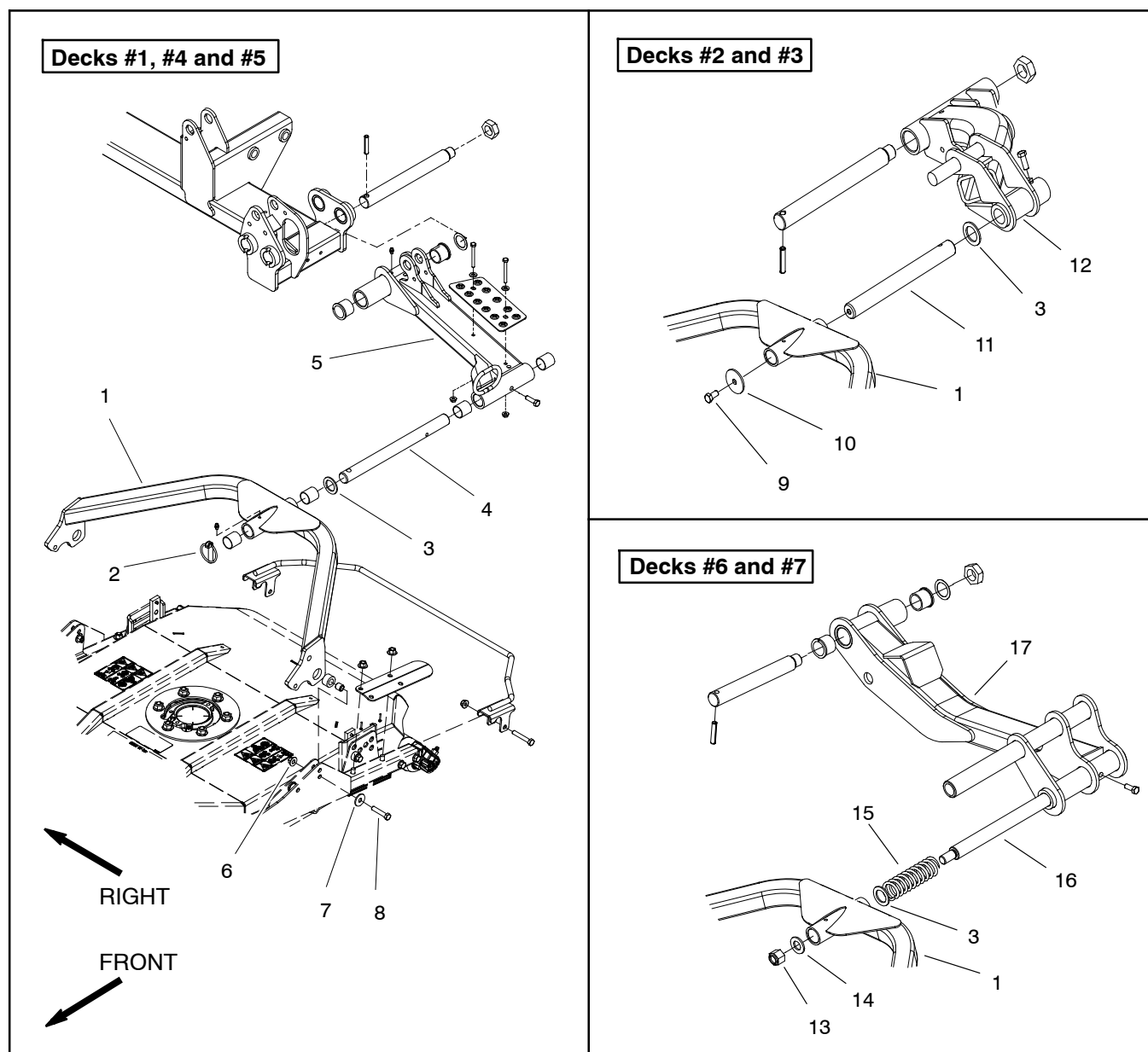


Figure 19

- |                                 |                                      |                         |
|---------------------------------|--------------------------------------|-------------------------|
| 1. Carrier frame                | 7. Hardened washer (2 used per deck) | 13. Lock nut            |
| 2. Lynch pin                    | 8. Cap screw (2 used per deck)       | 14. Flat washer         |
| 3. Thrust washer                | 9. Cap screw                         | 15. Compression spring  |
| 4. Pivot shaft                  | 10. Rebound washer                   | 16. Pivot shaft         |
| 5. Lift arm (#4 shown)          | 11. Pivot shaft                      | 17. Lift arm (#6 shown) |
| 6. Flange nut (2 used per deck) | 12. Lift arm (#2 shown)              |                         |

## Removal and Installation (Fig. 19)

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 20.

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.

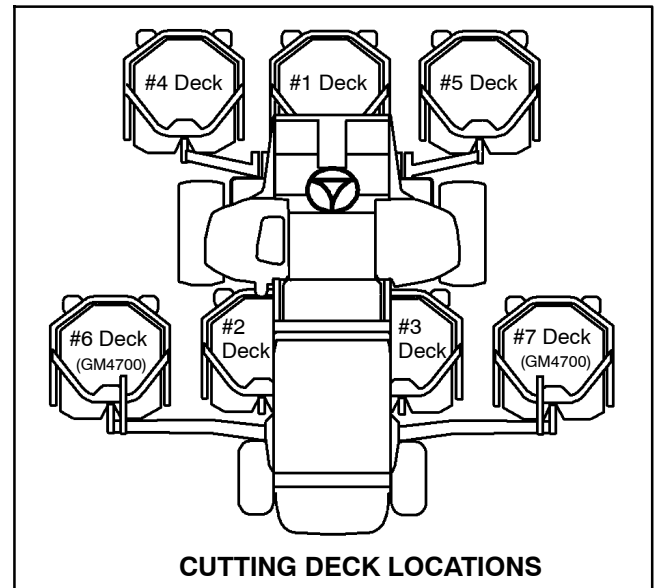


Figure 20

This page is intentionally blank.





## Foldout Drawings

### Table of Contents

ELECTRICAL DRAWING DESIGNATIONS .....	2	Main Wire Harness (Serial Numbers 400000000 to 403450000) .....	23
HYDRAULIC SCHEMATICS		Main Wire Harness (Serial Numbers above 403450001) .....	25
Groundsmaster 4500-D .....	3	Seat and Console Wire Harness (Serial number below 399999999) .....	27
Groundsmaster 4500-D with Optional Flow Divider Kit .....	4	Seat and Console Wire Harness (Serial number 400000000 to 403450000) .....	29
Groundsmaster 4700-D .....	5	Seat and Console Wire Harness (Serial number 403450001) .....	31
Groundsmaster 4700-D with Optional Flow Divider Kit .....	6	Power Center Wire Harness (Serial number below 403450000) .....	33
ELECTRICAL SCHEMATICS		Power Center Wire Harness (Serial number above 403450001) .....	35
Groundsmaster 4500-D/4700-D Models 30881 and 30882 (Serial numbers below 315000300) .....	7	Deck 6 and 7 Wire Harness (Groundsmaster 4700-D) .....	37
Groundsmaster 4500-D/4700-D Models 30873 and 30874 (Serial numbers below 315000300) .....	8	Engine Wire Harness Models 30881 and 30882 (Serial number below 315000000) .....	39
Groundsmaster 4500-D/4700-D Models 30881 and 30882 (Serial Numbers 315000301 to 399999999) .....	9	Engine Wire Harness Models 30881 and 30882 (Serial number 315000001 to 408000000) .....	41
Groundsmaster 4500-D/4700-D Models 30873 and 30874 (Serial Numbers 315000301 to 399999999) .....	10	Engine Wire Harness Models 30881 and 30882 (Serial number Above 408000000) .....	43
Groundsmaster 4500-D/4700-D Models 30881 and 30882 (Serial Numbers 400000000 to 403450000) .....	11	Engine DPF Sub-Wire Harness Models 30881 and 30882 (Serial number Above 408000000) .....	45
Groundsmaster 4500-D/4700-D Models 30873 and 30874 (Serial Numbers 400000000 to 403450000) .....	12	Engine Wire Harness Models 30873 and 30874 .....	46
Groundsmaster 4500-D/4700-D Models 30881 and 30882 (Serial Numbers 403450001 to 408000000) .....	13	Wire Harness Diagram - Two Post ROPS Extension .....	48
Groundsmaster 4500-D/4700-D Models 30873 and 30874 (Serial Numbers 403450001 to 408000000) .....	14	Power Harness Kit - Wiring Diagram .....	50
Groundsmaster 4500-D/4700-D Models 30881 and 30882 (Serial Numbers Above 408000000) .....	15		
Groundsmaster 4500-D/4700-D Models 30873 and 30874 (Serial Numbers Above 408000000) .....	16		
Groundsmaster 4500-D/4700-D Operator Cab (Serial number below 399999999) .....	17		
Groundsmaster 4500-D/4700-D Operator Cab (Serial number above 400000000) .....	18		
WIRE HARNESS DRAWINGS			
Main Wire Harness (Serial number below 315000300) .....	19		
Main Wire Harness (Serial Numbers 315000301 to 399999999) .....	21		

# Electrical Drawing Designations

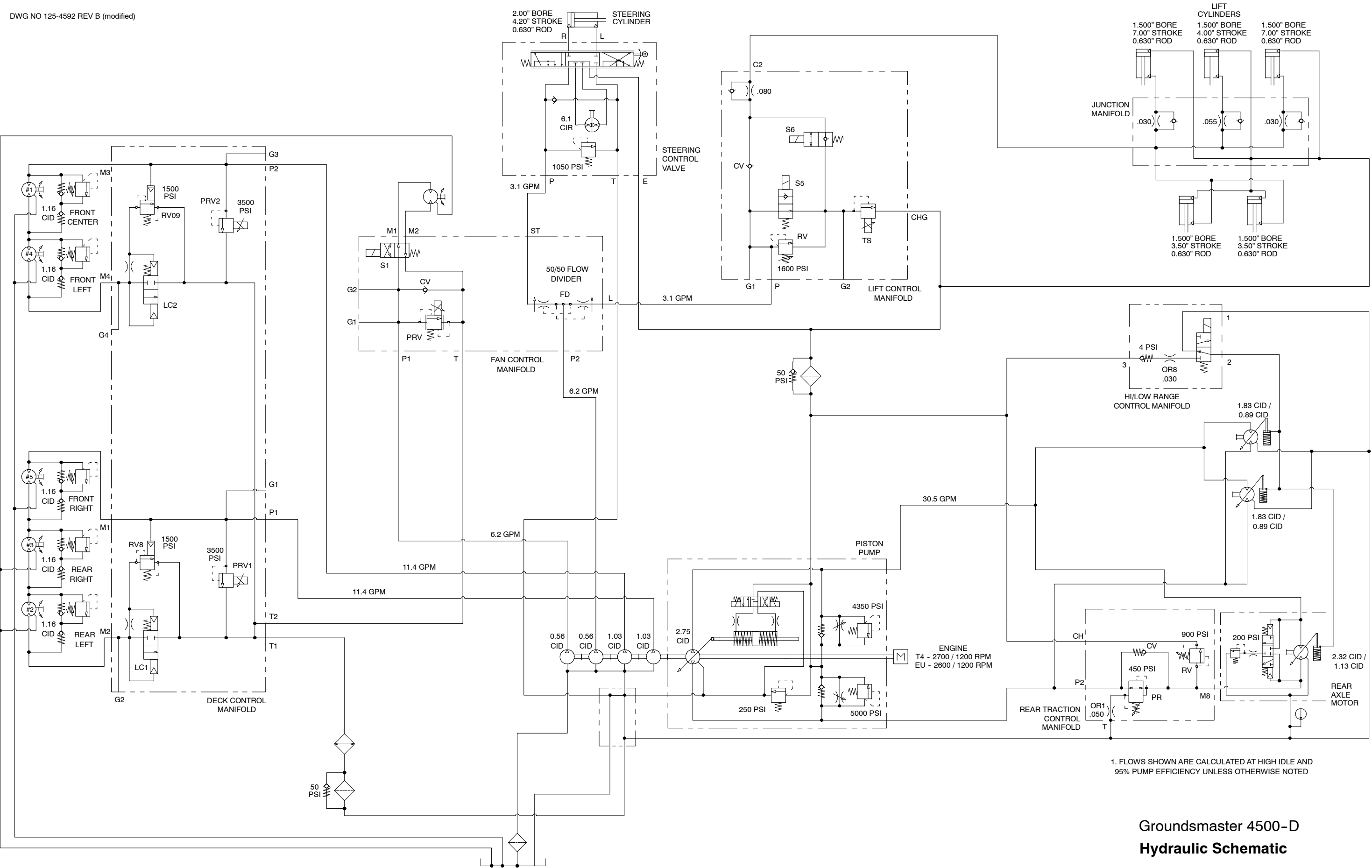
The following abbreviations are used for wire harness colors on the electrical schematics and wire harness drawings in this chapter.

<b><u>ABBREVIATION</u></b>	<b><u>COLOR</u></b>
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 Groundsmaster 4500 and 4700 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).

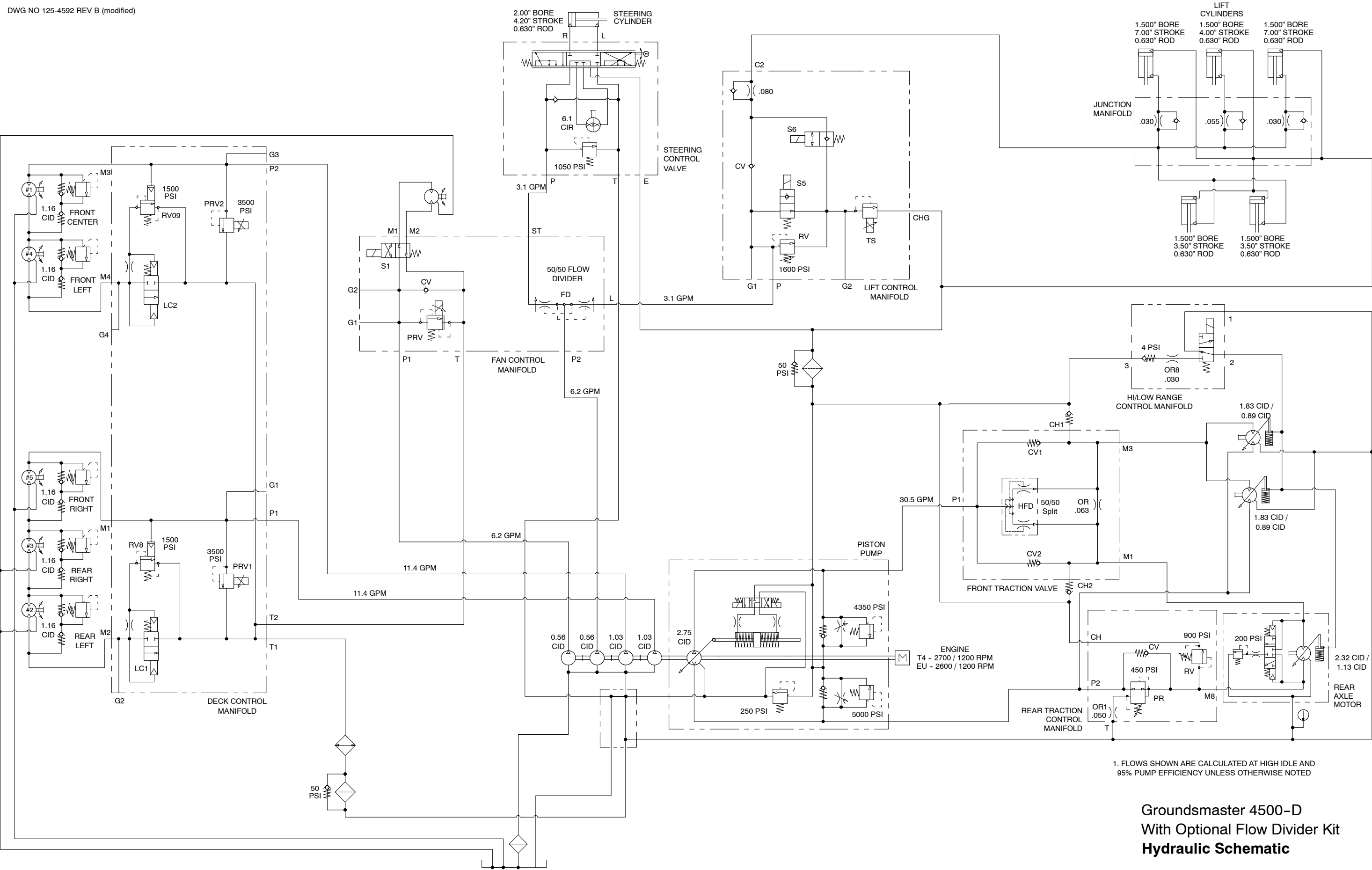
**NOTE:** The electrical harness drawings in this chapter identify both the wire color and the wire gauge. For example, 16 BK on a harness diagram identifies a 16 gauge wire that has a black insulator.

