Form No. 10177SL Rev B

TORO®

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Service Manual

Groundsmaster® 4100-D & 4110-D

(Models 30449 and 30447)

Original Instructions (EN)

Revision History

Revision	Date	Description
--	2010	Initial Issue.
A	2012	Updated Hydraulic chapter.
B	03/2018	Added revision history.

Reader Comments

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NOTES

Part No. 10177SL (Rev. B)

Service Manual

(Models 30449 and 30447)

Groundsmaster® 4100–D & 4110–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 4100–D (Model 30449) and 4110–D (Model 30447).

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.

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 4100–D

Groundsmaster 4110–D

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Chapter 1

Safety

Safety

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General Safety Instructions

The Groundsmaster 4100-D and 4110–D have been tested and certified by TORO for compliance with existing safety standards and specifications. Although hazard control and accident prevention partially are dependent upon the design and configuration of the machine, these factors are also dependent upon the awareness, concern and proper training of the personnel involved in the operation, transport, maintenance and storage of the machine. Improper use or maintenance of the machine can result in injury or death. To reduce the potential for injury or death, comply with the following safety instructions.

WARNING

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

Before Operating

1. Review and understand the contents of the Operator's 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.

2. Keep all shields, safety devices and decals in place. If a shield, safety device or decal is defective, illegible or damaged, repair or replace it before operating the machine.

3. Tighten any loose nuts, bolts or screws to ensure machine is in safe operating condition.

4. Assure interlock switches are adjusted correctly so engine cannot be started unless traction pedal is in NEUTRAL and cutting deck is DISENGAGED.

5. 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.

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 linkage 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 parking brake.

   C. Disengage cutting deck 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 deck should be lowered to the ground. This relieves pressure from the lift circuit and eliminates the risk of the cutting deck unexpectedly lowering to the ground.

   F. Do not park on slopes unless wheels are chocked or blocked.

Maintenance and Service

1. Before servicing or making adjustments, lower deck, stop engine, apply parking brake and remove key from the 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 line connectors are tight and all hydraulic hoses and lines are in good condition before applying pressure to the system.

5. Keep body and hands away from pin hole leaks 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 deck 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 deck 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 jacks and supports. 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 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.

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 suitable 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 suitable jack stands under the rear axle to support the machine.

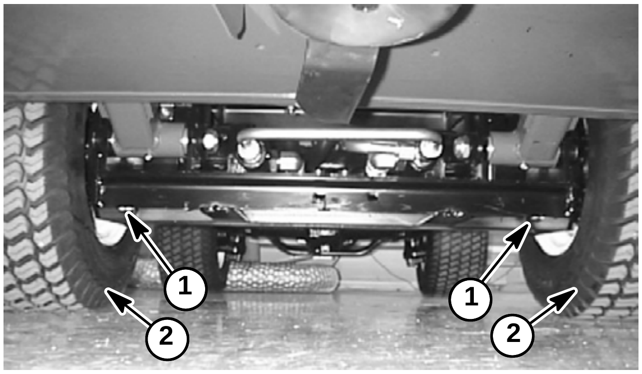

Figure 1

1. **Frame jacking point**
2. **Front tire**

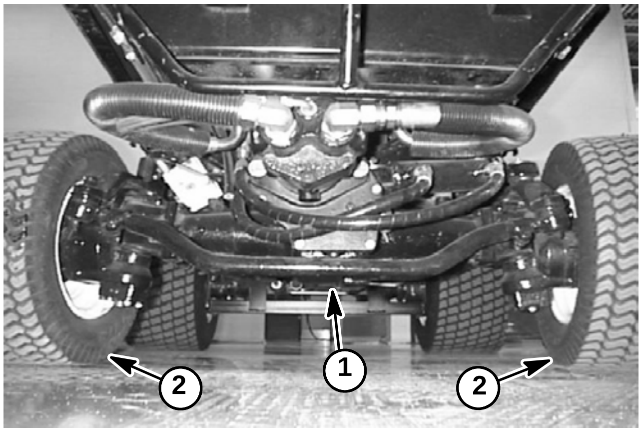

Figure 2

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.

Chapter 2

Product Records and Maintenance

Product Records and Maintenance

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Product Records

Insert Operator's Manual and Parts Catalog for your Groundsmaster at the end of this chapter. Refer to Operator's Manual for recommended maintenance intervals. Additionally, insert Installation Instructions, Operator's Manuals and Parts Catalogs for any accessories that have been installed on your Groundsmaster at the end of this section.

Maintenance

Maintenance procedures and recommended service intervals for your Groundsmaster are covered in the Operator's Manual. Refer to that publication when performing regular equipment maintenance. Several maintenance procedures have break–in intervals identified in the Operator's Manual. Refer to the Engine Operator's Manual for additional engine specific maintenance procedures.

Equivalents and Conversions

Decimal and Millimeter Equivalents

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

U.S.to Metric Conversions

	To Convert	Into	Multiply By
Linear Measurement	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
Area	Square Miles	Square Kilometers	2.59
	Square Feet	Square Meters	0.0929
	Square Inches	Square Centimeters	6.452
	Acre	Hectare	0.4047
Volume	Cubic Yards	Cubic Meters	0.7646
	Cubic Feet	Cubic Meters	0.02832
	Cubic Inches	Cubic Centimeters	16.39
Weight	Tons (Short)	Metric Tons	0.9078
	Pounds	Kilograms	0.4536
	Ounces (Avdp.)	Grams	28.3495
Pressure	Pounds/Sq. In.	Kilopascal	6.895
	Pounds/Sq. In.	Bar	0.069
Work	Foot-pounds	Newton-Meters	1.356
	Foot-pounds	Kilogram-Meters	0.1383
	Inch-pounds	Kilogram-Centimeters	1.152144
Liquid Volume	Quarts	Liters	0.9463
	Gallons	Liters	3.785
Liquid Flow	Gallons/Minute	Liters/Minute	3.785
Temperature	Fahrenheit	Celsius	1. Subract 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

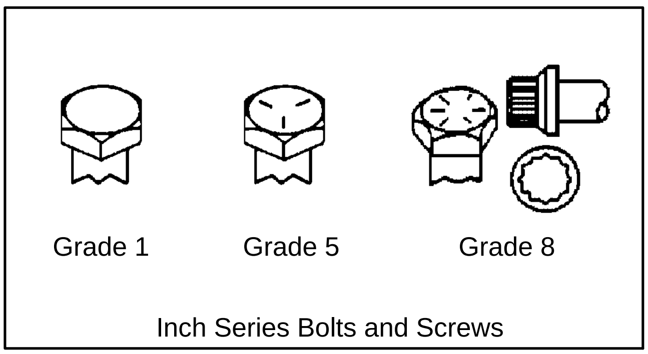

Figure 1

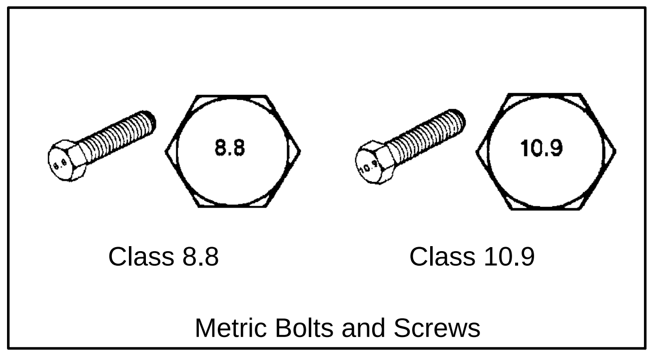

Figure 2

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.

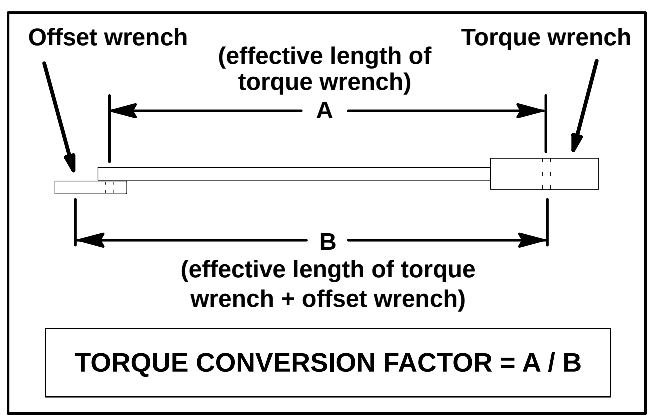

Figure 3

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

Other Torque Specifications

SAE Grade 8 Steel Set Screws

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

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

in–lb X 11.2985 = N–cm
ft–lb X 1.3558 = N–m

N–cm X 0.08851 = in–lb
N–m X 0.7376 = ft–lb

Chapter 3

Kubota Diesel Engine

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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 cc (cu. in.)	148.5 in^3 (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	19.0 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)	1450 $\pm$ 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	10.0 U.S. quarts (9.5 liters) with Filter
Oil Pump	Trochoid Type
Coolant Capacity Groundsmaster 4100–D Groundsmaster 4110–D	 13 U.S. quarts (12.3 liters) 17 U.S. quarts (16.1 liters)
Starter	12 VDC, 2.0 kW
Alternator/Regulator Groundsmaster 4100–D Groundsmaster 4110–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 the Groundsmaster 4100–D and 4110–D.

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 Series 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 Series. 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.

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

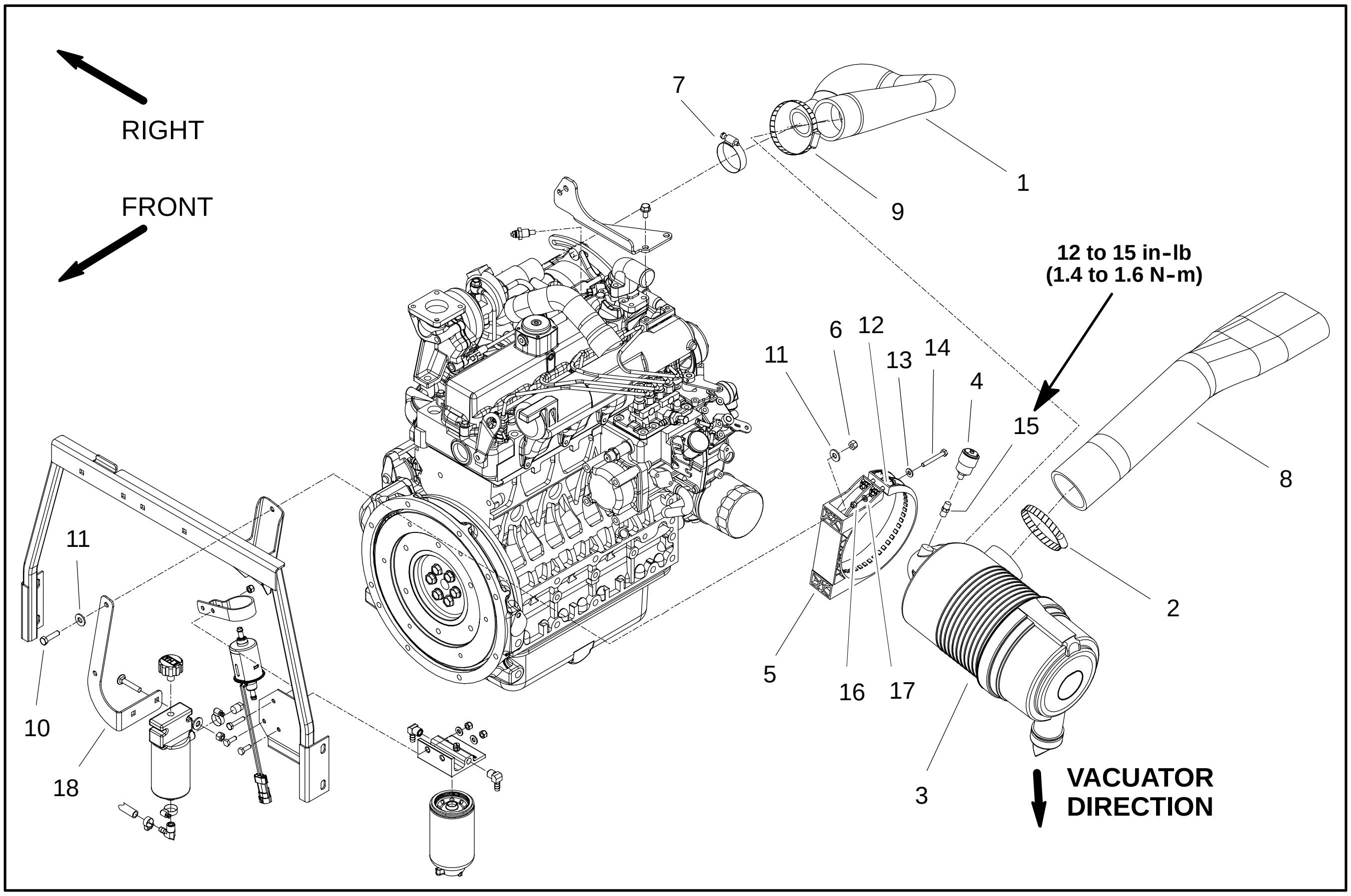

Figure 1

1. **Air cleaner hose**
2. **Hose clamp**
3. **Air cleaner assembly**
4. **Service 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 deck, 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.

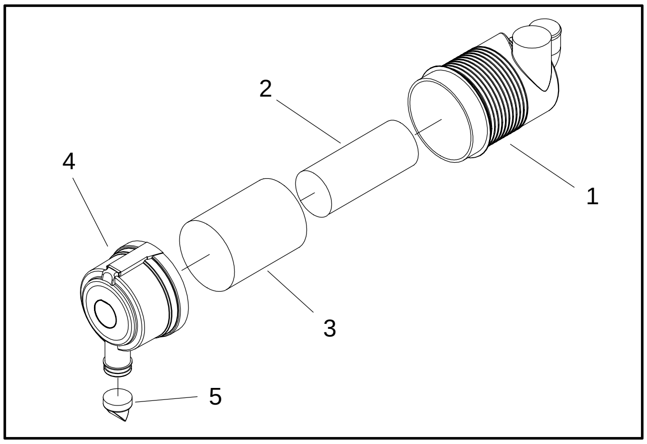

Figure 2

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

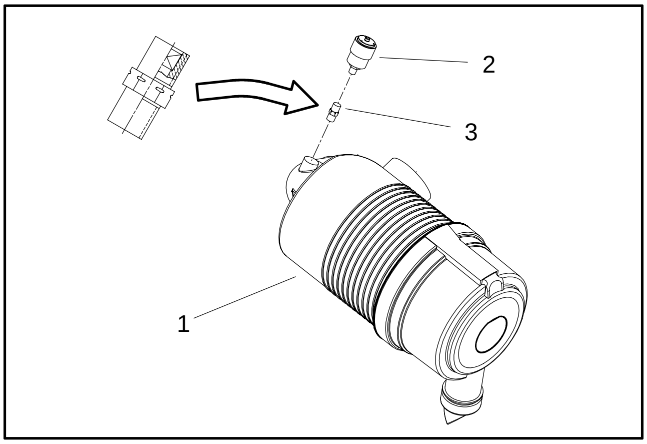

Figure 3

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

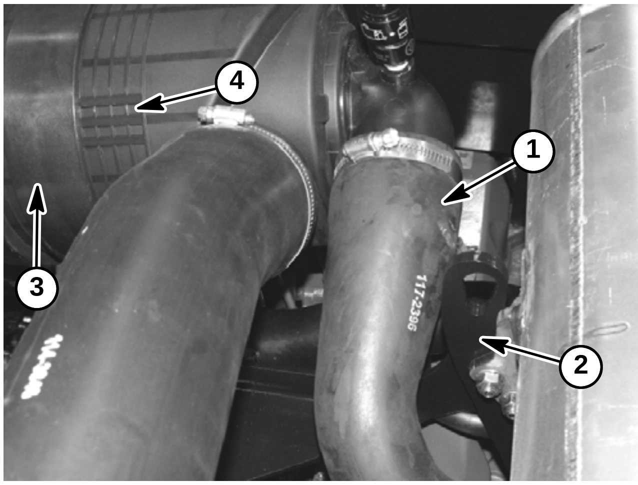

Figure 4

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

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Exhaust System

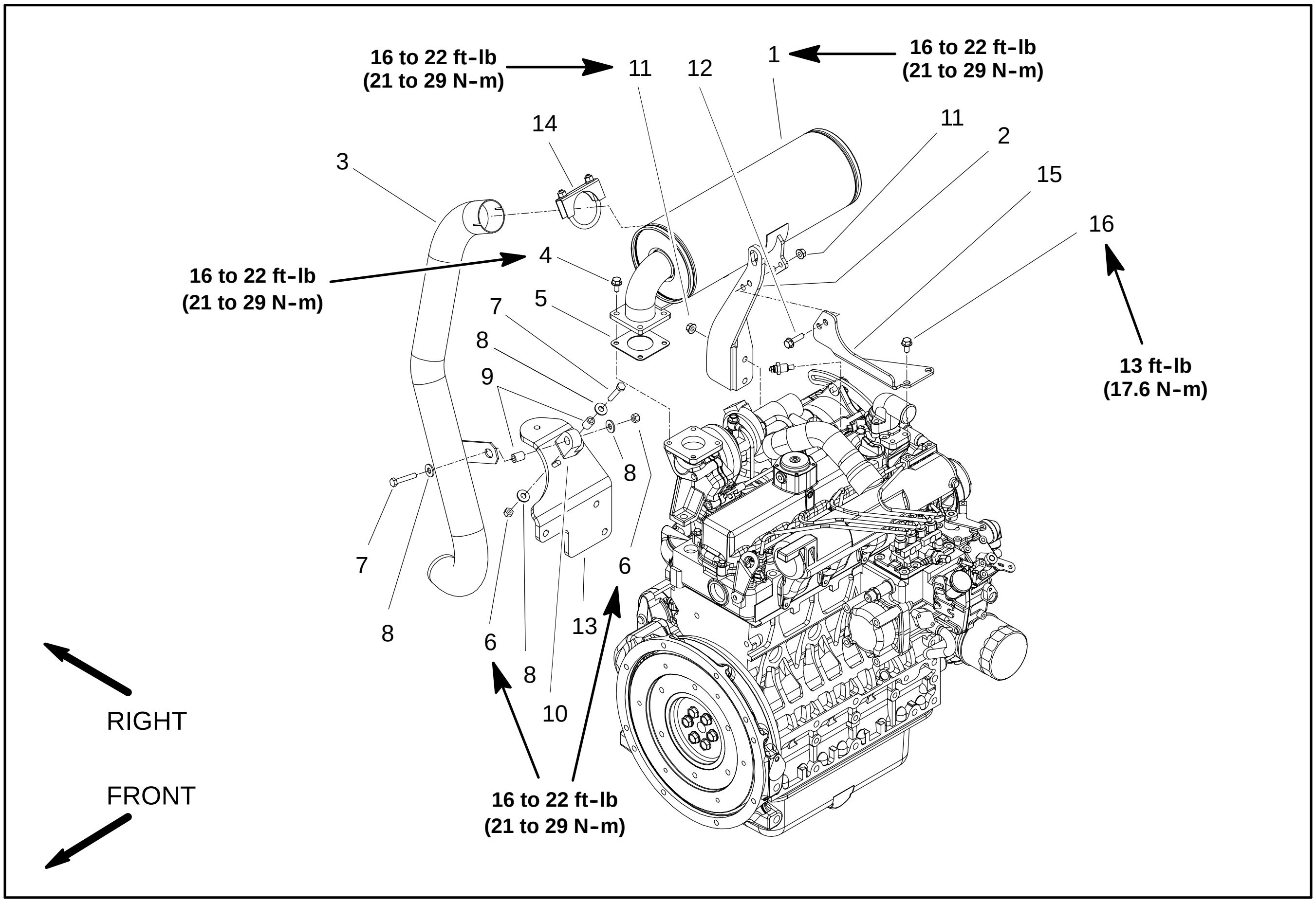

Figure 5

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

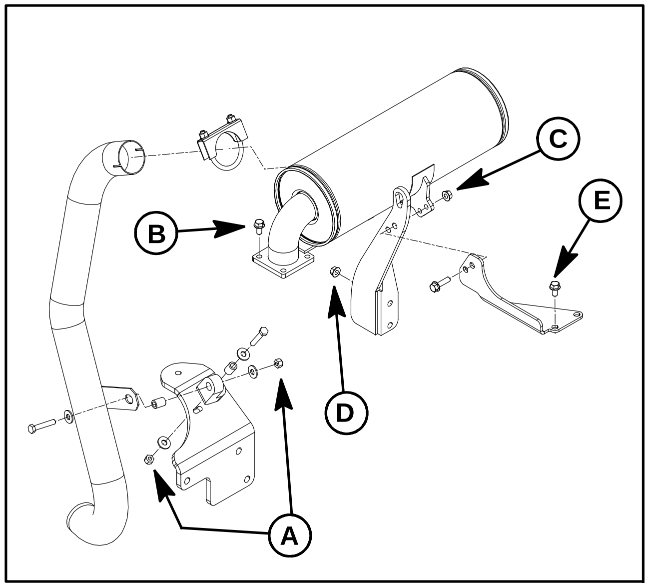

Figure 6

Fuel System

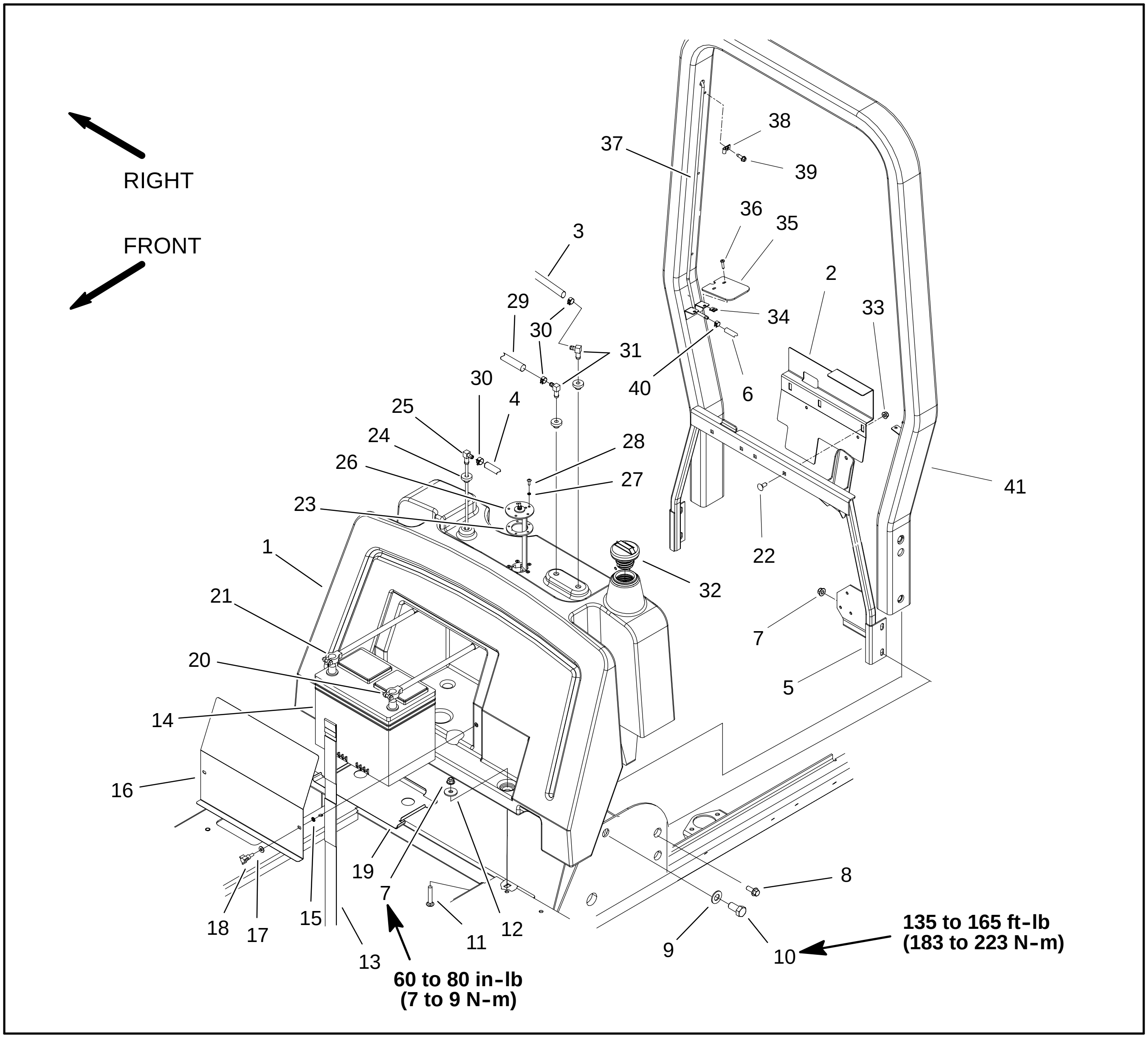

Figure 7

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

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, leaks 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 contaminates and debris.

Fuel Tank Removal (Fig. 7)

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

2. Raise and support 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 electrical wiring from the fuel sender on the fuel tank.

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 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).

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 seat and hood.

7. Fill fuel tank.

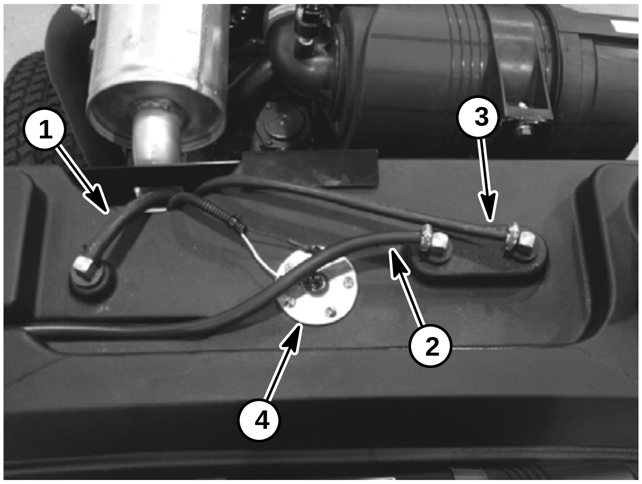

Figure 8

1. **Fuel supply hose**
2. **Vent hose**
3. **Overflow hose**
4. **Fuel sender**

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Radiator

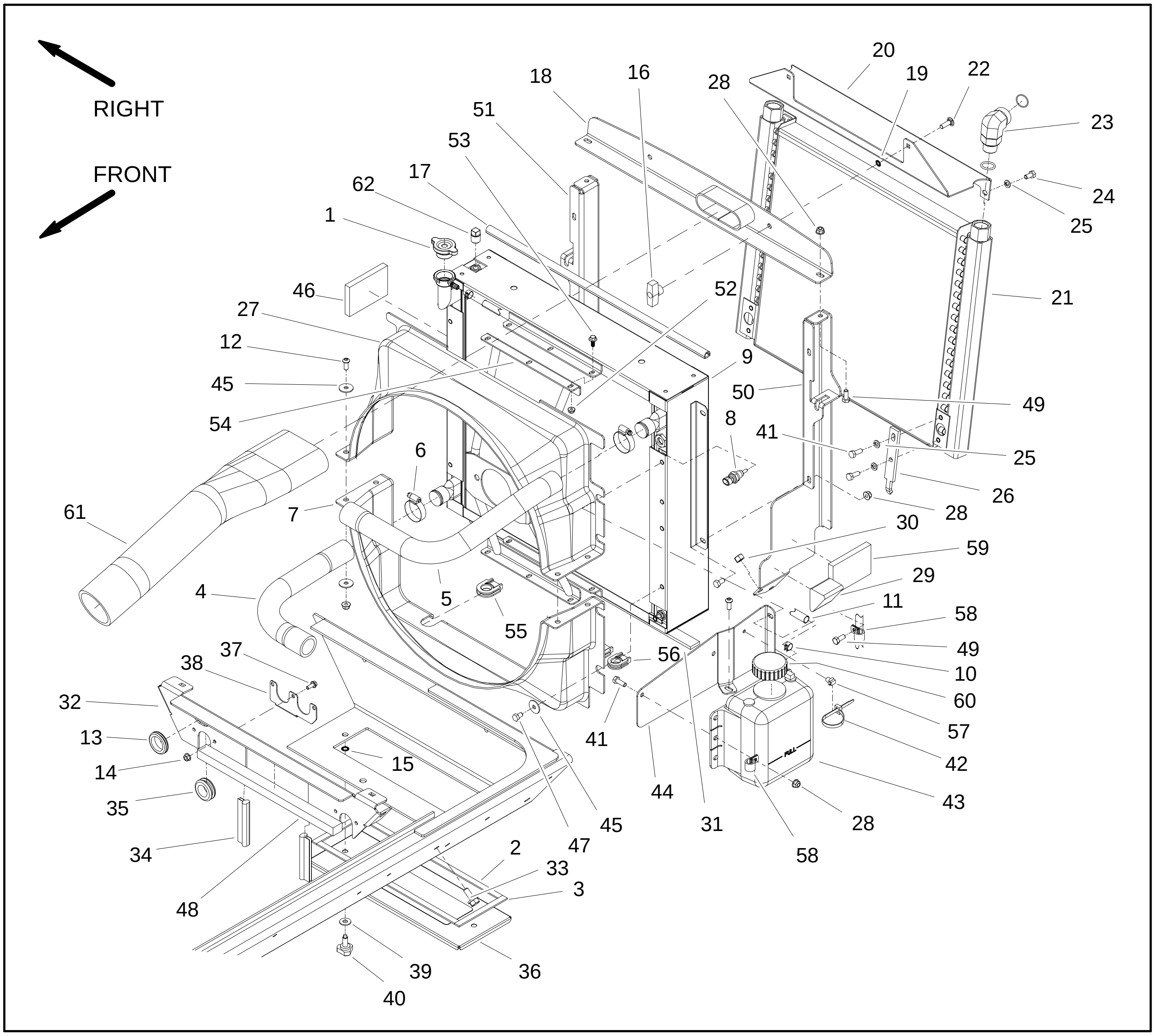

Figure 9

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

Removal (Fig. 9)

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

2. Open 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.

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 from radiator and hose openings that were 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

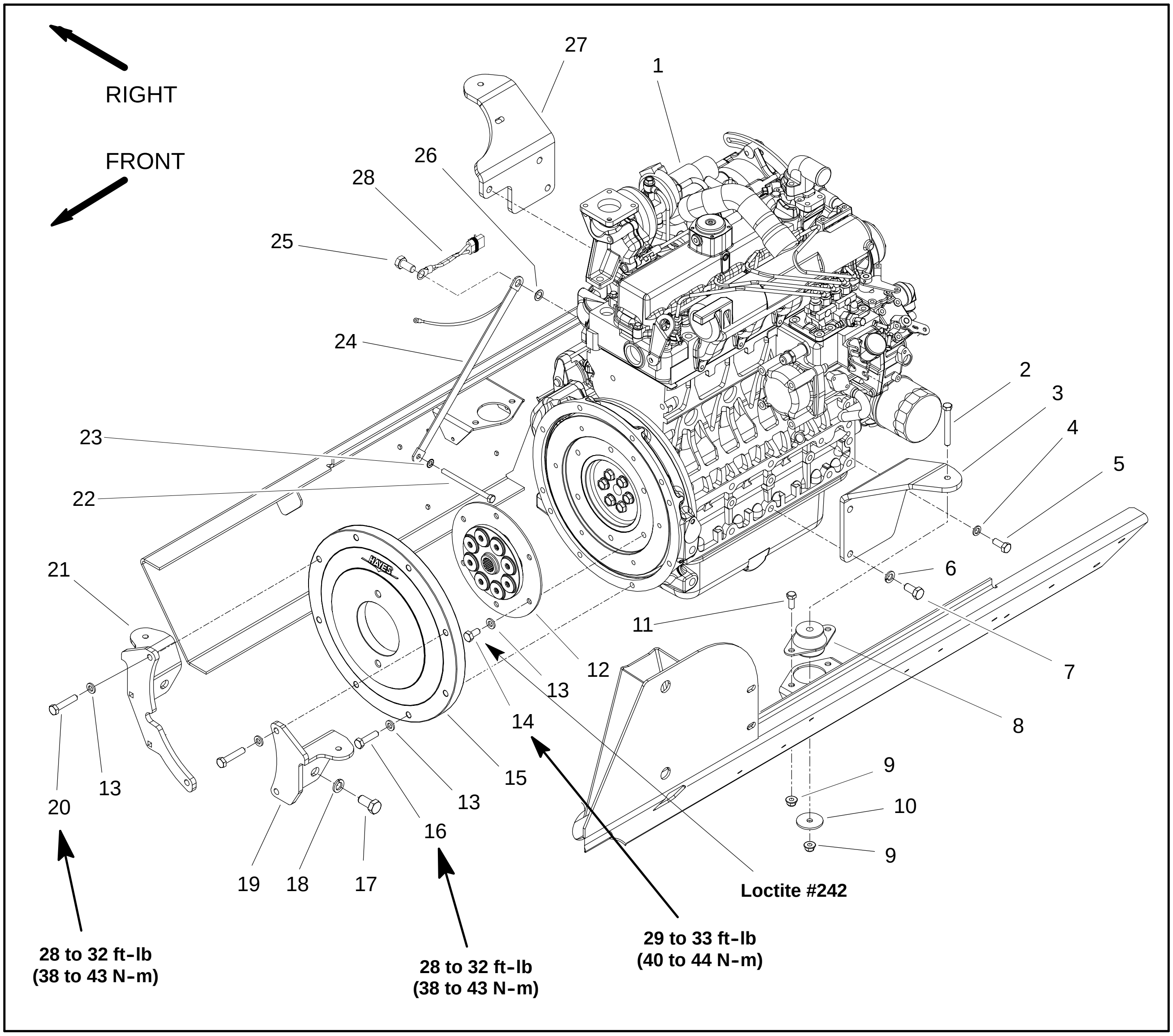

Figure 10

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

Engine Removal (Fig. 10)

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

2. Remove battery cover and strap. Disconnect negative battery cable first and then positive battery cable. Remove battery from machine.

3. Open 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 plug lead (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 (on RH side of engine).

F. The air conditioning compressor (Groundsmaster 4110-D machines).

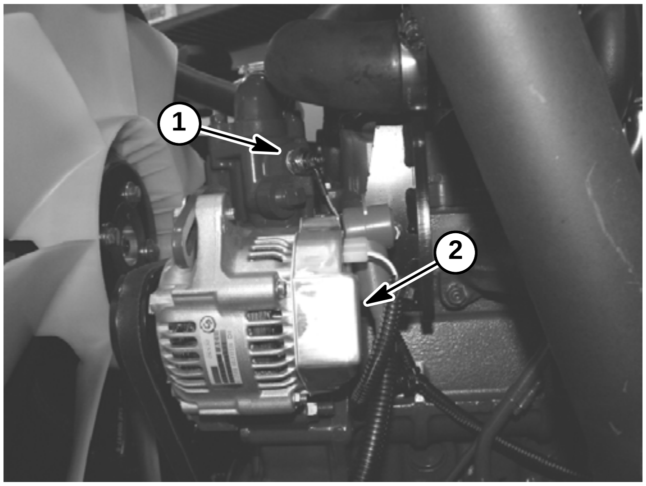

Figure 11

1. **Temperature sender**
2. **Alternator**

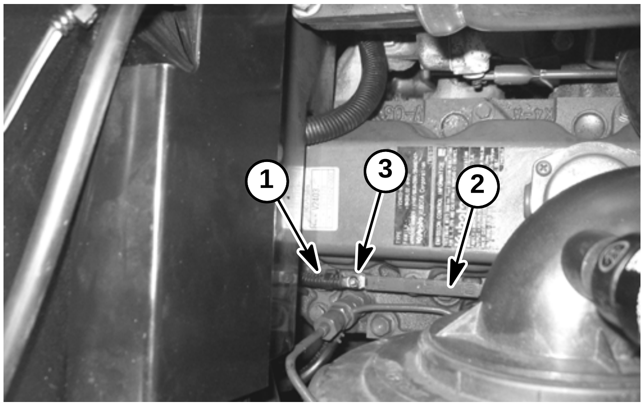

Figure 12

1. **Glow plug wire**
2. **Glow plug lead**
3. **Cylinder #4 glow plug**

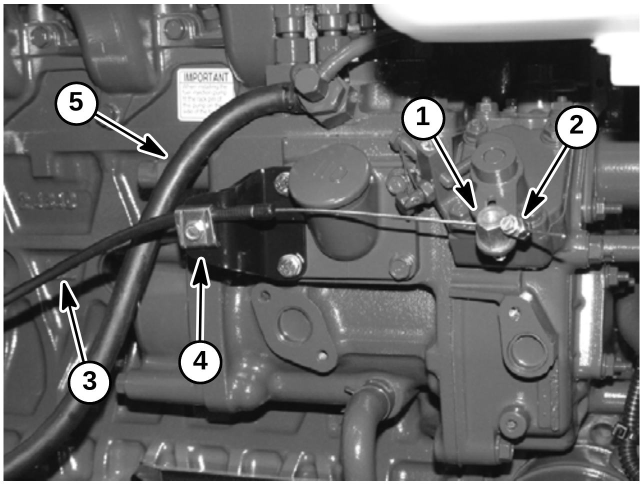

Figure 13

1. **Cable swivel**
2. **Cable stop**
3. **Throttle cable**
4. **Cable clamp**
5. **Fuel supply hose**

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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 hoses for proper assembly.

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

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

12. On Groundsmaster 4110–D machines:

A. Remove windshield washer reservoir from reservoir mount on engine (Fig. 16). 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.

13. 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).

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

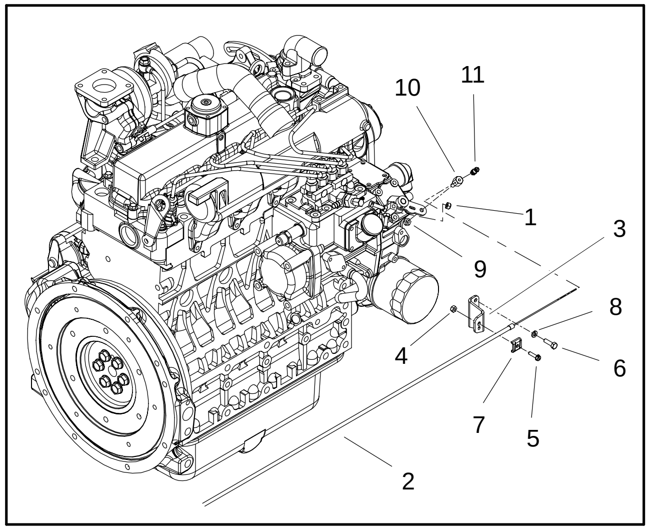

Figure 14

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

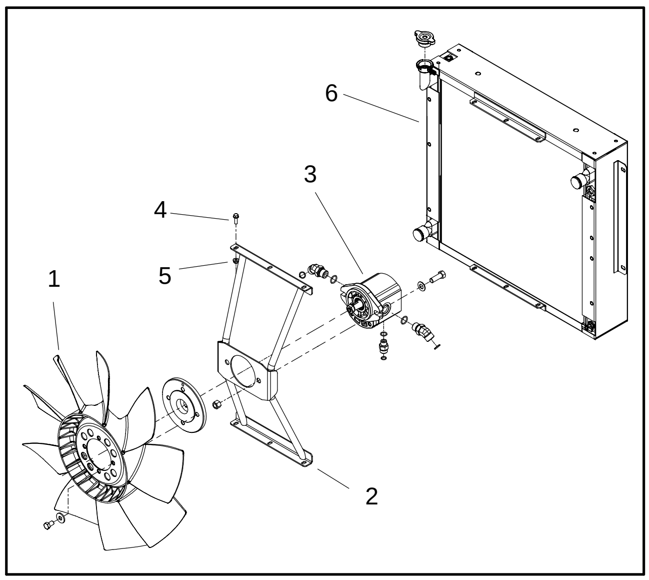

Figure 15

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

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

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

CAUTION

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

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

17.Slowly remove engine assembly from the machine.

18.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.

CAUTION

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

IMPORTANT: Make sure to not damage the engine, fuel hoses, 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).

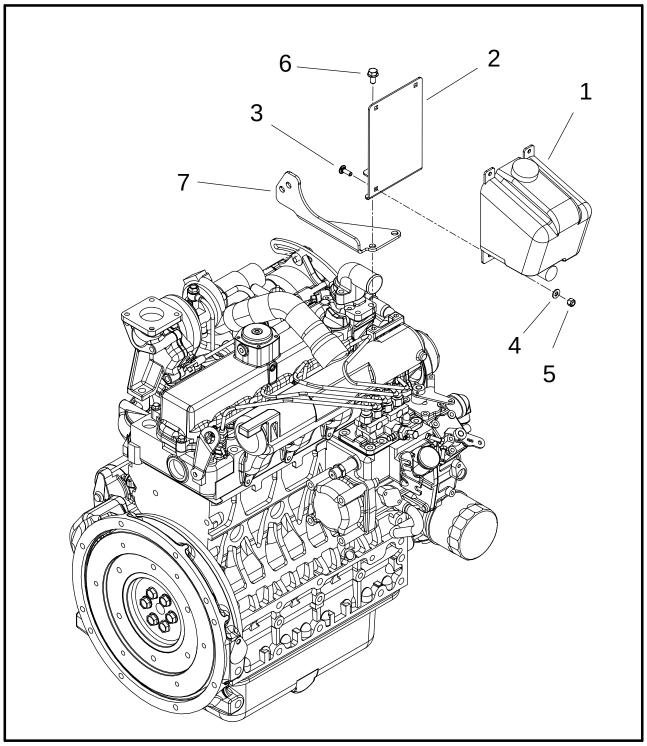

Figure 16

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

7. Install cooling 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 that were 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.

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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. On Groundsmaster 4110–D machines:

A. Position windshield washer reservoir to bracket reservoir mount on engine (Fig. 16). 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.

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

A. The temperature sender and alternator (Fig 11).

B. The engine run solenoid.

C. The glow plug lead (Fig. 12).

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 4110–D machines).

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

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

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

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

17. 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.

18. Check and adjust engine oil as needed.

19. Check and adjust hydraulic oil as needed.

20. Bleed fuel system.

21. 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).

22. Close and secure hood.

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Spring Coupler

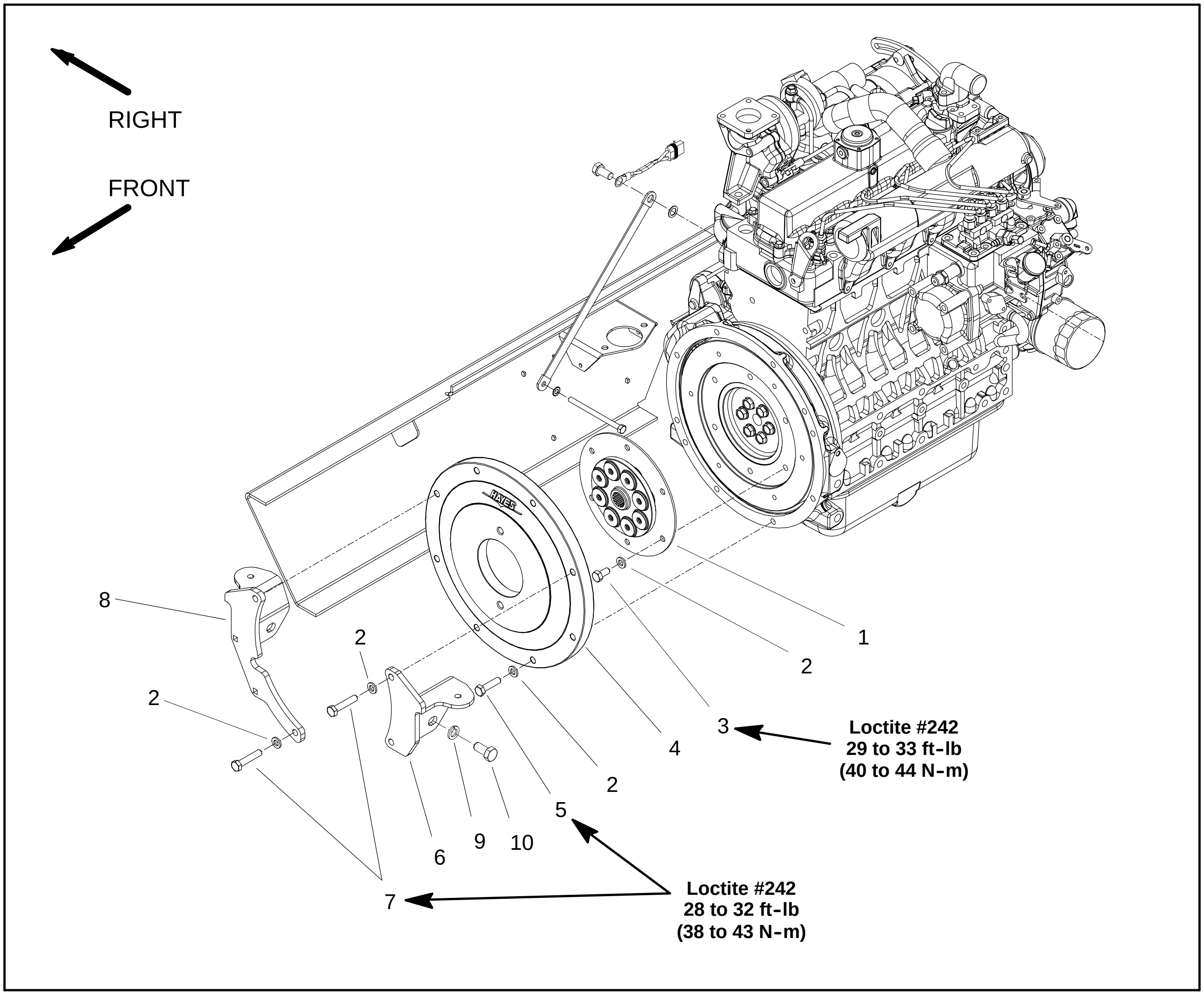

Figure 17

1. **Spring coupler**
2. **Washer (14 used)**
3. **Cap screw (6 used)**
4. **Flywheel plate**
5. **Cap screw (4 used)**
6. **LH engine mount**
7. **Cap screw (2 used)**
8. **RH engine mount**
9. **Lock washer (2 used)**
10. **Cap screw (2 used)**

Coupler Removal (Fig. 17)

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

2. Remove flywheel plate and spring coupler from engine using Figure 17 as a guide.

Coupler Installation (Fig. 17)

1. Position spring coupler to engine flywheel and align mounting holes. Make sure that coupler hub is away from engine flywheel (Fig. 18).

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. Position flywheel plate to engine and engine mounts. Apply Loctite #242 (or equivalent) to threads of cap screws (items 5 and 7). 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 hydraulic pump assembly (see Piston (Traction) Pump Installation in the Service and Repairs section of Chapter 4 – Hydraulic System).

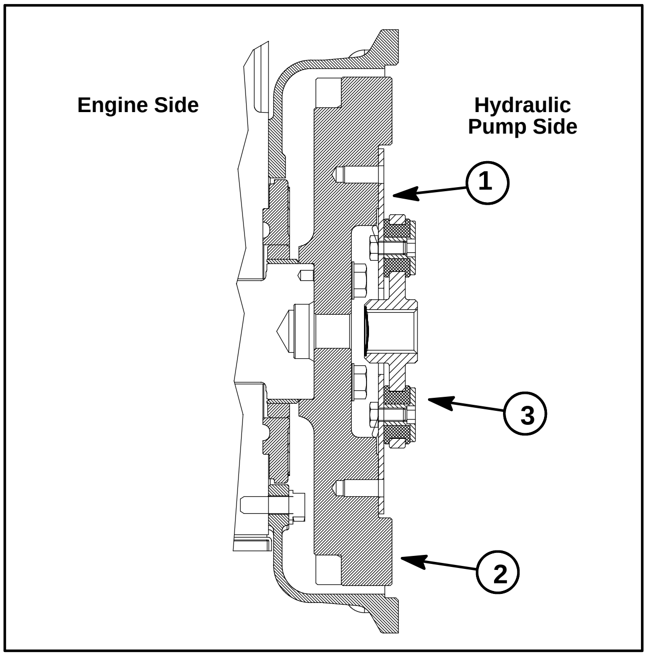

Figure 18

1. **Spring coupler**
2. **Engine flywheel**
3. **Coupler hub**

Kubota Diesel Engine

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Chapter 4

Hydraulic System

Table of Contents

Hydraulic System

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^3 (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 74328) 3.02 in^3 (49.4 cc)
Rear Axle Motor Displacement (per revolution)	Eaton Fixed Displacement Piston Motor (Model 74315) 2.01 in^3 (32.9 cc)
Gear Pump Section P1/P2 Displacement (per revolution) Section P3/P4 Displacement (per revolution)	Casappa 4 section, positive displacement gear type pump 1.37 in^3 (22.46 cc) 0.56 in^3 (9.16 cc)
Steering Control Valve Displacement (per revolution)	Eaton Steering Unit, Series 5 6.1 in^3 (100 cc)
Steering Relief Pressure	1350 PSI (93 bar)
Lift/Lower Relief Pressure	2500 PSI (172 bar)
Cutting Deck Motors Displacement (per revolution)	Sauer Danfoss Gear Motor 1.17 in^3 (19.2 cc)
Cutting Deck Circuit Relief Pressure Center 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^3 (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

Your Groundsmaster hydraulic system is designed to operate on anti–wear hydraulic fluid. The reservoir 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 hydraulic oil recommendations.

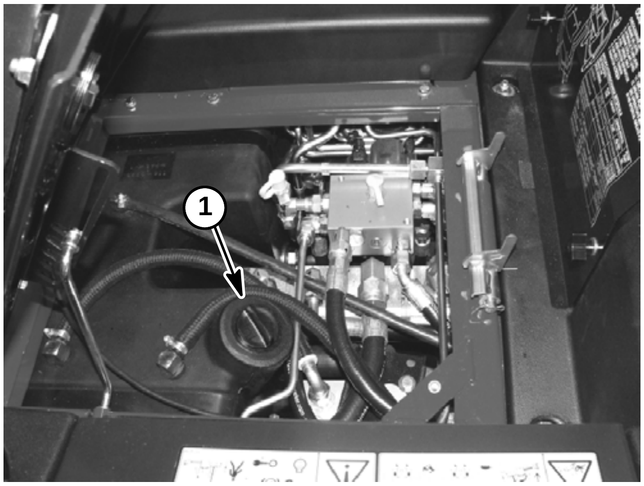


Figure 1

1. Hydraulic reservoir cap

Towing Traction Unit

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

If it becomes necessary to tow (or push) the machine, tow (or push) in a **forward direction only** 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 90º for towing. See Operator's Manual for Towing Procedures.

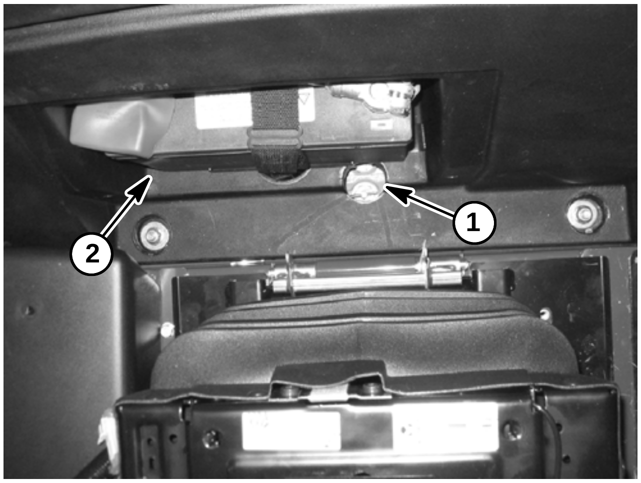


Figure 2

1. By–pass valve **2. Battery**

Hydraulic System

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, lower cutting deck 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 deck (including the wing 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 4100–D and 4110–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 contaminates are removed from the closed loop and thus, do not cause additional component damage.

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

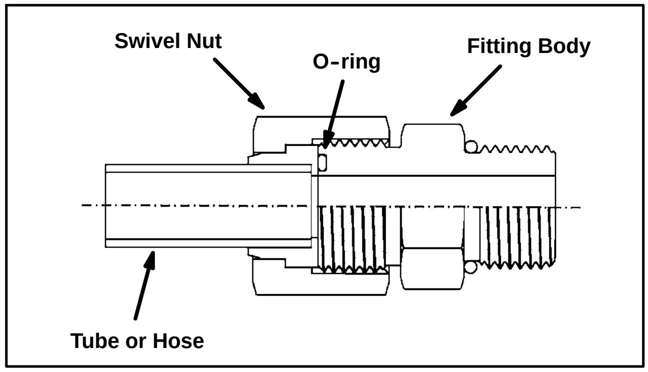


Figure 3

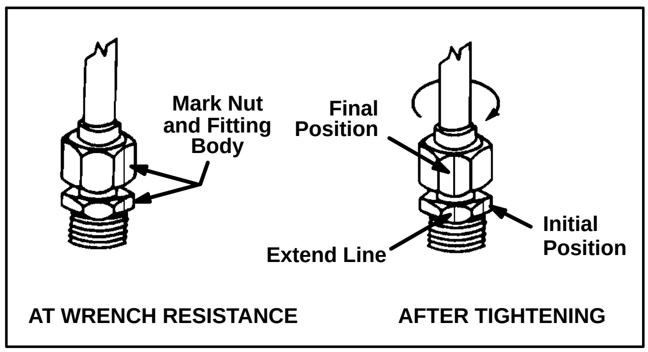


Figure 4

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

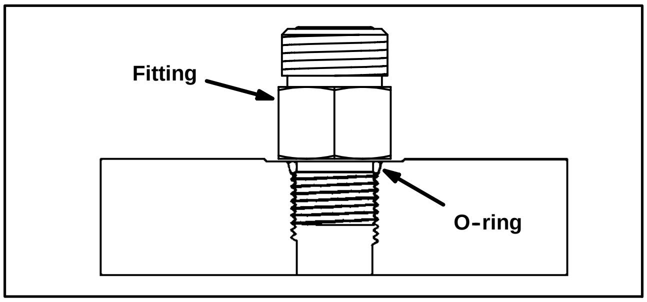


Figure 6

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.

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

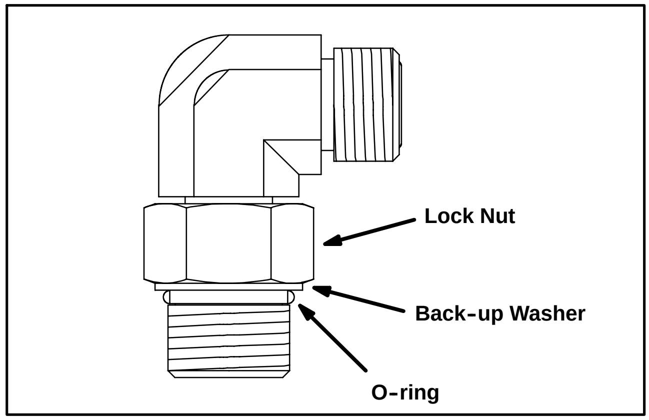


Figure 8

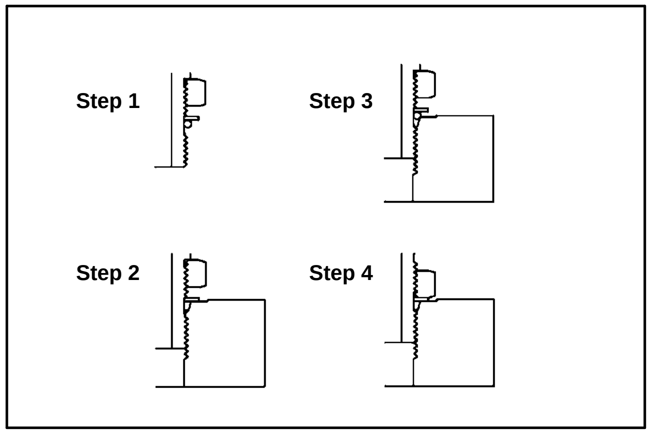
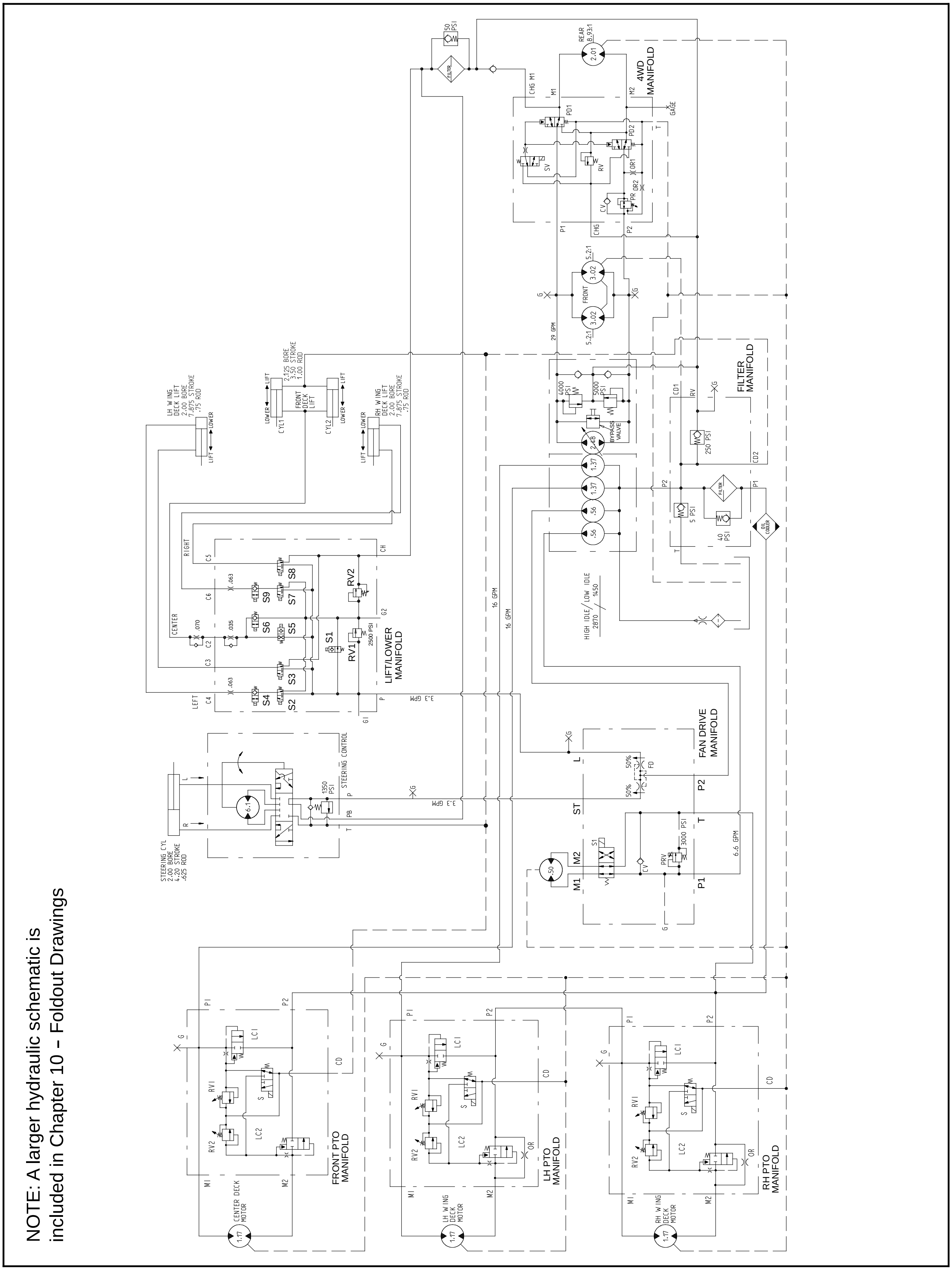
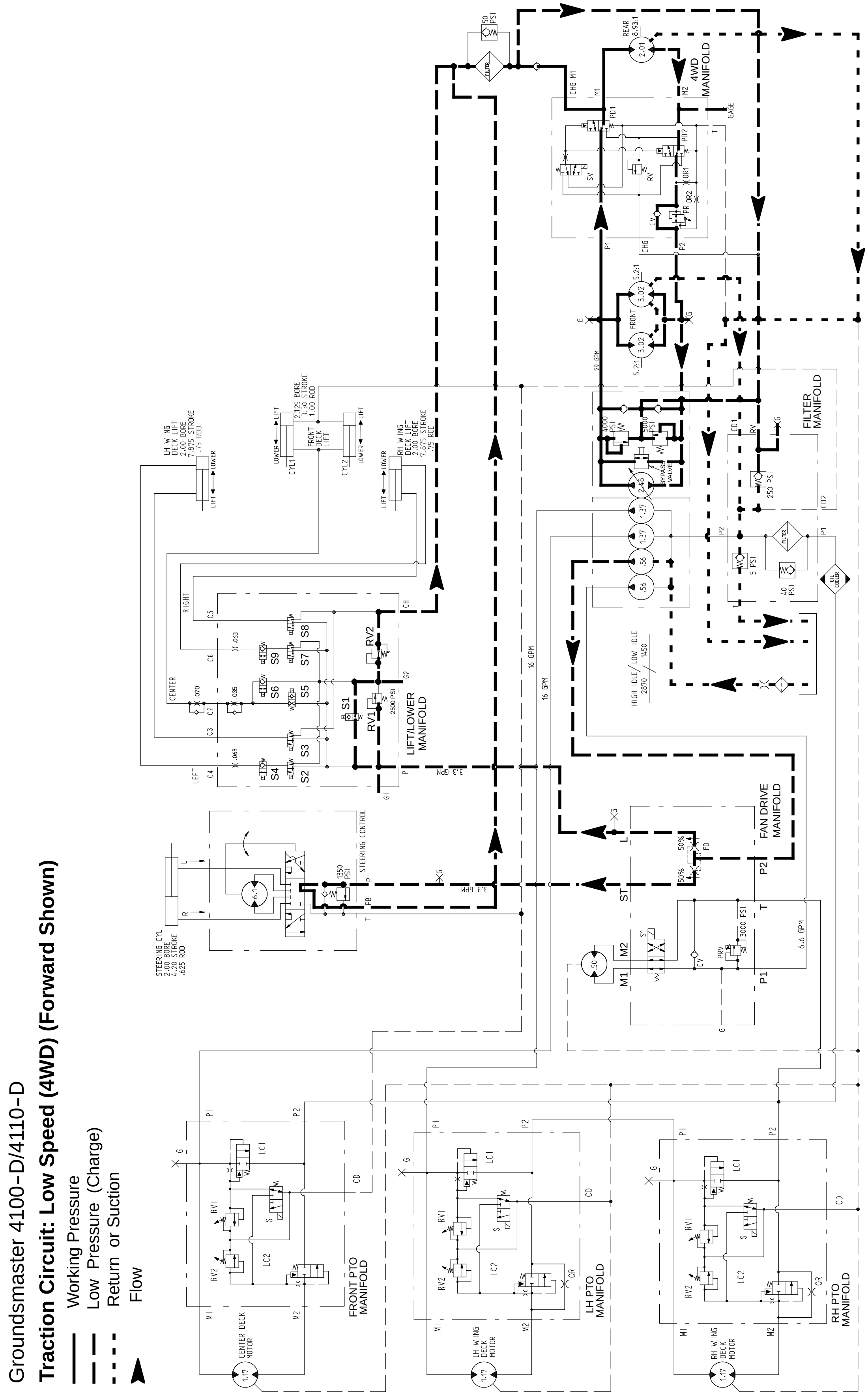


Figure 9

Hydraulic Schematic



Hydraulic Flow Diagrams



Traction Circuit: Low Speed (4WD)

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 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.

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 is directed to the front wheel motors and 4WD manifold. Oil flow to the front wheel motors drives the motors in the forward direction and then returns to the hydrostat. Oil flow to the 4WD manifold enters the P1 port and then is directed to the PD1 cartridge and out of the manifold M1 port 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 hydrostat.

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.

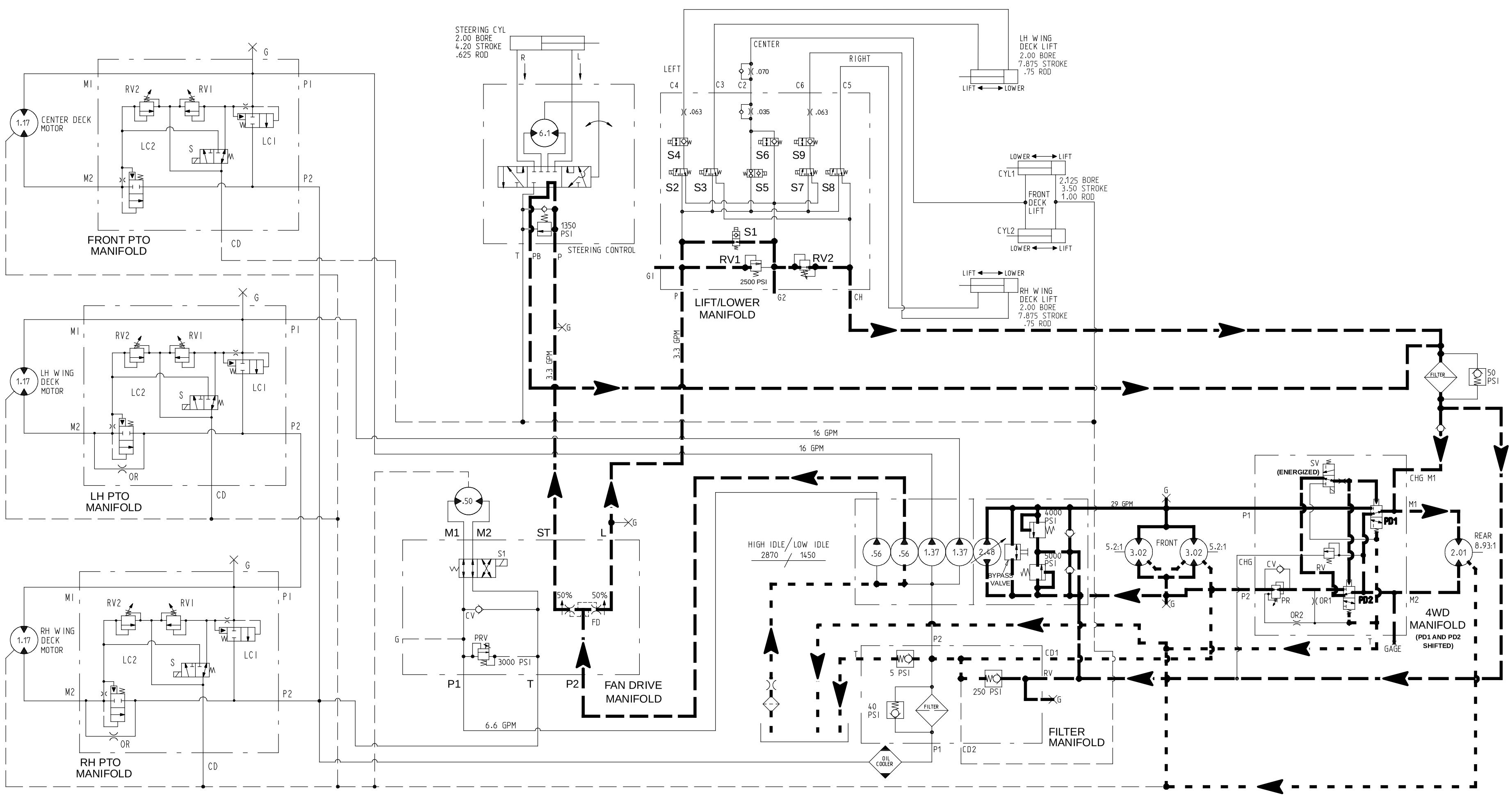
Reverse Direction

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. 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.

Groundsmaster 4100–D/4110–D

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, solenoid valve (SV) in the 4WD control 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.

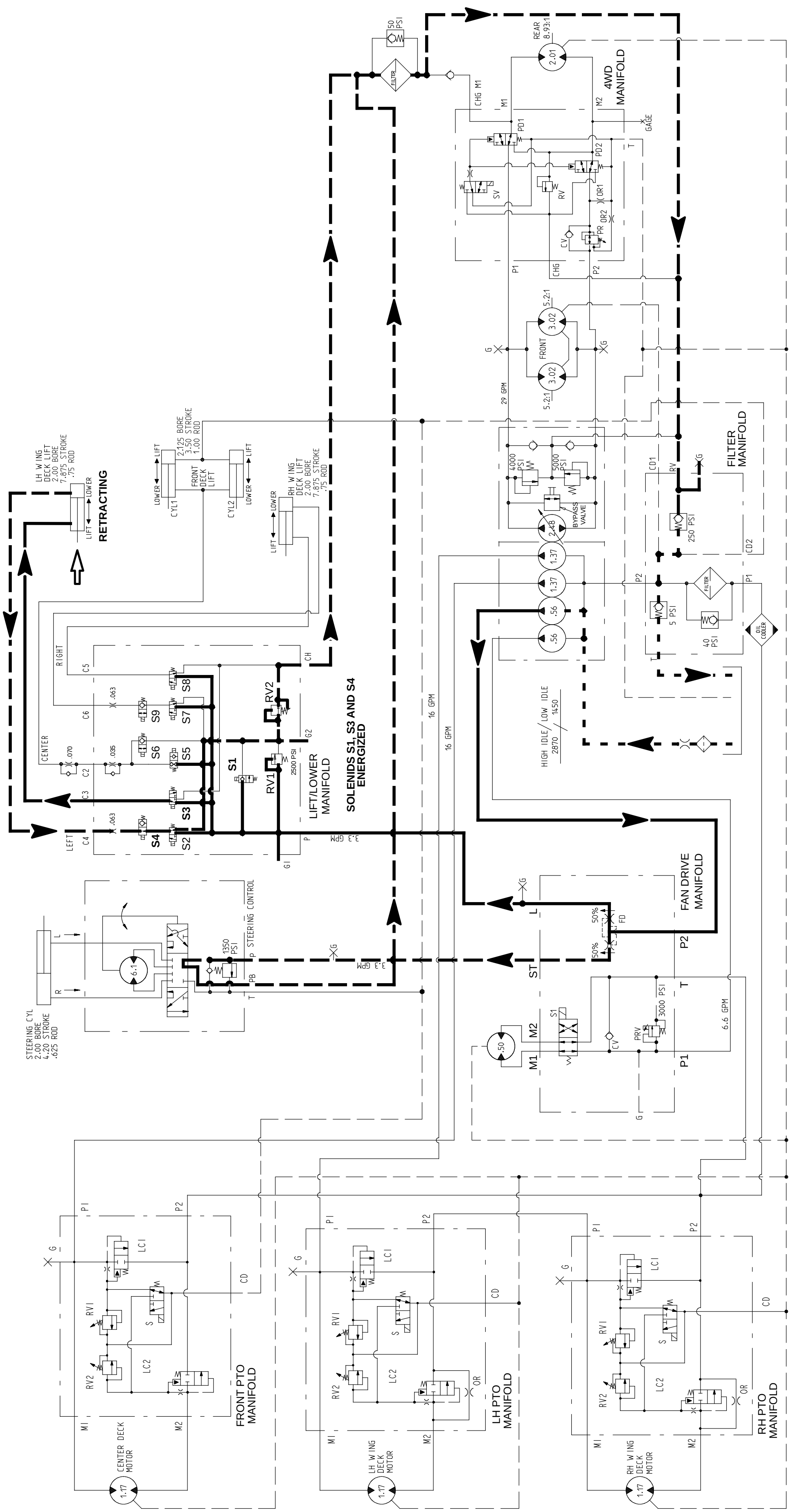
Reverse Direction

The traction circuit operates essentially the same in reverse transport (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 hydrostat 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 hydrostat. Oil circulation through the rear axle motor loop is the same as in the Hi speed (2WD) forward direction.

Groundsmaster 4100–D/4110–D

Lower Cutting Deck (LH Wing 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.

The cutting deck and wing decks 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 the cutting deck or wing deck. The controller provides electrical outputs to solenoids in the lift/lower manifold to allow appropriate manifold valve shift to cause the cutting deck or wing deck to lower.

When the cutting deck is 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 the cutting deck or wing decks, the operator must be in the operator seat and the traction speed must be in the Low speed (4WD) position.

Lower Cutting Deck

To lower the 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 deck lift cylinders. The weight of the cutting deck causes the deck lift cylinders to extend and lower the 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, through 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 cutting deck are held in position.

Lower Right Wing 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 wing 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 wing deck. Oil from the retracting cylinder flows through the orifice in manifold port C6 to control the drop speed of the wing deck. Flow is then directed through the shifted S9, valve RV2, out manifold port CH, through 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 wing deck are held in position.

Lower Left Wing 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 wing 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 wing deck. Oil from the retracting cylinder flows through the orifice in manifold port C4 to control the drop speed of the wing deck. Flow is then directed through the shifted S4, valve RV2, out manifold port CH, through 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 wing deck are held in position.

Cutting Deck Float

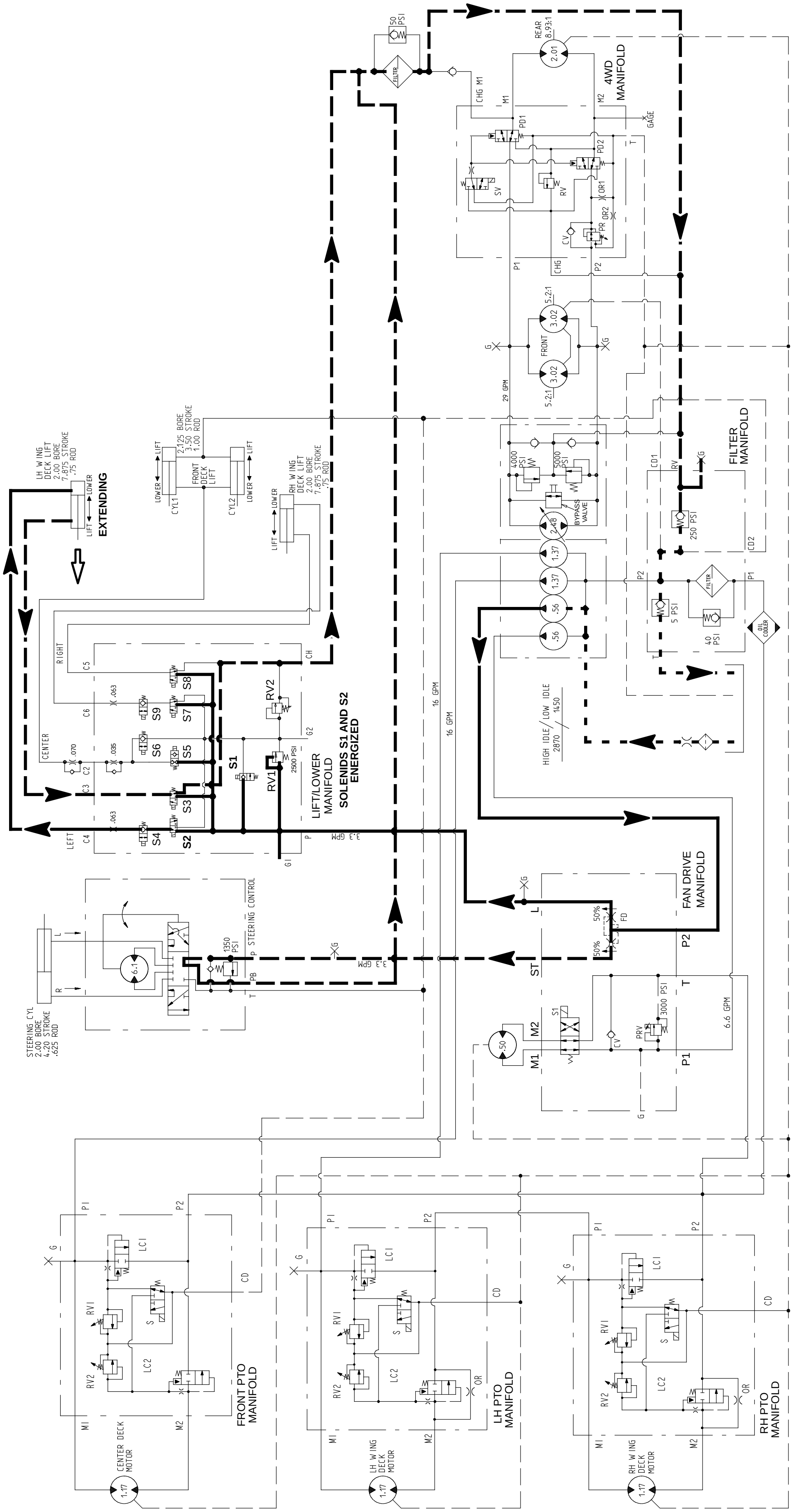
Cutting deck float allows the fully lowered cutting deck to follow ground surface contours. Lift/lower manifold solenoid valves S4 (left wing deck), S6 (cutting deck) and S9 (right wing deck) are energized when the deck is fully lowered. These energized solenoids provide an oil passage to and from the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

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

Groundsmaster 4100–D/4110–D

Raise Cutting Deck (LH Wing Deck Shown)

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



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.

The cutting deck and wing decks 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 the cutting deck or wing deck. The controller provides electrical outputs to solenoids in the lift/lower manifold to allow appropriate valve shift to cause the cutting deck or wing deck to raise.

When the cutting deck is 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 the cutting deck or wing decks, the operator must be in the operator seat.

Raise Cutting Deck

To raise the 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 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 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 deck lift cylinders and cutting deck are held in position.

Raise Right Wing Cutting Deck

To raise the right wing 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 wing 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 wing deck. Oil from the extending cylinder is directed through S8 (de-energized), out manifold port CH, through 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 wing deck are held in position.

Raise Left Wing Cutting Deck

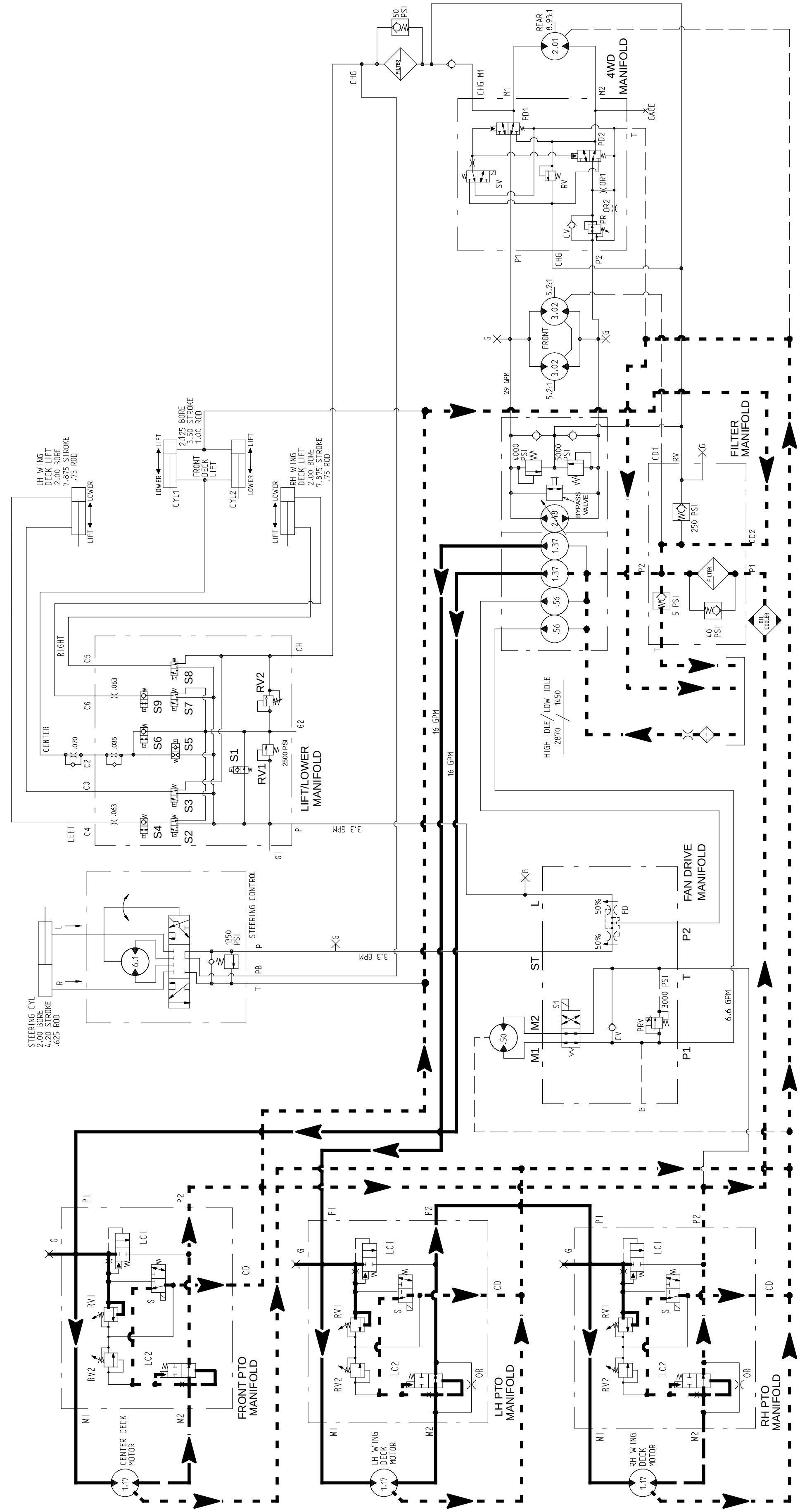
To raise the left wing deck, the rear of the left console switch is depressed as an input to the TEC-5001 controller. The controller provides an electrical output to solenoid valves S1 and S2 in the lift/lower manifold. The energized solenoid valves shift to allow a passage for circuit oil flow to the barrel end of the left wing 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 wing deck. Oil from the extending cylinder is directed through S3 (de-energized), out manifold port CH, through 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 wing deck are held in position.

Groundsmaster 4100–D/4110–D

Mow Circuit (All Deck Motors Rotating)

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



Mow Circuit

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 wing cutting decks, while the next gear pump section supplies the center cutting deck.

Each cutting deck section 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 or wing 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 deck is 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.

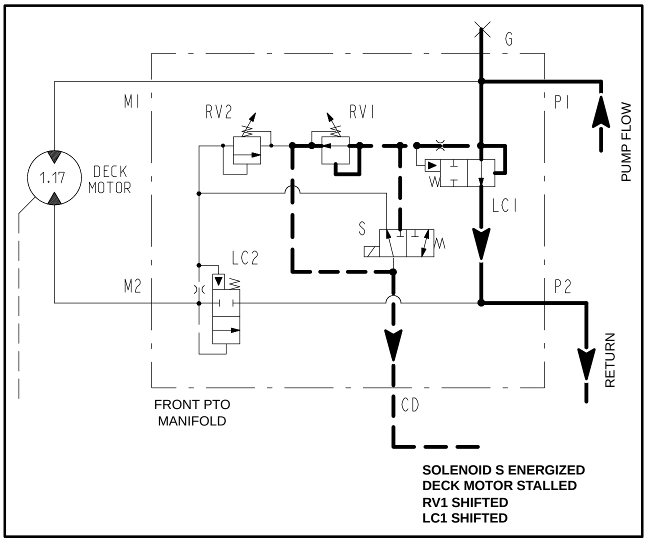


Figure 10

Hydraulic System

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.

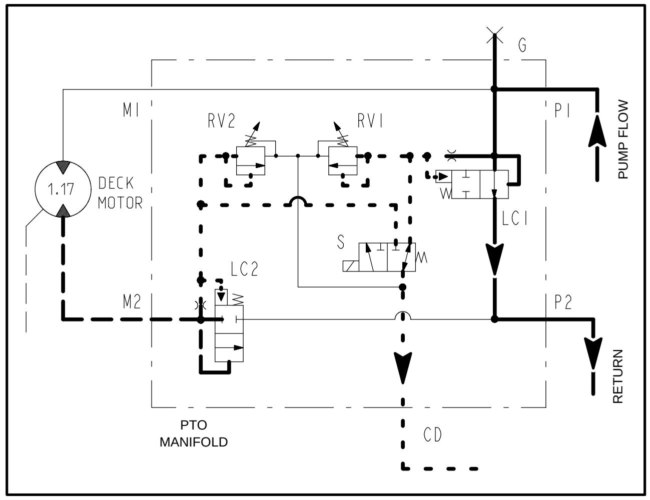


Figure 11

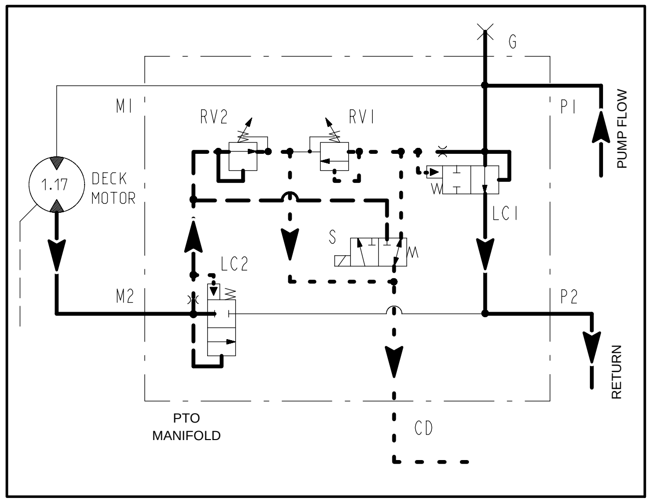


Figure 12

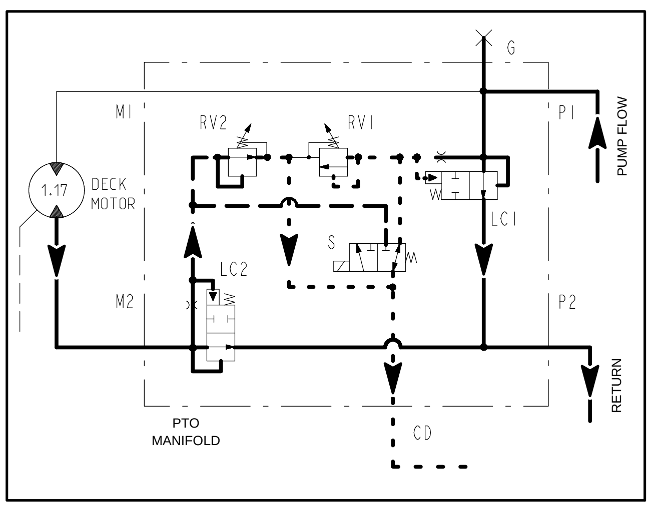


Figure 13

Hydraulic System

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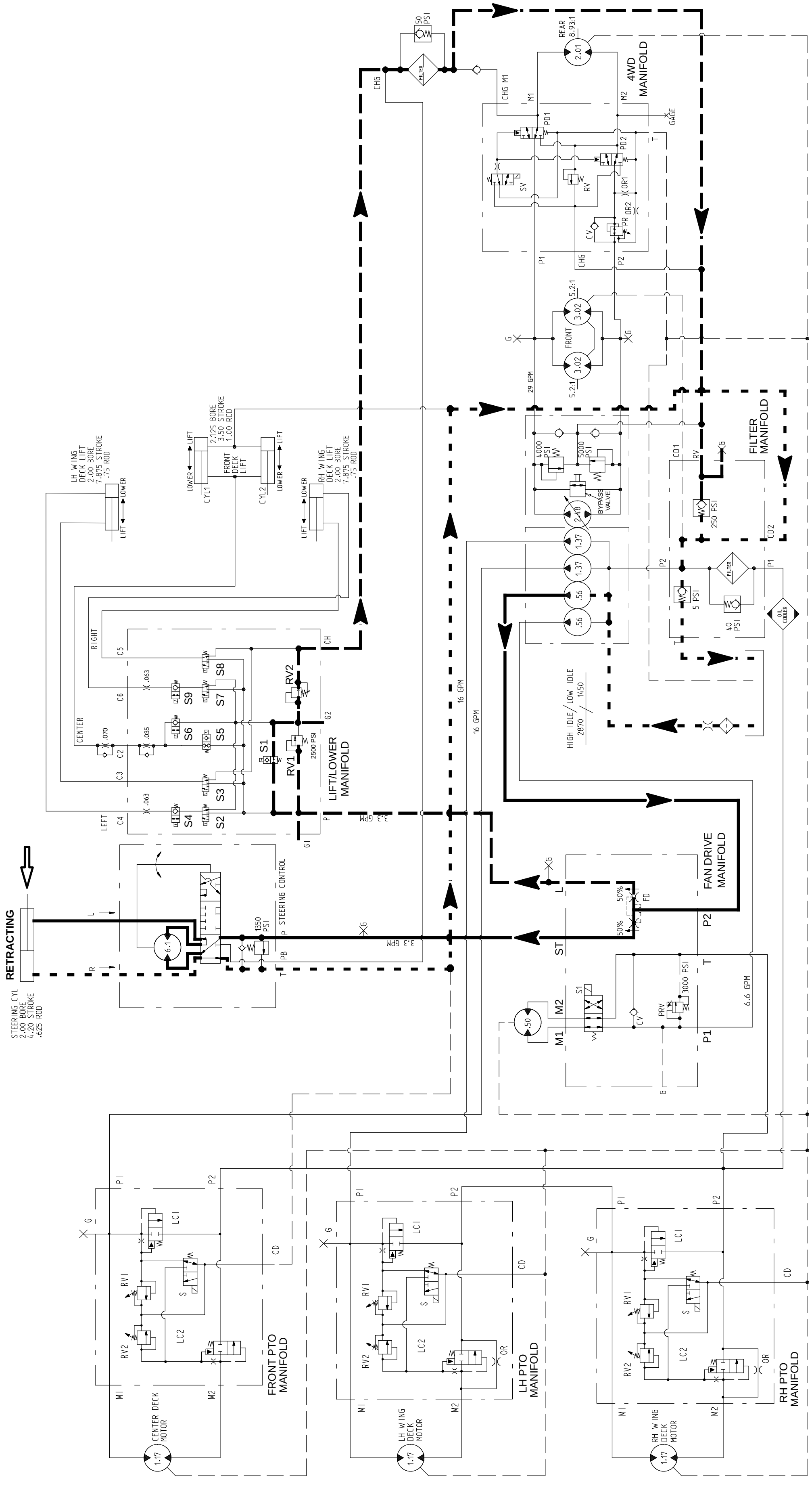
Groundsmaster 4100–D/4110–D

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 contracts 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.

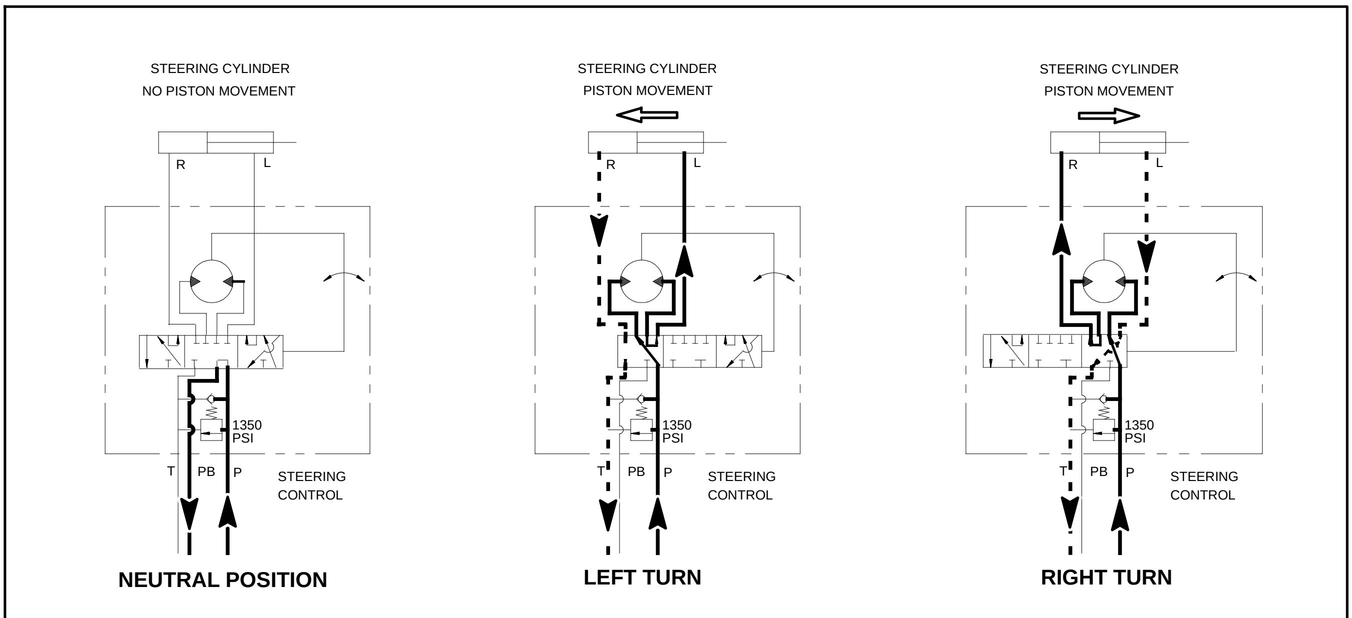


Figure 14

Hydraulic System

Groundsmaster 4100–D/4110–D

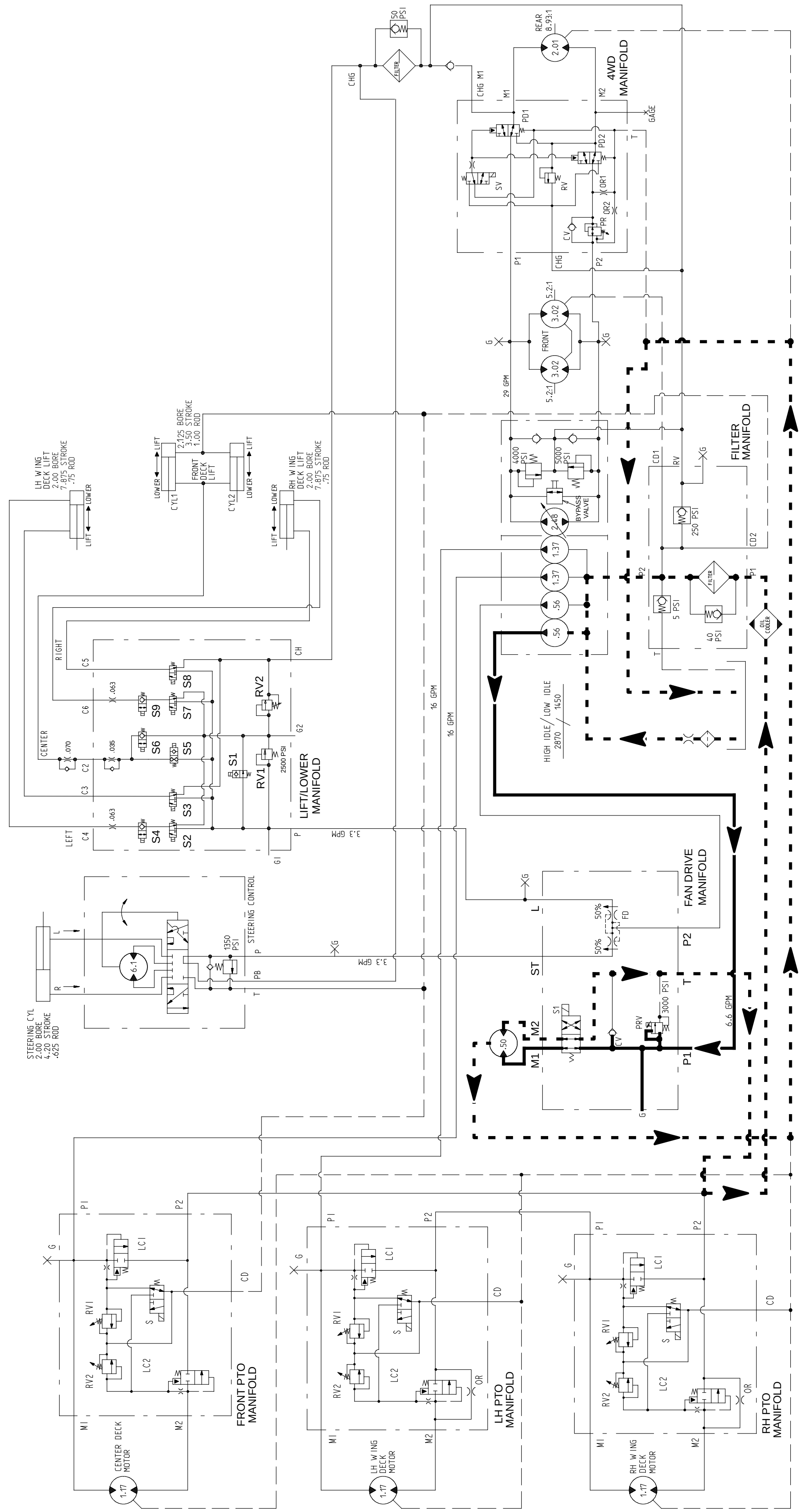
Engine Cooling Fan Circuit (Forward Direction Shown)

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 circuits. The electronically controlled proportional relief valve (PRV) in the manifold controls the oil flow to the fan motor. 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 allowing 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.

