



# Service Manual

(Models 30448 and 30446)

## Groundsmaster® 4000-D & 4010-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 4000-D (Model 30448) and 4010-D (Model 30446).

REFER TO THE OPERATOR'S MANUAL FOR OPERATING, MAINTENANCE AND ADJUSTMENT INSTRUCTIONS. For reference, insert a copy of the Operator's Manual and Parts Catalog for your machine into Chapter 2 of this service manual. Additional copies of the Operator's Manual 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 4000-D

Groundsmaster 4010-D



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Safety

Product Records  
and Maintenance

Kubota  
Diesel Engine

Hydraulic  
System

Electrical  
System

Axles, Planetaries  
and Brakes

Chassis

Cutting  
Decks

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Operator Cab

Foldout Drawings

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# General Safety Instructions

The Groundsmaster 4000-D and 4010-D are tested and certified by Toro for compliance with existing safety standards and specifications. Although hazard control and accident prevention partially are dependent upon the design and configuration of the machine, these factors are also dependent upon the awareness, concern and proper training of the personnel involved in the operation, transport, maintenance and storage of the machine. Improper use or maintenance of the machine can result in injury or death. 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.**

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### Before Operating

1. Review and understand the contents of the Operator's Manual 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. Also tighten any loose nuts, bolts or screws to ensure machine is in safe operating condition.
3. Assure interlock switches are adjusted correctly so engine cannot be started unless traction pedal is in NEUTRAL and cutting decks are DISENGAGED.
4. Since diesel fuel is highly 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.

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## While Operating

1. Sit on the seat when starting and operating the machine.
2. Before starting the engine:
  - A. Apply the parking brake.
  - B. Make sure traction pedal is in neutral and the PTO switch is OFF (disengaged).
  - C. After engine is started, release parking brake and keep foot off traction pedal. Machine must not move. If movement is evident, the traction pedal linkage is adjusted incorrectly; therefore, shut engine off and adjust until machine does not move when traction pedal is released.
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, muffler or exhaust pipe 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. Apply the parking brake.
  - C. Disengage cutting decks and wait for blades to stop.
  - D. Stop engine and remove key from switch.
  - E. Toro recommends that anytime the machine is parked (short or long term), the cutting decks should be lowered to the ground. This relieves hydraulic pressure from the lift circuit and eliminates the risk of the cutting decks unexpectedly lowering to the ground.
  - F. Do not park on slopes unless wheels are chocked or blocked.

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## Maintenance and Service

1. Before servicing or making adjustments, lower decks, stop engine, apply parking brake and remove key from the ignition switch.
2. Make sure machine is in safe operating condition by keeping all nuts, bolts and screws tight.
3. Never store the machine or fuel container inside where there is an open flame, such as near a water heater or furnace.
4. Make sure all hydraulic connectors are tight and all hydraulic hoses and lines are in good condition before applying pressure to the system.
5. Keep body and hands away from pin hole leaks 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.
6. Before disconnecting or performing any work on the hydraulic system, all pressure in system must be relieved by lowering cutting decks to the ground and stopping engine.
7. If major repairs are ever needed or assistance is desired, contact an Authorized Toro Distributor.
8. To reduce potential fire hazard, keep engine area free of excessive grease, grass, leaves and dirt. Clean protective screen on machine frequently.
9. 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.
10. Do not overspeed the engine by changing governor setting. To assure safety and accuracy, check maximum engine speed.
11. Shut engine off before checking or adding oil to the crankcase.
12. Disconnect battery before servicing the machine. Disconnect negative cable first and positive cable last. If battery voltage is required for troubleshooting or test procedures, temporarily connect the battery. Reconnect positive cable first and negative cable last.
13. 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.
14. Battery gases can explode. Keep cigarettes, sparks and flames away from the battery.
15. 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.
16. When changing attachments, tires or performing other service, use correct blocks, hoists and jacks. Make sure machine is parked on a solid level surface such as a concrete floor. Prior to raising the machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use appropriate jack stands to support the raised machine. If the machine is not properly supported by jack stands, the machine may move or fall, which may result in personal injury (see Jacking Instructions in this chapter).
17. When welding on machine, disconnect all battery cables to prevent damage to machine electronic equipment. Disconnect negative battery cable first and positive cable last. Also, disconnect wire harness connector from both of the TEC controllers and disconnect the terminal connector from the alternator. Attach welder ground cable no more than two (2) feet (0.61 meters) from the welding location.

# 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.

Safety

### Jacking the Front End (Fig. 1)

1. Set parking brake and chock both rear tires to prevent the machine from moving.
2. Position jack securely under the frame, just to the inside of the front tire. Jack front wheel off the ground.
3. Once the machine is raised, position jack stand under the frame as close to the wheel as possible to support the machine.

### Jacking the Rear End (Fig. 2)

1. Place jack securely under the center of rear axle.
2. Chock both front tires. Jack rear of machine off the ground.
3. Once the machine is raised, use jack stands under the axle to support the machine.

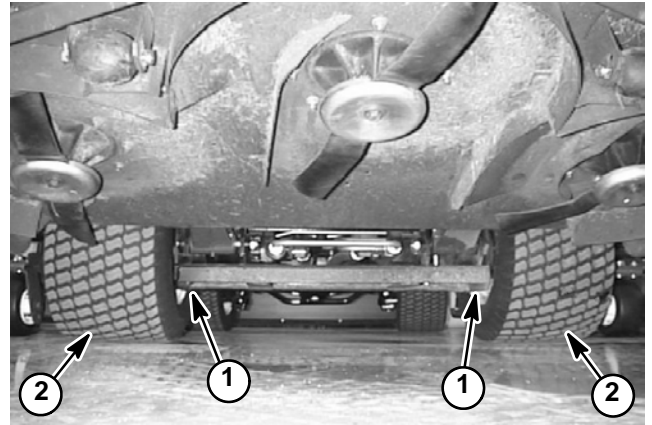


Figure 1

1. Front jacking point      2. Front tire

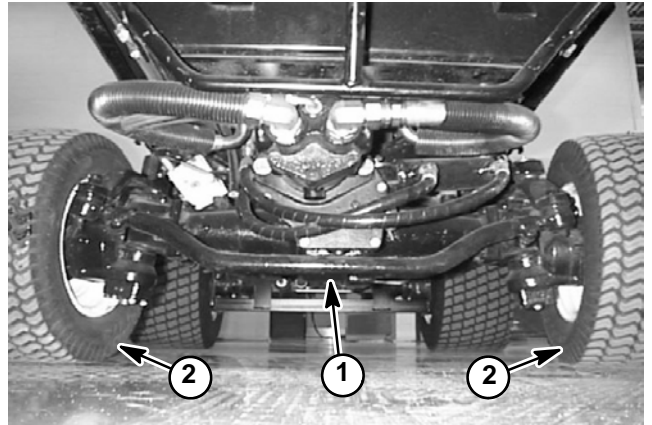


Figure 2

1. Rear axle jacking point      2. Rear tire

# Safety and Instruction Decals

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





# Product Records and Maintenance

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## Product Records

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

## Maintenance

Maintenance procedures and recommended service intervals for your Groundsmaster are covered in the Operator's Manual. Refer to that publication when performing regular equipment maintenance.

# 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

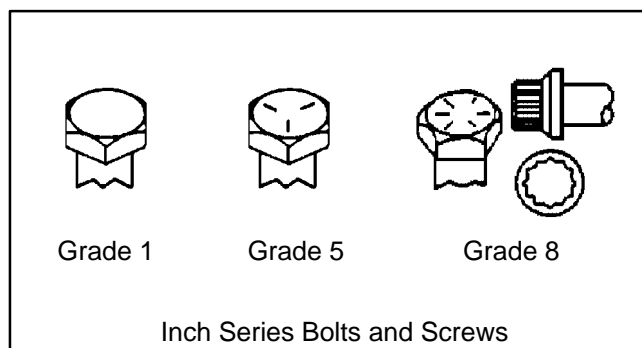


Figure 1

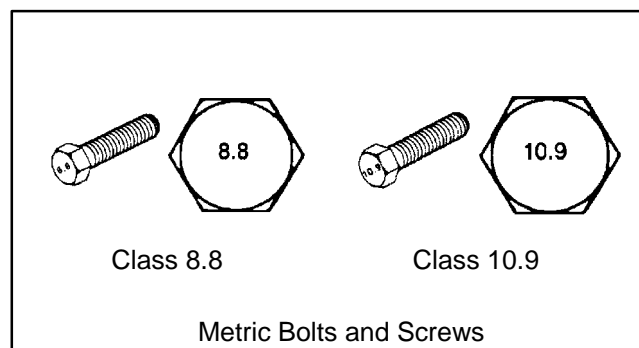


Figure 2

## 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.

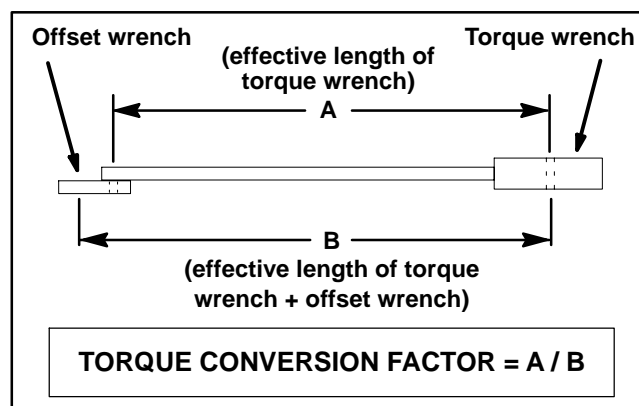


Figure 3

## 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

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

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

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

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



# Kubota Diesel Engine

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KUBOTA WORKSHOP MANUAL, DIESEL ENGINE, 03-M-E3B SERIES	

# Specifications

Item	Description
Make / Designation	Kubota Model V2403-M-T-E3B: 4-Cycle, 4 Cylinder, Water Cooled, Turbocharged, Diesel Engine
Bore	3.43 in (87.0 mm)
Stroke	4.031 in (102.4 mm)
Total Displacement	148.5 in <sup>3</sup> (2434 cc)
Firing Order	1 (closest to gear case end) - 3 - 4 (closest to flywheel end) - 2
Combustion Chamber	Spherical Type (E-TVCS)
Compression Ratio	23.0:1
Direction of Rotation	Counterclockwise (viewed from flywheel)
Fuel	Diesel or Biodiesel (up to B20) Fuel with Low or Ultra Low Sulfur Content
Fuel Capacity	19 U.S. gallons (72 liters)
Fuel Injection Pump	Denso PFR 4M Type Mini Pump
Injection Nozzle	Denso OPD Mini Nozzle
Governor	Centrifugal Mechanical
Low Idle (no load)	1425 ± 50 RPM
High Idle (no load)	2870 + 50/-120 RPM
Engine Oil	API CH-4, CI-4 or higher
Engine Oil Viscosity	See Operator's Manual
Crankcase Oil Capacity	10 U.S. quarts (9.5 liters) with Filter
Oil Pump	Trochoid Type
Coolant Capacity Groundsmaster 4000-D Groundsmaster 4010-D	13 U.S. quarts (12.3 liters) 17 U.S. quarts (16.1 liters)
Starter	12 VDC, 2.0 kW
Alternator/Regulator Groundsmaster 4000-D Groundsmaster 4010-D	12 VDC 40 amp 90 amp
Engine Dry Weight	419 U.S. pounds (190 kg)



# General Information

This Chapter gives information about specifications and repair of the diesel engine used in Groundsmaster 4000-D and 4010-D machines.

General maintenance procedures are described in your Operator's Manual. Information on engine troubleshooting, testing, disassembly and reassembly is identified in the Kubota Workshop Manual, Diesel Engine, 03-M-E3B that is included at the end of this section.

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

tools are described in the Kubota Workshop Manual, Diesel Engine, 03-M-E3B. 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 Kubota 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.

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## 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.

---

## 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.

# Service and Repairs

## Air Filter System

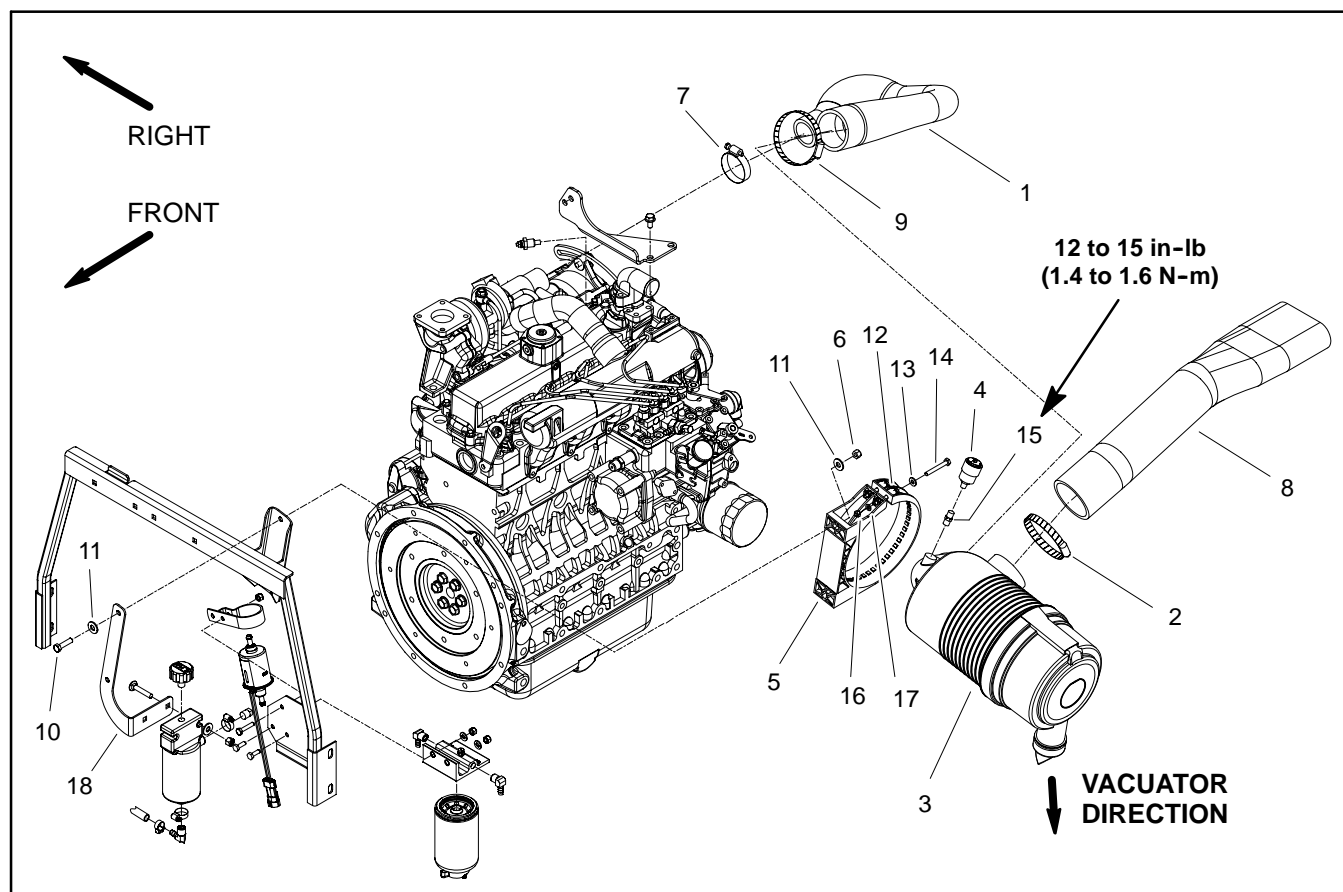


Figure 1

- 1. Air cleaner hose
- 2. Hose clamp
- 3. Air cleaner assembly
- 4. Indicator
- 5. Air cleaner strap
- 6. Lock nut (2 used)

- 7. Hose clamp
- 8. Air cleaner hose
- 9. Hose clamp
- 10. Cap screw (2 used)
- 11. Flat washer (4 used)
- 12. Spring (2 used)

- 13. Flat washer (2 used)
- 14. Cap screw (2 used)
- 15. Adapter
- 16. Lock nut (2 used)
- 17. Flat washer (2 used)
- 18. Overflow bracket

## Removal (Fig. 1)

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 1 as a guide.

## Installation (Fig. 1)

**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 system using Figure 1 as a guide.

A. If service indicator (item 4) and adapter (item 15) were removed from air cleaner housing, apply thread sealant to adapter threads before installing adapter and indicator to housing. Install adapter so that grooves in adapter hex and adapter filter element are installed toward service indicator (Fig. 3). Torque indicator from **12 to 15 in-lb (1.4 to 1.6 N-m)**.

B. When securing air cleaner in air cleaner strap, tighten cap screws (item 14) only enough to prevent air cleaner from rotating in strap.

2. When installing air cleaner hose (item 1) between air cleaner and turbo-charger (Fig. 4):

A. Make sure that hose does not contact engine valve cover. To ensure clearance, move and/or rotate air cleaner body in air cleaner strap.

B. Position hose to allow maximum clearance between air cleaner hose and muffler bracket.

3. Lower and secure hood.

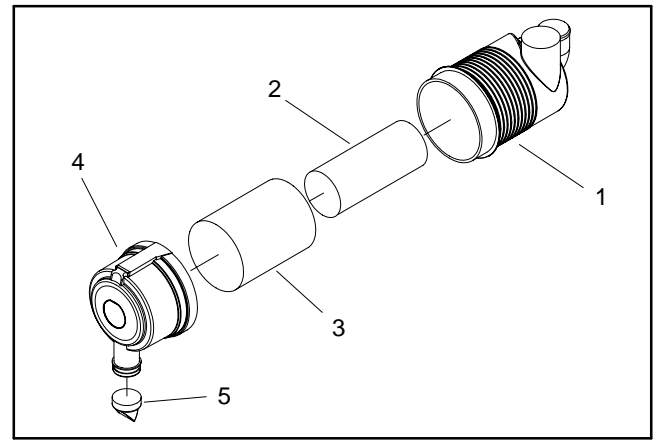


Figure 2

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

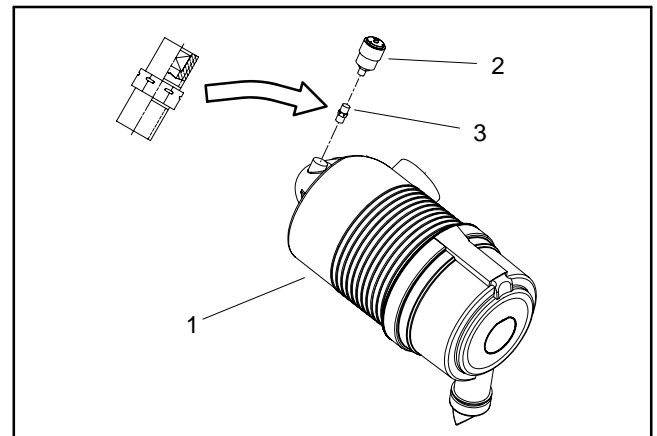


Figure 3

- |                         |            |
|-------------------------|------------|
| 1. Air cleaner assembly | 3. Adapter |
| 2. Service indicator    |            |

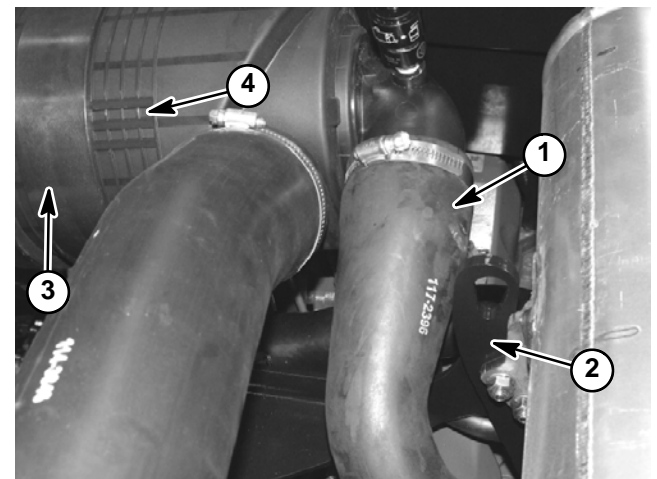


Figure 4

- |                     |                      |
|---------------------|----------------------|
| 1. Air cleaner hose | 3. Air cleaner strap |
| 2. Muffler bracket  | 4. Air cleaner slots |

## Exhaust System

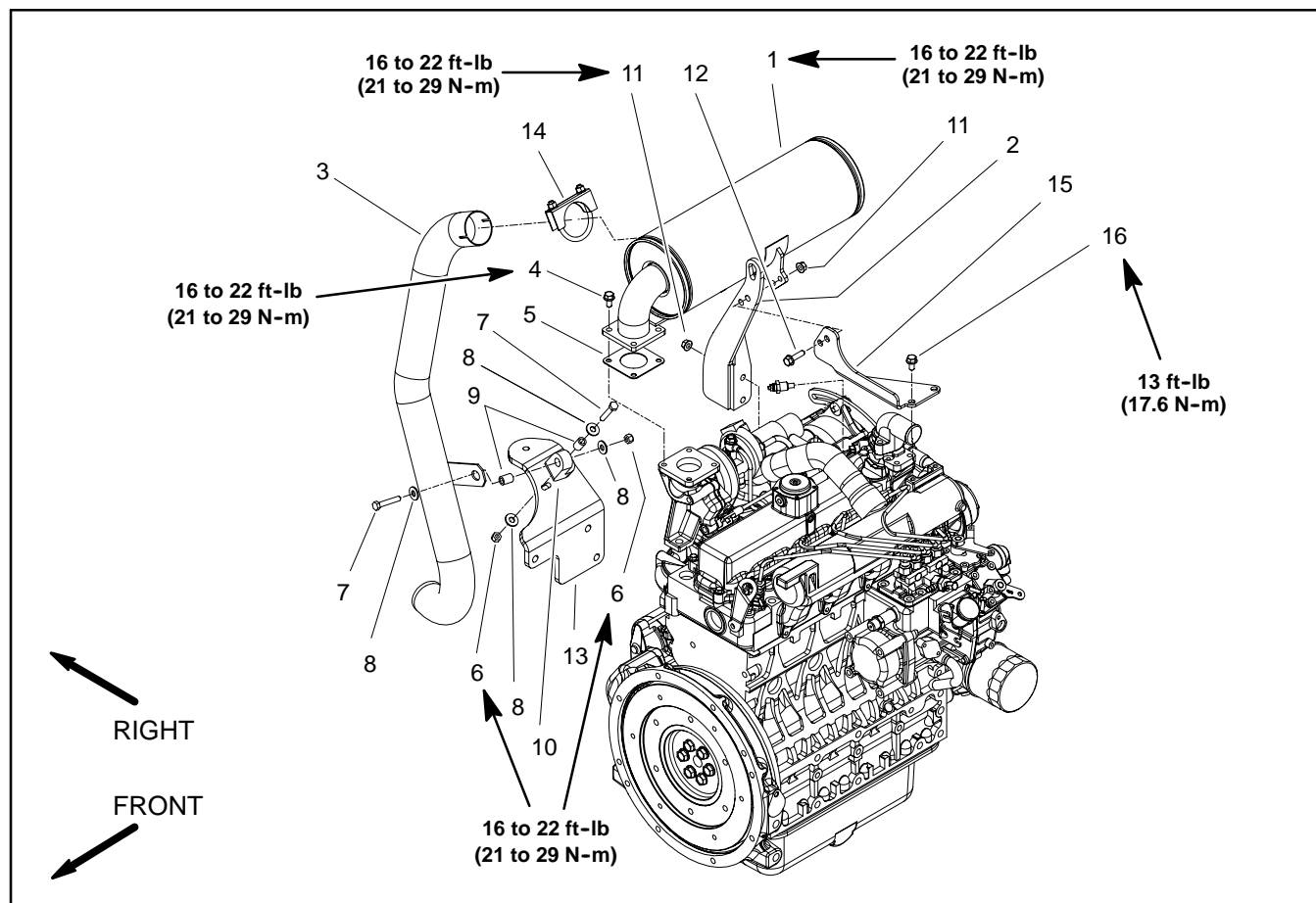


Figure 5

- |                               |                         |                                |
|-------------------------------|-------------------------|--------------------------------|
| 1. Muffler                    | 7. Cap screw (2 used)   | 12. Flange head screw (2 used) |
| 2. Muffler bracket            | 8. Flat washer (4 used) | 13. Engine mount               |
| 3. Exhaust pipe               | 9. Spacer (2 used)      | 14. Muffler clamp              |
| 4. Flange head screw (4 used) | 10. Rubber hanger       | 15. Exhaust mount              |
| 5. Exhaust gasket             | 11. Flange nut (4 used) | 16. Flange head screw (2 used) |
| 6. Lock nut (2 used)          |                         |                                |

## Removal (Fig. 5)



## CAUTION

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

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.
2. Raise and support hood.
3. Remove exhaust system components from the engine as necessary using Figure 5 as a guide.

## Installation (Fig. 5)

**IMPORTANT:** If exhaust studs were removed from engine cylinder head, thoroughly clean threads in head and apply Loctite #277 (or equivalent) to stud threads before installing studs into head.

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

1. Install **new** exhaust gasket if original gasket is damaged or torn.

**IMPORTANT:** Failure to follow the suggested muffler fastener sequence may result in premature muffler failure.

2. Install exhaust system components to the engine using Figure 5 as a guide. Hand tighten exhaust system fasteners and then torque in the sequence shown in Fig. 6 as follows:

A. Torque lock nuts used on rubber hanger cap screws from **16 to 22 ft-lb (21 to 29 N-m)**.

B. Torque flange head screws that secure muffler flange to engine from **16 to 22 ft-lb (21 to 29 N-m)**.

C. Torque flange nuts that secure muffler to muffler bracket from **16 to 22 ft-lb (21 to 29 N-m)**.

D. Torque flange nuts that secure muffler bracket to engine from **16 to 22 ft-lb (21 to 29 N-m)**.

E. Torque flange screws that secure exhaust mount to engine to **13 ft-lb (17.6 N-m)**.

3. Tailpipe should have equal clearance between frame and engine after installation.

4. Lower and secure hood.

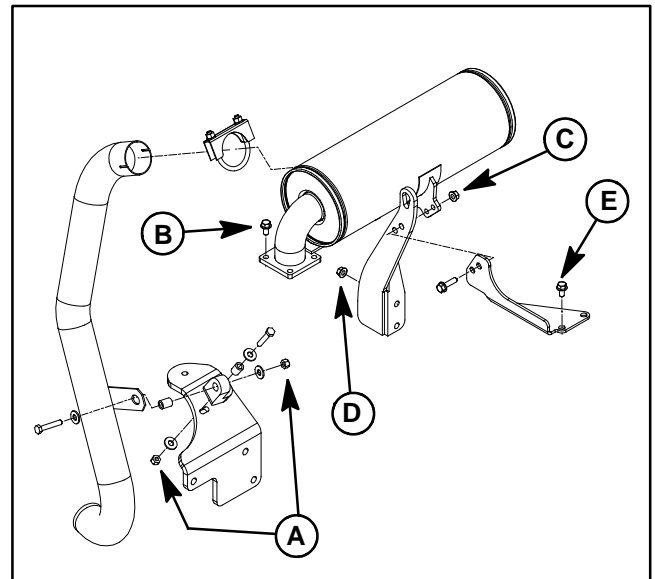


Figure 6

## Fuel System

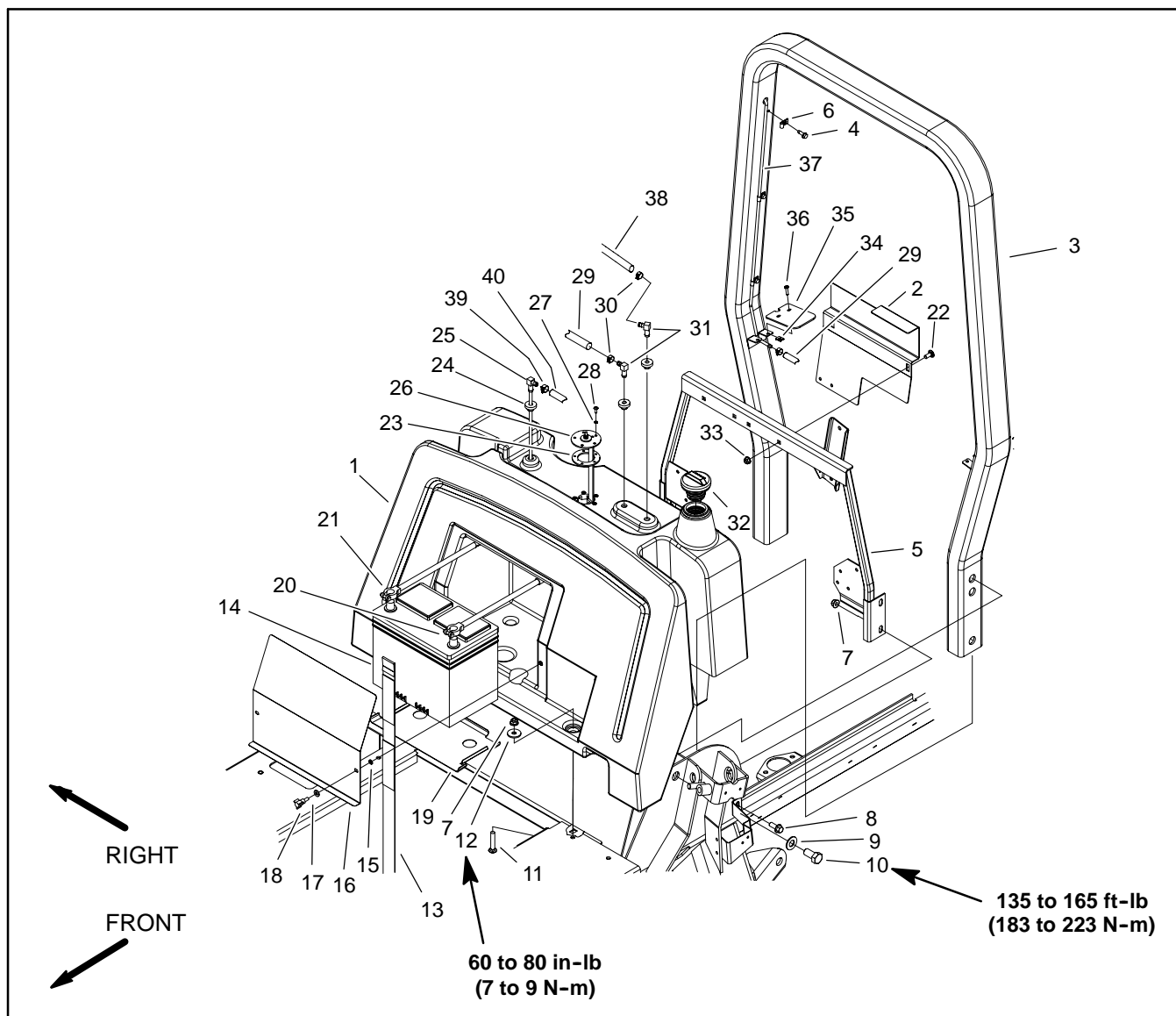


Figure 7

- |                               |                             |                                  |
|-------------------------------|-----------------------------|----------------------------------|
| 1. Fuel tank                  | 15. Retaining ring (2 used) | 28. Phillips head screw (5 used) |
| 2. Fuel tank bracket          | 16. Battery cover           | 29. Vent hose                    |
| 3. ROPS assembly              | 17. Flat washer (2 used)    | 30. Hose clamp                   |
| 4. Washer head screw (3 used) | 18. Knob (2 used)           | 31. Elbow fitting (2 used)       |
| 5. Tank support assembly      | 19. Battery plate           | 32. Fuel cap                     |
| 6. Insulated clip (3 used)    | 20. Negative cable          | 33. Locking flange nut (2 used)  |
| 7. Flange nut (6 used)        | 21. Positive cable          | 34. Speed nut (4 used)           |
| 8. Cap screw (4 used)         | 22. Carriage screw          | 35. Tank cover (2 used)          |
| 9. Flat washer (4 used)       | 23. Gasket                  | 36. Phillips head screw (4 used) |
| 10. Cap screw (4 used)        | 24. Bushing (3 used)        | 37. Vent tube                    |
| 11. Carriage screw (2 used)   | 25. Stand pipe              | 38. Overflow hose                |
| 12. Washer (2 used)           | 26. Fuel sender             | 39. Hose clamp                   |
| 13. Battery strap             | 27. Lock washer (5 used)    | 40. Fuel supply hose             |
| 14. Battery                   |                             |                                  |



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

### Empty and Clean Fuel Tank

Empty and clean the fuel tank periodically as recommended in the Operator's Manual. Also, empty 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.

### Fuel Tank Removal (Fig. 7)

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 operator seat and hood.
3. Remove battery cover and strap. Disconnect negative battery cable first and then positive battery cable. Remove battery from machine.
4. Use a fuel transfer pump to remove fuel from the fuel tank and into a suitable container.
5. Disconnect wire harness connections from the fuel sender (item 26).
6. Disconnect fuel supply hose from standpipe and vent and overflow hoses from elbow fittings in top of tank (Fig. 8).
7. Remove phillips head screws that secure two (2) tank covers (item 35) to ROPS assembly. Remove tank covers.
8. Remove fuel tank using Figure 7 as a guide.

### Fuel Tank Installation (Fig. 7)

1. Install fuel tank using Figure 7 as a guide.
  - A. Torque two (2) flange nuts (item 7) that secure the fuel tank to the frame from **60 to 80 in-lb (7 to 9 N-m)**.
2. Install two (2) tank covers to ROPS assembly.
3. Connect fuel supply hose to the standpipe and vent and overflow hoses to the elbow fittings (Fig. 8). Secure hoses with clamps.
4. Connect wire harness connections to the fuel sender.
  - A. Connect white wire to the center terminal and black wire to any of the screws that secure the fuel sender to the fuel tank.
  - B. Apply skin-over grease to the wire terminal connections.



## CAUTION

**Connecting battery cables to the wrong battery post could result in personal injury and/or damage to the electrical system.**

5. Position battery in machine. Connect positive battery cable first and then negative battery cable. Install battery strap and cover.
6. Lower and secure operator seat and hood.
7. Fill fuel tank.

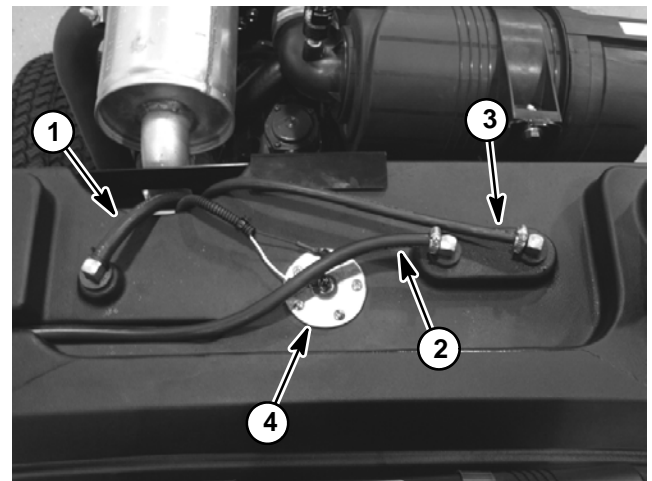


Figure 8

- |                     |                  |
|---------------------|------------------|
| 1. Fuel supply hose | 3. Overflow hose |
| 2. Vent hose        | 4. Fuel sender   |

## Radiator

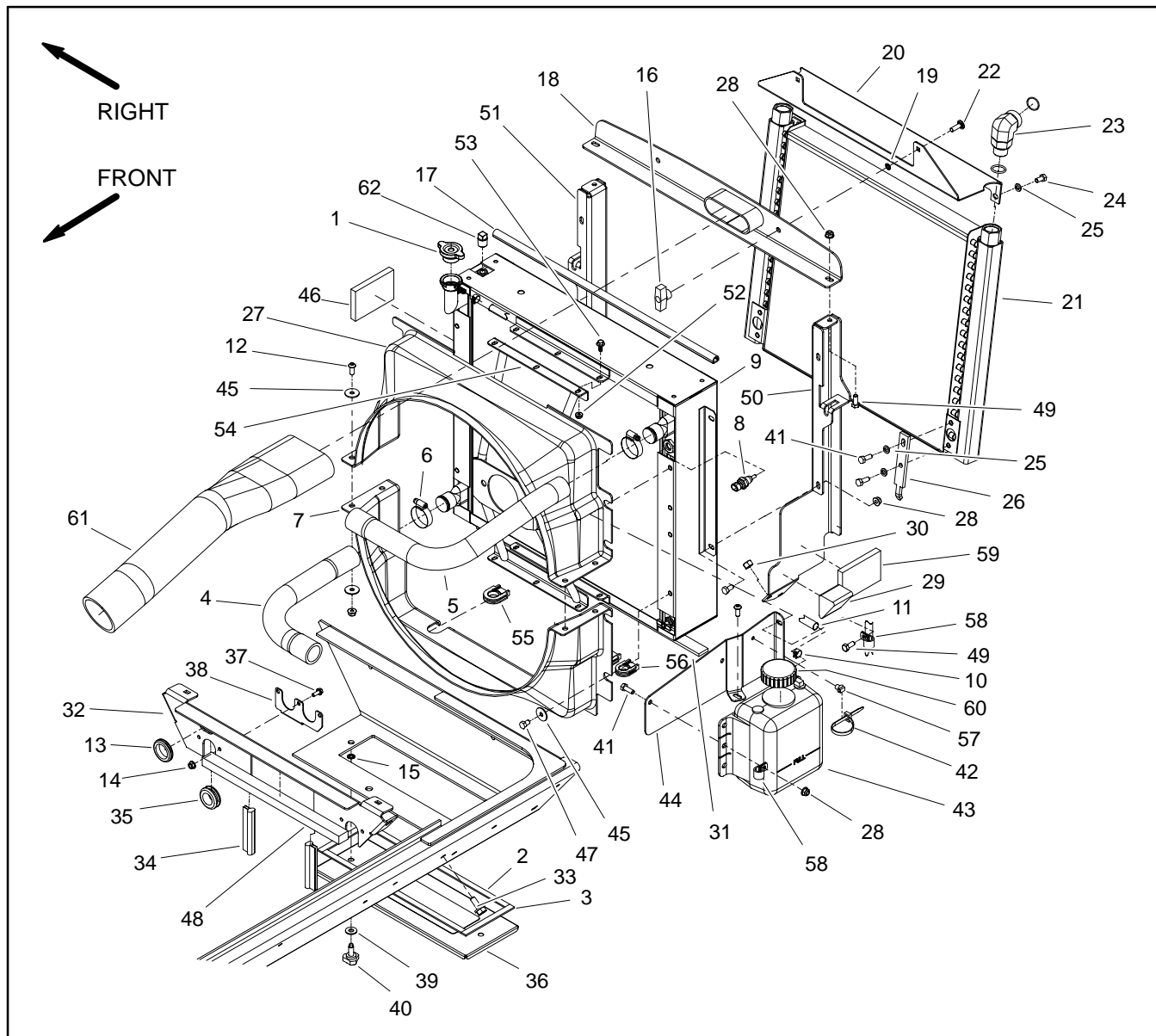


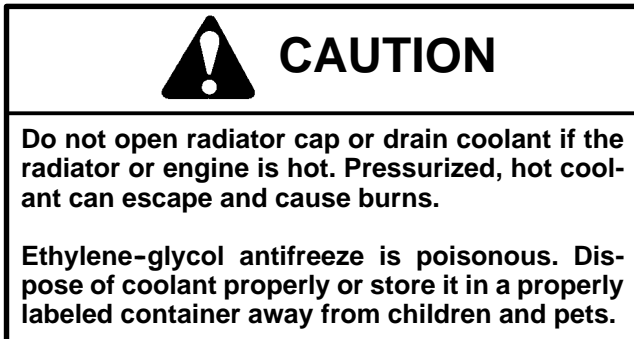
Figure 9

- |                             |                                     |                           |
|-----------------------------|-------------------------------------|---------------------------|
| 1. Radiator cap             | 22. Carriage screw (2 used)         | 43. Coolant reservoir     |
| 2. Foam strip (2 used)      | 23. 90° hydraulic fitting (2 used)  | 44. Tank bracket          |
| 3. Foam strip (2 used)      | 24. Cap screw (6 used)              | 45. Flat washer (10 used) |
| 4. Lower radiator hose      | 25. Lock washer (6 used)            | 46. Foam pad              |
| 5. Upper radiator hose      | 26. Oil cooler mount plate (2 used) | 47. Cap screw (7 used)    |
| 6. Clamp (4 used)           | 27. Upper radiator shroud           | 48. Foam seal             |
| 7. Lower radiator shroud    | 28. Flange nut (10 used)            | 49. Cap screw (3 used)    |
| 8. Temperature sender       | 29. Foam plug (2 used)              | 50. LH radiator support   |
| 9. Radiator                 | 30. Lock nut (6 used)               | 51. RH radiator support   |
| 10. Hose clamp (3 used)     | 31. Foam strip                      | 52. Flange nut (6 used)   |
| 11. Hose (2 used)           | 32. Base bracket                    | 53. Cap screw (6 used)    |
| 12. Screw (4 used)          | 33. Flange head screw (6 used)      | 54. Fan motor bracket     |
| 13. Rubber grommet          | 34. Bulb seal (2 used)              | 55. Grommet (2 used)      |
| 14. Flange nut (4 used)     | 35. Grommet (2 used)                | 56. Grommet               |
| 15. Retaining ring (2 used) | 36. Cover                           | 57. Harness clip          |
| 16. Knob (2 used)           | 37. Flange head screw (4 used)      | 58. R-clamp (2 used)      |
| 17. Bulb seal               | 38. Plate (2 used)                  | 59. Foam pad              |
| 18. Top radiator support    | 39. Flat washer (2 used)            | 60. Reservoir cap         |
| 19. Retaining ring (2 used) | 40. Knob (2 used)                   | 61. Air cleaner hose      |
| 20. Oil cooler bracket      | 41. Cap screw (6 used)              | 62. Plug                  |
| 21. Oil cooler              | 42. Cable tie                       |                           |



## Removal (Fig. 9)

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



3. Drain radiator into a suitable container using the radiator drain. The radiator drain hose is located near the engine oil filter.
4. Disconnect upper and lower radiator hoses from the radiator.
5. Remove air cleaner hose (item 61).
6. Disconnect reservoir hose from the vent tube near the radiator cap.
7. Detach upper radiator shroud from the radiator and lower radiator shroud. Remove upper shroud from machine.
8. Remove fasteners that secure lower radiator shroud to radiator.
9. Remove six (6) flange head screws and flange nuts that secure fan motor bracket to radiator.
10. Position lower radiator shroud and fan motor bracket assembly away from radiator.
11. Disconnect wire harness connector from temperature sender (item 8).
12. Remove cap screws and flange nuts securing the radiator to the support frame. Carefully pull radiator from the machine.
13. Plug all radiator and hose openings to prevent contamination.

## Installation (Fig. 9)

1. Remove all plugs placed during the removal procedure.
2. Carefully position radiator to the support frame. Secure radiator to the support frame with cap screws and flange nuts.
3. If temperature sender (item 8) was removed from radiator, install new O-ring on sender and thread sender into radiator. Torque sender from **9 to 11 ft-lb (12.3 to 14.9 N-m)**. Reconnect wire harness connector to sender.
4. Position lower radiator shroud and fan motor bracket assembly to the radiator.
5. Secure fan motor bracket to radiator with six (6) flange head screws and flange nuts. Position bracket as far as possible from radiator to maximize distance between radiator and fan motor location.
6. Position upper radiator shroud to lower radiator shroud to radiator. Secure shrouds with removed fasteners.
7. Attach radiator shroud assembly to the radiator with cap screws and flat washers. Make sure that clearance between shroud and cooling fan is at least 0.180" (4.6 mm) at all points.
8. Connect reservoir hose to the vent tube near the radiator cap.
9. Connect upper and lower radiator hoses to the radiator.
10. Reinstall air cleaner hose (item 61).
11. Make sure radiator drain is closed. Fill radiator with coolant.
12. Close and secure hood.

# Engine

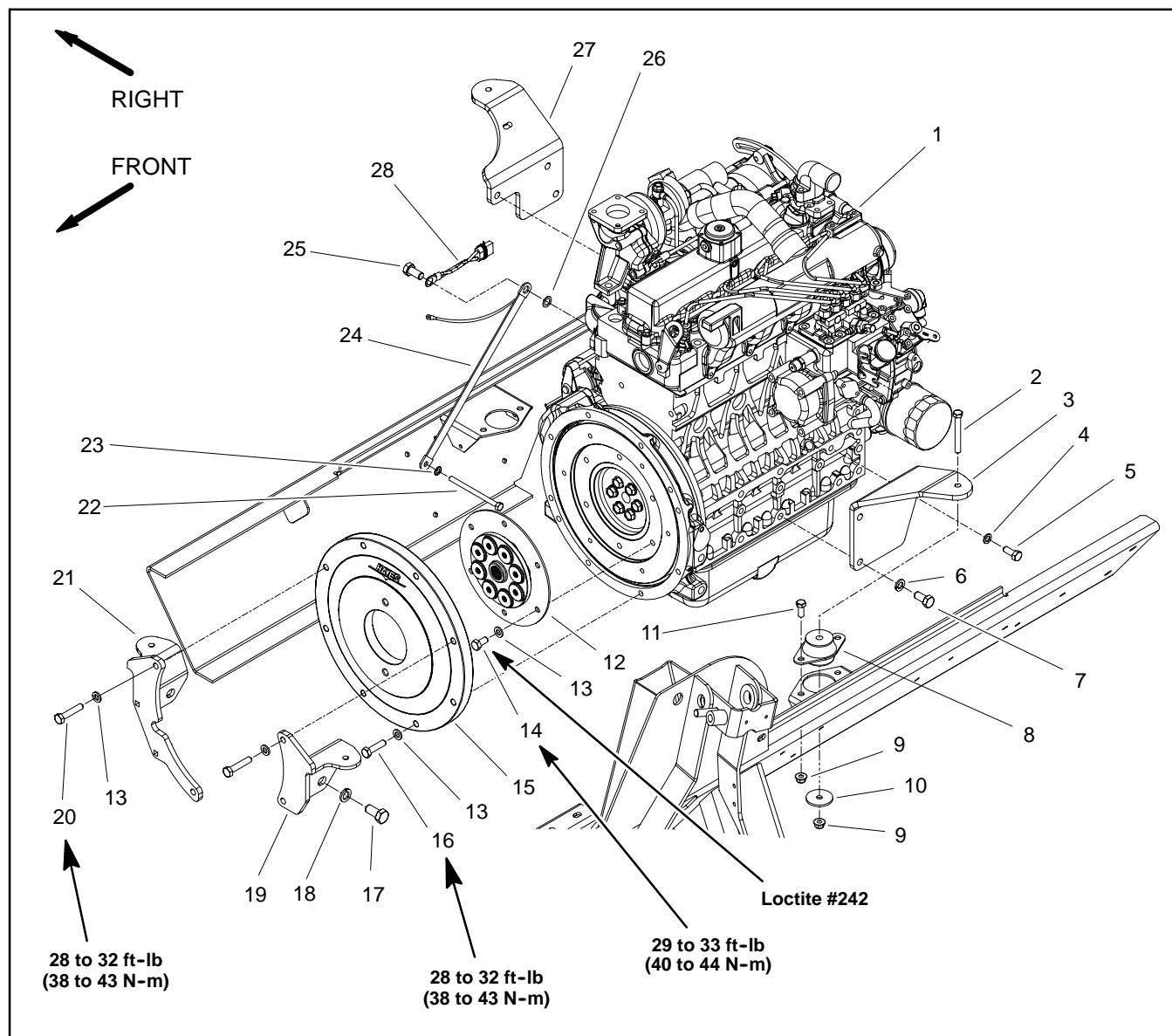


Figure 10

- |                             |                          |                              |
|-----------------------------|--------------------------|------------------------------|
| 1. Engine                   | 11. Cap screw (8 used)   | 20. Cap screw (4 used)       |
| 2. Cap screw (4 used)       | 12. Spring coupler       | 21. RH engine mount          |
| 3. LH engine mount          | 13. Washer (14 used)     | 22. Cap screw (PTO manifold) |
| 4. Lock washer              | 14. Cap screw (6 used)   | 23. Lock washer              |
| 5. Cap screw                | 15. Flywheel plate       | 24. Ground cable             |
| 6. Lock washer (5 used)     | 16. Cap screw (4 used)   | 25. Cap screw                |
| 7. Cap screw (5 used)       | 17. Cap screw (2 used)   | 26. Lock washer              |
| 8. Engine support (4 used)  | 18. Lock washer (2 used) | 27. RH engine mount          |
| 9. Flange nut (12 used)     | 19. LH engine mount      | 28. Ground harness           |
| 10. Rebound washer (4 used) |                          |                              |

## Engine Removal (Fig. 10)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.
2. Remove battery from machine (see Battery Service in the Service and Repairs section of Chapter 5 - Electrical System).
3. Raise and support hood.



### CAUTION

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

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

4. Drain coolant from the radiator into a suitable container (see Radiator Removal in this section). Disconnect upper and lower hoses from the radiator.



### CAUTION

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

5. Remove exhaust system from engine (see Exhaust System Removal in this section).
6. Remove air cleaner system from engine (see Air Filter System Removal in this section).
7. Note location of cable ties used to secure wire harness to the machine. Disconnect wires and/or electrical connections from the following electrical components:
  - A. The temperature sender and alternator (Fig 11).
  - B. The glow plugs (Fig. 12).
  - C. The engine run solenoid.
  - D. Battery, frame and wire harness ground at the engine block.
  - E. The electric starter and low oil pressure switch (near electric starter).
  - F. The air conditioning compressor (Groundsmaster 4010-D machines).

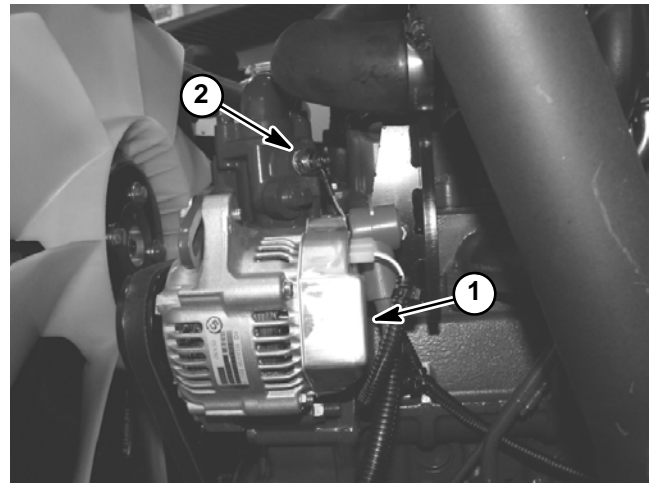


Figure 11

1. Alternator

2. Temperature sender

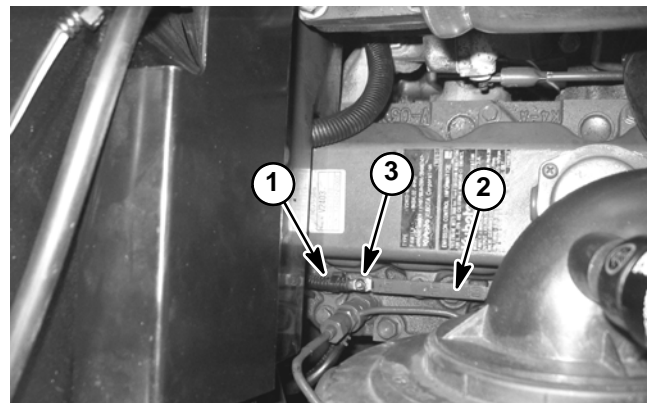


Figure 12

1. Glow plug wire  
2. Glow plug lead

3. Cylinder #4 glow plug

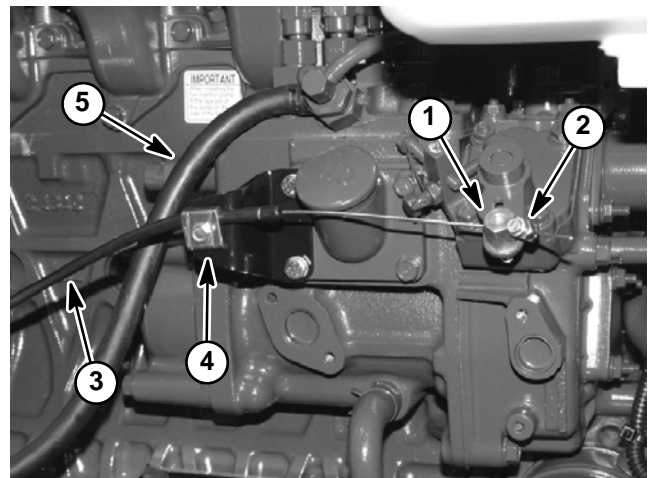


Figure 13

1. Cable swivel  
2. Cable stop  
3. Throttle cable

4. Cable clamp  
5. Fuel supply hose

8. Disconnect fuel supply hose from injection pump (Fig. 13).

9. Remove throttle cable from engine (Figs. 13 and 14):

A. Remove lock nut that secures throttle cable swivel to speed control lever.

B. Loosen cable clamp and remove throttle cable from under clamp.

C. Position throttle cable away from the engine.

10. Remove fasteners that secure the upper radiator shroud to the lower shroud and radiator (see Radiator Removal in this section). Position coolant reservoir and bracket away from the radiator. Remove upper radiator shroud from machine.

11. Remove cooling fan motor and fan assembly (Fig. 15).

A. To prevent contamination of hydraulic system, thoroughly clean exterior of fan motor and fittings.

B. Disconnect hydraulic hoses from cooling fan motor. Put caps or plugs on fittings and hoses to prevent contamination. Label hydraulic lines for proper assembly.

C. Remove six (6) cap screws and flange nuts that secure fan motor bracket to radiator.

D. Carefully remove fan motor, fan and motor bracket assembly from machine.

12. Remove transport cylinder assembly from engine mount (Fig. 16). It is not necessary to remove the hydraulic hose from the cylinder. Locate and remove cylinder spacer from between transport cylinder and engine mount.

13. On Groundsmaster 4010-D machines:

A. Remove windshield washer reservoir from reservoir mount on engine (Fig. 17). Position reservoir away from engine. Do not remove reservoir mount from engine.

B. Remove air conditioning compressor from brackets (see Air Conditioning Compressor Removal in the Service and Repairs section of Chapter 9 - Operator Cab). Position compressor away from engine taking care to not damage compressor or hoses. Support compressor to make sure it will not fall during engine removal.

C. Disconnect coolant hose from fitting on engine water flange.

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

14. Support hydraulic pump assembly. Remove fasteners that secure pump assembly to engine (see Pump Assembly Removal in the Service and Repairs section of Chapter 4 - Hydraulic System).

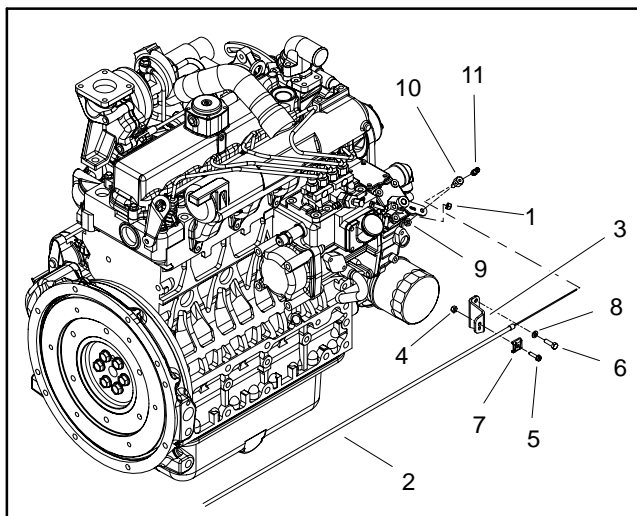


Figure 14

- |                       |                           |
|-----------------------|---------------------------|
| 1. Lock nut           | 7. Cable clamp            |
| 2. Throttle cable     | 8. Spring washer (2 used) |
| 3. Cable support      | 9. Lock nut               |
| 4. Lock nut           | 10. Cable swivel          |
| 5. Washer head screw  | 11. Cable stop            |
| 6. Cap screw (2 used) |                           |

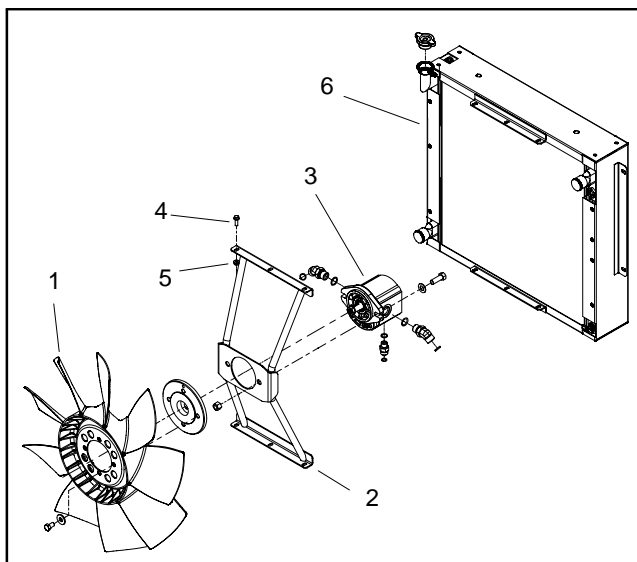


Figure 15

- |                      |                        |
|----------------------|------------------------|
| 1. Fan               | 4. Cap screw (6 used)  |
| 2. Fan motor bracket | 5. Flange nut (6 used) |
| 3. Fan motor         | 6. Radiator            |

15. Make sure all cable ties securing the wiring harness, fuel lines or hydraulic hoses to the engine are removed.

16. Connect hoist or lift to the lift tabs on engine.

17. Remove flange nuts, rebound washers and cap screws securing the engine mounts to the engine supports.



**IMPORTANT:** Make sure not to damage the engine, fuel and hydraulic lines, electrical harness or other components while removing the engine.

18. Carefully remove engine assembly from machine.

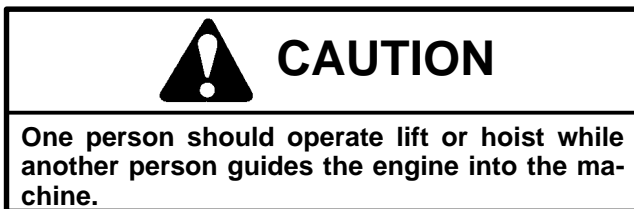
19. If necessary, remove engine mounts from the engine using Figure 10 as a guide.

#### Engine Installation (Fig. 10)

1. Make sure that all parts removed from the engine during maintenance or rebuilding are installed to the engine.

2. If removed, install engine mounts to the engine using Figure 10 as a guide.

3. Connect hoist or lift to the engine lift tabs.



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

4. Carefully lower engine into the machine.

5. Align engine to the engine supports and hydraulic pump input shaft. Secure engine to engine supports with cap screws, rebound washers and flange nuts.

6. Secure hydraulic pump assembly to engine (see Pump Assembly Installation in the Service and Repairs section of Chapter 4 – Hydraulic System).

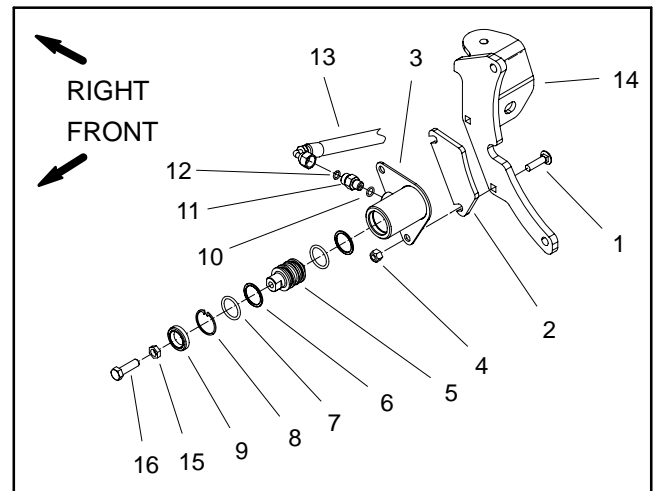


Figure 16

- |                            |                     |
|----------------------------|---------------------|
| 1. Carriage screw (2 used) | 9. Seal             |
| 2. Cylinder spacer         | 10. O-ring          |
| 3. Transport cylinder      | 11. Fitting         |
| 4. Lock nut (2 used)       | 12. O-ring          |
| 5. Piston                  | 13. Hydraulic hose  |
| 6. Backup ring (2 used)    | 14. RH engine mount |
| 7. O-ring (2 used)         | 15. Jam nut         |
| 8. Retaining ring          | 16. Cap screw       |

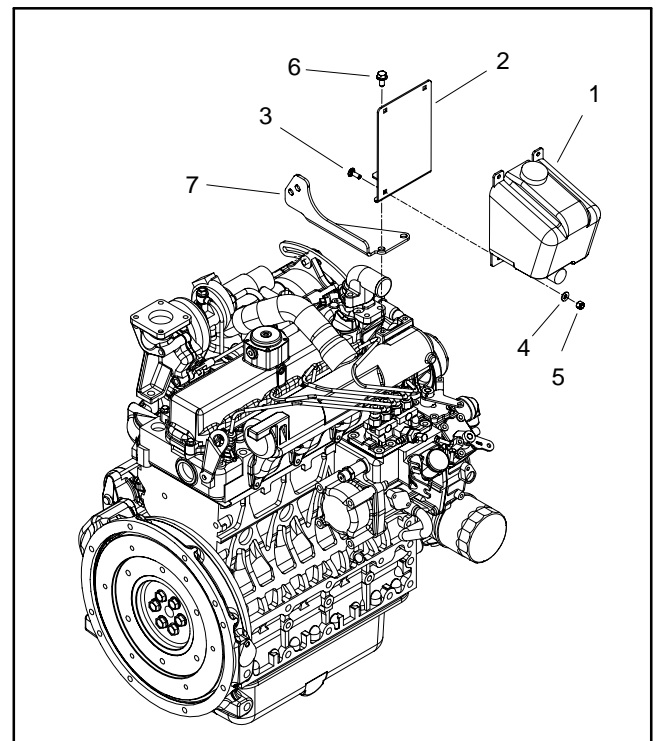


Figure 17

- |                            |                      |
|----------------------------|----------------------|
| 1. Reservoir               | 5. Nut (3 used)      |
| 2. Mount                   | 6. Flange head screw |
| 3. Carriage screw (3 used) | 7. Exhaust mount     |
| 4. Washer (3 used)         |                      |

7. Install fan motor and fan assembly (Fig. 15).

- A. Carefully position fan motor, fan and motor bracket assembly to radiator.
- B. Secure fan motor bracket to radiator with six (6) cap screws and flange nuts.
- C. Remove caps and plugs placed in hoses and fittings during removal to prevent contamination.
- D. Connect hydraulic hoses to cooling fan motor (see Hydraulic Hose and Tube Installation in the General Information section of Chapter 4 – Hydraulic System).

8. Position upper radiator shroud and coolant reservoir with bracket to the radiator. Secure shroud and reservoir bracket to the radiator and lower radiator bracket with removed fasteners (see Radiator Installation in this section). Make sure that clearance between shroud and fan is at least 0.180" (4.6 mm) at all points.

9. Connect throttle cable to injector pump (Figs. 13 and 14):

- A. Secure throttle cable swivel to speed control lever with lock nut.
- B. Place throttle cable under cable clamp.
- C. Adjust throttle cable position in cable clamp so that engine governor lever contacts the high speed stop bolt at the same time that the throttle lever contacts the end of the slot in the control console.
- D. Tighten cable clamp to secure throttle cable.

10. Connect fuel line to the injection pump (Fig. 13).

11. Install transport cylinder assembly to engine adapter plate (Fig. 16). Make sure that cylinder spacer is positioned between transport cylinder and engine mount.

12. On Groundsmaster 4010-D machines:

- A. Position windshield washer reservoir to bracket on engine (Fig. 17). Secure with removed fasteners.
- B. Install air conditioning compressor to brackets (see Air Conditioning Compressor Installation in the Service and Repairs section of Chapter 9 – Operator Cab). Make sure that drive belt is properly tensioned.
- C. Connect coolant hose to fitting on engine water flange.

13. Connect wires and/or electrical connections to the following electrical components:

- A. The temperature sender and alternator (Fig 11).
- B. The glow plug (Fig. 12).
- C. The engine run solenoid.
- D. Battery, frame and wire harness ground to the engine block.
- E. The starter and low oil pressure switch (near starter).
- F. The air conditioning compressor (Groundsmaster 4010-D machines).

14. Install air cleaner assembly to the engine (see Air Filter System Installation in this section).

15. Install exhaust system to machine (see Exhaust System Installation in this section).

16. Connect coolant hoses to the radiator. Make sure radiator drain is shut. Fill radiator and reservoir with coolant.

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

18. Install battery to machine (see Battery Service in the Service and Repairs section of Chapter 5 – Electrical System). Make sure to connect positive battery cable first and then negative battery cable. Secure battery to machine with strap and cover.

19. Check and adjust engine oil as needed.

20. Check and adjust hydraulic oil as needed.

21. Bleed fuel system.

22. 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 System).

23. Close and secure hood.

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## Spring Coupler

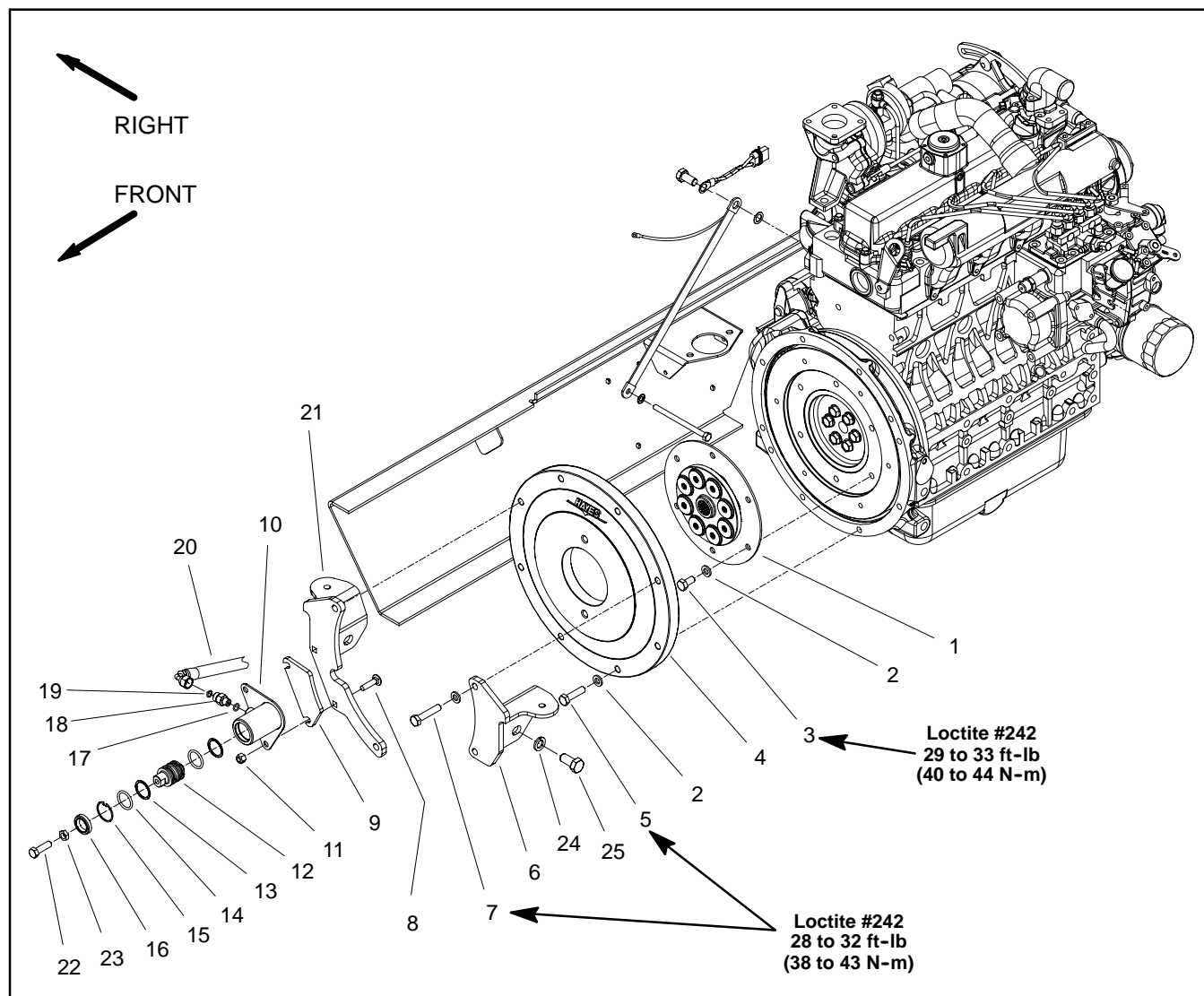


Figure 18

- |                            |                          |                          |
|----------------------------|--------------------------|--------------------------|
| 1. Spring coupler          | 10. Transport cylinder   | 18. Hydraulic fitting    |
| 2. Washer (14 used)        | 11. Lock nut (2 used)    | 19. O-ring               |
| 3. Cap screw (6 used)      | 12. Cylinder piston      | 20. Hydraulic hose       |
| 4. Flywheel plate          | 13. O-ring (2 used)      | 21. RH engine mount      |
| 5. Cap screw (4 used)      | 14. Backup ring (2 used) | 22. Cap screw            |
| 6. LH engine mount         | 15. Retaining ring       | 23. Jam nut              |
| 7. Cap screw (2 used)      | 16. Seal                 | 24. Lock washer (2 used) |
| 8. Carriage screw (2 used) | 17. O-ring               | 25. Cap screw (2 used)   |
| 9. Cylinder spacer         |                          |                          |



### Coupler Removal (Fig. 18)

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

1. If engine is in machine, support engine from below to prevent it from shifting. Remove the following:

A. Remove hydraulic pump assembly from machine (see Piston (Traction) Pump Removal in the Service and Repairs section of Chapter 4 – Hydraulic System).

B. Remove transport cylinder assembly from engine mount. It is not necessary to remove the hydraulic hose from the cylinder. Locate and remove cylinder spacer from between transport cylinder and engine mount.

2. Remove flywheel plate and spring coupler from engine using Figure 18 as a guide.

### Coupler Installation (Fig. 18)

1. Position spring coupler to engine flywheel and align mounting holes. Make sure that coupling hub is away from engine flywheel (Fig. 19).

2. Apply Loctite #242 (or equivalent) to threads of cap screws (item 3). Secure coupler to flywheel with six (6) cap screws and washers. Torque cap screws in a crossing pattern from **29 to 33 ft-lb (40 to 44 N-m)**.

3. Apply Loctite #242 (or equivalent) to threads of cap screws (items 5 and 7) used to secure flywheel plate to engine. Position flywheel plate to engine and engine mounts. Secure flywheel plate and mounts with cap screws (items 5 and 7) and washers using a crossing pattern tightening procedure. Torque cap screws in a crossing pattern from **28 to 32 ft-lb (38 to 43 N-m)**.

4. If engine is in machine, install the following:

A. Install transport cylinder assembly to engine mount. Make sure that cylinder spacer is placed between transport cylinder and engine mount. Check transport cylinder adjustment (see Transport Cylinder in the Service and Repairs section of Chapter 4 – Hydraulic System).

B. Install hydraulic pump assembly to machine (see Piston (Traction) Pump Installation in the Service and Repairs section of Chapter 4 – Hydraulic System).

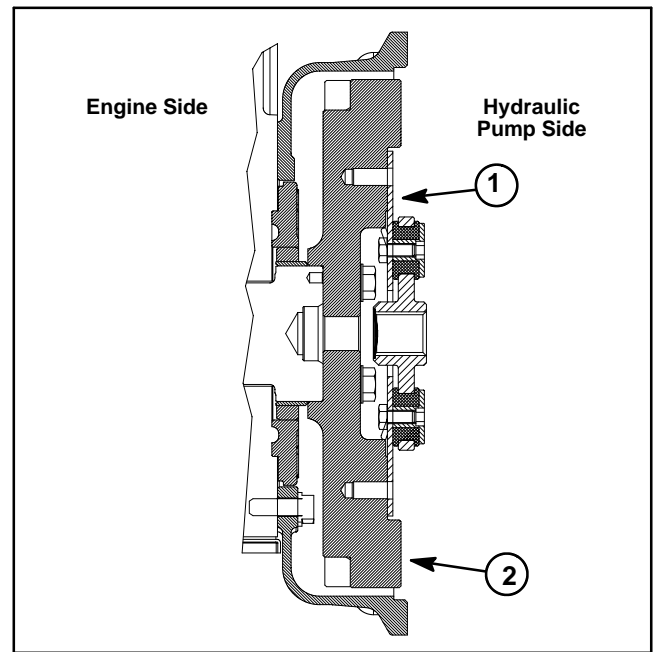


Figure 19

1. Coupler

2. Engine flywheel

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## Hydraulic System

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# Specifications

Item	Description
Piston (Traction) Pump Maximum Displacement (per revolution) System Relief Pressure: Forward System Relief Pressure: Reverse Charge Pressure	Eaton Variable Displacement Piston Pump (Model 72400) 2.48 in <sup>3</sup> (40.6 cc) 4000 PSI (274 bar) 5000 PSI (343 bar) 250 PSI (17 bar)
Front Wheel Motors Displacement (per revolution)	Eaton Fixed Displacement Piston Motors (Model 74318) 2.48 in <sup>3</sup> (40.6 cc)
Rear Axle Motor Displacement (per revolution)	Eaton Fixed Displacement Piston Motor (Model 74315) 2.01 in <sup>3</sup> (32.9 cc)
Gear Pump Section P1/P2 Displacement (per revolution) Section P3/P4 Displacement (per revolution)	Casappa 4 Section, Positive Displacement Gear pump 1.16 in <sup>3</sup> (19.09 cc) 0.56 in <sup>3</sup> (9.16 cc)
Steering Control Valve Displacement (per revolution)	Eaton Steering Unit, Series 5 6.1 in <sup>3</sup> (100 cc)
Steering Circuit Relief Pressure	1350 PSI (93 bar)
Lift/Lower Circuit Relief Pressure	1600 PSI (110 bar)
Cutting Deck Motors Displacement (per revolution)	Sauer Danfoss Gear Motor 1.17 in <sup>3</sup> (19.2 cc)
PTO Circuit Relief Pressure Front and Left Side Right Side	3000 PSI (207 bar) 2000 PSI (137 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	8 U.S. Gallons (30.3 Liters)
Hydraulic Oil	See Operator's Manual

# General Information

## Operator's Manual

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

## Check Hydraulic Fluid

The Groundsmaster hydraulic system is designed to operate on anti-wear hydraulic fluid. The hydraulic reservoir located beneath the operator seat holds approximately 8 U.S. gallons (30.3 liters) of hydraulic fluid. **Check level of hydraulic fluid daily.** See Operator's Manual for fluid level checking procedure and oil recommendations.

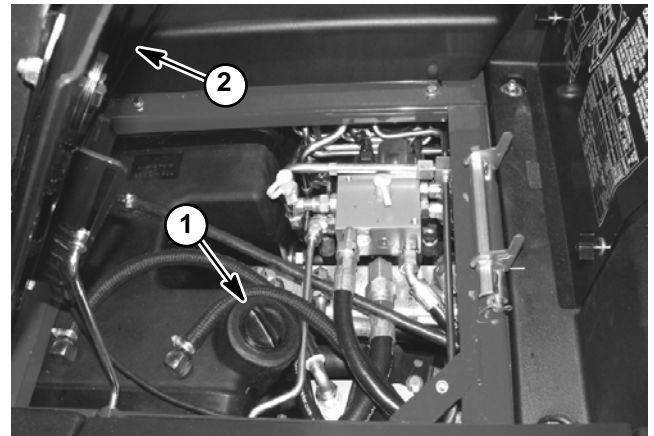


Figure 1

1. Hydraulic reservoir cap      2. Operator seat

Hydraulic  
System

## Towing Traction Unit

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

If it becomes necessary to tow (or push) the machine, tow (or push) in a **forward direction only** and at a speed **below 3 mph (5 kph)**. The piston (traction) pump is equipped with a by-pass valve that needs to be turned 90° (one quarter turn) for towing. Refer to your Operator's Manual for additional towing instructions.

**IMPORTANT:** Do not turn by-pass valve when engine is running.

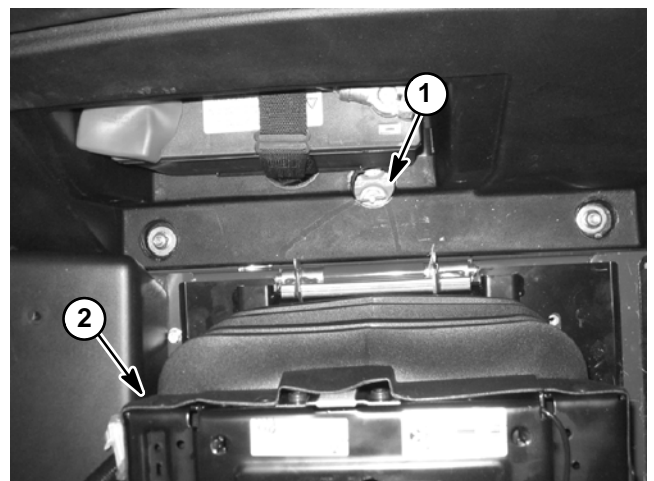


Figure 2

1. Bypass valve location      2. Operator seat

---

## 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.

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

To relieve hydraulic pressure in lift circuit, start engine and fully lower the cutting decks. Turn key switch to OFF and remove key from the ignition switch.

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

---

## Traction Circuit Component Failure

The traction circuit on Groundsmaster 4000-D and 4010-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, tubes and 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 when tightening a hose; hold the hose straight with one wrench and tighten the hose swivel nut onto the fitting with the second 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

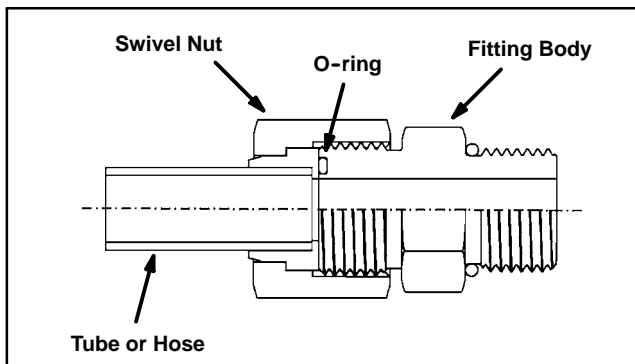


Figure 3

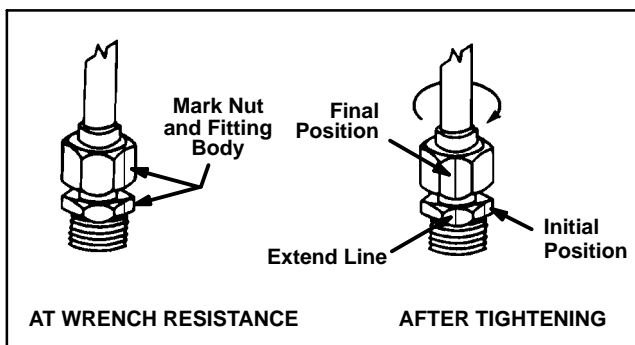


Figure 4

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

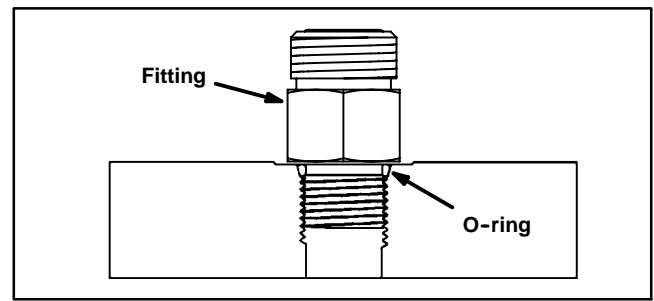


Figure 6

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 in Figure 9). Make sure that the fitting does not bottom in the port during installation.

6. To put the fitting in the desired position, unscrew it by the required amount to align fitting with incoming hose or tube, but no more than one full turn (Step 3 in Figure 9).

7. Hold the fitting in the desired position with a wrench and use a torque wrench to tighten the lock nut 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 in Figure 9). If port material is aluminum, tighten fitting to 60% of listed F.F.F.T.

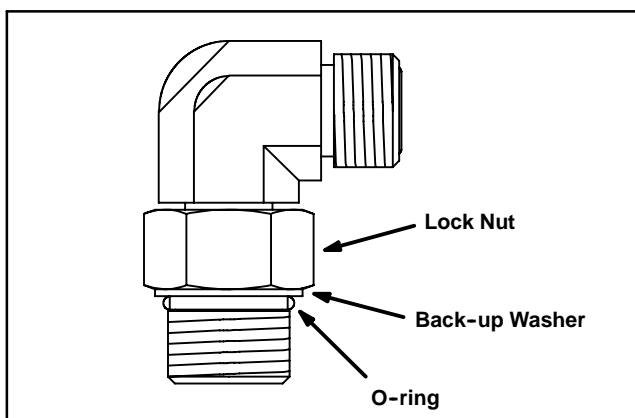


Figure 8

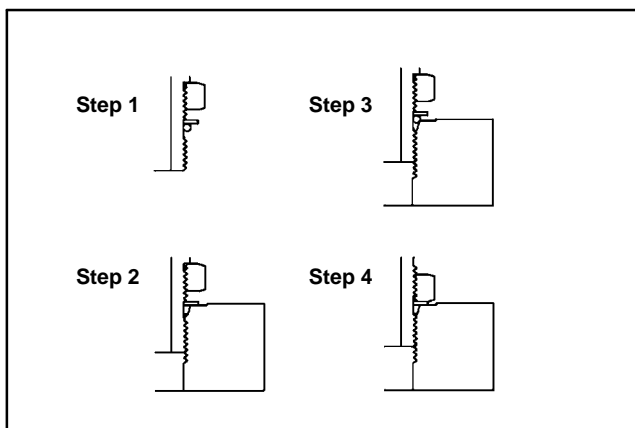
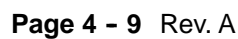


Figure 9

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

## Hydraulic System

## Groundsmaster 4000-D/4010-D

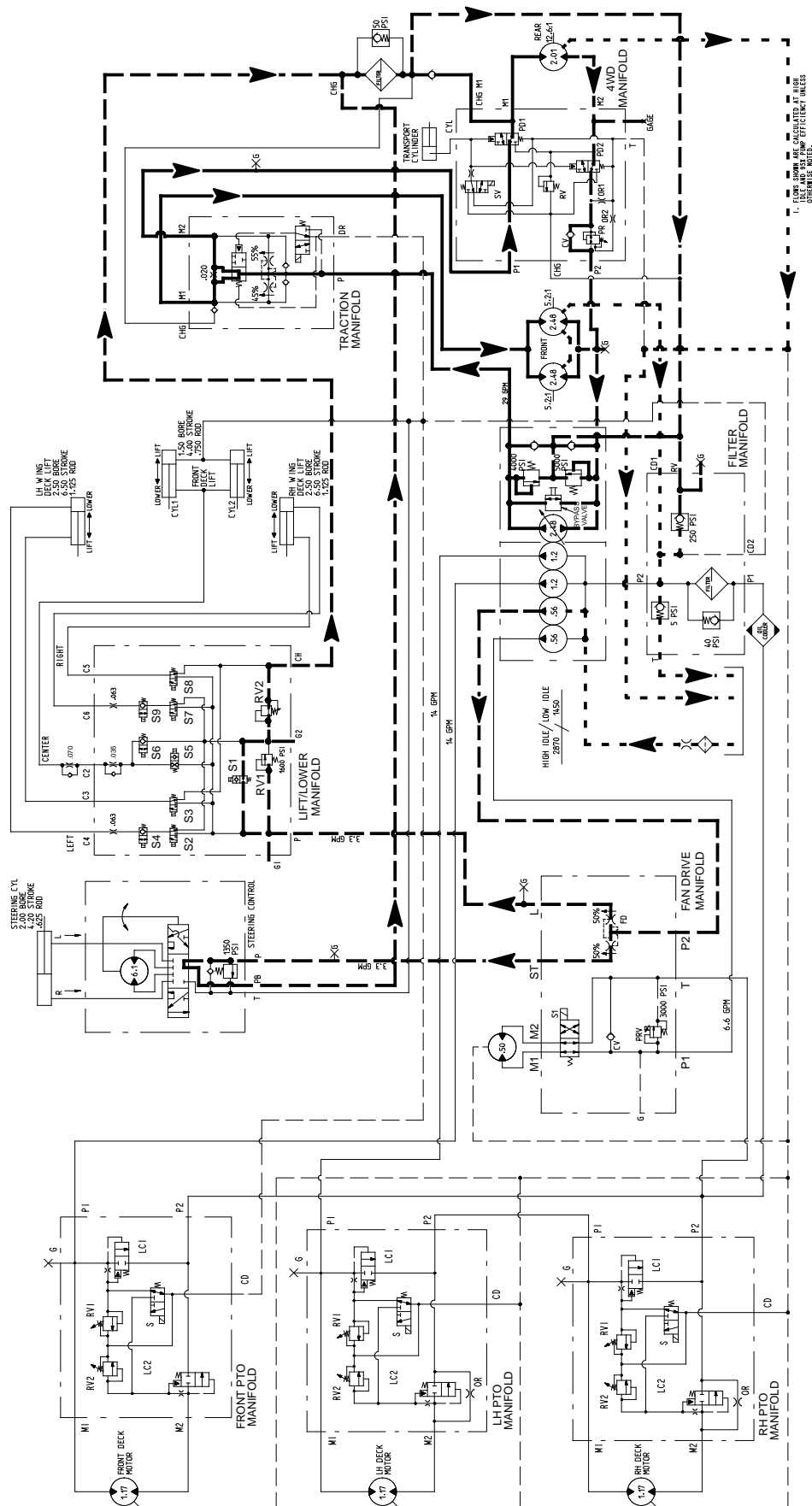


FLOWS SHOWN ARE CALCULATED AT HIGH  
PUMP EFFICIENCY UNLESS  
NOTED OTHERWISE.

# Hydraulic Flow Diagrams

## Traction Circuit: Low Speed (4WD) (Forward Shown)

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



1. FLOW SHOWN ARE CALCULATED AT 100% EFFICIENCY UNLESS OTHERWISE NOTED.

## Traction Circuit: Low Speed (4WD)

The traction circuit piston pump is a variable displacement pump that is directly coupled to the engine fly-wheel. Pushing the traction pedal engages a hydraulic servo valve which controls the variable displacement piston pump swash plate to create a flow of oil. This oil is directed to the 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 fixed displacement wheel and axle motors. As the load increases, circuit pressure can increase to relief valve settings: 4000 PSI (274 bar) in forward and 5000 PSI (343 bar) in reverse. If pressure exceeds the relief setting, oil flows through the piston pump relief valve to the low pressure side of the closed loop traction circuit. The traction circuit provides operation in either Hi speed (2WD) or Low speed (4WD).

Traction circuit pressure (forward and reverse) can be measured at test ports in hydraulic tubes. The forward traction port is on the left side of the machine and the reverse traction port is on the right side of the machine.

The traction circuit pump and motors use a small amount 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. This gear pump is driven directly off the traction pump. It provides a constant supply of charge oil to make up for oil that is lost due to internal leakage in the traction pump and motors.

Pump flow for the charge circuit is directed through the oil filter and to the low pressure side of the closed loop traction circuit. A filter bypass valve allows charge oil flow to the closed loop if the filter becomes plugged. Charge pressure is limited to 250 PSI (17 bar) by a relief valve located in the oil filter manifold. Charge pressure can be measured at the charge circuit pressure test port on the oil filter manifold.

A flow divider is incorporated into the traction circuit and is located in the traction manifold. When in Low speed (4WD), the operator can momentarily engage this flow divider when low traction situations could lead to wheel spin. Depressing the flow divider switch energizes the solenoid valve in the traction manifold. This energized solenoid valve causes traction pump hydraulic flow to split between the front wheel motors (approximately 45%) and rear axle motor (approximately 55%) to reduce the chance that excessive circuit flow goes to a spinning wheel.

### Forward Direction

When the Hi/Low switch is in the Low speed (4WD) position and the traction pedal is pushed in the forward direction, oil from the piston pump passes through the traction manifold. Oil flow from traction manifold port M1 drives the front wheel motors in the forward direction and then returns to the piston pump. Oil flow from traction manifold port M2 is routed to the P1 port of the 4WD manifold where it is directed to the PD1 cartridge and out of the manifold to drive the rear axle motor in the forward direction. Oil returning from the rear motor re-enters the 4WD manifold at the M2 port. Flow passes through the PD2 cartridge, through the CV check valve, out manifold port P2 and back to the piston pump.

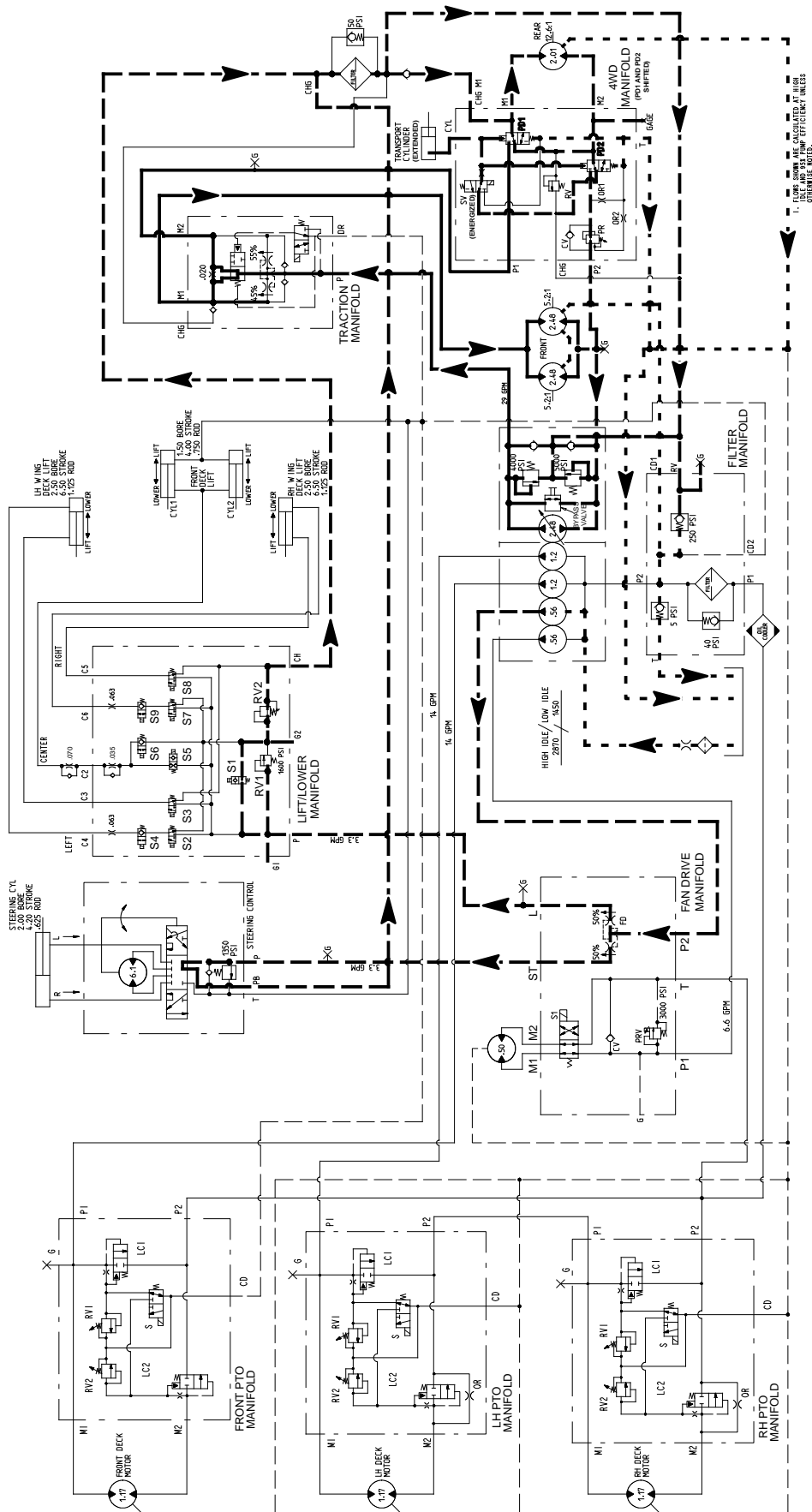
When going down a hill, the tractor becomes an over-running load that drives the wheel and axle motors. In this condition, the rear axle motor could lock up as the oil pumped from the motor increases pressure as it returns to the piston pump. To prevent rear wheel lock up, an adjustable relief valve (RV) in the 4WD 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 (4WD) 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 4WD manifold. The oil to the front wheel motors drives them in the reverse direction and then returns to the piston pump through the traction manifold. The oil to the 4WD 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 650 PSI (45 bar) so the rear wheels will not scuff the turf during reverse operation. This reduced pressure flows through the PD2 cartridge and out port M2 to the rear axle motor. Return oil from the rear motor re-enters the 4WD manifold at port M1, flows through the PD1 cartridge, exits the manifold at port P1 and returns to the piston pump.

# Traction Circuit: Hi Speed (2WD) (Forward Shown)

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



## Traction Circuit: Hi Speed (2WD)

The traction circuit piston pump is a variable displacement pump that is directly coupled to the engine flywheel. Pushing the traction pedal engages a hydraulic servo valve which controls the variable displacement piston pump swash plate to create a flow of oil. This oil is directed to the 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 fixed displacement wheel and axle motors. As the load increases, circuit pressure can increase to relief valve settings: 4000 PSI (274 bar) in forward and 5000 PSI (343 bar) in reverse. If pressure exceeds the relief setting, oil flows through the piston pump relief valve to the low pressure side of the closed loop traction circuit. The traction circuit provides operation in either Hi speed (2WD) or Low speed (4WD).

Traction circuit pressure (forward and reverse) can be measured at test ports in hydraulic tubes. The forward traction port is on the left side of the machine and the reverse traction port is on the right side of the machine.

The traction circuit pump and motors use a small amount 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 charge oil for the traction circuit. This gear pump is driven directly off the traction pump. It provides a constant supply of charge oil to the traction circuit to make up for oil that is lost due to internal leakage in the traction pump and motors.

Charge pump flow is directed through the oil filter and to the low pressure side of the closed loop traction circuit. A filter bypass valve allows charge oil flow to the closed loop if the filter becomes plugged. Charge pressure is limited to 250 PSI (17 bar) by a relief valve located in the oil filter manifold. Charge pressure can be measured at the charge circuit pressure test port on the oil filter manifold.

### Forward Direction

With the Hi/Low speed switch in the Hi speed position (2WD), solenoid valve (SV) in the 4WD manifold is energized. The solenoid valve spool shifts to direct charge pressure that shifts the PD1 and PD2 control valve spools. The shifted PD1 valve prevents piston pump hydraulic flow from reaching the rear axle motor. With flow blocked to the rear axle motor, all traction pump flow is directed to the front wheel motors to allow a higher transport speed in the forward direction.

Without flow to the rear axle motor, the rotating rear wheels drive the axle motor so it acts like a pump. Inlet oil to the axle motor is provided by a check valve that allows charge circuit oil into the rear axle motor circuit. Oil leaving the axle motor enters the 4WD manifold at port M2 and is directed back to the axle motor through the shifted PD1 cartridge and manifold port M1. To allow for rear wheel loop cooling when in forward transport operation, a small amount of oil exits through the shifted PD1 and PD2 cartridges that returns to the reservoir. This oil loss is replaced by charge circuit oil.

A transport cylinder is included in the traction circuit to reduce traction control arm movement on the piston pump when operating in Hi speed (2WD). This reduced arm movement limits swash plate rotation to prevent excessive transport speed.

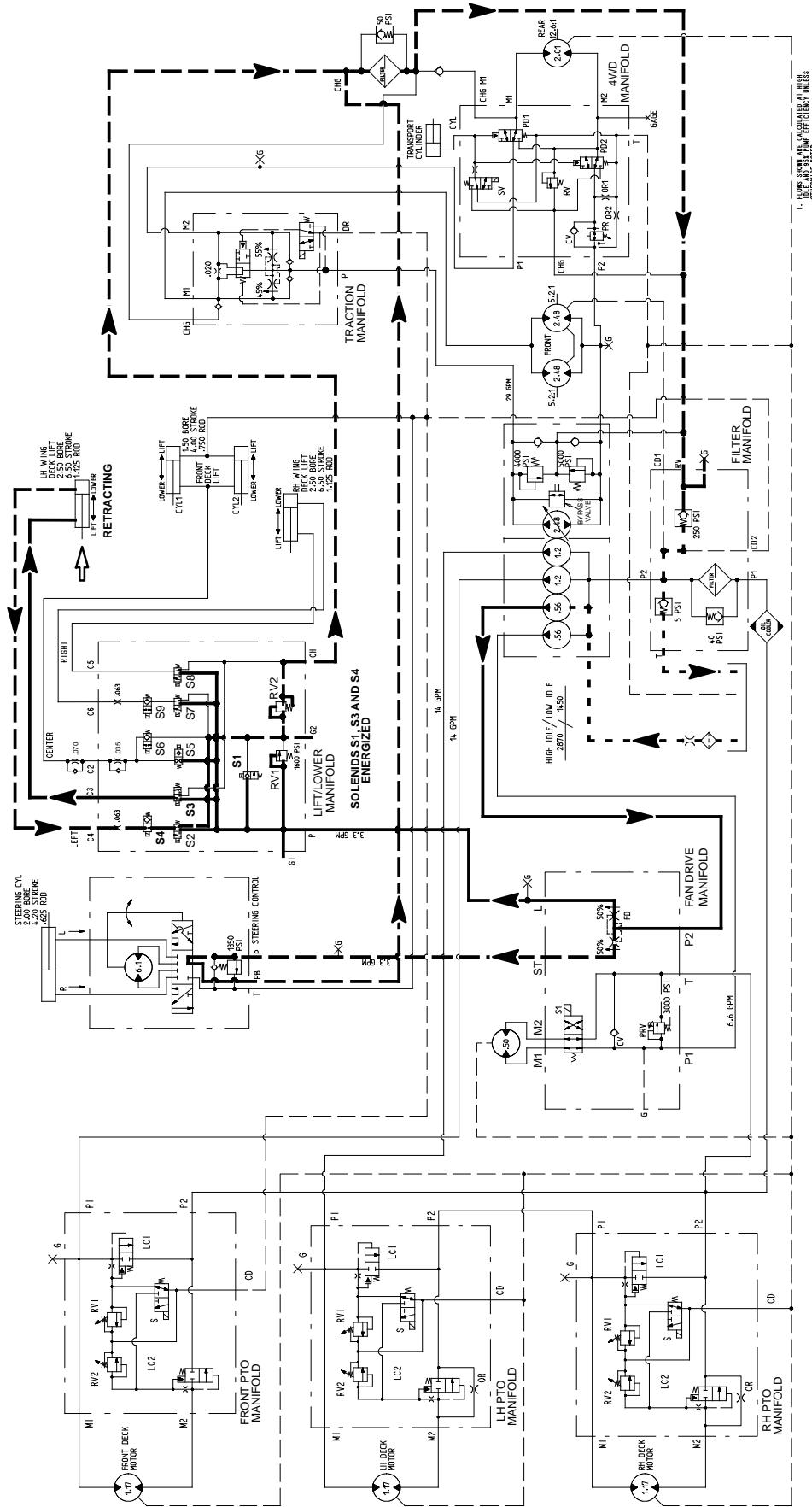
The traction manifold flow divider cannot be engaged by the operator during Hi speed (2WD) operation.

### Reverse Direction

The traction circuit operates essentially the same in reverse Hi speed (2WD) as it does in the forward direction. However, the flow through the circuit is reversed. The shifted solenoid valve (SV) and directional valves PD1 and PD2 in the 4WD manifold prevent oil flow to the rear axle motor. Oil flow from the piston pump is therefore directed to only the front wheel motors. This oil drives the front wheel motors in the reverse direction and then returns to the piston pump. Oil circulation through the rear axle motor loop is the same as in the Hi speed (2WD) forward direction.

## Lower Cutting Deck (LH Deck Shown)

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





## Lower Cutting Deck

A four section gear pump is coupled to the piston (traction) pump. The third gear pump section supplies hydraulic flow to both the steering and lift/lower circuits. Hydraulic flow from this pump section is delivered to the two circuits through a proportional flow divider that is located in the fan drive manifold. This flow divider splits pump flow approximately 50% for the steering circuit and 50% for the lift/lower circuit.

A relief valve (RV1) located in the lift/lower manifold limits lift/lower circuit pressure to 1600 PSI (110 bar). An adjustable valve (RV2) in the lift/lower manifold maintains back pressure (counterbalance) on the deck lift cylinders to allow some of the cutting deck weight to be transferred to the traction unit to improve traction.

Each of the cutting decks (center, right and left) can be lowered independently with the use of three (3) switches on the armrest console. Pressing the front of a switch provides an input for the TEC-5001 controller to lower a cutting deck. The controller provides electrical outputs to solenoids in the lift/lower manifold to allow appropriate manifold valve shift to cause a deck to lower.

When the cutting decks are in a stationary position, all solenoids in the lift/lower manifold are de-energized. In this position, lift/lower circuit flow bypasses the lift cylinders and is directed through the lift/lower manifold, oil filter and then to the traction charge circuit.

**NOTE:** To lower a cutting deck, the operator must be in the operator seat and the traction speed must be in the Low speed (4WD) position.

### Lower Center Cutting Deck

To lower the center cutting deck, the front of the center console switch is depressed. The switch signal is an input to the TEC-5001 controller which provides an electrical output to solenoid valve S6 in the lift/lower manifold. Energized solenoid valve S6 shifts to allow a passage for oil flow from the rod end of the center deck lift cylinders. The weight of the cutting deck causes the center deck lift cylinders to extend and lower the center cutting deck. Oil from the extending cylinders flows through an orifice in the fitting at manifold port C2 (.070) to control the drop speed of the cutting deck. Flow is then directed through the shifted S6, valve RV2, out manifold port CH, to the oil filter and is then available for the traction charge circuit.

When the center deck switch is released, solenoid S6 is de-energized and the lift cylinders and center cutting deck are held in position.

### Lower Right Cutting Deck

To lower the right wing deck, the front of the right console switch is pushed as an input to the TEC-5001 controller. The controller provides an electrical output to solenoid valves S1, S8 and S9 in the lift/lower manifold. The energized solenoid valves shift to allow a passage for circuit oil flow to the rod end of the right deck lift cylinder. Shifted S1 prevents oil flow from bypassing the lift cylinders. Shifted S8 allows an oil path to the rod end of the right lift cylinder to retract the lift cylinder and lower the right cutting deck. Oil from the retracting cylinder flows through the orifice in manifold port C6 (.063) to control the drop speed of the cutting deck. Flow is then directed through shifted S9, valve RV2, out manifold port CH, to the oil filter and then to the traction charge circuit.

When the deck switch is released, the manifold solenoids are de-energized and the lift cylinder and right cutting deck are held in position.

### Lower Left Cutting Deck

To lower the left wing deck, the front of the left console switch is pushed as an input to the TEC-5001 controller. The controller provides an electrical output to solenoid valves S1, S3 and S4 in the lift/lower manifold. The energized solenoid valves shift to allow a passage for circuit oil flow to the rod end of the left deck lift cylinder. Shifted S1 prevents oil flow from bypassing the lift cylinders. Shifted S3 allows an oil path to the rod end of the left lift cylinder to retract the lift cylinder and lower the left cutting deck. Oil from the retracting cylinder flows through the orifice in manifold port C4 (.063) to control the drop speed of the cutting deck. Flow is then directed through the shifted S4, valve RV2, out manifold port CH, to the oil filter and then to the traction charge circuit.

When the deck switch is released, the manifold solenoids are de-energized and the lift cylinder and left cutting deck are held in position.

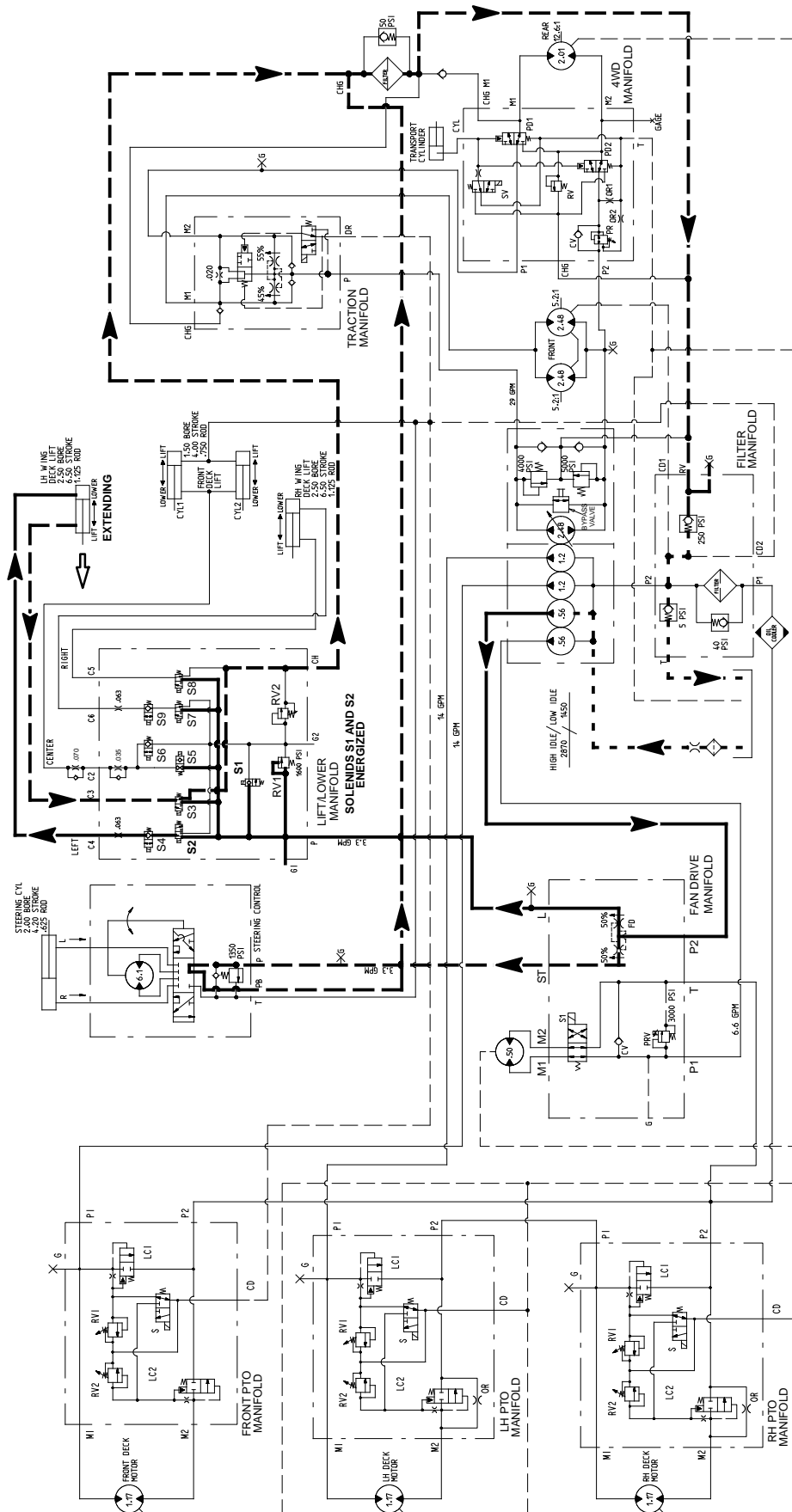
### Cutting Deck Float

Cutting deck float allows the fully lowered cutting decks to follow ground surface contours. Lift/lower manifold solenoid valves S4 (left deck), S6 (center deck) and S9 (right deck) are energized when the decks are fully lowered. These energized solenoids provide an oil passage to and from the lift cylinders to allow cylinder and cutting deck movement while mowing. Counterbalance pressure (RV2) will affect deck float operation.

**NOTE:** If a deck is already fully lowered when the ignition switch is moved from OFF to RUN, the deck will not be in float until the appropriate deck lift/lower switch is momentarily pressed to lower.

# Raise Cutting Deck (LH Deck Shown)

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



1. FLOWS SHOWN ARE CALCULATED AT 100% EFFICIENCY UNLESS OTHERWISE NOTED.

## Raise Cutting Deck

A four section gear pump is coupled to the piston (traction) pump. The third gear pump section supplies hydraulic flow to both the steering and lift/lower circuits. Hydraulic flow from this pump section is delivered to the two circuits through a proportional flow divider that is located in the fan drive manifold. This flow divider splits pump flow approximately 50% for the steering circuit and 50% for the lift/lower circuit.

A relief valve (RV1) located in the lift/lower manifold limits lift/lower circuit pressure to 1600 PSI (110 bar). An adjustable valve (RV2) in the lift/lower manifold maintains back pressure (counterbalance) on the deck lift cylinders to allow some of the cutting deck weight to be transferred to the traction unit to improve traction.

Each of the cutting decks (center, right and left) can be raised independently with the use of three (3) switches on the armrest console. Pressing the rear of a switch provides an input for the TEC-5001 controller to raise a cutting deck. The controller provides electrical outputs to solenoids in the lift/lower manifold to allow appropriate valve shift to cause a deck to raise.

When the cutting decks are in a stationary position, all solenoids in the lift/lower manifold are de-energized. In this position, lift/lower circuit flow bypasses the lift cylinders and is directed through the lift/lower manifold, oil filter and is then available for the traction charge circuit.

**NOTE:** To raise a cutting deck, the operator must be in the operator seat.

### Raise Center Cutting Deck

To raise the center cutting deck, the rear of the center console switch is depressed. The switch signal is an input to the TEC-5001 controller which provides an electrical output to solenoid valves S1 and S5 in the lift/lower manifold. The energized solenoid valves shift to allow a passage for circuit oil flow to the rod end of the center deck lift cylinders. Shifted S1 prevents oil flow from bypassing the lift cylinders. Shifted S5 allows an oil path to the rod end of the front lift cylinders causing the lift cylinders to retract and raise the center cutting deck. An orifice in manifold port C2 (.035) exists to control the raise speed of the cutting deck. Oil from the barrel end of the retracting cylinders returns to the hydraulic reservoir.

When the deck switch is released, the manifold solenoids are de-energized and the center deck lift cylinders and center cutting deck are held in position.

### Raise Right Cutting Deck

To raise the right deck, the rear of the right console switch is depressed as an input to the TEC-5001 controller. The controller provides an electrical output to solenoid valves S1 and S7 in the lift/lower manifold. The energized solenoid valves shift to allow a passage for circuit oil flow to the barrel end of the right deck lift cylinder. Shifted S1 prevents oil flow from bypassing the lift cylinders. Shifted S7 allows an oil path through the orifice in manifold port C6 and to the barrel end of the right lift cylinder to extend the lift cylinder and raise the right cutting deck. Oil from the extending cylinder is directed through S8 (de-energized), out manifold port CH, to the oil filter and then to the traction charge circuit.

When the deck switch is released, the manifold solenoids are de-energized and the lift cylinder and right cutting deck are held in position.

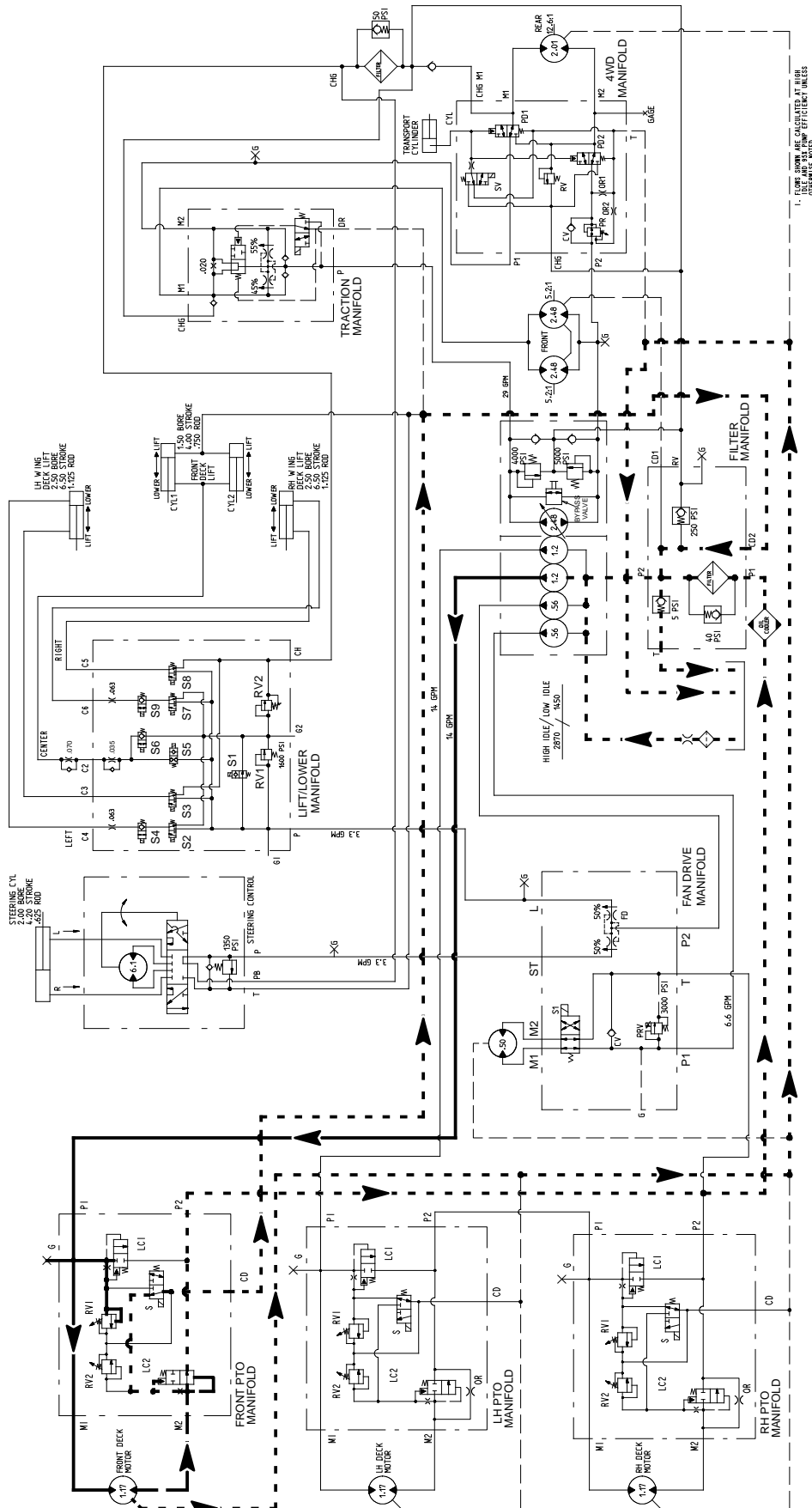
### Raise Left Cutting Deck

To raise the left deck, the rear of the left console switch is depressed as an input to the TEC-5001 controller. The controller provides an electrical output to solenoid valves S1 and S2 in the lift/lower manifold. The energized solenoid valves shift to allow a passage for circuit oil flow to the barrel end of the left deck lift cylinder. Shifted S1 prevents oil flow from bypassing the lift cylinders. Shifted S2 allows an oil path through the orifice in manifold port C4 and to the barrel end of the left lift cylinder to extend the lift cylinder and raise the left cutting deck. Oil from the extending cylinder is directed through S3 (de-energized), out manifold port CH, to the oil filter and then to the traction charge circuit.

When the deck switch is released, the manifold solenoids are de-energized and the lift cylinder and left cutting deck are held in position.

# Mow (Front Deck Shown)

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



## Mow

A four section gear pump is coupled to the piston (traction) pump. Hydraulic flow for the mow circuit is supplied by two sections of the gear pump. The gear pump section closest to the piston (traction) pump supplies hydraulic flow to the side cutting decks, while the next gear pump section supplies the front cutting deck.

Each cutting deck is controlled by a hydraulic manifold equipped with a solenoid control valve (S), bypass cartridge (LC1), brake cartridge (LC2) and two (2) relief cartridges (RV1 and RV2). Circuit pressure can be measured at port (G) of the hydraulic manifold for each cutting deck.

**NOTE:** To engage the mow circuit, the operator must be in the operator seat, the cutting deck(s) must be fully lowered and the traction speed must be in the Low speed (4WD) position.

### PTO Not Engaged

When the PTO switch is OFF or if the deck is raised with the PTO switch ON, the PTO manifold solenoid valve (S) is not energized and the solenoid spool is in the neutral position. This solenoid spool in neutral allows a small amount of hydraulic flow to return to tank through a manifold sensing line which causes a pressure increase that shifts bypass cartridge LC1. The pump flow is routed through shifted LC1 and out manifold port P2. Brake cartridge LC2 remains in the unshifted position to prevent any return flow from the deck motor to keep the motor from rotating.

Return flow from the front and right PTO manifolds is routed through the oil cooler, oil filter and then to the gear pump input. Return flow from the left PTO manifold provides supply for the right deck.

### PTO Engaged

When the PTO switch is turned ON and the decks are lowered, the PTO manifold solenoid valve (S) is energized by the TEC-5001 controller. This shifted solenoid valve prevents any sense line flow through the valve which allows the bypass cartridge LC1 to be in its neutral position. Gear pump flow entering the manifold is routed out manifold port M1 and to the cutting deck motor. The return flow from the deck motor re-enters manifold port M2. The shifted solenoid valve (S) allows a small amount of this return flow to return to tank through a manifold sensing line which causes a pressure increase that shifts brake cartridge LC2. Hydraulic flow is routed through shifted LC2, out manifold port P2, through the oil cooler and filter and then is routed to the gear pump input. The deck motor continues to rotate as long as solenoid valve (S) is energized.

Deck motor case drain leakage returns to the hydraulic reservoir.

### PTO Circuit Relief

Maximum mow circuit pressure is limited for each deck by a relief valve (RV1) in the PTO manifold. The center and left deck relief valves are set at 3000 PSI (207 bar) and the right deck relief valve is set at 2000 PSI (138 bar).