**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).

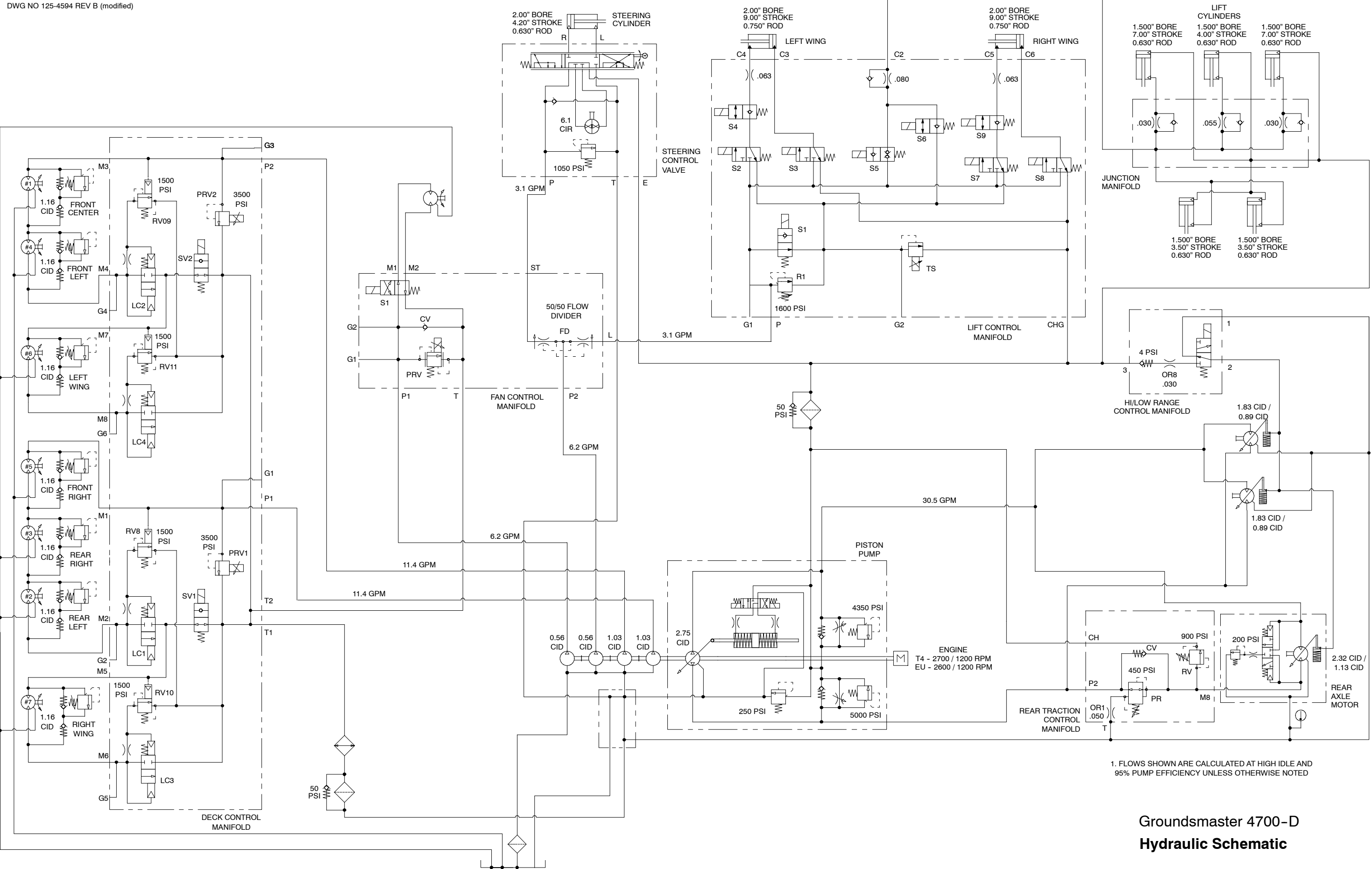


1. FLOWS SHOWN ARE CALCULATED AT HIGH IDLE AND 95% PUMP EFFICIENCY UNLESS OTHERWISE NOTED

Groundsmaster 4500-D  
Hydraulic Schematic

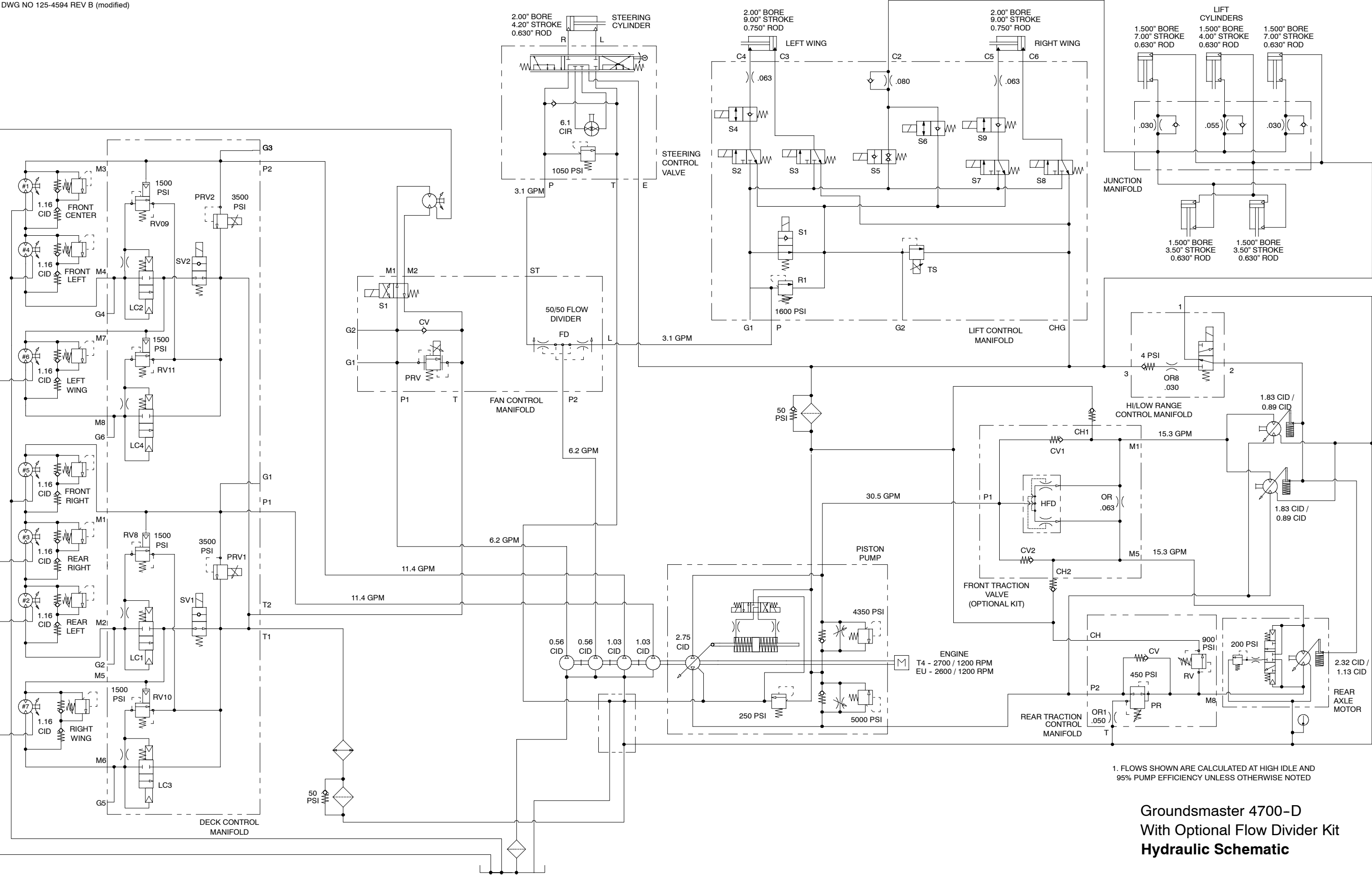


Groundsmaster 4500-D  
With Optional Flow Divider Kit  
**Hydraulic Schematic**



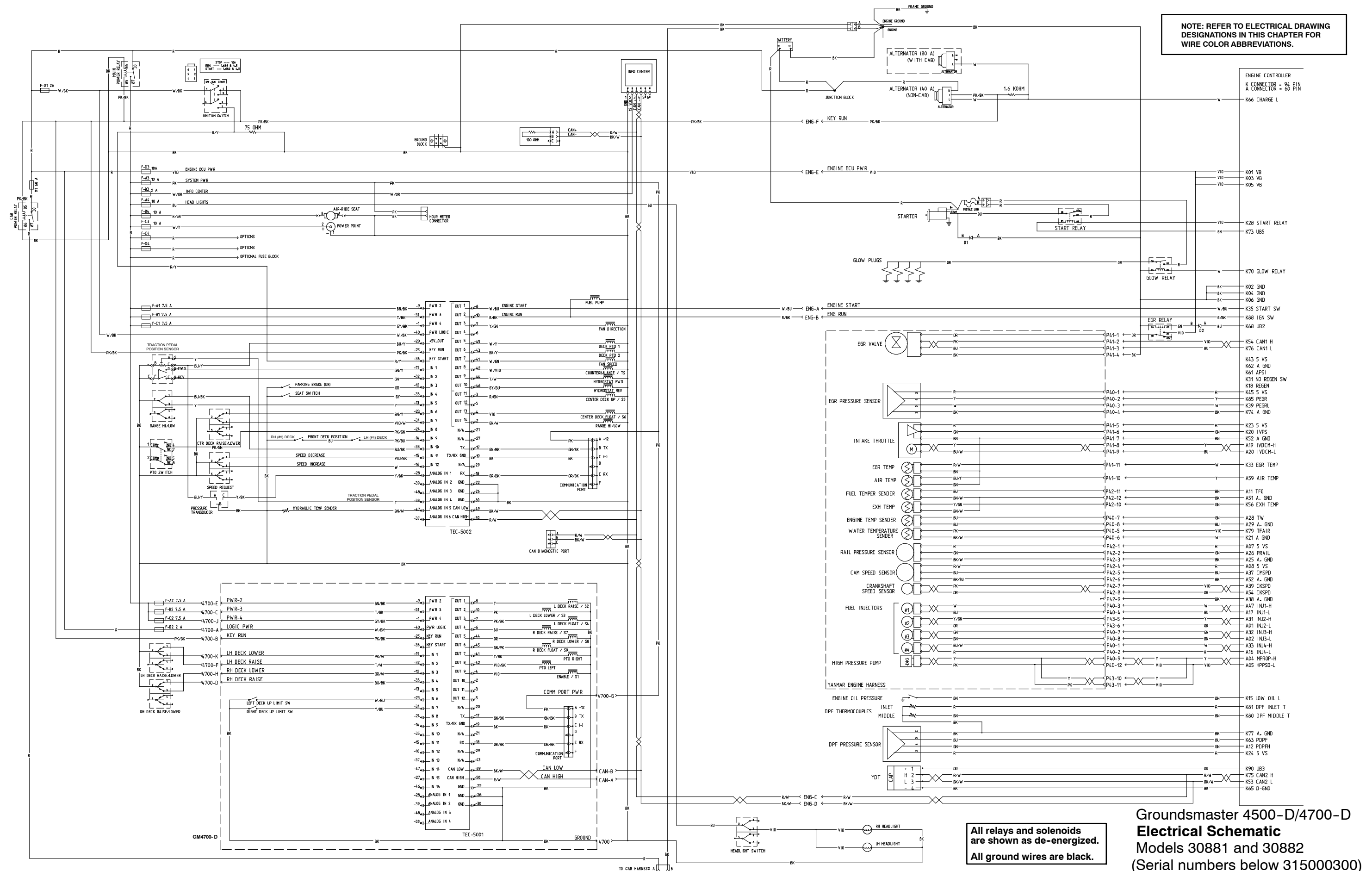
1. FLOWS SHOWN ARE CALCULATED AT HIGH IDLE AND 95% PUMP EFFICIENCY UNLESS OTHERWISE NOTED

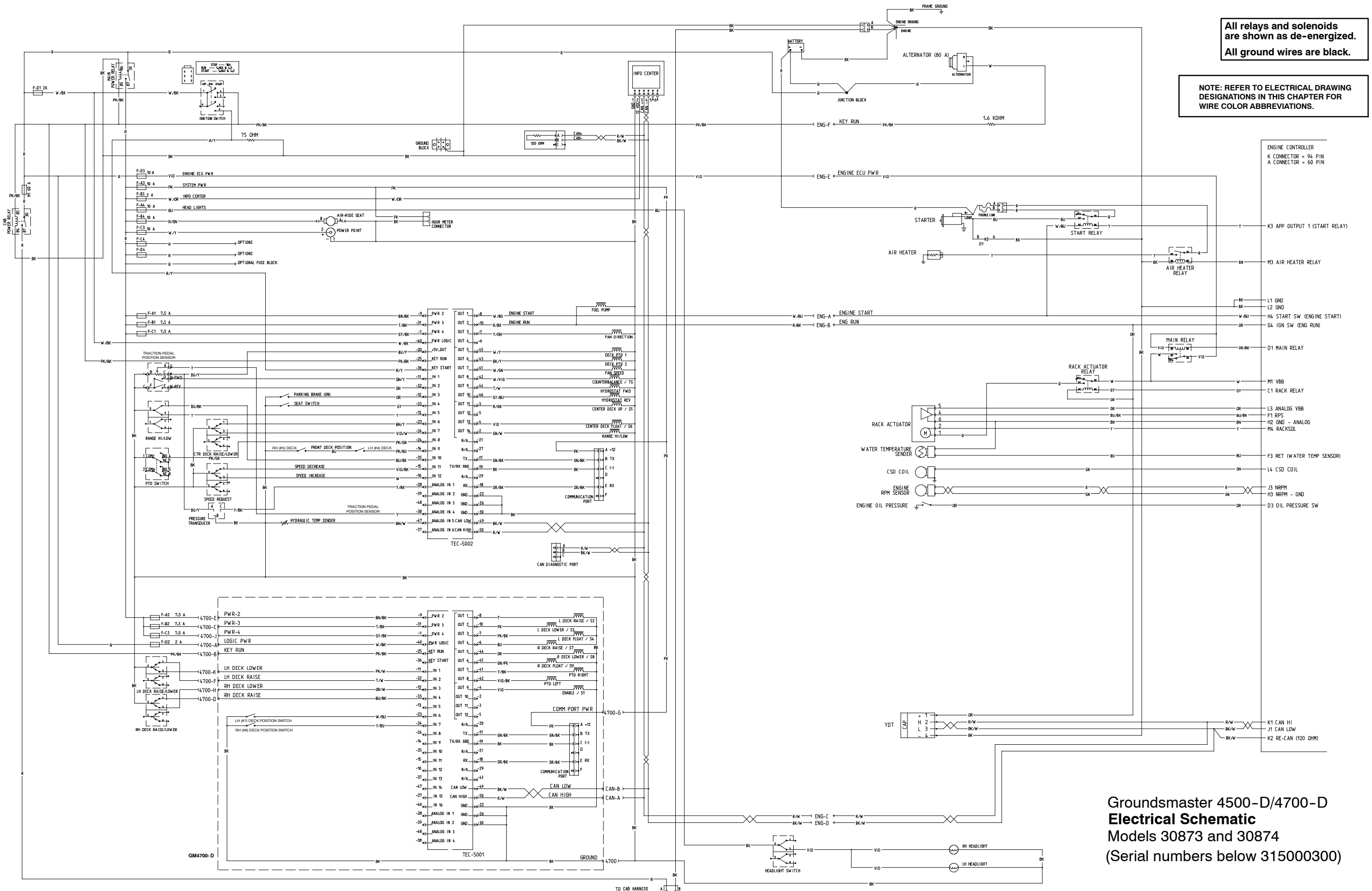
Groundsmaster 4700-D  
Hydraulic Schematic



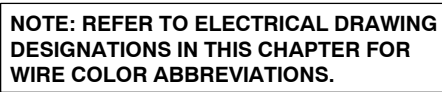
1. FLOWS SHOWN ARE CALCULATED AT HIGH IDLE AND 95% PUMP EFFICIENCY UNLESS OTHERWISE NOTED

Groundsmaster 4700-D  
With Optional Flow Divider Kit  
Hydraulic Schematic

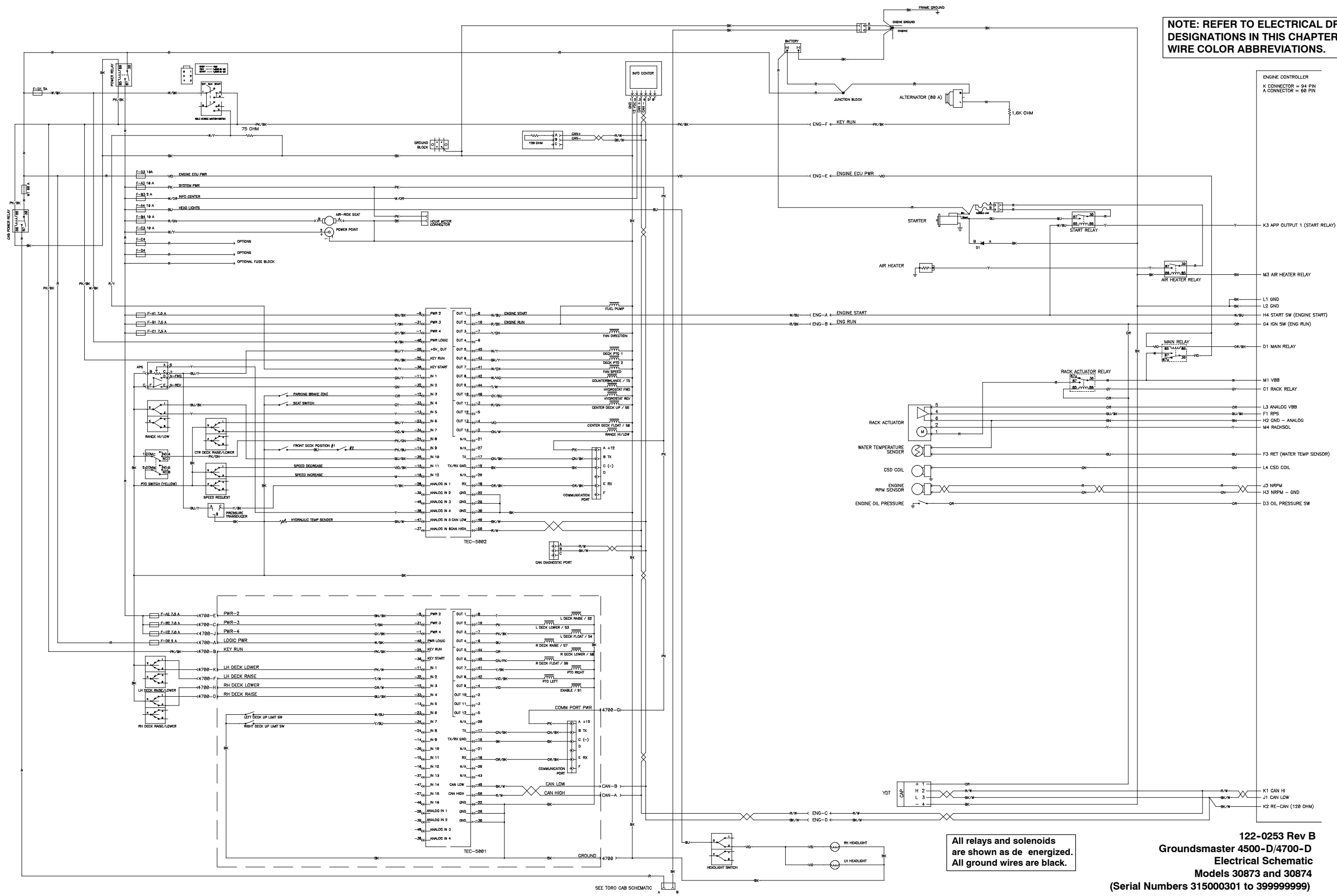








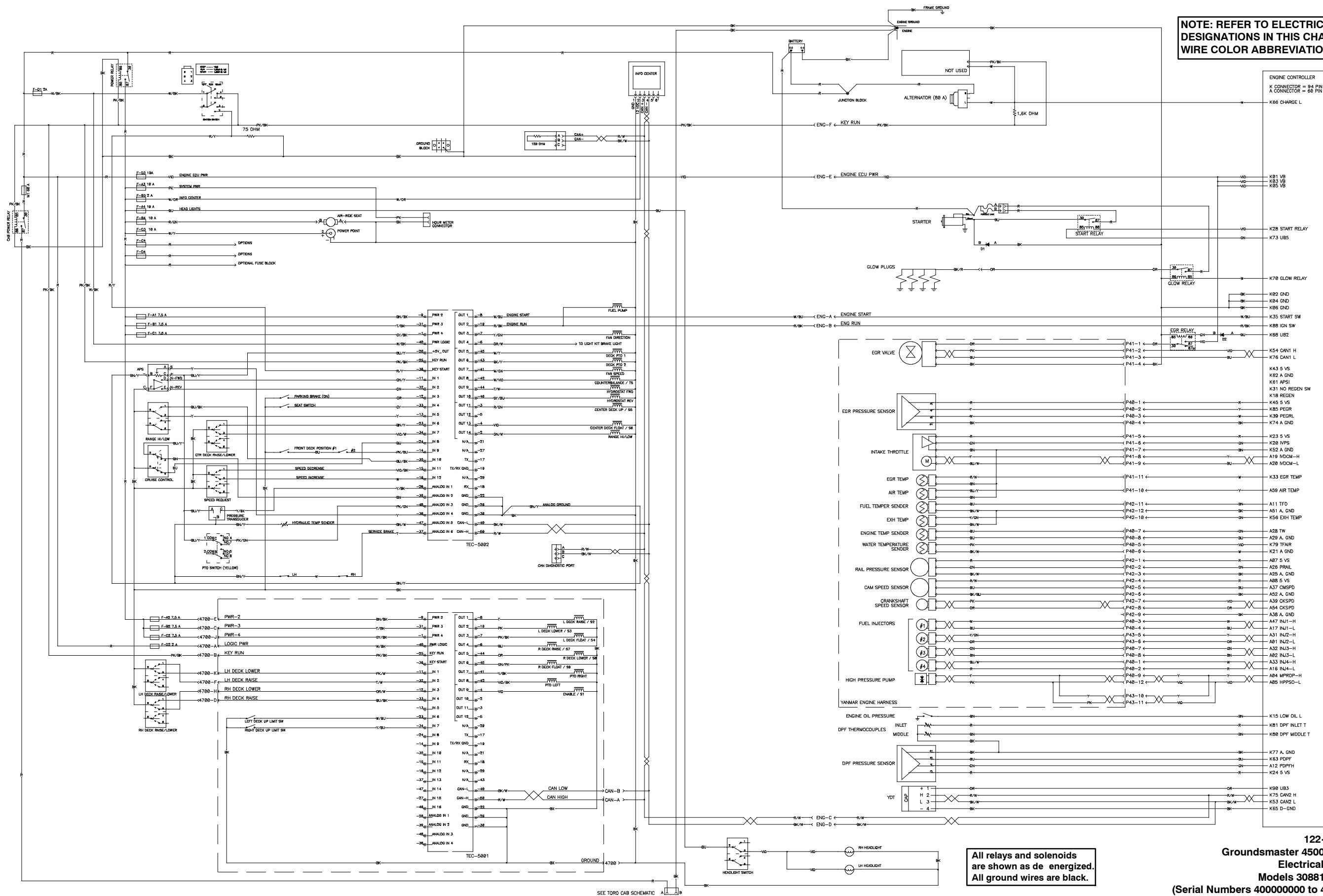
**122-0253 Rev B**  
**Groundsmaster 4500-D/4700-D**  
**Electrical Schematic**  
**Models 30881 and 30882**  
**(Serial Numbers 315000301 to 399999999)**

