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TORO®

Count on it.

Service Manual

Groundsmaster® 360

(Models with Kubota Engine)

Original Instructions (EN)

Revision History

Revision	Date	Description
--	2011	Initial Issue.
A	2016	Updated Hydraulic and Electrical chapters.
B	03/2018	Added revision history.

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NOTES

Service Manual

(Models with Kubota Engine)

Groundsmaster 360

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 360 models with a Kubota diesel engine.

REFER TO THE OPERATOR'S MANUAL FOR OPERATING, MAINTENANCE AND ADJUSTMENT INSTRUCTIONS. Space is provided in Chapter 2 of this book to insert the Operator's Manual and Parts Catalog for your machine. Replacement Operator's Manuals and Parts Catalogs 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 ma-
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Chapter 1

Safety

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General Safety Instructions

The Groundsmaster 360 has been tested and certified by TORO for compliance with existing safety standards and specifications. Although hazard control and accident prevention partially are dependent upon the design and configuration of the machine, these factors are also dependent upon the awareness, concern and proper training of the personnel involved in the operation, transport, maintenance and storage of the machine. Improper use or maintenance of the machine can result in injury or death. To reduce the potential for injury or death, comply with the following safety instructions.

WARNING

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

Before Operating

1. Review and understand the contents of the Operator's Manual and Operator Training DVD before starting and operating the machine. Become familiar with the controls and know how to stop the machine and engine quickly. A replacement Operator's Manual is available on the Internet at www.Toro.com.

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

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

4. Assure interlock switches are adjusted correctly so engine cannot be started unless traction pedal is in NEUTRAL, PTO switch is OFF (disengaged) and either the seat is occupied or the parking brake is applied.

5. Since fuel is highly flammable, handle it carefully:

   A. Store fuel in containers specifically designed for this purpose.

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

   C. Do not smoke while handling fuel.

   D. Fill fuel tank outdoors and only to the bottom of the filler neck. Do not overfill fuel tank.

   E. Replace fuel tank and fuel container caps securely after refueling machine.

   F. If fuel is spilled, do not attempt to start the engine but move the machine away from the area of the spillage. 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 the traction pedal is in NEUTRAL and the PTO switch is OFF (disengaged).

   NOTE: If machine is on any type of slope, it may move when parking brake is released.

   C. With machine on a level surface after engine is started, release parking brake and keep foot off traction pedal. Machine must not move. If movement is evident, the traction linkage may be adjusted incorrectly. Shut engine off and check traction linkage adjustment. If necessary, adjust linkage until machine does not move when traction pedal is in NEUTRAL.

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, radiator or exhaust system 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. Lower and disengage cutting deck and wait for all movement to stop.

   C. Set parking brake.

   D. Stop engine and remove key from ignition switch.

6. Anytime the machine is parked (short or long term), the cutting deck should be lowered to the HOC pin. This relieves pressure from the lift circuit and eliminates the risk of the cutting deck accidentally lowering.

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

Maintenance and Service

1. Before servicing or making adjustments, position cutting deck to allow necessary service to be completed. Then, stop engine, set parking brake and remove key from the switch.

2. Make sure machine is in safe operating condition by routinely inspecting fasteners (nuts, bolts and screws) to make sure they are tight.

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

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

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

6. Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved by parking the machine on a level surface, lowering the cutting deck completely to the ground and then stopping the engine.

7. When working on the hydraulic system and its components, wear eye protection.

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

9. Use care when checking or servicing the cutting deck. Wear gloves and use caution when servicing it.

10. To reduce potential fire hazard, keep engine and brake areas free of excessive grease, grass, leaves and dirt. Clean protective screen on machine when debris is present.

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

12. Do not overspeed the engine by changing engine governor setting. To assure safety and accuracy, check maximum engine speed with a tachometer.

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

14. 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.

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

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

17. If welding on the machine is necessary, disconnect the battery cables to prevent electrical system damage. Disconnect negative battery cable first and positive cable last. Also, disconnect the wire harness connector(s) from the machine controller and disconnect the terminal connector from the alternator.

18. At the time of manufacture, the machine conformed to applicable standards. 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.

19. When changing attachments, tires or performing other service, use correct supports, hoists and jacks. Make sure machine is parked on a solid level floor 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 jack stands or appropriate load holding devices to support the raised machine. If the machine is not properly supported, the machine may move or fall, which may result in personal injury (see Jacking Instructions in this section).

Jacking Instructions

CAUTION

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

Front End Jacking (Fig. 1)

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

2. Position jack securely under the front axle pivot. Do not use the cutting deck or implement as a jacking point.

3. Use jack to raise front of machine.

IMPORTANT: Do not support machine on front steering fork or front wheel motors (4WD machines).

4. After raising the front of the machine, use appropriate jack stands under the frame to support the front of the machine.

Rear End Jacking (Fig. 2)

1. Chock both front wheels to prevent the machine from moving.

2. Place jack securely under the rear frame.

3. Jack rear wheels off the ground.

IMPORTANT: Do not support machine on rear wheel hubs or wheel motors.

4. Use appropriate jack stands under the frame to support the rear of the machine.

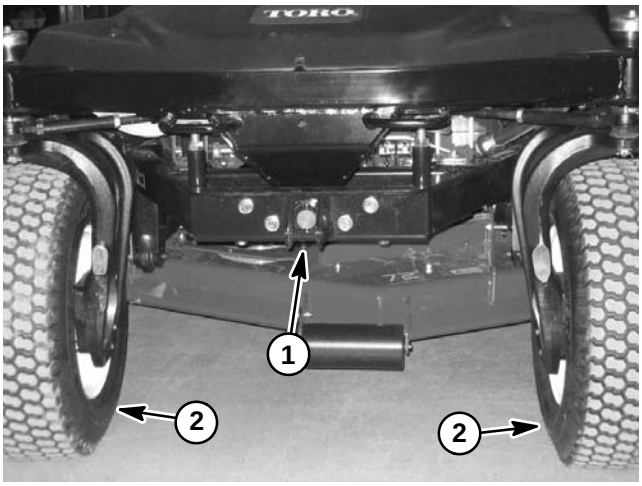

Figure 1

1. Front axle pivot **2. Front tire**

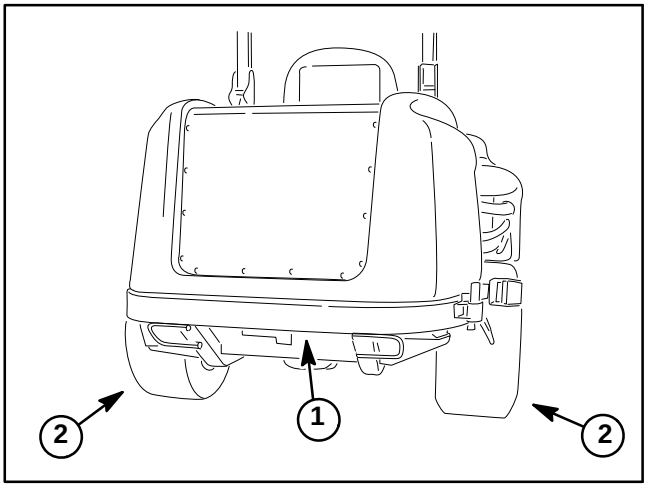

Figure 2

1. Rear frame jacking point **2. Rear tire**

Safety and Instruction Decals

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

Product Records and Maintenance

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Product Records

Insert a copy of the Operator's Manual and Parts Catalog for your Groundsmaster 360 at the end of this chapter. Additionally, if any optional equipment or accessories have been installed to your machine, insert the Installation Instructions, Operator's Manuals and Parts Catalogs for those options at the end of this chapter.

Maintenance

Maintenance procedures and recommended service intervals for the Groundsmaster 360 are covered in the Operator's Manuals. Refer to that publication when performing regular equipment maintenance.

Equivalents and Conversions

Decimal and Millimeter Equivalents

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

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

U.S.to Metric Conversions

	To Convert	Into	Multiply By
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 should 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

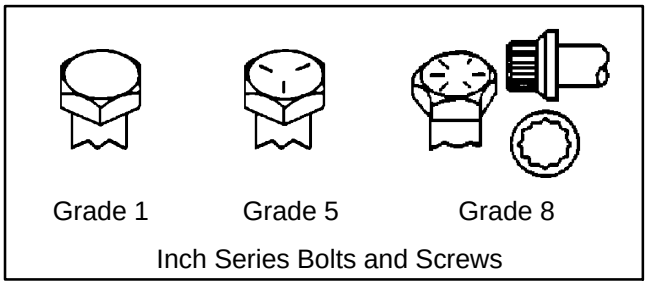

Figure 1

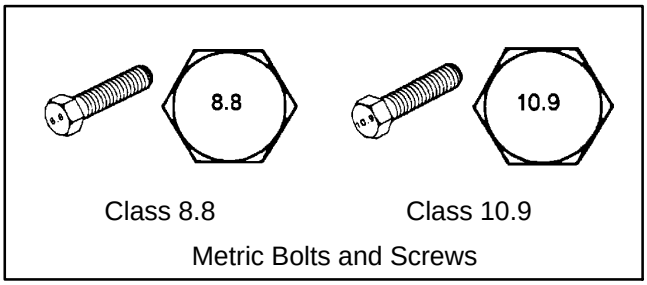

Figure 2

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.

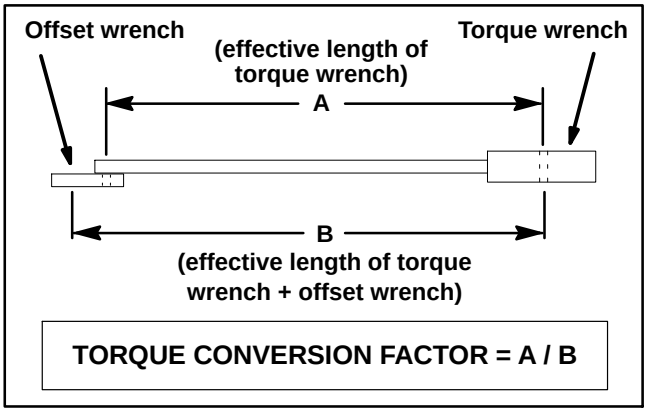

Figure 3

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: 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.

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.

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

Thread Size	Class 8.8 Bolts, Screws and Studs with Regular Height Nuts (Class 8 or Stronger Nuts)		Class 10.9 Bolts, Screws and Studs with Regular Height Nuts (Class 10 or Stronger Nuts)	
M5 X 0.8	57 ± 6 in−lb	644 ± 68 N−cm	78 ± 8 in−lb	881 ± 90 N−cm
M6 X 1.0	96 ± 10 in−lb	1085 ± 113 N−cm	133 ± 14 in−lb	1503 ± 158 N−cm
M8 X 1.25	19 ± 2 ft−lb	26 ± 3 N−m	28 ± 3 ft−lb	38 ± 4 N−m
M10 X 1.5	38 ± 4 ft−lb	52 ± 5 N−m	54 ± 6 ft−lb	73 ± 8 N−m
M12 X 1.75	66 ± 7 ft−lb	90 ± 10 N−m	93 ± 10 ft−lb	126 ± 14 N−m
M16 X 2.0	166 ± 17 ft−lb	225 ± 23 N−m	229 ± 23 ft−lb	310 ± 31 N−m
M20 X 2.5	325 ± 33 ft−lb	440 ± 45 N−m	450 ± 46 ft−lb	610 ± 62 N−m

NOTE: 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.

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.

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 & finish must be considered when determining specific torque values. All torque values are based on non−lubricated fasteners.

Conversion Factors

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

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

Chapter 3

Kubota Diesel Engine

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KUBOTA WORKSHOP MANUAL, DIESEL ENGINE, 05−E3B SERIES

KUBOTA WORKSHOP MANUAL, DIESEL ENGINE, 05−E4B SERIES

Specifications (Machines with 4 Cylinder Engine)

Item	Description
Make / Designation	Kubota V1505−E3B, 4−stroke, Liquid Cooled, OHV Diesel
Number of Cylinders	4
Bore x Stroke	3.07” x 3.09” (78 mm x 78.4 mm)
Total Displacement	91.41 in^3 (1498 cc)
Direction of Rotation	Counterclockwise (viewed from flywheel)
Firing Order	1 (fan end) − 3 − 4 (flywheel end) − 2
Fuel	Diesel or Biodiesel (up to B20) Fuel with Low or Ultra Low Sulfur Content
Fuel Injection Pump	Bosch MD Type Mini
Fuel Injector Nozzle	Mini Nozzle (DNOPD)
Fuel Tank Capacity	14 U.S. Gallons (53 Liters)
Governor	Centrifugal Mechanical
Low Idle Speed (no load)	1300 RPM
High Idle Speed (no load)	3100 to 3250 RPM
Engine Oil	API CH−4, CI−4 or higher
Engine Oil Viscosity	See Operator’s Manual
Oil Pump	Gear Driven Trochoid Type
Crankcase Oil Capacity	5.5 U.S. Quarts (5.2 Liters) with Filter
Cooling System Capacity (including reserve tank)	7 U.S. Quarts (6.6 Liters)
Starter	12 VDC 1.4 KW
Alternator	12 VDC 60 Amp with Internal Regulator
Engine Dry Weight (approximate)	243 lb. (110 kg)

Specifications (Machines with 3 Cylinder Engine)

Item	Description
Make / Designation	Kubota V1105−E3B or E4B, 4−stroke, Liquid Cooled, OHV Diesel
Number of Cylinders	3
Bore x Stroke	3.07” x 3.09” (78 mm x 78.4 mm)
Total Displacement	68.53 in^3 (1123 cc)
Direction of Rotation	Counterclockwise (viewed from flywheel)
Firing Order	1 (fan end) − 2 − 3 (flywheel end)
Fuel	Diesel or Biodiesel (up to B20) Fuel with Low or Ultra Low Sulfur Content
Fuel Injection Pump	Bosch MD Type Mini
Fuel Injector Nozzle	Mini Nozzle (DNOPD)
Fuel Tank Capacity	14 U.S. Gallons (53 Liters)
Governor	Centrifugal Mechanical
Low Idle Speed (no load) V1105−E3B Engine V1105−E4B Engine	 1300 RPM 1600 RPM
High Idle Speed (no load)	3100 to 3250 RPM
Engine Oil	API CH−4, CI−4 or higher
Engine Oil Viscosity	See Operator’s Manual
Oil Pump	Gear Driven Trochoid Type
Crankcase Oil Capacity	3.9 U.S. Quarts (3.7 Liters) with Filter
Cooling System Capacity (including reserve tank)	7 U.S. Quarts (6.6 Liters)
Starter	12 VDC 1.2 KW
Alternator	12 VDC 40 Amp with Internal Regulator
Engine Dry Weight (approximate)	205 lb. (93 kg)

General Information

This Chapter gives information about specifications, troubleshooting, testing and repair of the Kubota diesel engine used in the Groundsmaster 360. Refer to the Operator's Manual for engine maintenance information.

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

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

Operator's Manual

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

Adjust Throttle Control

Proper throttle operation is dependent upon proper adjustment of throttle control. Make sure throttle control is operating properly.

1. Move remote throttle control lever to **FAST** (detent) position.

2. Check position of speed control lever on engine fuel injection pump. Speed control lever should be contacting high speed screw when throttle control lever is in **FAST** (detent) position (Fig. 1).

3. If necessary, position of throttle control cable jam nuts can be adjusted until speed control lever contacts high speed screw when throttle control lever is at **FAST** (detent) position (Fig. 1).

4. Make sure that cable jam nuts are fully tightened after adjustment.

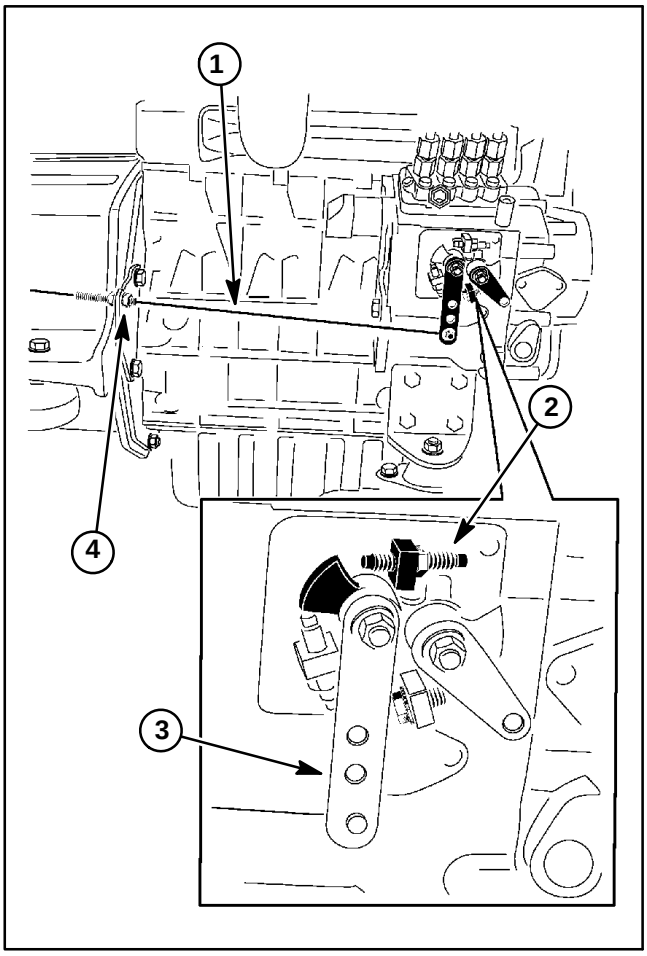

Figure 1

1. **Throttle cable**
2. **High speed screw**
3. **Speed control lever**
4. **Cable jam nut**

Air Cleaner Assembly

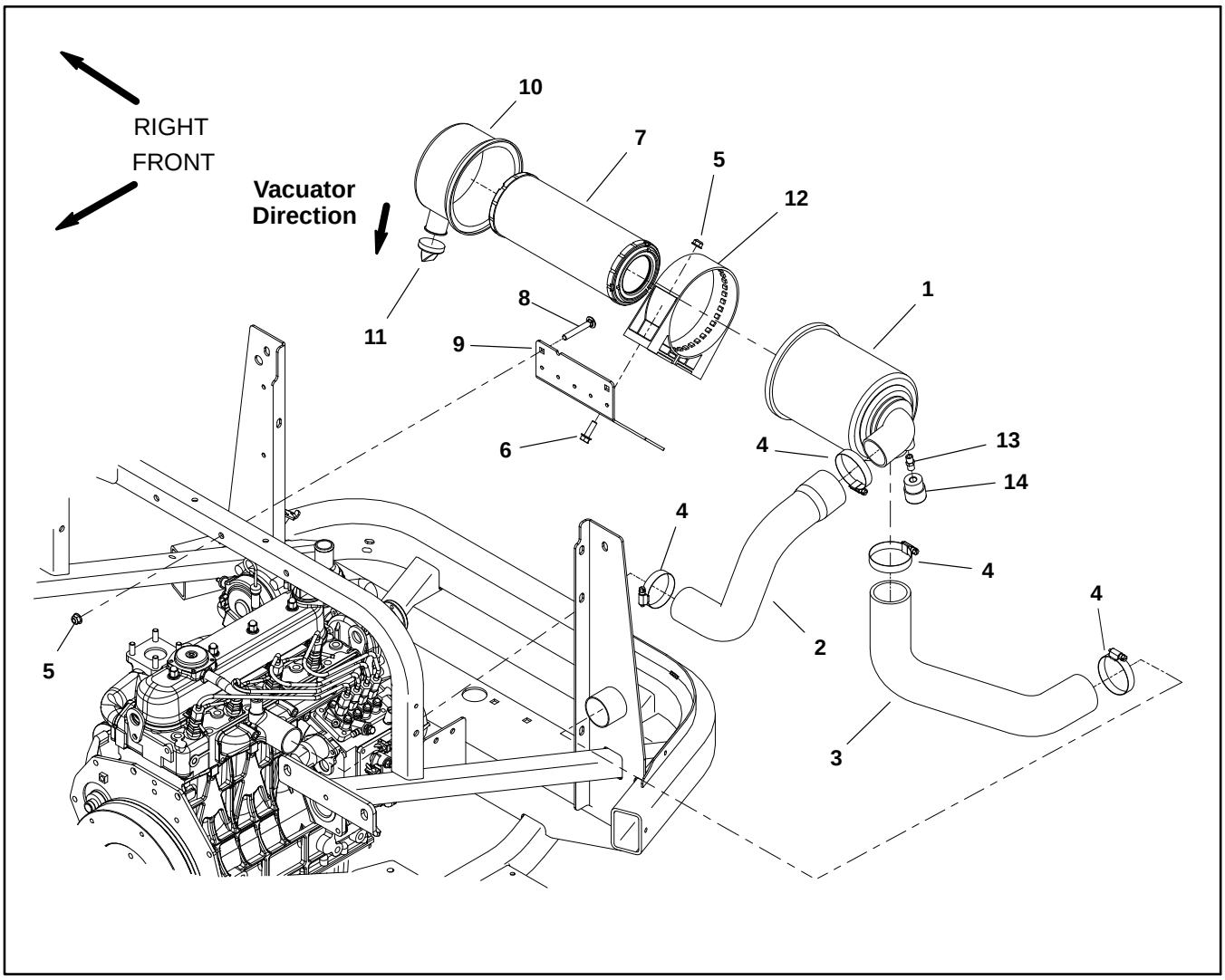

Figure 2

1. Air cleaner housing
2. Air intake hose
3. Air inlet hose
4. Hose clamp (4)
5. Flange nut (4)
6. Flange head screw (2)
7. Air filter element
8. Carriage screw (2)
9. Air cleaner plate
10. Air cleaner cover
11. Vacuator valve
12. Air cleaner bracket
13. Nipple
14. Service indicator

Removal (Fig. 2)

NOTE: See Operator's Manual for air cleaner maintenance procedures and intervals.

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

2. Unlatch and raise hood.

3. Remove air cleaner components as needed using Figure 2 as a guide.

4. Check air cleaner housing and cover for damage that could cause possible air leaks.

5. Check air inlet hoses for damage or wear.

Installation (Fig. 2)

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

1. Assemble air cleaner system using Figure 2 as a guide.

   A. Make sure that vacuator valve is pointed down after assembly.

   B. Make sure that air intake hose (item 2) has clearance around it at all points after air cleaner installation is completed.

   C. If indicator and nipple were removed from housing, apply thread sealant to threads of nipple before assembly.

2. Close and latch hood.

Exhaust System

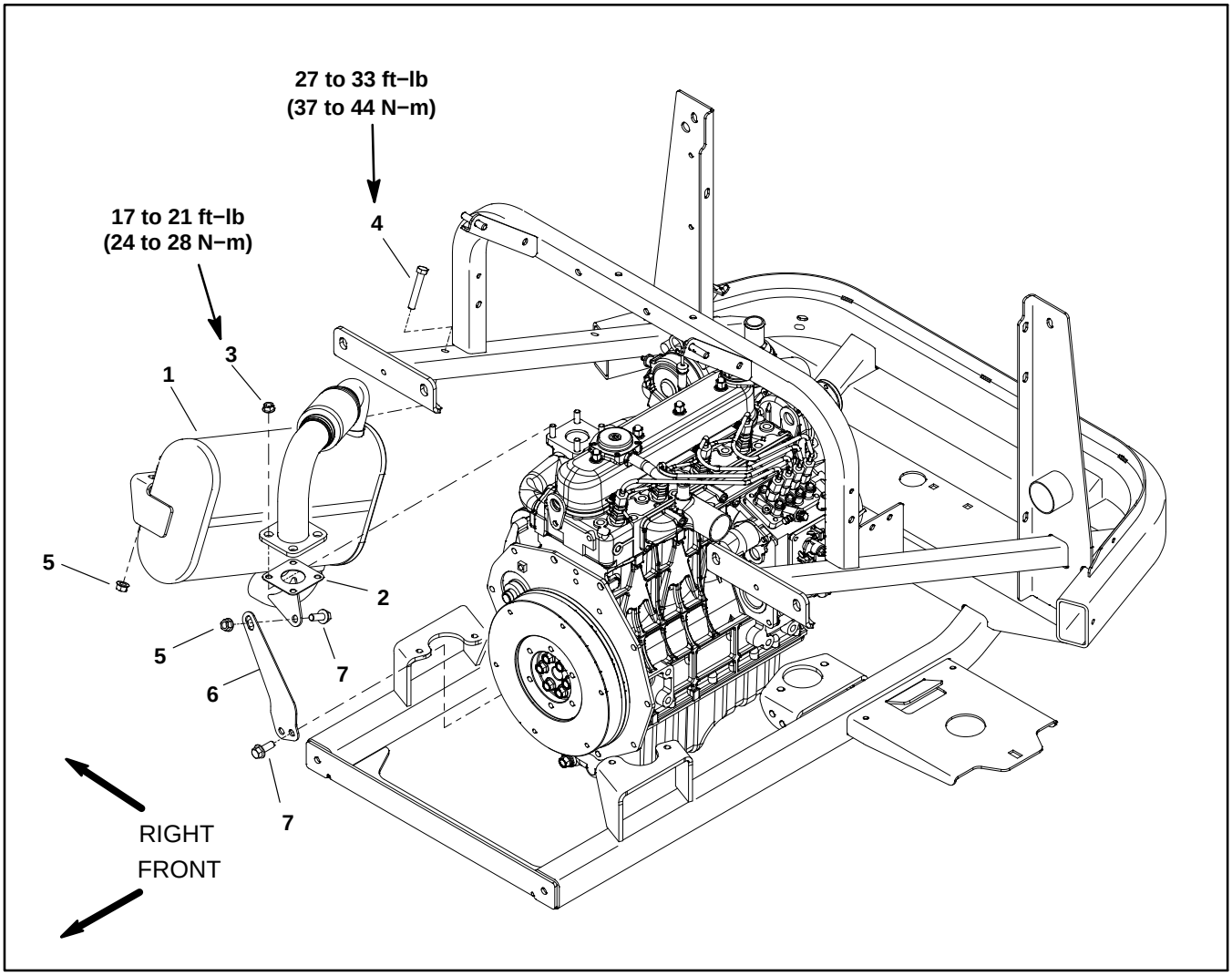

Figure 3

1. **Muffler assembly**
2. **Exhaust gasket**
3. **Flange nut (4)**
4. **Cap screw (2)**
5. **Flange nut (5)**
6. **Muffler support**
7. **Flange head screw (3)**

Removal (Fig. 3)

CAUTION

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

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

2. Unlatch and raise hood.

3. Support muffler to prevent it from falling.

4. Remove flange head screw (item 7) and flange nut that secure the muffler to the muffler support (item 6).

5. Remove four (4) flange nuts from the exhaust manifold studs.

6. Remove two (2) cap screws (item 4) and flange nuts that secure the muffler bracket to the frame (Fig. 4).

7. Remove muffler from the machine.

8. Remove and discard exhaust gasket.

Installation (Fig. 3)

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

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

1. Place new exhaust gasket on the engine exhaust manifold.

2. Position muffler flange to the engine exhaust manifold and loosely install four (4) flange nuts.

3. With the muffler flange tight to the engine exhaust manifold (no gaps visible), slide and rotate muffler until top of muffler bracket is flush with rear frame tube with no tension on muffler flex joint.

4. Tighten four (4) flange nuts to secure muffler flange to exhaust manifold. Torque flange nuts **17 to 21 ft−lb (24 to 28 N−m)**.

5. Secure muffler to the frame by tightening two (2) cap screws (item 4) and flange nuts making sure that muffler flex joint does not deform (Fig. 4). Torque cap screws from **27 to 33 ft−lb (37 to 44 N−m)**. If flex joint does deform during tightening, loosen all fasteners and return to step 3 above.

6. Install and tighten flange head screw (item 7) and flange nut that secure the muffler to the muffler support (item 6).

7. Close and latch hood.

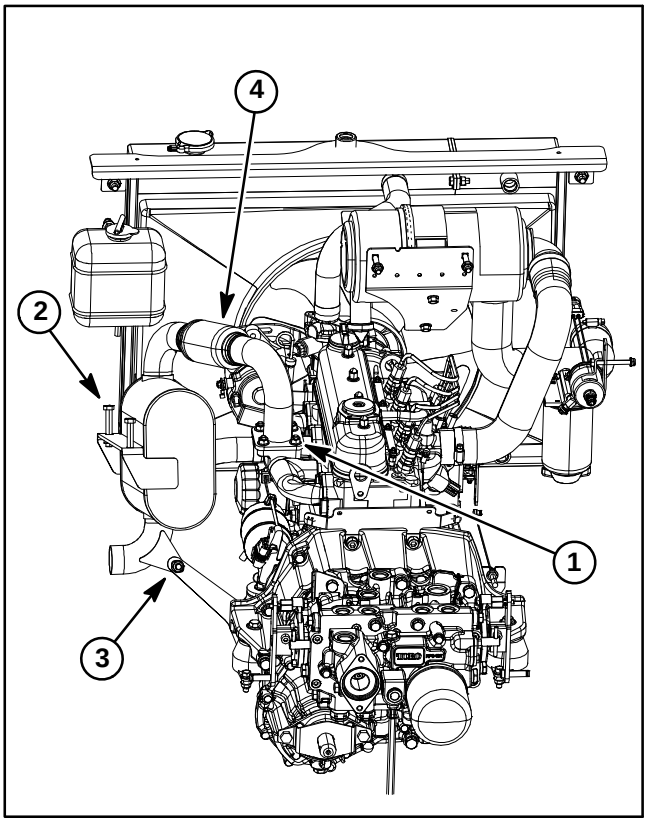

Figure 4

1. **Flange nut (4)**
2. **Cap screw (2)**
3. **Flange head screw**
4. **Muffler flex joint**

Fuel System

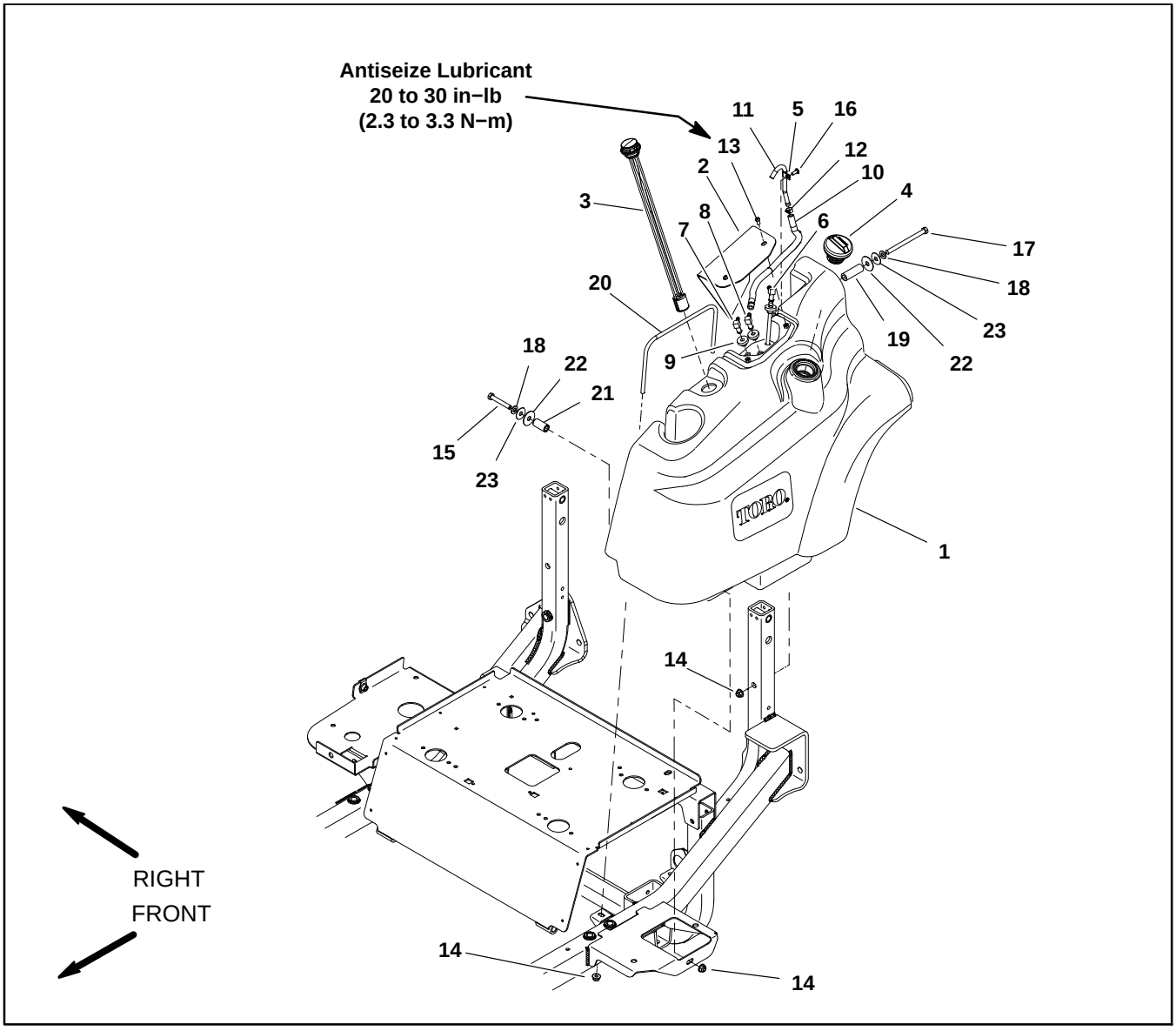

Figure 5

1. Fuel tank
2. Cover plate
3. Fuel gauge
4. Fuel cap
5. R−clamp
6. Stand pipe (fuel supply)
7. Elbow fitting (return)
8. Elbow fitting (tank vent)
9. Bushing (3)
10. Fuel hose
11. Vent tube
12. Hose clamp
13. Screw (2)
14. Flange nut (4)
15. Cap screw
16. Rivet
17. Cap screw
18. Flat washer (2)
19. Spacer
20. Tank bracket
21. Spacer
22. Rubber washer (2)
23. Flat washer (2)

DANGER

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

Check Fuel Lines and Connections

Check fuel lines and connections periodically as recommended in the Operator's Manual. Check lines for deterioration, damage, leakage or loose connections. Replace fuel lines, clamps and connections as needed.

Drain and Clean Fuel Tank

Drain and clean the fuel tank periodically as recommended in the 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 all contaminates and debris.

Fuel Tank Removal (Fig. 5)

1. Park machine on a level surface, lower cutting unit, stop engine, engage parking brake and remove key from the ignition switch. Unlatch and raise hood and operator seat.

2. Use a fuel transfer pump to remove fuel from fuel tank.

3. Remove two (2) screws (item 13) that secure cover plate (item 2) to fuel tank. Remove cover plate from fuel tank.

NOTE: Before removing fuel hoses from fuel tank fittings, label hoses for assembly purposes (Fig. 6).

4. Disconnect fuel supply hose, tank vent and return hoses from fittings in top of fuel tank.

5. Remove two (2) flange nuts (item 14) from threaded ends of tank bracket (item 20). Remove tank bracket.

6. Loosen and remove cap screw (item 17), three (3) washers (items 18, 23 and 22) and flange nut (item 14) that secure rear of fuel tank to frame. Locate and retrieve spacer (item 19).

7. Loosen and remove cap screw (item 15), three (3) washers (items 18, 23 and 22) and flange nut (item 14) that secure front of fuel tank to frame. Locate and retrieve spacer (item 21).

8. Lift fuel tank from machine.

Fuel Tank Installation (Fig. 5)

1. Position fuel tank to the machine.

2. Secure tank to frame:

   A. Secure rear of fuel tank with spacer (item 19), cap screw (item 17), three (3) washers (items 18, 23 and 22) and flange nut (item 14).

   B. Secure front of fuel tank with spacer (item 21), cap screw (item 15), three (3) washers (items 18, 23 and 22) and flange nut (item 14).

   C. Position tank bracket (item 20) to fuel tank and frame. Secure bracket with two (2) flange nuts (item 14). Tighten flange nuts evenly and only enough so tank is snug to frame. Do not overtighten flange nuts on bracket.

3. Using labels placed during fuel tank removal, correctly connect hoses to stand pipe (item 6), return fitting (item 7) and tank vent fitting (item 8) on the top of the fuel tank. Secure hoses with hose clamps.

4. Apply antiseize lubricant to threads of screws (item 13) that secure cover plate to fuel tank. Install cover plate (item 2) and secure with two (2) screws. Torque screws from **20 to 30 in−lb (2.3 to 3.3 N−m)**.

5. Lower and secure hood and operator seat. Fill fuel tank.

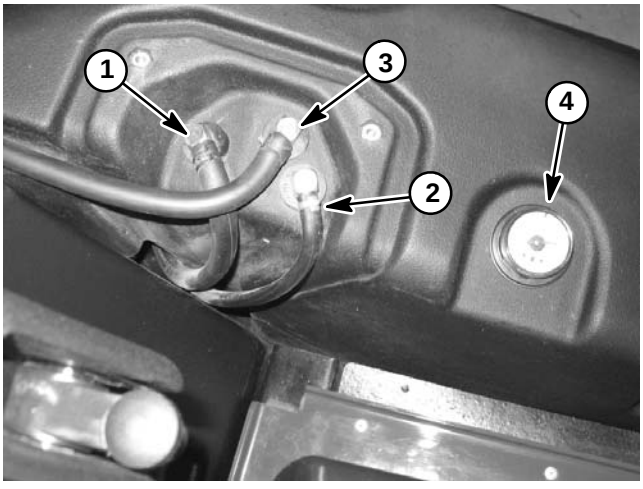

Figure 6

1. **Fuel supply hose**
2. **Fuel return hose**
3. **Tank vent hose**
4. **Fuel gauge**

Radiator

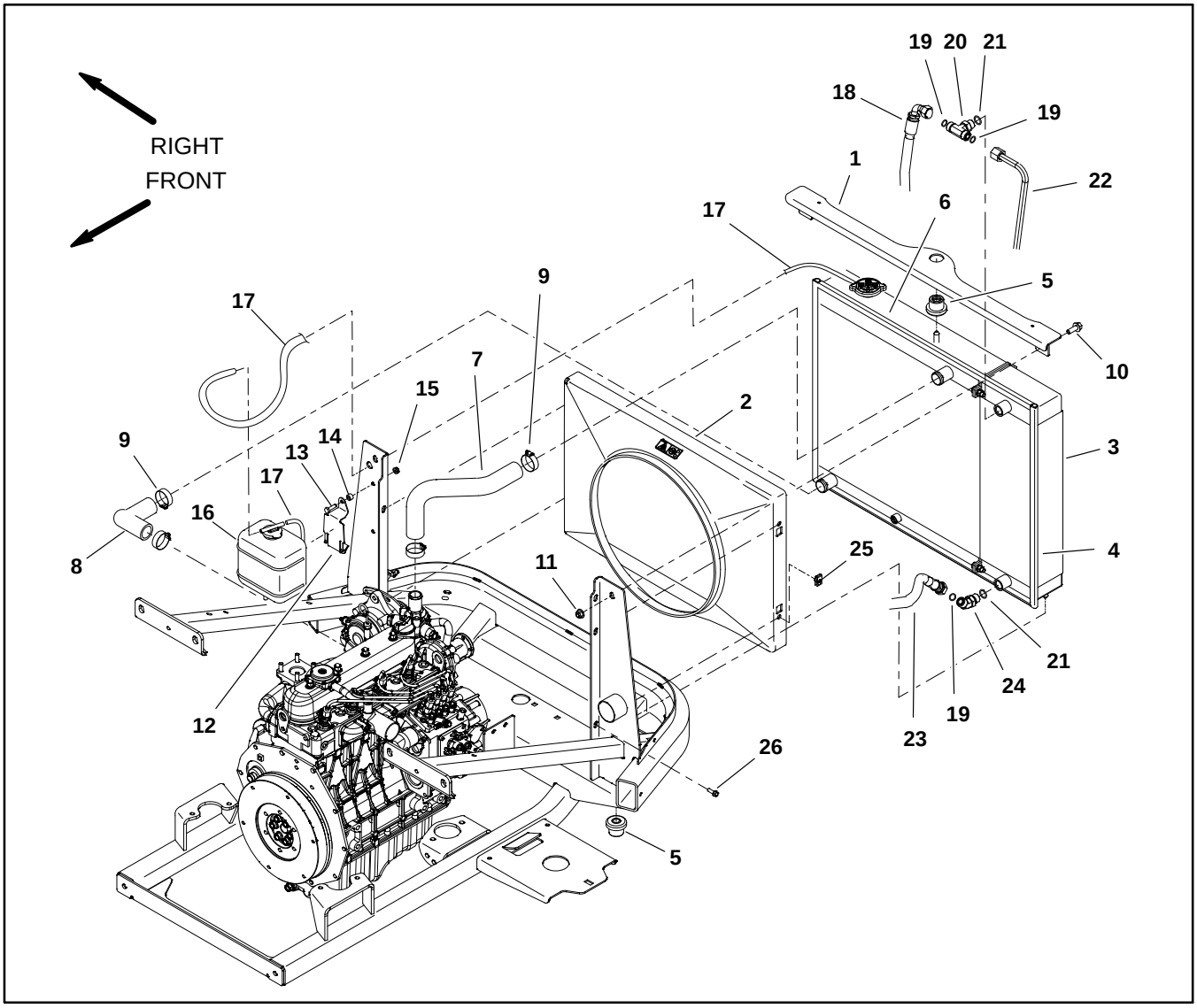

Figure 7

1. Radiator support
2. Fan shroud
3. Radiator/oil cooler assembly
4. Bulb seal (2)
5. Isolator mount (3)
6. Bulb seal (2)
7. Upper radiator hose
8. Lower radiator hose
9. Hose clamp (4)
10. Flange head screw (2)
11. Flange nut (2)
12. Bracket
13. Cap screw (2)
14. Spacer (2)
15. Flange nut (2)
16. Overflow bottle
17. Hose (2)
18. Hydraulic hose
19. O−ring
20. Hydraulic tee fitting
21. O−ring
22. Hydraulic tube
23. Hydraulic hose
24. 45º hydraulic fitting
25. Clip (4)
26. Screw (4)

Removal (Fig. 7)

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

2. Open hood and secure it in the raised position.

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. Place a suitable container under the center of the radiator to allow coolant draining. Remove pipe plug (item 12 in Fig. 8) (hex socket head) from bottom of the radiator and completely drain the radiator.

4. Disconnect upper and lower radiator hoses from the radiator. Also, disconnect overflow bottle hose from the vent tube near the radiator cap.

5. Thoroughly clean hydraulic hose ends and oil cooler fittings to prevent hydraulic system contamination. Label hydraulic lines for assembly purposes.

6. Remove hydraulic lines from oil cooler fittings. Install clean plugs in hose and tube openings to prevent contamination. Remove and discard O−rings from oil cooler fittings.

7. Remove four (4) screws that secure fan shroud to frame. Carefully position fan shroud away from radiator taking care to not damage fan.

8. Remove two (2) flange head screws (item 10) and flange nuts (item 11) that secure the radiator support to the frame. Lift support from radiator.

9. Carefully lift radiator and oil cooler assembly from the machine.

10. Plug radiator, oil cooler and all hose openings to prevent contamination.

11. Inspect bulb seals on radiator and oil cooler assembly and replace them if damaged or hardened. Also, make sure that three (3) isolator mounts (item 5) are in good condition.

12. Separate radiator and oil cooler if necessary (Fig. 8).

Installation (Fig. 7)

1. If radiator and oil cooler were disassembled, position oil cooler to radiator and secure with removed fasteners (Fig. 8).

2. Check that gap between radiator and oil cooler is less than 0.090” (2.3 mm). If gap is more than 0.090” (2.3 mm), fill gap with silicone sealer to ensure effective sealing.

3. Remove all plugs placed in radiator, oil cooler and hose openings during the removal procedure.

4. Carefully position radiator and oil cooler assembly to the machine. Make sure that lower pins engage isolator mounts (item 5).

5. Position the radiator support to the top of the radiator and oil cooler assembly. Make sure that radiator pin engages isolator mount in support. Secure support with two (2) flange head screws (item 10) and flange nuts (item 11).

6. Carefully position fan shroud to radiator taking care to not damage fan. Secure fan shroud to the frame with four (4) screws.

7. Make sure that equal clearance exists at all points between fan shroud and fan. Clearance should be from **0.250” to 0.330” (6.4 to 8.3 mm)**.

8. Connect radiator hoses to the radiator and overflow bottle hose to the vent tube near the radiator cap. Secure hoses with hose clamps. Make sure that hose clamp on lower radiator hose does not contact alternator belt.

9. Install new O−rings to oil cooler fittings. Connect hydraulic lines to oil cooler (see Hydraulic Hose and Tube Installation in the General Information section of Chapter 4 − Hydraulic System).

10. Apply thread sealant to threads of radiator plug (item 12 in Fig. 8). Install plug into radiator opening.

11. Check that no gaps exist between radiator, radiator frame and machine frame. If necessary, seal gaps with silicone caulk.

12. Fill radiator with coolant. Make sure that overflow bottle coolant level is correct.

13. Check hydraulic oil level and adjust if necessary.

14. Close and latch hood.

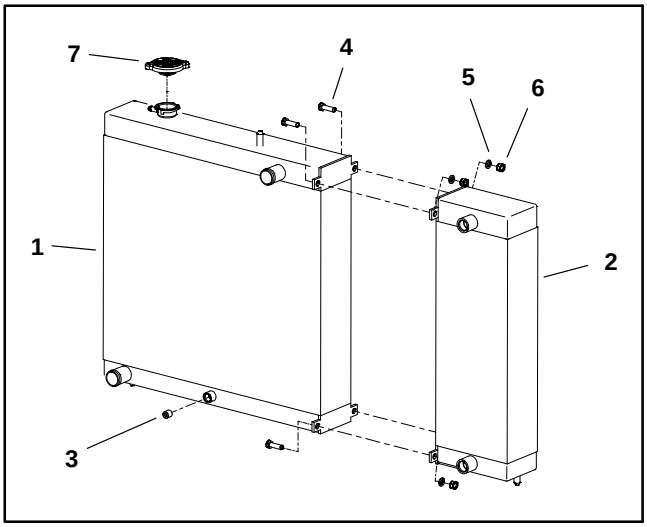

Figure 8

1. **Radiator**
2. **Oil cooler**
3. **Pipe plug**
4. **Cap screw (4)**
5. **Lock washer (4)**
6. **Nut (4)**
7. **Radiator cap**

Engine

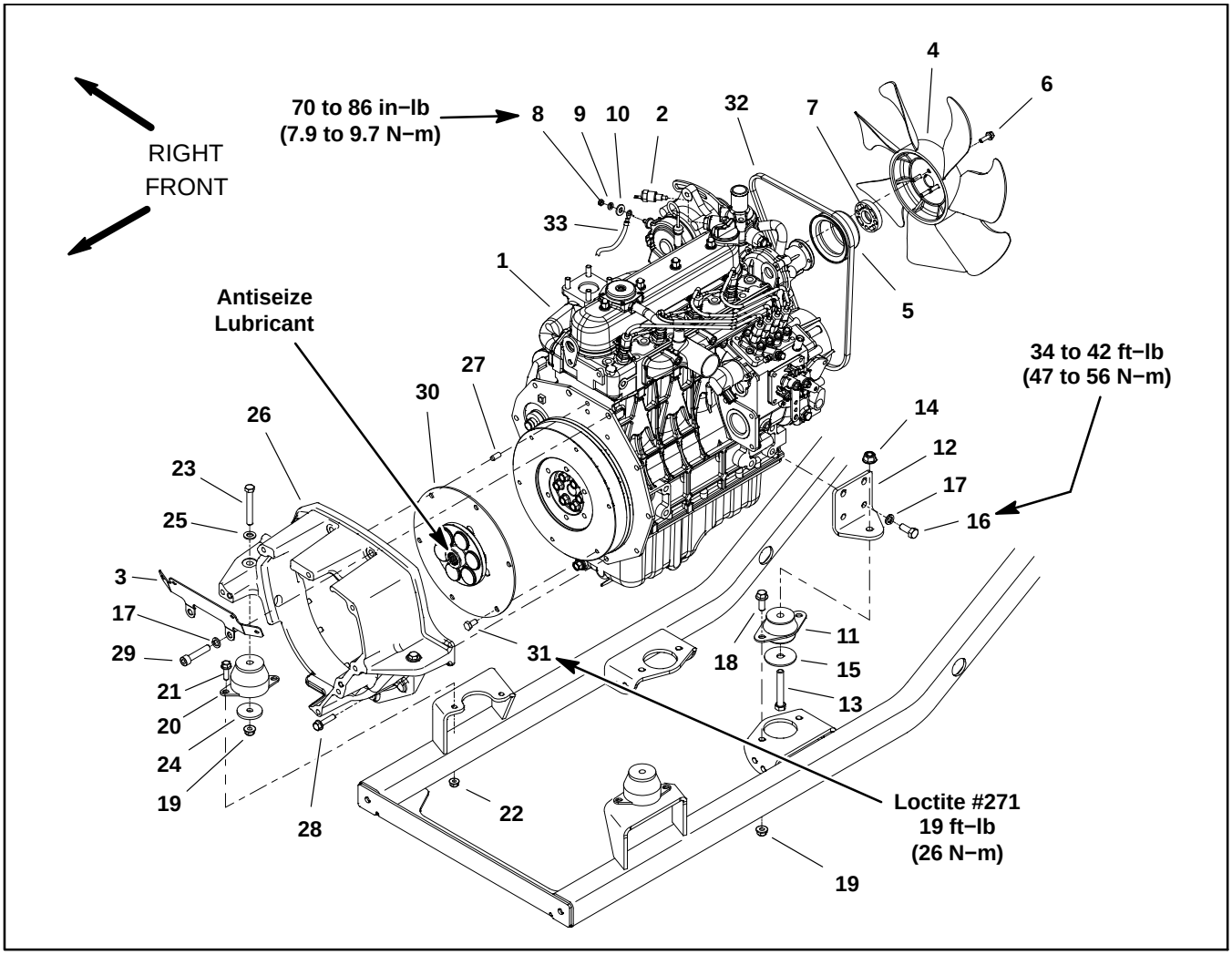

Figure 9

1. Engine
2. Thermo−switch
3. Cable support
4. Fan
5. Fan pulley
6. Flange head screw (4)
7. Fan spacer
8. Hex nut
9. Lock washer
10. Flat washer
11. Engine mount (2) (yellow top)
12. Motor mount plate (2)
13. Cap screw (2)
14. Flange nut (2)
15. Snubbing washer (2)
16. Cap screw (4 per plate)
17. Lock washer (10)
18. Flange screw (4)
19. Flange nut (6)
20. Engine mount (2) (red top)
21. Flange head screw (4)
22. Flange nut (4)
23. Cap screw (2)
24. Hardened washer (2)
25. Flat washer (2)
26. Flywheel housing
27. Dowel pin (2)
28. Flange head screw (6)
29. Socket head screw (2)
30. Flywheel coupling
31. Cap screw (6)
32. V−belt

Engine Removal (Fig. 9)

NOTE: When removing the engine using the following procedure, the flywheel housing and transmission will remain in the machine.

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

2. Remove hood from machine (see Hood Removal in the Service and Repairs section of Chapter 6 − Chassis).

3. Raise and support operator seat.

4. Disconnect both battery cables from the battery. Disconnect negative cable first and then positive cable (see Battery Service in the Service and Repairs section of Chapter 5 − Electrical System).

5. Remove air cleaner from the engine (see Air Cleaner Assembly Removal in this section).

6. Remove muffler from the engine (see Muffler Removal in this section).

7. Remove radiator and oil cooler assembly from machine (see Radiator Removal in this section). Remove fan shroud from machine.

8. Remove rear steering cylinder to allow clearance for engine removal (see Steering Cylinder Removal in the Service and Repairs section of Chapter 4 − Hydraulic System).

9. Label and disconnect harness wires from engine:

   A. Negative battery cable, wire harness ground and fuel stop solenoid (Fig. 10).

   B. Glow plug bus (Fig. 11).

   C. Alternator connector and stud (Fig. 12).

   D. High temperature warning switch and high temperature shutdown switch (Fig. 12).

   E. Starter motor and fusible link harness (Fig. 13).

   F. Oil pressure switch (near oil filter).

10. Disconnect throttle cable from the throttle bracket and the speed control lever (Fig. 10). Position cable away from engine.

11. Remove two (2) flange head screws that secure throttle bracket to engine. Remove bracket from engine.

12. Disconnect fuel supply hose at injector pump and return fuel hose from front injector nozzle. Plug disconnected hoses to prevent fuel leakage. Position hoses away from engine.

13. Note location of cable ties securing the wire harness to engine. Remove cable ties.

14. On machines with an operator cab (Fig. 14):

   A. Remove windshield washer reservoir from reservoir mount on engine. Position reservoir away from engine.

   IMPORTANT: To prevent compressor oil from filling the compressor cylinders, keep compressor in the same orientation as the installed position.

   B. Remove air conditioning compressor from bracket (see Air Conditioning Compressor Removal in the Service and Repairs section of Chapter 8 − Operator Cab). Position compressor away from engine taking care to not damage compressor or hoses. Make sure that compressor remains in a horizontal position. Support compressor to make sure it will not fall during engine removal.

   C. Disconnect cab heater hose from fitting on engine water flange.

15. Support transmission to prevent it from moving during engine removal. Do not rely on hydraulic hoses to retain transmission position.

CAUTION

When removing engine assembly, make sure lift or hoist can safely support 250 pounds (114 kg).

16. Attach a suitable lift or hoist to lift tabs on front and rear of engine. Support engine with lift or hoist to prevent engine from shifting or moving.

17. Remove six (6) flange head screws and two (2) socket head screws with lock washers securing the flywheel housing to engine. Remove cable support (item 3) from housing.

18. Remove flange nut (item 14), snubbing washer (item 15) and cap screw (item 13) that secures each side of engine to the engine mounts attached to the frame.

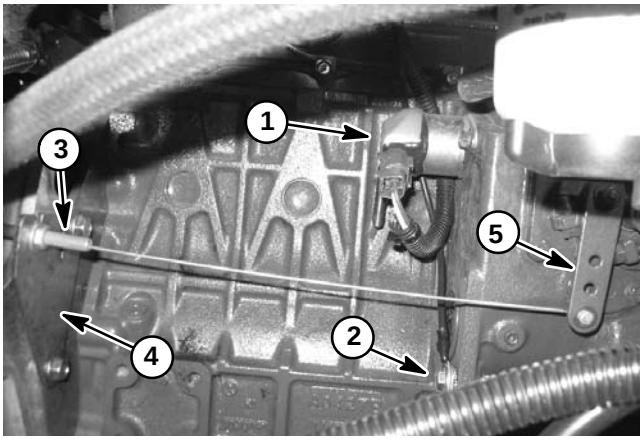

Figure 10

1. Fuel stop solenoid
2. Ground connections
3. Throttle cable
4. Throttle bracket
5. Speed control lever

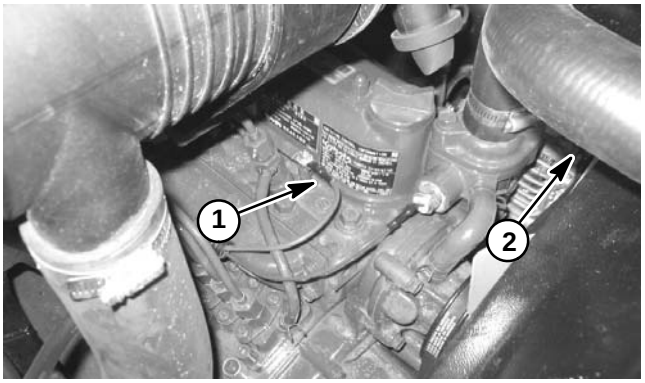

Figure 11

1. Glow plug wire
2. Upper radiator hose

IMPORTANT: Make sure to not damage the engine, flywheel housing, fuel hoses, hydraulic lines, electrical harness or other parts while removing engine. Also, make sure that transmission does not shift location during engine removal.

CAUTION

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

19. Move engine toward the rear of the machine to separate it from the transmission input shaft and flywheel housing. Carefully raise engine from the machine.

20. Locate and retrieve two (2) dowel pins (item 27) that locate flywheel housing to engine.

21. If necessary, remove six (6) cap screws (item 31) that secure flywheel coupling (item 30) to engine flywheel and remove coupling from engine.

22. If necessary, remove motor mount plates (item 12) from engine.

Engine Installation (Fig. 9)

1. Make sure that all removed engine components are correctly installed to the engine.

2. If removed, install motor mount plates (item 12) to engine with cap screws and lock washers. Torque cap screws from **34 to 42 ft−lb (47 to 56 N−m)**.

3. If flywheel coupling was removed from engine, apply Loctite #271 (or equivalent) to threads of six (6) cap screws and secure coupling to engine flywheel. Torque cap screws **19 ft−lb (26 N−m)** twice in sequence (Fig. 15).

4. Apply a generous amount of antiseize lubricant to female splines of flywheel coupling.

5. Position two (2) dowel pins (item 27) to engine endplate.

6. Support transmission to prevent it from moving during engine installation.

CAUTION

When installing engine assembly, make sure lift or hoist can safely support 250 pounds (114 kg).

7. Connect lift or hoist to the front and rear engine lift tabs.

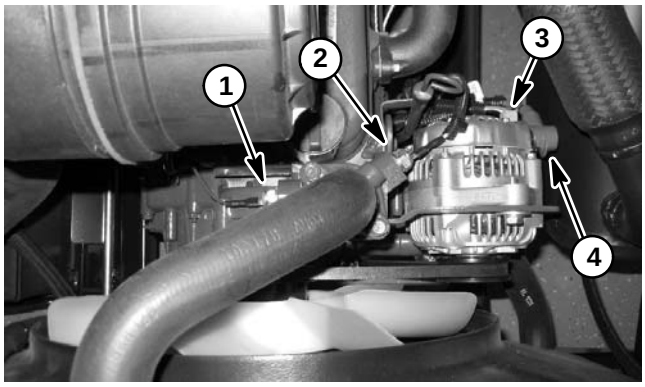

Figure 12

1. Temp shutdown switch
2. Temp warning switch
3. Alternator connector
4. Alternator stud

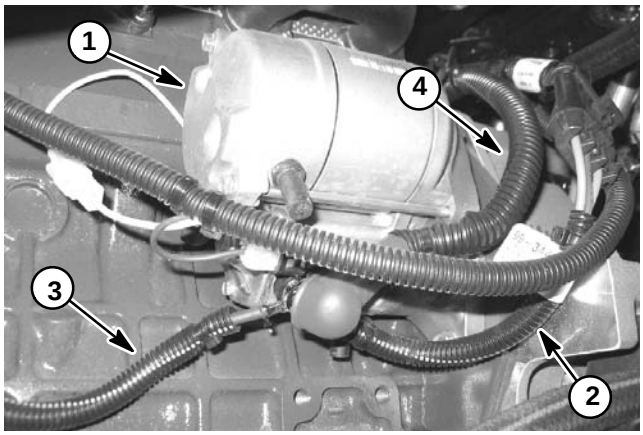

Figure 13

1. Starter motor
2. Fusible link harness
3. Alternator fusible link
4. Positive battery cable

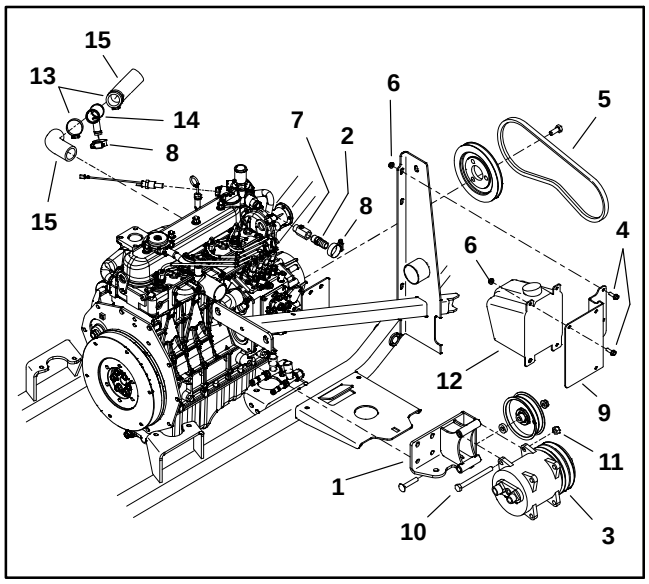

Figure 14

1. AC mount bracket
2. Fitting
3. AC compressor
4. Screw (4)
5. AC drive belt
6. Flange nut (4)
7. Ball valve
8. Hose clamp (2)
9. Reservoir mount
10. Cap screw (2)
11. Lock nut (2)
12. Washer reservoir
13. Hose clamp (2)
14. Tee fitting
15. Radiator hose (2)

CAUTION

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

IMPORTANT: Make sure to not damage the engine, flywheel housing, fuel or hydraulic lines, electrical harness or other parts while installing the engine. Also, make sure that transmission does not shift location during engine installation.

8. Carefully lower engine assembly into the machine. Move engine toward the front of the machine while aligning flywheel coupling to transmission input shaft and engine end plate to flywheel housing.

9. Secure flywheel housing and fuel/water separator bracket to engine end plate with eight (8) flange head screws and two (2) socket head screws.

10. Secure engine to the engine mounts attached to the frame with two (2) cap screws, snubbing washers and lock nuts.

11. Connect fuel hoses to the fuel/water separator (Fig. 10). Connect return fuel hose to front injector nozzle (Fig. 11).

12. On machines with an operator cab (Fig. 14):

A. Position windshield washer reservoir to bracket on engine. Secure with removed fasteners.

IMPORTANT: After the compressor has been installed, make sure to rotate the compressor drive shaft several times to properly distribute oil in the compressor. Compressor damage due to oil slugging can occur if this procedure is not performed.

B. Install air conditioning compressor to brackets (see Air Conditioning Compressor Installation in the Service and Repairs section of Chapter 9 − Operator Cab). Make sure that compressor drive belt is properly tensioned.

C. Connect cab heater hose to fitting on engine water flange.

13. Connect all electrical harness connectors to engine using labels placed during engine removal.

A. When securing negative battery cable and wire harness ground to engine, make sure that lock washer is between ground cable and engine flange. Torque flange nut from **175 to 225 in−lb (20 to 25 N−m)** and coat connection with skin−over grease (Toro part #TOR50547) to prevent corrosion.

14. Secure wire harness to engine with cable ties at locations noted during engine removal.

15. Install rear steering cylinder (see Steering Cylinder Installation in the Service and Repairs section of Chapter 4 − Hydraulic System).

16. Carefully position fan shroud around the engine fan.

17. Install radiator and oil cooler assembly to machine (see Radiator Installation in this section). Make sure that radiator hoses are secured with hose clamps.

18. Make sure that drain plug is installed in radiator. Fill radiator with coolant.

19. Install muffler to the engine (see Exhaust System Installation in this section).

20. Connect throttle cable to the throttle bracket and the speed control lever.

21. Adjust throttle cable (see Adjust Throttle Cable in the Adjustments section of this chapter).

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

23. Connect and secure positive battery cable to the battery. Then connect negative battery cable.

24. Check engine oil level and adjust as needed.

25. Install hood to the machine (see Hood Installation in the Service and Repairs section of Chapter 6 − Chassis).

26. Bleed fuel system.

27. Close and latch hood. Lower operator seat.

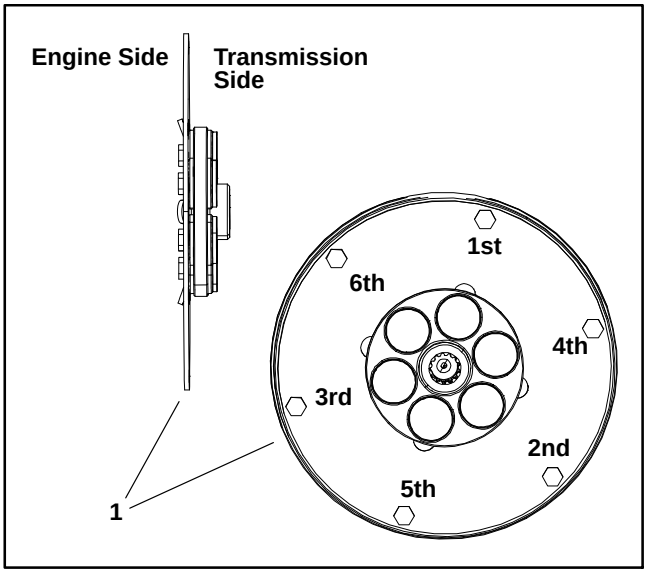

Figure 15

1. Flywheel coupling

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Chapter 4

Hydraulic System

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PARKER TORQMOTOR™ SERVICE PROCEDURE (TC, TB, TE, TJ, TF, TG, TH AND TL SERIES)

Specifications

Item	Description
Transmission	Kanzaki dual, variable displacement traction piston pumps with integral charge pump and multi−disc PTO clutch
Maximum Traction Pump Displacement (per revolution)	1.1 in^3 (18 cc)
Traction Circuit Relief Pressure (Forward and Reverse)	4000 PSI (276 bar)
Charge Pump Displacement (per revolution)	0.37 in^3 (6 cc)
Charge Pressure	100 to 130 PSI (6.9 to 8.9 bar)
Gear Pump	Casappa single section, positive displacement gear type pump
Displacement (per revolution)	0.41 in^3 (6.7 cc)
Implement Relief Pressure	1800 PSI (125 bar)
Wheel Motors	Parker geroller motor, LSHT Series
Displacement (per revolution)	17.1 in^3 (280 cc)
Steering Control Valve	Eaton Steering Unit, Series 5
Displacement (per revolution)	6.1 in^3 (100 cc)
Hydraulic Filter	Spin−on cartridge type
Hydraulic Oil Capacities (Approximate)	
Hydraulic Oil Change (Hydraulic Tank and Transmission)	18 US qt (17 l)
Hydraulic System (All Components and Lines)	22.5 US qt (21.3 l)
Hydraulic Oil	See Operator's Manual

General Information

Operator's Manual

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

Pushing Traction Unit

In case of emergency, your Groundsmaster can be pushed for a very short distance. However, Toro does not recommend this as a standard procedure.

1. Make sure that engine is not running.

2. Locate two (2) bypass valves on transmission (Fig. 1). Loosen (rotate counterclockwise) both of the valves from one (1) to two (2) turns.

IMPORTANT: Do not push the machine faster than 2 mph because the drive system may be damaged. If machine must be moved a considerable distance (more than a few feet), transport it on a truck or trailer.

3. Slowly push machine.

4. Before starting engine, tighten both bypass valves to close them. Torque valves from **62 to 79 in−lb (7 to 9 N−m)**. Do not start engine when bypass valves are open or transmission damage will occur.

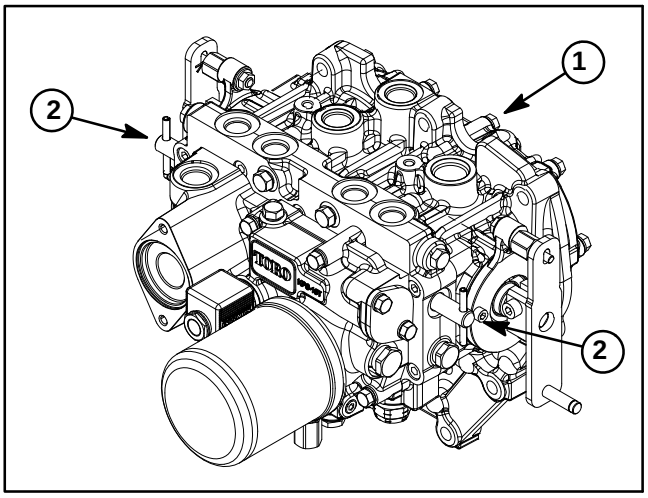

Figure 1

1. **Transmission**
2. **Bypass valve**

Relieving Hydraulic System Pressure

Before disconnecting or performing any work on the Groundsmaster 360 hydraulic system, all pressure in the hydraulic system must be relieved.

To relieve hydraulic pressure in the traction circuit, park machine on a level surface with the cutting deck lowered and off. Turn ignition switch to OFF and allow engine to stop. If machine is parked on an incline or slope, pressure in the traction circuit WILL NOT be relieved.

To relieve hydraulic pressure in lift circuit, fully lower the cutting deck onto solid blocks. Turn ignition switch to OFF and allow engine to stop. Make sure that after lowering, the cutting deck is not being supported by the lift cylinder.

To relieve hydraulic pressure in the steering circuit, park machine on a level surface with the cutting deck lowered and off. Turn ignition switch to OFF. After engine has come to a complete stop, rotate steering wheel in both directions.

Hydraulic pressure in the PTO circuit is relieved when the ignition switch is turned to OFF.

If machine is equipped with optional hydraulic kits (e.g. Quick Attach System), make sure that attachments are fully lowered and supported. Then, with the engine stopped, turn the ignition switch to RUN and move the hydraulic kit switches to all switch positions. As hydraulic solenoids are energized, circuit pressure will be relieved.

Traction Circuit Component Failure

The traction circuit on Groundsmaster 360 machines is a closed loop system that includes the dual piston (traction) pump and either two (2) or four (4) wheel motors. If a component in the traction circuit should fail, debris and contamination from the failed component will circulate throughout the traction circuit. This contamination can damage other components in the circuit so it must be removed to prevent additional component failure.

The recommended method of removing traction circuit contamination would be to temporarily install the Toro high flow hydraulic filter (see Special Tools in this chapter) into the circuit. This filter should be used when connecting hydraulic test gauges in order to test traction circuit components or after replacing a failed traction circuit component (e.g. traction (piston) pump or wheel motor). The filter will ensure that contaminates are removed from the closed loop and thus, do not cause additional component damage.

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

The alternative to using the Toro high flow hydraulic filter kit after a traction circuit component failure would be to disassemble, drain and thoroughly clean all components, tubes and hoses in the traction circuit. If any debris remains in the traction circuit and the machine is operated, the debris can cause additional circuit component failure.

Hydraulic Hoses

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

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

Kinked, crushed, flattened or twisted hose.

Blistered, soft, degraded or loose hose cover.

Cracked, damaged or badly corroded hose fittings.

When replacing a hydraulic hose, be sure that the hose is straight (not twisted) before tightening the fittings. This can be done by observing the imprint (layline) on the hose. Use two (2) 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 4. 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

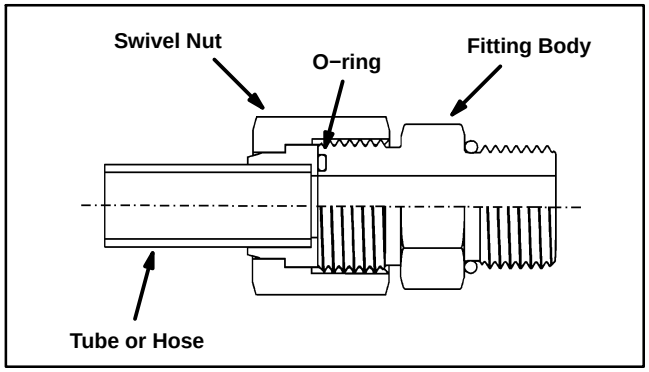

Figure 2

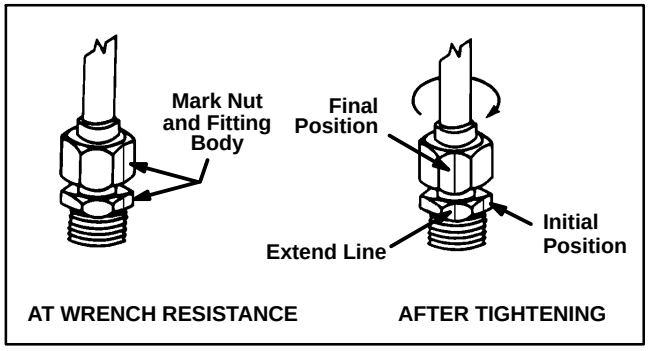

Figure 3

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 4

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

Non−Adjustable Fitting (Fig. 5)

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 6.

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

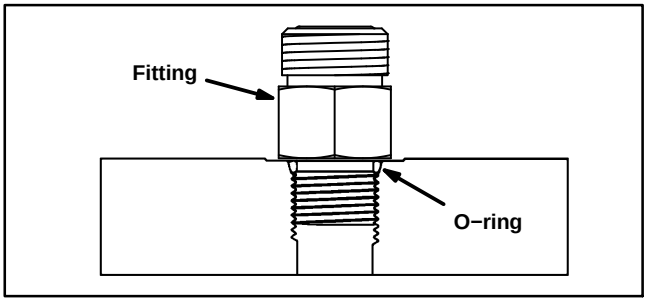

Figure 5

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 6

Adjustable Fitting (Fig. 7)

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 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).

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

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

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

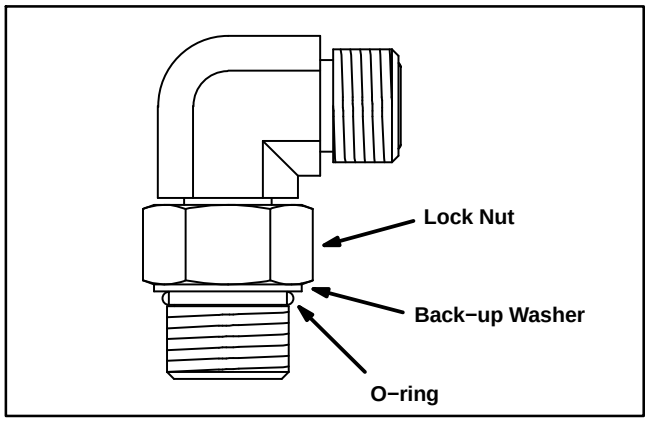

Figure 7

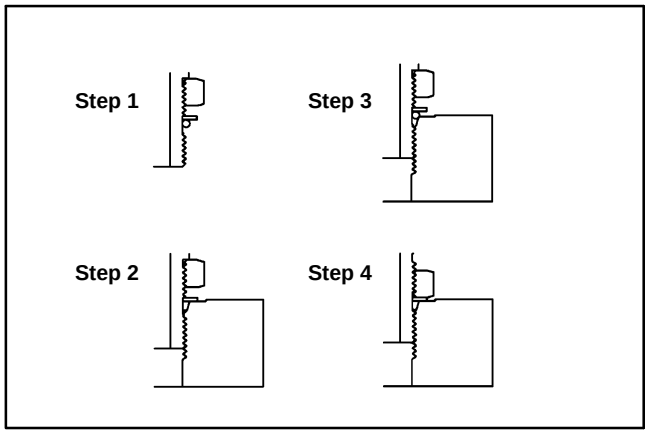

Figure 8

Hydraulic Schematics

The hydraulic schematics for Groundsmaster 360 machines are located in Chapter 9 − Foldout Drawings.

Hydraulic Flow Diagrams

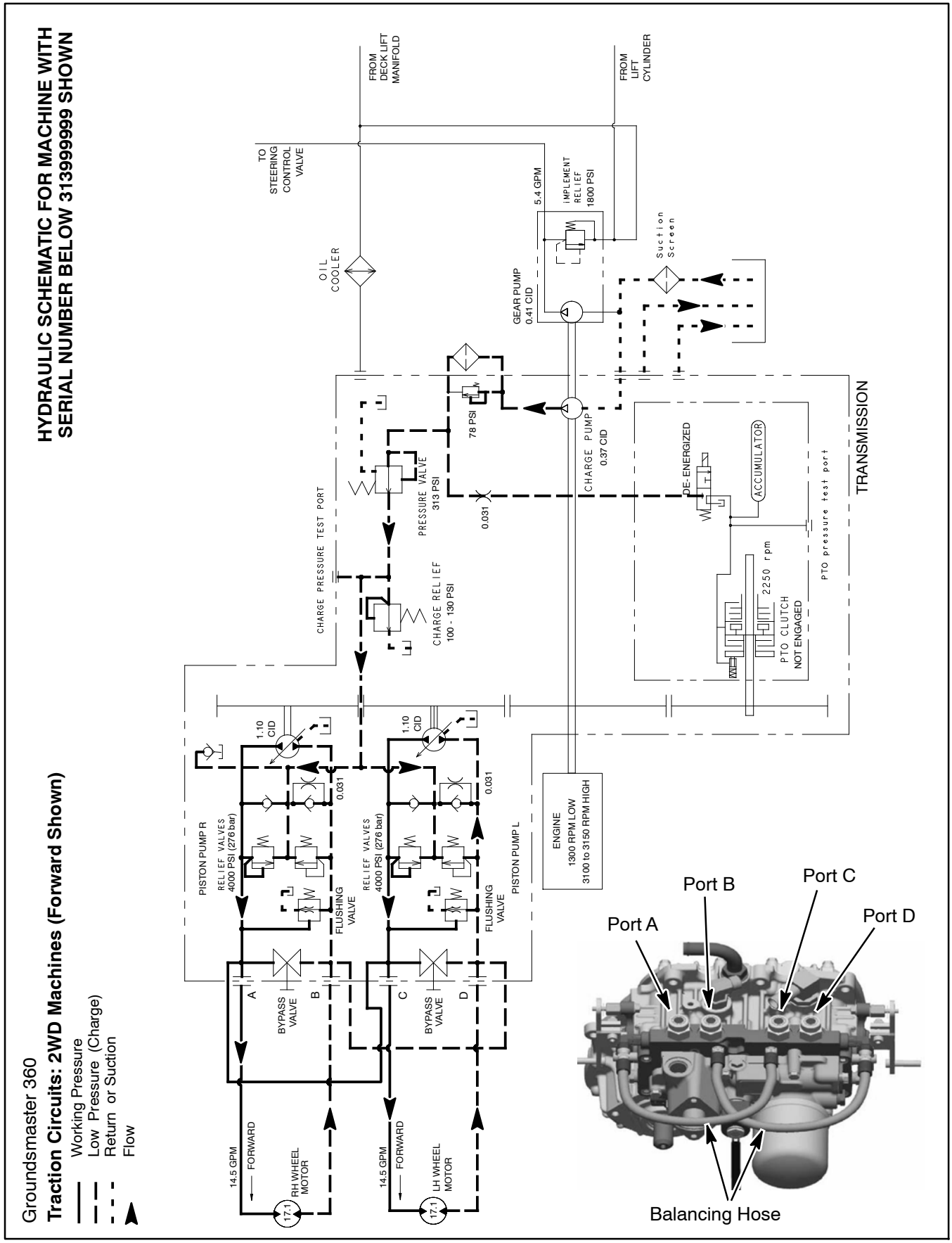

Figure 9

Traction Circuits: 2WD Machines

The traction system for Groundsmaster 360 machines with 2WD consists of a transmission that is directly coupled to, and driven by, the engine flywheel. The transmission provides two identical and independent closed loop traction circuits: one for the right wheel motor and one for the left wheel motor. Each of these transmission circuits include a variable displacement, slipper foot design piston pump which provides hydraulic flow for the wheel motor on one side of the machine. The swash plate in each of the piston pumps is controlled by the operator traction pedal through a linkage system.

The angle of the pump swash plates determines pump flow and ultimately traction speed. When the traction pedal is moved a small amount, a small swash plate rotation results in low pump output and lower traction speed. When the traction pedal is moved fully, the pump swash plates rotate fully to provide maximum pump output flow and traction speed.

With the engine running and the traction pedal in the neutral position, the piston pump swash plates are held in the vertical position, providing no flow to either of the wheel motors so the machine remains stationary. The transmission reverse check valves include an orifice to make it easier to locate the neutral position.

Forward

When the traction pedal is pushed forward, the linkage connected to the traction pedal positions the swash plates in both piston pumps to provide oil flow from the transmission (port A for the RH side and port C for the LH side). This oil flows from the pumps to the wheel motors and turns the motors in the forward direction. Oil flow from the wheel motors returns to the transmission (port B for the RH side and port D for the LH side) and is continuously pumped as long as the traction pedal is pushed forward. A pair of hydraulic hoses connect the pressure and return sides of the two traction circuits to prevent unequal pressures in the circuits especially when turning.

As the traction load increases, forward traction circuit pressure can increase to the relief valve setting of 4000 PSI (276 bar). If pressure exceeds the relief setting, oil flows through the transmission forward relief valve to the low pressure side of the closed loop traction circuit.

The piston pumps use a small amount of hydraulic fluid for internal lubrication. Fluid is designed to leak across pump parts into the transmission case drain. This leakage results in the loss of hydraulic fluid from the closed loop traction circuits that must be replenished.

A charge pump in the transmission supplies hydraulic flow for maintaining 100 to 130 PSI (6.9 to 8.9 bar) to the low pressure side of both of the traction circuits. The charge pump also provides pressure for the transmission PTO drive system. The charge pump replenishes the closed loop traction circuits with fluid from the hydraulic tank. The charge relief valve in the transmission maintains sufficient pressure so that charge pump flow is guided past check valves to the low pressure side of each traction circuit. Charge pump flow in excess of system requirements is relieved through the charge relief valve back to the hydraulic tank.

Both of the transmission traction circuits include a flushing valve that bleeds off a small amount of hydraulic fluid for cooling of the closed loop traction circuits. The flushing valves are opened only during forward direction operation. When the flushing valves are unseated, a small amount of oil from the low pressure side of the traction loop is returned to the hydraulic tank. Oil loss from the closed loop due to the flushing valve is replenished by the charge pump.

Groundsmaster 360 machines with serial numbers below 314999999 are equipped with Automatic Speed Control (ASC) which modulates ground speed when turning the machine. This modulation maintains speed control and also minimizes possible turf and machine damage. The traction pedal linkage is designed to limit traction pedal movement when the machine is turning.

Reverse

The traction circuit operates essentially the same in reverse as it does in forward.

When the traction pedal is pushed for reverse, the linkage connected to the pedal positions the swash plates in both transmission piston pumps to provide oil flow from the transmission (port B for the RH side and port D for the LH side). This oil flows to the wheel motors and turns the motors in the reverse direction. Oil flow from the wheel motors returns to the transmission (port A for the RH side and port C for the LH side) and is continuously pumped as long as the traction pedal is pushed for reverse.

As the traction load increases, reverse traction circuit pressure can increase to the relief valve setting of 4000 PSI (276 bar). If pressure exceeds the relief setting, oil flows through the transmission reverse relief valve to the low pressure side of the closed loop traction circuit.

The charge circuit functions the same in reverse as it does in the forward direction. The check valve placed in the reverse side of the traction circuit includes an orifice which allows the traction neutral position to be easier to adjust. The transmission flushing valves remain seated during reverse operation.

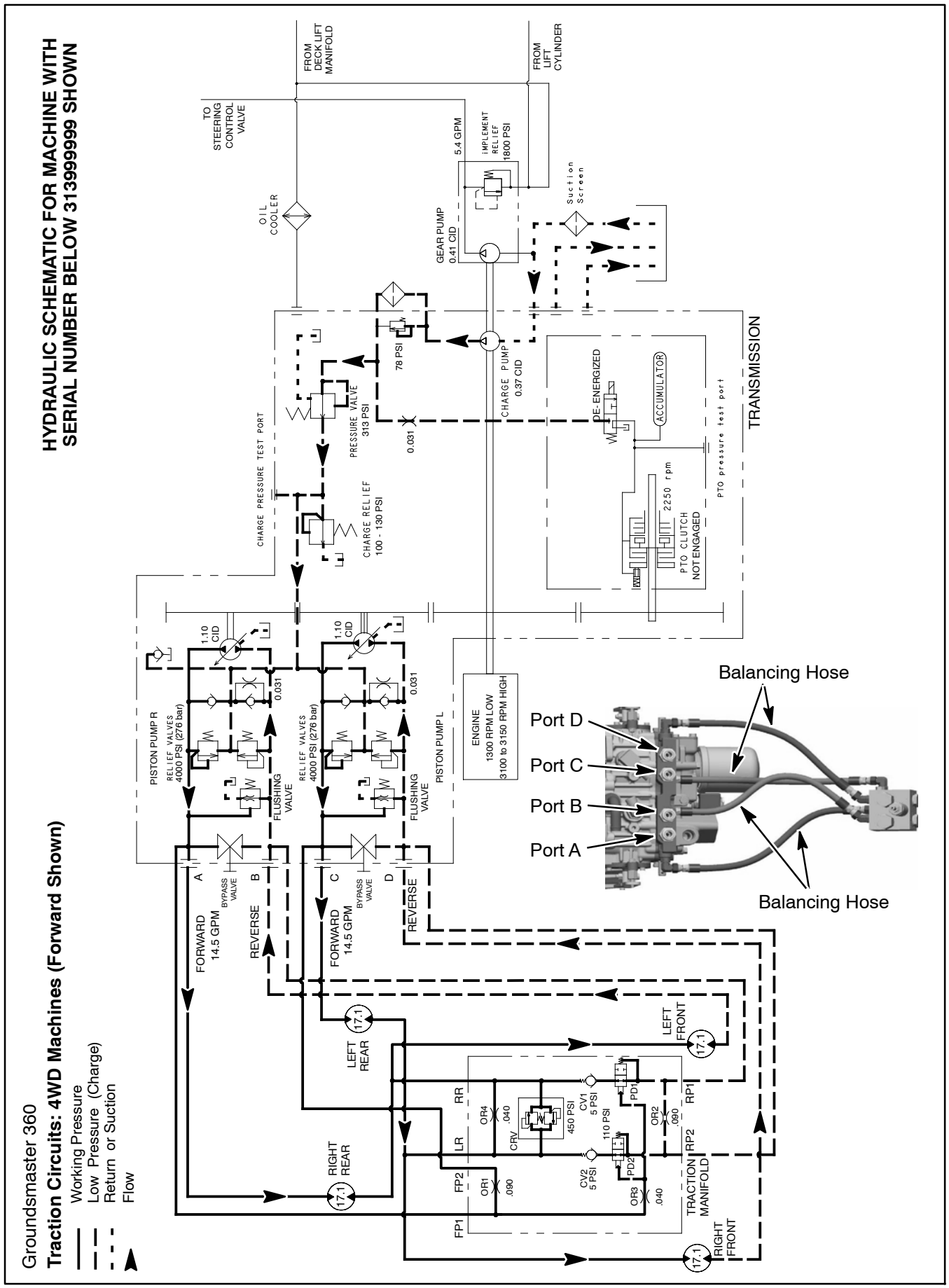
HYDRAULIC SCHEMATIC FOR MACHINE WITH SERIAL NUMBER BELOW 313999999 SHOWN
Groundsmaster 360
Traction Circuits: 4WD Machines (Forward Shown)
Working Pressure
Low Pressure (Charge)
Return or Suction
Flow
FROM DECK LIFT MANIFOLD
FROM LIFT CYLINDER
TO STEERING CONTROL VALVE
OIL COOLER
5.4 GPM
IMPLEMENT RELIEF 1800 PSI
Suction Screen
GEAR PUMP 0.41 CID
78 PSI
PRESSURE VALVE 313 PSI
0.031
CHARGE PUMP 0.37 CID
DE-ENERGIZED
ACCUMULATOR
TRANSMISSION
CHARGE PRESSURE TEST PORT
CHARGE RELIEF 100 - 130 PSI
2250 rpm
PTO CLUTCH NOT ENGAGED
PTO pressure test port
1.10 CID
PISTON PUMP R
RELIEF VALVES 4000 PSI (276 bar)
FLUSHING VALVE
PISTON PUMP L
ENGINE 1300 RPM LOW 3100 to 3150 RPM HIGH
Balancing Hose
Port D
Port C
Port B
Port A
Balancing Hose
FORWARD 14.5 GPM
REVERSE
BYPASS VALVE
A
B
C
D
LEFT REAR
LEFT FRONT
RIGHT REAR
RIGHT FRONT
17.1
RR
LR
FP2
FP1
OR4 .040
CRV
450 PSI
CV1 5 PSI
CV2 5 PSI
110 PSI
PD1
PD2
OR1 .090
OR2 .090
OR3 .040
RP1
RP2
TRACTION MANIFOLD

Figure 10

Traction Circuits: 4WD Machines

The traction system on 4WD machines allows hydraulic drive to all four wheels. Traction components include a transmission with two independent closed loop circuits, two rear wheel motors, two front wheel motors and the CrossTrax™ AWD control manifold. The transmission and rear wheel motors used on 4WD machines are the same as the hydraulic components used on 2WD machines. The traction circuit on 4WD machines, therefore, operates basically the same as the traction circuit on 2WD machines with the added benefit of the additional front wheel motors. Refer to Traction Circuit: 2WD Machines in this section for information on traction system operation.

NOTE: On Groundsmaster 360 4WD machines with serial numbers below 314999999, the Automatic Speed Control (ASC) system is only active when the machine is in the 4 wheel steering position.

Forward

For each of the transmission piston pumps, flow for the forward direction is routed to a rear wheel motor and then to the opposite front wheel motor (e.g. right rear and then to left front) to maximize traction. Forward traction circuit relief valve setting of 4000 PSI (276 bar) is the same as 2WD machines.

When operating the machine in a forward, straight direction (not turning), transmission oil flow to the two traction circuits routes from a rear wheel motor to the opposite front wheel motor. Both traction circuits require similar flow to drive the wheel motors so minimal circuit flow change is provided through the CrossTrax AWD control manifold and balancing oil lines.

When turning the machine in a forward direction, the four wheel motors require different flows due to different wheel distances traveled going around the corner. The balancing lines and the CrossTrax AWD control manifold allow the two traction circuits to be connected so differences in wheel motor flows can be achieved. In the forward direction, pilot directional valves PD1 and PD2 in the CrossTrax AWD control manifold are shifted. These shifted valves along with the manifold check valves (CV1 and CV2) help to provide oil where needed in the traction circuits for optimal traction operation when turning.

The control manifold includes a bi−directional relief valve (CRV) and orifice fittings to prevent pressure differences in the two circuits reducing tire scuffing when turning.

To provide 4−wheel dynamic braking when the traction pedal is released, pilot directional valves PD1 and PD2 in the CrossTrax AWD control manifold shift to their normally closed position. This disables the manifold check valves (CV1 and CV2) ensuring 4−wheel hydrostatic braking.

Reverse

The 4WD traction circuit operates essentially the same in reverse as it does in forward. In the reverse direction, transmission pump flow to the two traction circuits is routed first to a front wheel motor and then to the opposite rear wheel motor (e.g. right front and then to left rear). The reverse traction circuit relief valve setting is 4000 PSI (276 bar).

In the reverse direction, pilot directional valves PD1 and PD2 in the CrossTrax AWD control manifold are not shifted. This disables the manifold check valves (CV1 and CV2) ensuring optimal 4WD traction while in reverse.

Because vehicle speed in the reverse direction is typically reduced, there is less hydraulic flow through the traction circuit. This lower flow results in less circuit flow change necessary through the CrossTrax AWD control manifold and balancing oil lines.

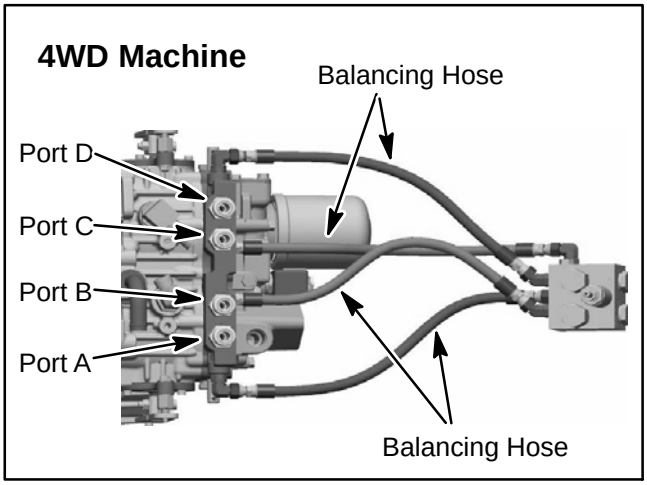

Figure 11

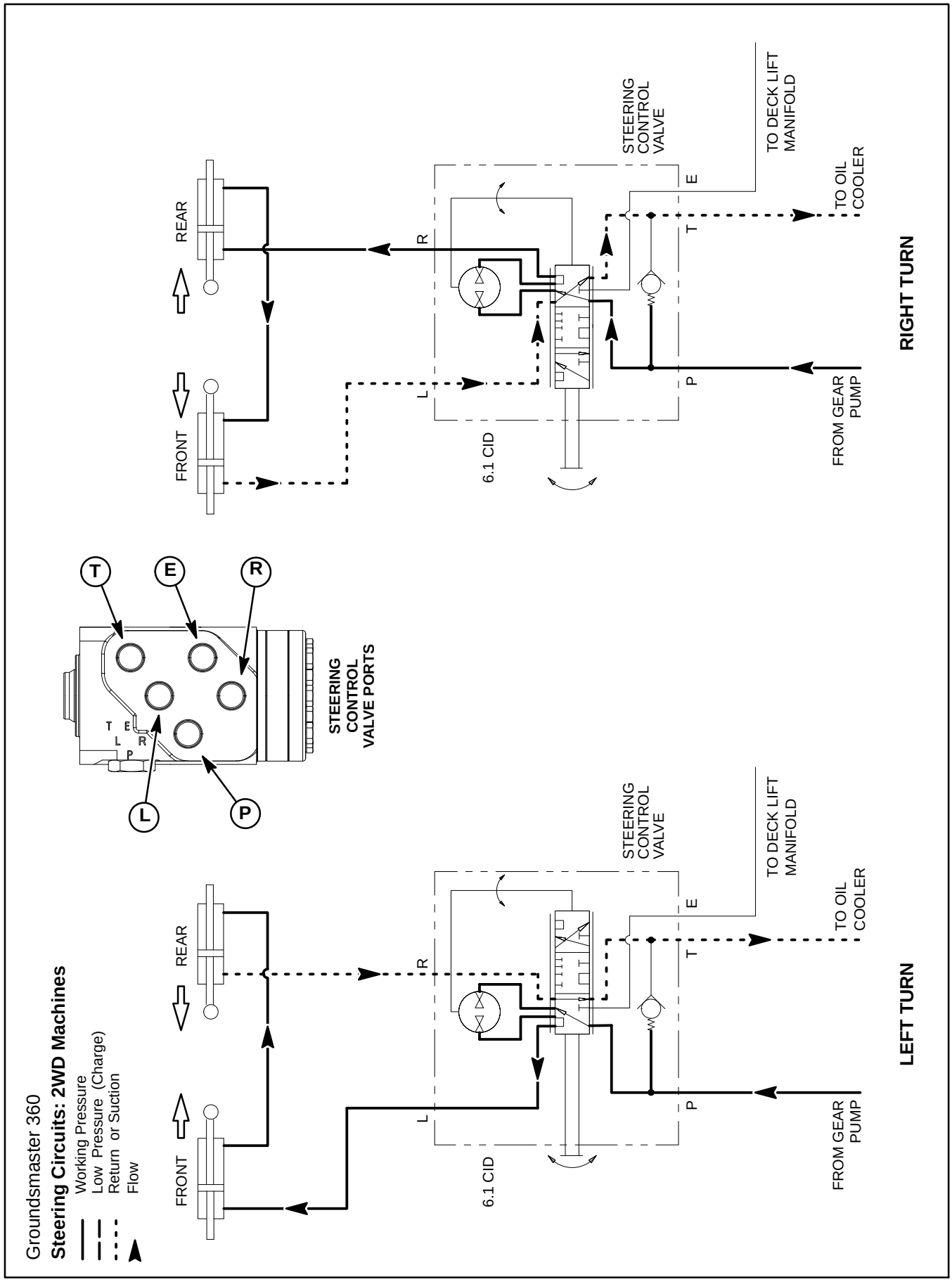
Groundsmaster 360
Steering Circuits: 2WD Machines
Working Pressure
Low Pressure (Charge)
Return or Suction
Flow
REAR
FRONT
R
L
6.1 CID
STEERING CONTROL VALVE
E
T
P
TO DECK LIFT MANIFOLD
TO OIL COOLER
FROM GEAR PUMP
RIGHT TURN
LEFT TURN
T
E
R
L
P
STEERING CONTROL VALVE PORTS

Figure 12

Steering Circuits: 2WD Machines

The Groundsmaster 360 Quad Steer™ all wheel steering system uses Ackermann four wheel steering. Ackermann steering enables the inside and outside wheels to turn around a common pivot point. This results in reduced turf damage and greater operator response when turning.

A single section gear pump is directly coupled to the transmission which is driven by the engine. This gear pump supplies hydraulic flow for both the steering and lift/lower circuits. Hydraulic pump flow from the gear pump is routed to the steering control valve first so the steering circuit has priority. The pump takes its suction from the hydraulic tank. Steering circuit pressure is limited to 1800 PSI (125 bar) by a relief valve located in the gear pump. Two (2) steering cylinders are used to provide four wheel steering: one cylinder turns the front wheels and the second cylinder turns the rear wheels.

The steering control valve includes a check valve that allows steering operation when the engine is not running. Steering wheel rotation with the engine off causes oil flow from the steering control gerotor. The check valve opens in this situation to allow oil flow from the steering control to the steering cylinder in a closed loop.

To allow for synchronization of the front and rear steering cylinders, both steering cylinders include an internal re−phasing check valve assembly in the cylinder piston (Fig. 13). While rotating the steering wheel for a turn when in 4 wheel steer (either right or left), the cylinder check valve will open once the cylinder is fully extended or retracted. Once both cylinders have moved fully, the 4 wheel steering system has been synchronized. If the steering wheel continues to be turned, the check valves will stay open and will allow flow through the circuit.

With the steering wheel in the neutral position and the engine running, gear pump flow enters the steering control valve at the P port and goes through the steering control spool valve, bypassing the rotary meter and steering cylinders. Flow leaves the control valve through the E port and is routed to the lift/lower circuit, oil cooler and transmission case. The transmission case drain allows oil to return to the hydraulic tank.

Left Turn (Fig. 12)

When a left turn is made with the engine running, the turning of the steering wheel positions the steering control spool valve so that gear pump flow is directed through the top of the spool. Flow entering the steering control valve at the P port goes through the spool, is routed through rotary meter and out the control valve L port. This flow moves to the front steering cylinder to extend the cylinder and turn the front wheels in the direction for a left turn. The oil displaced from the extending front cylinder is directed to the rear steering cylinder to extend that cylinder and turn the rear wheels in the direction for a left turn. The rotary meter ensures that the oil flow to the steering cylinders is proportional to the amount of turning on the steering wheel. Fluid leaving the rear steering cylinder flows back through the steering control spool valve and then out of the steering control valve through the T port and is routed to the oil cooler and transmission case.

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

Right Turn (Fig. 12)

When a right turn is made with the engine running, the turning of the steering wheel positions the steering control spool valve so that gear pump flow is directed through the bottom of the spool. Flow entering the steering control valve at the P port goes through the spool, is routed through rotary meter and out the control valve R port. This flow moves to the rear steering cylinder to retract the cylinder and turn the rear wheels in the direction for a right turn. The oil displaced from the retracting rear cylinder is directed to the front steering cylinder to retract that cylinder and turn the front wheels in the direction for a right turn. The rotary meter ensures that the oil flow to the steering cylinders is proportional to the amount of turning on the steering wheel. Fluid leaving the front steering cylinder flows back through the steering control spool valve and then out of the steering control valve through the T port and is routed to the oil cooler and transmission case.

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

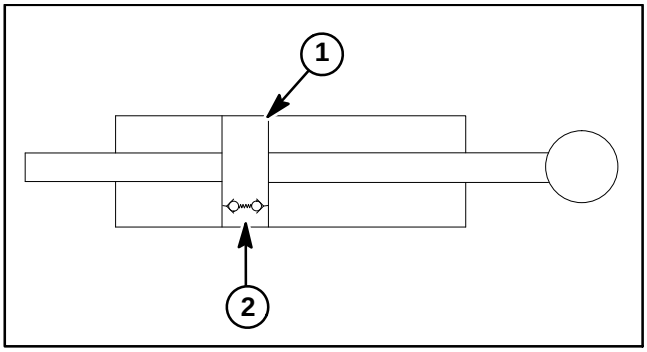

Figure 13

1. Cylinder piston
2. Check valve assembly

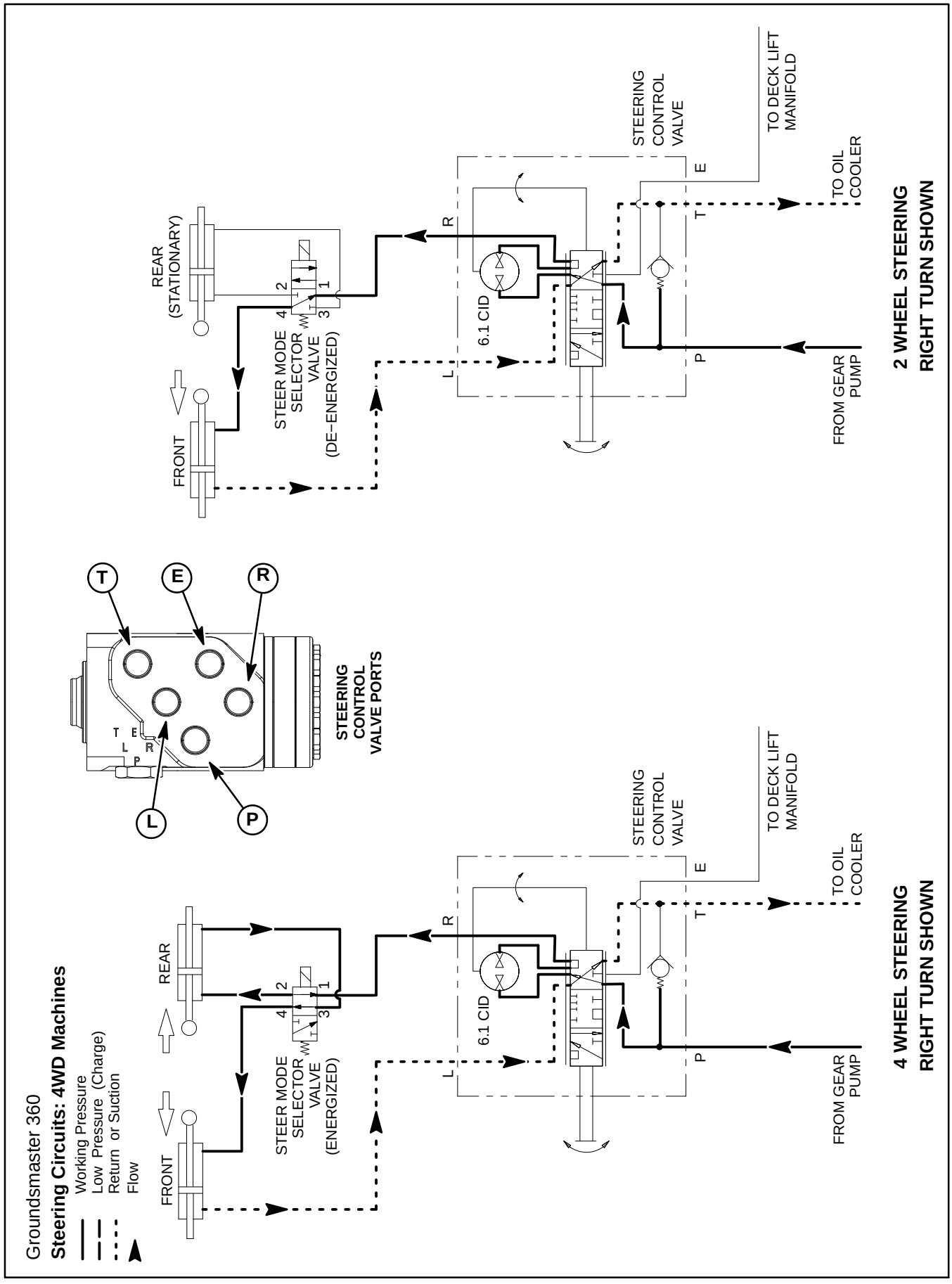
Groundsmaster 360
Steering Circuits: 4WD Machines
Working Pressure
Low Pressure (Charge)
Return or Suction
Flow
4 WHEEL STEERING
RIGHT TURN SHOWN
2 WHEEL STEERING
RIGHT TURN SHOWN
FRONT
REAR
STEER MODE SELECTOR VALVE (ENERGIZED)
STEER MODE SELECTOR VALVE (DE−ENERGIZED)
REAR (STATIONARY)
6.1 CID
STEERING CONTROL VALVE
TO DECK LIFT MANIFOLD
TO OIL COOLER
FROM GEAR PUMP
T
E
R
L
P
STEERING CONTROL VALVE PORTS

Figure 14

Steering Circuit: 4WD Machines

The gear pump, steering control valve and steering cylinders used on 4WD machines are the same as the hydraulic components used on 2WD machines. The steering circuit on 4WD machines, therefore, operates basically the same as the steering circuit on 2WD machines. Refer to Steering Circuit: 2WD Machines in this section for information on steering system operation.