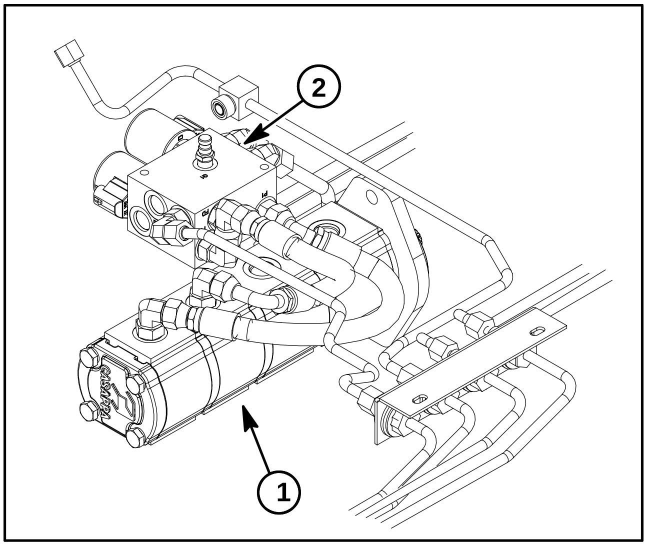


Figure 15

1. **Gear pump**
2. **Fan drive manifold**

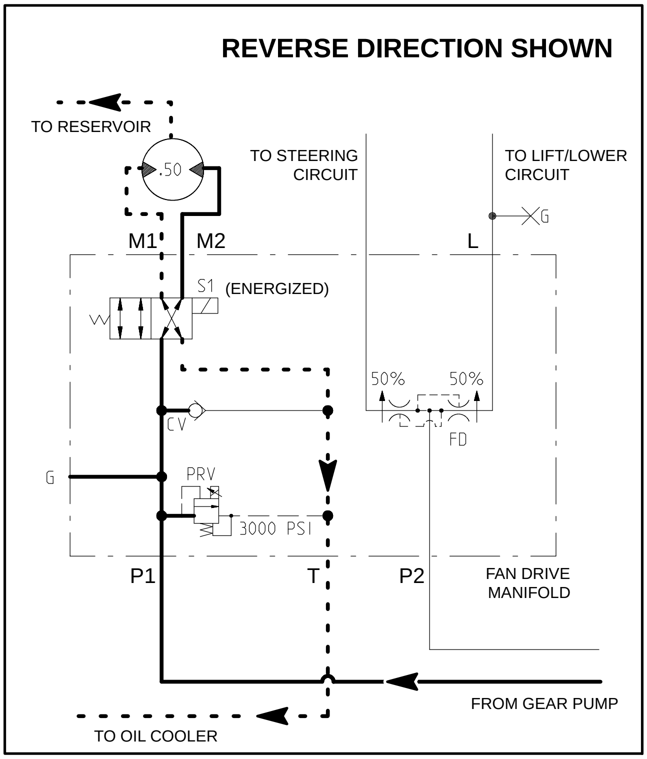


Figure 16

Special Tools

Order these special tools from your Toro Distributor.

Hydraulic Pressure Test Kit

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

Toro Part Number: **TOR47009**

Figure 17

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

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 hydraulic hoses (see Hydraulic Hose Kit TOR6007 below).

Figure 19

Hydraulic Hose Kit

This kit includes hydraulic 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**

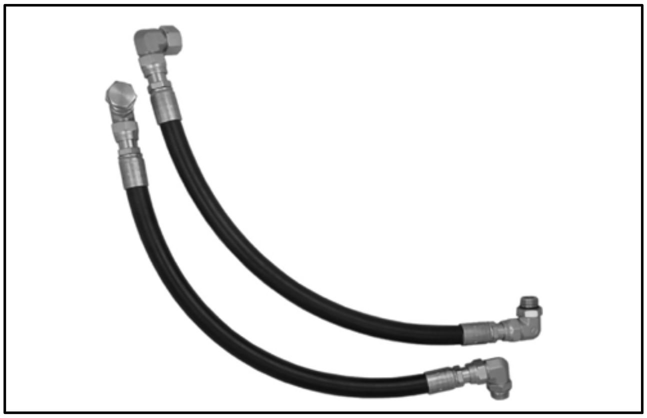


Figure 20

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 contaminates are removed from the closed loop and thus, do not cause additional component damage.

Toro Part Number: **TOR6011**

NOTE: This kit does not include hydraulic 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)**.

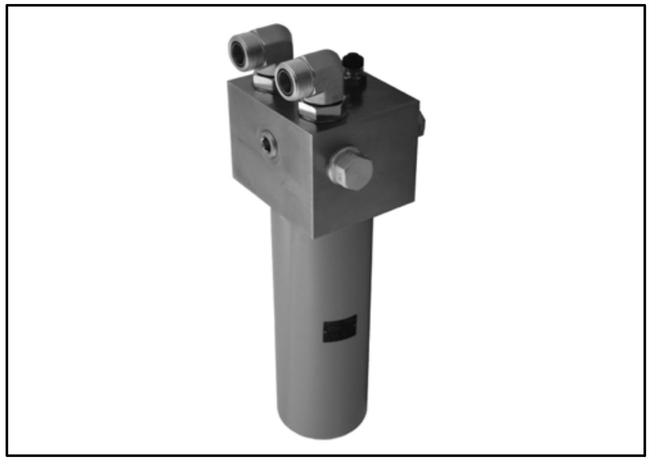


Figure 21

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**

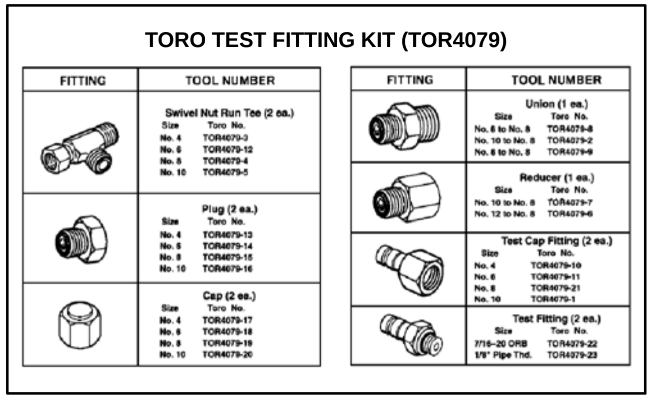
Figure 22

Hydraulic Test Fitting Kit

This kit includes a variety of O–ring face seal fittings to enable the connection of test gauges into the system.

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

Toro Part Number: **TOR4079**



TORO TEST FITTING KIT (TOR4079)

FITTING	TOOL NUMBER
	Swivel Nut Run Tee (2 ea.) Size / Toro No. No. 4 TOR4079-3 No. 6 TOR4079-12 No. 8 TOR4079-4 No. 10 TOR4079-5
	Plug (2 ea.) Size / Toro No. No. 4 TOR4079-13 No. 6 TOR4079-14 No. 8 TOR4079-15 No. 10 TOR4079-16
	Cap (2 ea.) Size / Toro No. No. 4 TOR4079-17 No. 6 TOR4079-18 No. 8 TOR4079-19 No. 10 TOR4079-20

FITTING	TOOL NUMBER
	Union (1 ea.) Size / Toro No. No. 6 to No. 8 TOR4079-8 No. 10 to No. 8 TOR4079-2 No. 6 to No. 6 TOR4079-9
	Reducer (1 ea.) Size / Toro No. No. 10 to No. 8 TOR4079-7 No. 12 to No. 8 TOR4079-6
	Test Cap Fitting (2 ea.) Size / Toro No. No. 4 TOR4079-10 No. 6 TOR4079-11 No. 8 TOR4079-21 No. 10 TOR4079-1
	Test Fitting (2 ea.) Size / Toro No. 7/16–20 ORB TOR4079-22 1/8" Pipe Thd. TOR4079-23

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. **NOTE:** An indication that the hydraulic system is operating at excessive temperatures would be frequent reversing of the cooling fan and a normal engine coolant temperature.	Engine RPM is too low. Brakes are applied or sticking. Hydraulic reservoir oil level is low. Hydraulic oil is contaminated or the wrong type. Piston pump by–pass valve is open or damaged. Cooling system is not operating properly. 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. Charge pressure is low. Piston (traction) pump servo control valve orifices are plugged or damaged.
Traction power is lost or unit 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.
Low speed (4WD) will not engage.	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.
Low speed (4WD) will not disengage.	Electrical problem exists (see Chapter 5 – Electrical System). Solenoid valve (SV) in 4WD hydraulic manifold is faulty. Cartridge valve in 4WD manifold is damaged or sticking.

Mow Circuit Problems

Problem	Possible Cause
Cutting deck will not operate. **NOTE:** To engage the mow circuit, the seat must be occupied, the traction speed must be in the Low (4WD) position and the PTO switch needs to be ON.	Electrical problem exists (see Chapter 5 – Electrical System). Gear pump or its coupler is damaged (NOTE: other hydraulic circuits impacted as well).
One cutting deck section 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 deck motor to another cutting deck section. If problem follows the motor, motor needs repair or replacement.
All cutting deck sections operate slowly.	Engine RPM is low. Deck motor or gear pump sections are damaged.
Cutting deck section 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
Cutting deck (or wing decks) will not raise. **NOTE:** The seat must be occupied in order to raise cutting deck.	Engine RPM is too low. Hydraulic oil level in reservoir is low. Solenoid valve (S1) in lift/lower manifold is faulty. Electrical problem exists (see Chapter 5 – Electrical System). Lift arm pivots are binding. Relief valve in lift/lower manifold is stuck. Lift cylinder(s) is (are) damaged. Gear pump section for lift/lower circuit is inefficient (NOTE: steering and traction charge circuits impacted as well).
Cutting deck (or wing decks) raise, but will not stay up. **NOTE:** Lift cylinders cannot provide an absolutely perfect seal. The cutting deck will eventually lower if left in the raised position during storage.	Lift circuit lines or fittings are leaking. Lift cylinder is damaged. Cartridge valve(s) in lift/lower manifold has damaged seals or is faulty.
Cutting deck (or wing decks) will not lower. **NOTE:** To lower cutting deck (or wing deck), the seat must be occupied and the traction speed must be in the Low (4WD) position.	Lift arm pivots are binding. Electrical problem exists (see Chapter 5 – Electrical System). Solenoid valve (S1) in lift/lower manifold is faulty. Counterbalance pressure is excessive. Lift cylinder is damaged.

Steering Circuit Problems

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

Engine Cooling Fan Circuit Problems

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

Hydraulic System

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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) 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 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 hydraulic 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. The inlet and the outlet hoses for tester with pressure and flow capabilities must be properly connected and not reversed to prevent damage to the hydraulic tester or components.

5. When using hydraulic tester with pressure and flow capabilities, open load valve completely in the tester to minimize the possibility of damaging components.

6. Install tester 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. Also, check for hydraulic leaks after test equipment has been removed from hydraulic system.

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.

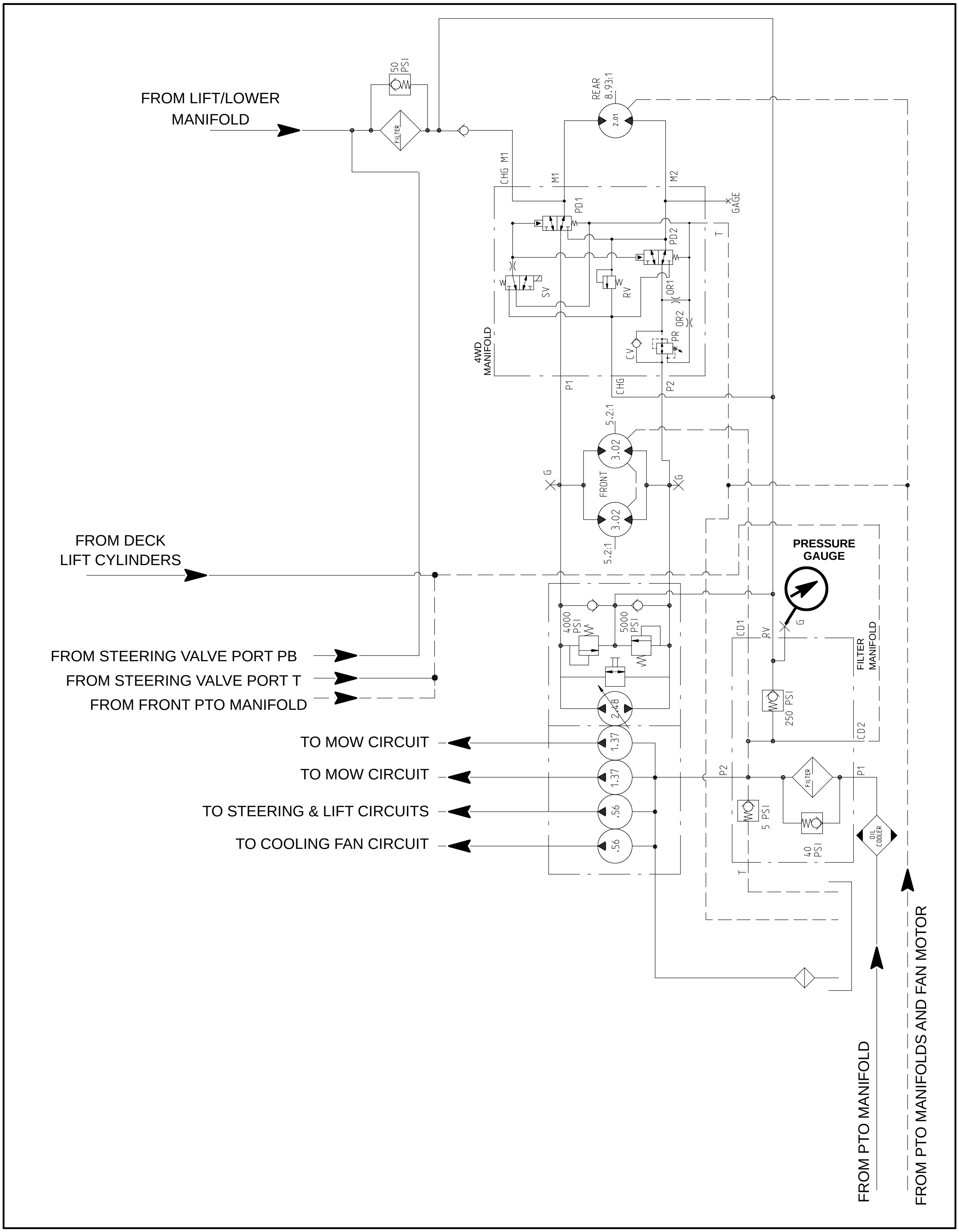
2. If a cutting (mow) circuit problem exists, consider performing one or more of the following tests: Cutting Deck Circuit Pressure, PTO Relief Pressure, Cutting Deck Motor Case Drain Leakage and/or Cutting Deck Gear Pump Flow Tests.

3. If a 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.

4. 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.

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 deck lowered and off. Make sure engine is off and the parking brake is engaged. 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.**

3. Connect a 1000 PSI (70 bar) pressure gauge onto charge pressure test port on filter manifold under operator seat (Fig. 26).

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

5. Move throttle so engine is running 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 at 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.

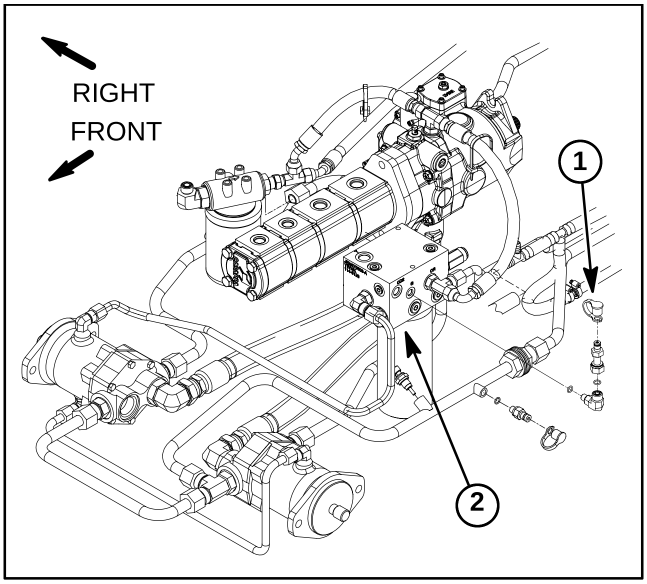
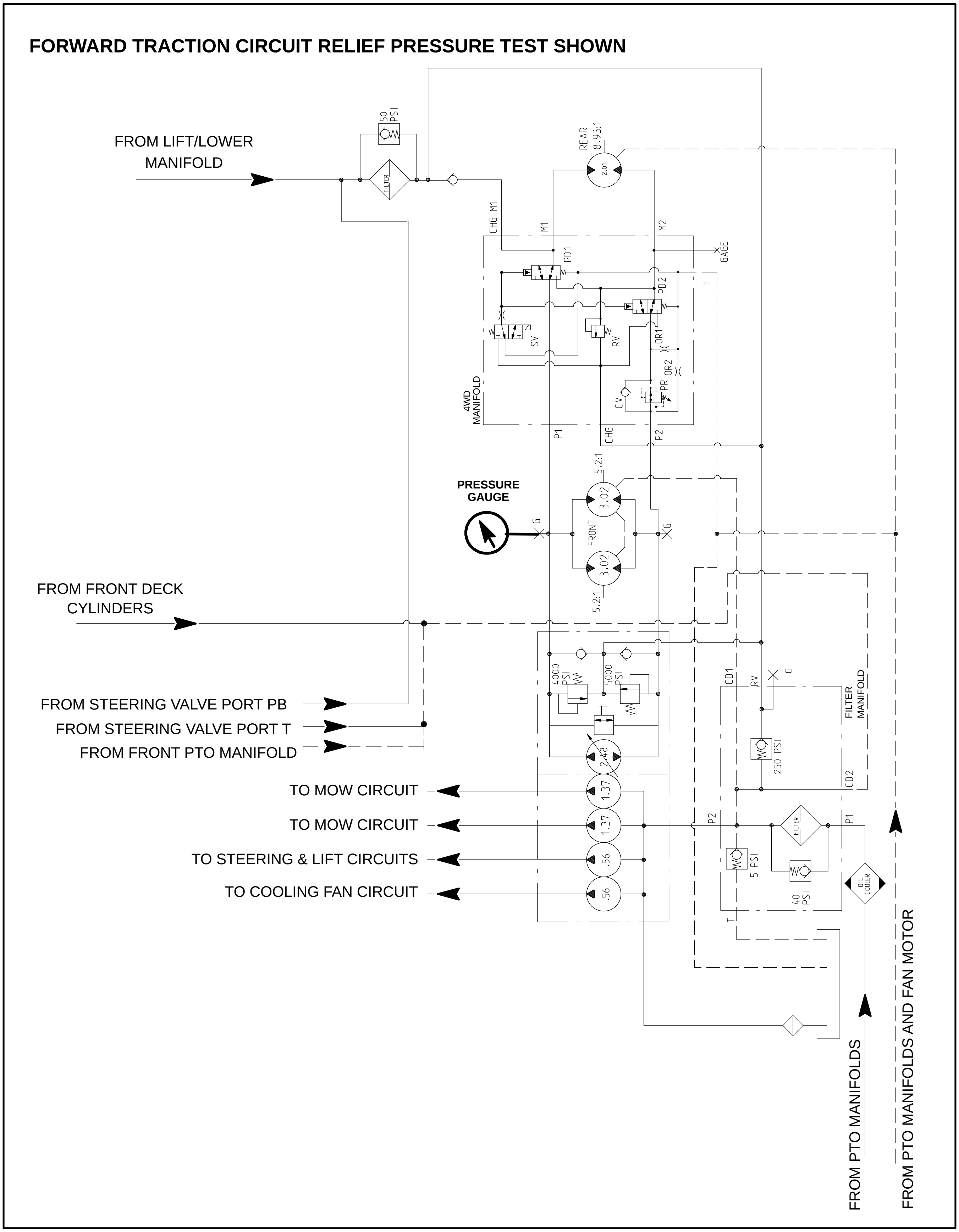


Figure 26

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 deck, turn the engine off and engage 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: forward (Fig. 27) or reverse (Fig. 28).

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

5. Move throttle so engine is running at high idle speed **(2870 RPM)**. Make sure that Hi/Low speed switch is in the Hi speed (2WD) position.

6. Sit on seat, apply brakes fully and slowly depress the traction pedal in the appropriate direction. While pushing traction pedal, look at pressure reading on gauge:

GAUGE READING TO BE:
Forward: **3750 to 4250 PSI (259 to 293 bar)**
Reverse: **4750 to 5250 PSI (328 to 362 bar)**

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

8. If traction relief pressure is too low, inspect traction pump relief valves (Fig. 29). Clean or replace 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.

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

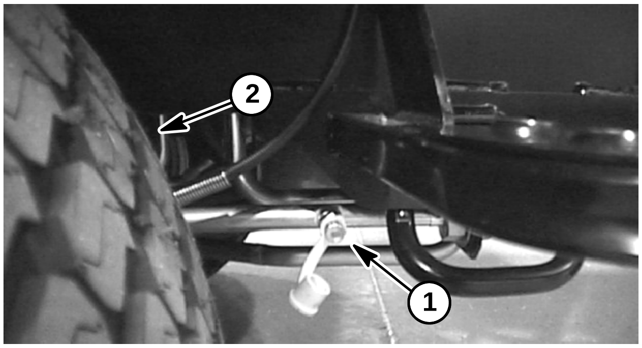


Figure 27

1. **Forward traction port**
2. **LH front tire**

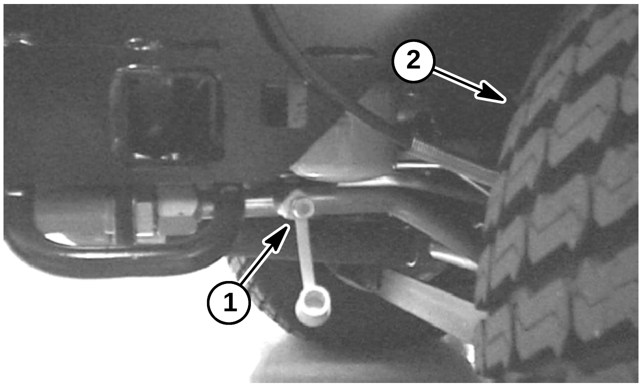


Figure 28

1. **Reverse traction port**
2. **RH front tire**

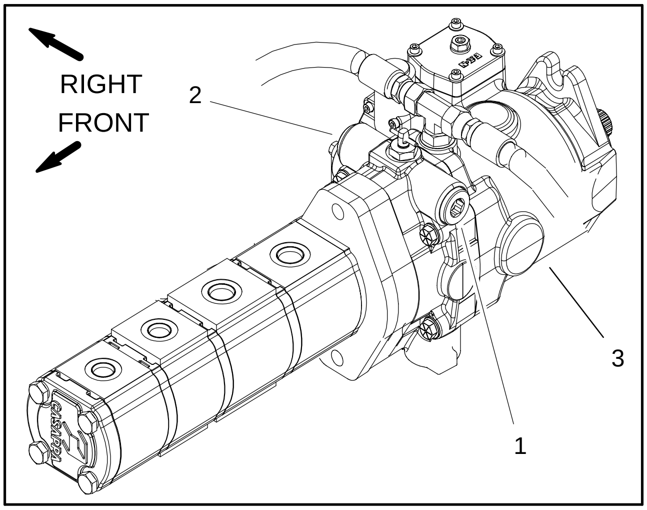
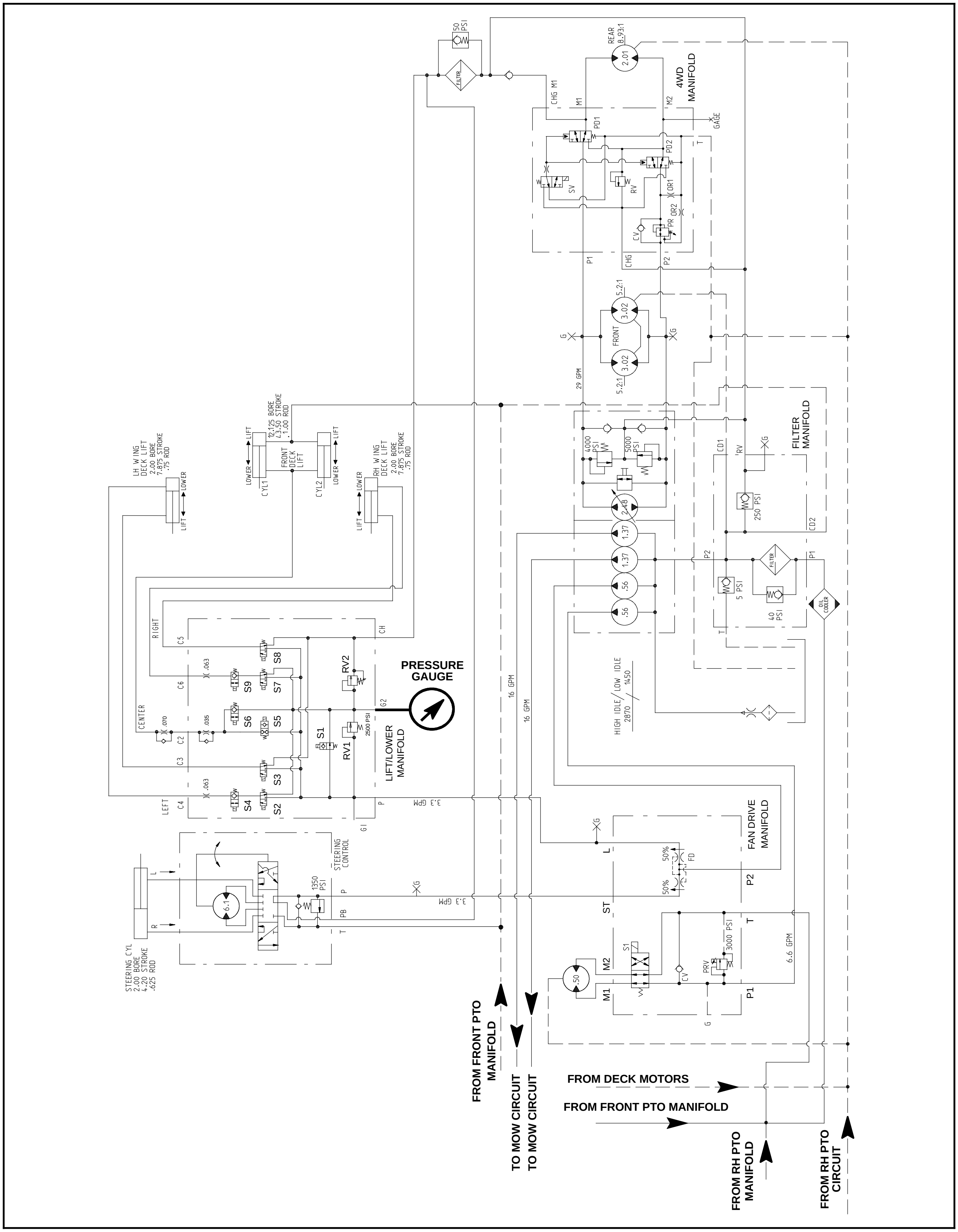


Figure 29

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

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 deck lowered and off. Make sure engine is off and the parking brake is engaged.

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 in this section).

5. Connect a 1000 PSI (70 bar) pressure gauge to counterbalance test port G2 on lift/lower manifold under controller cover (Fig. 31).

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

7. Move throttle so engine is running at high idle speed **(2870 RPM)** with no load on the system. **Do not engage the cutting deck**.

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))**.**

8. Stop the engine and record test results.

9. 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. After adjustment, recheck counterbalance pressure. Readjust as needed.

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

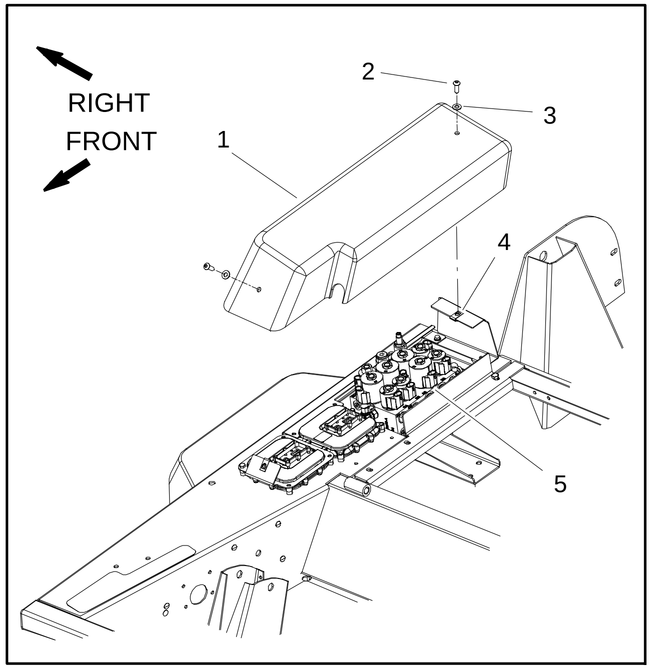


Figure 30

1. **Controller cover**
2. **Screw (2 used)**
3. **Flat washer (2 used)**
4. **U-nut (2 used)**
5. **Lift/lower manifold**

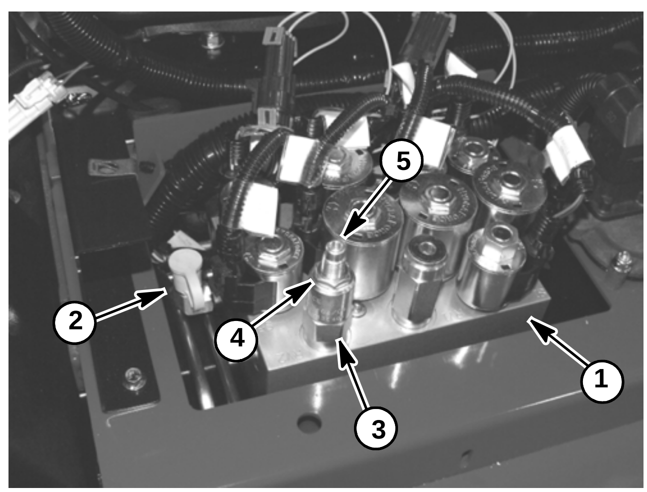
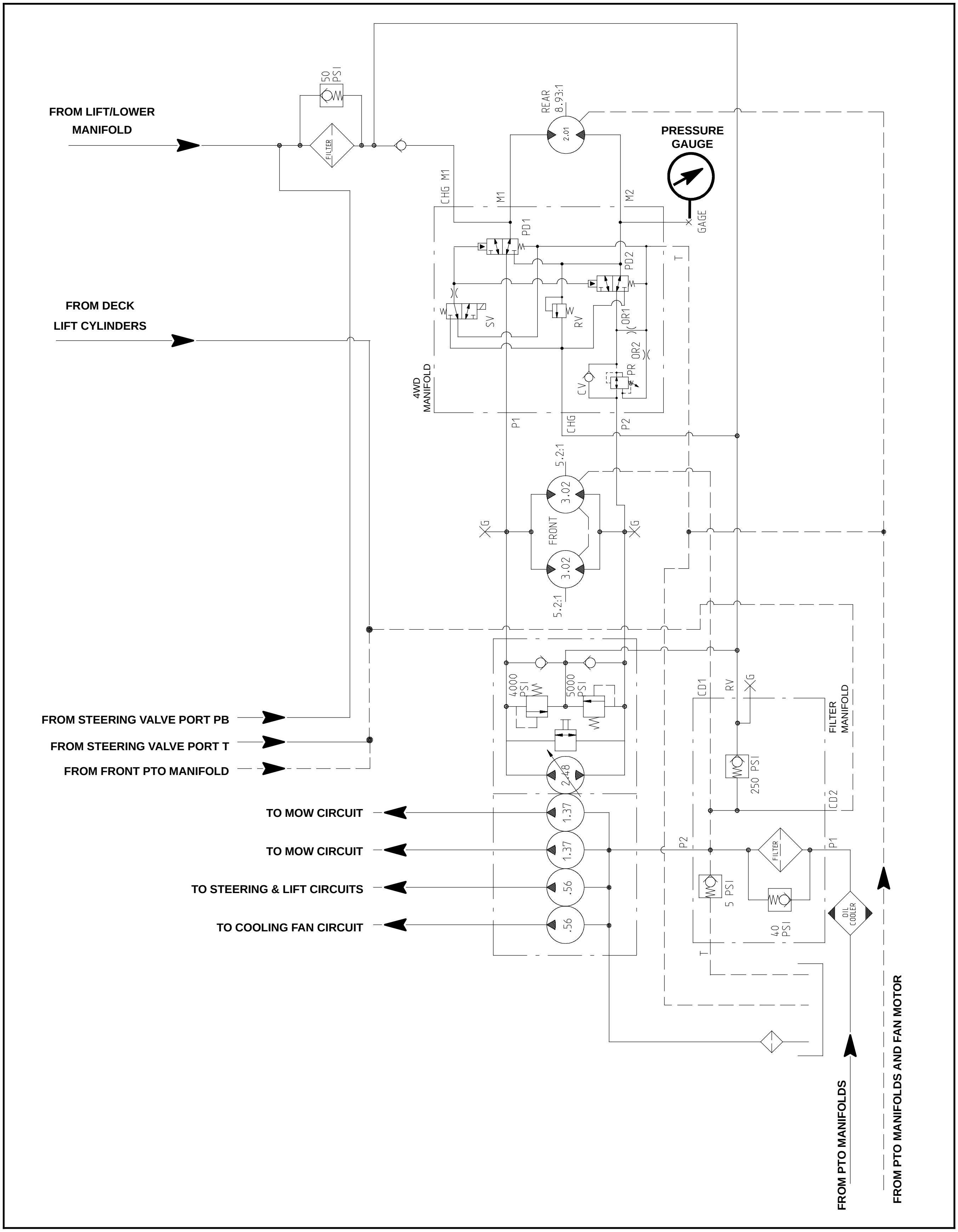


Figure 31

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

Hydraulic System



FROM LIFT/LOWER MANIFOLD
FROM DECK LIFT CYLINDERS
FROM STEERING VALVE PORT PB
FROM STEERING VALVE PORT T
FROM FRONT PTO MANIFOLD
TO MOW CIRCUIT
TO MOW CIRCUIT
TO STEERING & LIFT CIRCUITS
TO COOLING FAN CIRCUIT
PRESSURE GAUGE
GAGE
4WD MANIFOLD
FILTER MANIFOLD
FROM PTO MANIFOLDS
FROM PTO MANIFOLDS AND FAN MOTOR
50 PSI
FILTER
REAR 8.93:1
2.01
CHG M1
M1
M2
PD1
PD2
T
SV
RV
OR1
OR2
PR
CV
P1
CHG
P2
5.2:1
3.02
FRONT
3.02
5.2:1
G
G
4000 PSI
5000 PSI
2.48
1.37
1.37
.56
.56
CD1
RV
G
250 PSI
CD2
P2
P1
FILTER
5 PSI
40 PSI
OIL COOLER
T

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 deck lowered and off. Make sure engine is off and the parking brake is engaged.

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 control manifold under radiator (Fig. 32).

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

5. Move throttle so engine is running at high idle speed **(2870 RPM)**. Make sure that Hi/Low speed switch is in the Low speed (4WD) position.

6. 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).

7. Stop engine and record test results.

8. If specification is **not** met, clean or adjust pressure reducing valve (PR) in 4WD control manifold. This valve is located on the front side of the 4WD control manifold (Fig. 33). See Adjust Control Manifold Relief Valves in the Adjustments section of this chapter for the valve adjustment procedure. Recheck reducing valve (PR) pressure setting and readjust as needed.

9. When testing is complete, disconnect pressure gauge from test port on control manifold.

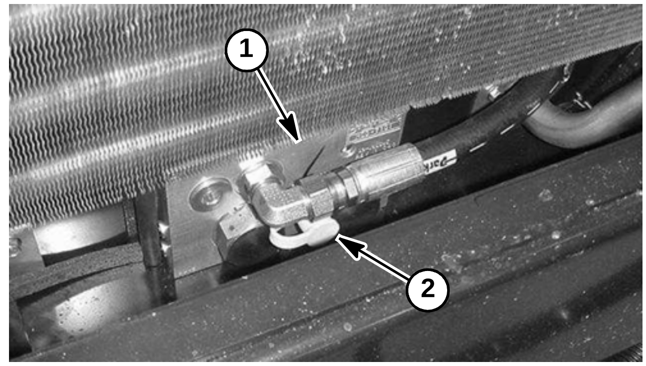


Figure 32

1. **4WD control manifold**
2. **Pressure test port**

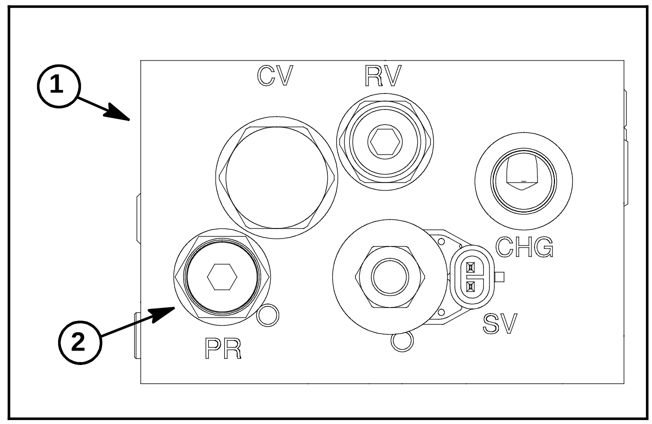
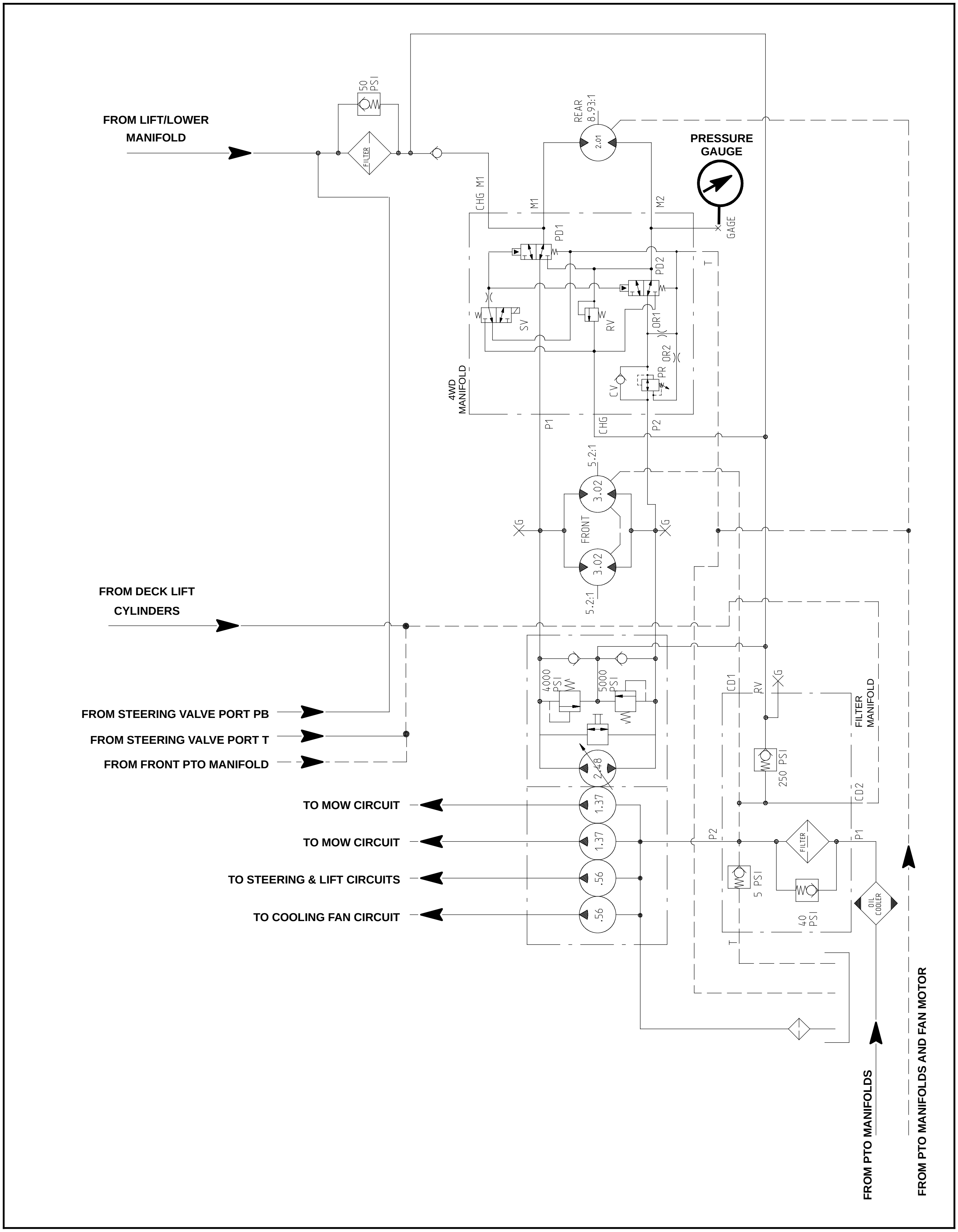


Figure 33

1. **Manifold: front side**
2. **Reducing valve (PR)**

Hydraulic System

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 deck lowered and off. Make sure engine is off and the parking brake is engaged.

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

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

7. Operate the machine in Low speed (4WD) with the cutting deck lowered. Drive down a slope in a forward direction, decrease pressure on the traction pedal and monitor the pressure gauge. Pressure should increase until the rear traction relief valve (RV) lifts. Record test results.

8. Stop engine and record test results.

9. 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).

10. If specification is **not** met, clean or adjust relief valve (RV) in 4WD control manifold. Relief valve (RV) is located on the lower, front side of the 4WD control manifold (Fig. 35). See Adjust Control Manifold Relief Valves in the Adjustments section of this chapter for the valve adjustment procedure. Recheck relief valve (RV) pressure setting after adjustment and readjust as needed.

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

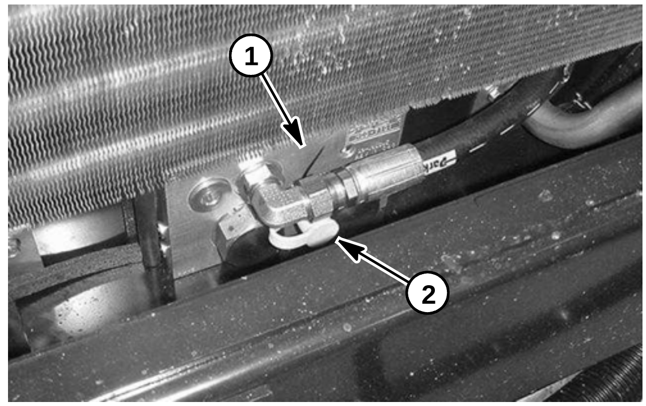


Figure 34

1. **4WD control manifold**
2. **Pressure test port**

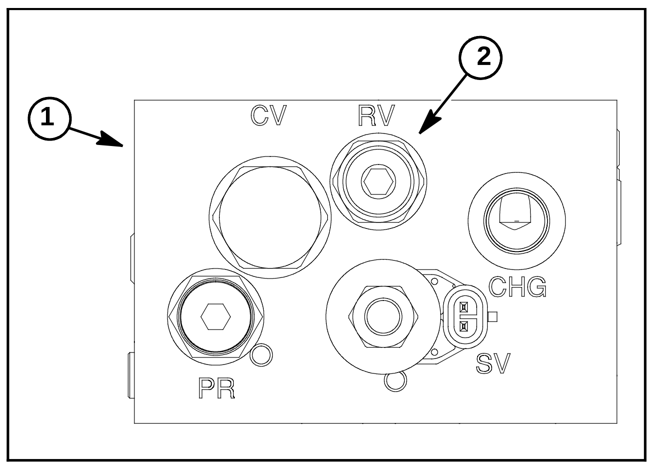
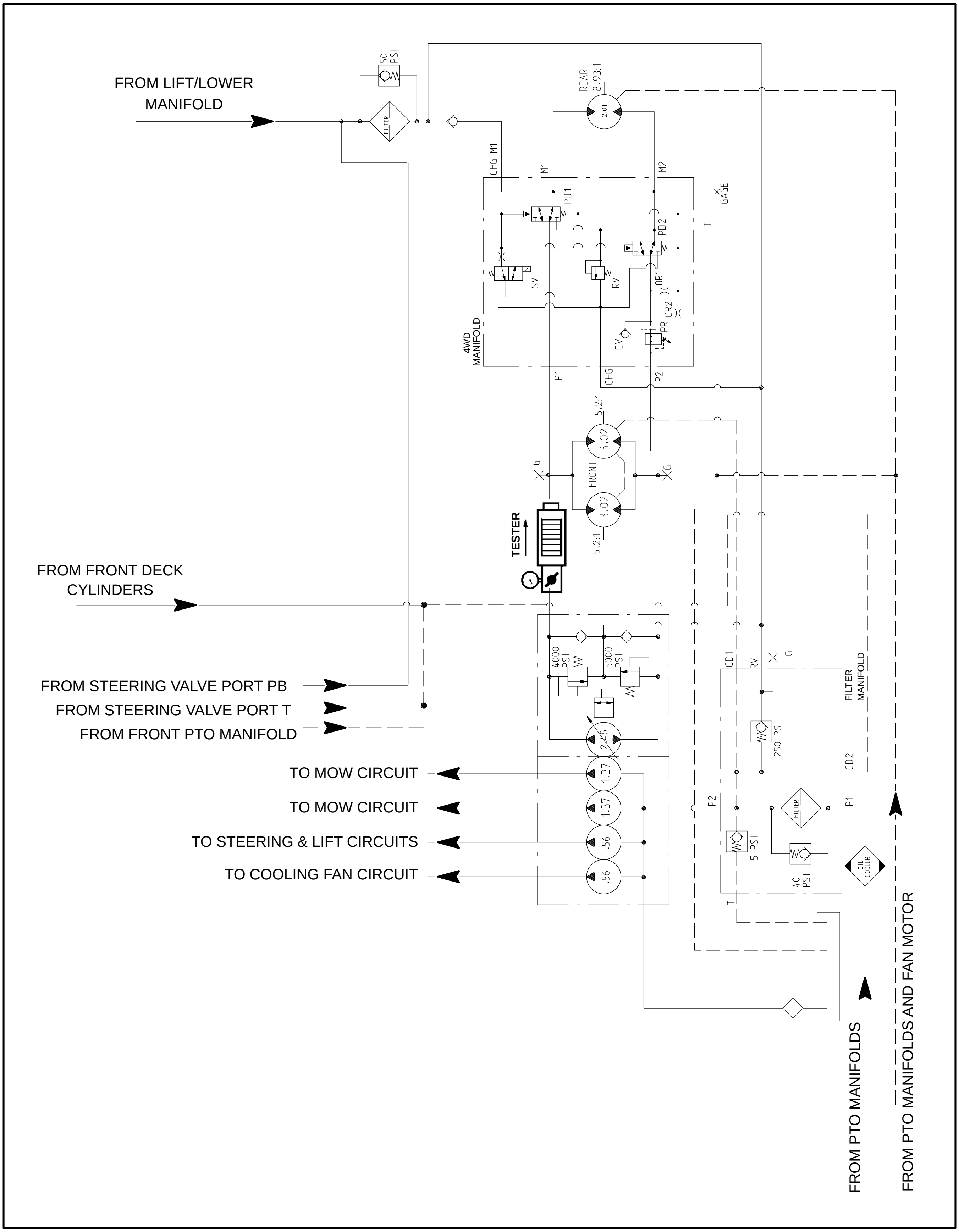


Figure 35

1. **Manifold: front side**
2. **Relief valve (RV)**

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 4100/4110 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 deck 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. 36). Disconnect hose from left side pump fitting.

6. Install 40 GPM Hydraulic Tester #AT40002 (pressure and flow) 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 carefully watch pressure gauge on tester 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 machine hydraulic hose to pump fitting. Lower machine to ground.

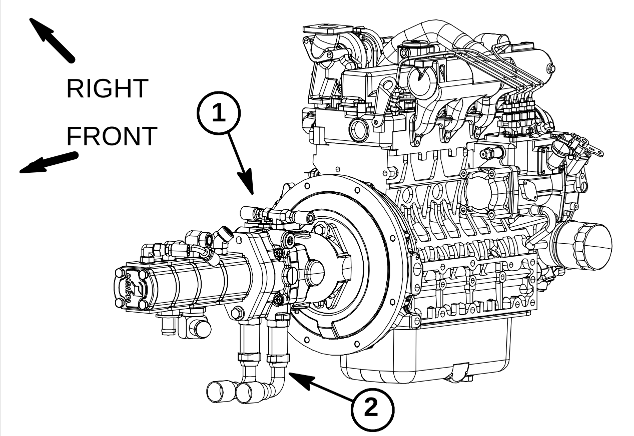
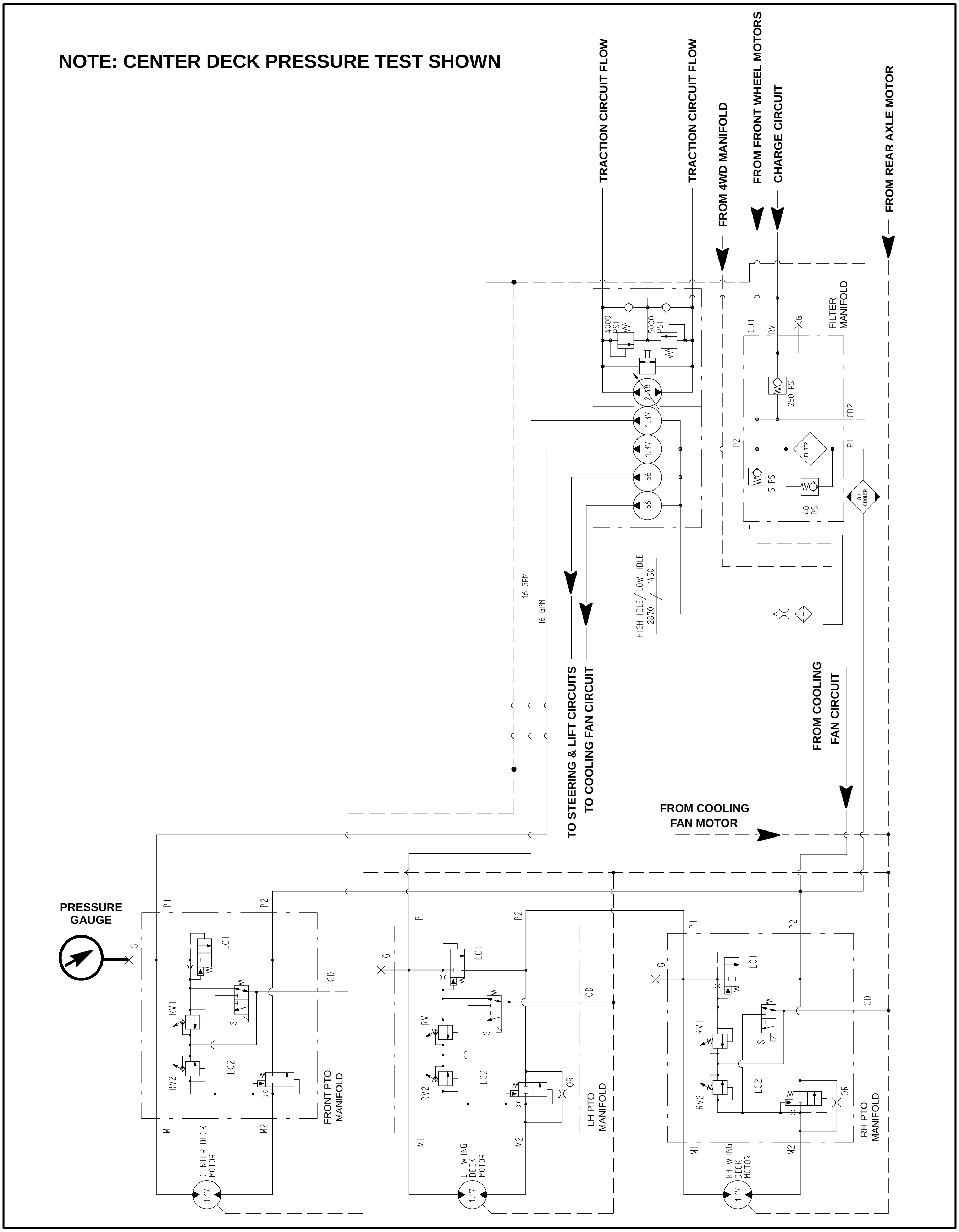


Figure 36

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

Hydraulic System

Cutting Deck Circuit Pressure (Using Pressure Gauge)



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 deck lowered and off. Make sure engine is off and the parking brake is engaged.

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 PTO manifold test port for the deck to be tested (Fig. 37, 38 or 39).

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

CAUTION

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

5. Move throttle so engine is running at high idle speed **(2870 RPM)**. Engage the cutting deck.

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

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

LH Wing Deck: 1000 to 3000 PSI (69 to 207 bar)
Center Deck: 1000 to 3000 PSI (69 to 207 bar)
RH Wing Deck: 1000 to 2000 PSI (69 to 137 bar)

8. Disengage cutting deck and shut off engine. Record test results.

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

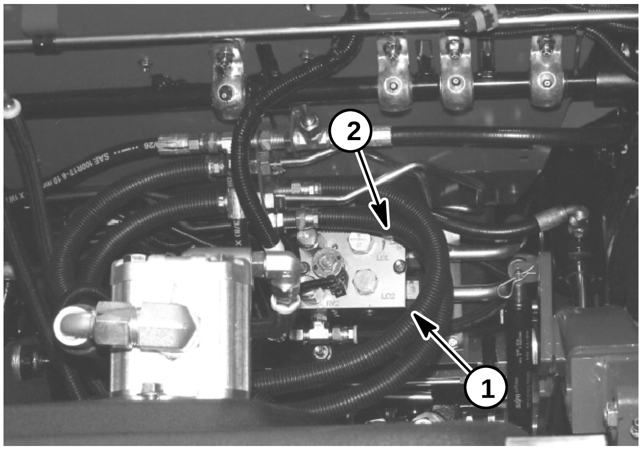


Figure 37

1. **Center deck hydraulic manifold**
2. **Center deck circuit pressure test port**

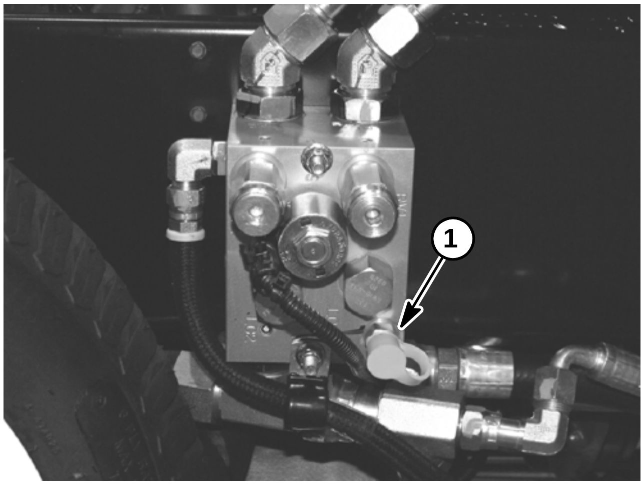


Figure 38

1. **Right wing deck circuit pressure test port**

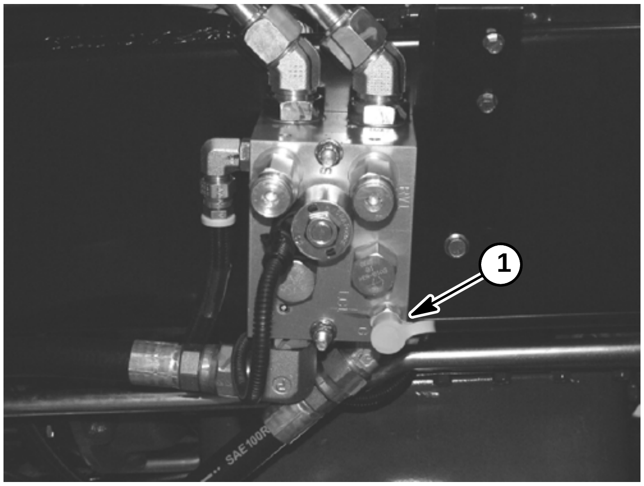
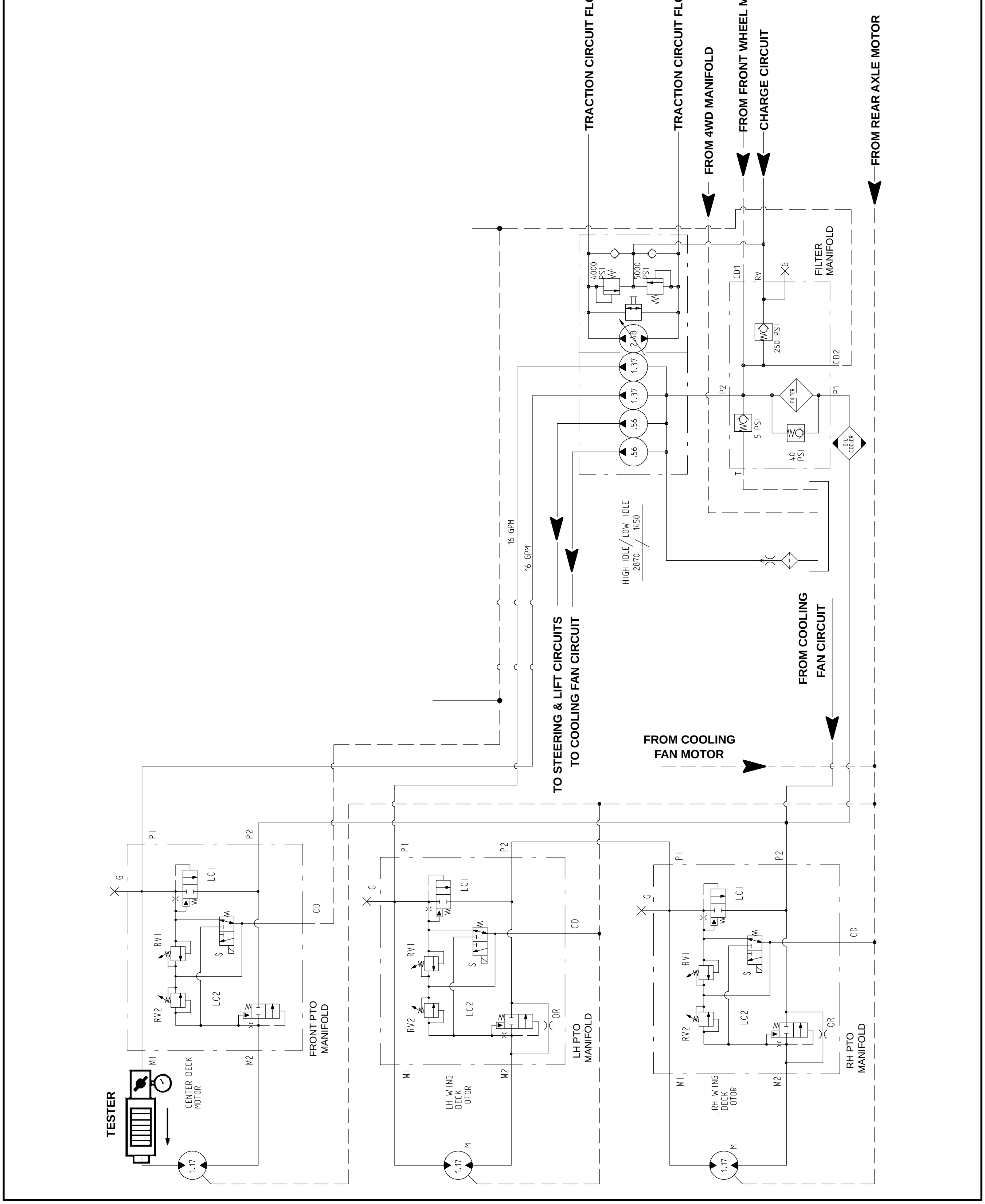


Figure 39

1. **Left wing deck circuit pressure test port**

Hydraulic System

CENTER DECK PTO RELIEF PRESSURE TEST SHOWN



Procedure for Cutting Deck Manifold Relief Pressure Test

IMPORTANT: Mow circuit flow for the Groundsmaster 4100/4110 is approximately 16 GPM (61 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 deck lowered and off. Make sure engine is off and the parking brake is engaged.

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 PTO manifold to be tested (Fig. 40). Thoroughly clean junction of manifold fitting and hydraulic hose at manifold port (M1). Disconnect hydraulic hose at manifold port (M1).

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

4. Install 40 GPM Hydraulic Tester #AT40002 (pressure and flow) in series with the disconnected hose and hydraulic manifold port (M1) (or motor inlet if hose was disconnected at deck motor). Use hydraulic hose kit (see Special Tools in this chapter) to connect tester to machine. **Make sure the flow control valve on the tester is fully open.**

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

CAUTION

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

6. Move throttle so engine is running at high idle speed **(2870 RPM)**. Engage the cutting deck.

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

8. As the relief valve lifts, the pressure gauge needle will momentarily stop or hesitate. System pressure should be approximately:

2900 to 3100 PSI (200 to 213 bar) for the center deck and LH wing deck
1900 to 2100 PSI (131 to 144 bar) for the RH wing deck

9. Fully open tester flow control valve and disengage cutting deck. Shut off engine and record test results.

10. If specification is **not** met, clean or adjust relief valve in deck manifold port (RV1). See Adjust Control Manifold Relief Valves in the Adjustments section of this chapter for the valve adjustment procedure. Recheck relief valve pressure setting after adjustment.

11. After testing is completed, disconnect tester and hose kit from manifold and machine hydraulic hose. Reconnect hydraulic hose that was disconnected for test procedure.

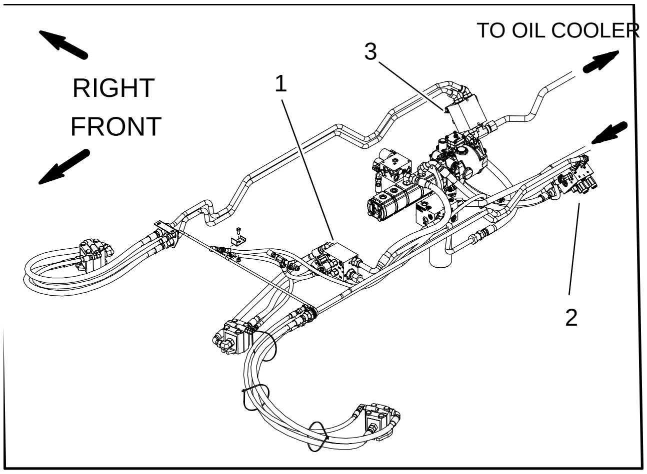


Figure 40

1. Center deck manifold
2. LH wing deck manifold
3. RH wing deck manifold

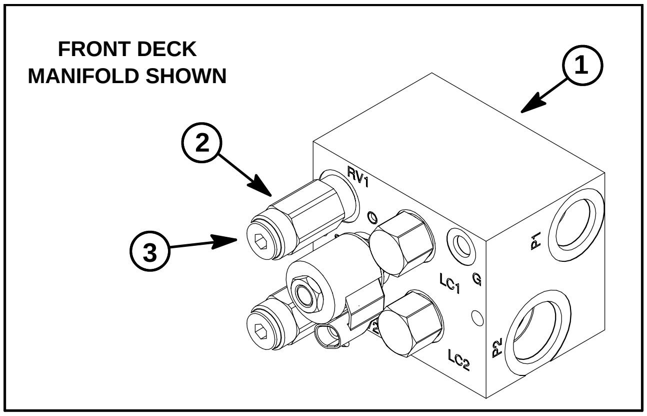
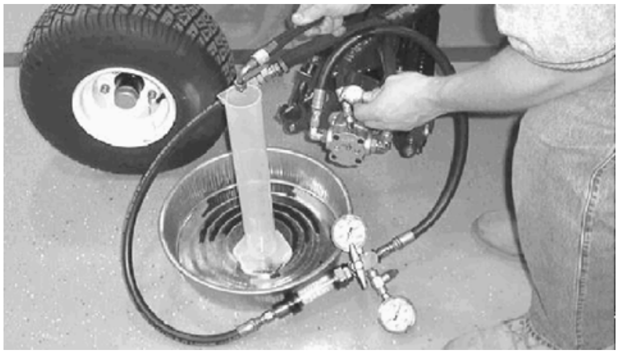


Figure 41

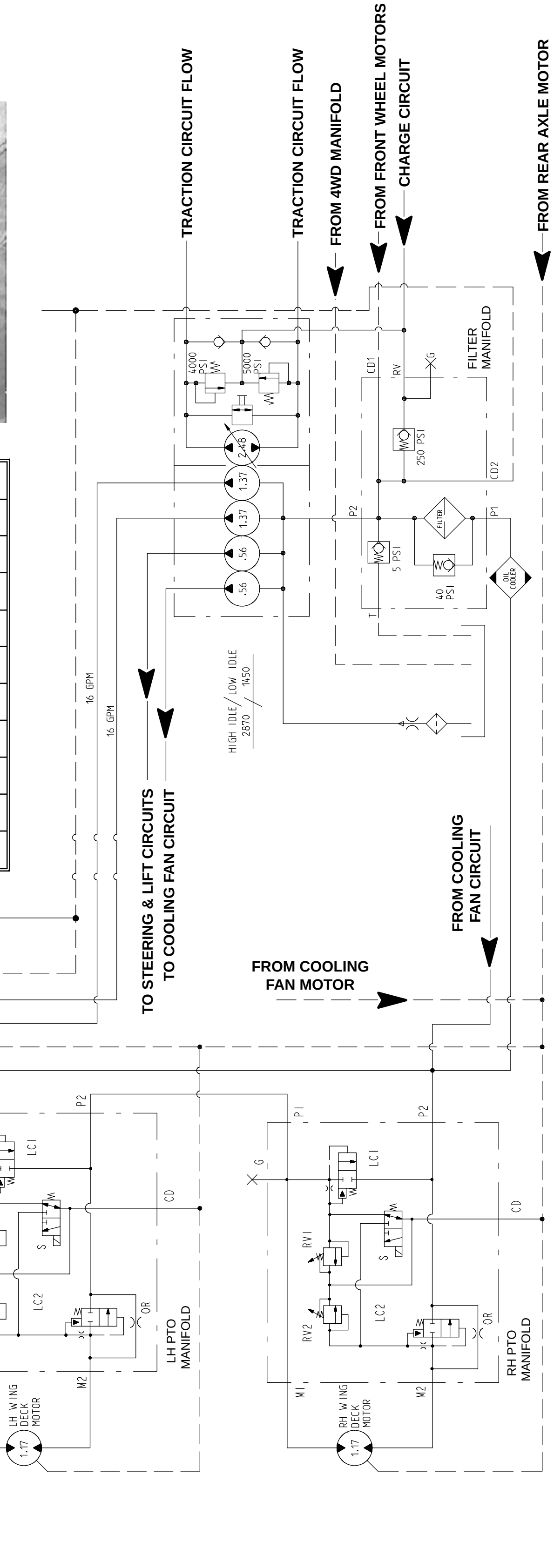
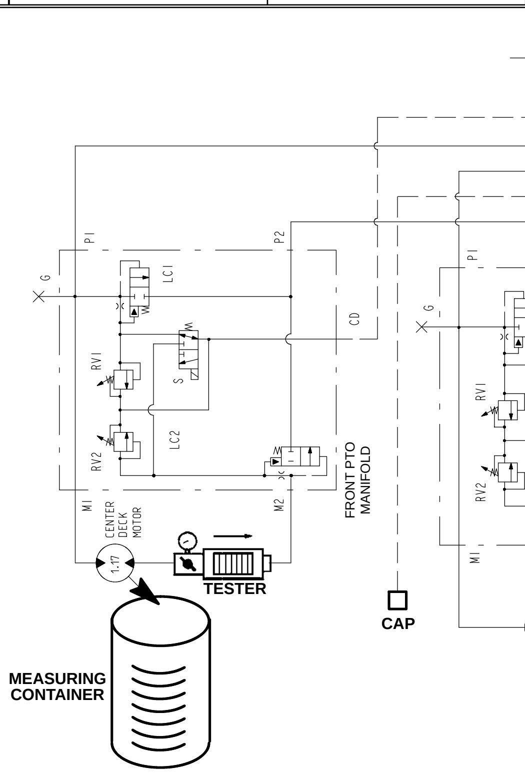
1. Deck manifold
2. Relief valve (RV1)
3. Relief valve cap

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

CENTER 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 motor can generate excessive heat and cause damage to hydraulic system components.

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 deck motor will run slower, produce fewer clippings and may cause a different appearance on the turf.

IMPORTANT: Mow circuit flow for the Groundsmaster 4100/4110 is approximately 16 GPM (61 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 deck lowered and off. Make sure engine is off and the parking brake is engaged.

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 wing 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 return hose from the motor to be tested (Fig. 42).

4. Install 40 GPM Hydraulic Tester #AT40002 (pressure and flow) in series with the motor and the disconnected return hose. Use hydraulic hose kit (see Special Tools in this chapter) to connect tester to machine. **Make sure the flow control valve on the tester is fully open.**

5. Disconnect the motor case drain hose (small diameter hose) where it connects to the machine (not at the motor). Put a steel cap on the fitting; leave the case drain hose open.

6. After installing flow tester, start engine and run at idle speed. Check for hydraulic leakage and correct before proceeding with test.

CAUTION

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

7. Sit on seat and move throttle so engine is running at high idle speed **(2870 RPM)**. Move PTO switch to ON.

8. 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.

9. Have a second person measure flow from the case drain line for **15 seconds**, then move the PTO switch to OFF. Open the tester flow control valve and stop the engine. Record test results.

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

10. 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.

11. When testing is complete, disconnect tester and hose kit from motor and machine hydraulic hose. Reconnect hose to the deck motor. Remove cap from machine fitting and reconnect case drain hose.

12. If required, repeat test procedure for other deck motors.

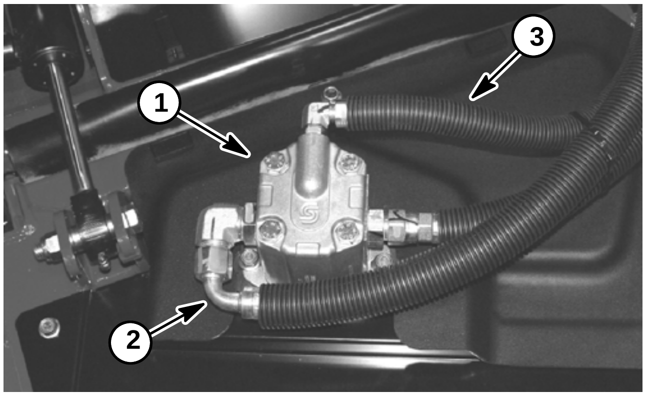
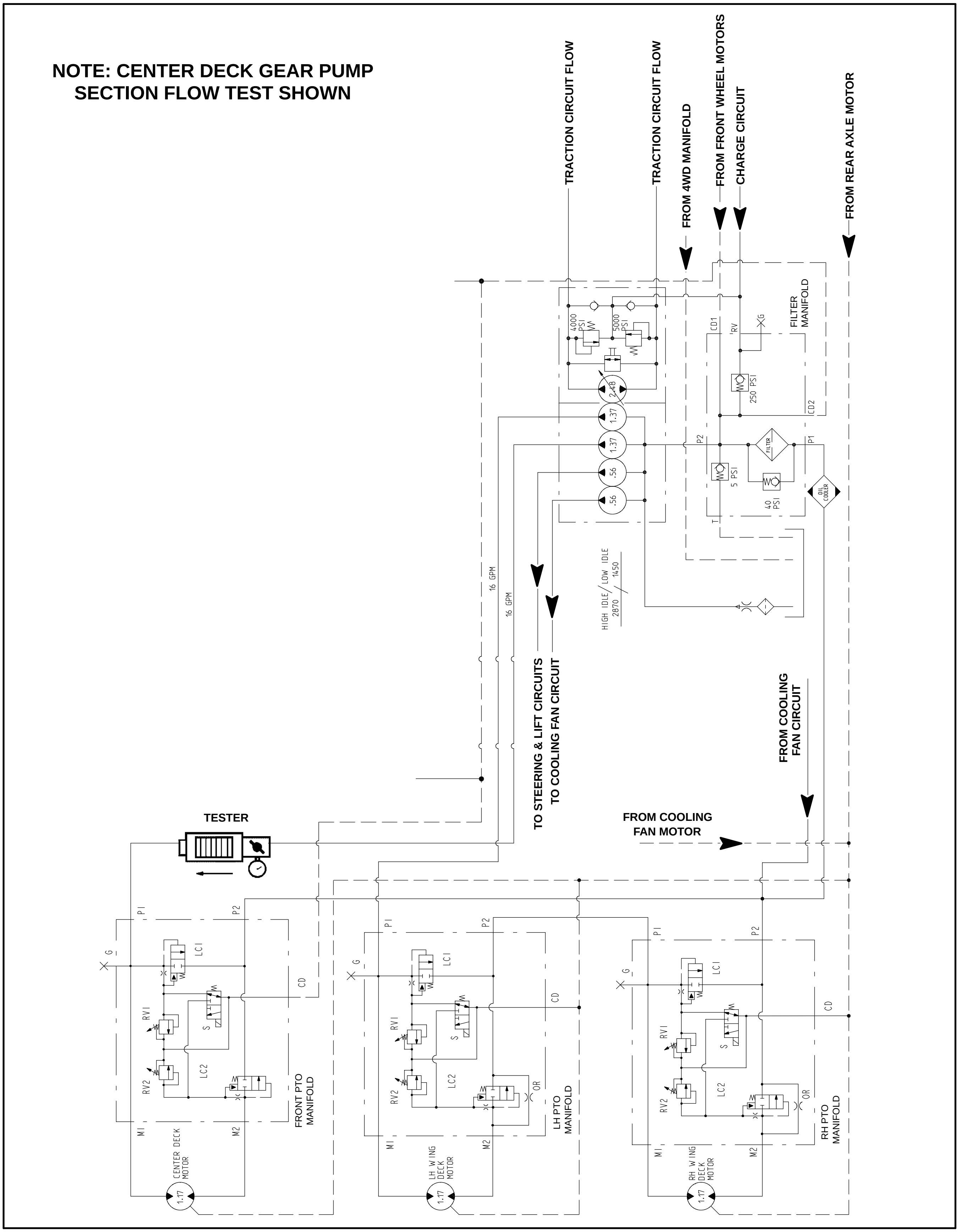


Figure 42

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

Hydraulic System


NOTE: CENTER DECK GEAR PUMP SECTION FLOW TEST SHOWN
TRACTION CIRCUIT FLOW
TRACTION CIRCUIT FLOW
FROM 4WD MANIFOLD
FROM FRONT WHEEL MOTORS
CHARGE CIRCUIT
FROM REAR AXLE MOTOR
FILTER MANIFOLD
TO STEERING & LIFT CIRCUITS
TO COOLING FAN CIRCUIT
FROM COOLING FAN CIRCUIT
FROM COOLING FAN MOTOR
TESTER
FRONT PTO MANIFOLD
LH PTO MANIFOLD
RH PTO MANIFOLD
CENTER DECK MOTOR
LH WING DECK MOTOR
RH WING DECK MOTOR
16 GPM
16 GPM
HIGH IDLE/LOW IDLE
2870 / 1450

Procedure for Cutting Deck Gear Pump Flow Test

NOTE: Over a period of time, the gears and wear plates in the gear pump can wear. A worn pump will by-pass oil and make the pump less efficient. Eventually, enough oil loss will occur to cause 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.

IMPORTANT: Mow circuit flow for the Groundsmaster 4100/4110 is approximately 16 GPM (61 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 deck lowered and off. Make sure engine is off and the parking brake is engaged.

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 PTO control manifold for gear pump section to be tested (front or LH manifold). Thoroughly clean junction of manifold fitting and hydraulic hose at PTO manifold port (P1) (Fig. 43). Disconnect hydraulic hose from port (P1) fitting.

4. Install 40 GPM Hydraulic Tester #AT40002 (pressure and flow) in series with the disconnected hose and hydraulic manifold port (P1). Use hydraulic hose kit (see Special Tools in this chapter) to connect tester to machine. **Make sure the flow control valve on the tester is fully open.**

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

6. Move throttle so engine is running at high idle speed **(2870 RPM)**. **Do not engage the cutting deck**.

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 tester flow control valve until **2000 PSI** 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. For a gear pump in good condition, pump flow should be approximately **16 GPM (61 LPM)**. Fully open tester flow control valve and shut off engine. Record test results.

9. If measured flow is **less than 14 GPM (53 LPM)** or if a pressure of **2000 PSI** cannot be obtained, check for restriction in the pump intake line. If line is not restricted, remove gear pump and repair or replace as necessary.

10. When testing is complete, disconnect tester and hose kit from manifold port and machine hydraulic hose. Reconnect machine hose to the manifold.

11. Repeat test for second cutting deck gear pump section if required.

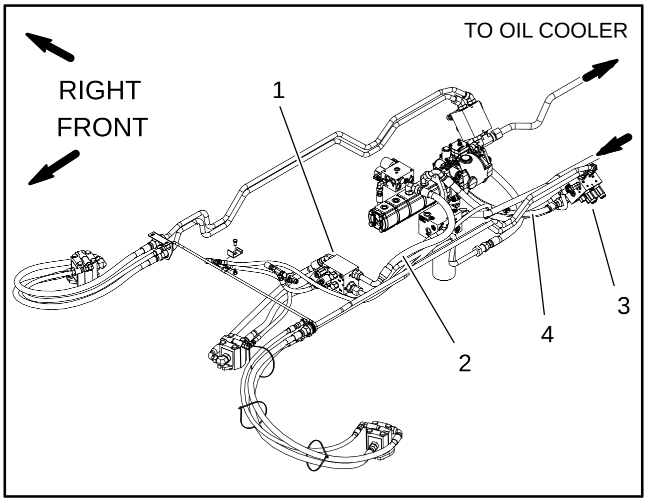
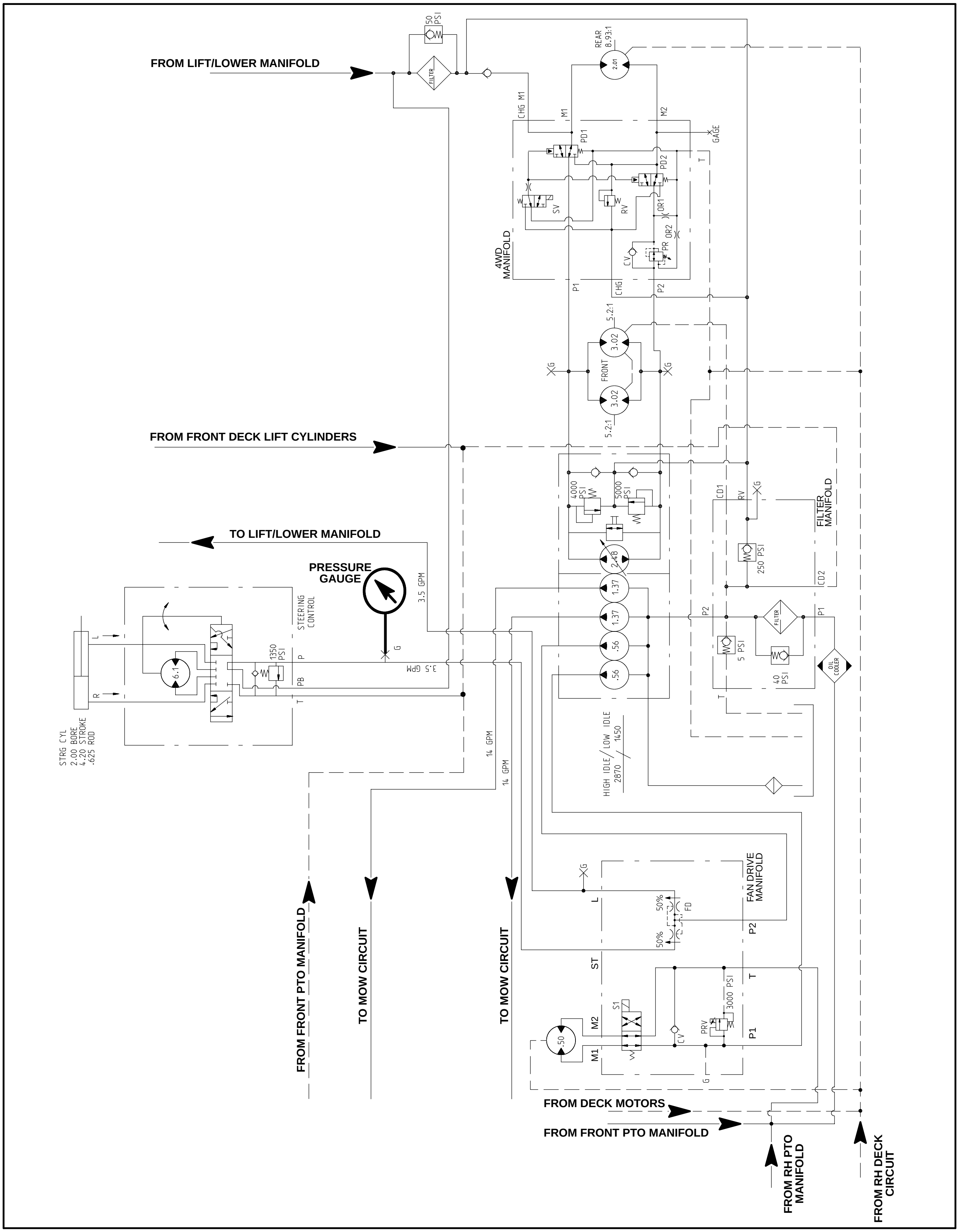


Figure 43

1. **Center deck manifold**
2. **Hyd. hose to front P1**
3. **LH wing deck manifold**
4. **Hyd. hose to side P1**

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 deck lowered and off. Make sure engine is off and the parking brake is engaged.

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 5000 PSI (350 bar) pressure gauge onto steering circuit pressure test port (Fig. 44).

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

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

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

6. 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).

7. Stop the engine and record test results.

8. If pressure is incorrect, inspect steering relief valve in control valve (see Steering Control Valve in the Service and Repairs section of this chapter). If steering relief valve is operating properly and if lift/lower problems also exist, gear pump 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.

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

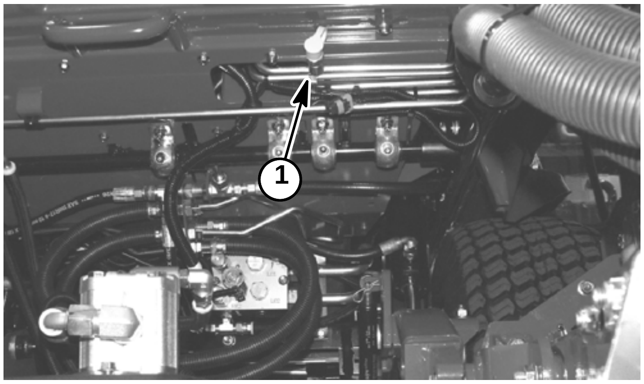
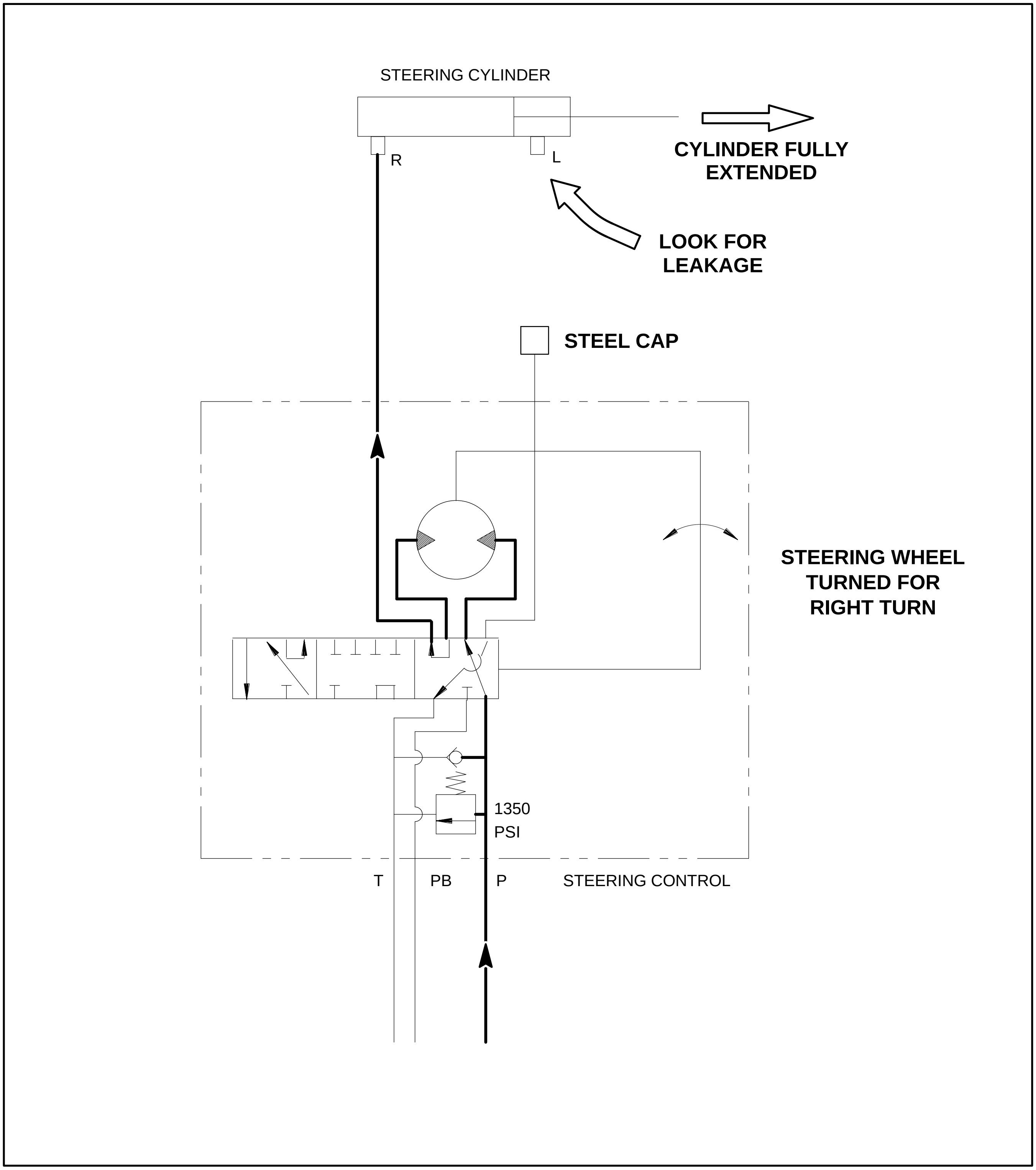


Figure 44

1. Steering circuit pressure test port

Hydraulic System

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 deck 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, consider the following:

A. Steering and lift/lower gear pump section is worn or damaged (see Steering and Lift/Lower Gear Pump Flow Test in this section).

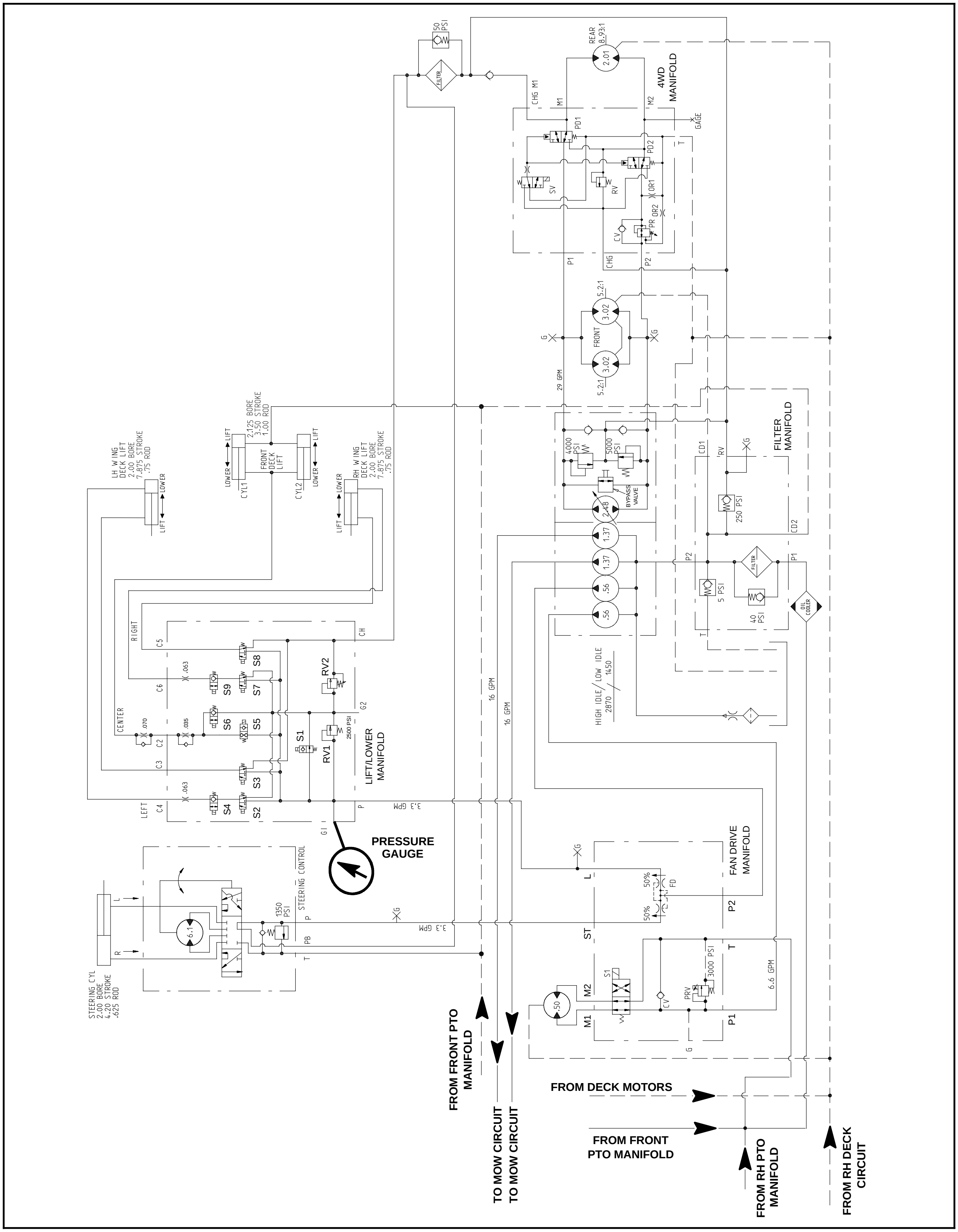
NOTE: If steering and lift/lower gear pump section is worn or damaged, charge, steering and lift circuits will all be affected.