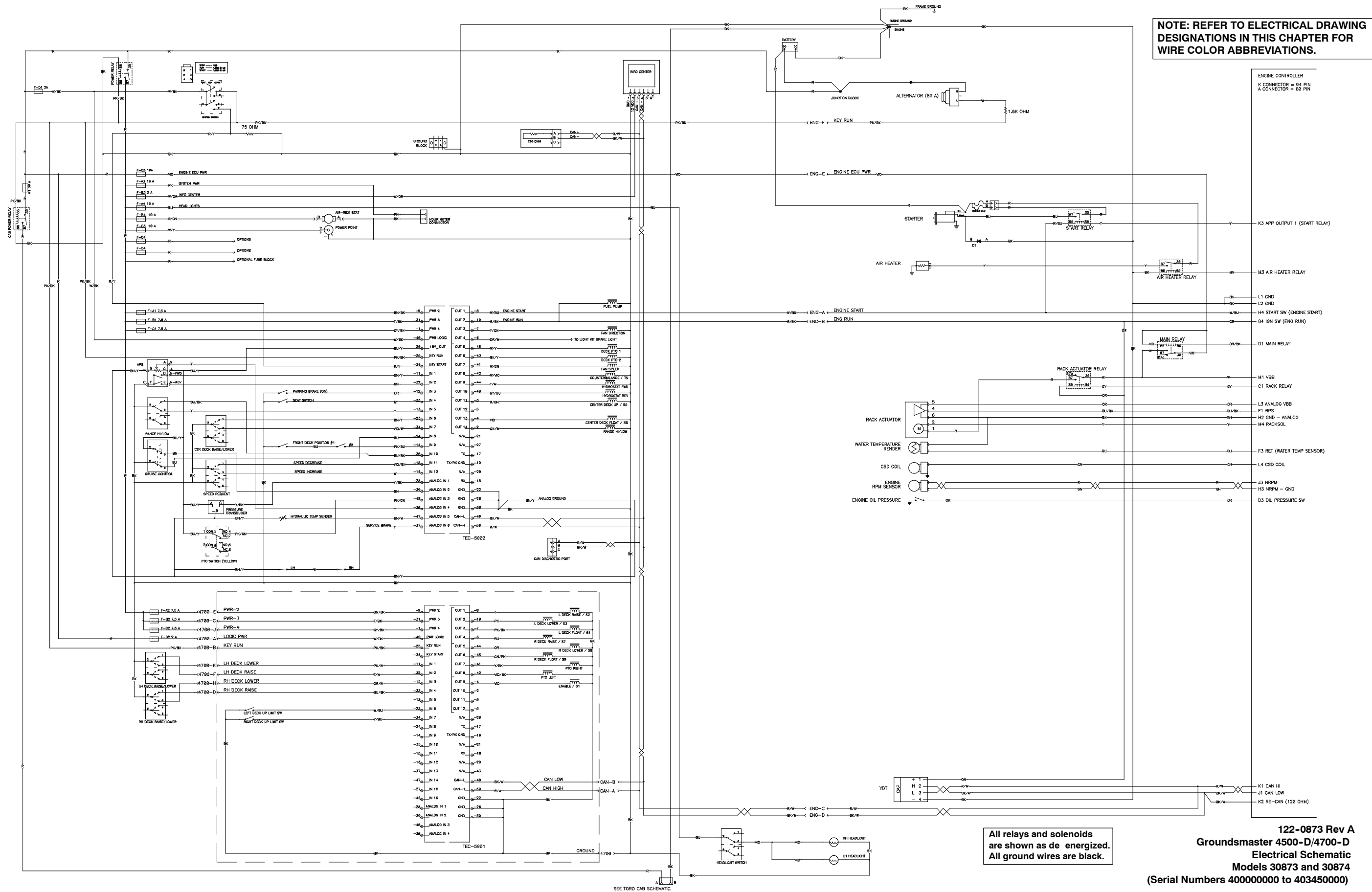


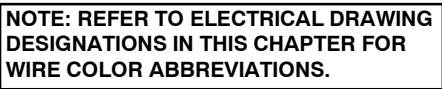
NOTE: REFER TO ELECTRICAL DRAWING DESIGNATIONS IN THIS CHAPTER FOR WIRE COLOR ABBREVIATIONS.

All relays and solenoids are shown as de energized. All ground wires are black.

122-0253 Rev B  
Groundsmaster 4500-D/4700-D  
Electrical Schematic  
Models 30873 and 30874  
(Serial Numbers 315000301 to 399999999)

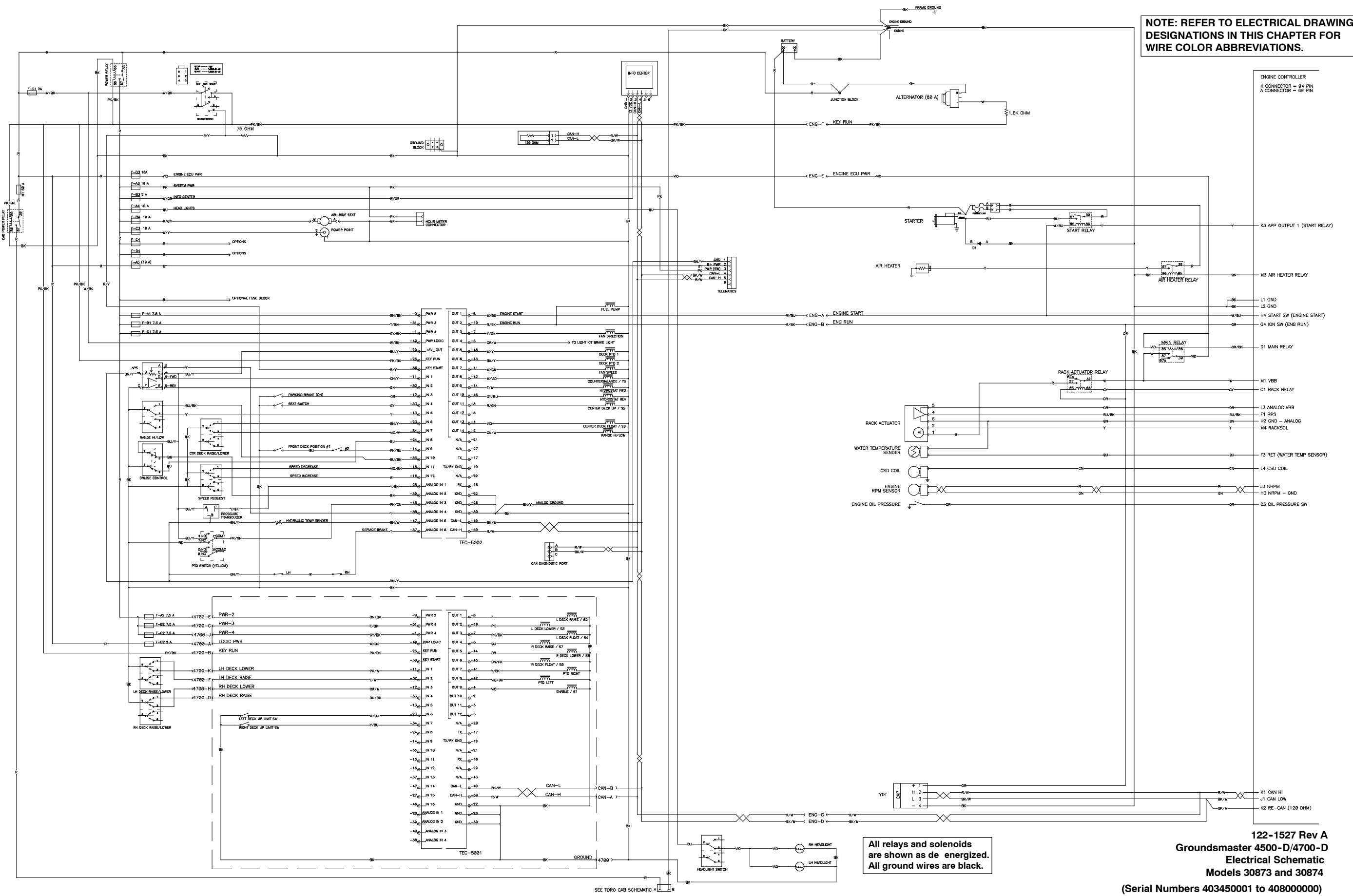






**All relays and solenoids are shown as de energized. All ground wires are black.**

122-1527 Rev A  
Groundsmaster 4500-D/4700-D  
Electrical Schematic  
Models 30881 and 30882  
(Serial Numbers 403450001 to 408000000)

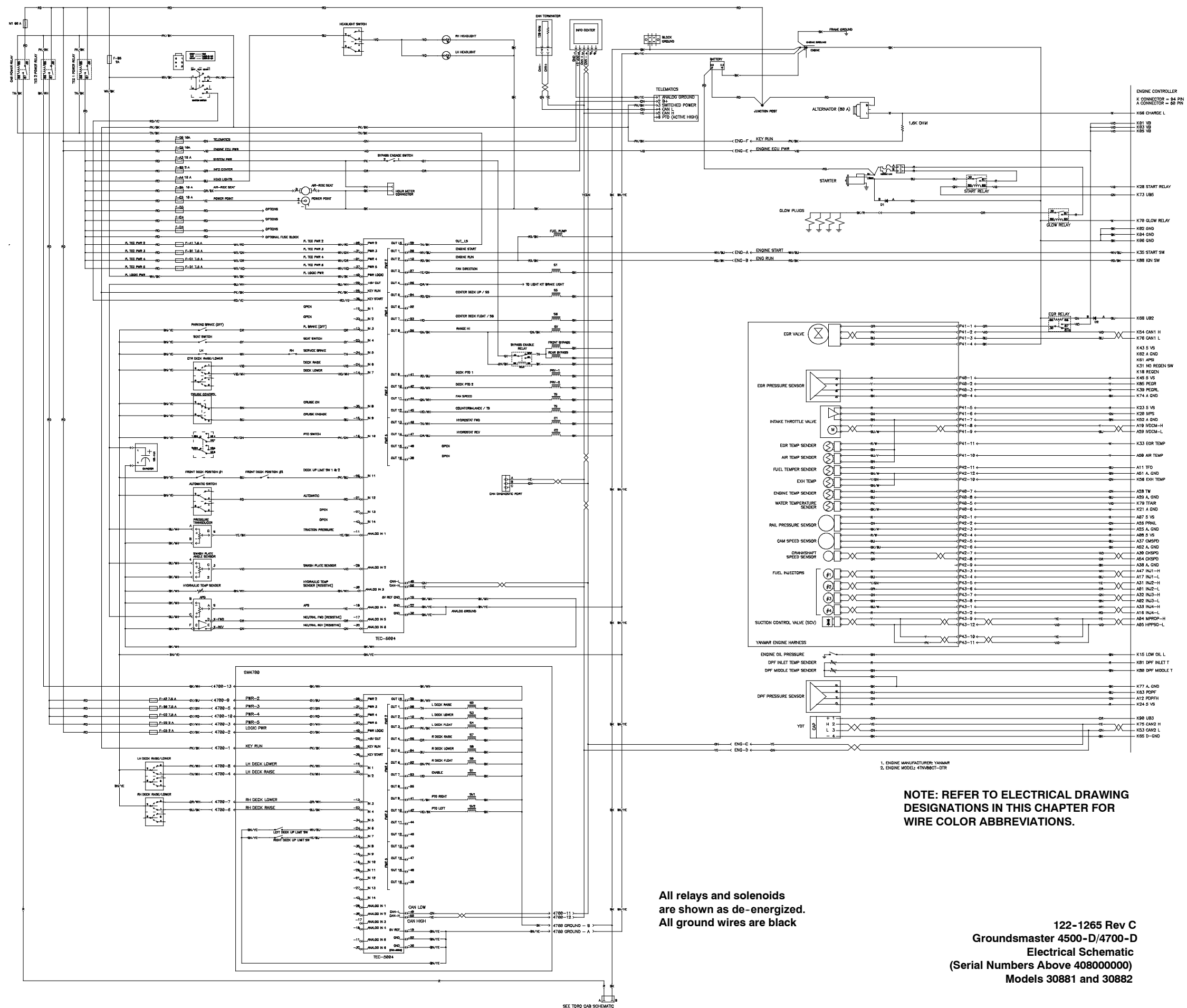


NOTE: REFER TO ELECTRICAL DRAWING DESIGNATIONS IN THIS CHAPTER FOR WIRE COLOR ABBREVIATIONS.

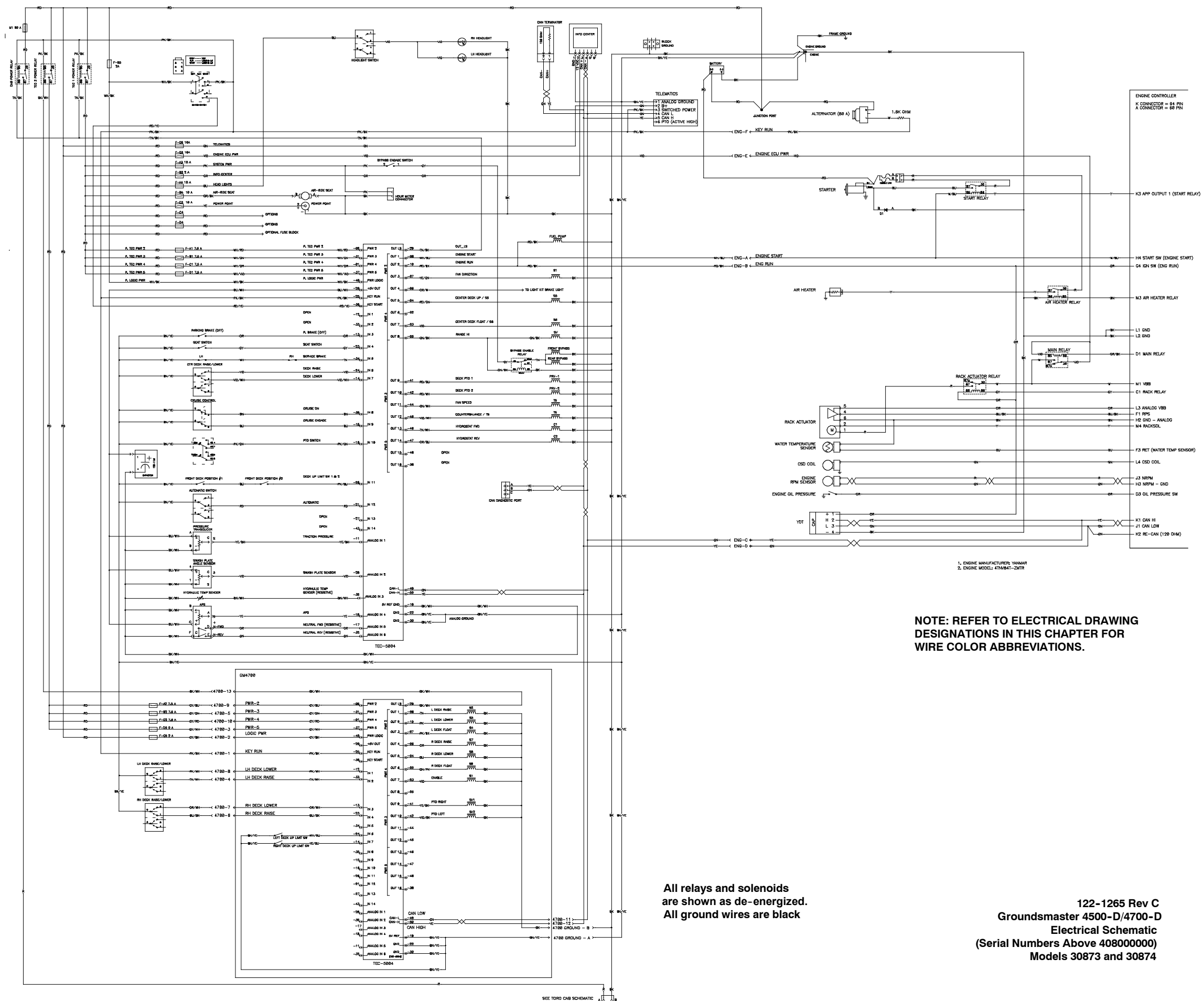
ENGINE CONTROLLER  
K CONNECTOR = 94 PIN  
A CONNECTOR = 68 PIN

All relays and solenoids are shown as de energized.  
All ground wires are black.

