Form No. 09172SL Rev B

Count on it.

Service Manual

Groundsmaster® 4500-D/4700-D

(Models 30857 and 30858)

Original Instructions (EN)

Revision History

Revision	Date	Description
--	2009	Initial Issue.
A	03/2018	Added revision history.
B	05/2018	Added VA02 series planetary information.

Reader Comments

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

or Mail to:

Technical Publication Manager, Commercial
The Toro Company

8111 Lyndale Avenue South

Bloomington, MN 55420-1196

Phone: +1 952-887-8495

NOTES

Part No. 09172SL Rev. B

Service Manual

(Models 30857 and 30858)

Groundsmaster® 4500–D/4700–D

Preface

The purpose of this publication is to provide the service technician with information for troubleshooting, testing and repair of major systems and components on the Groundsmaster 4500–D (Model 30857) and 4700–D (Model 30858).

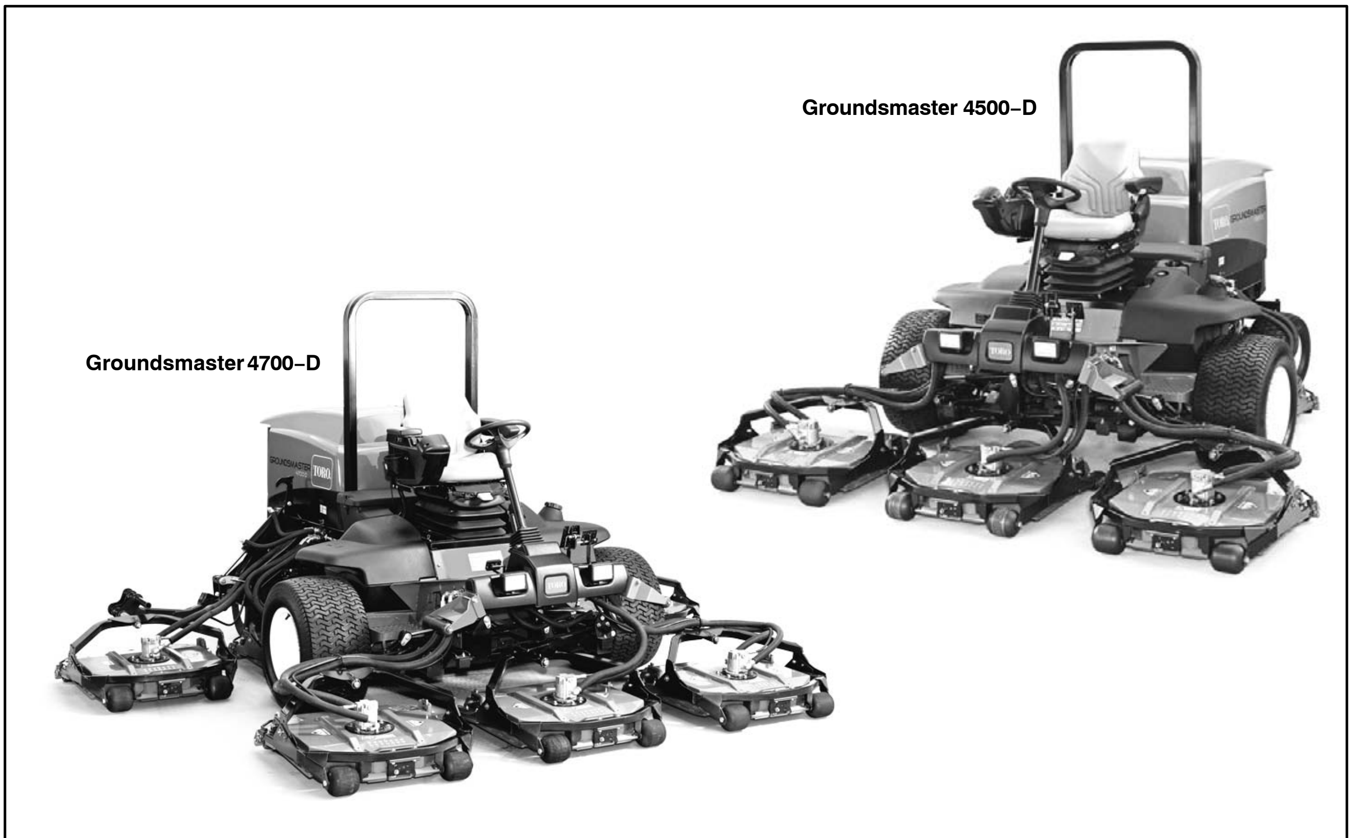
REFER TO THE TRACTION UNIT AND CUTTING UNIT OPERATOR'S MANUALS FOR OPERATING, MAINTENANCE AND ADJUSTMENT INSTRUCTIONS. For reference, insert a copy of the Operator's Manuals and Parts Catalog for your machine into Chapter 2 of this service manual. Additional copies of the Operator's Manuals and Parts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

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.



This page is intentionally blank.

Table Of Contents

This page is intentionally blank.

Chapter 1

Safety

Table of Contents

General Safety Instructions

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

WARNING

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

Before Operating

1. Review and understand the contents of the Operator's Manuals and Operator's DVD before starting and operating the vehicle. Become familiar with the controls and know how to stop the vehicle and engine quickly. Additional copies of the Operator's Manual are available on the internet at www.Toro.com.

2. Keep all shields, safety devices and decals in place. If a shield, safety device or decal is defective, illegible or damaged, repair or replace it before operating the machine. Also tighten any loose nuts, bolts or screws to ensure machine is in safe operating condition.

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

4. Since diesel fuel is highly flammable, handle it carefully:

   A. Use an approved fuel container.

   B. Do not remove fuel tank cap while engine is hot or running.

   C. Do not smoke while handling fuel.

   D. Fill fuel tank outdoors and only to within an inch of the top of the tank, not the filler neck. Do not overfill.

   E. Wipe up any spilled fuel.

While Operating

1. Sit on the seat when starting and operating the machine.

2. Before starting the engine:

   A. Engage the parking brake.

   B. Make sure traction pedal is in neutral and the PTO switch is OFF (disengaged).

   C. After engine is started, release parking brake and keep foot off traction pedal. Machine must not move. If movement is evident, the traction pedal linkage is adjusted incorrectly; therefore, shut engine off and adjust traction pedal 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, exhaust system components or radiator while engine is running or soon after it is stopped. These areas could be hot enough to cause burns.

5. Before getting off the seat:

   A. Ensure that traction pedal is in neutral.

   B. Engage parking brake.

   C. Disengage PTO and wait for deck blades to stop.

   D. Stop engine and remove key from switch.

   E. Toro recommends that anytime the machine is parked (short or long term), the cutting decks should be lowered to the ground. This relieves pressure from the lift circuit and eliminates the risk of cutting decks accidentally lowering to the ground.

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

Maintenance and Service

1. The Traction Unit and Cutting Deck Operator's Manuals provide information regarding the operation, general maintenance and maintenance intervals for your Groundsmaster machine. Refer to these publications for additional information when servicing the machine.

2. Before servicing or making adjustments, lower cutting decks, stop engine, set parking brake and remove key from the ignition switch.

3. Make sure machine is in safe operating condition by keeping all nuts, bolts and screws tight.

4. Never store the machine or fuel container inside where there is an open flame, such as near a water heater or furnace.

5. Make sure all hydraulic line connectors are tight and all hydraulic hoses and lines are in good condition before applying pressure to the hydraulic system.

6. Keep body and hands away from pin hole leaks in hydraulic lines that eject high pressure hydraulic fluid. Use cardboard or paper to find hydraulic leaks. Hydraulic fluid escaping under pressure can penetrate skin and cause injury. Fluid accidentally injected into the skin must be surgically removed within a few hours by a doctor familiar with this form of injury or gangrene may result.

7. Before disconnecting or performing any work on the hydraulic system, all pressure in system must be relieved by stopping engine and lowering cutting decks to the ground.

8. If major repairs are ever needed or assistance is desired, contact an Authorized Toro Distributor.

9. To reduce potential fire hazard, keep engine area free of excessive grease, grass, leaves and dirt. Clean protective screen on machine frequently.

10. If engine must be running to perform maintenance or an adjustment, keep hands, feet, clothing and other parts of the body away from cutting decks and other moving parts. Keep bystanders away.

11. Do not overspeed the engine by changing governor setting. To assure safety and accuracy, check maximum engine speed.

12. Shut engine off before checking or adding oil to the crankcase.

13. Disconnect battery before servicing the machine. Disconnect negative battery cable first and positive cable last. If battery voltage is required for troubleshooting or test procedures, temporarily connect the battery. Reconnect positive battery cable first and negative cable last.

14. Battery acid is poisonous and can cause burns. Avoid contact with skin, eyes and clothing. Protect your face, eyes and clothing when working with a battery.

15. Battery gases can explode. Keep cigarettes, sparks and flames away from the battery.

16. When welding on machine, disconnect both battery cables to prevent damage to machine electronic equipment. Disconnect negative battery cable first and positive cable last.

17. 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.

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

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.

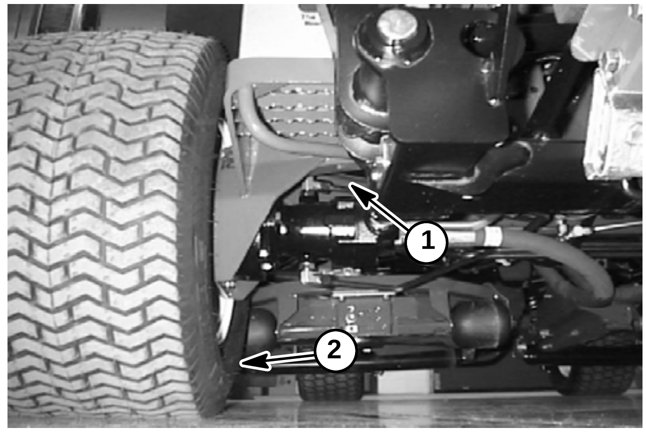


Figure 1

1. **Frame**
2. **Front tire (RH shown)**

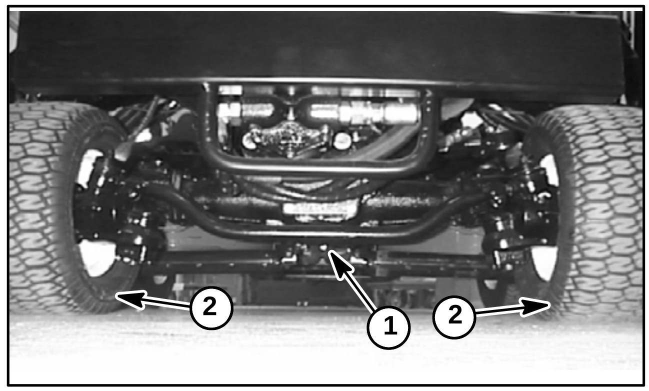


Figure 2

1. **Rear axle**
2. **Rear tire**

Jacking the Front End (Fig. 1)

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

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

2. Position jack securely under the frame, just to the inside of the front tire.

3. Jack front of machine off the ground.

4. Position appropriate jack stands under the frame as close to the wheels as possible to support the machine.

Jacking the Rear End (Fig. 2)

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

2. Place jack securely under the center of rear axle.

3. Jack rear of machine off the ground.

4. Position appropriate jack stands under the rear axle to support the machine.

Safety and Instruction Decals

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

This page is intentionally blank.

Product Records and Maintenance

Table of Contents

Product Records

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

Maintenance

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

Equivalents and Conversions

Decimal and Millimeter Equivalents

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

1 mm = 0.03937 in. **0.001 in. = 0.0254 mm**

U.S.to Metric Conversions

	To Convert	Into	Multiply By
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

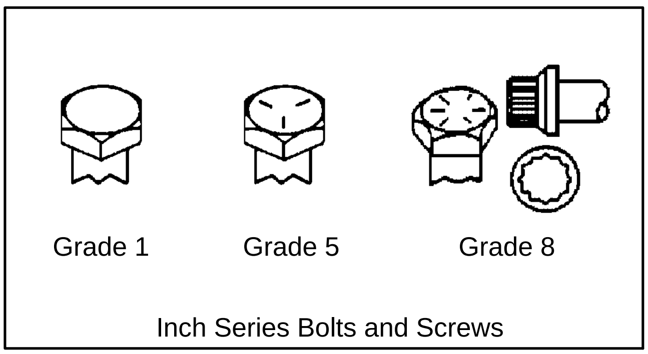


Figure 1

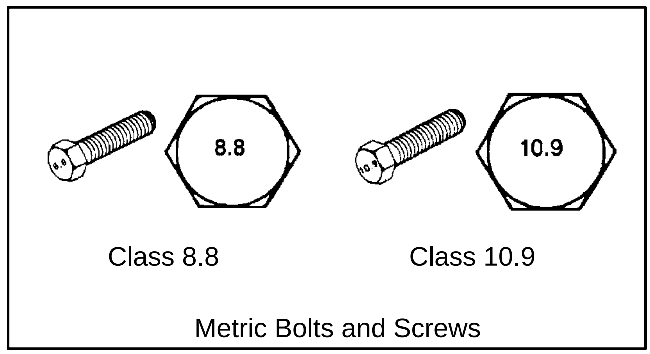


Figure 2

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.

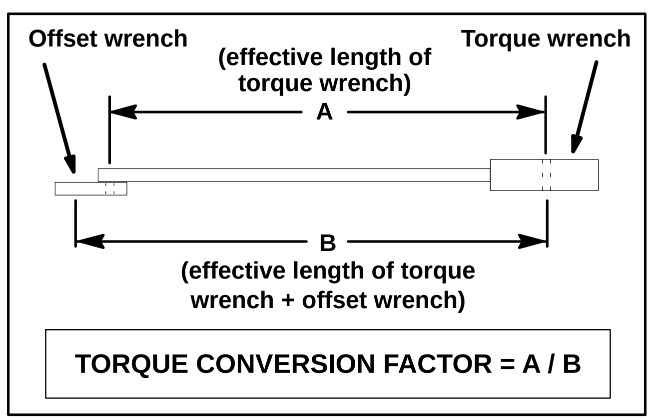


Figure 3

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

Kubota Diesel Engine

Table of Contents

Specifications

Item	Description
Make / Designation	Kubota Model V2403−M−T−E3B: 4−Cycle, 4 Cylinder, Water Cooled, Turbocharged, Diesel Engine
Bore	3.425” (87.0 mm)
Stroke	4.031” (102.4 mm)
Total Displacement	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	22 U.S. gallons (83 liters)
Fuel Injection Pump	Denso PFR 4M Type Mini Pump
Injection Nozzle	Denso OPD Mini Nozzle
Governor	Centrifugal Mechanical
Low Idle (no load)	1425 ± 50 RPM
High Idle (no load)	2870 +50/−120 RPM
Engine Oil	API CH−4, CI−4 or higher
Engine Oil Viscosity	See Operator’s Manual
Crankcase Oil Capacity	10.0 U.S. Quarts (9.5 Liters) with Filter
Oil Pump	Trochoid Type
Coolant Capacity	13 U.S. Quarts (12.3 Liters)
Starter	12 VDC, 2.0 kW
Alternator/Regulator Standard Alternator Optional Alternator	12 VDC 40 amp 60 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 4500–D and 4700–D.

General maintenance procedures are described in your Traction Unit Operator's Manual. Information on engine troubleshooting, testing, disassembly and assembly is identified in the Kubota Workshop Manual, Diesel Engine, V2403–M–T–E3B that is included at the end of this section.

Most repairs and adjustments require tools which are commonly available in many service shops. Special tools are described in the Kubota Workshop Manual, Diesel Engine, V2403–M–T–E3B. The use of some specialized test equipment is explained. However, the cost of the test equipment and the specialized nature of some repairs may dictate that the work be done at an engine repair facility.

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

Operator's Manual

The Traction Unit and Engine Operator's Manuals provide information regarding the operation, general maintenance and maintenance intervals for your Groundsmaster machine. Refer to these publications for additional information when servicing the machine.

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.

Air Filter System

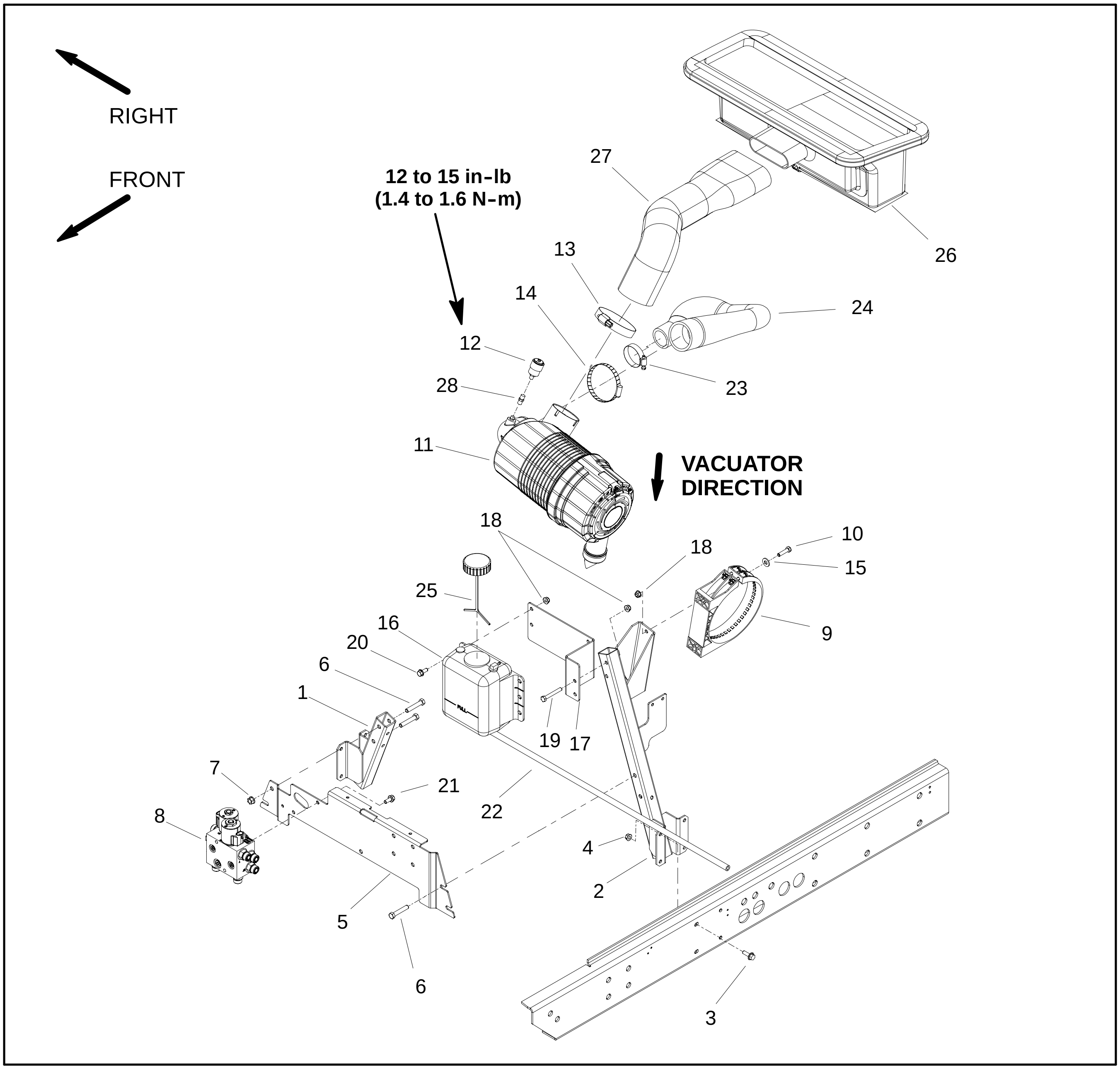


Figure 1

1. Battery support
2. Bracket
3. Flange head screw (8 used)
4. Flange nut (8 used)
5. Support bracket
6. Cap screw (4 used)
7. Flange nut (4 used)
8. Fan drive manifold
9. Air cleaner strap
10. Cap screw (2 used)
11. Air cleaner assembly
12. Service indicator
13. Hose clamp
14. Hose clamp
15. Flat washer (2 used)
16. Coolant reservoir
17. Reservoir bracket
18. Flange nut (8 used)
19. Cap screw (2 used)
20. Flange head screw (4 used)
21. Flange head screw (2 used)
22. Hose
23. Hose clamp
24. Air cleaner hose
25. Reservoir cap
26. Plenum
27. Air intake hose
28. Adapter

Removal (Fig. 1)

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

2. Raise and support hood.

3. Remove air cleaner components as needed using Figure 1 as a guide.

Installation (Fig. 1)

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

1. Assemble air filter system using Figure 1 as a guide.

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

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

2. When installing air cleaner hose (item 24) between air cleaner and turbo–charger (Fig. 4):

   A. Make sure that hose does not contact engine valve cover or other engine components. To modify clearance, move and/or rotate air cleaner body in air cleaner strap. Verify that tabs in strap mesh fully with slots in air cleaner body.

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

3. Lower and secure hood.

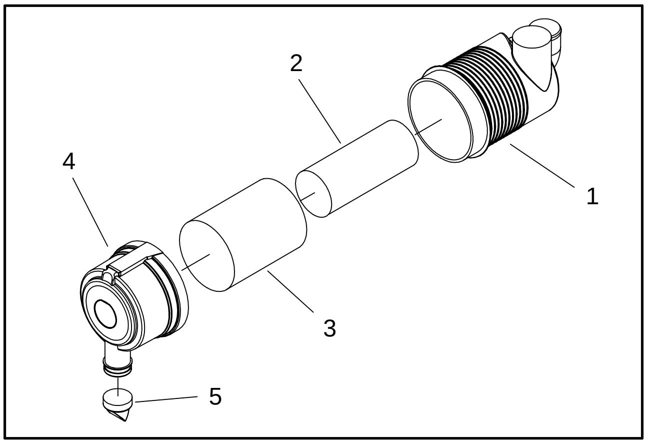


Figure 2

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

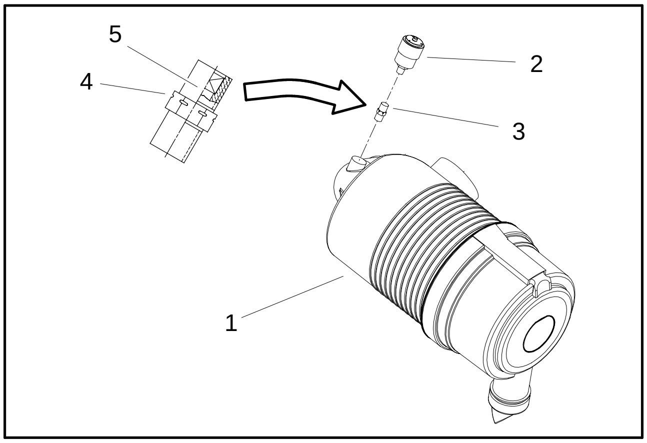


Figure 3

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

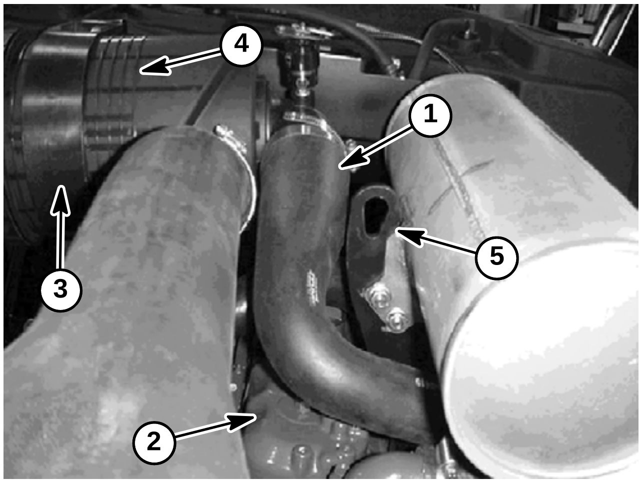


Figure 4

1. **Air cleaner hose**
2. **Engine valve cover**
3. **Air cleaner strap**
4. **Air cleaner body**
5. **Muffler bracket**

Exhaust System

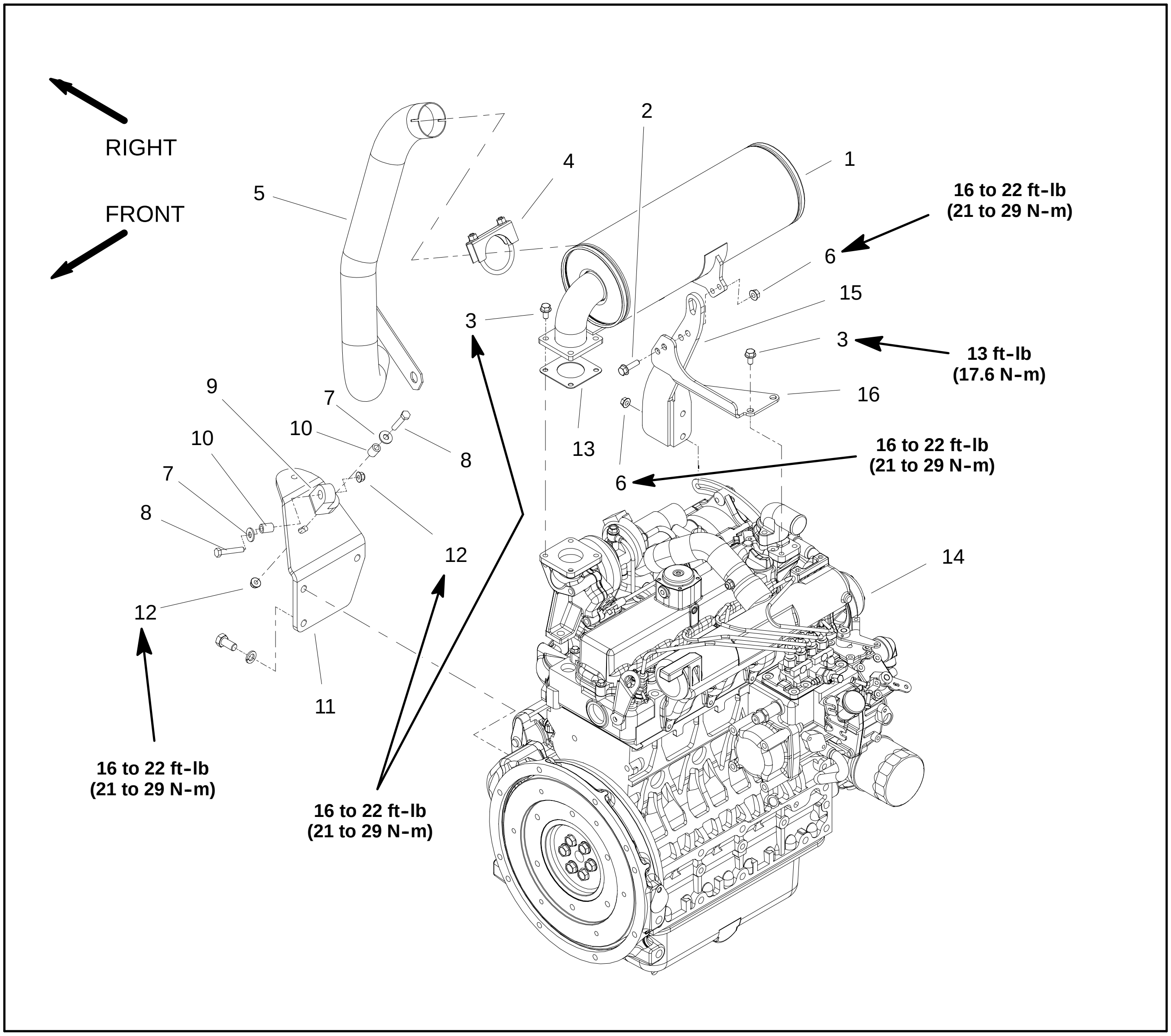


Figure 5

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

Removal (Fig. 5)

CAUTION

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

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

2. Raise and support hood.

3. Remove muffler and/or muffler bracket from the engine as necessary using Figure 5 as a guide.

Installation (Fig. 5)

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

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

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

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

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

F. Tighten muffler clamp nuts.

3. Tailpipe should have equal clearance between frame and engine after installation. Also, make sure that clearance exists between tailpipe and engine motor mount bracket.

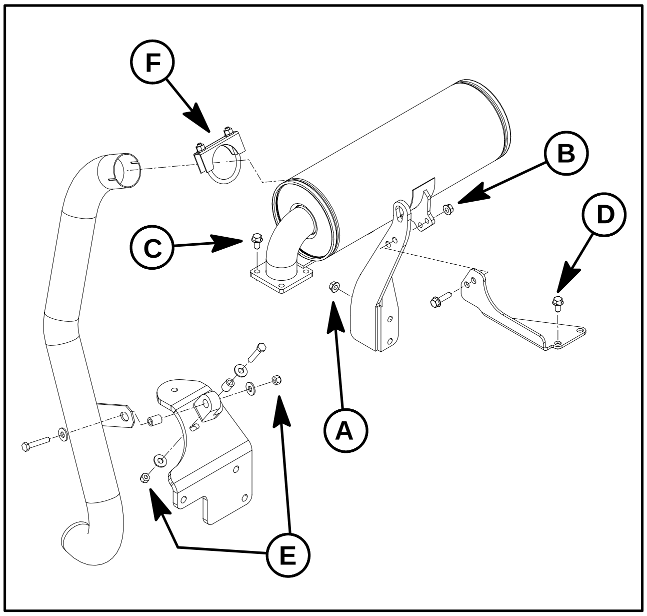


Figure 6

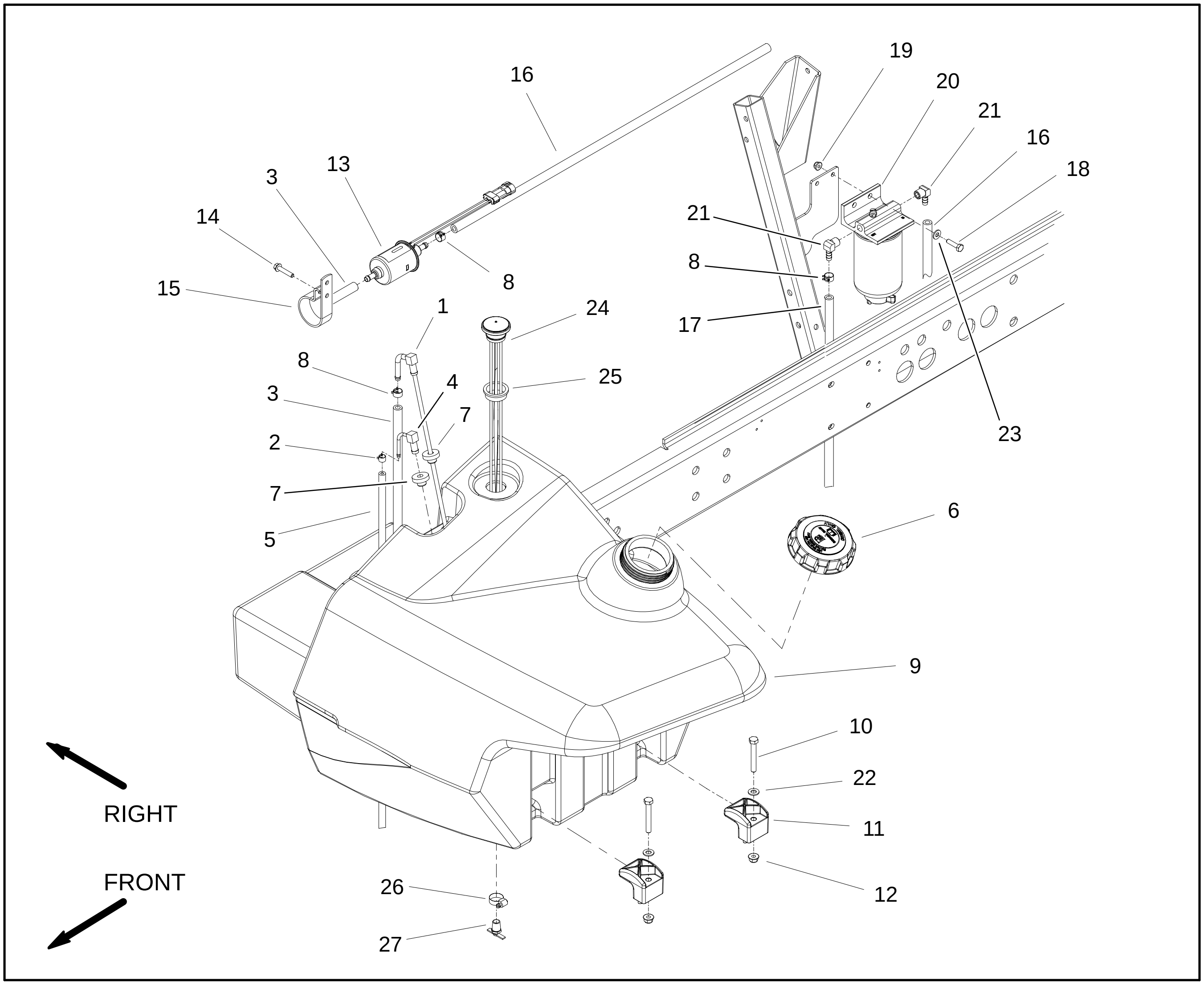


Figure 7

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

DANGER

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

Check Fuel Lines and Connections

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

Drain and Clean Fuel Tank

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

Fuel Tank 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. Disconnect fuel hoses from the suction and return fittings in top of tank.

3. Use draincock to empty fuel tank into a suitable container.

4. Remove fuel tank using Figure 7 as a guide.

Fuel Tank Installation (Fig. 7)

1. Install fuel tank to frame using Figure 7 as a guide.

2. Connect fuel hoses to the suction and return fittings in top of tank.

3. Make sure that draincock is closed.

4. Fill fuel tank with clean fuel.

Radiator

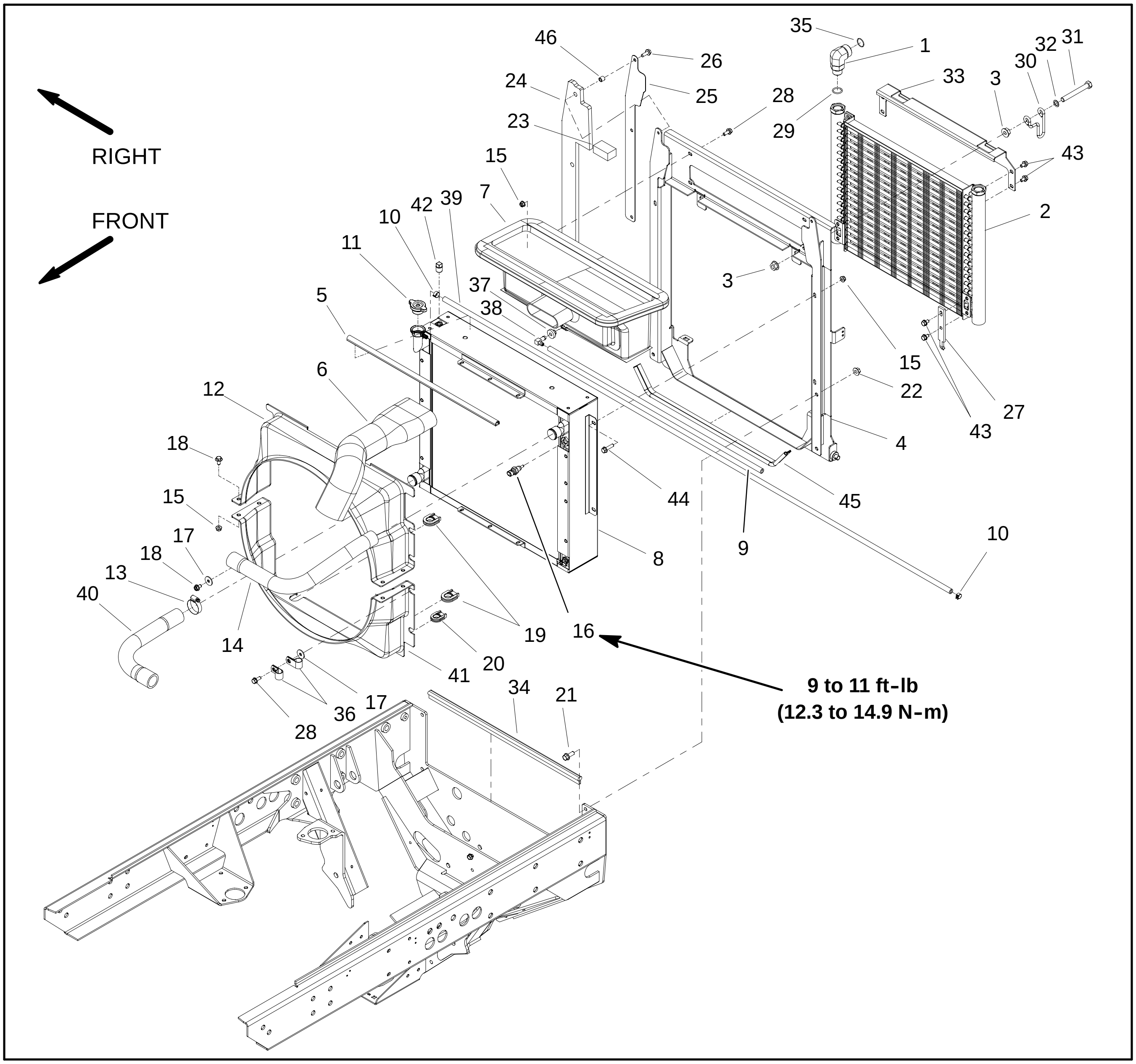


Figure 8

1. 90º hydraulic fitting (2 used)
2. Oil cooler
3. Flange nut (4 used)
4. Radiator mount
5. Bulb seal
6. Air cleaner hose
7. Plenum
8. Radiator
9. Hose
10. Hose clamp (3 used)
11. Radiator cap
12. Upper radiator shroud
13. Clamp (4 used)
14. Upper radiator hose
15. Flange nut (12 used)
16. Temperature sender
17. Flat washer (8 used)
18. Flange head screw (11 used)
19. Rubber grommet (2 used)
20. Rubber grommet
21. Flange head screw (4 used)
22. Flange nut (4 used)
23. Foam seal (2 used)
24. Recirculation barrier (2 used)
25. Recirculation barrier bracket (2 used)
26. Screw (2 used)
27. Oil cooler mount plate (2 used)
28. Flange head screw (9 used)
29. O–ring
30. Clamp (2 used)
31. Cap screw (2 used)
32. Washer (2 used)
33. Oil cooler top bracket
34. Bulb seal
35. O–ring
36. R–clamp (2 used)
37. Bushing
38. Elbow fitting
39. Reservoir hose
40. Lower radiator hose
41. Lower radiator shroud
42. Pipe plug
43. Flange head screw (8 used)
44. Flange head screw (4 used)
45. Bulb seal
46. Spacer

Removal (Fig. 8)

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

2. Remove hood from the machine (see Hood Removal in the Service and Repairs section of Chapter 7 – Chassis).

CAUTION

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

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

3. Remove radiator cap. Drain radiator into a suitable container using the radiator draincock.

4. Disconnect upper and lower hoses from the radiator.

5. Remove air cleaner hose (item 6).

6. Remove four (4) flange head screws and flange nuts that secure plenum (item 7) to radiator mount. Remove plenum.

7. Disconnect reservoir hose (item 39) from the radiator vent tube.

8. Detach upper radiator shroud from the radiator and lower radiator shroud. Remove upper shroud from machine.

9. Remove fasteners that secure lower radiator shroud to radiator.

10. Remove six (6) cap screws and flange nuts that secure fan motor bracket to radiator (Fig. 9).

11. Position lower radiator shroud and fan motor bracket assembly away from radiator.

12. Remove four (4) flange head screws and flange nuts securing the radiator and recirculation barriers (items 24 and 25) to the radiator mount. Carefully remove barriers and radiator from the machine.

13. Plug all radiator and hose openings to prevent contamination.

Installation (Fig. 8)

1. Remove plugs placed in radiator and hose openings during the removal procedure. Make sure that radiator draincock is closed.

2. Carefully position radiator and recirculation barriers (items 24 and 25) to the radiator mount. Secure radiator and barriers in place with four (4) flange head screws and flange nuts.

3. Position lower radiator shroud and fan motor bracket assembly to the radiator. Make sure that hydraulic hoses are correctly positioned in grommets in lower radiator shroud.

4. Secure fan motor bracket to radiator with six (6) cap screws and flange nuts (Fig. 9).

5. Secure lower radiator shroud to radiator with removed fasteners.

6. Position upper radiator shroud to lower radiator shroud and radiator. Secure shrouds with removed fasteners. Make sure that clearance between shrouds and fan is at least 0.180” (4.6 mm) at all points.

7. Connect reservoir hose (item 39) to the radiator vent tube.

8. Connect upper and lower hoses to the radiator.

9. Install plenum (item 7) to radiator mount and secure with flange head screws and flange nuts.

10. Install air cleaner hose (item 6) to the air cleaner and plenum.

11. Fill radiator with coolant.

12. Install hood on the machine (see Hood Installation in the Service and Repairs section of Chapter 7 – Chassis).

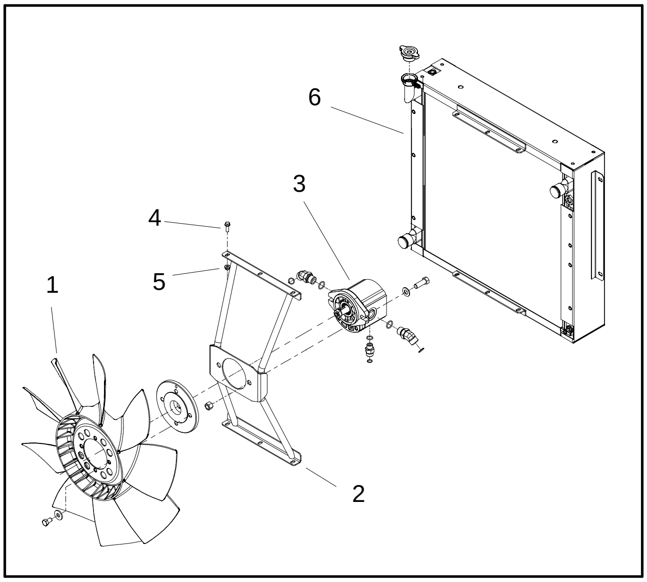


Figure 9

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

Kubota Diesel Engine

Engine

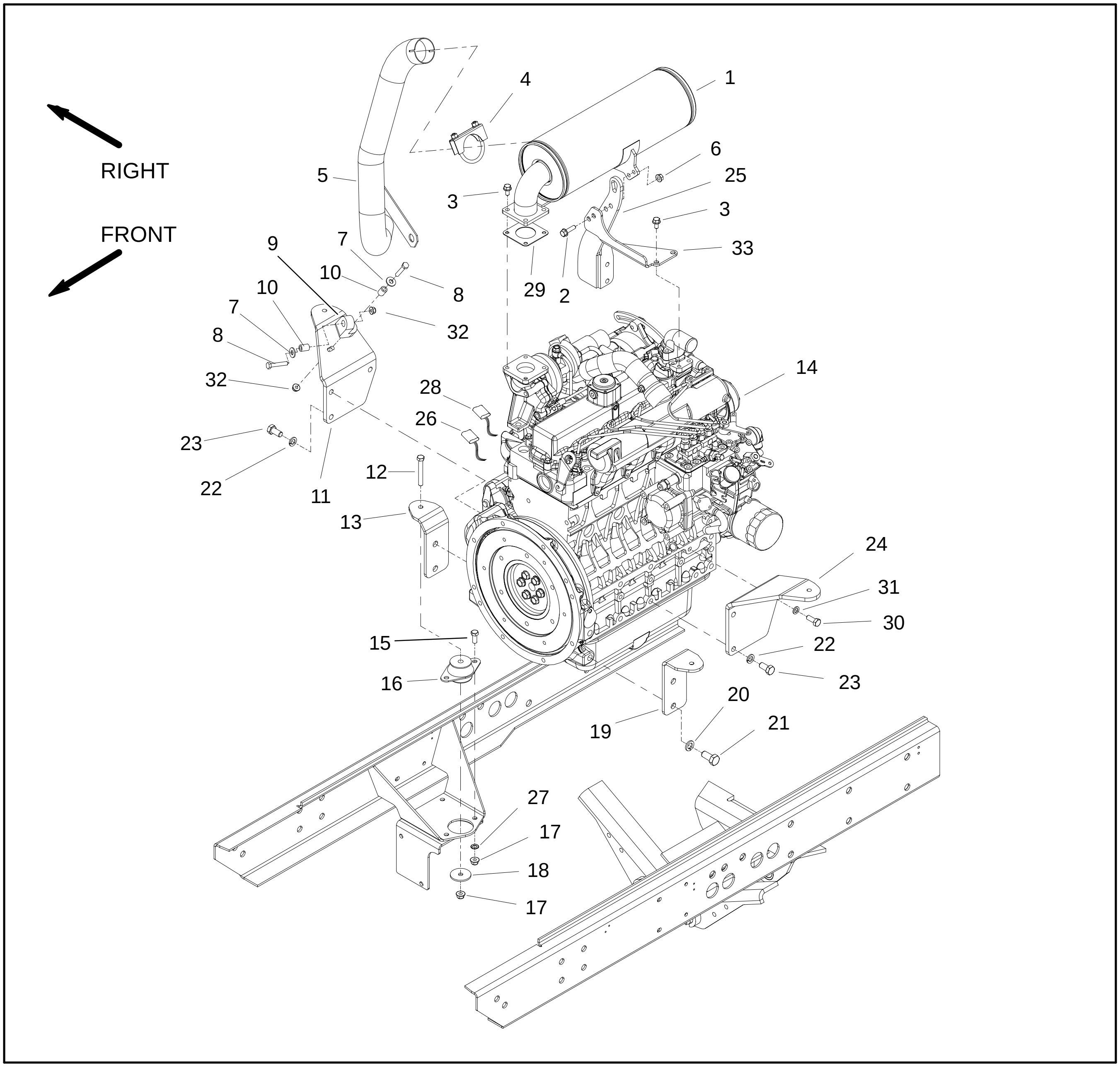


Figure 10

1. **Muffler**
2. **Flange head screw (2 used)**
3. **Flange head screw (6 used)**
4. **Muffler clamp**
5. **Exhaust pipe**
6. **Flange nut (4 used)**
7. **Flat washer (2 used)**
8. **Cap screw (2 used)**
9. **Rubber hanger**
10. **Spacer (2 used)**
11. **RH engine mount**
12. **Cap screw (4 used)**
13. **RH engine mount**
14. **Engine**
15. **Flange head screw (10 used)**
16. **Engine support (4 used)**
17. **Flange nut (14 used)**
18. **Rebound washer (4 used)**
19. **LH engine mount**
20. **Lock washer (4 used)**
21. **Cap screw (4 used)**
22. **Lock washer (5 used)**
23. **Bolt (5 used)**
24. **LH engine mount**
25. **Exhaust mount**
26. **Alternator wire harness**
27. **Lock washer**
28. **Ground harness**
29. **Muffler gasket**
30. **Cap screw**
31. **Lock washer**
32. **Flange nut (2 used)**
33. **Exhaust mount**

Engine Removal (Fig. 10)

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

2. Remove hood from the machine (see Hood Removal in the Service and Repairs section of Chapter 7 – Chassis).

3. Remove battery cover. Disconnect negative battery cable first and then positive battery cable.

CAUTION

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

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

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

CAUTION

The exhaust system 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 Muffler Removal in this section).

6. Remove air cleaner system from engine (see Air Cleaner Removal in this section).

7. Note location of cable ties used to secure wire harness. Disconnect wire harness connectors from the following engine components:

A. The engine run solenoid (Fig. 11).

B. The temperature sender (Fig. 12).

C. The alternator (Fig. 12).

D. The glow plug connection.

E. Wire harness connector from engine ground harness.

F. The electric starter.

G. Low oil pressure switch located on alternator side of engine (above electric starter).

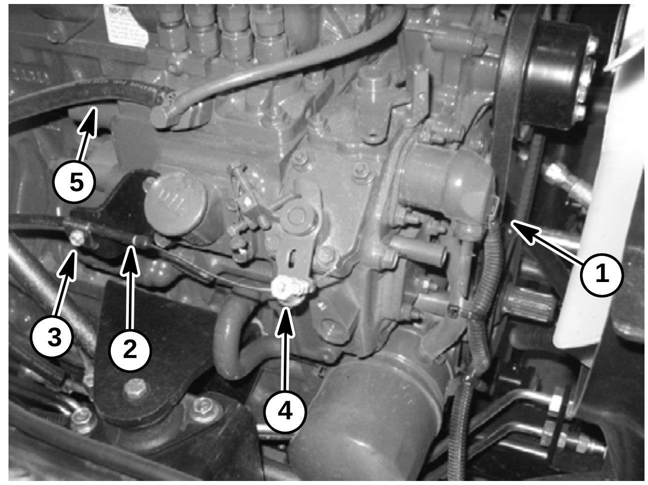


Figure 11

1. **Engine run solenoid**
2. **Throttle cable**
3. **Cable clamp**
4. **Cable swivel**
5. **Fuel supply hose**

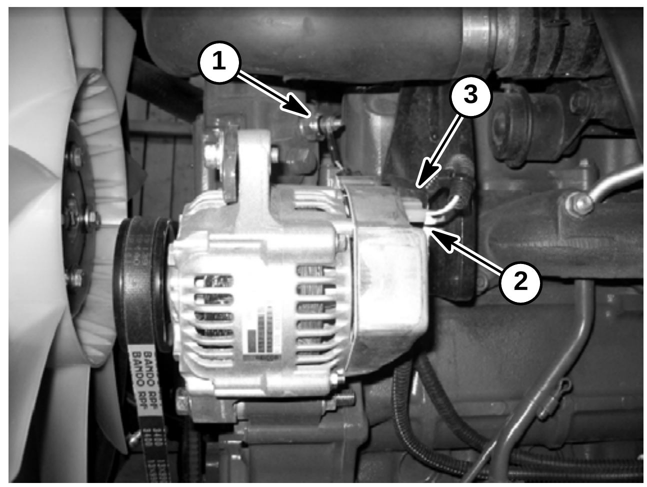


Figure 12

1. **Temperature sender**
2. **Harness connector**
3. **Battery cable**

8. Disconnect fuel supply hose from injection pump (Fig. 11). Cap fuel hose and injector pump fuel inlet to prevent contamination.

9. Remove throttle cable from engine (Fig. 11):

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). Remove upper radiator shroud from machine.

11. Remove fan motor and fan assembly (Fig. 13).

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

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

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

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

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 pump mounting fasteners are removed.

12. 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).

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

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

15. Remove flange nuts, rebound washers and cap screws that secure the engine mounts to the rubber engine supports.

CAUTION

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

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

16. Carefully lift engine from the machine.

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

Engine Installation (Fig. 10)

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

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

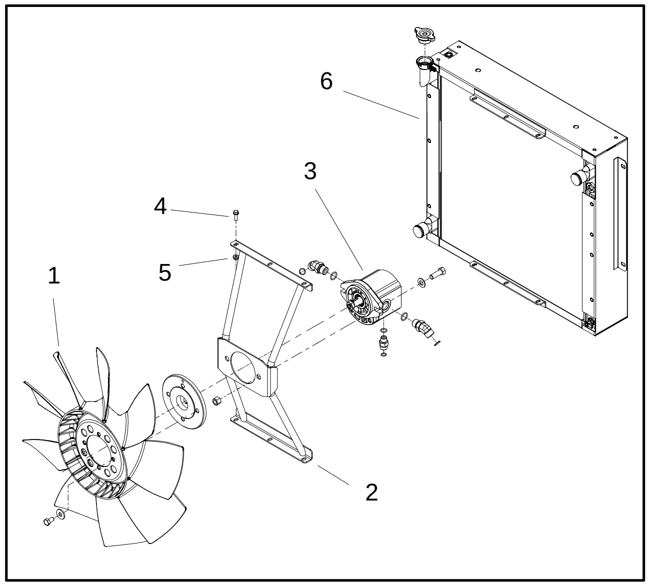


Figure 13

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

CAUTION

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

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

3. Carefully lower engine into the machine.

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

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

6. Install fan motor and fan assembly (Fig. 13).

A. Carefully position fan motor, fan and motor bracket assembly to radiator.

B. Secure fan motor bracket to radiator with six (6) cap screws and flange nuts.

C. Remove caps and plugs placed in hoses and fittings during removal to prevent contamination.

D. Connect hydraulic hoses to cooling fan motor (see Hydraulic Hose and Tube Installation in the General Information section of Chapter 4 – Hydraulic System).

7. Position upper radiator shroud to the radiator. Secure shroud 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.

8. Connect throttle cable to the speed control lever with washer and lock nut. Install cable to mounting bracket. Adjust throttle cable.

9. Connect throttle cable to engine (Fig. 11):

   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. Remove caps from fuel hose and injector pump fuel inlet that were placed during engine removal to prevent contamination. Connect fuel supply hose to injection pump (Fig. 11).

11. Connect wire harness connectors to the following engine components:

   A. The engine run solenoid (Fig. 11).

   B. The temperature sender (Fig. 12).

   C. The alternator (Fig. 12).

   D. The glow plug connection.

   E. Wire harness connector to engine ground harness.

   F. The electric starter. Torque nut at starter B+ terminal from **70 to 86 in–lb (7.9 to 9.7 N–m)**.

   G. Low oil pressure switch located on alternator side of engine (above electric starter).

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

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

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

15. Connect coolant hoses to the radiator. Make sure radiator draincock is closed. 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. Connect positive battery cable first and then negative battery cable. Secure battery cover to machine.

18. Check and adjust engine oil level as needed.

19. Check and adjust hydraulic oil level as needed.

20. Bleed fuel system.

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

22. Install hood on the machine (see Hood Installation in the Service and Repairs section of Chapter 7 – Chassis).

Pump Adapter Plate

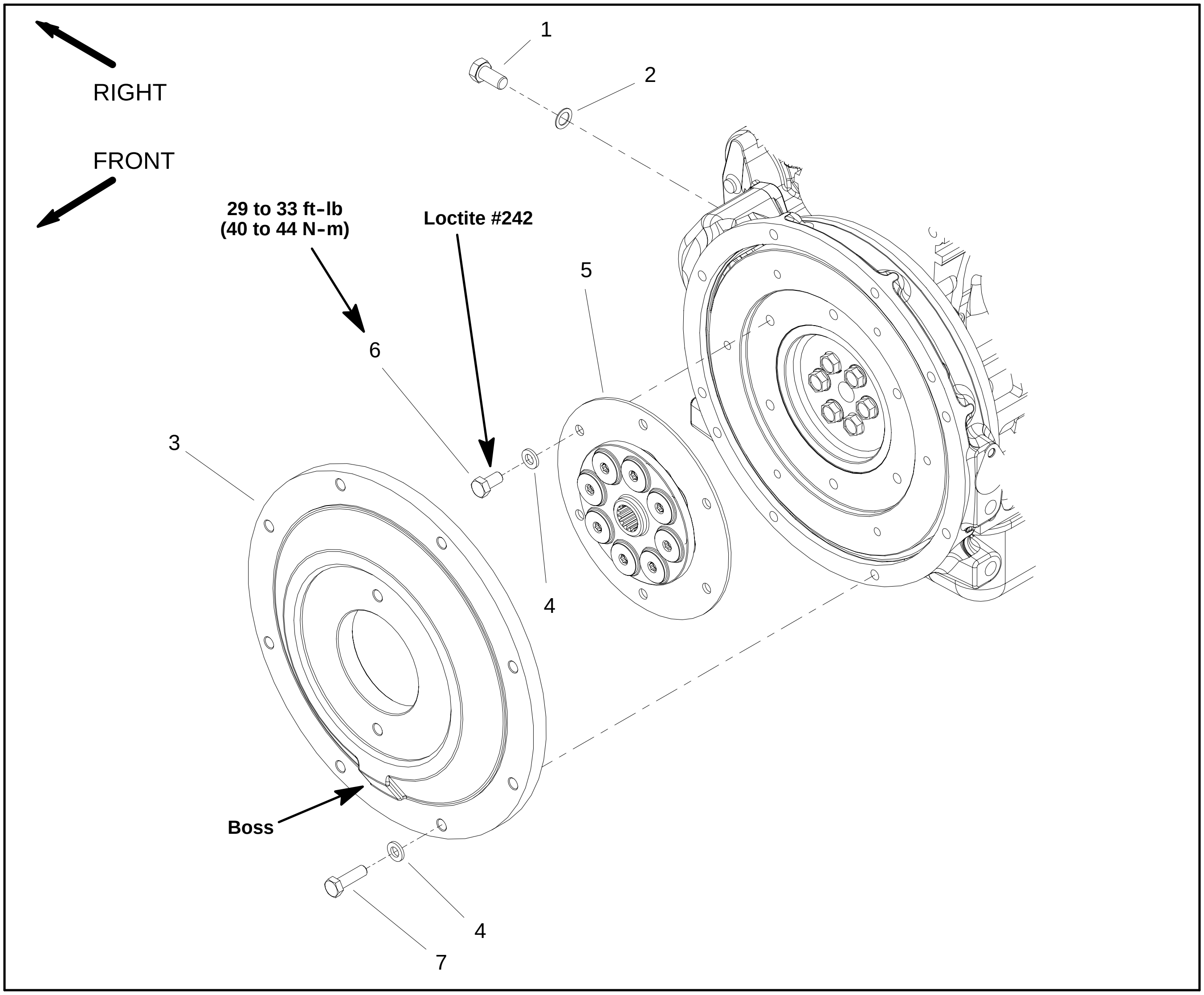


Figure 14

1. **Bolt**
2. **Lock washer**
3. **Flywheel plate**
4. **Hardened washer (14 used)**
5. **Spring coupler**
6. **Bolt (6 used)**
7. **Cap screw (8 used)**

Coupler Removal (Fig. 14)

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

1. If engine is in machine, remove hydraulic pump assembly (see Piston (Traction) Pump Removal in the Service and Repairs section of Chapter 4 – Hydraulic System).

2. Remove flywheel plate and spring coupler from engine using Figure 14 as a guide.

Coupler Installation (Fig. 14)

1. Position spring coupler to engine flywheel and align mounting holes. Make sure that coupling hub is away from engine flywheel (Fig. 15).

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

3. Position flywheel plate to engine. Make sure that boss on plate is orientated down. Secure flywheel plate with cap screws (item 7) and hardened washers using a crossing pattern tightening procedure.

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).

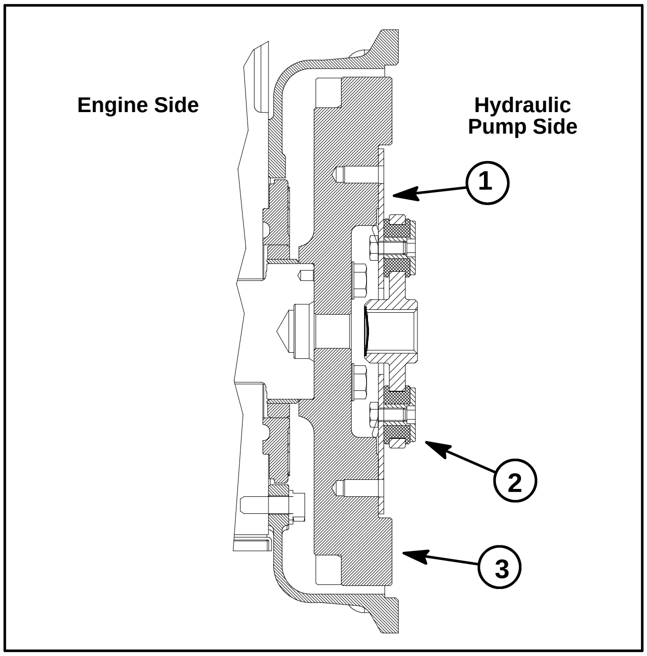


Figure 15

1. Coupler
2. Coupler hub
3. Engine flywheel

Kubota Diesel Engine

This page is intentionally blank.

Chapter 4

Hydraulic System

Table of Contents

Hydraulic System

This page is intentionally blank.

Specifications

Item	Description
Piston (Traction) Pump System Relief Pressure: Forward System Relief Pressure: Reverse	Eaton variable displacement piston pump (Model 72400) 5000 PSI (345 bar) 5000 PSI (345 bar)
Charge Pressure	207 PSI (14.3 bar)
Front Wheel Motors Displacement (per revolution)	Eaton fixed displacement piston motors (Model 74315) 2.01 in^3 (32.9 cc)
Rear Axle Motor Displacement (per revolution)	Eaton fixed displacement piston motor (Model 74318) 2.48 in^3 (40.6 cc)
Gear Pump Section P1/P2 Displacement (per revolution) Section P3/P4 Displacement (per revolution)	Casappa 4 section, positive displacement gear type pump 1.03 in^3 (16.85 cc) 0.56 in^3 (9.16 cc)
Steering Control Valve Displacement (per revolution)	Sauer–Danfoss Steering Unit, Series OSPM 6.1 in^3 (100 cc)
Steering Relief Pressure	1050 PSI (72 bar)
Lift/Lower Relief Pressure	1600 PSI (110 bar)
Cutting Deck Motors Displacement (per revolution)	Casappa Gear Motor 1.16 in^3 (19 cc)
Cutting Deck Circuit Relief Pressure	3500 PSI (241 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 Capacity	8.25 U.S. Gallons (31.3 Liters)
Hydraulic Oil	See Traction Unit Operator's Manual

NOTE: The pressure specifications listed above are component settings. When using pressure gauges to measure circuit pressures, values may be different than these specifications. See the Testing section of this chapter for hydraulic test procedures and expected test results.

General Information

Operator's Manual

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

Towing Traction Unit

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

If it becomes necessary to tow (or push) the machine, tow (or push) in a **forward direction only**, at a speed **below 3 mph (4.8 kph)** and for a distance **less than 1/4 mile (0.4 km)**. The piston (traction) pump is equipped with a bypass valve that needs to be turned 90^{o} for towing. Do not turn bypass valve when engine is running.

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

IMPORTANT: If the machine must be pushed or towed in a reverse direction, the check valve in the 4WD/2WD control manifold must be bypassed. To bypass this check valve, connect a hydraulic hose between the reverse traction pressure test port and the 4WD/2WD control manifold test port (G). Toro part numbers 95–8843 (hydraulic hose), 95–0985 (coupler fitting) (2 required) and 340–77 (hydraulic fitting) (2 required) are needed for this connection.

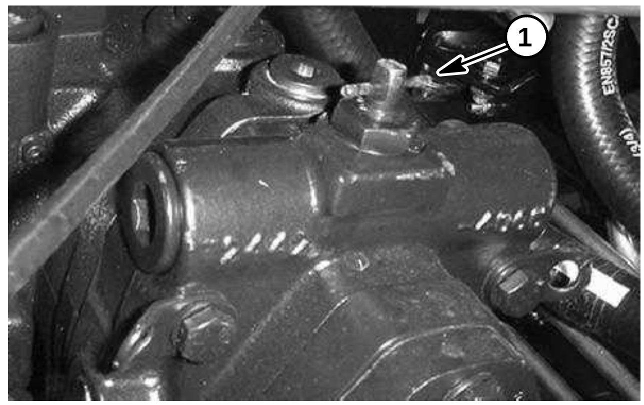


Figure 1

1. Bypass valve location

Check Hydraulic Fluid

The Groundsmaster 4500–D and 4700–D hydraulic systems are designed to operate on anti–wear hydraulic fluid. The reservoir holds approximately 8.25 gallons (31.3 liters) of hydraulic fluid. **Check level of hydraulic fluid daily.**

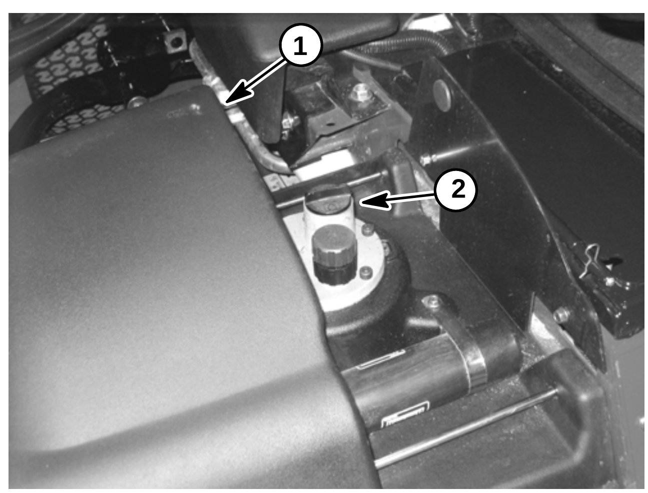


Figure 2

1. Reservoir cover **2. Reservoir cap**

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 decks fully, stop engine and apply parking brake.

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.

System pressure in mow circuit is relieved when the cutting decks are disengaged (PTO switch in OFF position).

To relieve hydraulic pressure in lift circuit, fully lower the cutting decks to the ground. Turn ignition switch to OFF.

Traction Circuit Component Failure

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

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

An alternative method of removing traction circuit contamination would be to temporarily install a high pressure hydraulic oil filter (see Special Tools) into the circuit. The 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 filter has been placed in the circuit, operate the traction circuit to allow oil flow through the circuit. The filter will remove contamination from the traction circuit during circuit operation. The filter can be removed from the machine after contamination has been removed from the traction circuit.

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

NOTE: If traction circuit contamination exists, the traction pump case drain could allow contaminates to enter other hydraulic circuits on the machine.

Hydraulic Hoses

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

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

Kinked, crushed, flattened or twisted hose.

Blistered, soft, degraded or loose hose cover.

Cracked, damaged or badly corroded hose fittings.

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

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

WARNING

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

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

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

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

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

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

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

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

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

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

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

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

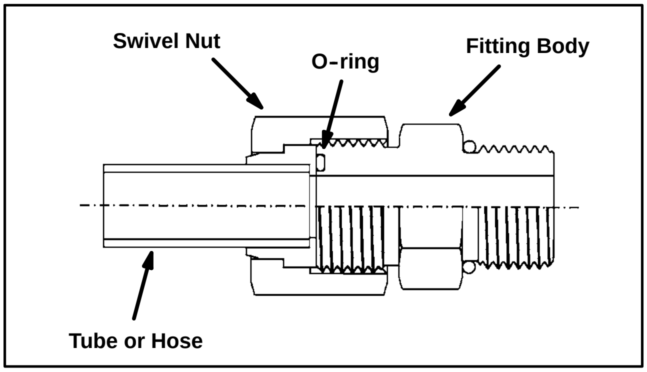


Figure 3

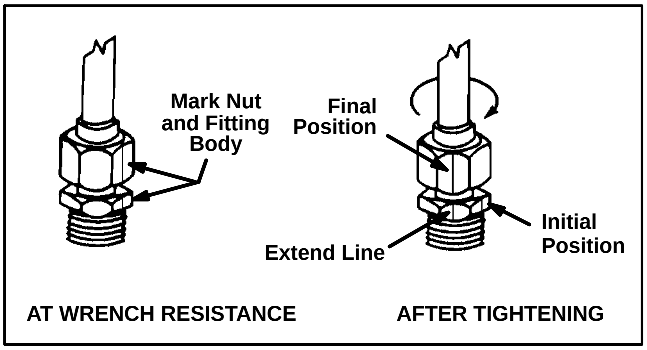


Figure 4

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

Figure 5

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

Non–Adjustable Fitting (Fig. 6)

1. Make sure all threads and sealing surfaces of fitting and component port are free of burrs, nicks, scratches or any foreign material.

2. As a preventative measure against leakage, it is recommended that the O–ring be replaced any time the connection is opened.

3. Lightly lubricate the O–ring with clean hydraulic oil. Fitting threads should be clean with no lubricant applied.

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

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

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

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

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

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

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

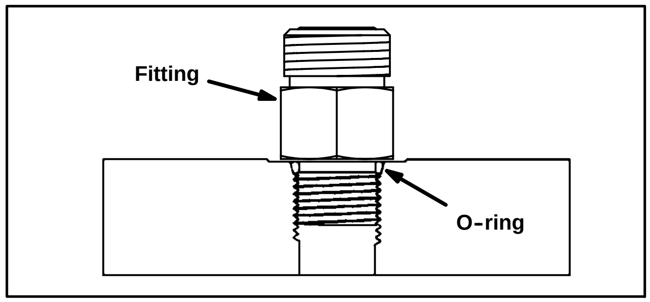


Figure 6

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

Figure 7

Adjustable Fitting (Fig. 8)

1. Make sure all threads and sealing surfaces of fitting and component port are free of burrs, nicks, scratches or any foreign material.

2. As a preventative measure against leakage, it is recommended that the O–ring be replaced any time the connection is opened.

3. Lightly lubricate the O–ring with clean hydraulic oil. Fitting threads should be clean with no lubricant applied.

4. Turn back the lock nut as far as possible. Make sure the back up washer is not loose and is pushed up as far as possible (Step 1 in Figure 9).

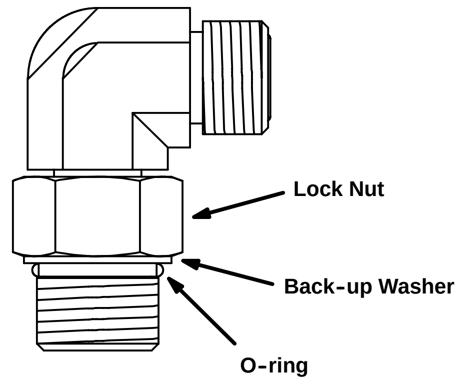


Figure 8

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

5. Install the fitting into the port and tighten finger tight until the washer contacts the face of the port (Step 2).

6. To put the fitting in the desired position, unscrew it by the required amount, but no more than one full turn (Step 3).

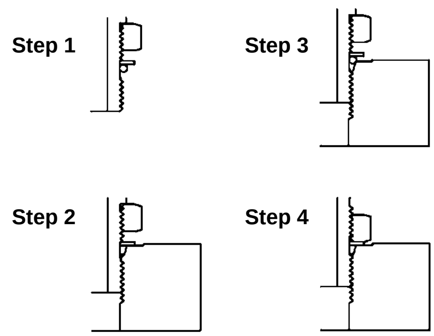


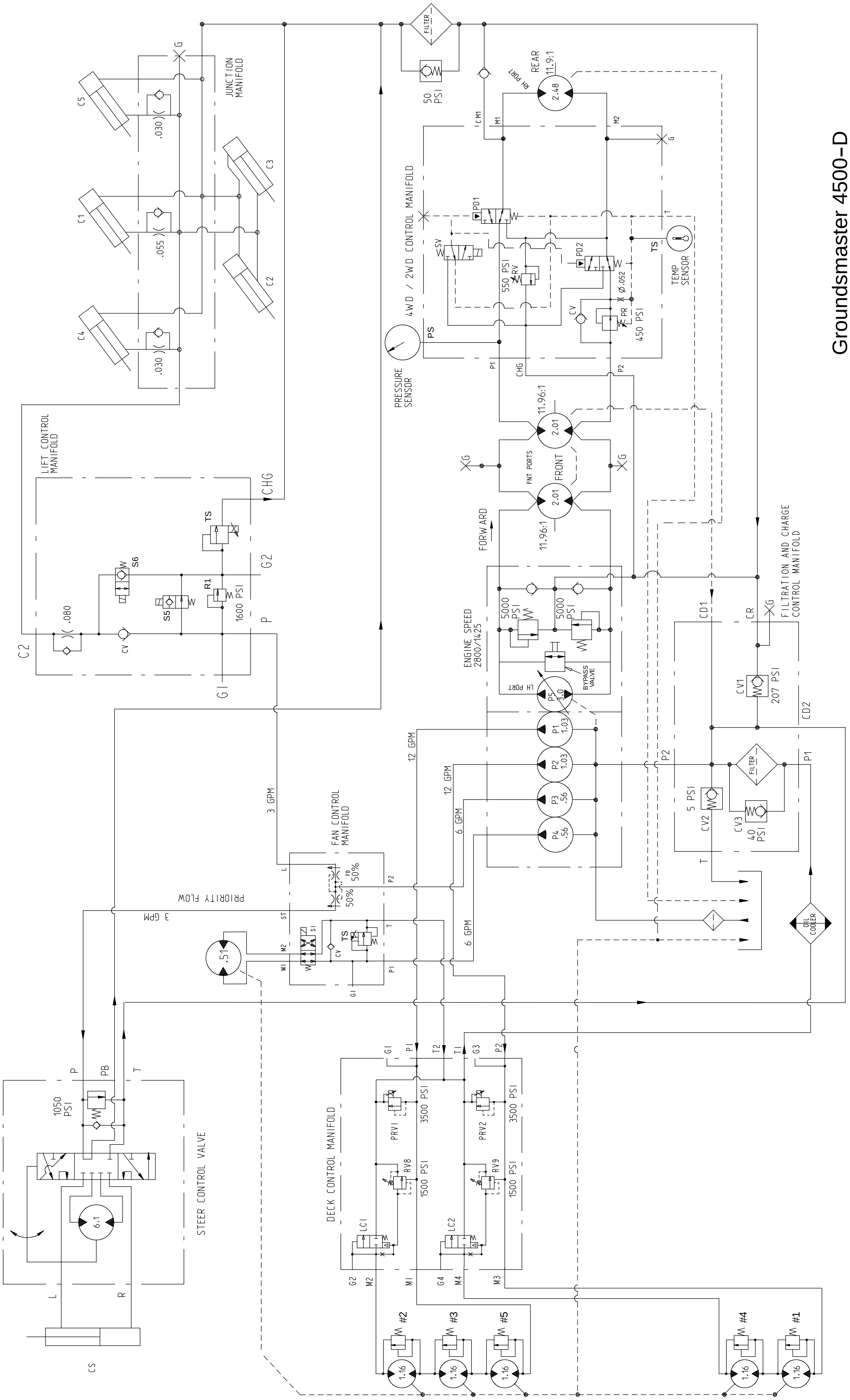
Figure 9

7. Hold the fitting in the desired position with a wrench and use a torque wrench to tighten the fitting to the recommended installation torque shown in Figure 7. This tightening process will require the use of an offset wrench (e.g. crowfoot wrench). Use of an offset wrench will affect torque wrench calibration due to the effective length change of the torque wrench. Tightening torque when using a torque wrench with an offset wrench will be lower than the listed installation torque (see Using a Torque Wrench with an Offset Wrench in the Torque Specifications section of Chapter 2 – Product Records and Maintenance).

8. If a torque wrench is not available, or if space at the port prevents use of a torque wrench, an alternate method of assembly is the Flats From Finger Tight (F.F.F.T.) method. Hold the fitting in the desired position with a wrench and, if port material is steel, tighten the lock nut with a second wrench to the listed F.F.F.T (Step 4). If port material is aluminum, tighten fitting to 60% of listed F.F.F.T.

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

Hydraulic Schematics

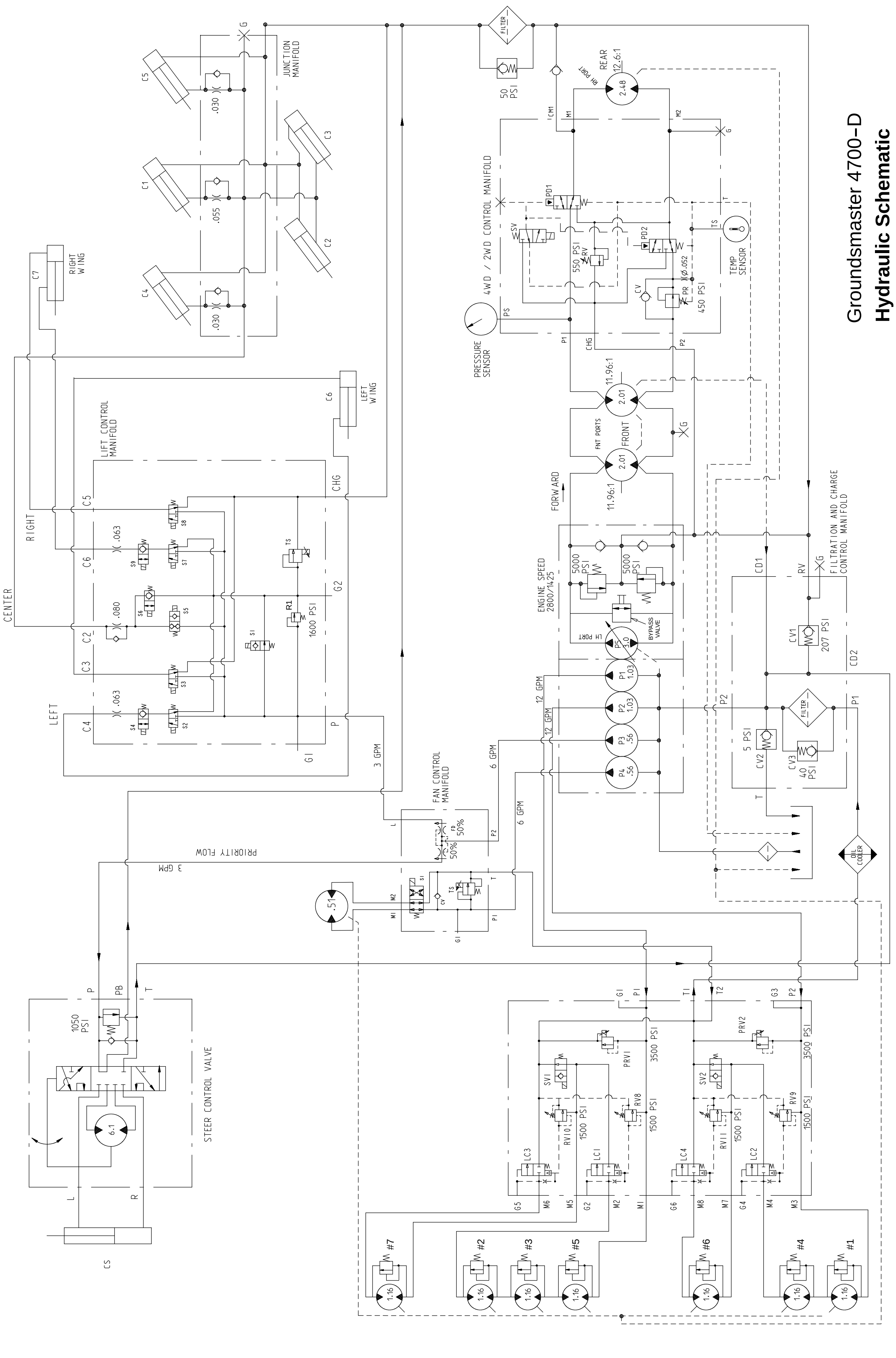


Groundsmaster 4500–D

Hydraulic Schematic

All solenoids are shown as de–energized

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



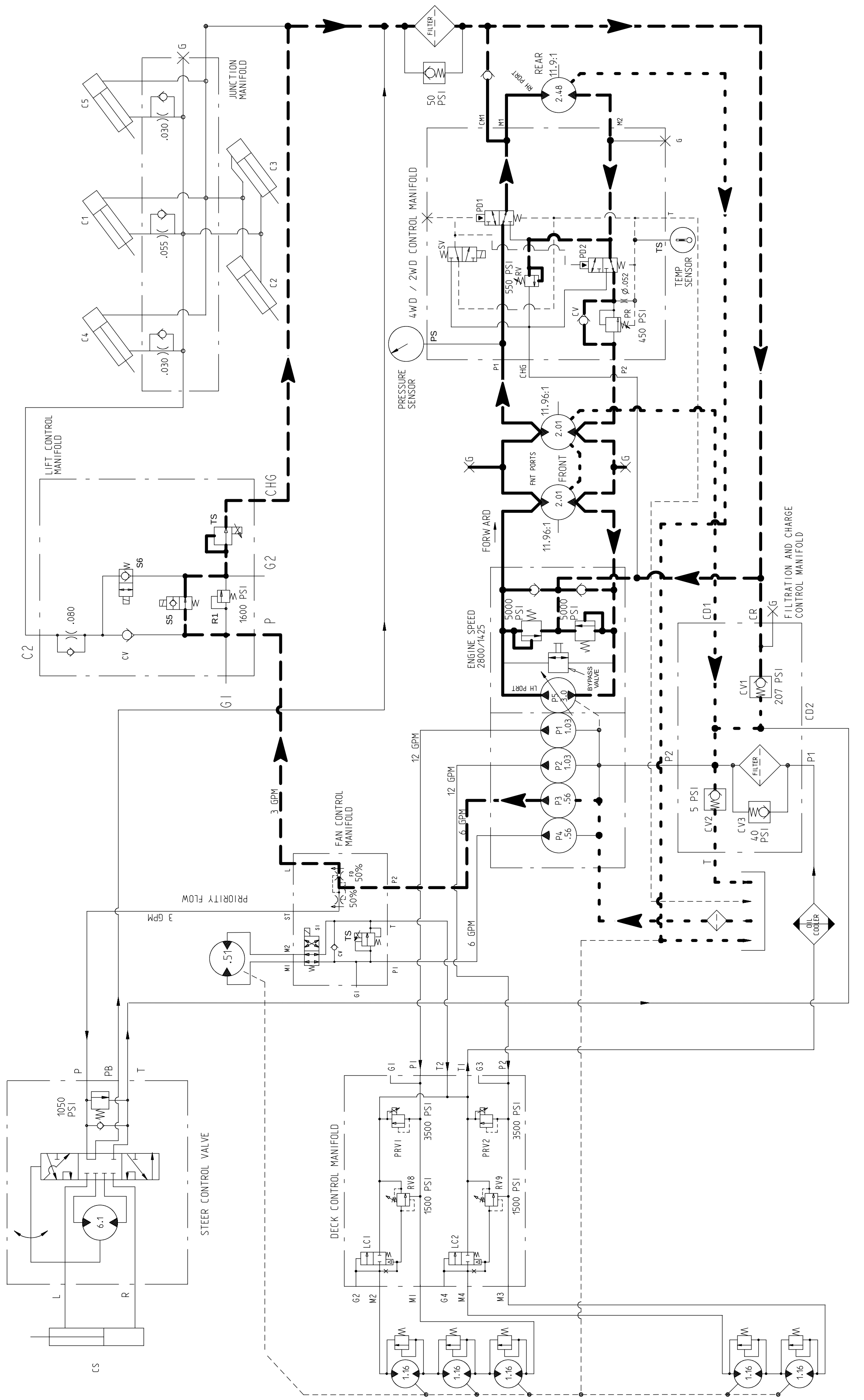
Groundsmaster 4700–D

Hydraulic Schematic

All solenoids are shown as de–energized

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

Hydraulic Flow Diagrams



Groundsmaster 4500–D/4700–D

Traction Circuit: Low Speed (GM 4500–D Forward Shown)

Working Pressure
Low Pressure (Charge)
Return or Suction
Flow

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: 5000 PSI (345 bar) in both forward and reverse. If pressure exceeds the relief setting, oil flows through the relief valve to the low pressure side of the closed loop traction circuit. The traction circuit provides operation in either low speed (4WD) or high speed (2WD).

Traction circuit pressure (forward and reverse) can be measured at test ports located on the traction circuit hydraulic tubes 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 207 PSI (14.3 bar) by a relief valve located in the filtration/charge control manifold. Charge pressure can be measured at the charge circuit pressure test port on the filtration/charge control manifold.

To enhance traction control, the lift/lower circuit is equipped with a counterbalance system. A proportional relief valve (TS) located in the lift control manifold allows cutting deck weight to be transferred to the machine for traction improvement (see Counterbalance in Lower Cutting Decks in this section).

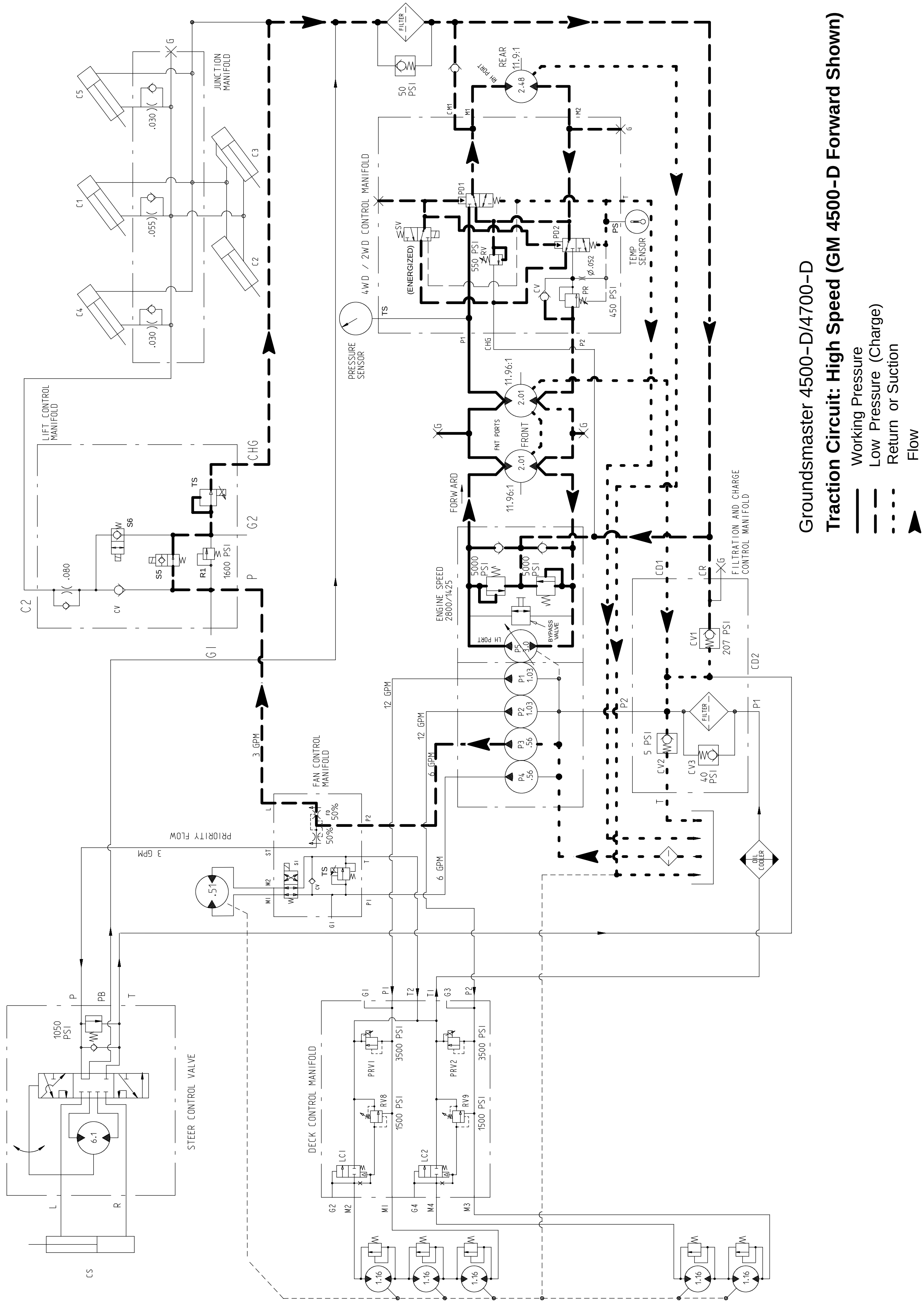
Forward Direction

When the Hi–Lo speed control 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/2WD control manifold. Oil flow to the front wheel motors drives the motors in the forward direction and then returns to the piston pump. Oil flow to the 4WD/2WD control 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/2WD control manifold at the M2 port. Flow passes through the PD2 cartridge, through the check valve (CV), out manifold port P2 and back to the piston pump.

When going down a hill, the machine 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/2WD control manifold reduces rear axle motor pressure created in down hill, dynamic braking conditions.

Reverse Direction

The traction circuit operates essentially the same in reverse 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/2WD control 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/2WD control manifold enters the manifold at port P2 and flows through pressure reducing valve (PR) which limits the down stream pressure to the rear axle motor to 450 PSI (31 bar) so the rear wheels will not scuff the turf during reverse operation. This reduced pressure flows through the PD2 cartridge and out port M2 to the rear axle motor. Return oil from the rear motor re–enters the 4WD/2WD control manifold at port M1, flows through the PD1 cartridge, exits the manifold at port P1 and returns to the piston pump.


Groundsmaster 4500–D/4700–D
Traction Circuit: High Speed (GM 4500–D Forward Shown)
Working Pressure
Low Pressure (Charge)
Return or Suction
Flow
JUNCTION MANIFOLD
LIFT CONTROL MANIFOLD
4WD / 2WD CONTROL MANIFOLD
PRESSURE SENSOR
TEMP SENSOR
FILTRATION AND CHARGE CONTROL MANIFOLD
ENGINE SPEED 2800/1425
FORWARD
FAN CONTROL MANIFOLD
PRIORITY FLOW
STEER CONTROL VALVE
DECK CONTROL MANIFOLD
OIL COOLER
BYPASS VALVE

Traction Circuit: High 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: 5000 PSI (345 bar) in both forward and reverse. If pressure exceeds the relief setting, oil flows through the relief valve to the low pressure side of the closed loop traction circuit. The traction circuit provides operation in either low speed (4WD) or high speed (2WD).

Traction circuit pressure (forward and reverse) can be measured at test ports located on the traction circuit hydraulic tubes 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 207 PSI (14.3 bar) by a relief valve located in the filtration/charge control manifold. Charge pressure can be measured at the test port on the filtration/charge control manifold.

NOTE: When in high speed (2WD), the cutting decks are prevented from being lowered and the mow circuit cannot be engaged.

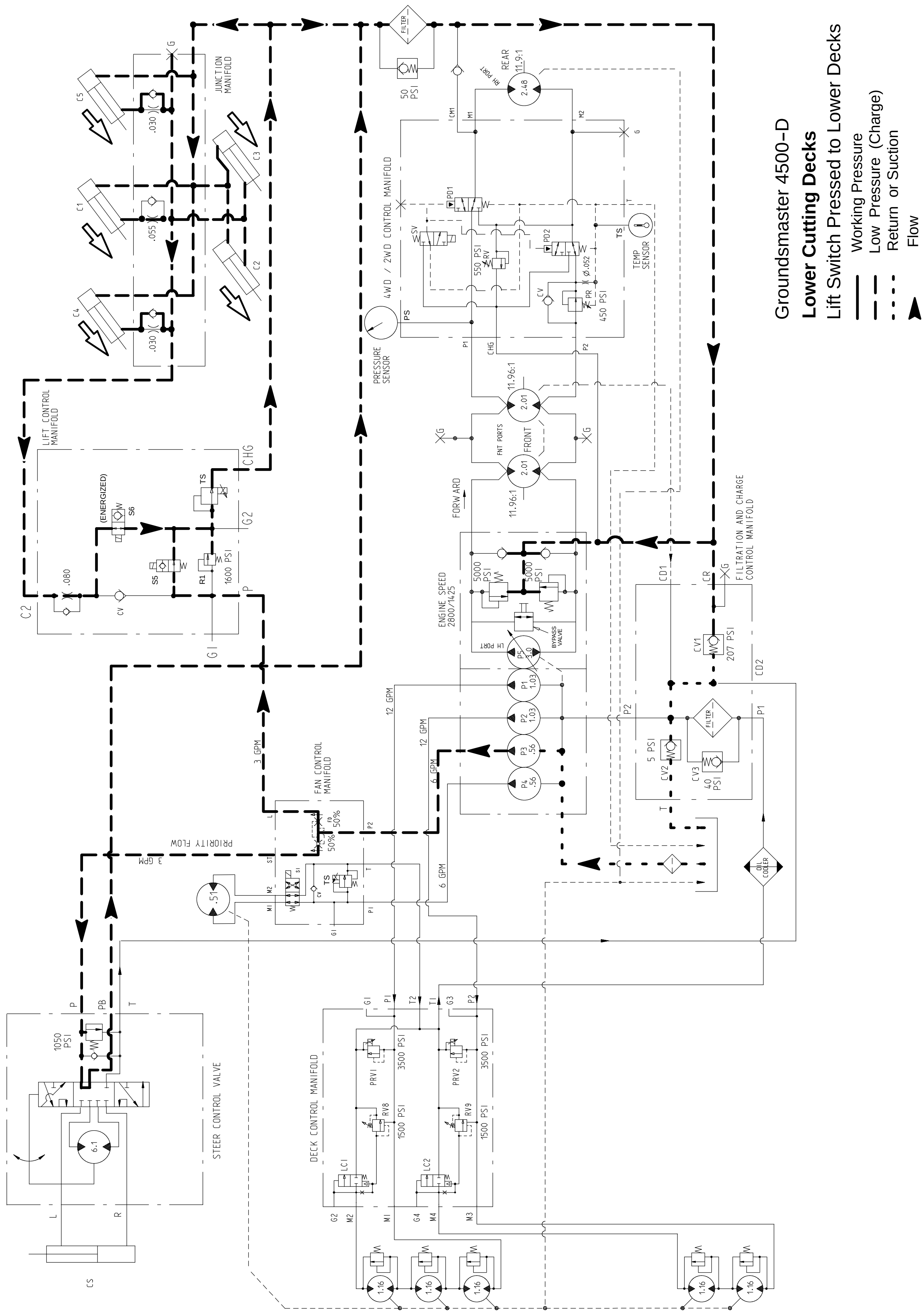
Forward Direction

With the Hi–Lo speed control switch is in the high speed (2WD) position, solenoid valve (SV) in the 4WD/2WD 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 hydraulic flow from the piston pump to the rear axle motor. With flow blocked to the rear axle motor, all piston 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 oil into the rear axle motor circuit. Oil leaving the axle motor enters the 4WD/2WD control 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 high speed operation, a small amount of oil exits through the shifted PD1 and PD2 cartridges that returns to the reservoir.

Reverse Direction

The traction circuit operates essentially the same in reverse high speed 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/2WD manifold prevent oil flow from the rear axle motor. Oil flow from the piston pump is therefore directed to only the front wheel motors. This oil drives the front wheel motors in the reverse direction and then returns to the piston pump. Oil circulation through the rear axle motor loop is the same as in the 2WD forward direction.


Groundsmaster 4500–D
Lower Cutting Decks
Lift Switch Pressed to Lower Decks
Working Pressure
Low Pressure (Charge)
Return or Suction
Flow
JUNCTION MANIFOLD
LIFT CONTROL MANIFOLD
FAN CONTROL MANIFOLD
PRIORITY FLOW
4WD / 2WD CONTROL MANIFOLD
PRESSURE SENSOR
TEMP SENSOR
FILTRATION AND CHARGE CONTROL MANIFOLD
ENGINE SPEED 2800/1425
BYPASS VALVE
OIL COOLER
DECK CONTROL MANIFOLD
STEER CONTROL VALVE
FORWARD
(ENERGIZED)
1600 PSI
1050 PSI
3500 PSI
1500 PSI
550 PSI
450 PSI
207 PSI
5000 PSI
50 PSI
5 PSI
40 PSI
12 GPM
6 GPM
3 GPM

Lower Cutting Decks: Groundsmaster 4500-D

A four section gear pump is coupled to the piston (traction) pump. Gear pump section P3 supplies hydraulic flow to both the lift control manifold and the steering control valve. Hydraulic flow from this pump section is delivered to the circuits through a proportional flow divider located in the fan control manifold. Maximum lift/lower circuit pressure is limited to 1600 PSI (110 bar) by a relief valve (R1) in the lift control manifold. Lift circuit pressure can be monitored at lift control manifold test fitting G1.

On the Groundsmaster 4500-D, a single lift switch on the console arm is used to raise and lower the five (5) cutting decks (Fig. 10).

When the cutting decks are in a stationary position (not raising or lowering), lift circuit flow from gear pump section P3 bypasses the lift cylinders through the lift control manifold solenoid valve S5 (de-energized) and proportional relief valve TS. Return flow from the manifold is routed to the oil filter and traction charge circuit.

NOTE: The operator must be in the operator seat in order to lower the cutting decks. Also, when in high speed (2WD), the cutting decks will not lower.

Cutting Deck Lower

To lower the five (5) cutting decks on a Groundsmaster 4500-D, the front of the lift switch is depressed. The switch acts as an input to the TEC-5002 controller which then provides an electrical output to solenoid valve S6 in the lift control manifold. This energized solenoid valve shifts to allow a passage for oil flow from the rod ends of the five (5) deck lift cylinders. The weight of the cutting decks causes the lift cylinders to extend and lowers all of the cutting decks. An orifice in the lift control manifold restricts oil flow from the lift cylinders to control deck drop speed. Additionally, an orifice in the junction manifold further controls the lowering speed of the #1 deck.

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

Cutting Deck Float

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

Counterbalance

Once the cutting decks are fully lowered, the lift control manifold proportional relief valve (TS) maintains back pressure (counterbalance) on the deck lift cylinders. This counterbalance pressure transfers cutting deck weight to the machine to improve traction.

A pressure sensor located in the 4WD/2WD control manifold is used by the TEC-5002 controller as an input to determine traction circuit pressure. Based on this sensor input, a PWM (Pulse Width Modulation) signal from the TEC-5002 controller is provided to the proportional relief valve (TS) to maintain counterbalance pressure.