B. The flow divider in the fan drive control manifold is faulty (see Fan Drive Manifold Service in the Service and Repairs section of this chapter).

C. 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.

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 deck lowered and off. Make sure engine is off and the parking brake is engaged.

3. Remove controller cover to gain access to lift/lower manifold (Fig. 45).

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. 46).

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

6. Sit on the seat and move throttle so engine is running at high idle speed **(2870 RPM)**.

7. While sitting on the seat, depress the rear of the center lift switch 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 **2500 PSI (172 bar)**.

8. Release the lift switch, stop the engine and record test results.

9. If specification is **not** met, clean or adjust relief valve (RV1) in lift/lower control manifold. Relief valve (RV1) is located on the top side of the lift/lower manifold (Fig. 46). See Adjust Control Manifold Relief Valves in the Adjustments section of this chapter for the valve adjustment procedure. Recheck relief valve pressure setting after adjustment.

10. 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.

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

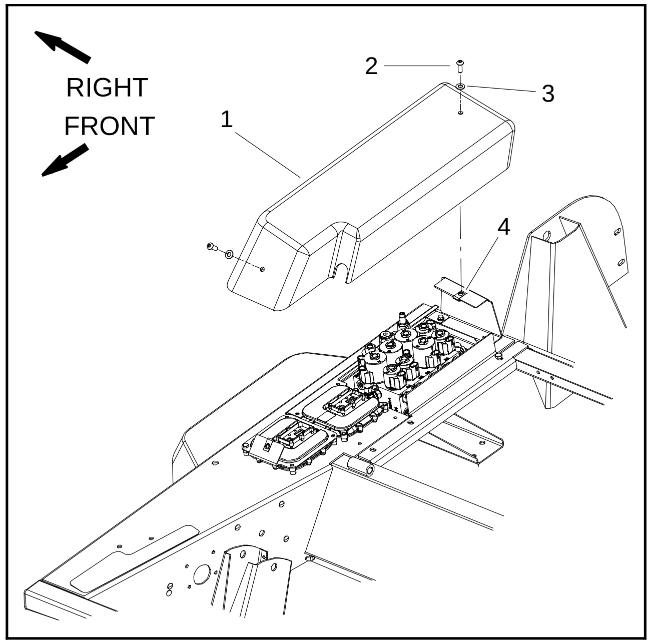


Figure 45

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

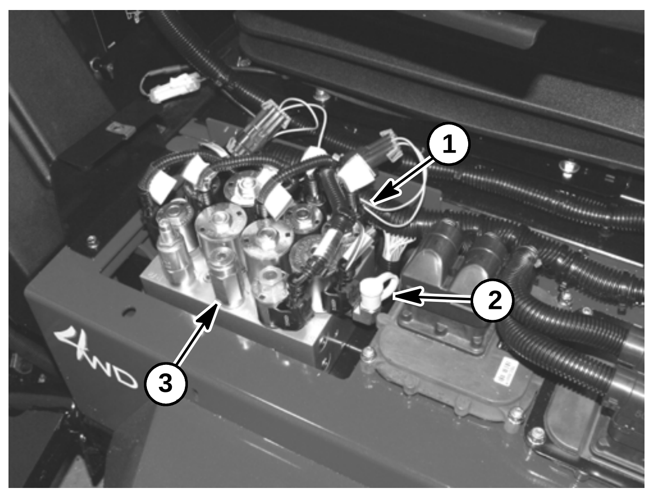
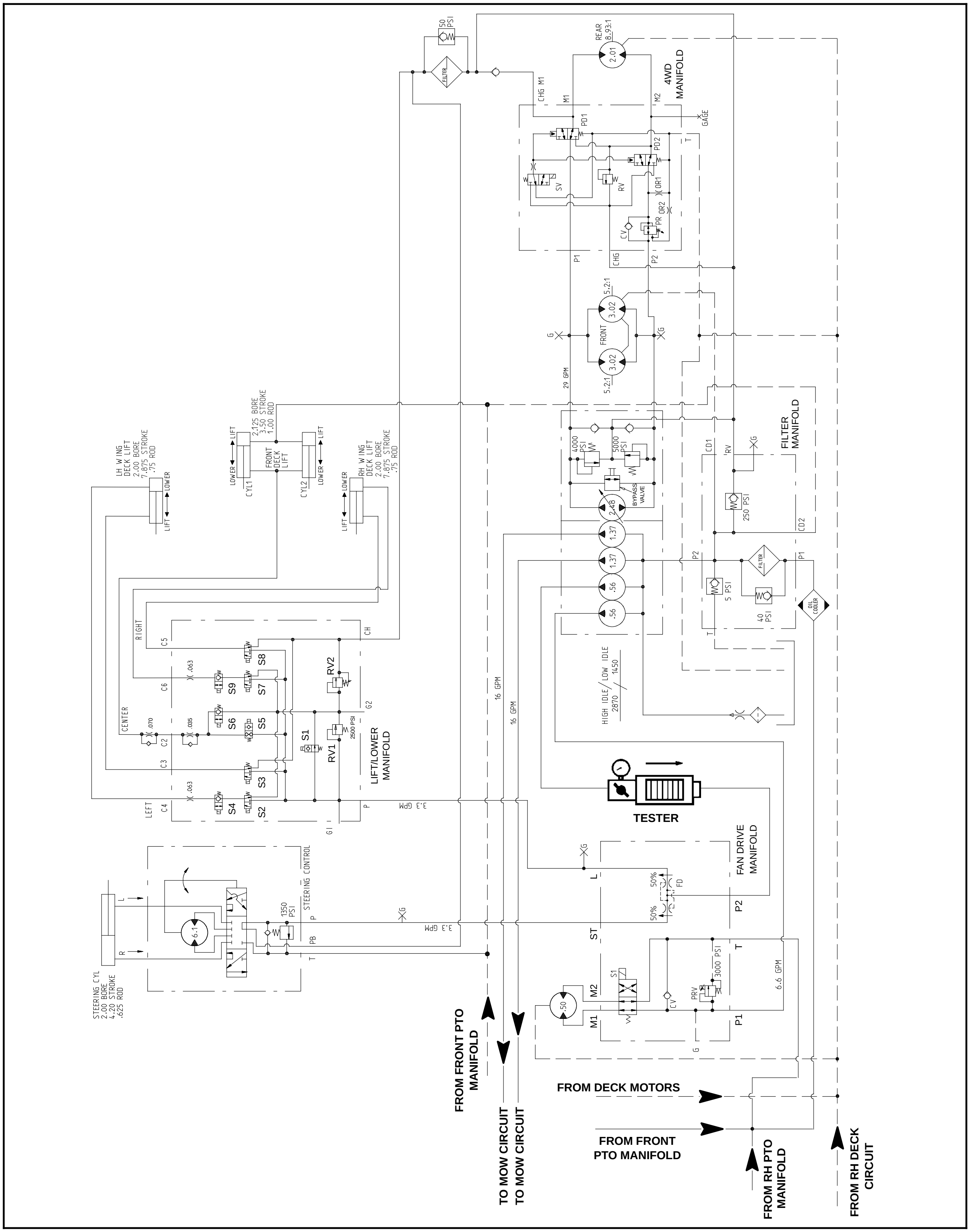


Figure 46

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

Steering and Lift/Lower Gear Pump Flow (Using Tester with Pressure Gauge and Flow Meter)



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: If steering and lift/lower gear pump section is worn or damaged, charge, steering and lift circuits will all be affected.

NOTE: While rotating the steering wheel and raising the deck 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 deck 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 deck lowered and off. Make sure engine is off and the parking brake is engaged. Raise and support 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.

3. Thoroughly clean junction of fitting and hydraulic hose at the third gear pump section which supplies the steering and lift/lower circuits (Fig. 47).

4. With the engine off and cutting deck lowered, disconnect the hydraulic hose from the 90º fitting in the third gear pump section.

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.

5. Install tester with pressure gauge and flow meter in series between the fitting and the disconnected hose. **Make sure the flow control valve on the tester is fully open.**

6. After installing tester, start engine and run at idle speed. Check for hydraulic leakage at tester location and correct before proceeding with test.

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

7. Move throttle so engine is running at high idle speed **(2870 RPM)**. DO NOT engage the cutting deck.

8. While watching pressure gauge on the 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.

9. Open the tester flow control valve and stop the engine. Record test results.

10. 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 the gear pump is worn or damaged.

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

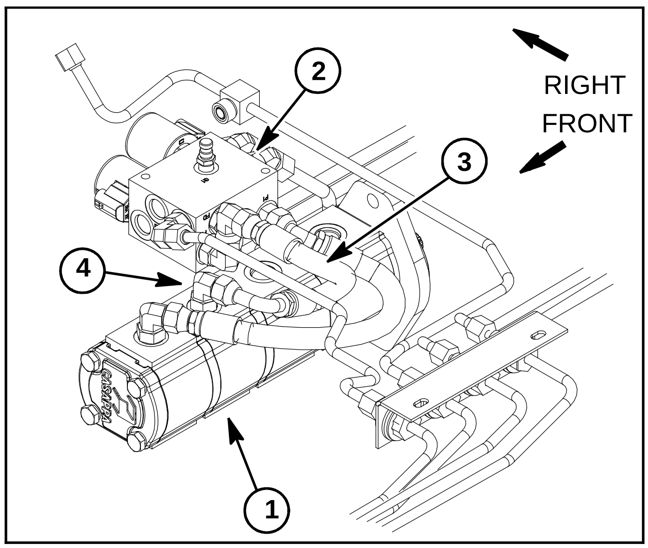
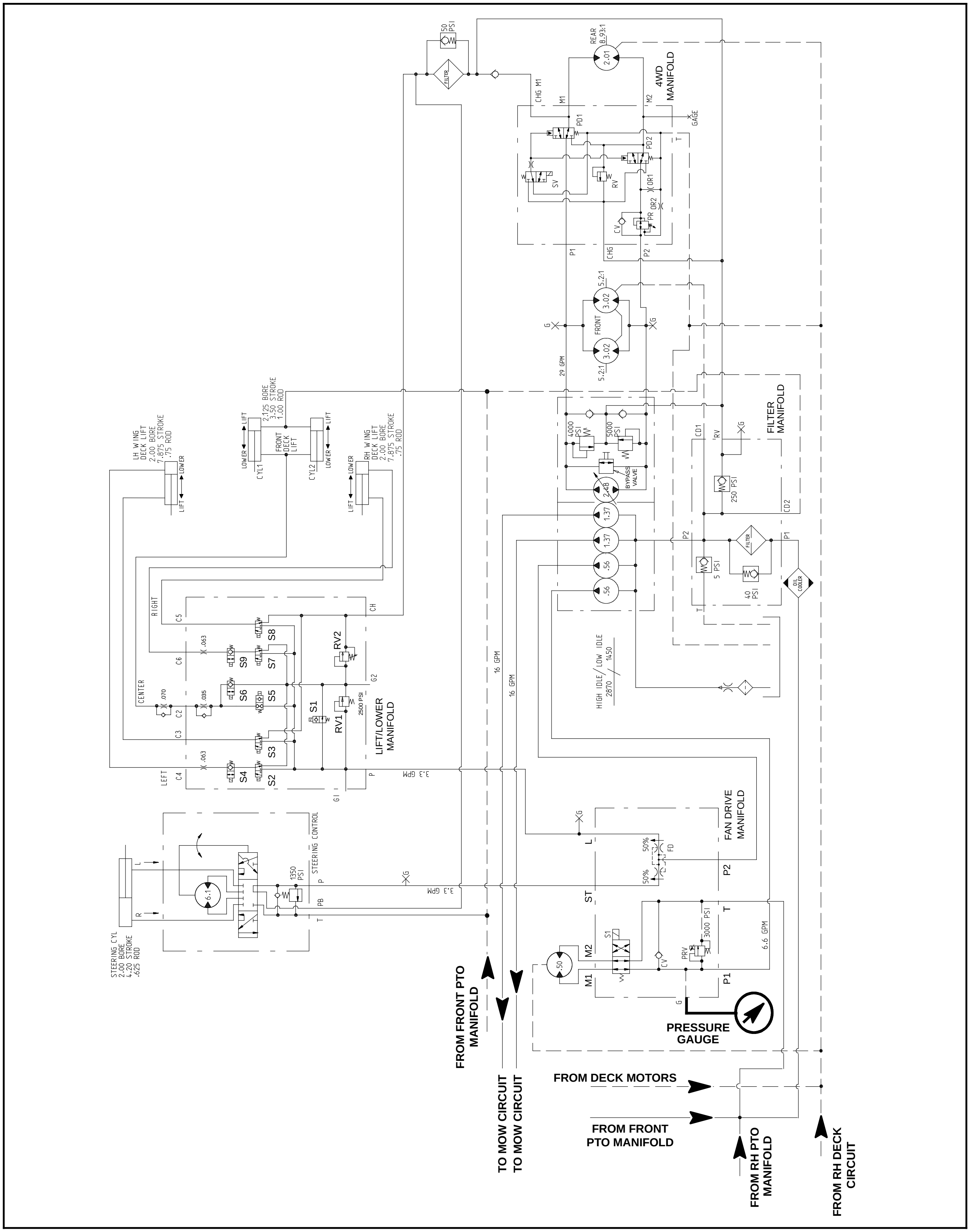


Figure 47

1. **Gear pump**
2. **Fan drive manifold**
3. **Steering/lift supply hose**
4. **90º fitting**

Hydraulic System

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 deck 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 fan drive manifold (Fig. 48). Connect a 5,000 PSI (345 bar) pressure gauge with hydraulic hose attached to test port on top of manifold (Fig. 49).

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

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

6. 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. 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**.

7. Stop engine and record test results.

8. 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).

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).

9. When testing is complete, remove pressure gauge and reconnect wire harness to PRV solenoid.

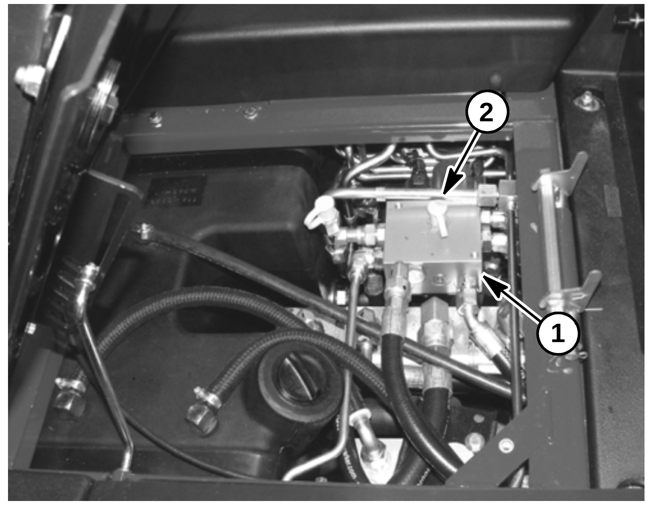


Figure 48

1. Fan drive manifold
2. Test port G1

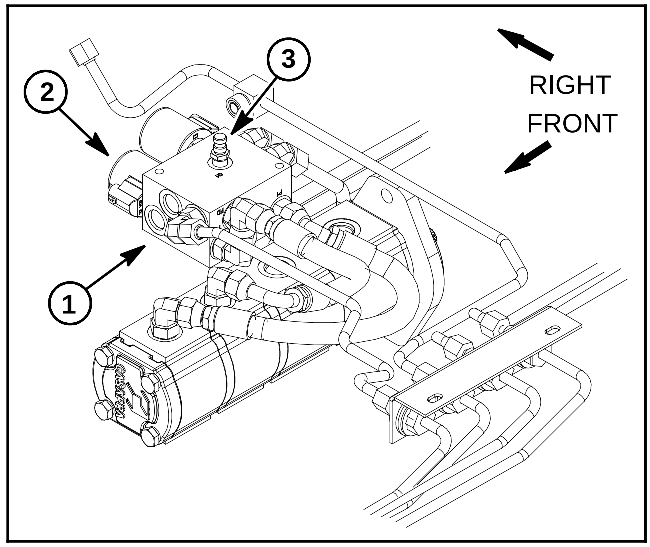
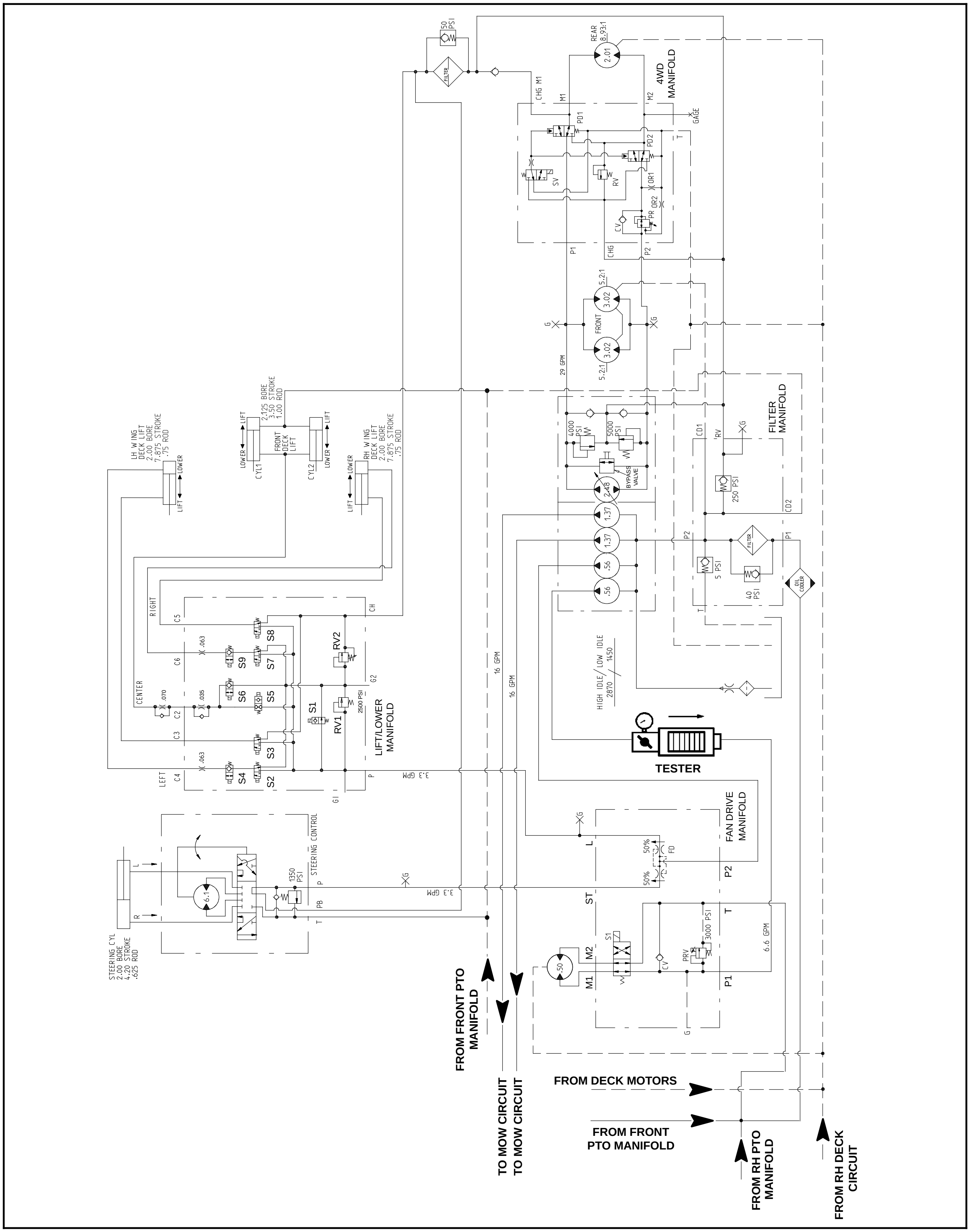


Figure 49

1. Fan drive manifold
2. PRV solenoid
3. Test port G1

Hydraulic System

Engine Cooling Fan Circuit Gear Pump Flow (Using Tester with Pressure Gauge and Flow Meter)



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 deck lowered and off. Make sure engine is off and the parking brake is applied. Raise and support 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.

3. Thoroughly clean junction of fitting and hydraulic hose at the last gear pump section which supplies the engine cooling fan circuit (Fig. 50).

4. With the engine off and cutting deck lowered, disconnect the hydraulic hose from the 90º fitting in the last gear pump section.

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.

5. Install tester with pressure gauge and flow meter in series between the fitting and the disconnected hose. **Make sure the flow control valve on the tester is fully open.**

6. After installing tester, start engine and run at idle speed. Check for hydraulic leakage at tester location and correct before proceeding with test.

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.

7. Move throttle so engine is running at high idle speed **(2870 RPM)**. DO NOT engage the cutting deck.

8. While watching tester pressure gauge, slowly close flow control valve until **1000 PSI (69 bar)** is obtained on pressure 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 during testing, expect pump flow to decrease.

9. Open the tester flow control valve and stop the engine. Record test results.

10. 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 is worn or damaged.

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

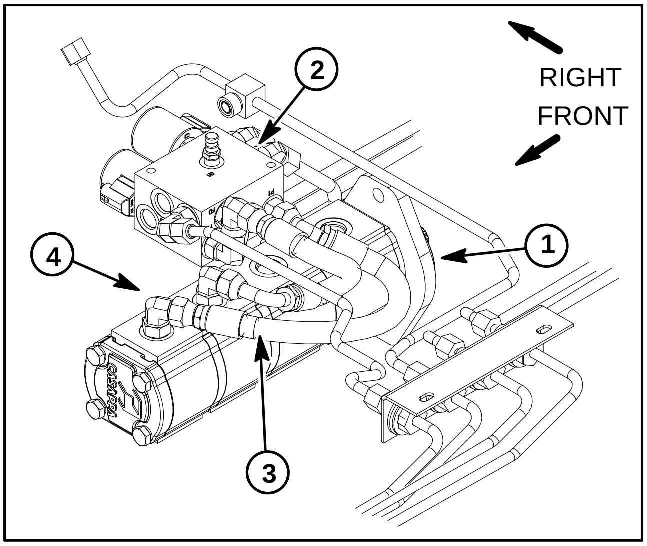


Figure 50

1. Gear pump
2. Fan drive manifold
3. Cooling fan supply hose
4. 90º fitting

Hydraulic System

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Adjustments

Adjust Control Manifold Relief Valves

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

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

1. Locate relief valve and remove cap from valve.

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

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

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

5. Install and tighten cap on relief valve.

6. Recheck relief pressure and readjust as needed.

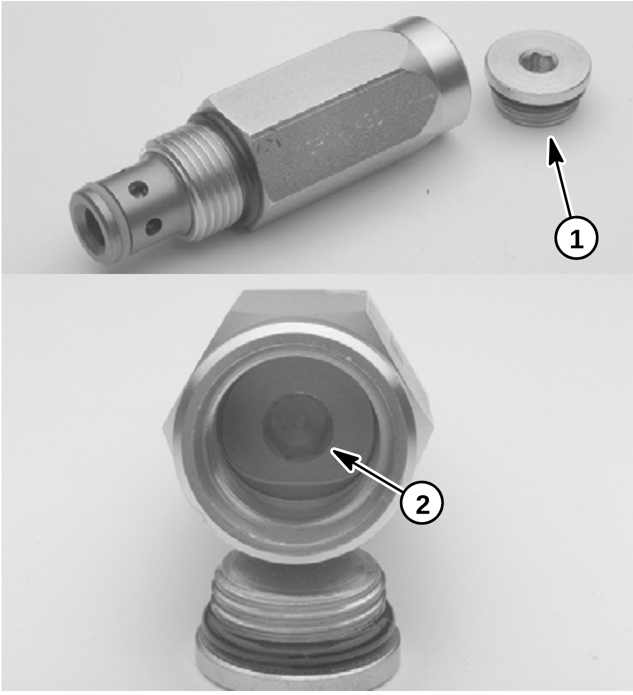

Figure 51

1. **Relief valve cap**
2. **Adjustment socket**

Hydraulic System

Traction Linkage Adjustment

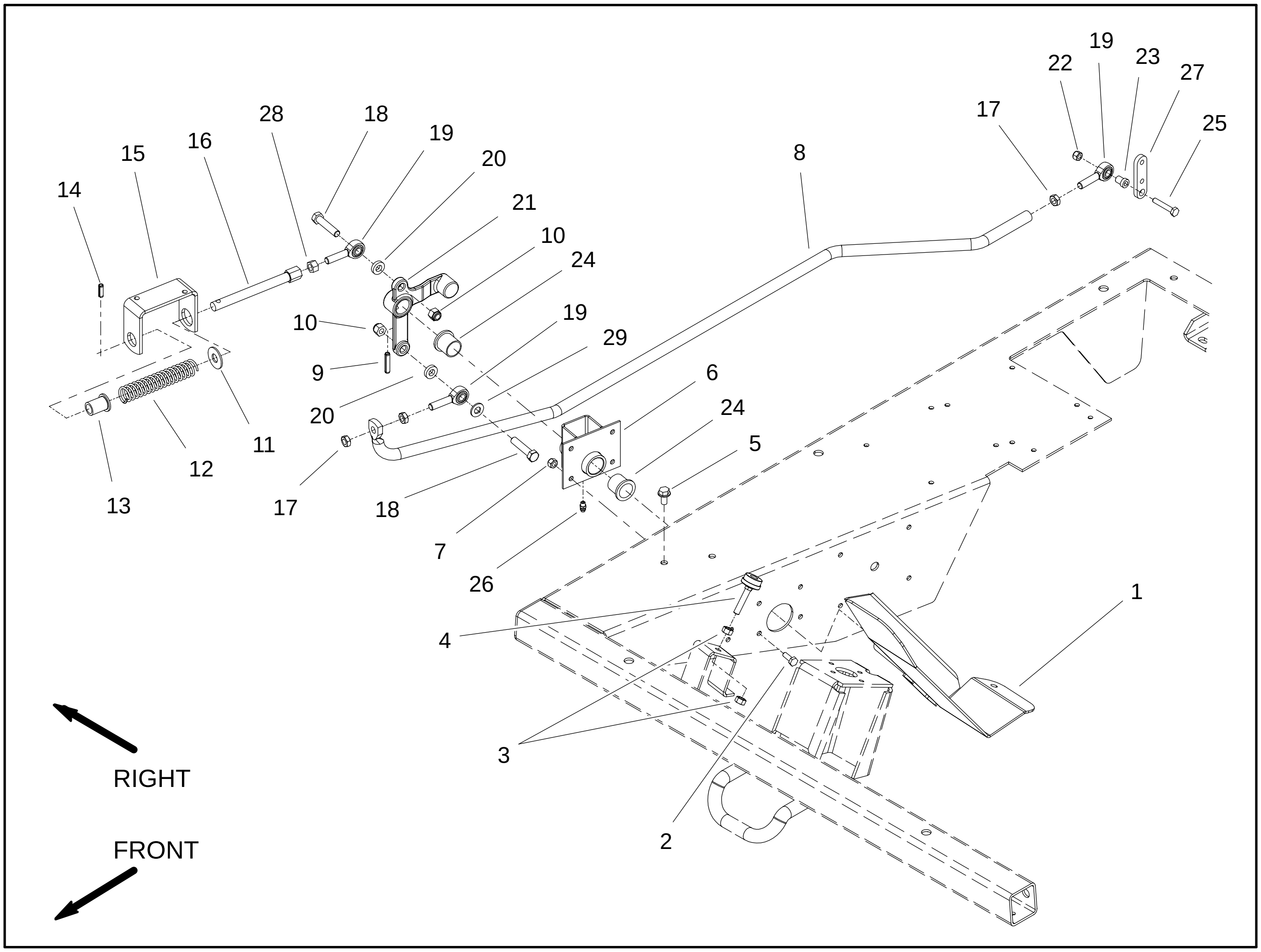

Figure 52

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

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. 53). 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. 53). Tighten jam nut to secure rod end to traction rod.

3. On traction lever end of traction rod (item 4 in Fig. 53), jam nuts should position traction rod so traction pedal remains in the neutral detent position and is at an approximate 56^{o} 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).

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

6. To check and adjust neutral position:

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

CAUTION

All wheels will be off the ground and rotating when checking neutral position. Make sure machine is supported so it will not move and accidentally fall to prevent injuring anyone near the machine.

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

C. When traction pedal is released from either forward or reverse, pedal should return to the neutral position and wheels should stop rotating.

D. If necessary, adjust spring shaft (item 5 in Fig. 53) until neutral operation is correct.

E. Lower machine to ground.

7. 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.

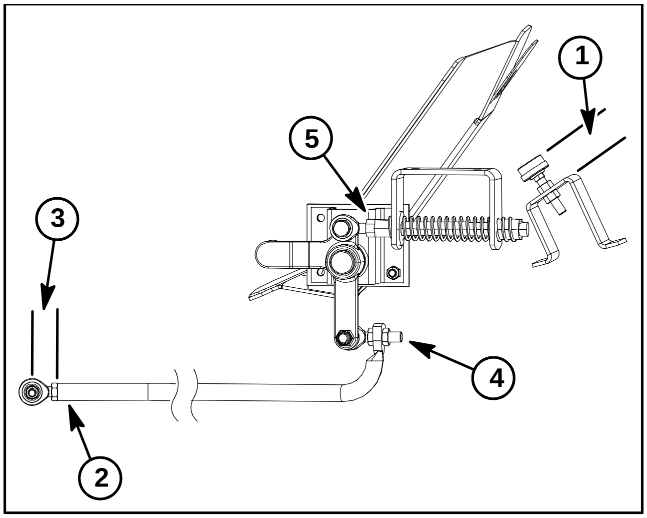

Figure 53

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

Hydraulic System

Service and Repairs

General Precautions for Removing and Installing Hydraulic System Components

Before Repair or Replacement of Components

1. Before removing any parts from the hydraulic system, park machine on a level surface, engage parking brake, lower cutting deck 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 reinstalling 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 all caps or plugs are removed from hydraulic tubes, hydraulic fittings and components before reconnecting.

4. Use proper tightening methods when installing hydraulic hoses and fittings (see Hydraulic Fitting Installation and Hydraulic Hose and Tube Installation in the General Information section of this chapter).

5. After repairs, check control linkages 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 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 deck 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 deck 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. 54). 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.

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.

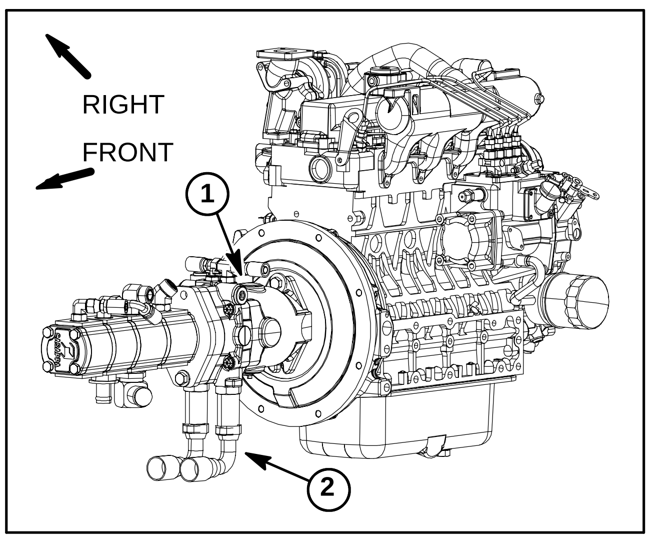

Figure 54

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 and its components to reduce the chance of damage.

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

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

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

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

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

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

6. Disconnect wire harness connector from 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. Connect wire harness 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 support jack stands under the frame. 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 **(1400 RPM)**. The charge pump should pick up oil and fill the hydraulic system. If there is no indication of fill in 30 seconds, stop the engine and determine the cause.

11. After the hydraulic system starts to show signs of fill, actuate lift control switch so that the lift cylinder rod moves in and out several times. If the cylinder rod does not move after fifteen (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.

    D. Faulty gear pump.

12. If cylinder does move in fifteen (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 neutral switch.

16. Remove jack stands from frame and lower machine to the ground. Remove chocks from remaining wheels.

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

18. Operate machine by gradually increasing it's 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.

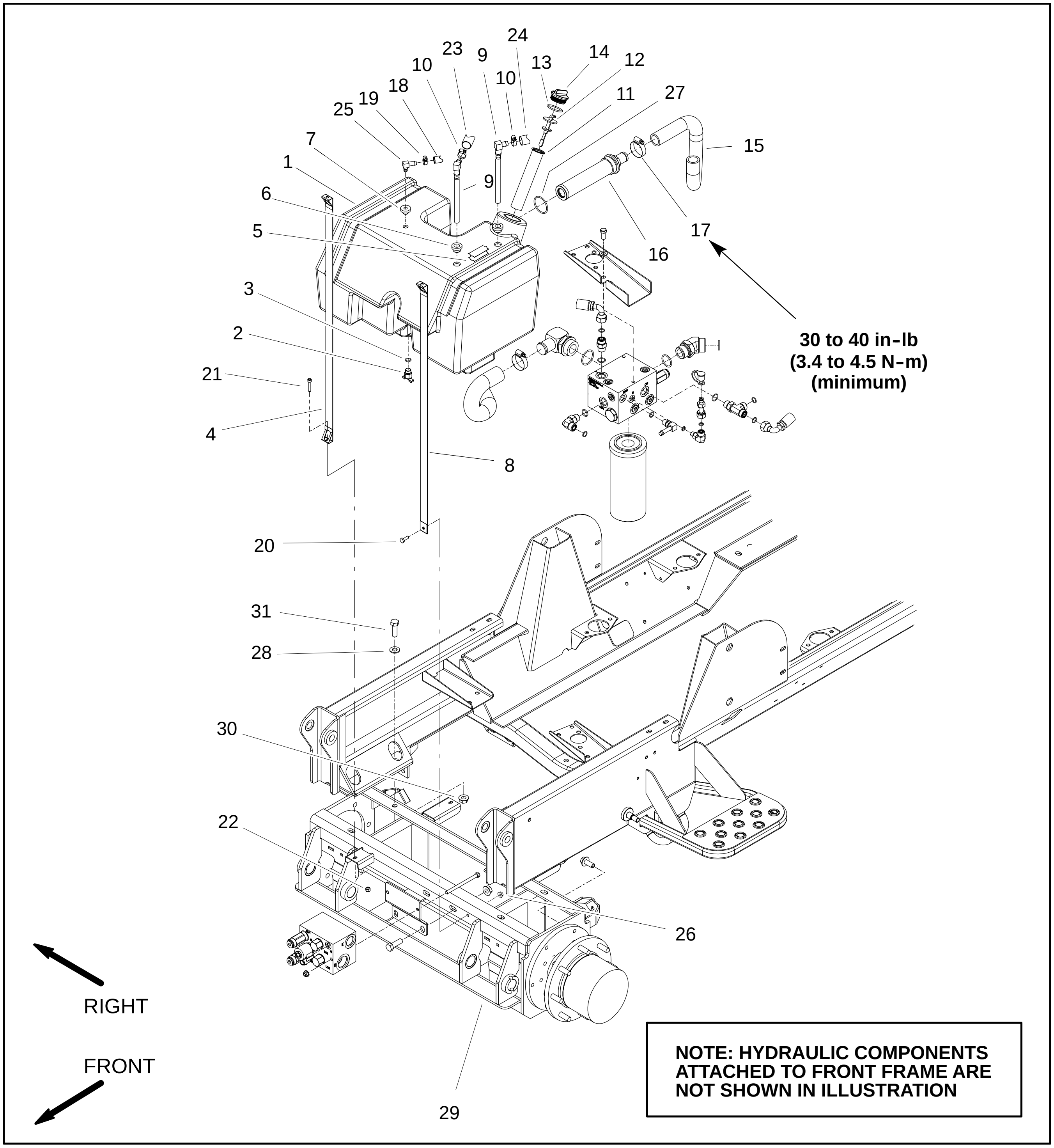

Figure 55

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. 55)

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

2. Remove front cutting deck (see Cutting Deck Removal in the Service and Repairs section of Chapter 8 – Cutting Deck).

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 and front deck PTO 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 tank strainer with solvent.

2. Inspect reservoir for leaks, cracks or other damage.

Installation (Fig. 55)

1. Using a wrench, turn tank strainer into port from 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 manifold (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

8. Install front cutting deck (see Cutting Deck Installation in the Service and Repairs section of Chapter 8 – Cutting Deck).

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

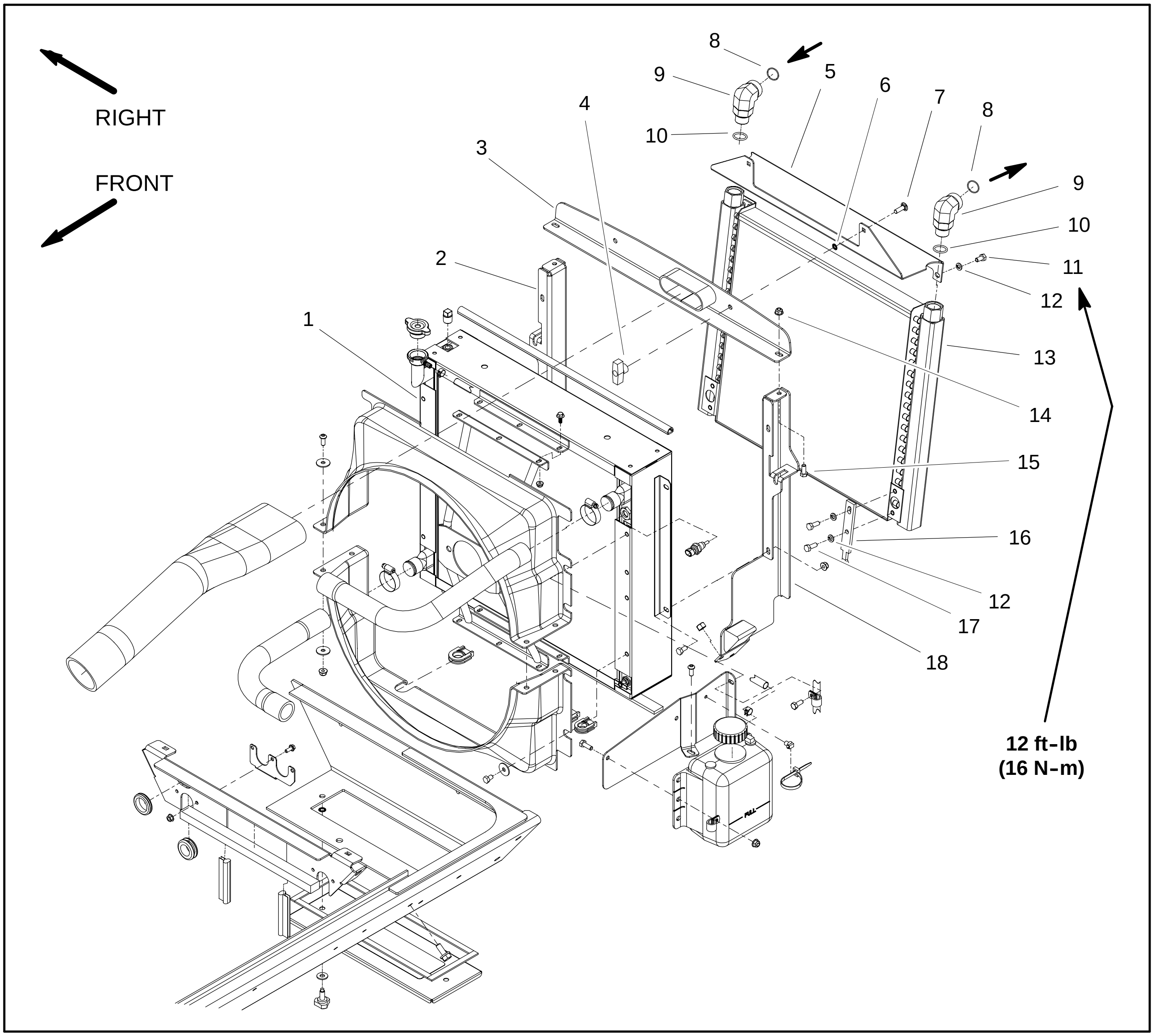

Figure 56

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

Removal (Fig. 56)

CAUTION

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.

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

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 Figures 56 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.

CAUTION

Use eye protection such as goggles when using compressed air.

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. 56)

1. Install oil cooler using Figure 56 as a guide.

2. Fill reservoir with new hydraulic fluid to proper level.

3. Lower and secure hood.

Gear Pump

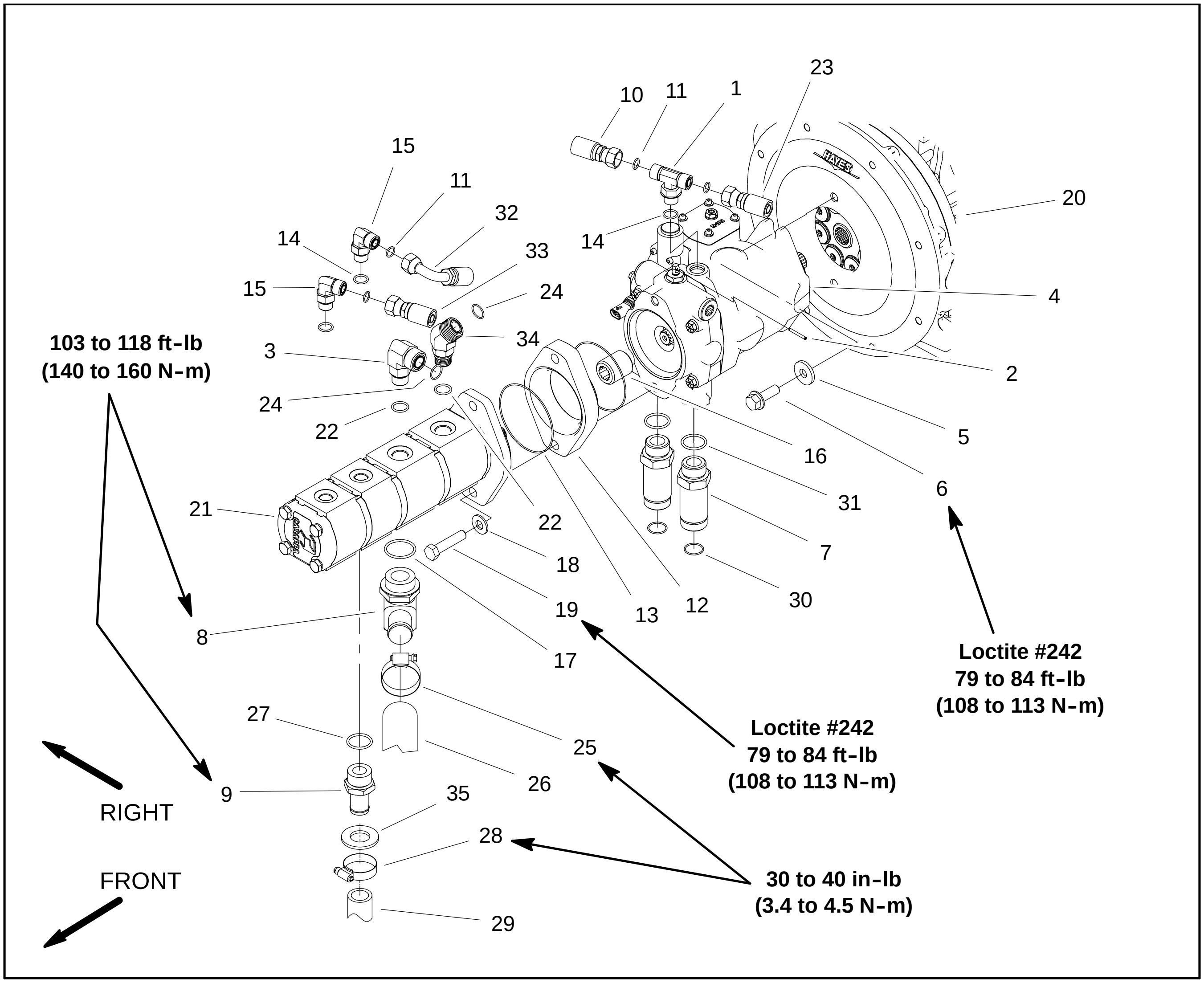

Figure 57

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

Removal (Fig 57)

1. Park machine on a level surface, lower cutting deck, stop engine, engage 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 pump removal, thoroughly clean exterior of pump and fittings.

5. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of this section.

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 that secure gear pump to piston pump. Remove gear pump, coupler, spacer and O–rings from machine through the seat opening.

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 57)

1. If fittings were removed from gear pump, 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).

   A. If 90º hydraulic suction fitting (item 8) and straight fitting (item 9) were removed from gear pump, torque fittings from **103 to 118 ft–lb (140 to 160 N–m)**.

2. Slide coupler onto the piston pump output shaft.

3. Lubricate new O–rings (item 13) with clean hydraulic oil. Position O–rings and spacer to gear pump.

4. Apply Loctite #242 (or equivalent) to threads of cap screws (item 19).

5. Align gear teeth and slide gear pump input shaft into coupler. Secure gear pump to piston pump with two (2) cap screws and washers. Torque cap screws from **79 to 84 ft–lb (108 to 113 N–m)**.

6. Remove caps or plugs from all hydraulic lines and fittings. Using labels placed during pump removal, properly install hydraulic 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 crank the engine for ten (10) seconds. Wait fifteen (15) seconds to allow the starter motor to 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

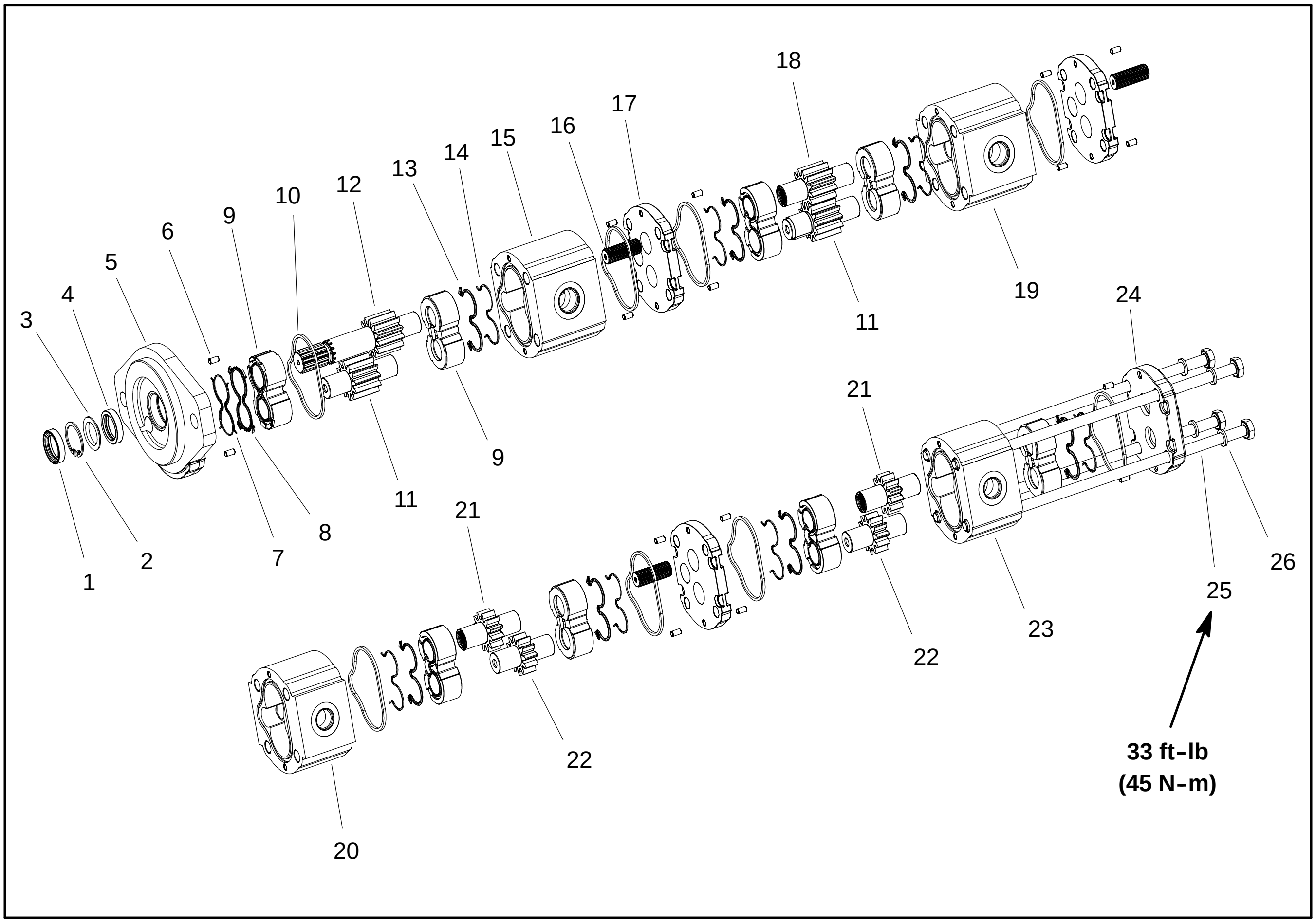

Figure 58

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

Disassembly (Fig. 58)

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. 59).

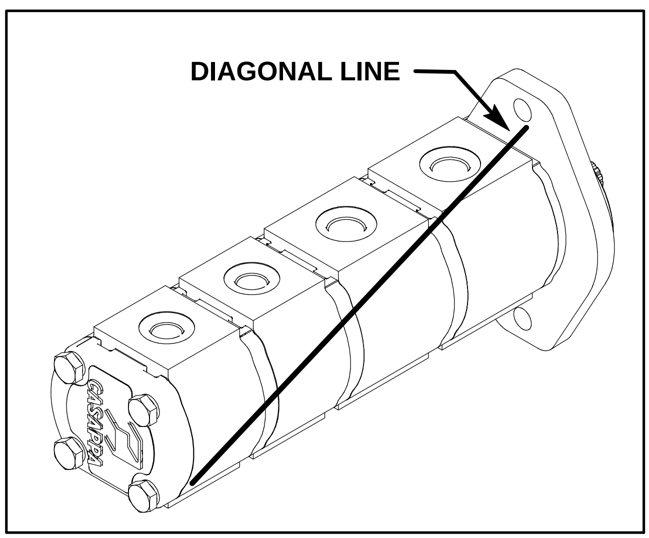

Figure 59

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 cap screws.

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. 58)

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 to rotate shaft.

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

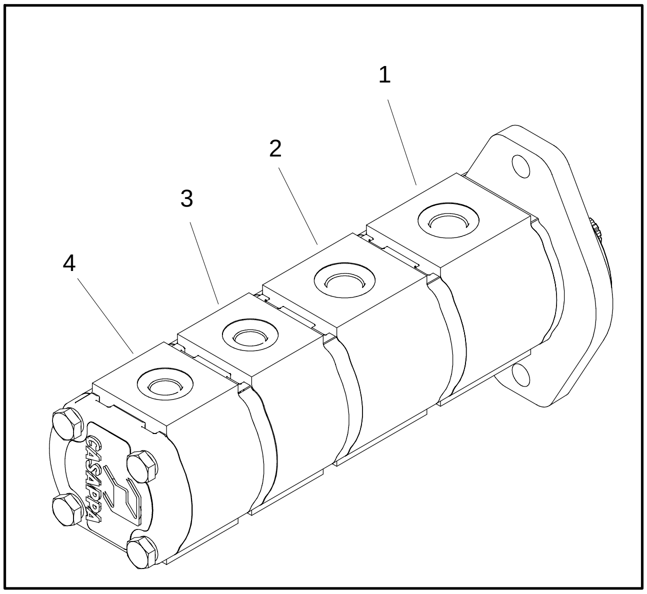

Figure 60

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**

Hydraulic System

Traction Circuit

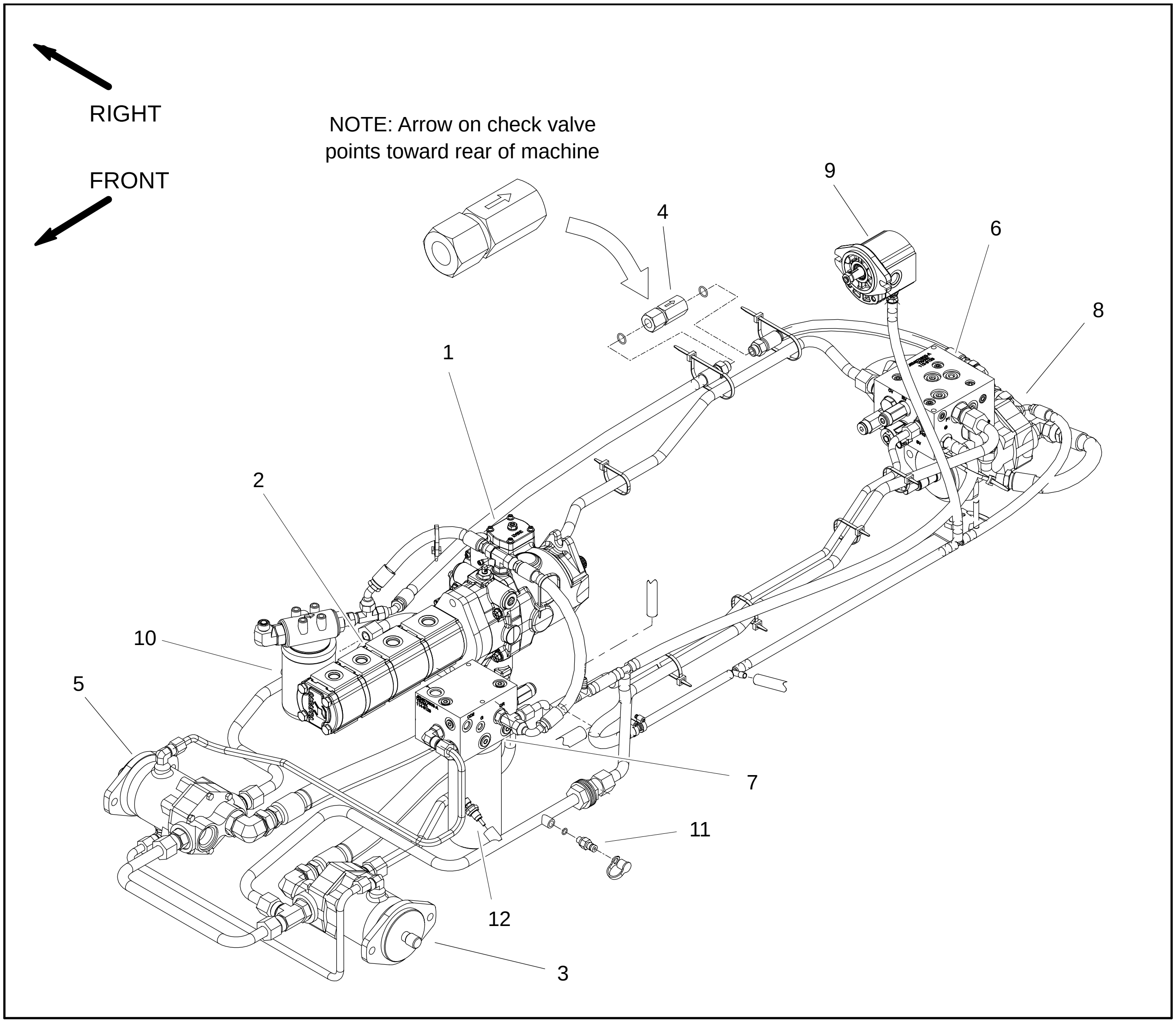

Figure 61

1. **Piston (traction) pump**
2. **Gear pump**
3. **LH front wheel motor**
4. **Check valve**
5. **RH front wheel motor**
6. **4WD manifold**
7. **Filter manifold**
8. **Rear axle motor**
9. **Cooling fan motor**
10. **Reverse traction pressure port**
11. **Forward traction pressure port**
12. **Hydraulic temperature sender**

Figure 61 illustrates the components that are used in the Groundsmaster 4100–D and 4110–D traction circuit. Procedures for removal, installation and disassembly/ assembly of these components are provided on the following pages of this section.

Hydraulic System

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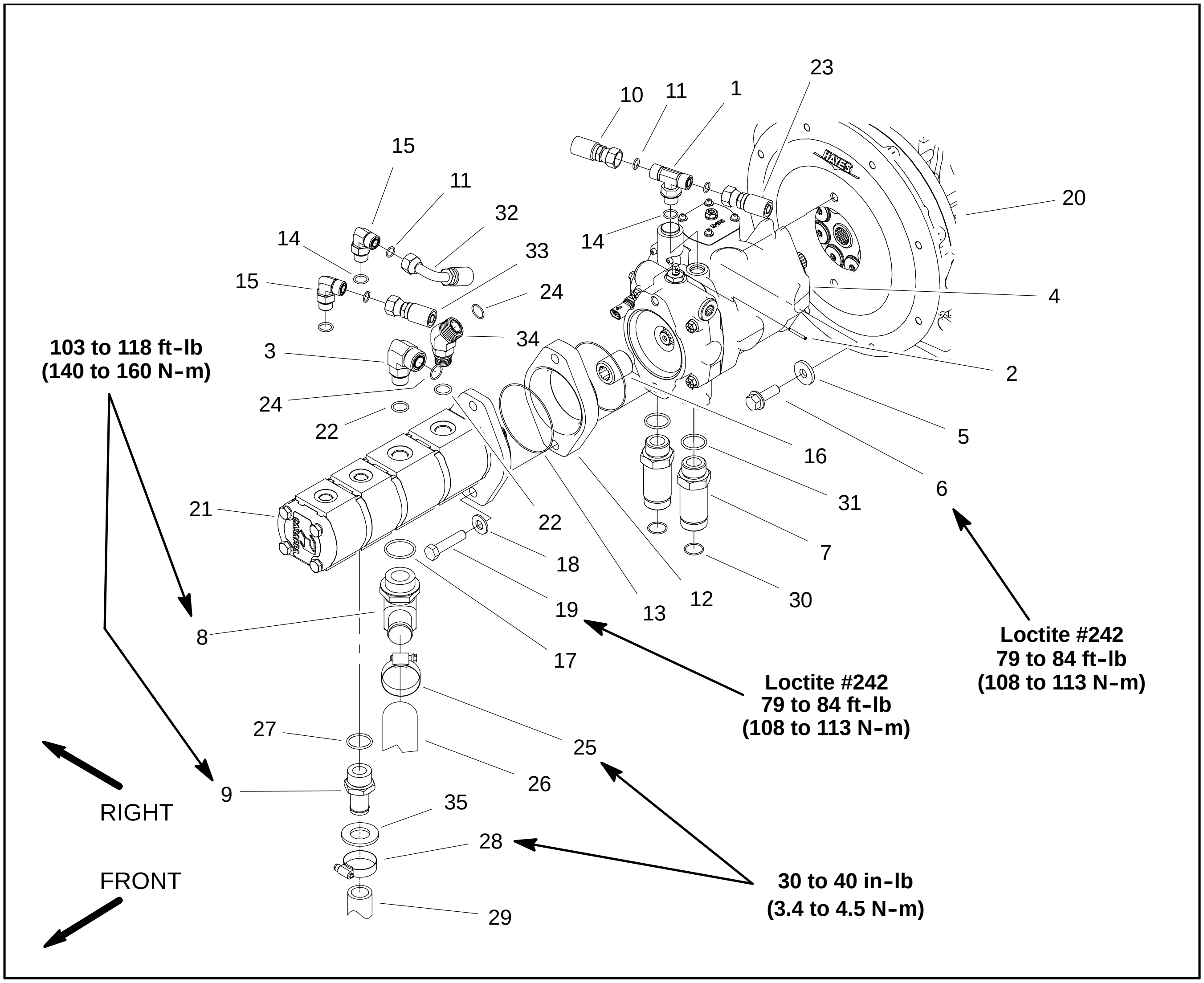

Figure 62

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

Removal (Fig. 62)

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

2. To prevent contamination of hydraulic system during removal, thoroughly clean exterior of pump assembly.

3. Raise and support machine to gain access to pump assembly from the underside of machine.

4. Remove traction rod from piston pump control arm by removing lock nut, spacer and cap screw (Fig. 63).

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 (traction) pump to prevent it from falling while removing two (2) cap screws and washers retaining pump assembly to engine flywheel plate. Carefully pull pump assembly from flywheel plate and lower it from the machine.

Installation (Fig. 62)

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

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

4. Secure traction rod to control arm on piston pump by installing cap screw, spacer and lock nut (Fig. 63).

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

6. Remove plugs or caps from disconnected hydraulic hoses and open ports of the pump assembly. Using labels placed during pump removal, install hydraulic fittings and lines 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).

7. Lower machine to ground.

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

9. Disconnect engine run solenoid electrical connector to prevent engine from starting. Prime the hydraulic pumps by turning the ignition key switch to start and crank the engine for ten (10) seconds. Wait fifteen (15) seconds to allow the starter motor to 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.

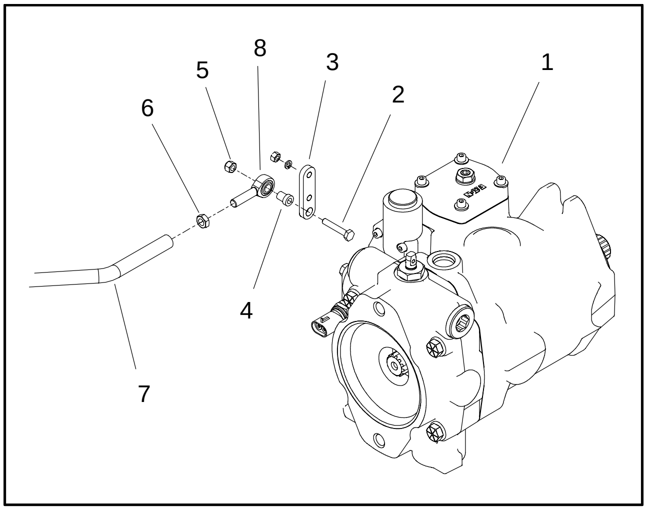

Figure 63

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

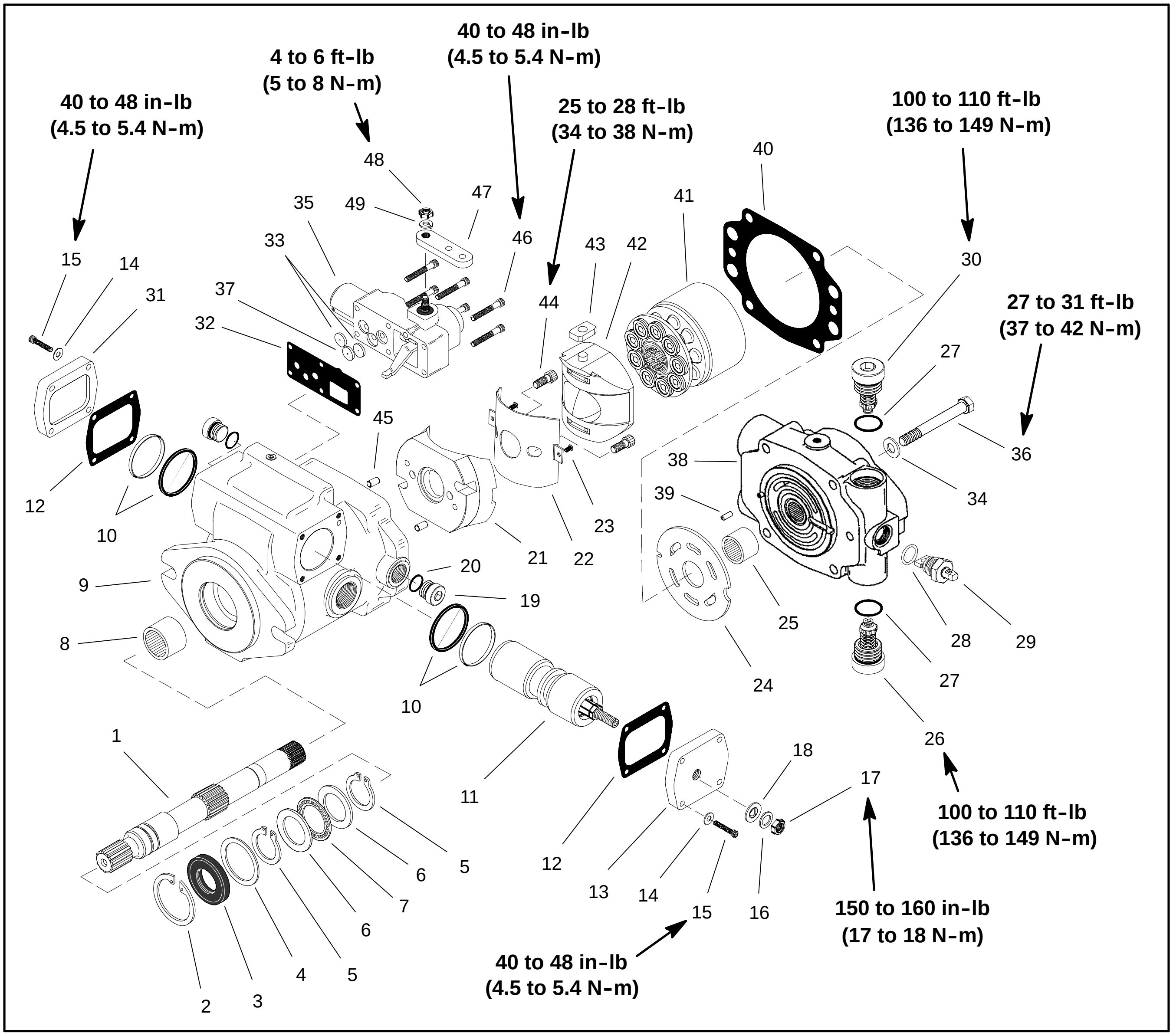

Figure 64

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

Piston (Traction) Pump Service (Fig. 64)

For service of the piston (traction) pump (including the servo control (item 35) assembly), see the Eaton Model 72400 Servo Controlled Piston Pump Repair Information at the end of this chapter.

Rear Axle Motor

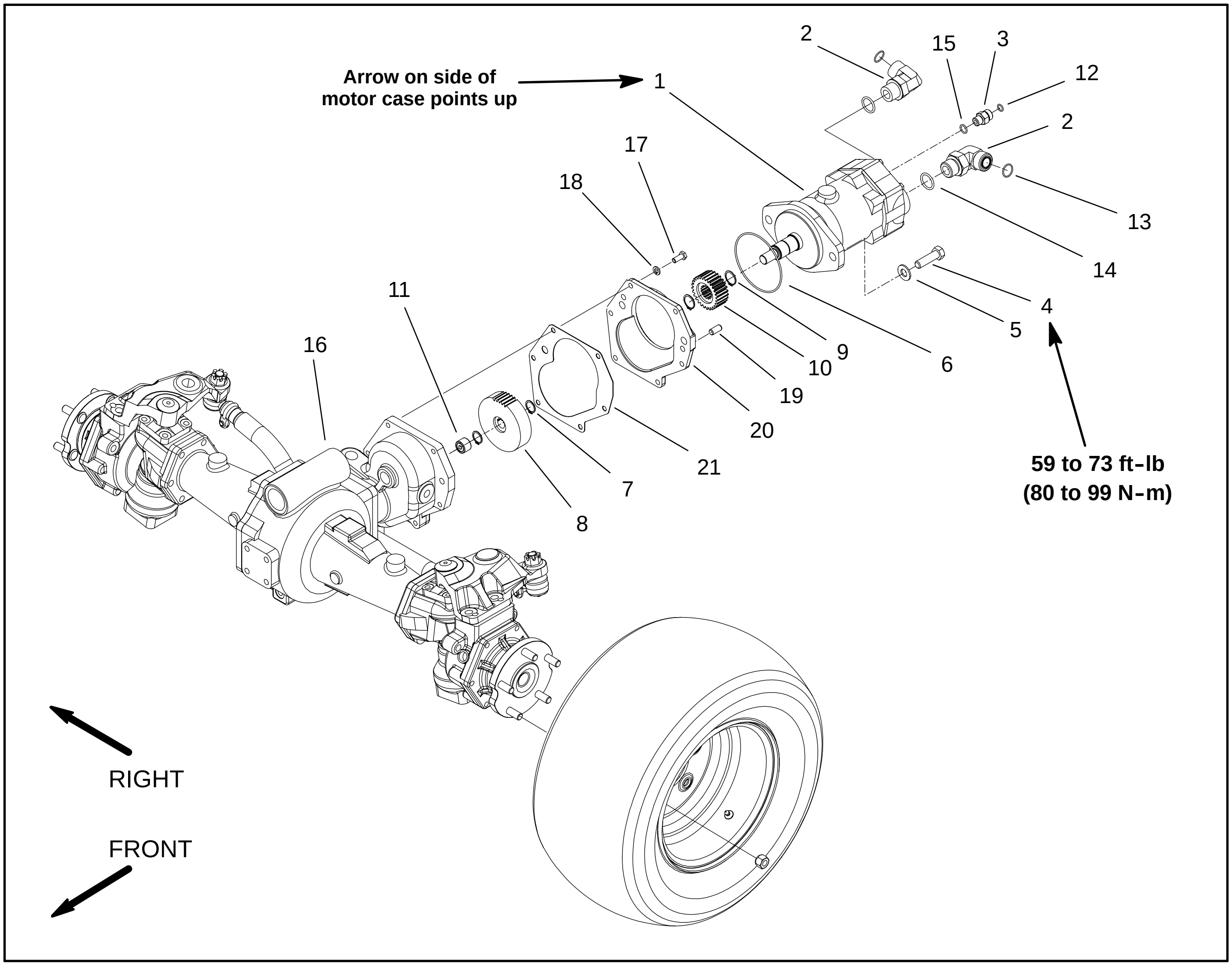

Figure 65

1. **Axle motor**
2. **90º hydraulic fitting (2 used)**
3. **Hydraulic fitting**
4. **Cap screw (2 used)**
5. **Flat washer (2 used)**
6. **O-ring**
7. **External snap ring (2 used)**
8. **Gear (39T)**
9. **External snap ring (2 used)**
10. **Pinion gear (33T)**
11. **Needle bearing**
12. **O-ring**
13. **O-ring**
14. **O-ring**
15. **O-ring**
16. **Drive axle assembly**
17. **Cap screw (6 used)**
18. **Lock washer (6 used)**
19. **Dowel pin (2 used)**
20. **Cover plate**
21. **Gasket**

Removal (Fig. 65)

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

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

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 fittings 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 65 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. 65)

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 fittings and hose openings. Using labels placed during axle motor removal, properly 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. After assembly is completed, verify that hydraulic hoses and fittings do not contact anything.

Front Wheel Motors

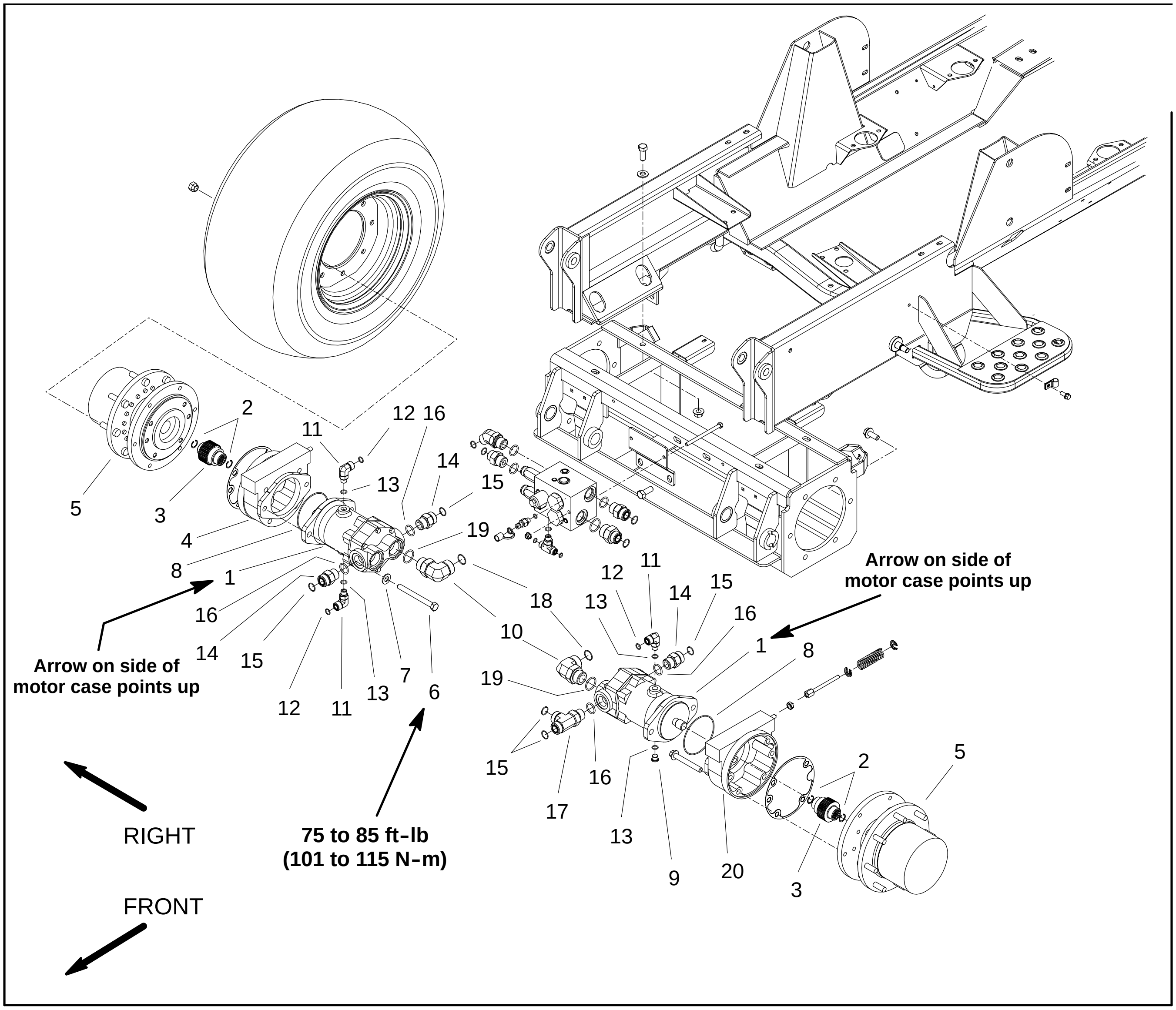

Figure 66

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

Removal (Fig. 66)

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

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

NOTE: To ease installation, label the hydraulic lines 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 66 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. 66)

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

Rear Axle and Front Wheel Motor Service

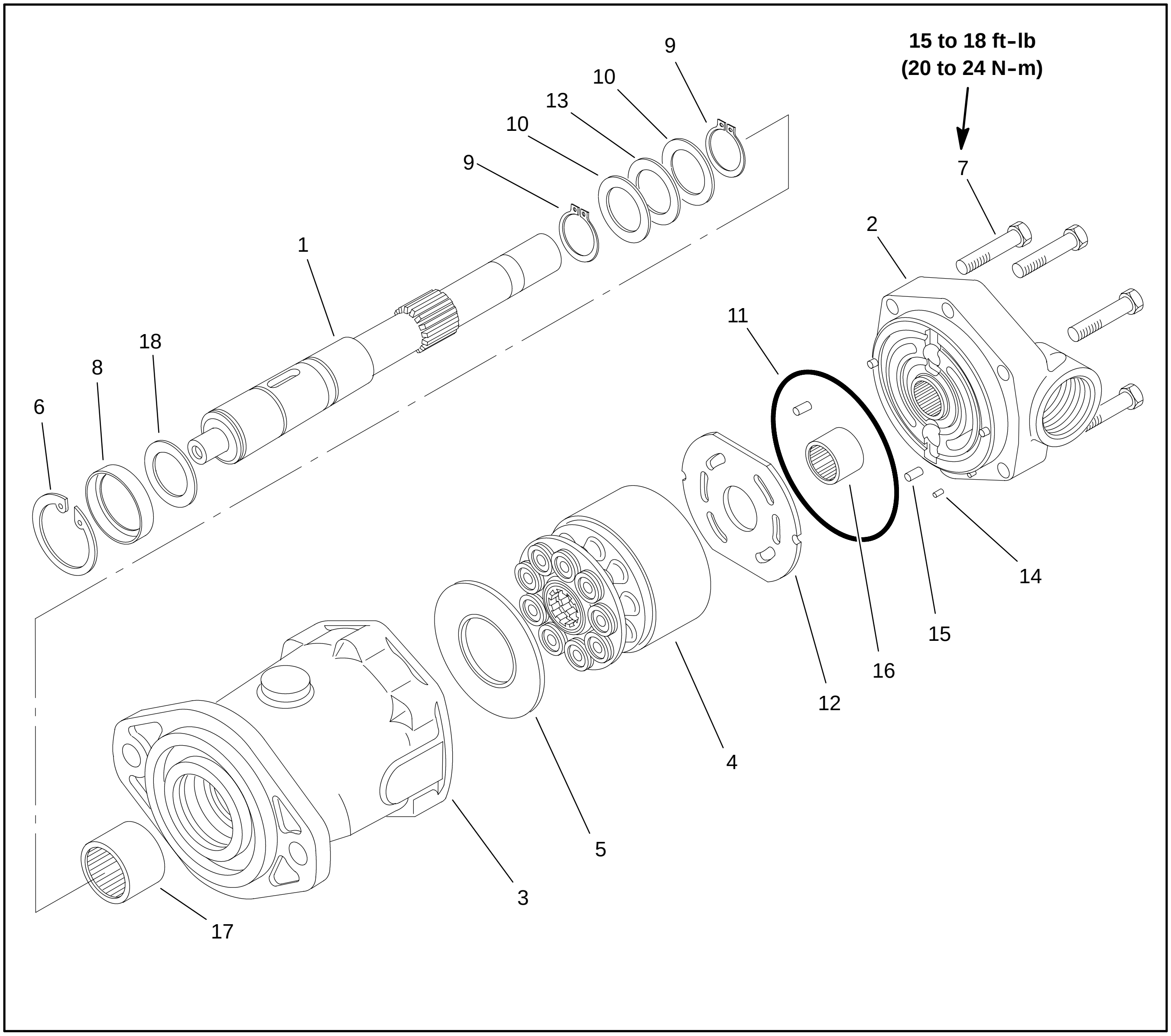

Figure 67

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.

Hydraulic System

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4WD Manifold

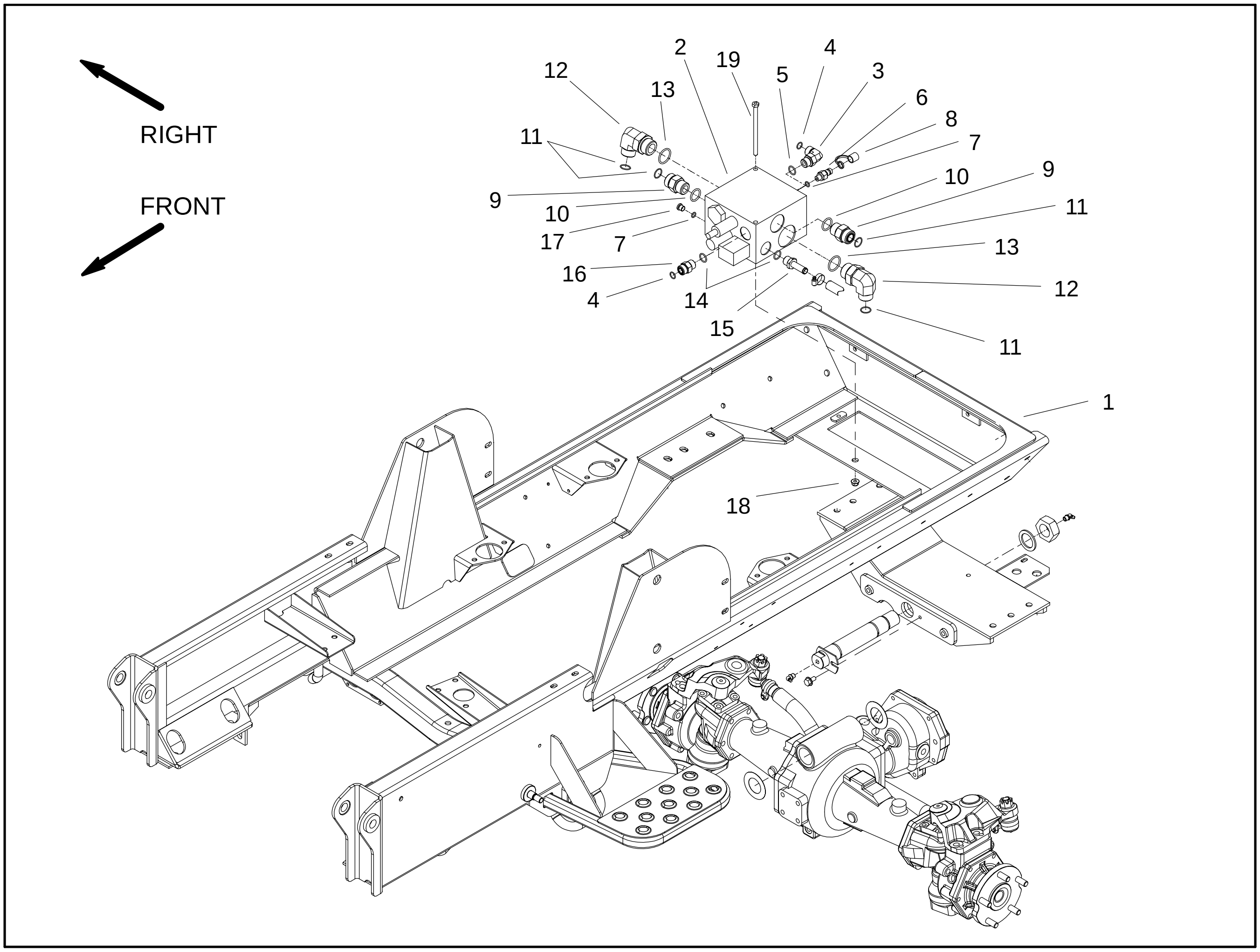

Figure 68

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

Removal (Fig. 68)

NOTE: The ports on the 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).

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

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. 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.

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 68 as 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. 68)

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 68 as guide.

3. Remove caps and plugs from fittings and hoses. Using labels placed during manifold removal, properly connect hydraulic lines to manifold (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

4. Connect wire harness connector to the solenoid valve.

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

4WD Manifold Service

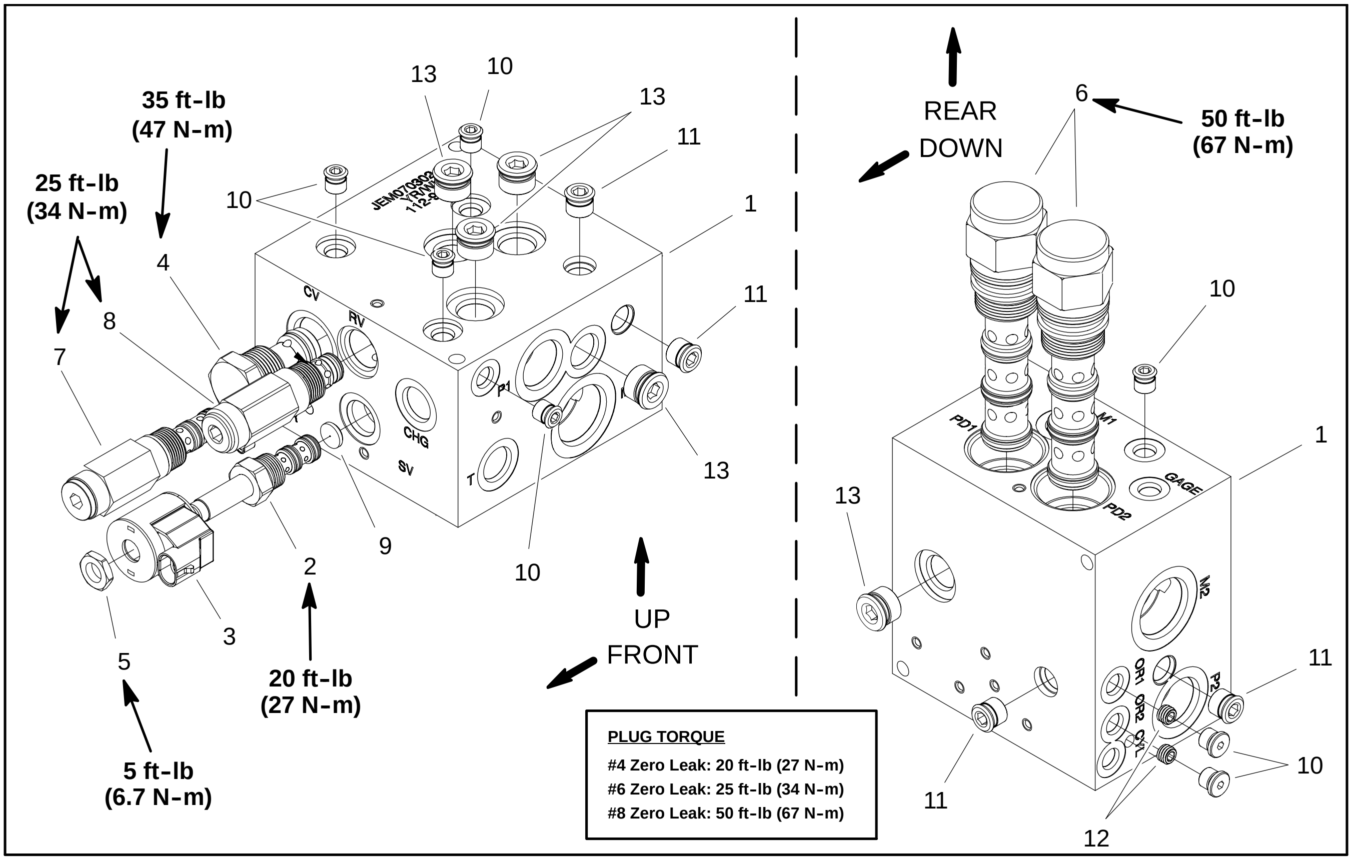

Figure 69

1. **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 and OR2)**
13. **#8 zero leak plug with O-ring**

NOTE: The ports on the 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. 69)

1. Make sure the manifold is clean before removing a cartridge valve.

2. If cartridge 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 on valve. 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.

CAUTION

Use eye protection such as goggles when using compressed air.

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 to not damage cartridge. Use compressed air for cleaning.

7. The 4WD control 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 valve 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.

Filter Manifold

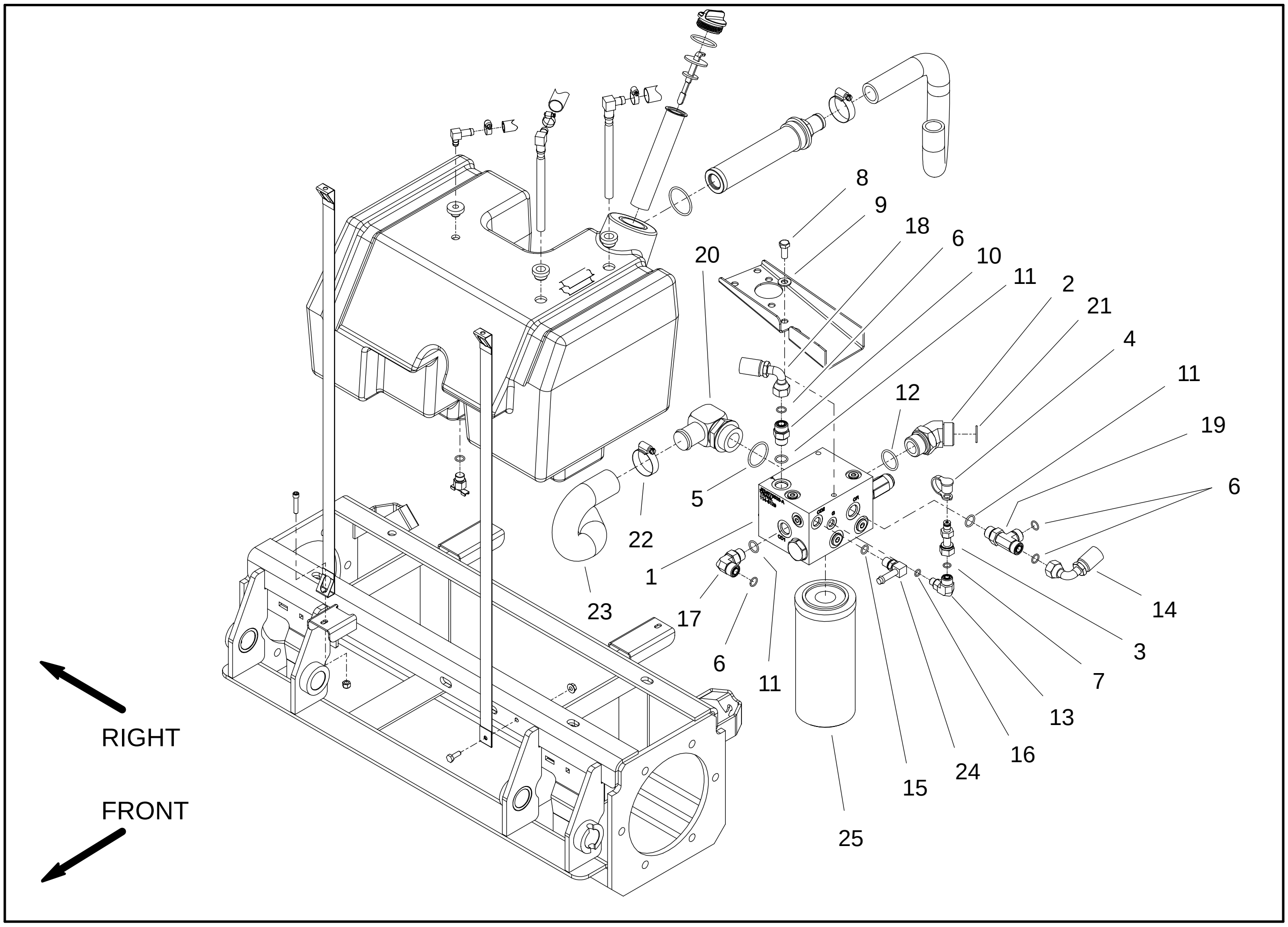

Figure 70

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

NOTE: The ports on the 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. 70)

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 hydraulic lines from 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 70 as 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. 70)

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 70 as guide.

3. Remove caps and plugs from fittings and hoses. Using labels placed during manifold removal, properly connect hydraulic lines to manifold (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

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

Filter Manifold Service

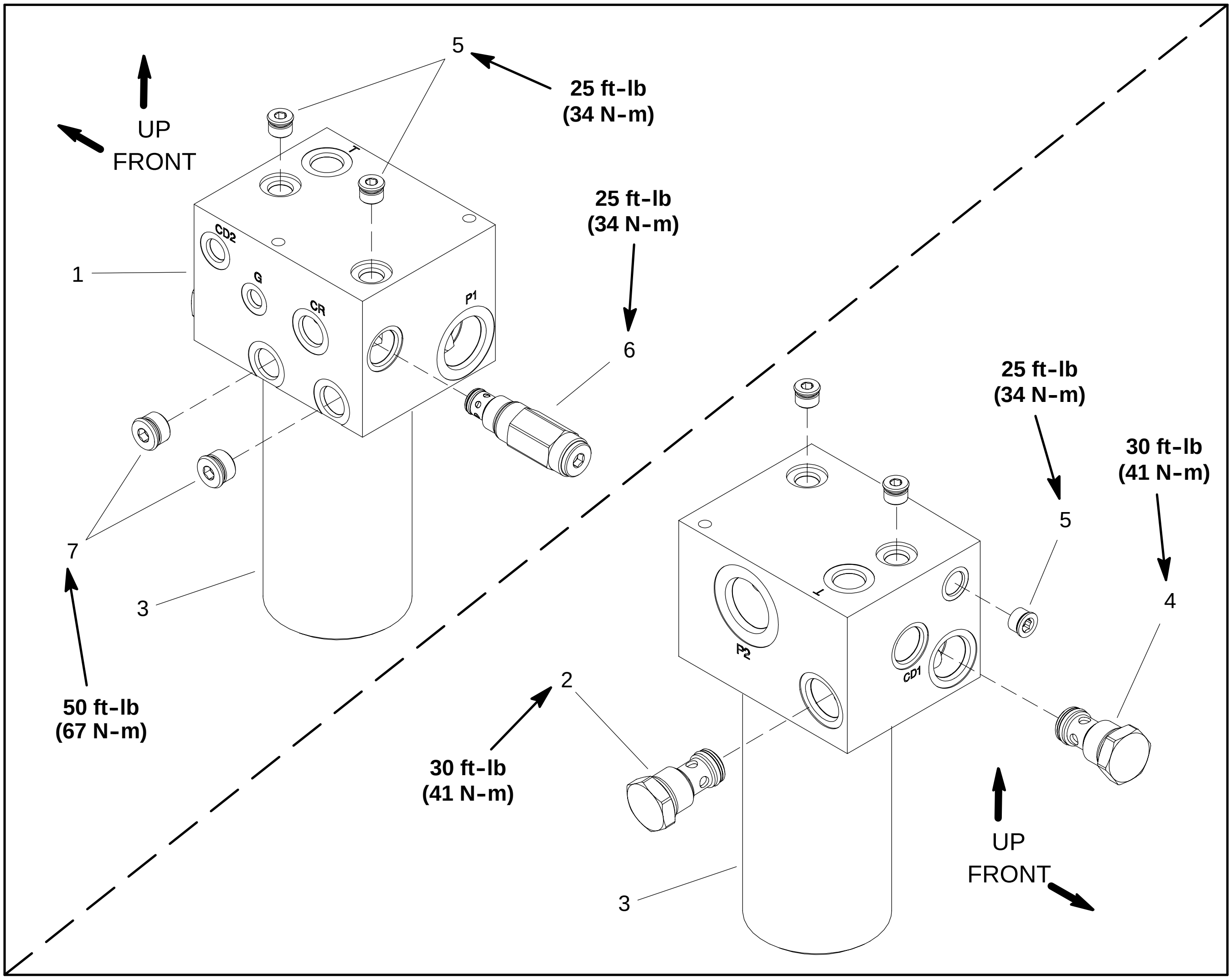

Figure 71

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

NOTE: The ports on the 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. 71)

For filter manifold cartridge valve service procedures, see 4WD Manifold Service in this section. Refer to Figure 71 for filter manifold cartridge valve and plug installation torque.