122-1527 Rev A  
Groundmaster 4500-D/4700-D  
Electrical Schematic  
Models 30873 and 30874  
(Serial Numbers 403450001 to 408000000)

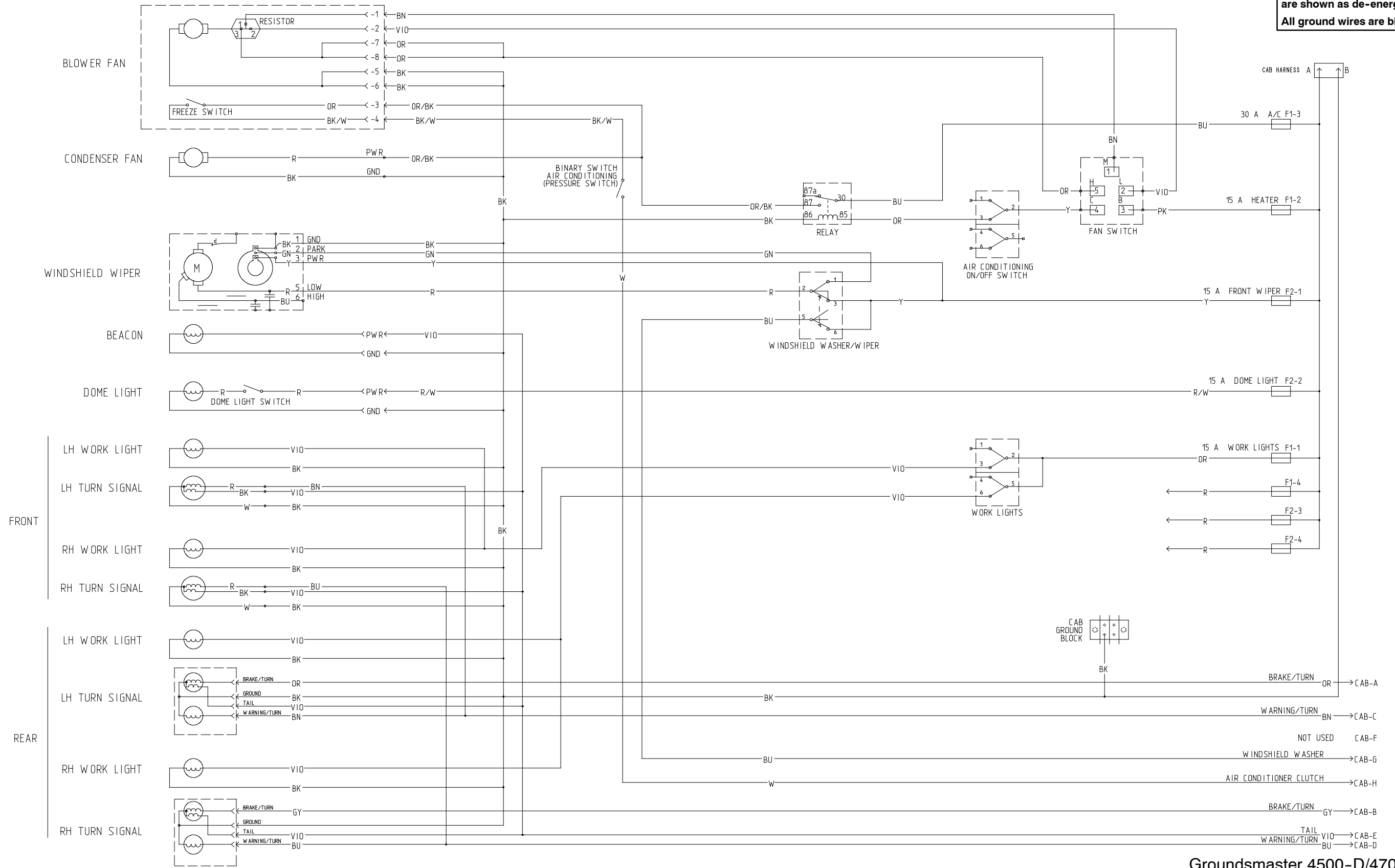


All relays and solenoids  
are shown as de-energized.  
All ground wires are black

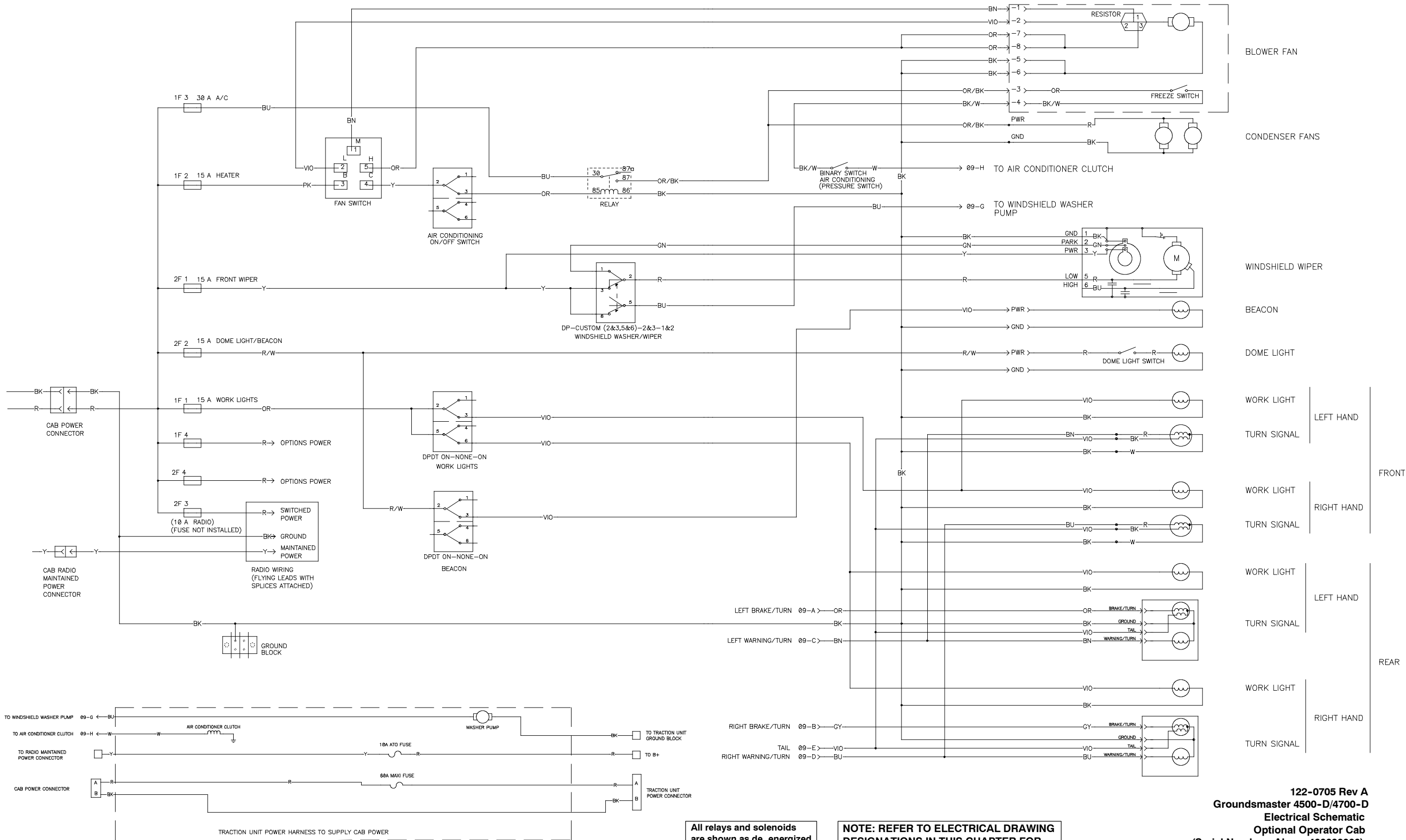


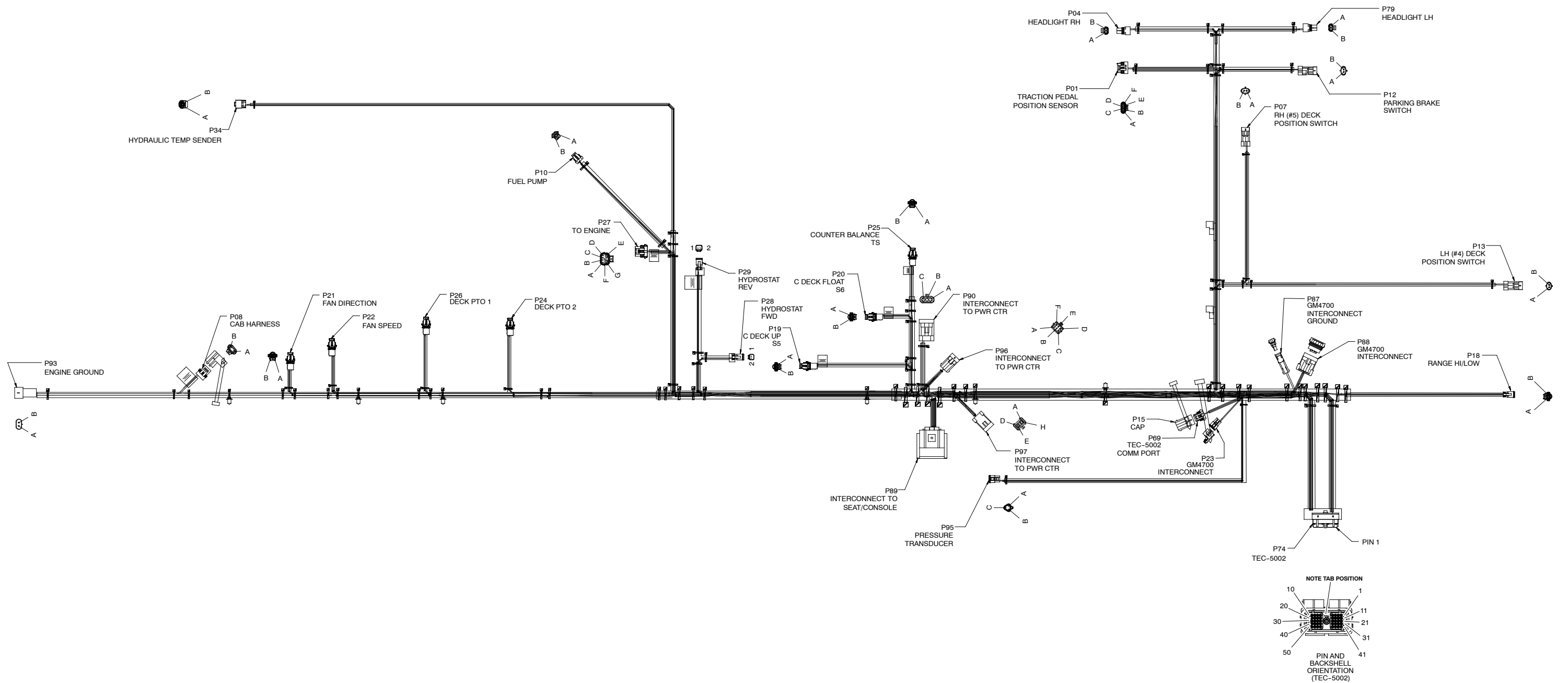


All relays and solenoids are shown as de-energized.  
All ground wires are black.



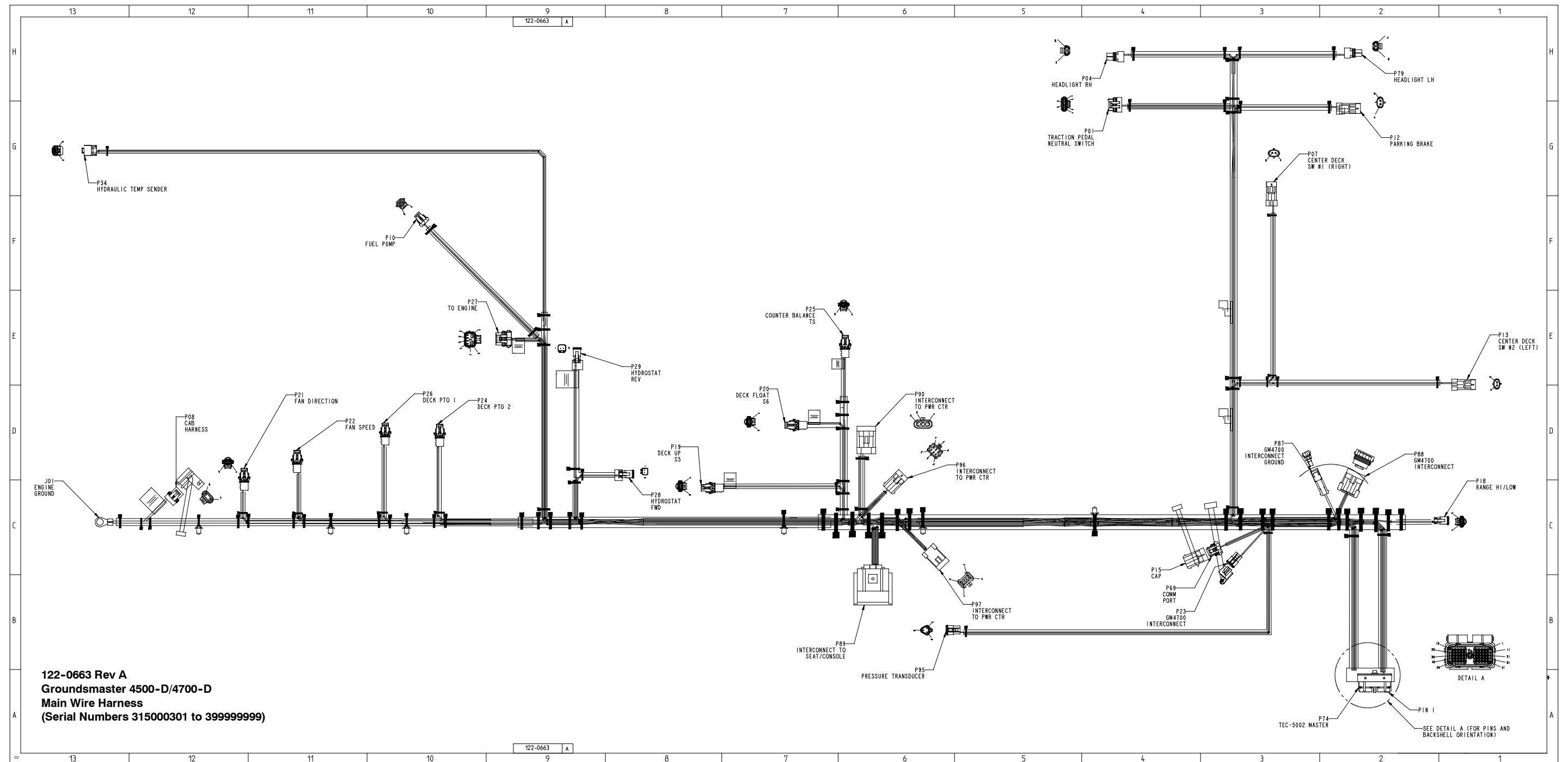
Groundsmaster 4500-D/4700-D  
Electrical Schematic  
Optional Operator Cab  
(Serial number below 399999999)



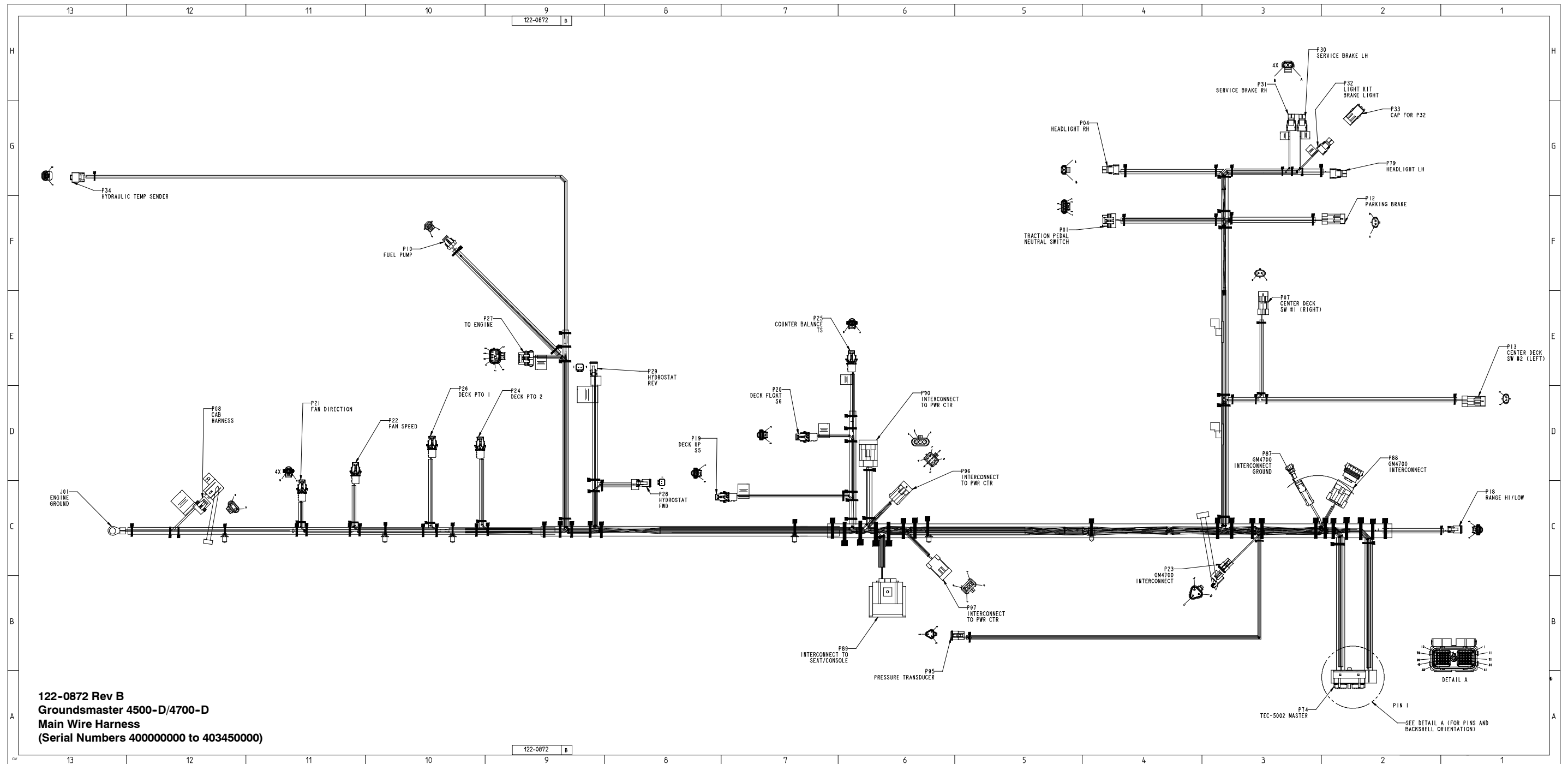


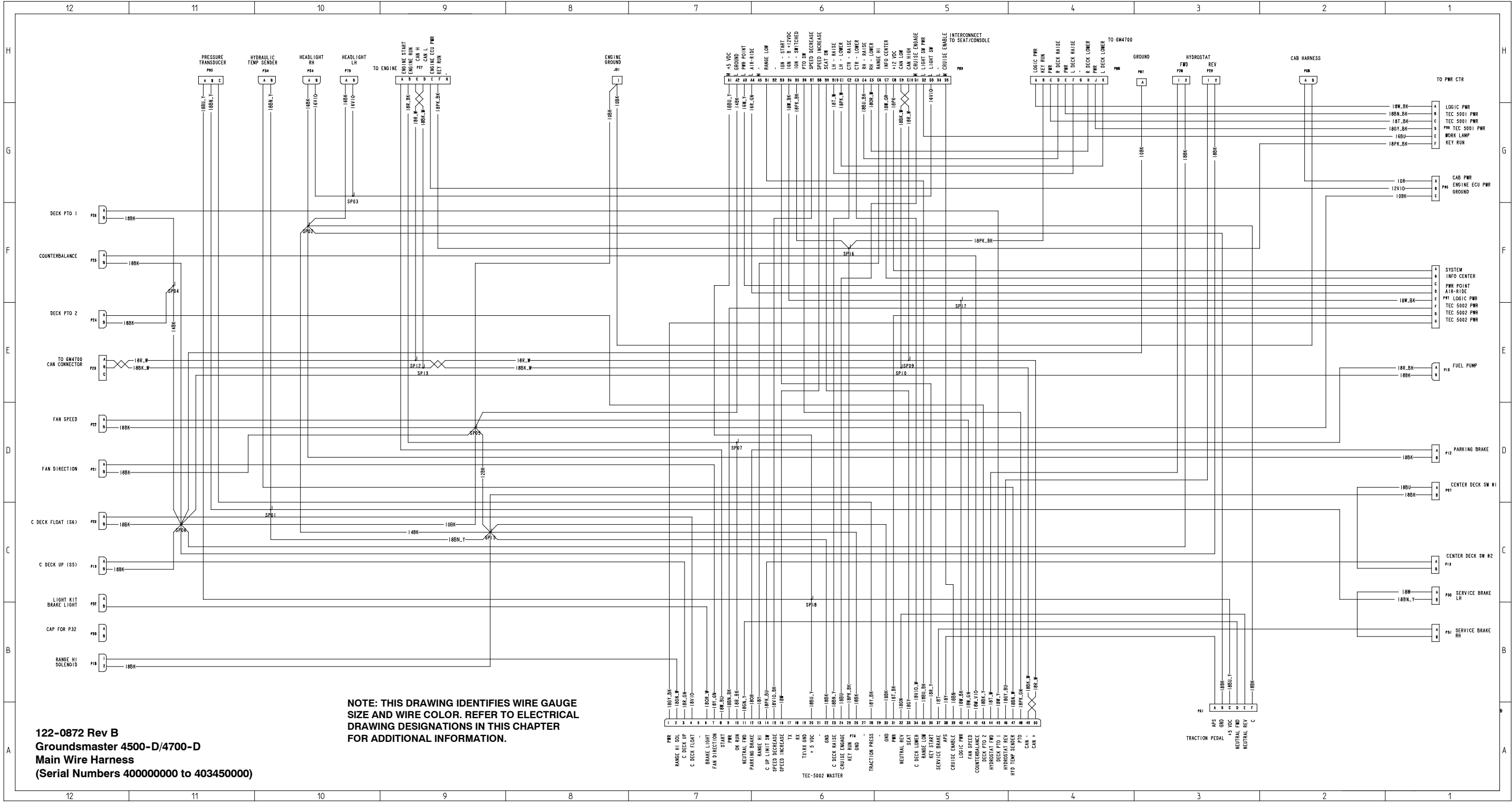
Groundsmaster 4500-D/4700-D  
**Main Wire Harness**  
 (Serial number below 315000300)