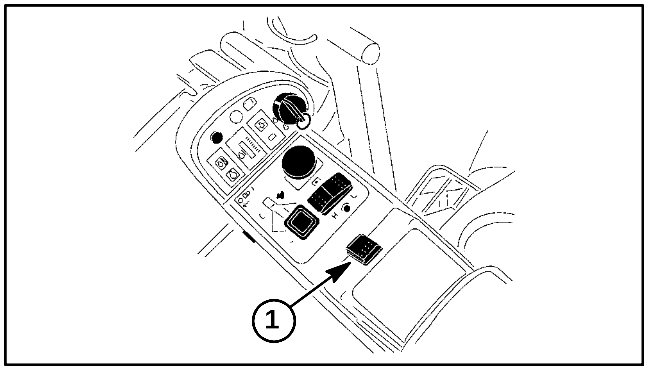


Figure 10

1. **Lift switch (#1 to #5)**

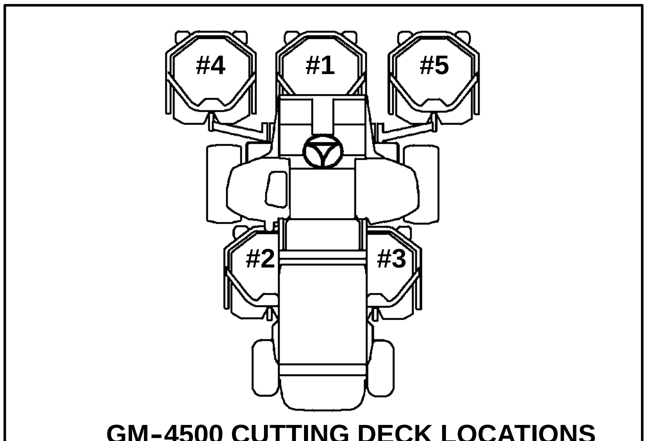
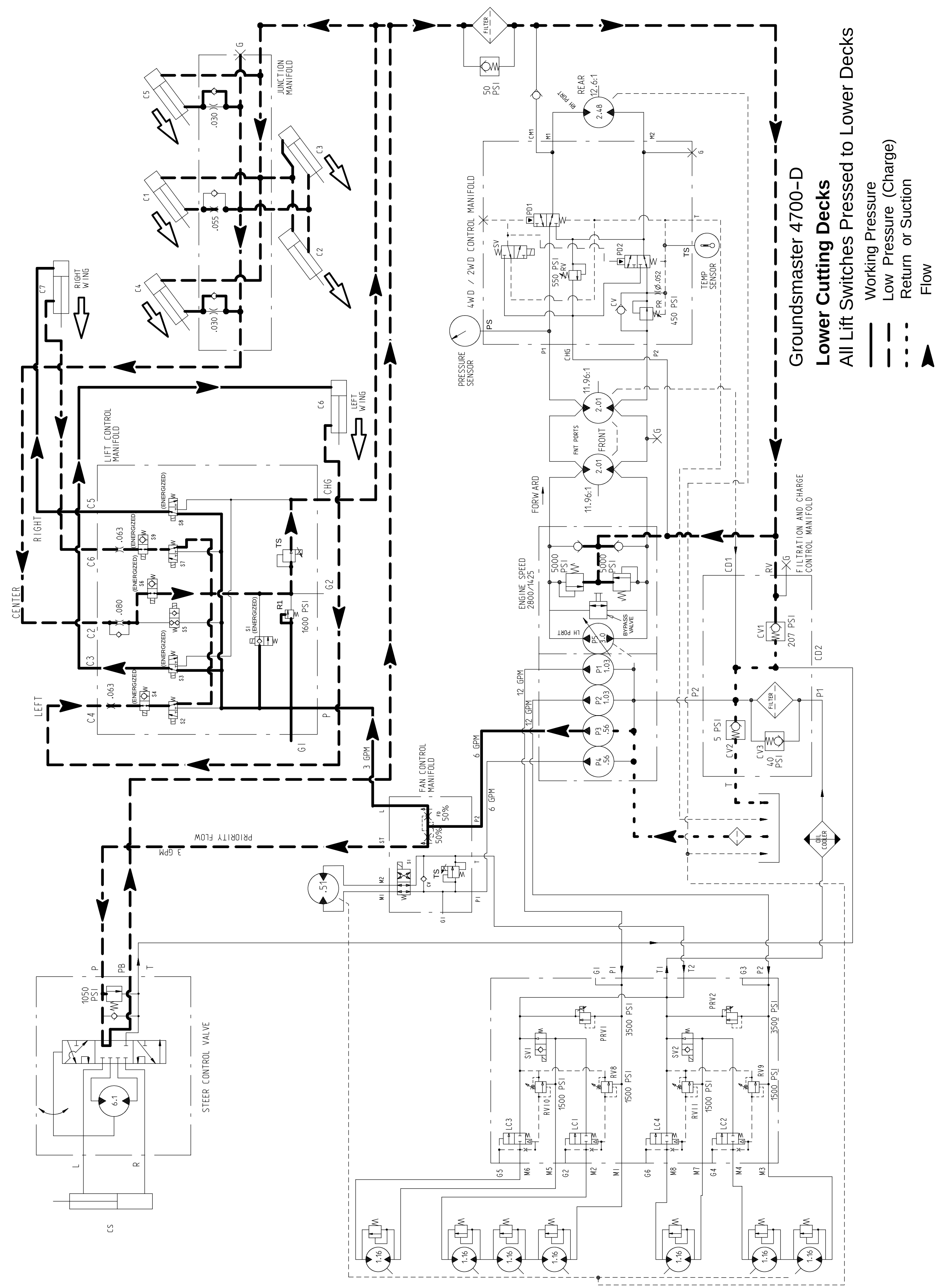


Figure 11

Hydraulic System


Groundsmaster 4700–D
Lower Cutting Decks
All Lift Switches Pressed to Lower Decks
Working Pressure
Low Pressure (Charge)
Return or Suction
Flow

Lower Cutting Decks: Groundsmaster 4700–D

A four section gear pump is coupled to the piston (traction) pump. Gear pump section P3 supplies hydraulic flow to both the lift control manifold and the steering control valve. Hydraulic flow from this pump section is delivered to the circuits through a proportional flow divider located in the fan control manifold. Maximum lift/lower circuit pressure is limited to 1600 PSI (110 bar) by a relief valve (R1) in the lift control manifold. Lift circuit pressure can be monitored at lift control manifold test fitting G1.

The Groundsmaster 4700–D has three (3) lift switches to control the cutting decks (Fig. 12). The center switch is for the five (5) center decks, the left switch controls the left, rear deck (#6) and the right switch controls the right, rear deck (#7) (Fig. 13).

When the cutting decks are in a stationary position (not raising or lowering), lift circuit flow from pump section P3 bypasses the lift cylinders through the lift control manifold solenoid valve S1 and proportional relief valve TS which are de–energized. Return flow from the manifold is routed to the oil filter and traction charge circuit.

NOTE: The operator must be in the operator seat in order to lower the cutting decks. Also, when in high speed (2WD), the cutting decks will not lower.

Cutting Deck Lower

To lower the center five (5) cutting decks on a Groundsmaster 4700–D, the front of the center lift switch is depressed. The switch acts as an input to the TEC–5002 controller which then provides an electrical output to solenoid valve S6 in the lift control manifold. This energized solenoid valve shifts to allow oil flow from the rod ends of the center five (5) deck lift cylinders. The weight of the cutting decks cause the lift cylinders to extend and the center decks to lower. An orifice in the lift control manifold restricts oil flow from the lift cylinders to control deck drop speed. Additionally, an orifice in the junction manifold further controls the lowering speed of the #1 deck.

To lower a side cutting deck on the Groundsmaster 4700–D (deck #6 or #7), the front of the appropriate lift switch is depressed. The switch acts as an input to the TEC–5001 controller which then provides electrical output to the appropriate solenoid valves in the lift control manifold: S1, S3 and S4 for deck #6 or S1, S8 and S9 for deck #7. The energized solenoid valves shift to allow pump flow to the barrel end of the deck lift cylinder and a passage for oil from the rod end of the cylinder. The cylinder extends to lower the side cutting deck. An orifice in the lift manifold restricts oil flow from the lift cylinder to control side deck drop speed.

When a deck switch is released, the solenoid valves controlled by the switch are de–energized and the lift cylinders and cutting decks are held in position.

Cutting Deck Float

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

Counterbalance

Once the cutting decks are fully lowered, the lift control manifold proportional relief valve (TS) maintains back pressure (counterbalance) on the deck lift cylinders. This counterbalance pressure transfers cutting deck weight to the machine to improve traction.

A pressure sensor located in the 4WD/2WD control manifold is used by the TEC–5002 controller as an input to determine traction circuit pressure. Based on this sensor input, a PWM (Pulse Width Modulation) signal from the TEC–5002 controller is provided to the proportional relief valve (TS) to maintain counterbalance pressure.

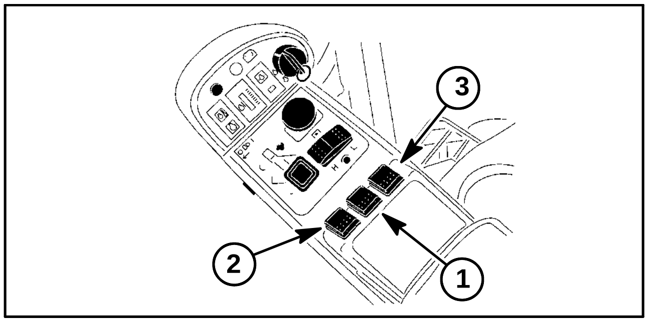


Figure 12

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

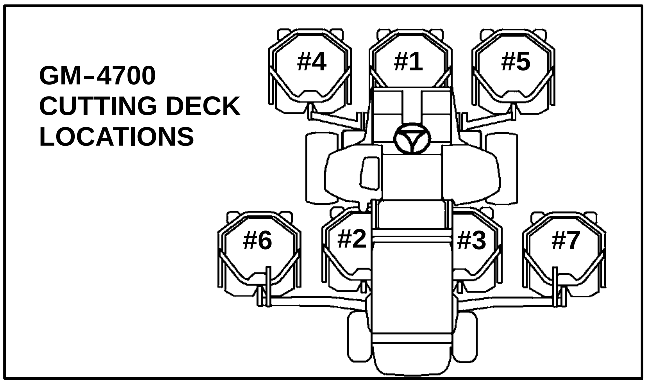
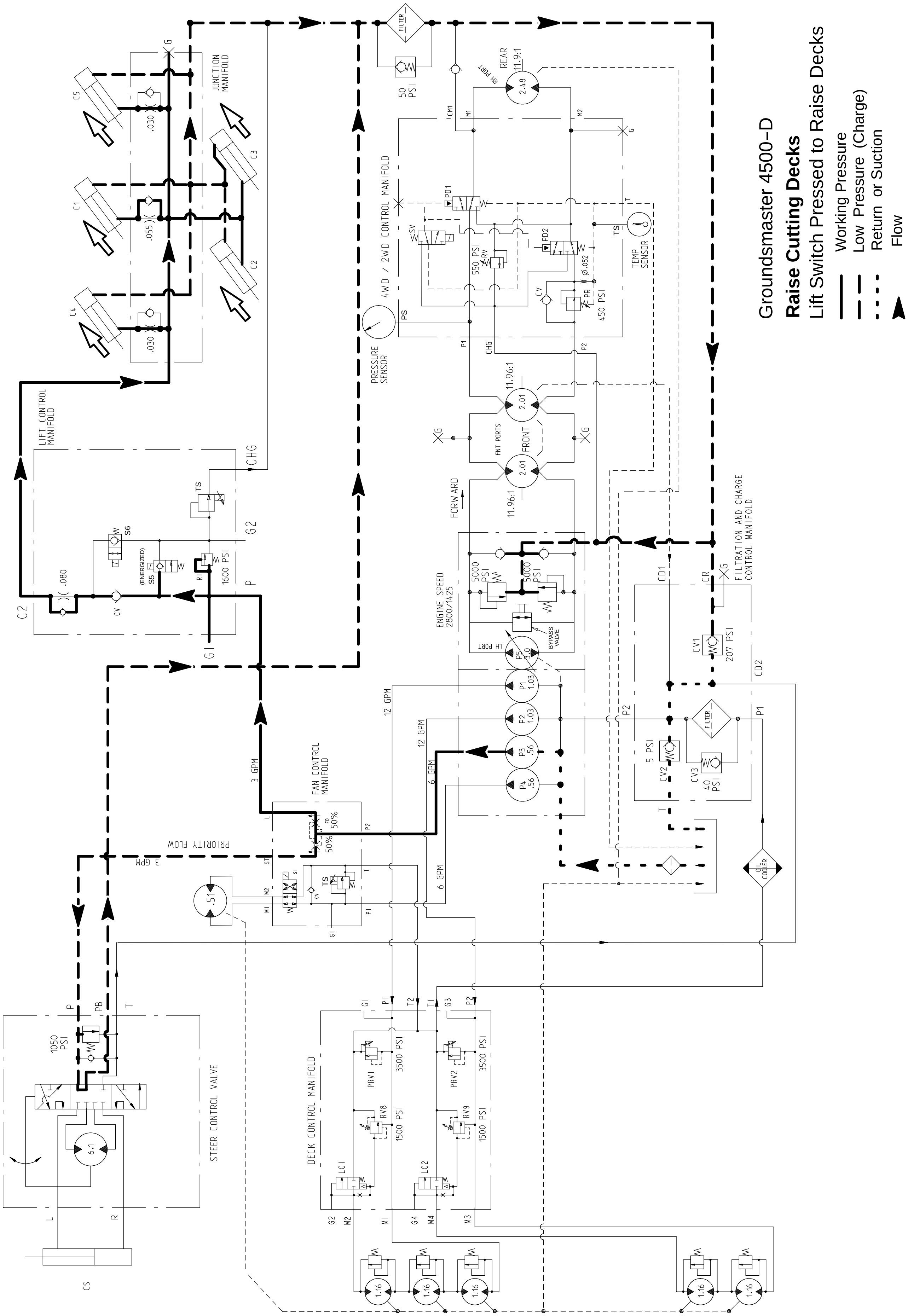


Figure 13

Hydraulic System


Groundsmaster 4500–D
Raise Cutting Decks
Lift Switch Pressed to Raise Decks
Working Pressure
Low Pressure (Charge)
Return or Suction
Flow
LIFT CONTROL MANIFOLD
JUNCTION MANIFOLD
FAN CONTROL MANIFOLD
PRIORITY FLOW
STEER CONTROL VALVE
DECK CONTROL MANIFOLD
4WD / 2WD CONTROL MANIFOLD
FILTRATION AND CHARGE CONTROL MANIFOLD
ENGINE SPEED 2800/1425
PRESSURE SENSOR
TEMP SENSOR
BYPASS VALVE
OIL COOLER
FILTER
FORWARD
1600 PSI
1050 PSI
3500 PSI
1500 PSI
5000 PSI
550 PSI
450 PSI
207 PSI
50 PSI
40 PSI
5 PSI
3 GPM
6 GPM
12 GPM

Raise Cutting Decks: Groundsmaster 4500–D

A four section gear pump is coupled to the piston (traction) pump. Gear pump section P3 supplies hydraulic flow to both the lift control manifold and the steering control valve. Hydraulic flow from this pump section is delivered to the circuits through a proportional flow divider located in the fan control manifold. Maximum lift/lower circuit pressure is limited to 1600 PSI (110 bar) by a relief valve (R1) in the lift control manifold. Lift circuit pressure can be monitored at test fitting G1 on the lift control manifold.

On the Groundsmaster 4500–D, a single lift switch on the console arm is used to raise and lower the five (5) cutting decks (Fig. 14).

When the cutting decks are in a stationary position (not raising or lowering), lift circuit flow from gear pump section P3 bypasses the lift cylinders through the lift control manifold solenoid valve S5 and proportional relief valve PRV which are de–energized. Return flow from the manifold is routed to the oil filter and traction charge circuit.

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

Cutting Deck Raise

To raise the five (5) cutting decks on a Groundsmaster 4500–D, the rear of the lift switch is depressed. The switch acts as an input to the TEC–5002 controller which then provides an electrical output to solenoid valve S5 in the lift control manifold. Energized solenoid valve S5 shifts to allow a passage for oil flow to the rod ends of the center five (5) deck lift cylinders. The oil flow causes the lift cylinders to retract and raise the five (5) cutting decks. Two (2) orifices in the junction manifold control the raising speed of the #2 and #3 decks.

When the deck switch is released, solenoid valve S5 is de–energized and the lift cylinders and cutting decks are held in position.

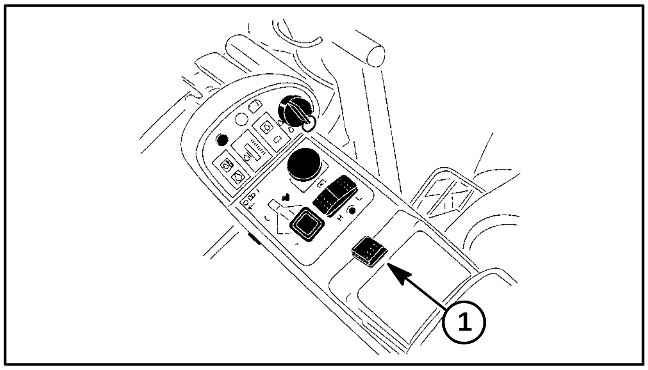
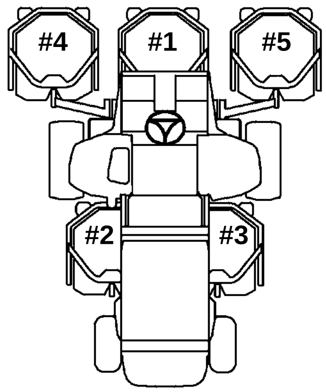


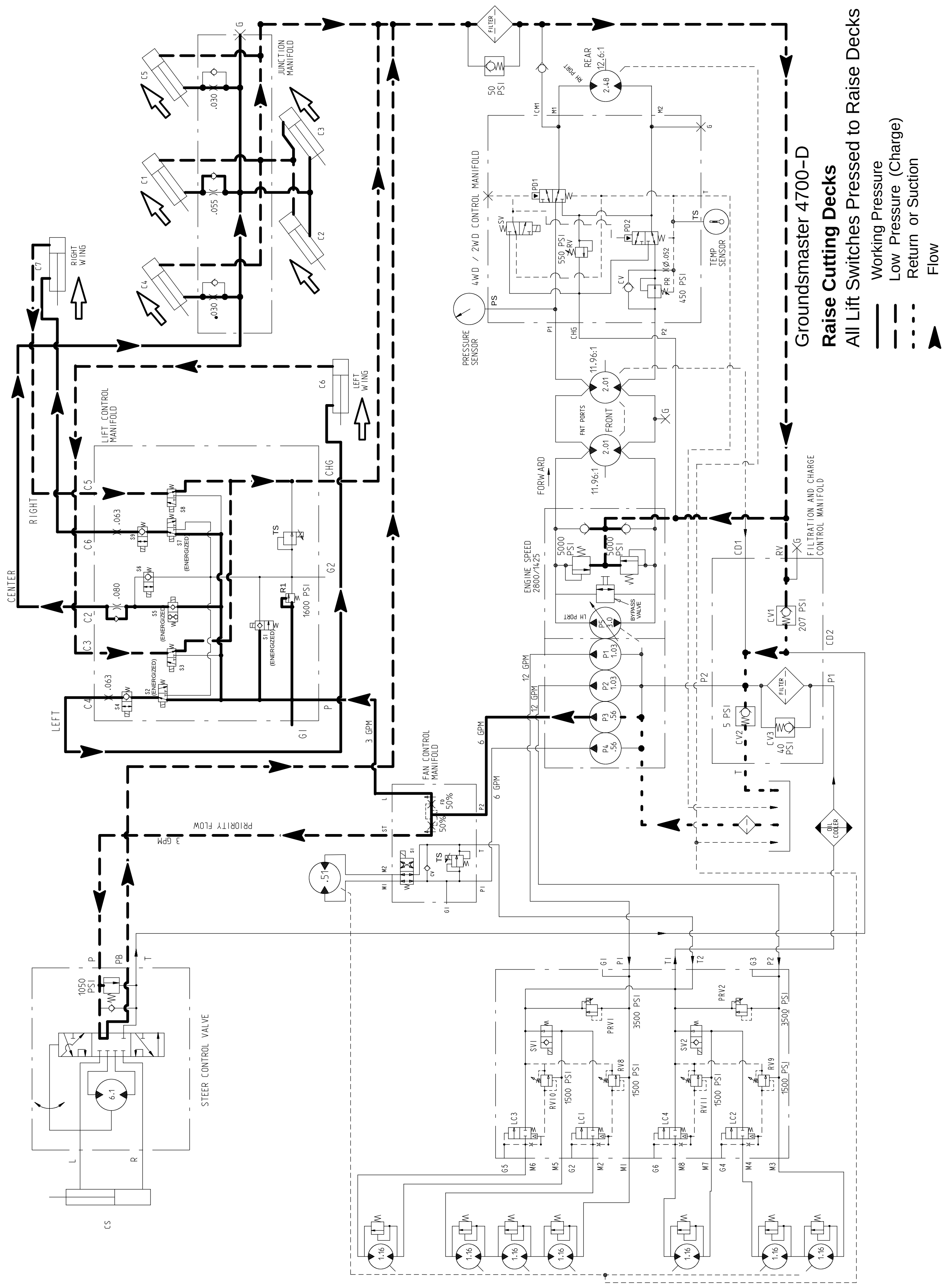
Figure 14

1. Lift switch (#1 to #5)



GM–4500 CUTTING DECK LOCATIONS

Figure 15



Groundsmaster 4700–D
Raise Cutting Decks
All Lift Switches Pressed to Raise Decks
Working Pressure
Low Pressure (Charge)
Return or Suction
Flow
LIFT CONTROL MANIFOLD
JUNCTION MANIFOLD
FAN CONTROL MANIFOLD
STEER CONTROL VALVE
4WD / 2WD CONTROL MANIFOLD
FILTRATION AND CHARGE CONTROL MANIFOLD
PRIORITY FLOW
RIGHT WING
LEFT WING
RIGHT
CENTER
LEFT
ENGINE SPEED 2800/1425
FORWARD
FRONT
REAR
PRESSURE SENSOR
TEMP SENSOR
BYPASS VALVE
OIL COOLER
FILTER

Raise Cutting Decks: Groundsmaster 4700–D

A four section gear pump is coupled to the piston (traction) pump. Gear pump section P3 supplies hydraulic flow to both the lift control manifold and the steering control valve. Hydraulic flow from this pump section is delivered to the circuits through a proportional flow divider located in the fan control manifold. Maximum lift/lower circuit pressure is limited to 1600 PSI (110 bar) by a relief valve (R1) in the lift control manifold. Lift circuit pressure can be monitored at test fitting G1 on the lift control manifold.

The Groundsmaster 4700–D has three (3) lift switches to control the cutting decks (Fig. 16). The center switch is for the five (5) center decks, the left switch controls the left, rear deck (#6) and the right switch controls the right, rear deck (#7) (Fig. 17).

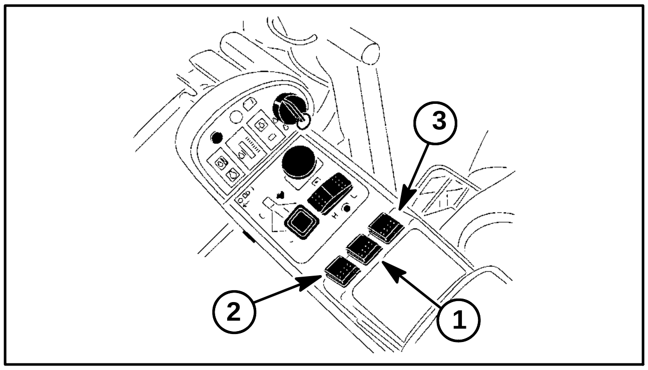


Figure 16

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

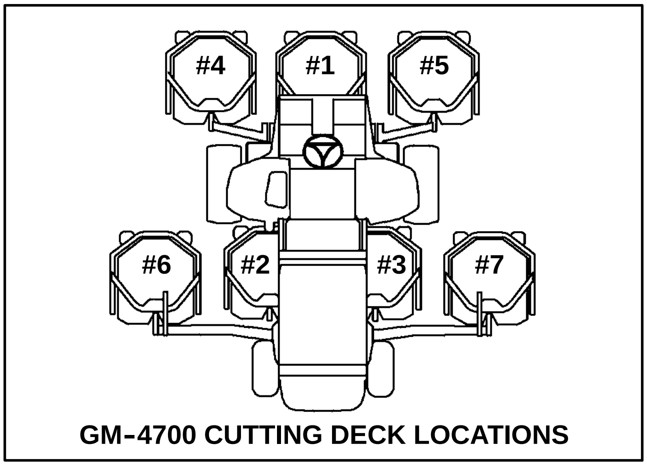


Figure 17

When the cutting decks are in a stationary position (not raising or lowering), lift circuit flow from pump section P3 bypasses the lift cylinders through the lift control manifold solenoid valve S1 and proportional relief valve PRV which are de–energized. Return flow from the manifold is routed to the oil filter and traction charge circuit.

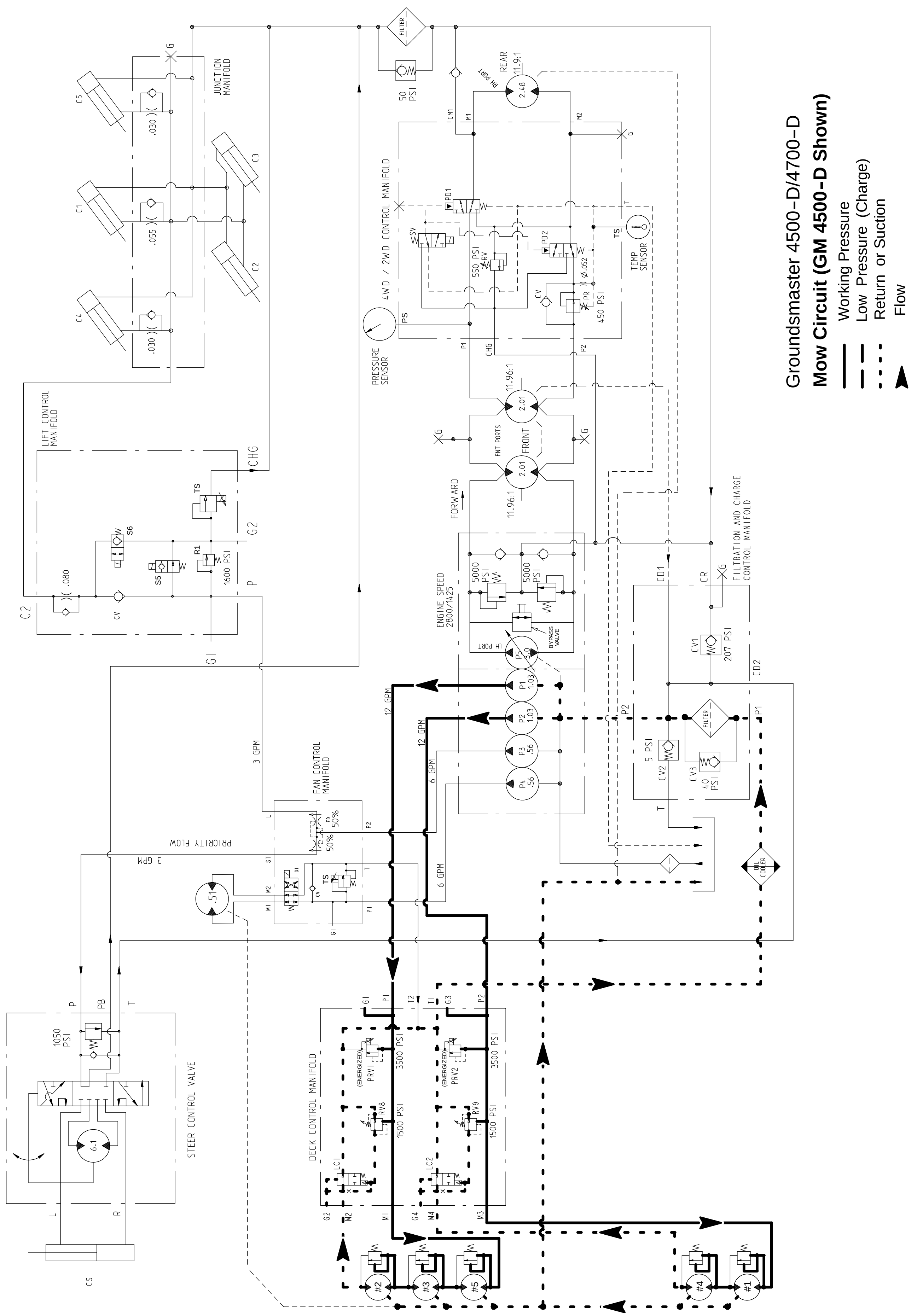
NOTE: The operator must be in the operator seat in order to raise the cutting decks.

Cutting Deck Raise

To raise the center five (5) cutting decks on the Groundsmaster 4700–D, the rear of the center console switch is depressed. The switch acts as an input to the TEC–5002 controller which then provides an electrical output to solenoid valves S1 and S5 in the lift control manifold. The energized solenoid valves shift to allow a passage for oil flow to the rod ends of the center five (5) deck lift cylinders. The oil flow causes the lift cylinders to retract and raises the center five (5) cutting decks. Two (2) orifices in the junction manifold control the raising speed of the #2 and #3 decks.

To raise a side cutting deck on the Groundsmaster 4700–D (deck #6 or #7), the rear of the appropriate console arm lift switch is depressed. The switch acts as an input to the TEC–5001 controller which then provides an electrical output to the appropriate solenoid valves in the lift control manifold: S1 and S2 for deck #6 and S1 and S7 for deck #7. The energized solenoid valve shifts to allow a passage for oil flow to the rod ends of the deck lift cylinder. The oil flow causes the lift cylinder to retract and raises the cutting deck. An orifice in the lift manifold restricts oil flow to the lift cylinder to control deck raising speed.

When a deck switch is released, the solenoid valves controlled by the switch are de–energized and the lift cylinders and cutting decks are held in position.


Groundsmaster 4500–D/4700–D
Mow Circuit (GM 4500–D Shown)
Working Pressure
Low Pressure (Charge)
Return or Suction
Flow
STEER CONTROL VALVE
DECK CONTROL MANIFOLD
FAN CONTROL MANIFOLD
LIFT CONTROL MANIFOLD
JUNCTION MANIFOLD
4WD / 2WD CONTROL MANIFOLD
FILTRATION AND CHARGE CONTROL MANIFOLD
PRESSURE SENSOR
TEMP SENSOR
ENGINE SPEED 2800/1425
PRIORITY FLOW
FORWARD

Mow Circuit

Hydraulic flow for the mow circuit is supplied by two (2) sections of the gear pump (P1 and P2). Gear pump section P1 supplies hydraulic flow to decks 5, 3 and 2 (also deck 7 on the GM 4700–D), while gear pump section P2 supplies decks 1 and 4 (also deck 6 on the GM 4700–D).

A single deck control manifold is used to control flow from the two (2) pump sections. The manifold includes cartridge valves for control of each of the two (2) pump circuits. Each manifold circuit is equipped with a solenoid controlled, proportional relief valve (PRV1/PRV2), a logic cartridge (LC1/LC2) and a brake relief cartridge (RV8/RV9). The Groundsmaster 4700–D deck manifold includes additional cartridges to control hydraulic flow for decks 6 and 7: an additional logic cartridge (LC3/LC4), a solenoid valve (SV1/SV2) and an additional brake relief cartridge (RV10/RV11).

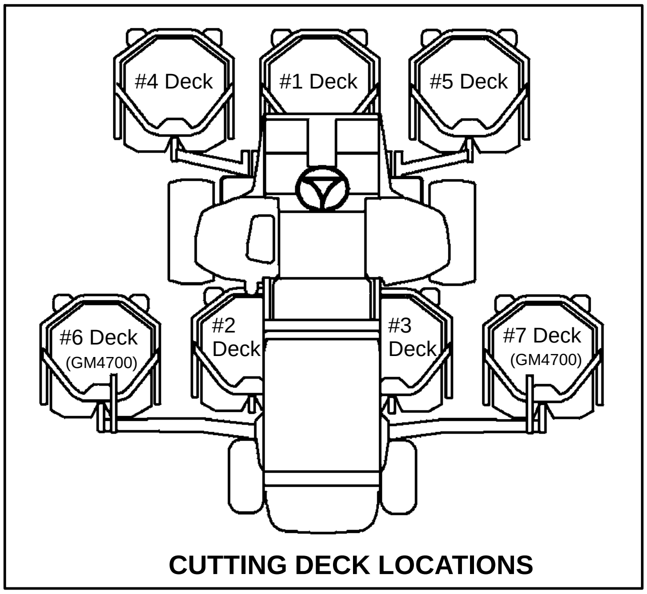


Figure 18

PTO Disengaged

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

PTO Engaged

When the PTO switch is turned ON with the decks lowered, the solenoid valves (PRV1 and PRV2) are energized with outputs from the TEC–5002 controller. The energized valves shift to direct pump flow toward the deck motors. As circuit pressure to the deck motors increases, the brake relief cartridge (RV) opens which allows an oil flow through the manifold orifice positioned before the logic cartridge (LC). This flow creates a pressure increase at the logic cartridge that will shift the logic cartridge and allow oil return from the deck motors.

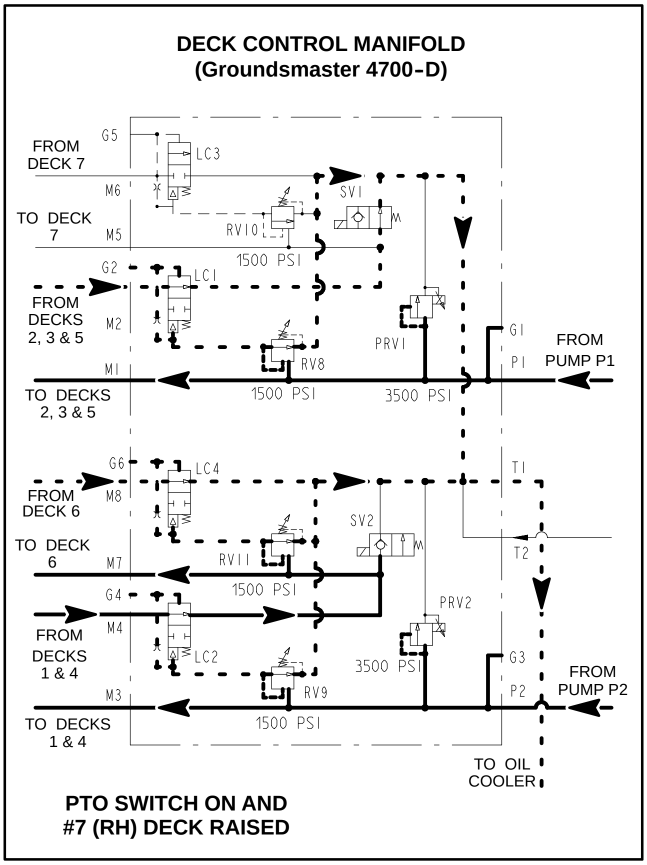


Figure 19

On the Groundsmaster 4700–D (Fig. 19), if deck 6 or deck 7 is lowered and the PTO switch is ON, the deck control manifold solenoid valve (SV1/SV2) will be energized by the TEC–5001 controller. This energized solenoid valve allows oil flow to the appropriate deck motor as described above.

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

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

Cutting Deck Blade Braking

When the operator turns the PTO switch OFF (or if the decks are raised), deck manifold solenoid valves (PRV1, PRV2, SV1 and SV2) are de-energized. The valves will shift to direct oil away from the deck motors and toward the oil cooler and filter. Hydraulic pressure is reduced to the cutting deck motors which slows the cutting blades and also allows the deck manifold relief valve (RV) to shift. The shifted relief valve removes the flow path from the orifice at the logic cartridge, causing the logic cartridge to shift and block the return oil path from the deck motors (Fig. 20).

The inertia of the rotating cutting blades, however, effectively turns the deck motors into pumps causing an increase in pressure as the flow from the motors comes up against the closed logic cartridge (LC). When this pressure builds to approximately 1500 PSI (104 bar), the relief valve opens which allows a small amount of hydraulic flow past the relief valve (Fig. 21). This flow causes a pressure increase that shifts the logic cartridge to once again allow oil flow from the deck motors (Fig. 22). When return pressure drops below 1500 PSI (104 bar), the relief valve reseats and causes the logic cartridge to close again, blocking return flow from the deck motors to further slow the cutting blades. This action of the relief valve opening and the logic cartridge shifting occurs several times in a very short time frame as the blades finally come to a stop. Once the blades have stopped, the logic cartridge remains in the neutral position to keep the deck motors from rotating.

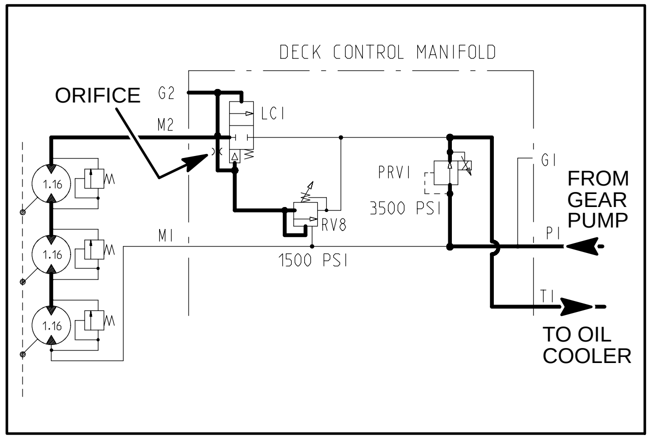


Figure 20

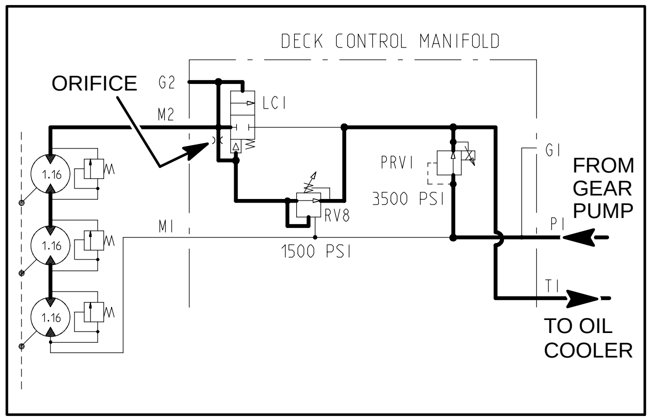


Figure 21

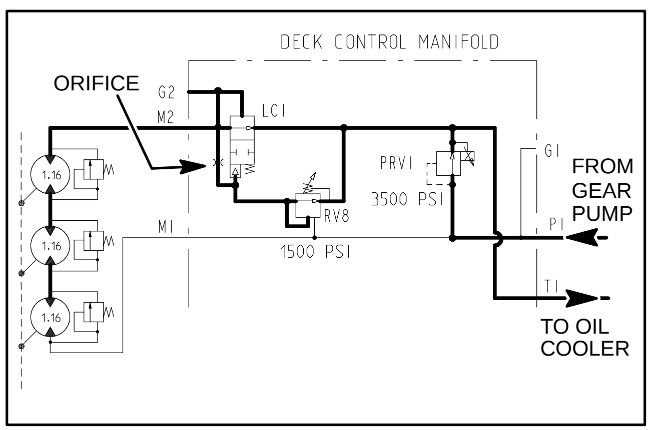


Figure 22

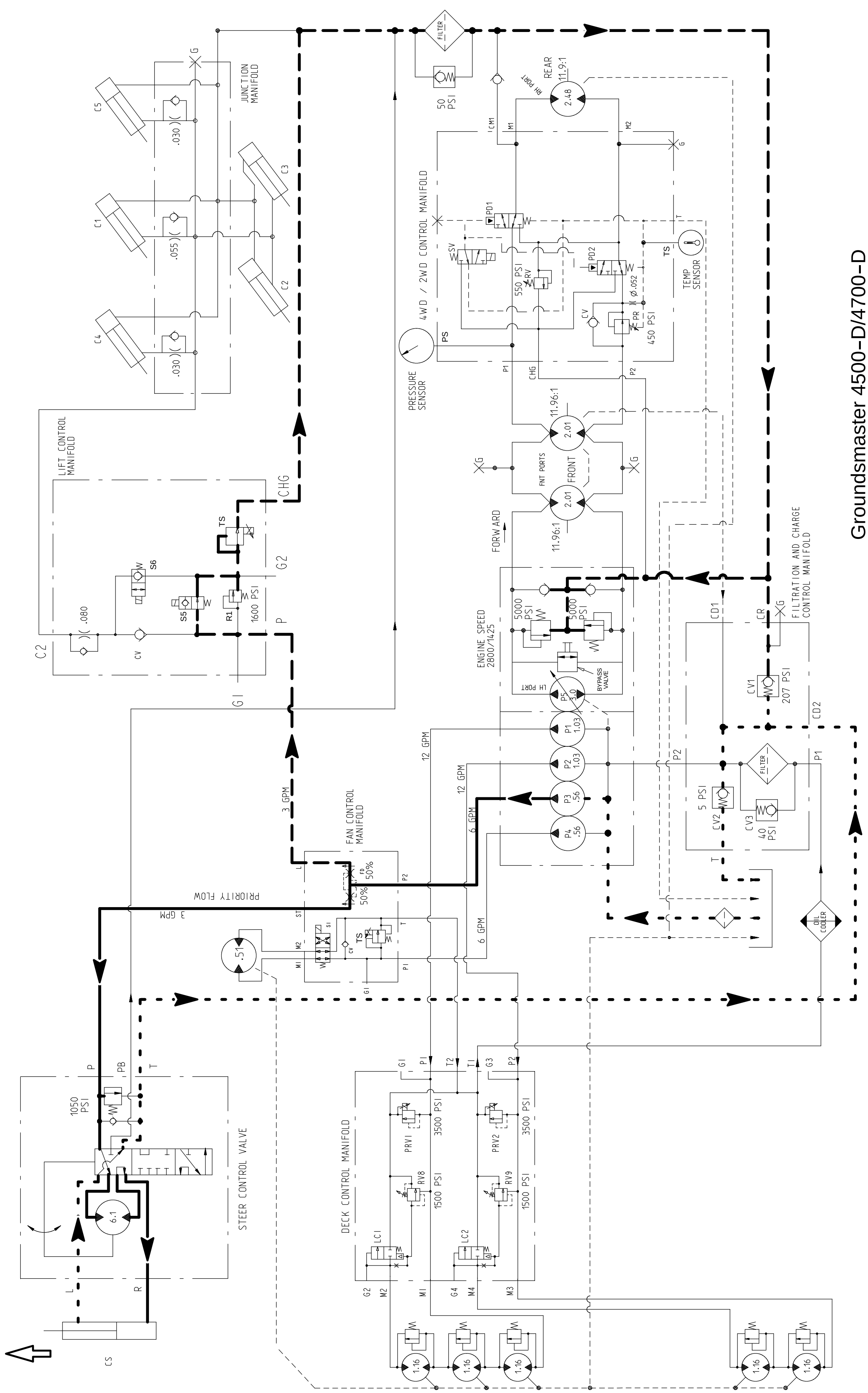
Hydraulic System

This page is intentionally blank.

Groundsmaster 4500–D/4700–D

Steering Circuit (GM 4500–D Right 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 gear pump section P3 supplies hydraulic flow to the steering control valve and the lift/lower control valve. Pump hydraulic flow is delivered to the two circuits through a proportional flow divider located in the fan control manifold. Steering circuit pressure is limited to 1050 PSI (72 bar) by a relief valve located in the steering control valve.

With the steering wheel in the neutral position and the engine running, pump section P3 flow enters the steering control valve at the P port and goes through the steering control spool valve, bypassing 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 bypassed 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 lift cylinder for a left turn. The rotary meter ensures that the oil flow to the cylinder is proportional to the amount of the turning on the steering wheel. Fluid leaving the cylinder flows back through the spool valve then through the T port and to the hydraulic reservoir.

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

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

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

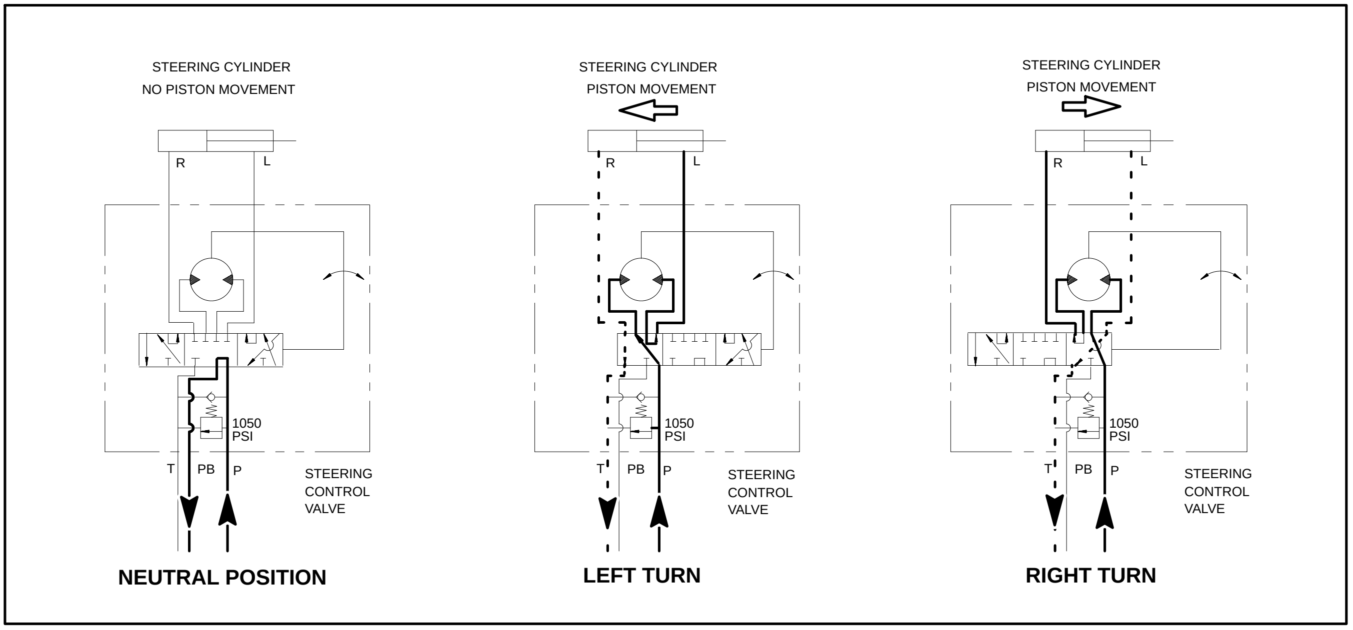


Figure 23

Hydraulic System

Groundsmaster 4500–D/4700–D

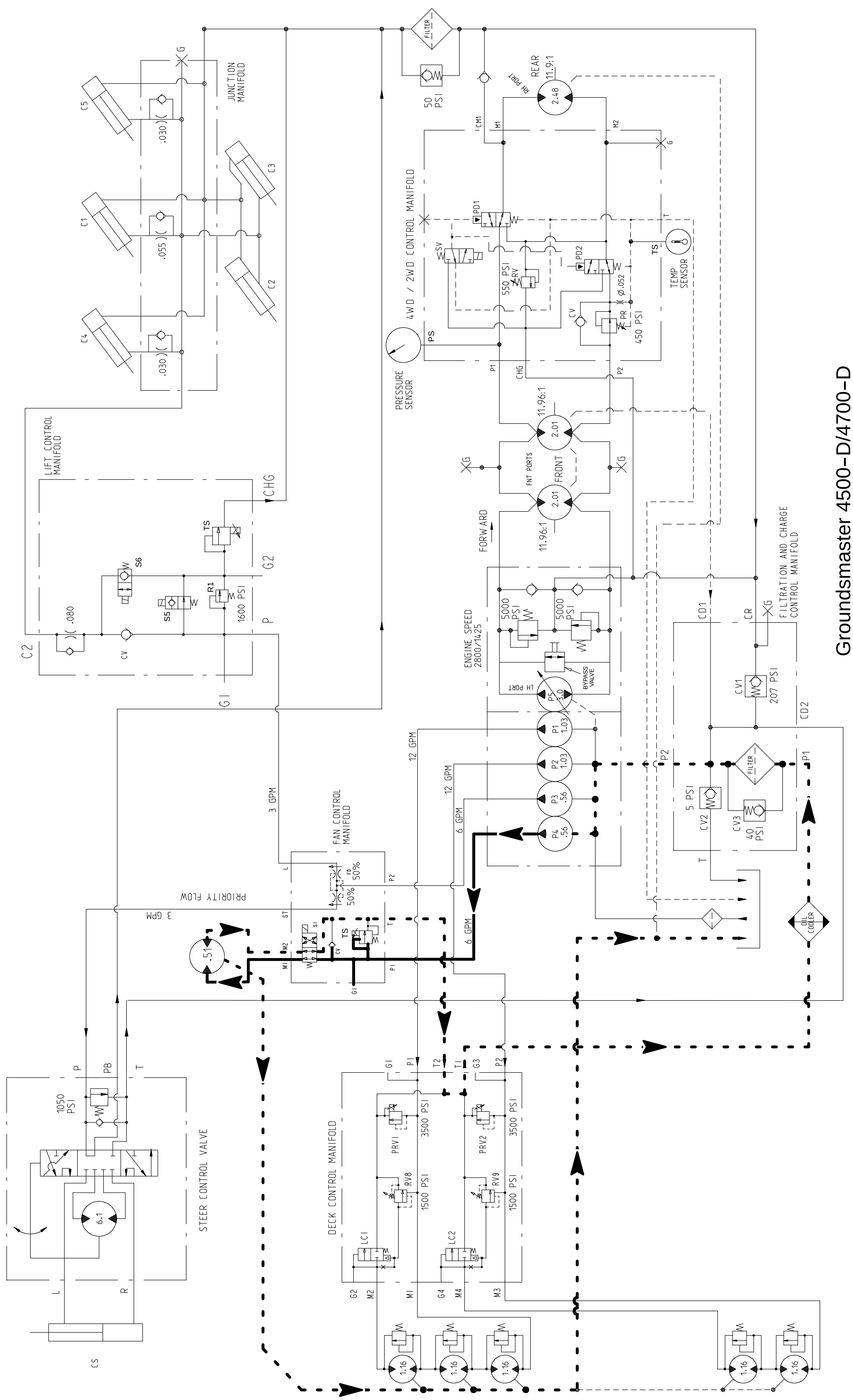
Engine Cooling Fan Circuit (GM 4500–D Normal Fan Direction Shown)

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 P4 (farthest from the piston pump) supplies hydraulic flow for the hydraulic engine cooling fan motor (Fig. 24).

The fan control manifold controls the operation of the hydraulic motor that drives the engine cooling fan in addition to including the flow divider for the steering and lift circuits. The electronically controlled proportional relief valve (TS) in the manifold controls the oil flow to the fan motor. The fan control manifold controls the speed and direction of the fan motor based on electrical output from the TEC–5002 controller.

Oil flow from the gear pump to the cooling fan motor is controlled by the proportional relief valve (TS) in the fan control manifold. This valve adjusts fan circuit flow based on a PWM (Pulse Width Modulation) signal from the TEC–5002 controller. The controller uses engine coolant and hydraulic oil temperatures as inputs to determine the proper PWM signal for the TS valve. The fan circuit flow determines the speed of the cooling fan motor.

> The fan motor runs at half speed until coolant reaches approximately 165^{o}F (74^{o}C). The fan motor increases to full speed (approximately 2800 RPM) as coolant reaches 180^{o}F (82^{o}C).
>
> The fan motor automatically reverses if coolant reaches 203^{o}F (95^{o}C) or hydraulic oil reaches 212^{o}F (100^{o}C).

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

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

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

Forward Direction Fan Operation

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

Reverse Direction Fan Operation (Fig. 25)

The TEC–5002 controller can reverse the cooling fan to clean debris from the rear intake screen. If hydraulic oil and/or engine coolant temperatures increase to an unsuitable level or if the engine cooling fan switch is pressed to manual reverse, a high PWM signal is sent to the TS valve to slow the cooling fan and direct pump oil flow away from the fan motor. The controller then energizes solenoid valve S1 in the fan control manifold to reverse cooling fan motor oil flow so that the motor runs in the reverse direction. A lower PWM signal is sent to the TS valve allowing oil flow to return to the fan motor but in the reverse direction causing the motor and cooling fan to run in reverse for a short time.

NOTE: The fan reversal process is not designed to clean the radiator of debris. Refer to Operator's Manual for radiator cleaning maintenance recommendations.

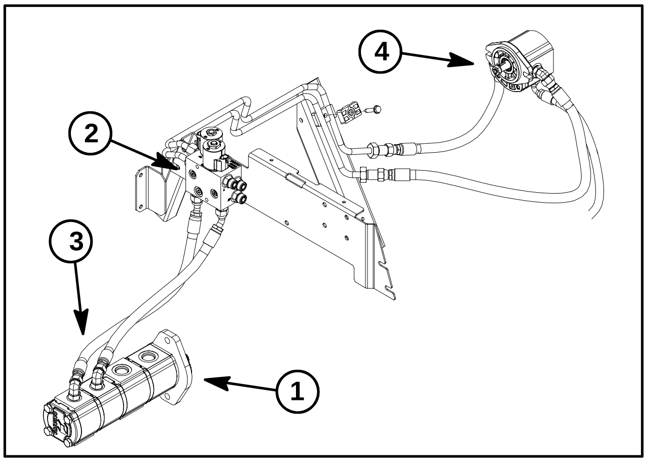


Figure 24

1. **Gear pump**
2. **Fan control manifold**
3. **Fan circuit supply hose**
4. **Hydraulic fan motor**

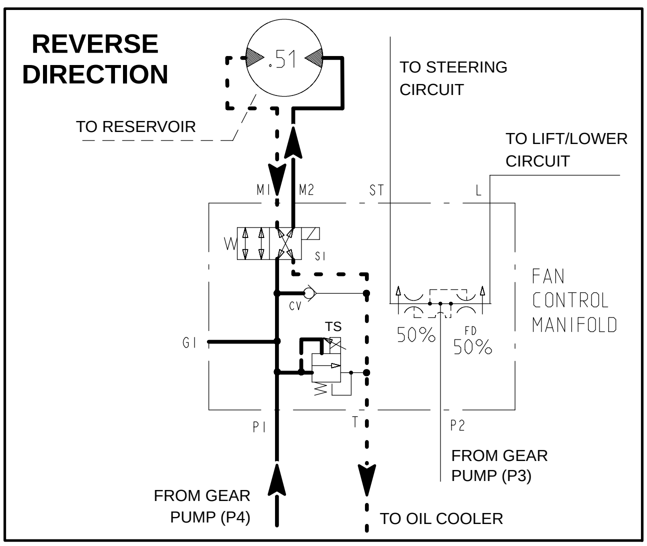


Figure 25

Special Tools

Order these special tools from your Toro Distributor.

Hydraulic Pressure Test Kit

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

Toro Part Number: **TOR47009**

Figure 26

Hydraulic Tester (Pressure and Flow)

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

1. INLET HOSE: Hose connected from the system circuit to the inlet side of the hydraulic tester.

2. LOAD VALVE: A simulated working load is created in the circuit by turning the valve to restrict flow.

3. PRESSURE GAUGE: 0 to 5000 PSI gauge to provide operating circuit pressure.

4. FLOW METER: This meter measures actual oil flow in the operating circuit with a gauge rated at 15 GPM.

5. OUTLET HOSE: A hose from the outlet side of the hydraulic tester connects to the hydraulic system circuit.

Toro Part Number: **TOR214678**

Figure 27

Hydraulic Test Fitting Kit

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

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

Toro Part Number: **TOR4079**

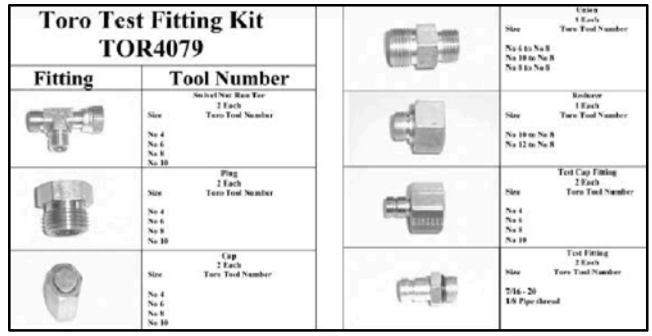


Figure 28

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

Toro Part Number: **TOR4077**

Figure 29

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 30

Hydraulic System

O–ring Kit

The 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: **16–3799**

Figure 31

High Pressure Hydraulic Oil Filter

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. traction pump or wheel motor), a high pressure 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.

A high pressure hydraulic oil filter can be obtained locally.

Figure 32

Troubleshooting

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

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

General Hydraulic System Problems

Problem	Possible Cause
Hydraulic system operates hot. **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. Hydraulic reservoir oil level is low. Hydraulic oil is contaminated or the wrong type. Brakes are applied or sticking. Piston pump bypass valve is open or damaged. Cooling system is not operating properly. Charge pressure is low. Engine cooling fan circuit is malfunctioning (see Engine Cooling Fan Circuit Problems in this section). Traction circuit pressure is incorrect. Pump(s) or motor(s) are damaged.
Hydraulic oil in reservoir foams.	Hydraulic reservoir oil level is low. Wrong type of oil is in the hydraulic system. Air is leaking in suction line.
Hydraulic oil leak(s).	Fitting(s), hose or tube loose or damaged. Missing or damaged O-ring in fitting.

Traction Circuit Problems

NOTE: When troubleshooting traction circuit problems, if a problem exists in both low (4WD) and high (2WD) speeds, consider a faulty component that affects the entire traction circuit (e.g. charge circuit, relief valves, piston pump, front wheel motors). If the problem exists in low speed (4WD) but not in high speed (2WD), consider a problem in the 4WD traction system (e.g. rear axle motor, cartridge valves in 4WD/2WD control manifold).

Problem	Possible Cause
Machine operates in one direction only.	Traction control linkage is faulty. Traction relief valve is defective.
Traction pedal reaction is sluggish when in either low speed (4WD) or high speed (2WD).	Traction control linkage is stuck or binding. Charge pressure is low. Piston (traction) pump servo control valve orifices are plugged or damaged.
Traction pedal reaction is sluggish when in low speed (4WD). Pedal reaction is normal when in high speed (2WD).	PD1 and PD2 pilot directional valve seals in 4WD/2WD control manifold are leaking or damaged.
Machine travels too far before stopping when the traction pedal is released.	Traction linkage is out of adjustment. Charge pressure is low. Piston (traction) pump servo control valve orifices are plugged or damaged. Traction pedal does not return to neutral.
Traction power is lost or machine will not operate in either direction.	Hydraulic reservoir oil level is low. Piston pump bypass valve is open or damaged. Charge pressure is low. Traction circuit pressure is low. Front wheel motor couplers are damaged. If traction is lost in low speed (4WD) but is normal in high speed (2WD), rear axle motor or rear axle motor drive may be faulty.
Low speed (4WD) will not engage.	Electrical problem exists (see Chapter 5 – Electrical System). Solenoid valve SV in 4WD/2WD control manifold is faulty. Cartridge valve(s) in 4WD/2WD control manifold is (are) faulty.
Low speed (4WD) will not disengage.	Electrical problem exists (see Chapter 5 – Electrical System). Cutting decks are fully lowered. Cartridge valve in 4WD/2WD control manifold is damaged or sticking.

PTO Problems

Problem	Possible Cause
No cutting decks will operate. **NOTE:** Decks have to be fully lowered and traction speed needs to be in low speed (4WD) for decks to operate.	Decks are not fully lowered to ground. Operator seat is unoccupied. Traction system is in high speed (2WD). Electrical problem exists that prevents deck control manifold solenoid valve operation (see Chapter 5 – Electrical System). Gear pump sections P1 and P2 are damaged. Gear pump coupler is damaged (other hydraulic circuits will be affected as well).
One cutting deck will not operate.	System pressure to the affected deck motor is low. Cutting deck problem exists (see Chapter 8 – Cutting Decks). Spline on affected deck motor (or spindle) is damaged. Deck motor relief valve is stuck or damaged. Deck motor is damaged. NOTE: If appropriate, transfer a suspected damaged motor to another cutting deck. If problem follows the motor, motor needs repair or replacement. On GM 4700–D, deck not fully lowered to ground (decks #6 and #7). On GM 4700–D, cartridge valve SV1 or SV2 in deck control manifold is damaged or sticking (decks #6 and #7).
Several cutting decks will not operate.	Electrical problem exists that prevents deck control manifold solenoid valve operation (see Chapter 5 – Electrical System). Decks are not fully lowered to ground. Deck control manifold solenoid cartridge valve (PRV1 or PRV2) for affected decks is faulty. Logic cartridge valve (LC1 or LC2) in deck control manifold is stuck or damaged. Gear pump section (P1 or P2) is worn or damaged.

PTO Problems (Continued)

Problem	Possible Cause
All cutting decks operate slowly.	Engine RPM is low. Deck motor is damaged. Gear pump section (P1 or P2) is worn or damaged.
Cutting deck stops under load.	Relief valve in deck control manifold is bypassing. Cutting conditions (e.g. very tall or wet grass) exceed deck capacity. Deck motor relief valve is stuck or damaged. Deck motor has internal leakage (bypassing oil). Cutting deck gear pump section (P1 or P2) is worn or damaged.

Steering Circuit Problems

Problem	Possible Cause
Steering inoperative or sluggish.	Steering components (e.g. tie rods, steering cylinder ends) are worn or binding. Steering cylinder is binding. Oil level in hydraulic reservoir is low (other hydraulic systems affected as well). Steering relief valve in steering control valve is stuck or damaged. Flow divider (FD) in fan control manifold is faulty. Steering cylinder leaks internally. Steering control valve is worn or damaged. Gear pump section (P3) is worn or damaged (NOTE: A worn or damaged gear pump section (P3) will also affect the traction (charge) and lift circuits).

Lift/Lower Circuit Problems

Problem	Possible Cause
Cutting decks will not raise. **NOTE:** Operator must be in seat in order to raise the cutting decks.	Operator seat is unoccupied. Hydraulic oil level in reservoir is low. Electrical problem exists that prevents lift control manifold solenoid valve operation (see Chapter 5 – Electrical System). Lift cylinder(s) is (are) damaged. Lift arm pivots are binding. Lift/lower circuit relief valve in lift control manifold is stuck open. Solenoid valve in lift control manifold is damaged or sticking. Flow divider (FD) in fan control manifold is faulty. Gear pump section (P3) is worn or damaged (NOTE: A worn or damaged gear pump section (P3) will also affect the traction (charge) and steering circuits).
Cutting decks raise, but will not stay up. **NOTE:** Lift cylinders cannot provide an absolutely perfect seal. The lift arms will eventually lower if left in the raised position during storage.	Lift circuit hydraulic lines or fittings are leaking. Cartridge valve in lift control manifold is stuck open. Air exists in lift circuit. Lift cylinder is damaged.
Cutting decks will not lower. **NOTE:** Operator must be in seat and traction system must be in low speed (4WD) in order to lower the cutting decks.	Operator seat is unoccupied. Traction system is in high speed (2WD). Lift arm pivots are binding. Lift cylinder is damaged. Proportional relief cartridge valve (TS) in lift control manifold is damaged or sticking.

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 (P4) 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 (TS) is stuck open. Hydraulic fan motor is worn or damaged.
Cooling fan always rotates at fast speed.	Fan control manifold proportional relief valve (TS) is faulty. Electrical problem exists that prevents fan control manifold proportional relief valve (TS) operation (see Chapter 5 – Electrical System).

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.

CAUTION

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

CAUTION

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

WARNING

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

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved and all rotating machine parts must be stopped. Stop engine; lower or support attachments.

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

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

3. The engine must be in good operating condition. Use a phototac to determine engine speed when performing a hydraulic test. Engine speed will affect the accuracy of the tester readings.

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

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

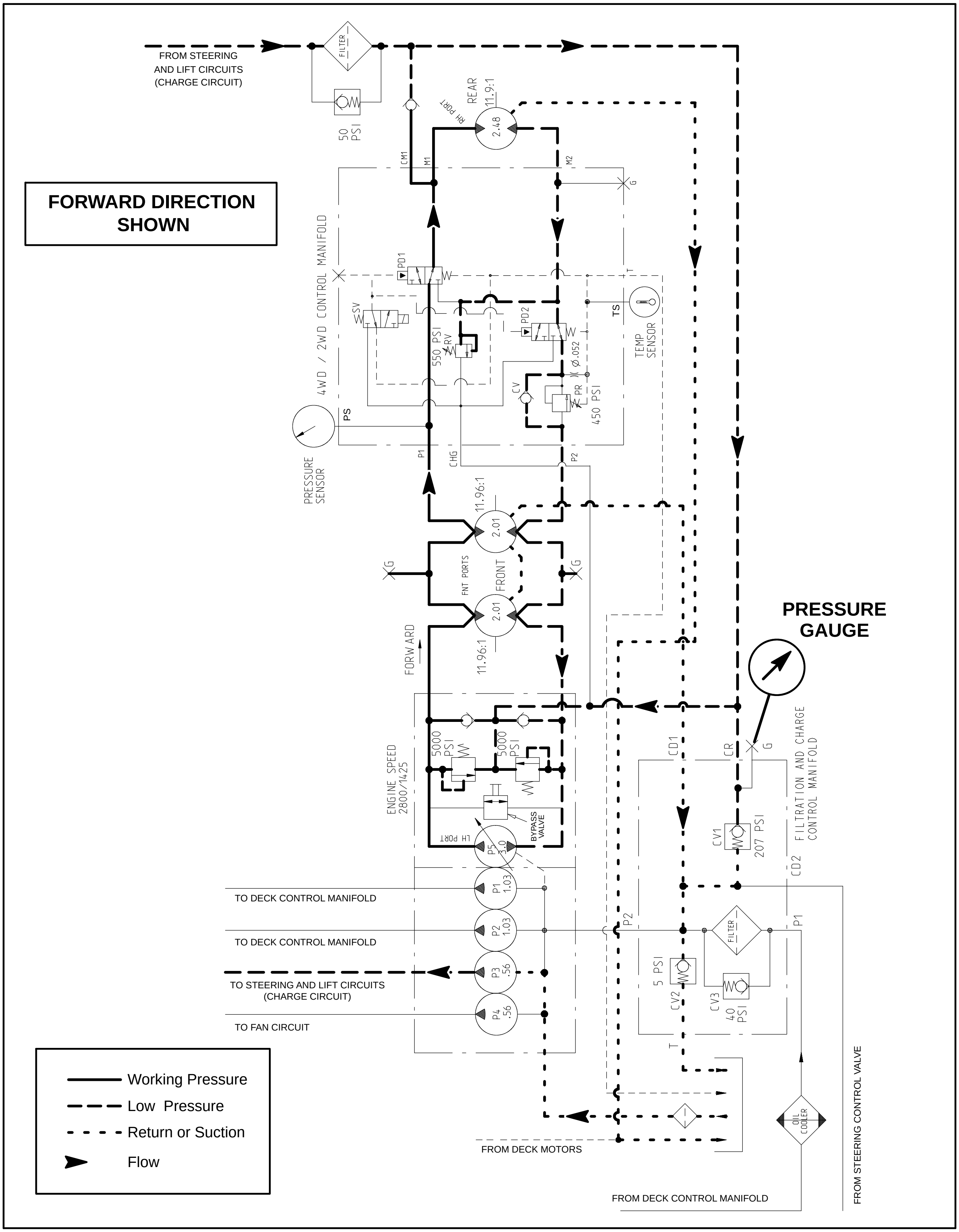
7. Position tester hoses to prevent rotating machine parts from contacting and damaging the hoses or tester.

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

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


FROM STEERING AND LIFT CIRCUITS (CHARGE CIRCUIT)
FILTER
50 PSI
REAR
11.9:1
2.48
RH PORT
FORWARD DIRECTION SHOWN
4WD / 2WD CONTROL MANIFOLD
PD1
SV
PD2
TS
TEMP SENSOR
550 PSI
RV
Ø.052
PR
450 PSI
CV
PS
PRESSURE SENSOR
P1
CHG
P2
11.96:1
2.01
FNT PORTS
FRONT
FORWARD
ENGINE SPEED 2800/1425
5000 PSI
5000 PSI
BYPASS VALVE
LH PORT
PRESSURE GAUGE
CD1
CR
G
CV1
207 PSI
FILTRATION AND CHARGE CONTROL MANIFOLD
CD2
P5 3.0
P1 1.03
TO DECK CONTROL MANIFOLD
P2 1.03
TO DECK CONTROL MANIFOLD
P3 .56
TO STEERING AND LIFT CIRCUITS (CHARGE CIRCUIT)
P4 .56
TO FAN CIRCUIT
5 PSI
CV2
CV3
40 PSI
OIL COOLER
FROM DECK MOTORS
FROM DECK CONTROL MANIFOLD
FROM STEERING CONTROL VALVE
Working Pressure
Low Pressure
Return or Suction
Flow

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

Procedure for Traction Circuit Charge Pressure Test

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

2. Park machine on a level surface with the cutting decks lowered and off. Make sure engine is off and the parking brake is 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 onto charge pressure test port G located on the bottom of the filtration and charge control manifold under right side frame rail (Fig. 33).

4. Start the engine and put throttle at full engine speed **(2870 RPM)** with no load on the hydraulic system.

GAUGE READING TO BE **210 to 300 PSI (14.5 to 20.6 bar)**

5. Stop engine and record test results.

6. If there is no pressure or pressure is low, check for the following:

A. Restriction in pump intake line.

B. Charge relief valve in filtration and charge control manifold is leaking (see Filtration/Charge Control Manifold Service in the Service and Repairs section of this chapter).

C. If necessary, check for internal damage or worn parts in gear pump P3 (see Gear Pump P3 Flow Test in this section). NOTE: Steering and lift/lower circuits would also be affected if gear pump P3 is worn or damaged.

7. Also, with the pressure gauge still connected to the charge pressure test port, monitor the gauge reading while operating the machine in forward and reverse. Start the engine and put throttle at full engine speed **(2870 RPM)**. Apply the brakes and push the traction pedal forward, then reverse.

GAUGE READING TO BE **within 20% of no-load charge pressure measured in step 4 above** (e.g. if charge pressure in step 4 is 250 PSI (17.2 bar), charge pressure in forward or reverse should be from 200 to 250 PSI (13.8 to 17.2 bar)

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

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

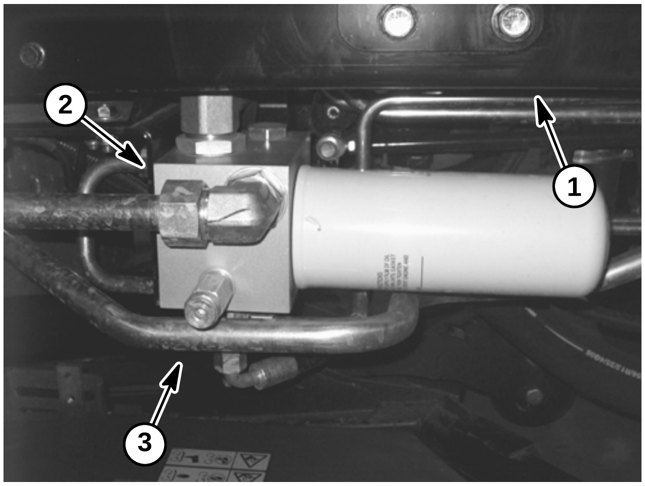
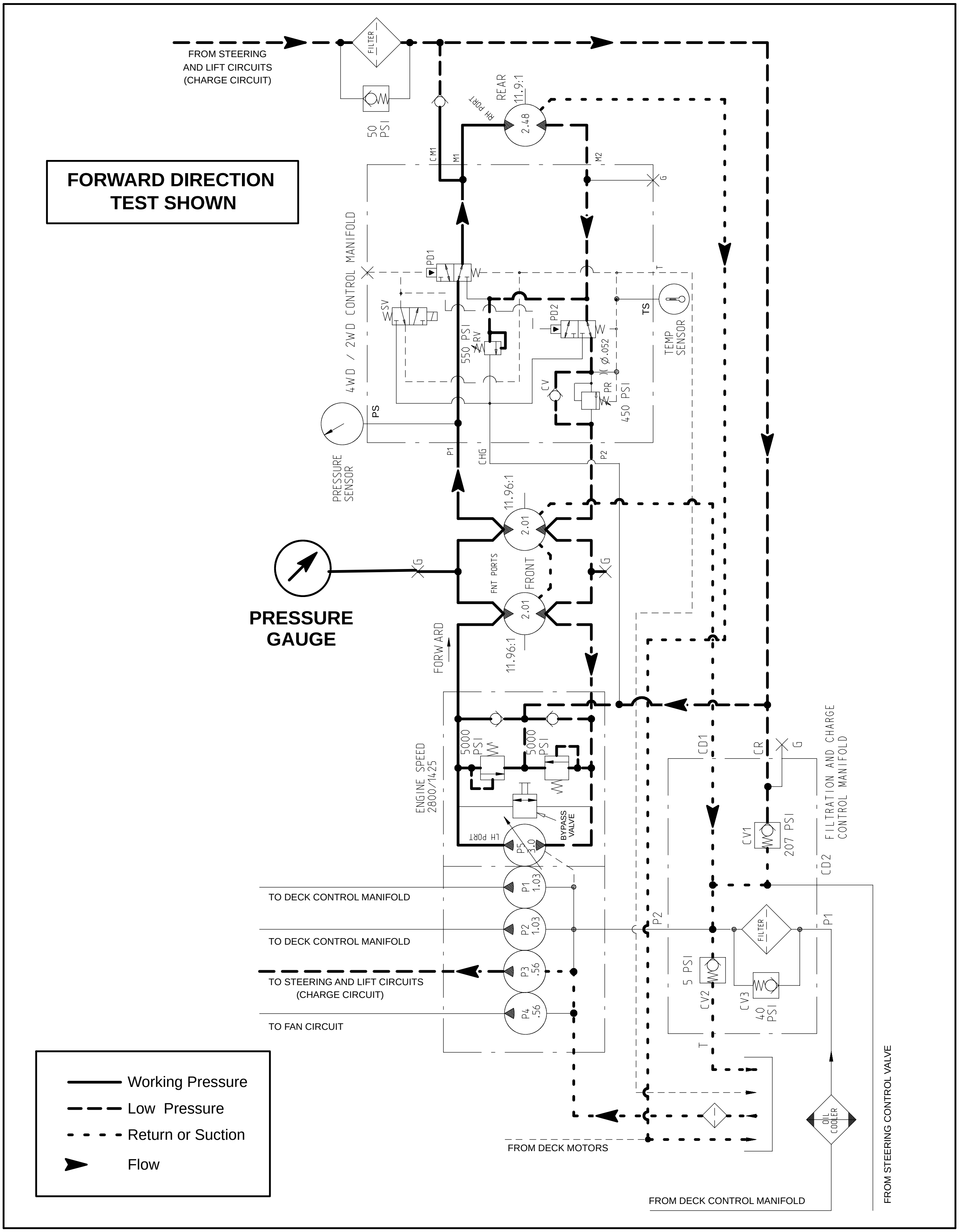


Figure 33

1. **Right side frame rail**
2. **Filtration manifold**
3. **Test port location**

Hydraulic System



FORWARD DIRECTION TEST SHOWN
FROM STEERING AND LIFT CIRCUITS (CHARGE CIRCUIT)
FILTER
50 PSI
REAR
11.9:1
2.48
RH PORT
4WD / 2WD CONTROL MANIFOLD
PD1
PD2
SV
RV
550 PSI
CV
PR
450 PSI
TS
TEMP SENSOR
PS
PRESSURE SENSOR
PRESSURE GAUGE
11.96:1
2.01
FRONT
FNT PORTS
FORWARD
ENGINE SPEED 2800/1425
5000 PSI
BYPASS VALVE
LH PORT
P5 3.0
P1 1.03
P2 1.03
P3 .56
P4 .56
TO DECK CONTROL MANIFOLD
TO DECK CONTROL MANIFOLD
TO STEERING AND LIFT CIRCUITS (CHARGE CIRCUIT)
TO FAN CIRCUIT
FILTRATION AND CHARGE CONTROL MANIFOLD
CD1
CR
CV1
207 PSI
CD2
5 PSI
CV2
CV3
40 PSI
OIL COOLER
FROM DECK MOTORS
FROM DECK CONTROL MANIFOLD
FROM STEERING CONTROL VALVE
Working Pressure
Low Pressure
Return or Suction
Flow

Procedure for Traction Circuit Relief Pressure Test

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

CAUTION

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

2. Drive machine to an open area, lower cutting decks, turn the engine off and apply 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 or reverse) (Fig. 34). Test ports are located on hydraulic lines toward the front of machine. Forward traction port faces the front and reverse port faces rearward.

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

5. Move throttle to full speed **(2870 RPM)**. Make sure that traction speed is in the High (transport) range. Release parking brake.

6. Sit on seat, apply brakes fully and slowly depress the traction pedal in the appropriate direction. While pushing traction pedal, identify pressure reading on gauge as relief valve opens:

GAUGE READING TO BE:
Forward: **4800 to 5300 PSI (332 to 365 bar)**
Reverse: **4800 to 5300 PSI (332 to 365 bar)**

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

8. If traction pressure is too low, makes sure that bypass valve on traction pump is fully seated and then inspect traction pump relief valves in piston (traction) pump (Fig. 35). Clean or replace valves as necessary. These cartridge type valves are factory set and are not adjustable. If relief valves are in good condition, piston (traction) pump, wheel motors and/or rear axle motor should be suspected of wear and inefficiency.

NOTE: Seal leakage across pilot directional valves PD1 and PD2 in 4WD/2WD control manifold can also cause low forward traction pressure with reverse pressure meeting specifications.

NOTE: Forward and reverse relief valves are identical. Relief valves can be switched in piston (traction) pump to help in identifying a faulty relief valve.

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

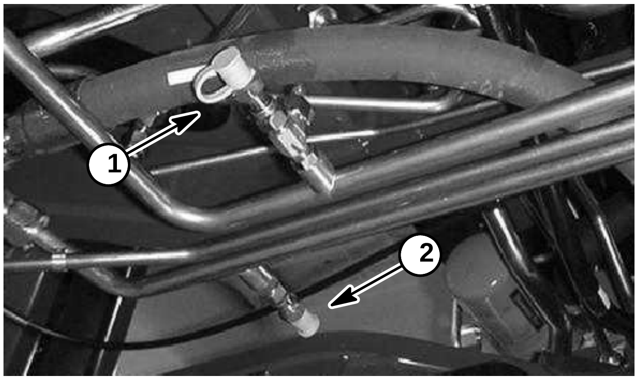


Figure 34

1. Forward traction port (faces forward)
2. Reverse traction port (faces rearward)

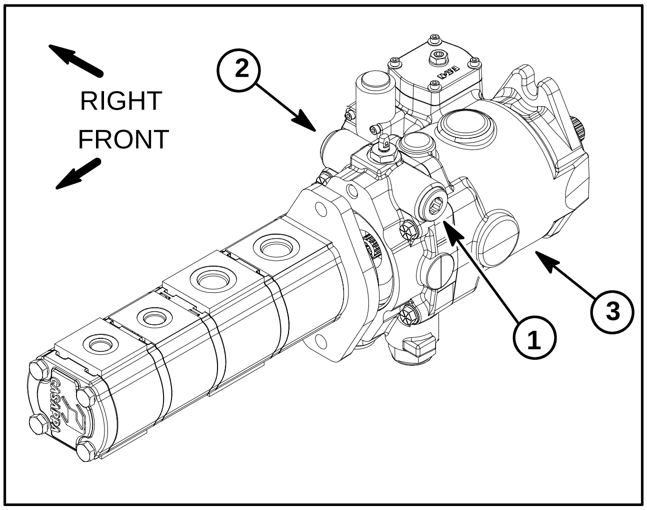
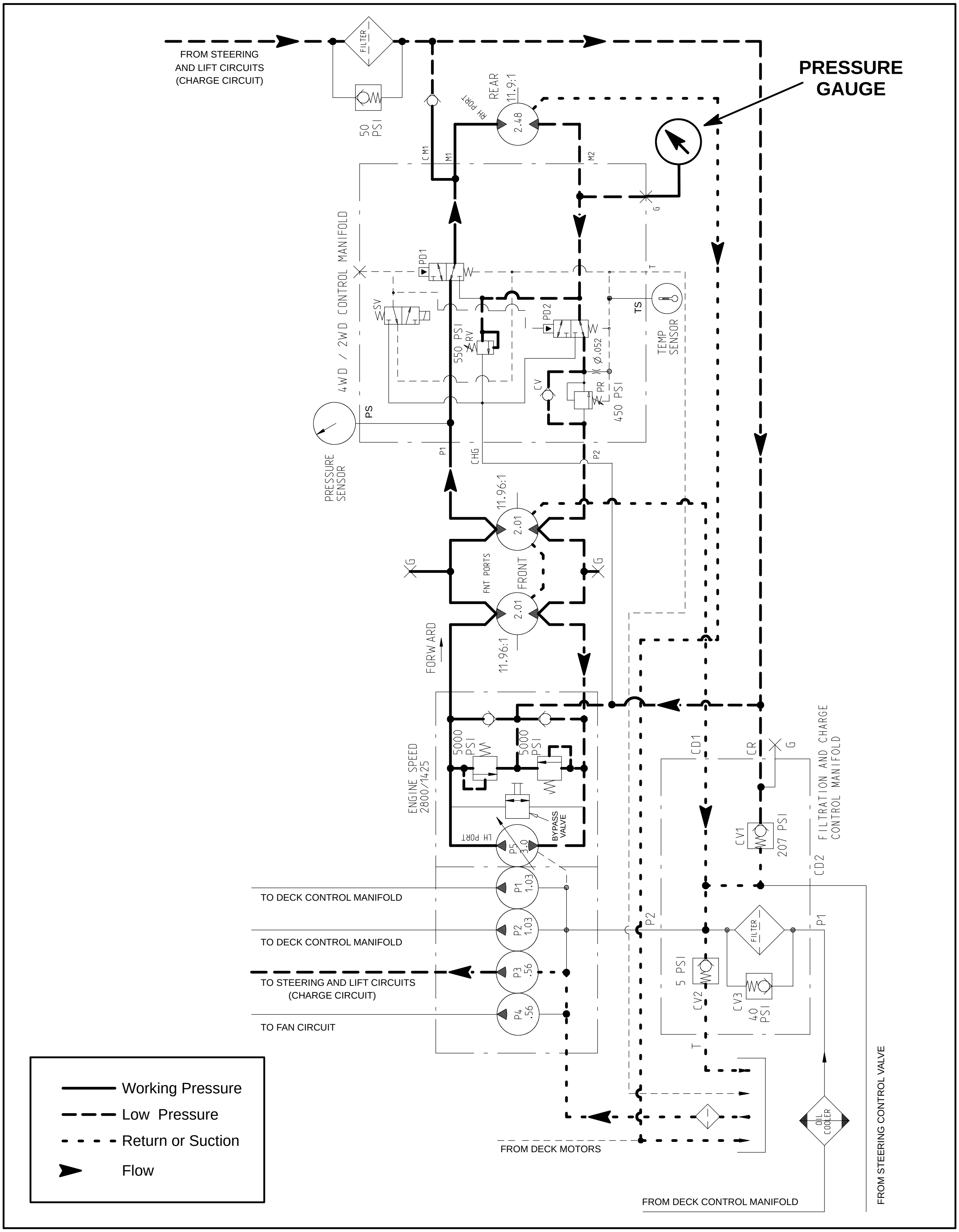


Figure 35

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

Hydraulic System

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



NOTE: Adjustable relief valve (RV) in the 4WD/2WD control manifold reduces rear axle motor pressure created in down hill, dynamic braking conditions to prevent rear wheel lock up.

Procedure for Rear Traction Circuit Relief (RV) Pressure Test

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

2. Park machine on a level surface with the cutting decks lowered and off. Make sure engine is off and the parking brake is 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 G on on rear side of 4WD/2WD control manifold under operator's platform (Fig. 36).

4. Start the engine and put throttle at full engine speed **(2870 RPM)**.

5. Operate the machine in Low speed with the cutting decks lowered. Drive down a slope in a forward direction and decrease pressure on the traction pedal while carefully monitoring the pressure gauge. Pressure should increase until the relief valve lifts.

GAUGE READING TO BE **520 to 570 PSI (36 to 39 bar)**

6. Relief valve (RV) is located on the left side of the 4WD/2WD control manifold in the RV port (Fig. 36). Adjustment of the relief valve can be performed as follows:

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

A. To **increase** relief pressure setting, remove cap on relief valve and turn the adjustment socket on the relief valve in a clockwise direction (Fig. 37). A 1/8 turn on the socket will make a measurable change in relief pressure.

B. To **decrease** pressure setting, remove cap on relief valve and turn the adjustment socket on the relief valve in a counterclockwise direction (Fig. 37). A 1/8 turn on the socket will make a measurable change in relief pressure.

C. After adjustment is made, recheck relief pressure and make additional adjustment if necessary.

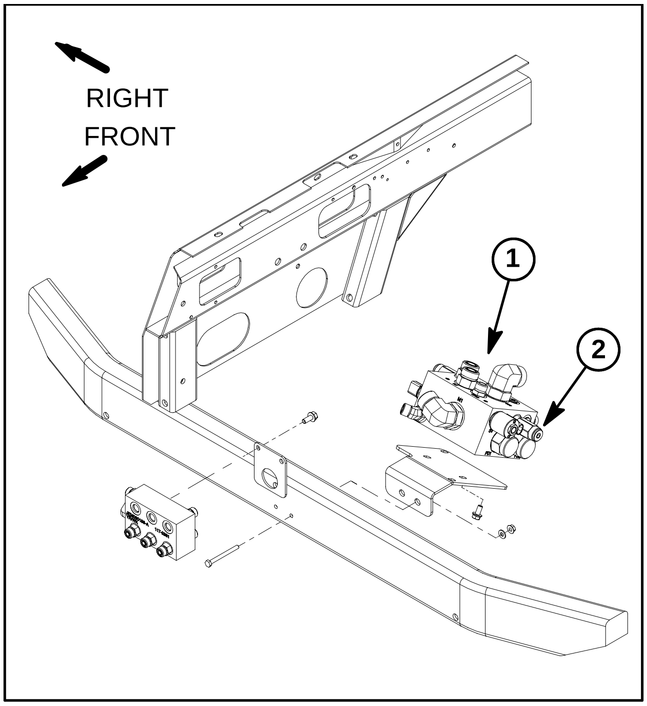


Figure 36

1. **4WD/2WD manifold**
2. **Relief valve (RV)**

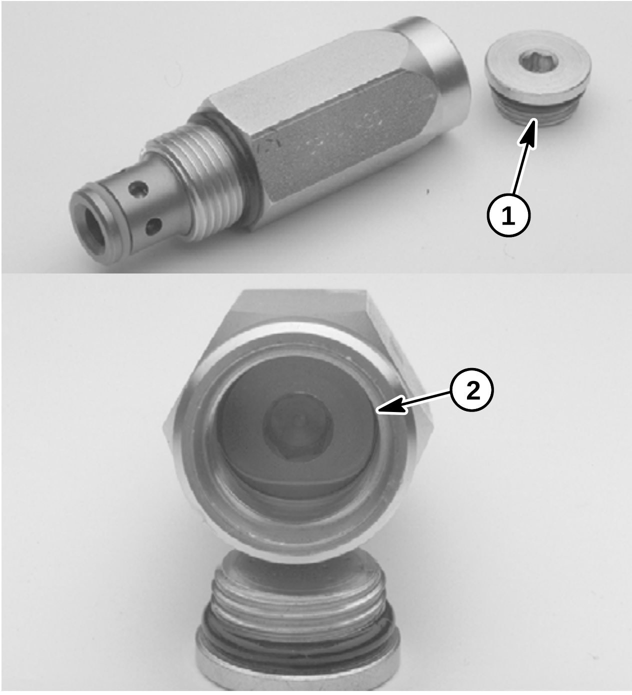
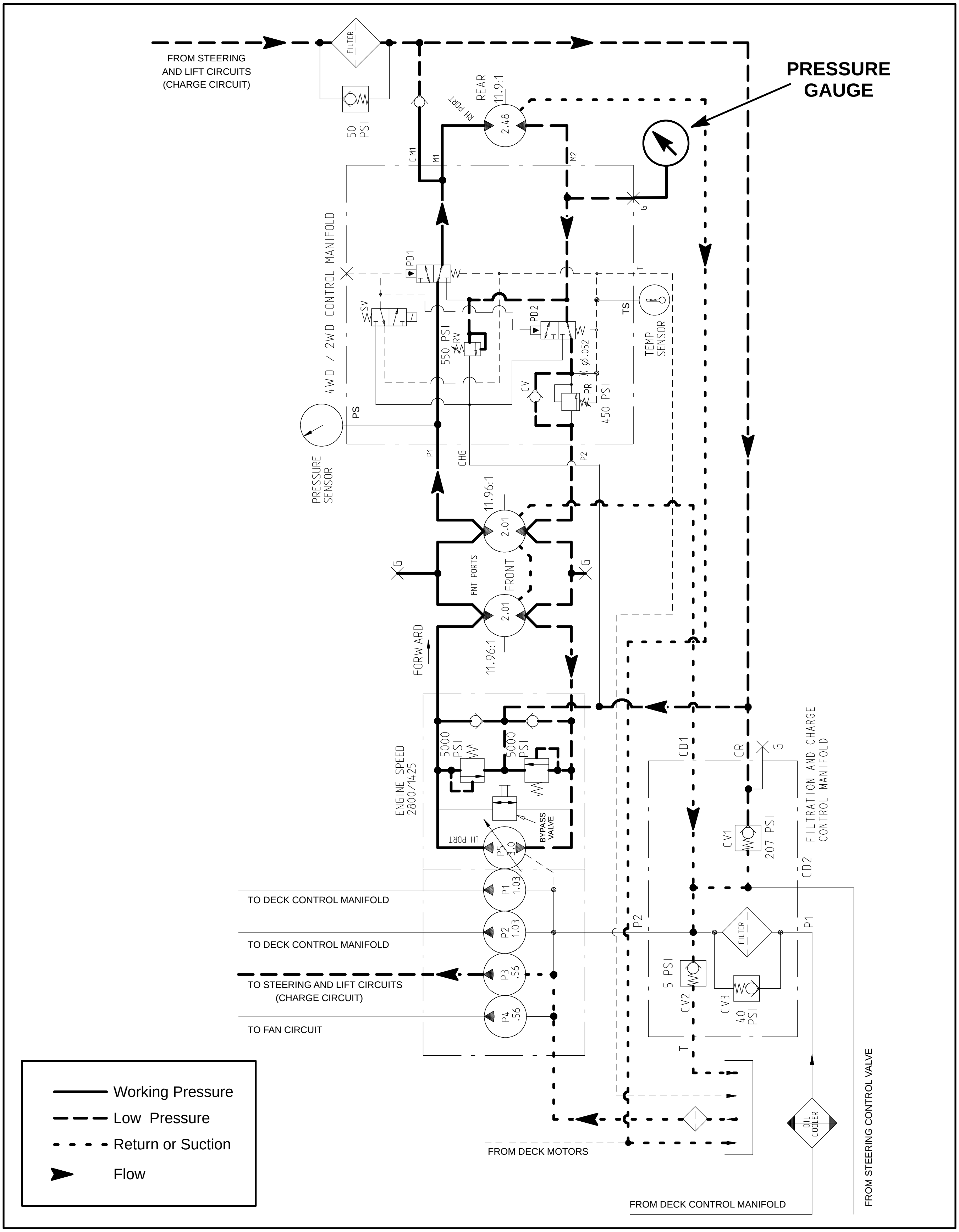


Figure 37

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

Hydraulic System



PRESSURE GAUGE
FROM STEERING AND LIFT CIRCUITS (CHARGE CIRCUIT)
FILTER
50 PSI
REAR 11.9:1
2.48
RH PORT
M1
M2
G
4WD / 2WD CONTROL MANIFOLD
PD1
SV
550 PSI
RV
PD2
Ø.052
PR
CV
450 PSI
TS
TEMP SENSOR
PS
PRESSURE SENSOR
P1
CHG
P2
11.96:1
2.01
FRONT
FNT PORTS
FORWARD
ENGINE SPEED 2800/1425
5000 PSI
BYPASS VALVE
LH PORT
P5 3.0
P1 1.03
P2 1.03
P3 .56
P4 .56
TO DECK CONTROL MANIFOLD
TO DECK CONTROL MANIFOLD
TO STEERING AND LIFT CIRCUITS (CHARGE CIRCUIT)
TO FAN CIRCUIT
CD1
CR
FILTRATION AND CHARGE CONTROL MANIFOLD
CV1
207 PSI
CD2
5 PSI
CV2
CV3
40 PSI
T
OIL COOLER
FROM DECK MOTORS
FROM DECK CONTROL MANIFOLD
FROM STEERING CONTROL VALVE
Working Pressure
Low Pressure
Return or Suction
Flow

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

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

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

2. Park machine on a level surface with the cutting decks lowered and off. Make sure engine is off and the parking brake is 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 G on rear side of 4WD/2WD control manifold under operator's platform (Fig. 38).

4. Start the engine and put throttle at full engine speed **(2870 RPM)**.

5. Sit on seat, apply brakes fully and slowly depress the traction pedal in the reverse direction. While pushing traction pedal, carefully monitor the pressure gauge. Pressure should increase until the pressure reducing valve opens.

GAUGE READING TO BE **420 to 470 PSI (29 to 32 bar)**.

6. Release traction pedal, stop engine and record test results.

7. The pressure reducing valve (PR) is located on the right side of the 4WD/2WD control manifold in the PR port (Fig. 39). Adjustment of this valve can be performed as follows:

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

A. To **increase** pressure setting, remove cap on reducing valve and turn the adjustment socket on the valve in a clockwise direction (Fig. 40). A 1/8 turn on the socket will make a measurable change in pressure setting.

B. To **decrease** pressure setting, remove cap on reducing valve and turn the adjustment socket on the valve in a counterclockwise direction (Fig. 40). A 1/8 turn on the socket will make a measurable change in pressure setting.

C. After adjustment is made, recheck relief pressure and make additional adjustment if necessary.

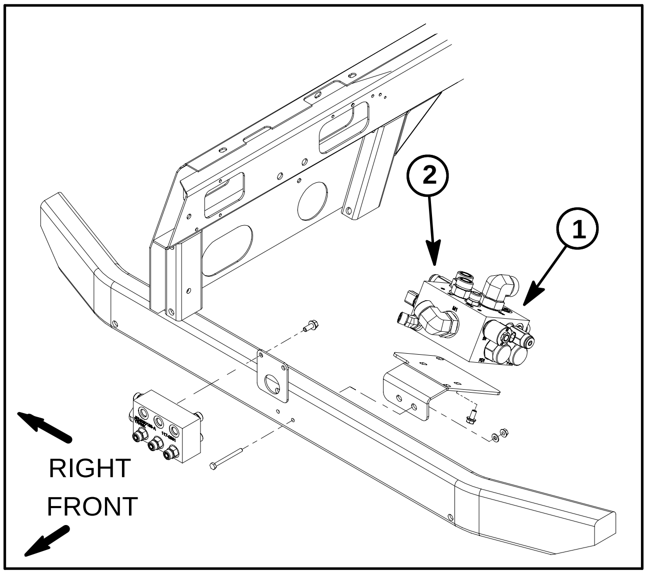


Figure 38

1. **4WD/2WD manifold** 2. **Reducing valve (PR)**

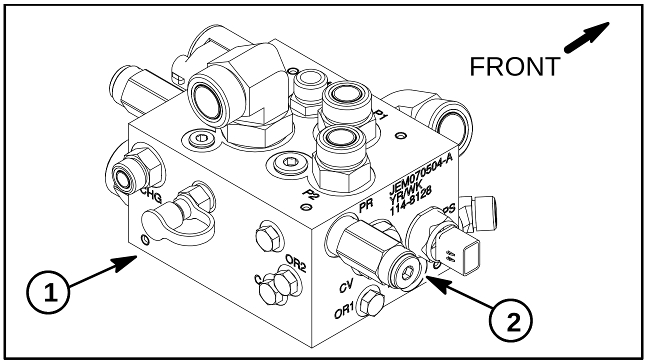


Figure 39

1. **4WD/2WD manifold** 2. **Reducing valve (PR)**

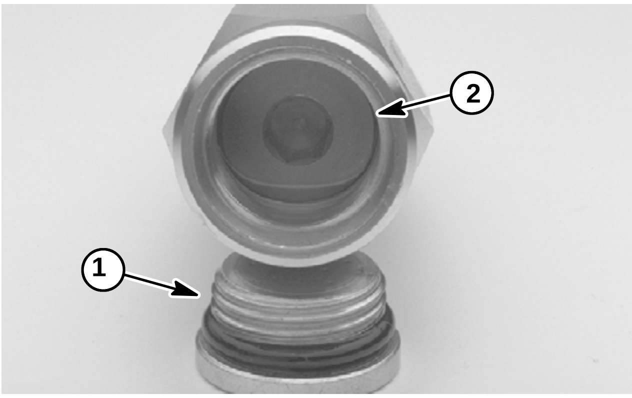
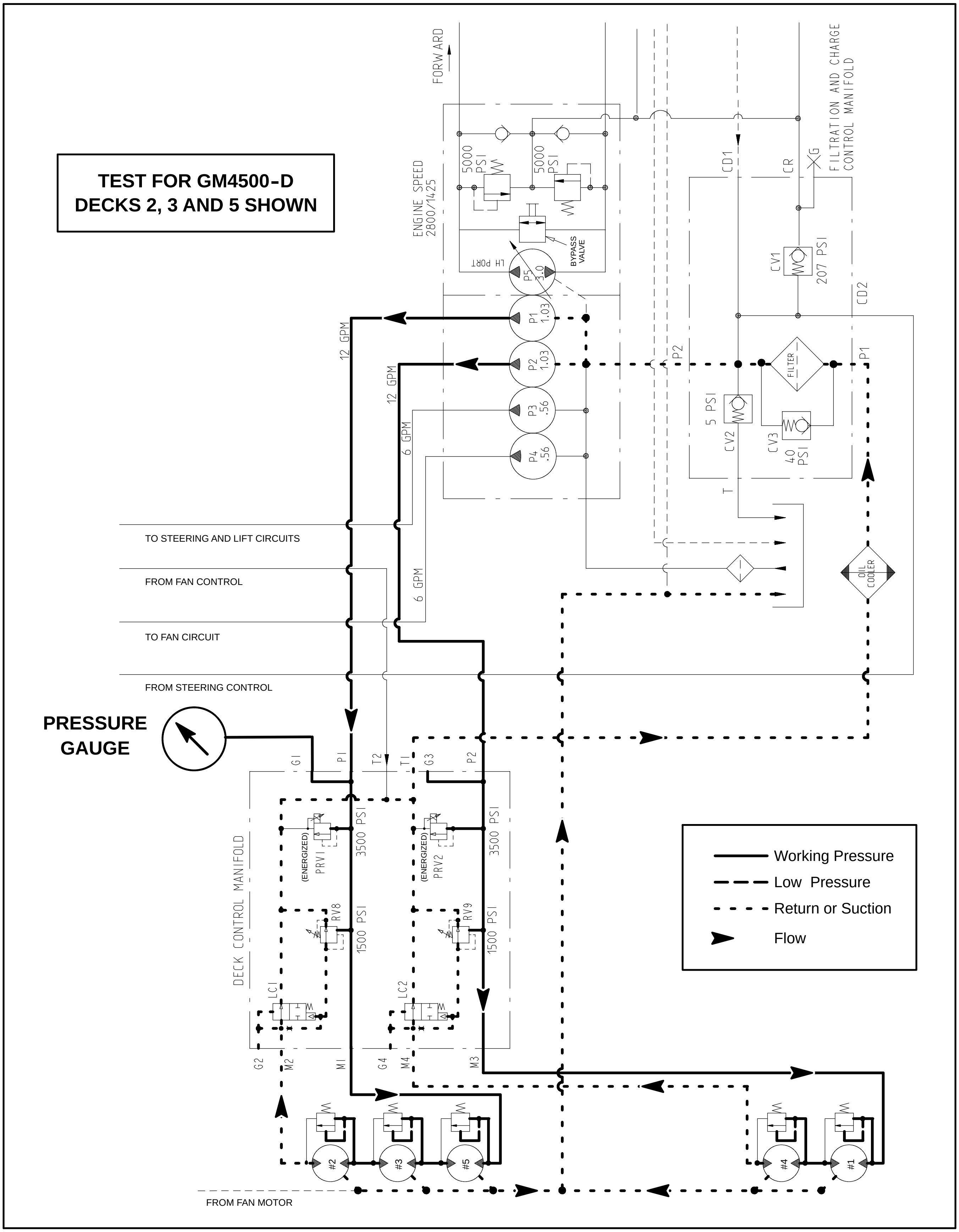


Figure 40

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

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 for approximately ten (10) minutes. Make sure the hydraulic tank is full.

2. Park machine on a level surface with the cutting decks lowered and off. Make sure engine is off and the parking brake is engaged.

3. Raise hood to allow access to deck control manifold.

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. Install 5000 PSI (350 bar) pressure gauge with hydraulic hose attached to deck control manifold test port for the cutting deck circuit to be tested (Fig. 41 or 42).