4WD machines include the feature of allowing the operator to choose between 2 or 4 wheel steering. The steering selector switch on the control panel is used to control the hydraulic steering system for this feature.

2 Wheel Steering (Fig. 14)

When the front of the steering selector switch is depressed with the wheels directed straight ahead, steering will only be active on the front wheels. This position is recommended for transporting the machine. The switch indicator light will be illuminated when the machine is in 2 wheel steering operation.

In this switch position, the steering control manifold solenoid valve is not energized. Flow from the steering control valve in either steering direction is directed only to the front steering cylinder. The rear steering cylinder remains in the centered, straight ahead position.

4 Wheel Steering (Fig. 14)

When the rear of the steering selector switch is depressed with the wheels directed straight ahead, 4 wheel steering will be active. The switch indicator light will not be illuminated when 4 wheel steering is active.

In this switch position, the steering control manifold solenoid valve is energized. Flow from the steering control valve in either steering direction is directed to both the front and rear steering cylinders.

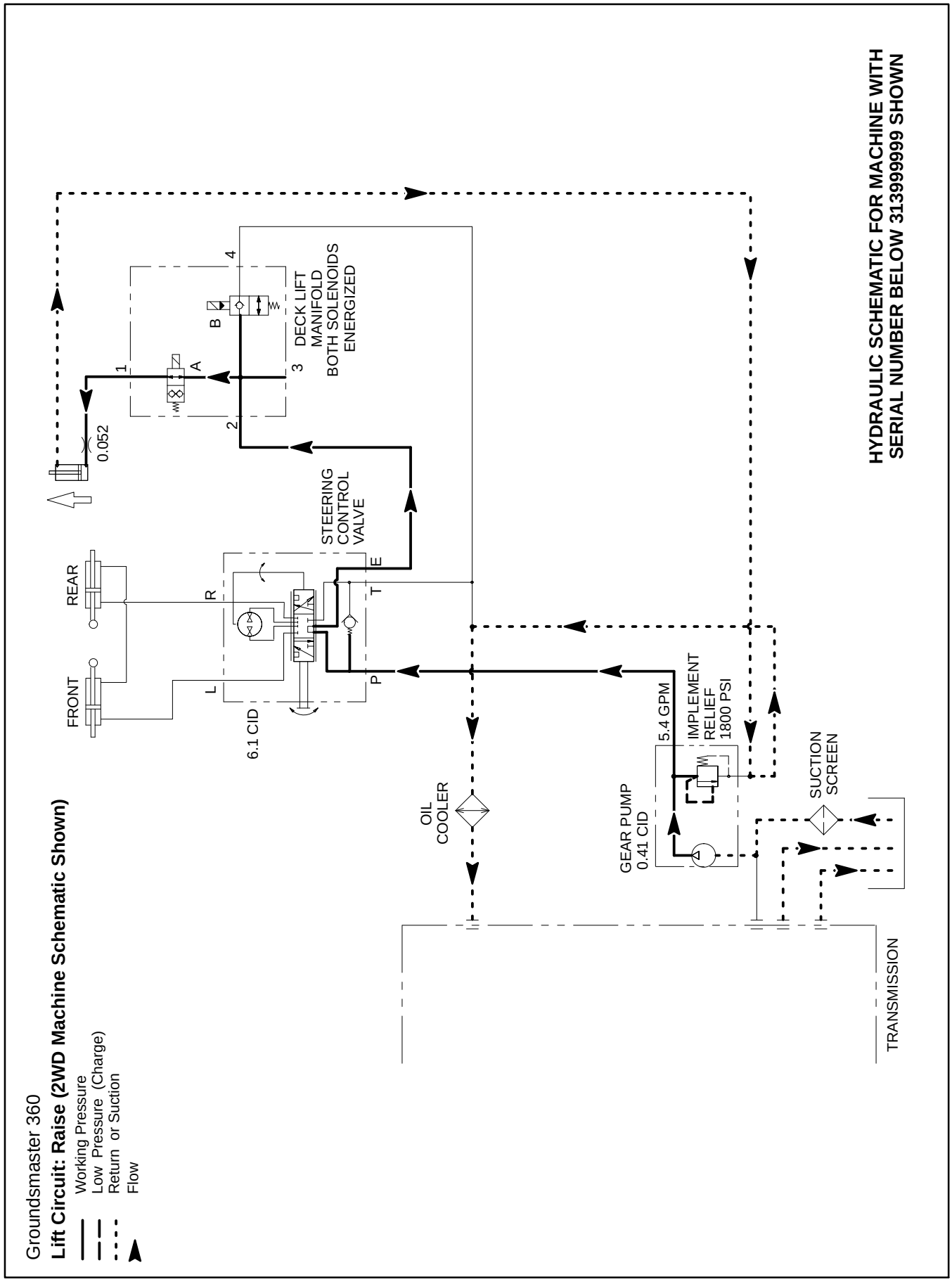
HYDRAULIC SCHEMATIC FOR MACHINE WITH SERIAL NUMBER BELOW 313999999 SHOWN
Groundsmaster 360
Lift Circuit: Raise (2WD Machine Schematic Shown)
Working Pressure
Low Pressure (Charge)
Return or Suction
Flow
DECK LIFT MANIFOLD BOTH SOLENOIDS ENERGIZED
STEERING CONTROL VALVE
0.052
REAR
FRONT
6.1 CID
OIL COOLER
GEAR PUMP 0.41 CID
5.4 GPM
IMPLEMENT RELIEF 1800 PSI
SUCTION SCREEN
TRANSMISSION

Figure 15

Lift Circuit: Raise

A single section gear pump is directly coupled to the transmission which is driven by the engine. This gear pump supplies hydraulic flow for both the steering and lift/lower circuits. Gear pump flow is routed to the steering control valve first so the steering circuit has priority. The pump takes its suction from the hydraulic tank.

When the deck lift switch is in its neutral state, flow from the gear pump bypasses the lift cylinder and is routed through the deck lift manifold directly to the oil cooler and then to the transmission. The transmission case drain allows oil to return to the hydraulic tank.

NOTE: If the deck lift switch is pressed to the RAISE position while the steering wheel is being turned, lift speed will be reduced.

NOTE: The engine must be running to allow the cutting deck to be raised. When the rear of the lift switch is depressed and held, the deck will raise. If the switch is released when raising the deck, the deck will stop raising and remain in position.

When the deck lift switch is pressed to the RAISE position and held, both solenoid valves (A and B) in the deck lift manifold are energized to cause the valves to shift. Energized solenoid valve B prevents gear pump flow from bypassing the lift cylinder. Energized solenoid valve A allows hydraulic flow from the gear pump to the barrel end of the lift cylinder. The lift cylinder extends, causing the cutting deck to raise. The fluid displaced from the rod end of the lift cylinder is routed to the oil cooler, transmission and then to the hydraulic tank.

NOTE: On machine with serial number below 313999999, an orifice fitting at the barrel end of the lift cylinder controls the extending speed of the lift cylinder while raising the cutting deck.

Load on the lift cylinder causes lift circuit pressure to increase. If lift circuit pressure reaches 1800 PSI (125 bar), the relief valve in the gear pump shifts to allow pump flow to return to the hydraulic tank.

When the deck lift switch is released from RAISE, both solenoid valves (A and B) in the deck lift manifold are de−energized. De−energized solenoid valve B allows gear pump flow to bypass the lift cylinder, returning to the oil cooler, transmission and then to the hydraulic tank. De−energized solenoid valve A prevents hydraulic flow to and from the lift cylinder to keep the cutting deck in the raised position.

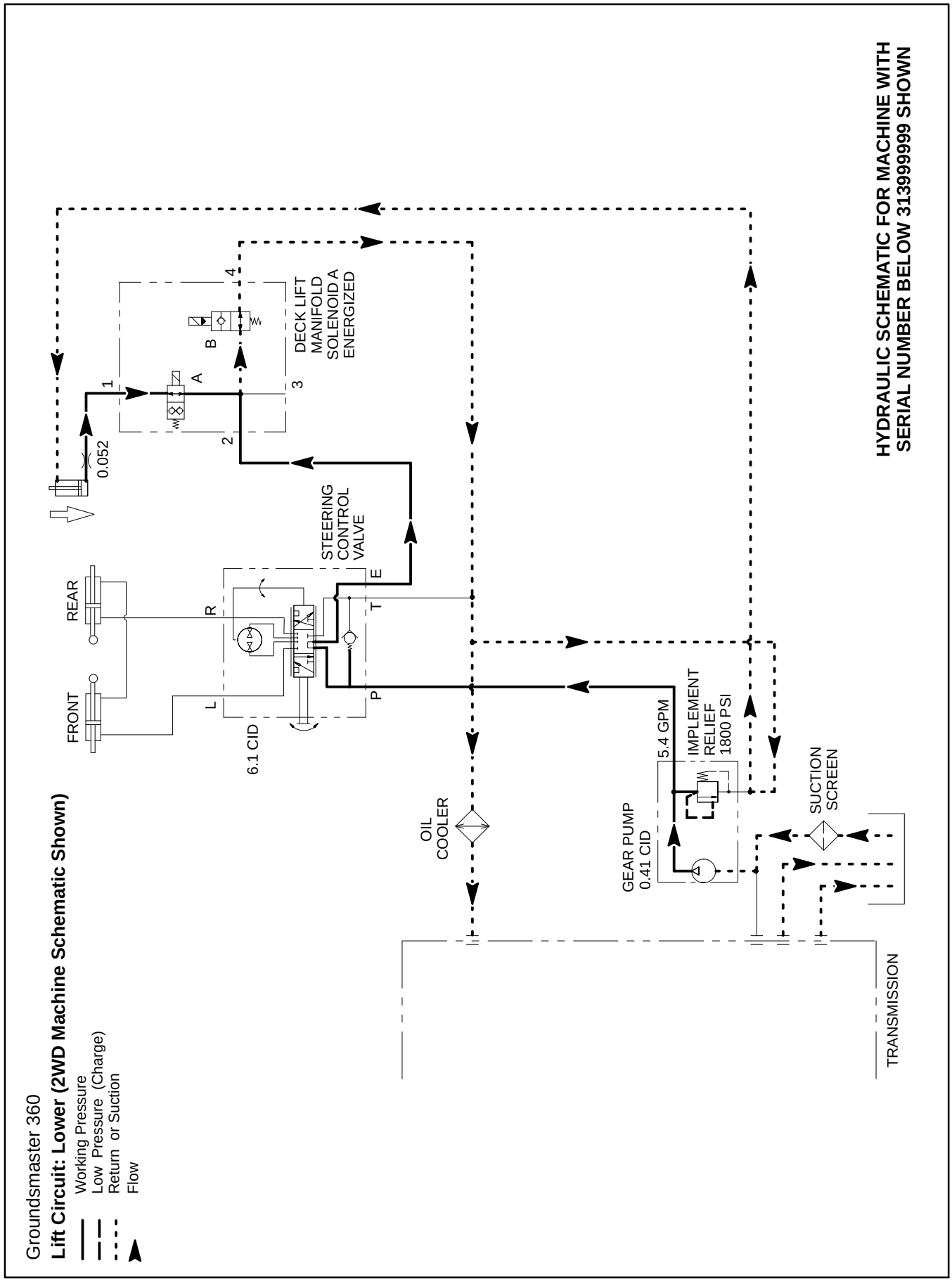
HYDRAULIC SCHEMATIC FOR MACHINE WITH SERIAL NUMBER BELOW 313999999 SHOWN
Groundsmaster 360
Lift Circuit: Lower (2WD Machine Schematic Shown)
Working Pressure
Low Pressure (Charge)
Return or Suction
Flow
DECK LIFT MANIFOLD SOLENOID A ENERGIZED
STEERING CONTROL VALVE
0.052
REAR
FRONT
6.1 CID
OIL COOLER
GEAR PUMP 0.41 CID
5.4 GPM
IMPLEMENT RELIEF 1800 PSI
SUCTION SCREEN
TRANSMISSION

Figure 16

Lift Circuit: Lower

A single section gear pump is directly coupled to the transmission which is driven by the engine. This gear pump supplies hydraulic flow for both the steering and lift/lower circuits. Gear pump flow is routed to the steering control valve first so the steering circuit has priority. The pump takes its suction from the hydraulic tank.

When the deck lift switch is in its neutral state, flow from the gear pump bypasses the lift cylinder and is routed through the deck lift manifold directly to the oil cooler and then to the transmission. The transmission case drain allows oil to return to the hydraulic tank.

NOTE: The engine must be running to allow the cutting deck to be lowered. When the front of the deck lift switch is depressed, the deck will lower fully and enter the float position. The switch on 4WD machines has momentary contacts in the lower position so the switch returns to the center position after being pressed to lower the cutting deck. The switch on 2WD machines remains in position when pressed to lower.

When the deck lift switch is pressed to the LOWER position, solenoid valve A in the deck lift manifold is energized to cause the valve to shift. Energized solenoid valve A allows a path for oil flow from the barrel end of the lift cylinder. The weight of the cutting deck causes the lift cylinder to retract, allowing the cutting deck to lower to the ground.

NOTE: On machine with serial number below 313999999, an orifice fitting at the barrel end of the lift cylinder controls the retracting speed of the lift cylinder while lowering the cutting deck.

Cutting Deck Float

Cutting deck float allows the fully lowered cutting deck to follow ground surface contours. On Groundsmaster 360 machines, deck lift manifold solenoid valve A stays energized for deck float when the deck is fully lowered. This energized solenoid provides an oil passage to and from the lift cylinder to allow cylinder and cutting deck movement while mowing.

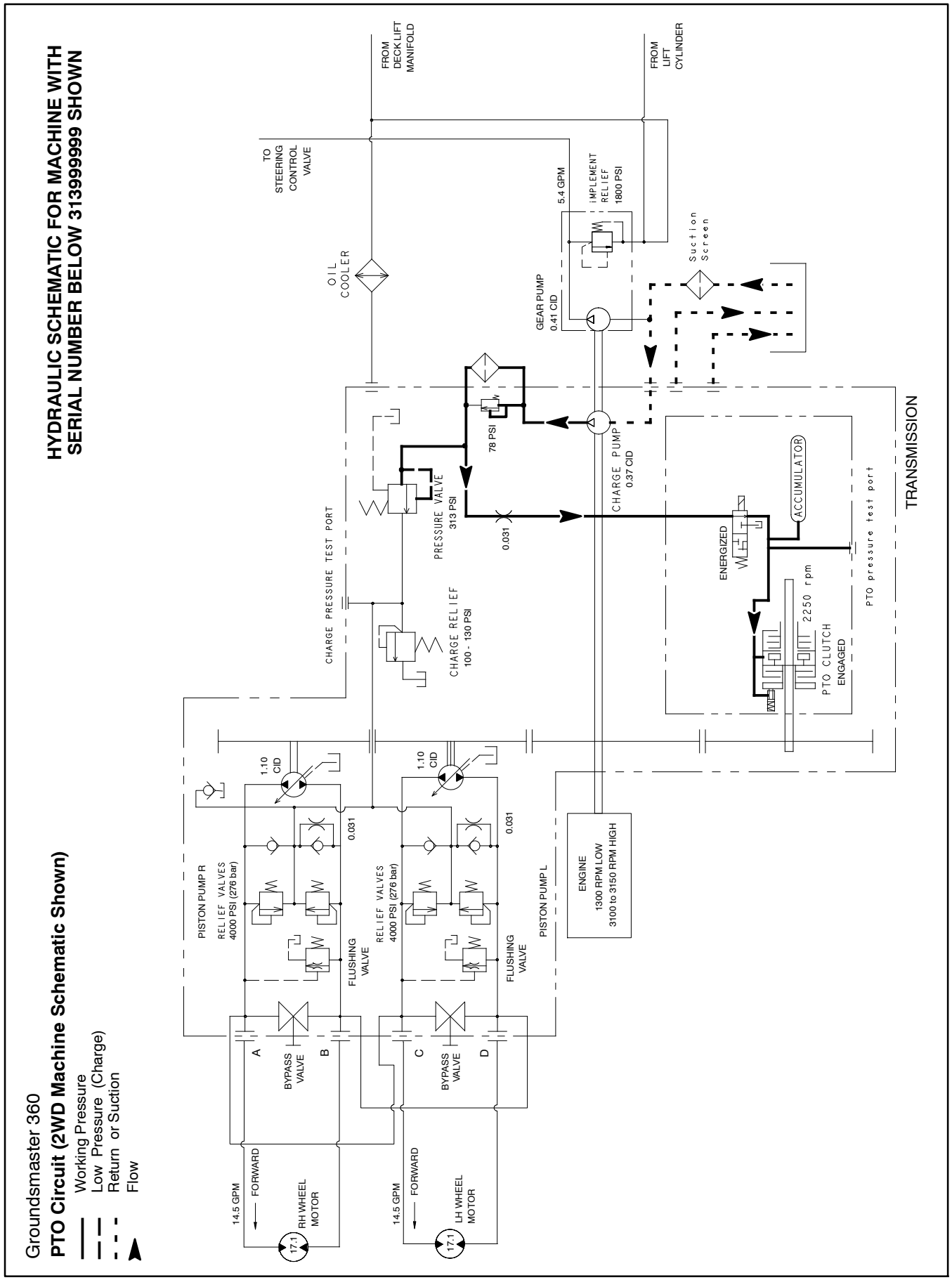
HYDRAULIC SCHEMATIC FOR MACHINE WITH SERIAL NUMBER BELOW 313999999 SHOWN
Groundsmaster 360
PTO Circuit (2WD Machine Schematic Shown)
Working Pressure
Low Pressure (Charge)
Return or Suction
Flow
FROM DECK LIFT MANIFOLD
FROM LIFT CYLINDER
TO STEERING CONTROL VALVE
OIL COOLER
5.4 GPM
IMPLEMENT RELIEF 1800 PSI
Suction Screen
GEAR PUMP 0.41 CID
78 PSI
CHARGE PUMP 0.37 CID
PRESSURE VALVE 313 PSI
0.031
CHARGE PRESSURE TEST PORT
CHARGE RELIEF 100 - 130 PSI
ACCUMULATOR
ENERGIZED
PTO pressure test port
2250 rpm
PTO CLUTCH ENGAGED
TRANSMISSION
1.10 CID
PISTON PUMP R
RELIEF VALVES 4000 PSI (276 bar)
FLUSHING VALVE
PISTON PUMP L
ENGINE 1300 RPM LOW 3100 to 3150 RPM HIGH
A
B
C
D
BYPASS VALVE
14.5 GPM
FORWARD
RH WHEEL MOTOR
LH WHEEL MOTOR
17.1

Figure 17

PTO Circuit

The transmission used on Groundsmaster 360 machines includes a hydraulic, multi−plate clutch that is used to engage the PTO. Hydraulic flow for PTO clutch engagement is provided by the transmission charge pump.

When the PTO switch is turned on (pulled up), the transmission solenoid valve is energized to allow hydraulic flow to engage the PTO clutch. As the PTO clutch engages, an integral PTO brake is simultaneously released to allow rotation of the drive shaft and cutting deck. An orifice and accumulator in the transmission prevent abrupt engagement of the PTO.

Pressure to the PTO clutch is limited by the pressure valve in the transmission. Pressure valve setting is from 280 to 340 PSI (19.3 to 23.4 bar).

When the PTO switch is turned off (pushed down), the transmission solenoid valve is de−energized and the PTO clutch is disengaged. The integral PTO brake is applied to control the stopping rate of the drive shaft and cutting deck.

Special Tools

Order special tools from your Toro Distributor.

Hydraulic Pressure Test Kit

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

Toro Part Number: **TOR47009**

Figure 18

15 GPM Hydraulic Tester Kit (Pressure and Flow)

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

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

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

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

4. FLOW METER: This meter measures actual oil flow in the operating circuit with a gauge rated from 1 to 15 GPM (5 to 55 LPM).

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

6. FITTINGS: An assortment of hydraulic fittings are included with this kit.

Toro Part Number: **TOR214678**

Figure 19

40 GPM Hydraulic Tester (Pressure and Flow)

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

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

2. PRESSURE GAUGE: Glycerine filled 0 to 5000 PSI gauge to provide operating circuit pressure.

3. FLOW METER: This meter measures actual oil flow in the operating circuit with a gauge rated from 4 to 40 GPM (20 to 150 LPM).

Toro Part Number: **AT40002**

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

Figure 20

Hydraulic Hose Kit

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

Toro Part Number: **TOR6007**

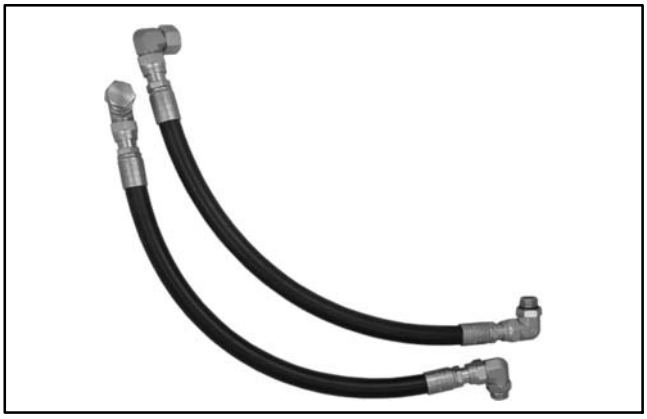

Figure 21

O−ring Kit

This kit includes O−rings in a variety of sizes for face seal and port seal hydraulic connections. As a preventative measure against leakage, it is recommended that an O−ring be replaced any time a hydraulic connection is opened.

Toro Part Number: **117−2727**

Figure 22

High Flow Hydraulic Filter Kit

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

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

Toro Part Number: **TOR6011**

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

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

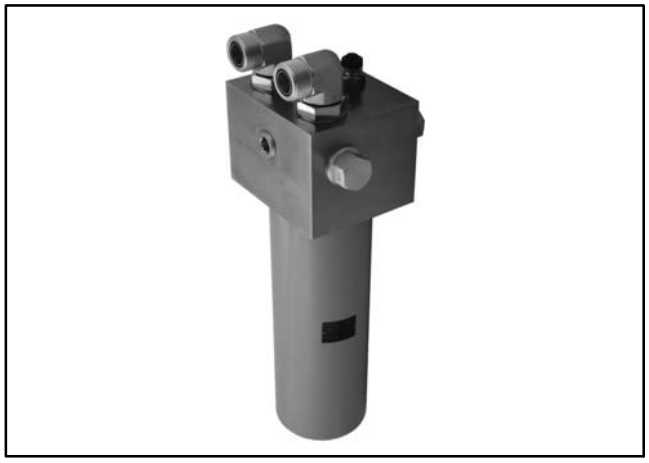

Figure 23

Hydraulic Test Fitting Kit

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

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

Toro Part Number: **TOR4079**

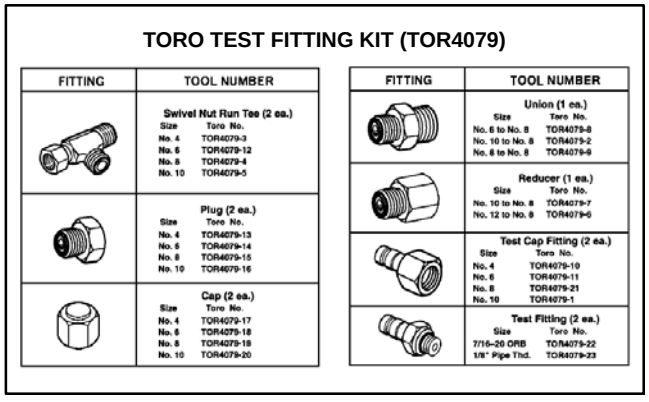

Figure 24

Wheel Hub Puller

The wheel hub puller allows safe removal of the wheel hub from the wheel motor shaft.

Toro Part Number: **TOR6004**

Figure 25

Troubleshooting

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

Review the hydraulic schematic included in Chapter 9 − Foldout Drawings and information on hydraulic system operation in the Hydraulic Flow Diagrams section of this Chapter. This information will be useful during the hydraulic troubleshooting process.

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

General Hydraulic System Problems

Problem	Possible Causes
Hydraulic oil leaks from system.	Fitting(s), hose(s) or tube(s) are loose or damaged. O−ring(s) or seal(s) are missing or damaged.
Hydraulic fluid foams excessively causing oil leakage from hydraulic tank breather. **NOTE:** Some aeration of hydraulic oil on this machine is normal. This aeration (foaming) may be more noticeable after initial filling of hydraulic tank.	Oil level in hydraulic tank is low. Hydraulic system has wrong type of oil. One of the pump suction lines has an air leak. Incompatible hydraulic oils mixed in system. Water in hydraulic system.
Hydraulic system operates hot.	Transmission pressure is high due to load or dragging brakes. Oil cooler air flow is obstructed. Oil level in hydraulic tank is low or inlet filter is loose or clogged. Oil is contaminated or oil viscosity is too light. Oil cooler is damaged or plugged. Transmission bypass valve(s) is open or defective. Gear pump relief valve is stuck open. Deck lift switch is held in the raise position for too long causing hydraulic oil to be at relief pressures. An electrical problem could exist with deck lift switch or circuit wiring that could cause excessive hydraulic temperatures. Transmission check valve is not seating or is damaged. Charge pressure is low. Transmission or wheel motor(s) is worn or damaged. **NOTE:** If one traction circuit component has internal wear or damage, it is possible that other traction components are also damaged.

Traction Circuit Problems

Problem	Possible Causes
Traction response is sluggish.	Transmission bypass valve(s) is open or defective. Brake is dragging or binding. Hydraulic oil is very cold. Transmission check valve, relief valve and/or flushing valve is leaking. Charge pressure is low. Transmission or wheel motor(s) is worn or damaged. Make sure hydraulic hoses between pump and 4WD manifold are connected to the correct ports (4WD machines only) **NOTE:** If one traction circuit component has internal wear or damage, it is possible that other traction components are also damaged.
Neutral is difficult to find.	External control linkage is misadjusted, disconnected, binding or damaged. Make sure neutral devise tension springs are fully tensioned. Make sure the two (2) traction pedal isolator mounts are not worn or damaged. Orifice in transmission check valve(s) is plugged. This orifice is included in the reverse relief cartridge and is not serviceable separately. Transmission is worn or damaged.
No traction exists in either direction and engine speed remains constant.	Oil level in hydraulic tank is low. Transmission bypass valves are both open. Charge pressure is low. Engine flywheel coupling is damaged. Transmission or wheel motor(s) is worn or damaged. **NOTE:** If one traction circuit component has internal wear or damage, it is possible that other traction components are also damaged.
Wheel motor will not turn and engine speed reduces when traction pedal is pressed..	Transmission bypass valve(s) is open. Transmission or wheel motor is worn or damaged. **NOTE:** If one traction circuit component has internal wear or damage, it is possible that other traction components are also damaged.

Traction Circuit Problems (Continued)

Problem	Possible Causes
Wheel motor will not hold load in neutral. **NOTE:** Machine may not be completely stationary if parked on an incline without the parking brake engaged.	Make up fluid from charge pump is not available. Check valves in transmission are damaged. On 4WD machine, PD1 or PD2 cartridge in CrossTrax™ AWD control manifold is leaking or is damaged. Valve plate(s) in transmission is worn or damaged. Cylinder block assembly in transmission is worn or damaged.
Single wheel motor turns while unloaded, but slows down or stops when load is applied.	Transmission bypass valve(s) is open or leaking. Wheel motor is worn or damaged. Transmission components (e.g. piston pump, relief valve, check valve) for the problem wheel motor are worn or damaged. **NOTE:** If one traction circuit component has internal wear or damage, it is possible that other traction components are also damaged.
Machine does not track straight. **NOTE:**If 2WD machine does not track straight, look for problem with components that effect the lagging traction side of the machine.	External traction control linkage is misadjusted, disconnected, binding or damaged. Steering cylinders are not synchronized preventing front and rear wheel alignment (synchronize steering cylinders by turning in one direction and holding until all wheels stop turning). Steering components are out of adjustment or are damaged. Brake is dragging or binding. Verify the steering forks do not touch the over rotation stop bolts at full turn in both directions. Maintain a 1/8” gap between the steering forks and stop bolts; contact with the stop blot prevents normal steering system purge and proper wheel alignment. Transmission bypass valve(s) is open. Air may be trapped in the hydraulic system; resolve by turning the steering wheel over relief several times in both directions. Transmission check valve is not seating or is damaged. Transmission or wheel motor(s) is worn or damaged. On 4WD machines, steering home sensor may be out of adjustment.

PTO Circuit Problems

Problem	Possible Causes
Cutting deck blades will not turn.	Cutting deck problem exists (see Chapter 7 − Cutting Deck). An electrical problem exists that prevents PTO from engaging (see Chapter 5 − Electrical System). The engine coolant temperature is excessive. Transmission solenoid valve is stuck. Transmission charge pump is damaged (traction charge circuit also affected). Transmission pressure valve is faulty.
Cutting deck blade(s) turn too slowly.	Engine speed is too low. Cutting deck problem exists (see Chapter 7 − Cutting Deck). Transmission PTO clutch is worn or damaged.
PTO does not stop when disengaged.	An electrical problem exists that prevents PTO from dis−engaging (see Chapter 5 − Electrical System). Transmission solenoid valve is stuck or damaged. Transmission PTO brake friction plates are worn or damaged. Machine is equipped with attachment that includes an over−running clutch.

Steering and Lift/Lower Circuit Problems

Problem	Possible Causes
Gear pump is noisy (cavitation).	Hydraulic tank oil level is low. Hydraulic oil is very cold. Suction line is restricted. Suction line has an air leak.
Steering inoperative or sluggish.	Steering components (e.g. steering forks, steering arms, tie rods, steering cylinder ends) are binding and need to be greased. Steering components (e.g. steering forks, steering arms, tie rods, steering cylinder ends) are worn or damaged. Steering cylinder is binding (e.g. bent rod on steering cylinder). Oil level in hydraulic reservoir is low (other hydraulic systems are affected as well). Implement relief valve in gear pump is stuck or damaged. Steering cylinder leaks internally. Steering cylinder internal re−phasing valve is stuck, worn or damaged. Steering control valve is worn or damaged. Gear pump is worn or damaged **NOTE:** A worn or damaged gear pump will also affect the deck lift circuit.
Cutting deck will not lift or lifts slowly.	Engine speed is too low. Cutting deck being raised during steering input (steering has priority). Lift cylinder linkage is binding or broken. Lift arm bushings are binding. Hydraulic tank oil level is low. Implement relief valve in gear pump is stuck or damaged. Lift cylinder leaks internally. Gear pump is worn or damaged **NOTE:** A worn or damaged gear pump will also affect the steering circuit.
Cutting deck raises, but will not stay up. **NOTE:** Lift cylinder and solenoid valve in deck lift manifold cannot provide an absolutely perfect seal. The cutting deck may eventually lower if left in the raised position.	Lift cylinder leaks internally. Solenoid valve in lift control manifold port A leaks.

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, oil 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 expected 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. The second person should monitor test equipment and record test results.

WARNING

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

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

2. When conducting tests on the hydraulic system, wear eye protection.

3. Before testing, check traction control linkages for improper adjustment, binding or broken parts.

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

WARNING

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

5. Put clean metal caps or plugs on any hydraulic lines left open or exposed during testing or component removal (see Hydraulic Test Fitting Kit in the Special Tools section of this chapter).

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

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

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

9. After connecting test equipment, check oil level in the hydraulic tank to make sure that oil level is correct.

10. When using hydraulic tester (pressure and flow), open tester load valve completely before starting engine to minimize the possibility of damaging components.

11. The engine must be in good operating condition. Engine speed can affect the accuracy of the hydraulic tester readings. When performing hydraulic tests, verify engine speed.

Which Hydraulic Tests Are Necessary?

Before beginning any hydraulic test, identify if the problem is related to the traction circuit, PTO circuit, lift/lower circuit or steering circuit. Once the faulty system has been identified, perform tests that relate to that circuit.

1. If a traction circuit problem exists, consider performing one or more of the following tests: Charge Relief Valve Pressure, Traction Relief Valve Pressure, Transmission Piston Pump Flow and/or Rear Wheel Motor Efficiency.

2. If a PTO circuit problem exists, consider performing the PTO Pressure Valve Test.

3. If a lift/lower circuit problem exists, consider performing one or more of the following tests: Implement Relief Pressure, Gear Pump Flow and/or Lift Cylinder Internal Leakage.

4. If a steering circuit problem exists, consider performing one or more of the following tests: Implement Relief Pressure and/or Gear Pump Flow.

Traction System Operation Testing

Because the Groundsmaster 360 traction system uses two (2) separate but interconnected circuits, it can be difficult to identify which circuit is causing a problem and what hydraulic tests should be performed. Use the following operation tests and suggestions before performing the hydraulic tests described in this section.

1. If a 2WD machine does not track in a straight line, look for a problem with components that affect the lagging traction side of the machine. During operation, a 2WD machine might steer toward the weaker side of the traction system. Because the piston pump swash plates are controlled by traction control linkage movement, if one swash plate is rotated more than the other, the machine might not track in a straight line.

2. On 2WD machines, drive up a moderate incline, stop the engine, place the traction pedal in the neutral position and allow the transmission to hold the machine in place (parking brake not applied). The machine should remain stationary on the incline or drift slowly backwards in a straight line. If one of the transmission traction circuits is faulty, the machine will roll backwards toward the lagging traction circuit.

3. On 2WD or 4WD machines, wheel speed should be the same on both rear wheels. Make sure hydraulic oil is at normal operating temperature. With the machine drive wheels raised up off the ground and the machine securely supported with jack stands, have an operator in the seat move the traction control pedal to the full forward speed. Check the rotational speed of both rear wheels. The wheel speed of both rear wheels should be approximately the same.

4. If any of these operation tests suggest a traction system problem, check the following before performing hydraulic tests.

   A. Check oil level in the hydraulic tank to make sure that oil level is correct.

   B. Check brake adjustment to make sure that the brakes are not dragging.

   C. Check that both transmission bypass valves are seated.

   D. Check that traction pedal is rotating the transmission pump swash plates equally.

   E. Check for free movement of all traction linkage control components.

Charge Relief Valve Pressure Test (Using Pressure Gauge)

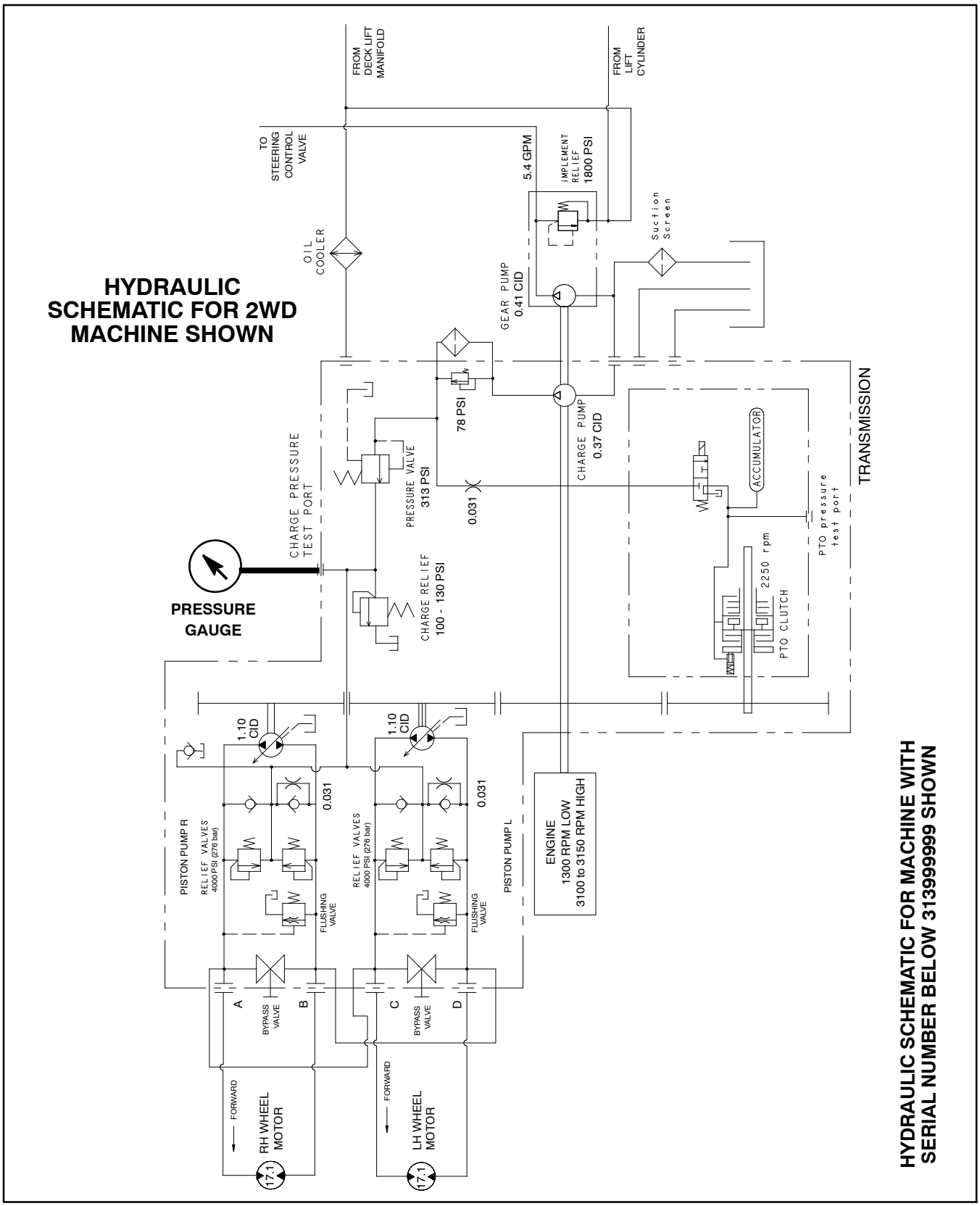

Figure 26

The Charge Relief Valve Pressure Test should be performed if a traction circuit problem is identified. This test will determine if the traction charge circuit is functioning correctly.

Procedure for Charge Relief Valve Pressure Test:

1. Make sure hydraulic oil is at normal operating temperature and hydraulic tank is full.

2. Make sure that traction drive is correctly adjusted for the neutral position.

WARNING

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

3. Park machine on a level surface with the cutting deck lowered and off. Apply parking brake. Make sure engine is off.

4. Read Precautions for Hydraulic Testing listed at the beginning of this section.

5. Thoroughly clean charge pressure test port on right side of transmission (Fig. 27). Connect a 1000 PSI (70 bar) pressure gauge with an attached hydraulic hose to the transmission charge pressure test port.

6. Start engine and run at low idle speed **(1300 RPM)**. Check for any hydraulic leakage from test connections and correct before proceeding with test.

7. With engine running, move throttle to full speed **(3100 to 3150 RPM)**.

8. Pressure gauge should read from **105 to 135 PSI (7.2 to 9.3 bar)**. Record test result.

9. If charge relief pressure specification **is not** met, consider the following transmission issues (see Transmission Service in the Service and Repairs section of this chapter):

   A. The transmission charge relief valve is faulty. Repair or replace the charge relief valve.

   B. A transmission traction relief valve or flushing valve is leaking or damaged.

   C. The charge pump in the transmission is faulty (PTO operation would also be affected).

10. Next, determine charge pressure under traction load by operating the machine in a direct forward and reverse direction. Make sure that engine is running at full speed **(3100 to 3150 RPM)**.

NOTE: When applying brakes, make sure that parking brake latch is not depressed. Engine will stop if parking brake latch is pressed.

11. Firmly apply the brakes and press the traction pedal in the forward direction and then to reverse while monitoring the pressure gauge. Release traction pedal to neutral, stop engine and record test results.

    A. The charge pressure should drop no more than 15% from initial test reading (Step 8 above) as the machine is moving (e.g. if initial charge pressure was 120 PSI (8.3 bar), charge pressure while machine is moving should be above 102 PSI (7.0 bar)).

    B. A pressure drop of more than 15% indicates a traction circuit leak (e.g. a leaking transmission check valve, a worn/damaged transmission piston pump). If charge pressure is good under no load, but drops below specification when under traction load, the transmission piston pump(s) should be suspected of wear or damage. When a piston pump is worn or damaged, the charge pump is not able to keep up with internal leakage in the traction circuit.

12. Stop machine and shut off engine.

13. Relieve hydraulic system pressure (see Relieving Hydraulic System Pressure in the General Information section). Remove pressure gauge from transmission charge pressure test port.

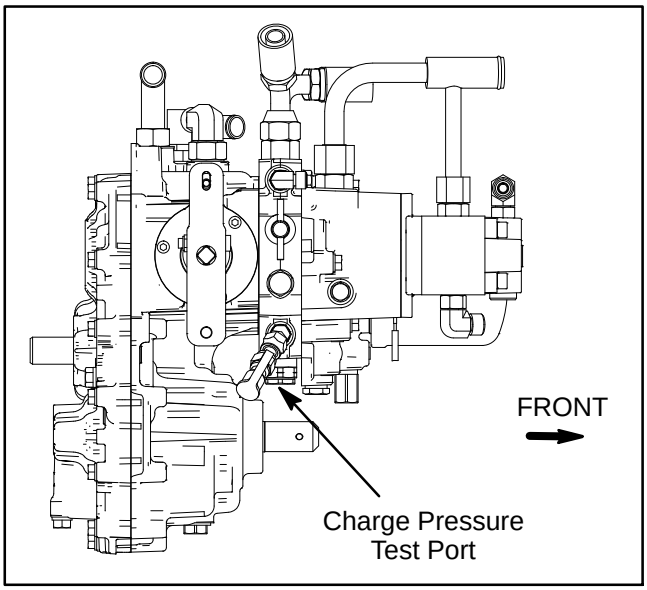

Figure 27

Traction Relief Valve Pressure Test (Using Pressure Gauge)

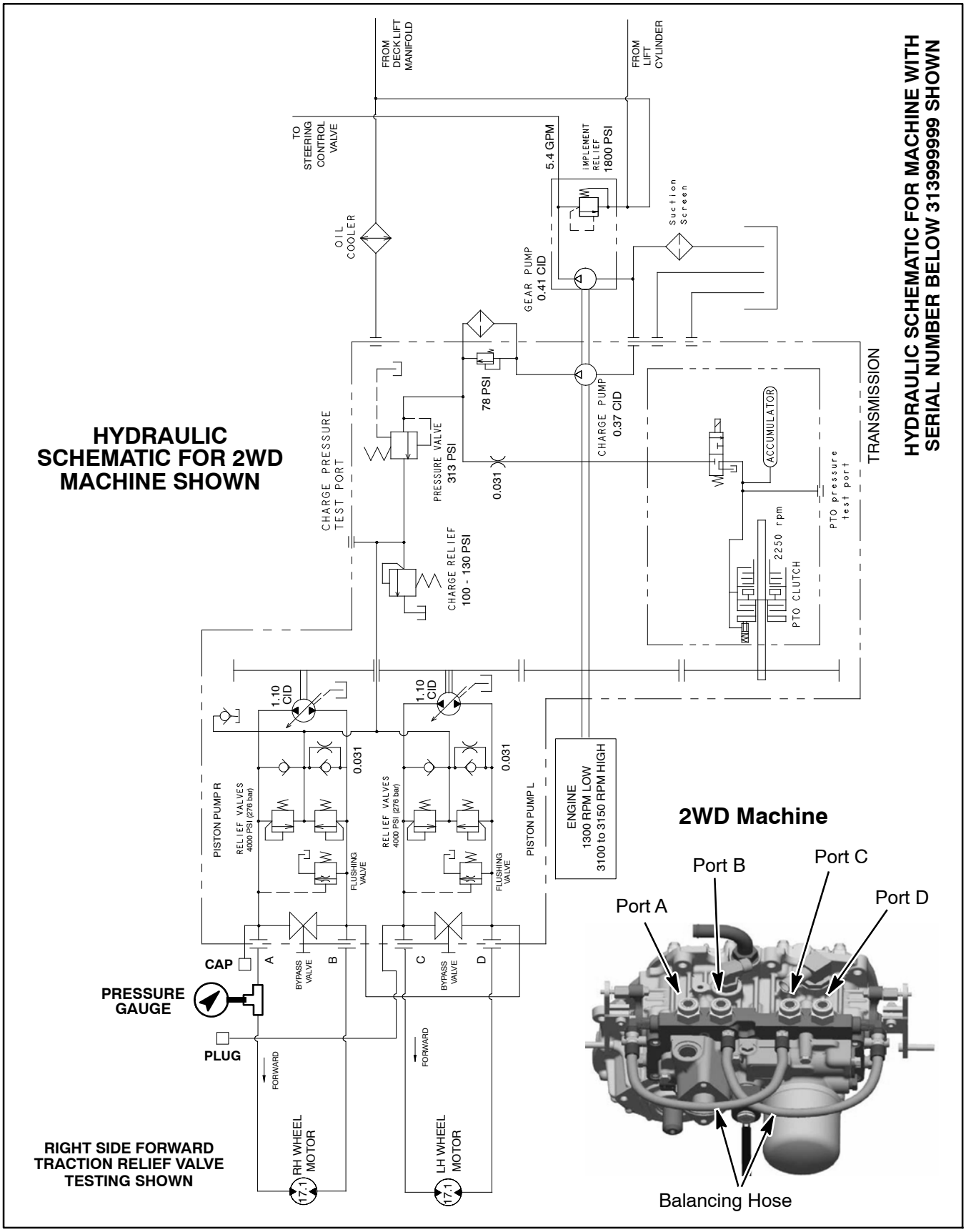

Figure 28

The Traction Relief Valve Pressure Test should be performed if a traction circuit problem is identified. This test will determine if a transmission relief valve is operating correctly.

Procedure for Traction Relief Valve Pressure Test:

1. Make sure hydraulic oil is at normal operating temperature. Also, make sure that traction drive is correctly adjusted for the neutral position.

WARNING

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

2. Park machine on a level surface with the cutting deck lowered and off. Make sure engine is off and that the parking brake is **not** applied.

3. Read Precautions for Hydraulic Testing listed at the beginning of this section.

4. Thoroughly clean area surrounding traction circuit hoses on top of transmission (Fig. 28 or 29).

5. Determine which traction relief valve is to be tested. Disconnect hydraulic hose from transmission pump outlet fitting for relief valve to be tested (Fig. 28 or 29):

Relief Valve to be Tested	Pump Outlet
Right Side Forward	Port A
Right Side Reverse	Port B
Left Side Forward	Port C
Left Side Reverse	Port D

NOTE: Pump outlet ports are not identified on the pump housing. Use illustration in Figure 28 (2WD machine) or 29 4WD machine) to identify pump ports.

6. Install a tee fitting between the disconnected hydraulic hose and the transmission fitting. Install a 5000 PSI (350 bar) pressure gauge to the tee fitting.

7. Disconnect balancing hose from transmission fitting closest to transmission pump outlet fitting for relief valve to be tested (Fig. 28 or 29). Install steel cap on fitting and steel plug in balancing hose.

8. Start engine and run at low idle speed **(1300 RPM)**. Check for any hydraulic leakage from test connections and correct before proceeding with test.

9. Move throttle to full speed **(3100 to 3150 RPM)**.

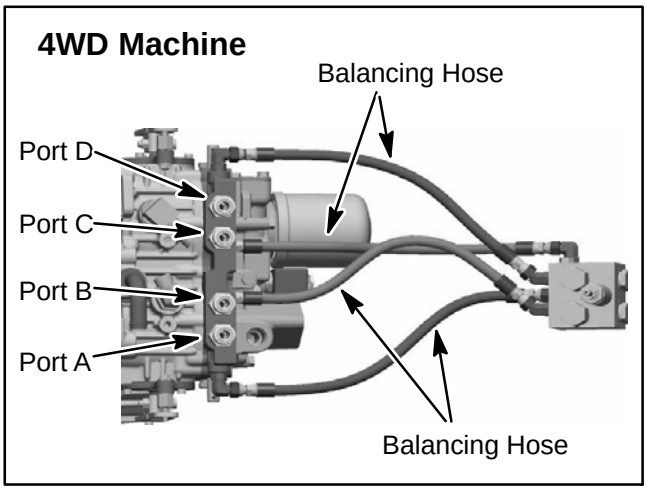

Figure 29

10. Sit on seat and move machine against an immovable object (e.g. wall) to prevent movement of the machine.

CAUTION

Use extreme caution when performing test. The drive wheels will be trying to move the machine during test.

NOTE: When applying brakes, make sure that parking brake latch is not depressed. Engine will stop if parking brake latch is pressed.

11. Firmly apply brakes to prevent the rear wheels from rotating and then slowly depress the traction pedal in the direction to be tested (forward or reverse). While pressing traction pedal, carefully watch the pressure gauge needle. As the traction relief valve lifts, the gauge needle will momentarily stop. Traction system pressure as the relief valve opens should be:

3900 to 4100 PSI (269 to 282 bar) in either forward or reverse

NOTE: It may be difficult to achieve traction circuit relief pressure. If traction pedal is depressed slowly, it is more likely that relief pressure can be obtained.

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

NOTE: The forward relief valves for the two (2) transmission pump circuits are identical and thus can be interchanged. The reverse relief valves are also identical. The forward relief valves, however, are different than the reverse relief valves so **do not** interchange forward and reverse relief valves. The relief valve locations are shown in Figure 30.

13. If traction relief valve pressure **is not** met, relieve hydraulic system pressure (see Relieving Hydraulic System Pressure in the General Information section). Remove and inspect relief valve(s) from transmission (see Transmission Service in the Service and Repairs section of this chapter). Clean or replace relief valve(s). Traction relief valves are not adjustable.

14. After testing is completed, make sure that engine is stopped and then relieve hydraulic system pressure (see Relieving Hydraulic System Pressure in the General Information section of this chapter). Remove pressure gauge and tee fitting from machine. Connect pump outlet and balancing hoses to transmission fittings.

15. If necessary, repeat pressure test for other traction relief valves.

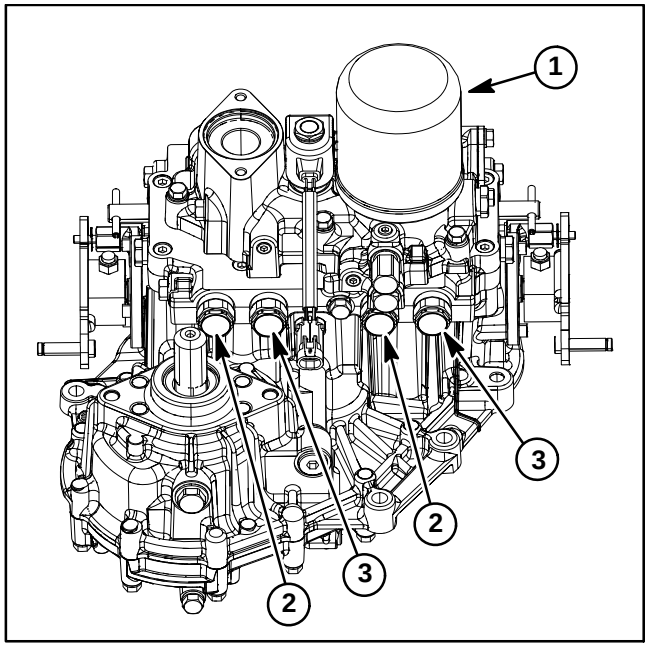

Figure 30

1. **Oil filter**
2. **Forward relief valve**
3. **Reverse relief valve**

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Transmission Piston Pump Flow Test (Using Tester with Pressure Gauges and Flow Meter)

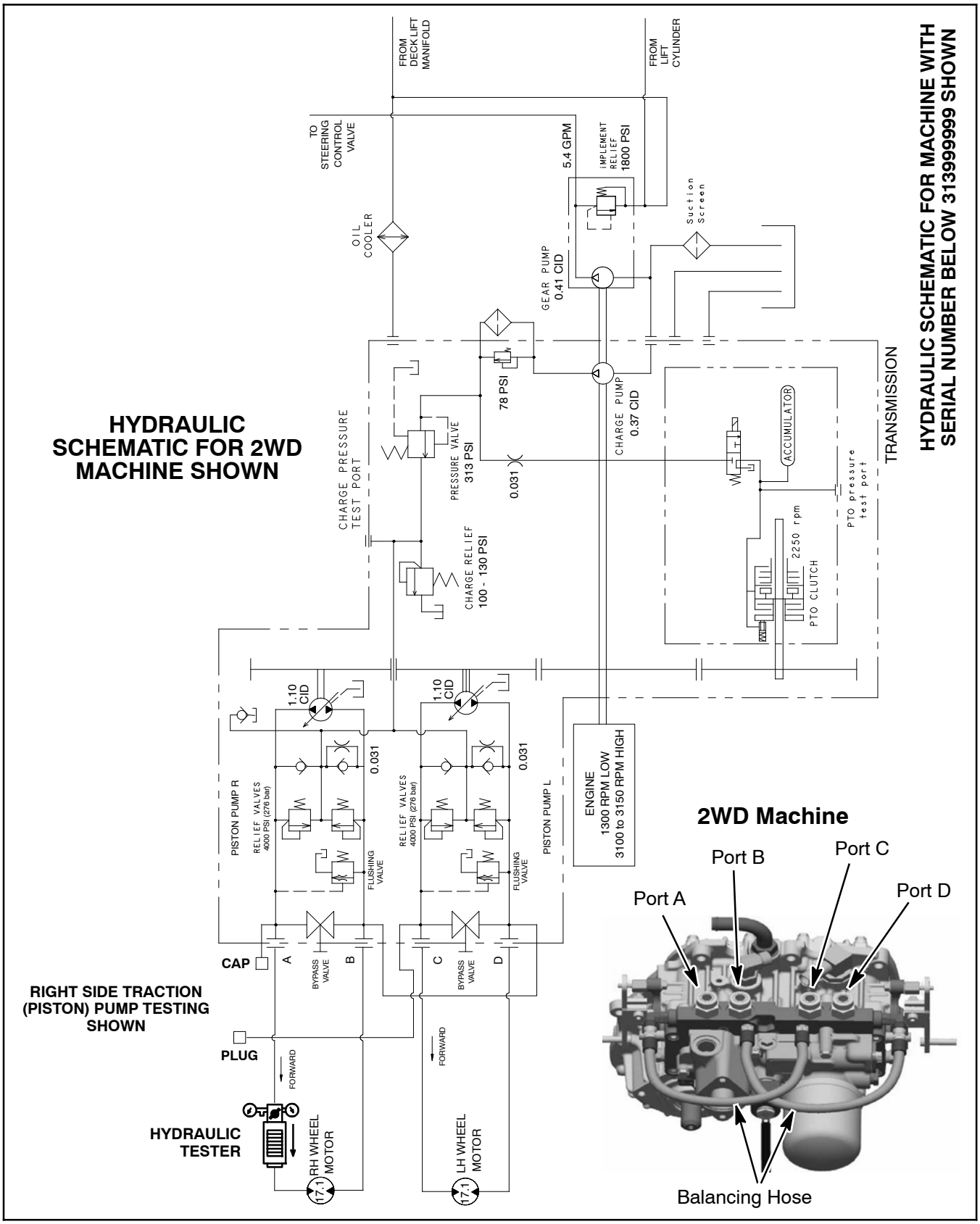

Figure 31

The Transmission Piston Pump Flow Test should be performed if a traction circuit problem is identified. This test will determine if hydraulic flow from a transmission piston pump is correct.

Procedure for Transmission Piston Pump Flow Test:

IMPORTANT: Traction circuit flow for the Groundsmaster 360 is approximately 15 GPM (57 LPM). Use 40 GPM Hydraulic Tester #AT40002 (pressure and flow) for this test (see Special Tools in this chapter).

1. Make sure hydraulic oil is at normal operating temperature. Also, make sure that traction drive is correctly adjusted for the neutral position and that the hydraulic tank is full.

WARNING

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

2. Park machine on a level surface with the cutting deck lowered and off. Make sure engine is off.

3. Read Precautions for Hydraulic Testing listed at the beginning of this section.

WARNING

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

4. Raise and support machine with jack stands so that all drive wheels are off the ground. In this test, the drive wheels need to spin freely to allow hydraulic flow through the traction circuit. Make sure that the parking brake is **not** applied.

5. Thoroughly clean area surrounding traction circuit hoses on top of transmission (Fig. 31 or 32). Determine which piston pump is to be tested.

6. Disconnect hydraulic hose from transmission pump outlet fitting for piston pump to be tested (Fig. 31 or 32):

Piston Pump to be Tested	Pump Outlet
Right Side Pump	Port A
Left Side Pump	Port C

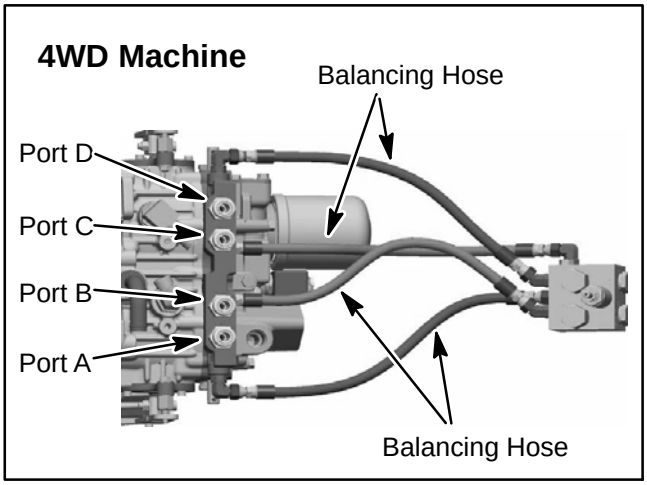

Figure 32

7. Install 40 GPM hydraulic tester (pressure and flow) in series between the pump outlet fitting and the disconnected hose. Make sure that the tester flow arrow points from the pump outlet and toward the hose. **Make sure the flow control valve on the tester is fully open.**

8. Disconnect balancing hose from transmission fitting closest to transmission pump outlet fitting for pump to be tested (Fig. 31 or 32). Install steel cap on fitting and steel plug in balancing hose.

9. Sit in the operator seat, start engine and run at low idle speed **(1300 RPM)**. Check for any hydraulic leakage from test connections and correct before proceeding with test.

10. With engine running, move throttle so engine is running at high idle speed **(3100 to 3150 RPM)**. Use a phototac to measure engine speed.

11. Have operator slowly push traction pedal to the full **forward** position.

12. Slowly close tester flow control valve until pressure gauge reads **1000 PSI (69 bar)**. Verify with a phototac that the engine speed is still **3100 to 3150 RPM**.

13. Observe flow gauge on tester. TESTER READING should be approximately **14 GPM (53 LPM)** for a traction pump in good condition.

14. Open tester flow control valve, release traction pedal to the neutral position and stop engine. Record test results.

15. Lower pump flow would result in reduced traction circuit performance. If flow is less than **12.5 GPM (47.4 LPM)** or a pressure of **1000 PSI (69 bar)** cannot be obtained:

A. The transmission bypass valve(s) may be open or damaged.

B. The traction control assembly may need adjustment (e.g. traction pedal not rotating pump swash plate fully).

C. If the engine speed drops excessively as the tester flow control valve is closed, engine performance should be evaluated.

D. If engine speed does not drop and pressure and flow specifications are not met, the tested transmission piston pump needs to be inspected, repaired or replaced as necessary.

16. If transmission piston pump flow specification **is** met, and a traction circuit problem has been identified, consider that a wheel motor is worn or damaged (see Rear Wheel Motor Efficiency Test in this section).

17. Relieve hydraulic system pressure (see Relieving Hydraulic System Pressure in the General Information section). Disconnect tester from transmission fitting and hose. Connect pump outlet and balancing hoses to transmission fittings.

18. If necessary, repeat flow test for other transmission piston pump.

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Rear Wheel Motor Efficiency Test (Using Tester with Pressure Gauges and Flow Meter)

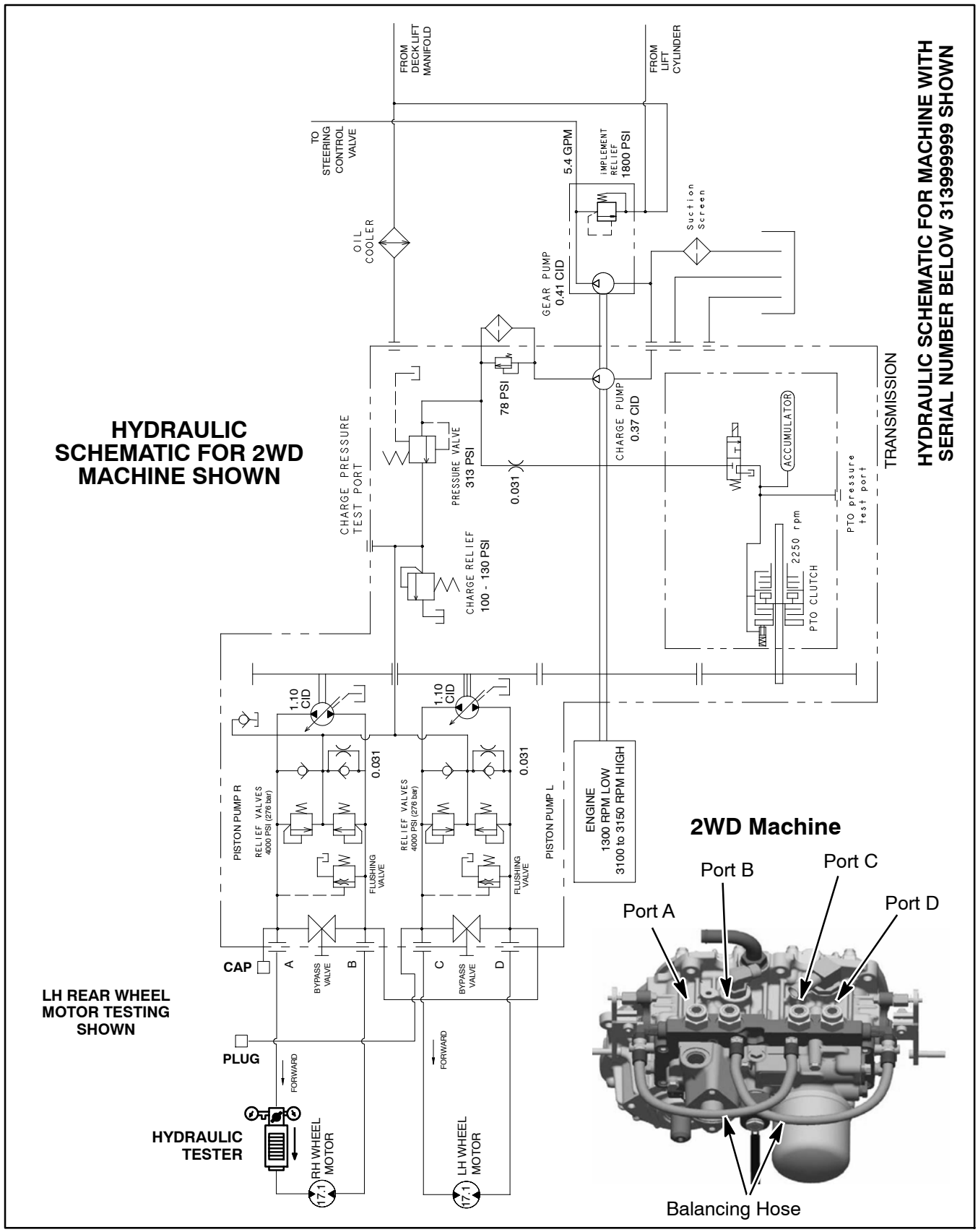

Figure 33

The Rear Wheel Motor Efficiency Test should be performed if a traction circuit problem is identified. This test will determine if a rear wheel motor has excessive internal leakage and wear.

NOTE: Over a period of time, a wheel motor can wear internally. A worn motor may bypass oil internally causing the motor to be less efficient. Eventually, enough oil loss will cause the wheel motor to stall under heavy load 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 overall machine performance.

Procedure for Rear Wheel Motor Efficiency Test:

IMPORTANT: Traction circuit flow for the Groundsmaster 360 is approximately 15 GPM (57 LPM). Use 40 GPM Hydraulic Tester #AT40002 (pressure and flow) for this test (see Special Tools in this chapter).

1. Make sure hydraulic oil is at normal operating temperature. Also, make sure that traction drive is correctly adjusted for the neutral position.

WARNING

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

2. Park machine on a level surface with the cutting deck lowered and off. Apply parking brake and make sure engine is off.

3. Read Precautions for Hydraulic Testing listed at the beginning of this section.

4. Attach a heavy chain to the rear of the machine frame and an immovable object to prevent the machine from moving during testing.

WARNING

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

5. Jack up and support the front wheels off the ground to allow flow through the front wheel motors.

6. Chock rear wheels to prevent wheel rotation.

7. Thoroughly clean area surrounding traction circuit hoses on top of transmission (Fig. 33 or 34). Determine which rear wheel motor is to be tested.

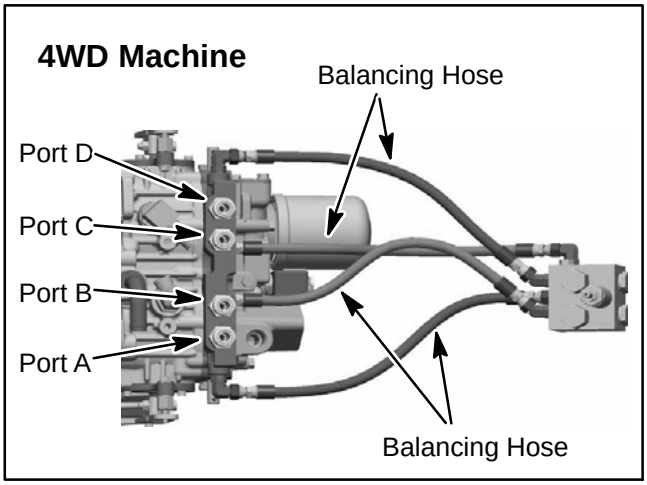

Figure 34

8. Disconnect hydraulic hose from transmission pump outlet fitting for rear wheel motor to be tested (Fig. 33 or 34):

Wheel Motor to be Tested	Pump Outlet
Right Side Rear Motor	Port A
Left Side Rear Motor	Port C

9. Install 40 GPM hydraulic tester (pressure and flow) in series between the pump outlet fitting and the disconnected hose. Make sure that the tester flow arrow points from the pump outlet and toward the hose. **Make sure the flow control valve on the tester is fully open.**

10. Disconnect balancing hose from transmission fitting closest to transmission pump outlet fitting for rear wheel to be tested (Fig. 33 or 34). Install steel cap on fitting and steel plug in balancing hose.

11. Start engine and run at low idle speed **(1300 RPM)**. Check for any hydraulic leakage from test connections and correct before proceeding with test.

12. With engine running, move throttle so engine is running at high idle speed **(3100 to 3150 RPM)**. Use a phototac to measure engine speed.

CAUTION

Use extreme caution when performing test. The rear wheels will be trying to move the machine forward.

13. While sitting in operator seat, and with brakes firmly applied to prevent the rear wheels from rotating, slowly depress the traction pedal in the **forward** direction until **1000 PSI (69 bar)** is displayed on the tester pressure gauge.

14. Rear wheel motor internal leakage will be shown on the tester flow meter in GPM (LPM).

15. Return traction pedal to the neutral position. Release brakes, shut off engine and record test results. Rotate wheel and retest. Testing of wheel motor leakage in three (3) different wheel positions will provide the most accurate test results.

16. Flow should be **less than 1.5 GPM (5.7 LPM)** for the tested rear wheel motor. If specification **is not** met, the tested wheel motor needs to be repaired or replaced.

17. Relieve hydraulic system pressure (see Relieving Hydraulic System Pressure in the General Information section). Disconnect tester from transmission pump outlet fitting and hydraulic hose. Connect pump outlet and balancing hoses to transmission fittings.

18. If other rear wheel motor requires testing, complete steps 7 to 17 for the remaining motor.

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PTO Pressure Valve Test (Using Pressure Gauge)

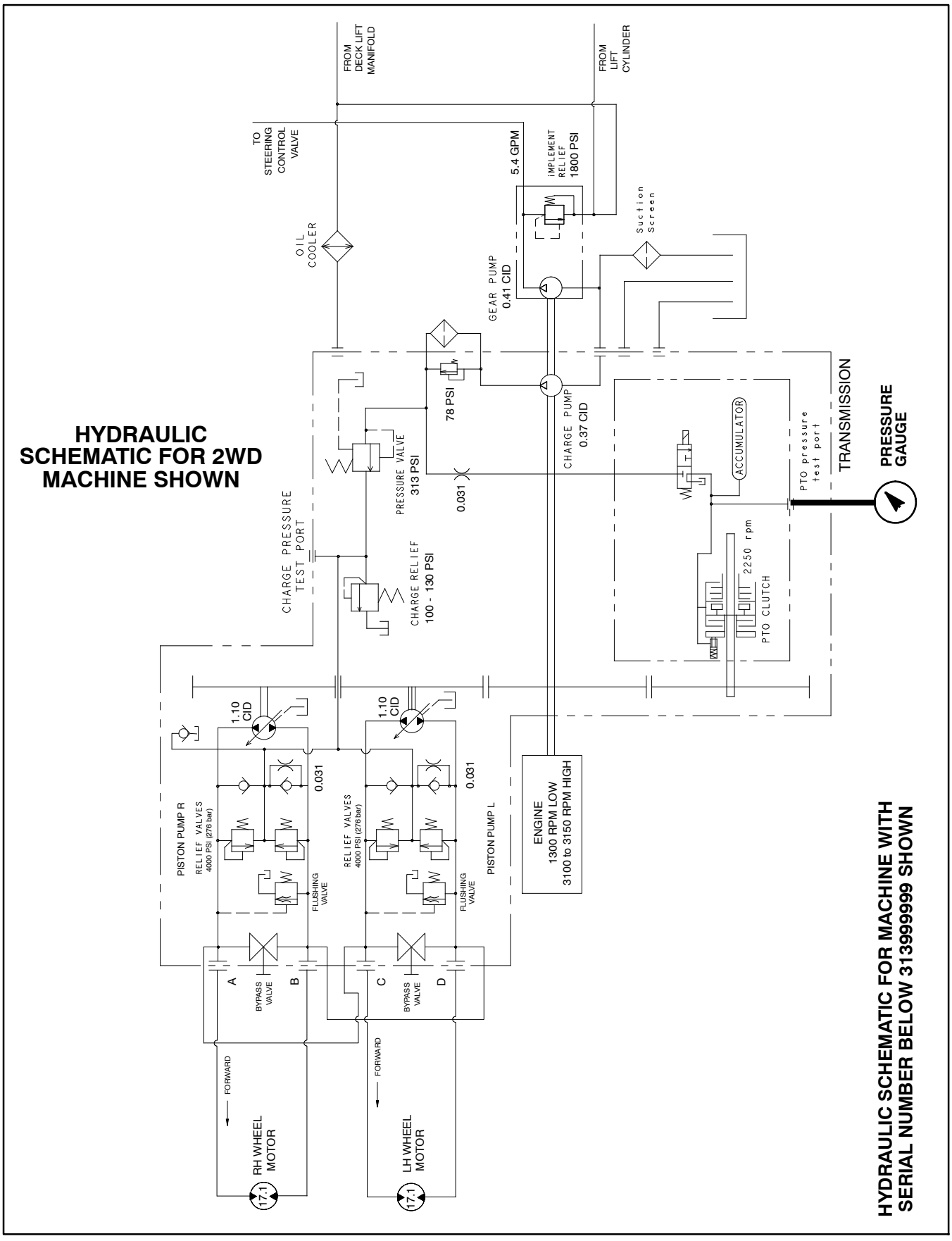

Figure 35

The PTO Pressure Valve Test should be performed if a PTO engagement problem is identified. This test will determine if the PTO pressure valve in the transmission is operating correctly.

Procedure for PTO Pressure Valve Test:

1. Make sure hydraulic oil is at normal operating temperature.

WARNING

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

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

3. Read Precautions for Hydraulic Testing listed at the beginning of this section.

4. Thoroughly clean transmission area surrounding pressure valve test port (Fig. 36).

NOTE: If machine is equipped with optional speed reduction kit, a hydraulic fitting and hose for the kit is connected to the transmission pressure valve test port. To perform the PTO pressure valve test, disconnect hydraulic hose and remove fitting from transmission port. Install cap in speed reduction kit hose. Then, install pressure gauge and proceed with remaining steps of test. When PTO pressure valve testing is completed, reinstall fitting to transmission port, remove cap from hydraulic hose and connect hose to fitting.

5. Remove plug from pressure valve test port (Fig. 36). Connect hydraulic pressure gauge (1000 PSI / 70 bar) with an attached hydraulic hose to the test port.

6. Start engine and run at low idle speed **(1300 RPM)**. Check for any hydraulic leakage from test connections and correct before proceeding with test.

7. With engine running, move throttle to full speed **(3100 to 3150 RPM)**.

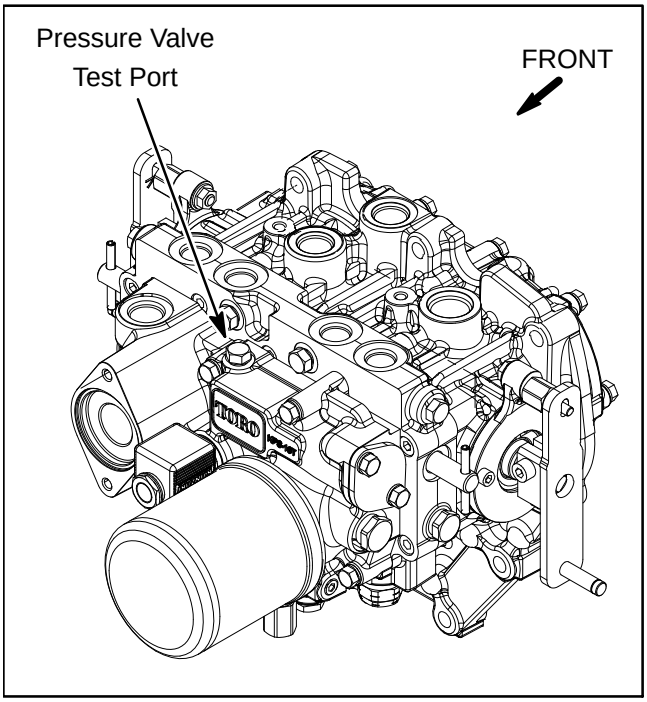

Figure 36

CAUTION

Keep away from deck during test to prevent personal injury.

8. Have operator engage PTO and monitor the pressure gauge.

9. With the engine running at full speed and PTO engaged, pressure should be from **280 to 340 PSI (19.3 to 23.4 bar)**.

10. Disengage PTO and then stop engine. Record test results.

11. If specification **is not** met, repair or replace pressure valve in transmission (see Transmission Service in the Service and Repairs section of this chapter). Also consider a worn or damaged charge pump in the transmission (traction charge circuit would be affected as well).

12. Relieve hydraulic system pressure (see Relieving Hydraulic System Pressure in the General Information section). Disconnect test gauge from pressure valve test port. Install plug into port and torque plug from **14 to 15 ft−lb (18 to 21 N−m)**.

Implement Relief Pressure Test (Using Pressure Gauge)

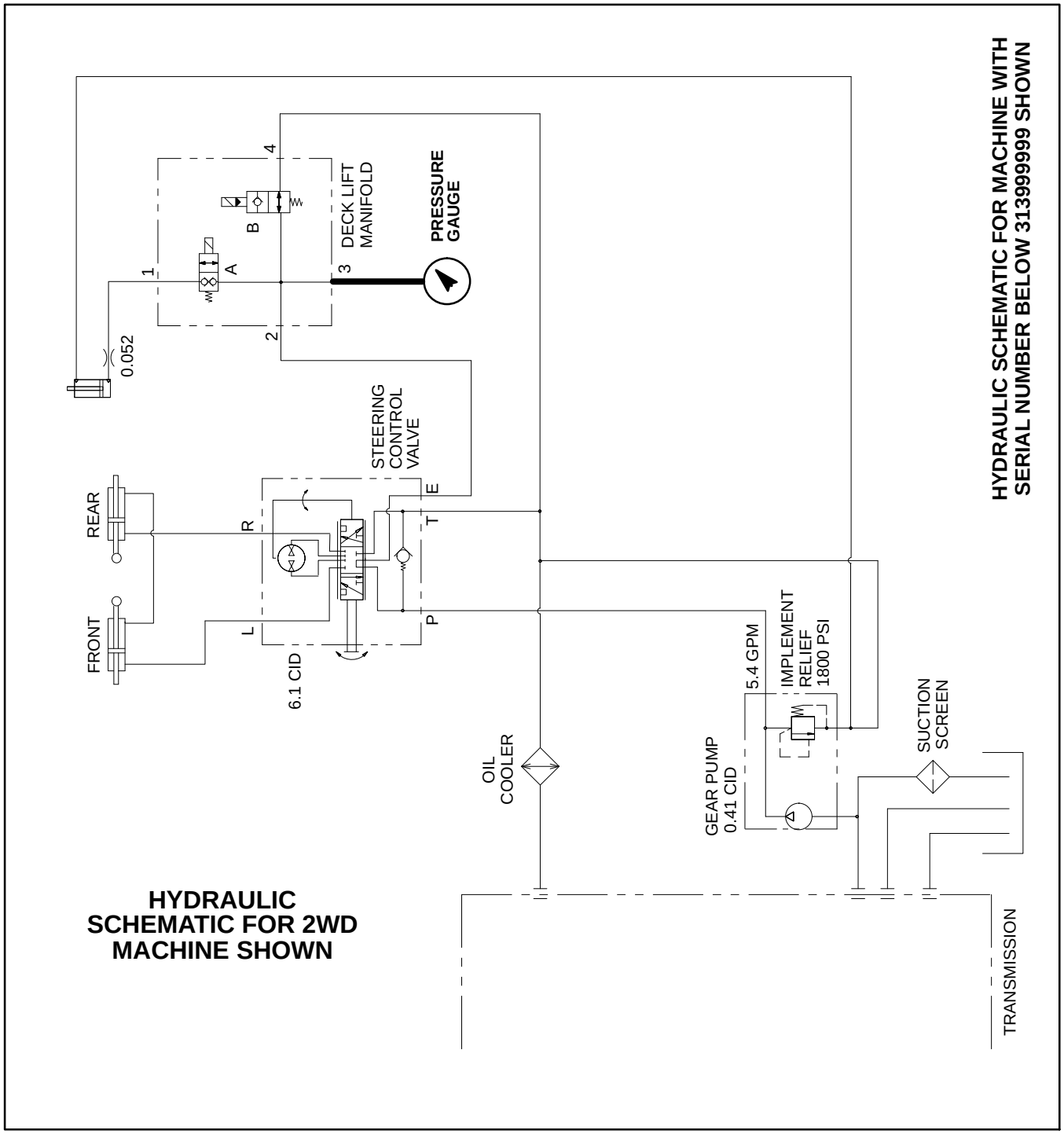

Figure 37

The Implement Relief Pressure Test should be performed if a steering or cutting deck raise and lower problem is identified. This test will determine if the implement relief valve is operating correctly.

Procedure for Implement Relief Pressure Test:

1. Make sure hydraulic oil is at normal operating temperature.

2. Make sure that traction drive is correctly adjusted for the neutral position.

WARNING

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

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

4. Read Precautions for Hydraulic Testing listed at the beginning of this section.

5. Raise and support operator seat to allow access to deck lift manifold.

6. Thoroughly clean deck lift manifold around the plug in port 3 on rear of the deck lift manifold (Fig. 39). Remove plug from deck lift manifold port 3.

7. Install 5000 PSI (345 bar) pressure gauge into deck lift manifold port 3.

8. Start engine and run at low idle speed **(1300 RPM)**. Check for any hydraulic leakage from test connections and correct before proceeding with test.

9. With engine running, move throttle to full speed **(3100 to 3150 RPM)**.

IMPORTANT: Hold lift switch in the raise position only long enough to get a system relief pressure reading. Holding the lift switch in the raise position for an extended period may damage circuit components.

10. Watch pressure gauge carefully while pressing lift switch to the raise position and holding.

11. When the lift cylinder is fully extended (deck raised) and the implement relief valve lifts, the pressure gauge needle will momentarily stop. System pressure as the relief valve opens should be be approximately **1800 PSI (124 bar)**. Return lift switch to the neutral position after observing relief valve pressure.

NOTE: If lift switch continues to be pressed after the relief valve has opened, system pressure can increase higher than relief pressure.

12. Stop engine. Record test results.

13. If specification **is not** met, repair or replace implement relief valve in gear pump (see Gear Pump Service in the Service and Repairs section of this chapter). Also consider a leaking lift cylinder, leaks in the deck lift manifold, a leaking check valve in the steering control valve or a worn gear pump.

14. Relieve hydraulic system pressure (see Relieving Hydraulic System Pressure in the General Information section). Remove pressure gauge from deck lift manifold port. Install plug into deck lift manifold port 3 and torque plug **25 ft−lb (34 N−m)**.

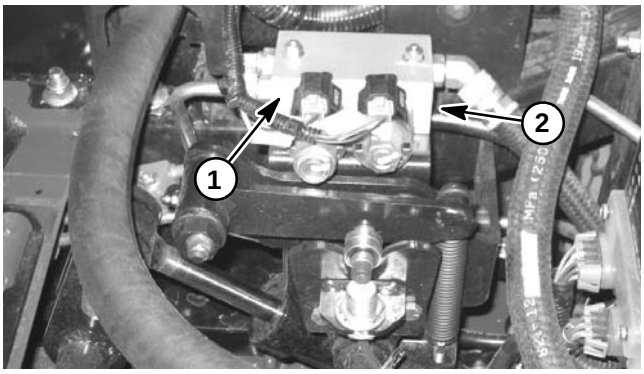

Figure 38

1. Deck lift manifold **2. Port 3 location**

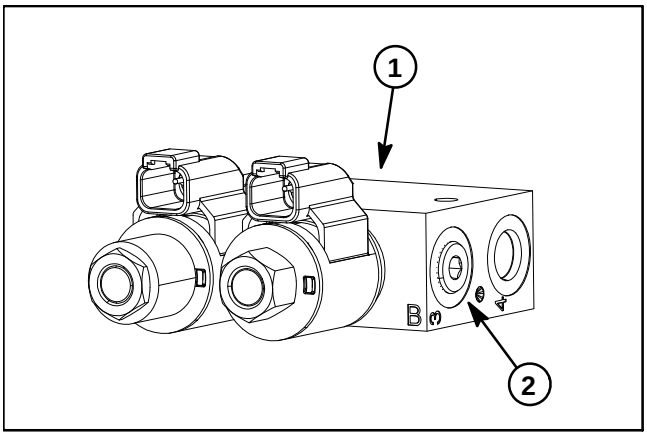

Figure 39

1. Deck lift manifold **2. Port 3 plug**

Gear Pump Flow Test (Using Tester with Pressure Gauges and Flow Meter)

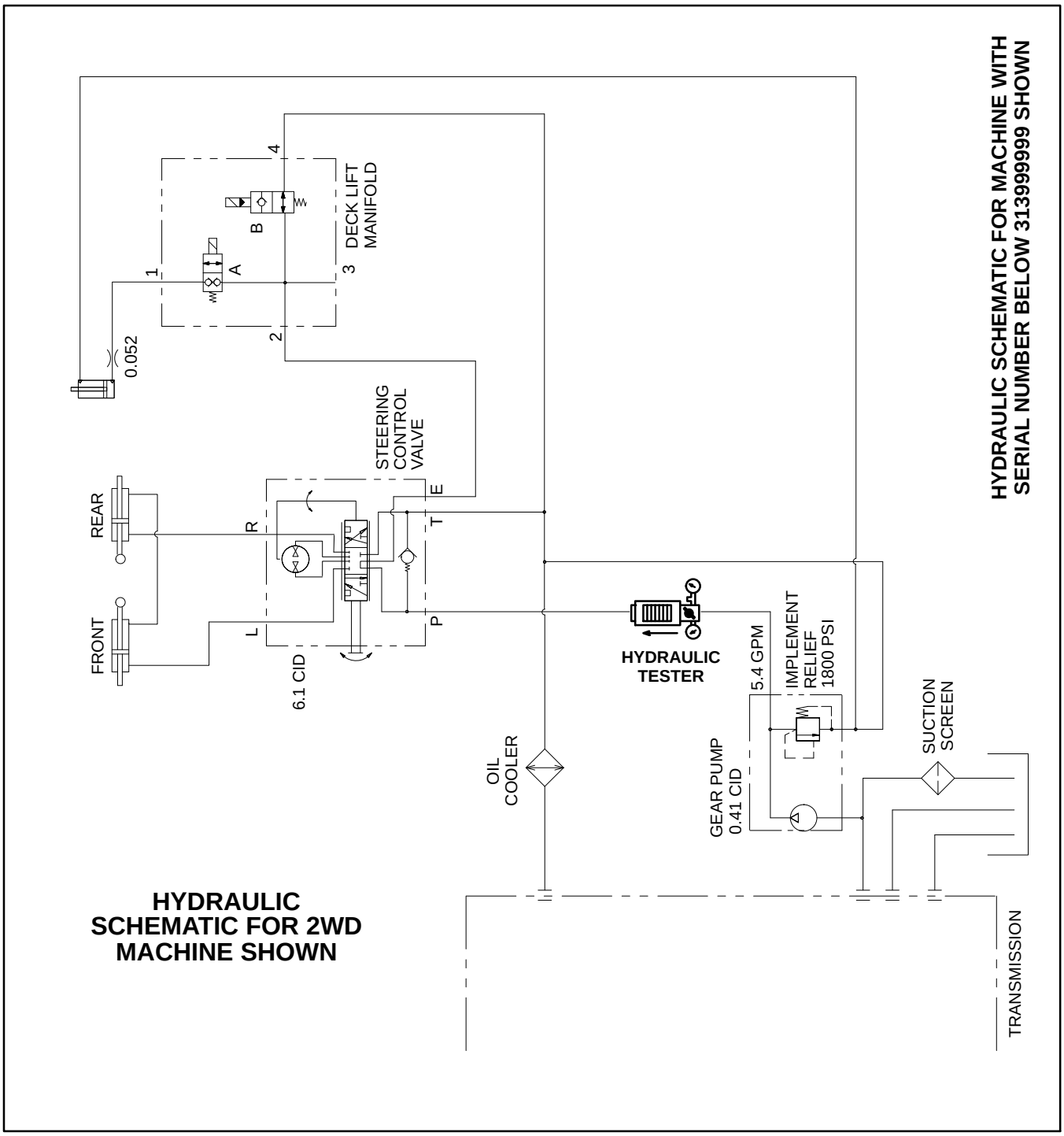

Figure 40

The Gear Pump Flow Test should be performed if a steering or cutting deck raise and lower problem is identified. This test will determine if hydraulic flow from the gear pump is correct.

Procedure for Gear Pump Flow Test:

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

1. Make sure hydraulic oil is at normal operating temperature.

2. Make sure that traction drive is correctly adjusted for the neutral position.

WARNING

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

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

4. Read Precautions for Hydraulic Testing listed at the beginning of this section.

5. Thoroughly clean junction of hydraulic hose and lower fitting on gear pump.

6. Disconnect hydraulic hose from lower fitting on gear pump (Fig. 41).

7. Install hydraulic tester (pressure and flow) in series with the gear pump fitting and the disconnected hose. Make sure that tester flow arrow points from the pump outlet port and toward the disconnected hose. **Make sure the flow control valve on the tester is fully open.**

8. Start engine and run at low idle speed **(1300 RPM)**. Check for any hydraulic leakage from test connections and correct before proceeding with test.

9. With engine running, move throttle to full speed **(3100 to 3150 RPM)**.

10. Watch tester pressure gauge carefully while slowly closing the flow control valve until **1000 PSI (69 bar)** is obtained. Do not close tester load valve fully. Verify with a phototac that the engine speed remains **3100 to 3150 RPM** while maintaining **1000 PSI (69 bar)** on the tester pressure gauge.

11. Observe flow gauge. Flow indication for a pump in good condition is **5.2 GPM (19.7 LPM)**.

12. Open tester load valve and then stop engine. Record test results.

13. Lower pump flow would result in reduced steering and lift/lower circuit performance. If measured flow was less than **4.4 GPM (16.6 LPM)** or a pressure of **1000 PSI (69 bar)** cannot be obtained, check for restriction in the pump inlet line. If inlet line is not restricted, remove gear pump and repair or replace as necessary.

NOTE: Implement relief valve pressure can also be tested with hydraulic tester (pressure and flow) in series with the gear pump fitting and the disconnected hose. Use pressure gauges on hydraulic tester and follow procedure for Implement Relief Pressure Test in this section.

14. Relieve hydraulic system pressure (see Relieving Hydraulic System Pressure in the General Information section). Disconnect tester from deck lift valve fitting and hydraulic hose. Connect hose to the control valve fitting.

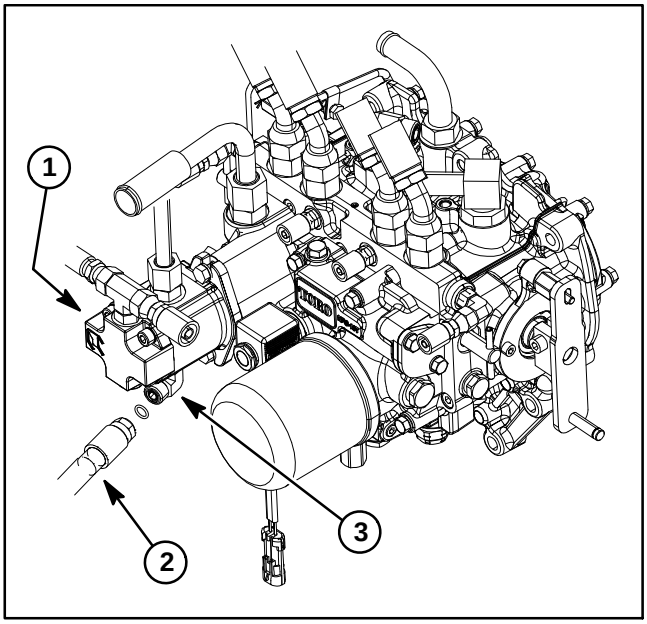

Figure 41

1. **Gear pump**
2. **Hydraulic hose**
3. **Lower fitting**

Lift Cylinder Internal Leakage Test

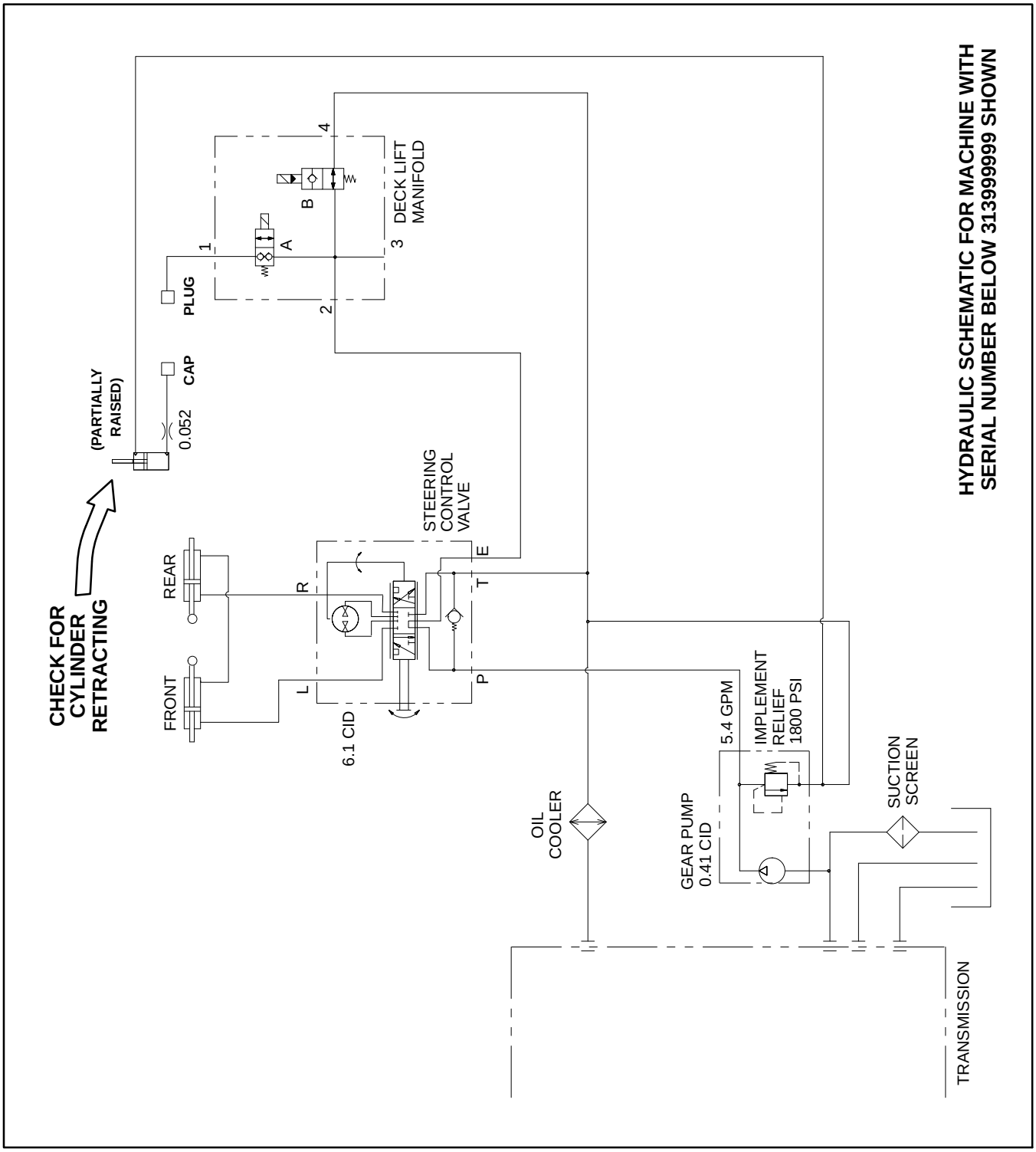

Figure 42

The Lift Cylinder Internal Leakage Test should be performed if a cutting deck raise and lower problem is identified. This test will determine if the lift cylinder is faulty.

NOTE: Raise/lower circuit operation will be affected by lift cylinder binding, extra weight on the cutting deck and/or binding of lift components. Make sure that these items are checked before proceeding with the lift cylinder internal leakage test.

Procedure for Lift Cylinder Internal Leakage Test:

1. Park machine on a level surface with the PTO switch OFF. Position the cutting deck in a partially raised position and turn the engine off. Apply the parking brake.

2. Under both sides of the cutting deck, use a jack to raise the cutting deck slightly. This will remove the load from the lift cylinder and relieve lift cylinder hydraulic pressure. Support both sides of the cutting deck with jack stands to prevent the lift cylinder from retracting.

3. Thoroughly clean the area around the hydraulic hose end at the barrel end of the lift cylinder. Disconnect the hydraulic hose from the lift cylinder barrel end fitting.

IMPORTANT: When capping the lift cylinder fitting and hydraulic hose end, use a steel cap and plug to ensure that fluid leakage will not occur. Plastic plugs will not hold hydraulic pressure that will be developed during this test procedure.

4. Place a steel cap on the open lift cylinder fitting to seal the lift cylinder. Also, install a steel plug in the open end of the disconnected hose to prevent leakage or contamination.

5. Remove the jack stands from under the cutting deck. The cutting deck should settle slightly and then be supported by the capped lift cylinder.

6. Place a piece of tape on the lift cylinder rod near the rod end (Fig. 43). Measure and record the distance from the lift cylinder collar to the tape location.

7. Leave the machine parked for two (2) hours and monitor the lift cylinder. The weight of the cutting deck may cause the lift cylinder to gradually retract due to internal leakage in the cylinder. Use the change in distance from the lift cylinder collar to the tape location to determine lift cylinder rod movement.

   A. If the cutting deck is still suspended after two (2) hours and lift cylinder rod movement is less than **1.250" (31.7 mm)**, consider that the lift cylinder is in good condition. A lift cylinder in good, usable condition will show minimal rod movement.

   B. Rod movement in excess of **1.250" (31.7 mm)** after two (2) hours indicates a lift cylinder with internal seal damage or excessive internal wear. Replace or repair the lift cylinder (see Lift Cylinder and Lift Cylinder Service in the Service and Repairs section of this chapter).

8. Once lift cylinder condition has been determined, use a jack to raise both sides of the cutting deck slightly which will remove the load from the lift cylinder. Support both sides of the cutting deck with jack stands. Remove the cap from the cylinder fitting and the plug from the hydraulic hose. Connect the hydraulic hose to the lift cylinder fitting.

9. Remove tape from lift cylinder rod.

10. Remove the jack stands from under the cutting deck. Start engine and operate lift cylinder through several raise and lower cycles. Stop the engine and check for any leakage.

11. Check oil level in hydraulic reservoir.

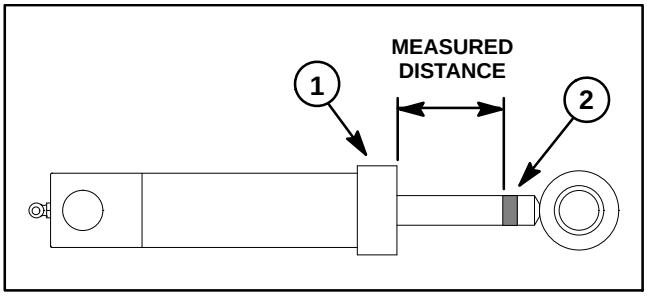

Figure 43

1. Lift cylinder collar **2. Tape**

General Precautions for Removing and Installing Hydraulic System Components

Before Repair or Replacement of Components

1. Before removing any parts from the hydraulic system, park machine on a level surface, engage parking brake, lower cutting deck and stop engine. Remove key from the ignition switch.

2. Thoroughly 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 components.

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

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

WARNING

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

5. Hydraulic oil may be hot. Be careful when loosening and removing hydraulic system components.

6. Put clean caps or plugs on any hydraulic lines, hydraulic fittings and components left open or exposed to prevent contamination. Cap the opening as soon as line or port is exposed.

After Repair or Replacement of Components

1. Check oil level in the hydraulic tank and add correct oil if necessary. Use only hydraulic fluids specified in Operator's Manual. Drain and refill hydraulic tank and change oil filter if component failure was severe or system is contaminated (see Flush Hydraulic System in this section).

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

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

4. Use proper tightening methods when installing hydraulic hoses and fittings (see 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 tank 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.

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

Flush Hydraulic System

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

IMPORTANT: If a component failure occurred in the traction circuit, refer to Traction Circuit (Closed Loop) Component Failure in the General Information section for information regarding the importance of removing contamination from the traction circuit.

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for at least four (4) hours.

WARNING

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

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

IMPORTANT: Make sure to thoroughly clean around all hydraulic connections that will be disassembled.

3. Drain hydraulic tank and transmission.

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

5. Remove and replace hydraulic oil filter.

6. Inspect and clean hydraulic oil tank (see Hydraulic Tank Inspection in this section).

7. Reconnect all hydraulic hoses, lines and components that were disconnected to drain hydraulic system (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

IMPORTANT: Use only hydraulic fluids specified in Operator's Manual. Other fluids may cause system damage. Use of biodegradable hydraulic fluid in Groundsmaster 360 machines is not recommended.