Relief valve (RV1) and bypass cartridge (LC1) work together as a two stage relief. When increased circuit resistance is met or if a cutting blade should strike an object, the pressure increase is felt at the relief valve. If the pressure should exceed the relief valve setting, the relief valve will open, creating a small amount of hydraulic flow to return to tank through a manifold sensing line. This flow causes a pressure increase that shifts bypass cartridge LC1 and diverts circuit flow away from the deck motor to manifold port P2 (Fig. 10). When circuit pressure lowers, relief valve (RV1) closes which returns bypass cartridge LC1 back to its neutral position allowing flow to return to the deck motor.

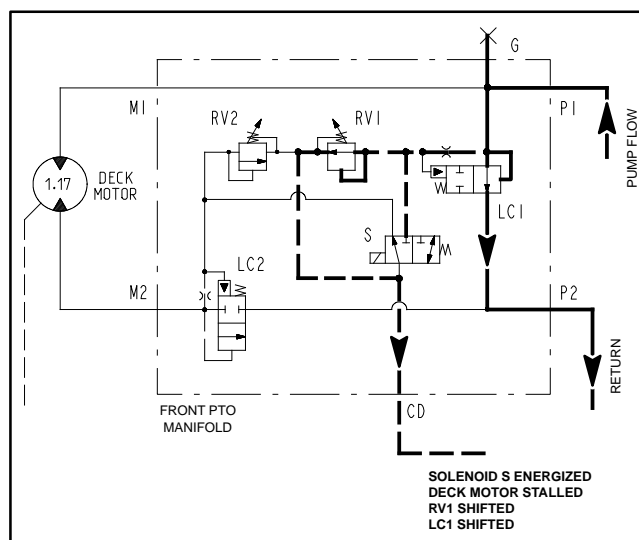


Figure 10

## Mow Circuit Cutting Deck Blade Braking

When the operator turns the PTO switch OFF or if a deck is raised with the PTO switch ON, PTO manifold solenoid valve (S) is de-energized causing bypass cartridge (LC1) to shift (refer to information in Mow Circuit in this section). This shifted cartridge allows oil return out manifold port P2. At the same time, solenoid valve (S) in its neutral position prevents any sense line flow through the spool which causes the brake cartridge (LC2) to shift to its neutral position blocking return flow from the deck motor and slowing the cutting blades (Fig. 11).

The inertia of the rotating cutting blades, however, effectively turns the deck motor into a pump causing an increase in pressure as the flow from the motor comes up against the closed brake cartridge (LC2). When this pressure builds to approximately 600 PSI (41 bar), relief valve (RV2) opens which allows a small amount of hydraulic flow to return to tank through a manifold sensing line (Fig. 12). This flow causes a pressure increase that shifts brake cartridge (LC2) to once again allow oil flow from the motor (Fig. 13). When return pressure drops below 600 PSI (41 bar), relief valve (RV2) reseats and causes LC2 to close again blocking return flow from the deck motor to further slow the cutting blades. This action of the brake relief valve opening and the brake cartridge shifting occurs several times in a very short time frame as the blades finally come to a stop. Once the blades have stopped, brake cartridge LC2 remains in the neutral position to keep the deck motor from rotating.

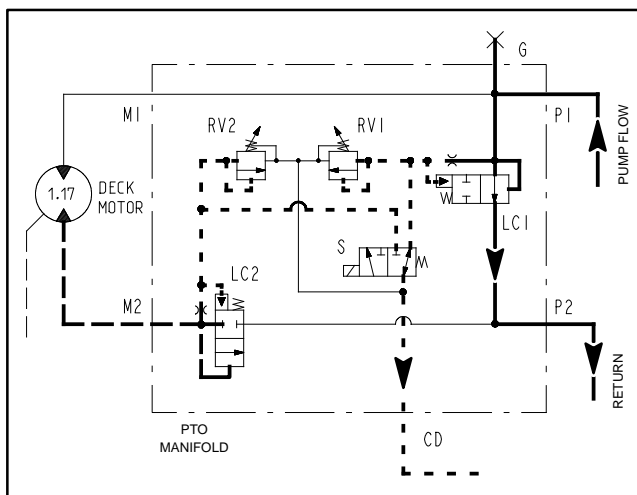


Figure 11

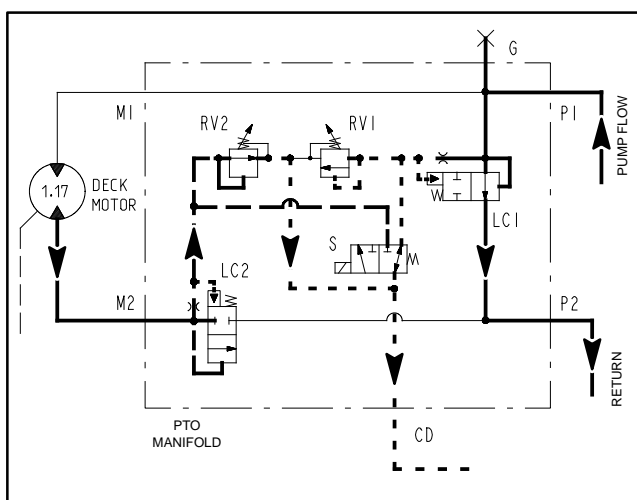


Figure 12

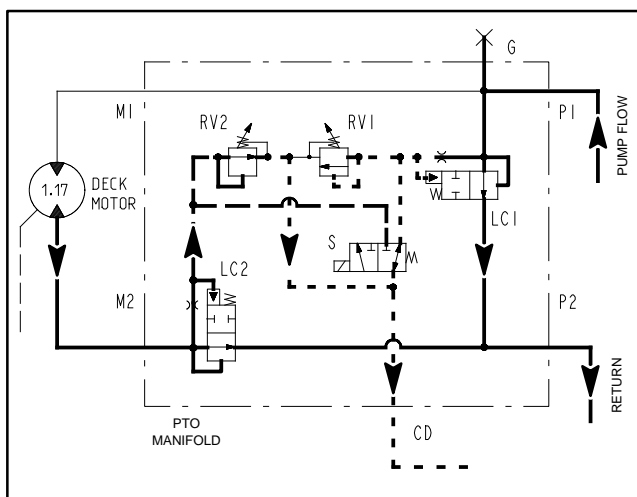
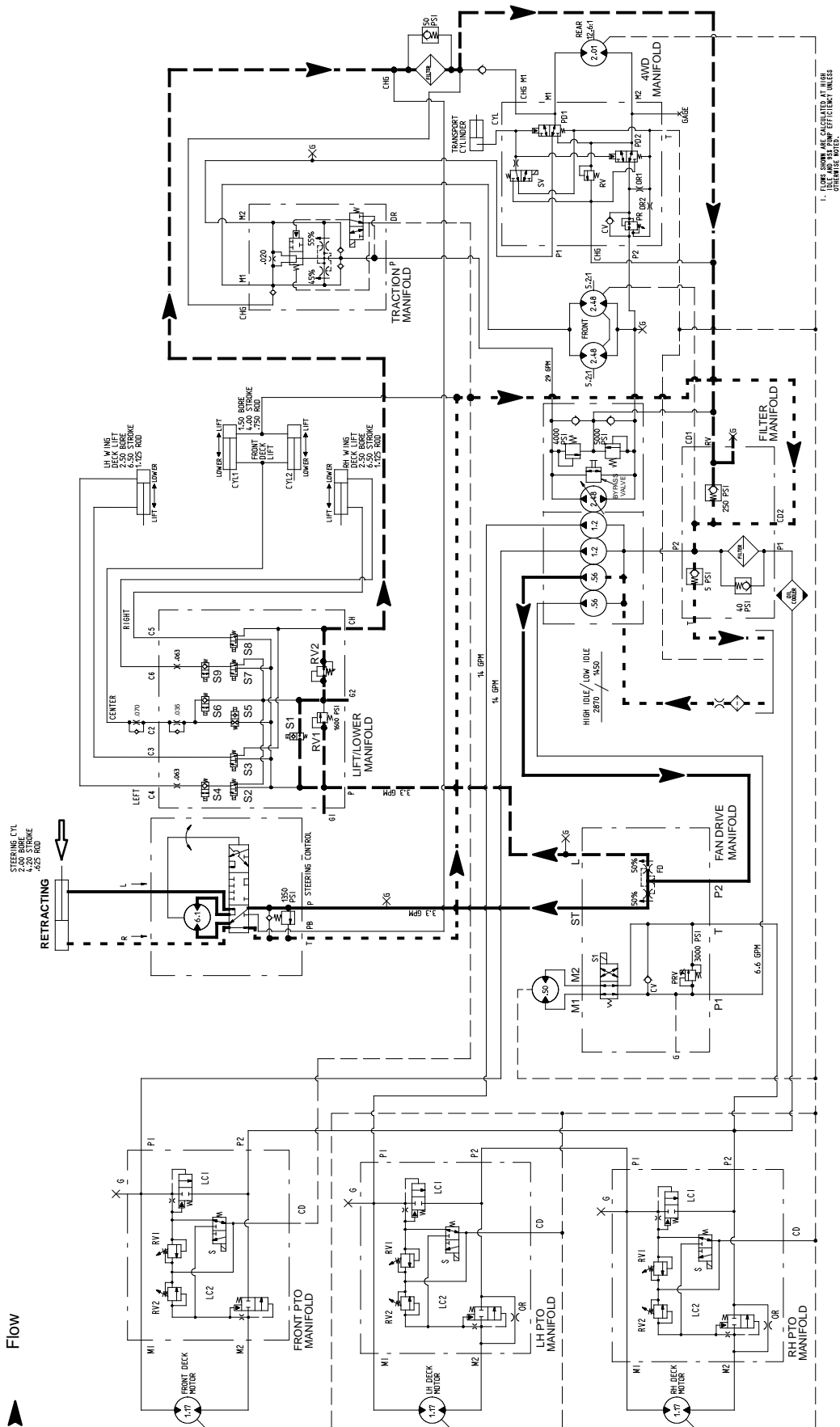


Figure 13

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## Steering Circuit (Left Turn Shown)

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





## Steering Circuit

A four section gear pump is coupled to the piston (traction) pump. The third gear pump section supplies hydraulic flow to both the steering and lift/lower circuits. Hydraulic flow from this pump section is delivered to the two circuits through a proportional flow divider that is located in the fan drive manifold. This flow divider splits pump flow approximately 50% for the steering circuit and 50% for the lift/lower circuit.

Steering circuit pressure is limited to 1350 PSI (93 bar) by a relief valve located in the steering control valve. Circuit pressure can be measured at a test port in the hydraulic supply tube.

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

### Left Turn

When a left turn is made with the engine running, the turning of the steering wheel positions the 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. First, most of the flow through the valve is by-passed out the PB port back to the oil filter and traction charge circuit. Second, the remainder of the flow is drawn through the rotary meter

(V1) and out the L port. Pressure retracts the steering cylinder piston 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.

### 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. As in a left turn, most of the flow through the valve is by-passed out the PB port back to the oil filter and traction charge circuit. Also like a left turn, the remainder of the flow is drawn through rotary meter (V1) but goes out port R. Pressure extends the steering cylinder piston for a right turn. The rotary meter ensures that the 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.

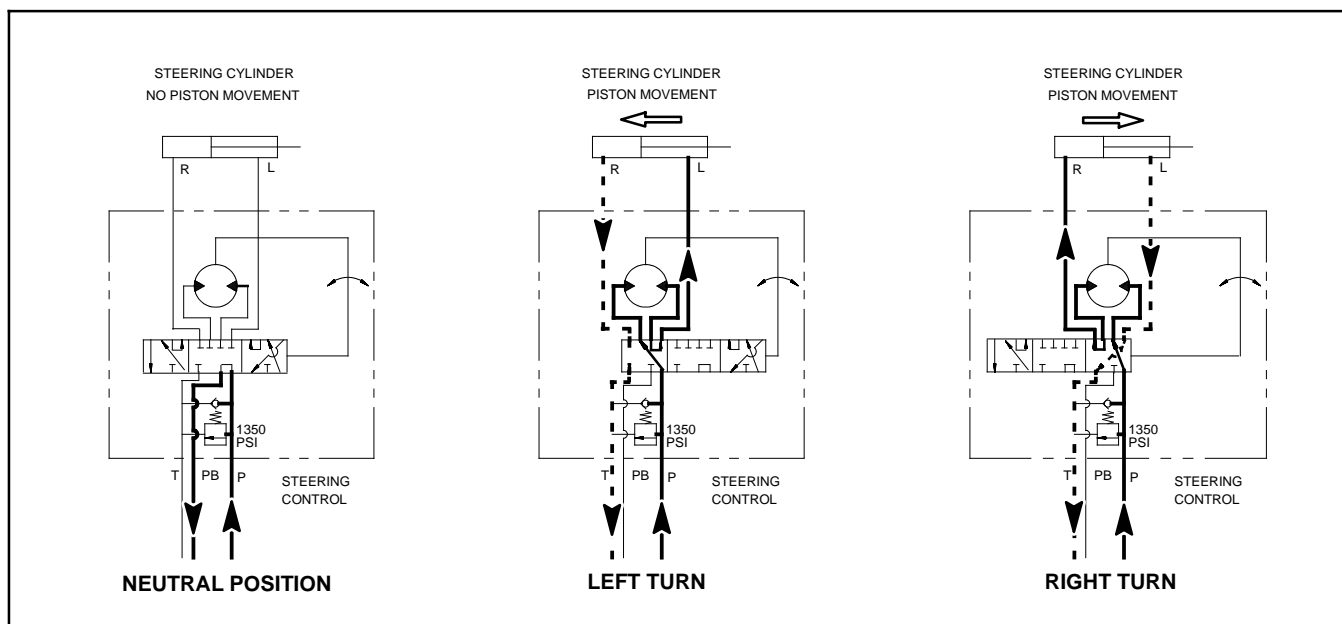
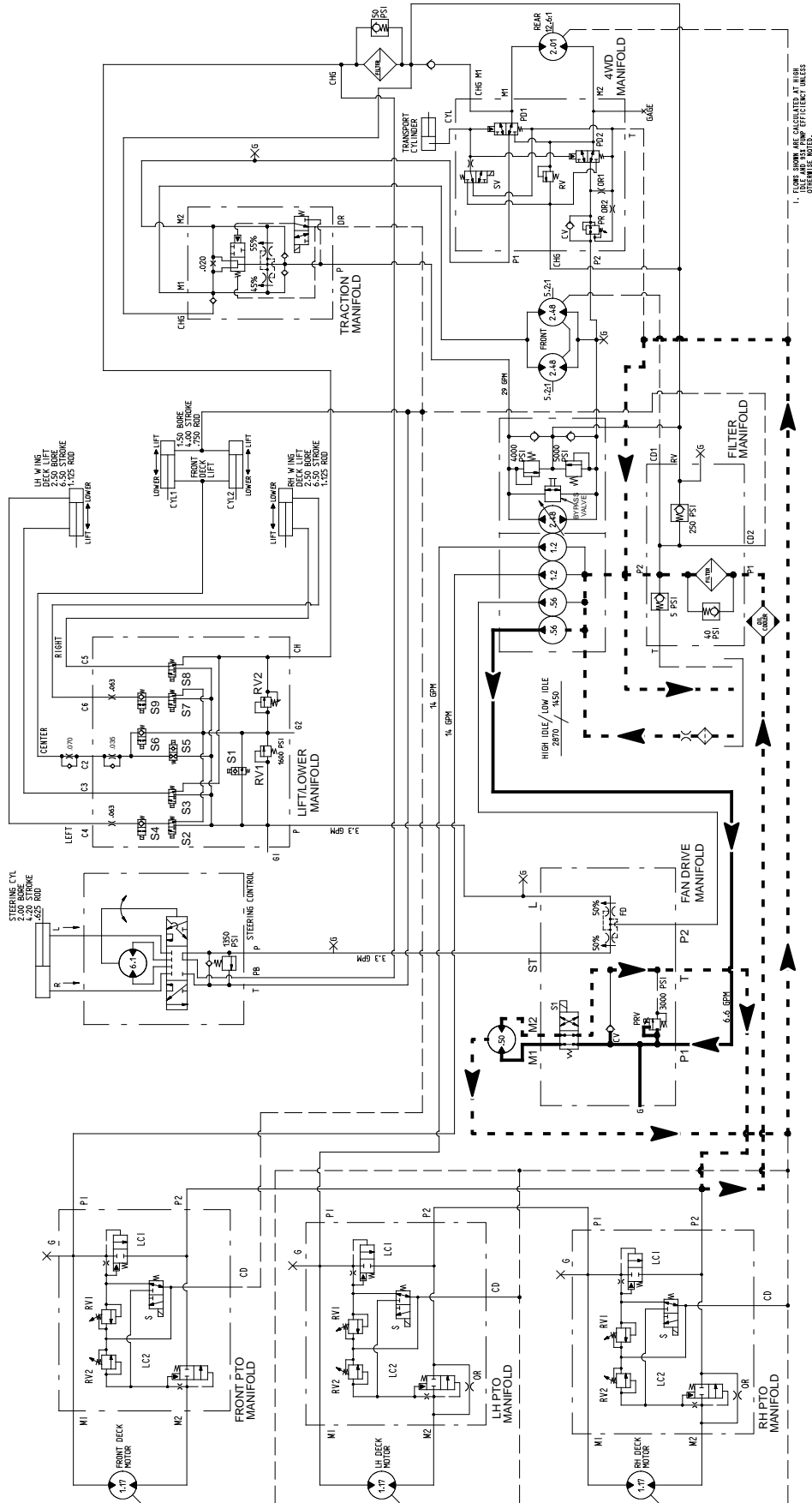


Figure 14

# Engine Cooling Fan Circuit (Forward Direction Shown)

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



## Engine Cooling Fan Circuit

A four section gear pump is coupled to the piston (traction) pump. The gear pump section farthest from the piston pump supplies hydraulic flow for the engine cooling fan circuit (Fig. 15).

The fan drive 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/lower circuits. The fan drive 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 to the cooling fan motor is controlled by the proportional relief valve (PRV) in the fan drive manifold. This valve adjusts fan circuit pressure and 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 and thus, the speed of the cooling fan.

If the 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 drive manifold will open to keep the motor circuit full of oil so the fan motor will not cavitate.

### Forward Direction Fan Operation

Oil flow from the gear pump is sent through the de-energized fan manifold 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 oil cooler and oil filter.

### Reverse Direction Fan Operation (Fig. 16)

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, a high PWM signal is sent to the (PRV) valve to slow the cooling fan and direct pump oil flow to the reservoir. The controller then energizes solenoid valve (S1) in the fan drive 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 allow-

ing oil flow to return to the fan motor but in the reverse direction causing the motor and cooling fan to run in reverse. The controller determines the length of time that the fan should be run in reverse before fan rotation is returned to the forward direction.

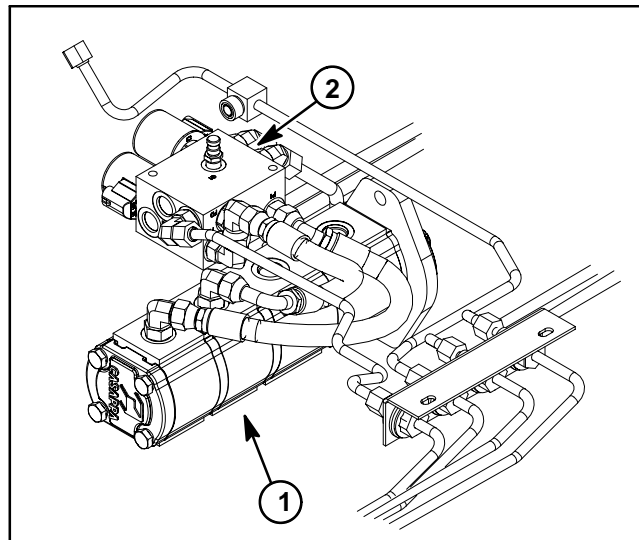


Figure 15

1. Gear pump

2. Fan drive manifold

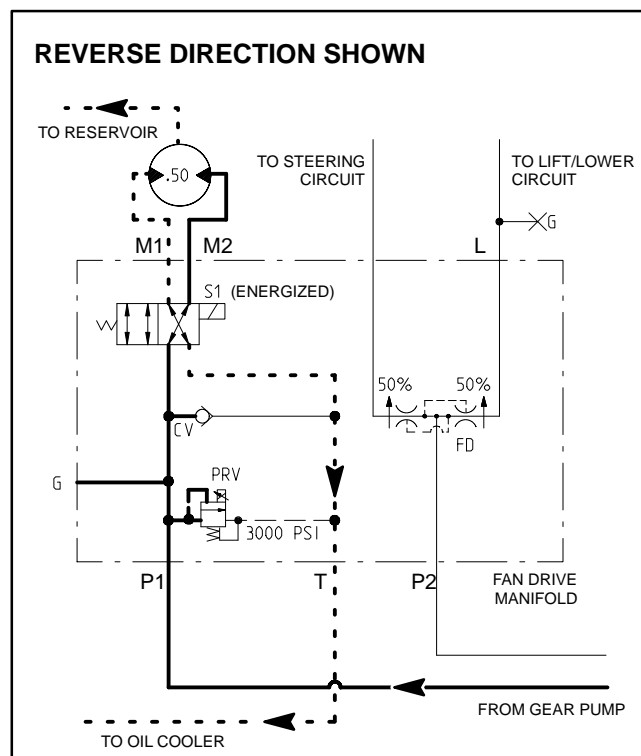


Figure 16

# Special Tools

Order special tools from your Toro Distributor.

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## 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. Kit contains one each: 1000 PSI (70 bar), 5000 PSI (350 bar) and 10000 PSI (700 bar) gauges. Use gauges as recommended in the Testing section of this chapter.

Toro Part Number: **TOR47009**



Figure 17

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## 15 GPM Hydraulic Tester Kit (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. **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:** Glycerine filled 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 from 1 to 15 GPM (5 to 55 LPM).
5. **OUTLET HOSE:** A hose from the outlet side of the hydraulic tester connects to the hydraulic system circuit.
6. **FITTINGS:** An assortment of hydraulic fittings are included with this kit.

Toro Part Number: **TOR214678**



Figure 18

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## 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 19

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## 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**

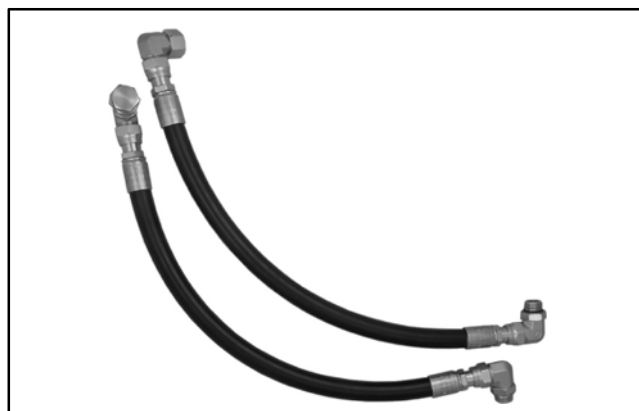


Figure 20

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## 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. hydrostat 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 21

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## 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 22

# 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	FITTING	TOOL NUMBER
	Swivel Nut Run Tee (2 ea.)		Union (1 ea.)
	Size Toro No.		Size Toro No.
	No. 4 TOR4079-3		No. 4 to No. 8 TOR4079-8
	No. 6 TOR4079-12		No. 10 to No. 8 TOR4079-2
	Plug (2 ea.)		Reducer (1 ea.)
	Size Toro No.		Size Toro No.
	No. 4 TOR4079-13		No. 10 to No. 8 TOR4079-7
	No. 6 TOR4079-14		No. 12 to No. 8 TOR4079-6
	Cap (2 ea.)		Test Cap Fitting (2 ea.)
	Size Toro No.		Size Toro No.
	No. 4 TOR4079-17		No. 4 TOR4079-10
	No. 6 TOR4079-18		No. 6 TOR4079-11
	Male Test Fitting (2 ea.)		Test Fitting (2 ea.)
	Size Toro No.		Size Toro No.
	No. 8 TOR4079-19		7/16-20 ORB TOR4079-23
	No. 10 TOR4079-20		1/8" Pipe Thd. TOR4079-22

Figure 23

# 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 25 provides gallons per minute (GPM) conversion for measured milliliter or ounce motor case drain leakage.

Toro Part Number: **TOR4077**



Figure 24

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 25

# Troubleshooting

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

Review the hydraulic schematic and information on hydraulic system operation in the Hydraulic Flow Diagrams section of this Chapter. This information will be useful during the hydraulic troubleshooting process.

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

**NOTE:** When troubleshooting traction problems on your Groundsmaster, if a problem exists in both Low (4WD) and Hi (2WD) speeds, consider a faulty component that affects the entire traction circuit (e.g. charge circuit, traction relief valves, piston pump, front wheel motors). If the problem exists in Low (4WD) but not in Hi (2WD), consider a problem in the 4WD traction system (e.g. rear axle motor, 4WD manifold).

---

## General Hydraulic System Problems

Problem	Possible Cause
Hydraulic oil leaks from machine	Fitting(s), hose(s) or tube(s) is (are) loose or damaged. O-ring(s) or seal(s) is (are) missing or damaged.
Hydraulic system operates hot. <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. Brakes are applied or sticking. Hydraulic reservoir oil level is low. Hydraulic oil is contaminated or the wrong type. Piston pump by-pass valve is open or damaged. Cooling system is not operating properly. Charge pressure is low. Traction circuit pressure is incorrect. Pump(s) or motor(s) are damaged.
Hydraulic oil in reservoir foams.	Hydraulic reservoir oil level is low. Wrong type of oil is in the hydraulic system. Air is leaking into a pump suction line.



## Traction Circuit Problems

Problem	Possible Cause
Machine operates in one direction only.	Traction control linkage is faulty. Traction relief valve is faulty.
Traction pedal is sluggish.	Traction control linkage is stuck or binding. Charge pressure is low. Piston (traction) pump servo control valve orifices are plugged or damaged. 4WD manifold PD1 and PD2 pilot directional valves seals are leaking or damaged.
Machine travels too far before stopping when the traction pedal is released.	Traction linkage is out of adjustment. Traction pedal does not return to neutral position. Charge pressure is low. Piston (traction) pump servo control valve orifices are plugged or damaged.
Traction power is lost or machine will not operate in either direction.	Hydraulic reservoir oil level is low. Piston pump by-pass valve is open or damaged. Charge pressure is low. Traction circuit pressure is low. Front wheel motor couplers are damaged.
Four wheel drive will not engage.  <b>NOTE:</b> Low (4WD) will not engage when the cutting decks are lowered.	Electrical problem exists (see Chapter 5 – Electrical System). Solenoid valve (SV) in 4WD manifold is faulty. Cartridge valve(s) in 4WD manifold is faulty. Drive gear on rear axle motor or driven gear for rear axle is loose or damaged. Rear axle motor is damaged.
Four wheel drive will not disengage.	Electrical problem exists (see Chapter 5 – Electrical System). Solenoid valve (SV) in 4WD manifold is faulty. Cartridge valve in 4WD manifold is damaged or sticking.

## Mow Circuit Problems

Problem	Possible Cause
No cutting decks will operate.  <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 (4WD) position and the PTO switch must be ON.	Electrical problem exists (see Chapter 5 - Electrical System).  Gear pump is damaged (NOTE: other hydraulic circuits impacted as well).
One cutting deck will not operate.	Electrical problem exists (see Chapter 5 - Electrical System).  System pressure to the affected deck is low.  Woodruff key on affected deck motor is damaged.  Solenoid valve (S) in PTO manifold for affected deck is faulty.  Cartridge valve in PTO manifold for affected deck is damaged or sticking.  Deck motor or gear pump section is damaged.  NOTE: If appropriate, transfer a suspected damaged motor to another cutting deck. If problem follows the motor, motor needs repair or replacement.
All cutting decks operate slowly.	Engine RPM is low.  Deck motor or gear pump sections are damaged.
Cutting deck stops under load.	Relief valve in PTO manifold for affected deck is by-passing.  Deck motor has internal leakage (by-passing oil).  Cutting deck gear pump section is worn or damaged.

## Lift Circuit Problems

Problem	Possible Cause
<p>Cutting decks will not raise.</p> <p><b>NOTE:</b> Seat must be occupied in order to raise cutting decks.</p>	<p>Engine RPM is too low.</p> <p>Hydraulic oil level in reservoir is low.</p> <p>Solenoid valve (S1) in lift/lower manifold is faulty.</p> <p>Electrical problem exists (see Chapter 5 – Electrical System).</p> <p>Lift arm pivots are binding.</p> <p>Relief valve in lift/lower manifold is stuck.</p> <p>Lift cylinder(s) is (are) damaged.</p> <p>Gear pump section for lift circuit is inefficient (NOTE: steering circuit impacted as well).</p>
<p>Cutting decks raise, but will not stay up.</p> <p><b>NOTE:</b> Lift cylinders cannot provide an absolutely perfect seal. The cutting deck will eventually lower if left in the raised position during storage.</p>	<p>Lift circuit lines or fittings are leaking.</p> <p>Lift cylinder is damaged.</p> <p>Cartridge valve(s) in lift/lower manifold has damaged seals or is faulty.</p>
<p>Cutting decks will not lower.</p> <p><b>NOTE:</b> To lower a cutting deck, the seat must be occupied and the traction speed must be in the Low (4WD) position.</p>	<p>Lift arm pivots are binding.</p> <p>Electrical problem exists (see Chapter 5 – Electrical System).</p> <p>Solenoid valve (S1) in lift/lower manifold is faulty.</p> <p>Counterbalance pressure is excessive.</p> <p>Lift cylinder is damaged.</p>

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## Steering Circuit Problems

Problem	Possible Cause
Steering inoperative or sluggish	<p>Steering components (e.g. tie rods, steering cylinder ends) are worn or binding.</p> <p>Steering cylinder is binding.</p> <p>Oil level in hydraulic reservoir is low (NOTE: other hydraulic systems are affected as well).</p> <p>Steering relief valve in steering control valve is stuck or damaged.</p> <p>Steering cylinder leaks internally.</p> <p>Steering control valve is worn or damaged.</p> <p>Gear pump section is worn or damaged (NOTE: a worn or damaged gear pump section will also affect the lift and traction (charge) circuits).</p>

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## Engine Cooling Fan Circuit Problems

Problem	Possible Cause
Cooling fan runs only in forward direction (fan does not run in reverse direction).	<p>Fan control manifold solenoid cartridge valve (S1) is faulty.</p> <p>Electrical problem exists that prevents fan control manifold solenoid valve (S1) operation (see Chapter 5 – Electrical System).</p>
Cooling fan does not rotate.	<p>Fan motor is worn or damaged.</p> <p>Gear pump section for engine cooling fan circuit is worn or damaged.</p>
Cooling fan always rotates at slow speed.	<p>Fan control manifold cartridge valve seals are leaking.</p> <p>Check valve in fan control manifold is not seating.</p> <p>Fan control manifold proportional relief valve (PRV) is stuck open.</p> <p>Hydraulic fan motor is worn or damaged.</p>
Cooling fan always rotates at fast speed.	<p>Fan control manifold proportional relief valve (PRV) is faulty.</p> <p>Electrical problem exists that prevents fan control manifold proportional relief valve (PRV) operation (see Chapter 5 – Electrical System).</p>

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# 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).

## Before Performing Hydraulic Tests

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

## Precautions for Hydraulic Testing



### CAUTION

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



### WARNING

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



### 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.



### CAUTION

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

1. Clean machine thoroughly before disconnecting or disassembling any hydraulic components. Always keep in mind the need for cleanliness when working on hydraulic equipment. Contamination will cause excessive wear of components.

2. Put metal caps or plugs on any hydraulic lines left open or exposed during testing or removal of components.

3. The engine must be in good operating condition. Use a phototac when performing a hydraulic test. Engine speed can affect the accuracy of the tester readings. Check actual speed of the pump when performing flow testing.

4. When using the hydraulic tester with flow and pressure capabilities, the inlet and the outlet hoses must be properly connected and not reversed to prevent damage to the hydraulic tester or components.

5. When using the hydraulic tester with flow and pressure capabilities, completely open flow control valve on tester before starting the engine to minimize the possibility of damaging components.

6. Install fittings finger tight and far enough to make sure that they are not cross-threaded before tightening them with a wrench.

7. Position tester hoses to prevent rotating machine parts from contacting and damaging the hoses or tester.

8. Check oil level in the hydraulic reservoir. After connecting test equipment, make sure tank is full.

9. Check control linkages for improper adjustment, binding or broken parts.

10. After installing test gauges, run engine at low speed and check for any hydraulic oil leaks.

11. All hydraulic tests should be made with the hydraulic oil at normal operating temperature.

12. Before returning machine to use, make sure that hydraulic reservoir has correct fluid level.

## Which Hydraulic Tests Are Necessary?

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

1. If a traction circuit problem exists, consider performing one or more of the following tests: Traction Circuit Charge Pressure, Traction Circuit Relief Pressure, Counterbalance Pressure, Rear Traction Circuit (RV) Relief Pressure, Traction Circuit Reducing Valve (PR) Pressure 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.**

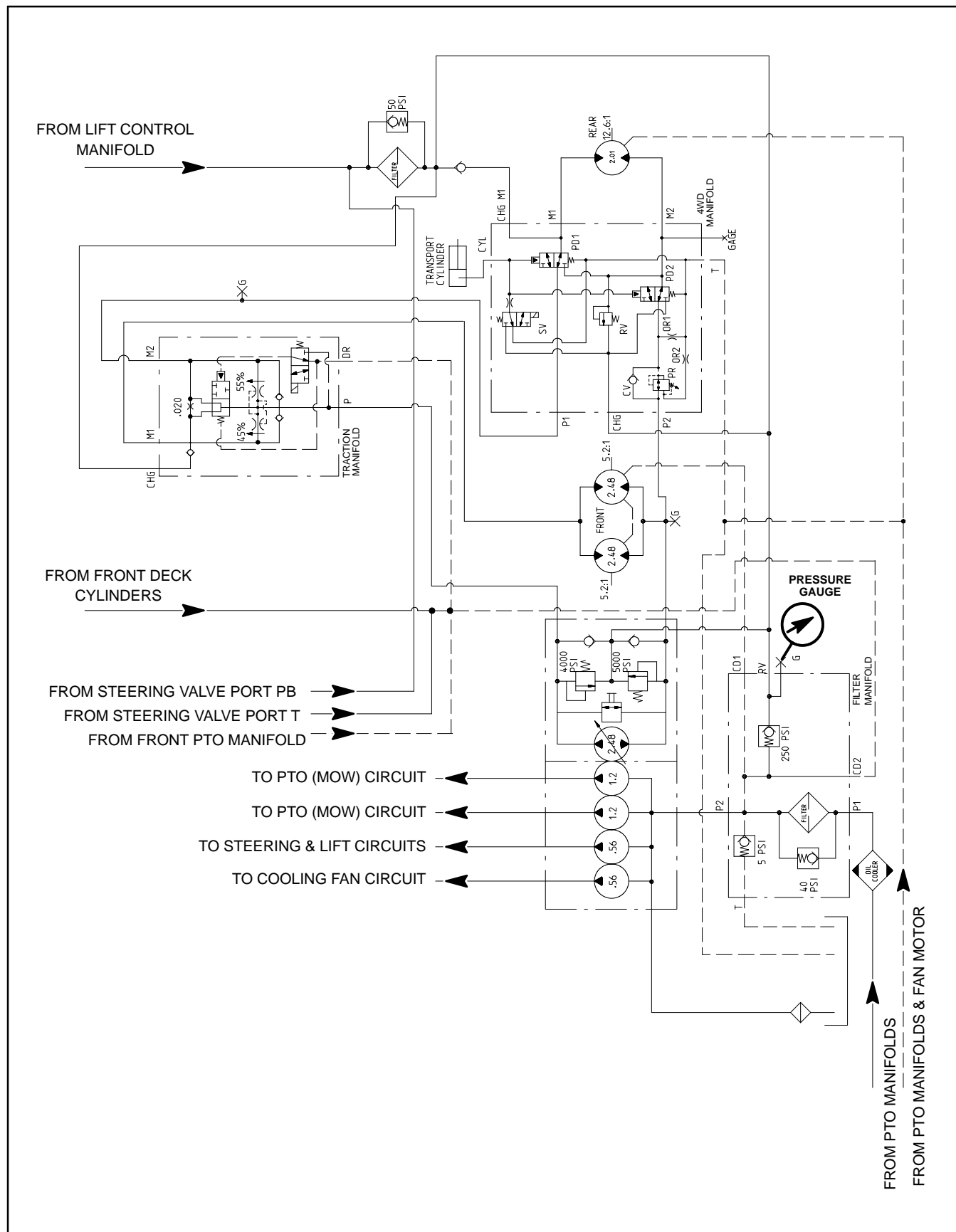
2. If a cutting (mow) circuit problem exists, consider performing one or more of the following tests: Cutting Deck Circuit Pressure, PTO Relief Pressure, Cutting Deck Motor Case Drain Leakage and/or Cutting Deck Gear Pump Flow Tests.

3. If a lift circuit problem exists, consider performing one or more of the following tests: Lift/Lower Circuit Relief Pressure and/or Steering and Lift/Lower 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 Steering and Lift/Lower 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 Engine Cooling Fan Circuit Gear Pump Flow Tests.

### Traction Circuit Charge Pressure (Using Pressure Gauge)





## Procedure for Traction Circuit Charge Pressure Test

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



### CAUTION

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

4. Connect a 1000 PSI (70 bar) pressure gauge onto charge pressure test port on filter manifold (Fig. 26).
5. Start the engine and put throttle at high idle speed (**2870 RPM**) with no load on the hydraulic system.

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

6. Stop engine and record test results.
7. If there is no pressure or pressure is low, check for restriction in pump intake line. Also, inspect charge relief valve located in filter manifold (see Filter Manifold Service in the Service and Repairs section of this chapter). A worn or damaged gear pump (P3) could also be considered (see Steering and Lift/Lower Gear Pump Flow Test in this section).

**NOTE:** If gear pump (P3) is worn or damaged, charge, steering and lift circuits will all be affected.

8. Next, with the pressure gauge still connected to the charge pressure test port, take a gauge reading while operating the machine in forward and reverse. Start the engine and put throttle at high idle speed (**2870 RPM**). Apply the brakes and push the traction pedal forward while monitoring the pressure gauge. Repeat for reverse direction. Stop engine and record test results.

9. If charge pressure meets specifications under no load conditions (step 5 above), but consistently drops more than 15% when under traction load, the piston (traction) pump and/or traction motor(s) should be suspected of wear and inefficiency. When the pump or motors are worn or damaged, the charge pump is not able to keep up with internal leakage in the traction system components.

10. When testing is completed, disconnect pressure gauge from test port. Lower and secure operator's seat.

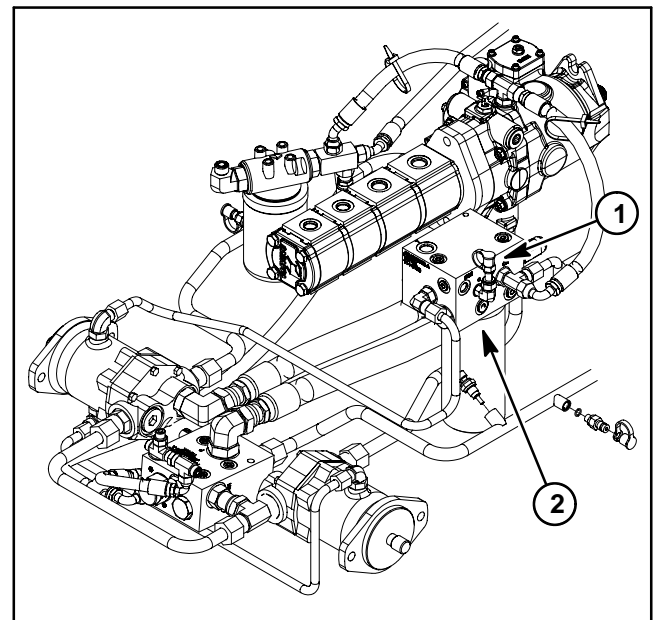
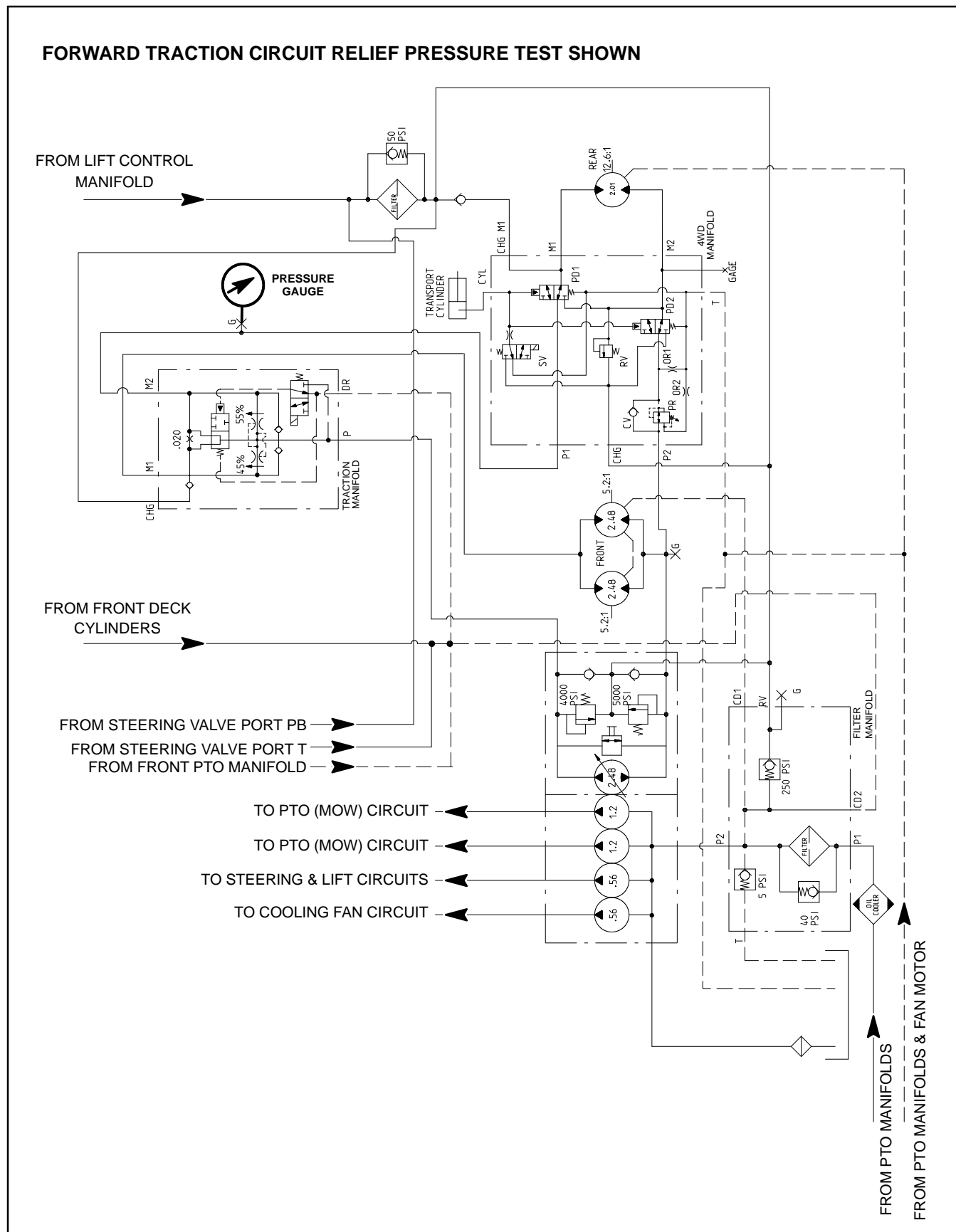


Figure 26

1. Charge pressure port      2. Filter manifold

## Traction Circuit Relief Pressure (Using Pressure Gauge)



## Procedure for Traction Circuit Relief Pressure Test

1. Make sure hydraulic oil is at normal operating temperature by operating the machine under load for approximately ten (10) minutes. Make sure the hydraulic tank 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 the parking brake.



### CAUTION

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

3. Connect a 10,000 PSI (700 bar) pressure gauge to traction circuit test port for function to be checked (Fig. 27 or 28).

4. Start the engine and move throttle to high idle speed (**2870 RPM**). Release parking brake. Make sure that Hi/Low speed switch is in the Hi speed (2WD) position.

5. Sit on seat, apply brakes fully and slowly depress the traction pedal in the appropriate direction (forward or reverse). While pushing traction pedal, look at pressure reading on gauge:

GAUGE READING TO BE:

Forward: **3750 to 4250 PSI (259 bar to 293 bar)**

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

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

7. If traction pressure is too low, inspect traction pump relief valves (Fig. 29). Clean or replace relief valves as necessary. These cartridge type valves are factory set, and are not adjustable. If relief valves are in good condition, traction pump or wheel motors should be suspected of wear and inefficiency.

**NOTE:** Seal leakage across pilot directional valves PD1 and PD2 in 4WD manifold can cause low forward traction pressure with reverse pressure meeting specifications.

8. When testing is completed, disconnect pressure gauge from test port.

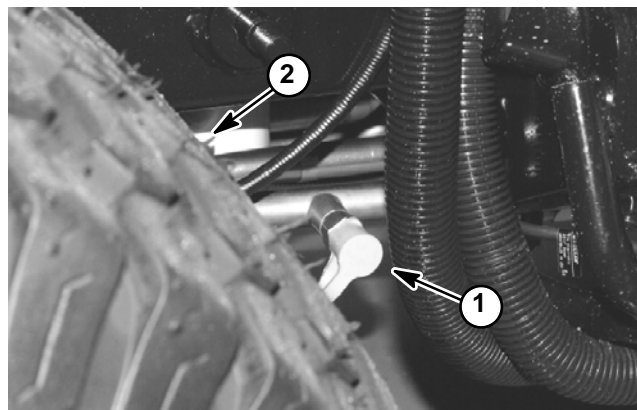


Figure 27

1. Forward traction port      2. Left front wheel

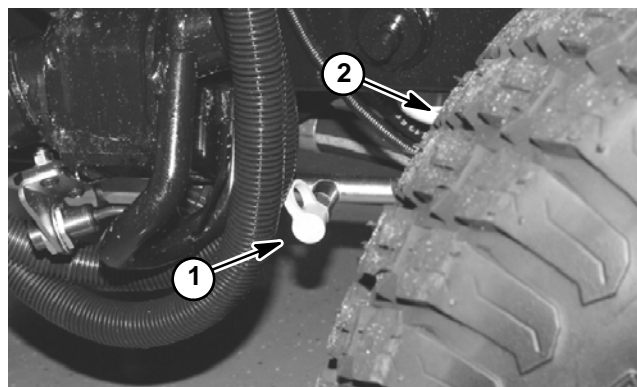


Figure 28

1. Reverse traction port      2. Right front wheel

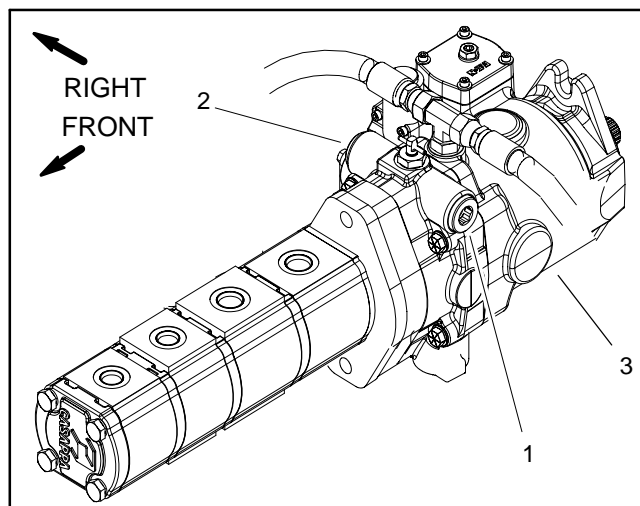
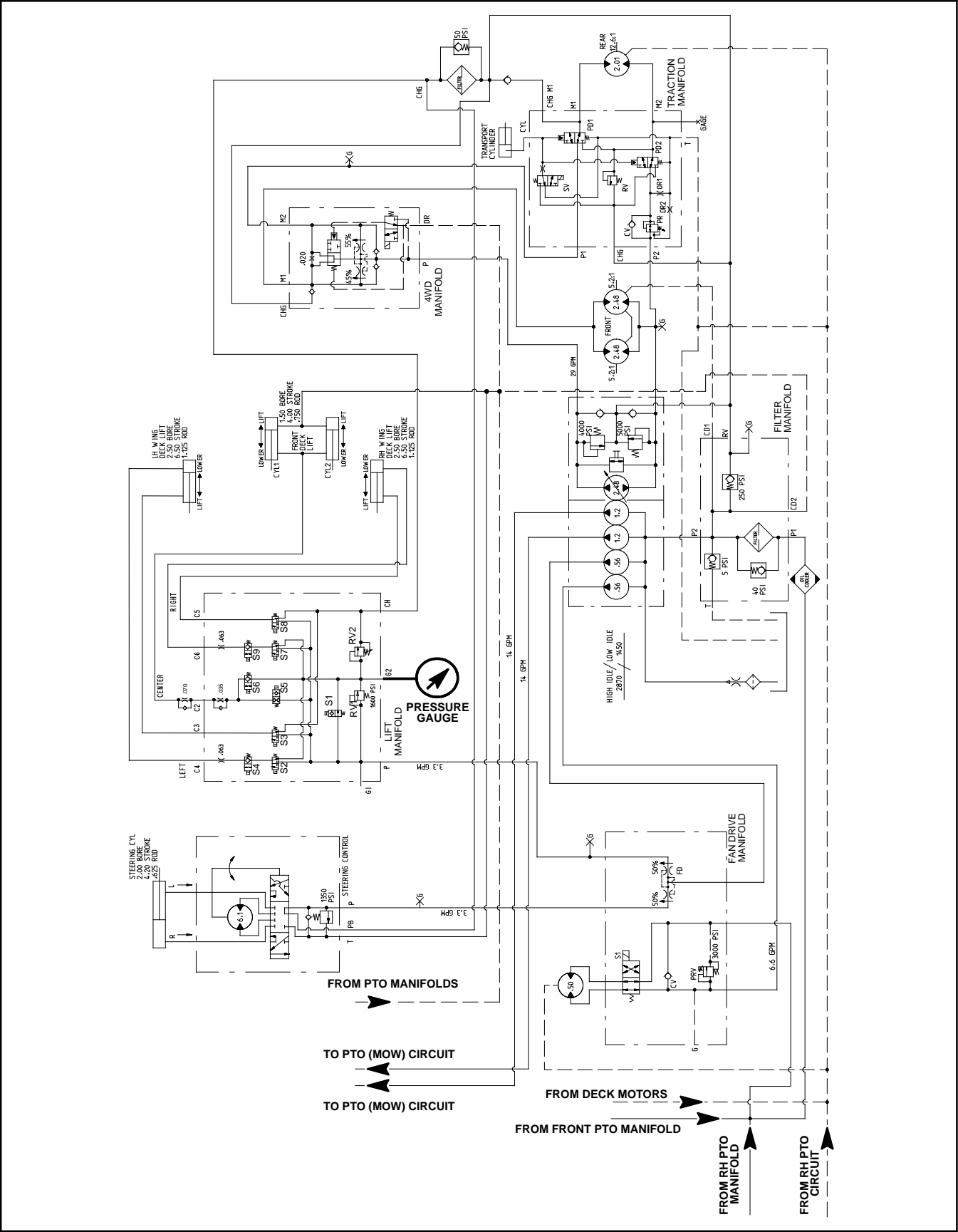


Figure 29

1. Forward relief valve      3. Traction pump  
2. Reverse relief valve

Counterbalance Pressure (Using Pressure Gauge)



## Procedure for Counterbalance Pressure Test

1. Make sure hydraulic oil is at normal operating temperature by operating the machine under load for approximately ten (10) minutes. Make sure the hydraulic tank 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. Remove controller cover to gain access to lift/lower manifold (Fig. 30).



### CAUTION

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

4. Determine system charge pressure (see Traction Circuit Charge Pressure Test in this section).
5. Connect a 1000 PSI (70 bar) pressure gauge to counterbalance test port G2 on lift/lower manifold (Fig. 31).
6. Start the engine and put throttle at high idle speed (**2870 RPM**) with no load on the system. **Do not engage the cutting decks.**

**GAUGE READING TO BE 220 PSI (15.2 bar) over system charge pressure** (e.g. if charge pressure is 250 PSI (17.2 bar), counterbalance pressure should be 470 PSI (32.4 bar)).

7. Stop engine and record test results.
8. Adjustment of the counterbalance valve can be performed as follows:

**NOTE:** Do not remove the counterbalance valve from the hydraulic manifold for adjustment.

- A. Loosen lock nut on counterbalance valve (Fig. 31).
- B. To **increase** pressure setting, turn the adjustment screw on the valve in a clockwise direction. A 1/8 turn on the screw will make a measurable change in counterbalance pressure.
- C. To **decrease** pressure setting, turn the adjustment screw on the valve in a counterclockwise direction. A 1/8 turn on the screw will make a measurable change in counterbalance pressure.

D. Tighten lock nut to secure adjustment. Check counterbalance pressure and readjust as needed.

9. When testing is completed, disconnect pressure gauge from manifold test port. Install controller cover.

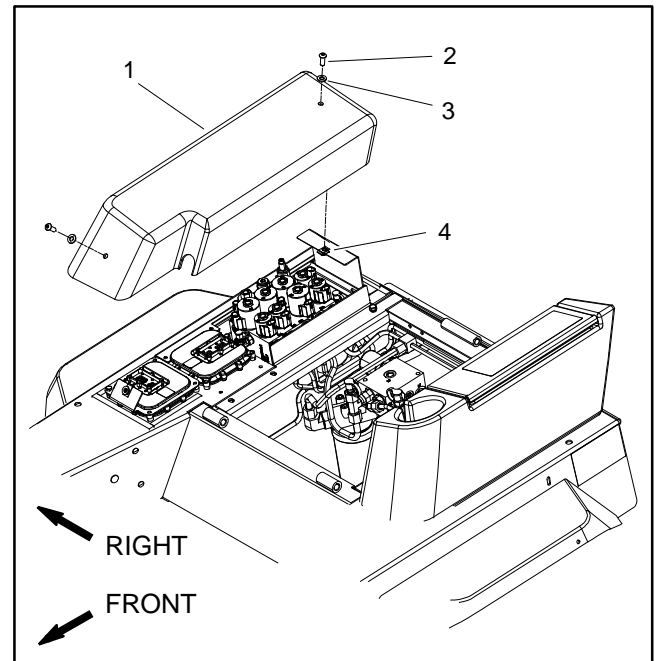


Figure 30

- |                     |                         |
|---------------------|-------------------------|
| 1. Controller cover | 3. Flat washer (2 used) |
| 2. Screw (2 used)   | 4. U-nut (2 used)       |

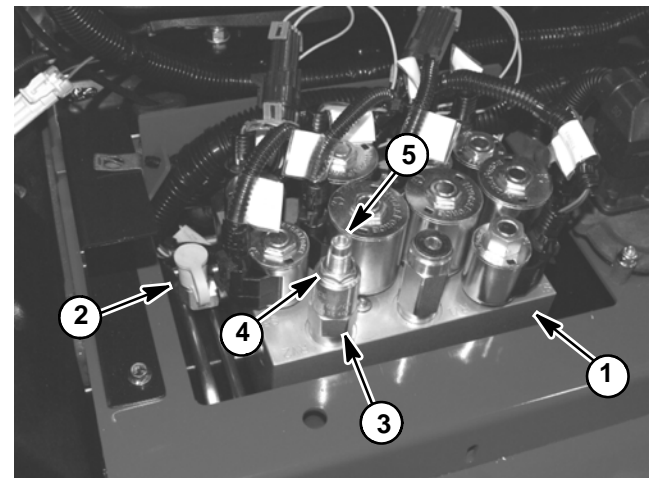
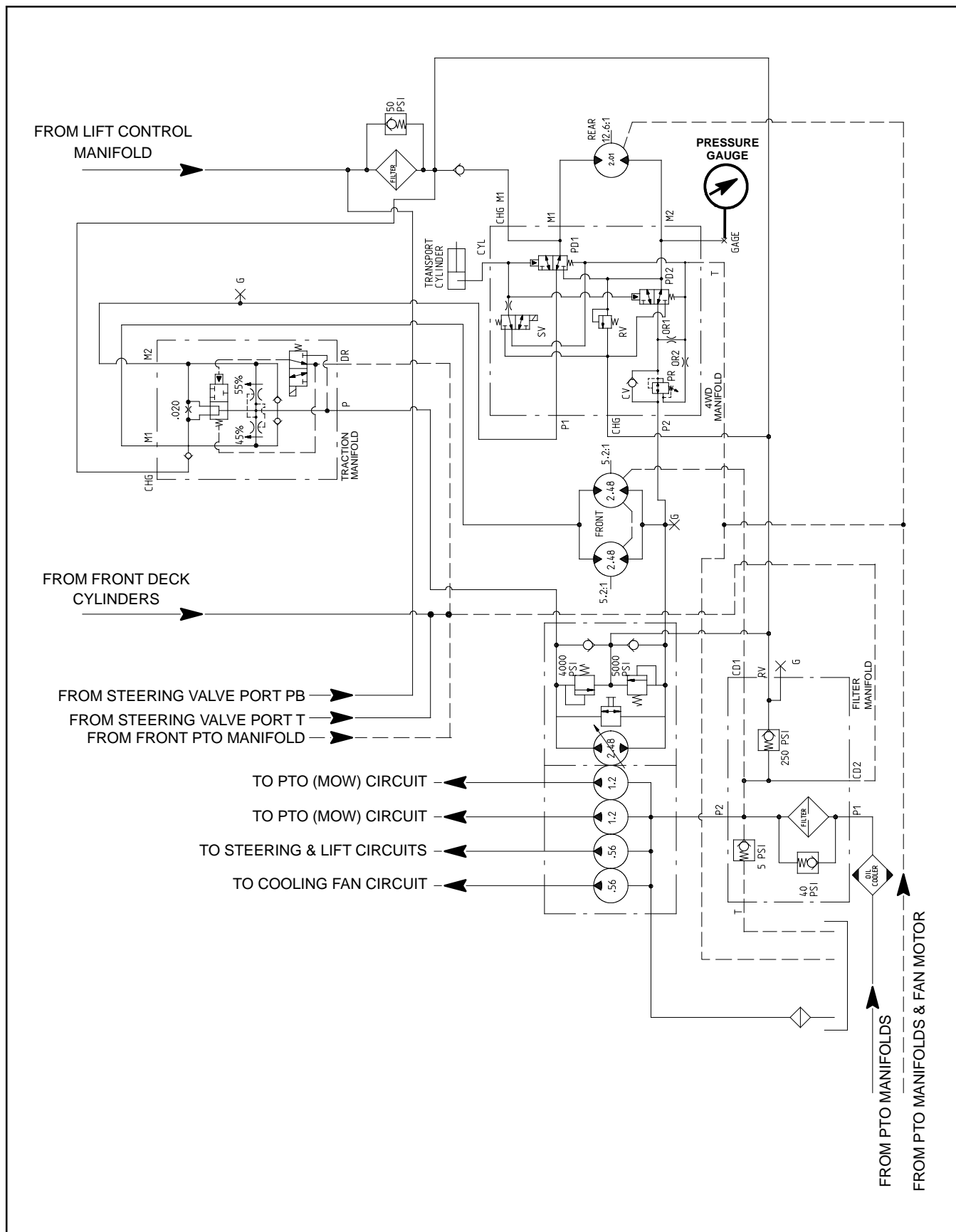


Figure 31

- |                         |                    |
|-------------------------|--------------------|
| 1. Lift/lower manifold  | 4. Lock nut        |
| 2. Test port G2         | 5. Adjusting screw |
| 3. Counterbalance valve |                    |

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



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

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



### CAUTION

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

3. Connect a 1000 PSI (70 bar) pressure gauge to test port on 4WD manifold under radiator (Fig. 32).
4. Start the engine and put throttle at high idle speed (**2870 RPM**). Make sure that Hi/Low speed switch is in the Low speed (4WD) position.
5. Sit on seat, apply brakes fully and slowly depress the traction pedal in the reverse direction. While pushing traction pedal, look at pressure reading on gauge:

GAUGE READING TO BE approximately **650 PSI (45 bar)**.

6. Stop engine and record test results.
7. Pressure reducing valve (PR) is located on the front side of the 4WD manifold (Fig. 33). Adjustment of this valve can be performed as follows:

**NOTE:** Do not remove the pressure reducing valve from the hydraulic manifold for adjustment.

A. To **increase** pressure setting, remove cap on reducing valve and turn the adjustment socket on the valve in a clockwise direction. A 1/8 turn on the socket will make a measurable change in pressure setting.

B. To **decrease** pressure setting, remove cap on reducing valve and turn the adjustment socket on the valve in a counterclockwise direction. A 1/8 turn on the socket will make a measurable change in pressure setting.

C. Recheck reducing valve (PR) pressure setting and readjust as needed.

8. When testing is completed, disconnect pressure gauge from manifold test port.

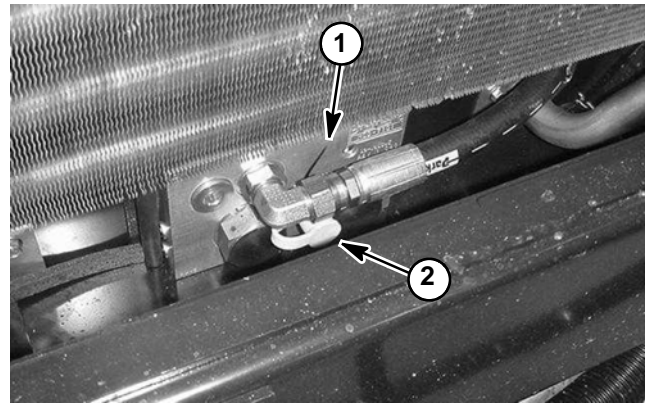


Figure 32

1. 4WD manifold      2. Pressure test port

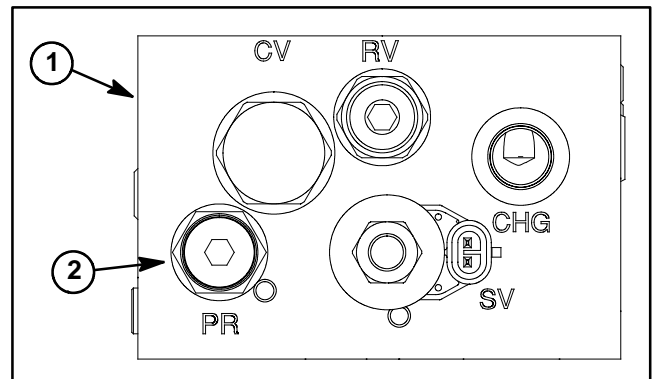


Figure 33

1. 4WD manifold (front)      2. Reducing valve (PR)

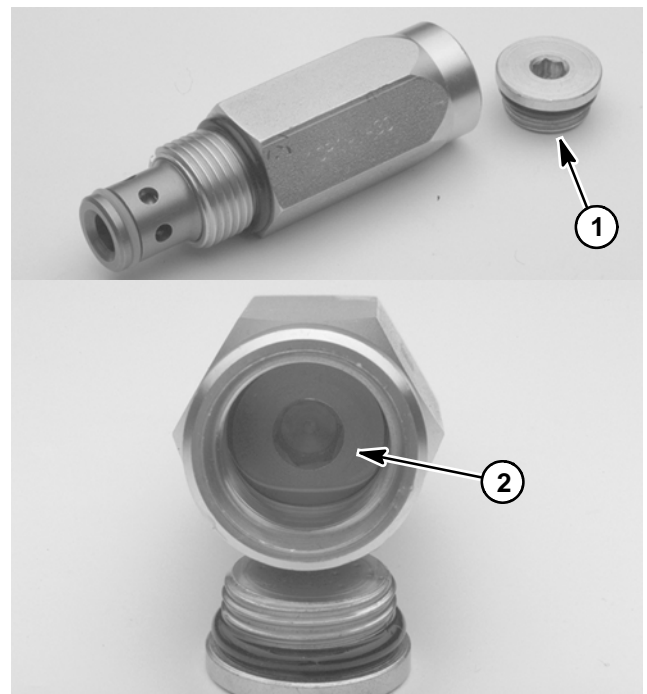
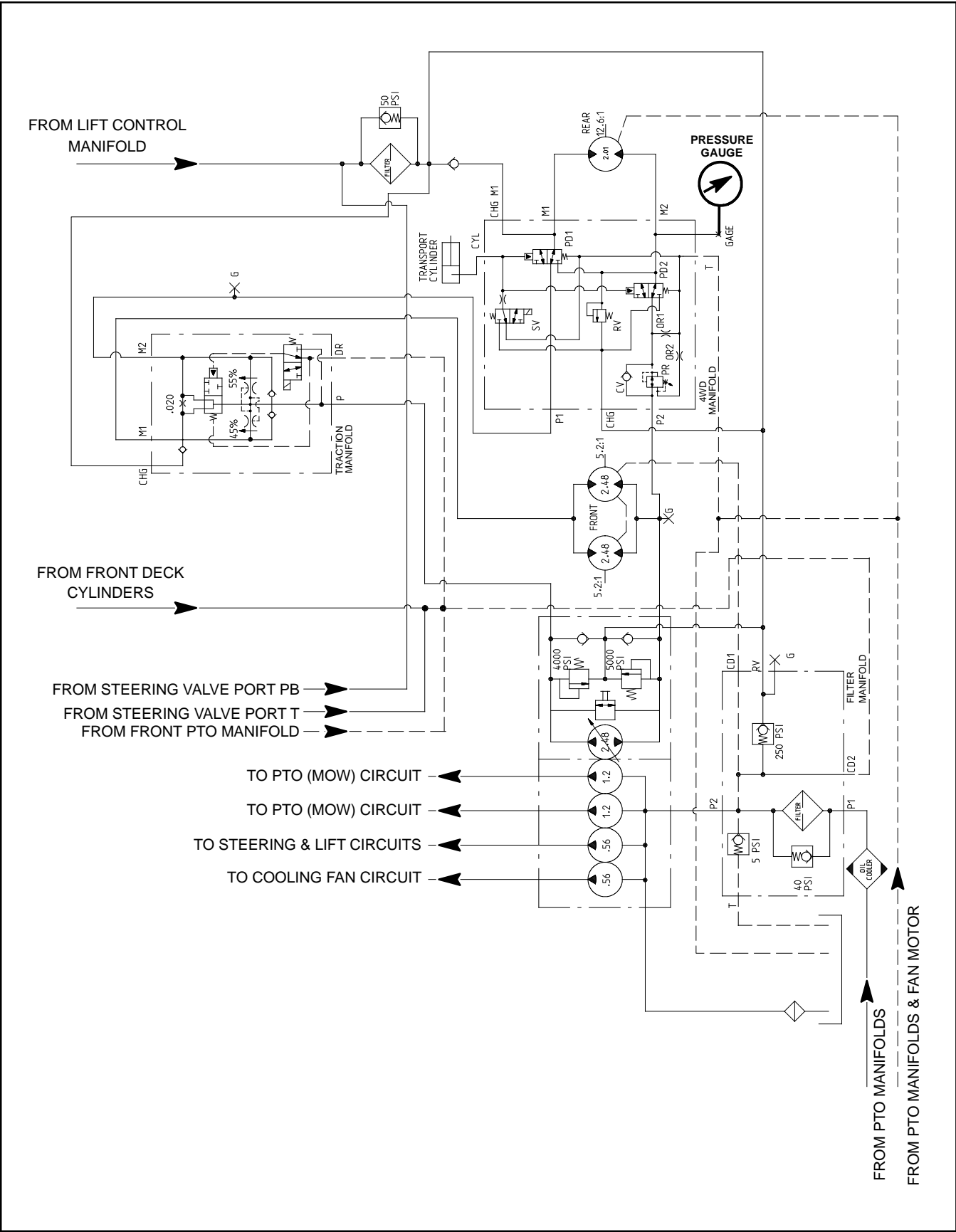


Figure 34

1. Relief valve cap      2. Adjustment socket

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





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

1. Make sure hydraulic oil is at normal operating temperature by operating the machine under load for approximately ten (10) minutes. Make sure the hydraulic tank 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. Measure and record traction circuit pressure reducing valve (PR) pressure (see Traction Circuit Pressure Reducing Valve (PR) Pressure Test in this section).
4. Connect a 1000 PSI (70 bar) pressure gauge to test port on 4WD manifold under radiator. This is the same pressure gauge position as used to measure traction circuit pressure reducing valve (PR) pressure.
5. Start the engine and put throttle at high idle speed **(2870 RPM)**. Make sure that Hi/Low switch is in the Low (4WD) position.
6. Operate the machine in Low speed (4WD) 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 relief valve lifts.
7. Stop engine and record test results.
8. Relief (RV) pressure should be **approximately 750 PSI (52 bar) and at least 100 PSI (7 bar) higher than the traction circuit pressure reducing valve (PR) pressure** (e.g. if the pressure reducing valve (PR) pressure is 650 PSI (45 bar), relief (RV) pressure should be at least 750 (52 bar) but not much higher).
9. Relief valve (RV) is located on the front side of the 4WD manifold (Fig. 35). Adjustment of the relief valve (RV) can be performed as follows:

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

- A. Remove cap on relief valve to locate the adjustment socket (Fig. 36). A 1/8 turn on the socket will make a measurable change in relief pressure.

- B. To **increase** relief pressure setting, rotate adjustment socket in a clockwise direction.

- C. To **decrease** pressure setting, rotate adjustment socket in a counterclockwise direction.

- D. Recheck relief pressure and readjust as needed.

10. When testing is completed, disconnect pressure gauge from manifold test port.

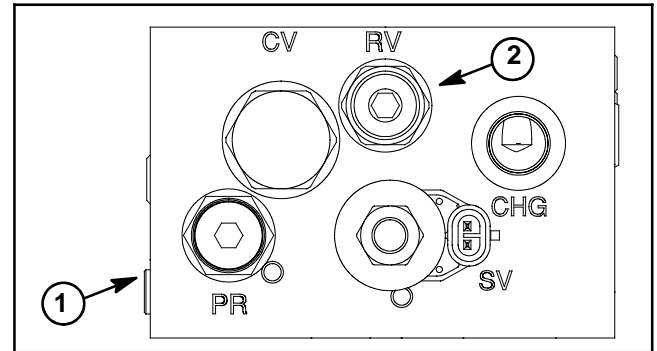


Figure 35

1. 4WD manifold (front)
2. Relief valve (RV)

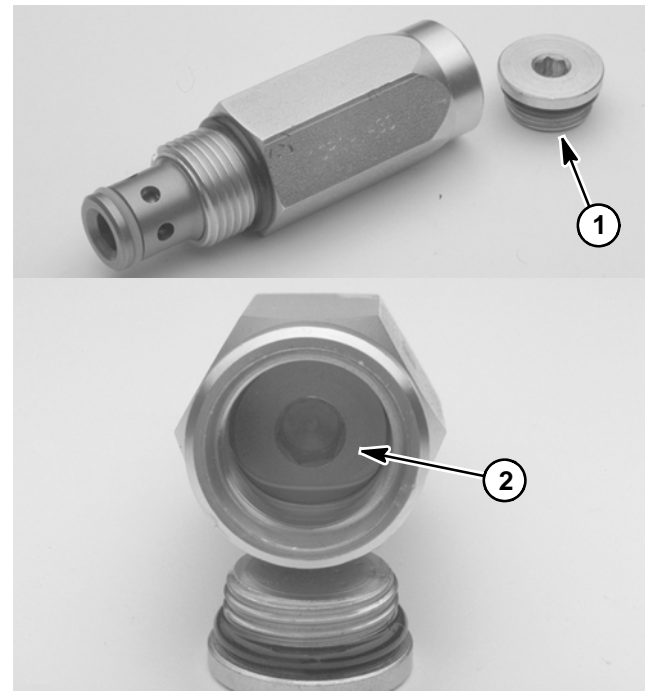
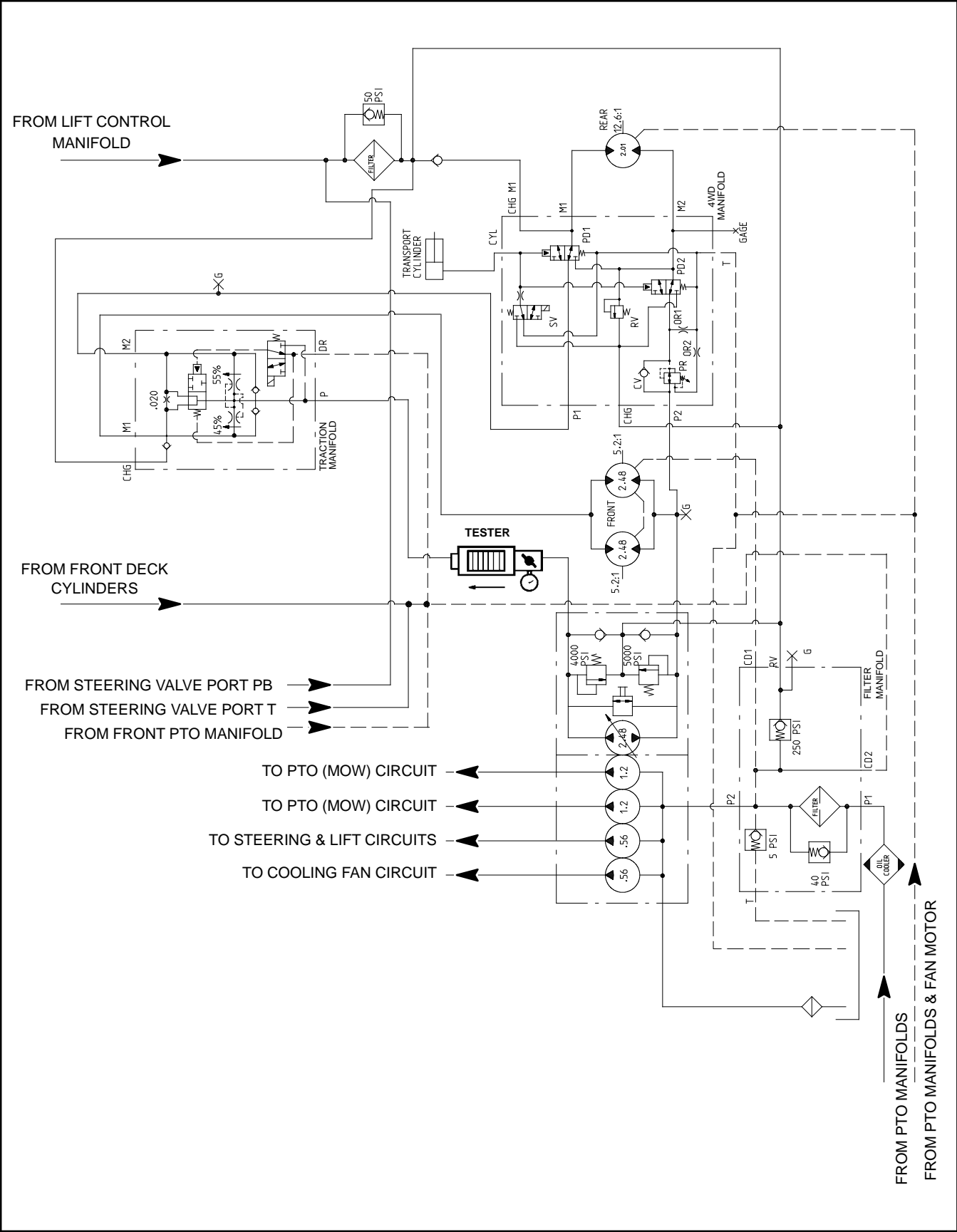


Figure 36

1. Relief valve cap
2. Adjustment socket

Piston (Traction) Pump Flow Test (Using Tester with Flow meter and Pressure Gauge)



## 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.

**IMPORTANT:** Traction circuit flow for the Groundsmaster 4000/4010 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).

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

2. Park machine on a level surface with the cutting decks raised and off. Latch wing decks in raised position. Make sure that the Hi/Low switch is in the Low speed (4WD) position. Shut off engine.



**CAUTION**


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

3. Make sure that traction pedal is adjusted to the neutral position. Also, ensure that traction pump is at full stroke when traction pedal is pushed into fully forward position.

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

5. Thoroughly clean junction of hydraulic hose and left side fitting on bottom of traction pump (forward port) (Fig. 37). Disconnect hose from left side pump fitting.

6. Install tester with pressure gauge and flow meter in series between traction pump fitting and disconnected hose to allow flow from traction pump to tester. Use hydraulic hose kit (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.



**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.

7. Start engine and run at idle speed. Check for any hydraulic leakage from tester and hose connections. Correct any leaks before proceeding.

8. Move throttle so engine is running at high idle speed (2870 RPM).

9. Slowly push traction pedal to fully forward position. Keep pedal fully depressed in the forward position.

10. 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 a phototac that the **engine speed** is still **2870 RPM**.

**NOTE:** If engine speed drops below 2870 RPM, pump flow will decrease.

11. Observe flow gauge. Flow indication should be approximately **29 GPM (110 LPM)**.

12. Release traction pedal to the neutral position, open flow control valve on tester and shut off engine. Record test results.

13. If flow is less than **26 GPM (98 LPM)**, consider the following:

A. The traction pump swash plate is not being rotated fully (e.g. Hi/Low switch is not in Low speed (4WD), traction pedal linkage may need adjustment).

B. The hydrostat needs to be repaired or replaced as necessary.

14. Make necessary repairs before performing any additional tests.

15. When testing is complete, disconnect tester and hose kit from pump fitting and machine hydraulic hose. Reconnect hose to pump fitting. Lower machine to ground.

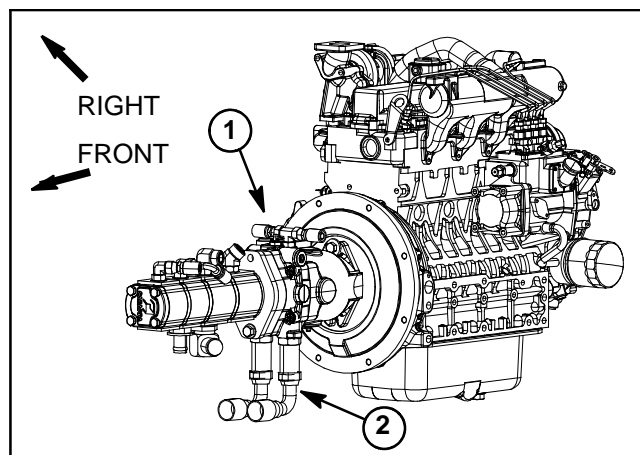
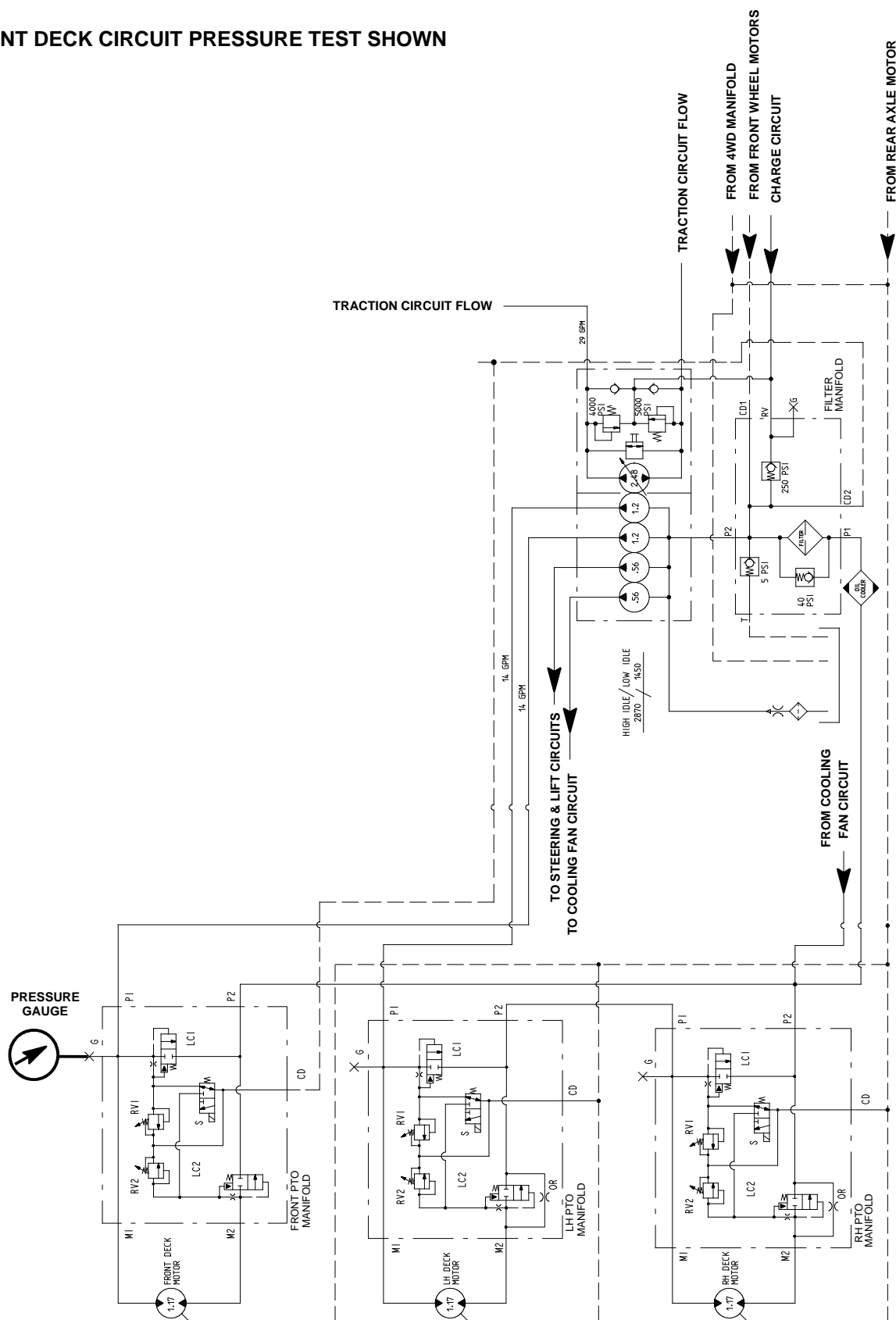


Figure 37

1. Piston (traction) pump      2. LH fitting (forward port)

### Cutting Deck Circuit Pressure (Using Pressure Gauge)

### FRONT DECK CIRCUIT PRESSURE TEST SHOWN



### Procedure for Cutting Deck Circuit Pressure Test

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



### CAUTION

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

3. Install 5000 PSI (350 bar) pressure gauge with hydraulic hose attached to manifold test port for the deck to be tested (Figs. 38, 39 and 40).



### 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.

4. Start engine and move throttle to high idle speed (2870 RPM). Engage the cutting decks.

5. Watch pressure gauge carefully while mowing with the machine.

6. Cutting deck circuit pressure should be as follows and will vary depending on mowing conditions:

**LH Deck: 1000 to 3000 PSI (69 to 207 bar)**  
**Front Deck: 1000 to 3000 PSI (69 to 207 bar)**  
**RH Deck: 1000 to 2000 PSI (69 to 137 bar)**

7. Disengage cutting decks. Shut off engine and record test results.

8. When testing is completed, disconnect pressure gauge with hose from manifold test port.

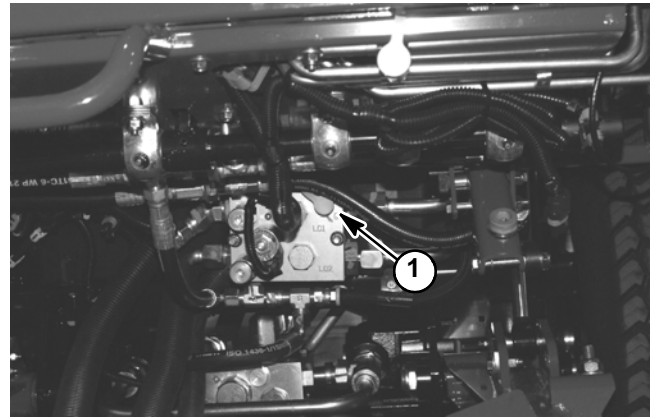


Figure 38

1. Front deck circuit pressure test port

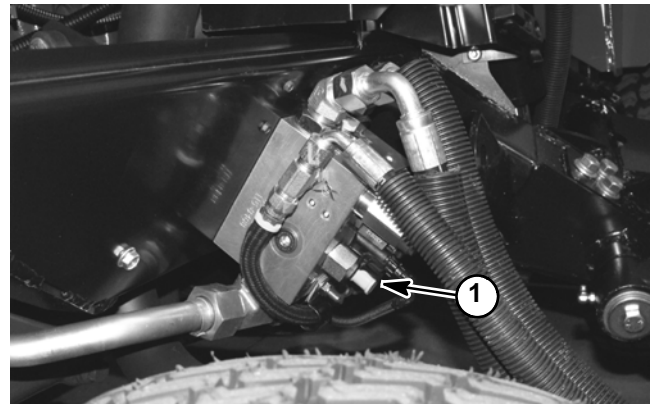


Figure 39

1. Right deck circuit pressure test port

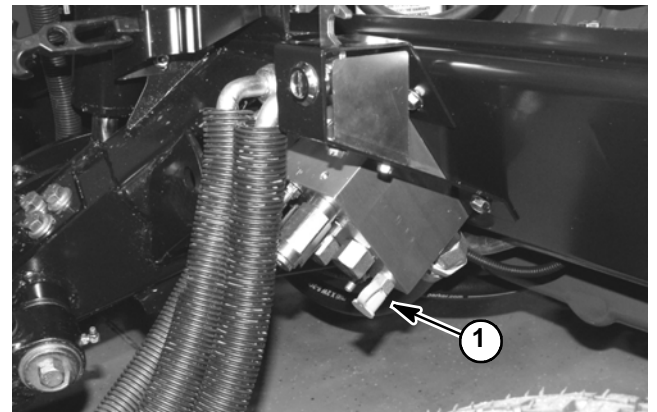
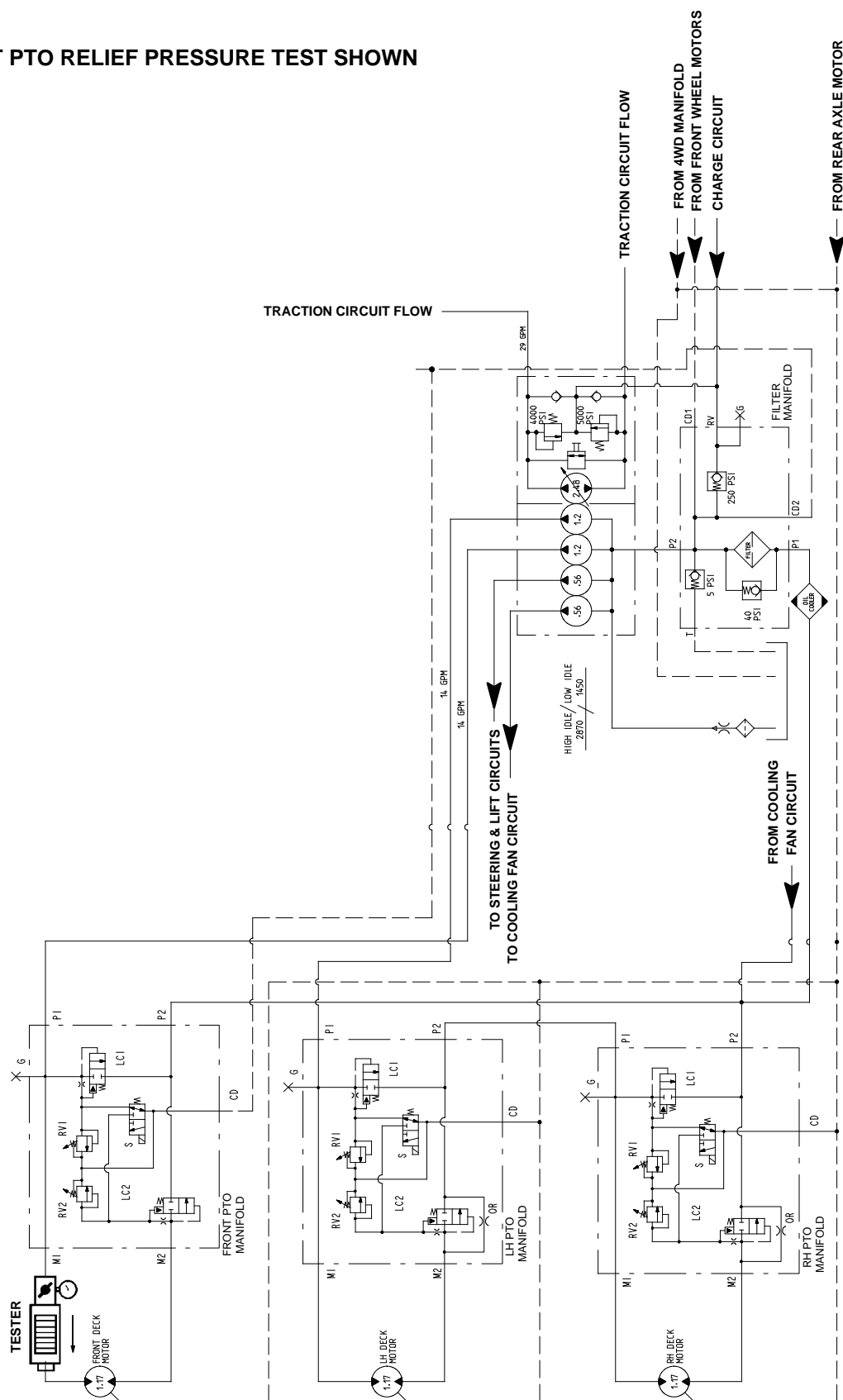


Figure 40

1. Left deck circuit pressure test port


### FRONT PTO RELIEF PRESSURE TEST SHOWN



## Procedure for PTO Relief Pressure Test

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


**CAUTION**

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

3. Locate deck manifold to be tested (Fig. 41). Disconnect hydraulic hose at deck manifold port (M1).

**NOTE:** An alternative to using manifold port (M1) would be to disconnect the inlet hydraulic hose to the deck motor.

4. Install tester (flow and pressure) in series with the disconnected hose and hydraulic manifold port (M1) (or motor inlet if hose was disconnected at deck motor). Make sure the flow control valve on tester is fully 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.**

5. Start engine and move throttle to high idle speed (2870 RPM). Engage the cutting decks.

6. Watch pressure gauge carefully while slowly closing the tester flow control valve to fully closed.

7. As the relief valve lifts, system pressure should be approximately:

**2900 to 3100 PSI (200 to 213 bar)** for the front and left decks

**1900 to 2100 PSI (131 to 144 bar)** for the right deck

8. Fully open tester flow control valve and disengage cutting decks. Shut off engine and record test results. If specification is **not** met, adjust or clean relief valve in deck manifold port (RV1). Adjust relief valve as follows:

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

A. Remove cap on relief valve with an allen wrench.

B. To **increase** pressure setting, turn the adjustment screw on the valve in a clockwise direction. A 1/8 turn on the screw will make a measurable change in relief pressure.

C. To **decrease** pressure setting, turn the adjustment screw on the valve in a counterclockwise direction. A 1/8 turn on the screw will make a measurable change in relief pressure.

D. Reinstall and tighten cap to secure adjustment. Recheck relief pressure and readjust as needed.

9. Disconnect tester from manifold and hose. Reconnect hydraulic hose that was disconnected for test procedure.

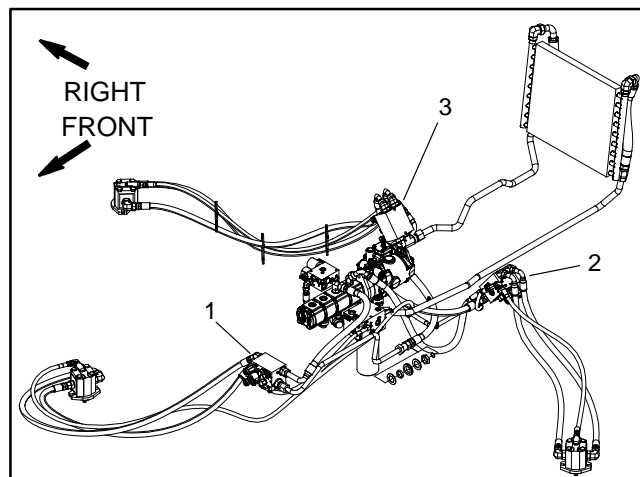


Figure 41

1. Front PTO manifold      3. RH PTO manifold  
2. LH PTO manifold

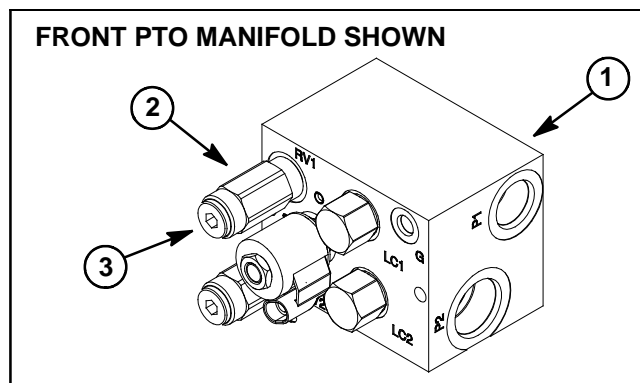


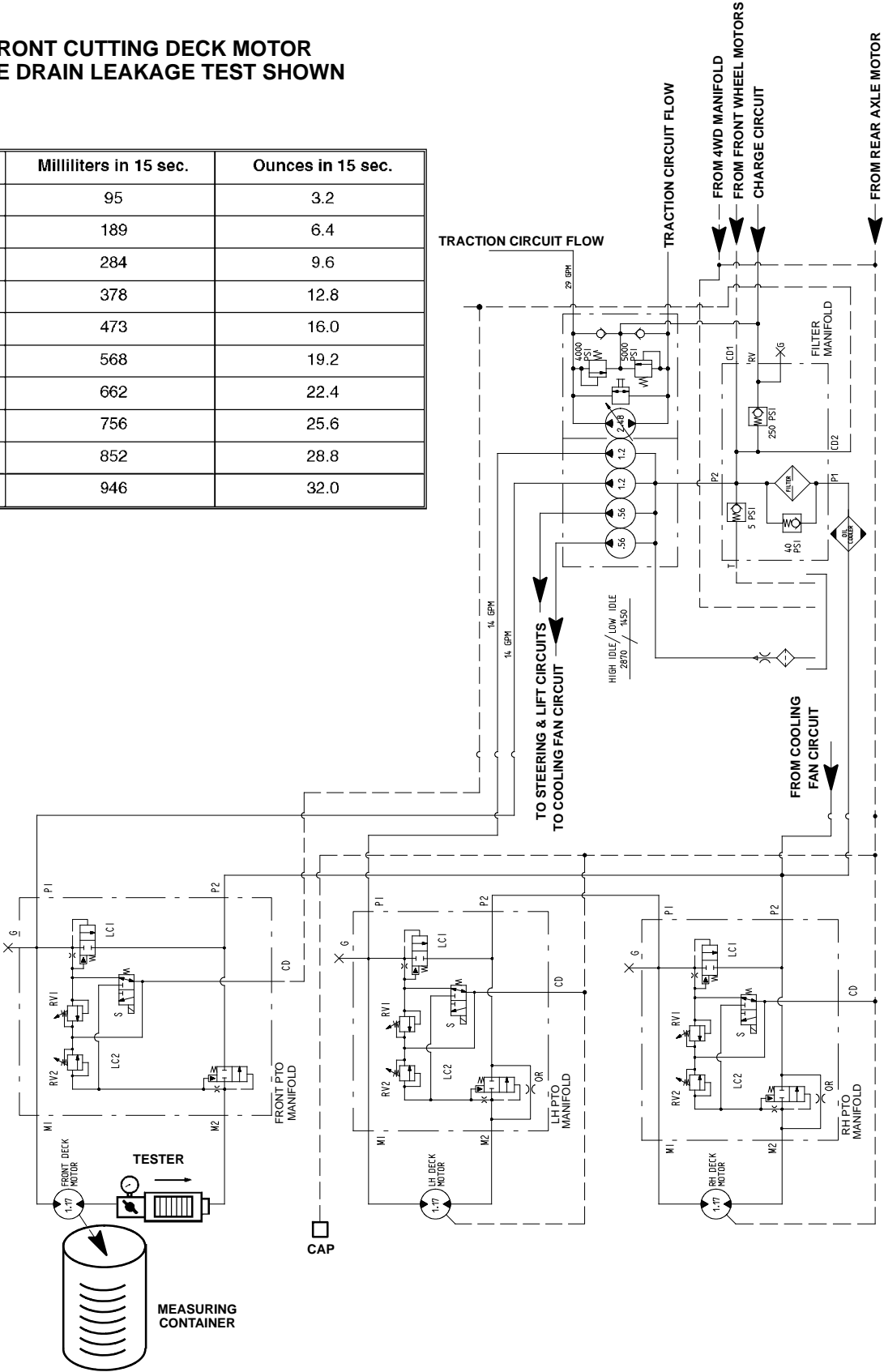
Figure 42

1. PTO manifold      3. Relief valve cap  
2. PTO relief valve (RV1)

# Cutting Deck Motor Case Drain Leakage (Using Tester with Pressure Gauge and Flow Meter)

FRONT CUTTING DECK MOTOR  
CASE DRAIN LEAKAGE TEST SHOWN

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





## Procedure for Cutting Deck Motor Case Drain Leakage Test

**NOTE:** Over a period of time, a deck motor can wear internally. A worn motor may by-pass 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.

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



### CAUTION

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

**NOTE:** The side deck motors are connected in series. To isolate a faulty motor, both motors in the circuit may have to be tested by starting with the left side motor first.

3. Disconnect hose from return of the motor to be tested (Fig. 43). Install tester (flow and pressure) in series with the motor and 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 hydraulic manifold tee-fitting (not at the motor). Put a steel cap on the fitting at the tee-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.

5. Sit on seat and start the engine. Move throttle to high idle speed (**2870 RPM**). Move PTO switch to ON.

6. While watching pressure gauge, 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 (Fig. 44).

7. Have a second person collect the flow from the case drain line for **15 seconds**, then move the PTO switch to OFF and stop the engine (Fig. 44). Record test results.

**TEST RESULTS:** Flow less than **22.4 ounces (662 ml) (0.7 GPM/2.6 LPM)** of hydraulic fluid in 15 seconds.

8. If flow is more than **22.4 ounces (662 ml) (0.7 GPM/2.6 LPM)** in 15 seconds, the motor is worn or damaged and should be repaired or replaced.

9. After testing is completed, disconnect tester from motor and hose. Reconnect hose to the deck motor. Remove cap from tee-fitting and reconnect case drain hose.

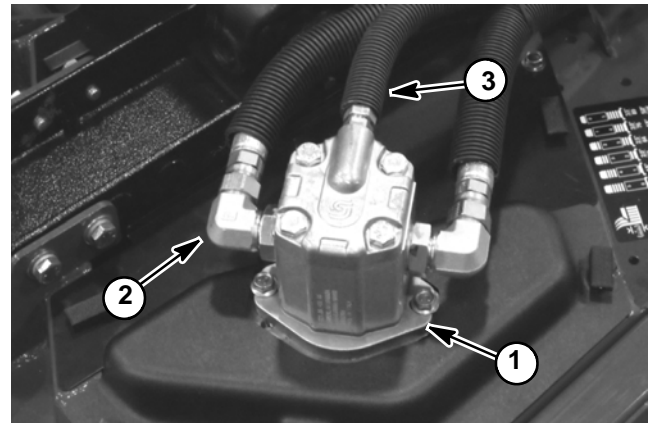


Figure 43

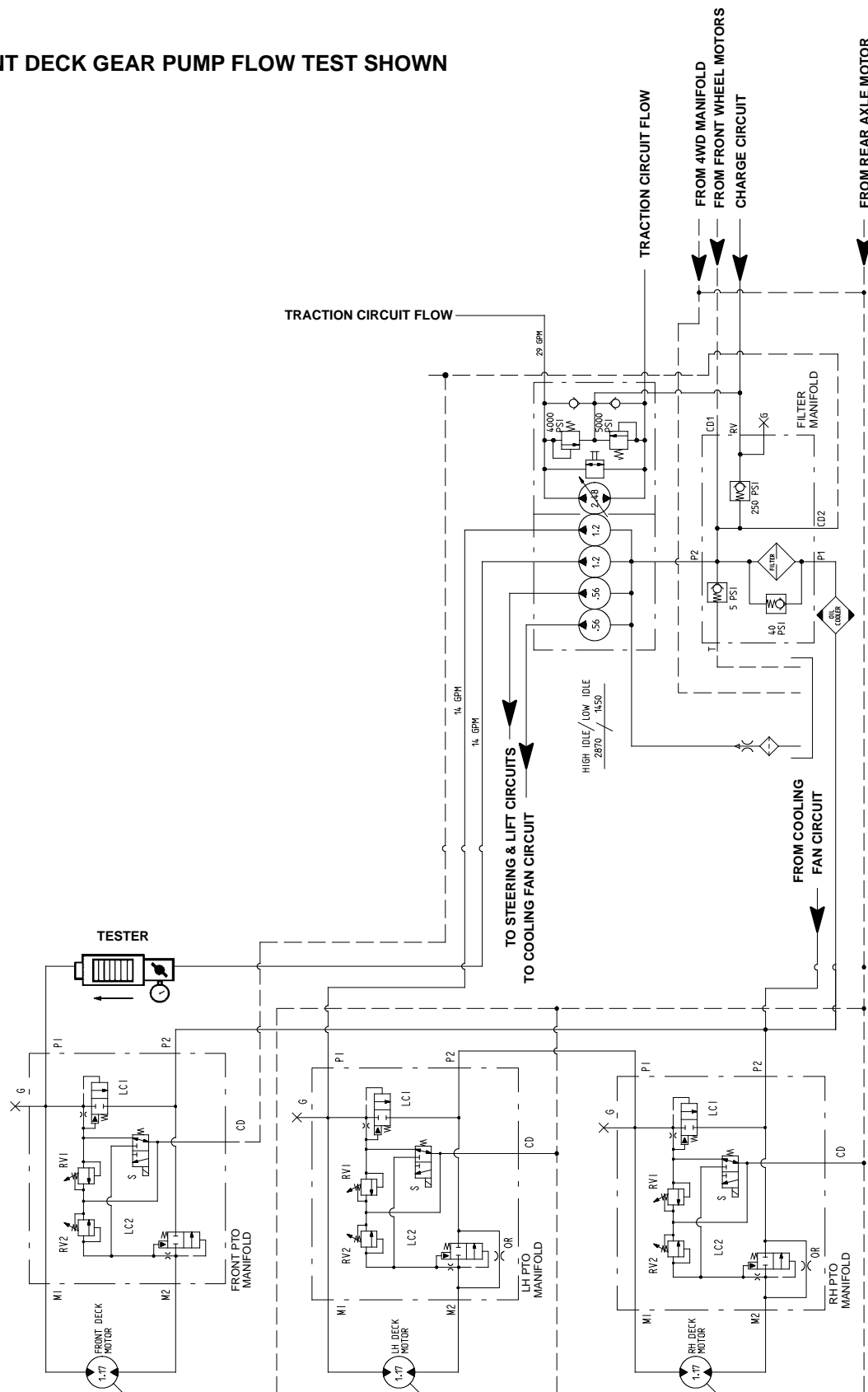
1. Deck motor (RH shown)
2. Return hose
3. Case drain hose



Figure 44

### Cutting Deck Gear Pump Flow (Using Tester with Pressure Gauge and Flow Meter)

## FRONT DECK GEAR PUMP FLOW TEST SHOWN



## Procedure for Cutting Deck Gear Pump Flow Test

**NOTE:** Over a period of time, the gears and wear plates in the pump can wear. A worn pump will by pass oil and make the pump less efficient. Eventually, enough oil loss will occur to cause the cutting deck motors to stall under heavy cutting conditions. Continued operation with a worn, inefficient pump can generate excessive heat and cause damage to the seals and other components in the hydraulic system.

1. Make sure hydraulic oil is at normal operating temperature by operating the machine under load for approximately ten (10) minutes. Make sure the hydraulic tank 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. Locate deck manifold for gear pump section to be tested. Disconnect hydraulic hose from fitting in deck manifold port (P1) (Fig. 45).
4. Install tester (flow and pressure) in series with the disconnected hose and hydraulic fitting in manifold port (P1).
5. Make sure the flow control valve on tester is fully open.
6. Start engine and move throttle to high idle speed (2870 RPM). **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.

7. Watch pressure gauge carefully while slowly closing the flow control valve until **2000 PSI (138 bar)** is obtained. Verify with a phototac that the **engine speed** is still **2870 RPM**.

**NOTE:** If engine speed drops below 2870 RPM, pump flow will decrease.

8. Flow indication should be approximately **14 GPM (53 LPM)**.
9. Shut off engine and record test results.
10. If a pressure of **2000 PSI (138 bar)** cannot be obtained or flow was less than **12 GPM (45 LPM)**, check for restriction in the pump intake line. If line is not restricted, consider that gear pump section for cutting deck circuit is worn or damaged.
11. After testing is completed, disconnect flow tester from hydraulic hose and manifold port. Reconnect hose to the manifold.

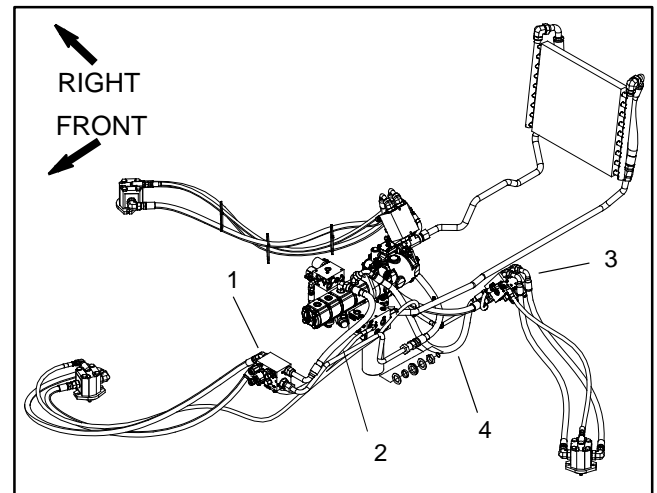
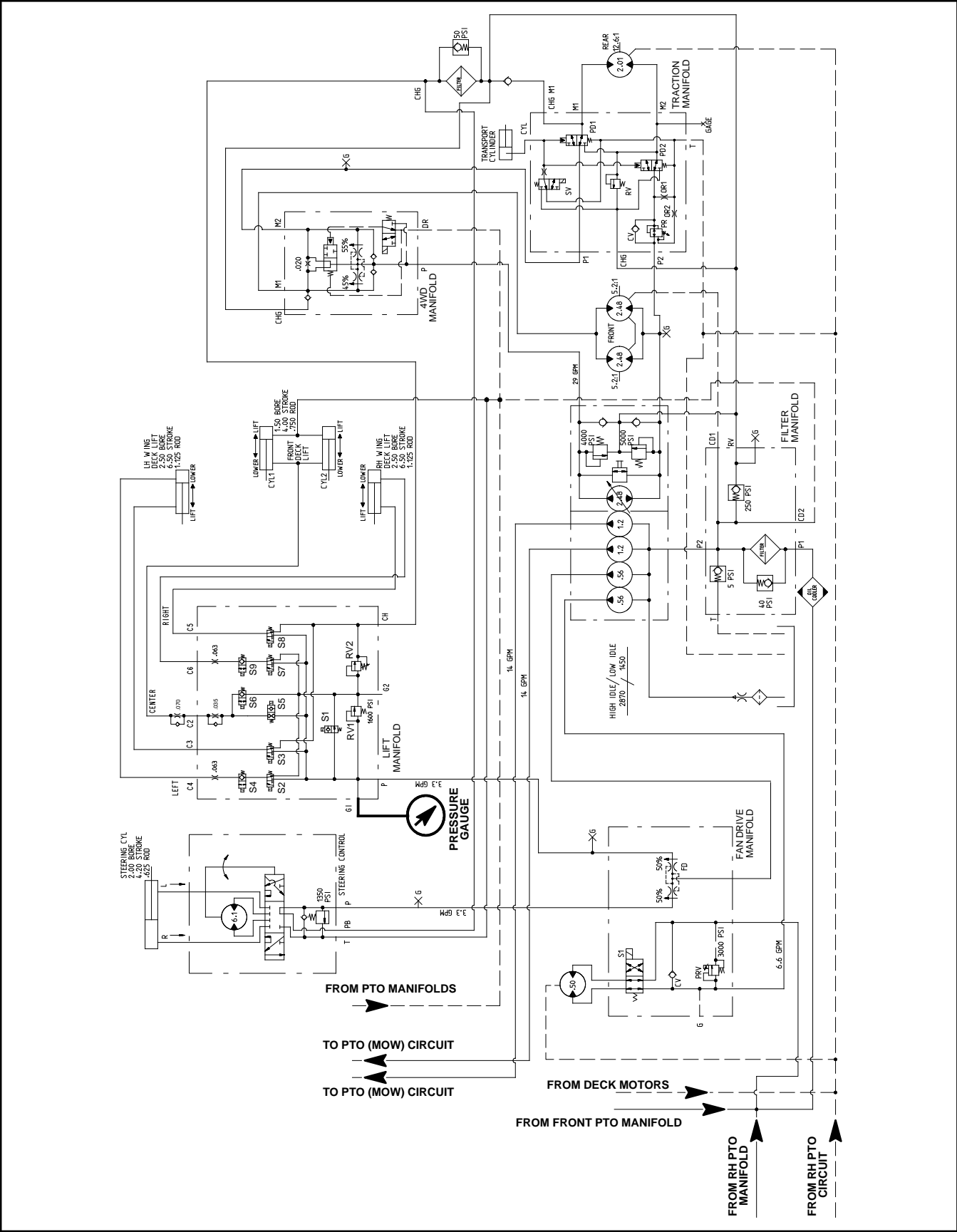


Figure 45

- |                          |                       |
|--------------------------|-----------------------|
| 1. Front PTO manifold    | 3. LH PTO manifold    |
| 2. Hyd. hose to front P1 | 4. Hyd. hose to LH P1 |

Lift/Lower Circuit Relief Pressure (Using Pressure Gauge)



## Procedure for Lift/Lower Circuit Relief Pressure Test

**NOTE:** Before attempting to check or adjust lift/lower circuit relief pressure, make sure that counterbalance pressure is correctly adjusted (see Counterbalance Pressure Test in this section).

1. Make sure hydraulic oil is at normal operating temperature by operating the machine under load for approximately ten (10) minutes. Make sure the hydraulic tank 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. Remove controller cover to gain access to lift/lower manifold (Fig. 46).



### CAUTION

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

4. Connect a 5,000 PSI (345 bar) pressure gauge to test port G1 on lift/lower manifold (Fig. 47).
5. Sit on the seat and start the engine. Move throttle to high idle speed (**2870 RPM**).
6. While sitting on the seat, depress the rear of one of the lift switches to fully raise the cutting deck. Momentarily hold the switch with the deck fully raised while looking at the gauge.

**GAUGE READING TO BE approximately 1600 PSI (110 bar).**

7. Release the lift switch, stop the engine and record test results.
8. Relief valve (RV1) is located on the top side of the lift/lower manifold (Fig. 47). Adjustment of this valve can be performed as follows:

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

A. To **increase** pressure setting, remove cap on relief valve and turn the adjustment socket on the valve in a clockwise direction. A 1/8 turn on the socket will make a measurable change in pressure setting.

B. To **decrease** pressure setting, remove cap on relief valve and turn the adjustment socket on the valve in a counterclockwise direction. A 1/8 turn on the socket will make a measurable change in pressure setting.

C. After relief valve adjustment, recheck pressure setting and readjust as needed.

9. If relief valve adjustment does not change relief pressure, check for restriction in pump intake line, lift cylinder(s) internal leakage or gear pump damage.

10. When testing is completed, disconnect pressure gauge from test port. Install controller cover.

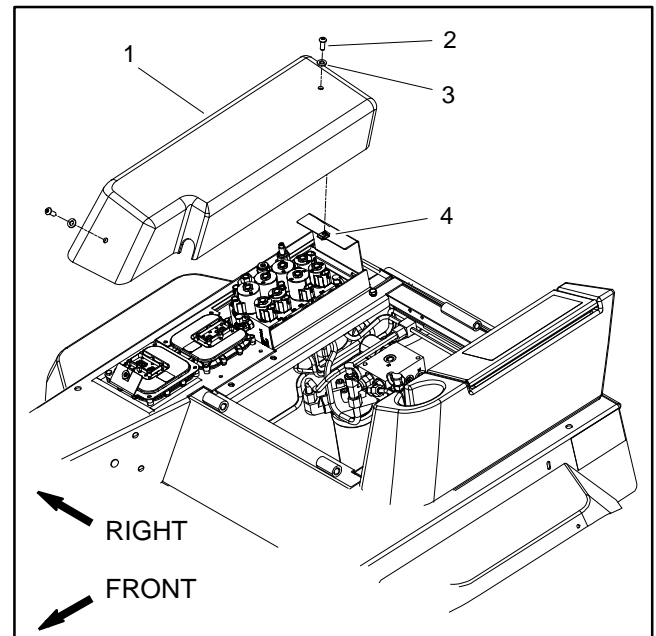


Figure 46

- |                     |                         |
|---------------------|-------------------------|
| 1. Controller cover | 3. Flat washer (2 used) |
| 2. Screw (2 used)   | 4. U-nut (2 used)       |

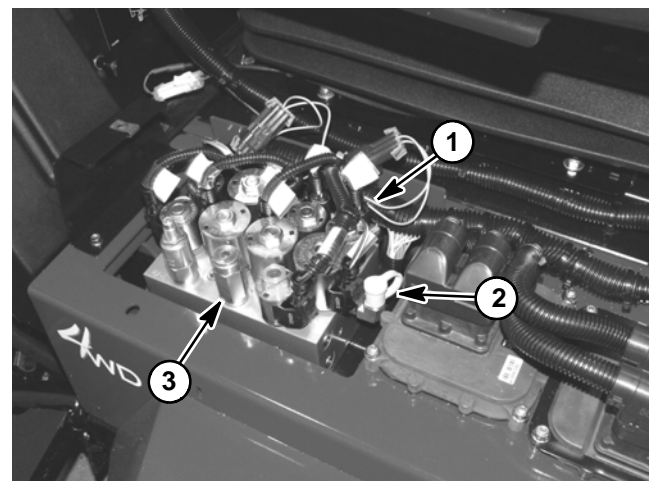
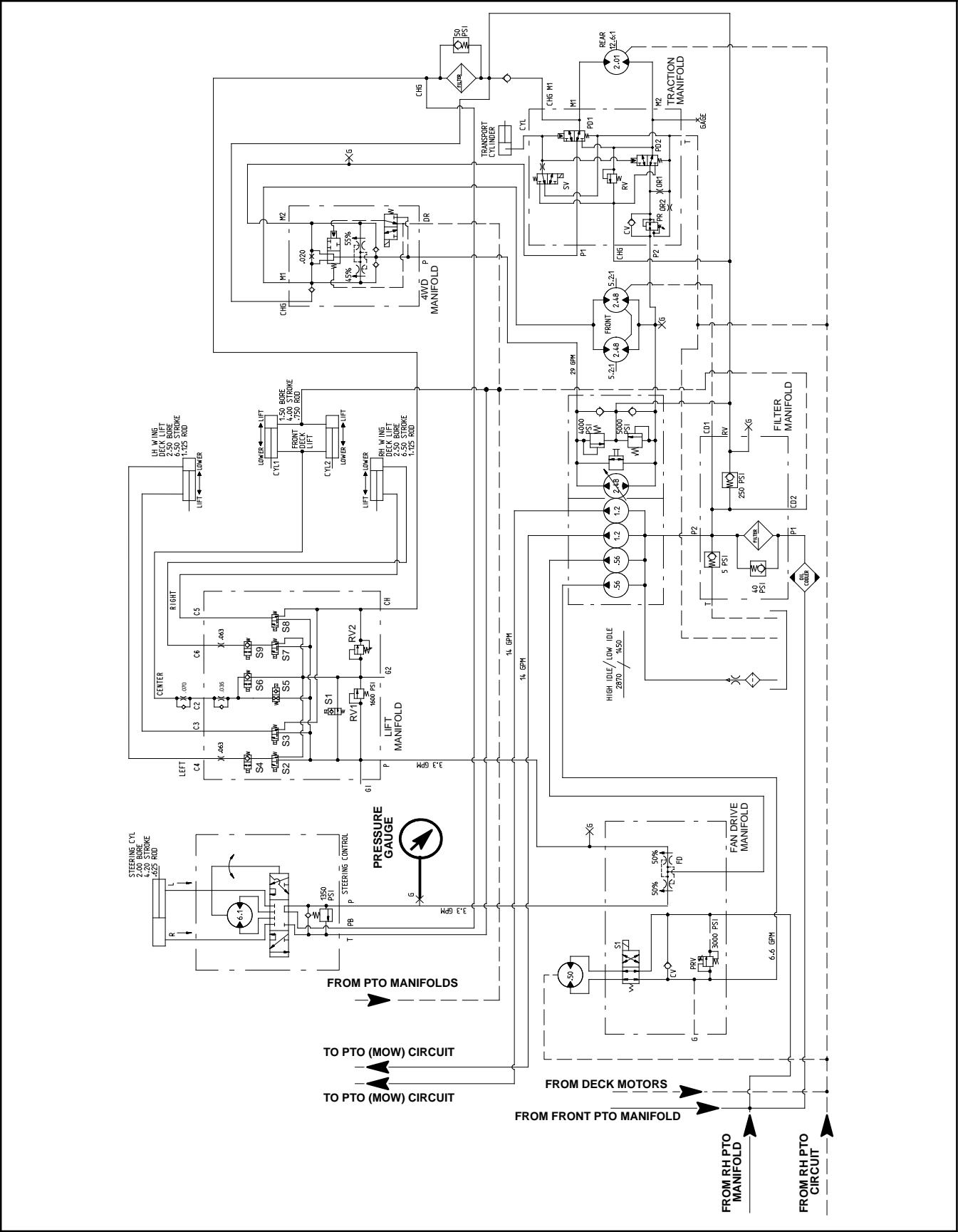


Figure 47

- |                        |                     |
|------------------------|---------------------|
| 1. Lift/lower manifold | 3. Relief valve RV1 |
| 2. Test port G1        |                     |

Steering Circuit Relief Pressure (Using Pressure Gauge)



## Procedure for Steering Circuit Relief Pressure Test

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



### CAUTION

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

3. Locate steering circuit pressure test port and connect a 5000 PSI (350 bar) pressure gauge onto test port.

A. On Groundsmaster 4000-D machines, the test port is located on the steering supply hydraulic tube under the front of the machine (Fig. 48).