Steering and Engine Cooling Fan Circuits

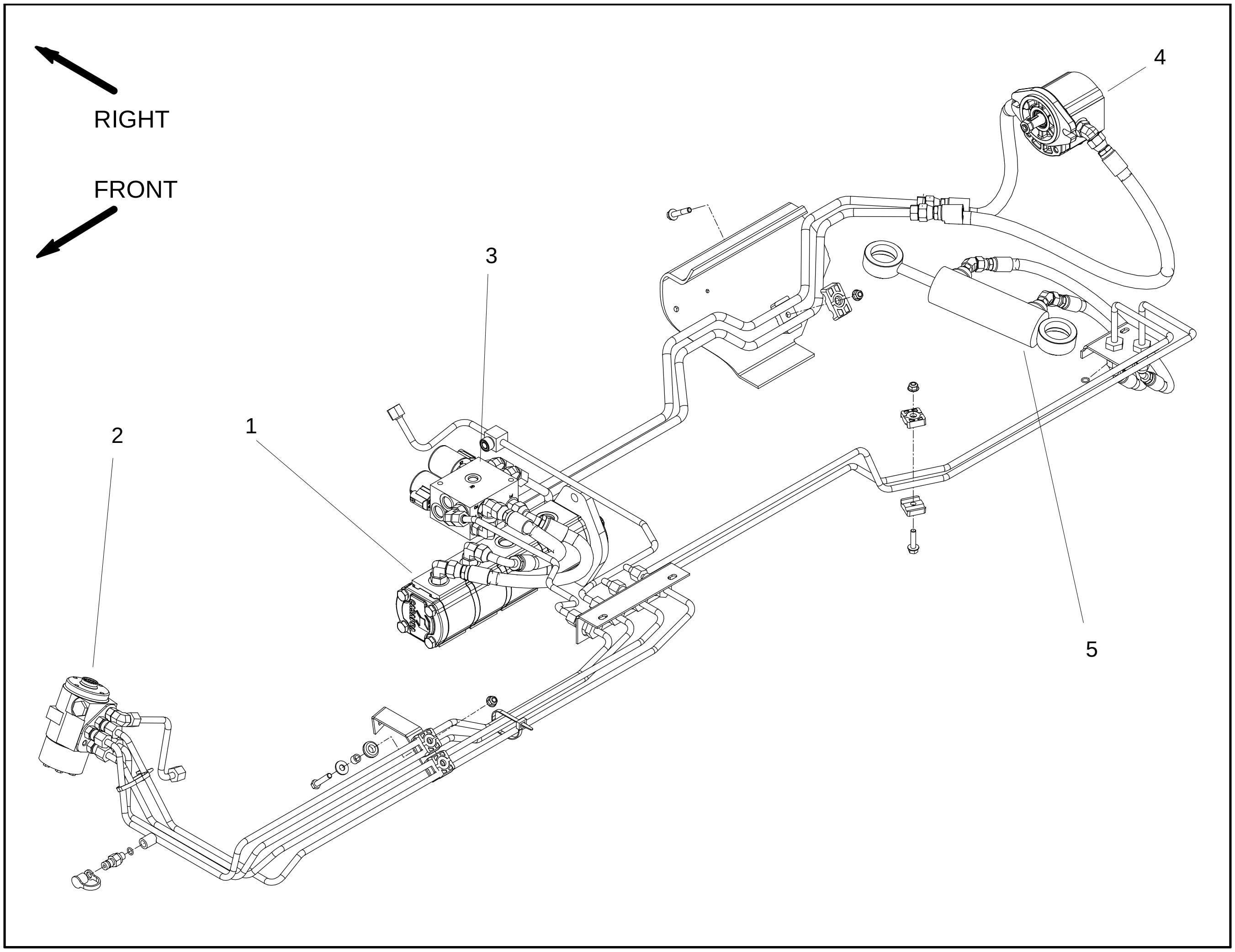

Figure 72

1. **Gear pump**
2. **Steering control valve**
3. **Fan drive manifold**
4. **Fan motor**
5. **Steering cylinder**

Figure 72 illustrates the components that are used in the Groundsmaster 4100–D and 4110–D steering and engine cooling fan circuits. Procedures for removal, installation and disassembly/assembly of these components are provided on the following pages of this section.

Hydraulic System

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Steering Control Valve

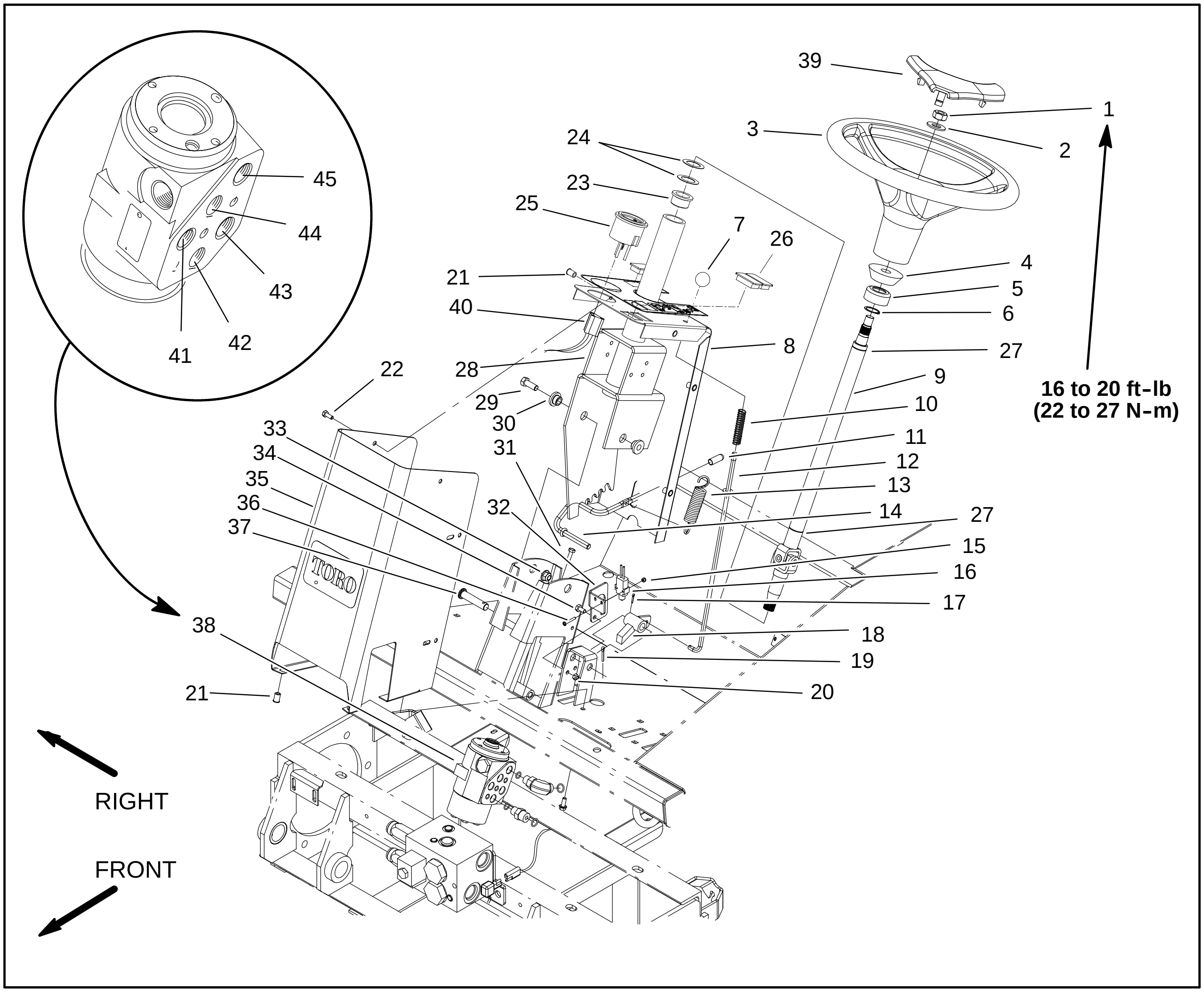

Figure 73

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

Removal (Fig. 73)

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

2. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of this section.

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 73 as a guide.

6. If hydraulic fittings are to be removed from steering control valve, mark fitting orientation to allow correct assembly (Fig. 74). Remove fittings from control valve and discard O–rings.

Installation (Fig. 73)

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. 74). Tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).

2. Install steering control valve using Figure 73 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. Add correct oil if necessary before returning machine to service.

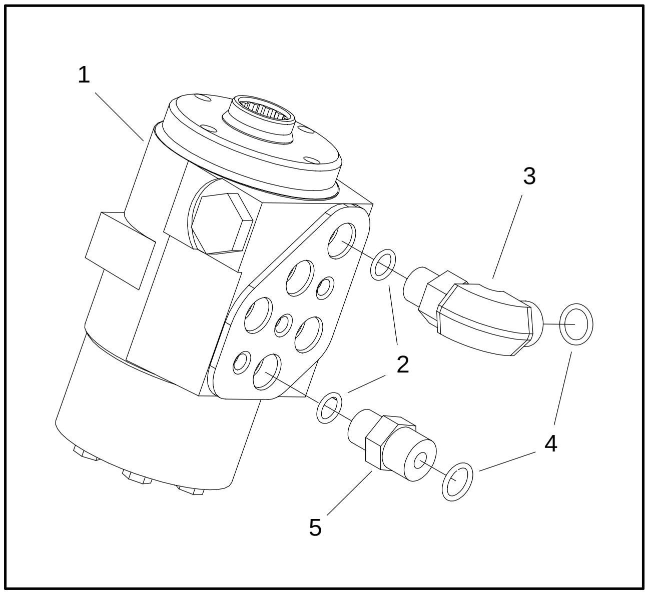

Figure 74

1. **Steering control valve**
2. **O–ring**
3. **90º hydraulic fitting**
4. **O–ring**
5. **Straight fitting (4 used)**

Hydraulic System

Steering Control Valve Service

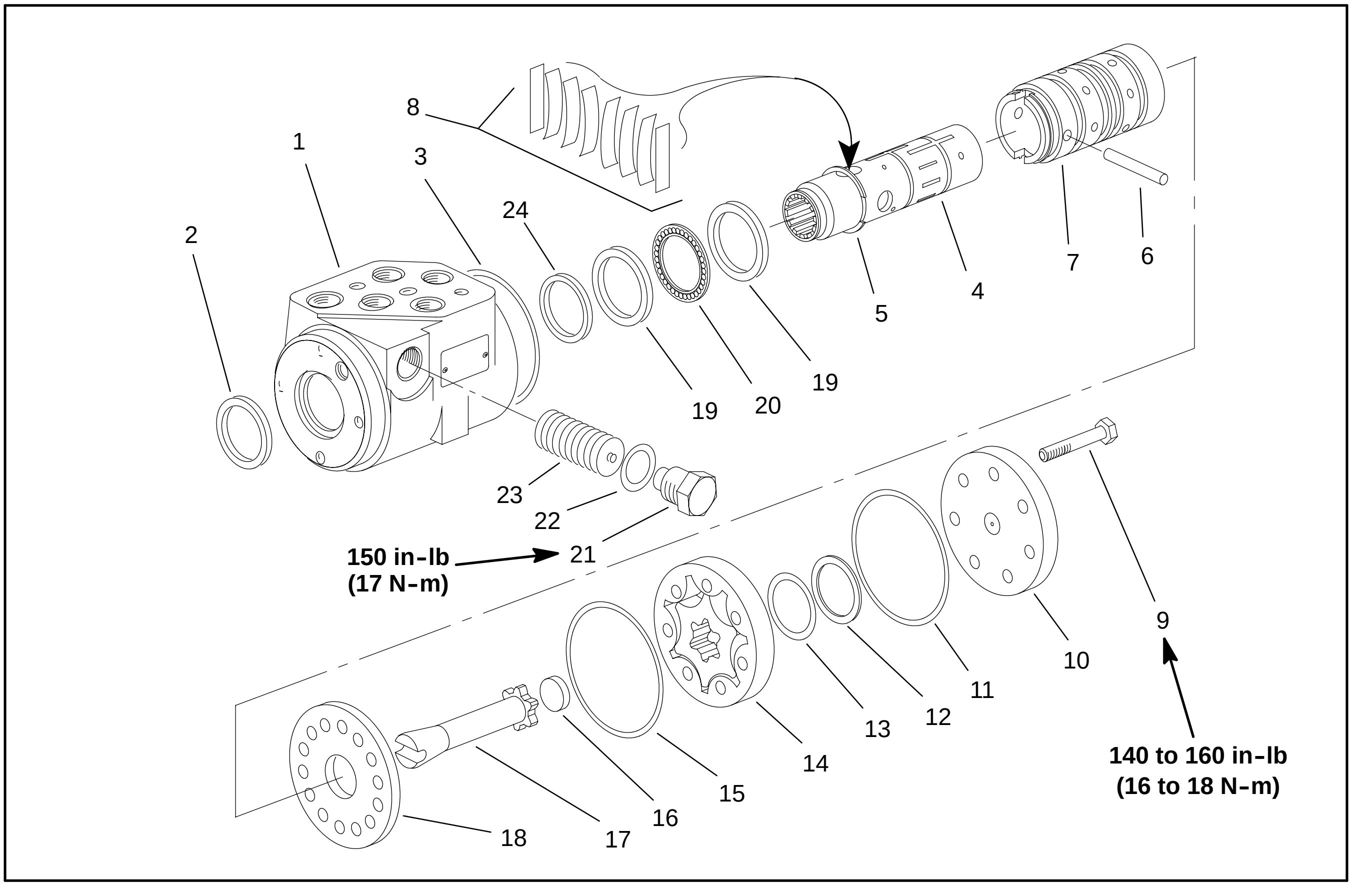

Figure 75

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

Disassembly (Fig. 75)

NOTE: Cleanliness is extremely important when repairing steering control units. Work in a clean area. Before disconnecting the hydraulic lines, clean the port area of the steering control valve assembly. Before disassembly, drain the oil, then plug the ports and thoroughly clean the exterior. During repairs, always protect machined surfaces.

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. 75)

CAUTION

Use eye protection such as goggles when using compressed air

Check all mating surfaces. Replace any parts that have 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 as 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 (Fig. 76):

   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. 76).

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 carefully slide 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 geroter 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)**.

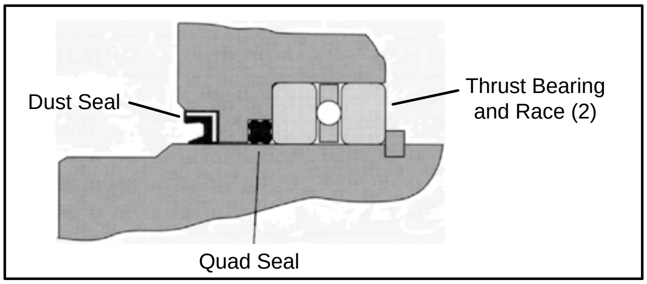

Figure 76

Hydraulic System

Steering Cylinder

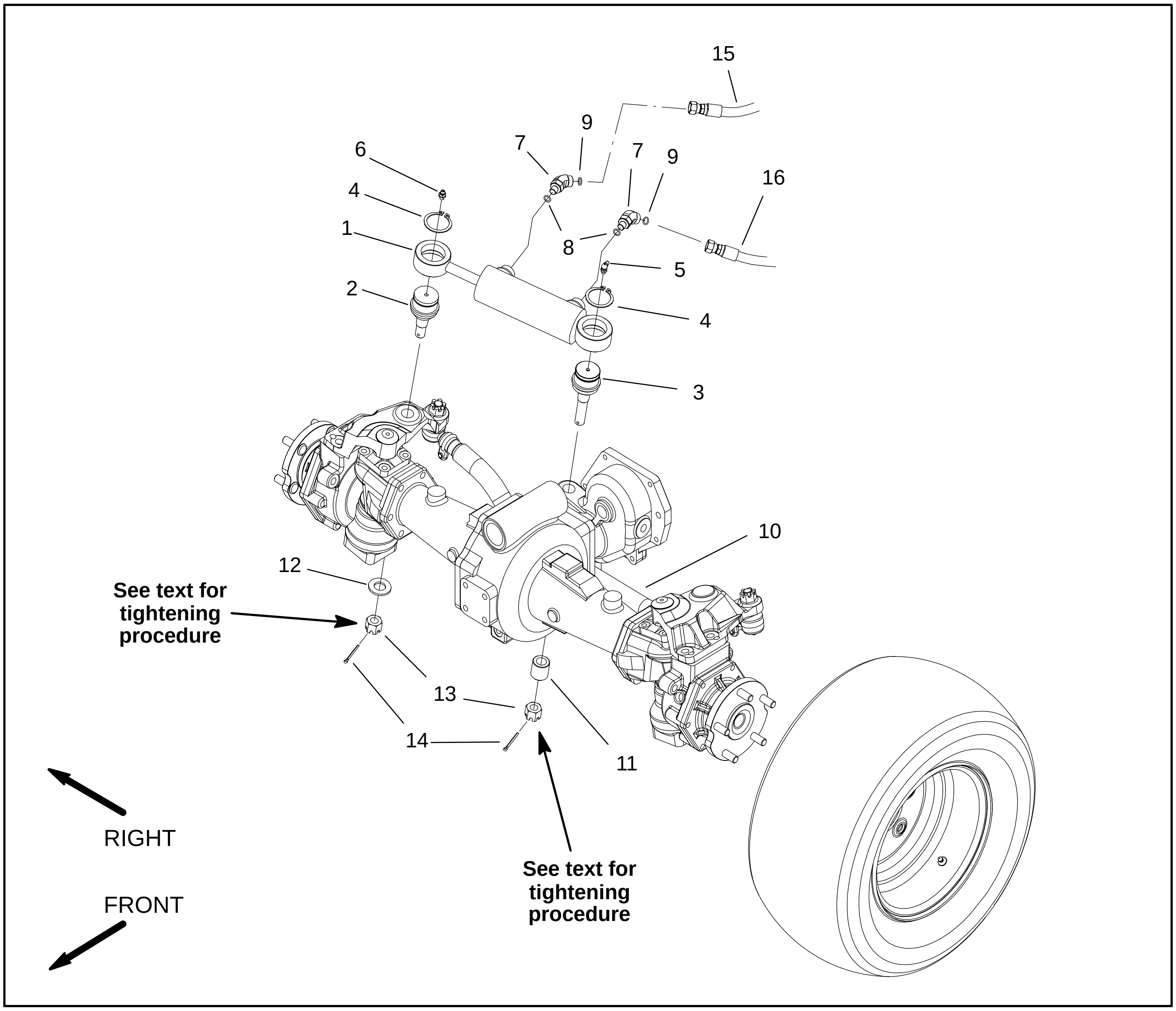

Figure 77

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

Removal (Fig. 77)

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

2. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of this section.

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

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

4. Remove hydraulic hoses from steering cylinder.

5. Remove cotter pins, hex slotted nuts, axle washer and ball joint spacer from the threaded ends of ball joints.

6. Separate steering cylinder ball joints from rear axle. Remove steering cylinder with ball joints from machine.

7. 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.

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

Installation (Fig. 77)

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. Thoroughly clean tapered surfaces of ball joints and axle bores.

4. Slide rod end ball joint through hole on steering arm. Secure with axle washer and hex slotted nut. Slide barrel end ball joint through hole on axle. Secure with ball joint spacer and 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 (final torque on hex nuts should be from 100 to 125 ft–lb (136 to 169 N–m)). Install cotter pin to nut and ball joint.

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

6. Fill reservoir with hydraulic fluid as required.

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

Steering Cylinder Service

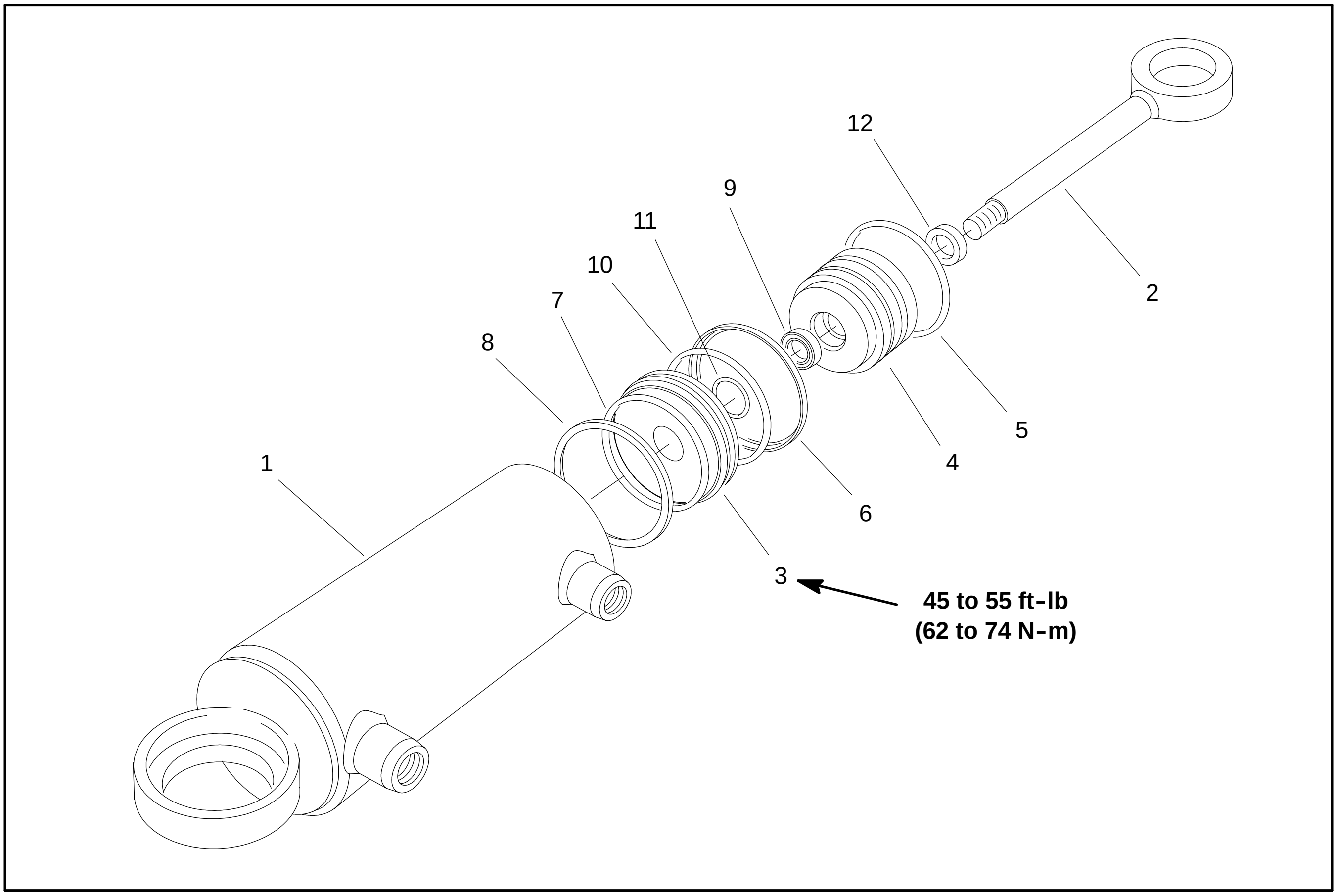

Figure 78

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. 78)

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 tube for damage (deep scratches, out–of–round, etc.). Inspect rod and piston for evidence of excessive scoring, pitting or wear. Replace cylinder if internal damage or wear is found.

Assembly (Fig. 78)

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.

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

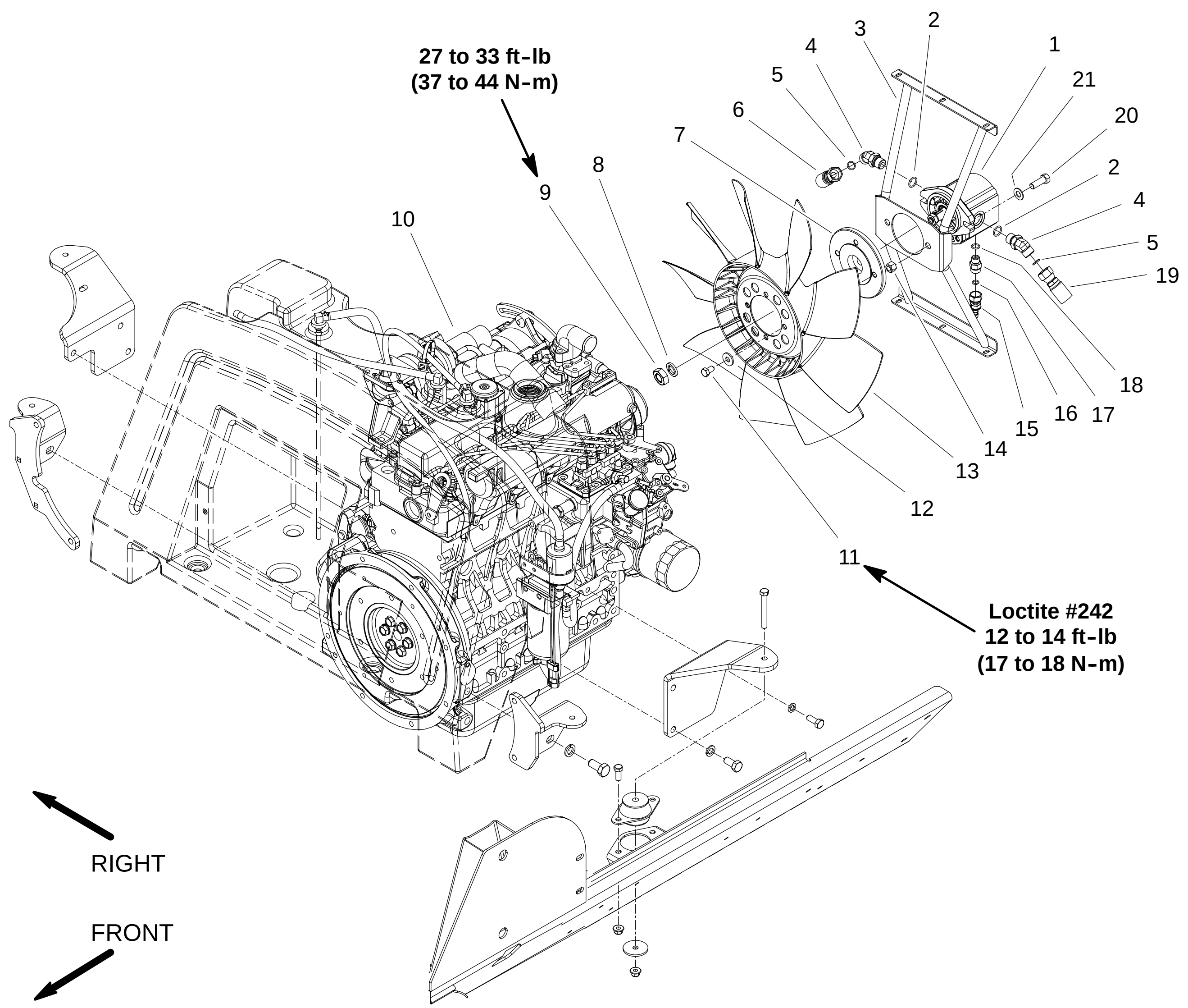

Figure 79

1. **Hydraulic fan motor**
2. **O-ring**
3. **Fan motor 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. 79)

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

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

3. 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. 80).

5. Remove four (4) cap screws and washers used to secure fan (item 13) to fan hub. Remove fan.

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

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. 79)

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. Using labels placed during motor removal, properly 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. 80). 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. Add correct oil if necessary before returning machine to service.

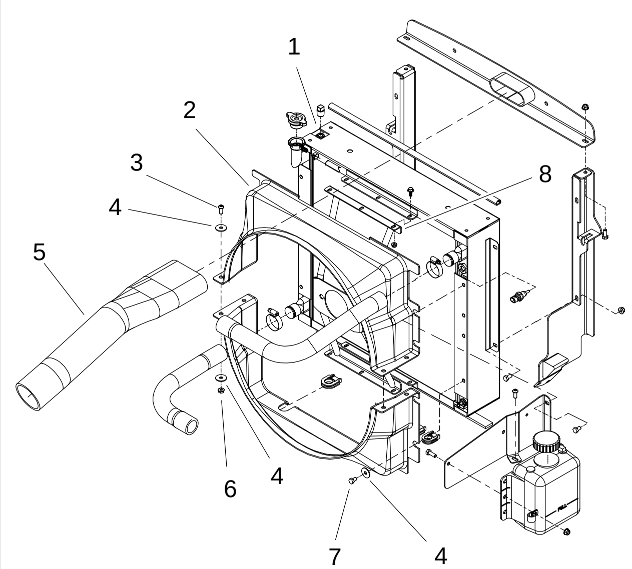

Figure 80

1. **Radiator**
2. **Upper radiator shroud**
3. **Screw (4 used)**
4. **Flat washer**
5. **Air cleaner hose**
6. **Flange nut (4 used)**
7. **Cap screw**
8. **Fan motor bracket**

Hydraulic System

Engine Cooling Fan Motor Service

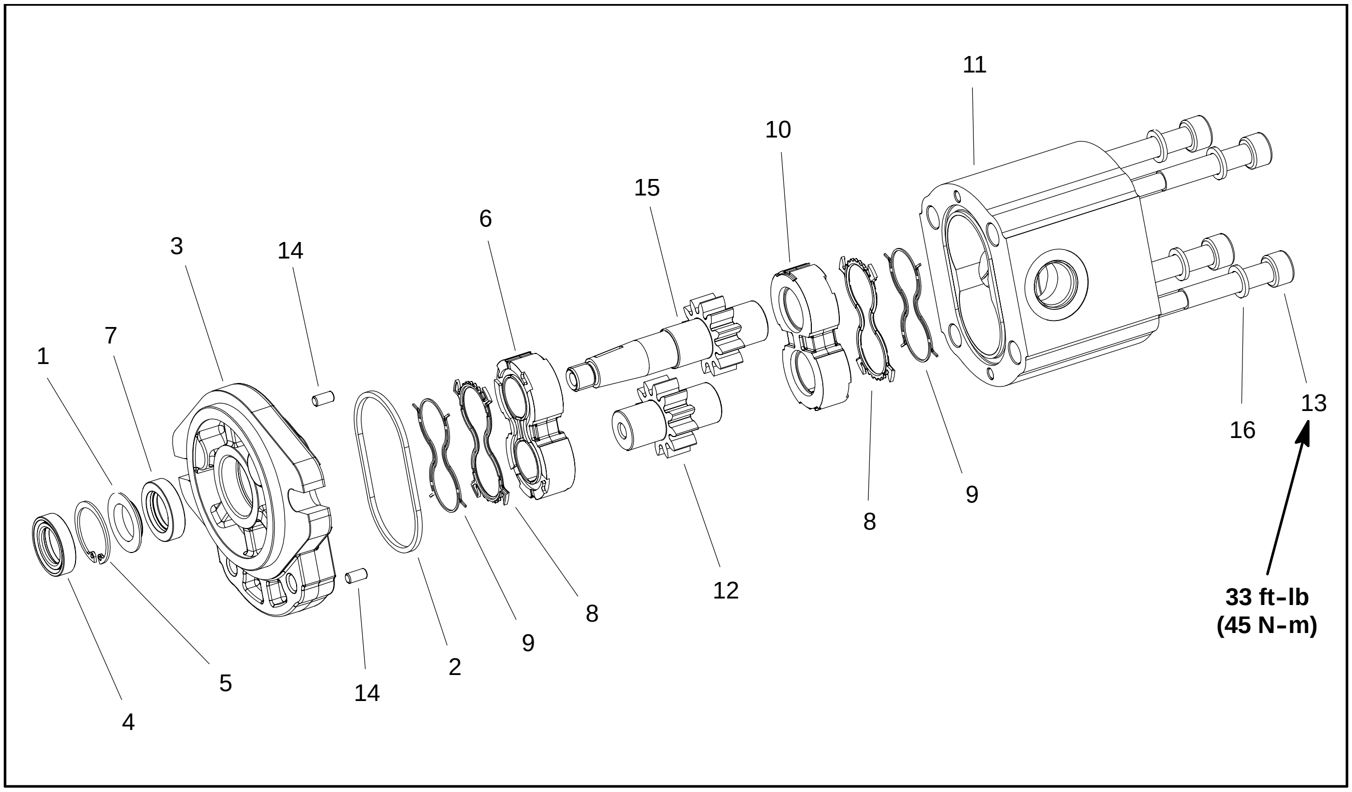

Figure 81

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 pins (2 used)**
15. **Drive gear**
16. **Washer (4 used)**

Disassembly (Fig. 81)

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. 82).

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 four (4) cap screws (item 13).

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.

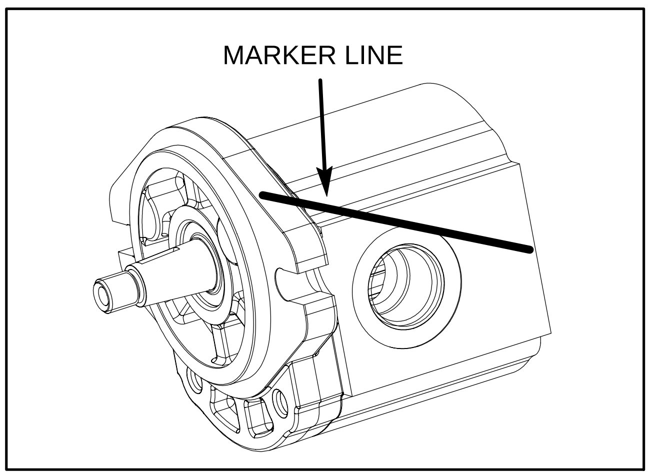

Figure 82

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. 83). Note orientation of seal lips during removal. Discard removed seals.

Inspection

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

CAUTION

Use eye protection such as goggles when using compressed air.

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

3. Inspect drive gears and idler gears for the following (Fig. 84):

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.

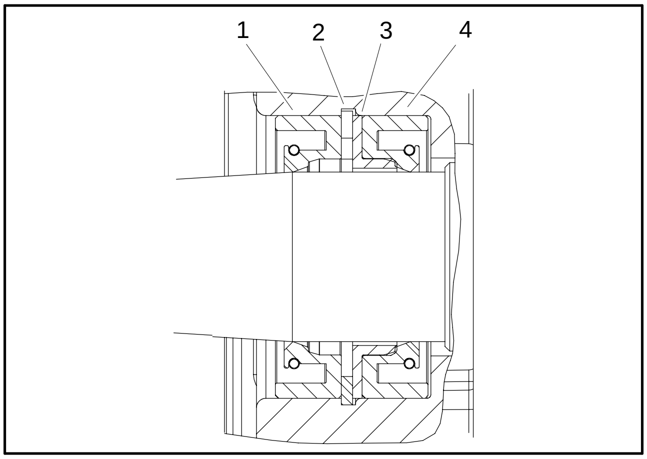

Figure 83

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

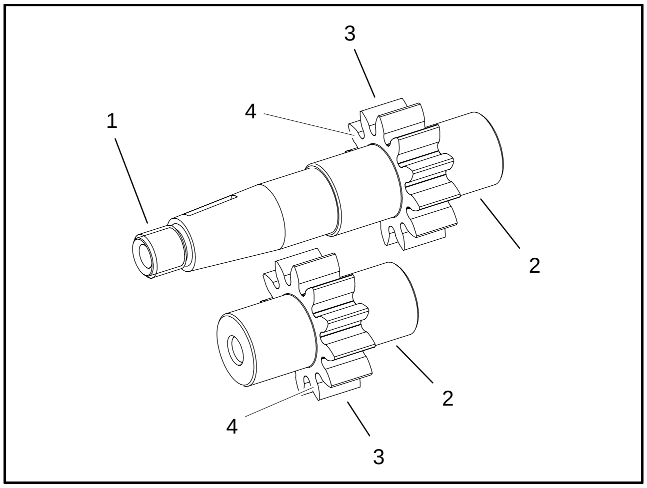

Figure 84

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

Assembly (Fig. 81)

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

1. Lubricate O–rings, pressure seals, back–up gaskets and wear plate grooves with a thin coat of petroleum jelly. Lubricate all other internal parts freely with clean hydraulic oil.

2. Install new seals into front flange (Fig. 83). 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.

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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–ring and O–ring groove in the body. Install new O–ring to the body.

10. Install locating dowel pins in front flange. 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 dowel pins.

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

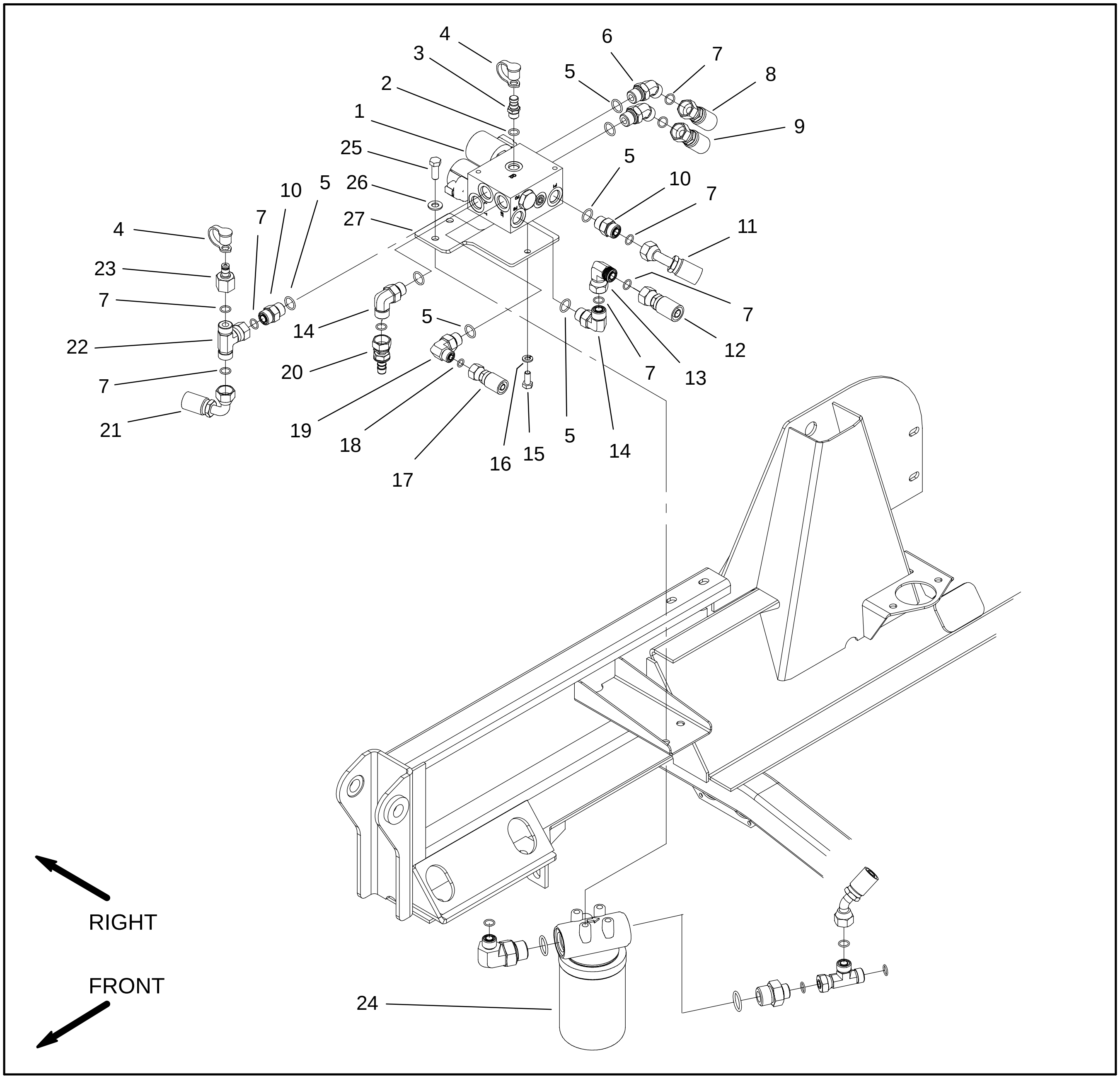

Figure 85

1. Fan drive manifold
2. O-ring
3. Test fitting
4. Dust cap (2 used)
5. O-ring
6. 45° hydraulic fitting (2 used)
7. O-ring
8. Hydraulic hose
9. Hydraulic hose
10. Hydraulic fitting
11. Hydraulic hose
12. Hydraulic hose
13. 90° hydraulic fitting
14. 90° hydraulic fitting (2 used)
15. Cap screw (2 used)
16. Lock washer (2 used)
17. Hydraulic hose
18. O-ring
19. 90° hydraulic fitting
20. Hydraulic hose
21. Hydraulic hose
22. Hydraulic tee fitting
23. Hydraulic test fitting
24. Oil filter assembly
25. Cap screw (2 used)
26. Flat washer (2 used)
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. 85)

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

2. Raise and support operator seat to allow access to fan drive manifold (Fig. 86).

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 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 manifold and put caps or plugs on open hydraulic lines and fittings. Label disconnected hydraulic lines for proper reassembly.

7. Remove hydraulic manifold from the frame using Figure 85 as 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. 85)

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 85 as guide.

3. Remove caps and plugs from fittings and hoses. Using labels placed during manifold removal, properly connect hydraulic lines to manifold (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

4. 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.

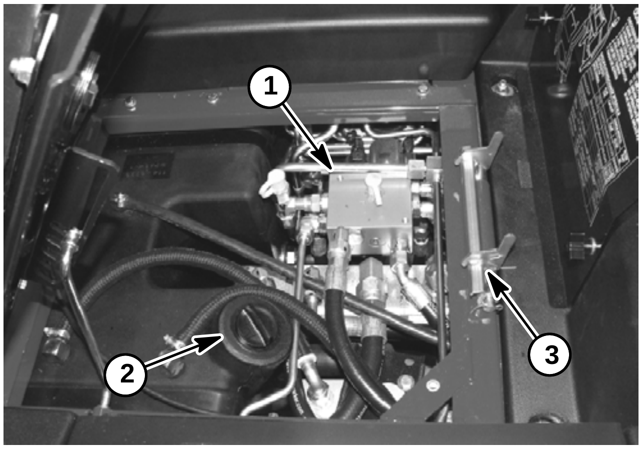

Figure 86

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

Fan Drive Manifold Service

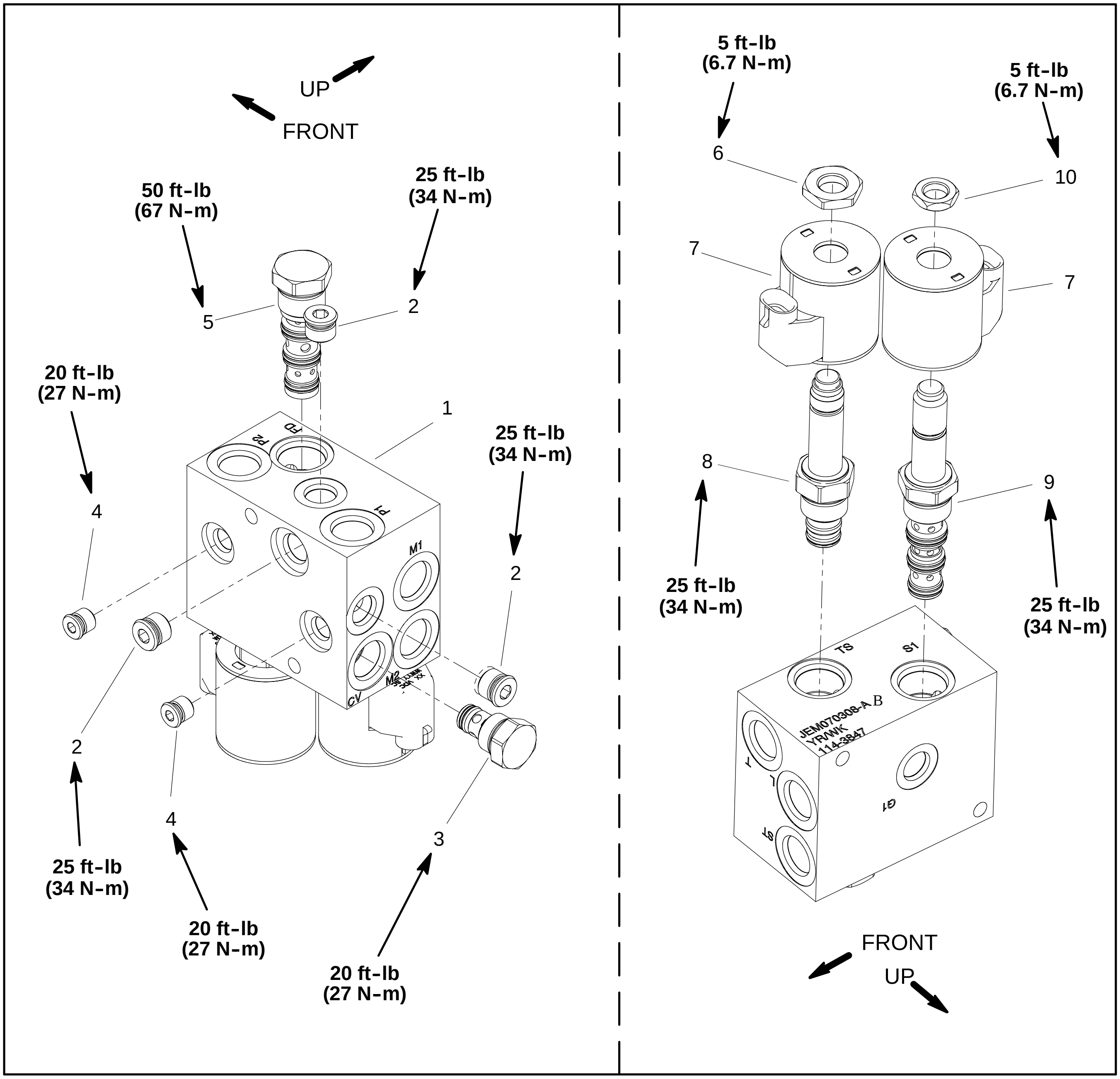

Figure 87

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

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. 87)

For fan drive manifold cartridge valve service procedures, see 4WD Manifold Service in this section. Refer to Figure 87 for fan drive manifold cartridge valve and plug installation torque.

Mow Circuit

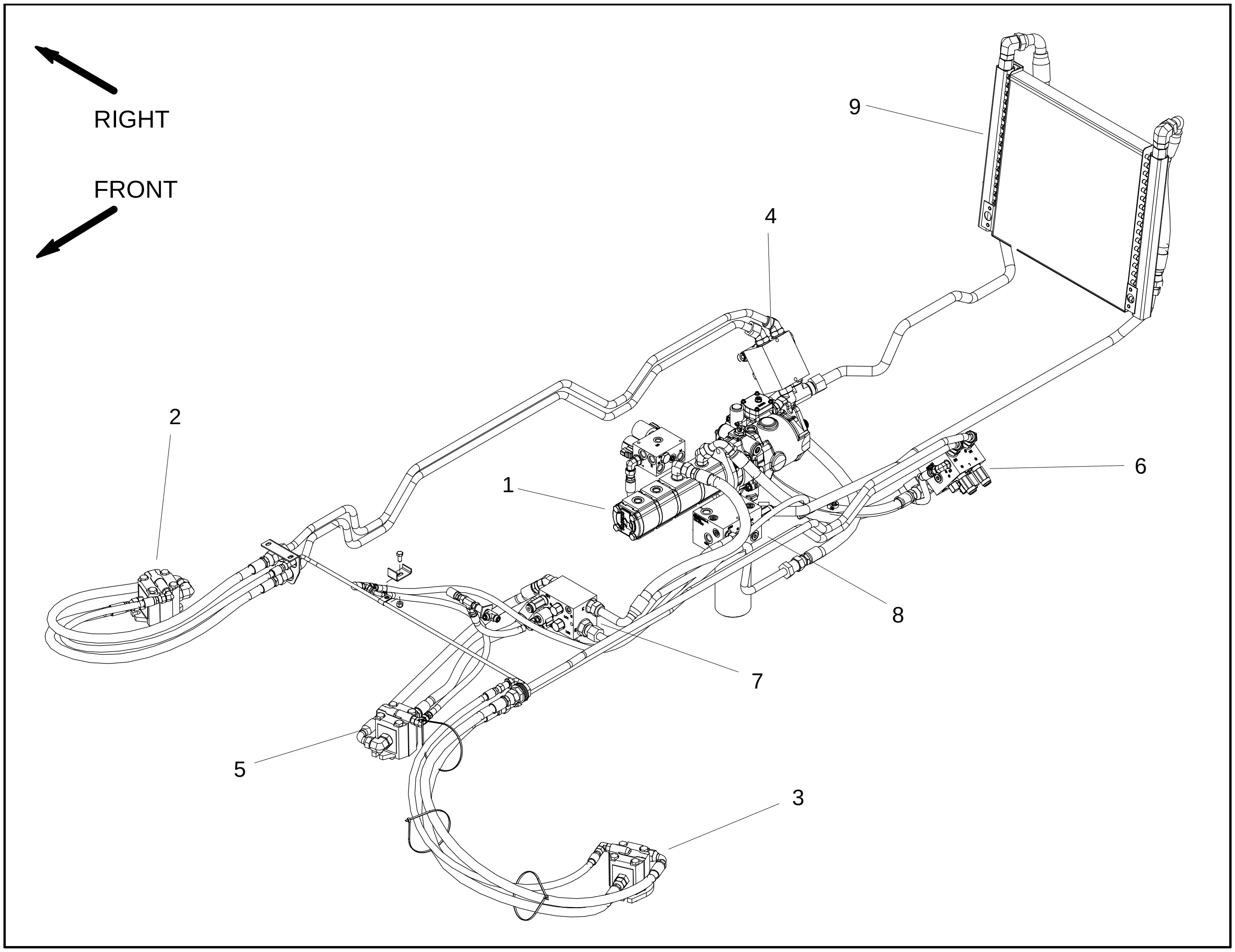

Figure 88

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

Figure 88 illustrates the components that are used in the Groundsmaster 4100–D and 4110–D mow circuits. 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 deck, stop engine, engage parking brake and remove key from the ignition switch.

2. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of this section.

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

4. Disconnect hydraulic lines from deck motor. Put caps or plugs on fittings and hoses to prevent contamination. Label hydraulic lines for proper installation.

5. Remove two (2) flange head screws that secure hydraulic motor to motor mount (Fig. 89).

6. 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 present) from the deck.

7. If required, remove spider hub from motor shaft. Straighten tab washer and remove nut, spider and woodruff key.

Installation

1. If spider hub was removed from motor shaft, thoroughly clean tapered surfaces of hub and shaft. Install spider hub to motor shaft with tab washer and nut. Torque nut from **27 to 33 ft–lb (37 to 45 N–m)**. Bend small tab of washer into keyway and large tab against nut.

2. 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 shims between motor and motor mount to adjust clearance.

3. Position spider in spindle pulley. Place mounting shim(s) (if required) on deck. Carefully install hydraulic motor to the cutting deck taking care to not damage spider hub attached to motor.

4. Secure motor to cutting deck with two (2) flange head screws (Fig. 89).

IMPORTANT: For proper hydraulic hose routing, make sure cutting deck is fully lowered before installing hoses to deck motor.

5. Remove caps or plugs from fittings and hoses. Using labels placed during motor removal, properly connect hydraulic hoses to deck motor (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

6. After assembly is completed, verify that hydraulic hoses and fittings are not contacted by moving components through full range of deck movement.

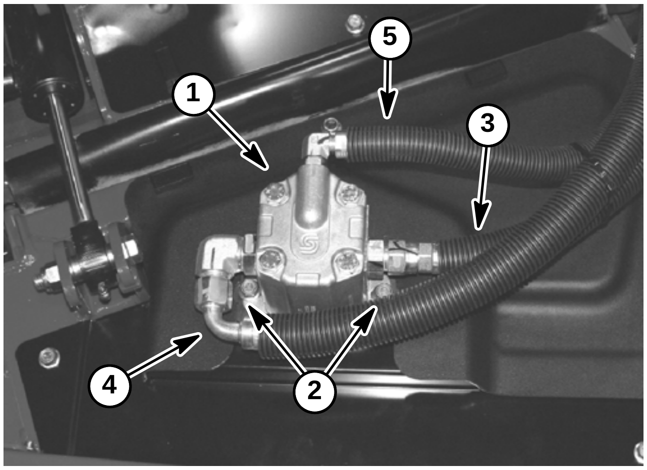

Figure 89

1. **Cutting deck motor**
2. **Flange head screw**
3. **Inlet hose**
4. **Return hose**
5. **Case drain hose**

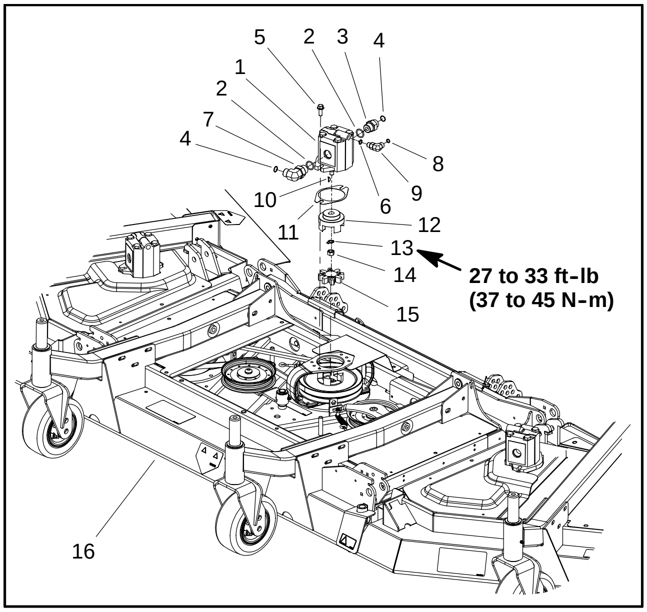

Figure 90

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

Cutting Deck Motor Service

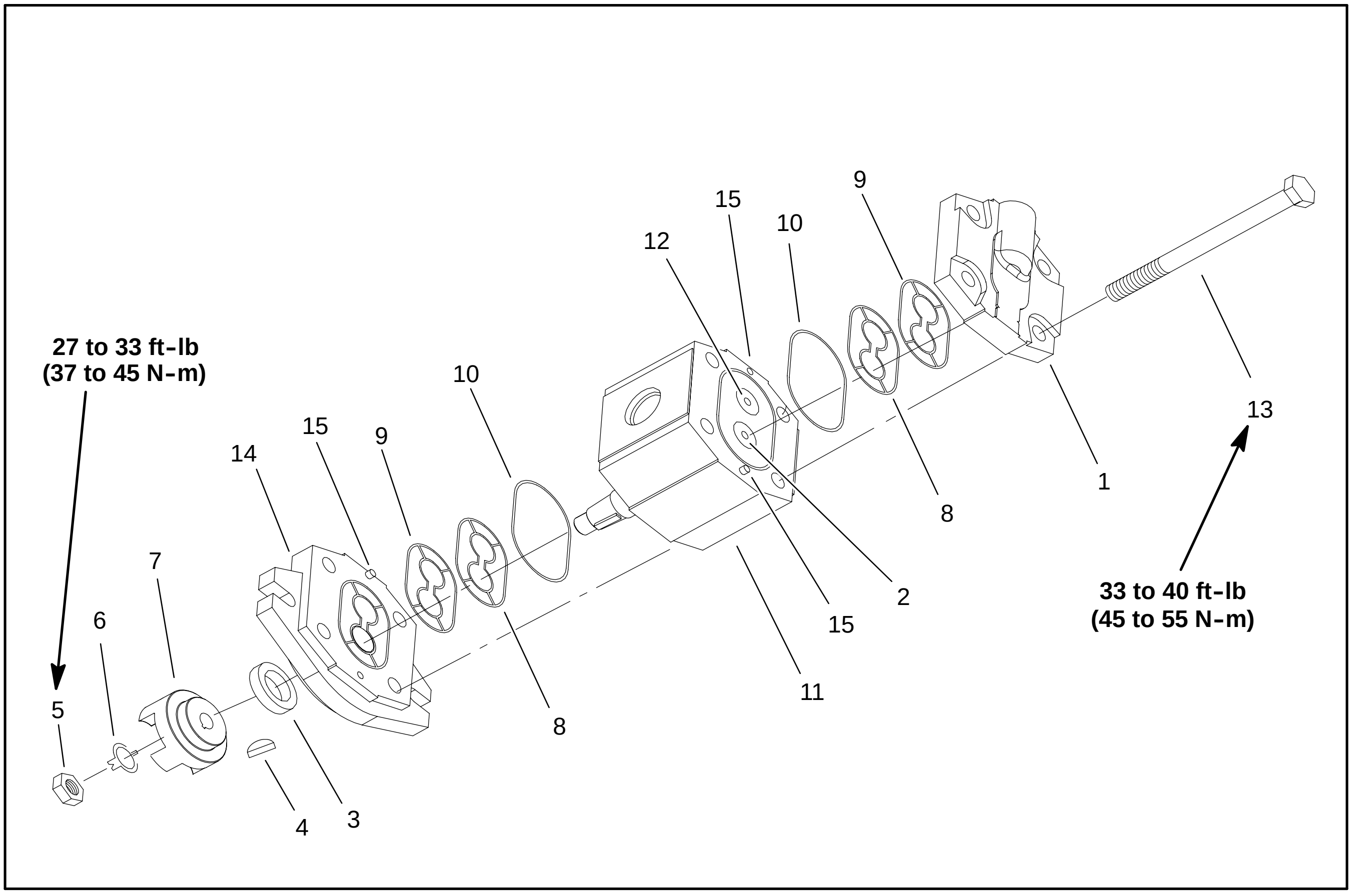

Figure 91

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

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. Straighten tabs on tab washer to allow removal of nut from motor shaft. Remove tab washer, spider hub and woodruff key from motor.

3. Use a marker to make a **diagonal** mark across the front flange, body and rear cover for assembly purposes (Fig. 92).

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

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

5. Loosen cap screws that secure the rear cover.

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

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

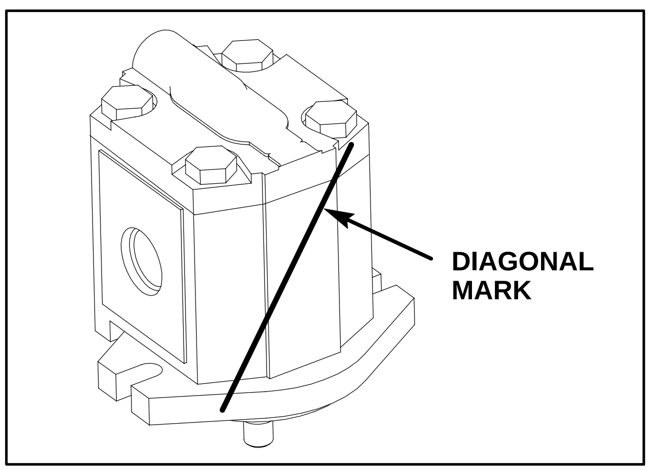

Figure 92

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

8. Place the motor on its side and push on the rear bearing block to remove the bearing block and gear set (Fig. 93).

9. Carefully remove and discard O–rings, pressure seals and back–up rings (Fig. 94) from motor. Do not cause any damage to the machined grooves during the removal process.

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

10. Position front flange with seal side up. Carefully remove shaft seal from front flange.

Inspection

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

> **CAUTION**
>
> **Use eye protection such as goggles when using compressed air.**

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

3. Inspect drive gear, idler gear and bearing blocks (Fig. 95) 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 and rear cover for damage or wear.

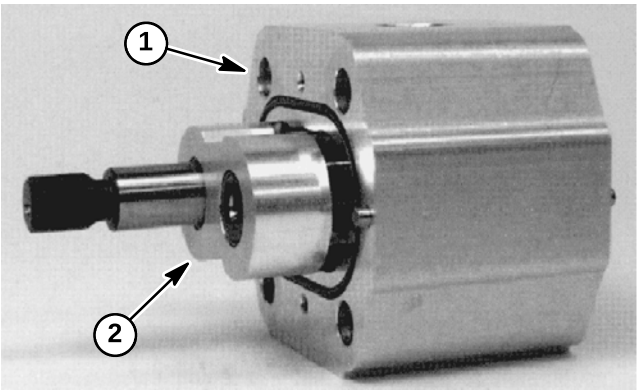

Figure 93

1. **Motor body**
2. **Bearing block & gear set**

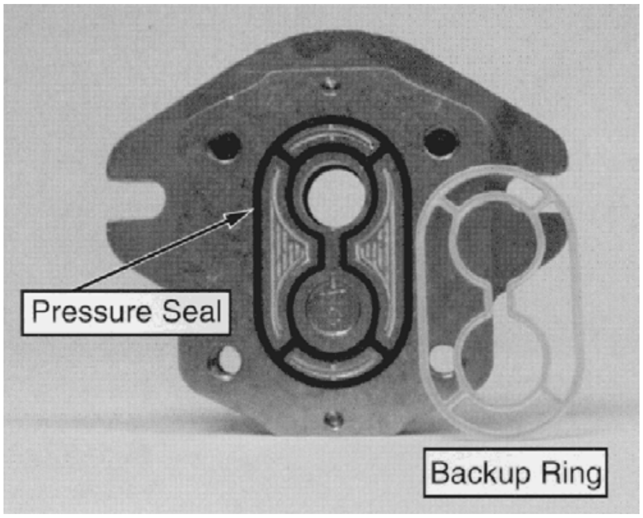

Figure 94

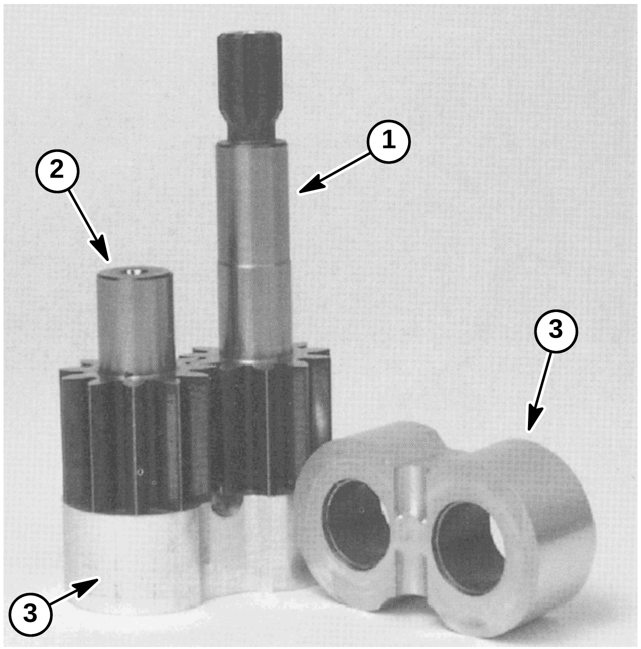

Figure 95

1. **Drive gear**
2. **Idler gear**
3. **Bearing block**

Assembly (Fig. 91)

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 with clean hydraulic oil. 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 line 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. Make sure that tapered surface of motor shaft and spider hub are thoroughly clean.

15. Place woodruff key in motor shaft slot. Install spider hub and tab washer on shaft. Secure spider hub to shaft with nut. Torque nut from **27 to 33 ft–lb (37 to 45 N–m)**.

16. Secure nut to motor shaft by bending small tab of tab washer into keyway and large tab against nut.

17. Remove motor from vise.

Hydraulic System

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PTO Manifolds

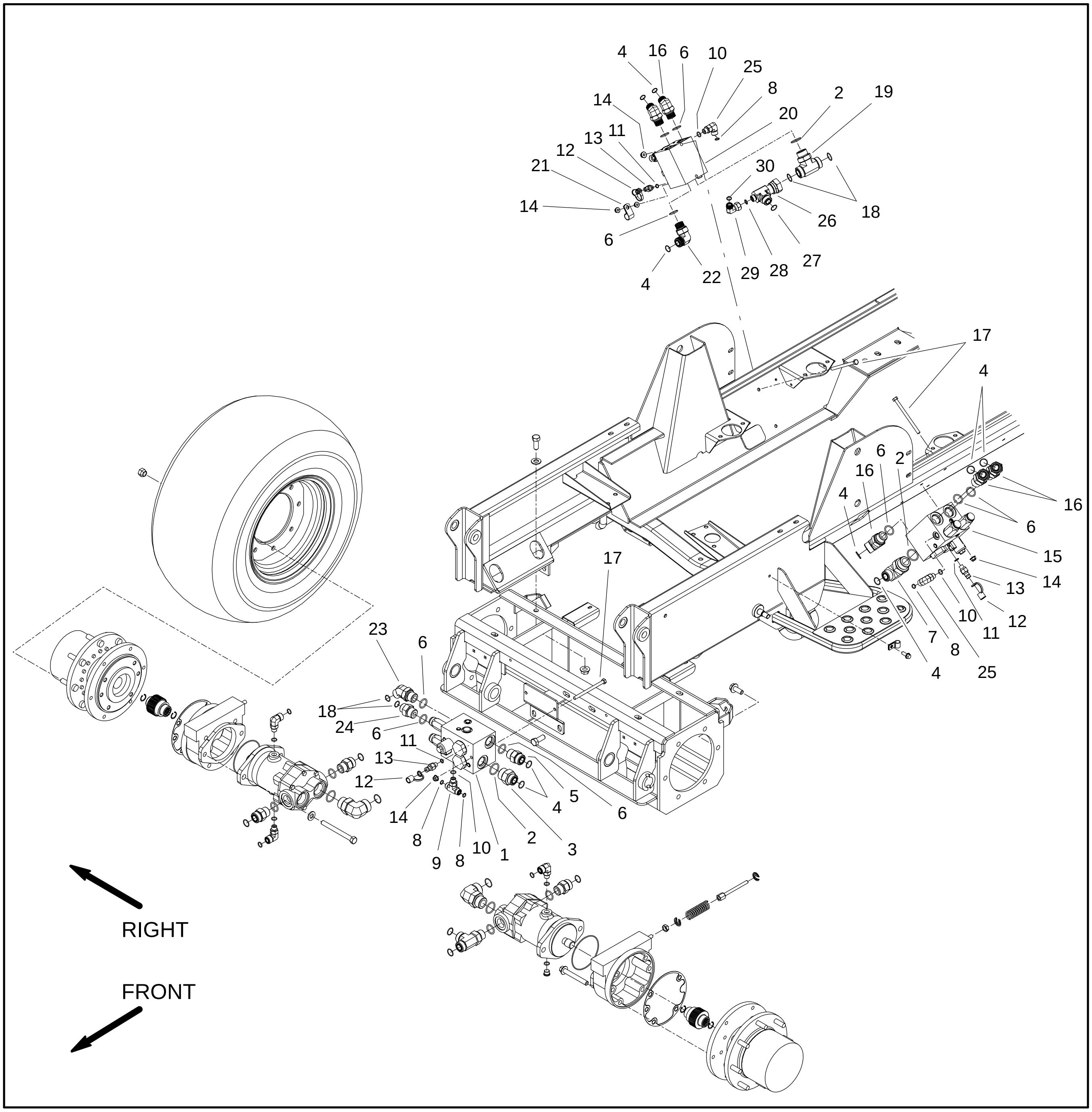

Figure 96

1. Front PTO manifold
2. O-ring
3. Hydraulic adapter
4. O-ring
5. Straight hydraulic fitting
6. O-ring
7. 90° hydraulic fitting
8. O-ring
9. Hydraulic tee fitting
10. O-ring
11. O-ring
12. Dust cap
13. Quick fitting
14. Flange nut
15. LH PTO manifold
16. 45° hydraulic fitting
17. Cap screw (2 used per manifold)
18. O-ring
19. Hydraulic tee fitting
20. RH PTO manifold
21. R-clamp
22. 90° hydraulic fitting
23. Hydraulic fitting
24. Hydraulic adapter
25. 90° hydraulic fitting
26. Hydraulic tee fitting
27. O-ring
28. O-ring
29. 90° hydraulic fitting
30. O-ring

NOTE: The ports on the PTO manifolds are marked for easy identification of components. Example: SV1 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 manifold port).

The PTO control manifolds for the three (3) cutting deck sections are very similar.

IMPORTANT: When servicing the PTO manifolds, DO NOT interchange parts from one control manifold to another.

Removal (Fig. 96)

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

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.

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

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.

5. Remove hydraulic PTO manifold from the frame using Figure 96 as 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. 96)

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 PTO manifold to the frame using Figure 96 as 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

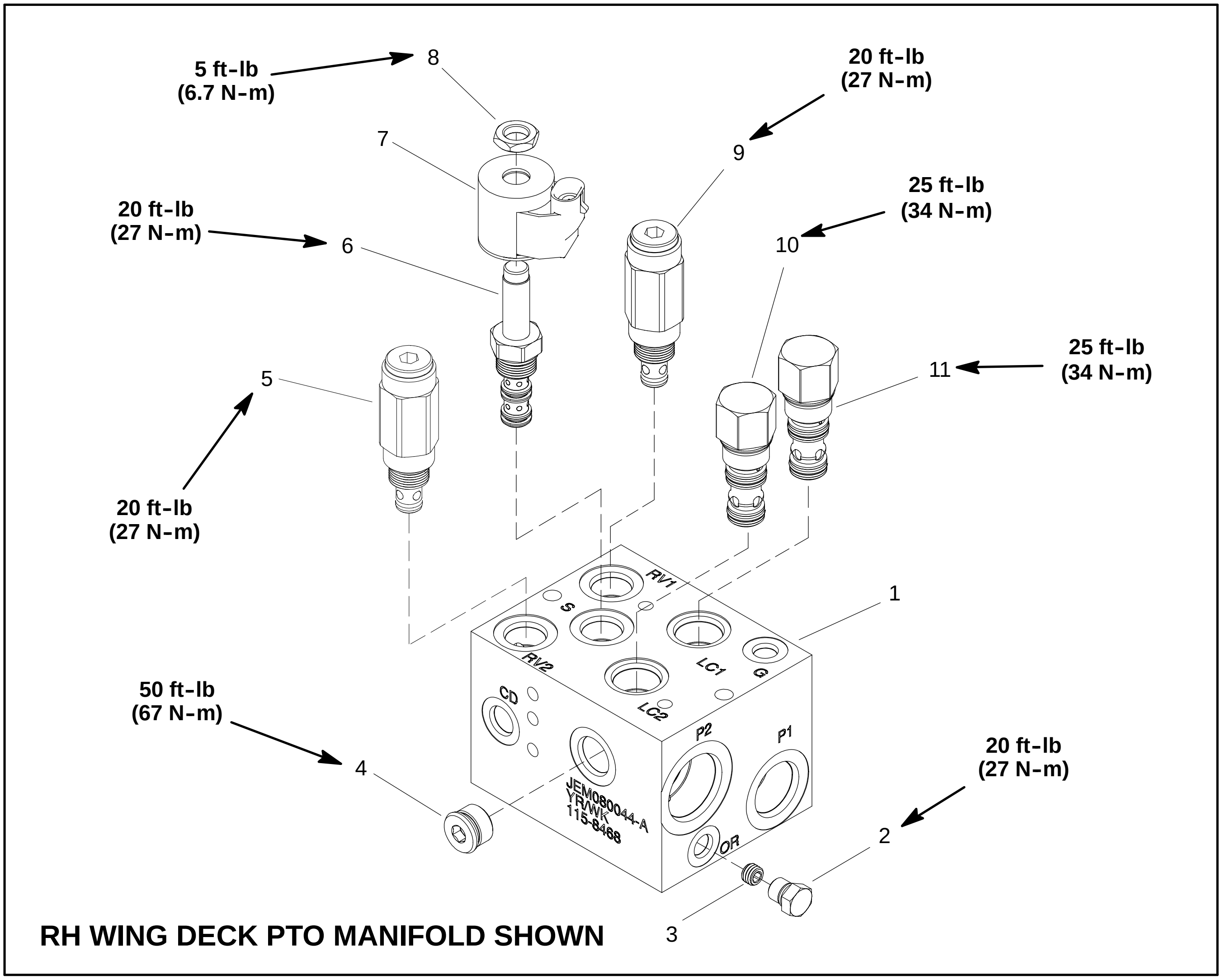

Figure 97

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

NOTE: The ports on the PTO manifolds 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 control manifolds for the three (3) cutting deck sections are very similar. The PTO manifold for the front (center) deck does not include an orifice (item 3).

IMPORTANT: When servicing the PTO manifolds, DO NOT interchange parts from one control 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. 97)

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

Cutting Deck Lift/Lower Circuit

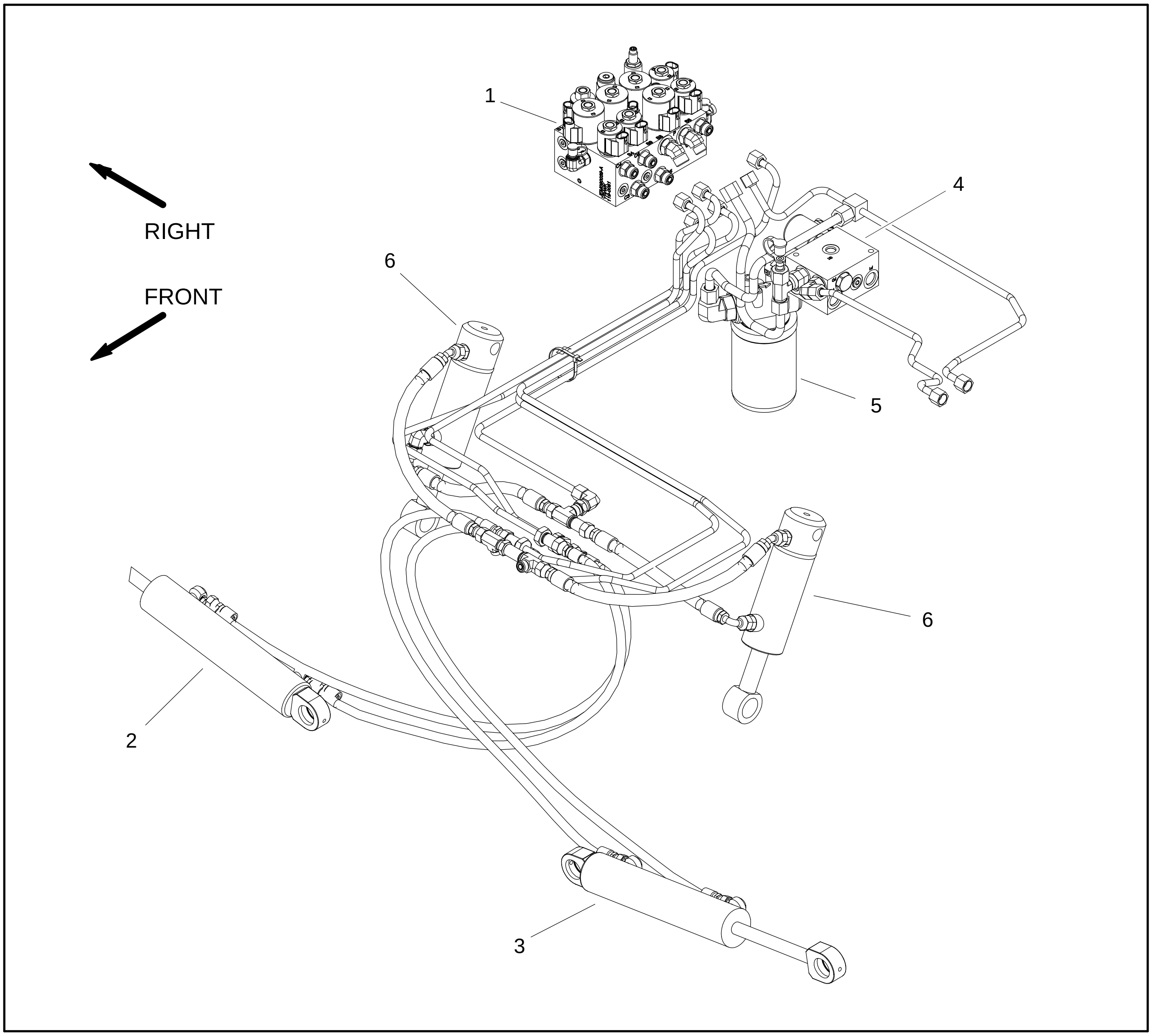

Figure 98

1. **Lift/lower manifold**
2. **RH wing deck lift cylinder**
3. **LH wing deck lift cylinder**
4. **Fan drive manifold**
5. **Oil filter**
6. **Front deck lift cylinder**

Figure 98 illustrates the components that are used in the Groundsmaster 4100–D and 4110–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.

Hydraulic System

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Lift/Lower Manifold

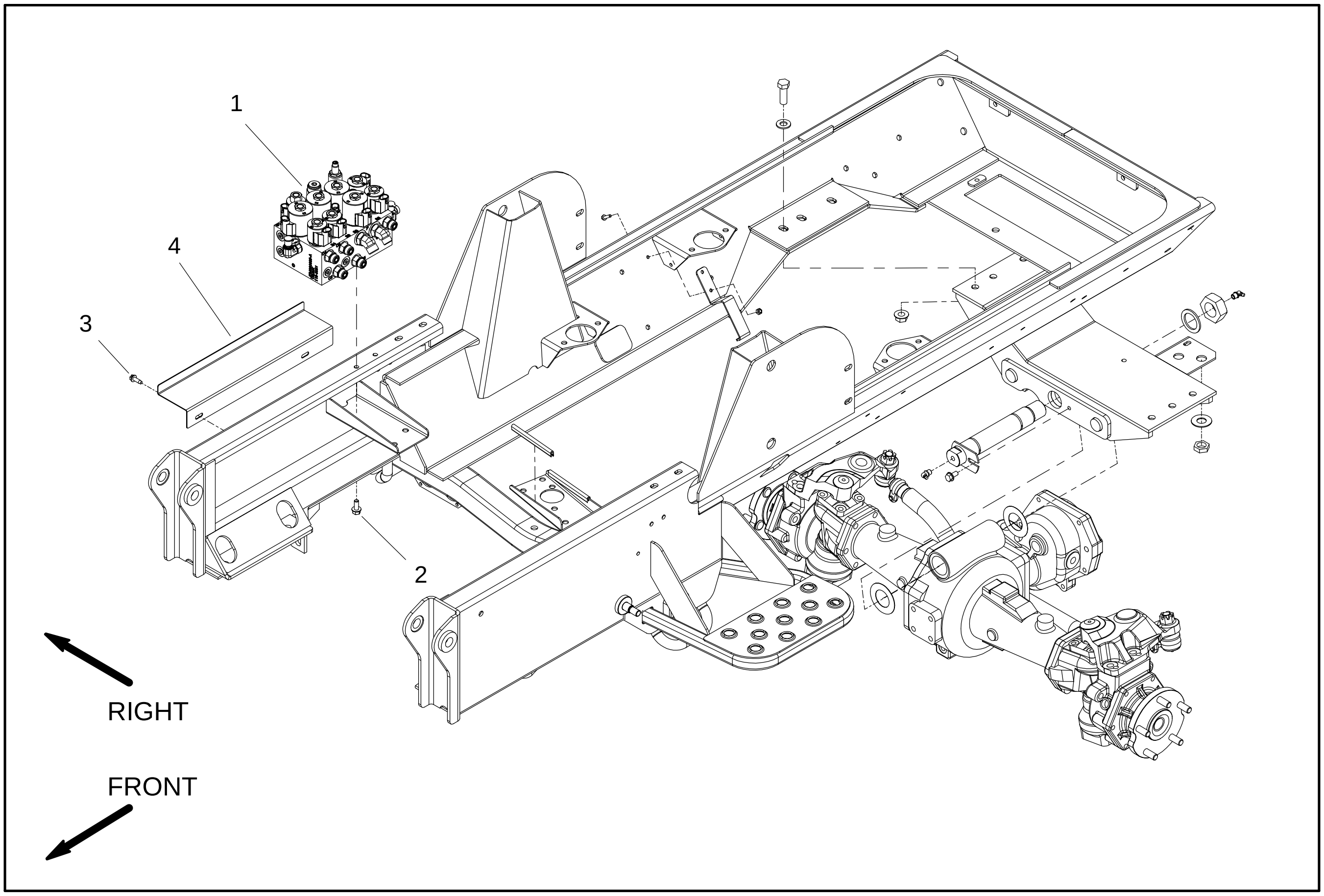

Figure 99

1. **Lift/lower manifold**
2. **Flange head screw (2 used)**
3. **Washer head screw (2 used)**
4. **Splash shield**

Removal (Fig. 99)

1. Park machine on a level surface, lower cutting deck (including wing decks), stop engine, engage 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. 100).

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 deck (including wing decks) is 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 99 as a guide.

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.

8. If hydraulic fittings are to be removed from control manifold, mark fitting orientation to allow correct assembly. Remove fittings from manifold and discard O–rings (Fig. 101).

Installation (Fig. 99)

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. 101). Tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).

2. Install lift/lower manifold using Figure 99 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 labels 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. 100).

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

7. Lower and secure operator seat.

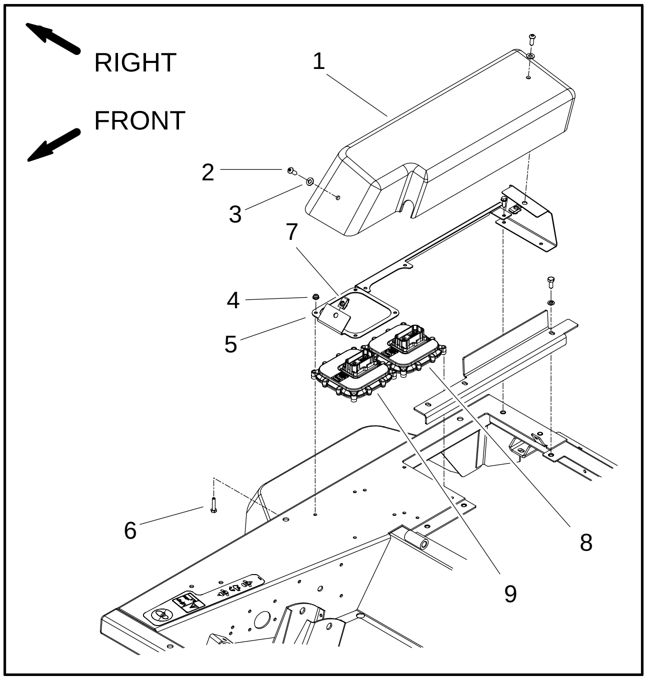

Figure 100

1. **Controller cover**
2. **Screw (2 used)**
3. **Flat washer (2 used)**
4. **Flange nut (8 used)**
5. **Front cover mount**
6. **Cap screw (8 used)**
7. **U–nut (2 used)**
8. **TEC–5001**
9. **TEC–5002**

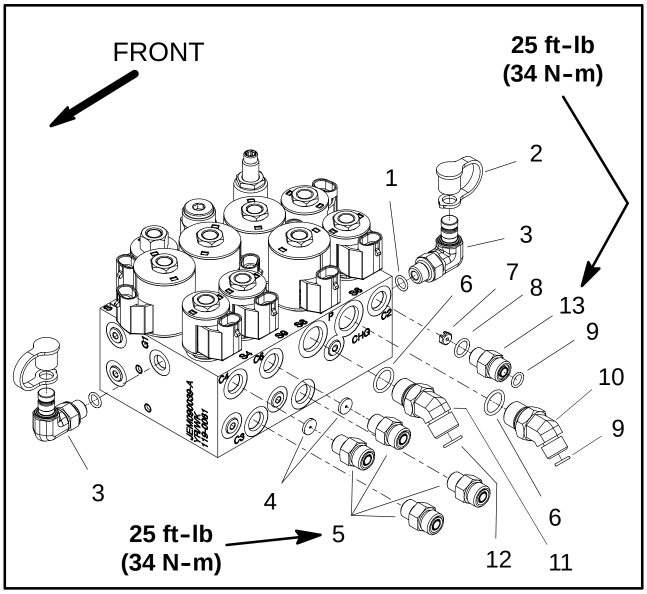

Figure 101

1. **O–ring**
2. **Dust cap**
3. **Test port**
4. **Orifice (0.063)**
5. **Straight fitting**
6. **O–ring**
7. **Orifice (0.080)**
8. **O–ring**
9. **O–ring**
10. **45º hydraulic fitting**
11. **45º hydraulic fitting**
12. **O–ring**
13. **Fitting with orifice (.070)**

Lift/Lower Manifold Service

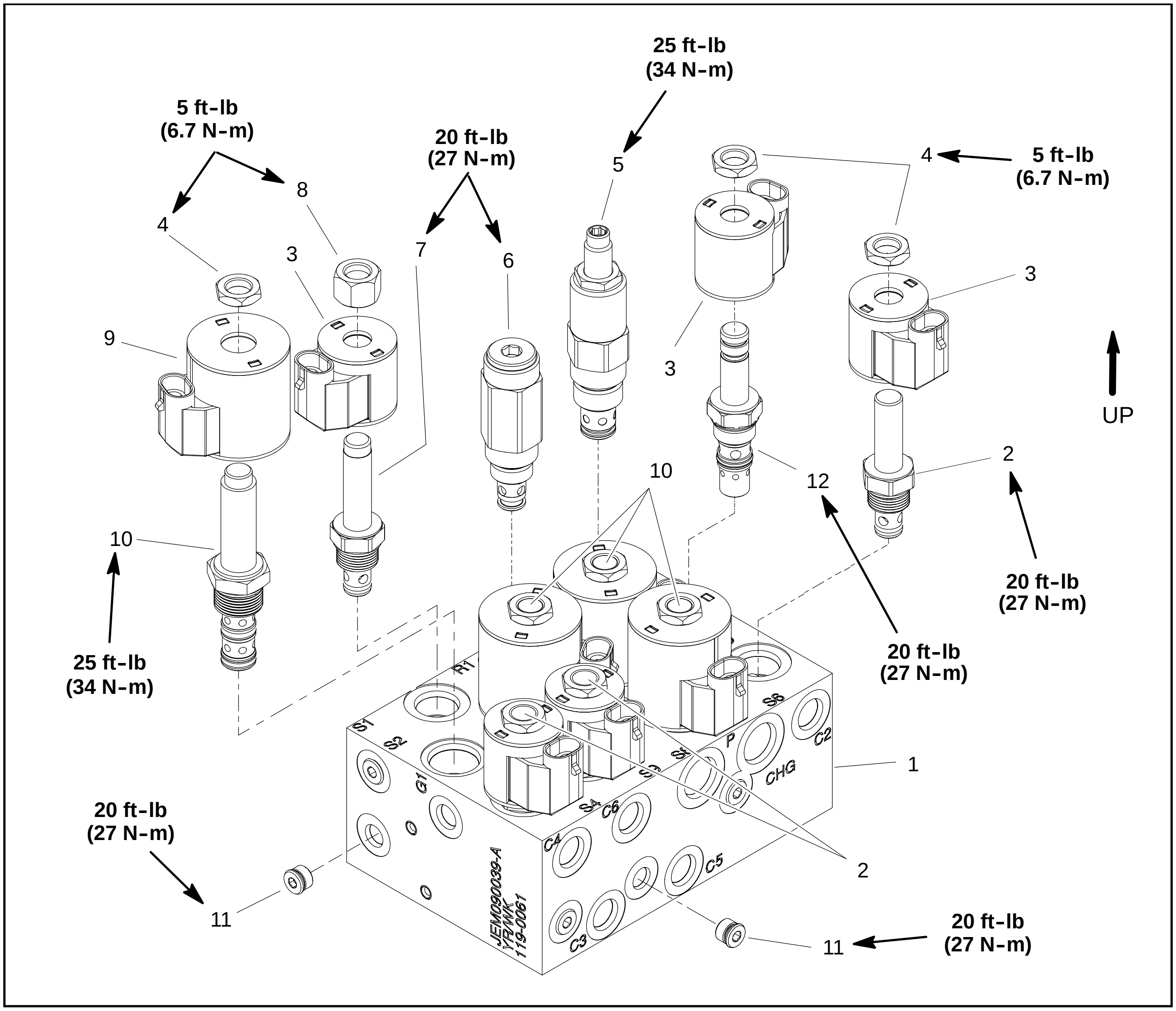

Figure 102

1. **Lift/lower manifold body**
2. **Solenoid valve (S4, S6 & S9)**
3. **Solenoid coil (5 used)**
4. **Nut (8 used)**
5. **Relief valve (RV2)**
6. **Relief valve (RV1)**
7. **Solenoid valve (S1)**
8. **Nut**
9. **Solenoid coil (4 used)**
10. **Solenoid valve (S2, S3, S7 & S8)**
11. **#4 zero leak plug with O-ring**
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.

Lift/Lower Manifold Service (Fig. 102)

WARNING

If lift/lower manifold is attached to machine, make sure that cutting deck (including wing decks) is fully lowered before loosening hydraulic lines, cartridge valves or plugs from lift/lower manifold. If decks are not fully lowered when manifold components are loosened, decks may drop unexpectedly.

For lift/lower manifold solenoid and control valve service procedures, see 4WD Manifold Service in this section. Refer to Figure 102 for lift/lower manifold cartridge valve and plug installation torque.

Front Deck Lift Cylinder

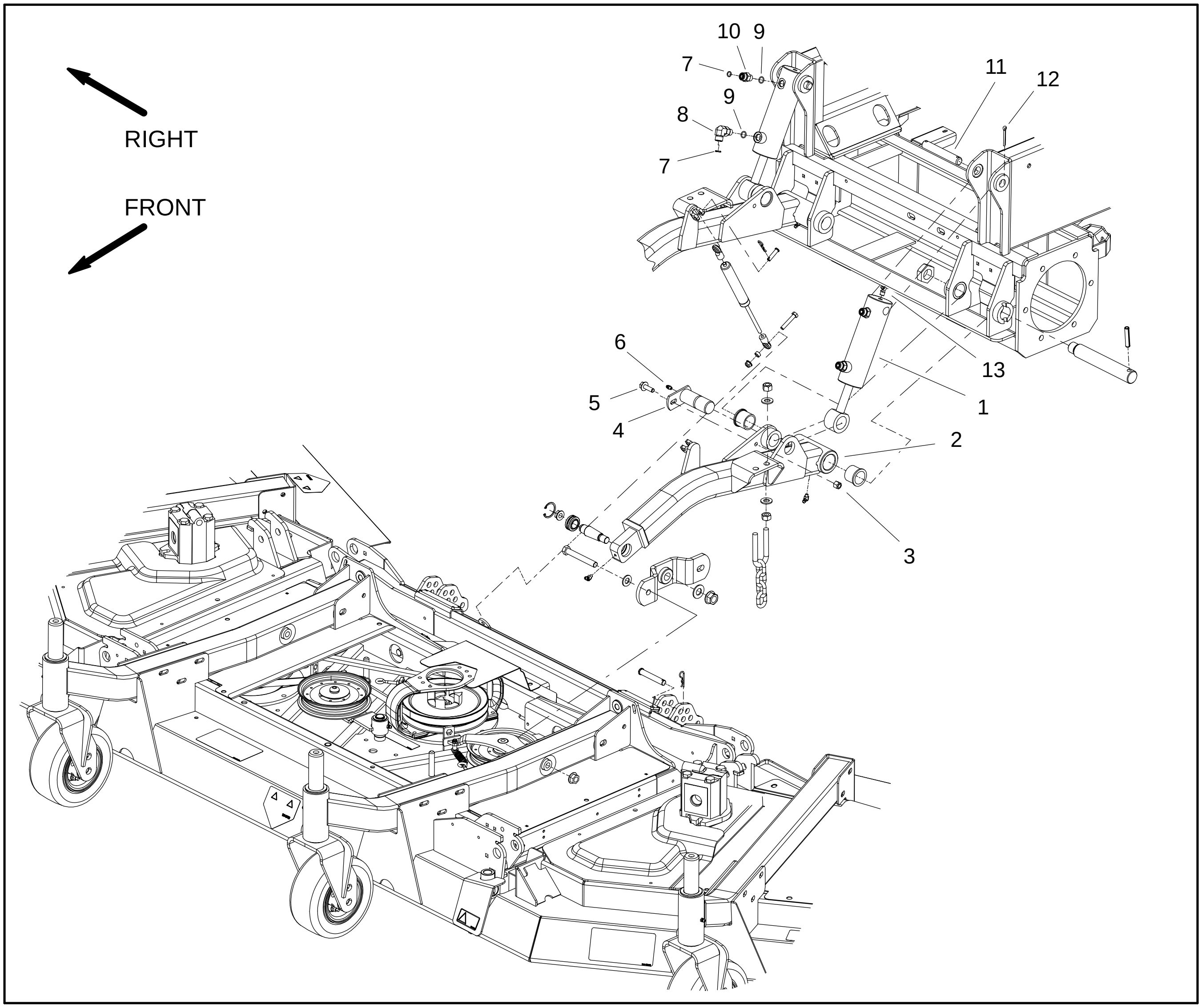

Figure 103

1. Lift cylinder (2 used)
2. Lift arm (LH shown)
3. Lock nut
4. Pin
5. Flange head screw
6. Grease fitting
7. O-ring
8. 90° hydraulic fitting
9. O-ring
10. Hydraulic fitting
11. Pivot pin
12. Cotter pin (2 used per pin)
13. Grease fitting

Removal (Fig. 103)

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

2. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of this section.

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

WARNING

Make sure that cutting deck (including wing decks) is fully lowered before loosening hydraulic lines from lift cylinders. If decks are not fully lowered as hydraulic lines are loosened, deck may drop unexpectedly.

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

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

5. Support lift cylinder to prevent it from falling.

6. Remove flange head screw and lock nut that secure the pin (item 4) to the lift arm. Remove pin from lift arm and cylinder shaft clevis which will free lift cylinder from lift arm.