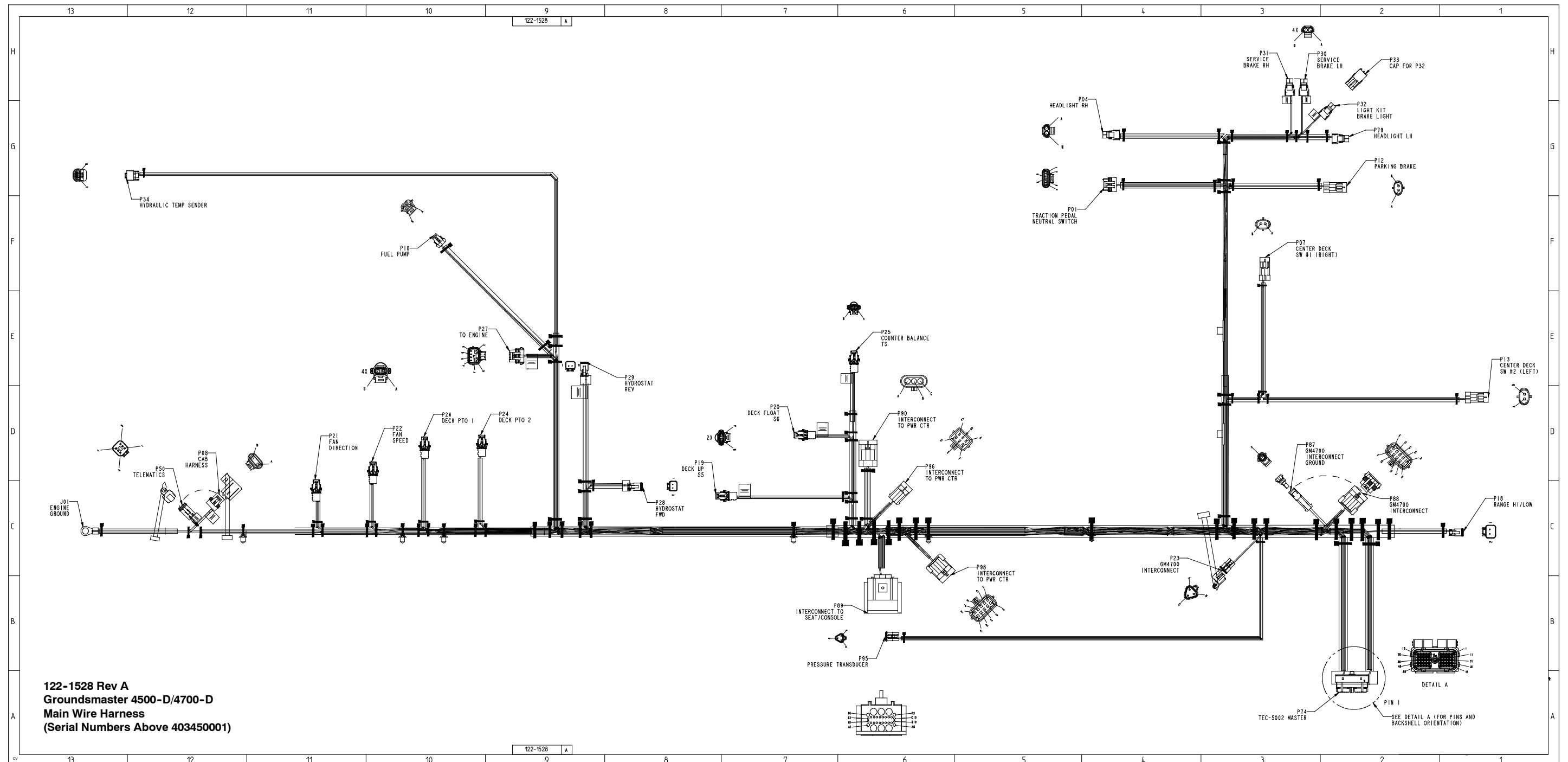




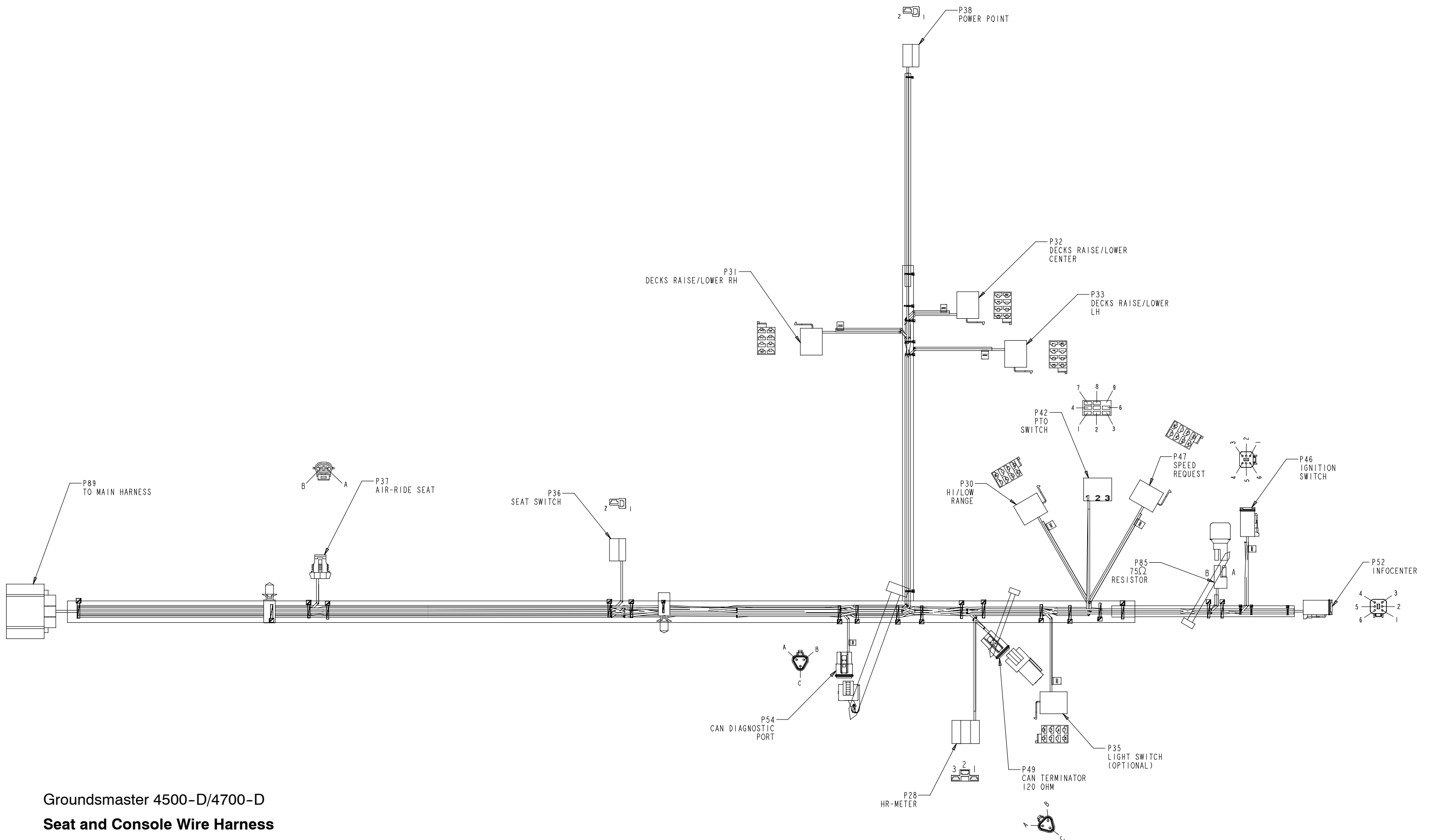




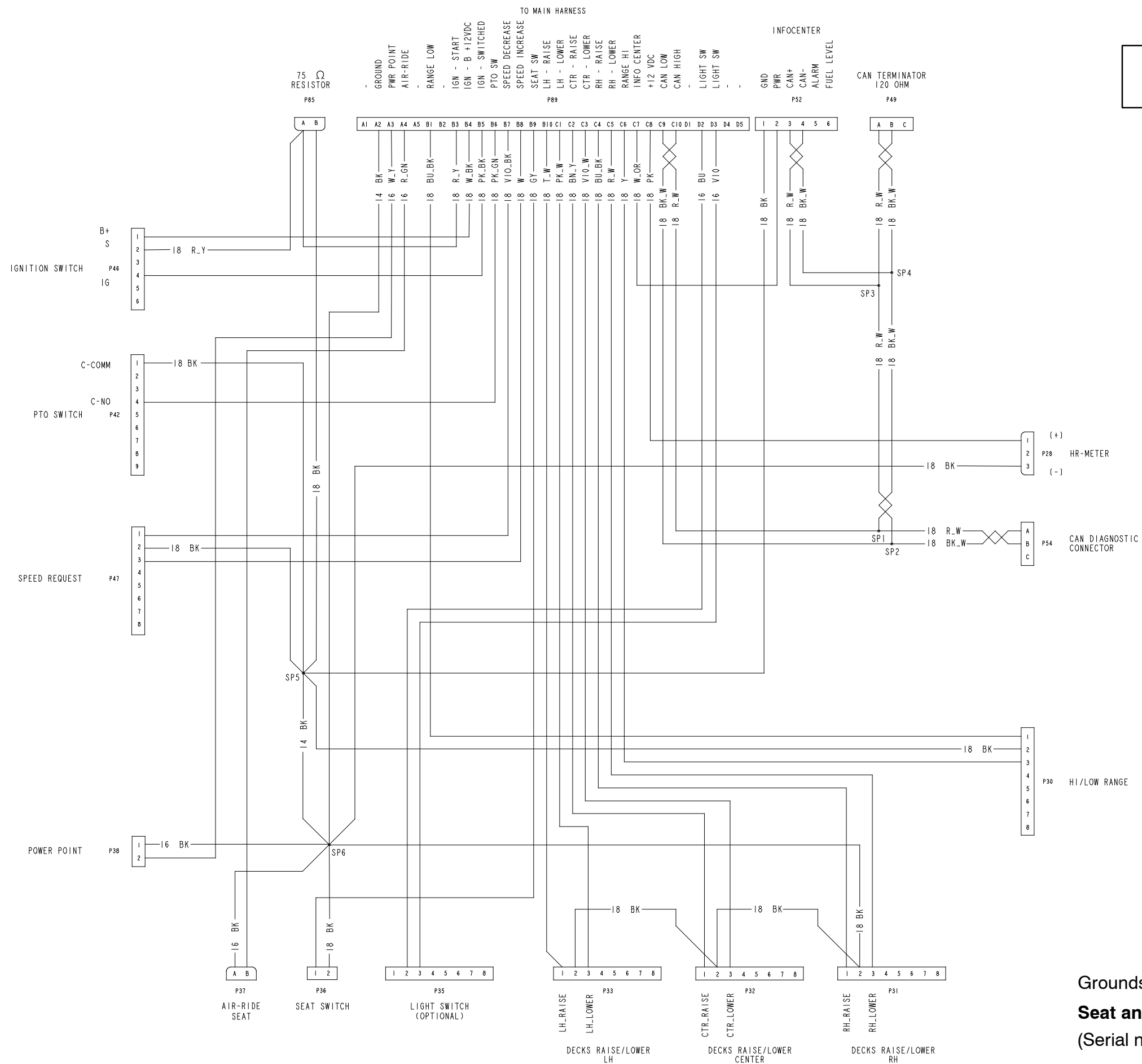






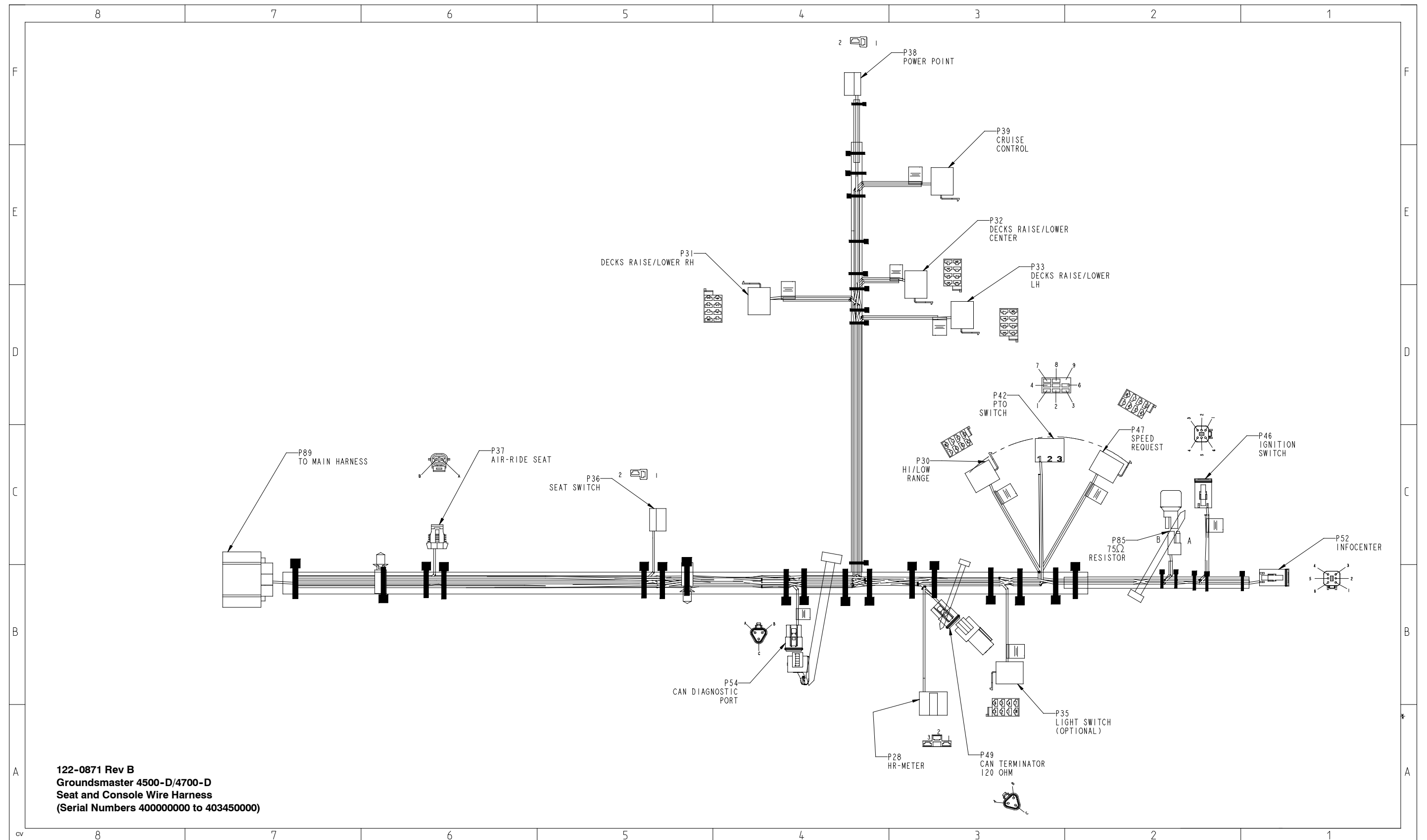


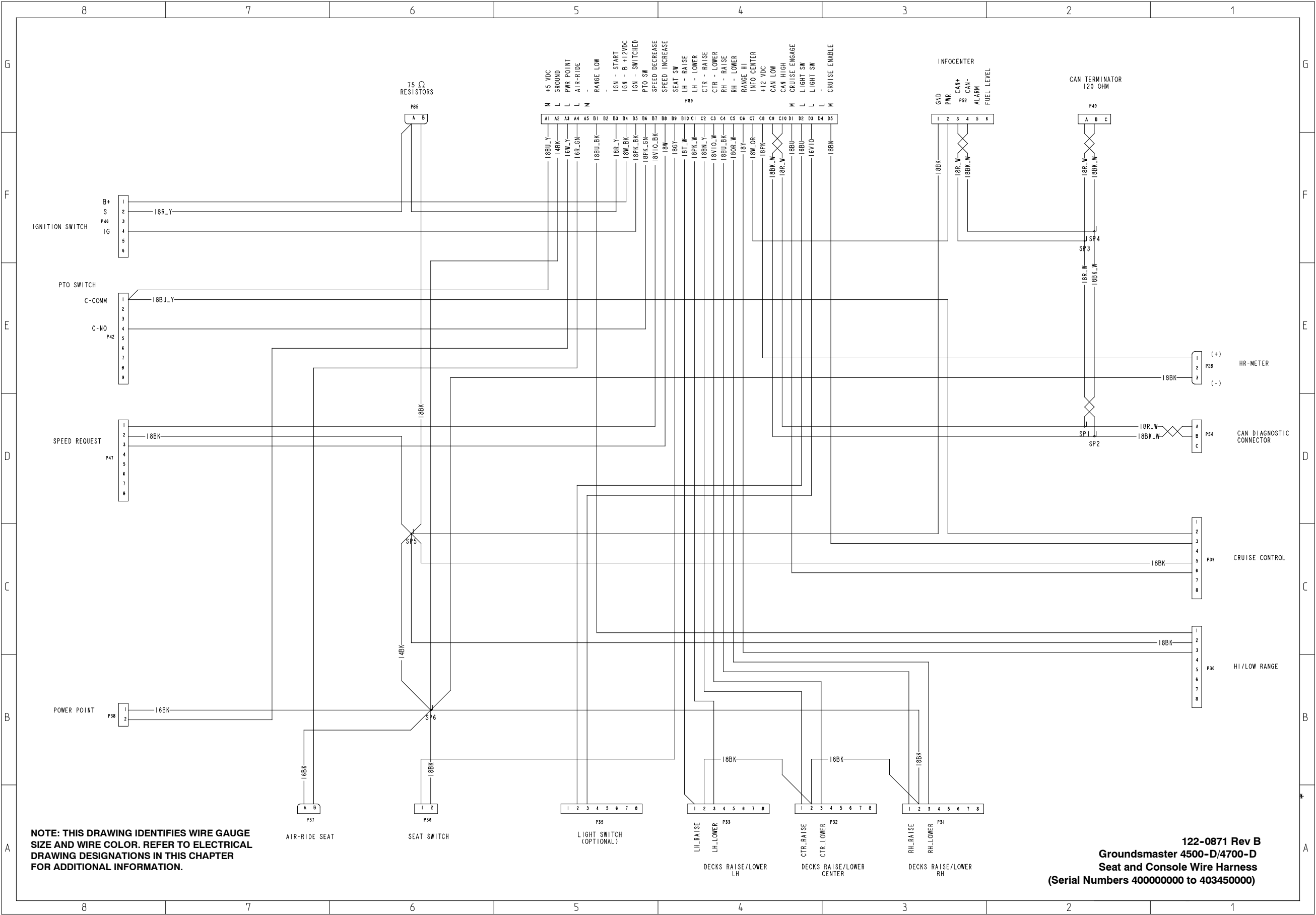
Groundsmaster 4500-D/4700-D  
**Seat and Console Wire Harness**  
 (Serial number below 399999999)



NOTE: THIS DRAWING IDENTIFIES WIRE GAUGE SIZE AND WIRE COLOR. REFER TO ELECTRICAL DRAWING DESIGNATIONS IN THIS CHAPTER FOR ADDITIONAL INFORMATION.