B. On Groundsmaster 4010-D machines, the test port is located on the steering supply hydraulic tube under the operator seat (Fig. 49).

4. Start the engine and move throttle to high idle engine speed (**2870 RPM**).

**IMPORTANT: Hold steering wheel at full lock only long enough to get a system relief pressure reading. Holding the steering wheel against the stop for an extended period can damage the steering control valve.**

5. Turn steering all the way in one direction and momentarily hold the steering wheel against resistance.

**GAUGE READING TO BE 1300 to 1400 PSI (90 to 96 bar).**

6. Stop the engine and record test results.

7. If pressure is incorrect, inspect steering relief valve in steering control valve (see Steering Control Valve in the Service and Repairs section of this chapter). If relief valve is operating properly and if lift/lower problems also exist, flow divider in fan manifold and/or gear pump (third section) should be suspected of wear and inefficiency. If steering wheel continues to turn at end of cylinder travel (with lower than normal effort), steering cylinder or steering control valve should be suspected of wear or damage.

8. When testing is completed, disconnect pressure gauge from test port.

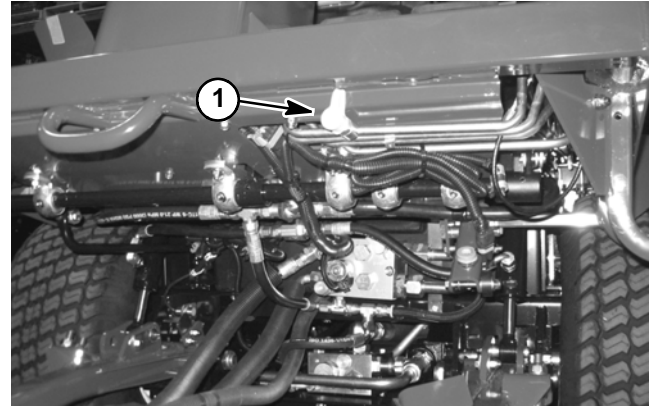


Figure 48

1. Steering circuit pressure test port (GM4000-D)

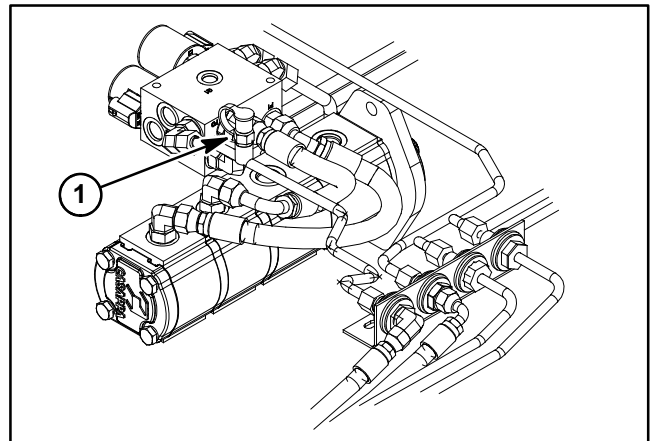
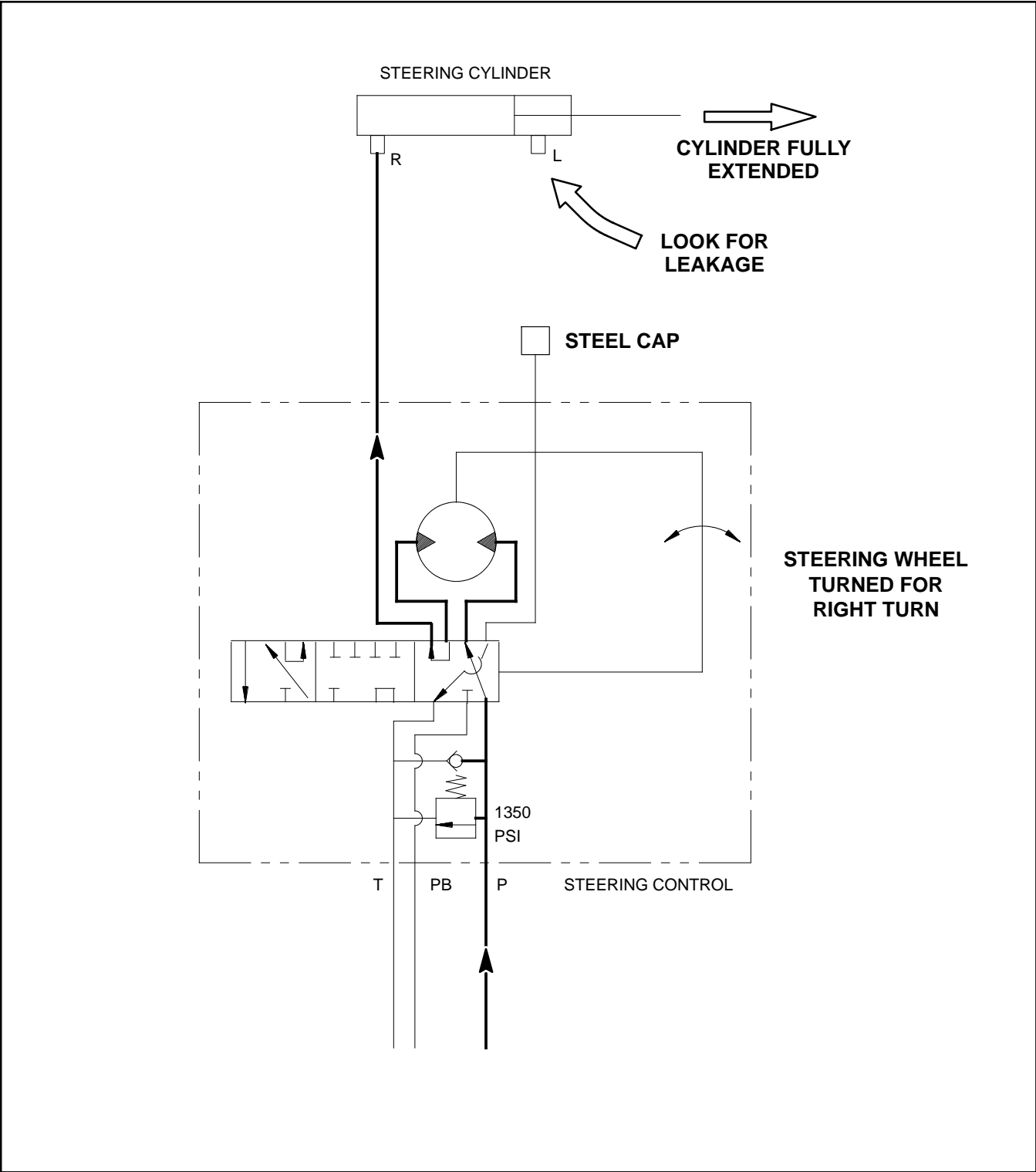


Figure 49

1. Steering circuit pressure test port (GM4010-D)

Steering Cylinder Internal Leakage





## 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. Make sure hydraulic oil is at normal operating temperature by operating the machine under load for approximately ten (10) minutes. Make sure the hydraulic tank 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.



### CAUTION

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

3. Turn the steering wheel for a right turn so that the steering cylinder rod is fully extended.
4. Thoroughly clean the area around the hydraulic hose at the rod end of the steering cylinder.

5. 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.

6. Remove all hydraulic oil from drain pan. Make sure that empty drain pan remains under the open fitting of the steering cylinder.

7. 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.

8. After testing is completed, remove plug from the hydraulic hose. Connect hose to the steering cylinder fitting.

9. 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).

10. Check oil level in hydraulic reservoir and adjust if needed.

This hydraulic schematic diagram illustrates the power distribution for a John Deere 4WD tractor. The system is divided into several main sections:

- Steering and Lift Section:** Includes a steering cylinder (2.00 stroke, 4.20 stroke, 4.25 RD) and a lift manifold (1.50 stroke, 1.75 RD). The lift manifold is controlled by a 4WD P manifold and a lift valve (LIFT) with a 1.25 RD stroke.
- PTO and Deck Section:** Features a PTO manifold (1.50 stroke, 1.75 RD) and a deck manifold (1.50 stroke, 1.75 RD). The deck manifold is controlled by a 4WD P manifold and a deck valve (DECK) with a 1.25 RD stroke.
- Front and Rear PTO Section:** Includes a front PTO manifold (1.25 stroke, 1.25 RD) and a rear PTO manifold (1.25 stroke, 1.25 RD). The front PTO manifold is controlled by a 4WD P manifold and a front valve (FRONT) with a 1.25 RD stroke. The rear PTO manifold is controlled by a 4WD P manifold and a rear valve (REAR) with a 1.25 RD stroke.
- Filter and Pressure Section:** Includes a filter manifold (1.25 stroke, 1.25 RD) and a pressure section with a 1.25 stroke, 1.25 RD valve.
- Tester and Fan Drive Section:** Includes a tester (1.25 stroke, 1.25 RD) and a fan drive manifold (1.25 stroke, 1.25 RD).

The diagram shows the flow of hydraulic fluid from the PTO and deck manifolds through various valves and filters to the front and rear PTO circuits and the lift manifold. Key components include the 4WD P manifold, the lift valve, the deck valve, the front valve, the rear valve, the filter manifold, the tester, and the fan drive manifold. The flow is controlled by a series of valves and filters, ensuring proper operation of the tractor's hydraulic system.

## Procedure for Steering and Lift/Lower Gear Pump Flow Test

**NOTE:** Output from the steering and lift/lower gear pump section is equally divided by a proportional valve to provide flow to the steering circuit and the lift circuit. The proportional valve is in the fan drive manifold.

**NOTE:** While rotating the steering wheel and raising the decks at the same time with the engine running at high idle speed (2870 RPM), an indication of gear pump damage may be the steering wheel getting hard to turn and/or the cutting decks raising very slowly.

1. Make sure hydraulic oil is at normal operating temperature by operating the machine under load for approximately ten (10) minutes. Make sure the hydraulic tank 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. Raise and support seat to gain access to the gear pump.



## CAUTION

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

3. With the engine off and cutting decks lowered, disconnect the hydraulic hose from the 90° fitting in the third gear pump section which supplies the steering and lift/lower circuits (Fig. 50).

**IMPORTANT:** Make sure that the oil flow indicator arrow on the flow gauge is showing that the oil will flow from the pump section, through the tester and into the hydraulic hose.

4. Install tester (flow and pressure) in series between the fitting and the disconnected hose. Make sure the flow control valve on tester is fully open.

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

5. Start the engine and move throttle to high idle speed (**2870 RPM**). DO NOT engage the cutting decks.

6. While watching pressure gauge on tester, slowly close flow control valve until **1000 PSI (69 bar)** is obtained on gauge. Verify that engine speed continues to be **2870 RPM**.

**GAUGE READING TO BE:** Flow approximately **7 GPM (26 LPM)** at **1000 PSI (69 bar)**.

**NOTE:** If engine speed drops below 2870 RPM, pump flow will decrease.

7. Open flow tester control valve, stop engine and record test results.

8. If a pressure of **1000 PSI (69 bar)** could not be obtained or flow is lower than **6 GPM (23 LPM)**, check for restriction in pump intake line. If intake line is not restricted, consider that gear pump section for steering and lift/lower circuits is worn or damaged.

9. When testing is complete, remove tester and reconnect hose to pump fitting.

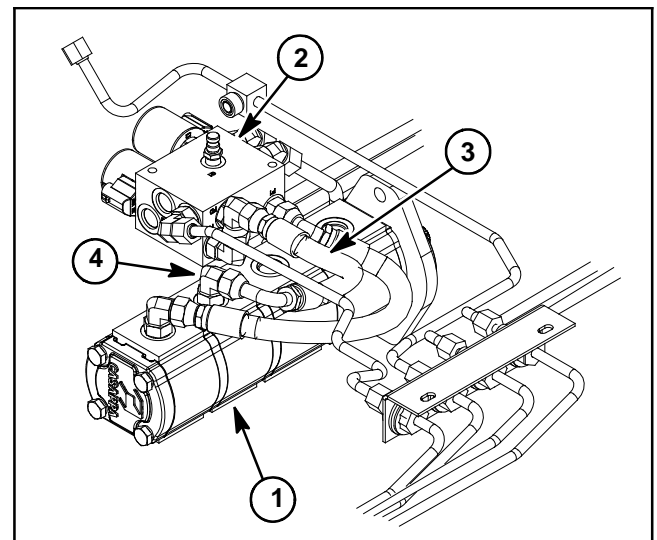
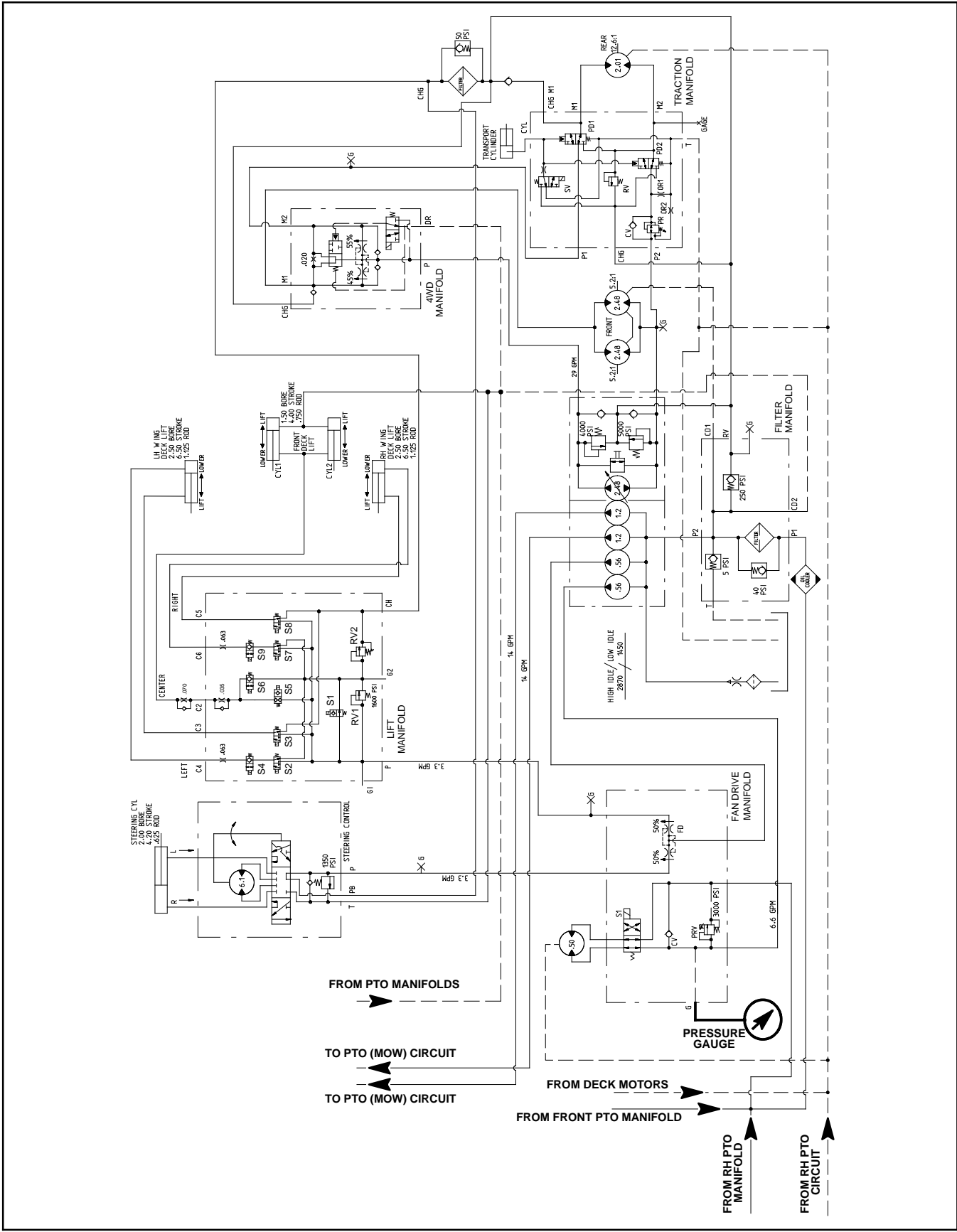


Figure 50

- |                       |                              |
|-----------------------|------------------------------|
| 1. Gear pump          | 3. Steering/lift supply hose |
| 2. Fan drive manifold | 4. 90° fitting               |

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



## Procedure for Engine Cooling Fan Circuit Test

1. Make sure hydraulic oil is at normal operating temperature by operating the machine under load for approximately ten (10) minutes. Make sure the hydraulic tank 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. Raise and support hood.



### CAUTION

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

3. Raise seat to gain access to the fan drive manifold (Fig. 51). Connect a 5,000 PSI (345 bar) pressure gauge with hydraulic hose attached to test port on top of manifold.
4. Start the engine. Move throttle to high idle speed (**2870 RPM**).
5. While monitoring the pressure gauge and using a phototac to identify the cooling fan speed, disconnect the wire harness connector (white/green and black wires) from the PRV solenoid on fan drive manifold (Fig. 52). 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 READING TO BE: fan speed should be at least **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 fan motor is worn or damaged. If pressure and fan speed are both low, consider that the gear pump is worn or damaged (see Engine Cooling Fan Circuit Gear Pump Flow Test in this section).
- NOTE:** If pressure and fan speed are both low and gear pump flow proves to be correct, suspect that seals in fan drive manifold are leaking or faulty (see Fan Drive Manifold Service in the Service and Repairs section of this chapter).
8. When testing is complete, remove pressure gauge and reconnect wire harness to PRV solenoid. Lower and secure hood and operator seat.

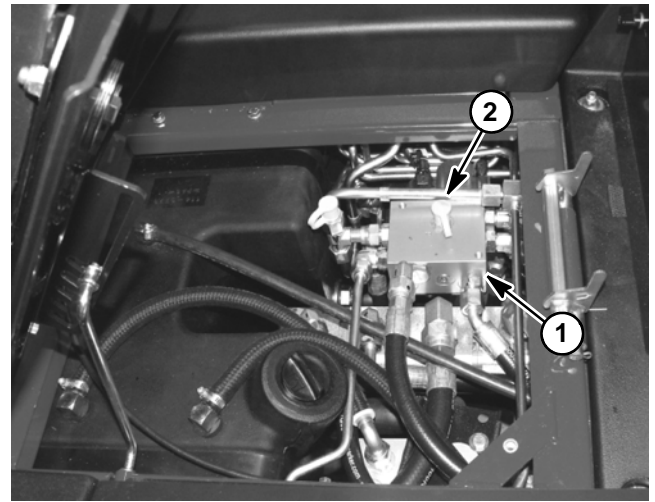


Figure 51

1. Fan drive manifold
2. Test port G1

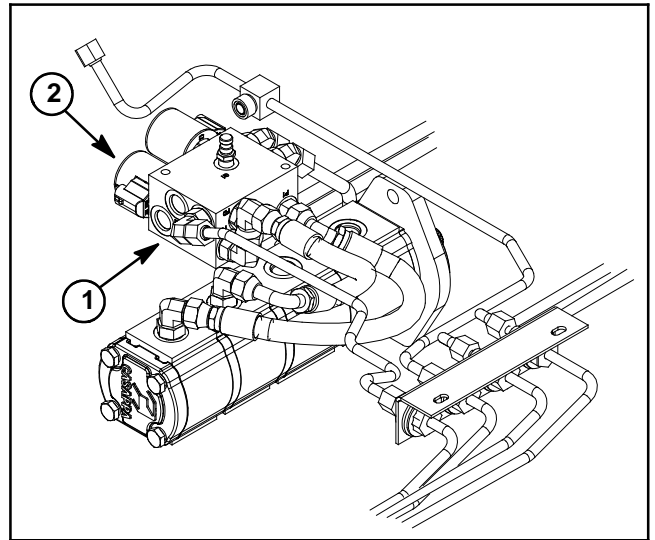


Figure 52

1. Fan drive manifold
2. PRV solenoid



## Procedure for Engine Cooling Fan Circuit Gear Pump Flow Test

1. Make sure hydraulic oil is at normal operating temperature by operating the machine under load for approximately ten (10) minutes. Make sure the hydraulic tank 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. Raise and support seat to gain access to the gear pump.



3. With the engine off and cutting decks lowered, disconnect the hydraulic hose from the 90° fitting in the last gear pump section which supplies the engine cooling fan circuit (Fig. 54).

**IMPORTANT:** Make sure that the oil flow indicator arrow on the flow gauge is showing that the oil will flow from the pump section, through the tester and into the hydraulic hose.

4. Install tester (flow and pressure) in series between the fitting and the disconnected hose. Make sure the flow control valve on tester is fully open.

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

5. Start the engine and move throttle to high idle speed (2870 RPM). DO NOT engage the cutting decks.

6. While watching tester pressure gauges, slowly close tester flow control valve until **1000 PSI (69 bar)** is obtained on gauge. Verify engine speed continues to be **2870 RPM**.

**GAUGE READING TO BE:** Flow approximately **7 GPM (26 LPM)** at **1000 PSI (69 bar)**.

**NOTE:** If engine speed drops below 2870 RPM, pump flow will decrease.

7. Open tester flow control valve, stop engine and record test results.

8. If a pressure of **1000 PSI (69 bar)** could not be obtained or flow is lower than **6 GPM (23 LPM)**, check for restriction in pump intake line. If intake line is not restricted, consider that gear pump section for engine cooling fan circuit is worn or damaged.

9. When testing is complete, remove tester and reconnect hose to pump fitting.

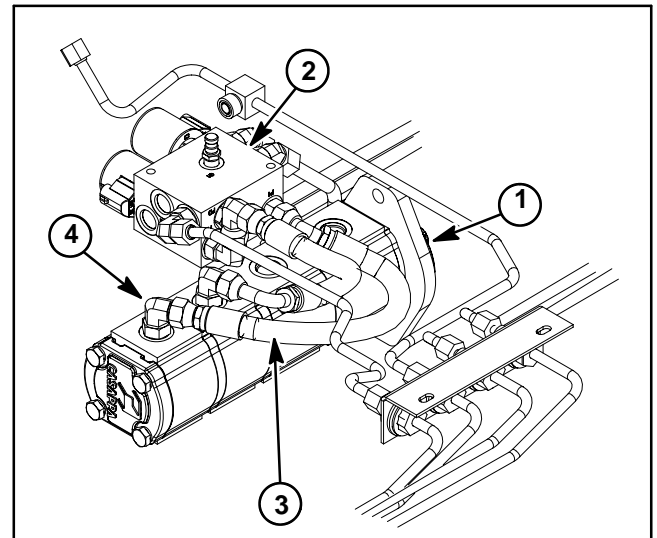


Figure 54

- |                       |                        |
|-----------------------|------------------------|
| 1. Gear pump          | 3. Engine cooling hose |
| 2. Fan drive manifold | 4. 90° fitting         |

# Adjustments

## Traction Linkage Adjustment

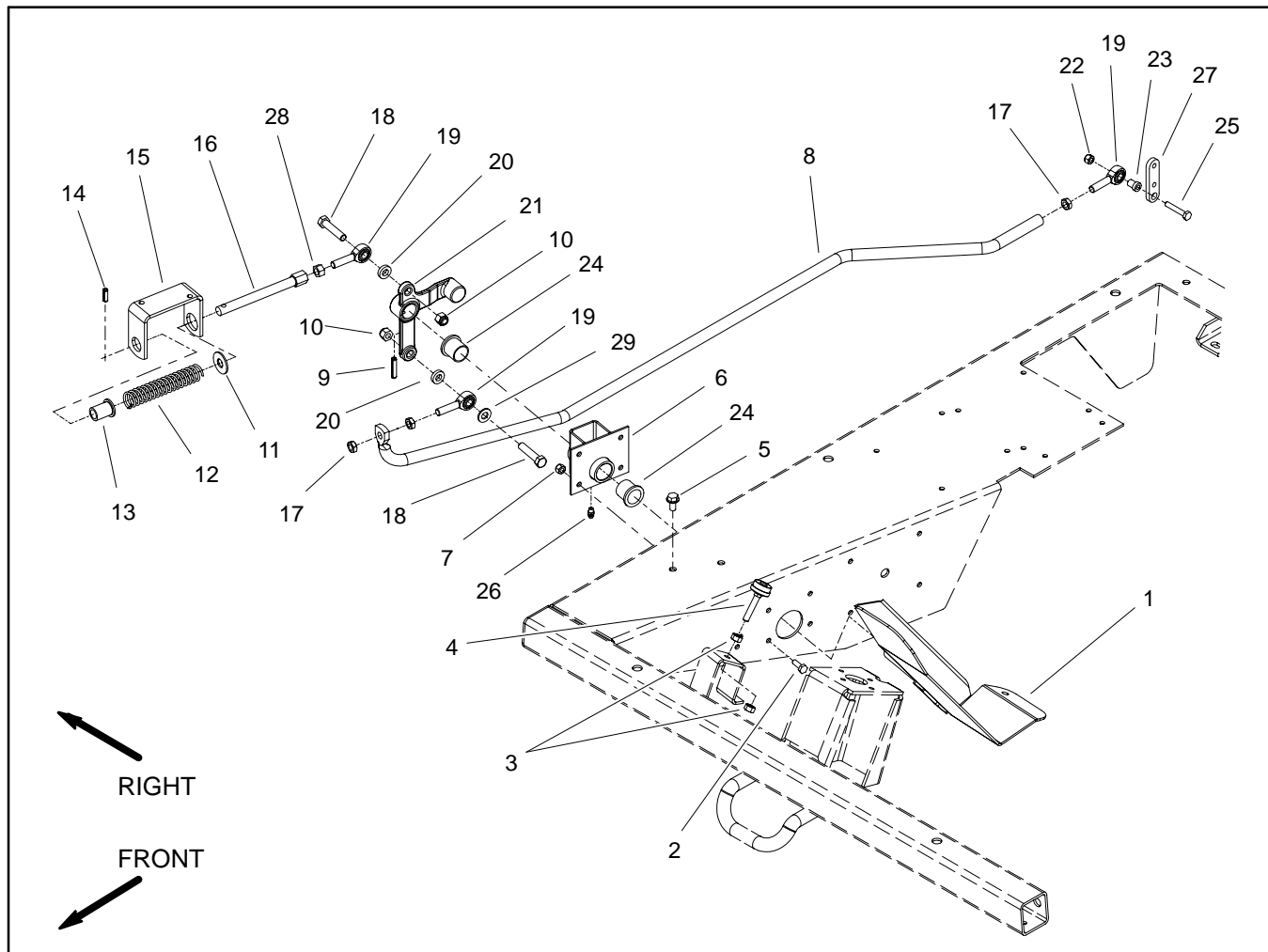


Figure 55

- |                               |                        |                               |
|-------------------------------|------------------------|-------------------------------|
| 1. Traction pedal             | 11. Flat washer        | 21. Traction lever            |
| 2. Cap screw (4 used)         | 12. Compression spring | 22. Lock nut                  |
| 3. Hex nut                    | 13. Spring retainer    | 23. Spacer                    |
| 4. Pedal stop                 | 14. Roll pin           | 24. Flange bushing            |
| 5. Washer head screw (2 used) | 15. Spring bracket     | 25. Cap screw                 |
| 6. Pedal bracket              | 16. Spring shaft       | 26. Grease fitting            |
| 7. Lock nut (4 used)          | 17. Jam nut            | 27. Traction pump control arm |
| 8. Traction rod               | 18. Cap screw          | 28. Hex nut                   |
| 9. Slotted roll pin           | 19. Rod end            | 29. Flat washer               |
| 10. Lock nut                  | 20. Spacer             |                               |

Adjustment of the traction linkage should be checked whenever traction drive components are replaced or removed.

### Assembly Adjustments

1. Traction pedal stop should be 1.500" (38 mm) above platform bracket (item 1 in Fig. 56). If necessary, loosen jam nuts and adjust stop location. Make sure that both jam nuts are tightened to secure adjustment.

2. On traction pump end of traction rod, rod end should be installed so that distance from end of traction rod to center of rod end is 1.140" (29 mm) (item 3 in Fig. 56). Tighten jam nut to secure rod end to traction rod.

3. On traction lever end of traction rod (item 4 in Fig. 56), jam nuts should position traction rod so traction pedal remains in the neutral detent position and is at an approximate 56° angle. Use a magnetic protractor to check pedal angle.



4. With ignition switch in the ON position (engine not running), use Diagnostic Display to make sure that neutral switch is closed when traction pedal is released to the neutral detent position (see Diagnostic Display in the Troubleshooting section of Chapter 5 – Electrical System).

### Adjustments with Engine Running



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

2. Start engine and make sure that Hi/Low switch is in the Low (4WD) position. Depress traction pedal to allow oil flow through the traction circuit. Allow all wheels to rotate to warm up the hydraulic oil.

3. The traction pedal should contact the pedal stop when fully depressed. At this point, the piston pump should be at full stroke.

4. When traction pedal is released from either forward or reverse, pedal should return to the neutral position and wheels should stop rotating. If necessary, adjust spring shaft (item 5 in Fig. 56) until neutral operation is correct.

5. With the engine running, the transport cylinder on engine should extend when Hi/Low speed switch is moved to the Hi speed (2WD) position. This cylinder extension prevents the piston (traction) pump swash plate from reaching full stroke when in Hi speed (2WD). Also, the traction pedal should not contact the pedal stop when fully depressed in Hi speed (2WD).

6. Adjust the transport cylinder as follows (Fig. 57):

A. Place Hi/Low speed switch in the Hi speed (2WD) position.

B. Lock one front wheel by applying the wheel brake.

C. Use a phototac to measure the other front wheel speed. When the traction pedal is fully depressed to forward, the wheel speed should be from 370 to 422 RPM.

D. If wheel speed is incorrect, adjust cap screw in transport cylinder to provide correct wheel speed. Make sure that jam nut is tightened after any adjustment.

7. Shut engine off.

8. After adjustments have been made and all fasteners are tightened, make sure that traction rod does not contact anything through both forward and reverse directions.

9. Lower machine to ground.

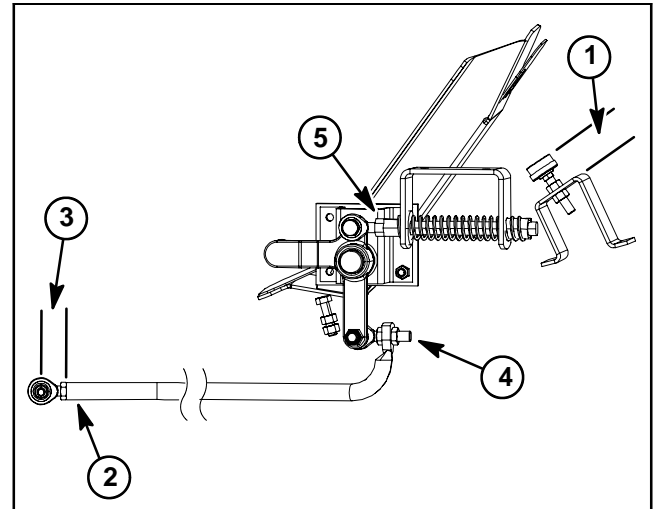


Figure 56

- |                      |                       |
|----------------------|-----------------------|
| 1. Pedal stop height | 4. Traction lever end |
| 2. Traction pump end | 5. Neutral adjustment |
| 3. Rod end dimension |                       |

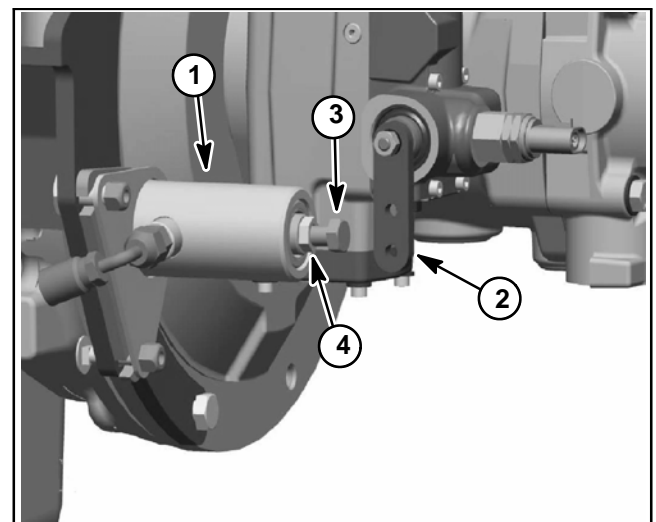


Figure 57

- |                       |              |
|-----------------------|--------------|
| 1. Transport cylinder | 3. Cap screw |
| 2. Pump control arm   | 4. Jam nut   |

# Service and Repairs

## General Precautions for Removing and Installing Hydraulic System Components

### Before Repair or Replacement of Components

1. Before removing any parts from the hydraulic system, park machine on a level surface, apply parking brake, lower cutting decks or attachments and stop engine. Remove key from the ignition switch.
2. Clean machine before disconnecting, removing or disassembling any hydraulic components. Make sure hydraulic components, hoses 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 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 filter if component failure was severe or system is contaminated (see Flush Hydraulic System in this section).
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 Hose and Tube Installation and Hydraulic Fitting Installation in the General Information section of this chapter).
5. After repairs, check control linkages or cables for proper adjustment, binding or broken parts.
6. After disconnecting or replacing any hydraulic components, operate machine functions slowly until air is out of system (see Charge Hydraulic System in this section).
7. Check for hydraulic oil leaks. Shut off engine and correct leaks if necessary. Check oil level in hydraulic reservoir and add correct oil if necessary.

## Check Hydraulic Lines and Hoses



### WARNING

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

**IMPORTANT: Check hydraulic lines and hoses daily for leaks, kinked lines, loose mounting supports, wear, loose fittings or any hose deterioration. Make all necessary repairs before operating.**

## Flush Hydraulic System

**IMPORTANT:** Flush the hydraulic system any time there is a severe component failure or the system is contaminated. Contaminated oil may appear milky or black or may contain metal particles.

**IMPORTANT:** If a component failure occurred in the closed loop traction circuit (e.g. piston pump or wheel motor), filtering the traction circuit is recommended. See **Filtering Closed-Loop Traction Circuit** in this section.

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



### WARNING

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

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

2. Drain hydraulic reservoir. Remove suction screen from reservoir and clean thoroughly. Consider removing and cleaning reservoir if necessary.

3. Drain hydraulic system. Drain all hoses, tubes and components while the system is warm.

4. Change and replace both hydraulic oil filters.

5. Inspect and clean hydraulic reservoir (see Hydraulic Reservoir Inspection in this section).

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

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

7. Fill hydraulic reservoir with **new** hydraulic fluid.

8. Disconnect electrical connector from engine run solenoid.

9. Turn ignition key switch and engage starter for ten (10) seconds to prime hydraulic pumps. Wait fifteen (15) seconds to allow the starter motor to cool and then repeat cranking procedure again.

10. Connect electrical connector to engine run solenoid.

11. Start engine and let it idle at low speed (**1450 RPM**) for a minimum of two (2) minutes. Increase engine speed to high idle (**2870 RPM**) for minimum of one (1) minute under no load.

12. Raise and lower cutting decks several times. Turn steering wheel fully left and right several times.

13. Shut off engine and check for hydraulic oil leaks. Check oil level in hydraulic reservoir and add correct amount of oil if necessary.

14. Operate machine for two (2) hours under normal operating conditions.

15. Check condition of hydraulic oil. If the new fluid shows any signs of contamination, repeat steps 1 through 14 again until oil is clean.

16. Assume normal operation and follow recommended maintenance intervals.

## Filtering Closed-Loop Traction Circuit

Filtering of a closed-loop hydraulic system after a major component failure (e.g. traction (piston) pump or front wheel motor) is a requirement to prevent debris from transmitting throughout the system. If a closed-loop hydraulic system filtering tool is not used to ensure system cleanliness, repeat failures, as well as subsequent damage to other hydraulic components in the affected system, will occur. To effectively remove contamination from closed-loop traction circuit, use of the Toro high flow hydraulic filter and hydraulic hose kits are recommended (see Special Tools 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 elbow fitting on bottom of traction pump (Fig. 58). Disconnect hose from left side pump fitting.

4. Connect Toro high flow hydraulic filter in series between traction 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 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 indicator on the high flow hydraulic filter. If the indicator should show red, either reduce pressure on the traction pedal or reduce engine speed to decrease hydraulic flow through the filter.

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 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.

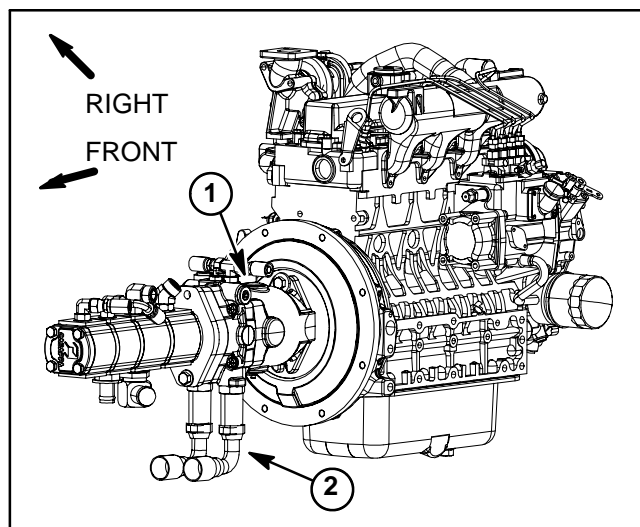


Figure 58

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

## Charge Hydraulic System

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

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

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

2. Make sure all hydraulic connections, lines and components are secured tightly.

3. If component failure was severe or the system is contaminated, flush and refill hydraulic system and tank (see Flush Hydraulic System in this section).

4. Make sure hydraulic reservoir is full. Add correct hydraulic oil if necessary.

5. Check control rod to the piston (traction) pump for proper adjustment, binding or broken parts.

6. Disconnect wire harness electrical connector from the engine run solenoid to prevent the engine from starting.

7. Make sure traction pedal and lift control lever are in the **neutral** position. Turn ignition key switch and engage starter for ten (10) seconds to prime the traction and gear pumps. Wait fifteen (15) seconds to allow the starter motor to cool and then repeat cranking procedure again.

8. Reconnect wire harness electrical connector to engine run solenoid.



### WARNING

**Before jacking up the machine, review and follow Jacking Instructions in Chapter 1 - Safety.**

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

10. Make sure traction pedal and lift control lever are in **neutral**. Start engine and run it at low idle (**1450 rpm**). The charge pump should pick up oil and fill the hydraulic system. If there is no indication of fill in thirty (30) seconds, stop the engine and determine the cause.

11. After the hydraulic system starts to show signs of fill, actuate a lift switch until the lift cylinder rod moves in and out several times. If the cylinder rod does not move after **10 to 15 seconds**, or the pump emits abnormal sounds, shut the engine off immediately and determine cause or problem. Inspect for the following:

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

12. If cylinder does move in **10 to 15 seconds**, proceed to step 13.

13. 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 check for proper hose connections at traction pump and motors. Correct as needed.
- B. If the wheels rotate in the proper direction, stop engine.

14. Adjust traction pedal to the neutral position.

15. Check operation of the traction interlock switch (see Check Interlock System in Chapter 5 - Electrical System).

16. Remove blocks from frame and lower machine. Remove chocks from remaining wheels.

17. 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.

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

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

## Hydraulic Reservoir

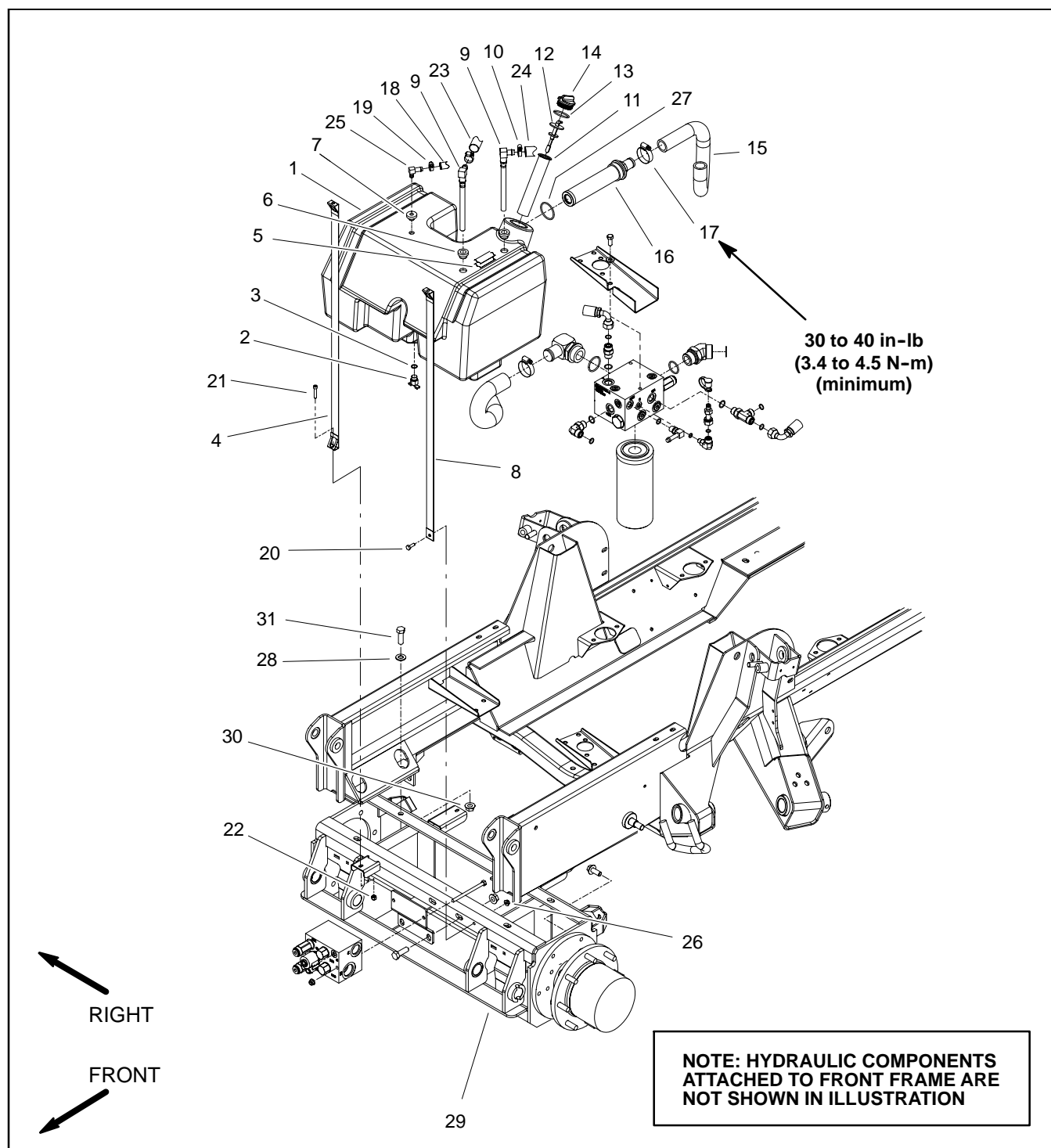


Figure 59

1. Hydraulic reservoir
2. Petcock
3. O-ring
4. Strap
5. Felt strap (2 used)
6. Bushing (2 used)
7. Bushing
8. Strap
9. Stand pipe (2 used)
10. Hose clamp (2 used)
11. Screen filter

12. Dipstick
13. O-ring
14. Reservoir cap
15. Suction hose
16. Tank strainer
17. Hose clamp
18. Hose
19. Hose clamp
20. Cap screw
21. Socket head screw (3 used)

22. Lock nut (3 used)
23. Hose
24. Hose
25. Elbow fitting
26. Flange nut
27. O-ring
28. Flat washer (6 used)
29. Front frame
30. Flange nut (6 used)
31. Cap screw (6 used)

**NOTE:** The front frame needs to be lowered from the main frame to allow clearance to remove the hydraulic reservoir from the machine.

### Removal (Fig. 59)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.
2. Remove front cutting deck (see Front Cutting Deck Removal in the Service and Repairs section of Chapter 8 – Cutting Decks).
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. Drain reservoir into a suitable container.
5. Disconnect hydraulic hoses from reservoir. Label disconnected hydraulic lines for proper installation.
6. Remove straps (items 4 and 8) that secure reservoir to front frame. Remove felt straps (item 5) from between straps and reservoir.
7. To allow front frame to be lowered for reservoir removal, remove hydraulic tubes that connect hydraulic components on front frame (wheel motors, front deck PTO manifold and traction manifold) to components on main frame. Put caps or plugs on open hydraulic lines and fittings.
8. Chock rear wheels to prevent the machine from moving. Use jack or hoist to raise front of machine and support machine with jackstands.
9. Support front frame to prevent it from moving.
10. Remove cap screws (item 31), flat washers (item 28) and flange nuts (item 30) that secure front frame to main frame.
11. Carefully lower front frame assembly to allow clearance for reservoir removal. Once lowered, support front frame to prevent it from shifting.
12. Carefully remove hydraulic reservoir from machine.

### Inspection

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

### Installation (Fig. 59)

1. Using a wrench, turn tank strainer into port at least 1-1/2 to 2 full turns beyond finger tight.
2. Position reservoir to machine.
3. Carefully raise front frame assembly to main frame. Align frame mounting holes and support front frame to prevent it from moving.
4. Secure front frame to main frame with cap screws (item 31), flat washers (item 28) and flange nuts (item 30). Tighten two (2) fasteners at rear of frame before tightening top four (4) fasteners.
5. Lower machine to ground.
6. Position felt straps (item 5) between straps and reservoir. Secure reservoir to front frame with straps (items 4 and 8).
7. Remove caps and plugs from hydraulic lines and fittings that were placed during the removal process. Using labels placed during reservoir removal, connect hydraulic hoses and tubes to fittings on reservoir, wheel motors and hydraulic manifolds (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).
8. Install front cutting deck (see Front Cutting Deck Installation in the Service and Repairs section of Chapter 8 – Cutting Decks).
9. Fill reservoir with new hydraulic fluid to proper level.
10. Properly fill hydraulic system (see Charge Hydraulic System in this section).
11. Stop engine and check for hydraulic oil leaks. Check hydraulic reservoir oil level.

## Hydraulic Oil Cooler

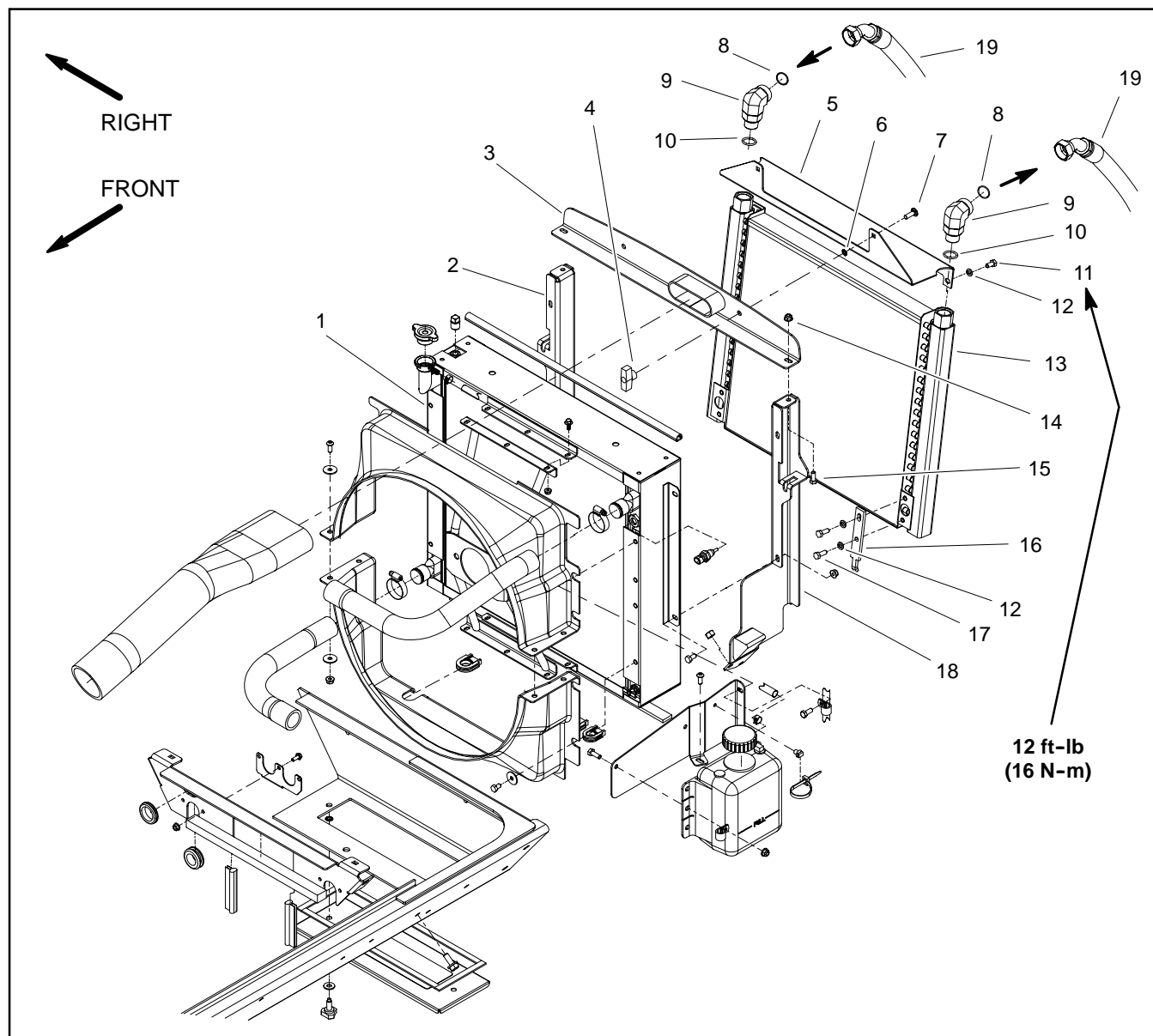



Figure 60

- |                            |                                   |                                     |
|----------------------------|-----------------------------------|-------------------------------------|
| 1. Radiator                | 8. O-ring                         | 14. Flange nut (2 used)             |
| 2. RH radiator support     | 9. 90° hydraulic fitting (2 used) | 15. Cap screw (2 used)              |
| 3. Top radiator support    | 10. O-ring                        | 16. Oil cooler mount plate (2 used) |
| 4. Knob (2 used)           | 11. Cap screw (2 used)            | 17. Cap screw (4 used)              |
| 5. Oil cooler bracket      | 12. Lock washer (6 used)          | 18. LH radiator support             |
| 6. Retaining ring (2 used) | 13. Oil cooler                    | 19. Hydraulic hose (2 used)         |
| 7. Carriage screw (2 used) |                                   |                                     |



## Removal (Fig. 60)

 <b>CAUTION</b>
<b>The radiator and oil cooler may be hot. To avoid possible burns, allow the engine and cooling systems to cool before working on the oil cooler.</b>

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. Remove oil cooler using Figure 60 as a guide.

### Inspection

1. Back flush oil cooler with cleaning solvent. After cooler is clean, make sure all solvent is drained from the cooler.

 <b>CAUTION</b>
<b>Use eye protection such as goggles when using compressed air.</b>

2. Dry inside of oil cooler using compressed air in the opposite direction of the oil flow.
3. Plug both ends of oil cooler. Clean exterior of cooler. Make sure fins are clear of dirt and debris.
4. The oil cooler should be free of corrosion, cracked tubes and excessive pitting of tubes.

### Installation (Fig. 60)

1. Install oil cooler using Figure 60 as a guide.
2. Fill reservoir with hydraulic fluid as required.

## Gear Pump

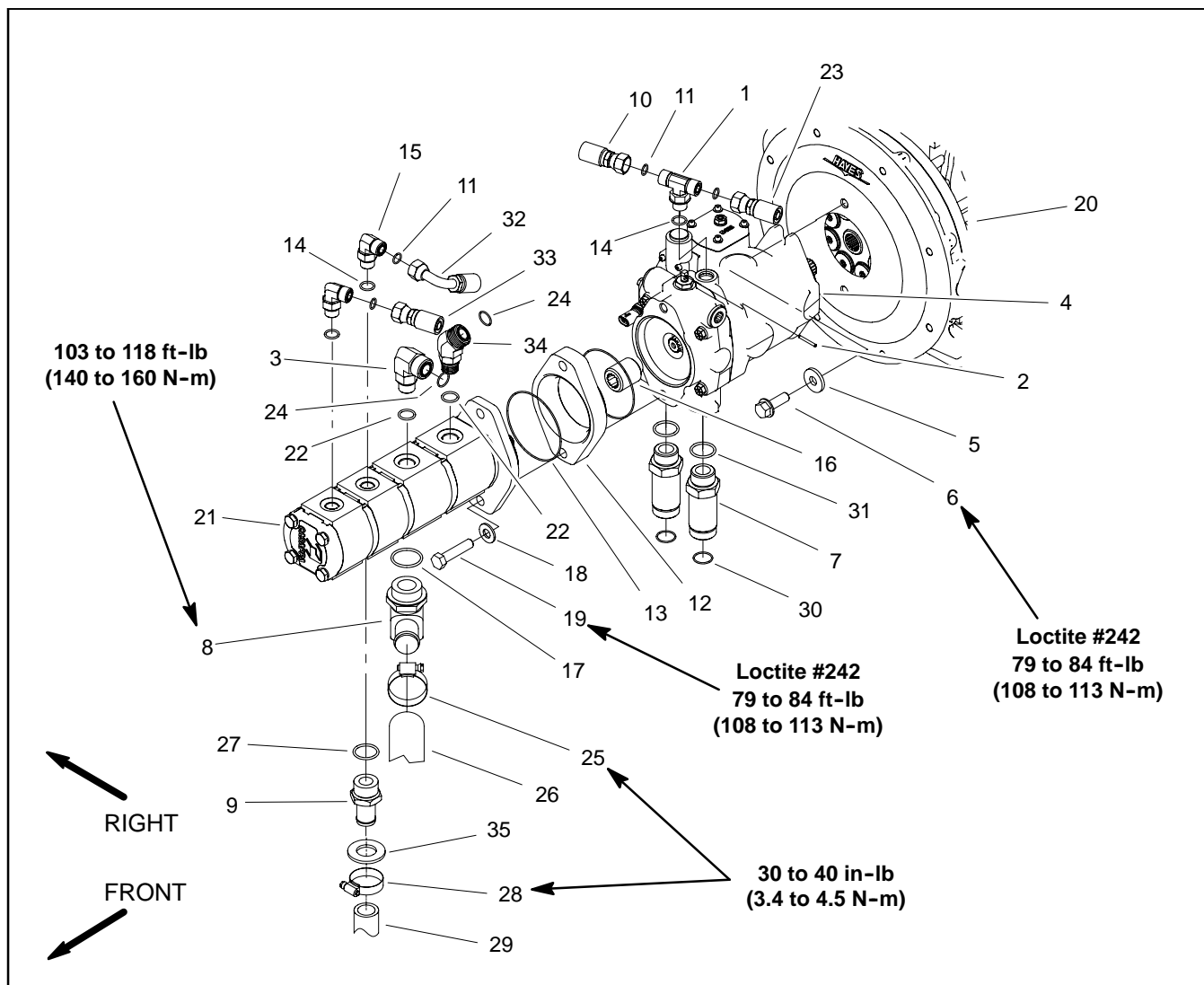


Figure 61

- |                               |                                    |                       |
|-------------------------------|------------------------------------|-----------------------|
| 1. Hydraulic T fitting        | 13. O-ring (2 used)                | 25. Hose clamp        |
| 2. Roll pin                   | 14. O-ring                         | 26. Hydraulic hose    |
| 3. 90° hydraulic fitting      | 15. 90° hydraulic fitting (2 used) | 27. O-ring            |
| 4. Piston pump                | 16. Pump coupler                   | 28. Hose clamp        |
| 5. Flat washer (2 used)       | 17. O-ring                         | 29. Hydraulic hose    |
| 6. Cap screw (2 used)         | 18. Flat washer (2 used)           | 30. O-ring            |
| 7. Hydraulic fitting (2 used) | 19. Cap screw (2 used)             | 31. O-ring            |
| 8. 90° hydraulic fitting      | 20. Engine                         | 32. Hydraulic hose    |
| 9. Hydraulic fitting          | 21. Gear pump                      | 33. Hydraulic hose    |
| 10. Hydraulic hose            | 22. O-ring                         | 34. Hydraulic fitting |
| 11. O-ring                    | 23. Hydraulic hose                 | 35. Washer            |
| 12. Pump spacer               | 24. O-ring                         |                       |

### Removal (Fig. 61)

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 machine to gain access to gear pump from the underside of the machine.
3. Drain the hydraulic reservoir.
4. To prevent contamination of hydraulic system during removal, thoroughly clean exterior of pump and fittings.
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. Disconnect hydraulic lines from gear pump and put caps or plugs on open hydraulic lines and fittings. Label disconnected hydraulic lines for proper installation.
7. Support gear pump assembly to prevent it from falling.
8. Remove two (2) cap screws and washers securing gear pump to piston pump. Lower and remove gear pump, coupler, spacer and O-rings from machine.
9. 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. 61)

1. If fittings were removed from gear pump, lubricate and place new O-rings onto fittings. Install fittings into pump openings using marks made during the removal process to properly orientate fittings. Tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).
  - A. If 90° hydraulic suction fitting (item 8) was removed, torque fitting nut from **103 to 118 ft-lb (140 to 160 N-m)**.

2. Lubricate new O-rings (item 13) with clean hydraulic oil. Position O-rings on gear pump and pump spacer flanges.
3. Slide coupler onto the piston pump output shaft.
4. Apply Loctite #242 (or equivalent) to threads of cap screws (item 19) used to secure gear pump to piston pump.
5. Position pump spacer to gear pump. Align gear teeth and slide gear pump input shaft into coupler. Secure gear pump to piston pump with two (2) cap screws and flat washers. Torque screws from **79 to 84 ft-lb (108 to 113 N-m)**.
6. Remove caps and plugs from hydraulic lines and fittings. Using labels placed during pump removal, properly install lines to gear pump (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).
7. Lower machine to ground.
8. Replace hydraulic filter and fill hydraulic reservoir with new hydraulic oil.
9. Disconnect engine run solenoid electrical connector to prevent engine from starting. Prime the hydraulic pump by turning the ignition key switch to start and cranking the engine for ten (10) seconds. Let starter cool and then repeat cranking procedure again.
10. Connect engine run solenoid electrical connector, start the engine and check for proper operation.
11. Properly fill hydraulic system (see Charge Hydraulic System in this section).
12. Stop engine and check for hydraulic oil leaks. Check hydraulic reservoir oil level.

## Gear Pump Service

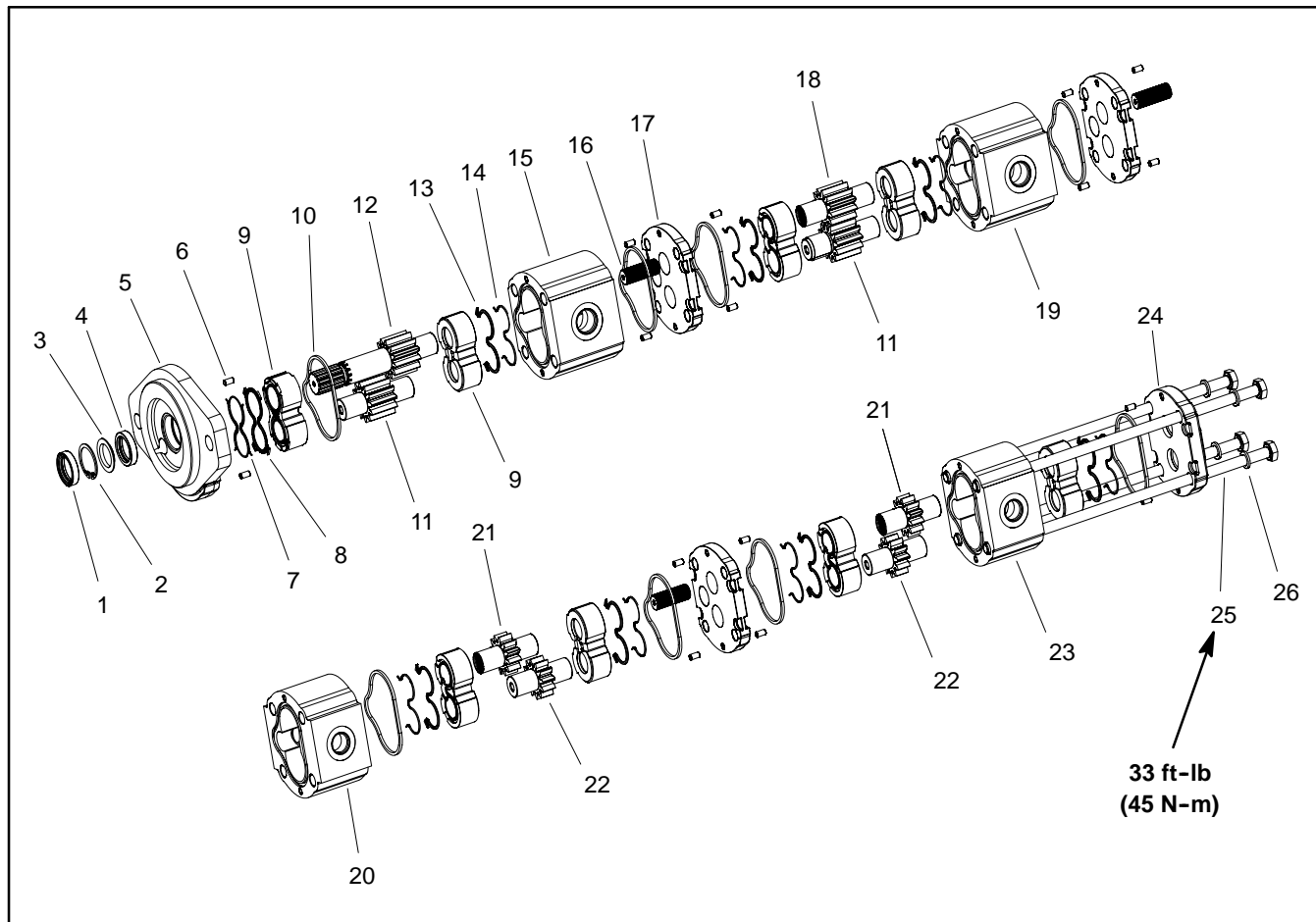


Figure 62

- |                          |                                       |                        |
|--------------------------|---------------------------------------|------------------------|
| 1. Dust seal             | 10. Seal (8 used)                     | 19. Body               |
| 2. Retaining ring        | 11. Idler gear                        | 20. Body               |
| 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          |
| 6. Dowel pin (16 used)   | 15. Front body                        | 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. 62)

**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. 63).

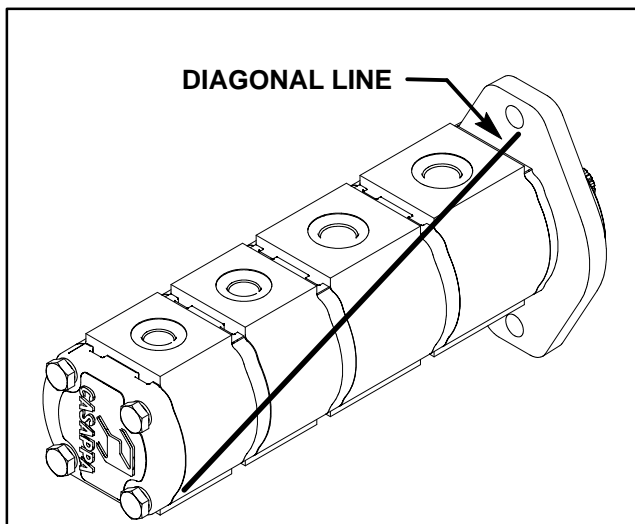


Figure 63

**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. 62)

1. Apply clean hydraulic oil to all 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 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)**.

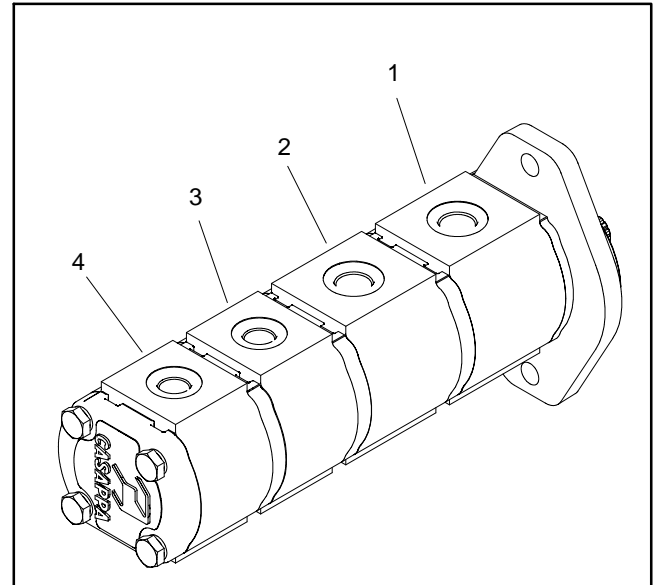


Figure 64

1. LH and RH PTO pump section
2. Front PTO pump section
3. Steering, lift/lower and charge pump section
4. Engine cooling fan pump section

## Traction Circuit

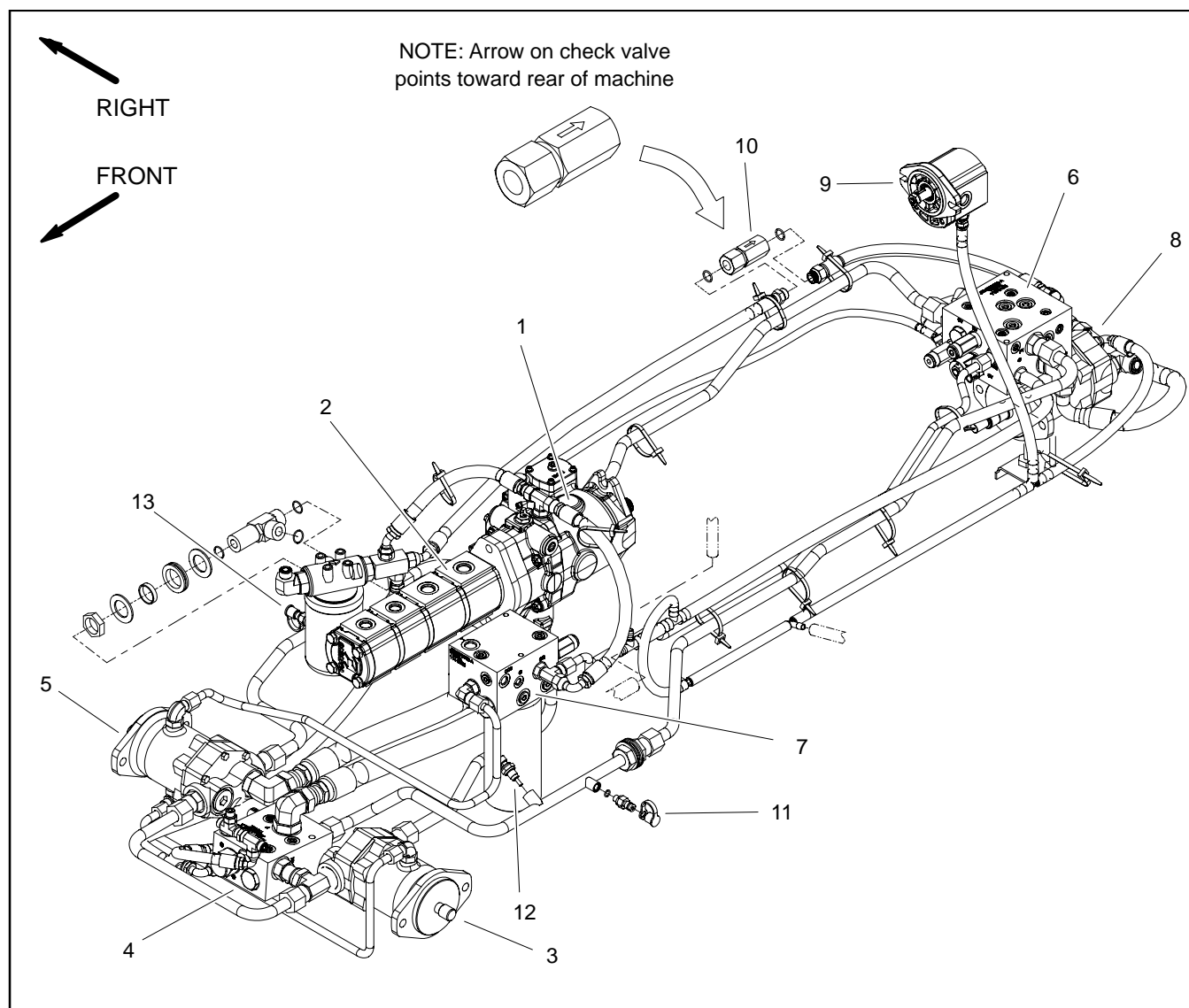


Figure 65

1. Piston (traction) pump
2. Gear pump
3. LH front wheel motor
4. Traction manifold
5. RH front wheel motor

6. 4WD manifold
7. Filter manifold
8. Rear axle motor
9. Cooling fan motor

10. Check valve
11. Forward traction pressure port
12. Hydraulic temperature sender
13. Reverse traction pressure port

Figure 65 illustrates the components that are used in the Groundsmaster 4000-D and 4010-D traction circuits. Procedures for removal, installation and disassembly/assembly of these components are provided on the following pages of this section.

## Transport Cylinder

A transport cylinder is included in the traction circuit to reduce traction pump control arm movement when operating in Hi speed (2WD). This reduced control arm movement limits pump swash plate rotation to prevent excessive transport speed. The transport cylinder is attached to the forward, right side engine mount (Fig. 66).

### Disassembly (Fig. 66)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch. Raise and support hood.
2. To prevent contamination of hydraulic system during removal, thoroughly clean exterior of pump assembly.
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. Put a drain pan below the transport cylinder. Remove hydraulic hose from cylinder fitting. Put plugs in hose and fitting to prevent contamination of the system.
5. Remove transport cylinder assembly from engine mount. Locate and remove cylinder spacer from between transport cylinder and engine mount.
6. If cap screw is to be removed from piston, carefully measure the distance from the piston to the end of the cap screw before loosening the jam nut (Fig. 67). This distance will be necessary for assembly.
7. Disassemble transport cylinder using Figure 66 as a guide.

### Assembly (Fig. 66)

1. Lubricate all transport cylinder components with clean hydraulic oil. Assemble transport cylinder and install cylinder to engine mount using Figure 66 as a guide. Make sure that cylinder spacer is between transport cylinder and engine mount.
2. If the cap screw was removed from the piston, make sure that distance from the piston to the end of the cap screw is the same as the distance measured before disassembly (Fig. 67).
3. Remove plugs from hose and fitting. Install hose to fitting on transport cylinder (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

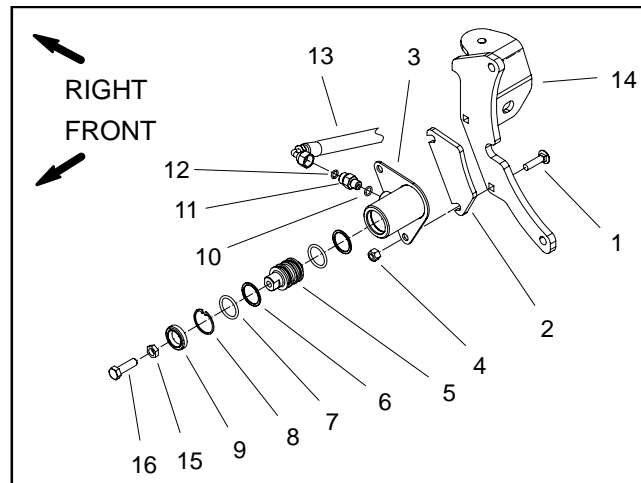


Figure 66

- |                            |                     |
|----------------------------|---------------------|
| 1. Carriage screw (2 used) | 9. Seal             |
| 2. Cylinder spacer         | 10. O-ring          |
| 3. Transport cylinder      | 11. Fitting         |
| 4. Lock nut (2 used)       | 12. O-ring          |
| 5. Piston                  | 13. Hydraulic hose  |
| 6. Backup ring (2 used)    | 14. RH engine mount |
| 7. O-ring (2 used)         | 15. Jam nut         |
| 8. Retaining ring          | 16. Cap screw       |

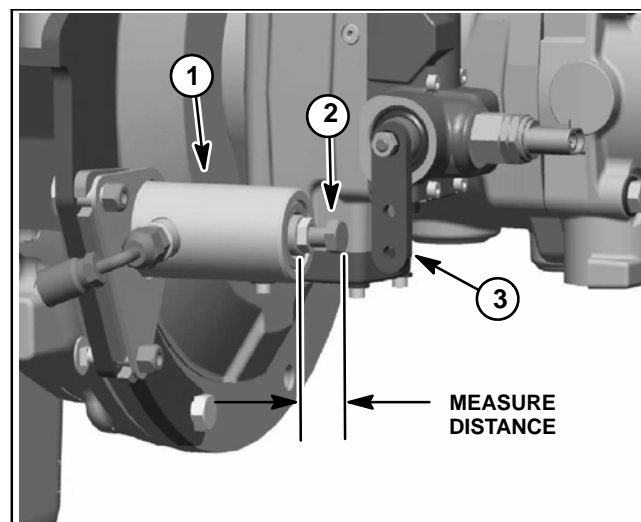


Figure 67

- |                       |                     |
|-----------------------|---------------------|
| 1. Transport cylinder | 3. Pump control arm |
| 2. Cap screw          |                     |

## Piston (Traction) Pump

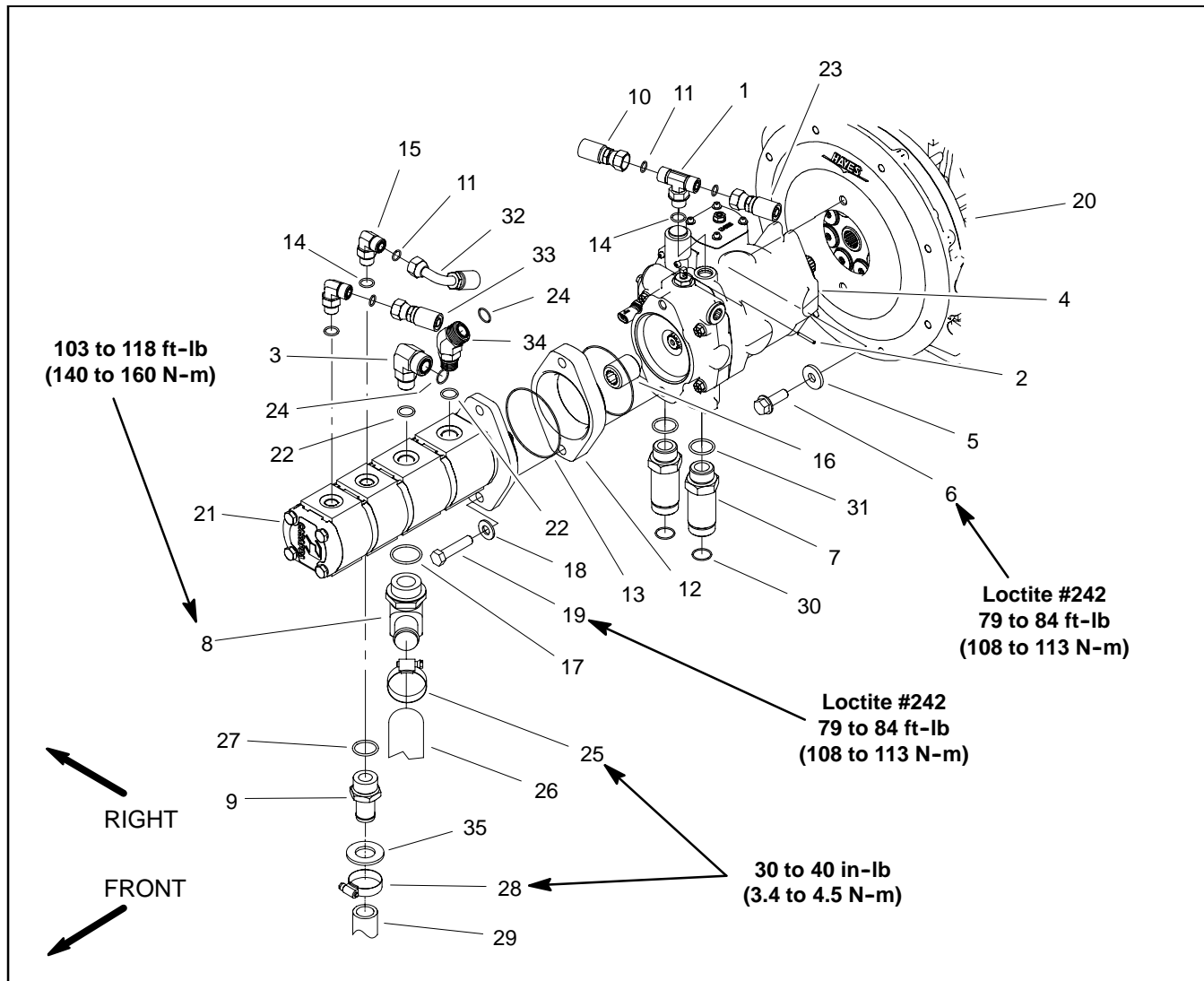


Figure 68

- |                               |                                    |                       |
|-------------------------------|------------------------------------|-----------------------|
| 1. Hydraulic T fitting        | 13. O-ring (2 used)                | 25. Hose clamp        |
| 2. Roll pin                   | 14. O-ring                         | 26. Hydraulic hose    |
| 3. 90° hydraulic fitting      | 15. 90° hydraulic fitting (2 used) | 27. O-ring            |
| 4. Piston pump                | 16. Pump coupler                   | 28. Hose clamp        |
| 5. Flat washer (2 used)       | 17. O-ring                         | 29. Hydraulic hose    |
| 6. Cap screw (2 used)         | 18. Flat washer (2 used)           | 30. O-ring            |
| 7. Hydraulic fitting (2 used) | 19. Cap screw (2 used)             | 31. O-ring            |
| 8. 90° hydraulic fitting      | 20. Engine                         | 32. Hydraulic hose    |
| 9. Hydraulic fitting          | 21. Gear pump                      | 33. Hydraulic hose    |
| 10. Hydraulic hose            | 22. O-ring                         | 34. Hydraulic fitting |
| 11. O-ring                    | 23. Hydraulic hose                 | 35. Washer            |
| 12. Pump spacer               | 24. O-ring                         |                       |

### Removal (Fig. 68)

1. Park machine on a level surface, lower cutting decks, stop engine, apply 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. Raise and support machine to gain access to pump assembly from the underside of machine.
4. Remove traction rod from control arm on piston pump by removing lock nut, spacer and cap screw (Fig. 69).



5. Disconnect wire harness connector from neutral switch on piston pump.

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

7. For installation purposes, label all hydraulic lines that connect to gear pump and piston pump.

8. Put a drain pan below the pump assembly. Remove hydraulic hoses and fittings connected to piston and gear pumps. Put plugs or caps on disconnected hydraulic hoses to prevent contamination of the system. Put plugs in open ports of pumps.

**NOTE:** If fuel tank is removed from the machine, the gear pump and piston pump can be removed as a complete assembly.

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

10. 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 raise it out of the machine.

### Installation (Fig. 68)

**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.

1. 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.

2. Apply Loctite #242 (or equivalent) to threads of cap screws (item 6) used to secure piston pump to engine flywheel plate.

3. While maintaining pump alignment with spring coupler and flywheel plate, install two (2) cap screws and washers to secure piston pump to engine. Torque screws from **79 to 84 ft-lb (108 to 113 N-m)**.

4. Install gear pump to piston pump (see Gear Pump Installation).

5. Position traction rod to control arm on piston pump by installing cap screw, spacer and lock nut (Fig. 69).

6. Connect wire harness connector to neutral switch on traction pump.

7. Remove plugs or caps from disconnected hydraulic hoses and open ports of the pump assembly. Install fittings and hoses to correct location on gear and piston pumps (see Hydraulic Fitting Installation and Hydraulic Hose and Tube Installation in the General Information section of this chapter).

8. Lower machine to ground.

9. Install new 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.

10. Disconnect engine run solenoid electrical connector to prevent engine from starting. Prime pumps by turning ignition key switch to crank engine for ten (10) seconds. Let starter cool and then repeat cranking procedure again.

11. Connect engine run solenoid electrical connector, start the engine and check for proper operation.

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.

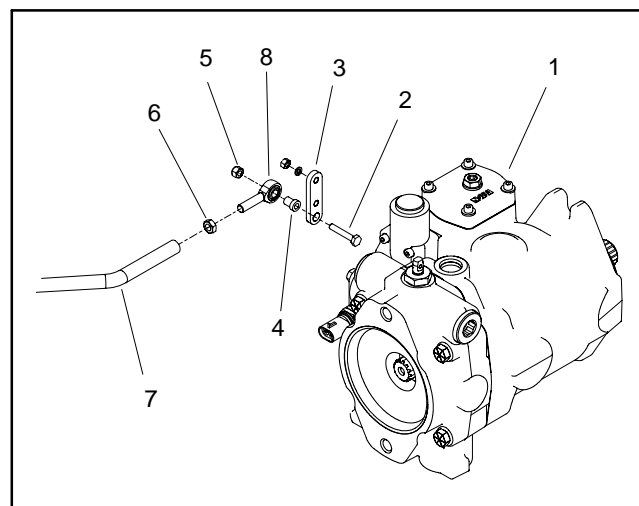


Figure 69

- |                     |                 |
|---------------------|-----------------|
| 1. Piston pump      | 5. Lock nut     |
| 2. Cap screw        | 6. Jam nut      |
| 3. Pump control arm | 7. Traction rod |
| 4. Spacer           | 8. Rod end      |

## Piston (Traction) Pump Service

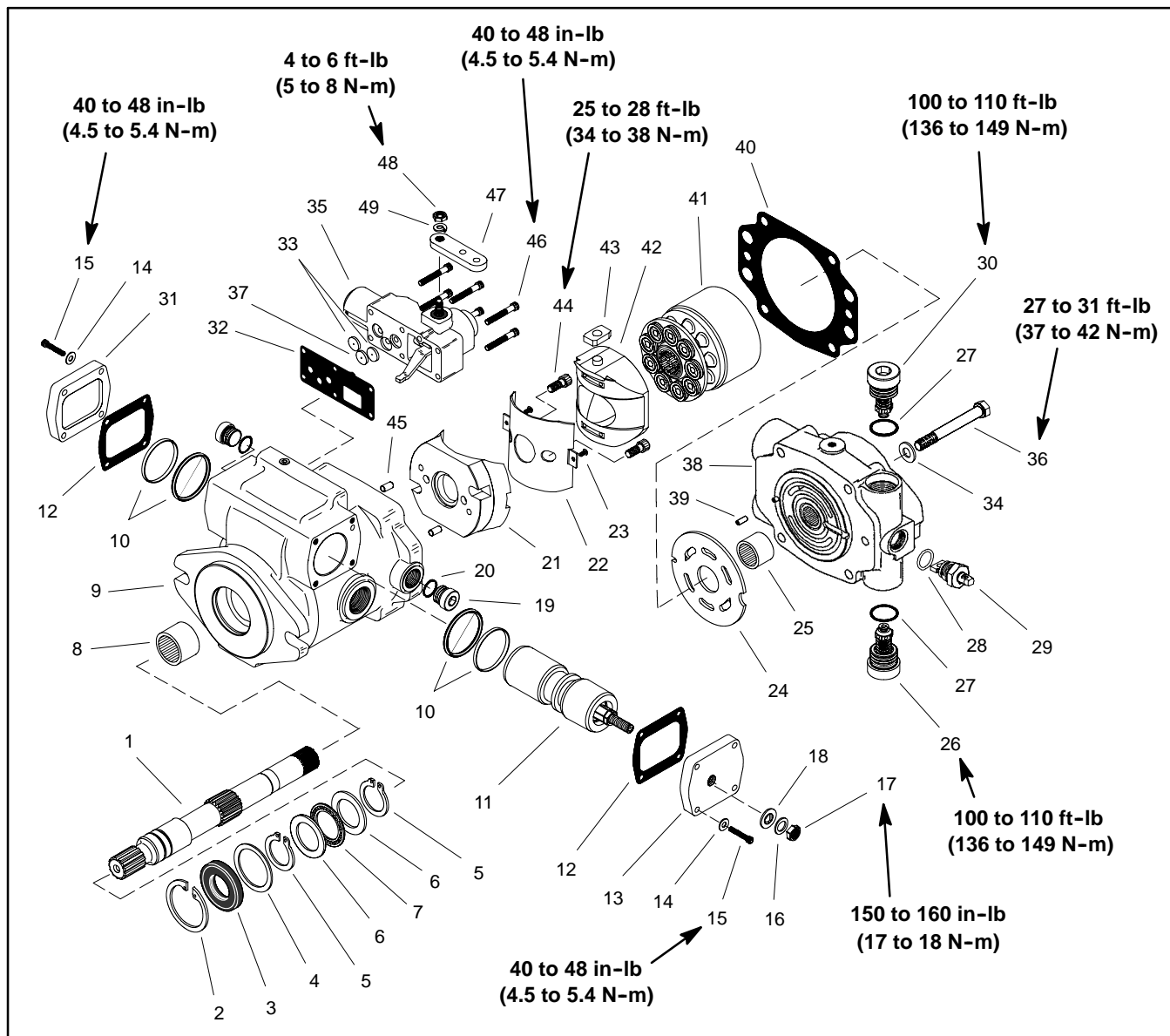


Figure 70

- |  |                                     |                                   |
|--|-------------------------------------|-----------------------------------|
| 1. Drive shaft                           | 18. Seal washer                     | 34. Flat washer (4 used)          |
| 2. Retaining ring                        | 19. Plug                            | 35. Manual servo control assembly |
| 3. Shaft seal                            | 20. O-ring                          | 36. Cap screw (4 used)            |
| 4. Washer                                | 21. Cradle                          | 37. Control orifice (.036)        |
| 5. Retaining ring                        | 22. Bushing                         | 38. Backplate                     |
| 6. Thrust bearing race                   | 23. Screw                           | 39. Roll pin                      |
| 7. Thrust bearing                        | 24. Valve plate                     | 40. Housing gasket                |
| 8. Bearing                               | 25. Bearing                         | 41. Rotating kit                  |
| 9. Housing                               | 26. Forward relief valve            | 42. Camplate                      |
| 10. Seal set                             | 27. O-ring                          | 43. Servo piston follower         |
| 11. Servo piston                         | 28. O-ring                          | 44. Cap screw (2 used)            |
| 12. Gasket                               | 29. Bypass valve                    | 45. Bushing dowel (2 used)        |
| 13. Cover plate                          | 30. Reverse relief valve            | 46. Socket head screw (6 used)    |
| 14. Flat washer (4 used per cover)       | 31. Cover plate                     | 47. Control arm                   |
| 15. Socket head screw (4 used per cover) | 32. Housing gasket                  | 48. Hex nut                       |
| 16. Washer                               | 33. Control orifice (.028) (2 used) | 49. Lock washer                   |
| 17. Jam nut                              |                                     |                                   |

### **Piston (Traction) Pump Service (Fig. 70)**

For service of the piston (traction) pump (including the servo control (item 28) assembly), see the Eaton Model 72400 Servo Controlled Piston Pump Repair Information at the end of this chapter.

## Rear Axle Motor

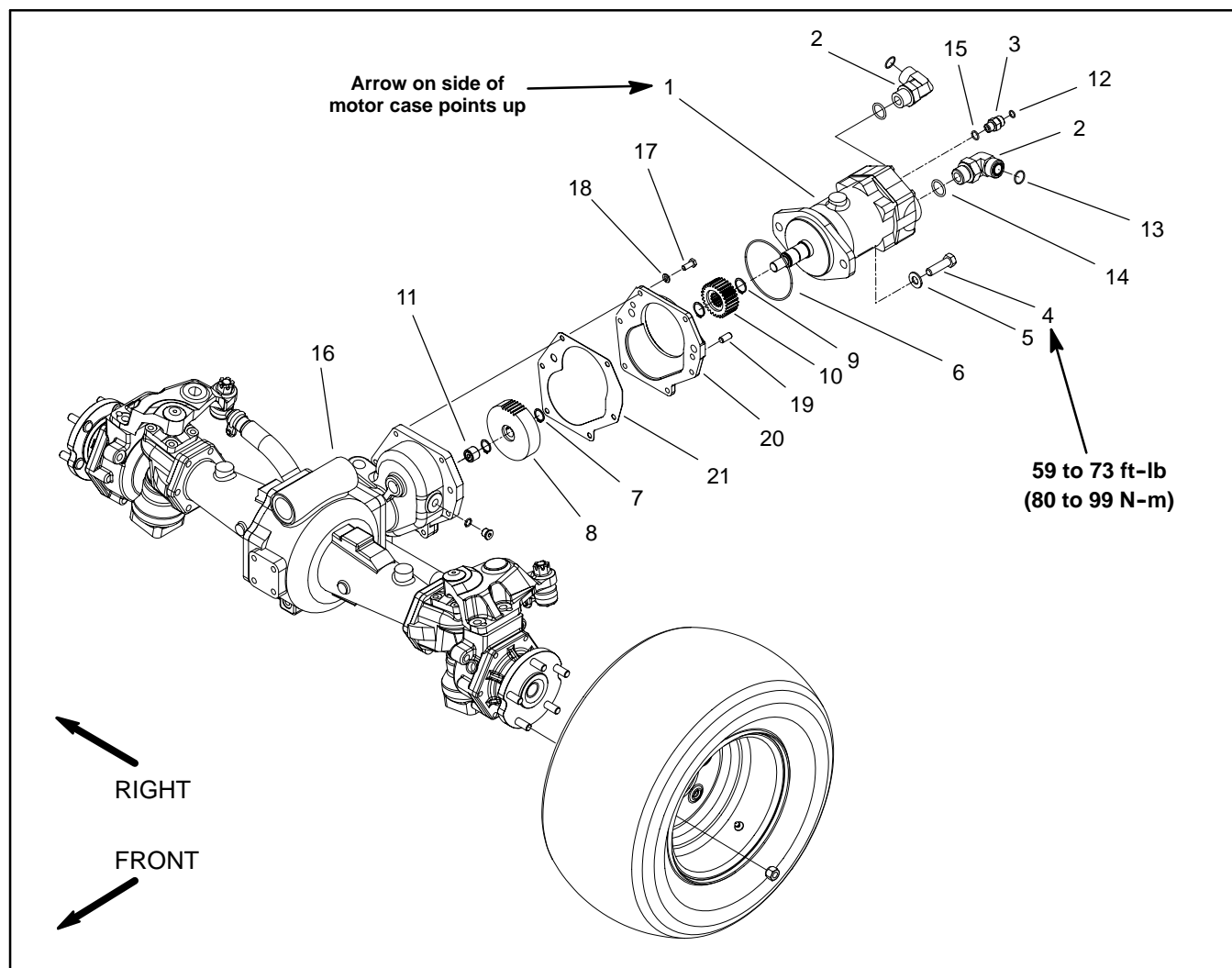


Figure 71

- |                                   |                                |                          |
|-----------------------------------|--------------------------------|--------------------------|
| 1. Axle motor                     | 8. Gear (45T)                  | 15. O-ring               |
| 2. 90° hydraulic fitting (2 used) | 9. External snap ring (2 used) | 16. Drive axle assembly  |
| 3. Hydraulic fitting              | 10. Pinion gear (27T)          | 17. Cap screw (6 used)   |
| 4. Cap screw (2 used)             | 11. Needle bearing             | 18. Lock washer (6 used) |
| 5. Flat washer (2 used)           | 12. O-ring                     | 19. Dowel pin (2 used)   |
| 6. O-ring                         | 13. O-ring                     | 20. Cover plate          |
| 7. External snap ring (2 used)    | 14. O-ring                     | 21. Gasket               |

## Removal (Fig. 71)

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.

**NOTE:** To ease installation, label the hydraulic hoses to show their correct position on the axle motor.

3. Disconnect hydraulic hoses from motor. Put caps or plugs on motor ports and hose openings to prevent contamination.

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

4. Remove motor from rear axle using Figure 71 as a guide.

5. If hydraulic fittings are to be removed from motor, mark fitting orientation to allow correct assembly. Remove fittings from motor and discard O-rings.

## Installation (Fig. 71)

**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.**

1. If fittings were removed from motor, lubricate and place new O-rings onto fittings. Install fittings into port 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. If removed, install pinion gear (item 10) to axle motor.

3. Install O-ring (item 6) onto motor. Position motor to rear axle assembly making sure that arrows on the side of motor case point upward. Align gear teeth and slide motor into place.

4. Secure motor to axle with cap screws and flat washers. Torque screws from **59 to 73 ft-lb (80 to 99 N-m)**.

5. Remove plugs from motor ports and hose openings. Using labels placed during motor removal, correctly attach hydraulic hoses to axle motor (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

6. Fill reservoir with hydraulic fluid as required.

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

8. After assembly is completed, verify that hydraulic hoses and fittings do not contact anything.

## Front Wheel Motor

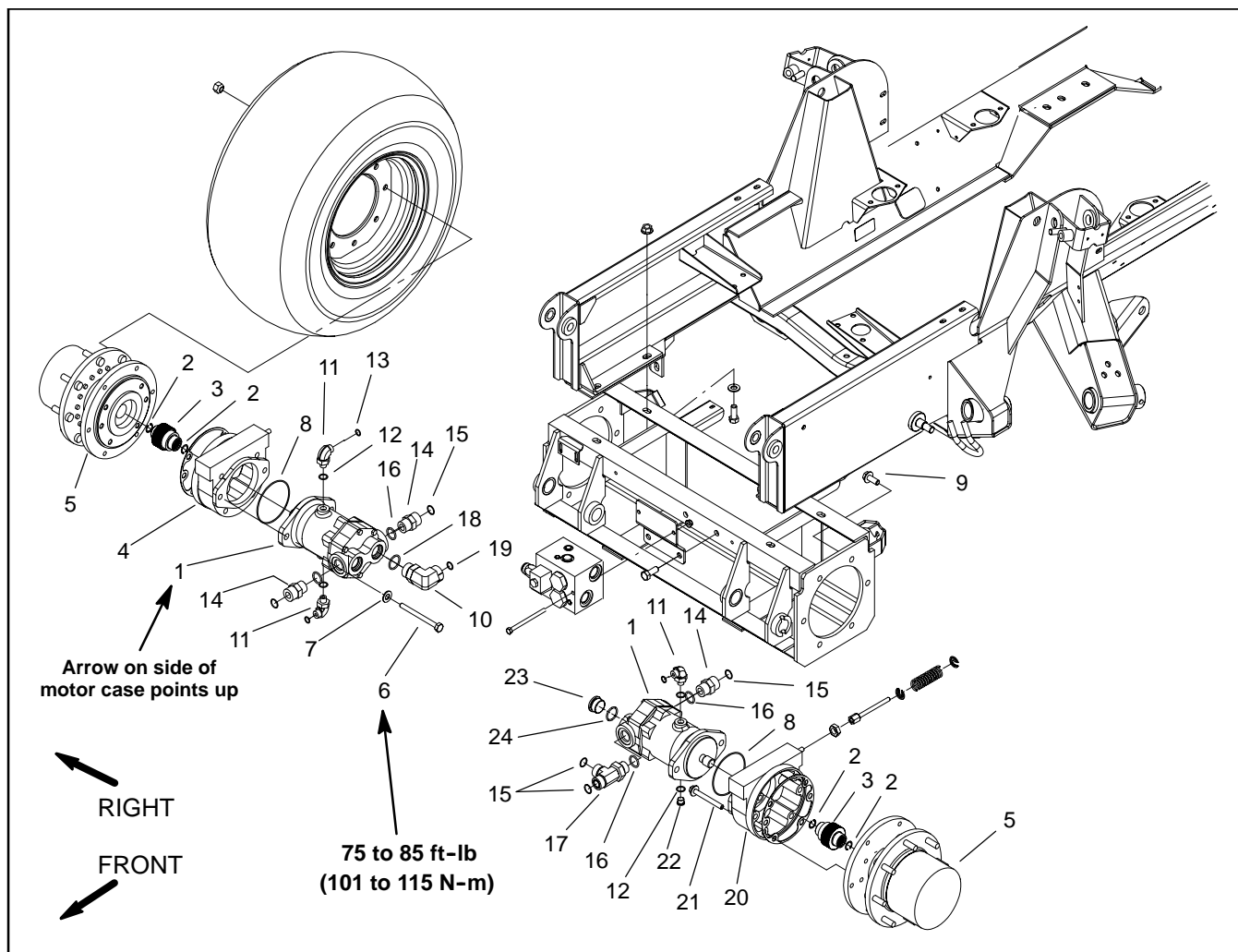


Figure 72

- |                                  |  |   |
|----------------------------------|--|---|
| 1. Front wheel motor             | 9. Flange head screw (6 used per side) | 17. Hydraulic fitting                   |
| 2. Internal retaining ring       | 10. 90° hydraulic fitting              | 18. O-ring                              |
| 3. Splined brake shaft           | 11. 90° hydraulic fitting (3 used)     | 19. O-ring                              |
| 4. RH brake assembly             | 12. O-ring                             | 20. LH brake assembly                   |
| 5. Planetary assembly            | 13. O-ring                             | 21. Flange head screw (4 used per side) |
| 6. Cap screw (2 used per side)   | 14. Hydraulic fitting (3 used)         | 22. Hex plug                            |
| 7. Flat washer (2 used per side) | 15. O-ring                             | 23. Plug                                |
| 8. O-ring                        | 16. O-ring                             | 24. O-ring                              |

### Removal (Fig. 72)

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.

**NOTE:** To ease installation, label the hydraulic hoses to show their correct position on the wheel motor.

3. Disconnect hydraulic hoses and tubes from wheel motor. Put caps or plugs on motor ports and hose openings to prevent contamination.

**IMPORTANT:** Before loosening fasteners, support wheel motor to prevent motor from falling during removal.

4. Remove wheel motor using Figure 72 as a guide.

5. If hydraulic fittings are to be removed from motor, mark fitting orientation to allow correct assembly. Remove fittings from motor and discard O-rings.

### Installation (Fig. 72)

**IMPORTANT:** If 90° fitting (item 10) was removed from backplate of RH wheel motor, make sure that straight fittings (item 14) are installed and correctly torqued before installing 90° fitting.

1. If fittings were removed from motor, lubricate and place new O-rings onto fittings. Install fittings into port 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. Install O-ring (item 8) onto motor. Position wheel motor to brake assembly making sure that arrows on the side of motor case point upward.

3. Align splines on motor shaft and splined brake shaft. Slide motor into brake assembly.

4. Secure motor to brake assembly with cap screws and flat washers. Tighten cap screws from **75 to 85 ft-lb (101 to 115 N-m)**.

5. Remove plugs from wheel motor ports and hose openings. Using labels placed during motor removal, correctly attach hydraulic hoses and tubes to wheel motor (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

6. Fill reservoir with hydraulic fluid as required.

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

## Rear Axle and Front Wheel Motor Service

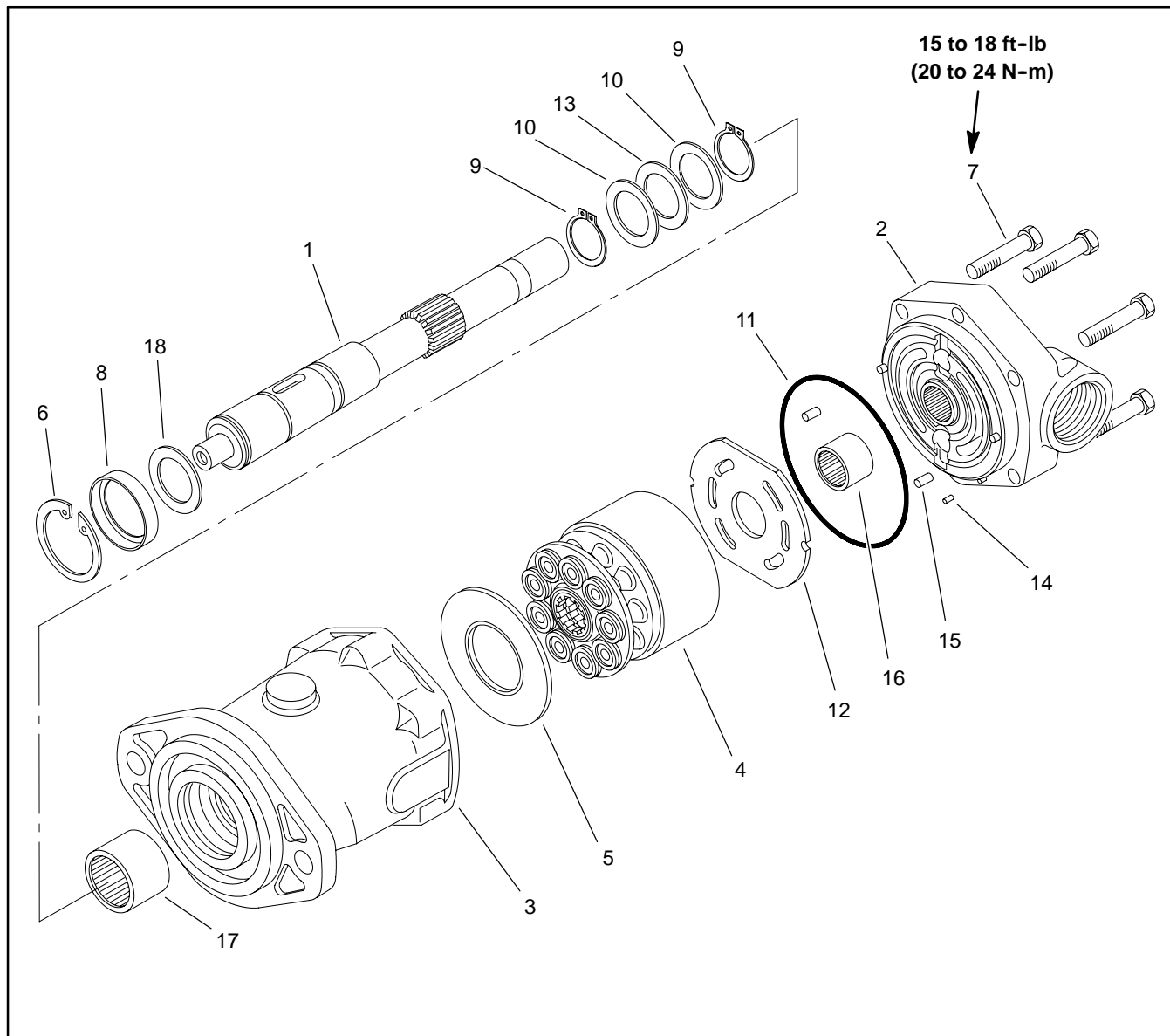


Figure 73

- |                                  |                       |                       |
|----------------------------------|-----------------------|-----------------------|
| 1. Drive shaft                   | 7. Cap screw (6 used) | 13. Thrust bearing    |
| 2. Backplate (front motor shown) | 8. Shaft seal         | 14. Roll pin (3 used) |
| 3. Housing assembly              | 9. Retaining ring     | 15. Roll pin          |
| 4. Rotating assembly             | 10. Thrust race       | 16. Bearing           |
| 5. Cam plate insert              | 11. O-ring            | 17. Bearing           |
| 6. Retaining ring                | 12. Valve plate       | 18. Washer            |

**NOTE:** The front wheel motors are identical. The rear axle motor has some differences from the front motors. Service of the front and rear motors requires the same procedures.

**NOTE:** For service of the wheel motors, see the Eaton Model 74318 and 74348 Piston Motors: Fixed Displacement, Valve Plate Design Repair Information at the end of this chapter.



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## 4WD Manifold

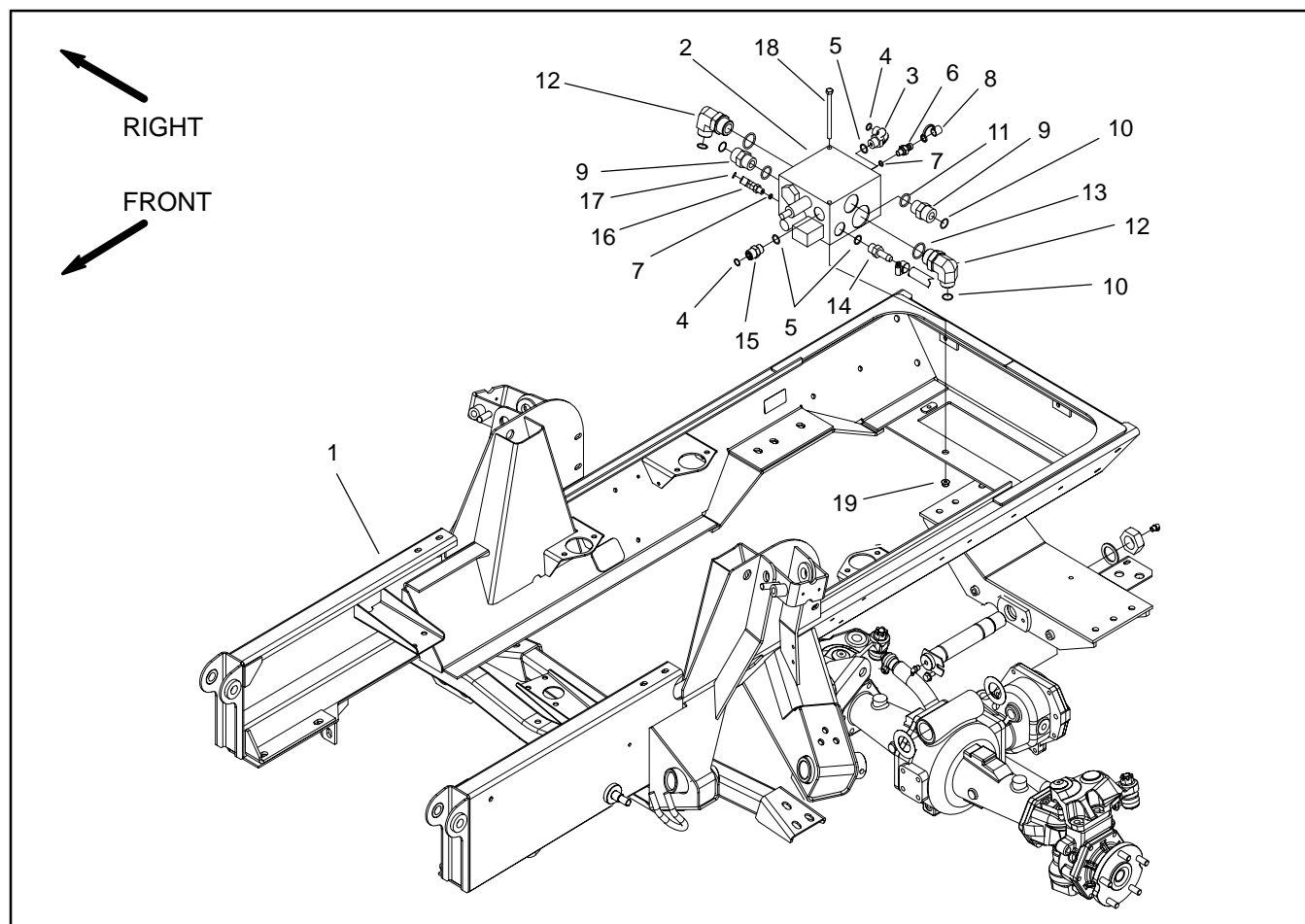


Figure 74

- |                          |                           |                         |
|--------------------------|---------------------------|-------------------------|
| 1. Frame assembly        | 8. Dust cap               | 14. Hydraulic fitting   |
| 2. 4WD manifold          | 9. Hydraulic fitting      | 15. Adapter             |
| 3. 90° hydraulic fitting | 10. O-ring                | 16. Hydraulic fitting   |
| 4. O-ring                | 11. O-ring                | 17. O-ring              |
| 5. O-ring                | 12. 90° hydraulic fitting | 18. Cap screw (2 used)  |
| 6. Quick fitting         | 13. O-ring                | 19. Flange nut (2 used) |
| 7. O-ring                |                           |                         |

**NOTE:** The ports on the 4WD manifold are marked for easy identification of components. Example: P1 is a piston pump connection port and SV is the location for the solenoid valve (see Hydraulic Schematic in Chapter 10 – Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port).

## Removal (Fig. 74)

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

**NOTE:** Removal of the radiator (see Radiator Removal in the Service and Repairs section of Chapter 3 – Kubota Diesel Engine) or rear axle (see Rear Axle Assembly Removal in the Service and Repairs section of Chapter 6 – Axles, Planetaries and Brakes) will improve access to 4WD manifold.

2. Disconnect wire harness connector from the solenoid valve coil.

3. To prevent contamination of hydraulic system during manifold removal, thoroughly clean exterior of manifold and fittings.

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

5. Remove hydraulic manifold from the frame using Figure 74 as a guide.

6. If hydraulic fittings are to be removed from manifold, mark fitting orientation to allow correct assembly. Remove fittings from manifold and discard O-rings.

## Installation (Fig. 74)

1. If fittings were removed from 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).

2. Install hydraulic manifold to the frame using Figure 74 as a 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. Connect wire harness connector to the solenoid valve coil.

5. Make sure hydraulic tank is full. Add correct oil if necessary before returning machine to service.

## 4WD Manifold Service

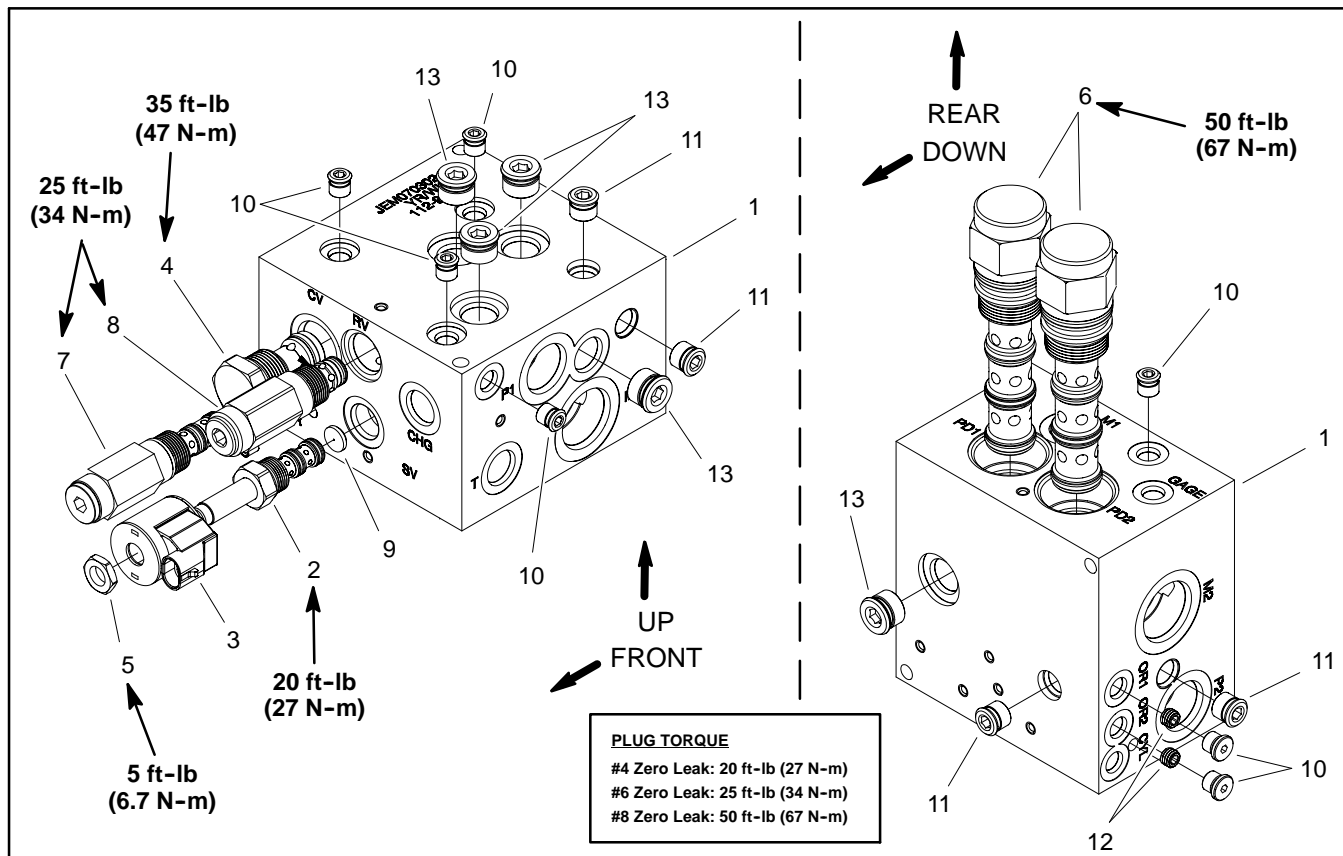


Figure 75

1. 4WD manifold body
2. Solenoid valve (port SV)
3. Solenoid coil
4. Check valve (port CV)
5. Nut

6. Directional valve (ports PD1 & PD2)
7. Pressure reducing valve (port PR)
8. Relief valve (port RV)
9. Orifice (0.030) (port SV)

10. #4 zero leak plug with O-ring
11. #6 zero leak plug with O-ring
12. Orifice (0.050) (ports OR1 & OR2)
13. #8 zero leak plug with O-ring

**NOTE:** The ports on the 4WD manifold are marked for easy identification of components. Example: P1 is a piston pump connection port and SV is the location for the solenoid 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 4WD 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.

#### 4WD Manifold Service (Fig. 75)

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

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

3. Remove cartridge valve with a deep well socket. Note correct location for O-rings, sealing rings and backup rings. Remove and discard seal kit.
4. Visually inspect the port in the manifold for damage to the sealing surfaces, damaged threads or 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.



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. The 4WD manifold includes three (3) orifice fittings (items 9 and 12). The 0.030 orifice (item 9) is positioned in the SV port under the solenoid cartridge valve. The 0.050 orifices (item 12) thread into the manifold in ports OR1 and OR2. Before removing or installing the orifice in OR1, removal of the #6 plug in the bottom of the manifold is necessary.

8. Reinstall the cartridge valve:

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.

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

B. Lubricate threads of cartridge with clean hydraulic oil. Thread cartridge valve carefully into manifold port. The valve should go in easily without binding.

C. Torque cartridge valve using a deep well socket to value identified in manifold illustration.

D. If cartridge is solenoid operated, carefully install solenoid coil to the cartridge valve. Torque nut to value identified in manifold illustration.

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

## Traction (Flow Divider) Manifold

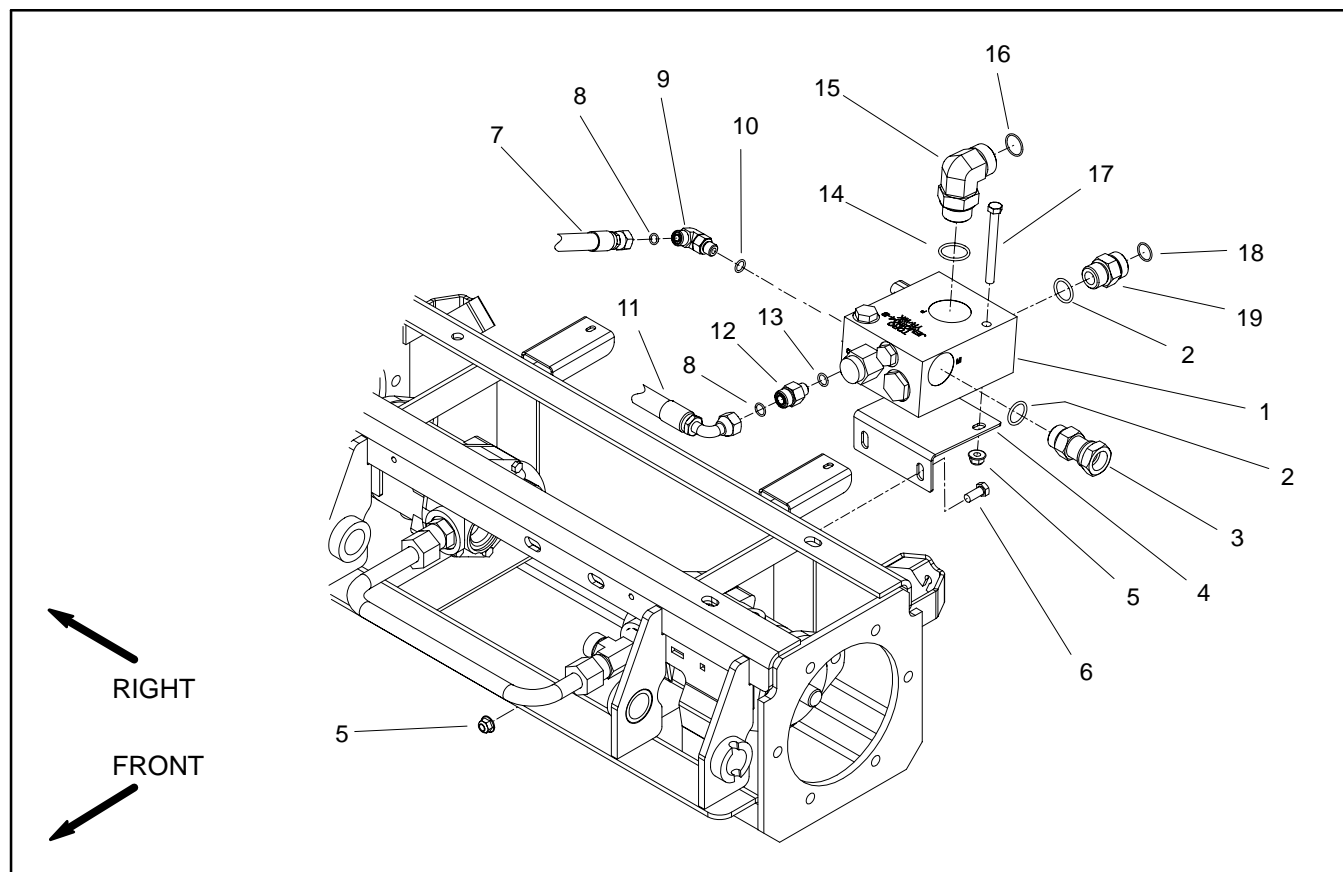


Figure 76

- |                       |                        |                         |
|-----------------------|------------------------|-------------------------|
| 1. Traction manifold  | 8. O-ring              | 14. O-ring              |
| 2. O-ring             | 9. 90° hydraulic elbow | 15. 90° hydraulic elbow |
| 3. Hydraulic fitting  | 10. O-ring             | 16. O-ring              |
| 4. Bracket            | 11. Hydraulic hose     | 17. Cap screw           |
| 5. Flange nut         | 12. Hydraulic fitting  | 18. O-ring              |
| 6. Cap screw (2 used) | 13. O-ring             | 19. Hydraulic fitting   |
| 7. Hydraulic hose     |                        |                         |

**NOTE:** The ports on the traction manifold are marked for easy identification of hydraulic line connections. Example: P is the traction pump connection port and M1 is the connection for the front traction motors (see Hydraulic Schematic in Chapter 10 – Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port).