7. Remove one cotter pin from upper pivot pin (item 11). Pull pivot pin from frame and cylinder barrel clevis.

8. Remove lift cylinder from machine.

9. 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. 103)

1. If fittings were removed from lift cylinder, lubricate and place new O–rings onto fittings. Install fittings into cylinder port openings using marks made during the removal process to properly orientate fittings. Tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).

2. Position cylinder barrel clevis to frame and insert upper pivot pin into frame and clevis. Secure pivot pin with cotter pin.

3. Insert pin through lift arm and cylinder shaft clevis. Secure pin to lift arm with flange head screw and lock nut.

4. Remove caps and plugs from fittings and hydraulic lines. Using labels placed during cylinder removal, properly 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.

Wing Deck Lift Cylinder

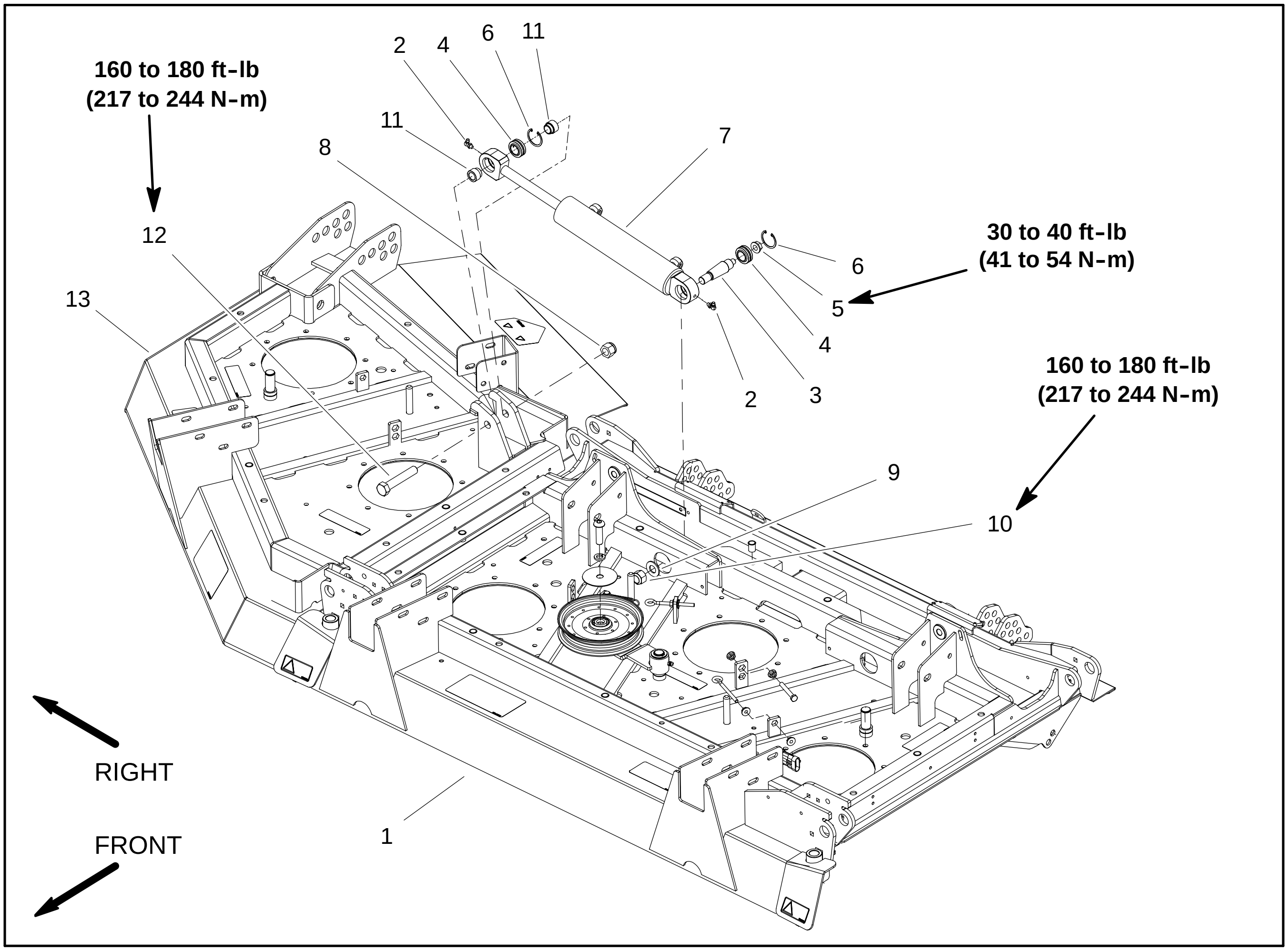

Figure 104

1. **Center deck**
2. **Grease fitting**
3. **Tapered stud**
4. **Spherical bearing**
5. **Flange nut**
6. **Retaining ring**
7. **Wing deck lift cylinder**
8. **Lock nut**
9. **Flat washer**
10. **Lock nut**
11. **Pilot spacer**
12. **Cap screw**
13. **Wing deck (RH shown)**

Removal (Fig. 104)

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

2. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of this section.

WARNING

Make sure that cutting deck (including wing decks) is fully lowered before loosening hydraulic lines from wing deck lift cylinders. If decks are not fully lowered as hydraulic lines are loosened, deck may drop unexpectedly.

3. Remove deck covers as needed to allow access to lift cylinder hoses and fasteners.

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

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

5. Disconnect hydraulic hoses from lift cylinder and put caps or plugs on open hydraulic hoses and fittings. Label disconnected hydraulic hoses for proper installation.

6. Remove cap screw and lock nut that secure the lift cylinder clevis to the wing deck.

7. Remove lock nut and flat washer from the tapered stud on the barrel end of the lift cylinder.

8. Remove lift cylinder from deck assembly.

9. Remove spherical bearings from lift cylinder clevis ends, if required.

A. On shaft clevis, remove retaining ring and then press spherical bearing from clevis.

B. On barrel clevis, remove retaining ring and then press tapered stud with spherical bearing and flange nut from clevis. Remove flange nut and then spherical bearing from stud.

Installation (Fig. 104)

1. If removed, install spherical bearings into lift cylinder clevis ends.

A. On shaft clevis, press spherical bearing into clevis and secure with retaining ring.

B. On barrel clevis, install spherical bearing on tapered stud and secure with flange nut. Torque flange nut from **30 to 40 ft–lb (41 to 54 N–m)**. Install stud with spherical bearing into clevis and secure with retaining ring.

2. Thoroughly clean tapered surfaces of lift cylinder stud and mounting boss on deck.

3. Position lift cylinder to cutting deck. Insert tapered stud into deck mounting boss. Secure stud with flat washer and lock nut. Torque flange nut from **160 to 180 ft–lb (217 to 244 N–m)**.

4. Insert cap screw from the front of the deck through the deck brackets and cylinder shaft clevis. Secure cap screw with lock nut. Torque lock nut from **160 to 180 ft–lb (217 to 244 N–m)**.

5. Remove caps and plugs from fittings and hydraulic hoses. Using labels placed during cylinder removal, properly attach hydraulic hoses to lift cylinder (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

6. Install all removed deck covers.

7. Fill reservoir with hydraulic fluid as required.

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

Lift Cylinder Service

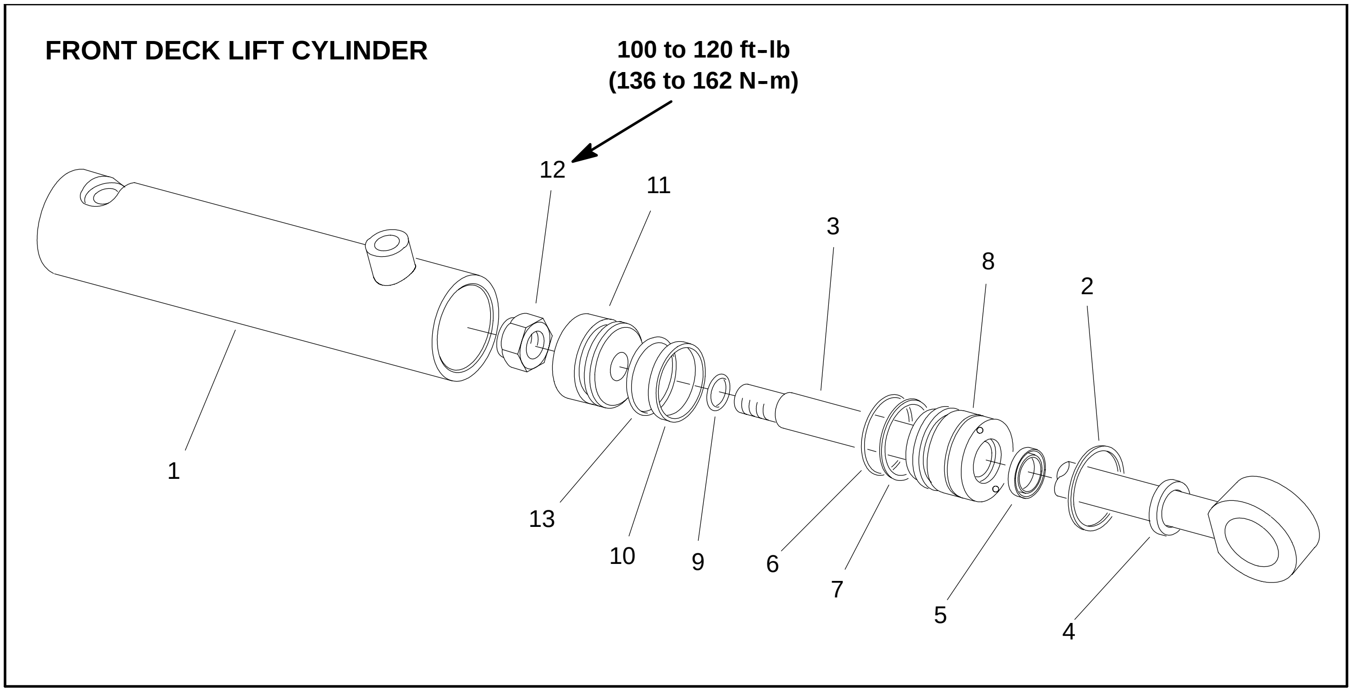

Figure 105

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. **Seal with loader**

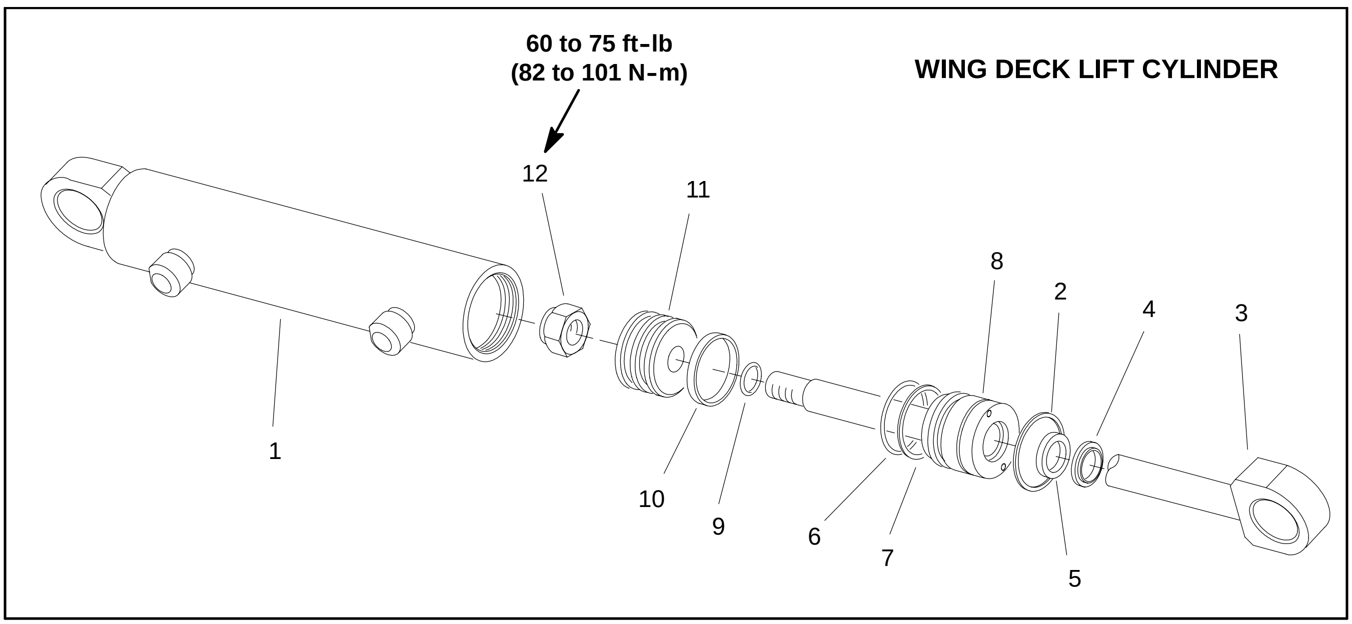

Figure 106

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. **Seal with O–ring**
11. **Piston**
12. **Lock nut**

Disassembly (Figs. 105 and 106)

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.

CAUTION

Use eye protection such as goggles when using compressed air

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. 105 and 106)

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 105 (front deck lift cylinder) or Figure 106 (wing deck lift 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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TORO

Chapter 5

Electrical System

Table of Contents

General Information

Operator’s Manual

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

Toro Electronic Controllers (TEC)

Groundsmaster 4100–D and 4110–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 Toro Electronic 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 4100–D and 4110–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 the Groundsmaster 4100–D and 4110–D 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.

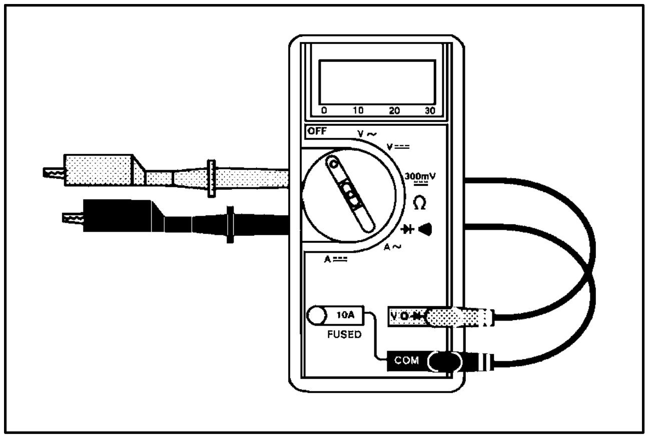


Figure 1

Skin–Over Grease

Special non–conductive grease which forms a light protective skin to help 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: **119–5303**

TEC–5001: **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

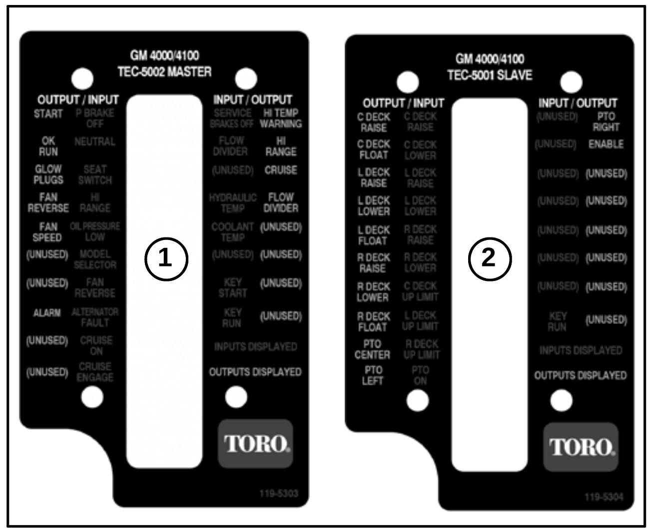


Figure 5

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

Electrical System

Troubleshooting

CAUTION

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

For effective troubleshooting and repairs, there must be a good understanding of the electrical circuits and components used on this machine (see electrical schematic in Chapter 10 – Foldout Drawings).

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

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 4100–D and 4110–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, traction 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 also 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 deck, 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).

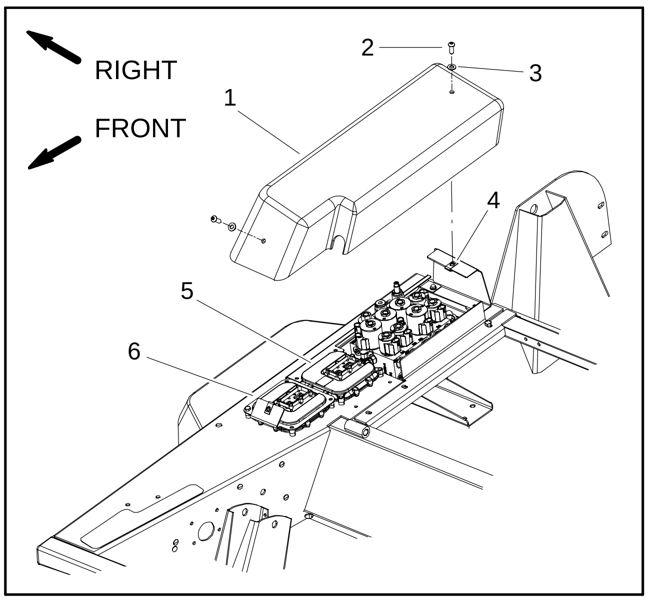


Figure 8

1. **Controller cover**
2. **Screw (2 used)**
3. **Flat washer (2 used)**
4. **U–nut (2 used)**
5. **TEC–5001**
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 harness connector is disconnected from the sensor for either of these inputs, 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 machine.

Figure 9

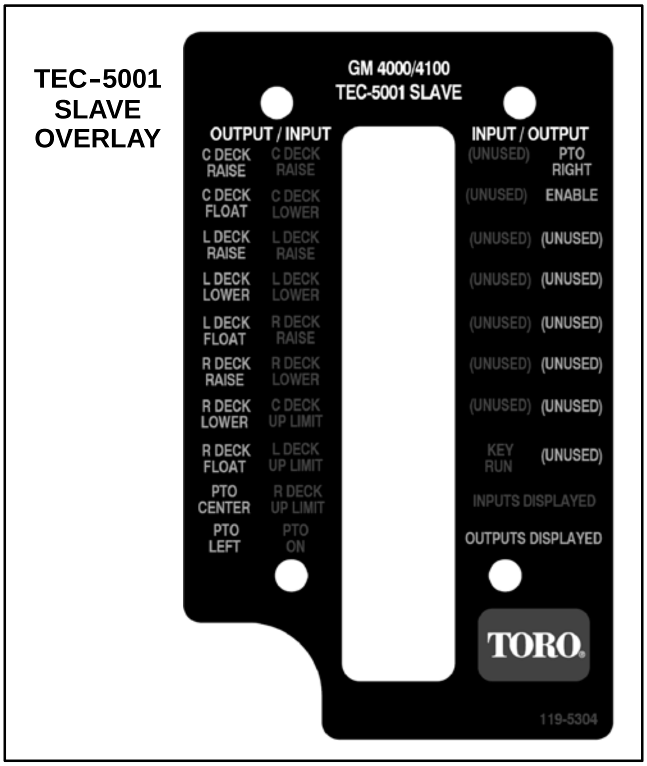


Figure 10

Diagnostic Display TEC–5002 Master Inputs	Diagnostic Display LED Operation
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 4100–D and 4110–D machines, the model selector LED should always be OFF
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 (NOTE: Turn PTO switch ON so engine will not start when turning ignition switch to 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

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 deck, stop the engine and engage the parking brake.

2. Remove controller cover to allow access to wire harness loopback connector (Fig. 11). Locate wire harness 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 UP, 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.

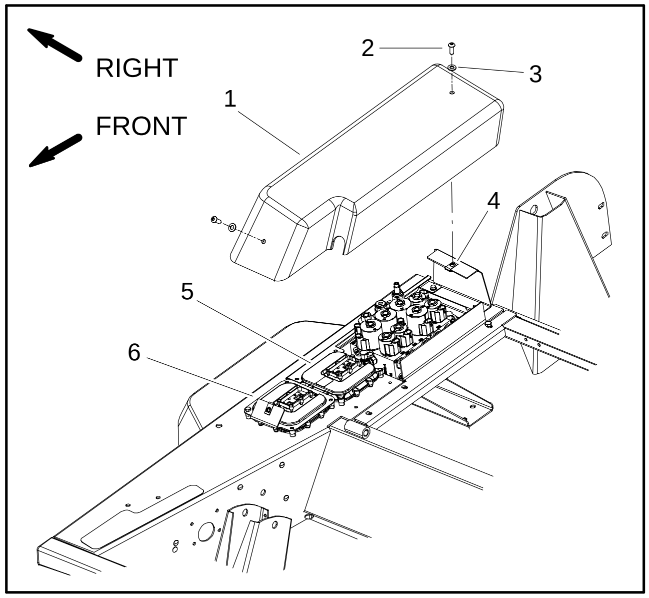


Figure 11

1. Controller cover
2. Screw (2 used)
3. Flat washer (2 used)
4. U-nut (2 used)
5. TEC-5001
6. TEC-5002

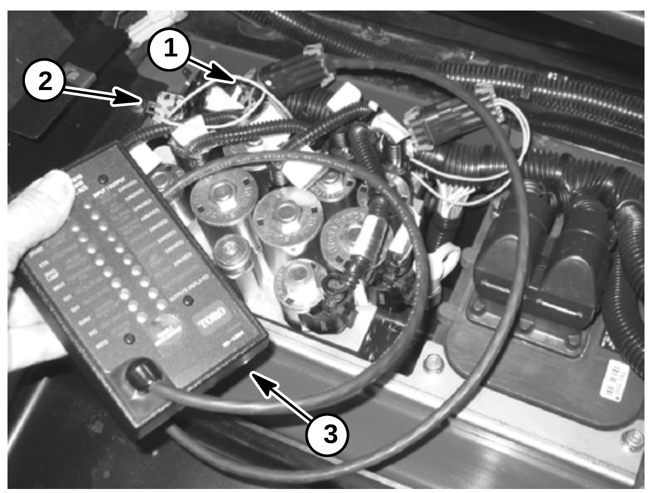


Figure 12

1. Wire harness connector
2. Loopback connector
3. Diagnostic display

Starting Problems

Problem	Possible Causes
No electrical power to machine (including gauges).	The battery is discharged. The battery cables are loose or corroded. Fuse F3–1 (2 amp) to the ignition switch is faulty. A faulty ground connection exists on machine. The ignition switch or circuit wiring is faulty.
Starter solenoid clicks, but starter will not crank. **NOTE:** If the solenoid clicks, the problem **is not** in the interlock circuit.	The battery is discharged. The battery cables are loose or corroded. A ground wire or cable is loose or corroded. Wiring at the starter motor is faulty. The starter solenoid is faulty. The starter motor is faulty.
Nothing happens when start attempt is made. Control panel lights and gauges operate with the ignition switch in ON.	The traction pedal is not in the neutral position. Operator seat is unoccupied OR the parking brake is not applied. The PTO switch is ON (engaged). Fuse F1–1 (20 amp) is faulty. TEC–5002 fuses (F3–2, F3–3 or F3–4) (7.5 amp) are faulty. The ignition switch or circuit wiring is faulty. The traction neutral switch or circuit wiring is faulty. The seat switch or circuit wiring is faulty. The parking brake switch or circuit wiring is faulty. The start relay or circuit wiring is faulty. The starter solenoid or starter motor is faulty. The TEC–5002 controller is faulty.
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.	The traction neutral switch is out of adjustment. The traction neutral switch or circuit wiring is faulty.

Starting Problems (Continued)

Problem	Possible Causes
Engine cranks, but does not start.	The fuel tank is empty. The engine is not cranking fast enough. Fuse F5–1 (40 amp) is faulty preventing the engine run solenoid pull coil from being energized. Fuse M1 (60 amp) is faulty preventing glow plug operation. The glow relay or circuit wiring is faulty preventing glow plug operation. Glow plug(s) is faulty. The engine run solenoid or circuit wiring is faulty. The fuel pump or circuit wiring is faulty. The engine or fuel system is malfunctioning (see Chapter 3 – Kubota Diesel Engine).

General Run and Transport Problems

Problem	Possible Causes
The engine continues to run, but should not, when the ignition switch is turned off.	The engine run solenoid is stuck or is faulty. The ignition switch or circuit wiring is faulty.
The engine continues to run, but should not, when the traction pedal is engaged with no operator in the seat.	The seat switch or circuit wiring is faulty. The traction neutral switch or circuit wiring is faulty.
The engine stops during operation, but is able to restart. **NOTE:** 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.	The operator is lifting off the seat switch. The seat switch or circuit wiring is faulty. The ignition switch or circuit wiring is faulty. The engine coolant temperature is excessive. The engine or fuel system is malfunctioning (see Chapter 3 – Kubota Diesel Engine).
The engine stops when the traction pedal is depressed.	The operator is lifting off the seat switch. The parking brake is applied. The seat switch or circuit wiring is faulty. The parking brake switch or circuit wiring is faulty.
The battery does not charge.	Loose, corroded or broken wire(s) in charging circuit. The engine alternator belt is out of adjustment. The charge indicator lamp is faulty or burned out. The charge indicator lamp wiring is loose, corroded or damaged. The battery is faulty. The alternator is faulty.

Cutting Deck Operating Problems

Problem	Possible Causes
The cutting deck remains engaged, but should not, with no operator in the seat.	The seat switch or circuit wiring is faulty. TEC–5001 controller is faulty.
The cutting deck runs, but should not, with PTO switch in the OFF (disengage) position.	The PTO switch or circuit wiring is faulty. A hydraulic problem exists (see Troubleshooting section of Chapter 4 – Hydraulic System). TEC–5001 controller is faulty.
A wing cutting deck runs, but should not, when raised. Deck shuts off with PTO switch.	The wing deck position switch or circuit wiring is faulty. TEC–5001 controller is faulty.
Cutting deck does not operate.	The operator is lifting off the seat switch. Traction circuit is not in Low speed (4WD) mode. High temperature of engine coolant or hydraulic oil has disabled the cutting deck. Fuse F4–4 (7.5 amp) is faulty preventing PTO manifold solenoids from being energized. Front deck jumper harness is faulty or not plugged into platform wire harness. The seat switch or circuit wiring is faulty. The PTO switch or circuit wiring is faulty. The Hi/Low speed switch or circuit wiring is faulty. Hydraulic valve solenoid(s) or circuit wiring to the affected deck section manifold is faulty. A hydraulic problem exists (see Troubleshooting section of Chapter 4 – Hydraulic System). TEC–5001 controller is faulty.
Wing cutting deck does not operate.	The wing cutting deck is not fully lowered. The wing deck deck position switch or circuit wiring is faulty. Hydraulic valve solenoid(s) or circuit wiring to the affected wing deck manifold is faulty. A hydraulic problem exists (see Troubleshooting section of Chapter 4 – Hydraulic System). TEC–5001 controller is faulty.

Cutting Deck Lift/Lower Problems

Problem	Possible Causes
Neither the cutting deck or wing decks will lower.	Hi/Low speed switch is in the Hi speed position. Operator is not fully depressing the seat switch. TEC–5001 fuse(s) (F4–1, F4–2, F4–3, F4–4) are faulty. Seat switch or circuit wiring is faulty. Hi/Low speed switch or circuit wiring is faulty. Lift control manifold solenoid coil S1 or circuit wiring is faulty. A hydraulic problem in the lift/lower circuit exists (see Troubleshooting section of Chapter 4 - Hydraulic System). TEC–5001 controller is faulty.
Neither the cutting deck or wing decks will raise.	TEC–5001 fuse(s) (F4–1, F4–2, F4–3, F4–4) are faulty. Lift control manifold solenoid coil S1 or circuit wiring is faulty. A hydraulic problem in the lift/lower circuit exists (see Troubleshooting section of Chapter 4 - Hydraulic System). TEC–5001 controller is faulty.
Front cutting deck **will not** raise or lower, but both wing cutting decks **will** raise and lower.	Front deck lift switch or circuit wiring is faulty. Lift control manifold solenoid coils S5 or S6 or circuit wiring is faulty. A hydraulic problem exists (see Troubleshooting section of Chapter 4 - Hydraulic System). TEC–5001 controller is faulty.
RH wing cutting deck **will not** raise or lower, but the front and LH wing cutting decks **will** raise and lower.	RH deck lift switch or circuit wiring is faulty. Fuse F4–3 (7.5 amp) is faulty. Lift control manifold solenoid coils S7, S8 or S9 or circuit wiring is faulty. A hydraulic problem exists (see Troubleshooting section of Chapter 4 - Hydraulic System). TEC–5001 controller is faulty.

Cutting Deck Lift/Lower Problems (Continued)

Problem	Possible Causes
LH wing cutting deck **will not** raise or lower, but the front and RH wing cutting decks **will** raise and lower.	LH deck lift switch or circuit wiring is faulty. Lift control manifold solenoid coils S2, S3 or S4 or circuit wiring is faulty. A hydraulic problem exists (see Troubleshooting section of Chapter 4 - Hydraulic System). TEC–5001 controller is faulty.

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 60ºF to 100ºF (16ºC to 38ºC). The ignition key should be off and all accessories turned off. Connect the positive (+) meter lead to the positive battery post and the negative (–) meter lead to the negative battery post.

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

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

Charging System Test

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

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 run anytime hard starting (cold engine) is encountered on a diesel engine equipped with a glow plug system.

Use a digital multimeter and/or inductive Ammeter (AC/DC Current Transducer). Properly connect the ammeter to the digital multimeter (refer to manufacturers' 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 Operator's Manual. Your Groundsmaster is equipped with two (2) Toro Electronic Controllers (TEC) which monitor interlock switch operation. Testing of 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.

Adjustments

Wing Deck Position Switches

Adjustment

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

2. Remove switch cover from deck to allow access to position switch that requires adjustment.

3. Raise and lower wing deck while monitoring the wing deck latch and the position switch LED on cable end of switch:

   A. The position switch should open (switch LED **is not** illuminated) when the wing deck link causes the wing deck latch to disengage as wing deck is raised.

   B. The position switch should close (switch LED **is** illuminated) when the wing deck link causes the wing deck latch to engage as wing deck is lowered.

4. If necessary, adjust switch location to allow correct operation:

   A. Loosen jam nuts on switch and adjust switch location to allow proper switch operation.

   B. After switch adjustment, torque jam nuts from **165 to 195 in–lb (18.7 to 22.0 N–m)**.

   C. Make sure that position switch does not contact bolt head on wing deck link when wing deck is fully lowered.

5. After testing is complete, make sure that switch connector is plugged into deck wire harness and switch cover is secured to deck.

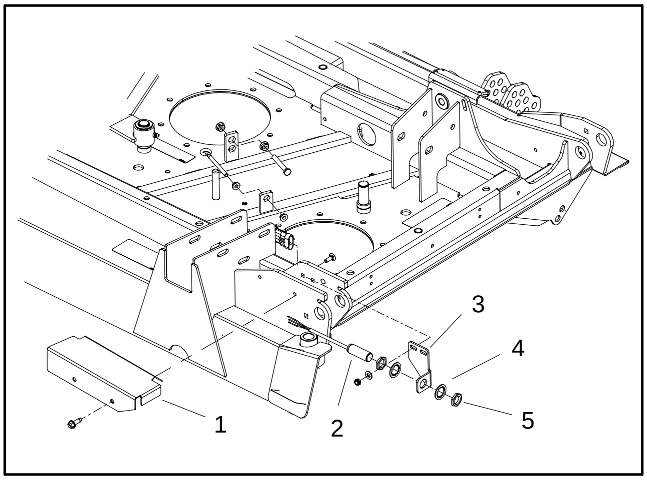


Figure 13

1. **Switch cover**
2. **Position switch**
3. **Switch bracket**
4. **Lock washer (2 used)**
5. **Jam nut (2 used)**

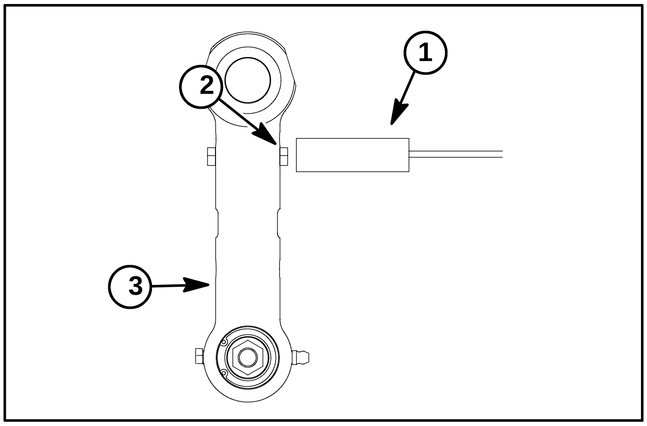


Figure 14

1. **Position switch**
2. **Bolt head**
3. **Wing deck link**

Electrical System

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 doing a continuity check).

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 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).

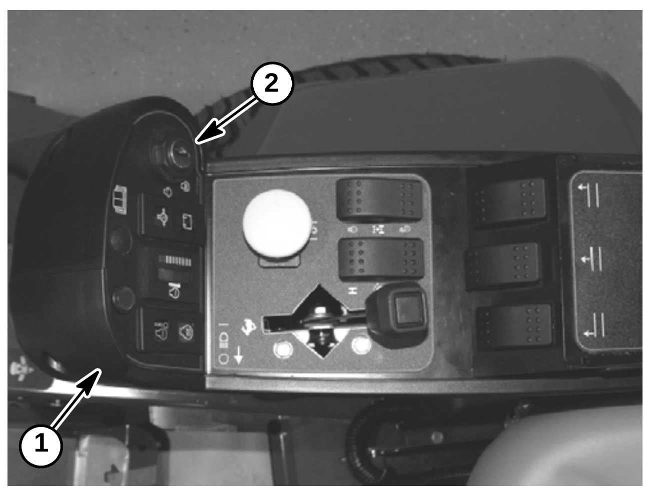


Figure 15

1. Console arm
2. Ignition switch

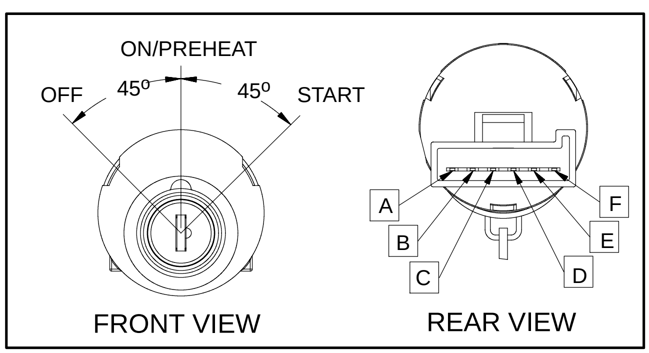


Figure 16

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. 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 4110–D.

Fuse F1–4 (10 amp) protects signal light circuit on Groundsmaster 4110–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 4110–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.

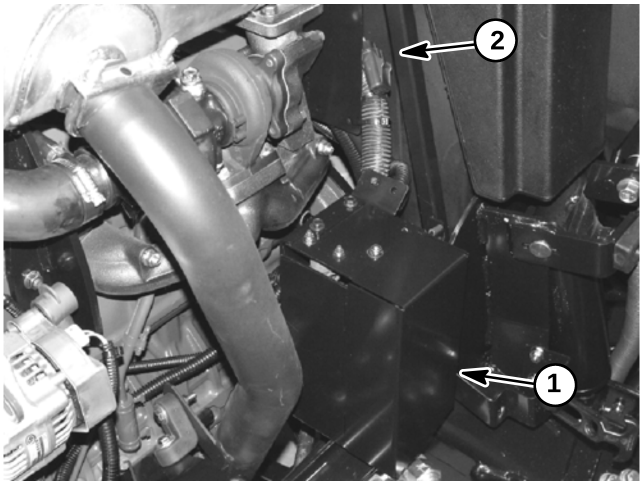


Figure 17

1. **Power center** 2. **Fuse F5–1**

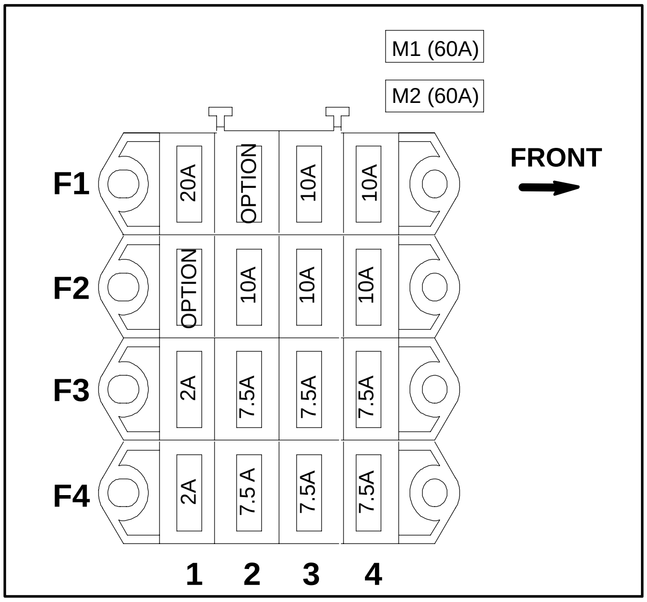


Figure 18

Operator Cab Fuses (Groundsmaster 4110–D)

The cab fuse blocks are located in the cab headliner (Fig. 19).

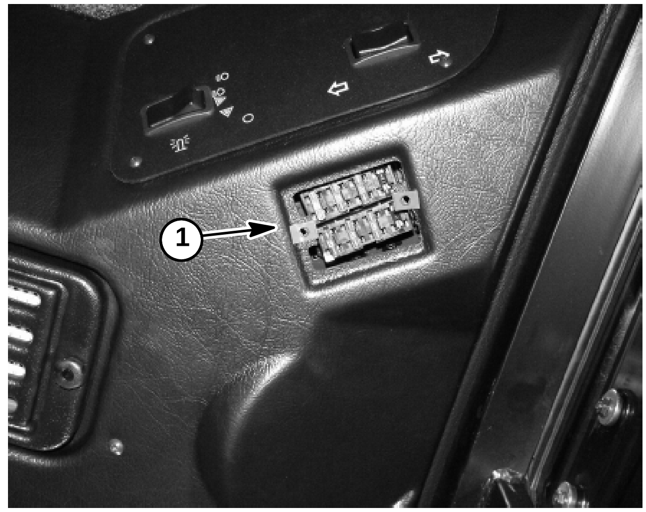


Figure 19

1. **Cab fuse blocks**

Identification and Function (Figs. 19 and 21)

Fuse F1–1 (20 Amp) protects the air conditioner circuit.

Fuse F1–2 (20 Amp) protects the cab lighting circuit.

Fuse F1–3 (20 Amp) protects the cab fan and dome light circuits.

Fuse F2–1 (20 Amp) protects the heater circuit.

Fuse F2–3 (20 Amp) protects the windshield wiper/ washer circuit.

Fuses F1–4, F2–2 and F2–4 are available for optional cab equipment (work lights and rear window wiper).

Figure 20

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.

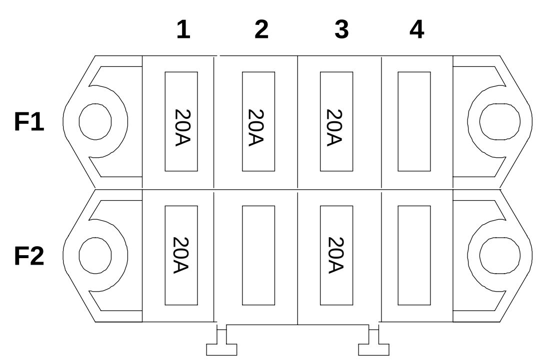


Figure 21

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 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^2).

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^{o}F (105^{o}C), the high temperature light should come on and the PTO (cutting deck) 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 Warning 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. 23).

4. Ground terminals 1B and 2B (Fig. 23).

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).

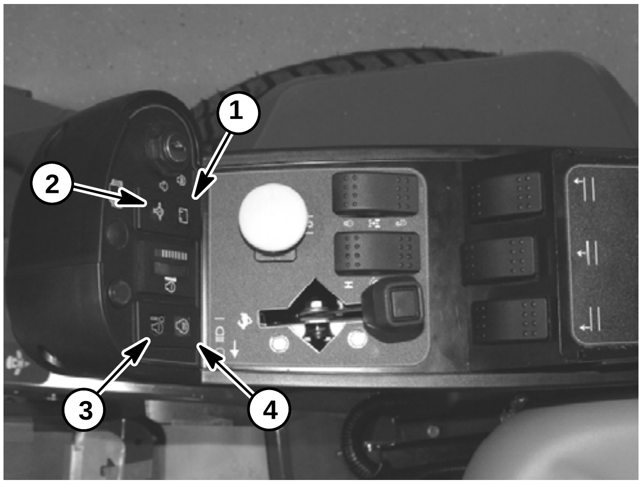


Figure 22

1. **Charge indicator**
2. **Engine oil pressure**
3. **High temp warning**
4. **Glow plug indicator**

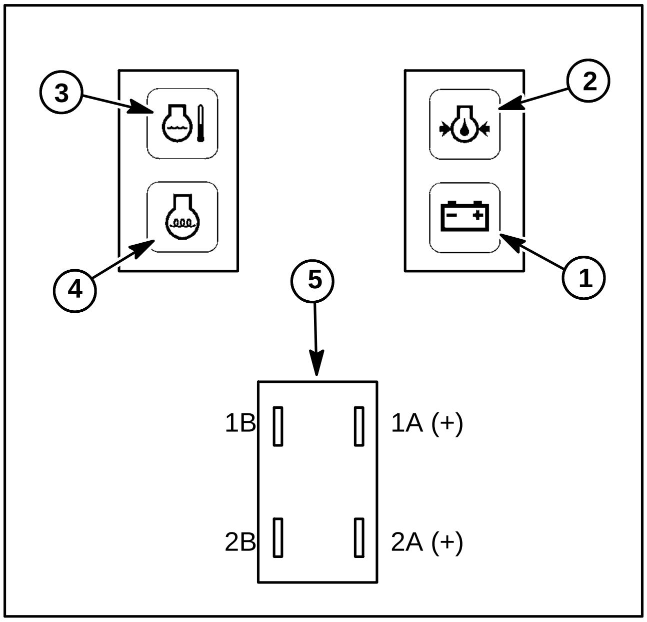


Figure 23

1. **Charge indicator**
2. **Engine oil pressure**
3. **High temp shutdown**
4. **Glow plug indicator**
5. **Warning light back**

PTO Switch

The PTO switch is located on the console arm (Fig. 24). 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 deck has 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–5001 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 25. The circuit logic of the PTO switch is shown in the chart below. With the use of a multimeter (ohms setting), the switch functions can be tested to determine whether continuity exists between the various terminals for each switch position. Verify continuity between switch terminals. Replace switch if testing identifies that switch is faulty.

SWITCH POSITION	CLOSED CIRCUITS	OPEN CIRCUITS
OFF (DOWN)	COM B + NC B COM C + NC C	COM B + NO B COM C + NO C
ON (UP)	COM B + NO B COM C + NO C	COM B + NC B COM C + NC C

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).

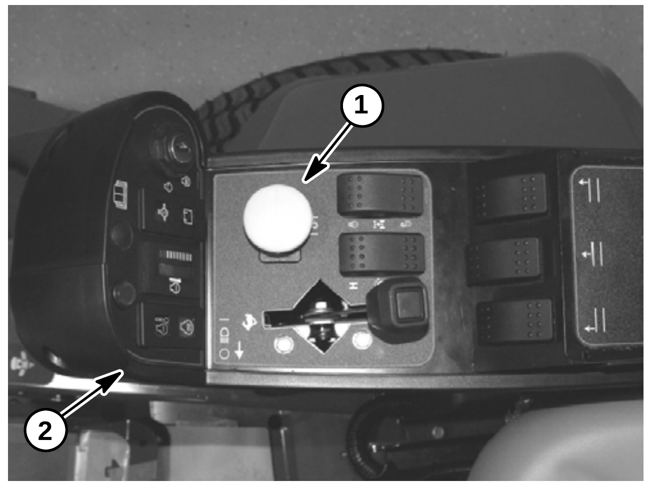


Figure 24

1. **PTO switch**
2. **Control console**

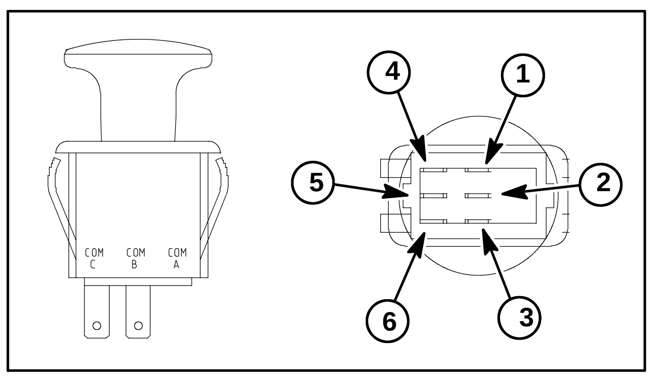


Figure 25

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 4100–D and 4110–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 deck sections. When the front of a lift switch is depressed and held, the controlled deck will lower. When the rear of a lift switch is depressed and held, the controlled deck will raise. The deck section will remain in position when the switch is released. The lift switches are located on the console arm (Fig. 26).

NOTE: To lower the cutting deck (or wing decks), traction speed has to be in low range (4WD). Also, to raise or lower the deck, 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.

5. The switch terminals are marked as shown in Figure 27. 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 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).

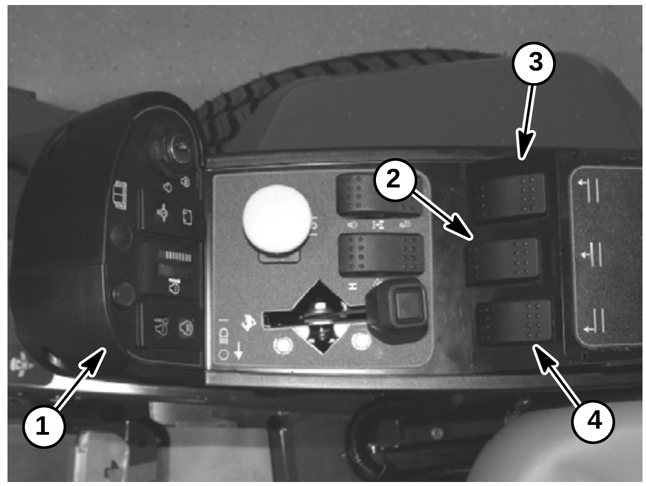
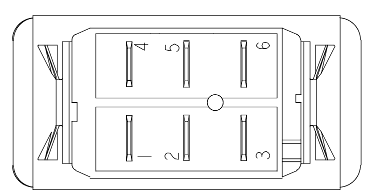


Figure 26

1. **Console arm**
2. **Front deck lift switch**
3. **RH deck lift switch**
4. **LH deck lift switch**



BACK OF SWITCH

Figure 27

NOTE: Lift switch terminals 4, 5 and 6 are not used on Groundsmaster 4100–D and 4110–D machines.

Hi/Low Speed and Headlight (Groundsmaster 4110–D) Switches

The Hi/Low speed and headlight switches (Groundsmaster 4110–D) are identical, two (2) position rocker switches that are located on the control console.

The Hi/Low speed switch (Fig. 28) 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 4110–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 29. 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).

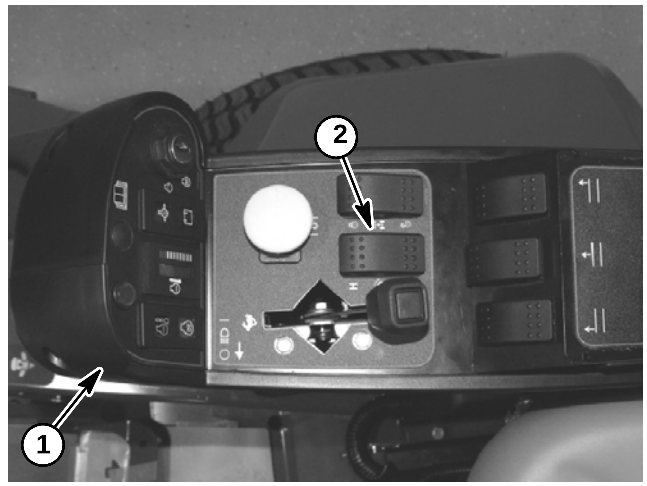
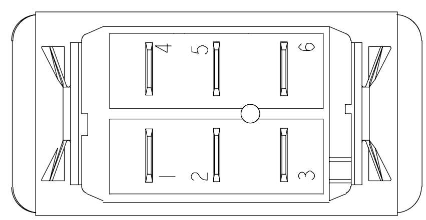


Figure 28

1. Console arm
2. Hi/Low speed switch



BACK OF SWITCH

Figure 29

NOTE: Switch terminals 1, 4, 5 and 6 are not used on Groundsmaster 4100–D and 4110–D machines.

Engine Cooling Fan Switch

The engine cooling fan switch is a two (2) position rocker switch that is located on the outside of the control console (Fig. 30). The switch has a normal and a momentary 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 engine cooling fan 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 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 cooling fan switch (see Console Arm Disassembly in the Service and Repairs section of Chapter 7 – Chassis).

4. Disconnect wire 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 switch position. The switch terminals are marked as shown in Figure 31. The circuitry of the 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).

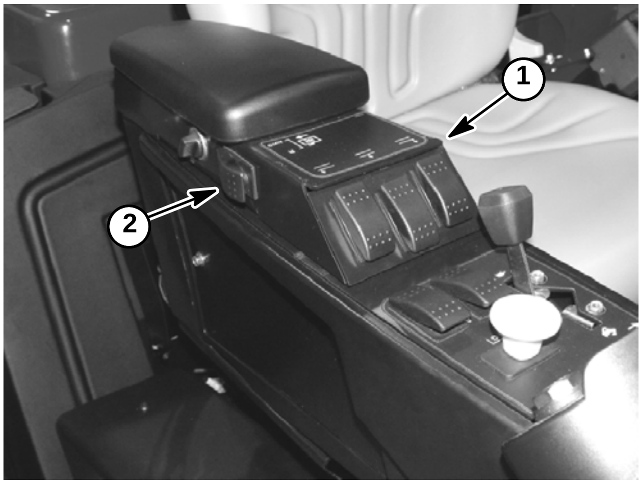


Figure 30

1. Console arm
2. Cooling fan switch

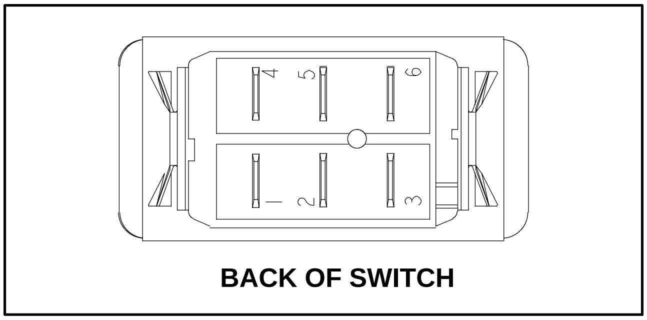


Figure 31

NOTE: Only cooling fan switch terminals 1 and 2 are used on Groundsmaster 4100–D and 4110–D machines.

Electrical System

Seat Switch

The seat switch is normally open and closes when the operator is occupying 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. 32).

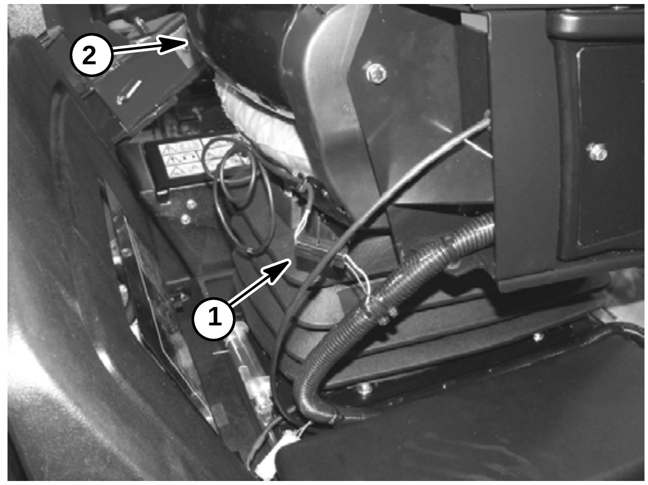


Figure 32

1. **Seat switch electrical connector**
2. **Operator seat**

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.

Parking Brake Switch

The switch used for the parking brake is a normally open switch that is located under the steering tower cover (Fig. 33). 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 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 steering tower components (see Steering Tower Assembly in the Service and Repairs section of Chapter 7 – Chassis).

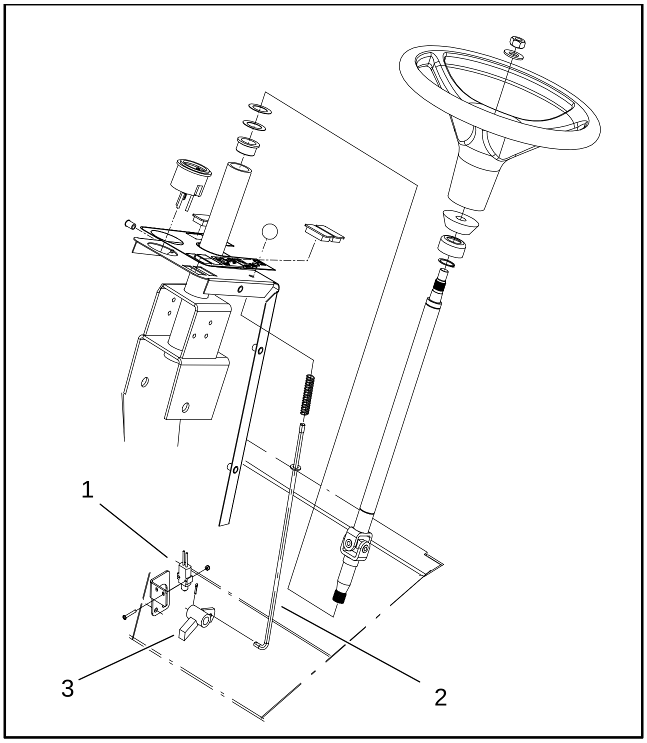


Figure 33

1. **Parking brake switch**
2. **Parking brake rod**
3. **Parking brake pawl**

Main Power, Glow and Cab Power (Groundsmaster 4110-D) Relays

The main power, glow and cab power relays are located at the power center behind the operator seat (Fig. 34). The wire harness is attached to these relays with a four (4) wire connector (Fig. 35).

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 cab power relay on Groundsmaster 4110-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 deck, 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.

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 from the measured value of the component you are 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. Replace relay if necessary.

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.

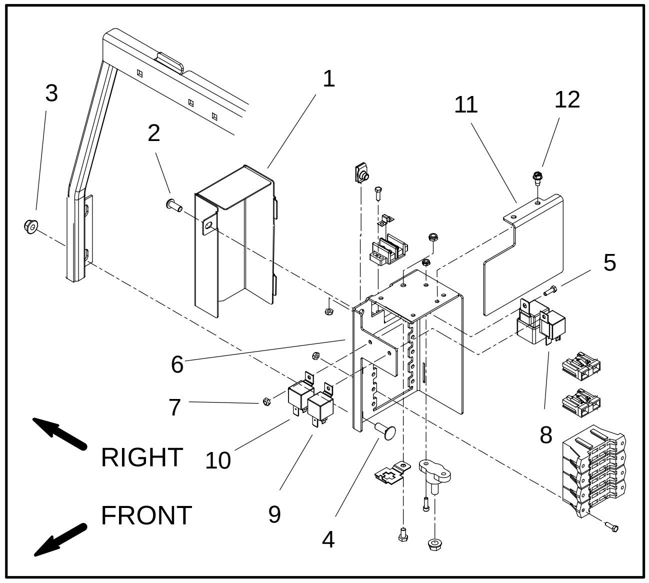


Figure 34

1. **Cover**
2. **Screw**
3. **Flange nut (2 used)**
4. **Carriage screw (2 used)**
5. **Screw**
6. **Mount**
7. **Lock nut**
8. **Main power relay**
9. **Glow relay**
10. **Cab power relay**
11. **Heat shield**
12. **Screw (2 used)**

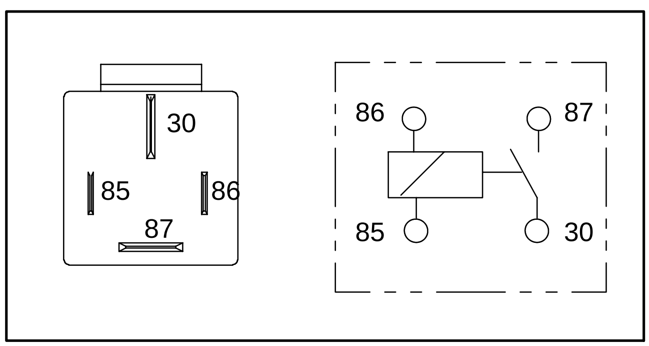


Figure 35

Start and Air Conditioning (Groundsmaster 4110–D) Relays

When energized by the TEC–5002 controller, the start relay is used to provide current to the engine starter motor solenoid. The TEC–5002 controls and monitors the operation of the start relay. The start relay is located at the power center behind the operator seat (Fig. 36).

An identical relay is used to control the air conditioning electrical power circuit on the Groundsmaster 4110–D. When energized by the air conditioning switch, the relay provides current for the air conditioning components. The relay is attached to the evaporator assembly in the cab headliner.

Testing

1. Park machine on a level surface, lower cutting deck, 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 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.

4. Disconnect wire harness connector from relay. Remove relay from mounting bracket for testing.

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 from the measured value of the component you are 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 terminals 30 and 87 should have continuity as +12 VDC is applied to terminal 85. The relay terminals 30 and 87 should not have continuity as +12 VDC is 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. With terminal 86 grounded, apply +12 VDC to terminal 85. The relay terminals 30 and 87A should not have continuity as +12 VDC is applied to terminal 85. The relay terminals 30 and 87A should have continuity as +12 VDC is removed from terminal 85.

9. Disconnect voltage and multimeter test leads from the relay terminals. Replace relay if necessary.

10. 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 9) to power center.

11. Connect positive (+) cable to battery and then connect negative (–) cable to battery (see Battery Service in the Service and Repairs section of this chapter).

12. Lower and secure hood.

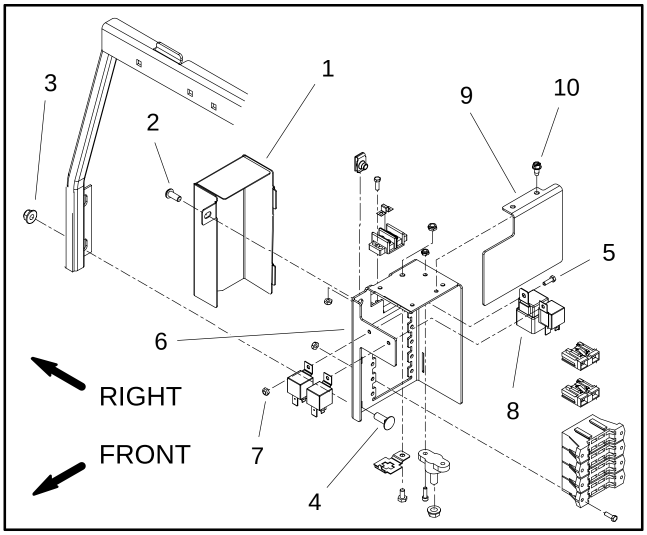


Figure 36

1. **Cover**
2. **Screw**
3. **Flange nut (2 used)**
4. **Carriage screw (2 used)**
5. **Screw**
6. **Mount**
7. **Lock nut**
8. **Start relay**
9. **Heat shield**
10. **Screw (2 used)**

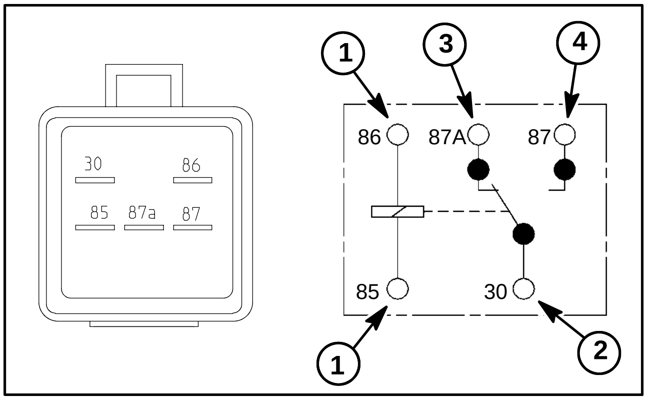


Figure 37

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

Hydraulic Valve Solenoid Coils

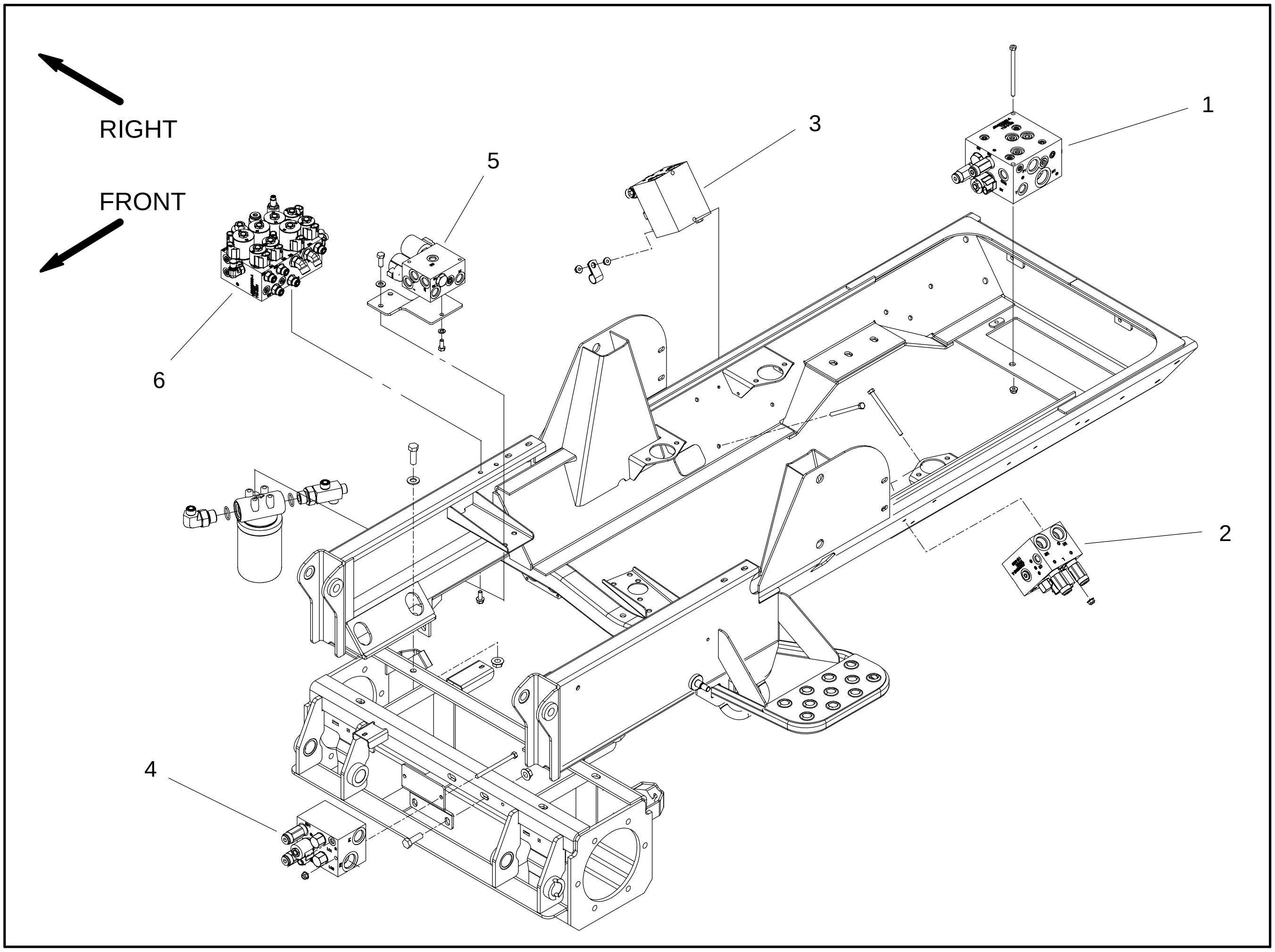


Figure 38

1. **4WD manifold**
2. **LH wing deck manifold**
3. **RH wing deck manifold**
4. **Front deck manifold**
5. **Fan drive manifold**
6. **Lift/lower manifold**

Several hydraulic solenoid valve coils are used on the hydraulic control manifolds of Groundsmaster 4100–D and 4110–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 4100–D and 4110–D. The correct resistance of a coil can be identified by measuring the height and diameter of the coil (Fig. 39). 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 deck, stop engine, engage parking brake and remove key from the ignition switch.

2. Locate hydraulic valve solenoid coil to be tested (Fig. 38). Disconnect wire harness connector from coil.

3. Identify coil resistance specification by measuring the coil diameter and coil height (Fig. 39).

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 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 coil. The correct resistance for the solenoid coil is identified in the chart 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 68ºF (20ºC). 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 coil:

   A. Remove nut securing solenoid coil to the cartridge valve. Carefully slide solenoid coil 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 coil.

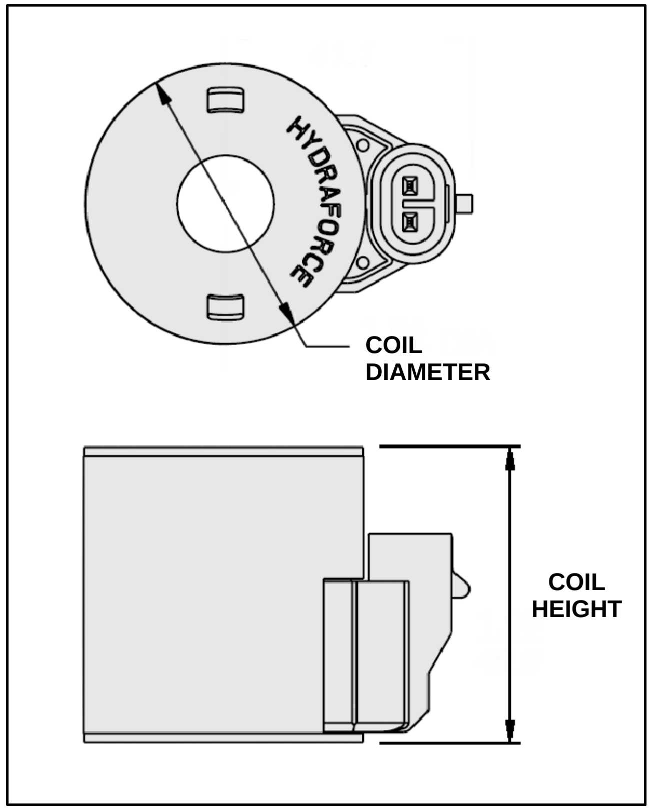


Figure 39

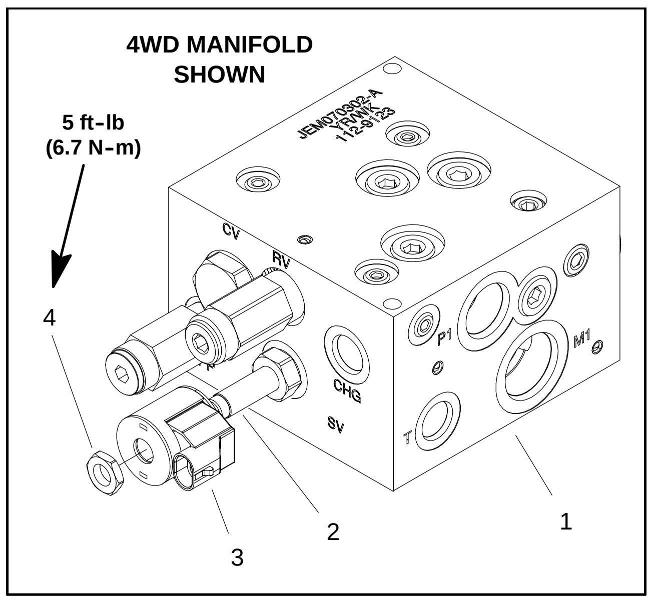


Figure 40

1. Hydraulic manifold
2. Cartridge valve
3. Solenoid coil
4. Nut

Toro Electronic Controllers (TEC)

Groundsmaster 4100–D and 4110–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 (Fig. 41).

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, Hi/Low speed switch, hydraulic temperature sender, engine coolant temperature sender and engine cooling fan switch. The TEC–5002 also monitors the optional flow divider and cruise control switches if the machine is equipped with those options.

The TEC–5002 master controller controls electrical output to the 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 and hydraulic traction manifold solenoid coil (Hi/Low speed). The TEC–5002 also controls the optional hydraulic 4WD manifold solenoid coil (flow divider) and cruise control coil if the machine is equipped with those options. 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 wing deck position switches.

The TEC–5001 slave 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).

IMPORTANT: Before performing welding on the machine, disconnect both negative and positive 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.

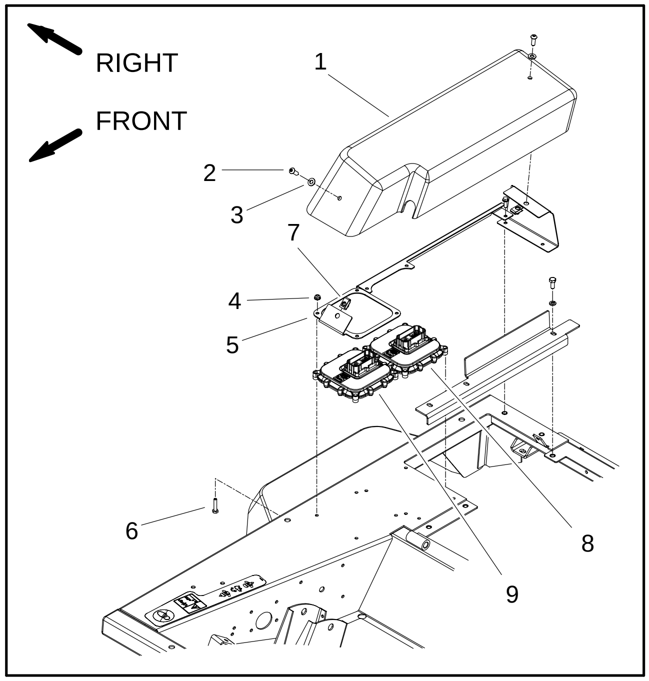


Figure 41

1. **Controller cover**
2. **Screw (2 used)**
3. **Flat washer (2 used)**
4. **Flange nut (8 used)**
5. **Front cover mount**
6. **Cap screw (8 used)**
7. **U–nut (2 used)**
8. **TEC–5001**
9. **TEC–5002**

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. 42).

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 minutes.

6. Disconnect voltage source from the hour meter. Reconnect harness connector to meter.

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

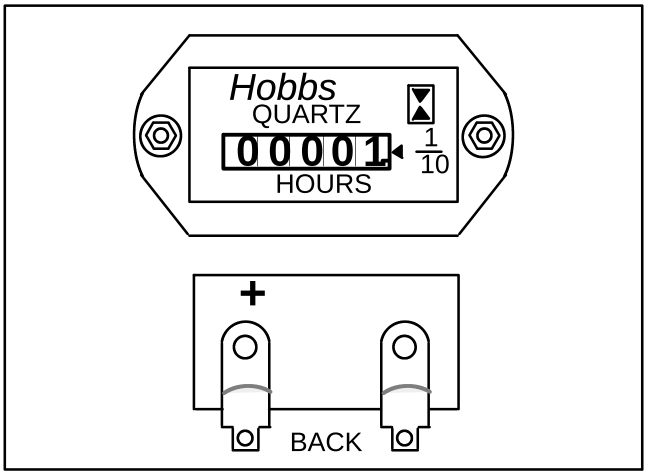


Figure 42

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. 43).

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).

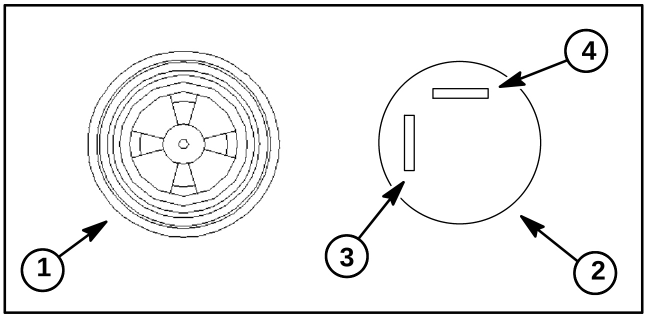


Figure 43

1. **Top view**
2. **Bottom view**
3. **Positive (+) terminal**
4. **Negative (-) terminal**

Fuel Sender

The fuel sender is located on top of the fuel tank (Fig. 44).

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 sender to the fuel tank.

5. Remove sender and gasket from the fuel tank. Clean any 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 (usually 0.5 ohms or less). 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 tank to prevent an explosion or fire from sparks.

6. Check resistance of the sender with a multimeter (Fig. 45).

A. Resistance with the float in the full position should be 27.5 to 39.5 ohms.

B. Resistance with the float in the empty position should be 240 to 260 ohms.

7. Replace sender as necessary. Reinstall sender into fuel tank.

8. Connect wires to fuel sender. Apply skin–over grease (see Special Tools in this chapter) to sender terminals.

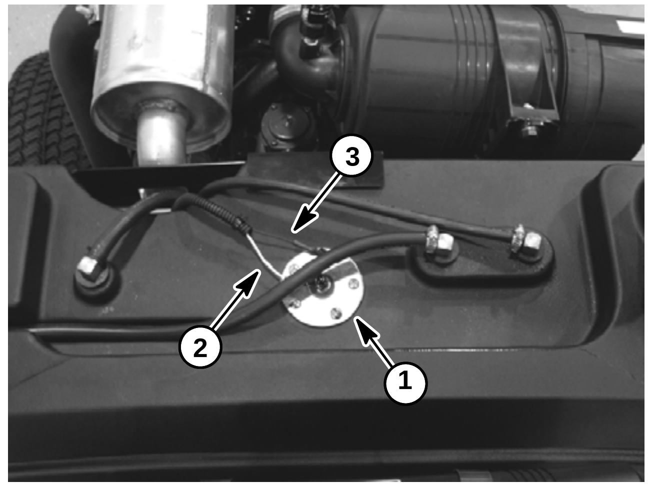


Figure 44

1. **Fuel sender**
2. **White (+) lead**
3. **Black (–) lead**

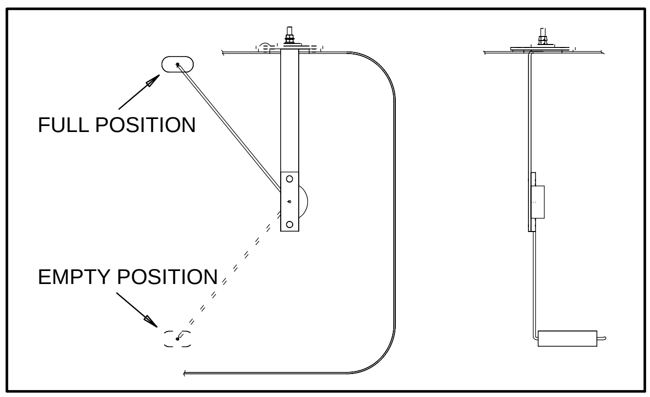


Figure 45

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 (see Fuel Sender Testing in this section for additional information).

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. 46).

NOTE: When reading the gauge test point, there are two white dots on the gauge face below the edge of the glass cover for each test point. For each variable resistance setting, the needle must be pointed between the two white dots.

4. Take test point readings (Fig. 47).

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 ± 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).

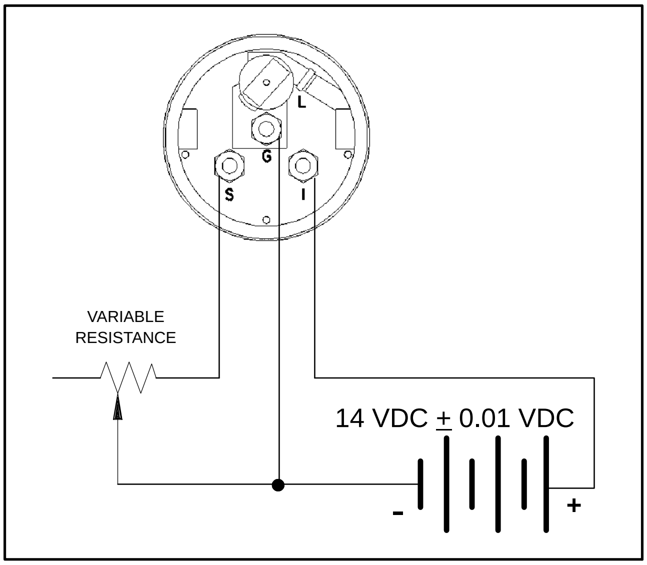


Figure 46

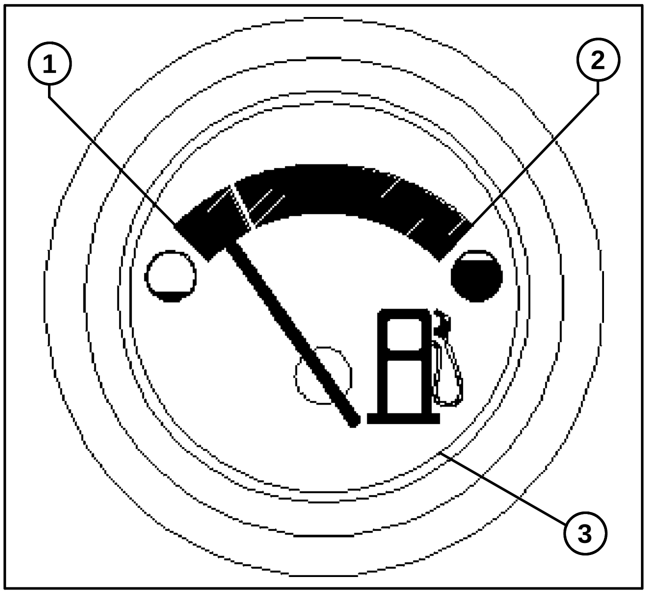


Figure 47

1. **Empty position**
2. **Full position**
3. **Glass face edge**

Electrical System

Fuel Pump

The fuel pump is attached to the frame above the fuel water separator (Fig. 48).

Operational Test

1. Park machine on a level surface, lower cutting deck, stop engine and apply parking brake. Raise and support hood.

2. Remove fuse F1–1 (20A) (Fig. 49) 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 (20A) into fuse block.

10. Prime fuel system.

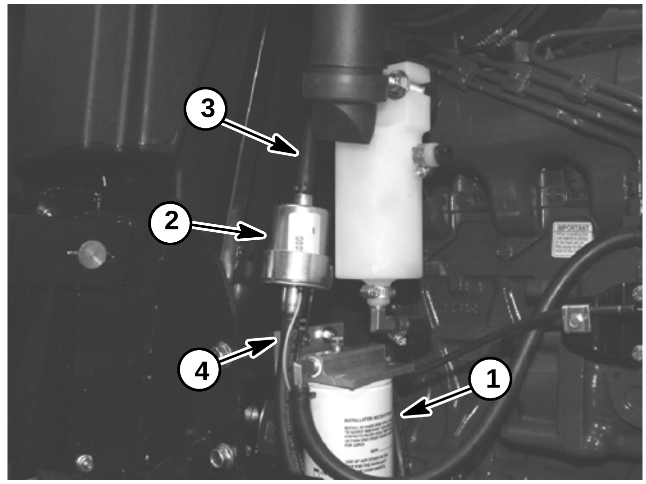


Figure 48

1. **Fuel water separator**
2. **Fuel pump**
3. **Pump inlet hose**
4. **Pump discharge hose**

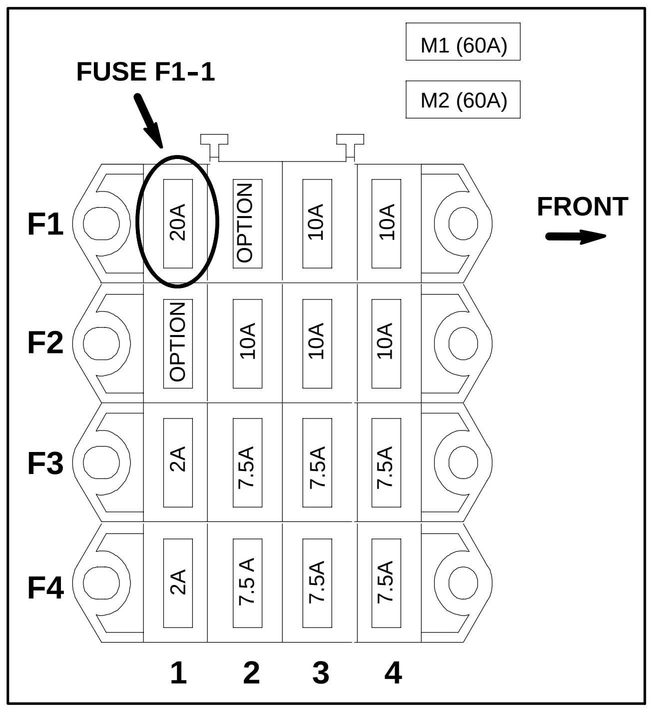


Figure 49

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. 50). The resistance of the temperature sender reduces as the engine coolant temperature increases. There is a gray harness wire attached to the switch.

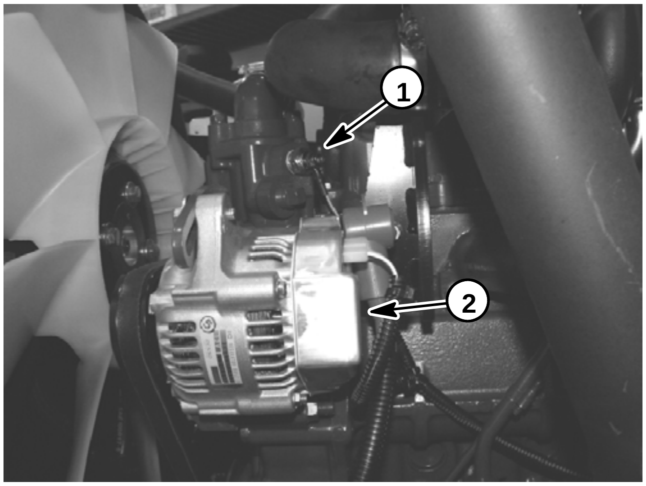


Figure 50

1. **Temperature sender** 2. **Alternator**

Testing

1. Lower coolant level in the engine, disconnect gray harness wire from temperature sender 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. 51).

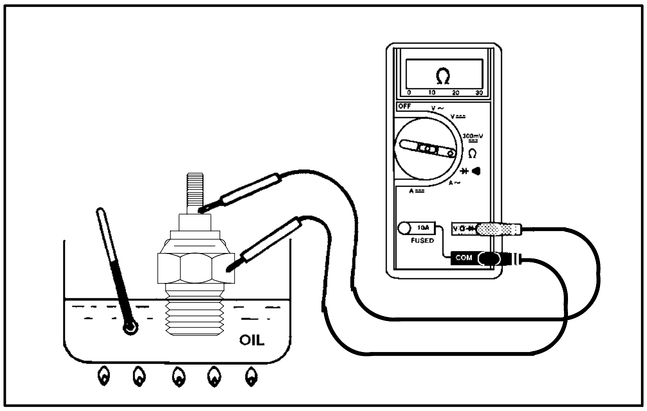


Figure 51

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 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^{o}F (38^{o}C)	460 ohms (approximate)
160^{o}F (71^{o}C)	140 ohms (approximate)
200^{o}F (93^{o}C)	54 to 78 ohms
221^{o}F (105^{o}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.

Temperature Gauge

The temperature gauge on the control panel indicates engine coolant temperature level during machine operation (Fig. 52). 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^{o}F (100^{o}C).

When engine coolant temperature rises to approximately 221^{o}F (105^{o}C), the temperature gauge should display the first red segment.

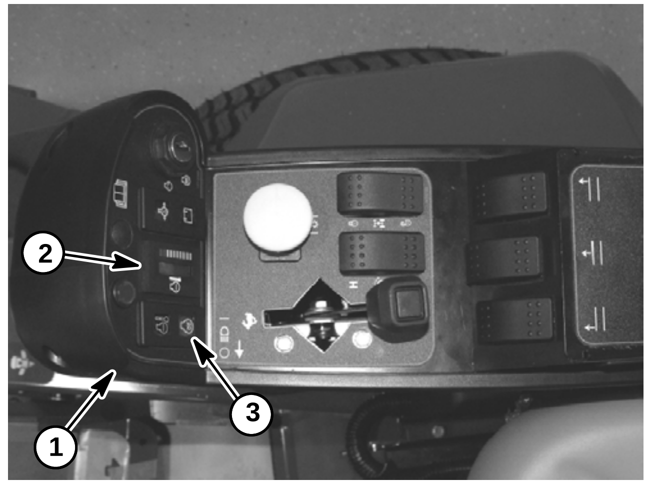


Figure 52

1. **Console arm**
2. **Temperature gauge**
3. **High temp indicator**

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. 53).

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 wires from the switch terminals 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 (low resistance). Allow the traction pedal to return to the neutral position. There should be continuity (low 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 disassembly and assembly procedures for the traction neutral switch.

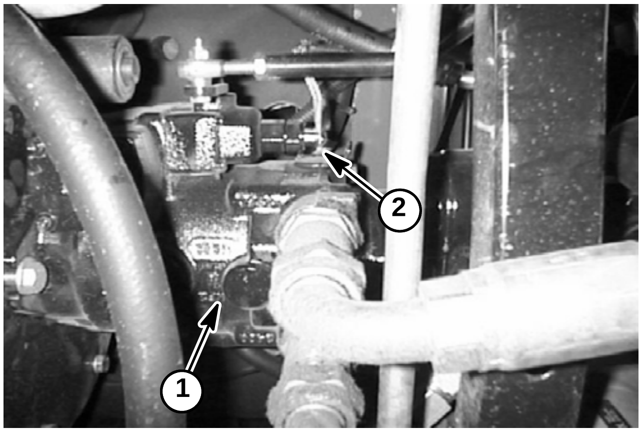


Figure 53

1. **Piston pump (bottom)**
2. **Neutral switch**

Electrical System

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 wire 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 chart to the right.

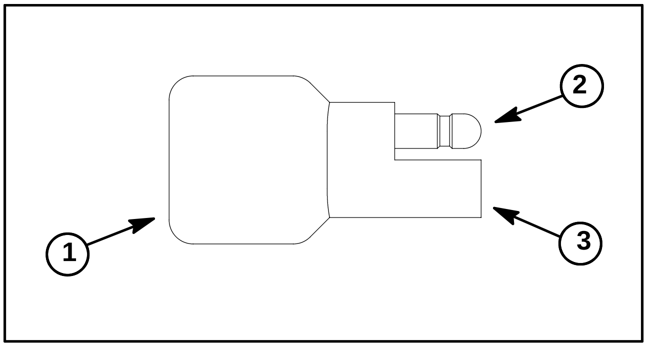


Figure 54

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

Wing Deck Position Switches

Two (2) wing deck position switches are used on the Groundsmaster 4100–D and 4110–D as inputs for the TEC–5001 controller. The position switches are powered proximity switches that are normally open. The switches incorporate an internal reed switch and a LED. These switches are secured to the center section of the cutting deck (Fig. 55). A bolt head on the wing deck link is the sensing plate for the position switch (Fig. 56).

When a wing deck is lowered, the bolt head on the wing deck link is positioned close to the position switch causing the switch to close. The closed switch provides an input for the TEC–5001 controller to allow wing deck operation. When a wing deck is raised, the bolt head on the wing deck link is moved away from the position switch so the switch is in its normally open state. The open position switch prevents wing deck operation when the wing deck is raised.

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 deck (including wing decks), stop engine and apply parking brake. Remove switch cover from deck to allow access to switch that requires testing (Fig. 55).

3. Turn ignition switch to the ON position (do not start engine) and check LED on cable end of position switches. LED **should be** illuminated when the wing decks are fully lowered.

4. Start engine, fully raise wing 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. LED **should not be** illuminated when the wing decks are fully raised.

5. Lower wing decks and then stop engine.

6. If a position switch LED did not function correctly:

   A. Make sure that ignition switch is OFF and disconnect the switch connector from deck wire harness.

   B. Using a multimeter, verify that wire harness connector terminal for pink wire has 12 VDC when the ignition switch is ON.

   C. Make sure that gap between end of position switch and bolt head on wing deck link when the wing deck is lowered is from 0.070” to 0.130” (1.8 to 3.3 mm) (Fig. 56).

   D. If pink wire has system voltage present and gap is correct but switch LED did not function, replace position switch.

7. After testing is complete, make sure that switch connector is plugged into deck wire harness. Install switch cover to deck.

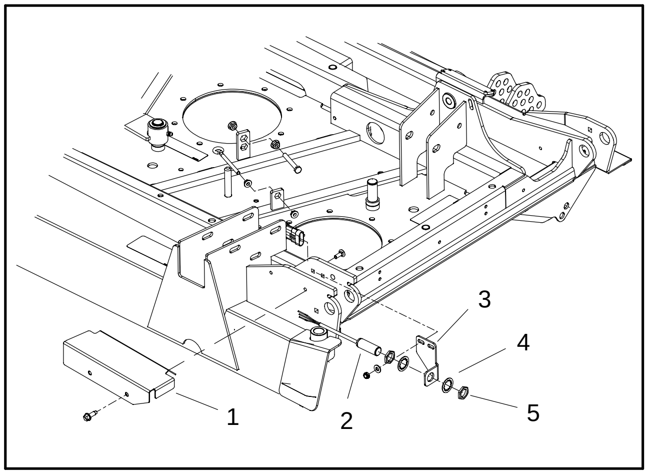


Figure 55

1. **Switch cover**
2. **Position switch**
3. **Switch bracket**
4. **Lock washer (2 used)**
5. **Jam nut (2 used)**

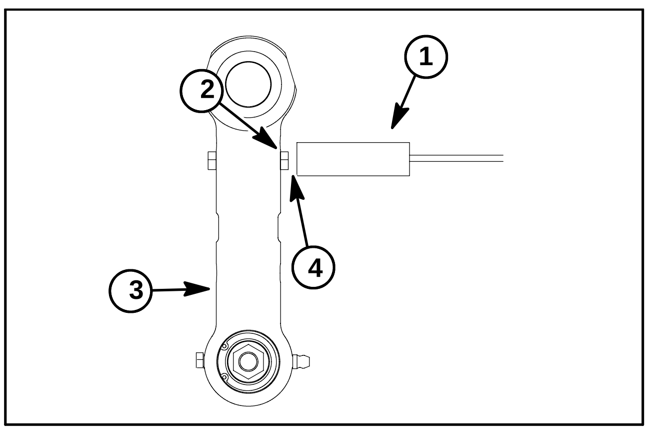


Figure 56

1. **Position switch**
2. **Bolt head**
3. **Wing deck link**
4. **Gap location**

Engine Coolant and Hydraulic Oil Temperature Senders

The Groundsmaster 4100–D and 4110–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. 57). The hydraulic oil temperature sender is attached to the hydraulic hydraulic tube on the left side of the machine (Fig. 58).

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. 59).

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 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.

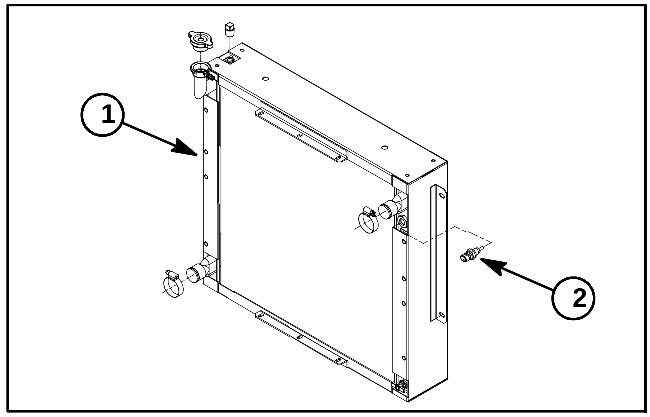


Figure 57

1. **Radiator**
2. **Coolant temp sender**

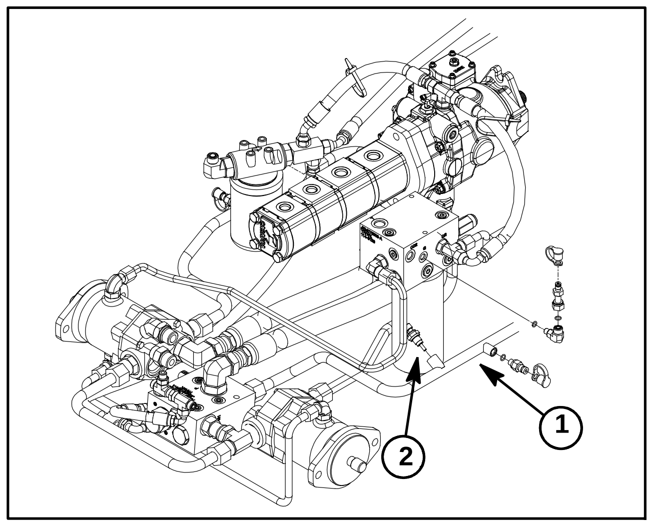


Figure 58

1. **Hydraulic tube**
2. **Oil temp sender**

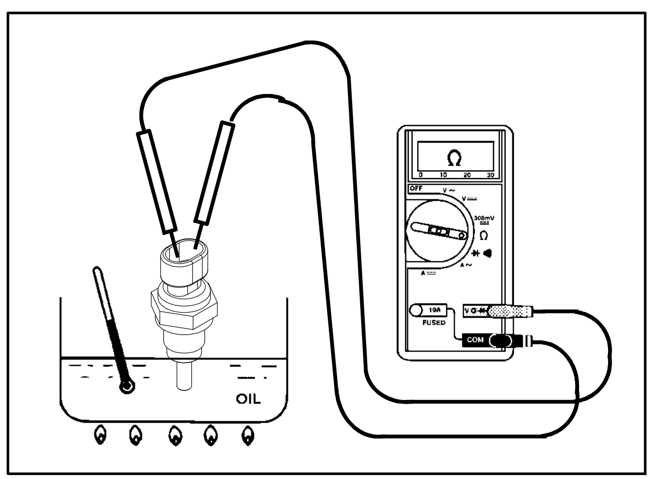


Figure 59

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.