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

CAUTION

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

6. Move throttle to full speed **(2870 RPM)**. Engage the cutting decks.

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

8. Cutting deck circuit pressure should be from **1000 to 3500 PSI (69 to 241 bar)** and will vary depending on mowing conditions.

9. Disengage cutting decks. Shut off engine. Record test results.

10. After testing is complete, disconnect pressure gauge from manifold test port.

11. Lower and secure hood.

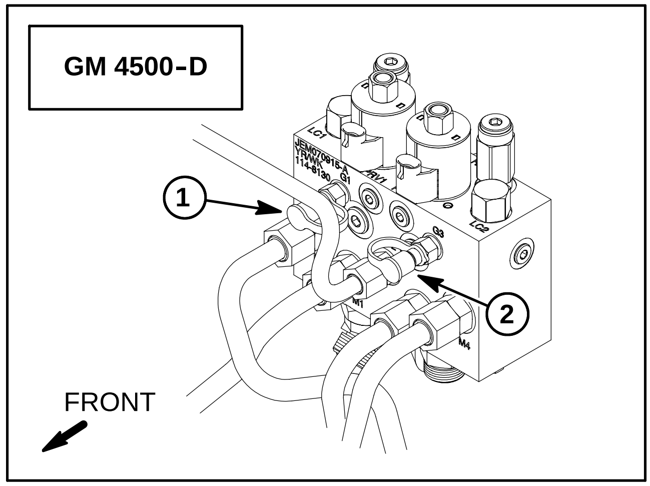


Figure 41

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

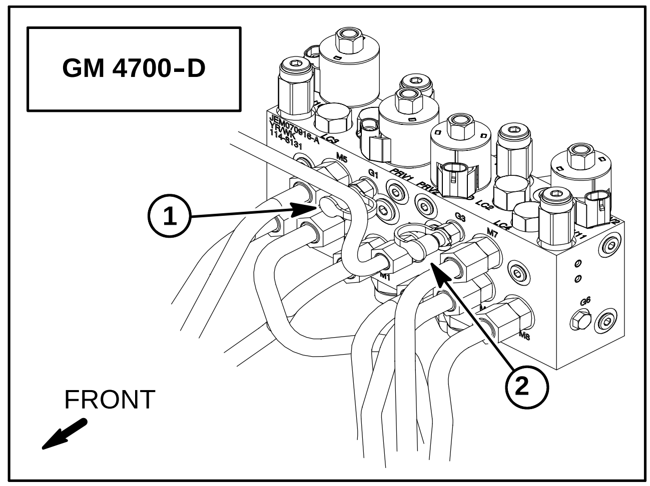


Figure 42

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

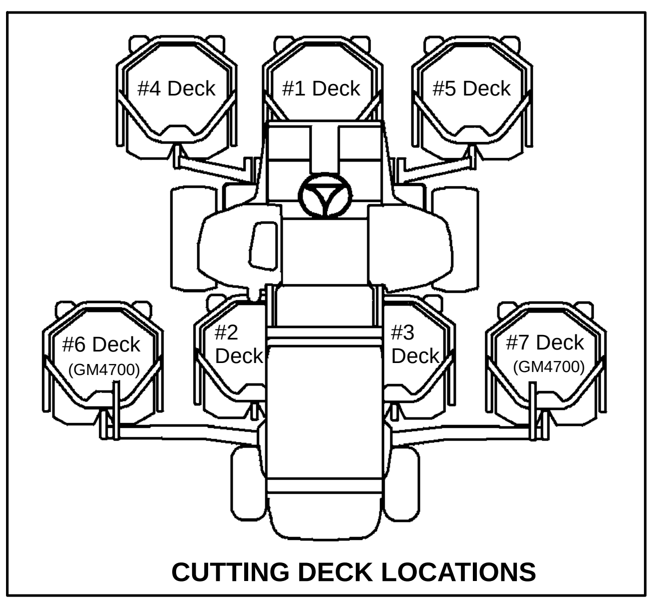
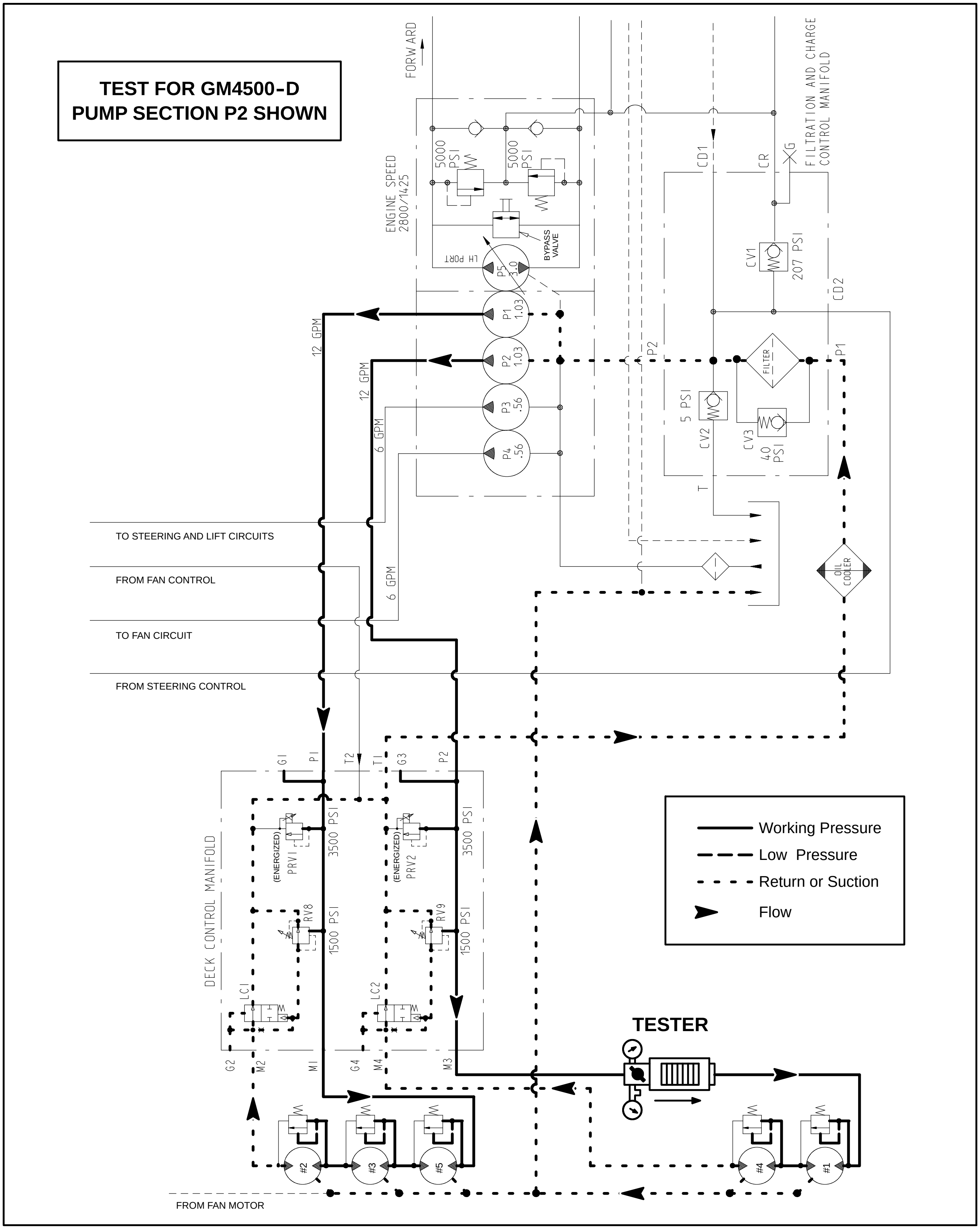


Figure 43

Cutting Deck Circuit Relief Pressure (Using Tester with Pressure Gauges and Flow Meter)



Procedure for Cutting Deck Circuit Relief Pressure Test

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

2. Park machine on a level surface with the cutting decks lowered and off. Make sure engine is off and the parking brake is 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. Determine cutting deck manifold relief pressure to be tested:

A. For pump section (P1), cutting deck manifold relief is tested at the inlet to the deck #5 motor (Fig. 44).

B. For pump section (P2), cutting deck manifold relief is tested at the inlet to the deck #1 motor (Fig. 44).

4. Thoroughly clean junction of appropriate hydraulic inlet hose and deck motor fitting (Fig. 45). Disconnect the inlet hydraulic hose from the deck motor.

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

5. Install tester with pressure gauge and flow meter in series with the the disconnected hose and deck motor inlet.

6. Make sure the flow control valve on the tester is fully open.

CAUTION

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

7. Move throttle to full speed **(2870 RPM)**. Engage the cutting decks.

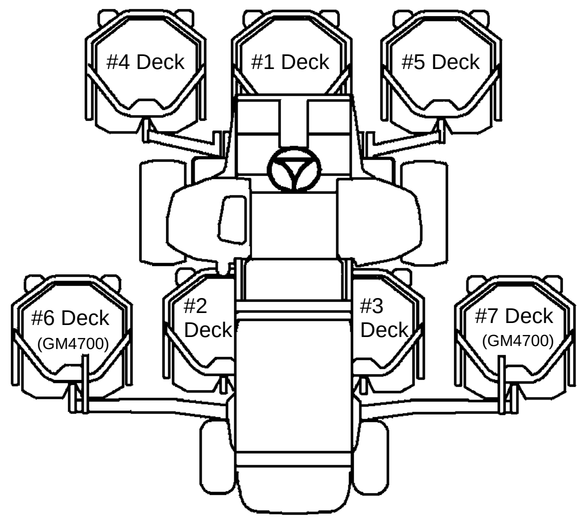
8. Watch tester pressure gauge carefully while slowly closing the flow control valve on tester.

9. As the relief valve lifts, system pressure should be from **3400 to 3750 PSI (235 to 258 bar)**.

10. Open the tester flow control valve, disengage cutting decks and stop the engine. Record test results.

11. If specification is **not** met, make sure that electrical connections at deck control manifold are secure and then clean or replace relief valve (PRV1 or PRV2) in the deck control manifold (see Deck Control Manifold Service in the Service and Repairs section of this chapter). Also, if pressure is still low after relief valve service, check for restriction in pump intake line. Gear pump P1 and/or P2 could also be suspected of wear or damage (see Gear Pump P1 and P2 Flow Test in this section).

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



CUTTING DECK LOCATIONS

Figure 44

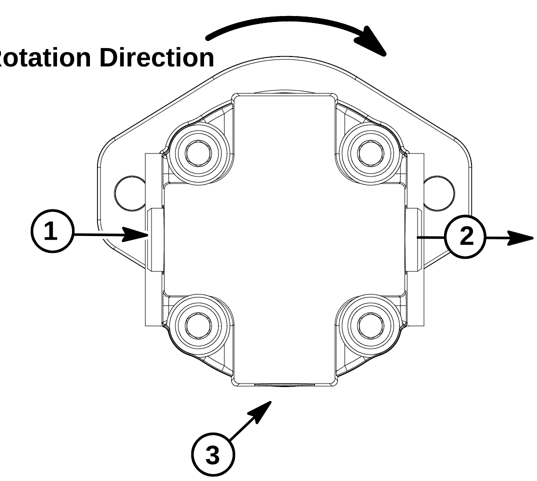
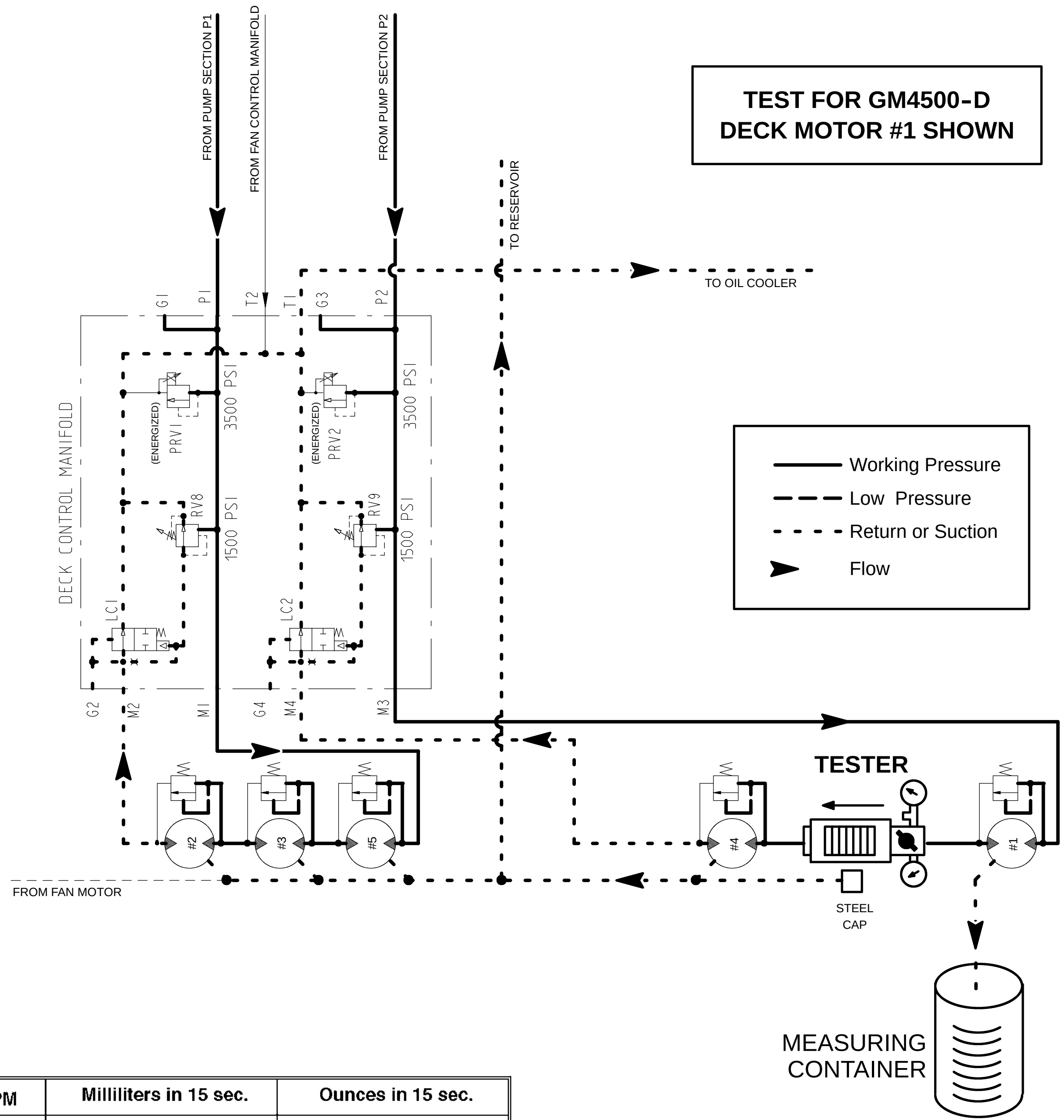


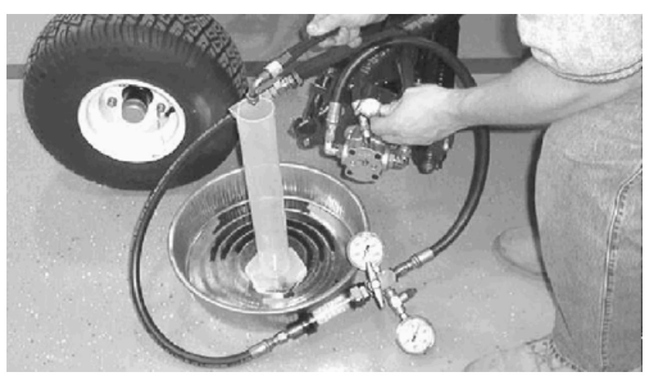
Figure 45

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

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



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



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 bypass oil to its case drain causing the motor to be less efficient. Eventually, enough oil loss will cause the deck motor to stall under heavy cutting conditions. Continued operation with a worn, inefficient motor can generate excessive heat, cause damage to seals and other components in the hydraulic system and affect quality of cut.

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

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

2. Park machine on a level surface with the cutting decks lowered and off. Make sure engine is off and the parking brake is 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 deck motors are connected in series. To isolate a faulty motor, all motors in the circuit may have to be tested by starting with the first motor in the circuit (see Hydraulic Schematic).

3. Disconnect pressure return hose from the motor to be tested (Fig. 47). Install tester with pressure gauge and flow meter in series with the motor and the disconnected return hose. Make sure the flow control valve on tester is fully open.

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

CAUTION

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

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

6. While watching tester 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.

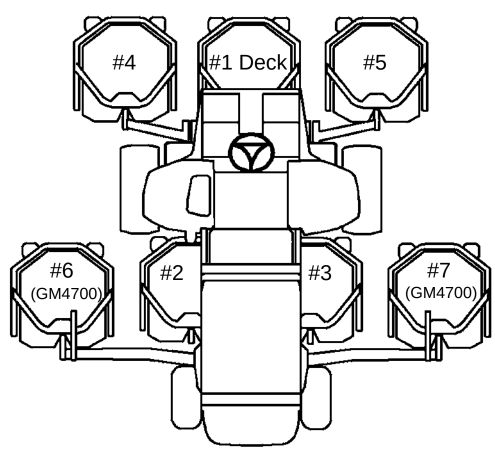
7. Have a second person measure flow from the case drain line for **fifteen (15) seconds**, then move the PTO switch to OFF and stop the engine. Record test results.

TEST RESULTS: Case drain leakage less than **22.4 ounces (662 ml)** of hydraulic fluid in 15 seconds (0.7 GPM / 2.7 LPM)

8. If case drain flow is more than **22.4 ounces (662 ml)**, the motor is worn or damaged and should be repaired or replaced.

9. Disconnect tester from motor and hose. Reconnect hose to the deck motor. Remove cap from bulkhead fitting and reconnect case drain hose.

10. Repeat test for additional motors if required.



CUTTING DECK LOCATIONS

Figure 46

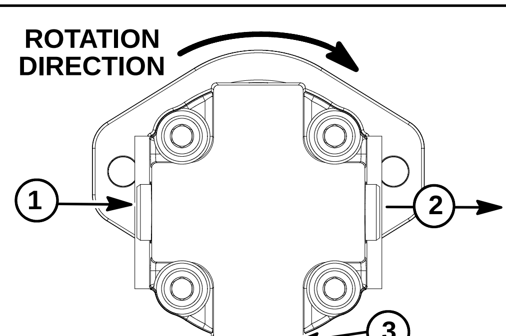
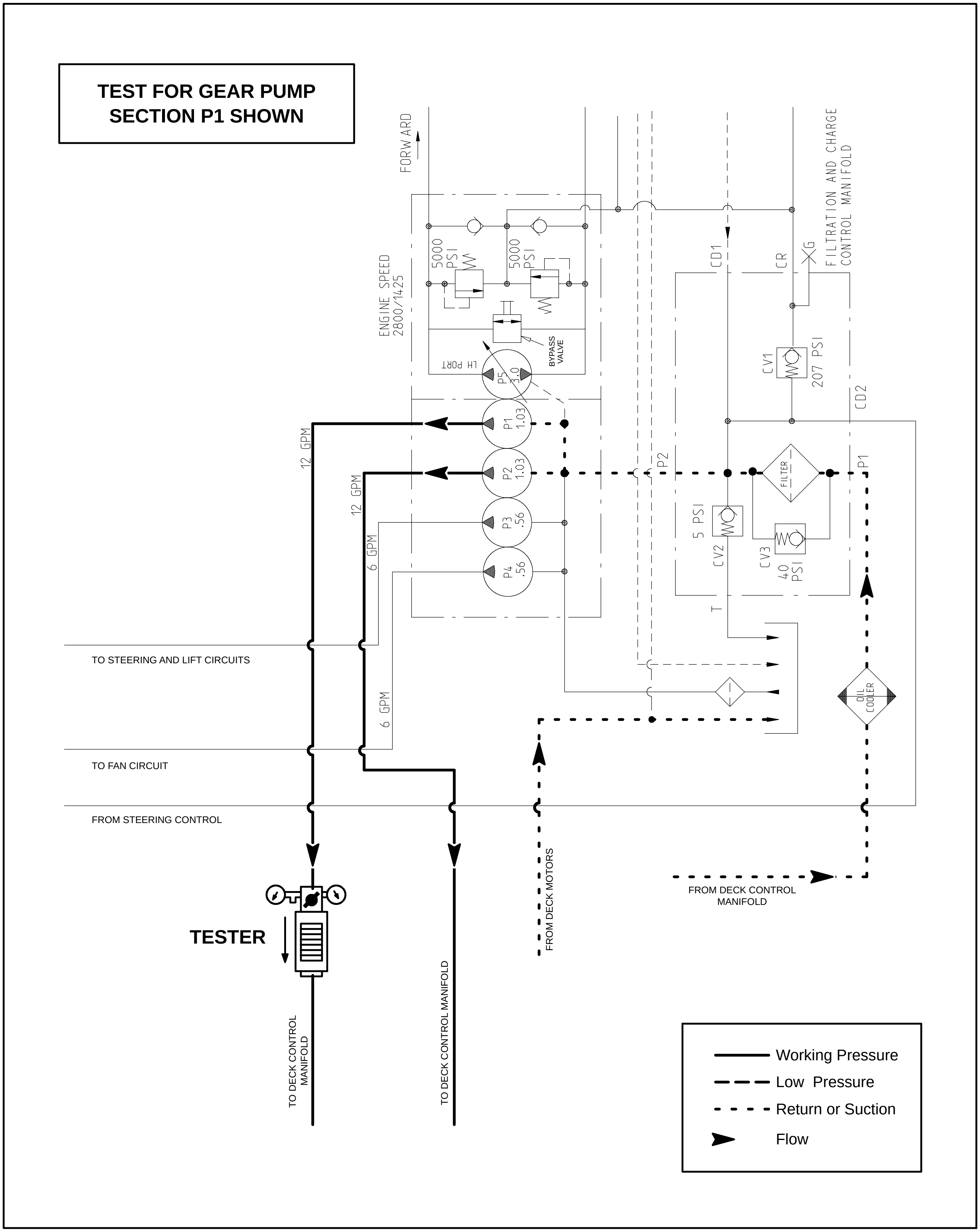


Figure 47

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

Hydraulic System

Gear Pump P1 and P2 Flow (Cutting Deck Circuits) (Using Tester with Pressure Gauges and Flow Meter)



NOTE: Gear pump P1 supplies hydraulic flow to cutting decks 5, 3 and 2 (also deck 7 on the GM 4700–D). Gear pump P2 supplies flow to cutting decks 1 and 4 (also deck 6 on the GM 4700–D).

Procedure for Gear Pump P1 and P2 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.

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

2. Park machine on a level surface with the cutting decks lowered and off. Make sure engine is off and the parking brake is engaged.

3. Raise hood to allow access to pump assembly.

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. Locate gear pump section to be tested (P1 or P2). Thoroughly clean junction of appropriate hydraulic hose and gear pump fitting. Disconnect hydraulic hose from hydraulic fitting in gear pump (Fig. 48).

IMPORTANT: Make sure that the oil flow indicator arrow on the tester is showing that the oil will flow from the gear pump fitting, through the tester and into the disconnected hose.

5. Install tester with pressure gauge and flow meter in series with the disconnected hose and fitting in gear pump section. **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 and correct before proceeding with test.

7. Start engine and move throttle to full speed **(2870 RPM)**. **Do not engage the cutting decks**.

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

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

9. For a pump in good condition, flow indication should be approximately **11.5 GPM (43.5 LPM)**.

10. Fully open flow control valve on tester and then shut engine off. Record test results.

11. If measured flow is **less than 9.6 GPM (36.3 LPM)** or a pressure of **2000 PSI (138 bar)** cannot be obtained, check for restriction in the pump intake line (including oil filter and oil cooler). If line is not restricted, remove gear pump and repair or replace as necessary.

12. After testing is complete, disconnect tester from hydraulic hose and fitting. Connect hose to the gear pump fitting.

13. Repeat test for second pump section if required.

14. Lower and secure hood after testing is completed.

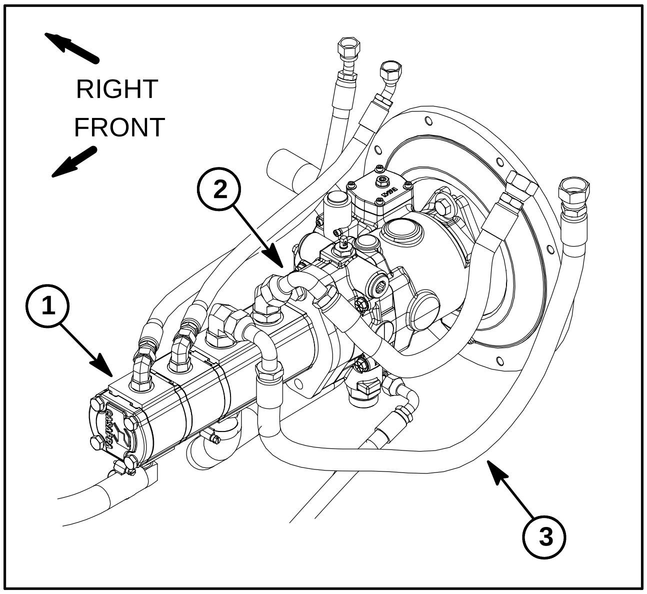
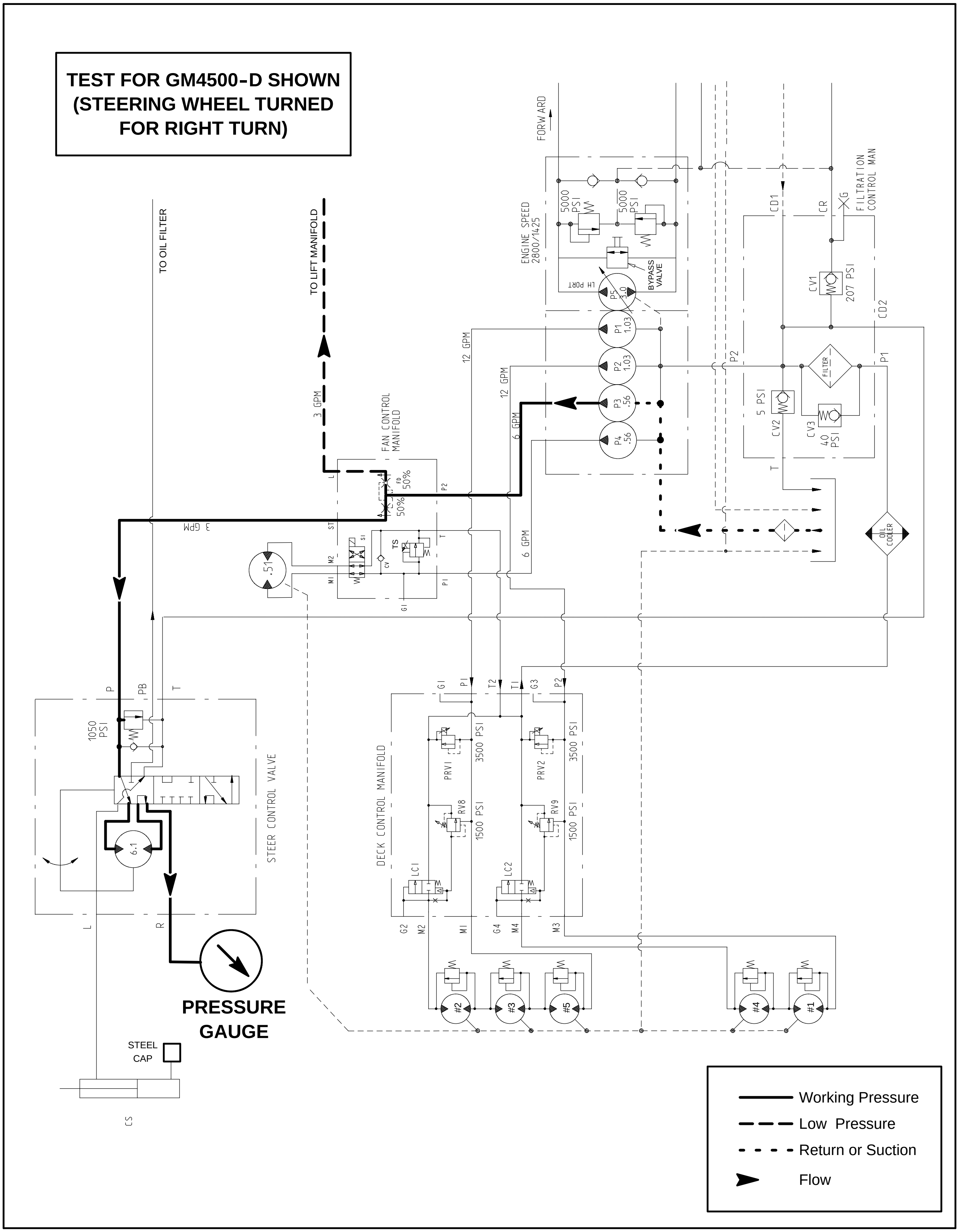


Figure 48

1. **Gear pump**
2. **Pump section P1 hose**
3. **Pump section P2 hose**

Hydraulic System

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 for approximately ten (10) minutes. Make sure the hydraulic tank is full.

2. Park machine on a level surface with the cutting decks lowered and off. Make sure engine is off and the parking brake is 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. Thoroughly clean junction of hydraulic hose and steering cylinder fitting at the barrel end of the steering cylinder (Fig. 49). Disconnect hose from fitting in barrel end of steering cylinder.

4. Install 5000 PSI (350 bar) pressure gauge with hydraulic hose attached to disconnected hose. Install steel cap on steering cylinder fitting to prevent any leakage from cylinder.

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

6. Move throttle to full engine speed **(2870 RPM)**.

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

7. Turn steering wheel to the right while monitoring the pressure gauge. When steering circuit pressure reaches the relief pressure setting, pressure should stabilize briefly and then may continue to increase. The steering circuit relief pressure is the gauge reading when pressure stabilizes.

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

8. Stop the engine. Record test results.

9. If steering relief pressure is incorrect, inspect steering relief valve located in the steering control valve (see Steering Control Valve Service in the Service and Repairs section of this chapter). If relief valve is operating properly and if lift/lower problems also exist, gear pump P3 should be suspected of wear or damage. If steering wheel continues to turn at end of cylinder travel (with lower than normal effort), steering cylinder or steering control valve may be worn or damaged.

10. When testing is complete, turn steering wheel to both the right and the left with the engine not running to relieve steering circuit pressure. Remove pressure gauge from hydraulic hose and steel cap from steering cylinder fitting. Connect hydraulic hose to steering cylinder fitting.

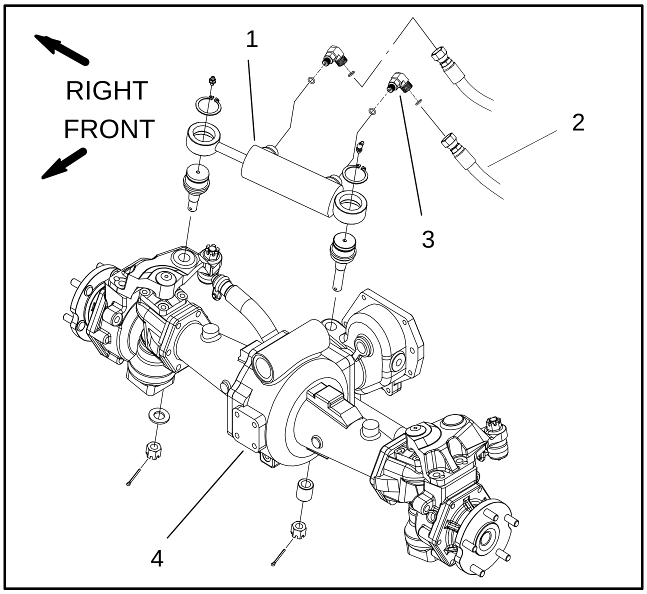
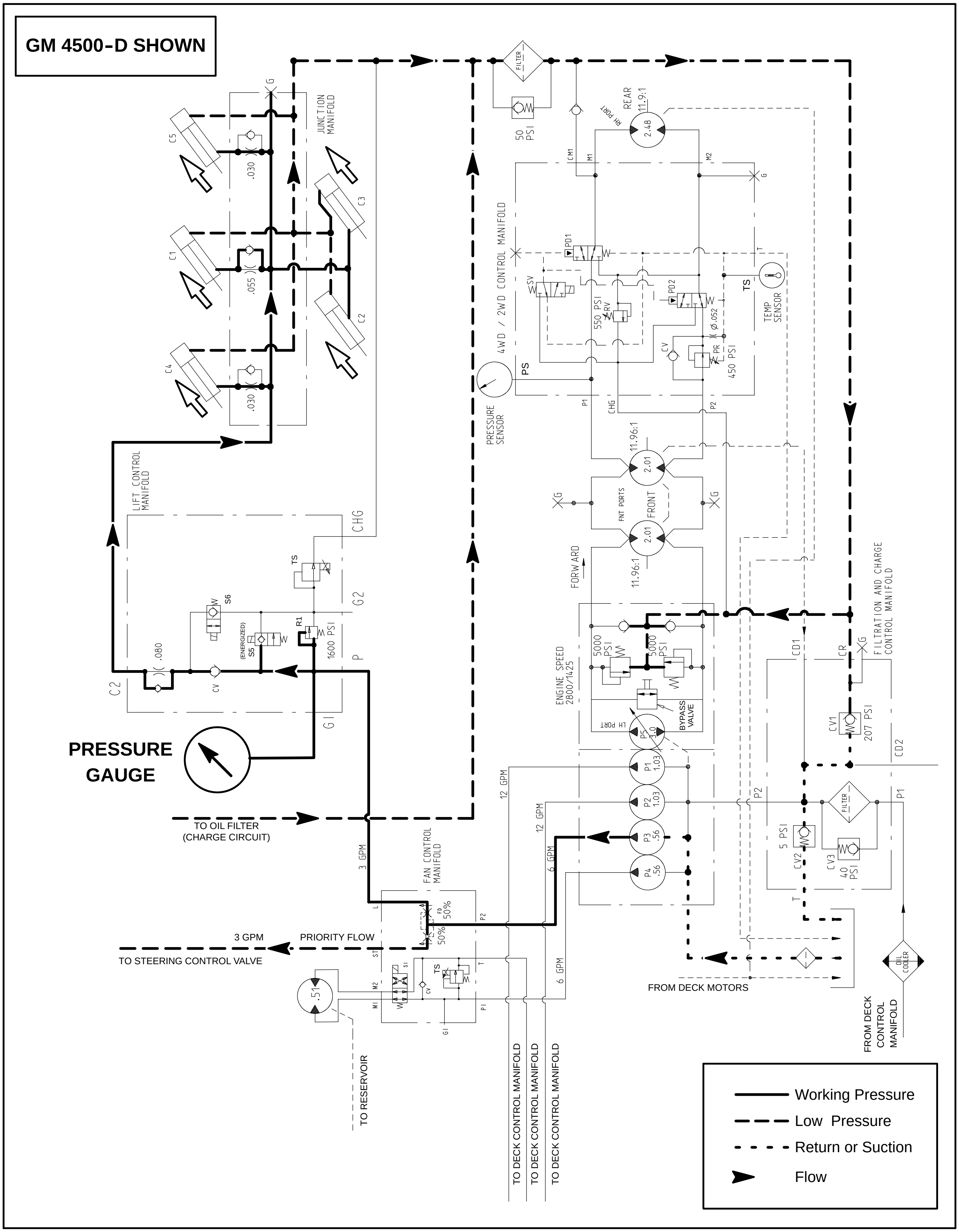


Figure 49

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

Hydraulic System

Lift/Lower Circuit Relief Pressure (Using Pressure Gauge)



Procedure for Lift/Lower Circuit Relief Pressure Test

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

2. Park machine on a level surface with the cutting decks fully raised. Apply the parking brake and stop 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. Raise and support hood to gain access to lift control manifold (Fig. 50 or 51). Connect a 5000 PSI (350 bar) pressure gauge with hydraulic hose attached to lift manifold test port G1. Route gauge hose to allow hood to be safely lowered.

4. Sit on the seat and start the engine. Move throttle to full speed **(2870 RPM)**.

5. While sitting on the seat, with the cutting decks fully raised, monitor the pressure gauge to identify lift/lower circuit pressure with no load. Record this pressure.

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

   GAUGE READING TO BE **approximately 1600 PSI (179 bar) higher than measured lift/lower circuit pressure with no load from step 5 above** (e.g. if circuit no load pressure is 300 PSI (21 bar), lift/lower relief pressure should be approximately 1900 PSI (200 bar))

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

8. If specification is not met, adjust or clean relief valve located in the lift control manifold (see Lift Control Manifold Service in the Service and Repairs section of this chapter).

   A. If pressure is too high, remove cap on relief valve (Fig. 52). Adjust relief valve by rotating adjustment socket counterclockwise (decrease relief pressure).

   B. If pressure is too low, check for restriction in gear pump intake line. Check the lift cylinders for internal leakage. If pump intake line is not restricted and lift cylinders are not leaking, remove cap on relief valve (Fig. 52). Adjust the relief valve by rotating adjustment socket clockwise (increase relief pressure).

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

9. Lower and secure hood after testing is completed.

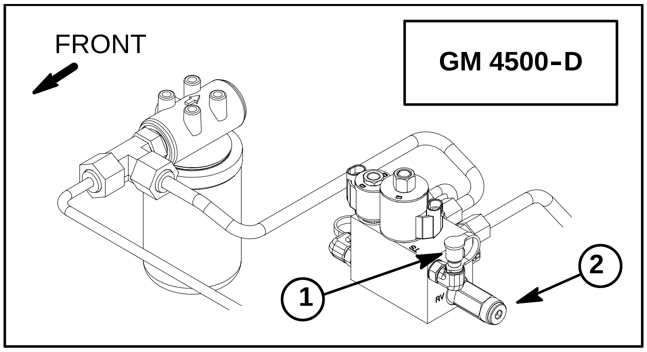


Figure 50

1. **Test port G1** 2. **Relief valve**

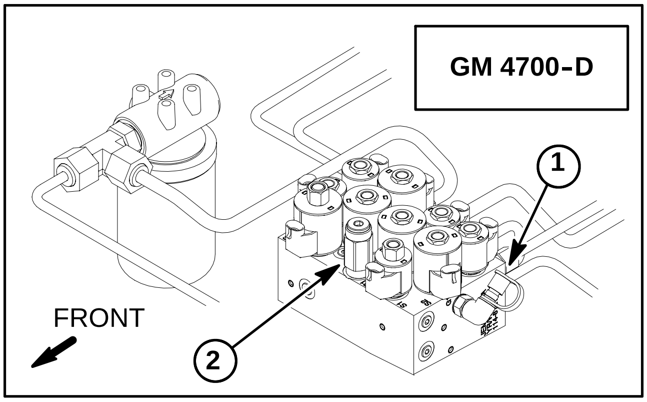


Figure 51

1. **Test port G1** 2. **Relief valve**

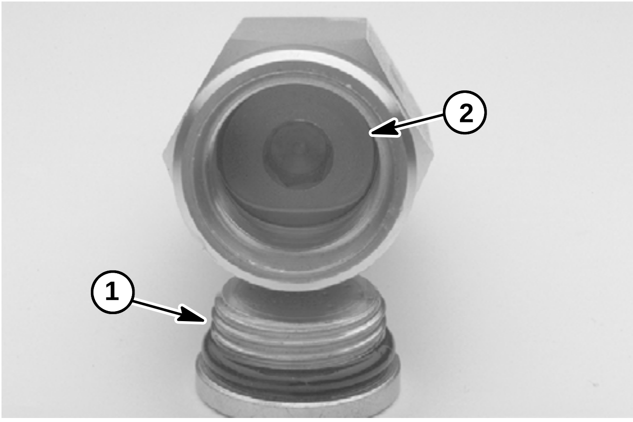
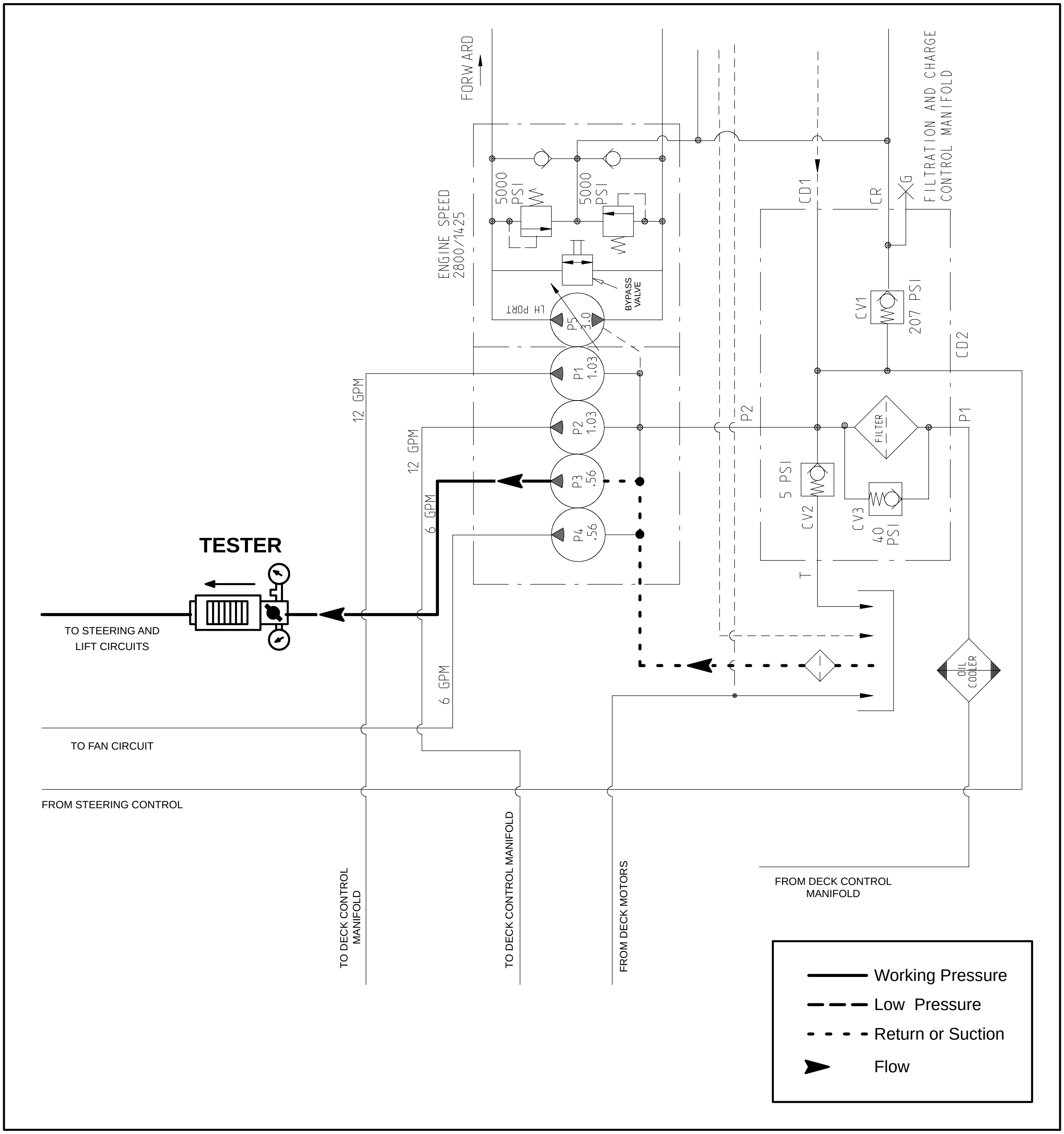


Figure 52

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

Gear Pump P3 Flow (Steering and Lift/Lower Circuits) (Using Tester with Pressure Gauges and Flow Meter)



NOTE: Gear Pump P3 supplies oil flow for the steering and lift circuits.

Procedure for Gear Pump P3 Flow Test

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

2. Park machine on a level surface with the cutting decks lowered and off. Make sure engine is off and the parking brake is engaged.

3. Raise hood to allow access to pump assembly.

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. Thoroughly clean junction of hydraulic hose and fitting in gear pump section P3 (Fig. 53). Disconnect hydraulic hose from fitting.

IMPORTANT: Make sure that the oil flow indicator arrow on the tester is showing that the oil will flow from the gear pump fitting, through the tester and into the disconnected hose.

5. Install tester with pressure gauges and flow meter in series with the disconnected hose and fitting in gear pump section P3. **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 and correct before proceeding with test.

7. Move throttle to full speed **(2870 RPM)**. DO NOT engage the cutting decks.

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.

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

9. For a pump in good condition, flow indication should be approximately **6.3 GPM (23.8 LPM)**.

10. Fully open flow control valve on tester and then shut engine off. Record test results.

11. If the flow is lower than **5.3 GPM (20.1 LPM)** or a pressure of **1000 PSI (69 bar)** could not be obtained, check for restriction in pump intake line. If intake line is not restricted, remove gear pump and repair or replace as necessary.

12. Lower and secure hood after testing is completed.

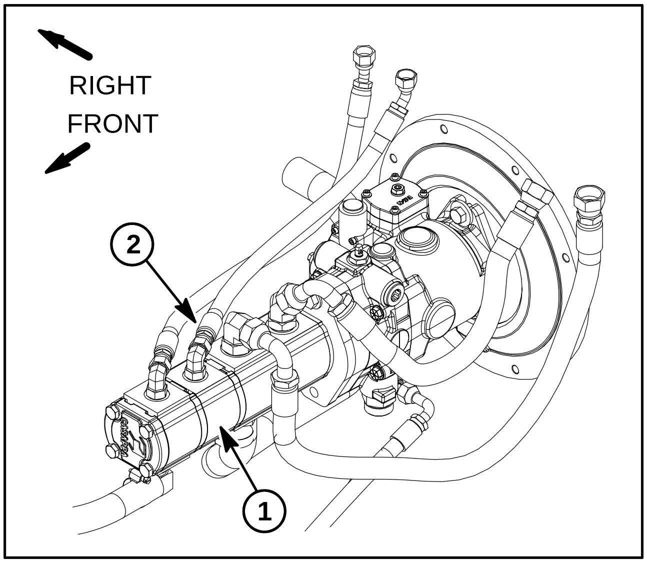
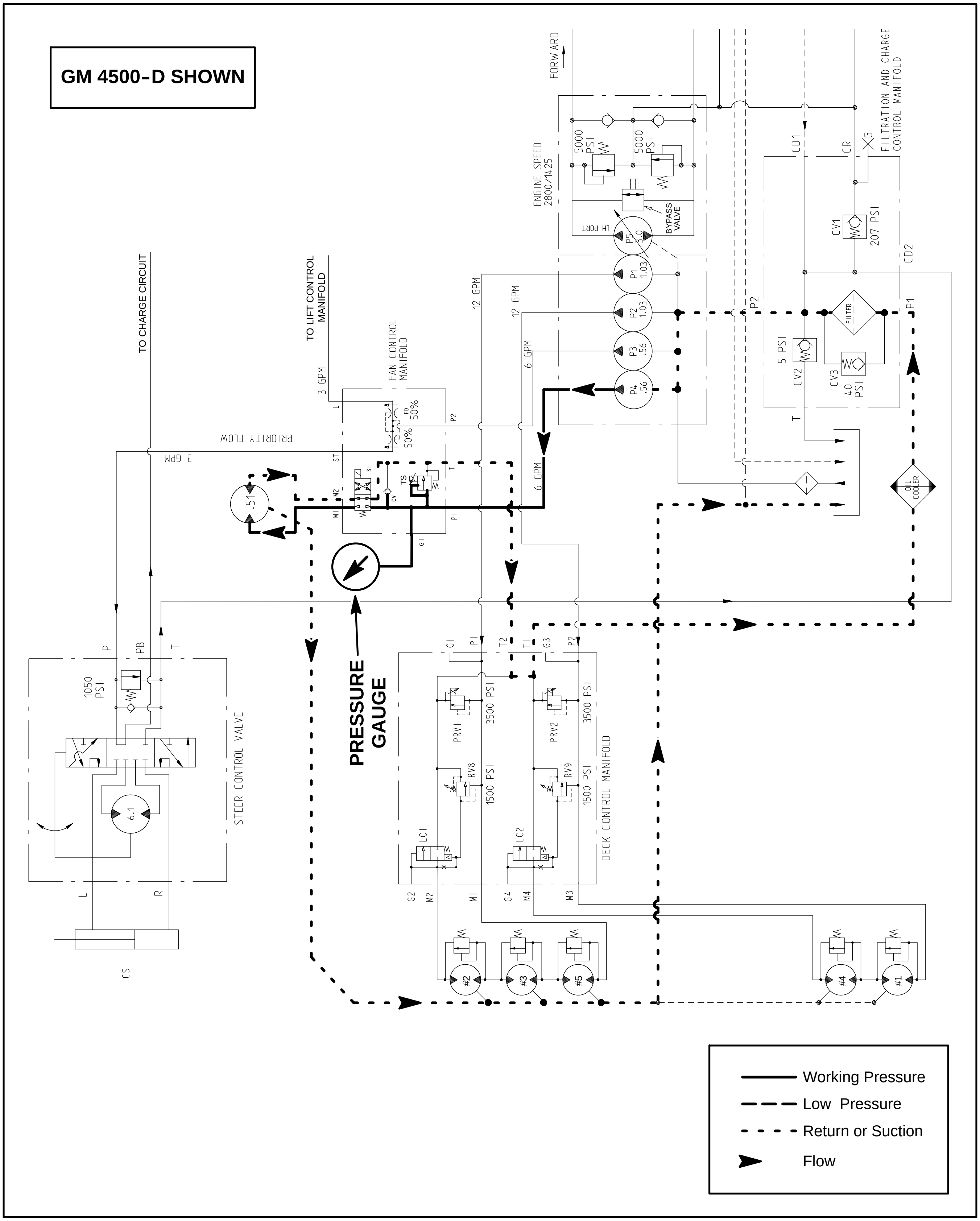


Figure 53

1. **Gear pump section P3**
2. **Pump section P3 hose**


GM 4500–D SHOWN
TO CHARGE CIRCUIT
TO LIFT CONTROL MANIFOLD
FAN CONTROL MANIFOLD
PRIORITY FLOW
3 GPM
12 GPM
6 GPM
ENGINE SPEED 2800/1425
FORWARD
5000 PSI
BYPASS VALVE
LH PORT
FILTRATION AND CHARGE CONTROL MANIFOLD
207 PSI
5 PSI
40 PSI
FILTER
OIL COOLER
PRESSURE GAUGE
STEER CONTROL VALVE
1050 PSI
DECK CONTROL MANIFOLD
3500 PSI
1500 PSI
Working Pressure
Low Pressure
Return or Suction
Flow

Procedure for Cooling Fan Circuit Test

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

2. Park machine on a level surface with the cutting decks lowered and off. Make sure engine is off and the parking brake is applied.

CAUTION

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

3. Raise and support hood to gain access to fan control manifold (Fig. 54). Connect a 5,000 PSI (345 bar) gauge with hydraulic hose attached to test fitting in port G on rear of manifold.

4. Start the engine. Move throttle to full speed **(2870 RPM)**.

5. While monitoring the pressure gauge and using a phototac to identify the cooling fan speed, disconnect the wire harness connector (white/violet and black wires) from the proportional relief valve solenoid at fan control manifold (port TS). Both fan speed and pressure should increase and stabilize after the solenoid is disconnected.

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

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

6. Stop engine and record test results.

7. If pressure rises to approximately **3000 PSI (207 bar)** but fan speed is low, consider that the fan motor is worn or damaged. If pressure and fan speed are both low, consider that gear pump P4 is worn or damaged (see Gear Pump P4 Flow Test in this section).

NOTE: If pressure and fan speed are both low and gear pump P4 flow proves to be correct (see Gear Pump P4 Flow Test in this section), suspect that seals in fan control manifold are leaking or faulty (see Fan Control Manifold Service in the Service and Repairs section of this chapter) or that fan motor is worn or damaged.

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

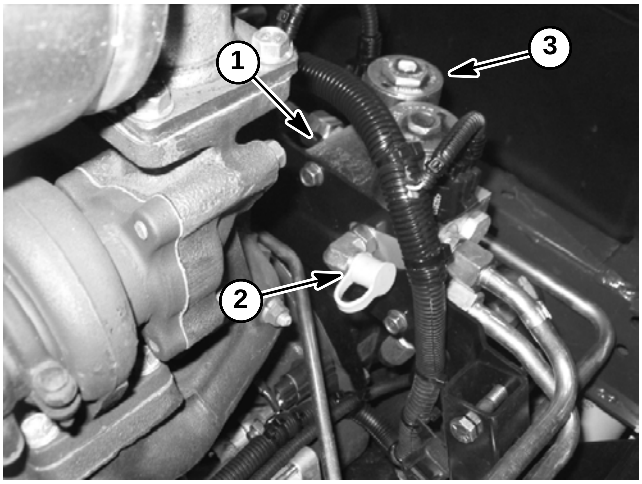
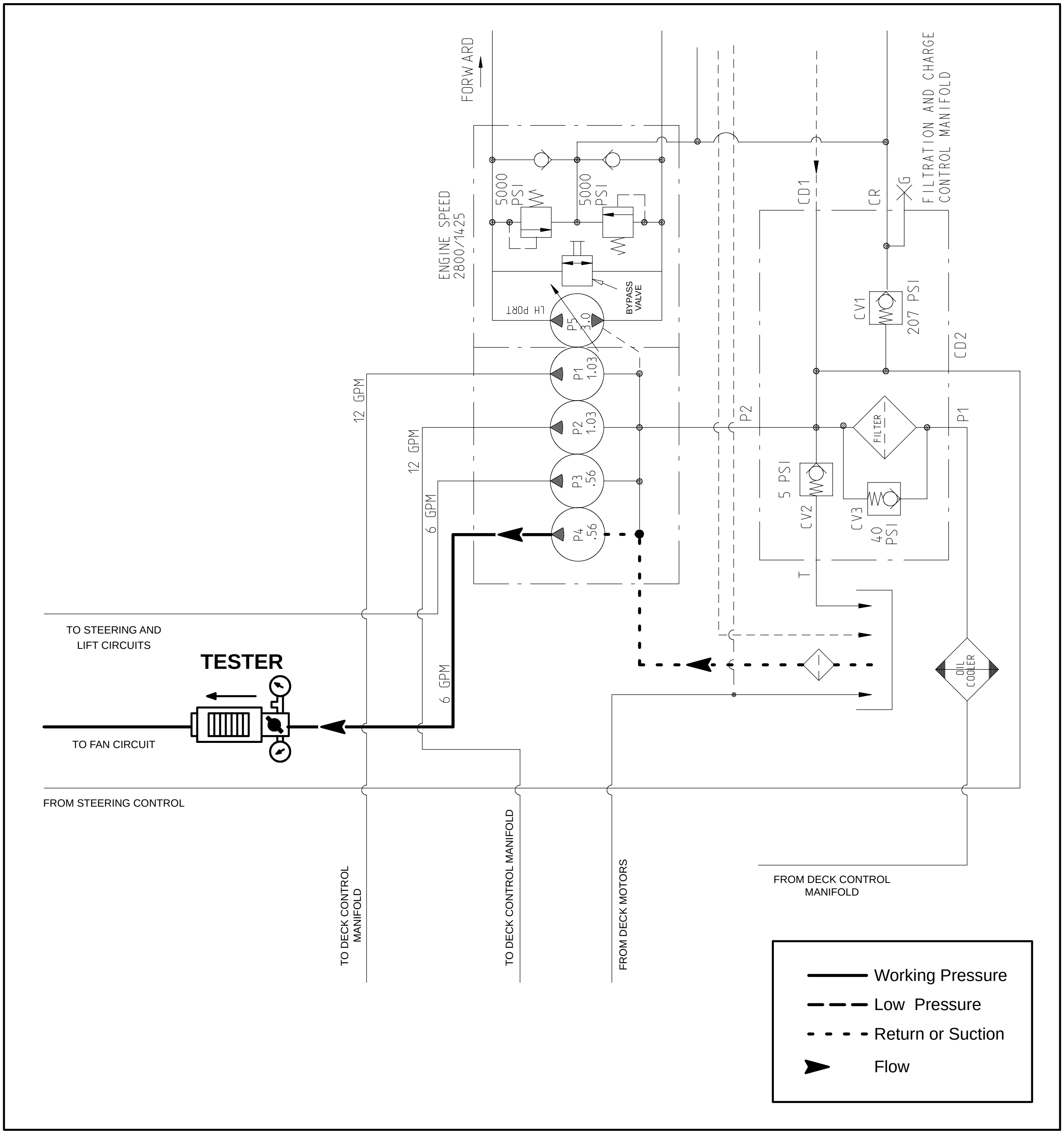


Figure 54

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

Hydraulic System

Gear Pump P4 Flow (Cooling Fan Circuit) (Using Tester with Pressure Gauges and Flow Meter)



NOTE: Gear Pump P4 supplies oil flow for the engine cooling fan circuit.

Procedure for Gear Pump P4 Flow Test

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

2. Park machine on a level surface with the cutting decks lowered and off. Make sure engine is off and the parking brake is engaged.

3. Raise hood to allow access to pump assembly.

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. Thoroughly clean junction of hydraulic hose and fitting in gear pump section P4 (Fig. 55). Disconnect hydraulic hose from fitting.

IMPORTANT: Make sure that the oil flow indicator arrow on the tester is showing that the oil will flow from the gear pump fitting, through the tester and into the disconnected hose.

5. Install tester with pressure gauge and flow meter in series with the disconnected hose and fitting in gear pump section P4. **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 and correct before proceeding with test.

7. Move throttle to full speed **(2870 RPM)**. DO NOT engage the cutting decks.

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.

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

9. For a pump in good condition, flow indication should be approximately **6.3 GPM (23.8 LPM)**.

10. Fully open flow control valve on tester and then shut engine off. Record test results.

11. If the flow is lower than **5.3 GPM (20.1 LPM)** or a pressure of **1000 PSI (69 bar)** could not be obtained, check for restriction in pump intake line. If intake line is not restricted, remove gear pump and repair or replace as necessary.

12. Lower and secure hood after testing is completed.

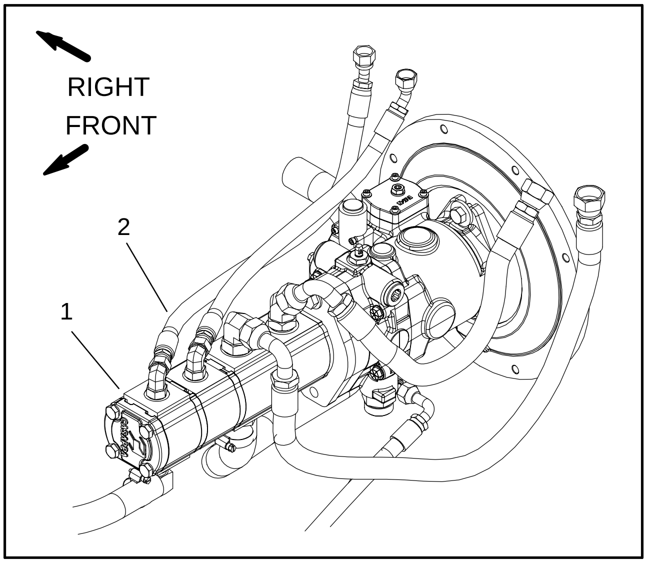


Figure 55

1. **Gear pump**
2. **Pump section P4 hose**

Service and Repairs

General Precautions for Removing and Installing Hydraulic System Components

Before Repair or Replacement of Components

1. Before removing any parts from the hydraulic system, park machine on a level surface, engage parking brake, lower cutting decks 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.

CAUTION

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

3. Put caps or plugs on any hydraulic lines, hydraulic fittings and components left open or exposed to prevent system contamination.

4. Put labels on disconnected hydraulic lines and hoses for proper installation after repairs are completed.

5. Note the position of hydraulic fittings (especially elbow fittings) on hydraulic components before removal. Mark parts if necessary to make sure they will be aligned properly when installing hydraulic hoses and tubes.

After Repair or Replacement of Components

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

2. Lubricate O–rings and seals with clean hydraulic oil before installing hydraulic components.

3. Make sure caps or plugs are removed from the hydraulic tubes, hydraulic fittings and components before reconnecting.

4. Use proper tightening methods when installing hydraulic hoses and fittings (see Hydraulic Fitting Installation 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 the machine.

Flush Hydraulic System

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

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

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

CAUTION

Operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil. Controls must be operated with the ignition switch in OFF. Remove key from the ignition switch.

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

2. Drain hydraulic reservoir into a suitable container.

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 the Service and Repair section).

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

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

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

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

9. Turn ignition key switch to start and engage starter for ten (10) seconds to prime pump. Let starter cool and then repeat cranking procedure again.

10. Connect wire harness connector to engine run solenoid.

11. Start engine and let it idle at low speed **(1425 RPM)** for a minimum of two (2) minutes. Increase engine speed to high idle **(2870 RPM)** for minimum of one (1) minute under no load.

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

13. Move PTO switch to ON to engage cutting decks and let them run for several minutes. Move PTO switch to OFF.

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

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

16. Check condition of hydraulic oil. If the new fluid shows any signs of contamination, repeat steps 1 through 14 again until oil is clean. If changing to biodegradable fluid, repeat steps 1 through 14 again at least once and until the oil is clean.

17. Assume normal operation and follow recommended maintenance intervals.

Charge Hydraulic System

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

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

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

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

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

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

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

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

7. Make sure traction pedal is in the **neutral** position. Turn ignition key switch to start and engage starter for **ten (10) seconds** to prime the traction and gear pumps. Let starter 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 blocks under the frame. Chock remaining wheels to prevent movement of the machine.

10. Make sure traction pedal is in **neutral**. Start engine and run it at low idle **(1425 rpm)**. The pumps should pick up oil and fill the hydraulic system. If there is no indication of fill in **30 seconds**, stop the engine and determine the cause.

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

    A. Loose filter or suction lines.

    B. Blocked suction line.

    C. Faulty charge relief valve.

    D. Faulty gear pump.

12. Once lift cylinders do move, 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 inspect hydraulic line placement at piston (traction) pump and wheel motors. Correct hydraulic line installation before proceeding.

    B. If the wheels rotate in the proper direction, proceed with procedure.

14. Adjust traction pedal to the neutral position.

15. Check operation of the traction interlock switch.

16. Stop engine, remove blocks from frame and lower machine. Remove chocks from remaining wheels.

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

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

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

Hydraulic System

This page is intentionally blank.

Gear Pump

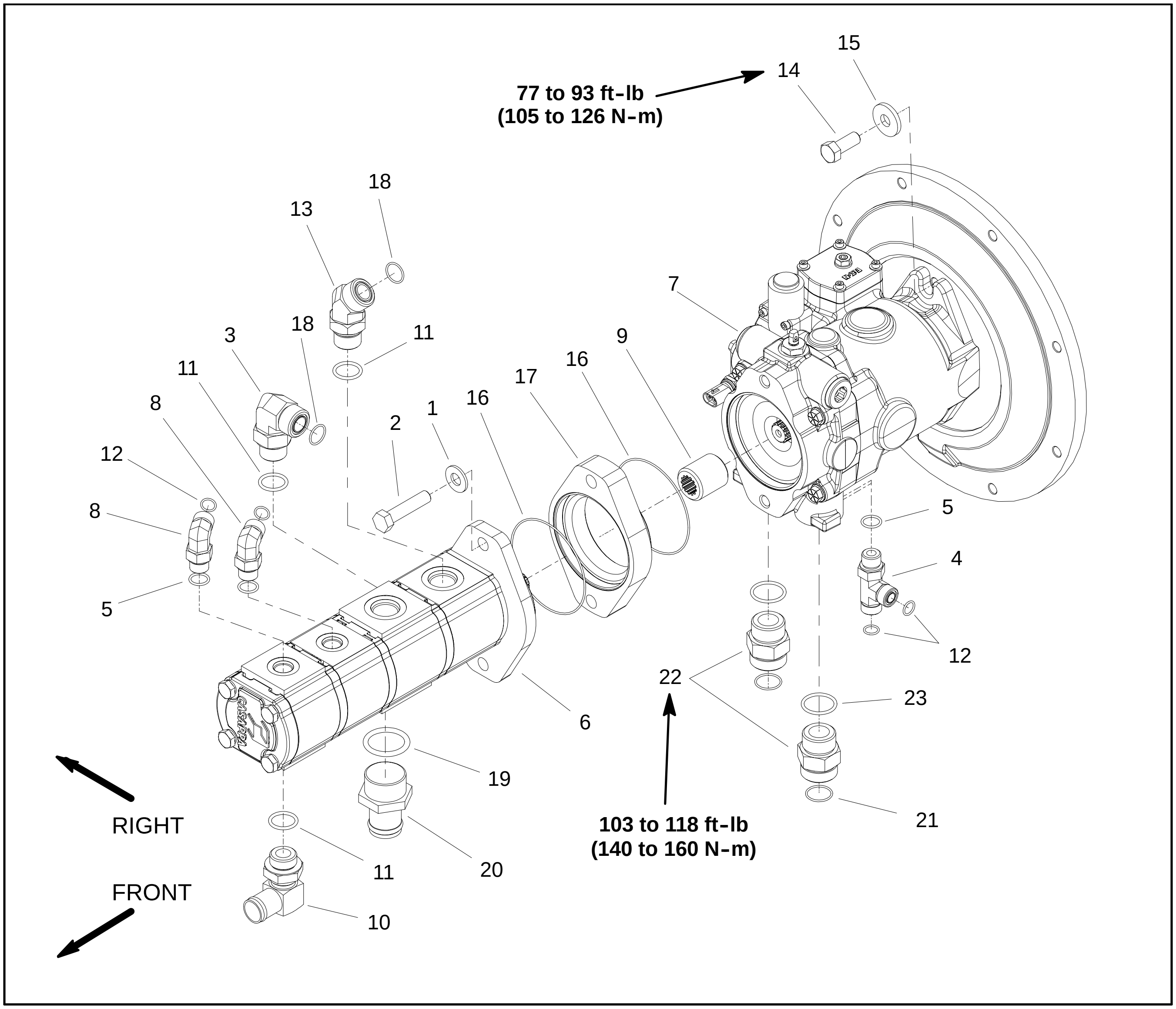


Figure 56

1. **Flat washer (2 used)**
2. **Cap screw (2 used)**
3. **90° hydraulic fitting**
4. **Hydraulic tee fitting**
5. **O-ring**
6. **Gear pump assembly**
7. **Piston pump assembly**
8. **90° hydraulic fitting**
9. **Coupler**
10. **90° hydraulic fitting**
11. **O-ring**
12. **O-ring**
13. **45° hydraulic fitting**
14. **Cap screw**
15. **Washer**
16. **O-ring**
17. **Spacer**
18. **O-ring**
19. **O-ring**
20. **Straight hose fitting**
21. **O-ring**
22. **Straight hydraulic fitting**
23. **O-ring**

Removal (Fig. 56)

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

2. Raise seat and secure it with prop rod to gain access to gear pump.

3. Drain the hydraulic reservoir into a suitable container.

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

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

6. Disconnect hydraulic lines from gear pump and put caps or plugs on open hydraulic lines and fittings. Label disconnected hydraulic lines for proper assembly (Fig. 57).

7. Support gear pump assembly to prevent it from falling.

8. Remove two (2) cap screws and washers securing gear pump to piston pump. Remove gear pump, coupler (item 9), spacer (item 17) and O–rings (item 16) from machine.

9. If hydraulic fittings are to be removed from gear pump, mark fitting orientation to allow correct assembly. Remove fittings from pump and discard O–rings.

Installation (Fig. 56)

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

2. Lubricate new O–rings (item 16) with clean hydraulic oil. Position O–rings on gear pump and pump spacer flanges.

3. Slide coupler (item 9) onto the piston pump output shaft.

4. Position pump spacer (item 17) to gear pump. Align gear teeth and slide gear pump input shaft into coupler. Secure gear pump to piston pump with two (2) cap screws and flat washers.

5. Remove caps and plugs from hydraulic hoses and fittings. Install hoses to gear pump (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

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

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

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

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

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

11. Lower and secure seat.

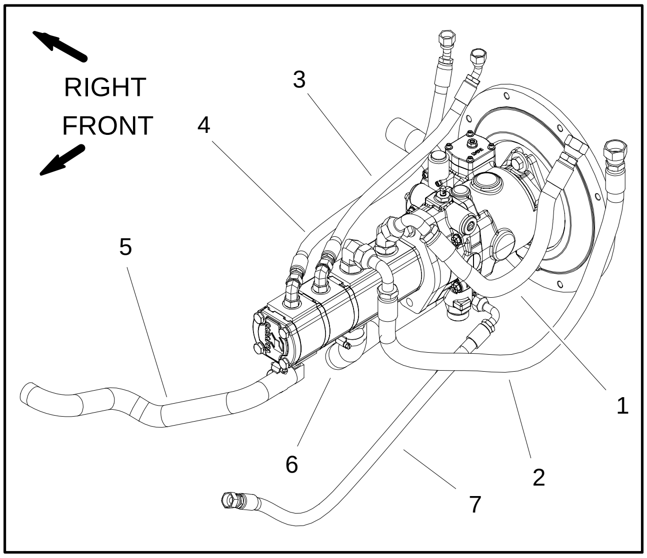


Figure 57

1. **Supply hose to deck manifold P1 port**
2. **Supply hose to deck manifold P2 port**
3. **Supply hose to fan manifold P2 port**
4. **Supply hose to fan manifold P1 port**
5. **Suction hose from filter manifold**
6. **Suction hose from reservoir**
7. **Supply hose for charge circuit**

Hydraulic System

Gear Pump Service

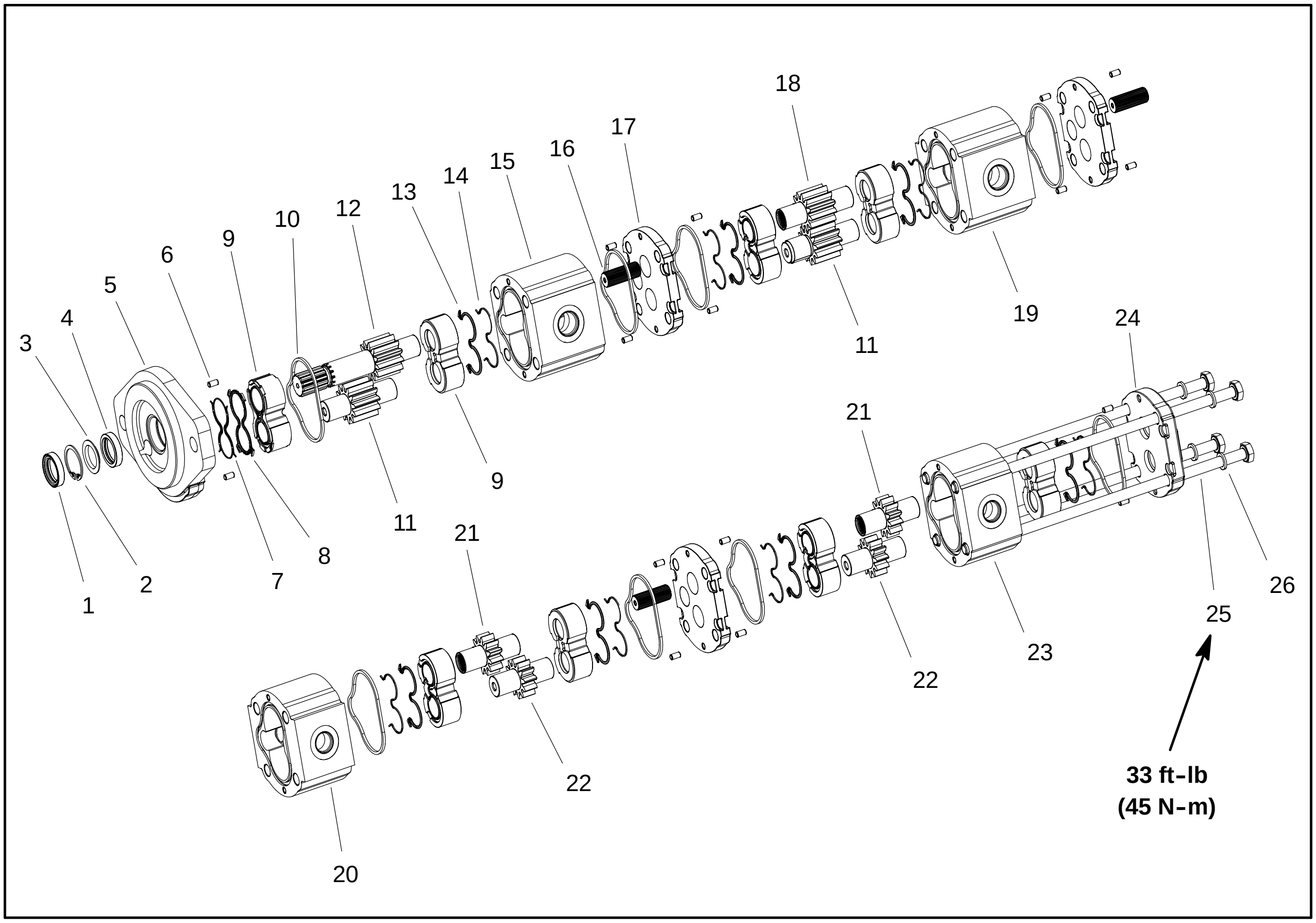


Figure 58

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 (section P1)
16. Splined connecting shaft (3 used)
17. Flange
18. Drive gear
19. Body (section P2)
20. Body (section P3)
21. Drive gear
22. Idler gear
23. Rear body (section P4)
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).

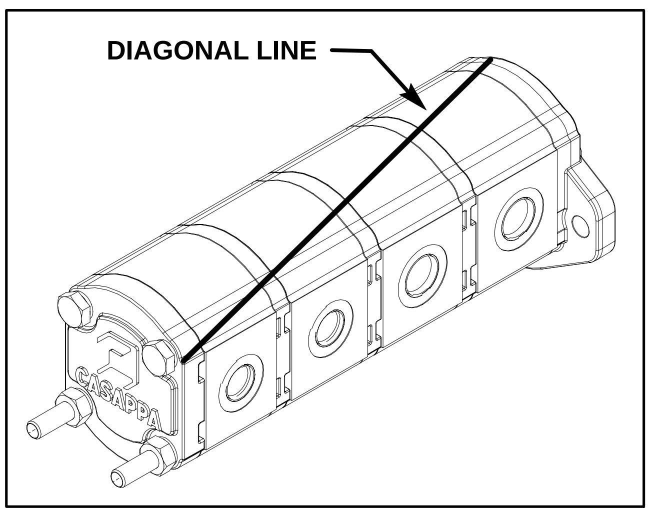


Figure 59

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 fasteners.

6. Support the pump assembly and gently tap the pump case with a soft face hammer to loosen the pump sections. Be careful to not drop parts or disengage gear mesh.

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

7. Remove the thrust plates and seals from each pump section. Before removing each gear set, apply marking dye to mating teeth to retain ”timing”. Pump efficiency may be affected if the teeth are not installed in the same position during assembly. Keep the parts for each pump section together; do not mix parts between sections.

8. Clean all parts. Check all components for burrs, scoring, nicks and other damage.

9. Replace the entire pump assembly if parts are excessively worn or scored.

Assembly (Fig. 58)

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

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

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

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

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

Piston (Traction) Pump

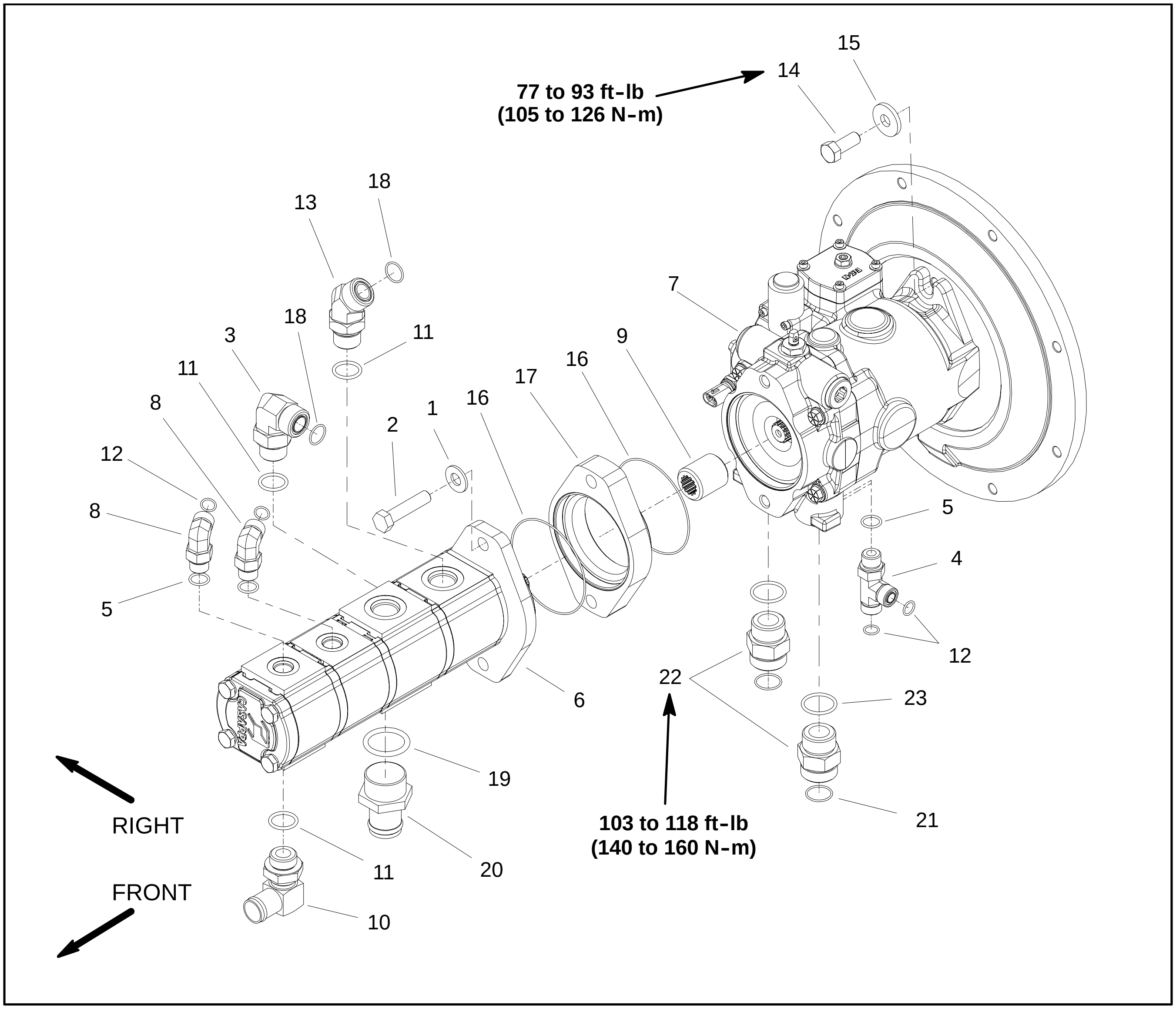


Figure 60

1. **Flat washer (2 used)**
2. **Cap screw (2 used)**
3. **90° hydraulic fitting**
4. **Hydraulic tee fitting**
5. **O-ring**
6. **Gear pump assembly**
7. **Piston pump assembly**
8. **90° hydraulic fitting**
9. **Coupler**
10. **90° hydraulic fitting**
11. **O-ring**
12. **O-ring**
13. **45° hydraulic fitting**
14. **Cap screw**
15. **Washer**
16. **O-ring**
17. **Spacer**
18. **O-ring**
19. **O-ring**
20. **Straight hose fitting**
21. **O-ring**
22. **Straight hydraulic fitting**
23. **O-ring**

Removal (Fig. 60)

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

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

3. Remove traction rod from control arm on piston pump by removing lock nut and flange head screw (Fig. 61).

4. Disconnect wire harness connector from neutral switch on traction pump (Fig. 61).

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

6. Put a drain pan below the pump assembly. Remove hydraulic hoses connected to piston and gear pumps. Put plugs or caps on disconnected hydraulic hoses and fittings to prevent contamination of the system (Fig. 62).

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

8. Support the piston pump to prevent it from falling while removing two (2) cap screws and washers retaining pump assembly to engine adapter plate. Carefully pull pump assembly from adapter plate and raise it out of the machine.

9. If hydraulic fittings are to be removed from piston pump, mark fitting orientation to allow correct assembly. Remove fittings from pump and discard O–rings.

Installation (Fig. 60)

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

2. Carefully lower piston pump into the machine and position it to the engine adapter plate. Support pump to prevent it from falling while installing two (2) cap screws and washers securing piston pump to engine adapter plate. Torque screws from **77 to 93 ft–lb (105 to 126 N–m)**.

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

4. Position traction rod to control arm on piston pump and secure with flange head screw and lock nut (Fig. 61).

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

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

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

8. Disconnect engine run solenoid electrical connector to prevent engine from starting. Prime pumps by turning ignition key switch to crank engine for ten (10) seconds. Repeat cranking procedure again.

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

10. Properly fill hydraulic system (see Charge Hydraulic System).

11. Stop engine and check for hydraulic oil leaks. Check hydraulic reservoir oil level.

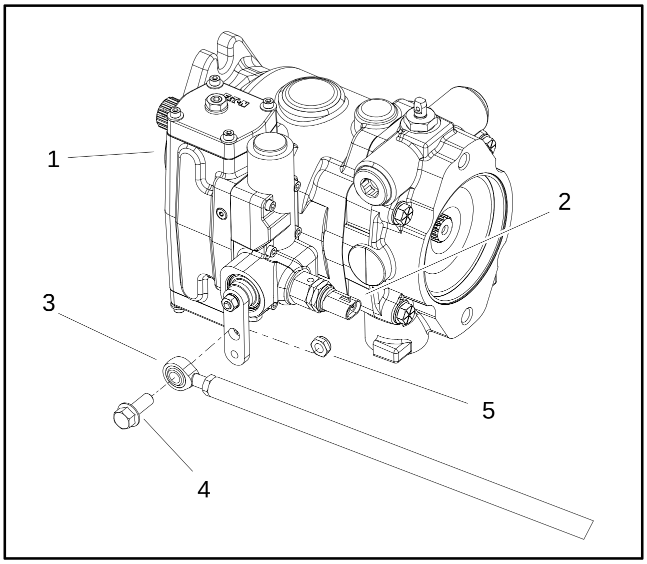


Figure 61

1. **Piston pump**
2. **Neutral switch**
3. **Traction rod**
4. **Flange head screw**
5. **Lock nut**

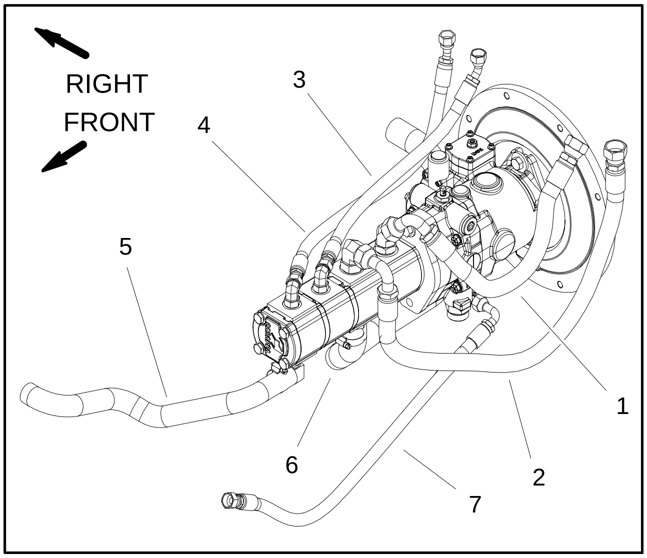


Figure 62

1. **Supply hose to deck manifold P1 port**
2. **Supply hose to deck manifold P2 port**
3. **Supply hose to fan manifold P2 port**
4. **Supply hose to fan manifold P1 port**
5. **Suction hose from filter manifold**
6. **Suction hose from reservoir**
7. **Supply hose for charge circuit**

Hydraulic System

Piston (Traction) Pump Service

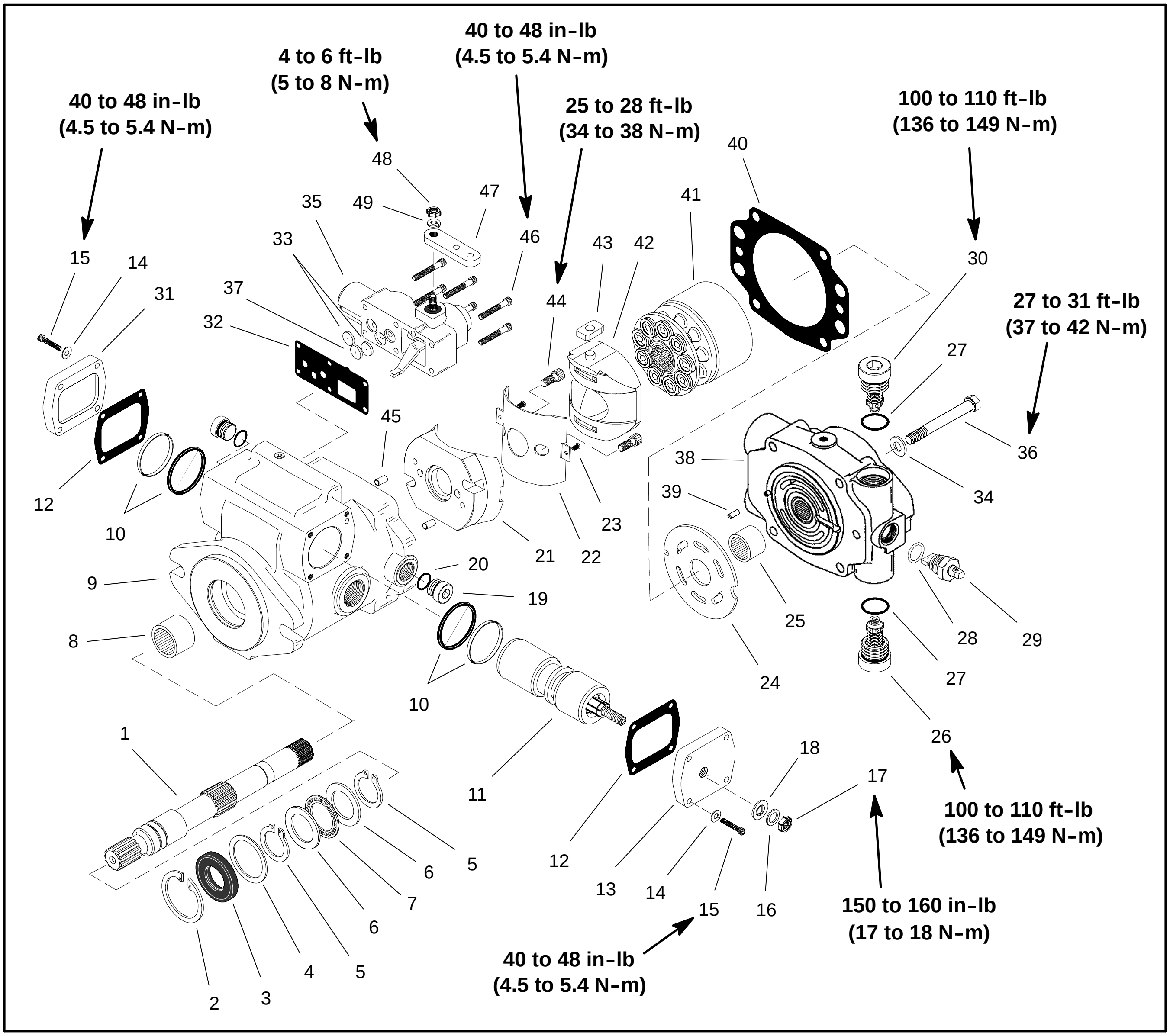


Figure 63

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. **Reverse relief valve**
27. **O-ring**
28. **O-ring**
29. **Bypass valve**
30. **Forward 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**

NOTE: For service of the piston (traction) pump, see the Eaton Model 72400 Servo Controlled Piston Pump Repair Information at the end of this chapter.

Hydraulic System

This page is intentionally blank.

4WD/2WD and Filtration/Charge Control Manifolds

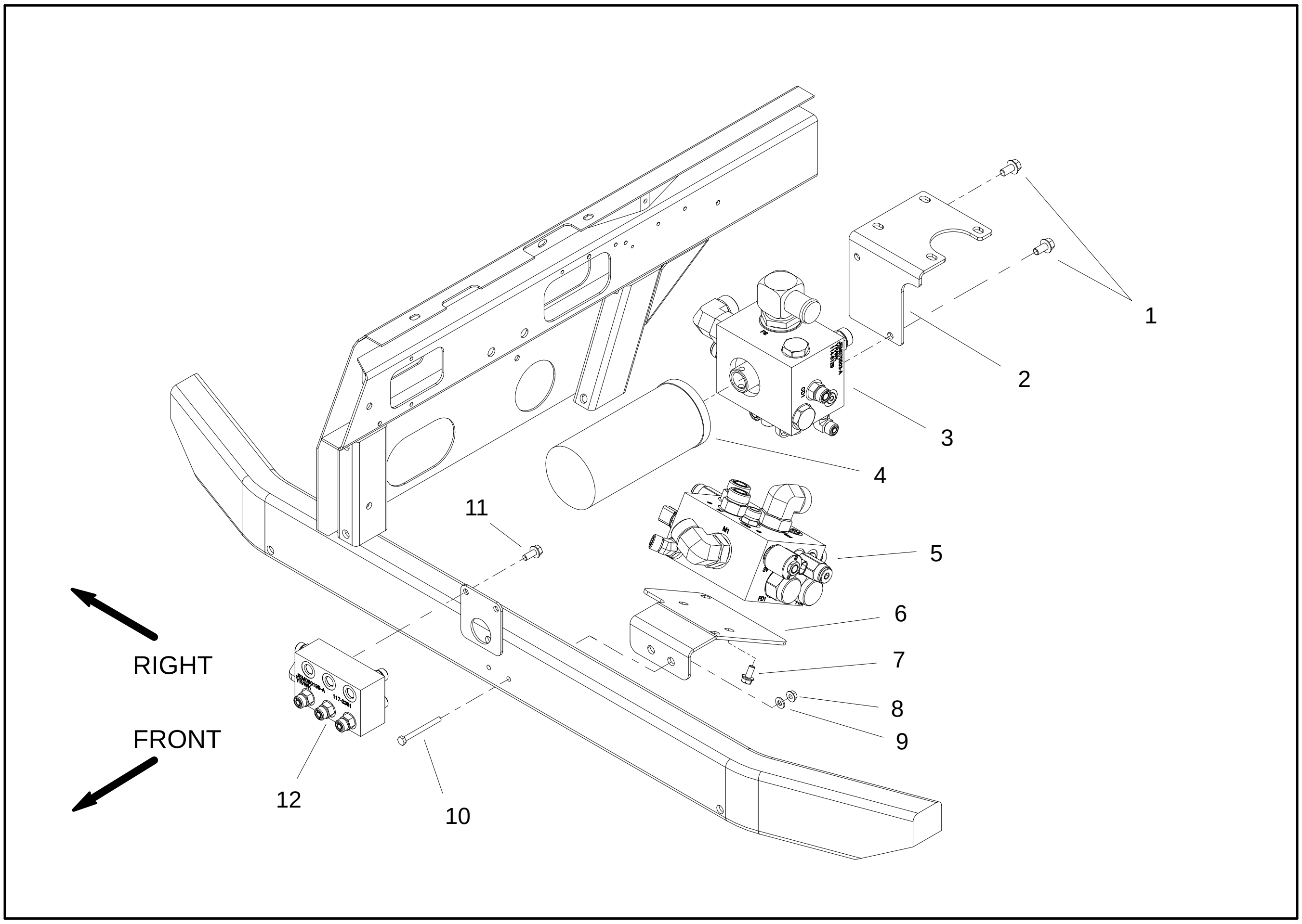


Figure 64

1. **Flange head screw (2 used)**
2. **Filtration manifold bracket**
3. **Filtration/charge control manifold**
4. **Hydraulic oil filter**
5. **4WD/2WD control manifold**
6. **Manifold bracket**
7. **Flange head screw (3 used)**
8. **Flange nut (2 used)**
9. **Flat washer (2 used)**
10. **Cap screw (2 used)**
11. **Flange head screw (2 used)**
12. **Lift circuit junction manifold**

Removal (Fig. 64)

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

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

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

3. If 4WD/2WD control manifold is being removed, label wire harness electrical connectors that attach to manifold components. Disconnect harness electrical connectors from the solenoid valve coil and electrical sensors (pressure and temperature).

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

5. Remove hydraulic manifold from the frame using Figure 64 as guide.

6. If hydraulic fittings are to be removed from control manifold, mark fitting orientation to allow correct assembly (Figure 65 or 66). Remove fittings from manifold and discard O–rings.

Installation (Fig. 64)

1. If fittings were removed from control manifold, lubricate and place new O–rings onto fittings. Install fittings into manifold ports using marks made during the removal process to properly orientate fittings. Tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter). Refer to Figure 65 or 66 for fitting installation torque.

2. Install hydraulic manifold to the frame using Figure 64 as guide.

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

4. If 4WD/2WD control manifold was removed, connect wire harness electrical connectors to the solenoid valve coil and electrical sensors.

5. Fill hydraulic reservoir with hydraulic fluid as required.

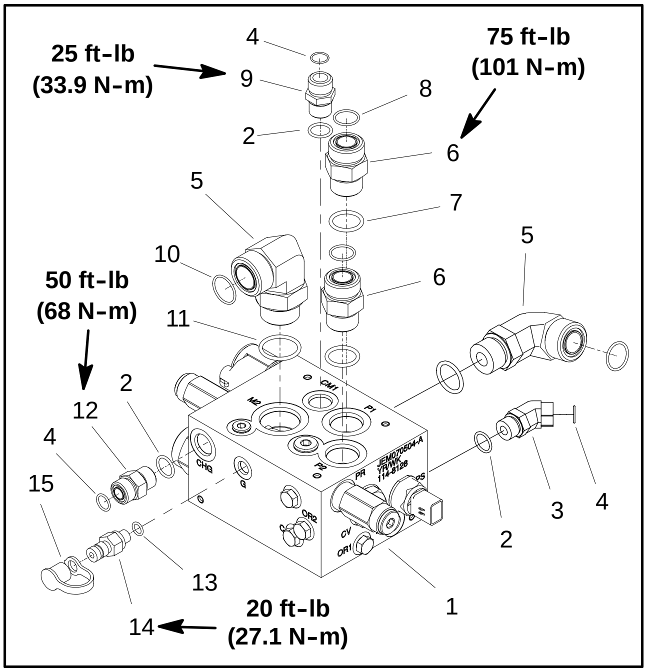


Figure 65

1. **4WD/2WD manifold**
2. **O–ring**
3. **45° fitting**
4. **O–ring**
5. **90° fitting**
6. **Straight fitting**
7. **O–ring**
8. **O–ring**
9. **Check fitting**
10. **O–ring**
11. **O–ring**
12. **Straight fitting**
13. **O–ring**
14. **Test fitting**
15. **Dust cap**

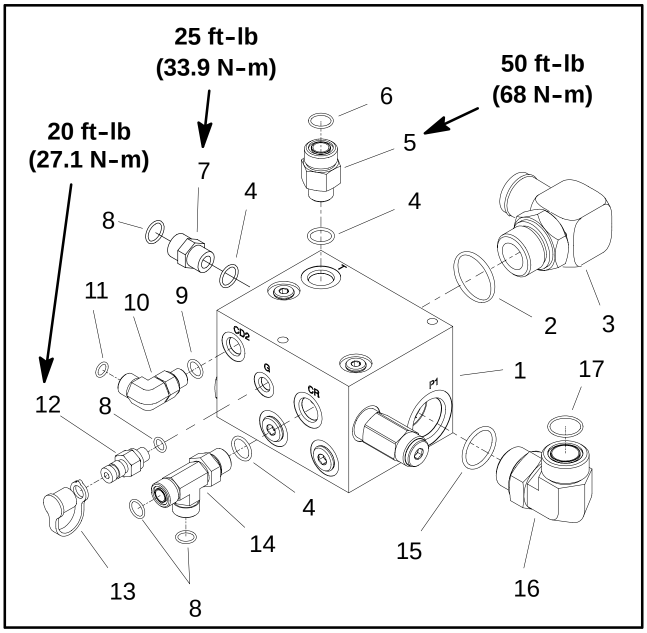


Figure 66

1. **Filtration manifold**
2. **O–ring**
3. **90° fitting**
4. **O–ring**
5. **Straight fitting**
6. **O–ring**
7. **Straight fitting**
8. **O–ring**
9. **O–ring**
10. **90° fitting**
11. **O–ring**
12. **Test fitting**
13. **Dust cap**
14. **Tee fitting**
15. **O–ring**
16. **90° fitting**
17. **O–ring**

Hydraulic System

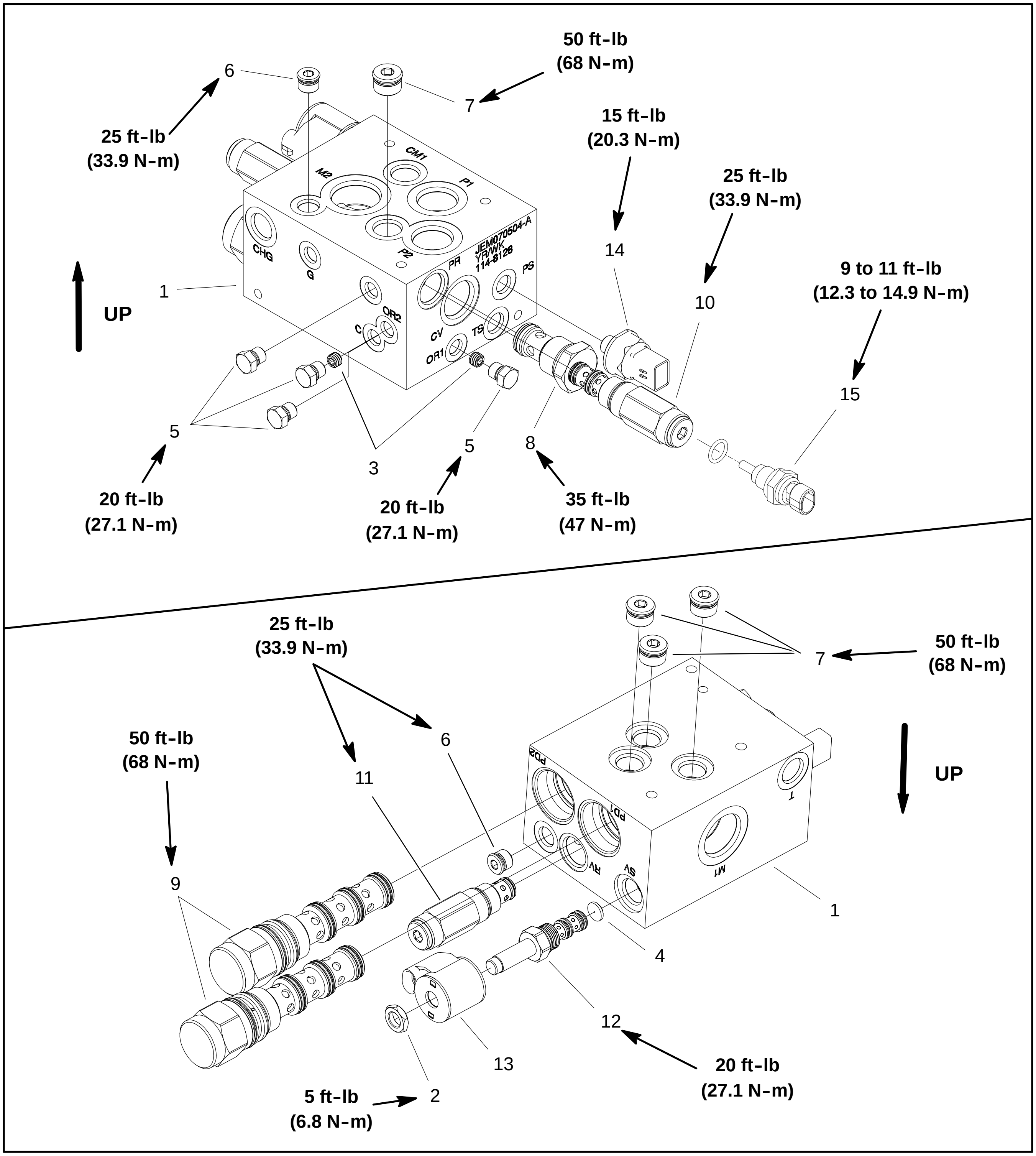


Figure 67

1. **Manifold body**
2. **Nut**
3. **Orifice (0.050)**
4. **Orifice disc (0.030)**
5. **Zero leak plug (#4)**
6. **Zero leak plug (#6)**
7. **Zero leak plug (#8)**
8. **Check valve (CV)**
9. **Pilot directional valve (PD1 & PD2)**
10. **Pressure reducing valve (PR)**
11. **Relief valve (RV)**
12. **Solenoid valve (SV)**
13. **Solenoid coil**
14. **Pressure sensor (PS)**
15. **Temperature sensor (TS)**

NOTE: The ports on the manifold are marked for easy identification of components (e.g. P1 is a piston pump connection port and SV is the location for the solenoid valve). See Hydraulic Schematics in Chapter 9 – Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port.