**Removal (Fig. 76)**

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 and fittings.
3. Disconnect wire harness connector from the solenoid valve coil on the traction manifold.
4. Disconnect hydraulic lines from manifold and put caps or plugs on open hydraulic lines and fittings. Label disconnected hydraulic lines for proper reassembly.
5. Remove traction manifold from the frame using Figure 76 as a guide.
6. If hydraulic fittings are to be removed from manifold, mark fitting orientation to allow correct assembly. Remove fittings from manifold and discard O-rings.

**Installation (Fig. 76)**

1. If fittings were removed from 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).
2. Install traction manifold to the frame using Figure 76 as a 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. Connect wire harness connector to the solenoid valve coil on the traction manifold.
5. Make sure hydraulic tank is full. Add correct oil if necessary before returning machine to service.

## Traction (Flow Divider) Manifold Service

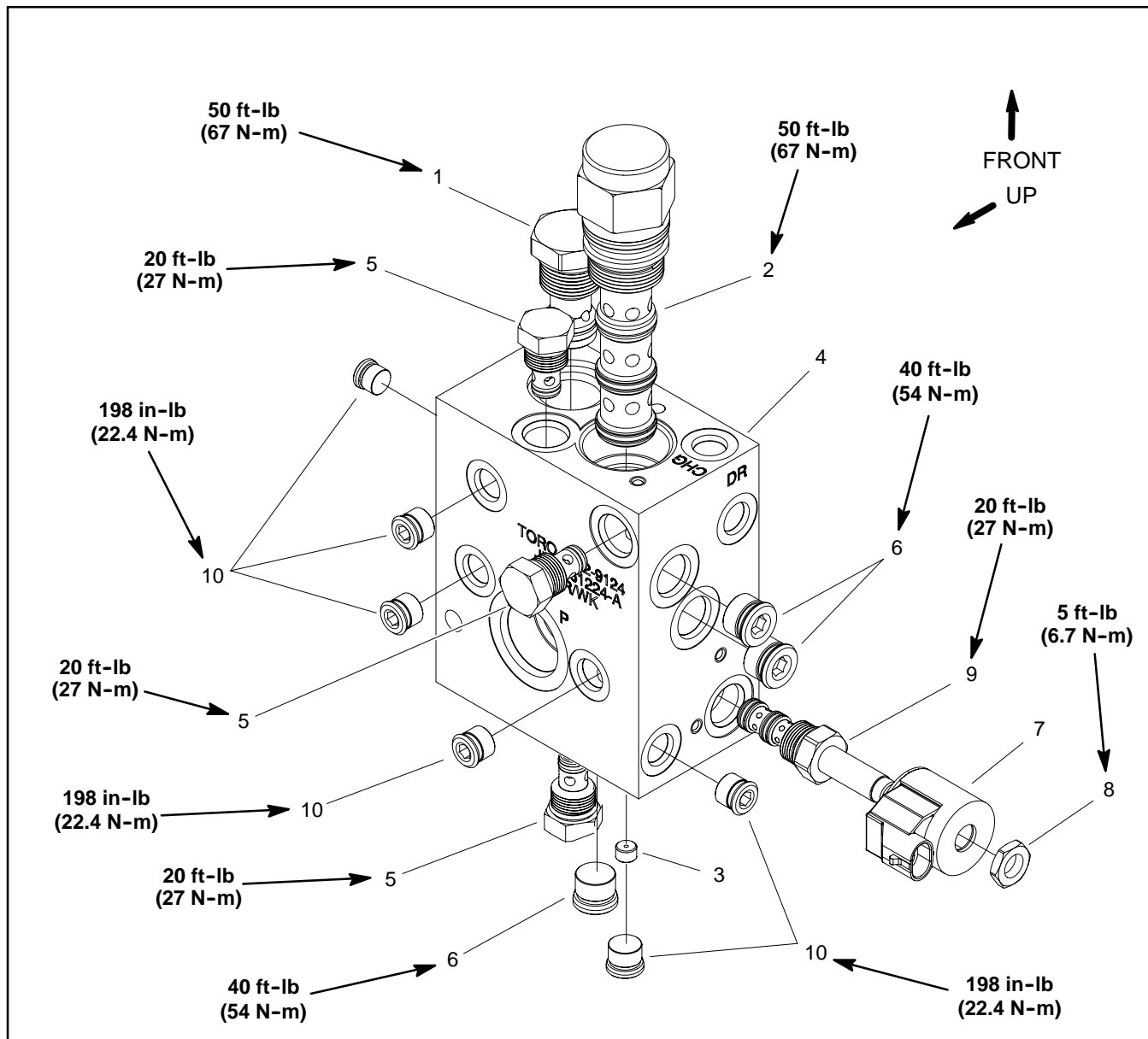


Figure 77

- |                            |                            |                             |
|----------------------------|----------------------------|-----------------------------|
| 1. Flow divider valve      | 5. Check valve             | 8. Nut                      |
| 2. Pilot directional valve | 6. SAE #8 plug with O-ring | 9. Solenoid cartridge valve |
| 3. Orifice (0.020)         | 7. Solenoid coil           | 10. SAE #6 plug with O-ring |
| 4. Traction manifold       |                            |                             |

**NOTE:** The ports on the traction manifold are marked for easy identification of components. Example: P2 is the gear pump connection port and CD is the connection for the case drain from the deck motors (see Hydraulic Schematic in Chapter 10 - Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port).



## Traction Manifold Service (Fig. 77)

**NOTE:** If the check valve (item 5) next to the pilot directional valve (item 2) needs to be removed from manifold, remove directional valve first. When installing this check valve, install and torque check valve before installing directional valve.

For traction manifold cartridge valve service procedures, see 4WD Manifold Service in this section. Refer to Figure 77 for traction (flow divider) manifold cartridge valve and plug installation torque.

## Filter Manifold

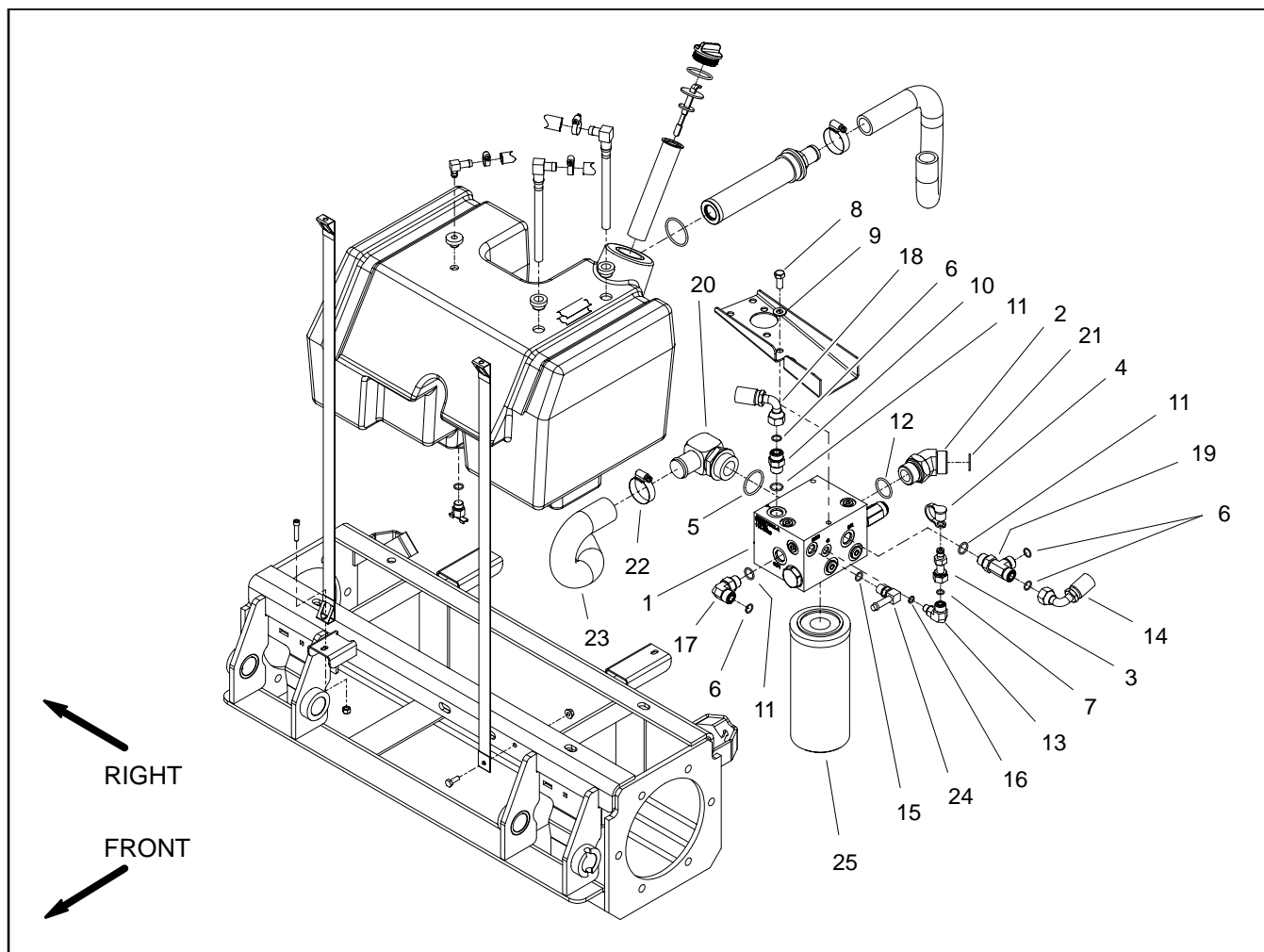


Figure 78

- |                          |                           |                           |
|--------------------------|---------------------------|---------------------------|
| 1. Filter manifold       | 10. Hydraulic fitting     | 18. Hydraulic hose        |
| 2. 45° hydraulic fitting | 11. O-ring                | 19. Hydraulic tee fitting |
| 3. Test nipple           | 12. O-ring                | 20. 90° hydraulic fitting |
| 4. Dust cap              | 13. 90° hydraulic fitting | 21. O-ring                |
| 5. O-ring                | 14. Hydraulic hose        | 22. Hose clamp            |
| 6. O-ring                | 15. O-ring                | 23. Hydraulic hose        |
| 7. O-ring                | 16. O-ring                | 24. Barb fitting          |
| 8. Cap screw (3 used)    | 17. 90° hydraulic fitting | 25. Oil filter            |
| 9. Flat washer (3 used)  |                           |                           |

**NOTE:** The ports on the filter manifold are marked for easy identification of components. Example: P2 is the gear pump connection port and T is the connection for the hydraulic reservoir return port (see Hydraulic Schematic in Chapter 10 – Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port).

**Removal (Fig. 78)**

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 filter manifold and fittings.
3. Disconnect hydraulic lines from filter manifold and put caps or plugs on open hydraulic lines and fittings. Label disconnected hydraulic lines for proper reassembly.
4. Remove filter manifold from the frame using Figure 78 as a guide.
5. If hydraulic fittings are to be removed from manifold, mark fitting orientation to allow correct assembly. Remove fittings from manifold and discard O-rings.

**Installation (Fig. 78)**

1. If fittings were removed from 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).
2. Install filter manifold to the frame using Figure 78 as a 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. Make sure hydraulic tank is full. Add correct oil if necessary before returning machine to service.

## Filter Manifold Service

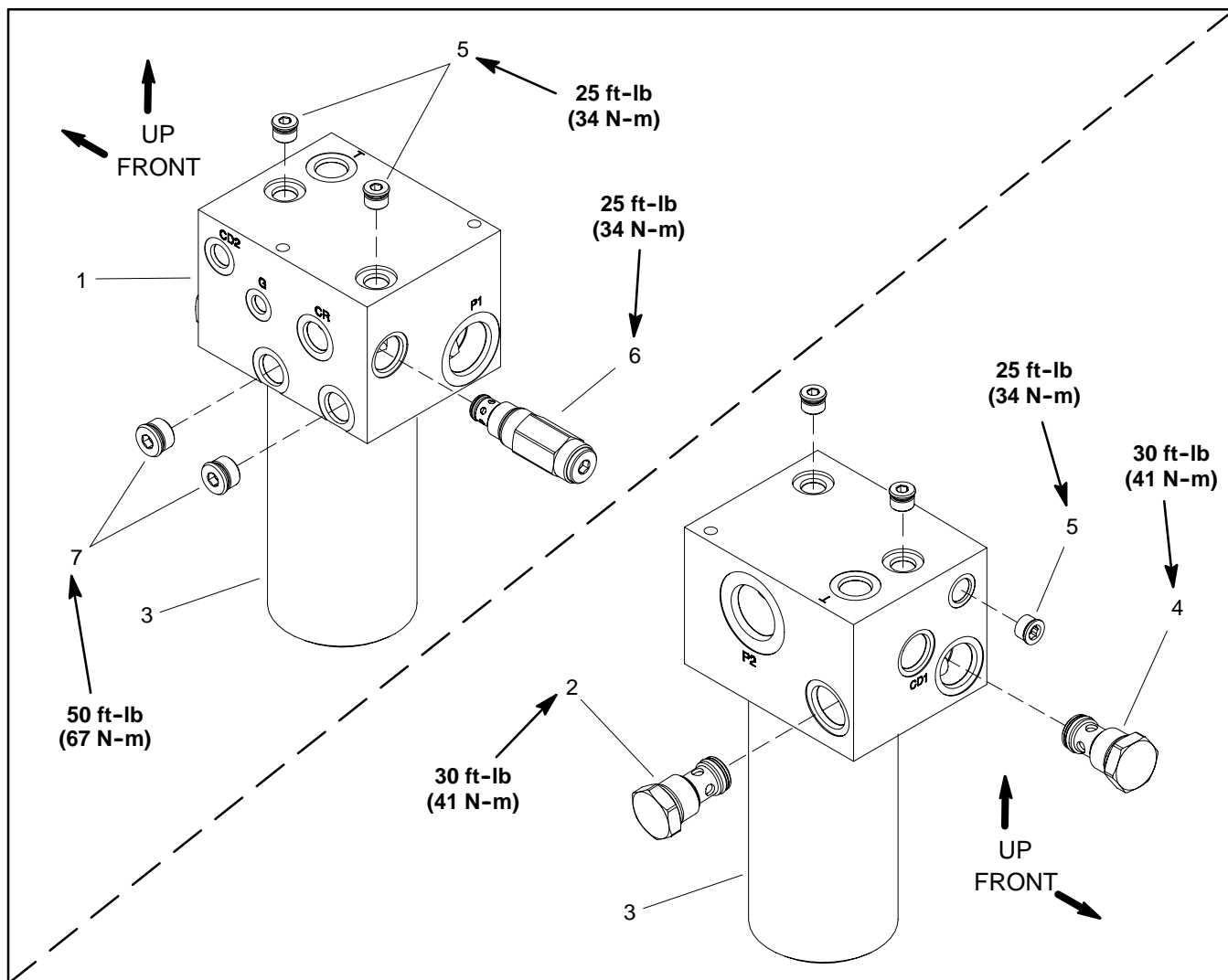


Figure 79

- |                                   |                                  |                                  |
|-----------------------------------|----------------------------------|----------------------------------|
| 1. Filter manifold                | 4. Check valve (filter bypass)   | 6. Charge relief valve           |
| 2. Check valve (reservoir return) | 5. #6 zero leak plug with O-ring | 7. #8 zero leak plug with O-ring |
| 3. Oil filter element             |                                  |                                  |

**NOTE:** The ports on the filter manifold are marked for easy identification of components. Example: P2 is the gear pump connection port and T is the connection for the hydraulic reservoir return port (see Hydraulic Schematic in Chapter 10 - Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port).

**NOTE:** The filter 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.

### **Filter Manifold Service (Fig. 79)**

For filter manifold cartridge valve service procedures, see 4WD Manifold Service in this section. Refer to Figure 79 for filter manifold cartridge valve and plug installation torque.

## Steering and Engine Cooling Fan Circuits

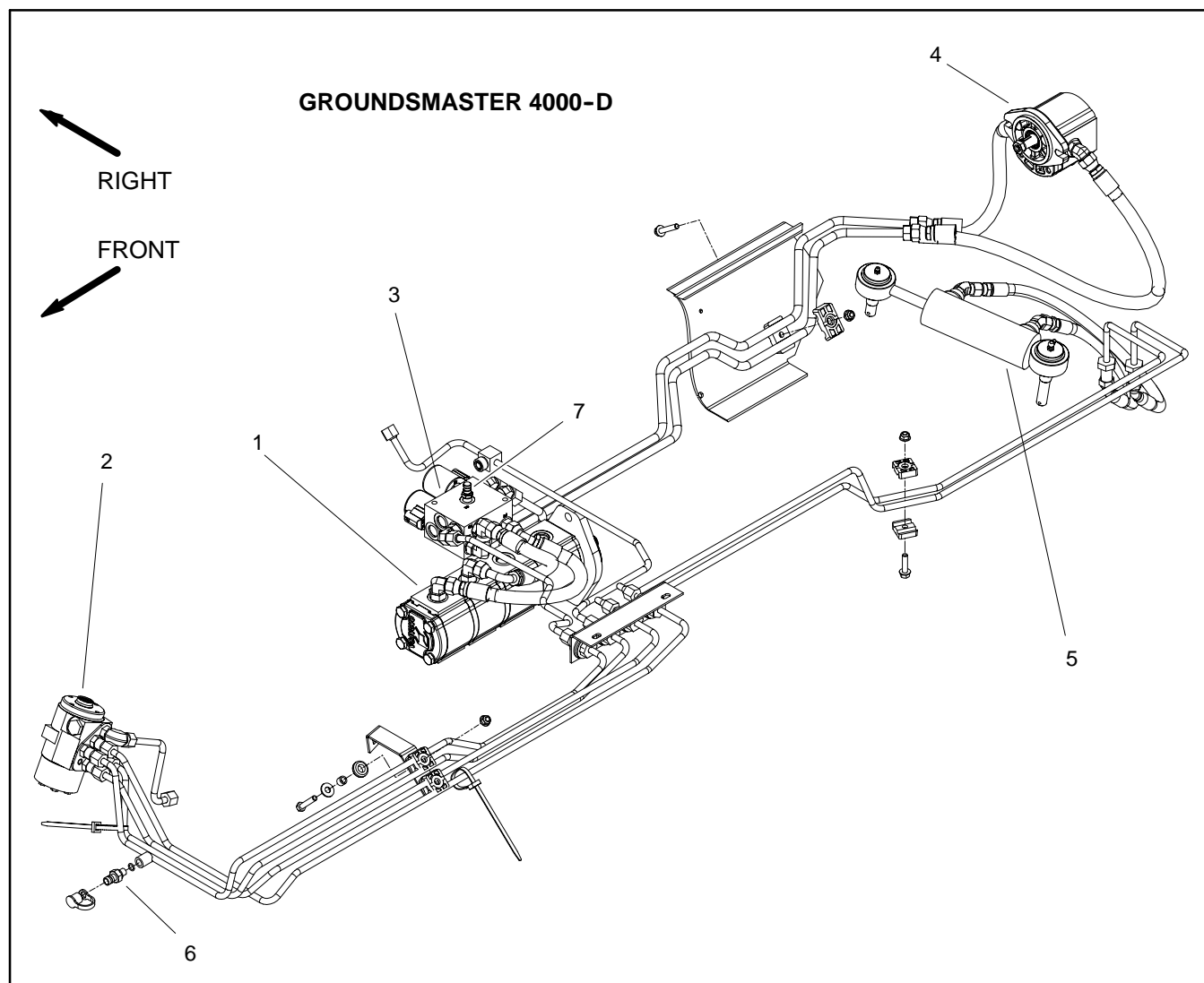


Figure 80

1. Gear pump
2. Steering control valve
3. Fan drive manifold

4. Fan motor
5. Steering cylinder

6. Steering circuit test port (GM4000)
7. Fan circuit test port

Figure 80 illustrates the components that are used in the Groundsmaster 4000-D steering and engine cooling fan circuits. The steering control valve hydraulic lines used on the Groundsmaster 4010-D are slightly different and are shown in Figure 81. Procedures for removal, installation and disassembly/assembly of these components are provided on the following pages of this section.

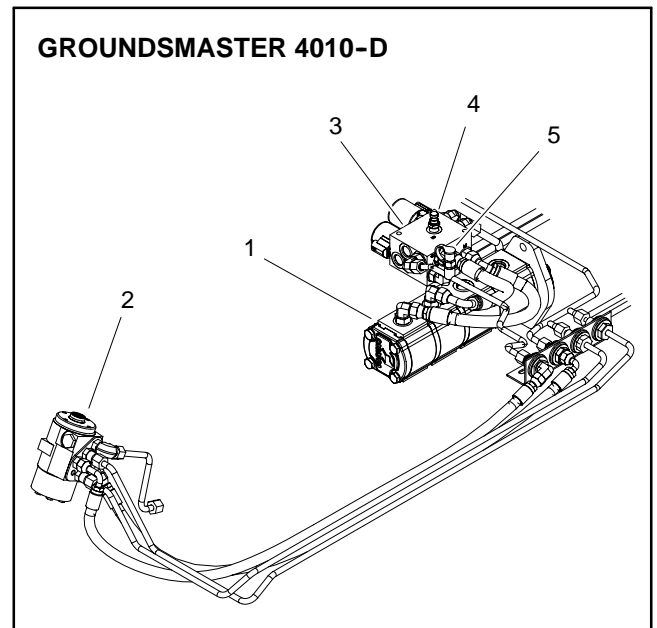


Figure 81

- |                           |                          |
|---------------------------|--------------------------|
| 1. Gear pump              | 4. Fan circuit test port |
| 2. Steering control valve | 5. Steering test port    |
| 3. Fan drive manifold     |                          |

## Steering Control Valve

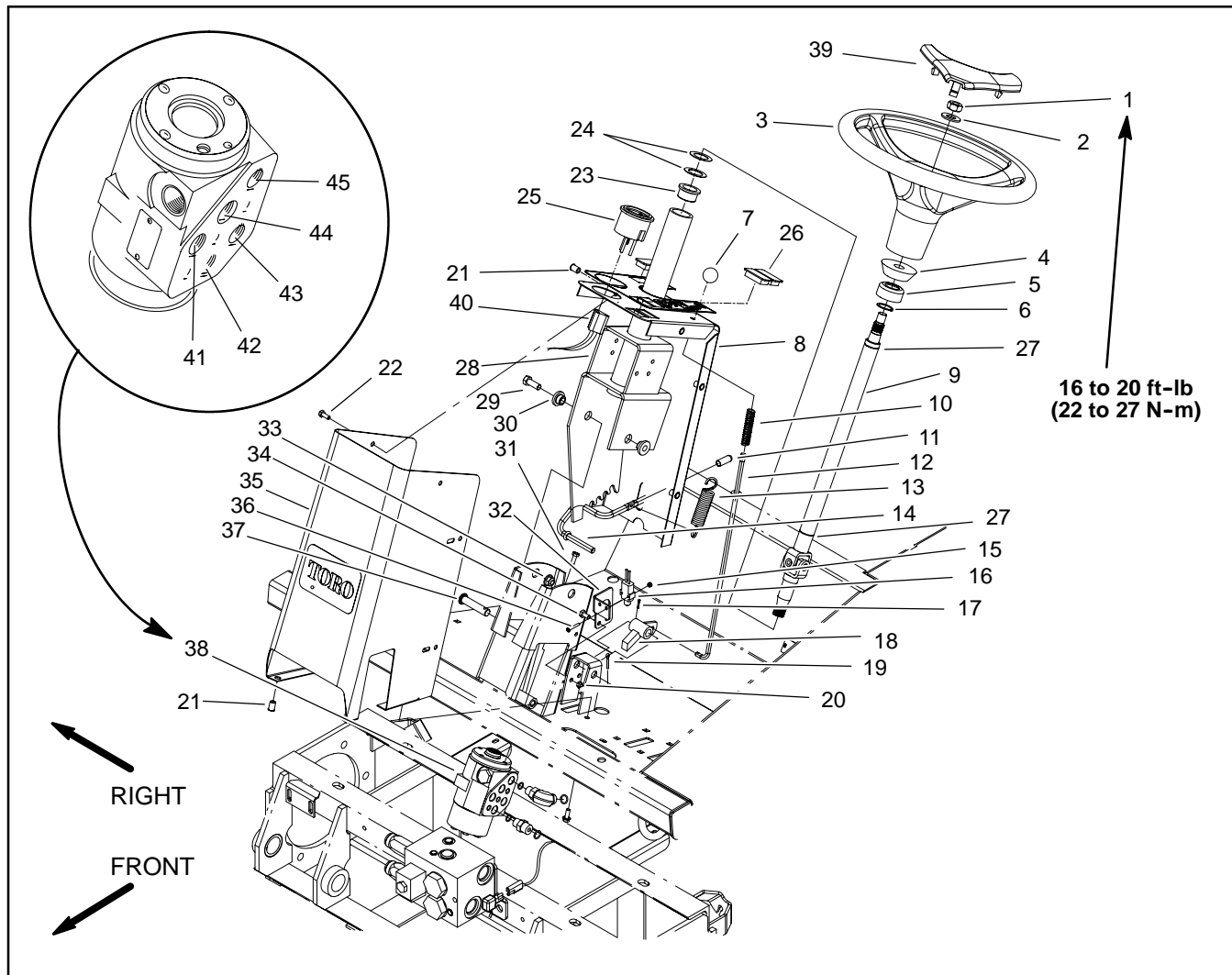


Figure 82

- |                                |                                 |                                  |
|--------------------------------|---------------------------------|----------------------------------|
| 1. Hex nut                     | 16. Parking brake switch        | 31. Flange head screw (4 used)   |
| 2. Flat washer                 | 17. Cotter pin                  | 32. Switch bracket               |
| 3. Steering wheel              | 18. Brake pawl                  | 33. Flange nut (2 used)          |
| 4. Foam collar                 | 19. Cotter pin                  | 34. Cap screw (2 used)           |
| 5. Steering seal               | 20. Lock nut (2 used)           | 35. Steering tower               |
| 6. External snap ring (2 used) | 21. Nut insert (10 used)        | 36. Phillips head screw (2 used) |
| 7. Knob                        | 22. Flange head screw (10 used) | 37. Clevis pin                   |
| 8. Steering tower cover        | 23. Flange bushing (2 used)     | 38. Steering control valve       |
| 9. Steering shaft              | 24. Thrust washer (as needed)   | 39. Steering wheel cover         |
| 10. Compression spring         | 25. Temperature gauge           | 40. Platform wire harness        |
| 11. Cap                        | 26. Plug                        | 41. In port (P)                  |
| 12. Rod assembly               | 27. Snap ring location          | 42. Right turn port (R)          |
| 13. Extension spring           | 28. Steering column             | 43. Load sensing port (PB)       |
| 14. Tilt rod                   | 29. Cap screw (2 used)          | 44. Left turn port (L)           |
| 15. Lock nut (2 used)          | 30. Pivot hub (2 used)          | 45. Out port (T)                 |



## Removal (Fig. 82)

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. To prevent contamination of hydraulic system during steering control valve removal, thoroughly clean exterior of control valve and fittings.

**NOTE:** To ease installation, label the hydraulic lines to show their correct position on the steering control valve.

4. Remove hydraulic lines from steering control valve.

5. Remove steering control valve from machine using Figure 82 as a guide.

6. If hydraulic fittings are to be removed from steering control valve, mark fitting orientation to allow correct assembly. Remove fittings from valve and discard O-rings (Fig. 83 or 84).

## Installation (Fig. 82)

1. If fittings were removed from steering control valve, lubricate and place new O-rings onto fittings. Install fittings into port openings using marks made during the removal process to properly orientate fittings (Fig. 83 or 84). Tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).

2. Install steering control valve using Figure 82 as a guide.

3. Using labels placed during steering control valve removal, properly install hydraulic lines to control valve (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

4. Make sure hydraulic tank is full.

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

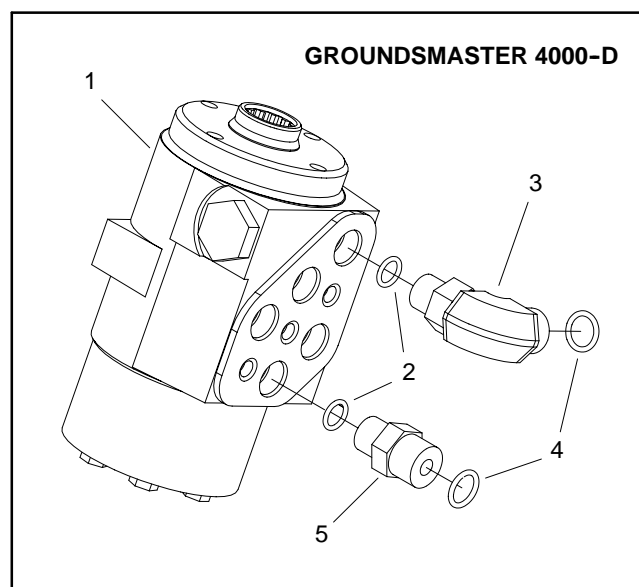


Figure 83

- |                           |                              |
|---------------------------|------------------------------|
| 1. Steering control valve | 4. O-ring                    |
| 2. O-ring                 | 5. Straight fitting (4 used) |
| 3. 90° hydraulic fitting  |                              |

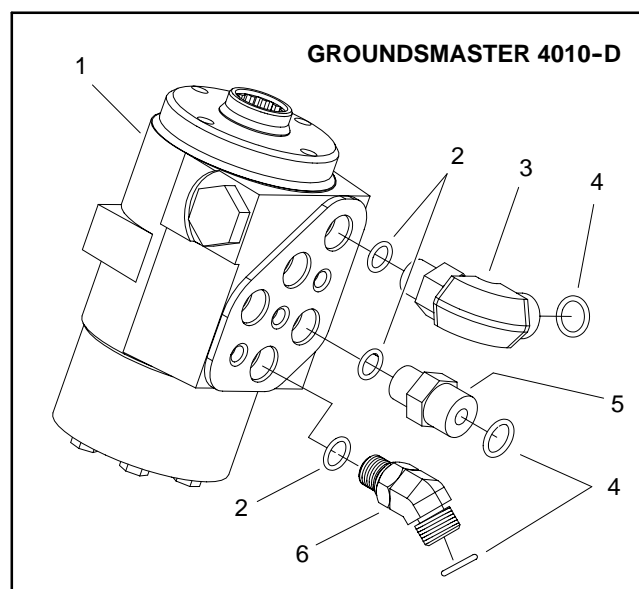


Figure 84

- |                           |                              |
|---------------------------|------------------------------|
| 1. Steering control valve | 4. O-ring                    |
| 2. O-ring                 | 5. Straight fitting (3 used) |
| 3. 90° hydraulic fitting  | 6. 45° hydraulic fitting     |

## Steering Control Valve Service

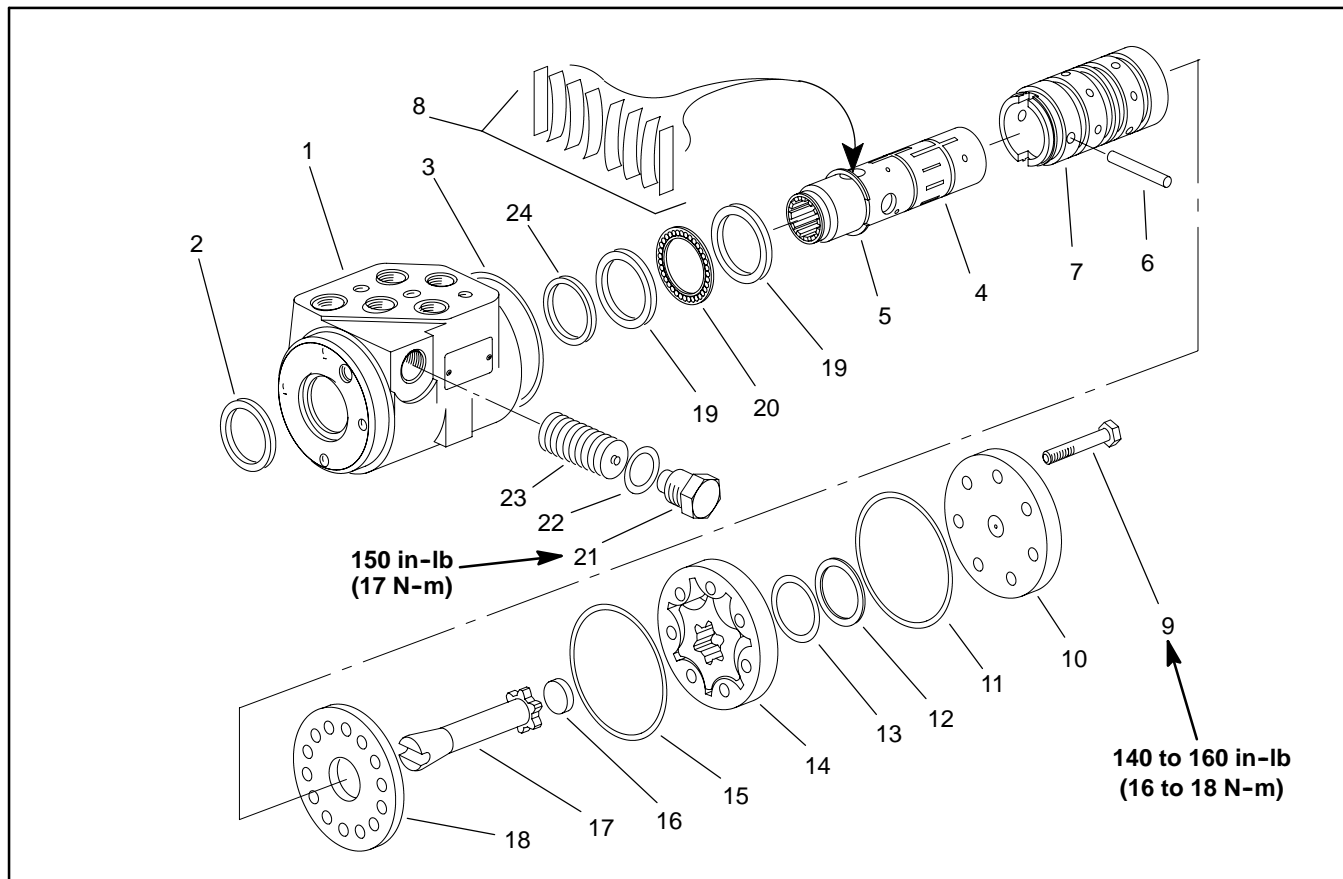


Figure 85

- |                                   |                       |                    |
|-----------------------------------|-----------------------|--------------------|
| 1. Steering control valve housing | 9. Cap screw (7 used) | 17. Geroter drive  |
| 2. Dust seal                      | 10. End cap           | 18. Wear plate     |
| 3. O-ring                         | 11. O-ring            | 19. Bearing race   |
| 4. Spool                          | 12. Seal ring         | 20. Thrust bearing |
| 5. Spring retaining ring          | 13. O-ring            | 21. Plug           |
| 6. Pin                            | 14. Geroter           | 22. O-ring         |
| 7. Sleeve                         | 15. O-ring            | 23. Relief valve   |
| 8. Centering springs/spacers      | 16. Spacer            | 24. Quad seal      |

**NOTE:** Cleanliness is extremely important when repairing hydraulic components. Work in a clean area. Before disassembly, drain the oil, then plug the ports and thoroughly clean the exterior. During repairs, always protect machined surfaces.

### Disassembly (Fig. 85)

1. Remove the seven (7) cap screws from the steering control valve assembly.
2. Remove end cap, geroter, spacer, geroter drive, wear plate, seal ring and O-rings from housing.
3. Remove the plug and relief valve.
4. Slide the spool and sleeve assembly from the housing.
5. Remove the thrust bearing and bearing races (2).
6. Remove the quad seal.
7. Use a small blade screwdriver to carefully pry the dust seal from the housing. Be careful to not damage the dust seal seat in the housing.
8. Remove the pin that holds the spool and sleeve together.
9. Carefully slide the spool out of the sleeve. The centering springs and spring retaining ring will stay with the spool as it is removed.



## CAUTION

**The centering springs are under tension. Remove the retaining ring carefully.**

10. Remove the spring retaining ring and centering springs from the spool.

### Assembly (Fig. 85)

Check all mating surfaces. Replace any parts with scratches or burrs that could cause leakage. Wash all metal parts in clean solvent. Blow them dry with pressurized air. Do not wipe parts dry with paper towels or cloth. Lint in a hydraulic system will cause damage.

**NOTE:** Always use new seals and O-rings when assembling the steering control valve.

**IMPORTANT:** During assembly, lubricate the new seals with petroleum jelly. Also, lubricate machined surfaces and bearings with clean hydraulic fluid.

1. Install the quad seal:

A. Put one of the bearing races and sleeve into the housing.

B. Together, the housing and bearing race create a groove into which the quad seal will be installed.

C. Hold the bearing race tightly against the input end of the housing by pushing on the gerotor end of the sleeve.

D. Fit the quad seal into its seat through the input end of the housing. Be sure the seal is not twisted.

E. Remove the sleeve and bearing race.

2. Lubricate and install the dust seal.

3. Install the centering springs in the spool. It is best to install the two flat pieces first. Next, install the curved pieces, three at a time.

4. Fit the retaining ring over the centering springs.

5. Apply a light coating of clean hydraulic fluid to the spool and slide it into the sleeve. Be sure the centering springs fit into the notches in the sleeve.

6. Install the pin.

7. Apply a light coating of petroleum jelly to the inner edge of the dust and quad seals.

8. Put the thrust bearing and races into the housing. The thrust bearing goes between the two races (Fig. 86).

**IMPORTANT:** Do not damage the dust or quad seals when installing the spool and sleeve assembly.

9. Apply a light coating of clean hydraulic fluid to the spool and sleeve assembly and slide carefully the assembly into the housing.

10. Clamp the housing in a vise. Use only enough clamping force to hold the housing securely.

11. Lubricate and install a new o-ring seal in the groove in the housing.

12. Install the wear plate and align screw holes in the wear plate with threaded holes in the housing.

**NOTE:** The holes in the wear plate are symmetrical.

13. Install the gerotor drive, making sure the slot in the drive engages the pin.

14. Lubricate and install new o-ring in wear plate groove.

15. Install the gerotor and align the screw holes.

16. Lubricate and install new o-ring in gerotor ring groove.

17. Lubricate and install new o-ring and seal ring in gerotor star groove.

18. Install the spacer.

19. Install the end cap and seven (7) cap screws. Tighten the cap screws, in a crossing pattern, from **140 to 160 in-lb (16 to 18 N-m)**.

20. Remove the steering control valve from the vise.

21. Install the relief valve and plug. Tighten the plug to **150 in-lb (17 N-m)**.

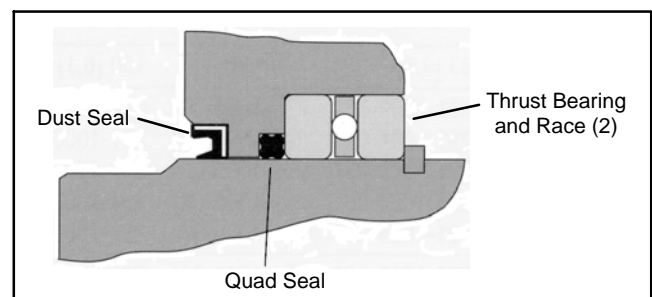


Figure 86

## Steering Cylinder

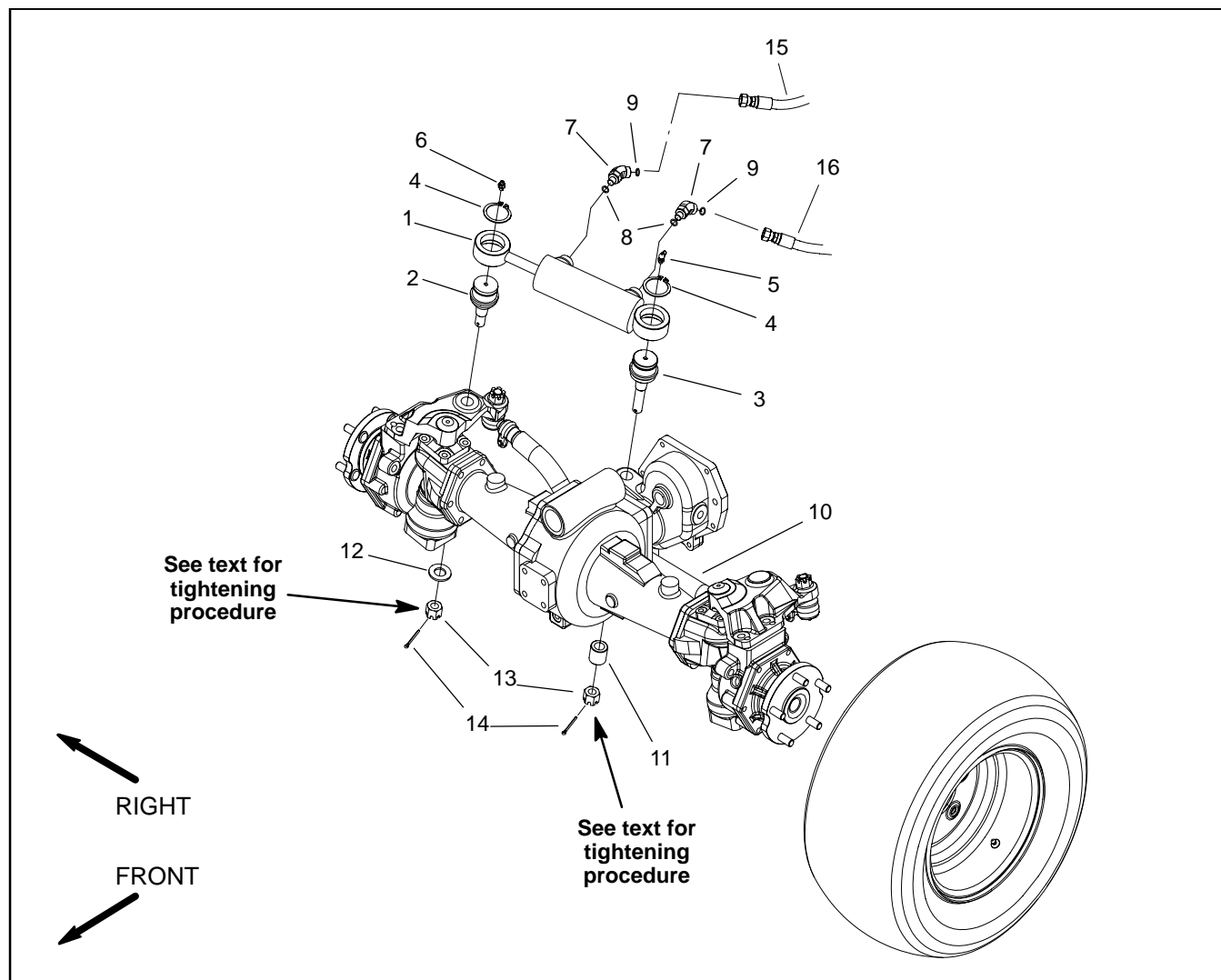


Figure 87

- 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. 87)

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. To prevent contamination of hydraulic system during cylinder removal, thoroughly clean exterior of cylinder and fittings.

**NOTE:** To ease installation, tag the hydraulic hoses to show their correct position on the steering cylinder.

4. Remove hydraulic hoses from steering cylinder.

5. 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.

6. 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.

7. If needed, remove ball joints from steering cylinder.

### Installation (Fig. 87)

1. If removed, install ball joints into steering cylinder.

2. If fittings were removed from steering cylinder, lubricate and place new O-rings onto fittings. Install fittings into port 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).

3. Slide ram end ball joint through hole on steering arm. Secure with axle washer and hex slotted nut. Slide fixed end of cylinder through hole on axle. Secure with slotted hex nut. Torque slotted hex nuts to **100 ft-lbs (135 N-m)** and then continue tightening the nut until hex nut groove aligns with cotter pin hole in ball joint. Install cotter pin to nut and ball joint.

4. Install hydraulic hoses to steering cylinder (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

5. Fill reservoir with new hydraulic fluid as required.

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

7. After assembly is completed, operate steering cylinder to verify that hydraulic hoses and fittings are not contacted by anything.

## Steering Cylinder Service

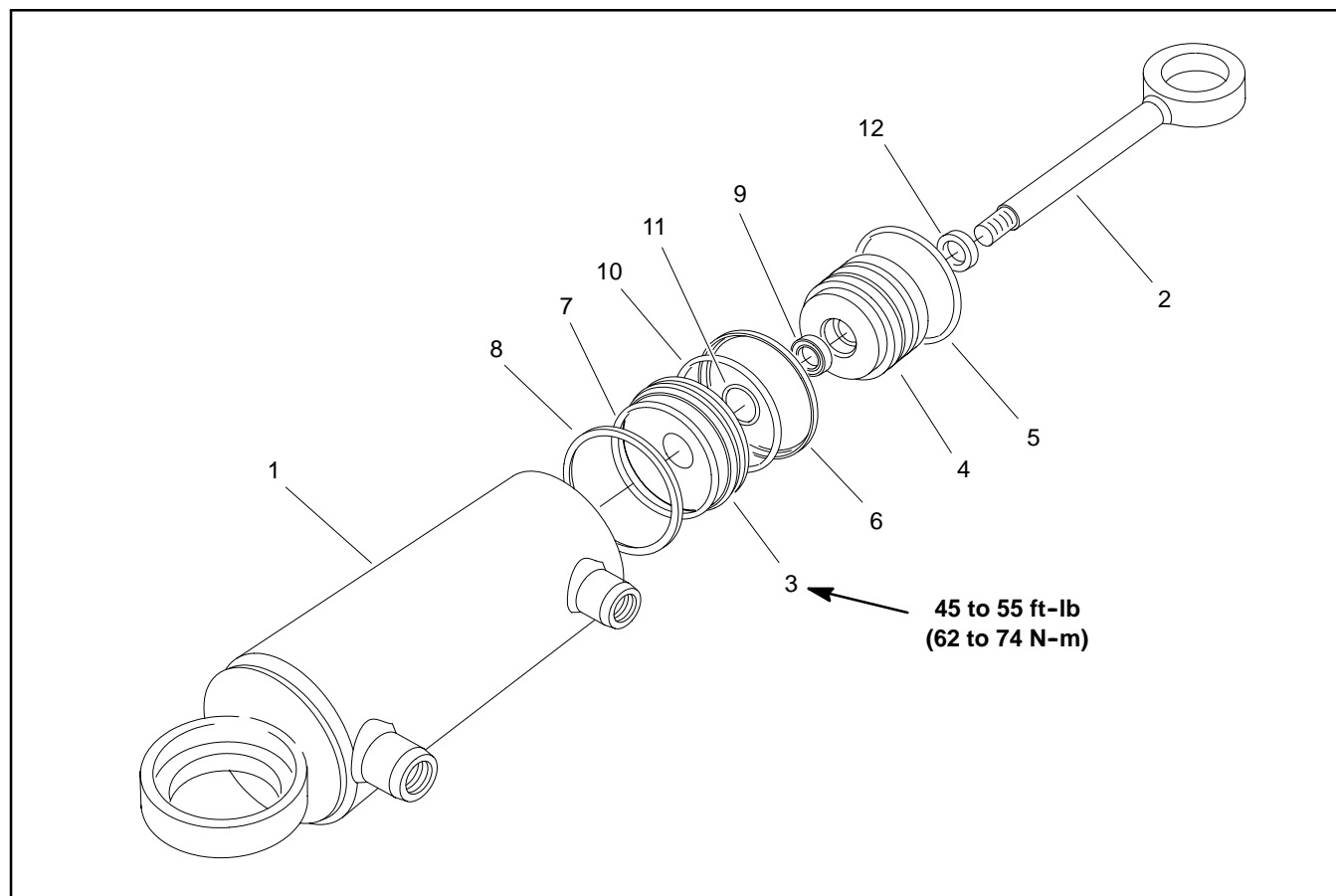


Figure 88

- 1. Tube assembly
- 2. Rod
- 3. Piston assembly
- 4. Head

- 5. Retaining ring
- 6. Backup ring
- 7. O-ring
- 8. Cap seal

- 9. Rod seal
- 10. O-ring
- 11. O-ring
- 12. Wiper

**Disassembly (Fig. 88)**

1. Pump oil out of cylinder into a drain pan by SLOWLY moving rod and piston in and out of cylinder bore. Plug ports and clean outside of cylinder.

**IMPORTANT: To prevent damage when clamping cylinder in a vise, clamp only on pivotal ends. Use of a vise with soft jaws is recommended.**

2. Mount cylinder in a vise so rod end of cylinder is tilted up slightly. Do not close vise so firmly that cylinder tube could become distorted.

3. Loosen head from tube:

A. Use a spanner wrench to rotate head clockwise until the edge of the retaining ring appears in the tube 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 tube and head.

4. Grasp end of piston rod and use a twisting and pulling motion to carefully extract piston, piston rod and head from cylinder tube.

**IMPORTANT: Do not clamp vise jaws against piston rod surface; the piston rod will be damaged.**

5. Securely mount piston, piston rod and head assembly into vise with soft jaws.

6. Remove set screws that secure piston to piston rod. Remove piston from piston rod and then slide head from rod.

7. Remove and discard all seals and O-rings from head and piston.

**CAUTION**

**Use eye protection such as goggles when using compressed air to dry cylinder components.**

8. 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.

9. Carefully inspect internal surface of barrel for damage (deep scratches, out-of-round, etc.). Replace entire cylinder if barrel is damaged. Inspect rod and piston for evidence of excessive scoring, pitting or wear. Replace any damaged parts.

**Assembly (Fig. 88)**

1. Use a complete repair kit when rebuilding the cylinder. Put a coating of clean hydraulic oil on all new seals and O-rings.

2. Install new O-rings and seals to the piston and head.

3. Lubricate shaft with clean hydraulic oil. Slide head onto shaft.

4. Install and tighten piston onto shaft. Torque piston from **45 to 55 ft-lb (62 to 74 N-m)**.

5. Apply Loctite #242 (or equivalent) to set screws and install set screws into piston. Torque set screws from **5 to 7 ft-lb (7 to 9 N-m)**.

6. Put a coating of clean hydraulic oil on all cylinder parts to ease assembly.

7. Slide rod assembly into cylinder tube.

**IMPORTANT: To prevent damage when clamping cylinder in a vise, clamp only on pivotal ends. Use of a vise with soft jaws is recommended.**

8. 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 tube.

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

C. Apply silicone sealer to tube access slot.

## Engine Cooling Fan Motor

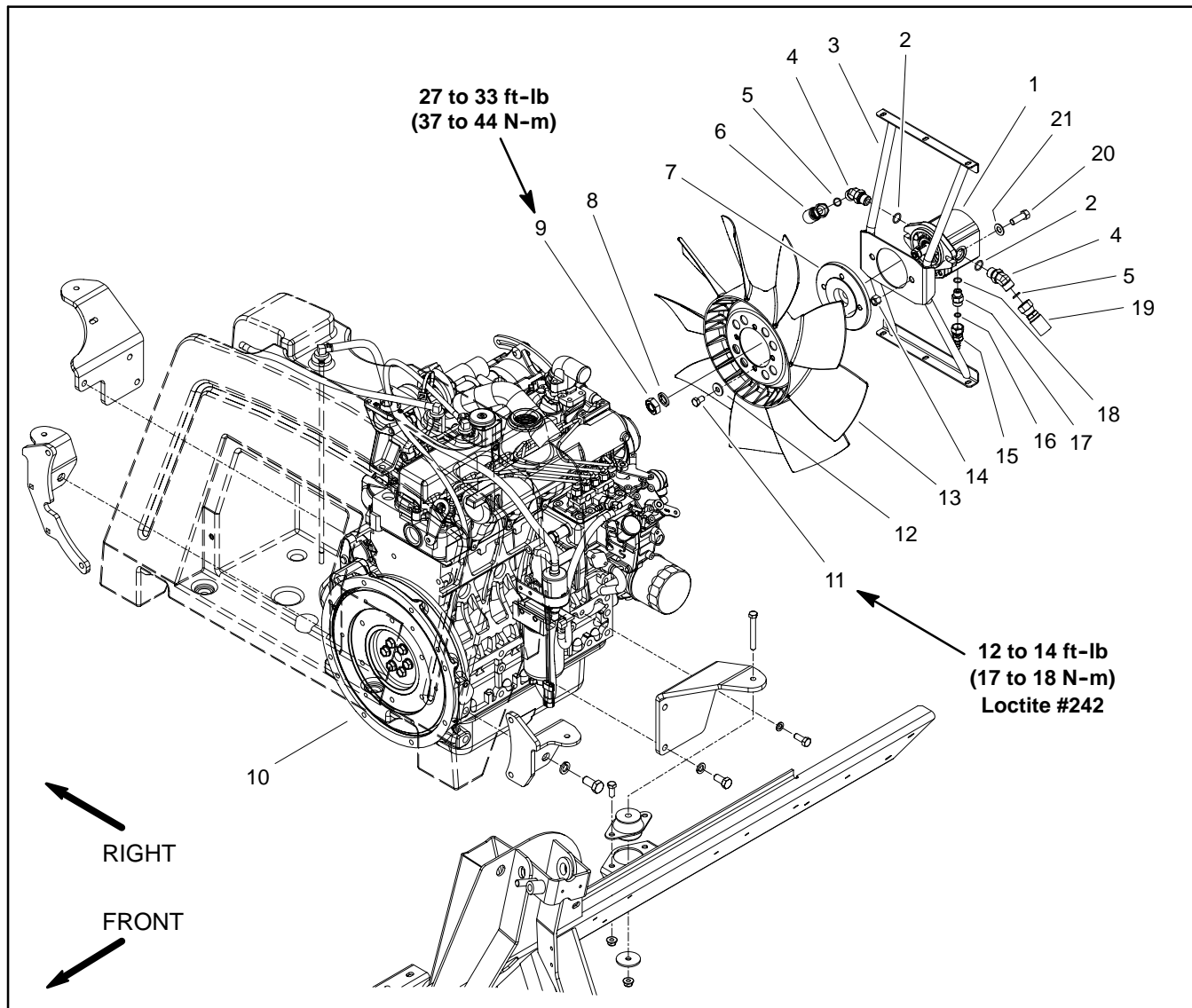


Figure 89

1. Hydraulic fan motor
2. O-ring
3. Bracket
4. 45° hydraulic fitting
5. O-ring
6. Hydraulic hose
7. Fan hub

8. Washer
9. Hex nut
10. Engine
11. Cap screw (4 used)
12. Washer (4 used)
13. Fan
14. Lock nut (2 used)

15. Hydraulic hose
16. O-ring
17. Hydraulic fitting
18. O-ring
19. Hydraulic hose
20. Cap screw (2 used)
21. Flat washer (2 used)

### Removal (Fig. 89)

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.



### CAUTION

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

4. Remove air cleaner hose and upper radiator shroud to allow easier access to hydraulic fan motor (Fig. 90).



5. Remove four (4) cap screws (item 11) and washers used to secure fan to fan hub. Remove fan.

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

6. Remove cooling fan motor and bracket assembly.

A. To prevent contamination of hydraulic system, thoroughly clean exterior of fan motor and fittings.

B. Disconnect hydraulic hoses from fan motor. Put caps or plugs on fittings and hoses to prevent contamination. Label hydraulic lines for proper assembly.

C. Remove six (6) cap screws and flange nuts that secure fan motor bracket to radiator.

D. Carefully remove fan motor and bracket assembly from machine and place on suitable work surface.

7. Remove hex nut (item 9) and washer (item 8) that secure fan hub to fan motor. Use suitable puller to carefully remove fan hub from fan motor shaft. Locate and retrieve woodruff key.

8. Remove two (2) cap screws (item 20), flat washers (item 21) and lock nuts (item 14) that secure fan motor to fan motor bracket. Remove fan motor from bracket.

9. If hydraulic fittings are to be removed from fan motor, mark fitting orientation to allow correct assembly. Remove fittings from motor and discard O-rings.

### Installation (Fig. 89)

1. If fittings were removed from fan motor, lubricate and place new O-rings onto fittings. Install fittings into port 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 fan motor to fan motor bracket and secure with cap screws (item 20), flat washers (item 21) and lock nuts (item 14).

3. Thoroughly clean tapered surfaces of fan motor shaft and fan hub. Place woodruff key in slot in motor shaft.

4. Position fan hub onto motor shaft and secure with washer (item 8) and hex nut (item 9). Torque nut from **27 to 33 ft-lb (37 to 44 N-m)**.

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

5. Carefully position fan motor and bracket assembly to radiator and secure with six (6) cap screws and flange nuts.

6. Remove caps and plugs placed in hoses and fittings during removal to prevent contamination. Connect hydraulic hoses to cooling fan motor (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

7. Apply Loctite #242 (or equivalent) to threads of cap screws (item 11) used to secure fan to fan hub. Position fan to fan hub and secure with four (4) cap screws and washers. Torque screws from **12 to 14 ft-lb (17 to 18 N-m)**.

8. Install upper radiator shroud and air cleaner hose (Fig. 90). Make sure that clearance between shroud and cooling fan is at least 0.180" (4.6 mm) at all points.

9. Lower and secure hood.

10. Make sure hydraulic tank is full.

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

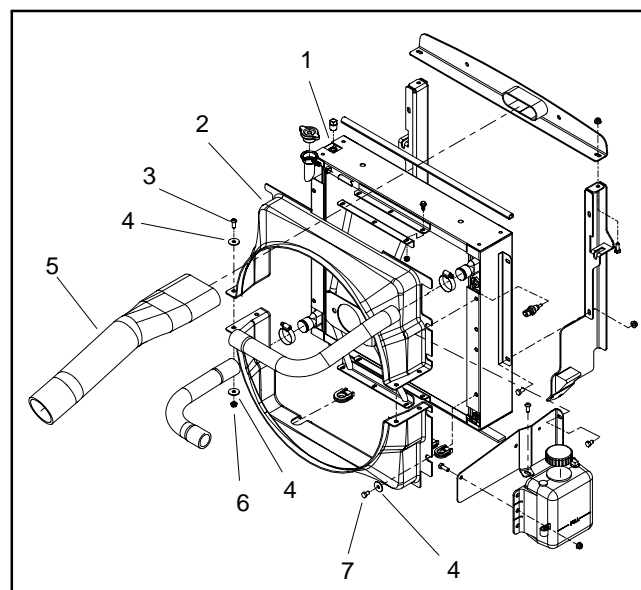


Figure 90

- |                          |                        |
|--------------------------|------------------------|
| 1. Radiator              | 5. Air cleaner hose    |
| 2. Upper radiator shroud | 6. Flange nut (4 used) |
| 3. Screw (4 used)        | 7. Cap screw           |
| 4. Flat washer           |                        |

## Engine Cooling Fan Motor Service

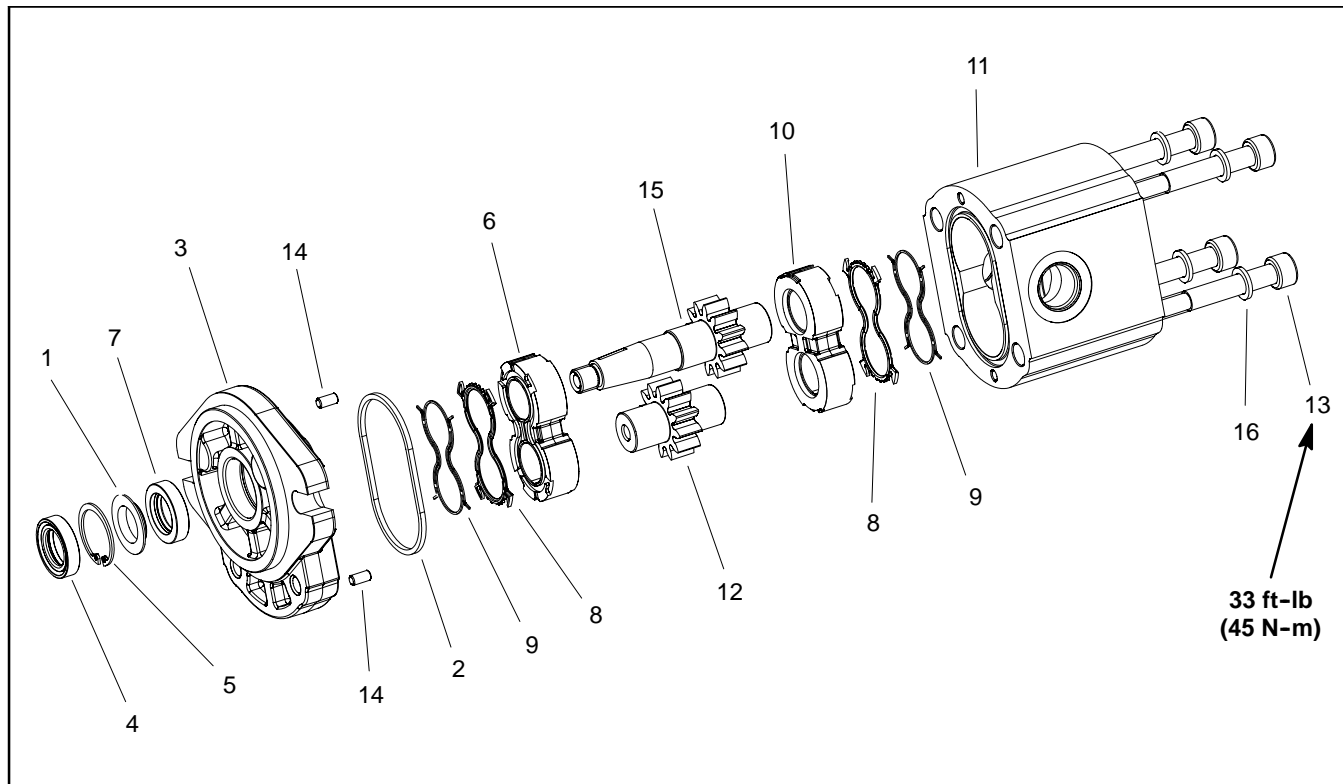


Figure 91

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)

### Disassembly (Fig. 91)

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 and body for assembly purposes (Fig. 92).

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

3. Clamp front flange of motor in a vise with soft jaws with the shaft end down.

4. Loosen cap screws from the rear cover.

5. Remove motor from the vise. Turn motor so that the shaft end is facing down. Remove cap screws.

6. 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.

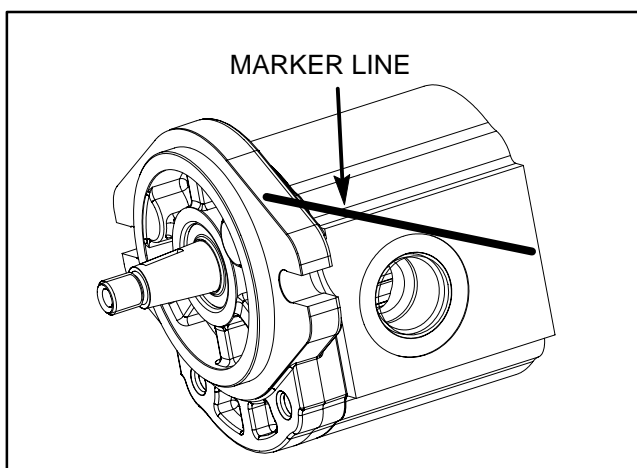


Figure 92

**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.**

7. Carefully remove rear wear plate, idler gear, drive gear and front wear plate from the front flange.

8. Remove and discard back-up gaskets and pressure seals from wear plates.

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

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

10. Carefully remove dust seal, retaining ring, flange washer and shaft seal from the front flange (Fig. 93). Note orientation of seal lips during removal. 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. 94):

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 body for damage or wear.

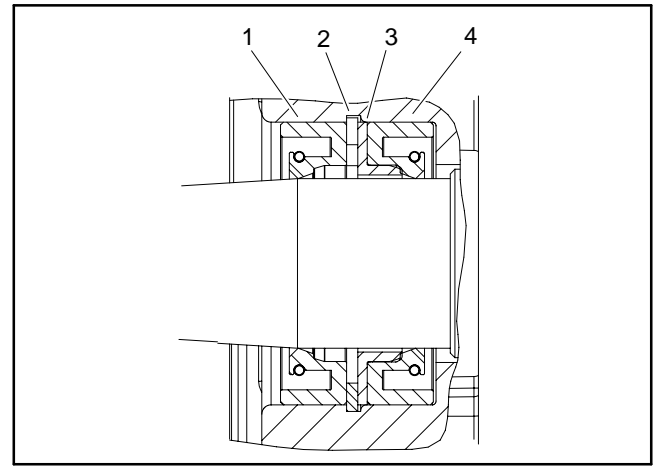


Figure 93

- |                   |                  |
|-------------------|------------------|
| 1. Dust seal      | 3. Flange washer |
| 2. Retaining ring | 4. Shaft seal    |

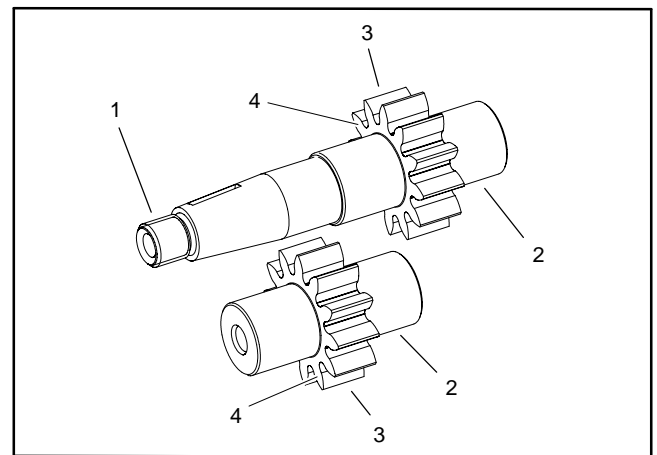


Figure 94

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

### Assembly (Fig. 91)

**NOTE:** When assembling motor, check the marker line on each part to make sure 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. 93). Note orientation of seal lips during installation:

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

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

13. Place front flange of the motor into a vise with soft jaws and alternately torque the cap screws **33 ft-lb (45 N-m)**.

14. Remove motor from vise.

15. 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.

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## Fan Drive Manifold

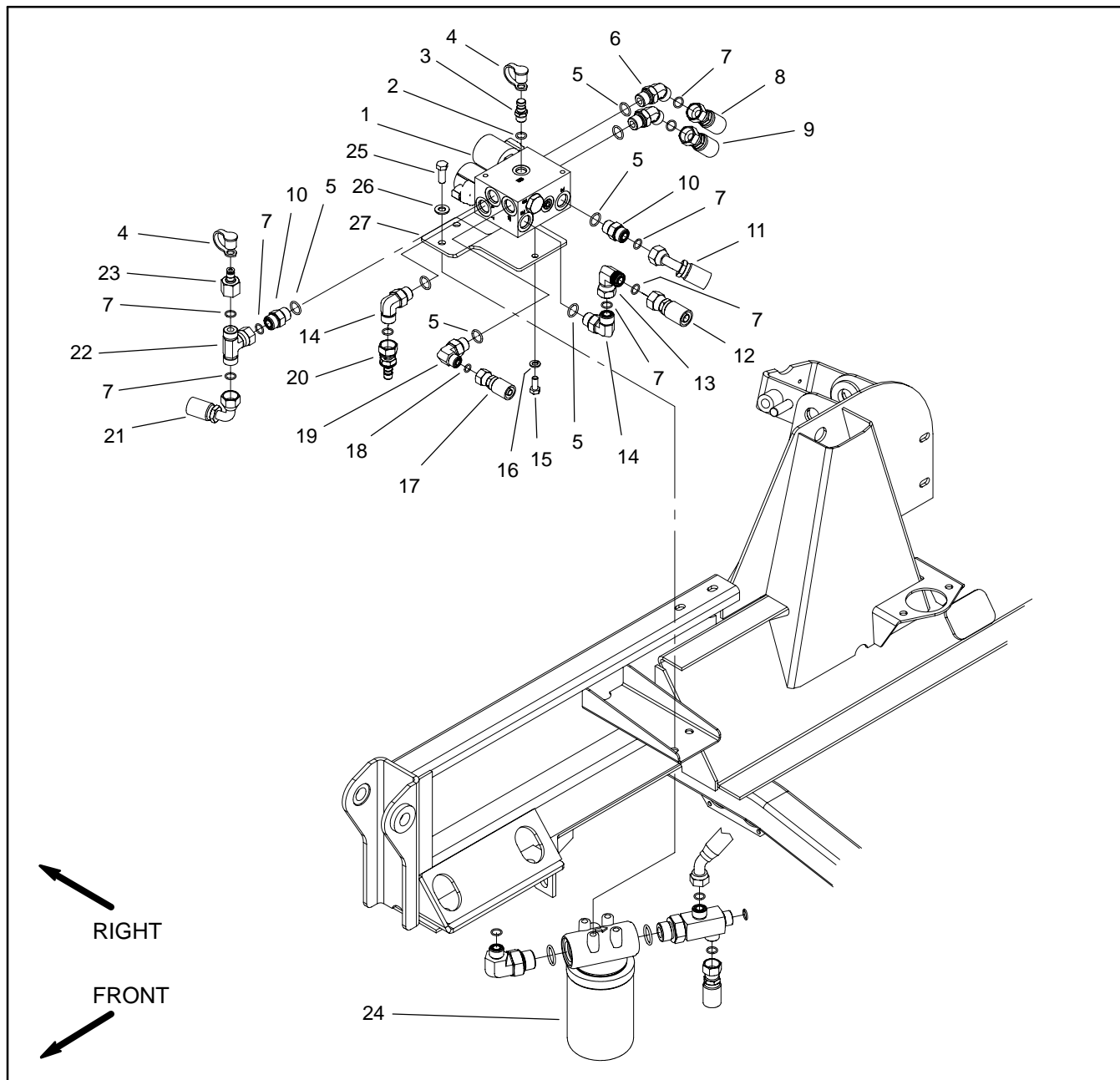


Figure 95

- |                                   |                                    |                            |
|-----------------------------------|------------------------------------|----------------------------|
| 1. Fan drive manifold             | 10. Hydraulic fitting              | 19. 90° hydraulic fitting  |
| 2. O-ring                         | 11. Hydraulic hose                 | 20. Hydraulic hose         |
| 3. Test fitting                   | 12. Hydraulic hose                 | 21. Hydraulic hose         |
| 4. Dust cap (2 used)              | 13. 90° hydraulic fitting          | 22. Hydraulic tee fitting  |
| 5. O-ring                         | 14. 90° hydraulic fitting (2 used) | 23. Hydraulic test fitting |
| 6. 45° hydraulic fitting (2 used) | 15. Cap screw (2 used)             | 24. Oil filter assembly    |
| 7. O-ring                         | 16. Lock washer (2 used)           | 25. Cap screw (2 used)     |
| 8. Hydraulic hose                 | 17. Hydraulic hose                 | 26. Flat washer (2 used)   |
| 9. Hydraulic hose                 | 18. O-ring                         | 27. Manifold mount         |

**NOTE:** The ports on the manifold are marked for easy identification of components. Example: P1 and P2 are gear pump connection ports and S1 is the solenoid valve port (see Hydraulic Schematic in Chapter 10 - Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port).

### Removal (Fig. 95)

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 operator seat to allow access to fan drive manifold (Fig. 96).
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 manifold removal, thoroughly clean exterior of fan drive manifold and fittings.
5. Label wire harness electrical connectors that attach to manifold solenoid valve coils. Disconnect wire harness connectors from the solenoid coils.
6. Disconnect hydraulic lines from fan drive manifold and put caps or plugs on open hydraulic lines and fittings. Label disconnected hydraulic lines for proper re-assembly.
7. Remove fan drive manifold from the frame using Figure 95 as a guide.
8. If hydraulic fittings are to be removed from manifold, mark fitting orientation to allow correct assembly. Remove fittings from manifold and discard O-rings.

### Installation (Fig. 95)

1. If fittings were removed from 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).
2. Install fan drive manifold to the frame using Figure 95 as a 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. Connect wire harness connectors to the solenoid valve coils on the fan drive manifold.
5. Make sure hydraulic tank is full. Add correct oil if necessary before returning machine to service.
6. Lower and secure operator seat.

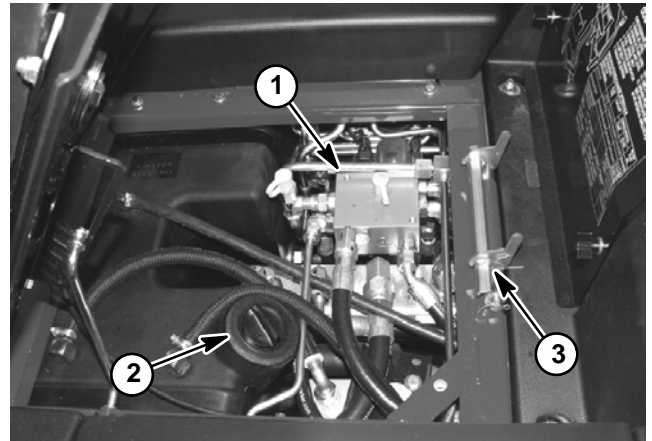


Figure 96

- |                        |                        |
|------------------------|------------------------|
| 1. Fan drive manifold  | 3. Operator seat latch |
| 2. Hydraulic reservoir |                        |

## Fan Drive Manifold Service

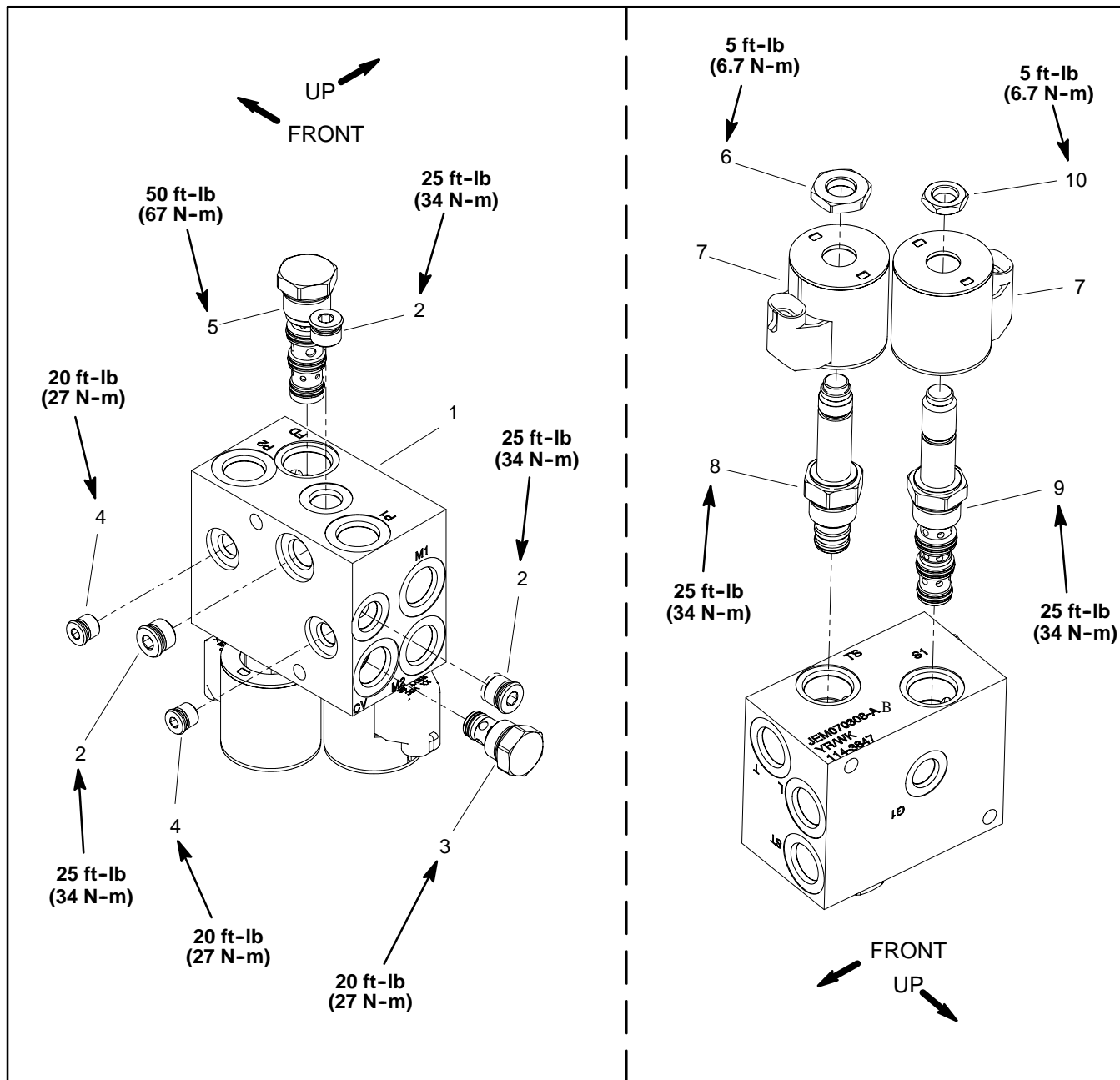


Figure 97

- |   |                                 |  |
|---|---------------------------------|--|
| 1. Fan drive manifold body                | 5. Flow divider valve (port FD) | 8. Proportional relief valve (port TS) |
| 2. #4 zero leak plug with O-ring (3 used) | 6. Nut                          | 9. Solenoid valve (port S1)            |
| 3. Check valve (port CV)                  | 7. Solenoid coil (2 used)       | 10. Nut                                |
| 4. #6 zero leak plug with O-ring (2 used) |                                 |  |

**NOTE:** The ports on the manifold are marked for easy identification of components. Example: P1 and P2 are gear pump connection ports and S1 is the solenoid valve port (see Hydraulic Schematic in Chapter 10 - Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port).

**NOTE:** The fan drive 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.



### **Fan Drive Manifold Service (Fig. 97)**

For fan drive manifold cartridge valve service procedures, see 4WD Manifold Service in this section. Refer to Figure 97 for fan drive manifold cartridge valve and plug installation torque.

## PTO Circuit

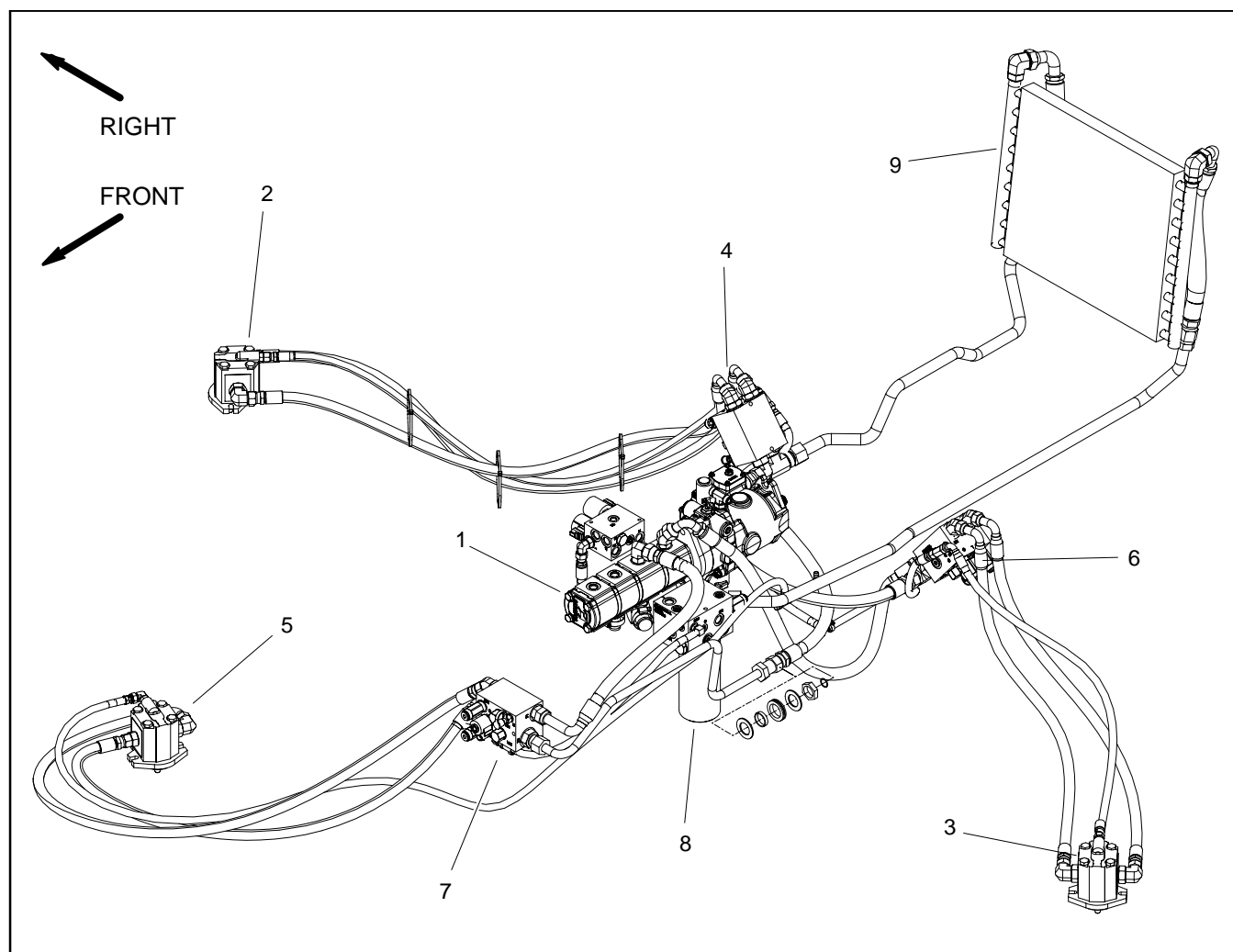


Figure 98

- |                          |                             |                       |
|--------------------------|-----------------------------|-----------------------|
| 1. Gear pump             | 4. RH PTO manifold          | 7. Front PTO manifold |
| 2. RH cutting deck motor | 5. Front cutting deck motor | 8. Filter manifold    |
| 3. LH cutting deck motor | 6. LH PTO manifold          | 9. Oil cooler         |

Figure 98 illustrates the components that are used in the Groundsmaster 4000-D and 4010-D PTO circuit. Procedures for removal, installation and disassembly/assembly of these components are provided on the following pages of this section.

## Cutting Deck Motor

### Removal

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. Thoroughly clean exterior of deck motor and fittings. Disconnect hydraulic lines from motor. Put caps or plugs on fittings and hoses to prevent contamination. Tag hydraulic lines for proper installation.
4. Remove two (2) flange head screws that secure hydraulic motor to motor mount (Fig. 99).
5. Carefully remove hydraulic motor from cutting deck taking care not to damage spider hub attached to motor. Locate and remove spider and mounting shim(s) (if equipped) from the deck.
6. If necessary, straighten tab washer and remove nut, tab washer and spider hub from motor shaft.
7. If hydraulic fittings are to be removed from motor, mark fitting orientation to allow correct assembly. Remove fittings from motor and discard O-rings.

### Installation

1. If fittings were removed from motor, lubricate and place new O-rings onto fittings. Install fittings into port 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. If removed, install spider hub on motor shaft. Secure with tab washer and nut. Torque nut from **27 to 33 ft-lb (37 to 44 N-m)**. Bend small tab of washer into keyway and large tab against nut.
3. Check for proper clearance between spider hub and spindle pulley. Install motor to cutting deck without placing the spider in the spindle pulley. The clearance between hub and pulley valleys should be from 0.830" to 0.930" (21.1 to 23.6 mm). If required, use mounting shim(s) between motor and motor mount to adjust clearance.
4. Position spider in spindle pulley. Place mounting shim(s) (if required) on deck. Carefully install hydraulic motor to the cutting deck taking care not to damage spider hub attached to motor.

5. Secure motor to cutting deck with two (2) flange head screws (Fig. 99).
6. Remove caps or plugs from fittings and hoses. Connect hydraulic hoses to deck motor (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).
7. After assembly is completed, verify that hydraulic hoses and fittings are not contacted by moving components.

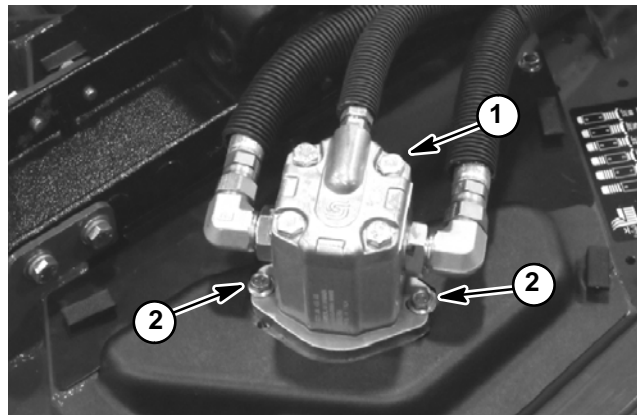


Figure 99

1. Deck motor (RH shown)      2. Flange head screw

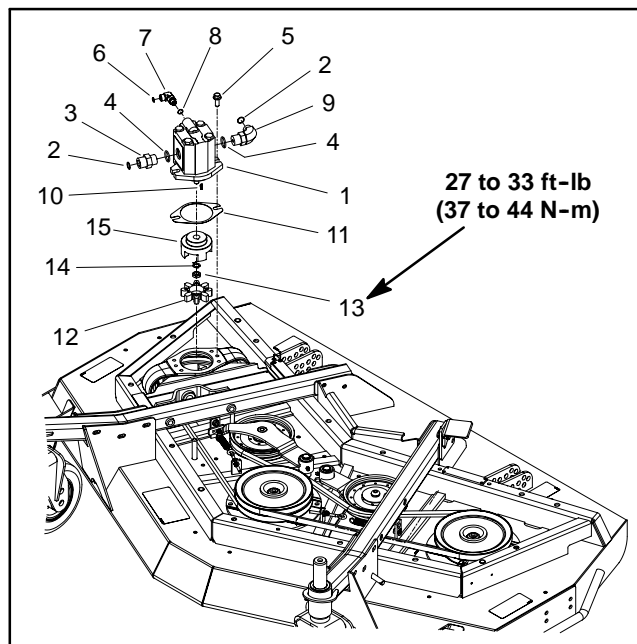


Figure 100

- |                       |                          |
|-----------------------|--------------------------|
| 1. Cutting deck motor | 9. 90° hydraulic fitting |
| 2. O-ring             | 10. Woodruff key         |
| 3. Hydraulic adapter  | 11. Shim (if required)   |
| 4. O-ring             | 12. Spider               |
| 5. Flange head screw  | 13. Nut                  |
| 6. O-ring             | 14. Tab washer           |
| 7. Hydraulic adapter  | 15. Spider hub           |
| 8. O-ring             |                          |

## Cutting Deck Motor Service

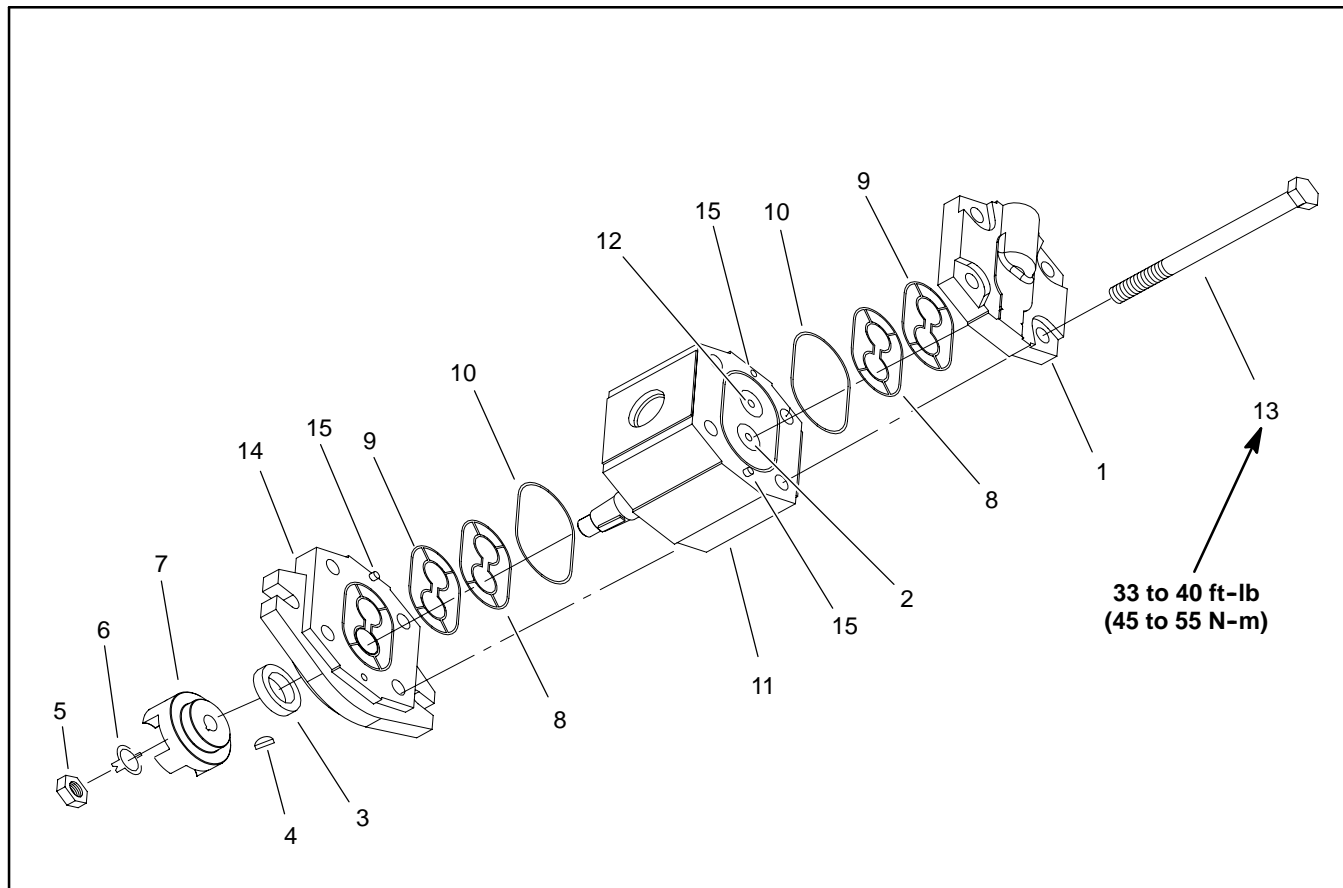


Figure 101

- |                 |                  |                        |
|-----------------|------------------|------------------------|
| 1. Rear cover   | 6. Tab washer    | 11. Body               |
| 2. Drive gear   | 7. Spider hub    | 12. Idler gear         |
| 3. Seal         | 8. Pressure seal | 13. Cap screw (4 used) |
| 4. Woodruff key | 9. Back-up ring  | 14. Front flange       |
| 5. Nut          | 10. O-ring       | 15. Dowel pin          |

### Disassembly (Fig. 101)

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 or scribe to make a **diagonal** mark across the front flange, body and rear cover for reassembly purposes (Fig. 102).

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

3. Clamp mounting flange of motor in a vise with the shaft end down.

4. Loosen cap screws on the rear cover.

5. Take motor from the vise and remove cap screws.

6. Remove front flange from the body, then remove rear cover. Locate and remove dowel pins from body.

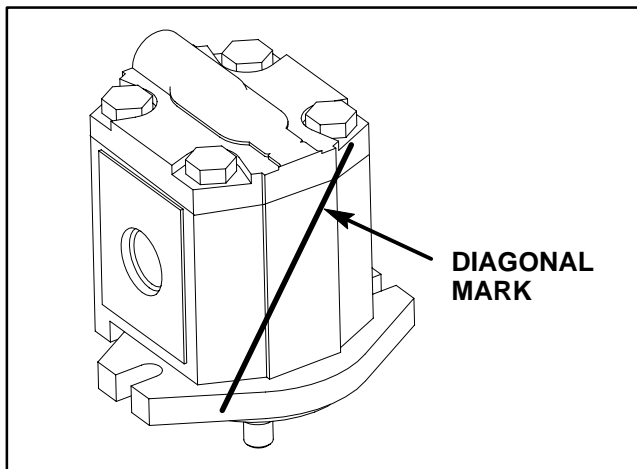


Figure 102

**IMPORTANT:** Mark the relative positions of the gear teeth and the bearing blocks so they can be re-assembled in the same position. Do not touch the gear surfaces as residue on hands may be corrosive to gear finish.

7. Place the motor on its side and push on the rear bearing block to remove the bearing block and gear set (Fig. 103).

8. Carefully remove and discard O-rings, pressure seals and back-up rings (Fig. 104) from motor. Do not cause any damage to the machined grooves during the removal process.

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

9. Position front flange with seal side up. Carefully remove shaft seal taking care to not damage seal bore.

### Inspection

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

 <b>CAUTION</b>
<p>Use eye protection such as goggles when using compressed air.</p>

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

3. Inspect drive gear, idler gear and bearing blocks (Fig. 105) for the following:

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

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

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

D. Bearing areas of bearing blocks should not have excessive wear or scoring.

E. Face of bearing blocks that are in contact with gears should be free of wear, roughness or scoring.

4. Inspect front flange, body and rear cover for damage or wear.

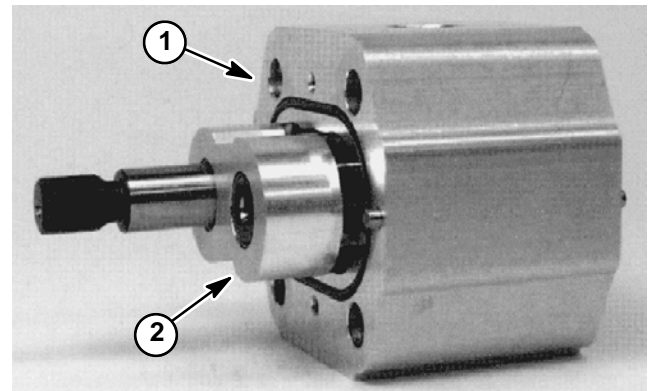


Figure 103

1. Motor body

2. Bearing block & gear set

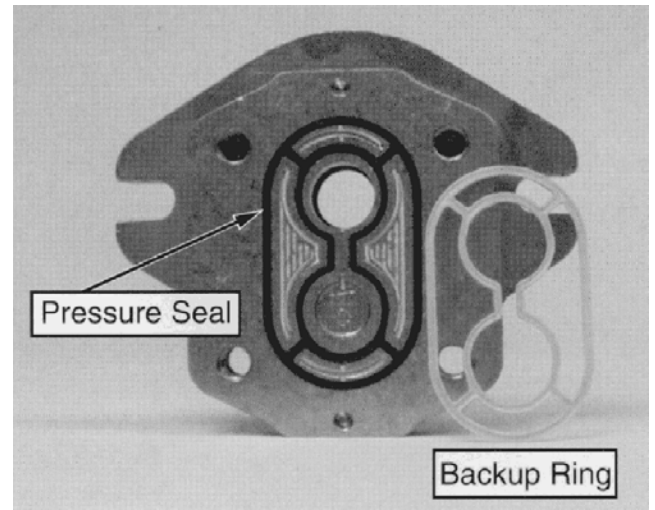


Figure 104

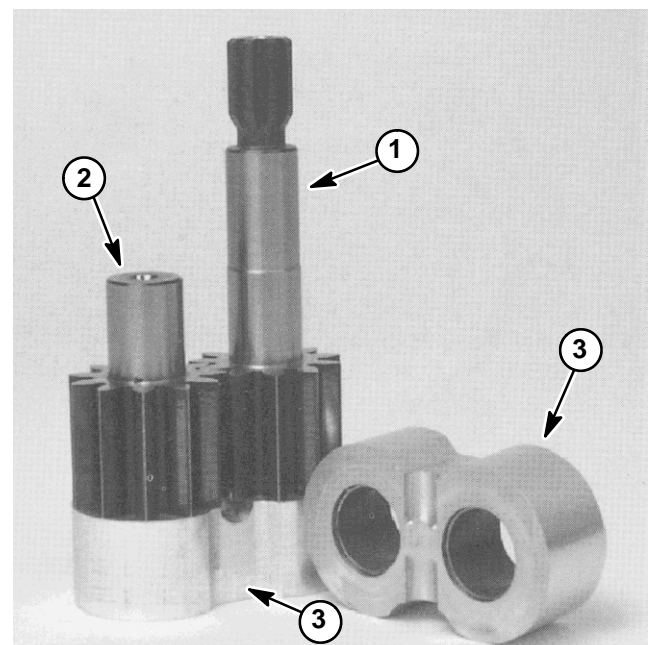


Figure 105

1. Drive gear  
2. Idler gear

3. Bearing block

## Assembly (Fig. 101)

**NOTE:** When assembling the motor, check the identification marks made during disassembly to make sure the parts are properly aligned during assembly.

1. Lubricate O-rings, pressure seals, back-up gaskets and seal grooves with a thin coat of petroleum jelly. Lubricate all other internal parts freely with clean hydraulic oil.
2. Install new shaft seal into front flange.
3. Install lubricated pressure seals into the grooves in the front flange and rear cover. Follow by carefully placing the back-up rings into the grooves.
4. Install new O-rings to the body.
5. Lubricate gear faces and bearing surfaces of drive gear, idler gear and bearing blocks. Carefully assemble bearing blocks and gears noting identification marks made during disassembly.
6. Position the motor body on its side. Carefully slide bearing block and gear assembly into the body cavity using identification marks made during disassembly.
7. Remove any excess lubrication from mating surfaces of body, rear cover and front flange. Make sure that these surfaces are clean and dry.

8. Install dowel pins in body.

**IMPORTANT: Do not dislodge O-rings, pressure seals or back-up rings during final assembly.**

9. Gently slide the rear cover onto the assembly using marker or scribe mark for proper location. Firm hand pressure should be sufficient to engage the dowel pins.
10. Position the motor with rear cover downwards. Carefully slide the front flange onto the assembly using marker or scribe mark for proper location.
11. Install the four (4) cap screws and hand tighten.

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

12. Place motor front flange in a vise and alternately torque the screws from **33 to 40 ft-lb (45 to 55 N-m)**.
13. Put a small amount of hydraulic oil in port on motor and rotate driveshaft one revolution. Protect the shaft if using a pliers. If drive shaft binds, disassemble motor and repeat assembly process.
14. Remove motor from vise.

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## PTO Manifold

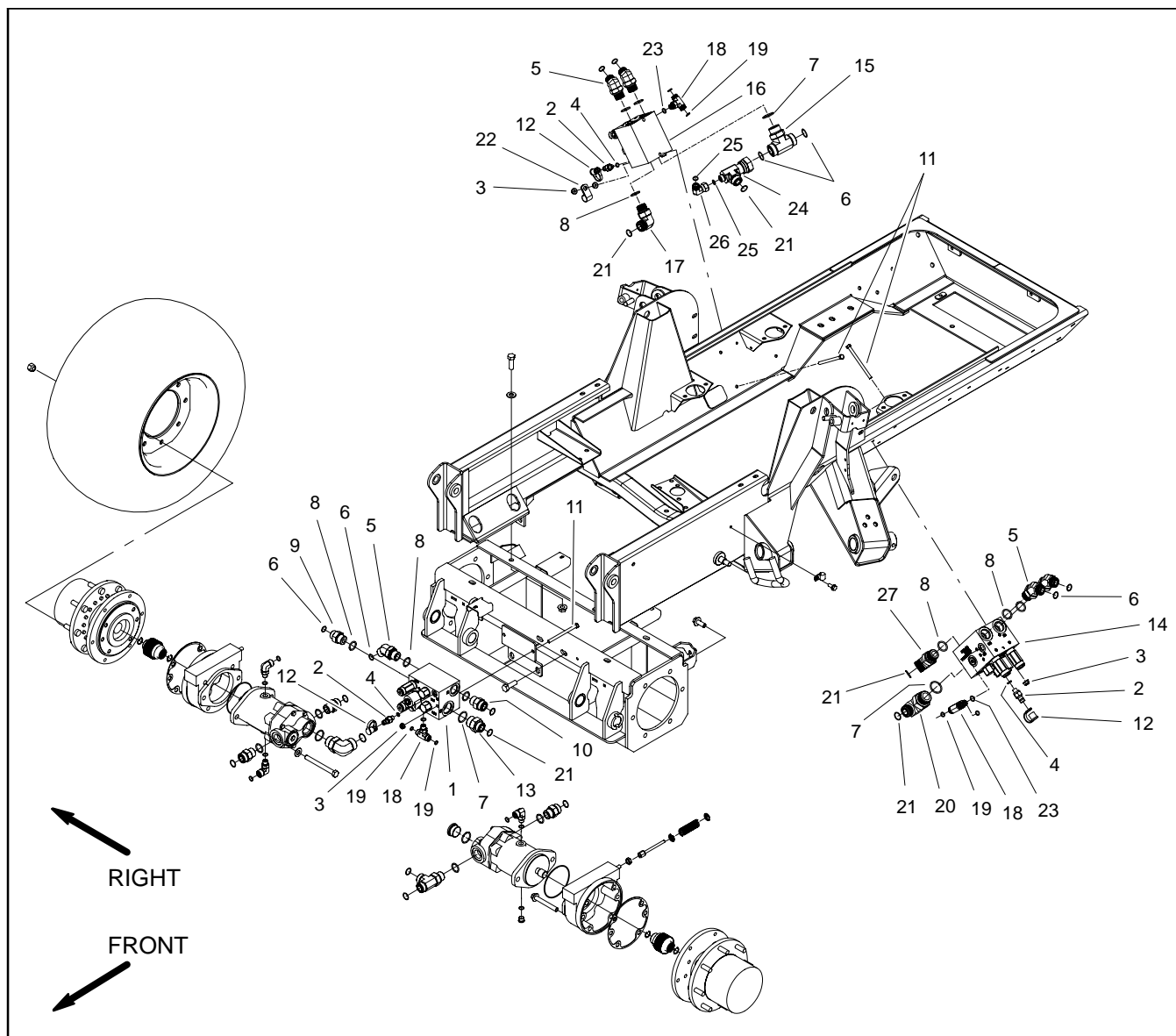


Figure 106

- |  |                                      |                           |
|--|--------------------------------------|---------------------------|
| 1. Hydraulic PTO manifold (front deck) | 10. Straight fitting                 | 19. O-ring                |
| 2. Quick fitting (1 used per manifold) | 11. Cap screw (2 used per manifold)  | 20. 90° hydraulic fitting |
| 3. Flange nut                          | 12. Dust cap                         | 21. O-ring                |
| 4. O-ring                              | 13. Hydraulic adapter                | 22. R-clamp               |
| 5. Hydraulic fitting                   | 14. Hydraulic PTO manifold (LH deck) | 23. O-ring                |
| 6. O-ring                              | 15. Hydraulic fitting                | 24. Hydraulic tee fitting |
| 7. O-ring                              | 16. Hydraulic PTO manifold (RH deck) | 25. O-ring                |
| 8. O-ring                              | 17. 90° hydraulic fitting            | 26. Hydraulic fitting     |
| 9. Hydraulic adapter                   | 18. Hydraulic adapter                | 27. 45° hydraulic fitting |

**NOTE:** The ports on the manifold are marked for easy identification of components. Example: S is the deck solenoid valve and P1 is a gear pump connection port (see Hydraulic Schematic in Chapter 10 - Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port).



**Removal (Fig. 106)**

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 PTO manifold and fittings.
3. Disconnect wire harness connector from the solenoid valve coil on the PTO manifold.
4. Disconnect hydraulic lines from manifold and put caps or plugs on open hydraulic lines and fittings. Label disconnected hydraulic lines for proper installation.
5. Remove PTO manifold from the frame using Figure 106 as a guide.

**NOTE:** The upper cap screw on the right side PTO manifold also secures the ground cable and has a lock washer to ensure a good grounding path. Make sure that lock washer is retrieved when removing RH PTO manifold from frame.

6. If hydraulic fittings are to be removed from manifold, mark fitting orientation to allow correct assembly. Remove fittings from manifold and discard O-rings.

**Installation (Fig. 106)**

1. If fittings were removed from 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).

2. Install PTO manifold to the frame using Figure 106 as a guide.

**NOTE:** Make sure that lock washer and ground cable are positioned under upper cap screw head when installing RH PTO manifold.

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. Connect wire harness connector to the solenoid valve coil on the PTO manifold.

5. Make sure hydraulic tank is full. Add correct oil if necessary before returning machine to service.

## PTO Manifold Service

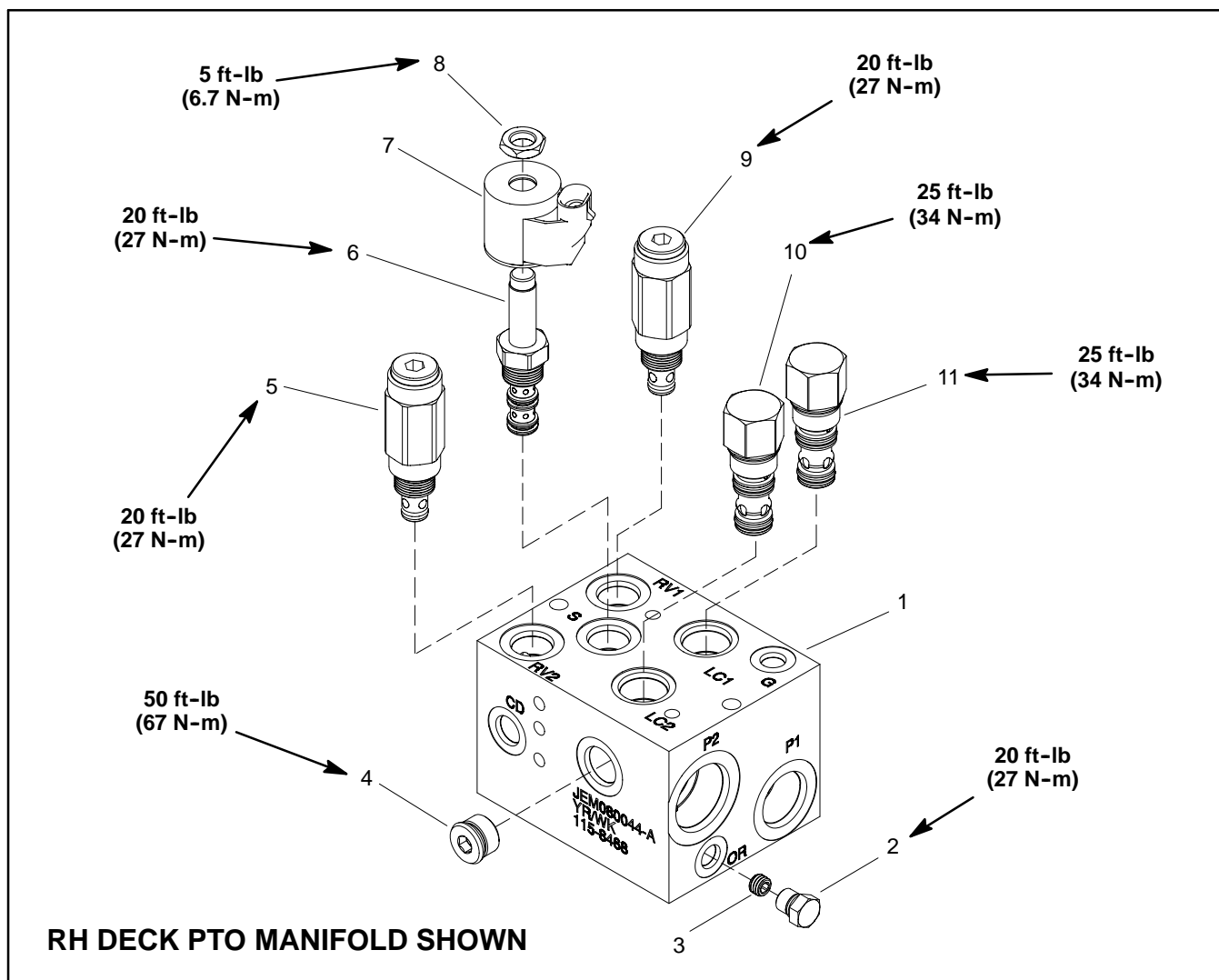


Figure 107

- |                                  |                            |                                      |
|----------------------------------|----------------------------|--------------------------------------|
| 1. PTO manifold body             | 5. Relief valve (port RV2) | 9. Relief valve (port RV1)           |
| 2. NWD SAE #4 plug with O-ring   | 6. Solenoid valve (port S) | 10. Spool logic cartridge (port LC2) |
| 3. Orifice (0.063) (port OR)     | 7. Solenoid coil           | 11. Spool logic cartridge (port LC1) |
| 4. #8 zero leak plug with O-ring | 8. Nut                     |                                      |

**NOTE:** The ports on the manifold are marked for easy identification of components. Example: S is the deck solenoid valve and P1 is the gear pump connection port (see Hydraulic Schematic in Chapter 10 - Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port location).

The manifolds for the three (3) cutting decks are very similar. The front deck manifold does not include an orifice (item 3). **Note:** When servicing the PTO manifolds, **DO NOT** interchange parts from one manifold to another.

**NOTE:** The PTO manifold assembly includes 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.

### **PTO Manifold Service (Fig. 107)**

For PTO manifold solenoid and control valve service procedures, see 4WD Manifold Service in this section. Refer to Figure 107 for PTO manifold cartridge valve and plug installation torque.

## Cutting Deck Lift/Lower Circuit

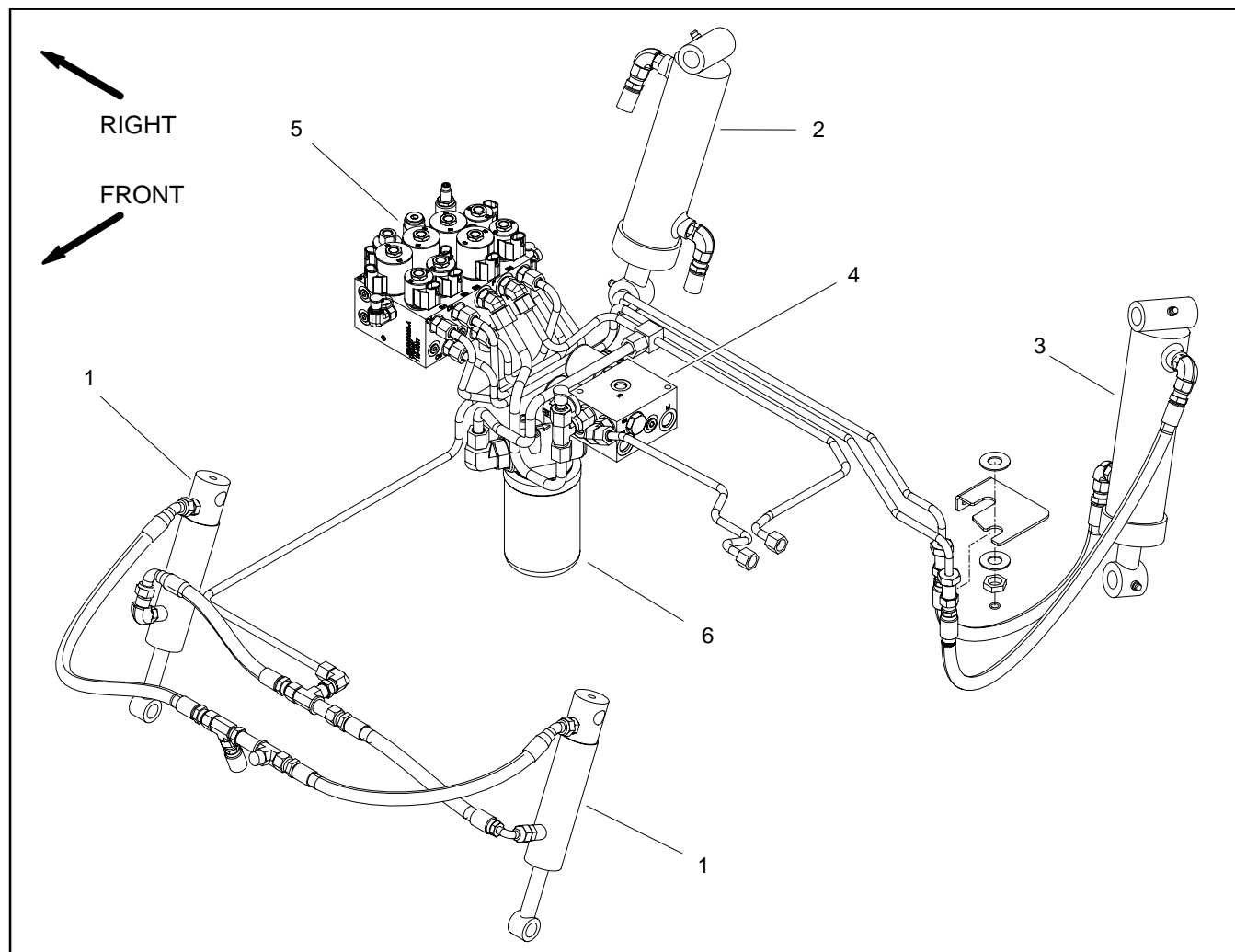


Figure 108

- 1. Front lift cylinder (2 used)
- 2. RH lift cylinder

- 3. LH lift cylinder
- 4. Fan drive manifold

- 5. Lift/lower manifold
- 6. Oil filter

Figure 108 illustrates the components that are used in the Groundsmaster 4000-D and 4010-D cutting deck lift and lower circuits. Procedures for removal, installation and disassembly/assembly of these components are provided on the following pages of this section.



### WARNING

Make sure that cutting decks are fully lowered before loosening any hydraulic lines, cartridge valves or plugs from lift circuit components. If decks are not fully lowered as components are loosened, decks may drop unexpectedly.

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## Lift/Lower Manifold

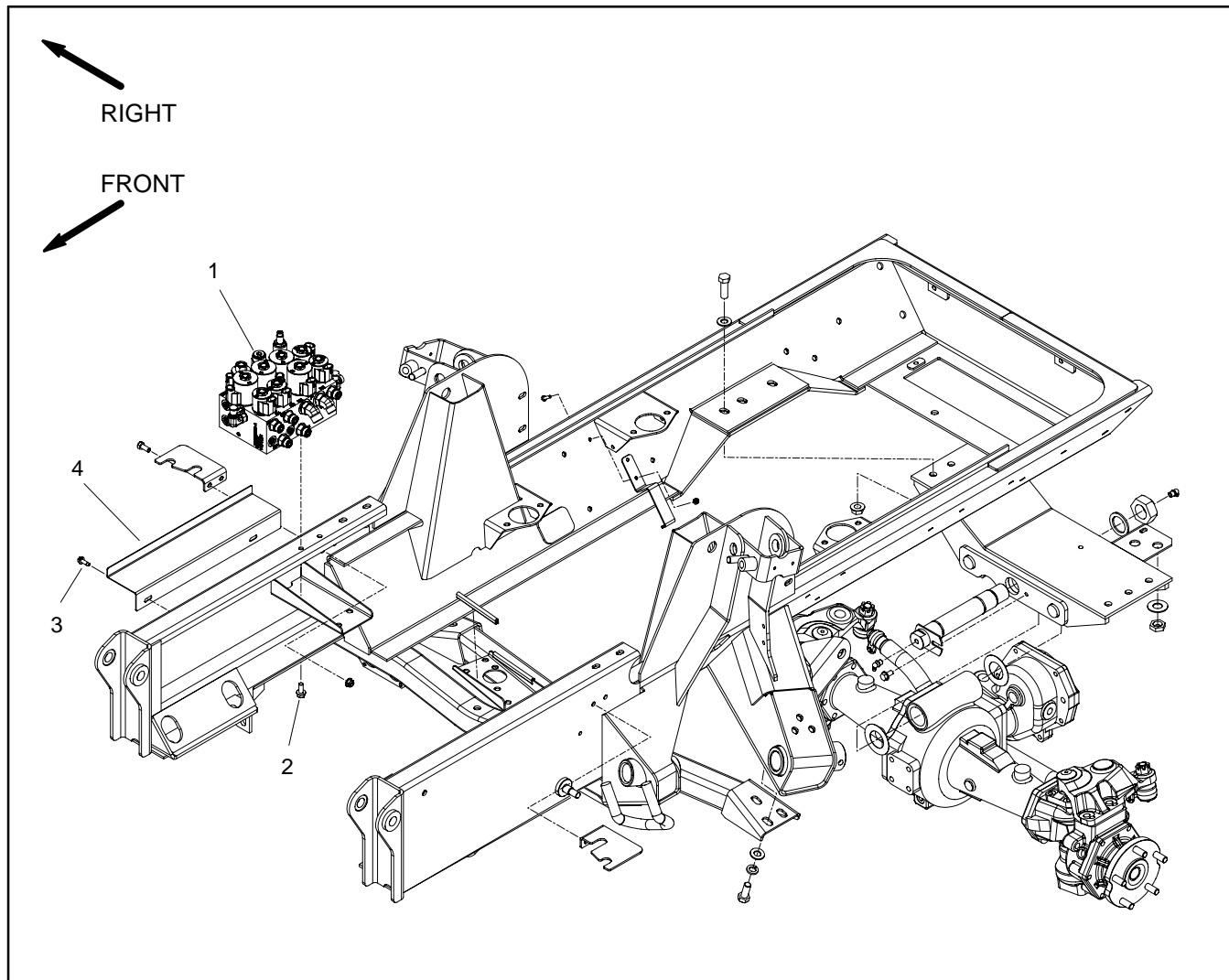


Figure 109

- 1. Lift/lower manifold
- 2. Flange head screw (2 used)

- 3. Washer head screw (2 used)

- 4. Splash shield

### Removal (Fig. 109)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch. Raise and support operator seat.
2. Remove controller cover and then support bracket from the right side of the operator seat (Fig. 110).
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 lift/lower manifold removal, thoroughly clean exterior of manifold including fittings and hydraulic lines.