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 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.

WARNING

Wear safety goggles and rubber gloves when working with electrolyte. Charge battery in a well ventilated place so gasses produced while charging can dissipate. Since the gases are explosive, keep open flames and electrical sparks away from the battery; do not smoke. Nausea may result if the gases are inhaled. Unplug charger from electrical outlet before connecting or disconnecting charger leads to or from battery posts.

IMPORTANT: Do not remove fill caps 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 terminal protector (Toro Part No. 107–0392) or petroleum jelly to prevent corrosion.

3. Battery cables must be tight on terminals to provide good electrical contact.

WARNING

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

4. If corrosion occurs at terminals, disconnect cables. Always disconnect negative (–) cable first. Clean clamps and terminals separately. Connect cables with positive (+) cable first. Coat battery posts and cable connectors with 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 80ºF (27ºC)
Discharged: less than 1.240

Battery Specifications
BCI group size 34
690 CCA at 0º F (–18º C)
110 minutes reserve capacity at 80ºF (27ºC)

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. 60)

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.

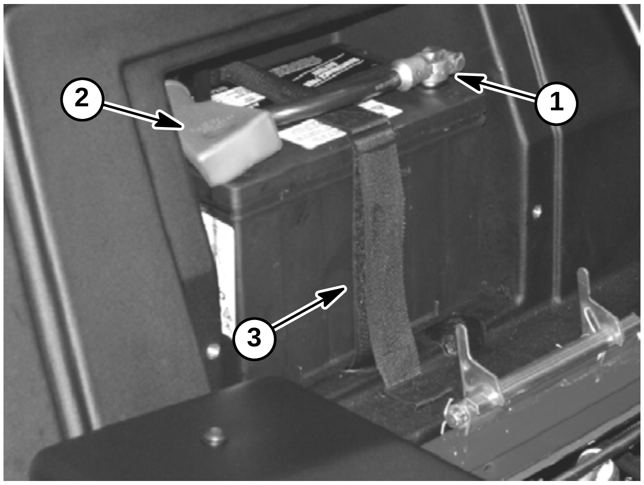


Figure 60

1. Negative (–) cable
2. Positive (+) cable
3. Battery strap

Battery Inspection, Maintenance and Testing

1. Perform following inspections and maintenance:

A. Check 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 15 minutes to allow sufficient mixing of the electrolyte.

Electrical System

2. Conduct a hydrometer test of the battery electrolyte.

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

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

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

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

C. If the difference between the highest and lowest cell specific gravity is 0.050 or greater or the lowest cell specific gravity is less than 1.225, charge the battery. Charge at the recommended rate and time given in **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.

3. 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 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 continuing with load testing procedure.

B. If the battery has recently been charged, apply a 150 amp load for 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 battery cold cranking amp rating) for 15 seconds.

G. Take a battery voltage reading at 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**	
9.6	70°F (and up)	21°C (and up)
9.5	60°F	16°C
9.4	50°F	10°C
9.3	40°F	4°C
9.1	30°F	–1°C
8.9	20°F	–7°C
8.7	10°F	–12°C
8.5	0°F	–18°C

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

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 locally.

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 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.

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Chapter 6

Axles, Planetaries and Brakes

Table of Contents

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 (136 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

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

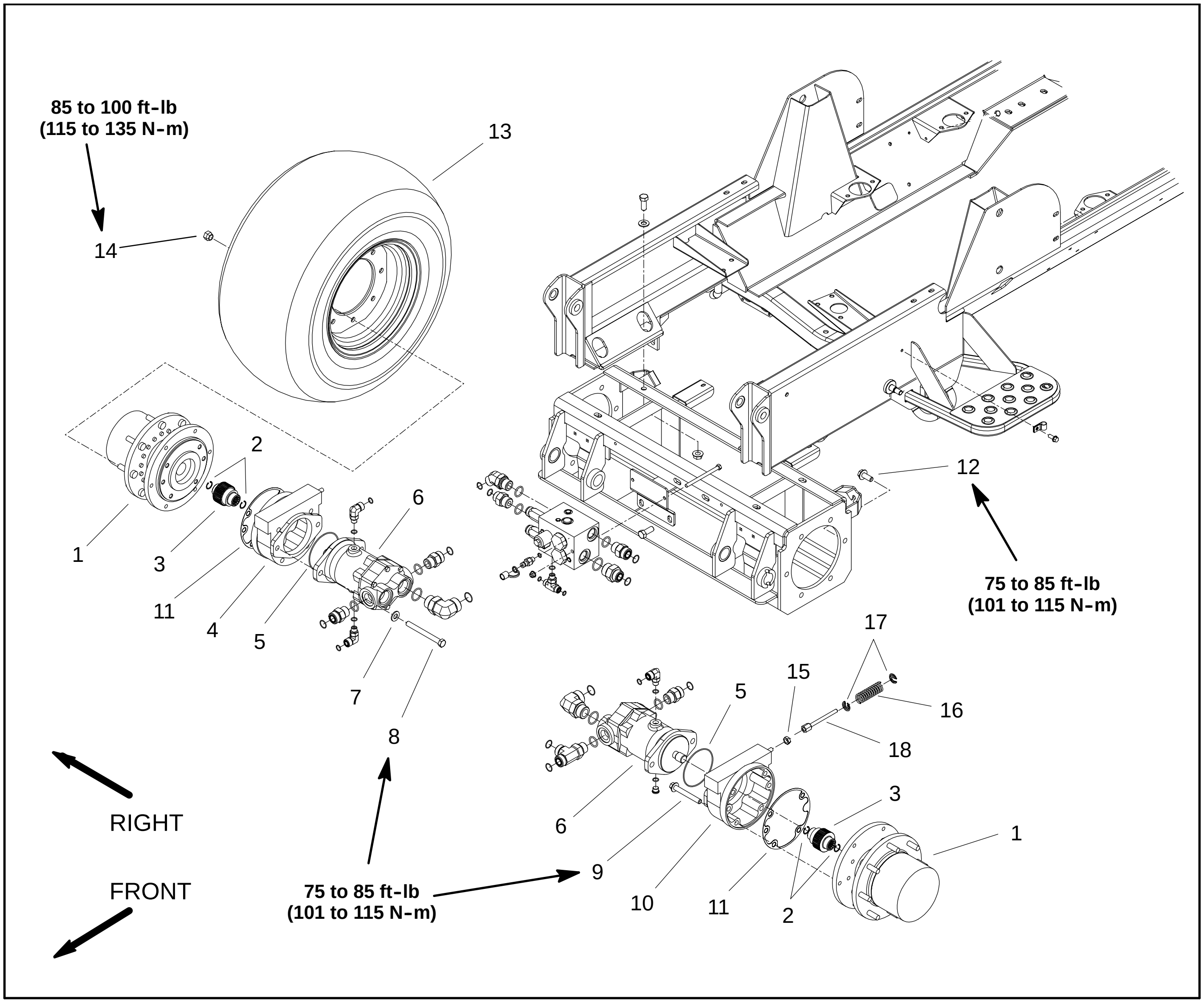

Figure 1

1. Planetary assembly
2. Retaining ring
3. Splined brake coupler
4. Brake assembly (RH)
5. O-ring
6. Hydraulic wheel motor
7. Flat washer
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. Tire and wheel assembly
14. Lug nut (8 used per wheel)
15. Jam nut
16. Compression spring
17. Spring plate
18. Brake link

Removal (Fig. 1)

1. Park machine on a level surface, lower cutting deck, 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. Tilt the cutting deck upright to allow front wheel removal (see Operator's Manual).

5. Remove front wheel assembly.

6. Remove hydraulic wheel motor (see Front Wheel Motors in the Service and Repairs section of Chapter 4 – Hydraulic System).

7. Disconnect brake link assembly from brake lever, frame bracket and pull rod on brake assembly (Fig. 2).

8. Support brake assembly to prevent it from falling.

9. Remove flange head cap screws (item 9) securing brake assembly to frame.

10. Remove brake assembly from machine. Be careful to not drop splined brake shaft (item 3) as brake assembly is removed.

11. Remove splined brake shaft from brake assembly.

12. Remove and discard gasket (item 11). Make sure that all gasket material is removed from both brake and planetary assemblies.

13. Complete brake inspection and repair (see Brake Inspection and Repair in this section).

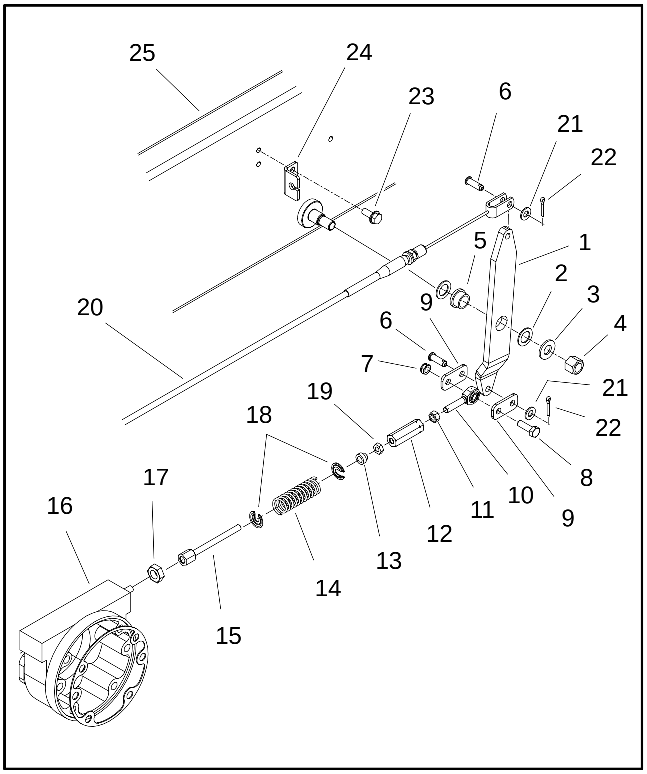

Figure 2

1. **Brake lever**
2. **Thrust washer (2 used)**
3. **Flat washer**
4. **Lock nut**
5. **Bushing**
6. **Clevis pin**
7. **Lock nut**
8. **Cap screw**
9. **Brake link**
10. **Rod end (LH thread)**
11. **Jam nut (LH thread)**
12. **Hex link**
13. **Flanged spacer**
14. **Compression spring**
15. **Brake link**
16. **Brake assembly**
17. **Jam nut**
18. **Spring plate**
19. **Jam nut**
20. **Brake cable**
21. **Flat washer**
22. **Cotter pin**
23. **Screw (2 used)**
24. **Cable bracket**
25. **Frame rail**

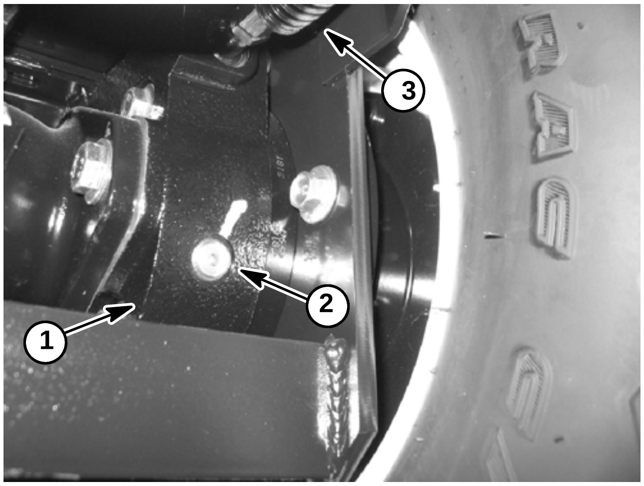

Figure 3

1. **Brake housing**
2. **Check plug**
3. **Brake link assembly**

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).

2. Apply gasket sealant to sealing surfaces of new gasket (item 11). Apply gasket to brake assembly.

3. Install brake assembly to 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 front wheel assembly.

8. Lower machine to ground. Torque wheel lug nuts from **85 to 100 ft-lb (115 to 135 N-m)**.

9. Pivot the cutting deck down (see Operator's Manual).

10. 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.

11. 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 in. (12.0 to 13.4 mm) from brake casting surface when brakes are disengaged (Fig. 5).

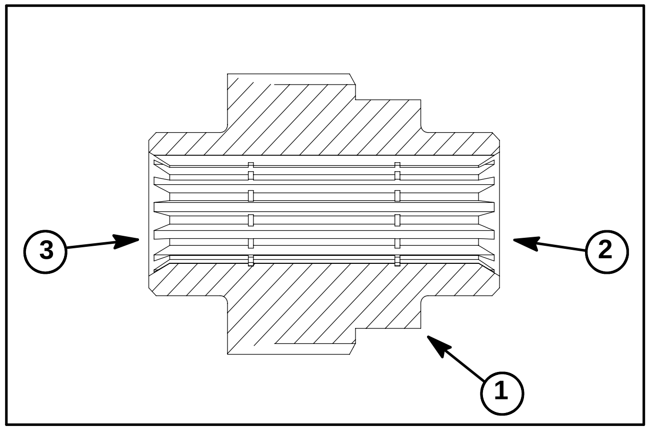

Figure 4

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

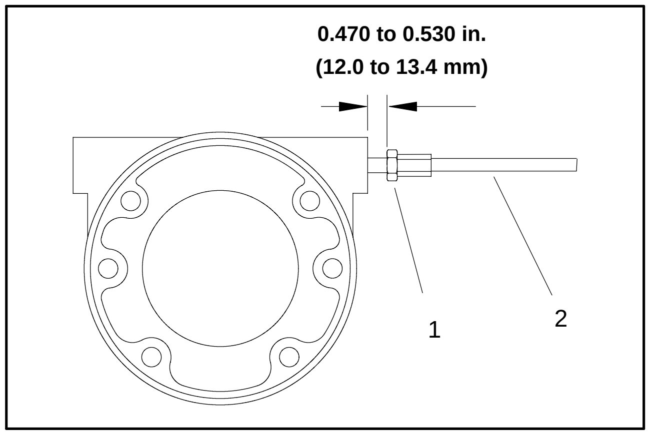

Figure 5

1. **Pull rod jam nut**
2. **Brake link**

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Brake Service

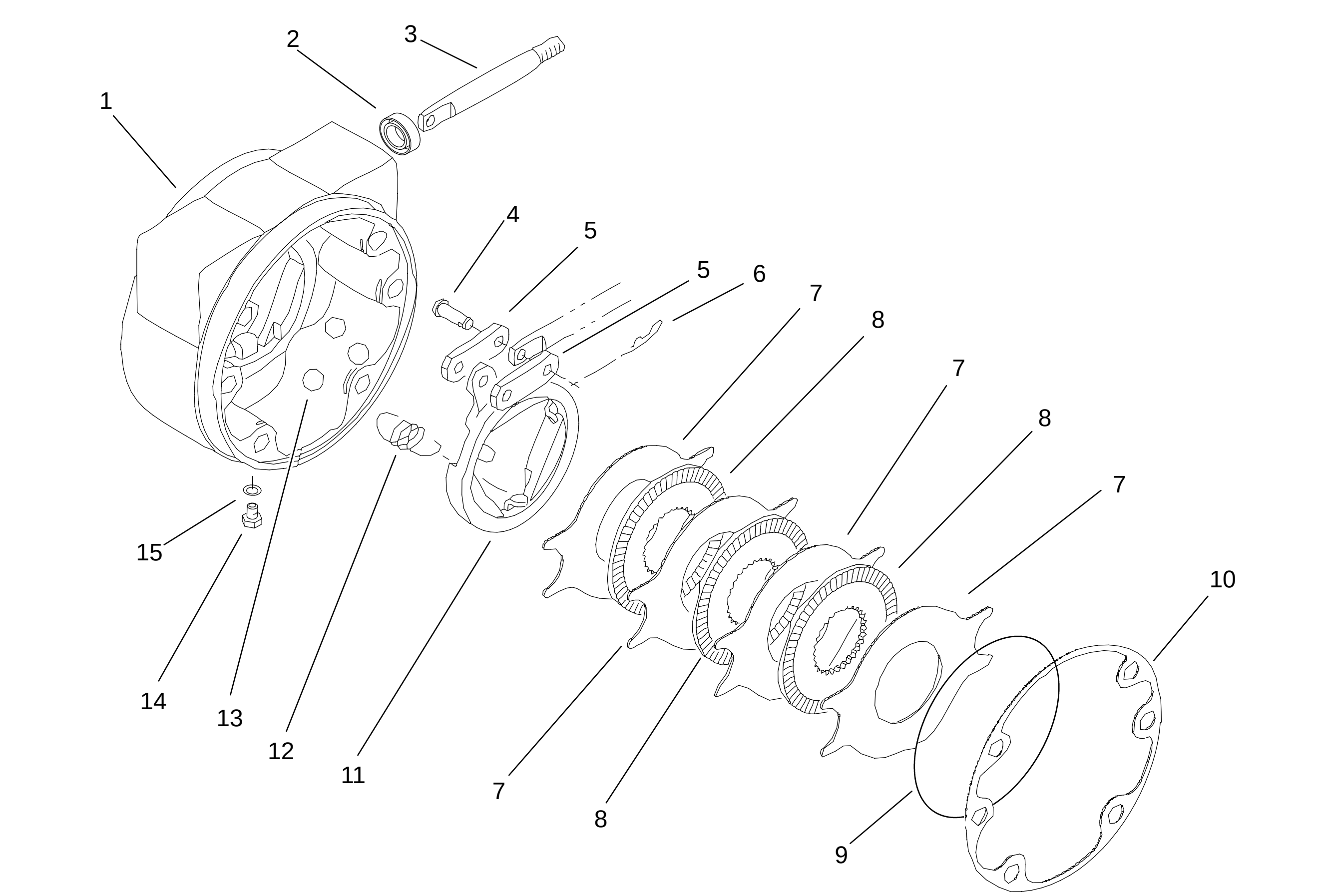

Figure 6

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	**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).

3. Remove four (4) stationary discs (item 7) and three (3) rotating discs (item 8).

4. Remove three (3) 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.

   A. The stack of four (4) stationary and three (3) rotating discs should have a minimum thickness of 0.440 in. (11.2 mm).

8. Reverse steps 2 – 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

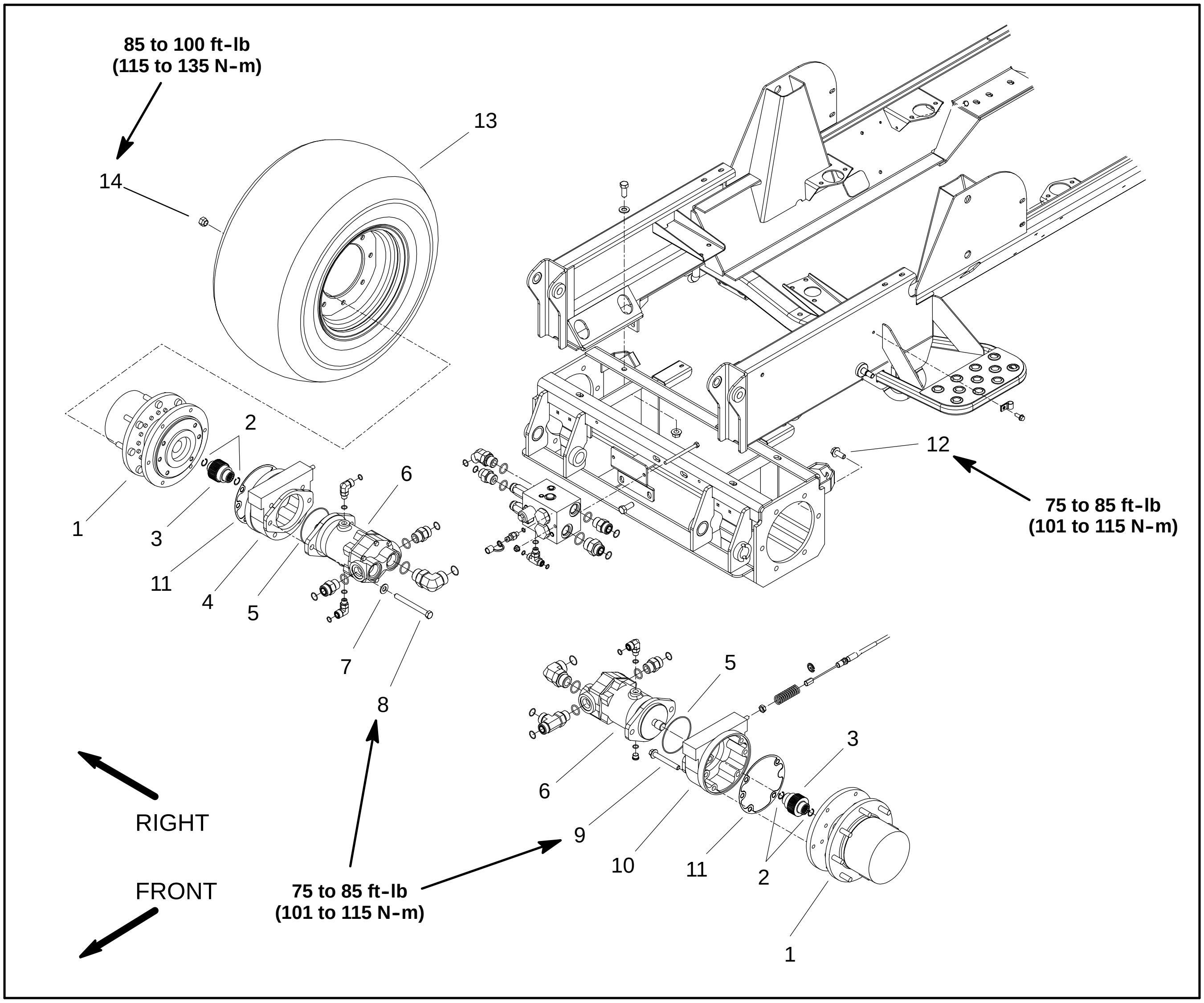

Figure 7

1. **Planetary assembly**
2. **Retaining ring**
3. **Splined brake coupler**
4. **Brake assembly (RH)**
5. **O-ring**
6. **Hydraulic wheel motor**
7. **Flat washer**
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. **Tire and wheel assembly**
14. **Lug nut (8 used per wheel)**

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 deck, stop engine, engage parking brake 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 suitable jack stands.

4. Tilt the cutting deck upright to allow front wheel removal (see Operator's Manual).

5. Remove front wheel assembly.

6. Remove four (4) flange head screws that secure brake assembly to planetary assembly (see Brake Assembly Removal in this Chapter).

7. Support hydraulic wheel motor to prevent it from falling. Remove two (2) cap screws that secure wheel motor to planetary assembly.

8. 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. Inspect gasket between brake and planetary assemblies. Replace as needed.

2. Position planetary assembly to machine. Install flange head screws that secure planetary assembly to frame. Torque screws from **75 to 85 ft–lb (101 to 115 N–m)**.

3. Secure brake assembly to planetary assembly with four (4) flange head screws (see Brake Assembly Installation in this Chapter). Torque screws from **75 to 85 ft–lb (101 to 115 N–m)**.

4. Secure hydraulic wheel motor to planetary assembly with two (2) cap screws. Torque screws from **75 to 85 ft–lb (101 to 115 N–m)**.

5. Install front wheel assembly.

WARNING

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

6. Lower machine from jack stands. Torque wheel lug nuts from **85 to 100 ft–lb (115 to 135 N–m)**.

7. Pivot the cutting deck down (see Operator's Manual).

8. 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 l) per wheel.

9. Check for proper brake operation.

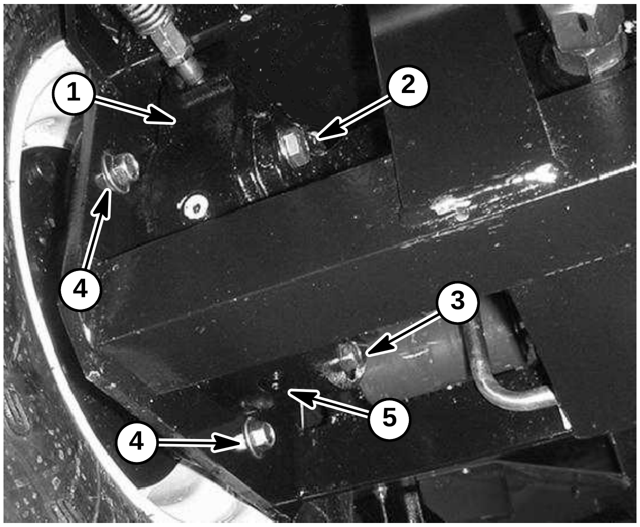

Figure 8

1. **Brake housing**
2. **Wheel motor cap screw**
3. **Brake flange screw**
4. **Planetary flange screw**
5. **Brake drain plug**

Planetary Wheel Drive Service

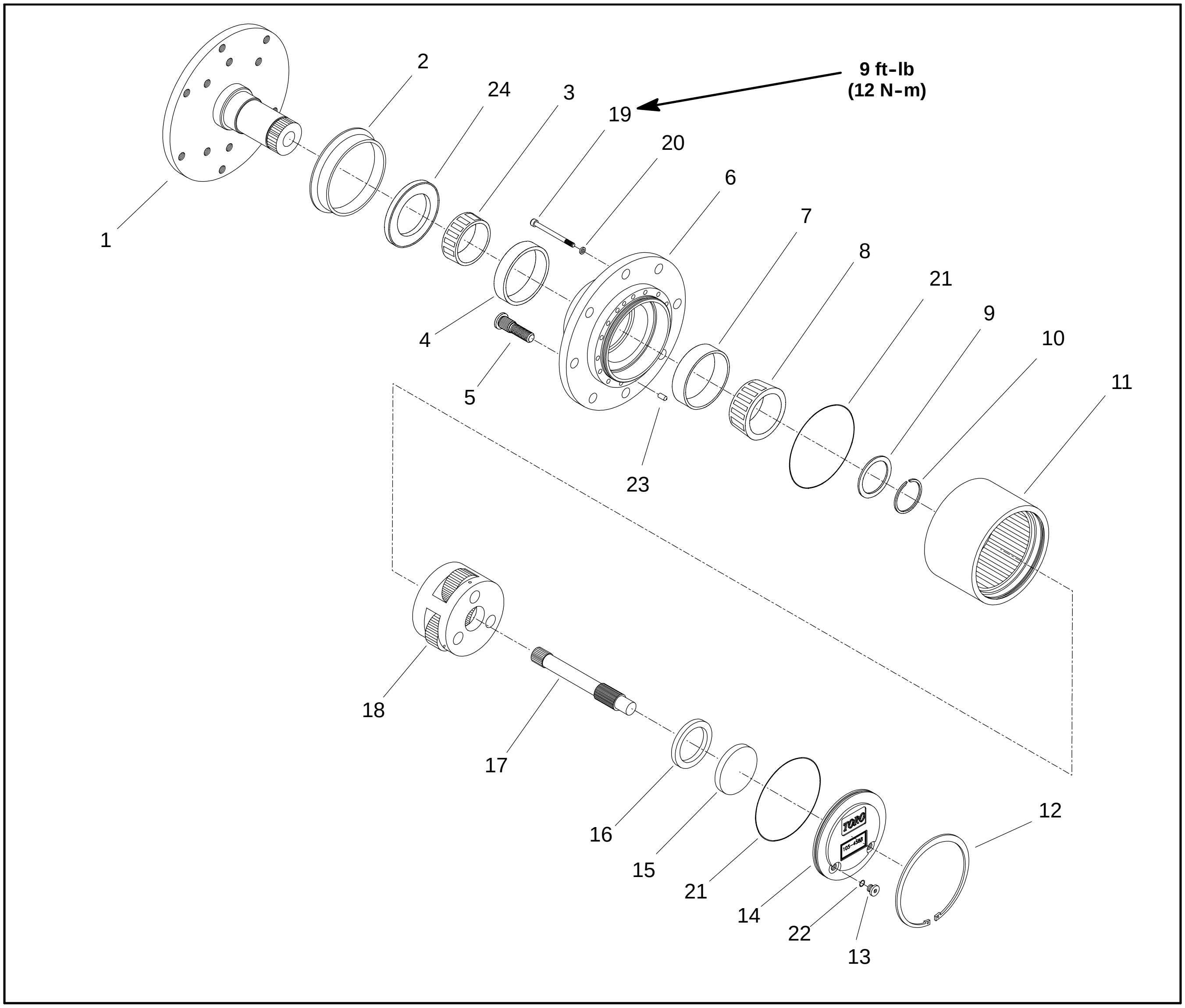

Figure 9

1. Spindle
2. Boot seal
3. Bearing cone
4. Bearing cup
5. Wheel stud (8 used)
6. Housing
7. Bearing cup
8. Bearing cone
9. Thrust washer
10. Retaining ring (external)
11. Ring gear
12. Retaining ring (internal)
13. Plug (2 used)
14. End cap
15. Thrust plug
16. Thrust washer
17. Drive shaft
18. Carrier assembly
19. Socket head screw (16 used)
20. Lock washer (16 used)
21. O-ring
22. O-ring
23. Dowel pin (2 used)
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 deck, 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. Tilt the cutting deck upright to allow front wheel removal (see Operator’s Manual).

   E. 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.

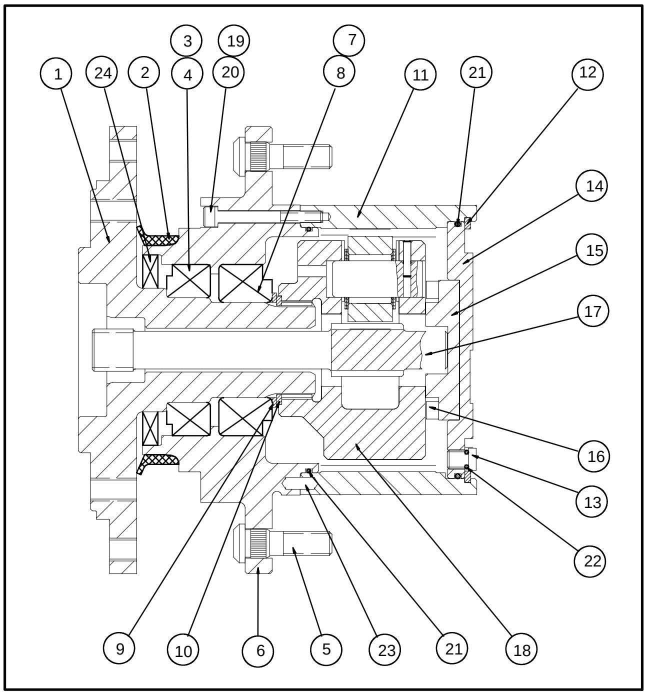

Figure 10

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. 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 front 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 wheel lug nuts from **85 to 100 ft-lb (115 to 135 N-m)**.

C. Pivot the cutting deck down (see Operator's Manual).

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.

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Axles, Planetaries and Brakes

Rear Axle Assembly

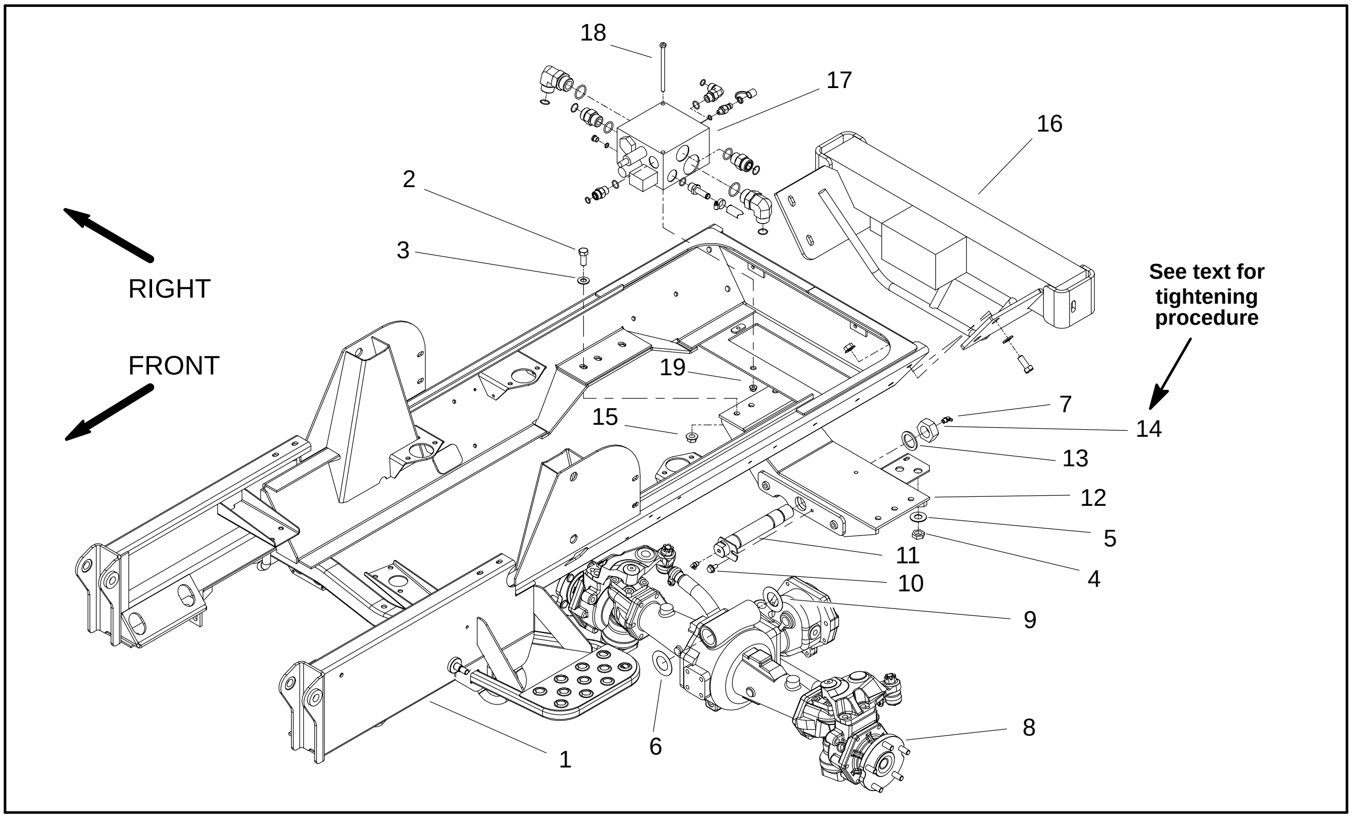

Figure 11

1. **Frame**
2. **Cap screw (6 used)**
3. **Flat washer**
4. **Bulkhead lock nut (2 used)**
5. **Washer**
6. **Thrust washer (thick)**
7. **Grease fitting (2 used)**
8. **Rear axle assembly**
9. **Thrust washer (thin)**
10. **Washer head screw**
11. **Pivot pin**
12. **Rear frame mount**
13. **Washer**
14. **Lock nut**
15. **Flange nut**
16. **Rear bumper**
17. **4WD manifold**
18. **Cap screw (2 used)**
19. **Flange nut (2 used)**

Removal (Fig. 11)

1. Park machine on a level surface, lower cutting deck, stop engine, engage 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 suitable 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 in the Service and Repairs section of Chapter 4 – Hydraulic System).

6. Remove steering cylinder from rear axle (see Steering Cylinder in the Service and Repairs section of Chapter 4 – Hydraulic System).

7. Disconnect both steering cylinder hydraulic hoses from hydraulic tubes at rear frame mount (Fig. 12). Remove bulkhead locknuts and washers that secure steering cylinder hydraulic tubes to rear frame mount. Separate tubes from frame mount.

8. Remove cap screw and flange nut that secures front corner of 4WD hydraulic manifold to rear frame mount.

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 frame mount to equipment frame. Lower rear axle and rear frame mount from machine.

11. Remove lock nut and washer from pivot pin that attaches rear axle to rear frame mount. Remove washer head screw that secures flange of pivot pin to frame mount (Fig. 14).

12. Remove pivot pin. Separate rear frame mount from rear axle. Note location of thrust washers on both ends of axle mounting boss.

Installation (Fig. 11)

1. Position rear frame mount to axle. Install thrust washers between axle boss and frame 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 in. (0.05 mm to 0.51 mm) clearance between rear frame mount and axle mounting boss. Add thrust washers if needed to adjust clearance.

2. Install axle pivot pin to secure axle to rear frame mount. Tighten lock nut and then loosen it slightly to allow the axle pin to pivot freely. Secure pivot pin to frame mount with washer head screw (Fig. 14).

3. If removed, install the tie rod to rear axle (Fig. 13). Tighten ball joint castle nuts and install new cotter pins.

4. Position axle and rear mount under machine with a jack. Raise assembly to machine frame and align mounting holes of rear mount and machine frame.

5. Secure rear mount to frame with six (6) cap screws, flat washers and flange nuts.

6. Install cap screw and flange nut that secures front corner of 4WD hydraulic manifold to rear frame mount.

7. Attach steering cylinder hydraulic tubes to rear frame mount with washers and bulkhead lock nuts (Fig. 12). Install steering cylinder hoses to hydraulic tubes.

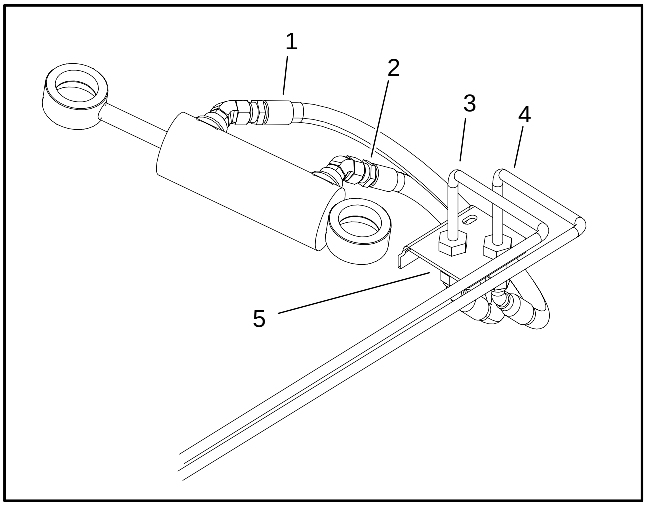

Figure 12

1. **Hydraulic hose**
2. **Hydraulic hose**
3. **Hydraulic tube**
4. **Hydraulic tube**
5. **Rear frame mount**

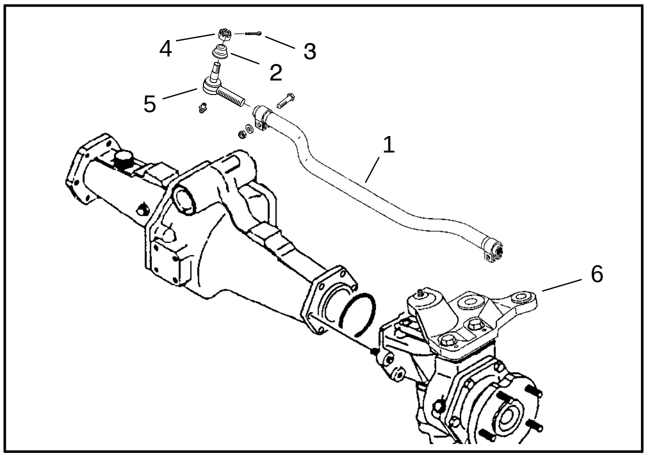

Figure 13

1. **Tie rod**
2. **Dust cover**
3. **Cotter pin**
4. **Castle nut**
5. **Tie rod end**
6. **Steering arm (LH)**

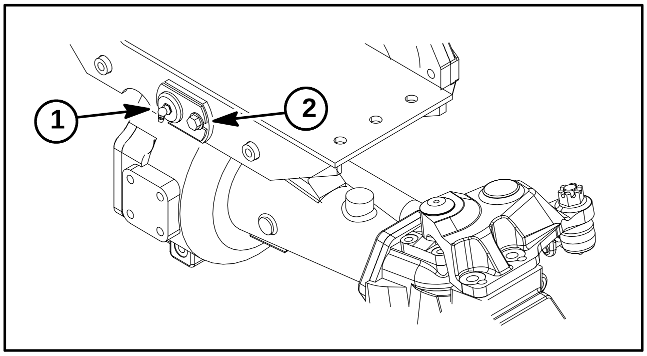

Figure 14

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).

10. Install wheels to rear axle.

WARNING

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

11. Lower machine to ground. Torque wheel lug nuts from **85 to 100 ft–lb (115 to 135 N–m)**.

12. Fill axle and input gearbox 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 in. (1.6 mm) should exist between bevel gear case casting and stop bolt on left axle case. Figure 15 shows stop bolt location.

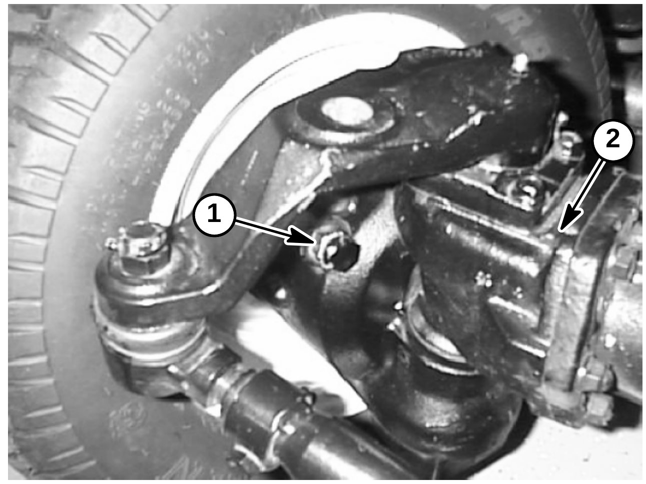

Figure 15

1. **Steering stop bolt**
2. **Bevel gear case (LH)**

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Rear Axle Service

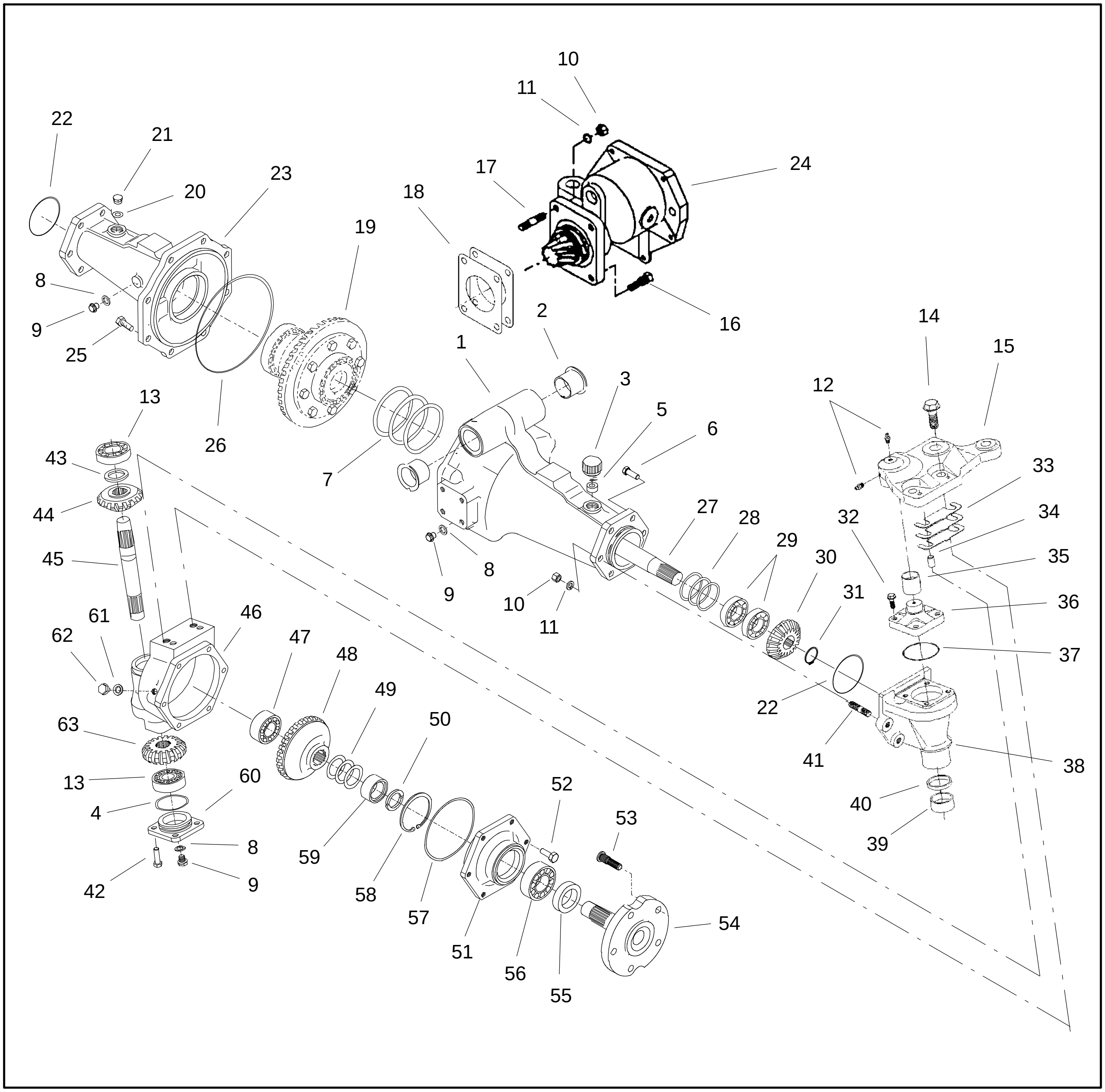

Figure 16

Figure 16 (Continued)

1. **LH axle support**
2. **Flange bushing (2 used)**
3. **Axle vent**
4. **O–ring**
5. **Vent extension**
6. **Cap screw (4 used per gear case)**
7. **Shim set**
8. **Seal washer**
9. **Plug**
10. **Lock nut**
11. **Lock washer**
12. **Grease fitting**
13. **Ball bearing**
14. **Screw (2 used per steering arm)**
15. **Axle case support (LH shown)**
16. **Bolt (2 used)**
17. **Stud (2 used)**
18. **Shim set**
19. **Differential assembly**
20. **O–ring**
21. **Plug**
22. **O–ring**
23. **RH axle support**
24. **Input shaft assembly**
25. **Bolt (8 used)**
26. **O–ring**
27. **Differential shaft (LH shown)**
28. **Shim set**
29. **Ball bearing**
30. **Bevel gear (15 tooth)**
31. **Retaining ring**
32. **Bolt (4 used per knuckle)**
33. **Shim set**
34. **Dowel pin (2 used per axle case)**
35. **Bushing**
36. **Knuckle pin**
37. **O–ring**
38. **Bevel gear case (LH shown)**
39. **Bushing**
40. **Shaft seal**
41. **Stud (2 used per gear case)**
42. **Bolt (4 used per cover)**
43. **Collar**
44. **Bevel gear (17 tooth)**
45. **Bevel gear shaft**
46. **Axle case (LH shown)**
47. **Ball bearing**
48. **Bevel gear (29 tooth)**
49. **Shim set**
50. **Clip (2 used per axle case)**
51. **Axle cover**
52. **Screw (6 used per cover)**
53. **Wheel stud (5 used per axle)**
54. **Axle**
55. **Oil seal**
56. **Ball bearing**
57. **O–ring**
58. **Retaining ring**
59. **Spacer**
60. **Axle case cover**
61. **Seal washer**
62. **Plug**
63. **Bevel gear (17 tooth)**

NOTE: Figure 16 illustrates the rear axle used on the Groundsmaster 4100–D and 4110–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 (see Rear Axle Assembly Removal in this section).

Bevel Gear Case and Axle Case 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.

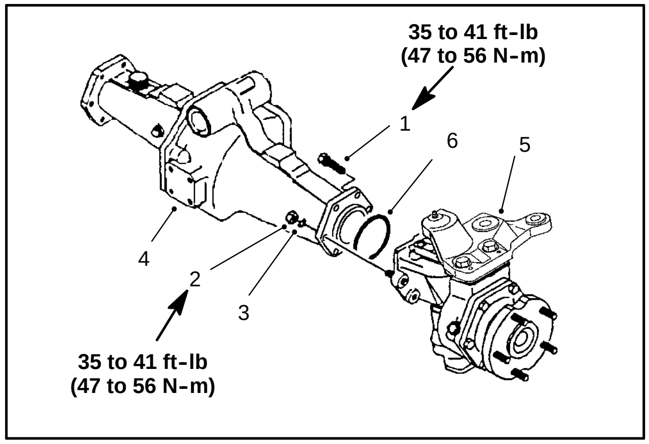

Figure 17

1. **Cap screw (4 used)**
2. **Lock nut (2 used)**
3. **Lock washer (2 used)**
4. **Axle support**
5. **Bevel gear case/axle case assembly**
6. **O-ring**

3. Remove the axle cover mounting screws. Remove the axle cover from the axle case as an assembly (Fig. 18).

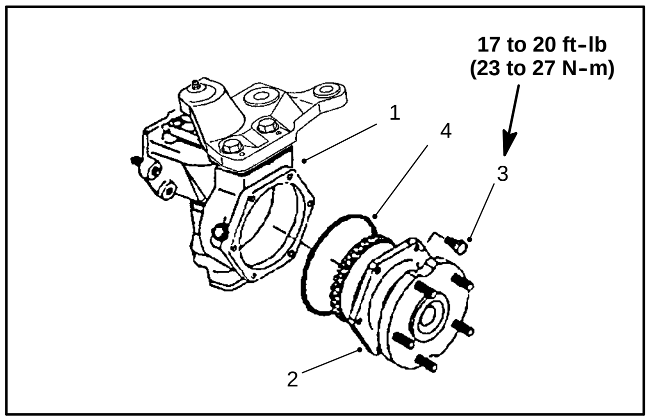

Figure 18

1. **Axle case**
2. **Axle cover assembly**
3. **Mounting screw (6 used)**
4. **O-ring**

4. Remove the axle case support mounting screws, the axle case support and the support shims (Fig. 19).

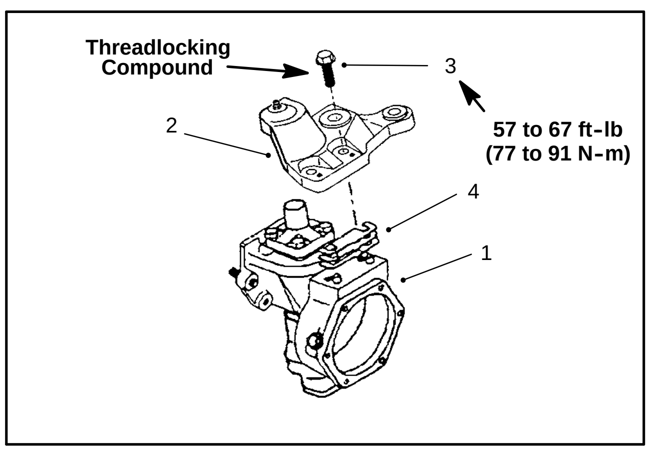

Figure 19

1. **Axle case**
2. **Axle case support**
3. **Mounting screw (2 used)**
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).

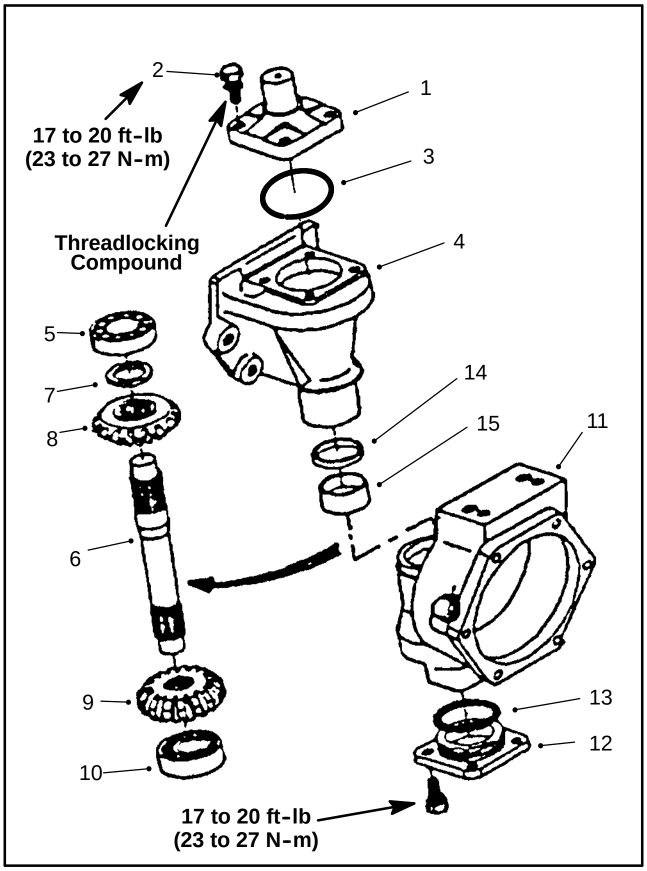

Figure 20

1. **Knuckle pin**
2. **Mounting screw (4 used)**
3. **O-ring**
4. **Bevel gear case**
5. **Upper bearing**
6. **Bevel gear shaft**
7. **Collar**
8. **Upper bevel gear**
9. **Lower bevel gear**
10. **Lower bearing**
11. **Axle case**
12. **Axle case cover**
13. **O-ring**
14. **Shaft seal**
15. **Bushing**

Bevel Gear Case and Axle Case 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.

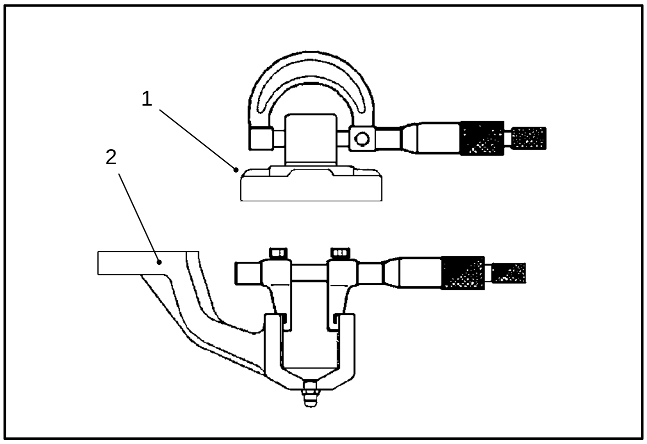

Figure 21

1. **Knuckle pin**
2. **Axle case support**

Axles, Planetaries and Brakes

Bevel Gear Case and Axle Case Installation

1. Coat new shaft seal with grease and install in axle case as shown (Fig. 22).

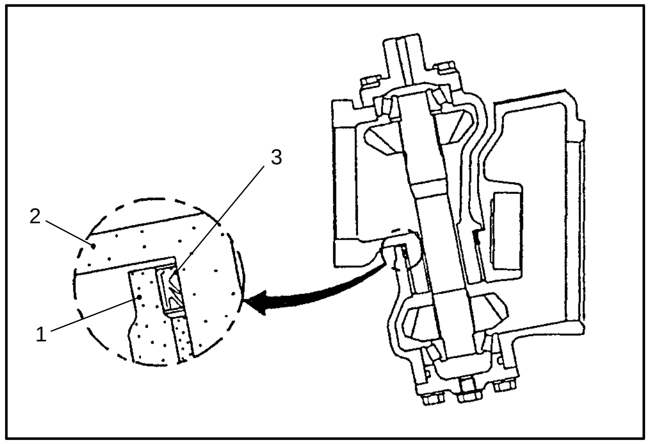

Figure 22

1. **Axle case**
2. **Bevel gear case**
3. **Shaft seal**

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). Torque 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 Loctite thread locker and torque the knuckle pin mounting screws from **17 to 20 ft-lb (23 to 27 N–m)**.

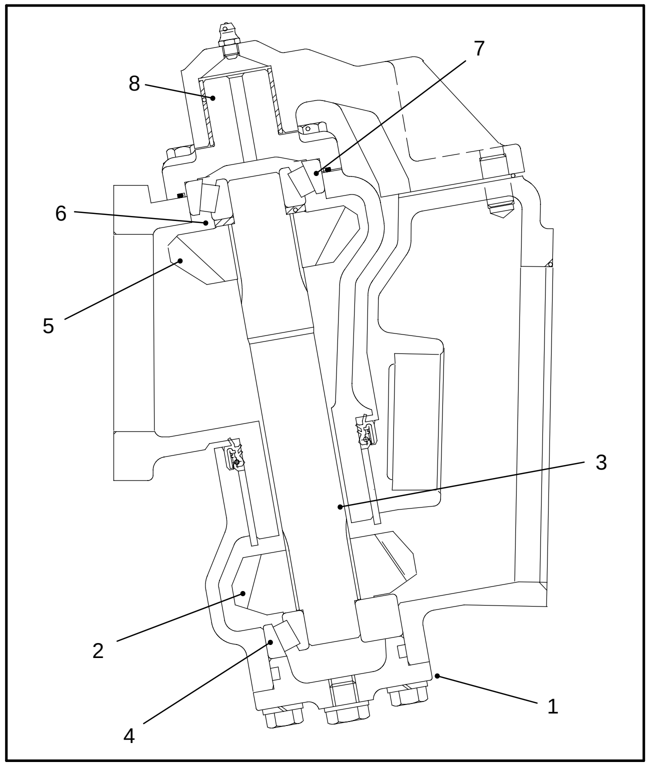

Figure 23

1. **Axle case cover**
2. **Lower bevel gear**
3. **Bevel gear shaft**
4. **Lower bearing**
5. **Upper bevel gear**
6. **Collar**
7. **Upper bearing**
8. **Knuckle pin**

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 tooths 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.

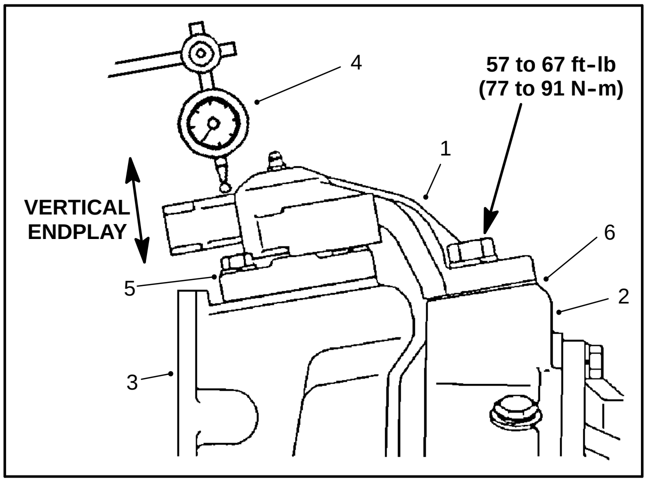

Figure 24

1. Axle case support
2. Axle case
3. Bevel gearcase
4. Dial indicator
5. Knuckle pin
6. Support shim location

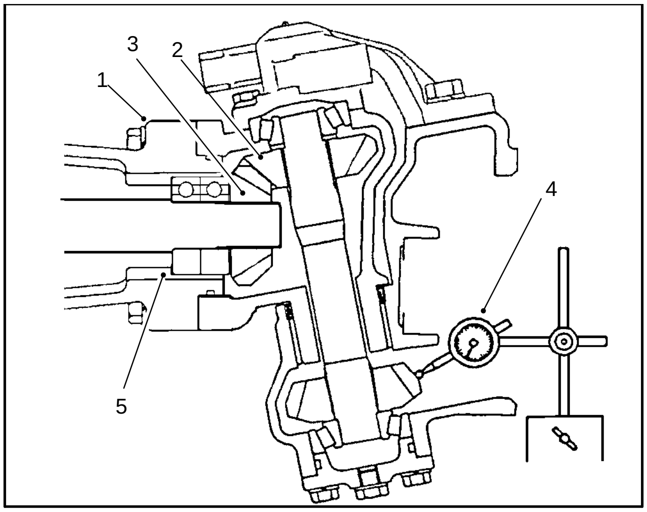

Figure 25

1. Axle support
2. Upper bevel gear
3. Differential shaft gear
4. Dial indicator
5. Axle bearing shims

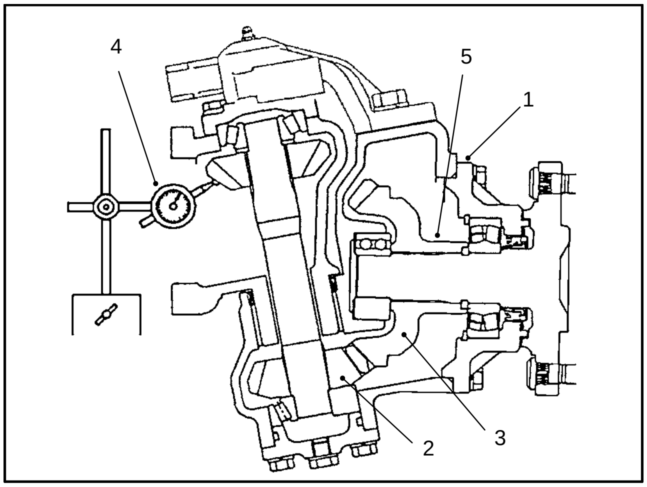

Figure 26

1. Axle cover assembly
2. Lower bevel gear
3. Axle gear
4. Dial indicator
5. Axle bearing shims

Axles, Planetaries and Brakes

9. Remove the bevel gear case/axle case assembly from the axle support. Coat a new O-ring with grease and temporarily install the axle cover assembly. Position a dial indicator at the tooths center. Prevent the axle from turning and measure the lower bevel gear to axle gear backlash (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. Torque 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. Torque 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 (see Rear Axle Assembly Removal in this section).

Differential Shaft 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.

Differential Shaft 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).

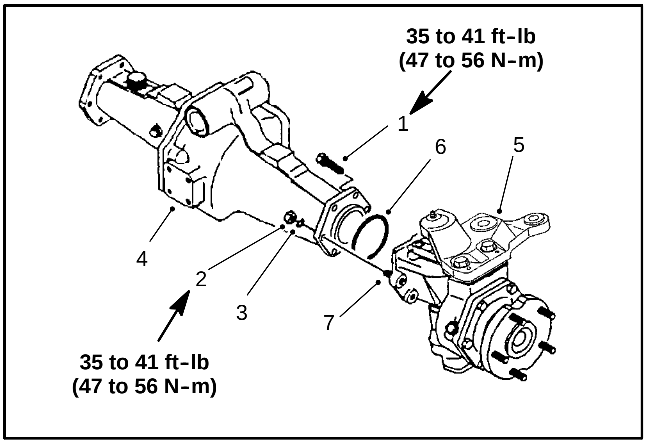

Figure 27

1. **Cap screw (4 used)**
2. **Lock nut (2 used)**
3. **Lock washer (2 used)**
4. **Axle support**
5. **Bevel gear/axle case assembly**
6. **O-ring**
7. **Stud (2 used)**

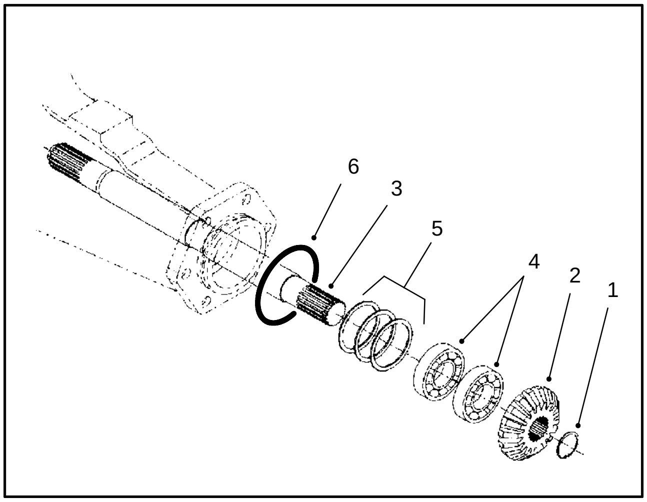

Figure 28

1. **Retaining ring**
2. **Bevel gear**
3. **Differential shaft**
4. **Bearing**
5. **Bearing shims**
6. **O-ring**

Axles, Planetaries and Brakes

Axle Shafts

The following procedures assume the rear axle assembly has been removed from the machine (see Rear Axle Assembly Removal in this section).

Axle Shaft 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.

Axle Shaft 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. Torque axle cover screws from **17 to 20 ft-lb (23 to 27 N-m)**.

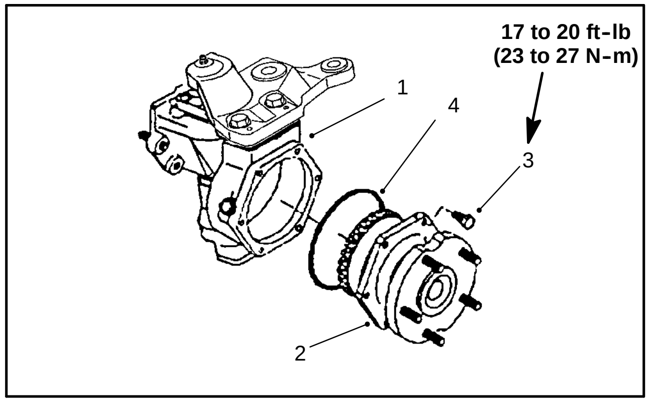

Figure 29

1. **Axle case**
2. **Axle cover assembly**
3. **Mounting screw (6 used)**
4. **O-ring**

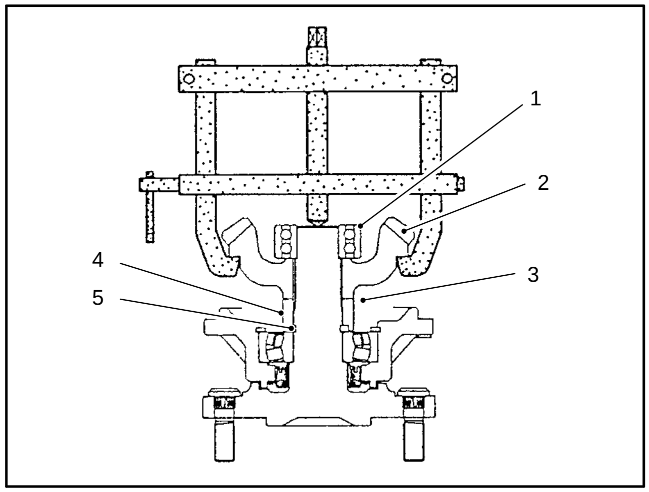

Figure 30

1. **Bearing**
2. **Bevel gear**
3. **Bearing shims**
4. **Spacer**
5. **Retaining ring**

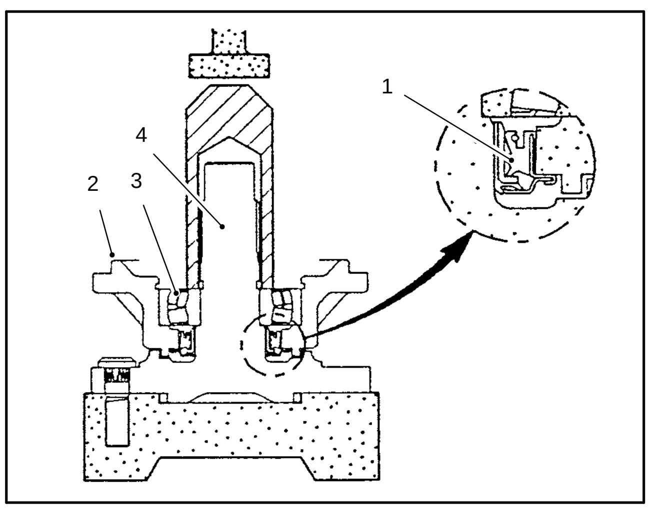

Figure 31

1. **Axle shaft seal**
2. **Axle cover**
3. **Bearing**
4. **Axle shaft**

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Input Shaft/Pinion Gear

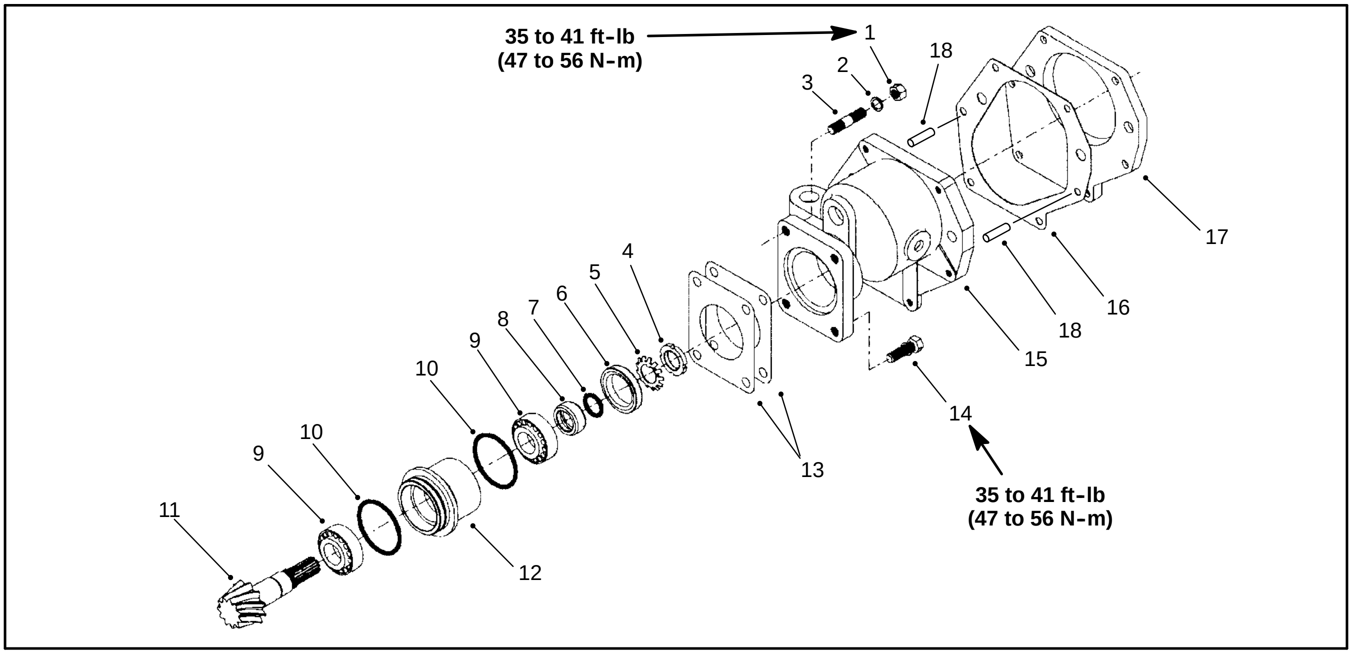

Figure 32

1. Nut (2 used)
2. Lock washer (2 used)
3. Stud (2 used)
4. Lock nut
5. Stake washer
6. Oil seal
7. O-ring
8. Seal collar
9. Bearing
10. O-ring
11. Input shaft/pinion gear
12. Bearing case
13. Shim
14. Screw (2 used)
15. Gear case
16. Gasket
17. Cover plate
18. Dowel pin

The following procedures assume the rear axle assembly has been removed from the machine (see Rear Axle Assembly Removal in this section).

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 gears are only available in matched ring and pinion sets.

Installation (Fig. 32)

NOTE: When installing new bearing cones, 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.

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 $\pm$ 0.002 in. (47.5 $\pm$ 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. Torque 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. Torque 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.

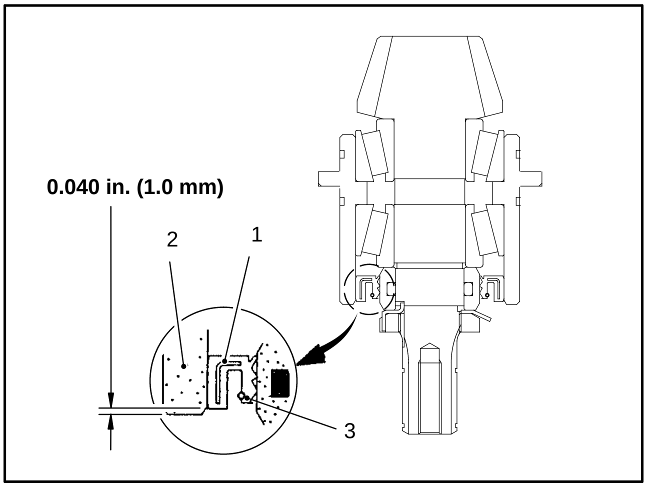

Figure 33

1. **Oil seal**
2. **Bearing case**
3. **Seal garter spring**

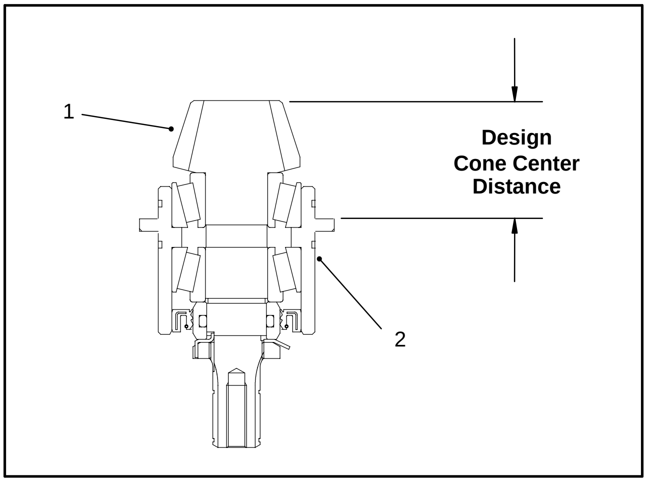

Figure 34

1. **Input shaft/pinion gear**
2. **Bearing case**

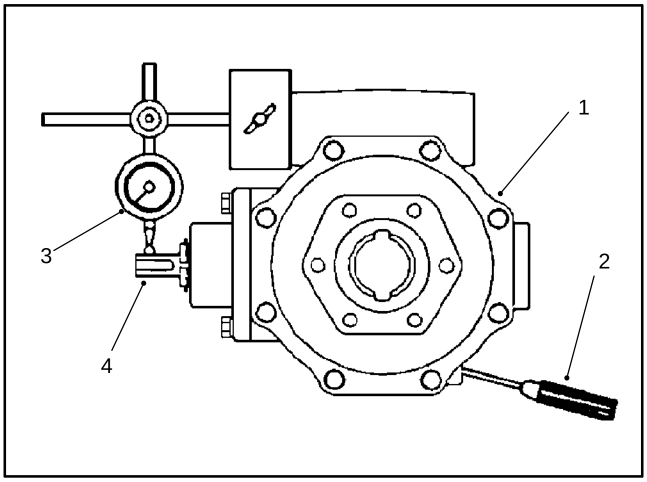

Figure 35

1. **Axle case**
2. **Screwdriver**
3. **Dial indicator**
4. **Input shaft/pinion gear**

Axles, Planetaries and Brakes

Differential Gear

The following procedures assume the rear axle assembly has been removed from the machine (see Rear Axle Assembly Removal in this section).

Differential Gear 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.

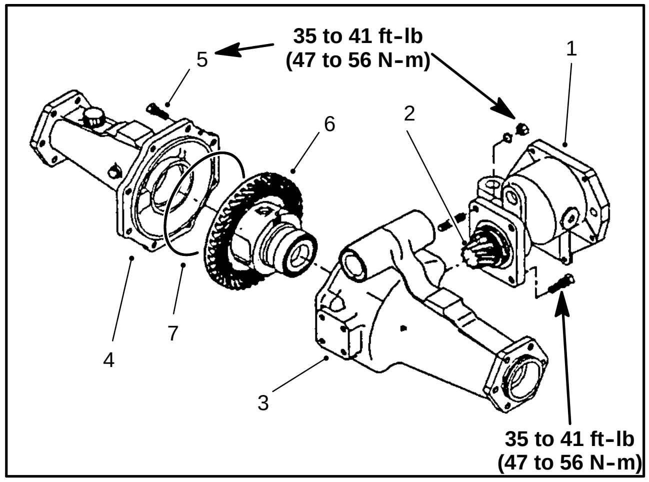

Figure 36

1. **Gear Case**
2. **Pinion Gear**
3. **Axle support (left)**
4. **Axle support (right)**
5. **Case screw (8 used)**
6. **Differential gear**
7. **O-ring**

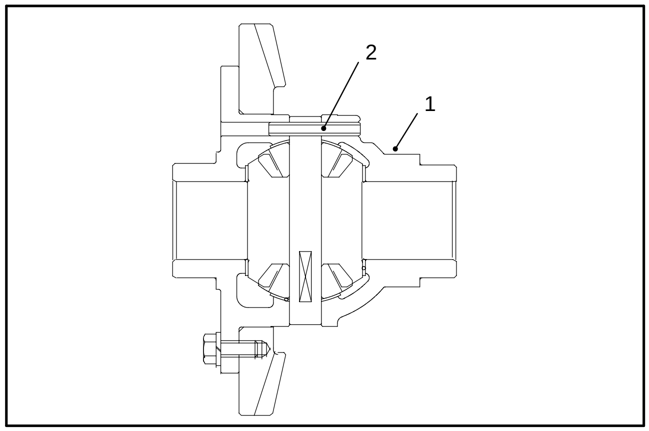

Figure 37

1. **Differential case**
2. **Spring pin**

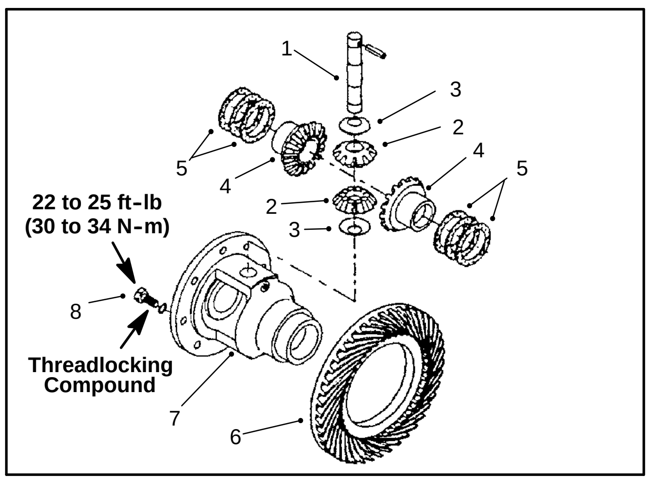

Figure 38

1. **Differential pinion shaft**
2. **Pinion gear**
3. **Pinion washer**
4. **Side gear**
5. **Side gear shims**
6. **Ring gear**
7. **Differential case**
8. **Bolt/washer (8 used)**

Differential Gear 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.

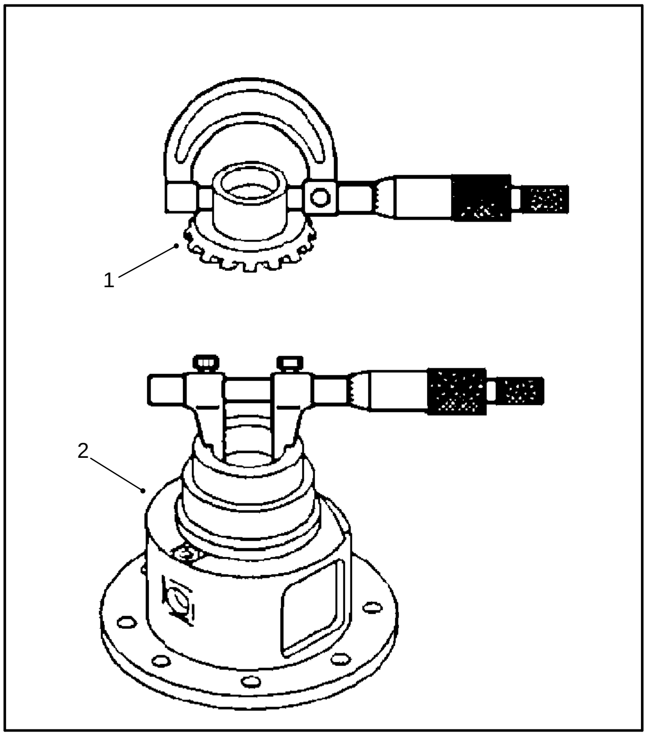

Figure 39

1. **Side gear** 2. **Differential case**

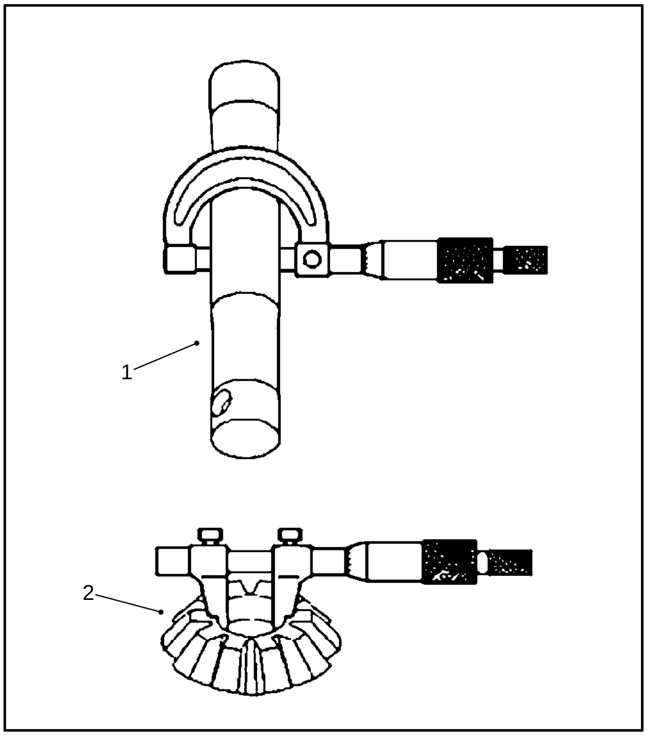

Figure 40

1. **Pinion shaft** 2. **Pinion gear**

Axles, Planetaries and Brakes

Differential Gear Installation

1. If the ring gear was removed, use medium strength thread locking compound and torque the mounting screws from **22 to 25 ft-lb (30 to 34 N–m)**.

2. Apply molybdenum disulfide grease 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 vise. Position a dial indicator at the tooths center and measure the differential 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. (1.1 mm), 0.047 in. (1.2 mm) and 0.051 in. (1.3 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.

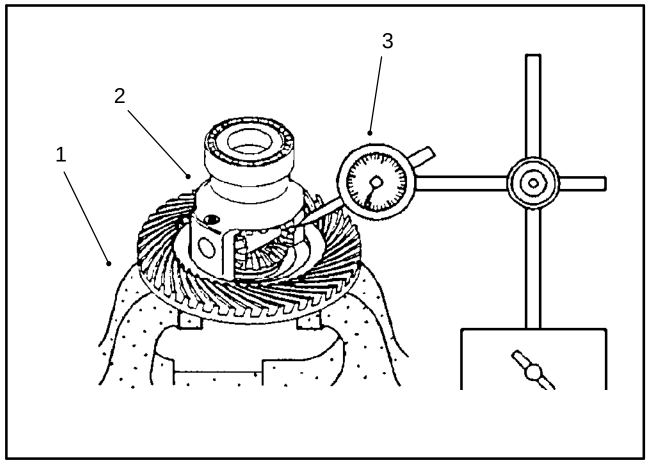

Figure 41

1. **Vise**
2. **Differential gear case**
3. **Dial indicator**

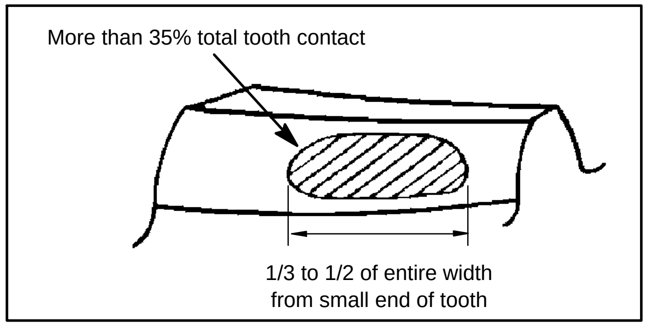

Figure 42

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. Torque 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 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.

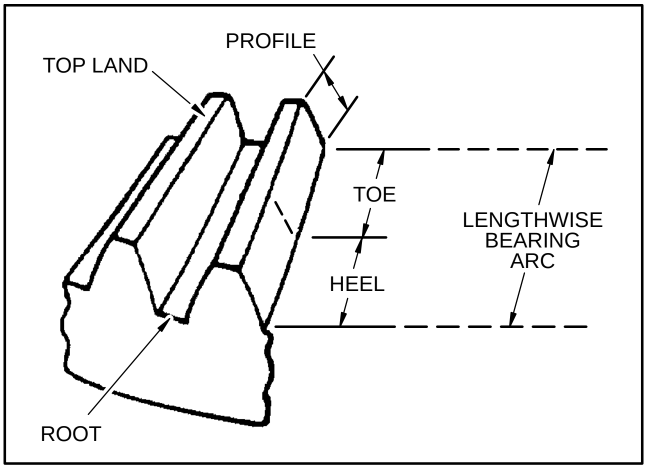

Figure 43

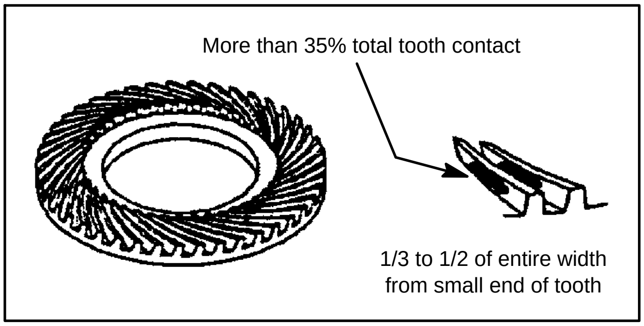

Figure 44

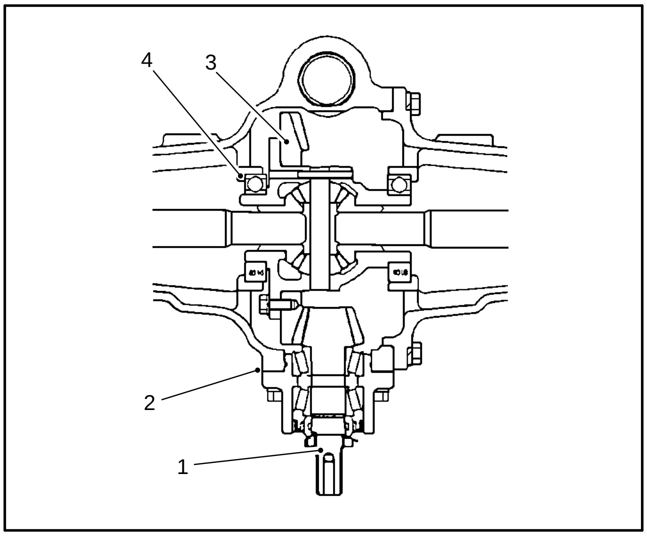

Figure 45

1. **Input shaft/pinion gear**
2. **Bearing case shims**
3. **Differential gear case**
4. **Differential bearing shims**

Axles, Planetaries and Brakes

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.

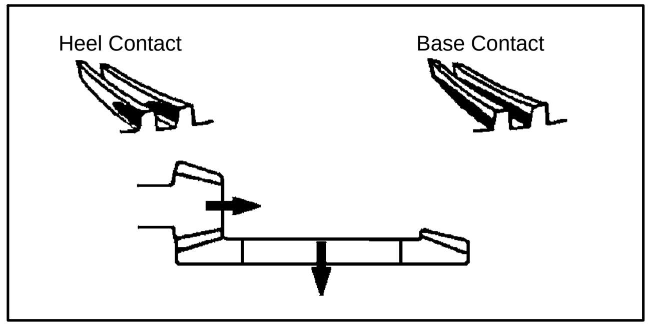

Figure 46

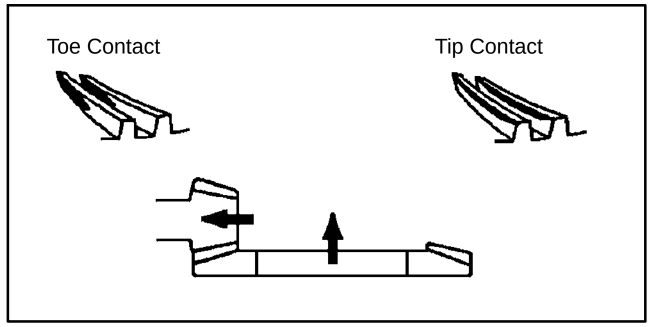

Figure 47

Chapter 7

Chassis

Table of Contents

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.

Service and Repairs

Steering Tower

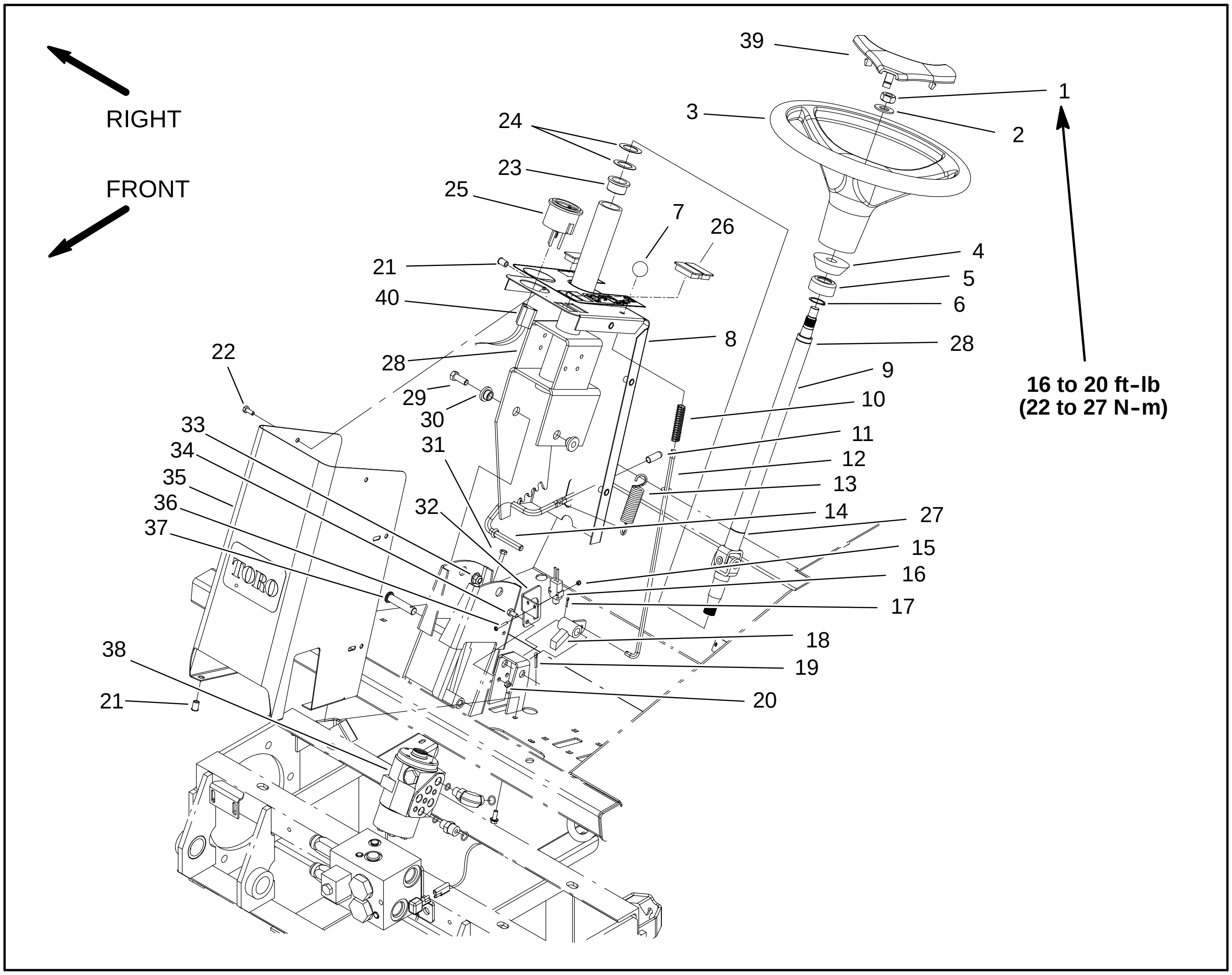

Figure 1

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

Disassembly (Fig. 1)

1. Park machine on a level surface, lower cutting deck, stop engine, engage 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 washers (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 (item 1) from **16 to 20 ft lb (22 to 27 N–m)**.