NOTE: The 4WD/2WD control manifold uses several zero leak plugs. These plugs have a tapered sealing surface on the plug head that is designed to resist vibration induced plug loosening. The zero leak plugs also have an O–ring as a secondary seal. If zero leak plug removal is necessary, lightly rap the plug head using a pin punch and hammer before using an allen wrench to remove the plug: the impact will allow plug removal with less chance of damage to the head of the plug.

IMPORTANT: A flow control orifice (item 3) is located beneath the plug in 4WD/2WD control manifold ports OR1 and OR2. If either of these plugs is removed from the manifold, make sure to remove orifice and label its position 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.

IMPORTANT: An orifice disc (item 4) is located beneath the 4WD/2WD control manifold solenoid valve (SV). If this valve is removed from the manifold, make sure to remove orifice and label its position for assembly purposes. When installing the orifice in the manifold, make sure that the orifice is flat in the base of the port.

Cartridge Valve Service

1. Make sure the manifold is clean before removing the 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 handling the cartridge valve. Slight bending or distortion of the stem tube can cause binding and malfunction.

3. Remove cartridge valve with a deep socket wrench. Note correct location for O–rings, sealing rings and backup rings. Remove and discard seal kit.

4. Visually inspect the port in the manifold for damage to the sealing surfaces, damaged threads and contamination.

5. Visually inspect cartridge valve for damaged sealing surfaces and contamination.

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

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

CAUTION

Use 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 not to damage cartridge. Use compressed air for cleaning.

7. Install 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 handling the valve cartridge. Slight bending or distortion of the stem tube can cause binding and malfunction.

B. Thread cartridge valve carefully into manifold port. The valve should go in easily without binding.

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

D. If cartridge is solenoid operated, carefully install solenoid coil to the cartridge valve. Torque nut to **5 ft–lb (6.8 N–m)**.

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

Filtration/Charge Control Manifold Service

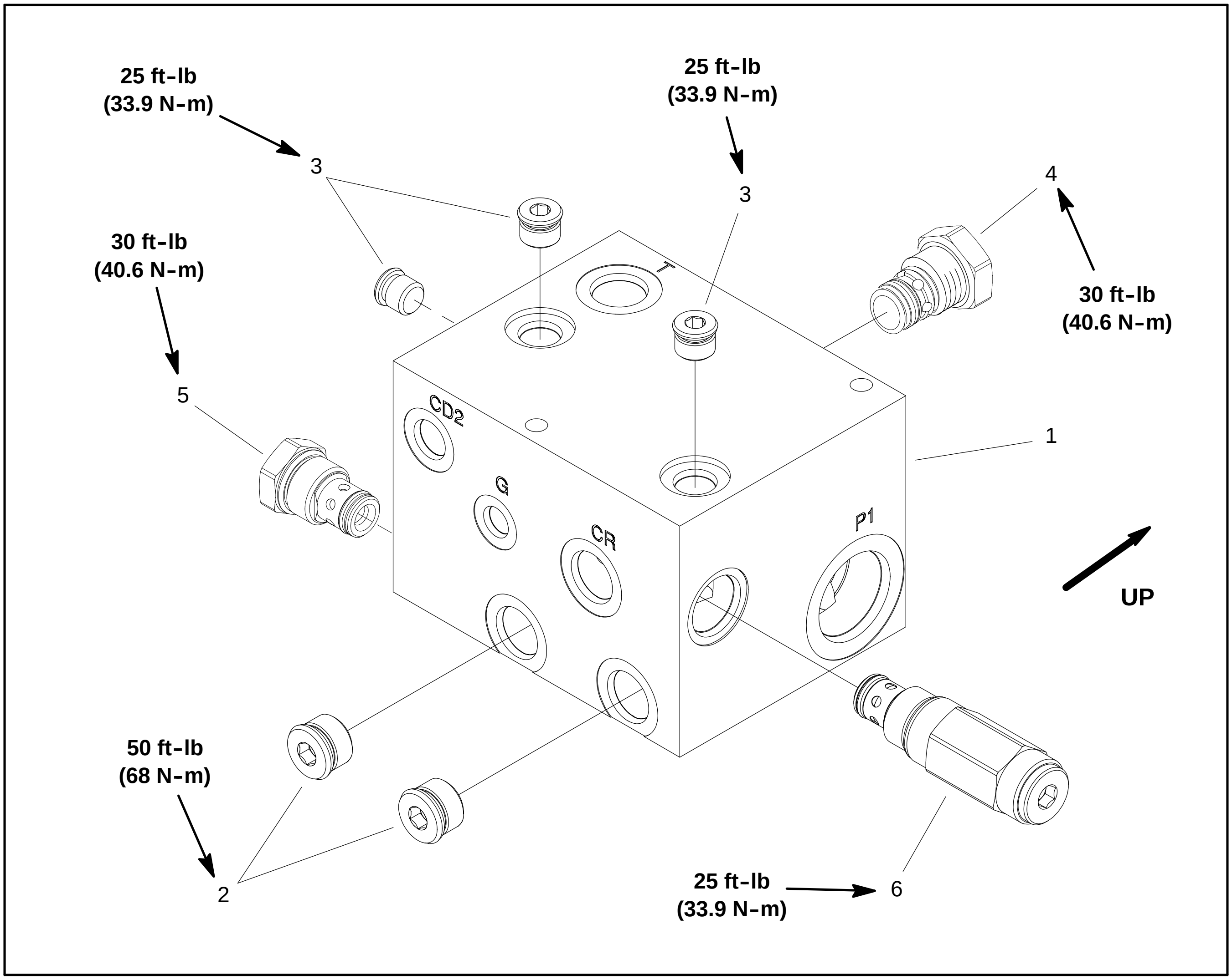


Figure 68

1. **Manifold body**
2. **Zero leak plug (#8)**
3. **Zero leak plug (#6)**
4. **Check valve (reservoir return)**
5. **Check valve (filter bypass)**
6. **Check valve (charge pressure)**

NOTE: The ports on the manifold are marked for easy identification of components (e.g. P2 is the gear pump connection port and P1 is the connection from the oil cooler). See Hydraulic Schematics in Chapter 9 – Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port.

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

For cartridge valve service procedures, see 4WD/2WD Control Manifold Service in this section. Refer to Figure 68 for cartridge valve and plug installation torque.

This page is intentionally blank.

Rear Axle Motor

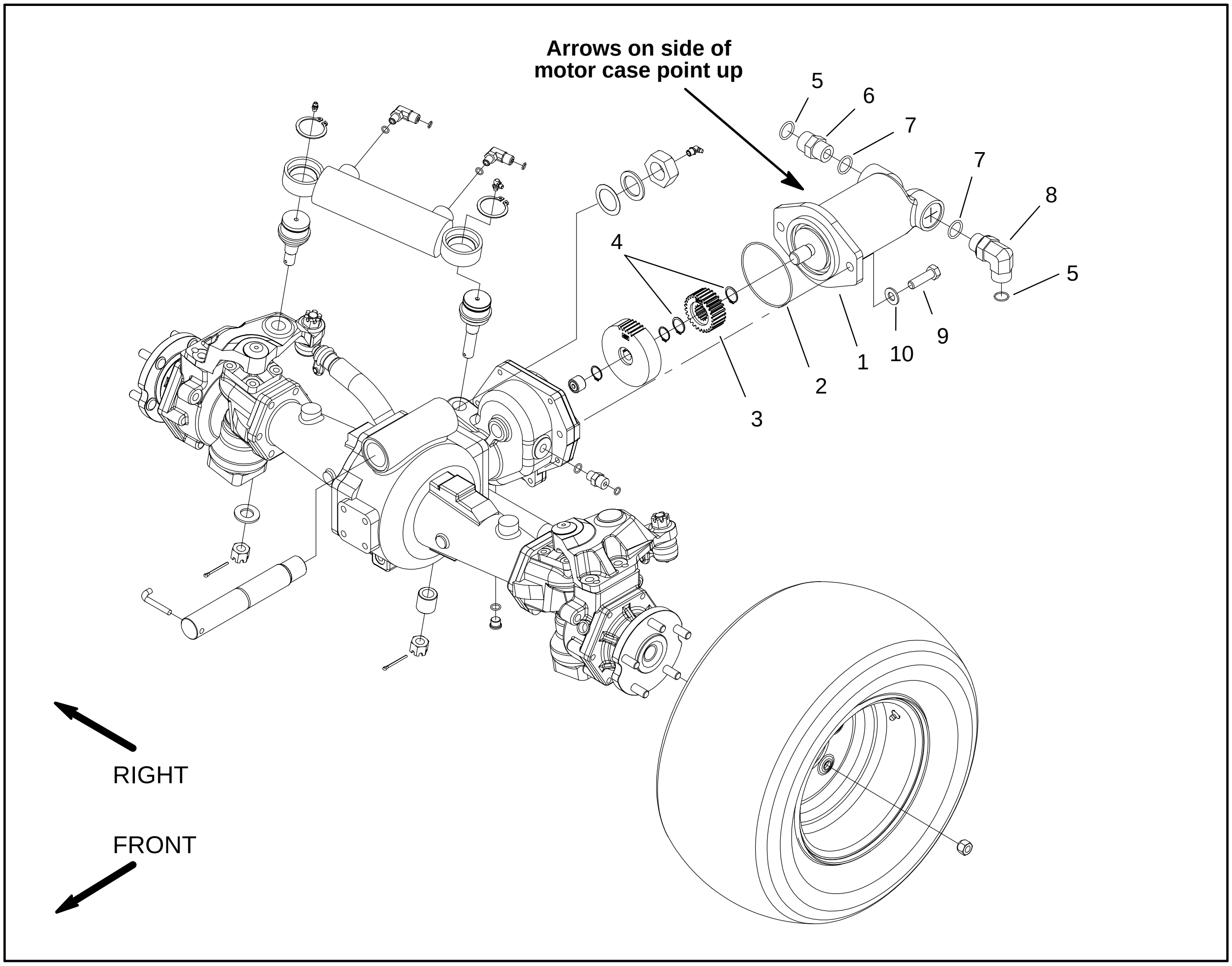


Figure 69

1. Axle motor
2. O-ring
3. Pinion gear
4. External snap ring
5. O-ring
6. Hydraulic fitting
7. O-ring
8. 90° hydraulic fitting
9. Cap screw (2 used)
10. Flat washer (2 used)

Removal (Fig. 69)

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

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

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

4. Disconnect hydraulic lines from motor. Put caps or plugs on lines and fittings to prevent contamination. Label the hydraulic hoses to show their correct position on the axle motor for assembly purposes.

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

5. Remove motor using Figure 69 as a guide.

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

Installation (Fig. 69)

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

2. If removed, install pinion gear to axle motor.

3. Install O–ring 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.

5. Remove plugs from lines and fittings. Attach hydraulic lines to axle motor (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

6. Fill hydraulic reservoir with hydraulic fluid as required.

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

Front Wheel Motors

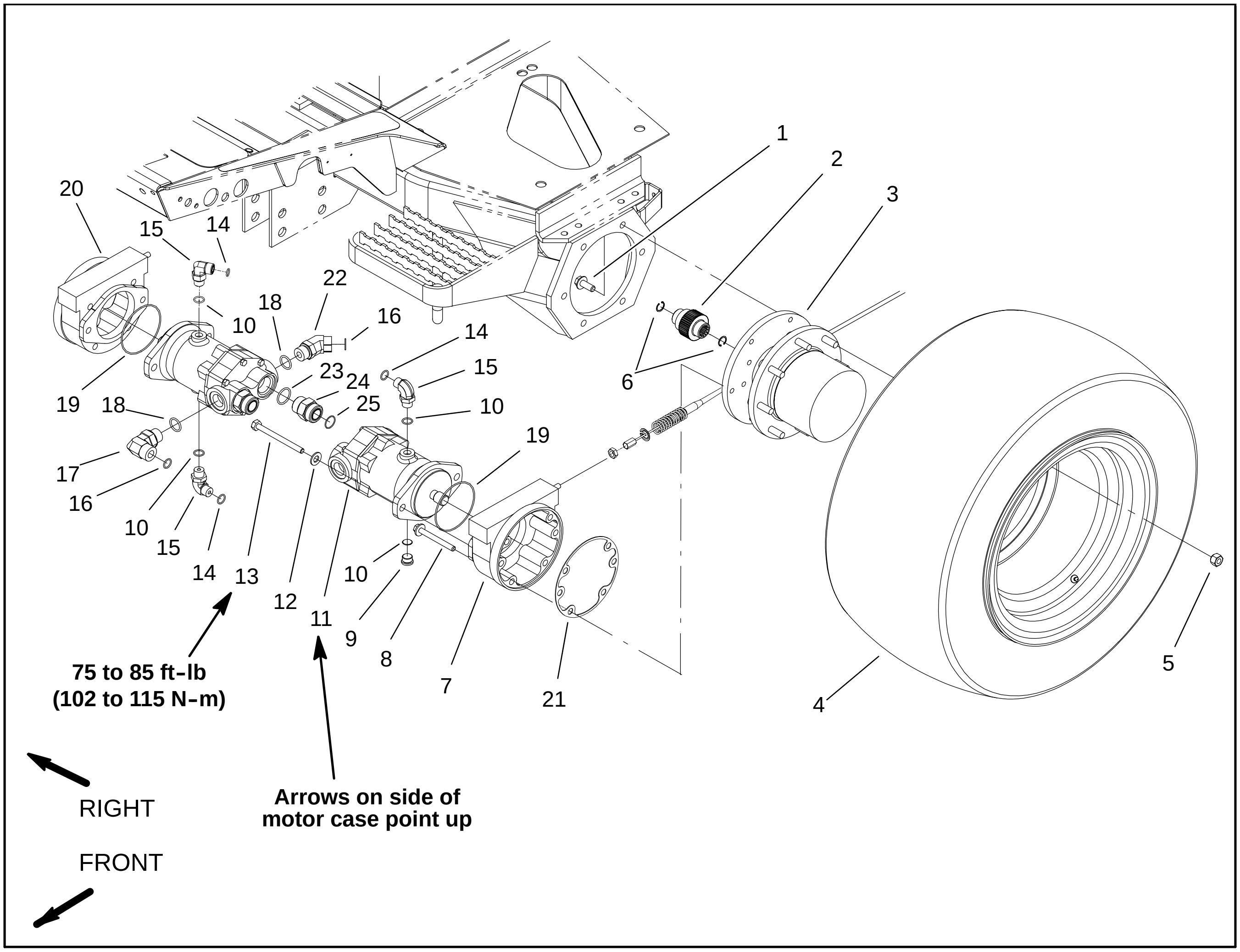


Figure 70

1. **Flange head screw (6 per planetary)**
2. **Splined brake shaft**
3. **Planetary assembly**
4. **Wheel assembly**
5. **Lug nut (8 per wheel)**
6. **Retaining ring**
7. **LH brake assembly**
8. **Flange head screw (4 per brake)**
9. **Plug**
10. **O-ring**
11. **Piston wheel motor**
12. **Flat washer (2 per motor)**
13. **Cap screw (2 per motor)**
14. **O-ring**
15. **90° hydraulic fitting**
16. **O-ring**
17. **90° hydraulic elbow**
18. **O-ring**
19. **O-ring**
20. **RH brake assembly**
21. **Gasket**
22. **45° hydraulic fitting**
23. **O-ring**
24. **Hydraulic fitting**
25. **O-ring**

Removal (Fig. 70)

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

2. Raise front of machine and support with jackstands.

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

4. To prevent contamination of hydraulic system during wheel motor removal, thoroughly clean exterior of motor.

5. Disconnect hydraulic hoses and tubes from wheel motor. Put caps or plugs on hoses and fittings to prevent contamination. Label the hydraulic lines to show their correct position on the wheel motor for assembly purposes.

IMPORTANT: Support wheel motor to prevent motor from falling during removal.

6. Remove wheel motor using Figure 70 as a guide.

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

Installation (Fig. 70)

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

2. 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 (102 to 115 N–m)**.

5. Remove plugs from lines and fittings. Attach hydraulic lines and tubes to wheel motor (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

6. Lower machine to ground.

7. Fill reservoir with hydraulic fluid as required.

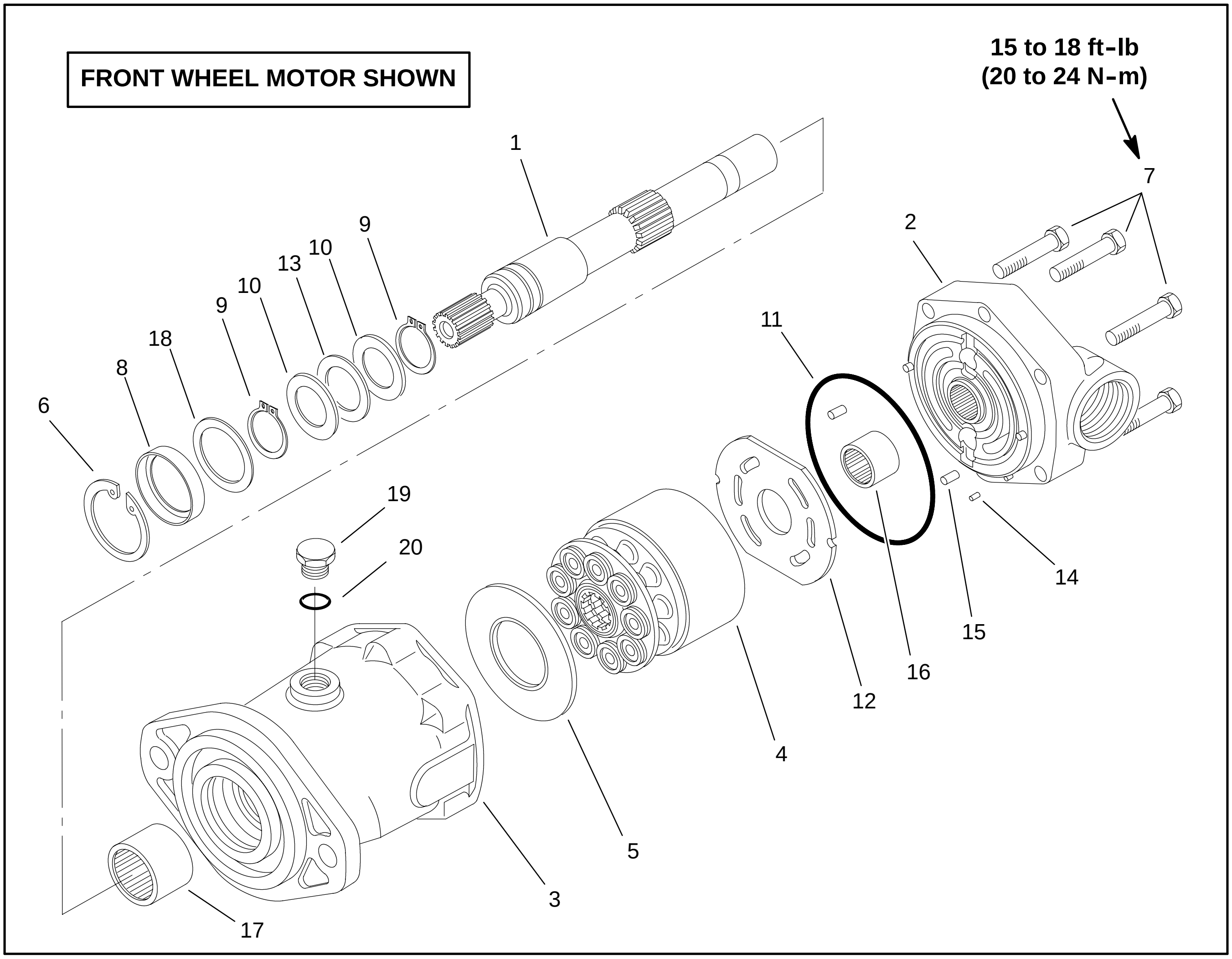


Figure 71

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

NOTE: The front wheel motors (shown in Figure 71) are identical. The rear axle motor is similar to the front wheel motors. Service of the front and rear motors requires the same procedure.

NOTE: The rear axle motor **does not** have a shaft seal (item 8). The case drain from the rear axle motor provides lubrication for the input gear case of the rear axle.

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.

Cutting Deck Motor

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

Removal

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

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

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

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

5. Remove two (2) socket head screws and flat washers that secure hydraulic motor to cutting deck (Fig. 72).

6. Lift hydraulic motor from cutting deck.

7. Place cover on deck spindle opening to prevent contamination.

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

Installation

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

2. Remove cover from deck spindle opening.

3. Align splines on motor shaft and spindle shaft. Position hydraulic motor to the cutting deck.

4. Secure motor to cutting deck with two (2) socket head screws and flat washers (Fig. 72).

5. Remove caps or plugs from hydraulic fittings and hoses. Connect hydraulic hoses to deck motor (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

6. After assembly is completed, verify that hydraulic hoses and fittings are not contacted by any moving components.

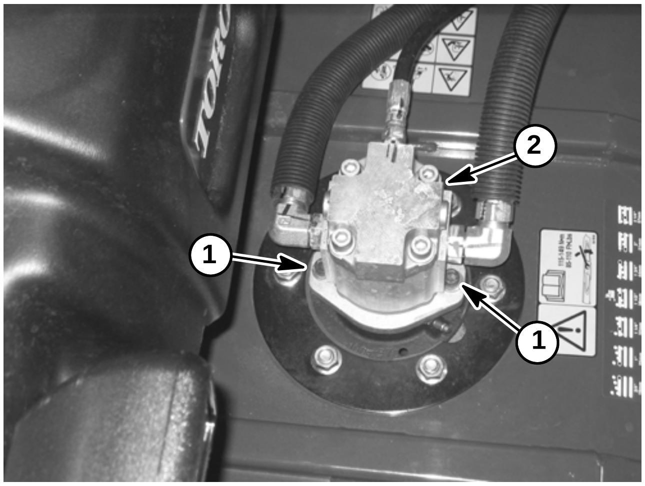


Figure 72

1. **Socket head screw**
2. **Hydraulic motor**

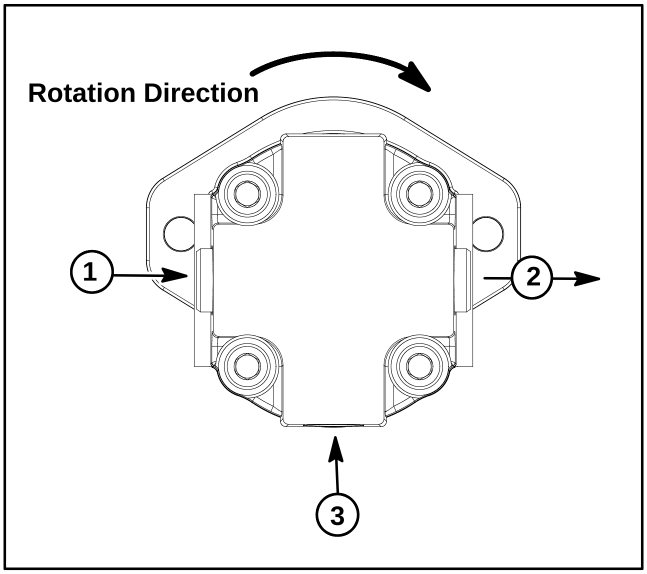


Figure 73

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

Hydraulic System

Cutting Deck Motor Service

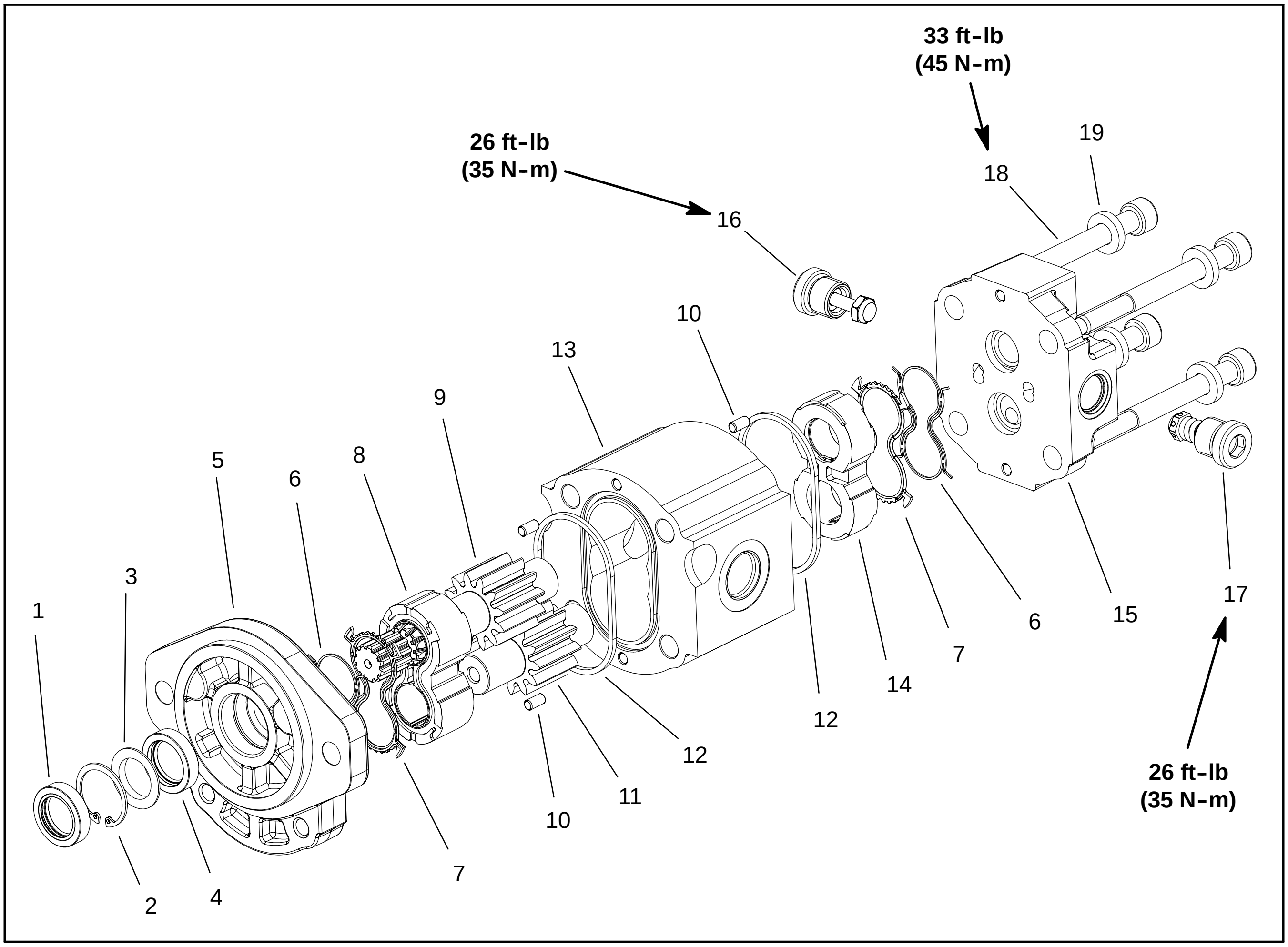


Figure 74

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

Disassembly (Fig. 74)

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

2. Use a marker to make a **diagonal** line across the front flange, body and rear cover for assembly purposes (Fig. 75).

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

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

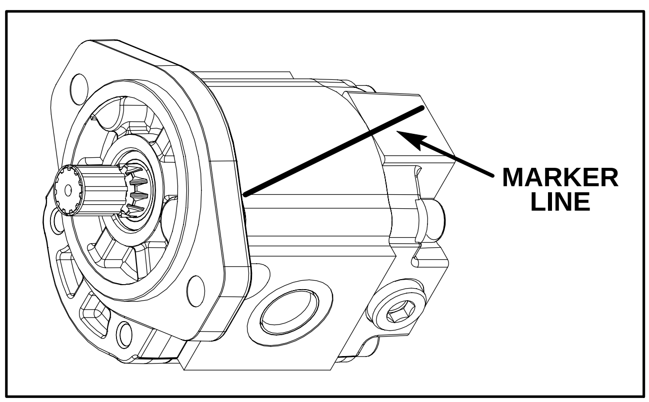


Figure 75

4. Loosen cap screws from the rear cover.

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

6. Separate rear cover from body. Lift rear cover from motor.

7. Carefully remove body. Lift body straight up to remove. Make sure the rear wear plate remains on the drive and idler gear shafts. Remove and discard O–rings from the body. Locate and retrieve dowel pins.

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

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

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

9. Remove and discard back–up gaskets and pressure seals from wear plates.

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

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

11. Carefully remove dust seal, retaining ring, flange washer and shaft seal from the front flange (Fig. 76). Discard 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. 77):

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

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

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

4. Inspect wear plates for the following:

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

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

C. Thickness of wear plates should be equal.

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

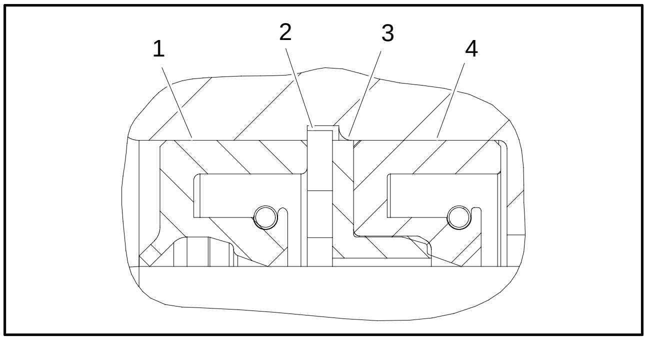


Figure 76

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

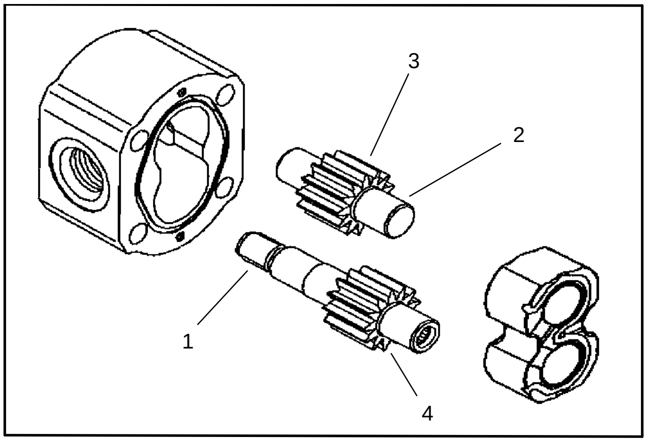


Figure 77

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

Hydraulic System

Assembly (Fig. 74)

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. 76):

   A. Press shaft seal into front flange until it reaches the bottom of the bore.

   B. Install flange washer into front flange and then install retaining ring into the groove of the front flange.

   C. Install new dust seal into front flange.

3. Place front flange, seal side down, on a flat surface.

4. Install the pressure seals, flat side outward, into the grooves in the wear plates. Follow by carefully placing the backup gaskets, flat side outward, between the pressure seals and the grooves in the wear plate.

5. Apply a light coating of petroleum jelly to the exposed side of the front flange.

6. Lubricate the drive gear shaft with clean hydraulic oil. Insert the drive end of the drive shaft through the wear plate with the pressure seal side down and the open side of the pressure seal pointing to the inlet side of the motor. Carefully install shaft into front flange.

7. Lubricate the idler gear shaft with clean hydraulic oil. Install idler gear shaft into the remaining position in the front wear plate. Apply a light coating of clean hydraulic oil to gear faces.

8. Install rear wear plate with pressure seal side up and open side of the pressure seal pointing to the inlet side of the motor.

9. Apply a light coating of petroleum jelly to new O–rings and O–ring grooves in the body. Install new O–rings to the body.

10. Install locating dowels in body. Align marker line on the body and front flange.

IMPORTANT: Do not dislodge seals during installation.

11. Gently slide the body onto the assembly. Firm hand pressure should be sufficient to engage the dowels.

12. Check to make sure that the surface of the rear wear plate is slightly below the face of the body. If the wear plate is not below the body, check assembly for a shifted pressure seal, backup gasket or O–ring. Correct before proceeding.

13. Apply a light coating of petroleum jelly to the exposed side of the rear cover.

14. Place rear cover on assembly using marker line for proper location. Firm hand pressure should be sufficient to engage the dowel pins.

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

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

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

17. Remove motor from vise.

18. Place a small amount of clean hydraulic oil in the inlet of the motor and rotate the drive shaft away from the inlet one revolution. If any binding is noted, disassemble the motor and check for assembly problems.

Hydraulic System

This page is intentionally blank.

Deck Control Manifold

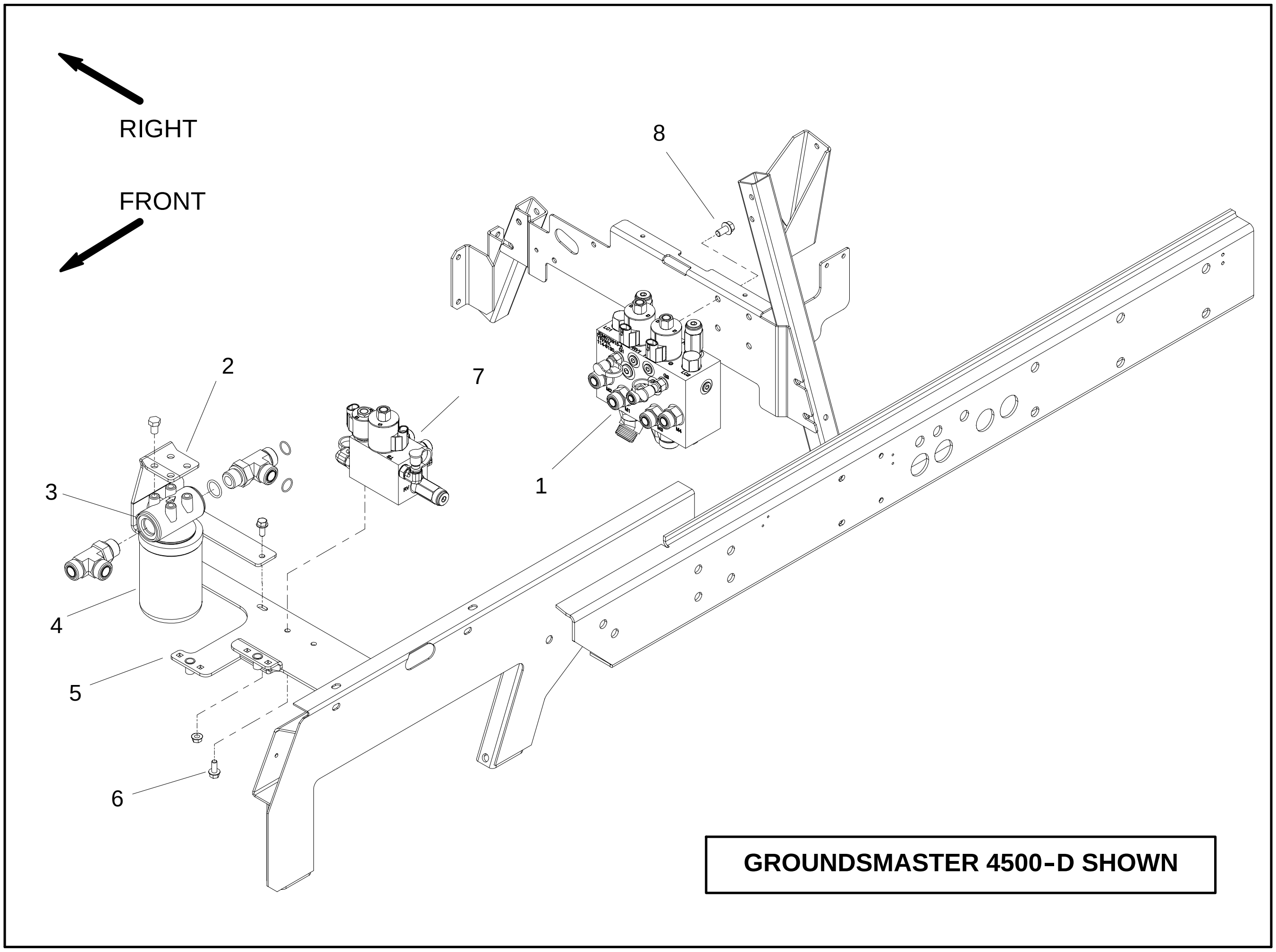


Figure 78

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

NOTE: The deck control manifolds used on Groundsmaster 4500–D and 4700–D are different but they mount to the machine in the same location. The control manifolds used on the Groundsmaster 4500–D are shown in Figure 78.

Removal (Fig. 78)

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

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

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

3. Unlatch and raise hood.

4. To prevent contamination of hydraulic system during manifold removal, thoroughly clean exterior of manifold.

5. Label wire harness electrical connectors that attach to manifold solenoid coils. Disconnect connectors from the solenoid coils.

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

7. Remove hydraulic manifold from the frame using Figure 78 as guide.

8. If hydraulic fittings are to be removed from control manifold, mark fitting orientation to allow correct assembly (Fig. 79 or 80). Remove fittings from manifold and discard O–rings.

Installation (Fig. 78)

1. If fittings were removed from control manifold, lubricate and place new O–rings onto fittings. Install fittings into manifold ports using marks made during the removal process to properly orientate fittings. Tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter). Refer to Figure 79 or 80 for fitting installation torque.

2. Install hydraulic manifold to the frame using Figure 78 as guide.

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

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

5. Lower and secure hood.

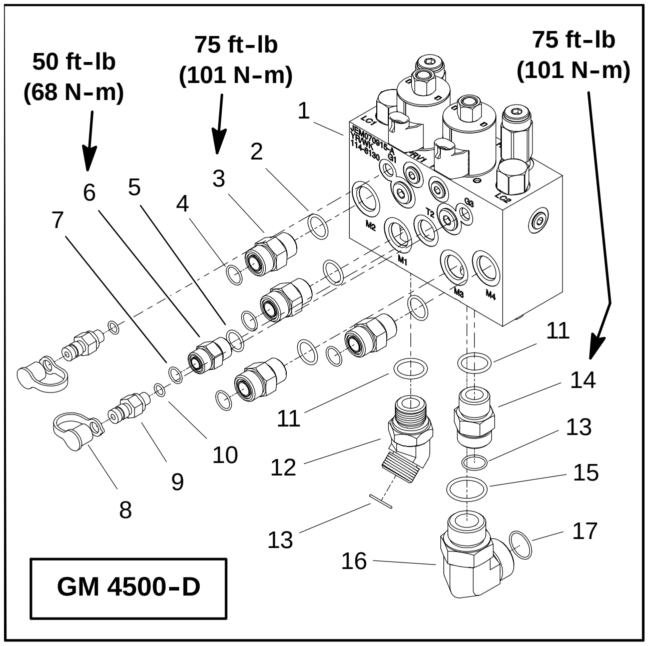


Figure 79

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

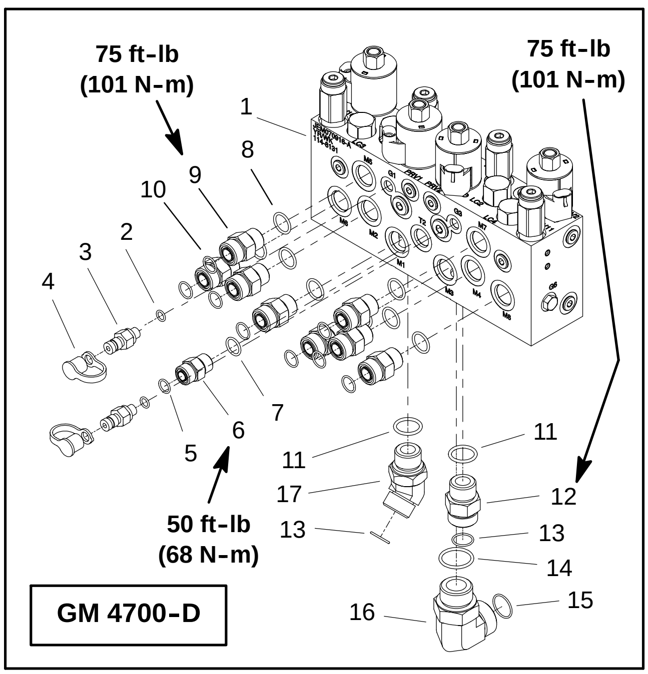


Figure 80

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

Hydraulic System

Deck Control Manifold Service (GM 4500–D)

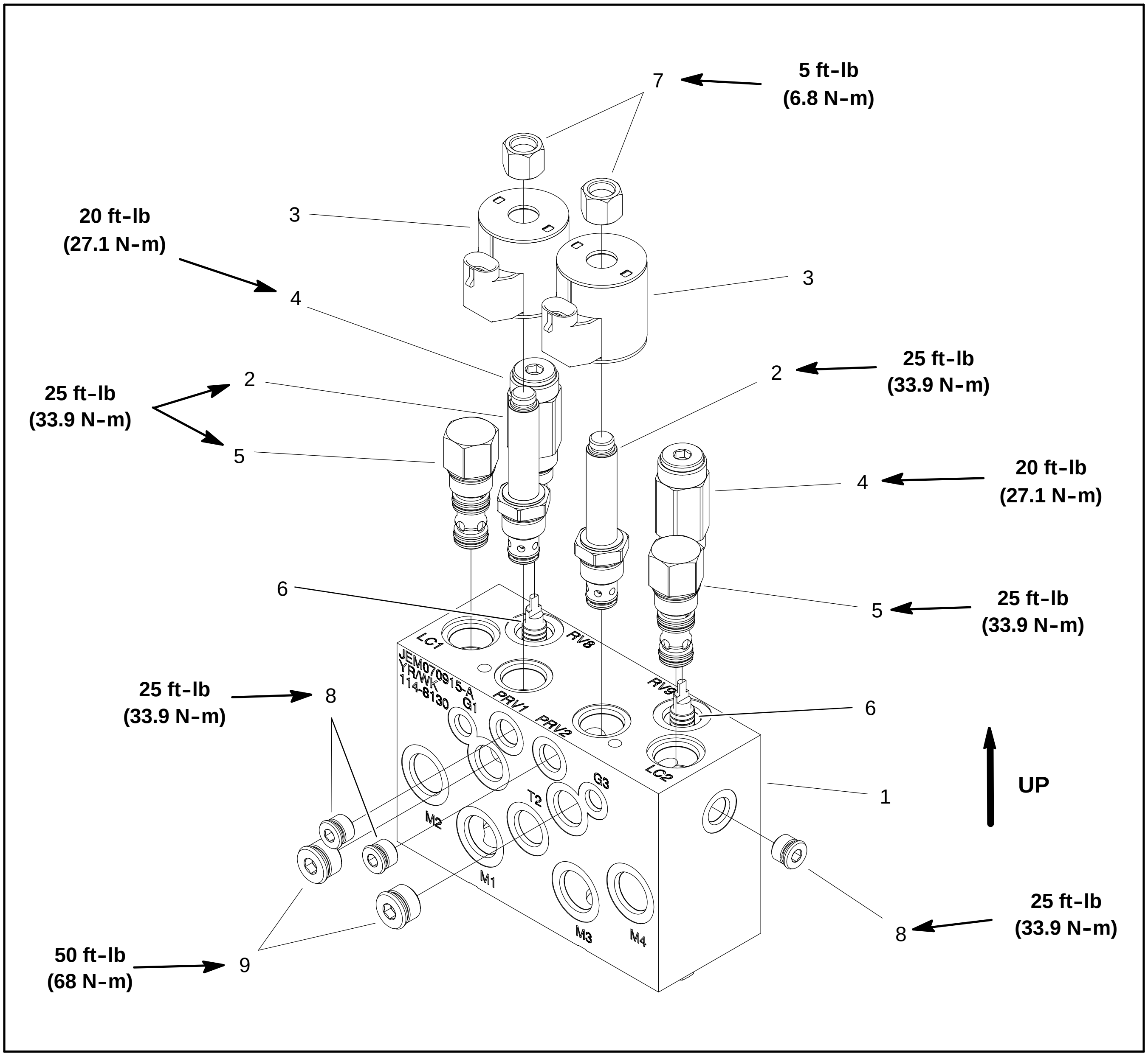


Figure 81

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

NOTE: The ports on the manifold are marked for easy identification of components (e.g. P1 is a gear pump connection port and PRV1 is the location for a proportional relief valve). See Hydraulic Schematics in Chapter 9 – Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port location.

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

For solenoid and control valve service procedures, see 4WD/2WD Control Manifold Service in this section. Refer to Figures 81 and 82 for cartridge valve and plug installation torque.

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

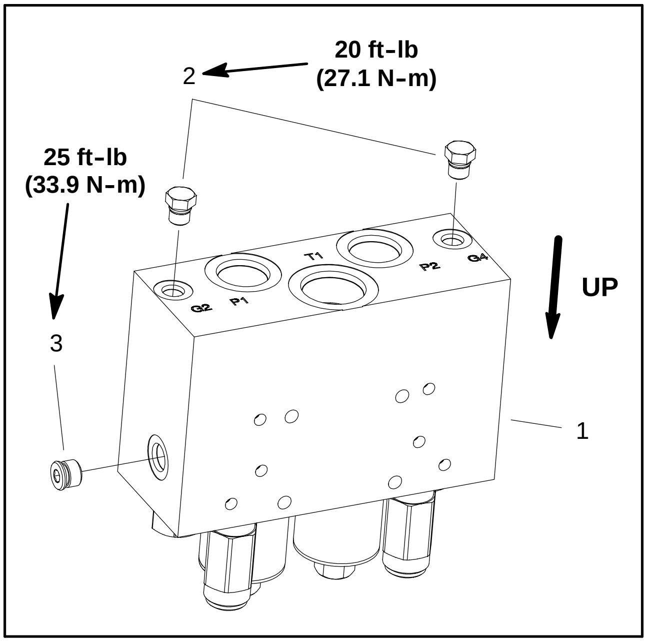


Figure 82

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

Hydraulic System

Deck Control Manifold Service (GM 4700-D)

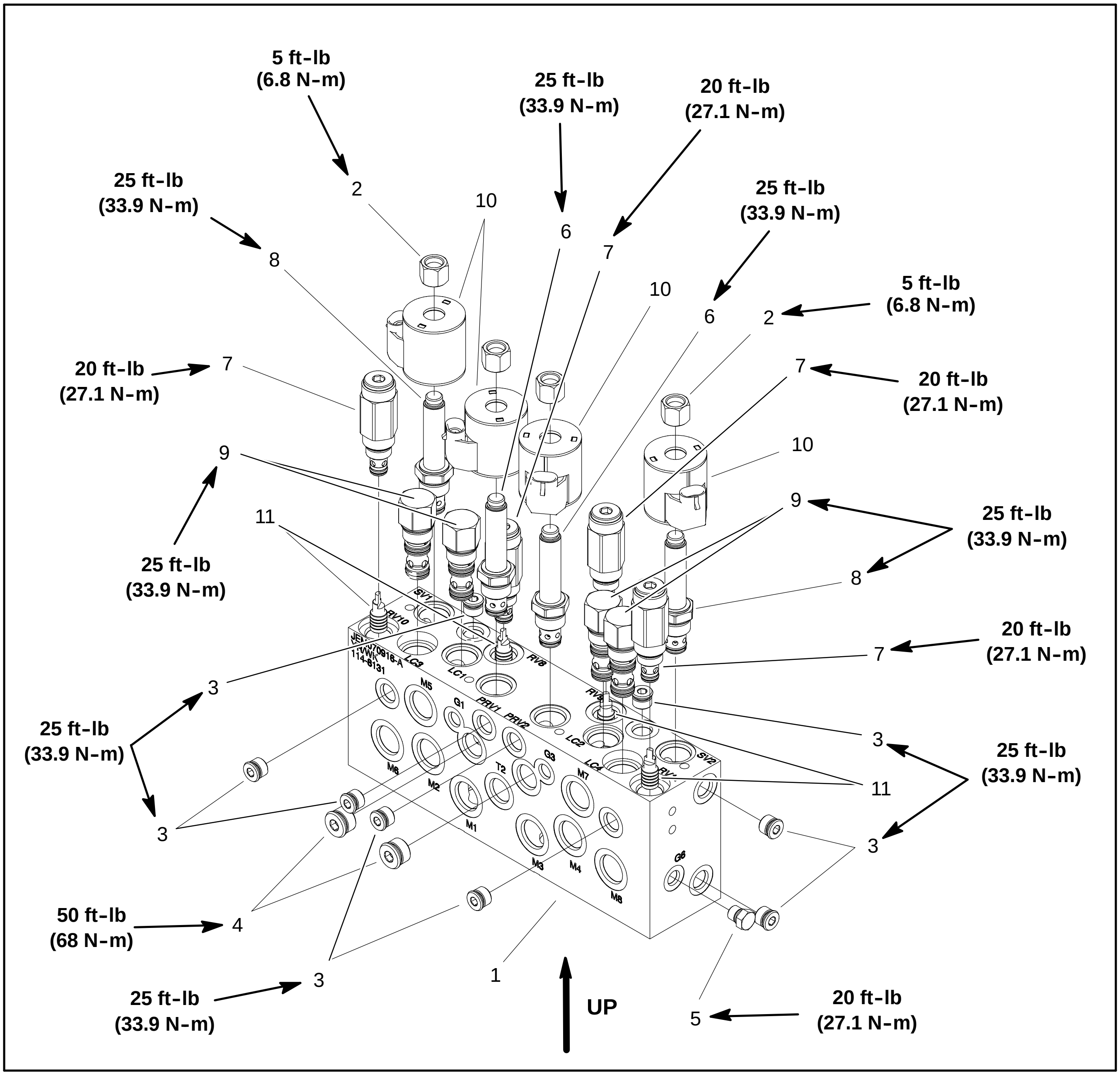


Figure 83

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

NOTE: The ports on the manifold are marked for easy identification of components (e.g. P1 is a gear pump connection port and RV8 is the location for a relief valve). See Hydraulic Schematics in Chapter 9 - Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port location.

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

For solenoid and control valve service procedures, see 4WD/2WD Control Manifold Service in this section. Refer to Figures 83 and 84 for cartridge valve and plug installation torque.

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

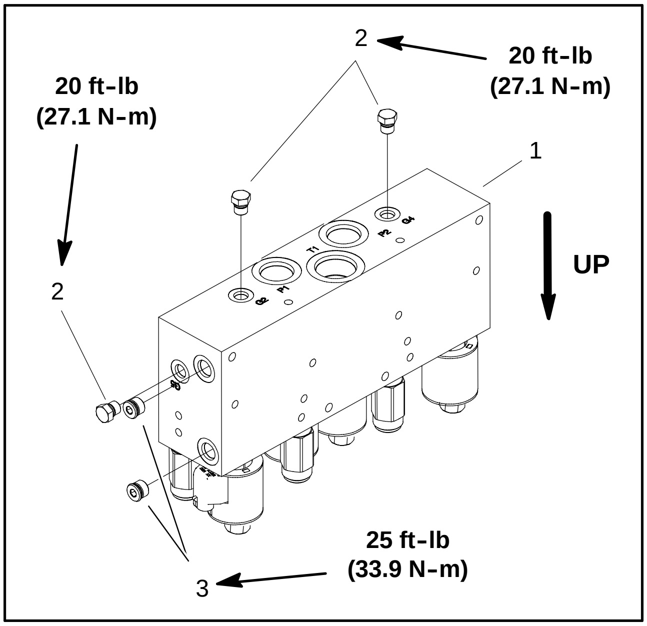


Figure 84

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

Hydraulic System

Steering Control Valve

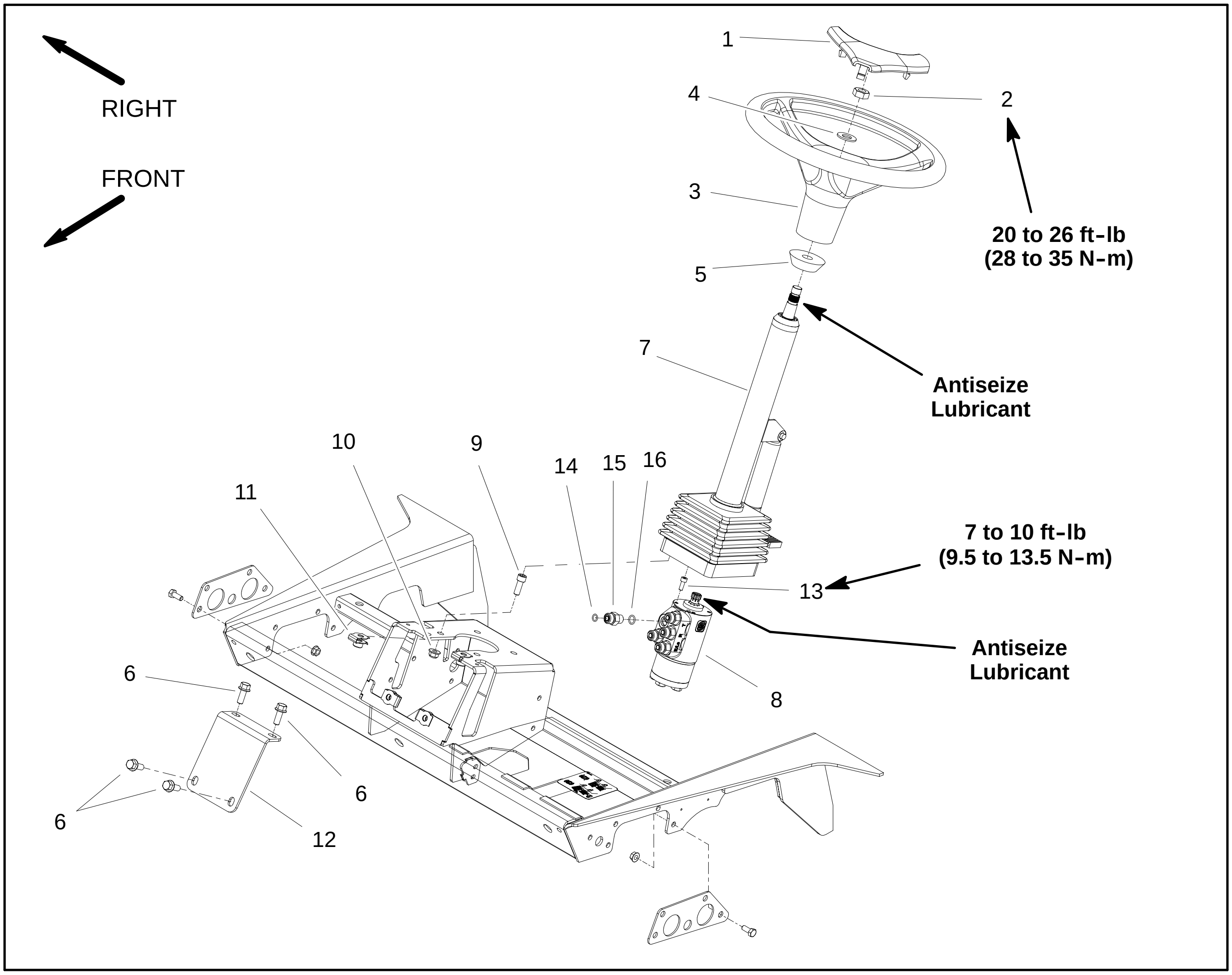


Figure 85

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

Removal (Fig. 85)

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 shroud to front of machine (Fig. 86). Remove shroud from machine to allow access to steering control valve.

3. Remove four (4) flange head screws that secure column brace (item 12) to frame platform. Remove brace from machine to allow access to steering column fasteners.

4. Slide rubber bellows up from bottom of steering column. Support steering column to prevent it from falling.

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

6. Thoroughly clean hydraulic connections prior to loosening hydraulic lines.

7. Label all hydraulic connections for assembly purposes. Note port designations on steering control valve (Fig. 87).

CAUTION

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

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

9. Put caps or plugs on disconnected lines and fittings to prevent contamination.

10. Loosen and remove four (4) socket head screws and flange nuts that secure steering column to machine.

11. Remove steering column assembly with steering control valve attached from machine.

12. Loosen and remove four (4) socket head screws that secure steering control valve to steering column.

13. Remove steering control valve from steering column.

14. If necessary, remove fittings and O–rings from steering control valve. Discard all removed O–rings.

Installation (Fig. 85)

1. If fittings were removed, lubricate new O–rings with clean hydraulic oil and install fittings to steering control valve (see Hydraulic Fitting Installation in the General Information section of this chapter).

2. Apply antiseize lubricant to splines of steering control valve shaft.

3. Slide steering control valve shaft into steering column universal joint. Position control valve with ports toward front of machine. Secure steering control valve to steering column with four (4) socket head screws. Torque screws in a criss–cross pattern from **7 to 10 ft–lb (9.5 to 13.5 N–m)**.

4. Position steering column assembly to machine. Secure steering column in place with four (4) socket head screws and flange nuts.

5. Remove caps and plugs from disconnected lines and fittings.

6. Lubricate new O–rings and connect hydraulic lines to fittings on steering control valve (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

7. Position steering column brace (item 12) to machine and secure with four (4) flange head screws.

8. Slide rubber bellows to bottom of steering column.

9. Position shroud in place and secure with removed fasteners (Fig. 86).

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

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

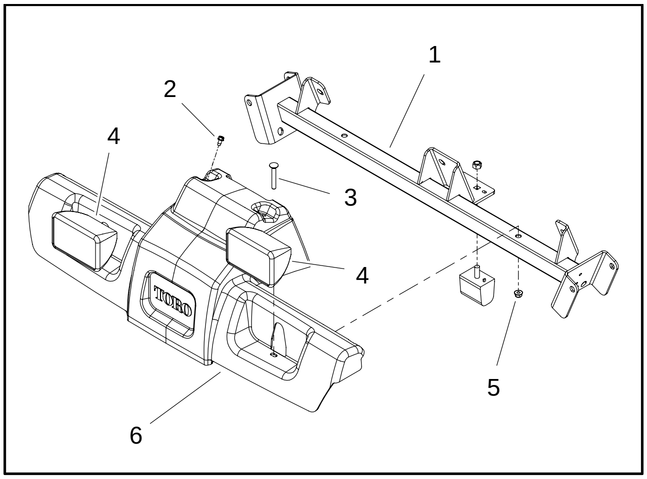


Figure 86

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

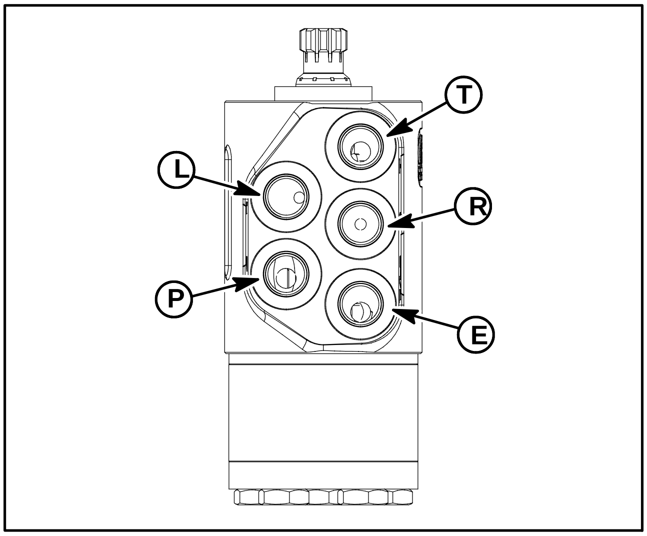


Figure 87

Hydraulic System

Steering Control Valve Service

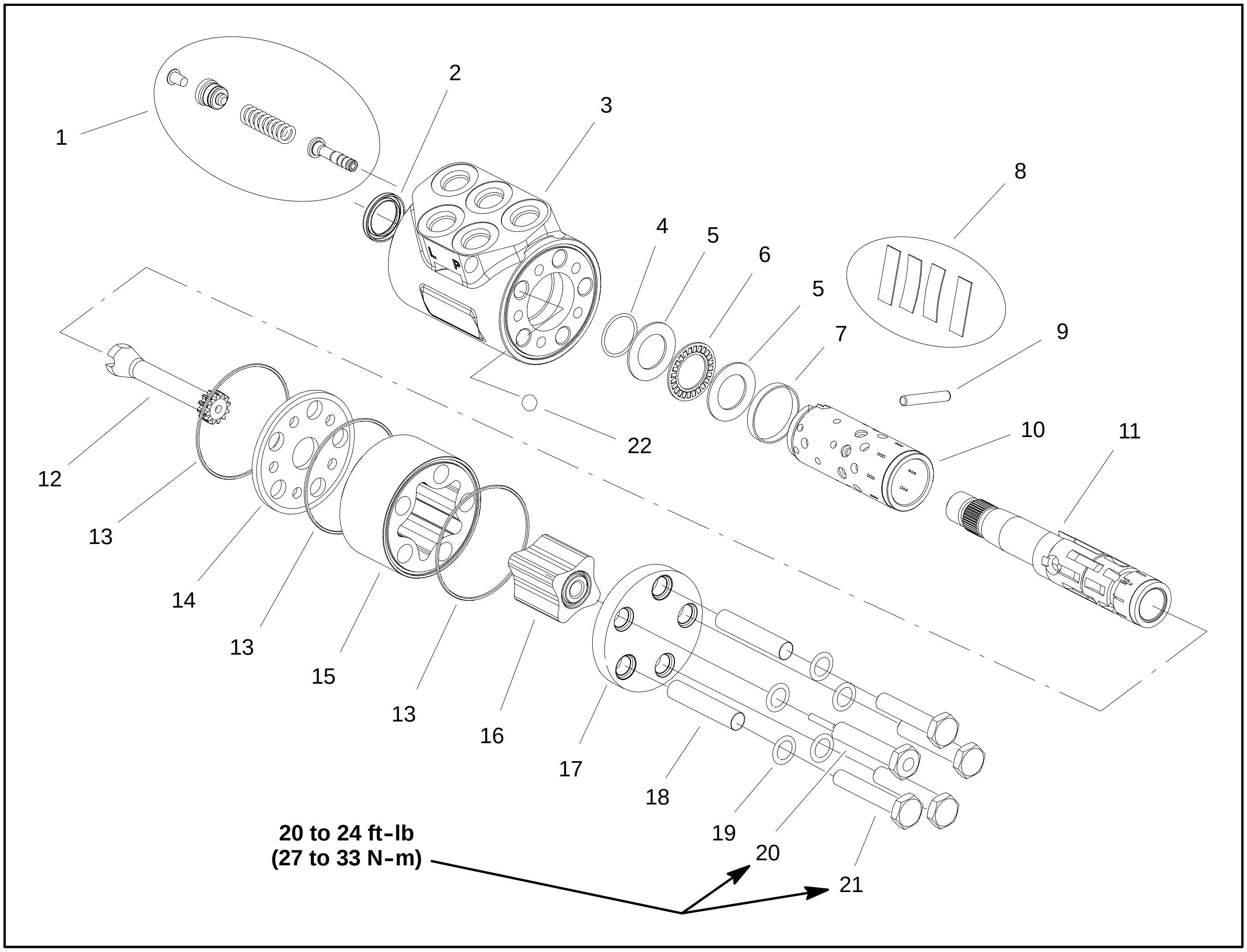


Figure 88

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

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

Hydraulic System

This page is intentionally blank.

Steering Cylinder

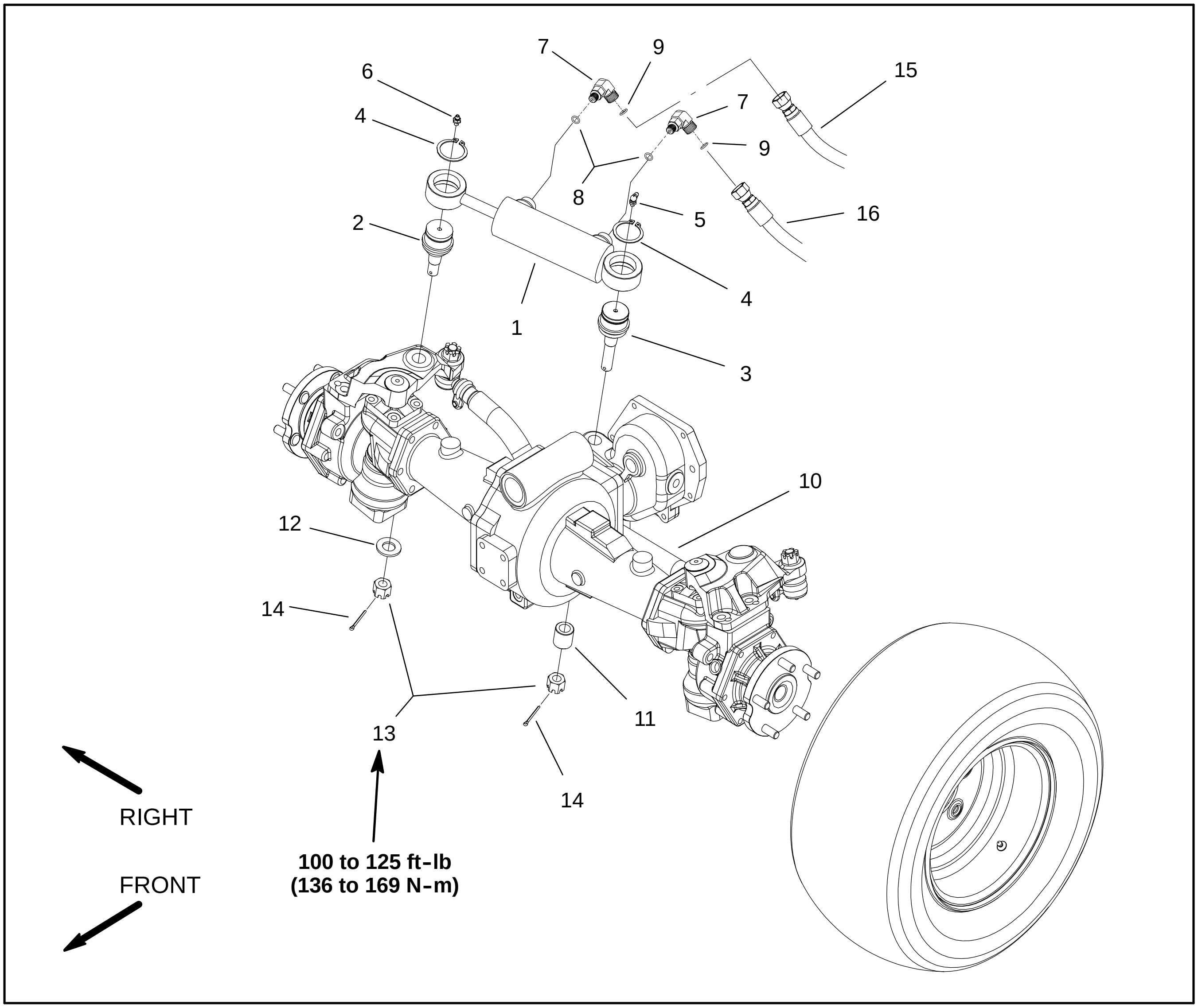


Figure 89

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

Removal (Fig. 89)

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

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

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

4. Remove hydraulic hoses from steering cylinder. Label the hydraulic hoses to show their correct position on the steering cylinder for assembly purposes.

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

6. If necessary, remove ball joints from steering cylinder.

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.

Installation (Fig. 89)

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

2. If removed, press ball joints into lift cylinder and secure with retaining ring.

3. Slide ram end ball joint through hole on steering arm. Secure with axle washer and slotted hex nut. Slide fixed end of cylinder through hole on axle. Install spacer onto ball joint and secure with slotted hex nut. Torque slotted hex nuts from **100 to 125 ft–lbs (136 to 169 N–m)** prior to inserting cotter pins.

4. Install hydraulic hoses to steering 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 steering cylinder to verify that hydraulic hoses and fittings are not contacted by anything.

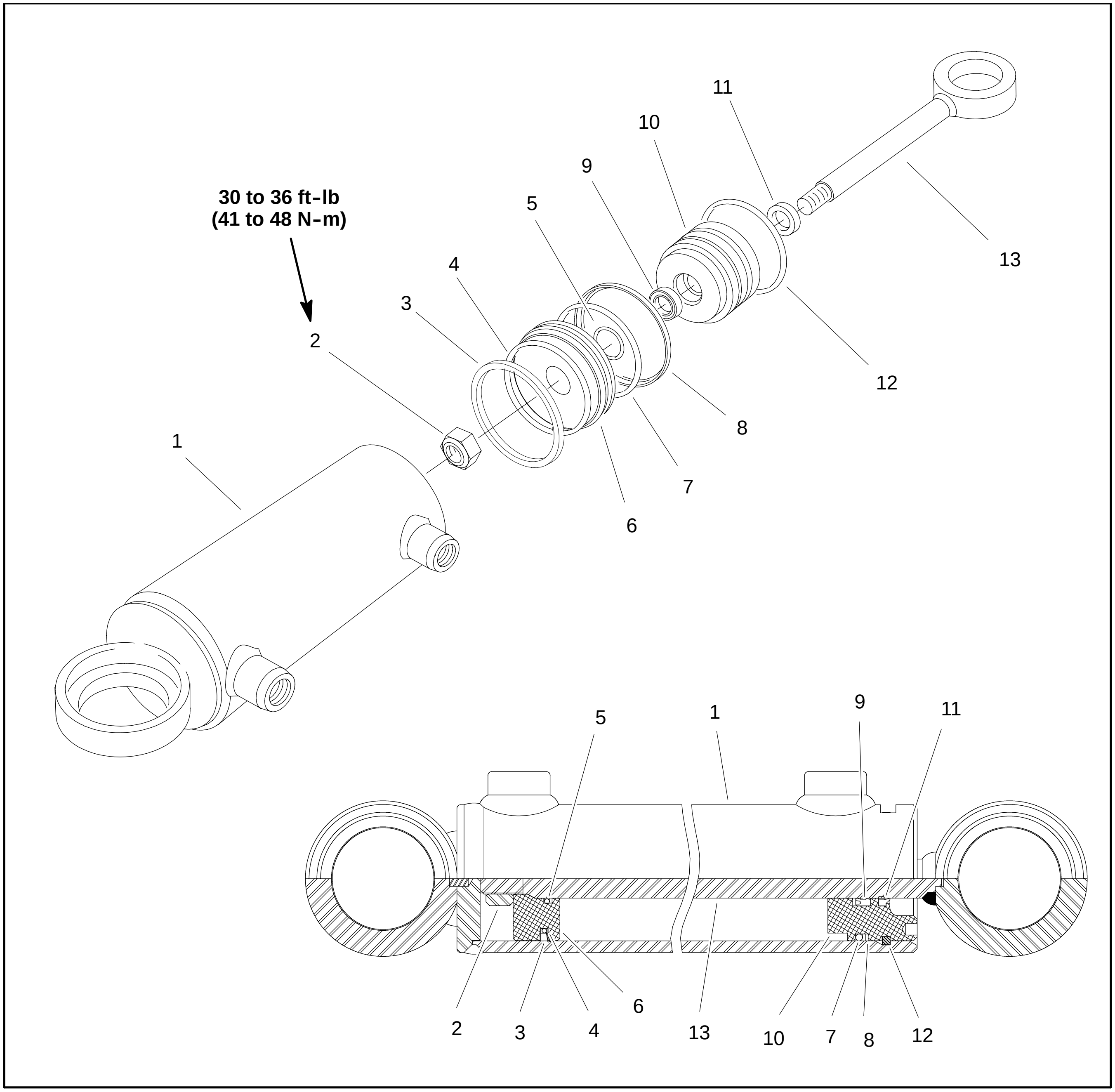


Figure 90

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

Disassembly (Fig. 90)

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

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

2. Mount steering cylinder securely in a vise by clamping on the clevis end of the barrel. Use of a vise with soft jaws is recommended.

3. Loosen head from barrel:

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

   B. Insert a screwdriver under the beveled edge of the retaining ring to start the retaining ring through the opening.

   C. Rotate the head counter–clockwise to remove retaining ring from barrel and head.

4. Extract shaft with head and piston by carefully twisting and pulling on the shaft.

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

5. Mount shaft securely in a vise by clamping on the clevis of the shaft. Remove lock nut and piston from the shaft. Slide head off the shaft.

6. Remove and discard all seals and O–rings from the piston and the head.

7. Wash parts in clean solvent. Dry parts with compressed air. Do not wipe parts dry with paper towels or cloth. Lint in a hydraulic system will cause damage.

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

Assembly (Fig. 90)

1. Make sure all cylinder components are clean before assembly.

2. Coat new seal kit components with clean hydraulic oil.

   A. Install new seals and O–rings to the piston.

   B. Install new seals, O–ring and back–up seal to the head.

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

3. Mount shaft securely in a vise by clamping on the clevis of the shaft.

   A. Coat shaft with clean hydraulic oil.

   B. Carefully slide head and piston onto the shaft. Secure piston to shaft with lock nut.

   C. Torque lock nut from **30 to 36 ft–lb (41 to 48 N–m)**.

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

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

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

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

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

   C. Apply silicone sealer to barrel access slot.

Engine Cooling Fan Motor

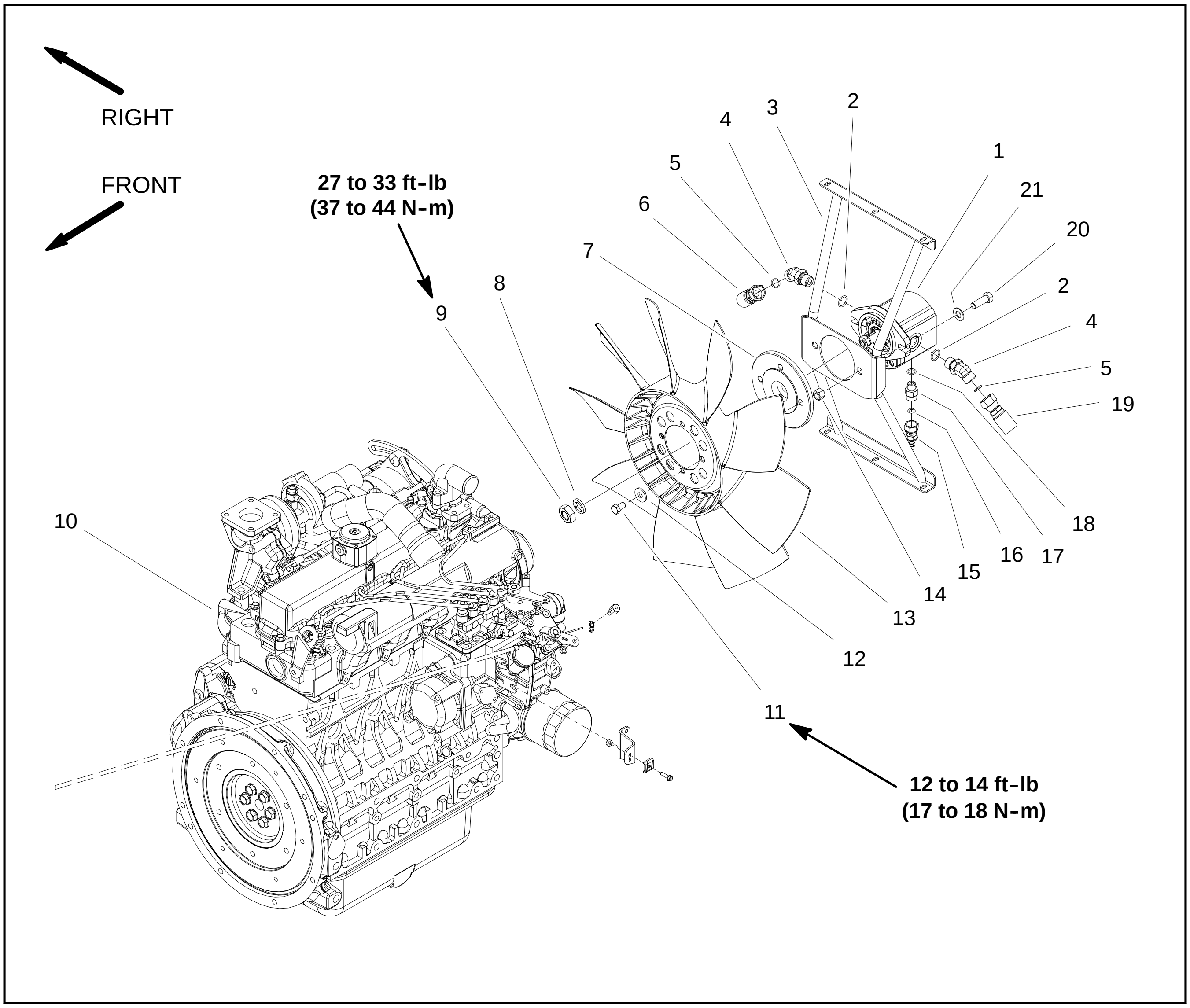


Figure 91

1. **Hydraulic fan motor**
2. **O-ring**
3. **Bracket**
4. **45º 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. 91)

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

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

3. Unlatch and raise hood.

CAUTION

The radiator and engine 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 access to hydraulic fan motor (Fig. 92).

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 or other machine components while loosening and removing the fan motor and bracket assembly.

6. Remove cooling fan motor and bracket assembly.

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

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

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

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

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

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

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

Installation (Fig. 91)

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

2. Position fan motor to fan motor bracket and secure with cap screws (item 20), flat washers (item 21) and lock nuts (item 14).

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

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

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

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

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

7. Position fan to fan hub and secure with four (4) cap screws and washers.

8. Install upper radiator shroud and air cleaner hose (Fig. 92). 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.

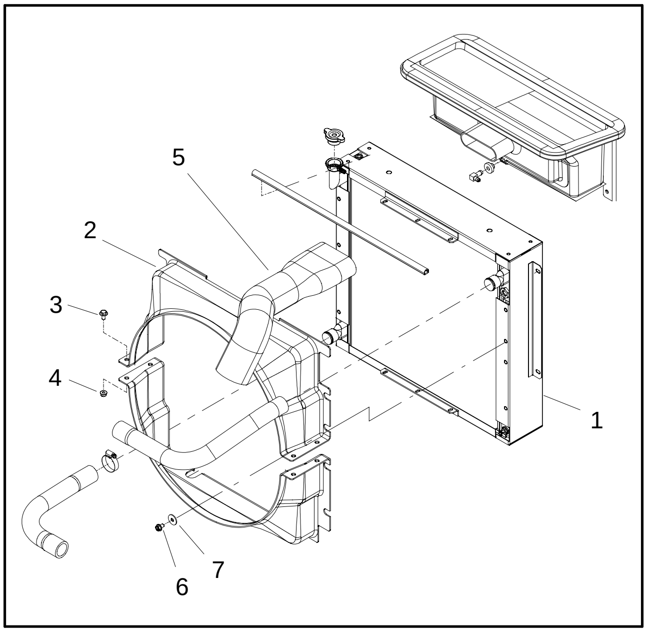


Figure 92

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

Engine Cooling Fan Motor Service

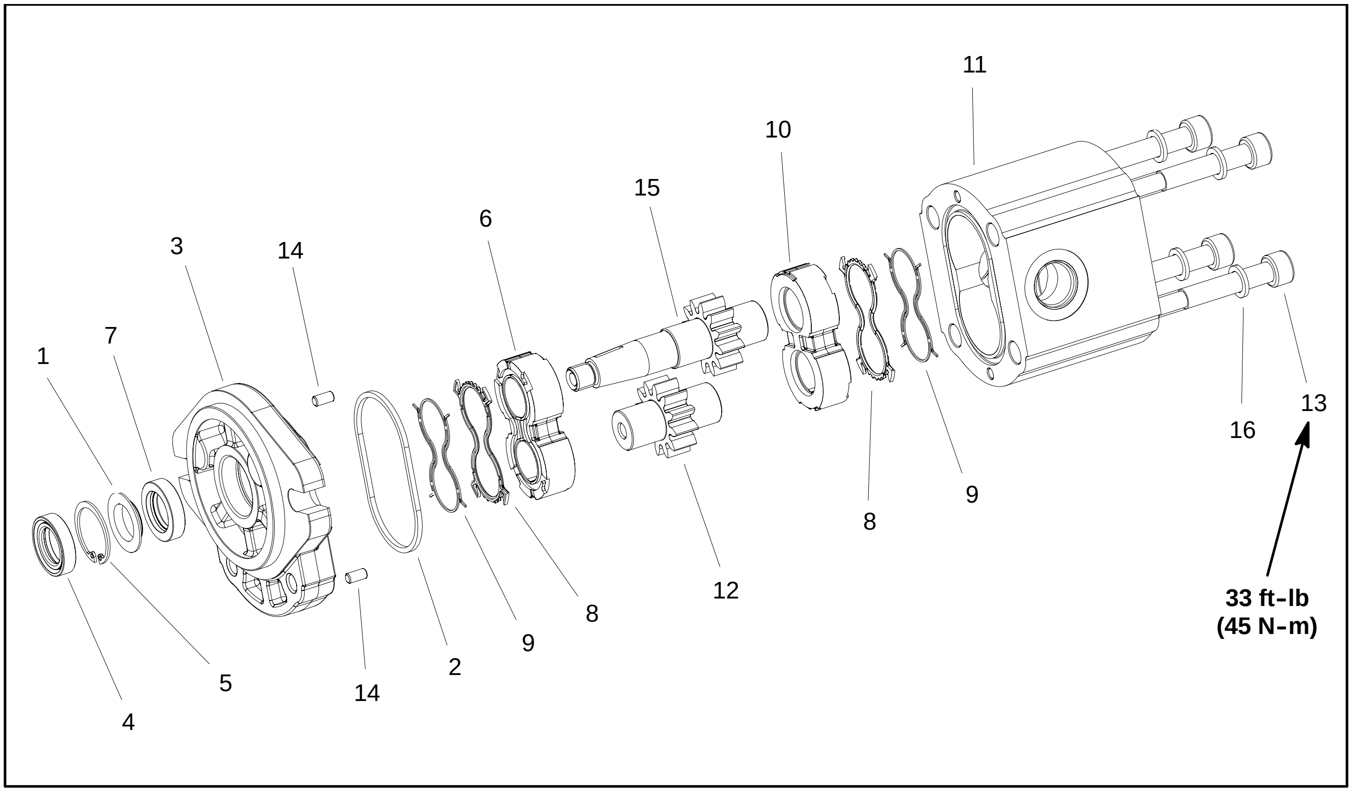


Figure 93

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

For disassembly, inspection and assembly procedures of the cooling fan motor, see Cutting Deck Motor Service in this section.

Hydraulic System

This page is intentionally blank.

Fan Control Manifold

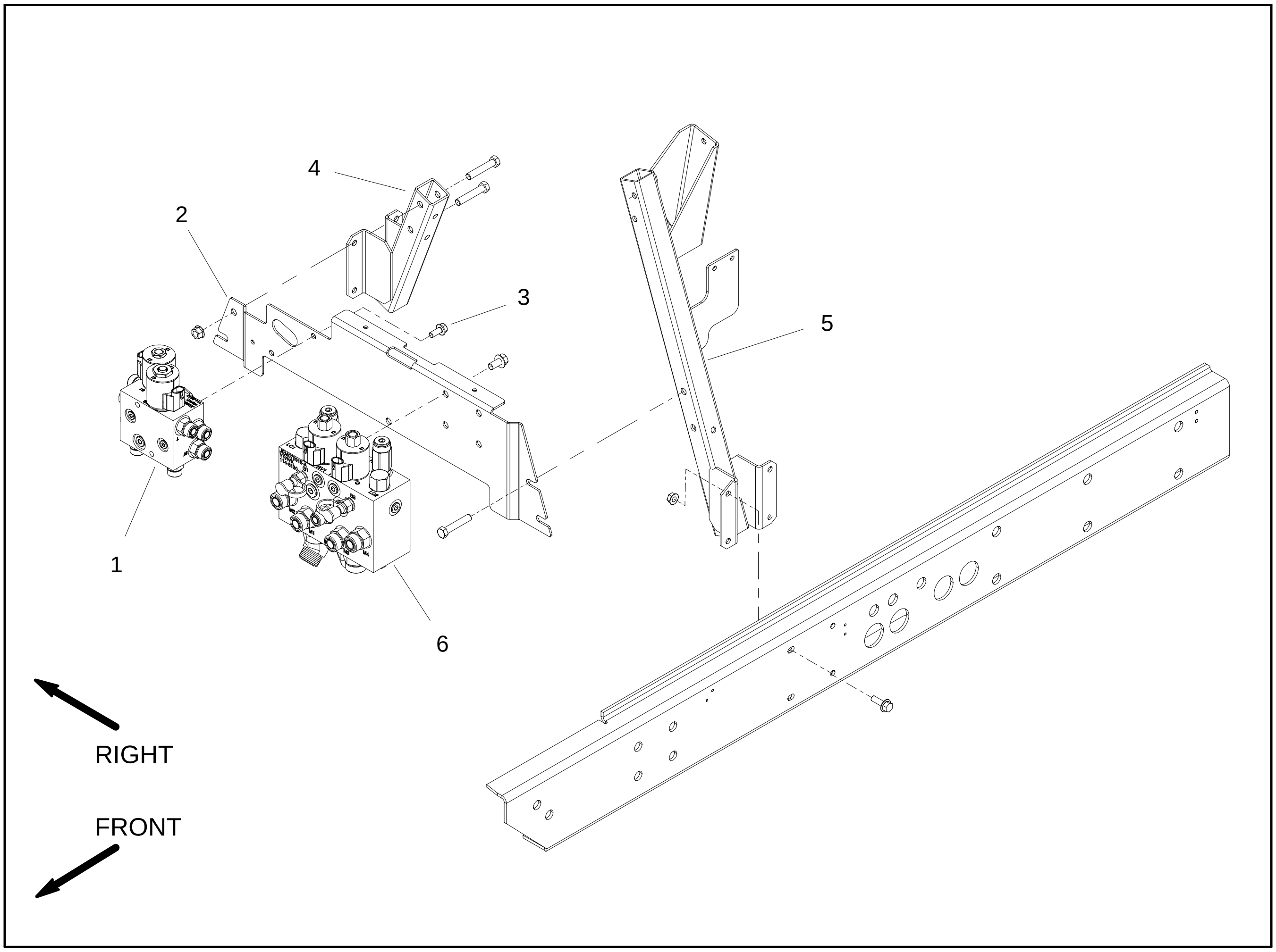


Figure 94

1. **Fan control manifold**
2. **Support bracket**
3. **Flange head screw (2 used)**
4. **Battery support**
5. **Bracket**
6. **Deck manifold (GM 4500–D shown)**

Removal (Fig. 94)

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

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

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

3. Unlatch and raise hood.

4. To prevent contamination of hydraulic system during fan control manifold removal, thoroughly clean exterior of manifold.

5. Label wire harness electrical connectors that attach to manifold solenoid coils. Disconnect connectors from the solenoid coils.

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

7. Remove hydraulic manifold from the frame using Figure 94 as guide.

8. If hydraulic fittings are to be removed from fan control manifold, mark fitting orientation to allow correct assembly (Fig. 95). Remove fittings from manifold and discard O–rings.

Installation (Fig. 94)

1. If fittings were removed from fan control manifold, lubricate and place new O–rings onto fittings. Install fittings into manifold ports using marks made during the removal process to properly orientate fittings. Tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter). Refer to Figure 95 for fitting installation torque.

2. Install hydraulic manifold to the frame using Figure 94 as guide.

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

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

5. Lower and secure hood.

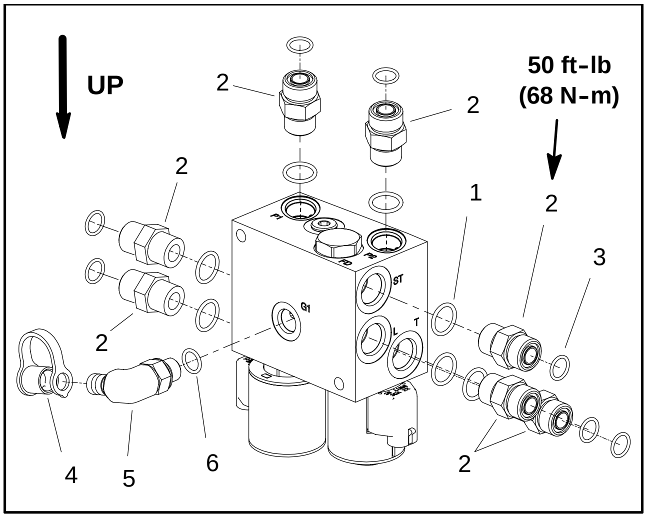


Figure 95

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

Hydraulic System

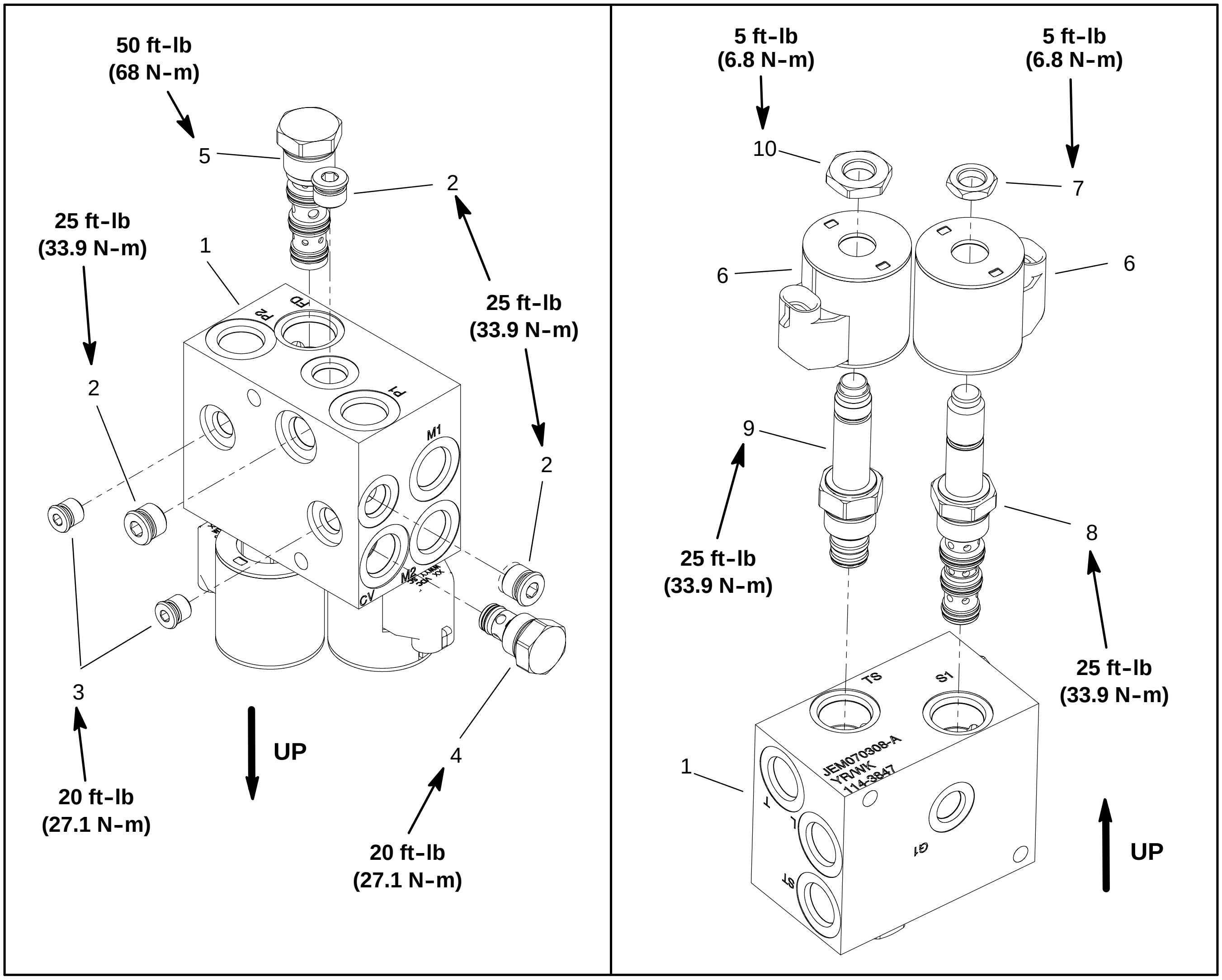


Figure 96

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

NOTE: The ports on the fan control manifold are marked for easy identification of components (e.g. ST is the supply to the steering control valve and FD is the location of the flow divider cartridge valve). See Hydraulic Schematics in Chapter 9 – Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port location.

For solenoid and control valve service procedures, see 4WD/2WD Control Manifold Service in this section. Refer to Figure 96 for cartridge valve and plug installation torque.

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

Hydraulic System

This page is intentionally blank.

Lift Control Manifold

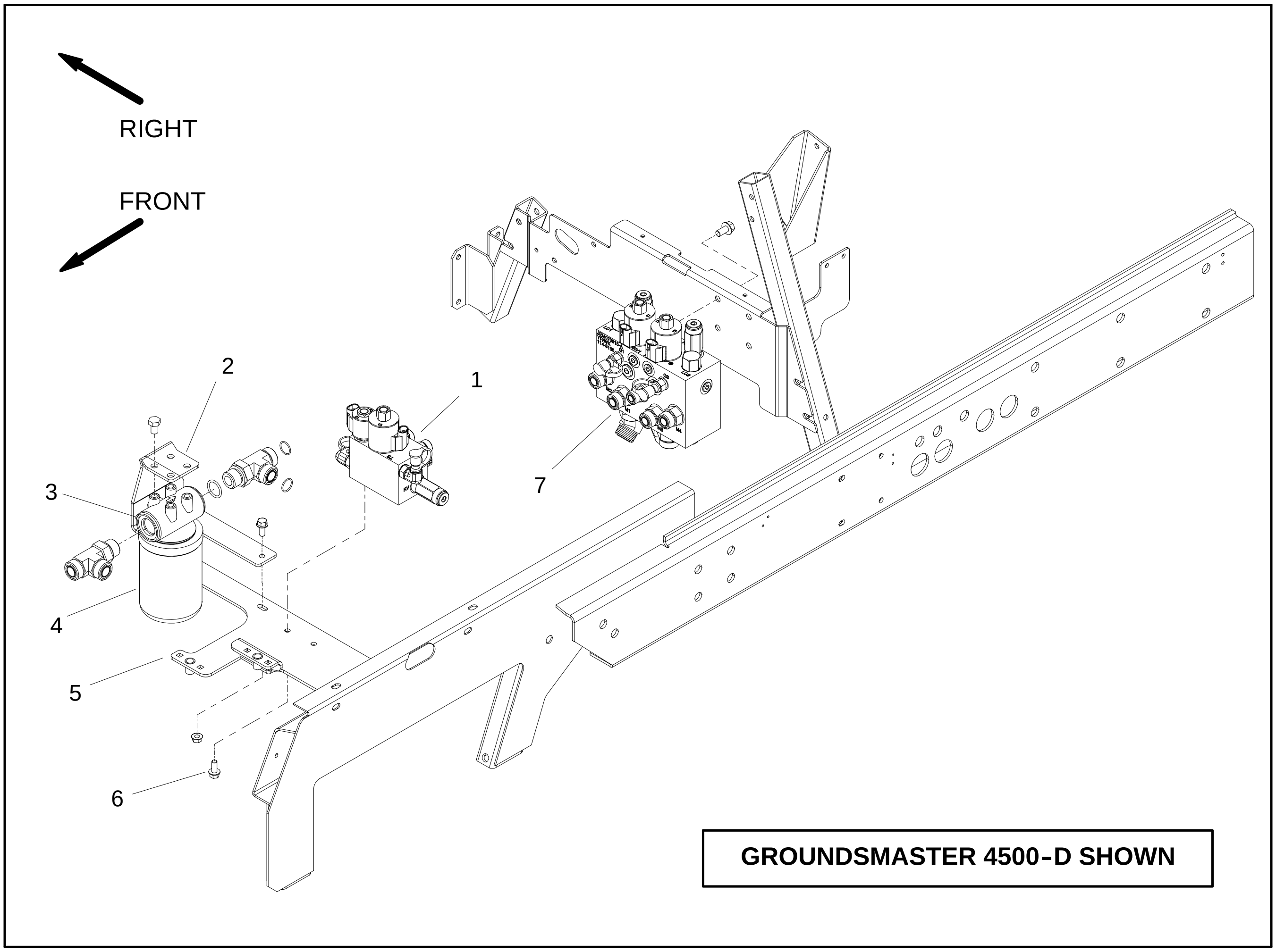


Figure 97

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

NOTE: The lift control manifolds used on Groundsmaster 4500–D and 4700–D machines are different but they mount to the machine in the same location. The Groundsmaster 4500–D control manifolds are shown in Figure 97.

Removal (Fig. 97)

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

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

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

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

3. Unlatch and raise hood.

4. To prevent contamination of hydraulic system during manifold removal, thoroughly clean exterior of manifold.

5. Label wire harness electrical connectors that attach to manifold solenoid coils. Disconnect wire harness electrical connectors from the solenoid valve coils.

WARNING

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

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

7. Remove hydraulic manifold from the frame using Figure 97 as guide.

8. If hydraulic fittings are to be removed from lift control manifold, mark fitting orientation to allow correct assembly (Fig. 98 or 99). Remove fittings from manifold and discard O–rings.

Installation (Fig. 97)

1. If fittings were removed from lift control manifold, lubricate and place new O–rings onto fittings. Install fittings into manifold openings using marks made during the removal process to properly orientate fittings. Tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter). Refer to Figure 98 or 99 for fitting installation torque.