8. Fill hydraulic tank with **new** hydraulic fluid.

9. Disconnect wire harness connector from engine fuel stop solenoid to prevent the engine from starting. Make sure traction pedal is in the **neutral** position.

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

11. Connect wire harness electrical connector to fuel stop solenoid.

12. Start engine and let it run at low idle speed **(1300 RPM)** for a minimum of two (2) minutes. Increase engine speed to high idle **(3100 to 3150 RPM)** for a minimum of one (1) minute under no load.

13. Raise and lower cutting deck several times.

14. Turn steering wheel in both directions several times.

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

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

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

18. When no signs of contamination are evident, resume normal operation and follow recommended maintenance intervals.

Filtering Closed−Loop Traction Circuit

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

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

WARNING

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

2. Raise and support machine so all drive wheels are off the ground (see Jacking Instructions in Chapter 1 − Safety). On 2WD machines, chock non−drive (front) wheels remaining on ground.

NOTE: If wheel motor was replaced, install high flow filter to the inlet of new motor instead of to the transmission. This will prevent system contamination from entering and damaging the new wheel motor.

3. Thoroughly clean area surrounding traction circuit hoses on top of transmission (Fig. 44 or 45). Determine which piston pump circuit is to be filtered.

4. Disconnect hydraulic hose from transmission pump inlet fitting for piston pump to be filtered (Fig. 44 or 45):

Piston Pump to be Filtered	Pump Inlet
Right Side Pump	Port B
Left Side Pump	Port D

5. Connect Toro high flow hydraulic filter in series between pump inlet fitting and the disconnected hose. Use hydraulic hose kit (see Special Tools in this chapter) to connect filter to machine. Make sure that hose connections are properly tightened.

6. Disconnect balancing hose from transmission fitting closest to transmission pump inlet for pump to be filtered (Fig. 44 or 45). Install steel cap on fitting and steel plug in balancing hose.

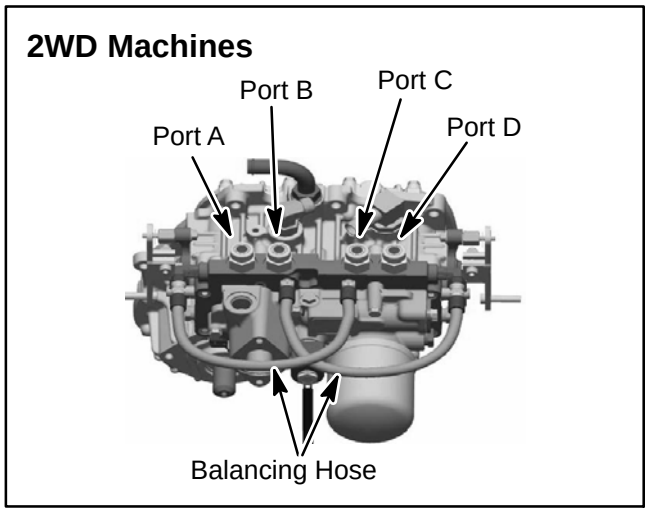

Figure 44

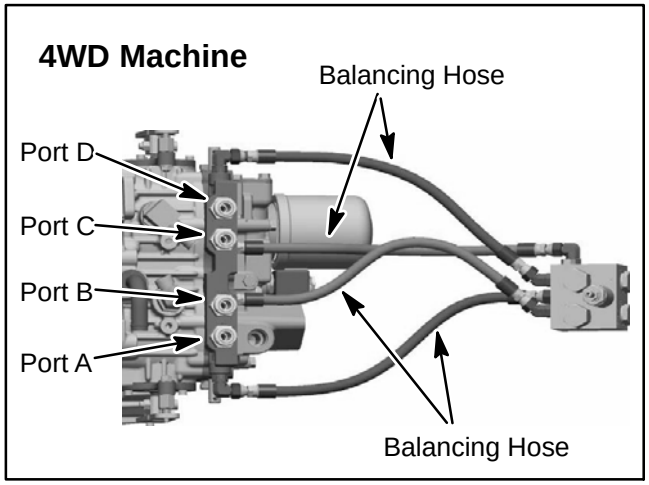

Figure 45

IMPORTANT: Use only hydraulic fluids specified in Operator's Manual. Other fluids could cause system damage.

7. After installing high flow filter to machine, check and fill hydraulic reservoir with new hydraulic oil as required.

8. Start engine and run at low idle speed **(1300 RPM)**. Check for any hydraulic leakage from filter and hose connections. Correct any leaks before proceeding.

CAUTION

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

IMPORTANT: While engaging the traction circuit, monitor the indicator on the high flow hydraulic filter. If the indicator should show red, either reduce pressure on the traction pedal or reduce engine speed to decrease hydraulic flow through the filter.

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

NOTE: When applying brakes to increase traction system pressure, make sure that parking brake latch is not depressed. If parking brake latch is depressed, engine will stop running.

10. With engine running at high idle speed **(3100 to 3150 RPM)** and traction pedal moved to the forward direction, periodically apply brakes to increase pressure in traction circuit. While monitoring filter indicator, continue this process for an additional five (5) minutes.

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

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

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

13. Remove high flow hydraulic filter and hydraulic hose kit from machine. Reconnect pump inlet and balancing hoses to transmission fittings. Make sure to properly tighten hoses (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

14. Repeat steps 4 through 13 to filter remaining piston pump circuit.

15. After filtering has been completed, lower machine to ground.

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

Charge Hydraulic System

NOTE: When initially starting the hydraulic system with new or rebuilt components such as wheel motors, gear pump or lift cylinder, 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 with engine off.

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 tank is full. Add correct oil if necessary.

5. Check traction control components for proper adjustment, binding or damaged parts.

6. Disconnect wire harness connector from engine fuel stop solenoid to prevent the engine from starting.

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

8. Connect wire harness connector to fuel stop solenoid.

WARNING

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

9. Raise the machine so all drive wheels are off the ground. Place jackstands under the frame to support the machine.

CAUTION

Make sure machine is safely supported so it will not move and accidentally fall to prevent injuring anyone under machine.

10. Make sure traction pedal is in the **neutral** position. Start engine and run at low idle speed **(1300 RPM)**. The charge and gear pumps should pick up oil and fill the hydraulic system. If there is no indication of fill in thirty (30) seconds, stop the engine and determine the cause.

11. After the hydraulic system starts to show signs of fill, actuate lift control switch until the lift cylinder moves in and out several times. If the lift cylinder does not move after three (3) to five (5) seconds or if the pump emits abnormal sounds, shut the engine off immediately and determine cause or problem. Inspect for the following:

    A. Loose oil filter or suction lines.

    B. Incorrect hose routing.

    C. Blocked suction line.

    D. Faulty implement relief valve.

    E. Faulty gear pump.

12. After lift cylinder moves normally, proceed to step 13.

13. Turn the steering wheel in both directions so that the steering cylinders move in and out several times.

14. Operate the traction pedal in the forward and reverse directions. The drive wheels should rotate in the proper direction. If the wheels rotate in the wrong direction, stop engine, inspect wheel motor location and hydraulic lines to wheel motors (see Transmission Installation in the Service and Repairs section of this chapter).

15. Adjust traction pedal to the neutral position (see Operator's Manual).

16. Lower machine to ground.

17. If the transmission or a wheel motor was replaced or rebuilt, operate the traction circuit on level ground so all drive wheels turn slowly for ten (10) minutes.

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

NOTE: Some aeration of hydraulic oil on this machine is normal. This aeration (foaming) may be more noticeable after initial filling of hydraulic tank.

19. Stop the machine. Check hydraulic oil level and adjust if necessary (do not overfill). Check hydraulic components for leaks. Tighten any loose connections.

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Hydraulic Tank

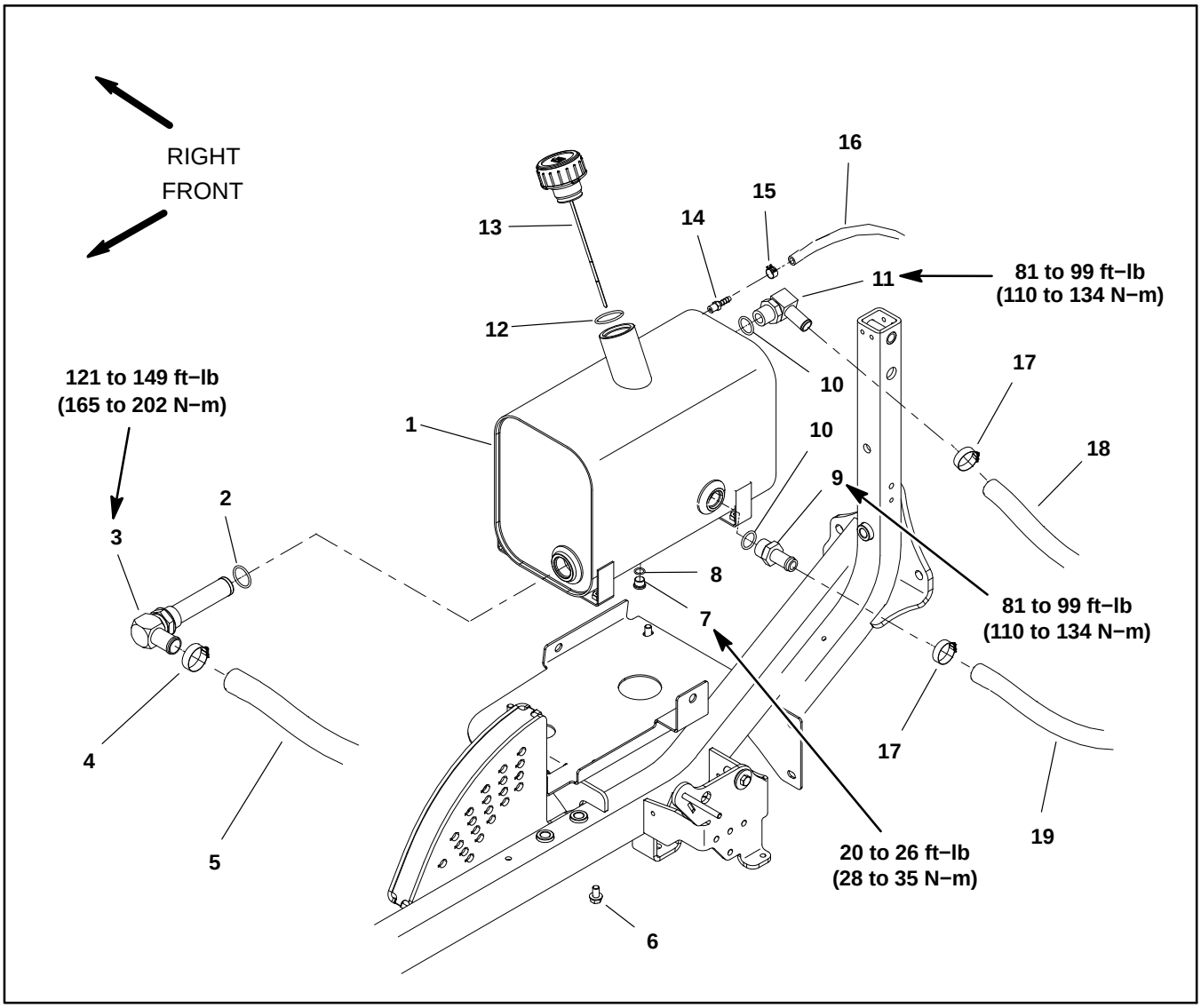

Figure 46

1. Hydraulic tank
2. O−ring
3. Suction strainer
4. Hose clamp
5. Suction hose
6. Flange head screw (4)
7. Plug
8. O−ring
9. Barbed fitting
10. O−ring
11. 90º hydraulic fitting
12. O−ring
13. Tank cap
14. Barbed fitting
15. Hose clamp
16. Hose
17. Hose clamp (2)
18. Suction hose
19. Suction hose

Hydraulic Tank Removal (Fig. 46)

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

2. Raise and support operator seat.

3. Drain hydraulic oil from hydraulic tank into a suitable container.

4. Remove hydraulic tank cover from machine (see Control Console Disassembly in the Service and Repairs section of Chapter 6 − Chassis).

5. Thoroughly clean hydraulic hose ends and fittings on hydraulic tank to prevent hydraulic system contamination.

6. Label all hydraulic hoses and fittings for assembly purposes. Remove hydraulic hoses from fittings on hydraulic tank (Fig. 47). Drain hoses into a suitable container.

7. Put clean plugs in disconnected hydraulic hoses and fittings to prevent system contamination.

8. Remove four (4) flange head screws that secure hydraulic tank to frame.

9. Remove hydraulic tank from machine.

10. As needed, remove fittings from hydraulic tank using Figure 46 as a guide. Discard and replace any removed O−rings.

Hydraulic Tank Inspection (Fig. 46)

1. Clean hydraulic tank and suction strainer with solvent.

2. Inspect hydraulic tank for leaks, cracks or other damage.

Hydraulic Tank Installation (Fig. 46)

1. Attach removed suction strainer and fittings with new, lubricated O−rings to hydraulic tank using Figure 46 as a guide (see Hydraulic Fitting Installation in the General Information section of this chapter). Torque fittings to values identified in Figure 46.

2. Position hydraulic tank to machine. Secure tank to frame with four (4) flange head screws.

3. Remove plugs that were installed in hydraulic hoses and fittings during the removal procedure.

4. Using labels placed during removal, attach hydraulic hoses to fittings on hydraulic tank (Fig. 47) (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

5. Fill hydraulic tank with **new** hydraulic fluid.

6. Install hydraulic tank cover to machine (see Control Console Assembly in the Service and Repairs section of Chapter 6 − Chassis).

7. Lower and secure operator seat.

8. Operate machine. Check hydraulic oil level and adjust if necessary. Check hydraulic components for leaks. Tighten any loose connections.

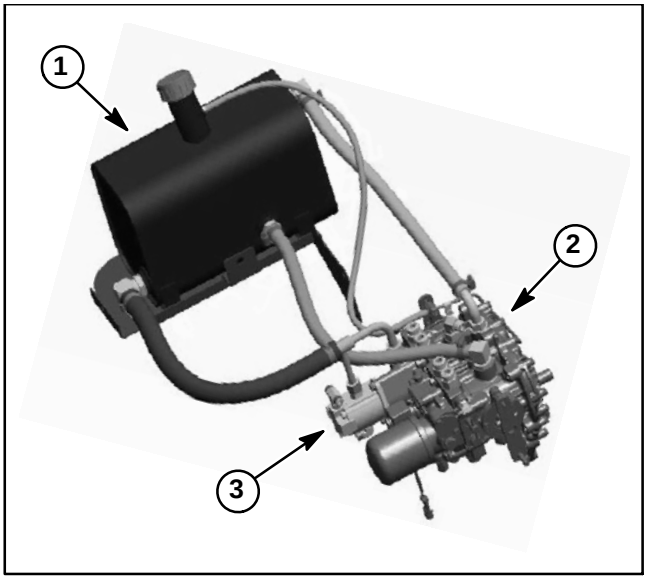

Figure 47

1. **Hydraulic tank**
2. **Transmission**
3. **Gear pump**

Rear Wheel Motors

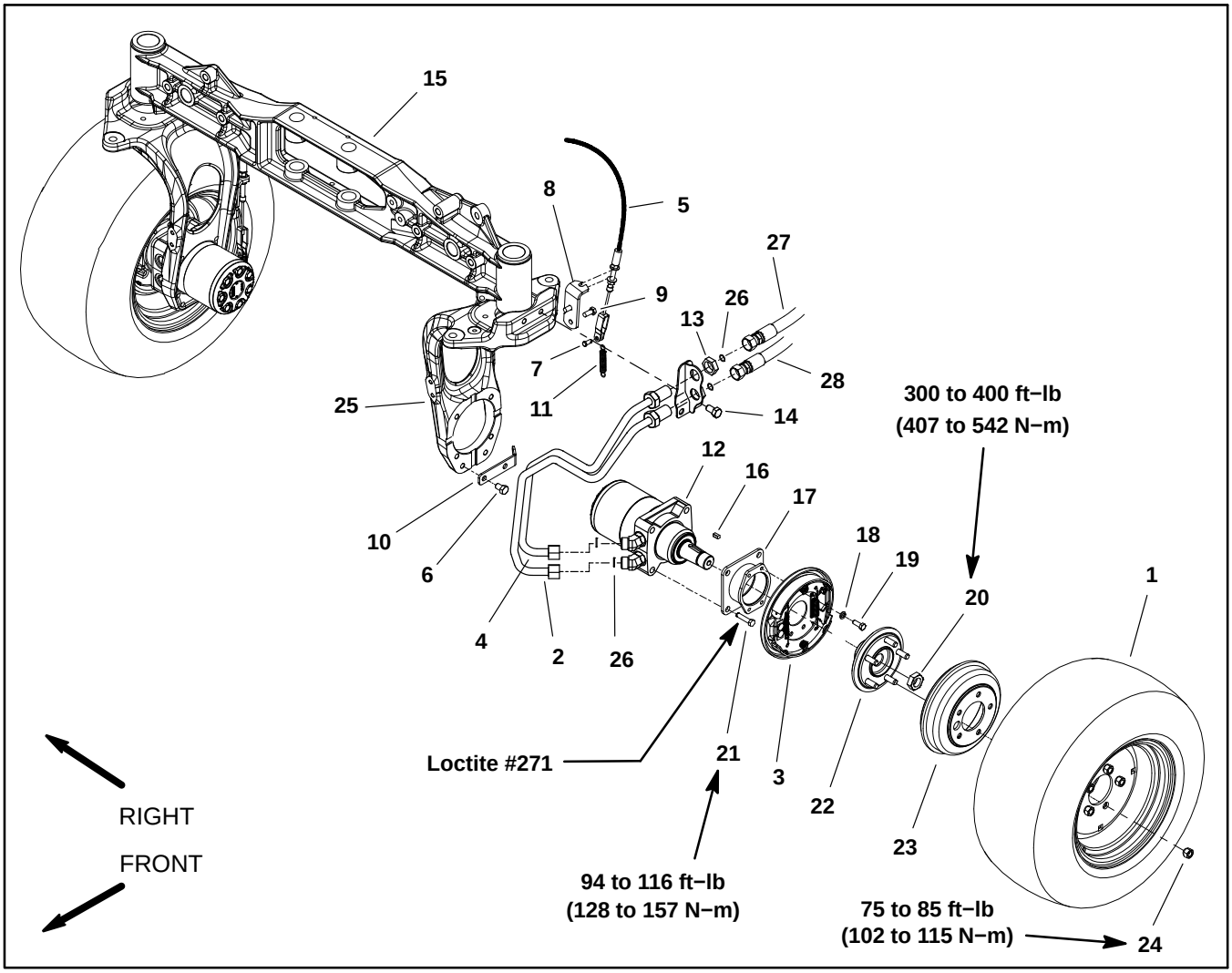

Figure 48

1. Rear wheel assembly (LH shown)
2. Hydraulic tube
3. Brake assembly (LH shown)
4. Hydraulic tube
5. Brake cable
6. Cap screw (2 per bracket)
7. Clevis pin
8. Brake cable bracket (LH shown)
9. Cap screw (2 per bracket)
10. Return spring bracket
11. Brake return spring
12. Wheel motor (LH shown)
13. Bulkhead nut (2 per bracket)
14. Cap screw (2 per bracket)
15. Rear axle
16. Square key
17. Brake support
18. Lock washer (4 per brake assy)
19. Cap screw (4 per brake assy)
20. Lock nut
21. Cap screw (4 per wheel motor)
22. Wheel hub
23. Brake drum
24. Lug nut (5 per wheel)
25. Steering fork assembly
26. O−ring
27. Hydraulic hose
28. Hydraulic hose

Removal (Fig. 48)

WARNING

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

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

2. Loosen but do not remove lock nut (item 20) that secures wheel hub to wheel motor. Also loosen wheel lug nuts.

WARNING

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

3. Jack up machine enough to allow the removal of the rear wheel. Support machine with jack stands.

4. Remove wheel assembly (item 1), brake drum (item 23), wheel hub (item 22) and brake assembly (item 3) from the machine (see Brake Service in the Service and Repairs section of Chapter 6 − Chassis).

5. Thoroughly clean hydraulic hose ends and fittings on wheel motor to prevent hydraulic system contamination.

6. Loosen and remove hydraulic tubes from fittings on wheel motor. Allow tubes to drain into a suitable container.

7. Put clean plugs in disconnected hydraulic tubes and fittings to prevent system contamination.

8. Support the wheel motor to prevent it from falling during removal.

9. Remove four (4) cap screws that secure wheel motor and brake support to the machine.

10. Remove wheel motor and brake support from steering fork.

11. If removal of wheel motor hydraulic fittings is necessary, mark fitting orientation to allow correct assembly. Remove hydraulic fittings from wheel motor (Fig. 49). Remove and discard O−rings from fittings.

Installation (Fig. 48)

IMPORTANT: Because of internal differences in wheel motors, DO NOT interchange wheel motors on machine (i.e. do not put RH motor on left side of machine). If necessary, use parts catalog and part number on wheel motor to identify RH and LH motors.

1. If fittings were removed from wheel motor, lubricate and install new O−rings to hydraulic fittings. Install fittings into wheel motor ports (see Hydraulic Fitting Installation in the General Information section of this chapter). Make sure that fittings are orientated correctly.

2. Clean threads in steering fork and on cap screws used to secure wheel motor to machine.

3. Position rear wheel motor to steering fork. Make sure that ports in wheel motor are facing forward.

4. Apply Loctite #271 (or equivalent) to threads of cap screws. Secure rear wheel motor and brake support to steering fork with four (4) cap screws. Torque cap screws from **94 to 116 ft−lb (128 to 157 N−m)**.

5. Remove plugs from disconnected hydraulic tubes and wheel fittings.

6. Connect hydraulic tubes to wheel motor fittings (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

7. Install brake assembly (item 3), wheel hub (item 22), brake drum (item 23) and wheel assembly (item 1) to the machine (see Brake Service in the Service and Repairs section of Chapter 6 − Chassis).

8. Lower the machine to the ground.

WARNING

Failure to properly torque wheel lug nuts and wheel hub lock nut could result in failure or loss of wheel and may result in personal injury.

9. Torque lock nut (item 20) from **300 to 400 ft−lb (407 to 542 N−m)**. Also, make sure that wheel lug nuts are torqued evenly in a crossing pattern from **75 to 85 ft−lb (102 to 115 N−m)**.

10. Make sure hydraulic tank is full. Add correct oil if necessary.

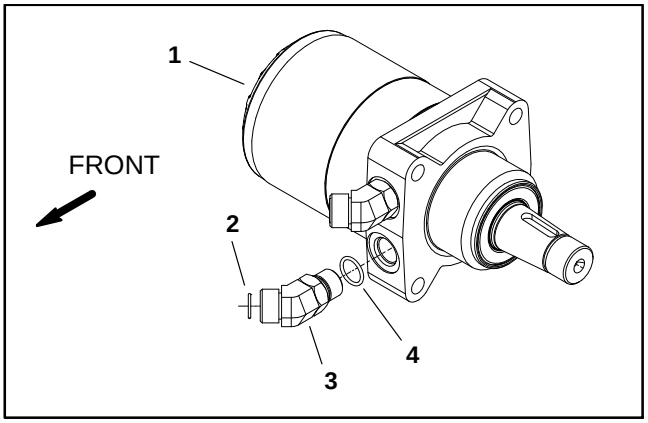

Figure 49

1. **Wheel motor**
2. **O−ring**
3. **45° fitting (2)**
4. **O−ring**

Front Wheel Motors (4WD Machines)

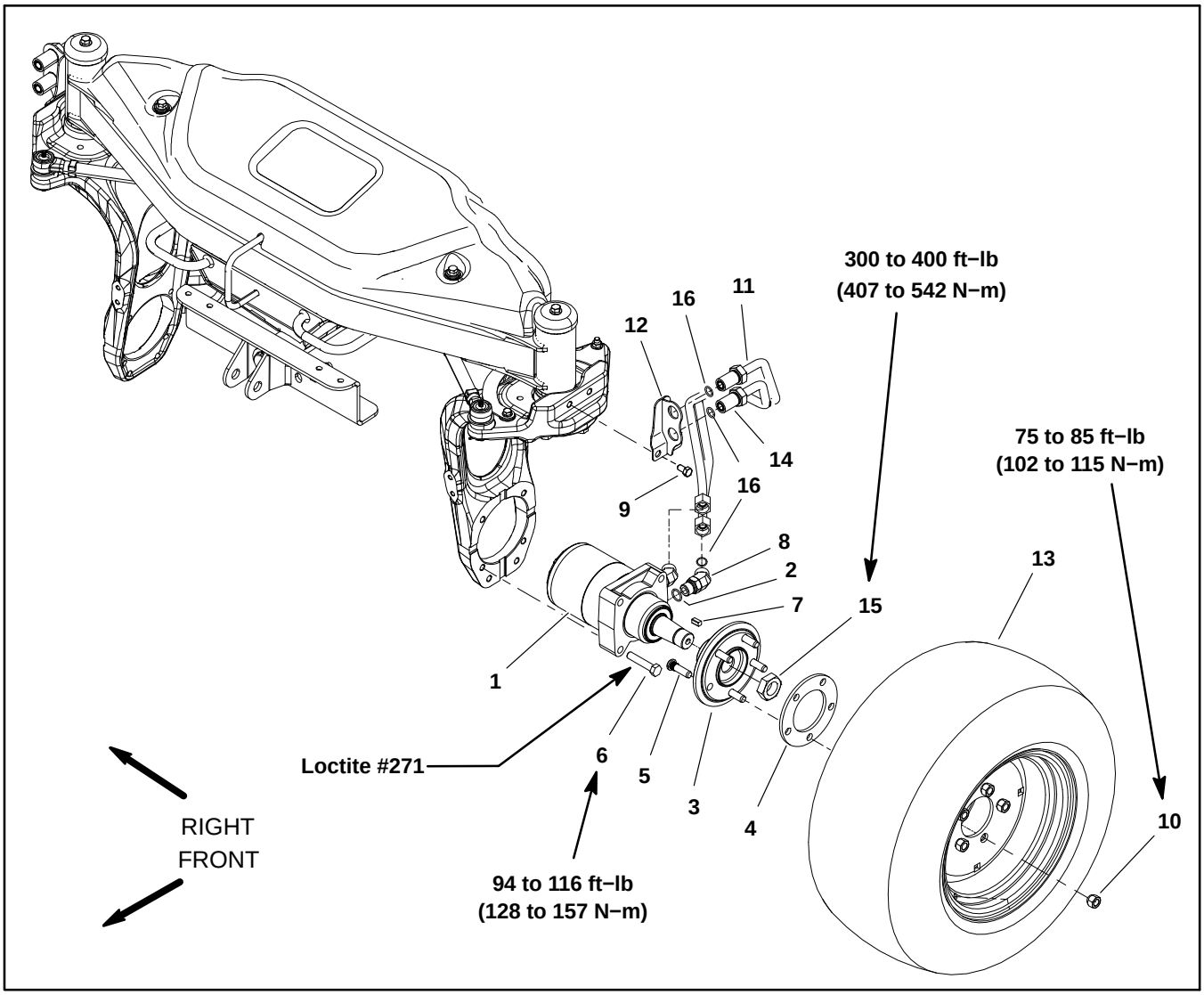

Figure 50

1. Front wheel motor (LH shown)
2. O−ring
3. Wheel hub
4. Wheel spacer
5. Wheel stud (5 per wheel)
6. Cap screw (4 per motor)
7. Square key
8. 45º fitting (2 per motor)
9. Cap screw (2 per bracket)
10. Lug nut (5 per wheel)
11. Hydraulic tube
12. Bulkhead bracket
13. Front wheel assembly
14. Hydraulic tube
15. Lock nut
16. O−ring

Removal (Fig. 50)

WARNING

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

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

2. Loosen but do not remove lock nut (item 15) that secures wheel hub to wheel motor. Also loosen wheel lug nuts.

WARNING

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

3. Jack up machine enough to allow the removal of the front wheel. Support machine with jack stands.

4. Remove front wheel from the machine (see Wheel Removal in the Service and Repairs section of Chapter 6 − Chassis). Remove wheel spacer (item 4).

IMPORTANT: DO NOT hit wheel hub, puller or wheel motor with a hammer during wheel hub removal or installation. Hammering may cause damage to the wheel motor.

5. Make sure that lock nut on wheel motor shaft is loosened at least two (2) turns. Use hub puller (see Special Tools in this chapter) to loosen wheel hub from wheel motor.

6. Remove lock nut (item 15) and wheel hub from motor shaft. Discard lock nut. Locate and retrieve square key (item 7).

7. Thoroughly clean hydraulic tube ends and fittings on wheel motor to prevent hydraulic system contamination.

8. Loosen and remove hydraulic tubes from fittings on wheel motor. Allow tubes to drain into a suitable container.

9. Put clean plugs in disconnected hydraulic tubes and fittings to prevent system contamination.

10. Support the wheel motor to prevent it from falling during removal.

11. Remove four (4) cap screws that secure wheel motor to the steering fork.

12. Remove wheel motor from steering fork.

13. If removal of wheel motor hydraulic fittings is necessary, mark fitting orientation to allow correct assembly. Remove hydraulic fittings from wheel motor. Remove and discard O−rings from fittings.

Installation (Fig. 50)

IMPORTANT: Because of internal differences in wheel motors, DO NOT interchange wheel motors on machine (i.e. do not put RH motor on left side of machine). If necessary, use parts catalog and part number on wheel motor to identify RH and LH motors.

1. If fittings were removed from wheel motor, lubricate and install new O−rings to hydraulic fittings. Install fittings into wheel motor ports (see Hydraulic Fitting Installation in the General Information section of this chapter). Make sure that fittings are orientated correctly.

2. Clean threads in steering fork and on cap screws used to secure wheel motor to machine.

3. Position front wheel motor to steering fork. Make sure that ports in wheel motor are facing toward rear of machine.

4. Apply Loctite #271 (or equivalent) to threads of cap screws. Secure front wheel motor to steering fork with four (4) cap screws. Torque cap screws from **94 to 116 ft−lb (128 to 157 N−m)**.

IMPORTANT: Before wheel hub is installed, thoroughly clean tapers of wheel hub and wheel motor shaft. Make sure that tapers are free of grease, oil, rust and dirt. Do not use antiseize lubricant when installing wheel hub.

5. Mount square key (item 7) in the wheel motor shaft, then install the wheel hub onto the wheel motor shaft.

IMPORTANT: Do not reuse lock nut that secures wheel hub to wheel motor after it has been removed.

6. Install new lock nut (item 15) onto the wheel motor shaft to secure wheel hub to motor shaft.

7. Remove plugs from disconnected hydraulic tubes and wheel fittings.

8. Connect hydraulic tubes to wheel motor fittings (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

9. Install wheel spacer (item 4) and wheel assembly to the machine (see Wheel Installation in the Service and Repairs section of Chapter 6 − Chassis).

10. Lower the machine to the ground.

WARNING

Failure to properly torque wheel lug nuts and wheel hub lock nut could result in failure or loss of wheel and may result in personal injury.

11. Torque lock nut (item 15) from **300 to 400 ft−lb (407 to 542 N−m)**. Also, make sure that wheel lug nuts are torqued evenly in a crossing pattern from **75 to 85 ft−lb (102 to 115 N−m)**.

12. Make sure hydraulic tank is full. Add correct oil if necessary.

Wheel Motor Service

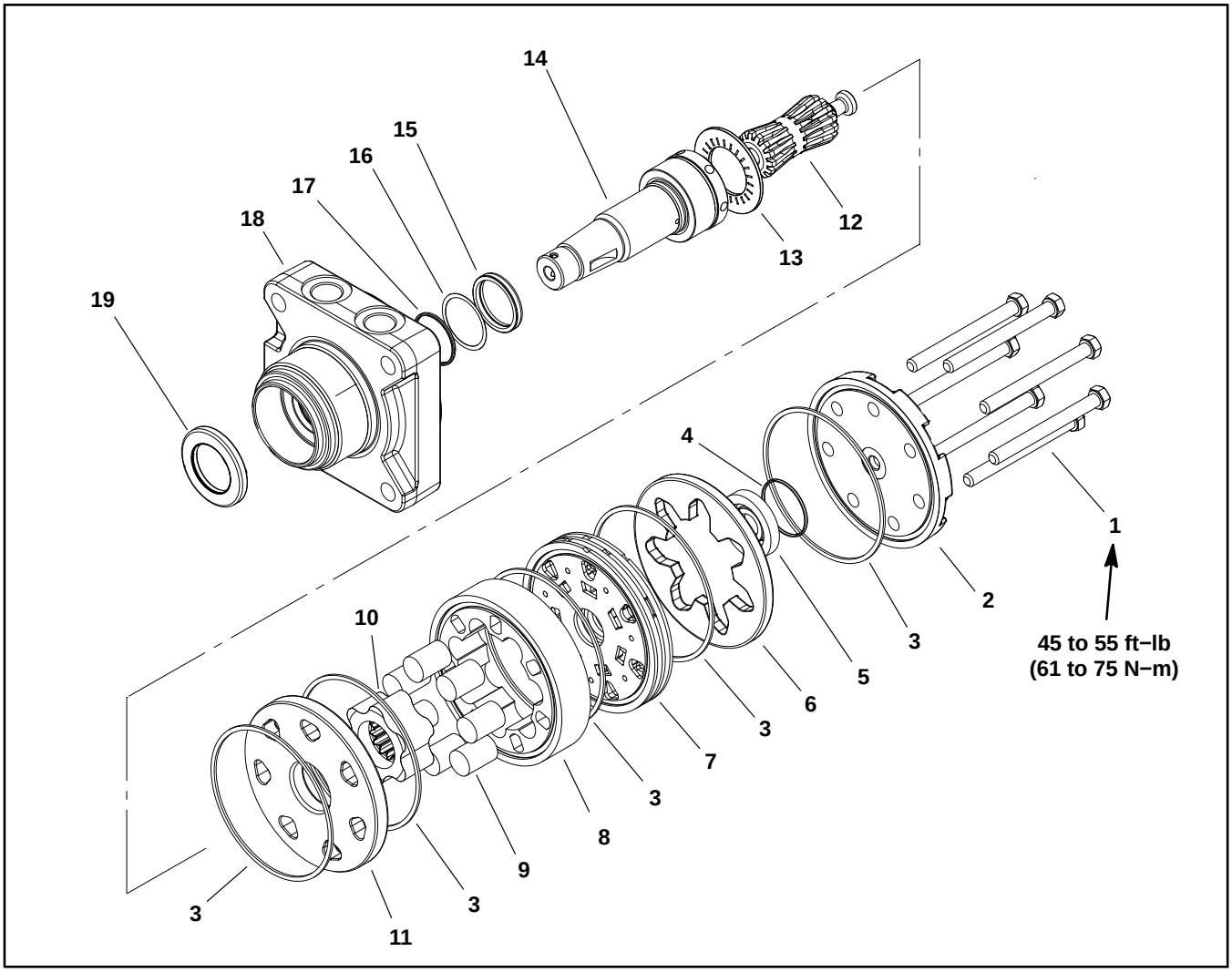

Figure 51

1. Cap screw (7)
2. End cover
3. Body seal (5)
4. Commutator ring
5. Commutator
6. Commutator ring
7. Manifold
8. Stator
9. Vane (7)
10. Rotor
11. Wear plate
12. Drive link
13. Thrust bearing
14. Coupling shaft
15. Shaft seal
16. Back−up washer
17. Back−up ring
18. Housing
19. Dirt and water seal

NOTE: The wheel motors used on the Groundsmaster 360 have the same basic construction. The left wheel motor(s) has a yellow sticker on the port side of the stator. The right wheel motor(s) has a reverse timed manifold.

IMPORTANT: DO NOT interchange wheel motors on machine (i.e. do not put RH motor on left side of machine). If necessary, use parts catalog and part number on wheel motor to identify RH and LH motors.

NOTE: For wheel motor repair procedures, see the Parker Torqmotor™ Service Procedure (TC, TB, TE, TJ, TF, TG, TH and TL Series) at the end of this chapter.

IMPORTANT: If a wheel motor failure occurred, refer to Traction Circuit (Closed Loop) Component Failure in the General Information section for information regarding the importance of removing contamination from the traction circuit.

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Traction Linkage Assembly (Serial Number Below 313999999)

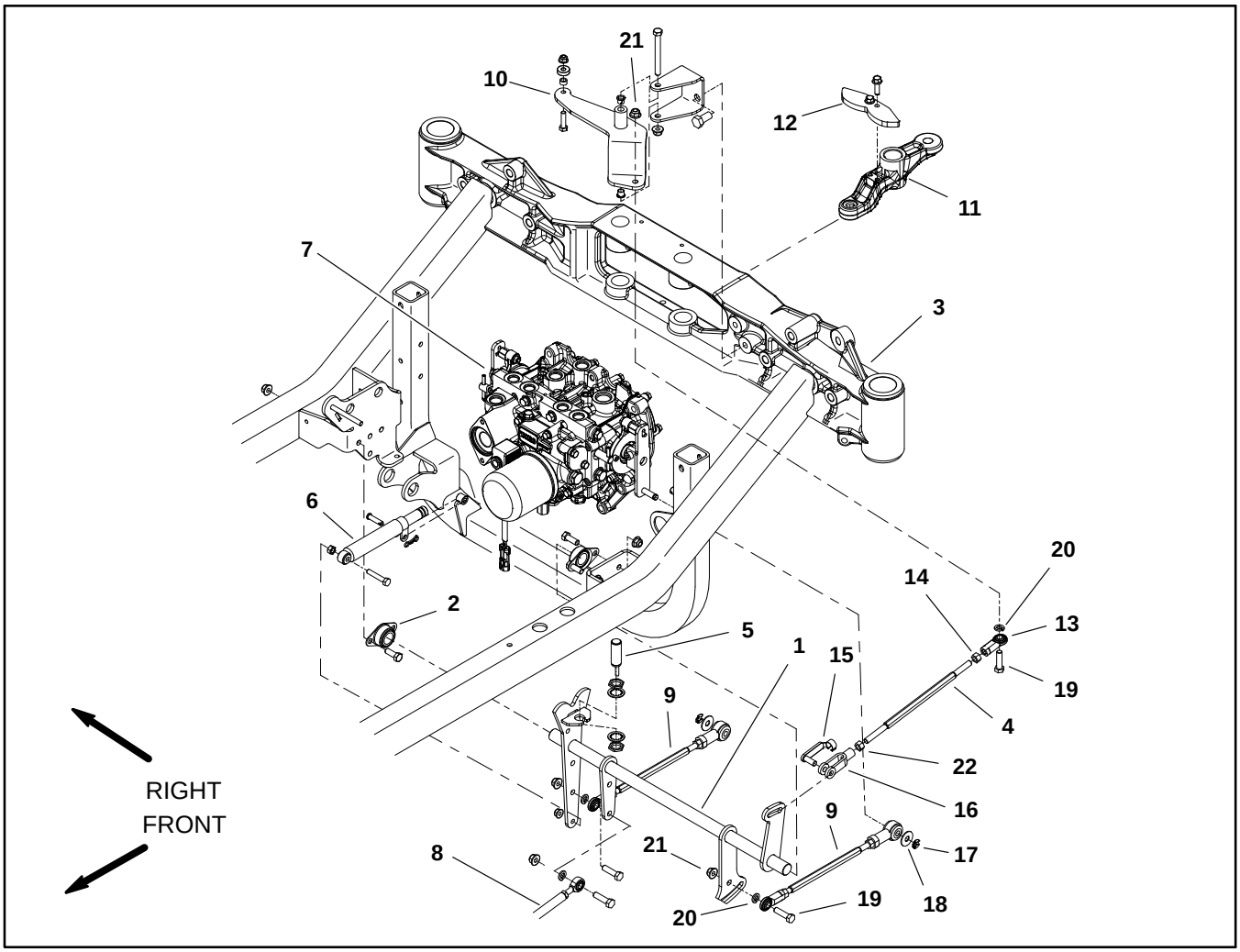

Figure 52

1. Speed control shaft
2. Flange bearing (2)
3. Rear axle
4. ASC control arm
5. Neutral sensor
6. Damper
7. Transmission assembly
8. Traction rod assembly
9. Control arm (2)
10. ASC lever
11. LH steering arm
12. ASC cam
13. Ball joint (LH threads)
14. Jam nut (LH threads)
15. Clevis spring pin
16. Linkage yoke
17. Retaining ring
18. Washer
19. Cap screw
20. Lock washer
21. Flange nut
22. Jam nut

The Groundsmaster 360 transmission includes two (2) piston pumps. The swash plate in each of the piston pumps is controlled by the operator traction pedal through the traction linkage assembly. Correct assembly of the traction linkage assembly (Fig. 53) is required for proper traction circuit operation.

NOTE: Groundsmaster 360 machines with serial number below 314999999 are equipped with Automatic Speed Control (ASC) which modulates ground speed when turning the machine. The traction pedal linkage is designed to limit traction pedal movement when the machine is turning.

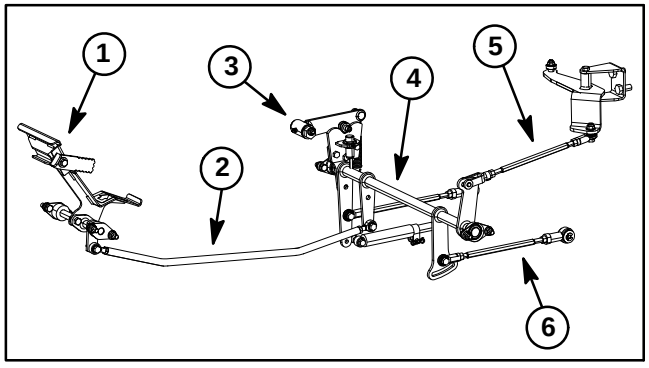

Figure 53

1. Traction pedal
2. Traction rod assembly
3. Neutral arm
4. Speed control shaft
5. ASC control arm
6. Control arm (2)

When servicing the traction linkage on your Groundsmaster 360, use the following information:

NOTE: Refer to the Operator's Manual for information on adjusting traction pedal stops, mow speed limiter lever and traction pedal neutral position.

1. Rod ends on traction rod assembly should be installed equally into traction rod so that distance between center of rod ends is 28.520" (724.4 mm) (Fig. 54). Leave rod end jam nuts loose until traction rod is secured to traction pedal and speed control shaft to make sure that rod ends do not bind.

2. If eye bolt that locates the bottom of the neutral arm spring is removed, install eye bolt so threads extend below the flange nut from 0.250 to 0.370" (6.4 to 9.3 mm) (Fig. 56). If quicker return to the traction neutral position is desired, adjustment can made to increase amount of thread extension. This adjustment will also result in higher pressure required to depress traction pedal.

3. Adjust the control arms as follows:

   A. Align transmission control arm with transmission side cover with a 3/8" alignment pin (Fig. 57). This ensures that transmission is in the neutral position.

   B. Adjust length of control arm (Fig. 58) until alignment pin can freely slide in transmission components. Tighten control arm jam nuts after adjustment. Make sure that control arm rod end and ball joint remain vertical and parallel after adjustment.

   C. After adjustment, make sure that control arm ball joint rotates freely and that alignment pin still slides freely in transmission components when in neutral. Also, check that control arms do not bind as traction pedal is depressed.

4. Make sure that traction neutral sensor is closed when the traction pedal is in the neutral position:

   A. On 2WD machines, use LED on Standard Control Monitor to check traction neutral sensor operation (see Standard Control Module (2WD Machines) in the Service and Repairs section of Chapter 5 − Electrical System).

   B. On 4WD machines, use Diagnostic Display to check traction neutral sensor operation (see Diagnostic Display (4WD machines) in the Troubleshooting section of Chapter 5 − Electrical System).

   C. The traction neutral sensor LED should be illuminated when the traction pedal is in the neutral position (see Traction Neutral Sensor in the Adjustments section of Chapter 5 − Electrical System).

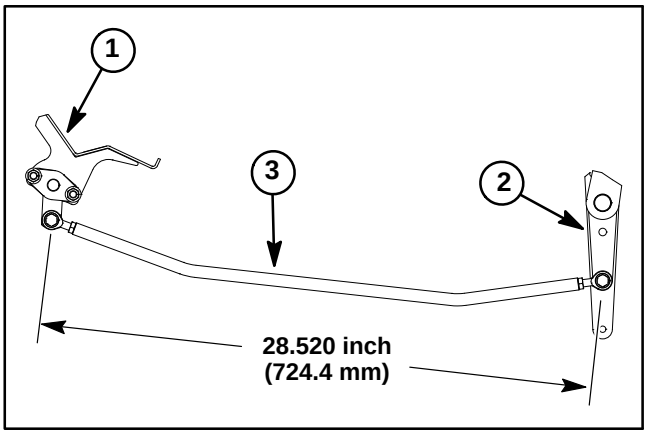

Figure 54

1. Traction pedal
2. Speed control shaft
3. Traction rod assembly

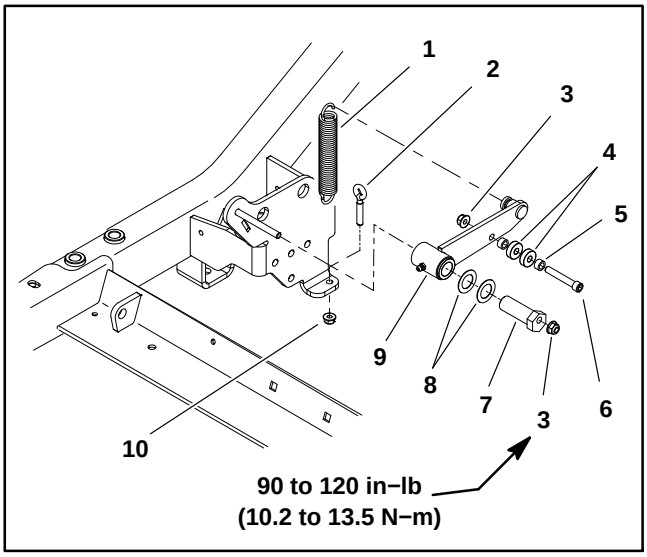

Figure 55

1. Extension spring
2. Eye bolt
3. Flange nut (2)
4. Ball bearing (2)
5. Spacer (2)
6. Socket head screw
7. Traction stud
8. Thrust washer
9. Neutral arm
10. Flange nut

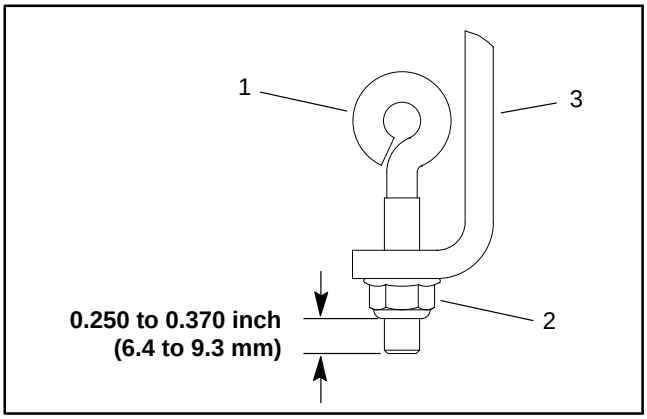

Figure 56

1. Eye bolt
2. Flange nut
3. Frame bracket

5. For correct operation of Automatic Speed Control (ASC), adjust the ASC control arm as follows (Fig. 59):

NOTE: Before adjusting the ASC control arm, make sure that traction pedal stop is correctly adjusted.

A. With the rear wheels in the straight forward position (not turned), fully depress and hold the traction pedal in the full forward direction.

B. Check that the clevis spring pin that secures the ASC control arm to the speed control shaft is just contacting the rear of the slot in the speed control shaft.

C. If necessary, loosen jam nuts on ASC control arm and adjust control arm length until clevis spring pin just contacts the rear of the control shaft slot. Make sure that linkage yoke and ball joint on ASC control arm are at right angles (90^{o}). Tighten control arm jam nuts after adjustment.

D. Make sure that ASC control arm does not bind through complete range of operation.

6. After adjustments have been made and all traction linkage fasteners are tightened, make sure that no binding exists as the traction pedal is depressed. The traction pedal should freely return to the neutral position after it is released from either forward or reverse. Also, make sure that the traction rod does not contact anything through both forward and reverse directions.

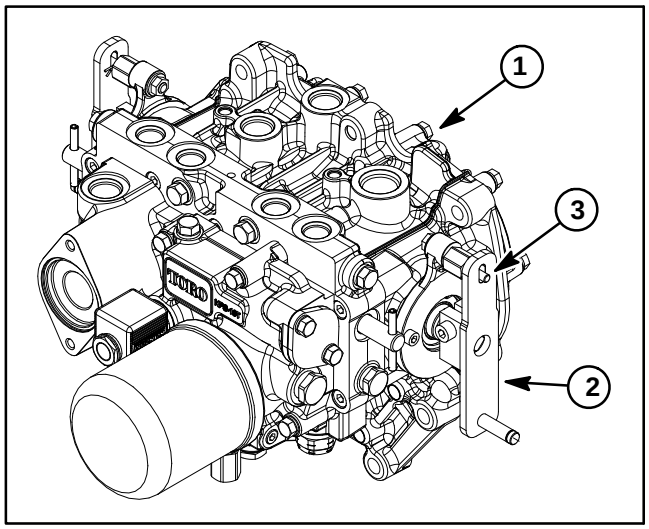

Figure 57

1. **Transmission assembly**
2. **Control arm**
3. **Alignment pin**

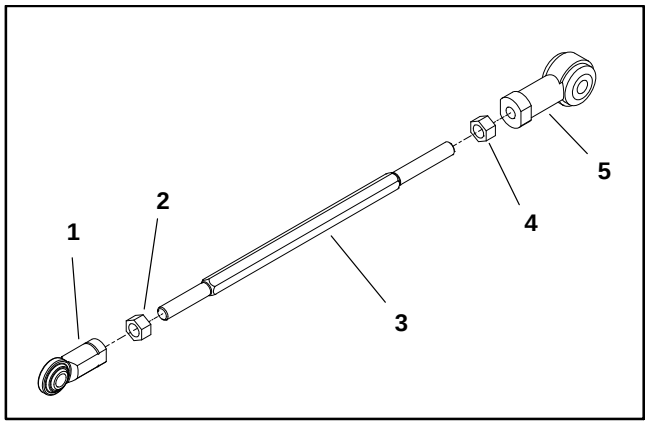

Figure 58

1. **Ball joint (LH threads)**
2. **Jam nut (LH threads)**
3. **Control arm**
4. **Jam nut**
5. **Rod end**

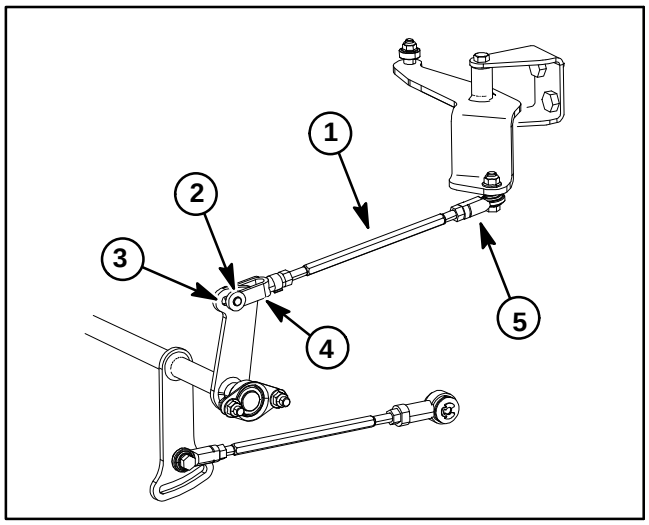

Figure 59

1. **ASC control arm**
2. **Clevis spring pin**
3. **Speed control slot**
4. **Linkage yoke**
5. **Ball joint**

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Traction Linkage Assembly (Serial Number Above 314000000)

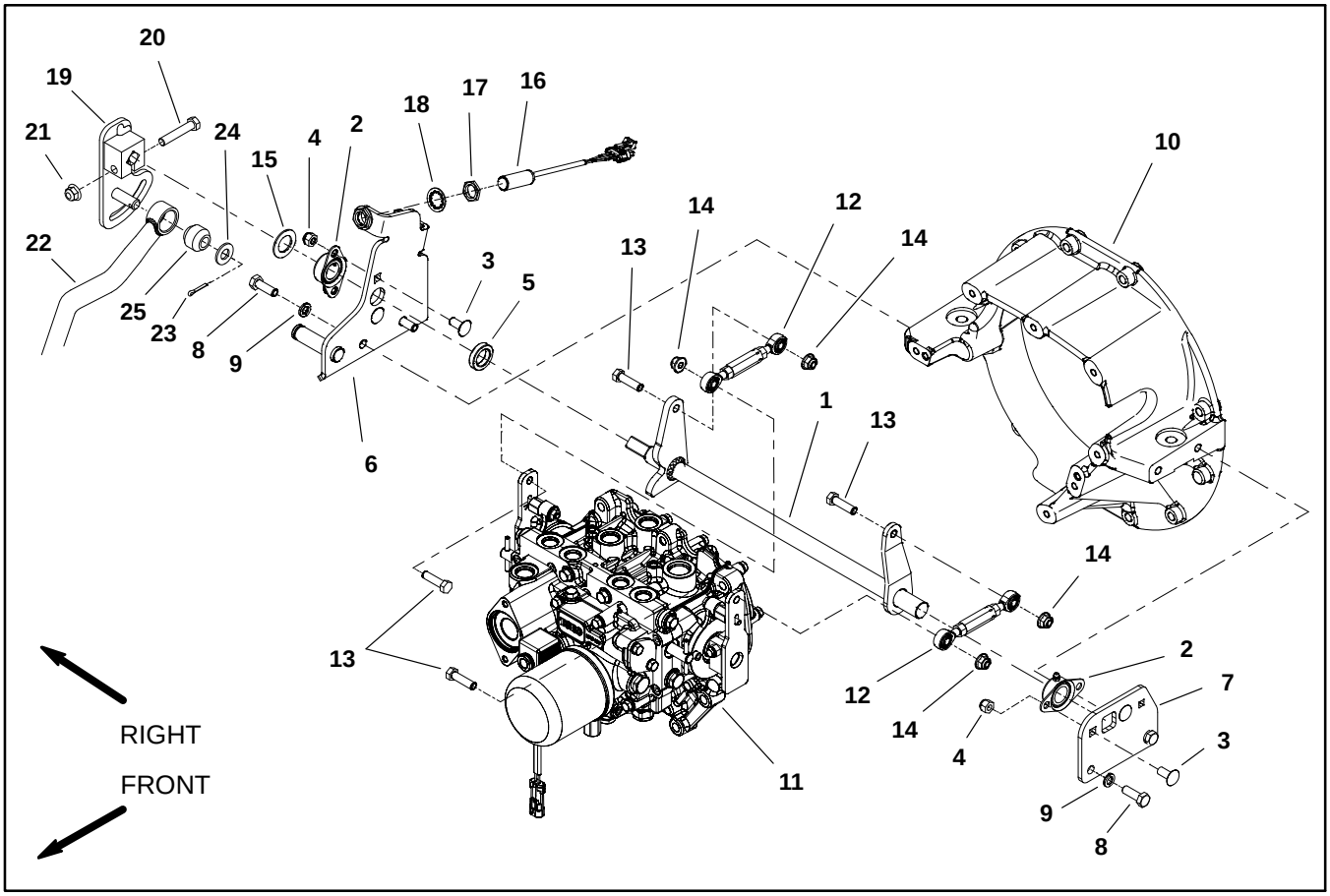

Figure 60

1. **Speed control shaft**
2. **Flange bearing (2)**
3. **Carriage screw (2 per bearing)**
4. **Lock nut (2 per bearing)**
5. **Spacer**
6. **RH end plate**
7. **LH end plate**
8. **Cap screw (2 per plate)**
9. **Lock washer (2 per plate)**
10. **Flywheel housing**
11. **Transmission assembly**
12. **Link assembly (2)**
13. **Cap screw (2 per link)**
14. **Flange nut (2 per link)**
15. **Flat washer**
16. **Neutral sensor**
17. **Jam nut (2)**
18. **Lock washer (2)**
19. **Traction lever**
20. **Cap screw**
21. **Flange nut**
22. **Traction rod (to traction pedal)**
23. **Cotter pin**
24. **Flat washer**
25. **Rubber bushing**

The Groundsmaster 360 transmission includes two (2) piston pumps. The swash plate in each of the piston pumps is controlled by the operator traction pedal through the traction linkage assembly. Correct assembly of the traction linkage assembly (Fig. 60) and neutral system (Fig. 61) is required for proper traction circuit operation.

NOTE: Refer to the Operator's Manual for information on adjusting traction pedal stops, mow speed limiter lever and traction pedal neutral position.

When servicing the traction linkage on your Groundsmaster 360, use the following information:

1. If spring hook (item 17 in Fig. 61) that locates the bottom of the neutral arm spring is removed, install hook with flange nut so that distance from bracket on RH end plate to front side of spring hook is from **1.530" to 1.560" (38.9 to 39.3 mm)** (Fig. 62). If quicker return to the traction neutral position is desired, adjustment to spring hook can made to increase spring tension. This adjustment will also result in higher pressure required to depress traction pedal.

2. When securing traction lever (item 19 in Fig. 60) to speed control shaft (item 1), make sure that cap screw is inserted through the relief in the control shaft.

3. If link assemblies (item 12 in Fig. 60) are removed, install the links so that the rod end with left hand threads is secured to the speed control shaft.

4. Adjust the link assemblies (item 12 in Fig. 60) as follows:

A. Align transmission control arm with transmission side cover with a 3/8" alignment pin (Fig. 63). This ensures that transmission is in the neutral position.

B. Adjust length of link assembly (Fig. 64) until alignment pin can freely slide in transmission components. Tighten link jam nuts after adjustment. To prevent binding, make sure that rod ends on link remain vertical and parallel after adjustment.

C. After adjustment, make sure that control arm ball joint rotates freely and that alignment pin still slides freely in transmission components when in neutral. Also, check that control arms do not bind as traction pedal is depressed.

5. Make sure that traction neutral sensor is closed when the traction pedal is in the neutral position:

A. On 2WD machines, use LED on Standard Control Monitor to check traction neutral sensor operation (see Standard Control Module (2WD Machines) in the Service and Repairs section of Chapter 5 − Electrical System).

B. On 4WD machines, use Diagnostic Display to check traction neutral sensor operation (see Diagnostic Display (4WD machines) in the Troubleshooting section of Chapter 5 − Electrical System).

C. The traction neutral sensor LED should be illuminated when the traction pedal is in the neutral position (see Traction Neutral Sensor in the Adjustments section of Chapter 5 − Electrical System).

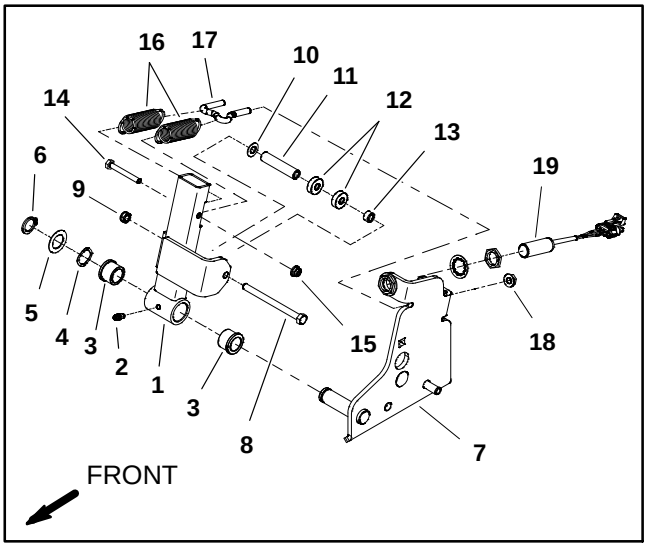

Figure 61

1. **Neutral arm**
2. **Grease fitting**
3. **Flange bushing (2)**
4. **Wave washer**
5. **Thrust washer**
6. **Retaining ring**
7. **RH end plate**
8. **Cap screw**
9. **Lock nut**
10. **Thrust washer**
11. **Spacer**
12. **Ball bearing (2)**
13. **Pivot spacer**
14. **Cap screw**
15. **Flange nut**
16. **Spring (2)**
17. **Spring hook**
18. **Flange nut**
19. **Neutral sensor**

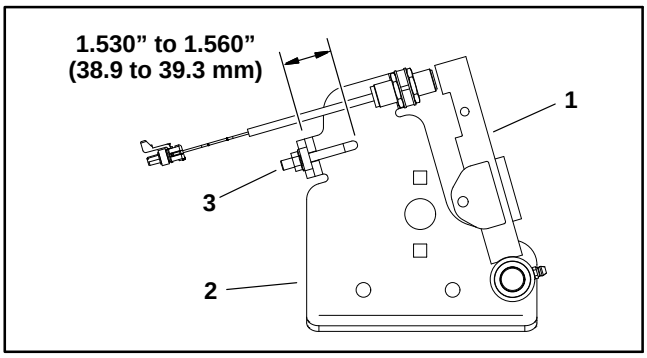

Figure 62

1. **Neutral arm**
2. **RH end plate**
3. **Spring hook**

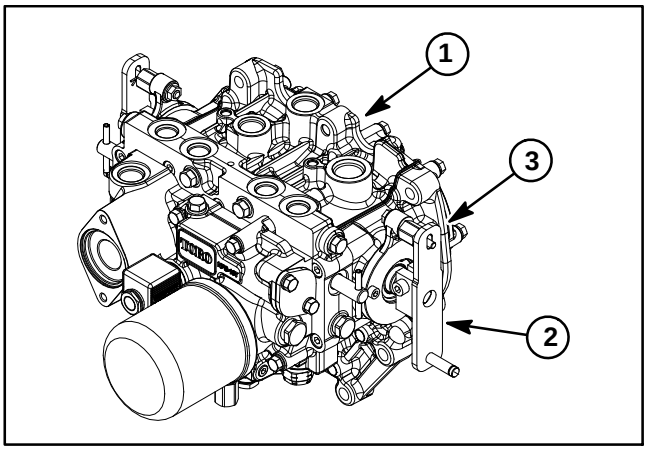

Figure 63

1. **Transmission assembly**
2. **Control arm**
3. **Alignment pin**

6. The rod end on the traction rod assembly is used to adjust the orientation of the traction pedal. With the traction pedal in the neutral position (shown in Figure 65), the standard height from the front platform (footrest) to the rear of the pedal is **1.760” to 1.890” (44.7 to 48.0 mm)**. If your Groundsmaster is equipped with an operator cab which has a layer of padding on the footrest, the standard height is **1.340” to 1.460” (34.3 to 37.0 mm)**. If the pedal height is changed, the pedal may not be capable of reaching the full forward or reverse direction.

7. Leave traction rod assembly rod end jam nut (at traction pedal) loose until traction rod is secured to both traction pedal and traction lever at speed control shaft. This process will make sure that rod end does not bind at traction pedal.

8. Lubricate grease fitting on neutral arm (item 2 in Fig. 61) after assembly of all traction linkage components.

9. After adjustments have been made and all traction linkage fasteners are tightened, make sure that no binding exists as the traction pedal is depressed in both the forward and reverse direction. The traction pedal should freely return to the neutral position after it is released from either forward or reverse. Also, make sure that the traction rod does not contact other machine components through both forward and reverse directions.

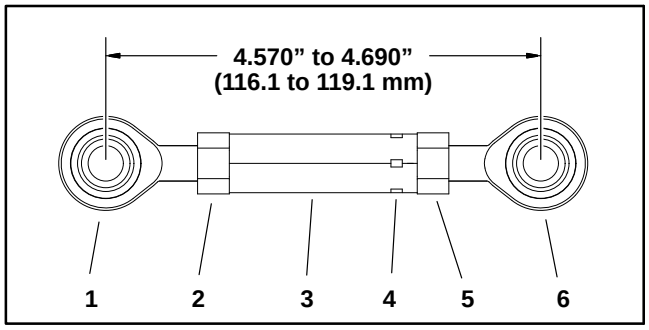

Figure 64

1. **Rod end (RH threads)**
2. **Jam nut (RH threads)**
3. **Control arm**
4. **LH thread identification**
5. **Jam nut (LH threads)**
6. **Rod end (LH threads)**

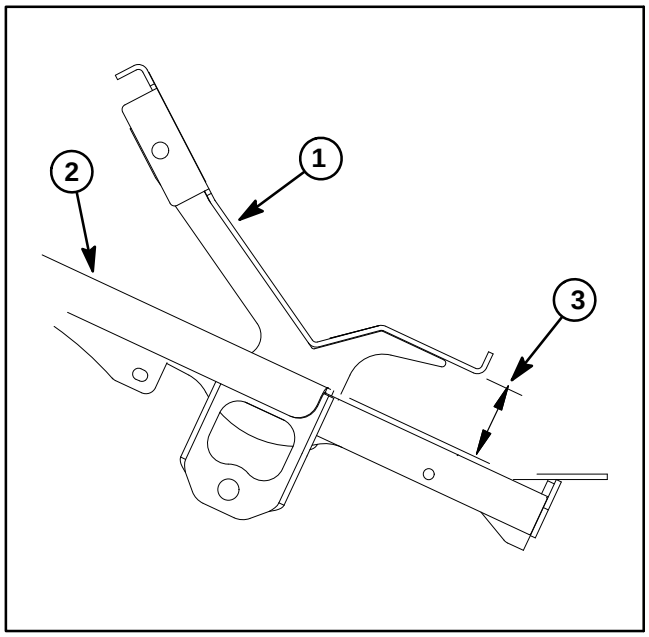

Figure 65

1. **Traction pedal**
2. **Floor**
3. **Pedal height**

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Transmission

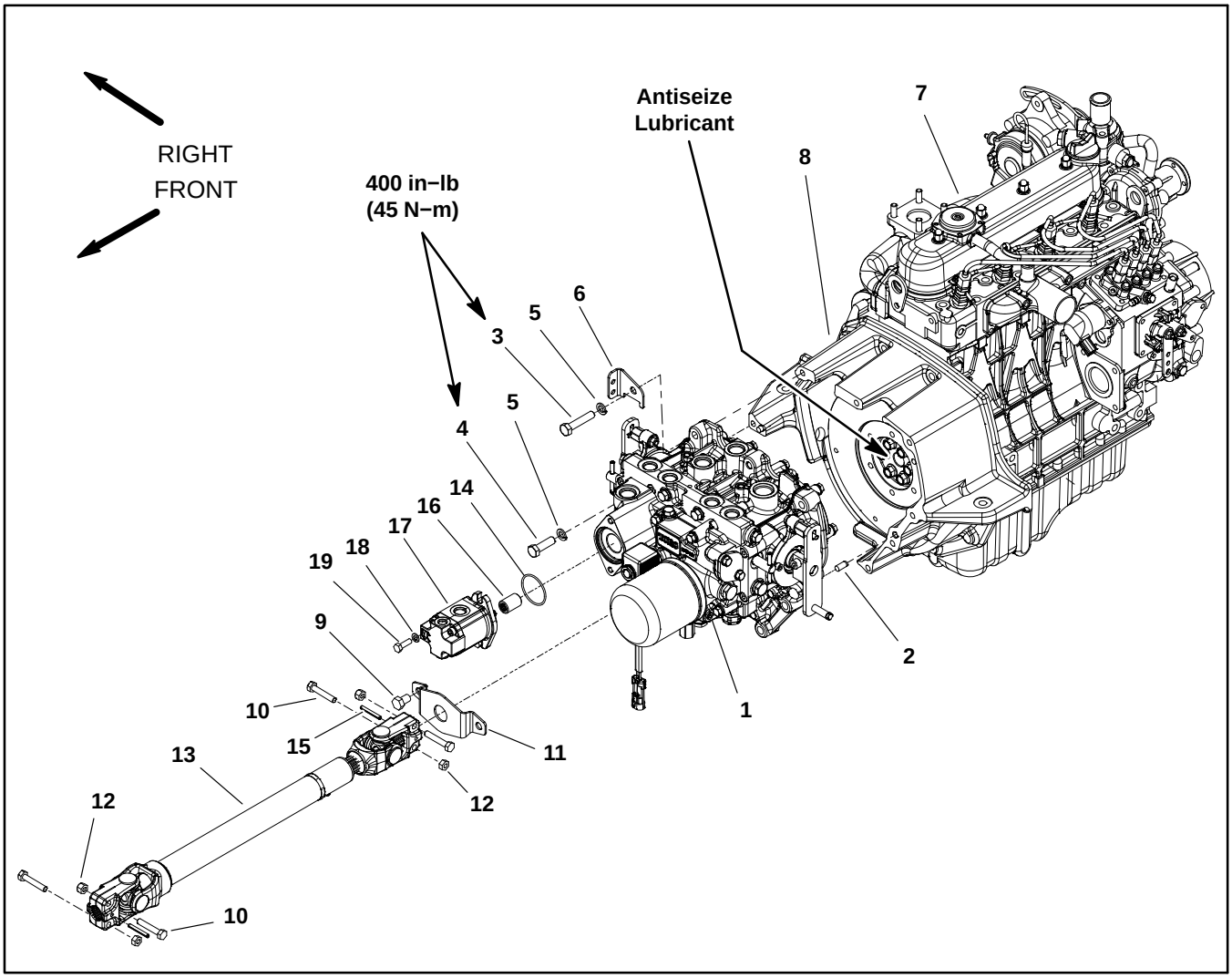

Figure 66

1. Transmission assembly
2. Dowel pin (2)
3. Cap screw (50 mm long) (6)
4. Cap screw (35 mm long)
5. Lock washer (7)
6. Bracket
7. Engine
8. Flywheel housing
9. Cap screw (2)
10. Cap screw (4)
11. Shield
12. Lock nut (4)
13. Driveshaft assembly
14. O−ring
15. Roll pin (2)
16. Coupler
17. Gear pump assembly
18. Lock washer (2)
19. Cap screw (2)

Transmission Removal (Fig. 66)

WARNING

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

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

2. Remove seat and seat plate from machine (see Operator Seat Removal in the Service and Repairs section of Chapter 6 − Chassis).

3. To allow easier access to transmission area, remove storage compartment from behind operator seat (see Storage Compartment Removal in the Service and Repairs section of Chapter 6 − Chassis or, if machine is equipped with operator cab, see Storage Compartment Removal in the Service and Repairs section of Chapter 8 − Operator Cab).

4. On both sides of machine, remove cap screw and flange nut that secures the pump control arm to the speed control shaft (Fig. 67). Note that cap screw is installed toward the right side of the machine. Locate and retrieve lock washer from between control arm and control shaft.

5. Unplug wire harness electrical connector from transmission solenoid valve coil. Position wire harness away from transmission.

6. Drain oil from hydraulic tank and transmission.

IMPORTANT: When repositioning seat channel to allow transmission removal, make sure to not damage the electrical harness or other parts.

7. Remove two (2) carriage screws and flange nuts that secure seat channel to frame (Fig. 68). Separate channel from frame and carefully position channel away from frame to allow easier transmission removal.

8. Thoroughly clean hydraulic hose ends and fittings on transmission and gear pump to prevent hydraulic system contamination.

9. Label all hydraulic hoses and fittings on transmission and gear pump for assembly purposes. Remove hydraulic hoses from fittings on transmission and gear pump. Allow hoses to drain into a suitable container.

10. Install clean plugs in hose and fitting openings to prevent system contamination.

NOTE: Two (2) 8 mm eye bolts can be installed into threaded bosses in top of transmission to allow use of a lift or hoist to remove transmission.

CAUTION

Support transmission assembly when removing it from the flywheel housing to prevent it from falling and causing personal injury. Transmission weighs approximately 90 pounds (41 kg).

11. Remove seven (7) cap screws and lock washers that secure the transmission to the flywheel housing. Note location of the shorter cap screw for assembly purposes.

IMPORTANT: Make sure to not damage the transmission, flywheel housing, hydraulic lines, electrical harness or other parts while removing transmission.

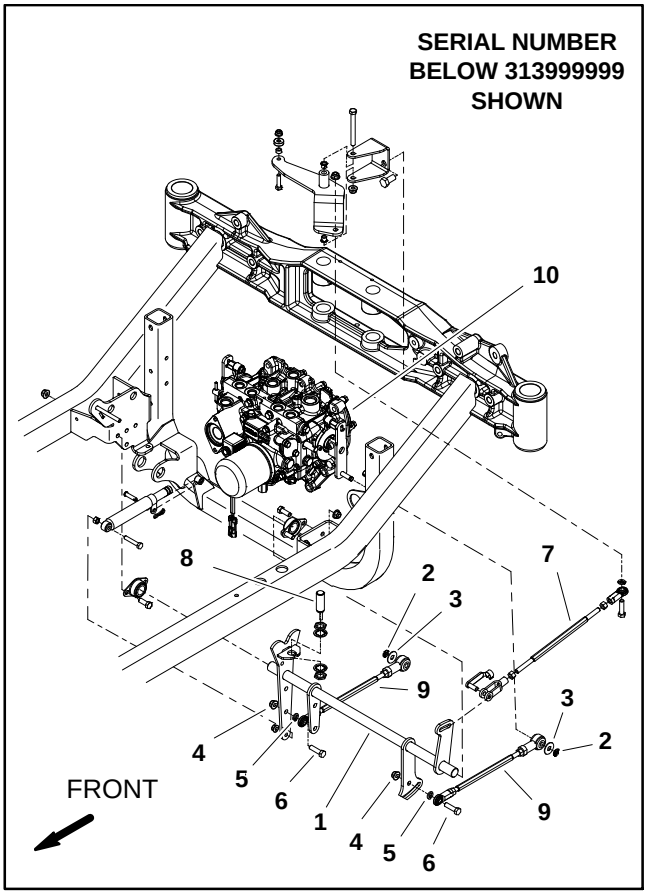

Figure 67

1. Speed control shaft
2. Retaining ring
3. Washer
4. Flange nut
5. Lock washer
6. Cap screw
7. ASC control arm
8. Neutral sensor
9. Control arm
10. Transmission

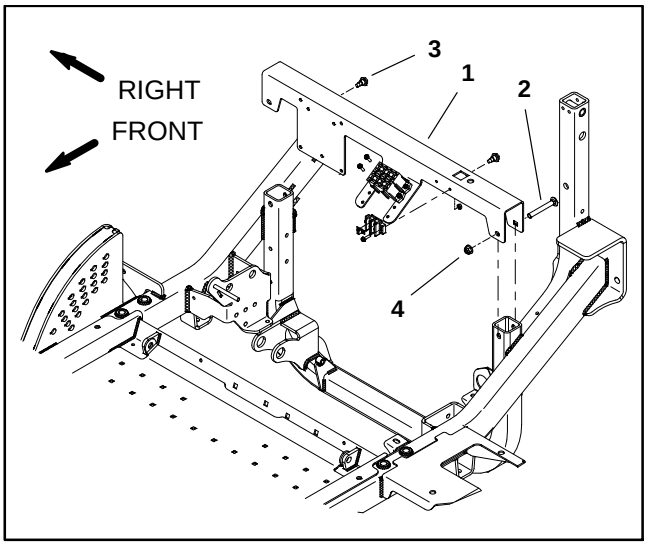

Figure 68

1. Seat channel
2. Carriage screw (2)
3. Shoulder bolt (2)
4. Flange nut (2)

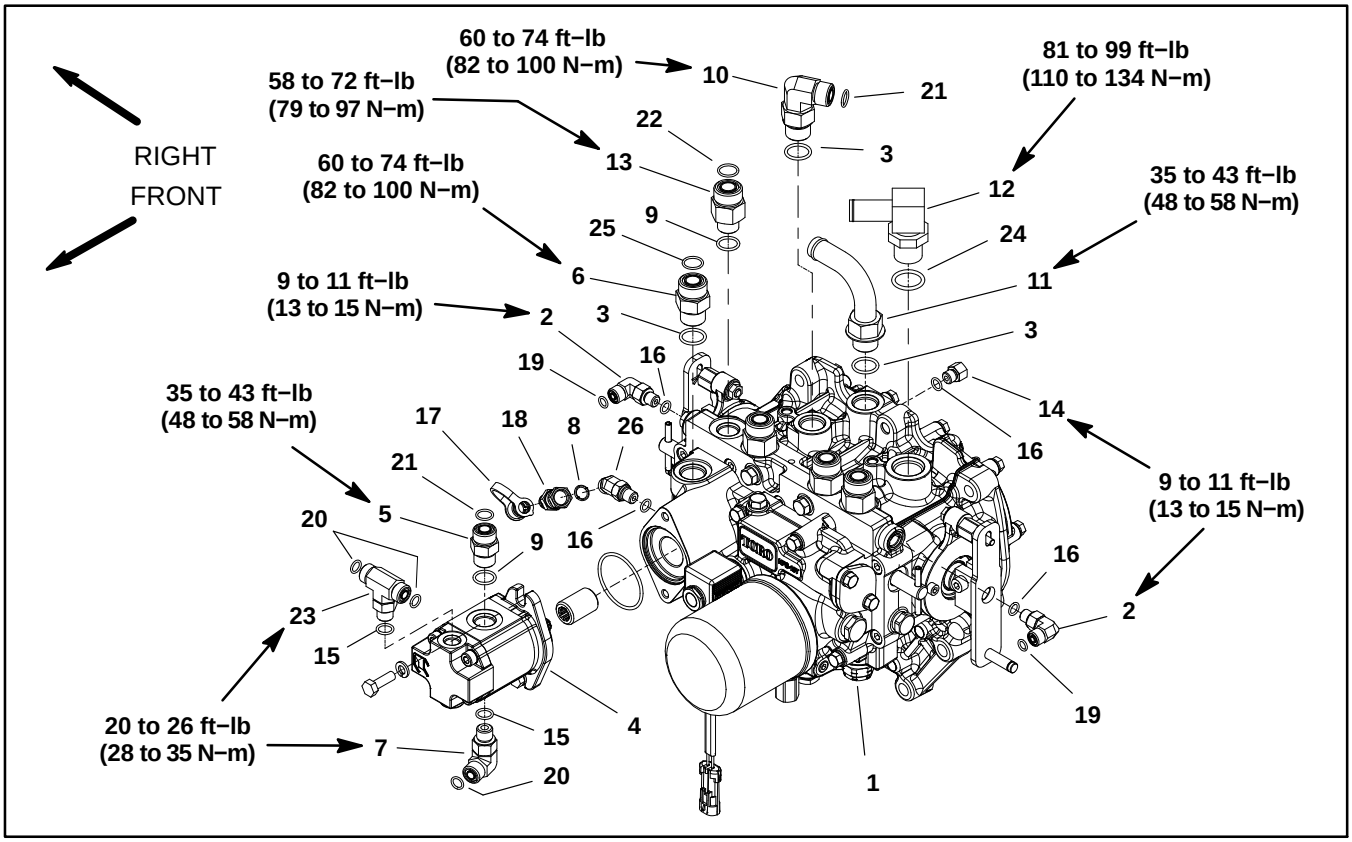

Figure 69

1. Transmission assembly
2. 90º hydraulic fitting
3. O−ring
4. Gear pump assembly
5. Hydraulic fitting
6. Hydraulic fitting
7. 90º hydraulic fitting
8. O−ring
9. O−ring
10. 90º hydraulic fitting
11. Elbow fitting
12. 90º hydraulic fitting
13. Hydraulic fitting (4)
14. Hydraulic fitting
15. O−ring
16. O−ring
17. Dust cap
18. Test fitting
19. O−ring
20. O−ring
21. O−ring
22. O−ring
23. Tee hydraulic fitting
24. O−ring
25. O−ring
26. 45º hydraulic fitting

12. Move transmission assembly toward the front of the machine and away from the flywheel housing and coupler on engine flywheel. Lift transmission from machine.

13. Locate and note location of two (2) dowel pins from transmission and flywheel housing.

14. On both sides of transmission, remove retaining ring that secures pump control arm onto transmission control arm (Fig. 67). Slide control arm from transmission control arm.

15. If hydraulic fittings are to be removed from transmission, mark fitting orientation to allow correct assembly. Remove hydraulic fittings from transmission as needed. Discard fitting O−rings.

16. Inspect flywheel housing and coupler on engine flywheel for evidence of wear or damage.

17. Remove gear pump from transmission (see Gear Pump Removal in this section).

18. Remove oil filter from transmission. Discard filter.

Transmission Installation (Fig. 66)

1. Make sure that flywheel coupler and flywheel housing are secure on engine (see Engine Installation in the Service and Repairs section of Chapter 3 − Kubota Diesel Engine).

2. If hydraulic fittings were removed from transmission, lubricate and install new O−rings to fittings. Install fittings into transmission ports (see Hydraulic Fitting Installation in the General Information section of this chapter). Tighten fittings to torque values identified in Figure 69.

3. Lubricate gasket of new oil filter and install new filter on transmission.

4. Slide both pump control arms onto transmission control arms and secure with retaining rings (Fig. 67).

5. Apply a very generous amount of antiseize lubricant to splines of transmission input shaft and flywheel coupler.

6. Carefully place two (2) dowel pins in flywheel housing. Make sure that dowel pins are perpendicular to face of housing during installation.

IMPORTANT: Make sure to not damage the transmission, flywheel housing, hydraulic lines, electrical harness or other parts while installing transmission.

CAUTION

Support transmission assembly when installing it to the flywheel housing to prevent it from falling and causing personal injury. Transmission weighs approximately 90 pounds (41 kg).

7. Lower transmission into machine. Align transmission input shaft with flywheel coupler and slide transmission to flywheel housing. It may be necessary to turn engine crankshaft to help align splines of transmission shaft and coupler. Support transmission to prevent it from shifting.

8. Secure transmission to the flywheel housing with seven (7) cap screws and lock washers. Make sure that shorter cap screw is installed in proper location. Torque cap screws **400 in−lb (45 N−m)**.

9. Install gear pump (see Gear Pump Installation in this section).

10. On both sides of machine, secure the pump control arm to the speed control shaft with cap screw and flange nut (Fig. 67). Make sure that lock washer is between control arm and control shaft and also that cap screw is installed toward the right side of the machine.

11. Carefully position seat channel to frame (Fig. 68). Secure seat channel to frame with two (2) carriage screws and flange nuts.

12. Position storage compartment to machine and secure with removed fasteners (see Storage Compartment Installation in the Service and Repairs section of Chapter 6 − Chassis or, if machine is equipped with operator cab, in the Service and Repairs section of Chapter 8 − Operator Cab).

13. Remove plugs that were installed to hydraulic hoses and fittings during the removal procedure.

14. Using labels placed during the removal process, properly connect hydraulic hoses to transmission and gear pump (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

15. Make sure that drain plugs are properly installed in hydraulic tank and transmission. Fill hydraulic tank with **new** hydraulic fluid.

16. Plug wire harness electrical connector to solenoid valve coil.

17. Lower and secure operator seat.

18. Adjust traction linkage as necessary (see Traction Linkage Assembly in this section).

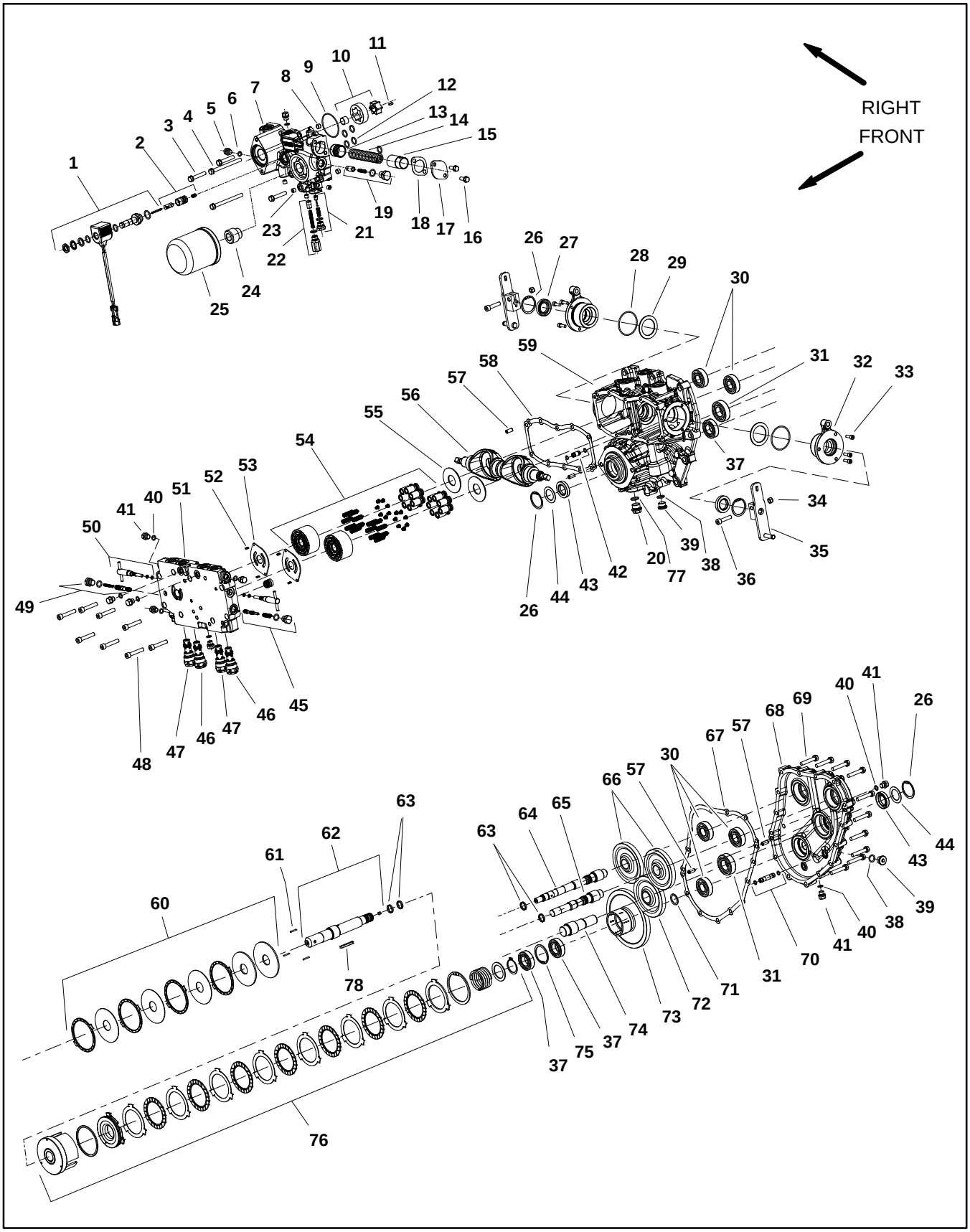
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Figure 70

Figure 70 (continued)

1. Solenoid assembly
2. Solenoid valve assembly
3. Bolt (3)
4. Bolt (2)
5. Hex plug (2)
6. O−ring
7. Pump body
8. Pin (2)
9. O−ring
10. Charge pump assembly
11. Key
12. O−ring (5)
13. Piston
14. Spring
15. Collar
16. Bolt and washer (2)
17. Accumulator cover
18. Gasket
19. Filter bypass valve assembly
20. Hex drain plug
21. Charge relief valve assembly
22. Pressure valve assembly
23. Socket head plug (4)
24. Filter adapter
25. Oil filter
26. Retaining ring (4)
27. Seal (4)
28. O−ring (2)
29. Washer (2)
30. Bearing (5)
31. Bearing (2)
32. Side cover (2)
33. Socket head screw (3 used per cover)
34. Nut (2)
35. Control arm (2)
36. Socket head screw (2)
37. Bearing (3)
38. O−ring (2)
39. Socket head plug (2)
40. O−ring (8)
41. Hex plug (8)
42. Pipe assembly
43. Seal (2)
44. Washer (2)
45. LH flushing valve
46. Reverse relief valve (2)
47. Forward relief valve (2)
48. Socket head screw (8)
49. RH flushing valve
50. Bypass valve (2)
51. Center case
52. Pin (4)
53. Valve plate (2)
54. Cylinder block assembly (2)
55. Thrust plate (2)
56. Swash plate (2)
57. Pin (4)
58. Gasket
59. Pump housing
60. PTO brake assembly
61. Push rod (3)
62. PTO shaft
63. Seal ring (4)
64. RH pump shaft
65. LH pump shaft
66. Pump gear (2)
67. Gasket
68. Gear case housing
69. Flange head screw (13)
70. Pipe assembly
71. Spacer
72. Input gear
73. PTO gear
74. Input shaft
75. Retaining ring
76. Clutch assembly
77. O−ring
78. Key

IMPORTANT: If a transmission failure occurred, refer to Traction Circuit (Closed Loop) Component Failure in the General Information section for information regarding the importance of removing contamination from the traction circuit.

Transmission Disassembly (Fig. 70)

1. Thoroughly clean exterior of transmission.

2. Remove nut, lock washer, washer, O−ring, solenoid coil and O−ring from solenoid valve stem. For assembly purposes, note that “KANZAKI” molded into the coil has the “I” nearest the nut location as coil direction is important for proper solenoid operation.

3. Remove solenoid valve stem from transmission pump body.

4. Remove pin from spool. Remove spool, sleeve and solenoid valve spring from transmission pump body. For assembly purposes, note that step in spool is toward spring location and that sleeve is installed so that holes are closest to the spring location as well.

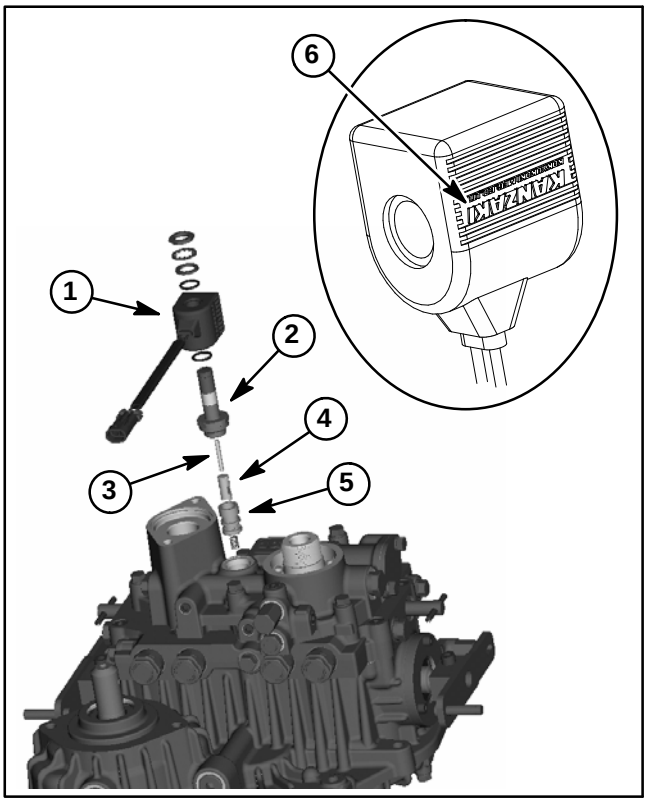

Figure 71

1. Solenoid coil
2. Solenoid valve stem
3. Pin
4. Spool
5. Sleeve
6. Letter I

5. Remove filter bypass plug, spring and valve from transmission pump body. Remove and discard O−ring from plug.

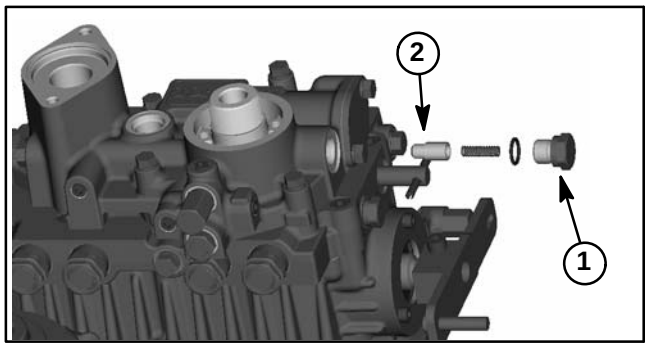

Figure 72

1. **Filter bypass plug**
2. **Bypass valve**

6. Remove pressure valve plug, spring and valve from transmission pump body. Remove and discard O−ring from plug.

7. Remove charge relief plug, spring and valve from transmission pump body. Remove and discard O−ring from plug.

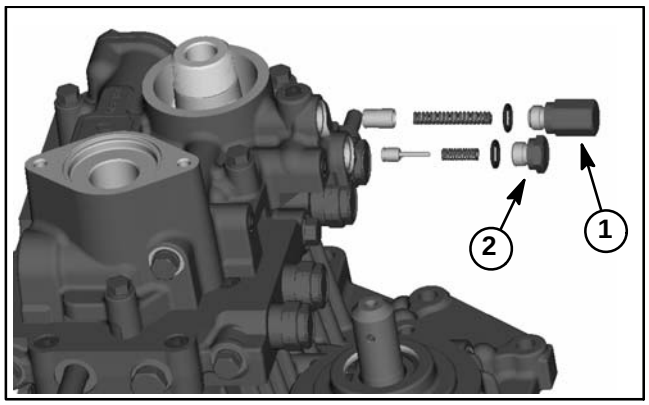

Figure 73

1. **Pressure valve plug**
2. **Charge relief plug**

8. Remove two (2) bolts that secure accumulator cover to transmission pump body.

9. Remove cover, gasket, collar, spring and piston from pump body. For assembly purposes, note that hole in collar is toward the outside of the pump body. Discard gasket.

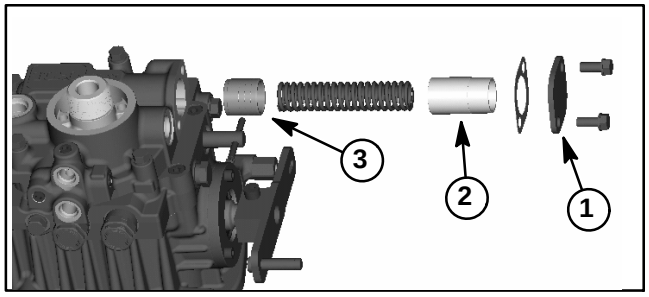

Figure 74

1. **Accumulator cover**
2. **Collar**
3. **Piston**

10. Remove two (2) hex plugs from pump body. Remove and discard O−rings from plugs.

11. Remove four (4) socket head plugs from pump body.

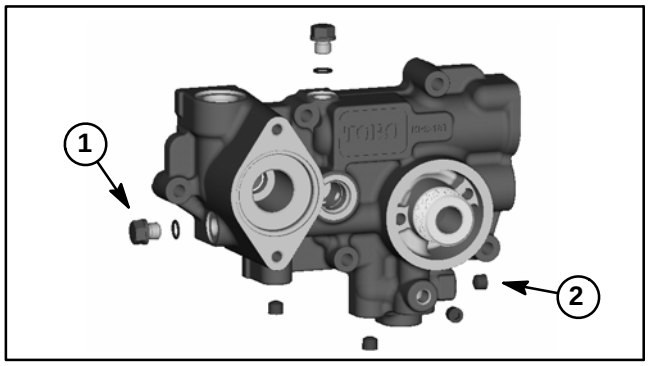

Figure 75

1. **Hex plug (2)**
2. **Socket plug (4)**

12. Remove three (3) shorter (45 mm) and two (2) longer (95 mm) flange head screws that secure pump body to center case. Remove pump body from center case.

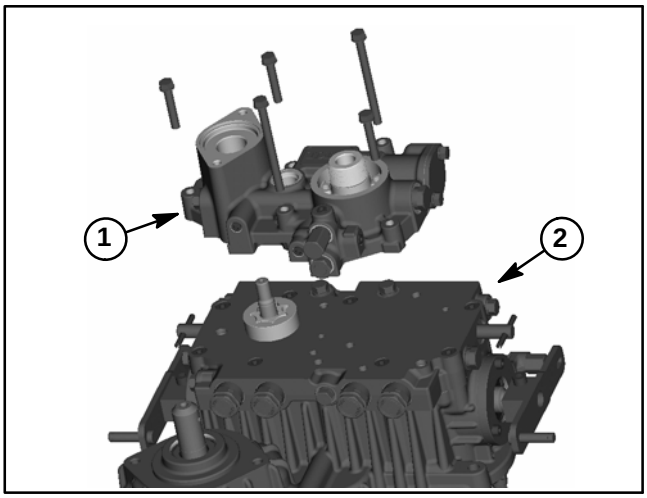

Figure 76

1. Pump body **2. Center case**

13. Remove two (2) pins that locate pump body. Remove and discard O−rings.

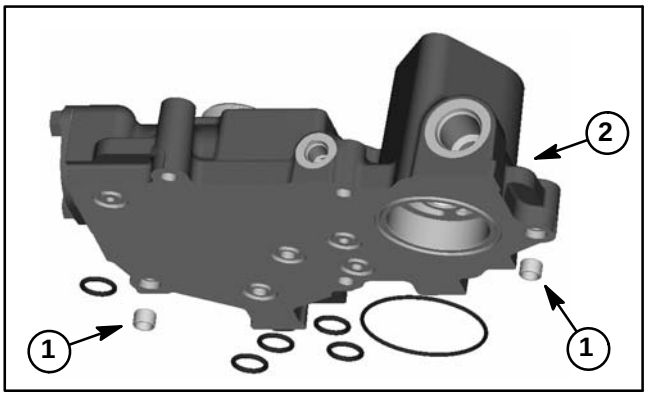

Figure 77

1. Pin **2. Pump body**

14. Slide outer and inner charge pump rotors from RH pump shaft. Remove key from key slot in pump shaft.

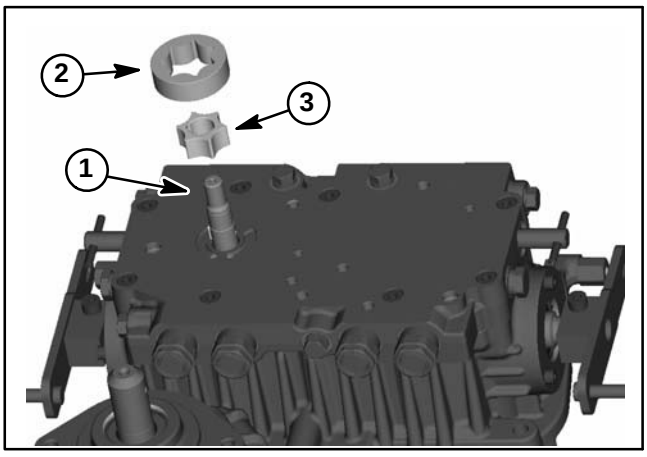

Figure 78

1. RH pump shaft
2. Outer pump rotor
3. Inner pump rotor

15. Remove eight (8) socket head screws that secure center case to transmission pump housing.

16. Carefully remove center case assembly from transmission pump housing.

17. Remove two (2) pins from transmission pump housing bores. Remove and discard gasket.

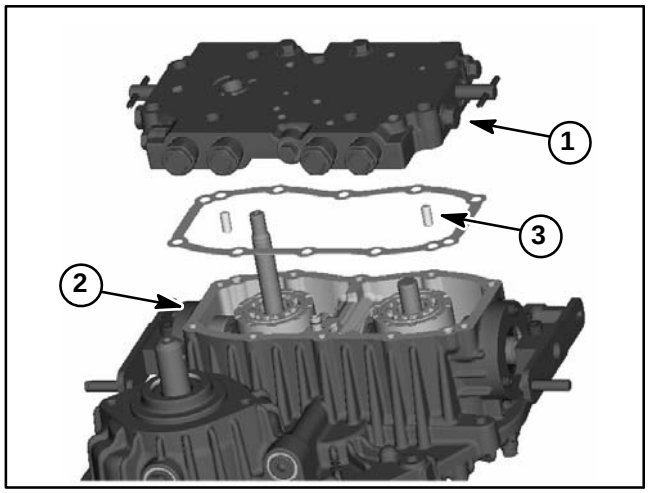

Figure 79

1. **Center case**
2. **Pump housing**
3. **Pin (2)**

18. Remove bypass valves from center case. Remove and discard O−rings and backup rings from bypass valves.

IMPORTANT: The forward and reverse relief cartridges are different. Label the relief cartridges for assembly purposes.

19. Remove forward and reverse relief valve cartridges from center case noting relief cartridge location for assembly purposes. The reverse relief valve cartridges can be identified by the groove in the hex head (Fig. 81).

20. Remove valve plates from center case. Mark the positions of the valve plates so they can be assembled in the same position.

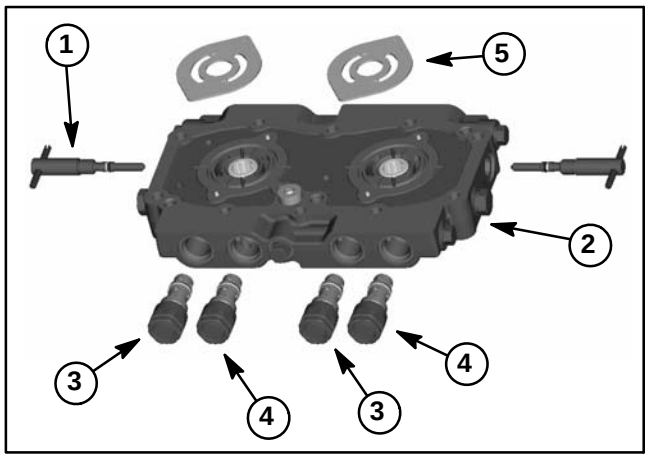

Figure 80

1. **Bypass valve**
2. **Center case**
3. **Reverse relief cartridge**
4. **Forward relief cartridge**
5. **Valve plate**

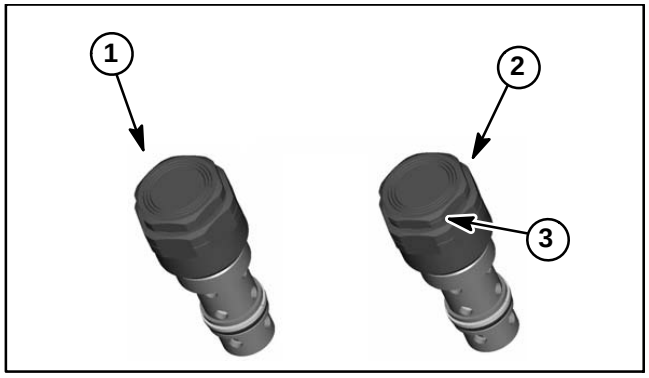

Figure 81

1. **Forward relief cartridge**
2. **Reverse relief cartridge**
3. **Hex head groove**

21. Remove six (6) hex plugs from center case. Remove and discard O−rings from plugs.

22. Remove RH and LH flushing valve plugs, springs and valves from center case. Note differences in flushing valves and their locations for assembly purposes. Remove and discard O−rings from plugs.