### WARNING

**Make sure that cutting decks are fully lowered before loosening hydraulic lines, cartridge valves or plugs from lift/lower manifold. If decks are not fully lowered as manifold components are loosened, decks may drop unexpectedly.**

5. Label wire harness electrical connectors that attach to manifold solenoid valve coils. Disconnect wire harness connectors from the solenoid valve coils on lift/lower manifold.

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

7. Remove lift/lower manifold using Figure 109 as a guide.

**IMPORTANT:** The fitting in manifold port C2 includes a .070 orifice to control the lowering speed of the front deck. If this fitting is removed from the manifold, label its position for assembly purposes.

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

**IMPORTANT:** A flow control orifice is placed beneath the hydraulic fittings in lift/lower manifold ports C2, C4 and C6. If any of these fittings 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.

#### Installation (Fig. 109)

1. If fittings were removed from control manifold, lubricate and place new O-rings onto fittings. Correctly place orifice in port C2, C4 or C6 if removed. Install fittings into port openings using marks made during the removal process to properly orientate fittings (Fig. 111). Tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).

2. Install lift/lower manifold using Figure 109 as a 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. Using tags placed during manifold removal, correctly connect wire harness connectors to the solenoid valve coils on the lift/lower manifold.

5. Install support bracket and controller cover to the right side of the operator seat (Fig. 110).

6. Make sure hydraulic tank is full. Add correct oil if necessary before returning machine to service.

7. Lower and secure operator seat.

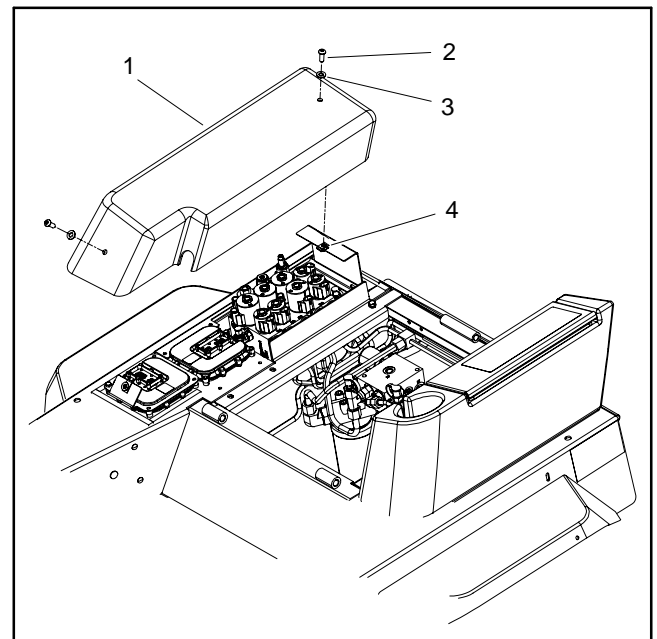


Figure 110

- |                     |                         |
|---------------------|-------------------------|
| 1. Controller cover | 3. Flat washer (2 used) |
| 2. Screw (2 used)   | 4. U-nut (2 used)       |

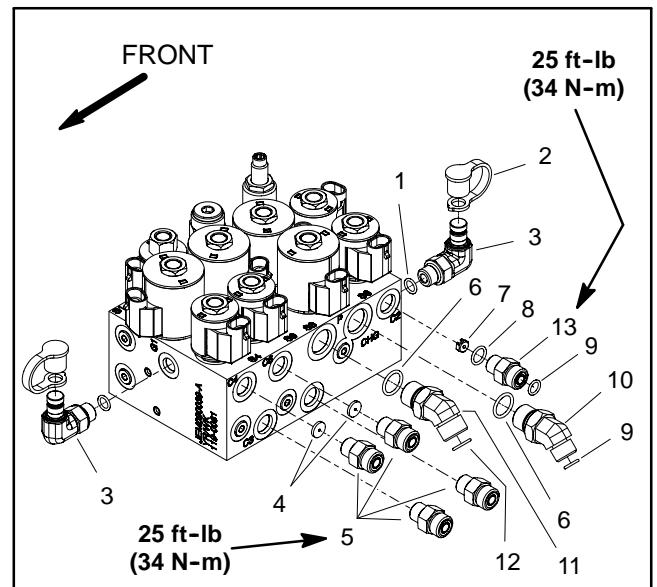


Figure 111

- |                     |                                 |
|---------------------|---------------------------------|
| 1. O-ring           | 8. O-ring                       |
| 2. Dust cap         | 9. O-ring                       |
| 3. Test port        | 10. 45° hydraulic fitting       |
| 4. Orifice (.063)   | 11. 45° hydraulic fitting       |
| 5. Straight fitting | 12. O-ring                      |
| 6. O-ring           | 13. Fitting with orifice (.070) |
| 7. Orifice (.035)   |                                 |

## Lift/Lower Manifold Service

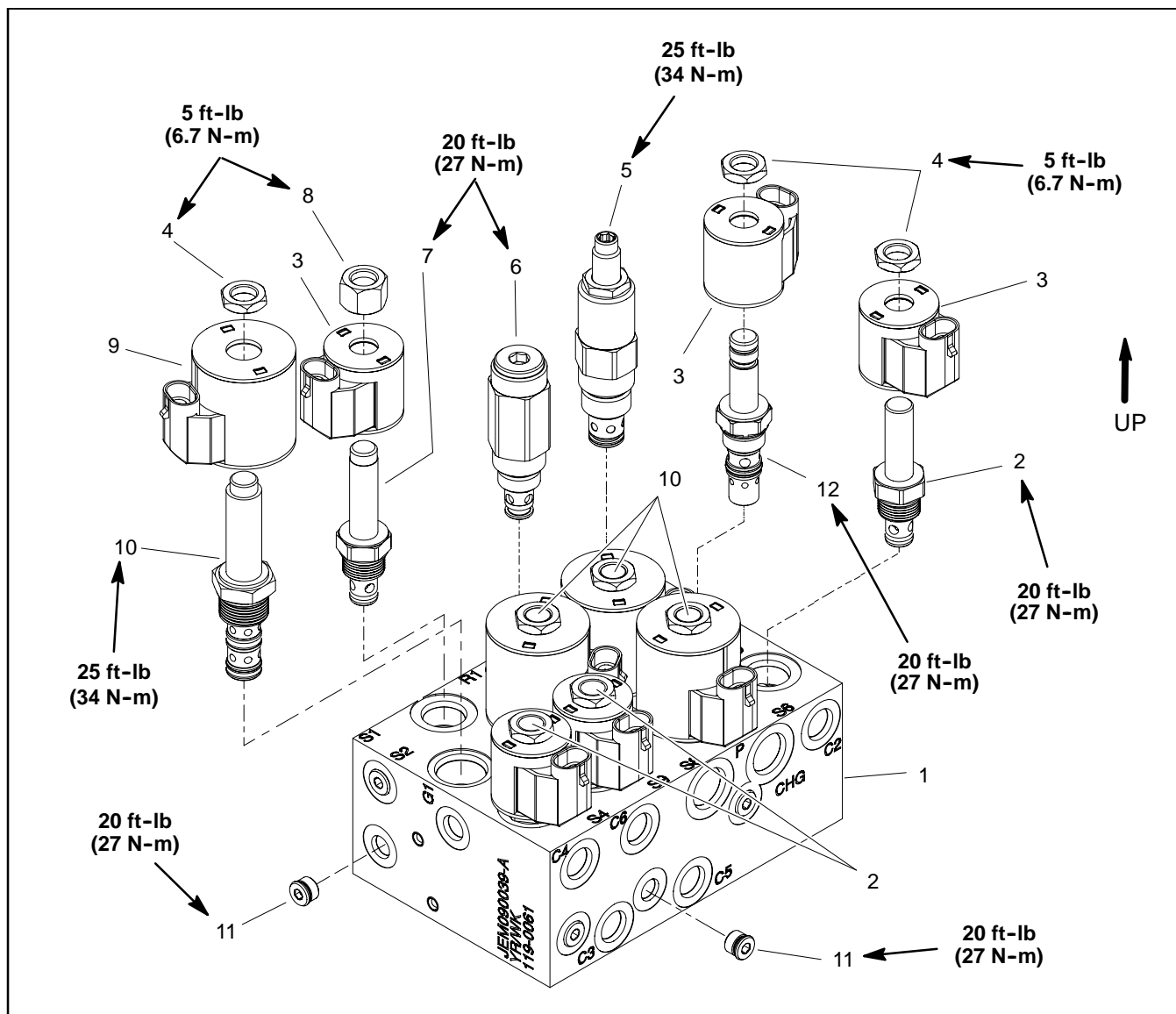


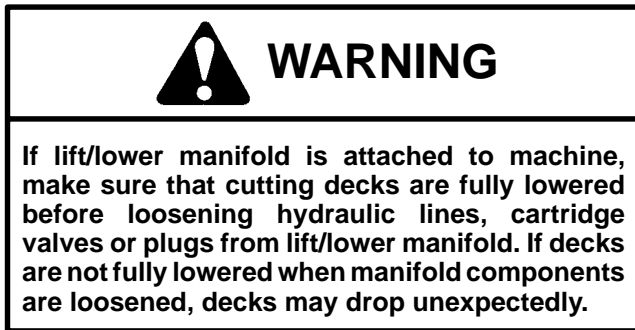
Figure 112

- |                                 |                        |                                      |
|---------------------------------|------------------------|--------------------------------------|
| 1. Lift/lower manifold body     | 5. Relief valve (RV2)  | 9. Solenoid coil (4 used)            |
| 2. Solenoid valve (S4, S6 & S9) | 6. Relief valve (RV1)  | 10. Solenoid valve (S2, S3, S7 & S8) |
| 3. Solenoid coil (5 used)       | 7. Solenoid valve (S1) | 11. #4 zero leak plug with O-ring    |
| 4. Nut (8 used)                 | 8. Nut                 | 12. Solenoid valve (S5)              |

**NOTE:** The ports on the lift/lower manifold are marked for easy identification of components. Example: S1 is solenoid valve S1 and P is the gear pump connection port (see Hydraulic Schematic in Chapter 10 - Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port location).

**NOTE:** The lift/lower manifold assembly 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.





For lift/lower manifold solenoid and control valve service procedures, see 4WD Manifold Service in this section. Refer to Figure 112 for lift/lower manifold cartridge valve and plug installation torque.

## Side Deck Lift Cylinder

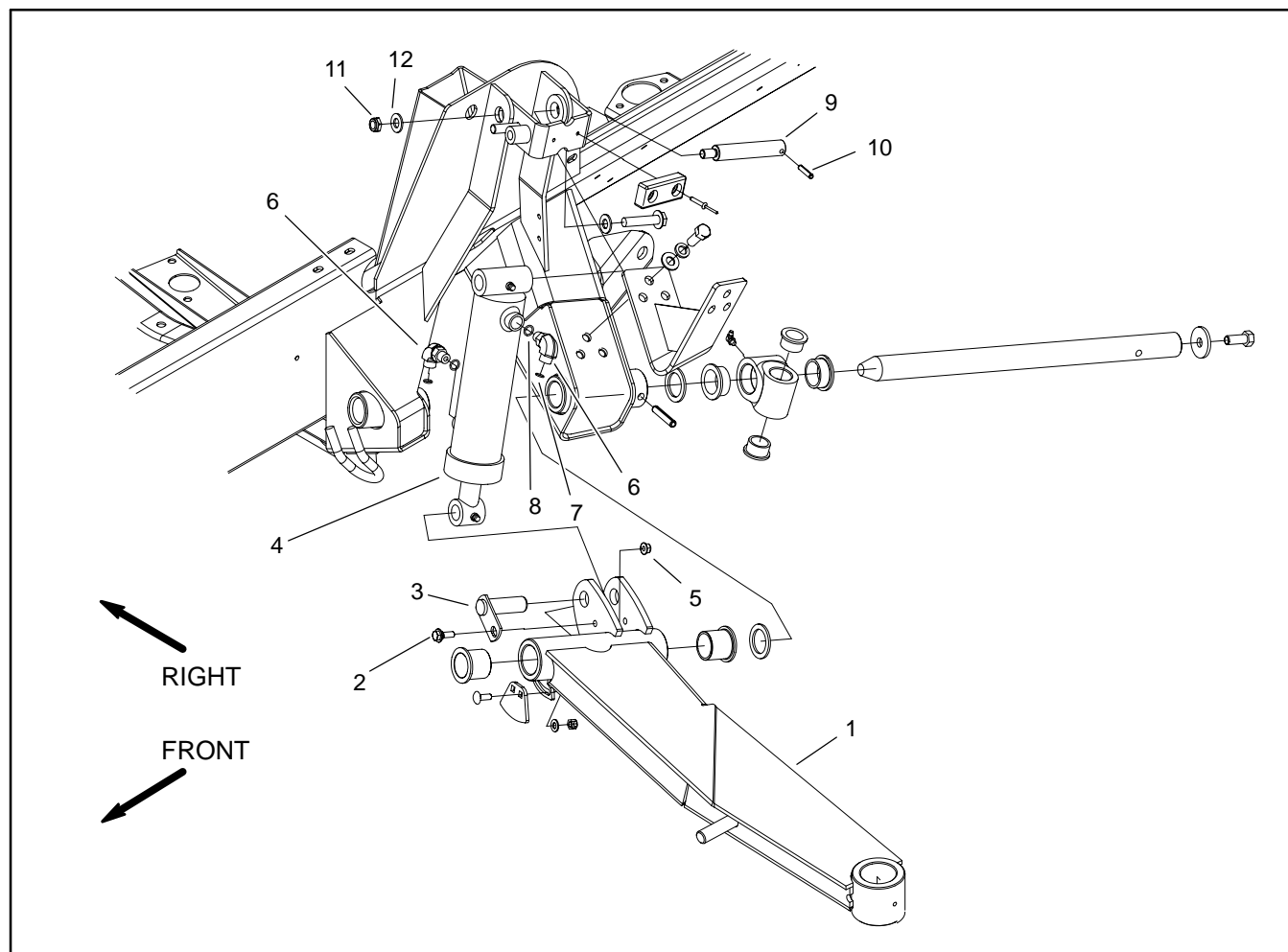
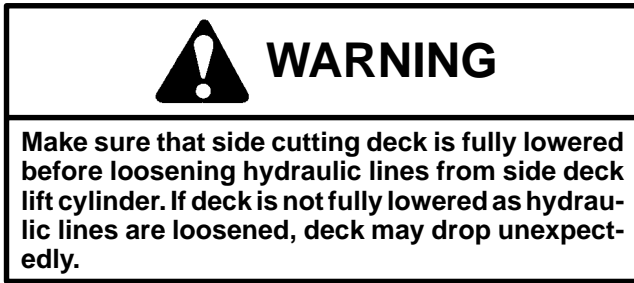


Figure 113

- |                                 |                                   |                 |
|---------------------------------|-----------------------------------|-----------------|
| 1. Lift arm assembly (LH shown) | 5. Flange locking nut             | 9. Cylinder pin |
| 2. Shoulder screw               | 6. 90° hydraulic fitting (2 used) | 10. Spring pin  |
| 3. Pin assembly                 | 7. O-ring                         | 11. Lock nut    |
| 4. Lift cylinder                | 8. O-ring                         | 12. Flat washer |

### Removal (Fig. 113)

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. To prevent contamination of hydraulic system during lift cylinder removal, thoroughly clean exterior of cylinder and fittings.



**NOTE:** To ease installation, tag the hydraulic hoses to show their correct position on the lift cylinder.

4. Disconnect hydraulic hoses from lift cylinder.
5. Remove shoulder screw and flange locking nut that secure the pin assembly to the lift arm. Remove pin assembly from lift arm and cylinder shaft clevis.
6. Remove lock nut and flat washer from the cylinder pin. Remove cylinder pin with spring 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.

### Installation (Fig. 113)

1. If fittings were removed from lift cylinder, lubricate and place new O-rings onto fittings. Install fittings into port 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 through the frame and cylinder clevis. Secure pin with flat washer and lock nut.
3. Insert pin assembly through the lift arm and cylinder shaft clevis. Secure pin assembly to lift arm with shoulder screw and flange locking nut.
4. 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. After installation is completed, operate lift cylinder to verify that hydraulic hoses and fittings are not contacted by anything.

## Front Deck Lift Cylinder

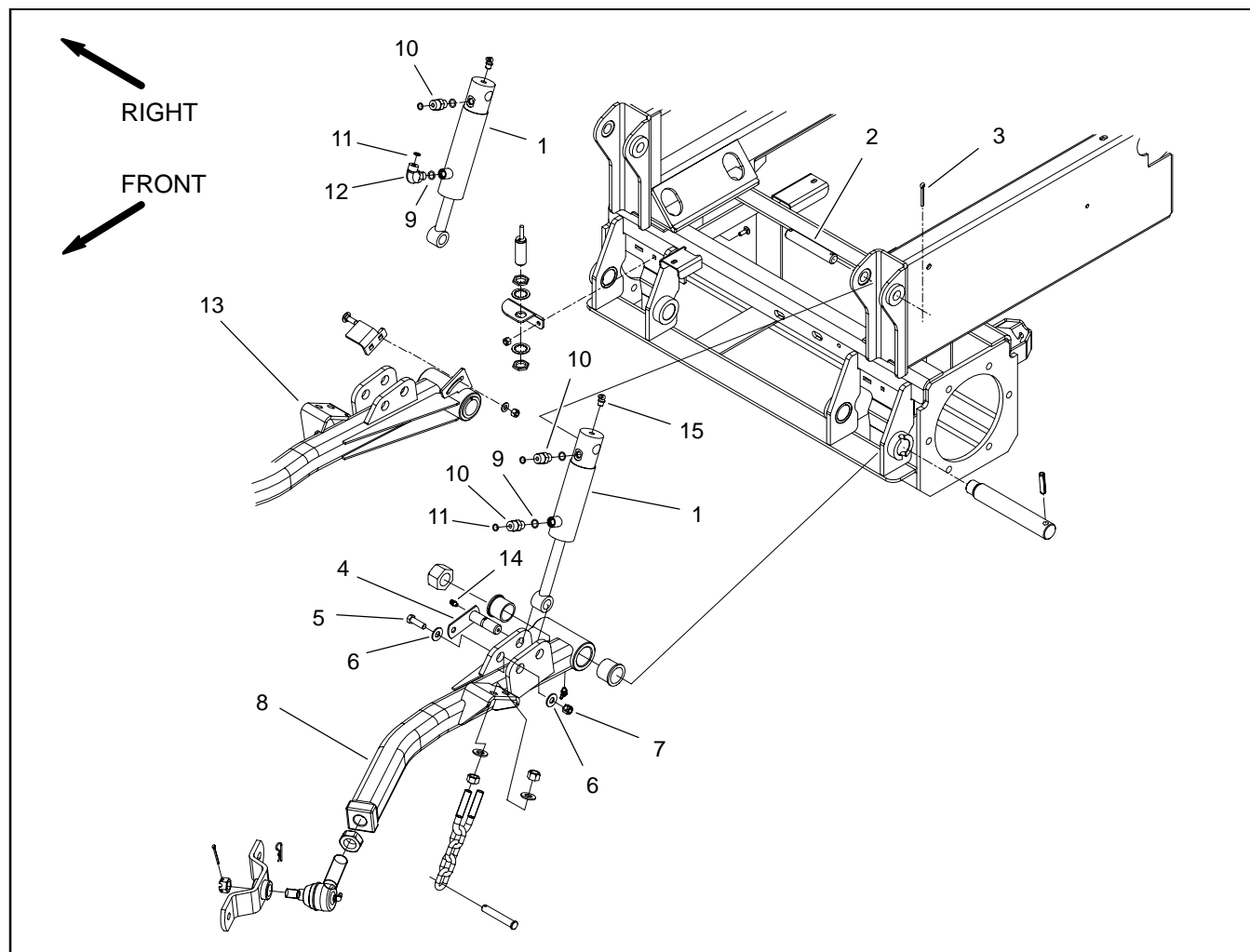
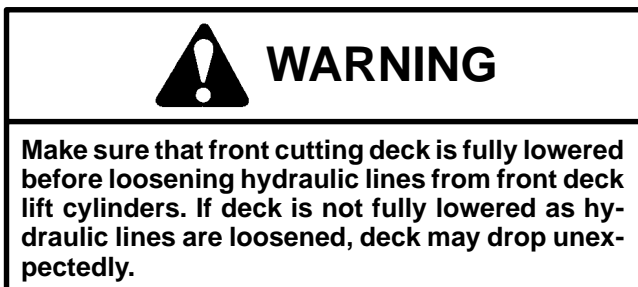


Figure 114

- |                                |                                |                           |
|--------------------------------|--------------------------------|---------------------------|
| 1. Lift cylinder               | 6. Flat washer                 | 11. O-ring                |
| 2. Pivot pin                   | 7. Lock nut                    | 12. 90° hydraulic fitting |
| 3. Cotter pin (2 used per pin) | 8. LH lift arm assembly        | 13. RH lift arm assembly  |
| 4. Pin assembly                | 9. O-ring                      | 14. Grease fitting        |
| 5. Cap screw                   | 10. Straight hydraulic fitting | 15. Grease fitting        |

**Removal (Fig. 114)**

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. To prevent contamination of hydraulic system during lift cylinder removal, thoroughly clean exterior of cylinder and fittings.



**NOTE:** To ease installation, tag the hydraulic hoses to show their correct position on the lift cylinder.

4. Disconnect hydraulic hoses from lift cylinder.
5. Remove lock nut, two (2) flat washers and cap screw that secure the pin assembly to the lift arm. Remove pin assembly from lift arm and cylinder shaft clevis which will free lift cylinder from lift arm.
6. Remove one cotter pin from pivot pin that secures upper end of lift cylinder to machine. Pull pivot 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.

**Installation (Fig. 114)**

1. If fittings were removed from lift cylinder, lubricate and place new O-rings onto fittings. Install fittings into port 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 pivot pin into frame and clevis. Secure pivot pin with cotter pin.
3. Insert pin assembly through lift arm and cylinder shaft clevis. Secure pin to lift arm with cap screw, two (2) flat washers and lock nut.
4. 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. After assembly is completed, operate lift cylinder to verify that hydraulic hoses and fittings are not contacted by anything.

## Lift Cylinder Service

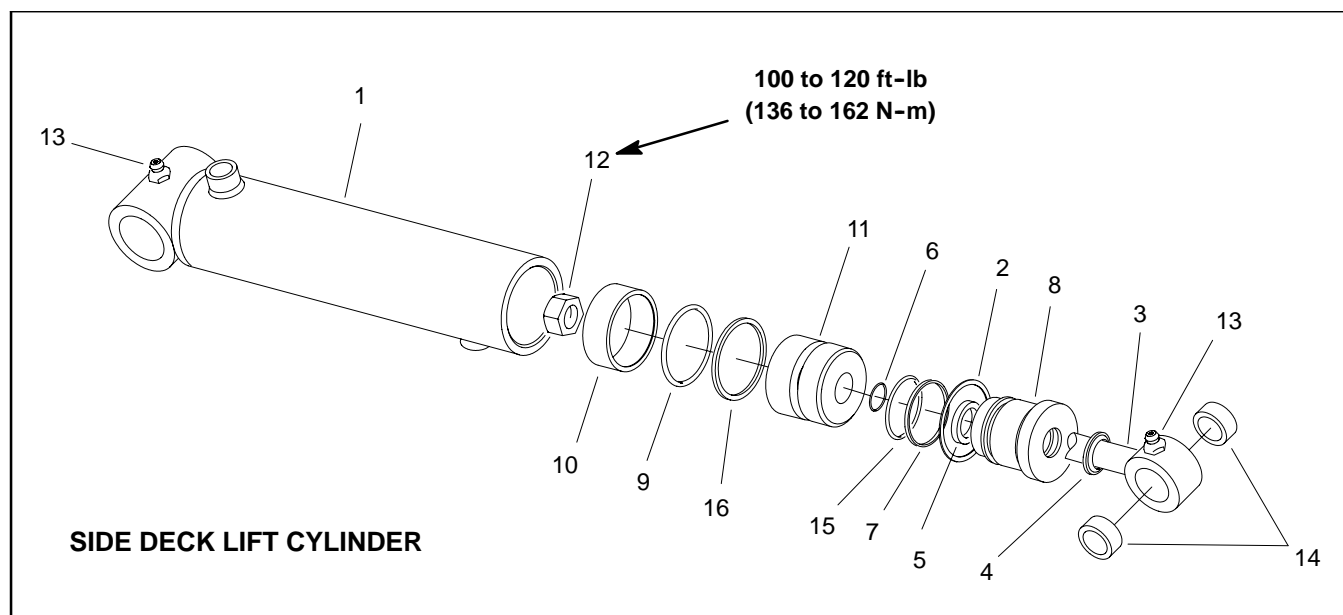


Figure 115

- 1. Barrel with clevis
- 2. Retaining ring
- 3. Shaft with clevis
- 4. Dust seal
- 5. Rod seal
- 6. O-ring

- 7. Back-up ring
- 8. Head
- 9. O-ring
- 10. Wear ring
- 11. Piston

- 12. Lock nut
- 13. Grease fitting
- 14. Bushing
- 15. O-ring
- 16. Seal

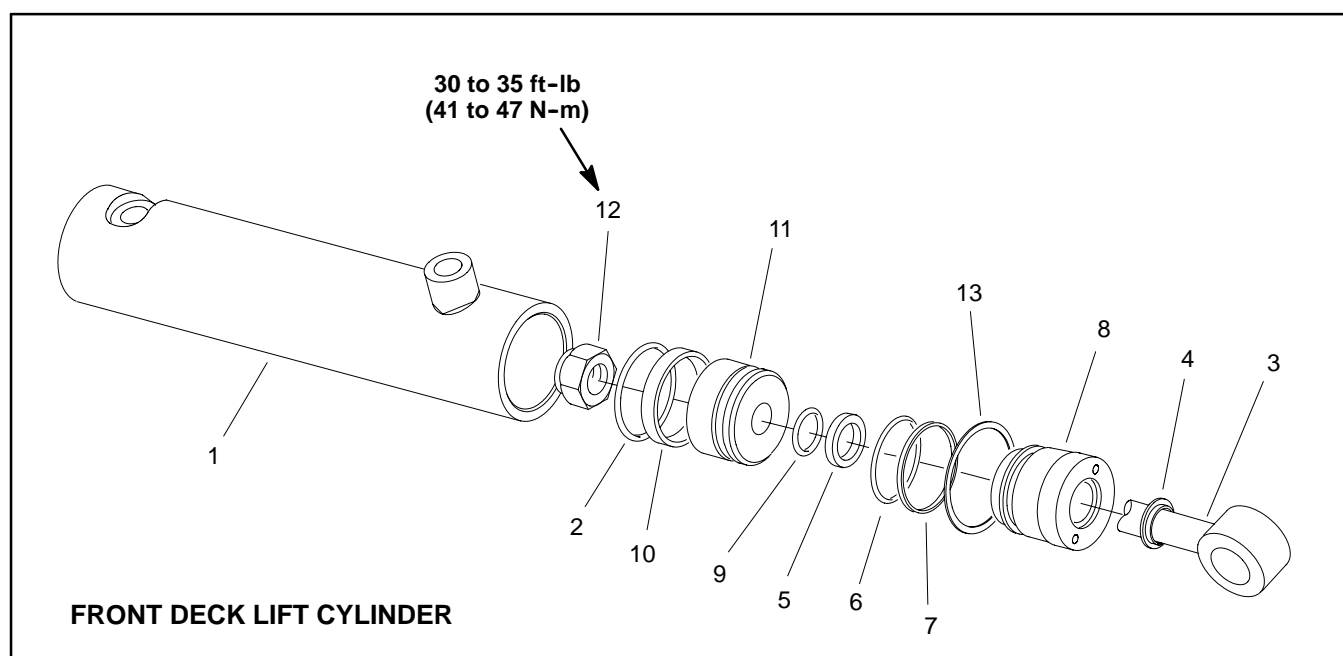


Figure 116

- 1. Barrel with clevis
- 2. Seal
- 3. Shaft with clevis
- 4. Dust seal
- 5. Rod seal

- 6. O-ring
- 7. Back-up ring
- 9. O-ring

- 10. Wear ring
- 11. Piston
- 12. Lock nut
- 13. Retaining ring

**Disassembly (Figs. 115 and 116)**

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.**

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.**

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.). Inspect piston rod and piston for evidence of excessive scoring, pitting or wear. Replace lift cylinder if internal components are found to be worn or damaged.

**Assembly (Figs. 115 and 116)**

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 ring to the head.

**IMPORTANT: Do not clamp vise jaws against the shaft surface.**

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 to specification in Figure 115 (side deck cylinder) or Figure 116 (front deck cylinder).

4. Lubricate head and piston with clean 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.**

5. 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.

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# Electrical System

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# General Information

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## 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.

---

## Toro Electronic Controllers (TEC)

Groundsmaster 4000-D and 4010-D machines use two (2) Toro Electronic Controllers (TEC) to manage machine electrical functions. The controllers are microprocessor controlled that sense the condition of various switches (inputs) and direct electrical power to control appropriate machine functions (outputs) based on the inputs. Communication between the two Toro controllers 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 Diagnostic Display (see Special Tools in this chapter).

The controllers appear identical but they are different in terms of the connectors and internal hardware. They are arranged in "master / slave" configuration and therefore cannot be interchanged. The TEC-5002 master controller is responsible for powering up the TEC-5001 slave controller. The TEC-5002 also controls the engine start circuit.

**IMPORTANT: Before performing any welding on the machine, disconnect the battery cables from the battery, disconnect the wire harness connector from both of the TEC controllers and disconnect the terminal connector from the alternator. These steps will prevent damage to the machine electrical system.**

---

## CAN-bus Communications

The two (2) TEC controllers (TEC-5001 and TEC-5002) used on the Groundsmaster 4000-D and 4010-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 machine 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.

CAN identifies the Controller Area Network that is used between the controllers on the Groundsmaster. Two (2) specially designed, twisted cables form the bus. These wires provide the data pathways between the controllers (TEC-5001 and TEC-5002) used on the machine. The engineering term for these two (2) cables are CAN-high and CAN-low. At the ends of the twisted pair of bus cables are 120 ohm termination resistors.

Each of the components that is controlled by the CAN-bus link only needs four (4) wires to operate and communicate to the system: CAN-high, CAN-low, B+ (power) and ground.

---

## Electrical Drawings

The electrical schematic and wire harness drawings for Groundsmaster 4000-D and 4010-D machines are located in Chapter 10 - Foldout Drawings.

---

# 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, resistance or voltage.

**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.

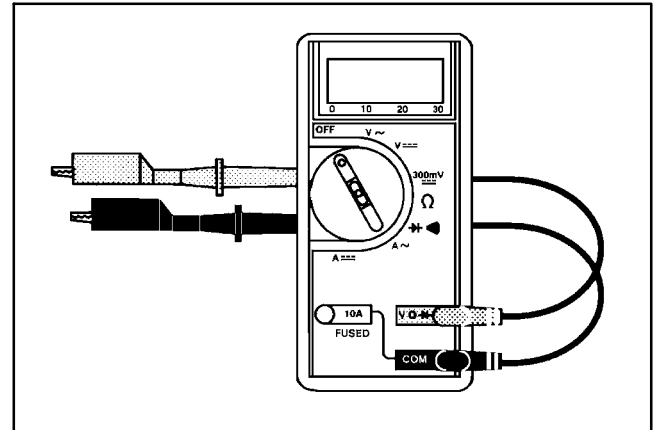


Figure 1

## Skin-Over Grease

Special non-conductive grease which forms a light protective skin which helps waterproof electrical switches and contacts.

Toro Part Number: **TOR50547**



Figure 2

## Dielectric Gel

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

Toro Part Number: **107-0342**



Figure 3

## Diagnostic Display

The Diagnostic Display (Fig. 4) can be connected to the wiring harness communication connector located under the controller cover to verify correct electrical functions of the machine. Toro Electronic Controller (TEC) inputs and outputs can be checked using the Diagnostic Display.

Toro Part Number for Diagnostic Display: **85-4750**

Toro Part Number for Overlay (English):

TEC-5002 Master: **119-5303**

TEC-5001 Slave: **119-5304**

**NOTE:** Diagnostic Display overlays are available in several languages for your Groundsmaster. Refer to your Parts Catalog for overlay language options and part numbers.

**IMPORTANT:** The Diagnostic Display must not be left connected to the machine. It is not designed to withstand the environment of the machine's every day use. When use of Diagnostic Display is completed, disconnect it from the machine and reconnect loopback connector to harness connector. Machine will not operate without loopback connector installed on harness. Store Diagnostic Display in a dry, secure, indoor location and not on machine.



Figure 4

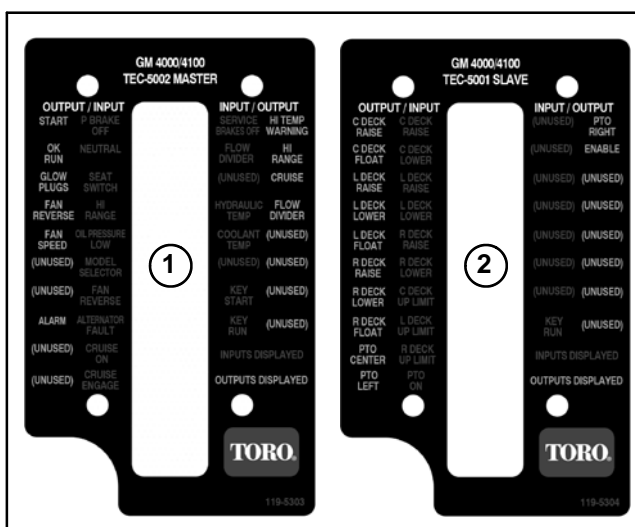


Figure 5

1. Overlay 119-5303

2. Overlay 119-5304

## Battery Terminal Protector

Aerosol spray that should be used on battery terminals to reduce corrosion problems. Apply 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

# Troubleshooting



## CAUTION

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

For effective troubleshooting and repairs, you must have a good understanding of the electrical circuits and components used on this machine (see Chapter 10 – Foldout Drawings).

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

**NOTE:** Use the Diagnostic Display (see Special Tools in this chapter) to test Toro Electronic Controller inputs and outputs when troubleshooting an electrical problem on your Groundsmaster.

## Diagnostic Display

Groundsmaster 4000-D and 4010-D machines are equipped with two (2) Toro Electronic Controllers (TEC) which control machine electrical functions. The controllers monitor various input switches (e.g. ignition switch, seat switch, neutral switch) and energize outputs to actuate solenoids or relays for the requested machine function.

For the TEC to control the machine as desired, each of the inputs (switches and sensors) and outputs (solenoids and relays) must be connected and functioning properly.

The Diagnostic Display (see Special Tools in this chapter) is a tool to help the technician verify correct electrical functions of the machine.

**IMPORTANT:** The Diagnostic Display must not be left connected to the machine. It is not designed to withstand the environment of the machine's every day use. When use of the Diagnostic Display is completed, disconnect it from the machine and reconnect loopback connector to harness connector. The machine will not operate without the loopback connector installed on the harness. Store the Diagnostic Display in a dry, secure, indoor location and not on machine.



## CAUTION

The interlock switches are for the protection of the operator and bystanders and to ensure correct operation of the machine. Do not bypass or disconnect switches. Check the operation of the interlock switches daily for proper operation. Replace any malfunctioning switches before operating the machine.

## Verify Diagnostic Display Input Functions

1. Park machine on a level surface, lower the cutting decks, stop the engine and apply the parking brake.
2. Remove the controller cover to allow access to wire harness loopback connector (Fig. 8). Locate wire harness communication port and loopback connector. Carefully unplug loopback connector from harness connector.
3. Connect the Diagnostic Display connector to the wire harness connector. Make sure correct overlay decal is positioned on the Diagnostic Display (Figs. 9 and 10).

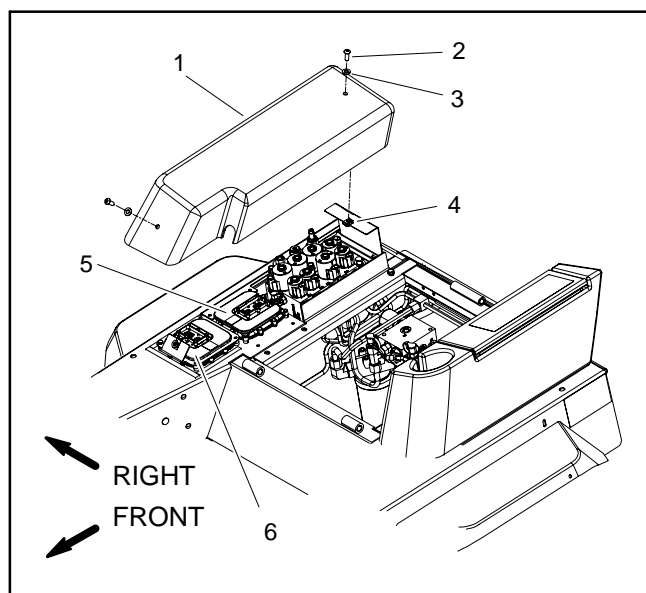


Figure 8

- |                         |                   |
|-------------------------|-------------------|
| 1. Controller cover     | 4. U-nut (2 used) |
| 2. Screw (2 used)       | 5. TEC-5001       |
| 3. Flat washer (2 used) | 6. TEC-5002       |

4. Turn the ignition switch to the ON position, but do not start machine.

**NOTE:** The **red** text on the Diagnostic Display overlay decal refers to input switches and the **green** text refers to TEC outputs.

5. Make sure that the “INPUTS DISPLAYED” LED, on lower right column of the Diagnostic Display, is illuminated. If “OUTPUTS DISPLAYED” LED is illuminated, press the toggle button on the Diagnostic Display to change to “INPUTS DISPLAYED” LED.

6. The Diagnostic Display will illuminate the LED associated with each of the inputs when that input switch is closed. Individually, change each of the switches from open to closed (i.e., sit on seat, press traction pedal, etc.), and note that the appropriate LED on the Diagnostic Display will illuminate when the corresponding switch is closed. Repeat on each switch that is possible to be changed by hand (see Inputs and LED Operation chart on following page).

**NOTE:** When the Diagnostic Display is attached to the wire harness connector and the ignition switch is in the ON position, the input LED for hydraulic temp and coolant temp should be illuminated. If the wire harness connector is disconnected from either of these sensors, the appropriate LED should go off after a few second delay. Then, if the harness connector is reattached to the sensor, the input LED should again illuminate after a few seconds.

7. If appropriate LED does not toggle on and off when switch state is changed, check all wiring and connections to that switch and/or test switch (see Component Testing in this chapter). Replace any defective switches and repair any damaged wiring.

8. After input functions testing is complete, disconnect the Diagnostic Display connector from the harness connector and plug loopback connector into wire harness. Secure controller cover to frame.

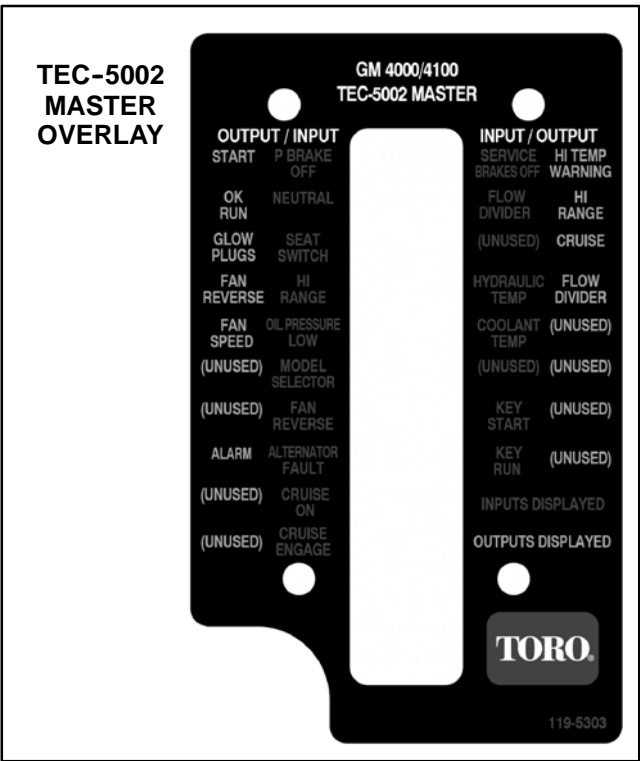


Figure 9

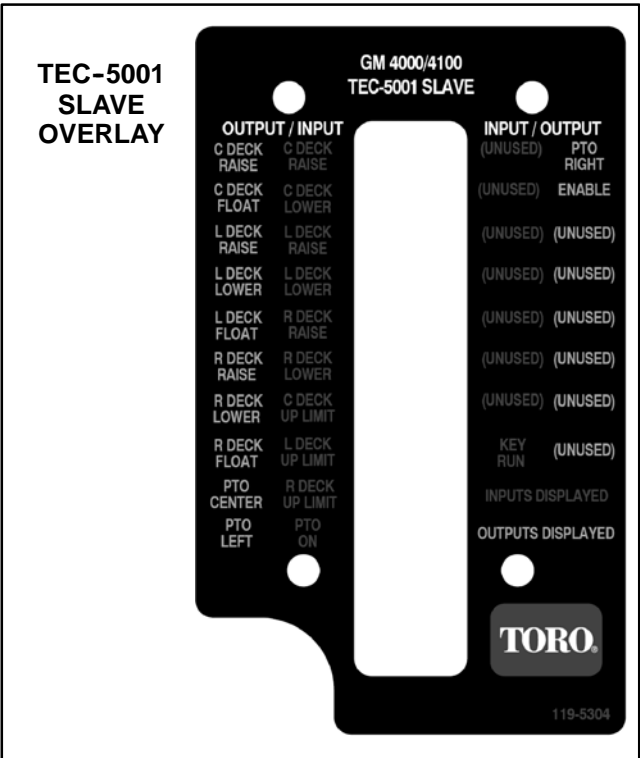


Figure 10

<b>Diagnostic Display TEC-5002 Master Inputs</b>	<b>Diagnostic Display LED Operation</b>
P BRAKE OFF	Parking brake released: LED ON Parking brake applied: LED OFF
NEUTRAL	Traction pedal in neutral: LED ON Traction pedal in forward or reverse: LED OFF
SEAT SWITCH	Operator seat occupied: LED ON Operator seat empty: LED OFF
HI RANGE	Hi/Lo speed switch in HI range: LED ON Hi/Lo speed switch in LO range: LED OFF
OIL PRESSURE LOW	Engine not running OR low engine oil pressure: LED ON Engine oil pressure OK: LED OFF
MODEL SELECTOR	On Groundsmaster 4000-D and 4010-D, LED should always be ON
FAN REVERSE	Engine cooling fan switch in momentary REVERSE: LED ON Fan switch in AUTO position: LED OFF
ALTERNATOR FAULT	Engine not running or alternator faulty: LED ON Alternator OK: LED OFF
CRUISE ON	Cruise switch (optional kit) in ON: LED ON Cruise switch (optional kit) in OFF: LED OFF
CRUISE ENGAGE	Cruise switch (optional kit) in momentary ENGAGE: LED ON Cruise switch (optional kit) NOT in momentary ENGAGE: LED OFF
SERVICE BRAKES OFF	Service brake (equipped with optional kit) released: LED ON Service brake (equipped with optional kit) applied: LED OFF
FLOW DIVIDER	Flow divider switch in momentary ENGAGE: LED ON Flow divider switch in normal position: LED OFF
HYDRAULIC TEMP	Wire harness connector attached to hydraulic sensor: LED ON Wire harness connector NOT attached to sensor: LED OFF
COOLANT TEMP	Wire harness connector attached to coolant sensor: LED ON Wire harness connector NOT attached to sensor: LED OFF
KEY START	Ignition switch in START: LED ON Ignition switch in ON or OFF: LED OFF
KEY RUN	Ignition switch in ON or START: LED ON Ignition switch in OFF: LED OFF

**NOTE:** When the ignition switch is in the OFF position, all Diagnostic Display LED's should be OFF.



Diagnostic Display TEC-5001 Slave Inputs	Diagnostic Display LED Operation
C DECK RAISE	Cutting deck lift switch for center deck in RAISE position: LED ON Lift switch for center deck NOT in RAISE position: LED OFF
C DECK LOWER	Cutting deck lift switch for center deck in LOWER position: LED ON Lift switch for center deck NOT in LOWER position: LED OFF
L DECK RAISE	Cutting deck lift switch for left deck in RAISE position: LED ON Lift switch for left deck NOT in RAISE position: LED OFF
L DECK LOWER	Cutting deck lift switch for left deck in LOWER position: LED ON Lift switch for left deck NOT in LOWER position: LED OFF
R DECK RAISE	Cutting deck lift switch for right deck in RAISE position: LED ON Lift switch for right deck NOT in RAISE position: LED OFF
R DECK LOWER	Cutting deck lift switch for right deck in LOWER position: LED ON Lift switch for right deck NOT in LOWER position: LED OFF
C DECK UP LIMIT	Center cutting deck lowered: LED ON Center cutting deck raised: LED OFF
L DECK UP LIMIT	Left cutting deck lowered: LED ON Left cutting deck raised: LED OFF
R DECK UP LIMIT	Right cutting deck lowered: LED ON Right cutting deck raised: LED OFF
PTO ON	PTO switch ON: LED ON PTO switch OFF: LED OFF
KEY RUN	Ignition switch in ON or START: LED ON Ignition switch in OFF: LED OFF

**NOTE:** When the ignition switch is in the OFF position, all Diagnostic Display LED's should be OFF.

## Verify Diagnostic Display Output Functions

The Diagnostic Display also has the ability to detect which output solenoids or relays are energized by the TEC controllers. This is a quick way to determine if a machine malfunction is electrical or hydraulic.

**NOTE:** An open output (e.g. an unplugged connector or a broken wire) cannot be detected with the Diagnostic Display.

1. Park machine on a level surface, lower the cutting decks, stop the engine and engage the parking brake.
2. Remove the controller cover to allow access to wire harness loopback connector (Fig. 11). Locate wire harness communication port and loopback connector (Fig. 12). Carefully unplug loopback connector from harness connector.

3. Connect the Diagnostic Display connector to the harness connector. Make sure correct overlay decal is positioned on the Diagnostic Display (Figs. 9 and 10).

4. Turn the ignition switch to the ON position.

**NOTE:** The **red** text on the Diagnostic Display overlay decal refers to input switches and the **green** text refers to TEC outputs.

5. Make sure that the "OUTPUTS DISPLAYED" LED, on lower right column of the Diagnostic Display, is illuminated. If "INPUTS DISPLAYED" LED is illuminated, press the toggle button on the Diagnostic Display to change the LED to "OUTPUTS DISPLAYED".

**NOTE:** It may be necessary to toggle between "INPUTS DISPLAYED" and "OUTPUTS DISPLAYED" several times to perform the following step. To change from inputs to outputs, press toggle button once. This may be done as often as required. **Do not press and hold toggle button.**

6. Sit on seat and attempt to operate the desired function of the machine. The appropriate output LED's should illuminate on the Diagnostic Display to indicate that the TEC controller is turning on that function. The GLOW PLUGS, HI RANGE and OK RUN outputs can be checked with the ignition switch in the ON position and the engine not running. For testing of the hydraulic solenoid outputs (e.g. ENABLE, C DECK RAISE, R DECK FLOAT), the engine must be running.

A. If the correct output LED's do not illuminate, verify that the required input switches are in the necessary positions to allow that function to occur.

B. If the output LED's are on as specified, but the machine does not function properly, suspect a failed electrical component, an open in the tested circuit or a non-electrical problem (e.g. hydraulic component problem). Repair as necessary.

C. If each input switch is in the correct position and functioning correctly, but the output LED's are not correctly illuminated, this indicates a TEC controller problem. If this occurs, contact your Toro Distributor for assistance.

7. After output functions testing is complete, disconnect the Diagnostic Display connector from the harness connector and plug loopback connector into wire harness. Secure controller cover to frame.

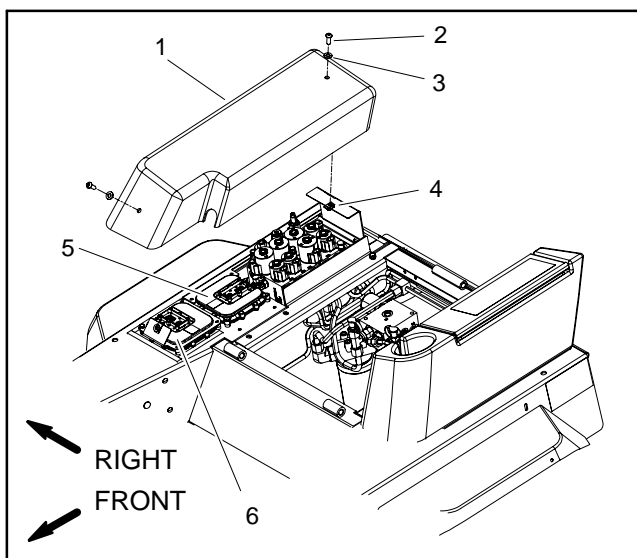


Figure 11

- |                         |                   |
|-------------------------|-------------------|
| 1. Controller cover     | 4. U-nut (2 used) |
| 2. Screw (2 used)       | 5. TEC-5001       |
| 3. Flat washer (2 used) | 6. TEC-5002       |

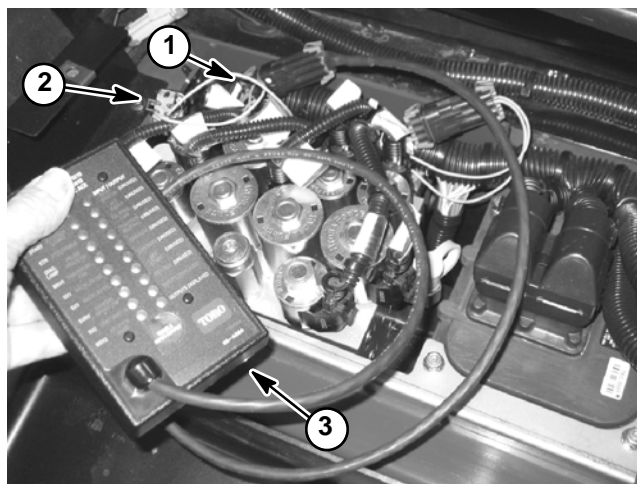


Figure 12

- |                           |                       |
|---------------------------|-----------------------|
| 1. Wire harness connector | 3. Diagnostic display |
| 2. Loopback connector     |                       |

## Starting Problems

Problem	Possible Causes
No electrical power to machine (including gauges).	<p>The battery is discharged.</p> <p>The battery cables are loose or corroded.</p> <p>Fuse F3-1 (2 amp) to the ignition switch is faulty.</p> <p>Bad ground connection on machine.</p> <p>The ignition switch or circuit wiring is faulty.</p>
<p>Starter solenoid clicks, but starter will not crank.</p> <p><b>NOTE:</b> If the solenoid clicks, the problem <b>is not</b> in the interlock circuit.</p>	<p>The battery is discharged.</p> <p>The battery cables are loose or corroded.</p> <p>A ground wire or cable is loose or corroded.</p> <p>The wiring at the starter motor is faulty.</p> <p>The starter solenoid is faulty.</p> <p>The starter motor is faulty.</p>
Nothing happens when start attempt is made. Control panel lights and gauges operate with the ignition switch in the ON position.	<p>The traction pedal is not in the neutral position.</p> <p>The operator seat is unoccupied OR the parking brake is not applied.</p> <p>The PTO switch is ON (engaged).</p> <p>Fuse F1-1 (20 amp) is faulty.</p> <p>TEC-5002 fuses (F3-2, F3-3 or F3-4) (7.5 amp) are faulty.</p> <p>The ignition switch or circuit wiring is faulty.</p> <p>The traction neutral switch or circuit wiring is faulty.</p> <p>The seat switch or circuit wiring is faulty.</p> <p>The parking brake switch or circuit wiring is faulty.</p> <p>The start relay or circuit wiring is faulty.</p> <p>The starter solenoid or starter motor is faulty.</p> <p>The TEC-5002 controller is faulty.</p>
Engine starts, but stops when the ignition switch is released from the START position.	The engine run solenoid or circuit wiring is faulty (solenoid pull coil operates but hold coil is faulty).
Starter cranks, but should not, when the traction pedal is depressed.	<p>The traction neutral switch is out of adjustment.</p> <p>The traction neutral switch or circuit wiring is faulty.</p>

---

## Starting Problems (Continued)

Problem	Possible Causes
Engine cranks, but does not start.	<p>The fuel tank is empty.</p> <p>The engine is not cranking fast enough.</p> <p>Fuse F5-1 (30 amp) is faulty preventing engine run solenoid pull coil from being energized.</p> <p>Fuse M1 (60 amp) is faulty preventing glow plug operation.</p> <p>The glow relay or circuit wiring is faulty preventing glow plug operation.</p> <p>Glow plug(s) is faulty.</p> <p>The engine run solenoid or circuit wiring is faulty.</p> <p>The fuel pump or circuit wiring is faulty.</p> <p>The engine or fuel system is malfunctioning (see Chapter 3 – Kubota Diesel Engine).</p>

## General Run and Transport Problems

Engine continues to run, but should not, when the ignition switch is turned off.	<p>The engine run solenoid is faulty.</p> <p>The ignition switch or circuit wiring is faulty.</p>
Engine continues to run, but should not, when the traction pedal is depressed with no operator in the seat.	<p>The seat switch or circuit wiring is faulty.</p> <p>The traction neutral switch or circuit wiring is faulty.</p>
<p>Engine stops during operation, but is able to restart.</p> <p><b>NOTE:</b> Excessive 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.</p>	<p>The operator is lifting off the seat switch.</p> <p>The seat switch or circuit wiring is faulty.</p> <p>The ignition switch or circuit wiring is faulty.</p> <p>The engine coolant temperature is excessive.</p> <p>The engine or fuel system is malfunctioning (see Chapter 3 – Kubota Diesel Engine).</p>
The engine stops when the traction pedal is depressed.	<p>The operator is lifting off the seat switch.</p> <p>The parking brake is applied.</p> <p>The seat switch or circuit wiring is faulty.</p> <p>The parking brake switch or circuit wiring is faulty.</p>
Battery does not charge.	<p>Loose, corroded or broken wire(s) exist in charging circuit.</p> <p>The engine alternator belt is out of adjustment.</p> <p>The charge indicator lamp or circuit wiring is faulty.</p> <p>The battery is faulty.</p> <p>The alternator is faulty.</p>

## Cutting Deck Operating Problems

The cutting decks remain engaged, but should not, with no operator in the seat.	<p>The seat switch or circuit wiring is faulty.</p> <p>The TEC-5001 controller is faulty.</p>
Cutting deck runs, but should not, when raised. Decks shut off with PTO switch.	<p>The deck position switch or circuit wiring is faulty.</p> <p>The TEC-5001 controller is faulty.</p>
Cutting decks run, but should not, when raised. Decks do not shut off with the PTO switch.	<p>Both the deck position switch or circuit wiring <b>and</b> PTO switch or circuit wiring are faulty.</p> <p>A hydraulic problem 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>The TEC-5001 controller is faulty.</p>
Cutting deck(s) do not operate.	<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 (4WD) mode.</p> <p>High temperature of engine coolant or hydraulic oil has disabled the cutting decks.</p> <p>Fuse F4-4 (7.5 amp) is faulty preventing PTO manifold solenoids from being energized.</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 exists (see Troubleshooting section of Chapter 4 - Hydraulic System).</p> <p>The TEC-5001 controller is faulty.</p>

## Cutting Deck Lift/Lower Problems

Problem	Possible Causes
None of the cutting decks will lower.	<p>The Hi/Low speed switch is in the Hi speed position.</p> <p>Operator is not fully depressing the seat switch.</p> <p>TEC-5001 fuse(s) (F4-1, F4-2, F4-3, F4-4) are faulty.</p> <p>The seat switch or circuit wiring is faulty.</p> <p>The Hi/Low speed switch or circuit wiring is faulty.</p> <p>Lift control manifold solenoid coil S1 or circuit wiring is faulty.</p> <p>A hydraulic problem in the lift/lower circuit exists (see Troubleshooting section of Chapter 4 - Hydraulic System).</p> <p>The TEC-5001 controller is faulty.</p>
None of the cutting units will raise.	<p>TEC-5001 fuse(s) (F4-1, F4-2, F4-3, F4-4) are faulty.</p> <p>Lift control manifold solenoid coil S1 or circuit wiring is faulty.</p> <p>A hydraulic problem in the lift/lower circuit exists (see Troubleshooting section of Chapter 4 - Hydraulic System).</p> <p>The TEC-5001 controller is faulty.</p>
Front cutting deck <b>will not</b> raise or lower, but both wing cutting decks <b>will</b> raise and lower.	<p>The front deck lift switch or circuit wiring is faulty.</p> <p>Lift control manifold solenoid coils S5 or S6 or circuit wiring is faulty.</p> <p>A hydraulic problem exists (see Troubleshooting section of Chapter 4 - Hydraulic System).</p> <p>The TEC-5001 controller is faulty.</p>

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## Cutting Deck Lift/Lower Problems (Continued)

Problem	Possible Causes
RH wing cutting deck <b>will not</b> raise or lower, but the front 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 F4-3 is faulty.</p> <p>Lift control manifold solenoid coils S7, S8 or S9 or circuit wiring is faulty.</p> <p>A hydraulic problem exists (see Troubleshooting section of Chapter 4 - Hydraulic System).</p> <p>The TEC-5001 controller is faulty.</p>
LH wing cutting deck <b>will not</b> raise or lower, but the front and RH wing cutting decks <b>will</b> raise and lower.	<p>The LH deck lift switch or circuit wiring is faulty.</p> <p>Lift control manifold solenoid coils S2, S3 or S4 or circuit wiring is faulty.</p> <p>A hydraulic problem exists (see Troubleshooting section of Chapter 4 - Hydraulic System).</p> <p>The TEC-5001 controller is faulty.</p>



# Adjustments

## Cutting Deck Position Switches

### Adjustment

1. Park machine on a level surface with front cutting deck raised and side cutting decks lowered. Stop engine, engage parking brake and remove key from the ignition switch.

2. There should be from 0.070" to 0.130" (1.8 to 3.3 mm) clearance between the target surface end of position switch and the sensing plate on lift arm.

3. If necessary, loosen jam nuts on switch and adjust switch location to allow proper clearance between switch and sensing plate.

4. After adjustment, torque jam nuts from **165 to 195 in-lb (18.7 to 22.0 N-m)**. Check that proper clearance between switch and sensing plate still exists after tightening jam nuts.

**NOTE:** The cutting deck position switches include a LED. The switch LED **should be** illuminated when the cutting decks are fully lowered.

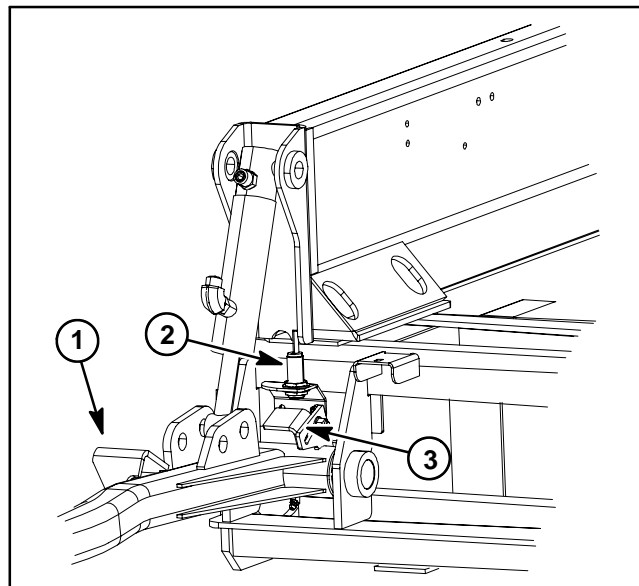


Figure 13

- |                             |                  |
|-----------------------------|------------------|
| 1. Front lift arm (lowered) | 3. Sensing plate |
| 2. Position switch          |                  |

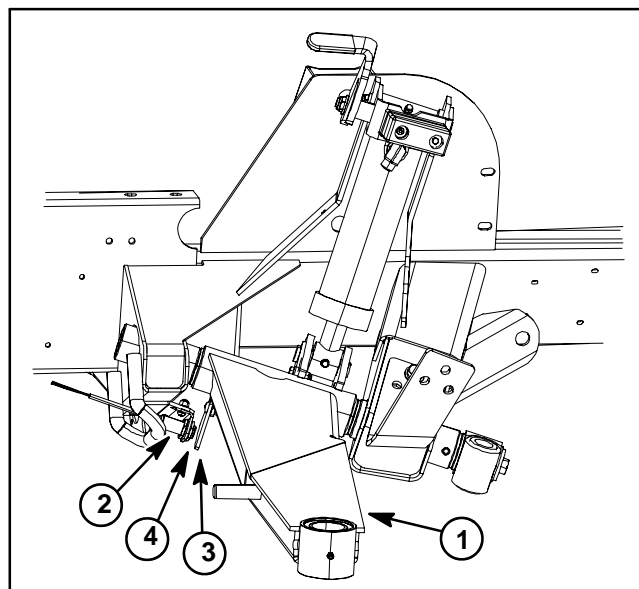


Figure 14

- |                             |                  |
|-----------------------------|------------------|
| 1. Side lift arm (LH shown) | 3. Sensing plate |
| 2. Position switch          | 4. Clearance     |

# 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 (+) multimeter lead to the positive battery post and the negative (-) multimeter lead to the negative battery post. The multimeter will display battery voltage.

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

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

## Charging System Test

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

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 (**2870 RPM**). Allow the battery to charge for at least three (3) minutes. Record the battery voltage.

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

An example of a charging system that is functioning:

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

## Glow Plug System Test

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

Use a digital multimeter and/or inductive Ammeter (AC/DC Current Transducer). Properly connect the ammeter to the digital multimeter (refer to manufacturers' instructions) and set the multimeter to the correct scale. With the ignition switch in the OFF position, place the

ammeter pickup around the main glow plug power supply wire and read the meter prior to activating the glow plug system. Adjust the meter to read zero (if applicable). Activate the glow plug system by turning the ignition switch to ON and record the multimeter results.

The Groundsmaster glow plug system should have a reading of approximately nine (9) amps per glow plug (36 amps total). If low current reading is observed, one (or more) of the glow plugs is faulty.

---

## 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 two (2) Toro Electronic Controllers (TEC) which monitor interlock switch operation. Testing of individual interlock switches and relays is included in the Component Testing section of this Chapter.

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

# Component Testing

For accurate resistance and/or continuity checks, electrically disconnect the component being tested from the circuit (e.g. unplug the ignition switch connector before checking continuity on the switch).

**NOTE:** For engine component testing information, see the Kubota Workshop Manual, Diesel Engine, 03-M-E3B Series at the end of Chapter 3 – Kubota Diesel Engine.

**CAUTION**

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

## Ignition Switch

The ignition (key) switch on the console arm has three (3) positions (OFF, ON/PREHEAT and START) (Fig. 15).

### Testing

1. Before disconnecting the ignition switch for testing, the switch and its circuit wiring should be tested as a TEC-5002 input with the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If the Diagnostic Display verifies that the ignition switch and circuit wiring **are** functioning correctly, no further switch testing is necessary. If, however, the Display determines that the ignition switch and circuit wiring **are not** functioning correctly, proceed with test.
2. Make sure ignition switch is OFF. Remove key from ignition switch.
3. Disassemble console arm to gain access to ignition switch (see Console Arm Disassembly in the Service and Repairs section of Chapter 7 – Chassis).
4. Disconnect wire harness electrical connector from the ignition switch.
5. The ignition switch terminals are identified as shown in Figure 16. The circuit logic of the ignition 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 ignition switch if testing identifies that switch is faulty.

POSITION	CIRCUIT
OFF	NONE
ON/PREHEAT	B + C + F, D + E
START	A + B + C

6. If ignition switch tests correctly and circuit problem still exists, check wire harness (see Electrical Schematics and Wire Harness Drawings in Chapter 10 – Foldout Drawings).
7. After testing is completed, connect the wire harness connector to the ignition switch.
8. Assemble console arm (see Console Arm Assembly in the Service and Repairs section of Chapter 7 – Chassis).

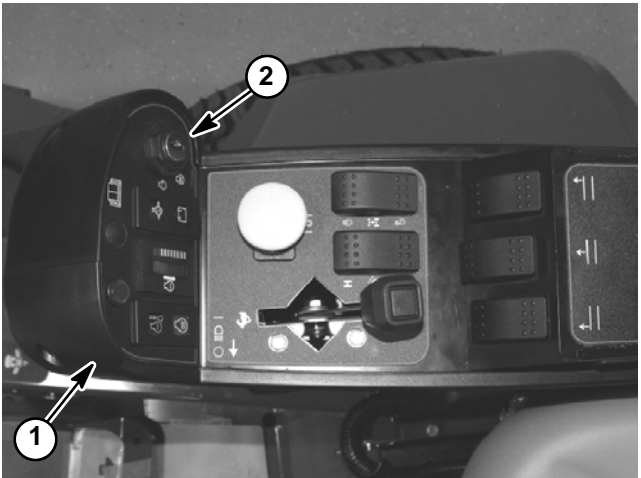


Figure 15

1. Console arm
2. Ignition switch

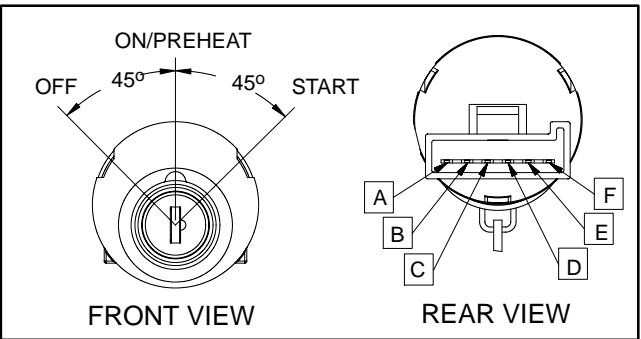


Figure 16

## Fuses

The fuse blocks are located in the power center under the hood on the right side of the machine (Fig. 17).

In addition to the fuses in the fuse blocks, a 40 amp fuse (F5-1) is included in the wire harness to protect the pull coil circuit for the engine run solenoid. This fuse resides in a fuse holder near the starter motor (Fig. 17).

### Fuse Identification and Function

Use Figure 18 to identify each individual fuse and its correct amperage in the fuse block. The fuses have the following functions.

**Fuse F1-1 (20 amp)** protects engine starter circuit.

**Fuse F1-3 (10 amp)** protects light circuit on Groundsmaster 4010-D.

**Fuse F1-4 (10 amp)** protects signal light circuit on Groundsmaster 4010-D.

**Fuse F2-2 (10 amp)** protects operator seat circuit.

**Fuse F2-3 (10 amp)** protects power point circuit.

**Fuse F2-4 (10 amp)** protects main power supply circuit.

**Fuse F3-1 (2 amp)** protects logic power circuit to the TEC-5002 controller.

**Fuse F3-2 (7.5 amp)** protects power supply for the TEC-5002 controller outputs.

**Fuse F3-3 (7.5 amp)** protects power supply for the TEC-5002 controller outputs.

**Fuse F3-4 (7.5 amp)** protects power supply for the TEC-5002 controller outputs.

**Fuse F4-1 (2 amp)** protects logic power circuit to the TEC-5001 controller.

**Fuse F4-2 (7.5 amp)** protects power supply for the TEC-5001 controller outputs.

**Fuse F4-3 (7.5 amp)** protects power supply for the TEC-5001 controller outputs.

**Fuse F4-4 (7.5 amp)** protects power supply for the TEC-5001 controller outputs.

**Fuse M1 (60A)** protects engine glow plug circuit.

**Fuse M2 (60A)** protects operator cab circuit on Groundsmaster 4010-D.

## Fuse Testing

Turn ignition switch to the ON position (do not start engine). With the fuse installed in the fuse block, use a multimeter to verify that 12 VDC exists at both of the terminal test points on the fuse. If 12 VDC exists at one of the fuse test points but not at the other, the fuse is faulty.

If necessary, make sure that ignition switch is OFF and key is removed from switch. Remove fuse from fuse block and check that fuse has continuity across the fuse terminals.

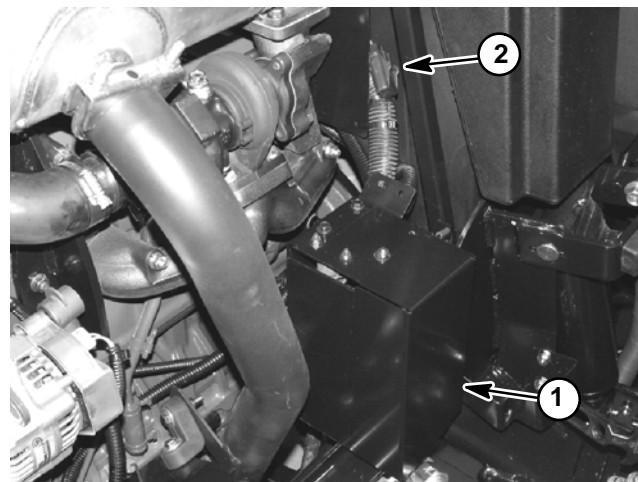


Figure 17

1. Power center

2. Fuse F5-1

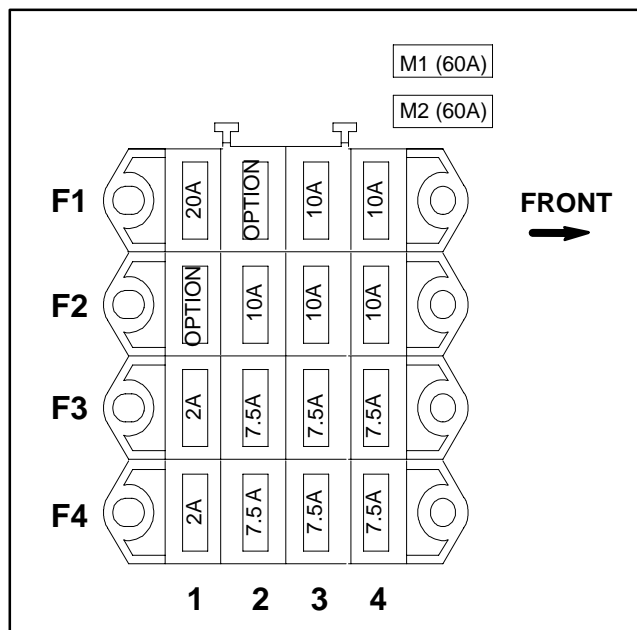


Figure 18

## Operator Cab Fuses (Groundsmaster 4010-D)

The cab fuse blocks are located in the cab headliner (Fig. 19).

### Identification and Function (Figs. 19 and 20)

Fuse F1-2 (15 Amp) protects the cab fan circuit.

Fuse F1-3 (30 Amp) protects the air conditioner circuit.

Fuse F2-1 (15 Amp) protects the windshield wiper/washer circuit.

Fuse F2-2 (15 Amp) protects the cab dome light circuit.

Fuses F1-1, F1-4, F2-3 and F2-4 are available for optional equipment.

### Testing

Turn ignition switch to the ON position (do not start engine). With the fuse installed in the fuse block, use a multimeter to verify that 12 VDC exists at both of the terminal test points on the fuse. If 12 VDC exists at one of the fuse test points but not at the other, the fuse is faulty.

If necessary, make sure that ignition switch is OFF and key is removed from switch. Remove fuse from fuse block and check that fuse has continuity across the fuse terminals.

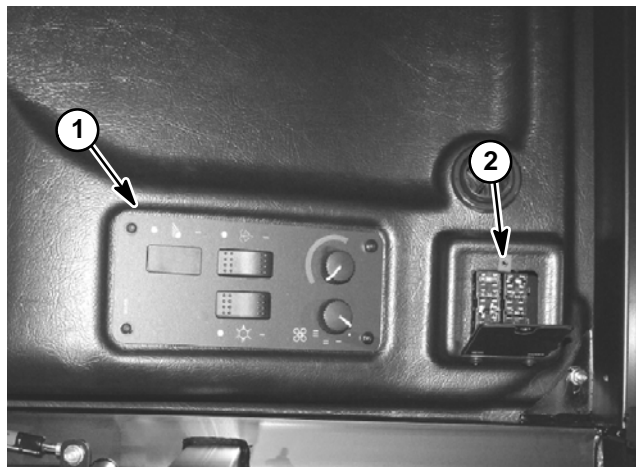


Figure 19

1. Cab headliner switches      2. Cab fuse blocks

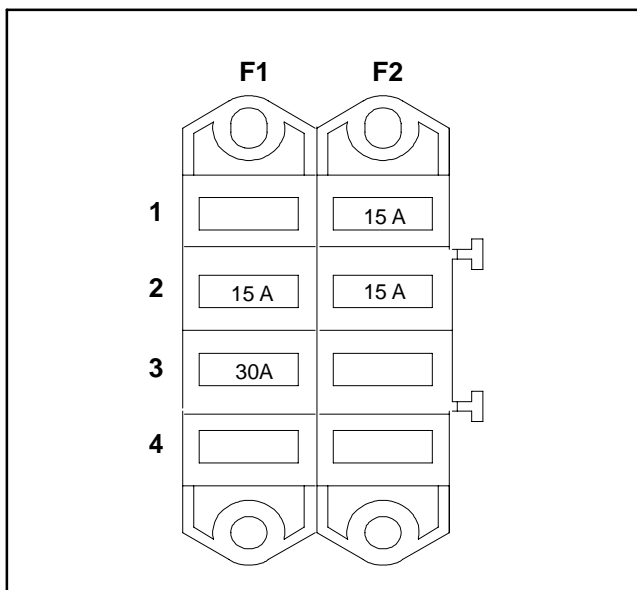


Figure 20

## Warning Lights

### Charge Indicator Light

The charge indicator light should come on when the ignition switch is in ON with the engine not running or with an improperly operating charging circuit while the engine is running.

To test the charge indicator light and circuit wiring, ground the white wire attached to alternator. Turn ignition switch to ON; the charge indicator light should illuminate indicating correct operation of the electrical wiring to the alternator.

### Engine Oil Pressure Light

The engine oil pressure light should come on when the ignition switch is in the ON position with the engine not running. Also, it should light with the engine running if the engine oil pressure drops below 7 PSI (0.5 kg/cm<sup>2</sup>).

To test the oil pressure light and circuit wiring, ground the green wire attached to oil pressure switch located on right side of engine near the starter motor. Turn ignition switch to ON; the oil pressure light should illuminate indicating correct operation of the electrical wiring to the oil pressure switch.

### High Temperature Warning Light

If the engine coolant temperature rises to approximately 220°F (105°C), the high temperature light should come on and the PTO (cutting decks) will disengage.

To test the high temperature warning light and circuit wiring, start the engine and ground the gray wire attached to the temperature sender attached to water flange on engine (see Temperature Sender in this section). Warning light should illuminate.

### Glow Plug Indicator Light

The glow plug light should come on when the ignition switch is placed in ON/PREHEAT prior to placing the ignition switch in START. The light should stay lit for approximately seven (7) seconds while the ignition switch is left in ON.

### Testing Indicator Lights

1. Remove control arm covers to gain access to indicator light and harness connectors (see Control Arm Disassembly in the Service and Repairs section of Chapter 7 - Chassis).

2. Locate the indicator light to be tested and disconnect the wire harness electrical connector from the light.

3. Apply 12 VDC to terminals 1A and 2A (Fig. 22).

4. Ground terminals 1B and 2B (Fig. 22).

5. Both indicator lights should illuminate.

6. Connect wire harness electrical connector to the indicator light.

7. Install control arm cover to machine (see Control Arm Assembly in the Service and Repairs section of Chapter 7 - Chassis).

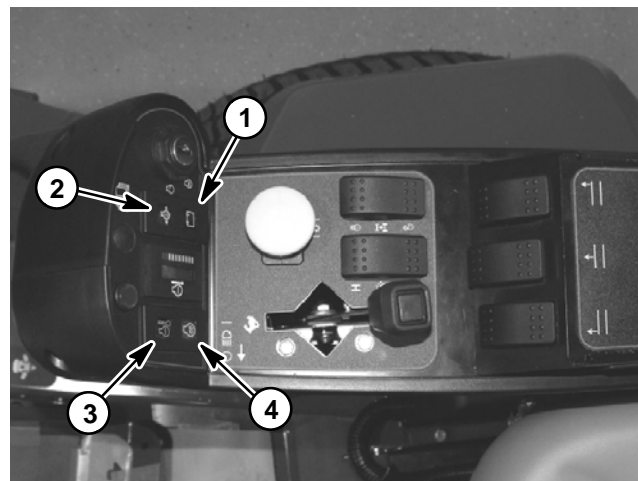


Figure 21

- |                        |                        |
|------------------------|------------------------|
| 1. Charge indicator    | 3. High temp warning   |
| 2. Engine oil pressure | 4. Glow plug indicator |

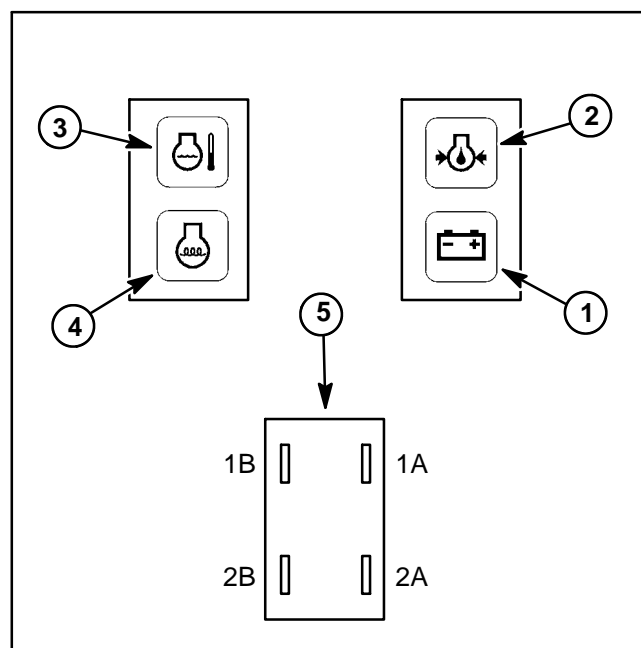


Figure 22

- |                        |                        |
|------------------------|------------------------|
| 1. Charge indicator    | 4. Glow plug indicator |
| 2. Engine oil pressure | 5. Warning light back  |
| 3. High temp warning   |                        |

## PTO Switch

The PTO switch is located on the console arm (Fig. 23). The PTO switch is pulled up to engage the PTO and pushed in to disengage the PTO.

The TEC-5001 controller monitors the position of the PTO switch (up or down). Using inputs from the PTO switch and other switches in the interlock system, the TEC-5001 controller controls the energizing of the hydraulic solenoid valves used to drive the cutting deck motors.

**NOTE:** To engage the PTO, the seat has to be occupied, traction speed has to be in Low range (4WD) and the cutting decks have to be fully lowered.

### Testing

1. Before disconnecting the PTO switch for testing, the switch and its circuit wiring should be tested as a TEC input with the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If the Diagnostic Display verifies that the PTO switch and circuit wiring **are** functioning correctly, no further switch testing is necessary. If, however, the Display determines that the PTO switch and circuit wiring **are not** functioning correctly, proceed with test.

2. Make sure ignition switch is OFF. Remove key from ignition switch.

3. Disassemble console arm to gain access to PTO switch (see Console Arm Disassembly in the Service and Repairs section of Chapter 7 - Chassis).

4. Disconnect harness electrical connector from the PTO switch.

5. The switch terminals are marked as shown in Figure 24. 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 PTO 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

6. If PTO switch tests correctly and circuit problem still exists, check wire harness (see Electrical Schematics and Wire Harness Drawings in Chapter 10 - Foldout Drawings).

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

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

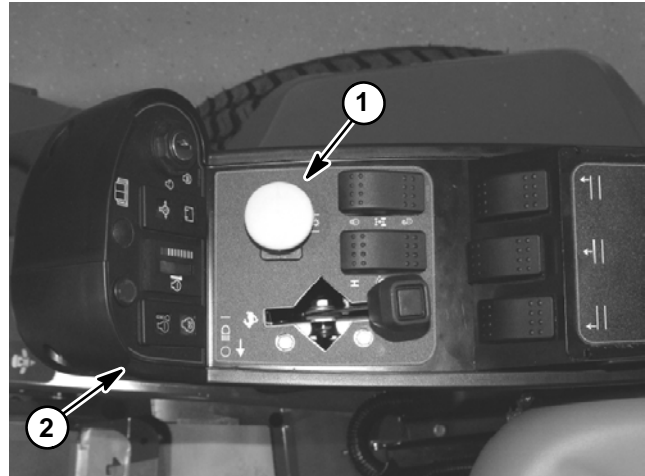


Figure 23

1. PTO switch

2. Control console

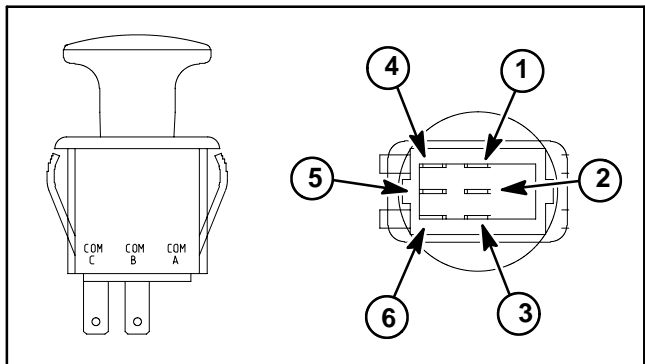


Figure 24

1. COM B terminal  
2. NO B terminal  
3. NC B terminal

4. COM C terminal  
5. NO C terminal  
6. NC C terminal

**NOTE:** Only PTO switch terminals COM C and NO C are used on Groundsmaster 4000-D and 4010-D machines.



## Cutting Deck Lift Switches

The cutting deck lift switches are used as inputs for the TEC-5001 controller to raise or lower the cutting decks. When the front of a lift switch is depressed and held, the controlled decks will lower. When the rear of a lift switch is depressed and held, the controlled decks will raise. The decks will remain in position when the switch is released. The lift switches are located on the console arm (Fig. 25).

**NOTE:** To lower the cutting decks, traction speed has to be in low range (4WD). Also, to raise or lower the decks, the operator seat has to be occupied.

### Testing

1. Before disconnecting the lift switch for testing, the switch and its circuit wiring should be tested as a TEC-5001 input with the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If the Diagnostic Display verifies that the lift switch and circuit wiring **are** functioning correctly, no further switch testing is necessary. If, however, the Display determines that the lift switch and circuit wiring **are not** functioning correctly, proceed with test.

2. Make sure ignition switch is OFF. Remove key from ignition switch.

3. Disassemble console arm to gain access to cutting deck lift switches (see Console Arm Disassembly in the Service and Repairs section of Chapter 7 - Chassis).

4. Disconnect harness electrical connector from the lift switch that is to be tested.

5. The switch terminals are marked as shown in Figure 26. The circuit logic of the lift switches 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 lift switch if testing identifies a faulty switch.

SWITCH POSITION	CLOSED CIRCUITS	OPEN CIRCUITS
DECK LOWER	2 + 3 5 + 6	2 + 1 5 + 4
NEUTRAL	NONE	ALL
DECK RAISE	2 + 1 5 + 4	2 + 3 5 + 6

6. If lift switch tests correctly and circuit problem still exists, check wire harness (see Electrical Schematics and Wire Harness Drawings in Chapter 10 - Foldout Drawings).

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

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

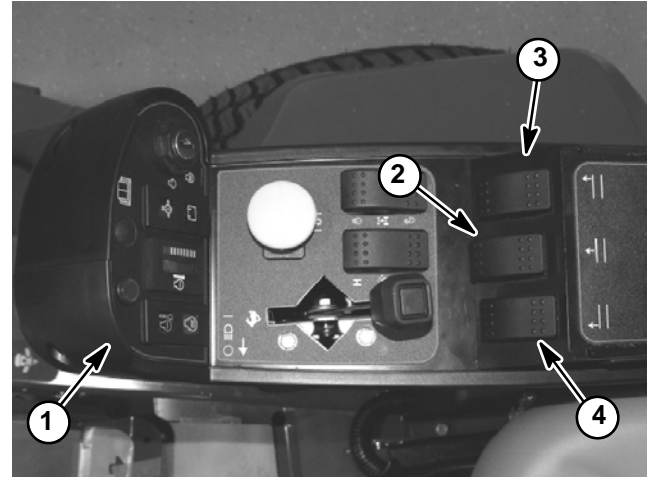
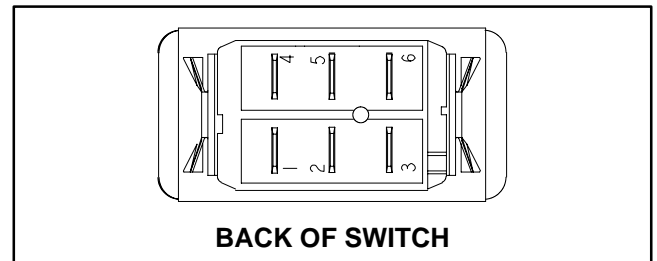


Figure 25

- 1. Console arm
- 2. Front deck lift switch
- 3. RH deck lift switch
- 4. LH deck lift switch



BACK OF SWITCH

Figure 26

**NOTE:** Lift switch terminals 4, 5 and 6 are not used on Groundsmaster 4000-D and 4010-D machines.

## Hi/Low Speed and Headlight (Groundsmaster 4010-D) Switches

The Hi/Low speed and headlight switches (Groundsmaster 4010-D) are identical, two (2) position rocker switches that are located on the control console.

The Hi/Low speed switch (Fig. 27) is used as an input for the TEC-5002 controller to set the machine traction speed for Hi speed (2WD) or Low speed (4WD).

The Groundsmaster 4010-D headlight switch allows the headlights to be turned on and off.

**NOTE:** Before disconnecting the Hi/Low speed switch for testing, the switch and its circuit wiring should be tested as a TEC-5002 input with the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If the Diagnostic Display verifies that the Hi/Low speed switch and circuit wiring **are** functioning correctly, no further switch testing is necessary. If, however, the Display determines that the Hi/Low speed switch and circuit wiring **are not** functioning correctly, proceed with test.

### Testing

1. Make sure ignition switch is OFF. Remove key from ignition switch.
2. Disassemble console arm to gain access to switch that is to be tested (see Console Arm Disassembly in the Service and Repairs section of Chapter 7 - Chassis).
3. Disconnect harness electrical connector from the 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 28. The circuitry of the switch is shown in the chart below. Verify continuity between switch terminals. Replace switch if testing identifies a faulty switch.

SWITCH POSITION	CIRCUIT 1	CIRCUIT 2
ON	2 + 3	5 + 6
OFF	2 + 1	5 + 4

5. If switch tests correctly and circuit problem still exists, check wire harness (see Electrical Schematics and Wire Harness Drawings in Chapter 10 - Foldout Drawings).

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

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

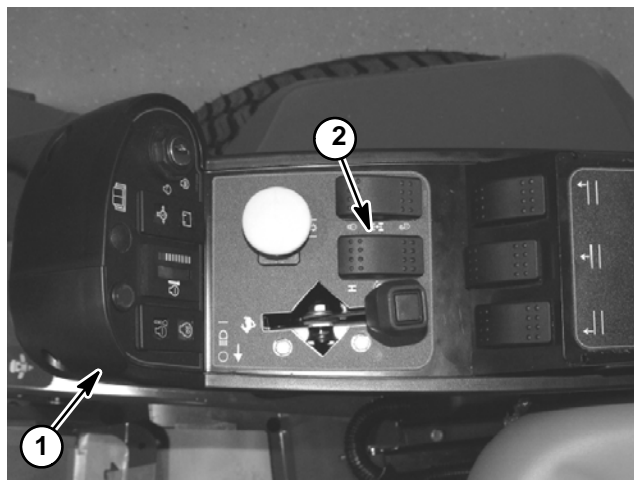


Figure 27

1. Console arm                      2. Hi/Low speed switch

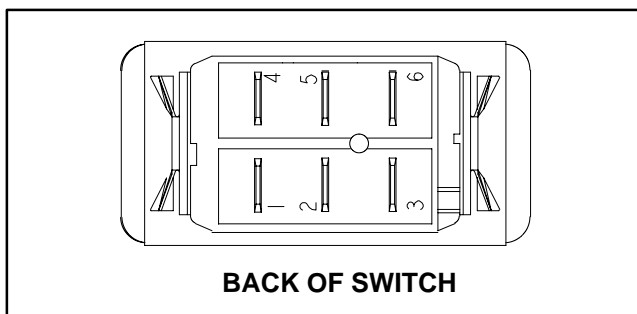


Figure 28

**NOTE:** Switch terminals 1, 4, 5 and 6 are not used on Groundsmaster 4000-D and 4010-D machines.

## Flow Divider and Engine Cooling Fan Switches

The flow divider and engine cooling fan switches are identical, two (2) position rocker switches that are located on the control console (Fig. 29). These switches have a normal and a momentary position.

The flow divider switch is used as an input for the TEC-5002 controller to energize the solenoid valve in the hydraulic traction manifold. When the flow divider switch is depressed (momentary), traction pump hydraulic flow is split between the front wheel motors (approximately 45%) and rear axle motor (approximately 55%) to reduce the chance that excessive traction pump flow goes to a spinning wheel. The flow divider switch only functions when the machine Hi/Low speed switch is in the Low speed (4WD) position.

The engine cooling fan switch is used as an input for the TEC-5002 controller to allow the engine cooling fan to run in the normal, automatic mode or in the manual, reverse (momentary) direction.

### Testing

1. Before disconnecting the flow divider or engine cooling fan switch for testing, the switch and its circuit wiring should be tested as a TEC input with the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If the Diagnostic Display verifies that switch and circuit wiring **are** functioning correctly, no further switch testing is necessary. If, however, the Display determines that the switch and circuit wiring **are not** functioning correctly, proceed with test.

2. Make sure ignition switch is OFF. Remove key from ignition switch.

3. Disassemble console arm to gain access to the switch that is to be tested (see Console Arm Disassembly in the Service and Repairs section of Chapter 7 - Chassis).

4. Disconnect harness electrical connector from the switch.

5. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each position. The switch terminals are marked as shown in Figure 30. The circuitry of the flow divider and cooling fan switch is shown in the chart below. Verify continuity between switch terminals.

SWITCH POSITION	NORMAL CIRCUITS	OTHER CIRCUITS
NORMAL	2 + 3	5 + 6
MOMENTARY	2 + 1	5 + 4

6. If switch tests correctly and circuit problem still exists, check wire harness (see Electrical Schematics and Wire Harness Drawings in Chapter 10 - Foldout Drawings).

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

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

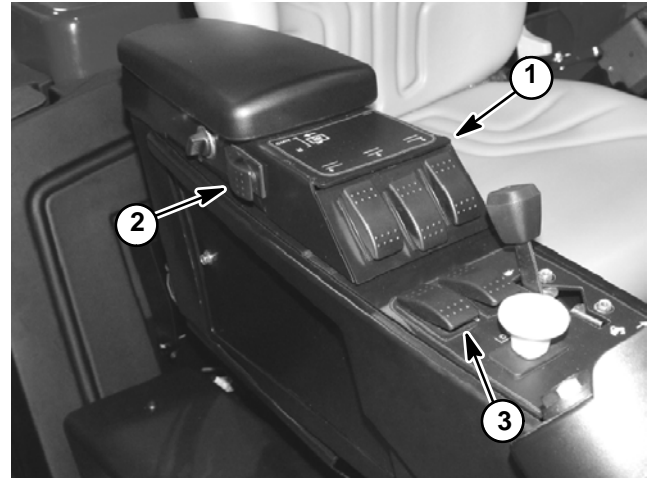


Figure 29

- 1. Console arm
- 2. Cooling fan switch
- 3. Flow divider switch

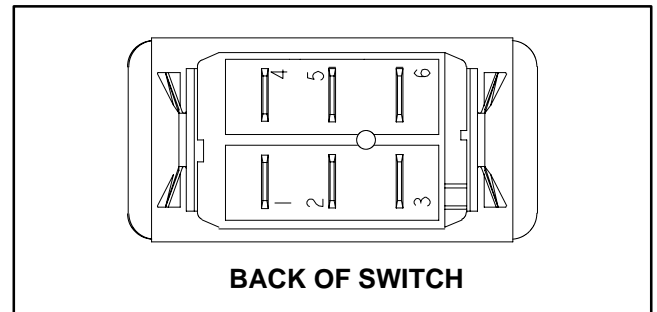


Figure 30

**NOTE:** Only flow divider and cooling fan switch terminals 1 and 2 are used on Groundsmaster 4000-D and 4010-D machines.

## Seat Switch

The seat switch is normally open and closes when the operator is on the seat. This switch is used as an input for the TEC-5002 controller. 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, the engine will stop. Testing of the switch can be done without seat removal by disconnecting the switch wire from the machine wire harness (Fig. 31).

### Testing

1. Before disconnecting the seat switch for testing, the switch and its circuit wiring should be tested as a TEC-5002 input with the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If the Diagnostic Display verifies that the seat switch and circuit wiring **are** functioning correctly, no further switch testing is necessary. If, however, the Display determines that the seat switch and circuit wiring **are not** functioning correctly, proceed with test.

2. Make sure ignition switch is OFF. Remove key from ignition switch.

3. Disconnect seat switch connector from the machine wire harness connector.

4. Check the continuity of the switch by connecting a multimeter (ohms setting) across the seat switch connector terminals.

5. With no pressure on the seat, there should not be continuity between the seat switch terminals.

6. Press directly onto the seat switch through the seat cushion. There should be continuity as the seat cushion approaches the bottom of its travel.

7. 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).

8. Connect seat switch connector to wire harness connector after testing is complete.

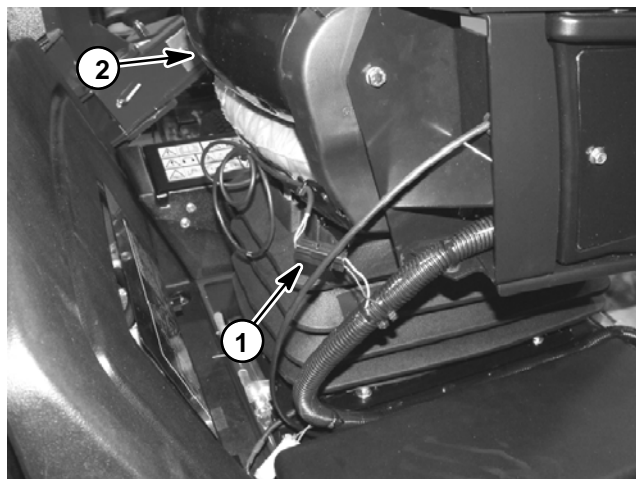


Figure 31

- 1. Seat switch electrical connector
- 2. Operator seat

## Parking Brake Switch

The switch used for the parking brake is a normally open switch that is located under the steering tower cover (Fig. 32). The brake switch is used as an input for the TEC-5002 controller. When the parking brake **is not** applied, the parking brake pawl depresses the switch plunger to close the switch. When the parking brake **is** applied, the parking brake pawl is positioned away from the switch plunger so the switch is in its normal, open state.

### Testing

1. Before disconnecting the parking brake switch for testing, the switch and its circuit wiring should be tested as a TEC-5002 input with the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If the Diagnostic Display verifies that the parking brake switch and circuit wiring **are** functioning correctly, no further switch testing is necessary. If, however, the Display determines that the brake switch and circuit wiring **are not** functioning correctly, proceed with test.

2. Make sure ignition switch is OFF. Remove key from ignition switch.

3. Locate parking brake switch for testing (see Steering Tower Disassembly in the Service and Repairs section of Chapter 7 – Chassis).

4. Disconnect wire harness connector from the brake switch.

5. Check the continuity of the switch by connecting a multimeter (ohms setting) across the connector terminals.

6. When the brake switch plunger is extended there **should not be** continuity between the switch terminals.

7. When the brake switch plunger is depressed, there **should be** continuity between the switch terminals.

8. After testing, connect wire harness connector to parking brake switch.

9. Secure all removed components to steering tower (see Steering Tower Assembly in the Service and Repairs section of Chapter 7 – Chassis).

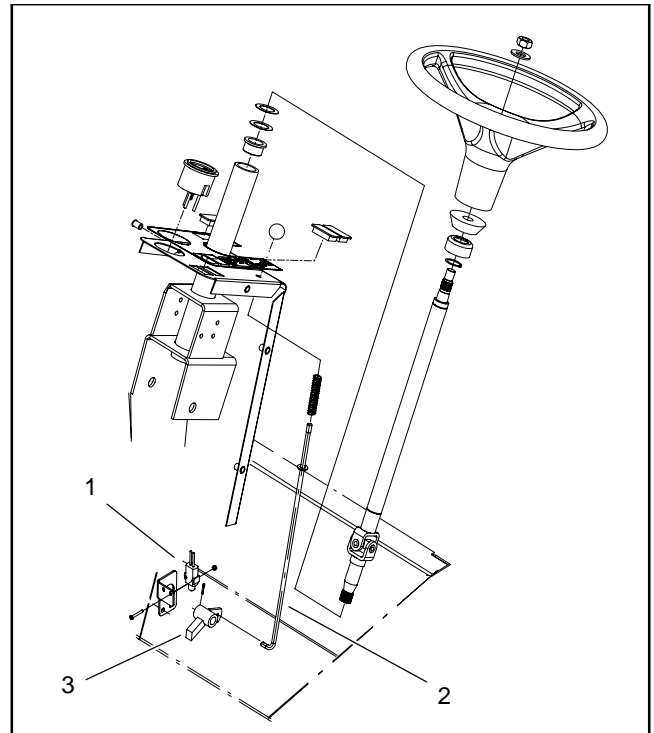


Figure 32

1. Parking brake switch  
2. Parking brake rod

3. Parking brake pawl

# Windshield Wiper/Washer Switch (Groundsmaster 4010-D)

The windshield wiper/washer switch is used to control operation of the windshield wiper and washer pump on the Groundsmaster 4010-D. The windshield wiper/washer switch is located in the cab headliner (Fig. 33).

## Testing

1. Make sure ignition switch is OFF. Remove key from ignition switch.
2. Remove switch plate from cab headliner.
3. Locate windshield wiper/washer switch and unplug wire harness connector from switch.
4. The switch terminals are marked as shown in Figure 34. The circuit logic of the wiper/washer 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 wiper/washer switch if testing identifies a faulty switch.

SWITCH POSITION	CLOSED CIRCUITS	OPEN CIRCUITS
OFF	NONE	ALL
WIPER ON	2 + 3	5 + 6
WASHER ON	2 + 3 5 + 6	NONE

5. If switch tests correctly and circuit problem still exists, check wire harness (see Electrical Schematics and Wire Harness Drawings in Chapter 10 - Foldout Drawings).
6. Connect the wire harness connector to the switch after testing.
7. Install switch plate to cab headliner after switch testing is complete.

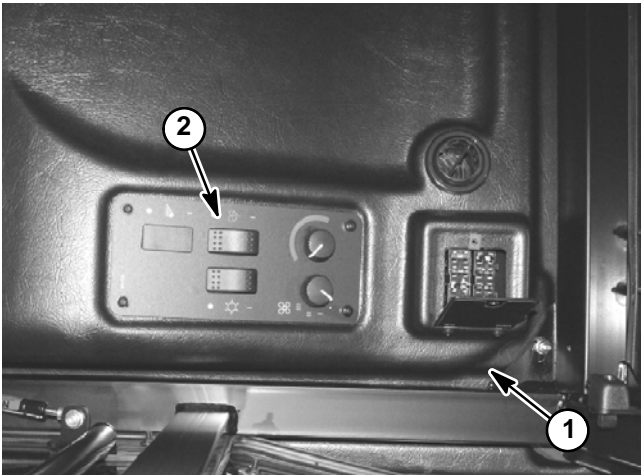


Figure 33

1. Cab headliner                      2. Wiper/washer switch

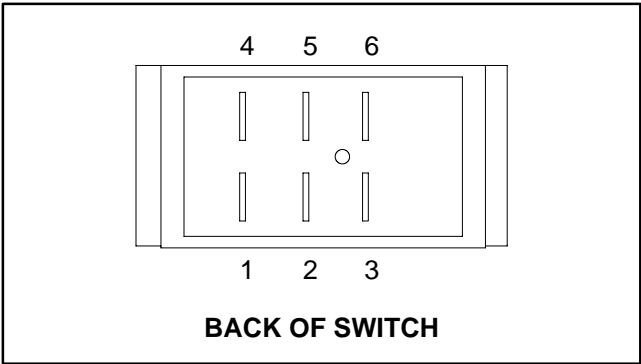


Figure 34

## Air Conditioning Switch (Groundsmaster 4010-D)

The air conditioning switch is used to control operation of the air conditioning system on the Groundsmaster 4010-D. The switch is located in the cab headliner (Fig. 35).

### Testing

1. Make sure ignition switch is OFF. Remove key from ignition switch.
2. Remove switch plate from cab headliner.
3. Locate air conditioning switch and unplug wire harness connector from switch.
4. The switch terminals are marked as shown in Figure 36. The circuit logic of the air conditioning 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
AC OFF	2 + 3 5 + 6	2 + 1 5 + 4
AC ON	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 10 - Foldout Drawings).

6. Connect the wire harness connector to the air conditioning switch after testing.

7. Install switch plate to cab headliner after switch testing is complete.

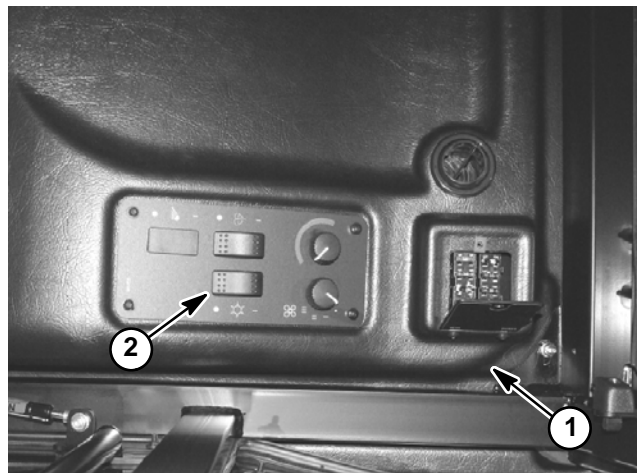


Figure 35

1. Cab headliner

2. Air conditioning switch

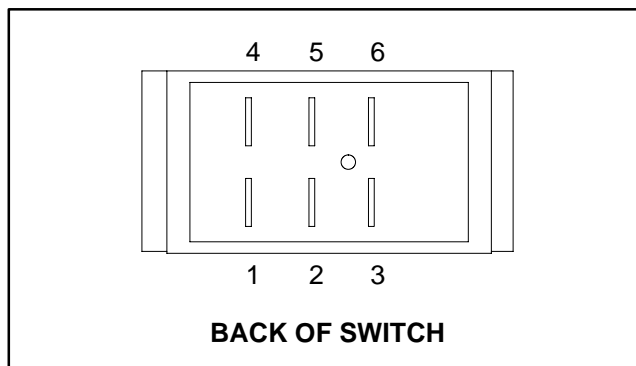


Figure 36

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## Hour Meter

The hour meter is located on the outside of the console arm.

### Testing

1. Make sure ignition switch is OFF. Remove key from ignition switch.
2. Disassemble console arm to gain access to the hour meter (see Console Arm Disassembly in the Service and Repairs section of Chapter 7 - Chassis).
3. Connect the positive (+) terminal of a 12 VDC source to the positive (+) terminal of the hour meter (Fig. 37).
4. Connect the negative (-) terminal of the voltage source to the other terminal of the hour meter.
5. The hour meter should move a 1/10 of an hour in six (6) minutes.
6. Disconnect voltage source from the hour meter. Reconnect harness connector to hour meter.

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

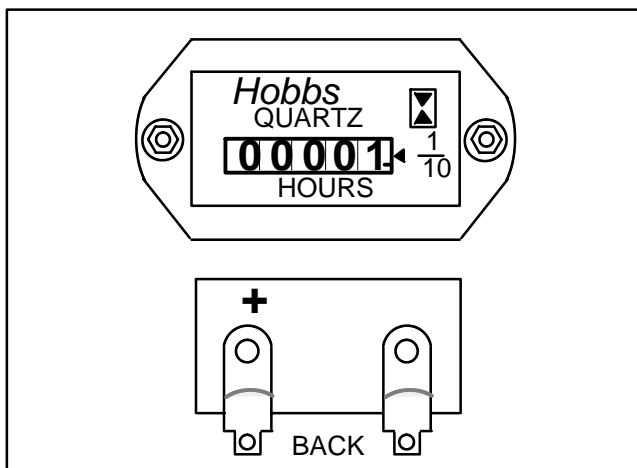


Figure 37

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## Audio Alarm

The audio alarm sounds to notify the operator when a machine problem exists. Electrical current for the alarm is provided as an output from the TEC-5002 controller. The alarm is attached to the console arm next to the operator seat.

### Testing

1. Make sure ignition switch is OFF. Remove key from ignition switch.
2. Disassemble console arm to gain access to the audio alarm (see Console Arm Disassembly in the Service and Repairs section of Chapter 7 - Chassis).
3. Disconnect wire harness connector from alarm.

**IMPORTANT: Make sure to observe polarity on the alarm terminals when testing. Damage to the alarm may result from an improper connection.**

4. Correctly connect 12VDC source to the alarm terminals (Fig. 38).
5. Alarm should sound as long as 12VDC is connected to the alarm terminals.

6. Disconnect voltage source from the alarm. Reconnect harness connector to alarm.

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

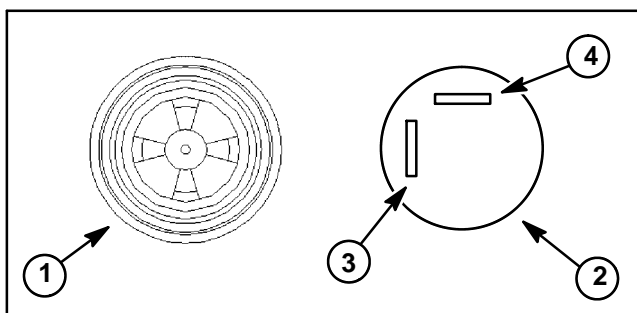


Figure 38

- |                      |                          |
|----------------------|--------------------------|
| 1. Alarm top view    | 3. Positive (+) terminal |
| 2. Alarm bottom view | 4. Negative (-) terminal |



## Main Power, Glow and Operator Cab Power (Groundsmaster 4010-D) Relays

The main power, glow and operator cab power relays are located at the power center behind the operator seat (Fig. 39). The wire harness is attached to these relays with a four (4) wire connector (Fig. 40).

The main power relay is used to provide current to the TEC controllers and most of the fuse protected circuits (operator seat, power point and optional electric equipment). When the ignition switch is in the ON or START position, the main power relay is energized.

The glow relay is used to provide current to the engine glow plugs when the relay is energized by the TEC-5002 controller. The TEC-5002 controls and monitors the operation of the glow relay.

The operator cab power relay on Groundsmaster 4010-D machines is used to provide current to the operator cab electrical components. When the ignition switch is in the ON or START position, the cab power relay is energized.

### Testing

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch. Raise and support hood.
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. Remove cover (item 1) and heat shield (item 11) from power center and locate relay to be tested. If necessary, remove two (2) flange nuts and carriage screws that secure power center to tank support.
4. Disconnect wire harness connector from relay. Remove relay from mounting bracket for testing.
5. Using a multimeter, verify that coil resistance between terminals 86 and 85 is approximately 72 ohms.
6. Connect multimeter (ohms setting) leads to relay terminals 30 and 87. Ground terminal 86 and apply +12 VDC to terminal 85. The relay should make and break continuity between terminals 30 and 87 as +12 VDC is applied and removed from terminal 85.
7. Disconnect voltage and test leads from the relay terminals.

8. Secure relay to mounting bracket and connect wire harness connector to relay. Secure power center to tank support if it was removed. Install cover (item 1) and heat shield (item 11) to power center.

9. Connect positive (+) cable to battery and then connect negative (-) cable to battery (see Battery Service in the Service and Repairs section of this chapter).

10. Lower and secure hood.

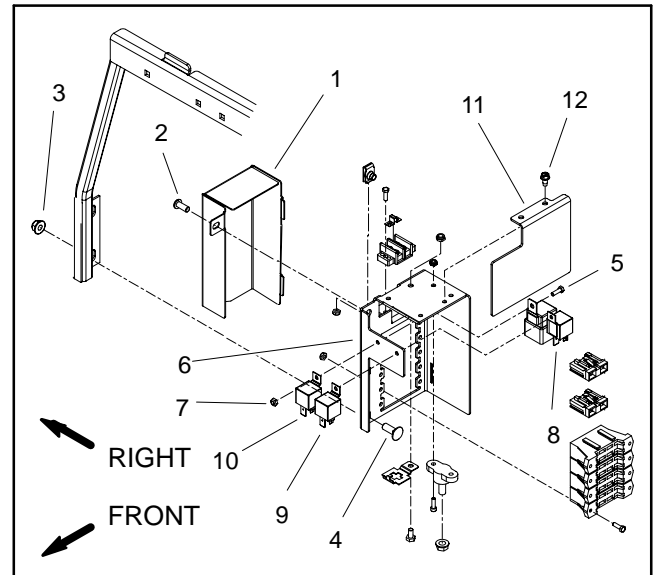


Figure 39

- |                            |                     |
|----------------------------|---------------------|
| 1. Cover                   | 7. Lock nut         |
| 2. Screw                   | 8. Main power relay |
| 3. Flange nut (2 used)     | 9. Glow relay       |
| 4. Carriage screw (2 used) | 10. Cab power relay |
| 5. Screw                   | 11. Heat shield     |
| 6. Mount                   | 12. Screw (2 used)  |

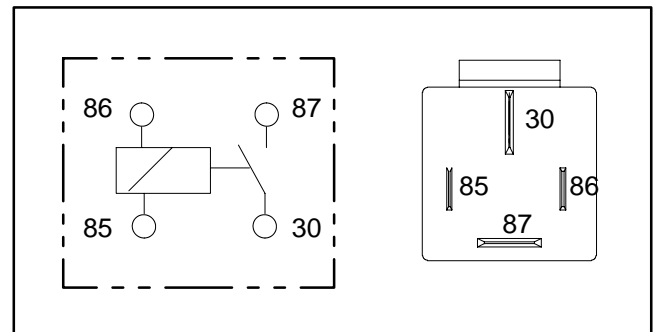


Figure 40

## Start and Air Conditioning (Groundsmaster 4010-D) Relays

When energized by the TEC-5002 controller, the start relay is used to provide current to the engine starter motor solenoid. The start relay is located at the power center behind the operator seat (Fig. 41).

An identical relay is used to control the air conditioning electrical power circuit on the Groundsmaster 4010-D. When energized by the air conditioning switch, the relay provides current for the air conditioning components. The relay is attached to the cab headliner above the switch panel.

The start and air conditioning relays are attached to the wire harness with a five (5) wire connector (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 access start relay:

A. Raise and support hood.

B. 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).

C. Remove cover (item 1) and heat shield (item 9) from power center and locate relay to be tested. If necessary, remove two (2) flange nuts and carriage screws that secure power center to tank support.

3. To access air conditioning relay, remove screws that secure switch panel to headliner in cab.

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 termi-

nals 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. If battery cables were disconnected, 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).

11. Make sure that hood is secured.

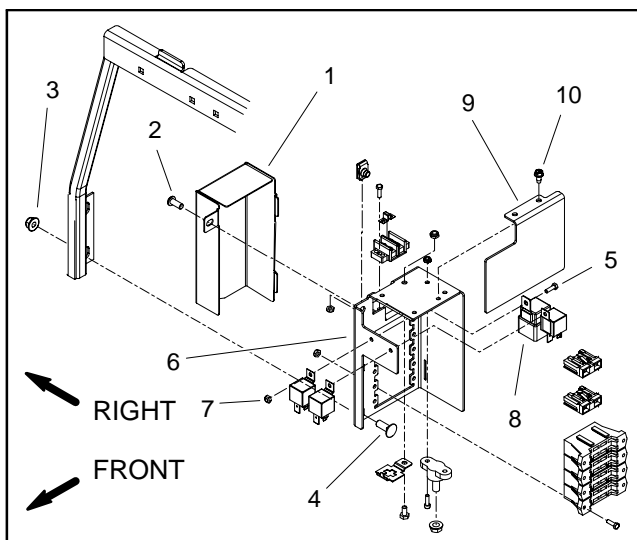


Figure 41

- |                            |                    |
|----------------------------|--------------------|
| 1. Cover                   | 6. Mount           |
| 2. Screw                   | 7. Lock nut        |
| 3. Flange nut (2 used)     | 8. Start relay     |
| 4. Carriage screw (2 used) | 9. Heat shield     |
| 5. Screw                   | 10. Screw (2 used) |

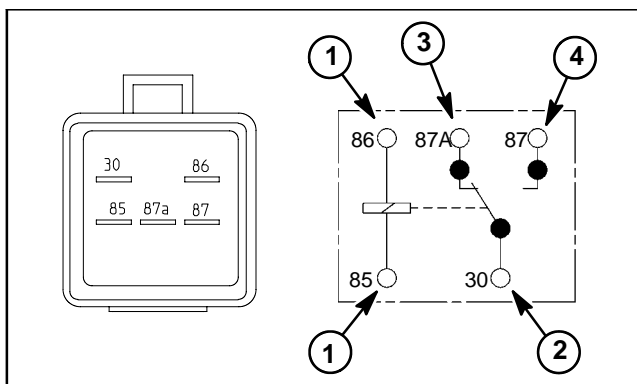


Figure 42

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

## Toro Electronic Controllers (TEC)

Groundsmaster 4000-D and 4010-D machines use two Toro Electronic Controllers (TEC) to control electrical system operation. The controllers are attached to the operator platform under the controller cover (Figs. 43 and 44).

Logic power is provided to the controllers as long as the battery cables are connected to the battery. A pair of 2 amp fuses (F3-1 and F4-1) provide circuit protection for this logic power to the controllers.

The TEC-5002 master controller monitors the states of the following components as inputs: ignition switch, parking brake switch, traction neutral switch, seat switch, engine oil pressure switch, flow divider switch, Hi/Low speed switch, hydraulic temperature sender, engine coolant temperature sender, engine cooling fan switch and optional cruise control switches (if equipped).

The TEC-5002 controller controls electrical output to the TEC-5001 controller, hydraulic fan drive manifold solenoid coils (speed and direction), fuel pump, engine run solenoid (hold coil), glow plug relay, start relay, high temperature warning light, diagnostic light, audio alarm, hydraulic 4WD manifold solenoid coil (flow divider), hydraulic traction manifold solenoid coil (Hi/Low speed) and optional cruise control coil (if equipped). Circuit protection for TEC-5002 outputs is provided by three (3) 7.5 amp fuses (F3-2, F3-3 and F3-4).

The TEC-5001 slave controller monitors the states of the following components as inputs: ignition switch, cutting deck lift switches, PTO switch and deck position switches.

The TEC-5001 controller controls electrical output to the hydraulic PTO and lift manifold solenoid coils. Circuit protection for TEC-5001 outputs is provided by three (3) 7.5 amp fuses (F4-2, F4-3 and F4-4).

Because of the solid state circuitry built into the TEC controllers, there is no method to test a controller directly. A controller may be damaged if an attempt is made to test it with an electrical test device (e.g. digital multimeter or test light).

**NOTE:** The TEC controllers used on the Groundsmaster 4000 and 4010 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 wire harness connector from both of the TEC controllers and disconnect the terminal connector from the alternator. These steps will prevent damage to the machine electrical system.