2. Install hydraulic manifold to the frame using Figure 97 as guide.

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

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

5. Lower and secure hood.

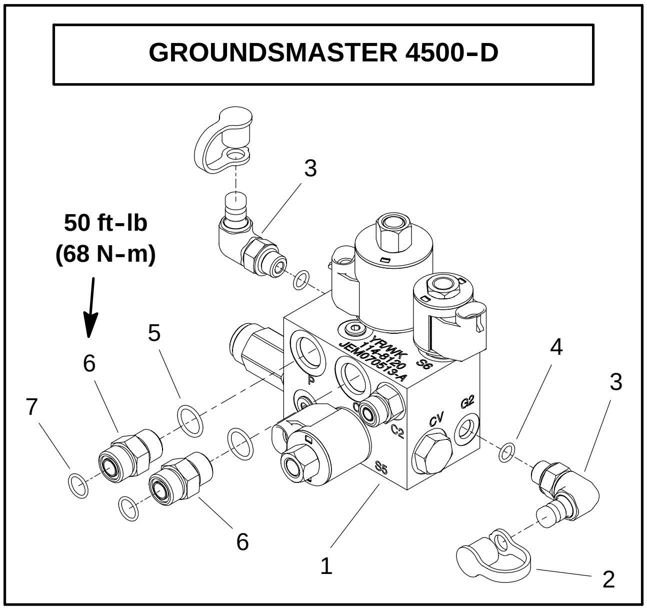


Figure 98

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

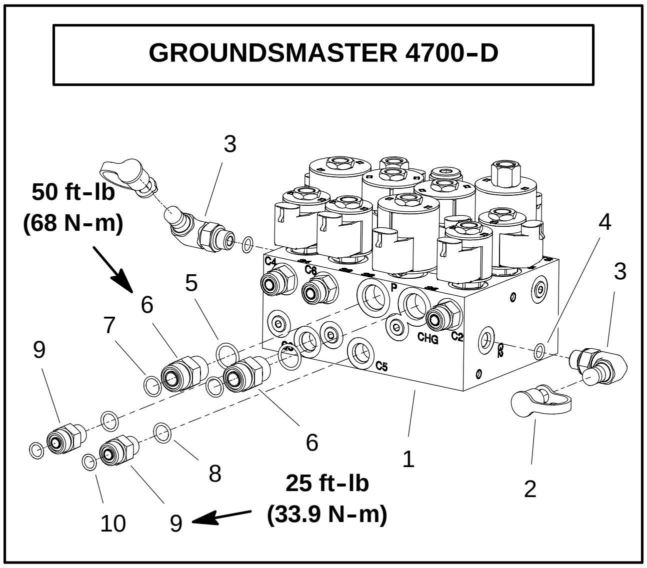


Figure 99

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

Hydraulic System

Lift Control Manifold Service (GM 4500–D)

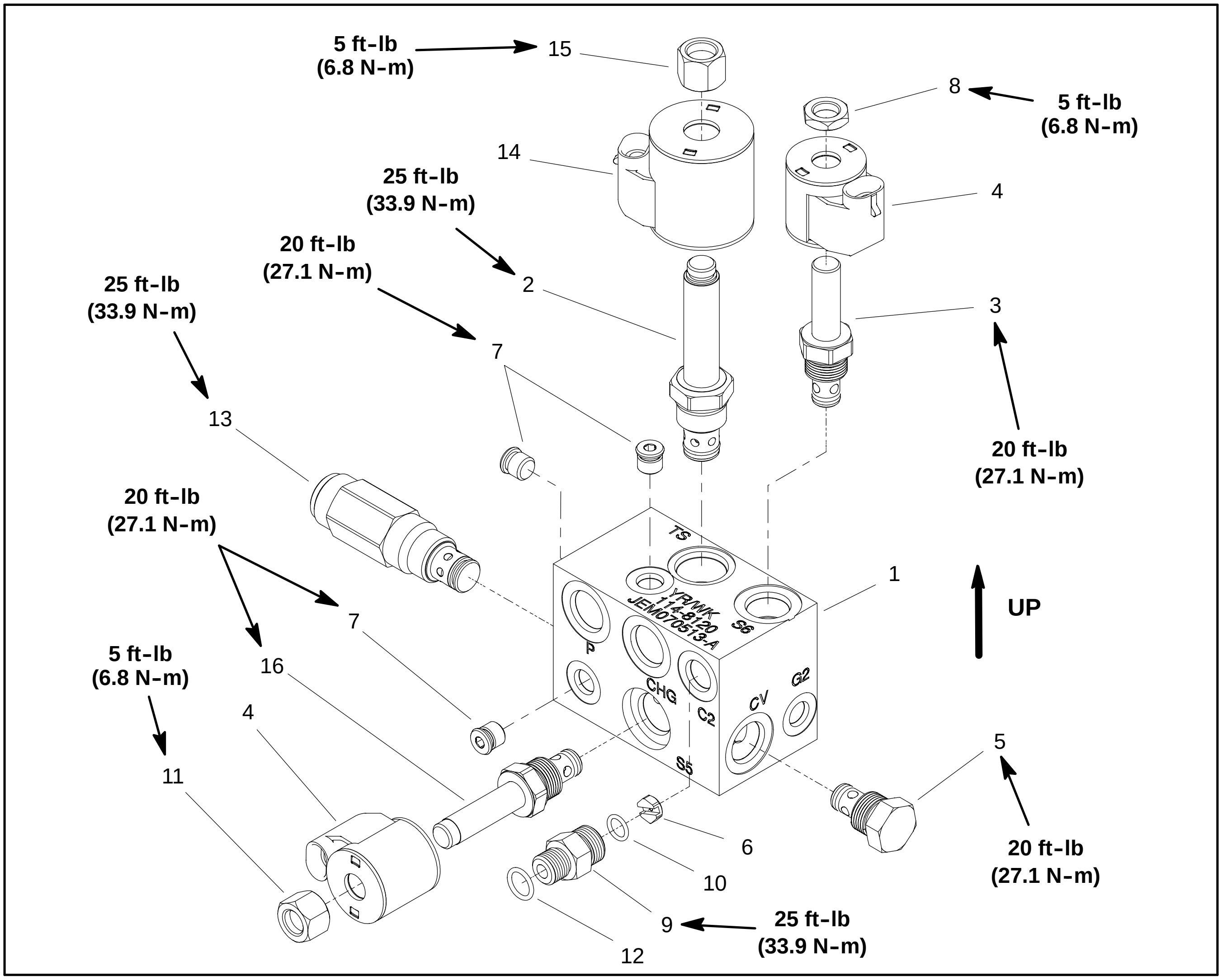


Figure 100

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

NOTE: The ports on the manifold are marked for easy identification of components (e.g. P is the supply connection port and R7 is the location for the lift relief valve). See Hydraulic Schematics in Chapter 9 – Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port location.

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

WARNING

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

For solenoid and control valve service procedures, see 4WD/2WD Control Manifold Service in this section. Refer to Figure 100 for cartridge valve and plug installation torque.

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

Lift Control Manifold Service (GM 4700-D)

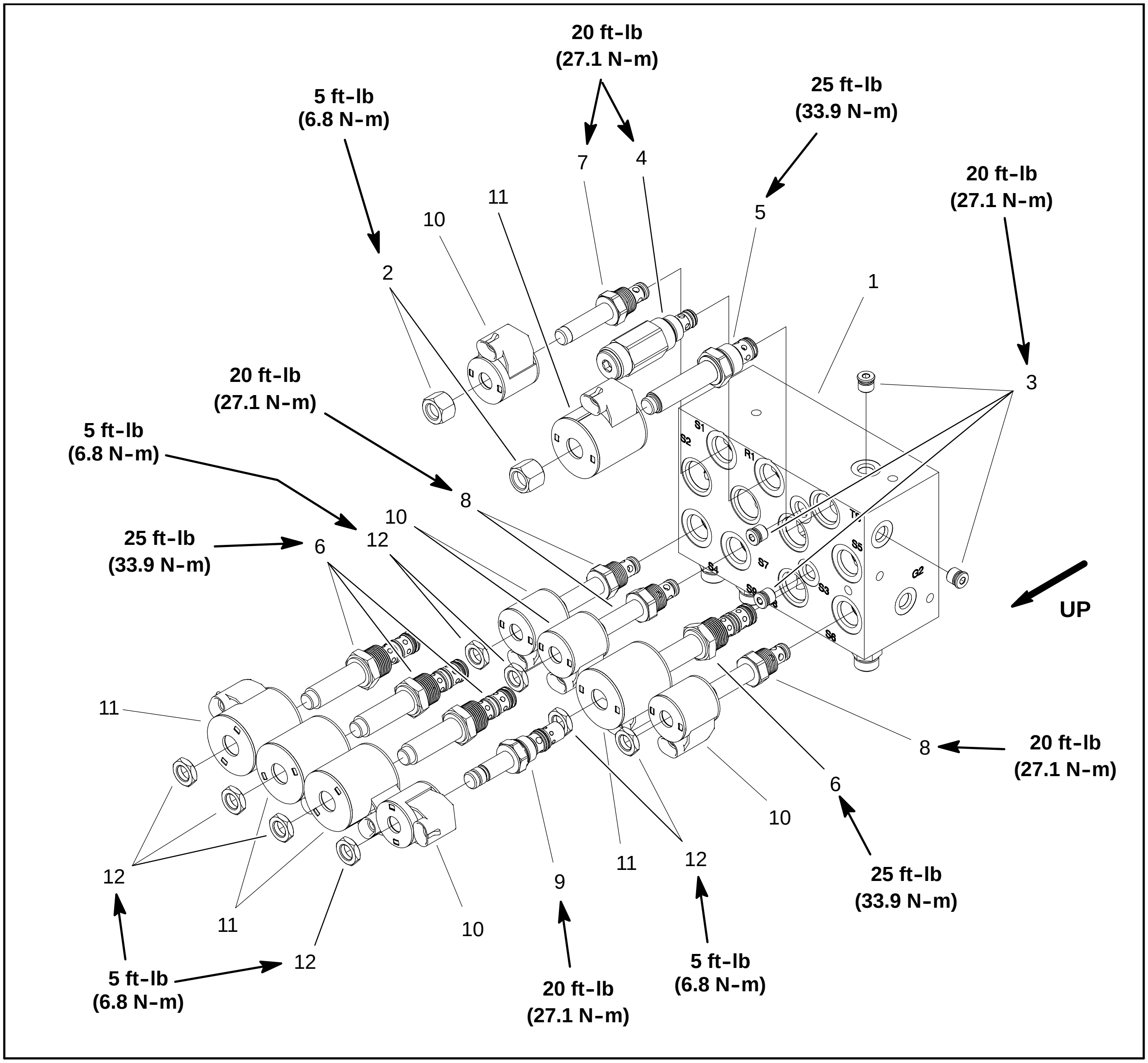


Figure 101

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

NOTE: The ports on the manifold are marked for easy identification of components (e.g. P is the gear pump connection port and R1 is the relief valve port). See Hydraulic Schematics in Chapter 9 – Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port location.

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

WARNING

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

For solenoid and control valve service procedures, see 4WD/2WD Control Manifold Service in this section. Refer to Figures 101 and 102 for cartridge valve and plug installation torque.

IMPORTANT: A flow control orifice is placed beneath several of the hydraulic fittings on the lift control manifold (Fig. 102). The lift manifold uses two (2) different orifice sizes. If a fitting is removed from the lift control manifold and an orifice is in the manifold port, make sure to remove orifice and label its position for assembly purposes. Also note location of groove in orifice for assembly purposes.

IMPORTANT: When installing orifice in manifold (Fig. 102), make sure that orifice is flat in the base of the manifold port. Manifold damage is possible if the orifice is cocked in the cavity.

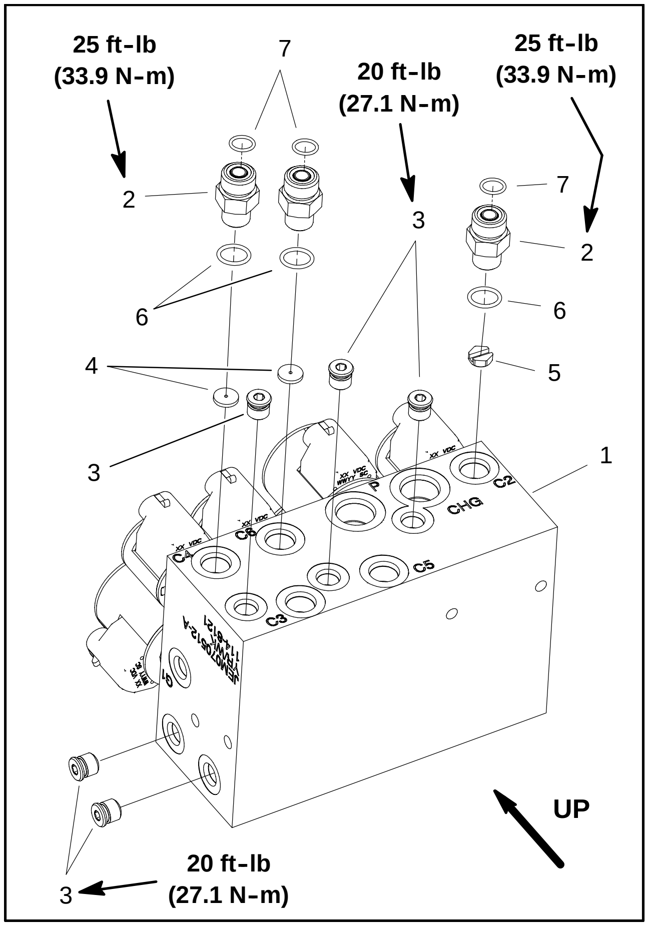


Figure 102

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

Hydraulic System

Lift Circuit Junction Manifold

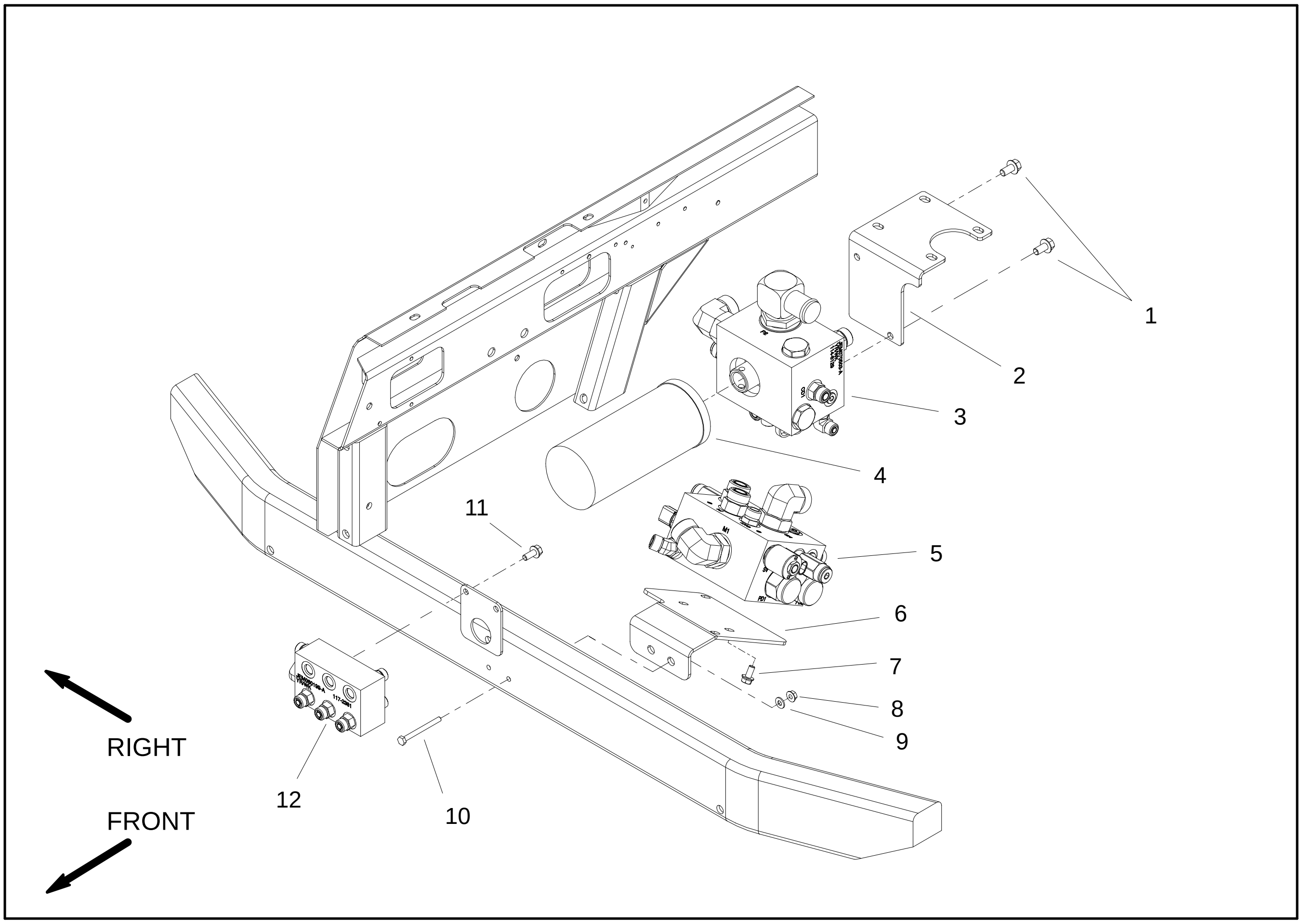


Figure 103

1. **Flange head screw (2 used)**
2. **Filter manifold bracket**
3. **Filtration and charge control manifold**
4. **Hydraulic oil filter**
5. **4WD/2WD control manifold**
6. **Manifold bracket**
7. **Flange head screw (3 used)**
8. **Flange nut (2 used)**
9. **Flat washer (2 used)**
10. **Cap screw (2 used)**
11. **Flange head screw (2 used)**
12. **Lift circuit junction manifold**

Removal (Fig. 103)

NOTE: The ports on the lift circuit junction manifold are marked for easy identification of components (e.g. P1 is the gear pump connection port). See Hydraulic Schematics in Chapter 9 – Foldout Drawings to identify the function of the hydraulic lines at each port.

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

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

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

WARNING

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

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

5. Remove hydraulic manifold from the frame using Figure 103 as guide.

IMPORTANT: A flow control orifice is placed beneath several of the hydraulic fittings on the lift circuit junction manifold (Fig. 104). The manifold uses two (2) different orifice sizes. If a fitting is removed from the lift junction manifold and an orifice is in the manifold port, make sure to remove orifice and label its position for assembly purposes. Also note location of groove in orifice for assembly purposes.

6. If necessary, remove fittings from manifold and discard O–rings (Fig. 104).

Installation (Fig. 103)

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

1. If fittings were removed from junction manifold, lubricate and place new O–rings onto fittings. Install fittings into manifold openings making sure that orifice is correctly placed before threading fitting into manifold. Tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter). Refer to Figure 104 for fitting installation torque.

2. Install hydraulic manifold to the frame using Figure 103 as guide.

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

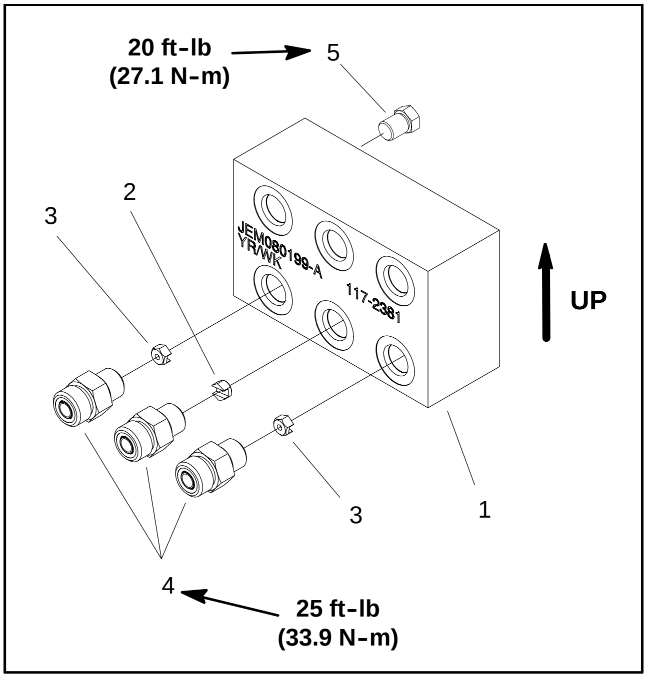


Figure 104

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

Hydraulic System

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

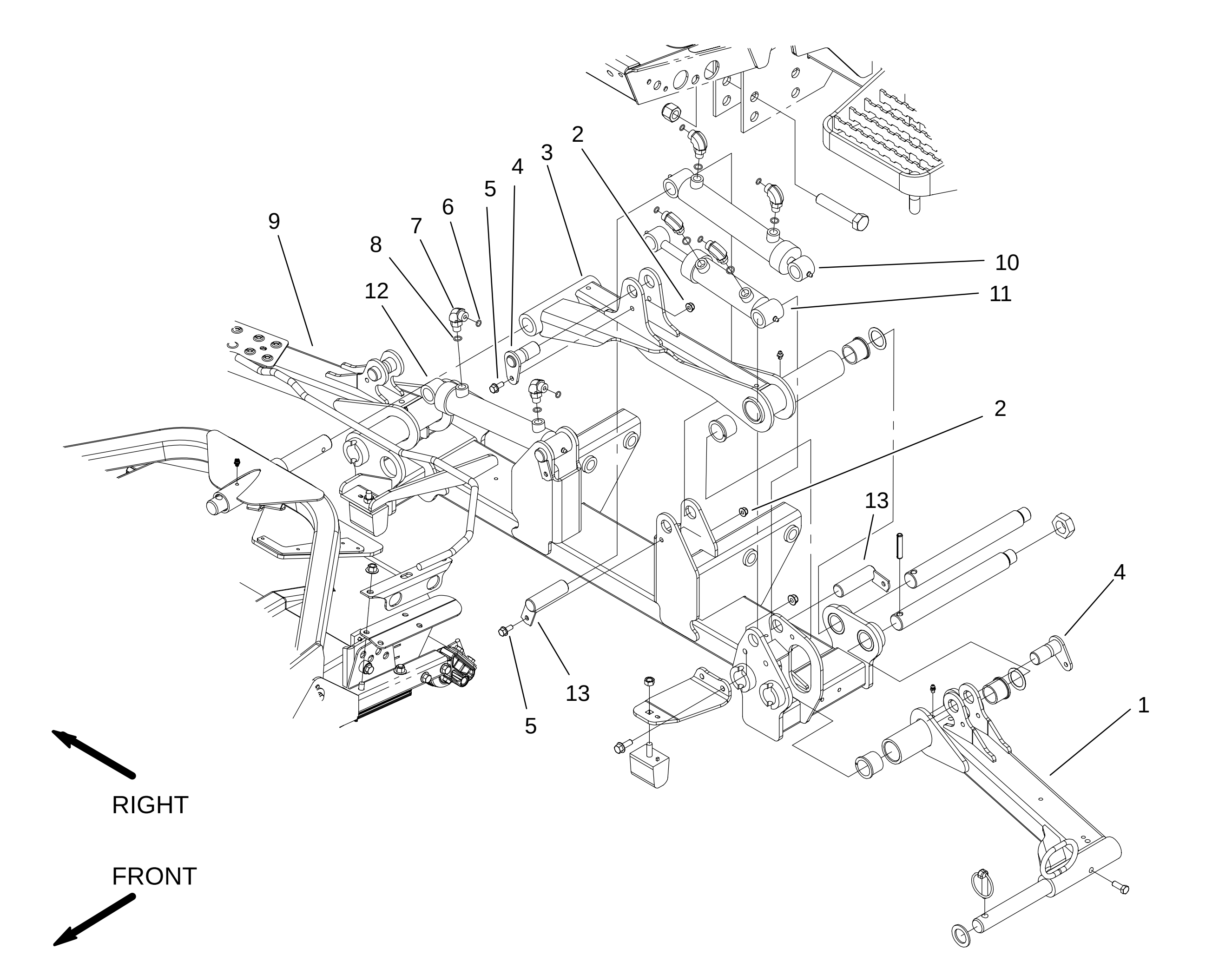


Figure 105

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

Removal (Fig. 105)

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

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

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

WARNING

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

4. Disconnect hydraulic hoses from lift cylinder. Put caps or plugs on open hydraulic lines and fittings to prevent system contamination. Label disconnected hydraulic lines for proper assembly.

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

6. Remove flange nut and flange head screw that secure the cylinder pin (item 13) to the frame. Pull pin from frame and cylinder barrel clevis.

7. Remove lift cylinder from machine.

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

Installation (Fig. 105)

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

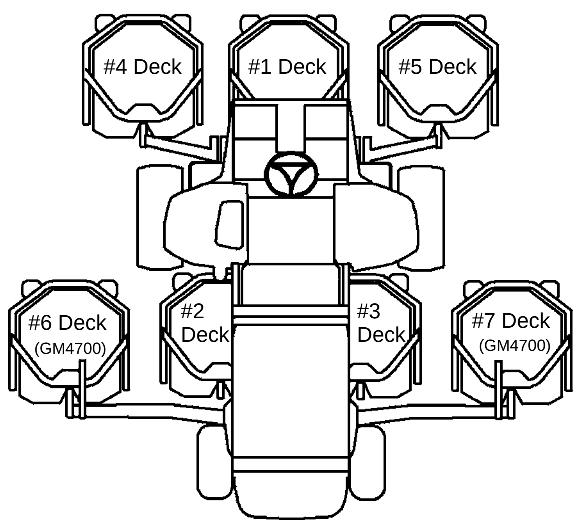
2. Position cylinder barrel clevis to frame and insert cylinder pin (item 13) into frame and clevis. Secure pin with flange nut and flange head screw.

3. Insert cylinder pin (item 4) through lift arm and cylinder shaft clevis. Secure pin to lift arm with flange nut and flange head screw.

4. Remove caps and plugs from hoses and fittings. Attach hydraulic hoses to lift cylinder (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

5. Fill reservoir with hydraulic fluid as required.

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



CUTTING DECK LOCATIONS

Figure 106

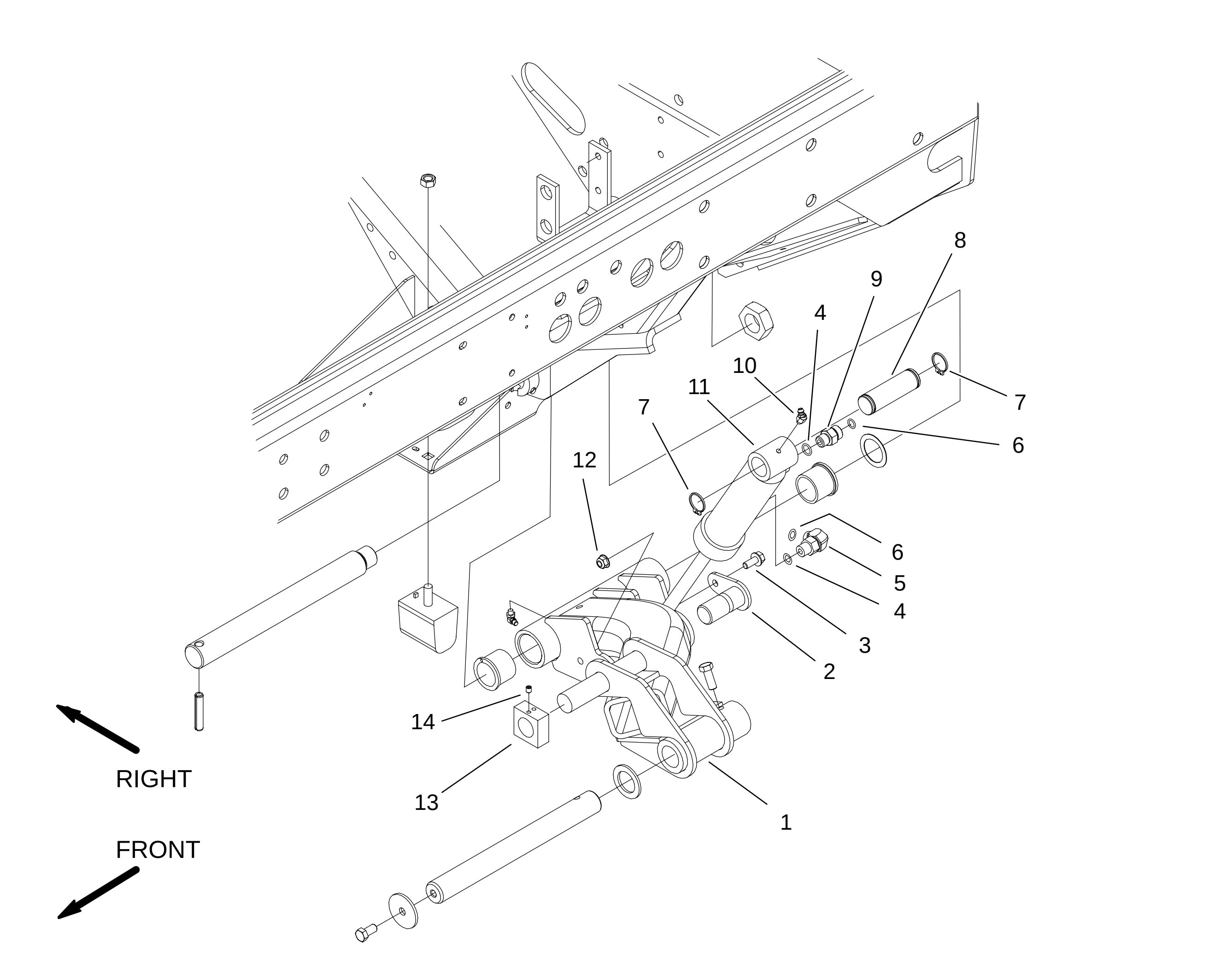


Figure 107

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

Removal (Fig. 107)

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

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

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

WARNING

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

4. Disconnect hydraulic hoses from lift cylinder. Put caps or plugs on open hydraulic lines and fittings to prevent system contamination. Label the hydraulic hoses to show their correct position on the lift cylinder for assembly purposes.

5. Remove flange head screw and flange nut that secure the cylinder pin (item 2) to the lift arm. Remove pin from lift arm and cylinder shaft clevis.

6. Remove one (1) retaining ring from the cylinder pin (item 8). Remove cylinder pin from the frame and cylinder barrel clevis.

7. Remove lift cylinder from machine.

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

Installation (Fig. 107)

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

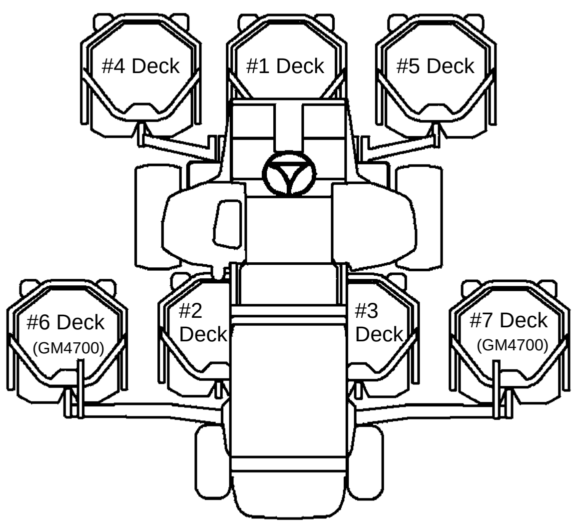
2. Position cylinder barrel clevis to frame and insert cylinder pin (item 8) with one (1) retaining ring installed through the frame and cylinder clevis. Secure pin with second retaining ring.

3. Insert cylinder pin (item 2) through the lift arm and cylinder shaft clevis. Secure pin to lift arm with flange head screw and flange nut.

4. Remove caps and plugs from hoses and fittings. Attach hydraulic hoses to lift cylinder (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

5. Fill reservoir with hydraulic fluid as required.

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



CUTTING DECK LOCATIONS

Figure 108

Hydraulic System

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

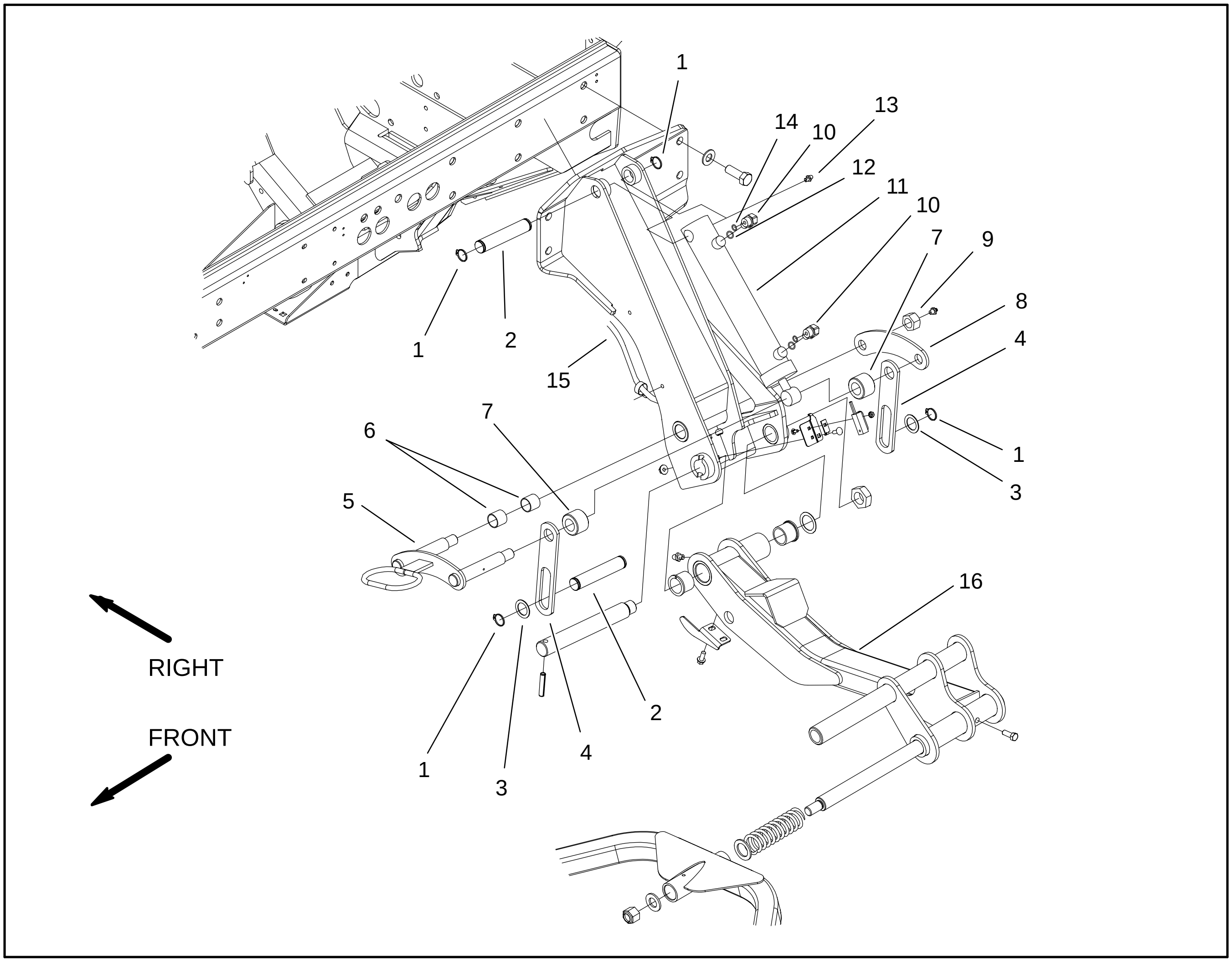


Figure 109

1. Retaining ring
2. Cylinder pin
3. Thrust washer
4. Lift link
5. Link assembly
6. Bushing
7. Plastic roller
8. Rear link
9. Lock nut
10. 90º hydraulic fitting
11. Lift cylinder
12. O–ring
13. Grease fitting
14. O–ring
15. Support frame
16. Lift arm (deck #6 shown)

Removal (Fig. 109)

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

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

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

WARNING

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

4. Disconnect hydraulic hoses from lift cylinder. Put caps or plugs on open hydraulic lines and fittings to prevent system contamination. Label the hydraulic hoses to show their correct position on the lift cylinder for assembly purposes.

5. Remove lock nuts (item 9) that secure link assembly (item 5). Remove rear link (item 8) from link assembly. Pull link assembly from support frame, lift links (item 4) and cylinder shaft clevis which will free lift cylinder from lift arm. Locate and remove plastic rollers (item 7) positioned on both sides of cylinder clevis.

6. Remove one retaining ring that secures the cylinder pin (item 2) to the support frame. Pull pin from frame and cylinder barrel clevis.

7. Remove lift cylinder from machine.

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

Installation (Fig. 109)

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

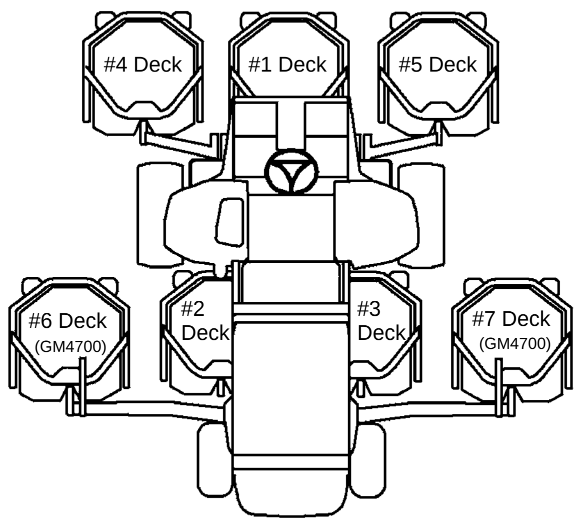
2. Position cylinder barrel clevis to support frame and insert cylinder pin (item 2) into frame and clevis. Secure pin with retaining ring.

3. Position plastic rollers (item 7) to cylinder shaft clevis. Insert link assembly (item 5) through support frame, lift links (item 4), plastic rollers and cylinder shaft clevis. Install rear link to link assembly and secure assembly with lock nuts.

4. Remove caps and plugs from hoses and fittings. Attach hydraulic hoses to lift cylinder (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

5. Fill reservoir with hydraulic fluid as required.

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



CUTTING DECK LOCATIONS

Figure 110

Hydraulic System

Lift Cylinder Service

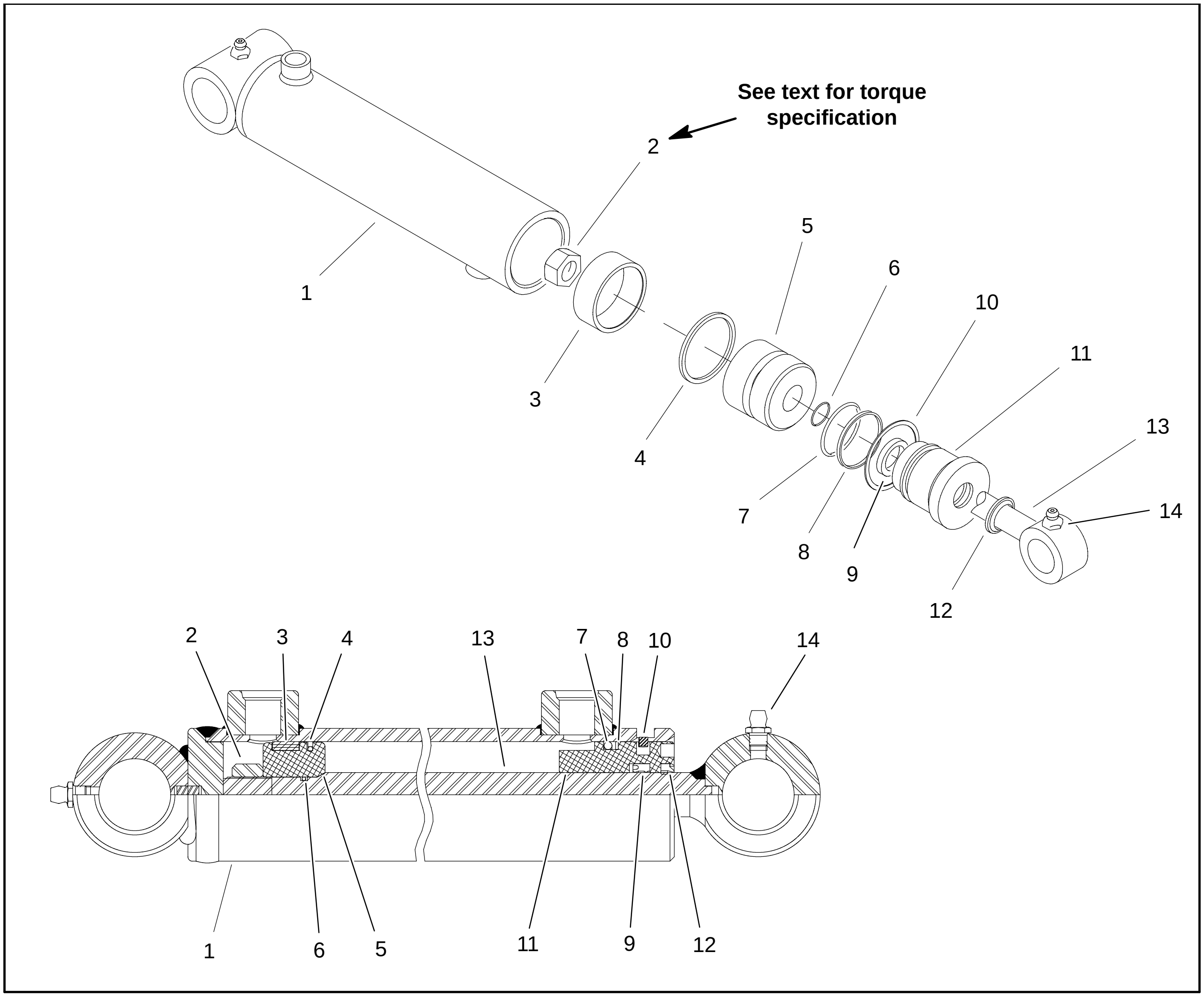


Figure 111

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

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

Disassembly (Fig. 111)

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

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

2. Mount lift cylinder securely in a vise by clamping on the clevis end of the barrel. Use of a vise with soft jaws is recommended.

3. Loosen head from barrel:

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

   B. Insert a screwdriver under the beveled edge of the retaining ring to start the retaining ring through the opening.

   C. Rotate the head counter–clockwise to remove retaining ring from barrel and head.

4. Extract shaft with head and piston by carefully twisting and pulling on the shaft.

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

5. Mount shaft securely in a vise by clamping on the clevis of the shaft. Remove lock nut and piston from the shaft. Slide head off the shaft.

6. Remove and discard all seals and O–rings from the piston and the head.

7. Wash parts in clean solvent. Dry parts with compressed air. Do not wipe parts dry with paper towels or cloth. Lint in a hydraulic system will cause damage.

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

Assembly (Fig. 111)

1. Make sure all cylinder components are clean before assembly.

2. Coat new seal kit components with clean hydraulic oil.

   A. Install new seals and O–rings to the piston.

   B. Install new seals, O–ring and back–up seal to the head.

3. Coat shaft with clean hydraulic oil. Carefully slide head and piston onto the shaft.

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

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

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

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

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

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

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

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

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

   C. Apply silicone sealer to barrel access slot.

Hydraulic Reservoir

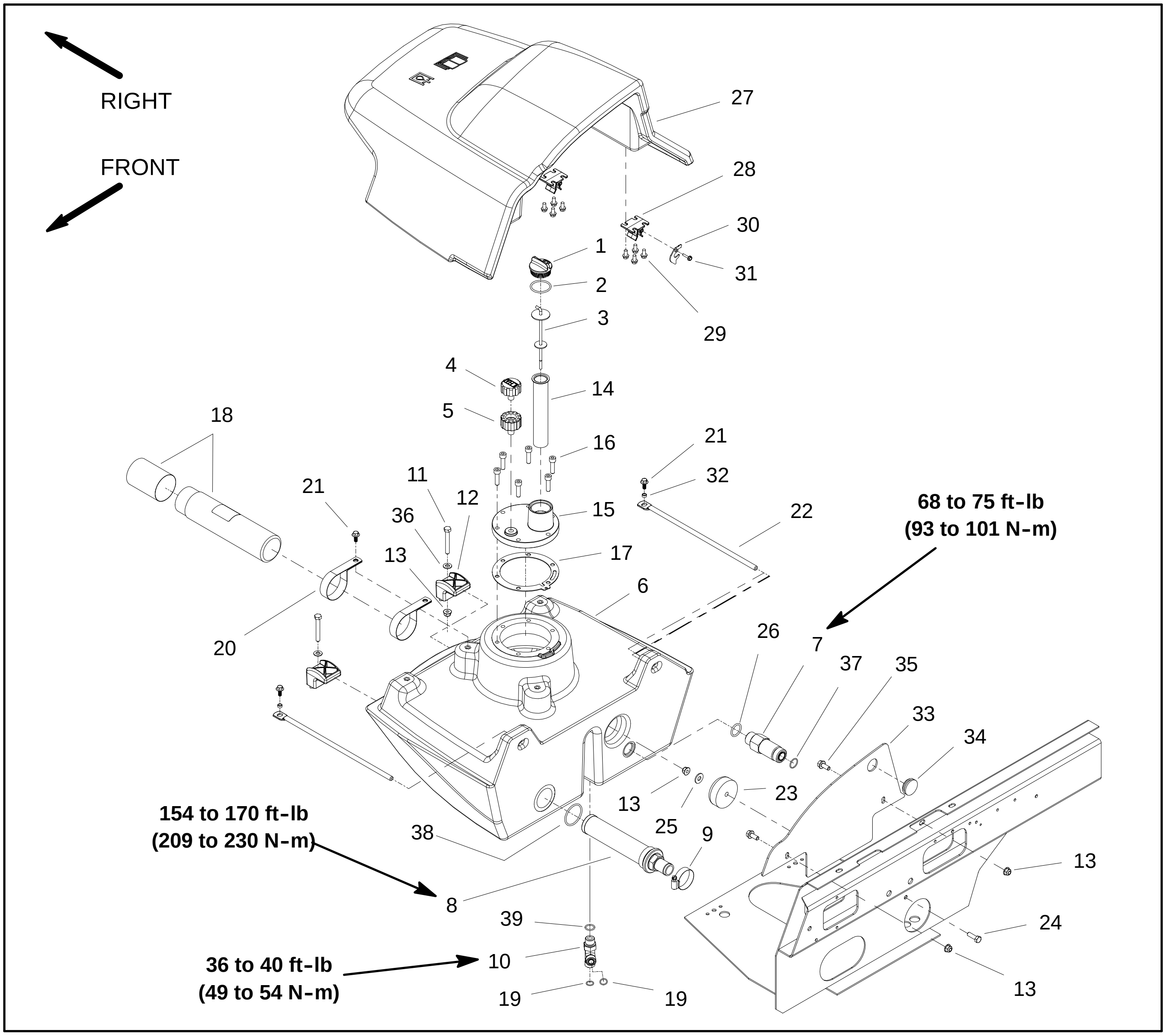


Figure 112

1. **Plug**
2. **O-ring**
3. **Dipstick**
4. **Breather**
5. **Breather adapter**
6. **Hydraulic reservoir**
7. **Hydraulic fitting**
8. **Tank strainer**
9. **Clamp**
10. **Hydraulic tee fitting**
11. **Cap screw (2 used)**
12. **Clamp (2 used)**
13. **Flange nut (5 used)**
14. **Screen filter**
15. **Cap**
16. **Socket head screw (6 used)**
17. **Flange gasket**
18. **Manual housing assembly**
19. **O-ring**
20. **R-clamp (2 used)**
21. **Cap screw (4 used)**
22. **Slide rail (2 used)**
23. **Bumper**
24. **Cap screw**
25. **Flat washer**
26. **O-ring**
27. **Reservoir cover**
28. **Retainer clip (4 used)**
29. **Screw (16 used)**
30. **Latch cover (2 used)**
31. **Washer head screw (2 used)**
32. **Spacer (2 used)**
33. **Plate**
34. **Plug**
35. **Flange head screw (2 used)**
36. **Washer (2 used)**
37. **O-ring**
38. **O-ring**
39. **O-ring**

Removal (Fig. 112)

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

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

3. To prevent contamination of hydraulic system during hydraulic reservoir removal, thoroughly clean exterior of reservoir.

4. Disconnect one of the hydraulic tubes from the tee fitting on bottom of reservoir to allow draining of reservoir. Drain reservoir into a suitable container.

5. Disconnect remaining hydraulic hoses from reservoir. Label the hydraulic hoses to show their correct position on the reservoir for assembly purposes.

6. Remove hydraulic reservoir using Figure 112 as a guide.

7. If hydraulic fittings are to be removed from reservoir, mark fitting orientation to allow correct assembly. Remove fittings from reservoir and discard O–rings.

Inspection

1. Clean hydraulic reservoir and suction strainer with solvent.

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

Installation (Fig. 112)

1. If fittings were removed from reservoir, lubricate and place new O–rings onto fittings. Install fittings into reservoir openings using marks made during the removal process to properly orientate fittings. Torque fittings to values identified in Figure 112.

2. Install reservoir using Figure 112 as a guide.

IMPORTANT: When tightening hoses to reservoir fittings, hold fitting with wrench to prevent over–tightening of fitting and potential reservoir damage.

3. Connect hydraulic hoses to reservoir fittings (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

4. Fill reservoir with hydraulic fluid to proper level.

Hydraulic Oil Cooler

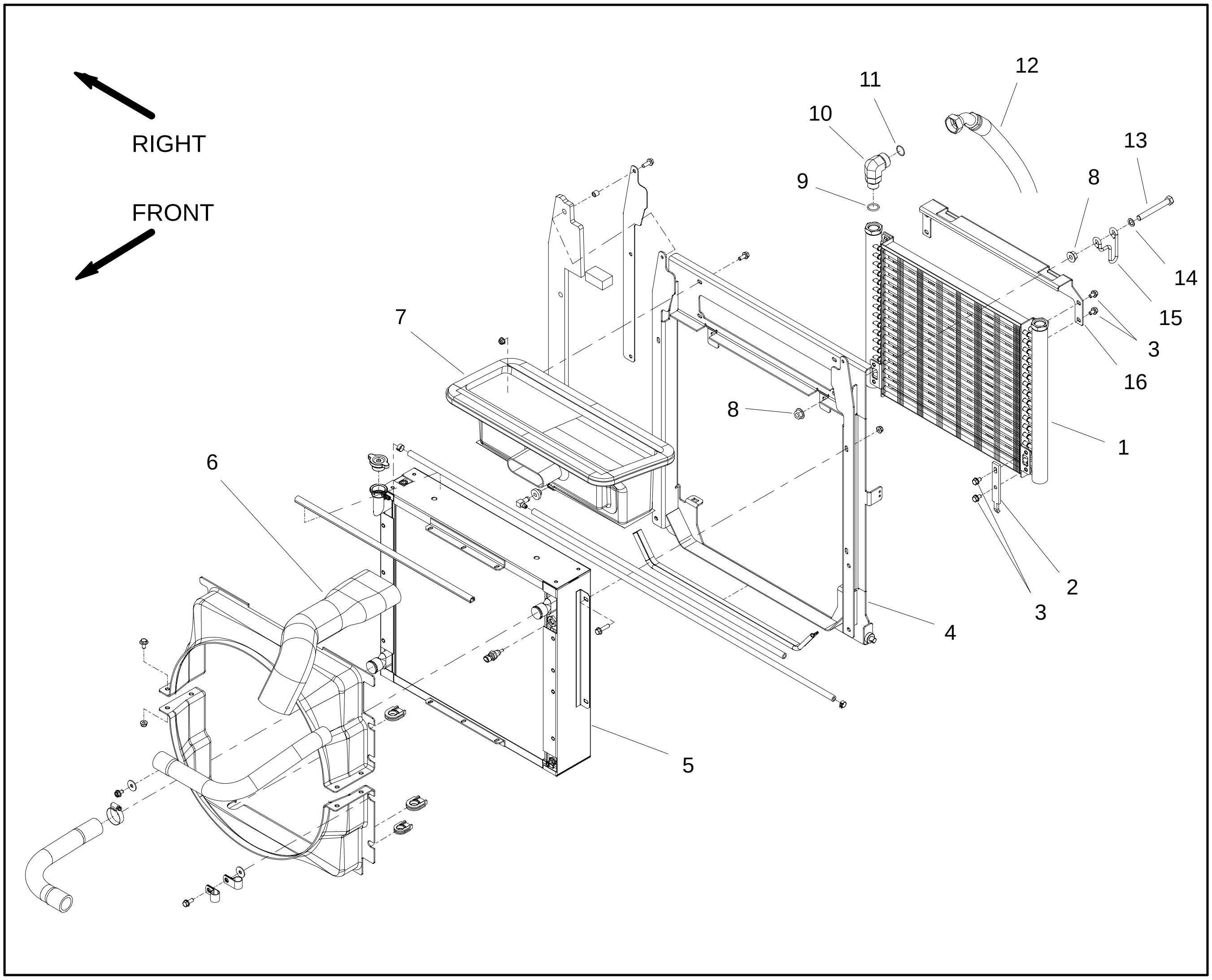


Figure 113

1. Oil cooler
2. Mount plate (2 used)
3. Flange head screw (8 used)
4. Radiator mount
5. Radiator
6. Air intake hose
7. Plenum
8. Flange nut (4 used)
9. O–ring
10. 90º hydraulic fitting (2 used)
11. O–ring
12. Hydraulic hose (2 used)
13. Cap screw (2 used)
14. Washer (2 used)
15. Wire form clamp (2 used)
16. Top oil cooler bracket

Removal (Fig. 113)

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 decks, stop engine, engage parking brake and remove key from the ignition switch.

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

3. To prevent contamination of hydraulic system during oil cooler removal, thoroughly clean exterior of cooler.

4. Remove oil cooler using Figures 113, 114 and 115 as guides.

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

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. 113)

1. If fittings were removed from oil cooler, lubricate and place new O–rings onto fittings. Install fittings into cooler 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 oil cooler using Figures 113, 114 and 115 as guides (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

3. Fill reservoir with hydraulic fluid as required.

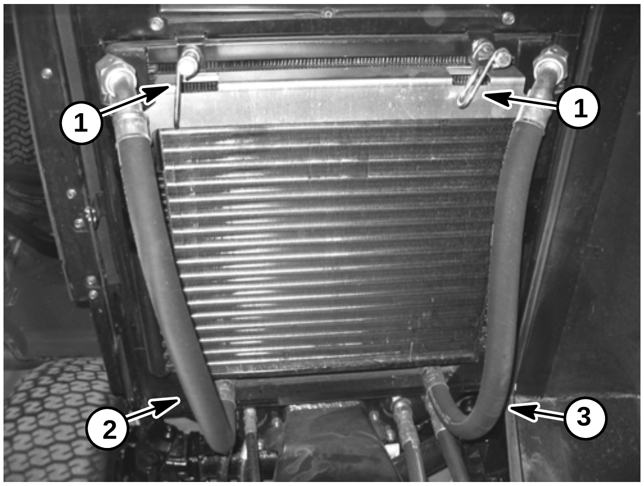


Figure 114

1. Oil cooler latch
2. Hose to oil cooler
3. Hose from oil cooler

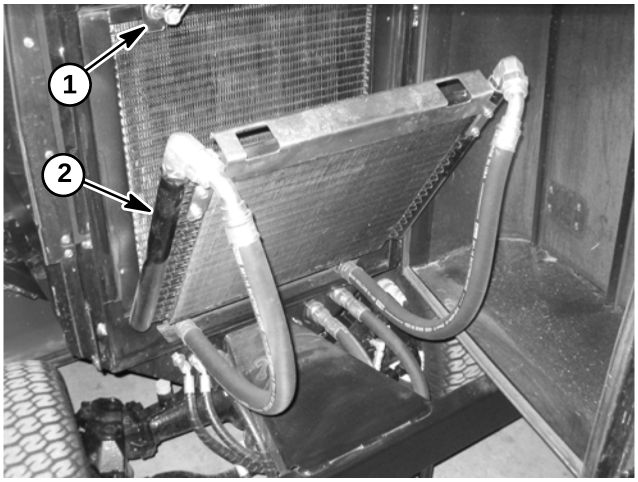


Figure 115

1. Oil cooler latch
2. Oil cooler

Hydraulic System

This page is intentionally blank.

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 the Operator's Manual for additional information when servicing the machine.

Toro Electronic Controllers (TEC)

Groundsmaster 4500–D machines use a single Toro Electronic Controller (TEC–5002) to manage machine electrical functions. Groundsmaster 4700–D machines use two (2) Toro Electronic Controllers (TEC–5002 and TEC–5001).

The controllers are microprocessor controlled that sense the condition of various machine switches (inputs) and direct electrical power to control appropriate machine functions (outputs) based on the state of the inputs. The status of inputs to the controllers as well as outputs from the controllers can be checked with the Diagnostic Display (see Special Tools).

The controllers on the Groundsmaster 4700–D appear identical but they are different in terms of the connectors and internal hardware. They are arranged in a master (TEC–5002) / slave (TEC–5001) configuration and therefore cannot be interchanged. Communication between the two controllers on the Groundsmaster 4700–D is provided with a CAN–bus system (see below).

Because of the solid state circuitry built into the Toro Electronic Controller (TEC), there is no method to test it directly. The TEC may be damaged if an attempt is made to test it with an electrical test device, such as a digital multimeter.

IMPORTANT: Before performing any welding on the machine, disconnect the battery cables from the battery, disconnect the wire harness connectors from the Toro Electronic Controller(s) and disconnect the terminal connector from the alternator to prevent damage to the machine electrical system.

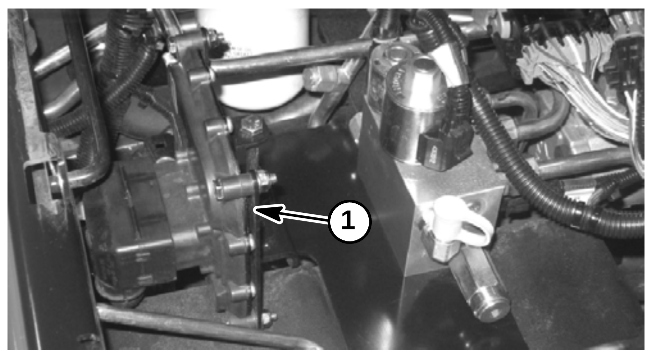


Figure 1

1. **Toro Electronic Controller (GM 4500–D shown)**

CAN–bus Communications (Groundsmaster 4700–D)

The two (2) TEC controllers (TEC–5002 and TEC–5001) used on the Groundsmaster 4700–D communicate with each other on a CAN–bus system. Using this system allows the traction unit to fully integrate all the different electrical components of the tractor and bring them together as one. The CAN–bus system reduces the number of electrical components and connections used on the machine and allows the number of wires in the wire harness to be significantly reduced.

CAN identifies the Controller Area Network that is used between the controllers on the Groundsmaster 4700–D.

Two (2) specially designed, twisted cables form the bus. These cables provide the data pathways between the controllers (TEC–5002 and TEC–5001) used on the machine. The engineering term for these two 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) cables to operate and communicate to the system: CAN High, CAN Low, B+ (power) and ground.

Electrical Drawings

The electrical schematics and other electrical drawings for the Groundsmaster 4500–D and Groundsmaster 4700–D are located in Chapter 9 – Foldout Drawings.

Electrical System

Special Tools

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

Multimeter

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

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

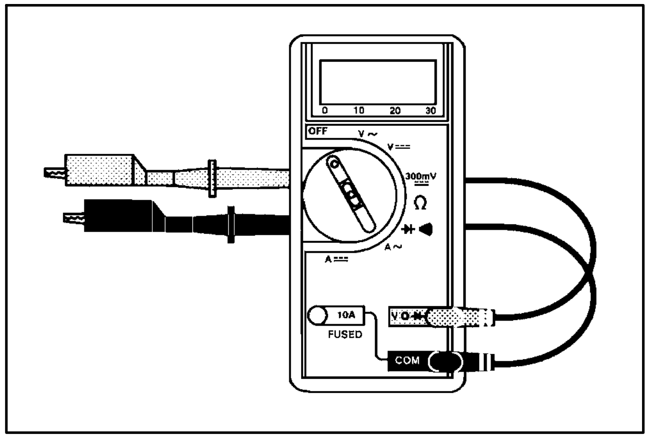


Figure 2

Skin–Over Grease

Special non–conductive grease which forms a light protective skin to help waterproof electrical switches and contacts.

Toro Part Number: **505–165**

Figure 3

Battery Hydrometer

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

Figure 4

Diagnostic Display

The Diagnostic Display (Fig. 5) can be connected to the wiring harness connector located inside the console arm to verify correct electrical functions of the machine. Toro Electronic Controllers (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 (GM4500–D / GM4700–D): **117–4795**

TEC–5001 (GM4700–D only): **117–4796**

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 5

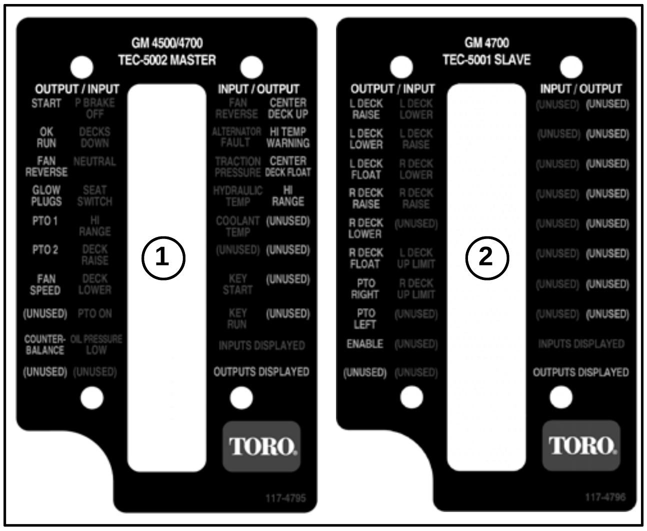


Figure 6

1. **Overlay 117–4795**
2. **Overlay 117–4796**

Battery Terminal Protector

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

Toro Part Number: **107–0392**

Figure 7

Troubleshooting

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

For effective troubleshooting and repairs, there must be a good understanding of the electrical circuits and components used on this machine (see Chapter 9 – Electrical Diagrams).

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

NOTE: Use the Diagnostic Display (see Special Tools in this chapter) to test Electronic Control Module inputs and outputs when troubleshooting an electrical problem on your Groundsmaster.

Diagnostic Display

Groundsmaster 4500–D and 4700–D machines are equipped with one (GM 4500–D) or two (GM 4700–D) Toro Electronic Controllers (TEC) which control machine electrical functions. The controllers monitor various input switches (e.g. ignition switch, seat switch, neutral switch) and energize outputs to actuate solenoids or relays for the requested machine function.

For the TEC to control the machine as desired, each of the inputs (switches and sensors) and outputs (solenoids and relays) must be connected and functioning properly.

The Diagnostic Display (see Special Tools in this chapter) is a tool to help the technician verify correct electrical functions of the machine.

IMPORTANT: The Diagnostic Display must not be left connected to the machine. It is not designed to withstand the environment of the machine's every day use. When use of the Diagnostic Display is completed, disconnect it from the machine and reconnect loopback connector to harness connector. The machine will not operate without the loopback connector installed on the harness. Store the Diagnostic Display in a dry, secure, indoor location and not on machine.

> ## CAUTION
>
> **The interlock switches are for the protection of the operator and bystanders and to ensure correct operation of the machine. Do not bypass or disconnect switches. Check the operation of the interlock switches daily for proper operation. Replace any malfunctioning switches before operating the machine.**

Verify Diagnostic Display Input Functions

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

2. Remove plate in front of seat to allow access to wire harness loop back connector. Locate wire harness and loop back connector (Fig. 8). Carefully unplug loop back 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).

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.

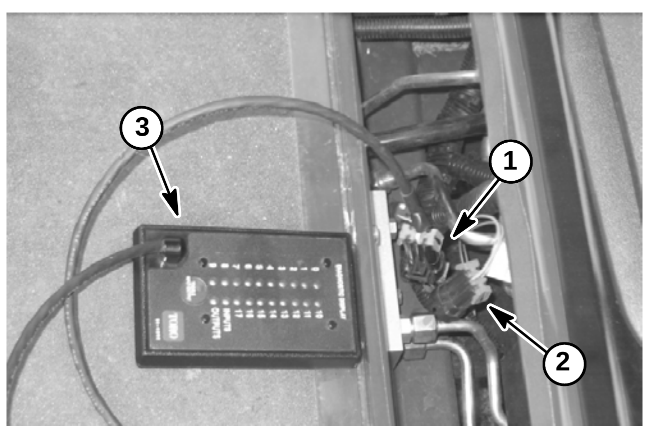


Figure 8

1. **Wire harness connector**
2. **Loop back connector**
3. **Diagnostic display**

5. The “inputs displayed” LED, on lower right column of the Diagnostic Display, should be 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 traction pressure, hydraulic temp and coolant temp should be illuminated. If the harness connector is disconnected from the sensor for any 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 loop back connector into wire harness. Secure access plate to frame.

TEC–5002 OVERLAY (BOTH GM4500–D AND GM4700–D)

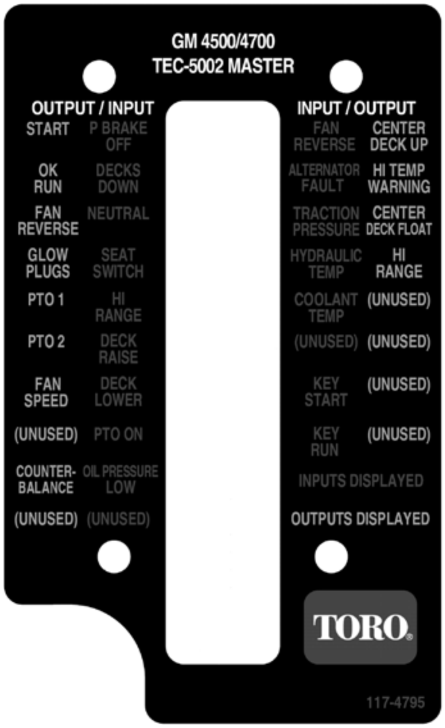


Figure 9

TEC–5001 OVERLAY (GM4700–D ONLY)

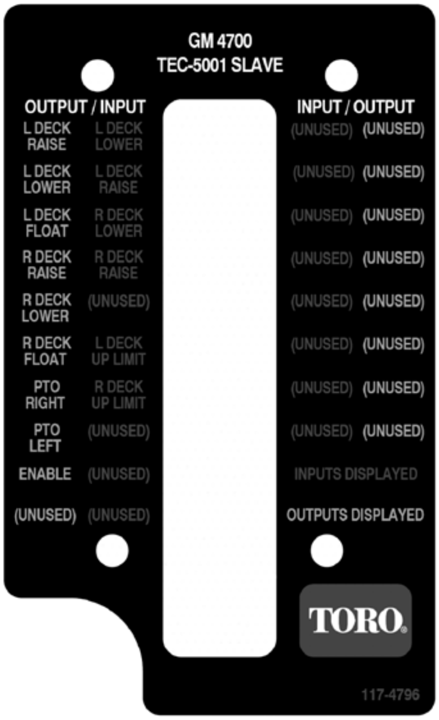


Figure 10

Electrical System

Diagnostic Display Inputs	Diagnostic Display LED Operation
P BRAKE OFF	Parking brake released: LED ON Parking brake applied: LED OFF
DECKS DOWN	Main 5 (center) cutting decks lowered: LED ON Main 5 (center) cutting decks raised: 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
DECK RAISE	Console arm lift switch for center decks in RAISE position: LED ON Lift switch for center decks NOT in RAISE position: LED OFF
DECK LOWER	Console arm lift switch for center decks in LOWER position: LED ON Lift switch for center decks NOT in LOWER position: LED OFF
PTO ON	PTO switch ON: LED ON PTO switch OFF: LED OFF
OIL PRESSURE LOW	Engine not running OR low engine oil pressure: LED ON Engine oil pressure OK: LED OFF
FAN REVERSE	Fan switch in momentary REVERSE position: LED ON Fan switch in AUTO position: LED OFF
ALTERNATOR FAULT	Engine not running or alternator faulty: LED ON Alternator OK: LED OFF
KEY START	Ignition switch in START: LED ON Ignition switch in ON or OFF: LED OFF
KEY RUN	Ignition switch in ON or START: LED ON Ignition switch in OFF: LED OFF
L DECK LOWER (GM 4700)	Console arm lift switch for left deck (#6) in LOWER position: LED ON Lift switch for left deck (#6) NOT in LOWER position: LED OFF
L DECK RAISE (GM 4700)	Console arm lift switch for left deck (#6) in RAISE position: LED ON Lift switch for left deck (#6) NOT in RAISE position: LED OFF
R DECK LOWER (GM 4700)	Console arm lift switch for right deck (#7) in LOWER position: LED ON Lift switch for right deck (#7) NOT in LOWER position: LED OFF
R DECK RAISE (GM 4700)	Console arm lift switch for right deck (#7) in RAISE position: LED ON Lift switch for right deck (#7) NOT in RAISE position: LED OFF
L DECK UP LIMIT (GM 4700)	Left cutting deck (#6) lowered: LED ON Left cutting deck (#6) raised: LED OFF
R DECK UP LIMIT (GM 4700)	Right cutting deck (#7) lowered: LED ON Right cutting deck (#7) raised: 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 controller(s). This is a quick way to determine if a machine malfunction is electrical or hydraulic.

NOTE: An open output (e.g. an unplugged connector or a broken wire) cannot be detected with the Diagnostic Display.

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

2. Remove plate in front of seat to allow access to wire harness loop back connector. Locate wire harness and loop back connector (Fig. 11). Carefully unplug loop back 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. The "outputs displayed" LED, on lower right column of the Diagnostic Display, should be 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 solenoid outputs (e.g. PTO 1, CENTER 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 loop back connector into wire harness. Secure access plate to frame.

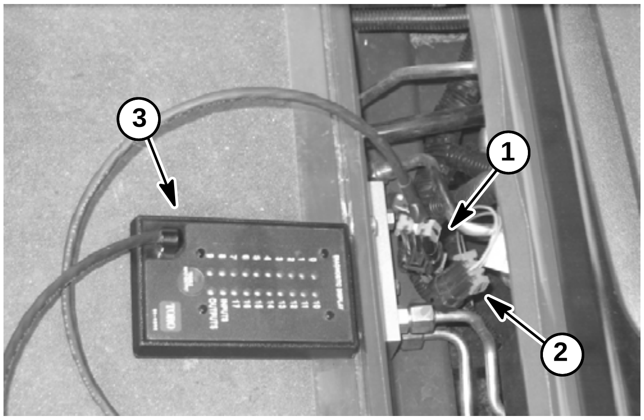


Figure 11

1. **Wire harness connector**
2. **Loop back connector**
3. **Diagnostic display**

Electrical System

Starting Problems

Problem	Possible Causes
No electrical power to machine (including gauges).	Battery is discharged. Battery cables are loose or corroded. Ground connection on machine is loose or corroded. The ignition switch or circuit wiring is faulty.
Starter solenoid clicks, but starter will not crank. **NOTE:** If the solenoid clicks, the problem is **not** in the interlock circuit.	Battery is discharged. Battery cables are loose or corroded. Ground connection on machine is loose or corroded. Wiring at the starter is faulty. Starter solenoid is faulty. Starter 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 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 (open). TEC–5002 fuses are faulty. The traction neutral switch or circuit wiring is faulty. Seat switch or circuit wiring is faulty. Ignition switch or circuit wiring is faulty. Parking brake switch or circuit wiring is faulty. Start relay or circuit wiring is faulty. Starter solenoid or starter motor is faulty. 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).

Starting Problems (continued)

Problem	Possible Causes
Engine cranks, but does not start.	Fuel tank is empty. Engine is not cranking fast enough. Engine and/or fuel may be too cold. Fuse F5–1 (40 amp) is faulty (open). Glow relay, glow plugs or fuse M1 (60 amp) are faulty. Engine run solenoid or circuit wiring is faulty. Fuel pump is faulty. Engine or fuel system is malfunctioning (see Chapter 3 – Kubota Diesel Engine).
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.

General Run and Transport Problems

Engine continues to run, but should not, when the ignition switch is turned off.	The engine fuel stop solenoid is stuck open. Ignition switch or circuit wiring is faulty.
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. Traction neutral switch or circuit wiring is faulty.
The engine stops during operation, but is able to restart.	The operator is lifting off the seat. The seat switch or circuit wiring is faulty. The ignition switch or circuit wiring is faulty.
The engine kills when the traction pedal is depressed.	The operator is lifting off the seat. The parking brake is applied. The seat switch or circuit wiring is faulty. The parking brake switch or circuit wiring is faulty.
Battery does not charge.	Loose, corroded or broken wire(s) in charging circuit. The alternator is faulty. Battery is damaged.

Cutting Deck Operating Problems

Cutting decks run, but should not, when raised. Decks shut off with PTO switch.	The cutting deck position switch or circuit wiring is faulty. Wire harness connections are incorrectly connected to hydraulic solenoid valve coils on hydraulic deck control manifold.
Cutting decks run, but should not, when raised. Decks do not shut off with the PTO switch.	The deck position switch or circuit wiring AND PTO switch or circuit wiring are faulty. A hydraulic problem exists (see Troubleshooting Section of Chapter 4 – Hydraulic System).
Cutting decks run, but should not, when lowered with PTO switch in the OFF (disengage) position.	The PTO switch or circuit wiring is faulty.
Cutting deck(s) do not operate.	The cutting decks are not fully lowered. The operator seat is unoccupied. Traction speed is not in LOW range (4WD). The PTO switch or circuit wiring is faulty. The cutting deck position switch or circuit wiring to the affected deck(s) is faulty. Hydraulic solenoid valve coil(s) or circuit wiring to the affected decks is faulty. A hydraulic problem exists (see Troubleshooting section of Chapter 4 – Hydraulic System).
Cutting deck(s) operation is intermittent over rough terrain.	The cutting deck lift/lower switch or circuit wiring for the affected decks 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 60º to 100ºF (16º 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 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 Traction Unit Operator's Manual. Your Groundsmaster is equipped with an Toro Electronic Controller (TEC) which monitors interlock switch operation. Testing of individual interlock switches and relays is included in the Component Testing section of this Chapter.

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

Component Testing

For accurate resistance and/or continuity checks, electrically disconnect the component being tested from the circuit (e.g. unplug the ignition switch connector before checking continuity on the switch terminals).

NOTE: For engine component testing information, see the Kubota Workshop Manual, Diesel Engine, V2403–M–T–E3B 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).

Testing

1. Before disconnecting the ignition switch for testing, the switch and its circuit wiring should be tested as a TEC input with the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If the Diagnostic Display verifies that the 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 13. 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 9 – 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).

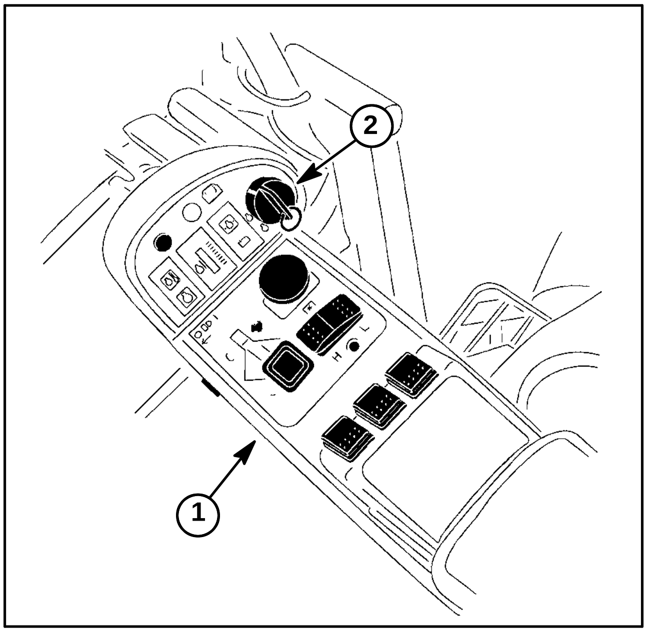


Figure 12

1. **Console arm**
2. **Ignition switch**

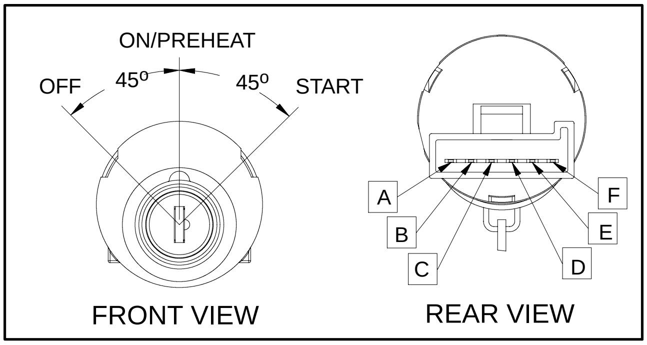


Figure 13

Fuses

Groundsmaster 4500–D and 4700–D use numerous fuses for circuit protection. The fuses are located in two (2) areas of the machine. Most of the fuses reside in the power center behind the operator's seat. An in–line fuse holder located in the wire harness near the engine starter motor holds an additional fuse (F5–1) that protects the engine run solenoid circuit.

Fuse Identification and Function (Figs. 14 and 15)

Fuse F1–1 (20 Amp) supplies power to engine starter circuit.

Fuse F1–2 position available for optional flow divider kit.

Fuse F1–3 position available for optional kit.

Fuse F1–4 position available for optional kit.

Fuse F2–1 (10 Amp) supplies power to the light circuit.

Fuse F2–2 (10 Amp) supplies power to the operator seat circuit.

Fuse F2–3 (10 Amp) supplies power to the powerpoint.

Fuse F2–4 (10 Amp) supplies power to the main power circuit.

Fuse F3–1 (2 Amp) supplies logic power to the TEC–5002 controller.

Fuse F3–2 (7.5 Amp) supplies power to the TEC–5002 controller.

Fuse F3–3 (7.5 Amp) supplies power to the TEC–5002 controller.

Fuse F3–4 (7.5 Amp) supplies power to the TEC–5002 controller.

Fuse F4–1 (2 Amp) supplies logic power to the TEC–5001 controller.

Fuse F4–2 (7.5 Amp) supplies power to the TEC–5001 controller.

Fuse F4–3 (7.5 Amp) supplies power to the TEC–5001 controller.

Fuse F4–4 (7.5 Amp) supplies power to the TEC–5001 controller.

Fuse M1 (60A) supplies power to the glow plug circuit.

Fuse M2 position available for operator cab option.

Fuse F5–1 (in–line 40A) supplies power for the engine run solenoid.

Fuse Testing

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

2. Remove power center cover from operator platform to access fuses.

3. Remove fuse from fuse block for testing. Fuse should have continuity across the terminals.

4. After fuse testing is completed, install and secure power center cover.

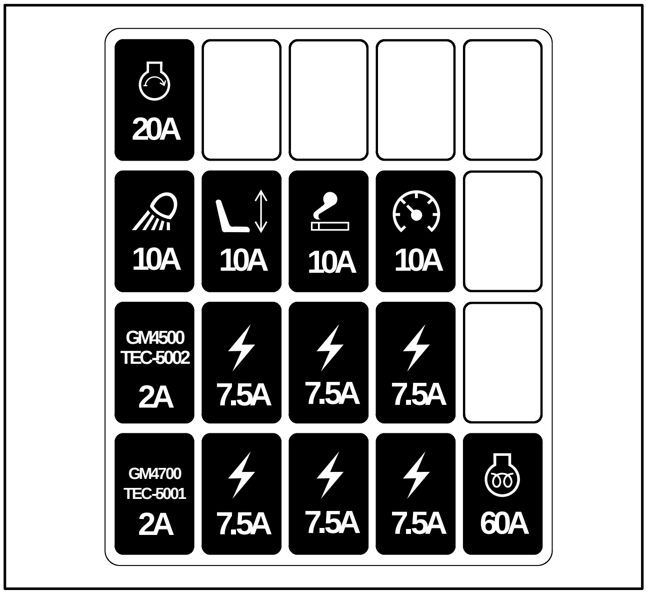


Figure 14

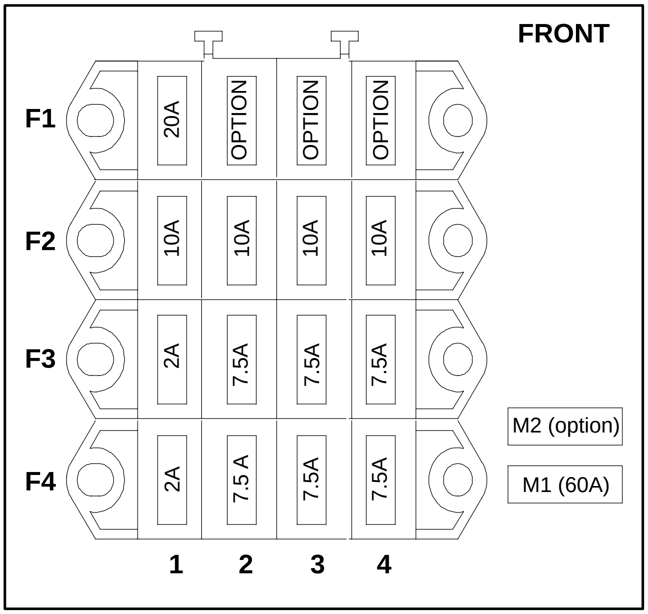


Figure 15

Indicator 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 decks) will disengage.

To test the high temperature shutdown 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 7 to 10 seconds while the ignition switch is left in ON.

Testing Indicator Lights

1. Apply 12 VDC to terminals 1A and 2A.

2. Ground terminals 1B and 2B.

3. Both indicator lights should light.

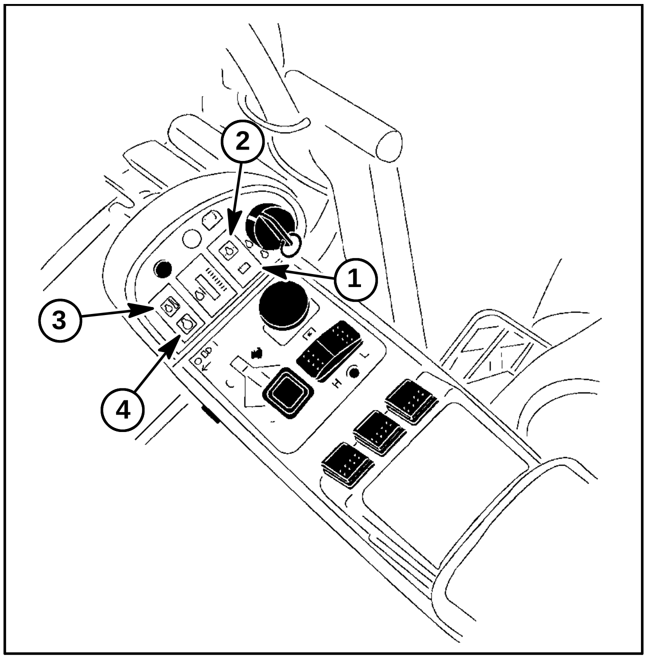


Figure 16

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

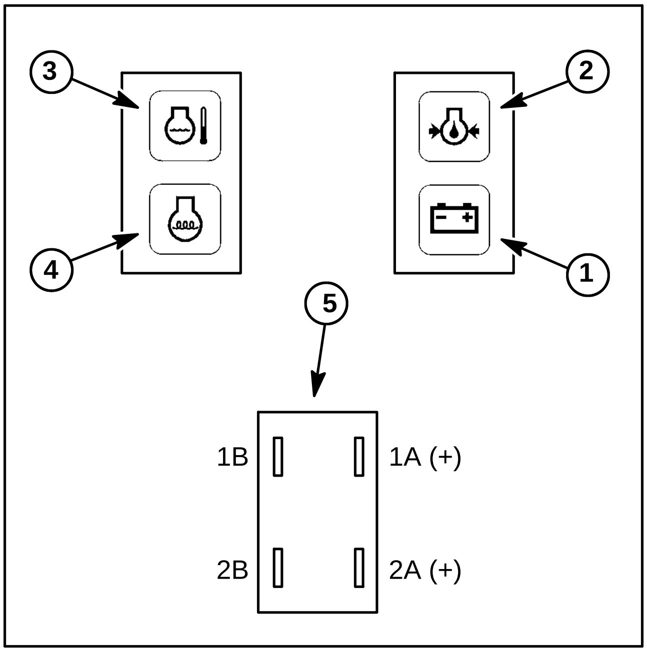


Figure 17

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. 18). The PTO switch is pulled up to engage the PTO and pushed in to disengage the PTO.

NOTE: To engage the PTO, the seat has to be occupied, traction speed has to be in low range (4WD) and the cutting decks have to be fully lowered.

Testing

1. Before disconnecting the PTO switch for testing, the switch and its circuit wiring should be tested as a TEC input with the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If the Diagnostic Display verifies that the PTO switch and circuit wiring **are** functioning correctly, no further switch testing is necessary. If, however, the Display determines that the PTO switch and circuit wiring **are not** functioning correctly, proceed with test.

2. Make sure ignition switch is OFF. Remove key from ignition switch.

3. Disassemble console arm to gain access to PTO switch (see Console Arm Disassembly in the Service and Repairs section of Chapter 7 – Chassis).

4. Disconnect harness electrical connector from the PTO switch.

5. The switch terminals are marked as shown in Figure 19. 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 9 – 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).

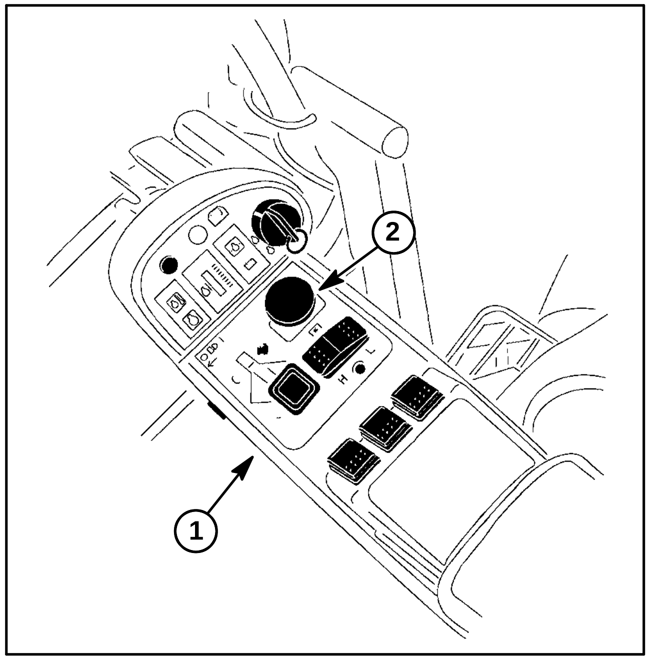


Figure 18

1. **Console arm**
2. **PTO switch**

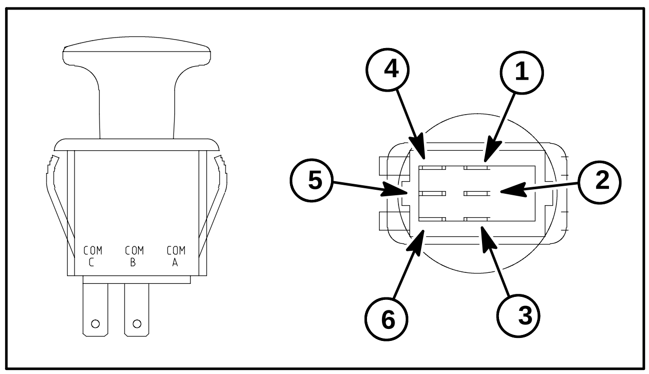


Figure 19

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

Cutting Deck Lift Switches

The cutting deck lift switches are used as inputs for the TEC controller to raise or lower the cutting decks. When the front of a lift switch is depressed and held, the controlled decks will lower. When the rear of a lift switch is depressed and held, the controlled decks will raise. The decks will remain in position when the switch is released. The lift switches are located on the console arm (Fig. 20).

NOTE: To lower the cutting decks, traction speed has to be in low range (4WD). Also, to raise or lower the decks, the 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 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 22. 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 9 – 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).

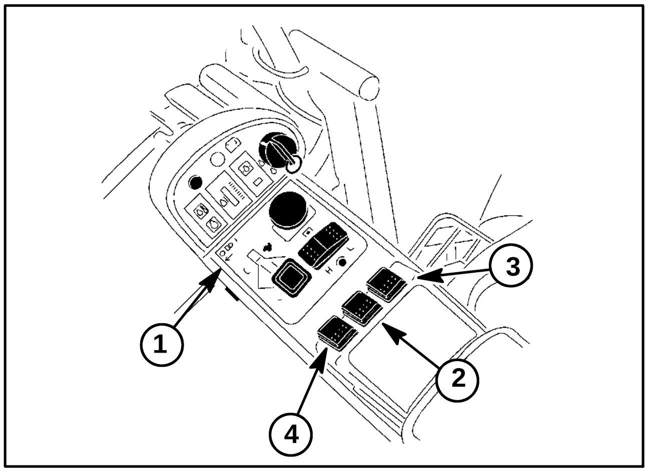


Figure 20

1. **Console arm**
2. **Lift switch (#1 to #5)**
3. **Lift switch (GM4700 #7)**
4. **Lift switch (GM4700 #6)**

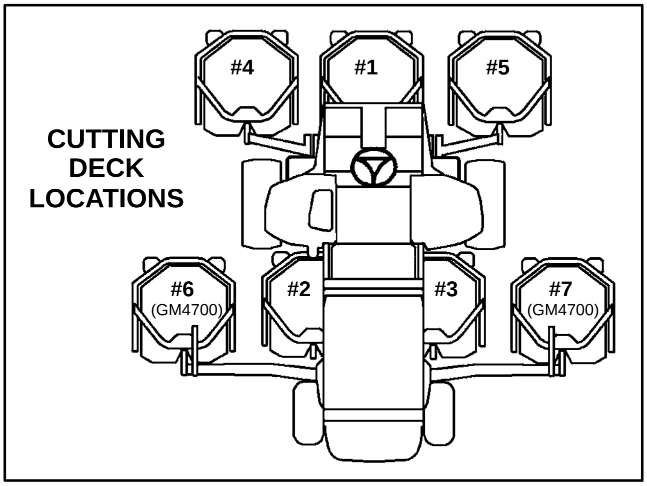


Figure 21

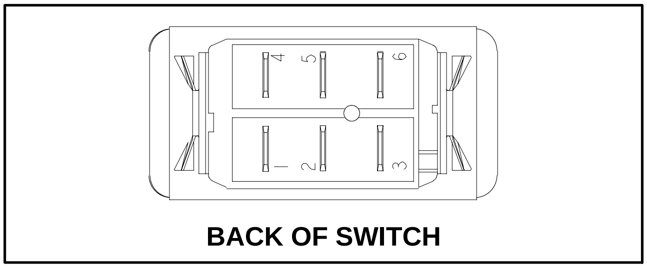


Figure 22

NOTE: Lift switch terminals 4, 5 and 6 are not used on Groundsmaster 4500–D and 4700–D machines.

Electrical System

Hi–Low Speed and Headlight Switches

The Hi–Low speed switch is located on the console arm (Fig. 23). This two position rocker switch allows the traction speed to be set to high speed (transport) or low speed (mow).

The headlight switch is located on the operator side of the console arm (Fig. 23). This two position rocker 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 input with the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter).

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 24. 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 9 – 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).

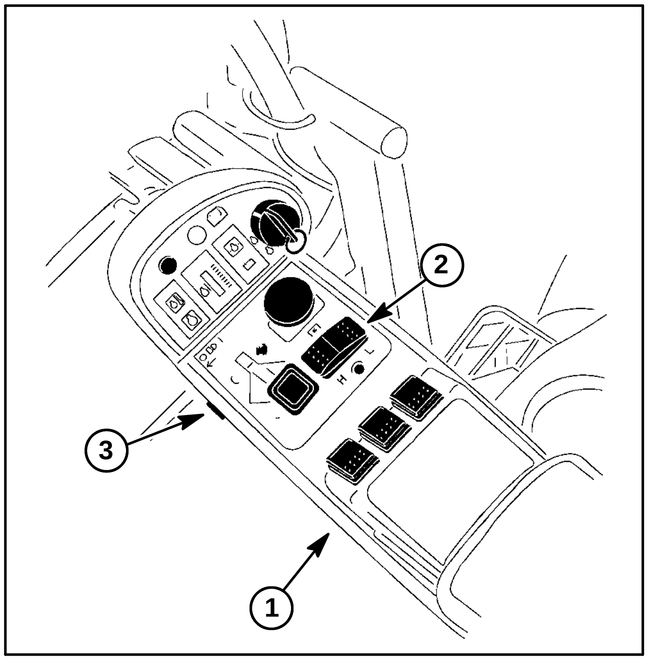
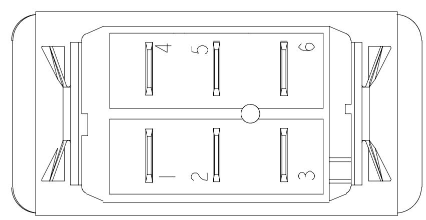


Figure 23

1. **Console arm**
2. **Hi–Low speed switch**
3. **Headlight switch**



BACK OF SWITCH

Figure 24

NOTE: Switch terminals 1, 4, 5 and 6 are not used on Groundsmaster 4500–D and 4700–D machines.

Engine Cooling Fan Switch

The engine cooling fan switch is located on the outside of the console arm (Fig. 25). This two position rocker switch allows 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 input with the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If the Diagnostic Display verifies that cooling fan switch and circuit wiring **are** functioning correctly, no further switch testing is necessary. If, however, the Display determines that cooling fan 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 engine cooling fan switch (see Console Arm Disassembly in the Service and Repairs section of Chapter 7 – Chassis).

4. Disconnect harness electrical connector from the cooling fan switch.

5. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each position. The switch terminals are marked as shown in Figure 26. The circuitry of the cooling fan switch is shown in the chart below. Verify continuity between switch terminals.

SWITCH POSITION	NORMAL CIRCUITS	OTHER CIRCUITS
AUTO	2 + 3	5 + 6
MANUAL REVERSE	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 9 – Foldout Drawings).

7. After testing is completed, connect wire harness connector to the cooling fan switch.

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

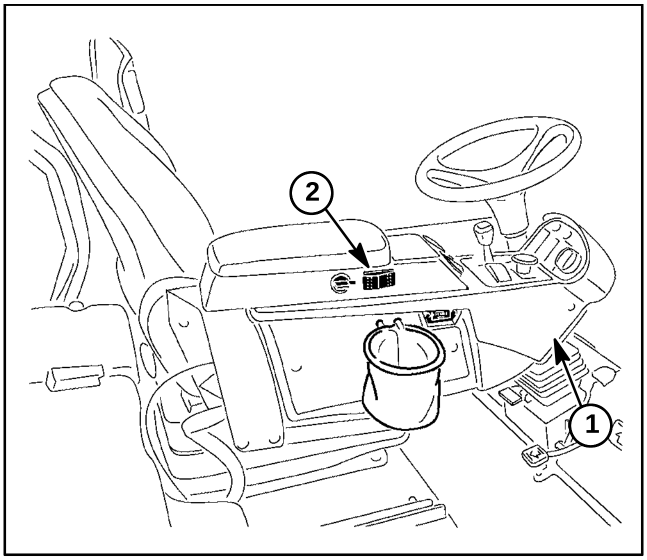


Figure 25

1. Console arm
2. Cooling fan switch

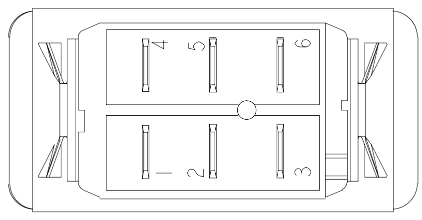


Figure 26

NOTE: Fan switch terminals 3, 4, 5 and 6 are not used on Groundsmaster 4500–D and 4700–D machines.

Electrical System

Seat Switch

The seat switch is normally open and closes when the operator is on the seat. The seat switch and its electrical connector are located in the seat assembly. If the traction system or PTO switch is engaged when the operator raises out of the seat, 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. 27).

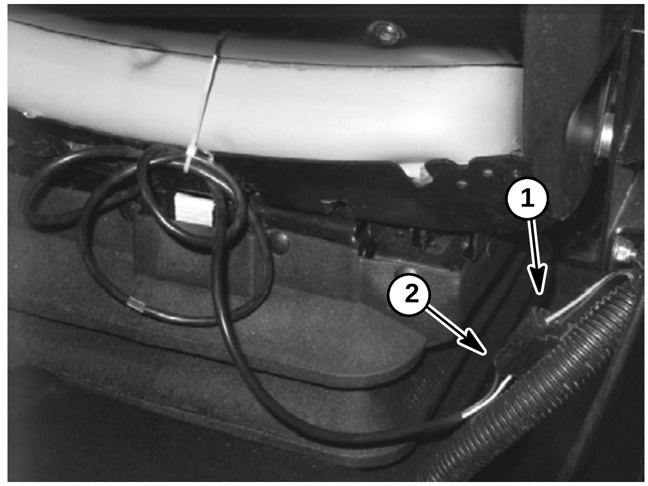


Figure 27

1. **Wire harness connector** 2. **Seat switch connector**

Testing

1. Before disconnecting the seat switch for testing, the switch and its circuit wiring should be tested as a TEC input with the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If the Diagnostic Display verifies that the 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 be no 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 parking brake switch is a normally open proximity switch. The parking brake switch is attached to the bottom of the RH brake pedal (Fig. 28).

When the parking brake is not applied, the parking brake detent is positioned near the target end of the parking brake switch so the switch is closed. The parking brake detent is moved away from the switch when the parking brake is applied causing the switch to open.

Switch Testing

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

2. Before disconnecting the parking brake switch for testing, the switch and its circuit wiring should be tested as a TEC input with the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If the Diagnostic Display verifies that the 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.

3. Make sure ignition switch is OFF. Remove key from ignition switch.

4. Disconnect wire harness electrical connector from the parking brake switch.

5. Check the continuity of the switch by connecting a multimeter (ohms setting) across the connector terminals.

6. When the parking brake is released (brake not applied), there should be continuity (closed) between the switch terminals.

7. When the parking brake pedal is depressed (brake applied), there should not be continuity (open) between the switch terminals.

NOTE: When installing the parking brake switch to the brake pedal, place switch plate tab into switch mounting hole that is closest to target end of switch (Fig. 29).