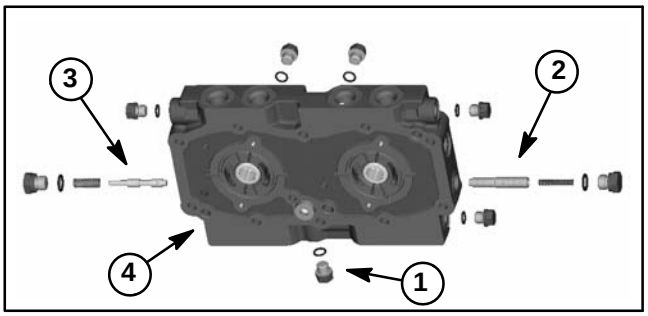

Figure 82

1. Hex plug (6)
2. RH flushing valve
3. LH flushing valve
4. Center case

23. Taking care to not drop pistons from cylinder block, slide both cylinder block assemblies from pump shafts. Mark the positions of the cylinder blocks so they can be assembled in the same position.

24. Slide pipe assembly from bore of transmission pump housing. Remove and discard O−rings from grooves in pipe.

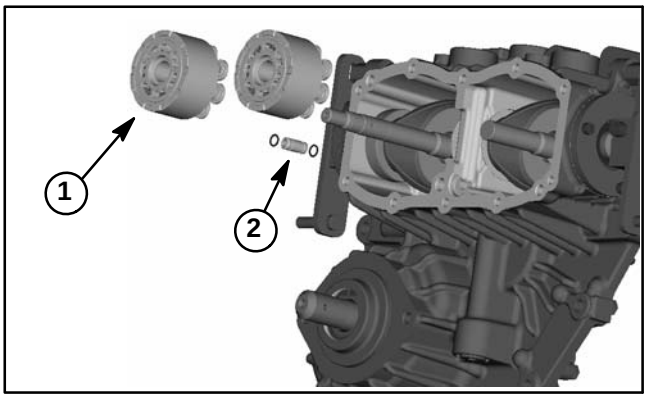

Figure 83

1. Cylinder block assembly
2. Pipe

25. Remove retaining ring that secures PTO shaft oil seal into housing bore. Remove spacer and oil seal from housing taking care to not damage housing bore.

26. Remove thrust plate from each swash plate. For assembly purposes, note that the beveled sides of the thrust plates are against the swash plate surfaces.

27. Remove socket head screw and nut that secures control arm onto each trunnion shaft. Slide control arm from each trunnion shaft.

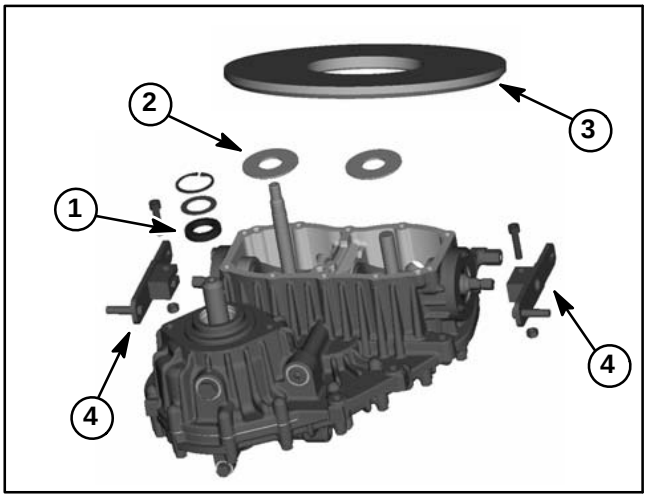

Figure 84

1. Oil seal
2. Thrust plate
3. Thrust plate bevel
4. Control arm

28. Remove two (2) hex plugs and one (1) socket head plug from gear case housing. Remove and discard O−rings from plugs.

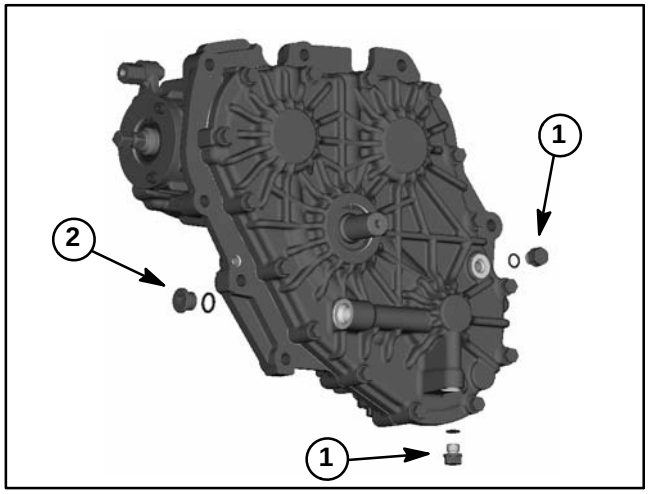

Figure 85

1. **Hex plug**
2. **Socket head plug**

29. Remove fifteen (15) flange head screws that secure gear case housing to transmission pump housing.

30. Carefully remove gear case housing from pump housing.

31. Locate and retrieve two (2) pins from gear case housing holes. Remove and discard gasket.

32. Remove retaining ring that secures input shaft oil seal into gear case housing bore. Remove spacer and oil seal from housing taking care to not damage seal bore in housing. Discard seal.

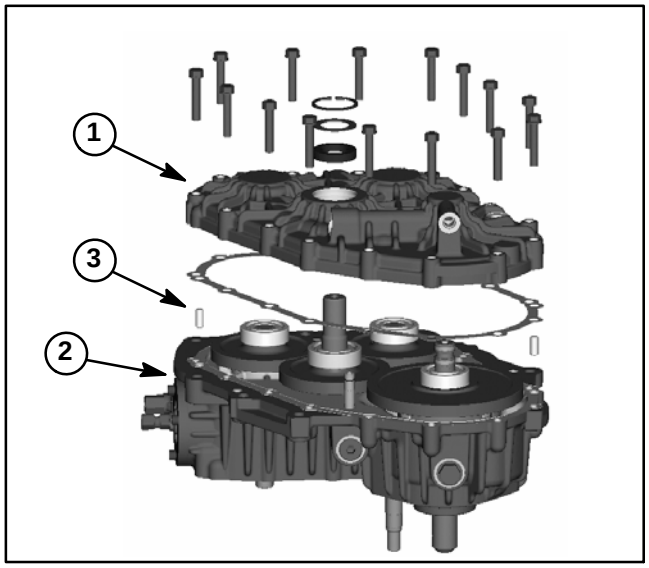

Figure 86

1. **Gear case housing**
2. **Pump housing**
3. **Pin (2)**

33. Remove input shaft, RH pump shaft and LH pump shaft assemblies from transmission pump housing.

34. Slide pipe assembly from bore of pump housing. Remove and discard two (2) O−rings from grooves in pipe.

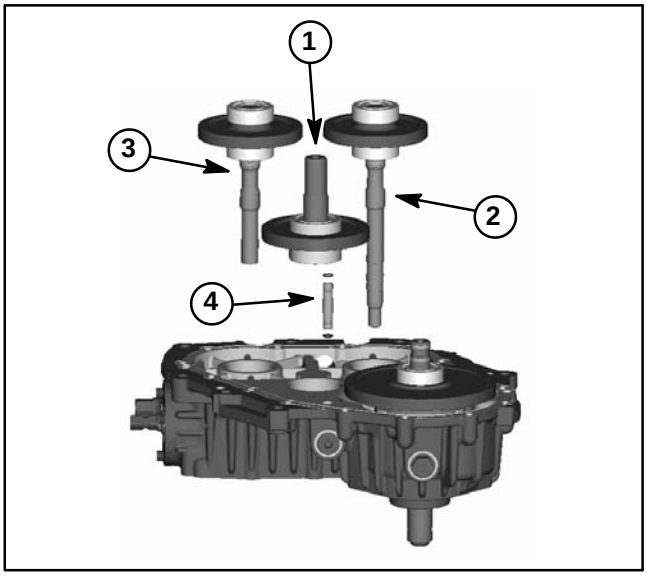

Figure 87

1. **Input shaft**
2. **RH pump shaft**
3. **LH pump shaft**
4. **Pipe**

35. If pump shaft bearing replacement is necessary, remove and discard seal ring from RH and LH pump shafts. Remove bearings from pump shaft using a bearing puller. Discard removed bearings. Remove gear from pump shaft.

36. If input shaft bearing replacement is necessary, remove bearings from input shaft using a bearing puller. Discard removed bearings. Remove gear from input shaft.

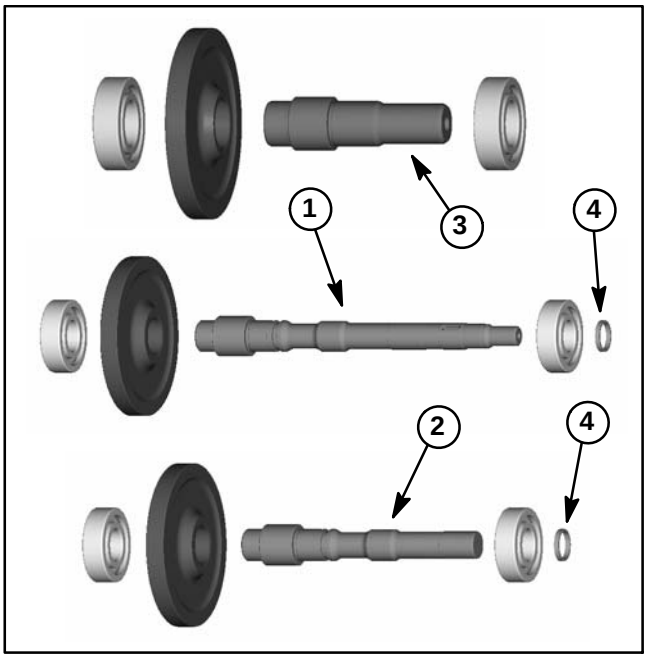

Figure 88

1. **RH pump shaft**
2. **LH pump shaft**
3. **Input shaft**
4. **Seal ring**

37. Remove PTO shaft assembly from transmission pump housing.

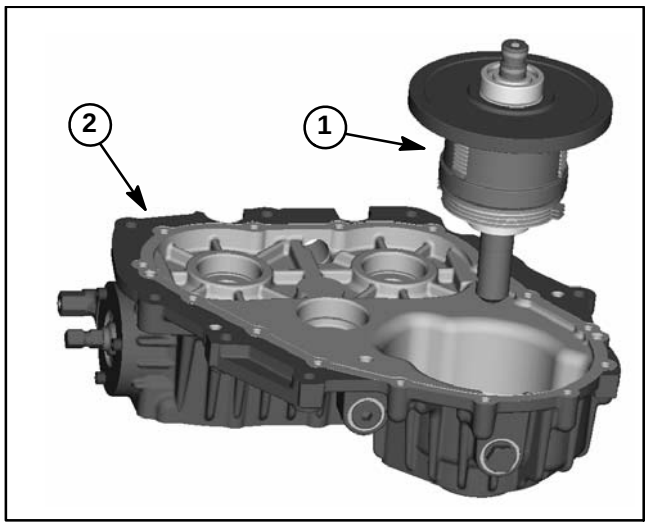

Figure 89

1. PTO shaft assembly **2. Pump housing**

38. Remove final friction plate from transmission pump housing.

NOTE: This friction plate may have been removed with PTO shaft assembly.

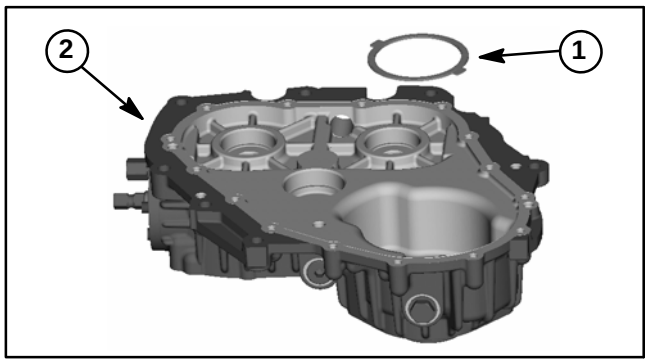

Figure 90

1. Friction plate **2. Pump housing**

39. Disassemble PTO shaft assembly:

A. Using a bearing puller, remove bearing from PTO shaft. Discard bearing.

B. Remove spacer from PTO shaft.

C. Slide gear and clutch assembly from PTO shaft.

D. Remove key from PTO shaft slot.

E. Remove two (2) seal rings from PTO shaft grooves. Discard seal rings.

F. Remove B−plate, C−plate, three (3) A−plates and three (3) friction plates from PTO shaft.

G. Using a bearing puller, remove bearing from PTO shaft. Discard bearing.

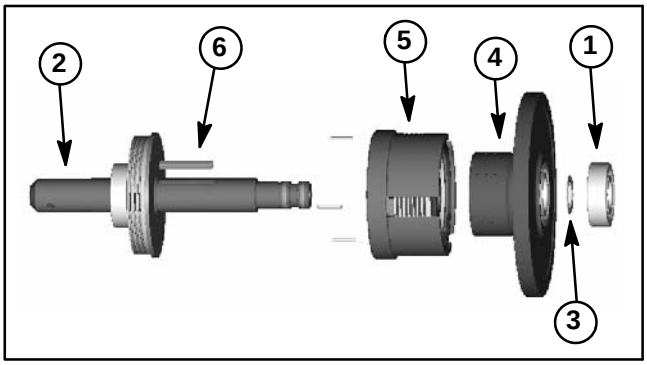

Figure 91

1. **Bearing**
2. **PTO shaft**
3. **Spacer**
4. **Gear**
5. **Clutch assembly**
6. **Key**

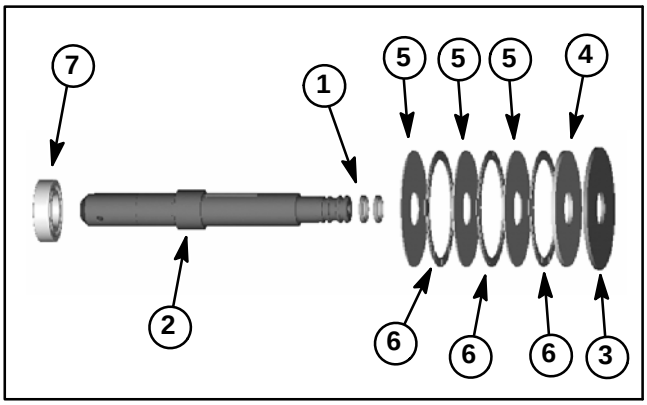

Figure 92

1. **Seal ring (2)**
2. **PTO shaft**
3. **B−plate**
4. **C−plate**
5. **A−plate (3)**
6. **Friction plate (3)**
7. **Bearing**

40. Slide three (3) rods from holes in clutch assembly.

41. Slide PTO gear assembly from clutch assembly.

NOTE: Because individual clutch components are not available, disassembly of the clutch assembly is not necessary.

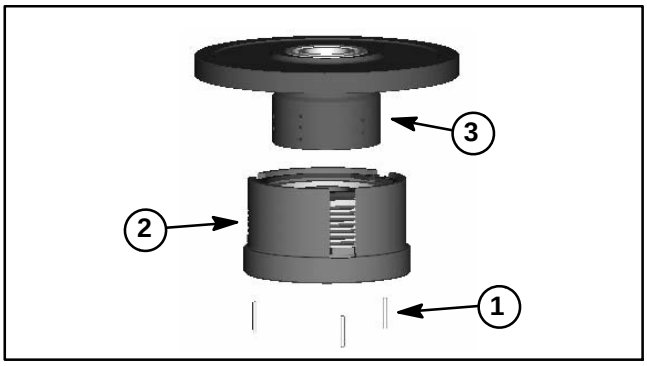

Figure 93

1. **Rod (3)**
2. **Clutch assembly**
3. **PTO gear**

42. If necessary, remove two (2) bearings from PTO gear. Discard removed bearings. Remove retaining ring from groove in PTO gear bore.

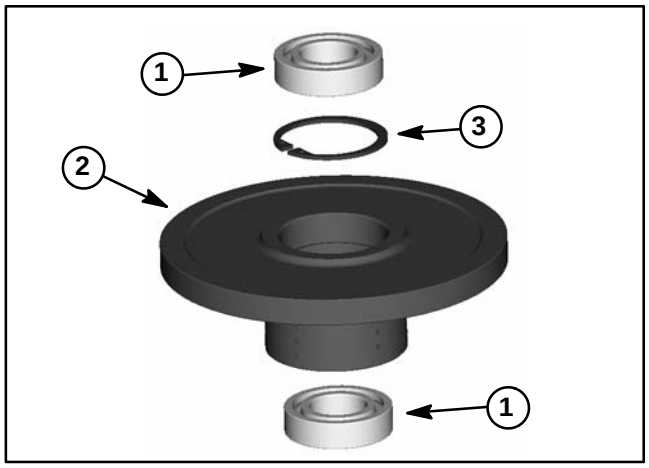

Figure 94

1. **Bearing**
2. **PTO gear**
3. **Retaining ring**

43. Remove two (2) plugs from transmission pump housing. Remove and discard O−rings from plugs.

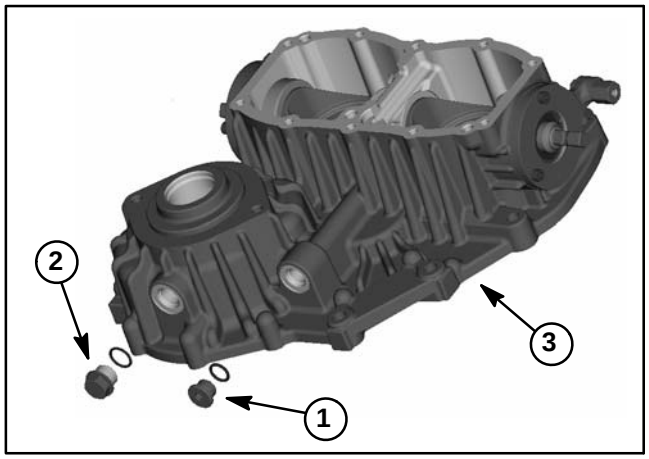

Figure 95

1. **Socket head plug**
2. **Hex plug**
3. **Pump housing**

44. Remove three (3) socket head screws that secure both side covers to transmission pump housing.

45. Carefully slide side covers from trunnion shafts and housing. Remove and discard O−rings from side covers.

46. Remove retaining rings that secure oil seals into both side covers. Remove oil seals from side covers. Discard seals.

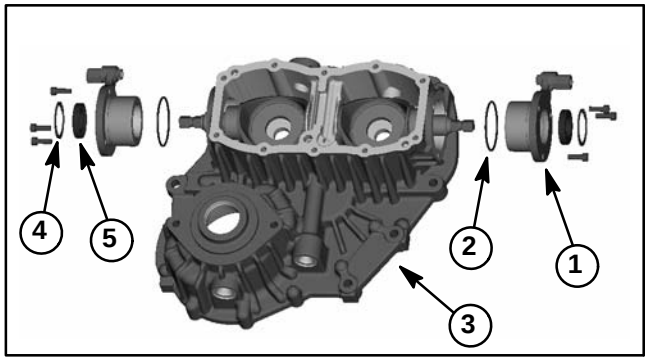

Figure 96

1. **Side cover**
2. **O−ring**
3. **Pump housing**
4. **Retaining ring**
5. **Oil seal**

47. Carefully remove swash plates from transmission pump housing. Remove washer from each swash plate.

48. Thoroughly clean and inspect all transmission components.

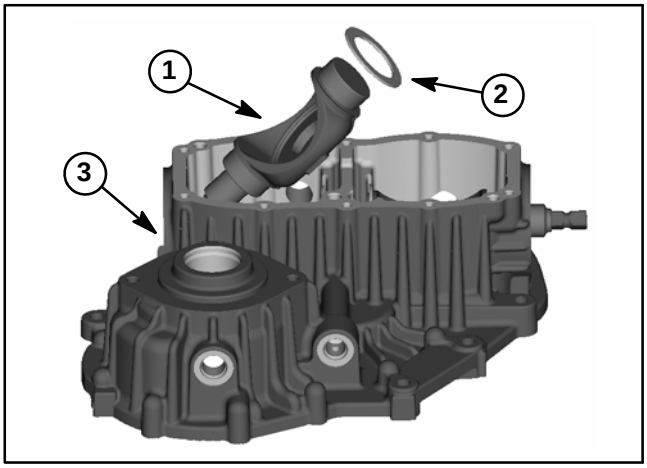

Figure 97

1. **Swash plate (2)**
2. **Washer**
3. **Pump housing**

Transmission Assembly (Fig. 70)

IMPORTANT: When assembling the transmission, lubricate all transmission components with clean hydraulic oil.

1. Make sure that all transmission components are thoroughly clean before assembling the transmission.

2. Apply clean hydraulic oil to washers and swash plate surfaces. Install washer onto each swash plate and carefully install swash plates into transmission pump housing.

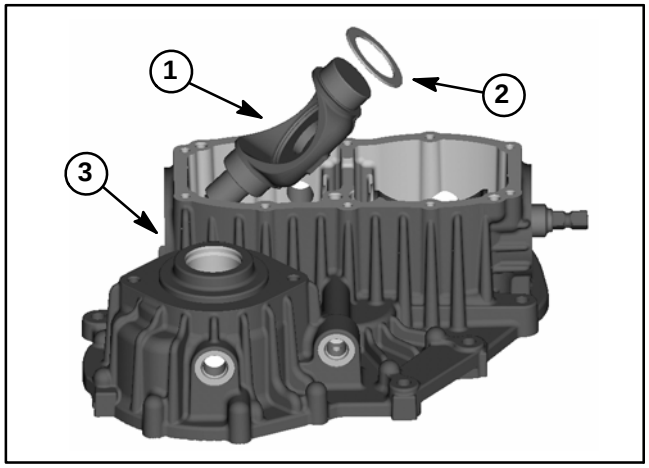

Figure 98

1. **Swash plate (2)**
2. **Washer**
3. **Pump housing**

3. Press oil seal into both side covers and secure with retaining ring. Lubricate new O−rings and install onto side covers.

4. Carefully slide side covers over trunnion shafts taking care to not damage seals. Secure both side covers to transmission pump housing with three (3) socket head screws. Torque screws from **78 to 95 in−lb (8.8 to 10.8 N−m)**.

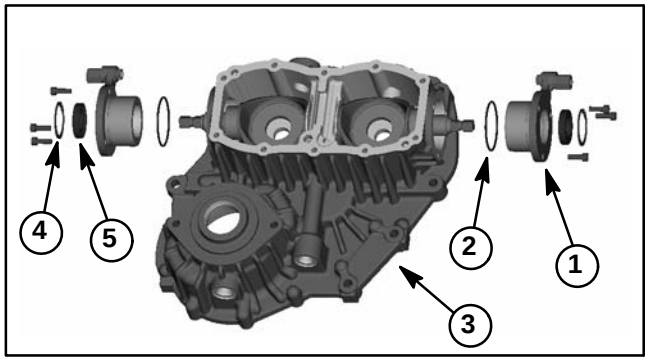

Figure 99

1. **Side cover**
2. **O−ring**
3. **Pump housing**
4. **Retaining ring**
5. **Oil seal**

5. Lubricate new O−rings and install onto two (2) plugs. Install plugs into transmission pump housing. Torque plugs from **17 to 19 ft−lb (22 to 27 N−m)**.

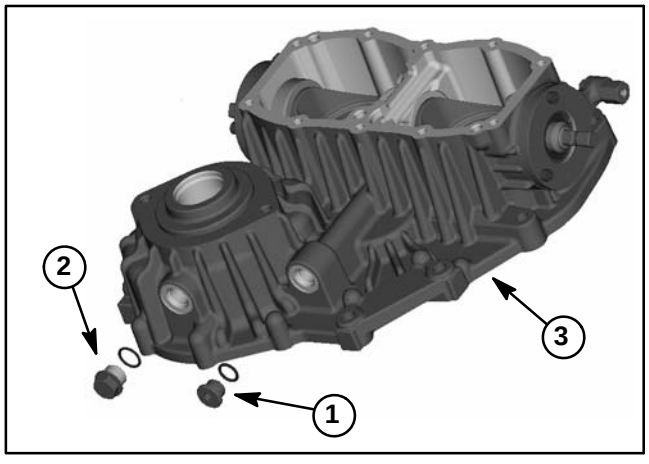

Figure 100

1. **Socket head plug**
2. **Hex plug**
3. **Pump housing**

6. Install retaining ring into groove in bore of PTO gear. Press two (2) bearings into PTO gear until each bearing contacts the installed retaining ring.

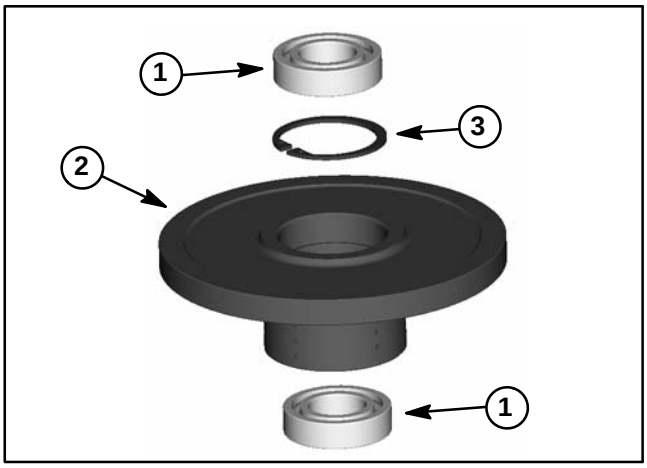

Figure 101

1. **Bearing**
2. **PTO gear**
3. **Retaining ring**

7. Slide three (3) rods into holes in clutch assembly.

8. Slide PTO gear assembly into clutch assembly.

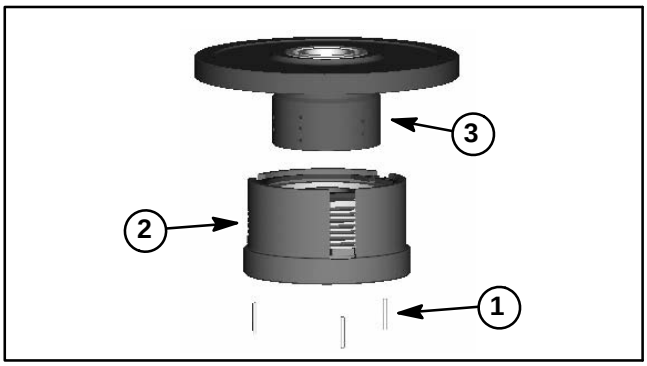

Figure 102

1. **Rod (3)**
2. **Clutch assembly**
3. **PTO gear**

9. Assemble PTO shaft:

   A. Press new bearing onto PTO shaft so that bearing is flush with shaft shoulder.

   B. Alternately place three (3) A−plates and three (3) friction plates onto PTO shaft.

   C. Place C−plate and then B−plate onto shaft.

   D. Carefully install two (2) seal rings into grooves of PTO shaft.

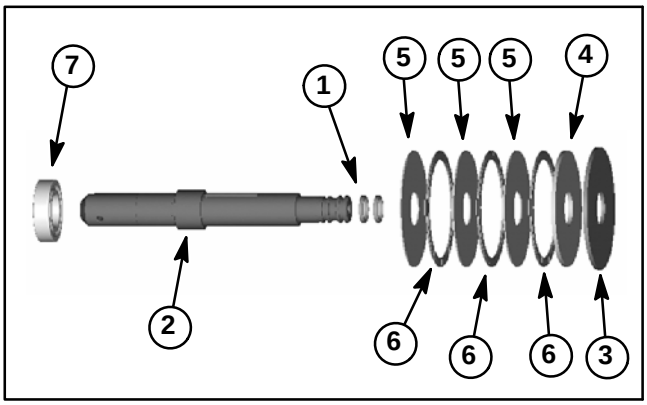

Figure 103

1. **Seal ring (2)**
2. **PTO shaft**
3. **B−plate**
4. **C−plate**
5. **A−plate (3)**
6. **Friction plate (3)**
7. **Bearing**

10. Install clutch assembly and gear onto PTO shaft:

    A. Install key into PTO shaft slot making sure that rounded ends of key align with rounded ends of shaft slot.

    B. Slide clutch assembly and gear onto PTO shaft making sure to align slot in clutch with key in shaft. Also, align rods in clutch with holes in B−plate.

    C. Place spacer onto PTO shaft.

    D. Press bearing onto PTO shaft so bearing is flush with shaft shoulder.

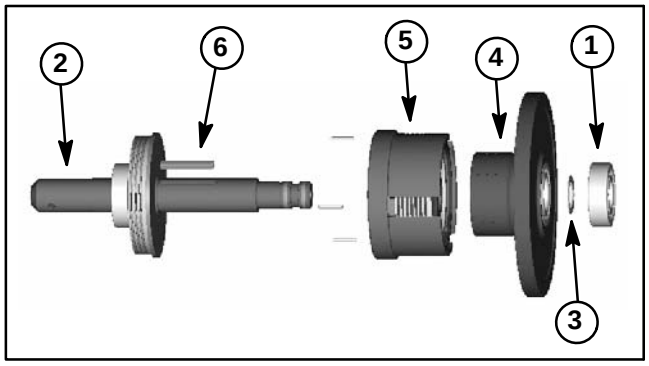

Figure 104

1. **Bearing**
2. **PTO shaft**
3. **Spacer**
4. **Gear**
5. **Clutch assembly**
6. **Key**

11. Apply clean hydraulic oil to friction plate and place in transmission pump housing. Make sure that tabs on friction plate are placed in housing grooves.

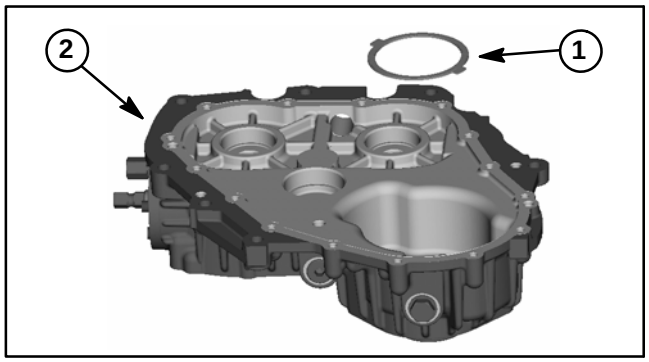

Figure 105

1. **Friction plate**
2. **Pump housing**

12. Install PTO shaft assembly into transmission pump housing. Make sure that tabs on friction plates are placed in housing grooves.

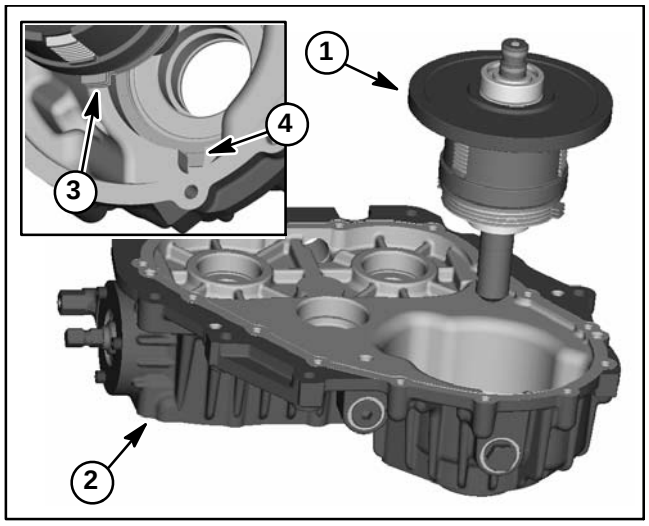

Figure 106

1. **PTO shaft assembly**
2. **Pump housing**
3. **Friction plate tabs**
4. **Housing groove**

13. If shafts were disassembled, install gear and two (2) bearings onto input shaft, RH pump shaft and/or LH pump shaft. Make sure that bearings are pressed fully to the shaft shoulder.

14. Lubricate seal rings and install seal ring onto RH and LH pump shafts.

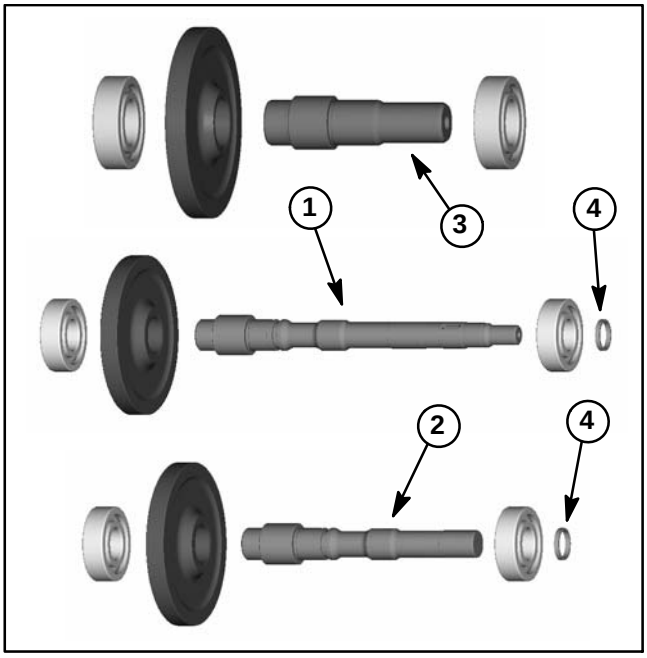

Figure 107

1. **RH pump shaft**
2. **LH pump shaft**
3. **Input shaft**
4. **Seal ring**

15. Install RH and LH pump shaft assemblies into transmission pump housing. Then, install input shaft into pump housing making sure to align input shaft gear teeth with gears on PTO and pump shafts.

16. Lubricate two (2) new O−rings and install O−rings into grooves in pipe. Slide pipe assembly into bore of transmission pump housing.

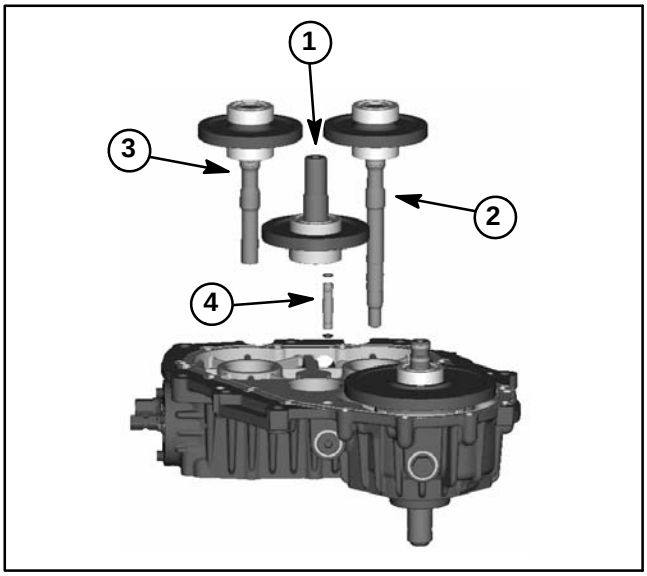

Figure 108

1. **Input shaft**
2. **RH pump shaft**
3. **LH pump shaft**
4. **Pipe assembly**

17. Place two (2) pins into transmission pump housing holes. Position new gasket to housing.

18. Carefully place gear case housing onto pump housing making sure to align pins, pipe and shaft bearings.

19. Secure gear case housing to pump housing with fifteen (15) flange head screws. Tighten screws evenly in a crossing pattern and then torque screws from **17 to 19 ft−lb (22 to 27 N−m)**.

20. Taking care to not damage input shaft oil seal, install oil seal into gear case housing bore. Place spacer on oil seal and secure with retaining ring.

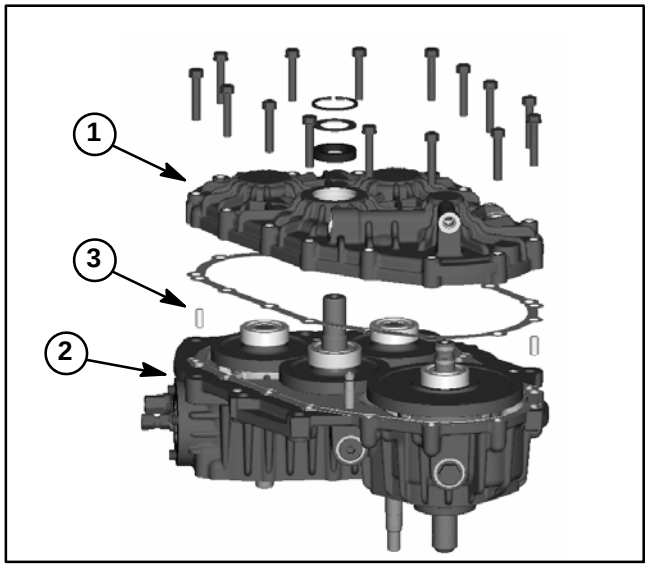

Figure 109

1. Gear case housing
2. Pump housing
3. Pin (2)

21. Lubricate new O−rings and install O−rings onto three (3) plugs. Install plugs into transmission assembly. Torque hex plugs from **14 to 15 ft−lb (18 to 21 N−m)** and socket head plug from **17 to 19 ft−lb (22 to 27 N−m)**.

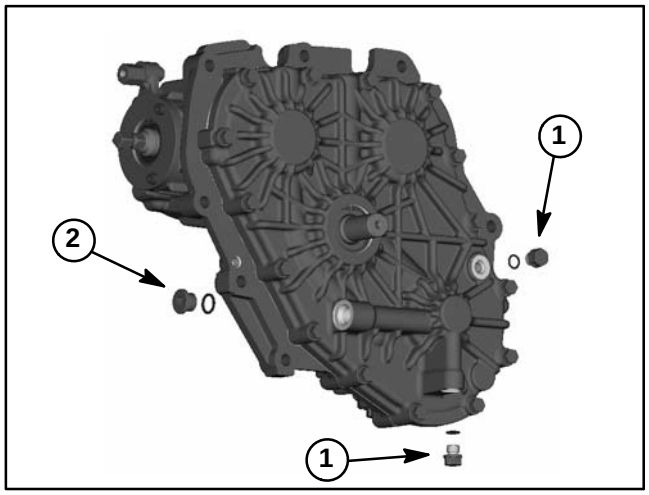

Figure 110

1. Hex plug
2. Socket head plug

22. Taking care to not damage PTO oil seal, install oil seal into pump housing bore at PTO shaft. Place spacer on oil seal and secure with retaining ring.

23. Lubricate both sides of thrust plates with clean hydraulic oil. Place thrust plate onto each swash plate making sure to position the beveled side of the thrust plates against the swash plate surface.

24. Slide control arm onto each trunnion shaft and secure with socket head screw and nut. Torque nut from **20 to 23 ft−lb (27 to 32 N−m)**.

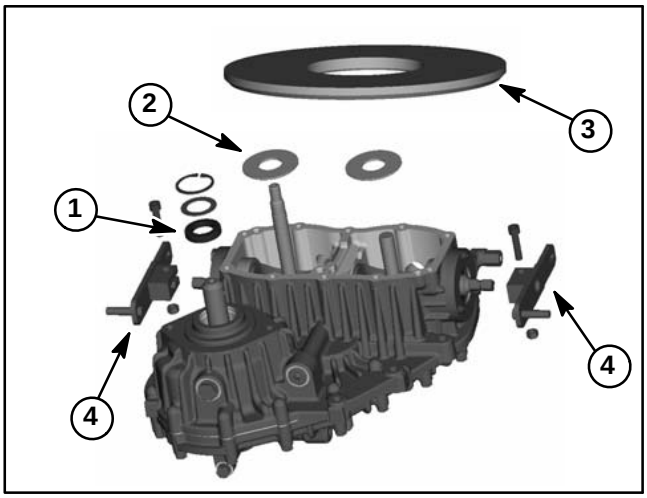

Figure 111

1. Oil seal
2. Thrust plate
3. Thrust plate bevel
4. Control arm

25. Lubricate all components of cylinder blocks liberally with clean hydraulic oil. Make sure that all pistons are placed in cylinder blocks. Taking care to not drop pistons from cylinder block, slide both cylinder block assemblies onto pump shafts.

26. Lubricate two (2) new O−rings and install O−rings into grooves in pipe. Slide pipe assembly into bore of transmission pump housing.

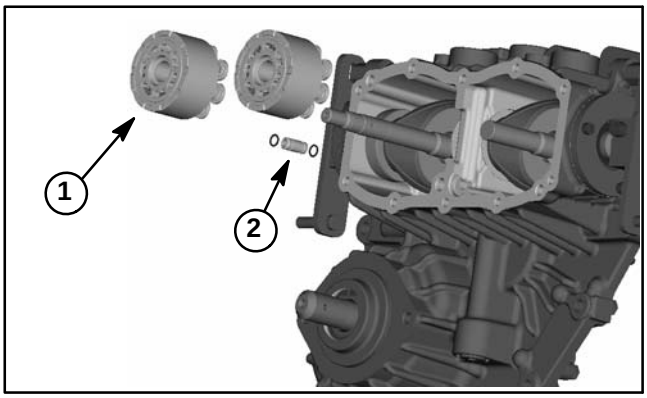

Figure 112

1. Cylinder block assembly
2. Pipe

27. Lubricate new O−rings and install O−rings onto six (6) hex plugs. Install plugs into center case. Torque plugs from **14 to 15 ft−lb (18 to 21 N−m)**.

28. Lubricate flushing valves with clean hydraulic oil and place them in center case bores making sure to place RH and LH flushing valves in correct location.

29. Lubricate new O−rings and install O−rings on two (2) flushing valve plugs. Install springs and plugs to secure flushing valves. Torque plugs from **17 to 19 ft−lb (22 to 27 N−m)**.

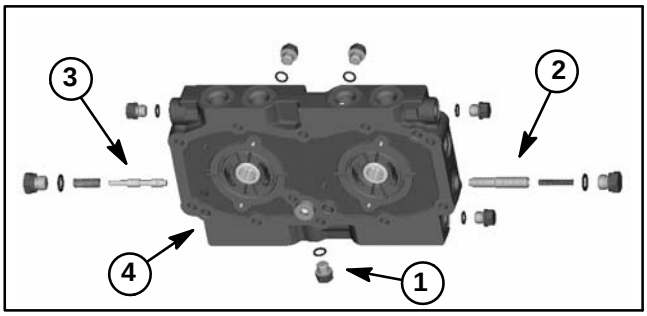

Figure 113

1. Hex plug (6)
2. RH flushing valve
3. LH flushing valve
4. Center case

30. Lubricate O−rings and backup rings for bypass valves. Position rings on bypass valves and install valves into center case. Torque valves from **62 to 79 in−lb (7 to 9 N−m)**.

31. Lubricate sealing washers and install onto forward and reverse relief valve cartridges.

IMPORTANT: The forward and reverse relief cartridges are different. Use labels made during disassembly to make sure the relief cartridges are properly installed.

32. Thread relief cartridges into correct center case ports and torque from **24 to 27 ft−lb (32 to 37 N−m)**. The reverse relief valve cartridges can be identified by the groove in the hex head (Fig. 115).

33. Apply clean grease to mating surfaces of center case and valve plates to hold valve plates in position during assembly. Install valve plates to dowel pins in center plate.

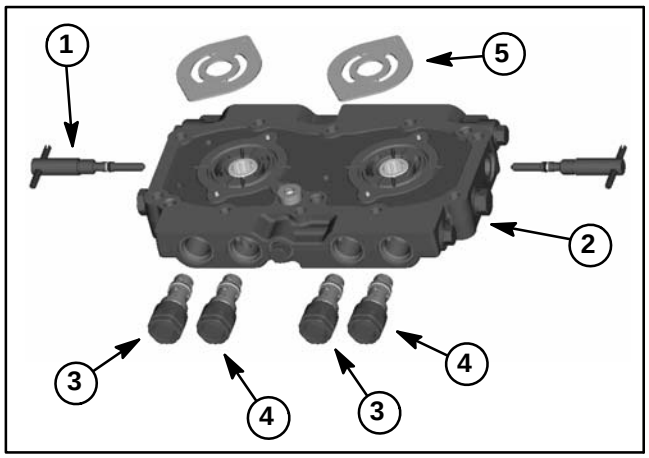

Figure 114

1. **Bypass valve**
2. **Center case**
3. **Reverse relief cartridge**
4. **Forward relief cartridge**
5. **Valve plate**

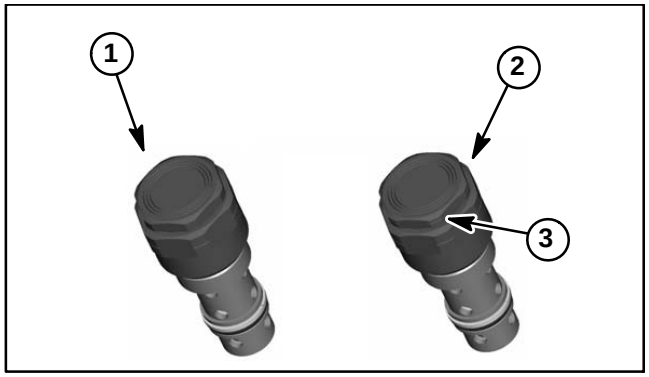

Figure 115

1. **Forward relief cartridge**
2. **Reverse relief cartridge**
3. **Hex head groove**

34. Install two (2) pins into transmission pump housing bores. Position new gasket on pump housing.

35. Position center case assembly to transmission pump housing making sure that valve plates remain in position.

36. Secure center case to transmission pump housing with eight (8) socket head screws. Tighten screws evenly in a crossing pattern and then torque screws from **17 to 19 ft−lb (22 − 27 N−m)**.

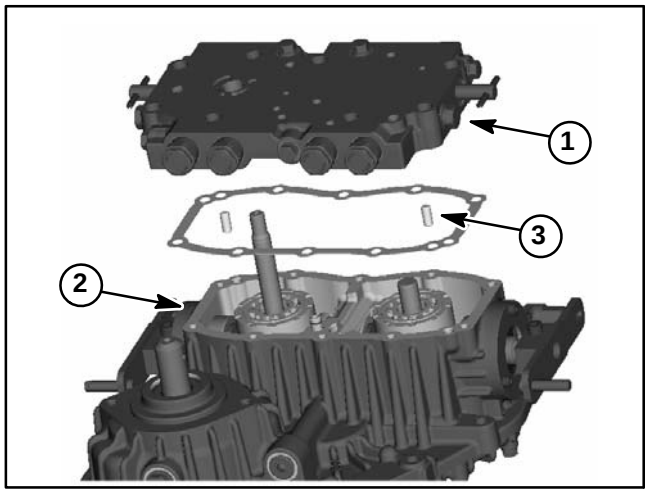

Figure 116

1. **Center case**
2. **Pump housing**
3. **Pin (2)**

37. Install key into key slot in RH pump shaft. Lubricate inner and outer charge pump rotors with clean hydraulic oil. Slide inner rotor onto pump shaft and align with key. Place outer rotor onto inner rotor.

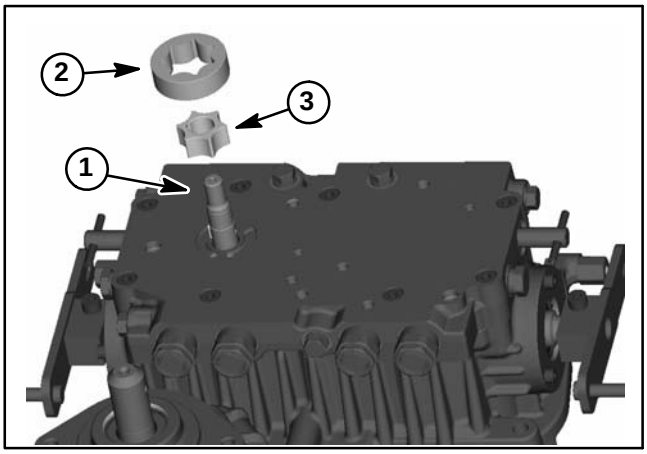

Figure 117

1. **RH pump shaft**
2. **Outer pump rotor**
3. **Inner pump rotor**

38. Install two (2) pins into pump body bores.

39. Apply clean grease to pump body O−rings to hold them in position during assembly. Place O−rings in pump body locations.

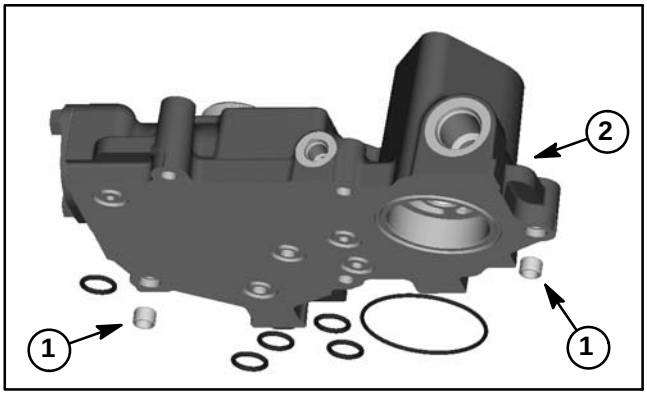

Figure 118

1. **Pin**
2. **Pump body**

40. Place pump body onto center case making sure that O−rings remain in position. Install three (3) shorter and two (2) longer flange head screws to secure pump body to center case. Torque screws in a crossing pattern from **17 to 19 ft−lb (22 to 27 N−m)**.

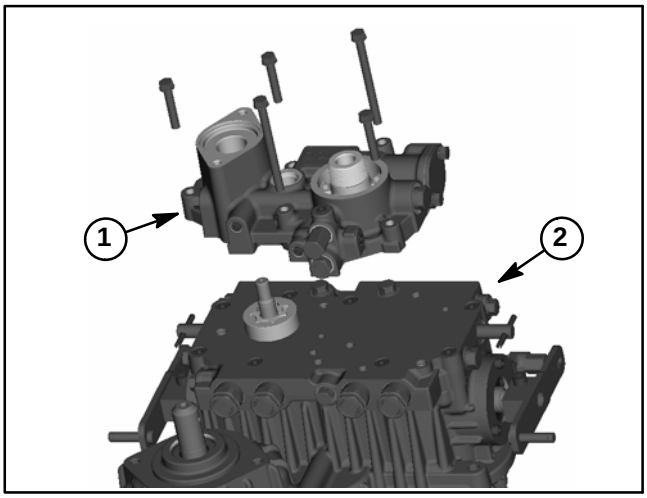

Figure 119

1. **Pump body**
2. **Center case**

41. Lubricate new O−rings and install O−rings onto two (2) hex plugs. Install plugs into pump body. Torque plugs from **14 to 15 ft−lb (18 to 21 N−m)**.

42. Apply sealant to threads of four (4) socket head plugs and install into pump body. Torque plugs from **78 to 95 in−lb (8.8 to 10.8 N−m)**.

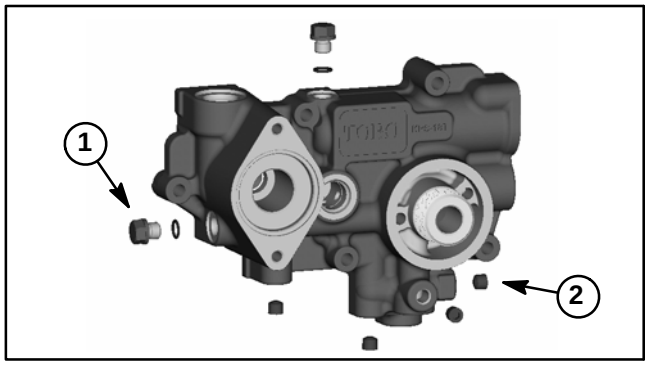

Figure 120

1. **Hex plug (2)**
2. **Socket plug (4)**

43. Lubricate accumulator components with clean hydraulic oil. Install piston, spring and collar into pump body. Make sure that hole in collar is toward the outside of the pump body.

44. Position new gasket to accumulator cover. Secure cover to pump body with two (2) bolts. Torque bolts from **17 to 19 ft−lb (22 to 27 N−m)**.

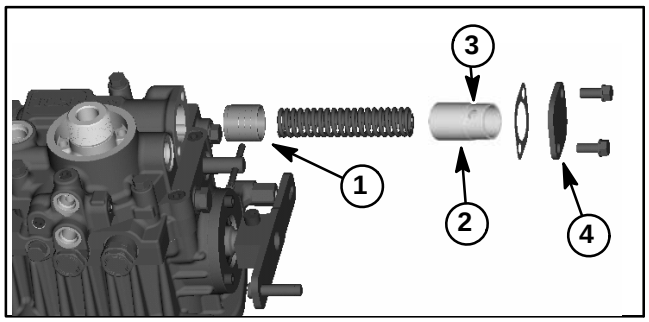

Figure 121

1. **Accumulator piston**
2. **Accumulator collar**
3. **Collar hole**
4. **Accumulator cover**

45. Lubricate charge relief valve and spring with clean hydraulic oil and install into pump body.

46. Lubricate pressure valve and spring with clean hydraulic oil and install into pump body.

47. Lubricate new O−rings and install O−rings onto valve plugs. Install plugs into pump body. Torque plugs from **17 to 19 ft−lb (22 to 27 N−m)**.

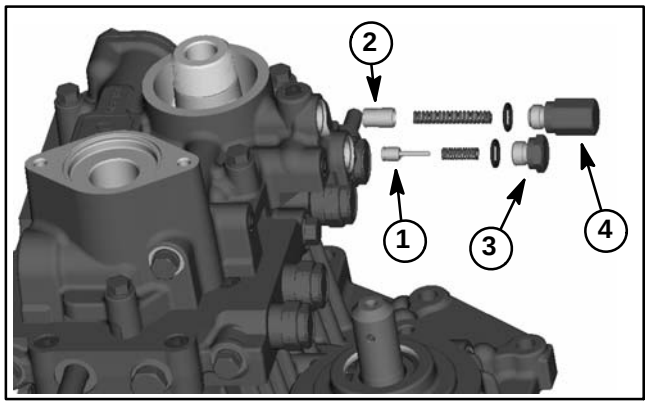

Figure 122

1. **Charge relief valve**
2. **Pressure valve**
3. **Charge relief plug**
4. **Pressure valve plug**

48. Lubricate filter bypass valve and spring with clean hydraulic oil and install into pump body.

49. Lubricate new O−ring and install O−ring onto plug. Install plug into pump body. Torque plug from **17 to 19 ft−lb (22 to 27 N−m)**.

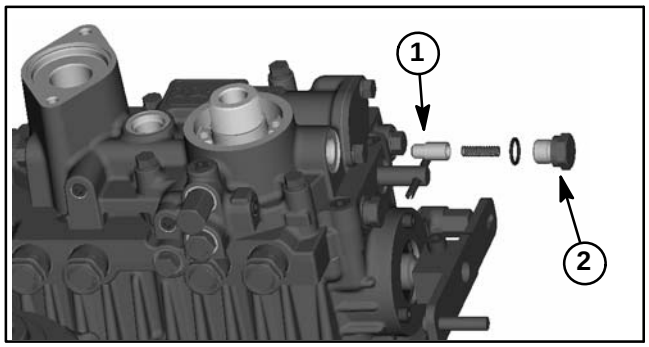

Figure 123

1. **Filter bypass valve**
2. **Filter bypass plug**

50. Lubricate solenoid valve spring, sleeve and spool with clean hydraulic oil and install into pump body. Make sure that sleeve is installed so that holes are closest to the spring location and that step in spool is toward spring location as well. Place pin in spool.

51. Install solenoid valve stem into pump body and torque from **186 to 195 in−lb (21 to 22 N−m)**.

52. Place O−ring, solenoid coil, O−ring, washer, lock washer and nut onto solenoid valve stem. Coil should be installed so the “KANZAKI” molded into the coil has the “I” nearest the nut location (Fig. 125). Torque nut from **53 to 69 in−lb (5.9 to 7.8 N−m)**.

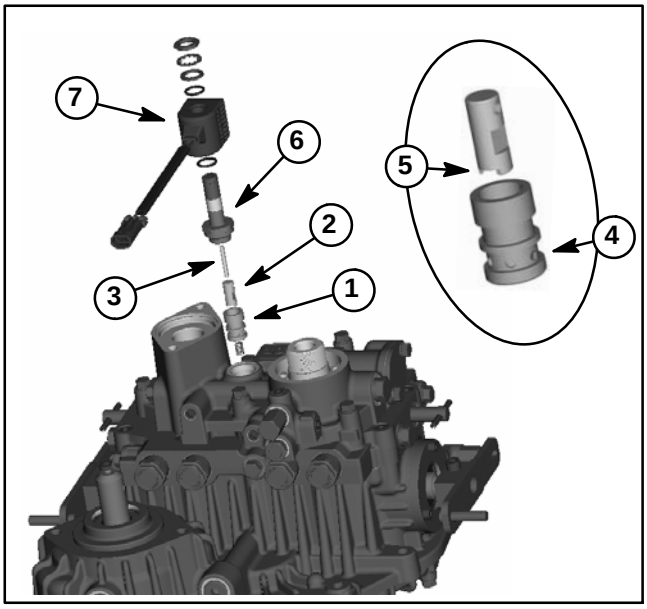

Figure 124

1. **Sleeve**
2. **Spool**
3. **Pin**
4. **Sleeve holes**
5. **Spool step**
6. **Solenoid valve stem**
7. **Solenoid coil**

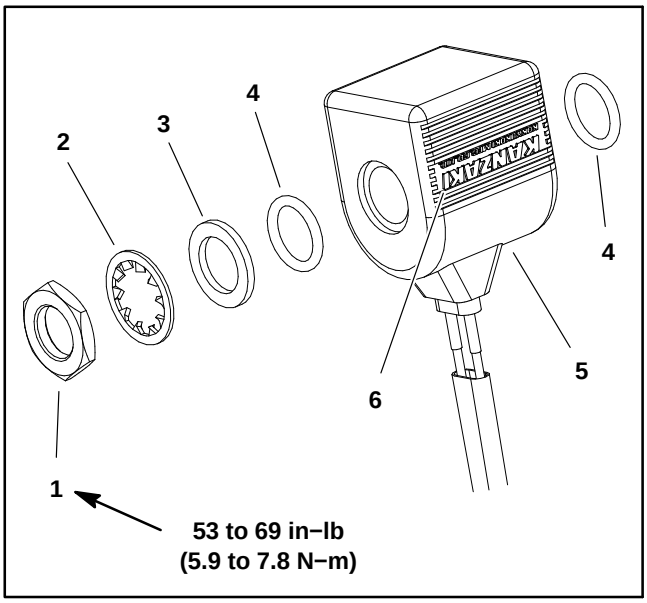

Figure 125

1. **Hex nut**
2. **Lock washer**
3. **Washer**
4. **Seal**
5. **Solenoid valve coil**
6. **Letter I**

CrossTrax™ AWD Control Manifold (4WD Machines)

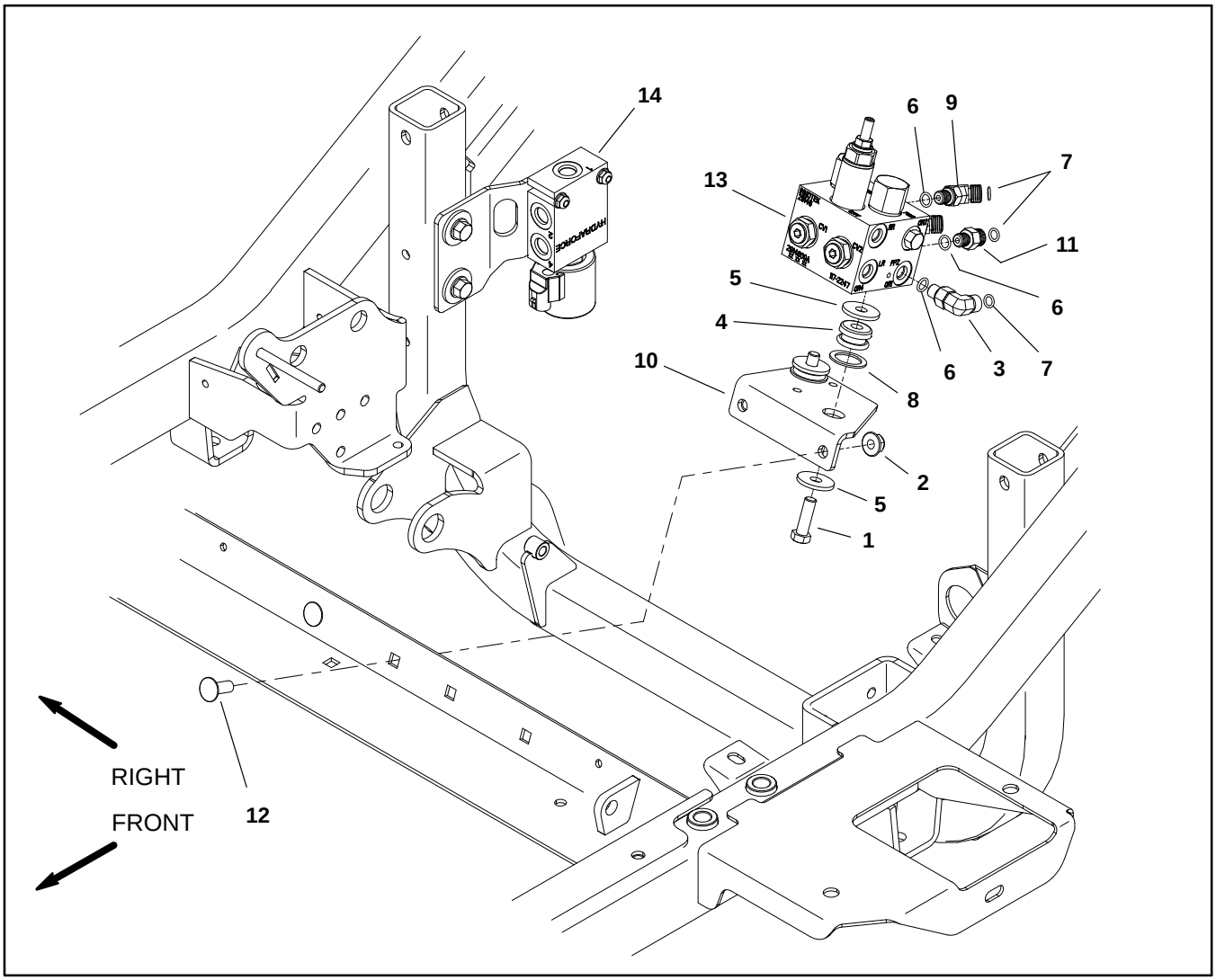

Figure 126

1. Cap screw (2)
2. Flange nut (2)
3. 90º hydraulic fitting
4. Mount (2)
5. Washer (4)
6. O−ring
7. O−ring
8. Washer (2)
9. 45º hydraulic fitting (2)
10. Mount plate
11. Straight fitting
12. Carriage screw (2)
13. AWD control manifold
14. Steering control manifold

Removal (Fig. 126)

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

WARNING

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

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

3. Raise and support operator seat. Locate AWD control manifold.

4. Thoroughly clean hydraulic hose ends prior to disconnecting hoses from the AWD control manifold. Label all hydraulic connections for assembly purposes (Fig. 127).

5. Disconnect hydraulic hoses from control manifold. The hoses at control manifold ports LR and RR need to be disconnected at hydraulic tubes before removal from manifold (Fig. 127).

6. Install clean caps or plugs on disconnected hoses and fittings to prevent contamination.

7. Support manifold to prevent it from falling.

8. Remove two (2) cap screws (item 1) and washers (item 5) that secure manifold to mount plate. Remove manifold from machine.

9. Locate and retrieve washers (items 5 and 8) from top and bottom of mounts (item 4).

10. If hydraulic fittings are to be removed from AWD control manifold, mark fitting orientation to allow correct assembly. Remove hydraulic fittings from manifold as needed. Discard fitting O−rings.

IMPORTANT: An orifice is threaded into control manifold ports OR1, OR2, OR3 and OR4. If any orifice is removed from manifold, make sure to label its position for assembly purposes.

Installation (Fig. 126)

IMPORTANT: If any orifice was removed from manifold, make sure to secure orifice into correct control manifold port before installing fittings.

1. If an orifice was removed from any manifold port, make sure that orifice is in port before installing the fitting (see CrossTrax™ AWD Control Manifold Service (4WD Machines) in this section).

2. If hydraulic fittings were removed from AWD control manifold, lubricate new O−rings with clean hydraulic oil, position O−rings to fittings and install fittings into manifold ports (see Hydraulic Fitting Installation in the General Information section of this chapter).

3. Position AWD control manifold to machine.

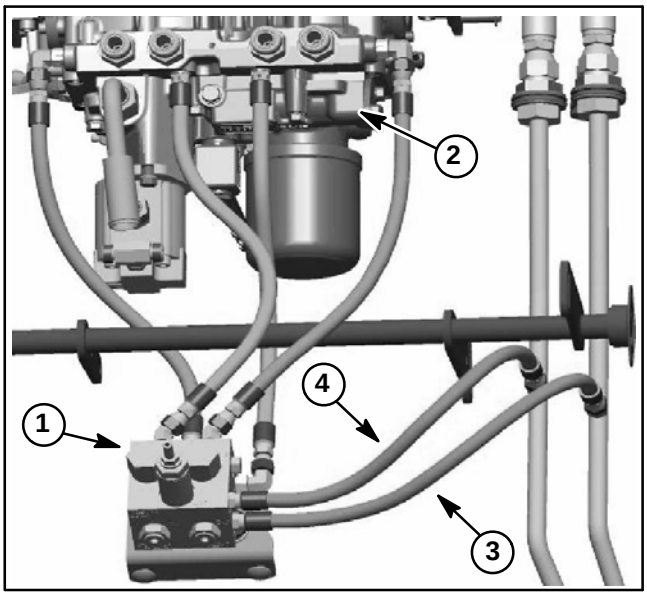

Figure 127

1. **AWD control manifold**
2. **Transmission**
3. **Hose to port LR**
4. **Hose to port RR**

4. Position washers (items 5 and 8) to top and bottom of mount (item 4). Secure control manifold to machine with two (2) cap screws (item 1) and washers (item 5).

5. Remove caps and plugs from hydraulic hoses and fittings.

6. Lubricate and install new O−rings on control manifold fittings. Using labels placed during manifold removal, correctly connect hydraulic hoses to control manifold and hydraulic tubes (Fig. 127) (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

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

8. Lower and secure operator seat.

9. Follow Hydraulic System Start−up procedures (see Hydraulic System Start−up in this section).

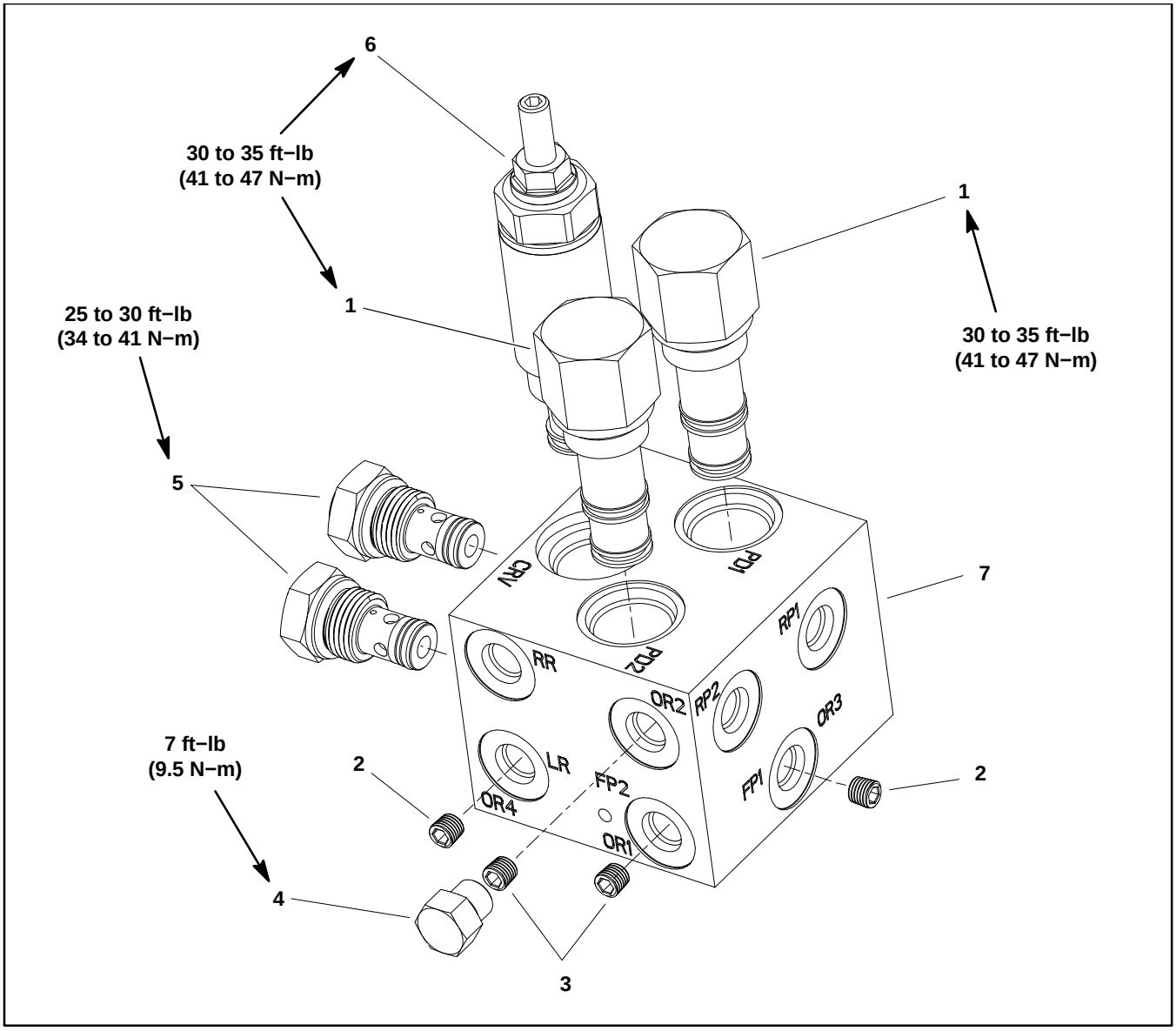

Figure 128

1. Pilot directional valve − PD1 & PD2 (2)
2. Orifice 0.040 − OR3 and OR4 (2)
3. Orifice 0.090 − OR1 and OR2 (2)
4. Hex plug
5. Check valve − CV1 and CV2 (2)
6. Relief valve (CRV)
7. AWD control manifold

NOTE: The ports on the CrossTrax AWD control manifold are marked for easy identification of components. Example: PD1 is the location for the pilot directional valve PD1 and OR1 is the location for a 0.090 orifice (see Hydraulic Schematic in Chapter 9 − Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each manifold port).

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.

IMPORTANT: An orifice is threaded into control manifold ports OR1, OR2, OR3 and OR4. If any orifice is removed from manifold, make sure to label its position for assembly purposes. During manifold assembly, make sure that orifice is correctly installed.

For cartridge valve service procedures, see Control Manifold Cartridge Valve Service in this section. Refer to Figure 128 for CrossTrax AWD manifold cartridge valve and plug installation torque.

Control Manifold Cartridge Valve Service

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.

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

2. If cartridge valve is solenoid operated, remove nut securing solenoid coil to the cartridge valve. Carefully slide coil off the valve.

IMPORTANT: Label the cartridge valves before removal from manifold so the valves can be correctly installed into the manifold.

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

3. Remove cartridge valve from manifold using a deep socket wrench. Note correct location for O−rings, sealing rings and backup rings. Remove seal kit from cartridge valve and discard removed seals.

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

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

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

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

CAUTION

Use eye protection such as goggles when using compressed air.

CAUTION

Abrupt movement of internal spools can cause stored fluid to be released suddenly.

6. Clean cartridge valve using clean mineral spirits. Submerge valve in clean mineral spirits to flush out contamination. Particles as fine as talcum powder can affect the operation of high pressure hydraulic valves. If cartridge design allows, use a wood or plastic probe to push the internal spool in and out 20 to 30 times to flush out contamination. Be extremely careful not to damage cartridge. Use compressed air for cleaning.

7. Install the cartridge valve into the manifold:

   A. Lubricate new seal kit components with clean hydraulic oil and install on valve. The O−rings, sealing rings and backup rings must be arranged properly on the cartridge valve for proper operation and sealing.

   B. Dip assembled cartridge into clean hydraulic oil.

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

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

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

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

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

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Gear Pump

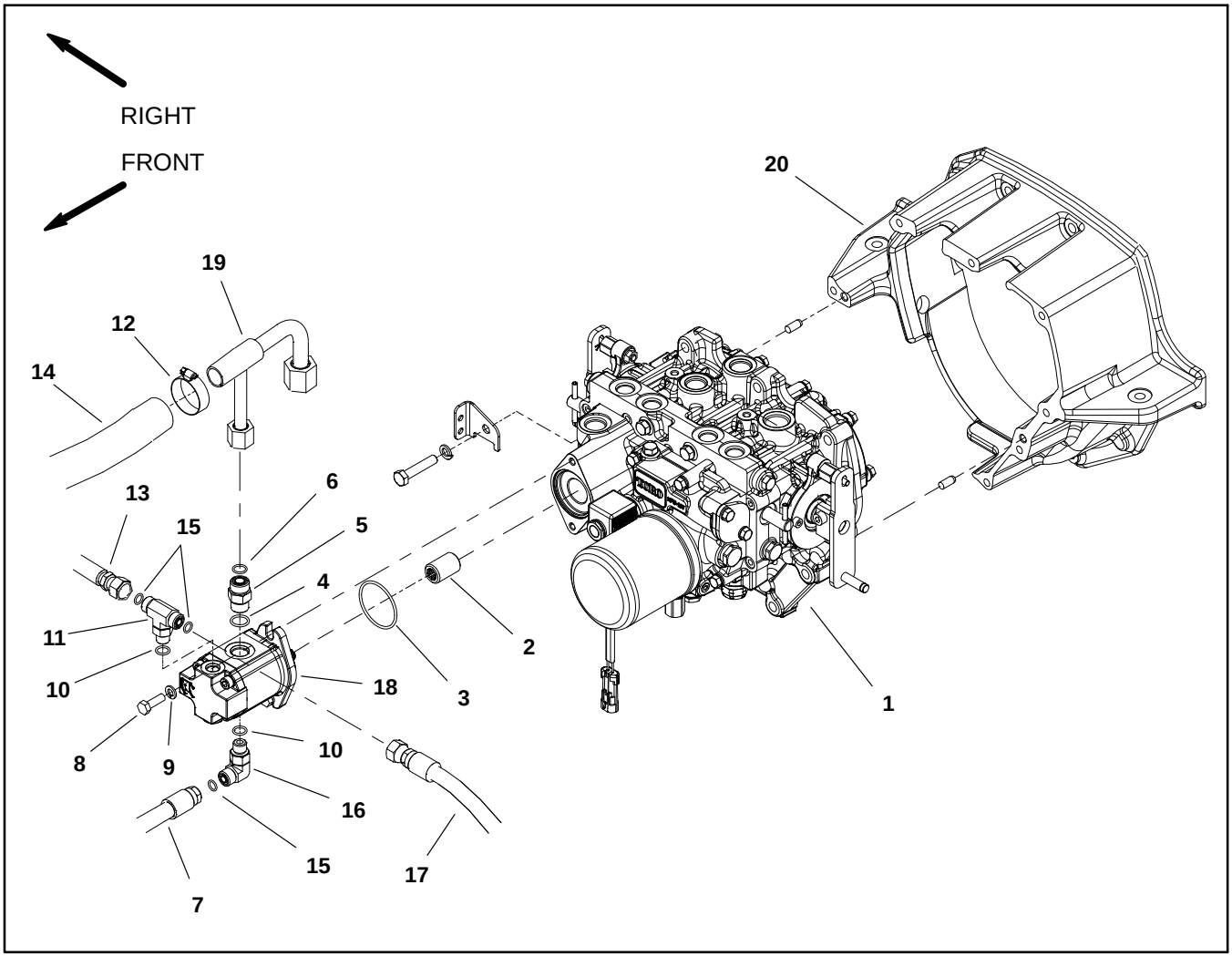

Figure 129

1. Transmission assembly
2. Coupler
3. O−ring
4. O−ring
5. Hydraulic fitting
6. O−ring
7. Hydraulic hose (output)
8. Cap screw (2)
9. Lock washer (2)
10. O−ring
11. Hydraulic tee fitting
12. Hose clamp
13. Hydraulic hose
14. Hydraulic hose (suction)
15. O−ring
16. Hydraulic 90° fitting
17. Hydraulic hose
18. Gear pump
19. Suction tube assembly
20. Flywheel housing

Removal (Fig. 129)

WARNING

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

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

2. Raise and support operator seat.

3. Drain hydraulic oil from hydraulic tank.

4. Thoroughly clean hydraulic hose ends and fittings on gear pump to prevent hydraulic system contamination.

5. Label all hydraulic hoses for assembly purposes.

6. Disconnect hydraulic hoses from fittings on the gear pump. Allow hoses to drain into a suitable container. Install clean plugs in hose and fitting openings to prevent system contamination.

7. Support the gear pump to prevent it from falling during removal.

8. Remove two (2) cap screws and lock washers that secure gear pump to the transmission.

9. Remove gear pump from transmission. Remove and discard O−ring (item 3). Locate and remove coupler (item 2).

10. If hydraulic fittings are to be removed from gear pump, mark fitting orientation to allow correct assembly. Remove hydraulic fittings from pump as needed. Discard fitting O−rings.

Installation (Fig. 129)

1. If hydraulic fittings were removed from pump, lubricate and install new O−rings to fitting. Install fittings into gear pump ports (see Hydraulic Fitting Installation in the General Information section of this chapter).

2. Slide coupler onto transmission shaft. Lubricate new O−ring (item 3) with grease and position on flange of gear pump.

IMPORTANT: Position gear pump to the transmission so that the gear pump suction port is facing up.

3. Position gear pump to the transmission and secure with two (2) cap screws and lock washers.

4. Remove plugs that were installed to hydraulic hoses and fittings during the removal procedure. Attach hydraulic hoses to fittings on gear pump and hydraulic tank using labels placed during removal (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

5. Fill hydraulic tank with **new** hydraulic oil.

6. Lower and secure operator seat.

7. Follow Hydraulic System Start−up procedures (see Hydraulic System Start−up in this section).

Gear Pump Service

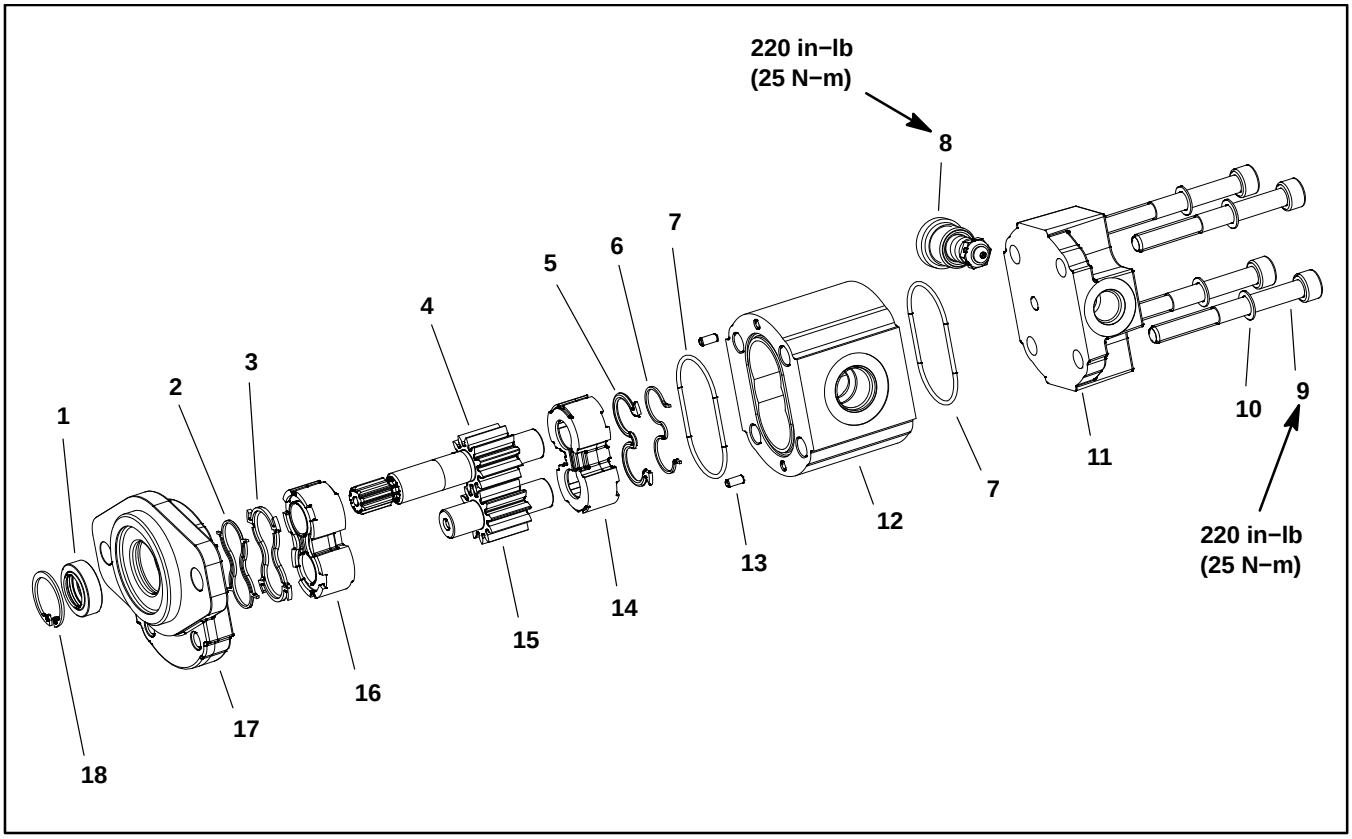

Figure 130

1. Shaft seal
2. Front back−up seal
3. Front pressure seal
4. Drive gear
5. Rear pressure ring
6. Rear back−up seal
7. O−ring
8. Implement relief valve
9. Socket head screw (4)
10. Lock washer (4)
11. Back plate
12. Body
13. Dowel pin
14. Rear bearing block
15. Idler gear
16. Front bearing block
17. Front plate
18. Retaining ring

Disassembly (Fig. 130)

1. Install clean plugs in pump ports and clean the outside of the pump thoroughly. After cleaning, remove plugs and drain any oil out of the pump.

2. Use a marker to make a “V” across the front plate, body and back plate for assembly purposes (Fig. 131).

IMPORTANT: When clamping the pump in a vise, clamp only on mounting flange. DO NOT clamp pump body in a vise.

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

4. Loosen four (4) socket head screws that secure the back plate.

5. Remove pump from the vise. Remove socket head screws and lock washers.

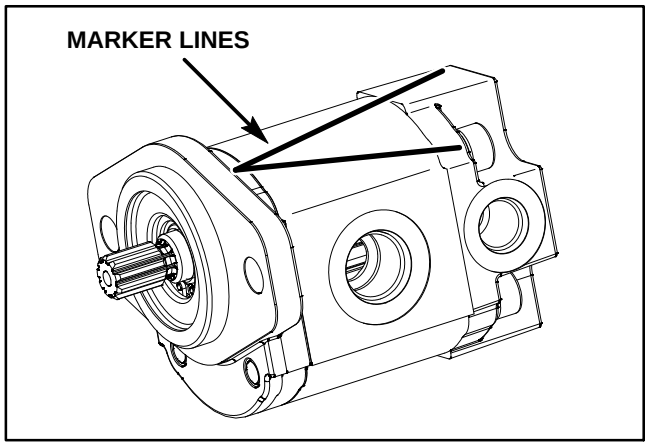

Figure 131

6. Remove front plate from the body, then remove back plate. Locate and remove dowel pins from body.

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

7. Place pump on its side and push on the rear bearing block to remove bearing blocks and gear set from the pump body.

NOTE: Pressure seals and back−up rings fit in grooves machined into bearing blocks. O−rings fit in grooves machined in the pump body.

8. Carefully remove and discard O−rings, pressure seals and back−up rings from pump body and bearing blocks. Do not cause any damage to the machined grooves during the removal process.

9. Turn front plate over, with seal side up and remove the retaining ring.

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

10. Carefully remove retaining ring and shaft seal from the front plate (Fig. 132). Note orientation of seal lips during removal. Discard removed seal.

11. Carefully remove shaft seal from the front plate.

12. If necessary, remove implement relief valve from back plate. Remove and discard sealing washers.

Inspection (Fig. 133)

CAUTION

Use eye protection such as goggles when using compressed air.

1. Clean all pump parts with solvent. Dry all parts with compressed air.

2. Inspect drive gear, idler gear and bearing blocks for the following. If damage is found, pump replacement is necessary.

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

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

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

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

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

3. Inspect front plate and back plate for damage or wear. Replace pump if plates are damaged or worn.

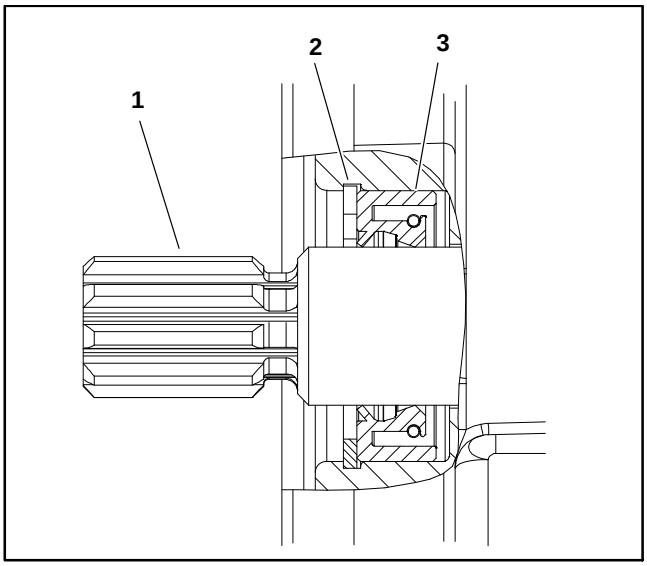

Figure 132

1. **Drive gear shaft**
2. **Retaining ring**
3. **Shaft seal**

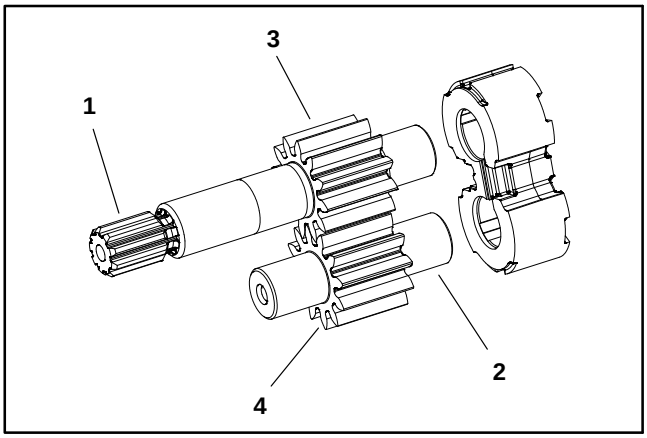

Figure 133

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

Assembly (Fig. 130)

NOTE: When assembling the pump, check the V−shaped marker line made during disassembly to make sure components are properly aligned.

1. Lubricate new O−rings, pressure seals and back−up gaskets with a thin coat of petroleum jelly. Lubricate all internal pump parts freely with clean hydraulic oil.

2. Install new shaft seal in front plate. Note orientation of seal lips during installation (Fig. 132). Seal should be pressed into place until it reaches the bottom of the bore.

3. Install retaining ring into the groove of the front plate.

4. Install lubricated O−rings to the body.

5. Install lubricated pressure seals into the machined grooves of the bearing blocks and follow by carefully placing the back−up rings into the grooves.

6. Lubricate gear faces and bearing surfaces of drive gear, idler gear and bearing blocks with clean hydraulic oil. Carefully assemble bearing blocks and gears noting identification marks made during disassembly.

7. Position the pump body on its side. Carefully slide bearing block and gear assembly into the body cavity using identification marks made during disassembly.

8. Remove any excess lubrication from mating surfaces of body, back plate and front plate. Make sure that these surfaces are clean and dry.

9. Install dowel pins in body.

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

10. Gently slide the back plate onto the assembly using marker lines for proper location. Firm hand pressure should be sufficient to engage the dowel pins.

11. Place thin sleeve or tape on pump shaft splines to prevent seal damage.

12. Position the pump with back plate downwards. Carefully slide the front plate onto the assembly using marker lines for proper location. Take care to not damage the seal during front plate installation. Remove sleeve or tape from shaft splines.

13. Install the four (4) socket head screws with lock washers and hand tighten.

IMPORTANT: When clamping the pump in a vise, clamp only on mounting flange. DO NOT clamp pump body in a vise.

14. Clamp mounting flange of pump in a vise with the shaft end down.

15. Alternately torque the socket head screws **220 in−lb (25 N−m)**.

16. If implement relief valve was removed from back plate, install relief valve. Torque relief valve **220 in−lb (25 N−m)**.

17. Put a small amount of hydraulic oil in inlet port of pump and rotate input shaft one revolution. Place coupler on input shaft and use pliers on coupler to rotate pump shaft. If input shaft binds, disassemble pump and repeat assembly process.

18. Remove pump from vise.

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Steering Control Valve

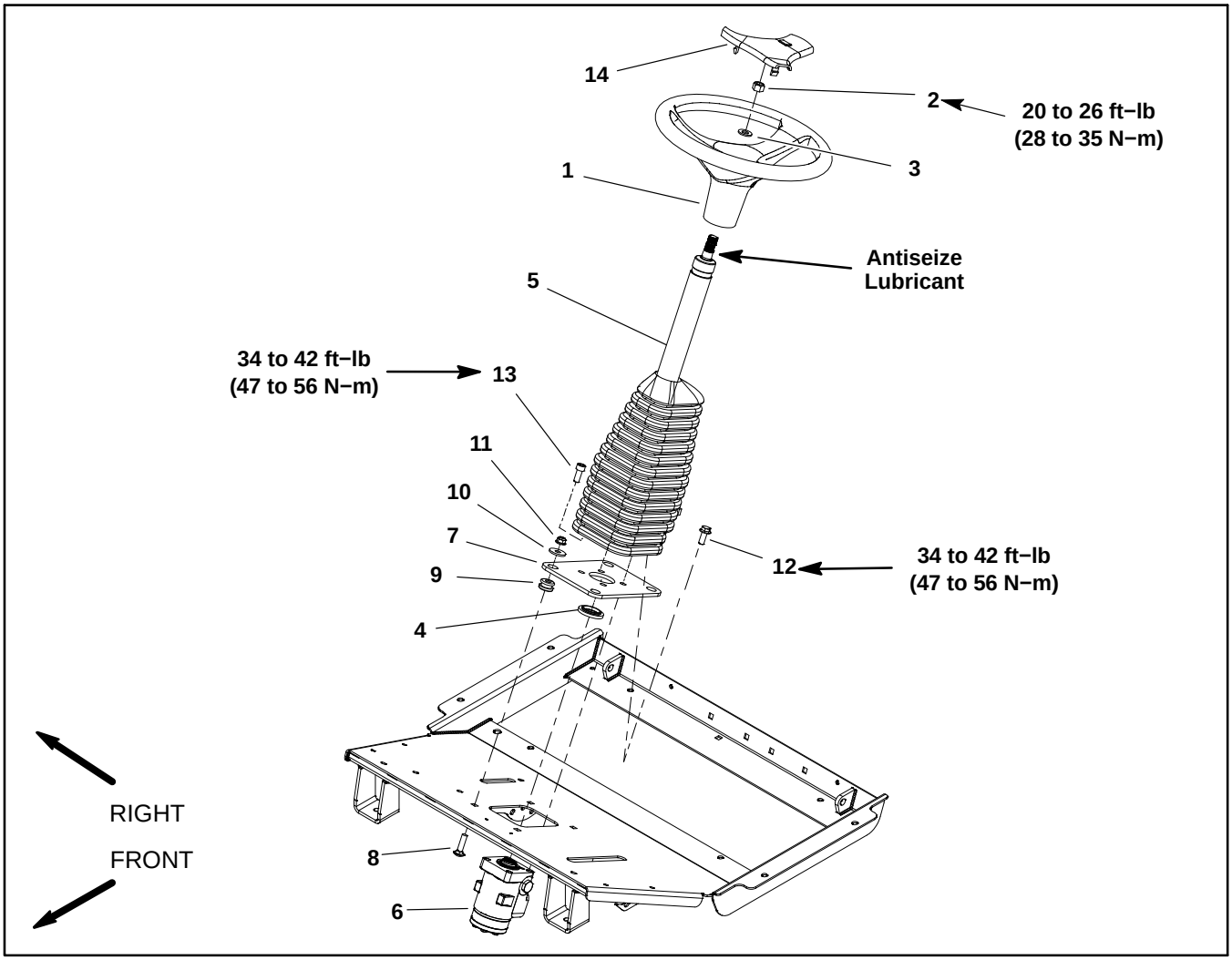

Figure 134

1. Steering wheel
2. Lock nut
3. Flat washer
4. Alignment bushing
5. Steering column assembly
6. Steering control valve
7. Steering plate
8. Carriage screw (4)
9. Mount (4)
10. Washer (4)
11. Flange nut (4)
12. Flange head screw (3)
13. Socket head screw
14. Steering wheel cover

Removal (Fig. 134)

WARNING

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

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

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

3. Label all hydraulic lines and fittings at steering control valve for assembly purposes. Note port designations on steering control valve (Fig. 136). Thoroughly clean hydraulic connections prior to loosening hydraulic lines.

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

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

6. While supporting steering column to prevent it from falling, loosen and remove four (4) carriage screws (item 8) and flange nuts (item 11) that secure steering column assembly to machine. Locate and retrieve four (4) washers (item 10) and mounts (item 9).

7. While carefully guiding steering control valve from hole in platform, lift steering column assembly (with steering control valve attached) and remove from machine.

8. Place steering column assembly on bench. Slide rubber bellows up from bottom of steering column.

9. Loosen and remove three (3) flange head screws (item 12) and one (1) socket head screw (item 13) that secure steering column to steering control valve. Note location of socket head screw for assembly purposes.

10. Remove steering control valve (item 6), alignment bushing (item 4) and steering plate (item 7) from steering column.

11. If necessary, remove fittings and O−rings from steering control valve (Fig. 135). Discard all removed O−rings.

Installation (Fig. 134)

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

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

3. Position alignment bushing (item 4) and steering plate (item 7) to steering control valve and then slide steering control valve input shaft onto steering column shaft. Position control valve with ports toward tilt lever on steering column. Make sure that alignment bushing is positioned on steering control valve and into steering plate bore.

4. Secure steering column in place with three (3) flange head screws (item 12) and one (1) socket head screw (item 13). Hand tighten screws in a crossing pattern and then torque screws again in a crossing pattern from **34 to 42 ft−lb (47 to 56 N−m)**.

5. Carefully position steering column assembly to machine.

6. Position mounts (item 9) between frame and steering plate at four (4) mounting holes. Secure steering column assembly to machine with four (4) carriage screws (item 8), washers (item 10) and flange nuts (item 11).

7. Remove caps and plugs from disconnected hydraulic lines and fittings.

8. Lubricate new O−rings and connect hydraulic lines to fittings on steering control valve using labels placed during valve removal. Tighten all connections (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

9. Slide rubber bellows to bottom of steering column.

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).

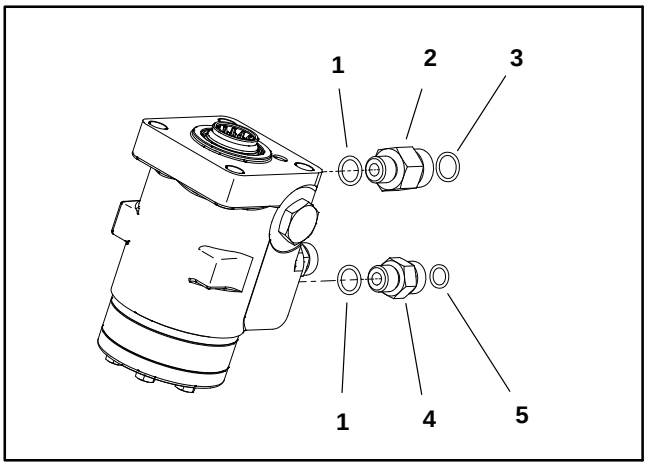

Figure 135

1. **O−ring**
2. **Fitting**
3. **O−ring**
4. **Fitting (4)**
5. **O−ring**

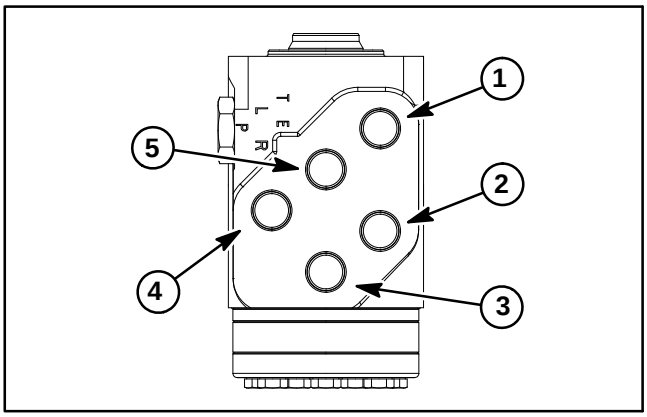

Figure 136

1. **Out port (T)**
2. **Load sensing port (E)**
3. **Right turn port (R)**
4. **In port (P)**
5. **Left turn port (L)**

Steering Control Valve Service

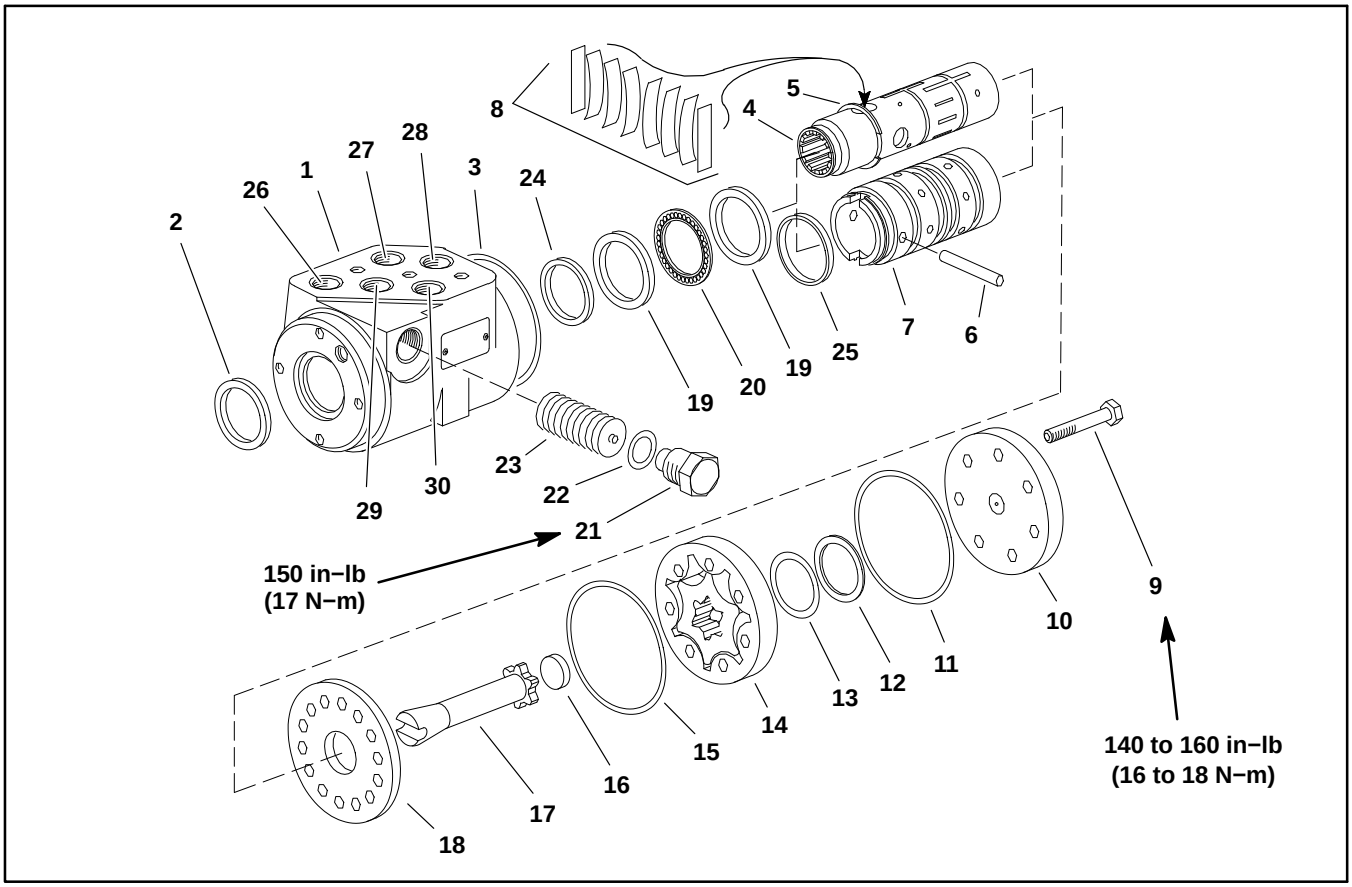

Figure 137

1. Steering valve housing
2. Dust seal
3. O−ring
4. Spool
5. Spring retaining ring
6. Pin
7. Sleeve
8. Centering springs/spacers
9. Cap screw (7)
10. End cap
11. O−ring
12. Seal ring
13. O−ring
14. Geroter
15. O−ring
16. Spacer
17. Geroter drive
18. Wear plate
19. Bearing race
20. Thrust bearing
21. Plug
22. O−ring
23. Relief valve
24. Quad seal
25. Ring
26. T port (return to tank)
27. E port (flow beyond)
28. R port
29. L port
30. P port (from pump)

Disassembly (Fig. 137)

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

1. Remove the seven (7) cap screws from the steering valve assembly.

2. Remove end cap, geroter, spacer, geroter drive, wear plate, seal ring, and O−rings from housing (Fig. 137).

3. Remove the plug and relief valve.

4. Slide the spool and sleeve assembly from the housing.

5. Remove the thrust bearing and bearing races (2).

6. Remove the quad seal.

7. Use a small blade screwdriver to carefully pry the dust seal from the housing. Be careful to not damage the dust seal seat in the housing.