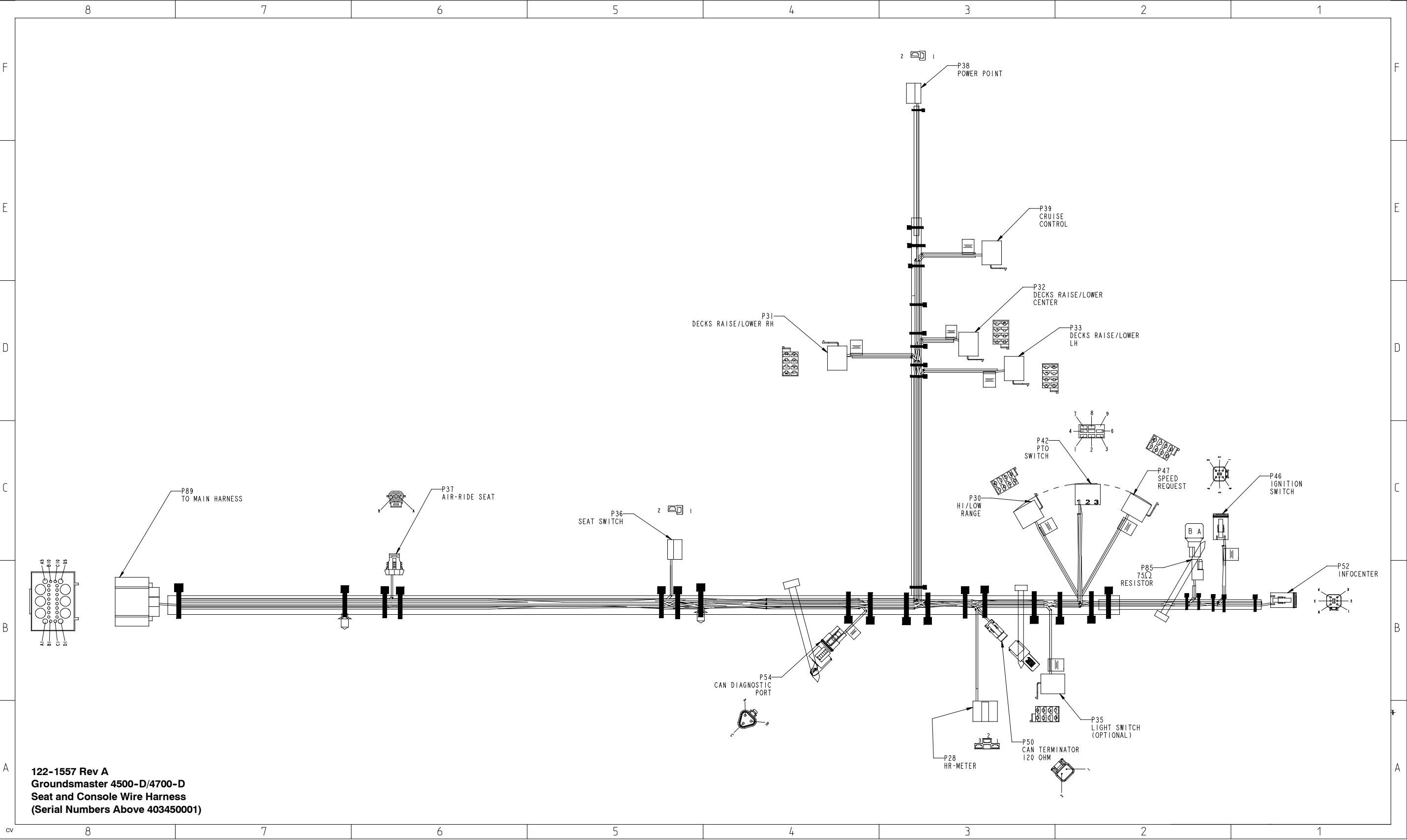
Groundsmaster 4500-D/4700-D  
**Seat and Console Wire Harness**  
(Serial number below 399999999)





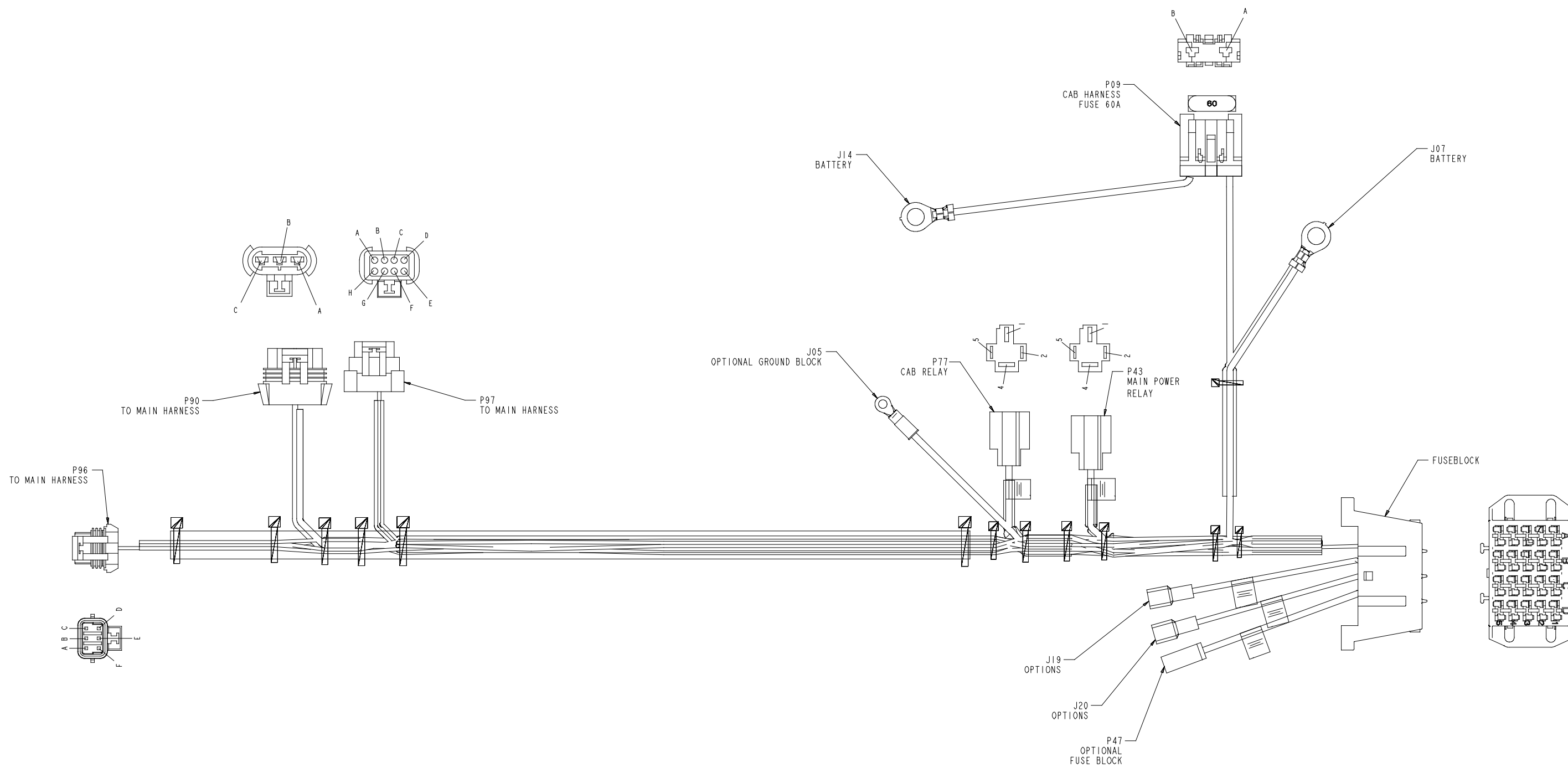
NOTE: THIS DRAWING IDENTIFIES WIRE GAUGE SIZE AND WIRE COLOR. REFER TO ELECTRICAL DRAWING DESIGNATIONS IN THIS CHAPTER FOR ADDITIONAL INFORMATION.

122-0871 Rev B  
Groundsmaster 4500-D/4700-D  
Seat and Console Wire Harness  
(Serial Numbers 400000000 to 403450000)