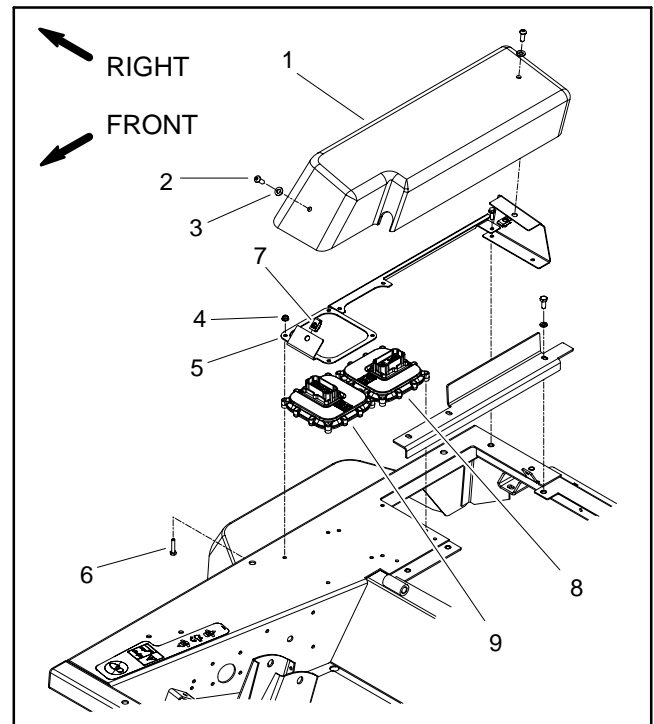


Figure 43

- |                         |                        |
|-------------------------|------------------------|
| 1. Controller cover     | 6. Cap screw (8 used)  |
| 2. Screw (2 used)       | 7. U-nut (2 used)      |
| 3. Flat washer (2 used) | 8. TEC-5001 controller |
| 4. Flange nut (8 used)  | 9. TEC-5002 controller |
| 5. Front cover mount    |                        |

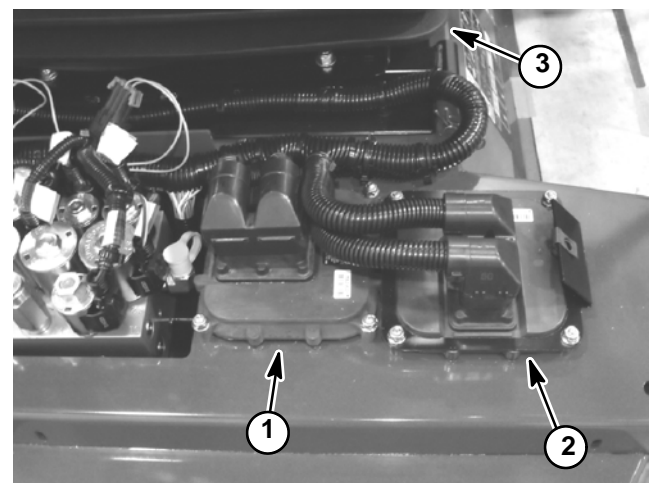


Figure 44

- |                        |                  |
|------------------------|------------------|
| 1. TEC-5001 controller | 3. Operator seat |
| 2. TEC-5002 controller |                  |

## Hydraulic Valve Solenoids

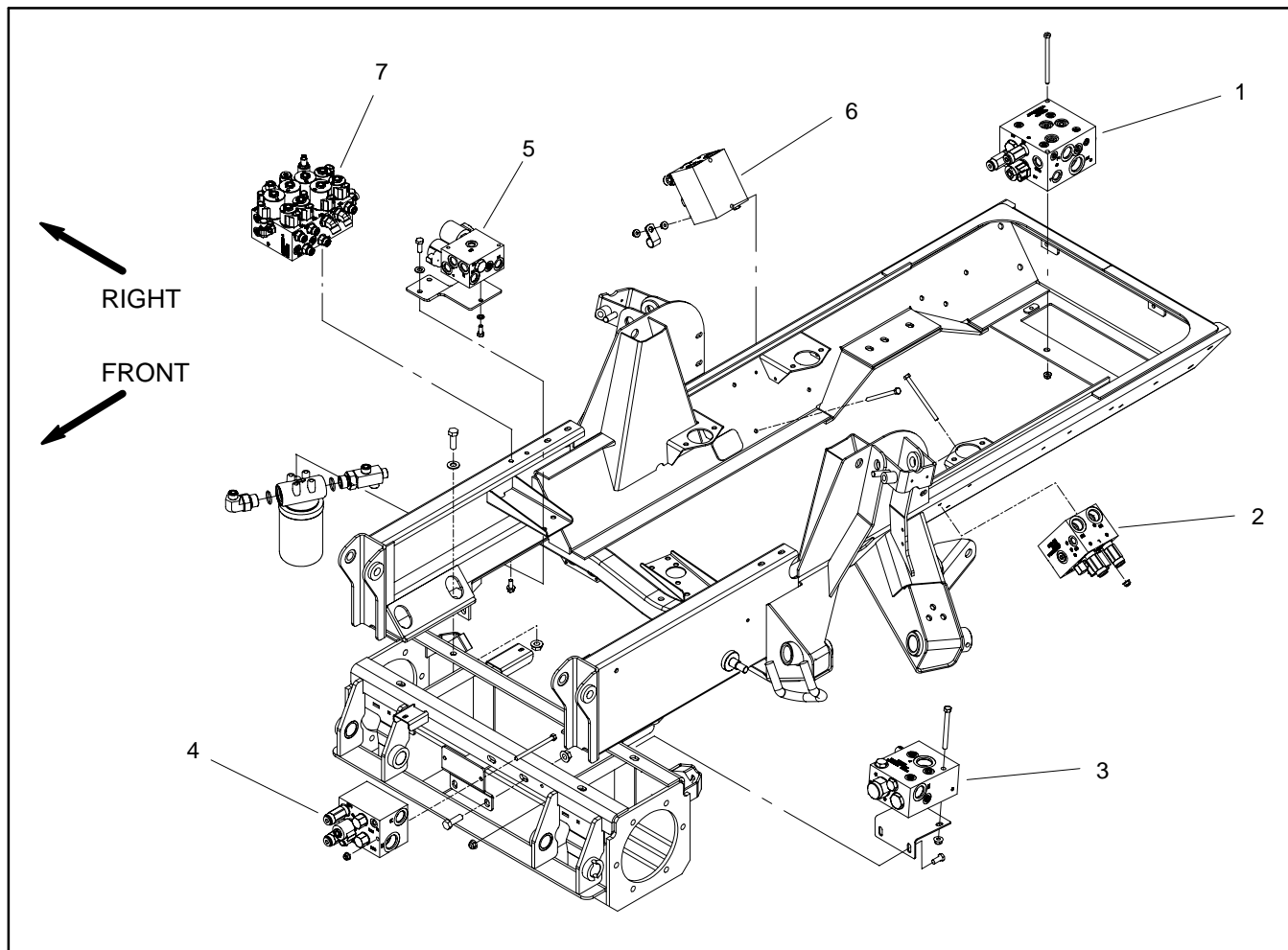


Figure 45

- 1. 4WD manifold
- 2. LH PTO manifold
- 3. Traction manifold

- 4. Front PTO manifold
- 5. Fan drive manifold

- 6. RH PTO manifold
- 7. Lift/lower manifold

Several hydraulic solenoid valve coils are used on the hydraulic control manifolds of Groundsmaster 4000-D and 4010-D machines. When energized by the TEC controller, these coils provide hydraulic circuit control.

Solenoid valve coils with two (2) different resistance specifications are used on the 4000-D and 4010-D. The correct resistance of a coil can be identified by measuring the height and diameter of the coil (Fig. 46). Resistance testing of the 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). Refer to your parts catalog to determine if solenoid coils are identical.

## 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 valve solenoid coil to be tested (Fig. 45). Disconnect wire harness connector from coil.
3. Identify coil resistance specification by measuring the coil diameter and coil height (Fig. 46).

**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. The correct resistance for the solenoid coil is identified below:

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

**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).

5. If solenoid coil resistance is incorrect, replace solenoid:

A. Remove nut securing solenoid to the cartridge valve. Carefully slide solenoid off the valve.

B. Install new solenoid coil to the cartridge valve. Install and torque nut **5 ft-lb (6.7 N-m)**. Over-tightening may damage the solenoid coil or cause the cartridge valve to malfunction.

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

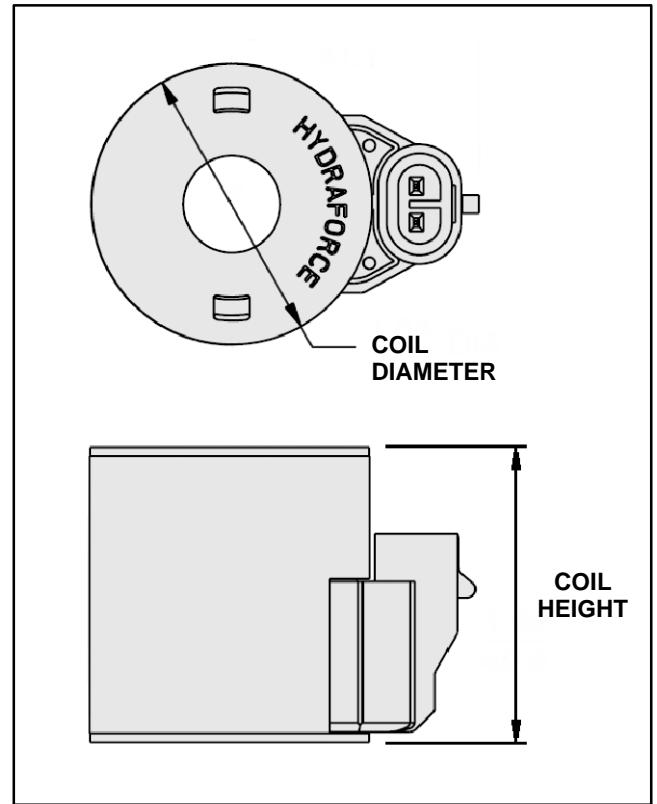


Figure 46

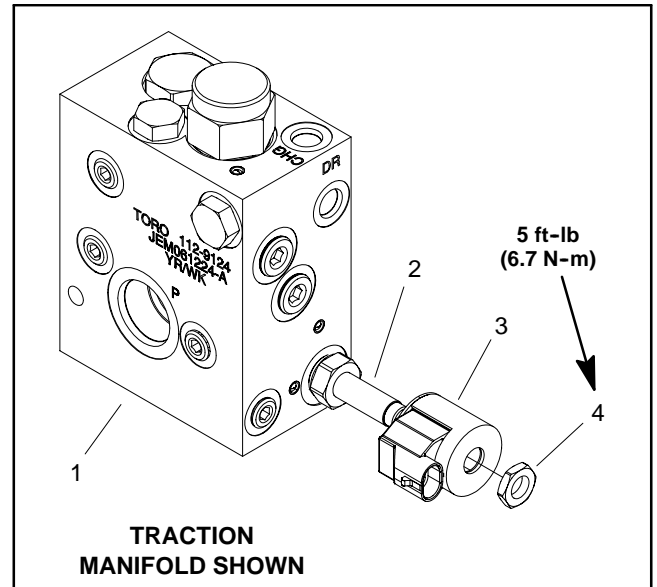


Figure 47

- |                       |                  |
|-----------------------|------------------|
| 1. Hydraulic manifold | 3. Solenoid coil |
| 2. Cartridge valve    | 4. Nut           |

# Traction Neutral Switch

The traction neutral switch is closed when the traction pedal is in the neutral position and opens when the pedal is depressed in either direction (forward or reverse). The neutral switch is used as an input to the TEC-5002 controller. The switch is located on the right side of the piston (traction) pump (Fig. 48).

## Testing

Before disconnecting the traction neutral switch for testing, the switch and its circuit wiring should be tested as a TEC-5002 input with the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If the Diagnostic Display verifies that the neutral switch and circuit wiring **are** functioning correctly, no further switch testing is necessary. If, however, the Display determines that the neutral switch and circuit wiring **are not** functioning correctly, proceed with test.

Test the neutral switch by disconnecting the wire harness connector from the switch and connecting a multimeter (set to ohms) across the two (2) switch terminals. With the engine turned off, slowly push the traction pedal in a forward or reverse direction while watching the multimeter. There should be indications that the traction neutral switch is opening (high resistance) and closing (no resistance). Allow the traction pedal to return to the neutral position. There should be continuity (no resistance) across the switch terminals when the traction pedal is in the neutral position.

See the Eaton Model 72400 Servo Controlled Piston Pump Repair Information at the end of Chapter 4 - Hydraulic System for neutral switch disassembly and assembly procedures.

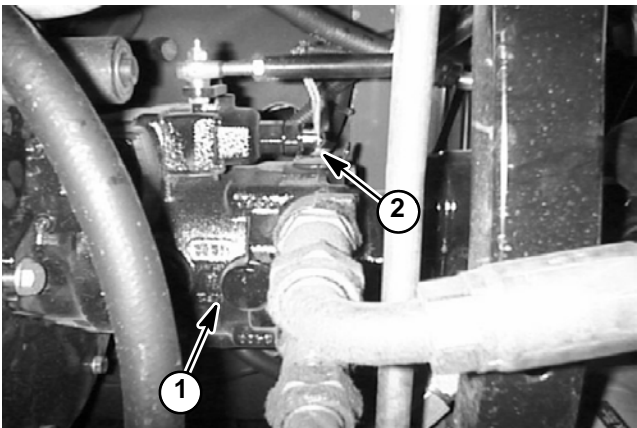


Figure 48

1. Piston pump (bottom)      2. Neutral switch

# Diode Assembly

The Groundsmaster engine wire harness contains a diode that is used for circuit protection from voltage spikes when the engine starter solenoid is de-energized. The diode plugs into the wiring harness near the engine starter motor (see Engine Wire Harness Drawing in Chapter 10 - Foldout Drawings).

## Testing

The diode can be tested using a digital multimeter (diode test or ohms setting) and the table to the right.

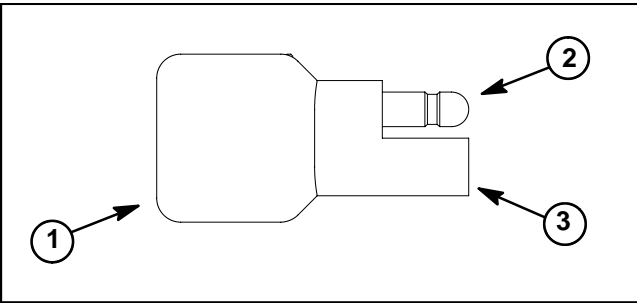


Figure 49

1. Diode      2. Male terminal      3. Female terminal

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

## Fuel Sender

The fuel sender is located on top of the fuel tank.

### Testing

1. Make sure ignition switch is OFF. Remove key from ignition switch.
2. Remove white (+) wire and black (-) wire from the fuel sender.



### CAUTION

If testing circuit wiring and fuel gauge, make sure wire connections are secure before turning ignition switch ON to prevent an explosion or fire from sparks.

3. To test the circuit wiring and fuel gauge, connect white and black wires and turn ignition switch to ON. Fuel gauge needle should point to the right edge of the green area (full). Turn ignition switch OFF and continue testing fuel sender if circuit wiring and gauge are acceptable.

4. Remove screws and lock washers that secure the fuel sender to the fuel tank.

5. Remove fuel sender and gasket from the fuel tank. Clean all fuel from the sender.

**NOTE:** Before taking small resistance readings with a digital multimeter, short meter test leads together. The meter will display a small resistance value. This internal resistance of the meter and test leads should be subtracted from the measured value of the component.



### CAUTION

Make sure sending unit is completely dry (no fuel on it) before testing. Perform test away from the fuel tank to prevent an explosion or fire from sparks.

6. Check resistance of the sender with a multimeter (Fig. 51):

A. Resistance with the float in the full position should be from 27.5 to 39.5 ohms.

B. Resistance with the float in the empty position should be from 240 to 260 ohms.

7. Replace sender as necessary. Install sender into fuel tank.

8. Connect wires to fuel sender. Apply skin-over grease (see Special Tools in this chapter) to sender terminals.

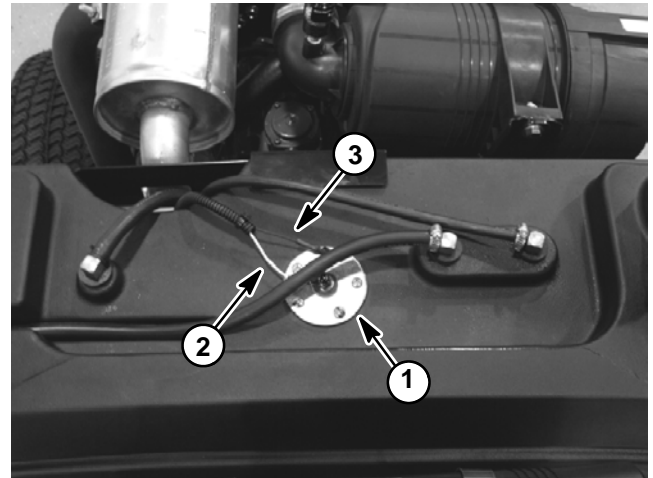


Figure 50

1. Fuel sender
2. White (+) lead

3. Black (-) lead

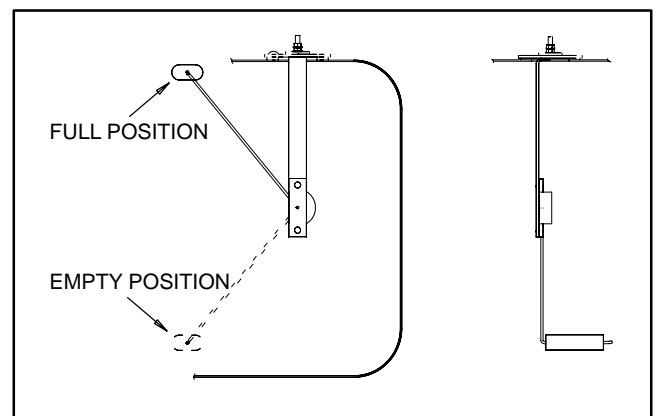


Figure 51

## Fuel Gauge

The fuel gauge can be tested using a new gauge as a substitute or with the use of a DC voltage source and a variable resistance box.

### Testing

1. Make sure ignition switch is OFF. Remove key from ignition switch.
2. Locate fuel gauge for testing (see Steering Tower Disassembly in the Service and Repairs section of Chapter 7 - Chassis).



### CAUTION

**Make sure the voltage source is turned OFF before connecting it to the electrical circuit to avoid electrical shock and to prevent damaging the gauge.**

3. Connect fuel gauge to the variable resistance and DC voltage source (Fig. 52).

**NOTE:** When reading the gauge test point, there are two white dots on the gauge face below the edge of the glass cover for the each test point. For each variable resistance setting, the needle must be pointed between the two white dots.

4. Take test point readings (Fig. 53):

**IMPORTANT:** Allow circuit to warm up for at least 5 minutes before taking test readings.

A. Set variable resistance to 240 ohms. Apply a  $14 \pm 0.01$  VDC to the circuit. The needle should point to the left edge of the red area (empty).

B. Set variable resistance to 33 ohms. The needle should point to the right edge of the green area (full).

5. Turn off the voltage source. Disconnect voltage source, gauge and variable resistance.
6. Secure all removed components to steering tower (see Steering Tower Assembly in the Service and Repairs section of Chapter 7 - Chassis).

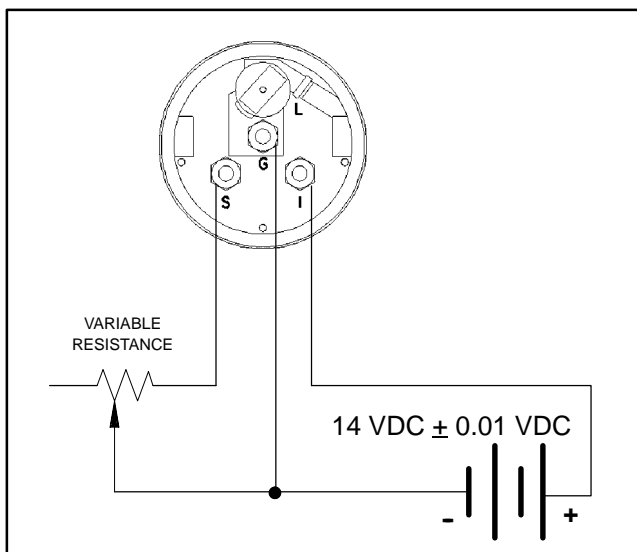


Figure 52

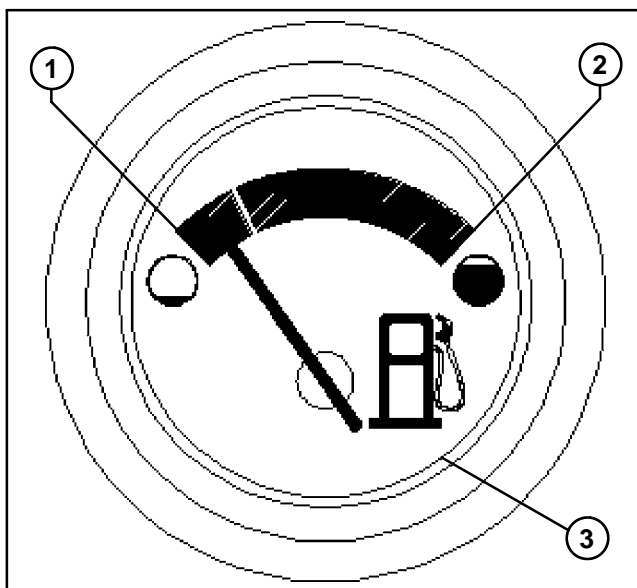


Figure 53

- |                   |                    |
|-------------------|--------------------|
| 1. Empty position | 3. Glass face edge |
| 2. Full position  |                    |



## Fuel Pump

The fuel pump is attached to the frame above the fuel water separator (Fig. 54).

### Operational Test

1. Park machine on a level surface, lower cutting decks, stop engine and apply parking brake.
2. Remove fuse F1-1 (20 amp) (Fig. 55) from fuse block to prevent the engine from cranking.
3. Disconnect fuel hose (pump discharge) from the fuel water separator.
4. Make sure fuel hoses attached to the fuel pump are free of obstructions.
5. Place fuel hose (pump discharge) into a large, graduated cylinder sufficient enough to collect 1 quart (0.95 liter).
6. 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.
7. The amount of fuel collected in the graduated cylinder should be approximately 16 fl oz (475 ml) after fifteen (15) seconds.
8. Replace fuel pump as necessary. Install fuel hose to the water separator.
9. Install fuse F1-1 (20 amp) into fuse block.
10. Prime fuel system.

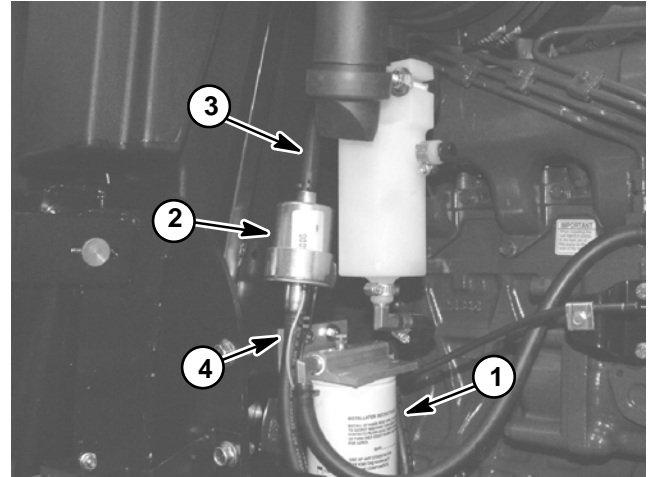


Figure 54

- |                         |                        |
|-------------------------|------------------------|
| 1. Fuel water separator | 3. Pump inlet hose     |
| 2. Fuel pump            | 4. Pump discharge hose |

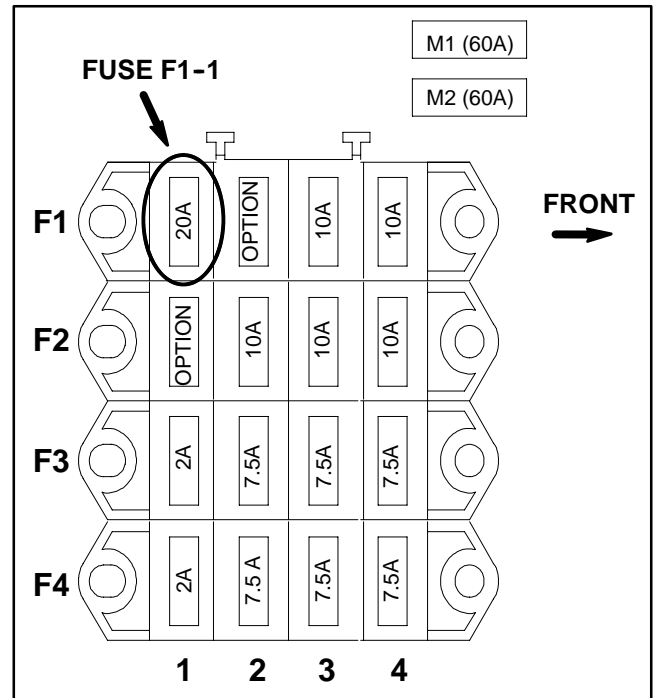


Figure 55

### Fuel Pump Specifications

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

## Temperature Sender

The temperature sender is located near the alternator on the water flange attached to the engine cylinder head (Fig. 56). The resistance of the temperature sender reduces as the engine coolant temperature increases. There is a gray harness wire attached to the terminal of the switch.

### Testing

1. Lower coolant level in the engine and remove the temperature sender from water flange.
2. Suspend sender in a container of oil with a thermometer and slowly heat the oil (Fig. 57).



## CAUTION

**Handle the hot oil with extreme care to prevent personal injury or fire.**

**NOTE:** Prior to taking resistance readings with a digital multi meter, 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. Check resistance of the sender with a multimeter (ohms setting) as the temperature increases. Replace sender if specifications are not met.

COOLANT TEMP	TEMP SENDER RESISTANCE
100°F (38°C)	460 ohms (approximate)
160°F (71°C)	140 ohms (approximate)
200°F (93°C)	54 to 78 ohms
221°F (105°C)	50 ohms (approximate)

4. After testing is complete, install sender to the water flange.

A. Thoroughly clean threads of water flange and sender. Apply thread sealant to the threads of the sender.

B. Screw sender into the water flange. Torque sender from **16 to 20 ft-lb (22 to 27 N-m)**.

C. Reconnect gray harness wire to sender. Apply skin-over grease (Toro Part No. 505-165) to sender terminal.

5. Fill engine cooling system.

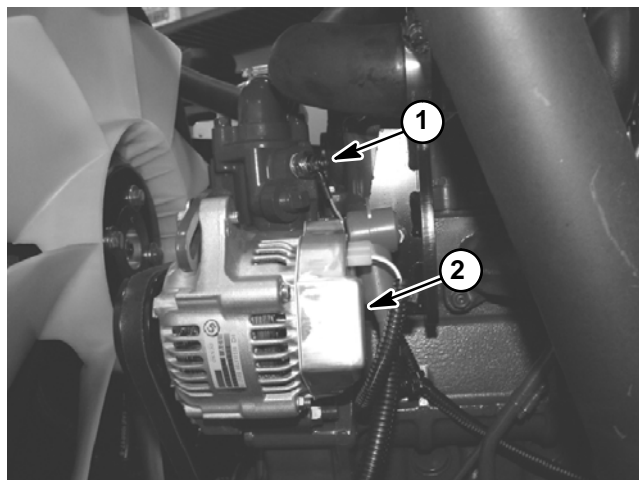


Figure 56

1. Temperature sender
2. Alternator

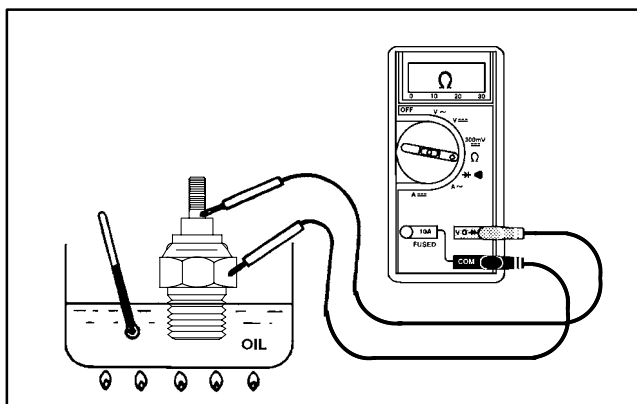


Figure 57

## Temperature Gauge

The temperature gauge on the control panel indicates engine coolant temperature level during machine operation (Fig. 58). The changing resistance of the engine temperature sender signals the temperature gauge.

The temperature gauge should display the first green segment when the ignition switch is turned to ON. The first yellow segment on the gauge should display when engine coolant temperature is approximately 212°F (100°C).

When engine coolant temperature rises to approximately 221°F (105°C), the temperature gauge should display the first red segment.

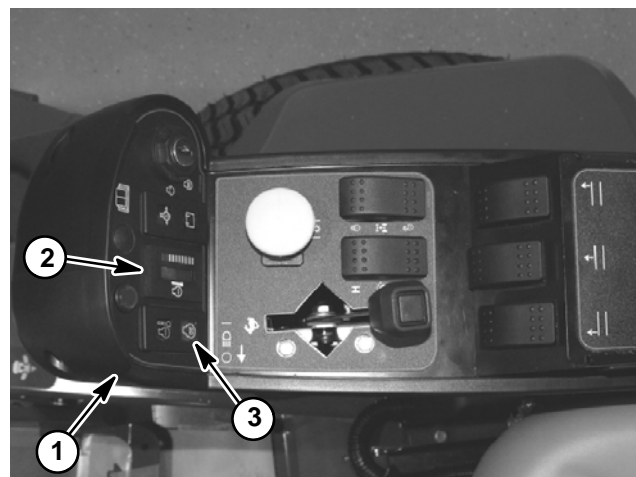


Figure 58

- 1. Console arm
- 2. Temperature gauge
- 3. High temp indicator

## Cutting Deck Position Switches

Three (3) cutting deck position switches are used on the Groundsmaster 4000-D and 4010-D. These switches are located on the traction unit frame (Figs. 59 and 60). The position switches are powered proximity switches that incorporate an internal reed switch and a LED. The deck position switches are used as inputs for the TEC-5001 controller to prevent deck operation when a cutting deck is raised. The switch sensing plates are attached to the cutting deck lift arms. The position switches for front and side decks are different.

The single front cutting deck position switch is a normally closed switch. When the front cutting deck is lowered, the sensing plate on the lift arm is away from the position switch so the switch is in its normally closed state. When the front cutting deck is raised, the sensing plate is moved near the position switch and the switch opens.

The two (2) side cutting deck position switches are normally open switches. When a side cutting deck is lowered, the sensing plate on the lift arm is near the position switch and the switch closes. When a side cutting deck is raised, the sensing plate is moved away from the position switch so the switch is in its normally open state.

### Testing

1. The cutting deck position switches and their circuit wiring should be tested as a TEC-5001 input with the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If the Diagnostic Display verifies that the position switches and circuit wiring **are** functioning correctly, no further switch testing is necessary. If, however, the Display determines that a position switch and circuit wiring **are not** functioning correctly, proceed with test.

2. Park machine on a level surface, lower cutting decks, stop engine and apply parking brake.

3. Turn ignition switch to the ON position (do not start engine) and check LED on cable end of position switches (Fig. 61). Switch LED **should be** illuminated when the cutting decks are fully lowered.

4. Start engine, fully raise cutting decks and then stop engine. Then, turn ignition switch to the ON position (do not start engine) and check LED on cable end of position switches. Switch LED **should not be** illuminated when the cutting decks are fully raised.

5. If a position switch LED did not function correctly:

A. Position cutting deck so sensing plate on the lift arm is near the position switch (front cutting deck raised and side cutting decks lowered).

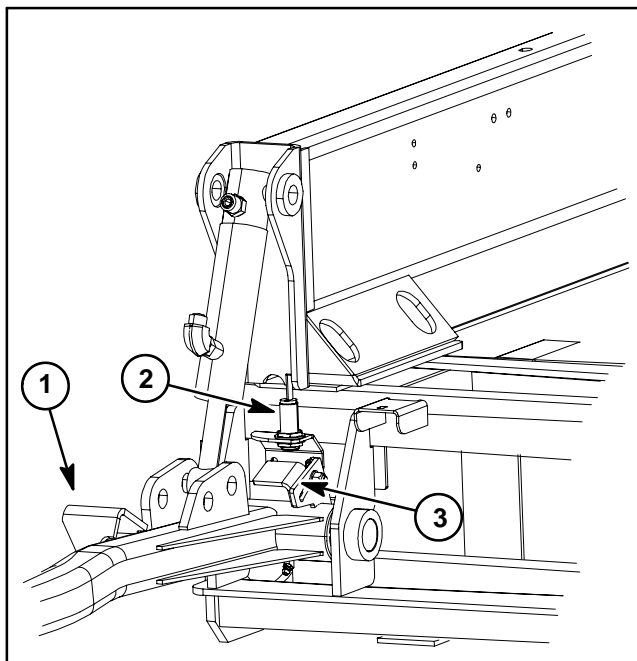


Figure 59

- |                             |                  |
|-----------------------------|------------------|
| 1. Front lift arm (lowered) | 3. Sensing plate |
| 2. Position switch          |                  |

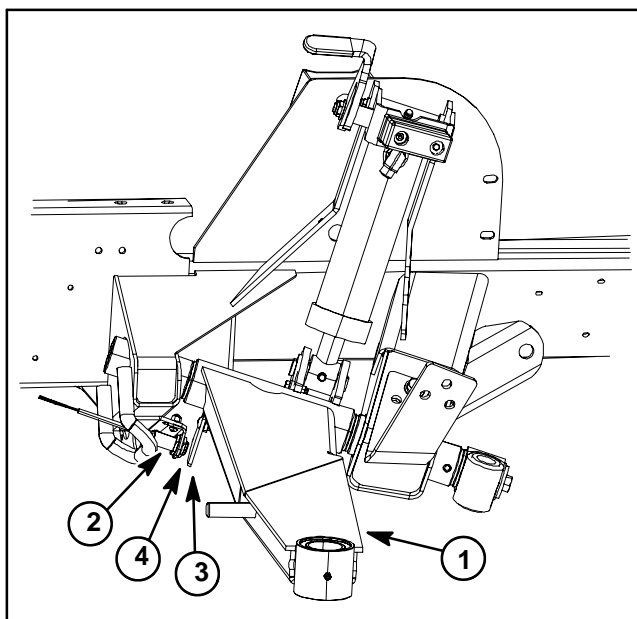


Figure 60

- |                             |                  |
|-----------------------------|------------------|
| 1. Side lift arm (LH shown) | 3. Sensing plate |
| 2. Position switch          | 4. Clearance     |

B. Make sure that ignition switch is OFF and disconnect the switch connector from wire harness.

C. Using a multimeter, verify that wire harness connector terminal for pink wire has 12 VDC when the ignition switch is ON.

D. Make sure that clearance between end of position switch and sensing plate is from 0.070" and 0.130" (1.8 to 3.3 mm). If necessary, adjust position switch (see Cutting Deck Position Switches in the Adjustments section of this chapter). Recheck switch operation after adjustment.

E. If pink wire has system voltage present and gap is correct but switch LED did not function, replace position switch.

6. After testing is complete, make sure that position switch connector is plugged into wire harness.

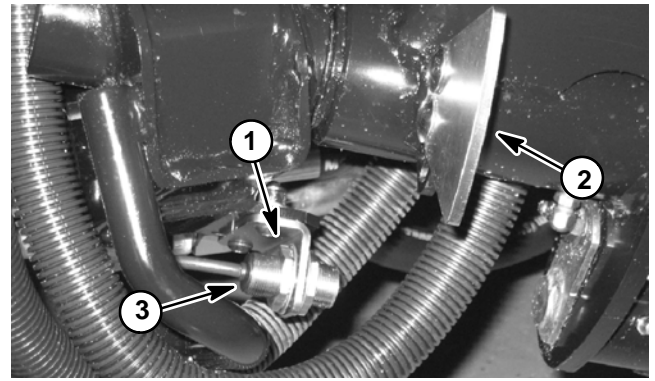


Figure 61

- |                         |                        |
|-------------------------|------------------------|
| 1. Side position switch | 3. Switch LED location |
| 2. Sensing plate        |                        |

## Engine Coolant and Hydraulic Oil Temperature Senders

The Groundsmaster 4000-D and 4010-D use two (2) temperature senders as inputs for the TEC-5002 to identify if either the engine coolant or hydraulic oil temperature has reached an excessive level. These senders are identical. The coolant temperature sender threads into the radiator (Fig. 62). The hydraulic oil temperature sender is attached to the hydraulic hydraulic tube on the left side of the machine (Fig. 63).

### Testing

1. Locate temperature sender that is to be tested. Disconnect wire harness connector from sender.
2. Thoroughly clean area around temperature sender and remove sender.
3. Put sensing end of sender in a container of oil with a thermometer and slowly heat the oil (Fig. 64).



### 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 component you are testing.

4. 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.

5. After allowing the sender to cool, install sender:

A. Install new O-ring on sender.

B. Install sender into port and torque from **9 to 11 ft-lb (12.3 to 14.9 N-m)**.

C. Reconnect harness wire to sender.

6. Check and fill system (coolant or hydraulic) to proper level.

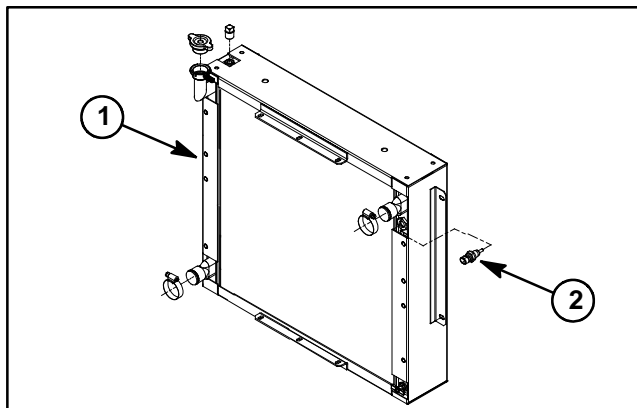


Figure 62

1. Radiator

2. Coolant temp sender

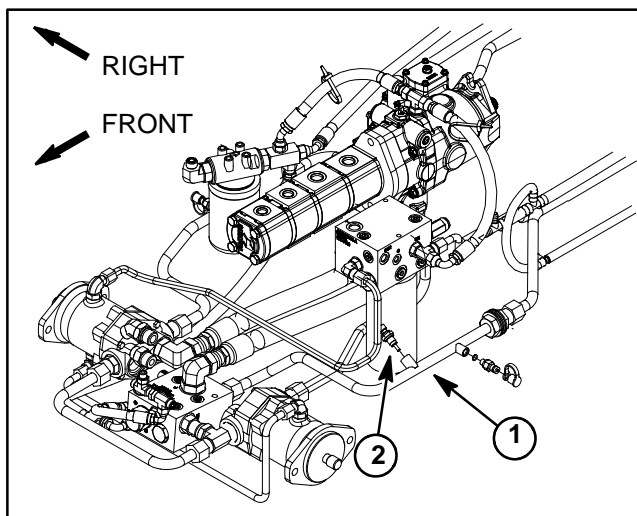


Figure 63

1. Hydraulic tube

2. Oil temp sender

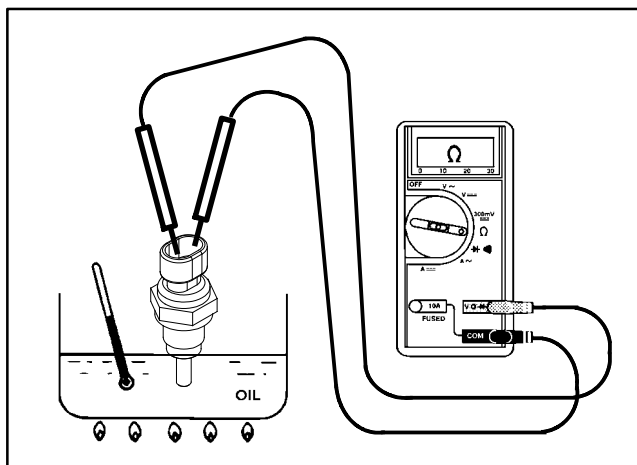


Figure 64

# Service and Repairs

**NOTE:** For engine component repair information (e.g. starter motor), see the Kubota Workshop Manual, Diesel Engine, 03-M-E3B Series at the end of Chapter 3 – Kubota Diesel Engine.

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## 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 Care

1. Battery electrolyte level must be properly maintained. The top of the battery must be kept clean. If the machine is stored in a location where temperatures are extremely high, the battery will discharge more rapidly than if the machine is stored in a location where temperatures are cool.
3. Battery cables must be tight on terminals to provide good electrical contact.

**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.**

**WARNING**

**Connecting battery cables to the wrong battery post could result in personal injury and/or damage to the electrical system.**

**IMPORTANT:** Do not remove fill caps while cleaning.

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.

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. Check electrolyte level every 25 operating hours and every 30 days if machine is in storage.
6. Maintain cell level with distilled water. Do not fill cells above the fill line.

## 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.

#### Electrolyte Specific Gravity

Fully charged: 1.265 corrected to 80°F (27°C)

Discharged: less than 1.240

#### Battery Specifications

BCI Group Size 34

690 CCA at 0°F (-18°C)

110 minutes reserve capacity at 80°F (27°C)

#### Dimensions (including terminal posts and caps)

Length 10.2 inches (259 mm)

Width 6.6 inches (167 mm)

Height 8.0 inches (203 mm)

#### Battery Removal and Installation (Fig. 65)

1. Raise and support operator seat. Remove battery access panel.
2. Loosen and remove negative cable from battery. After negative cable is removed, loosen and remove positive cable.
3. Loosen battery 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 negative cable.

**NOTE:** Before connecting the negative (ground) cable to the battery, connect a digital multimeter (set to DC amps) between the negative battery post and the negative (ground) cable connector. The reading should be less than 0.1 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. Secure battery with battery strap. Install battery access panel. Lower and secure operator seat.

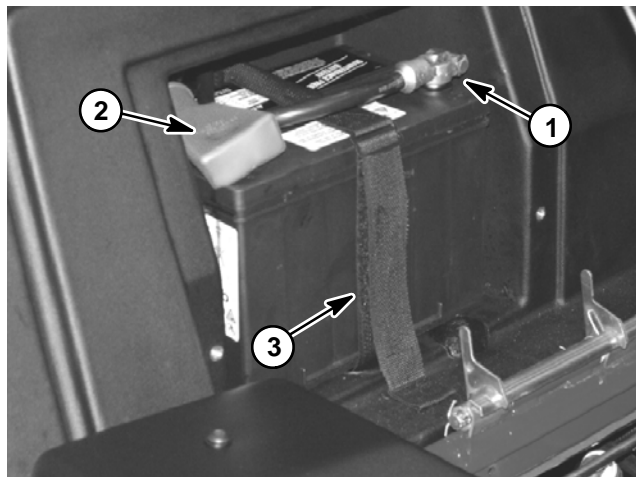


Figure 65

1. Negative cable
2. Positive cable

3. Battery strap

#### Battery Inspection and Maintenance

1. Perform following inspections and maintenance:
    - A. Check battery for cracks. Replace battery if cracked or leaking.
    - B. 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.
- C. 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.
  - D. Check that the cover seal is not broken away. Replace the battery if the seal is broken or leaking.
  - E. Check the electrolyte level in each cell. If the level is below the tops of the plates in any cell, fill all 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)	<u>0.008</u>
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 **Charging** or until all cells specific gravity is 1.225 or greater with the difference in specific gravity between the highest and lowest cell less than 0.050. If these charging conditions can not be met, replace the battery.

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 manufacturer's instructions when using a battery load tester.

A. Check the voltage across the battery terminals prior to testing the battery. If the voltage is less than 12.4 VDC, charge the battery before performing a load test.

B. If the battery has 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 cell.

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

F. Apply a test load of 345 amps (one half the cranking performance rating of the battery) for fifteen (15) seconds.

G. Take a battery voltage reading at fifteen (15) seconds, then remove the load.

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

Minimum Voltage	Battery Electrolyte Temperature	
	70°F (and up)	21°C (and up)
9.6	60°F	16°C
9.5	50°F	10°C
9.4	40°F	4°C
9.3	30°F	-1°C
9.1	20°F	-7°C
8.9	10°F	-12°C
8.7	0°F	-18°C
8.5		

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 readily available.



### CAUTION

Follow the 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 (52°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 consecutive readings.



# Axles, Planetaries and Brakes

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# Specifications

Item	Specification
Tire pressure (front and rear)	25 to 30 PSI (172 to 207 kPa)
Rear wheel toe-in	0.125 in (3.18 mm)
Planetary gear drive oil System gear lube capacity (each wheel)	SAE 85W-140 wt. gear lube 16 fl. oz. (0.47 liters)
Rear axle lubricant System gear lube capacity	SAE 85W-140 wt. gear lube 80 fl. oz. (2.37 liters)
Rear axle gear box lubricant System gear lube capacity	SAE 85W-140 wt. gear lube 16 fl. oz. (0.47 liters)
Wheel lug nut torque	85 to 100 ft-lb (115 to 135 N-m), front and rear
Steering cylinder castle nut torque	100 to 125 ft-lb (139 to 169 N-m)
Planetary mounting screw torque	75 to 85 ft-lb (101 to 115 N-m)
Brake housing mounting screw torque	75 to 85 ft-lb (101 to 115 N-m)
Front wheel motor mounting screw torque	75 to 85 ft-lb (101 to 115 N-m)

# General Information

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## 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.

# Service and Repairs

## Brake Assembly

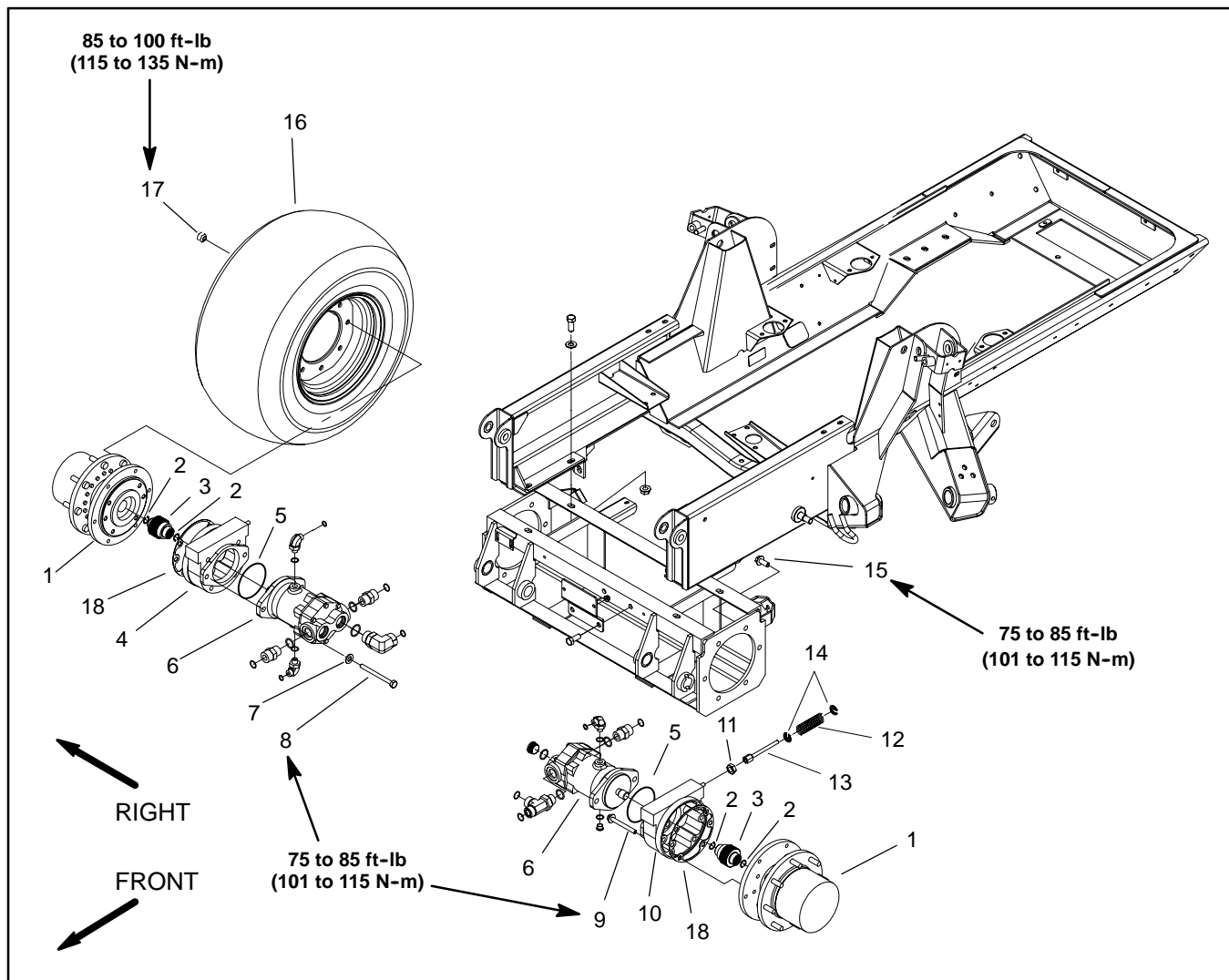


Figure 1

- |                          |  |   |
|--------------------------|--|---|
| 1. Planetary assembly    | 7. Flat washer (2 used per side)         | 13. Brake link (1 used per side)        |
| 2. Retaining ring        | 8. Cap screw (2 used per side)           | 14. Spring plate (2 used per side)      |
| 3. Splined brake shaft   | 9. Flange head screw (4 used per side)   | 15. Flange head screw (6 used per side) |
| 4. Brake assembly (RH)   | 10. Brake assembly (LH)                  | 16. Wheel assembly                      |
| 5. O-ring                | 11. Jam nut (1 used per side)            | 17. Lug nut (8 used per wheel)          |
| 6. Hydraulic wheel motor | 12. Compression spring (1 used per side) | 18. Gasket                              |

## Removal (Fig. 1)

1. Park machine on a level surface, lower cutting decks, stop engine and remove key from the ignition switch.
2. Drain oil from planetary wheel drive/brake assembly.



## CAUTION

**When removing front wheel, use correct jacks and supports. Make sure machine is parked on a solid, level surface such as a concrete floor. Prior to raising machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use jack stands to support the raised machine. If the machine is not properly supported by jack stands, the machine may move or fall, which may result in personal injury.**

3. Chock rear wheels and jack up front of machine (see Jacking Instructions in Chapter 1 – Safety). Support machine with 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 link assembly from brake lever, frame bracket and pull rod on brake assembly (Fig. 2).
7. Support brake assembly to prevent it from falling.
8. Remove flange head screws (item 9) securing brake assembly to frame.
9. Remove brake assembly from machine. Be careful to not drop splined brake shaft (item 3) as brake assembly is removed.
10. Remove splined brake shaft from brake assembly.
11. Remove and discard gasket (item 18). Make sure that all gasket material is removed from both brake and planetary assemblies.
12. Complete brake inspection and repair (see Brake Inspection and Repair in this section).

## Installation (Fig. 1)

1. Install splined brake shaft (item 3) into brake assembly. **NOTE:** The stepped end of the splined brake shaft must be aligned toward the hydraulic wheel motor (Fig. 4).

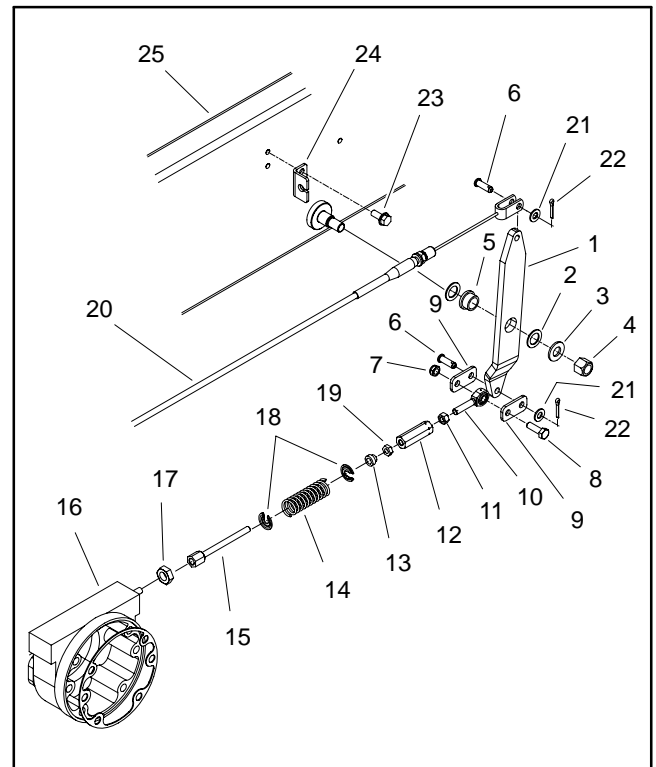


Figure 2

- |                           |                        |
|---------------------------|------------------------|
| 1. Brake lever            | 14. Compression spring |
| 2. Thrust washer (2 used) | 15. Brake link         |
| 3. Flat washer            | 16. Brake assembly     |
| 4. Lock nut               | 17. Jam nut            |
| 5. Bushing                | 18. Spring plate       |
| 6. Clevis pin             | 19. Jam nut            |
| 7. Lock nut               | 20. Brake cable        |
| 8. Cap screw              | 21. Flat washer        |
| 9. Brake link             | 22. Cotter pin         |
| 10. Rod end (LH thread)   | 23. Screw (2 used)     |
| 11. Jam nut (LH thread)   | 24. Cable bracket      |
| 12. Hex link              | 25. Frame rail         |
| 13. Flanged spacer        |                        |

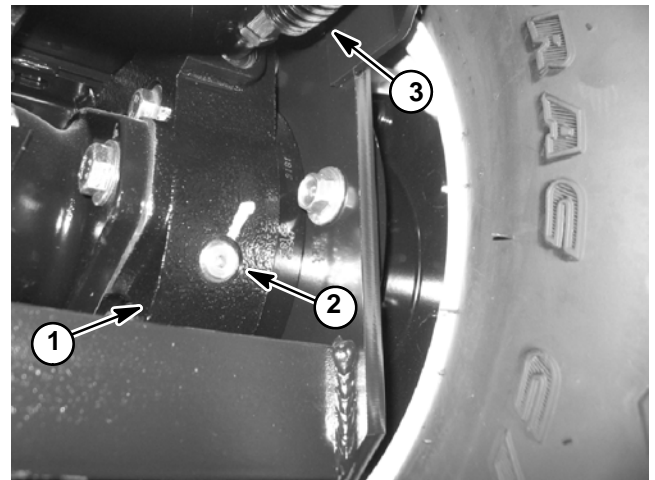


Figure 3

- |                  |                        |
|------------------|------------------------|
| 1. Brake housing | 3. Brake link assembly |
| 2. Check plug    |                        |

2. Apply gasket sealant to sealing surfaces of new gasket (item 18). Apply gasket to brake assembly.

3. Install brake assembly onto machine, aligning splined brake shaft with input shaft on planetary wheel drive.

4. Secure brake assembly to planetary assembly with four (4) flange head screws (item 9). Tighten screws in a crossing pattern to a torque from **75 to 85 ft-lb (101 to 115 N-m)**.

5. Secure brake link assembly to pull rod on brake assembly, frame bracket and brake lever (Fig. 2). Brake link end should be completely threaded onto pull rod before tightening jam nut.

6. Install new O-ring on hydraulic wheel motor. Install wheel motor and torque cap screws from **75 to 85 ft-lb (101 to 115 N-m)**.



## WARNING

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

7. Install wheel assembly.

8. Lower machine to ground. Torque lug nuts from **85 to 100 ft-lb (115 to 135 N-m)**.

9. Make sure drain plug is installed in bottom of brake assembly. Fill planetary wheel drive/brake assembly with SAE 85W-140 gear lube. Capacity is approximately 16 fl. oz. (0.47 liters) per wheel.

10. Check and adjust brake cables for proper brake operation. If necessary, adjust hex link (item 12 in Fig. 2) so that pull rod jam nut is positioned from 0.470" to 0.530" (12.0 to 13.4 mm) from brake casting surface when brakes are disengaged (Fig. 5).

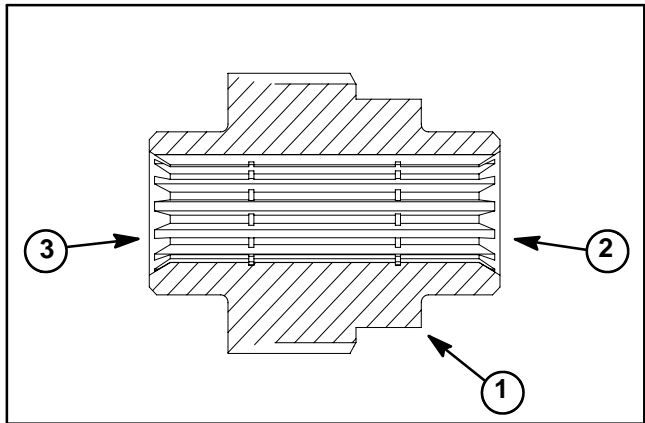


Figure 4

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

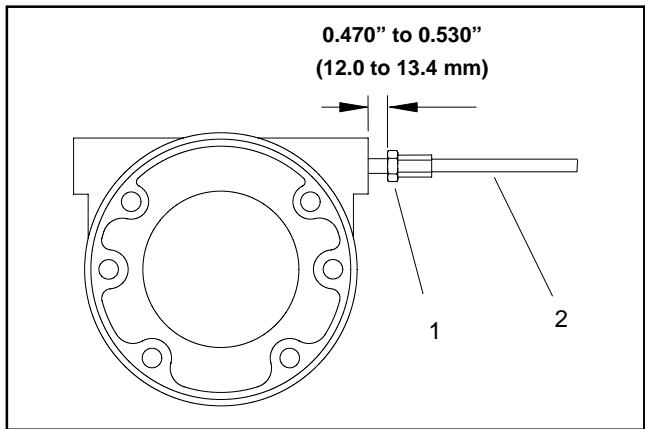


Figure 5

- 1. Pull rod jam nut
- 2. Brake link



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## Brake Inspection and Repair

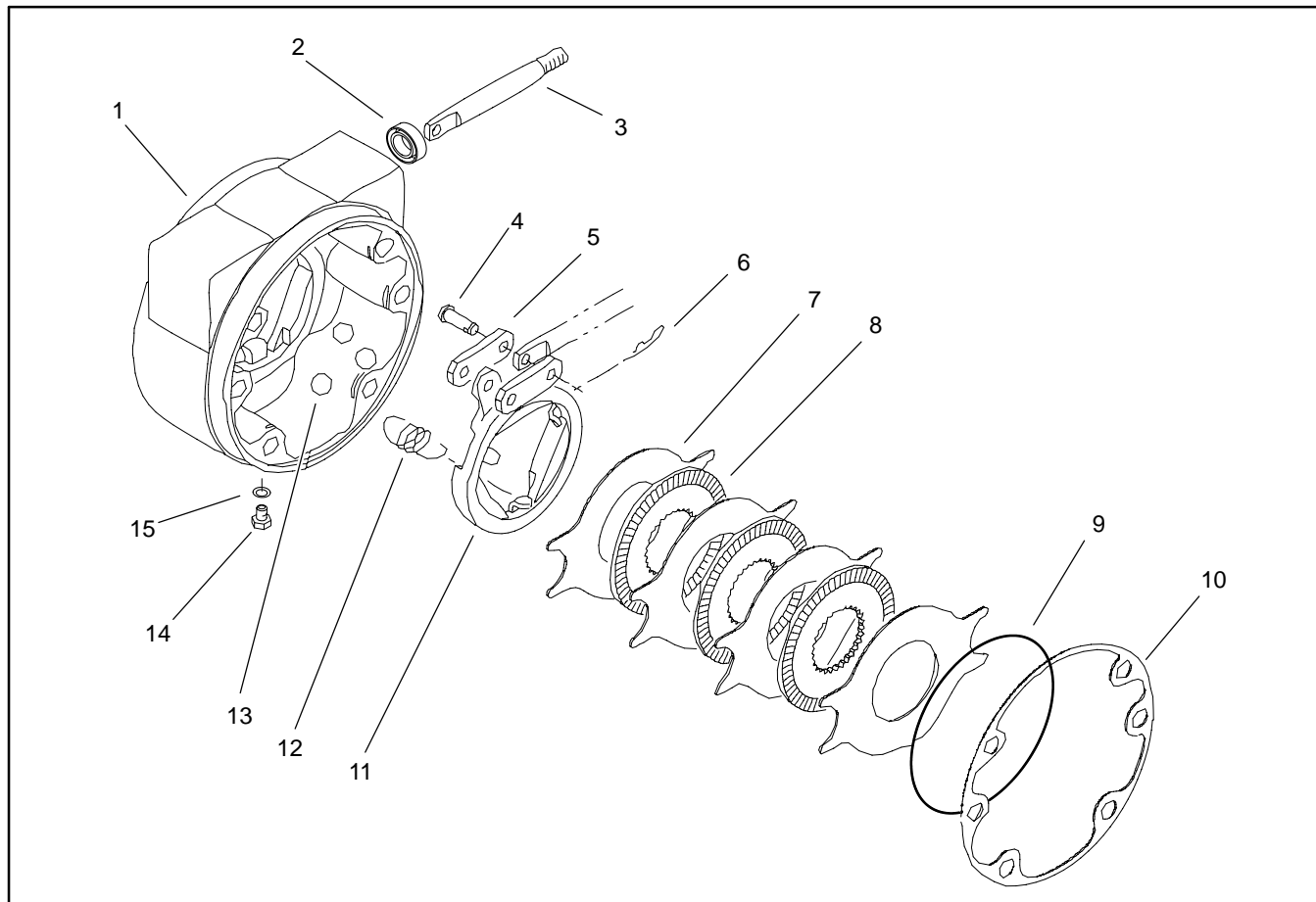


Figure 6

- |                             |                             |                               |
|-----------------------------|-----------------------------|-------------------------------|
| 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. 6)

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

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## Planetary Wheel Drive Assembly

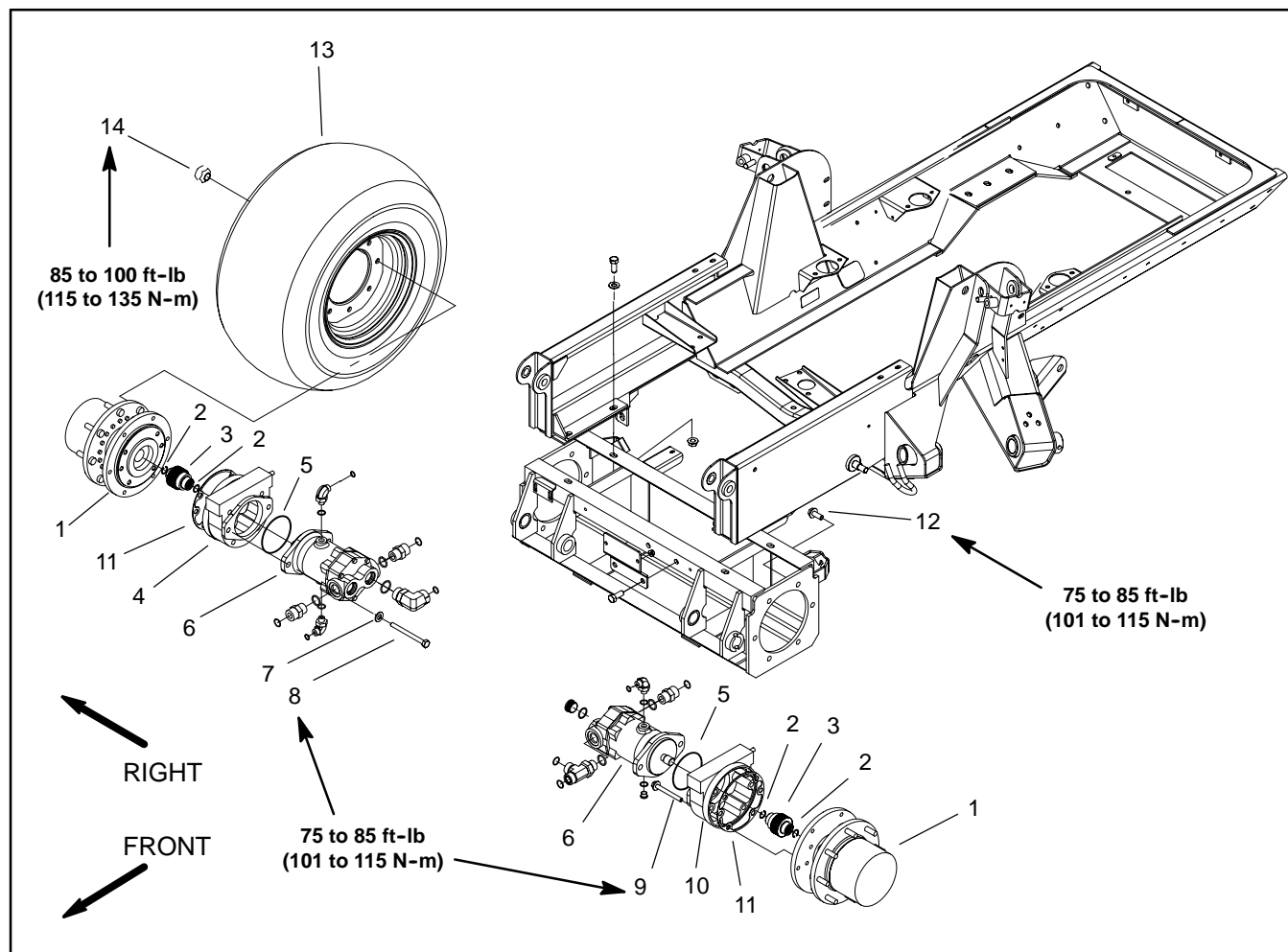


Figure 7

- 1. Planetary assembly
- 2. Retaining ring
- 3. Splined brake shaft
- 4. Brake assembly (RH)
- 5. O-ring

- 6. Hydraulic wheel motor
- 7. Flat washer (2 used per side)
- 8. Cap screw (2 used per side)
- 9. Flange head screw (4 used per side)
- 10. Brake assembly (LH)

- 11. Gasket
- 12. Flange head screw (6 used per side)
- 13. Wheel assembly
- 14. Lug nut (8 used per side)

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

### Removal (Fig. 7)

1. Park machine on a level surface, lower cutting decks, stop engine and remove key from the ignition switch.
2. Drain oil from planetary wheel drive/brake assembly.



### CAUTION

**When removing front wheel, use correct jacks and supports. Make sure machine is parked on a solid, level surface such as a concrete floor. Prior to raising machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use jack stands to support the raised machine. If the machine is not properly supported by jack stands, the machine may move or fall, which may result in personal injury.**

3. Chock rear wheels and jack up front of machine (see Jacking Instructions in Chapter 1 – Safety). Support machine with 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. Remove brake assembly (see Brake Assembly Removal in this section).
7. Support planetary assembly to prevent it from falling. Loosen and remove flange head screws that secure planetary assembly to frame. Remove planetary assembly from machine.

### Installation (Fig. 7)

1. Position planetary assembly to machine. Install flange head screws that secure planetary assembly. Torque screws in a crossing pattern from **75 to 85 ft-lb (101 to 115 N-m)**.

2. Install brake assembly (see Brake Assembly Installation in this section).
3. Install hydraulic wheel motor (see Front Wheel Motors in the Service and Repairs section of Chapter 4 – Hydraulic System).
4. Install wheel assembly.



### WARNING

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

5. Lower machine from jack stands. Torque lug nuts from **85 to 100 ft-lb (115 to 135 N-m)**.
6. Make sure drain plug is installed in bottom of brake assembly (Fig. 8). Fill planetary wheel drive/brake assembly with SAE 85W-140 gear lube. Capacity is approximately 16 fl. oz. (0.47 liters) per wheel.
7. Check and adjust brake cables for proper brake operation.

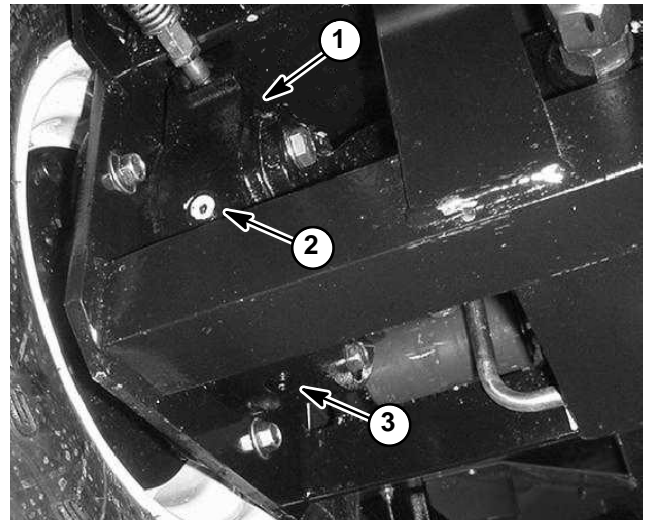


Figure 8

1. Brake housing
2. Check plug
3. Drain plug

## Planetary Wheel Drive Service

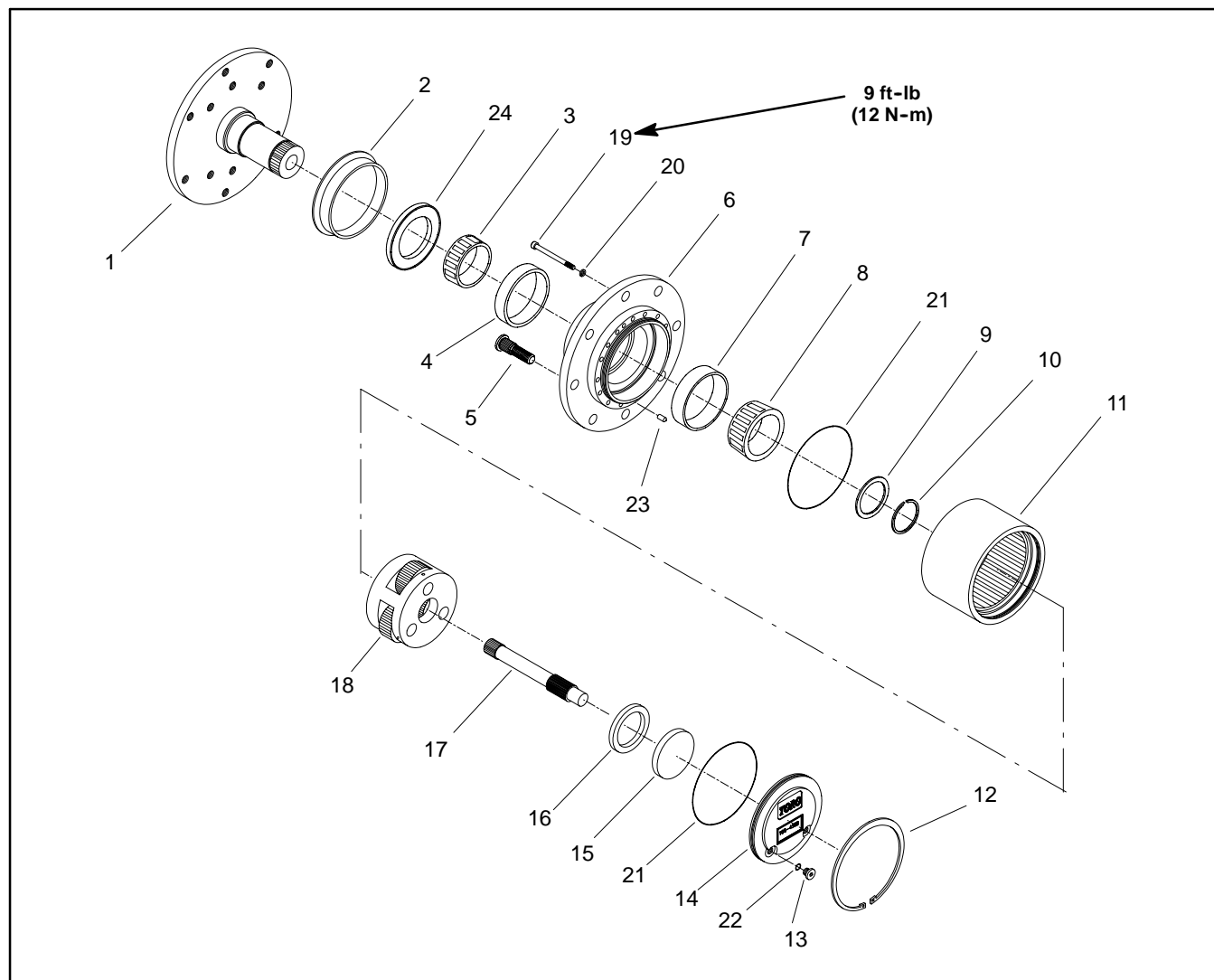


Figure 9

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

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

### Disassembly (Figs. 9 and 10)

1. If planetary wheel drive assembly is installed on machine:

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

B. Drain oil from planetary wheel drive/brake assembly.

C. Chock rear wheels and jack up front of machine (see Jacking Instructions in Chapter 1 - Safety). Support machine with jack stands.

D. Remove front wheel assembly.

2. Remove retaining ring (item 12).

3. Remove end cap (item 14). Thrust plug (item 15) and thrust washer (item 16) usually remain in end cap bore and should be removed for cleaning and inspection.

4. Remove drive shaft assembly (items 17).

5. Remove carrier assembly (item 18).

6. If wheel stud (item 5) removal is necessary, use press to extract stud(s) from housing.

**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.**

7. Remove retaining ring (item 10) and thrust washer (item 9). Discard retaining ring.

8. Remove housing (item 6) from spindle (item 1). Remove outer bearing cone (item 8).

9. Remove and discard all seals and O-rings (items 2, 21 and 24).

10. If bearings will be replaced, remove inner bearing cone (item 3) from housing. Remove bearing cups (items 4 and 7) from housing.

11. If necessary, remove socket head screws (item 19) with lock washers (item 20) that secure ring gear (item 11) to housing. Remove ring gear and two (2) dowel pins (item 23) from housing.

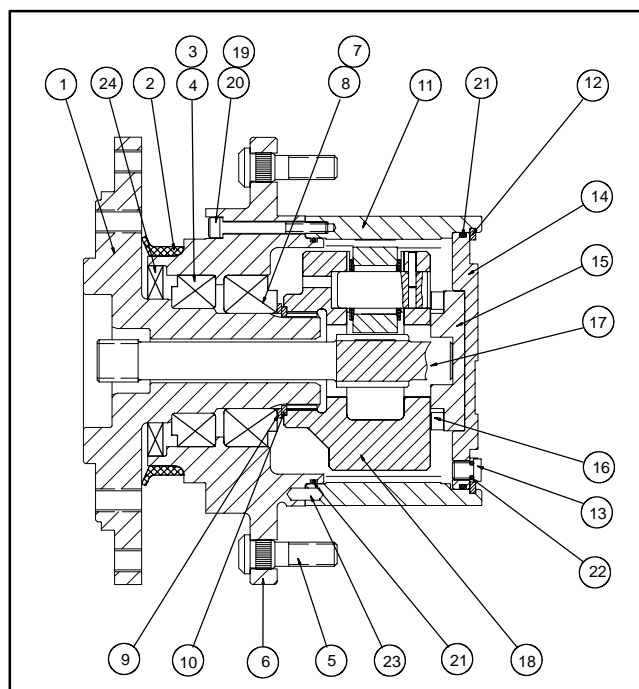


Figure 10

### Assembly (Figs. 9 and 10)

1. Thoroughly clean parts in solvent and dry completely after cleaning. Inspect parts for damage or excessive wear and replace as necessary.

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

2. If spindle and housing were separated:

A. Press bearing cups (items 4 and 7) into housing (item 6). Cups should be pressed fully to shoulder of the housing bore.

B. Set inner bearing cone (item 3) into bearing cup (item 4) that is installed in housing.

C. Make sure that seal bore in housing is thoroughly cleaned. If OD of seal (item 24) 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 23) in housing. Secure ring gear to housing with lock washers (item 20) and socket head screws (item 19). Torque socket head screws to **9 ft-lb (12 N-m)**.

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

G. Install outer bearing cone (item 8) 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 9) 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 and retaining ring. Install thrust washer onto spindle shaft.



## WARNING

**If retaining ring (item 10) is not fully installed in spindle groove, loss of wheel and personal injury may result.**

J. Carefully install new retaining ring (item 10) 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. After correct assembly, 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 21) to housing.

3. Install carrier assembly (item 18) making sure that carrier gear teeth align with ring gear and spline on spindle shaft.

4. Install drive shaft (item 17) making sure that drive shaft spline aligns with carrier gears.

5. Install thrust plug (item 15) and thrust washer (item 16) into end cap (item 14). Make sure that thrust plug and thrust washer are captive on inside of end cap.

6. Install new O-ring (item 21) to end cap (item 14) and then install end cap. Secure cap with retaining ring (item 12).

7. Check operation of planetary wheel 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.

8. If planetary wheel drive assembly is installed on machine:

A. Install wheel assembly.



## WARNING

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

B. Lower machine from jack stands. Torque lug nuts from **85 to 100 ft-lb (115 to 135 N-m)**.

C. Make sure drain plug is installed in bottom of brake assembly. Fill planetary wheel drive/brake assembly with SAE 85W-140 gear lube. Capacity is approximately 16 fl. oz. (0.47 liters) per wheel.



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## Rear Axle Assembly

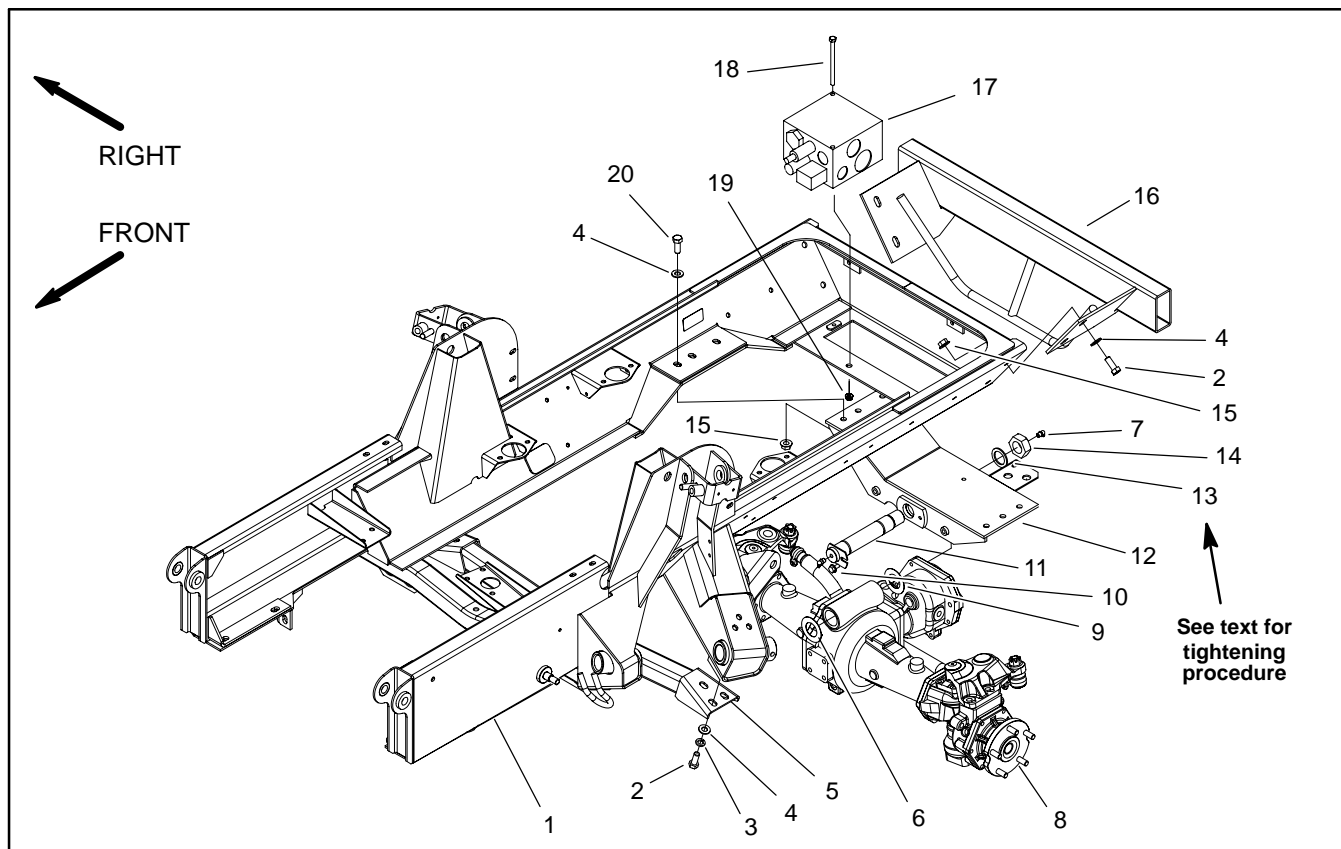


Figure 11

- |                          |                         |                              |
|--------------------------|-------------------------|------------------------------|
| 1. Frame assembly        | 8. Rear axle assembly   | 15. Flange nut (10 used)     |
| 2. Cap screw (10 used)   | 9. Thrust washer (thin) | 16. Rear bumper              |
| 3. Lock washer (6 used)  | 10. Washer head screw   | 17. Hydraulic manifold (4WD) |
| 4. Flat washer (16 used) | 11. Pivot pin           | 18. Cap screw (2 used)       |
| 5. Support frame         | 12. Rear axle mount     | 19. Flange nut (2 used)      |
| 6. Thrust washer (thick) | 13. Washer              | 20. Cap screw (6 used)       |
| 7. Grease fitting        | 14. Lock nut            |                              |

### Removal (Fig. 11)

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



## 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.

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

3. Drain oil from rear axle and axle gearbox.

4. Remove both wheels from rear axle.

5. Remove hydraulic motor from rear axle assembly (see Rear Axle Motor Removal in the Service and Repairs section of Chapter 4 – Hydraulic System).

6. Remove steering cylinder from rear axle (see Steering Cylinder Removal in the Service and Repairs section of Chapter 4 – Hydraulic System).

7. Disconnect both steering cylinder hydraulic hoses from hydraulic tubes at rear axle mount bracket (Fig. 12). Remove bulkhead lock nuts that secure steering cylinder hydraulic tubes to bracket. Separate tubes from axle mount bracket.

8. Remove cap screw and flange nut that secures front corner of 4WD hydraulic manifold to rear axle mount bracket.

9. If required, remove tie rod ends from steering arms on rear axle (Fig. 13). 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.

10. Support rear axle to prevent it from falling. Remove six (6) cap screws, flat washers and flange nuts that secure rear axle mount to equipment frame. Lower rear axle and rear axle mount from machine.

11. Remove lock nut and washer from pivot pin that attaches rear axle to rear axle mount. Remove washer head screw that secures flange of pivot pin to axle mount (Fig. 14).

12. Remove pivot pin. Separate rear axle mount from rear axle. Note location of thrust washers on both ends of axle mounting boss.

### Installation (Fig. 11)

1. Position rear axle mount to axle. Install thrust washers between axle boss and axle mount. The thinner thrust washer should be installed on the hydraulic motor end of the axle (toward the rear of the machine). With washers installed, there should be from 0.002" to 0.020" (0.05 mm to 0.51 mm) clearance between rear axle mount and axle mounting boss. Add thrust washers if needed to adjust clearance.

2. Install axle pivot pin to secure axle to rear axle mount. Install washer and lock nut onto pivot pin. Tighten lock nut and then loosen it slightly to allow the axle pin to pivot freely. Secure pivot pin to axle mount with washer head screw (Fig. 14).

3. Position axle and rear axle under machine. With a jack, raise assembly to machine frame and align mounting holes of rear axle mount and machine frame.

4. Secure rear axle mount to frame with six (6) cap screws, flat washers and flange nuts.

5. Install cap screw and flange nut that secures front corner of 4WD hydraulic manifold to rear axle mount bracket.

6. If removed, install the tie rod to rear axle (Fig. 13). Tighten ball joint castle nuts and install new cotter pins.

7. Attach steering cylinder hydraulic tubes to rear axle mount bracket with washers and bulkhead lock nuts (Fig. 12). Install steering cylinder hoses to hydraulic tubes.

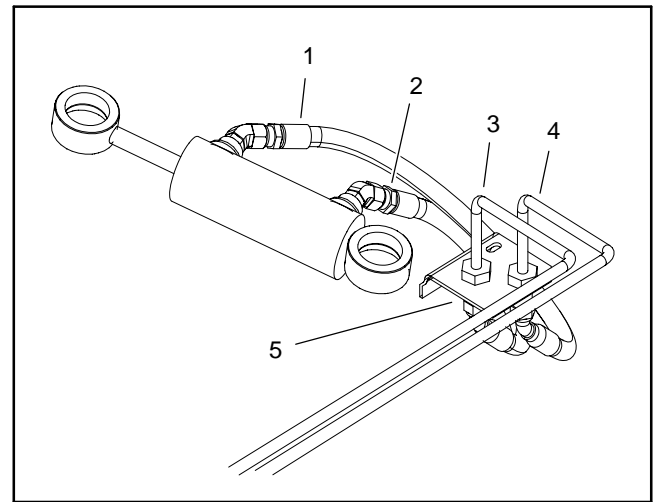


Figure 12

- |                   |                       |
|-------------------|-----------------------|
| 1. Hydraulic hose | 4. Hydraulic tube     |
| 2. Hydraulic hose | 5. Axle mount bracket |
| 3. Hydraulic tube |                       |

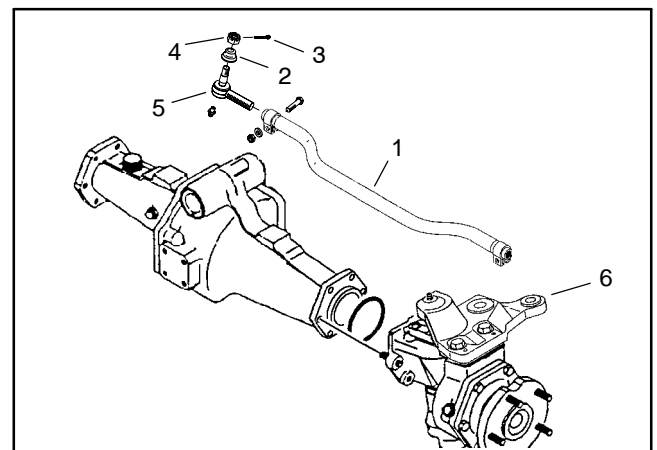


Figure 13

- |               |                      |
|---------------|----------------------|
| 1. Tie rod    | 4. Castle nut        |
| 2. Dust cover | 5. Tie rod end       |
| 3. Cotter pin | 6. Steering arm (LH) |

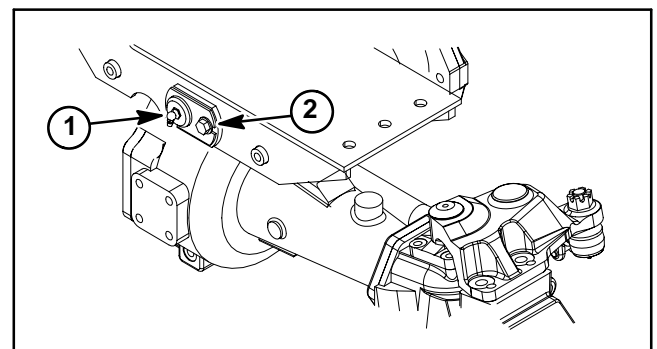


Figure 14

- |              |                      |
|--------------|----------------------|
| 1. Pivot pin | 2. Washer head screw |
|--------------|----------------------|

8. Install steering cylinder to axle assembly (see Steering Cylinder Installation in the Service and Repairs section of Chapter 4 – Hydraulic System).

9. Install hydraulic motor to axle assembly (see Rear Axle Motor Installation in the Service and Repairs 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.**

10. Install wheels to axle.

11. Lower machine to ground. Torque wheel lug nuts from **85 to 100 ft-lb (115 to 135 N-m)**.

12. Fill axle with SAE 85W-140 weight gear lube. Lubricant capacity is approximately 80 fl. oz. (2.37 liters) for the axle and 16 fl. oz. (0.47 liters) for the gearbox.

13. Check rear wheel toe-in and adjust if necessary.

14. Check steering stop bolt adjustment. When the steering cylinder is fully extended (right turn), a gap of 1/16" (1.6 mm) should exist between bevel gear case casting and stop bolt on left axle case. Figure 15 shows stop bolt location.

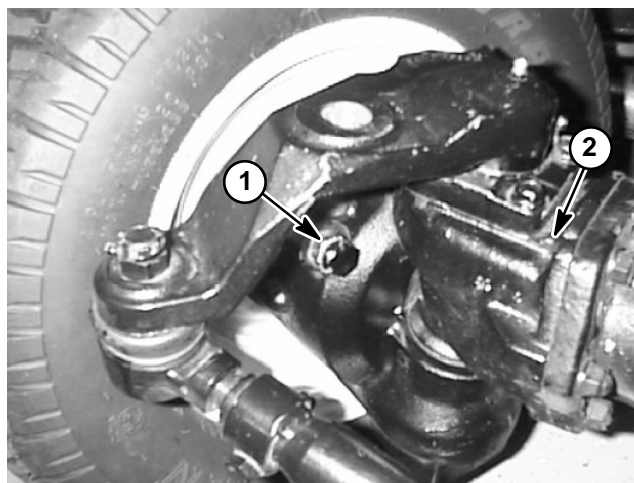


Figure 15

1. Steering stop bolt

2. Bevel gear case (LH)

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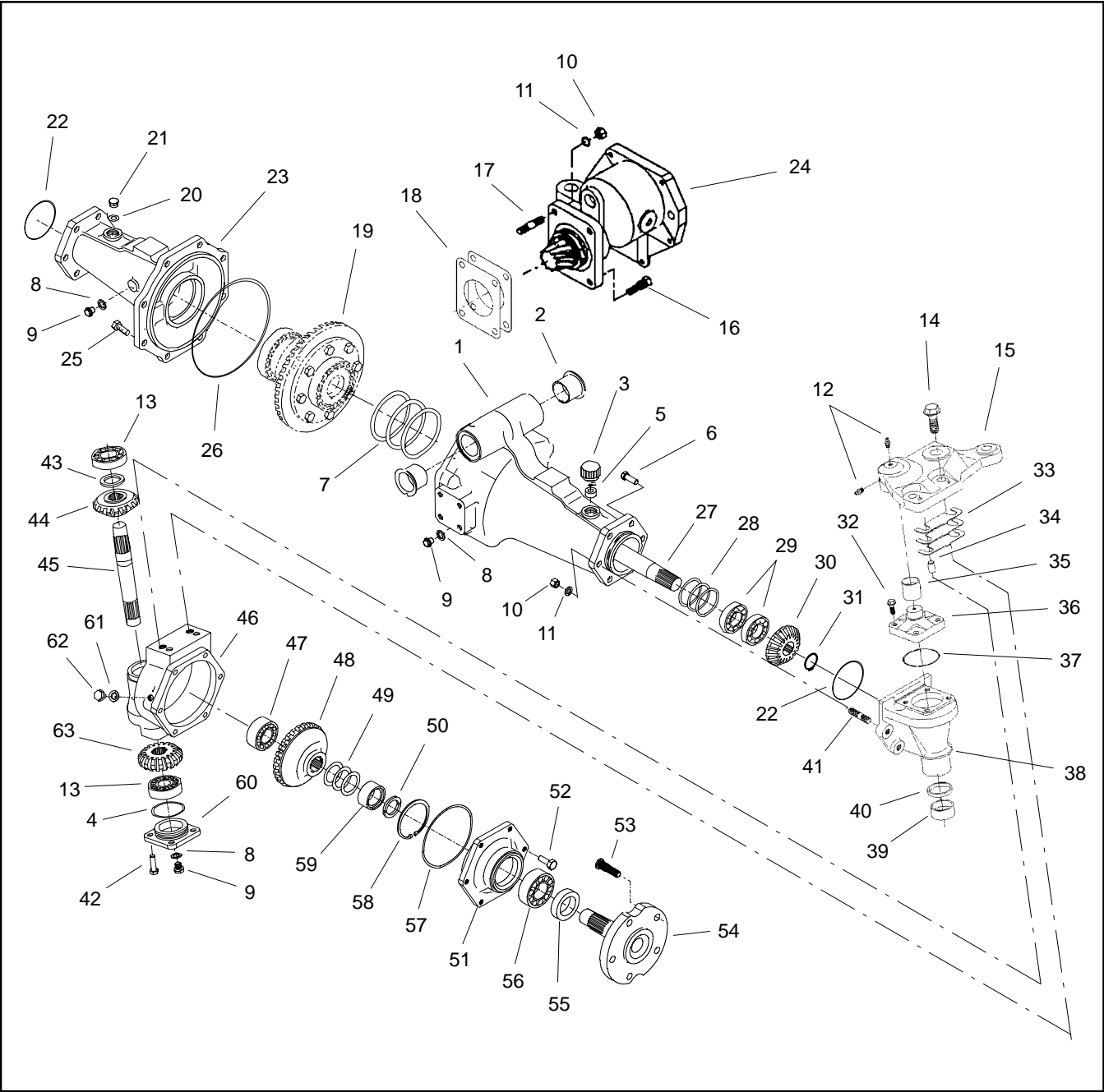


Figure 16

Figure 16 (Continued)

- |                                     |                                      |                                  |
|-------------------------------------|--------------------------------------|----------------------------------|
| 1. LH axle support                  | 22. O-ring                           | 43. Collar                       |
| 2. Flange bushing (2 used)          | 23. RH axle support                  | 44. Bevel gear (17 tooth)        |
| 3. Axle vent                        | 24. Input shaft assembly             | 45. Bevel gear shaft             |
| 4. O-ring                           | 25. Bolt (8 used)                    | 46. Axle case (LH shown)         |
| 5. Vent extension                   | 26. O-ring                           | 47. Ball bearing                 |
| 6. Cap screw (4 used per gear case) | 27. Differential shaft (LH shown)    | 48. Bevel gear (29 tooth)        |
| 7. Shim set                         | 28. Shim set                         | 49. Shim set                     |
| 8. Seal washer                      | 29. Ball bearing                     | 50. Clip (2 used per axle case)  |
| 9. Plug                             | 30. Bevel gear (15 tooth)            | 51. Axle cover                   |
| 10. Lock nut                        | 31. Retaining ring                   | 52. Screw (6 used per cover)     |
| 11. Lock washer                     | 32. Bolt (4 used per knuckle)        | 53. Wheel stud (5 used per axle) |
| 12. Grease fitting                  | 33. Shim set                         | 54. Axle                         |
| 13. Ball bearing                    | 34. Dowel pin (2 used per axle case) | 55. Oil seal                     |
| 14. Screw (2 used per steering arm) | 35. Bushing                          | 56. Ball bearing                 |
| 15. Axle case support (LH shown)    | 36. Knuckle pin                      | 57. O-ring                       |
| 16. Bolt (2 used)                   | 37. O-ring                           | 58. Retaining ring               |
| 17. Stud (2 used)                   | 38. Bevel gear case (LH shown)       | 59. Spacer                       |
| 18. Shim set                        | 39. Bushing                          | 60. Axle case cover              |
| 19. Differential assembly           | 40. Shaft seal                       | 61. Seal washer                  |
| 20. O-ring                          | 41. Stud (2 used per gear case)      | 62. Plug                         |
| 21. Plug                            | 42. Bolt (4 used per cover)          | 63. Bevel gear (17 tooth)        |

**NOTE:** Figure 16 illustrates the rear axle used on the Groundsmaster 4000-D and 4010-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. 17).

2. Mark both right and left bevel gear case/axle case assemblies.

**IMPORTANT: Do not interchange right and left bevel gear case/axle case assemblies.**

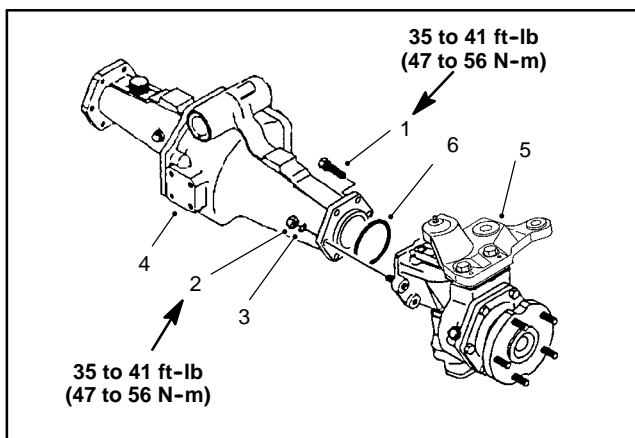


Figure 17

- |                         |                                       |
|-------------------------|---------------------------------------|
| 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         |                                       |

3. Remove the axle cover mounting screws. Remove the axle cover from the axle case as an assembly (Fig. 18).

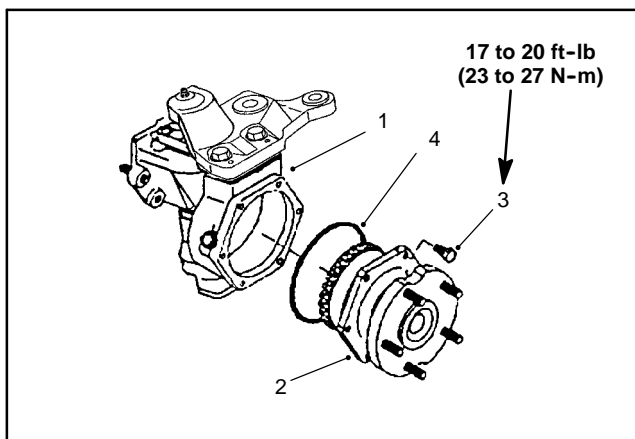


Figure 18

- |                        |                   |
|------------------------|-------------------|
| 1. Axle case           | 3. Screw (6 used) |
| 2. Axle cover assembly | 4. O-ring         |

4. Remove the axle case support mounting screws, the axle case support and the support shims (Fig. 19).

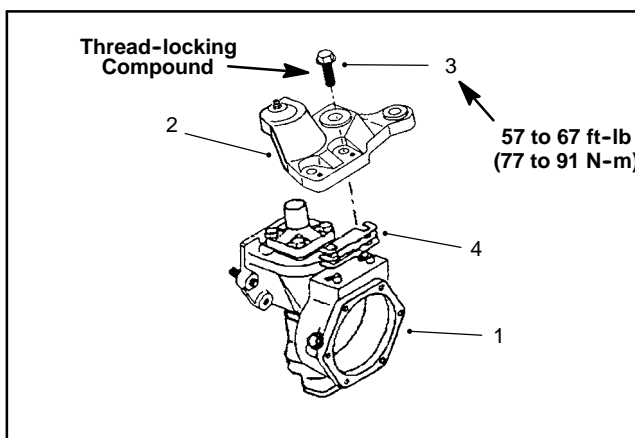


Figure 19

- |                      |                   |
|----------------------|-------------------|
| 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. 20).

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. 20).

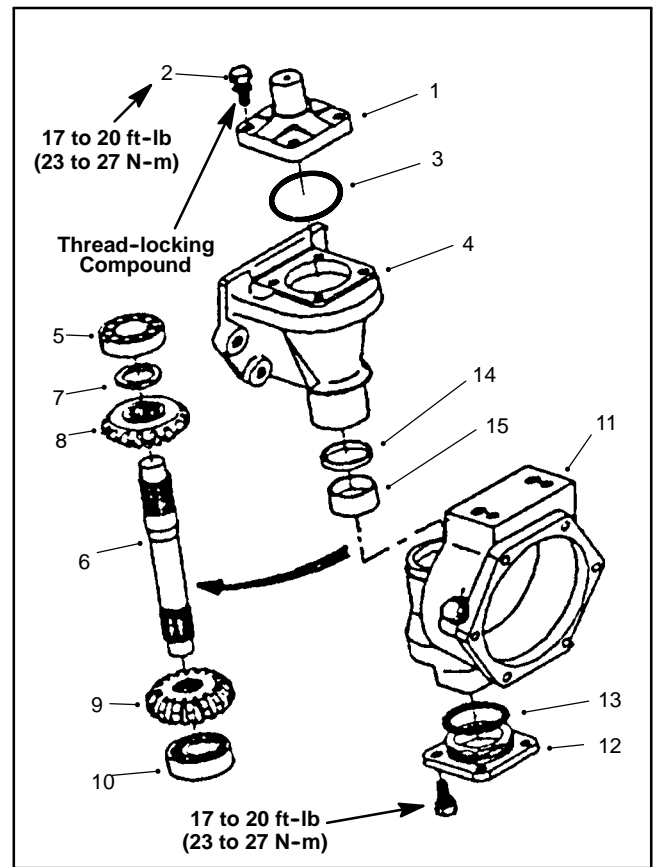


Figure 20

- |                            |                     |
|----------------------------|---------------------|
| 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. 21). 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.

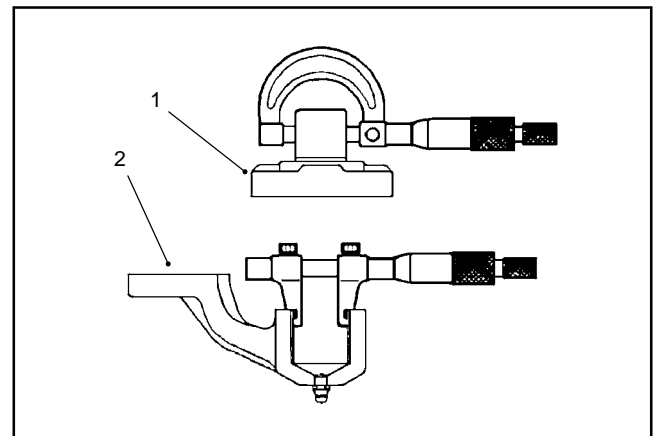


Figure 21

- |                |                      |
|----------------|----------------------|
| 1. Knuckle pin | 2. Axle case support |
|----------------|----------------------|

## Installation

1. Coat new shaft seal with grease and install in axle case as shown (Fig. 22).

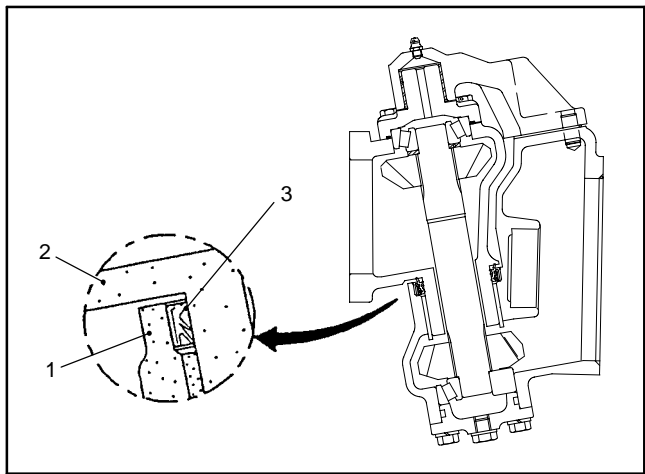


Figure 22

- |                    |               |
|--------------------|---------------|
| 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. 23). 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. 23).

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)**.

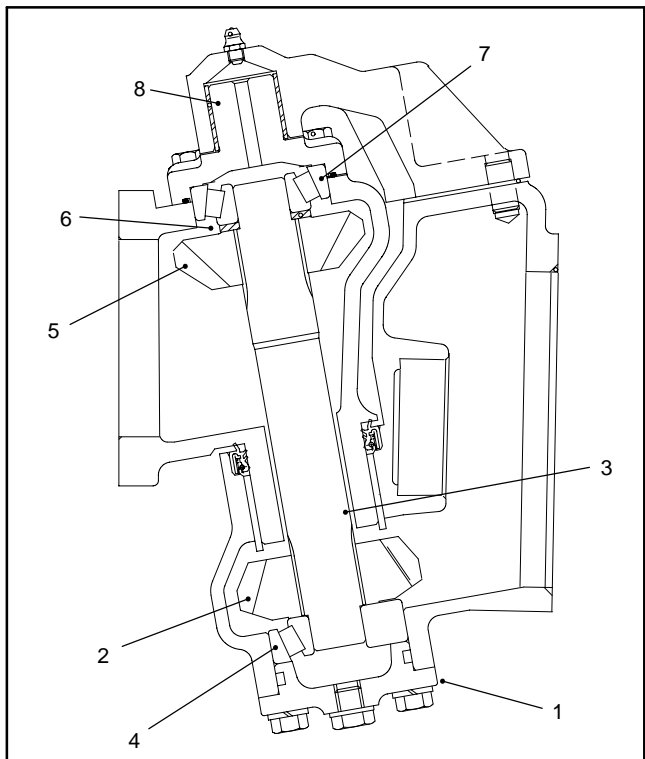


Figure 23

- |                     |                     |
|---------------------|---------------------|
| 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. 24).

**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 tooth's center. Prevent the axle from turning and measure the upper bevel gear to differential shaft gear backlash (Fig. 25).

**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.

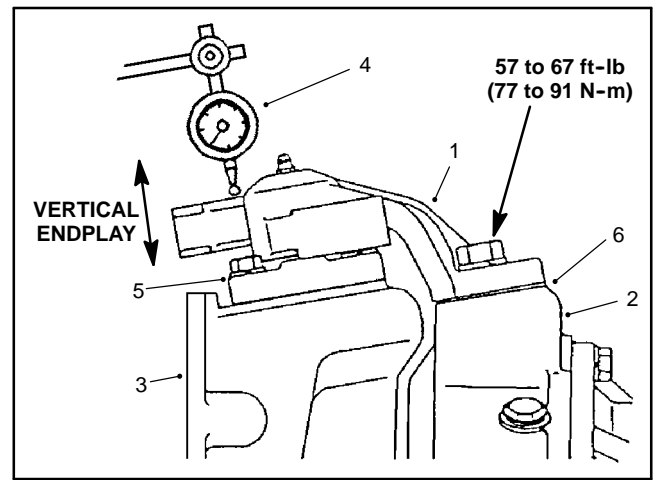


Figure 24

- |                      |                          |
|----------------------|--------------------------|
| 1. Axle case support | 4. Dial indicator        |
| 2. Axle case         | 5. Knuckle pin           |
| 3. Bevel gearcase    | 6. Support shim location |

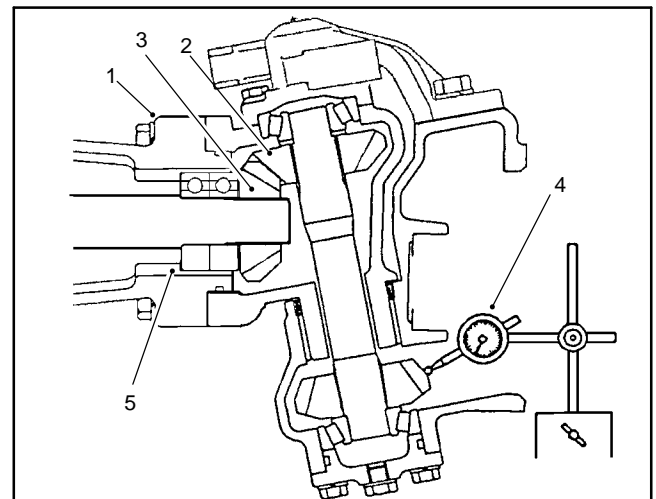


Figure 25

- |                            |                       |
|----------------------------|-----------------------|
| 1. Axle support            | 4. Dial indicator     |
| 2. Upper bevel gear        | 5. Axle bearing shims |
| 3. Differential shaft gear |                       |

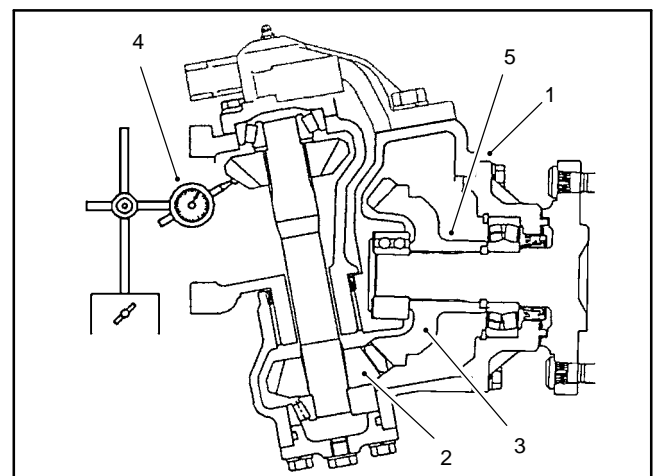


Figure 26

- |                        |                       |
|------------------------|-----------------------|
| 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 teeth center. Prevent the axle from turning and measure the lower bevel gear to axle gear backlash (Fig. 26).

**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. 17).

## 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. 27).
2. Mark and pull the differential shaft assembly from the axle support.
3. Remove the retaining ring and bevel gear (Fig 28).
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).

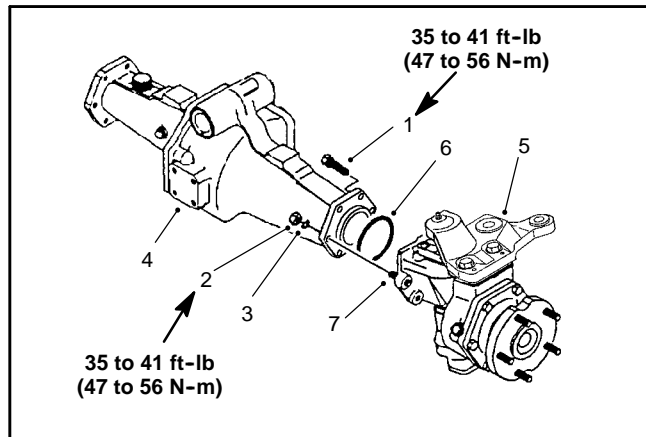


Figure 27

- |                         |                                  |
|-------------------------|----------------------------------|
| 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)                 |
| 4. Axle support         |                                  |

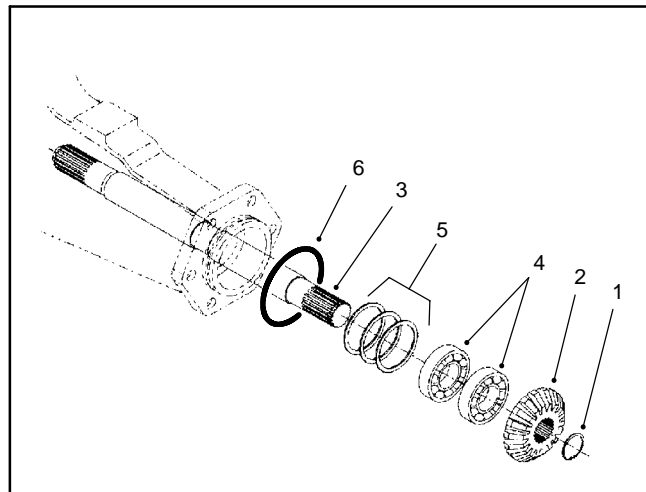


Figure 28

- |                       |                  |
|-----------------------|------------------|
| 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. 29).
2. Use a bearing puller to remove the bearing and bevel gear as shown (Fig. 30).
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. 31).
2. Press the axle cover and bearing assembly onto the axle shaft. Press only on the inner race of the cover bearing (Fig. 31).
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)**.

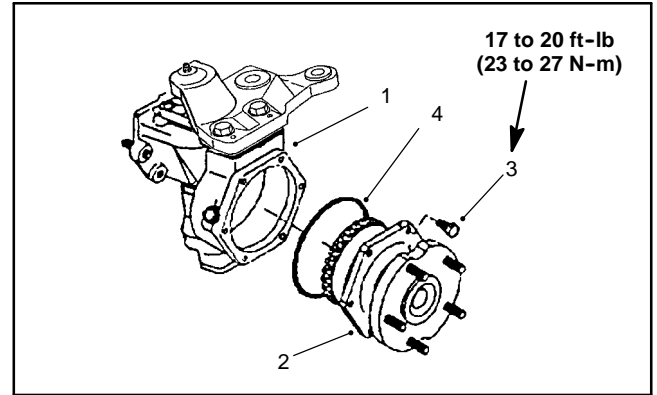


Figure 29

- |                        |                   |
|------------------------|-------------------|
| 1. Axle case           | 3. Screw (6 used) |
| 2. Axle cover assembly | 4. O-ring         |

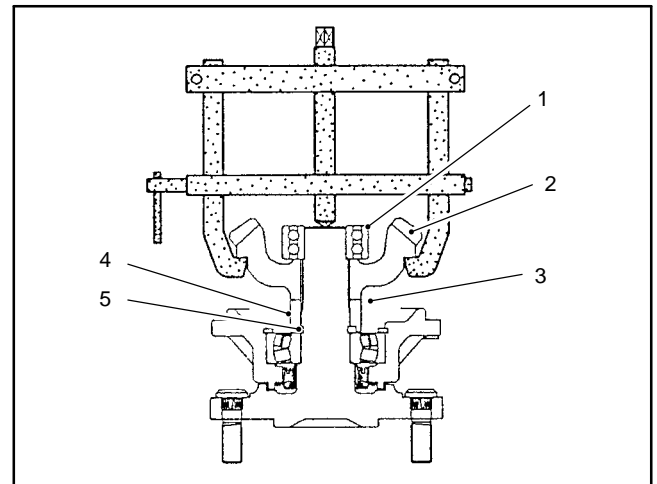


Figure 30

- |               |                   |
|---------------|-------------------|
| 1. Bearing    | 4. Spacer         |
| 2. Bevel gear | 5. Retaining ring |
| 3. Shims      |                   |

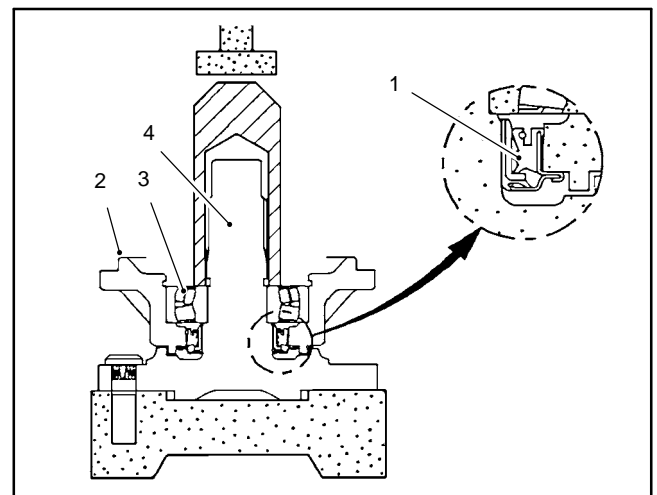


Figure 31

- |                    |               |
|--------------------|---------------|
| 1. Axle shaft seal | 3. Bearing    |
| 2. Axle cover      | 4. Axle shaft |

## Input Shaft/Pinion Gear

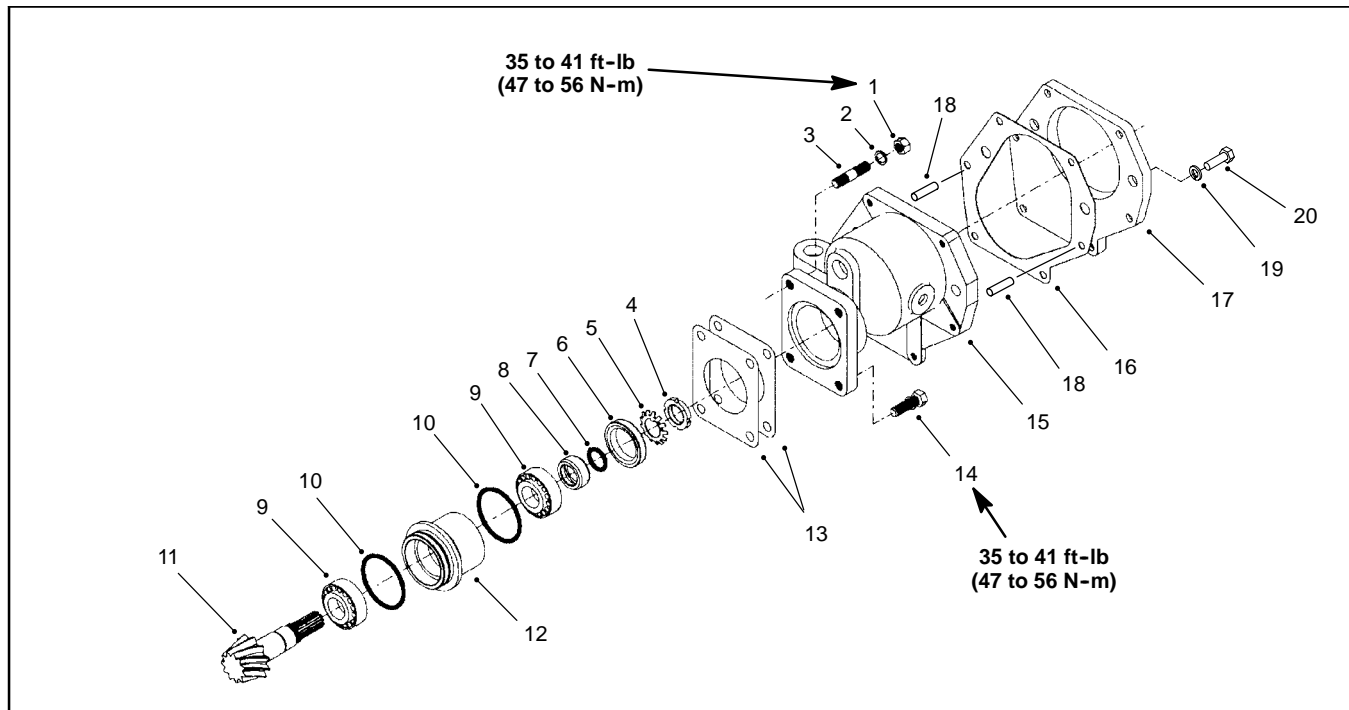


Figure 32

- |                         |                             |                          |
|-------------------------|-----------------------------|--------------------------|
| 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. 32)

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. 32)

**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. 33). 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. 34).

#### 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. 35).

#### 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.

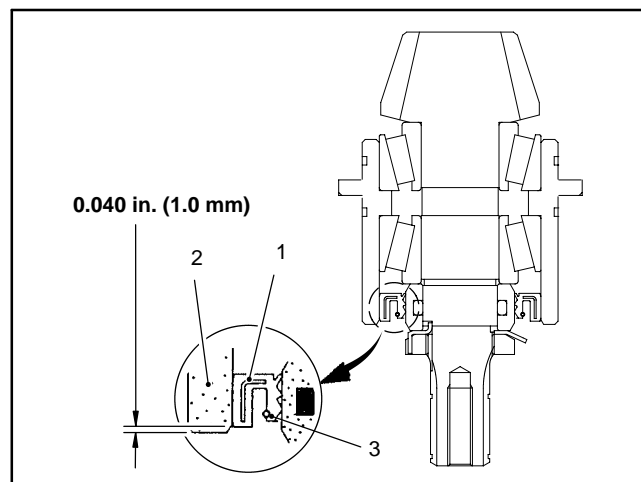


Figure 33

- 1. Oil seal
- 2. Bearing case
- 3. Seal garter spring

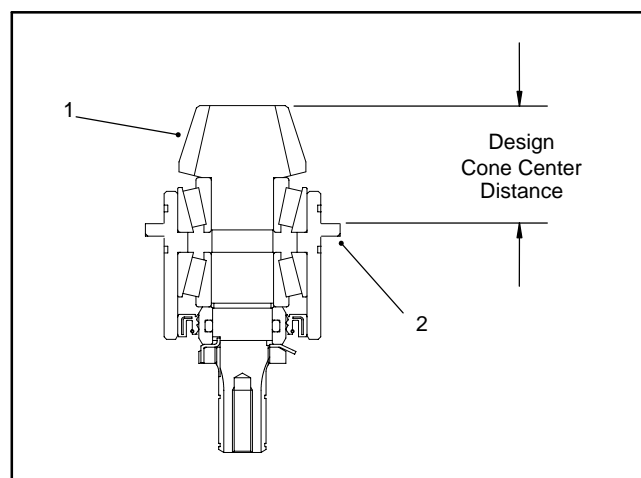


Figure 34

- 1. Input shaft/pinion gear
- 2. Bearing case

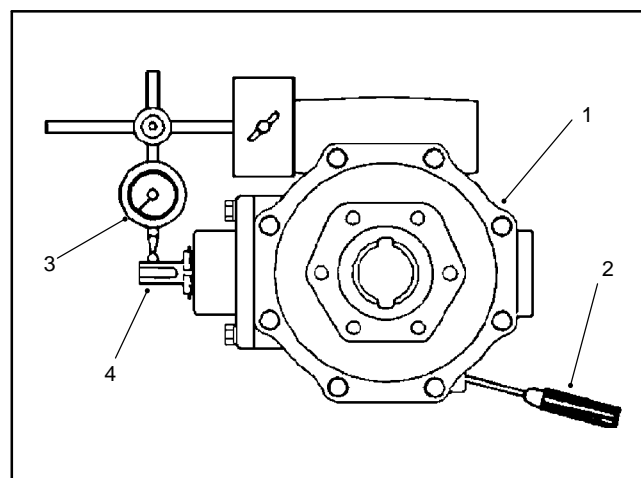


Figure 35

- 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. 36).