8. Remove the pin that holds the spool and sleeve together.

9. Carefully slide the spool out of the sleeve. The centering springs and spring retaining ring will stay with the spool as it is removed.

CAUTION

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

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

Assembly (Fig. 137)

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

NOTE: Always use new seals and O−rings when assembling the steering control unit.

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

1. Install the quad seal:

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

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

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

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

   E. Remove the sleeve and bearing race.

2. Lubricate and install the dust seal.

3. Install the centering springs in the spool. It is best to install the two (2) flat pieces first. Next, install the curved pieces, three (3) at a time.

4. Fit the retaining ring over the centering springs.

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

6. Install the pin.

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

8. Put the thrust bearing and races into the housing. The thrust bearing goes between the two races (Fig. 138).

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

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

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

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

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

NOTE: The holes in the wear plate are symmetrical.

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

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

15. Install the gerotor and align the screw holes.

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

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

18. Install the spacer.

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

20. Remove the steering control unit from the vise.

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

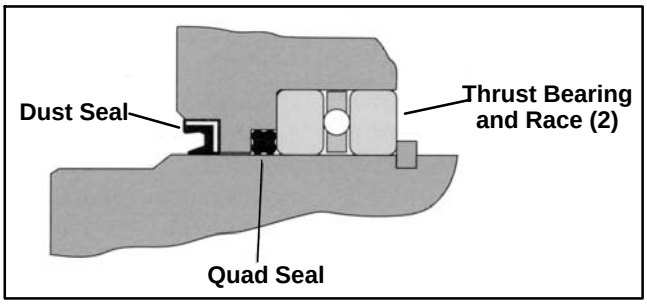

Figure 138

Steering Cylinder (Serial Number Below 314999999)

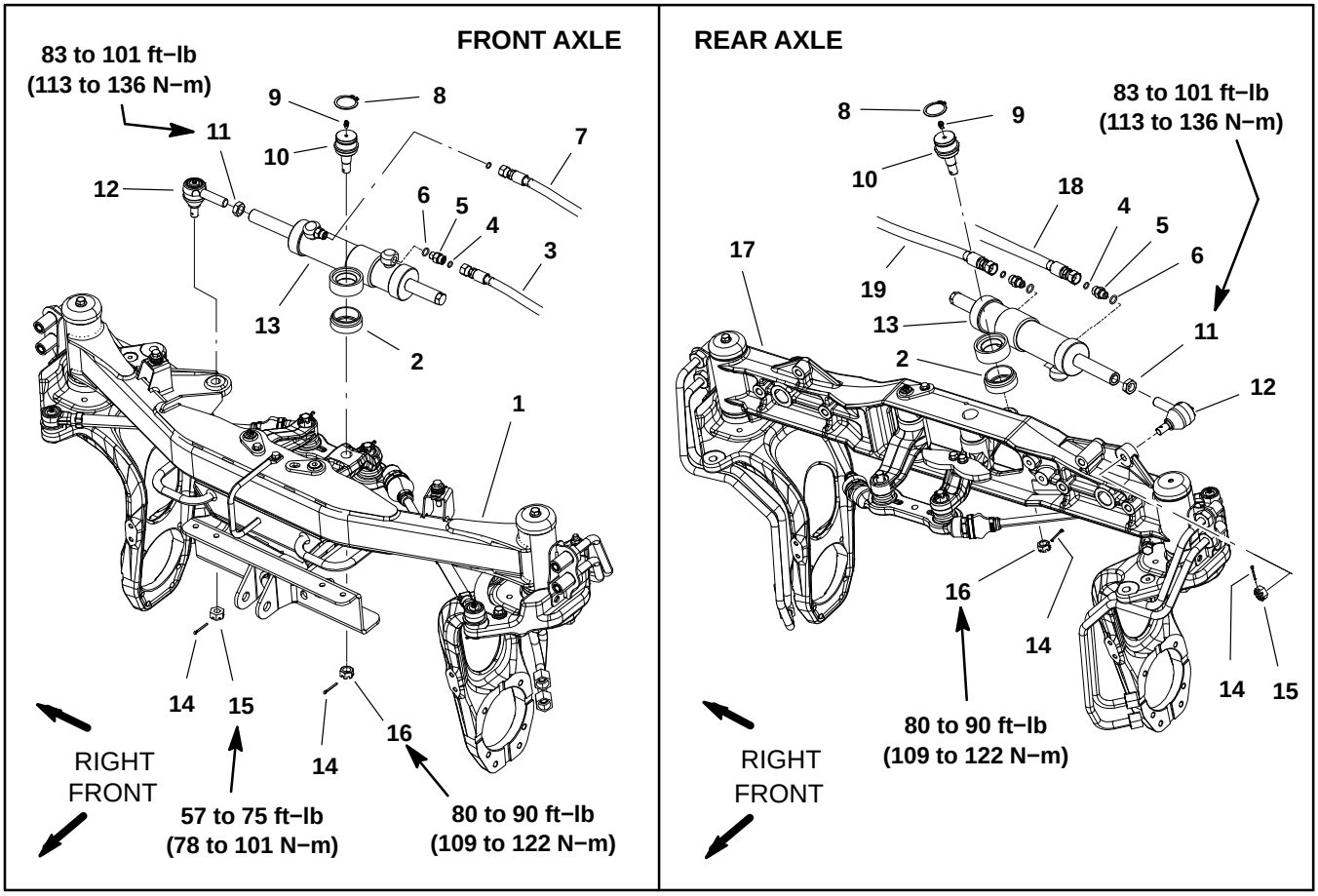

Figure 139

1. Front axle assembly
2. Steering cylinder spacer (2)
3. Hydraulic hose
4. O−ring (4)
5. Hydraulic fitting (4)
6. O−ring (4)
7. Hydraulic hose
8. Retaining ring (2)
9. Grease fitting (2)
10. Ball joint (2)
11. Jam nut (2)
12. Cylinder rod end (2)
13. Steering cylinder (2)
14. Cotter pin (4)
15. Slotted hex nut (2)
16. Slotted hex nut (2)
17. Rear axle assembly
18. Hydraulic hose
19. Hydraulic hose

NOTE: For additional information regarding the steering assemblies on your Groundsmaster 360 machine, refer to Front Steering Assembly or Rear Steering Assembly in the Service and Repairs section of Chapter 6 − Chassis.

Removal (Fig. 139)

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

2. If front steering cylinder is to be removed from machine, remove front cover from front axle to allow access to front steering cylinder (Fig. 140).

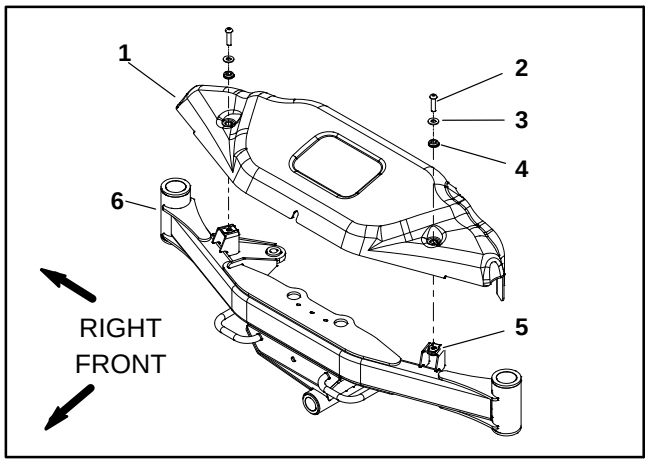

Figure 140

1. Front cover
2. Screw (2)
3. Flat washer (2)
4. Grommet (2)
5. Tinnerman nut (2)
6. Front axle

3. If rear steering cylinder is to be removed from machine, the storage compartment behind operator seat needs to be removed to allow clearance for cylinder removal. To remove storage compartment, see Storage Compartment Removal in the Service and Repairs section of Chapter 6 − Chassis or, if machine is equipped with operator cab, see Storage Compartment Removal in the Service and Repairs section of Chapter 8 − Operator Cab.

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

WARNING

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

5. Label all hydraulic connections for assembly purposes. Thoroughly clean hydraulic hose ends prior to disconnecting hoses from the steering cylinder.

6. Disconnect hydraulic hoses from steering cylinder that is being removed.

7. Put caps or plugs on disconnected hoses and fittings to prevent contamination.

8. Remove cotter pins (item 14) and slotted hex nuts (items 15 and 16) that secure steering cylinder to axle.

9. Use appropriate tool to separate steering cylinder ball joint and rod end from axle assembly. Remove steering cylinder from machine.

10. If ball joint (item 10) is to be removed from cylinder, note direction that ball joint is installed in cylinder. Remove ball joint from steering cylinder barrel.

11. If necessary, remove rod end (item 12) from steering cylinder shaft.

12. If necessary, remove fittings from steering cylinder and discard O−rings.

Installation (Fig. 139)

1. If hydraulic fittings were removed from steering cylinder, lubricate new O−rings with clean hydraulic oil, position O−rings to fittings and install fittings into steering cylinder ports (see Hydraulic Fitting Installation in the General Information section of this chapter).

2. If removed, press ball joint (item 10) into barrel and secure with retaining ring.

3. If rod end (item 141) was removed from steering cylinder shaft, thread rod end into shaft so that distance from end of shaft to center of grease fitting in rod end is **1.750" (44.5 mm)**. Torque jam nut from **83 to 101 ft−lb (113 to 136 N−m)**. Make sure that distance from end of shaft to center of grease fitting doesn't change during jam nut tightening.

4. Thoroughly clean tapers on ball joint, rod end and axle assembly bores.

NOTE: Front axle steering cylinder should be installed so ports are on the upper side. Rear axle steering cylinder should be installed so ports are on the lower side.

5. Position steering cylinder to machine.

6. Secure steering cylinder to machine with slotted hex nuts (items 15 and 16).

A. On front axle steering cylinder, torque rod end slotted hex nut (item 15) from **57 to 75 ft−lb (78 to 101 N−m)**. If necessary, continue to tighten hex nut to allow cotter pin installation.

B. On both front and rear axle steering cylinders, torque barrel end slotted hex nut (item 16) from **80 to 90 ft−lb (109 to 122 N−m)**. If necessary, continue to tighten hex nut to allow cotter pin installation.

C. Install cotter pins to secure hex nuts.

7. Remove caps and plugs from hydraulic hoses and fittings.

8. Lubricate and install new O−rings on steering cylinder fittings. Correctly connect hydraulic hoses to steering cylinder (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

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

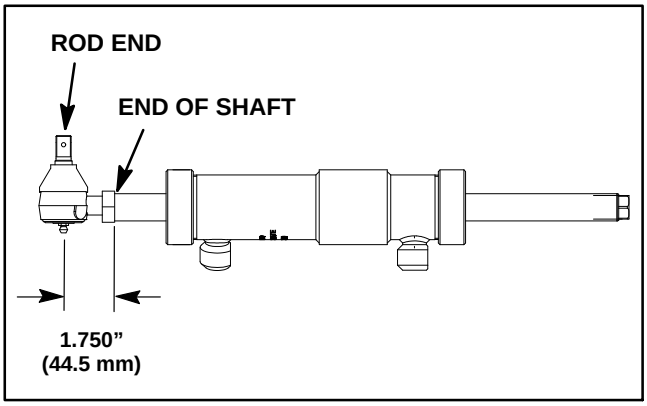

Figure 141

10. Lubricate steering cylinder ball joint grease fittings.

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

12. Check that steering cylinder does not contact the axle or frame as cylinder moves from fully retracted to fully extended. Also, check that distance between the drag links and steering stops are equal on both sides of the machine. If necessary, adjust location of rod end on cylinder shaft.

13. If removed, secure front cover to front axle (Fig. 140).

14. If removed, secure storage compartment to machine (see Storage Compartment Installation in the Service and Repairs section of Chapter 6 − Chassis or, if machine is equipped with operator cab, see Storage Compartment Installation in the Service and Repairs section of Chapter 8 − Operator Cab).

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Steering Cylinder (Serial Number Above 315000000)

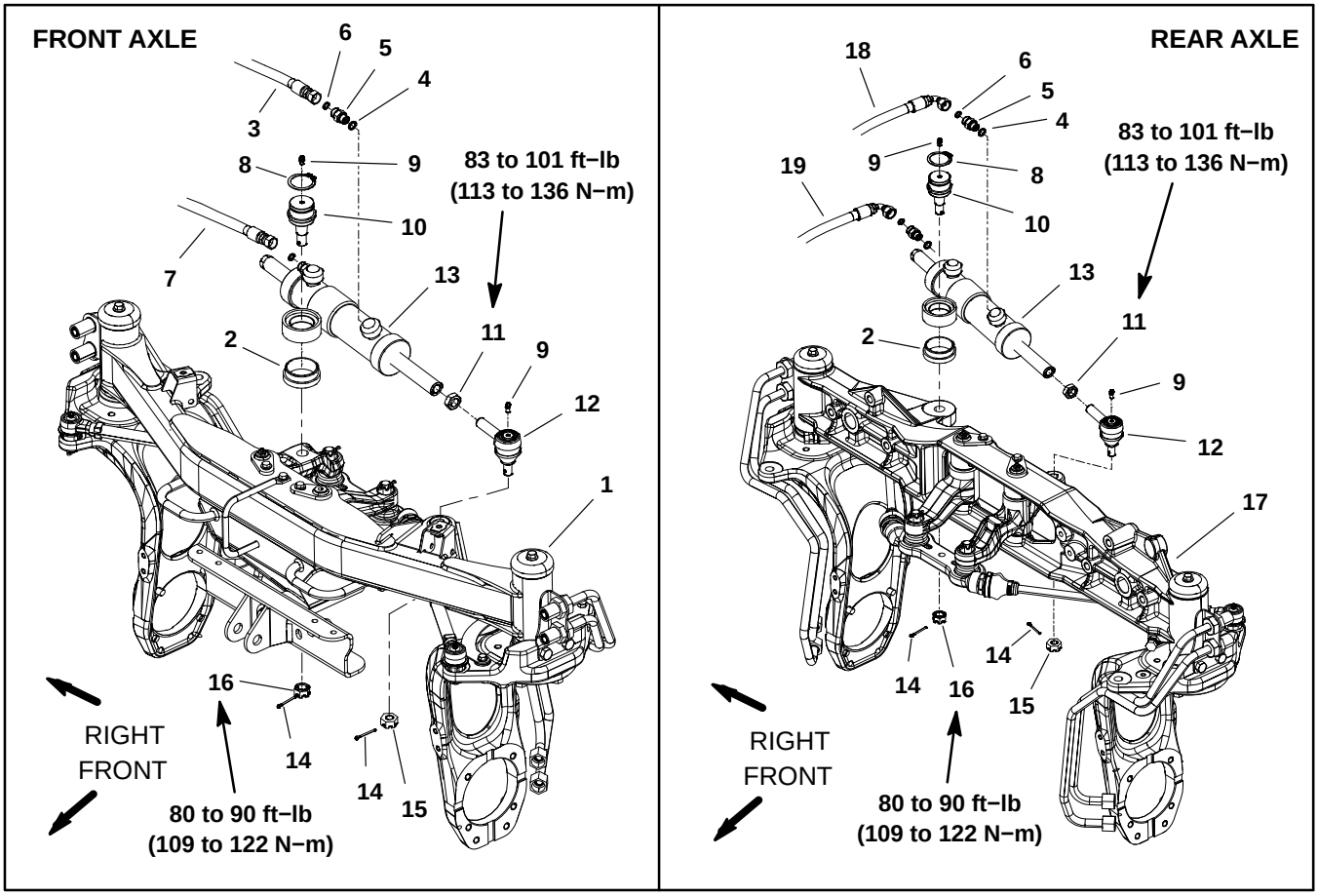

Figure 142

1. Front axle assembly
2. Steering cylinder spacer (2)
3. Hydraulic hose
4. O−ring (4)
5. Hydraulic fitting (4)
6. O−ring (4)
7. Hydraulic hose
8. Retaining ring (2)
9. Grease fitting (2)
10. Ball joint (2)
11. Jam nut (2)
12. Cylinder rod end (2)
13. Steering cylinder (2)
14. Cotter pin (4)
15. Slotted hex nut (2)
16. Slotted hex nut (2)
17. Rear axle assembly
18. Hydraulic hose
19. Hydraulic hose

NOTE: For additional information regarding the steering assemblies on your Groundsmaster 360 machine, refer to Front Steering Assembly or Rear Steering Assembly in the Service and Repairs section of Chapter 6 − Chassis.

Removal (Fig. 142)

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

2. If front steering cylinder is to be removed from machine, remove front cover from front axle to allow access to front steering cylinder (Fig. 143).

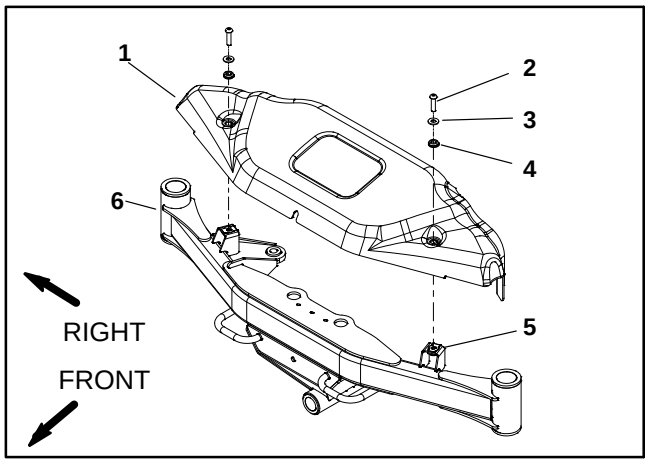

Figure 143

1. Front cover
2. Screw (2)
3. Flat washer (2)
4. Grommet (2)
5. Tinnerman nut (2)
6. Front axle

3. If rear steering cylinder is to be removed from machine, the storage compartment behind operator seat needs to be removed to allow clearance for cylinder removal. To remove storage compartment, see Storage Compartment Removal in the Service and Repairs section of Chapter 6 − Chassis or, if machine is equipped with operator cab, see Storage Compartment Removal in the Service and Repairs section of Chapter 8 − Operator Cab.

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

WARNING

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

5. Label all hydraulic connections for assembly purposes. Thoroughly clean hydraulic hose ends prior to disconnecting hoses from the steering cylinder.

6. Disconnect hydraulic hoses from steering cylinder that is being removed.

7. Put caps or plugs on disconnected hoses and fittings to prevent contamination.

8. Remove cotter pins (item 14) and slotted hex nuts (items 15 and 16) that secure steering cylinder to axle.

9. Use appropriate tool to separate steering cylinder ball joint and rod end from axle assembly. Remove steering cylinder from machine.

10. If ball joint (item 10) is to be removed from cylinder, note direction that ball joint is installed in cylinder. Remove ball joint from steering cylinder barrel.

11. If necessary, remove rod end (item 12) from steering cylinder shaft.

12. If necessary, remove fittings from steering cylinder and discard O−rings.

Installation (Fig. 142)

1. If hydraulic fittings were removed from steering cylinder, lubricate new O−rings with clean hydraulic oil, position O−rings to fittings and install fittings into steering cylinder ports (see Hydraulic Fitting Installation in the General Information section of this chapter).

2. If removed, press ball joint (item 10) into barrel and secure with retaining ring.

3. If rod end (item 12) was removed from steering cylinder shaft, thread rod end into shaft so that distance from end of shaft to center of grease fitting in rod end is 1.750” (44.5 mm) (Fig. 12). Torque jam nut from **83 to 101 ft−lb (113 to 136 N−m)**. Make sure that distance from end of shaft to center of grease fitting doesn’t change during jam nut tightening.

4. Thoroughly clean tapers on ball joint, rod end and axle assembly.

NOTE: Install steering cylinder so that ports are on the upper side.

5. Position steering cylinder to machine.

6. Secure steering cylinder to machine with slotted hex nuts (items 15 and 16).

   A. On both front and rear axle steering cylinders, torque barrel end slotted hex nut (item 16) from **80 to 90 ft−lb (109 to 122 N−m)**. If necessary, continue to tighten hex nut to allow cotter pin installation.

   B. Insert cotter pins to secure hex nuts.

7. Remove caps and plugs from hydraulic hoses and fittings.

8. Lubricate and install new O−rings on steering cylinder fittings. Correctly connect hydraulic hoses to steering cylinder (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

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

10. Lubricate steering cylinder ball joint grease fittings.

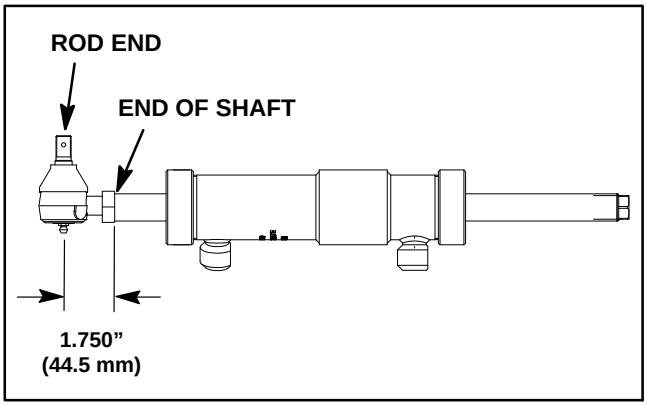

Figure 144

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

12. Check that steering cylinder does not contact the axle or frame as cylinder moves from fully retracted to fully extended. Also, check that distance between the drag links and steering stops are equal on both sides of the machine. If necessary, adjust location of rod end on cylinder shaft.

13. If removed, secure front cover to front axle (Fig. 7).

14. If removed, secure storage compartment to machine (see Storage Compartment Installation in the Service and Repairs section of Chapter 6 − Chassis or, if machine is equipped with operator cab, see Storage Compartment Installation in the Service and Repairs section of Chapter 8 − Operator Cab).

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Steering Cylinder Service

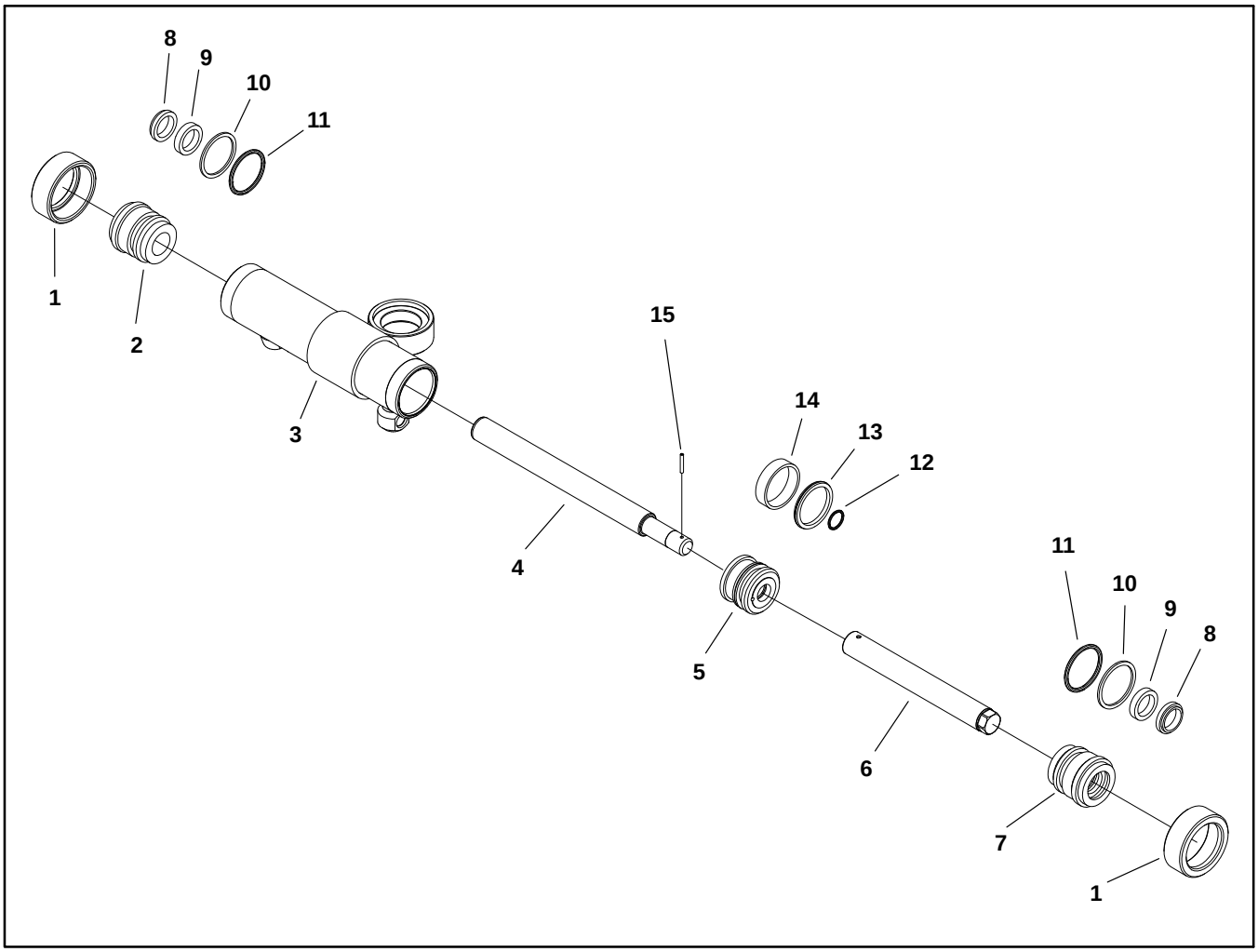

Figure 145

1. Collar (2)
2. Front head
3. Barrel
4. Front rod
5. Piston assembly
6. Rear rod
7. Rear head
8. Dust seal (2)
9. Head seal (2)
10. Back−up ring (2)
11. O−ring (2)
12. O−ring
13. Piston seal
14. Wear ring
15. Roll pin

NOTE: Front and rear steering cylinders used on the Groundsmaster 360 are the same and use the same service procedures.

NOTE: The following procedures assume the rod end and ball joint have been removed from the steering cylinder (see Steering Cylinder Removal in this section).

Disassembly (Fig. 145)

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

IMPORTANT: Prevent damage when clamping the steering cylinder into a vise; clamp on the barrel clevis ONLY. Do not close vise on barrel or rod.

2. Mount steering cylinder securely in a vise by clamping on the barrel clevis. Use of a vise with soft jaws is recommended.

3. Using a spanner wrench, loosen and remove external collars from both ends of barrel.

4. Use a twisting and pulling motion to carefully extract the rear head from the barrel and rear rod.

5. Grasp end of front rod and use a twisting and pulling motion to carefully extract the front rod, front head, piston and rear rod assembly from the barrel.

6. Remove cylinder barrel from vise.

IMPORTANT: When removing roll pin from front and rear rods, make sure that rod surfaces are not damaged.

7. Remove and discard roll pin (item 15) that secures front rod to rear rod. Then remove rear rod (item 6), piston (item 5) and front head (item 2) from front rod.

8. Remove and discard seals, O−rings and wear ring from piston and heads.

Inspection

CAUTION

Use eye protection such as goggles when using compressed air.

1. Wash all cylinder components in solvent. Dry parts with compressed air.

2. Inspect internal surface of barrel for deep scratches, out−of−roundness and bending.

3. Inspect head, rods and piston for excessive pitting, scoring and wear.

4. Check re−phasing valve in piston that exists to allow synchronization of the front and rear steering cylinders. Poppet valves should not be stuck in piston. If valves are stuck or damaged, replace piston assembly.

5. Replace steering cylinder if internal components are found to be worn or damaged.

Assembly (Fig. 145)

1. Use a new seal kit to replace all seals, O−rings and wear ring to piston and heads. Apply clean hydraulic oil to all seal kit components before installing.

2. Install front head (item 2) with new seals onto front rod (item 4) being careful to not damage head seals during installation.

IMPORTANT: Make sure to not damage O−ring (item 7) as piston is installed over roll pin hole in front rod.

3. Install piston (item 5) with new seal, O−ring and wear ring onto front rod.

IMPORTANT: When installing roll pin into front and rear rods, make sure that rod surfaces are not damaged.

4. Slide rear rod onto front rod and align roll pin holes in rods. Install new roll pin (item 15) to secure rods.

IMPORTANT: Prevent damage when clamping the cylinder's barrel into a vise; clamp on the clevis only. Do not close vise on barrel or rods.

5. Mount steering cylinder barrel in a vise equipped with soft jaws by clamping on the barrel clevis.

6. Coat all internal cylinder components with clean hydraulic oil. Slide rod assembly into barrel, being careful to not damage seals during installation.

7. Insert rear head with new seals into the barrel being careful to not damage head seals during installation.

8. Secure front and rear heads in barrel with external collars. Tighten collars with spanner wrench.

Steering Control Manifold (4WD Machines)

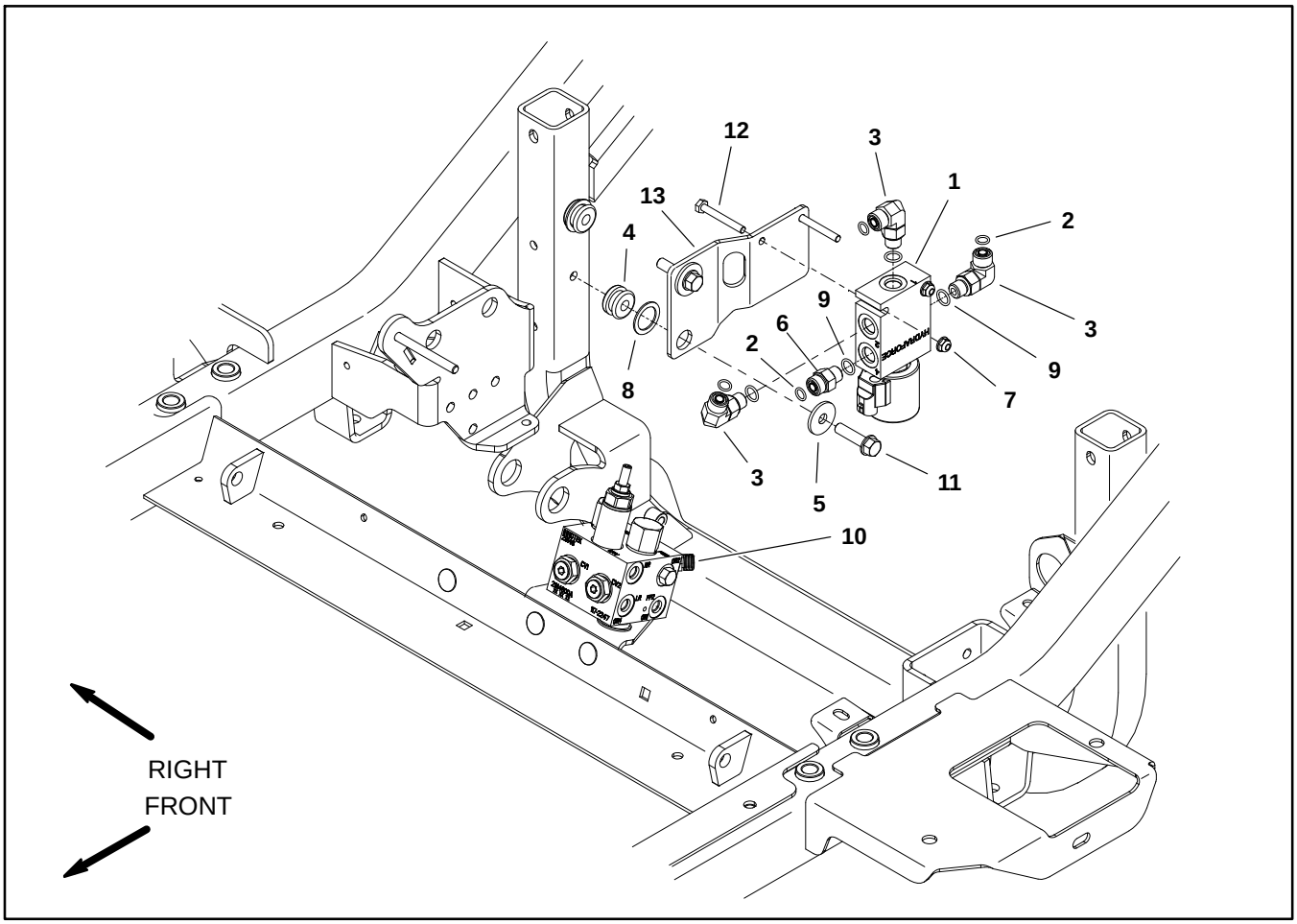

Figure 146

1. **Steering control manifold**
2. **O−ring (4)**
3. **90º hydraulic fitting (3)**
4. **Mount (2)**
5. **Washer (2)**
6. **Straight hydraulic fitting**
7. **Flange nut (2)**
8. **Washer (2)**
9. **O−ring (4)**
10. **AWD control manifold**
11. **Washer head screw (2)**
12. **Cap screw (2)**
13. **Mount plate**

The steering control manifold used on Groundsmaster 360 machines with 4WD prevents steering of the rear wheels when the operator presses the steering selector switch to the 2 wheel steering position (switch light illuminated).

Manifold Removal (Fig. 146)

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

WARNING

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

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

3. Raise and support operator seat. Locate steering control manifold.

4. Thoroughly clean hydraulic hose ends prior to disconnecting hoses from the steering control manifold. Label all hydraulic connections for assembly purposes.

5. Disconnect hydraulic hoses from control manifold.

6. Install clean caps or plugs on disconnected hoses and fittings to prevent contamination.

7. Disconnect wire harness connector from solenoid coil on manifold.

8. Support manifold to prevent it from falling.

9. Remove two (2) cap screws (item 12) and flange nuts (item 7) that secure manifold to mount plate. Remove manifold from machine.

10. If hydraulic fittings are to be removed from steering control manifold, mark fitting orientation to allow correct assembly. Remove hydraulic fittings from manifold as needed. Discard fitting O−rings.

Manifold Installation (Fig. 146)

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

2. Position steering control manifold to machine.

3. Secure control manifold to machine with two (2) cap screws (item 12) and flange nuts (item 7).

4. Remove caps and plugs from hydraulic hoses and fittings.

5. Lubricate and install new O−rings on control manifold fittings. Using labels placed during manifold removal, correctly connect hydraulic hoses to control manifold (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

6. Connect wire harness connector to solenoid coil on manifold.

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

8. Lower and secure operator seat.

9. Follow Hydraulic System Start−up procedures (see Hydraulic System Start−up in this section).

Steering Control Manifold Service (4WD Machines)

NOTE: The ports on the steering control manifold are marked for easy identification of components. See Hydraulic Schematic in Chapter 9 − Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each manifold port.

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.

For cartridge valve service procedures, see Control Manifold Cartridge Valve Service in this section. Refer to Figure 147 for steering control manifold cartridge valve installation torque.

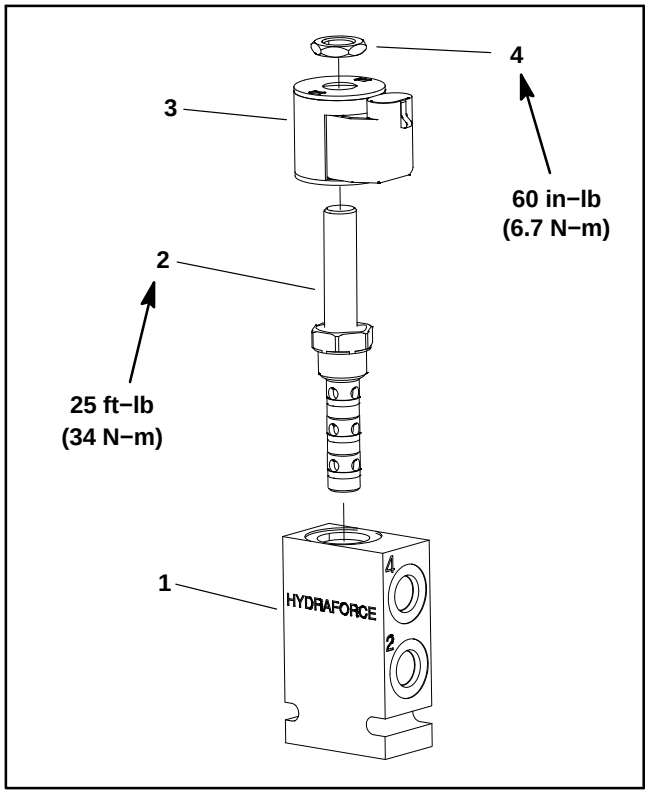

Figure 147

1. Steering control manifold
2. Solenoid valve
3. Solenoid coil
4. Nut

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Deck Lift Manifold

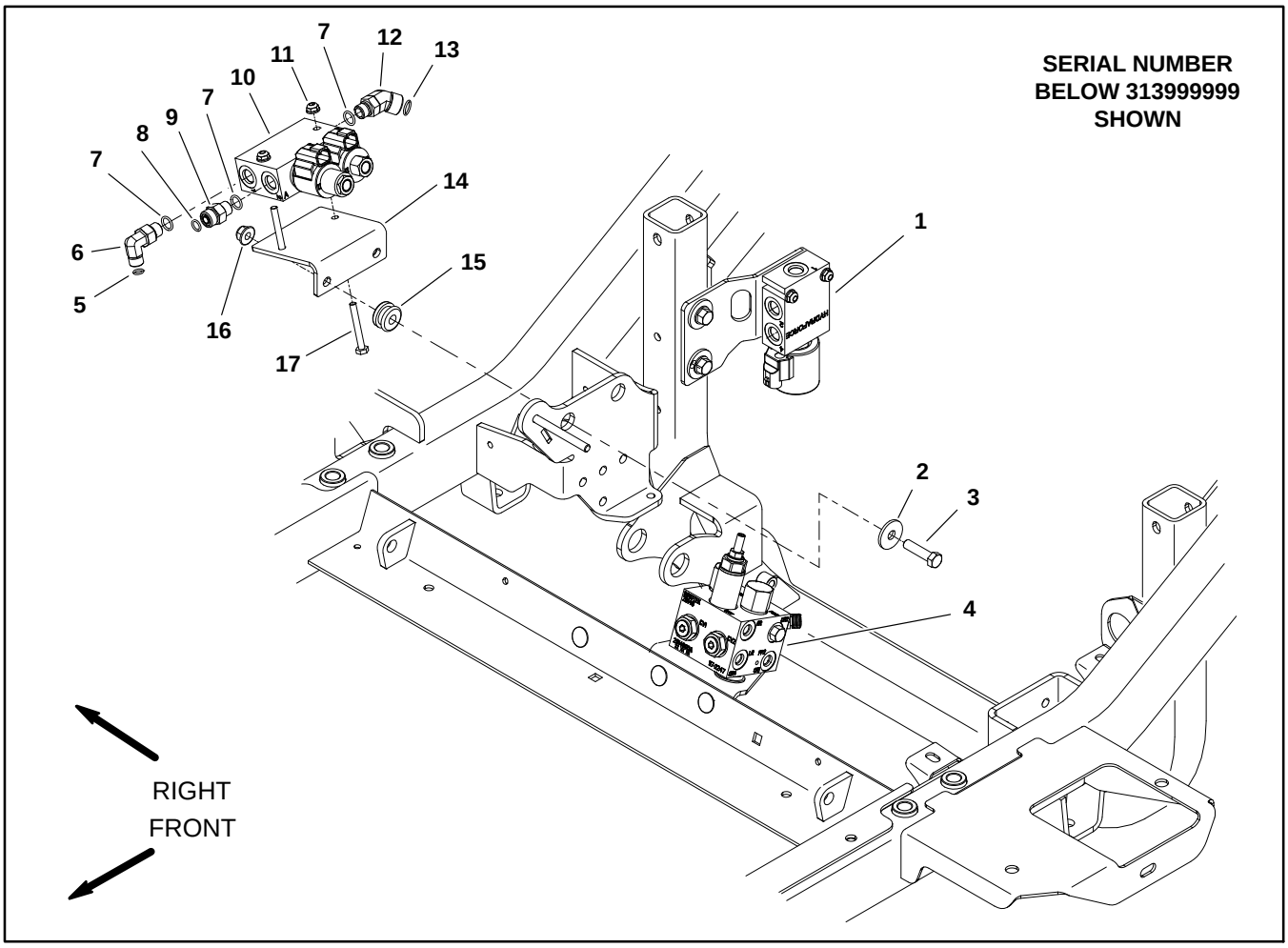

Figure 148

1. **Steering control manifold**
2. **Flat washer (2)**
3. **Cap screw (2)**
4. **AWD control manifold**
5. **O−ring**
6. **90º hydraulic fitting**
7. **O−ring (7)**
8. **O−ring**
9. **Straight hydraulic fitting**
10. **Deck lift manifold**
11. **Flange nut (2)**
12. **Hydraulic adapter**
13. **O−ring**
14. **Mount plate**
15. **Mount (2)**
16. **Flange nut (2)**
17. **Cap screw (2)**

NOTE: On machines with serial number below 313999999, the deck lift manifold mount plate is secured to the frame (Fig. 148). The mount plate is a frame component on machines with serial number above 314000000 (Fig. 149). The following procedure can be used for all Groundsmaster 360 machines.

Deck Lift Manifold Removal (Fig. 148 or 149)

WARNING

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

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

2. Raise and support operator seat to access deck lift manifold.

WARNING

Make sure that cutting deck is fully lowered and supported before loosening hydraulic lines, cartridge valves or plugs from lift manifold. If deck is raised as manifold components are loosened, deck may drop unexpectedly.

3. Thoroughly clean hydraulic hose ends and fittings on deck lift manifold to prevent hydraulic system contamination.

4. Label all hydraulic and electrical connections for assembly purposes.

5. Disconnect hydraulic hoses connected to the hydraulic fittings on the deck lift manifold. Allow hoses to drain into a suitable container. Install clean caps or plugs on disconnected hoses and fittings to prevent contamination.

6. Disconnect wire harness connectors from solenoid coils on manifold.

7. Support manifold to prevent it from falling.

8. Remove fasteners that secure manifold to mount plate. Remove manifold from machine.

9. If hydraulic fittings are to be removed from deck lift manifold, mark fitting orientation to allow correct assembly. Remove hydraulic fittings from manifold as needed. Discard fitting O−rings.

Deck Lift Manifold Installation (Fig. 148 or 149)

1. If hydraulic fittings were removed from deck lift manifold, lubricate new O−rings with clean hydraulic oil, position O−rings to fittings and install fittings into manifold ports (see Hydraulic Fitting Installation in the General Information section of this chapter).

2. Position deck lift manifold to machine and secure manifold with removed fasteners.

3. Remove caps and plugs from hydraulic hoses and fittings.

4. Lubricate and install new O−rings on control manifold fittings. Using labels placed during manifold removal, correctly connect hydraulic hoses to control manifold (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

5. Connect wire harness connectors to solenoid coils on manifold.

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

7. Lower and secure operator seat.

8. Follow Hydraulic System Start−up procedures (see Hydraulic System Start−up in this section).

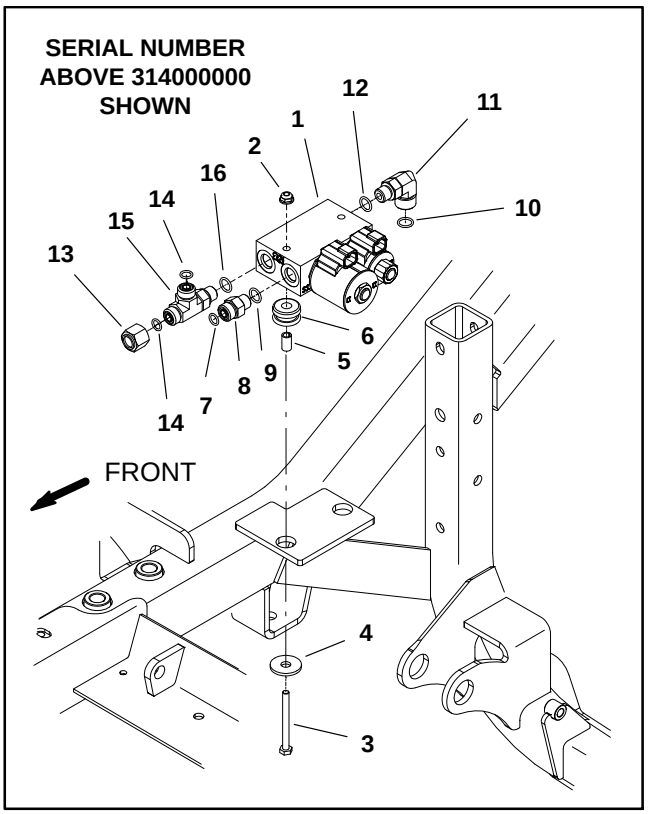

Figure 149

1. **Deck lift manifold**
2. **Flange nut (2)**
3. **Cap screw (2)**
4. **Washer (2)**
5. **Spacer (2)**
6. **Mount (2)**
7. **O−ring**
8. **Straight fitting**
9. **O−ring**
10. **O−ring**
11. **90° hydraulic fitting**
12. **O−ring**
13. **Cap**
14. **O−ring (2)**
15. **Tee fitting**
16. **O−ring**

Deck Lift Manifold Service

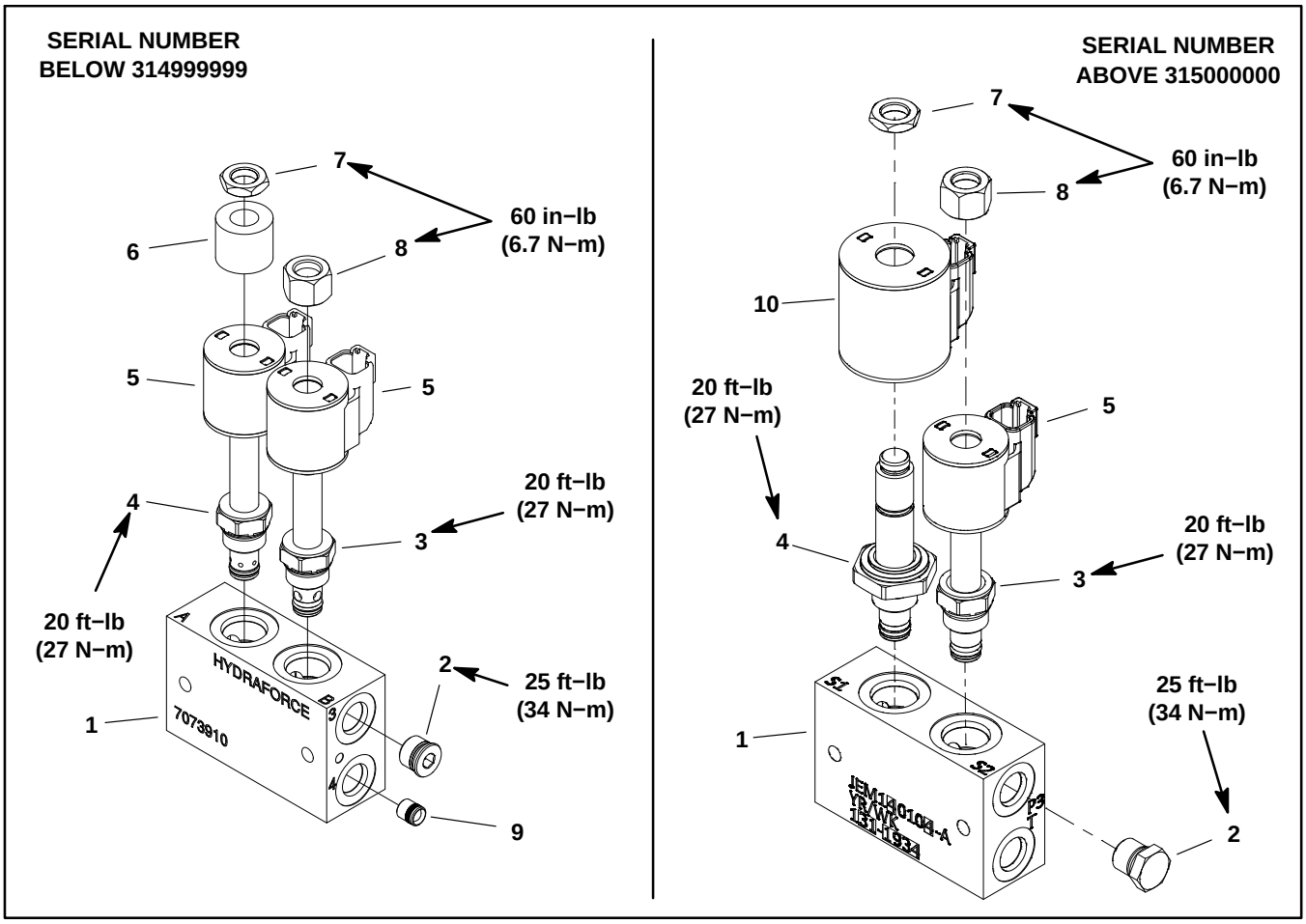

Figure 150

1. Lift control manifold
2. Zero leak plug with O−ring
3. Solenoid valve (raise)
4. Solenoid valve (lower)
5. Solenoid coil
6. Coil spacer
7. Nut
8. Nut
9. Expander plug (non−serviceable)
10. Solenoid coil

The lift control manifold on machines with a serial number below 314999999 is different than the manifold used on machines with a serial number above 315000000. Both manifolds are shown in Figure 150. Service for manifold valves, solenoid coils and plugs are similar on either manifold.

NOTE: The ports on the lift control manifold are marked for easy identification of components. See Hydraulic Schematic in Chapter 9 − Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each manifold port.

NOTE: The lift control manifold used on machines with a serial number below 314999999 has an expander plug (item 9) installed in manifold port 4. This plug is not a serviceable part and is used to prevent hydraulic flow from manifold port 1 to port 4.

NOTE: If the lift control manifold was replaced for some reason on a machine with a serial number below 314999999, the replacement manifold may have been the same manifold as used on machines with a serial number above 315000000.

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.

WARNING

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

IMPORTANT: The two (2) solenoid valves in the deck lift manifold are different. Label the valves before removal so the valves can be correctly installed into the manifold.

For cartridge valve service procedures, see Control Manifold Cartridge Valve Service in this section. Refer to Figure 150 for deck lift manifold cartridge valve installation torque.

Lift Cylinder

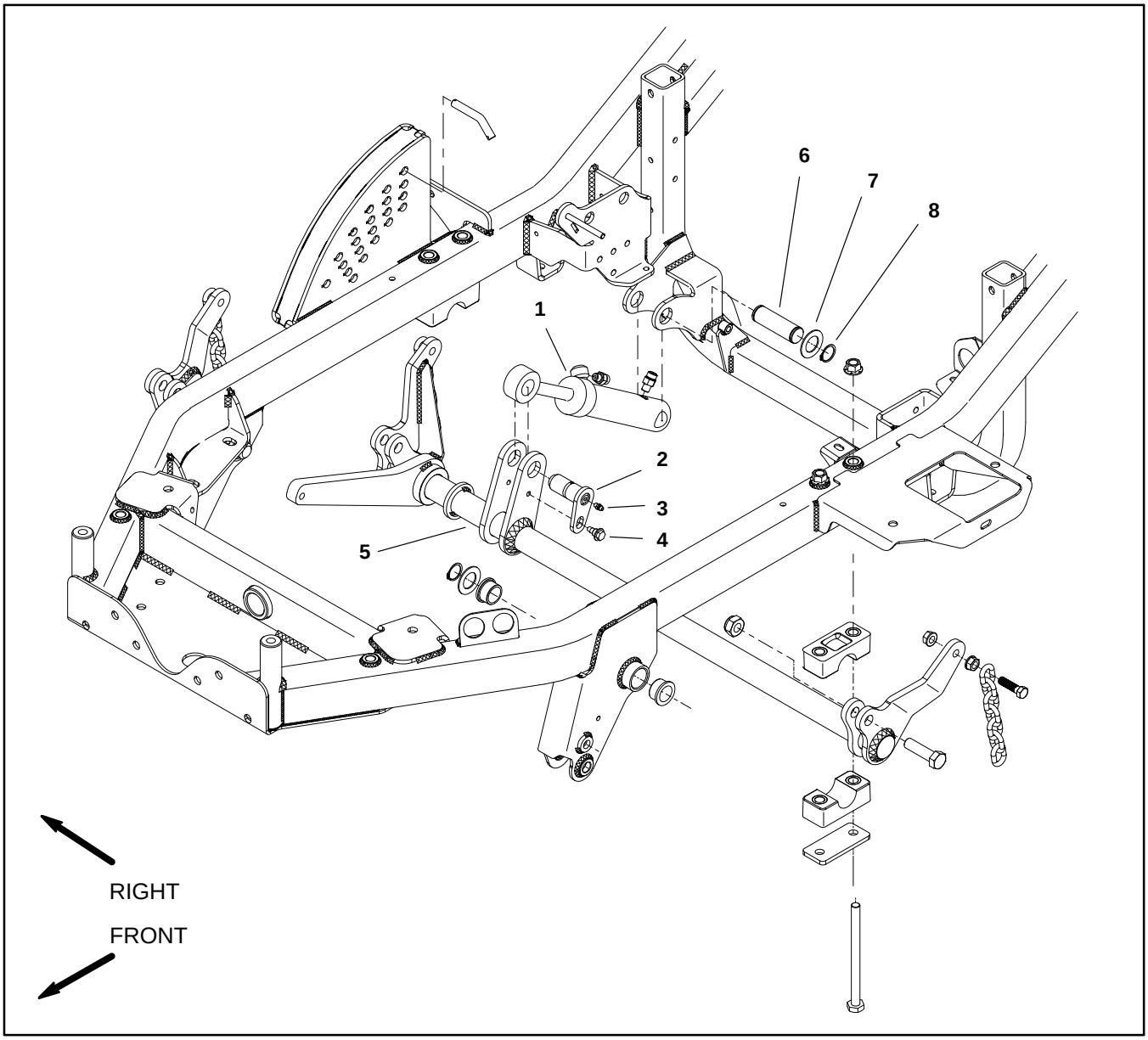

Figure 151

1. **Lift cylinder**
2. **Pivot pin**
3. **Grease fitting**
4. **Shoulder bolt**
5. **Lift shaft assembly**
6. **Cylinder shaft**
7. **Washer (2)**
8. **Retaining ring (2)**

Removal (Fig. 151)

WARNING

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

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

WARNING

Make sure that cutting deck is fully lowered and supported before loosening hydraulic lines from lift cylinder. If deck is not supported as hydraulic lines are loosened, deck may drop unexpectedly.

2. Make sure that cutting deck is supported by the HOC pin and not by the lift cylinder so deck will remain in position during lift cylinder removal. If necessary, support deck with solid blocks to prevent it from moving.

3. Thoroughly clean hydraulic hose ends and fittings on lift cylinder to prevent hydraulic system contamination.

4. Label hydraulic hoses for assembly purposes.

5. Disconnect hydraulic hoses connected to the hydraulic fittings on the lift cylinder. Install clean plugs on fittings and hose openings to prevent system contamination.

6. Remove one retaining ring (item 8) and washer (item 7) from the cylinder shaft (item 6) that secures lift cylinder barrel end to machine frame. Pull shaft from the lift cylinder and frame. Locate and retrieve second washer.

7. Remove shoulder bolt (item 4) and pivot pin (item 2) that secure lift cylinder rod end to lift shaft.

8. Remove lift cylinder from machine.

NOTE: On machines with serial number below 314999999, the fitting on barrel end of lift cylinder is an orifice fitting that is different than fitting on rod end of cylinder (shown in Fig. 152). Machines with serial number above 315000000 included two (2) identical fittings.

9. If necessary, remove hydraulic fittings from lift cylinder (Fig. 152). Remove and discard O−rings from fittings.

Installation (Fig. 151)

1. If hydraulic fittings were removed from lift cylinder, lubricate and install new O−rings to fittings. Install fittings into lift cylinder ports and torque fittings from **15 to 19 ft−lb (20 to 25 N−m)**. On machines with serial number below 314999999, make sure that fitting on barrel end of cylinder is the orifice fitting.

2. Position lift cylinder to the machine. The lift cylinder barrel end should be attached to the machine frame.

3. Secure cylinder rod end to lift shaft with pivot pin (item 2) and shoulder bolt (item 4).

4. Align lift cylinder to frame mounting holes. Slide cylinder shaft (item 6) (with washer (item 7) and retaining ring (item 8) installed on one end) through the lift cylinder and frame. Install second washer on shaft and secure with retaining ring (item 8).

5. Remove plugs that were installed in fittings and hydraulic hoses during the removal procedure. Correctly connect hydraulic hoses to lift cylinder fittings using labels placed during lift cylinder removal (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

6. Lubricate grease fittings on lift cylinder and pivot pin.

7. Make sure hydraulic tank is full. Add correct oil if necessary.

8. Follow Hydraulic System Start−up procedures (see Hydraulic System Start−up in this section).

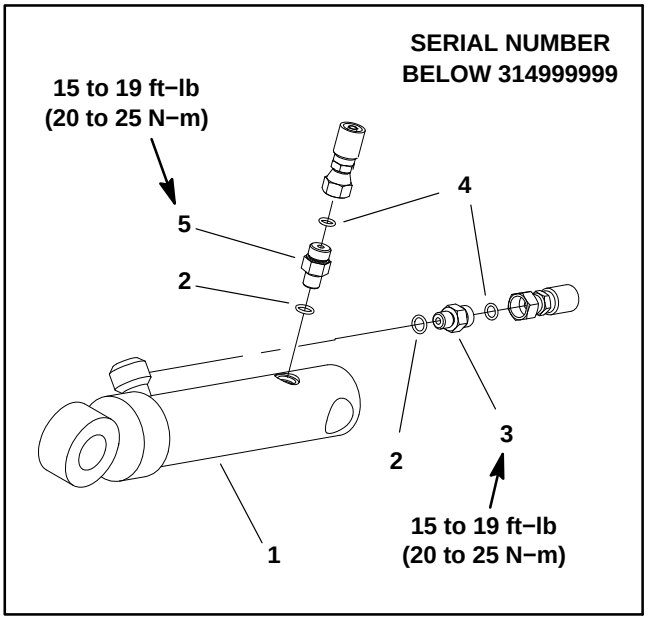

Figure 152

1. Lift cylinder
2. O−ring (2)
3. Fitting
4. O−ring (2)
5. Orifice fitting

Lift Cylinder Service

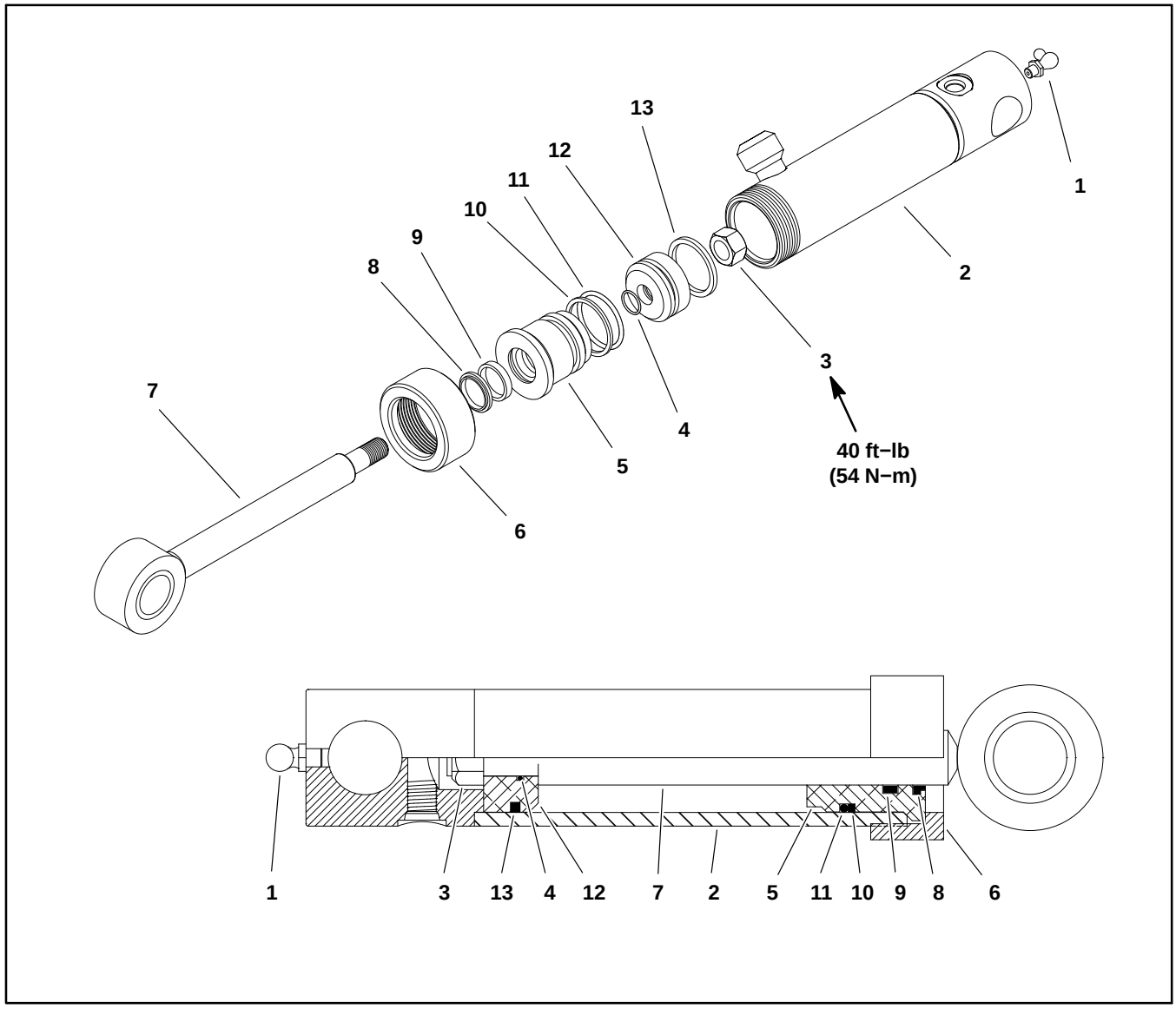

Figure 153

1. Grease fitting
2. Barrel
3. Nut
4. O−ring
5. Head
6. Collar
7. Shaft
8. Dust seal
9. Rod seal
10. Back−up ring
11. O−ring
12. Piston
13. Piston seal

Disassembly (Fig. 153)

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 hydraulic cylinder into a vise; clamp on the clevis ONLY.

2. Mount lift cylinder in a vise. Use of a vise with soft jaws is recommended.

3. Carefully remove collar with a pipe wrench.

4. Remove plugs from ports. Extract shaft, head and piston by carefully twisting and pulling on the shaft.

IMPORTANT: Do not clamp vise jaws against the shaft surface. Clamp on the clevis ONLY.

5. Mount shaft securely in a vise by clamping on the clevis of the shaft. Remove nut and piston from the shaft. Slide head off the shaft.

6. Remove piston seal and O−ring from the piston. Remove O−ring, back−up ring, rod seal and dust seal from the head.

Assembly (Fig. 153)

1. Make sure all parts are clean before reassembly.

2. Coat new O−rings, piston seal, rod seal, back−up ring and dust seal with clean hydraulic oil.

   A. Install piston seal and O−ring to the piston.

   B. Install dust seal, O−ring, back−up ring and dust seal to the head.

IMPORTANT: Do not clamp vise jaws against the shaft surface. Clamp on the clevis ONLY.

3. Mount shaft securely in a vise by clamping on the clevis of the shaft.

   A. Coat shaft with clean hydraulic oil.

   B. Slide head onto the shaft taking care to not damage the seals. Install rod seal onto shaft and into head.

   C. Install piston onto the shaft and secure with nut. Tighten nut from **40 fl−lb (54 N−m)**.

   D. Remove shaft from the vise.

IMPORTANT: Prevent damage when clamping the hydraulic cylinder into a vise; clamp on the clevis ONLY.

4. Mount barrel in a vise.

5. Coat all internal parts with a light coat of clean hydraulic oil. Carefully slide piston, shaft and head assembly into the barrel being careful not to damage the seals.

6. Install collar using a pipe wrench to secure head in barrel.

Quick Attach System (QAS) Control Manifolds (Optional Kit for 4WD Machines)

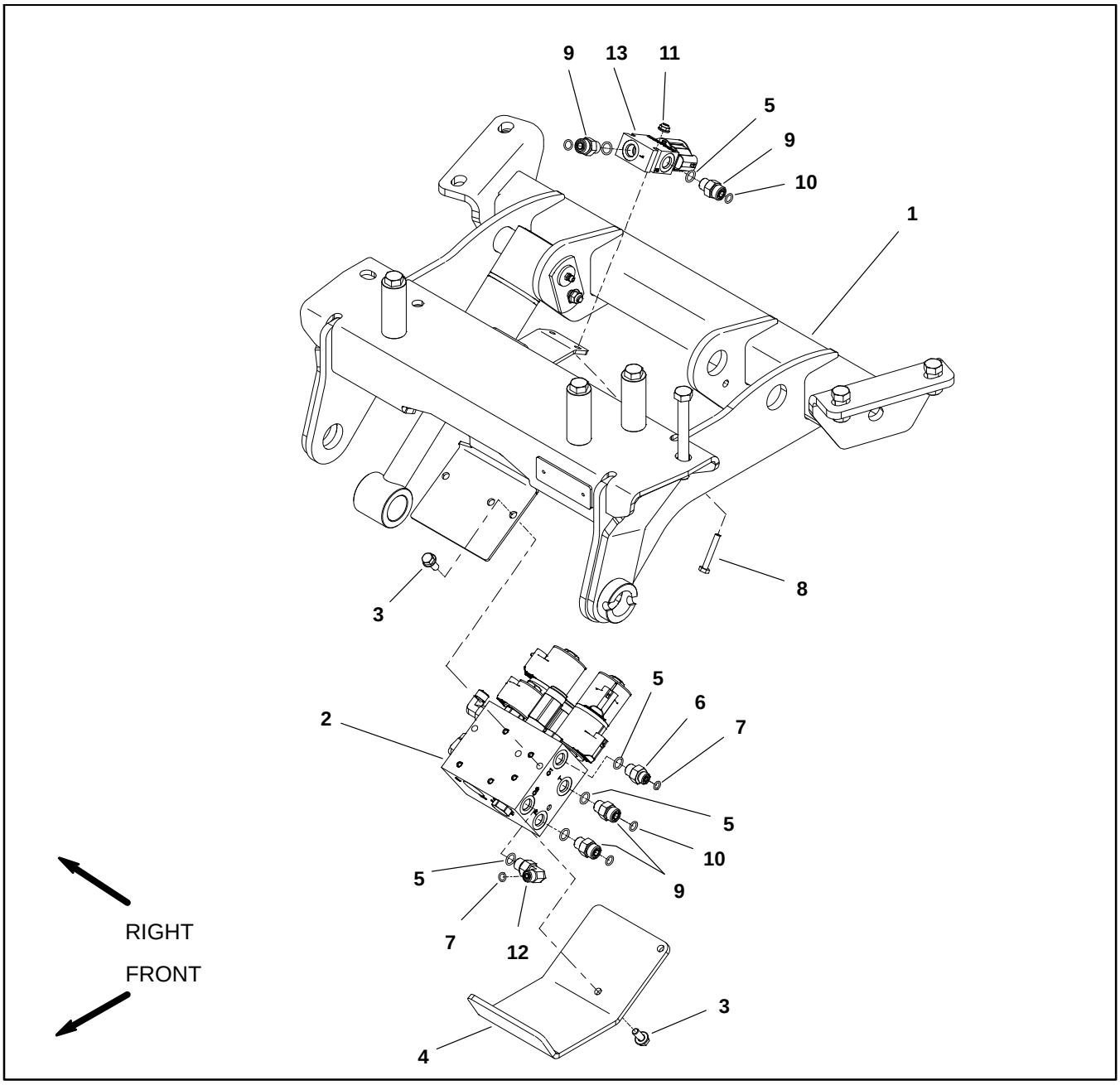

Figure 154

1. QAS frame assembly
2. Angle control manifold
3. Flange head screw (5)
4. Guard plate
5. O−ring (5)
6. Straight fitting
7. O−ring
8. Cap screw (2)
9. Straight hydraulic fitting (4)
10. O−ring (4)
11. Flange nut (2)
12. 90º hydraulic fitting
13. Poppet valve control manifold

Manifold Removal (Fig. 154)

1. Remove attachment from QAS frame.

2. Park machine on a level surface and make sure that QAS frame is fully lowered. Stop engine, engage parking brake and remove key from the ignition switch.

WARNING

Make sure that QAS frame is fully lowered and supported before loosening hydraulic lines from QAS hydraulic manifold. If frame is not supported as hydraulic lines are loosened, QAS frame may drop unexpectedly.

3. Make sure that QAS frame is not supported by the QAS lift cylinders so frame will remain in position during control manifold service. If necessary, support QAS frame with solid blocks to prevent it from moving.

WARNING

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

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

NOTE: QAS frame assembly can be removed from machine to allow easier access to QAS control manifolds. Reverse QAS installation procedure to remove QAS frame assembly from machine (refer to QAS Installation Instructions).

5. Locate QAS control manifold that is to be serviced.

6. Thoroughly clean hydraulic hose and tube ends prior to disconnecting hydraulic lines from the control manifold. Label all hydraulic connections for assembly purposes.

7. Disconnect hydraulic lines from control manifold.

8. Install clean caps or plugs on disconnected hydraulic lines and fittings to prevent contamination.

9. Disconnect wire harness connector from solenoid coil(s) on manifold.

10. Support manifold to prevent it from falling.

11. Using Figure 154 as a guide, remove fasteners that secure manifold to QAS frame. Remove manifold from machine.

12. If hydraulic fittings are to be removed from control manifold, mark fitting orientation to allow correct assembly. Remove hydraulic fittings from manifold as needed. Discard fitting O−rings.

Manifold Installation (Fig. 154)

1. If hydraulic fittings were removed from control manifold, lubricate new O−rings with clean hydraulic oil, position O−rings to fittings and install fittings into manifold ports (see Hydraulic Fitting Installation in the General Information section of this chapter).

2. Position control manifold to machine.

3. Secure control manifold to QAS frame with removed fasteners.

4. Remove caps and plugs from hydraulic lines and fittings.

5. Lubricate and install new O−rings on control manifold fittings. Using labels placed during manifold removal, correctly connect hydraulic hoses and tubes to control manifold (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

6. Connect wire harness connector(s) to solenoid coil(s) on manifold.

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

8. Follow Hydraulic System Start−up procedures (see Hydraulic System Start−up in this section).

Quick Attach System (QAS) Control Manifold Service (Optional Kit for 4WD Machines)

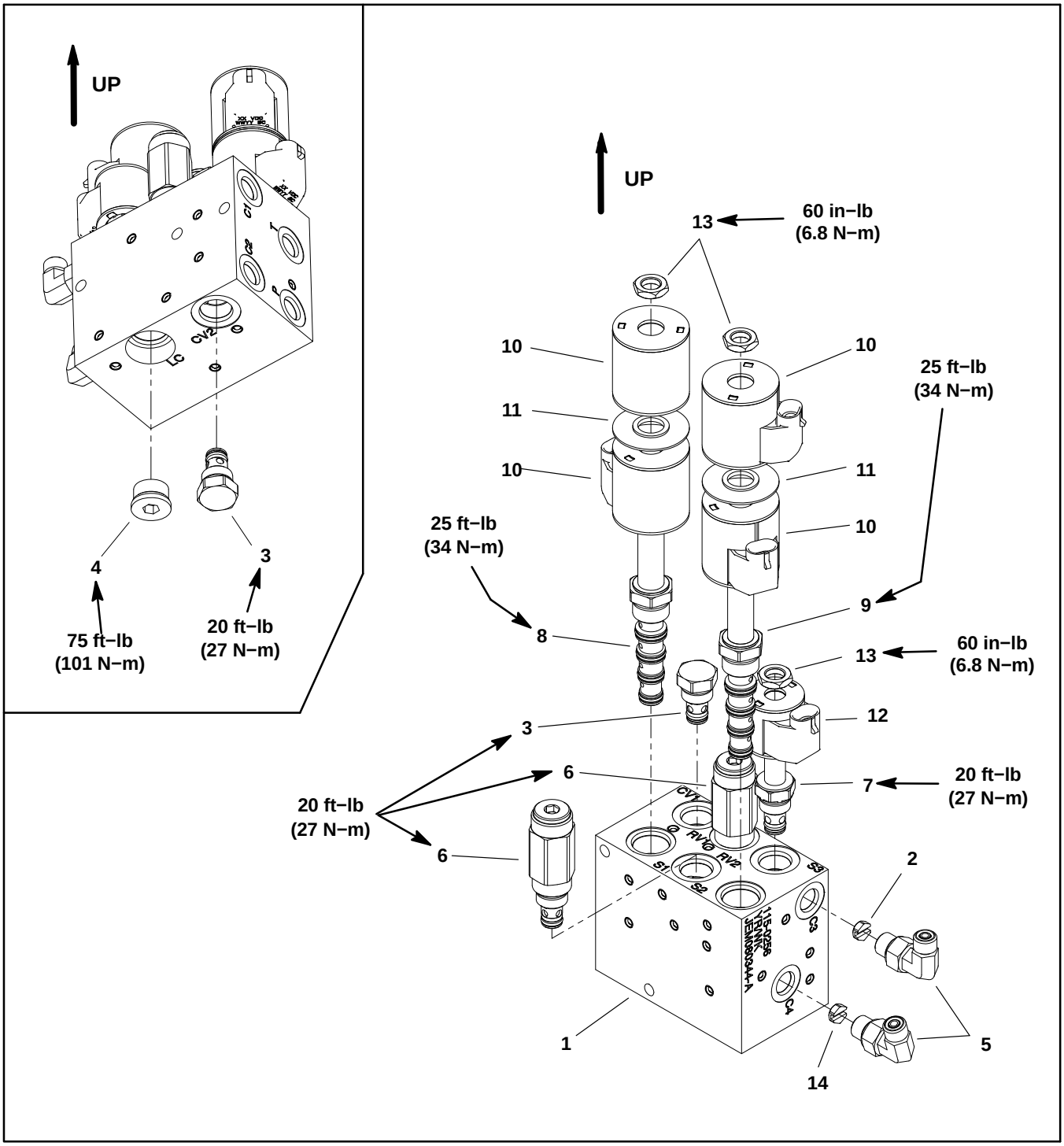

Figure 155

1. QAS angle control manifold
2. Orifice 0.080 − port C3
3. Check valve − ports CV1 and CV2 (2)
4. Plug
5. 90° hydraulic fitting (2)
6. Relief valve − ports RV1 and RV2 (2)
7. Solenoid valve − port S3
8. Solenoid valve − port S1
9. Solenoid valve − port S2
10. Solenoid coil (4)
11. Coil spacer (2)
12. Solenoid coil
13. Coil nut (2)
14. Orifice 0.046 − port C4

NOTE: The ports on the QAS control manifolds are marked for easy identification of components. See Hydraulic Schematic for Groundsmaster 360 with 4WD in Chapter 9 − Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each manifold port.

QAS Control Manifold Cartridge Valve Service

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.

WARNING

If control manifold is attached to machine, make sure that attachment and QAS frame are fully lowered and supported before loosening hydraulic lines, cartridge valves or plugs from control manifold. If attachment is not supported as manifold components are loosened, attachment and QAS frame may drop unexpectedly.

IMPORTANT: The solenoid cartridge valves in the QAS angle control manifold (Fig. 155) are different. Label the valves before removal so the valves can be correctly installed into the manifold.

IMPORTANT: An orifice is placed in ports C3 and C4 of the QAS angle control manifold (Fig. 155). If an orifice is removed from this manifold, make sure to label its position for assembly purposes. When installing orifice in manifold port, 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.

For cartridge valve service procedures, see Control Manifold Cartridge Valve Service in this section. Refer to Figure 155 for QAS angle control manifold cartridge valve installation torque. Refer to Figure 156 for QAS poppet valve control manifold cartridge valve installation torque.

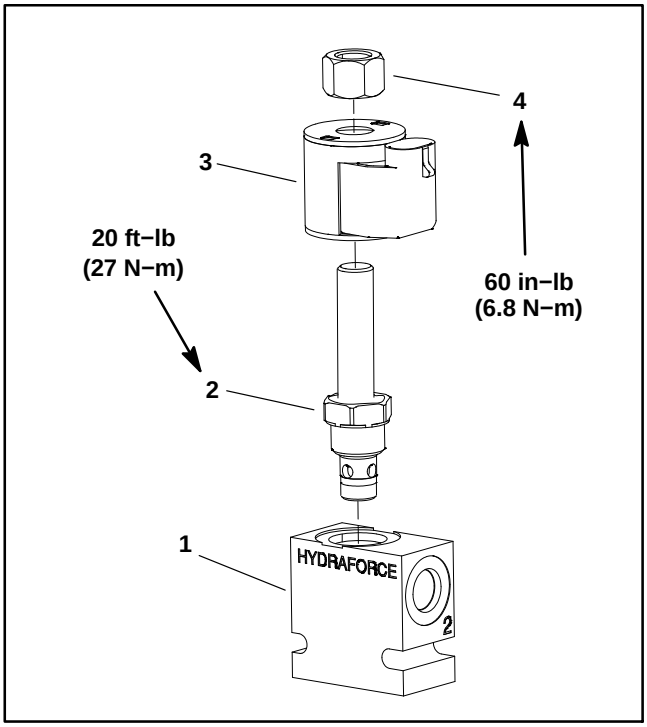

Figure 156

1. Poppet valve manifold
2. Solenoid valve
3. Solenoid coil
4. Coil nut

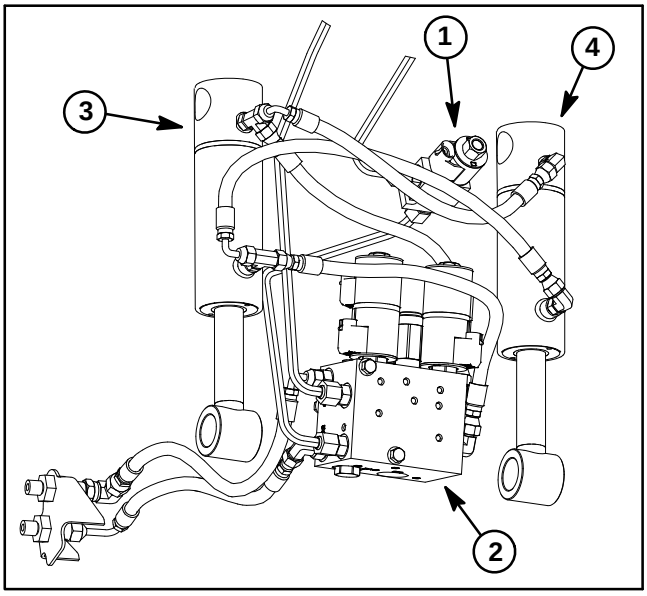

Figure 157

1. Poppet valve manifold
2. Angle manifold
3. LH QAS lift cylinder
4. RH QAS lift cylinder

Oil Cooler

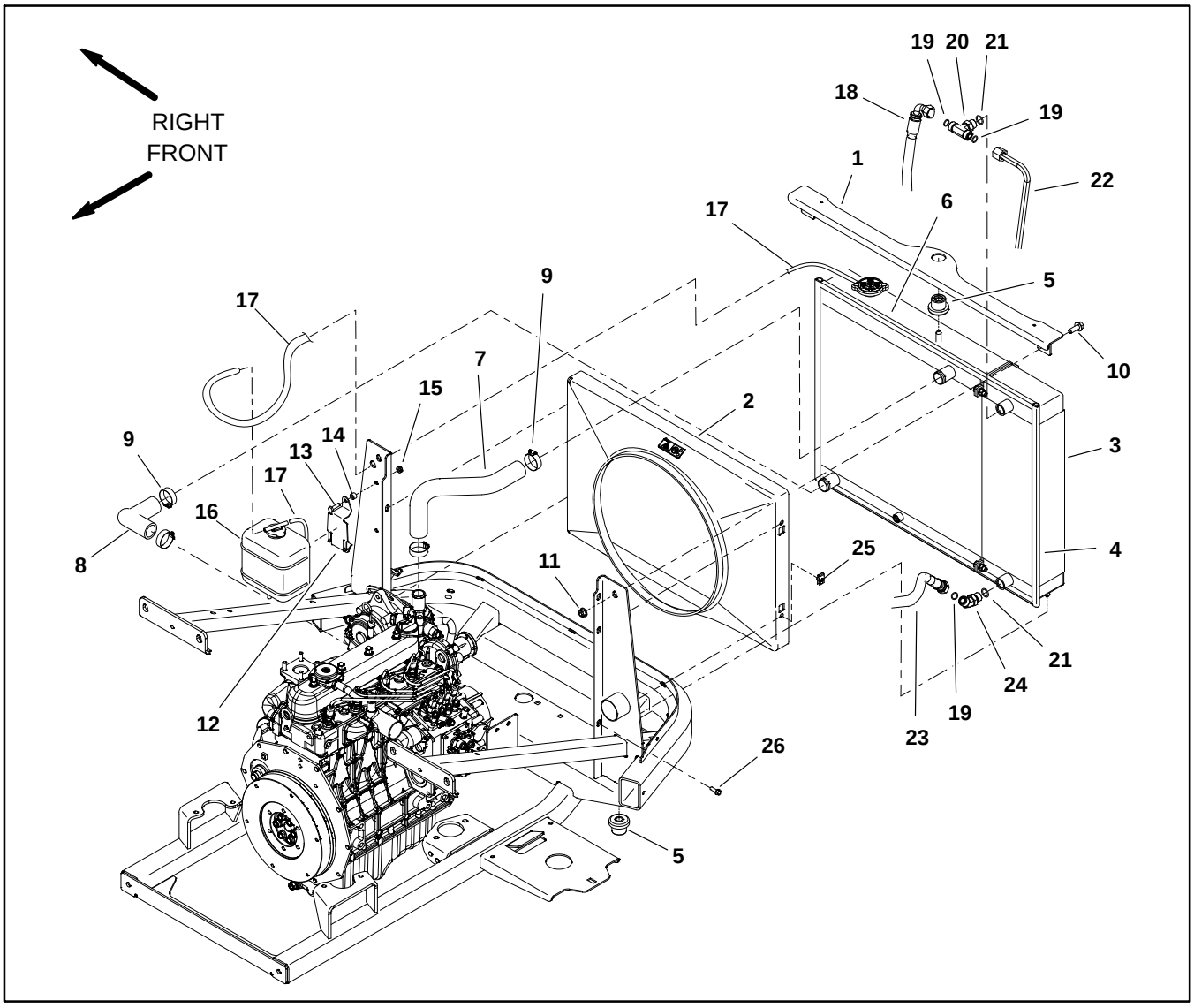

Figure 158

1. Radiator support
2. Fan shroud
3. Radiator/oil cooler assembly
4. Bulb seal (2)
5. Isolator mount (3)
6. Bulb seal (2)
7. Upper radiator hose
8. Lower radiator hose
9. Hose clamp (4)
10. Flange head screw (2)
11. Flange nut (2)
12. Bracket
13. Cap screw (2)
14. Spacer (2)
15. Flange nut (2)
16. Overflow bottle
17. Hose (2)
18. Hydraulic hose
19. O−ring
20. Hydraulic tee fitting
21. O−ring
22. Hydraulic tube
23. Hydraulic hose
24. 45º hydraulic fitting
25. Clip (4)
26. Screw (4)

Removal (Fig. 158)

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

2. Raise hood and secure it in the raised position.

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.

3. Remove radiator and oil cooler assembly from the machine (see Radiator Removal in the Service and Repairs section of Chapter 3 − Kubota Diesel Engine).

4. Separate oil cooler from radiator (Fig. 159).

5. If hydraulic fittings are to be removed from oil cooler, mark fitting orientation to allow correct assembly. Remove hydraulic fittings from oil cooler as needed. Discard fitting O−rings.

Inspection

1. Back flush oil cooler with cleaning solvent. Make sure all solvent is drained from the cooler.

CAUTION

Use eye protection such as goggles when using compressed air to dry oil cooler.

2. Dry inside of oil cooler using compressed air in the opposite direction of the oil flow.

3. Install clean plugs on oil cooler ports. Thoroughly clean exterior of cooler.

4. The oil cooler should be free of corrosion, cracked tubes or excessive pitting of tubes.

5. Inspect bulb seals on radiator and oil cooler assembly and replace them if damaged or hardened.

Installation (Fig. 158)

1. If hydraulic fittings were removed from oil cooler, lubricate and install new O−rings to fittings. Install fittings into oil cooler ports.

2. Secure oil cooler to radiator (Fig. 159).

3. Check that gap between oil cooler and radiator is less than 0.090” (2.3 mm). If gap is more than 0.090” (2.3 mm), fill gap with silicone sealer to ensure effective sealing.

4. Install radiator and oil cooler assembly to the machine (see Radiator Installation in the Service and Repairs section of Chapter 3 − Kubota Diesel Engine).

5. Make sure hydraulic tank is full. Add correct oil if necessary.

6. Lower and latch hood.

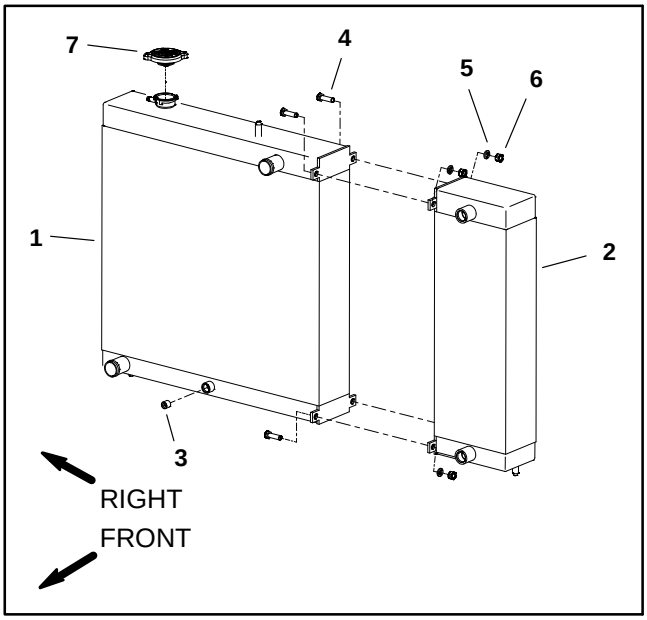

Figure 159

1. **Radiator**
2. **Oil cooler**
3. **Pipe plug**
4. **Cap screw (4)**
5. **Lock washer (4)**
6. **Nut (4)**
7. **Radiator cap**

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Chapter 5

Electrical System

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General Information

Operator's Manual

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

Electrical Drawings

The electrical schematic and wire harness drawings for the Groundsmaster 360 are located in Chapter 9 − Foldout Drawings.

Toro Electronic Controller (TEC) (4WD Machines)

Groundsmaster 360 machines with 4WD use a Toro Electronic Controller (TEC) to manage machine electrical functions. The controller is microprocessor controlled that senses the condition of various switches (inputs) and directs electrical power to control appropriate machine functions (outputs) based on the inputs. The status of inputs to the controller as well as outputs from the controller can be monitored with the Diagnostic Display (see Special Tools in this chapter).

NOTE: Optional kits for the Groundsmaster 360 are available that require the use of an additional TEC controller. Even though the additional controller appears identical to the standard controller, they are different in terms of the connectors and internal hardware. The two controllers cannot be interchanged.

IMPORTANT: Before performing any welding on the machine, disconnect the battery cables from the battery, disconnect the wire harness connector from the Toro Electronic Controller(s) and disconnect the terminal connector from the alternator. These steps will prevent damage to the machine electrical system.

CAN−bus Communications (4WD Machines)

On Groundsmaster 360 machines with 4WD, the TEC controller communicates with other electrical components on a CAN−bus communication system. 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 reduced.

CAN identifies the Controller Area Network that is used on the Groundsmaster. Two (2) specially designed, twisted cables form the bus. These wires provide the data pathways between machine components. The engineering term for these two (2) cables are CAN−high and CAN−low. At the ends of the twisted pair of bus cables are 120 ohm termination resistors.

Each of the components that is controlled by the CAN−bus link only needs four (4) wires to operate and communicate to the system: CAN−high, CAN−low, B+ (power) and ground.

IMPORTANT: The termination resistors at the ends of the bus cables are required for proper electrical system operation.

Standard Control Module (SCM) (2WD Machines)

Groundsmaster 360 machines with 2WD are equipped with a Standard Control Module (SCM) to monitor and control electrical components required for safe operation. The SCM can be used to check operation of machine switches by monitoring the SCM LED's. Information on the Standard Control Module is included in the Component Testing section of this chapter.

Special Tools

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

Multimeter

The multimeter can test electrical components and circuits for current, resistance 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.

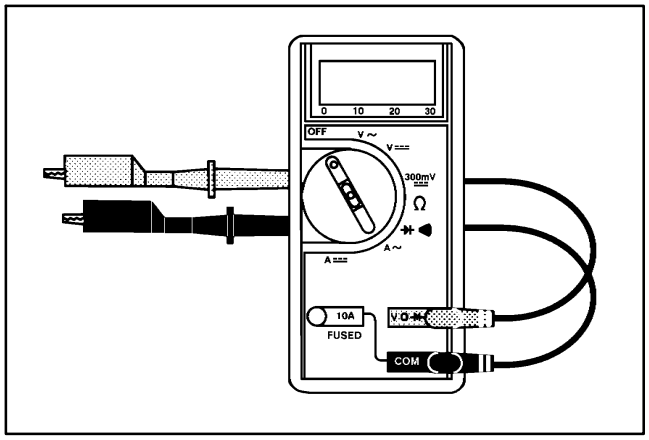


Figure 1

Diagnostic Display (4WD Machines)

The Diagnostic Display (Fig. 2) can be connected to the wiring harness communication connector located under the operator seat to verify correct electrical functions of 4WD machines that have a Toro Electronic Controller (TEC). TEC inputs and outputs can be checked using the Diagnostic Display.

Toro Part Number for Diagnostic Display: **85−4750**

Toro Part Number for Groundsmaster 360 Overlay (English)**: 120−0273**

NOTE: Diagnostic Display overlays are available in several languages for your Groundsmaster. Refer to your Parts Catalog for overlay language options and part numbers.

NOTE: Machine may have second TEC controller if equipped with optional accessories. Additional Diagnostic Display overlays in both English and other languages are available for use with machines that have the second controller.

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 2

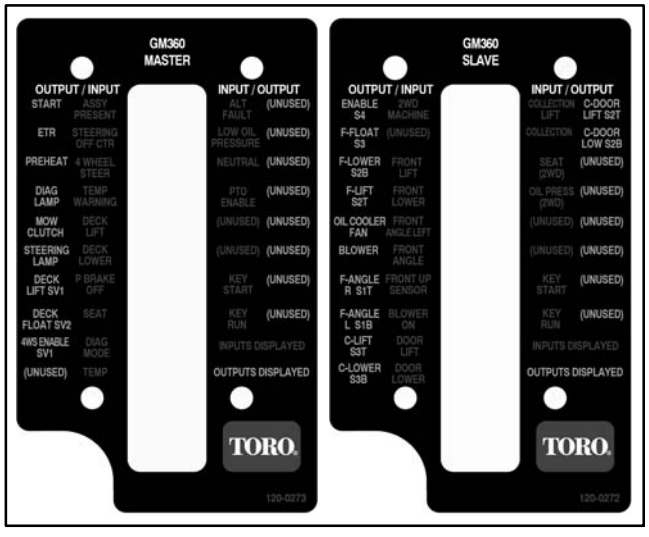


Figure 3

Battery Terminal Protector

Aerosol spray that should be used on battery terminals, ring terminals and fork terminals to reduce corrosion problems. Apply terminal protector to the connection after the battery cable, ring terminal or fork terminal has been secured.

Toro Part Number: **107−0392**

Figure 4

Dielectric Gel

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

Do not use dielectric gel on sealed connection terminals as the gel can unseat connector seals during assembly.

Toro Part Number: **107−0342**

Figure 5

Battery Hydrometer

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

Figure 6

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. Refer to Chapter 9 – Foldout Drawings for electrical schematics and wire harness drawings for your Groundsmaster.

Make sure that all machine interlock switches are functioning correctly for proper troubleshooting and safety.

NOTE: When troubleshooting an electrical problem on a Groundsmaster 360 with 2WD, use the Standard Control Module input and output LED's (see Standard Control Module in the Component Testing section of this chapter). When troubleshooting an electrical problem on a Groundsmaster 360 with 4WD, use the Diagnostic Light and the Diagnostic Display (see Diagnostic Light (4WD Machines) and Diagnostic Display (4WD Machines) in this section).

Diagnostic Light (4WD Machines)

Groundsmaster 360 machines with 4WD are equipped with a diagnostic light that indicates if the machine electrical system is functioning incorrectly. The diagnostic light is located on the control panel (Fig. 7).

When the ignition switch is moved to the RUN position and the machine electrical system is functioning properly, the diagnostic light will be illuminated for approximately three (3) seconds and then will turn off. The light should remain off during normal machine operation.

If the machine TEC controller detects an electrical system malfunction (fault) during machine operation, the diagnostic light will flash rapidly. The light will stop flashing and will automatically reset when the ignition switch is turned to the OFF position. The fault, however, will be retained in controller memory and can be retrieved at a future time (see Retrieving Fault Codes below).

If the diagnostic light does not illuminate when the ignition switch is turned to the RUN position, possible causes are:

The loopback connector is not connected to the machine wire harness (Fig. 8).

The diagnostic light (or circuit wiring) is faulty.

TEC controller fuses are faulty (see Fuses in the Component Testing section of this chapter).

The TEC controller is faulty.

Check electrical connections, controller fuses and the diagnostic light to determine malfunction. Make sure that the loopback connector is secured to the wire harness connector.

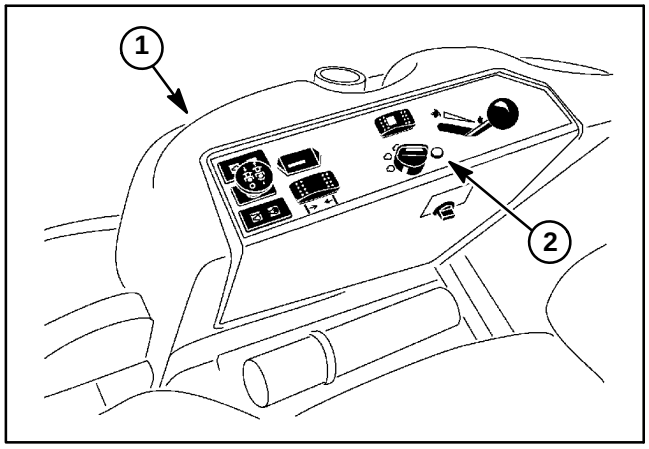


Figure 7

1. Control panel **2. Diagnostic light**

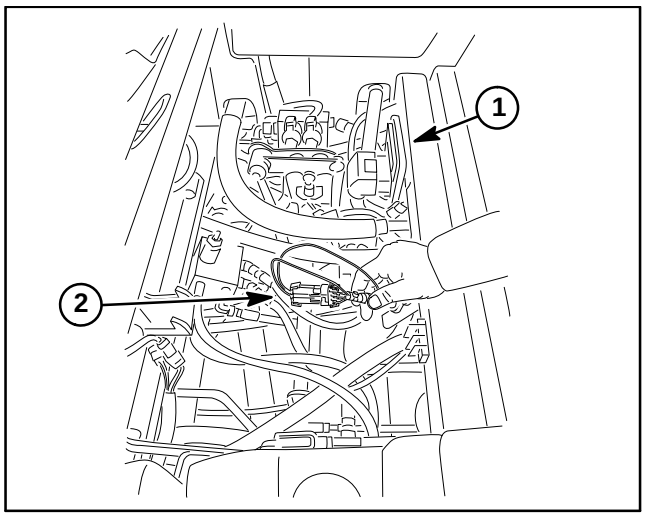


Figure 8

1. TEC controller location **2. Loopback connector**

Retrieving Fault Codes

All machine fault codes are retained in the TEC controller memory. The three (3) most recent fault codes that have occurred within the last forty (40) hours of operation can be retrieved using the diagnostic light. To retrieve these fault codes from the controller memory, perform the following steps:

1. Make sure that ignition switch is OFF.

2. Raise and support operator seat.

3. Locate diagnostic tether cap that connects the two (2) diagnostic shunt wires located under the operator seat (Fig. 9).

4. Remove diagnostic tether cap from diagnostic shunt wires and connect the two (2) shunt wires together (Fig. 10).

5. Turn ignition switch to the RUN position.

6. Monitor the diagnostic light for fault code(s).

Fault codes displayed by the diagnostic light are two digit numbers with no digit higher than five (5). Fault codes are listed in the chart on the following page. There will be a one (1) second pause between the first and second digit of a code. Up to three (3) fault codes retained in controller memory will be displayed by the diagnostic light in order from the most recent fault to the oldest fault. If there are multiple faults in controller memory, there will be a three (3) second pause between codes. The fault codes will continually repeat after a five (5) second pause until the ignition key is turned off.

If there are no faults that have occurred within the last forty (40) hours of operation, the diagnostic light will flash continuously after performing the above steps.

If a fault code is not retrieved from the controller memory within forty (40) hours of machine operating time, the fault cannot be retrieved from controller memory using this procedure. If necessary, contact your Toro distributor to retrieve older fault codes.

Clearing Fault Codes

After fault codes have been retrieved, clearing of those faults can be completed using the following switch sequence:

1. Make sure that the seat is not occupied and the parking brake is not applied. Also, put the steering selector switch in the 2 wheel steering position.

2. Place machine in fault retrieval mode (see above). The diagnostic light should be displaying the fault codes.

3. Press the steering selector switch to the 4 wheel steering position.

4. Monitor the diagnostic light for continuous flashing indicating that faults have been cleared.

5. After fault codes have been cleared, turn ignition switch to the OFF position. Unplug diagnostic shunt wires and connect diagnostic tether cap to wires.

6. Lower and secure operator seat.

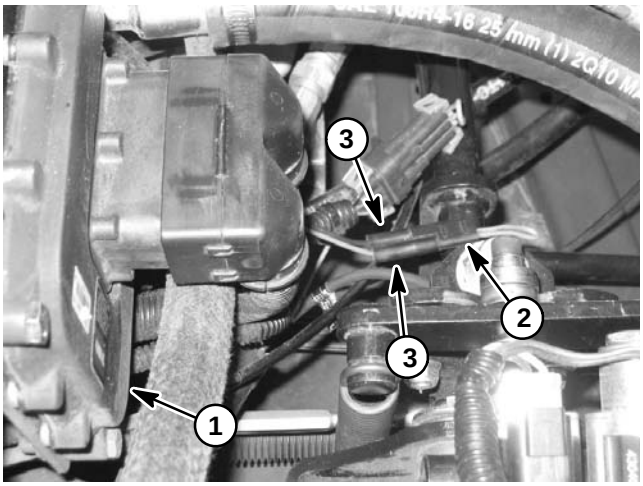


Figure 9

1. **TEC controller**
2. **Tether cap**
3. **Shunt wire**

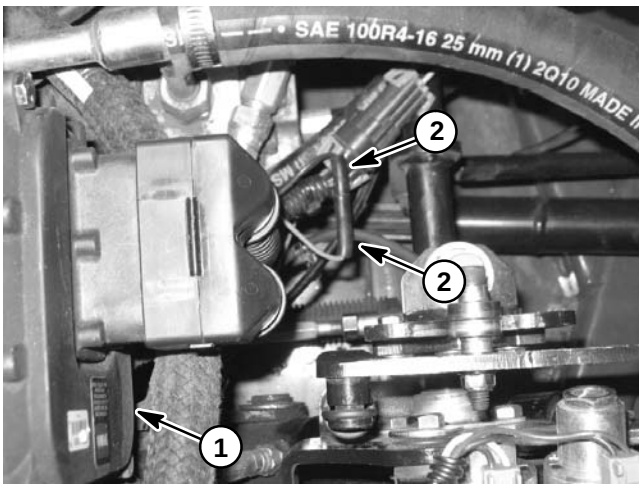


Figure 10

1. **TEC controller**
2. **Shunt wire**

Fault Code (Lamp Flashes)	Fault Description
1 − 1	High engine temp warning occurred (PTO was shutdown by controller)
1 − 2	High engine temp shutdown occurred (engine was shutdown by controller)
1 − 3	Low engine oil pressure occurred
1 − 4	Engine alternator fault occurred
1 − 5	Charging voltage was out of acceptable range
2 − 1	Upper fuse 3 (7.5 amp) for TEC outputs is faulty
2 − 2	Upper fuse 2 (7.5 amp) for TEC outputs is faulty
2 − 3	Upper fuse 1 (7.5 amp) for TEC outputs is faulty
2 − 4	No power available to TEC outputs (e.g. all fuses or main power relay faulty)
3 − 1	Current output to start relay was excessive (shorted or grounded)
3 − 2	Current output to run relay was excessive (shorted or grounded)
3 − 3	Current output to glow relay was excessive (shorted or grounded)
3 − 4	Current output to diagnostic light was excessive (shorted or grounded)
3 − 5	Current to PTO solenoid was excessive (shorted or grounded)
4 − 1	Current output to indicator light in steering selector switch circuit was excessive (shorted or grounded)
4 − 2	Current output to deck raise circuit was excessive (shorted or grounded)
4 − 3	Current output to deck float circuit was excessive (shorted or grounded)
4 − 4	Current output to 4 wheel steer solenoid was excessive (shorted or grounded)

Diagnostic Display (4WD Machines)

Groundsmaster 360 machines with 4WD are equipped with a Toro Electronic Controller (TEC) which controls machine electrical functions. The controller monitors various input switches (e.g. ignition switch, seat switch, etc.) and energizes outputs to actuate solenoids or relays for the requested machine function.