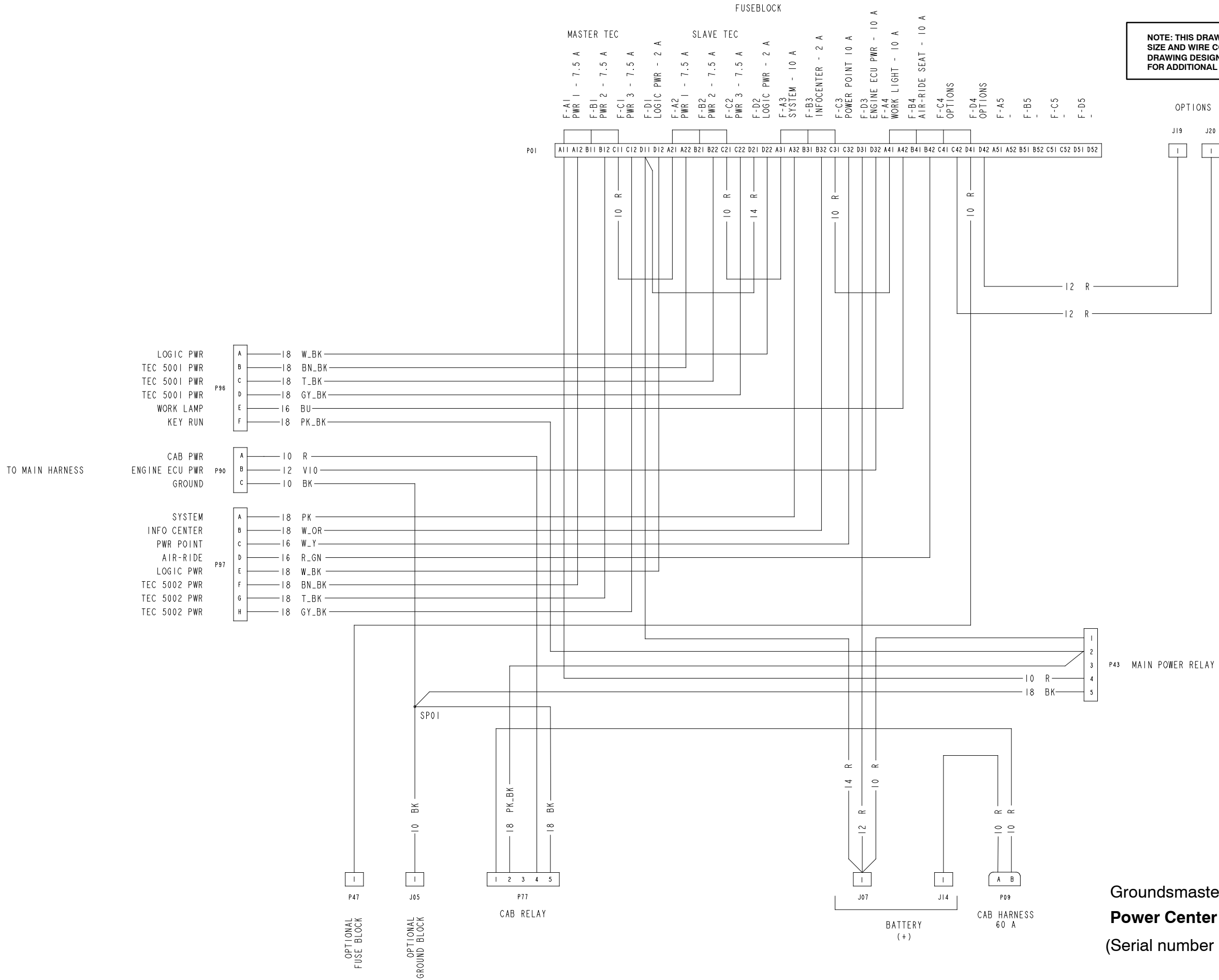


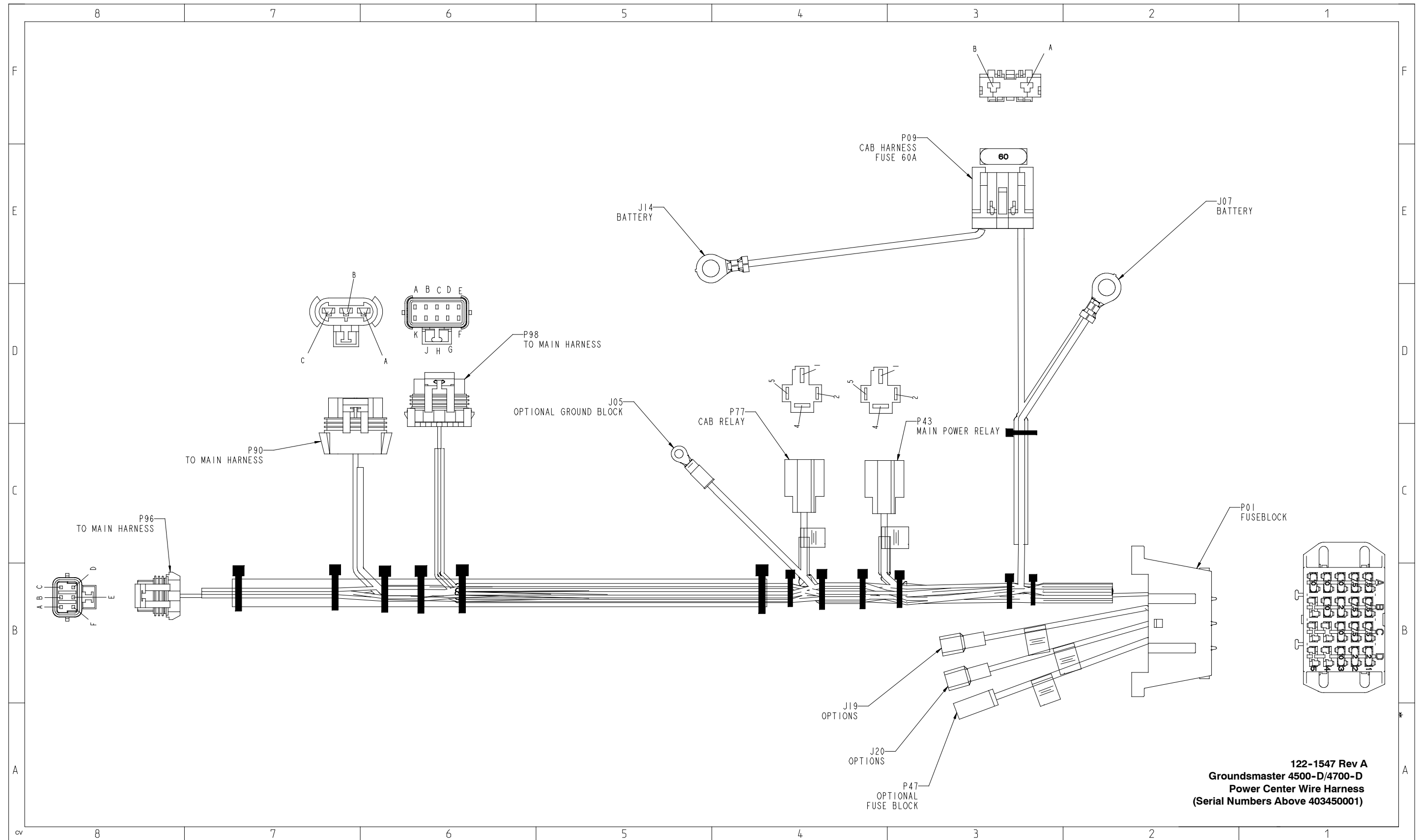


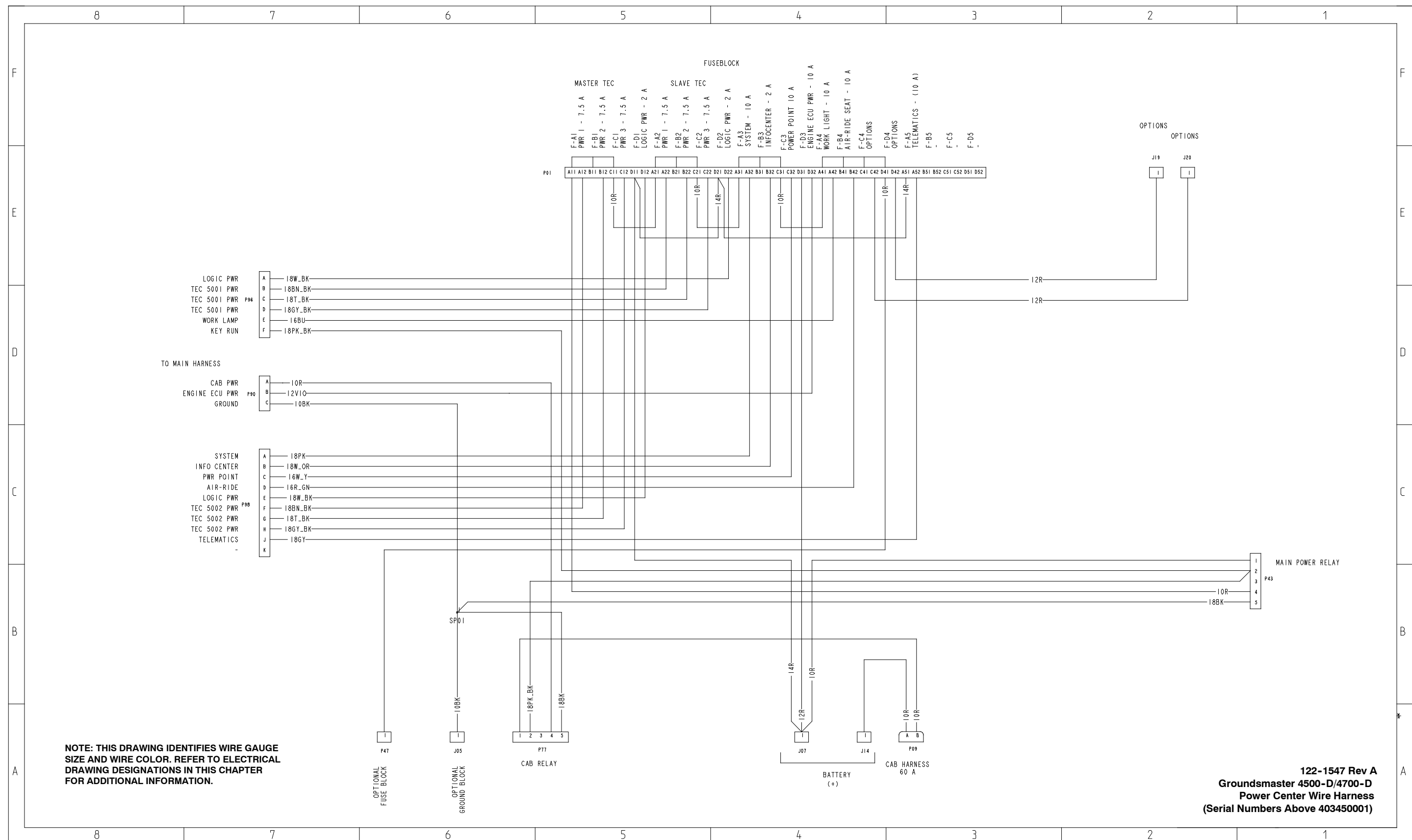


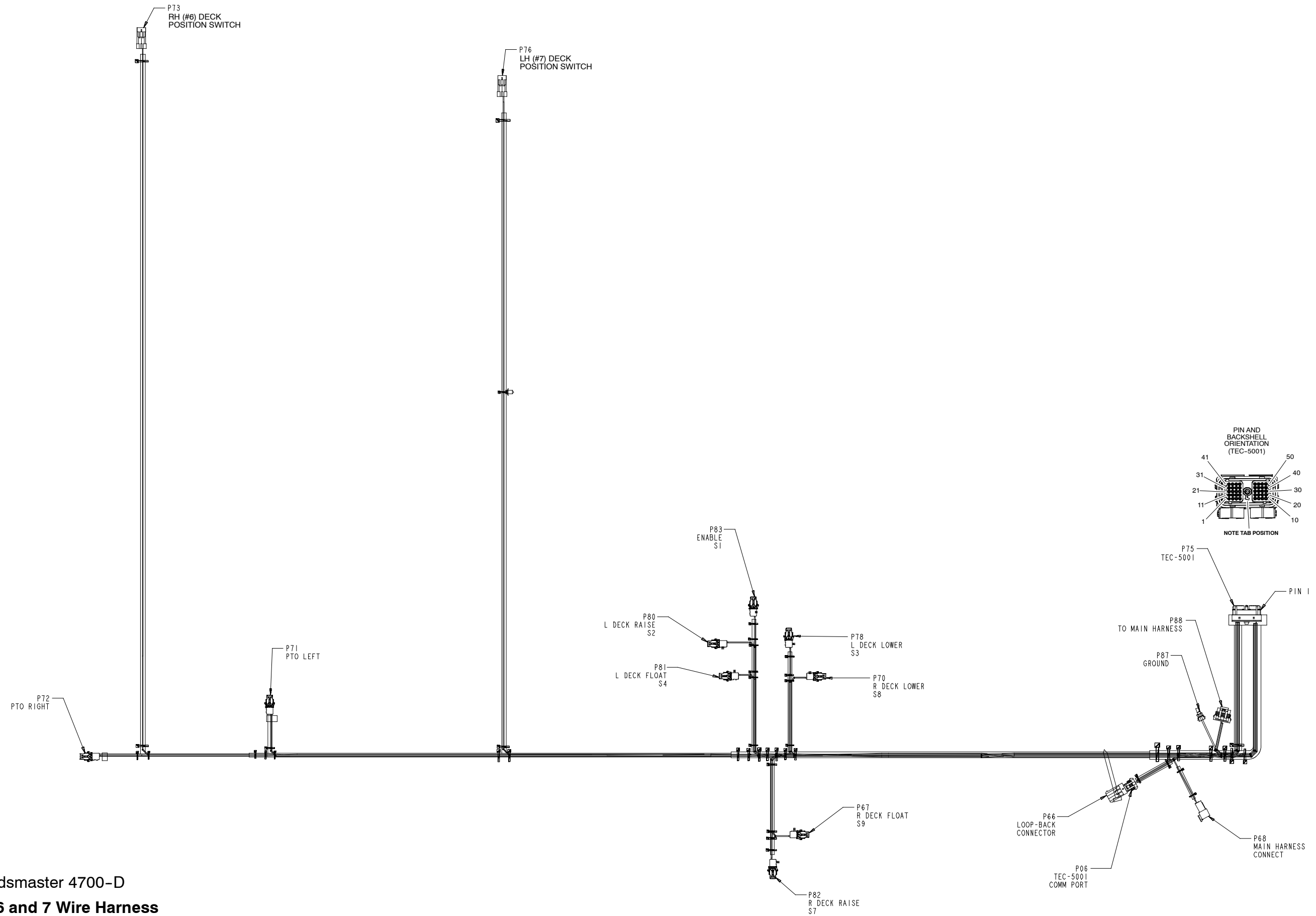


Groundsmaster 4500-D/4700-D  
**Power Center Wire Harness**  
 (Serial number below 403450000)

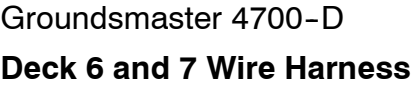


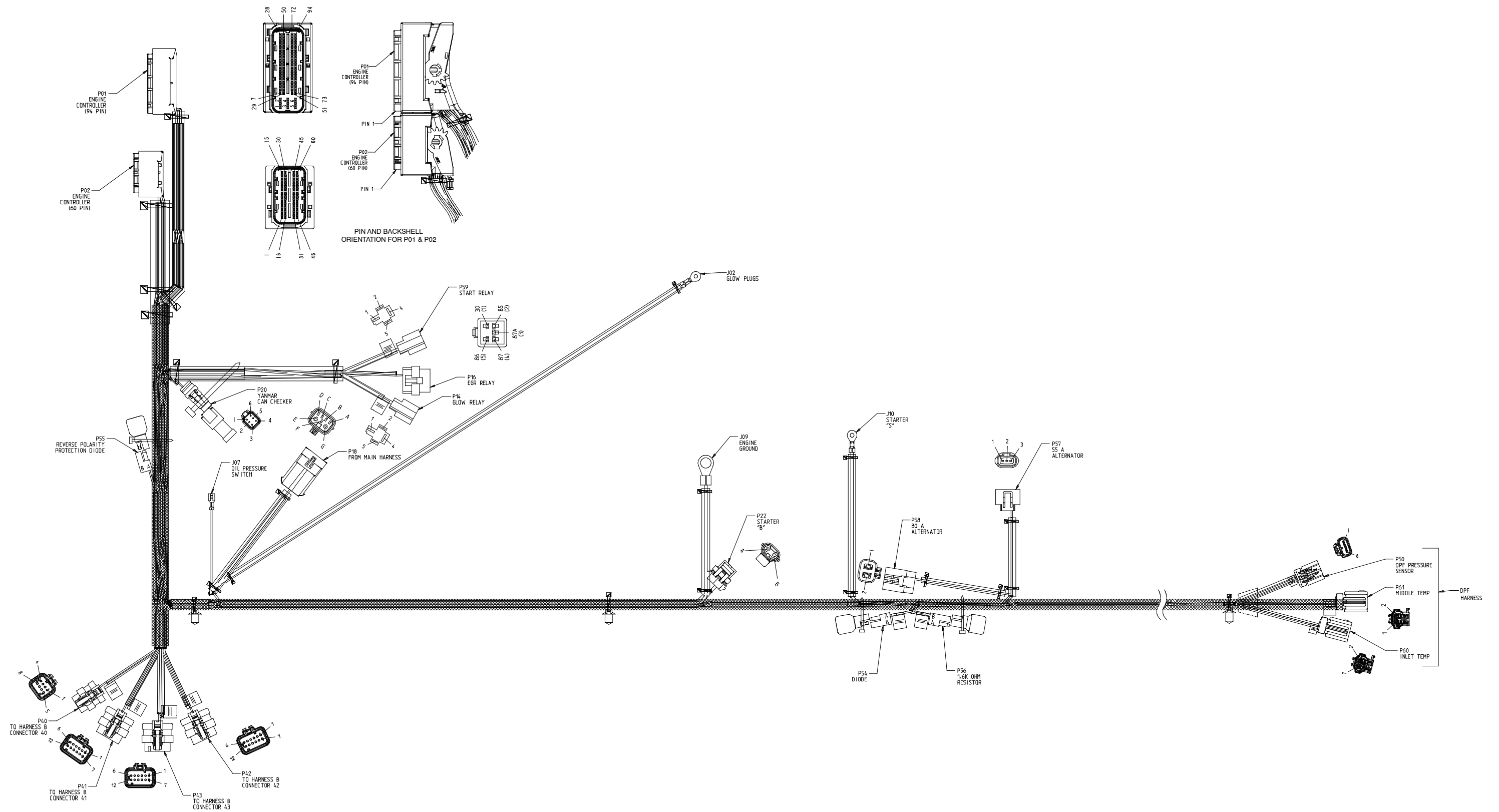




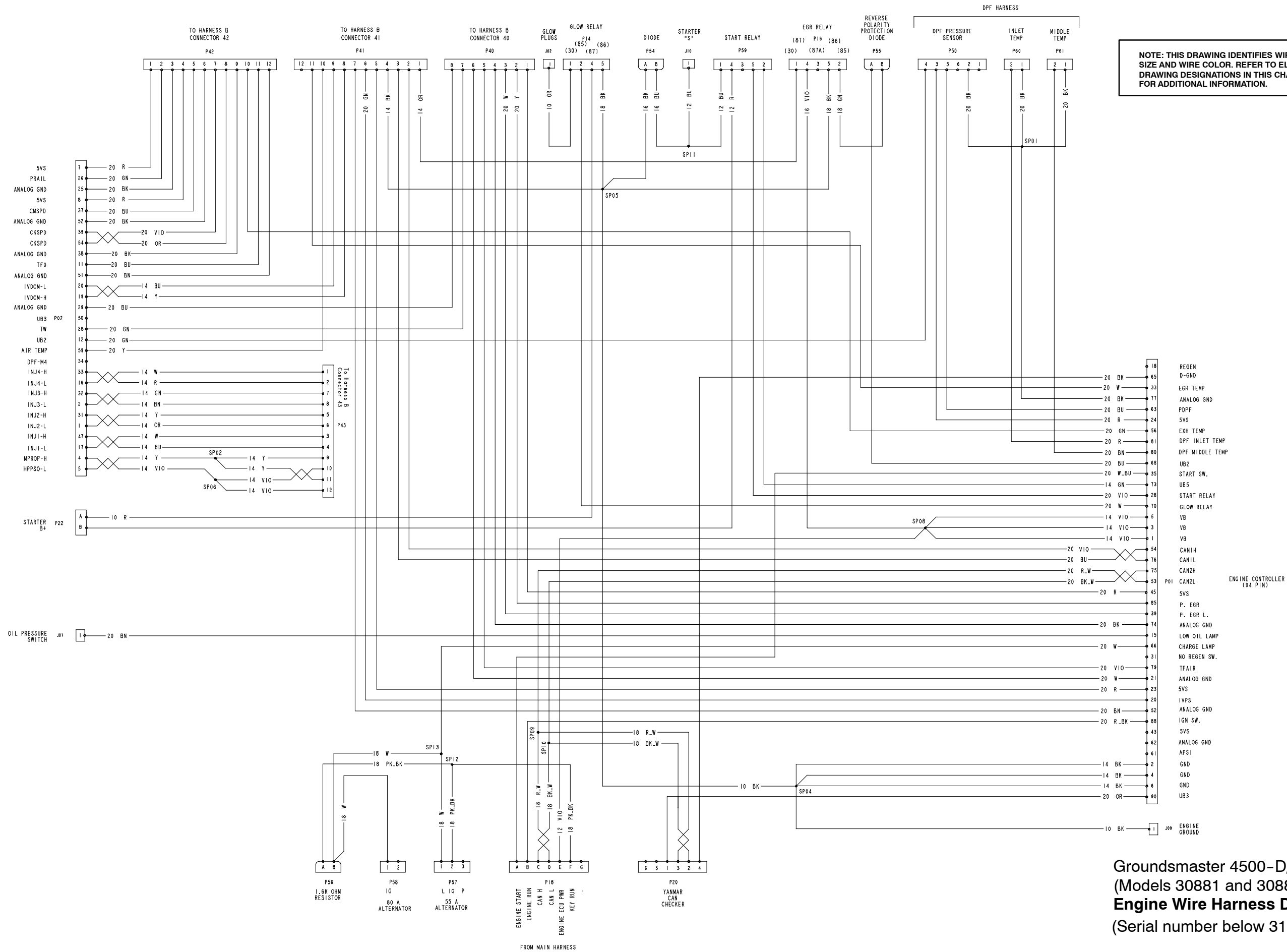


Groundsmaster 4700-D  
Deck 6 and 7 Wire Harness



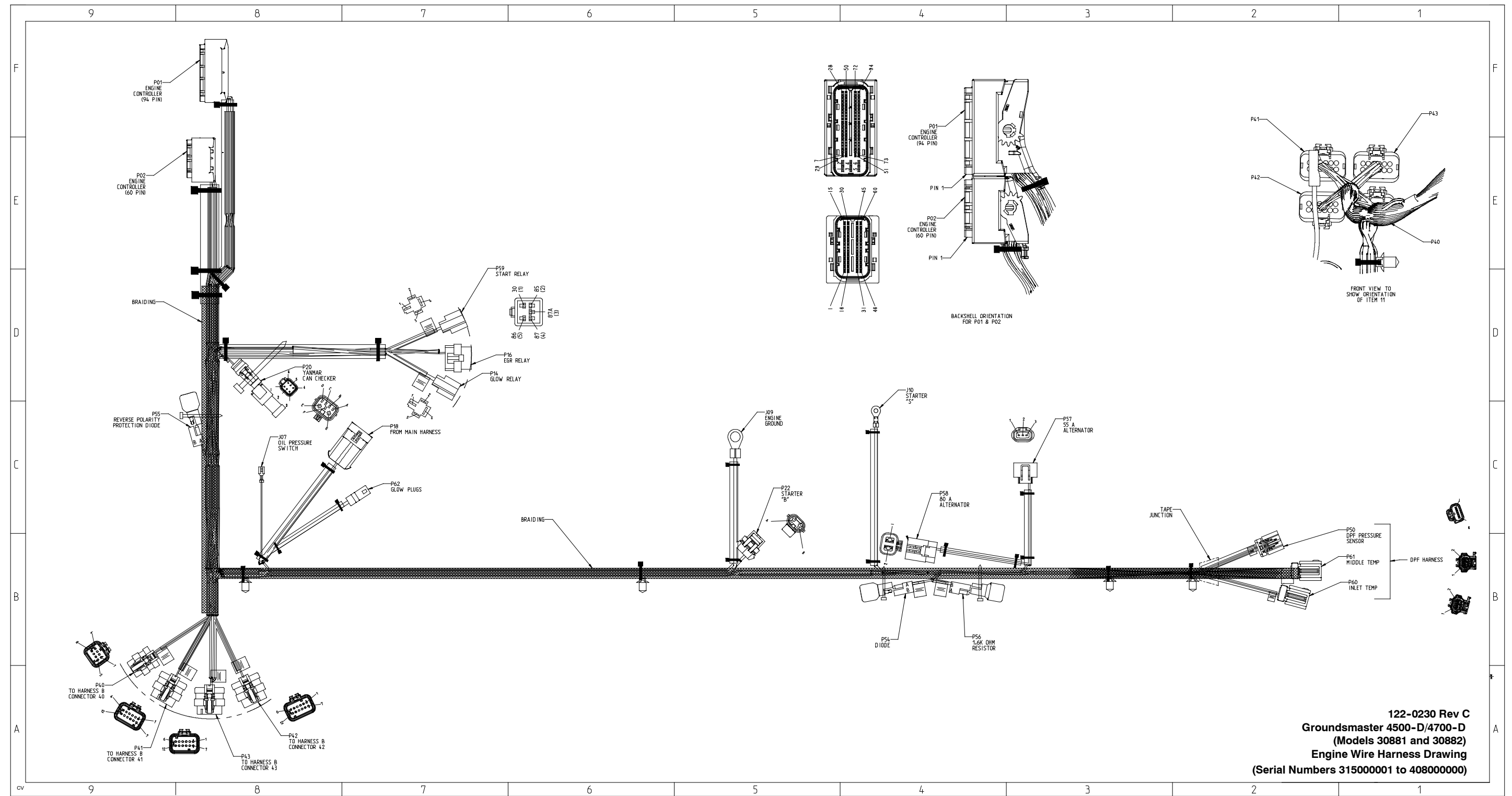


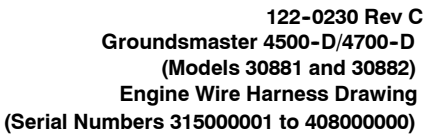
Groundsmaster 4500-D/4700-D  
(Models 30881 and 30882)  
**Engine Wire Harness Drawing**  
(Serial number below 315000000)

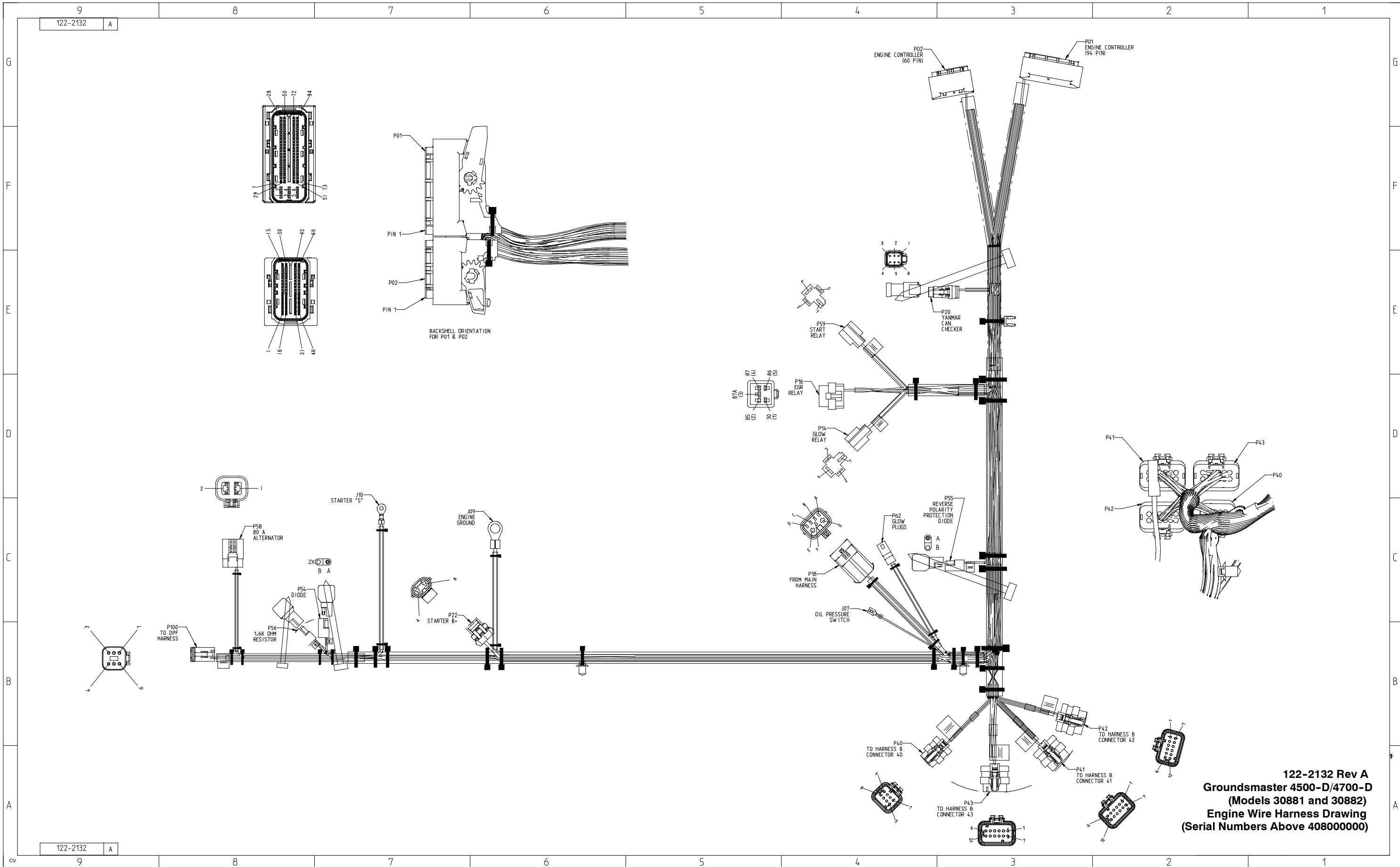


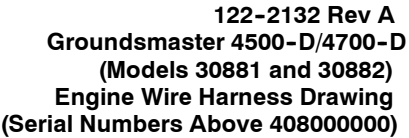
Groundsmaster 4500-D/4700-D  
(Models 30881 and 30882)  
**Engine Wire Harness Diagram**  
(Serial number below 315000000)