Cutting Deck Lift Arms

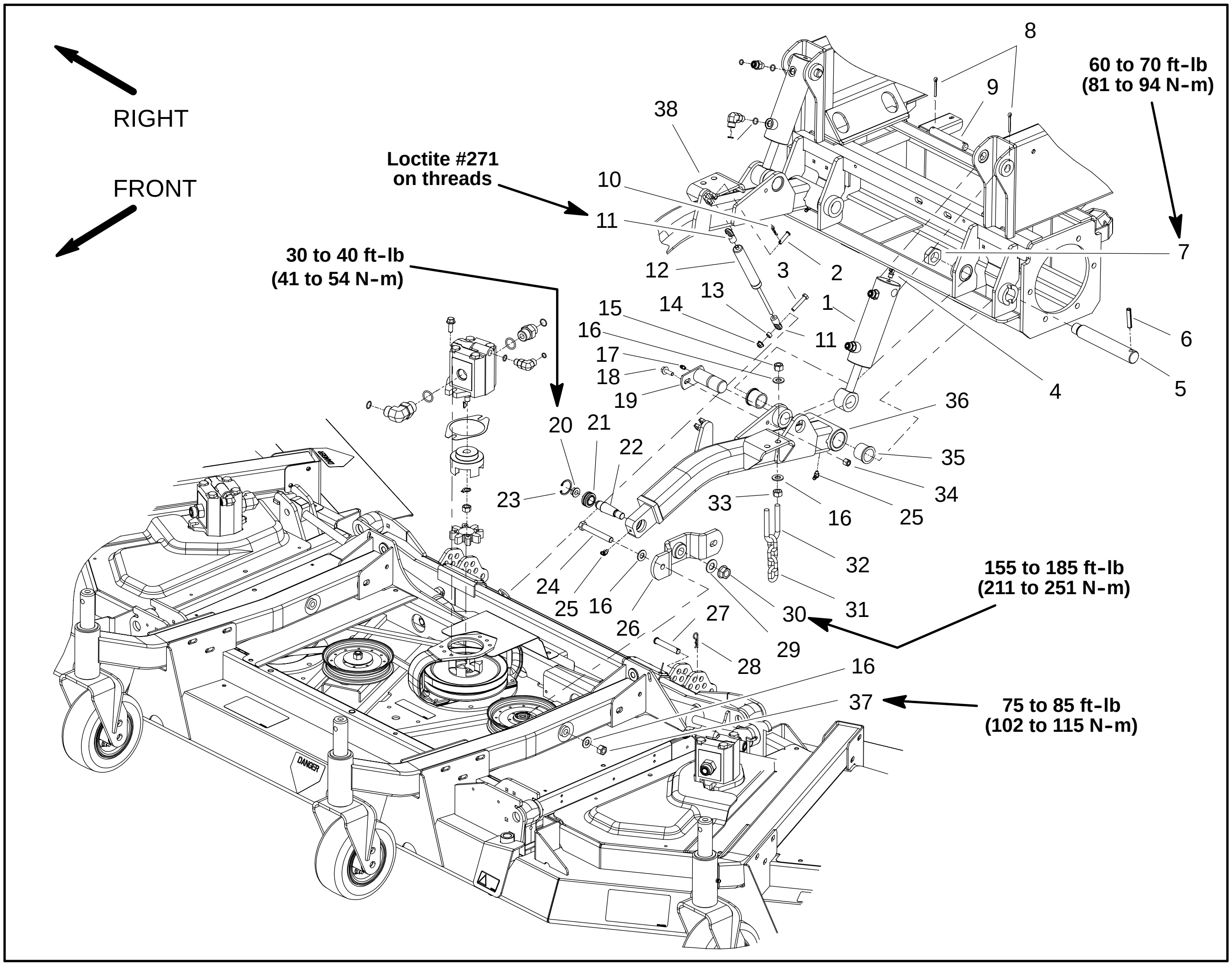

Figure 2

1. **Lift cylinder**
2. **Clevis pin**
3. **Cap screw**
4. **Grease fitting**
5. **Lift arm pin**
6. **Slotted roll pin**
7. **Lock nut**
8. **Cotter pin**
9. **Pivot pin**
10. **Hair pin**
11. **Spherical rod end**
12. **Damper**
13. **Yoke spacer**
14. **Flange nut**
15. **Lock nut**
16. **Flat washer**
17. **Grease fitting**
18. **Flange head screw**
19. **Lift cylinder pin**
20. **Flange nut**
21. **Spherical bearing**
22. **Tapered stud**
23. **Retaining ring**
24. **Cap screw**
25. **Grease fitting**
26. **Support hub**
27. **Clevis pin**
28. **Hair pin**
29. **Flat washer**
30. **Flange nut**
31. **Height-of-cut chain**
32. **U-bolt**
33. **Nut**
34. **Lock nut**
35. **Flange bushing (2 per lift arm)**
36. **Lift arm (LH)**
37. **Lock nut**
38. **Lift arm (RH)**

Removal (Fig. 2)

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

2. Remove front cutting deck (see Cutting Deck Removal in Chapter 8 – Cutting Deck).

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. Remove front wheel next to lift arm that is being removed.

4. Remove flange head screw and lock nut that secure lift cylinder pin to lift arm. Remove pin and separate lift cylinder from lift arm.

5. Remove lock nut that secures lift arm pin. Support lift arm and slide pin from frame and lift arm. Remove lift arm from frame.

6. As needed, disassemble lift arm:

   A. Remove height–of–cut chain and damper assembly.

   B. Press flange bearings from lift arm.

   C. Remove flange nut, flat washer and support hub from tapered stud. Remove tapered stud with spherical bearing from lift arm after removing retaining ring from lift arm. Remove flange nut and spherical bearing from stud.

Installation (Fig. 2)

1. If removed, install components to lift arm.

   A. Assemble height–of–cut chain u–bolt so that threaded portion of u–bolt extends 0.750 in. (19.1 mm) above mounting plate on lift arm (Fig. 3).

   B. If rod ends were removed from damper, apply Loctite #271 (or equivalent) to threads and install on damper. Install damper assembly to lift arm with damper rod end toward deck (Fig. 4).

   C. Press flange bearings into lift arm.

   D. Install spherical bearing on tapered stud and secure with flange nut. Torque flange nut from **30 to 40 ft–lb (41 to 54 N–m)**. Install stud with spherical bearing into lift arm and secure with retaining ring.

   E. Thoroughly clean tapered surfaces of stud and mounting boss of support hub. Secure support hub (position slotted hole in hub toward rear of deck) to tapered stud with flat washer and flange nut. Torque flange nut from **155 to 185 ft–lb (211 to 251 N–m)**.

2. 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)**.

3. Align lift cylinder with lift arm. Slide lift cylinder pin through lift arm and cylinder end. Secure pin with flange head screw and lock nut.

4. Install front wheel assembly. Lower machine to the ground. Torque wheel lug nuts from **85 to 100 ft–lb (115 to 135 N–m)**.

5. Install cutting deck (see Cutting Deck Installation in Chapter 8 – Cutting Deck).

6. Lubricate lift arm grease fittings.

7. After assembly is completed, raise and lower the cutting deck to verify that hydraulic hoses and fittings do not contact anything.

8. Check height–of–cut and deck pitch adjustment.

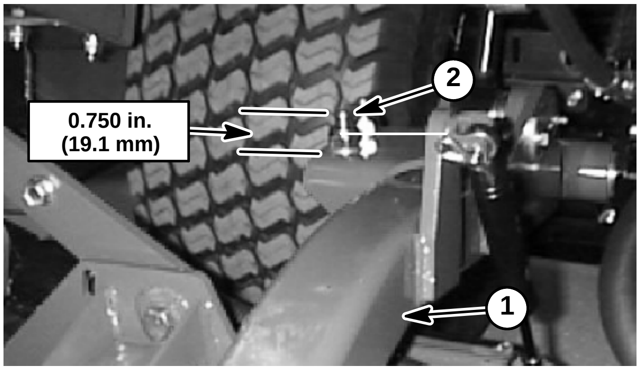

Figure 3

1. Lift arm
2. U–bolt threads

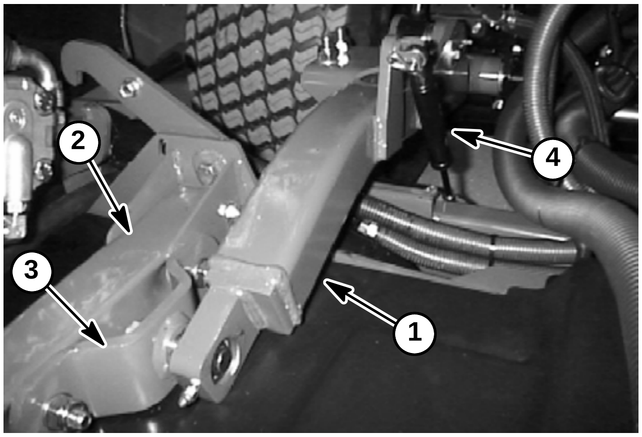

Figure 4

1. Lift arm
2. Deck castor arm
3. Support hub
4. Damper

Chassis

Console Arm

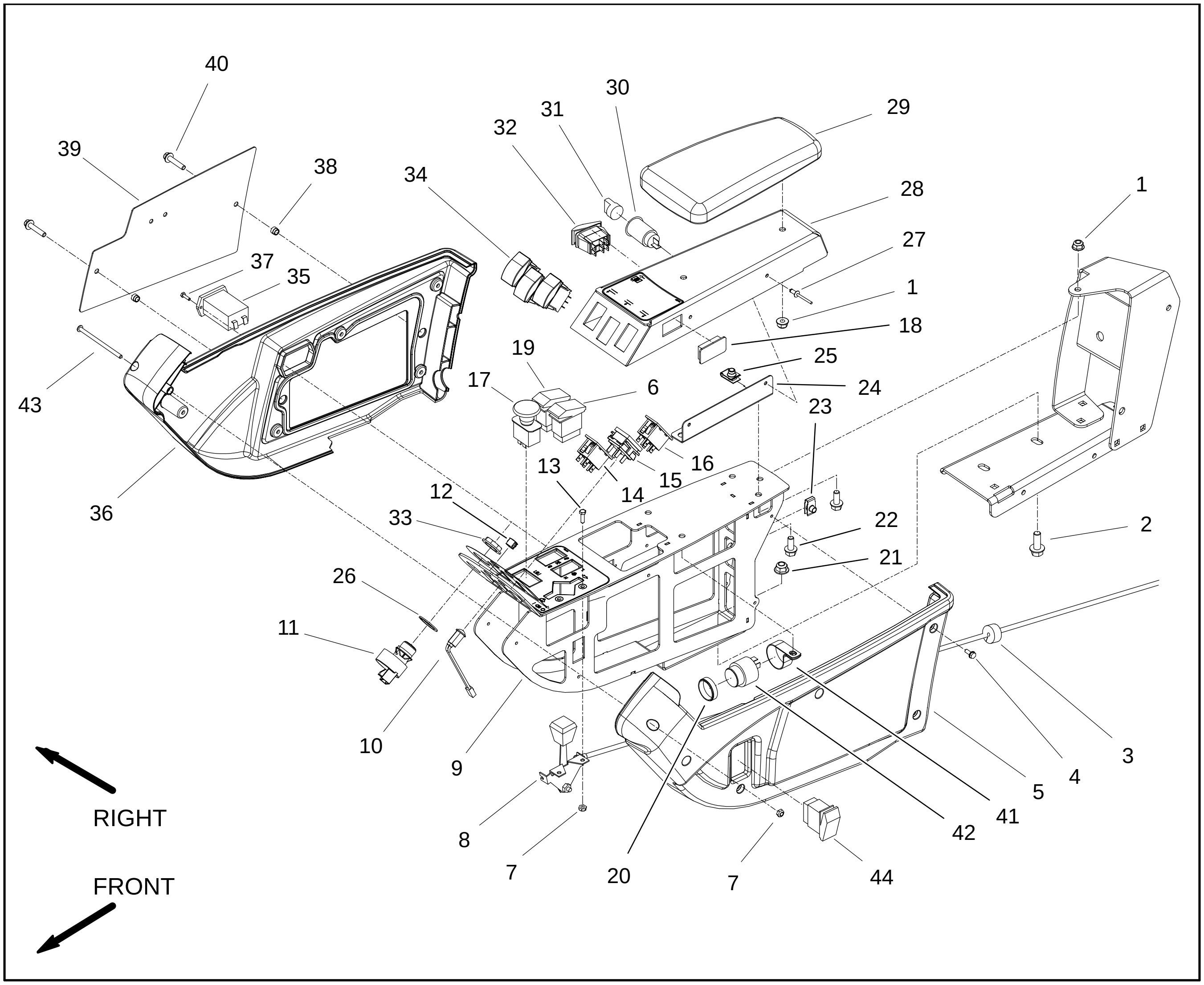

Figure 5

1. Flange nut (3 used)
2. Flange head screw (2 used)
3. Foam seal
4. Washer head screw (10 used)
5. LH cover
6. Hi–low speed switch
7. Lock nut (3 used)
8. Throttle control
9. Control arm
10. Diagnostic light
11. Ignition switch
12. Button plug
13. Screw (2 used)
14. Warning lamp (oil pressure/charge)
15. Temperature gauge
16. Warning lamp (glow plug/temp)
17. PTO switch
18. Hole plug
19. Flow divider switch (if equipped)
20. Nut
21. Flange nut (2 used)
22. Flange head screw (5 used)
23. Clip (2 used)
24. Bracket
25. U–nut (4 used)
26. Lock washer
27. Rivet (2 used)
28. Switch panel
29. Arm rest
30. Power point
31. Cap
32. Engine cooling fan control switch
33. Nut
34. Lift/lower switch (3 used)
35. Hour meter
36. RH cover
37. Cap screw (2 used)
38. Spacer (2 used)
39. Cover plate
40. Flange head screw (2 used)
41. R–clamp
42. Audio alarm
43. Screw
44. Headlight switch (if equipped)

Disassembly (Fig. 5)

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 5 as a guide.

7. If necessary, remove console panel and supports from machine using Figures 5 and 6 as guides.

Assembly (Fig. 5)

1. Install all removed electrical and console arm components using Figure 5 and 6 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.

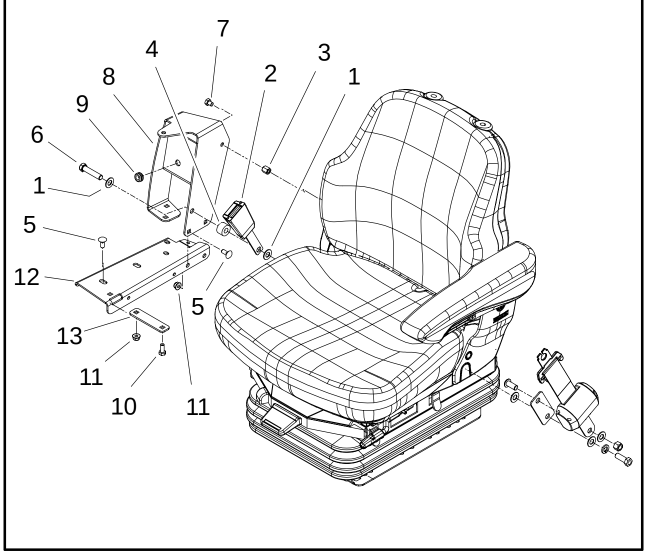

Figure 6

1. **Flat washer**
2. **Seat belt buckle**
3. **Coupling nut**
4. **Spacer**
5. **Carriage screw (5 used)**
6. **Cap screw**
7. **Cap screw**
8. **Arm support**
9. **Grommet**
10. **Cap screw**
11. **Flange nut (5 used)**
12. **Support channel**
13. **Support bracket**

Operator Seat

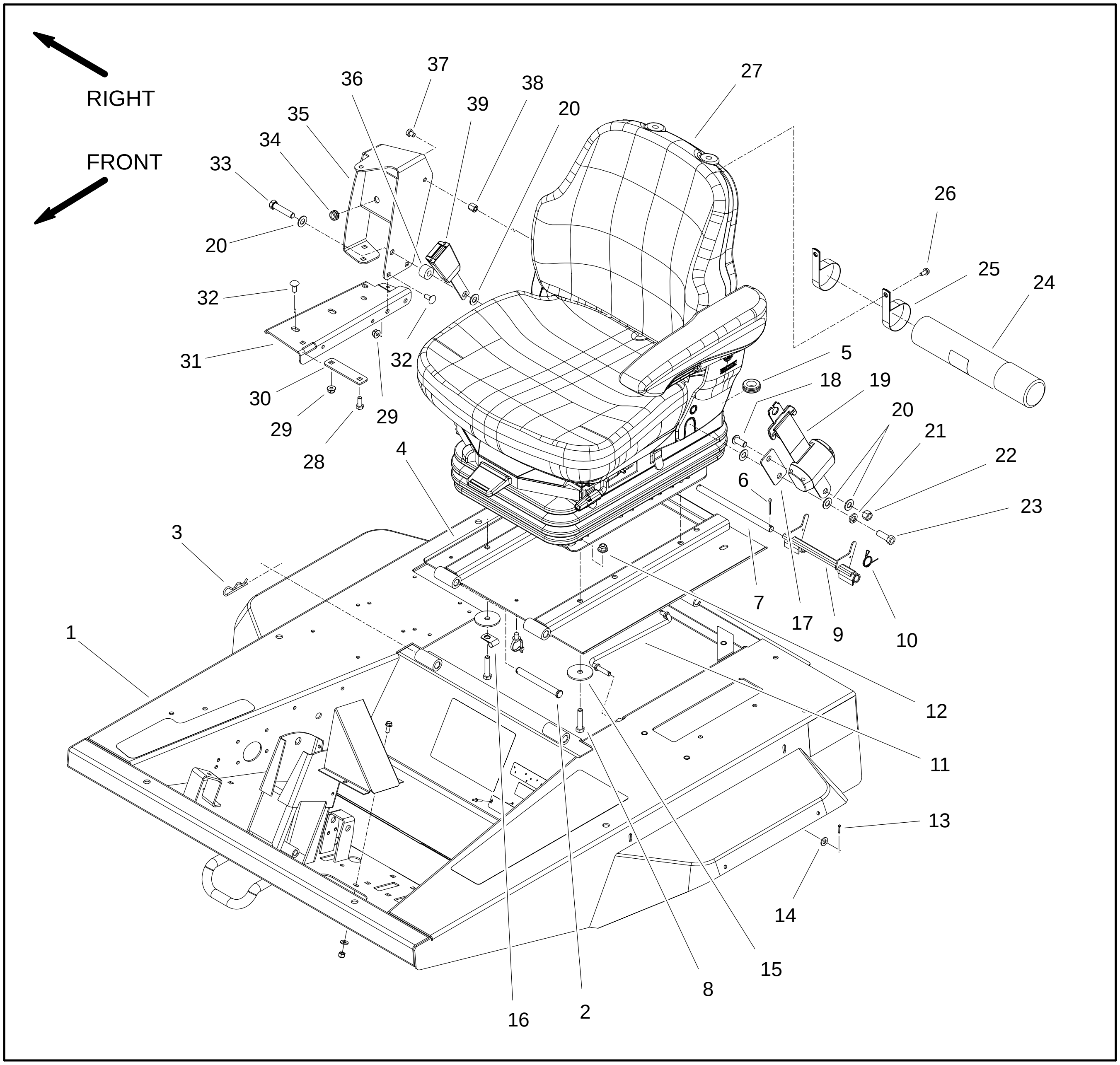

Figure 7

1. **Platform**
2. **Clevis pin (2 used)**
3. **Hair pin (2 used)**
4. **Seat plate**
5. **Grommet**
6. **Cotter pin (2 used)**
7. **Latch shaft**
8. **Cap screws (4 used)**
9. **Latch**
10. **Torsion spring**
11. **Prop rod**
12. **Flange nut (4 used)**
13. **Cotter pin (2 used)**
14. **Flat washer (2 used)**
15. **Flat washer (4 used)**
16. **R-clamp (2 used)**
17. **Seat belt mount**
18. **Button head screw**
19. **Seat belt**
20. **Flat washer (5 used)**
21. **Lock washer**
22. **Lock nut**
23. **Cap screw**
24. **Manual tube**
25. **R-clamp (2 used)**
26. **Screw (2 used)**
27. **Seat and suspension assembly**
28. **Cap screw**
29. **Flange nut (5 used)**
30. **Support bracket**
31. **Support channel**
32. **Carriage screw (5 used)**
33. **Cap screw**
34. **Grommet**
35. **Arm support**
36. **Spacer**
37. **Cap screw**
38. **Coupler nut**
39. **Seat belt latch**

Removal (Fig. 7)

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

2. Disconnect seat electrical connector from machine wire harness (Fig. 8).

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 coupling 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. 9). 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. 7)

1. Carefully position seat to seat suspension.

2. Secure seat to seat suspension with four (4) torx head screws (Fig. 9). 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. 8).

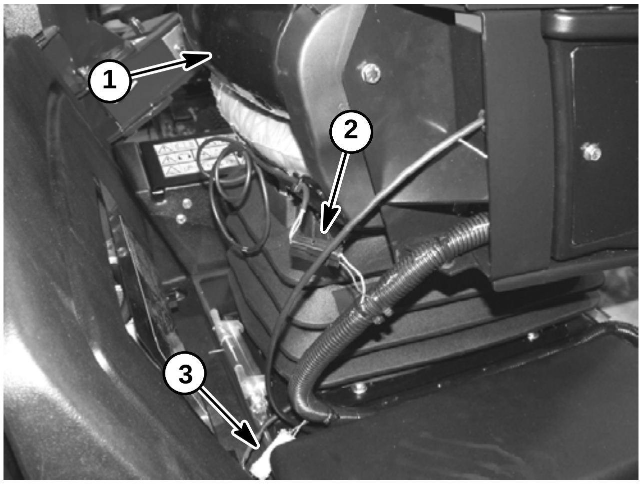

Figure 8

1. Operator seat
2. Seat switch connector
3. Suspension connector

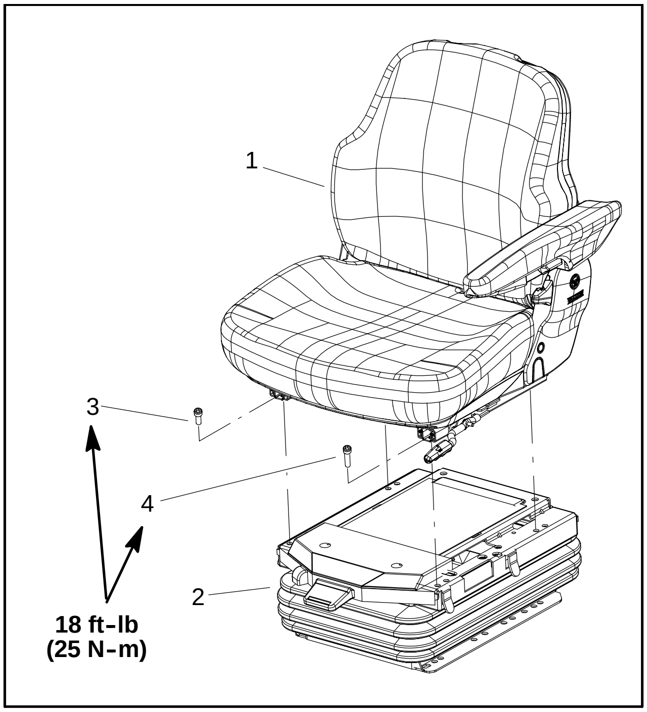

Figure 9

1. Seat
2. Suspension assembly
3. Screw (M8x12) (3 used)
4. Screw (M8x16)

Operator Seat Service

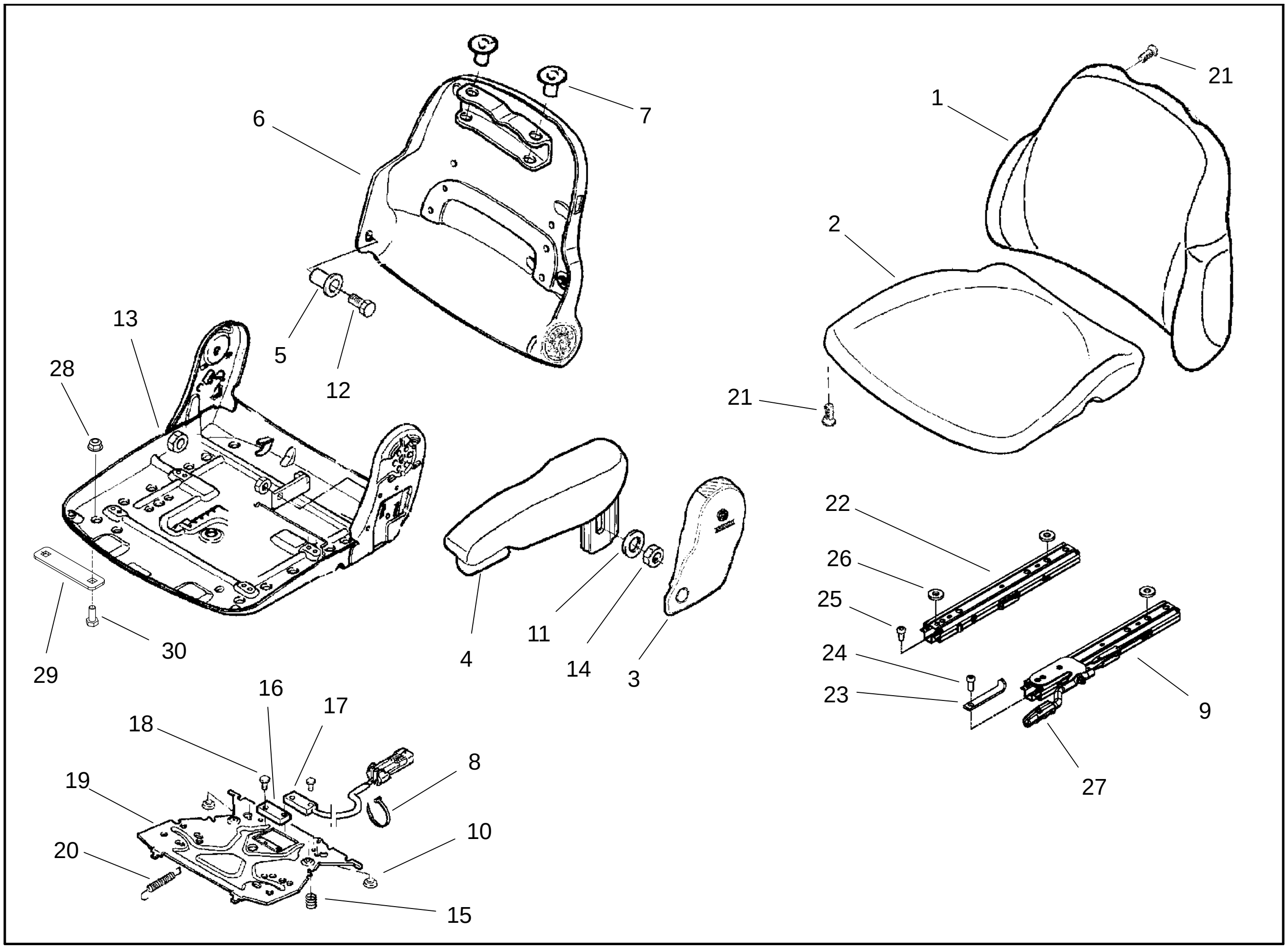

Figure 10

1. Backrest cushion
2. Seat cushion
3. Armrest cover
4. LH armrest
5. Bushing (2 used)
6. Backrest
7. Plug (2 used)
8. Cable tie (3 used)
9. LH adjustment rail
10. Bumper (2 used)
11. Washer
12. Cap screw (2 used)
13. Seat
14. Nut
15. Spring (2 used)
16. Magnet
17. Seat switch
18. Rivet (4 used)
19. Mounting plate
20. Return spring
21. Torx screw (5 used)
22. RH adjustment rail
23. Rail stop
24. Torx screw
25. Torx screw (3 used)
26. Washer (3 used)
27. Handle
28. Nut
29. Support bracket
30. Cap screw

Disassembly (Fig. 10)

1. Disassemble operator seat as necessary using Figures 10 and 11 as guides.

Assembly (Fig. 10)

1. Assemble operator seat using Figures 10 and 11 as guides.

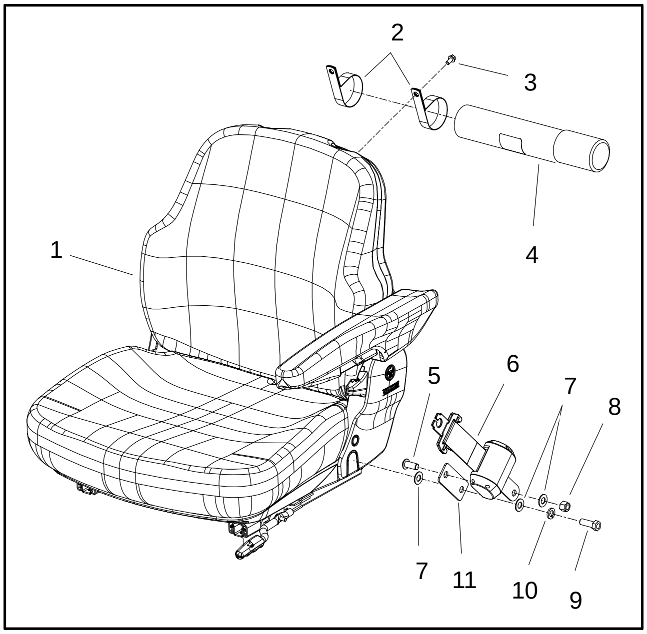

Figure 11

1. **Operator seat**
2. **R-clamp**
3. **Screw**
4. **Manual tube**
5. **Button head screw**
6. **Seat belt**
7. **Flat washer**
8. **Lock nut**
9. **Cap screw**
10. **Lock washer**
11. **Seat belt mount**

Chassis

Operator Seat Suspension

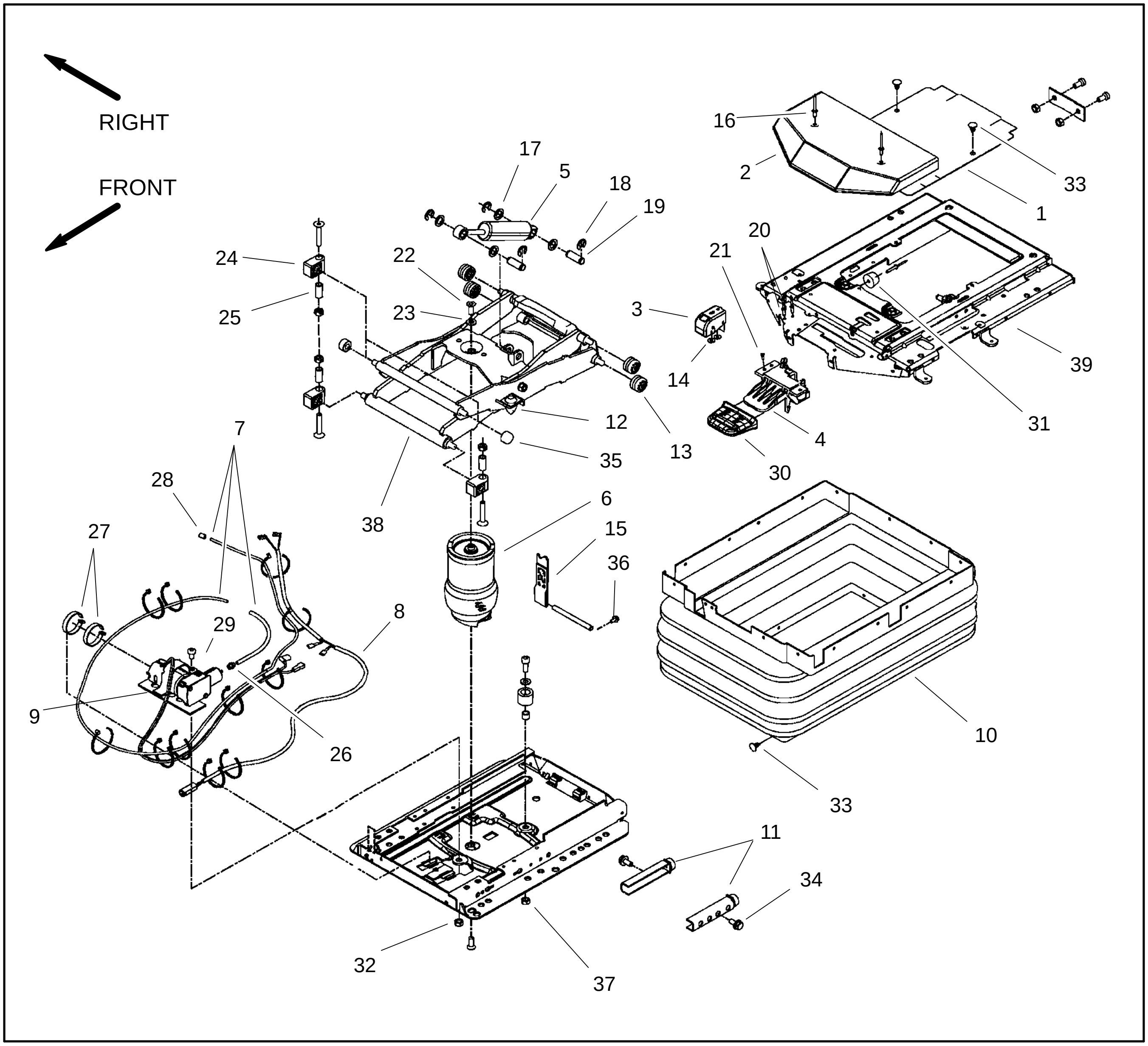

Figure 12

1. **Cover**
2. **Cover**
3. **Level control**
4. **Air control valve**
5. **Shock absorber**
6. **Air spring**
7. **Air tube assembly**
8. **Wire harness**
9. **Compressor**
10. **Bellows**
11. **Stop**
12. **Bumper set (2 used)**
13. **Roller (4 used)**
14. **Washer (2 used)**
15. **Tether**
16. **Rivet (2 used)**
17. **Washer (4 used)**
18. **C-clip (4used)**
19. **Pin (2 used)**
20. **Rivet (2 used)**
21. **Washer (3 used)**
22. **Screw (2 used)**
23. **Washer**
24. **Housing support (4 used)**
25. **Spacer (4 used)**
26. **Hose nipple**
27. **Clamp (2 used)**
28. **Hose nipple**
29. **Screw**
30. **Handle**
31. **Bumper**
32. **Nut**
33. **Plastic plug (23 used)**
34. **Screw (2 used)**
35. **Roller (2 used)**
36. **Screw (4 used)**
37. **Base plate**
38. **Suspension frame**
39. **Upper plate**

NOTE: Most of the seat suspension components can be serviced with the seat suspension base mounted to the 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. 12)

1. Remove operator seat from seat suspension (see Operator Seat Removal in this section).

2. Disconnect seat suspension connector from machine wire harness (Fig. 13).

3. If the air spring assembly (item 6) or base plate (item 37) requires removal, remove seat suspension from seat plate (Fig. 14):

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 12 as a guide.

Assembly (Fig. 12)

1. Install all removed seat suspension components using Figure 12 as a guide.

2. If seat suspension was removed from seat plate, secure suspension to seat plate (Fig. 14):

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. 13).

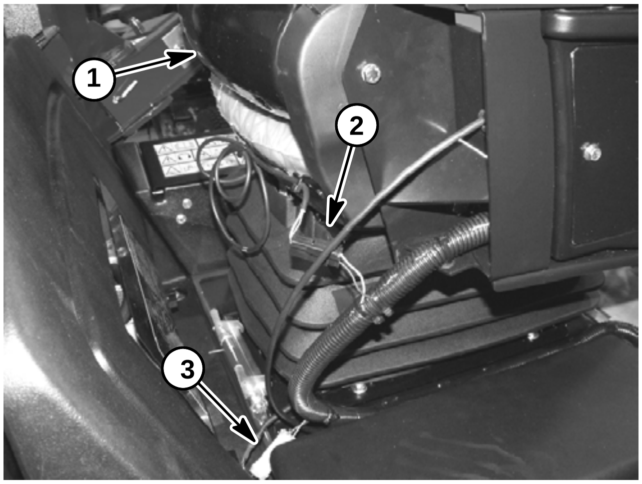

Figure 13

1. **Operator seat**
2. **Seat switch connector**
3. **Suspension connector**

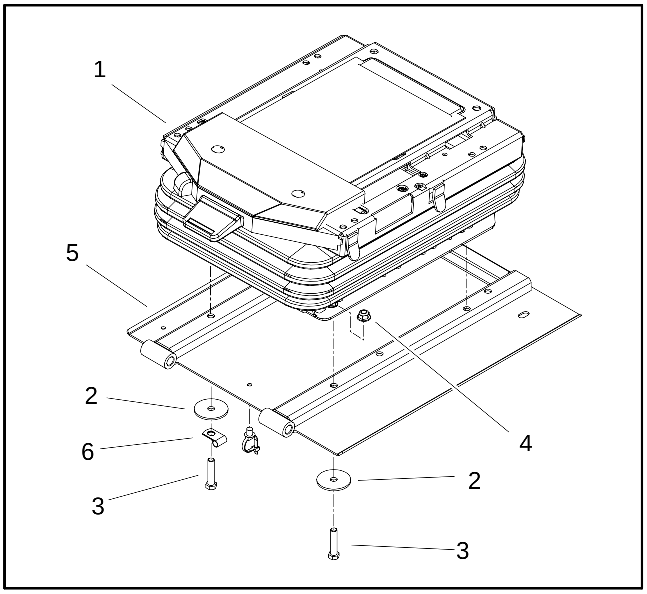

Figure 14

1. **Seat suspension**
2. **Flat washer (4 used)**
3. **Cap screw (4 used)**
4. **Flange nut (4 used)**
5. **Seat plate**
6. **R-clamp**

Chassis

Hood

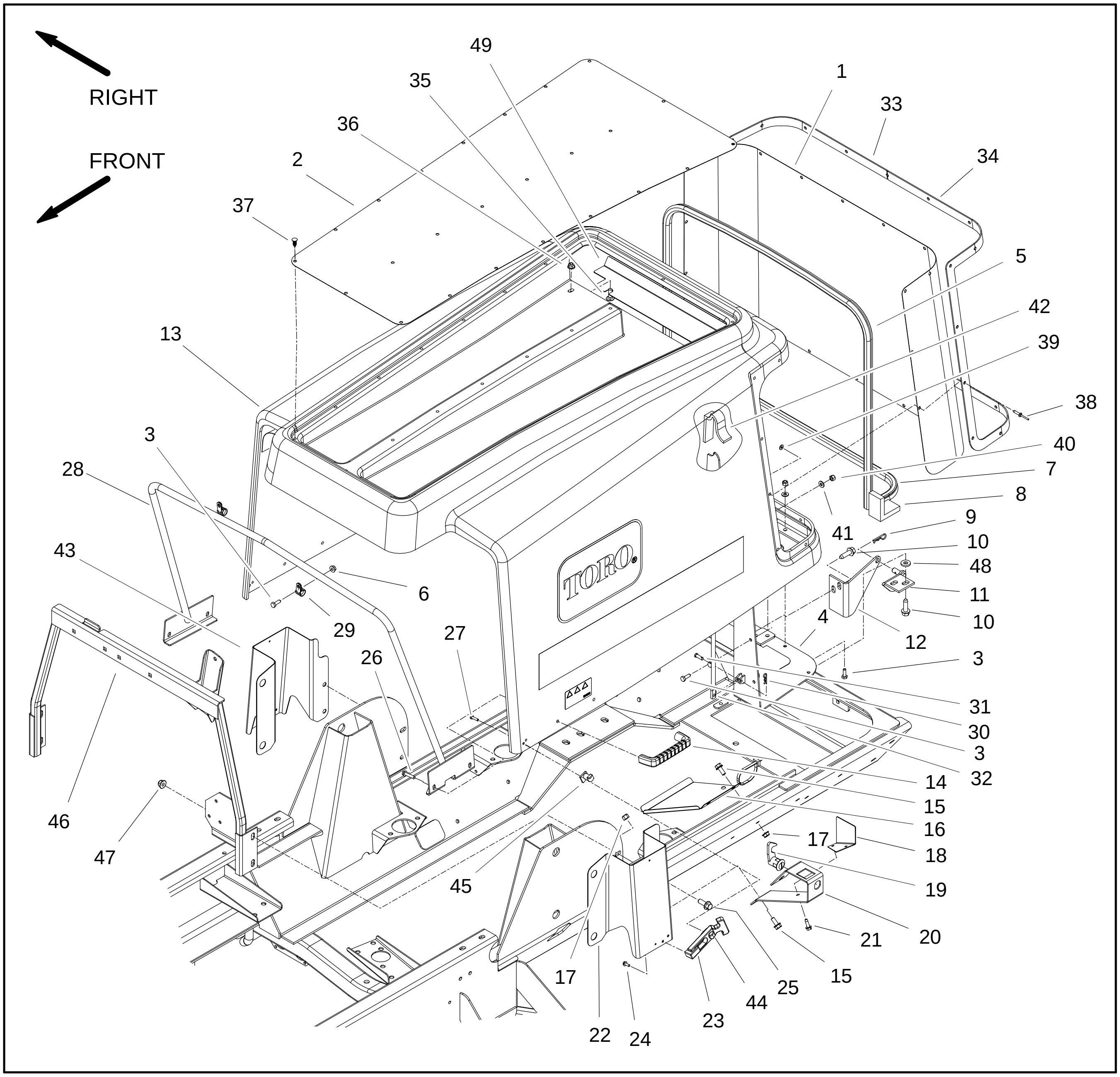

Figure 15

1. Rear screen
2. Top screen
3. Cap screw (22 used)
4. Screen assembly
5. Bulb seal
6. Flange nut (2 used)
7. Bulb seal
8. Screen corner seal (2 used)
9. Hair pin (2 used)
10. Screw (8 used)
11. Hood pivot (2 used)
12. Pivot bracket (2 used)
13. Hood
14. Handle (2 used)
15. Flange head screw (4 used)
16. Oil filter deflector
17. Flange nut (4 used)
18. Latch cover
19. Latch
20. Hood latch bracket
21. Washer head screw (2 used)
22. LH latch bracket
23. Latch bracket (2 used)
24. Screw (4 used)
25. Flange head screw (4 used)
26. Screw (4 used)
27. Screw (2 used)
28. Hood support
29. R-clamp (2 used)
30. Hair pin (2 used)
31. Clevis pin (2 used)
32. Hood rod (2 used)
33. RH screen mount
34. LH screen mount
35. Carriage bolt (2 used)
36. Flange nut (2 used)
37. Plastic plug (24 used)
38. Pop rivet (22 used)
39. Flat washer (22 used)
40. Lock nut (20 used)
41. Flat washer (20 used)
42. Foam seal (2 used)
43. RH latch bracket
44. Latch handle (2 used)
45. Latch keeper (2 used)
46. Fuel tank support
47. Flange nut (4 used)
48. Spacer (4 used)
49. Hood shield

Removal

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

2. Remove hood using Figure 15 as a guide.

Installation

1. Install hood using Figure 15 as a guide.

2. Align hood to machine to allow correct operation of hood latches and dust seals:

   A. Place shim that is 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. 16 and 17).

   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 pivot brackets to allow hood latches to pull hood against radiator support. Re-tighten pivot bracket fasteners.

3. After hood is assembled to machine, check for the following:

   A. Check that bulb seals are equally compressed at all contact points with hood.

   B. Hood should open and close without contacting oil cooler hardware.

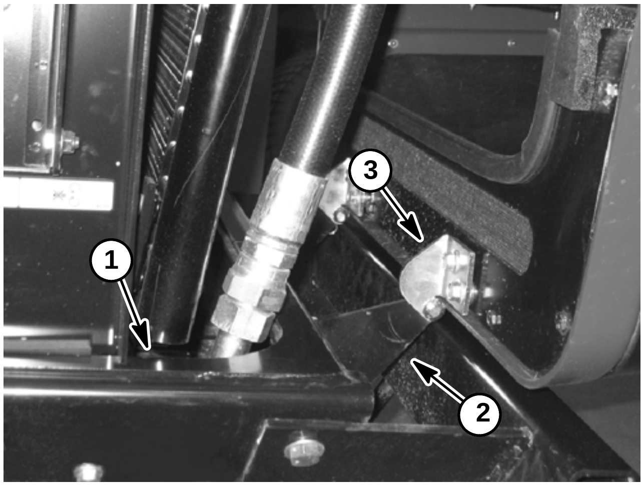

Figure 16

1. **LH shim location**
2. **LH hood pivot**
3. **LH pivot bracket**

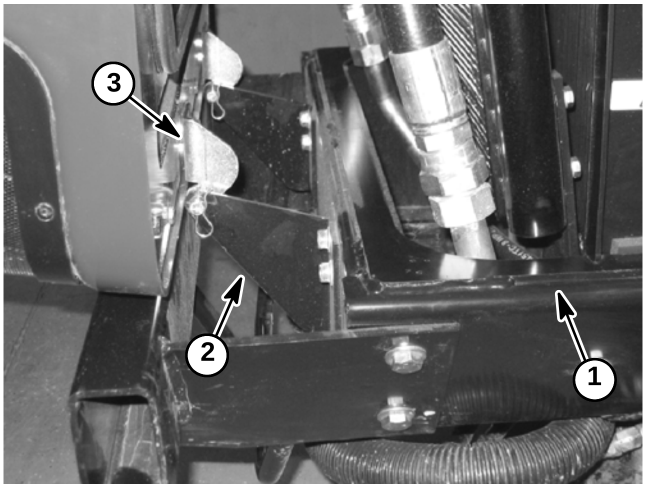

Figure 17

1. **RH shim location**
2. **RH hood pivot**
3. **RH pivot bracket**

Chassis

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Chapter 8

Cutting Deck

Table of Contents

Cutting Deck

Specifications

MOUNTING: Cutting deck is 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) adjustable in 1/2” (12.7 mm) increments. Center deck height-of-cut adjustment is achieved by changing spacers on castor wheels and adjusting length of deck support chains. Wing deck adjustment achieved by changing spacers on castor wheels, re-positioning the castor wheel axles in the castor forks and securing the castor wheel bracket to the correct height-of-cut bracket holes.

DECK DRIVE: Closed loop hydraulic system operates hydraulic motor on each cutting deck section. Motor drives one spindle directly with remaining deck section spindle(s) driven by B section kevlar v-belt(s). Blade spindles are 1-1/4” (31.7 mm) shafts supported by greaseable, tapered roller bearings.

CUTTING BLADE: Cutting blade dimensions are 19” (483 mm) long, 2.5” (64 mm) wide and 0.250” (6.4 mm) thick. Anti-scalp cup installed on each cutting blade. Center deck includes three (3) blades and each wing deck includes two (2) blades.

WIDTH OF CUT: Front deck provides 54” (1372 mm) width of cut. Each side deck has 37” (940 mm) width of cut. Total width of cut is 124” (3150 mm).

DISCHARGE: Clippings are discharged from the rear of the cutting deck.

SUSPENSION SYSTEM: A fully floating suspension with hydraulic counterbalance. Front deck suspended from lift arms and has six castor wheels, two adjustable skids and five anti-scalp rollers.

General Information

CAUTION

Never install or work on the cutting deck or lift arms with the engine running. Always stop engine and remove ignition key first.

Operator's Manual

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

Castor Wheel Tire Pressure

Castor tires on the cutting deck should be inflated to 50 PSI (345 kPa).

Blade Stopping Time

The blades of the cutting deck should come to a complete stop in approximately five (5) seconds after the PTO switch is pushed in (disengaged).

NOTE: Make sure the deck is lowered onto a clean section of turf or hard surface to avoid dust and debris.

To verify blade stopping stopping time, have a second person stand back from the deck at least twenty (20) feet and watch one of the cutting deck blades. Have the operator push the PTO switch in to disengage the cutting deck and record the time it takes for the blades to come to a complete stop. If this stopping time is excessive, the braking valve(s) (RV2) on the hydraulic deck control manifold(s) 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 (see Chapter 3 – Kubota Diesel Engine).
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. Cutting blade condition.	Sharpen cutting 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 deck height–of–cut adjustments are the same. Adjust deck 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, shafts or rollers 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 deck or lift arms with the engine running. Always stop engine and remove ignition key first.

Cutting Deck

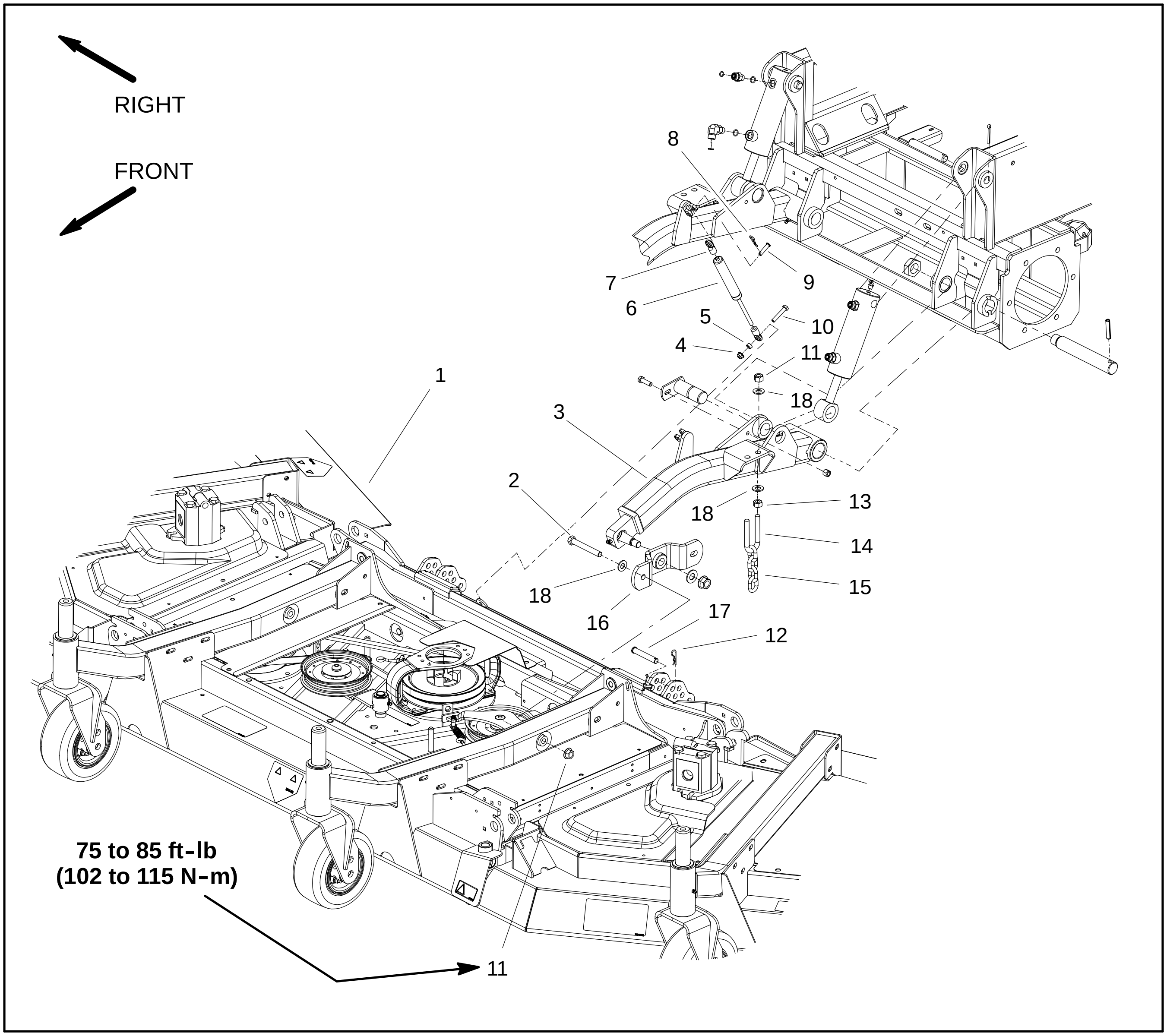

Figure 1

1. **Cutting deck**
2. **Cap screw**
3. **Lift arm (LH shown)**
4. **Flange nut**
5. **Spacer**
6. **Damper**
7. **Damper rod end (2 per damper)**
8. **Hair pin**
9. **Clevis pin**
10. **Cap screw**
11. **Flange nut**
12. **Hair pin**
13. **Hex nut**
14. **U-bolt**
15. **Height of cut chain**
16. **Support hub**
17. **Clevis pin**
18. **Flat washer**

Removal (Fig. 1)

1. Position machine on a clean, level surface. Lower cutting deck, stop engine, engage parking brake and remove key from the ignition switch.

NOTE: Removal of clevis pins from deck and height–of–cut chains is easier if deck is lifted slightly.

2. Remove hairpins and clevis pins that secure the height–of–cut chains to the rear of the cutting deck (Fig. 2).

3. Remove hydraulic motors from cutting deck (see Cutting Deck Motor Removal in the Service and Repairs Section of Chapter 4 – Hydraulic System). Position motors away from cutting deck.

4. Remove hairpins and clevis pins that secure dampers to lift arms (Fig. 3). Rotate dampers and place on cutting deck.

5. Remove hydraulic hoses from wing deck lift cylinders (Fig. 4):

A. Remove deck covers to allow access to wing deck lift cylinders.

B. Thoroughly clean exterior of wing deck lift cylinders and fittings. For assembly purposes, label hydraulic hoses to show their correct position on the lift cylinders.

C. Disconnect hydraulic hoses from wing deck lift cylinders. Cap hoses and fittings to prevent contamination.

6. Disconnect cutting deck wire harness from main machine harness (Fig. 5).

7. Remove cap screws, flat washers and flange nuts that secure support hubs to cutting deck castor arms (Fig. 3).

8. 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, engage parking brake and remove key from the ignition switch.

2. Position the cutting deck to the lift arms.

3. Align support hub to cutting deck castor arms and secure with cap screws, flat washers and flange nuts (Fig. 3). Torque flange nuts from **75 to 85 ft–lb (102 to 115 N–m)**.

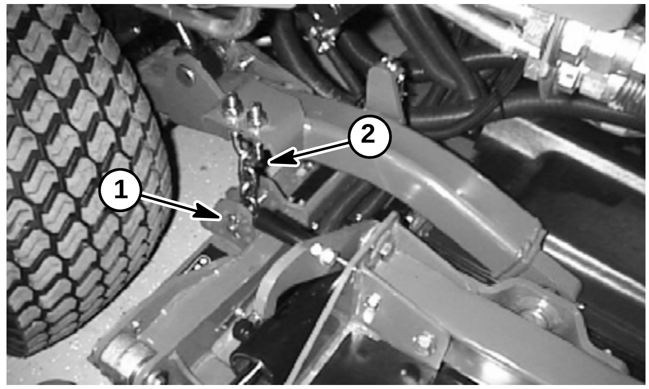

Figure 2

1. **Hairpin and clevis pin**
2. **Height–of–cut chain**

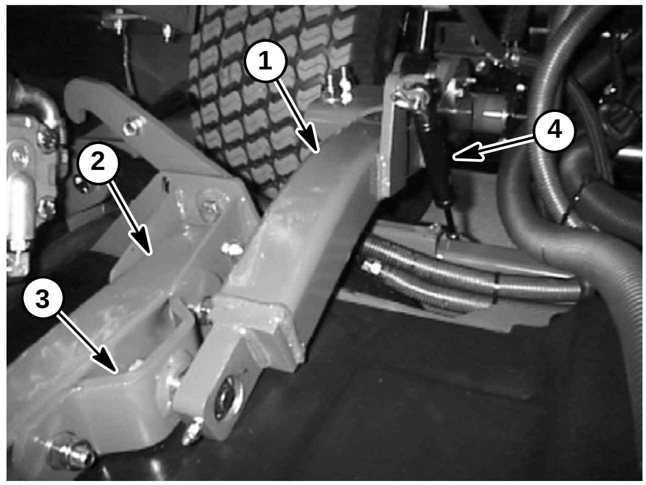

Figure 3

1. **Lift arm**
2. **Castor arm**
3. **Support hub**
4. **Damper**

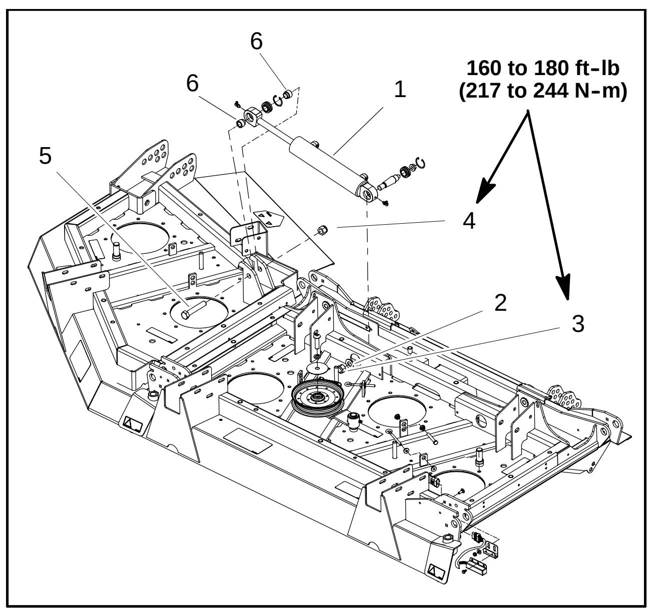

Figure 4

1. **Wing deck lift cylinder**
2. **Flat washer**
3. **Lock nut**
4. **Lock nut**
5. **Cap screw**
6. **Spacer**

NOTE: Installation of clevis pins to deck and height–of–cut chains is easier if deck is lifted slightly.

4. Install clevis pins and hairpins that secure the height–of–cut chains to the rear of the cutting deck (Fig. 2).

5. Remove plugs from hydraulic hoses and fittings on wing deck lift cylinders. Using labels placed during removal, correctly attach hydraulic hoses to lift cylinders.

6. Connect cutting deck wire harness to main machine wire harness (Fig. 5).

7. Position dampers to lift arms. Install clevis pins and hairpins to secure dampers to lift arms (Fig. 3).

8. Install all removed cutting deck covers.

9. Install hydraulic motors to cutting deck (see Cutting Deck Motor Installation in the Service and Repairs Section of Chapter 4 – Hydraulic System).

10. Lubricate grease fittings on cutting deck and lift assemblies.

11. Fill reservoir with hydraulic fluid as required.

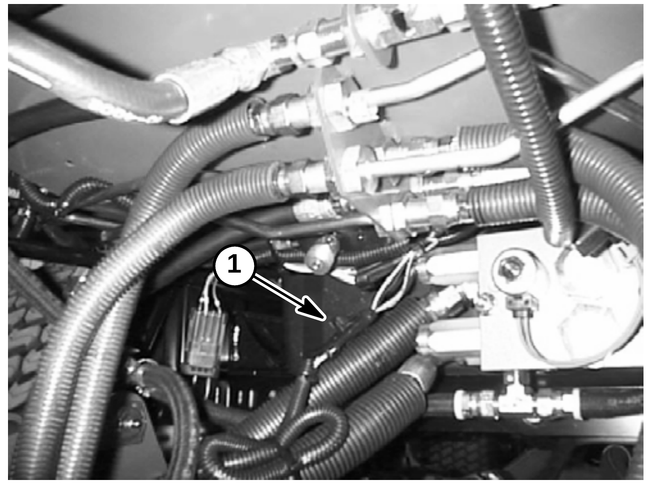

Figure 5

1. **Cutting deck wire harness connection**

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Wing Deck Service

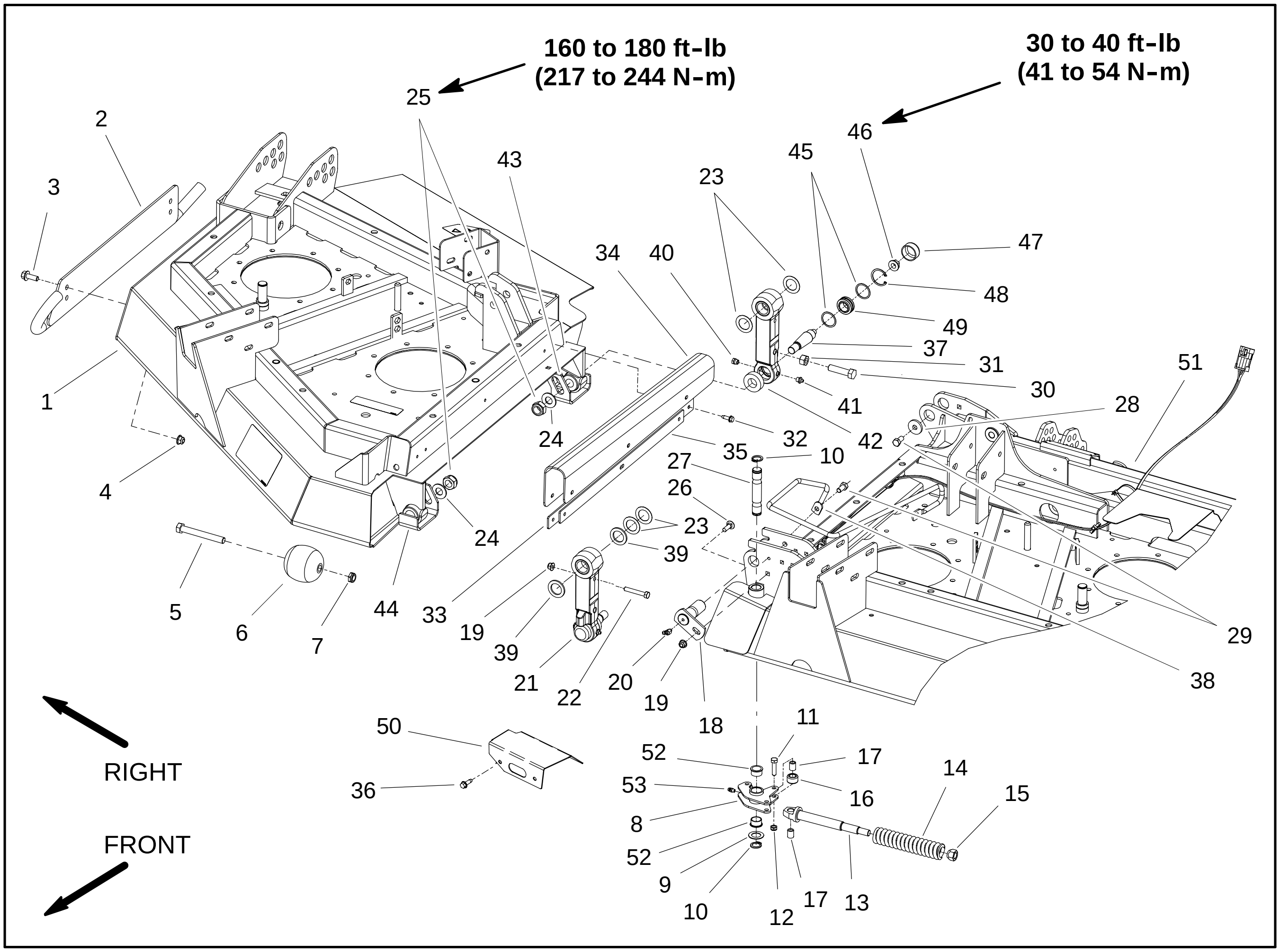

Figure 6

1. Wing deck (RH shown)
2. Skid (RH shown)
3. Flange screw (2 used per skid)
4. Flange nut (2 used per skid)
5. Cap screw
6. Roller (2 used)
7. Lock nut
8. Pivot latch (2 used)
9. Flat washer
10. Retaining ring (2 used per latch)
11. Cap screw (3 used per latch)
12. Lock nut (3 used per latch)
13. Spring support
14. Compression spring
15. Lug nut
16. Lock roller (2 used per latch)
17. Bushing (3 used per latch)
18. Pivot pin (4 used)
19. Flange nut (front links)
20. Grease fitting
21. Link assembly (4 used)
22. Cap screw (front links)
23. Thrust washer (0.030” thick)
24. Flat washer (4 used)
25. Lock nut (4 used)
26. Carriage bolt (4 used)
27. Latch pin
28. Flat washer (2 used)
29. Cap screw (4 used)
30. Cap screw (rear links)
31. Hex jam nut (rear links)
32. Washer head screw (12 used)
33. Wing strap (2 used)
34. Flex shield (2 used)
35. Shield strap (center deck)
36. Washer head screw (2 per shield)
37. Tapered stud
38. Hose guide
39. Hardened spacer (0.120” thick)
40. Plug
41. Grease fitting
42. Foam washer (4 used)
43. Link skid (2 used)
44. Link skid (2 used)
45. Flat washer
46. Flange nut
47. Dust cap
48. Retaining ring
49. Spherical bearing
50. Switch shield (RH shown)
51. Center deck
52. Flange bushing
53. Grease fitting

Removal (Fig. 6)

1. Position machine on a clean, level surface. Lower cutting deck and engage parking brake.

2. Fully raise wing deck, stop engine and remove key from the ignition switch. Remove three (3) washer head screws and shield strap that secure flex shield to wing deck. Lower wing deck.

3. Remove hydraulic motor from wing deck (see Cutting Deck Motor Removal in the Service and Repairs Section of Chapter 4 – Hydraulic System).

4. Remove cap screw and lock nut that secure lift cylinder clevis to the wing deck (Fig. 7).

5. Remove switch shield (item 50) from center deck.

6. Support wing deck to prevent it from falling as links are removed.

7. Remove cap screw (item 29) from pivot pin on upper end of both links. Cap screw on rear link also uses a flat washer (item 28).

NOTE: When removing pivot pins from deck, note location of thrust washers (item 6) and hardened spacers (item 42) for assembly purposes.

8. Remove flange nut (item 19) from carriage bolt (item 26) and pull pivot pins (item 18) from deck. Locate and retrieve thrust washers (item 6) and hardened spacers (item 42) from between links and deck brackets.

9. Slide the wing deck away from the center deck.

10. If required, remove link(s) from wing deck by removing lock nut and flat washer that secure tapered stud to deck. Press tapered stud from deck to remove link assembly. Remove foam washer (item 42) and link skid.

Installation (Fig. 6)

1. Park machine on a clean, level surface. Stop engine, engage parking brake and remove key from the ignition switch.

2. If links were removed from wing deck, thoroughly clean tapered stud on link and mounting boss of wing deck. Place foam washer on tapered stud and insert stud into deck mounting boss. Make sure that plug (item 40) is orientated toward wing deck and grease fitting (item 41) is toward center deck. Position link skid to stud and secure with flat washer and lock nut. Torque lock nut from **160 to 180 ft–lb (217 to 244 N–m)**.

NOTE: Pivot latches (item 8) may need to be manually opened prior to wing deck installation. If necessary, use a pry bar to carefully open latch.

3. Position the wing deck to the center deck.

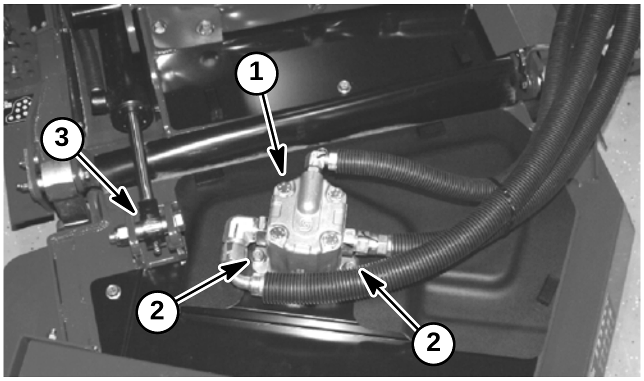

Figure 7

1. Hydraulic motor
2. Flange head screw
3. Lift cylinder clevis

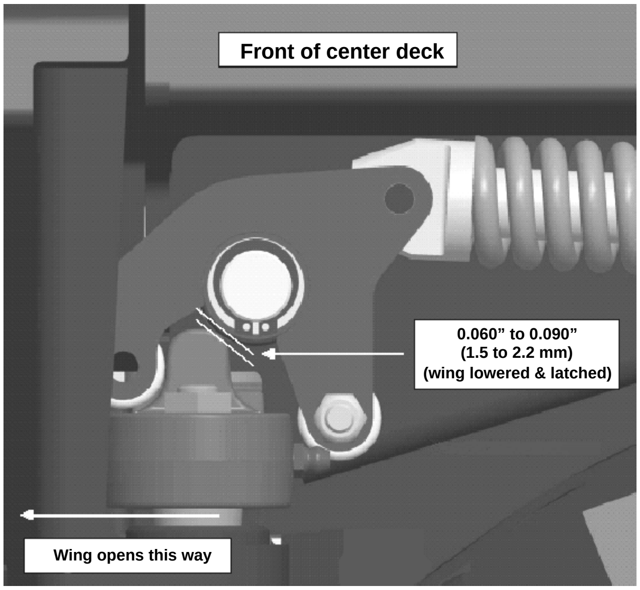

Figure 8

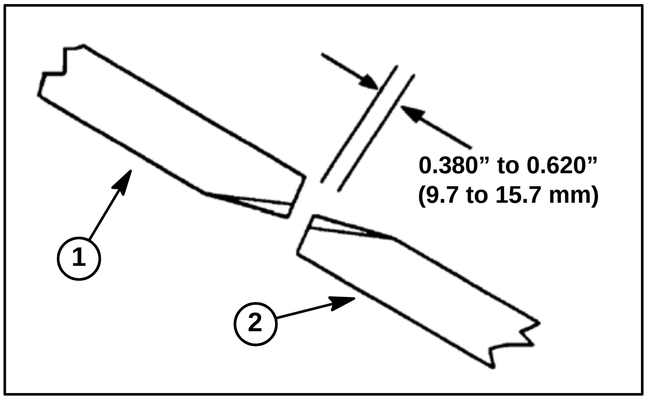

Figure 9

1. Wing deck blade
2. Center deck blade

Cutting Deck

4. Position upper end of links to center cutting deck brackets.

5. Align upper end of links with mounting holes in center deck. While installing pivot pins to center deck and links, insert spacers and washers as follows:

A. Place one (1) hardened spacer (item 42) on each side of the front link. Use two (2) thrust washers on rear side of assembly so that link is snug between deck brackets. Additional thrust washers should be installed, if necessary, to remove excess clearance.

B. Place one (1) thrust washer (item 6) on each side of rear link. Clearance between rear link and deck bracket is acceptable.

6. Secure pins with carriage screw and flange head screw.

7. Install cap screw (item 29) to pivot pin on both links. Cap screw on rear link uses a flat washer (item 28). Cap screw on front link also secures hose guide (item 38).

8. Position lift cylinder to the wing deck (Fig. 7). Secure cylinder with cap screw and lock nut.

9. Install hydraulic motor to cutting deck (see Cutting Deck Motor Installation in the Service and Repairs Section of Chapter 4 – Hydraulic System).

10. Fully raise wing deck, stop engine and remove key from the ignition switch. Secure flex shield to wing deck with shield strap and three (3) washer head screws. Lower wing deck.

11. Lower wing deck and inspect deck latch assembly to insure that front link is locked when the wing deck is in the lowered position. There should be a gap from 0.060” to 0.090” (1.5 to 2.2 mm) between the arm latch actuator and the latch pivot (Fig. 8). If gap is incorrect, adjust link position by repositioning the location of the hardened spacers (item 42) and thrust washers (item 6). At a minimum, there must be one (1) hardened spacer positioned to the rear of the front link.

12. Lubricate grease fittings on cutting deck and lift components.

13. Check distance between inner deck blade on wing deck and outer deck blade on center deck. Distance between blades should be 0.380” to 0.620” (9.7 to 15.7 mm) (Fig. 9). If blade distance is incorrect, loosen hex jam nut (item 32) on rear link assembly and adjust cap screw (item 31). Tighten jam nut when blade distance is correct.

14. Check operation of wing deck position switch. Adjust if necessary (see Wing Deck Position Switches in the Adjustments section of Chapter 5 – Electrical System).

15. Secure switch shield (item 50) to center deck.

Cutting Deck Link Service

Disassembly (Fig. 10)

1. Press bushings from top of link.

2. Remove dust cap and retaining ring from link.

3. Press tapered stud with spherical bearing, flat washers and flange nut from link.

4. Remove flange nut and press spherical bearing from tapered stud.

Assembly (Fig. 10)

1. Install new spherical bearing onto tapered stud. Secure bearing with flange nut. Torque nut from **30 to 40 ft-lb (41 to 54 N-m)**.

2. Position flat washer in both sides of spherical bearing.

3. Press tapered stud with spherical bearing, flat washers and flange nut into link. Secure spherical bearing into link with retaining ring.

4. Press bushings into top bore of link.

5. If cap screw and jam nut were removed from rear link, install cap screw to allow 1.625" (41.3 mm) between the head of the screw and the side of the link (Fig. 11).

6. After link is installed on deck, check distance between center deck blade and wing deck blade. Readjust cap screw and jam nut on rear link if needed (see Wing Deck Service in this Chapter).

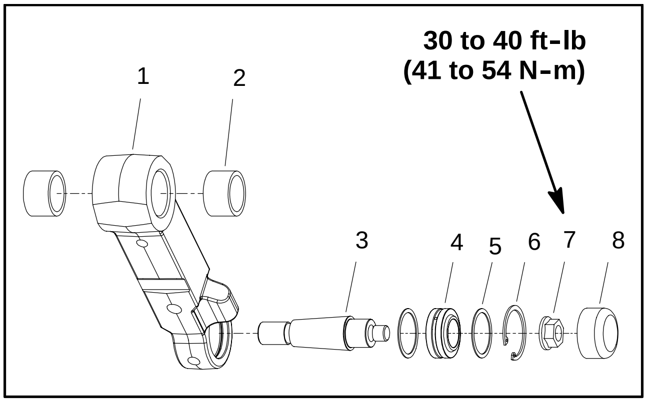

Figure 10

1. **Link**
2. **Bushing (2 used)**
3. **Tapered stud**
4. **Spherical bearing**
5. **Flat washer (2 used)**
6. **Retaining ring**
7. **Flange nut**
8. **Dust cap**

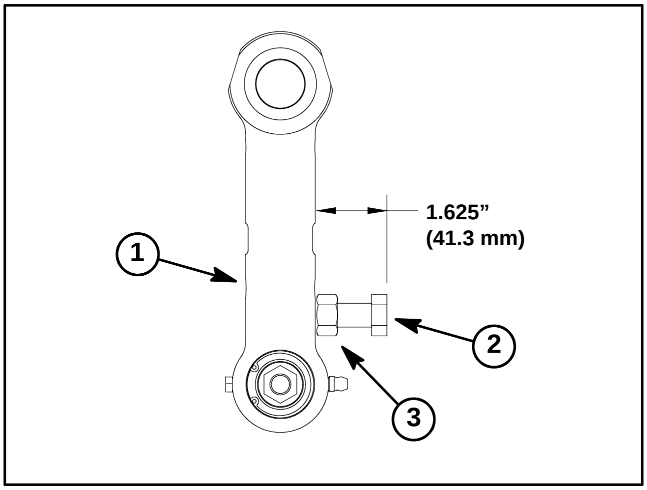

Figure 11

1. **Rear link**
2. **Cap screw**
3. **Hex jam nut**

Cutting Deck

Wing Deck Latch

Disassembly (Fig. 12)

1. Raise wing deck to transport position. Carefully rotate latch to closed position.

2. Loosen lug nut to release compression spring tension.

3. Remove retaining ring and flat washer from bottom of latch pin. Rotate lug nut enough to allow latch pin to be removed from latch.

4. Remove lug nut from spring support. Remove latch assembly from deck.

5. Disassemble latch (items 1 through 8) using Figure 12 as a guide.

Assembly (Fig. 12)

1. Assemble latch (items 1 through 8) using Figure 12 as a guide.

2. Slide spring onto spring support and insert end of spring support into hole located on underside of center deck. Start lug nut (tapered side towards plate on deck) onto spring support.

3. Tighten lug nut until holes in front of deck align with bushings in latch. Insert latch pin with retaining ring down through deck and latch. Secure latch pin on underside of deck with flat washer and retaining ring.

4. Carefully rotate latch to the open position. Lower wing deck to allow link to engage latch.

5. Lubricate latch grease fitting.

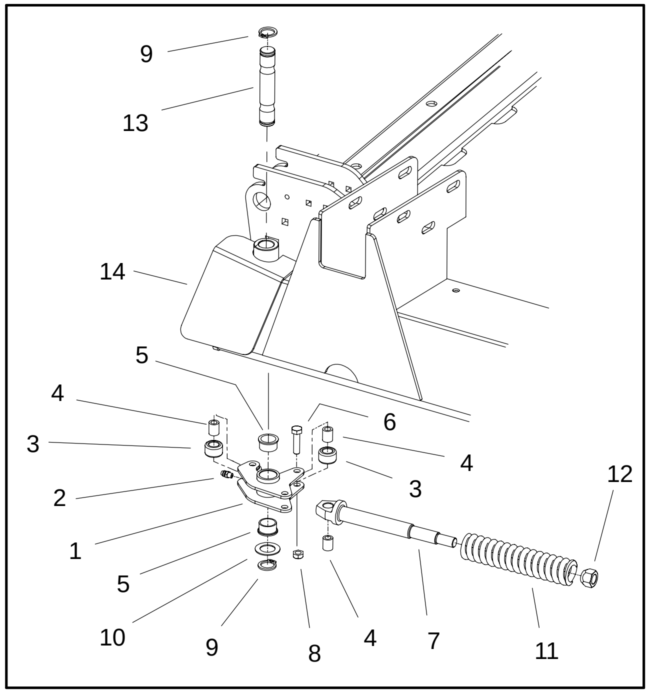

Figure 12

1. **Latch**
2. **Grease fitting**
3. **Lock roller**
4. **Bushing**
5. **Flange bushing**
6. **Cap screw (3 used)**
7. **Spring support**
8. **Lock nut (3 used)**
9. **Retaining ring**
10. **Flat washer**
11. **Compression spring**
12. **Lug nut**
13. **Latch pin**
14. **Center deck**

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Cutting Deck

Blade Spindle

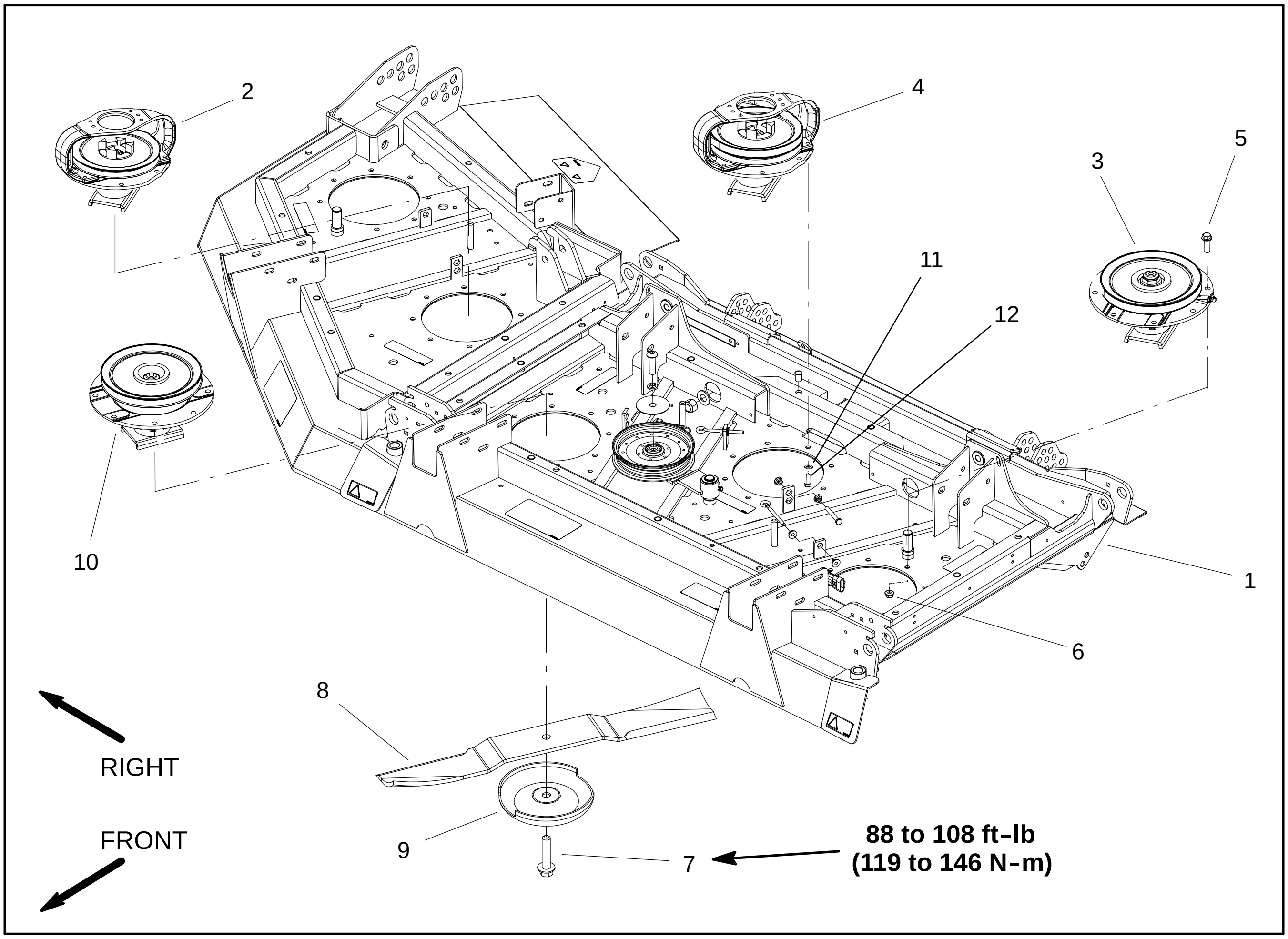

Figure 13

1. **Cutting deck**
2. **Drive spindle: single pulley (2 used)**
3. **Low driven spindle (3 used)**
4. **Drive spindle: double pulley (1 used)**
5. **Flange head screw**
6. **Flange nut**
7. **Blade bolt**
8. **Cutting blade (7 used)**
9. **Anti-scalp cup**
10. **High driven spindle (1 used)**
11. **Flat washer**
12. **Cap screw**

Removal (Fig. 13)

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

2. 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 System). Position motor away from spindle.

3. Remove belt covers from top of cutting deck. Loosen idler pulley to release belt tension (see Idler Assembly Removal in this section). Remove drive belt from spindle to be serviced.

4. 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.

5. Remove cutting blade, anti-scalp cup and blade bolt from spindle to be serviced.

6. 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, loosen and remove four (4) flange head screws with flange nuts that secure spindle to deck. Then, remove four (4) cap screws with flat washers that secure spindle and motor mount to deck.

Installation (Fig. 13)

1. Position spindle on cutting deck noting orientation of grease fitting (Fig. 15). Secure spindle assembly to deck with removed fasteners.

2. Install cutting blade, anti–scalp cup and blade bolt. Tighten blade bolt from **88 to 108 ft–lb (119 to 146 N–m)**.

3. Slowly rotate cutting blades to verify that blades do not contact any deck component(s).

4. Install drive belt and adjust 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 System).

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 belt covers to cutting deck.

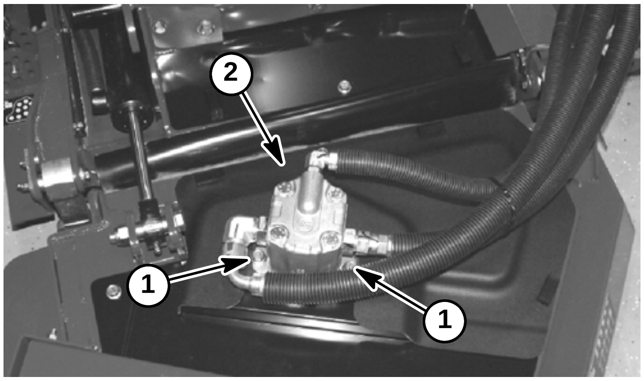

Figure 14

1. **Flange head screw**
2. **Hydraulic motor**

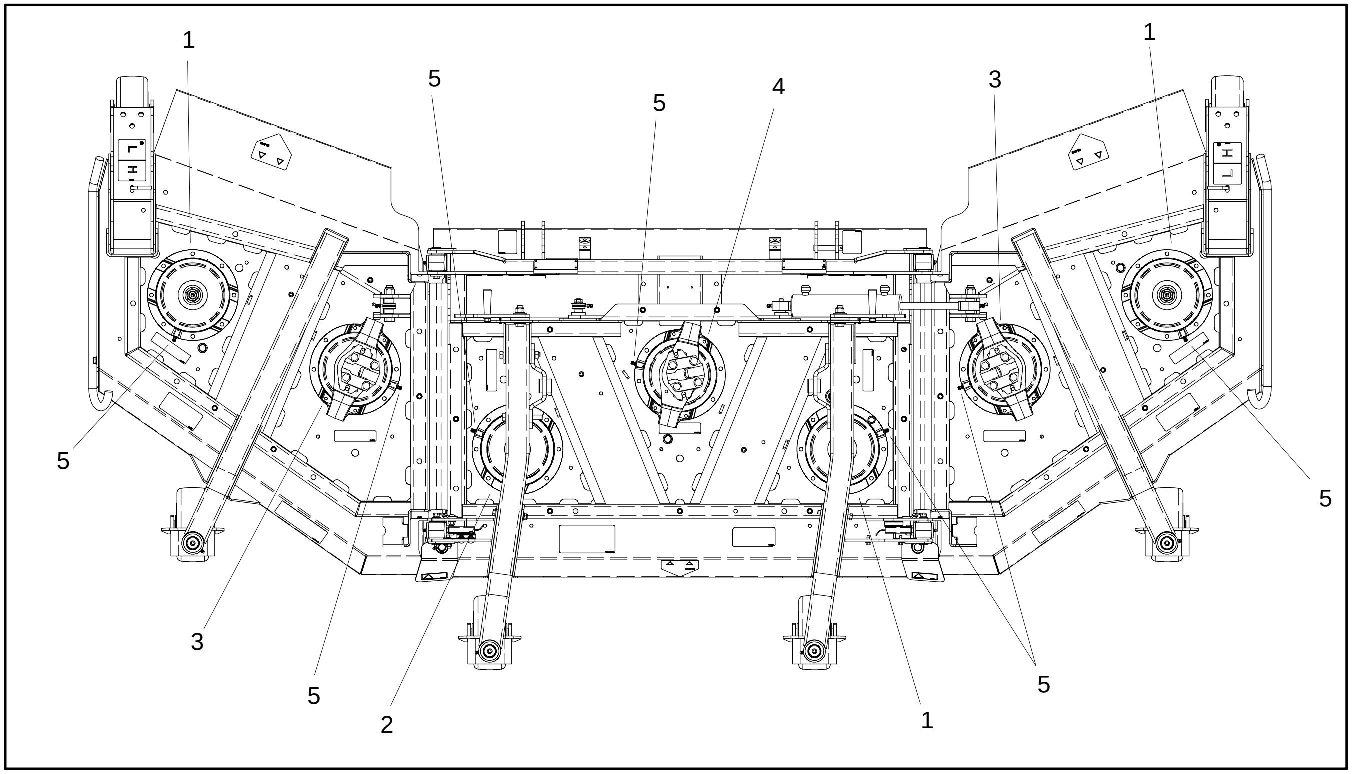

Figure 15

1. **Driven spindle**
2. **Driven spindle (high pulley)**
3. **Drive spindle (wing deck)**
4. **Drive spindle (center deck)**
5. **Spindle grease fitting location**

Cutting Deck

Blade Spindle Service

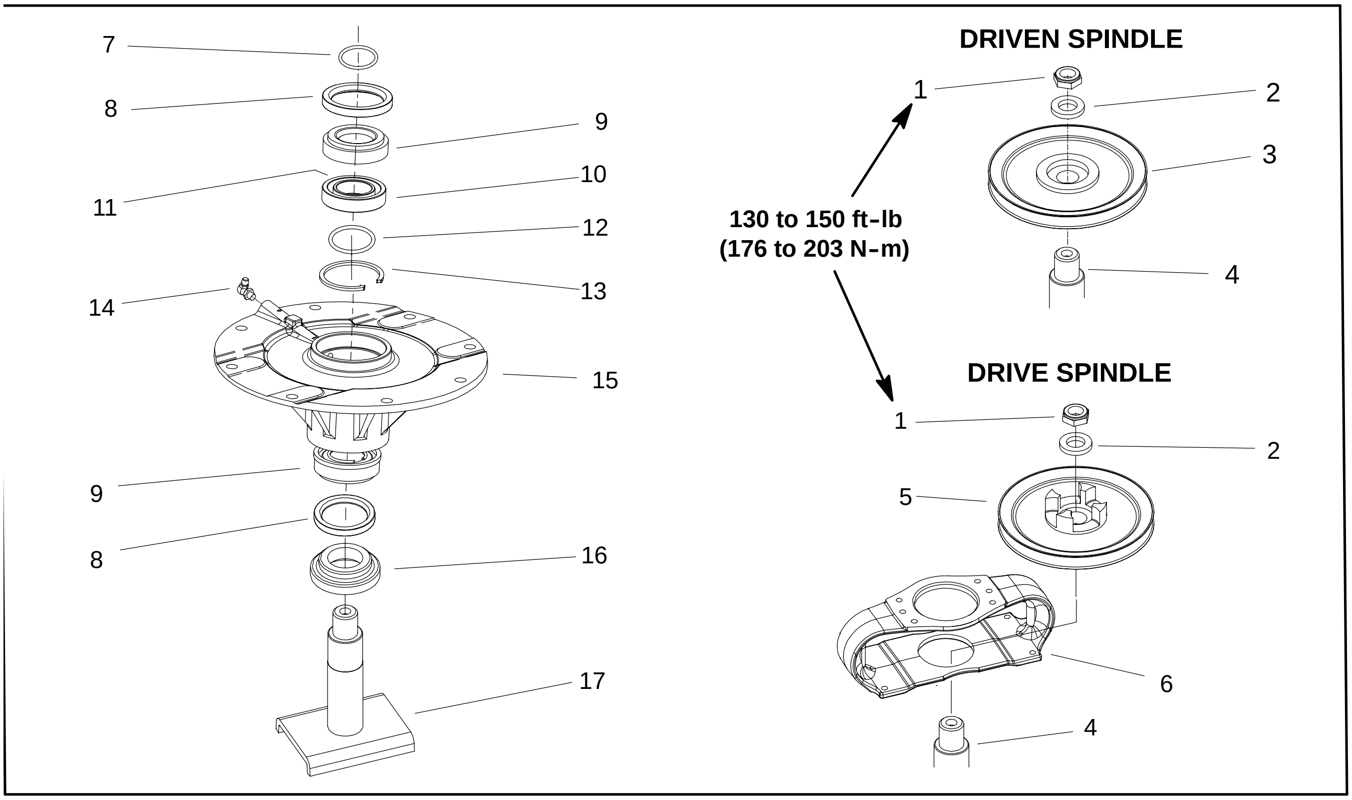

Figure 16

1. Lock nut
2. Flat washer
3. Driven pulley
4. Spindle shaft
5. Drive pulley (single shown)
6. Hydraulic motor mount
7. O-ring
8. Oil seal
9. Bearing cup and cone
10. Outer bearing spacer
11. Inner bearing spacer
12. Spacer ring
13. Snap ring
14. Grease fitting
15. Spindle housing
16. Spindle shaft spacer
17. Spindle shaft

Disassembly (Fig. 16)

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. 17).

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. 16)

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. 17). 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. 17). 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 18).

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. 19). 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. 17).

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. 19). 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.

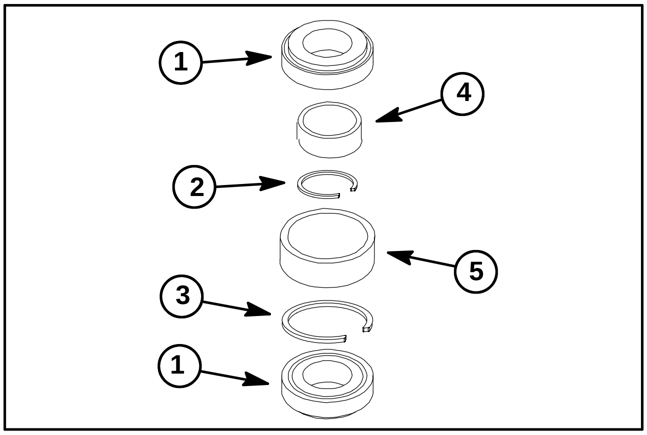

Figure 17

1. **Bearing**
2. **Spacer ring**
3. **Large snap ring**
4. **Inner bearing spacer**
5. **Outer bearing spacer**

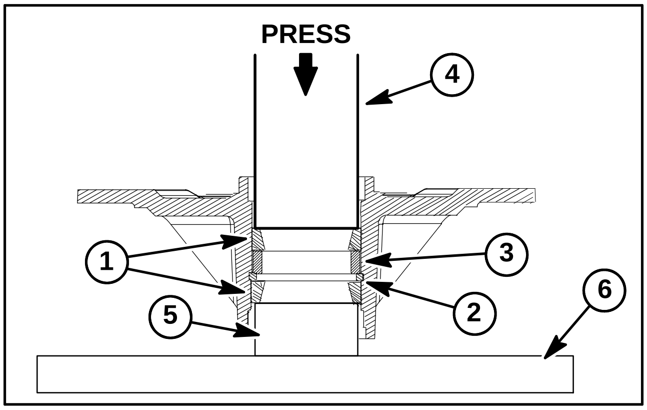

Figure 18

1. **Bearing cups**
2. **Large snap ring**
3. **Large outer spacer**
4. **Arbor press**
5. **Support**
6. **Arbor press base**

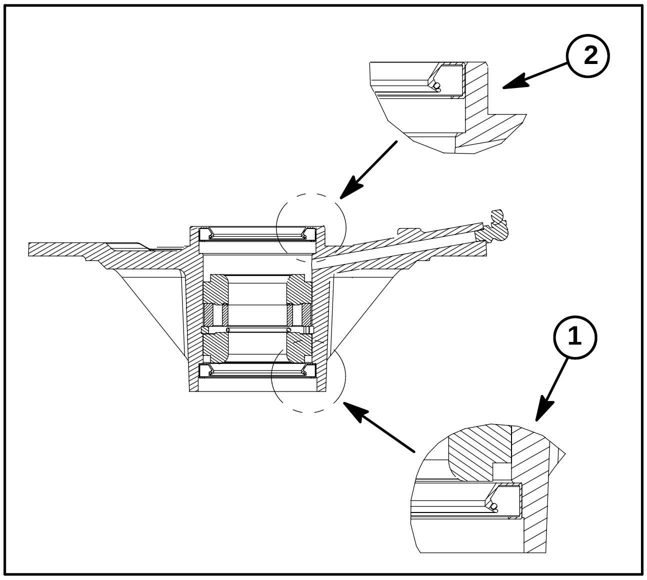

Figure 19

1. **Bottom seal installation**
2. **Upper seal installation**

Cutting Deck

Idler Assembly

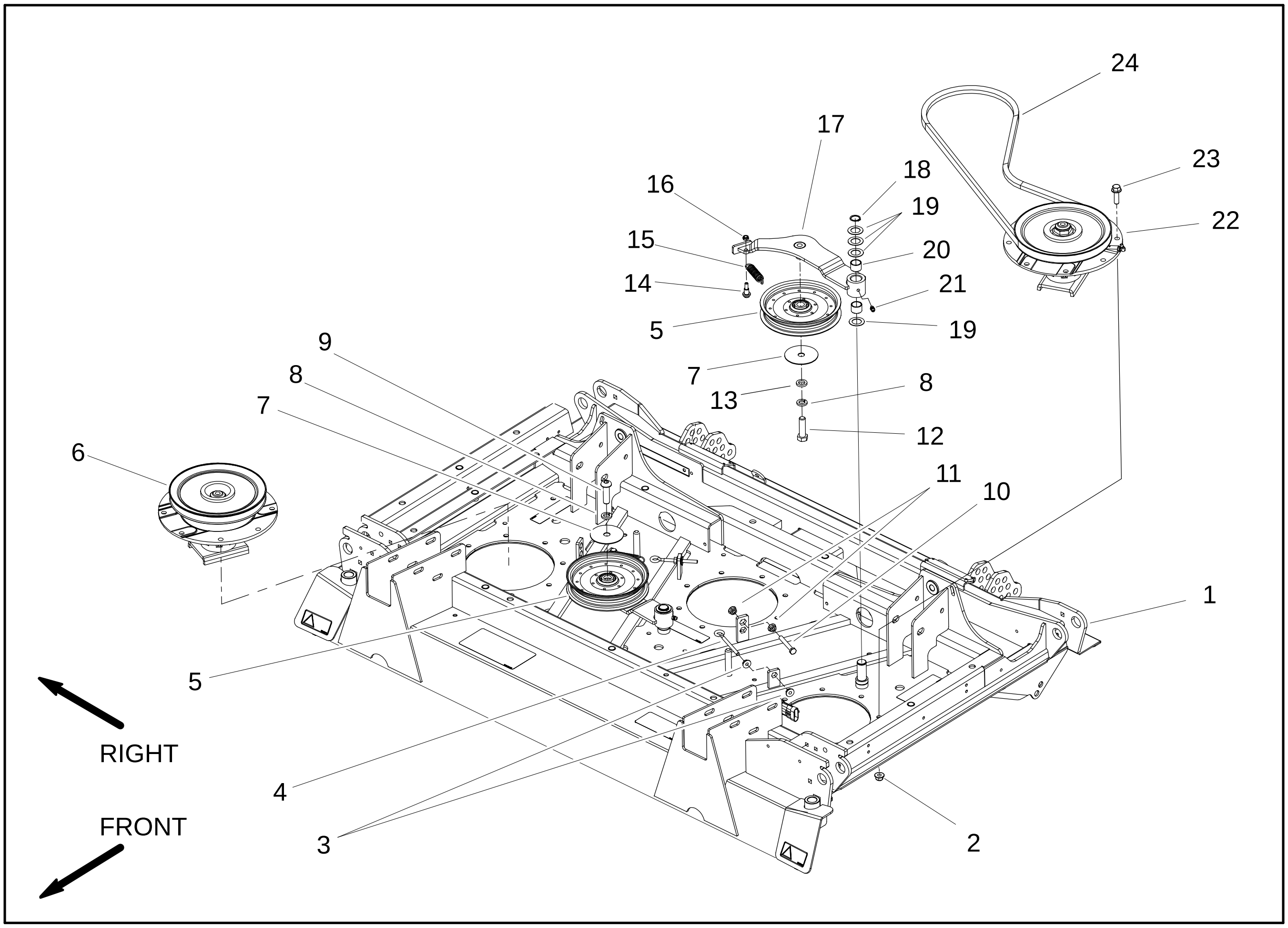

Figure 20

1. Center deck
2. Flange nut
3. Flange nut
4. Adjusting screw
5. Idler pulley
6. High driven pulley
7. Flat washer
8. Lock washer
9. Socket head screw
10. Idler stop bolt
11. Flange nut
12. Cap screw
13. Spacer
14. Shoulder bolt
15. Idler spring
16. Lock nut
17. Idler arm
18. Retaining ring
19. Thrust washer (4 used per idler)
20. Bushing (2 used per idler)
21. Grease fitting
22. Low driven pulley
23. Flange head screw
24. Drive belt

NOTE: The center deck is shown in Figure 20. The idler assemblies used on the wing decks use the same idler components.