For the controller to properly control the machine, each of the input switches, output 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, 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 interlock switches. Check the operation of the interlock switches daily for proper operation. Replace any malfunctioning switches before operating the machine.

Verify Diagnostic Display Input Functions

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

2. Tilt and support operator seat to access TEC controller. Locate wire harness and connectors near TEC controller. Carefully unplug loopback connector from harness connector (Fig. 11).

3. Connect the Diagnostic Display connector to the harness connector. Make sure correct overlay decal is positioned on the Diagnostic Display (Fig. 12).

4. Turn the ignition switch to the RUN position, but do not start machine.

NOTE: The **red** text on the overlay decal refers to controller inputs and the **green** text refers to outputs.

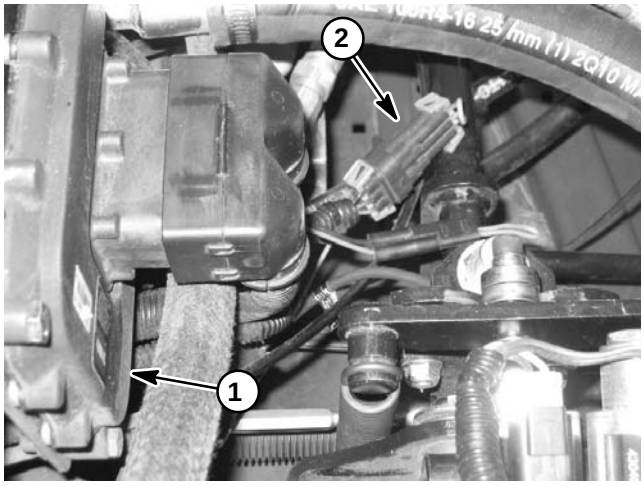


Figure 11

1. **TEC controller**
2. **Loopback connector**

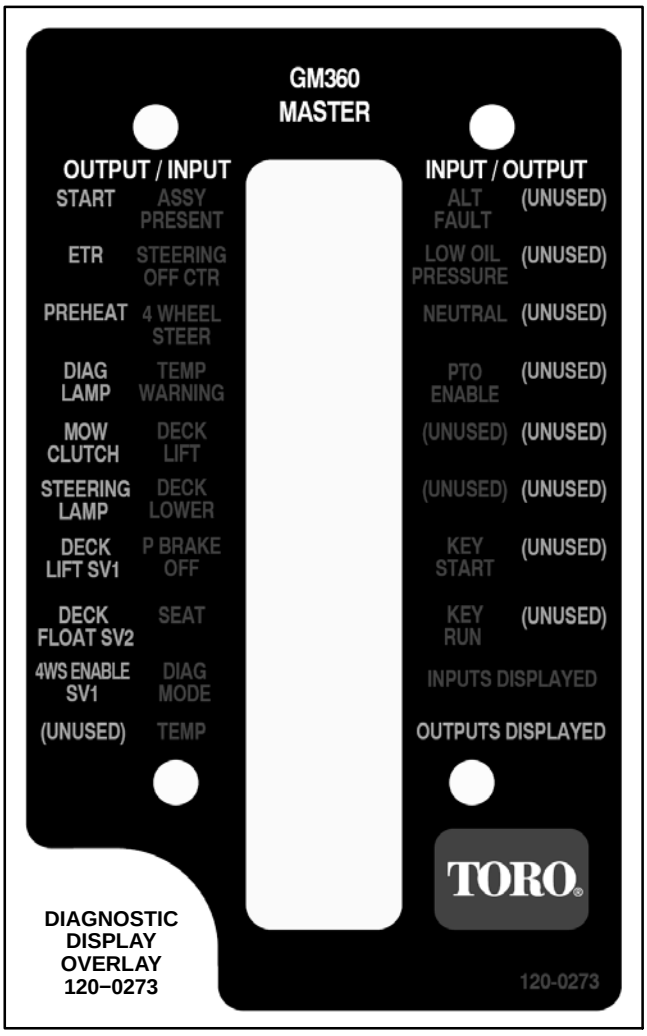


Figure 12

5. The “INPUTS DISPLAYED” LED, on lower right column of the Diagnostic Display, should be illuminated. If the green “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 is in the position identified on the Diagnostic Display overlay. Individually, change the position of each of the inputs (i.e. sit on seat, press traction pedal, etc.), and note that the appropriate LED on the Diagnostic Display toggles on and off when the input state is changed (see Diagnostic Display Inputs and LED Operation chart on next page). Repeat for all inputs that can be changed by hand.

7. If appropriate LED does not toggle on and off when input state is changed, check all wiring and connections to the switch for that input and/or test switch (see Component Testing in this chapter). Replace all defective switches and repair any damaged wiring.

NOTE: The ALT FAULT TEC controller input cannot be reliably tested by grounding the harness leads at the alternator. If the alternator is faulty, a TEC controller fault should have been detected. Refer to Diagnostic Light in this section for information on retrieval and clearing of TEC controller faults.

NOTE: When the ignition switch is in the OFF position, all Diagnostic Display LED’s should be OFF.

8. After input function testing is completed, disconnect the Diagnostic Display from wire harness. Plug loopback connector into harness connector. Lower and secure seat.

Diagnostic Display TEC Controller Inputs	Diagnostic Display LED Operation
ASSY PRESENT	Optional kit with second TEC controller installed: LED ON Optional kit with second TEC controller NOT installed: LED OFF
STEERING OFF CTR	RH front wheel turned (not aimed straight ahead): LED ON RH front wheel NOT turned (aimed straight ahead): LED OFF
4 WHEEL STEER	Steering selector switch in 4 wheel steering position: LED ON Steering selector switch in 2 wheel steering position: LED OFF
TEMP WARNING	Engine coolant temperature has exceeded 220ºF (105ºC): LED ON Engine coolant temperature below 220ºF (105ºC): LED OFF
DECK LIFT	Deck lift switch pressed to lift (raise): LED ON Deck lift switch NOT pressed to lift: LED OFF
DECK LOWER	Deck lift switch pressed to lower: LED ON Deck lift switch NOT pressed to lower: LED OFF
P BRAKE OFF	Parking brake released: LED ON Parking brake applied: LED OFF
SEAT	Seat occupied: LED ON Seat NOT occupied: LED OFF
DIAG MODE	Diagnostic mode shunt wires are connected: LED ON Diagnostic mode shunt wires are not connected: LED OFF
TEMP SHUTDOWN	Engine coolant temperature has exceeded 240ºF (115ºC): LED ON Engine coolant temperature below 240ºF (115ºC): LED OFF
ALT FAULT	Engine not running OR alternator faulty: LED ON Alternator OK: LED OFF
LOW OIL PRESSURE	Engine not running OR low engine oil pressure: LED ON Engine oil pressure OK: LED OFF
NEUTRAL	Traction pedal in neutral: LED ON Traction pedal in forward or reverse: LED OFF
PTO ENABLE	PTO switch ON: LED ON PTO switch OFF: LED OFF
KEY START **NOTE:** Turn PTO switch ON so engine will not start when turning ignition switch to START	Ignition switch in START: LED ON Ignition switch in RUN: LED OFF
KEY RUN	Ignition switch in RUN or START: LED ON

NOTE: When the ignition switch is in the OFF position, all Diagnostic Display LED's should be OFF.

NOTE: The TEMP WARNING and TEMP SHUTDOWN inputs can be simulated by disconnecting the wire from the warning or shutdown switch on the engine and then grounding the wire. The appropriate input LED on the Diagnostic Display should illuminate when the wire is grounded and the ignition switch is in the RUN position.

Verify Diagnostic Display Output Functions

The Diagnostic Display has the ability to detect which output solenoids or relays are turned on by the TEC controller. 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.

NOTE: Before checking TEC outputs, make sure that all controller inputs are functioning correctly.

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

2. Tilt and support operator seat to access TEC controller. Locate wire harness and connectors near TEC controller. Carefully unplug loopback connector from harness connector (Fig. 13).

3. Connect the Diagnostic Display connector to the harness connector. Make sure correct overlay decal is positioned on the Diagnostic Display (see Special Tools in this chapter).

4. Turn the ignition switch to the RUN position.

NOTE: The **red** text on the overlay decal refers to controller inputs and the **green** text refers to controller outputs.

5. The green “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, start engine 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 (see Diagnostic Display Outputs and LED Operation chart on next page). The outputs can be checked with the ignition switch in the RUN position and the engine not running.

NOTE: If the “DIAG. LAMP” output LED is blinking, this indicates that the TEC controller has detected a fault during machine operation. Refer to Diagnostic Light in this section for information on retrieval and clearing of controller faults.

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 (see TEC Controller Logic Chart in this section). Verify correct switch function.

B. If the output LED’s are on as specified, but the machine does not function properly, consider that the controller is operating correctly and a problem exists with some other component. Inspect electrical components and circuit for the affected function. Also, suspect 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 may indicate a controller problem. If this occurs, contact your Toro Distributor for assistance.

7. After output function testing is completed, disconnect the Diagnostic Display from wire harness. Plug loopback connector into harness connector. Lower and secure seat.

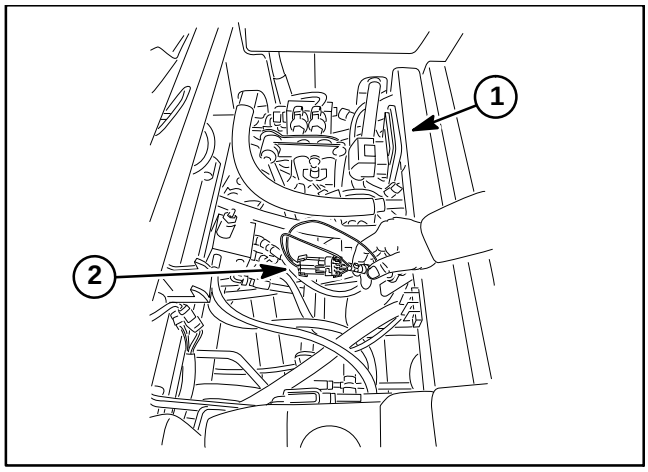


Figure 13

1. TEC controller location **2. Loopback connector**

Diagnostic Display Outputs	Diagnostic Display LED Operation
STARTER	TEC output exists to energize starter relay: LED ON No TEC output to starter relay: LED OFF
ETR	TEC output exists to energize fuel stop solenoid and fuel pump: LED ON No TEC output to fuel stop solenoid and fuel pump: LED OFF
PREHEAT	TEC output exists to energize glow plug relay: LED ON No TEC output to glow plug relay: LED OFF
DIAG LAMP	Diagnostic lamp is ON or FLASHING: LED ON or FLASHING Diagnostic lamp is not ON or FLASHING: LED OFF
MOW CLUTCH	TEC output exists to energize transmission PTO solenoid: LED ON No TEC output to transmission PTO solenoid: LED OFF
STEERING LAMP	TEC output exists to energize light in steering selector switch (switch is in 2 wheel steer position): LED ON No TEC output to energize light in steering selector switch (switch is in 4 wheel steer position): LED OFF
DECK LIFT SV1	TEC output exists to energize deck lift manifold solenoid SV1: LED ON No TEC output to deck lift manifold solenoid SV1: LED OFF
DECK FLOAT SV2	TEC output exists to energize deck lift manifold solenoid SV2: LED ON No TEC output to deck lift manifold solenoid SV2: LED OFF
4WS ENABLE SV1	TEC output exists to energize steer mode selector solenoid: LED ON No TEC output to steer mode selector solenoid: LED OFF

NOTE: When the vehicle ignition switch is in the OFF position, all Diagnostic Display LED's should be OFF.

Standard Control Module Logic Chart (2WD Machines)

Each line of the following chart identifies the necessary component position (INPUTS) in order for the Standard Control Module (SCM) to energize the appropriate OUTPUTS for machine operation.

Example: To start the engine with an operator in the seat, when the ignition key is in START, the traction control pedal is in the neutral position and the parking brake is not applied, engine components and the engine starter will be energized.

MACHINE FUNCTION	INPUTS: Power	Start	Neutral	Parking Brake Off	PTO Switch	In Seat	High Temperature Warning	High Temperature Shutdown	Backlap	OUTPUTS: Engine Run	Engine Start	PTO
Engine Start (Operator in Seat)	⊖	⊕	⊖	⊖	○	⊖	○	○	NA	⊖	⊖	○
Engine Start (No Operator in Seat)	⊖	⊕	⊖	○	○	○	○	○	NA	⊖	⊖	○
Engine Run (Operator in Seat)	⊖	○	○	⊖	○	⊖	○	○	NA	⊖	○	○
Engine Run (No Operator in Seat)	⊖	○	⊖	○	○	○	○	○	NA	⊖	○	○
Mow	⊖	○	○	⊖	⊖	⊖	○	○	NA	⊖	○	⊕
High Temperature Warning	⊖	○					⊕	○	NA	⊖	⊖	○
High Temperature Shutdown	⊖	○						⊕	NA	○	○	○

KEY TO CHART

⊖	LED ON − Circuit closed to ground
⊕	LED ON − Circuit is energized
○	LED OFF − Circuit is open to ground or circuit is de−energized
	Circuit is not involved with this machine function (LED OFF)
NA	Backlap Input is not used on the Groundsmaster 360

IMPORTANT: During machine operation, if the PTO shuts down and the console temperature warning light is illuminated, avoid shutting off the engine. Under this condition, the operator should push the PTO knob down, slowly drive to a safe flat area, move the throttle lever to the SLOW position, release the traction control pedal to the neutral position and engage the parking brake. The engine should be allowed to low idle speed for several minutes while it cools to a safe level. Then, the cooling system should be checked before returning the machine to service.

TEC Logic Chart (Machines with 4WD)

Each line of the following chart identifies the necessary component position (INPUTS) in order for the TEC to energize the appropriate OUTPUTS for machine operation.

Example: To start the engine with no operator in the seat, when the ignition key is in start, the traction pedal is in neutral and the parking brake is applied, the glow plugs and other necessary engine starting components will be energized.

KEY TO CHART

X	Component (Input) Position
	Not Relevent for Function
P	Component (Output) Energized

MACHINE FUNCTION / INPUTS	Ignition Key in RUN	Ignition Key in START	Traction Pedal in NEUTRAL	Seat Occupied	Parking Brake Applied	Normal Coolant Temperature	Lift Switch Pressed for Lower	Lift Switch Pressed for Raise	PTO Switch in ON	Diagnostic Shunt Wires Not Connected	Diagnostic Shunt Wires Connected		OUTPUTS	Engine Glow Plugs Energized	Fuel Pump and Engine Run Solenoid Hold Coil Energized	Engine Start (Run Solenoid and Start Solenoid Energized)	Lift Manifold SV1 Energized (Deck Lift)	Lift Manifold SV2 Energized (Deck Float)	PTO Solenoid Energized
Preheat	X													P					
Start (No Operator in Seat)		X	X		X					X				P	P	P			
Start (Operator in Seat)		X	X	X						X				P	P	P			
Run (No Operator in Seat)	X		X		X	X				X					P				
Run (Operator in Seat)	X			X		X				X					P				
Lower Cutting Deck (or Implement)	X						X			X					P		P		
Cutting Deck (or Implement) in Float	X									X					P		P		
Mow (Cutting Deck/Implement Lowered)	X			X		X			X	X					P		P		P
Raise Cutting Deck (or Implement)	X							X		X					P		P	P	
Diagnostic Light Fault Retrieval	X										X								
Clearing Faults (From Retrieval Mode)	X										X								

NOTE: For the **Start** machine function, the PTO switch must be OFF and the deck lift must be in the OFF position.

NOTE: The glow plugs are energized for approximately six (6) seconds when the ignition switch is turned from OFF to RUN. The glow plugs are also energized when the ignition switch is in the START position.

NOTE: The **Diagnostic Light Fault Retrieval** machine function requires that the diagnostic shunt wires be connected and the ignition key be in the RUN position (see Diagnostic Light (4WD Machines) in this section).

Starting Problems

Problem	Possible Causes
Nothing happens when start attempt is made. **NOTE:** On 4WD machines, if excessive engine coolant temperature causes the engine to stop, the engine can be restarted for ten (10) seconds to allow the machine to be moved. After ten seconds in this condition, the engine will again shutdown.	The traction pedal is not in the neutral position. The traction neutral sensor is out of adjustment or is faulty. The parking brake is disengaged and the operator seat is unoccupied. The PTO switch is in the ON (up) position or is faulty. The engine coolant temperature is excessive or the engine high temperature shutdown switch is faulty. The diagnostic mode shunt wires are connected (4WD machines). The battery is discharged or is faulty. The battery cables are loose or corroded. The ground connection is loose or corroded. Fuse(s) is (are) faulty. In−line fuse (2 amp) near battery is faulty (4WD machines). The fusible link harness at the engine starter motor is faulty. Wiring in the engine crank circuit is loose, corroded or damaged (see electrical schematic in Chapter 9 − Foldout Drawings). The ignition switch is faulty. Wiring at the starter solenoid is loose, corroded or damaged. Main power relay or circuit wiring is faulty. The starter solenoid is faulty. The Standard Control Module is faulty (2WD machines). The TEC controller is faulty (4WD machines).
Starter solenoid clicks, but starter will not crank. **NOTE:** If the starter solenoid clicks, the problem is not in the interlock circuit.	The battery is discharged or is faulty. The battery cables are loose or corroded. The ground connection is loose or corroded. The wiring at the starter is faulty. The starter solenoid is faulty. The starter motor is faulty.

Starting Problems (continued)

Problem	Possible Causes
The engine cranks, but does not start.	The fuel tank is empty. Wiring in the engine crank circuit is loose, corroded or damaged (see electrical schematic in Chapter 9 − Foldout Drawings). The fuel filter is plugged. The engine and/or fuel may be too cold. The wire harness fusible link to the engine run solenoid is faulty. The engine run solenoid or circuit wiring is faulty. The engine fuel pump or circuit wiring is faulty. The engine glow plug circuit does not operate properly (see below). The engine or fuel system is malfunctioning (see Chapter 3 − Kubota Diesel Engine).
The engine glow plug circuit does not operate properly.	Wiring in the engine glow circuit is loose, corroded or damaged (see electrical schematic in Chapter 9 − Foldout Drawings). One (or more) of the engine glow plugs is faulty. Fuse(s) is (are) faulty. The fusible link harness at the engine starter motor is faulty. The glow relay is faulty. The glow plug controller is faulty (2WD machines). The TEC Controller is faulty (4WD machines).
The engine cranks (but should not) with the PTO switch in the ON (up) position.	The PTO switch or circuit wiring is faulty. The Standard Control Module is faulty (2WD machines). The TEC Controller is faulty (4WD machines).
The engine starts, but stops when the ignition switch is released from the START position.	The engine fuel stop solenoid or circuit wiring is faulty (pull coil operates but hold coil or circuit wiring is faulty). Fuse(s) is (are) faulty (other electrical components most likely affected as well). The ignition switch is faulty.

General Run and Transport Problems

Problem	Possible Causes
Engine stops during operation (operator sitting on seat).	Operator not in center of seat (seat switch is not depressed). Fuel tank is empty. Machine is being operated on a slope with a low fuel level. The parking brake was engaged or the parking brake sensor is faulty. Fuse(s) is (are) faulty (other electrical components most likely affected as well). The engine temperature is excessive (above 240^{o}F / 115^{o}C). The seat switch is faulty. The engine high temperature shutdown switch is faulty. The engine run solenoid or fuel pump failed. Wiring in the run circuit is faulty or disconnected (see electrical schematic in Chapter 9 − Foldout Drawings).
Battery does not charge.	Loose or broken wire(s) (see electrical schematic in Chapter 9 − Foldout Drawings). The engine alternator belt is loose or damaged. The alternator warning lamp is faulty. The alternator warning lamp wiring is loose, corroded or damaged. The fusible link connecting the engine starter motor to the alternator is faulty. The battery is faulty. The alternator is faulty.

Cutting Deck Operating Problems

Problem	Possible Causes
With a running engine, the cutting deck will not run with the PTO switch in the ON (up) position.	The operator seat is unoccupied. The seat switch or circuit wiring is faulty. Wiring to the transmission PTO solenoid valve coil is loose, corroded or damaged (see electrical schematic in Chapter 9 − Foldout Drawings). The transmission PTO solenoid valve coil is faulty. The PTO switch is faulty. Upper fuse 2 for TEC outputs (7.5 amp) is faulty (4WD machines). Engine temperature is excessive (above 220^{o}F / 105^{o}C). High temperature warning switch or circuit wiring is faulty. Transmission hydraulic solenoid valve is faulty (see Chapter 4 − Hydraulic System). PTO clutch in transmission is worn or damaged (see Chapter 4 − Hydraulic System). Transmission pressure valve or charge pump is faulty (see Chapter 4 − Hydraulic System). The Standard Control Module is faulty (2WD machines). The TEC Controller is faulty (4WD machines).
Cutting deck will not raise or lower.	Engine is not running (2WD machines). Lower fuse 4 (10 amp) is faulty (2WD machines). Upper fuse 2 for TEC outputs (7.5 amp) is faulty (4WD machines). The deck lift relay or circuit wiring faulty (2WD machines). The deck lift switch or circuit wiring faulty. Deck lift manifold solenoid valve coil(s) or circuit wiring is faulty. A hydraulic problem in deck lift circuit exists (see Chapter 4 − Hydraulic System). The TEC controller is faulty (4WD machines).

4 Wheel Steer Operating Problems (4WD Machines)

Problem	Possible Causes
Cannot change between 2 and 4 wheel steer.	Wheels are not directed straight ahead when steering selector switch is pressed (switch light should be flashing). Upper fuse 1 for TEC outputs (7.5 amp) is faulty. The steering home sensor is out of adjustment. The steering home sensor bracket is loose or damaged. The steering selector switch or circuit wiring is faulty. The steering manifold solenoid valve coil is faulty. The steering home sensor or circuit wiring is faulty. A hydraulic problem exists (see Chapter 4 − Hydraulic System). The TEC controller is faulty.

Electrical System Quick Checks

Battery Test (Open Circuit Test)

Use a multimeter to measure the voltage between the battery terminals.

Set multimeter to the DC volts setting. The battery should be at a temperature of 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. Measure and record the battery voltage. Use the chart at right to determine charge level of battery.

NOTE: This test provides a relative condition of the battery. Load testing of the battery will provide additional and more accurate information (see Battery Service in the Service and Repairs section of this chapter).

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 charging system voltage will increase at different rates as the battery charges.

Start the engine and run at high idle **(3100 to 3150 RPM)**. Allow the battery to charge for at least three (3) minutes. Record the battery voltage.

After running the engine for at least three (3) minutes, battery voltage should be at least 0.50 volt higher than initial battery voltage.

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 RUN and record the multimeter results.

The Groundsmaster 360 glow plug system should have a reading of approximately 36 amps total (nine (9) amps per glow plug). If low current reading is observed, one (or more) of the glow plugs is faulty.

Check Operation of Interlock Switches

CAUTION

Check the operation of the interlock switches daily for proper operation. Replace any malfunctioning switches before operating the machine.

Groundsmaster 360 machines with 2WD are equipped with a Standard Control Module (SCM) to monitor interlock switch operation. Groundsmaster 360 machines with 4WD are equipped with a Toro Electronic Controller (TEC) to monitor interlock switch operation. Information on these electronic controllers is described in the Component Testing section of this Chapter. Testing of individual interlock switches is included in the Component Testing section of this Chapter.

NOTE: The Groundsmaster 360 is equipped with an interlock switch on the parking brake. The engine will stop if the traction control pedal is moved from the neutral position with the parking brake engaged.

1. Make sure all bystanders are away from the area of operation. Keep hands and feet away from cutting deck.

2. With the operator in the seat, the engine must not start with either the PTO switch in the ON position or the traction control pedal moved from the neutral position. Diagnose and correct problem if machine does not operate properly.

3. With the operator in the seat, the traction control pedal in the neutral position, the parking brake off and the PTO switch in the OFF position, the engine should start. Lift off the seat and slowly move traction control pedal from the neutral position, the engine should stop in one (1) to three (3) seconds. Diagnose and correct problem if machine does not operate properly.

Traction Neutral Sensor

The traction neutral sensor is a normally open proximity sensor that closes when the traction pedal is in the neutral position. The sensor mounts to a bracket on the right side of the traction speed control shaft (Fig. 14 or 15).

On machines with serial number below 315000000 (Fig. 14), the sensing plate for the traction neutral sensor is the head of the socket head screw that secures the ball bearings to the neutral centering arm assembly. On machines with serial number above 315000000 (Fig. 15), the neutral arm is used as the sensing plate.

Adjustment

1. Before adjusting the traction neutral sensor, check and adjust traction system neutral position (see Traction Unit Operator's Manual).

2. Loosen both jam nuts that secure neutral sensor to speed control bracket.

3. Adjust location of neutral sensor:

   A. Manually lift sensor and adjust lower nut until LED on cable end of traction neutral sensor **is not** illuminated.

   B. While still lifting sensor, rotate lower nut in the opposite direction until LED **is** illuminated. Then, rotate lower nut in the same direction an additional one (1) full turn.

   NOTE: On machines with serial number above 315000000 (Fig. 15), the gap between the neutral sensor and the neutral arm should be from **0.110" to 0.140" (2.8 to 3.5 mm)**.

   C. Tighten upper nut to secure sensor. Make sure that sensor position does not change. Jam nut should be torqued from **162 to 198 in−lb (18.4 to 22.4 N−m)**.

IMPORTANT: To prevent traction neutral sensor damage, make sure that sensor does not contact any machine components during traction pedal movement.

4. After adjustment to the traction neutral sensor, use the Diagnostic Display (4WD machine) or the SCM (2WD machines) to verify that traction neutral sensor and circuit wiring are functioning correctly (see Traction Neutral Sensor in the Component Testing section of this chapter).

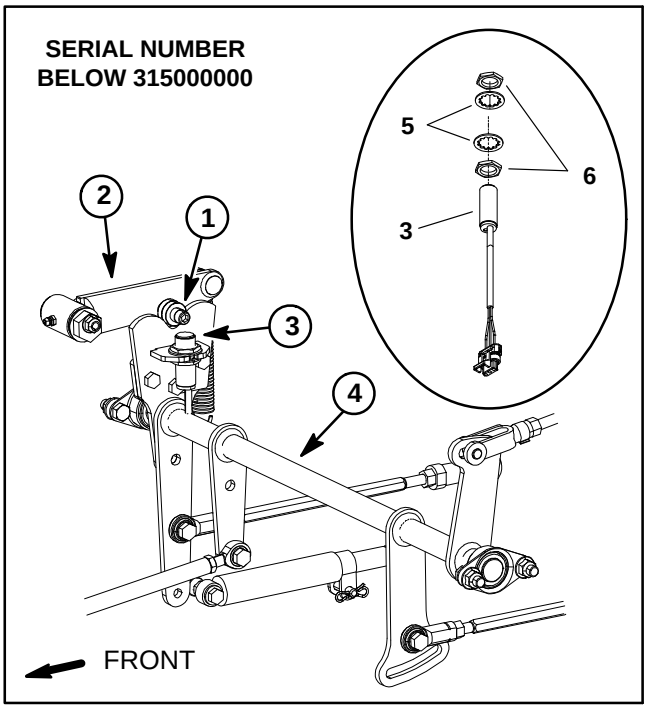


Figure 14

1. Socket head screw head
2. Neutral centering arm
3. Traction neutral sensor
4. Speed control shaft
5. Lock washer (2)
6. Jam nut (2)

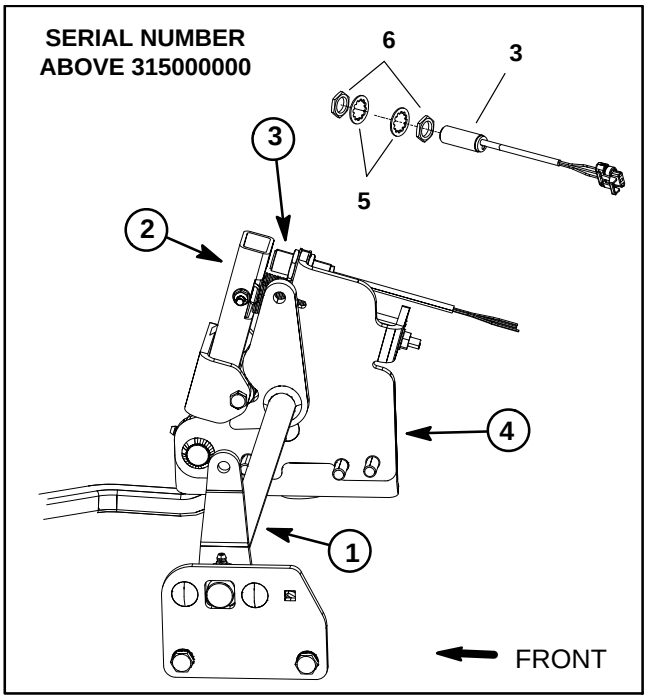


Figure 15

1. Speed control shaft
2. Neutral arm
3. Traction neutral sensor
4. RH end plate
5. Lock washer (2)
6. Jam nut (2)

Parking Brake Sensor

The parking brake sensor acts as an input for the TEC controller to determine when the parking brake is applied (brake latch engaged). The brake sensor is a normally open proximity sensor that is attached to the bottom of the brake pedal (Fig. 16).

When the parking brake is not applied (brake latch not engaged), the parking brake detent is positioned near the target end of the parking brake sensor so the sensor is closed. The parking brake detent is moved away from the sensor when the parking brake is applied (brake latch engaged) causing the sensor to open.

Adjustment

1. When the parking brake is not applied (brake latch not engaged), the gap between the parking brake sensor and the tab on the parking brake detent should be from 0.148” to 0.188” (3.8 to 4.7 mm).

2. If gap is incorrect, loosen jam nuts that secure sensor to brake lever. Position sensor with jam nuts to allow correct gap between sensor and brake detent tab. Tighten jam nuts to secure adjustment. Jam nuts should be torqued from **162 to 198 in−lb (18.4 to 22.4 N−m)**. After jam nuts are tightened, make sure that clearance between head of parking brake sensor and tab on the parking brake detent has not changed.

3. Check that LED on the cable end of parking brake sensor **is** illuminated when the parking brake **is not** applied (brake latch not engaged). The LED **should not** be illuminated when the parking brake **is** applied (brake latch is engaged).

4. After adjustment to the parking brake sensor, use the Diagnostic Display (4WD machine) or the SCM (2WD machines) to verify that parking brake sensor and circuit wiring are functioning correctly (see Parking Brake Sensor in the Component Testing section of this chapter).

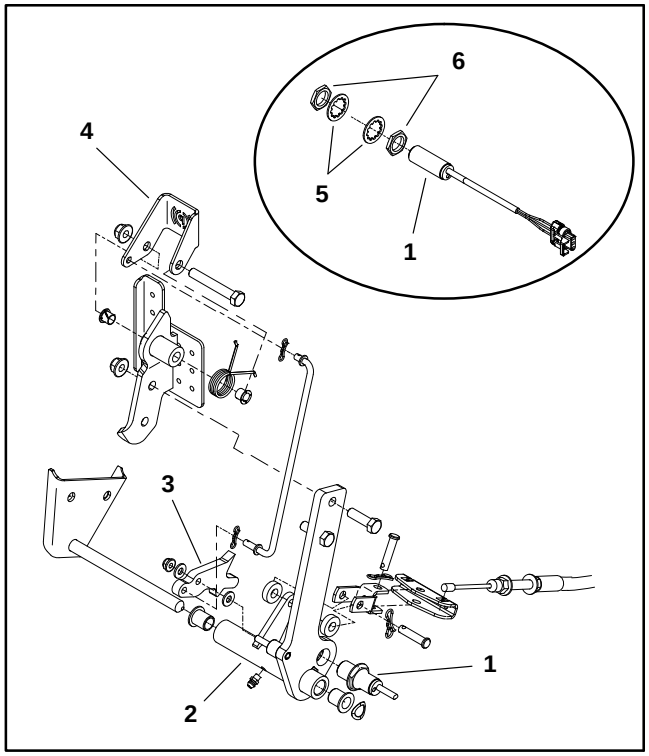


Figure 16

1. **Parking brake sensor**
2. **Brake lever**
3. **Parking brake detent**
4. **Parking brake latch**
5. **Lock washer (2)**
6. **Jam nut (2)**

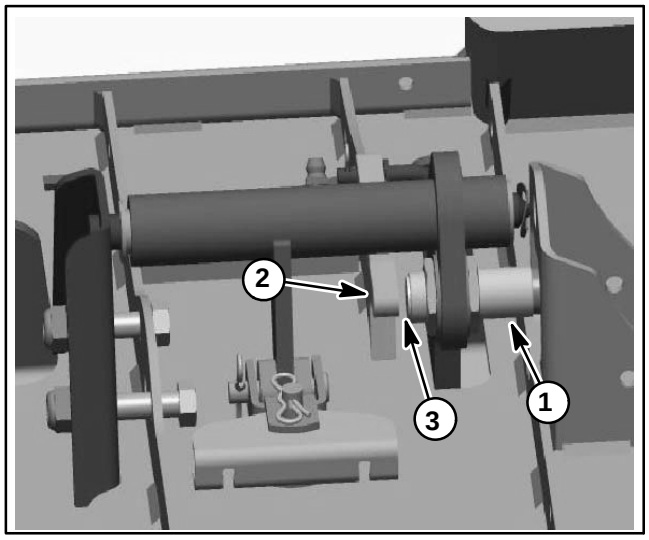


Figure 17

1. **Parking brake sensor**
2. **Parking brake detent**
3. **Gap**

Steering Home Sensor (4WD Machines)

The steering home sensor is used on Groundsmaster 360 machines with 4WD to determine when the wheels are directed straight ahead. The sensor acts as an input for the TEC controller to determine when steering can be changed from 4 wheel steering to 2 wheel steering.

The steering home sensor is a normally open proximity sensor. The sensor mounts to a bracket that is secured to the bottom of the front axle near the left side front steering fork (Fig. 18). The sensing plate for the sensor is a target bracket attached to the left side front fork.

When the left side front steering fork is in the straight ahead position, an oval hole in the target bracket is positioned directly below the steering home sensor allowing the sensor to be in its normally open state. The sensor closes when the left side front steering fork is not in the straight ahead position.

Before performing an adjustment to the steering home sensor, make sure that front and rear wheels are aligned in a straight ahead position. A rigid straight edge (e.g. angle iron or metal pipe) at least 80 inches (2 meters) long can be used to confirm wheel alignment. Place the straight edge across the sides of both front and rear tires to confirm wheel alignment. The straight edge should contact both front and rear tires at two (2) points when wheels are aligned (Fig. 19). If necessary, turn steering wheel until front and rear tires are aligned with the straight edge. Once front and rear wheels are aligned, proceed with steering home sensor adjustment.

NOTE: If wheel alignment cannot be achieved by turning steering wheel, additional adjustment may be required. See Wheel Alignment in the Adjustments section of Chapter 6 − Chassis.

Adjustment

1. When the wheels are in the straight ahead position, make sure that the steering home sensor is directly over the oval opening in the target bracket attached to the left side front steering fork. If necessary, loosen and change position of sensor bracket so that sensor is directly over the target bracket opening.

2. The gap between the steering home sensor and the target bracket should be from 0.150” to 0.170” (3.8 to 4.3 mm). If necessary, loosen jam nuts that secure sensor to sensor bracket. Position sensor with jam nuts to allow correct gap between sensor and target bracket. Tighten jam nuts to secure sensor adjustment. Jam nuts should be torqued from **162 to 198 in−lb (18.4 to 22.4 N−m)**. After jam nuts are tightened, make sure that clearance between head of steering home sensor and the target bracket has not changed.

3. After adjustment to the steering home sensor, use the Diagnostic Display to verify that the steering home sensor and circuit wiring are functioning correctly (see Steering Home Sensor in the Component Testing section of this chapter).

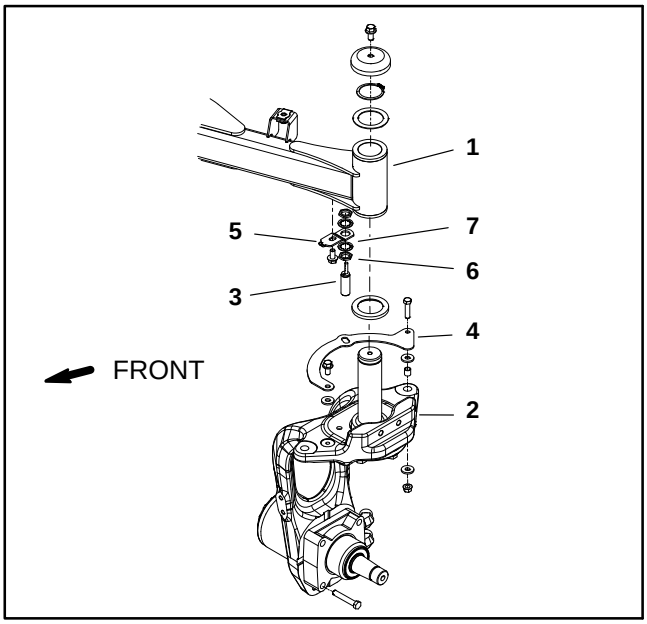


Figure 18

1. Front axle
2. LH front steering fork
3. Steering home sensor
4. Target bracket
5. Sensor bracket
6. Jam nut (2)
7. Lock washer (2)

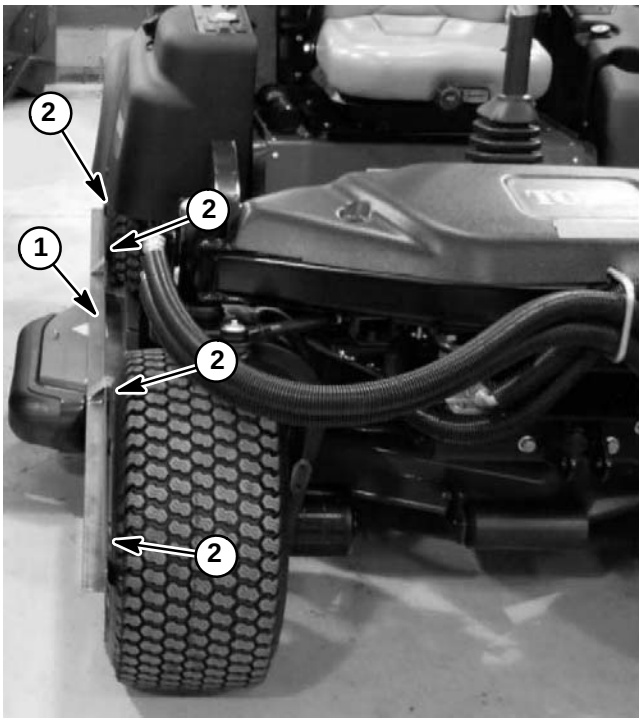


Figure 19

1. Straight edge
2. Tire contact point

Component Testing

For accurate resistance and/or continuity checks, electrically disconnect the component being tested from the circuit (e.g. unplug the ignition switch connector before doing a continuity check on the switch).

NOTE: For engine component testing information, see the Kubota Workshop Manual, Diesel Engine, 05−E3B Series that is included after 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 (Serial Number Below 312000300)

The ignition (key) switch is located on the control panel and has three positions: OFF, RUN and START (Fig. 20).

On 2WD machines, the Standard Control Module (SCM) monitors the operation of the ignition switch. When the ignition switch is in the RUN or START position, the SCM power input LED should be illuminated. If the ignition switch is in the START position, the SCM start input LED should be illuminated.

On 4WD machines, the Toro Electronic Controller (TEC) monitors the operation of the ignition switch.

Testing

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

2. Before disconnecting the ignition switch for testing, the switch and its circuit wiring should be tested as an electrical input using the SCM on 2WD machines or the Diagnostic Display on 4WD machines (see Standard Control Module or Diagnostic Display in the Troubleshooting section of this chapter). If input testing verifies that the ignition switch and circuit wiring **are** functioning correctly, no further ignition switch testing is necessary. If, however, input testing determines that the ignition switch and circuit wiring **are not** functioning correctly, proceed with the following ignition switch testing procedure.

3. Remove control panel to gain access to ignition switch (see Control Console Disassembly in the Service and Repairs section of Chapter 6 − Chassis).

4. Make sure ignition switch is in the OFF position. Disconnect wire harness connector from ignition switch.

5. The ignition switch terminals are identified in Figure 20 and the circuitry of the switch is shown in the chart in Figure 21. 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.

6. Replace ignition switch if testing determines that it is faulty.

7. If the ignition switch tests correctly and a circuit problem still exists, check wire harness (see Electrical Schematics and Wire Harness Drawings in Chapter 9 − Foldout Drawings).

8. After testing is complete, connect machine wire harness connector to ignition switch. Secure control panel to machine with removed fasteners.

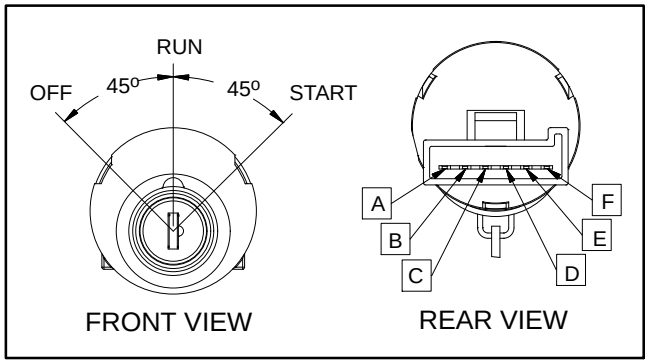


Figure 20

SWITCH POSITION	CIRCUITS
OFF	NONE
RUN	B + C + F, D + E
START	A + B + C

Figure 21

Ignition Switch (Serial Number Above 312000300)

The ignition (key) switch is located on the control panel and has three positions: OFF, RUN and START (Fig. 20).

On 2WD machines, the Standard Control Module (SCM) monitors the operation of the ignition switch. When the ignition switch is in the RUN or START position, the SCM power input LED should be illuminated. If the ignition switch is in the START position, the SCM start input LED should be illuminated.

On 4WD machines, the Toro Electronic Controller (TEC) monitors the operation of the ignition switch.

Testing

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

2. Before disconnecting the ignition switch for testing, the switch and its circuit wiring should be tested as an electrical input using the SCM on 2WD machines or the Diagnostic Display on 4WD machines (see Standard Control Module or Diagnostic Display in the Troubleshooting section of this chapter). If input testing verifies that the ignition switch and circuit wiring **are** functioning correctly, no further ignition switch testing is necessary. If, however, input testing determines that the ignition switch and circuit wiring **are not** functioning correctly, proceed with the following ignition switch testing procedure.

3. Remove control panel to gain access to ignition switch (see Control Console Disassembly in the Service and Repairs section of Chapter 6 − Chassis).

4. Make sure ignition switch is in the OFF position. Disconnect wire harness connector from ignition switch.

5. The ignition switch terminals are identified in Figure 22 and the circuitry of the switch is shown in the chart in Figure 23. 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.

6. Replace ignition switch if testing determines that it is faulty.

7. If the ignition switch tests correctly and a circuit problem still exists, check wire harness (see Electrical Schematics and Wire Harness Drawings in Chapter 9 − Foldout Drawings).

8. After testing is complete, connect machine wire harness connector to ignition switch. Secure control panel to machine with removed fasteners.

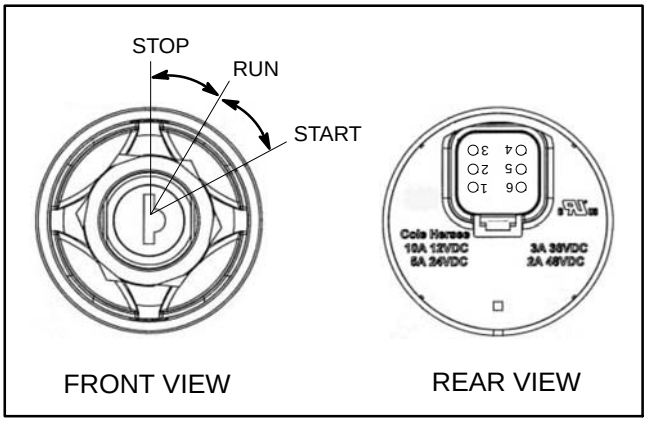


Figure 22

SWITCH POSITION	CIRCUITS
STOP	1 + 6
RUN	1 + 3 + 4 + 5 + 6
START	1 + 2 + 4 + 5 + 6

Figure 23

NOTE: Ignition switch terminals 1 and 6 are connected internally. Terminals 4 and 5 are also connected internally. These terminals should have continuity regardless of switch position.

Indicator Lights

Charge Indicator Light

The charge indicator light should come on when the ignition switch is in the RUN position with the engine not running. Also, it should illuminate with an improperly operating charging circuit while the engine is running.

Engine Oil Pressure Light

The engine oil pressure light should come on when the ignition switch is in the RUN position with the engine not running. Also, it should illuminate with the engine running if the engine oil pressure drops to an unsafe level.

IMPORTANT: If the oil pressure indicator light is illuminated with the engine running, shut off the engine immediately.

To test the oil pressure light and circuit wiring, ground the wire attached to oil pressure switch located on the engine near the oil filter. Turn ignition switch to the RUN position; the engine oil pressure light should come on indicating correct operation of the indicator light and circuit wiring.

High Temperature Warning Light

If the engine coolant temperature reaches 220ºF (105ºC) (approximate), the high temperature warning light will come on.

NOTE: The PTO will disengage if the engine coolant temperature reaches 220ºF (105ºC) (approximate).

To test the high temperature warning light and circuit wiring, turn ignition switch to the RUN position and ground the wire attached to high temperature warning switch located on the engine water pump housing (see High Temperature Warning Switch in this section). The high temperature warning light should illuminate.

Glow Plug Indicator Light

The glow plug light should come on when the ignition switch is placed in the RUN position prior to placing the ignition switch in START. The light should stay lit for approximately six (6) seconds while the ignition switch is left in the RUN position.

Testing Indicator Lights

1. Apply 12 VDC to terminals 1A and 2A (Fig. 25).
2. Ground terminals 1B and 2B (Fig. 25).
3. Both indicator lights should illuminate.

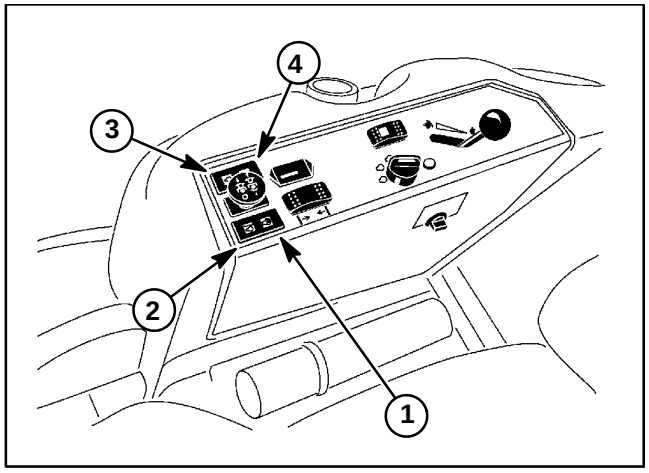


Figure 24

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

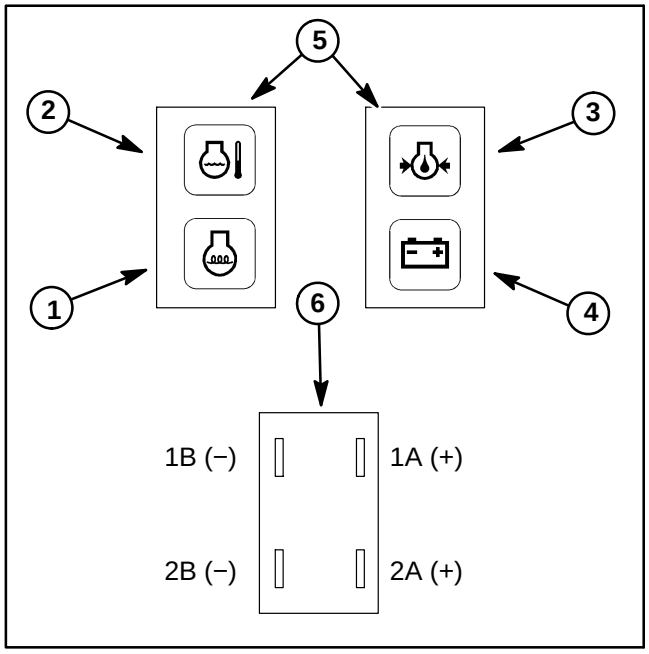


Figure 25

1. **Glow plug indicator**
2. **High temp warning**
3. **Engine oil pressure**
4. **Charge indicator**
5. **Indicator light front**
6. **Indicator light back**

Hour Meter

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

2. Remove control panel to gain access to hour meter (see Control Console Disassembly in the Service and Repairs section of Chapter 6 − Chassis).

3. Make sure ignition switch is in the OFF position. Disconnect machine wire harness electrical connector from the hour meter.

4. Connect the positive (+) terminal of a 12 VDC source to the positive terminal of the hour meter.

5. Connect the negative (−) terminal of the voltage source to the other terminal of the hour meter.

6. The hour meter should move 1/10 of an hour in six (6) minutes.

7. Disconnect the voltage source from the hour meter.

8. Replace the hour meter if necessary.

9. Connect harness electrical connector to the hour meter.

10. After testing is complete, connect machine wire harness connector to the hour meter. Secure control panel to machine with removed fasteners.

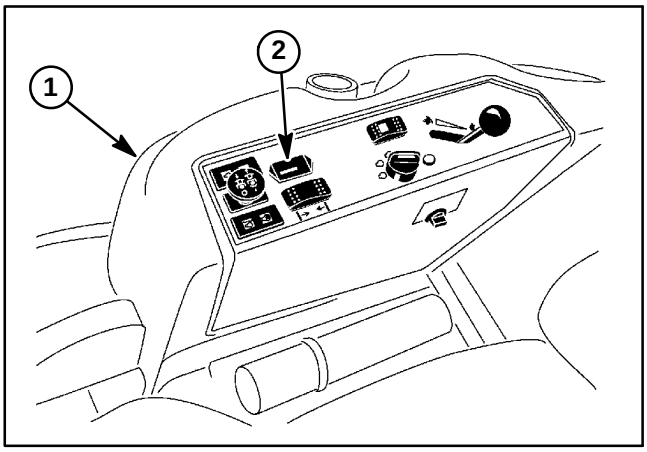


Figure 26

1. Control panel **2. Hour meter**

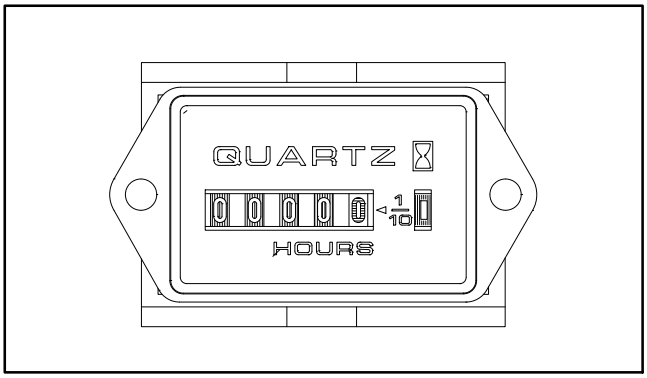


Figure 27

Fuses (2WD Machines)

The fuse block is attached to the seat support under the operator seat.

Fuse Identification and Function

Use Figure 28 to identify each individual fuse and its correct amperage. Fuses for the Groundsmaster 360 with 2WD have the following function:

Upper Fuse 1 (10 Amp): Protects power supply for ignition switch circuits.

Upper Fuse 2 (15 Amp): Protects power supply for power point and optional light kit.

Upper Fuse 3 (10 Amp): Protects main power supply including SCM outputs.

Upper Fuse 4 (10 Amp): Protects optional differential lock power supply.

Lower Fuse 1 (10 Amp): Protects power supply for cutting deck lift circuit.

Lower Fuse 2 (2 Amp): Protects power supply for SCM logic.

Lower Fuse 3 (10 Amp): Protects power supply for optional air ride seat.

Lower Fuse 4 (15 Amp): Protects power supply for optional light kit.

Fuse Testing

Make sure that ignition switch is OFF and key is removed from switch. Remove fuses from the fuse block for testing. Fuse should have continuity between fuse terminals.

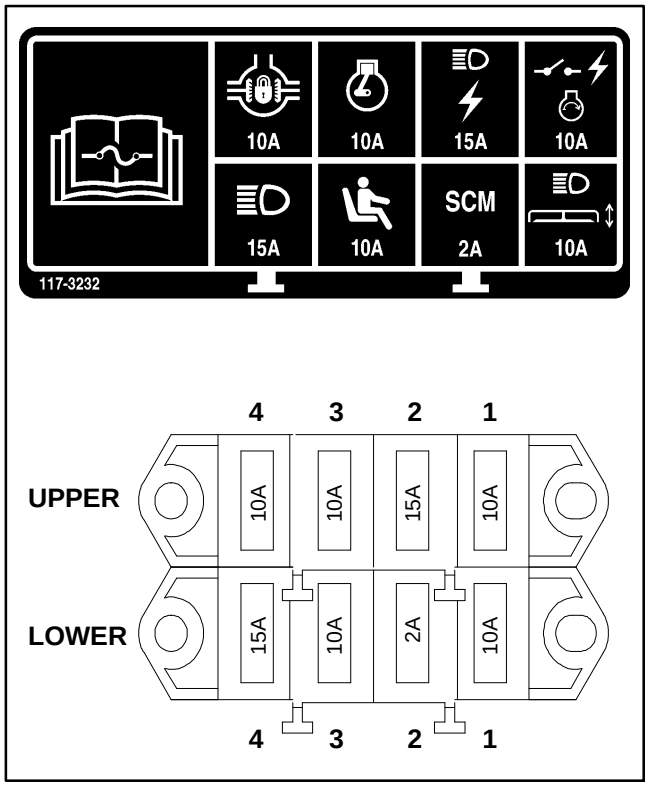


Figure 28

Fuses (4WD Machines)

The fuse block is attached to the seat support under the operator seat.

In addition to the fuses in the fuse blocks, an in−line fuse is included in the wire harness near the battery (Fig. 30).

Fuse Identification and Function

Use Figure 29 to identify each individual fuse and its correct amperage. Fuses for the Groundsmaster 360 with 4WD have the following function:

Upper Fuse 1 (10 Amp): Protects power supply for operator cab power relay circuit

Upper Fuse 2 (7.5 Amp): Protects power supply for TEC outputs 1 through 4 (start relay, fuel pump, fuel solenoid hold coil, glow relay and diagnostic light)

Upper Fuse 3 (7.5 Amp): Protects power supply for TEC outputs 5 through 8 (mow clutch coil, steering selector switch indicator light, deck lift manifold S1 and S2 coils)

Upper Fuse 4 (7.5 Amp): Protects power supply for TEC outputs 9 through 12 (steer mode selector valve coil). TEC outputs 10, 11 and 12 are not used on the Groundsmaster 360

Lower Fuse 1 (10 Amp): Protects power supply for main power supply

Lower Fuse 2 (15 Amp): Protects power supply for power point and optional light kit

Lower Fuse 3 (10 Amp): Protects power supply for optional air ride seat

Lower Fuse 4 (10 Amp): Protects power supply for optional light kit

In−Line Fuse (2 Amp): Protects the TEC logic power circuit

Fuse Testing

Make sure that ignition switch is OFF and key is removed from switch. Remove fuses from the fuse block for testing. Fuse should have continuity between fuse terminals.

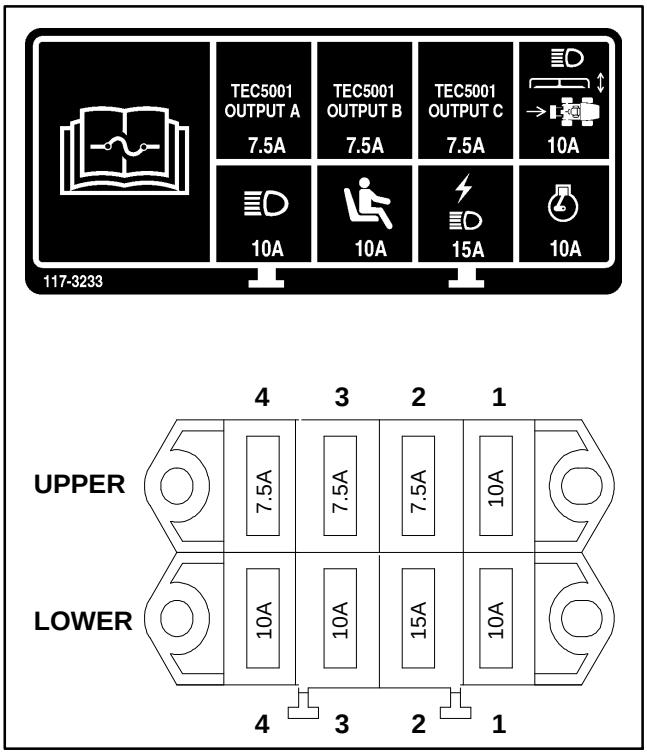


Figure 29

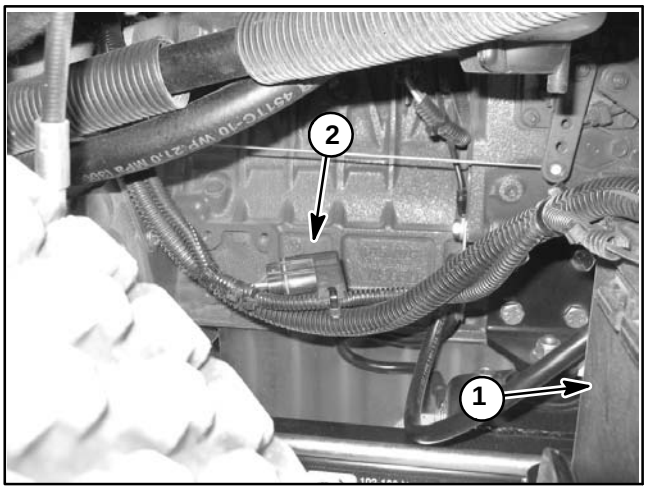


Figure 30

1. **Battery**
2. **In−line fuse**

Operator Cab Fuses (4WD Machines with Operator Cab)

The operator cab fuse blocks are located in the cab headliner (Fig. 31).

On machines with a serial number below 314999999 that include an operator cab, a 50 amp maxi−fuse is included in the operator cab wire harness. This fuse protects the cab power circuits and resides in a fuse holder attached to the air cleaner bracket near the rear steering cylinder.

On machines with a serial number above 315000000 that include an operator cab, a 60 amp maxi−fuse is included in the operator cab wire harness. This fuse protects the cab power circuits and resides in a fuse holder attached to the rear frame near the rear steering cylinder. These machines also include an in−line 10 amp fuse which protects the radio power supply.

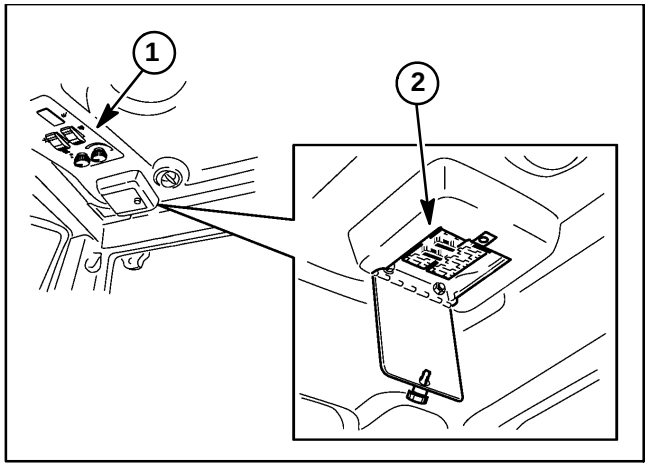


Figure 31

1. Cab headliner switches **2. Cab fuse blocks**

Fuse Identification and Function (Fig. 32)

Fuse F1−1 (15 Amp): Protects the cab work light circuit.

Fuse F1−2 (15 Amp): Protects the cab heater circuit.

Fuse F1−3 (30 Amp): Protects the air conditioner circuit.

Fuse F2−1 (15 Amp): Protects the windshield wiper/ washer circuit.

Fuse F2−2 (15 Amp): Protects the cab dome light circuit.

Fuses F1−4, F2−3 and F2−4 are available for optional equipment.

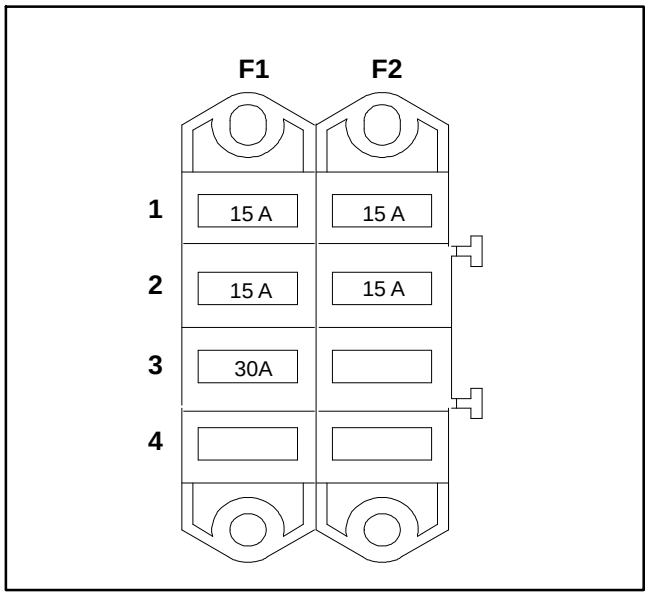


Figure 32

Fuse Testing

Make sure that ignition switch is OFF and key is removed from switch. Remove fuse from fuse block and check that fuse has continuity across the fuse terminals.

PTO Switch

The PTO switch is located on the control panel (Fig. 33). The PTO switch is pulled up to engage the PTO (cutting deck).

On 2WD machines, the Standard Control Module (SCM) monitors the operation of the PTO switch. If the ignition switch is in the RUN position and the PTO switch is engaged, the SCM PTO switch input LED should be illuminated.

On 4WD machines, the Toro Electronic Controller (TEC) monitors the operation of the PTO switch.

IMPORTANT: During machine operation, if the PTO shuts down and the console temperature warning light is illuminated due to excessive engine coolant temperature, avoid shutting off the engine. Under this condition, the operator should disengage PTO, drive slowly to a safe flat area, move the throttle lever to SLOW, release the traction pedal to the neutral position and engage the parking brake. Clean off all material from hood screen and allow engine to low idle speed for several minutes while it cools to a safe level. Then, the cooling system should be checked before returning the machine to service.

Testing

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

2. Before disconnecting the PTO switch for testing, the switch and its circuit wiring should be tested as an electrical input using the SCM on 2WD machines or the Diagnostic Display on 4WD machines (see Standard Control Module or Diagnostic Display in the Troubleshooting section of this chapter). If input testing verifies that the PTO switch and circuit wiring **are** functioning correctly, no further PTO switch testing is necessary. If, however, input testing determines that the PTO switch and circuit wiring **are not** functioning correctly, proceed with the following PTO switch testing procedure.

3. Remove control panel to gain access to PTO switch (see Control Console Disassembly in the Service and Repairs section of Chapter 6 − Chassis).

4. Make sure ignition switch is in the OFF position. Disconnect machine wire harness electrical connector from the PTO switch.

5. The PTO switch terminals are identified in Figure 34 and the circuitry of the PTO switch is shown in Figure 35. 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. Verify continuity between switch terminals.

6. Replace PTO switch if testing determines that it is faulty.

7. If the PTO switch tests correctly and a circuit problem still exists, check wire harness (see Electrical Schematics and Wire Harness Drawings in Chapter 9 − Foldout Drawings).

8. After testing is complete, connect machine wire harness connector to PTO switch. Secure control panel to machine with removed fasteners.

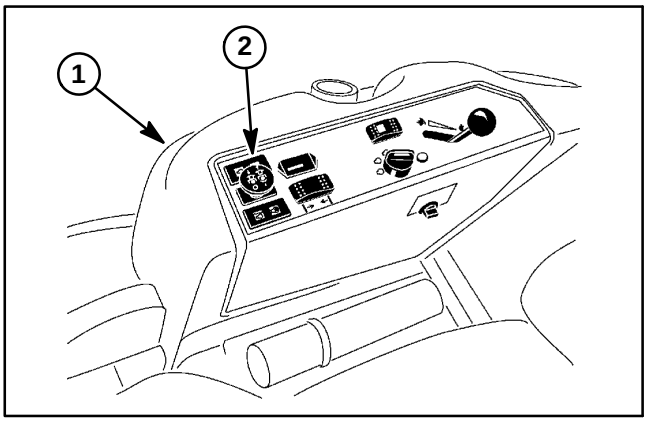


Figure 33

1. **Control panel**
2. **PTO switch**

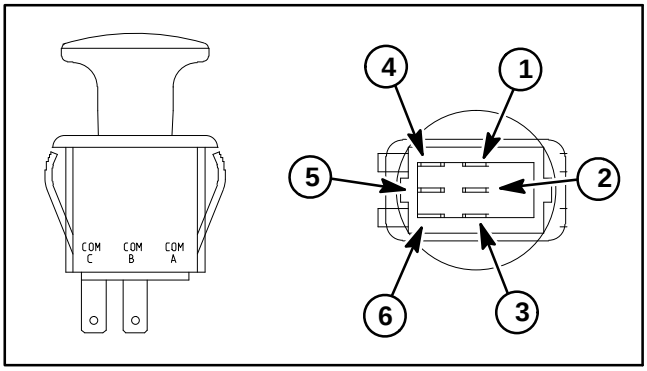


Figure 34

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

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

Figure 35

Deck Lift Switch

The deck lift switch is used to raise or lower the cutting deck. The deck lift switch is located on the control panel (Fig. 36).

The engine must be running to allow the cutting deck to be raised or lowered. When the front of the lift switch is depressed, the deck will lower fully. When the rear of the lift switch is depressed and held, the deck will raise. When raising the deck, the deck will remain in position if the switch is released.

The deck lift switch used on 2WD machines is different than the switch used on 4WD machines. The switch on 2WD machines has a momentary position in raise and remains in position when pressed to lower. The switch on 4WD machines has momentary contacts in both the raise and lower positions. The lift switch circuits on both 2WD and 4WD machines are identical.

On 4WD machines, the Toro Electronic Controller (TEC) monitors the operation of the deck lift switch. Before disconnecting the deck lift switch for testing on 4WD machines, the deck lift switch and its circuit wiring should be tested as an electrical input using the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If input testing verifies that the deck lift switch and circuit wiring **are** functioning correctly, no further lift switch testing is necessary. If, however, input testing determines that the lift switch and circuit wiring **are not** functioning correctly, proceed with the following deck lift switch testing procedure.

Testing

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

2. Remove control panel to gain access to deck lift switch (see Control Console Disassembly in the Service and Repairs section of Chapter 6 − Chassis).

3. Make sure ignition switch is in the OFF position. Disconnect machine wire harness electrical connector from the lift switch.

4. The deck lift switch terminals are identified in Figure 37 and the circuitry of the lift switch is shown in Figure 38. 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. Verify continuity between switch terminals.

5. Replace deck lift switch if testing determines that it is faulty.

6. If the deck lift switch tests correctly and a circuit problem still exists, check wire harness (see Electrical Schematics and Wire Harness Drawings in Chapter 9 − Foldout Drawings).

7. After testing is complete, connect machine wire harness connector to deck lift switch. Secure control panel to machine with removed fasteners.

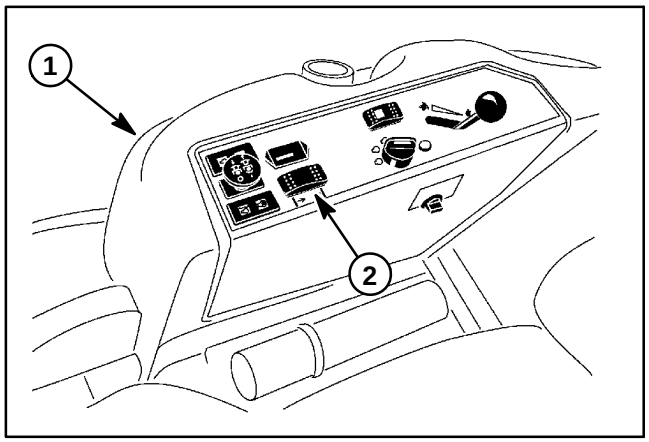


Figure 36

1. **Control panel**
2. **Deck lift switch**

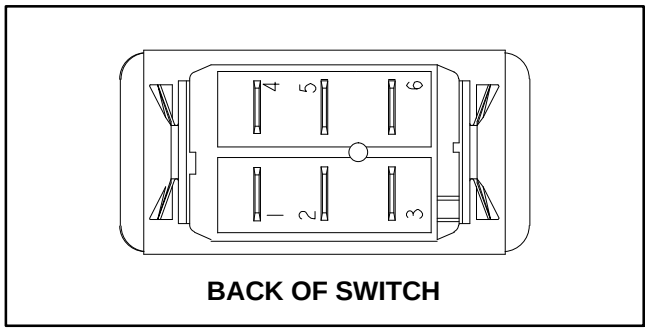


Figure 37

SWITCH POSITION	NORMAL CIRCUITS	OTHER CIRCUITS
RAISE	2 + 1	5 + 4
OFF	NONE	NONE
LOWER	2 + 3	5 + 6

Figure 38

NOTE: Lift switch terminals 4, 5 and 6 are not used on Groundsmaster 360 machines that have 4WD.

Steering Selector Switch (4WD Machines)

The steering selector switch on 4WD machines is used to control 4 wheel steer operation. The steering selector switch is located on the control panel (Fig. 39).

When the front of the steering selector switch is depressed with the wheels directed straight ahead, steering will only be active on the front wheels. This position is recommended for transporting the machine. When the rear of the steering selector switch is depressed with the wheels directed straight ahead, 4 wheel steering will be active.

The indicator light on the switch identifies when the machine is in 2 wheel steering operation and also can be used to determine when the wheels are directed straight ahead. The indicator light will not be illuminated when 4 wheel steering is active. A flashing light when changing steering selector switch positions indicates that the wheels are not directed straight ahead and the steering wheel needs to be slowly turned until the flashing ceases.

Testing

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

2. The Toro Electronic Controller (TEC) monitors the operation of the steering selector switch. Before disconnecting the steering selector switch for testing, the switch and its circuit wiring should be tested as an electrical input using the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If input testing verifies that the steering selector switch and circuit wiring **are** functioning correctly, no further switch testing is necessary. If, however, input testing determines that the steering steering switch and circuit wiring **are not** functioning correctly, proceed with the following steering steering switch testing procedure.

3. Remove control panel to gain access to steering selector switch (see Control Console Disassembly in the Service and Repairs section of Chapter 6 − Chassis).

4. Make sure ignition switch is in the OFF position. Disconnect machine wire harness electrical connector from the steering selector switch.

5. The steering selector switch terminals are identified in Figure 40 and the circuitry of the selector switch is shown in Figure 41. 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. Verify continuity between switch terminals.

6. Replace steering selector switch if testing determines that it is faulty.

7. If the steering selector switch tests correctly and a circuit problem still exists, check wire harness (see Electrical Schematics and Wire Harness Drawings in Chapter 9 − Foldout Drawings).

8. After testing is complete, connect machine wire harness connector to steering selector switch. Secure control panel to machine with removed fasteners.

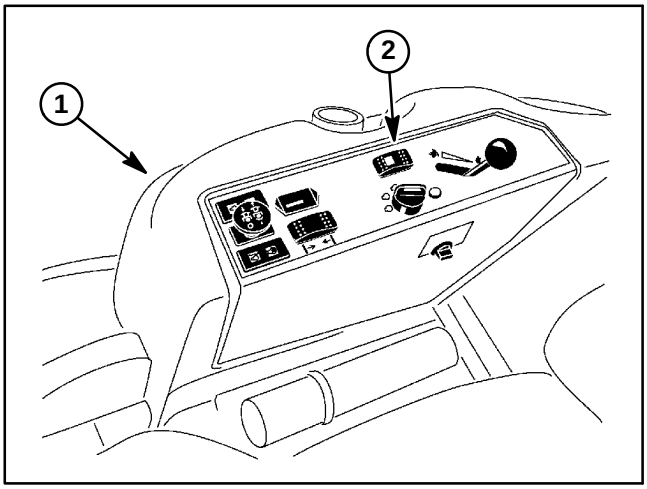


Figure 39

1. Control panel
2. Steering selector switch

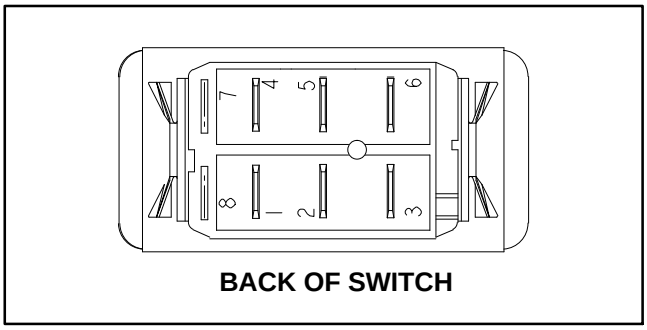


Figure 40

SWITCH POSITION	NORMAL CIRCUITS	OTHER CIRCUITS
4 WHEEL STEER	2 + 1	5 + 4
2 WHEEL STEER	2 + 3	5 + 6

Figure 41

NOTE: Steering selector switch terminals 3, 4, 5 and 6 are not used on Groundsmaster 360 machines.

Air Conditioning Switch (4WD Machines with Operator Cab)

The air conditioning switch is used to turn the air conditioning on and off. When the front of the switch is depressed, air conditioning will be on. When the rear of the switch is depressed, air conditioning will be off. The air conditioning switch is located on the cab control panel (Fig. 42).

Testing

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

2. Make sure ignition switch is in the OFF position. Remove control panel from cab headliner to gain access to air conditioning switch.

3. Disconnect machine wire harness electrical connector from the air conditioning switch.

4. The air conditioning switch terminals are identified in Figure 43 and the switch circuits are shown in Figure 44. 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. Verify continuity between switch terminals.

5. Replace air conditioning switch if testing determines that it is faulty.

6. If the air conditioning switch tests correctly and a circuit problem still exists, check wire harness (see Electrical Schematics and Wire Harness Drawings in Chapter 9 − Foldout Drawings).

7. After testing is complete, connect machine wire harness connector to air conditioning switch. Secure control panel to cab headliner with removed fasteners.

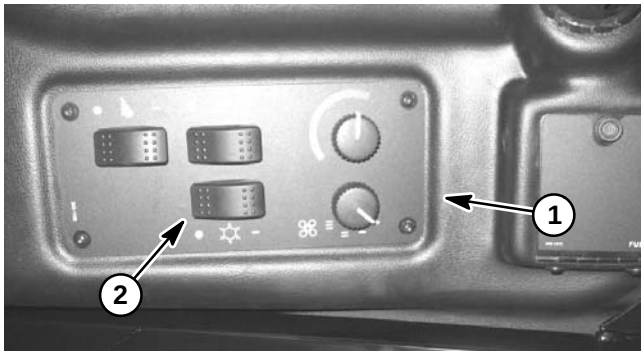
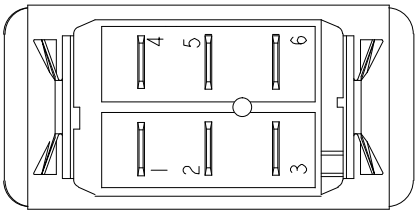


Figure 42

1. Cab control panel **2. Air conditioning switch**



BACK OF SWITCH

Figure 43

SWITCH POSITION	NORMAL CIRCUITS	OTHER CIRCUITS
OFF	2 + 1	5 + 4
ON	2 + 3	5 + 6

Figure 44

NOTE: Air conditioning switch terminals 1, 4, 5 and 6 are not used on Groundsmaster 360 machines.

Windshield Washer/Wiper Switch (4WD Machines with Operator Cab)

The windshield washer/wiper switch is used to control the windshield washer and wiper. When the front of the switch is depressed, both the wiper and the washer will be off. When the switch is in the center position, the wiper will be on. Both the washer and wiper will be on when the rear of the switch is depressed and held. The washer/wiper switch is located on the cab control panel (Fig. 45).

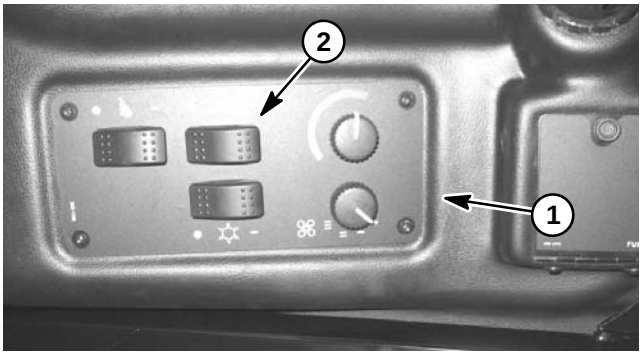


Figure 45

1. Cab control panel
2. Washer/wiper switch

Testing

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

2. Make sure ignition switch is in the OFF position. Remove control panel from cab headliner to gain access to windshield washer/wiper switch.

3. Disconnect machine wire harness electrical connector from the windshield washer/wiper switch.

4. The windshield washer/wiper switch terminals are identified in Figure 46 and the switch circuits are shown in Figure 47. 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. Verify continuity between switch terminals.

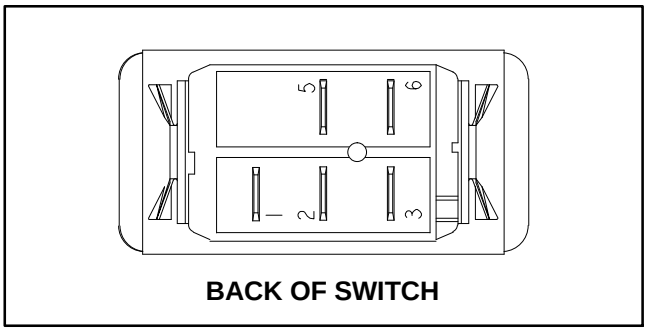


Figure 46

SWITCH POSITION	NORMAL CIRCUITS	OTHER CIRCUITS
OFF	2 + 1	
WIPER ON	2 + 3	
WASHER ON	2 + 3	5 + 6

Figure 47

5. Replace windshield washer/wiper switch if testing determines that it is faulty.

6. If the windshield washer/wiper switch tests correctly and a circuit problem still exists, check wire harness (see Electrical Schematics and Wire Harness Drawings in Chapter 9 − Foldout Drawings).

7. After testing is complete, connect machine wire harness connector to windshield washer/wiper switch. Secure control panel to cab headliner with removed fasteners.

Seat Switch

The seat switch is normally open and closes when the operator is on the seat. If the traction system or PTO switch is engaged when the operator raises out of the seat, the engine will stop. The seat switch and its electrical connector (Fig. 48) are located directly under the seat.

On 2WD machines, the Standard Control Module (SCM) monitors the operation of the seat switch. If the ignition switch is in the RUN position and the seat is occupied, the SCM in seat input LED should be illuminated.

On 4WD machines, the Toro Electronic Controller (TEC) monitors the operation of the seat switch.

Testing

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

2. Before disconnecting the seat switch for testing, the switch and its circuit wiring should be tested as an electrical input using the SCM on 2WD machines or the Diagnostic Display on 4WD machines (see Standard Control Module or Diagnostic Display in the Troubleshooting section of this chapter). If input testing verifies that the seat switch and circuit wiring **are** functioning correctly, no further seat switch testing is necessary. If, however, input testing determines that the seat switch and circuit wiring **are not** functioning correctly, proceed with the following seat switch testing procedure.

3. Make sure ignition switch is in the OFF position. Tilt seat assembly up to gain access to seat switch electrical connections.

NOTE: There is a short wire harness that is used to connect the seat switch to the main wire harness of the machine. This seat switch harness is between the seat and the seat plate.

4. Disconnect machine wire harness electrical connector from the seat switch harness electrical lead under the operator seat (Fig. 48).

5. Check the continuity of the seat switch by connecting a multimeter (ohms setting) across the seat switch harness connector terminals.

   A. With no pressure on the seat, there should be no continuity between the seat switch harness terminals.

   B. Press directly onto the seat switch through the seat cushion. There should be continuity between the seat switch harness terminals as the seat cushion approaches the bottom of its travel indicating that the seat switch is functioning.

WARNING

If seat switch service is necessary, remove seat from seat plate to access switch. To prevent injury, DO NOT attempt to reach switch through openings in seat plate.

6. If the continuity test determines that the seat switch is not operating correctly, remove seat (see Operator Seat in Chapter 6 − Chassis). Check seat switch and/or seat switch harness for continuity. Repair or replace components as needed.

7. If the seat switch tests correctly and a circuit problem still exists, check machine wire harness (see Electrical Schematics and Wire Harness Drawings in Chapter 9 − Foldout Drawings).

8. After seat switch testing is complete, connect machine wire harness connector to seat switch electrical lead. Lower seat assembly. Check seat switch operation.

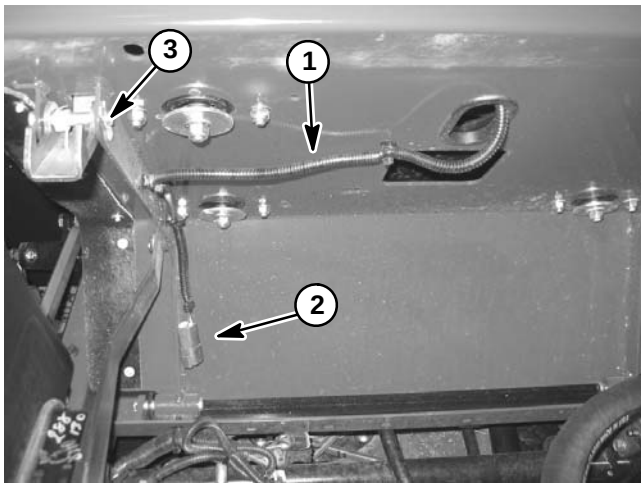


Figure 48

1. **Seat wire harness**
2. **Seat harness connector**
3. **Seat latch**

Traction Neutral Sensor

The traction neutral sensor is a normally open proximity sensor that closes when the traction pedal is in the neutral position. The sensor mounts to a bracket on the traction control shaft (Fig. 49 or 50).

On machines with serial number below 315000000 (Fig. 49), the sensing plate for the traction neutral sensor is the head of the socket head screw that secures the ball bearings to the neutral centering arm assembly. On machines with serial number above 315000000 (Fig. 50), the neutral arm is used as the sensing plate.

On 2WD machines, the Standard Control Module (SCM) monitors the operation of the neutral sensor. If the ignition switch is in the RUN position and the traction pedal is in the neutral position, the SCM neutral sensor input LED should be illuminated.

On 4WD machines, the Toro Electronic Controller (TEC) monitors the operation of the neutral sensor.

Testing

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

2. Before disconnecting the neutral sensor for testing, the sensor and its circuit wiring should be tested as an electrical input using the SCM on 2WD machines or the Diagnostic Display on 4WD machines (see Standard Control Module or Diagnostic Display in the Troubleshooting section of this chapter). If input testing verifies that the neutral sensor and circuit wiring **are** functioning correctly, no further neutral sensor testing is necessary. If, however, input testing determines that the neutral sensor and circuit wiring **are not** functioning correctly, proceed with the following neutral sensor testing procedure.

3. Raise and support operator seat. Locate neutral sensor (Fig. 53).

4. Turn ignition switch to the RUN position (do not start engine) and check LED on cable end of neutral sensor. LED **should be** illuminated when the traction pedal **is** in the neutral position.

5. With the ignition switch still in the RUN position (do not start engine), press traction pedal out of the neutral position and check LED on cable end of neutral sensor. LED **should not be** illuminated when the traction pedal **is not** in the neutral position.

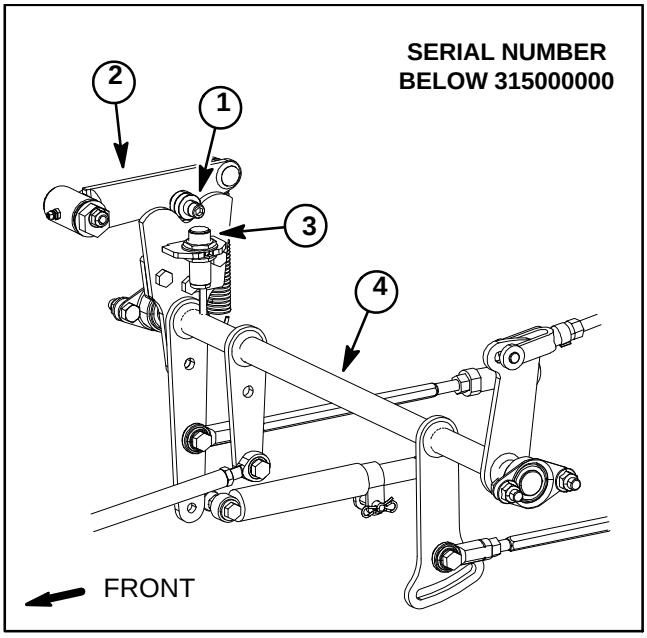


Figure 49

1. **Socket head screw head**
2. **Neutral centering arm**
3. **Traction neutral sensor**
4. **Speed control shaft**

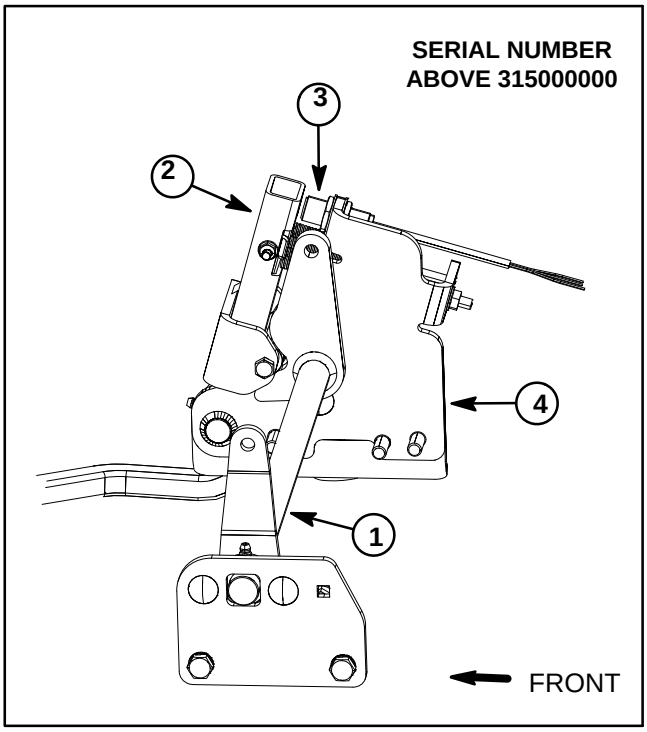


Figure 50

1. **Speed control shaft**
2. **Neutral arm**
3. **Traction neutral sensor**
4. **RH end plate**

6. If the neutral sensor LED did not function correctly:

   A. Make sure that neutral sensor is properly adjusted (see Traction Neutral Sensor in the Adjustments section of this chapter). If necessary, adjust sensor and return to step 4 above.

   B. Make sure ignition switch is OFF and disconnect the traction neutral sensor connector from the machine wire harness.

   C. Verify that the machine wire harness connector terminal for black wire is closed (continuity) to ground.

   D. Turn ignition switch to the RUN position (do not start engine) and verify with a multimeter that machine wire harness connector terminal for pink wire has system voltage (12 VDC) present.

   E. If black wire is closed to ground, pink wire has system voltage present and sensor LED did not function, replace traction neutral sensor. Adjust sensor after installation (see Traction Neutral Sensor in the Adjustments section of this chapter).

7. After testing is complete, make sure that sensor connector is plugged into machine wire harness.

8. Lower operator seat.

Parking Brake Sensor

The parking brake sensor is a normally open proximity sensor that mounts to the brake lever assembly (Fig. 53). The sensing plate for the brake sensor is the parking brake detent.

When the parking brake is not applied (brake latch not engaged), the parking brake detent is positioned near the target end of the parking brake sensor so the sensor is closed. The parking brake detent is moved away from the sensor when the parking brake is applied (brake latch engaged) causing the sensor to open.

On 2WD machines, the Standard Control Module (SCM) monitors the operation of the parking brake sensor. If the ignition switch is in the RUN position and the parking brake is not applied (brake latch not engaged), the SCM parking brake sensor input LED should be illuminated.

On 4WD machines, the Toro Electronic Controller (TEC) monitors the operation of the parking brake sensor.

Testing

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

2. Before disconnecting the parking brake sensor for testing, the sensor and its circuit wiring should be tested as an electrical input using the SCM on 2WD machines or the Diagnostic Display on 4WD machines (see Standard Control Module or Diagnostic Display in the Troubleshooting section of this chapter). If input testing verifies that the brake sensor and circuit wiring **are** functioning correctly, no further brake sensor testing is necessary. If, however, input testing determines that the brake sensor and circuit wiring **are not** functioning correctly, proceed with the following parking brake sensor testing procedure.

3. Locate parking brake sensor (Fig. 51). Make sure that parking brake is not applied.

4. Turn ignition switch to the RUN position (do not start engine) and check LED on cable end of parking brake sensor. LED **should be** illuminated when the parking brake **is not** applied (brake latch not engaged).

5. With the ignition switch still in the RUN position (do not start engine), apply parking brake (brake latch engaged) and check LED on cable end of parking brake sensor. LED **should not be** illuminated when the parking brake **is** applied (brake latch engaged).

6. If the brake sensor LED did not function correctly:

   A. Make sure that parking brake sensor is properly adjusted (see Parking Brake Sensor in the Adjustments section of this chapter). If necessary, adjust sensor and return to step 4 above.

   B. Make sure ignition switch is OFF and disconnect the parking brake sensor connector from the machine wire harness.

   C. Using a multimeter, verify that the machine wire harness connector terminal for black wire is closed (continuity) to ground.

   D. Turn ignition switch to the RUN position (do not start engine) and verify with a multimeter that machine wire harness connector terminal for pink wire has system voltage (12 VDC) present.

   E. If black wire is closed to ground, pink wire has system voltage present and sensor LED did not function, replace parking brake sensor. Adjust sensor after installation (see Parking Brake Sensor in the Adjustments section of this chapter).

7. After brake sensor testing is complete, make sure that sensor connector is plugged into machine wire harness.

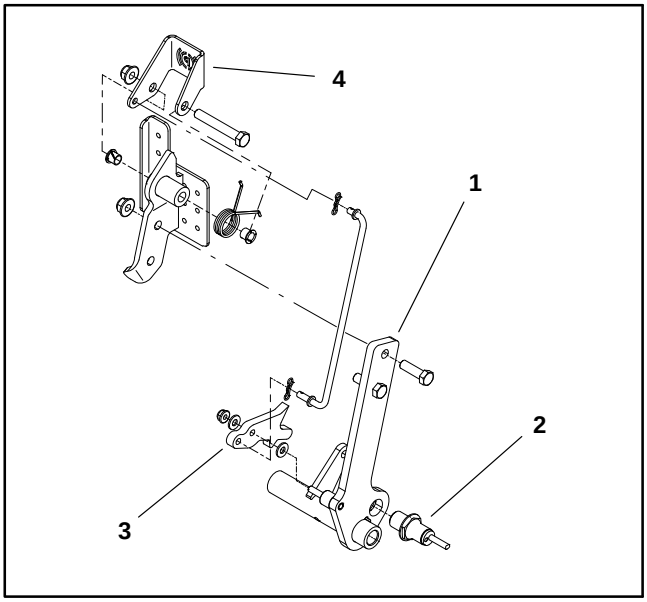


Figure 51

1. **Brake lever**
2. **Parking brake sensor**
3. **Brake detent**
4. **Parking brake latch**

Steering Home Sensor (4WD Machines)

The steering home sensor is used on Groundsmaster 360 machines with 4WD to determine when the wheels are directed straight ahead. The sensor acts as an input for the Toro Electronic Controller (TEC) to determine when steering can be changed from 4 wheel steering to 2 wheel steering.

The steering home sensor is a normally open proximity sensor. The sensor mounts to a bracket that is secured to the bottom of the front axle near the left side front steering fork (Fig. 52). The sensing plate for the steering home sensor is a target bracket attached to the left side front steering fork.

When the left side front steering fork is in the straight ahead position, a hole in the target bracket is positioned directly below the steering home sensor allowing the sensor to be in its normally open state. The sensor closes when the left side front steering fork is not in the straight ahead position.

Testing

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

2. Before disconnecting the steering home sensor for testing, the sensor and its circuit wiring should be tested as an electrical input using the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If input testing verifies that the steering home sensor and circuit wiring **are** functioning correctly, no further sensor testing is necessary. If, however, input testing determines that the steering home sensor and circuit wiring **are not** functioning correctly, proceed with the following steering home sensor testing procedure.

3. Locate steering home sensor and target bracket on LH front steering fork (Fig. 52).

4. Turn steering wheel so that front wheels are turned and check that hole in target bracket on LH steering fork is not directly below the steering home sensor. Turn ignition switch to the RUN position (do not start engine) and check LED on cable end of steering home sensor. LED **should be** illuminated when the front wheel **is turned** (is not aimed straight ahead).

5. Turn steering wheel so front wheels are straight ahead and check that hole in target bracket on LH steering fork is directly below the steering home sensor. With the ignition switch still in the RUN position (do not start engine), check LED on cable end of steering home sensor. LED **should not be** illuminated when the front wheel **is not turned** (is aimed straight ahead).

6. If the steering sensor LED did not function correctly:

   A. Make sure that parking brake sensor is properly adjusted (see Parking Brake Sensor in the Adjustments section of this chapter). If necessary, adjust sensor and return to step 4 above.

   B. Make sure ignition switch is OFF and disconnect the steering home sensor connector from the machine wire harness.

   C. Using a multimeter, verify that the machine wire harness connector terminal for black wire is closed (continuity) to ground.

   D. Turn ignition switch to the RUN position (do not start engine) and verify with a multimeter that machine wire harness connector terminal for pink wire has system voltage (12 VDC) present.

   E. If black wire is closed to ground, pink wire has system voltage present and sensor LED did not function, replace steering home sensor. Adjust sensor after installation (see Steering Home Sensor in the Adjustments section of this chapter).

7. After steering home sensor testing is complete, make sure that sensor connector is plugged into machine wire harness.

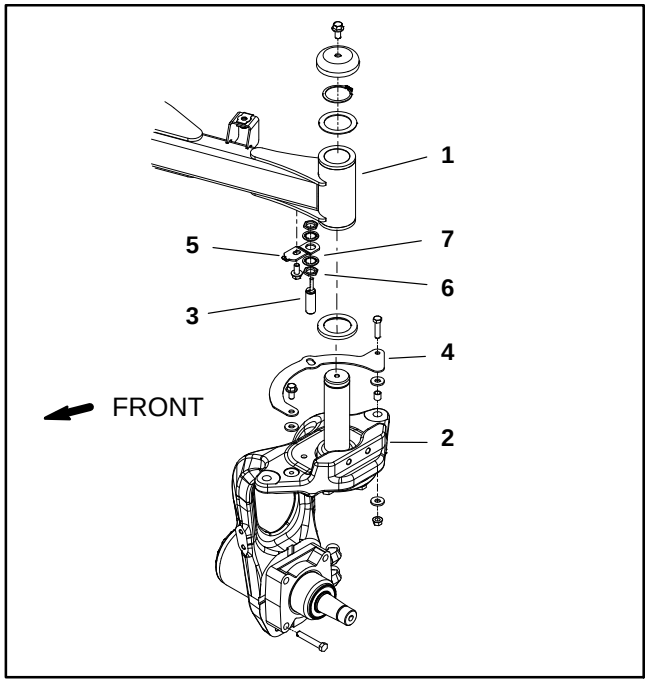


Figure 52

1. **Front axle**
2. **LH front steering fork**
3. **Steering home sensor**
4. **Target bracket**
5. **Sensor bracket**
6. **Jam nut (2)**
7. **Lock washer (2)**

Standard Control Module (2WD Machines)

Groundsmaster 360 machines with 2WD are equipped with a Standard Control Module (SCM) to monitor and control electrical components required for safe operation. The SCM is attached to the frame under the operator seat (Fig. 53).

Inputs from the ignition, neutral, parking brake, PTO, seat, high temperature warning and high temperature shutdown switches are monitored by the SCM. Current output to the PTO, engine starter motor and engine run components (fuel pump and engine run solenoid) are controlled based on the inputs monitored by the SCM.

The SCM can be used to check operation of machine switches by monitoring the SCM LED's. If a SCM LED does not illuminate (e.g. the In Seat input LED does not illuminate when the seat is occupied and the ignition switch is in the RUN position), testing of the switch, fuses and circuit wiring would be required.

The SCM does not connect to an external computer or hand held device, cannot be re−programmed and does not record intermittent fault data.

SCM Inputs (Fig. 54)

The Power input LED should be illuminated when the ignition switch is in the RUN position. The Power input LED should also be illuminated when the ignition switch is in the START position.

The Start input LED should be illuminated when the ignition switch is in the START position.

The Neutral input LED should be illuminated when the traction control pedal is in the neutral position.

The Parking Brake Off input LED should be illuminated when the parking brake is **not** applied.

The PTO Switch input LED should be illuminated when the PTO switch is on (pulled out).

The In Seat input LED should be illuminated when the operator is sitting in the seat.

The High Temperature Shutdown input LED should be illuminated when the engine high temperature shutdown switch closes due to engine coolant temperature of 240F (115C) (approximate).

The High Temperature Warning input LED should be illuminated when the engine high temperature warning switch closes due to engine coolant temperature of 220F (105C) (approximate).

The Backlap input LED is not used on the Groundsmaster 360.

SCM Outputs (Fig. 54)

The Start output LED should be illuminated when the ignition switch is in the START position with the traction control pedal in the neutral position, the PTO switch OFF and either the seat occupied or parking brake engaged.

The Run output LED should be illuminated when the ignition switch is in the RUN position and inputs from the neutral, parking brake, PTO, seat and engine coolant temperature switches indicate safe engine operation (e.g. seat occupied and parking brake disengaged when the traction control pedal is moved from the neutral position).

The PTO output LED should be illuminated when the ignition switch is in the RUN position and the PTO switch is ON (pulled out).

NOTE: If the SCM High Temperature Warning input LED is illuminated, PTO output LED will not be illuminated and PTO will be disengaged regardless of PTO switch position.

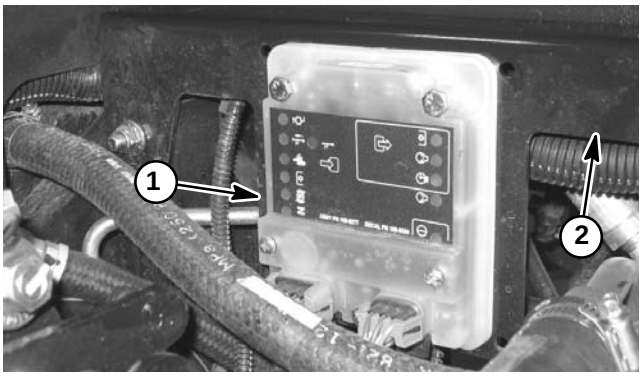


Figure 53

1. **Standard control module**
2. **Seat support channel**

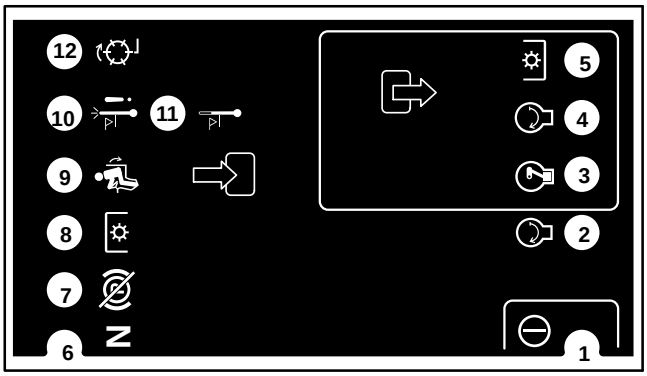


Figure 54

1. **Power input**
2. **Start input**
3. **Engine run output**
4. **Start output**
5. **PTO output**
6. **Neutral input**
7. **Park brake off input**
8. **PTO switch input**
9. **In seat input**
10. **Temp shutdown input**
11. **Temp warning input**
12. **Backlap input**

Toro Electronic Controller (TEC) (4WD Machines)

Groundsmaster 360 machines with 4WD use a Toro Electronic Controller (TEC) to monitor the condition of various switches (inputs) and then direct electrical power output to allow certain machine functions. The controller is attached to the frame under the operator seat (Fig. 55). The handheld Diagnostic Display (see Special Tools in this chapter) with the correct overlay should be used when checking inputs and outputs of the controller used on your Groundsmaster (see Troubleshooting in this chapter).

NOTE: Optional kits for the Groundsmaster 360 are available that require the use of an additional TEC controller. Even though the additional controller appears identical to the standard controller, they are different in terms of the connectors and internal hardware. The two controllers cannot be interchanged.

Inputs from the ignition, neutral, parking brake, PTO, seat, deck lift, steering selector, steering home, engine temperature, engine oil pressure and engine high temperature shutdown switches are all monitored by the controller.