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. 37).

**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. 38).

**NOTE:** Replacement ring gears are only available in matched ring and pinion sets.

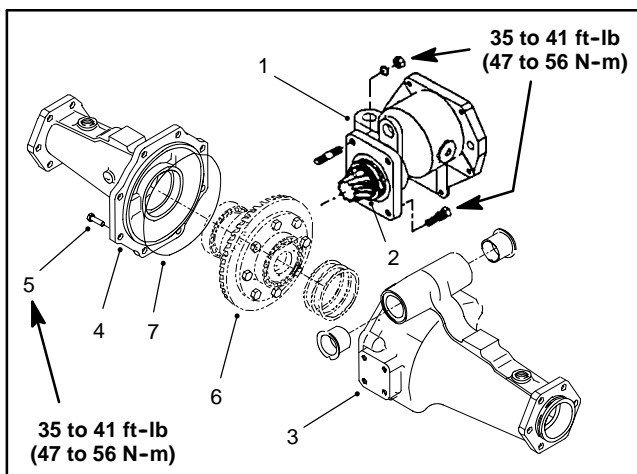


Figure 36

- |                         |                        |
|-------------------------|------------------------|
| 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) |                        |

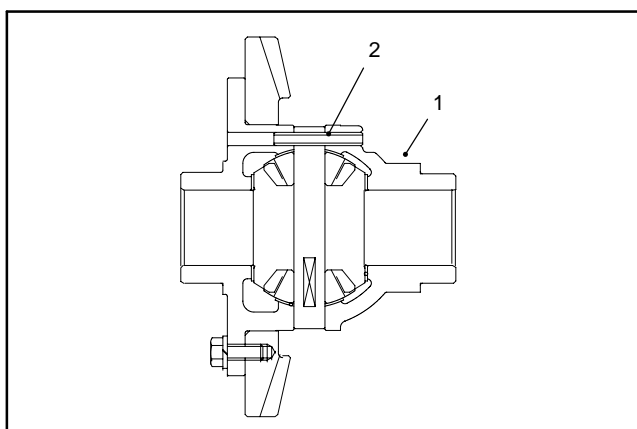


Figure 37

- |                      |               |
|----------------------|---------------|
| 1. Differential case | 2. Spring pin |
|----------------------|---------------|

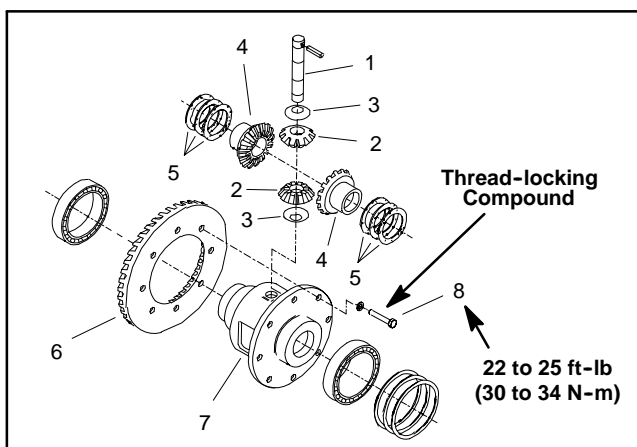


Figure 38

- |                              |                         |
|------------------------------|-------------------------|
| 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. 39). 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. 40). 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.

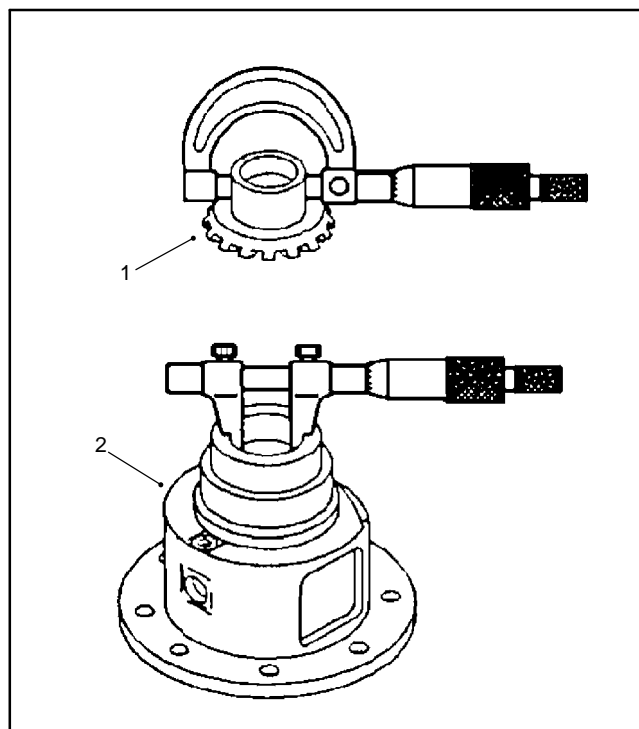


Figure 39

1. Side gear

2. Differential case

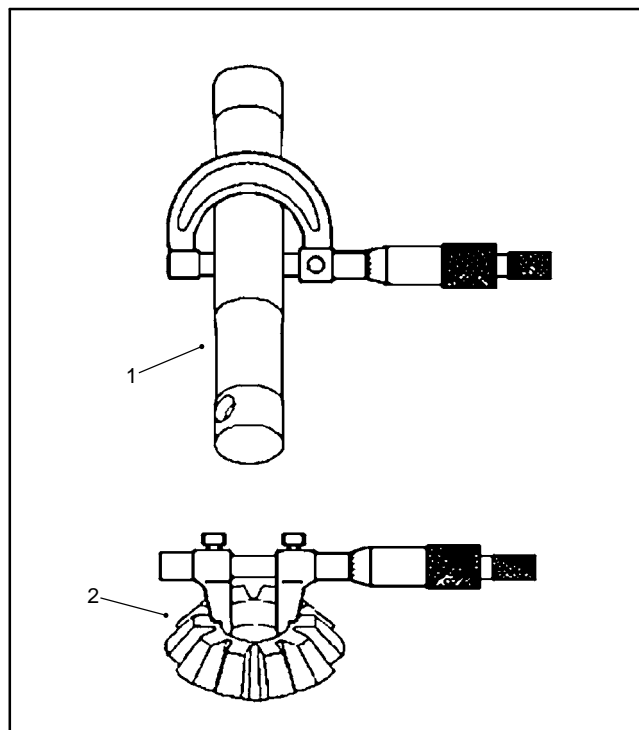


Figure 40

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. 41).

**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. 42).

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.

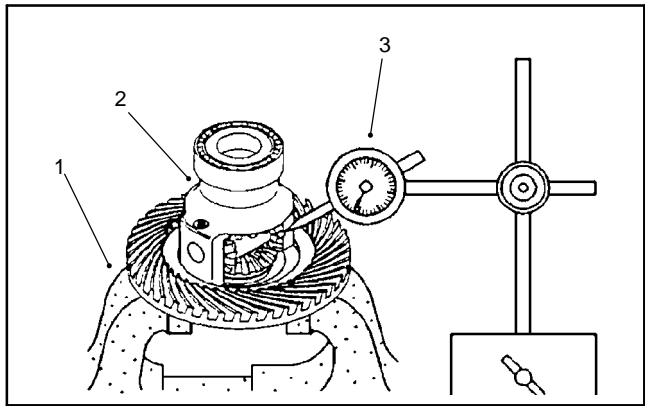


Figure 41

- 1. Vise
- 2. Differential gear case
- 3. Dial indicator

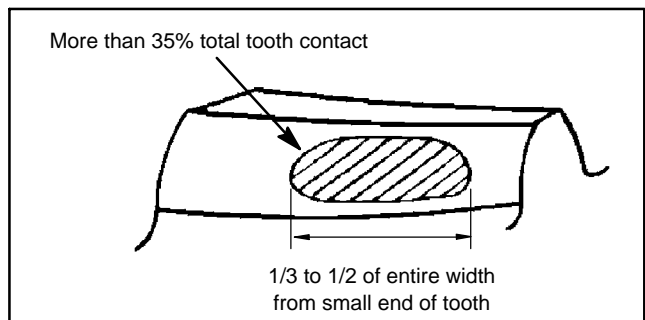


Figure 42

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. 43):

**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. 44).

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. 45).

**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. 46 and 47) 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.

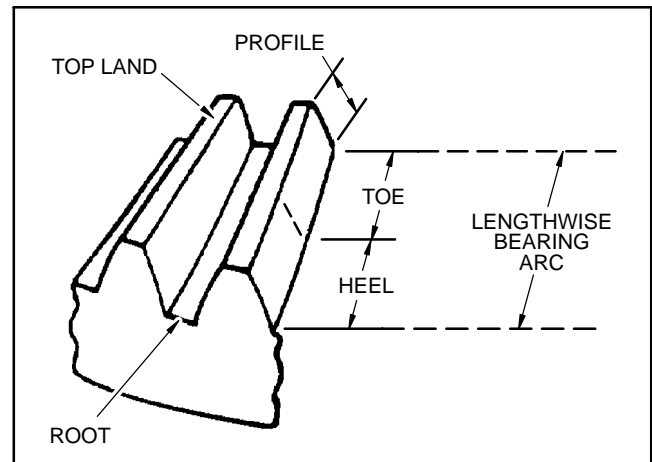


Figure 43

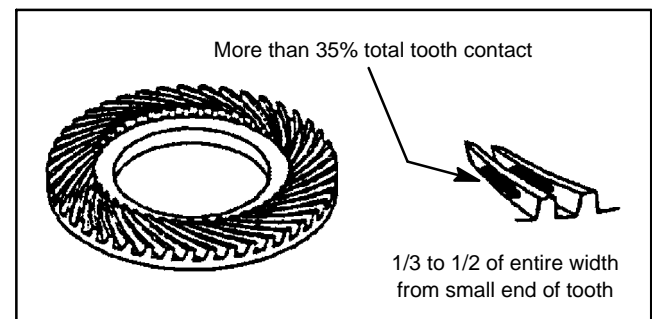


Figure 44

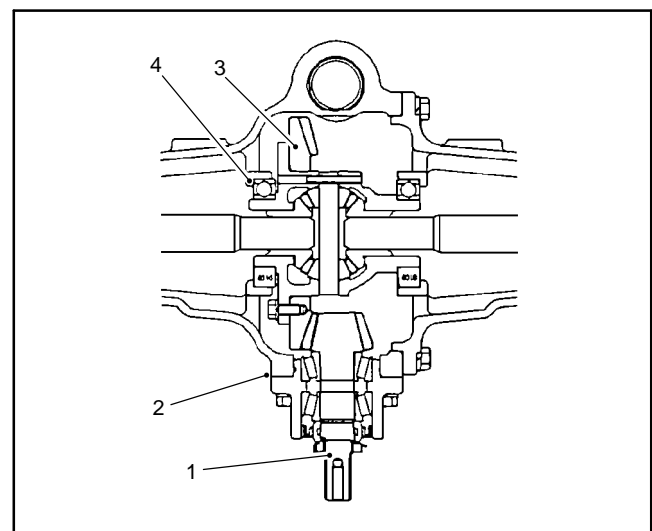


Figure 45

- |                            |                               |
|----------------------------|-------------------------------|
| 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. 46):

- 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. 47):

- 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.

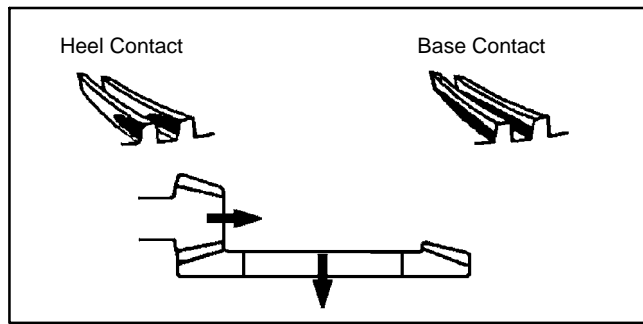


Figure 46

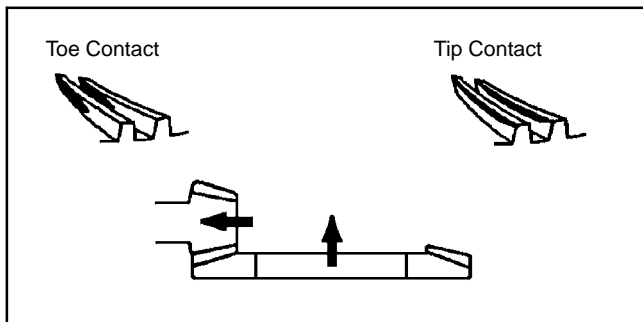


Figure 47



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### General Information

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#### 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.

# Service and Repairs

## Steering Tower

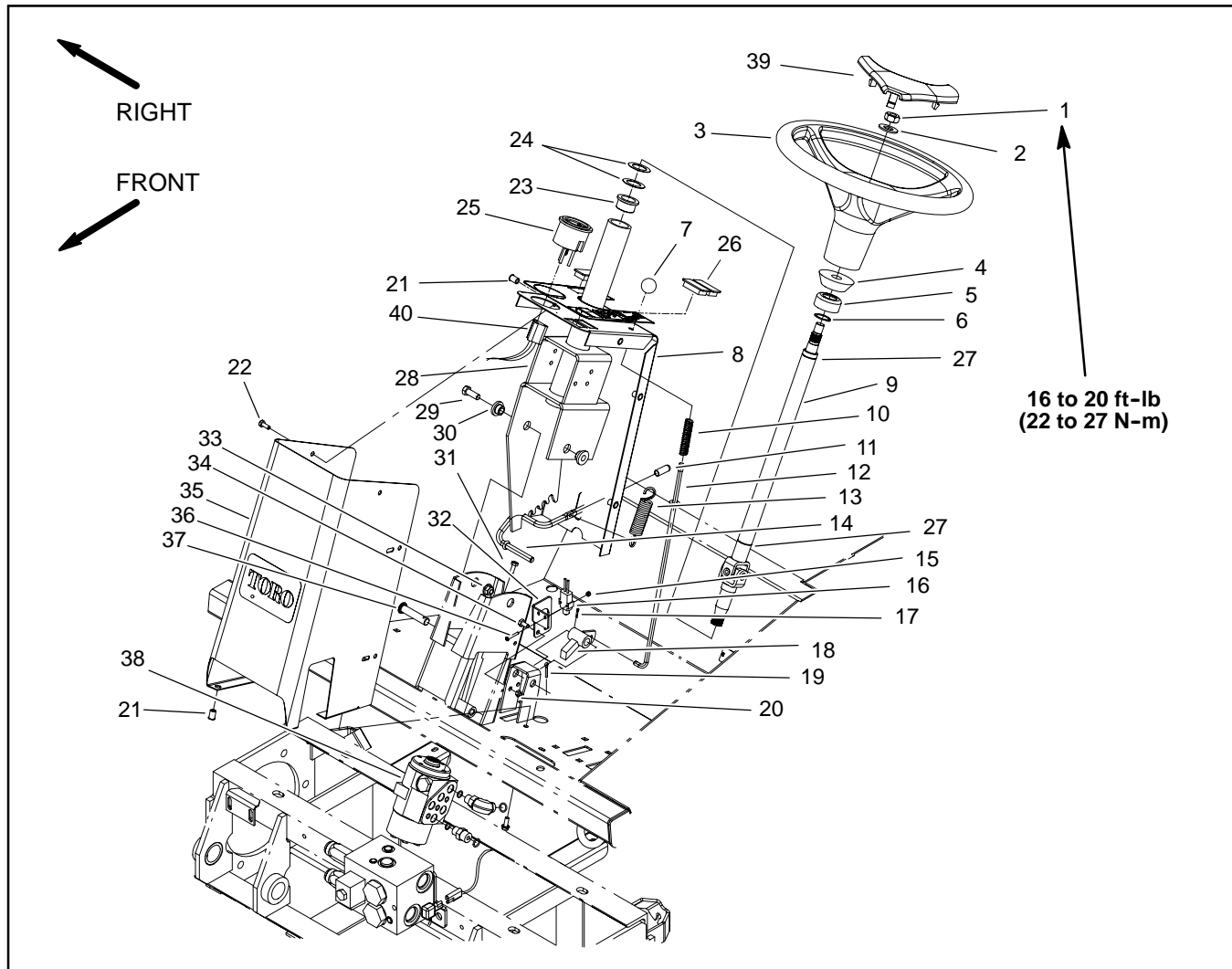


Figure 1

- |                                |                                 |                                  |
|--------------------------------|---------------------------------|----------------------------------|
| 1. Hex nut                     | 15. Lock nut (2 used)           | 28. Steering column              |
| 2. Flat washer                 | 16. Parking brake switch        | 29. Cap screw (2 used)           |
| 3. Steering wheel              | 17. Cotter pin                  | 30. Pivot hub (2 used)           |
| 4. Foam collar                 | 18. Brake pawl                  | 31. Flange head screw (4 used)   |
| 5. Steering seal               | 19. Cotter pin                  | 32. Switch bracket               |
| 6. External snap ring (2 used) | 20. Lock nut (2 used)           | 33. Flange nut (2 used)          |
| 7. Knob                        | 21. Nut insert (10 used)        | 34. Cap screw (2 used)           |
| 8. Steering tower cover        | 22. Flange head screw (10 used) | 35. Steering tower               |
| 9. Steering shaft              | 23. Flange bushing (2 used)     | 36. Phillips head screw (2 used) |
| 10. Compression spring         | 24. Thrust washer (as needed)   | 37. Clevis pin                   |
| 11. Cap                        | 25. Temperature gauge           | 38. Steering valve               |
| 12. Rod assembly               | 26. Plug                        | 39. Steering wheel cover         |
| 13. Extension spring           | 27. Snap ring location          | 40. Platform wire harness        |
| 14. Tilt rod                   |                                 |                                  |

### Disassembly (Fig. 1)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.
2. Disassemble steering tower as needed using Figure 1 as a guide.

### Assembly (Fig. 1)

1. Assemble steering tower using Figure 1 as a guide.
  - A. Thrust washer(s) (item 24) on steering column are used as needed to remove end play of steering shaft.
  - B. If steering wheel was removed, torque hex nut that secures steering wheel from **16 to 20 ft-lb (22 to 27 N-m)**.

## Front Deck Lift Arm

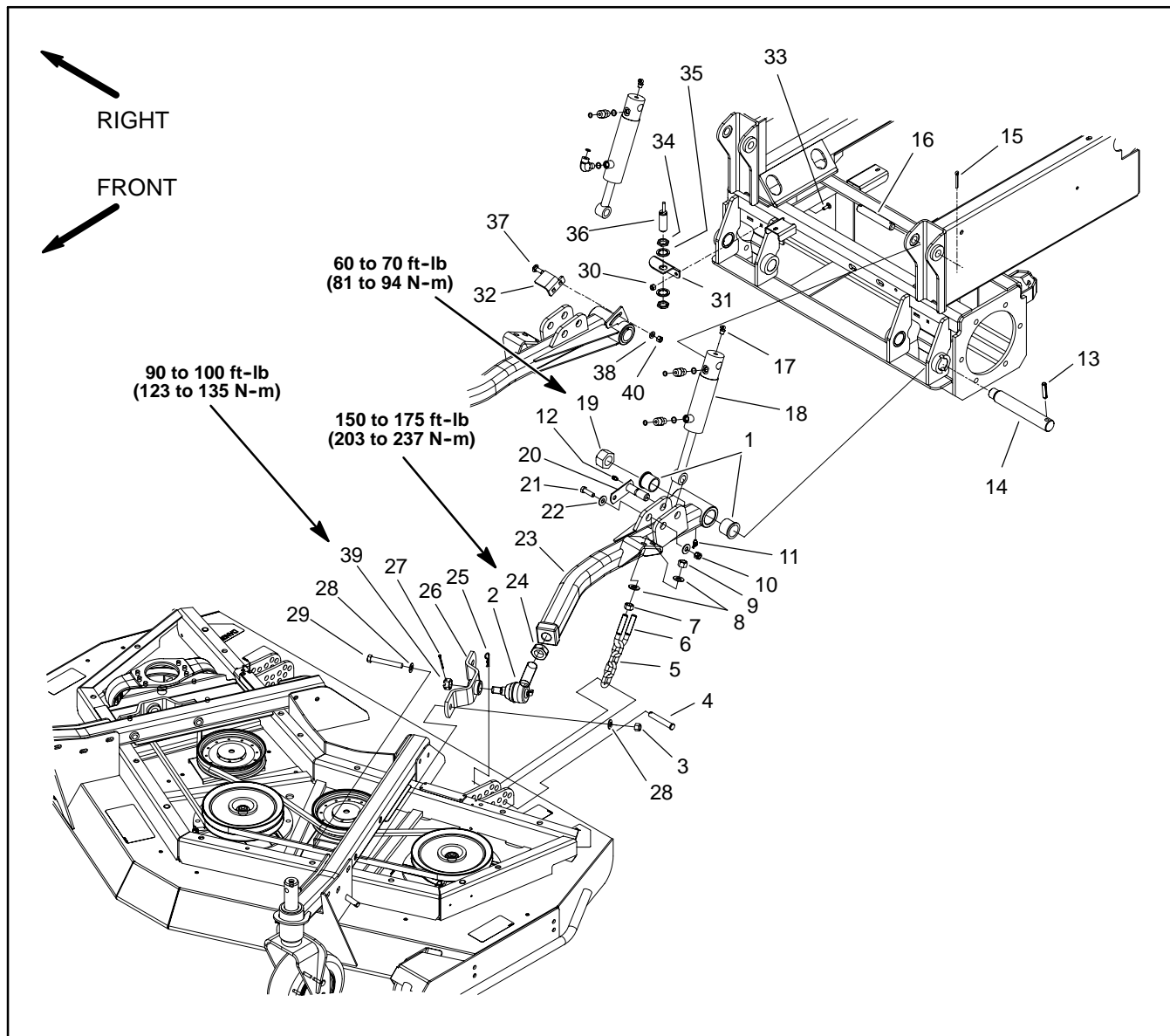


Figure 2

- |                               |                             |                             |
|-------------------------------|-----------------------------|-----------------------------|
| 1. Flange bushing             | 15. Cotter pin              | 28. Washer (4 per mount)    |
| 2. Ball joint                 | 16. Upper lift pin          | 29. Cap screw (2 per mount) |
| 3. Lock nut (2 per mount)     | 17. Grease fitting          | 30. Lock nut (2 used)       |
| 4. Clevis pin                 | 18. Lift cylinder           | 31. Switch mount            |
| 5. Height-of-cut chain        | 19. Lock nut                | 32. Sensing plate           |
| 6. U-bolt                     | 20. Pin                     | 33. Carriage screw (2 used) |
| 7. Hex nut (2 per u-bolt)     | 21. Cap screw               | 34. Jam nut (2 per switch)  |
| 8. Flat washer (4 per u-bolt) | 22. Flat washer (2 per pin) | 35. Washer (2 per switch)   |
| 9. Lock nut (2 per u-bolt)    | 23. Lift arm (LH shown)     | 36. Proximity switch        |
| 10. Lock nut                  | 24. Jam nut                 | 37. Carriage screw (2 used) |
| 11. Grease fitting (45°)      | 25. Hair pin                | 38. Flat washer (2 used)    |
| 12. Grease fitting            | 26. Ball joint mount        | 39. Slotted hex nut         |
| 13. Slotted roll pin          | 27. Cotter pin              | 40. Lock nut (2 used)       |
| 14. Lift arm pin              |                             |                             |

### Removal (Fig. 2)

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

2. Remove front cutting deck (see Front Cutting Deck Removal in Chapter 8 – Cutting Decks).





## 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.**

3. Chock rear wheels and jack up front of machine. Support machine on jack stands.
4. Remove front wheel next to lift arm that is to be removed.
5. Remove cap screw, washers and lock nut that secure lift cylinder pin to lift arm. Remove pin and separate lift cylinder and lift arm.
6. Remove lock nut that secures lift arm pin. Support lift arm and slide pin from frame and lift arm. Remove lift arm from frame.
7. Remove height-of-cut chain, ball joint mount and ball joint from removed lift arm as required.

### Installation (Fig. 2)

1. Position lift arm to frame and insert lift arm pin. Engage roll pin into frame slots and install lock nut on pin. Torque lock nut from **60 to 70 ft-lb (81 to 94 N-m)**.
2. Align lift cylinder with lift arm. Slide pin through lift arm and cylinder end. Secure pin with cap screw, washers and lock nut.
3. Install front wheel assembly and lower machine to the ground. Make sure that wheel lug nuts are torqued from **85 to 100 ft-lb (115 to 135 N-m)**.
4. If sensing plate (item 32) was removed from lift arm, secure plate fully forward in lift arm slot.
5. If height-of-cut chain u-bolt was removed from lift arm, assemble u-bolt so that threaded portion extends **0.870" (22.1 mm)** above mounting plate on lift arm (Fig. 3).
6. If removed, install ball joint to lift arm. Distance from end of lift arm to center of ball joint should be from **2.210" to 2.390" (56.1 to 60.7 mm)** (Fig. 4). Make sure that ball joint is horizontal and that stud is centered in ball joint. Install deck before torquing ball joint jam nut (item 24).

7. Install ball joint mount to ball joint with slotted hex nut. Torque nut from **90 to 100 ft-lb (123 to 135 N-m)** while aligning cotter pin holes. Install cotter pin.

8. Install front cutting deck (see Front Cutting Deck Installation in Chapter 8 - Cutting Decks).

9. If ball joint was removed from lift arm, torque ball joint jam nut from **150 to 175 ft-lb (203 to 237 N-m)**.

10. Lubricate lift arm grease fittings.

11. After assembly is completed, raise and lower the cutting deck to verify that hydraulic hoses and fittings do not contact anything.

12. Check height-of-cut and deck pitch adjustment.

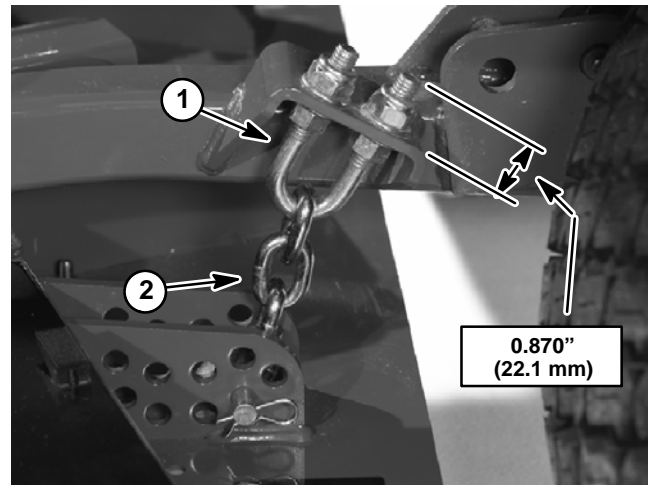


Figure 3

1. U-bolt

2. Height-of-cut chain

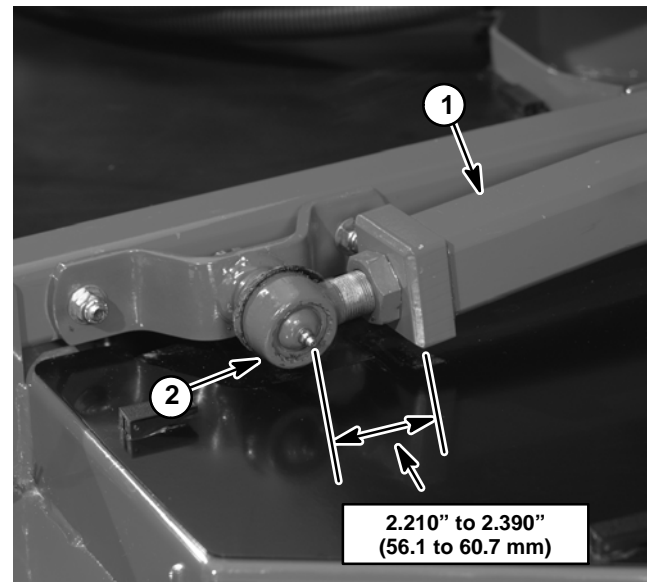


Figure 4

1. Lift arm

2. Ball joint

## Side Deck Lift Arm

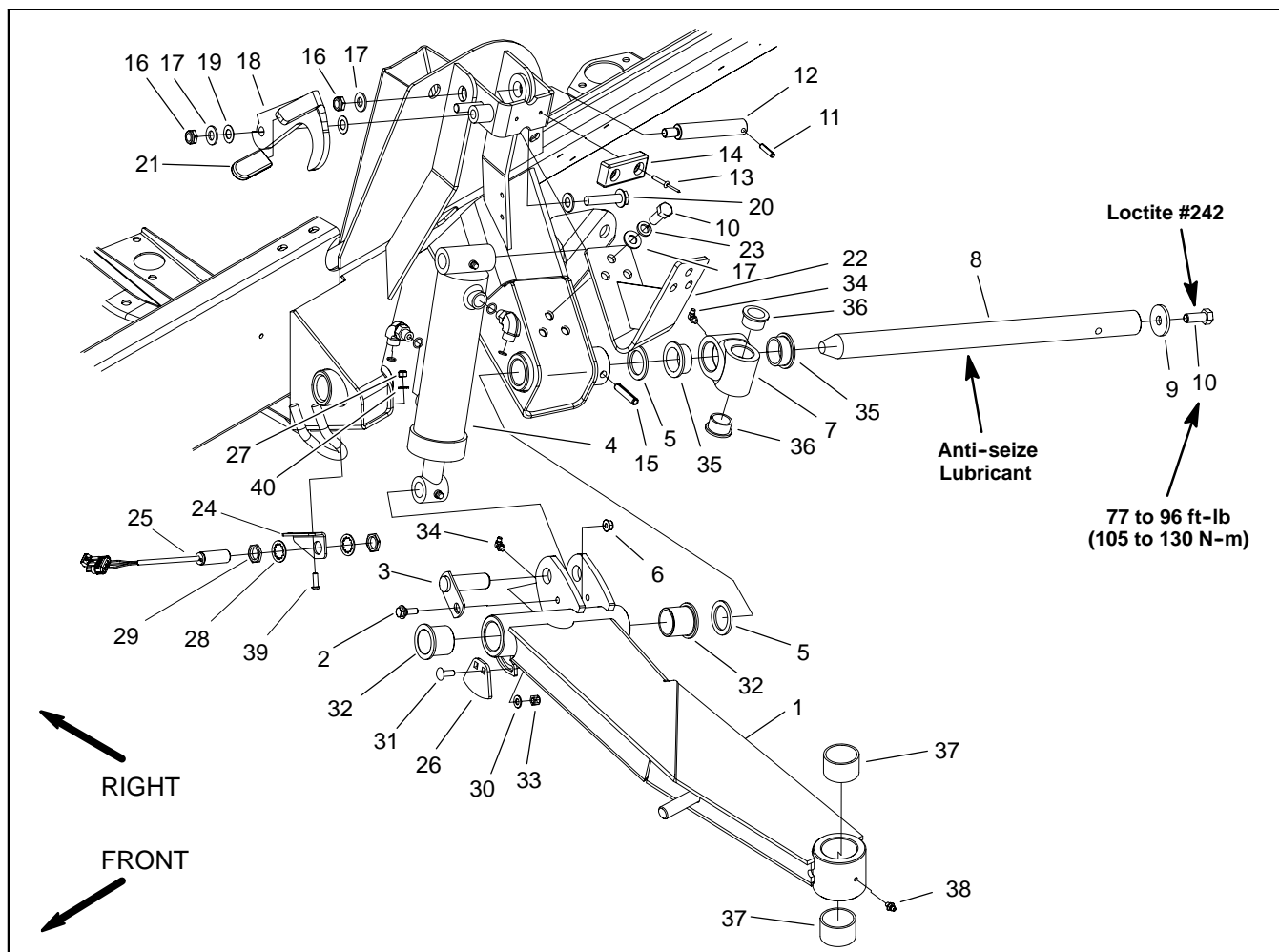


Figure 5

- |                          |                                 |                                  |
|--------------------------|---------------------------------|----------------------------------|
| 1. Lift arm (LH shown)   | 15. Slotted roll pin            | 28. Washer (2 per switch)        |
| 2. Shoulder screw        | 16. Lock nut                    | 29. Jam nut (2 per switch)       |
| 3. Lift cylinder pin     | 17. Flat washer                 | 30. Flat washer (2 per plate)    |
| 4. Lift cylinder         | 18. Latch (LH shown)            | 31. Carriage screw (2 per plate) |
| 5. Thrust washer         | 19. Thrust washer (2 per latch) | 32. Flange bushing               |
| 6. Flange nut            | 20. Flange head screw           | 33. Lock nut (2 per plate)       |
| 7. Pivot hub             | 21. Plastic grip                | 34. Grease fitting               |
| 8. Lift arm pivot shaft  | 22. Cam bracket                 | 35. Flange bushing               |
| 9. Thrust washer         | 23. Lock washer                 | 36. Flange bushing               |
| 10. Cap screw            | 24. Switch mount                | 37. Bushing                      |
| 11. Spring pin           | 25. Proximity switch            | 38. Grease fitting               |
| 12. Cylinder pin         | 26. Sensing plate               | 39. Screw (2 per mount)          |
| 13. Rivet (2 per bumper) | 27. Lock nut (2 per mount)      | 40. Flat washer (2 per mount)    |
| 14. Rubber bumper        |                                 |                                  |

**NOTE:** There are not bushings in the frame to support the lift arm pivot shaft (item 8) because the shaft is fixed in place by a roll pin (item 15). The lift arm (item 1) and pivot hub (item 7) rotate on the pivot shaft and have bushings that can be serviced.

**NOTE:** Allowable clearance between lift arm pivot shaft (item 8) and front frame bore (Fig. 6) is up to 0.025" (0.64 mm). Allowable clearance between lift arm pivot shaft and rear frame bore is up to 0.070" (1.78 mm).

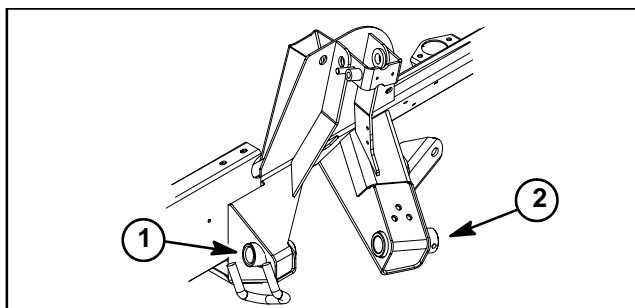


Figure 6

1. Front frame bore

2. Rear frame bore

### 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. Remove side deck from lift arm (see Side Cutting Deck Removal in Chapter 8 – Cutting Decks).
3. Remove side deck rear arm assembly from pivot hub (see Side Deck Rear Arm Assembly Removal in this section).
4. Remove lift cylinder pin (item 3) that secures lift cylinder to lift arm.
5. Drive out slotted roll pin (item 15) that retains lift arm pivot shaft. Discard roll pin.
6. Support lift arm and pull lift arm pivot shaft from lift arm and frame. Locate and remove thrust washers (item 5) during pivot shaft removal.
  - A. If pivot shaft is difficult to remove, fabricate a puller as shown in Figure 7.
  - B. Attach puller to end of pivot shaft with the pictured bolt and flat washer.
  - C. Drive pivot shaft from lift arm and frame with hammer.
7. Remove lift arm from machine.

### Installation (Fig. 5)

1. Apply anti-seize lubricant to lift arm pivot shaft.
2. Position lift arm to frame with thrust washers properly placed (Fig. 5). Slide pivot shaft into frame and lift arm until roll pin holes in shaft and frame align.
3. Install new slotted roll pin to secure lift arm pivot shaft.
4. If pivot hub was removed from pivot shaft, slide pivot hub onto shaft. Apply Loctite #242 (or equivalent) to cap screw threads and secure pivot hub with washer and cap screw. Torque cap screw from **77 to 96 ft-lb (105 to 130 N-m)**.

5. Align lift cylinder with lift arm. Secure lift cylinder to lift arm with lift cylinder pin (item 3).
6. Install side deck rear arm assembly (see Side Deck Rear Arm Assembly Installation in this section).
7. If sensing plate (item 26) was removed from lift arm, secure plate so it is rotated as far as possible toward center of machine.
8. Position and install side cutting deck to machine (see Side Cutting Deck Installation in Chapter 8 – Cutting Decks).
9. Lubricate lift arm grease fittings after assembly is complete.
10. After assembly is completed, raise and lower the cutting deck to verify that hydraulic hoses and fittings do not contact anything.

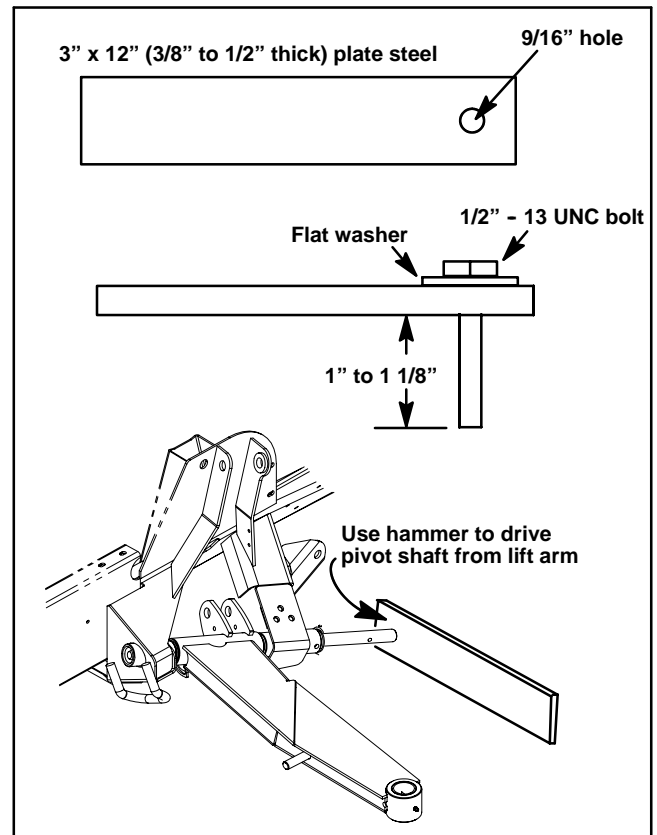


Figure 7

## Side Deck Rear Arm Assembly

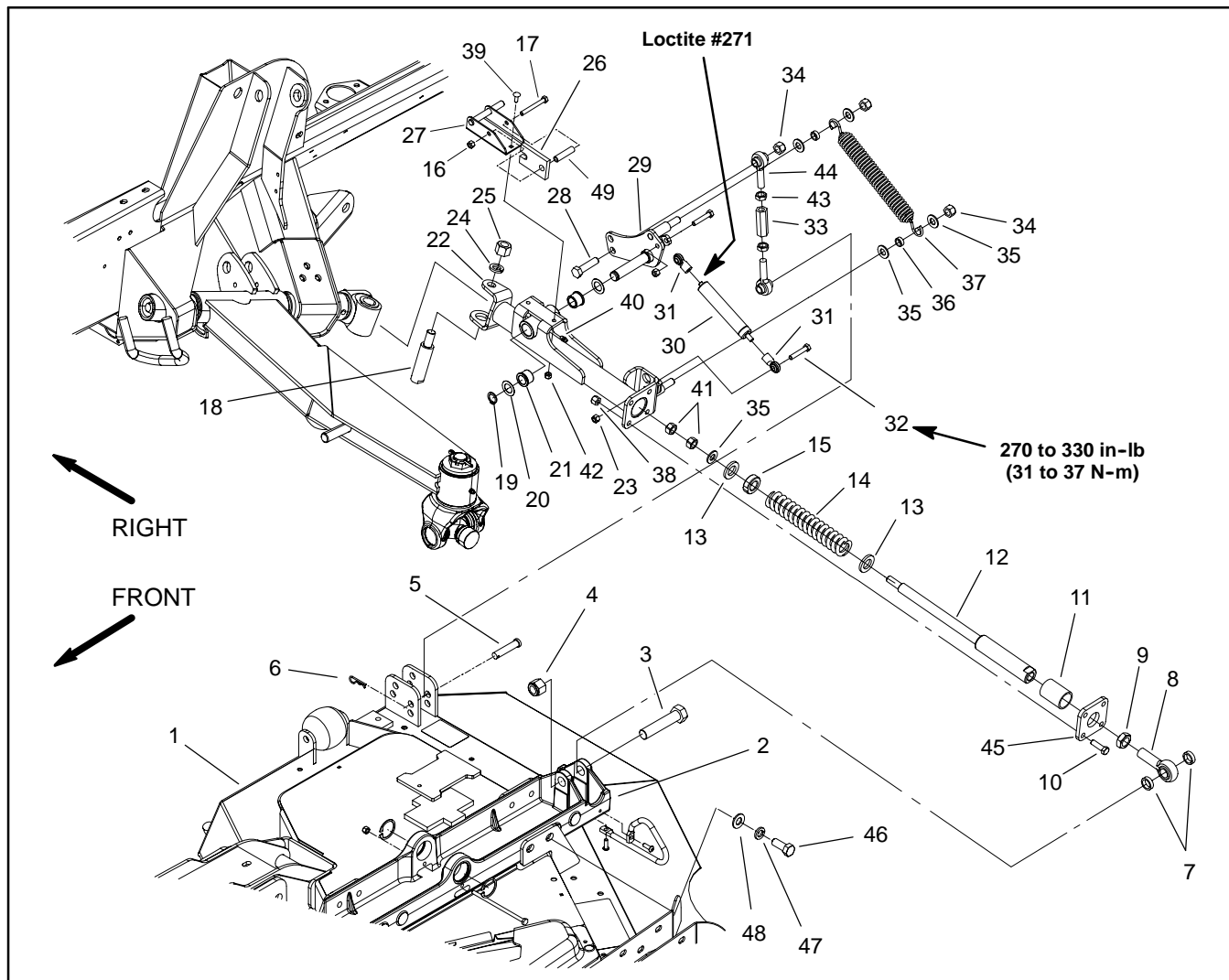


Figure 8

- |                            |                                   |                                |
|----------------------------|-----------------------------------|--------------------------------|
| 1. Cutting deck (LH shown) | 18. Pivot shaft                   | 34. Lock nut                   |
| 2. Deck mount (LH shown)   | 19. Retaining ring                | 35. Flat washer                |
| 3. Cap screw               | 20. Thrust washer (2 per arm)     | 36. Bushing                    |
| 4. Lock nut                | 21. Flange bushing                | 37. Damper spring              |
| 5. Clevis pin              | 22. Rear arm (LH shown)           | 38. Lock nut (4 per arm)       |
| 6. Hair pin                | 23. Lock nut (2 per damper)       | 39. Carriage screw (2 per arm) |
| 7. Spacer                  | 24. Lock washer                   | 40. Grease fitting             |
| 8. Rod end                 | 25. Lock nut                      | 41. Jam nut                    |
| 9. Jam nut                 | 26. Bumper pad (5 per arm)        | 42. Lock nut (2 per arm)       |
| 10. Cap screw (4 per arm)  | 27. Bumper mount                  | 43. Jam nut (2 per arm)        |
| 11. Straight bushing       | 28. Cap screw                     | 44. Rod end (2 per arm)        |
| 12. Spring shaft           | 29. Bell crank (LH shown)         | 45. Plate                      |
| 13. Flat washer            | 30. Damper                        | 46. Cap screw (8 used)         |
| 14. Compression spring     | 31. Damper rod end (2 per damper) | 47. Lock washer (8 used)       |
| 15. Plastic bearing        | 32. Cap screw (2 per damper)      | 48. Flat washer (8 used)       |
| 16. Lock nut               | 33. Link tube                     | 49. Spacer                     |
| 17. Cap screw              |                                   |                                |

### Rear Arm Removal (Fig. 8)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.
2. Remove hair pin and clevis pin that connects damper link to cutting deck (Fig. 9).
3. Remove cap screw and lock nut that secures rod end of rear arm to cutting deck. Locate and remove spacer from each side of rod end.
4. Remove lock nut and lock washer that secures rear arm pivot shaft. Slide pivot shaft from hub and rear arm. Remove rear arm assembly from machine.

### Rear Arm Disassembly (Fig. 8)

1. Disassemble rear arm assembly using Figure 8 as a guide.

### Rear Arm Assembly (Fig. 8)

1. Slide large flat washer, spring, plastic bearing, second large flat washer and small flat washer onto spring shaft. Loosely secure components to shaft with one jam nut.
2. Slide the straight bushing and plate onto other end of spring shaft.
3. While holding flats on end of spring shaft, rotate jam nut (on other end of assembly) until components are snug but spring is not compressed.
4. Insert assembly into rear arm housing.
5. From open end of rear arm housing, insert a 3/4" socket onto spring shaft jam nut. Tighten jam nut fully.
6. Mount plate to rear arm housing with two (2) cap screws and lock nuts. Grasp end of spring shaft. Push inward and pull outward on shaft to determine endplay in assembly.

**IMPORTANT:** All endplay must be removed from assembly to allow proper operation and ensure long life.

7. Loosen jam nut, 1/2 turn at a time, until all endplay in shaft is removed.
8. Remove two (2) cap screws and nuts securing plate to rear arm housing. Remove spring shaft assembly from housing.
9. Thread remaining jam nut onto end of spring shaft and, while retaining inner jam nut to prevent it from moving, torque outer jam nut from **22 to 28 ft-lb (30 to 37 N-m)** to lock adjustment.

10. Thoroughly pack spring with grease. Install spring shaft assembly into housing and secure plate with four (4) cap screws and lock nuts.

11. Thread rod end (item 8) with jam nut (item 9) into end of spring shaft. Do not tighten jam nut at this time.

12. If rod ends (item 31) were removed from damper (item 30), apply Loctite #271 (or equivalent) to damper shaft threads before installing rod ends. Secure damper to bellcrank and rear arm with cap screws and lock nuts. Torque fasteners from **270 to 330 in-lb (31 to 37 N-m)**.

13. If damper link was disassembled, adjust the length of the link from 5.295" to 5.445" (134.5 to 138.3 mm) (Fig. 9).

14. If damper springs (item 37) were removed, tighten lock nuts so that bushings (item 36) are free to rotate.

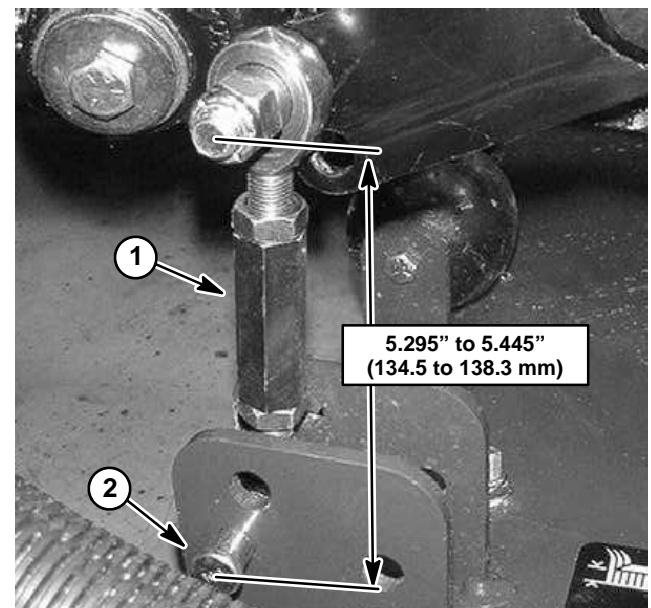


Figure 9

1. Damper link assembly      2. Clevis pin

### Rear Arm Installation (Fig. 8)

1. Position rear arm assembly to cutting deck and frame.
2. Slide pivot shaft through rear arm clevis and hub. Secure pivot shaft with lock washer and lock nut.
3. Connect damper link to cutting deck with clevis pin and hair pin (Fig. 9).
4. Position spacers on both sides of rod end of rear arm assembly. Secure rod end of rear arm assembly to deck mount with cap screw and lock nut.
5. Lubricate rear arm grease fittings.
6. Align cutting deck to traction unit as follows:
  - A. Make sure the machine is on a level, hard surface.
  - B. Place a square or straight edge against the deck weldment that contains the castor fork assembly (Fig. 10). Do not use the castor fork assembly itself.
  - C. Measure from the inset bead of the rim (not the outer edge of the rim) to the straight edge at two locations as indicated in Figure 10. Rim and paint irregularities make the rim outer edge an unreliable point of measure. These two measurements should be the same within a tolerance of 1/8" (3 mm).
  - D. Rotate spring shaft (item 12) in rear arm assembly until correct dimension is attained. Shaft should rotate freely inside the assembly. All adjustments must be made with the rod end of the rear arm bolted to the deck.
  - E. Raise and lower the deck and recheck dimensions for correct alignment.
  - F. When deck is properly aligned to traction unit, tighten rod end jam nut (item 9).

**NOTE:** Due to differences in turf conditions and the counterbalance setting of traction unit, it is advised that turf be cut and appearance checked before formal cutting is started. Refer to Operator's Manual for correcting cutting deck mismatch procedures.

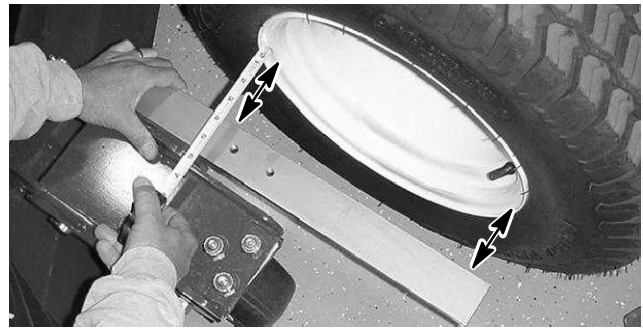


Figure 10

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## Lift Arm Joint Yoke

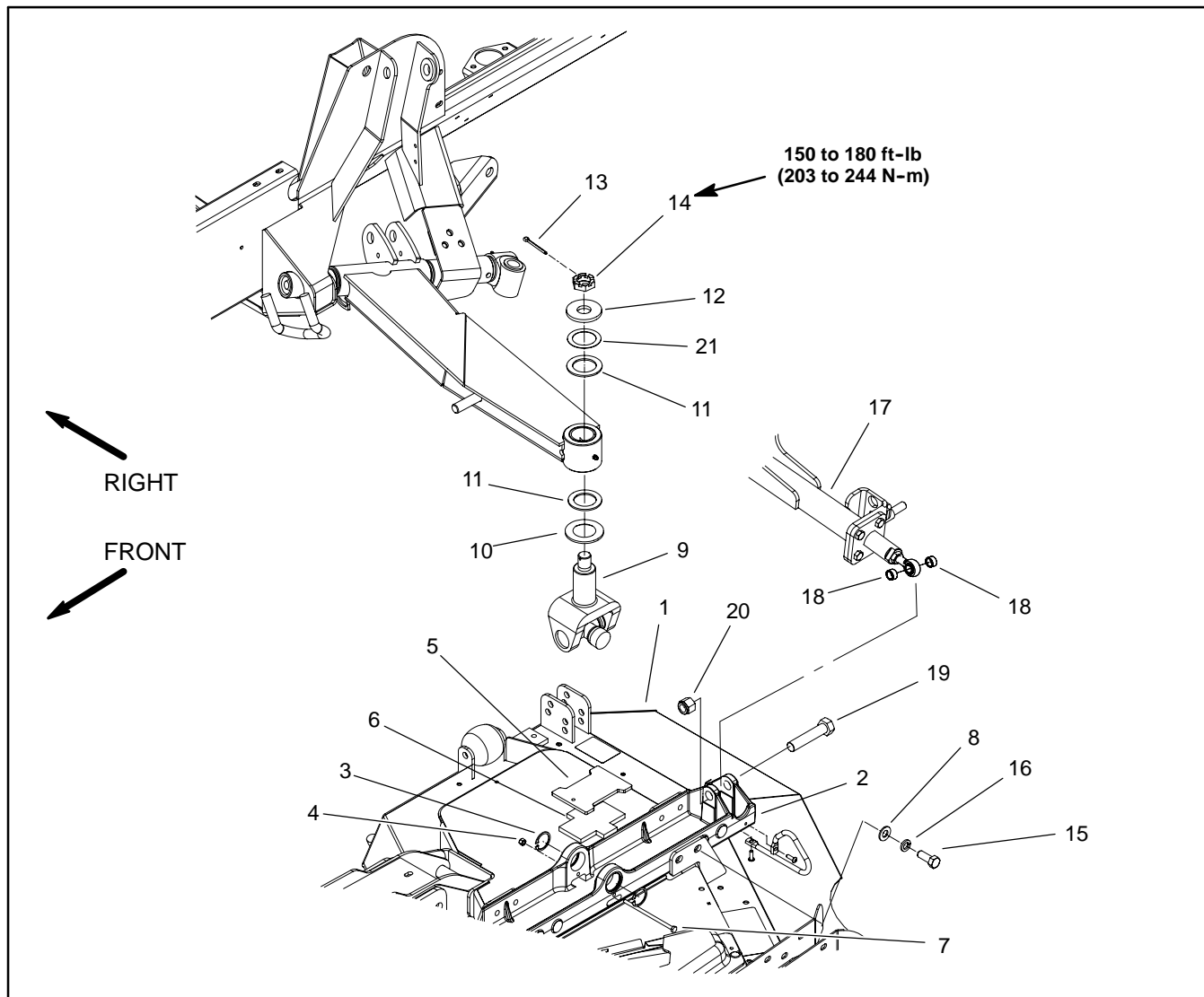


Figure 11

- |                                     |                                      |                                      |
|-------------------------------------|--------------------------------------|--------------------------------------|
| 1. Side cutting deck (LH shown)     | 8. Flat washer (8 used per mount)    | 15. Cap screw (8 used per mount)     |
| 2. Deck mount (LH shown)            | 9. Joint yoke                        | 16. Lock washer (8 used per mount)   |
| 3. Retaining ring (2 used per deck) | 10. Spacer                           | 17. Rear arm assembly                |
| 4. Lock nut                         | 11. Thrust washer (0.125" thickness) | 18. Spacer                           |
| 5. Plate                            | 12. Hardened washer                  | 19. Cap screw                        |
| 6. Rubber plate                     | 13. Cotter pin                       | 20. Lock nut                         |
| 7. Cap screw                        | 14. Slotted hex nut                  | 21. Thrust washer (0.032" thickness) |

### Removal (Fig. 11)

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

2. Remove cap screw (item 19) and lock nut (item 20) that secures rod end of rear arm assembly to cutting deck. Locate and remove spacer (item 18) from each side of rod end.

3. Remove eight (8) cap screws, lock washers and flat washers that secure deck mount to cutting deck (Fig. 12).

4. Remove cotter pin from joint yoke shaft. Make sure that deck mount is supported and remove slotted hex nut that secures joint yoke to lift arm. Take hardened washer (item 12) and thrust washers (items 21 and 11) from joint yoke shaft. Slowly raise lift arm enough to free joint yoke from lift arm. Remove thrust washer (item 11) and spacer (item 10) from yoke shaft.

5. Lift joint yoke and deck mount from lift arm and cutting deck.



## Joint Yoke Disassembly

1. Remove retaining rings from yoke and deck mount.

**IMPORTANT: Support yoke when removing cross and bearings to prevent yoke damage.**

2. Use a press to remove yoke from deck mount:
  - A. Place a small socket against one bearing in the deck mount and a large socket on the opposite side of the mount.
  - B. While supporting the large socket, apply pressure on small socket to partially push the opposite bearing into the large socket.
  - C. Remove assembly from press, grasp partially removed bearing and tap on yoke to completely remove the bearing.
  - D. Repeat process for remaining bearing.
  - E. Remove yoke from mount.
3. Use a press and the above process to remove bearings and cross from yoke.
4. Thoroughly clean and inspect all components.

## Joint Yoke Assembly

1. Make sure that rubber plate (item 6) and plate (item 5) are positioned in bottom of deck mount.
2. Apply a coating of grease to bearing bores of yoke and deck mount. Also, apply grease to bearings and seal of bearing assembly. Make sure that all bearing rollers are properly seated in bearing cage.
3. Use a press to install cross and bearings into yoke.

- A. Press one bearing partially into yoke.

**IMPORTANT: Take care when installing cross into bearing to avoid damaging bearing seal.**

- B. Carefully insert cross into bearing and yoke.
  - C. Hold cross in alignment and press bearing in until it hits the yoke.
  - D. Carefully place second bearing into yoke bore and onto cross shaft. Press bearing into yoke.
4. Use a press and the above process to install deck mount to yoke.

5. Install retaining rings to yoke and deck mount to secure bearings in place.

6. Make sure that assembled joint yoke moves without binding. Slight binding can usually be eliminated by lightly rapping the yoke lugs with a soft faced hammer. If binding continues, disassemble joint yoke and deck mount to identify and eliminate source of binding.

## Installation (Fig. 11)

1. Position joint yoke with deck mount to cutting deck.
2. Secure deck mount to deck with eight (8) cap screws, lock washers and flat washers (Fig. 12).
3. Place spacer washer (chamfered ID side down) and then thrust washer (item 11) onto joint yoke shaft. Insert yoke shaft up through lift arm bushings. Place additional thrust washers (items 11 and 21) and then hardened washer (item 12) on yoke shaft and secure with slotted hex nut. Torque nut from **150 to 180 ft-lb (203 to 244 N-m)** while aligning hole in shaft with slot in nut. Install cotter pin.
4. Position spacers on both sides of rod end of rear arm assembly. Secure rod end of rear arm assembly to deck mount with cap screw and lock nut.
5. Grease joint yoke and lift arm bushings after installation on machine.
6. After assembly is completed, raise and lower the cutting deck to verify that hydraulic hoses and fittings do not contact anything.

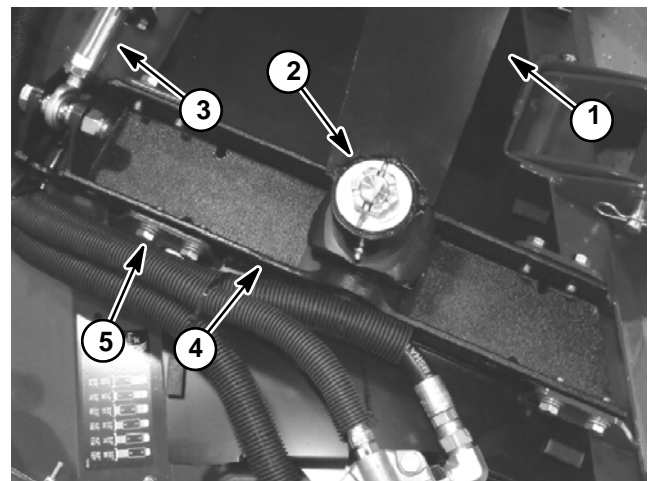


Figure 12

- |                        |                      |
|------------------------|----------------------|
| 1. Lift arm (RH shown) | 4. Deck mount        |
| 2. Joint yoke          | 5. Cap screw/washers |
| 3. Rear arm assembly   |                      |

## Console Arm

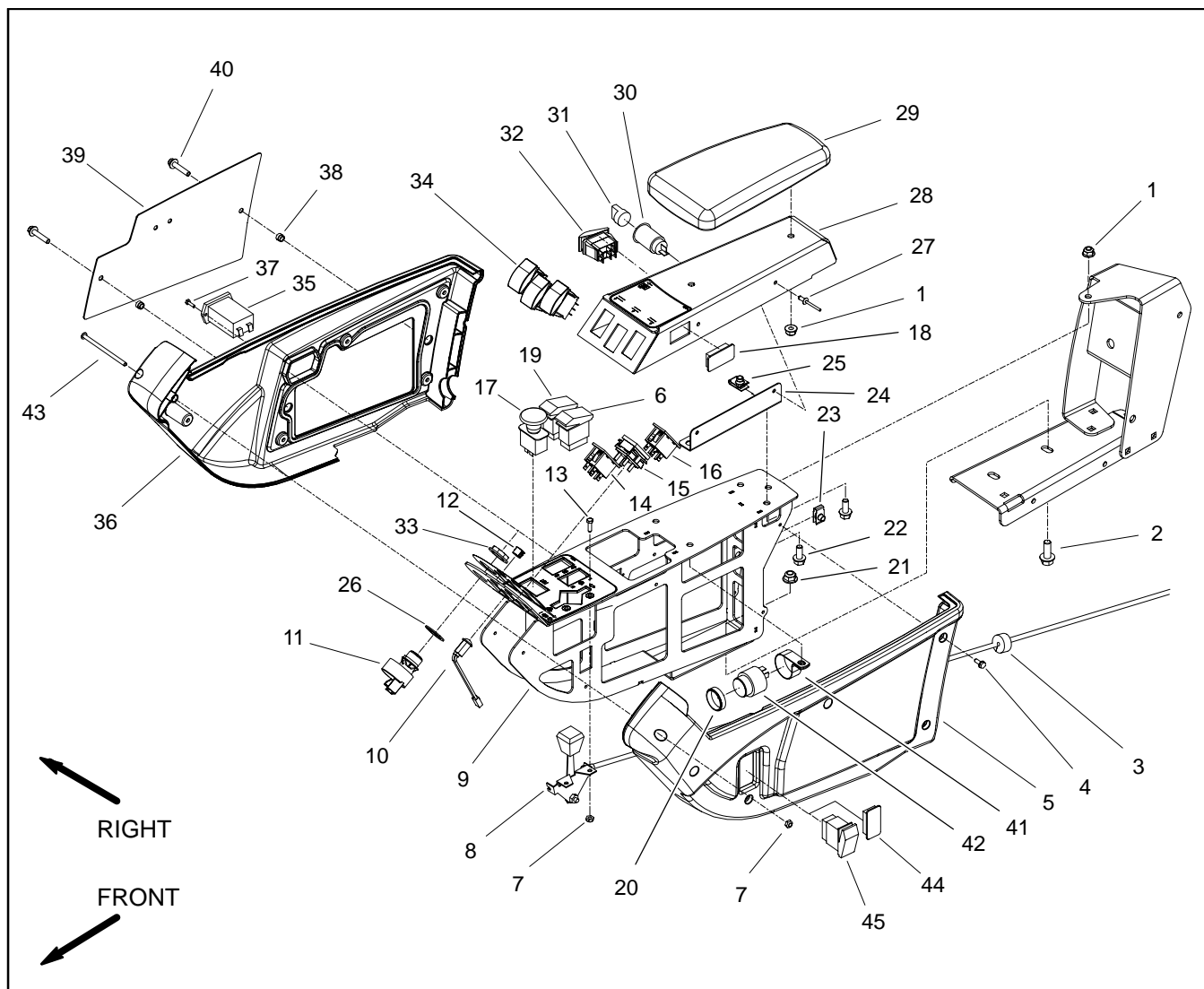


Figure 13

- |  |                                   |                                       |
|--|-----------------------------------|---------------------------------------|
| 1. Flange nut (3 used)                 | 16. Warning lamp (glow plug/temp) | 31. Cap                               |
| 2. Flange head screw (2 used)          | 17. PTO switch                    | 32. Engine cooling fan control switch |
| 3. Foam seal                           | 18. Hole plug                     | 33. Nut                               |
| 4. Washer head screw (10 used)         | 19. Flow divider switch           | 34. Lift/lower switch (3 used)        |
| 5. LH cover                            | 20. Nut                           | 35. Hour meter                        |
| 6. Hi-low speed switch                 | 21. Flange nut (2 used)           | 36. RH cover                          |
| 7. Lock nut (3 used)                   | 22. Flange head screw (5 used)    | 37. Cap screw (2 used)                |
| 8. Throttle control                    | 23. Clip (2 used)                 | 38. Spacer (2 used)                   |
| 9. Control arm                         | 24. Bracket                       | 39. Cover plate                       |
| 10. Diagnostic light                   | 25. U-nut (4 used)                | 40. Flange head screw (2 used)        |
| 11. Ignition switch                    | 26. Lock washer                   | 41. R-clamp                           |
| 12. Button plug                        | 27. Rivet (2 used)                | 42. Audio alarm                       |
| 13. Screw (2 used)                     | 28. Switch panel                  | 43. Screw                             |
| 14. Warning lamp (oil pressure/charge) | 29. Arm rest                      | 44. Hole plug (GM4000-D)              |
| 15. Temperature gauge                  | 30. Power point                   | 45. Headlight switch (GM4010-D)       |

### Disassembly (Fig. 13)

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

2. Remove two (2) flange head screws (item 40) and then cover plate (item 39) from outside of console arm. Locate and retrieve two (2) spacers (item 38).

3. At front of console arm, remove screw (item 43) and lock nut (item 7) 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 5) is removed from console arm, unplug wire harness connector from headlight switch if equipped.

6. Remove electrical components from console arm as needed using Figure 13 as a guide.

7. If necessary, remove console panel and supports from machine using Figures 13 and 14 as guides.

### Assembly (Fig. 13)

1. Install all removed electrical and console arm components using Figure 13 and 14 as guides.

2. Position covers to console arm. As LH cover (item 5) is placed, plug wire harness connector to headlight switch if equipped.

3. Secure each cover to console arm with five (5) washer head screws (item 4). Install screw (item 43) and lock nut (item 7) to secure covers at front of console arm.

4. Position cover plate and spacers to outside of console arm. Secure with two (2) flange head screws.

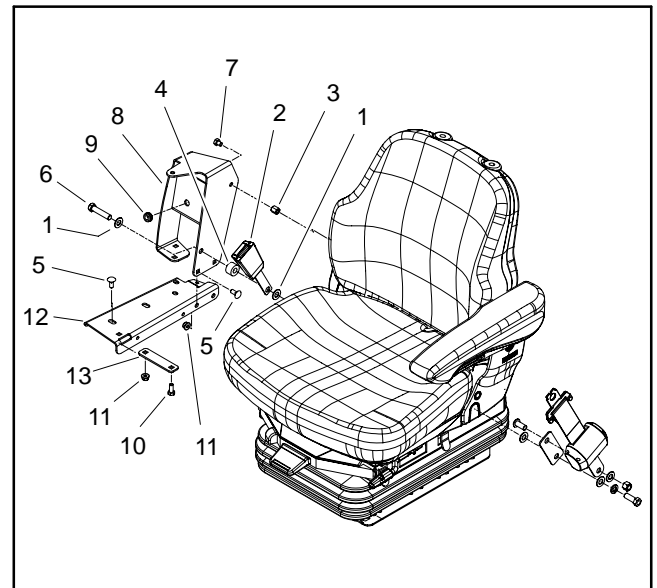


Figure 14

- |                            |                         |
|----------------------------|-------------------------|
| 1. Flat washer             | 8. Arm support          |
| 2. Seat belt buckle        | 9. Grommet              |
| 3. Coupling nut            | 10. Cap screw           |
| 4. Spacer                  | 11. Flange nut (5 used) |
| 5. Carriage screw (5 used) | 12. Support channel     |
| 6. Cap screw               | 13. Support bracket     |
| 7. Cap screw               |                         |

## Operator Seat

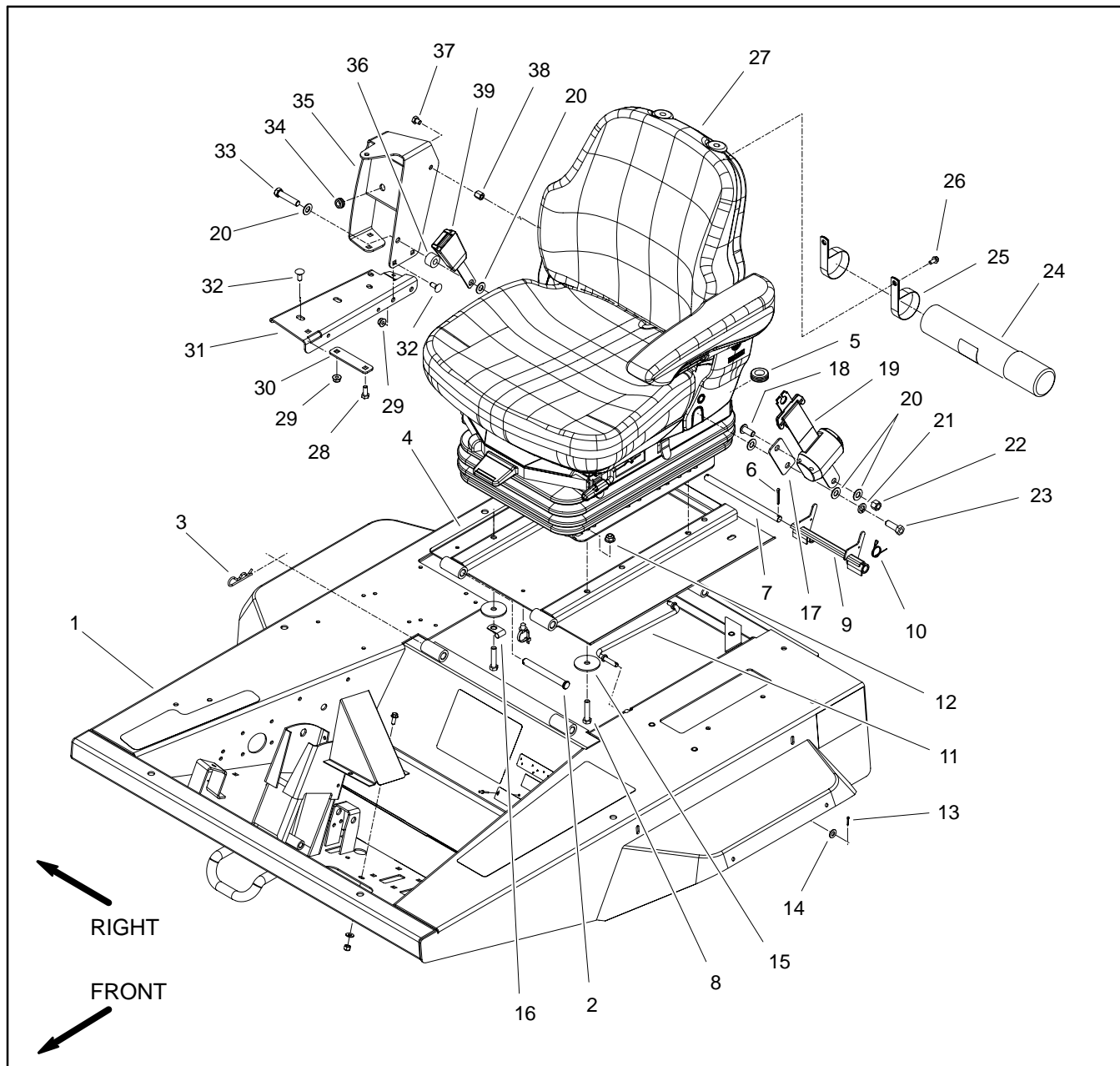


Figure 15

- |                         |                          |                                  |
|-------------------------|--------------------------|----------------------------------|
| 1. Platform             | 14. Flat washer (2 used) | 27. Seat and suspension assembly |
| 2. Clevis pin (2 used)  | 15. Flat washer (4 used) | 28. Cap screw                    |
| 3. Hair pin (2 used)    | 16. R-clamp (2 used)     | 29. Flange nut (5 used)          |
| 4. Seat plate           | 17. Seat belt mount      | 30. Support bracket              |
| 5. Grommet              | 18. Button head screw    | 31. Support channel              |
| 6. Cotter pin (2 used)  | 19. Seat belt            | 32. Carriage screw (5 used)      |
| 7. Latch shaft          | 20. Flat washer (5 used) | 33. Cap screw                    |
| 8. Cap screws (4 used)  | 21. Lock washer          | 34. Grommet                      |
| 9. Latch                | 22. Lock nut             | 35. Arm support                  |
| 10. Torsion spring      | 23. Cap screw            | 36. Spacer                       |
| 11. Prop rod            | 24. Manual tube          | 37. Cap screw                    |
| 12. Flange nut (4 used) | 25. R-clamp (2 used)     | 38. Coupler nut                  |
| 13. Cotter pin (2 used) | 26. Screw (2 used)       | 39. Seat belt latch              |

### Removal (Fig. 15)

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 (Fig. 16).
3. Support console arm assembly to prevent it from shifting.
4. Remove flange nut (item 29) and carriage screw (item 32) that secure support bracket (item 30) to support channel (item 31).
5. Remove cap screw (item 37) that secures console arm support (item 35) to coupler nut (item 38).
6. Remove cap screw (item 33), flat washers (item 20), spacer (item 36) and seat belt latch (item 39) from seat and console arm support (item 35).

**IMPORTANT: Make sure to not damage the electrical harness, control cable 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. 17). 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.

**NOTE:** Refer to Operator Seat Suspension in this section if seat suspension service is necessary.

### Installation (Fig. 15)

1. Carefully position seat to seat suspension.
2. Secure seat to seat suspension with four (4) torx head screws (Fig. 17). 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, control cable 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 30) and support channel (item 31) with flange nut (item 29) and carriage screw (item 32).

B. Secure console arm support (item 35) to coupler nut (item 38) with cap screw (item 37).

C. Place flat washer (item 20), seat belt latch (item 39) and spacer (item 36) between seat and console arm support (item 35). Secure with cap screw (item 33) and second flat washer (item 20).

D. Fully tighten all fasteners to secure console arm assembly to seat.

4. Connect seat electrical connector to machine wire harness (Fig. 16).

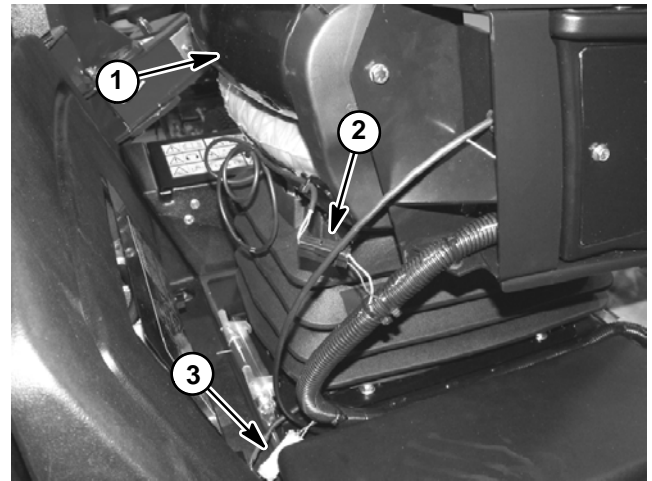


Figure 16

- |                          |                         |
|--------------------------|-------------------------|
| 1. Operator seat         | 3. Suspension connector |
| 2. Seat switch connector |                         |

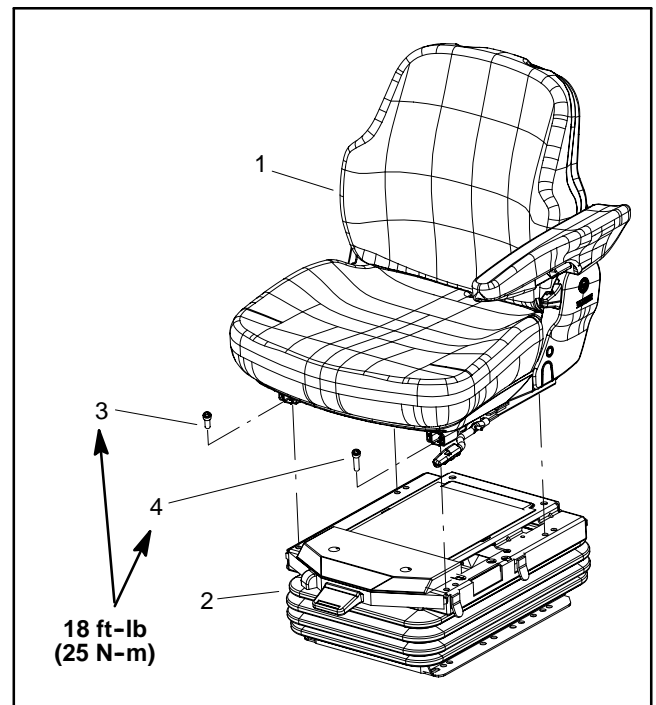


Figure 17

- |                        |                           |
|------------------------|---------------------------|
| 1. Seat                | 3. Screw (M8x12) (3 used) |
| 2. Suspension assembly | 4. Screw (M8x16)          |

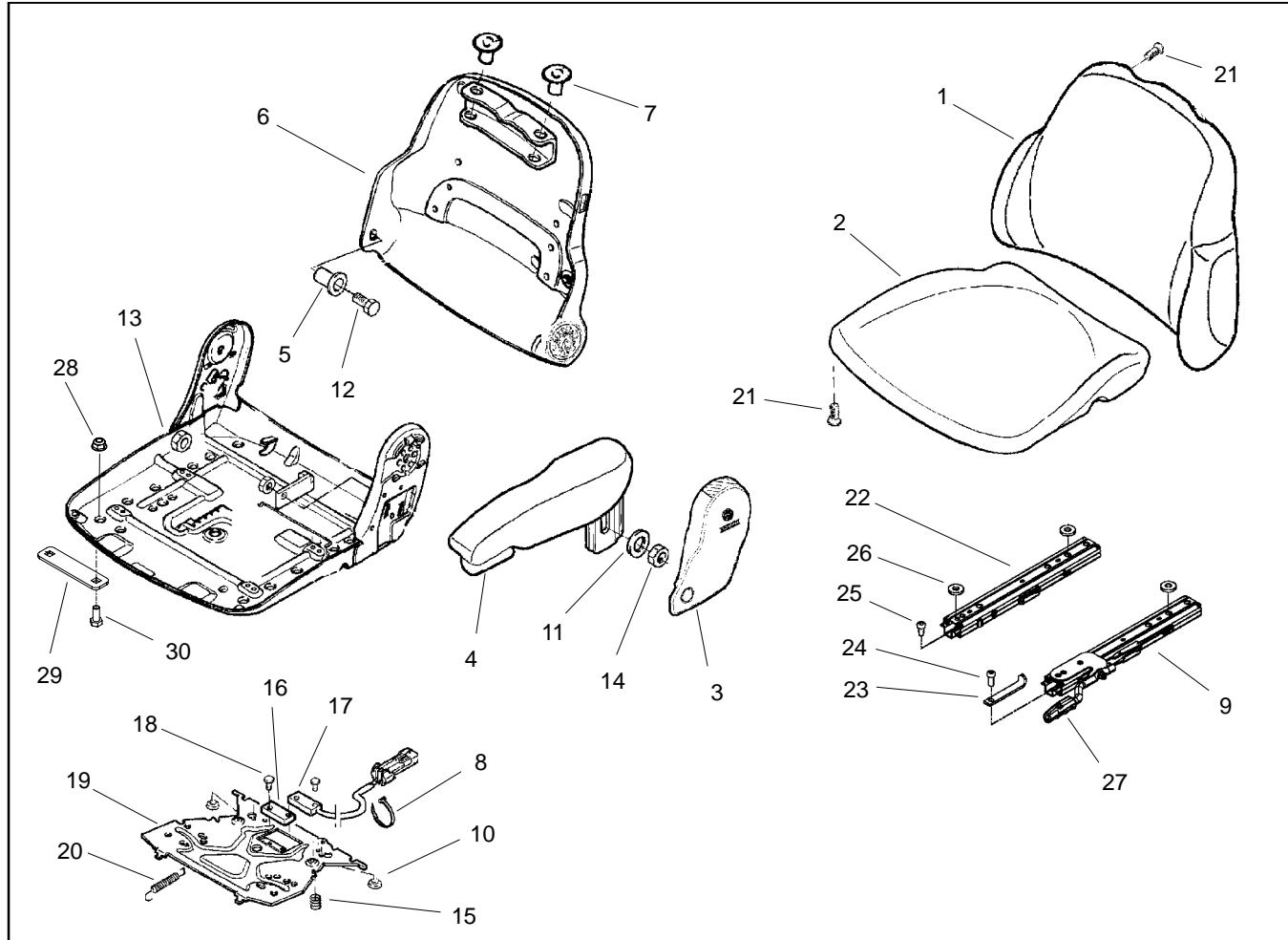


Figure 18

- |                       |                        |                         |
|-----------------------|------------------------|-------------------------|
| 1. Backrest cushion   | 11. Washer             | 21. Torx screw (5 used) |
| 2. Seat cushion       | 12. Cap screw (2 used) | 22. RH adjustment rail  |
| 3. Armrest cover      | 13. Seat               | 23. Rail stop           |
| 4. LH armrest         | 14. Nut                | 24. Torx screw          |
| 5. Bushing (2 used)   | 15. Spring (2 used)    | 25. Torx screw (3 used) |
| 6. Backrest           | 16. Magnet             | 26. Washer (3 used)     |
| 7. Plug (2 used)      | 17. Seat switch        | 27. Handle              |
| 8. Cable tie (3 used) | 18. Rivet (4 used)     | 28. Nut                 |
| 9. LH adjustment rail | 19. Mounting plate     | 29. Support bracket     |
| 10. Bumper (2 used)   | 20. Return spring      | 30. Cap screw           |

### Disassembly (Fig. 18)

1. Disassemble operator seat as necessary using Figures 18 and 19 as guides.

### Assembly (Fig. 18)

1. Assemble operator seat using Figures 18 and 19 as guides.

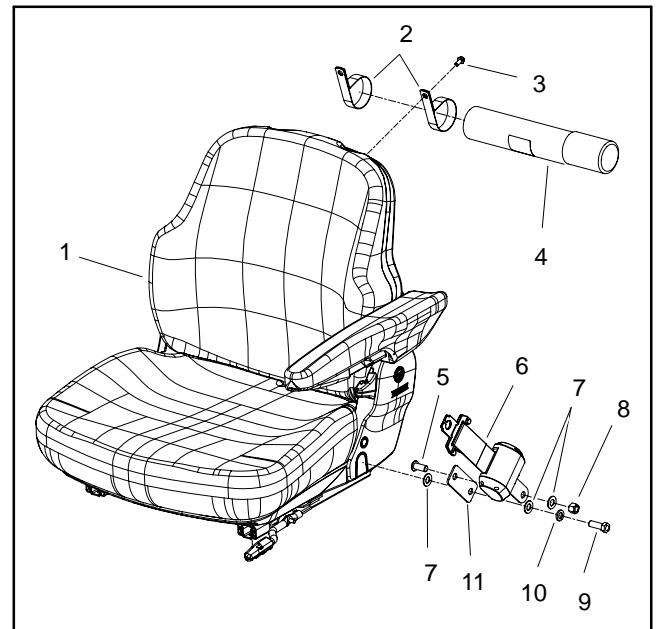


Figure 19

- |                      |                     |
|----------------------|---------------------|
| 1. Operator seat     | 7. Flat washer      |
| 2. R-clamp           | 8. Lock nut         |
| 3. Screw             | 9. Cap screw        |
| 4. Manual tube       | 10. Lock washer     |
| 5. Button head screw | 11. Seat belt mount |
| 6. Seat belt         |                     |

## Operator Seat Suspension

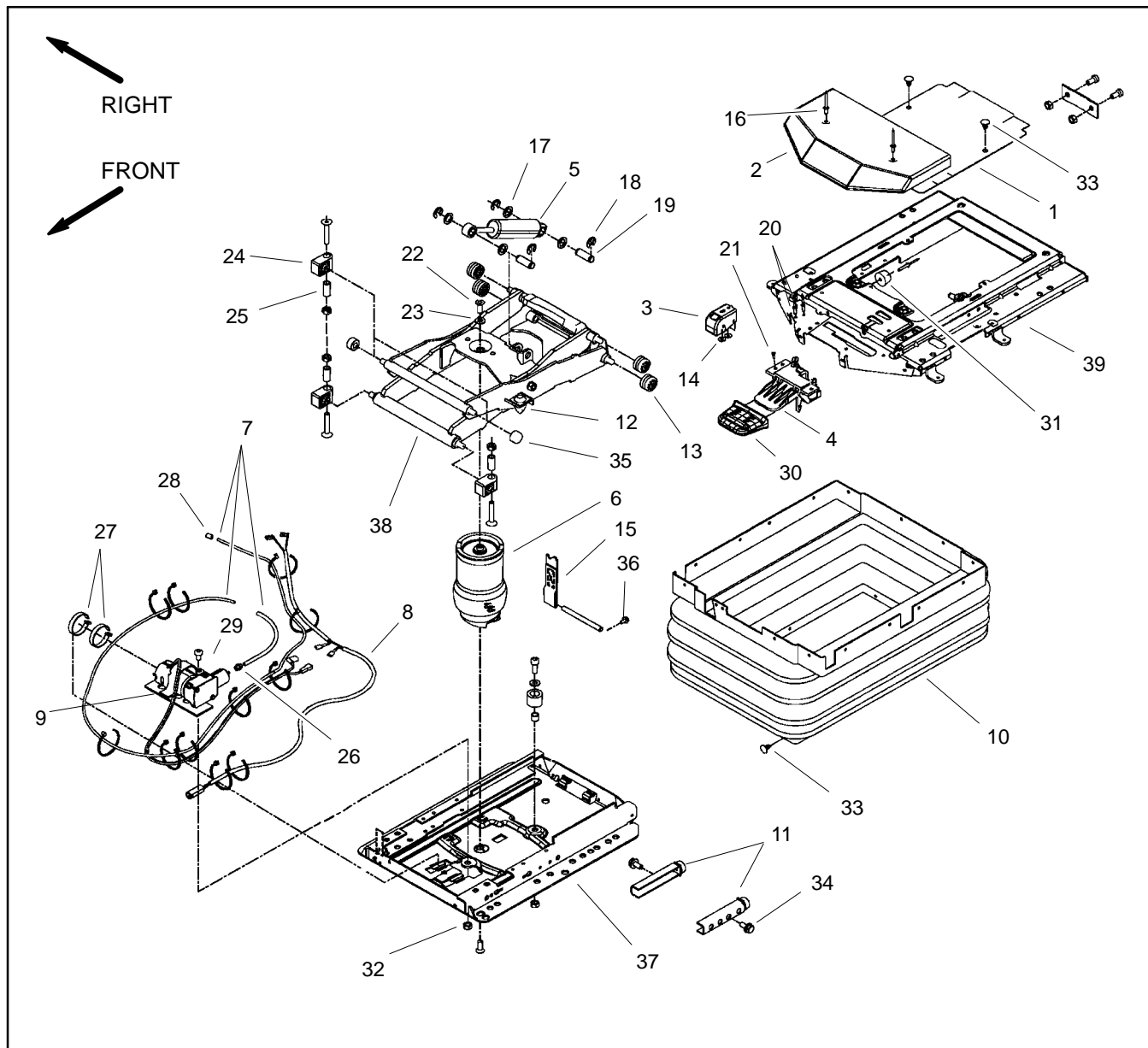


Figure 20

- |                         |                              |                            |
|-------------------------|------------------------------|----------------------------|
| 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 frame platform. If the air spring assembly (item 6) requires removal, the seat suspension base will have to be removed from the seat platform.

### Disassembly (Fig. 20)

1. Remove operator seat from seat suspension (see Operator Seat Removal in this section).
2. Disconnect seat suspension connector from machine wire harness (Fig. 21).
3. If the air spring assembly (item 6) or base plate (item 37) requires removal, remove seat suspension from seat plate (Fig. 22):

A. Raise and support seat plate assembly. Support seat suspension to prevent it from falling.

B. Remove four (4) cap screws, flat washers and flange nuts that secure seat suspension to seat plate.

C. Remove seat suspension from machine.

4. 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 plate, secure suspension to seat plate (Fig. 22):

A. Position seat suspension onto seat plate.

B. Secure seat suspension to seat plate with four (4) cap screws, flat washers and flange nuts.

C. Lower and secure seat plate assembly.

3. Install operator seat to seat suspension (see Operator Seat Installation in this section).

4. Make sure that seat electrical connectors are connected to machine wire harness (Fig. 21).

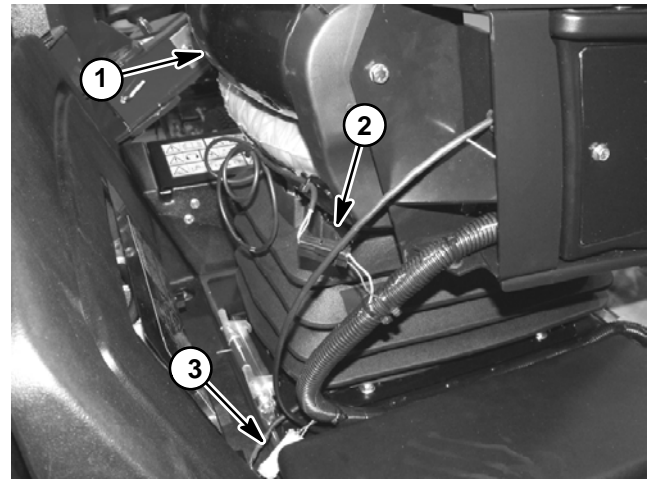


Figure 21

- |                          |                         |
|--------------------------|-------------------------|
| 1. Operator seat         | 3. Suspension connector |
| 2. Seat switch connector |                         |

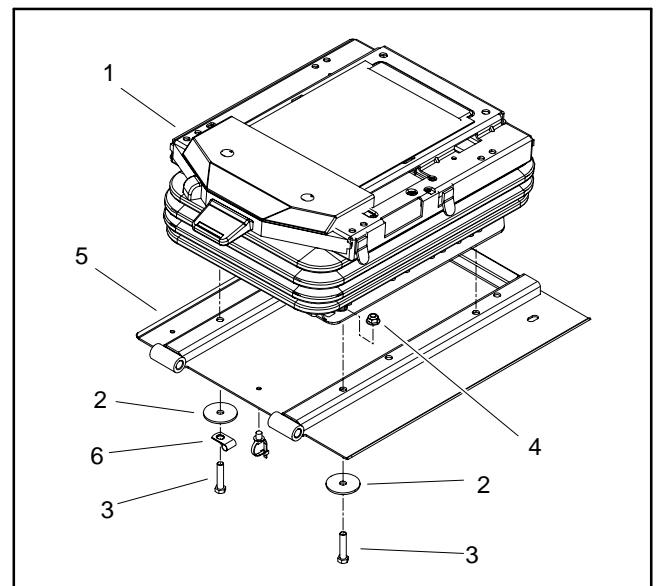


Figure 22

- |                         |                        |
|-------------------------|------------------------|
| 1. Seat suspension      | 4. Flange nut (4 used) |
| 2. Flat washer (4 used) | 5. Seat plate          |
| 3. Cap screw (4 used)   | 6. R-clamp             |

## Hood

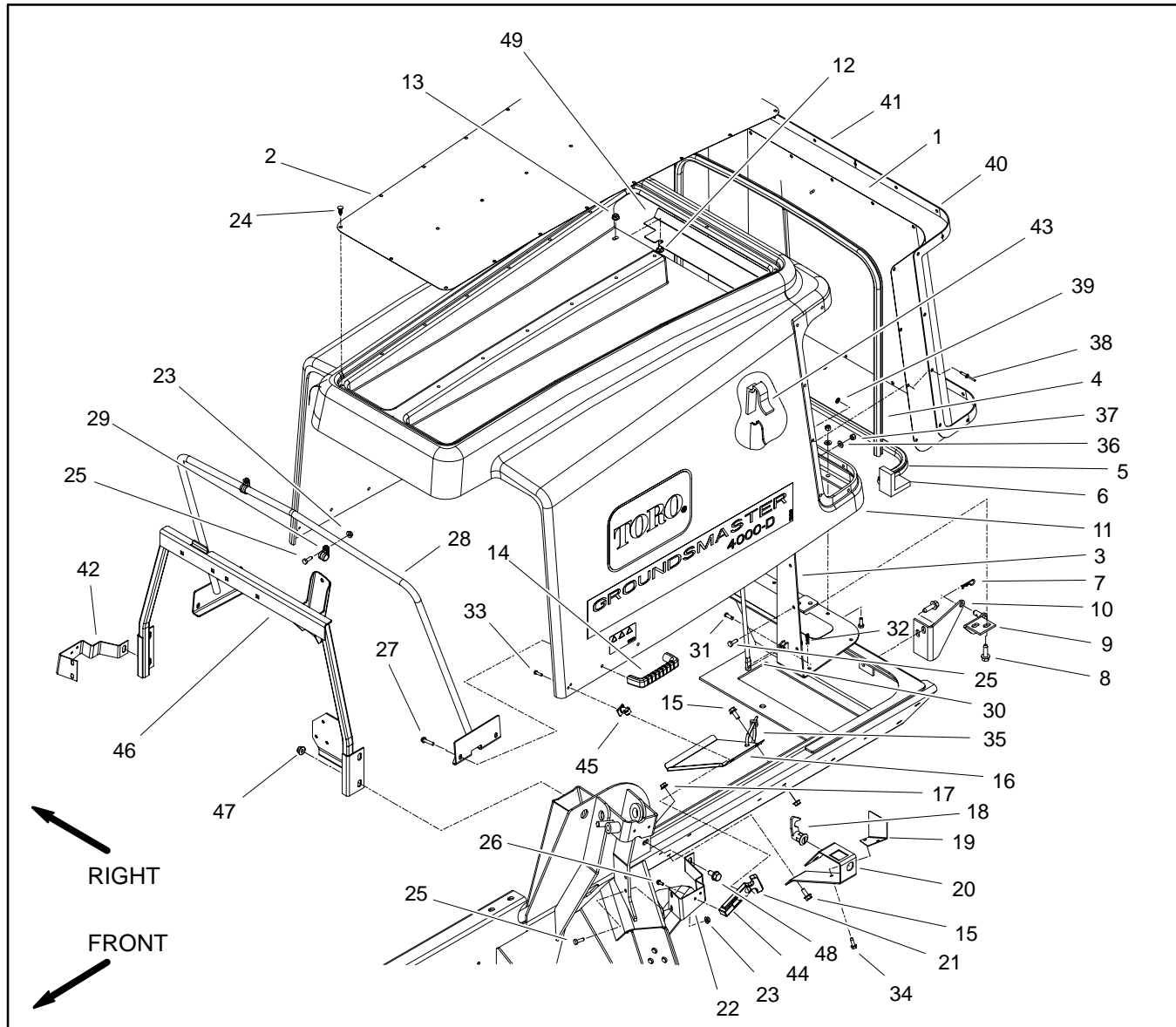


Figure 23

- |                                |                                  |                                |
|--------------------------------|----------------------------------|--------------------------------|
| 1. Rear screen                 | 18. Latch                        | 34. Washer head screw (2 used) |
| 2. Top screen                  | 19. Latch cover                  | 35. Cable tie                  |
| 3. Screen assembly             | 20. Hood latch bracket           | 36. Flat washer (20 used)      |
| 4. Bulb seal                   | 21. Flexible draw latch (2 used) | 37. Lock nut (20 used)         |
| 5. Bulb seal                   | 22. LH latch bracket             | 38. Pop rivet (22 used)        |
| 6. Corner screen seal (2 used) | 23. Flange nut (6 used)          | 39. Flat washer (22 used)      |
| 7. Hair pin (2 used)           | 24. Plastic plug (24 used)       | 40. RH screen mount            |
| 8. Screw (8 used)              | 25. Cap screw (26 used)          | 41. LH screen mount            |
| 9. Screen pivot (2 used)       | 26. Taptite screw (4 used)       | 42. RH latch bracket           |
| 10. Hood pivot (2 used)        | 27. Plastite screw (4 used)      | 43. Foam seal (2 used)         |
| 11. Hood                       | 28. Hood support                 | 44. Latch bracket (2 used)     |
| 12. Carriage bolt (2 used)     | 29. R-clamp (2 used)             | 45. Latch keeper (2 used)      |
| 13. Flange nut (2 used)        | 30. Hood rod (2 used)            | 46. Tank support               |
| 14. Door handle (2 used)       | 31. Clevis pin (2 used)          | 47. Flange nut (4 used)        |
| 15. Flange head screw (4 used) | 32. Hair pin (2 used)            | 48. Flange head screw (4 used) |
| 16. Oil filter deflector       | 33. Screw (2 used)               | 49. Hood shield                |
| 17. Flange nut (4 used)        |                                  |                                |

## Removal

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.
2. Remove hood using Figure 23 as a guide.

## Installation

1. Install hood using Figure 23 as a guide.
2. Align hood to machine to allow correct operation of hood latch and dust seals:
  - A. Place shim that is from 3/8" to 7/16" (9.5 to 11.1 mm) thick on top of frame (both RH and LH sides) near the sides of oil cooler (Figs. 24 and 25).
  - B. Close hood so that it rests on shims and fasten the hood latches.
  - C. Loosen hood pivots at frame to adjust vertical placement of pivots. Re-tighten hood pivot fasteners.
  - D. Loosen screen pivots to allow hood latches to pull hood against radiator support. Re-tighten screen pivot fasteners.
3. After hood is assembled to machine, check for the following:
  - A. Check that bulb and foam seals are equally compressed at all contact points with hood.
  - B. Hood should open and close without contacting oil cooler hardware.

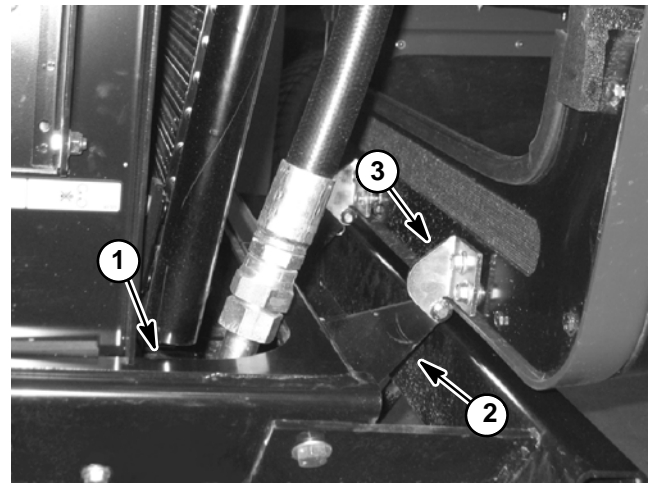


Figure 24

- |                     |                    |
|---------------------|--------------------|
| 1. LH shim location | 3. LH screen pivot |
| 2. LH hood pivot    |                    |

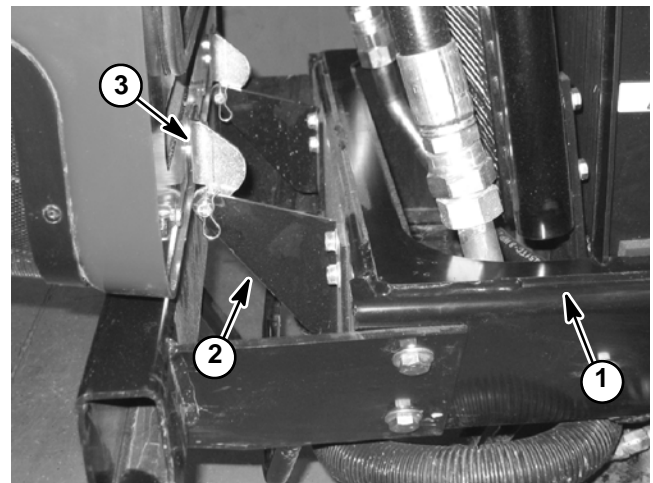


Figure 25

- |                     |                    |
|---------------------|--------------------|
| 1. RH shim location | 3. RH screen pivot |
| 2. RH hood pivot    |                    |

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# Specifications



**MOUNTING:** Cutting decks are supported by lift arms controlled with individual lift switches.

**CONSTRUCTION:** Deck chamber is welded 12 gauge steel construction reinforced with channels and plates.

**HEIGHT-OF-CUT RANGE:** 1" to 5" (25.4 mm to 127 mm) in 1/2" (12.7 mm) increments. Front deck height-of-cut adjustment is achieved by changing spacers on castor wheels and adjusting length of deck support chains. Side deck adjustment requires adding or removing spacers from the castor forks, re-positioning the castor wheel axles in the castor forks and securing the pivot arms to the correct height-of-cut bracket holes.

**DECK DRIVE:** Closed loop hydraulic system operates hydraulic motor on each cutting deck. The motor drives one spindle directly with remaining deck spindle(s) driven by B section kevlar v-belt(s). Blade spindles are 1.250" (31.7 mm) shafts supported by greaseable, tapered roller bearings.

**CUTTING BLADE:** Cutting blade dimensions are 21.750" (552 mm) long, 2.500" (64 mm) wide and 0.250" (6.4 mm) thick. Anti-scalp cup installed on each cutting blade. Three (3) blades on front deck and two (2) blades on each side deck.

**WIDTH OF CUT:** Front deck provides 62" (1575 mm) width of cut. Each side deck has 42" (1067 mm) width of cut. Total width of cut is 132" (3353 mm) with 7" (128 mm) overlap.

**DISCHARGE:** Clippings are discharged from the rear of the cutting decks. Provided mounting holes allow attachment of optional Guardian Recycler Kit.

**SUSPENSION SYSTEM:** A fully floating suspension with hydraulic counterbalance. Front deck suspended at rear from lift arms and has two (2) castor wheels, two (2) adjustable skids and two (2) anti-scalp rollers. Each side deck supported by three (3) castor wheels and a spring damper system which connects the fourth deck corner to the traction unit. There is a main lift arm that provides counterbalance to the side decks along with a rear anti-rotation link which also provides bi-directional impact protection. Optional Guardian Recycler Kit includes one anti-scalp roller on each cutting deck.

# General Information



## CAUTION

Never install or work on the cutting decks or lift arms with the engine running. Always stop engine and remove key first.

---

## 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 and adjusting the cutting decks on your Groundsmaster.

---

## Castor Wheel Tire Pressure

Castor tires on the front and side decks should be inflated to 50 PSI (345 kPa).

---

## Blade Stopping Time

The blades of the cutting deck are to come to a complete stop in approximately five (5) seconds after the cutting deck engagement switch is shut down.

**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 deck at least twenty (20) feet and watch

the blades on one of the cutting decks. Have the operator shut the cutting decks down and record the time it takes for the blades to come to a complete stop. If this time is greater than seven (7) seconds, the braking valve on the hydraulic manifold may need adjustment.

# 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, uneven ground conditions, “sponginess” or attempting to cut off too much grass height may not always be overcome by adjusting the machine.

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

---

## Factors That Can Affect Quality of Cut

Factor	Possible Problem/Correction
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 including castor tires. Adjust to pressures specified in 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. Set decks as specified in the Operator's Manual.
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 and castor wheel condition.	All rollers and caster wheels should rotate freely. Replace bearings if worn or damaged.
9. Grass conditions.	Mow when grass is dry for best cutting results. Also, remove only 1" (25 mm) or 1/3 of the grass blade when cutting.



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# 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.

### Front Cutting Deck

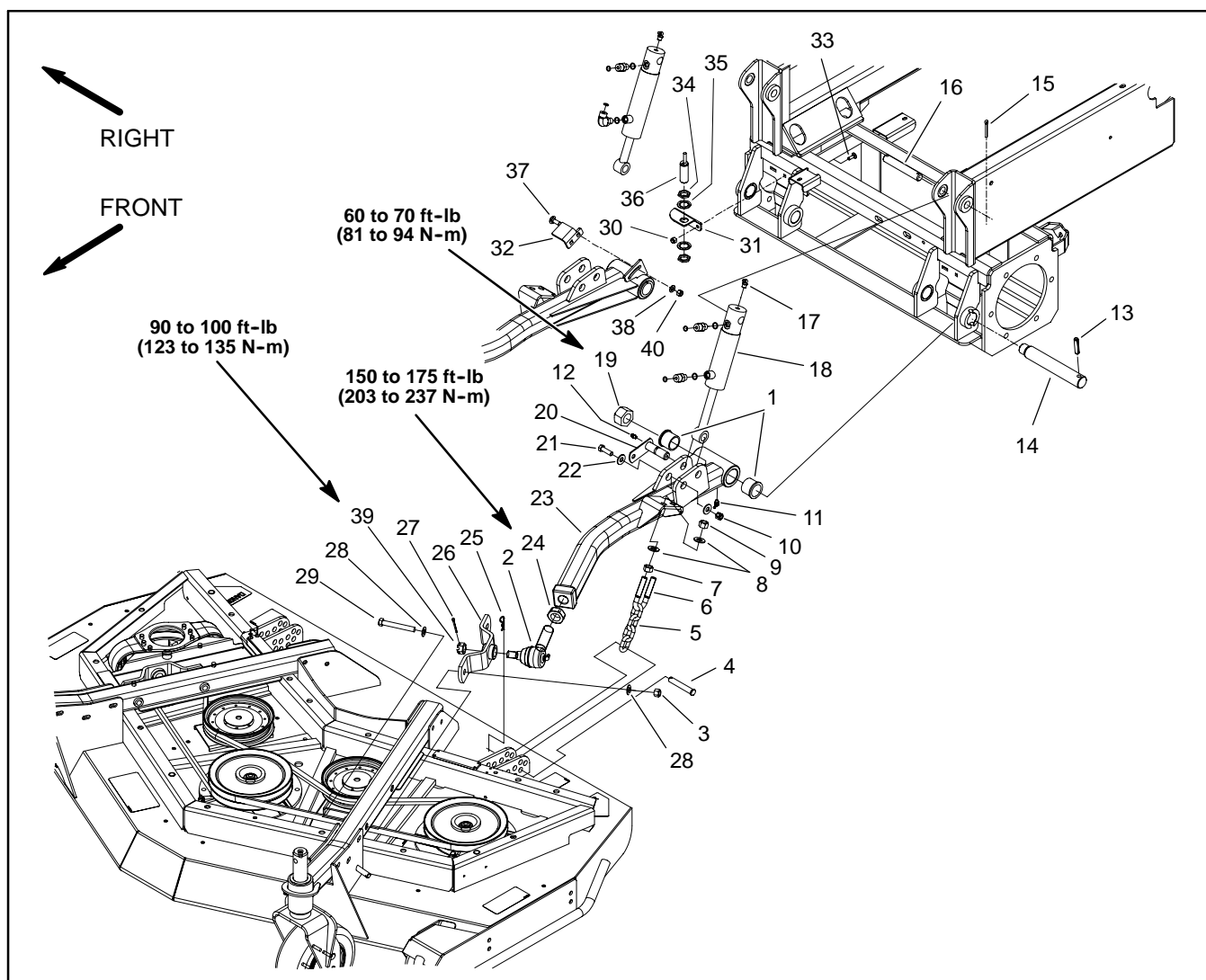


Figure 1

- |                               |                             |                             |
|-------------------------------|-----------------------------|-----------------------------|
| 1. Flange bushing             | 15. Cotter pin              | 28. Washer (4 per mount)    |
| 2. Ball joint                 | 16. Upper lift cylinder pin | 29. Cap screw (2 per mount) |
| 3. Lock nut (2 per mount)     | 17. Grease fitting          | 30. Lock nut (2 used)       |
| 4. Clevis pin                 | 18. Lift cylinder           | 31. Switch mount            |
| 5. Height-of-cut chain        | 19. Lock nut                | 32. Sensing plate           |
| 6. U-bolt                     | 20. Pin                     | 33. Carriage screw (2 used) |
| 7. Hex nut (2 per u-bolt)     | 21. Cap screw               | 34. Jam nut (2 per switch)  |
| 8. Flat washer (4 per u-bolt) | 22. Flat washer (2 per pin) | 35. Washer (2 per switch)   |
| 9. Lock nut (2 per u-bolt)    | 23. Lift arm (LH shown)     | 36. Proximity switch        |
| 10. Lock nut                  | 24. Jam nut                 | 37. Carriage screw (2 used) |
| 11. Grease fitting (45°)      | 25. Hair pin                | 38. Flat washer (2 used)    |
| 12. Grease fitting            | 26. Ball joint mount        | 39. Slotted hex nut         |
| 13. Slotted roll pin          | 27. Cotter pin              | 40. Lock nut (2 used)       |
| 14. Lift arm pin              |                             |                             |

### Removal (Fig. 1)

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

**NOTE:** Removal of clevis pin from deck and height-of-cut chain is easier if deck is lifted slightly.

2. Remove hairpin and clevis pin that secure the height-of-cut chain to the rear of the cutting deck (Fig. 2).

3. Remove hydraulic motor from cutting deck (see Cutting Deck Motor Removal in the Service and Repairs Section of Chapter 4 – Hydraulic System).

4. Remove cap screws, washers and lock nuts securing ball joint mounts to front deck castor arms (Fig. 4).

5. Slide the cutting deck away from the traction unit.

### Installation (Fig. 1)

1. Position machine on a clean, level surface. Lower lift arms, stop engine, apply parking brake and remove key from the ignition switch.

2. Position the front deck to the lift arms.

3. Align ball joint mounts to front deck castor arms and secure with cap screws, washers and lock nuts (Fig. 4).

**NOTE:** Installation of clevis pin to deck and height-of-cut chain is easier if deck is lifted slightly.

4. Install clevis pin and hairpin that secure the height-of-cut chain to the rear of the cutting deck (Fig. 2).

5. Install hydraulic motor to cutting deck (see Cutting Deck Motor Installation in the Service and Repairs Section of Chapter 4 – Hydraulic System).

6. Lubricate grease fittings on cutting deck and lift arm assemblies.

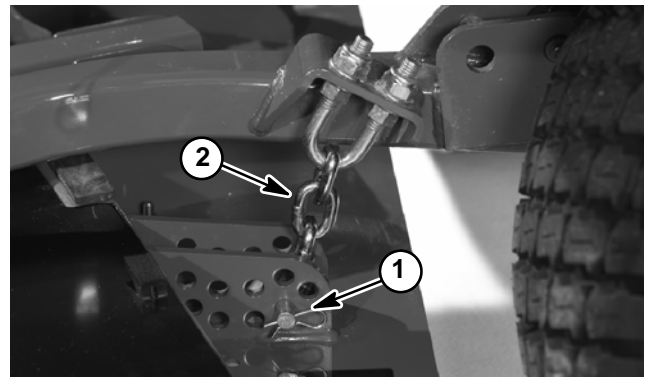


Figure 2

1. Hairpin and clevis pin      2. Height-of-cut chain

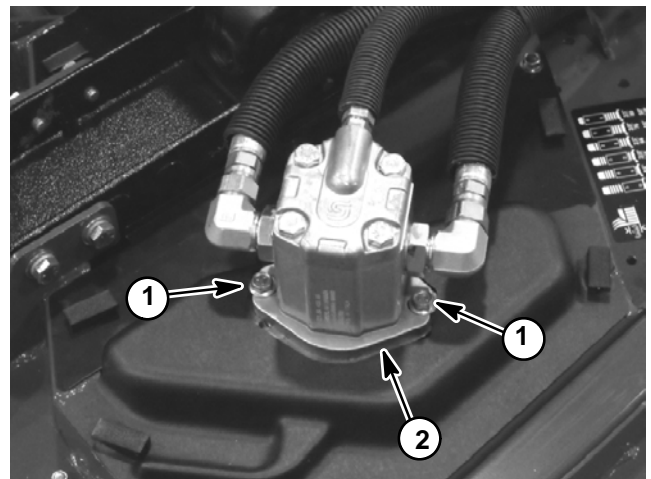


Figure 3

1. Flange head screw      2. Hydraulic motor

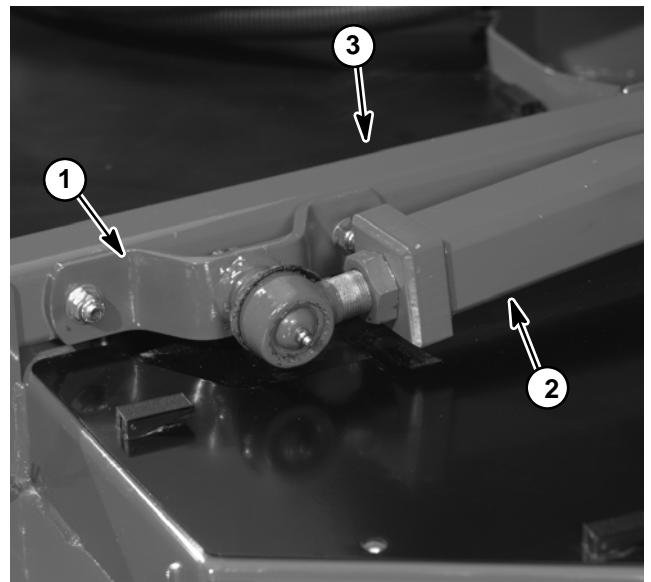


Figure 4

1. Ball joint mount      3. Castor arm  
2. Lift arm

## Side Cutting Deck

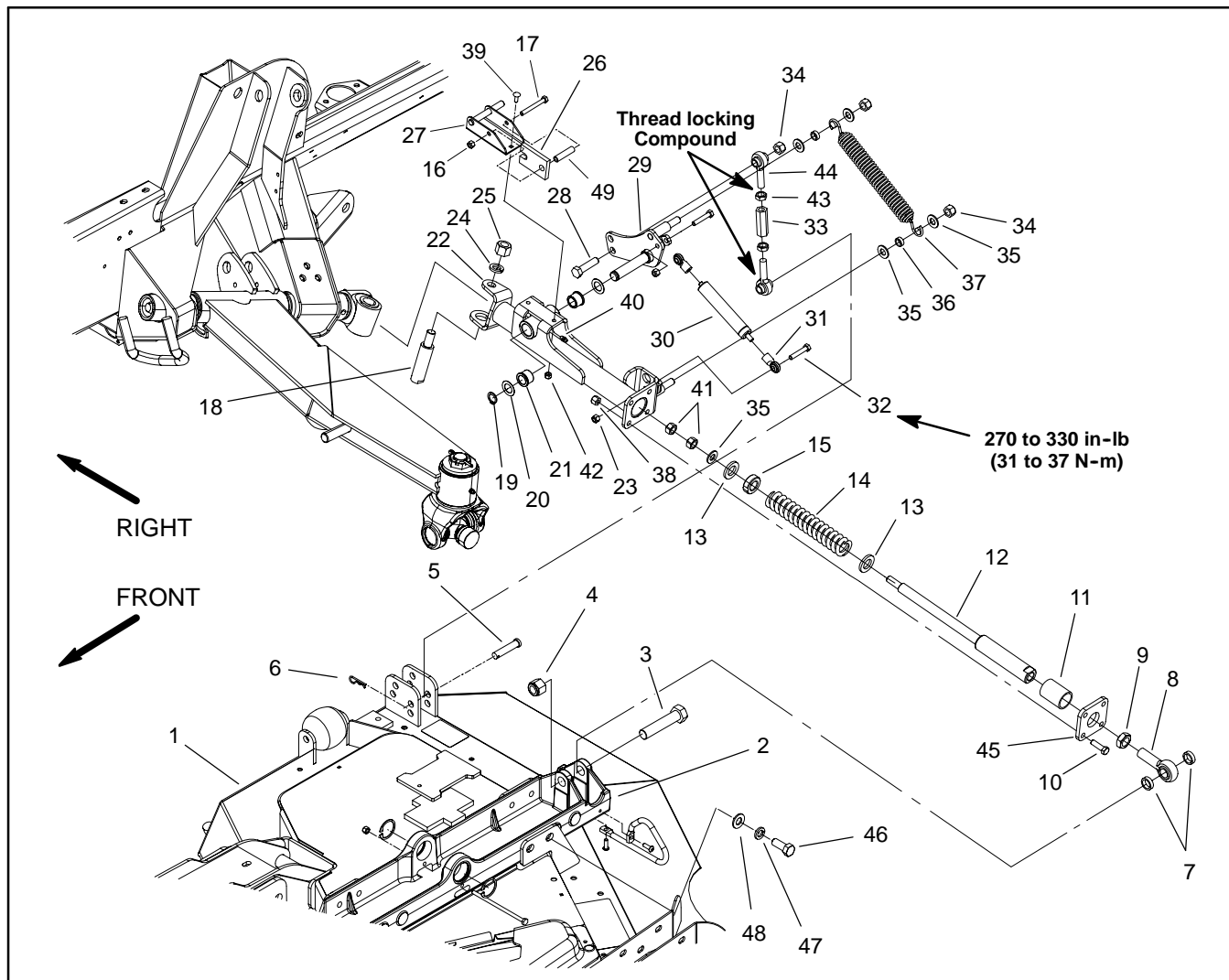


Figure 5

- |                            |                                   |                                    |
|----------------------------|-----------------------------------|------------------------------------|
| 1. Cutting deck (LH shown) | 18. Pivot shaft                   | 34. Lock nut (2 per spring)        |
| 2. Deck mount (LH shown)   | 19. Retaining ring                | 35. Flat washer (4 per spring)     |
| 3. Cap screw               | 20. Thrust washer (2 per arm)     | 36. Bushing (2 per spring)         |
| 4. Lock nut                | 21. Flange bushing (2 per arm)    | 37. Damper spring                  |
| 5. Clevis pin              | 22. Rear arm (LH shown)           | 38. Lock nut (4 per arm)           |
| 6. Hair pin                | 23. Lock nut (2 per damper)       | 39. Carriage screw (2 per arm)     |
| 7. Spacer                  | 24. Lock washer                   | 40. Grease fitting                 |
| 8. Rod end                 | 25. Lock nut                      | 41. Jam nut                        |
| 9. Jam nut                 | 26. Bumper pad (5 per arm)        | 42. Lock nut (2 per arm)           |
| 10. Cap screw (4 per arm)  | 27. Bumper mount                  | 43. Jam nut (2 per arm)            |
| 11. Straight bushing       | 28. Cap screw                     | 44. Rod end (2 per arm)            |
| 12. Spring shaft           | 29. Bell crank (LH shown)         | 45. Plate                          |
| 13. Flat washer            | 30. Damper                        | 46. Cap screw (8 used per mount)   |
| 14. Compression spring     | 31. Damper rod end (2 per damper) | 47. Lock washer (8 used per mount) |
| 15. Plastic bearing        | 32. Cap screw (2 per damper)      | 48. Flat washer (8 used per mount) |
| 16. Lock nut               | 33. Link tube                     | 49. Spacer                         |
| 17. Cap screw              |                                   |                                    |

### Removal (Fig. 5)

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

2. Remove hydraulic motor from cutting deck (see Cutting Deck Motor Removal in the Service and Repairs Section of Chapter 4 - Hydraulic System).