Removal (Fig. 20)

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.

CAUTION

Be careful when removing idler spring. The spring is under heavy load and may cause personal injury.

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 20 as a guide. Note location of washers, idler spacer and screw as idler assemblies are being removed.

Installation (Fig. 20)

1. Install removed idler components using Figure 20 as a guide.

   A. Make sure that one (1) thrust washer (item 19) is placed below the idler arm and three (3) thrust washers are placed between the idler and retaining ring location.

   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.

CAUTION

Be careful when installing the idler spring. The spring is under heavy load and may cause personal injury.

3. Use spring hook tool to attach the idler spring (item 15) onto the adjusting screw (item 4) and shoulder bolt on idler arm. With the idler arm tensioning the drive belt, the spring hook to hook length should be from 3.250” to 3.750” (82.6 to 95.2 mm) (Fig. 21). If necessary, disconnect spring and change position of adjusting screw. When idler spring is the correct length, tighten second flange nut to secure adjustment.

4. Adjust location of idler stop bolt (item 10) 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. 21).

5. Lubricate idler arm grease fitting.

6. Install deck covers to cutting deck.

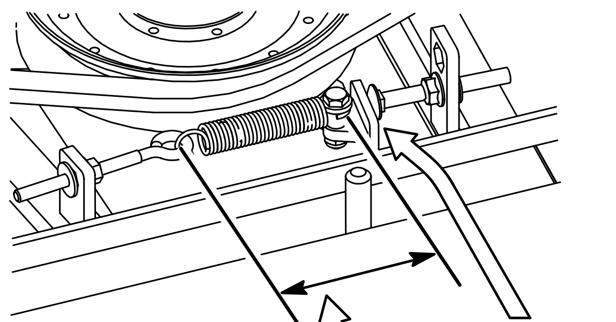

Figure 21

Castor Forks and Wheels

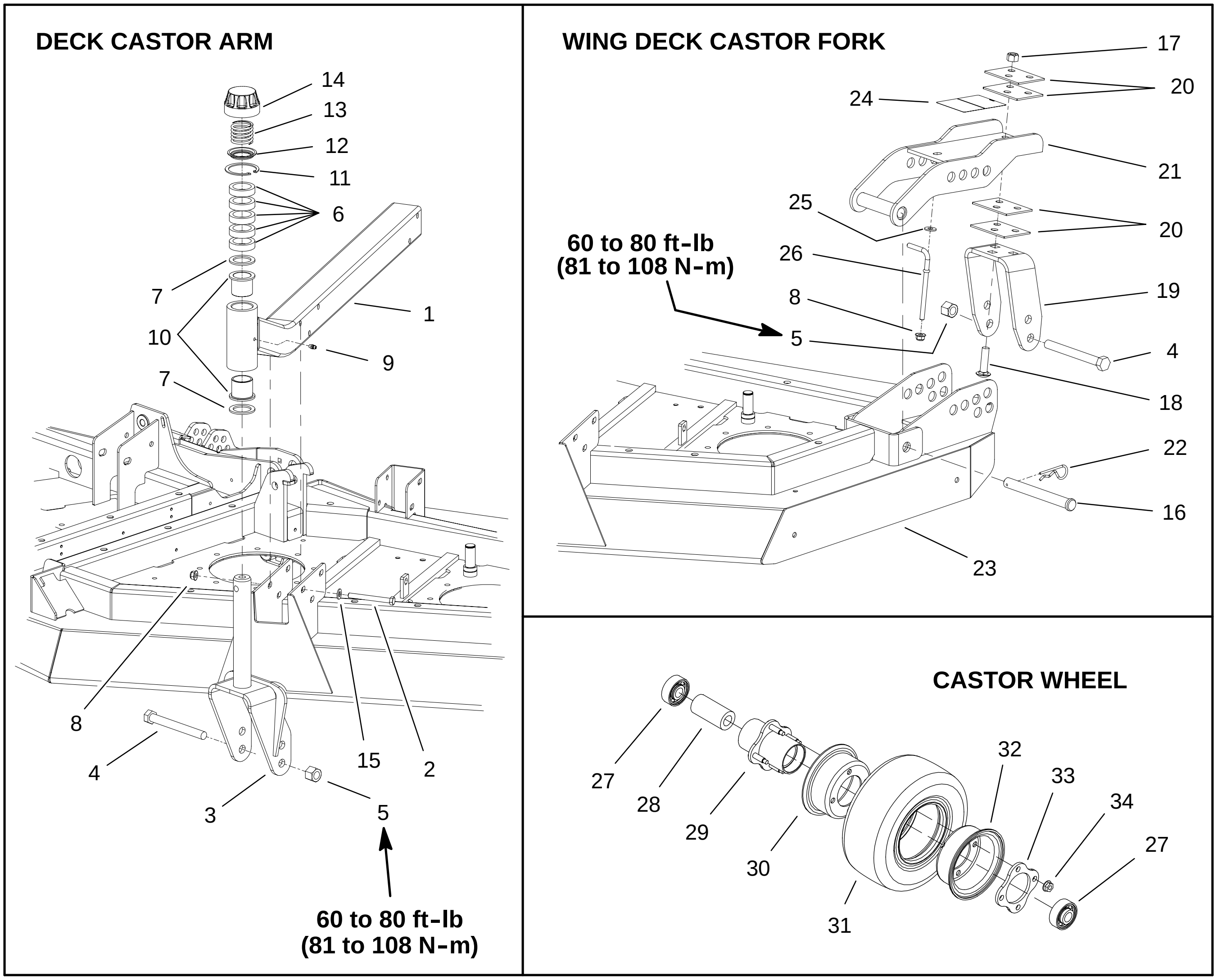

Figure 22

1. Castor arm (wing deck shown)
2. Cap screw (6 per arm)
3. Castor fork
4. Castor wheel bolt
5. Lock nut
6. Castor spacer
7. Thrust washer
8. Flange lock nut
9. Grease fitting
10. Flange bushing
11. Retaining ring
12. Cap washer
13. Compression spring
14. Cap
15. Flat washer (6 per arm)
16. Clevis pin (2 used per fork)
17. Lock nut
18. Carriage screw (3 used per fork)
19. Castor fork bracket
20. Shim
21. Castor fork bracket
22. Hairpin
23. Cutting deck (LH shown)
24. Decal
25. Flat washer
26. Tension rod
27. Bearing
28. Inner bearing spacer
29. Wheel hub
30. Wheel rim half
31. Castor tire/tube
32. Wheel rim half
33. Plate
34. Flange nut (4 used per wheel)

Disassembly (Fig. 22)

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

2. Disassemble castor forks and wheels using Figure 22 as a guide.

Assembly (Fig. 22)

1. Assemble castor forks and wheels using Figure 22 as a guide.

2. Torque castor wheel lock nut from **60 to 80 ft–lb (81 to 108 N–m)**.

3. If castor fork was removed, lubricate grease fitting.

4. See Operator’s Manual for castor wheel adjustment.

Deck Rollers and Skids

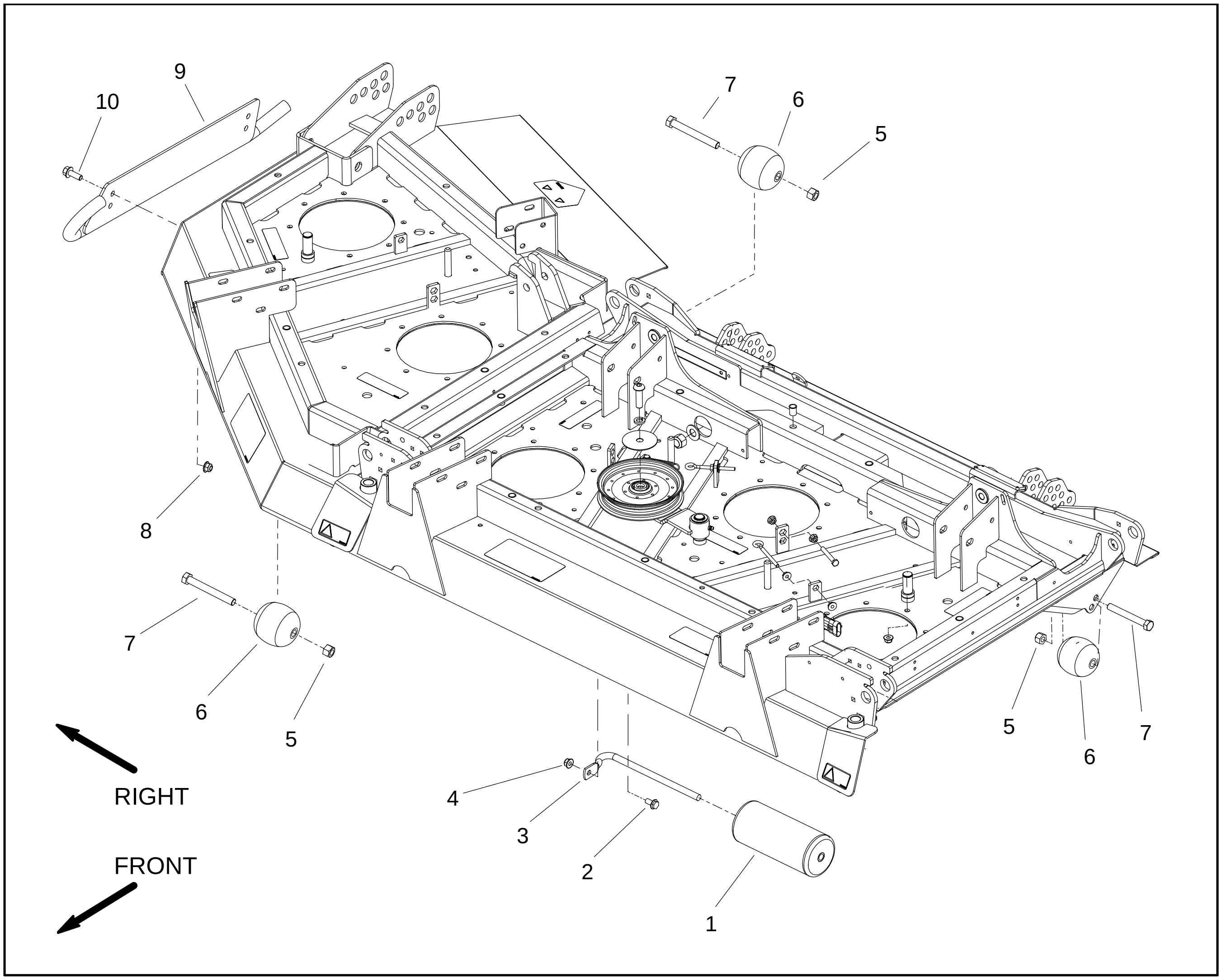

Figure 23

1. **Roller**
2. **Flange head screw**
3. **Roller shaft**
4. **Flange nut**
5. **Lock nut**
6. **Roller**
7. **Cap screw**
8. **Flange nut**
9. **Skid (RH shown)**
10. **Flange head screw**

Removal (Fig. 23)

1. Remove skids and rollers from deck using Figure 23 as a guide.

Installation (Fig. 23)

1. Install skids (item 9) to deck using Figure 23 as a guide. Make sure to install skids in the same mounting hole height position (lower or upper).

2. Install rollers (items 1 and 6) to deck using Figure 23 as a guide. When installing roller (item 6), install cap screw with the threads orientated toward the centerline of the deck. Install and tighten lock nut until roller will not rotate, then loosen lock nut only enough to allow roller to rotate freely. Make sure to install all deck rollers in the same mounting hole height position (lower or upper).

Chapter 9

Operator Cab

Table of Contents

General Information

The information in this chapter pertains to the operator cab on the Groundsmaster 4110–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 4110–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 4110–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 4110–D consists of the following components:

1. A heater core 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. 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.

4. Put labels on disconnected lines and hoses for proper installation after repairs are completed.

5. Put caps or plugs on any lines, fittings or components left open or exposed to prevent system contamination.

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 4110–D air conditioning system uses R134a refrigerant. DO NOT use other refrigerants in the system. A/C system capacity is approximately 1 pound 6 ounces (624 gm) 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

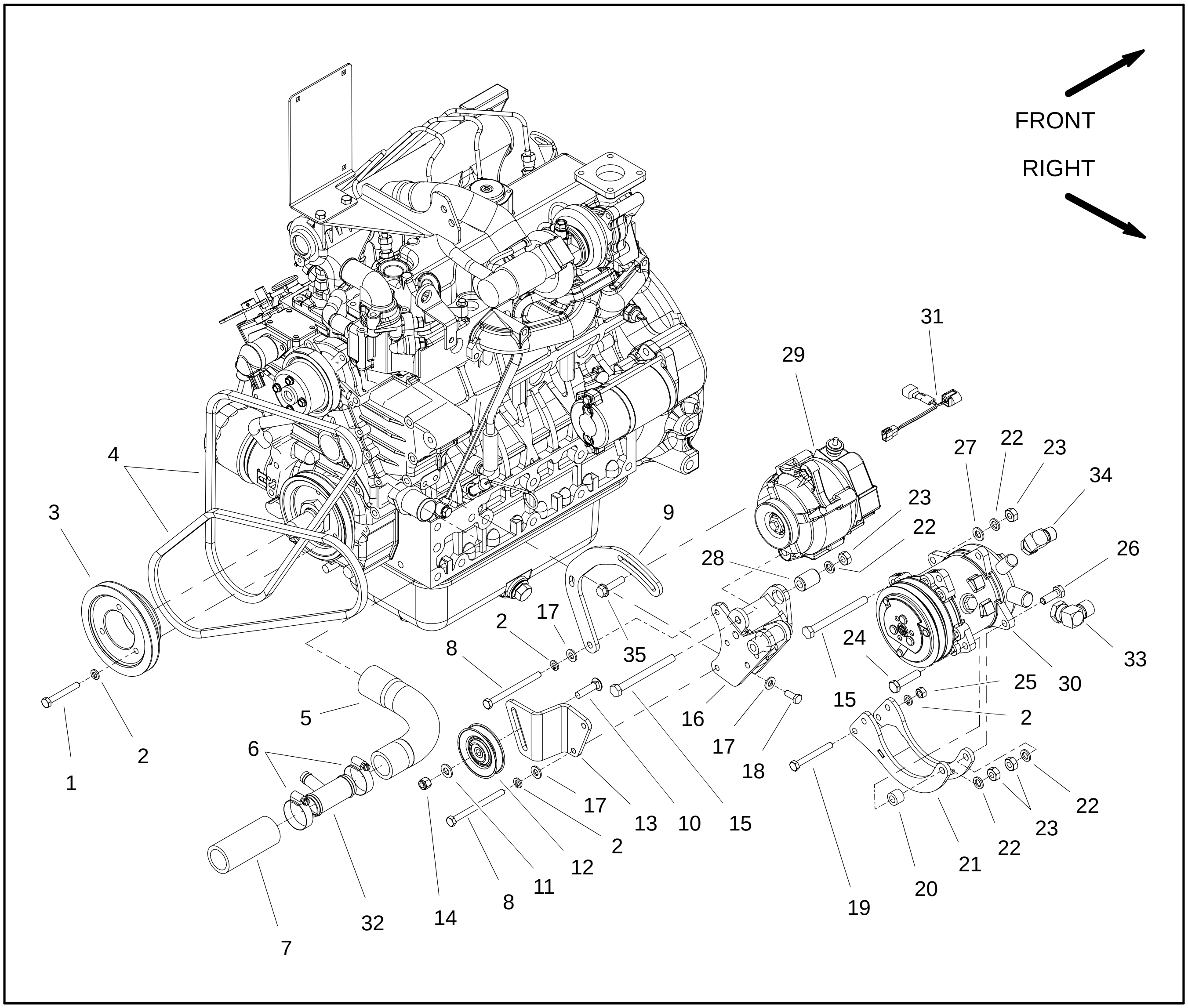

Figure 1

1. Cap screw (3 used)
2. Lock washer (8 used)
3. Pulley
4. V–belt
5. Lower radiator hose
6. Hose clamp (2 used)
7. Lower radiator hose
8. Cap screw
9. Alternator plate
10. Carriage screw
11. Flat washer
12. Idler pulley
13. Idler plate bracket
14. Lock nut
15. Cap screw
16. A/C compressor mount
17. Flat washer
18. Cap screw
19. Cap screw
20. Spacer
21. Compressor arm
22. Lock washer (5 used)
23. Hex nut (5 used)
24. Cap screw
25. Hex nut (2 used)
26. Cap screw
27. Flat washer
28. Spacer (2 used)
29. Alternator (90 amp)
30. Air conditioning compressor
31. Alternator wire harness
32. Radiator fitting
33. 90º fitting
34. 90º fitting
35. Bolt

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 drive 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 4110–D is a Sanden model SD5H09. For air conditioning compressor repair procedures, see the Sanden 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 mounting brackets must be less than 0.004" (0.10 mm). If necessary, install shims between compressor flanges and brackets 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 A/C 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 approximately 1 pound 6 ounces (624 gm) of R134a refrigerant.

10. Lower and secure hood.

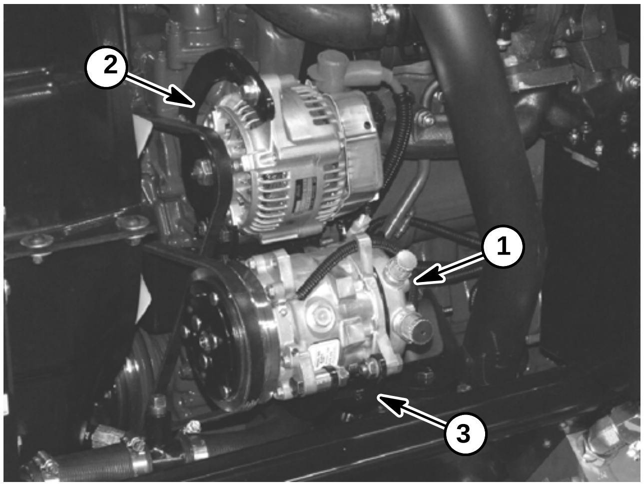

Figure 2

1. A/C compressor
2. Alternator
3. Compressor arm

Roof Assembly

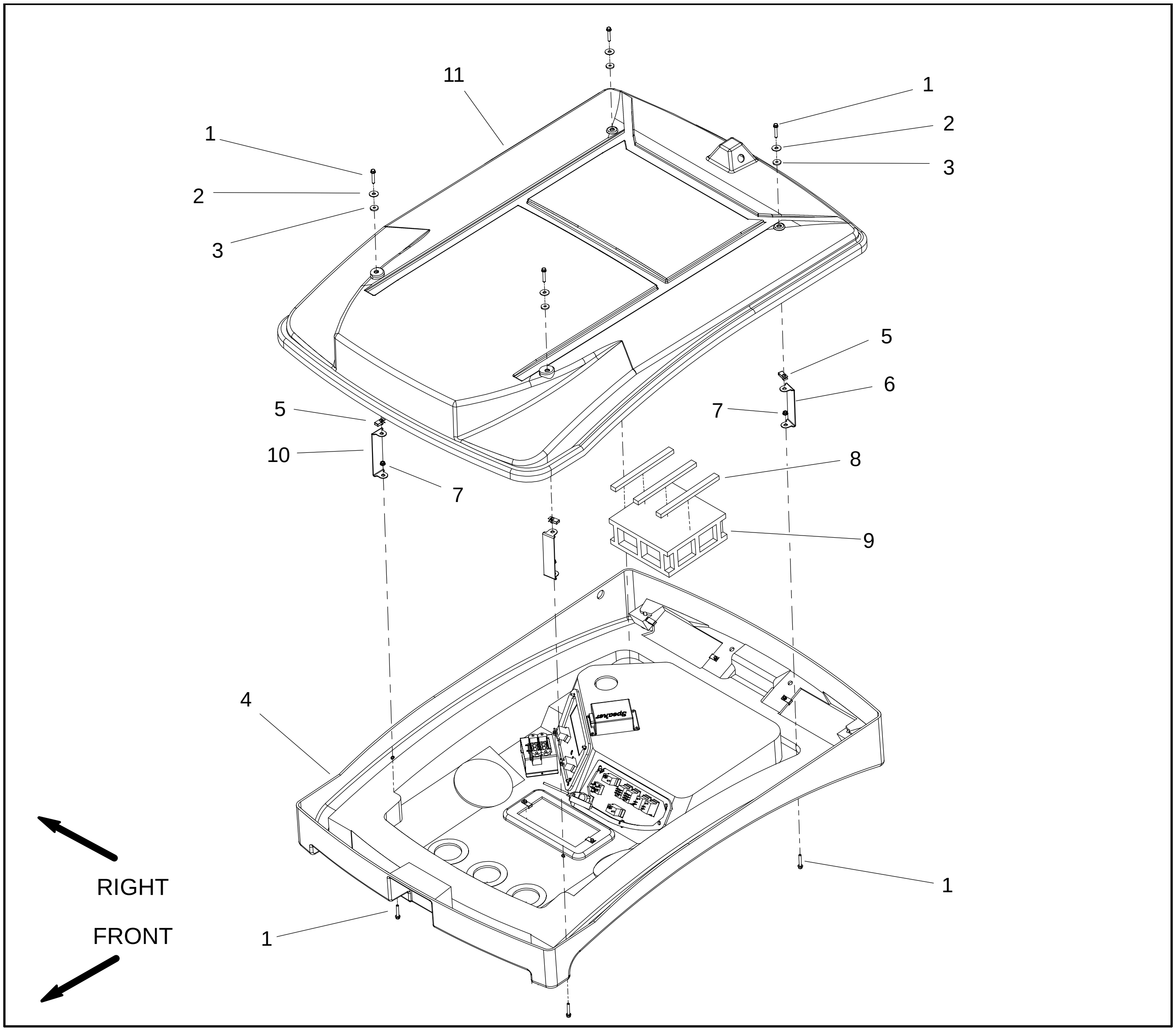

Figure 3

1. Flange head screw (8 used)
2. Flat washer (4 used)
3. Bushing (4 used)
4. Headliner
5. Panel nut (4 used)
6. Rear coupling plate (2 used)
7. Flange nut (4 used)
8. Foam spacer (3 used)
9. Headliner spacer
10. Front coupling plate (2 used)
11. Roof

To gain access to the heater core and air conditioning components that are located above the cab headliner, 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 four (4) flange head screws (item 1), flat washers (item 2) and bushings (item 3) that secure roof to front and rear coupling plates.

3. 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 removed fasteners.

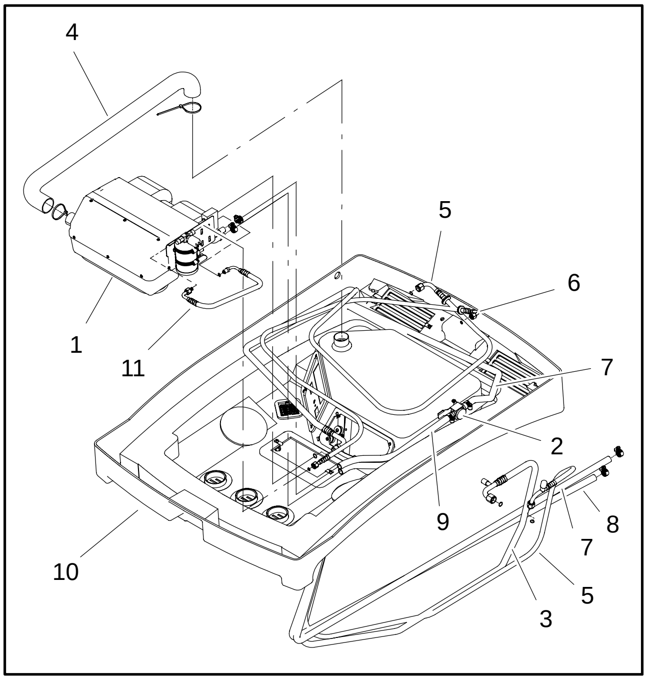

Figure 4

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 coil**
6. **A/C hose: condenser coil 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. **Headliner**
11. **A/C hose: drier to evaporator**

Cab Hose Identification

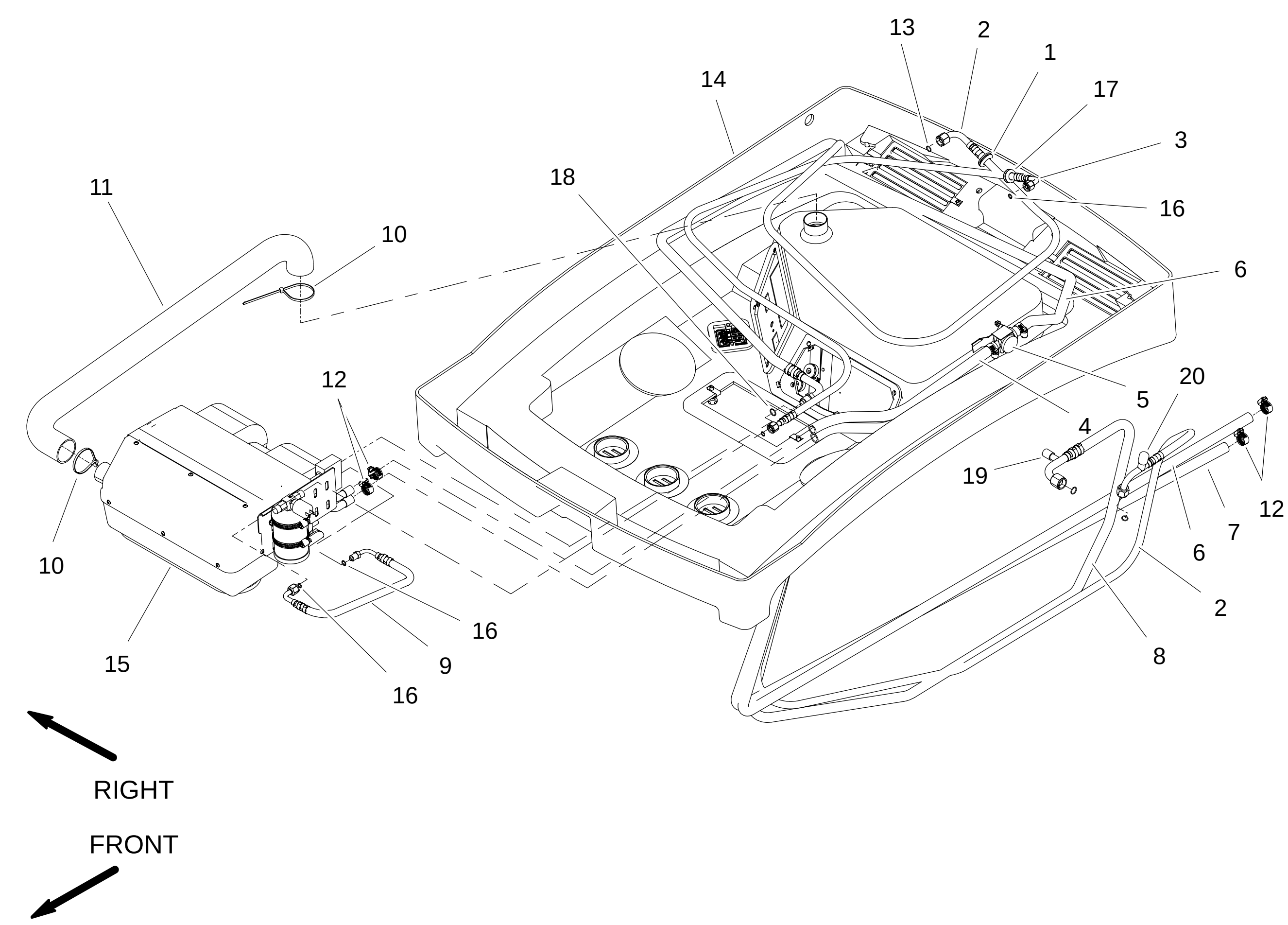

Figure 5

1. Grommet
2. AC hose (compressor to condenser)
3. AC hose (condenser coil to drier)
4. Heater hose (valve to heater)
5. Heater valve
6. Heater hose (thermostat to valve)
7. Heater hose (heater to pump)
8. AC hose (evaporator to compressor)
9. AC hose (drier to evaporator)
10. Cable tie (2 used)
11. Air duct hose
12. Hose clamp (6 used)
13. O–ring
14. Headliner
15. Heater evaporator assembly
16. O–ring
17. Grommet
18. O–ring
19. Cap (AC high side)
20. Cap (AC low side)

Figure 5 shows the location of air conditioning and heater components in the cab headliner. Use this illustration when service or repairs of these components are necessary.

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Air Conditioning Condenser Assembly

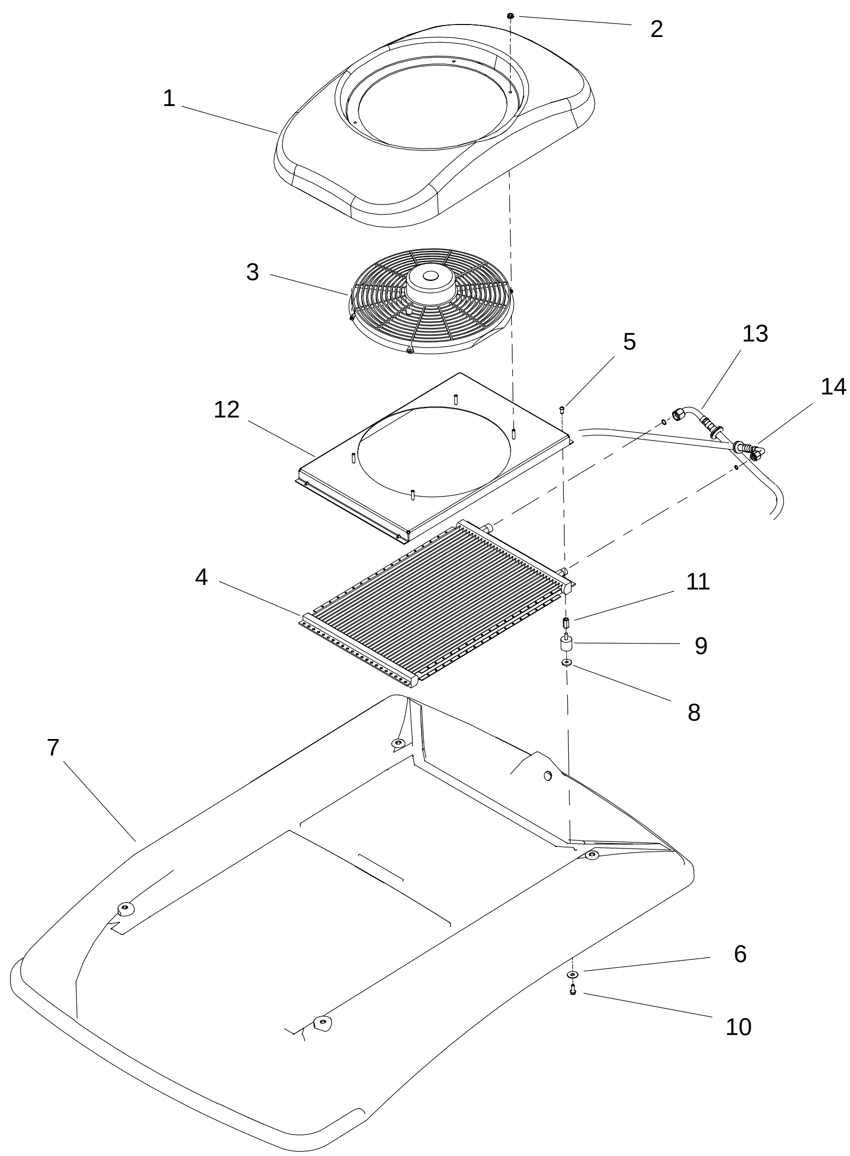

Figure 6

1. **Condenser cover**
2. **Flange nut (4 used)**
3. **Condenser fan**
4. **Condenser coil**
5. **Button head screw (4 used)**
6. **Flat washer (4 used)**
7. **Roof**
8. **Bushing (4 used)**
9. **Isolator mount (4 used)**
10. **Flange head screw (4 used)**
11. **Coupler nut (4 used)**
12. **Condenser fan mount**
13. **AC hose (compressor to coil)**
14. **AC hose (condenser coil to drier)**

Removal (Fig. 6)

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

2. 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 four (4) flange nuts (item 2) that secure condenser fan and cover to condenser fan mount. Lift cover and fan from roof.

5. Remove four (4) button head screws (item 5) that secure condenser fan mount (item 12) to roof. Lift fan mount 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 A/C hoses from condenser coil. Immediately cap hoses and fittings to prevent moisture and contaminants from entering the system.

9. Remove condenser coil from roof.

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. 6)

1. Position condenser coil to roof.

2. Remove caps that were placed on A/C hoses and fittings during the removal process. Using labels placed during removal, properly secure hoses to condenser coil.

3. Position condenser mount to condenser coil. Secure mount with four (4) button head screws (item 5).

4. Position condenser fan and cover to condenser fan mount and secure with four (4) flange nuts (item 2).

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 approximately 1 pound 6 ounces (624 gm) of R134a refrigerant.

8. Lower and secure roof assembly (see Roof Assembly Installation in this section).

Heater/Evaporator Assembly

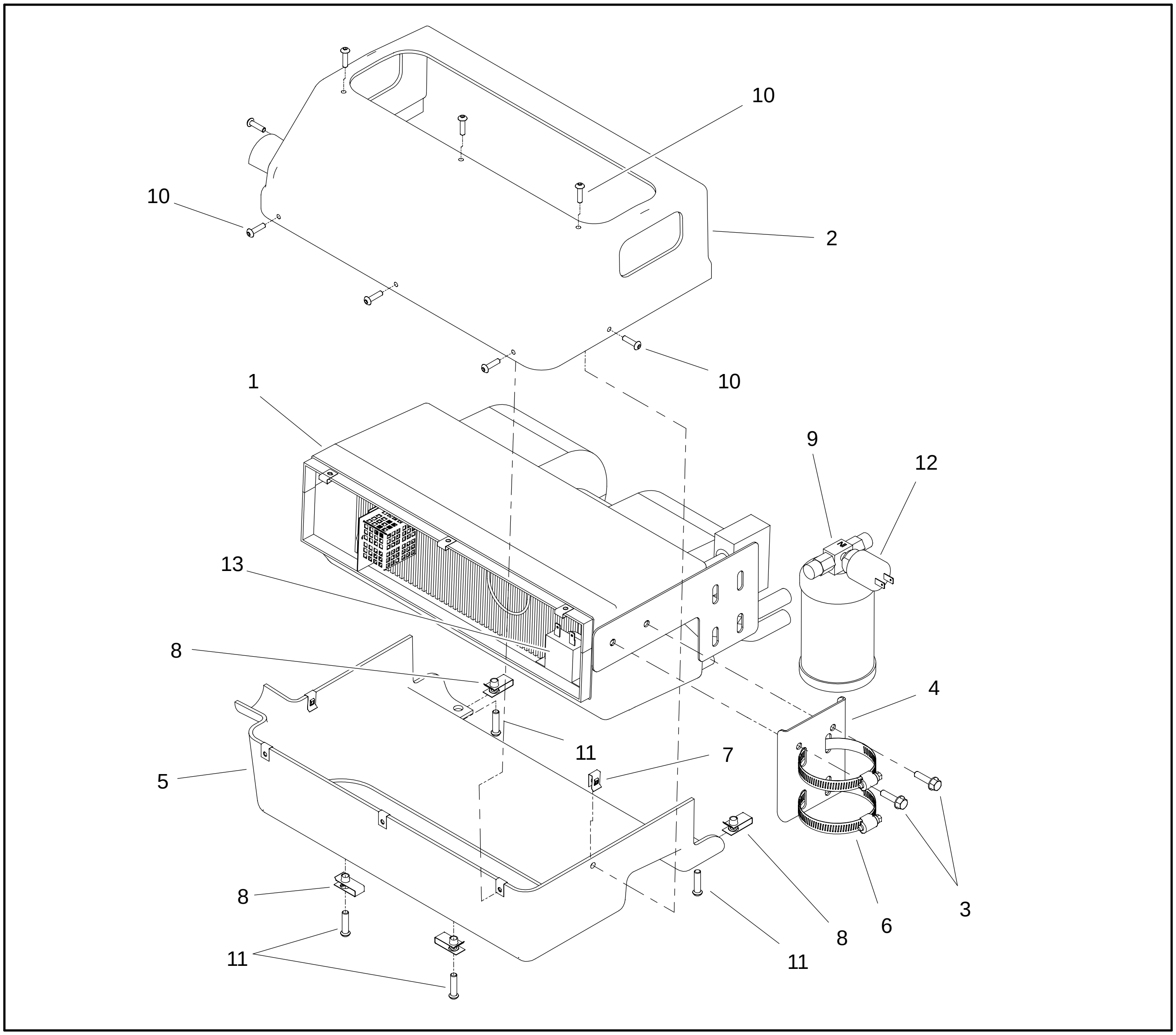

Figure 7

1. **Heater/evaporator assembly**
2. **Top cover**
3. **Flange head screw (2 used)**
4. **Drier-receiver mount**
5. **Bottom cover**
6. **Hose clamp (2 used)**
7. **Speed nut (8 used)**
8. **Panel nut (4 used)**
9. **Drier-receiver assembly**
10. **Screw (8 used)**
11. **Screw (5 used)**
12. **Binary switch**
13. **Relay**

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. Remove cable tie that secures air duct hose to heater/evaporator assembly covers. Slide hose from covers.

8. Remove screws that secure heater/evaporator 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.

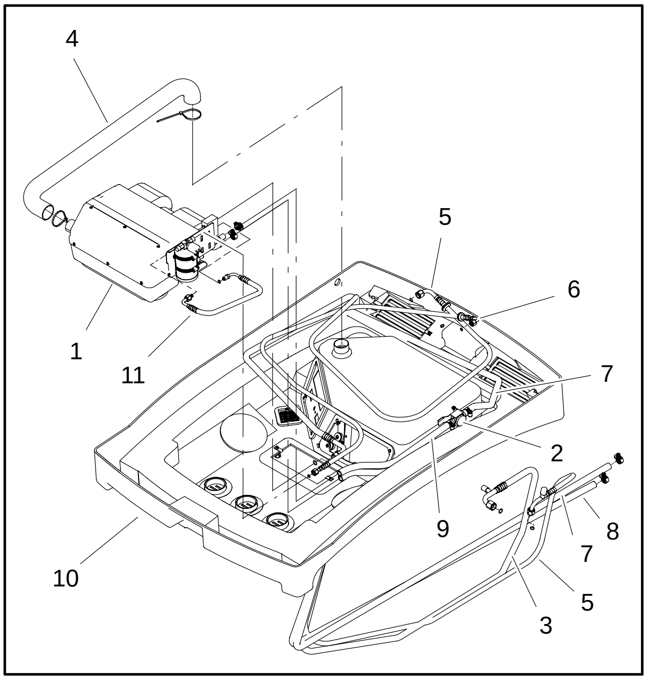

Figure 8

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 coil**
6. **A/C hose: condenser coil 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. **Headliner**
11. **A/C hose: drier to evaporator**

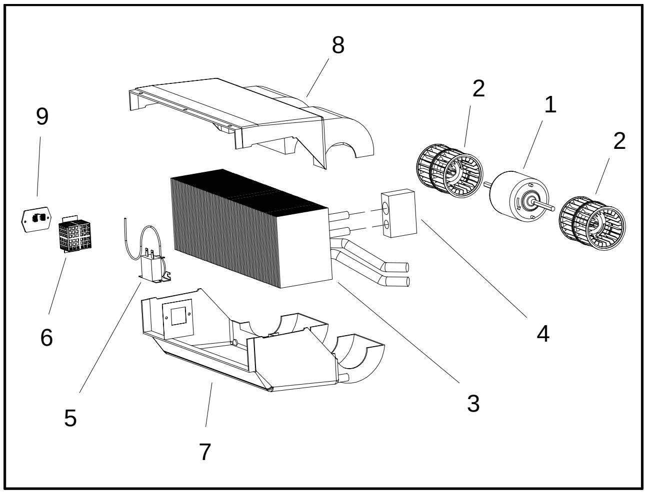

Figure 9

1. **Fan motor**
2. **Blower wheel**
3. **Heater/evaporator core**
4. **Expansion valve**
5. **Freeze switch**
6. **Resistor guard**
7. **Bottom housing**
8. **Top housing**
9. **Resistor**

3. Slide air duct hose onto heater/evaporator assembly covers and secure with cable tie.

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 approximately 1 pound 6 ounces (624 gm) 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).

Chapter 10

Foldout Drawings

Foldout Drawings

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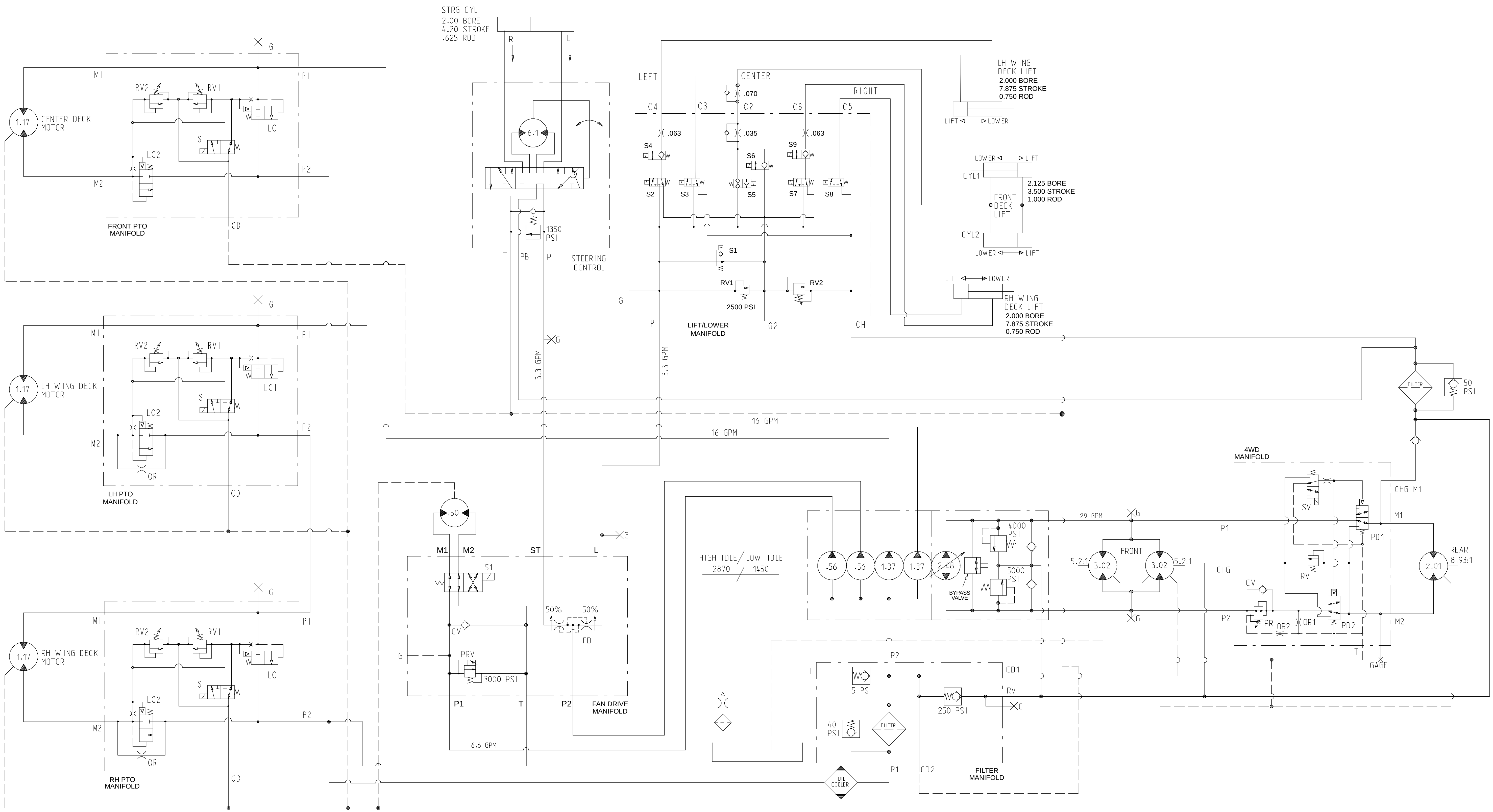
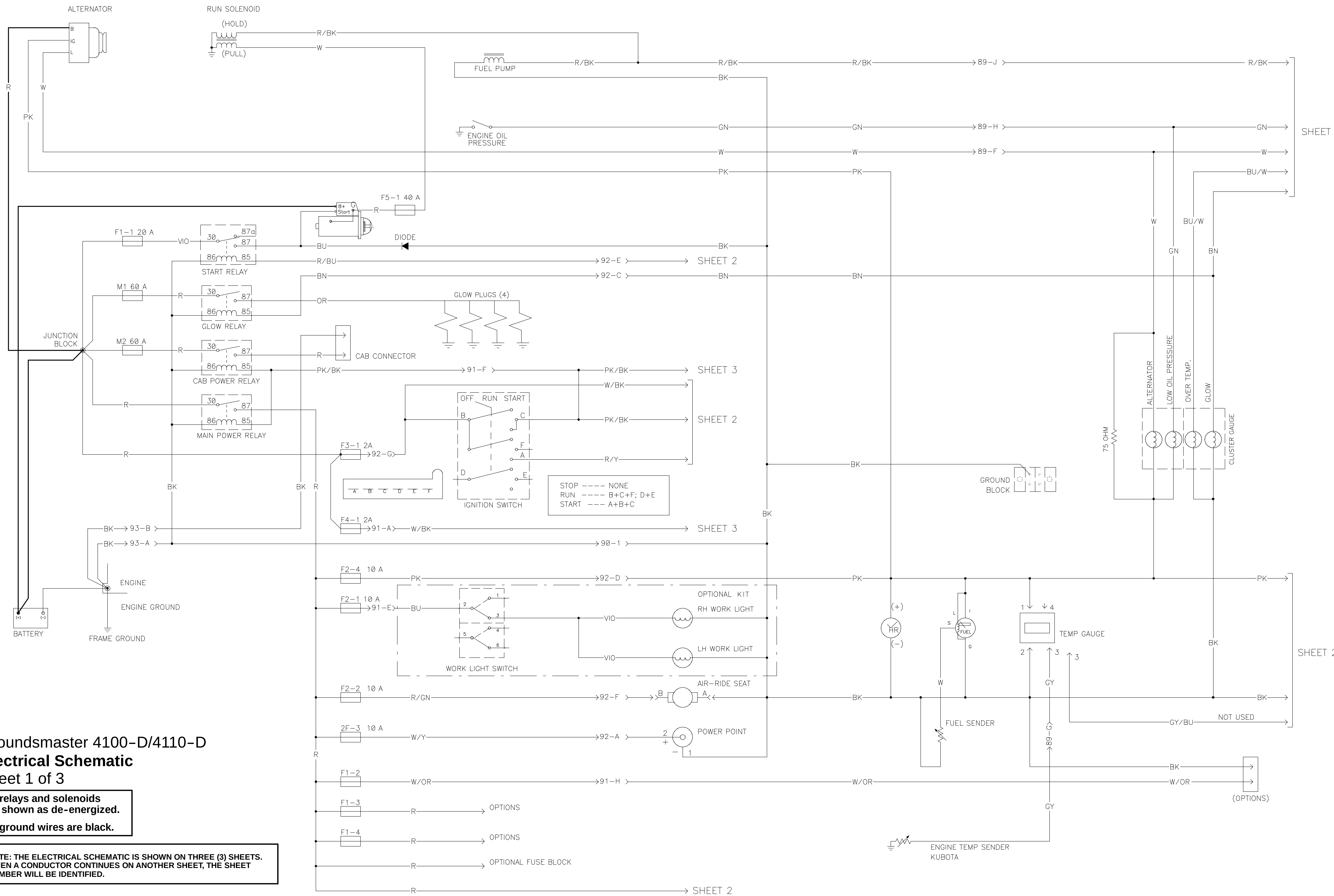


Groundsmaster 4100–D/4110–D
Hydraulic Schematic



Groundsmaster 4100-D/4110-D

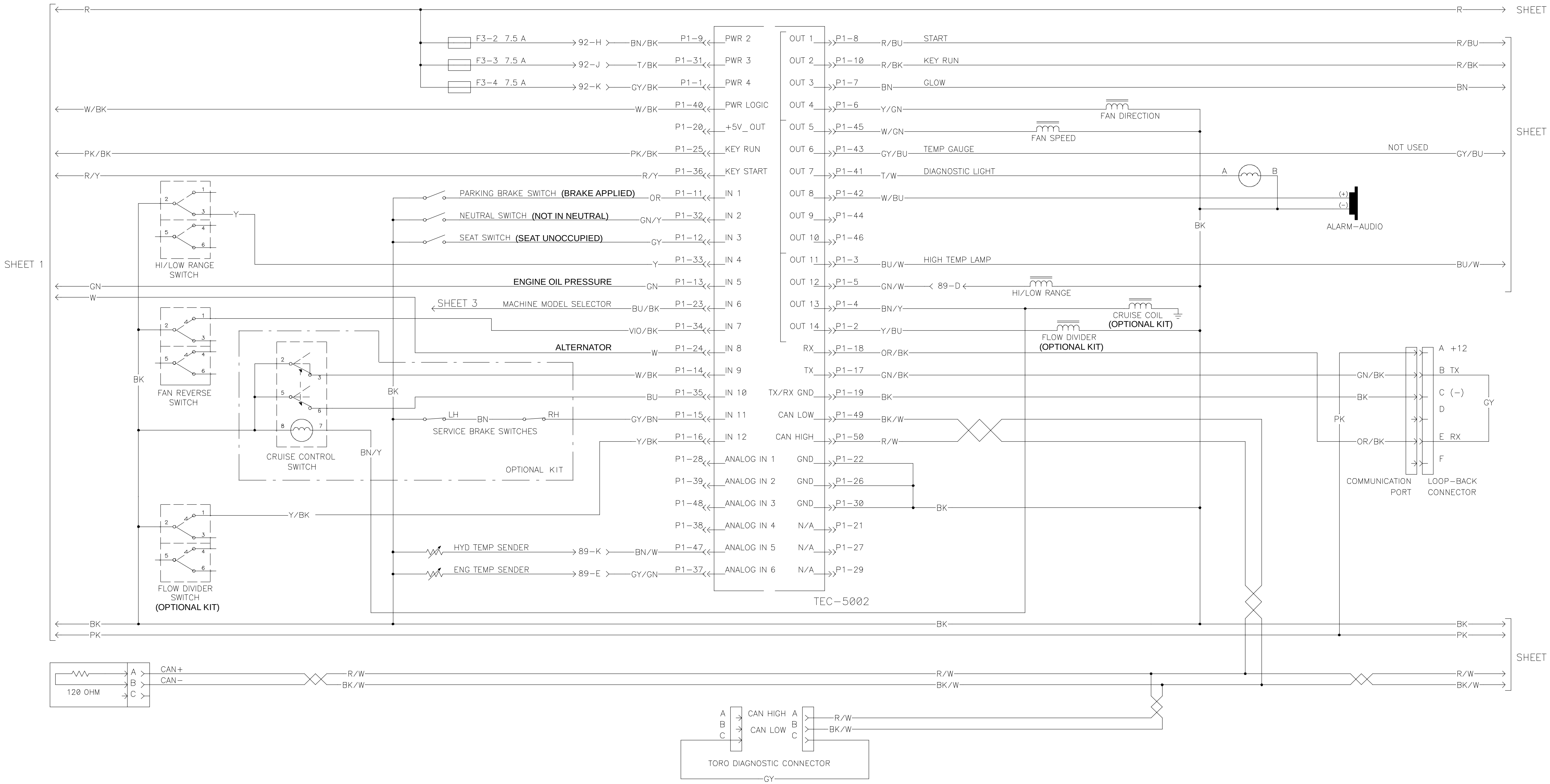
Electrical Schematic

Sheet 1 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 4100-D/4110-D

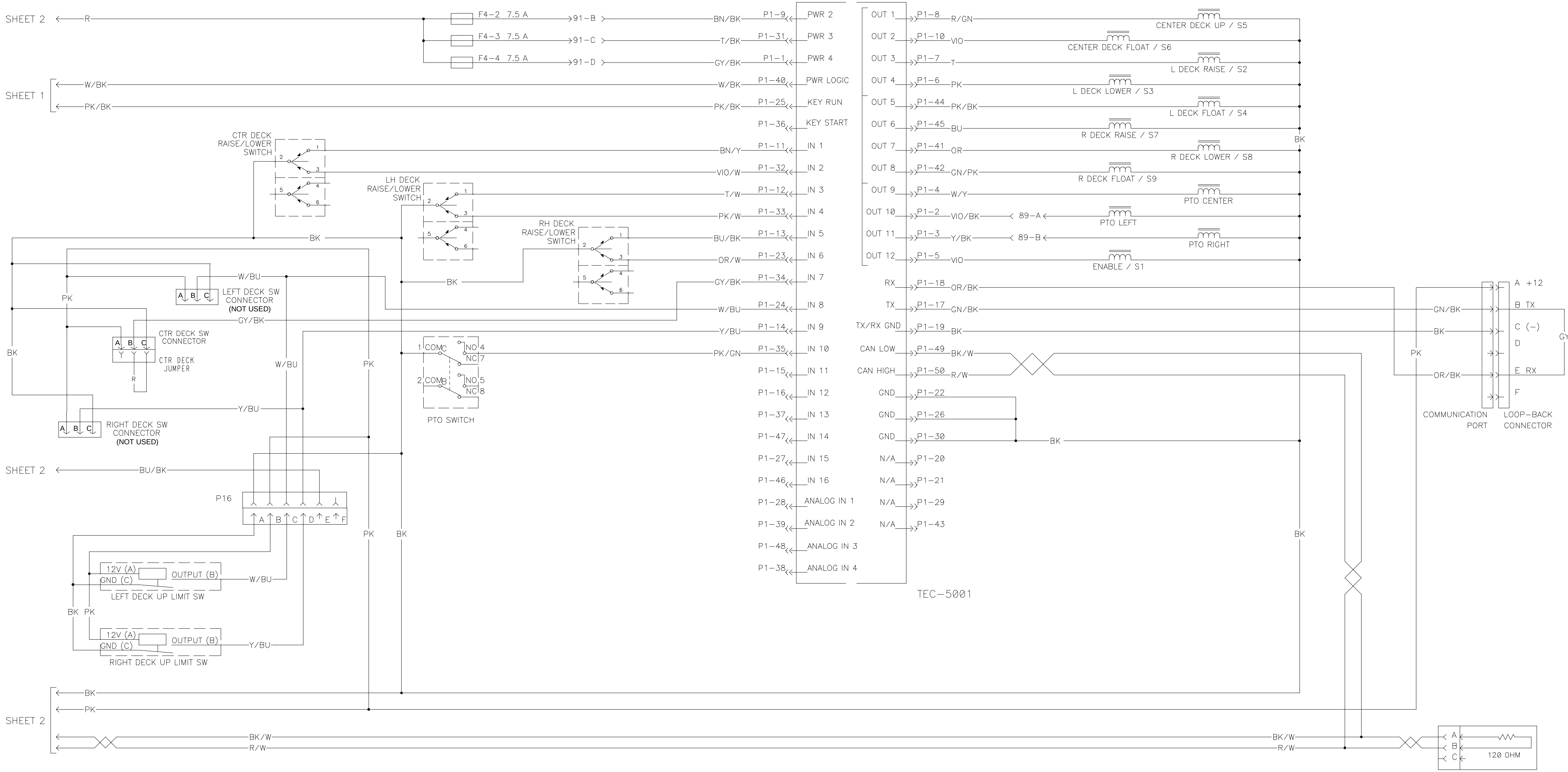
Electrical Schematic

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 4100-D/4110-D

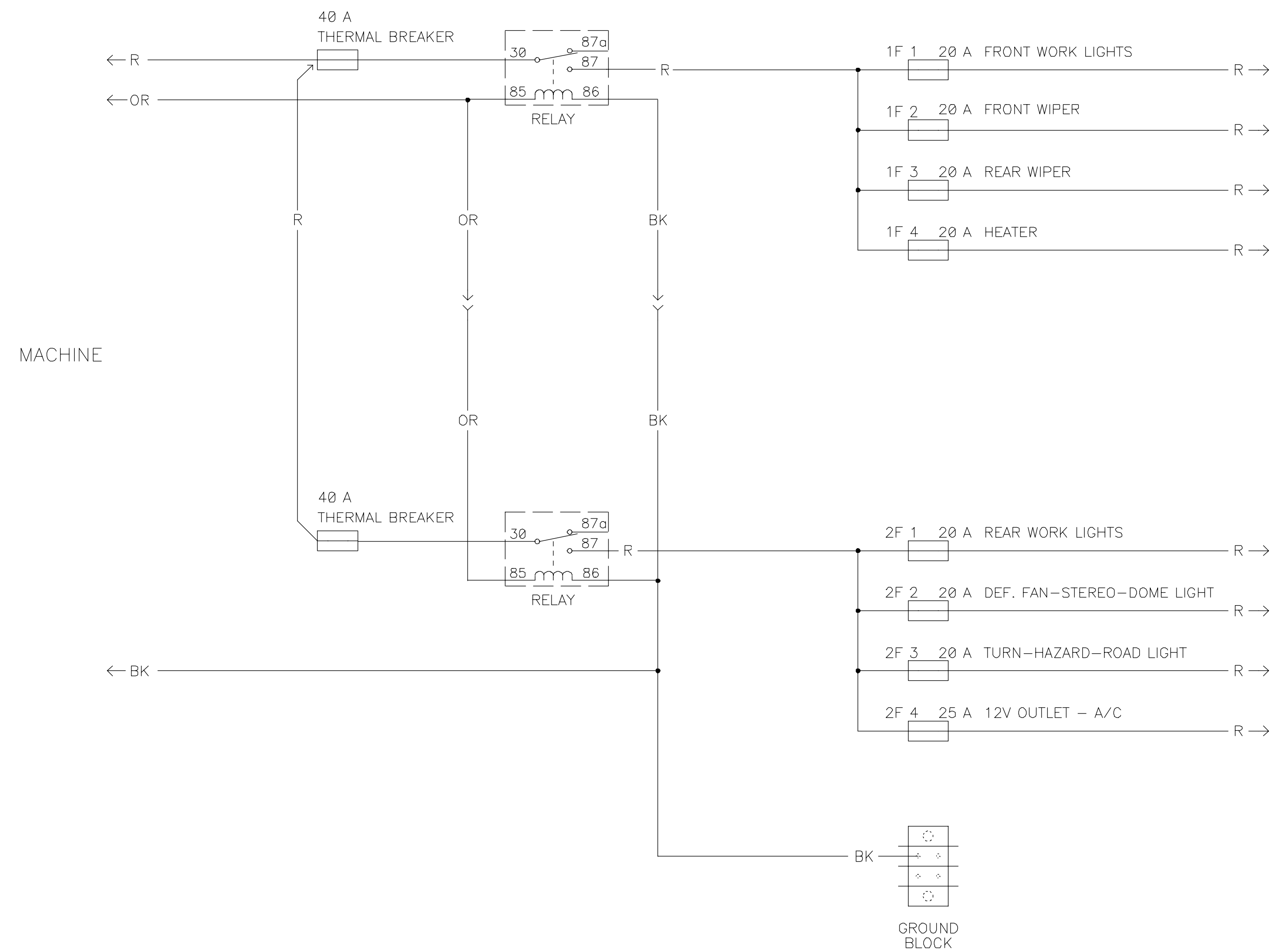
Electrical Schematic

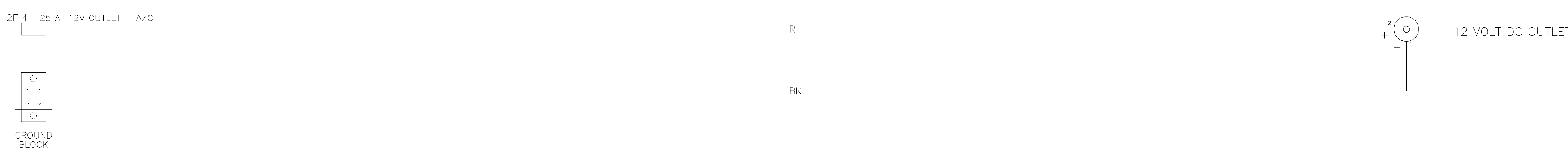
Sheet 3 of 3

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.





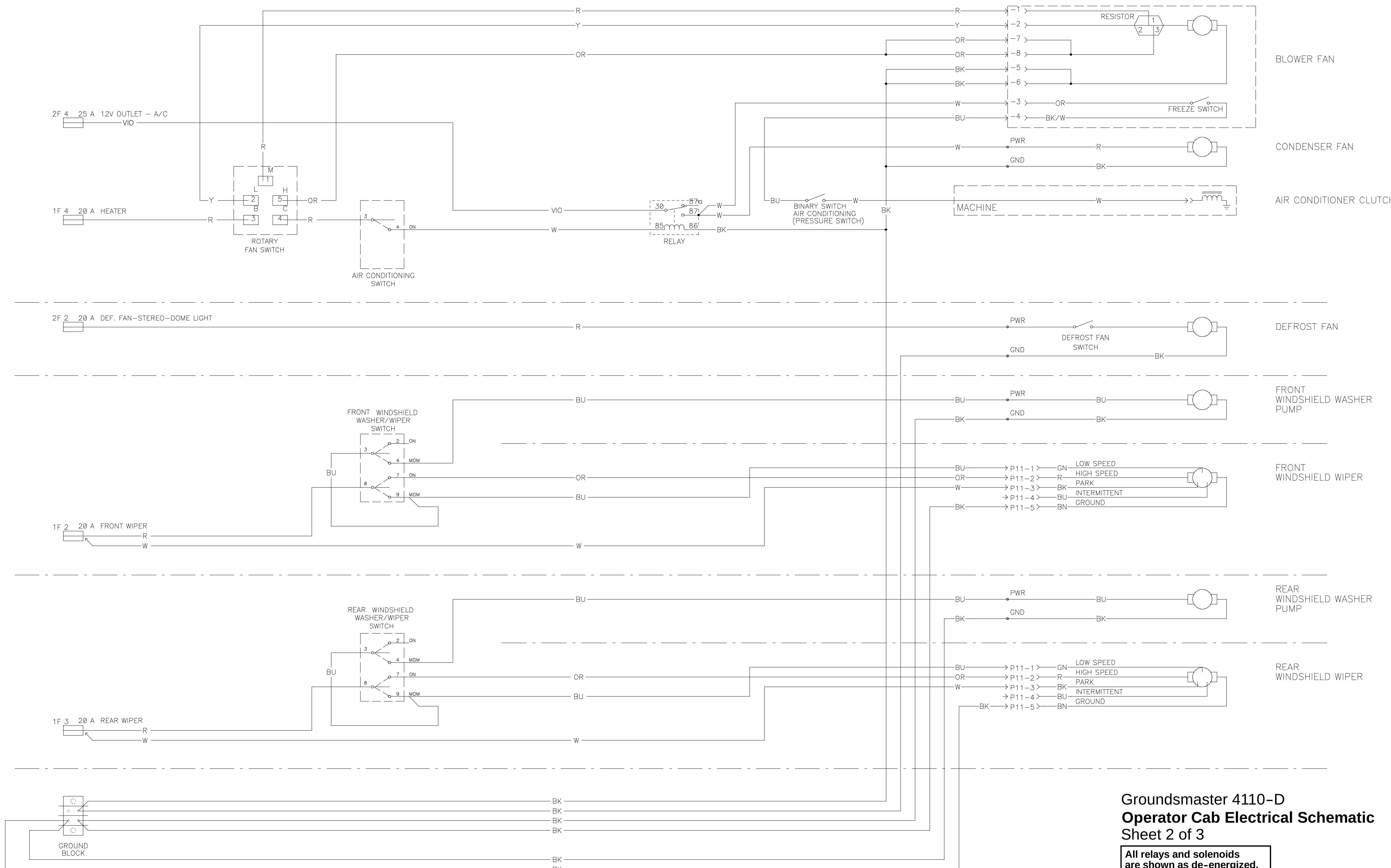
Groundsmaster 4110–D

Operator Cab Electrical Schematic

Sheet 1 of 3

All relays and solenoids are shown as de–energized.

All ground wires are black.



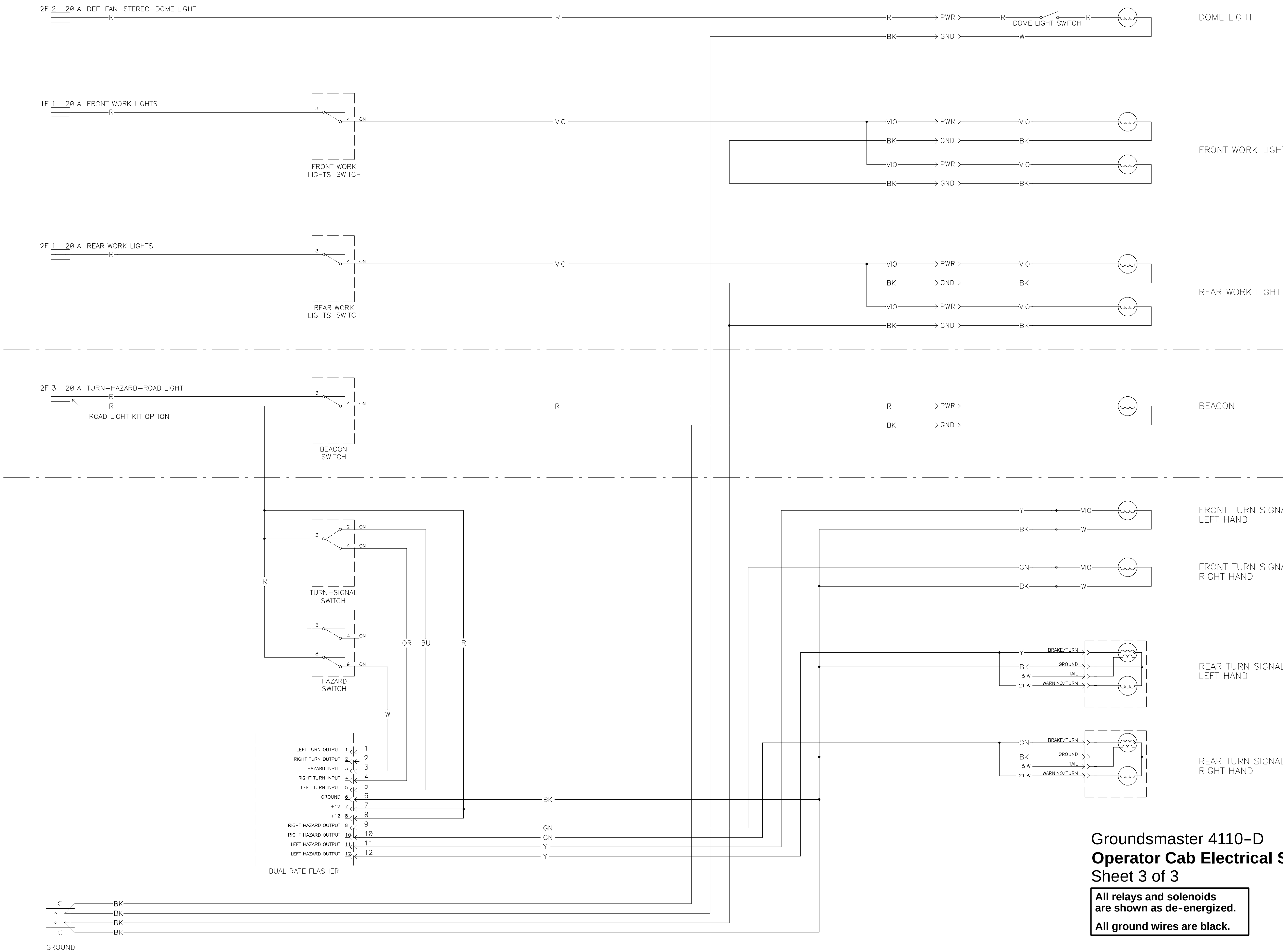
Groundsmaster 4110–D

Operator Cab Electrical Schematic

Sheet 2 of 3

All relays and solenoids are shown as de-energized.

All ground wires are black.



Groundsmaster 4110-D

Operator Cab Electrical Schematic

Sheet 3 of 3

All relays and solenoids are shown as de-energized.

All ground wires are black.

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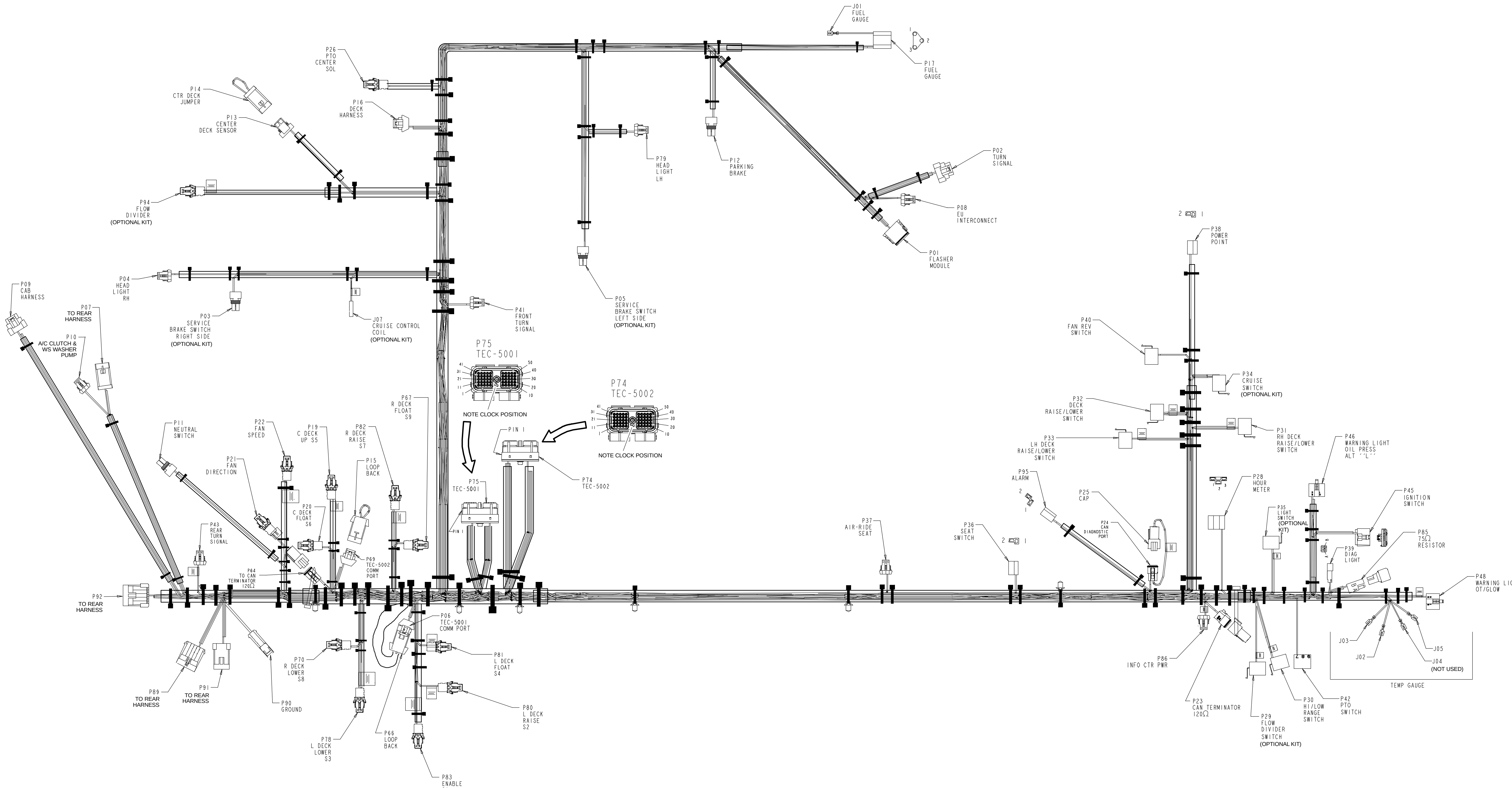
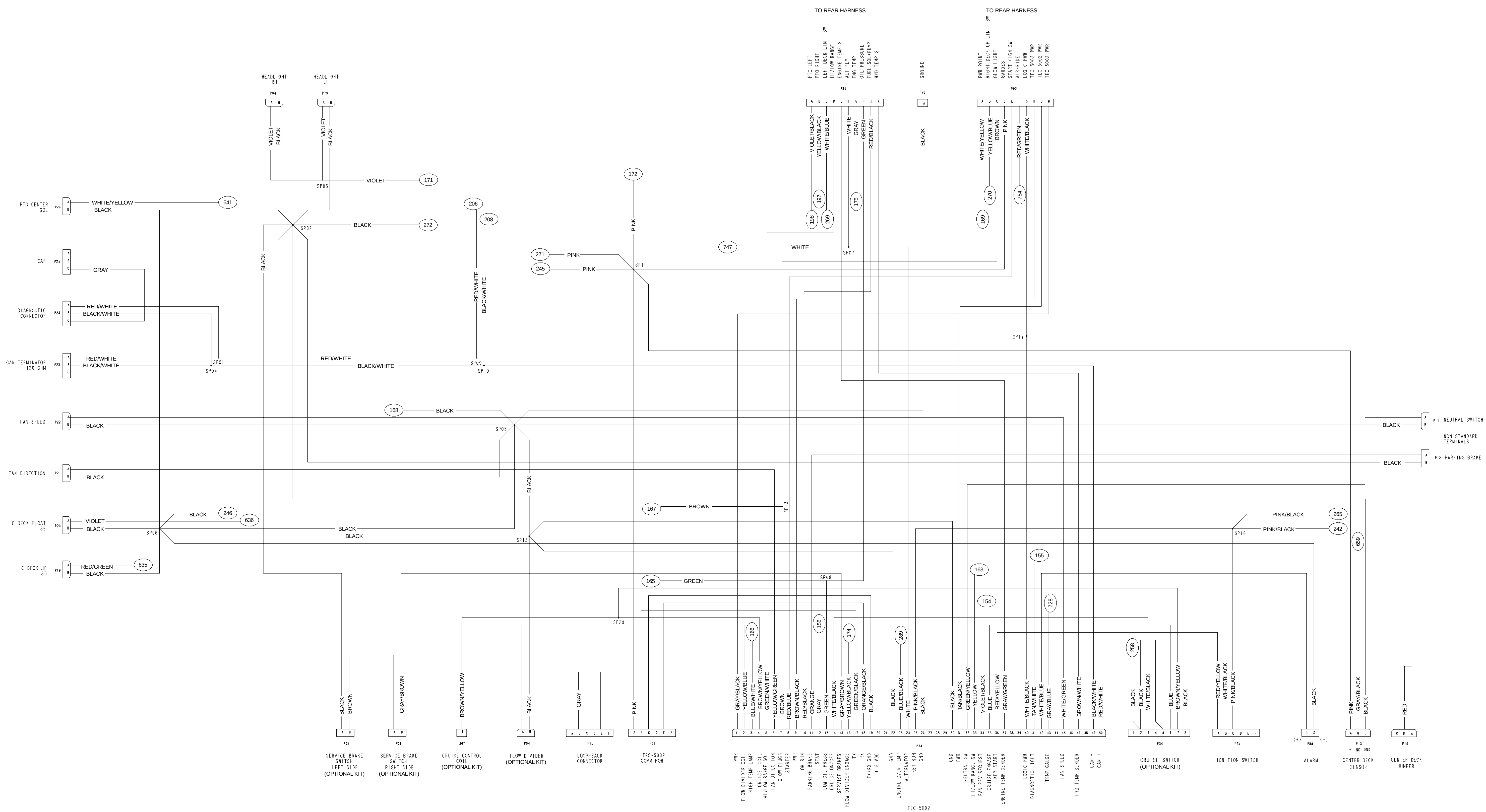
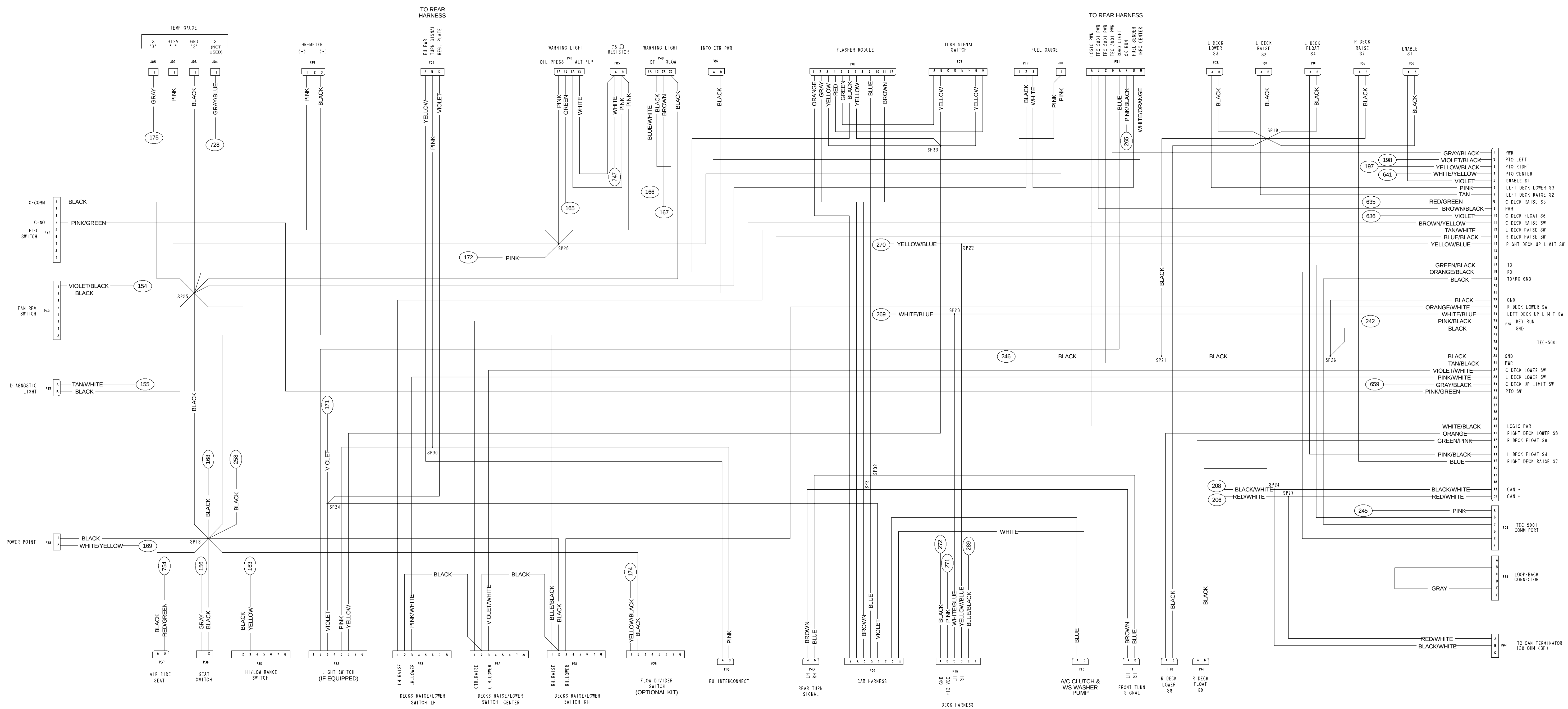


Groundsmaster 4100–D/4110–D
Platform Wire Harness Drawing



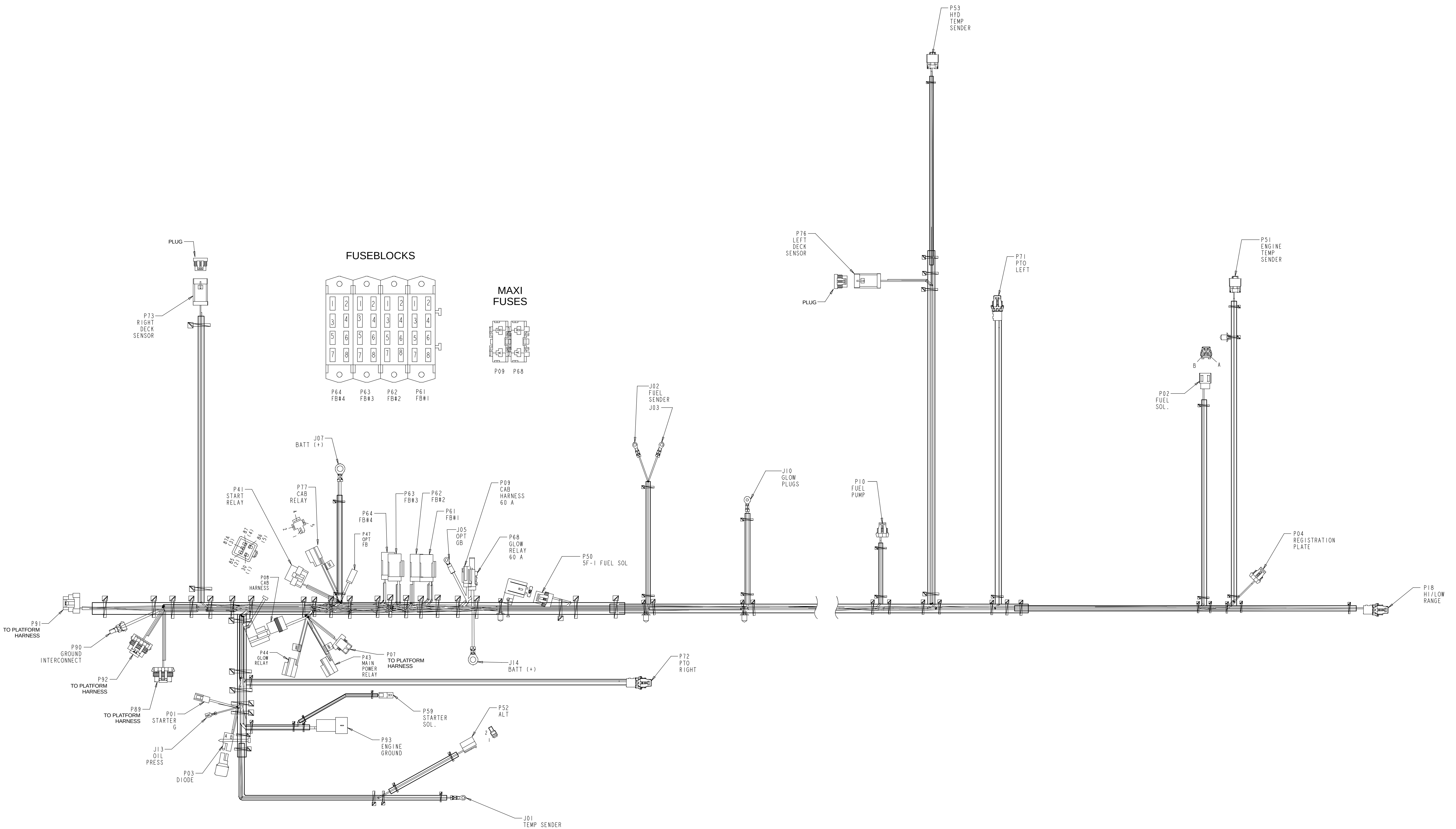
Groundsmaster 4100–D/4110–D
Platform Wire Harness Diagram
Sheet 1 of 2



Groundsmaster 4100–D/4110–D

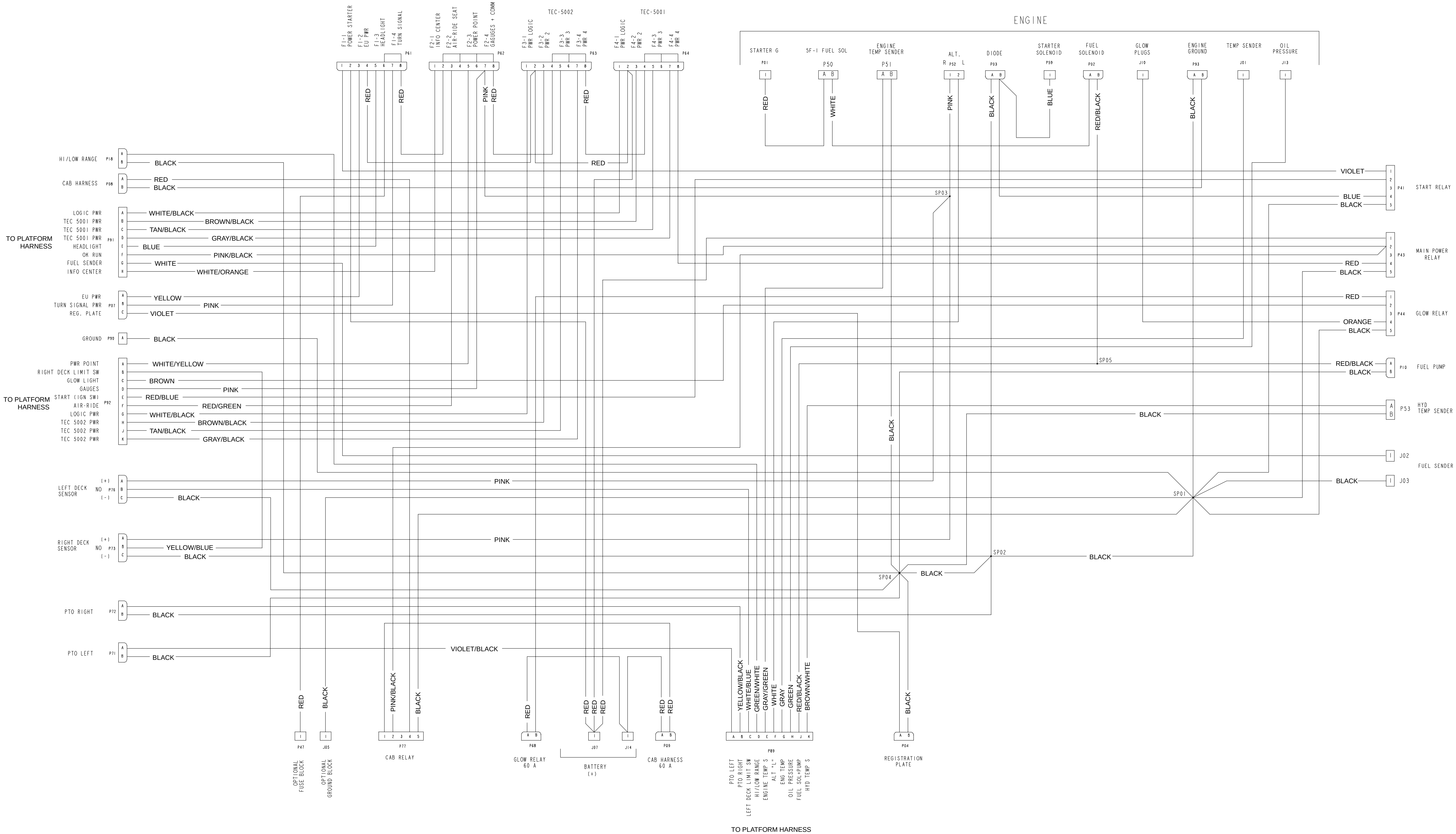
Platform Wire Harness Diagram

Sheet 2 of 2

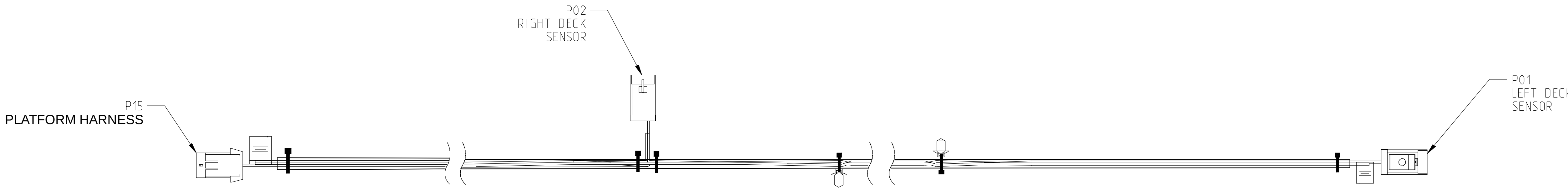


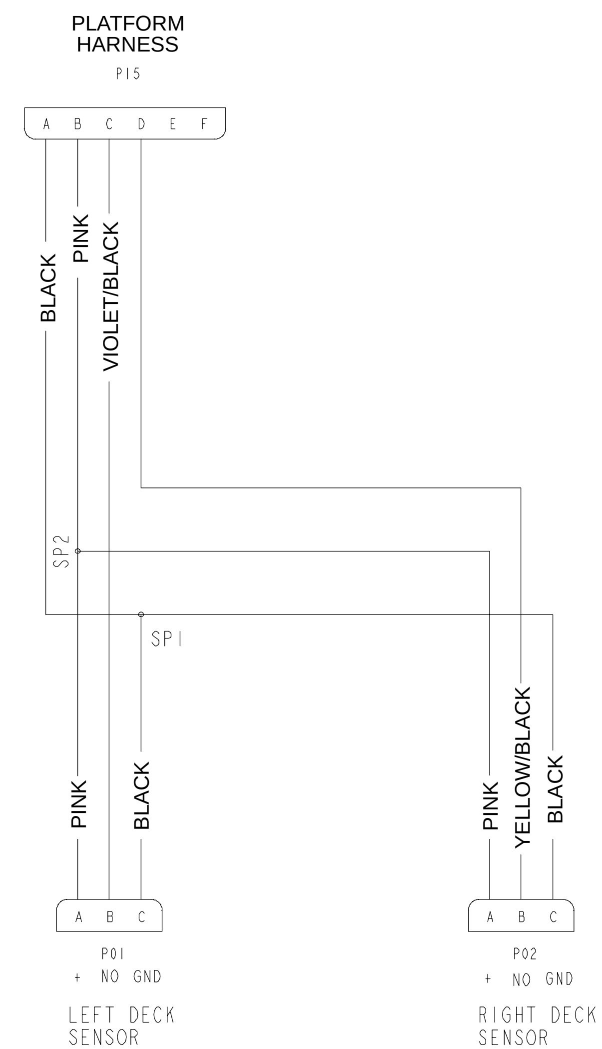
Groundsmaster 4100-D/4110-D

Rear Wire Harness Drawing



Groundsmaster 4100–D/4110–D
Rear Wire Harness Diagram





Groundsmaster 4100–D/4110–D
Cutting Deck Wire Harness