Current output to the PTO circuit hydraulic valve solenoid coil, lift circuit hydraulic valve solenoid coils, 4 wheel steering hydraulic valve solenoid coil, diagnostic light and engine components (glow plug relay, start relay, fuel pump and engine run solenoid) are controlled based on the inputs received by the controller.

If the controller detects a malfunction in any of the controlled circuits, the diagnostic light can be used to identify the fault (see Diagnostic Light in the Troubleshooting section of this chapter).

Because of the solid state circuitry built into the controller, there is no method to test it directly. The controller may be damaged if an attempt is made to test it with an electrical test device, such as a digital multimeter.

NOTE: The TEC used on the Groundsmaster 360 and the optional kits are programmed for correct machine operation. If a TEC is replaced for any reason, system software needs to be reprogrammed by your Toro Distributor.

IMPORTANT: Before performing any welding on the machine, disconnect both positive and negative battery cables from the battery, disconnect the wire harness connector from the TEC controller and disconnect the terminal connector from the alternator. This will prevent damage to the electrical system of your Groundsmaster.

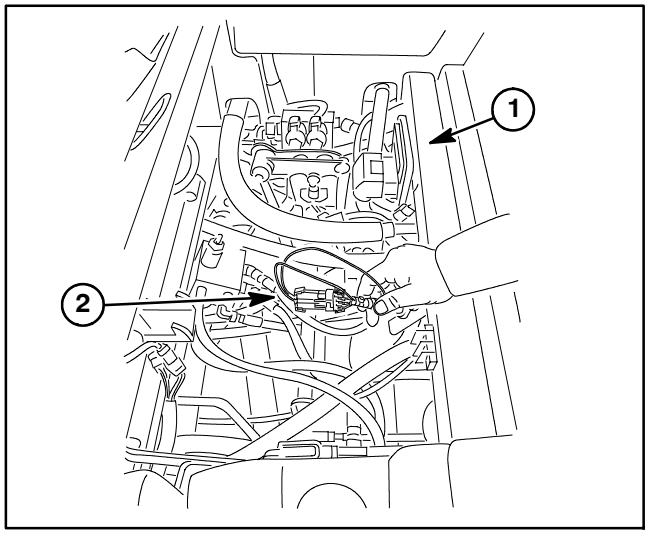


Figure 55

1. **TEC controller location** 2. **Loopback connector**

Fusible Links

The Groundsmaster 360 uses four (4) fusible links for circuit protection. Two (2) of these fusible links are included in a three (3) wire harness that connects the starter B+ terminal to the wire harness (Fig. 56 and 57). An additional fusible link is used that connects the starter B+ terminal to the alternator B+ terminal (Fig. 56 and 58). The remaining fusible link is included in the wire harness and connects the starter G terminal to the engine run solenoid pull coil. If any of these links should fail, current to the protected circuit will cease. Refer to the electrical schematic and wire harness drawings in Chapter 9 − Foldout Drawings for additional circuit information.

NOTE: The fusible link harness shown in Figure 57 uses the fusible links in connector terminals A and B on Groundsmaster 360 2WD machines. Groundsmaster 360 4WD machines use the fusible links in connector terminals B and C. The third fusible link is not used on the Groundsmaster 360.

Testing

Make sure that ignition switch is OFF. Disconnect negative battery cable from battery terminal and then disconnect positive cable from battery (see Battery Service in the Service and Repairs section of this chapter). Locate and unplug fusible link connector. Use a multimeter to make sure that continuity exists between the fusible link terminals. If a fusible link is open, replace the link.

After testing is complete, make sure that fusible link is securely attached to engine component and wire harness. Connect positive battery cable to battery terminal first and then connect negative cable to battery.

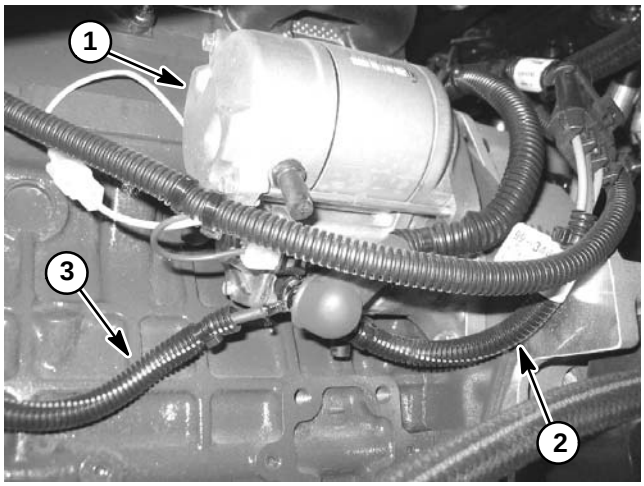


Figure 56

1. **Starter motor**
2. **Fusible link harness**
3. **Alternator fusible link**

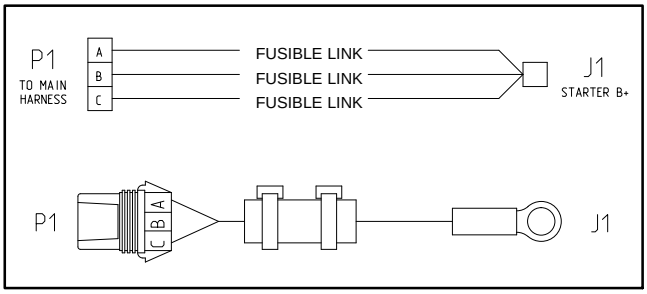


Figure 57

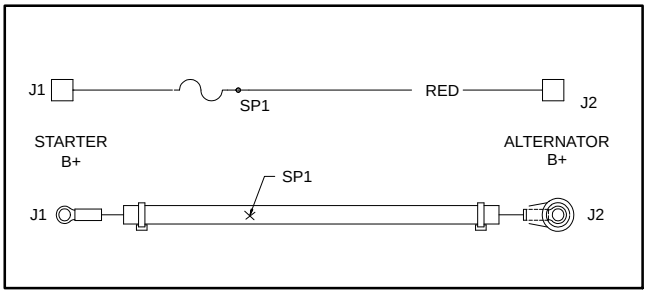


Figure 58

PTO Solenoid Valve Coil

The Groundsmaster 360 transmission includes a solenoid valve coil that is used to engage the PTO drive (Fig. 44). When the solenoid valve coil is energized, hydraulic flow is directed to operate the PTO system.

On 2WD machines, the Standard Control Module (SCM) provides current to the PTO solenoid valve coil based on the position of several input switches. The PTO LED on the SCM will be illuminated when the solenoid valve coil is energized.

On 4WD machines, the Toro Electronic Controller (TEC) provides current to the PTO solenoid valve coil based on the position of several input switches. Before disconnecting PTO solenoid valve coil on machines with 4WD, test the solenoid and its circuit wiring as TEC controller outputs with the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter).

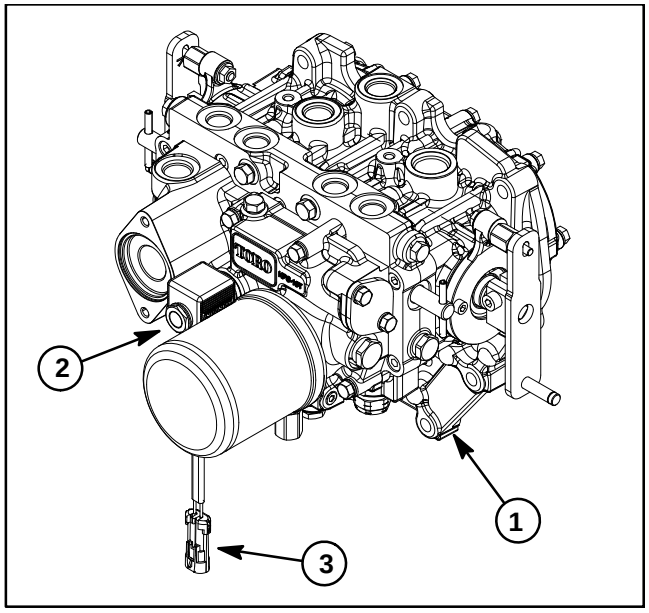


Figure 59

1. **Transmission**
2. **Solenoid valve and coil**
3. **Coil connector**

Testing

NOTE: The solenoid does not have to be removed from the cartridge valve for testing.

1. Make sure ignition switch is in the OFF position. Unplug wire harness electrical connector from solenoid valve coil.

NOTE: Prior to taking small resistance readings with a digital multimeter, short the test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from the measured value of the solenoid coil being testing.

2. Measure resistance between the two solenoid coil connector terminals. Resistance of the solenoid coil should be approximately **7.5 ohms**.

3. If solenoid coil needs replacement, see PTO Solenoid Valve Coil in the Service and Repairs section of this chapter.

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

Hydraulic Solenoid Valve Coils

The Groundsmaster 360 hydraulic control manifolds use several hydraulic solenoid valve coils for system control. The deck lift manifold includes two (2) solenoid valves and the steering control manifold on 4WD machines includes a single solenoid valve. When the solenoid coils are energized, hydraulic valve shift occurs to control hydraulic circuit flow. Testing of the coils can be done with the coil installed on the hydraulic valve.

Testing

NOTE: Before disconnecting solenoid valve coils on machines with 4WD, test the solenoids and their circuit wiring as TEC controller outputs with the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). The Diagnostic Display will identify if the TEC output to the solenoid coil exists when machine controls are in the correct position. If the TEC output exists for a solenoid coil but the coil is not functioning correctly, suspect a failed coil or an open in the solenoid valve coil circuit.

1. Park machine on level surface, lower cutting deck, stop engine, apply parking brake and remove key from ignition switch. To gain access to control manifolds and solenoid coils, raise and support the operator seat.

2. Disconnect harness electrical connector from hydraulic solenoid valve coil that is to be tested (Fig. 60).

3. Identify coil resistance specification by measuring the coil diameter and coil height (Fig. 61).

NOTE: Prior to taking small resistance readings with a digital multimeter, short the meter test leads together. The meter may display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from the measured value of the solenoid coil being testing.

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).

4. Using a multimeter (ohms setting), measure resistance between the two (2) connector terminals on the solenoid valve coil. The resistance for the solenoid coils is identified in Figure 62.

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).

NOTE: On machines with a serial number below 315000000, the two (2) solenoid valve coils on the deck lift manifold are identical. To assist in troubleshooting, identical coils can be exchanged. If the problem follows the exchanged coil, an electrical problem likely exists with the coil. If the problem remains unchanged, something other than the solenoid coil is the problem source (e.g. switch, circuit wiring, hydraulic problem).

6. After coil testing is completed, connect wire harness electrical connector to the solenoid valve coil. Lower and secure seat.

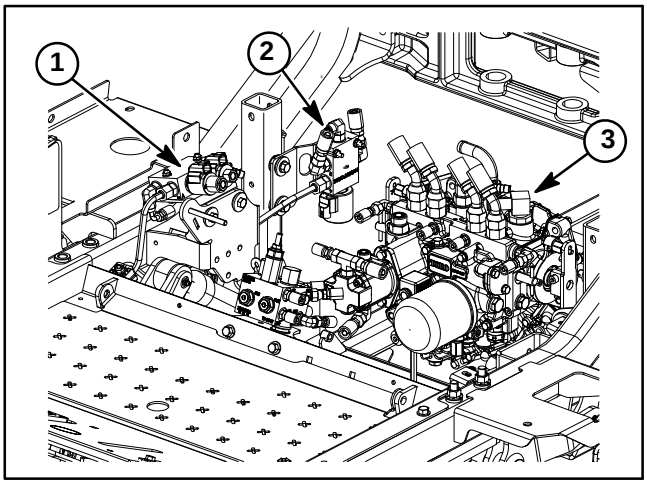


Figure 60

1. **Lift manifold**
2. **Steering manifold**
3. **Transmission**

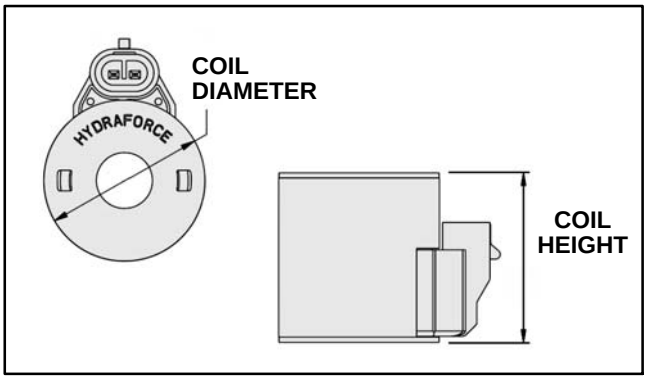


Figure 61

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

Figure 62

Main Power, Glow, Start (4WD Machines) and Cab Power (4WD Machines with Operator Cab) Relays

The Groundsmaster 360 electrical system includes identical relays for current control. The main power, glow, start (4WD machines) and cab power (4WD machines with operator cab) relays are attached to the air cleaner bracket near the rear steering cylinder (Fig. 63). The wire harness is attached to these relays with four (4) wire connectors. Relays can be identified by a tag on the wire harness.

The main power relay is used to provide current to the fuse blocks. When the ignition switch is in the RUN or START position, the main power relay is energized.

The glow relay is used to provide current to the engine glow plugs when the relay is energized. On 2WD machines, the glow relay is energized by the glow controller. On 4WD machines, the Toro Electronic Controller (TEC) provides current to energize the glow relay.

The start relay on 4WD machines is used in the engine starting circuit. When energized by the TEC controller, the start relay provides a current path to energize the engine starter solenoid.

The cab power relay on 4WD machines with cab is used to provide current to the operator cab electrical circuits. The cab power relay is energized when the main power relay is energized.

On 4WD machines, the glow relay and the start relay along with their circuit wiring **should** be tested as a TEC controller output with the Diagnostic Display before disconnecting and testing the relay (see Special Tools and Troubleshooting in this chapter).

Testing

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

2. Make sure ignition switch is in the OFF position. Disconnect wire harness electrical connector from relay that is to be tested. Remove relay from air cleaner bracket for easier 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 the measured value of the relay being testing.

3. Verify coil resistance between terminals 85 and 86 with a multimeter (ohms setting). Resistance should be approximately **72 ohms**.

4. 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.

5. Disconnect voltage and leads from the relay terminals.

6. Secure relay to air cleaner bracket and connect wire harness electrical connector to relay after testing is completed.

7. Close and secure hood.

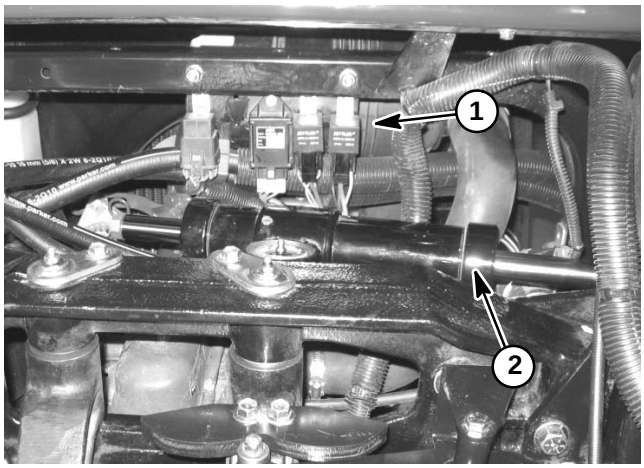


Figure 63

1. **Relay location**
2. **Rear steering cylinder**

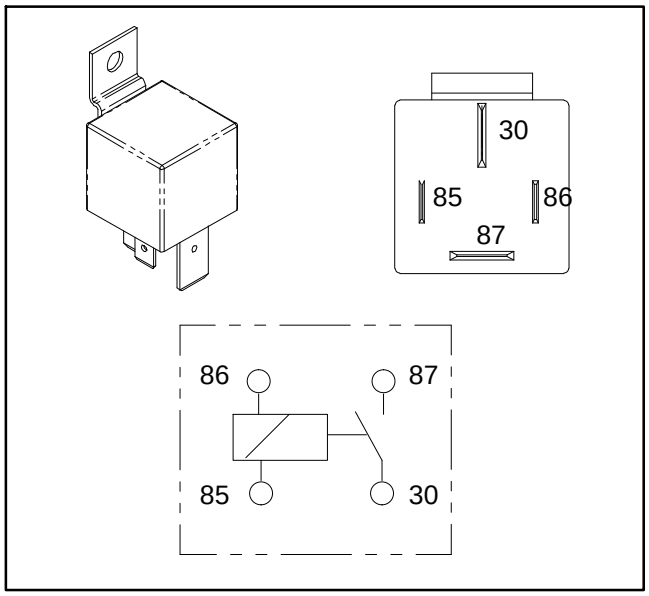


Figure 64

Deck Lift Relay (2WD Machines)

The deck lift relay is used to prevent cutting deck raising or lowering when the engine is not running. The deck lift relay is attached to the air cleaner bracket near the rear steering cylinder (Fig. 65). The relay can be identified by a tag on the wire harness.

When the engine is not running, the lack of engine oil pressure closes the engine oil pressure switch. This closed switch allows a grounding path to energize the deck lift relay. The energized deck lift relay prevents current from the deck lift/lower switch so that the cutting deck cannot be raised or lowered. When the engine is running, engine oil pressure opens the oil pressure switch removing the relay grounding path which de−energizes the deck lift relay. The de−energized relay allows current to the deck lift/lower switch for operation of the deck lift or lower system.

Testing

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

2. Locate start relay and disconnect the machine wire harness connector from the relay. Remove relay from machine for easier 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 the measured value of the relay being testing.

3. Using a multimeter (ohms setting), measure coil resistance between terminals 85 and 86 (Fig. 66). Resistance should be between **70 and 90 ohms**.

4. Connect multimeter (ohms setting) leads to relay terminals 30 and 87. Ground terminal 86 and apply +12 VDC to terminal 85. The relay terminals 30 and 87 should have continuity as +12 VDC is applied to terminal 85. The relay terminals 30 and 87 should not have continuity as +12 VDC is removed from terminal 85.

5. Disconnect voltage from terminal 85 and multimeter lead from terminal 87.

6. Connect multimeter (ohms setting) leads to relay terminals 30 and 87A. With terminal 86 grounded, apply +12 VDC to terminal 85. The relay terminals 30 and 87A should not have continuity as +12 VDC is applied to terminal 85. The relay terminals 30 and 87A should have continuity as +12 VDC is removed from terminal 85.

7. When relay testing is completed, disconnect voltage and multimeter leads from the relay terminals. Replace relay if necessary.

8. Secure relay to machine and connect machine wire harness connector to relay.

9. Lower and secure hood.

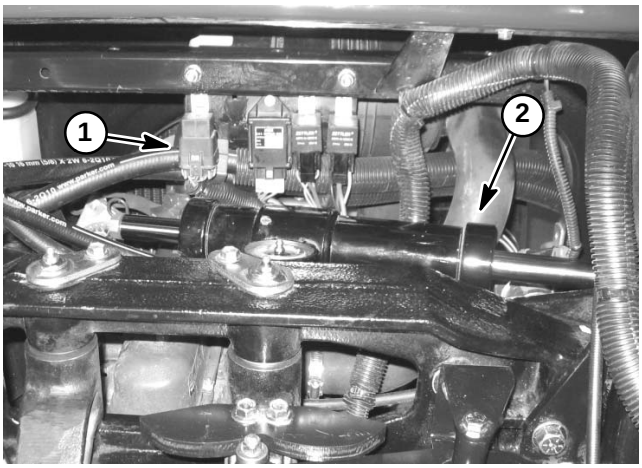


Figure 65

1. Deck lift relay **2. Rear steering cylinder**

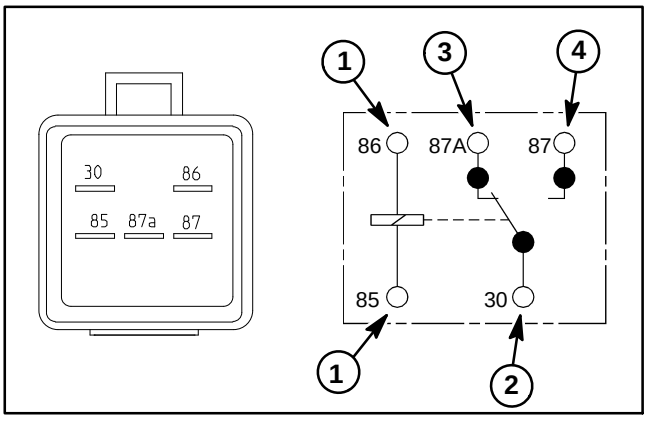


Figure 66

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

High Temperature Warning Switch (Machines without Operator Cab)

The high temperature warning switch is attached to the water pump housing on the engine (Fig. 67). This switch is normally open and closes when engine coolant temperature reaches approximately 220ºF (105ºC). If high engine coolant temperature causes the warning switch to close, the high temperature warning light on the console will illuminate and also the cutting deck will shut down. There is a yellow harness wire attached to the warning switch on 2WD machines. On 4WD machines, a violet harness wire attaches to the warning switch.

On 2WD machines, the Standard Control Module (SCM) monitors the operation of the high temperature warning switch. If the high temperature warning switch closes (high engine coolant temperature), the SCM high temperature warning LED should be illuminated.

On 4WD machines, the Toro Electronic Controller (TEC) monitors the operation of the high temperature warning switch.

Before performing the following testing procedure, the temperature warning switch and its circuit wiring **should** be tested as an electrical input using the SCM on 2WD machines or the Diagnostic Display on 4WD machines (see Standard Control Module or Diagnostic Display in the Troubleshooting section of this chapter).

Testing

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

CAUTION

Make sure engine is cool before removing the temperature warning switch from engine. Do not open radiator cap or drain coolant if the radiator or engine is hot. Pressurized, hot coolant can escape and cause burns.

2. Lower the coolant level in the engine, remove wire harness connector from high temperature warning switch and remove the switch from the engine.

3. Put the end of the switch in a container of oil with a thermometer and slowly heat the oil (Fig. 68).

CAUTION

Handle the hot oil with extreme care to prevent personal injury or fire.

4. Check resistance of the warning switch with a multimeter (ohms setting) as the oil temperature increases. The high temperature warning switch is normally open (high resistance) and should close (continuity) from 216º to 226ºF (102º to 108ºC).

5. Replace warning switch if specifications are not met.

6. After testing, install high temperature warning switch to the engine housing.

   A. Clean threads of housing and switch thoroughly. Apply thread sealant to the threads of the switch.

   B. Thread warning switch into the housing. Torque switch from **16 to 20 ft−lb (22 to 27 N−m)**.

   C. Connect wire harness connector to high temperature warning switch.

7. Fill engine cooling system. Lower and secure hood.

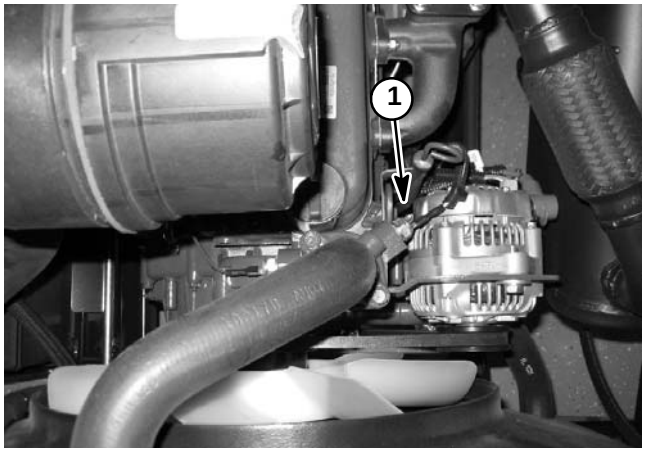


Figure 67

1. High temperature warning switch

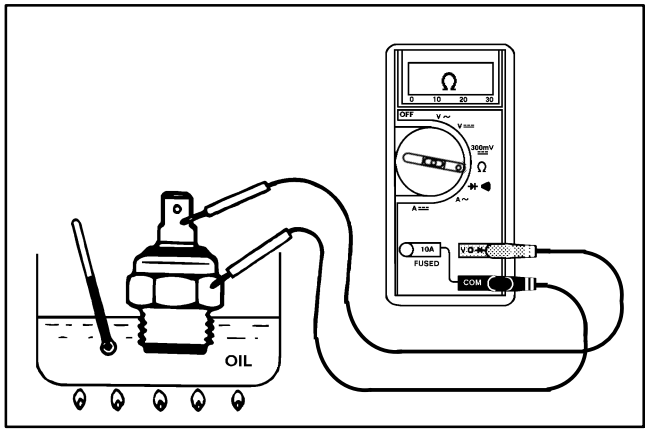


Figure 68

High Temperature Shutdown Switch (Machines without Operator Cab)

The high temperature shutdown switch is located on the water pump housing (Fig. 69). The high temperature shutdown switch is normally open and closes when engine coolant temperature reaches approximately 240ºF (115ºC). If excessive engine coolant temperature causes the shutdown switch to close, the engine shuts down. There is a red wire attached to the shutdown switch.

On 2WD machines, the Standard Control Module (SCM) monitors the operation of the high temperature shutdown switch. If the high temperature shutdown switch closes (excessive engine coolant temperature), the SCM high temperature warning LED should be illuminated.

On 4WD machines, the Toro Electronic Controller (TEC) monitors the operation of the high temperature shutdown switch.

Before performing the following testing procedure, the temperature shutdown switch and its circuit wiring **should** be tested as an electrical input using the SCM on 2WD machines or the Diagnostic Display on 4WD machines (see Standard Control Module or Diagnostic Display in the Troubleshooting section of this chapter).

Testing

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

CAUTION

Make sure engine is cool before removing the temperature warning switch from engine. Do not open radiator cap or drain coolant if the radiator or engine is hot. Pressurized, hot coolant can escape and cause burns.

2. Lower the coolant level in the engine and remove the high temperature shutdown switch from the engine.

3. Put the end of the switch in a container of oil with a thermometer and slowly heat the oil (Fig. 70).

CAUTION

Handle the hot oil with extreme care to prevent personal injury or fire.

4. Check resistance of the switch with a multimeter (ohms setting) as the oil temperature increases. The high temperature shutdown switch is normally open (high resistance) and should close (continuity) from 234º to 244ºF (112º to 118ºC).

5. Replace shutdown switch if specifications are not met.

6. After testing is complete, install shutdown switch to the engine housing.

   A. Clean threads of housing and switch thoroughly. Apply thread sealant to the threads of the switch.

   B. Thread switch into the housing. Torque switch from **22 to 28 ft−lb (30 to 38 N−m)**.

   C. Connect wire harness connector to shutdown switch.

7. Fill engine cooling system. Lower and secure hood.

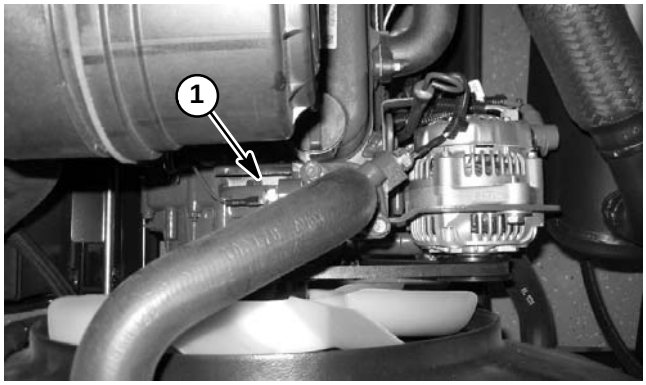


Figure 69

1. High temperature shutdown switch

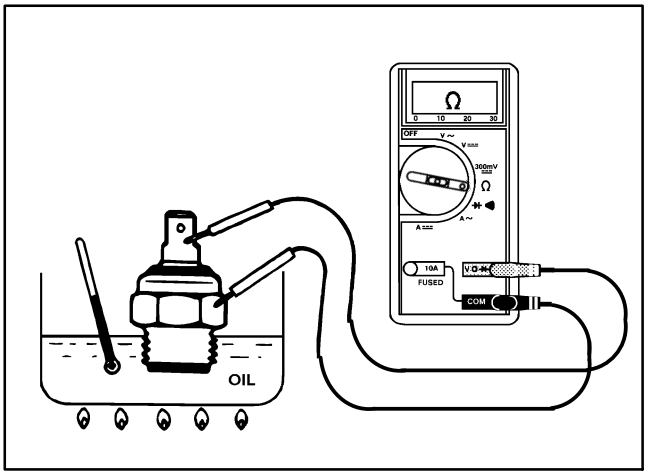


Figure 70

Dual Temperature Switch (Machines with Operator Cab)

On Groundsmaster 360 machines equipped with an operator cab, the dual temperature switch includes two (2) normally open circuits used to monitor engine coolant temperature. These switch circuits are the high temperature warning circuit and the high temperature shutdown circuit. The dual temperature switch is attached to the engine water pump housing (Fig. 71).

If engine coolant temperature rises to approximately 220ºF (105ºC), the high temperature warning circuit closes. This closed circuit causes the High Temperature Warning Light on the console to illuminate and also causes the PTO (cutting deck) to shut down.

If engine coolant temperature rises to approximately 240ºF (115ºC), the high temperature shutdown circuit closes and causes the engine to shut down.

The Toro Electronic Controller (TEC) monitors the operation of the dual temperature switch. Before performing the following testing procedure, the switch and its circuit wiring **should** be tested as an electrical input using the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter).

Testing

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

CAUTION

Make sure engine is cool before removing the dual temperature switch from engine. Do not open radiator cap or drain coolant if the radiator or engine is hot. Pressurized, hot coolant can escape and cause burns.

2. Lower the coolant level in the engine and remove the dual temperature switch from the engine.

3. Put the end of the switch in a container of oil with a thermometer and slowly heat the oil (Fig. 72).

CAUTION

Handle the hot oil with extreme care to prevent personal injury or fire.

4. Check resistance of the switch with a multimeter (ohms setting) as the oil temperature increases.

   A. The high temperature warning circuit is normally open (high resistance) and should close (continuity) from 214 to 226F (101 to 108C).

   B. The high temperature shutdown circuit is normally open and should close from 234 to 246F (112 to 119C).

5. Replace the switch if either of the specifications is not met.

6. After testing is complete, install temperature switch to the engine housing.

   A. Clean threads of housing and switch thoroughly. Apply thread sealant to the threads of the switch.

   B. Thread switch into the housing. Torque switch from **22 to 28 ft−lb (30 to 38 N−m)**.

   C. Reconnect harness wires to temperature switch.

7. Fill engine cooling system. Lower and secure hood.

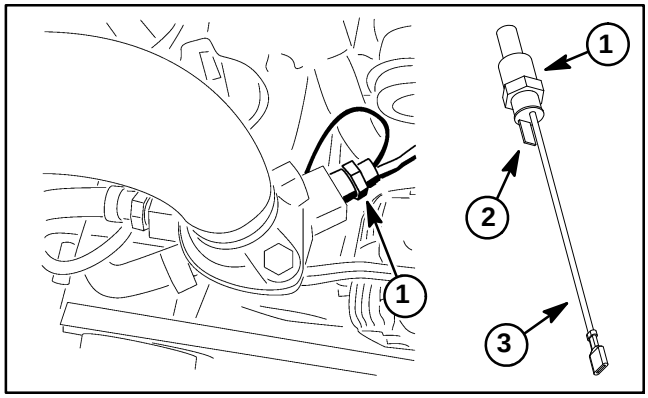


Figure 71

1. **Dual temp switch**
2. **Warning circuit**
3. **Shutdown circuit**

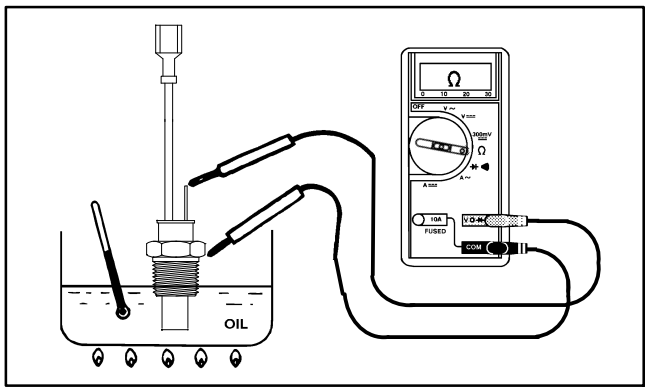


Figure 72

Oil Pressure Switch

The engine oil pressure switch is located on the engine near the oil filter (Fig.73). The oil pressure switch is a normally closed switch that opens with pressure.

The oil pressure switch should open at approximately 8 PSI (0.56 kg/cm^2).

On machines with 4WD, the TEC controller monitors the operation of the oil pressure switch. On these machines, the switch and its circuit wiring **should** be tested as a controller input with the Diagnostic Display (see Special Tools and Troubleshooting in this chapter).

If low engine oil pressure allowed the oil pressure switch to close during engine operation, the Diagnostic light can be used to identify the fault (see Diagnostic Light in the Troubleshooting section of this chapter).

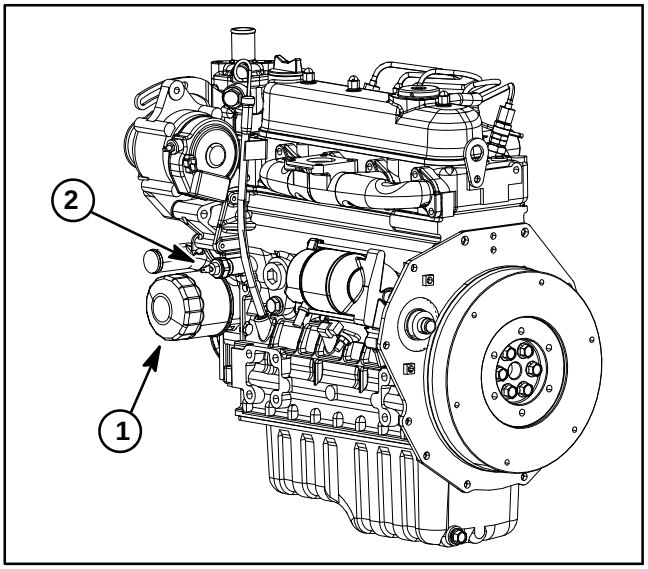


Figure 73

1. **Oil filter**
2. **Oil pressure switch**

Testing

NOTE: Refer to Kubota Workshop Manual, Diesel Engine, 05−E3B Series at the end of Chapter 3 − Kubota Diesel Engine for information regarding engine lubrication system and testing.

1. Turn the ignition switch to the RUN position. The oil pressure indicator light on the control panel should be illuminated.

2. If the indicator light is not illuminated, open hood to gain access to engine.

3. Locate oil pressure switch on engine and disconnect the wire harness connector from the switch.

4. With the ignition switch in the RUN position, ground the disconnected wire to the engine block.

5. If the indicator light comes on, the oil pressure switch is faulty. Replace oil pressure switch.

6. If the indicator light does not come on after step 5, check the oil pressure indicator light and circuit wiring (see Indicator Lights in this section).

7. After testing is completed, connect the wire harness connector to the oil pressure switch. Lower and secure hood.

Fuel Pump

The fuel pump is attached to the frame near the fuel filter (Fig. 74). Electrical current is available for the fuel pump when the ignition switch is in either the RUN or START position.

On 2WD machines, the Standard Control Module run output LED will be illuminated when the fuel pump is energized.

On 4WD machines, the Toro Electronic Controller (TEC) energizes the fuel pump.

IMPORTANT: When testing fuel pump, make sure that pump is not operated without fuel.

DANGER

Because diesel fuel is highly flammable, use caution when handling it. Do not smoke while testing the fuel pump. Do not test fuel pump while engine is hot. Make sure that there is adequate ventilation when testing. Always wipe up any spilled fuel before starting the engine.

Fuel Pump Capacity Test

1. Park machine on a level surface, lower cutting deck, stop engine and engage parking brake. Remove key from ignition switch. Raise and support operator seat and hood.

2. Disconnect wire harness electrical connector from the engine fuel stop solenoid to prevent the engine from starting (see Fuel Stop Solenoid in this section).

3. Disconnect fuel hose (fuel pump discharge) from the fuel/water separator inlet fitting (Fig. 74).

4. Make sure fuel hoses attached to the fuel pump, fuel filter and fuel tank suction tube screen are free of obstructions.

5. Place disconnected fuel hose into a large, graduated cylinder sufficient enough to collect 1 quart (0.95 liter).

IMPORTANT: When testing the fuel pump, DO NOT turn ignition switch to START.

6. Collect fuel in the graduated cylinder by turning ignition switch to the RUN position. Allow pump to run for fifteen (15) seconds, then turn ignition switch to OFF.

7. Fuel collected in the graduated cylinder should be approximately 16 fl oz (475 ml) after fifteen (15) seconds.

8. Replace fuel pump if necessary.

9. Install fuel hose to the fuel/water separator. Make sure to secure fuel hose with hose clamp.

10. Connect wire harness electrical connector to the engine fuel stop solenoid.

11. Bleed the fuel system.

12. Lower and secure operator seat and hood.

Fuel Pump Specifications

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

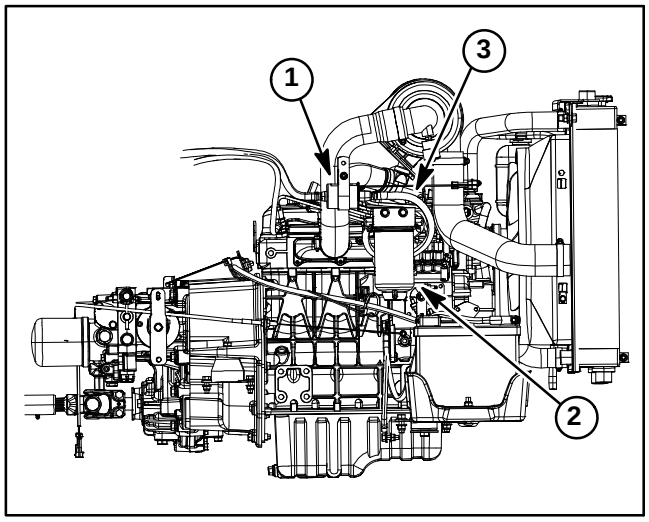


Figure 74

1. **Fuel pump**
2. **Fuel filter**
3. **Pump discharge hose**

Fuel Stop Solenoid

The fuel stop solenoid used on the Groundsmaster 360 must be energized for the diesel engine to run. The solenoid is mounted to the injection pump on the engine (Fig. 75).

The fuel stop solenoid includes two (2) coils for operation: the pull coil and the hold coil. When the ignition switch is turned to START, the fuel stop solenoid is initially energized and the pull coil retracts the solenoid plunger. Once the plunger is retracted, the hold coil will keep it retracted for continued engine operation. When the solenoid is de−energized, the plunger extends to shut off fuel supply to the engine causing the engine to stop running. The fuel stop solenoid is grounded through the solenoid housing.

On 2WD machines, the Standard Control Module run output LED will be illuminated when the fuel stop solenoid hold coil is energized.

NOTE: Refer to electrical drawings in Chapter 9 − Foldout Drawings when troubleshooting the fuel stop solenoid.

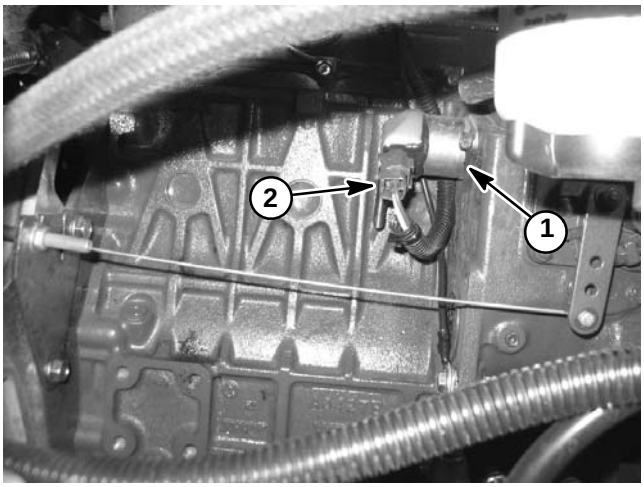


Figure 75

1. **Fuel stop solenoid**
2. **Harness connector**

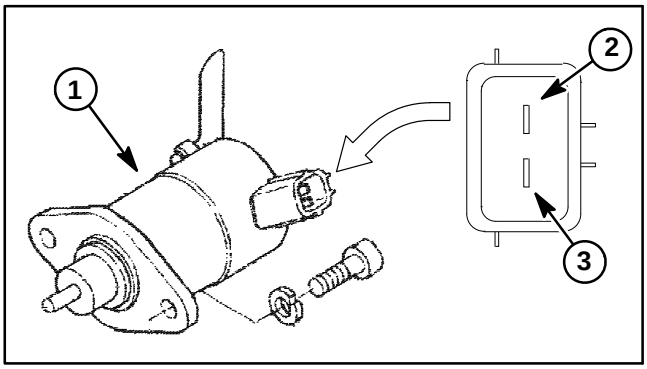


Figure 76

1. **Fuel stop solenoid**
2. **Pull coil terminal**
3. **Hold coil terminal**

In Place Testing

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

NOTE: Prior to taking small resistance readings with a digital multimeter, short the test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from the measured value of the solenoid being testing.

1. Make sure ignition switch is in the OFF position. Disconnect wire harness connector from fuel stop solenoid.

2. Using a digital multimeter, touch one test lead to the pull coil terminal and the other test lead to the fuel stop solenoid frame (ground) (Fig. 76). The resistance of the pull coil should be **less than 1 ohm (but not zero)**.

3. Using a digital multimeter, touch one test lead to the hold coil terminal and the other test lead to the fuel stop solenoid frame (ground) (Fig. 76). The resistance of the hold coil should be approximately **15 ohms**.

4. If resistance of either coil is incorrect, replace fuel stop solenoid.

5. Connect wire harness connector to fuel stop solenoid.

6. Lower and secure hood.

Glow Controller (2WD Machines)

On Groundsmaster 360 machines with 2WD, the glow controller is attached to the air cleaner bracket near the rear steering cylinder (Fig. 77).

NOTE: When troubleshooting the glow controller, refer to electrical drawings in Chapter 9 − Foldout Drawings.

Controller Operation

1. When the ignition switch is initially placed in the RUN position, the glow controller energizes the glow plugs for six (6) seconds. The console glow plug indicator light will also be illuminated for six (6) seconds.

2. When the ignition switch is turned to the START position, the glow plugs will energize as long as the switch is held in START. The console glow plug indicator light will **not** be illuminated.

3. When the ignition switch is released from the START to the RUN position, the glow plugs will de−energize and the console glow plug indicator light will remain off.

Controller Checks

1. Make sure there is electrical power from the battery.

2. Disconnect the wire harness electrical connector from the engine fuel stop solenoid to prevent the engine from starting.

3. Place ignition switch in the RUN position. Verify the following while in the RUN position:

   A. Glow plug indicator light is illuminated.

   B. Glow relay is energized.

   C. Glow plugs are energized.

   D. Glow plug indicator light goes out and glow plugs de−energize after approximately six (6) seconds.

4. Place ignition switch in the START position. Verify the following while in the START position:

   A. Glow plug indicator light is not illuminated.

   B. Glow relay is energized.

   C. Glow plugs are energized.

   D. Electrical power exists at terminal 1 of the glow controller.

NOTE: If there is no electrical power at terminal 1 of the glow controller, verify continuity of the circuitry from the ignition switch to the controller and perform Step 4 again (see Chapter 9 − Foldout Drawings).

5. If any of the conditions in Step 3 are not met or electrical power to terminal 1 exists and any of the other conditions in Step 4 are not met:

   A. Verify continuity of the circuitry from the battery to the glow relay and glow plugs (see Chapter 9 − Foldout Drawings).

   B. Verify continuity of the circuitry from the battery to ignition switch, glow controller, glow plug indicator light, glow relay and ground (see Chapter 9 − Foldout Drawings).

   C. Repair or replace components as necessary.

6. After testing is completed, connect wire harness electrical connector to the fuel stop solenoid.

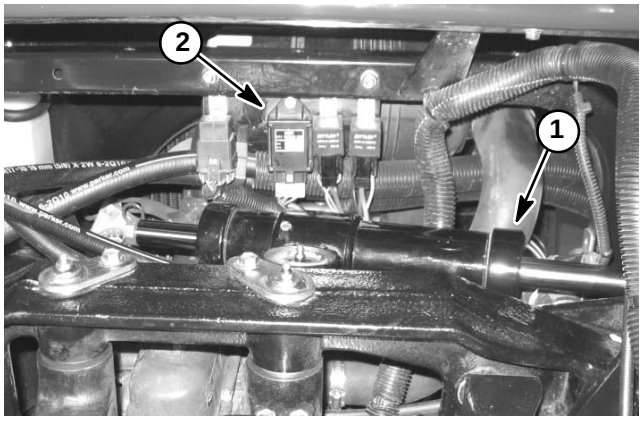


Figure 77

1. **Rear steering cylinder** 2. **Glow plug controller**

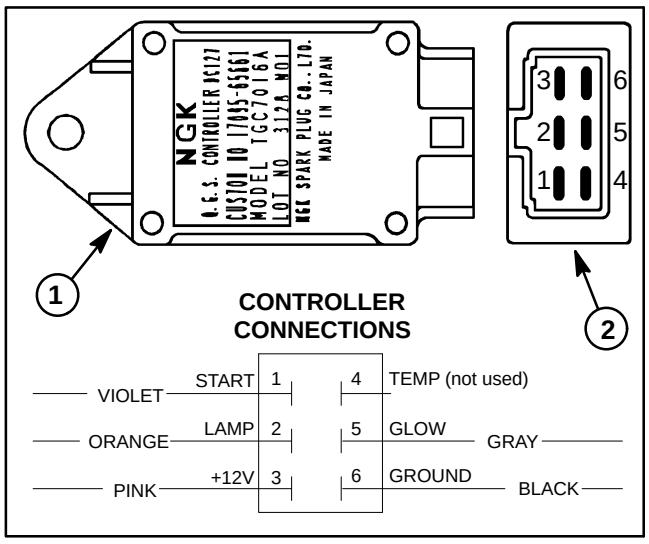


Figure 78

1. **Controller top view** 2. **Controller end view**

Service and Repairs

NOTE: For engine electrical component repair information, see the Kubota Workshop Manual, Diesel Engine, 05−E3B Series that is included after Chapter 3 − Kubota Diesel Engine.

PTO Solenoid Valve Coil

The PTO solenoid valve coil on the transmission (Fig. 79) can be replaced without opening the hydraulic system.

Removal

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

2. Raise and support the operator seat to access the PTO solenoid valve on the transmission.

3. Disconnect the wire harness electrical connector from the PTO solenoid valve coil connector.

4. Remove the nut from the spool assembly.

5. Slide the coil assembly from the solenoid valve stem (Fig. 80). For assembly purposes, note that “KANZAKI” molded into the coil has the “I” nearest the nut location as coil direction is important for proper solenoid operation.

6. Clean any corrosion or dirt from the valve stem.

Installation

1. Slide new coil assembly, seals and washers onto the solenoid valve stem. Make sure to properly position seals and washers (Fig. 80). Coil should be installed so the “KANZAKI” molded into the coil has the “I” nearest the nut location.

IMPORTANT: When securing solenoid valve coil to solenoid, do not over−tighten hex nut.

2. Install the hex nut onto the spool assembly and torque nut from **53 to 69 in−lb (5.9 to 7.8 N−m)**.

3. Connect the wire harness electrical connector to the solenoid valve coil connector.

4. Lower and secure operator seat.

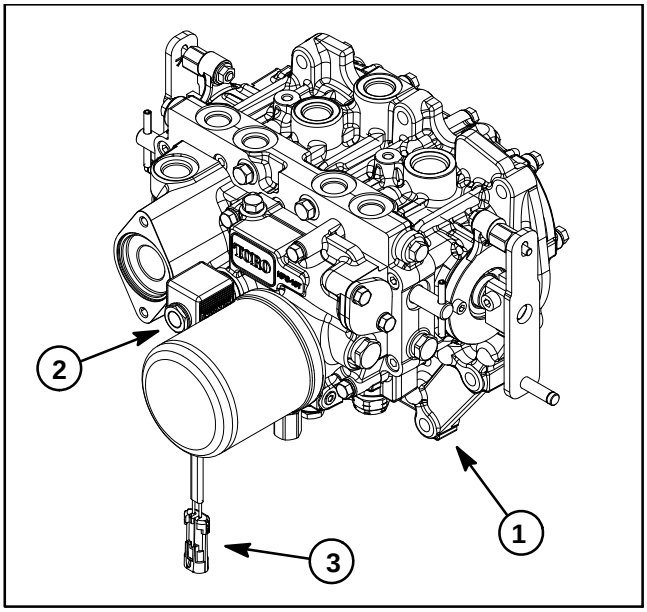


Figure 79

1. **Transmission**
2. **Solenoid valve and coil**
3. **Coil connector**

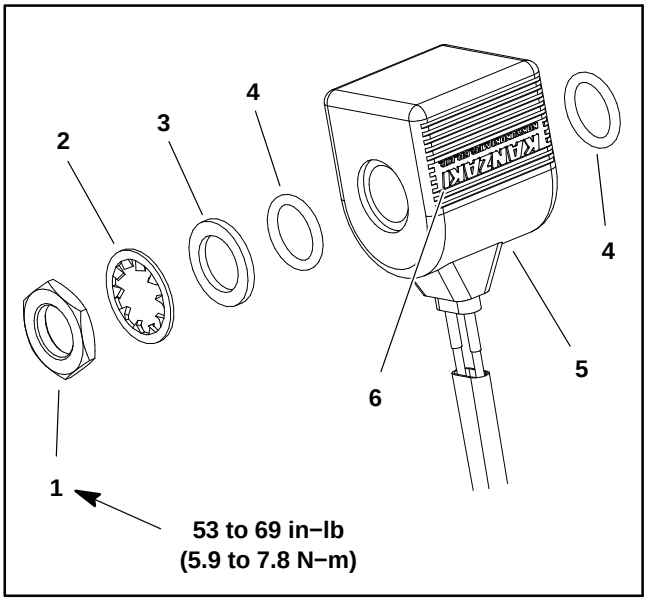


Figure 80

1. **Hex nut**
2. **Lock washer**
3. **Washer**
4. **Seal (2)**
5. **Solenoid valve coil**
6. **Letter I**

Hydraulic Manifold Solenoid Valve Coils

A hydraulic solenoid valve coil on the deck lift manifold (Fig. 81) or steering control manifold (machines with 4WD) (Fig. 82) can be replaced without opening the hydraulic system.

NOTE: The deck lift manifold solenoid valve coils on machines with serial number below 315000000 are identical (shown in Fig. 81). The coils on machines with serial number above 315000000 are different.

Removal

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

2. Locate the solenoid valve coil that is to be replaced.

   A. Raise and support operator seat to gain access to deck lift manifold. Refer to Figure 81 for solenoid coil locations on the deck lift manifold.

   B. Raise and support operator seat to gain access to steering control manifold used on 4WD machines. Refer to Figure 82 for solenoid coil location on the steering control manifold.

3. Disconnect the wire harness electrical connector from the solenoid valve coil to be removed.

4. Remove the nut from the hydraulic valve.

5. Slide the solenoid coil from the valve.

6. Clean any corrosion or dirt from the valve.

Installation

1. Slide coil assembly onto the hydraulic valve.

2. Install the nut onto the valve and torque nut to **60 in−lb (6.7 N−m)** (do not over−tighten).

3. Connect the machine wire harness connector to the solenoid coil.

4. Lower and secure seat.

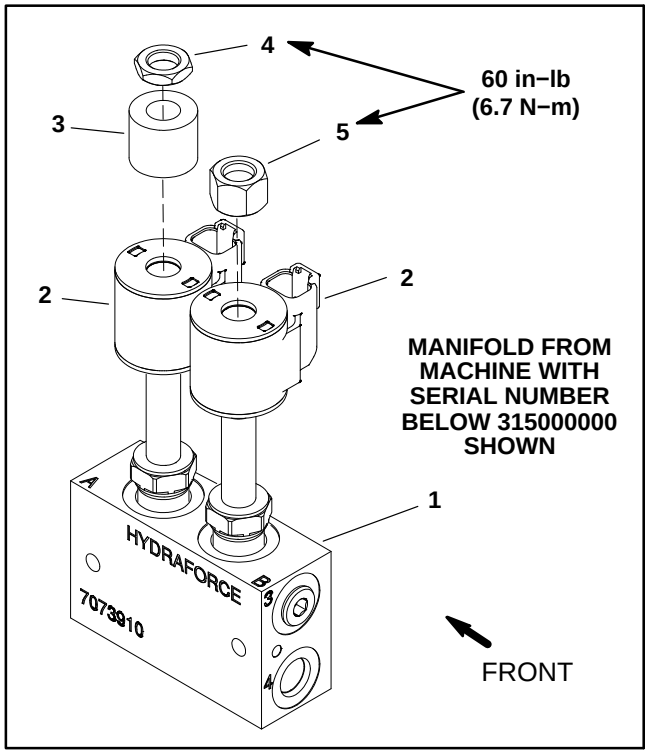


Figure 81

1. **Deck lift manifold**
2. **Solenoid coil (2)**
3. **Coil spacer**
4. **Nut**
5. **Nut**

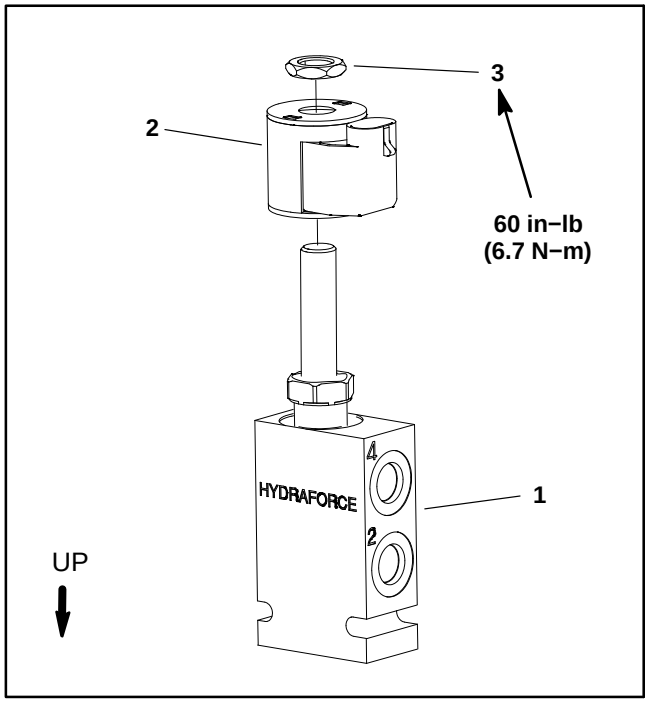


Figure 82

1. **Steering manifold**
2. **Solenoid coil**
3. **Nut**

Battery Storage

If the machine will be stored for more than thirty (30) days:

1. Make sure ignition switch is in the OFF position. 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 during storage, 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 battery 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.

2. Keep top of battery clean by washing periodically with a brush dipped in baking soda and water solution. Flush top surface with water after cleaning. Do not remove the fill caps while cleaning.

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

WARNING

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

4. If corrosion occurs at battery terminals, disconnect battery cables. Always disconnect negative (−) cable first. Clean cable clamps and terminals separately. Reconnect battery cables with positive (+) cable first. Coat terminals with battery terminal protector (Toro Part No. 107−0392) or a light coat of grease to reduce corrosion after connections are made.

5. Check battery electrolyte level every twenty five (25) operating hours and every thirty (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.

Battery Specifications

BCI Group 26 Battery
540 Amp Cranking Performance at 0F (−18C)
80 minute Reserve Capacity at 80F (27C)
Electrolyte Specific Gravity (fully charged): from 1.250 to 1.280
Electrolyte Specific Gravity (discharged): 1.240

Battery Removal and Installation (Fig. 83)

IMPORTANT: Be careful to not damage terminal posts or cable connectors when removing the battery cables.

1. Unlatch, raise and support hood.

2. Loosen and remove negative (−) cable from battery. After negative (−) cable is removed, loosen and remove positive (+) cable.

3. Loosen flange nut that secures battery retainer.

4. Carefully remove battery from machine.

5. Install battery in reverse order making sure to connect and tighten positive (+) cable to battery before connecting negative (−) cable. Use two (2) wrenches when tightening cables.

NOTE: Before connecting the negative (ground) cable to the battery, connect a digital multimeter (set to DC Amps) between the negative battery post and the negative (ground) cable connector. The reading should be less than 0.1 amp. If the reading is 0.1 amp or more, the machine's electrical system should be tested for short circuits or faulty components and repaired.

6. Lower and secure hood.

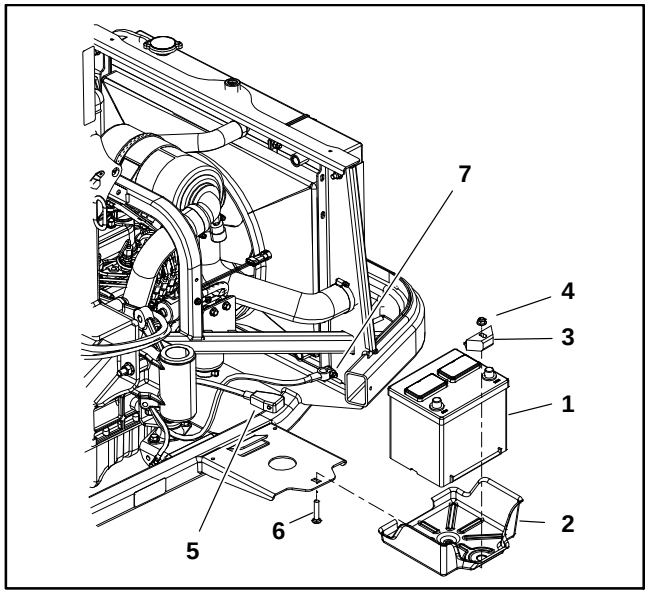


Figure 83

1. **Battery**
2. **Battery tray**
3. **Battery retainer**
4. **Flange nut**
5. **Positive cable**
6. **Carriage screw**
7. **Negative cable**

Battery Inspection and Maintenance

1. Check for cracks. Replace battery if 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 10F (5.5C) above 80F (27C) add 0.004 to the specific gravity reading. For each 10ºF (5.5C) below 80F (27C) subtract 0.004 from the specific gravity reading.

Example: Cell Temperature	100F
Cell Gravity	1.245
100F minus 80F equals 20F	
(38C minus 27C equals 11C)	
20F multiply by 0.004/10F equals 0.008	
(11C multiply by 0.004/5.5C equals 0.008)	
ADD (conversion above)	0.008
Correction to 80F (27C)	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 cannot be met, replace the battery.

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

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

CAUTION

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

A. Check the voltage across the battery terminals prior to testing the battery. If the voltage is less than 12.4 VDC, charge the battery before proceeding with test.

B. Make sure battery terminals are free of corrosion.

C. Measure the electrolyte temperature of the center battery cell.

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

E. If the battery has recently been charged, apply a 150 amp load for fifteen (15) seconds to remove the surface charge. Wait ten (10) minutes before proceeding with load test.

F. Apply a test load of 270 amps (one half of the battery cranking performance rating) for fifteen (15) seconds.

G. After test load has been applied for fifteen (15) seconds, take the test voltage reading and then remove the load. Record test voltage reading.

H. Using the table below, determine the minimum voltage based on the center cell electrolyte temperature reading.

Minimum Voltage	Battery Electrolyte Temperature	
9.6	70F (and up)	21C (and up)
9.5	60F	16C
9.4	50F	10C
9.3	40F	4C
9.1	30F	−1C
8.9	20F	−7C
8.7	10F	−12C
8.5	0F	−18C

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.

3. After connections are made, apply battery terminal protector (Toro Part No. 107−0392) or a light coat of grease on all battery posts and cable connectors to reduce corrosion.

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 should be available locally.

CAUTION

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

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

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

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

2. Determine the charging time and rate **using the manufacturer's battery charger 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 60F (15.5C) 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 manufacturer's instructions**, connect the charger cables to the battery posts. Make sure a good connection is made.

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

5. Occasionally check the temperature of the battery electrolyte. If the temperature exceeds 125F (52C) 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.

Chapter 6

Chassis

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Specifications

Item	Description
Rear tire pressure (all Groundsmaster 360 machines)	25 PSI (172 kPa)
Front tire pressure (machines without operator cab)	15 PSI (103 kPa)
Front tire pressure (machines with operator cab)	25 PSI (172 kPa)
Wheel lug nut torque	75 to 85 ft−lb (102 to 115 N−m)
Wheel hub lock nut torque	300 to 400 ft−lb (407 to 542 N−m)

General Information

Operator’s Manual

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

Special Tools

Order special tools from your Toro Distributor.

Wheel Hub Puller

The wheel hub puller allows safe removal of the wheel hub from the wheel motor shaft.

Toro Part Number: **TOR6004**

Figure 1

Steering Alignment Tools

The steering alignment tools are used to ensure that the front and rear steering assemblies are properly centered for steering assembly service. These tools are required for adjustment of wheel alignment or when replacing tie rods. The steering alignment tool kit includes the two (2) tools necessary for use on a machine. One of the tools centers the front steering assembly and one centers the rear. The tool kit also includes necessary hardware for attaching the tools to the machine.

Toro Part Number: **TOR6019**

The front alignment tool (TOR6019−1) requires the following hardware for attachment purposes:

1/2” − 13 x 1” cap screw (qty. 2) (Toro part #325−4)
1/2” − 13 x 2” cap screw (qty. 1) (Toro part #325−8)
1/2” nut (qty. 3) (Toro part #3217−9)

The rear alignment tool (TOR6019−2) requires the following hardware for attachment purposes:

3/8” − 16 x 1.25” cap screw (qty. 1) (Toro part #323−7)
3/8” nut (qty. 1) (Toro part #3217−7)
1/2” − 13 x 2” cap screw (qty. 1) (Toro part #325−8)
1/2” nut (qty. 1) (Toro part #3217−9)

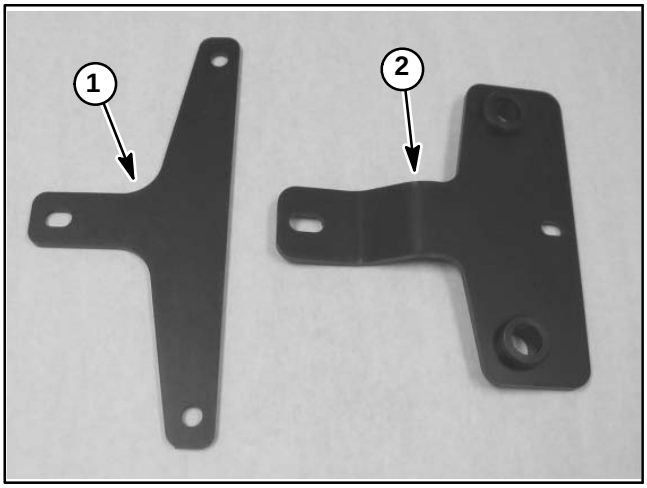

Figure 2

1. Front alignment tool **2. Rear alignment tool**

Adjustments

Brake Adjustment

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

NOTE: Adjustments to brake cables can be performed at two (2) places on the machine: under the footrest platform near the brake pedal assembly (Fig. 3) and also at the rear wheel (Fig. 4). Final brake cable adjustment is easiest to complete at rear wheel end of cable.

2. Adjust brake cables so that brake pedal has from 1/2" to 3/4" (13 to 19 mm) of free travel before wheel lock up is achieved.

3. After initial cable adjustment, sit in operator seat and apply full foot pressure to brake pedal and release pedal. Repeat this brake application five (5) to seven (7) times.

4. Check brake pedal free travel (step 2 above) and adjust brake cables if necessary.

CAUTION

After servicing the brakes, always check the brakes for proper operation in a wide open, level area that is free of other persons and obstructions.

5. Check brake operation before returning machine to operation.

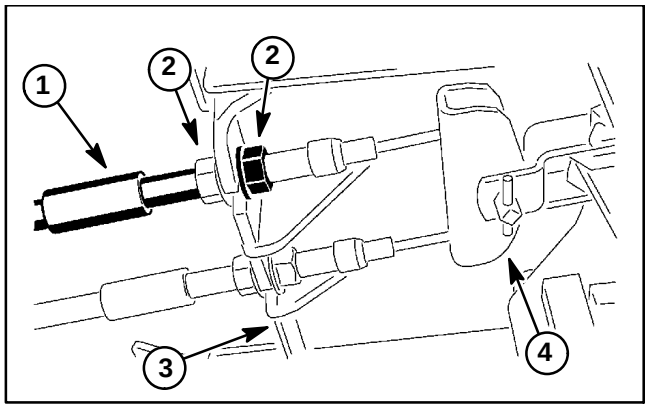

Figure 3

1. **Brake cable**
2. **Jam nut/washer**
3. **Platform bracket**
4. **Cable yoke**

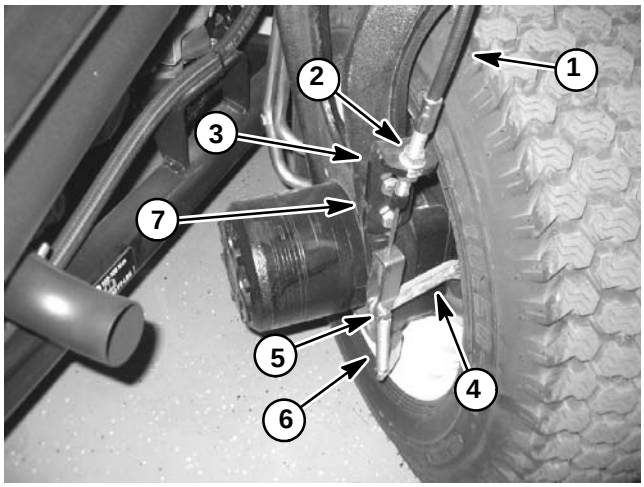

Figure 4

1. **Brake cable**
2. **Jam nut/washer**
3. **Brake bracket**
4. **Brake actuator lever**
5. **Clevis pin**
6. **Return spring**
7. **Bracket notch**

Steering Stop Adjustment

Proper adjustment of the steering stop bolts is necessary to allow full rotation of the wheels when steering your Groundsmaster 360.

1. Park machine on a level surface, lower cutting deck and engage parking brake. Make sure that the PTO switch is OFF.

2. Lubricate all grease fittings in front and rear steering assemblies.

3. Move the steering selector switch to the 2 wheel steer position which will allow the steering stops to be checked on the front axle.

   A. Rotate the steering wheel so that the front tires are fully turned in one direction. The front steering cylinder should extend or retract fully and the effort to turn the steering wheel should be consistent as the tires move to the fully turned position.

   B. If turning the steering wheel gets difficult as the tires turn fully and there is evidence that the steering system relief valve is opening, the cap screw on the front axle that acts as the stop needs to be adjusted.

   C. Loosen jam nut on the stop screw and adjust stop screw until system is no longer going over relief at full tire rotation. At the end of the steering cylinder stroke, the cylinder re−phasing check valve should allow the cylinder to stay extended without excessive circuit pressure.

   D. Turn the stop screw into the axle 1/2 turn and then tighten the jam nut. When the stop screw is properly adjusted, there should be a very small gap between the stop screw and the steering fork when the tires are fully turned in one direction.

   E. Repeat the above steps for the other direction of front wheel turning.

4. After the front axle stops are adjusted, move the steering selector switch to the 4 wheel steer position which will allow the steering stops to be checked on the rear axle. Follow the steps above to check and adjust the stops on the rear axle.

NOTE: If steering stops can not be adjusted using the above procedure, check that wheel alignment is correctly adjusted (see Wheel Alignment in this section). Also, carefully inspect all steering system components for wear or damage.

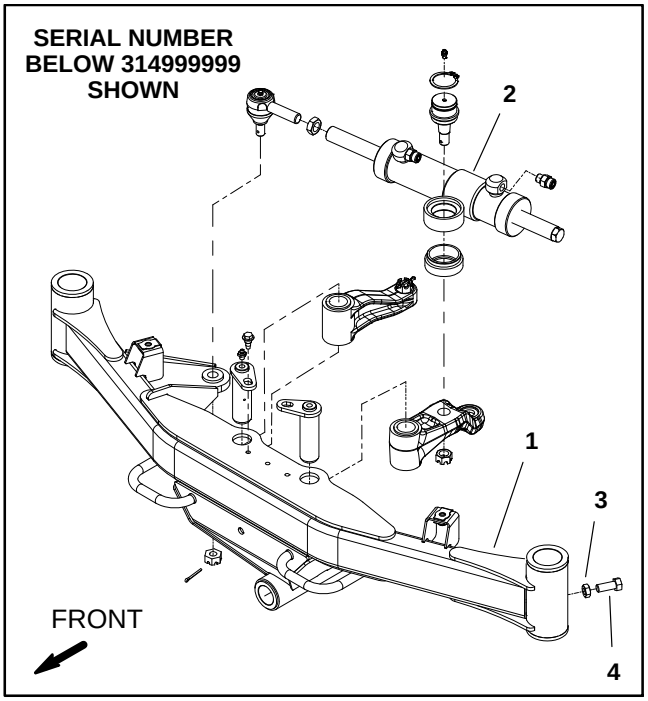

Figure 5

1. **Front axle**
2. **Steering cylinder**
3. **Jam nut (2)**
4. **Stop screw (2)**

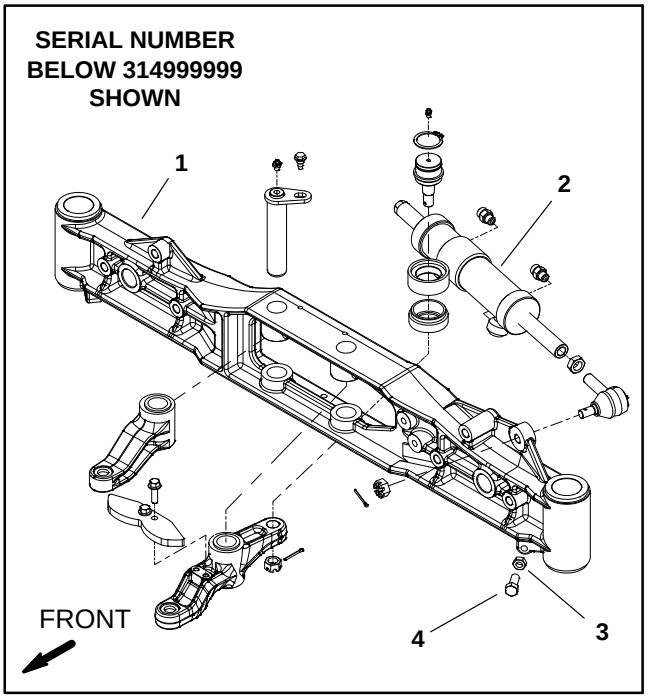

Figure 6

1. **Rear axle**
2. **Steering cylinder**
3. **Jam nut (2)**
4. **Stop screw (2)**

Wheel Alignment

1. Park machine on a level surface with the wheels directed straight ahead. Lower cutting deck, stop engine, engage parking brake and remove key from the ignition switch.

2. Make sure that all tire pressures (front and rear) are properly adjusted before checking or adjusting wheel alignment (see Specifications in this chapter).

3. Remove front cover from front axle to allow access to front steering components (Fig. 7).

4. Remove the storage compartment behind operator seat to allow access to rear steering components (see Storage Compartment Removal in the Service and Repairs section of this chapter or, if machine is equipped with operator cab, see Storage Compartment Removal in the Service and Repairs section of Chapter 8 − Operator Cab).

CAUTION

Before raising the machine, review and follow Jacking Instructions in Chapter 1 − Safety.

5. Jack up machine so all four (4) wheels are off the ground. Support raised machine with appropriate jack stands.

6. Make sure that the steering cylinder rod ends (both front and rear) are properly installed. The distance from the end of the cylinder shaft to the center of the rod end grease fitting should be 1.750" (44.5 mm) (Fig. 12). If needed, loosen jam nut and adjust location of rod end. If adjustment is made, torque jam nut from **83 to 101 ft−lb (113 to 136 N−m)**.

NOTE: Installation of steering alignment tools (see Special Tools in this chapter) to machine ensures that steering components are properly centered to machine so that correct wheel alignment can be achieved.

IMPORTANT: After installation of either of the steering alignment tools, DO NOT rotate the steering wheel. Rotating the steering wheel with either or both of the alignment tools in place will damage the tools.

7. Secure rear alignment tool (see Special Tools in this chapter) to rear axle and center link (Fig. 8). If necessary, use steering wheel to align rear steering components with alignment tool before securing tool to machine.

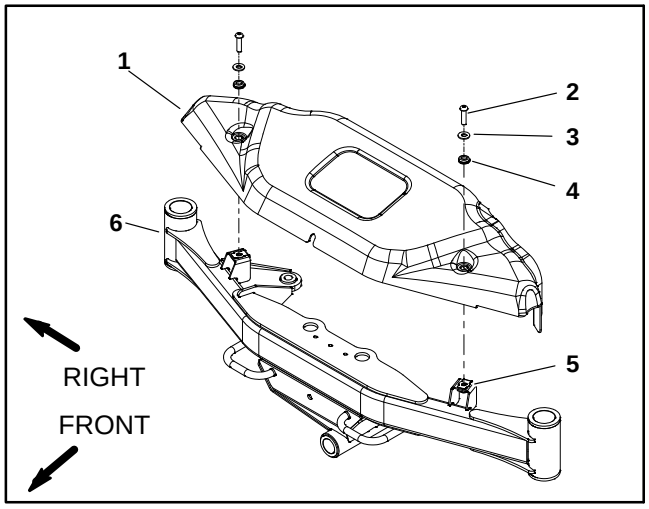

Figure 7

1. **Front cover**
2. **Screw (2)**
3. **Flat washer (2)**
4. **Grommet (2)**
5. **Tinnerman nut (2)**
6. **Front axle**

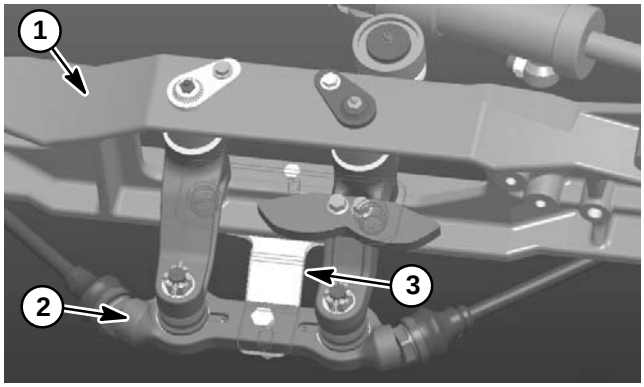

Figure 8

1. **Rear axle**
2. **Rear center link**
3. **Rear alignment tool**

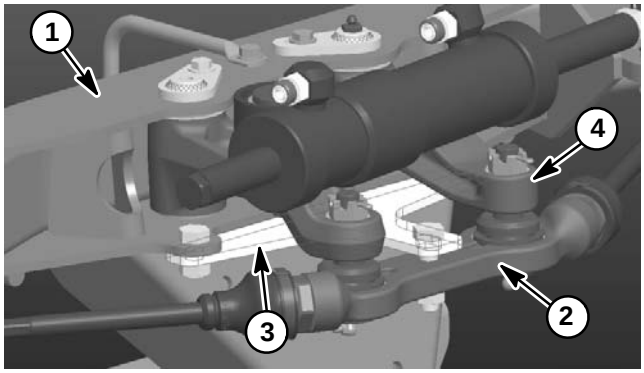

Figure 9

1. **Front axle**
2. **Front center link**
3. **Front alignment tool**
4. **Front steering arm**

8. Secure front alignment tool (see Special Tools in this chapter) to front axle and center link (Fig. 9). If necessary to align front steering components with alignment tool, loosen hydraulic hoses on front steering cylinder to allow front cylinder movement independent of the rear steering cylinder. Then, use a large adjustable wrench to rotate front steering arm so that front steering components are aligned with alignment tool.

9. With both alignment tools installed, place a rigid straight edge (e.g. angle iron, metal pipe) that is at least 80 inches (2 meters) long against the sides of the front and rear tires on one side of the machine (Fig. 10). The straight edge should contact the tires at four (4) points if the wheel alignment is correct.

10. If straight edge does not contact the tires at four (4) points, adjustments to tie rods are necessary to align wheels (Fig. 11).

   A. Loosen jam nut on tie rod and rotate inner tie rod end to adjust wheel alignment.

   B. Repeat tie rod adjustment for front and rear wheels as needed.

   C. When front and rear wheels are aligned, tighten tie rod jam nuts.

11. After tie rod adjustment has been completed, make sure that straight edge contacts the front and rear tires at four (4) points. Repeat tie rod adjustment if necessary.

12. Using rigid straight edge, repeat steps 9 through 11 for other side of machine.

13. Once wheel alignment adjustment is correct for both sides of machine:

   A. Remove alignment tools from front and rear steering components.

   B. Makes sure that hydraulic hoses on front steering cylinder are properly tightened.

   C. Install storage compartment behind operator seat (see Storage Compartment Installation in the Service and Repairs section of this chapter or, if machine is equipped with operator cab, see Storage Compartment Installation in the Service and Repairs section of Chapter 8 − Operator Cab).

   D. Install front cover to front axle (Fig. 7).

   E. Lower machine to ground.

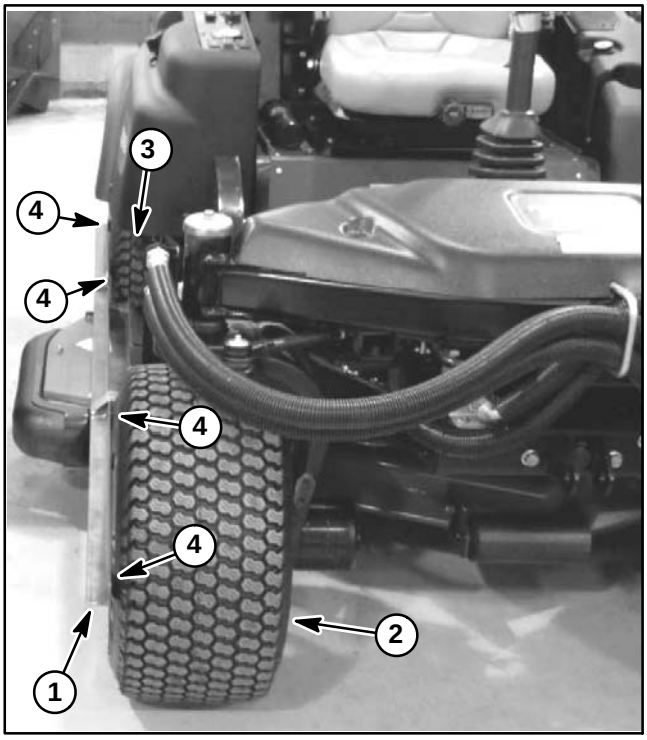

Figure 10

1. **Straight edge**
2. **Front wheel**
3. **Rear wheel**
4. **Tire contact point**

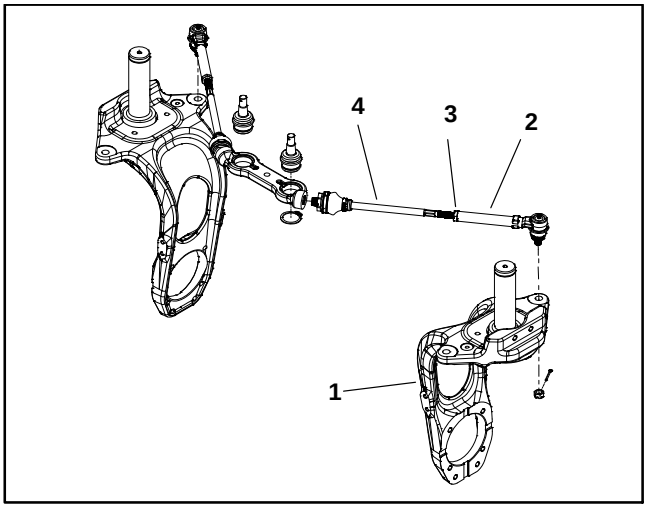

Figure 11

1. **Steering fork (rear)**
2. **Outer tie rod end**
3. **Jam nut**
4. **Inner tie rod end**

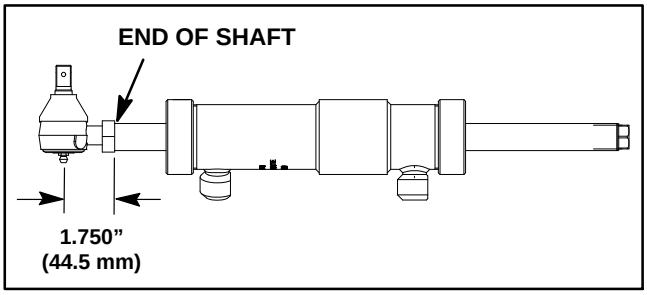

Figure 12

Wheels

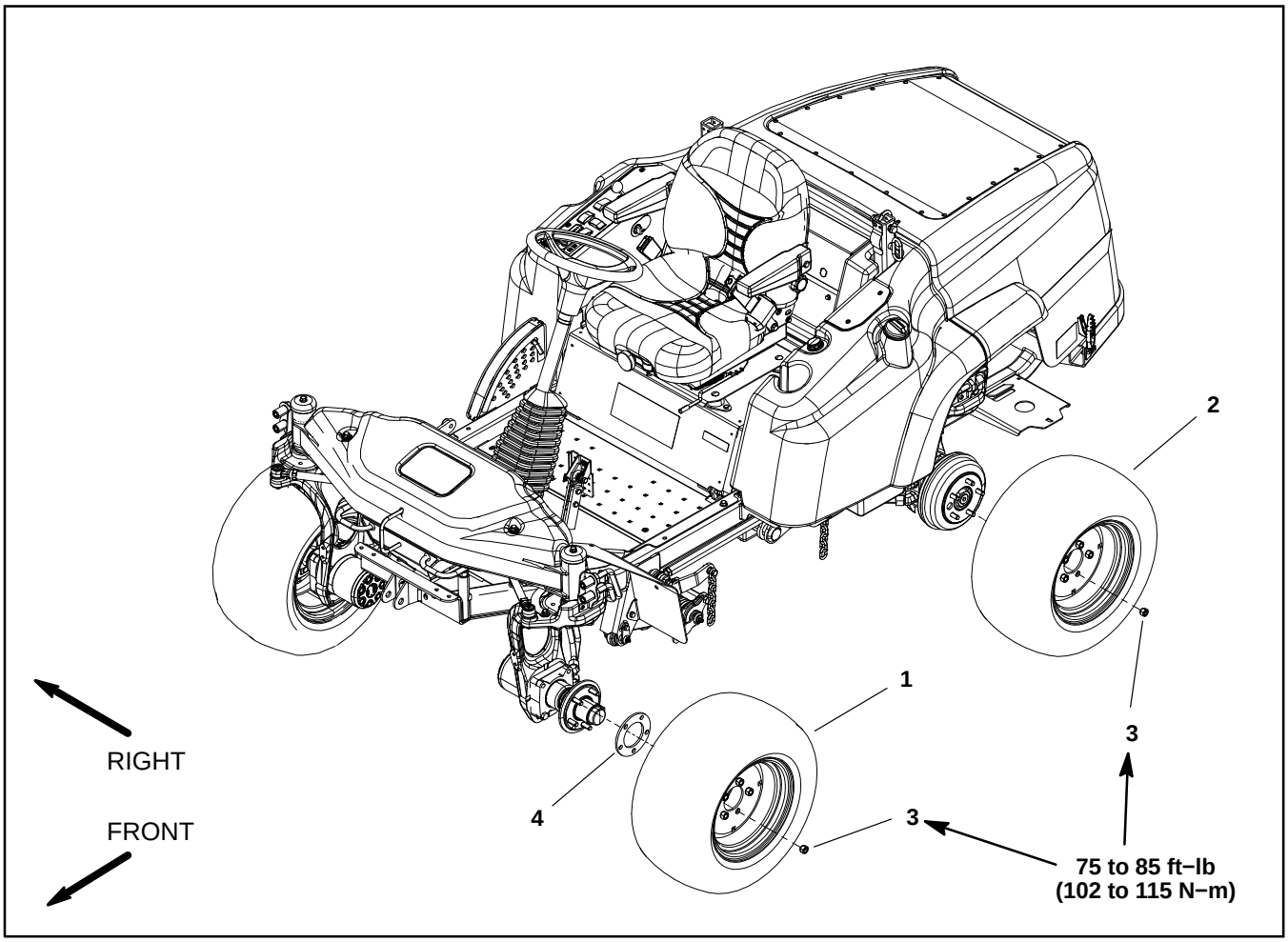

Figure 13

1. **Front wheel**
2. **Rear wheel**
3. **Lug nuts (5 used per wheel)**
4. **Front wheel spacer**

Removal (Fig. 13)

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

2. Chock wheels to prevent machine from shifting.

3. Loosen wheel lug nuts.

CAUTION

Before raising the machine, review and follow Jacking Instructions in Chapter 1 − Safety.

4. Using a jack, raise machine so wheel is off ground (see Jacking Instructions in Chapter 1 − Safety). Support machine with jack stands.

5. Remove lug nuts and then remove wheel from machine.

6. If front wheel was removed, locate and retrieve front wheel spacer.

Installation (Fig. 13)

1. If front wheel was removed, position front wheel spacer to wheel hub.

2. Install wheel and secure with five (5) lug nuts.

3. Lower machine to ground.

WARNING

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

4. Torque lug nuts evenly in a crossing pattern from **75 to 85 ft−lb (102 to 115 N−m)**.

5. Check and adjust tire pressures (see Specifications in this chapter).

Brake Service

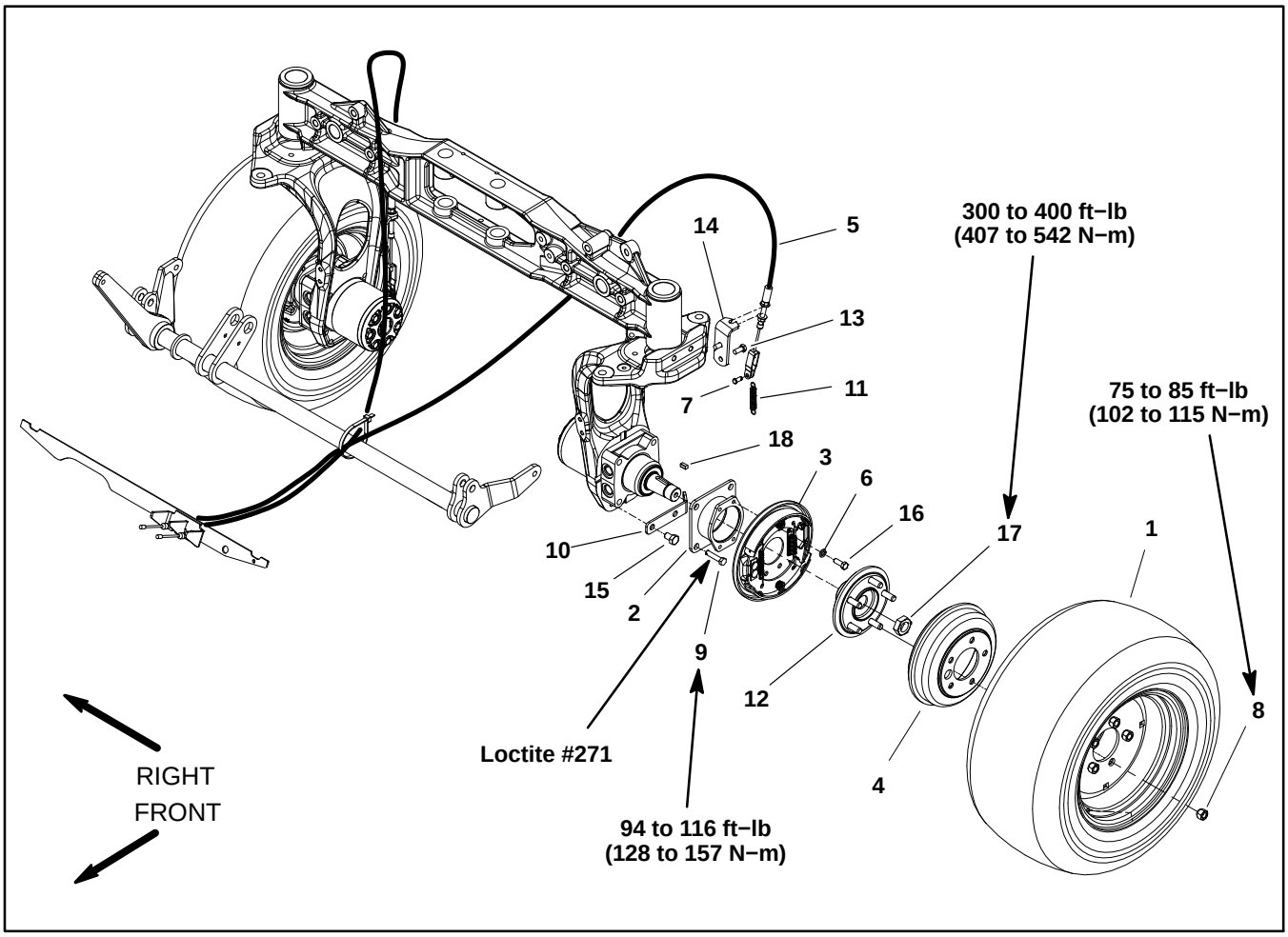

Figure 14

1. Rear tire (LH shown)
2. Brake support
3. Brake assembly (LH shown)
4. Brake drum
5. Brake cable (2)
6. Lock washer (4 per side)
7. Clevis pin
8. Lug nut (5 per wheel)
9. Cap screw (4 per side)
10. Return spring bracket
11. Brake return spring
12. Wheel hub
13. Cap screw (2 per bracket)
14. Brake bracket (LH shown)
15. Cap screw (2 per bracket)
16. Cap screw (4 per side)
17. Lock nut
18. Square key

Brake Disassembly (Fig. 14)

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

2. Chock front wheels to prevent machine from shifting.

3. Loosen, but do not remove, wheel lug nuts and lock nut (item 17) from rear wheel motor shaft.

4. Jack up rear of machine and remove rear wheel assembly (see Wheel Removal in this section). Make sure to support machine with jack stands.

5. Make sure parking brake is disengaged.

6. Remove brake return spring and clevis pin that secure brake cable to brake actuator lever. Position brake cable end away from lever.

7. Remove brake drum.

IMPORTANT: DO NOT hit wheel hub, puller or wheel motor with a hammer during wheel hub removal or installation. Hammering may cause damage to the wheel motor.

8. Make sure that lock nut on wheel motor shaft is loosened at least two (2) turns. Use hub puller (see Special Tools in this chapter) to loosen wheel hub from wheel motor.

9. Remove lock nut and wheel hub from motor shaft. Discard lock nut. Locate and retrieve square key.

NOTE: If desired, the complete brake assembly can be removed from the machine for disassembly (see step 12 below).

10. Remove both shoe springs from brake shoes.

11. Remove shoe hold down cups and hold down springs. Remove brake shoes and hold down pins from backing plate.

12. If necessary, remove brake backing plate from machine by loosening and removing four (4) cap screws (item 26) and lock washers (item 27).

Brake Assembly (Fig. 14)

1. Using a wire brush, remove rust and debris from all brake parts prior to installation. Clean all parts. Inspect brake shoe contact surfaces of the brake drum for excessive wear. Replace any worn or damaged parts.

2. If brake backing plate was removed from machine, secure backing plate to brake bracket with four (4) cap screws (item 26) and lock washers (item 27).

3. Lightly lubricate brake shoe pivot points with high temperature grease.

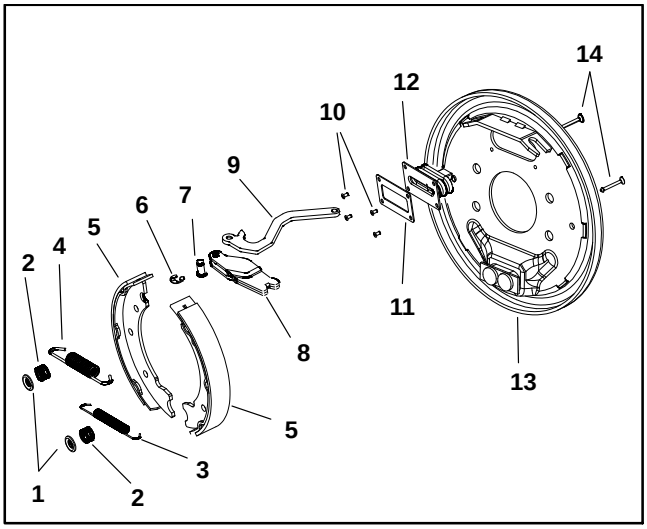

Figure 15

1. Hold down cup (2)
2. Hold down spring (2)
3. Shoe spring
4. Shoe spring
5. Brake shoe (2)
6. Retaining ring
7. Clevis pin
8. Brake actuator
9. Actuator lever
10. Rivet (4)
11. Back−up plate
12. Boot
13. Backing plate
14. Hold down pin (2)

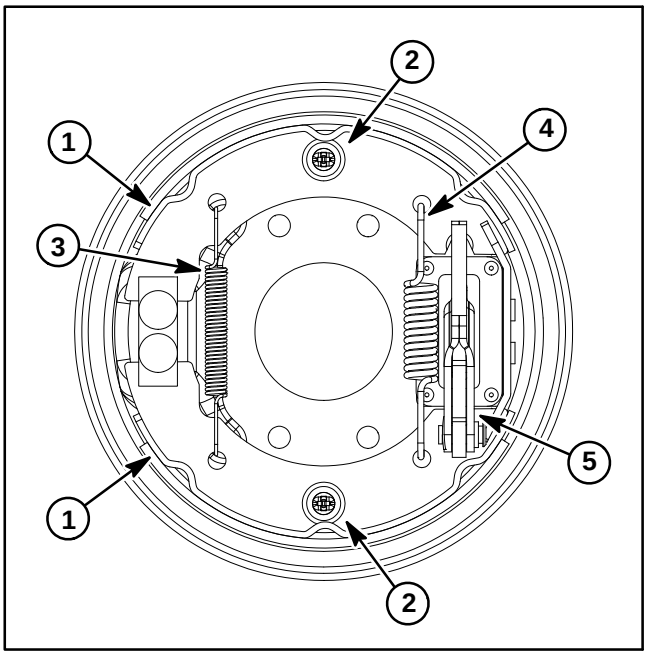

Figure 16

1. Brake shoe
2. Hold down components
3. Shoe spring
4. Shoe spring
5. Brake actuator

4. Position one brake shoe to the backing plate. Install brake hold down pin and secure with hold down spring and cup. Repeat for second brake shoe.

5. Install both shoe springs to brake shoes. Make sure that brake shoes are properly positioned to pivot and actuator points.

IMPORTANT: Before wheel hub is installed, thoroughly clean tapers of wheel hub and wheel motor shaft. Make sure that tapers are free of grease, oil, rust and dirt. Do not use antiseize lubricant when installing wheel hub.

6. Mount square key in the wheel motor shaft, then install the wheel hub onto the wheel motor shaft.

IMPORTANT: Do not reuse lock nut that secures wheel hub to wheel motor after it has been removed.

7. Install new lock nut (item 17) onto the wheel motor shaft to secure wheel hub to motor shaft.

8. Install brake drum.

9. Position brake cable end to brake actuator lever. Secure cable to actuator lever with clevis pin and return spring.

10. Install rear wheel assembly (see Wheel Installation in this section).

11. Check and adjust brakes (see Brake Adjustment in the Adjustments section of this chapter).

12. Lower machine to ground.

WARNING

Failure to properly torque wheel lug nuts and wheel hub lock nut could result in failure or loss of wheel and may result in personal injury.

13. Torque lug nuts evenly in a crossing pattern from **75 to 85 ft−lb (102 to 115 N−m)**. Torque lock nut (item 17) that secures wheel hub from **300 to 400 ft−lb (407 to 542 N−m)**.

CAUTION

After servicing the brakes, always check the brakes for proper operation in a wide open, level area that is free of other persons and obstructions.

14. Check brake operation before returning machine to operation.

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Brake Cables

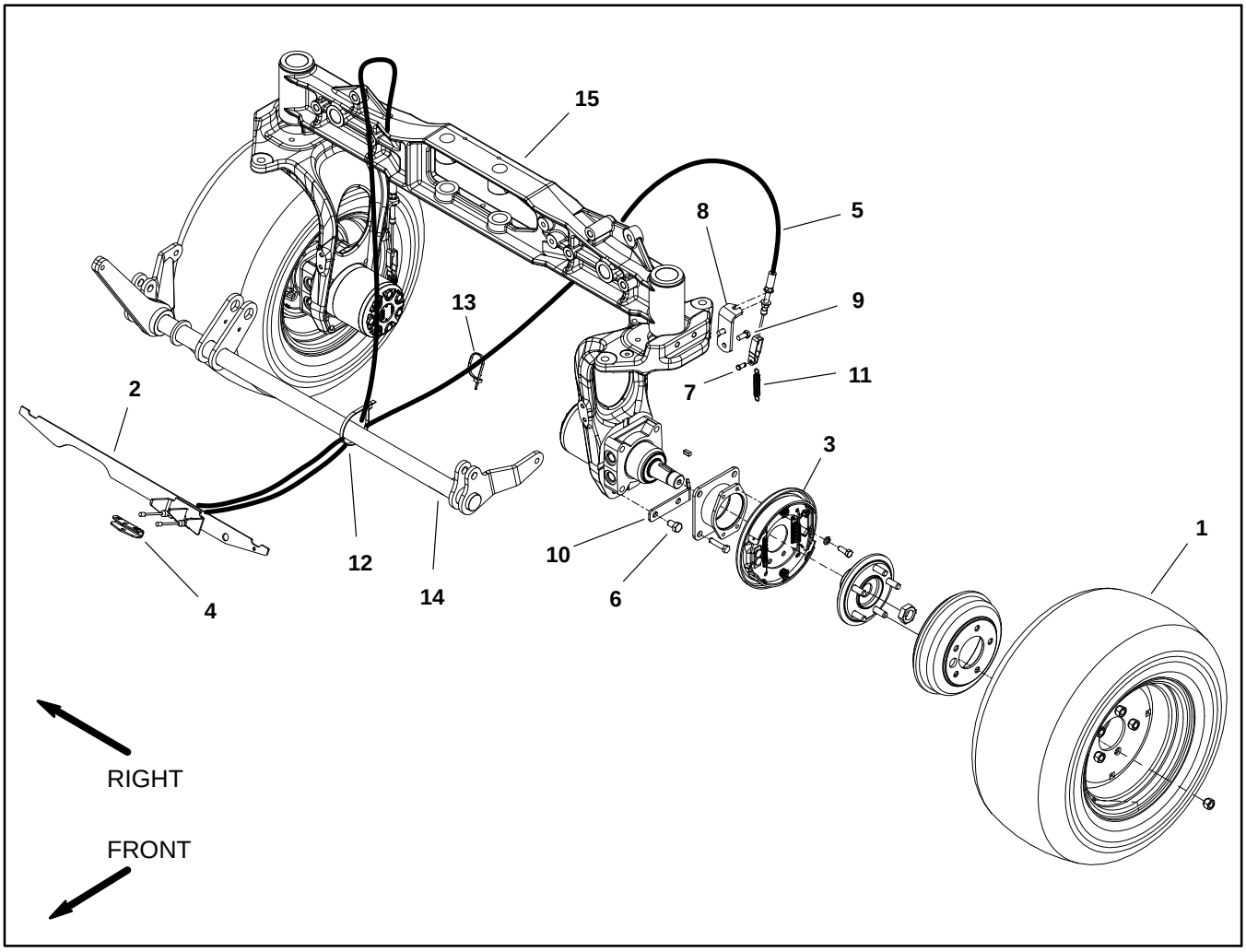

Figure 17

1. Rear tire (LH shown)
2. Operator platform bracket
3. Brake assembly (LH shown)
4. Cable yoke
5. Brake cable (2)
6. Cap screw (2 per bracket)
7. Clevis pin
8. Brake bracket (LH shown)
9. Cap screw (2 per bracket)
10. Return spring bracket
11. Brake return spring
12. Cable tie
13. Cable tie
14. Deck lift shaft
15. Rear axle

Brake Cable Removal (Fig. 17)

1. Park machine on a level surface, lower cutting deck, stop engine and remove key from the ignition switch. Make sure that parking brake is not applied.

2. Chock front wheels to prevent machine from moving.

3. Disconnect brake cable from front of machine:

   A. Loosen one of the jam nuts that secures brake cable to operator platform bracket.

   B. Separate cable from bracket.

   C. Remove cable end from cable yoke (item 4).

4. Disconnect brake cable from rear of machine:

   A. Remove return spring (item 11) and clevis pin (item 7) that secure brake cable to brake actuator lever.

   B. Loosen one of the jam nuts that secures brake cable to brake bracket (item 8).

5. Note location of cable ties and routing of brake cable for assembly purposes. Remove brake cable from machine.

Brake Cable Installation (Fig. 17)

1. Using notes taken during brake cable removal, position brake cable to machine.

NOTE: Brake bracket should have notch orientated toward machine frame (Fig. 18).

2. Connect brake cable to front of machine:

   A. Install cable end to cable yoke (item 4).

   B. Position brake cable to operator platform bracket.

   C. Tighten one of the jam nuts to secure brake cable to operator platform bracket.

3. Connect brake cable to rear of machine:

   A. Secure brake cable to brake actuator lever with clevis pin (item 7) and return spring (item 11).

   B. Position brake cable to brake bracket (item 8) and secure with jam nuts.

4. Secure brake cables to machine with cable ties in locations noted during cable removal.

5. Check and adjust brakes (see Brake Adjustment in the Adjustments section of this chapter).

CAUTION

After servicing the brakes, always check the brakes for proper operation in a wide open, level area that is free of other persons and obstructions.