8. Replace parking brake switch if testing determines that it is faulty.

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

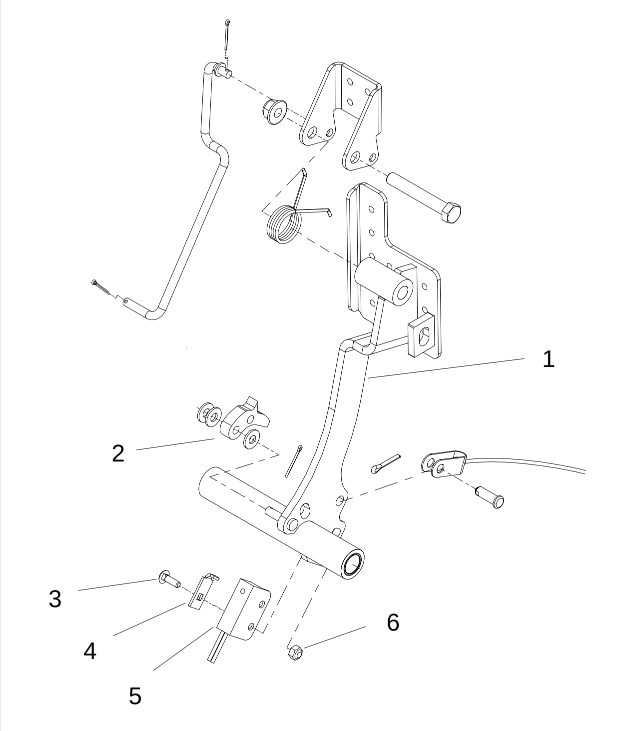


Figure 28

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

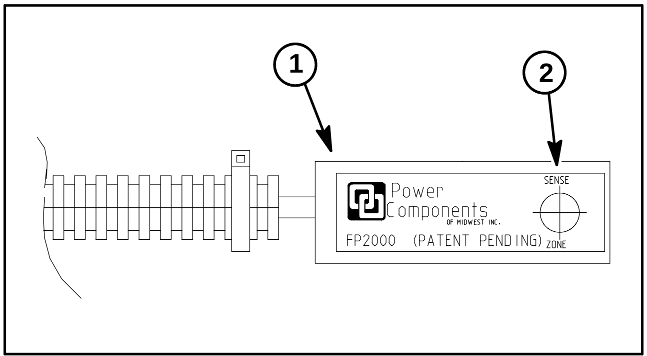


Figure 29

1. **Brake switch**
2. **Switch target area**

Cutting Deck Position Switch

The cutting deck position switch is a normally open proximity switch that is located on the traction unit frame (Fig. 30). The sensing plate is located on the cutting deck lift arm. The Groundsmaster 4500–D uses two (2) cutting deck position switches: for decks 4 and 5. There are four (4) deck position switches on the Groundsmaster 4700–D: for decks 4, 5, 6 and 7.

When a cutting deck is lowered, the sensing plate is located near the position switch and the switch closes. This closed switch provides an input for the TEC controller to allow the lowered cutting decks to operate.

Switch Testing

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

2. Before disconnecting the cutting deck position switch for testing, the switch and its circuit wiring should be tested as a TEC input with the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If the Diagnostic Display verifies that the position switch and circuit wiring **are** functioning correctly, no further switch testing is necessary. If, however, the Display determines that the position switch and circuit wiring **are not** functioning correctly, proceed with test.

3. Make sure ignition switch is OFF. Remove key from ignition switch.

4. Disconnect deck position switch that requires testing from machine wire harness.

5. Check the continuity of the switch by connecting a multimeter (ohms setting) across the switch connector terminals.

6. With the cutting deck in the lowered position, there should be continuity across the switch terminals.

7. Raise the cutting deck. There should be no continuity across the switch terminals.

8. Replace position switch if testing determines that it is faulty.

9. After testing is complete, connect wire harness electrical connector to the position switch.

Switch Adjustment

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

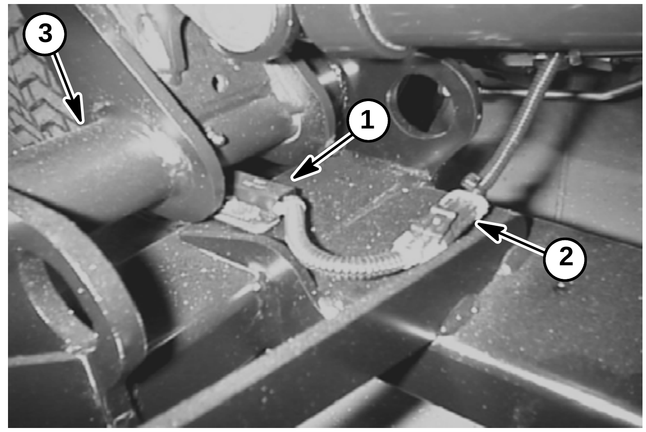


Figure 30

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

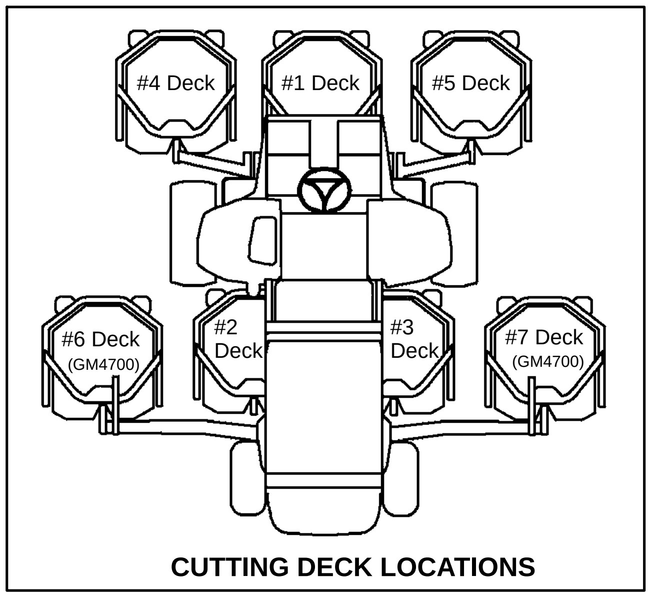


Figure 31

Hour Meter

The hour meter is located on the outside of the console arm.

1. Connect the positive (+) terminal of a 12 VDC source to the positive (+) terminal of the hour meter.

2. Connect the negative (–) terminal of the voltage source to the other terminal of the hour meter.

3. The hour meter should move a 1/10 of an hour in six minutes.

4. Disconnect voltage source from the hour meter.

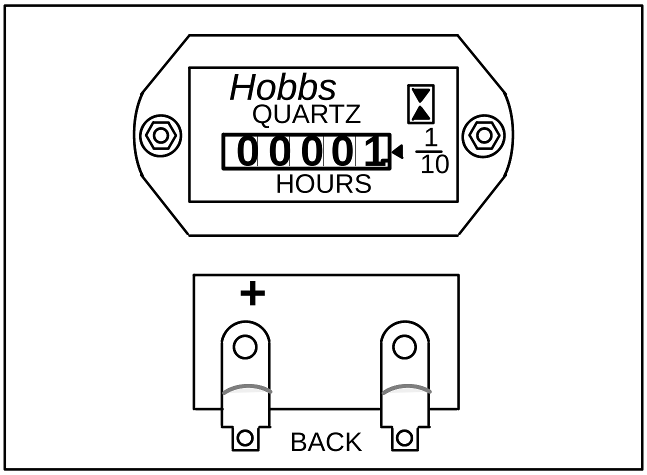


Figure 32

Temperature Gauge

The temperature gauge on the control panel indicates engine coolant temperature level during machine operation (Fig. 33). The changing resistance of the engine temperature sender signals the temperature gauge.

The temperature gauge should display the first green segment when the ignition switch is turned to ON. The first yellow segment on the gauge should display when engine coolant temperature is approximately 212°F (100°C).

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

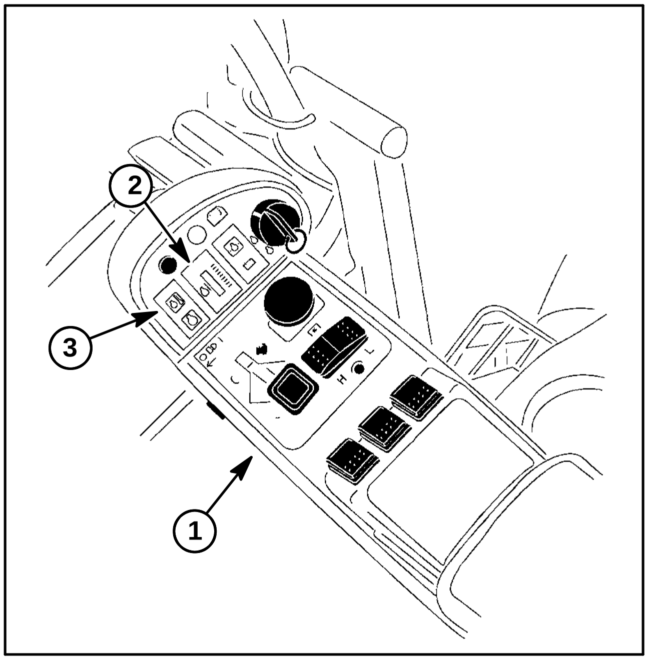


Figure 33

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

Electrical System

Glow and Main Power Relays

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

The glow relay is used to provide current to the engine glow plugs when energized by the TEC–5002 controller. The TEC–5002 controls and monitors the operation of the glow relay.

The main power relay is used to provide current to the TEC controllers and most of the fuse protected circuits (headlights, 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.

Testing

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

2. To make sure that machine operation does not occur unexpectedly, disconnect negative (–) cable from battery and then disconnect positive (+) cable from battery (see Battery Service in the Service and Repairs section of this chapter).

3. Remove cover from power center and locate relay to be tested.

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.

8. Secure relay to mounting bracket and connect wire harness connector to relay. Install cover 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).

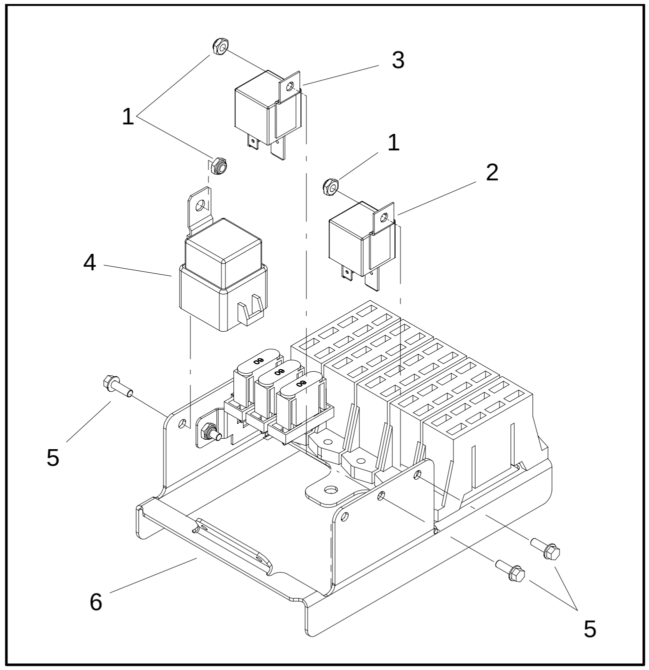


Figure 34

1. **Lock nut**
2. **Main power relay**
3. **Glow relay**
4. **Start relay**
5. **Flange head screw**
6. **Mounting bracket**

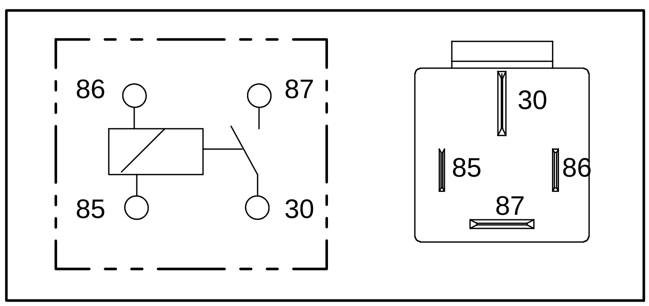


Figure 35

Start Relay

The start relay is located at the power center behind the operator seat. This relays is attached to the wire harness with a five (5) wire connector (Fig. 37).

The start relay is used to provide current to the engine starter motor when energized by the TEC–5002 controller. The TEC–5002 controls and monitors the operation of the start relay.

Testing

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

2. To make sure that machine operation does not occur unexpectedly, disconnect negative (–) cable from battery and then disconnect positive (+) cable from battery (see Battery Service in the Service and Repairs section of this chapter).

3. Remove cover from power center and locate start relay.

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 should make and break continuity between terminals 30 and 87 as +12 VDC is applied and removed from terminal 85.

7. Disconnect voltage from terminal 85 and multimeter lead from terminal 87.

8. Connect multimeter (ohms setting) leads to relay terminals 30 and 87A. Apply +12 VDC to terminal 85. The relay should make and break continuity between terminals 30 and 87A as +12 VDC is applied and removed from terminal 85.

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

10. Secure relay to mounting bracket and connect wire harness connector to relay. Install cover 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).

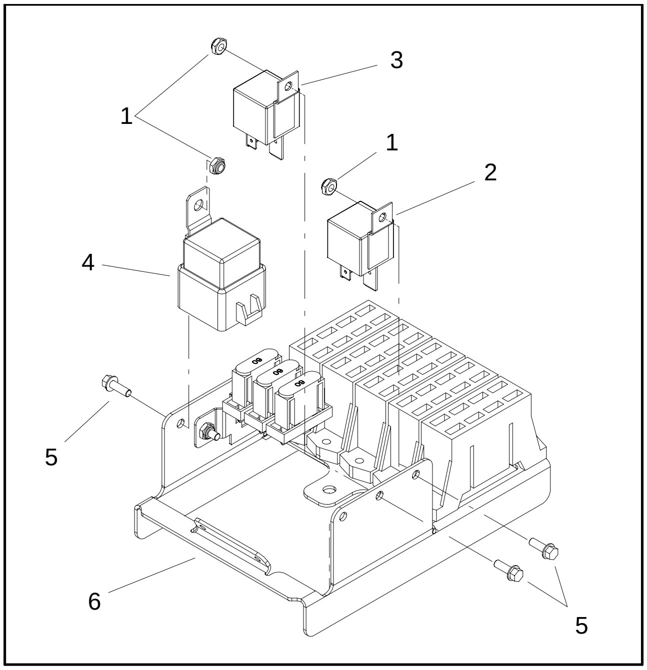


Figure 36

1. **Lock nut**
2. **Main power relay**
3. **Glow relay**
4. **Start relay**
5. **Flange head screw**
6. **Mounting bracket**

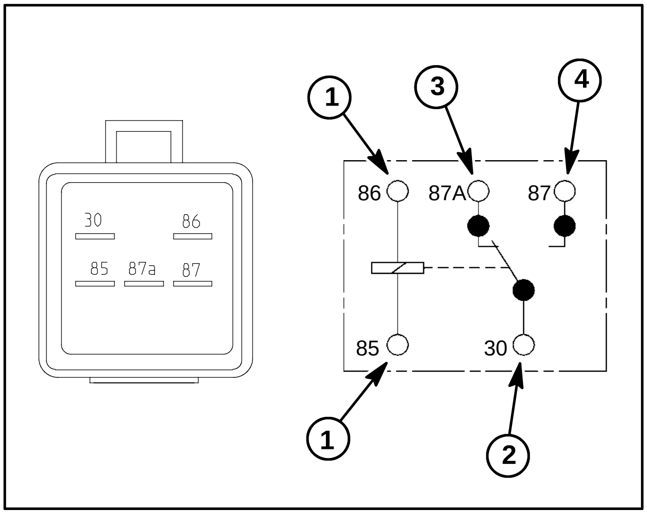


Figure 37

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

Electrical System

Hydraulic Solenoid Valve Coils

Numerous hydraulic solenoid valve coils are used on the hydraulic control manifolds of Groundsmaster 4500-D and 4700-D machines. When energized by the TEC controller, these coils provide hydraulic circuit control.

Two (2) different solenoid valve coils are used on the 4500-D and 4700-D. A coil can be identified by measuring it's height and diameter (Fig. 38). 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).

Testing

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

2. Locate hydraulic valve solenoid coil to be tested. Identify coil by measuring the coil diameter and coil height (Fig. 38).

3. Disconnect wire harness connector from coil.

NOTE: Prior to taking small resistance readings with a digital multimeter, short the meter test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from from the measured value of the component you are testing.

4. Using a multimeter (ohms setting), measure resistance between the two (2) connector terminals on the solenoid valve coil. The correct resistance for the solenoid coil is identified below:

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

NOTE: Solenoid coil resistance should be measured with solenoid at approximately 68^{o}F (20^{o}C). Resistance may be slightly different than listed at different temperatures. Typically, a failed solenoid coil will either be shorted (very low or no resistance) or open (infinite resistance).

5. If solenoid coil resistance is incorrect, replace solenoid (see Hydraulic Solenoid Valve Coil Removal and Installation in the Service and Repairs section of this chapter).

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

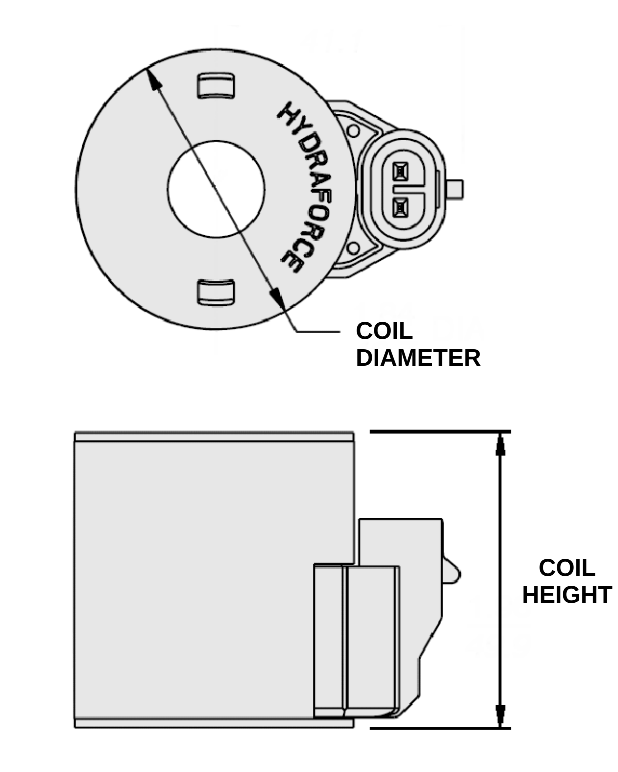


Figure 38

Engine Coolant and Hydraulic Oil Temperature Senders

Two (2) identical temperature senders are used as inputs for the TEC–5002 controller to identify if either the engine coolant or hydraulic oil temperature has reached an excessive level. The coolant temperature sender threads into the radiator (Fig. 39). The hydraulic oil temperature sender is attached to the 4WD/2WD control manifold at the front of the machine (Fig. 40).

Testing

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

2. Before disconnecting temperature sender for testing, the sender and its circuit wiring should be tested as a TEC input with the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If the Diagnostic Display verifies that the sender and circuit wiring **are** functioning correctly, no further sender testing is necessary. If, however, the Display determines that the temperature sender and circuit wiring **are not** functioning correctly, proceed with test.

3. Locate temperature sender that is to be tested. Disconnect wire harness connector from sender.

4. Thoroughly clean area around temperature sender and remove sender.

5. Put sensing end of sender in a container of oil with a thermometer and slowly heat the oil (Fig. 41).

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 tested component.

6. Check resistance of the sender with a multimeter (ohms setting) as the oil temperature increases. Replace sender if specifications are not met.

OIL TEMP	SENDER RESISTANCE
68°F (20°C)	11.6 to 13.5 ohms
140°F (60°C)	2.3 to 2.5 ohms
212°F (100°C)	0.6 to 0.7 ohms

7. After allowing the sender to cool, install sender:

A. Install new O–ring on sender and thread sender into port. Torque from **9 to 11 ft–lb (12.3 to 14.9 N–m)**.

B. Connect wire harness connector to sender.

8. Check and fill system (coolant or hydraulic) to proper level.

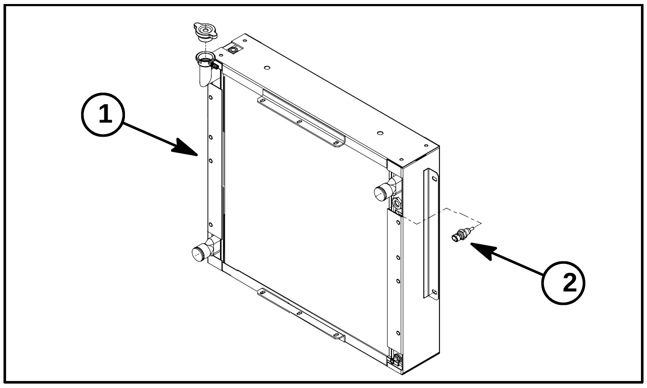


Figure 39

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

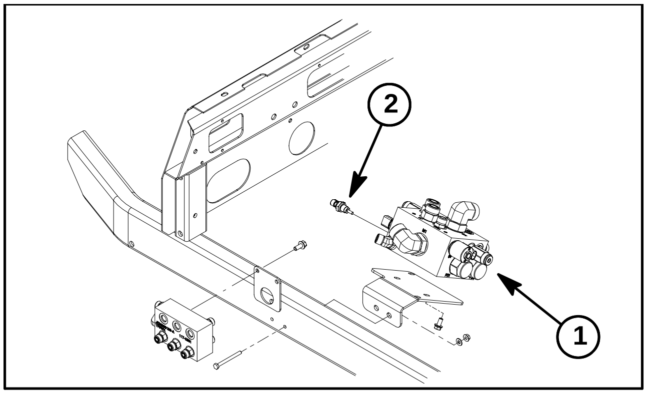


Figure 40

1. **4WD/2WD manifold**
2. **Oil temp sender**

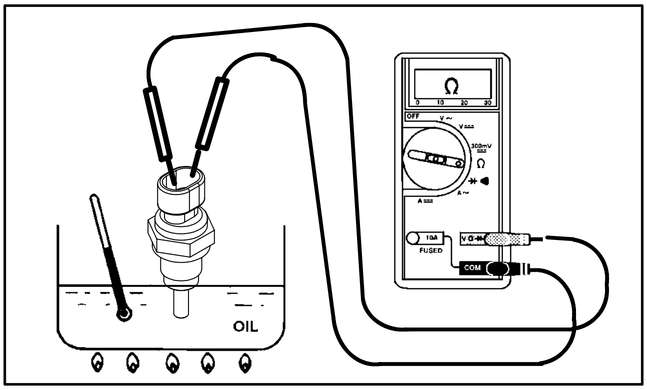


Figure 41

Fuel Pump

The fuel pump is energized by the TEC–5002 controller when the ignition switch is either in the START or ON position. The fuel pump is attached to the left side frame rail.

IMPORTANT: When testing fuel pump, make sure that pump is not operated without fuel.

Fuel Pump Capacity Test

1. Park machine on a level surface, lower cutting decks, stop engine and engage parking brake. Remove key from ignition switch.
2. Raise and support hood.
3. Remove 20A fuse (F1–1) (Fig. 43) from fuse block to prevent the engine from cranking.
4. Make sure fuel hoses attached to the fuel pump are free of obstructions.
5. Disconnect fuel pump discharge hose from the fuel/ water separator inlet fitting (Fig. 42).
6. Place disconnected fuel hose (pump discharge) into a large, graduated cylinder sufficient enough to collect 1 quart (0.95 liter).
7. Collect fuel in the graduated cylinder by turning ignition switch to the ON position. Allow pump to run for 15 seconds, then turn switch to OFF.
8. The amount of fuel collected in the graduated cylinder should be approximately 16 fl oz (475 ml) after 15 seconds.
9. Replace fuel pump if necessary.
10. Install fuel hose to the fuel/water separator. Secure hose with hose clamp.
11. Install 20A fuse into fuse block.
12. Bleed the fuel system.
13. Lower and secure hood.

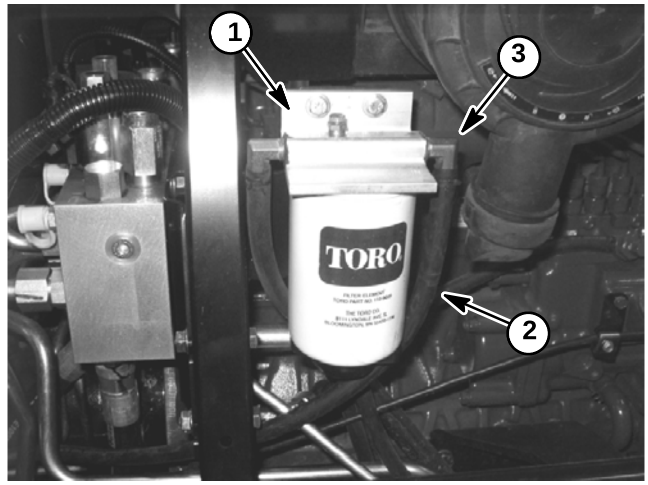


Figure 42

1. **Fuel/water separator**
2. **Pump discharge hose**
3. **Inlet fitting**

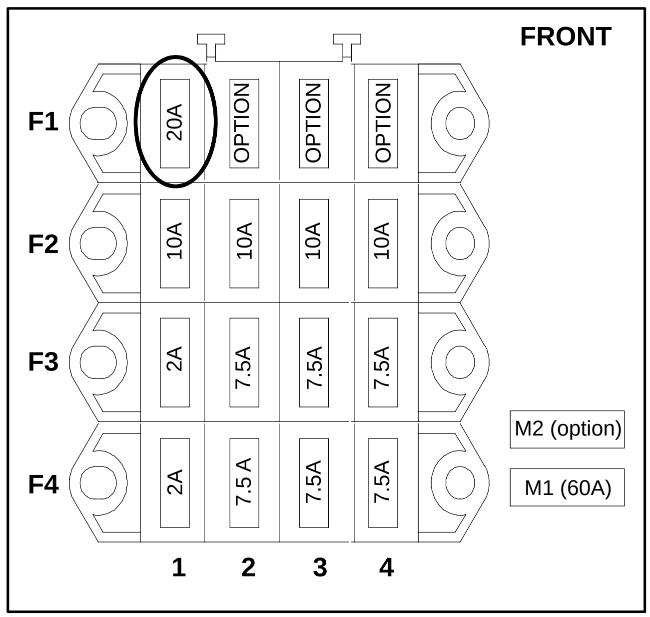


Figure 43

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. 44). There is a gray wire attached to the terminal of the sender.

The resistance of the temperature sender reduces as the engine coolant temperature increases. The changing resistance of the temperature sender signals the console temperature gauge to indicate engine coolant temperature during machine operation.

Temperature Sender Test

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

CAUTION

Make sure engine is cool before removing the temperature sender from engine.

2. Lower coolant level in the engine and remove the temperature sender from water flange.

3. Put sender in a container of oil with a thermometer and slowly heat the oil (Fig. 45).

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.

4. Check resistance of the sender with a multimeter (ohms setting) as the temperature increases. Replace sender if specifications are not met.

OIL TEMP	TEMP SENDER RESISTANCE
100°F (38°C)	460 ohms (approximate)
160°F (71°C)	140 ohms (approximate)
200°F (93°C)	54 to 78 ohms
221°F (105°C)	50 ohms (approximate)

5. Install sender to the water flange.

A. Clean threads of water flange and sender thoroughly. Apply thread sealant to the threads of the sender.

B. Screw sender into the water flange. Torque sender from **16 to 20 ft–lb (21.7 to 27.1 N–m)**.

C. Connect gray wire to sender. Apply skin–over grease (Toro Part No. 505–47) to sender terminal.

6. Fill engine cooling system.

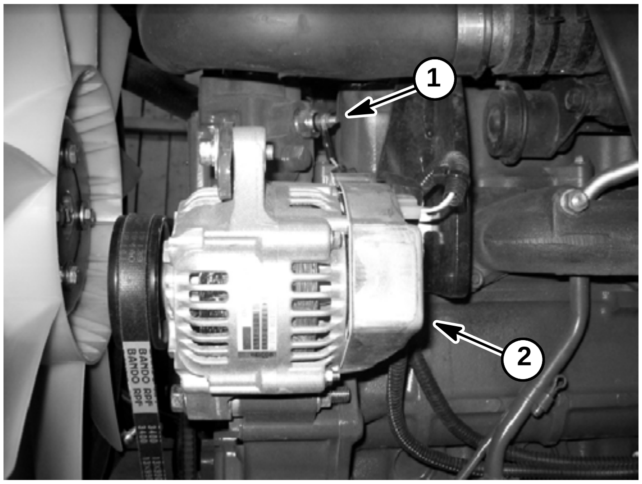


Figure 44

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

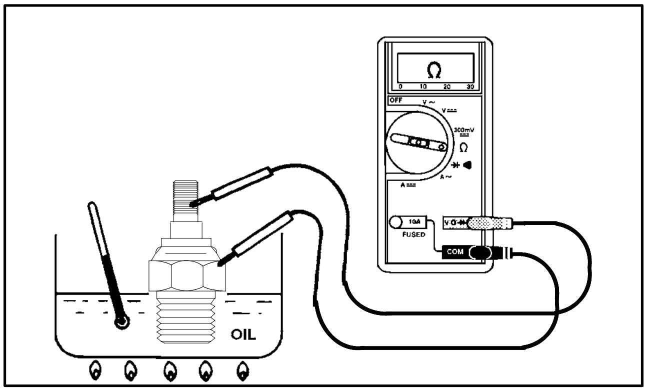


Figure 45

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. The switch is located on the right side of the piston (traction) pump (Fig. 46).

Testing

Before disconnecting the traction neutral switch for testing, the switch and its circuit wiring should be tested as a TEC input with the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If the Diagnostic Display verifies that neutral switch and circuit wiring **are** functioning correctly, no further switch testing is necessary. If, however, the Display determines that neutral switch and circuit wiring **are not** functioning correctly, proceed with test.

To test the traction neutral switch, make sure that the ignition switch is in the OFF position and the key is removed from the switch. Disconnect the wire harness connector from the neutral switch and connect a multimeter 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 and closing. Allow the traction pedal to return to the neutral position. There should be continuity across the switch terminals when the traction pedal is in the neutral position.

See Piston Pump Control Assembly in Chapter 4 – Hydraulic Systems for disassembly and assembly procedures for the neutral switch.

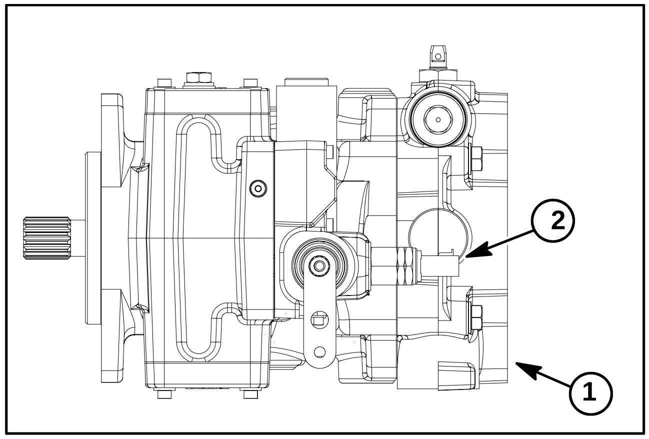


Figure 46

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

Diode Assembly

The engine wire harness contains a diode that is used for circuit protection from voltage spikes when the engine starter solenoid is de–energized. The diode plugs into the wiring harness near the starter motor (see Engine Wire Harness Drawing in Chapter 9 – Foldout Drawings).

Diode Test

The diode (Fig. 47) can be individually tested using a digital multimeter (diode test or ohms setting) and the table to the right.

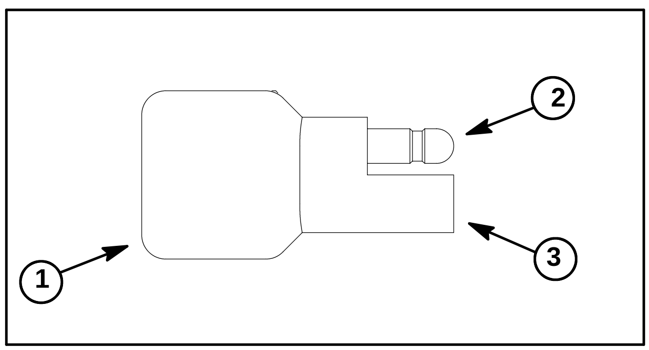


Figure 47

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

Service and Repairs

NOTE: For more component repair information, see the Kubota Workshop Manual, Diesel Engine, V2403–M–T–E3B at the end of Chapter 3 – Kubota Diesel Engines.

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 battery terminal protector (see Special Tools in this chapter) 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. Reconnect cables with positive (+) cable first. Coat battery posts and cable connectors with battery terminal protector (see Special Tools in this chapter) 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 or demineralized 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 (26.7ºC)
Discharged: less than 1.240

Battery Specifications
BCI Group Size 24
650 CCA at 0ºF (–17.8ºC)
Reserve Capacity of 105 minutes at 80ºF (26.7ºC)

Dimensions (including terminal posts and caps)

Length	11 inches (27.9 cm)
Width	6.76 inches (17.2 cm)
Height	9.2 inches (23.4 cm)

Battery Removal and Installation (Fig. 48)

1. Unlatch and raise operator's console panel behind the operator seat to access battery.

2. Loosen and remove negative cable from battery. After negative cable is removed, loosen and remove positive cable from battery.

3. Loosen strap that secures battery to machine.

4. Carefully remove battery from machine.

5. Install battery in reverse order making sure to connect and tighten positive cable to battery before connecting the negative cable.

NOTE: Before connecting the negative (ground) cable, connect a digital multimeter (set to amps) between the negative battery post and the negative (ground) cable connector. The reading should be less than 0.1 amp. If the reading is 0.1 amp or more, the machine's electrical system should be tested for short circuits or faulty components and repaired.

6. Make sure that rubber boot is properly placed over positive cable end and positive battery post.

7. Lower and secure operator's console panel.

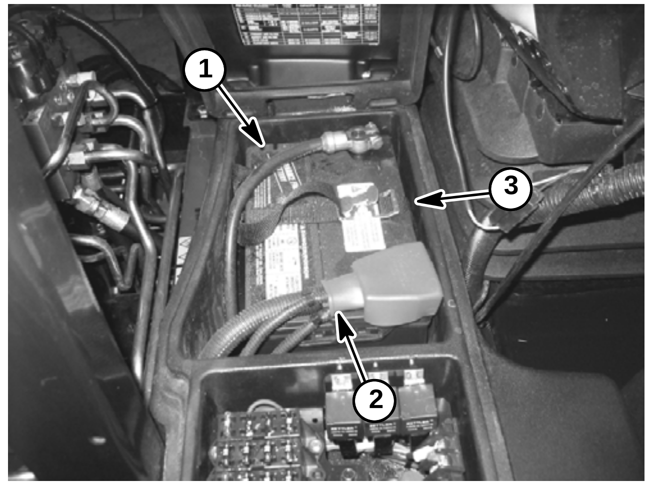


Figure 48

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

Battery Inspection and Maintenance

1. Replace battery if case is cracked or leaking.

2. Check battery terminal posts for corrosion. Use wire brush to clean corrosion from posts.

IMPORTANT: Before cleaning the battery, tape or block vent holes to the filler caps and make sure the caps are on tightly.

3. Check for signs of wetness or leakage on the top of the battery which might indicate a loose or missing filler cap, overcharging, loose terminal post or overfilling. Also, check battery case for dirt and oil. Clean the battery with a solution of baking soda and water, then rinse it with clean water.

4. Check that the cover seal is not broken away. Replace the battery if the seal is broken or leaking.

5. Check the electrolyte level in each cell. If the level is below the tops of the plates in any cell, fill all cells with **distilled water** between the minimum and maximum fill lines. Charge at 15 to 25 amps for fifteen (15) minutes to allow sufficient mixing of the electrolyte.

Battery Testing

1. Conduct a hydrometer test of the battery electrolyte.

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

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

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

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

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

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

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

CAUTION

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

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

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

C. Make sure battery terminals are free of corrosion.

D. Measure the temperature of the center battery cell.

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

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

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

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

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

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

Battery Charging

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

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

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

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

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

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

Battery Reserve Capacity (Minutes)	Battery Charge Level (Percent of Fully Charged)			
	75%	**50%**	**25%**	**0%**
80 or less	3.8 hrs @ 3 amps	7.5 hrs @ 3 amps	11.3 hrs @ 3 amps	15 hrs @ 3 amps
81 to 125	**5.3 hrs @ 4 amps**	**10.5 hrs @ 4 amps**	**15.8 hrs @ 4 amps**	**21 hrs @ 4 amps**
126 to 170	5.5 hrs @ 5 amps	11 hrs @ 5 amps	16.5 hrs @ 5 amps	22 hrs @ 5 amps
171 to 250	5.8 hrs @ 6 amps	11.5 hrs @ 6 amps	17.3 hrs @ 6 amps	23 hrs @ 6 amps
above 250	6 hrs @ 10 amps	12 hrs @ 10 amps	18 hrs @ 10 amps	24 hrs @ 10 amps

> **CAUTION**
>
> **Do not charge a frozen battery because it can explode and cause injury. Let the battery warm to 60°F (16°C) before connecting to a charger.**
>
> **Charge the battery in a well-ventilated place to dissipate gases produced from charging. These gases are explosive; keep open flame and electrical spark away from the battery. Do not smoke. Nausea may result if the gases are inhaled. Unplug the charger from the electrical outlet before connecting or disconnecting the charger leads from the battery posts.**

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

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

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

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

Hydraulic Solenoid Valve Coil

A hydraulic solenoid valve coil on a hydraulic control manifold can be replaced without opening the hydraulic system.

Removal (Fig. 49)

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

2. Locate the solenoid valve coil that is to be removed.

3. Disconnect the wire harness electrical connector from the coil that is to be removed. Note orientation of electrical connector on coil for assembly purposes.

4. Remove the nut from the hydraulic valve.

5. Slide the solenoid coil from the valve.

6. Clean any corrosion or dirt from valve stem.

Installation (Fig. 49)

1. Slide solenoid coil onto the hydraulic valve. Position coil so that connector is properly orientated.

2. Install the nut onto the valve and torque nut **5 ft–lb (6.7 N–m)** (do not over tighten).

3. Connect the machine wire harness connector to the solenoid coil.

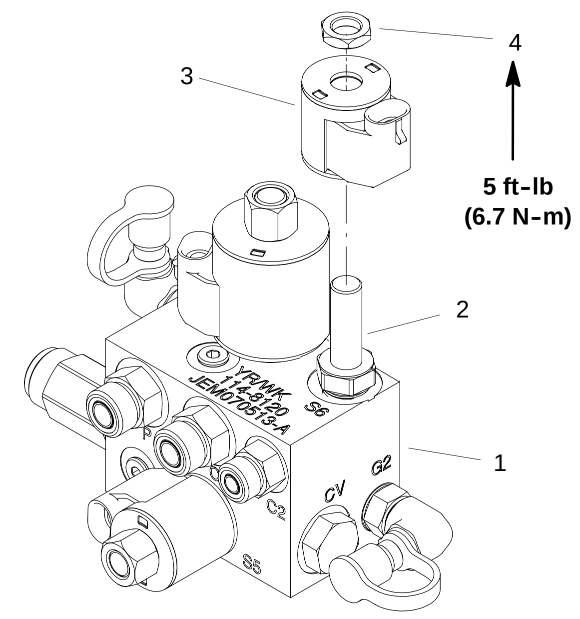


Figure 49

1. **Control manifold**
2. **Solenoid valve**
3. **Coil**
4. **Nut**

Electrical System

This page is intentionally blank.

Chapter 6

Axles, Planetaries and Brakes

Table of Contents

Specifications

Item	Specification
Wheel lug nut torque (front and rear)	85 to 100 ft−lb (116 to 135 N−m)
Steering cylinder bolt torque	100 to 125 ft−lb (136 to 169 N−m)
Planetary, Brake Assembly and Wheel Motor Mounting Screw Torque OPH−2 series planetary VA02 series planetary	 60 ft−lb (81 N−m) 75 to 85 ft−lb (101 to 115 N−m)
Rear wheel toe−in	0.125 in (3 mm)
Tire pressure (front and rear)	20 psi (138 kPa)
Planetary Drive Lubricant Capacity (each wheel)	SAE 85W−140 wt. Gear Lube 16 to 20 fl oz (0.47 to 0.59 L)
Rear axle lubricant Rear axle gear lube capacity	SAE 85W−140 wt. gear lube 80 fl oz (2.37 l)

General Information

Operator's Manual

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

Adjustments

Planetary Drive Endplay (OPH–2 series planetary drives)

A front planetary drive assembly that is properly operating should have no endplay. Any endplay in a planetary assembly indicates that there are potential problems with the planetary. Check planetary endplay at intervals specified in your Operator's Manual.

Endplay Checking Procedure

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

CAUTION

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

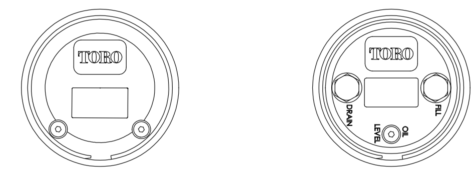


Figure 1

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

3. Grasp front wheel and check for endplay in the planetary assembly as indicated by axial wheel movement. Make sure that there is no endplay in assembly.

4. If any endplay is detected, the planetary should be disassembled, inspected and serviced as necessary (see Planetary Drive Assembly in the Service and Repairs section of this chapter).

5. After planetary endplay checking is completed, lower machine to ground.

This page is intentionally blank.

Axles, Planetaries and Brakes

Brake Assembly

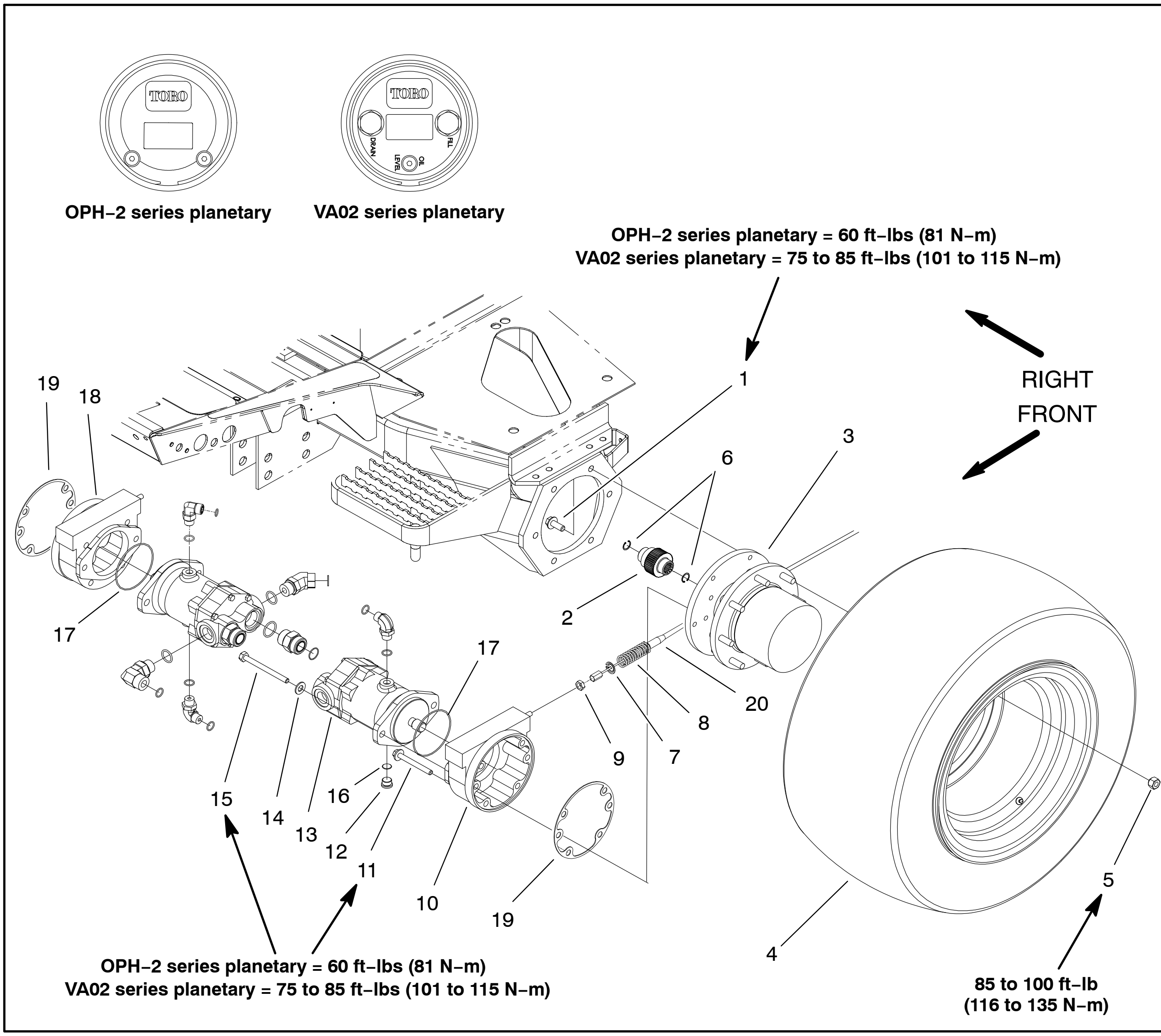


Figure 2

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

Brake Assembly Removal (Fig. 2)

1. Park machine on a level surface and raise cutting decks to allow easier access to front brake assembly. Stop engine, engage parking brake and remove key from the ignition switch.

2. Drain oil from planetary drive and brake assembly; refer to traction unit Operator's Manual.

CAUTION

When changing attachments, tires or performing other service, use correct blocks, hoists and jacks to raise and support machine. 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 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.

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

4. Remove front wheel assembly.

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

6. Disconnect brake cable from pull rod on brake.

NOTE: Be careful to not drop splined brake shaft as brake assembly is removed.

7. Support brake assembly and remove flange head cap screws (item 11) securing brake assembly to frame. Remove brake assembly.

8. Remove splined brake shaft.

9. Remove and discard gasket (item 19). Make sure that all gasket material and sealant is removed from both the brake and the planetary assembly.

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

Brake Assembly Installation (Fig. 2)

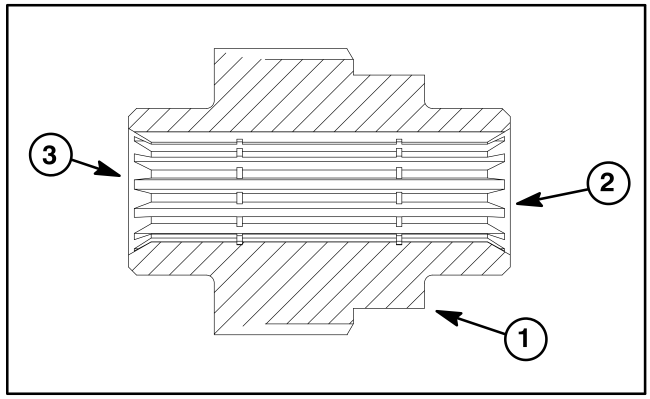


Figure 3

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

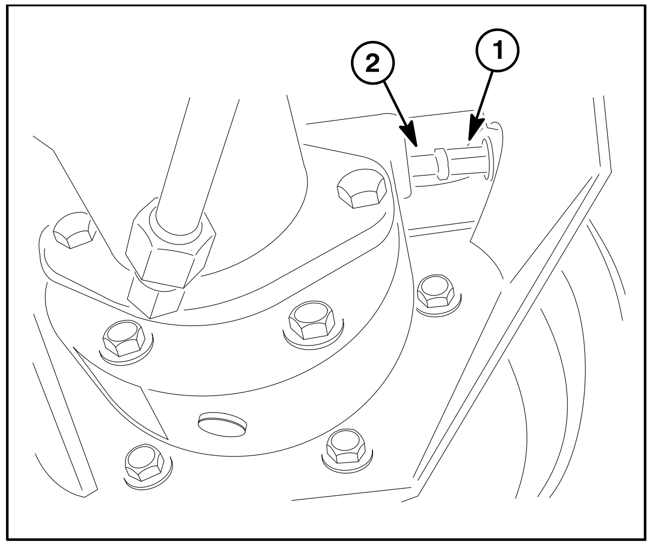


Figure 4

1. **Brake cable**
2. **Brake pull rod**

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

1. Install splined brake shaft into brake assembly. Make sure that splines engage rotating discs in brake assembly.

2. Apply gasket sealant (Loctite #2 or equivalent) to sealing surfaces of new gasket (item 19). Align gasket and secure brake assembly to planetary.

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

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

3. Install brake cable to pull rod on brake assembly. Brake cable end should be completely threaded onto pull rod before tightening jam nut.

4. Make sure wheel motor O−ring (item 4) is in position and secure wheel motor to planetary with two (2) cap screws and flat washers.

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

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

5. Install front wheel assembly.

6. Fill planetary drive with gear lube; refer to traction unit Operator's Manual. A portion of the gear lube will pass into the brake assembly automatically.

7. Check and adjust brake cables for proper brake operation (see machine Operator's Manual).

WARNING

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

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

Brake Inspection and Repair

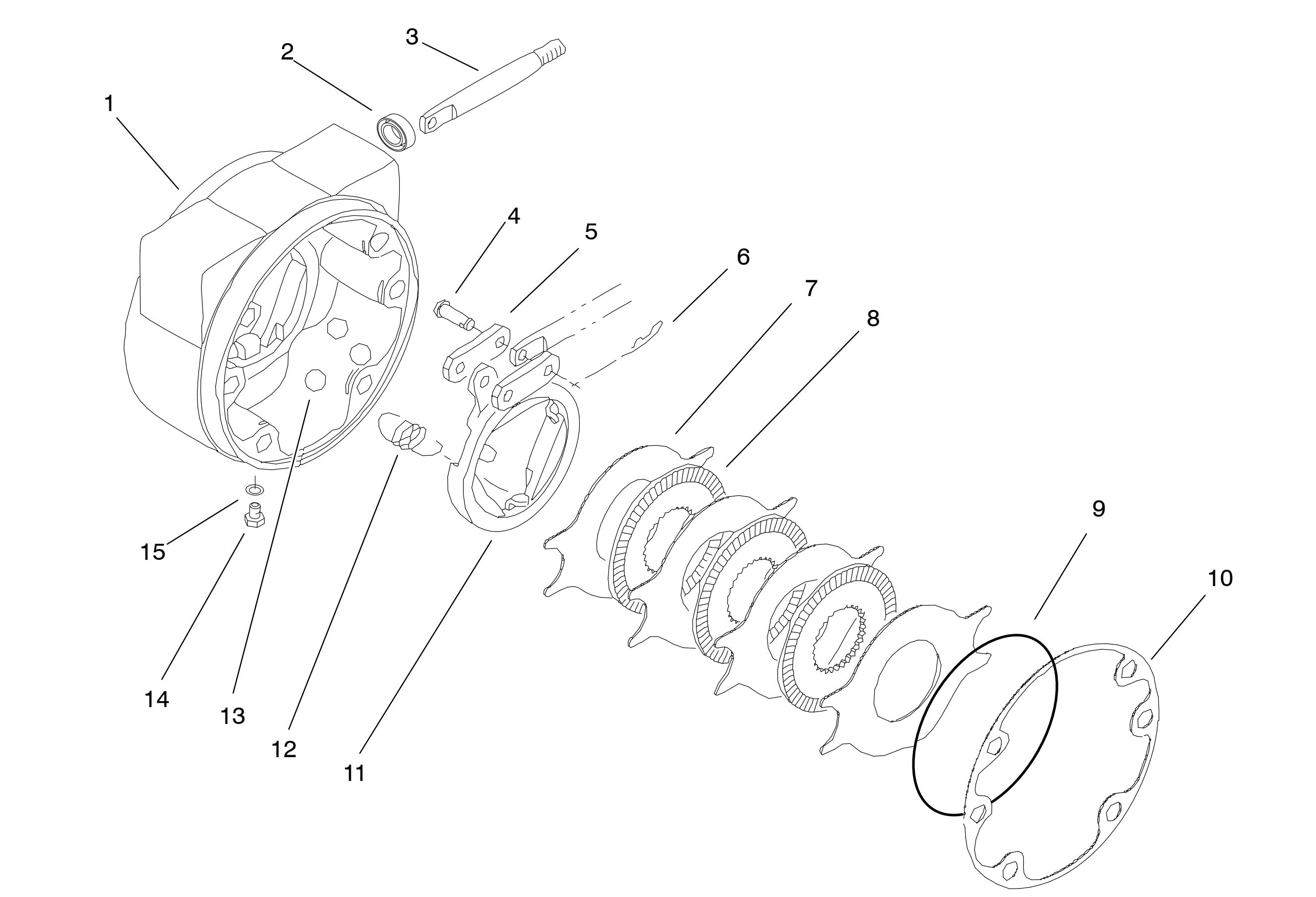


Figure 5

1. Brake housing (LH shown)	6. Hitch pin (2 used)	11. Rotating actuator
2. Seal	7. Stationary disc (4 used)	12. Extension spring (3 used)
3. Pull rod	8. Rotating disc (3 used)	13. Ball (3 used)
4. Clevis pin (2 used)	9. Retaining ring	14. Plug
5. Link (2 used)	10. Gasket	15. O−ring

Brake Inspection and Repair (Fig. 5)

1. Carefully scrape gasket material (item 10) from brake housing and planetary drive mounting surfaces.

2. Remove retaining ring (item 9).

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

4. Remove extension springs (item 12).

5. Remove actuator assembly (items 3, 4, 5, 6 and 11) and balls (item 13).

6. Remove seal (item 2) from brake housing.

7. Wash parts in cleaning solvent. Inspect components for wear or damage.

8. Reverse steps 2 − 6 to assemble brakes, installing new parts as necessary. Install a new seal (item 2).

9. Use a new gasket (item 10) when installing brake assembly to machine.

Planetary Drive Assembly

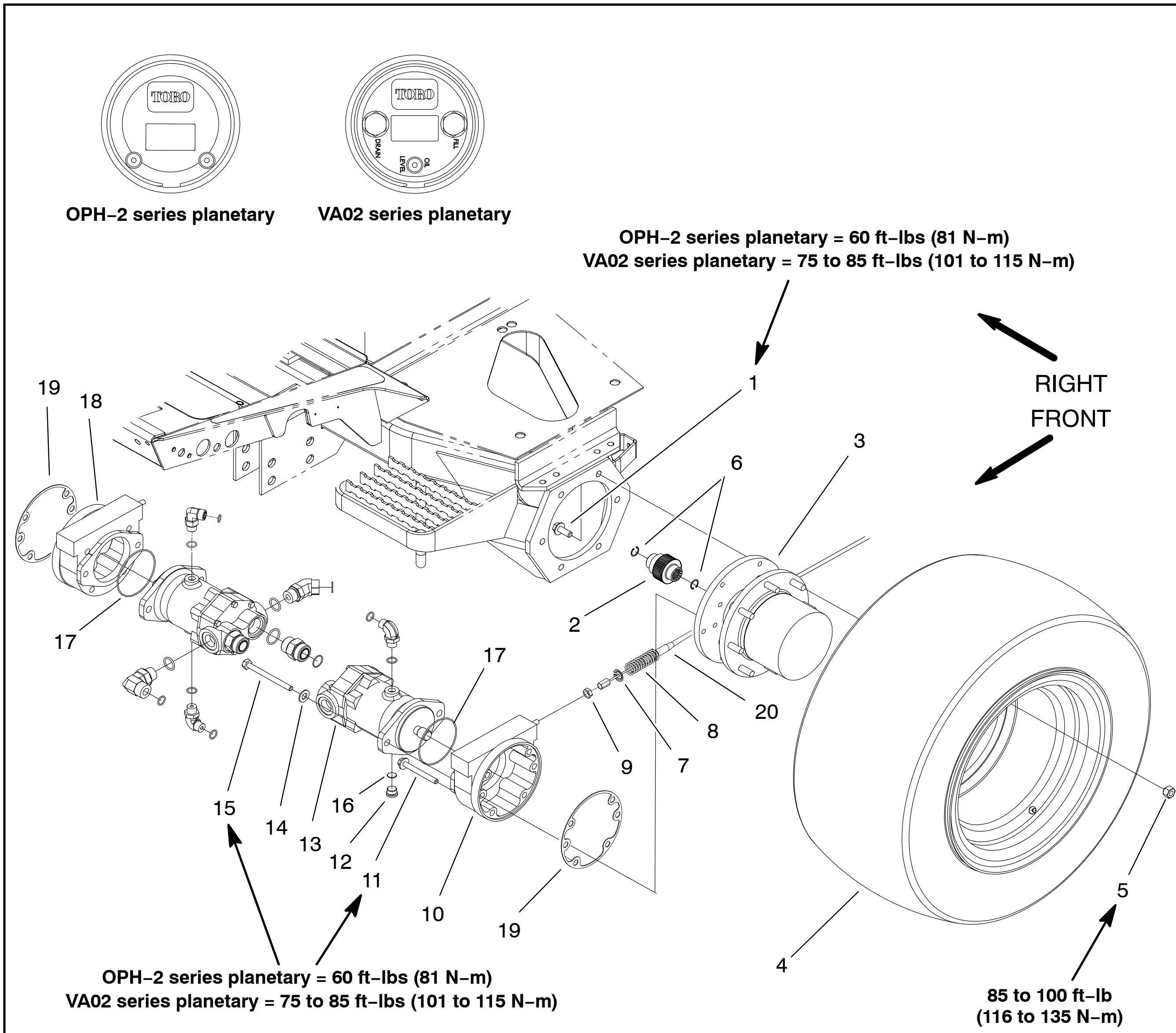


Figure 6

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

NOTE: The planetary 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 the planetary drive assembly from machine.

Planetary Drive Removal (Fig. 6)

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

2. Drain the oil from the brake assembly and the Planetary drive; refer to the traction unit Operator's Manual.

CAUTION

When changing attachments, tires or performing other service, use correct blocks, hoists and jacks to raise and support machine. 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 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.

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

4. Remove front wheel assembly.

5. Support wheel motor and brake assembly to prevent them from shifting during planetary removal.

NOTE: The wheel motor and brake assembly fasteners thread into the planetary housing, and must be removed prior to removing the planetary drive from the machine.

6. Remove hydraulic wheel motor fasteners.

7. Remove brake assembly fasteners.

8. Support planetary assembly to prevent it from falling. Loosen and remove six (6) flange head screws that secure planetary assembly to frame. Remove planetary assembly from machine.

9. Remove and discard gasket (item 19). Make sure that all gasket material and sealant is removed from both brake and planetary assemblies.

Planetary Drive Installation (Fig. 6)

1. Position planetary assembly to machine making sure to engage splined brake shaft with planetary drive shaft. Secure planetary assembly to frame with six (6) flange head screws.

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

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

2. Apply gasket sealant (Loctite #2 or equivalent) to sealing surfaces of new gasket (item 12). Align gasket and secure brake assembly to planetary (see Brake Assembly in this section of this chapter).

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

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

3. Make sure wheel motor O–ring (item 4) is in position and secure wheel motor to planetary with two (2) cap screws and flat washers.

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

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

4. Install front wheel assembly.

5. Fill planetary drive with gear lube; refer to traction unit Operator's Manual. A portion of the gear lube will pass into the brake assembly automatically.

6. Check for proper brake operation and adjust brake cables if necessary.

WARNING

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

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

OPH−2 Series Planetary Drive Service

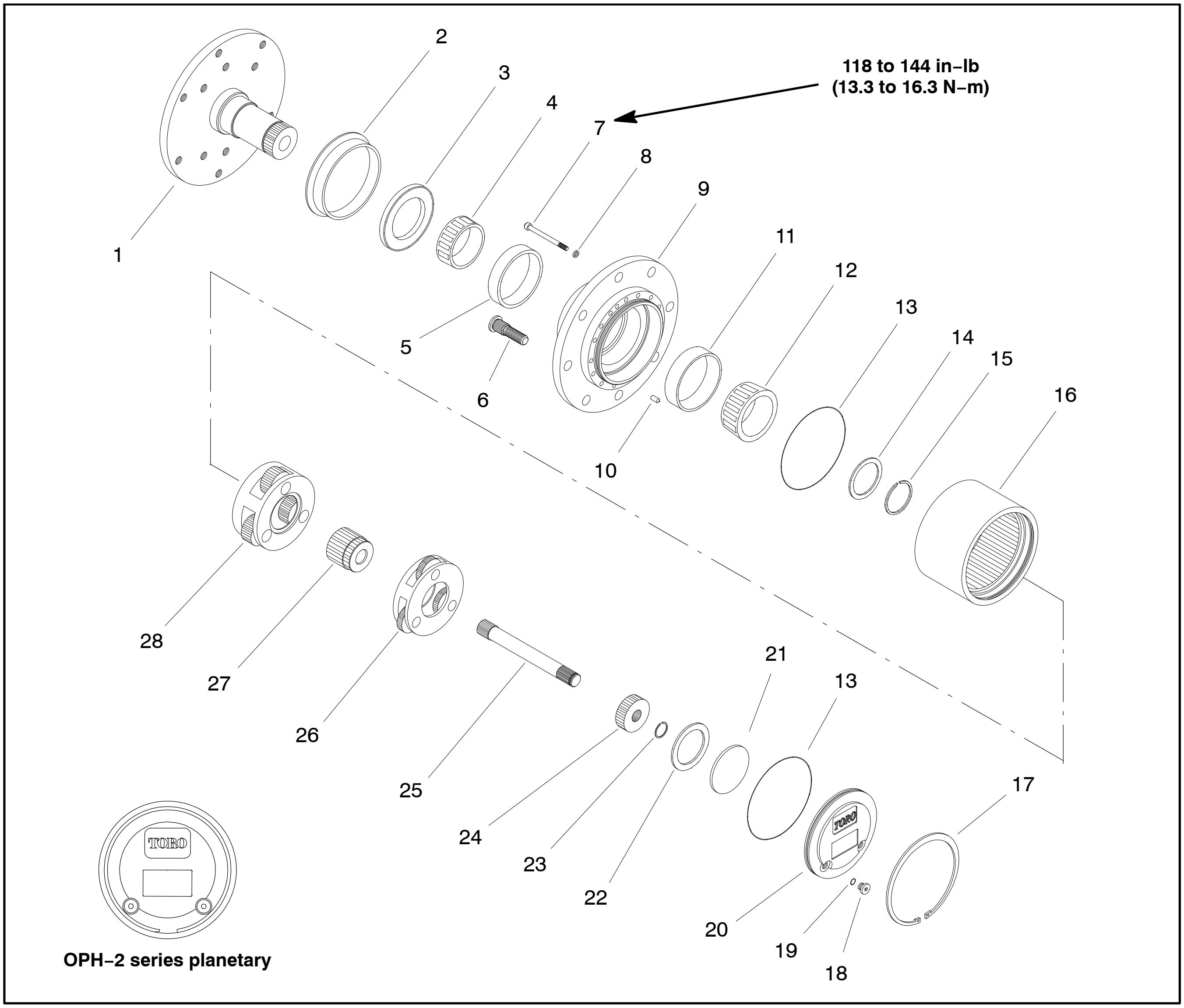


Figure 7

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

NOTE: The planetary 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 in this section.

Disassembly (Figs. 7 and 8)

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

2. Drain oil from planetary drive/brake assembly; refer to traction unit Operator's Manual.

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

4. Remove retaining ring (item 17).

5. Remove end cap (item 20). Thrust plug (item 21) and thrust washer (item 22) usually remain in end cap bore and should be removed for cleaning and inspection.

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

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

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

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

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

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

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

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

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

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

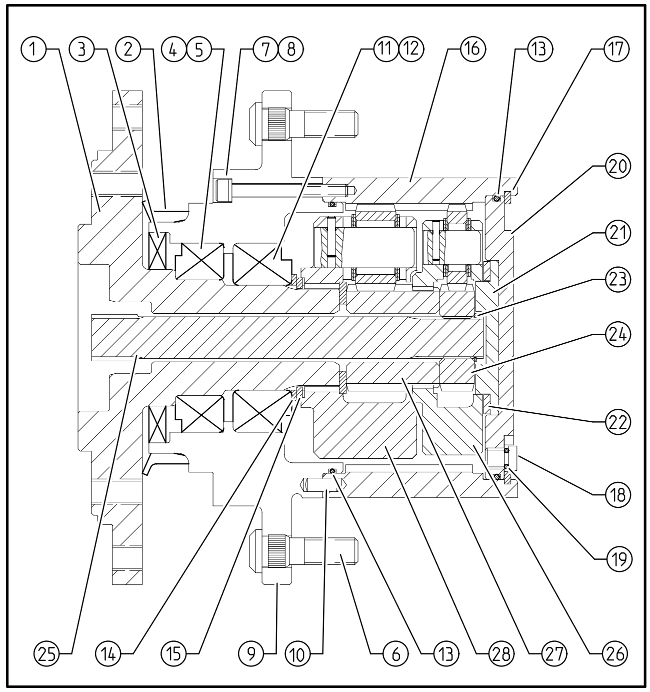


Figure 8

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

Assembly (Figs. 7 and 8)

1. Thoroughly clean parts in solvent and dry completely after cleaning. Inspect parts for damage or excessive wear and replace as necessary.

2. If any wheel studs were removed, use a press to install new studs into housing. Make sure that stud shoulder is fully pressed against housing surface.

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

3. If spindle and housing were separated:

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

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

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

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

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

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

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

NOTE: The planetary shim kit includes the retaining ring and several thrust washers with thickness in incremental steps of 0.004 in. (0.10 mm).

H. Measure thickness of thrust washer (item 14) that was removed during disassembly. Choose new thrust washer of equal thickness or the next available thickness from thrust washers in the shim kit.

I. Apply a light coating of oil to spindle shaft, thrust washer (item 14) and new retaining ring (item 15). Install thrust washer onto spindle shaft.

WARNING

If retaining ring (item 15) is not fully installed in spindle groove, loss of wheel and personal injury may result.

J. Carefully install new retaining ring (item 15) into the spindle shaft groove taking care to not distort ring. If the proper thrust washer has been installed, the retaining ring should fit tightly between the thrust washer and spindle groove. Tap the OD of the retaining ring starting in the center and working out toward each end to ensure that the retaining ring is properly seated into the spindle groove. Make sure that retaining ring ID is fully seated to spindle shaft groove.

K. After retaining ring is installed, make sure that there is no endplay in assembly. If required, remove retaining ring and install a thrust washer of different thickness to adjust endplay.

L. Install new O−ring (item 13) into groove in housing.

4. Install secondary carrier (item 28), secondary gear (item 27) and primary carrier (item 26) making sure that carrier gear teeth align with ring gear and spline on spindle shaft.

5. If primary gear (item 24) was removed from drive shaft, slide gear onto shaft and secure with retaining ring (item 23).

6. Install drive shaft assembly (items 25, 24 and 23) making sure that drive shaft spline aligns with carrier gears.

7. Install thrust plug (item 21) and thrust washer (item 22) into end cap (item 20). Make sure that thrust plug and thrust washer are captive on inside of end cap (item 20).

8. Install new O−ring (item 13) to end cap and then install end cap. Secure cap with retaining ring (item 17).

9. Check operation of planetary drive. With a constant turning force applied, rotation of the planetary should be consistent. If there is more drag at certain points, gears are not rolling freely and the planetary should be examined for improper assembly or damaged components.

10. Install front wheel assembly.

11. Fill planetary drive with gear lube; refer to traction unit Operator's Manual. A portion of the gear lube will pass into the brake assembly automatically.

12. Test planetary drive operation.

WARNING

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

13. Remove jack stands and lower machine to ground. Tighten wheel lug nuts in a crossing pattern from **85 to 100 ft−lb (116 to 135 N−m)**.

This page is intentionally blank.

Axles, Planetaries and Brakes

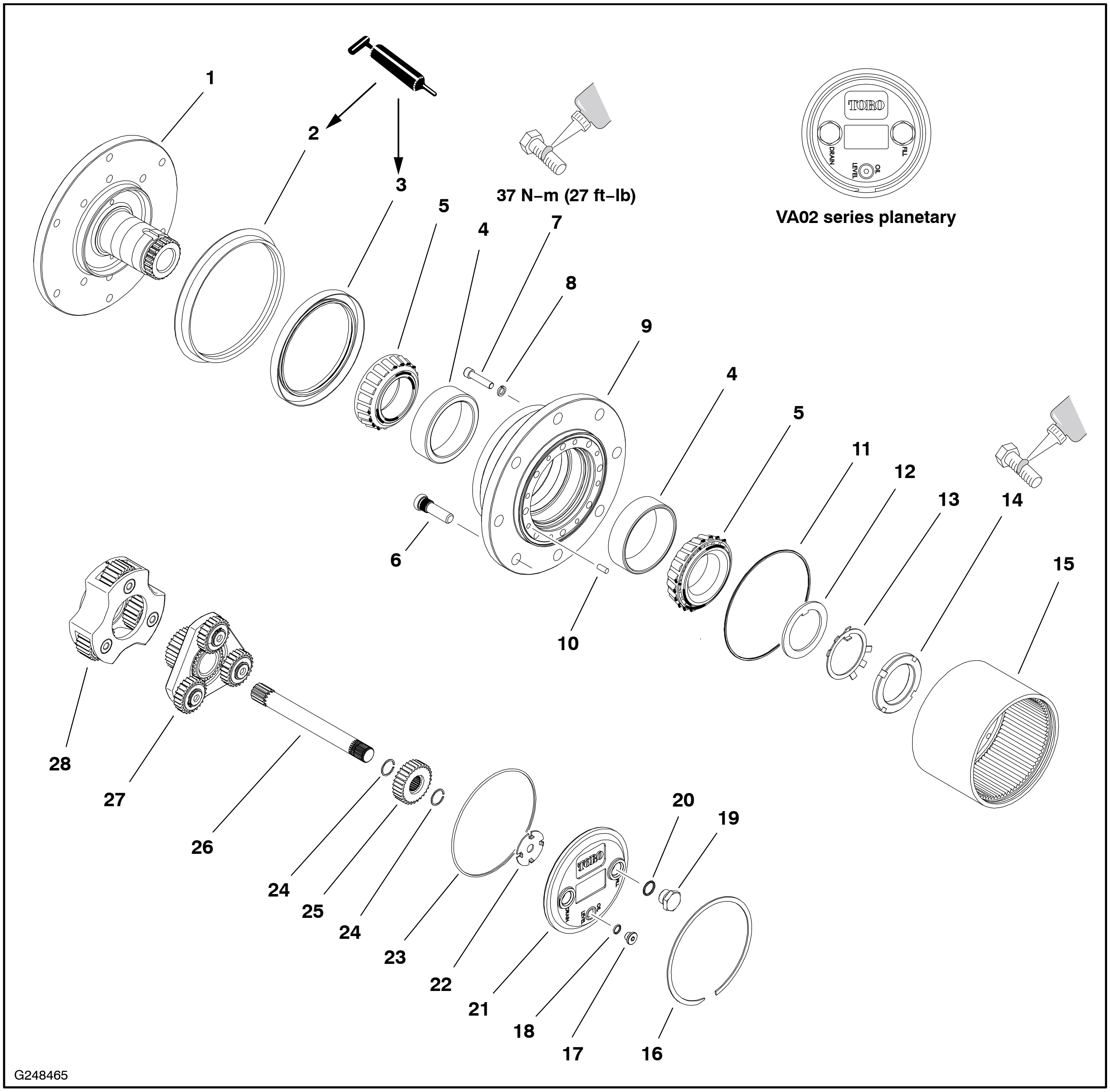


Figure 9

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

NOTE: The planetary drive assembly is best serviced with the planetary installed to machine or the spindle firmly secured to a fixture or workbench. If the spindle (item 1) needs to be removed from machine, see Planetary Drive Assembly in this chapter.

Disassembly

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

2. Drain oil from planetary drive and brake assembly; refer to traction unit Operator's Manual.

3. Chock **rear**/**front** wheels and jack up **front**/**rear** of machine (see Jacking Instructions in Chapter 1 − Safety). Support machine with jack stands and remove rear wheel assembly.

4. Remove retaining ring (item 16).

5. Remove end cap and thrust plate. Retrieve and discard O−ring from ring gear bore.

6. Remove primary gear and drive shaft assembly (items 24−26).

7. Remove primary carrier and secondary carrier from ring gear.

8. Bend the locking washer tab away from the lock nut. Use a TMFS12 spanner socket to remove the 55 x 1.5 mm lock nut. Remove the locking washer and spacer. Discard the locking washer.

9. Carefully remove housing and bearing cones from spindle.

10. Remove and discard seals from housing.

11. If necessary, remove bearing cups from housing.

12. If wheel stud removal is necessary, use a press to remove the stud(s) from the housing.

13. If necessary, remove the ring gear from the housing:

    NOTE: High strength thread locking compound was used during assembly. It may be necessary to heat the ring gear near the mounting screws to release the screws.

    A. Remove socket head screws (item 7) and lock washers that secure the ring gear to the housing.

    B. Remove the ring gear and retrieve the four (4) dowel pins (item 10) from housing.

    C. Remove the O−ring from the housing bore and discard.

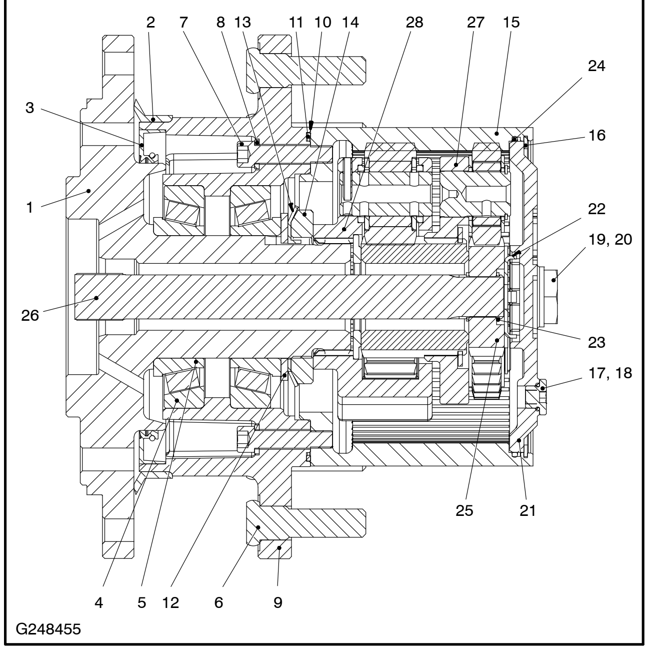


Figure 10

1. **Spindle**
2. **Boot seal**
3. **Lip seal**
4. **Inner bearing cup (2)**
5. **Inner bearing cone (2)**
6. **Wheel stud (8)**
7. **Socket head screw (8)**
8. **Lock washer (8)**
9. **Housing**
10. **Dowel pin (4)**
11. **O−ring**
12. **Spacer**
13. **Locking washer**
14. **Lock nut**
15. **Ring gear**
16. **Retaining ring**
17. **Plug**
18. **O−ring**
19. **Plug (2)**
20. **O−Ring (2)**
21. **End cap**
22. **Thrust plate**
23. **O−Ring**
24. **Retaining ring (2)**
25. **Primary gear**
26. **Drive shaft**
27. **Primary carrier asm**
28. **Secondary carrier asm**

Assembly

NOTE: Use new seals, O−rings and locking washer when assembling the planetary drive.

1. Thoroughly clean parts in solvent and dry completely after cleaning. Inspect parts for damage or excessive wear and replace as necessary.

2. If any wheel studs were removed, use a press to install new studs into housing. Make sure that stud shoulder is fully pressed against housing surface.

3. If ring gear was removed from housing:

    A. Fit four (4) dowel pins in housing.

    B. Apply a light coat of grease to a new O−ring and install it in the housing bore.

    C. Apply high strength thread locking compound and secure ring gear to housing with lock washers and socket head screws. Tighten screws to **27 ft−lb (37 N−m)**.

4. If previously removed, press bearing cups into housing. Cups should be pressed fully to shoulder of the housing bore.

5. Fit inner bearing cone onto spindle. Make sure inner bearing cone seats fully against spindle shoulder. If inner bearing is not seated fully, lightly tap bearing cone on inner hub until it seats properly.

6. Make sure that seal bore in housing is thoroughly cleaned. If OD of seal is not rubber or does not have a sealant coating, apply a light coating of silicone sealant to seal bore in housing. Install seal into housing so it is flush with housing face.

7. Install boot seal. Cover surface of lip seal and boot seal with grease.

8. Lightly oil bearing cups then place housing assembly over spindle and inner bearing cone. Take care to not damage seals or spindle during installation.

9. Fit outer bearing cone onto spindle.

10. Align key on spacer and install spacer onto spindle shaft.

11. Align key on locking washer and install locking washer onto spindle shaft.

IMPORTANT: .Perform the following steps without interruption. Once the thread locking compound is applied, you have only a few minutes before the curing process will influence the bearing lock nut torque.

12. Install the bearing lock nut:

A. Apply high strength thread locking compound (Loctite 263 or equivalent) and install the lock nut.

B. Tighten the lock nut to **110 ft−lb (150 N−m)**.

C. Rotate the housing on the spindle a few revolutions to align the bearings.

D. Tighten the lock nut to **150 ft−lb (200 N−m)**.

E. Rotate the housing on the spindle a few revolutions to seat the bearings.

IMPORTANT If installing the bearing nut with the spindle installed on machine, have an assistant hold the housing firmly in position during the following step.

F. Loosen the lock nut completely, then tighten to **90 ft−lb (122 N−m).**

IMPORTANT: Continue to tighten the lock nut until it aligns with one of the locking washer tabs. Do Not loosen the lock nut to align it with the locking washer tabs.

G. Secure the lock nut by bending one of the locking washer tabs into a slot in the lock nut.

13. Install secondary carrier and primary carrier making sure that carrier gear teeth align with ring gear and spline on spindle shaft.

14. If primary gear (item 25) was removed from drive shaft, slide gear onto shaft and secure with retaining rings.

15. Install drive shaft assembly (items 24−26) making sure that drive shaft spline aligns with carrier gears.

16. Cover the outer face of the thrust plate with grease and fit thrust plate onto end cap. Make sure that thrust plate tabs are captive in end cap.

17. Apply a light coat of grease to a new O−ring and install it in the ring gear bore. Avoid pinching or cutting the O−ring and install the end cap. Use a soft mallet to fully seat the end cap.

18. Secure the end cap with the retaining ring. Make sure the retaining ring is fully seated in the ring groove.

19. Check operation of planetary drive by hand. With a constant turning force applied, rotation of the planetary should be consistent. If there is more drag at certain points, gears are not rolling freely and the planetary should be examined for improper assembly or damaged components.

20. Fill planetary drive with gear lube; refer to traction unit Operator's Manual. A portion of the gear lube will pass into the brake assembly automatically.

21. Test planetary drive operation.

WARNING

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

22. Remove jack stands and lower machine to ground. Tighten wheel lug nuts in a crossing pattern from **85 to 100 ft−lb (116 to 135 N−m)**.

This page is intentionally blank.

Rear Axle Assembly

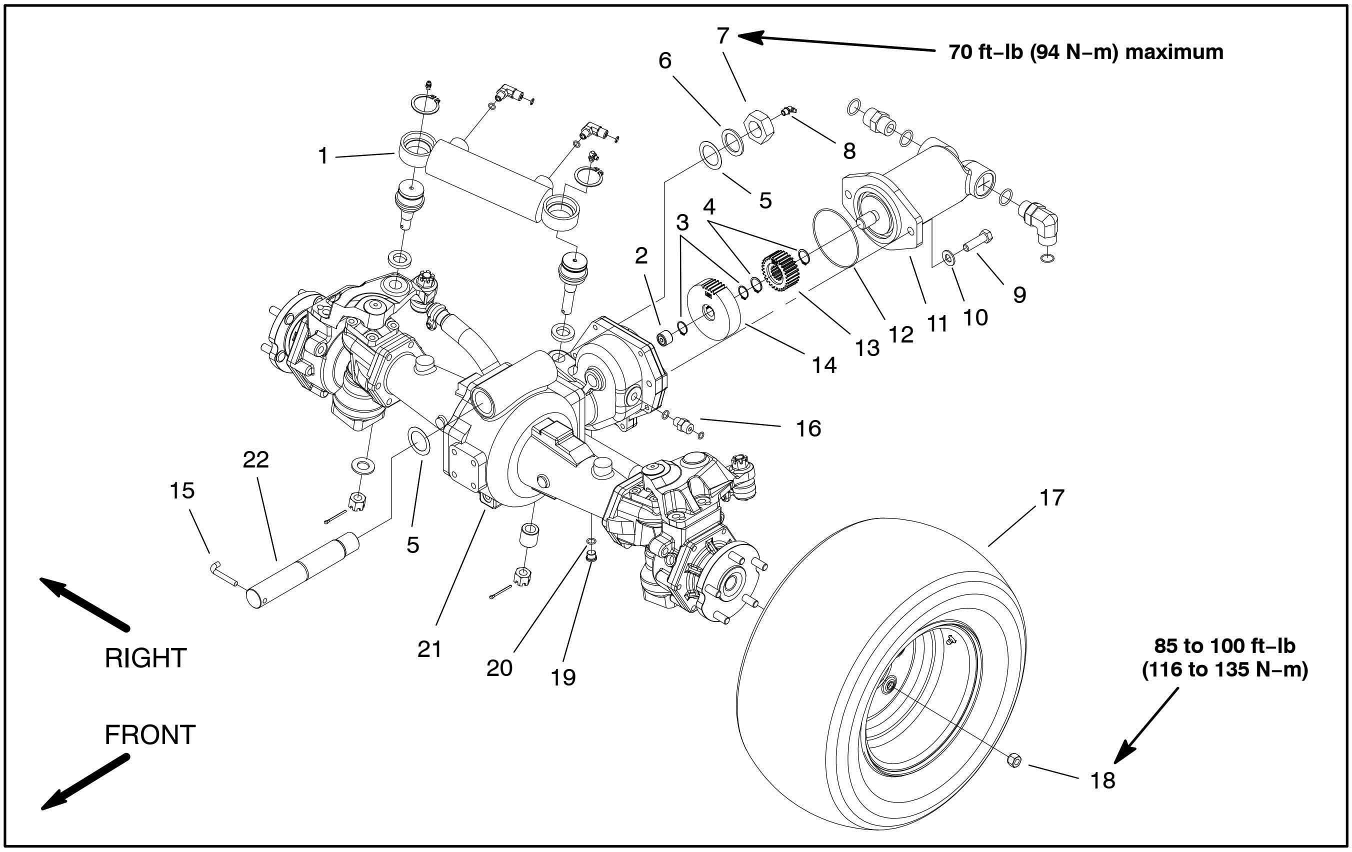


Figure 11

1. **Steering cylinder**
2. **Needle bearing**
3. **External snap ring**
4. **External snap ring**
5. **Thrust washer**
6. **Flat washer**
7. **Lock nut**
8. **Grease fitting**
9. **Cap screw (2 used)**
10. **Flat washer (2 used)**
11. **Piston motor**
12. **O−ring**
13. **Pinion gear**
14. **Gear**
15. **Stop pin**
16. **Hydraulic fitting**
17. **Rear wheel assembly (2 used)**
18. **Lug nut (5 used per wheel)**
19. **Hex plug**
20. **O−ring**
21. **Drive axle assembly**
22. **Axle pivot pin**

CAUTION

When changing attachments, tires or performing other service, use correct blocks, hoists and jacks to raise and support machine. 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 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.

Remove Rear Axle (Fig. 11)

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

2. Drain oil from rear axle and axle gearbox.

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

4. Remove both wheels from rear axle.

5. Remove hydraulic motor from axle assembly (see Rear Axle Motor in the Service and Repairs section of Chapter 4 − Hydraulic System).

6. Remove hydraulic hoses from steering cylinder.

7. Remove hydraulic hose from hydraulic fitting on side of input gear case.

8. Remove lock nut and flat washer from axle pivot pin.

9. Support rear axle to prevent it from falling. Remove pivot pin. Lower rear axle from machine. Note location of thrust washer on both ends of axle mounting boss.

10. If needed for further axle disassembly, remove steering cylinder from axle (see Steering Cylinder in Service and Repairs section of Chapter 4 − Hydraulic System).

11. If required, remove tie rod ends from steering arms on rear axle (Fig. 12). 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.

12. Clean the rear axle pivot pin and pivot bushings. Inspect the pin and bushings for wear or damage. Replace components as necessary.

Install Rear Axle (Fig. 11)

1. If removed, install steering cylinder to axle assembly (see Steering Cylinder in Service and Repairs section of Chapter 4 − Hydraulic System).

2. If removed, install the tie rod to rear axle (Fig. 12). Tighten ball joint castle nuts and install new cotter pins.

3. Support axle under machine with a jack. Position axle assembly to rear frame mount.

4. Install axle pivot pin to secure axle to frame. Make sure to install thrust washer between axle pivot and frame on both ends of the pivot. With washers installed, there should be from 0.002 to 0.020 inch (0.05 to 0.51 mm) clearance between rear frame mount and axle mounting boss. Add thrust washers if needed to adjust clearance.

5. Install flat washer and lock nut onto axle pivot pin. Lock nut should be tightened enough to allow pivot pin to rotate (**70 ft−lb (94 N−m) maximum**).

6. Install hydraulic motor to axle assembly (see Rear Axle Motor in Service and Repairs section of Chapter 4 − Hydraulic System).

7. Install hydraulic hoses to steering cylinder and input gear case.

WARNING

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

8. Install wheels to axle. Lower machine to ground. Torque wheel lug nuts from **85 to 100 ft−lb (116 to 135 N−m)**.

9. Fill axle with SAE 85W−140 weight gear lube.

10. Check rear wheel toe−in and adjust if necessary (see Traction Unit Operator's Manual).

11. Check steering stop bolt adjustment. When the steering cylinder is fully contracted (left turn), a gap of 1/16" (1.6 mm) should exist between bevel gear case casting and stop bolt on left axle case. Figure 13 shows stop bolt location.

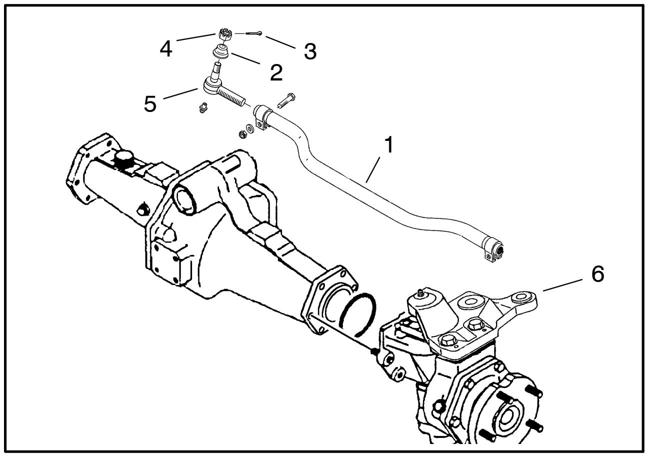


Figure 12

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

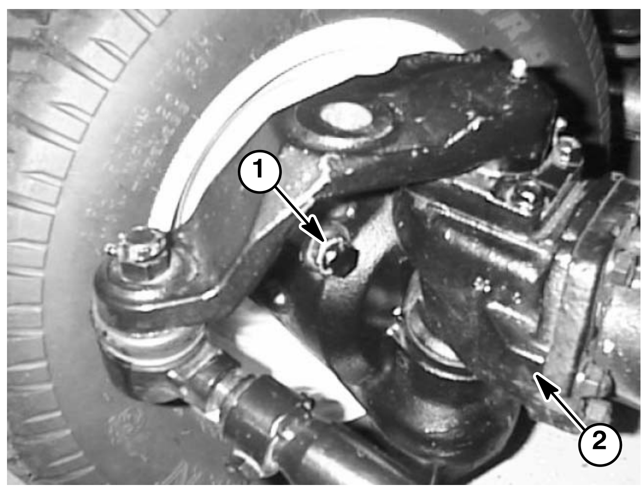


Figure 13

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

Axles, Planetaries and Brakes

Rear Axle Service

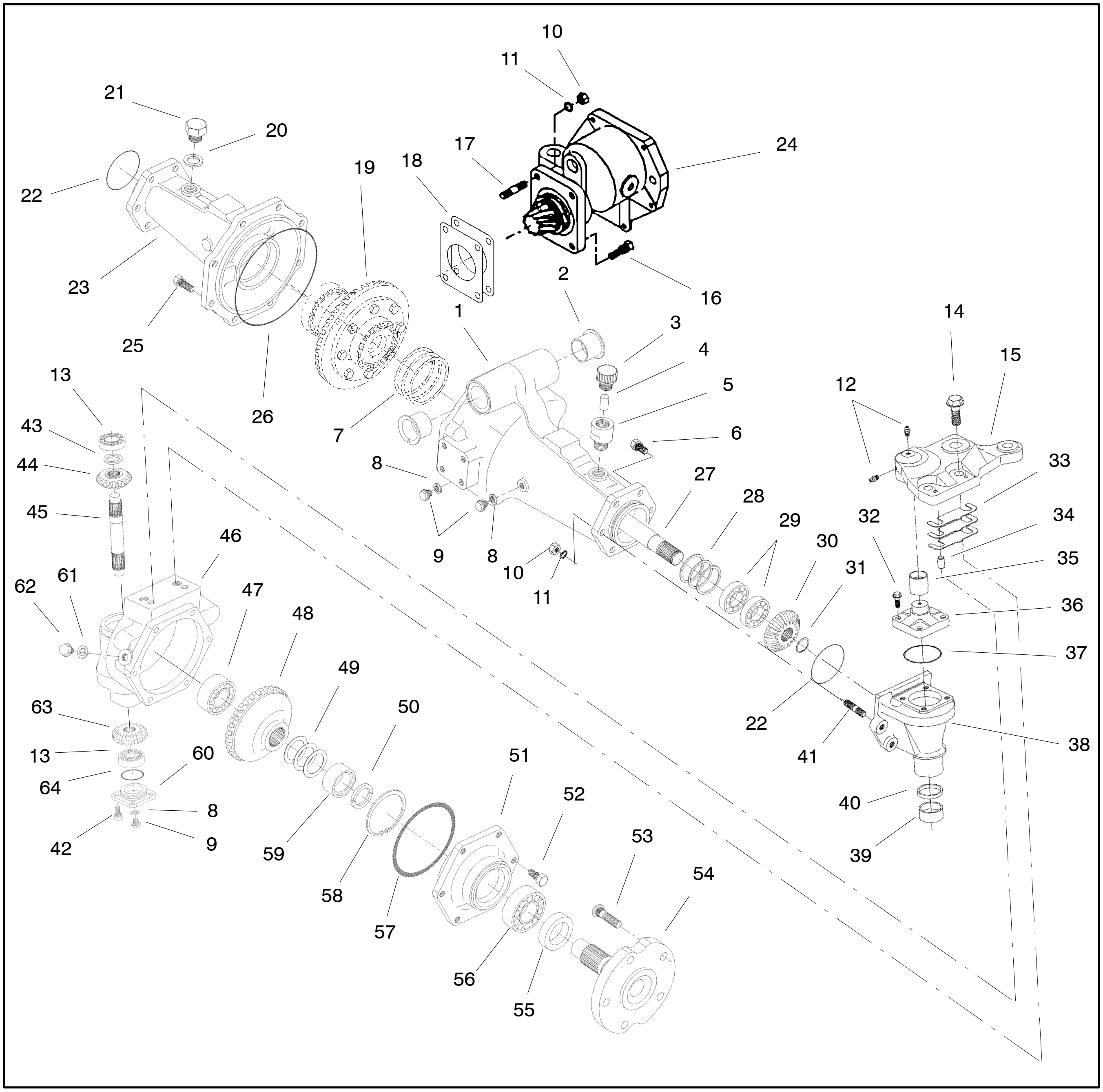


Figure 14

Figure 12 (Continued)

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

NOTE: Figure 14 illustrates the rear axle used on the Groundsmaster 4500–D and 4700–D. Service procedures for the rear axle is on the following pages of this section.

Bevel Gear Case and Axle Case

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

1. Remove the mounting screws, nuts and lock washers. Remove the bevel gear case/axle case assembly and O-ring from the axle support (Fig. 15).

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.

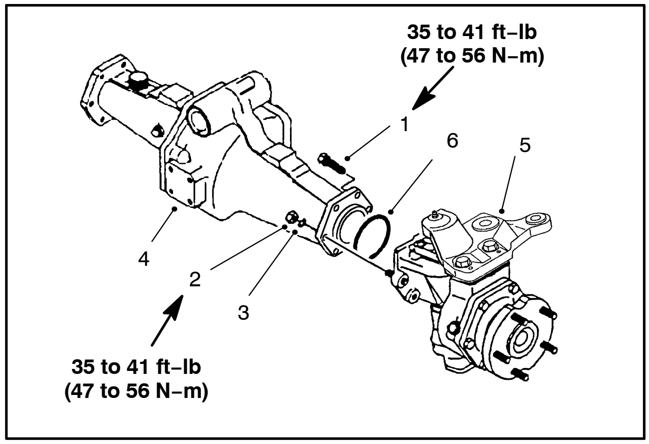


Figure 15

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. 16).

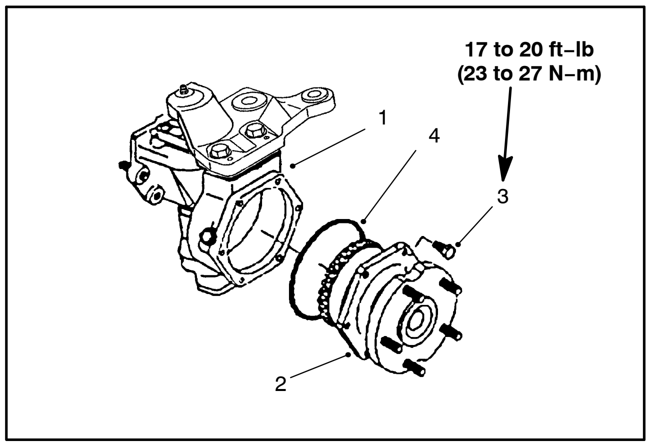


Figure 16

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

4. Remove the axle case support mounting screws, the axle case support and the support shims (Fig. 17).

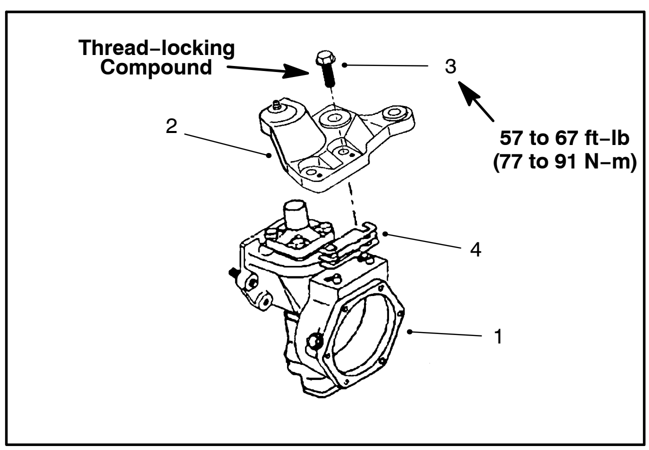


Figure 17

1. **Axle case**
2. **Axle case support**
3. **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. 18).

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. 18).

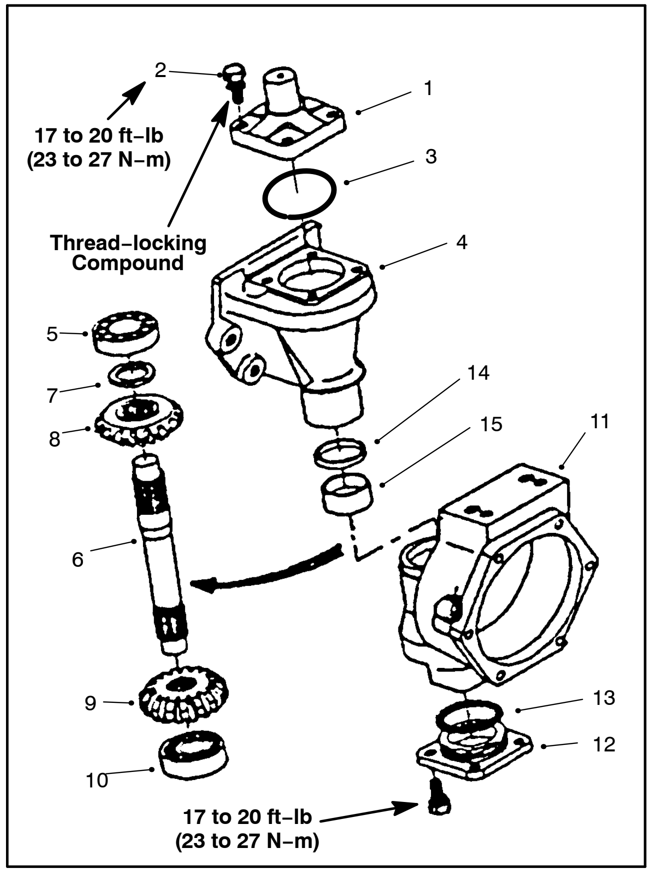


Figure 18

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

Inspection

1. Measure the knuckle pin O.D. and the axle case support bushing I.D. to determine the bushing to pin clearance (Fig. 19). 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.

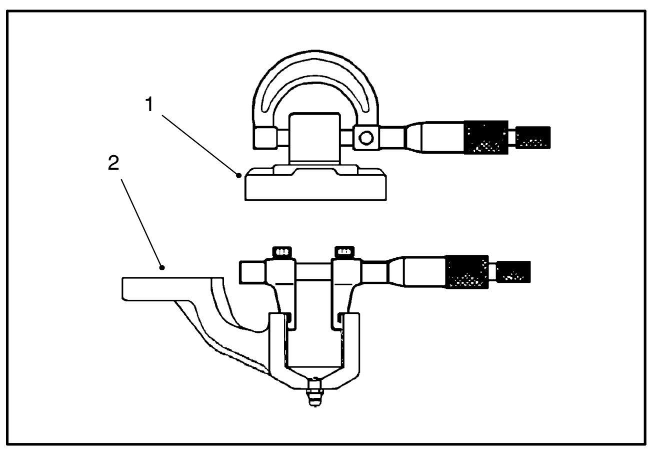


Figure 19

1. Knuckle pin
2. Axle case support

Axles, Planetaries and Brakes

Installation

1. Coat new shaft seal with grease and install in axle case as shown (Fig. 20).

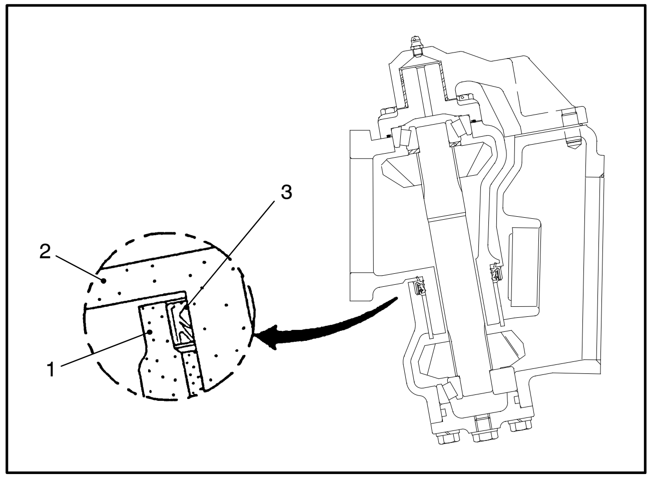


Figure 20

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. 21). Tighten cover screws from **17 to 20 ft-lb (23 to 27 N−m)**.

3. Slide the bevel gear case over the bevel gear shaft and install the bevel gear and collar. Make sure the bevel gear shaft is completely seated in the upper and lower bearings (Fig. 21).