**IMPORTANT: Do not change the length of the damper link (Fig. 8).**

3. Remove hairpin and clevis pin that secure the damper link to the rear of the cutting deck (Fig. 8).

4. Remove eight (8) cap screws, lock washers and flat washers that secure deck mount to cutting deck (Fig. 6).

5. Raise lift arm enough to separate deck mount from cutting deck (Fig. 7).

6. Slide the cutting deck away from the traction unit.

### Installation (Fig. 5)

1. Position machine on a clean, level surface. Stop engine, apply parking brake and remove key from the ignition switch.

2. Position the side cutting deck to the lift arm and deck mount.

3. Lower lift arm while aligning deck mount to cutting deck.

4. Install deck mount to cutting deck with (8) cap screws, lock washers and flat washers (Fig. 6). Tighten fasteners.

**IMPORTANT: The length of the damper link should be from 5.295" to 5.445" (134 to 138 mm) measured between rod end centers.**

5. Install clevis pin and hairpin that secure the damper link to the rear of the cutting deck (Fig. 8).

6. Install hydraulic motor to cutting deck (see Cutting Deck Motor Installation in the Service and Repairs Section of Chapter 4 - Hydraulic System).

7. Lubricate grease fittings on cutting deck and lift arm assembly.

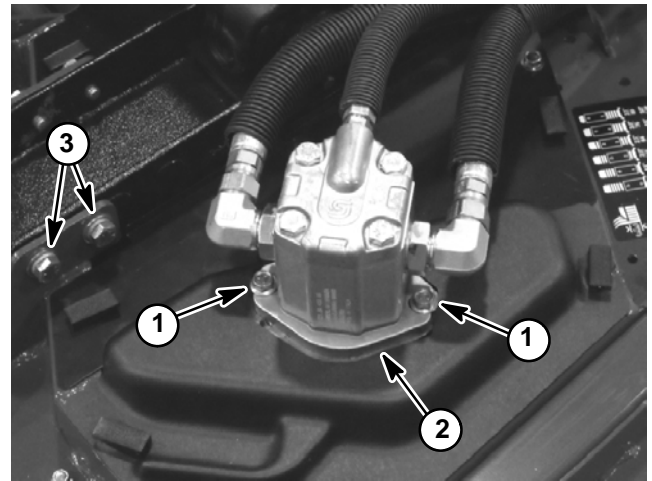


Figure 6

- 1. Flange head screw
- 2. Hydraulic motor
- 3. Deck mount screw

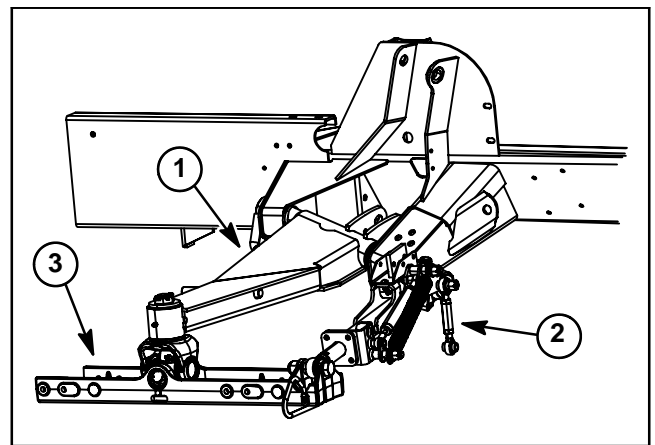


Figure 7

- 1. Lift arm (LH shown)
- 2. Damper link
- 3. Deck mount

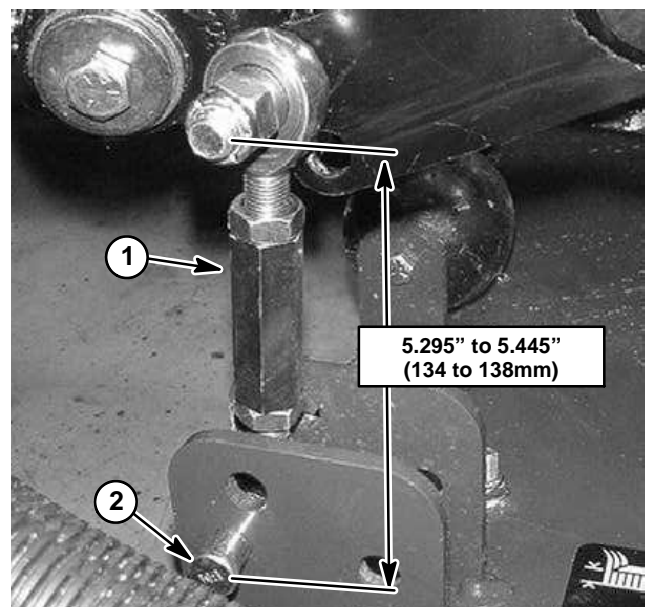


Figure 8

- 1. Damper link
- 2. Clevis pin

## Idler Assembly

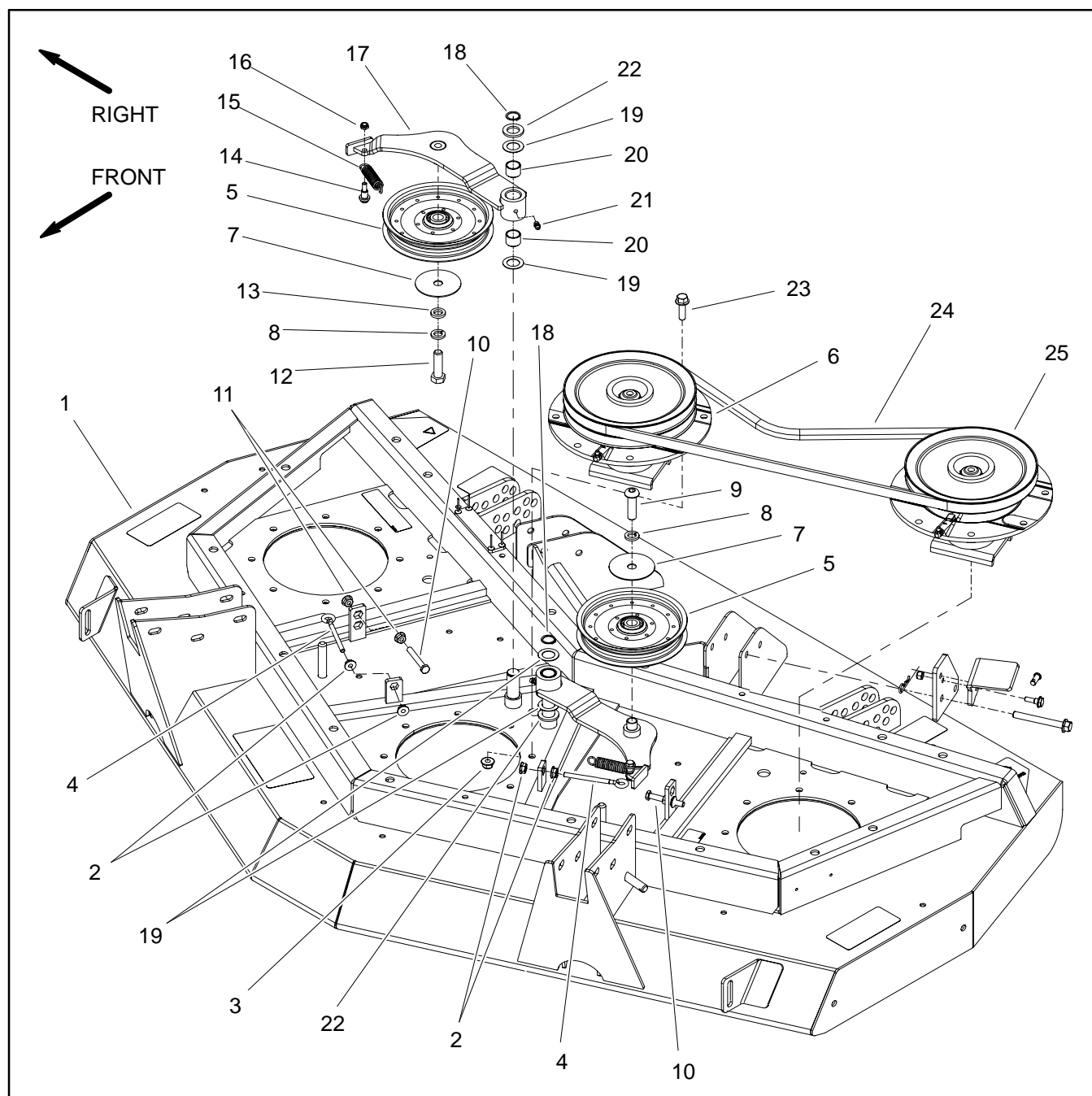


Figure 9

- |   |                     |                                    |
|---|---------------------|------------------------------------|
| 1. Cutting deck (front shown)           | 10. Idler stop bolt | 18. Retaining ring                 |
| 2. Flange nut                           | 11. Flange nut      | 19. Thrust washer                  |
| 3. Flange nut                           | 12. Cap screw       | 20. Bushing (2 used per idler)     |
| 4. Adjusting screw                      | 13. Spacer          | 21. Grease fitting                 |
| 5. Idler pulley                         | 14. Shoulder bolt   | 22. Washer                         |
| 6. Driven spindle (double pulley shown) | 15. Idler spring    | 23. Flange head screw              |
| 7. Flat washer                          | 16. Lock nut        | 24. Drive belt                     |
| 8. Lock washer                          | 17. Idler arm       | 25. Driven spindle (single pulley) |
| 9. Socket head screw                    |                     |                                    |

**NOTE:** The front deck is shown in Figure 9. The idler assemblies used on the wing decks use the same idler components.

### Removal (Fig. 9)

1. Park machine on a level surface, lower cutting deck, stop engine, engage parking brake and remove key from the ignition switch.
2. Remove deck covers from top of cutting deck.



3. Use spring hook tool to unhook the idler spring (item 15) from the adjusting screw (item 4).
4. Remove drive belt(s) from deck pulleys.
5. Loosen flange nuts (item 11) that secure idler stop bolt (item 10) to cutting deck to allow clearance between idler arm and stop bolt.
6. Remove idler components as needed using Figure 9 as a guide. Note location of washers, idler spacer and screw as idler assemblies are being removed.

### Installation (Fig. 9)

1. Install removed idler components using Figure 9 as a guide.
  - A. Make sure that one (1) thrust washer (item 19) is placed above and below the idler arm. Location of additional washer (item 22) depends on whether the idler pulley mounts on the bottom side of the idler arm or on the top of the idler arm.
  - B. Secure idler arm assembly to cutting deck with retaining ring.
  - C. If idler stop bolt (item 10) was removed from deck, make sure that it is installed in the hole that allows the stop bolt head to align with the idler arm.
2. Install drive belt to pulleys.



3. Use spring hook tool to attach the idler spring (item 15) onto the adjusting screw (item 4) and shoulder bolt on idler arm.
4. With the idler arm tensioning the drive belt, the idler spring hook to hook length should be from 3.250" to 3.750" (82.6 to 95.2 mm) (Fig. 10). If necessary, disconnect spring and change position of adjusting screw. When idler spring is the correct length, tighten second flange nut to secure idler adjustment.
5. Adjust location of idler stop bolt so that the clearance between idler arm and idler stop bolt head is from 0.125" to 0.185" (3.2 to 4.6 mm) (Fig. 10).
6. Lubricate idler arm grease fitting.
7. Install deck covers to cutting deck.

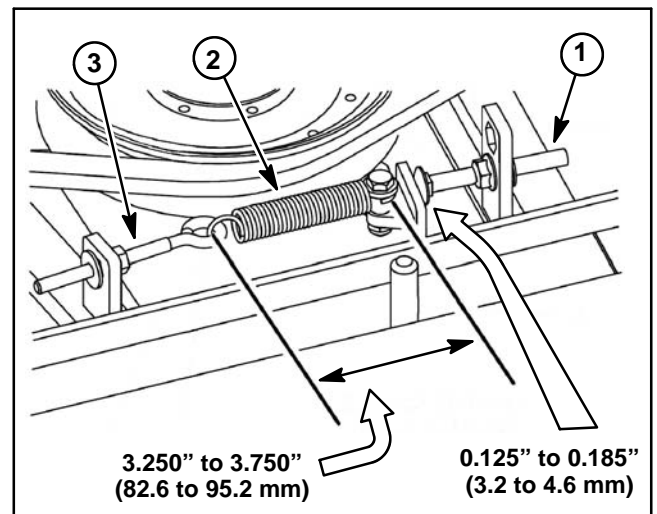


Figure 10

1. Idler stop bolt
2. Idler spring
3. Adjusting screw

## Blade Spindles

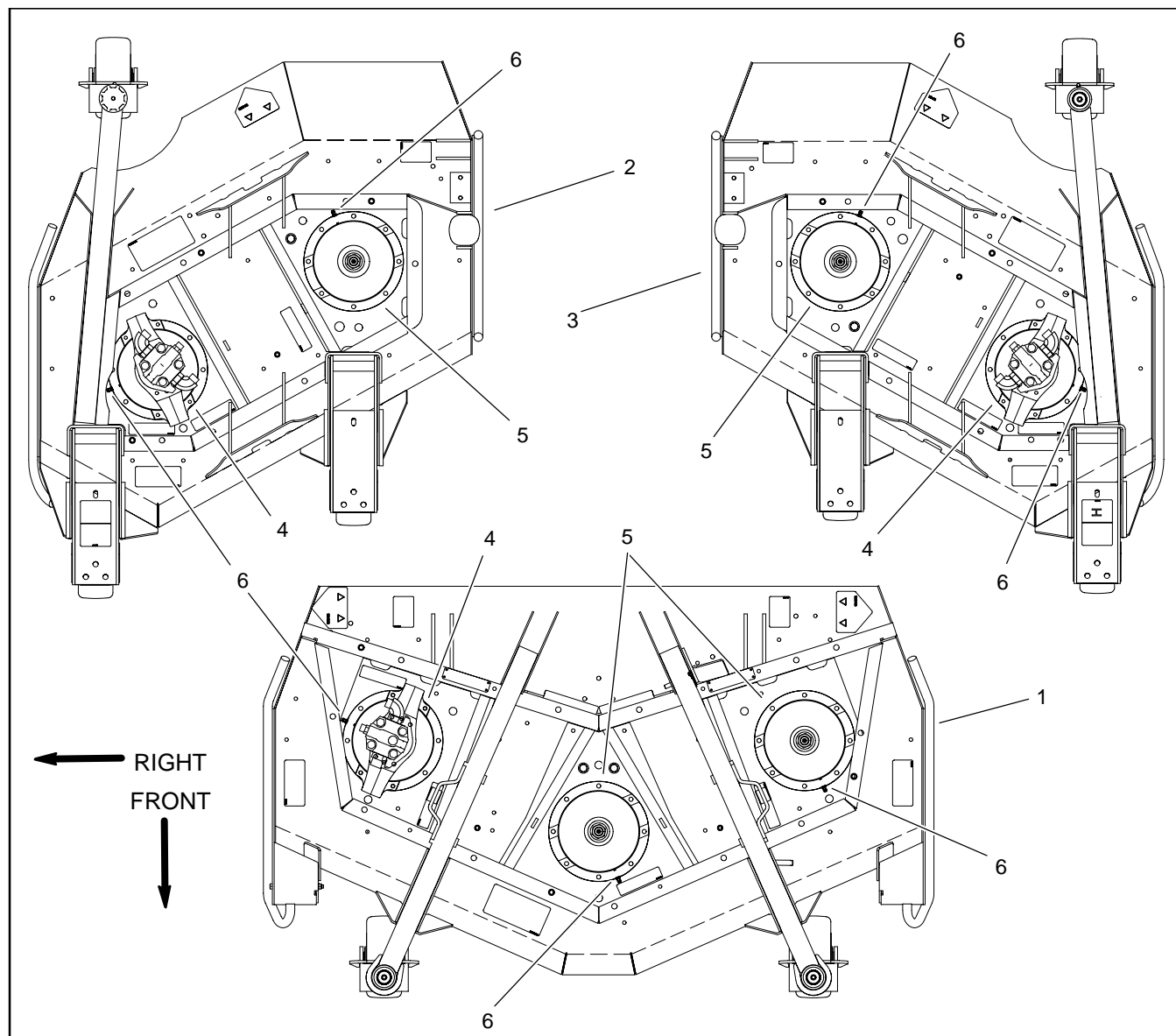


Figure 11

1. Front cutting deck  
2. RH cutting deck

3. LH cutting deck  
4. Drive spindle

5. Driven spindle  
6. Grease fitting location



## Removal (Figs. 11 and 12)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.
2. Remove covers from cutting deck to allow access to blade spindle.
3. If drive spindle is to be serviced, remove hydraulic motor from cutting deck (see Cutting Deck Motor Removal in the Service and Repairs Section of Chapter 4 - Hydraulic Systems). Position motor away from spindle.
4. Loosen idler assembly to release drive belt tension (see Idler Assembly Removal in this section). Remove drive belt from spindle to be serviced.
5. Start the engine and raise the cutting deck. Stop engine and remove key from the ignition switch. Latch or block up the cutting deck so it cannot fall accidentally.
6. Remove cutting blade, anti-scalp cup and blade bolt from spindle to be serviced.
7. Remove spindle housing assembly from deck.
  - A. For driven spindle assemblies, remove eight (8) flange head screws with flange nuts that secure spindle to deck.
  - B. For drive spindle assemblies, remove four (4) cap screws with washers that secure spindle and hydraulic motor mount to deck. Remove motor mount. Then, remove four (4) flange head screws with flange nuts that secure spindle to deck.
  - C. Lift spindle assembly from deck.

## Installation (Figs. 11 and 12)

1. Position spindle on cutting deck noting orientation of grease fitting (Fig. 11). Secure spindle assembly to deck with removed fasteners.
2. Install cutting blade, anti-scalp cup and blade bolt to spindle. Tighten blade bolt from **88 to 108 ft-lb (120 to 146 N-m)**.
3. Slowly rotate cutting blades to verify that blades do not contact any deck components.

4. Install drive belt to spindle pulleys and idler pulley. Adjust drive belt tension (see Idler Assembly Installation in this section).
5. If drive spindle was removed, install hydraulic motor to cutting deck (see Cutting Deck Motor Installation in the Service and Repairs Section of Chapter 4 - Hydraulic Systems).

**IMPORTANT: Pneumatic grease guns can produce air pockets when filling large cavities and therefore, are not recommended to be used for proper greasing of spindle housings.**

6. Attach a hand pump grease gun to grease fitting on spindle housing and fill housing cavity with grease until grease starts to come out of lower seal.
7. Install covers to cutting deck.

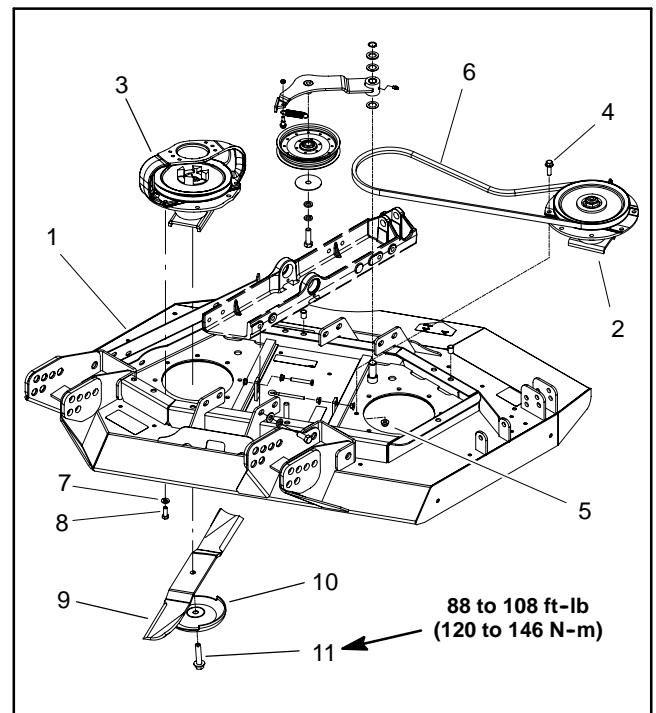


Figure 12

- |                      |                    |
|----------------------|--------------------|
| 1. Deck (RH shown)   | 7. Washer          |
| 2. Driven spindle    | 8. Cap screw       |
| 3. Drive spindle     | 9. Blade           |
| 4. Flange head screw | 10. Anti-scalp cup |
| 5. Flange nut        | 11. Blade bolt     |
| 6. Drive belt        |                    |

## Blade Spindle Service

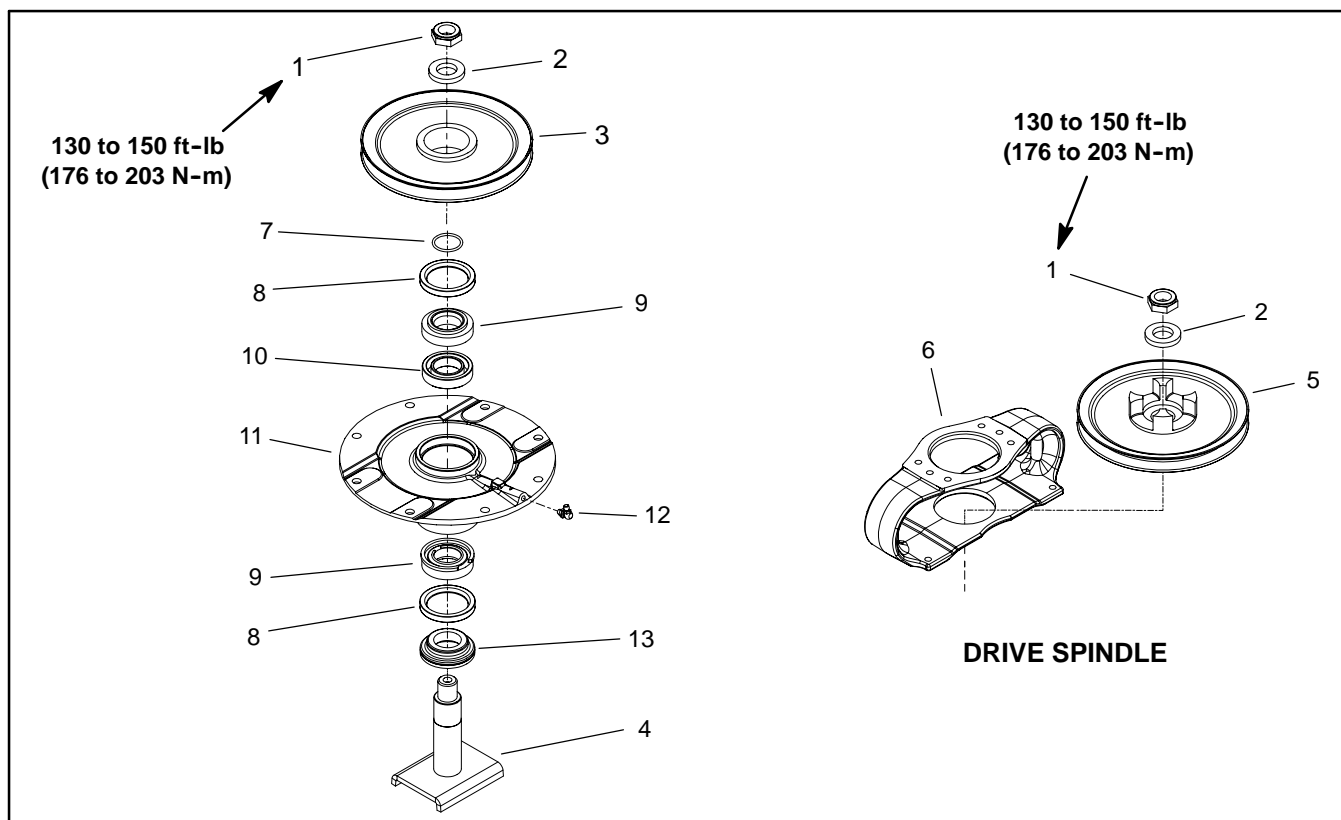


Figure 13

1. Lock nut
2. Hardened washer
3. Driven pulley (single shown)
4. Spindle shaft
5. Drive pulley

6. Hydraulic motor mount
7. O-ring
8. Oil seal
9. Bearing cup and cone

10. Spacer set
11. Spindle housing
12. Grease fitting
13. Spindle shaft spacer

### Disassembly (Fig. 13)

1. Loosen and remove lock nut from top of spindle shaft. Remove hardened washer and pulley from spindle. For drive spindle, remove hydraulic motor mount.
2. 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.
3. Carefully remove oil seals from spindle housing taking care to not damage seal bore in housing.
4. Allow the bearing cones, inner bearing spacer and spacer ring to drop out of the spindle housing (Fig. 14).
5. Using an arbor press, remove both of the bearing cups and the outer bearing spacer from the housing.
6. The large snap ring can remain inside the spindle housing. Removal of this snap ring is very difficult.

### Assembly (Fig. 13)

**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. 14). These parts cannot be purchased separately. Also, 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. 14). 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 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 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 housing groove.

2. Install outer bearing spacer into top of spindle housing. The spacer should fit against the 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 snap ring. Make sure that the assembly is correct by supporting the first bearing cup and pressing the second cup against it (Fig 15).

4. Pack the bearing cones with grease. Apply a film of grease on lips of oil seals and O-ring.

5. Install lower bearing cone and oil seal into bottom of spindle housing. **Note:** The bottom seal must have the lip facing out (down) (Fig. 16). 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 new bearing set (Fig. 14).**

6. Slide spacer ring and inner bearing spacer into spindle housing, then install upper bearing cone and oil seal into top of housing. **Note:** The upper seal must have the lip facing in (down) (Fig. 16). Also, upper seal should be flush or up to 0.060" (1.5 mm) recessed into housing.

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 fit together when the spindle is fully installed.

10. Install O-ring to top of spindle shaft. For drive spindle, position hydraulic motor mount to top of spindle.

11. Install pulley (hub down), hardened washer and lock nut to spindle shaft. Tighten lock nut from **130 to 150 ft-lb (176 to 203 N-m)**.

**IMPORTANT: Pneumatic grease guns can produce air pockets when filling large cavities and therefore, are not recommended to be used for proper greasing of spindle housings.**

12. Attach a hand pump grease gun to grease fitting on housing and fill housing cavity with grease.

13. Rotate spindle shaft to make sure that it turns freely.

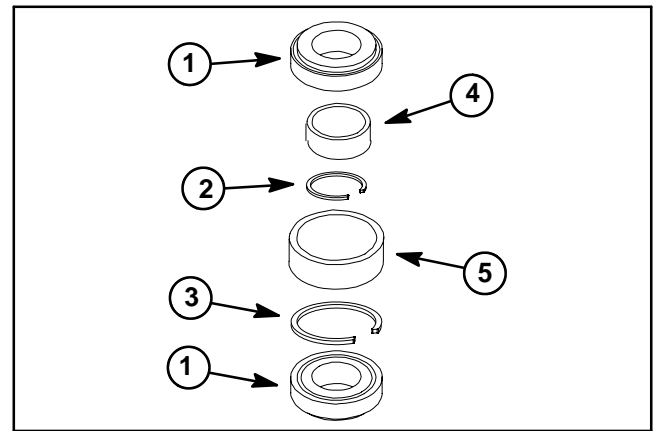


Figure 14

- |                    |                         |
|--------------------|-------------------------|
| 1. Bearing         | 4. Inner bearing spacer |
| 2. Spacer ring     | 5. Outer bearing spacer |
| 3. Large snap ring |                         |

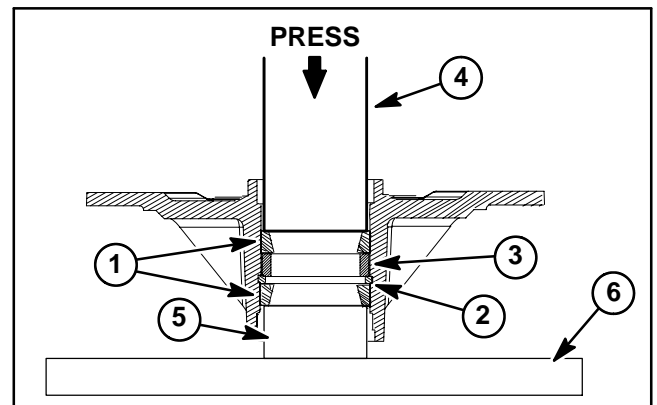


Figure 15

- |                         |                     |
|-------------------------|---------------------|
| 1. Bearing cups         | 4. Arbor press      |
| 2. Large snap ring      | 5. Support          |
| 3. Outer bearing spacer | 6. Arbor press base |

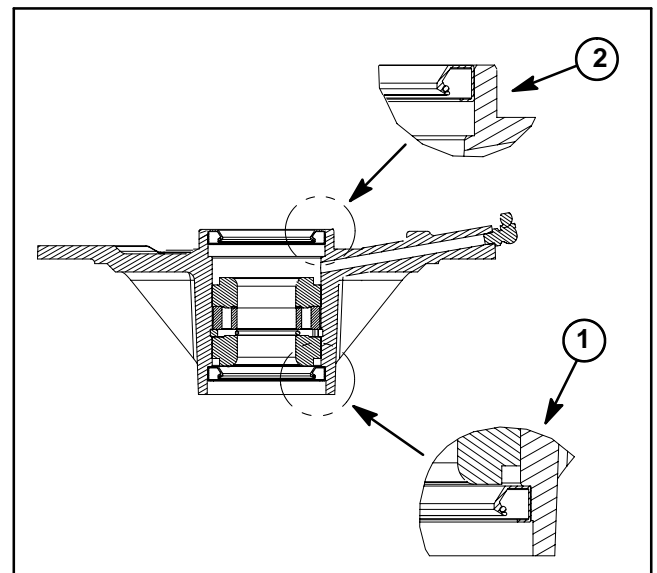


Figure 16

- |                             |                            |
|-----------------------------|----------------------------|
| 1. Bottom seal installation | 2. Upper seal installation |
|-----------------------------|----------------------------|

## Castor Forks and Wheels

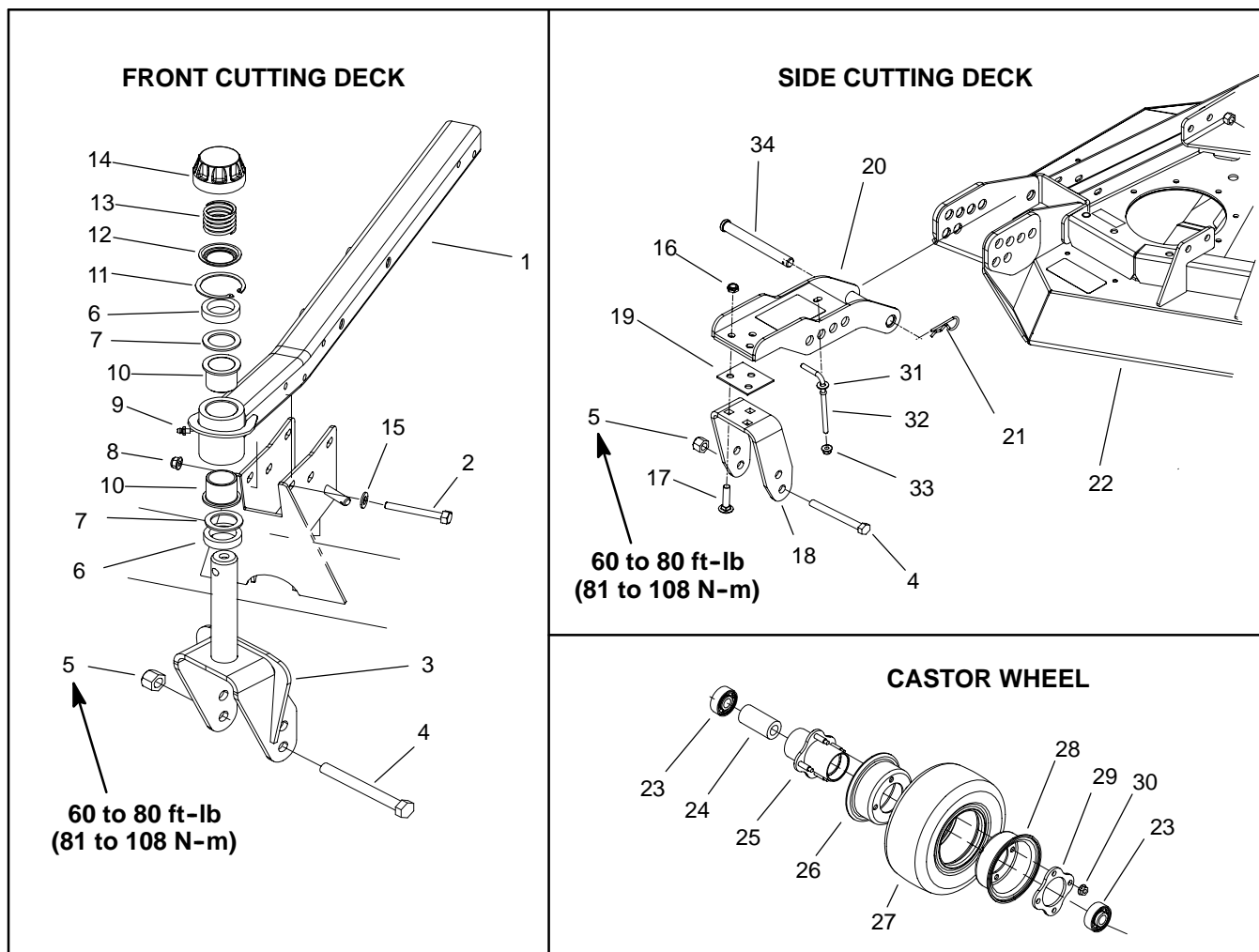


Figure 17

1. Castor arm (front deck)
2. Cap screw (5 used)
3. Castor fork
4. Cap screw
5. Lock nut
6. Castor spacer
7. Thrust washer
8. Flange nut (5 used)
9. Grease fitting
10. Flange bushing
11. Retaining ring
12. Cap washer

13. Compression spring
14. Cap
15. Flat washer
16. Lock nut (3 used per bracket)
17. Carriage screw (3 used per bracket)
18. Castor fork bracket
19. Shim
20. Castor bracket
21. Hairpin
22. Cutting deck (RH shown)
23. Bearing

24. Inner bearing spacer
25. Wheel hub
26. Wheel rim half
27. Castor tire
28. Wheel rim half
29. Plate
30. Flange nut
31. Flat washer
32. Tension rod
33. Flange nut
34. Clevis pin

### Disassembly

1. Disassemble castor wheel as needed using Figure 17 as a guide.

### Assembly

1. Assemble castor wheel using Figure 17 as a guide.
2. If castor fork was removed, lubricate grease fitting.
3. Torque castor wheel lock nut (item 5) from **60 to 80 ft-lb (81 to 108 N-m)**.



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# General Information

The information in this chapter pertains to the operator cab on the Groundsmaster 4010-D.

---

## Operator's Manual

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

---

## Electrical Components and Schematic

Information regarding Groundsmaster 4010-D electrical cab components (switches and relay) is included in Chapter 5 - Electrical System. The electrical schematic and harness drawings for the operator cab are included in Chapter 10 - Foldout Drawings.

---

## Air Conditioning System

The air conditioning system used on the Groundsmaster 4010-D consists of the following components:

1. A compressor mounted on the engine and driven by a v-belt.
  2. A condenser and condenser fan located on the top of the cab.
  3. A drier-receiver, an expansion valve and an evaporator (combined with the heater core) mounted in the headliner of the cab.
  4. The necessary hoses and tubes that connect the system components.
  5. A fan motor that provides air movement through the evaporator and into the cab. The fan motor is located in the cab headliner and is also used for the cab heater system.
  6. Operator controls to turn the air conditioning on, to adjust the fan speed and to control the cab air temperature.
- 

## Cab Heater System

The cab heater system used on the Groundsmaster 4010-D consists of the following components:

1. A heater core (combined with the A/C evaporator) located in the cab headliner.
2. Hoses to allow a circuit for engine coolant to circulate through the heater core. The heater core (combined with the A/C evaporator) is located in the headliner of the cab.
3. A fan motor that provides air movement through the heater core and into the cab. The fan motor is located in the cab headliner and is also used for the air conditioning system.
4. Operator controls to adjust the fan speed and to control the cab air temperature.

# Service and Repairs

## General Precautions for Removing and Installing Air Conditioning System Components



### CAUTION

**The air conditioning system is under high pressure. Do not loosen any system fitting or component until after the system has been completely discharged by a certified A/C service technician.**



### WARNING

**Always wear safety goggles or a face shield when working with air conditioning system components. Also, do not allow refrigerant contact with your skin or eyes as there would be the possibility of serious injury.**



### CAUTION

**Never use compressed air to leak test or pressure test the air conditioning system. Under certain conditions, pressurized mixtures of refrigerant and air can be combustible.**

1. Before servicing any air conditioning system components, park machine on a level surface, apply parking brake, lower cutting decks or attachments and stop engine. Remove key from the ignition switch.
2. Clean machine before disconnecting, removing or disassembling any air conditioning system components. Thorough cleaning will prevent system contamination while performing service procedures.
3. Put caps or plugs on any lines, fittings or components left open or exposed to prevent system contamination.
4. Before loosening or removing any air conditioning system hose or other component, have a certified air conditioning service technician recover the system refrigerant and then evacuate the air conditioning system completely. It is illegal to vent refrigerant to the atmosphere.

5. Put labels on disconnected lines and hoses for proper installation after repairs are completed.

6. If compressor is removed from machine, keep compressor in the same orientation as the installed position. This will prevent compressor oil from filling the compressor cylinders.

7. Note the position of fittings (especially elbow fittings) before removal. Mark parts if necessary to make sure they will be aligned properly when reinstalling hoses and tubes.

8. Always use a DOT approved tank for storing used and recycled refrigerants.

9. The Groundsmaster 4010-D air conditioning system uses R134a refrigerant. DO NOT use other refrigerants in the system. A/C system capacity is 1.25 pounds of R134a refrigerant.

10. Refrigerant containers (either full or empty) are under pressure that will increase if the containers are heated. DO NOT expose refrigerant containers to high heat sources or flame.

11. Be sure the work area is properly ventilated to prevent any accumulation of refrigerant or other fumes.

12. Make sure that caps are always placed on the pressure hose ports. These caps prevent refrigerant leakage from the system.

13. The drier-receiver component is used to collect moisture that will reduce air conditioning performance. If the air conditioning system is opened for component repair or replacement, drier-receiver replacement is recommended.

14. After installing air conditioning components, have a certified air conditioning service technician evacuate the air conditioning system completely, properly recharge the system with R134a refrigerant and then leak test the system.

## Air Conditioning Compressor

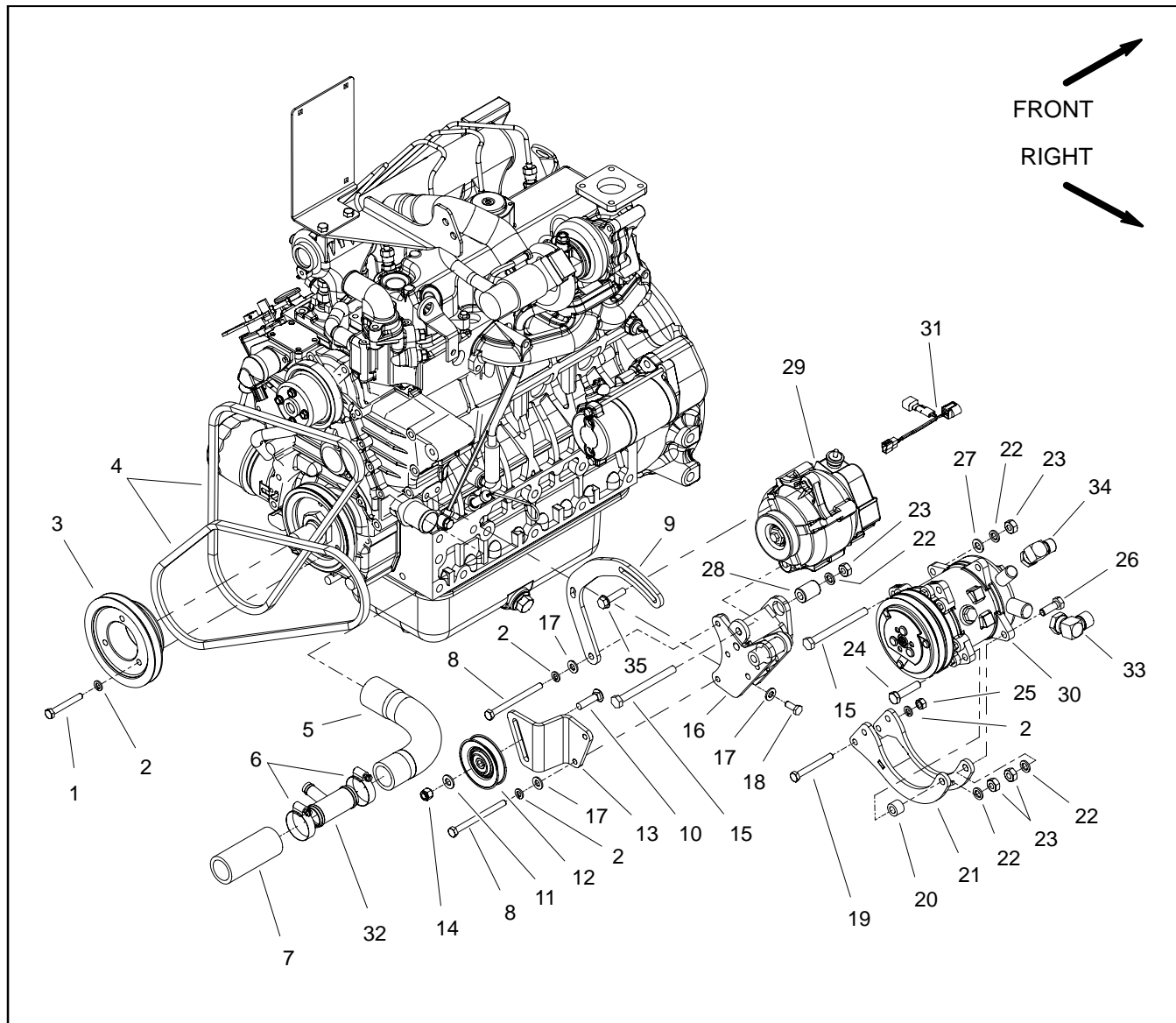


Figure 1

- |                         |                          |                                 |
|-------------------------|--------------------------|---------------------------------|
| 1. Cap screw (3 used)   | 13. Idler plate bracket  | 25. Hex nut (2 used)            |
| 2. Lock washer (8 used) | 14. Lock nut             | 26. Cap screw                   |
| 3. Pulley               | 15. Cap screw (3 used)   | 27. Flat washer                 |
| 4. V-belt               | 16. A/C compressor mount | 28. Spacer (2 used)             |
| 5. Lower radiator hose  | 17. Flat washer (5 used) | 29. Alternator (90 amp)         |
| 6. Hose clamp (2 used)  | 18. Cap screw (2 used)   | 30. Air conditioning compressor |
| 7. Lower radiator hose  | 19. Cap screw (2 used)   | 31. Alternator wire harness     |
| 8. Cap screw (3 used)   | 20. Spacer               | 32. Radiator fitting            |
| 9. Alternator plate     | 21. Compressor arm       | 33. 90° fitting                 |
| 10. Carriage screw      | 22. Lock washer (5 used) | 34. 90° fitting                 |
| 11. Flat washer         | 23. Hex nut (5 used)     | 35. Bolt                        |
| 12. Idler pulley        | 24. Cap screw            |                                 |

### Removal (Fig. 1)

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

2. Raise hood to allow access to engine.

3. Loosen lock nut that secures idler pulley. Move pulley to loosen A/C compressor drive belt. Remove drive belt from A/C compressor pulley.

4. Inspect compressor drive belt for glazing or damage. Replace belt if necessary.



5. Disconnect compressor electrical connector from machine wire harness.

6. Read the General Precautions for Removing and Installing Air Conditioning System Components at the beginning of the Service and Repairs section of this chapter.



## CAUTION

**The air conditioning system is under high pressure. Do not loosen any system fitting or component until after the system has been completely discharged by a certified A/C service technician.**

7. Have refrigerant evacuated from air conditioning system by a certified A/C service technician.

8. Label and remove hoses from compressor. Immediately cap hoses and fittings to prevent moisture and contaminants from entering the system.

9. Support compressor to prevent it from shifting or falling.

**NOTE:** There may be shims mounted between compressor and compressor arm. When removing compressor, note shim location and quantity for assembly purposes.

10. Remove fasteners and spacers that secure compressor to compressor mount and compressor arm.

**IMPORTANT:** To prevent compressor oil from filling the compressor cylinders, keep compressor in the same orientation as the installed position.

11. Carefully remove compressor from engine and machine.

**NOTE:** The replacement of the drier-receiver is recommended whenever A/C compressor is removed from the system (see Heater and Evaporator Assembly in this section).

**NOTE:** The air conditioning compressor used on the Groundsmaster 4010-D is a Sanden model SD5H09. For air conditioning compressor repair procedures, see the SD Compressor Service Guide at the end of this chapter.

### Installation (Fig. 1)

1. Position compressor to compressor mount and compressor arm.

2. The clearance between the compressor mounting flanges and pivot plate must be less than 0.004" (0.10 mm). If necessary, install shims between compressor flanges and pivot plate to adjust clearance. See Parts Catalog for shim kit.

3. Secure compressor to compressor mount and compressor arm with removed fasteners and spacers. Do not fully tighten fasteners.

**IMPORTANT:** After the compressor has been installed, make sure to rotate the compressor drive shaft several times to properly distribute oil in the compressor. Compressor damage due to oil slugging can occur if this procedure is not performed.

4. Manually rotate the compressor drive shaft at least ten (10) revolutions to make sure that no compressor oil is in the compressor cylinders.

5. Place drive belt onto compressor pulley.

6. Tension compressor drive belt with idler pulley. Make sure to tighten lock nut to secure belt adjustment.

7. Remove caps that were placed on hoses and fittings during the removal process. Using labels placed during removal, properly secure hoses to compressor.

8. Connect compressor electrical connector to machine wire harness.

9. Have a certified air conditioning service technician evacuate the air conditioning system completely, properly recharge the system with R134a refrigerant and then leak test the system. A/C system capacity is 1.25 pounds of R134a refrigerant.

10. Lower and secure hood.

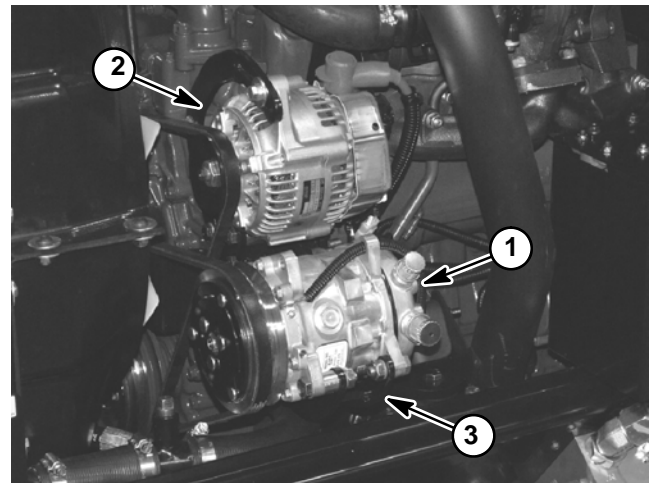


Figure 2

1. A/C compressor  
2. Alternator

3. Compressor arm

## Roof Assembly

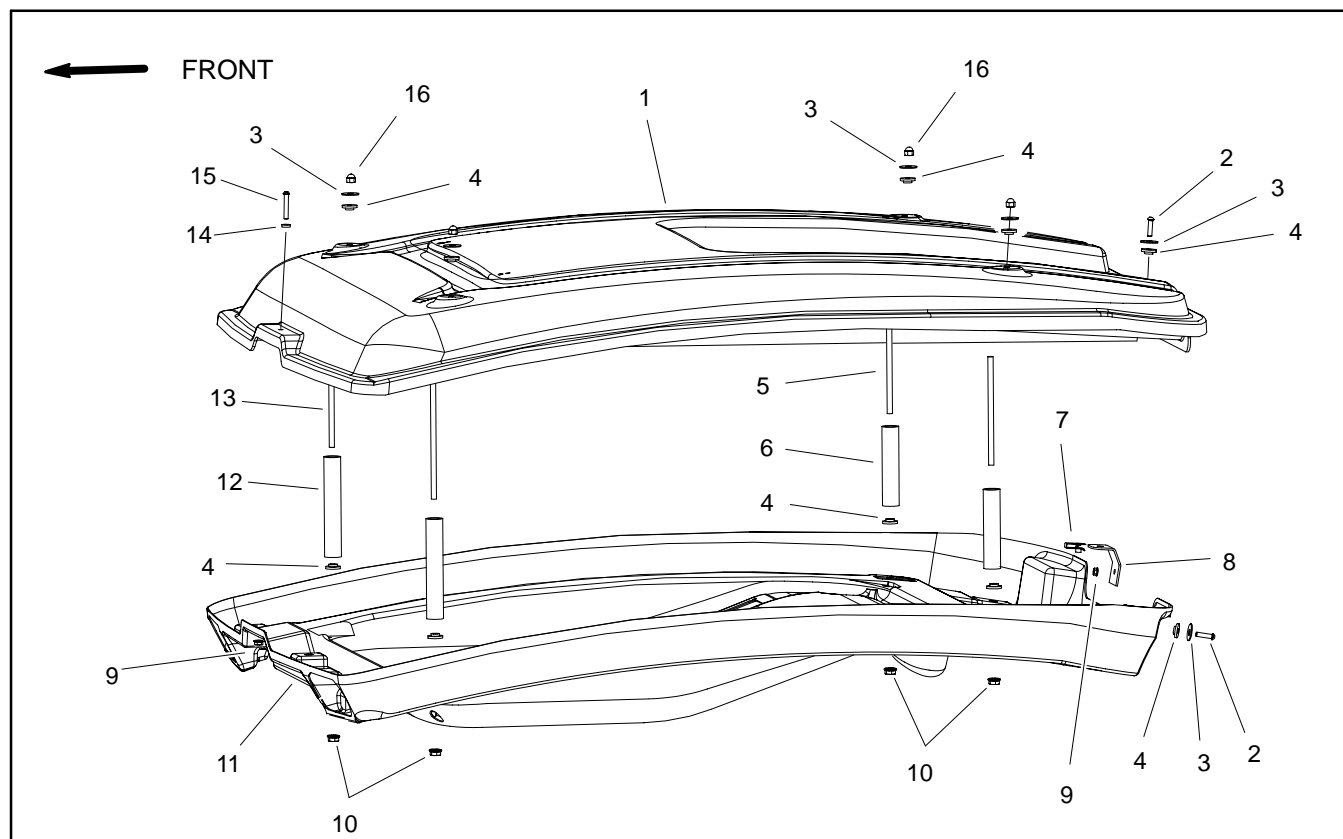


Figure 3

- |                           |                         |                             |
|---------------------------|-------------------------|-----------------------------|
| 1. Roof                   | 7. Panel nut            | 12. Front spacer (2 used)   |
| 2. Screw (2 used)         | 8. Roof mount           | 13. Front fastener (2 used) |
| 3. Flat washer (6 used)   | 9. Flange nut (2 used)  | 14. Rubber washer           |
| 4. Bushing (10 used)      | 10. Flange nut (4 used) | 15. Cap screw               |
| 5. Rear fastener (2 used) | 11. Headliner           | 16. Hex nut (4 used)        |
| 6. Rear spacer (2 used)   |                         |                             |

To gain access to the heater core and air conditioning components that are located under the cab roof, the roof panel can be loosened, raised and supported.

### Removal (Fig. 3)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.
2. Remove screw (item 2), flat washer (item 3) and bushing (item 4) that secure the rear of the roof to the roof mount.
3. Remove the cap screw (item 15) and rubber washer (item 14) that secure the front of the roof.
4. Remove four (4) hex nuts (item 16), flat washers (item 3) and bushings (item 4) that secure roof to front and rear fasteners.
5. Carefully lift front of roof while leaving rear of roof against headliner. Support front of roof in the raised position to allow access to heater and air conditioning components.

### Installation (Fig. 3)

1. Make sure that all components in headliner and roof are installed and secure.
2. Remove support and carefully lower roof into position.
3. Secure roof to headliner with all removed fasteners.

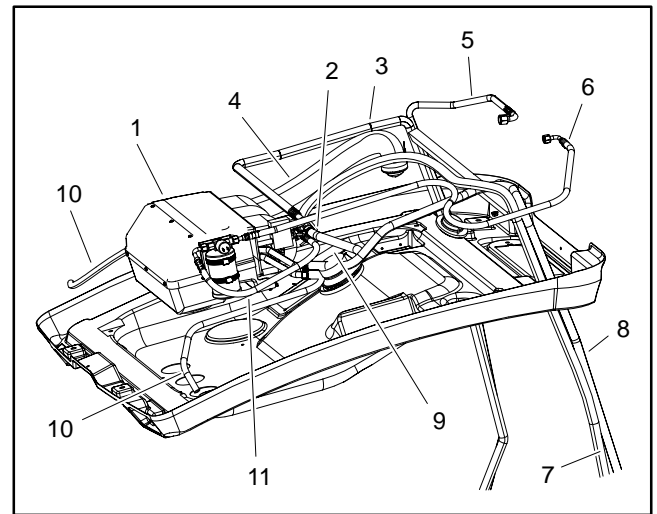


Figure 4

1. Heater/evaporator assembly
2. Heater valve
3. A/C hose: evaporator to compressor
4. Air duct hose
5. A/C hose: compressor to condenser
6. A/C hose: condenser to drier
7. Heater hose: thermostat to heater valve
8. Heater hose: heater core to water pump
9. Heater hose: heater valve to heater core
10. Condensation drain hose (2 used)
11. A/C hose: drier to evaporator

## Air Conditioning Condenser Assembly

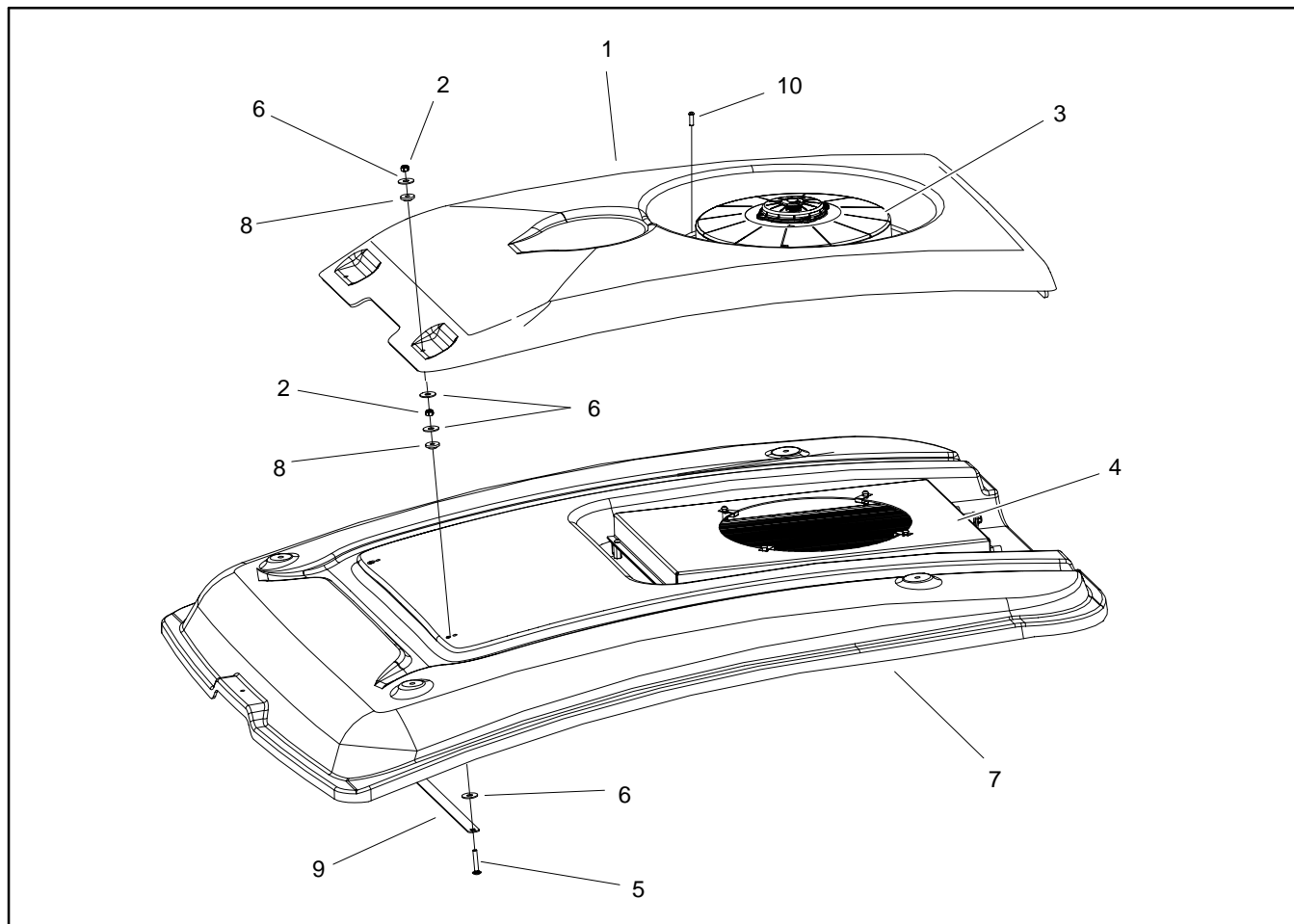


Figure 5

- |                            |                            |                                |
|----------------------------|----------------------------|--------------------------------|
| 1. Condenser cover         | 5. Carriage screw (2 used) | 8. Bushing (4 used)            |
| 2. Lock nut (4 used)       | 6. Flat washer (8 used)    | 9. Mounting strap              |
| 3. Condenser fan           | 7. Roof                    | 10. Button head screw (4 used) |
| 4. Condenser coil assembly |                            |                                |

### Removal (Fig. 5)

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 roof in place. Raise and support roof to allow access to condenser assembly (see Roof Assembly Removal in this section).

3. Disconnect wire harness connector from condenser fan motor.

4. Remove button head screws (item 10) that secure condenser fan and cover to condenser coil.

5. Remove fasteners (items 2, 6 and 8) that secure front of condenser cover to roof. Lift condenser fan and cover from roof.

6. Read the General Precautions for Removing and Installing Air Conditioning System Components at the beginning of the Service and Repairs section of this chapter.



### CAUTION

**The air conditioning system is under high pressure. Do not loosen any system fitting or component until after the system has been completely discharged by a certified A/C service technician.**

7. Have refrigerant evacuated from air conditioning system by a certified A/C service technician.

8. Label and remove hoses from condenser coil. Immediately cap hoses and fittings to prevent moisture and contaminants from entering the system.

9. Remove condenser coil from roof using Figure 6 as a guide.

**NOTE:** The replacement of the drier-receiver is recommended whenever the air conditioning system is opened (see Heater/Evaporator Assembly in this section).

### Installation (Fig. 5)

1. Install condenser coil to roof using Figure 6 as a guide.

2. Remove caps that were placed on hoses and fittings during the removal process. Using labels placed during removal, properly secure hoses to condenser coil.

3. Position condenser cover and condenser fan to roof. Secure cover and fan with removed fasteners (items 2, 6 and 8).

4. Secure condenser fan to condenser coil with button head screws (item 10).

5. Connect wire harness connector to condenser fan motor.

6. Make sure that all machine air conditioning components are installed and secure.

7. Have a certified air conditioning service technician evacuate the air conditioning system completely, properly recharge the system with R134a refrigerant and then leak test the system. A/C system capacity is 1.25 pounds of R134a refrigerant.

8. Lower and secure roof assembly (see Roof Assembly Installation in this section).

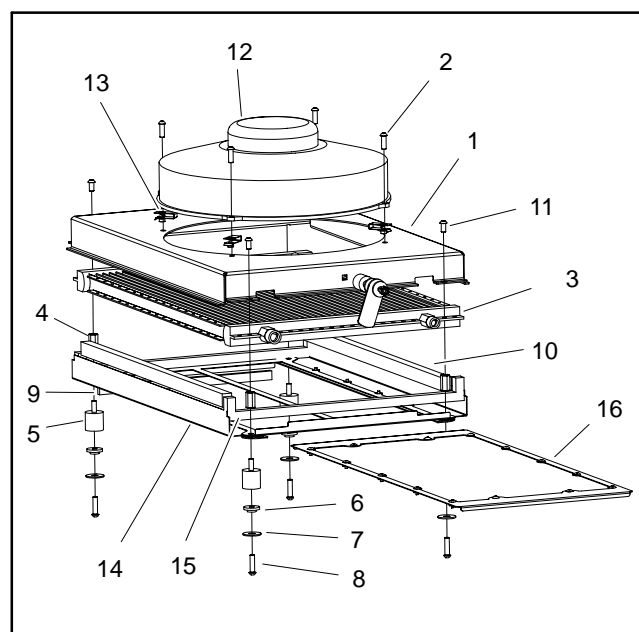


Figure 6

- |                            |                        |
|----------------------------|------------------------|
| 1. Condenser fan mount     | 9. Compression foam    |
| 2. Screw (4 used)          | 10. Side foam (2 used) |
| 3. Condenser coil          | 11. Screw (4 used)     |
| 4. Coupler nut (4 used)    | 12. Condenser fan      |
| 5. Isolator mount (4 used) | 13. Panel nut (4 used) |
| 6. Bushing (6 used)        | 14. Screen frame       |
| 7. Flat washer (4 used)    | 15. End foam (2 used)  |
| 8. Screw (4 used)          | 16. Screen             |

## Heater/Evaporator Assembly

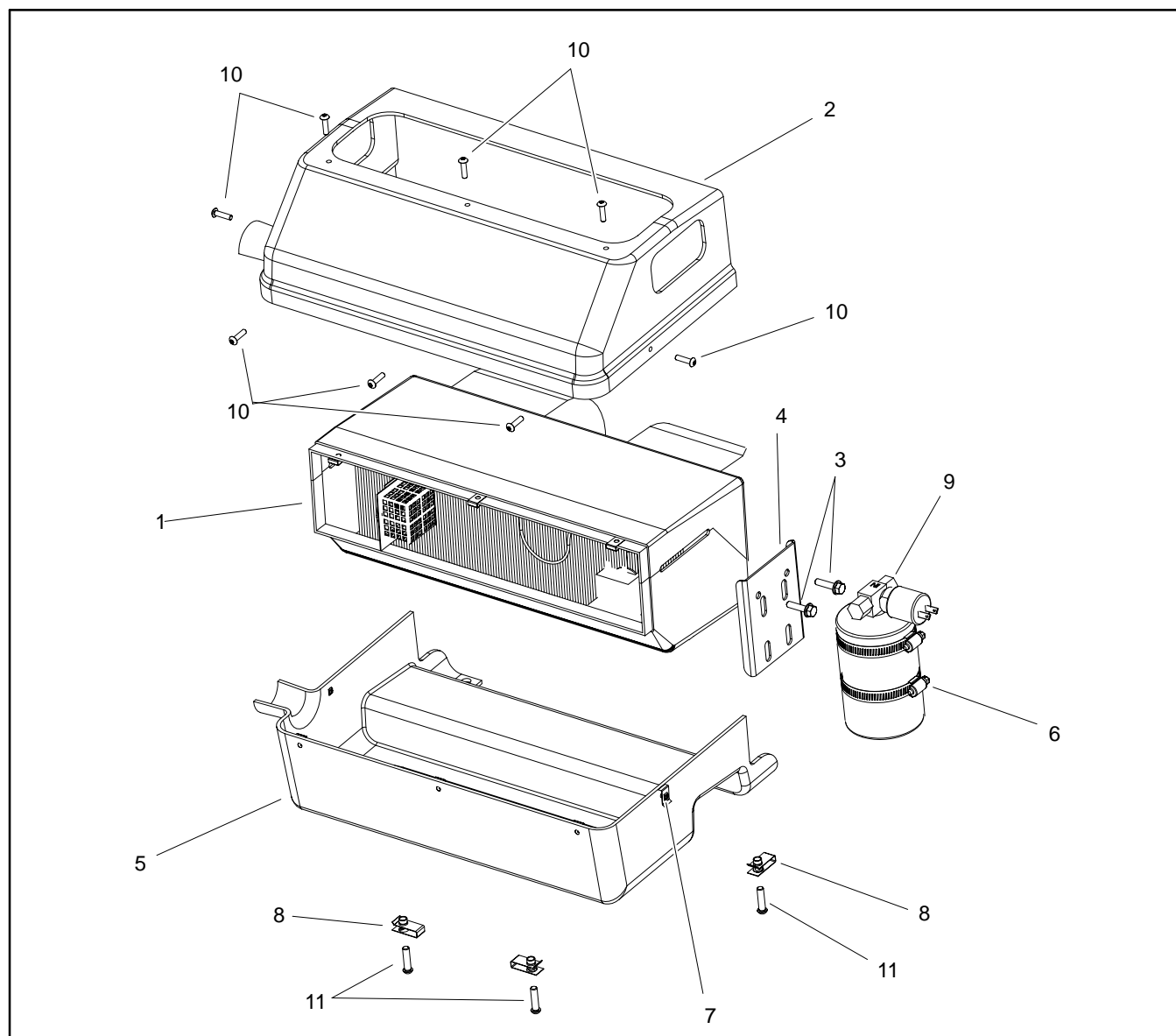


Figure 7

- |                               |                        |                            |
|-------------------------------|------------------------|----------------------------|
| 1. Heater/evaporator assembly | 5. Bottom cover        | 9. Drier-receiver assembly |
| 2. Top cover                  | 6. Hose clamp (2 used) | 10. Screw (8 used)         |
| 3. Flange head screw (2 used) | 7. Speed nut (8 used)  | 11. Screw (5 used)         |
| 4. Drier-receiver mount       | 8. Panel nut (4 used)  |                            |

### Removal (Fig. 7)

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 roof in place. Raise and support roof to allow access to heater/evaporator assembly (see Roof Assembly Removal in this section).

3. Disconnect wire harness connectors from fan motor and binary switch on drier-receiver.

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



## CAUTION

**The air conditioning system is under high pressure. Do not loosen any system fitting or component until after the system has been completely discharged by a certified A/C service technician.**

5. Have refrigerant evacuated from air conditioning system by a certified A/C service technician.
6. Label and remove hoses from heater core, evaporator and drier-receiver. Immediately cap hoses and fittings to prevent moisture and contaminants from entering the system.
7. Loosen hose clamp that secures air duct hose to heater/evaporator assembly covers. Slide hose from covers.
8. Remove screws that secure top cover to bottom cover. Remove top cover to access heater/evaporator assembly.
9. Disassemble heater/evaporator assembly using Fig. 9 as a guide.

**NOTE:** The replacement of the drier-receiver is recommended whenever the air conditioning system is opened.

### Installation (Fig. 7)

1. Assemble heater/evaporator assembly using Fig. 9 as a guide. Make sure that expansion valve is covered with insulating tape to prevent condensation issues.
2. Position heater/evaporator assembly into bottom cover in headliner. Secure top cover to bottom cover with removed screws.
3. Slide air duct hose onto heater/evaporator assembly covers and secure with hose clamp.
4. Remove caps that were placed on hoses and fittings during the removal process. Using labels placed during removal, properly secure hoses to heater core, evaporator and drier-receiver.
5. Make sure that condensation hoses are secured to bottom housing of heater/evaporator assembly and are routed to cab frame for proper draining of condensate.
6. Connect wire harness connectors to fan motor and binary switch on drier-receiver.
7. Make sure that all machine air conditioning components are installed and secure.

8. Have a certified air conditioning service technician evacuate the air conditioning system completely, properly recharge the system with R134a refrigerant and then leak test the system. A/C system capacity is 1.25 pounds of R134a refrigerant.

9. Operate the heater system to make sure that no engine coolant leaks exist.

10. Lower and secure roof assembly (see Roof Assembly Installation in this section).

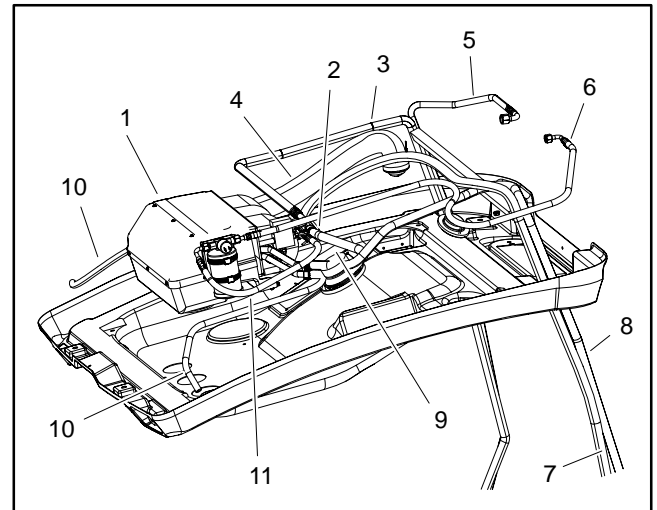


Figure 8

1. Heater/evaporator assembly
2. Heater valve
3. A/C hose: evaporator to compressor
4. Air duct hose
5. A/C hose: compressor to condenser
6. A/C hose: condenser to drier
7. Heater hose: thermostat to heater valve
8. Heater hose: heater core to water pump
9. Heater hose: heater valve to heater core
10. Condensation drain hose (2 used)
11. A/C hose: drier to evaporator

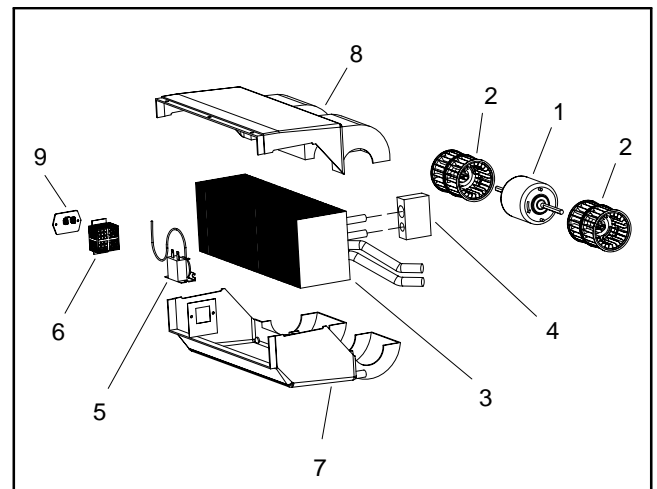


Figure 9

- |                           |                   |
|---------------------------|-------------------|
| 1. Fan motor              | 6. Resistor guard |
| 2. Blower wheel           | 7. Bottom housing |
| 3. Heater/evaporator core | 8. Top housing    |
| 4. Expansion valve        | 9. Resistor       |
| 5. Freeze switch          |                   |

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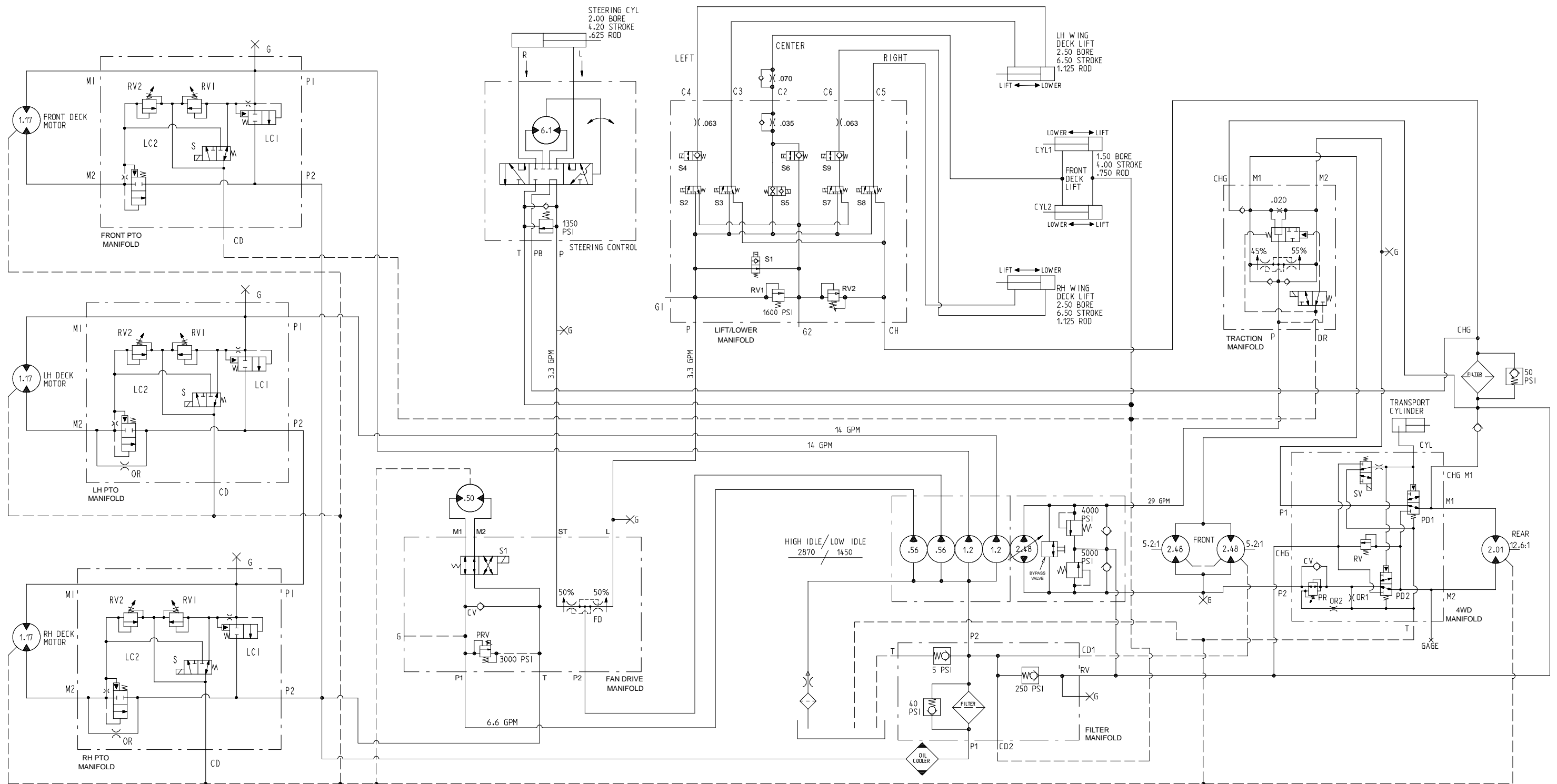


# Foldout Drawings

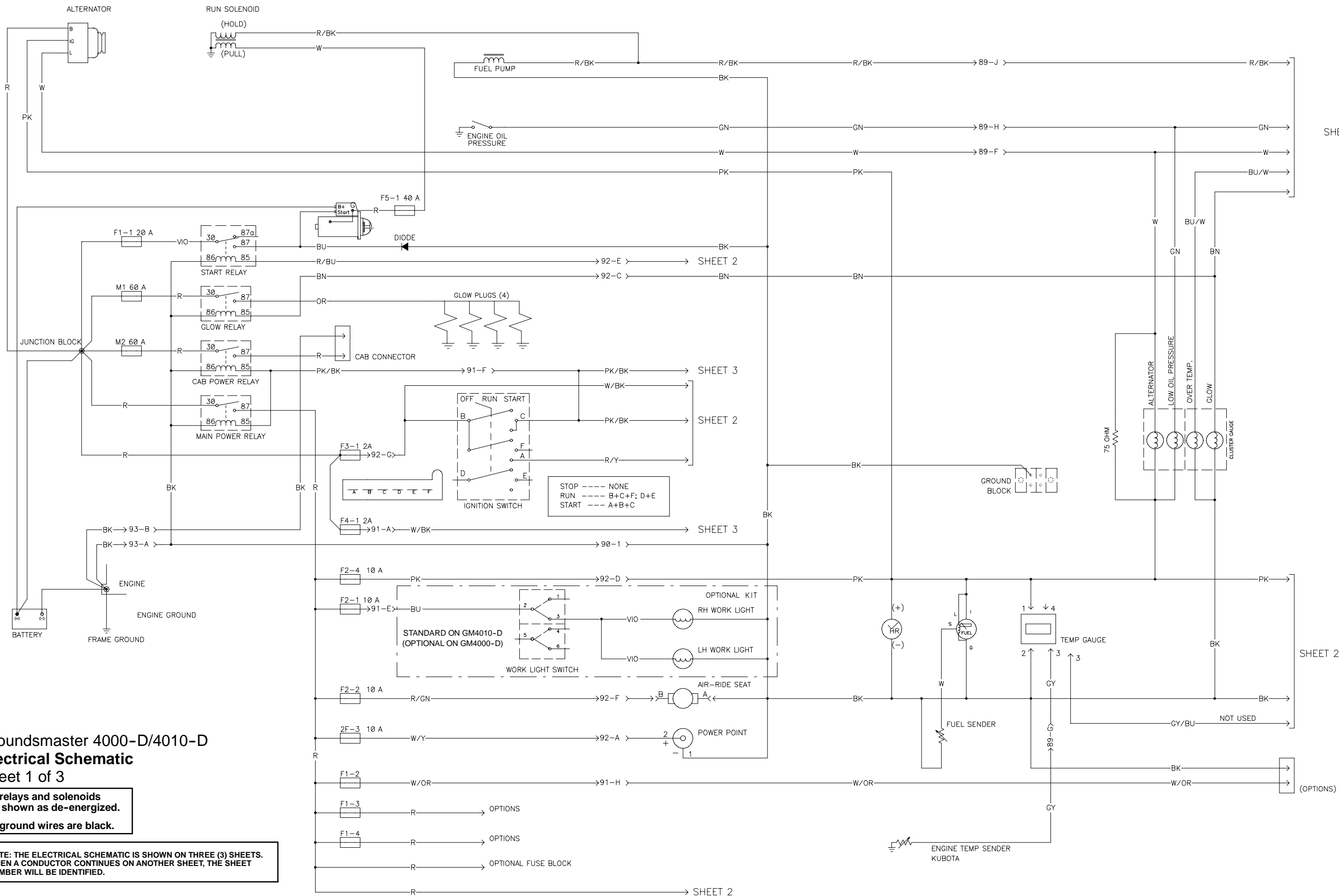
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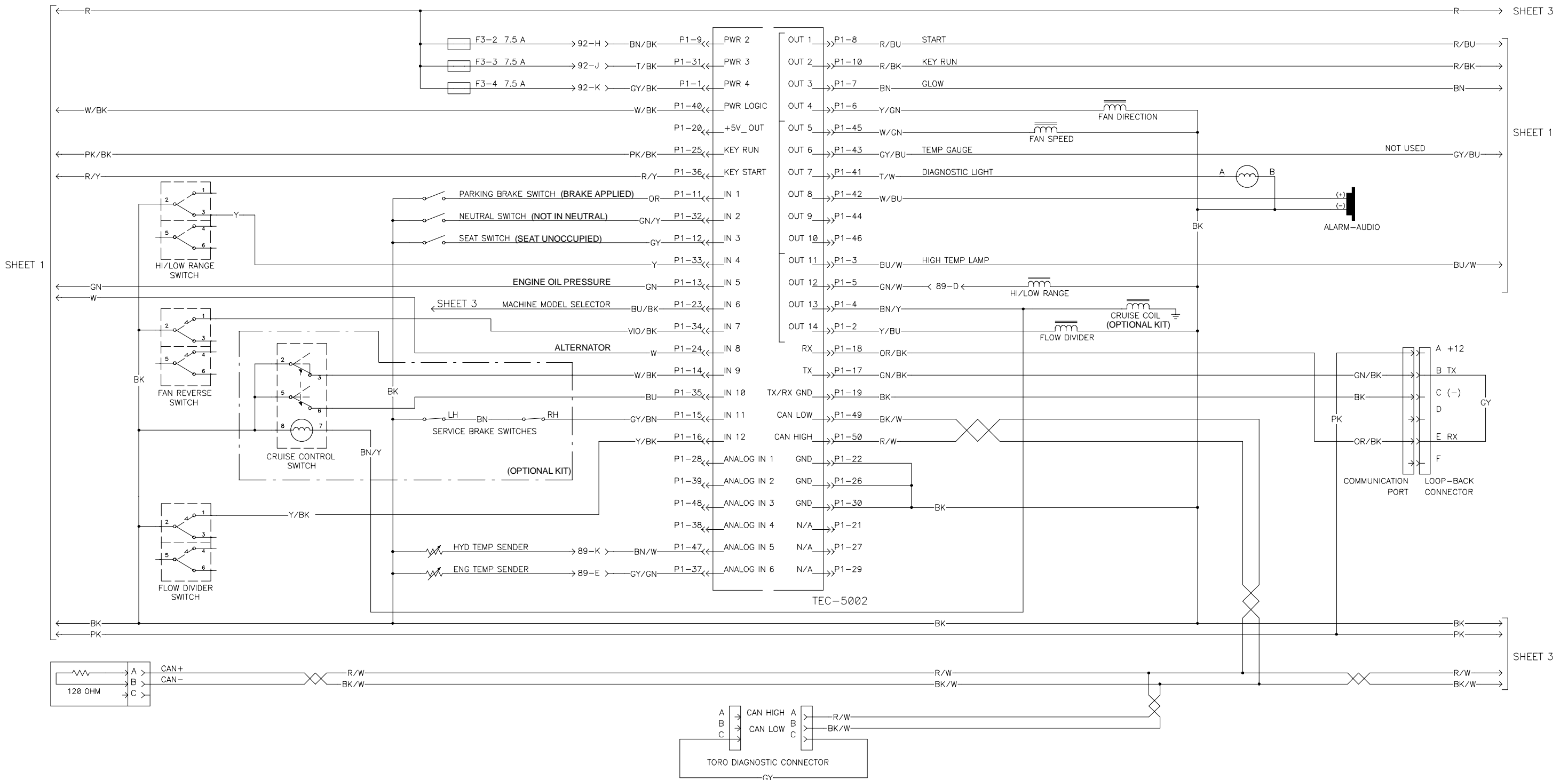
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Groundsmaster 4000-D/4010-D  
Hydraulic Schematic



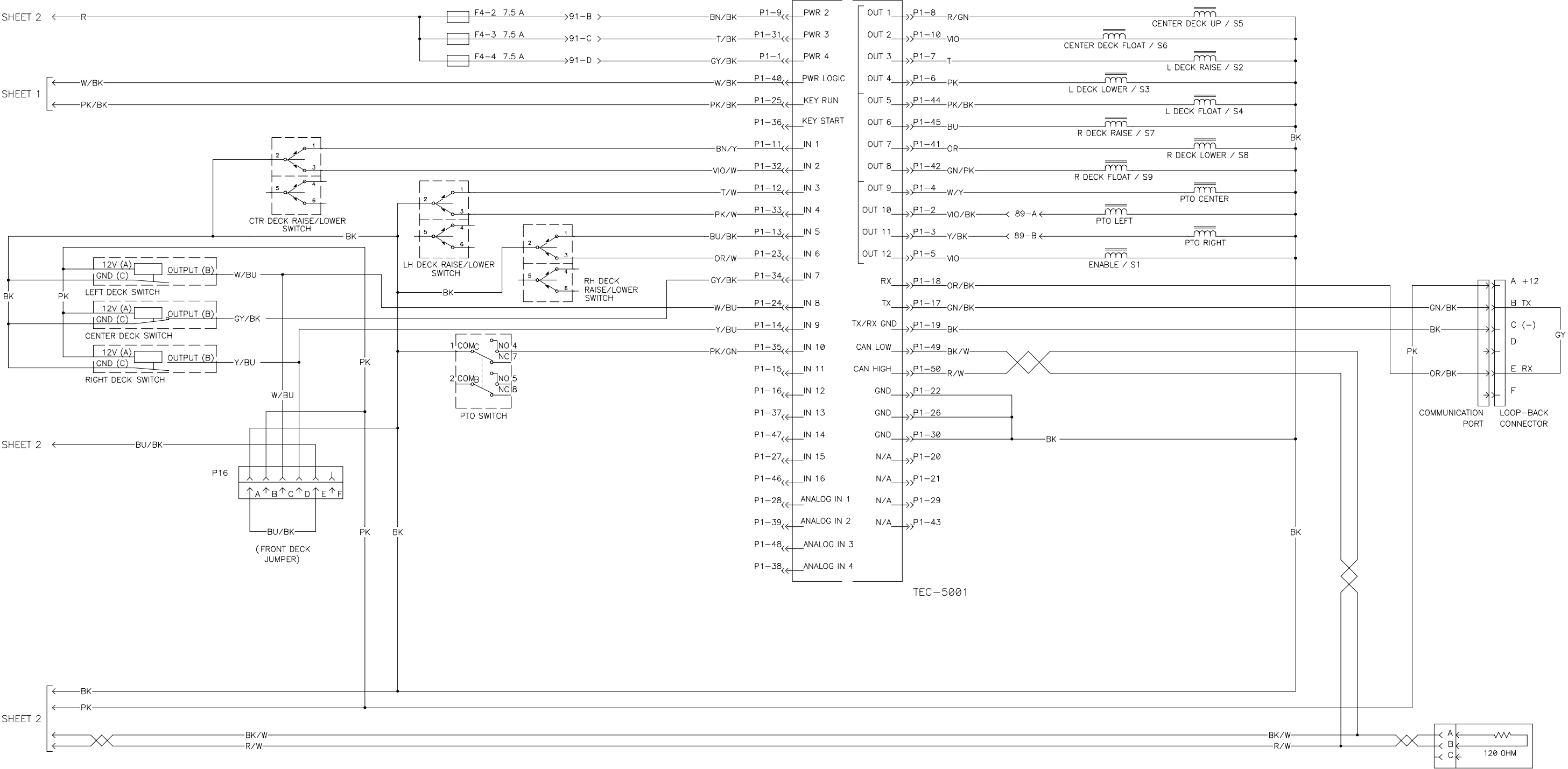


# Groundsmaster 4000-D/4010-D Electrical Schematic Sheet 2 of 3

All relays and solenoids are shown as de-energized.

All ground wires are black.

NOTE: THE ELECTRICAL SCHEMATIC IS SHOWN ON THREE (3) SHEETS. WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, THE SHEET NUMBER WILL BE IDENTIFIED.



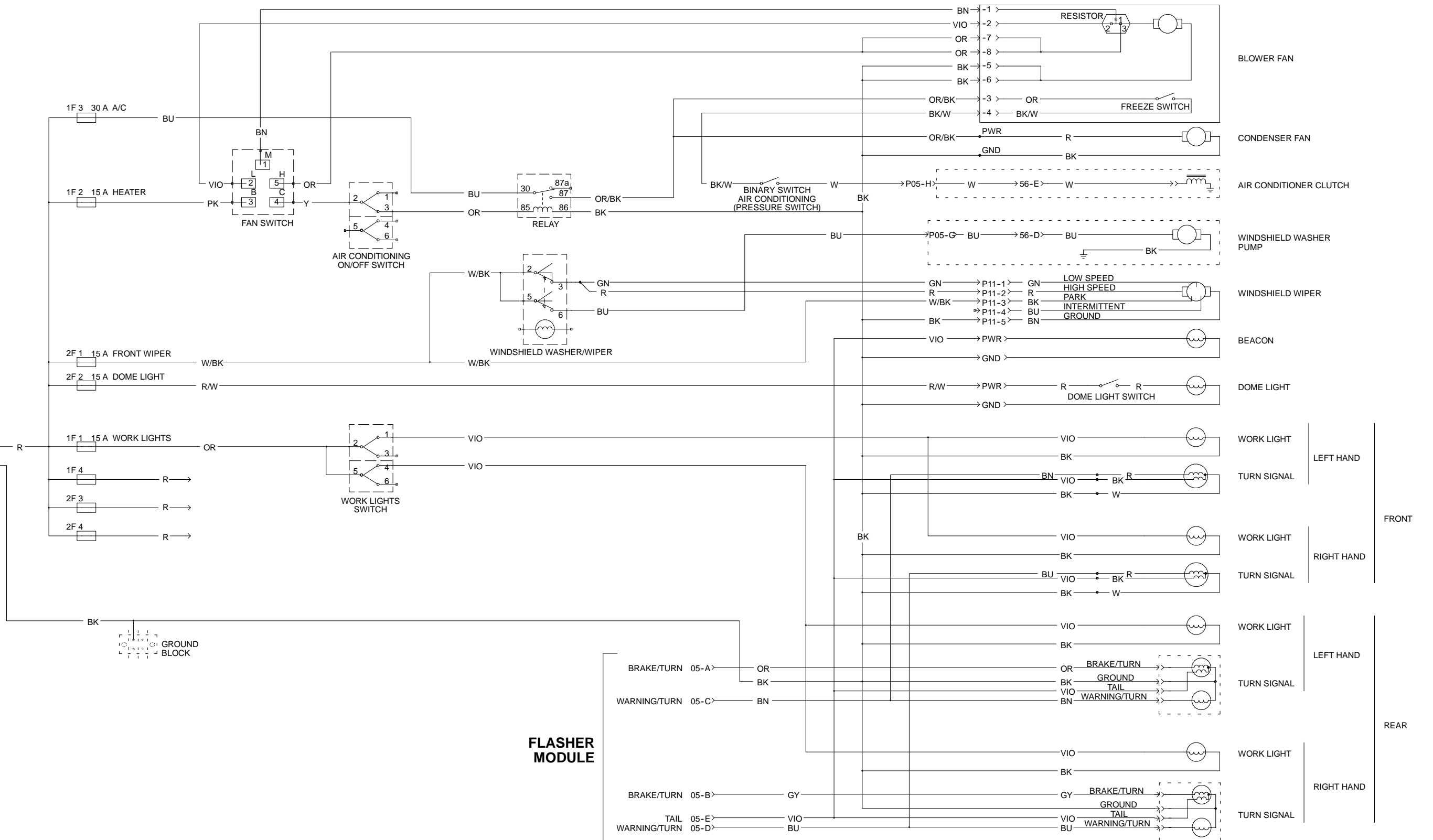
Groundsmaster 4000-D/4010-D  
Electrical Schematic  
Sheet 3 of 3

All relays and solenoids  
are shown as de-energized.  
All ground wires are black.

NOTE: THE ELECTRICAL SCHEMATIC IS SHOWN ON THREE (3) SHEETS.  
WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, THE SHEET  
NUMBER WILL BE IDENTIFIED.

**SHEET  
1 OF 3**

LINE 38  
LINE 39

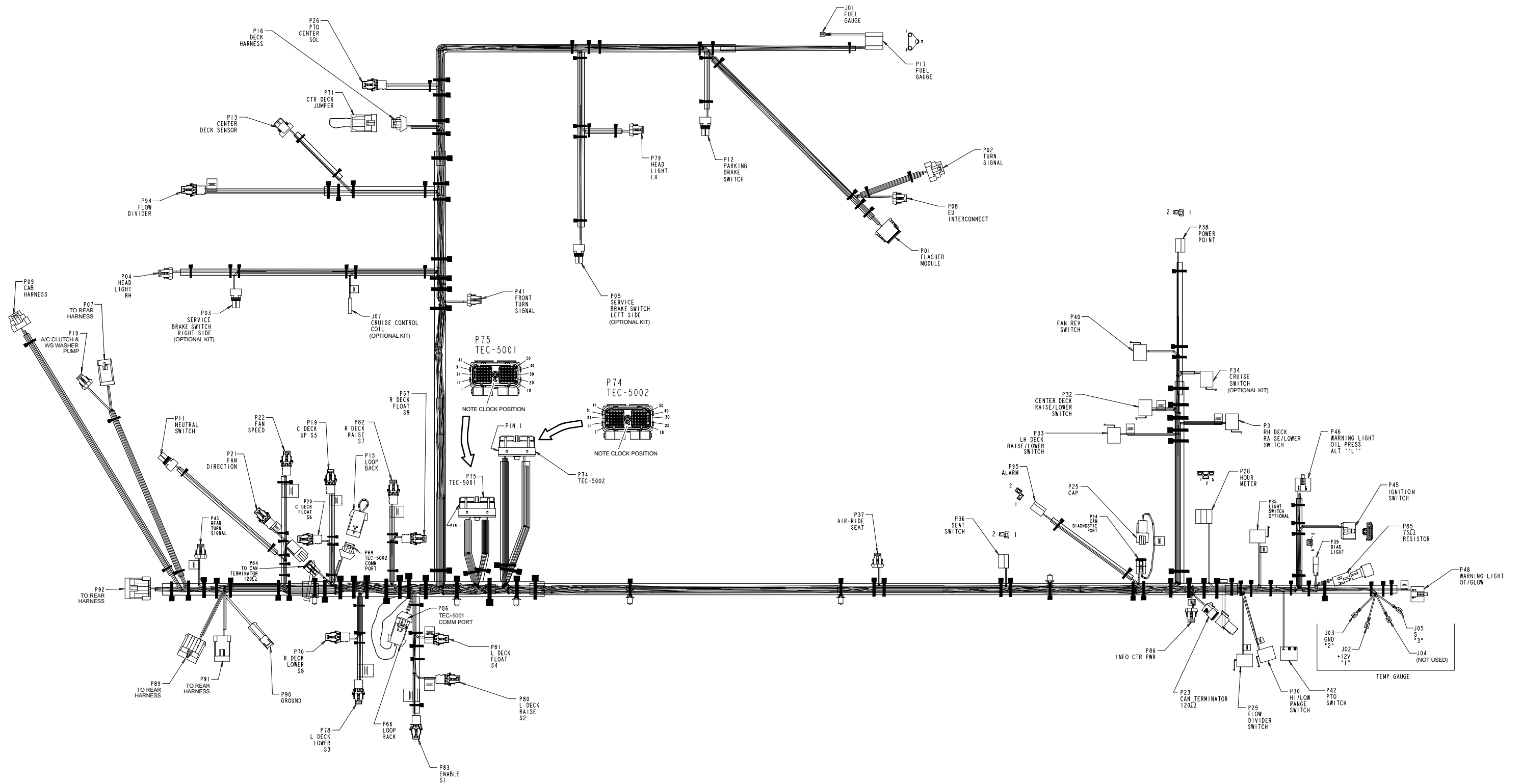


## Groundsmaster 4010-D Electrical Schematic Operator Cab

All relays and solenoids  
are shown as de-energized.  
All ground wires are black.

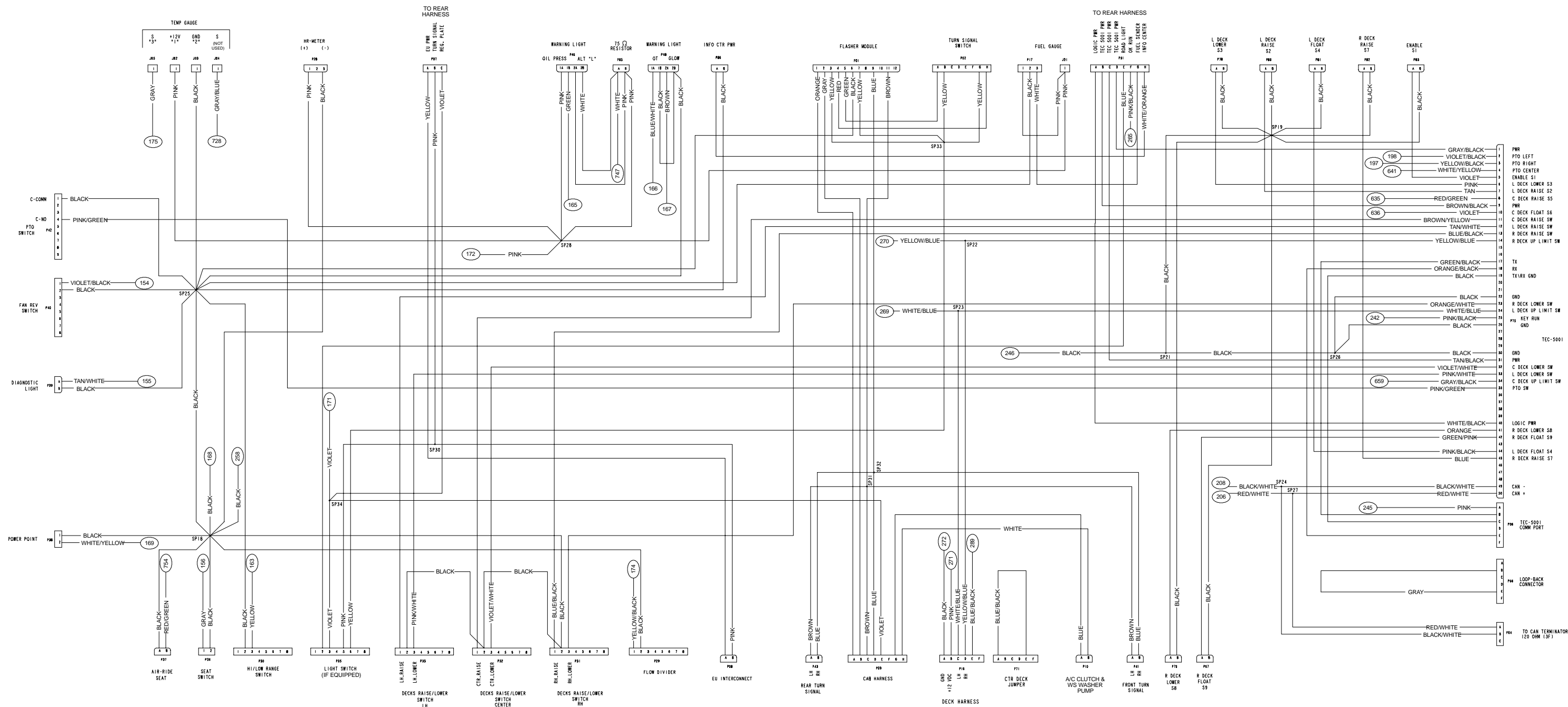
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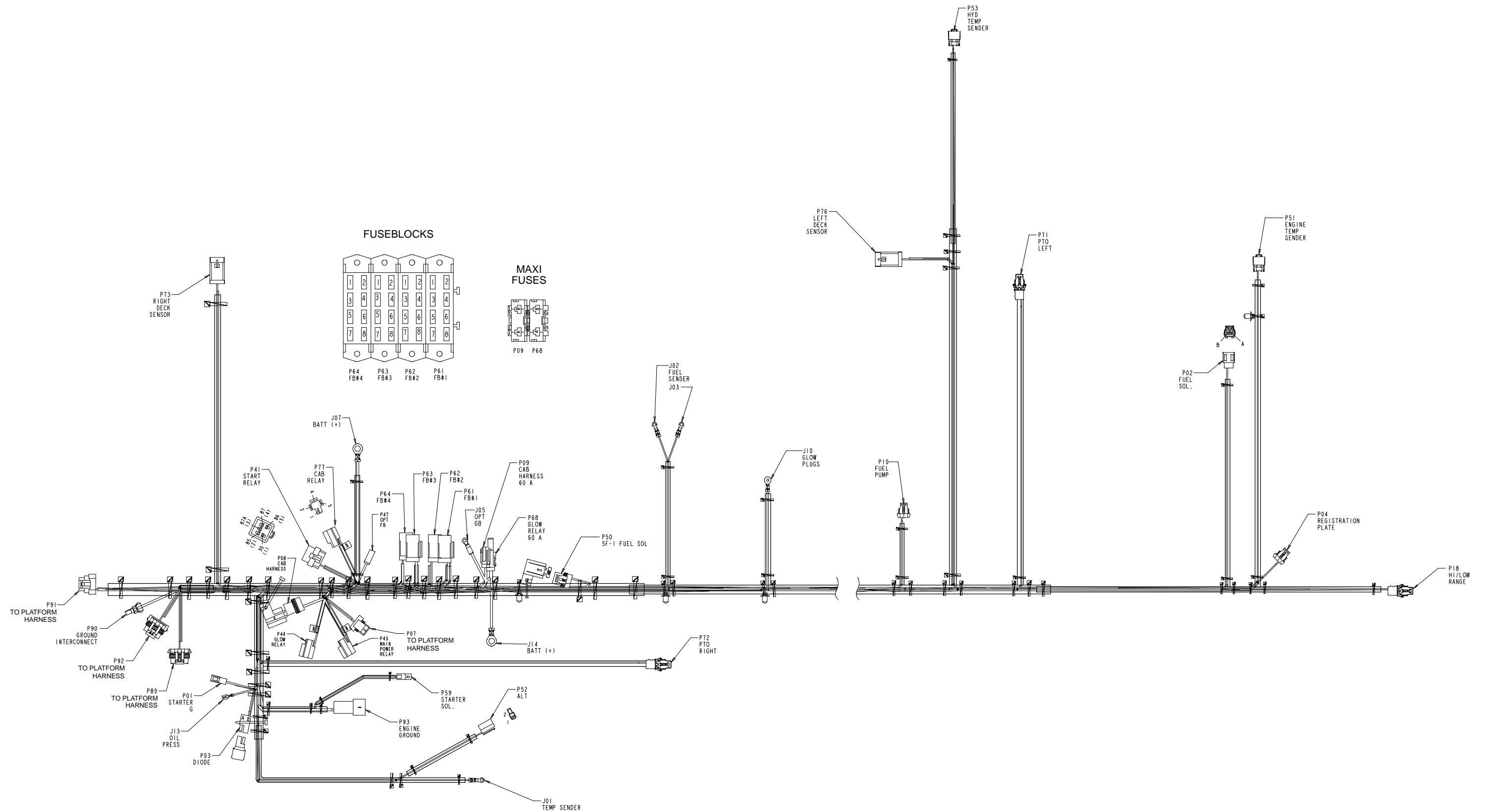
Groundsmaster 4000-D/4010-D  
Platform Wire Harness Drawing



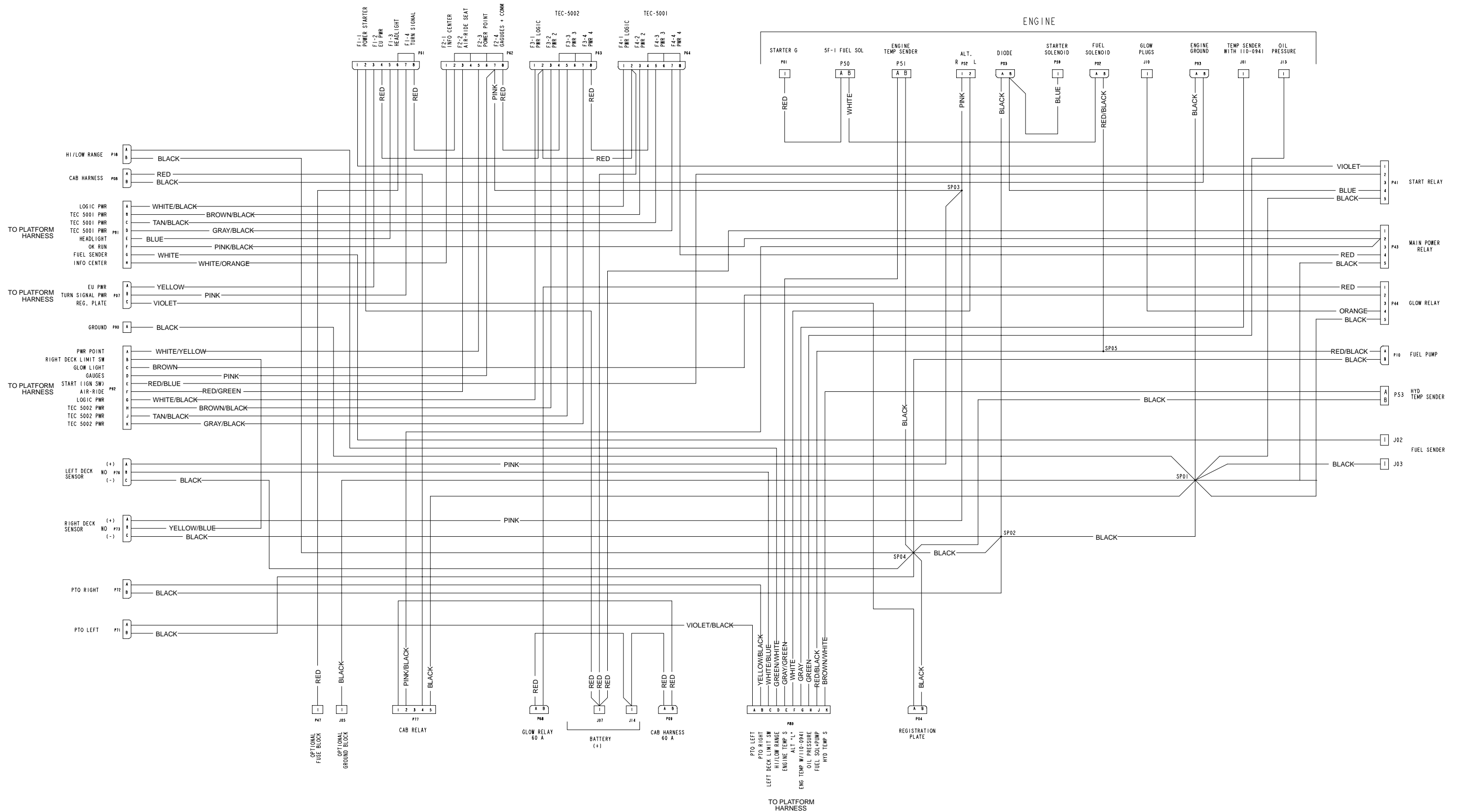


Groundsmaster 4000-D/4010-D  
**Platform Wire Harness Diagram**  
 Sheet 2 of 2

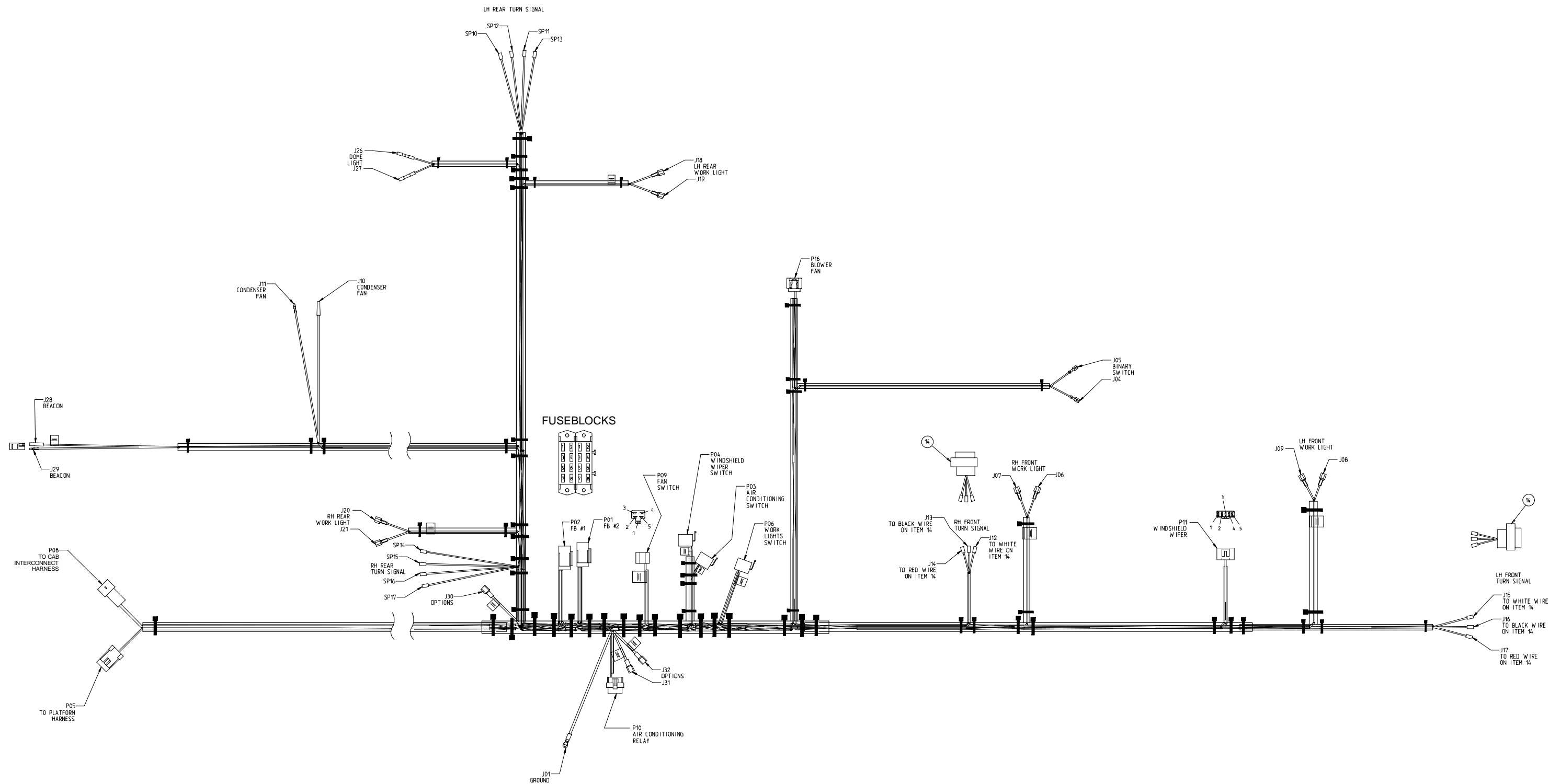
NOTE: THE PLATFORM WIRE HARNESS DIAGRAM IS SHOWN ON TWO (2) SHEETS. WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, A REFERENCE NUMBER WILL BE IDENTIFIED.



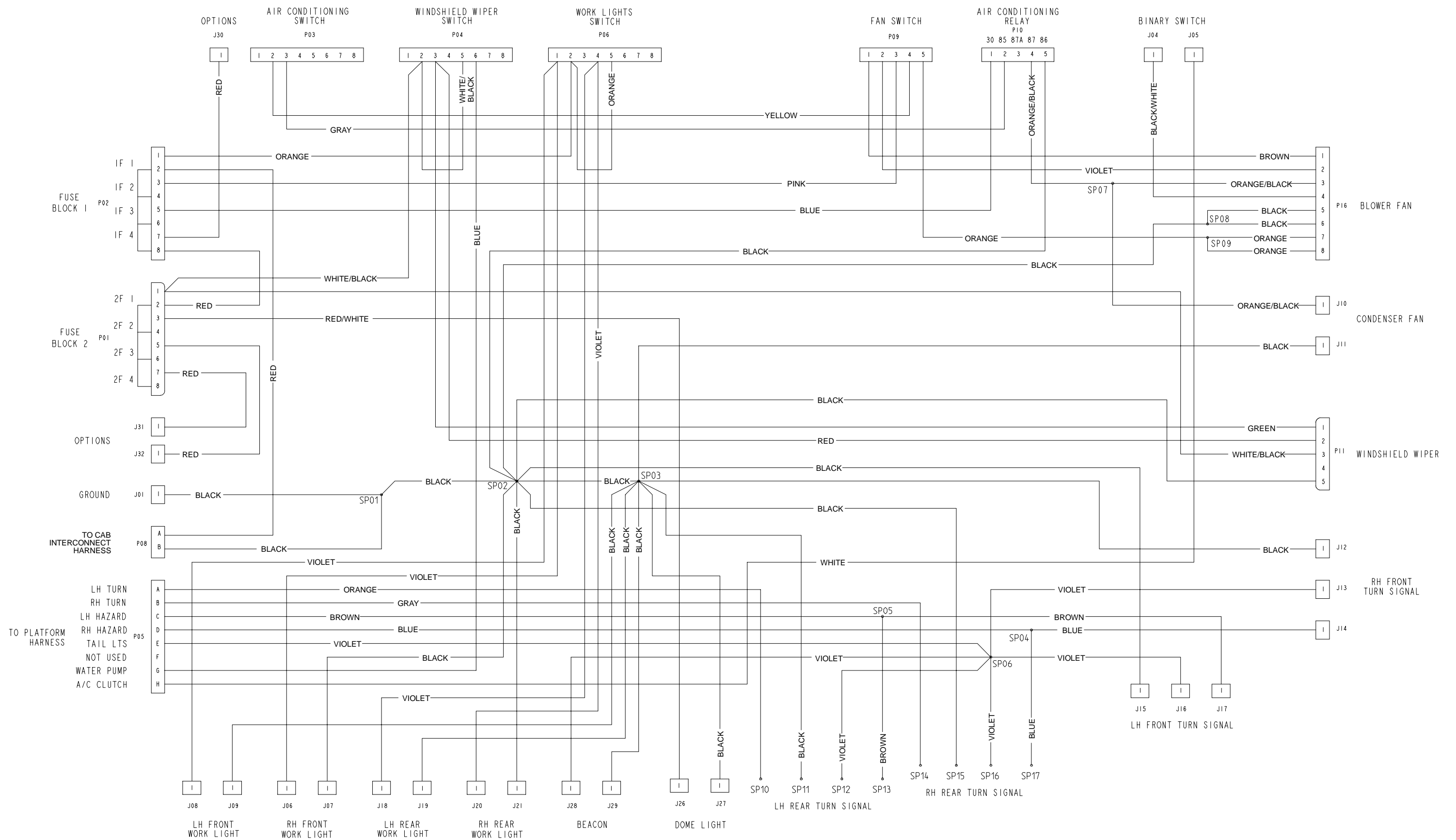
Groundsmaster 4000-D/4010-D  
Rear Wire Harness Drawing



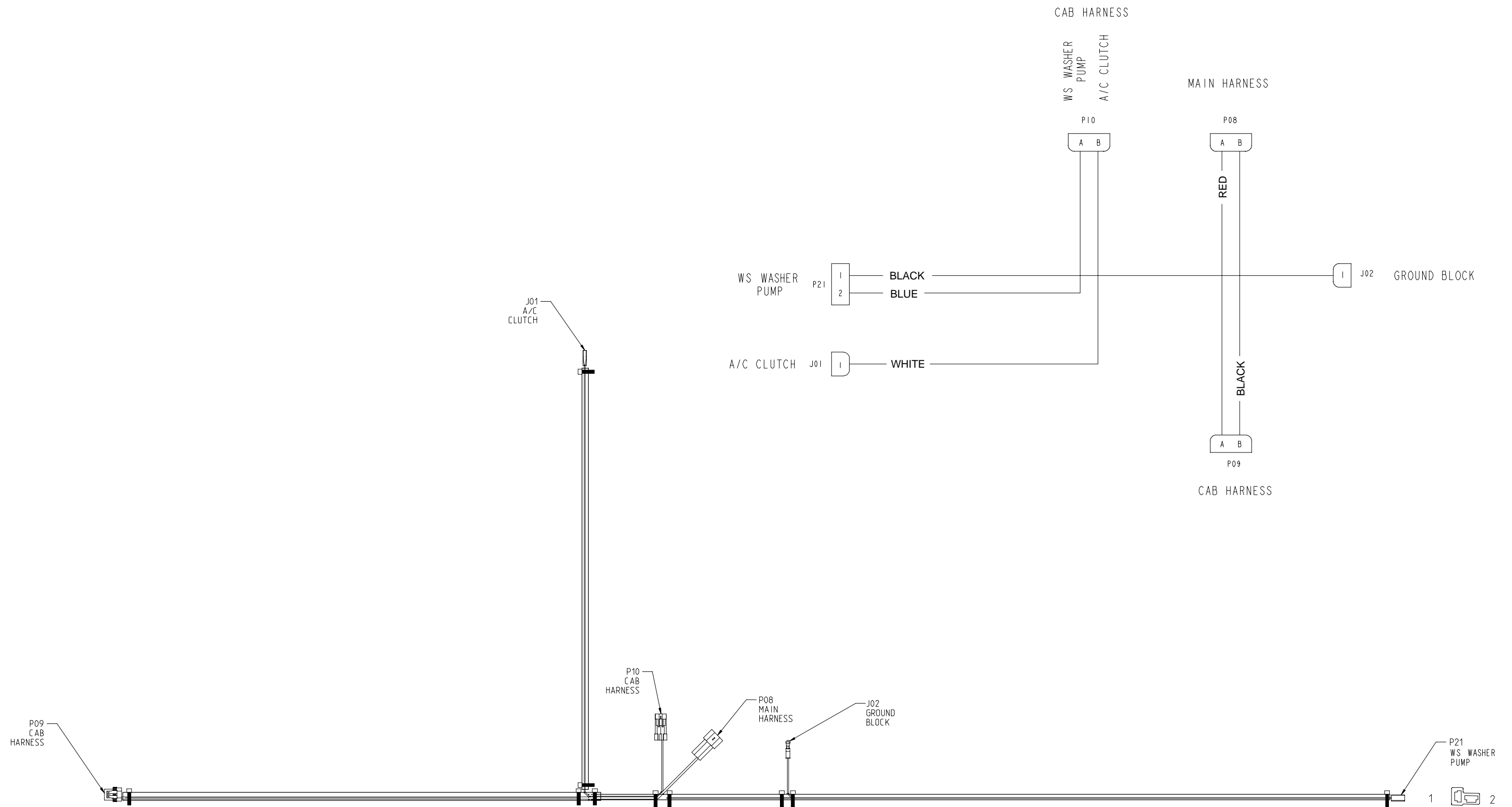
Groundsmaster 4000-D/4010-D  
Rear Wire Harness Diagram



Groundsmaster 4010-D  
**Cab Wire Harness Drawing**



Groundsmaster 4010-D  
Cab Wire Harness Diagram



Groundsmaster 4010-D  
Cab Interconnect Wire Harness