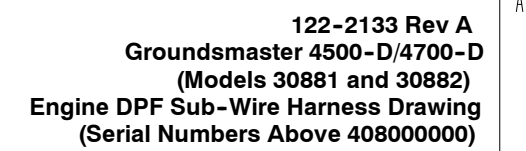


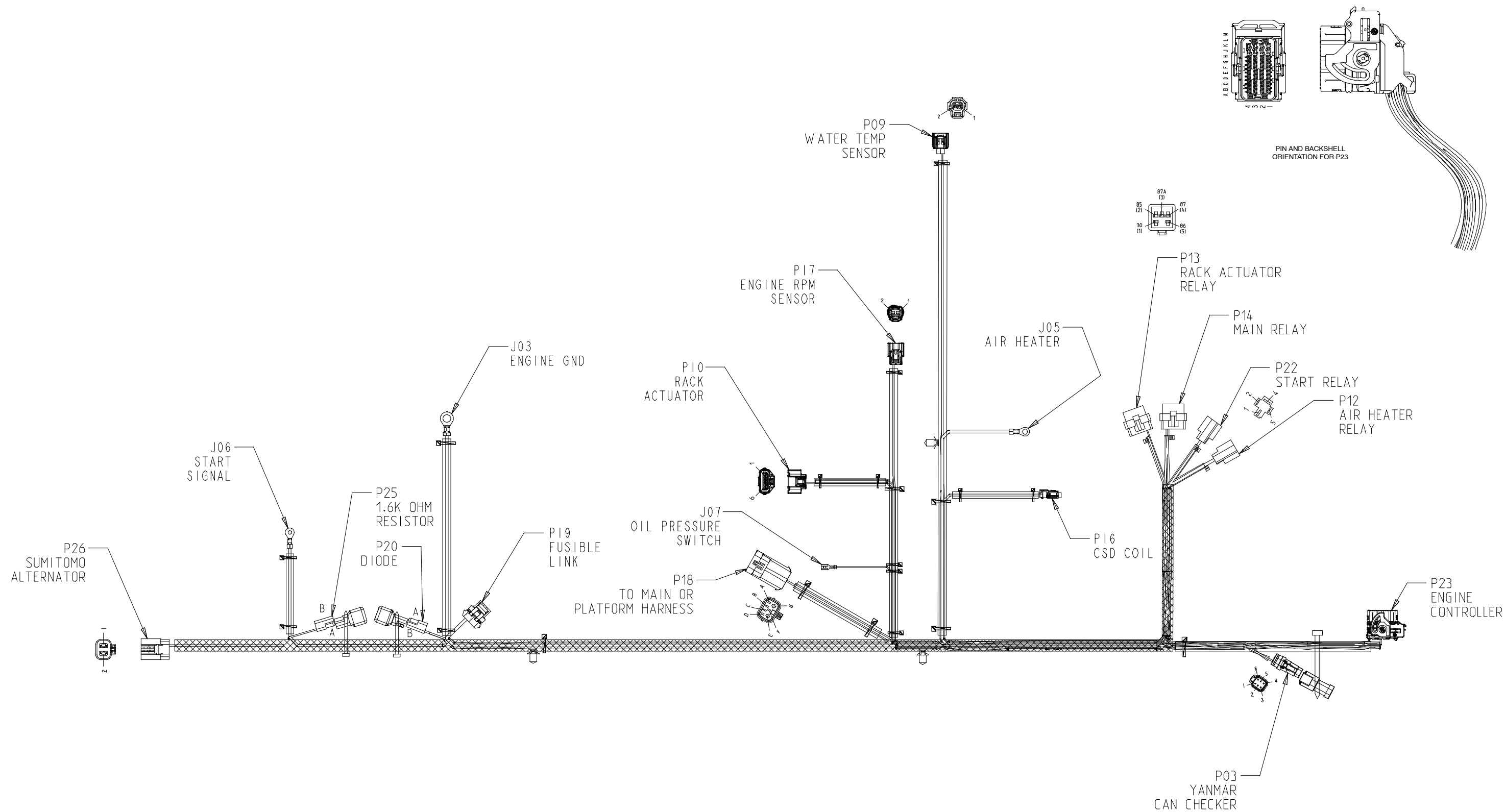




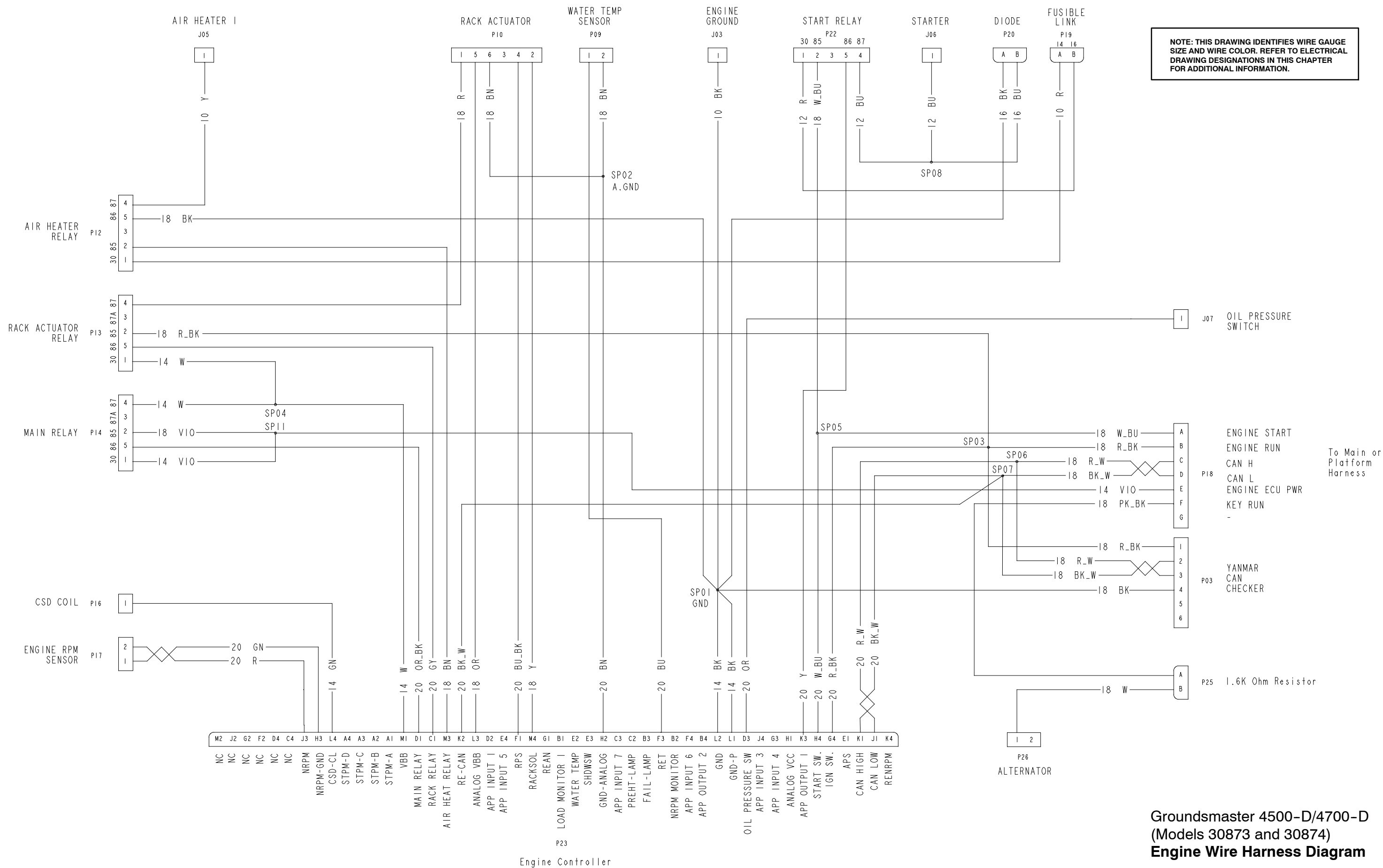




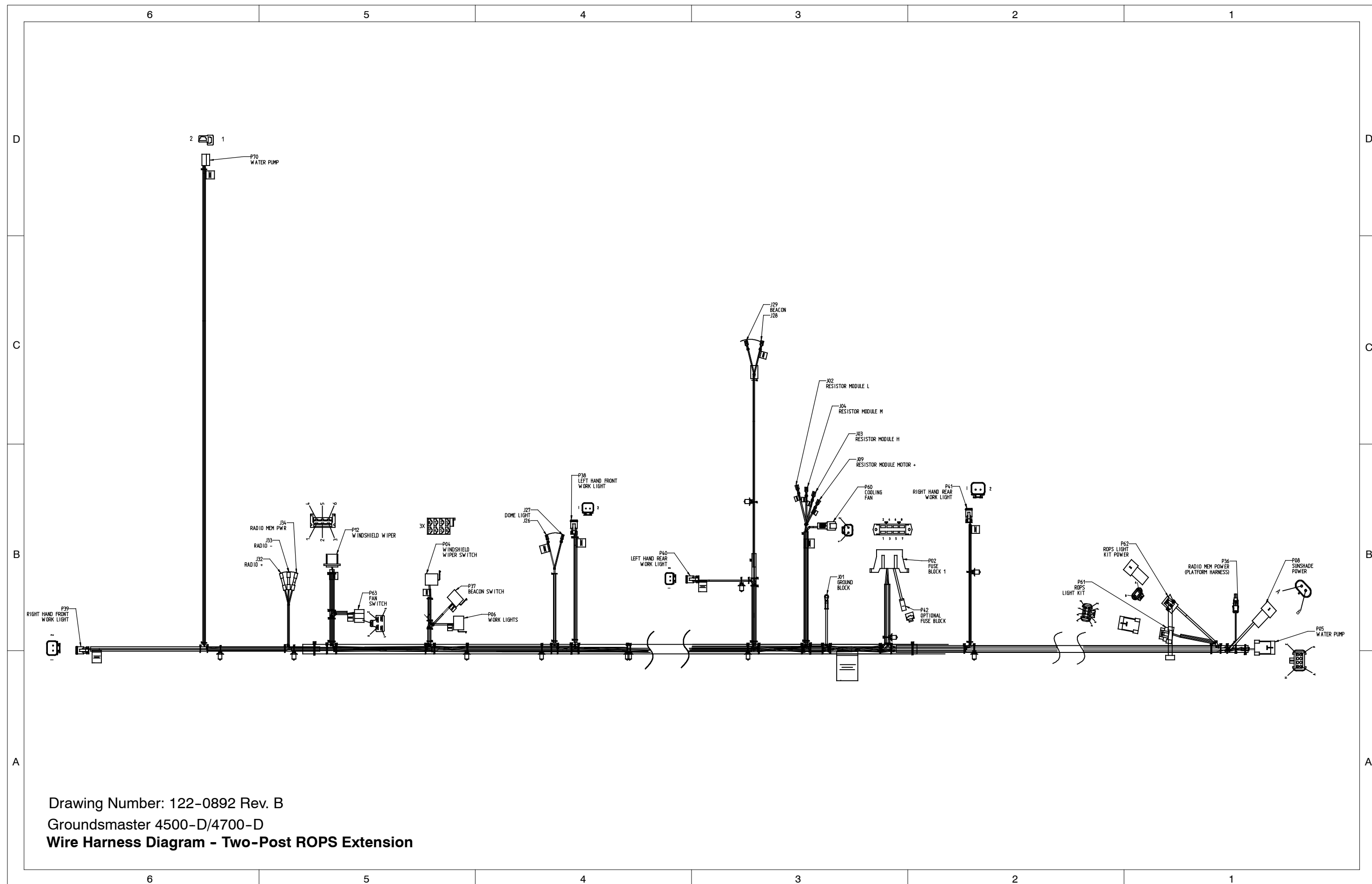




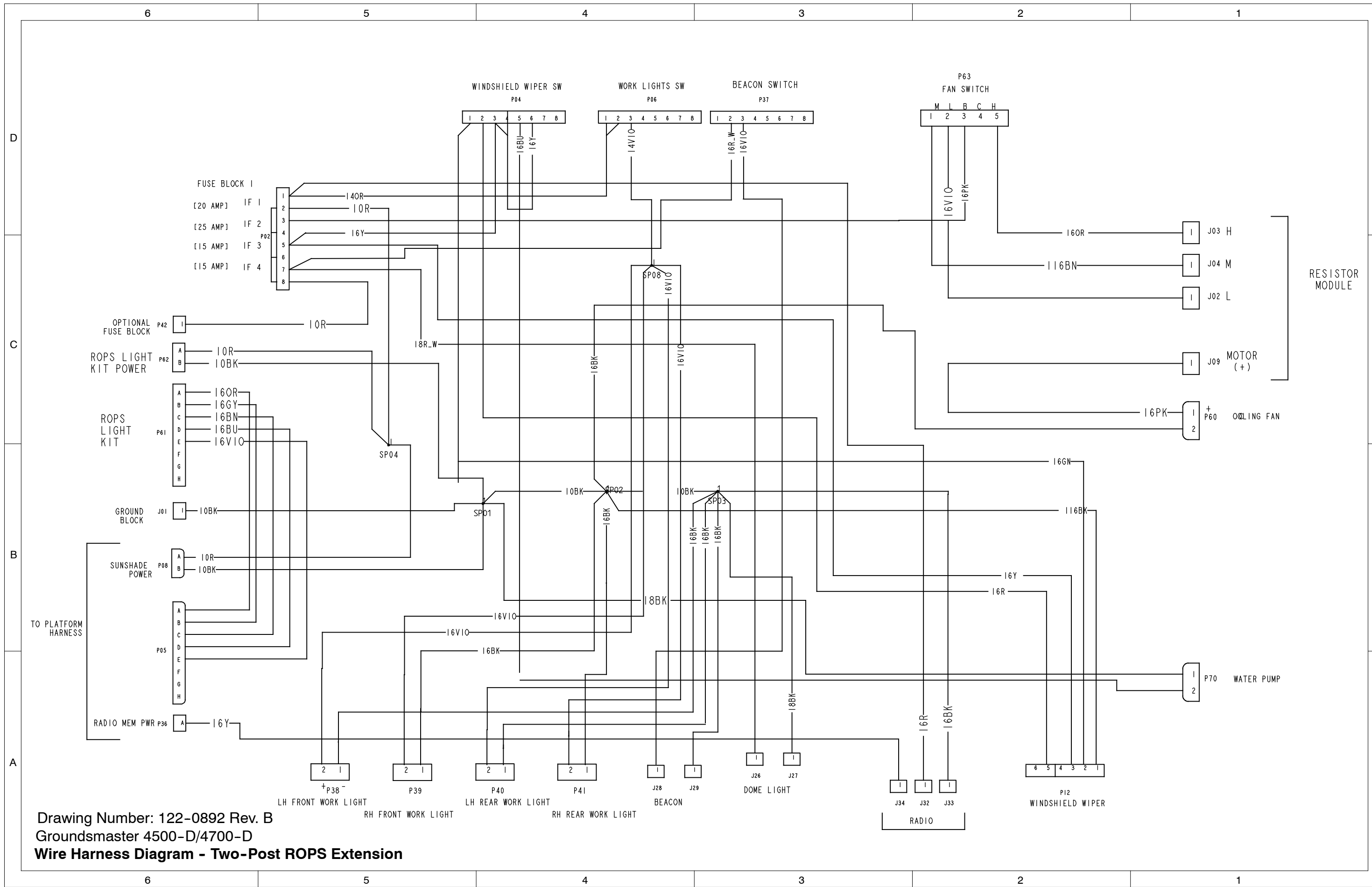
Groundsmaster 4500-D/4700-D  
(Models 30873 and 30874)  
**Engine Wire Harness Drawing**



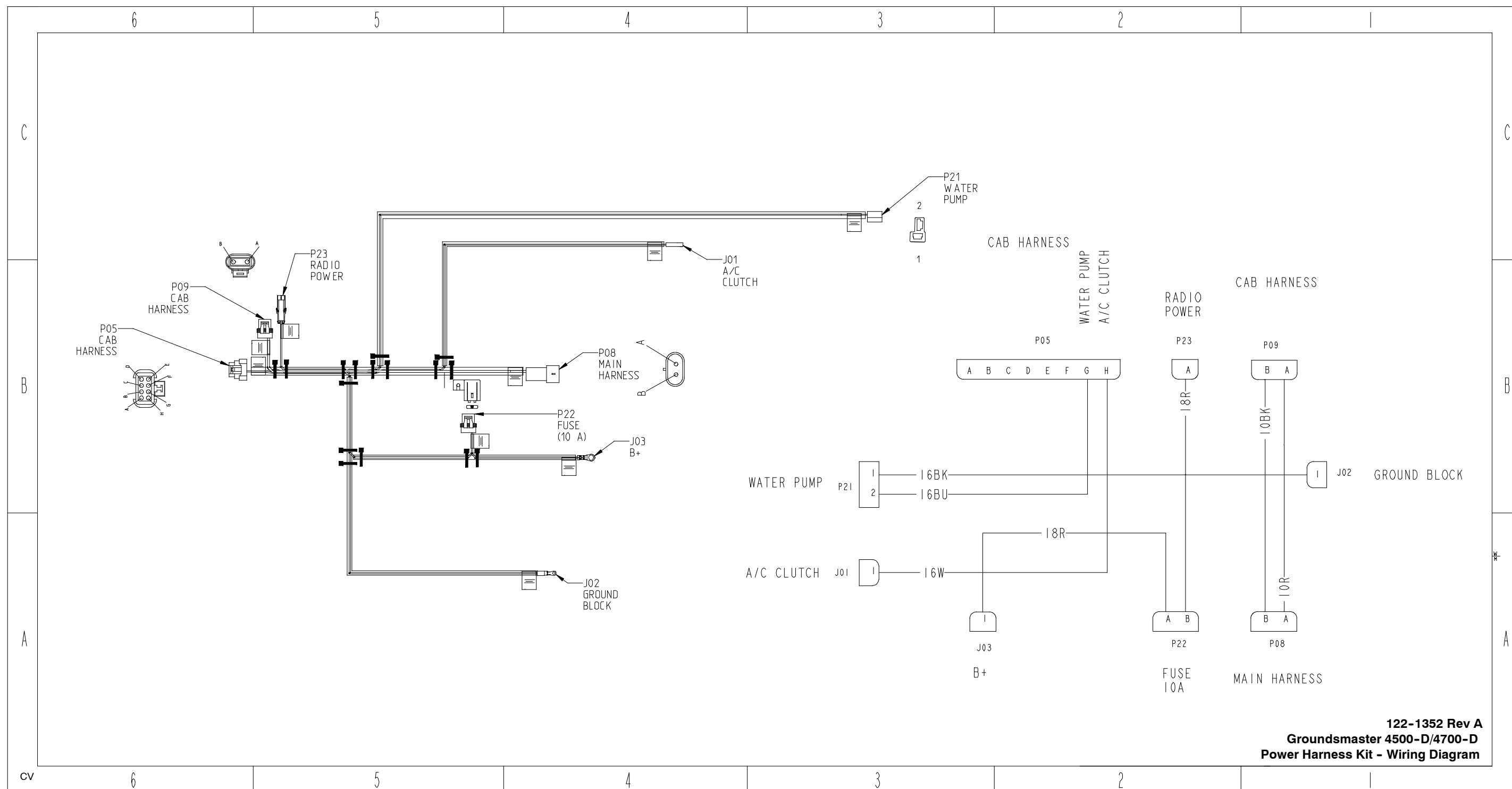
Groundsmaster 4500-D/4700-D  
(Models 30873 and 30874)  
**Engine Wire Harness Diagram**







Drawing Number: 122-0892 Rev. B  
Groundsmaster 4500-D/4700-D  
Wire Harness Diagram - Two-Post ROPS Extension



122-1352 Rev A  
Groundsmaster 4500-D/4700-D  
Power Harness Kit - Wiring Diagram