4. Install the knuckle pin. Use medium strength thread-locking compound and tighten the knuckle pin mounting screws from **17 to 20 ft-lb (23 to 27 N−m)**.

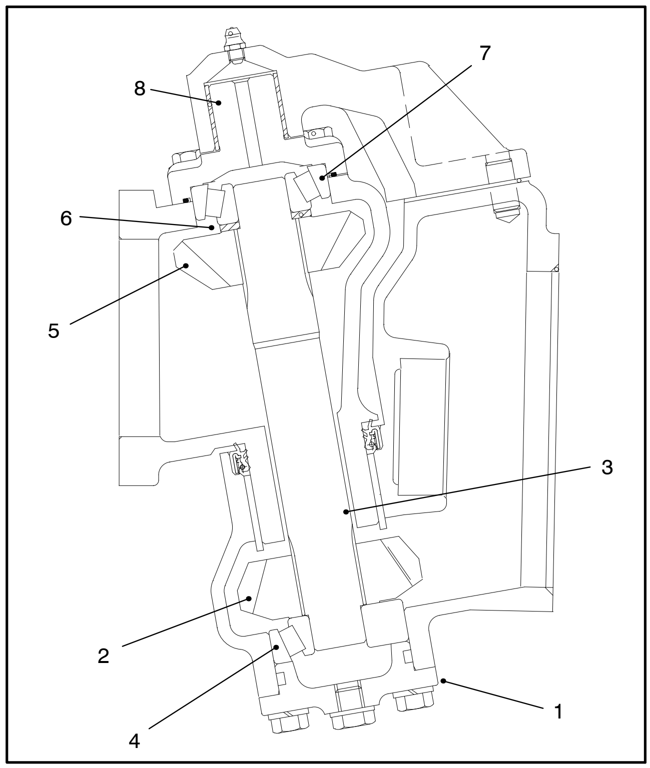


Figure 21

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. 22).

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. 23).

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.

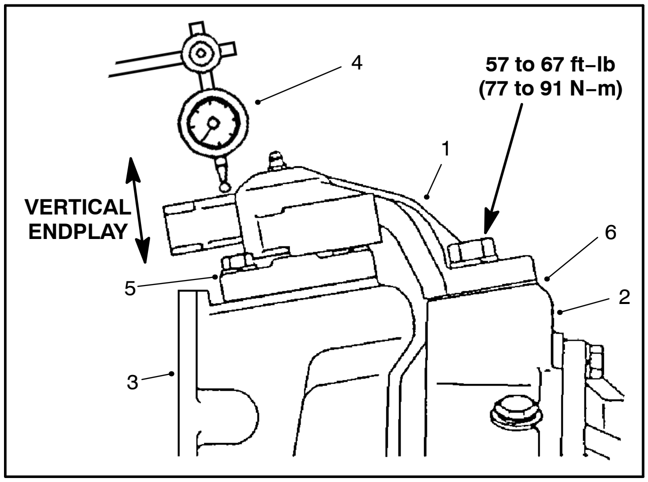


Figure 22

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

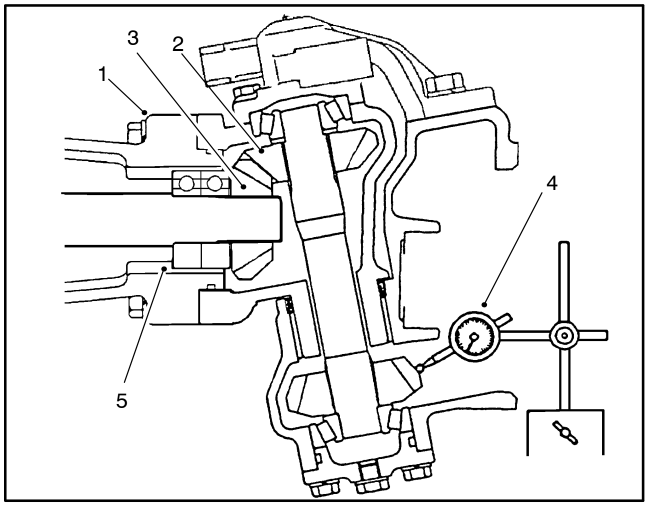


Figure 23

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

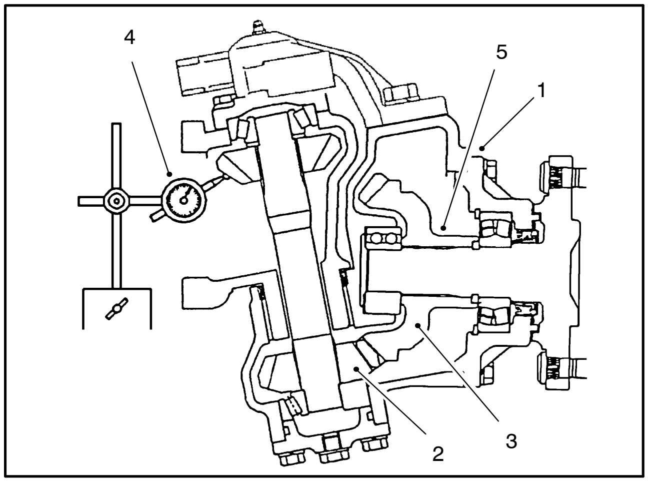


Figure 24

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

9. Remove the bevel gear case/axle case assembly from the axle support. Coat a new O-ring with grease and temporarily install the axle cover assembly. Position a dial indicator at the tooths center. Prevent the axle from turning and measure the lower bevel gear to axle gear backlash (Fig. 24).

LOWER BEVEL GEAR BACKLASH:
0.004 to 0.016 in. (0.10 to 0.40 mm)

10. Adjust backlash by increasing or reducing axle bearing shim thickness (see Axle Shafts in this section of this manual).

NOTE: Axle bearing shims are available in 0.008 in. (0.2 mm), 0.012 in. (0.3 mm) and 0.020 in. (0.5 mm) thickness.

11. Tighten axle cover screws from **17 to 20 ft-lb (23 to 27 N−m)**.

12. Coat a new O-ring with grease and install the bevel gear case/axle case assembly on the axle support. Tighten mounting screws and nuts from **35 to 41 ft-lb (47 to 56 N−m)** (Fig. 15).

Differential Shafts

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

IMPORTANT: Do not interchange right and left differential shaft assemblies.

1. Remove the mounting screws, nuts and lock washers. Remove the bevel gear case/axle case assembly and O-ring from the axle support (Fig. 25).

2. Mark and pull the differential shaft assembly from the axle support.

3. Remove the retaining ring and bevel gear (Fig 26).

4. Drive the differential shaft out of the bearings. Remove the bearings and bearing shims.

5. Inspect all gears, shafts, bearings and cases for damage and wear. Replace components as necessary.

Installation

1. Press bearings onto differential shaft. Place correct combination of bearing shims in axle support and drive differential shaft and bearing assembly into axle support.

2. Install bevel gear and retaining ring.

3. Coat new O-ring with grease. Align differential shaft splines with differential gear assembly and slide differential shaft assembly onto axle support.

4. Install bevel gear case/axle case assembly (see Bevel Gear Case/Axle Case Assembly in this section of this manual).

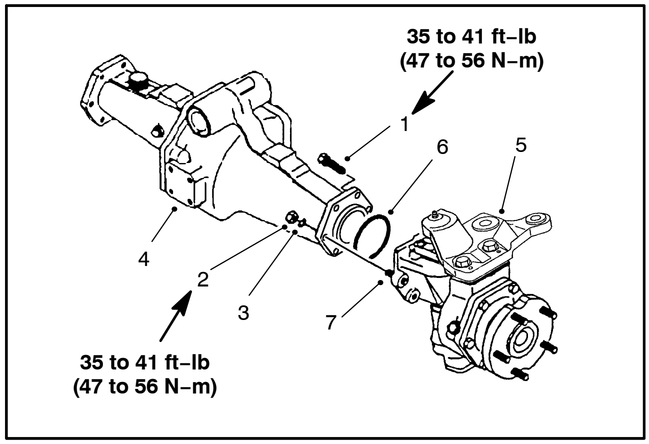


Figure 25

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)**

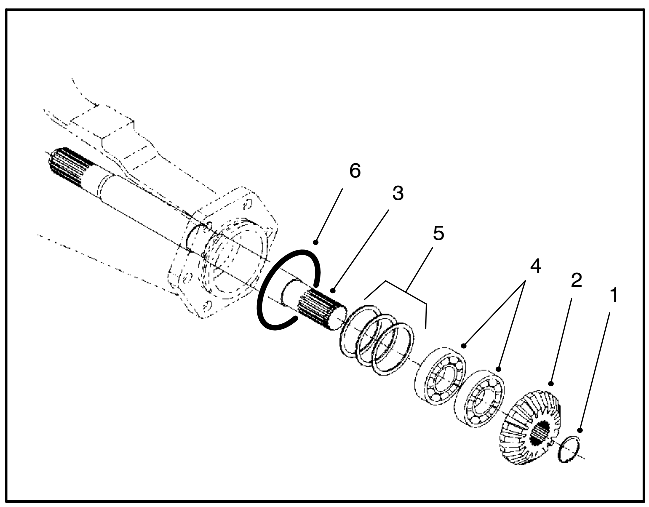


Figure 26

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

Axle Shafts

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

1. Remove the axle cover mounting screws. Remove the axle cover from the axle case as an assembly (Fig. 27).

2. Use a bearing puller to remove the bearing and bevel gear as shown (Fig. 28).

3. Remove the shims, spacer and retaining ring. Drive the axle out of the bearing and cover. Remove and discard the axle shaft seal.

4. Inspect all gears, shafts, bearings, spacers and cases for damage and wear. Replace components as necessary.

Installation

1. Coat new axle shaft seal with grease and install in axle cover as shown (Fig. 29).

2. Press the axle cover and bearing assembly onto the axle shaft. Press only on the inner race of the cover bearing (Fig. 29).

3. Install retaining ring, spacer and correct combination of bearing shims. Install bevel gear and bearing.

4. Coat a new O-ring with grease and install the axle cover assembly. Tighten axle cover screws from **17 to 20 ft-lb (23 to 27 N−m)**.

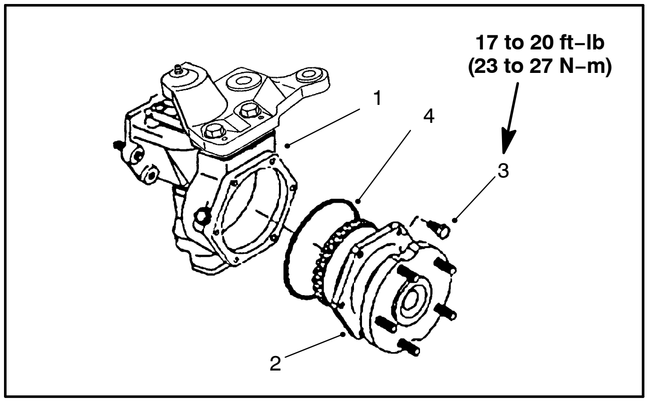


Figure 27

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

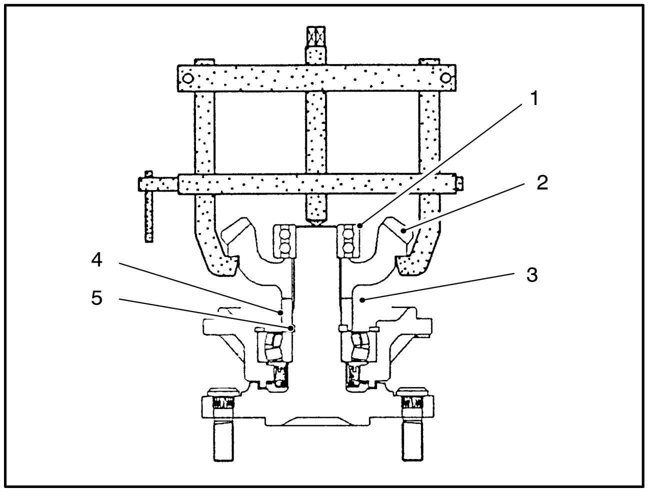


Figure 28

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

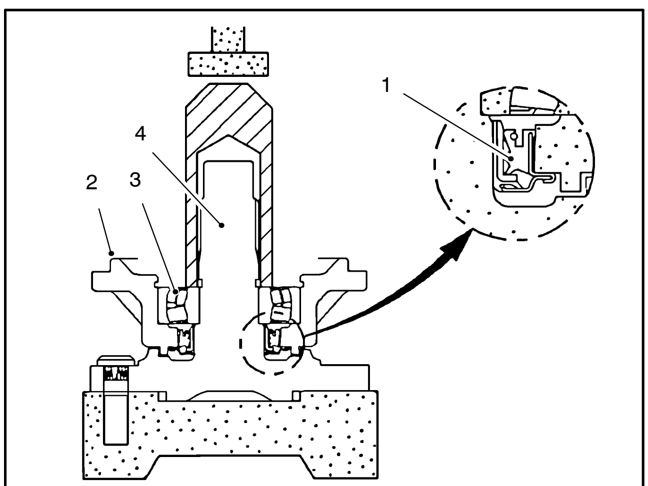


Figure 29

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

Input Shaft/Pinion Gear

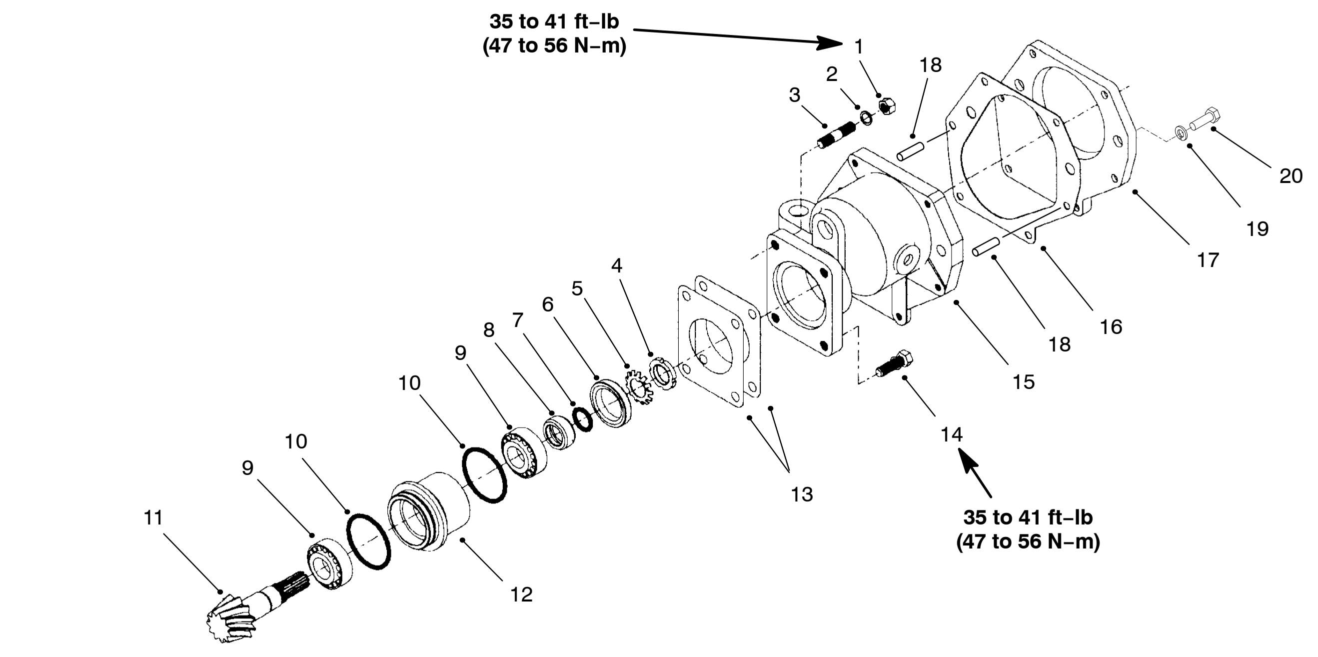


Figure 30

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
19. Lock washer (6 used)
20. Cap screw (6 used)

The following procedures assume the rear axle assembly has been removed from the machine.

Removal (Fig. 30)

1. Remove the cover plate, gasket and gear case assembly from the axle assembly. Remove the gasket and any remaining gasket material.

2. Remove the retaining rings and the driven gear from the input shaft/pinion gear.

3. Remove input shaft/pinion gear assembly from the gear case. Remove the shims and bearing case O-rings.

4. Release the stake washer and remove the lock nut. Remove and discard the stake washer.

5. Drive the input shaft/pinion gear out from the outer bearing cone and bearing case. Remove and discard the oil seal and O-ring.

6. Inspect all gears, shafts, bearings, spacers and cases for damage and wear. Replace components as necessary.

NOTE: Replacement input shaft/pinion gear (item 11) is only available in matched set with differential ring gear.

Installation (Fig. 30)

NOTE: When installing bearing cones onto the input shaft/pinion gear, press only on the inner race of the bearing cone.

1. If the inner bearing cone was removed, press a new bearing cone all the way onto the input shaft/pinion gear.

2. Place the shaft and bearing assembly in the bearing case and install the outer bearing cone.

NOTE: The bearings must be completely seated. There should be no input shaft/pinion gear end play.

3. Coat a new oil seal with grease and install as shown (Fig. 31). The seal should be installed with the garter spring towards the hydraulic motor location.

4. Coat new O-ring with grease. Install O-ring in the oil seal collar and install the collar.

5. Install a new stake washer. Install the lock nut finger tight.

6. Set the bearing preload by securing the bearing case in a vise. Thread a M12 x 1.5 hex head cap screw into the splined end of the input shaft/pinion gear and slowly tighten the lock nut until 4 to 6 in-lb (0.4 to 0.7 N−m) of force is required to rotate the input shaft/pinion gear in the bearing case.

7. Secure the lock nut with the stake washer.

8. Use a depth gauge to measure the distance from the end face of the input shaft/pinion gear to the mating surface of the bearing case. Subtract the “Design Cone Center Distance” from this distance to determine initial shim thickness (Fig. 32).

DESIGN CONE CENTER DISTANCE
(distance from mating surface of axle support to end face of pinion gear):
1.870 ± 0.002 in. (47.5 ± 0.05 mm)

NOTE: Bearing case shims are available in 0.004 in. (0.1 mm) and 0.008 in. (0.2 mm) thickness.

9. Coat new O-rings with grease and install the bearing case in the gear case. Place shims on the gear case and temporarily install gear case assembly into axle case. Tighten mounting nuts and screws from **35 to 41 ft-lb (47 to 56 N−m)**.

10. Insert a screwdriver through the drain plug hole to hold ring gear and measure the pinion gear to ring gear backlash (Fig. 33).

PINION GEAR TO RING GEAR BACKLASH:
0.004 to 0.016 in. (0.10 to 0.40 mm)

11. Adjust backlash by increasing or reducing gear case shim thickness.

12. Check pinion gear to ring gear engagement (see Pinion Gear to Ring Gear Engagement in this section of this manual).

13. Place the correct combination of shims on the gear case. Tighten mounting nuts and screws from **35 to 41 ft-lb (47 to 56 N−m)**.

14. Install retaining rings and driven gear on input shaft/pinion gear.

15. If the drive gear (on drive motor shaft) was removed, install the retaining rings and drive gear on the motor shaft.

16. Use a new gasket and install the cover plate. Use a new O-ring and install the drive motor.

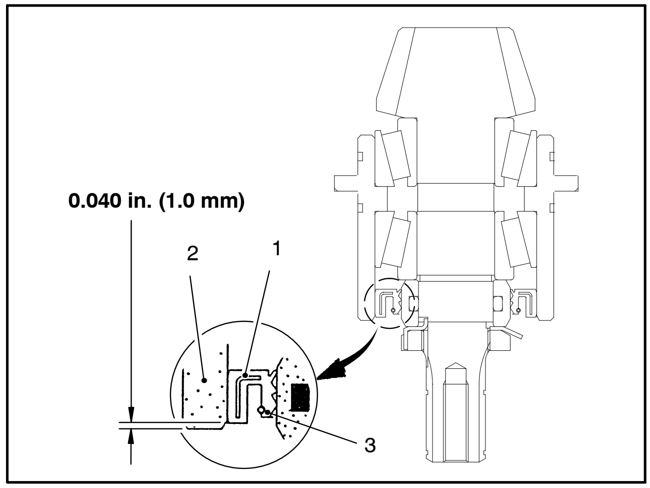


Figure 31

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

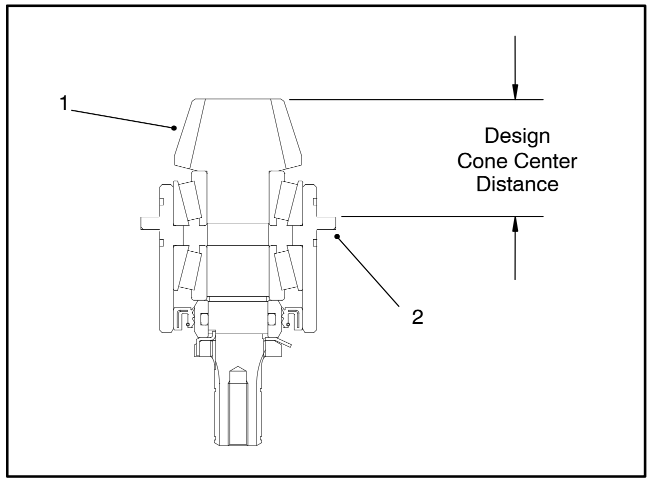


Figure 32

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

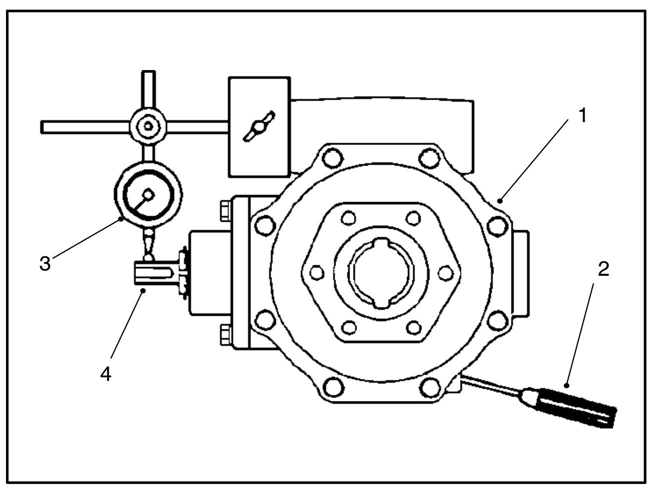


Figure 33

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

Differential Gear

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

1. Remove bevel gear case/axle case assemblies (see Bevel Gear Case/Axle Case Assembly in this section of this manual).

IMPORTANT: Do not interchange right and left differential shafts assemblies.

2. Mark and pull the differential shaft assemblies from the axle support.

3. Remove input shaft/pinion gear assembly, shims and O-ring from the axle support (Fig. 34).

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. 35).

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. 36).

NOTE: Replacement ring gears are only available in matched ring and pinion sets.

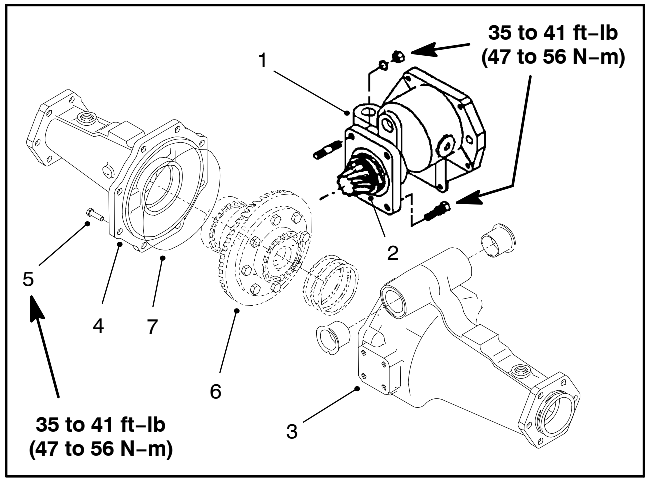


Figure 34

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**

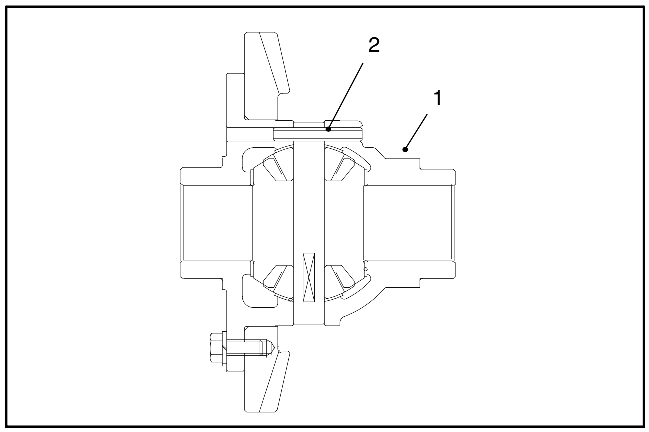


Figure 35

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

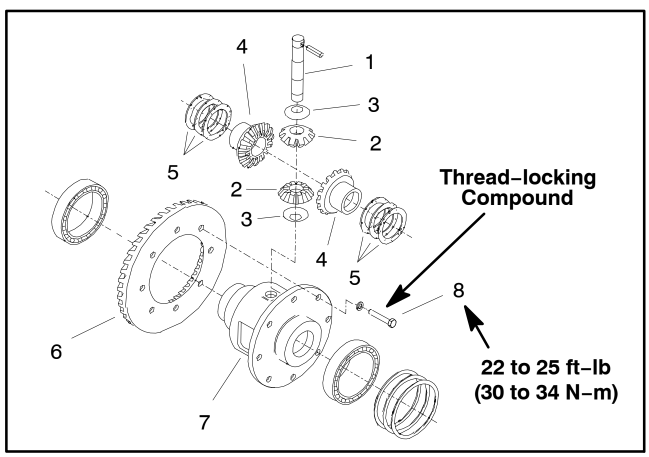


Figure 36

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)**

Inspection

1. Measure the differential side gear O.D. and the differential case I.D. to determine the side gear to case clearance (Fig. 37). 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. 38). 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.

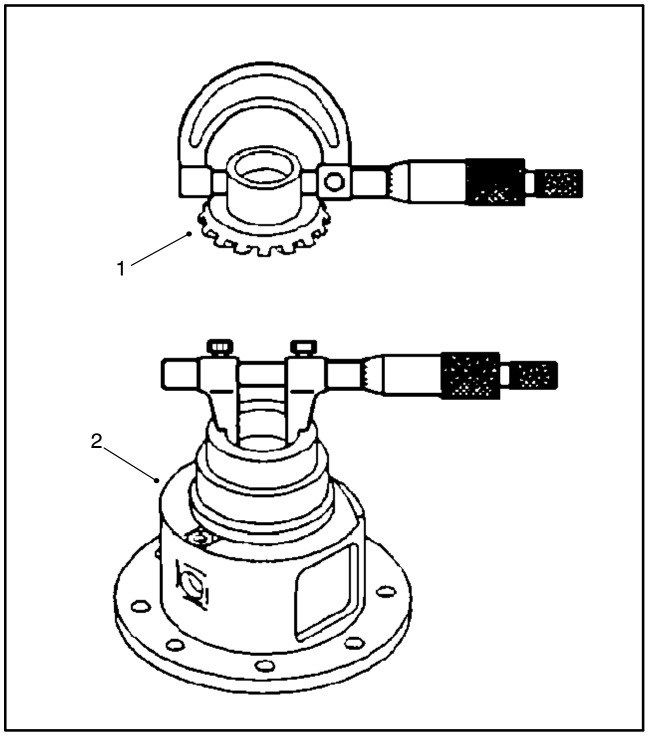


Figure 37

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

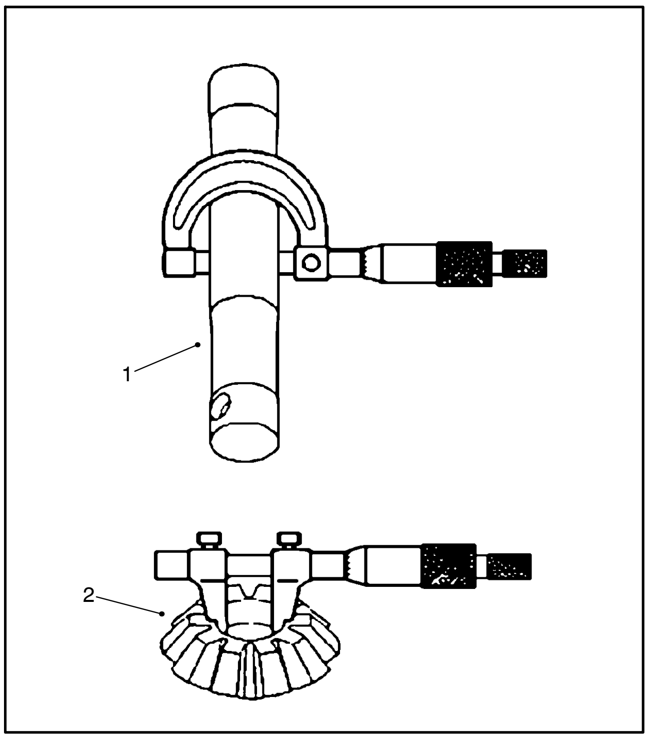


Figure 38

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

Installation

1. If the ring gear was removed from the differential case, use medium strength Loctite thread locker and tighten the mounting screws from **22 to 25 ft-lb (30 to 34 N–m)**.

2. Apply molybdenum disulfide lubricant (Three Bond 1901 or equivalent) to the splines and bearing surfaces of the differential pinion gears, pinion washers and side gears.

3. Install the side gear shims and side gears in their original location in the differential case.

4. Place the differential pinion gears and pinion washers in their original location in the differential case. Temporarily install the differential pinion shaft.

5. Secure the differential case in a soft jawed vise. Position a dial indicator on a tooth of the differential pinion gear. Press the pinion and side gear against the differential case and measure the pinion gear to side gear backlash (Fig. 39).

PINION GEAR TO SIDE GEAR BACKLASH:
0.004 to 0.016 in. (0.10 to 0.40 mm)

6. Adjust backlash by increasing or reducing side gear shim thickness.

NOTE: Side gear shims are available in 0.043 in. (1.10 mm), 0.047 in. (1.20 mm) and 0.051 in. (1.30 mm) thickness.

7. Apply gear marking compound, such as DyKem® Steel Blue lightly over several gear teeth.

8. While applying a light load to either side gear, rotate either pinion gear until the side gears have made one complete revolution.

9. Ideal tooth contact should cover more than 35% of each tooth surface. The contact area should be in the center of each tooth and extend 1/3 to 1/2 way across each tooth from the toe (small) end (Fig. 40).

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.

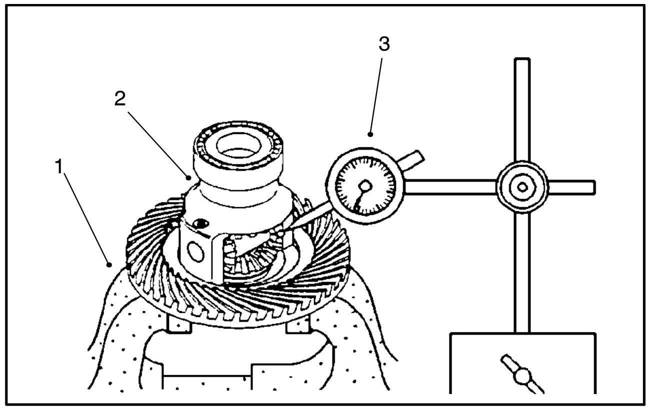


Figure 39

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

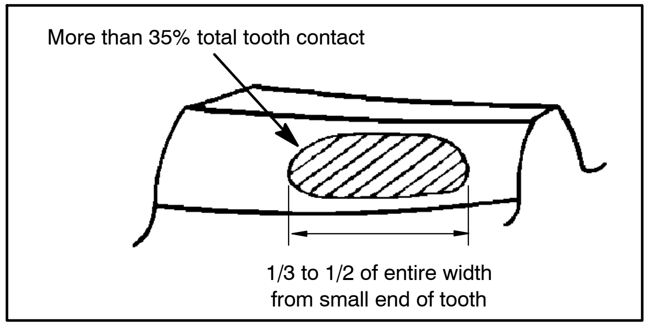


Figure 40

12. Install differential gear assembly in right side axle support half.

13. Coat a new o-ring with grease and install left side axle support half. Tighten axle support case screws from **35 to 41 ft-lb (47 to 56 N–m)**.

14. Install input shaft/pinion gear assembly (see Input Shaft/Pinion Gear in this section of this manual).

15. Coat new o-rings with grease, align differential shaft splines with differential gear assembly and slide differential shaft assemblies onto axle support.

16. Install bevel gear case/axle case assemblies (see Bevel Gear Case/Axle Case Assembly in this section of this manual).

Pinion Gear to Ring Gear Engagement

The final position of the pinion gear is verified by using the gear contact pattern method as described in the following procedure.

GEAR TOOTH DEFINITIONS (Fig. 41):

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. 42).

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. 43).

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. 44 and 45) 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.

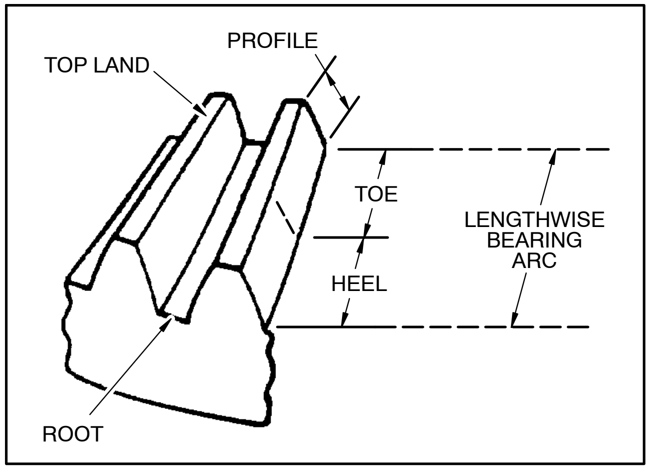


Figure 41

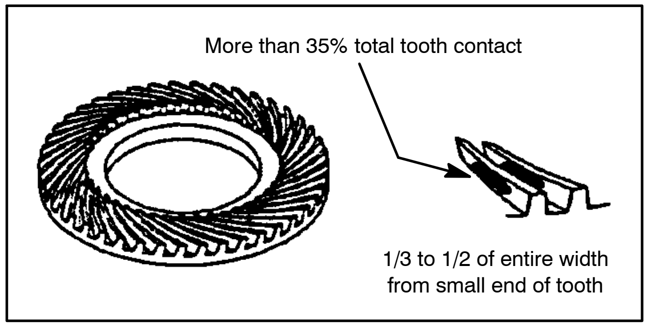


Figure 42

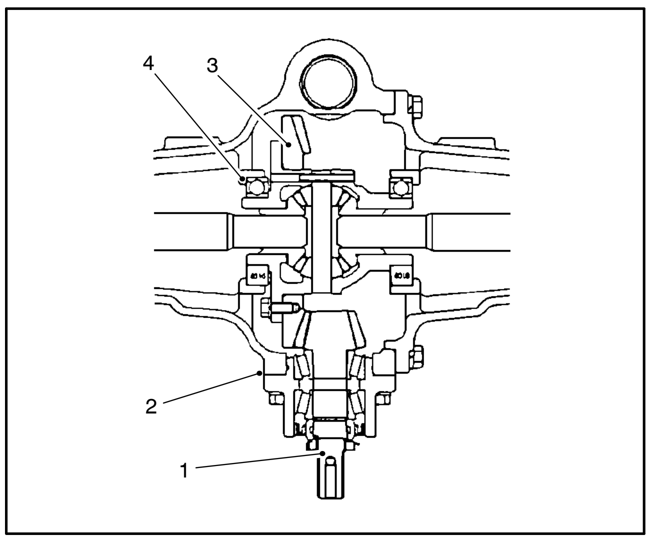


Figure 43

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

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. 44):

   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. 45):

   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.

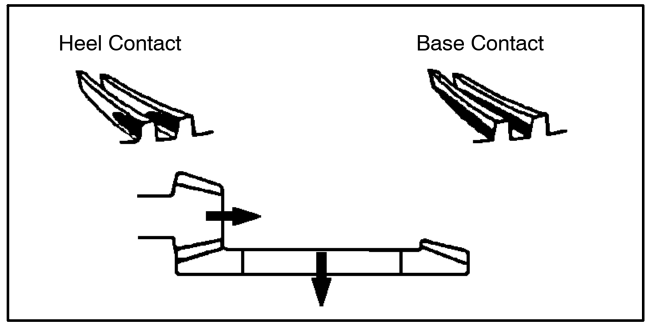


Figure 44

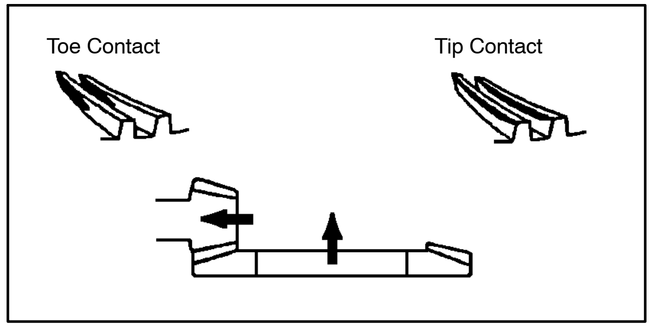


Figure 45

Chapter 7

Chassis

Table of Contents

General Information

Operator's Manual

The Traction Unit and Cutting Deck Operator's Manuals provide information regarding the operation, general maintenance and maintenance intervals for your Groundsmaster machine. Refer to these publications for additional information when servicing the machine.

Cutting Deck Identification

Cutting decks on the Groundsmaster 4500–D and 4700–D are identified as shown in Figure 1.

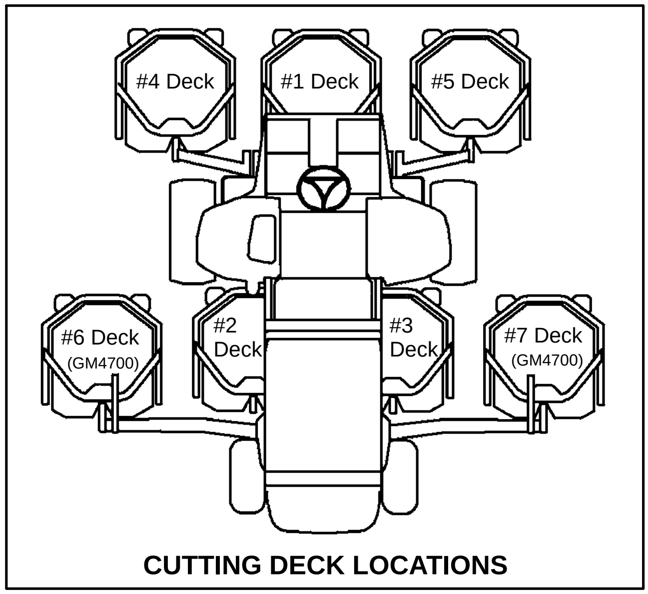


Figure 1

This page is intentionally blank.

Chassis

Service and Repairs

Steering Column

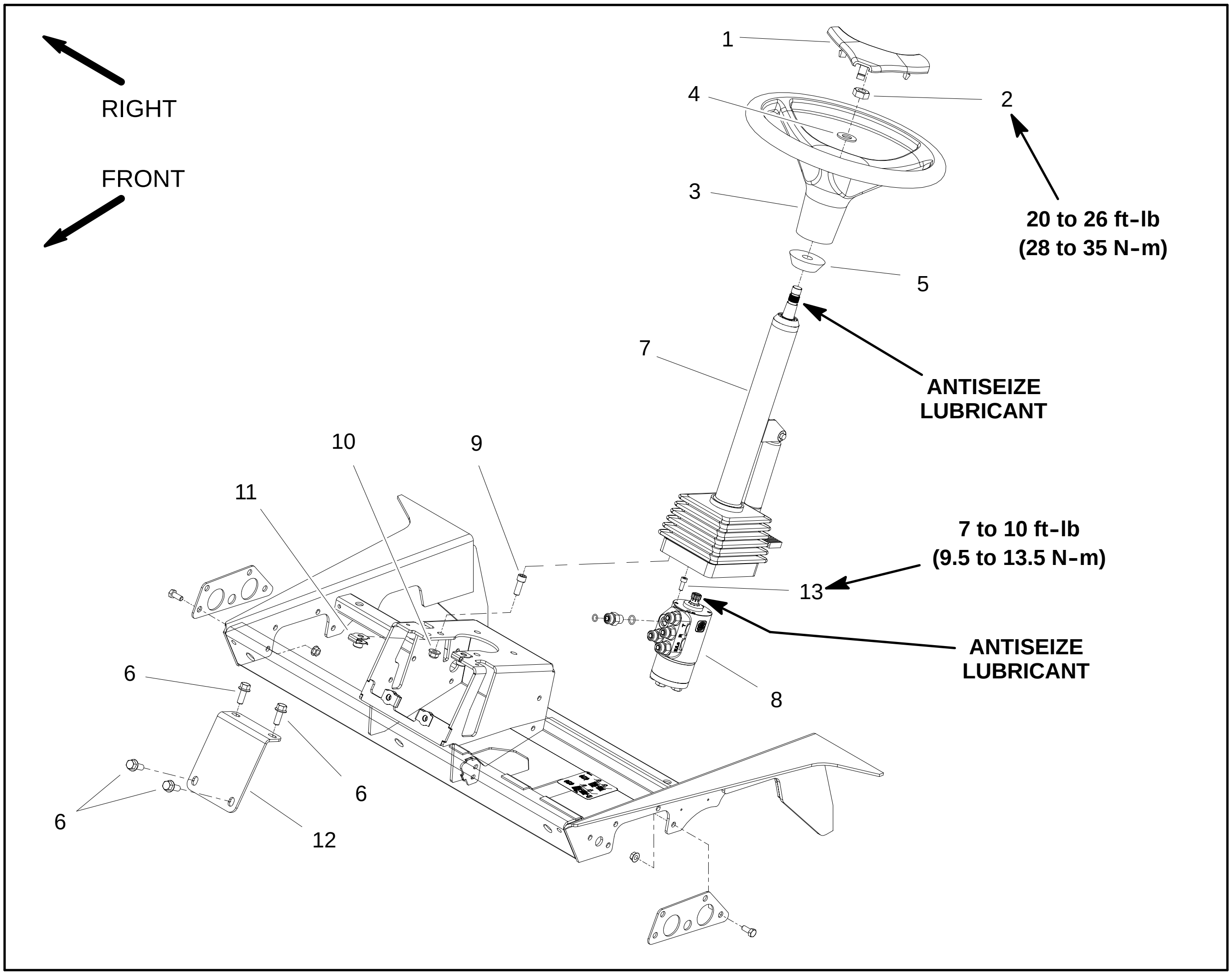


Figure 2

1. **Steering wheel cover**
2. **Lock nut**
3. **Steering wheel**
4. **Flat washer**
5. **Foam collar**
6. **Flange head screw (4 used)**
7. **Steering column**
8. **Steering control valve**
9. **Socket head screw (4 used)**
10. **Flange nut (4 used)**
11. **Tinnerman nut (4 used)**
12. **Column brace**
13. **Socket head screw (4 used)**

Removal (Fig. 2)

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

2. Remove platform shroud from machine to allow access to steering column fasteners (Fig. 3).

3. Remove cover from steering wheel by carefully prying up on one of the cover spokes.

4. Remove lock nut and flat washer that secure steering wheel to steering column.

5. Use a suitable puller to remove steering wheel from steering column. Remove foam collar.

6. Remove four (4) flange head screws that secure column brace (item 12) to frame platform. Remove brace from machine to allow access to steering column fasteners.

7. Slide rubber bellows up steering column to allow access to fasteners that secure steering control valve and steering column to machine.

8. Support steering control valve to prevent it from shifting during steering column removal.

9. Loosen and remove four (4) socket head screws (item 13) that secure steering control valve to steering column.

10. Loosen and remove four (4) socket head screws (item 9) and flange nuts (item 10) that secure steering column to machine.

11. Raise steering column assembly from steering control valve and machine.

12. Disassemble steering column assembly as needed using Figure 4 as a guide.

Installation (Fig. 2)

1. Assemble steering column using Figure 4 as a guide.

2. Apply antiseize lubricant to input shaft of steering control valve.

3. Slide steering column onto steering control valve. Secure steering column in place with four (4) socket head screws (item 9) and flange nuts (item 10).

4. Secure steering control valve to steering column with four (4) socket head screws (item 13). Torque screws from **7 to 10 ft-lb (9.5 to 13.5 N-m)**.

5. Slide rubber bellows to bottom of steering column.

6. Position column brace (item 12) in place and secure with four (4) flange head screws.

7. Slide foam collar onto steering column.

8. Thoroughly clean tapered surfaces of steering wheel and steering column.

9. Apply antiseize lubricant to splines of steering column taking care to keep antiseize lubricant from column taper. Slide steering wheel onto steering column.

10. Secure steering wheel to steering column with flat washer and lock nut. Torque hex nut from **20 to 26 ft-lb (28 to 35 N-m)**.

11. Install steering wheel cover to steering wheel.

12. Install and secure platform shroud to machine (Fig. 3).

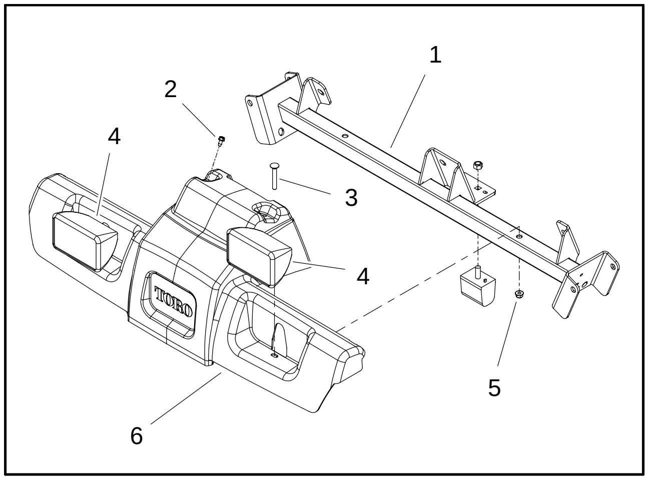


Figure 3

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

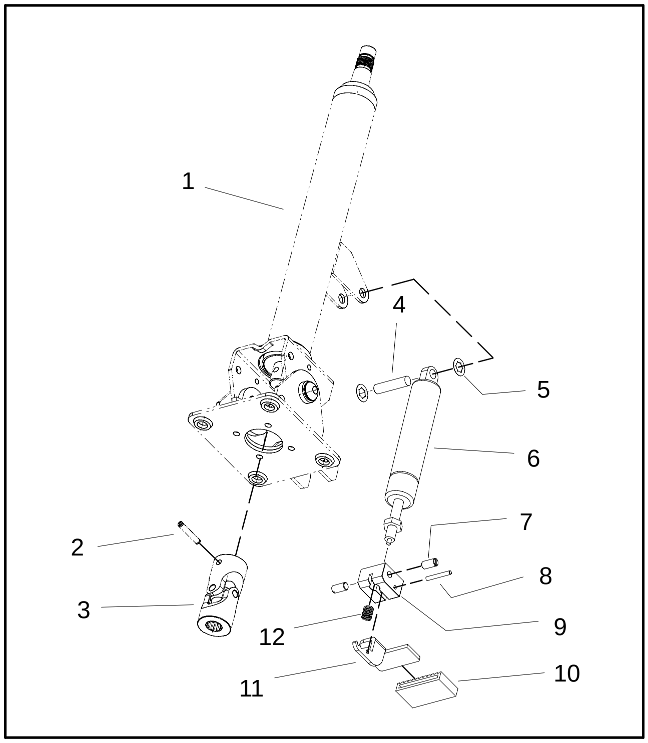


Figure 4

1. **Steering column**
2. **Pin**
3. **Universal joint**
4. **Pin**
5. **Lock washer (2 used)**
6. **Cylinder**
7. **Bolt (2 used)**
8. **Pin**
9. **Pedal block**
10. **Pedal cover**
11. **Pedal**
12. **Spring**

Chassis

Console Arm

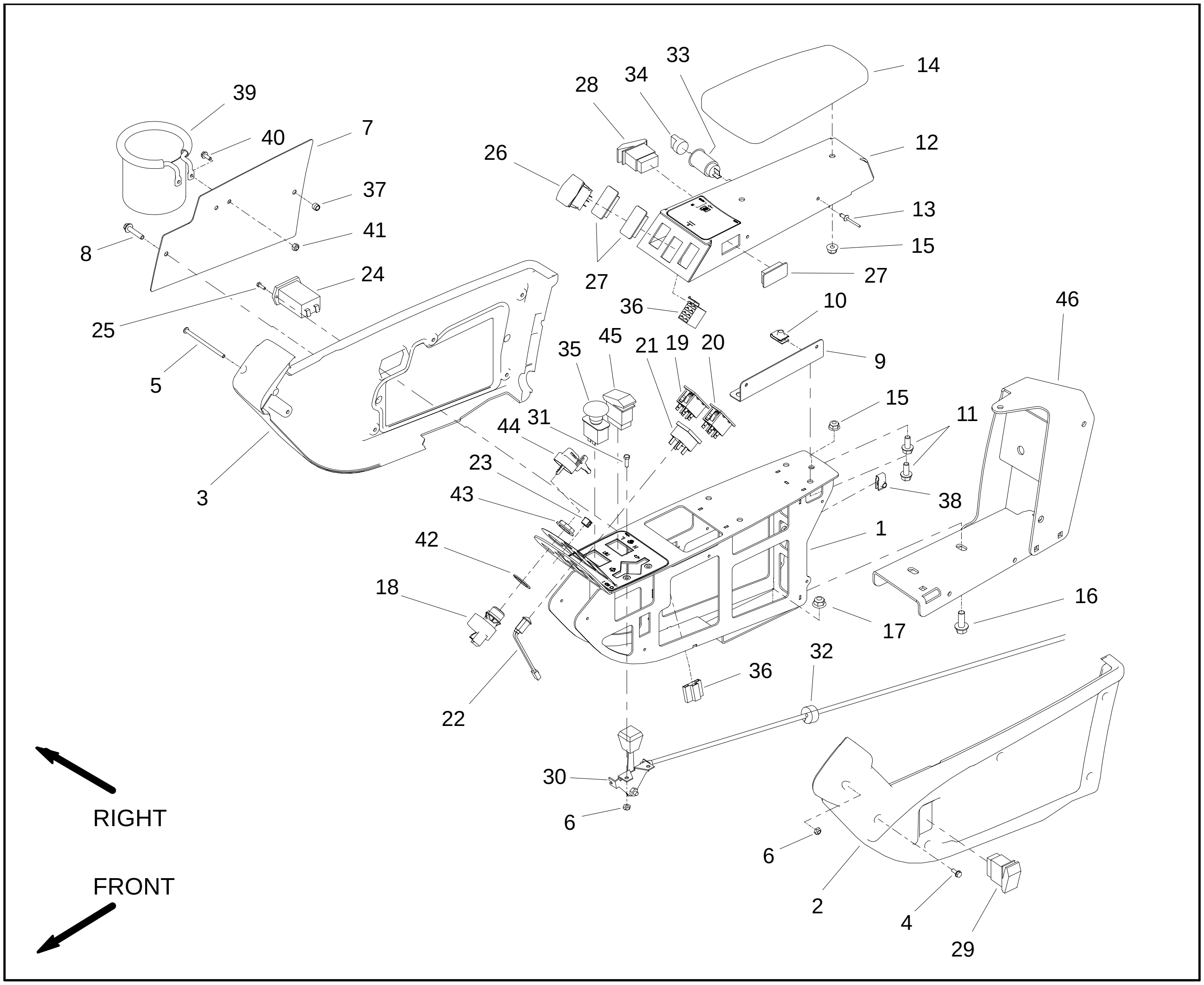


Figure 5

1. Console arm frame
2. LH cover
3. RH cover
4. Washer head screw (10 used)
5. Phillips head screw
6. Lock nut (3 used)
7. Cover plate
8. Flange head screw (2 used)
9. Mount
10. U–nut (4 used)
11. Flange head screw (5 used)
12. Switch panel
13. Rivet (2 used)
14. Arm rest
15. Flange nut (3 used)
16. Flange head screw (2 used)
17. Flange nut (2 used)
18. Ignition switch
19. Indicator light (charge/oil pressure)
20. Indicator light (high temp/glow plug)
21. Temperature gauge
22. Indicator light
23. Button plug
24. Hour meter
25. Cap screw (2 used)
26. Cutting deck lift switch
27. Hole plug
28. Engine cooling fan switch
29. Headlight switch
30. Throttle cable
31. Screw (2 used)
32. Foam seal
33. Power point
34. Cap
35. PTO switch
36. Console wire harness
37. Flange spacer (2 used)
38. Clip (2 used)
39. Bag holder
40. Washer head screw (2 used)
41. Lock nut (2 used)
42. Lock washer
43. Nut
44. Ignition key
45. Hi – Lo speed switch
46. Arm support

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 8) and then cover plate (item 7) from outside of console arm. Locate and retrieve two (2) flange spacers (item 37).

3. At front of console arm, remove screw (item 5) and lock nut (item 6) that secure console arm covers to each other.

4. Remove five (5) washer head screws (item 4) that secure each cover to console arm panel.

5. Remove console arm covers from machine. As LH cover (item 2) is removed from console arm, unplug wire harness connector from headlight switch.

6. Remove electrical components from console arm as needed using Figure 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 2) is placed, plug wire harness connector to headlight switch.

3. Secure each cover to console arm with five (5) washer head screws (item 4). Install screw (item 5) and lock nut (item 6) to secure covers at front of console arm.

4. Position cover plate and flange spacers to outside of console arm. Secure with two (2) flange head screws.

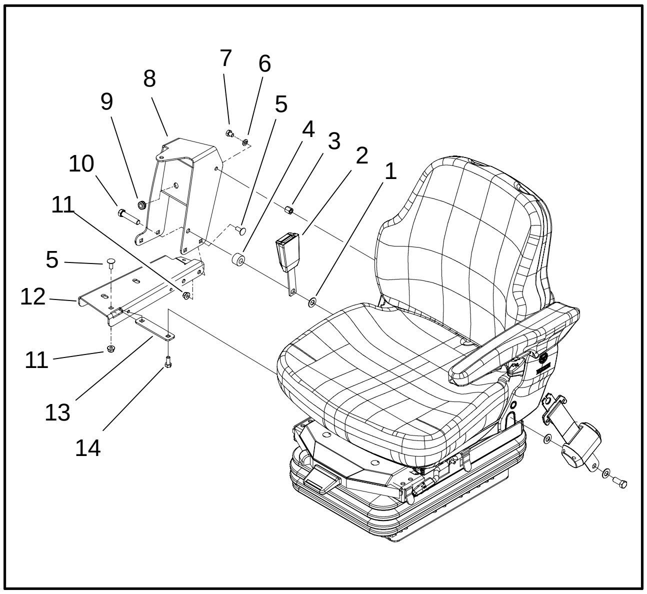


Figure 6

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

Chassis

Lift Arms for Cutting Decks #1, #4 and #5

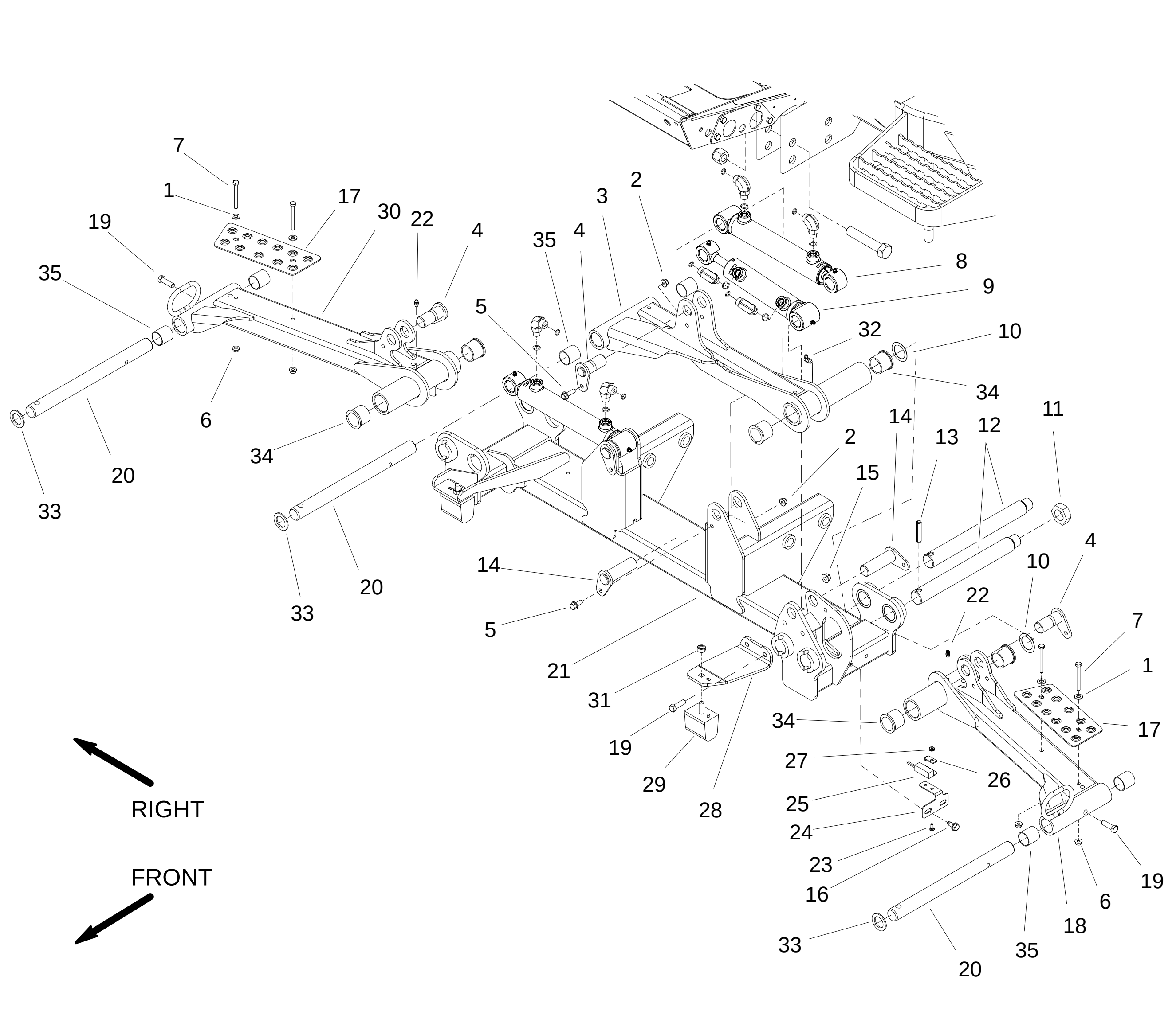


Figure 7

1. **Flat washer**
2. **Flange nut**
3. **Lift arm (#1 deck)**
4. **Lift cylinder pin**
5. **Flange head screw**
6. **Flange nut**
7. **Cap screw**
8. **Lift cylinder (#4 and #5 decks)**
9. **Lift cylinder (#1 deck)**
10. **Thrust washer**
11. **Lock nut**
12. **Pivot pin**
13. **Slotted roll pin**
14. **Lift cylinder pin**
15. **Flange nut**
16. **Washer head screw**
17. **Skid plate**
18. **Lift arm (#4 deck)**
19. **Cap screw**
20. **Carrier pivot shaft**
21. **Front carrier frame**
22. **Grease fitting**
23. **Carriage bolt**
24. **Switch bracket**
25. **Deck position switch**
26. **Switch plate**
27. **Lock nut**
28. **Bumper support bracket**
29. **Bumper**
30. **Lift arm (#5 deck)**
31. **Lock nut**
32. **Grease fitting**
33. **Thrust washer**
34. **Flange bushing (2 used per arm)**
35. **Bushing (2 used per arm)**

Removal (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 cutting deck assembly from lift arm (see Cutting Deck Operator’s Manual).

3. If lift arm for either deck #4 or #5 (Fig. 8) is to be removed, clean, label and remove hydraulic hoses from the deck motor (Fig. 9). Place plugs or caps on open fittings and hoses. Slide hoses out of the hose retaining loop on the lift arm.

4. Remove lift cylinder pin (item 4) that secures hydraulic lift cylinder to lift arm.

5. Loosen and remove lock nut (item 11) from lift arm pivot pin.

6. Support lift arm and pull lift arm pivot pin from lift arm and frame. Locate and remove thrust washer from rear of lift arm during pivot pin removal.

7. Remove lift arm from machine (see Cutting Deck Operator's Manual).

8. Disassemble lift arm as needed using Figure 7 as a guide.

9. Clean lift arm and pivot pin. Inspect lift arm bushings and pivot pin for damage or wear. Replace worn or damaged components.

Installation (Fig 7)

1. Assemble lift arm using Figure 7 as a guide.

2. Position lift arm to frame. Fit thrust washer (item 10) between rear of lift arm and frame. Slide pivot pin into frame and lift arm. Align roll pin in pivot pin with slot in frame flange.

3. Install and tighten lock nut (item 11) to secure lift arm pivot pin.

4. Install hydraulic lift cylinder to lift arm with cylinder pin. Secure cylinder pin to lift arm with flange head screw and flange nut.

NOTE: Install thrust washer (item 33) on carrier pivot shaft before installing cutting deck on pivot shaft.

5. Position and install cutting deck to lift arm (see Cutting Deck Operator's Manual).

6. If lift arm for either deck #4 or #5 was removed, slide hydraulic hoses through the hose retaining loop on the lift arm. Remove caps and plugs from hoses and fittings and install hoses to the deck motor (Fig. 9). Make sure that deck is fully lowered to the ground before tightening hoses.

7. Lubricate lift arm and lift cylinder grease fittings after assembly is complete.

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

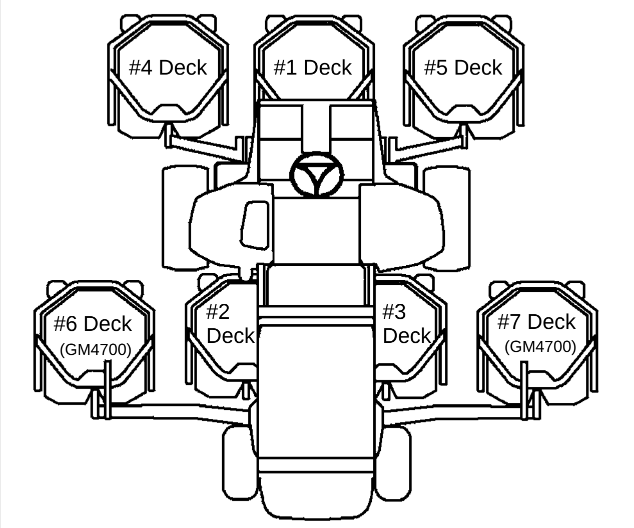


Figure 8

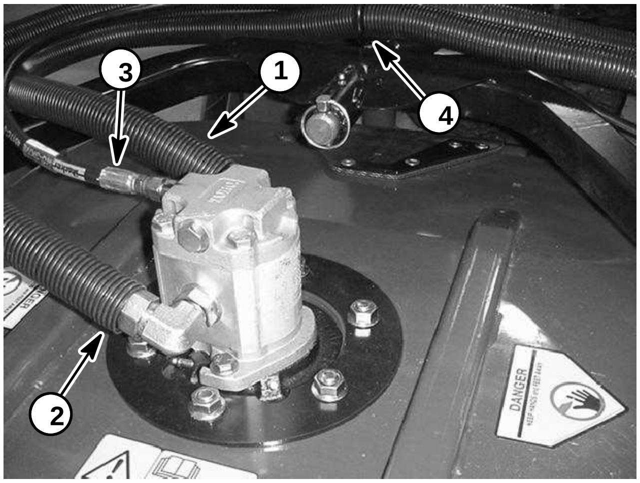


Figure 9

1. **Supply hose**
2. **Return hose**
3. **Case drain hose**
4. **Hose retaining loop**

Chassis

Lift Arms for Cutting Decks #2 and #3

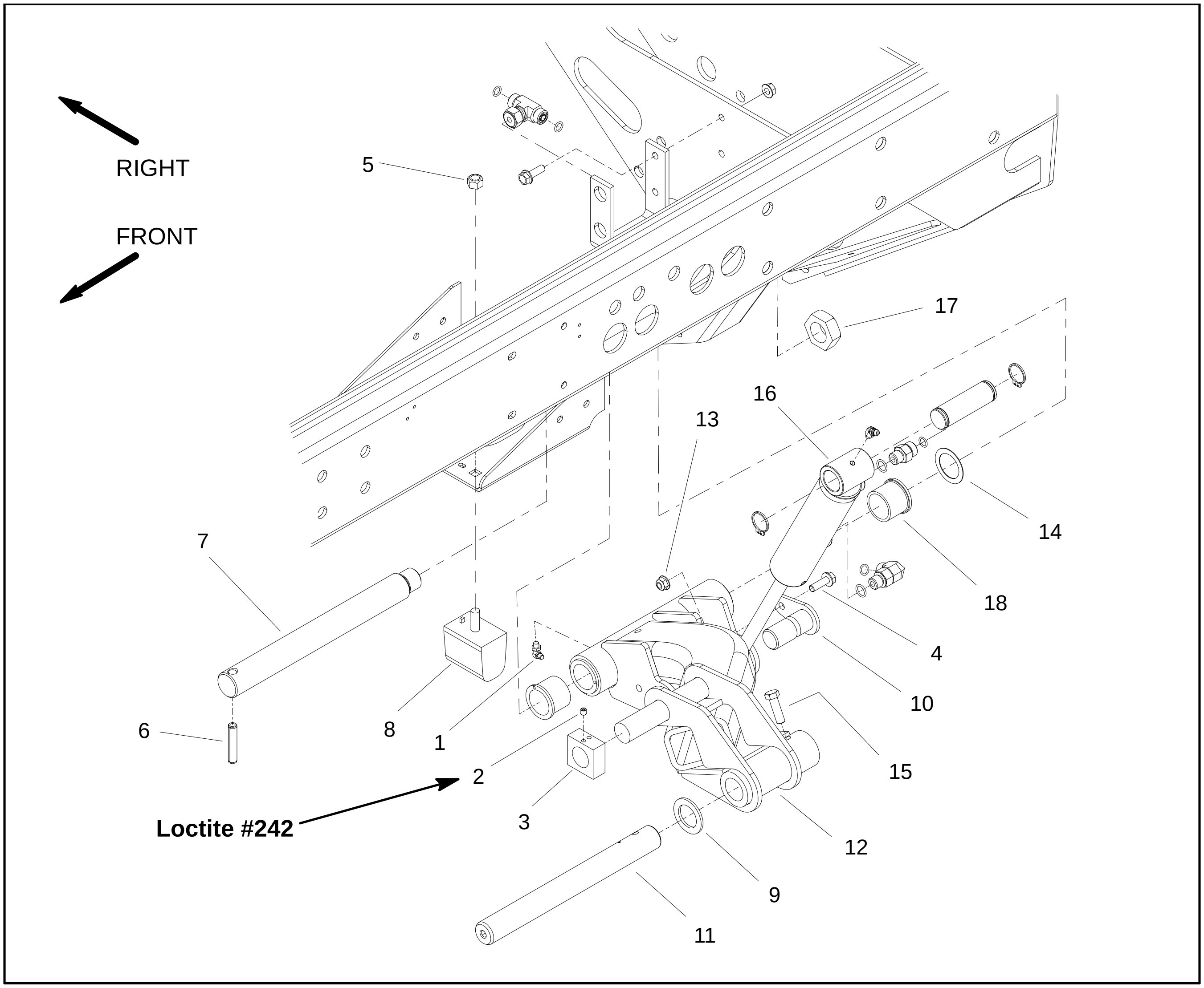


Figure 10

1. Grease fitting
2. Set screw (2 used per stop)
3. Rotation stop
4. Flange head screw
5. Lock nut
6. Slotted roll pin
7. Pivot pin
8. Bumper
9. Thrust washer
10. Lift cylinder pin
11. Deck pivot shaft
12. Lift arm (#2 deck shown)
13. Flange nut
14. Thrust washer
15. Cap screw
16. Lift cylinder
17. Lock nut
18. Flange bushing (2 used per arm)

Removal (Fig. 10)

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

2. Remove cutting deck from lift arm (see Cutting Deck Operator's Manual).

3. Remove lift cylinder pin (item 10) that secures lift cylinder to lift arm.

4. Loosen and remove lock nut (item 17) from pivot pin.

5. Support lift arm and pull lift arm pivot pin from lift arm and frame. Locate and remove thrust washer (item 14) from rear of lift arm during pivot pin removal.

6. Remove lift arm from machine.

7. Disassemble lift arm as needed using Figure 10 as a guide.

8. Clean lift arm and pivot pin. Inspect lift arm bushings and pivot pin for damage or wear. Replace worn or damaged components.

Installation (Fig. 10)

1. Assemble lift arm using Figure 7 as a guide.

2. Position lift arm to frame (Fig. 10). Fit thrust washer (item 14) between rear of lift arm and frame. Slide pivot pin into frame and lift arm. Align roll pin in pivot pin with slot in frame flange.

3. Install and tighten lock nut (item 17) to secure lift arm pivot pin.

4. Secure lift cylinder to lift arm with cylinder pin (item 10). Secure cylinder pin to lift arm with flange head screw and flange nut.

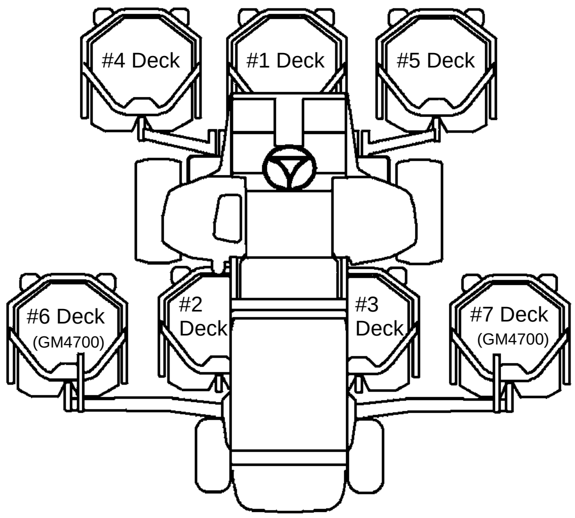
NOTE: Install thrust washer on deck pivot shaft before installing cutting deck on pivot shaft.

5. Position and install cutting deck to lift arm (see Cutting Deck Operator's Manual).

NOTE: The lift arms for cutting decks #2 and #3 are fitted with a lift arm rotation stop block (item 3). This stop is to keep the deck stable while raised. To adjust rotation stop, remove two (2) set screws from stop and fully raise cutting deck to position the stop. Apply Loctite #242 (or equivalent) to set screws and install set screws to secure stop. The rotation stop should contact the lift arm across the full width of the stop.

6. Lubricate lift arm and lift cylinder grease fittings after assembly is complete.

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



CUTTING DECK LOCATIONS

Figure 11

Lift Arms for Cutting Decks #6 and #7 (Groundsmaster 4700-D)

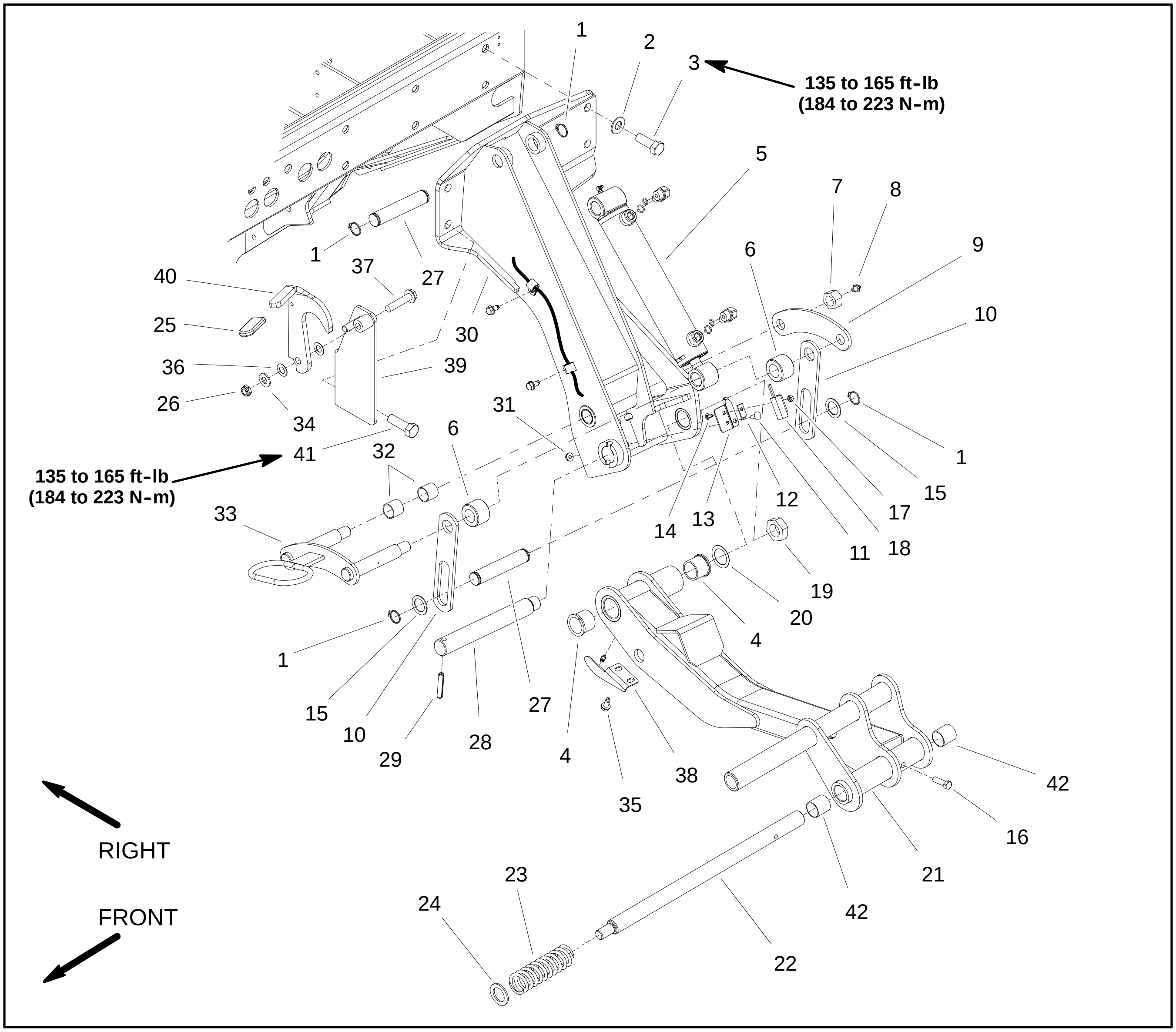


Figure 12

1. Retaining ring
2. Flat washer (4 used per support arm)
3. Cap screw (4 used per support arm)
4. Flange bushing
5. Lift cylinder
6. Plastic roller
7. Lock nut
8. Grease fitting
9. Rear link
10. Lift link
11. Carriage screw
12. Switch plate
13. Switch bracket
14. Carriage bolt
15. Thrust washer
16. Cap screw
17. Lock nut
18. Deck position switch
19. Lock nut
20. Thrust washer
21. Lift arm (deck #6 shown)
22. Carrier pivot pin
23. Compression spring
24. Thrust washer
25. Plastic grip
26. Lock nut
27. Pin
28. Pivot pin
29. Slotted roll pin
30. Support arm (deck #6 shown)
31. Flange nut
32. Bushing
33. Link
34. Flat washer
35. Self tapping screw
36. Washer
37. Flange head screw
38. Switch actuator
39. Latch arm (LH shown)
40. Latch (LH shown)
41. Cap screw
42. Bushing

Removal (Fig. 12)

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

2. Remove cutting deck from lift arm (see Cutting Deck Operator's Manual).

3. Remove pin (item 27) that secures lift links (item 10) to lift arm.

4. Loosen and remove lock nut (item 19) from pivot pin (item 28).

5. Support lift arm and pull lift arm pivot pin from lift arm and support arm. Locate and remove thrust washer (item 20) from rear of lift arm during pivot pin removal.

6. Remove lift arm from machine.

7. Disassemble lift arm as needed using Figure 12 as a guide.

8. Clean lift arm and pivot pin. Inspect lift arm bushings and pivot pin for damage or wear. Replace worn or damaged components.

Installation (Fig. 12)

1. Assemble lift arm using Figure 12 as a guide.

2. Position lift arm to support arm. Fit thrust washer (item 20) between rear of lift arm and support arm. Slide pivot pin into support arm and lift arm. Align roll pin in pivot pin with slot in support arm flange.

3. Install and tighten lock nut (item 19) to secure lift arm pivot pin.

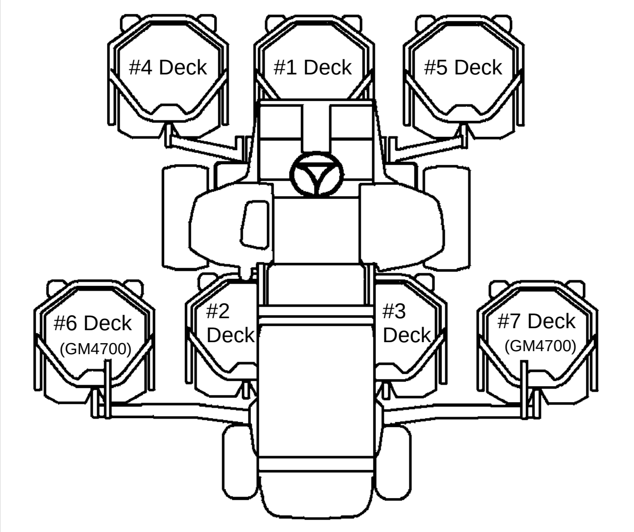
4. Secure lift links (item 10) to lift arm with pin (item 27). Make sure that thrust washer (item 15) and retaining ring (item 1) are on both ends of pin.

NOTE: Install compression spring (item 23) and thrust washer (item 24) on carrier pivot pin before installing cutting deck on pivot pin.

5. Position and install cutting deck to lift arm (see Cutting Deck Operator's Manual).

6. Lubricate lift arm grease fittings after assembly is complete.

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



CUTTING DECK LOCATIONS

Figure 13

Chassis

Operator Seat

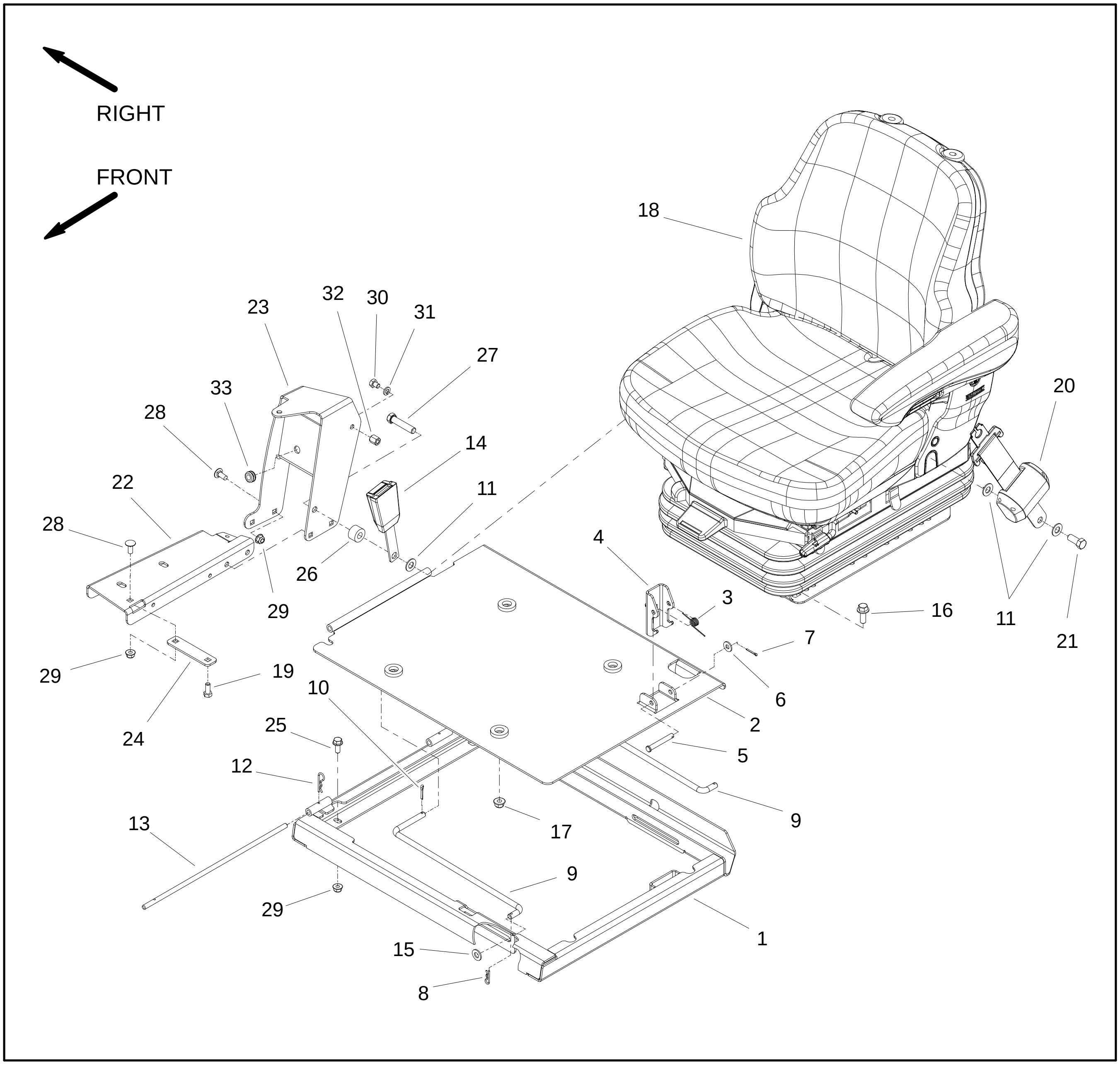


Figure 14

1. **Seat frame**
2. **Seat plate**
3. **Torsion spring**
4. **Seat plate latch**
5. **Clevis pin**
6. **Flat washer**
7. **Cotter pin**
8. **Hair pin (2 used)**
9. **Seat frame rod (2 used)**
10. **Cotter pin (2 used)**
11. **Flat washer (3 used)**
12. **Hair pin**
13. **Seat pivot shaft**
14. **Seat belt buckle**
15. **Flat washer (2 used)**
16. **Flange head screw (4 used)**
17. **Flange nut (4 used)**
18. **Seat assembly**
19. **Cap screw**
20. **Seat belt**
21. **Cap screw**
22. **Support channel**
23. **Arm support**
24. **Support bracket**
25. **Flange head screw (4 used)**
26. **Spacer**
27. **Cap screw**
28. **Carriage screw (5 used)**
29. **Flange nut (9 used)**
30. **Cap screw**
31. **Lock washer**
32. **Coupling nut**
33. **Grommet**

Removal (Fig. 14)

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

2. Disconnect seat electrical connector from machine wire harness.

3. Support console arm assembly to prevent it from shifting.

4. Remove flange nut (item 29) and carriage screw (item 28) that secure support bracket (item 24) to support channel (item 22).

5. Remove cap screw (item 30) and lock washer (item 31) that secure console arm support (item 23) to coupling nut (item 32).

6. Remove cap screw (item 27), flat washer (item 11), spacer (item 26) and seat belt buckle (item 14) from seat and console arm support (item 23).

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. 15). Note that the screw near the seat adjustment handle is longer than the other three (3) screws.

9. Lift seat from seat suspension and remove from machine.

Installation (Fig. 14)

1. Carefully position seat to seat suspension.

2. Secure seat to seat suspension with four (4) torx head screws (Fig. 15). 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 24) and support channel (item 22) with flange nut (item 29) and carriage screw (item 28).

B. Secure console arm support (item 23) to coupling nut with cap screw (item 30) and lock washer (item 31).

C. Place flat washer (item 11), seat belt buckle (item 14) and spacer (item 26) between seat and console arm support (item 23). Secure with cap screw (item 27).

D. Fully tighten all fasteners to secure console arm assembly to seat.

4. Connect seat electrical connector to machine wire harness.

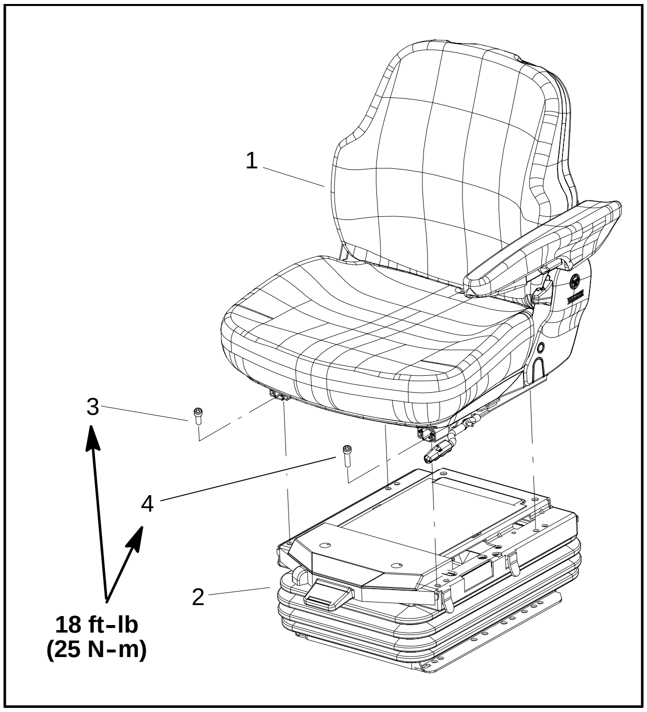


Figure 15

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

Chassis

Operator Seat Service

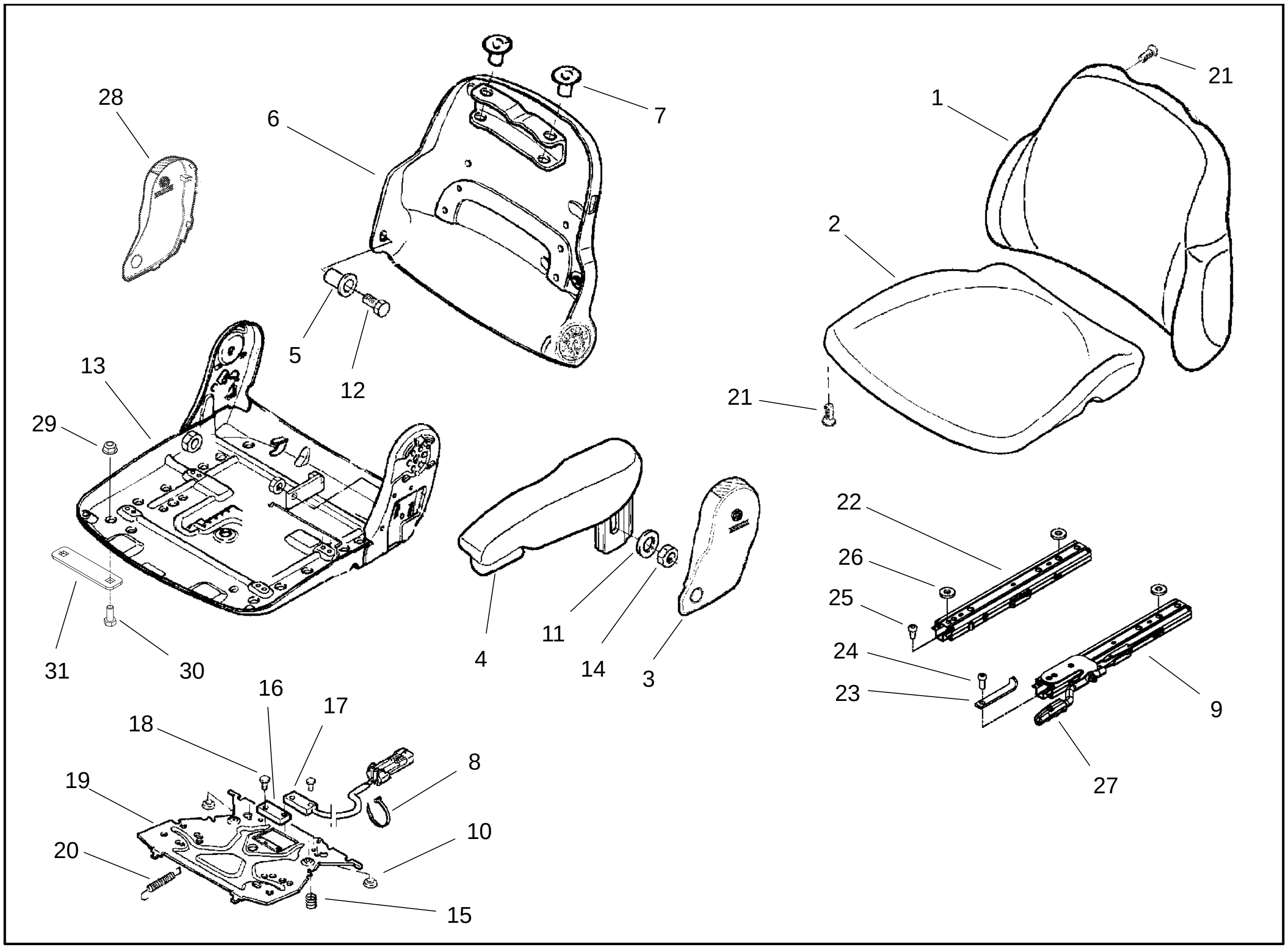


Figure 16

1. Backrest cushion
2. Seat cushion
3. LH 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. RH armrest cover
29. Nut
30. Cap screw
31. Support bracket

Disassembly (Fig. 16)

1. Remove seat from machine for service (see Operator Seat Removal in this section).

2. Disassemble operator seat as necessary using Figure 16 as a guide.

Assembly (Fig. 16)

1. Assemble operator seat using Figure 16 as a guide.

2. Install seat to machine (see Operator Seat Installation in this section).

Operator Seat Suspension

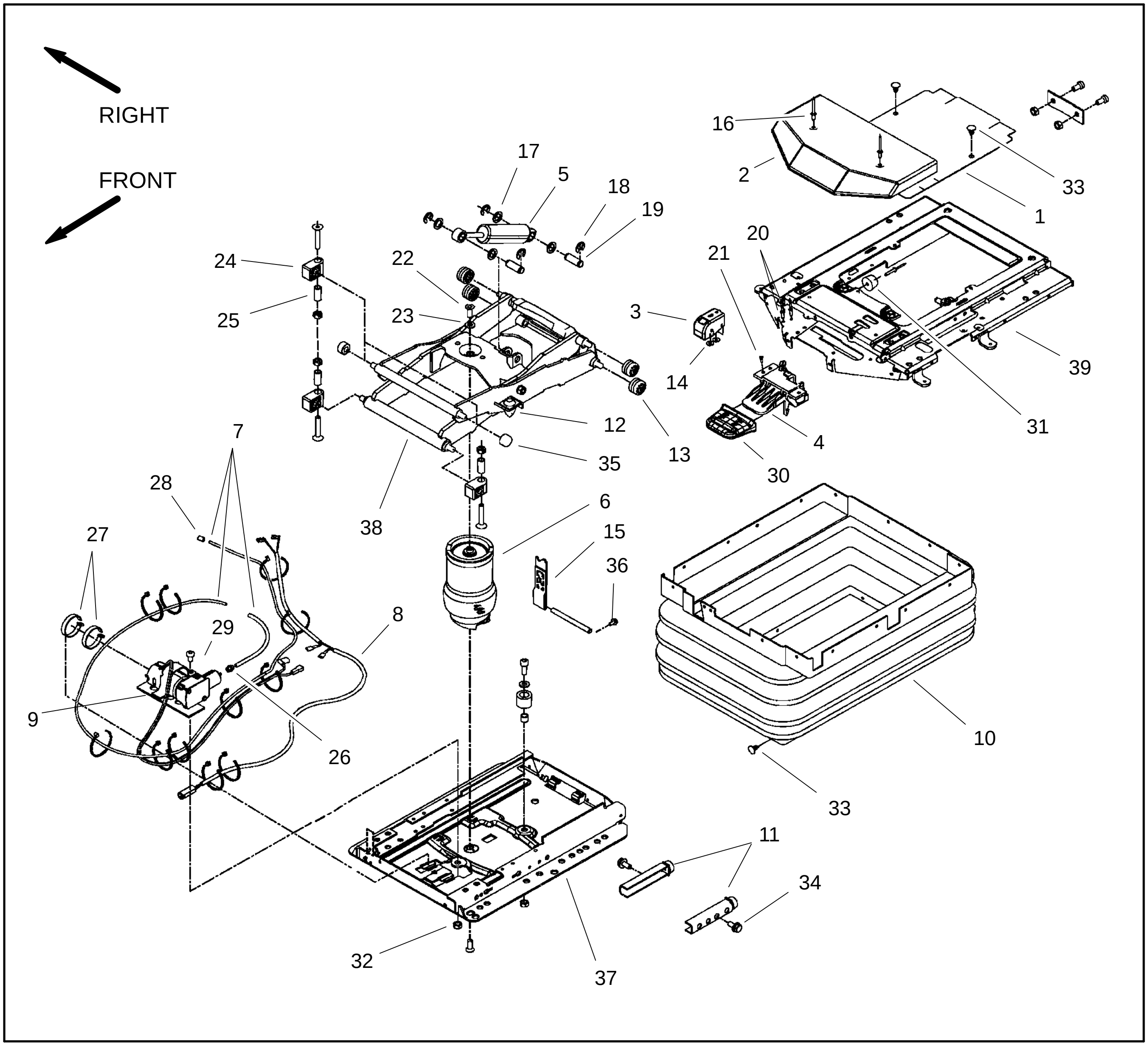


Figure 17

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 seat plate. If the air spring assembly (item 6) requires removal, the seat suspension base will have to be removed from the seat plate.

Disassembly (Fig. 17)

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

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

3. Disconnect seat suspension electrical connector from machine wire harness.

4. If the air spring assembly (item 6) or base plate (item 37) requires removal, remove seat suspension from seat plate (Fig. 18):

A. Raise and support seat plate assembly.

B. Remove four (4) flange head screws and flange nuts that secure seat suspension to seat plate.

C. Remove seat suspension from machine.

5. Remove seat suspension components as needed using Figure 17 as a guide.

Assembly (Fig. 17)

1. Install all removed seat suspension components using Figure 17 as a guide.

2. If seat suspension was removed from seat platform (Fig. 18):

A. Position seat suspension onto seat plate.

B. Secure seat suspension to seat plate with four (4) flange head screws and flange nuts.

3. Install operator seat to seat suspension (see Operator Seat Installation in this section).

4. Make sure that seat electrical connectors are secured to machine wire harness.

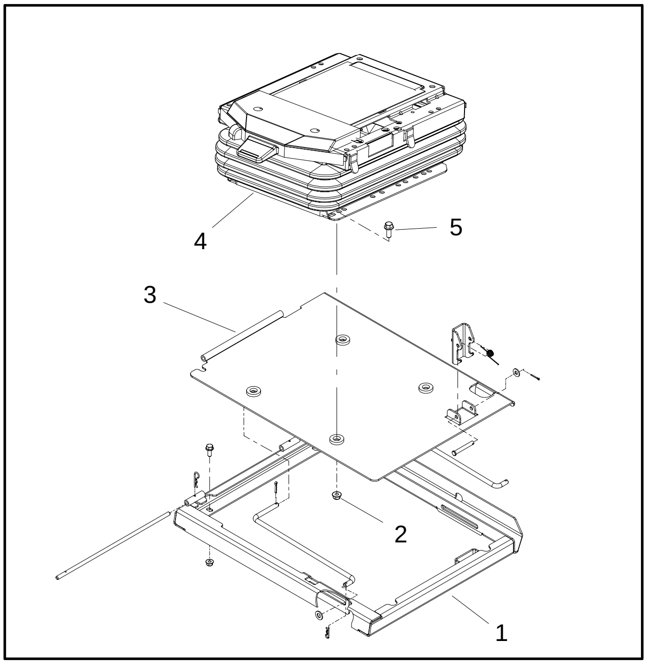


Figure 18

1. **Seat frame**
2. **Flange nut (4 used)**
3. **Seat plate**
4. **Seat suspension**
5. **Flange screw (4 used)**

Chassis

Hood

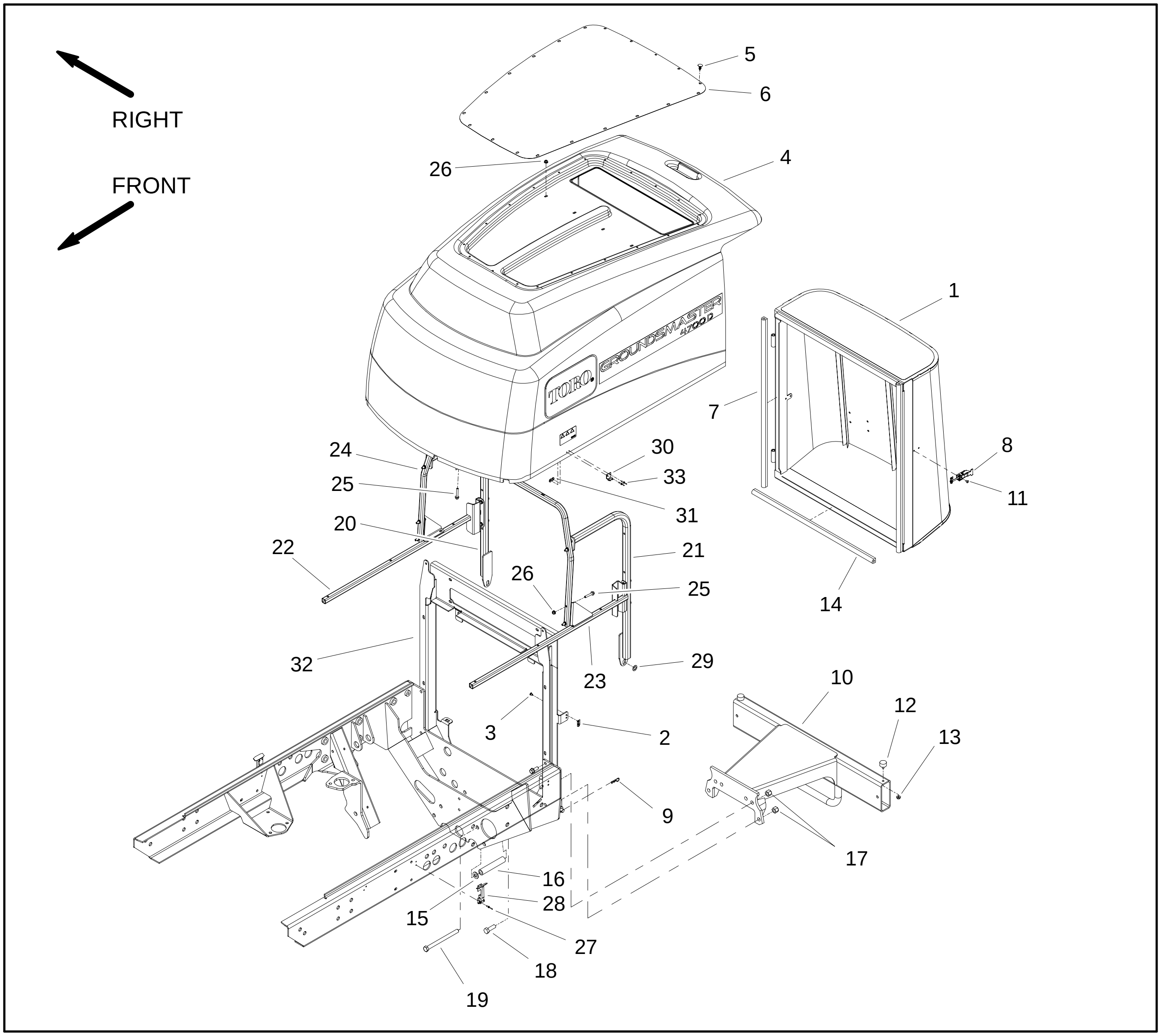


Figure 19

1. **Screen**
2. **Latch keeper**
3. **Pop rivet (2 used)**
4. **Hood**
5. **Plastic plug (20 used)**
6. **Hood screen**
7. **Bulb seal (2 used)**
8. **Adjustable latch**
9. **Hair pin (2 used)**
10. **Rear bumper**
11. **Pop rivet (2 used)**
12. **Rubber bumper (2 used)**
13. **Flange nut (2 used)**
14. **Bulb seal (2 used)**
15. **Flat washer (2 used)**
16. **Axle stop (2 used)**
17. **Lock nut (4 used)**
18. **Cap screw (2 used)**
19. **Cap screw (2 used)**
20. **RH hood frame tube**
21. **LH hood frame tube**
22. **RH hood frame tube**
23. **LH hood frame tube**
24. **Hood frame tube**
25. **Flange head screw (26 used)**
26. **Flange nut (26 used)**
27. **Pop rivet (4 used)**
28. **Flex draw latch (2 used)**
29. **Washer (2 used)**
30. **Latch keeper (2 used)**
31. **Back washer (4 used)**
32. **Radiator mount**
33. **Pop rivet (4 used)**

Removal (Fig. 19)

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

2. Release hood latches and raise hood.

3. Remove hair pins and washers from pivot pins on radiator frame.

4. Remove hood from pivot pins and machine.

5. If necessary, disassemble hood using Figure 19 as a guide.

Installation (Fig. 19)

1. If components were removed from hood, assemble hood using Figure 19 as a guide.

2. Slide hood frame onto radiator frame pivot pins.

3. Secure hood to frame with hair pins and washers.

4. Check hood alignment for correct operation of hood latches and dust seals.

This page is intentionally blank.

Cutting Decks

Table of Contents

Specifications

MOUNTING: All cutting decks are supported by independent lift arms and are interchangeable to any cutting deck positions. The Groundsmaster 4500–D uses five (5) cutting decks. The Groundsmaster 4700–D uses seven (7) cutting decks.

CONSTRUCTION: Deck chamber and frame are welded steel construction reinforced with channels and plates.

HEIGHT–OF–CUT RANGE: 3/4 to 4 inch (19 to 101 mm) in 1/4 inch (6.4 mm) increments. Height–of–cut adjustment is made by repositioning deck on deck frame.

DECK DRIVE: Closed loop, integrated relief, hydraulic system operates cutting deck hydraulic motors. Blade spindles are 1–1/4 inch (31.7 mm) shafts supported by greaseable, tapered roller bearings in a ductile iron housing.

CUTTING BLADE: Each cutting deck equipped with a 27 inch (686 mm) length, 0.250 inch (6.4 mm) thick, heat treated, steel blade. Anti–scalp cup installed on cutting blade. The standard blade is optimized for most cutting applications. Optional high lift, angled sail and Atomic blades are available for those situations where the standard blade is not ideal.

DISCHARGE: Clippings are discharged from the rear of the mowing decks. Pre–drilled mounting holes allow attachment of optional mulching baffle.

CUTTING DECK LIFT: Cutting decks on the Groundsmaster 4500–D are controlled with one (1) lift switch. The Groundsmaster 4700–D uses three (3) lift switches: one for the right wing deck, one for the left wing deck and the third (center) switch for the remaining five decks.

SUSPENSION SYSTEM: A fully floating suspension with hydraulic counterbalance. Main center pivot allows side–to–side deck oscillation. Individual decks supported with two (2) front rollers and one, full width, rear roller.

WEIGHT: Individual cutting deck weighs approximately 210 lb (95 kg).

General Information

CAUTION

Never install or work on the cutting decks or lift arms with the engine running. Always stop engine and remove key from ignition switch first.

Operator's Manual

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

Troubleshooting

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

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

Factors That Can Affect Quality of Cut

Factor	**Possible Problem/Correction**
1. Maximum governed engine speed.	Check maximum governed engine speed. Adjust speed to specifications if necessary.
2. Blade speed.	All deck blades should rotate at the same speed. See items in Troubleshooting Section of Chapter 4 – Hydraulic System.
3. Tire pressure.	Check air pressure of each tire. Adjust to pressures specified in Operator’s Manual.
4. Blade condition.	Sharpen blades if their cutting edges are dull or nicked. Inspect blade sail for wear or damage. Replace blade if needed.
5. Mower housing condition.	Make sure that cutting chambers are in good condition. Keep underside of deck clean. Debris buildup will reduce cutting performance.
6. Height–of–cut.	Make sure all cutting decks are set at the same height–of–cut. Adjust cutting decks as specified in the Cutting Deck Operator’s Manual. Adjust height–of–cut setting to remove only 1 inch (25 mm) or 1/3 of the grass blade when cutting.
7. Cutting deck alignment and ground following.	Check lift arms and cutting deck pivot linkages for wear, damage or binding. Also inspect for bent or damaged pivot shafts.
8. Roller condition.	All rollers should rotate freely. Replace bearings if worn or damaged.
9. Grass Conditions.	Mow when grass is dry for best cutting results.

Special Tools

Order special tools from your Toro Distributor.

Rear Roller Bearing and Seal Installation Tools

These tools are used to assemble the cutting deck rear roller.

Toro Part Numbers:

Inner Seal Tool	**115–0852**
Bearing/Outer Seal Tool	**115–0853**
Bearing Installation Washer	**107–8133**

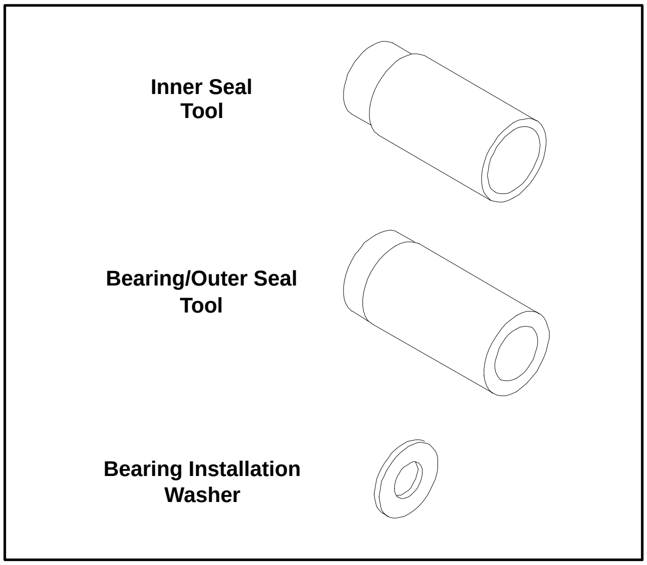


Figure 1

Spindle Plug

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

Toro Part Number: **94–2703**

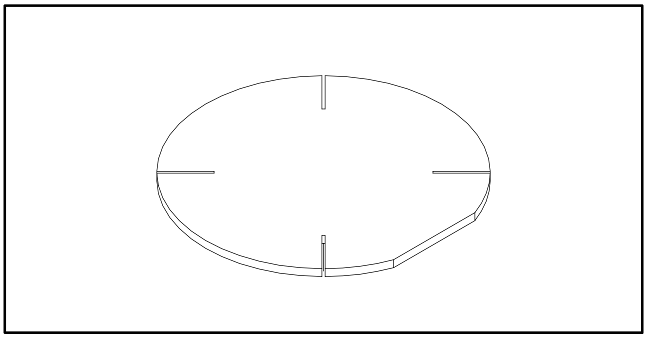


Figure 2

Cutting Decks

Adjustments

CAUTION

Never install or work on the cutting decks or lift arms with the engine running. Always stop engine and remove key from ignition switch first.

See the Cutting Deck Operator's Manual for adjustment procedures for cutting decks on the Groundsmaster 4500–D and Groundsmaster 4700–D.

Blade Stopping Time

The blades of the cutting decks are to come to a complete stop in approximately five (5) seconds after the PTO is disengaged.

NOTE: Make sure the decks are lowered onto a clean section of turf or hard surface to avoid dust and debris.

To verify this stopping time, have a second person stand back from the machine at least twenty (20) feet and watch the blade on one of the cutting decks. Have the machine operator disengage the PTO and record the time it takes for the cutting deck blade to come to a complete stop. If this time is greater than seven (7) seconds, the deck control manifold braking valve (RV) may need adjustment.

This page is intentionally blank.

Service and Repairs

CAUTION

Never install or work on the cutting decks or lift arms with the engine running. Always stop engine and remove key from ignition switch first.

Blade Spindle Assembly

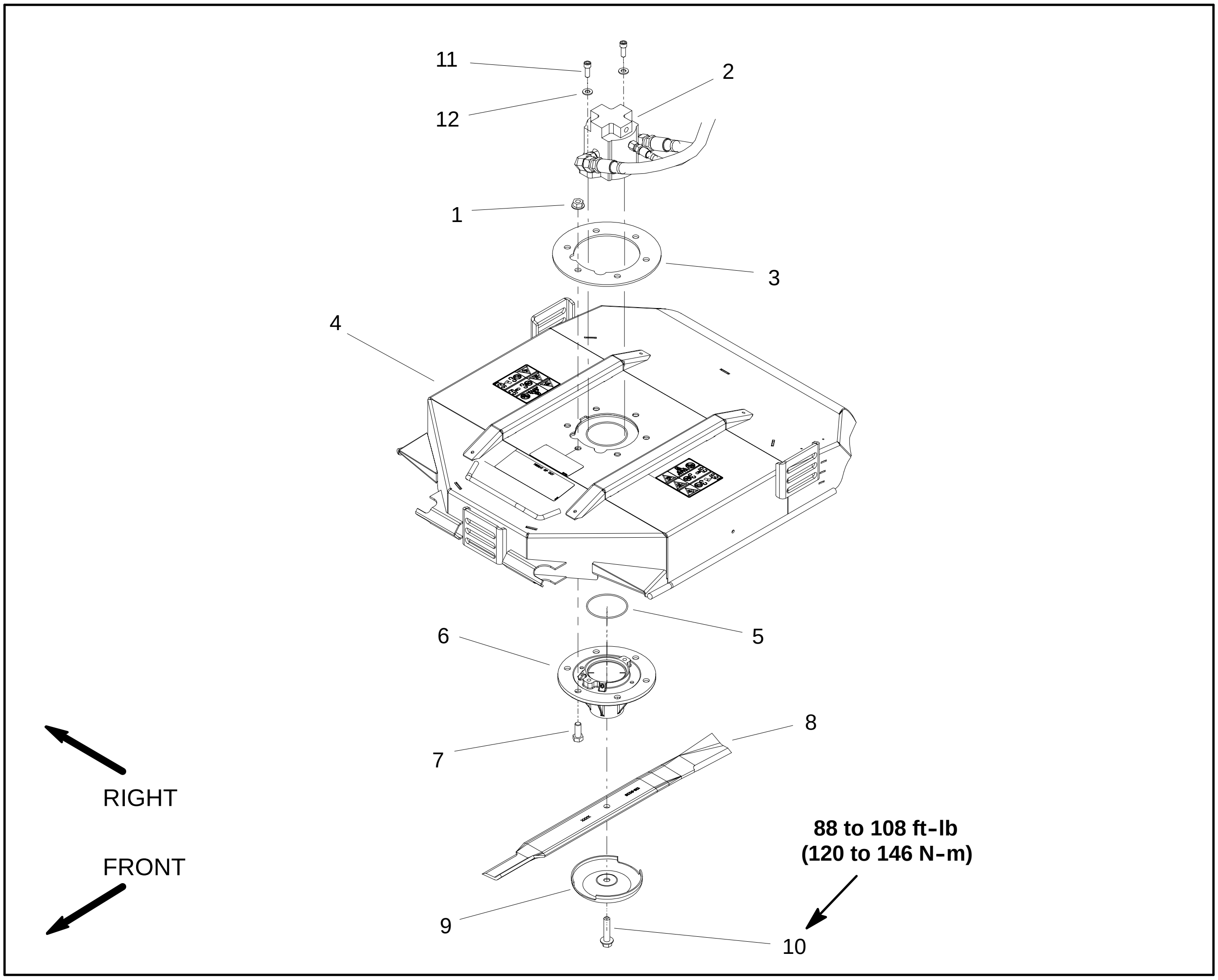


Figure 3

1. **Flange nut (6 used)**
2. **Hydraulic deck motor**
3. **Spindle plate**
4. **Cutting deck**
5. **O-ring**
6. **Spindle assembly**
7. **Cap screw (6 used)**
8. **Cutting blade**
9. **Anti-scalp cup**
10. **Blade bolt**
11. **Socket head screw (2 used)**
12. **Flat washer (2 used)**

Removal (Fig. 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 two (2) socket head screws and flat washers that secure hydraulic motor to the cutting deck (Fig. 4). Remove hydraulic motor and O–ring from deck.

3. Cover top of spindle to prevent debris from entering spindle. A spindle plug (see Special Tools in this chapter) can be used to cover spindle.

4. Start the engine and raise the cutting deck. Stop engine and remove key from the ignition switch. Support the cutting deck so it cannot fall accidentally. If required for easier service, remove cutting deck.

5. Remove blade bolt, anti–scalp cup and cutting blade.

6. Remove cap screws and flange nuts securing spindle assembly to cutting deck. Slide spindle assembly out the bottom of the deck. Remove spindle plate from top of deck.

Installation (Fig. 3)

1. Position spindle assembly and spindle plate to cutting deck. Notches on cutting deck and spindle plate should be aligned to front of deck.

2. Secure spindle assembly and spindle plate to cutting deck with cap screws and flange nuts. Tighten flange nuts in a star pattern.

3. Install cutting blade, anti–scalp cup and bolt. Tighten blade bolt from **88 to 108 ft–lb (120 to 146 N–m)**.

4. Remove cover from top of spindle that was placed to prevent debris from entering spindle.

5. Position O–ring to top of spindle housing. Secure hydraulic motor to the cutting deck with two (2) socket head screws and flat washers.

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

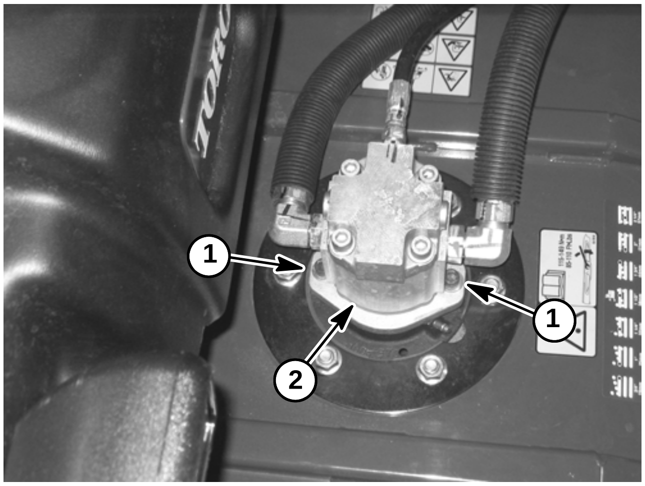


Figure 4

1. Socket head screw **2. Hydraulic motor**

Cutting Decks

Blade Spindle Service

Disassembly (Fig. 5)

1. Remove blade spindle from cutting deck (see Blade Spindle Removal in this section).

2. Loosen and remove spindle nut from top of spindle shaft.

3. Remove the spindle shaft from the spindle housing which may require the use of an arbor press. The spindle shaft spacer should remain on the spindle shaft as the shaft is being removed.

4. Carefully remove oil seals from spindle housing noting direction of seal lips.

5. Allow the bearing cones, inner bearing spacer and spacer ring to drop out of the spindle housing.

6. Using an arbor press, remove both of the bearing cups and the outer bearing spacer from the housing.

7. The large snap ring can remain inside the spindle housing. Removal of this snap ring is very difficult.

Assembly (Fig. 5)

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. 6). These parts cannot be purchased separately. Do not mix bearing set components from one deck spindle to another.

NOTE: A replacement bearing spacer set includes the inner spacer and outer spacer (items 4 and 5 in Fig. 6). Do not mix bearing spacers from one deck spindle to another.

IMPORTANT: If new bearings are installed into a used spindle housing, it may not be necessary to replace the original large snap ring. If the original large snap ring is in good condition with no evidence of damage (e.g. spun bearing), leave the snap ring in the housing and discard the large snap ring that comes with the new bearings. If the large snap ring is found to be damaged, replace the snap ring.

1. If large snap ring was removed from spindle housing, install snap ring into housing groove. Make sure snap ring is fully seated in groove.

2. Install outer bearing spacer into top of spindle housing. The spacer should fit against the large snap ring.

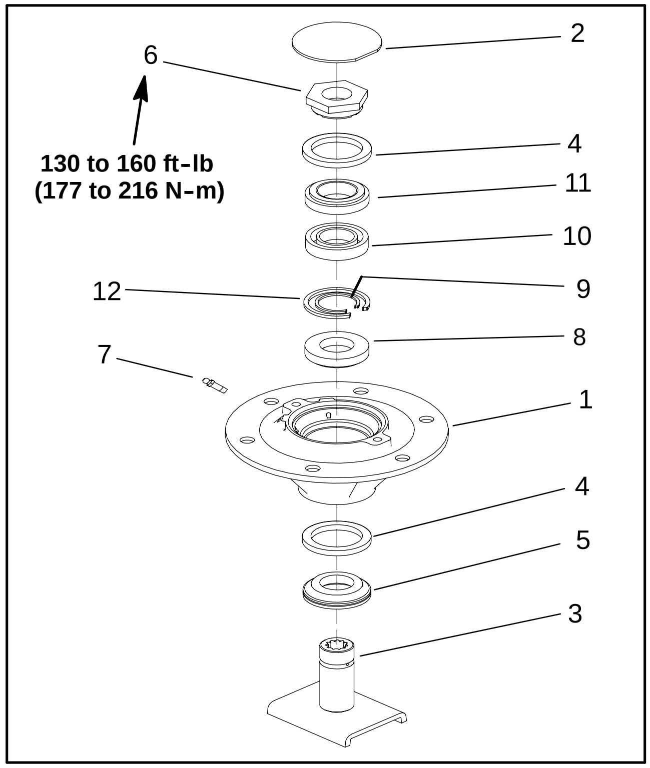


Figure 5

1. **Spindle housing**
2. **Spindle plug**
3. **Spindle shaft**
4. **Oil seal**
5. **Shaft spacer**
6. **Spindle nut**
7. **Grease fitting**
8. **Bearing**
9. **Spacer ring**
10. **Spacer set (2 piece)**
11. **Bearing**
12. **Large snap ring**

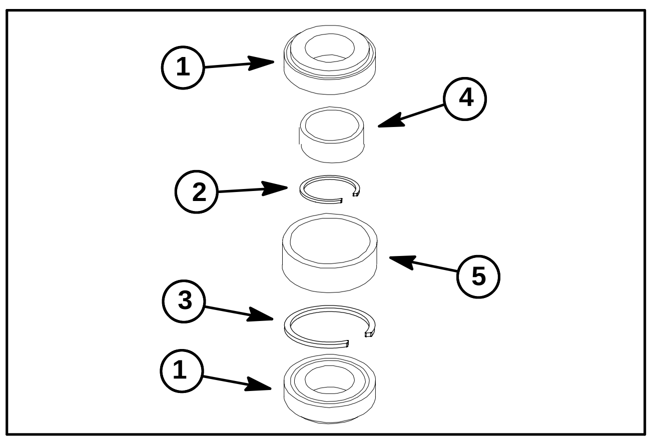


Figure 6

1. **Bearing**
2. **Spacer ring**
3. **Large snap ring**
4. **Inner bearing spacer**
5. **Outer bearing spacer**

3. Using an arbor press, push the bearing cups into the top and bottom of the spindle housing. The top bearing cup must contact the outer bearing spacer previously installed, and the bottom bearing cup must contact the large snap ring. Make sure that the assembly is correct by supporting the first bearing cup and pressing the second cup against it (Fig 7).

4. Pack the bearing cones with grease. Apply a film of grease on lips of oil seals.

5. Install lower bearing cone and greased oil seal into bottom of spindle housing. **Note:** The bottom seal must have the lip facing out (down) (Fig. 8). This seal installation allows grease to purge from the spindle during the lubrication process.

IMPORTANT: If bearings are being replaced, make sure to use the spacer ring that is included with the new bearing set (Fig. 6).

6. Slide spacer ring and inner bearing spacer into spindle housing, then install upper bearing cone and greased oil seal into top of housing. **Note:** The upper seal must have the lip facing out (up) (Fig. 8).

7. Inspect the spindle shaft and shaft spacer to make sure there are no burrs or nicks that could possibly damage the oil seals. Lubricate the shaft and spacer with grease.

8. Install spindle shaft spacer onto shaft. Place thin sleeve or tape on spindle shaft splines to prevent seal damage during shaft installation.

9. Carefully slide spindle shaft with spacer up through spindle housing. The bottom oil seal and spindle spacer should fit together when the spindle is fully installed.

10.Thread spindle nut onto shaft and tighten nut from **130 to 160 ft–lb (177 to 216 N–m)**.

IMPORTANT: Pneumatic grease guns can produce high pressure inside spindle housing that can damage spindle seals. Pneumatic grease guns, therefore, are not recommended to be used for greasing of spindle housings.

11.Attach a hand pump grease gun to one of the grease fittings on housing and fill housing cavity with grease until grease starts to come out of lower seal.

12.Rotate spindle shaft to make sure that it turns freely.

13.Install blade spindle assembly to cutting deck (see Blade Spindle Installation in this section).

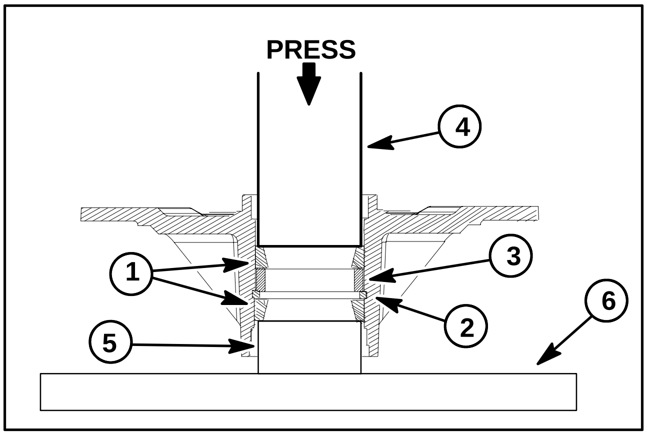


Figure 7

1. Bearing cup
2. Large snap ring
3. Large spacer
4. Arbor press
5. Support
6. Arbor press base

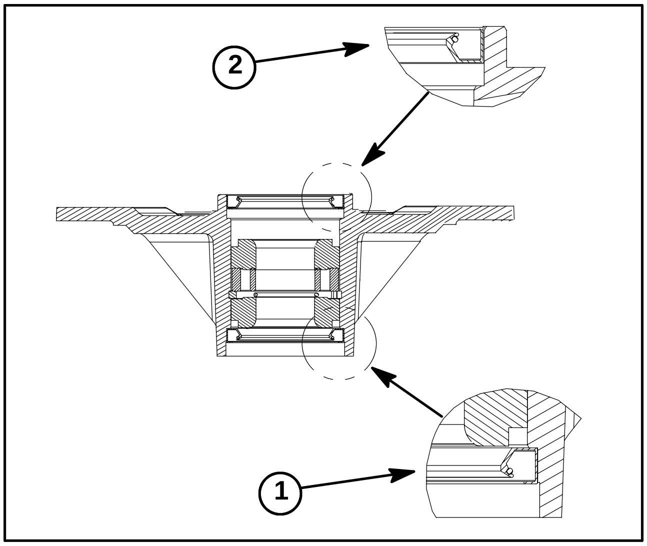


Figure 8

1. Bottom seal installation
2. Upper seal installation

Cutting Decks

Rear Roller

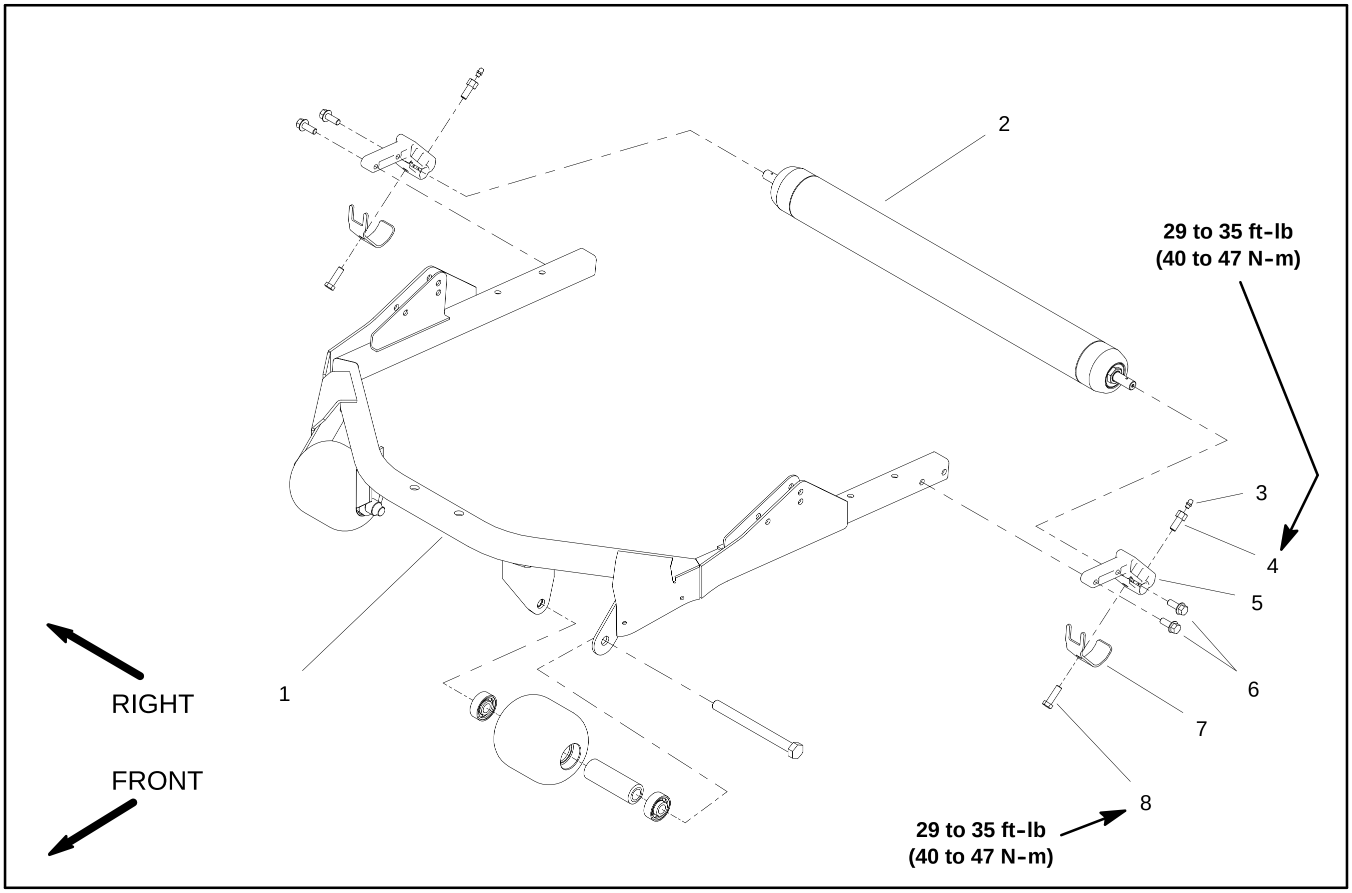


Figure 9

1. **Deck frame**
2. **Rear roller assembly**
3. **Grease fitting**
4. **Roller shaft screw**
5. **Roller mount**
6. **Flange head screw**
7. **Skid bracket**
8. **Cap screw**

Removal (Fig. 9)

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

2. If cutting deck is equipped with a roller scraper (Fig. 10), remove fasteners securing left and right scraper rod brackets to roller mounts. Remove scraper rod assembly.

3. Remove four (4) flange head screws securing roller mounts to rear of deck frame. Remove roller mounts and rear roller assembly from deck frame.

4. Loosen fasteners securing each end of roller to roller mounts. Remove mounts and skid brackets from roller.

Installation (Fig. 9)

1. Slide roller mounts onto roller shaft.

2. Install roller and roller mount assembly into rear of deck frame. Secure assembly to deck frame with four (4) flange head screws.

IMPORTANT: During assembly, make sure the grease groove in each roller mount aligns with the grease hole in each end of the roller shaft.

3. Align roller shaft grease hole with the roller mount grease groove. Use alignment mark on end of roller shaft to assist with alignment.

4. Position skid brackets to roller mounts and install cap screws to retain brackets in place.

5. If equipped with scraper rod, install and adjust scraper rod assembly to roller mounts (Fig. 10). The gap between the scraper rod and roller should be from 0.020 to 0.040 in (0.5 to 1.0 mm). Torque cap screws **30 ft-lb (41 N-m)**.

6. Install and tighten fasteners that secure each end of roller to roller mounts. Torque roller shaft screws (item 4) and cap screws (item 8) from **29 to 35 ft-lb (40 to 47 N-m)**.

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

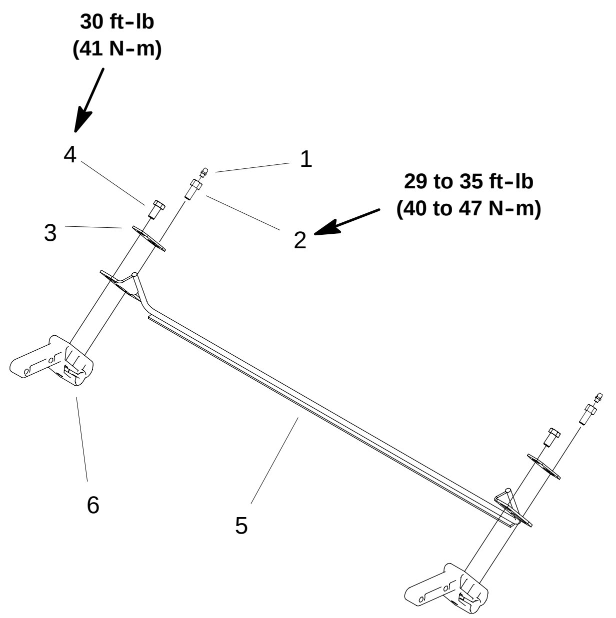


Figure 10

1. **Grease fitting**
2. **Roller shaft screw**
3. **Scraper plate**
4. **Cap screw**
5. **Roller scraper**
6. **Roller mount**

Cutting Decks

Rear Roller Service

Disassembly (Fig. 11)

1. Remove bearing lock nut from each end of roller shaft.

2. Loosely secure roller assembly in bench vise and lightly tap one end of roller shaft until outer seals and bearing are removed from opposite end of roller tube. Remove second set of outer seals and bearing from roller tube by tapping on opposite end of shaft. Remove shaft from roller tube.

3. Carefully remove inner seal from both ends of roller tube taking care to not damage tube surfaces.

4. Discard removed seals and bearings.

5. Clean roller shaft and all surfaces on the inside of the roller tube. Inspect components for wear or damage. Also, carefully inspect seating surface and threads of bearing lock nuts. Replace all damaged components.

Assembly (Fig. 11)

1. Install inner seals into roller tube making sure that seal lip (and garter spring) faces end of tube. Use inner seal tool (see Special Tools) and soft face hammer to fully seat seals against roller shoulder (Fig. 12). Apply a small amount of grease around the lip of both inner seals after installation.

IMPORTANT: During assembly process, frequently check that bearings rotate freely and do not bind. If any binding is detected, consider component removal and reinstallation.

2. Install new bearing and outer seals into one end of roller tube:

A. Position a new bearing into one end of roller tube. Use bearing/outer seal tool (see Special Tools) with a soft face hammer to fully seat bearing against roller shoulder (Fig. 13). After bearing installation, make sure that it rotates freely with no binding.

B. Apply a small amount of grease around the lip of both outer seals.

C. Install first outer seal into roller tube making sure that seal lip (and garter spring) faces end of tube. Use bearing/outer seal tool (see Special Tools) and soft face hammer to lightly seat seal against roller shoulder (Fig. 14). Make sure that bearing still freely rotates after seal installation.

D. Using the same process, install second outer seal making sure to not crush the installed outer seal. Again, make sure that bearing still freely rotates.

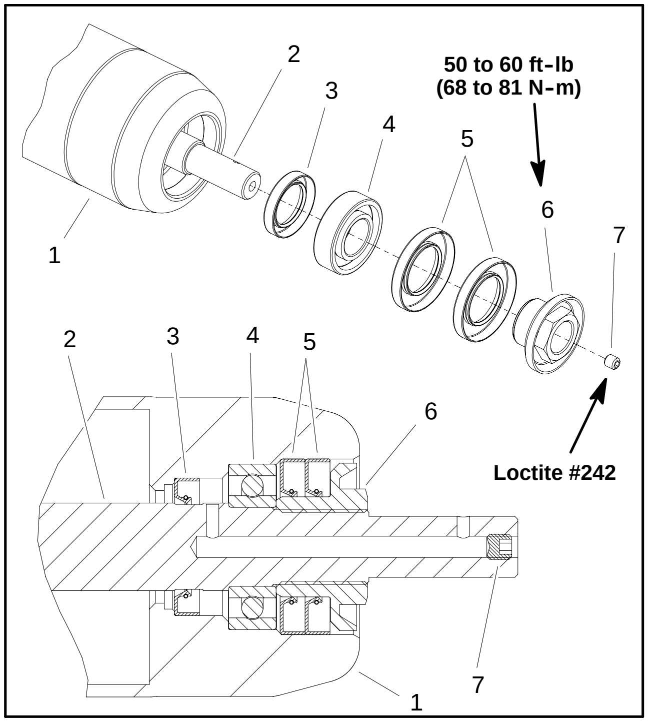


Figure 11

1. **Roller tube**
2. **Roller shaft**
3. **Inner seal**
4. **Bearing**
5. **Outer seal**
6. **Bearing lock nut**
7. **Set screw**

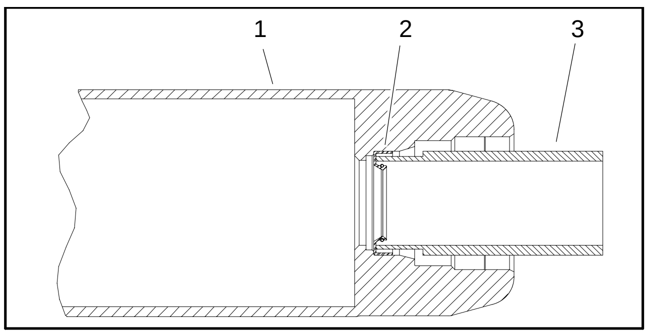


Figure 12

1. **Roller tube**
2. **Inner seal**
3. **Inner seal tool**

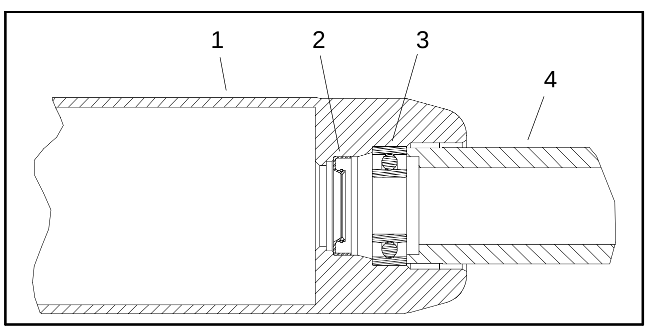


Figure 13

1. **Roller tube**
2. **Inner seal**
3. **Bearing**
4. **Bearing/outer seal tool**

3. From the roller tube end with only the inner seal installed, carefully install the roller shaft into the roller tube. Make sure that seals are not damaged as shaft is installed.

4. Install new bearing and outer seals into second end of roller tube:

A. Position a second new bearing to roller shaft and tube. Position washer (see Special Tools) on bearing to allow pressing on both inner and outer bearing races simultaneously.

B. Use washer and bearing/outer seal tool (see Special Tools) with a soft face hammer to fully seat bearing (Fig. 15). After bearing installation, make sure that shaft freely rotates and that no binding is detected. If necessary, lightly tap bearing and/or shaft ends to align shaft and bearings. Remove washer from roller.

C. Apply a small amount of grease around the lip of both outer seals.

D. Carefully install first outer seal into roller tube making sure that seal lip (and garter spring) faces end of tube. Use bearing/outer seal tool (see Special Tools) and soft face hammer to lightly seat seal (Fig. 16). Make sure that shaft and bearings still freely rotate after seal installation.

E. Using the same process, install second outer seal making sure to not crush the installed outer seal. Again, make sure that shaft and bearings still freely rotate.

IMPORTANT: Make sure that all grease is removed from shaft threads to prevent bearing lock nut loosening.

5. Thoroughly clean threads on both ends of roller shaft.

NOTE: If original bearing lock nut(s) are being used, apply Loctite #242 (or equivalent) to threads of lock nut(s).

6. Install bearing lock nut onto each end of the roller shaft. Make sure that outer seals are not damaged during nut installation. Torque lock nuts from **50 to 60 ft–lb (68 to 81 N–m)**.

7. If set screw was removed from either end of roller shaft, apply Loctite #242 (or equivalent) to threads of removed set screw and install into roller shaft. Tighten set screw until it bottoms in shaft and is recessed in shaft.

IMPORTANT: When roller assembly is installed to cutting deck, make sure that grease groove in each roller mount aligns with the grease hole in each end of roller shaft.

NOTE: After roller is installed to cutting deck, lubricate roller grease fittings, rotate roller to properly distribute grease in bearings and clean excess grease from roller ends. A properly assembled roller should rotate with less than 5 in–lbs (0.68 N–m) resistance.

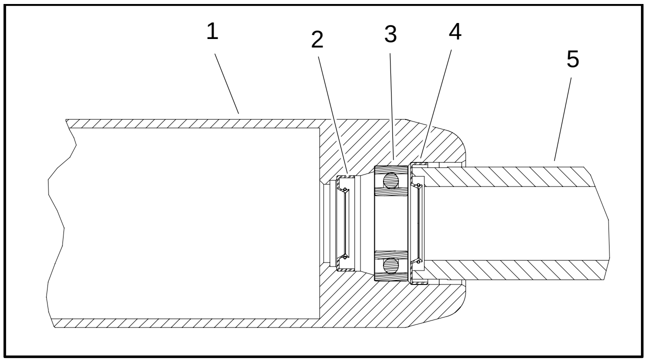


Figure 14

1. **Roller tube**
2. **Inner seal**
3. **Bearing**
4. **Outer seal**
5. **Bearing/outer seal tool**

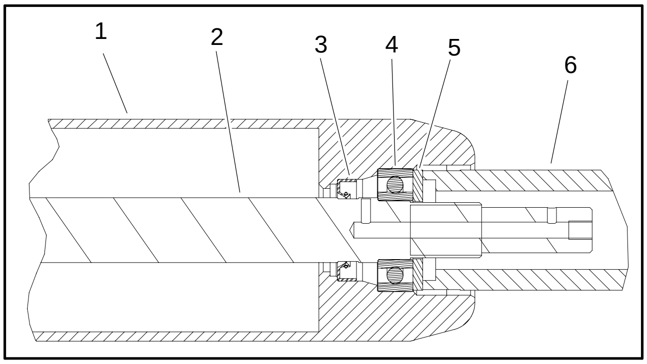


Figure 15

1. **Roller tube**
2. **Roller shaft**
3. **Inner seal**
4. **Bearing**
5. **Washer**
6. **Bearing/outer seal tool**

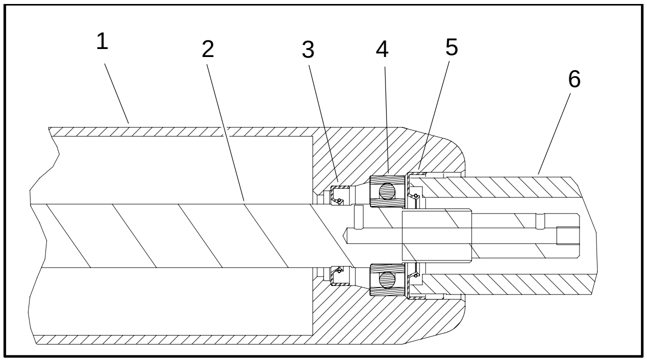


Figure 16

1. **Roller tube**
2. **Roller shaft**
3. **Inner seal**
4. **Bearing**
5. **Outer seal**
6. **Bearing/outer seal tool**

Front Roller Service

Disassembly (Fig. 17)

1. Remove roller mounting bolt.

2. Remove roller assembly from carrier frame.

3. To remove bearings and bearing spacer:

   A. Insert punch through end of roller and drive opposite bearing out by alternating taps to opposite side of inner bearing race. There should be a lip of inner race exposed for this process.

   B. Remove bearing spacer. Remove second bearing from roller using a press.

4. Inspect roller housing, bearings and bearing spacer for damage or wear. Replace components as needed.

Assembly (Fig. 17)

1. Install bearings and bearing spacer into roller:

   A. Press first bearing into housing. Press on outer race only or equally on inner and outer races.

   B. Insert bearing spacer.

   C. Press second bearing into roller housing pressing equally on inner and outer races until the inner race comes in contact with the bearing spacer.

2. Install roller assembly to deck frame.

NOTE: Securing roller assembly with a gap larger than 0.060 inch (1.5 mm) creates a side load on bearings and can lead to premature bearing failure.

3. Verify that there is no more than a 0.060 inch (1.5 mm) gap between roller assembly and the roller mount brackets of the deck frame. If this gap is larger than 0.060 inch (1.5 mm), shim excess clearance with 5/8” washers.

4. Insert mounting bolt and tighten to **80 ft–lb (108 N–m)**.

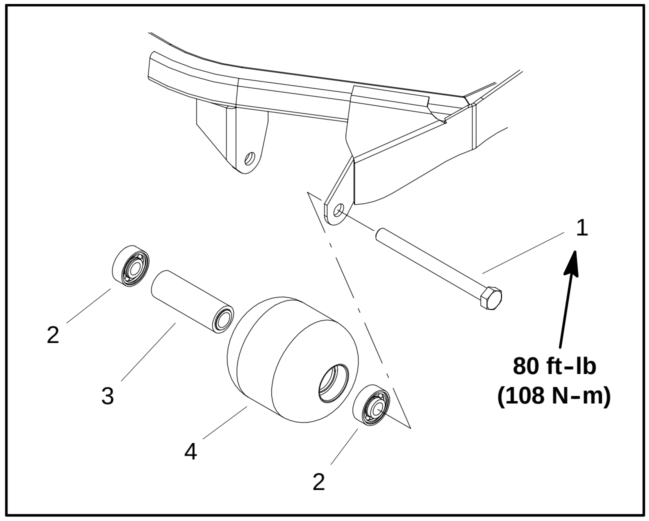


Figure 17

1. Mounting bolt
2. Bearing
3. Bearing spacer
4. Front roller

This page is intentionally blank.

Cutting Decks

Cutting Deck Carrier Frame

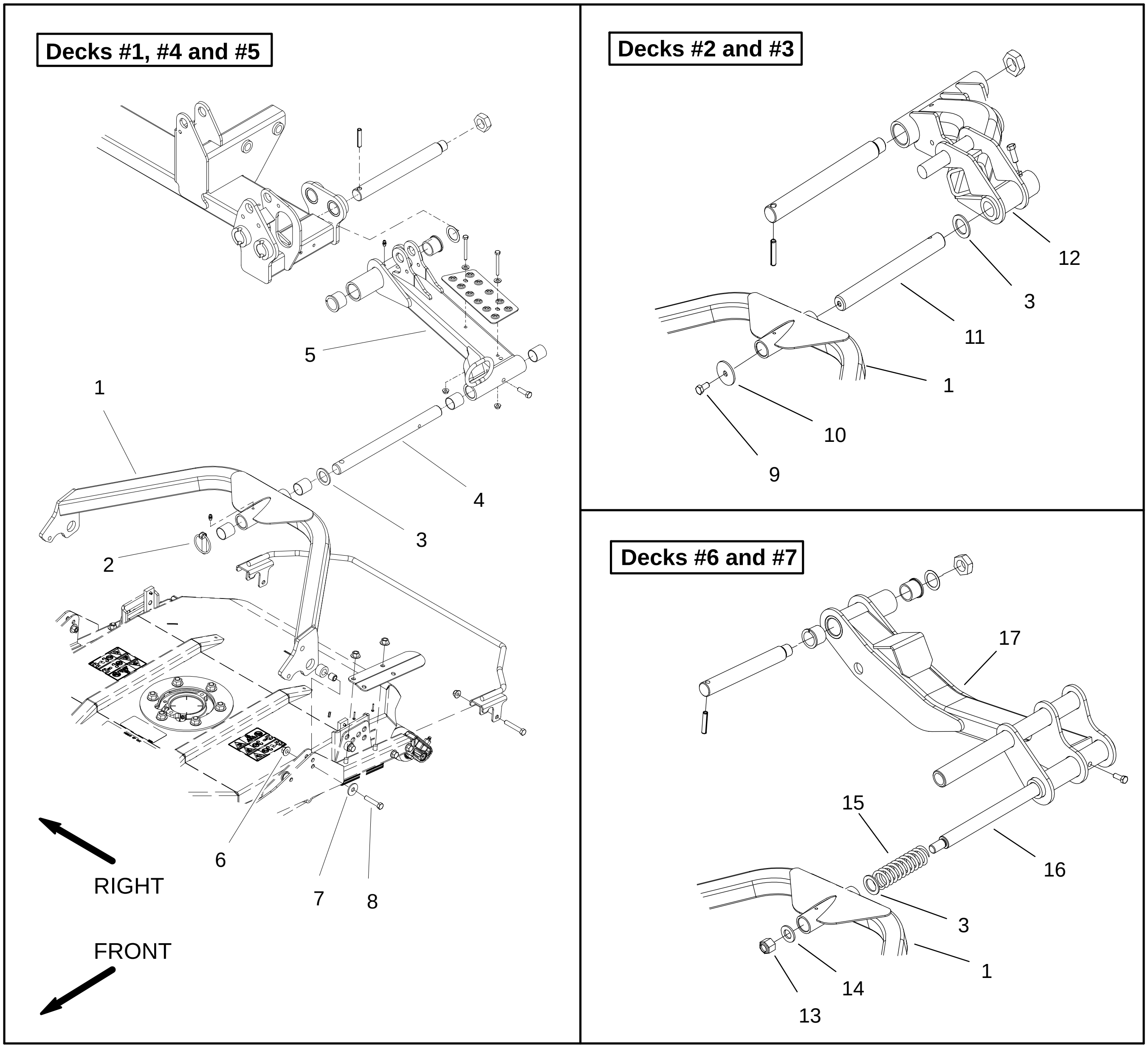


Figure 18

1. **Carrier frame**
2. **Lynch pin**
3. **Thrust washer**
4. **Pivot shaft**
5. **Lift arm (#4 shown)**
6. **Flange nut (2 used per deck)**
7. **Hardened washer (2 used per deck)**
8. **Cap screw (2 used per deck)**
9. **Cap screw**
10. **Rebound washer**
11. **Pivot shaft**
12. **Lift arm (#2 shown)**
13. **Lock nut**
14. **Flat washer**
15. **Compression spring**
16. **Pivot shaft**
17. **Lift arm (#6 shown)**

Removal and Installation (Fig. 18)

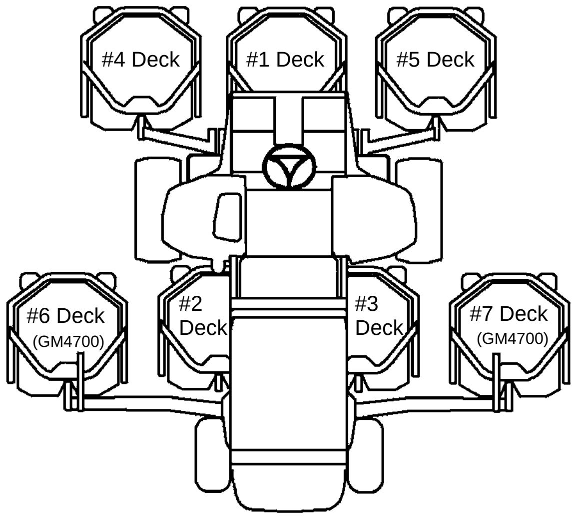
Each cutting deck is suspended from a carrier frame. The cutting deck carrier frame is attached to the lift arm and allows the cutting deck to pivot on the lift arm pivot shaft. Cutting deck positions are identified in Figure 19.

Cutting deck carrier frames are secured to lift arms as follows:

1. Carrier frames for the front three cutting decks (#1, #4 and #5) have a thrust washer between the carrier frame and the lift arm. The frame is secured to the lift arm pivot shaft with a lynch pin.

2. Carrier frames for the center two cutting decks (#2 and #3) have a thrust washer between the carrier frame and the lift arm. The frame is secured to the lift arm pivot shaft with a rebound washer and cap screw.

3. On Groundsmaster 4700–D machines, carrier frames for the rear two cutting decks (#6 and #7) have a compression spring and thrust washer between the carrier frame and the lift arm. The frame is secured to the lift arm pivot shaft with a flat washer and lock nut.



CUTTING DECK LOCATIONS

Figure 19

Cutting Decks

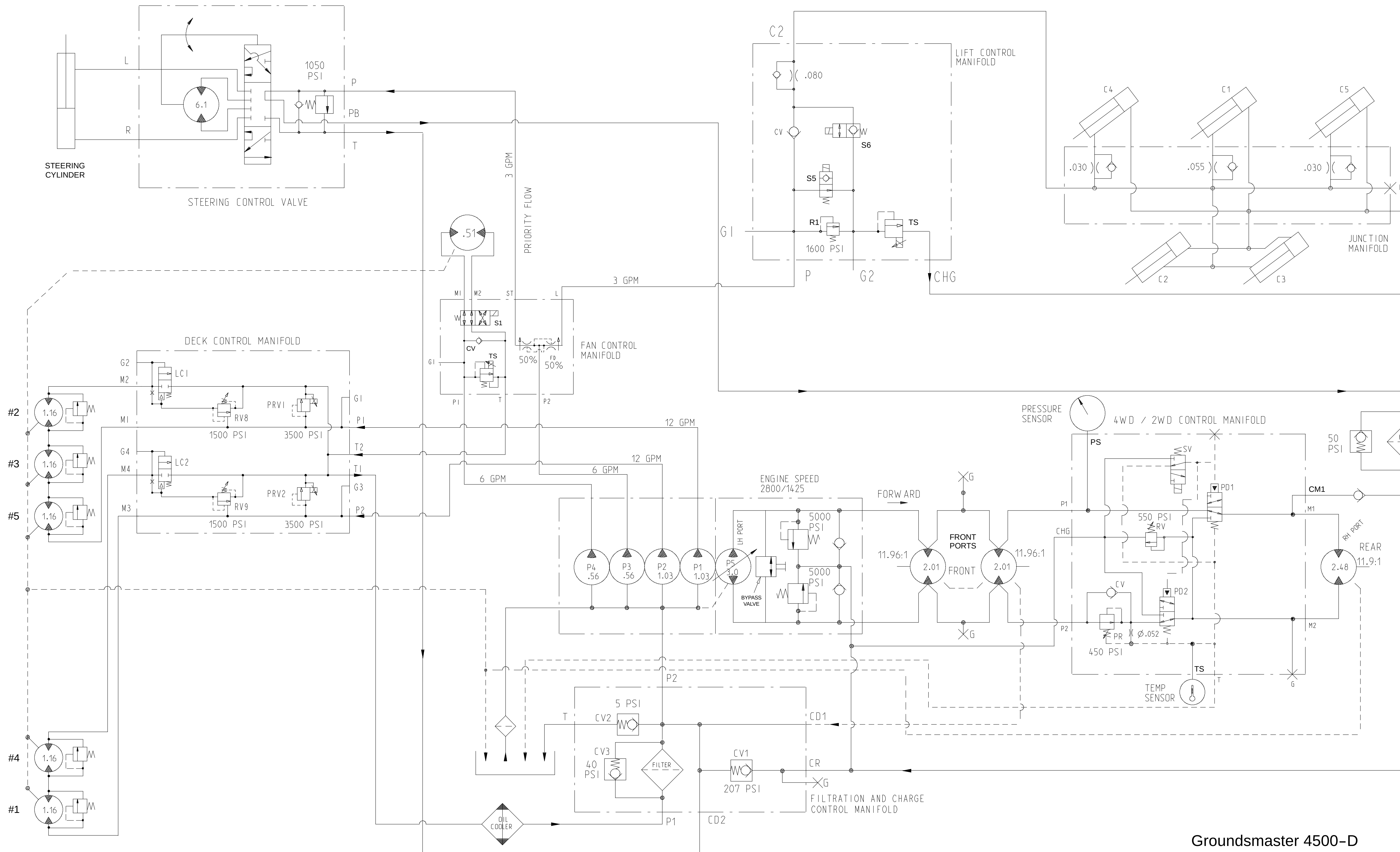
This page is intentionally blank.

Chapter 9

Foldout Drawings

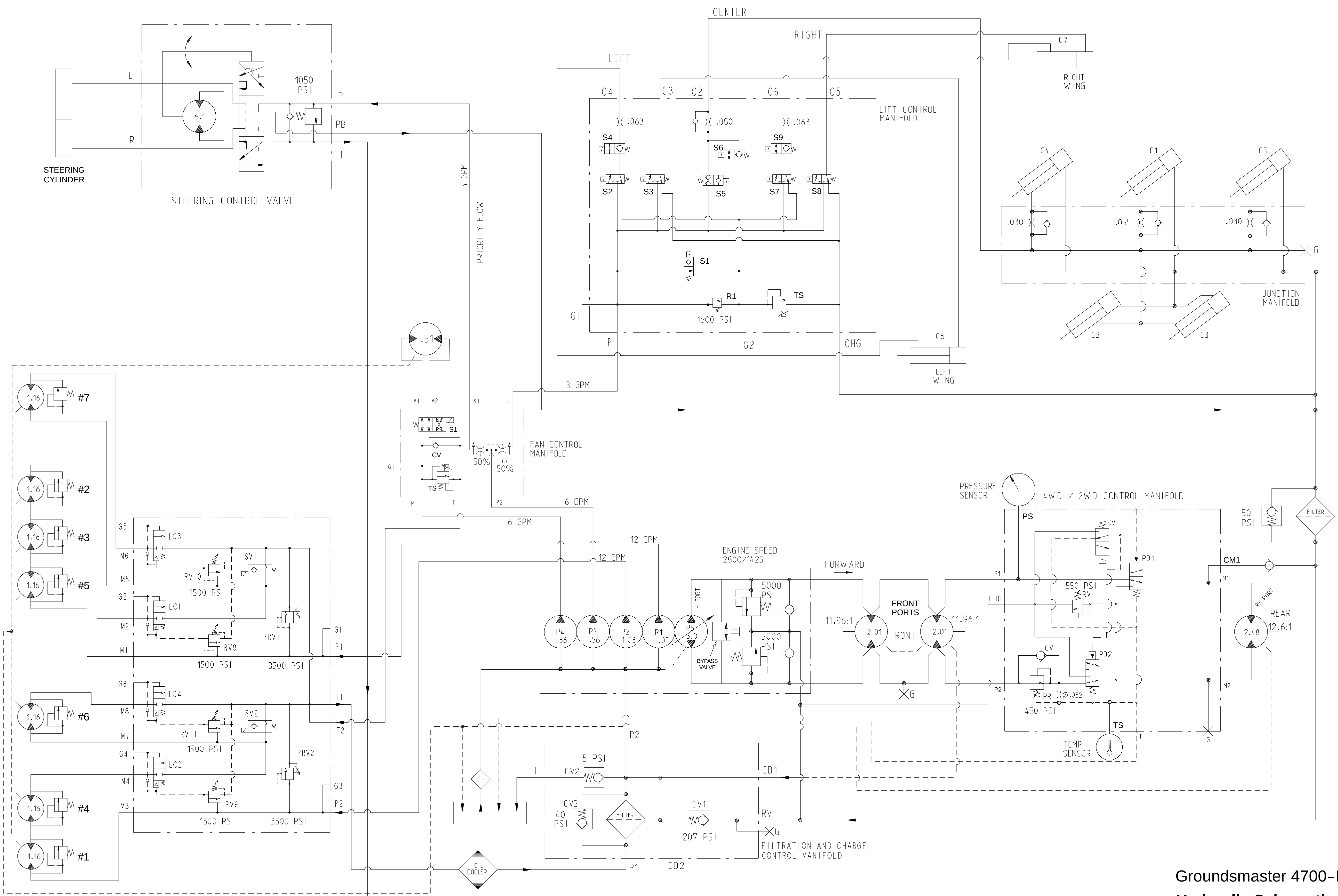
Table of Contents

This page is intentionally blank.



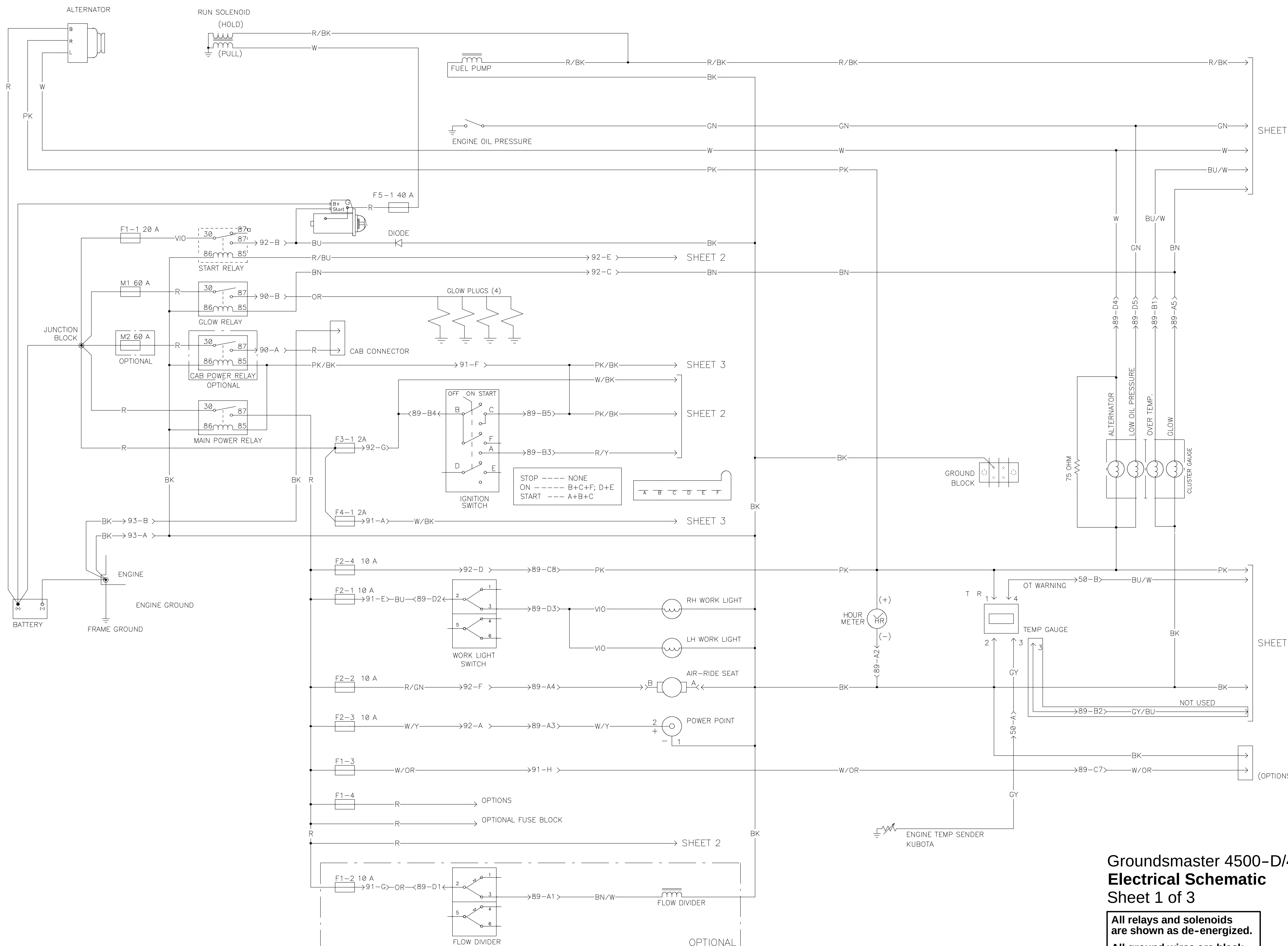
Groundsmaster 4500–D

Hydraulic Schematic



Groundsmaster 4700–D

Hydraulic Schematic



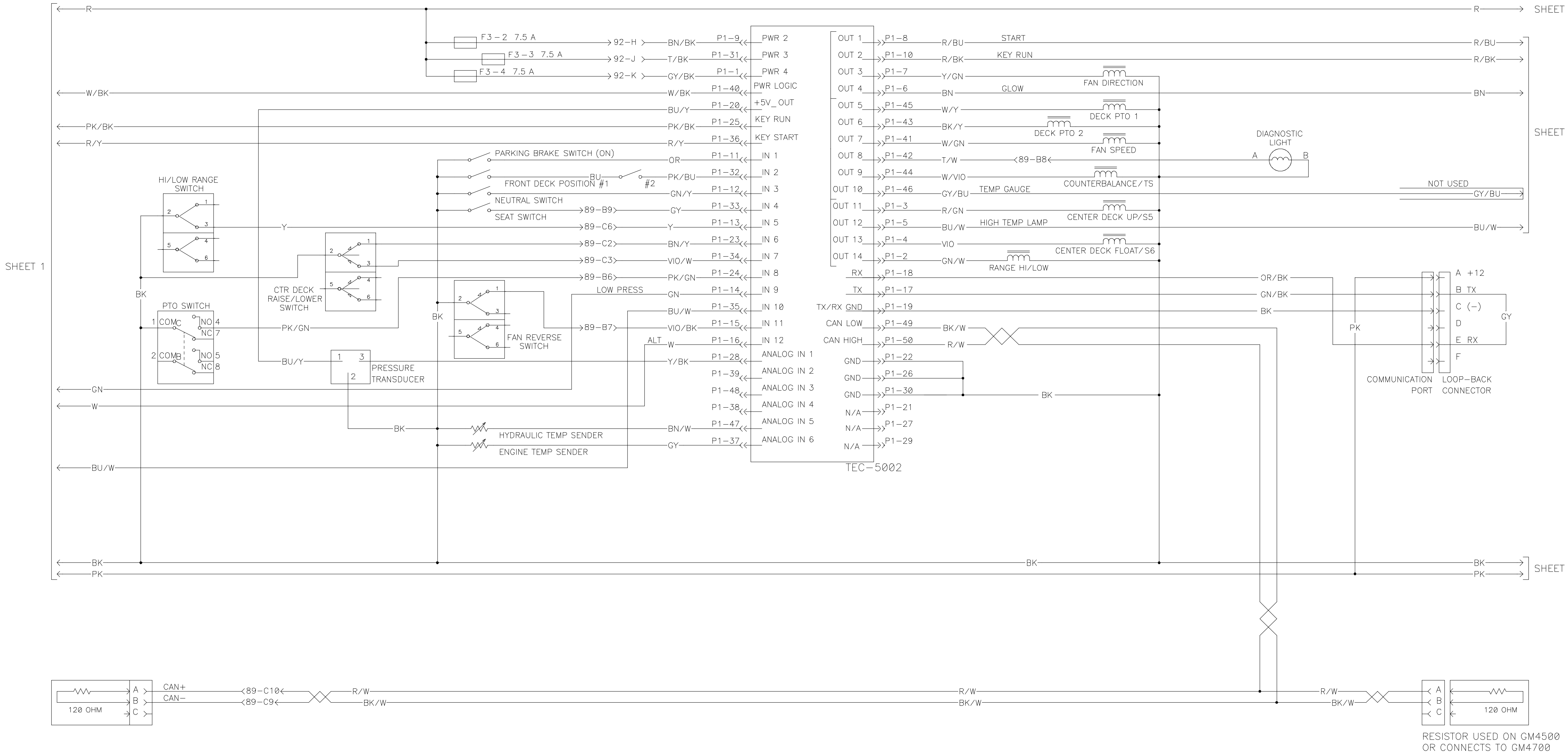
Groundsmaster 4500-D/4700-D

Electrical Schematic

Sheet 1 of 3

All relays and solenoids are shown as de-energized.

All ground wires are black.



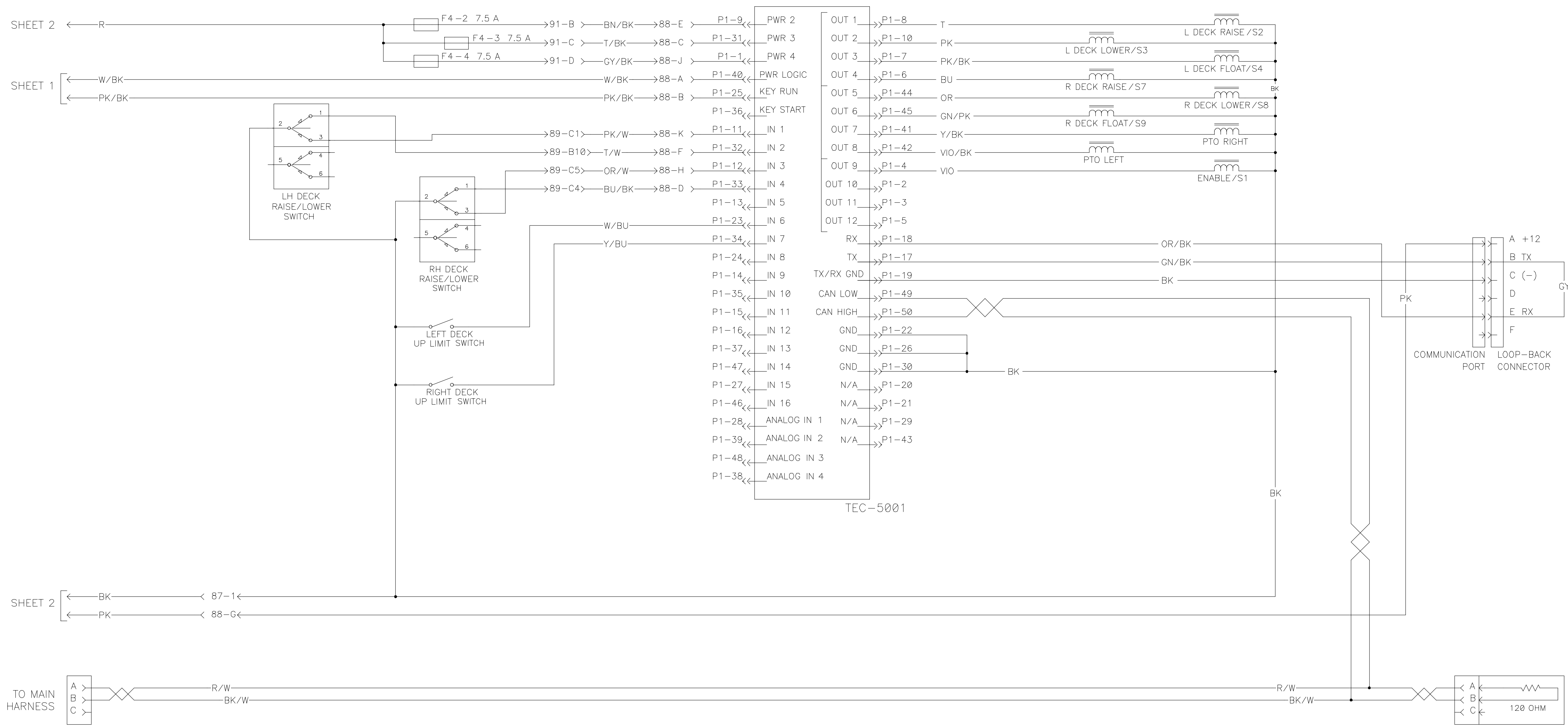
Groundsmaster 4500-D/4700-D

Electrical Schematic

Sheet 2 of 3

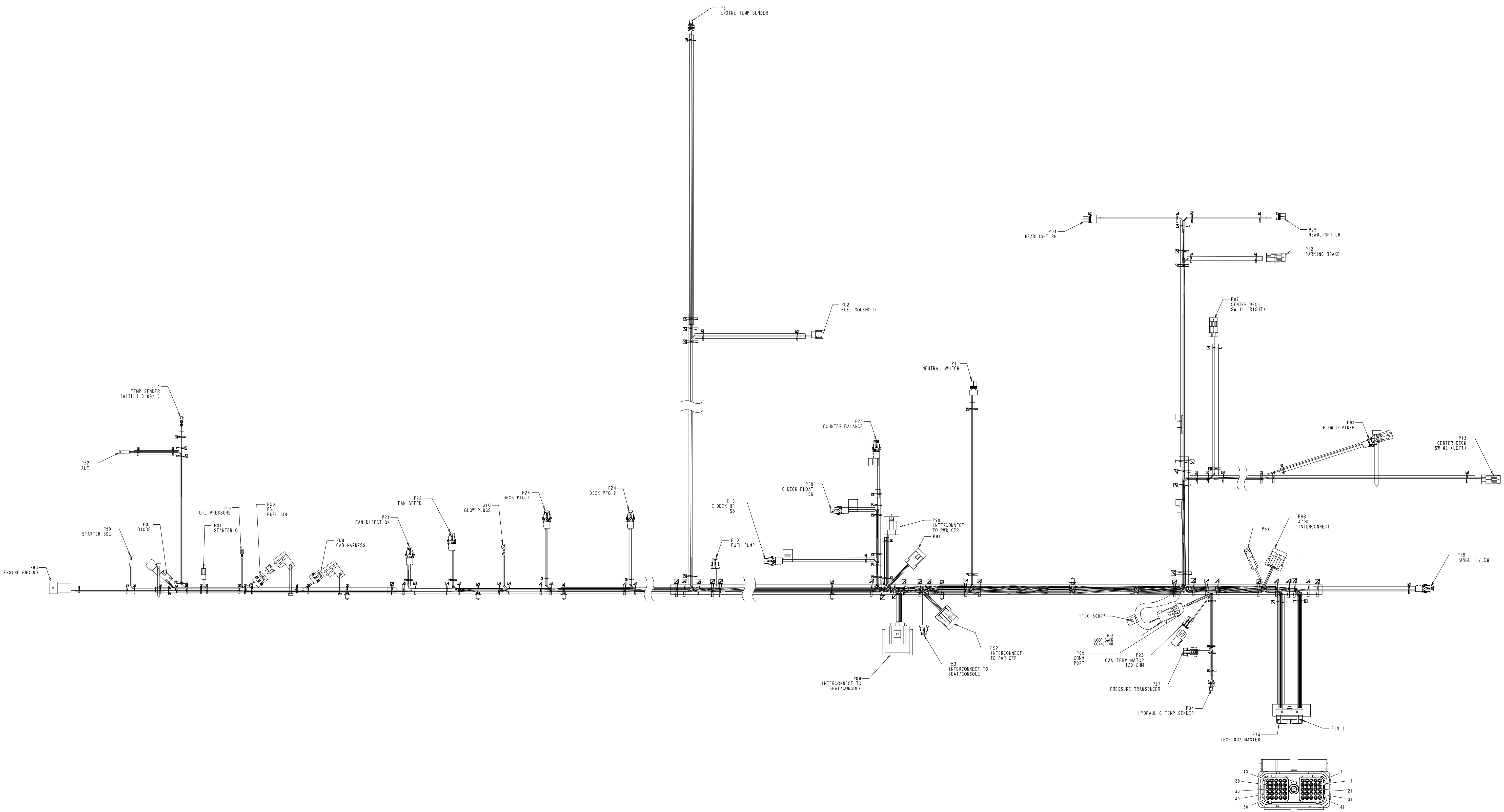
All relays and solenoids are shown as de-energized.

All ground wires are black.



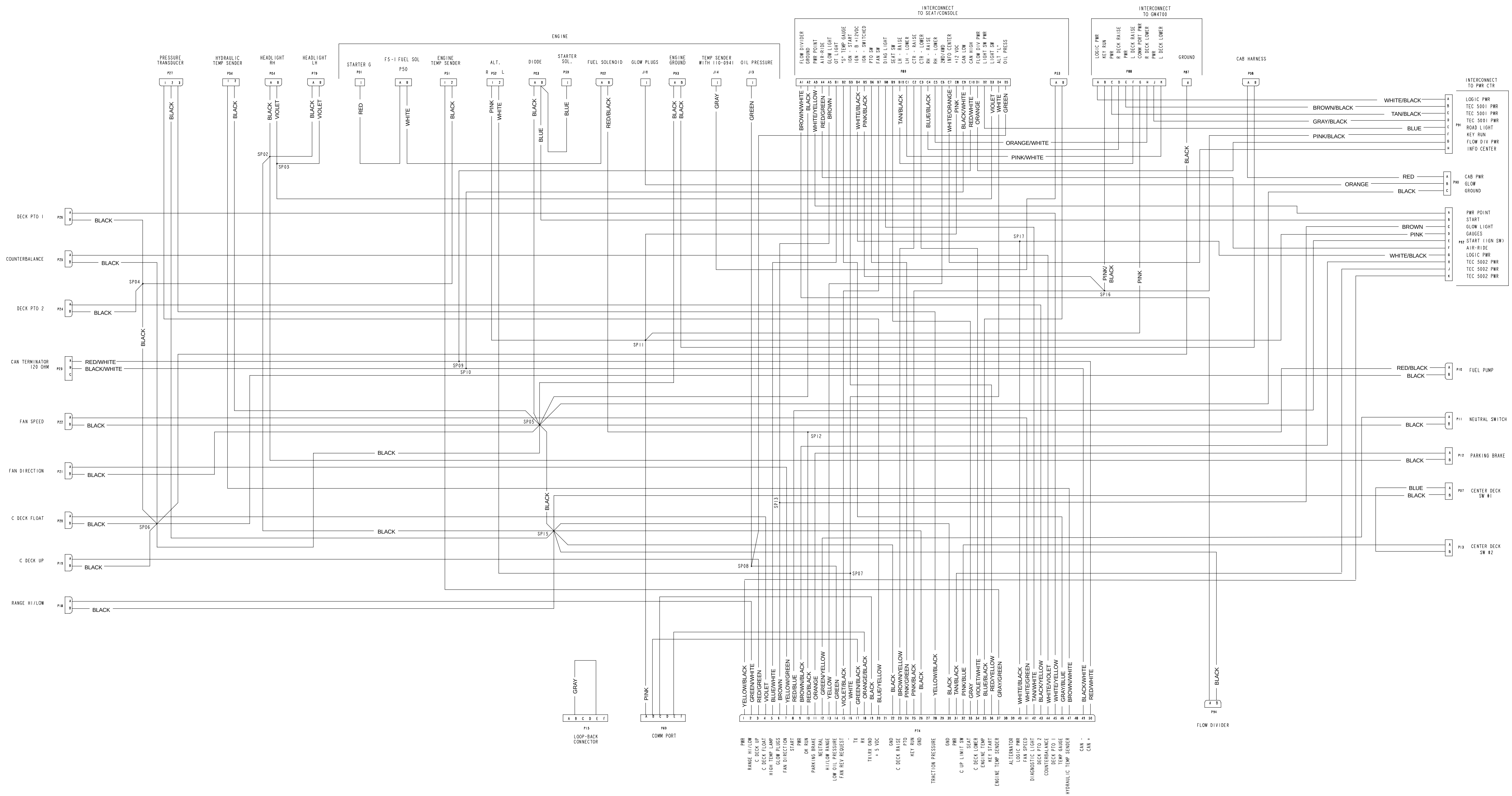
Groundsmaster 4500-D/4700-D
Electrical Schematic
Sheet 3 of 3 (Groundsmaster 4700-D)

All relays and solenoids are shown as de-energized.
All ground wires are black.



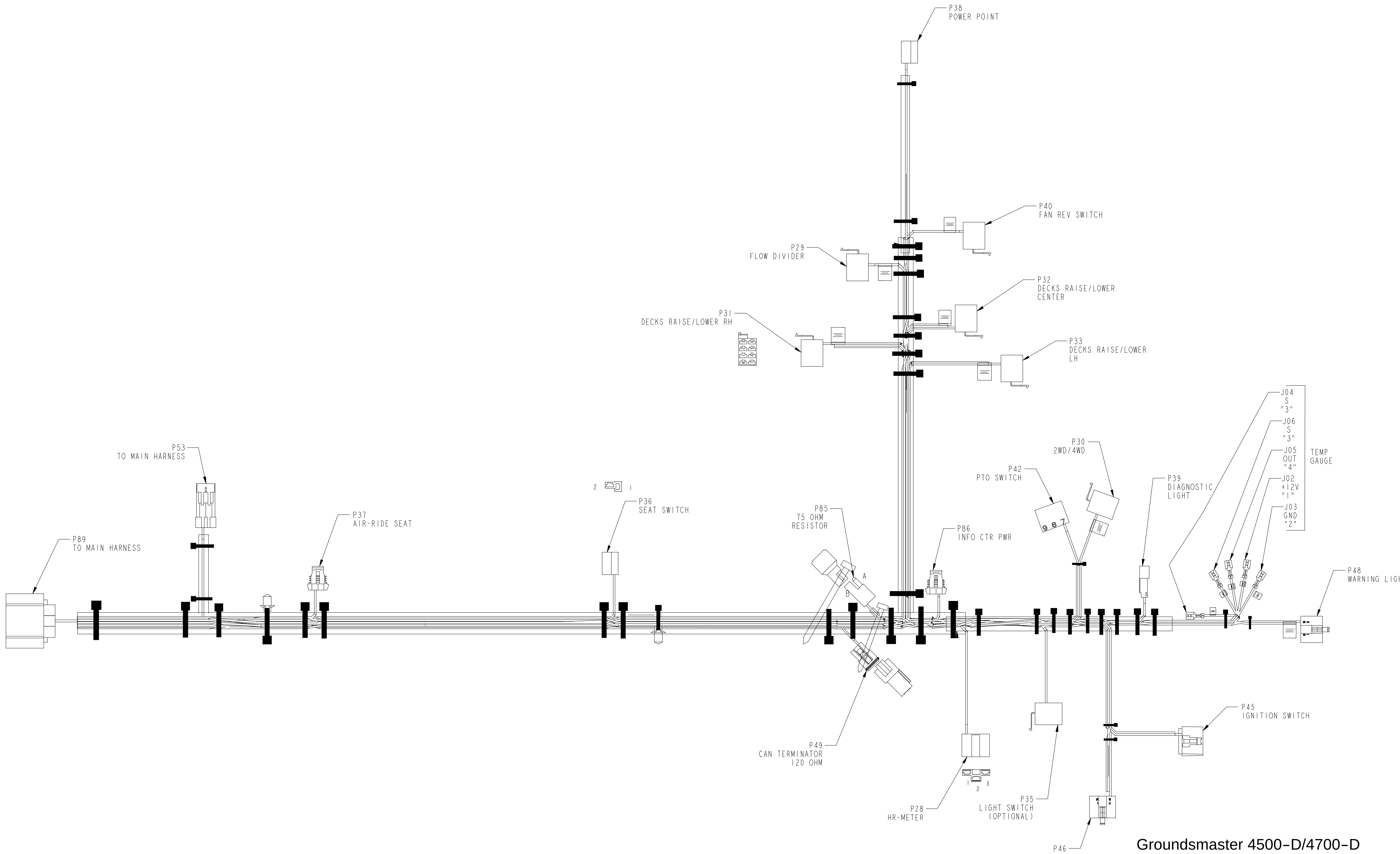
Groundsmaster 4500–D/4700–D

Main Wire Harness



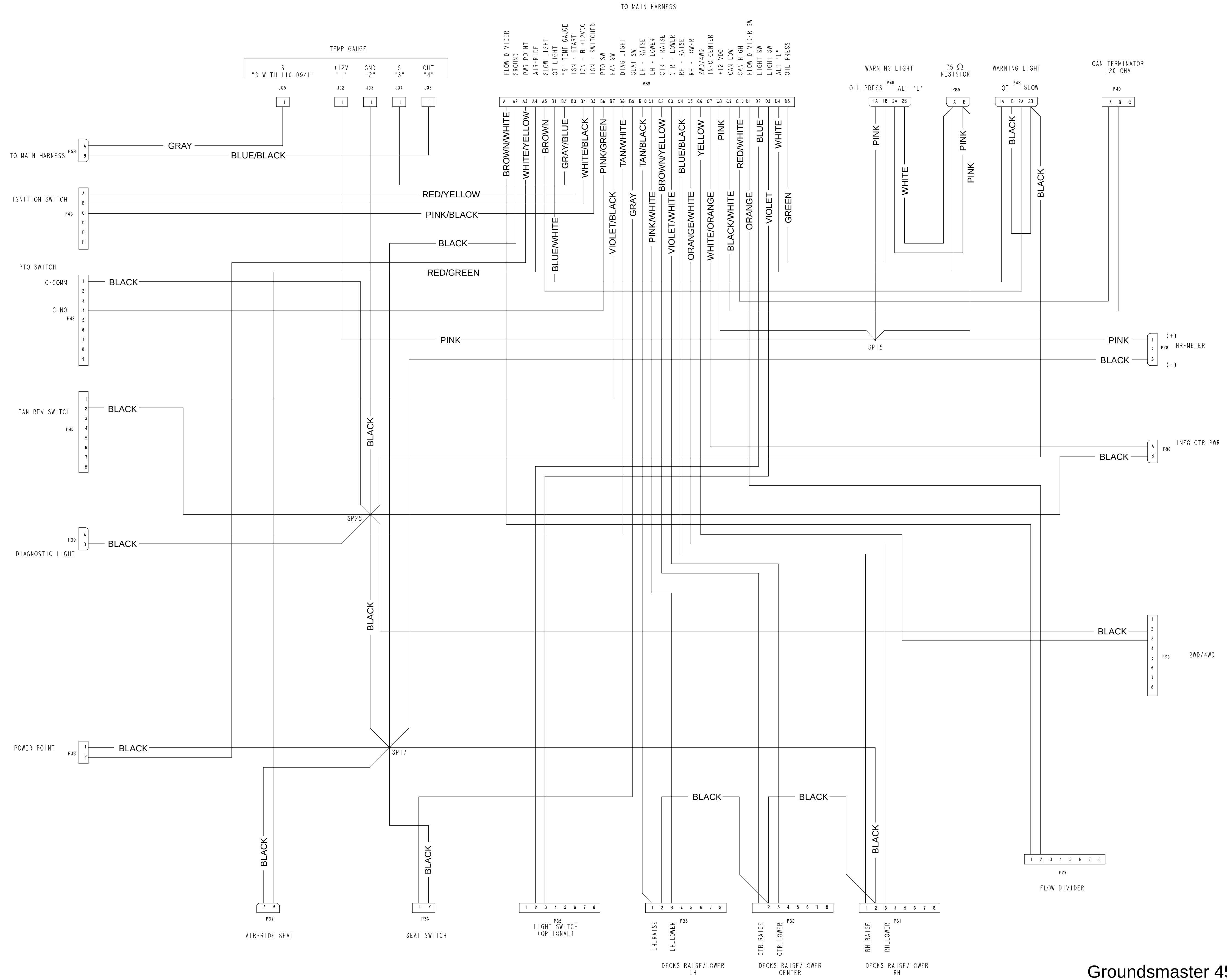
Groundsmaster 4500–D/4700–D

Main Wire Harness



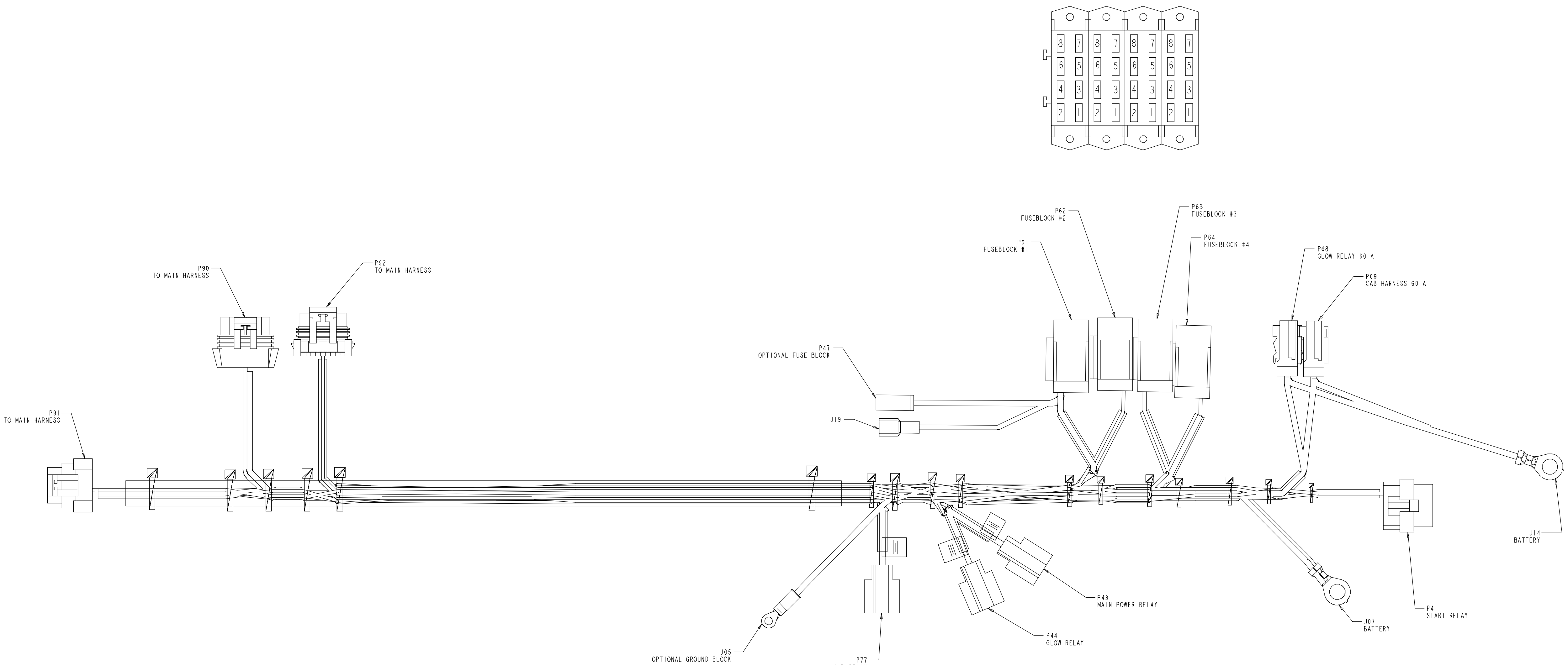
Groundsmaster 4500–D/4700–D

Seat and Console Wire Harness



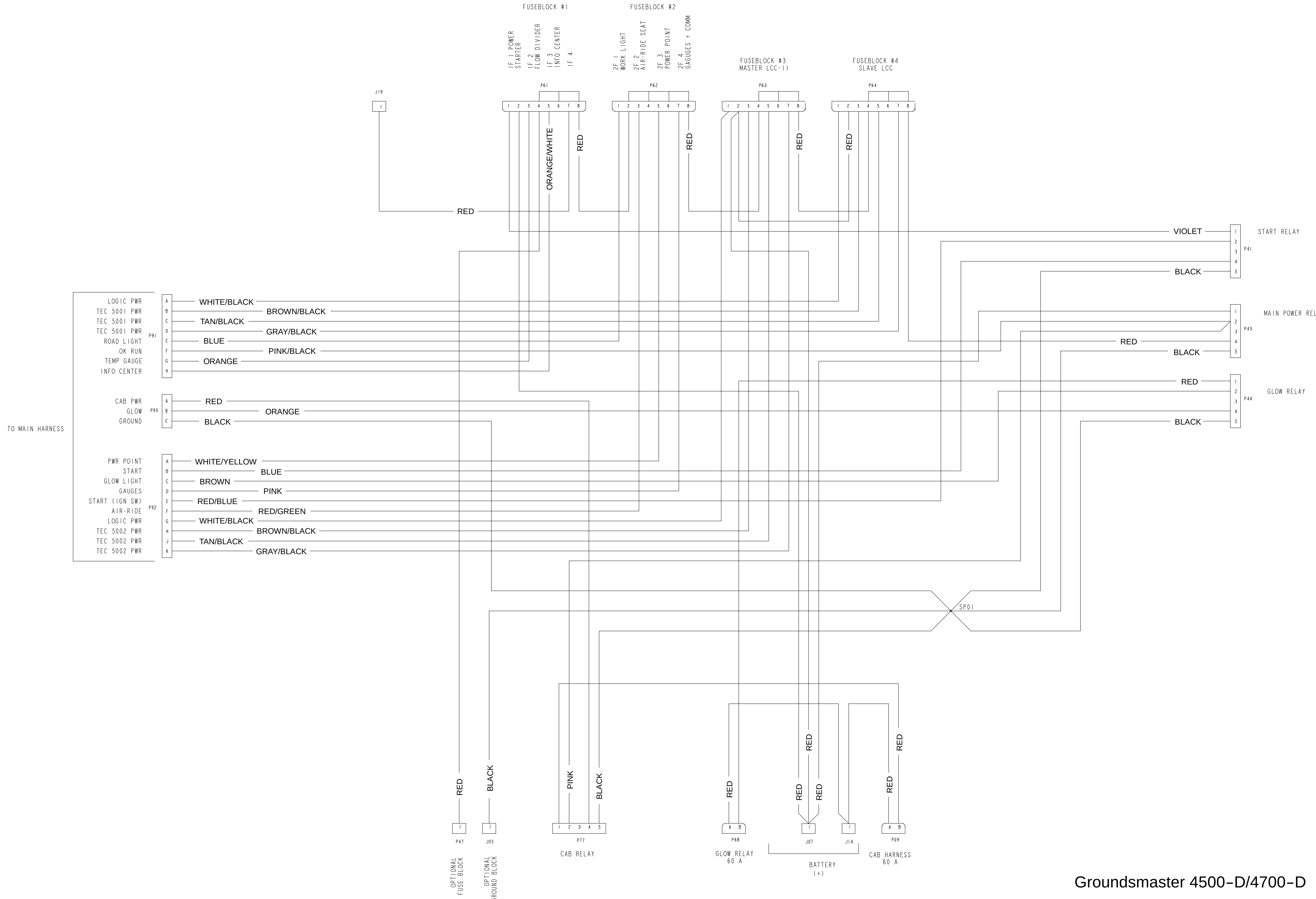
Groundsmaster 4500–D/4700–D

Seat and Console Wire Harness



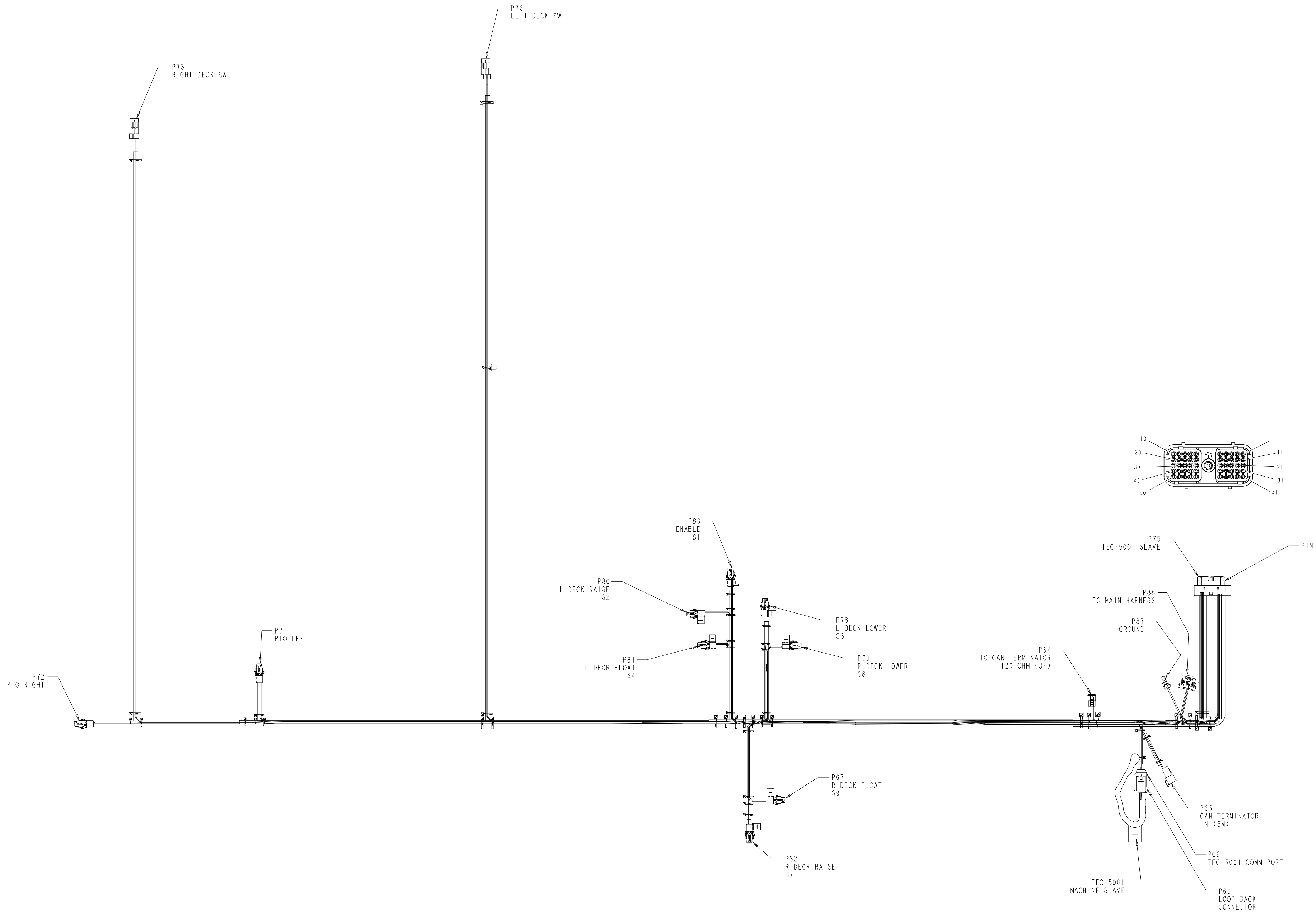
Groundsmaster 4500–D/4700–D

Power Center Wire Harness



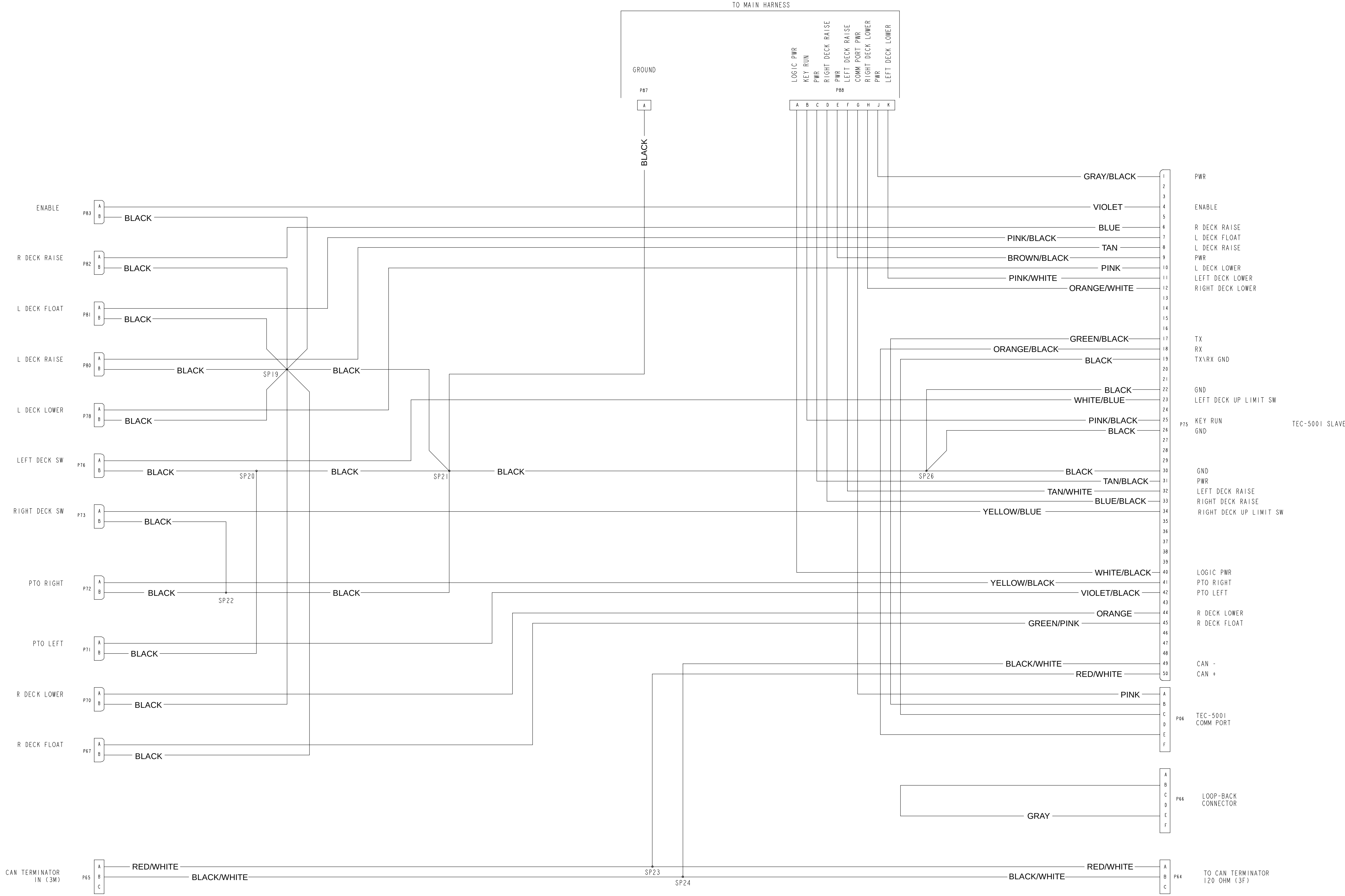
Groundsmaster 4500–D/4700–D

Power Center Wire Harness



Groundsmaster 4700–D

Deck 6 and 7 Wire Harness



Groundsmaster 4700-D

Deck 6 and 7 Wire Harness