6. Check brake operation before returning machine to operation.

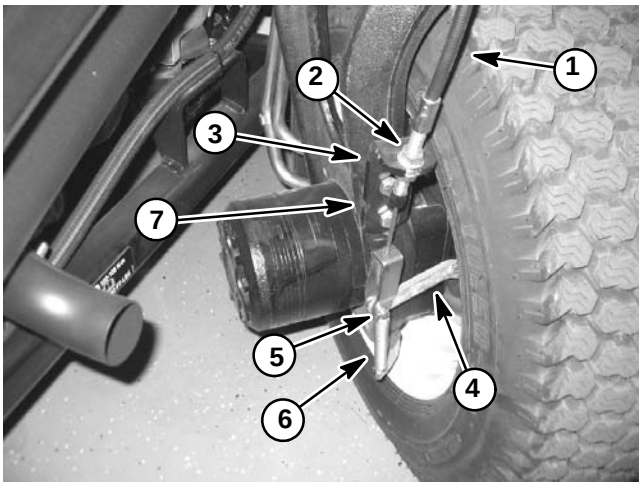

Figure 18

1. **Brake cable**
2. **Jam nut/washer**
3. **Brake bracket**
4. **Brake actuator lever**
5. **Clevis pin**
6. **Return spring**
7. **Bracket notch**

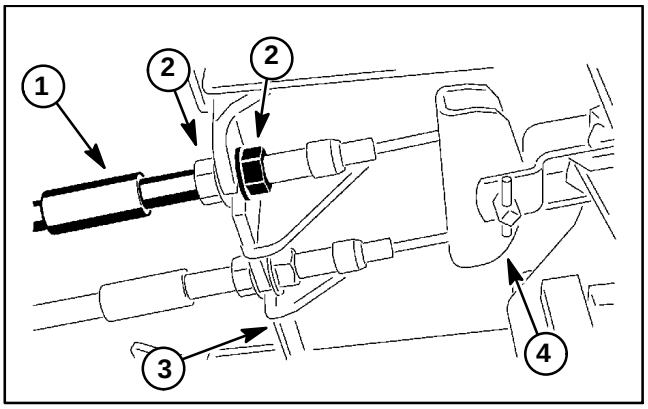

Figure 19

1. **Brake cable**
2. **Jam nut/washer**
3. **Platform bracket**
4. **Cable yoke**

Front Spindle Assembly (2WD Machines)

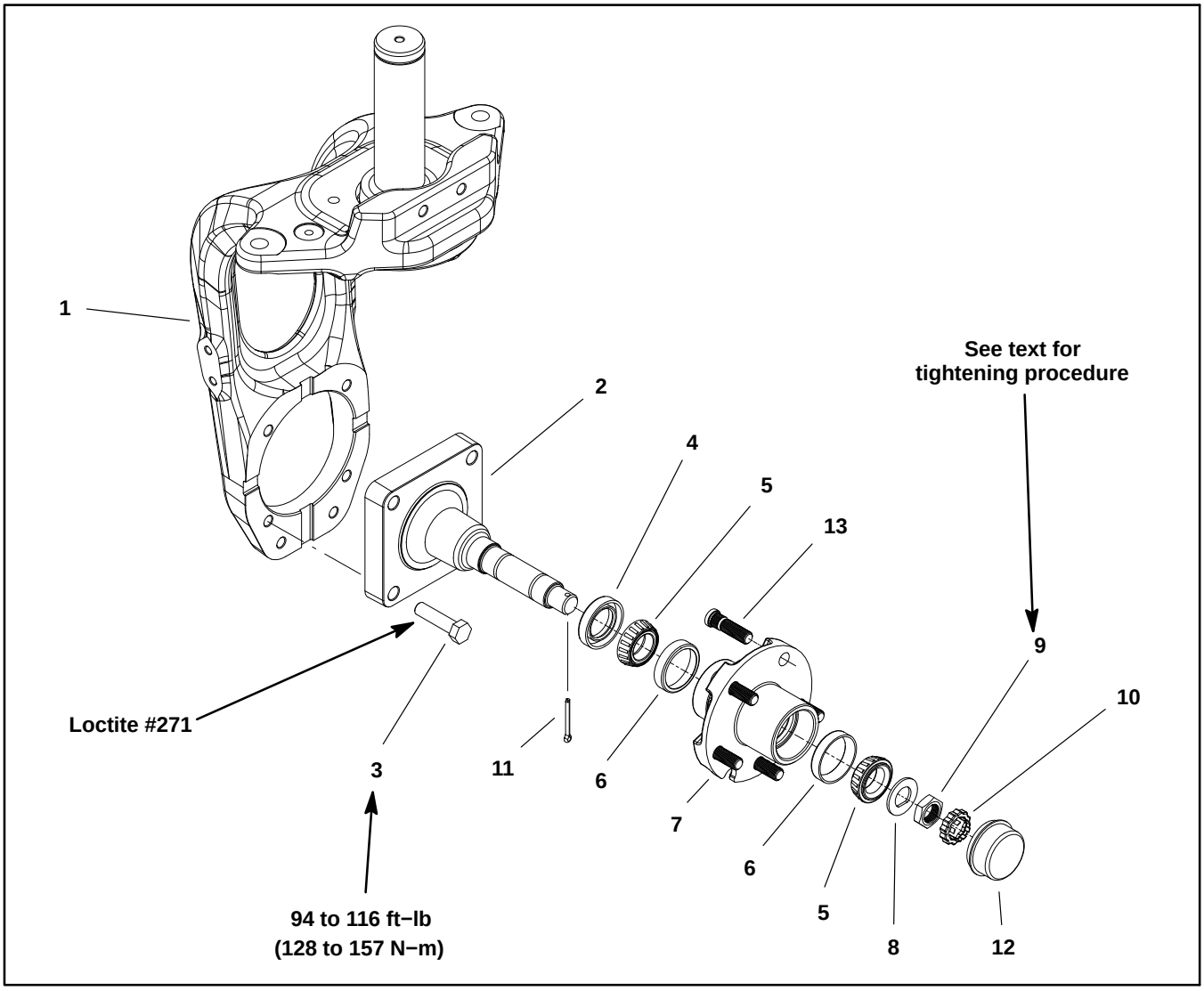

Figure 20

1. Steering fork assembly
2. Spindle
3. Cap screw (4)
4. Seal
5. Bearing cone
6. Bearing cup
7. Wheel hub
8. Spindle washer
9. Jam nut
10. Nut retainer
11. Cotter pin
12. Dust cap
13. Wheel stud (5 per hub)

Disassembly (Fig. 20)

1. Chock rear wheels to prevent machine from shifting.

2. Remove front wheel (see Wheel Removal in this section). Make sure to support machine with jack stands.

3. Remove the dust cap from the wheel hub.

4. Remove the cotter pin, nut retainer, jam nut and spindle washer. Slide the wheel hub from the spindle shaft.

5. Pull the seal (item 4) out of the wheel hub. Discard seal.

6. Remove the bearing cones from both sides of the wheel hub. Clean the bearings in solvent. Make sure the bearings are in good operating condition. Clean the inside of the wheel hub. Check the bearing cups for wear, pitting or other damage. Replace worn or damaged parts.

7. If wheel stud (item 13) removal is necessary, use press to extract stud(s) from wheel hub.

8. If necessary, remove four (4) cap screws (item 3) that secure spindle to steering fork assembly and remove spindle.

Assembly (Fig. 20)

1. If spindle was removed from steering fork assembly, apply Loctite #271 (or equivalent) to threads of cap screws (item 3). Secure spindle to steering fork with four (4) cap screws. Torque cap screws from **94 to 116 ft−lb (128 to 157 N−m)**.

2. If bearing cups were removed from the wheel hub, press new cups into the hub until they seat against the shoulder of the hub.

3. If any wheel studs were removed wheel hub, use a press to install new studs into hub. Make sure that stud shoulder is fully pressed against hub surface.

4. Pack both wheel bearing cones with grease.

5. Install one greased bearing into the bearing cup on inboard side of the wheel hub.

IMPORTANT: The lip of the seal must be toward the bearing. The seal should be pressed in so it is flush with the end of the wheel hub.

6. Lubricate the inside of a new seal (item 4) and press it into the wheel hub with the seal lip toward the bearing.

7. Fill wheel hub cavity between bearings approximately 50% full of grease. Position remaining greased bearing into the outer bearing cup.

8. Slide the wheel hub assembly onto the spindle shaft and secure it in place with the spindle washer and jam nut. DO NOT fully tighten the nut or install the cotter pin.

9. While rotating the wheel hub by hand, torque the jam nut from 75 to 100 in-lb (8.5 to 11.3 N−m) to set the bearings. Then, loosen the nut until the hub has endplay.

10. While rotating the wheel hub by hand, torque the jam nut from **15 to 20 in-lb (1.7 to 2.3 N−m)**. After tightening, make sure that the wheel hub does not have any free play.

11. Install nut retainer with slot aligned to cotter pin hole in spindle. Install cotter pin.

12. Fill dust cap approximately half full of grease. Install dust cap.

13. Install front wheel (see Wheel Installation in this section).

14. Lower machine to ground.

WARNING

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

15. Torque lug nuts evenly in a crossing pattern from **75 to 85 ft−lb (102 to 115 N−m)**.

Rear Steering Fork

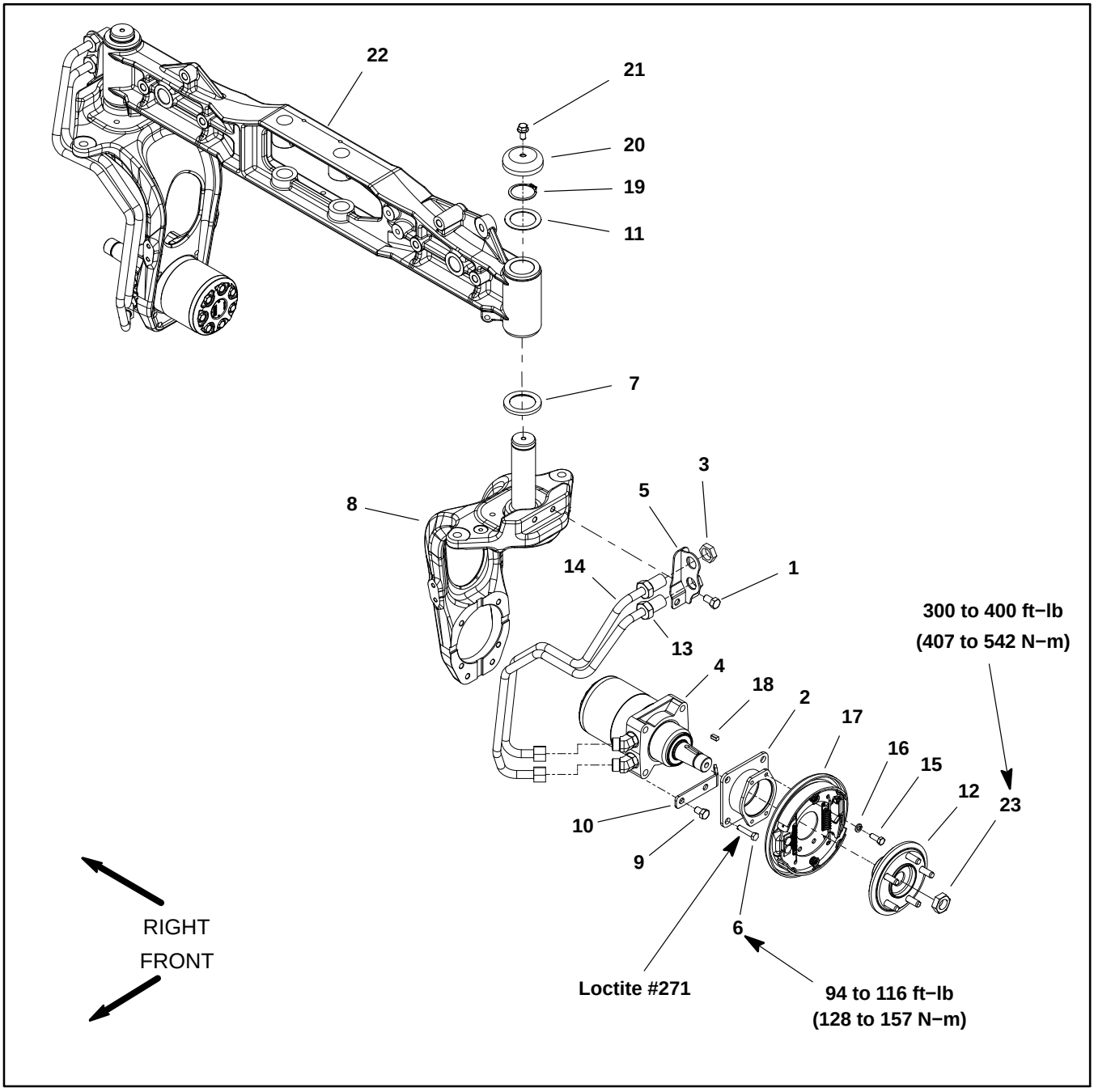

Figure 21

1. Cap screw (2 per bulkhead)
2. Brake support
3. Bulkhead nut (2 per bulkhead)
4. Wheel motor
5. Bulkhead bracket
6. Cap screw (4 per motor)
7. Thrust washer (0.250” thick)
8. Rear steering fork assembly
9. Cap screw (2 per bracket)
10. Spring bracket
11. Thrust washer (0.062” thick)
12. Wheel hub
13. Hydraulic tube
14. Hydraulic tube
15. Cap screw (4 per brake)
16. Lock washer (4 per brake)
17. Brake assembly
18. Square key
19. Retaining ring
20. Spindle cap
21. Flange head screw
22. Rear axle
23. Lock nut

NOTE: The rear steering fork assembly includes the brake assembly and wheel motor.

Removal (Fig. 21)

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

2. Chock wheels to prevent machine from shifting.

3. Loosen, but do not remove, wheel lug nuts and wheel motor shaft lock nut (item 23) at rear steering fork to be removed.

4. Jack up machine and support machine with jack stands (see Jacking Instructions in Chapter 1 − Safety).

5. Remove rear wheel assembly, brake drum, wheel hub (item 12) and brake assembly (item 17) from the machine (see Brake Service in this section).

6. Disconnect brake cable from brake actuator lever and brake bracket (Fig. 24) (see Brake Cables in this section). Position brake cable away from steering fork.

7. Remove cotter pin and slotted hex nut that secure tie rod end to the steering fork (Fig. 22). Separate tie rod end from the steering fork.

8. Remove two (2) cap screws (item 34) that secure bulkhead bracket (item 32) to steering fork.

9. Remove four (4) cap screws that secure wheel motor and brake support to steering fork. Slide wheel motor (with hydraulic lines attached) and brake support from steering fork. Carefully, position wheel motor assembly away from steering fork taking care to not damage hydraulic lines.

10. Support steering fork to prevent it from falling.

CAUTION

Support steering fork assembly when removing it to prevent it from falling and causing personal injury. Assembly weighs approximately 50 pounds (23 kg).

11. Remove the flange head screw (item 21), spindle cap (item 20) and retaining ring (item 19) that secure the steering fork shaft into the axle tube. Slide the steering fork out of the axle tube. Locate and retrieve thrust washers (items 7 and 11) from steering fork spindle.

12. Thoroughly clean the steering fork spindle. Inspect the shaft for wear and replace steering fork spindle if shaft is worn or damaged (Fig. 23). If spindle was removed from steering fork, torque cap screws from **94 to 116 ft−lb (128 to 157 N−m)** during assembly.

13. Clean and inspect flange bushings in axle. If bushings are worn or damaged, replace bushings (see Steering Assembly Bushing Service in this section).

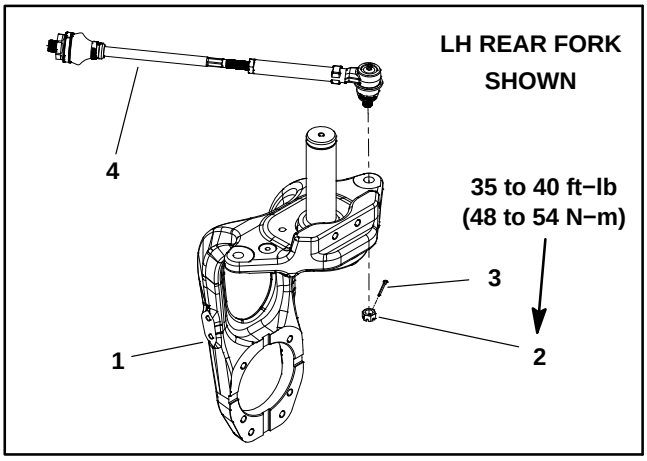

Figure 22

1. Rear steering fork
2. Slotted hex nut
3. Cotter pin
4. Tie rod

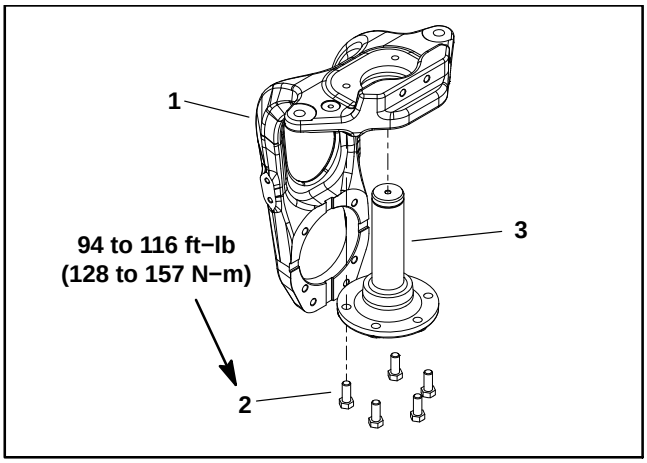

Figure 23

1. Steering fork
2. Cap screw (5)
3. Steering fork spindle

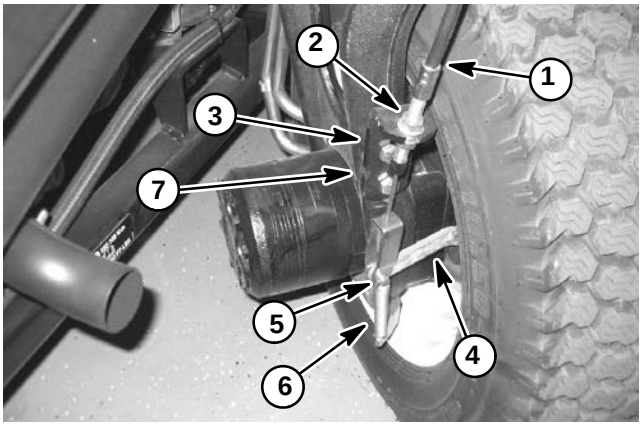

Figure 24

1. Brake cable
2. Jam nut/washer
3. Brake bracket
4. Brake actuator lever
5. Clevis pin
6. Return spring
7. Bracket notch

Installation (Fig. 21)

1. Apply a light coating of grease to steering fork spindle.

2. Install thrust washer (item 7) onto the steering fork spindle and slide the spindle up through the axle tube. Hold the steering fork in place and install the upper thrust washer (item 11) and retaining ring (item 19) onto the end of the spindle. Make sure that retaining ring is fully seated in spindle groove.

3. Place the spindle cap (item 20) to the top of the steering fork spindle and secure with flange head screw (item 21).

4. Secure wheel motor assembly and brake support to steering fork assembly:

   A. Position wheel motor assembly (with hydraulic hoses attached) and brake support to steering fork.

   B. Apply Loctite #271 (or equivalent) to threads of cap screws (item 6).

   C. Secure wheel motor and brake support to steering fork with four (4) cap screws and lock washers. Torque cap screws from **94 to 116 ft−lb (128 to 157 N−m)**.

   D. Secure bulkhead bracket (item 32) to steering fork with two (2) cap screws (item 34).

5. Connect the tie rod end to the steering fork and secure with slotted hex nut. Torque slotted hex nut from **35 to 40 ft−lb (48 to 54 N−m)**. If necessary, tighten nut further until slot in nut aligns with hole in tie rod ball joint stud. Install cotter pin.

NOTE: Brake bracket should have notch orientated toward machine frame (Fig. 24).

6. Install brake cable to brake actuator lever and brake bracket (Fig. 24) (see Brake Cables in this section).

7. Lubricate the steering fork spindle through the grease fitting on the axle. Grease should purge from ends of spindle identifying that grease cavity is completely filled. Wipe up excess grease.

8. Install brake assembly (item 17), wheel hub (item 12), brake drum and rear wheel assembly to the machine (see Brake Service in this section).

WARNING

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

9. Lower machine to ground and make sure that lug nuts are torqued evenly in a crossing pattern from **75 to 85 ft−lb (102 to 115 N−m)**. Torque lock nut (item 23) that secures wheel hub from **300 to 400 ft−lb (407 to 542 N−m)**.

10. Check and adjust wheel alignment (see Wheel Alignment in the Adjustments section of this chapter).

11. Check and adjust brakes (see Brake Adjustment in the Adjustments section of this chapter).

12. After all adjustments have been made, make sure that no contact is made between any machine components as the wheels are moved from lock to lock. Adjust if necessary.

CAUTION

Before returning the machine to operation, check the brakes for proper operation in a wide open, level area that is free of other persons and obstructions.

13. Check brake operation before returning machine to operation.

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Front Steering Fork

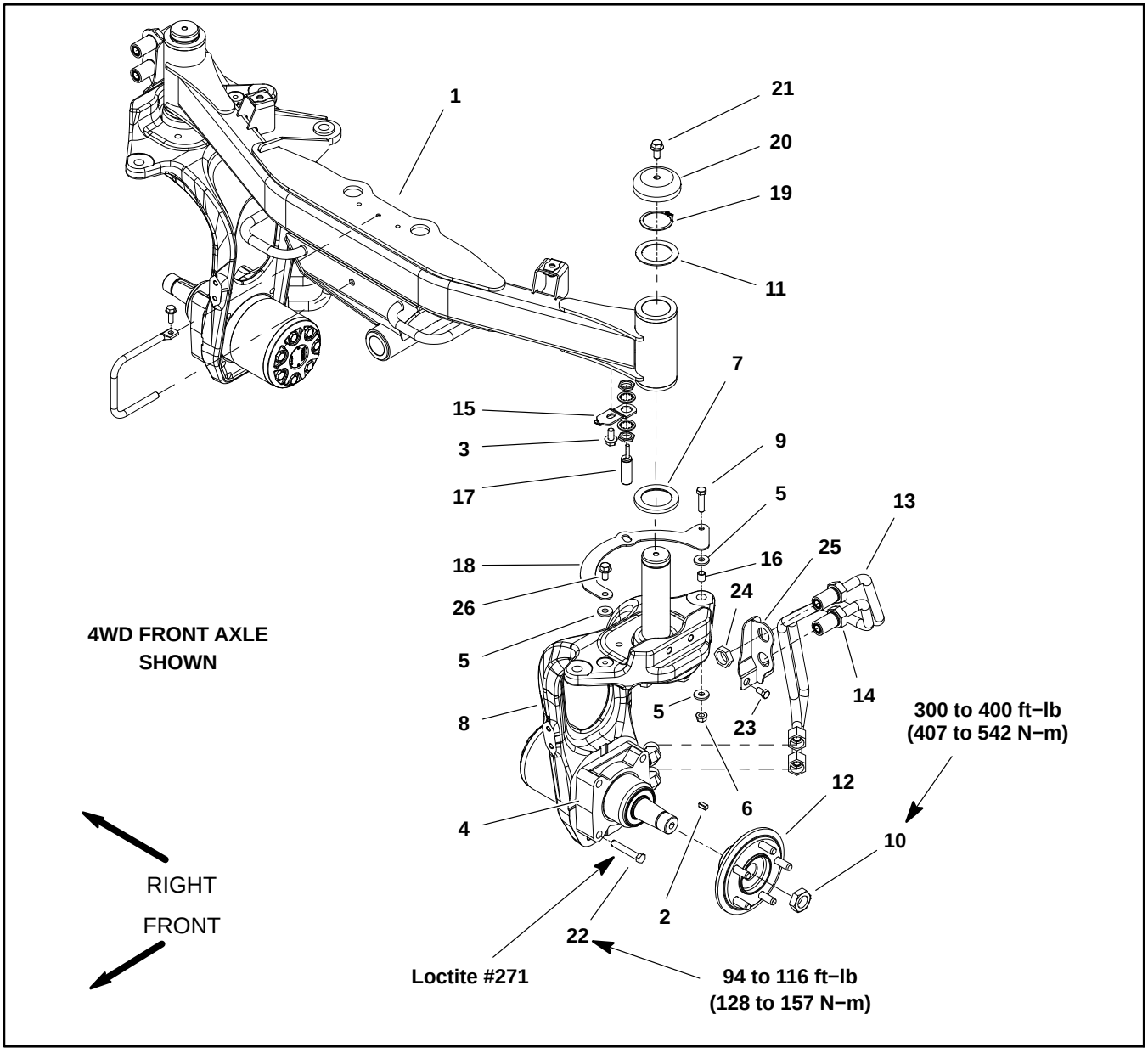

Figure 25

1. Front axle
2. Square key
3. Washer head screw
4. Wheel motor
5. Washer (3)
6. Flange nut
7. Thrust washer (0.250” thick)
8. Steering fork assembly
9. Cap screw
10. Lock nut
11. Thrust washer (0.062” thick)
12. Wheel hub
13. Hydraulic tube
14. Hydraulic tube
15. Sensor bracket
16. Spacer
17. Steering home sensor
18. Target bracket
19. Retaining ring
20. Spindle cap
21. Flange head screw
22. Cap screw (4)
23. Cap screw (2 per bracket)
24. Bulkhead nut (2 per bracket)
25. Bulkhead bracket
26. Flange head screw

NOTE: The front steering fork assemblies on 4WD machines include a wheel motor. The left front fork on 4WD machines (shown in Fig. 25) also includes a proximity sensor used by the TEC controller to determine when the front wheel is turned.

NOTE: The front steering fork assemblies on 2WD machines (shown in Fig. 26) include a spindle used to attach the wheel hub. The front steering fork on 2WD machines does not include a wheel motor nor a proximity sensor.

Removal (Fig. 25)

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

2. Chock wheels to prevent machine from shifting.

3. Loosen, but do not remove, wheel lug nuts on front wheel at steering fork to be removed.

4. Jack up machine and remove front wheel assembly (see Wheel Removal in this section). Make sure to support machine with jack stands.

5. Remove cotter pin and slotted hex nut that secure tie rod end to the steering fork (Fig. 27). Separate tie rod end from the steering fork.

6. If steering fork assembly includes a wheel motor:

   A. Remove two (2) cap screws (item 34) that secure bulkhead bracket (item 23) to steering fork.

   B. Remove four (4) cap screws that secure wheel motor to steering fork. Slide wheel motor assembly (with wheel hub and hydraulic lines attached) from steering fork. Carefully, position wheel motor away from steering fork taking care to not damage hydraulic lines.

7. Support steering fork to prevent it from falling.

CAUTION

Support steering fork assembly when removing it to prevent it from falling and causing personal injury. Assembly weighs approximately 50 pounds (23 kg).

8. Remove the flange head screw (item 21), spindle cap (item 20) and retaining ring (item 19) that secure the steering fork shaft into the axle tube. Slide the steering fork out of the axle tube. Locate and retrieve thrust washers (items 7 and 11) from steering fork spindle.

9. Thoroughly clean the steering fork spindle. Inspect the shaft for wear and replace steering fork spindle if shaft is worn or damaged (Fig. 28). If spindle was removed from steering fork, torque cap screws from **94 to 116 ft−lb (128 to 157 N−m)** during assembly.

10. Clean and inspect flange bushings in axle. If bushings are worn or damaged, replace bushings (see Steering Assembly Bushing Service in this section).

NOTE: On 2WD machines, if spindle or wheel hub requires removal or service, see Front Spindle Assembly (2WD Machines) in this section.

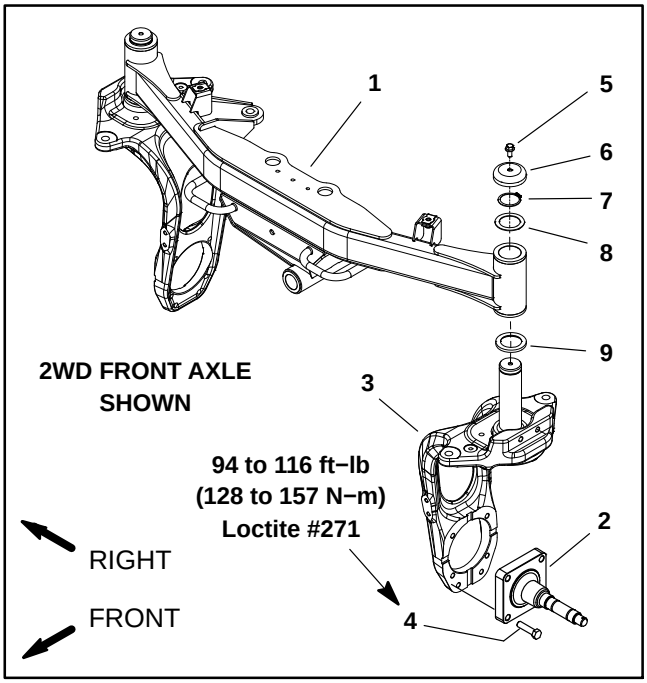

Figure 26

1. **Front axle**
2. **Spindle (2WD machines)**
3. **Steering fork assembly**
4. **Cap screw (4)**
5. **Flange head screw**
6. **Spindle cap**
7. **Retaining ring**
8. **Thrust washer**
9. **Thrust washer**

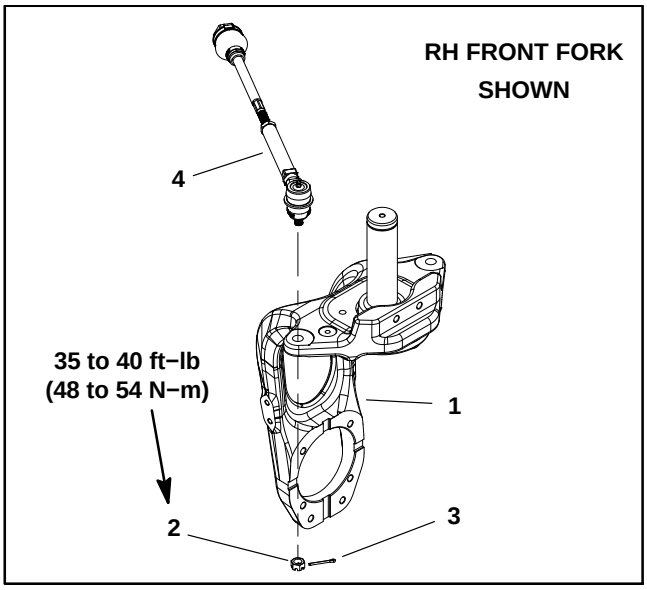

Figure 27

1. **Front steering fork**
2. **Slotted hex nut**
3. **Cotter pin**
4. **Tie rod**

Installation (Fig. 25)

1. Apply a light coating of grease to steering fork spindle.

2. Install thrust washer (item 7) onto the steering fork spindle and slide the spindle up through the axle tube. Hold the steering fork in place and install the upper thrust washer (item 11) and retaining ring (item 19) onto the end of the spindle. Make sure that retaining ring is fully seated in spindle groove.

3. Place the spindle cap (item 20) to the top of the steering fork spindle and secure with flange head screw (item 21).

4. If steering fork assembly includes a wheel motor:

   A. Slide wheel motor assembly (with wheel hub and hydraulic hoses attached) into steering fork.

   B. Secure wheel motor to steering fork with four (4) cap screws and lock washers. Torque cap screws from **94 to 116 ft−lb (128 to 157 N−m)**.

   C. Secure bulkhead bracket (item 32) to steering fork with two (2) cap screws (item 34).

5. Connect the tie rod end to the steering fork and secure with slotted hex nut. Torque slotted hex nut from **35 to 40 ft−lb (48 to 54 N−m)**. If necessary, tighten nut further until slot in nut aligns with hole in tie rod ball joint stud. Install cotter pin.

6. Lubricate the steering fork spindle through the grease fitting on the axle. Grease should purge from ends of spindle identifying that grease cavity is completely filled. Wipe up excess grease.

7. Install wheel assembly (see Wheel Installation in this section).

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 and make sure that lug nuts are torqued evenly in a crossing pattern from **75 to 85 ft−lb (102 to 115 N−m)**.

9. Check and adjust wheel alignment (see Wheel Alignment in the Adjustments section of this chapter).

10. After all adjustments have been made, make sure that no contact is made between any machine components as the wheels are moved from lock to lock. Adjust if necessary.

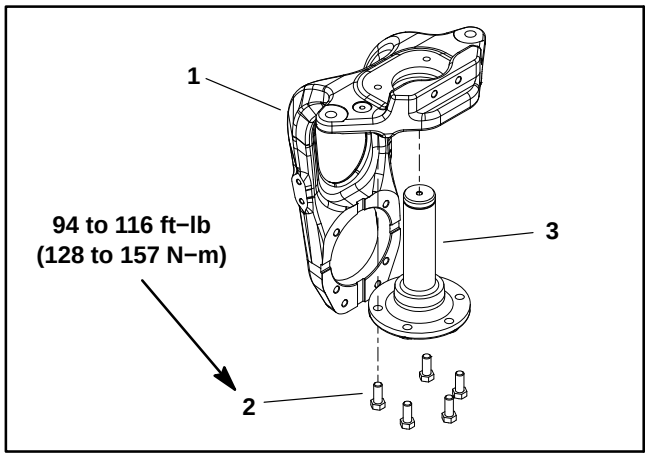

Figure 28

1. **Steering fork**
2. **Cap screw (5)**
3. **Steering fork spindle**

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Front Steering Assembly

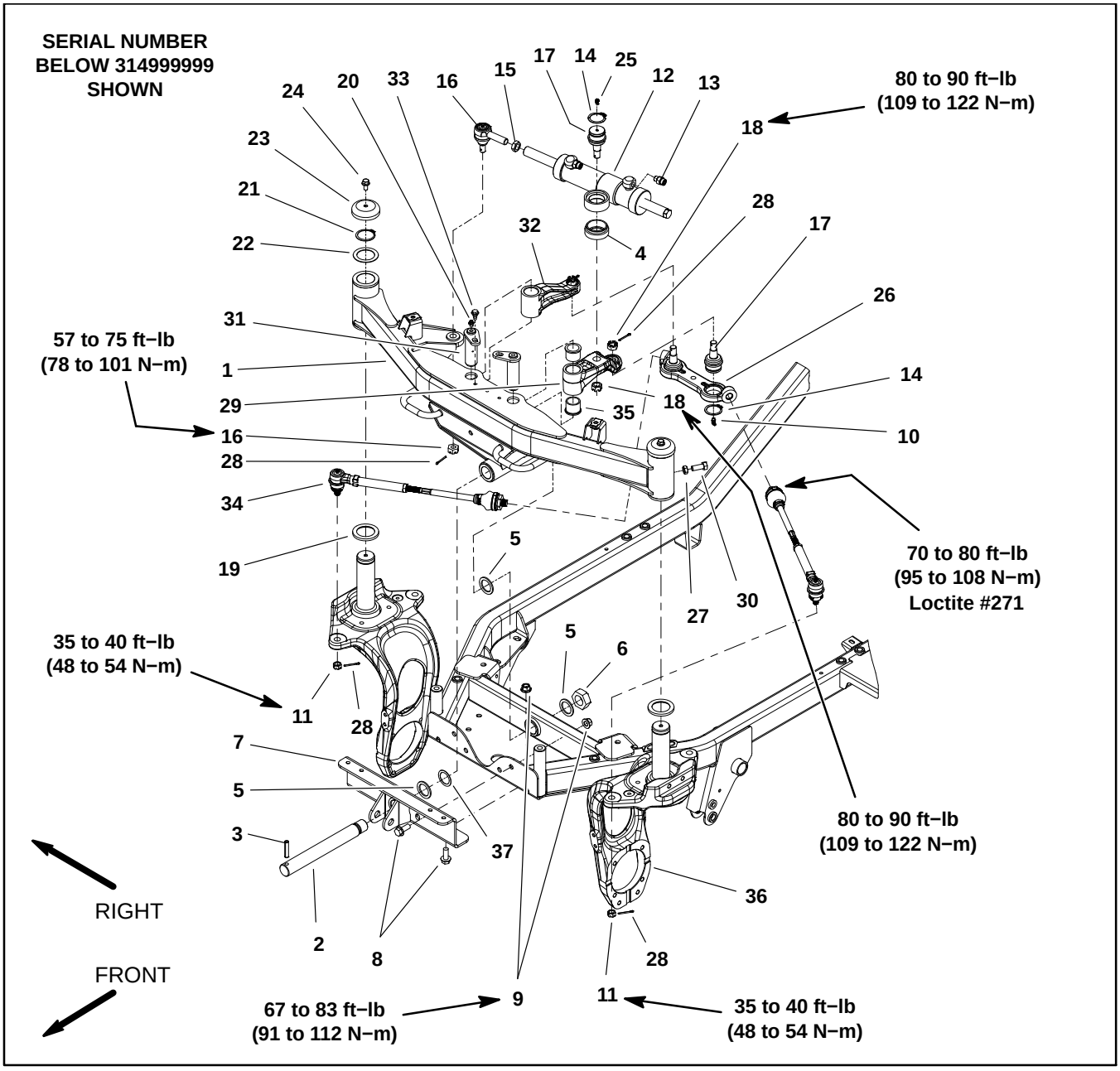

Figure 29

1. Front axle
2. Pivot shaft
3. Slotted roll pin
4. Cylinder spacer
5. Thrust washer (3)
6. Lock nut
7. Axle support
8. Flange head screw (6)
9. Lock nut (6)
10. Grease fitting (2)
11. Slotted hex nut (2)
12. Steering cylinder
13. Straight hydraulic fitting (2)
14. Retaining ring (3)
15. Jam nut
16. Tie rod end
17. Ball joint (3)
18. Slotted hex nut (3)
19. Thrust washer (2)
20. Grease fitting (2)
21. Retaining ring (2)
22. Thrust washer (2)
23. Spindle cap (2)
24. Flange head screw (2)
25. Grease fitting
26. Center link
27. Jam nut (2)
28. Cotter pin (6)
29. Front axle LH arm
30. Cap screw (2)
31. Front pin (2)
32. Front axle RH arm
33. Shoulder bolt (2)
34. Tie rod (2)
35. Flange bushing (2 per arm)
36. Steering fork assembly (2)
37. Washer (as needed)

NOTE: The front axle steering cylinder on machines with serial numbers above 315000000 is installed in the reverse direction of machines with lower serial numbers. Figure 30 shows the cylinder orientation for machines with the higher serial number. Use the following procedure and torque specifications identified in Figure 29 when servicing the front axle on all Groundsmaster 360 machines.

Disassembly (Fig. 29)

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

2. Remove front cover from front axle to allow access to front steering components (Fig. 31).

3. Remove front wheel if necessary (see Wheel Removal in this section).

4. Remove steering cylinder if necessary (see Steering Cylinder Removal in the Service and Repairs section of Chapter 4 − Hydraulic System).

5. On 2WD machines, remove front spindle if necessary (see Front Spindle Removal in this section).

6. On 4WD machines, remove front wheel motor if necessary (see Wheel Motor Removal in the Service and Repairs section of Chapter 4 − Hydraulic System).

7. Remove front steering fork assembly if necessary (see Front Steering Fork Removal in this section).

8. To remove tie rod (item 34) from machine:

   A. Remove cotter pin and slotted hex nut that secure outer tie rod ball joint stud to steering fork.

   B. Separate ball joint from steering fork.

   C. Unscrew inner tie rod end from center link and remove tie rod from machine.

NOTE: Inner and outer tie rod ends are not available separately. If wear or damage occurs to tie rod components, replace tie rod assembly.

9. Remove additional front steering components as necessary using Figure 29 as a guide.

10. If bushings in the front axle (item 5 or 6 in Fig. 31), front axle LH arm (item 29 in Fig. 29) or front axle RH arm (item 32 in Fig. 29) are worn or damaged, replace bushings (see Steering Assembly Bushing Service in this section).

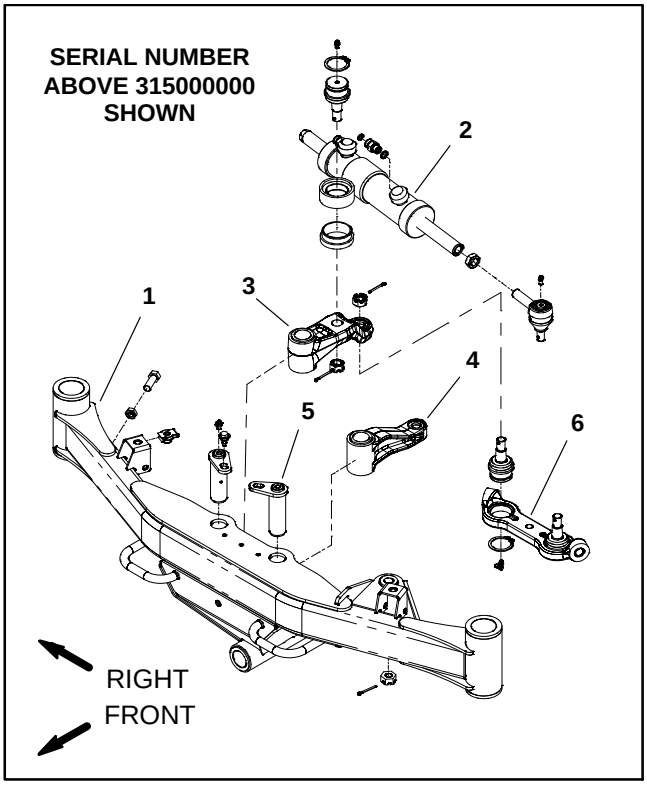

Figure 30

1. **Front axle**
2. **Steering cylinder**
3. **Front axle RH arm**
4. **Front axle LH arm**
5. **Front pin (2)**
6. **Center link**

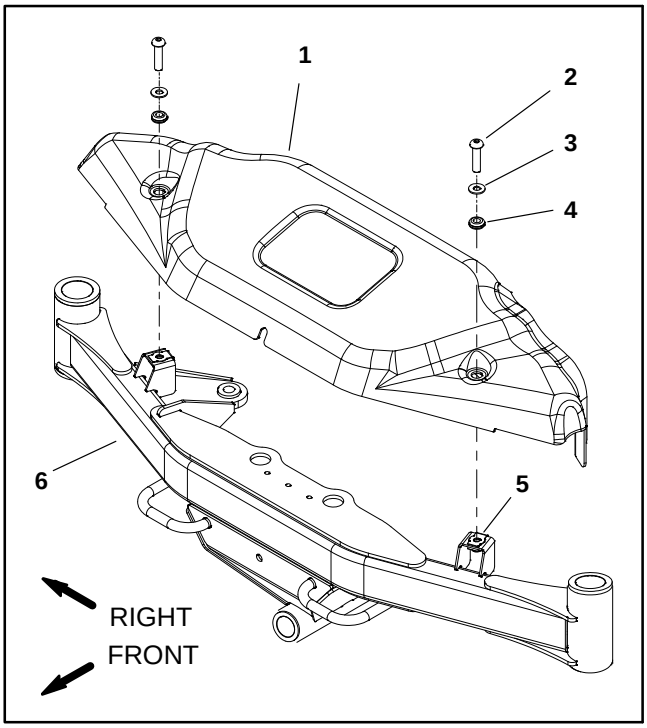

Figure 31

1. **Front cover**
2. **Screw (2)**
3. **Flat washer (2)**
4. **Grommet (2)**
5. **Tinnerman nut (2)**
6. **Front axle**

Assembly (Fig. 29)

1. Install all removed front steering components using Figure 29 as a guide. Note torque specifications identified in Figure 29 during assembly. If front axle was removed from frame, use washers (item 37) so axle has less than 0.030" (0.76 mm) free play between frame and axle support. If ball joints were removed from center link (item 26), press new ball joints into center link from the side of the link that has a notch at ball joint bore (Fig. 33).

2. To install tie rod (item 34) to vehicle:

   A. If tie rod assembly is being replaced, adjust new tie rod assembly to approximate length of removed tie rod.

   B. Apply Loctite #271 (or equivalent) to threads of inner tie rod end. Thread tie rod into center link and torque from **70 to 80 ft−lb (95 to 108 N−m)**.

   C. Clean tapers of steering fork and outer tie rod end ball joint stud.

   D. Insert outer tie rod end ball joint stud into steering fork and secure with slotted hex nut. Torque slotted hex nut from **35 to 40 ft−lb (48 to 54 N−m)**. If necessary, tighten nut further until slot in nut aligns with hole in tie rod ball joint stud. Install cotter pin.

3. If steering cylinder was removed, install cylinder (see Steering Cylinder Installation in the Service and Repairs section of Chapter 4 − Hydraulic System).

4. If front steering fork assembly was removed, install steering fork (see Front Steering Fork Installation in this section).

5. If front spindle on 2WD machine was removed, install front spindle (see Front Spindle Installation in this section).

6. If front wheel motor on 4WD machines was removed, install wheel motor (see Wheel Motor Installation in the Service and Repairs section of Chapter 4 − Hydraulic System).

7. If front wheel was removed, install wheel (see Wheel Installation in this section).

8. Install front cover to front axle (Fig. 31).

WARNING

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

9. If front wheel was removed, make sure that lug nuts are torqued evenly in a crossing pattern from **75 to 85 ft−lb (102 to 115 N−m)**.

10. Lubricate all grease fittings in front steering assembly.

11. Check and adjust wheel alignment (see Wheel Alignment in the Adjustments section of this chapter).

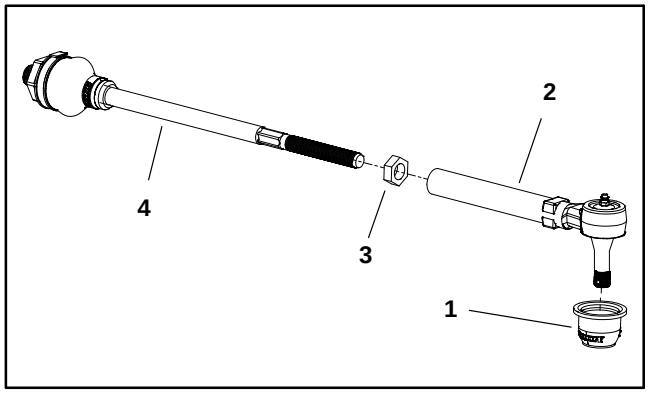

Figure 32

1. **Dust cover**
2. **Outer tie rod end**
3. **Jam nut**
4. **Inner tie rod end**

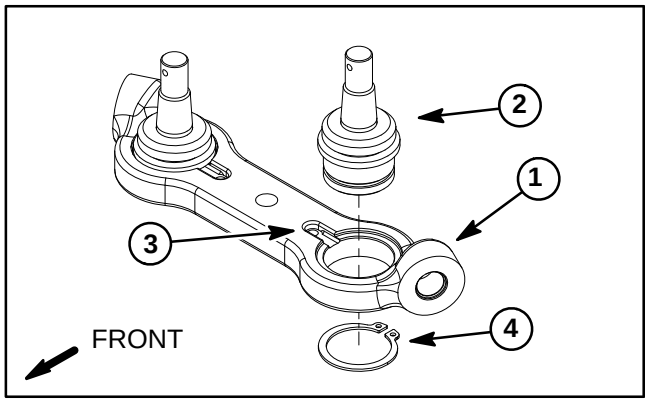

Figure 33

1. **Center link**
2. **Ball joint (2)**
3. **Center link notch**
4. **Retaining ring (2)**

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Rear Steering Assembly

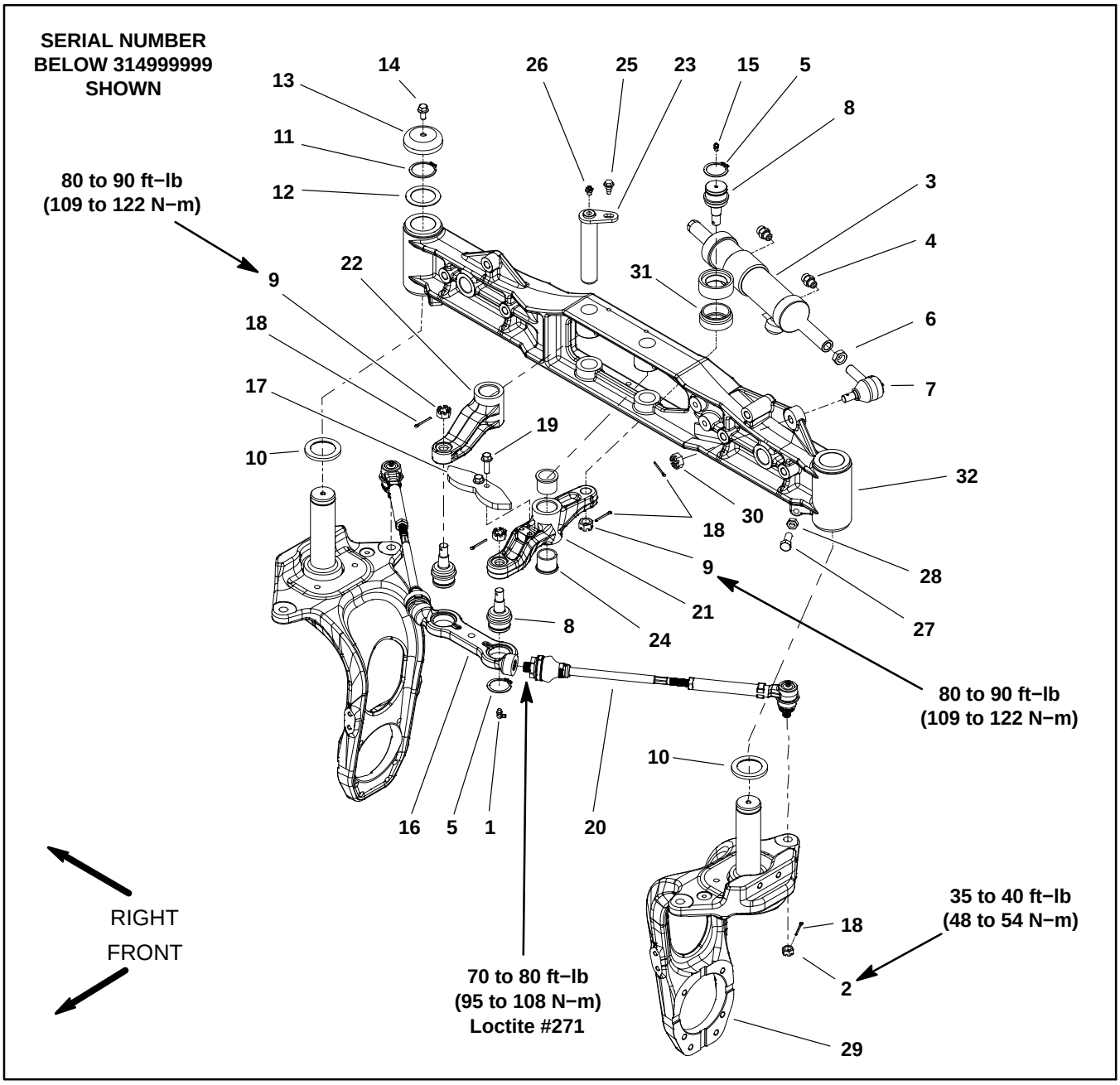

Figure 34

1. Grease fitting (2)
2. Slotted hex nut (2)
3. Steering cylinder
4. Straight hydraulic fitting (2)
5. Retaining ring (3)
6. Jam nut
7. Rod end
8. Ball joint (3)
9. Slotted hex nut (3)
10. Thrust washer (2)
11. Retaining ring (2)
12. Thrust washer (2)
13. Spindle cap (2)
14. Flange head screw (2)
15. Grease fitting
16. Center link
17. Cam plate
18. Cotter pin (6)
19. Flange head screw (2)
20. Rear tie rod (2)
21. Rear axle LH arm
22. Rear axle RH arm
23. Pin (2)
24. Flange bushing (2 per arm)
25. Shoulder bolt (2)
26. Grease fitting (2)
27. Flange head screw (2)
28. Jam nut (2)
29. Steering fork assembly (2)
30. Slotted hex nut
31. Cylinder spacer
32. Rear axle

NOTE: The rear axle steering cylinder on machines with serial numbers above 315000000 is installed differently than the cylinder on machines with lower serial numbers. Figure 35 shows the cylinder orientation for machines with the higher serial number. Use the following procedure and torque specifications identified in Figure 34 when servicing the rear axle on all Groundsmaster 360 machines.

Disassembly (Fig. 34)

1. Park machine on a level surface, lower cutting deck, stop engine and remove key from the ignition switch. Unlatch and raise hood.

2. Remove storage compartment from behind operator seat (see Storage Compartment Removal in this section or, if machine is equipped with operator cab, see Storage Compartment Removal in the Service and Repairs section of Chapter 8 − Operator Cab).

3. Remove rear wheel if necessary (see Wheel Removal in this section).

4. Remove steering cylinder if necessary (see Steering Cylinder Removal in the Service and Repairs section of Chapter 4 − Hydraulic System).

5. Remove rear wheel motor if necessary (see Wheel Motor Removal in the Service and Repairs section of Chapter 4 − Hydraulic System).

6. Remove rear steering fork assembly if necessary (see Rear Steering Fork Removal in this section).

7. To remove tie rod (item 20) from machine:

   A. Remove cotter pin and slotted hex nut that secure outer tie rod ball joint stud to steering fork.

   B. Separate ball joint from steering fork.

   C. Unscrew inner tie rod end from center link and remove tie rod from machine.

NOTE: Inner and outer tie rod ends are not available separately. If wear or damage occurs to tie rod components, replace tie rod assembly.

8. Remove additional rear steering components as necessary using Figure 34 as a guide.

9. If bushings in the rear axle (item 32), rear axle LH arm (item 21) or rear axle RH arm (item 22) are worn or damaged, replace bushings (see Steering Assembly Bushing Service in this section).

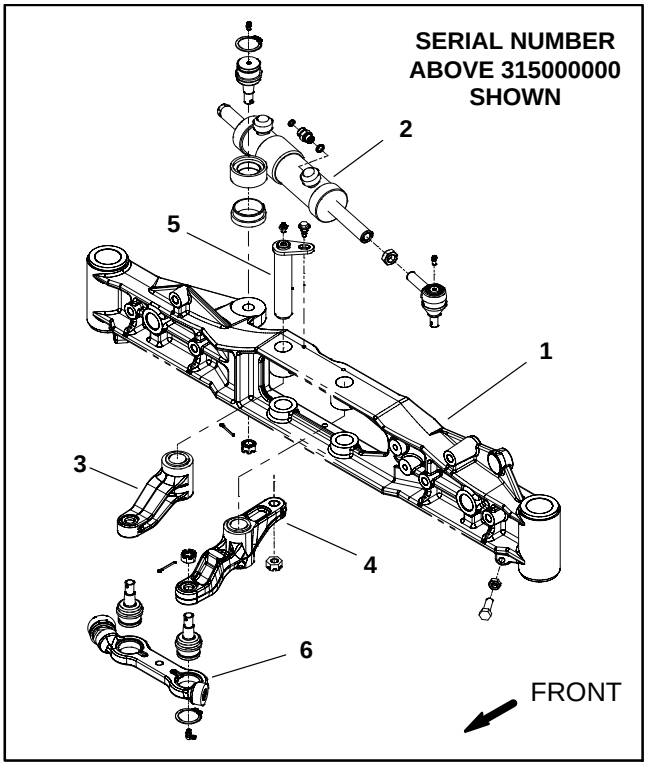

Figure 35

1. **Rear axle**
2. **Steering cylinder**
3. **Rear axle RH arm**
4. **Rear axle LH arm**
5. **Pin (2)**
6. **Center link**

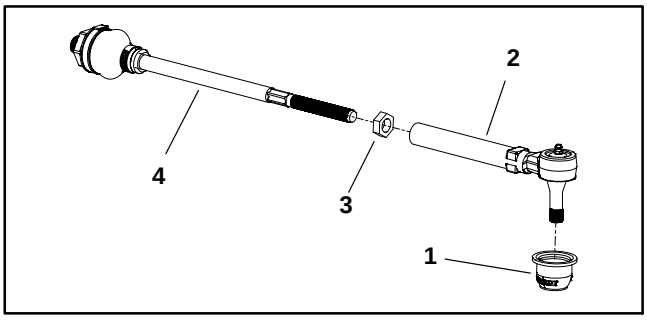

Figure 36

1. **Dust cover**
2. **Outer tie rod end**
3. **Jam nut**
4. **Inner tie rod end**

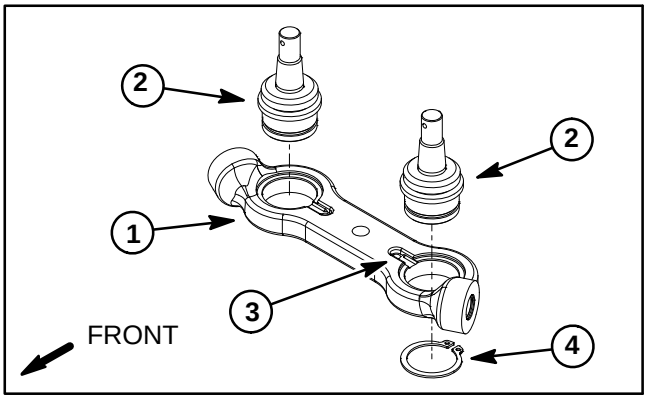

Figure 37

1. **Center link**
2. **Ball joint (2)**
3. **Center link notch**
4. **Retaining ring (2)**

Assembly (Fig. 34)

1. Install all removed rear steering components using Figure 34 as a guide. Note torque specifications identified in Figure 34 during assembly. If ball joints were removed from center link (item 16), press new ball joints into center link from the side of the link that has a notch at ball joint bore (Fig. 37).

2. To install tie rod (item 20) to vehicle:

   A. If tie rod assembly is being replaced, adjust new tie rod assembly to approximate length of removed tie rod.

   B. Apply Loctite #271 (or equivalent) to threads of inner tie rod end. Thread tie rod into center link and torque from **70 to 80 ft−lb (95 to 108 N−m)**.

   C. Clean tapers of steering fork and outer tie rod end ball joint stud.

   D. Insert outer tie rod end ball joint stud into steering fork and secure with slotted hex nut. Torque slotted hex nut from **35 to 40 ft−lb (48 to 54 N−m)**. If necessary, tighten nut further until slot in nut aligns with hole in tie rod ball joint stud. Install cotter pin.

3. If steering cylinder was removed, install cylinder (see Steering Cylinder Installation in the Service and Repairs section of Chapter 4 − Hydraulic System).

4. If rear steering fork assembly was removed, install fork assembly (see Rear Steering Fork Installation in this section).

5. If rear wheel motor was removed, install wheel motor (see Wheel Motor Installation in the Service and Repairs section of Chapter 4 − Hydraulic System).

6. If rear wheel was removed, install wheel (see Wheel Installation in this section).

WARNING

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

7. If rear wheel was removed, make sure that wheel lug nuts are torqued from **75 to 85 ft−lb (102 to 115 N−m)**.

8. Lubricate all grease fittings in rear steering assembly.

9. Check and adjust wheel alignment (see Wheel Alignment in the Adjustments section of this chapter).

10. Check and adjust brakes (see Brake Adjustment in the Adjustments section of this chapter).

11. After assembly and adjustments have been completed, make sure that no contact is made between any machine components as the wheels are moved from steering lock to lock. Adjust if necessary.

12. Position storage compartment to machine and secure with removed fasteners (see Storage Compartment Installation in this section or, if machine is equipped with operator cab, in the Service and Repairs section of Chapter 8 − Operator Cab).

13. Close and latch hood.

Steering Assembly Bushing Service

Bushings in the front axle (Fig. 38) or rear axle (Fig. 39) assembly can be replaced using the following procedure.

NOTE: Bushings in steering arms (item 6 in Fig. 38 and item 5 in Fig. 39) may require reaming after installation. If reaming tools are not available, replace arm assembly which has bushings installed and properly sized.

1. Use a bushing removal tool to extract both flange bushings from the component. Take care to not damage the bore of the component during bushing removal.

2. Thoroughly clean the inside of the component bore to remove any dirt or foreign material.

3. Apply grease to the inside and outside of the new flange bushings.

4. Press new flange bushings into the top and bottom of the component until bushing flange bottoms on component.

5. After bushing installation, make sure that appropriate shaft slides easily into bushings. If binding is noted, locate and correct source of binding before final assembly.

   A. LH arm and RH arm on both front and rear axles should have from 0.001” to 0.005” (0.03 to 0.13 mm) clearance between pin and ID of installed bushing in arm.

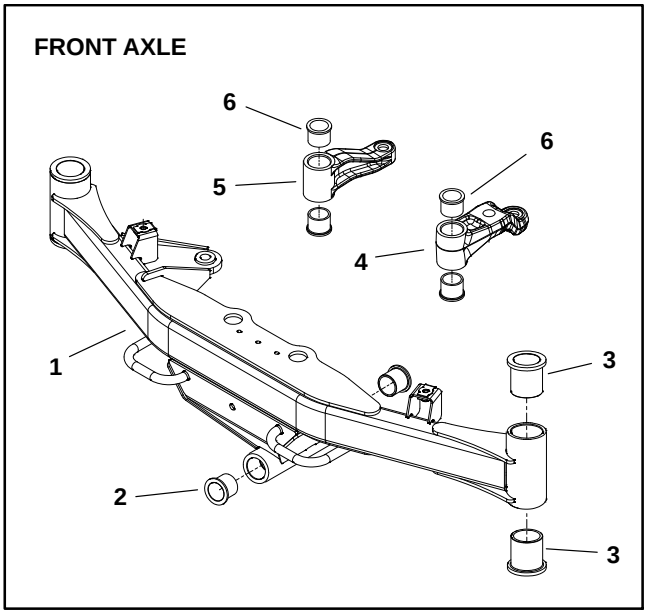

Figure 38

1. **Front axle**
2. **Flange bushing (2)**
3. **Flange bushing (4)**
4. **Front LH arm**
5. **Front RH arm**
6. **Flange bushing (4)**

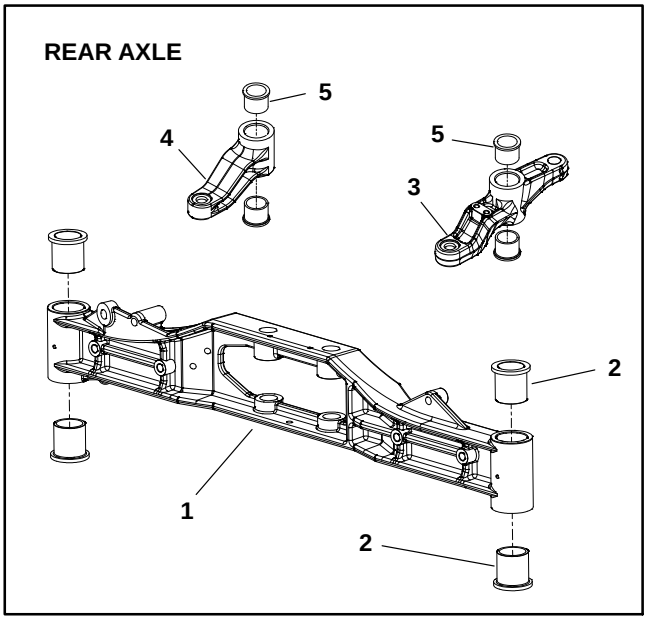

Figure 39

1. **Rear axle**
2. **Flange bushing (4)**
3. **Rear LH arm**
4. **Rear RH arm**
5. **Flange bushing (4)**

Frame Assembly

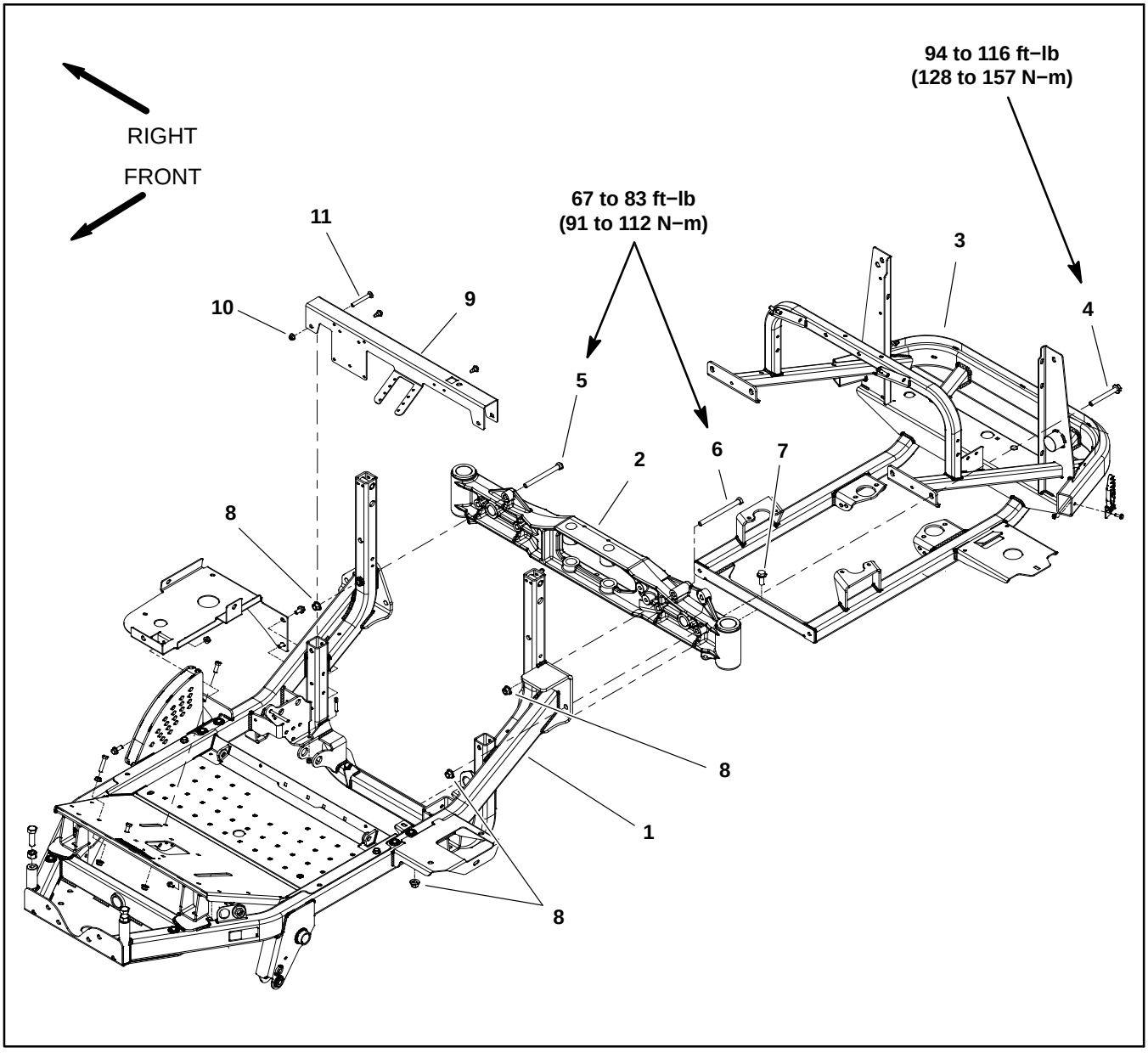

Figure 40

1. **Front frame**
2. **Rear axle**
3. **Rear frame**
4. **Flange head screw (4)**
5. **Cap screw**
6. **Cap screw**
7. **Flange head screw (3)**
8. **Flange nut (9)**
9. **Seat channel**
10. **Flange head screw (2)**
11. **Carriage screw (2)**

The Groundsmaster 360 frame assembly is illustrated in Figure 40. If the fasteners used to secure the front frame, rear axle or rear frame are loosened or removed, refer to Figure 40 for fastener tightening torque recommendations.

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Steering Column

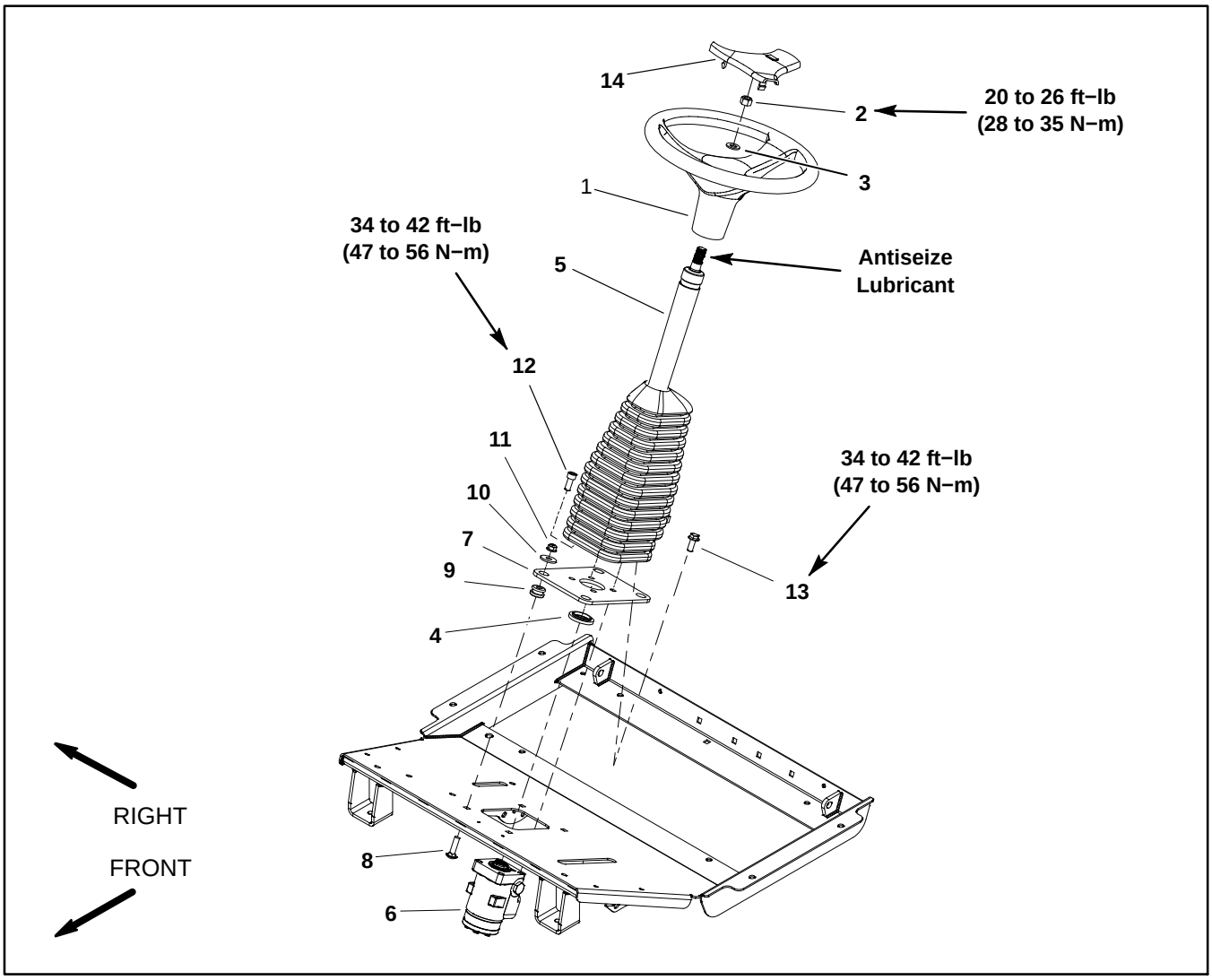

Figure 41

1. Steering wheel
2. Lock nut
3. Flat washer
4. Alignment bushing
5. Steering column assembly
6. Steering control valve
7. Steering plate
8. Carriage screw (4)
9. Mount (4)
10. Washer (4)
11. Flange nut (4)
12. Socket head screw
13. Flange head screw (3)
14. Steering wheel cover

Removal (Fig. 41)

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

2. Remove cover from steering wheel by carefully prying up on one of the cover spokes.

3. Remove lock nut and flat washer that secure steering wheel to steering column.

4. Use a suitable puller to remove steering wheel from steering column.

5. Slide rubber bellows up steering column to allow access to fasteners that secure steering column to machine.

6. Support steering control valve to prevent it from shifting during steering column removal.

7. Loosen and remove three (3) flange head screws (item 13) and one (1) socket head screw (item 12) that secure steering column to steering control valve. Note location of socket head screw for assembly purposes.

8. Slide steering column assembly from steering control valve and machine.

9. Disassemble steering column assembly as needed using Figure 42 as a guide.

Installation (Fig. 41)

1. Apply antiseize lubricant to input shaft of steering control valve.

2. Make sure that alignment bushing is positioned on steering control valve and into steering plate bore.

3. Slide steering column onto steering control valve. Secure steering column in place with three (3) flange head screws (item 13) and one (1) socket head screw (item 12). Hand tighten screws in a crossing pattern and then torque screws again in a crossing pattern from **34 to 42 ft−lb (47 to 56 N−m)**.

4. Slide rubber bellows to bottom of steering column.

5. Thoroughly clean tapered surfaces of steering wheel and steering column.

6. Apply antiseize lubricant to splines of steering column taking care to keep antiseize lubricant from steering column taper. Slide steering wheel onto steering column.

7. Secure steering wheel to steering column with flat washer and lock nut. Torque lock nut from **20 to 26 ft−lb (28 to 35 N−m)**.

8. Install steering wheel cover to steering wheel.

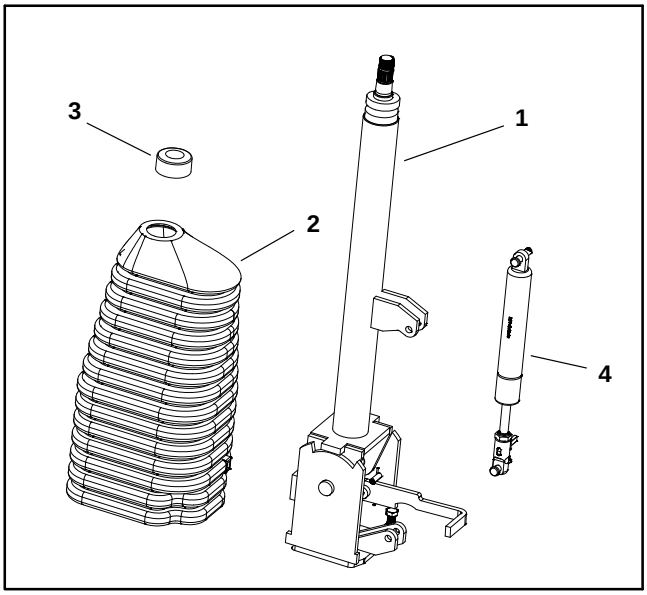

Figure 42

1. Steering column
2. Boot
3. Bearing
4. Cylinder

PTO Drive Shaft

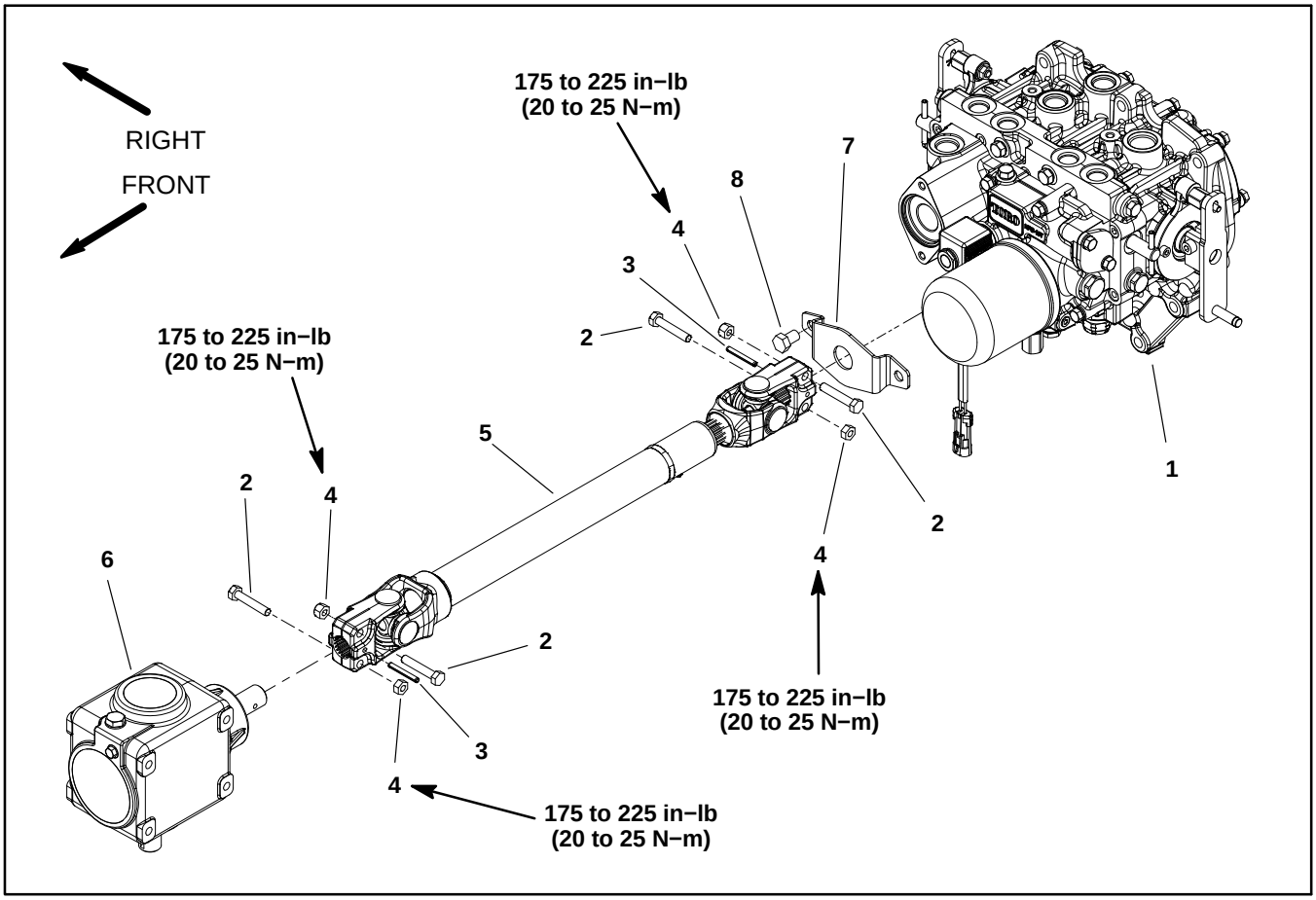

Figure 43

1. Transmission assembly
2. Cap screw (4)
3. Roll pin (2)
4. Lock nut (4)
5. PTO drive shaft
6. Cutting deck gearbox
7. Seal shield
8. Cap screw (2)

Removal (Fig. 43)

NOTE: PTO drive shaft removal is easier if machine is positioned on a hoist.

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

WARNING

Do not start the engine and engage the PTO switch when the PTO drive shaft is disconnected from the cutting deck. If the engine is started and the PTO shaft is allowed to rotate, serious personal injury and machine damage could result. Before the PTO drive shaft is disconnected from the cutting deck, disconnect PTO solenoid coil connector from wire harness to prevent unintentional engagement of the PTO clutch.

2. To prevent unintentional engagement of the PTO clutch, disconnect the wire harness electrical connector from the PTO solenoid valve coil connector (Fig. 44).

3. Disconnect end yoke of PTO drive shaft from PTO shaft on transmission:

   A. Remove roll pin from end yoke and PTO shaft.

   B. Loosen two (2) cap screws and lock nuts.

   C. Slide drive shaft end yoke from PTO shaft.

4. Disconnect end yoke of PTO drive shaft from cutting deck gearbox shaft:

   A. Remove roll pin from end yoke and gearbox shaft.

   B. Loosen two (2) cap screws and lock nuts.

   C. Slide drive shaft end yoke from gearbox shaft.

5. Remove PTO drive shaft from machine.

Installation (Fig. 43)

1. Position PTO drive shaft to machine. Make sure that drive shaft yoke and slip tube (item 6 in Fig. 46) is toward cutting deck gearbox shaft.

2. Align splines and roll pin holes of drive shaft yokes with transmission and gearbox shafts.

3. Slide PTO drive shaft end yokes onto transmission PTO shaft and gearbox shaft.

4. Secure end yokes of PTO drive shaft.

   A. Install roll pins in end yokes and shafts.

   B. Install cap screws in driveshaft end yokes. Alternate direction that screw is installed on each yoke.

   C. Install and tighten lock nuts to secure end yokes to gearbox and PTO shafts. Torque lock nuts from **175 to 225 in−lb (20 to 25 N−m)**.

5. Lubricate PTO drive shaft grease fittings.

6. Connect the wire harness electrical connector to the PTO solenoid valve coil connector (Fig. 44).

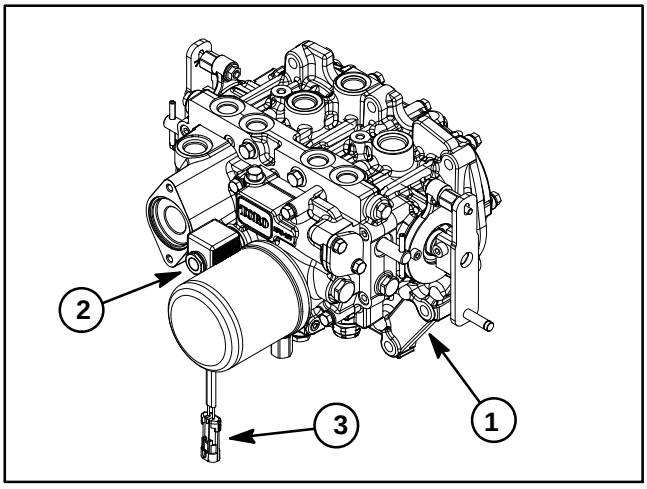

Figure 44

1. **Transmission**
2. **Solenoid valve and coil**
3. **Coil connector**

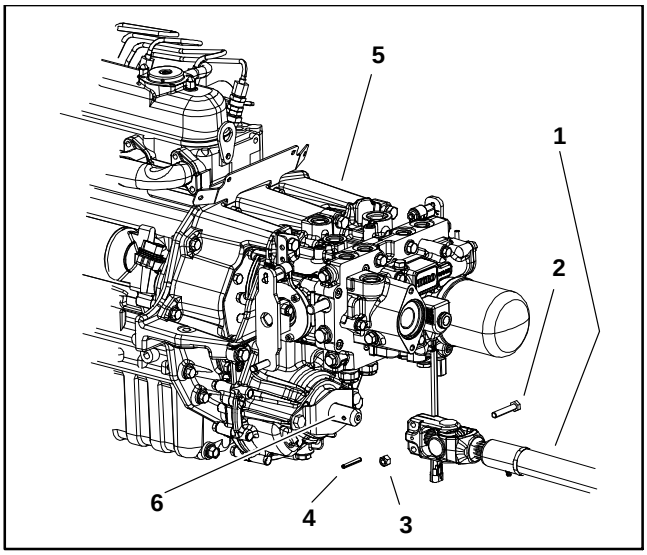

Figure 45

1. **PTO drive shaft**
2. **Cap screw**
3. **Lock nut**
4. **Roll pin**
5. **Transmission**
6. **PTO shaft**

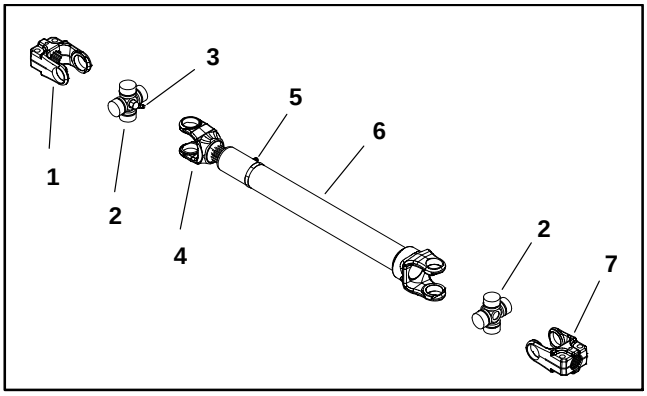

Figure 46

1. **End yoke**
2. **Cross and bearing set**
3. **Grease fitting**
4. **Yoke and shaft**
5. **Grease fitting**
6. **Yoke and slip tube**
7. **End yoke**

PTO Drive Shaft Cross and Bearing Service

1. Remove PTO drive shaft from vehicle (see PTO Drive Shaft Removal in this section).

IMPORTANT: When placing yoke in vise, clamp lightly on the solid part of the yoke to prevent yoke damage. Also, the use of a vise with soft jaws is recommended.

2. Lightly clamp yoke in vise. Use two screwdrivers to remove snap rings that secure bearings at the inside of each yoke. Remove yoke from vise.

IMPORTANT: Yokes must be supported when removing and installing bearings to prevent damage.

3. Use a press to remove cross and bearings from yokes:

   A. Place a small socket against one bearing and a large socket against the yoke on the opposite side.

   B. While supporting the large socket, apply pressure on small socket to partially push the opposite bearing into the large socket.

   C. Remove yoke from press, grasp partially removed bearing and tap on yoke to completely remove the bearing.

   D. Repeat process for remaining bearings.

   E. Thoroughly clean and inspect all components.

4. To install new cross and bearings:

   A. Apply a coating of grease to bearing bores of end yoke and shaft yoke. Also, apply grease to bearings and seal of bearing assembly. Make sure that all bearing rollers are properly seated in bearing cage.

   B. Press one bearing partially into yoke.

   IMPORTANT: Take care when installing cross into bearing to avoid damaging bearing seal.

   C. Carefully insert cross into bearing and yoke.

   D. Hold cross in alignment and press bearing in until it hits the yoke.

   E. Carefully place second bearing into yoke bore and onto cross shaft. Press bearing into yoke.

   F. Install snap rings to bearings to secure bearings in place.

   G. Repeat procedure for other yoke.

   H. Grease cross until grease comes out of all four (4) bearing cups.

5. Make sure that assembled joint moves without binding. Slight binding can usually be eliminated by lightly rapping the yoke lugs with a soft faced hammer. If binding continues, disassemble joint to identify source of binding.

6. Install drive shaft to vehicle (see PTO Drive Shaft Installation in this section).

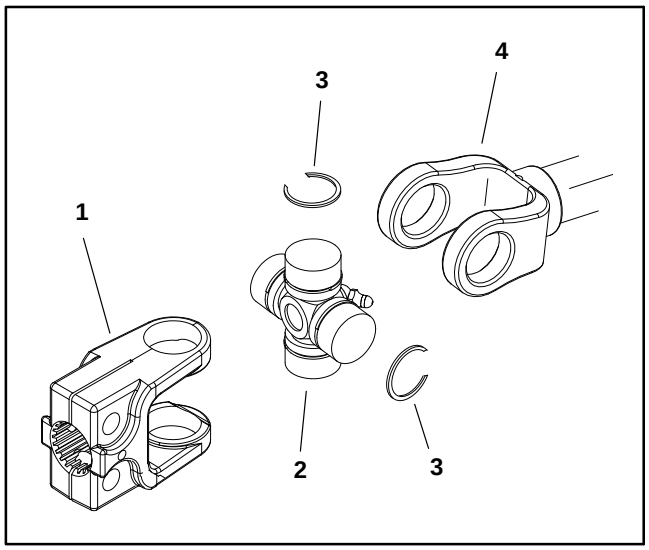

Figure 47

1. **End yoke**
2. **Cross and bearing kit**
3. **Snap ring (4)**
4. **Shaft yoke**

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Cutting Deck Lift Assembly

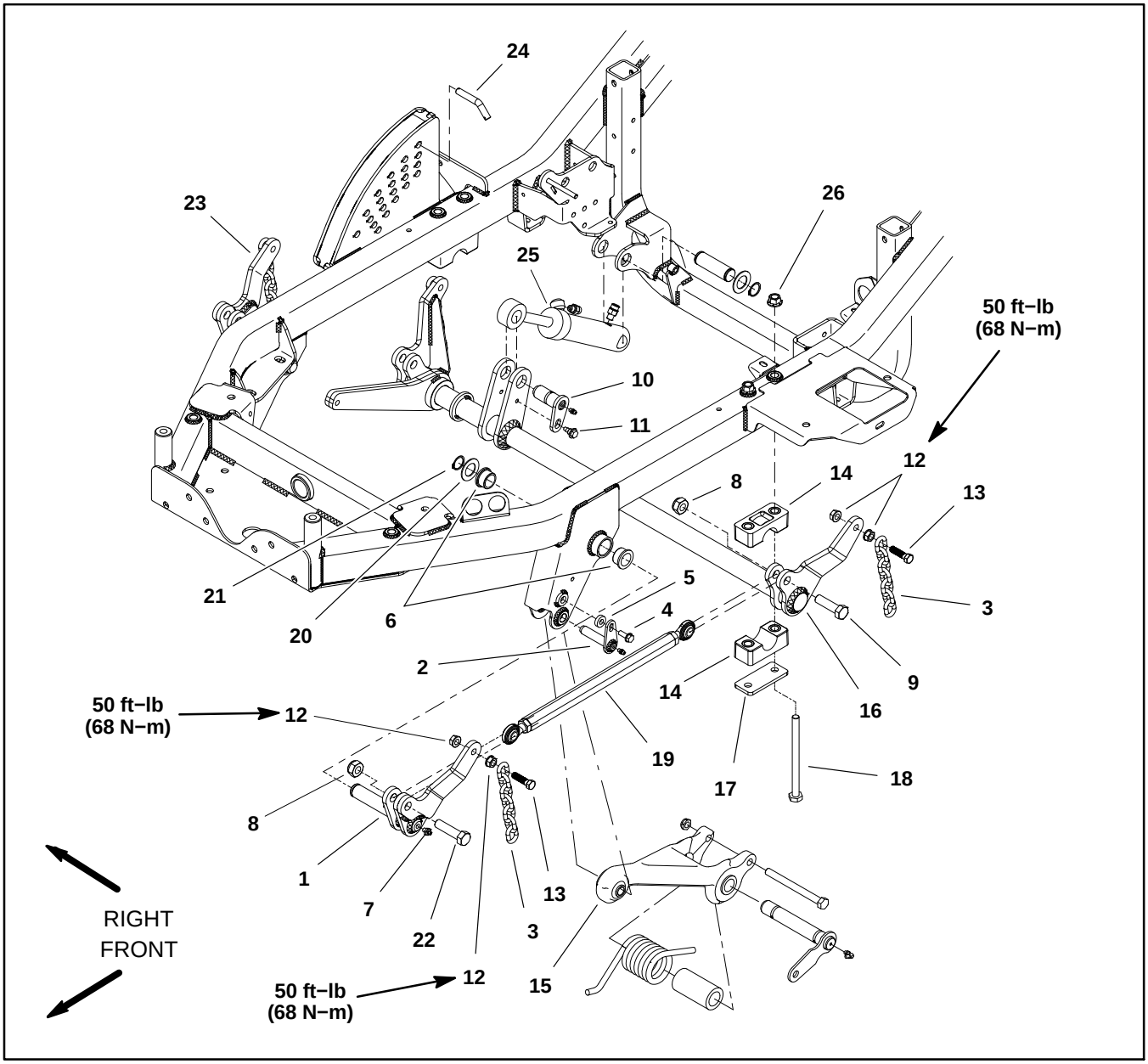

Figure 48

1. LH lift arm
2. Retainer pin
3. HOC chain (4)
4. Flange head screw
5. Spacer
6. Flange bushing (2)
7. Grease fitting
8. Lock nut
9. Cap screw
10. Pivot pin
11. Shoulder bolt
12. Flange nut (2 per chain)
13. Cap screw (1 per chain)
14. Bearing cap (4)
15. Pull link assembly
16. Lift shaft assembly
17. Bearing plate (2)
18. Cap screw (4)
19. Link assembly (2)
20. Washer (1 per lift arm)
21. Retaining ring (1 per lift arm)
22. Cap screw
23. RH lift arm
24. HOC pin
25. Lift cylinder
26. Lock nut (4)

Disassembly (Fig. 48)

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

NOTE: If cutting deck is to removed from machine, see Cutting Deck Removal and Installation in the Service and Repairs section of Chapter 7 − Cutting Deck.

2. Remove lift arm components as necessary using Figures 48 and 50 as guides.

NOTE: If pull link assembly (item 15) removal is necessary, refer to Cutting Deck Pull Links in the Service and Repairs section of Chapter 7 − Cutting Deck.

Assembly (Fig. 48)

1. Check bearing caps (item 14) and flange bushings (item 6) for wear or damage. Replace components if necessary.

2. Install lift arm components as necessary using Figures 48 and 50 as guides.

A. If ball joints were removed from link assembly (item 19), install ball joints equally on both ends of link. Adjust center to center length of link assembly from **18.070" to 18.180" (45.9 to 46.1 cm)** (Fig. 51). Tighten jam nuts to secure ball joints to link. Make sure that ball joints stay in−line when tightening jam nuts.

NOTE: Do not change the link assembly length to adjust the height−of−cut or for any other reason.

NOTE: Flange nuts (item 12) should have flange surface against lift arm and not against chain. Correct assembly will allow chain to free to pivot.

B. If cap screw (item 13) was removed from HOC chain (item 3), insert screw into upper link of chain and thread flange nut (item 12) onto screw with flange away from link. Torque flange nut to **50 ft−lb (67 N−m)**. When fastening chain to front lift arm, torque second flange nut to **50 ft−lb (67 N−m)**. When installing chain to rear lift arm, torque cap screw to **50 ft−lb (67 N−m)**.

3. Lubricate grease fittings on deck lift assembly.

4. Start engine and fully raise cutting deck. Stop engine and remove key from the ignition switch. Install HOC pin into HOC bracket to allow desired height−of−cut (Fig. 49).

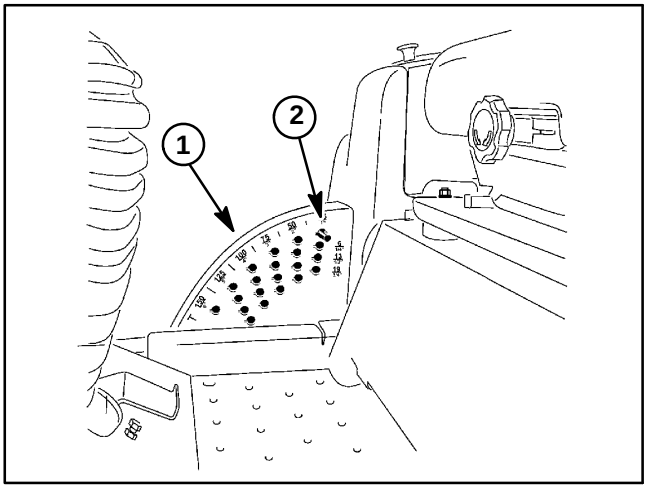

Figure 49

1. **HOC bracket**
2. **HOC pin**

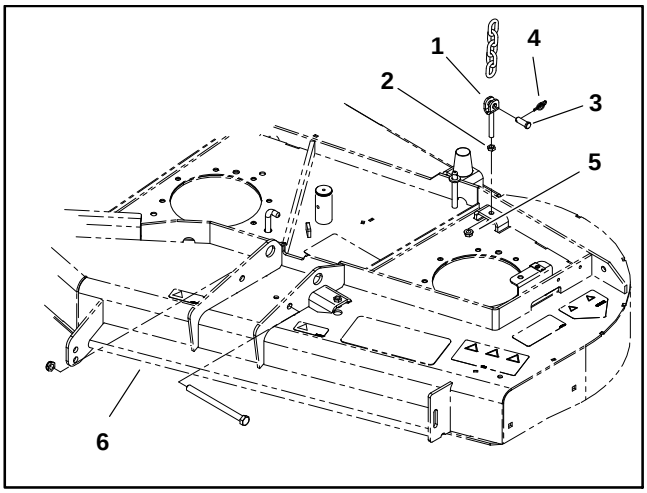

Figure 50

1. **Adjustment clevis**
2. **Jam nut**
3. **Clevis pin**
4. **Ring pin**
5. **Flange nut**
6. **Cutting deck**

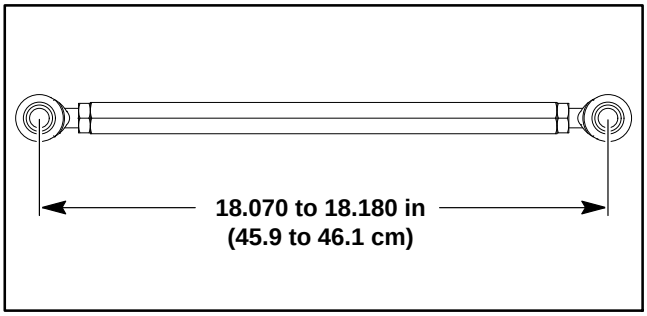

Figure 51

Control Console

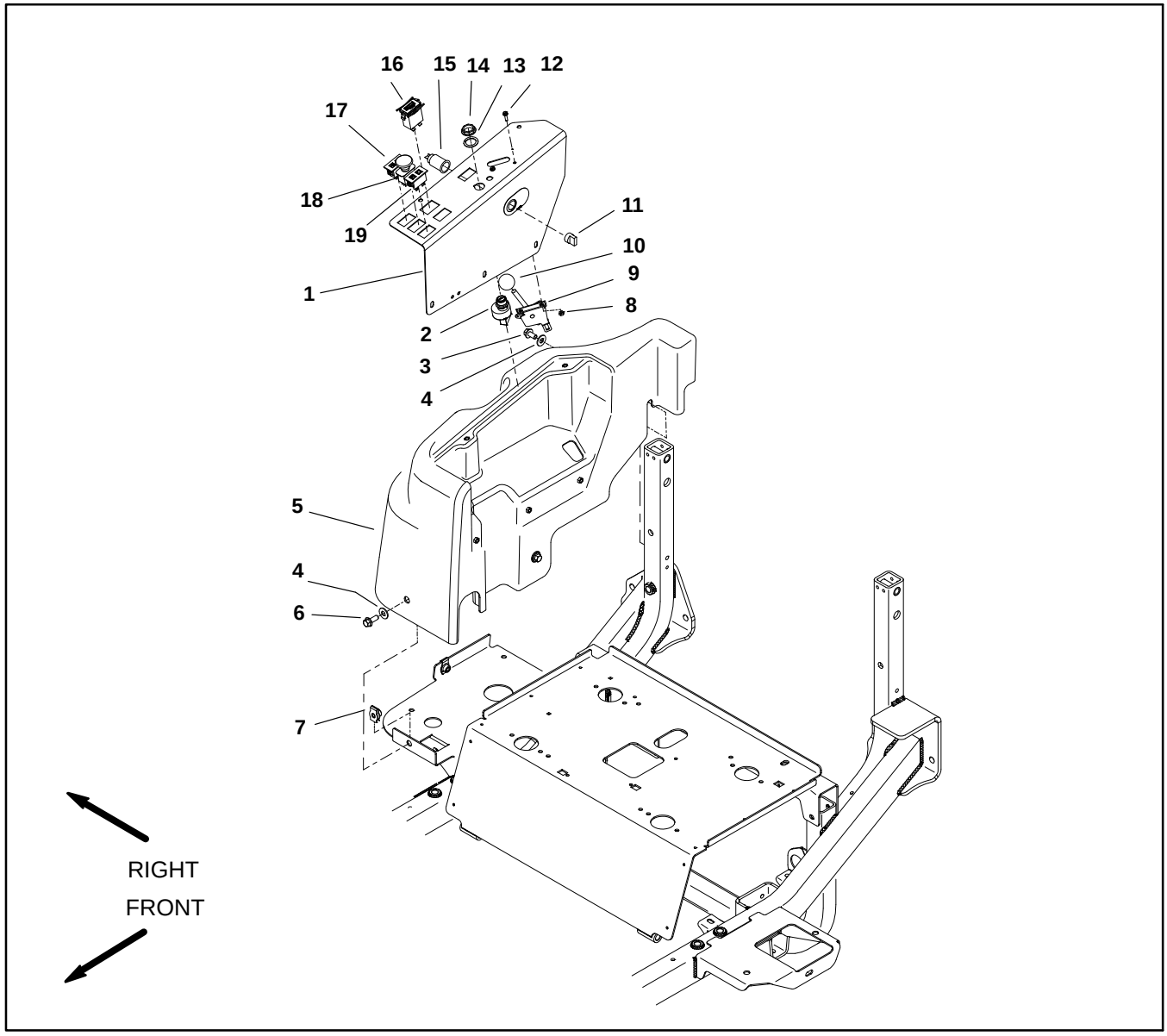

Figure 52

1. Control panel
2. Ignition switch
3. Washer head screw
4. Flat washer (4)
5. Hydraulic tank cover
6. Flange head screw (3)
7. Tinnerman nut (3)
8. Lock nut (2)
9. Throttle control lever
10. Knob
11. Cap
12. Screw (2)
13. Lock washer
14. Nut
15. Power point
16. Hour meter
17. Indicator light
18. PTO switch
19. Indicator light

Disassembly (Fig. 52)

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

2. Disconnect battery. Make sure to remove negative battery cable first and then positive cable (see Battery Service in this section).

3. Remove five (5) screws that secure control panel to hydraulic tank cover (Fig. 53). Carefully lift and support control panel to allow access to electrical connections.

4. Label all wire harness connectors for assembly purposes.

5. Disconnect wire harness connectors from all electrical components on control panel.

6. Remove knob from throttle control. Remove fasteners that secure throttle control to control panel. Separate throttle control from control panel.

7. Remove control panel from machine.

8. If necessary, remove hydraulic tank cover using Figure 52 as a guide.

Assembly (Fig. 52)

1. If hydraulic tank cover was removed, install cover using Figure 52 as a guide.

2. Position throttle control to control panel and secure with removed fasteners. Install knob on throttle control.

3. Using labels placed during disassembly, connect wire harness connectors to components on control panel.

4. Place control panel on hydraulic tank cover and secure with five (5) screws (Fig. 53).

5. Connect battery cables to battery. Make sure to connect positive cable first and then negative cable (see Battery Service in this section).

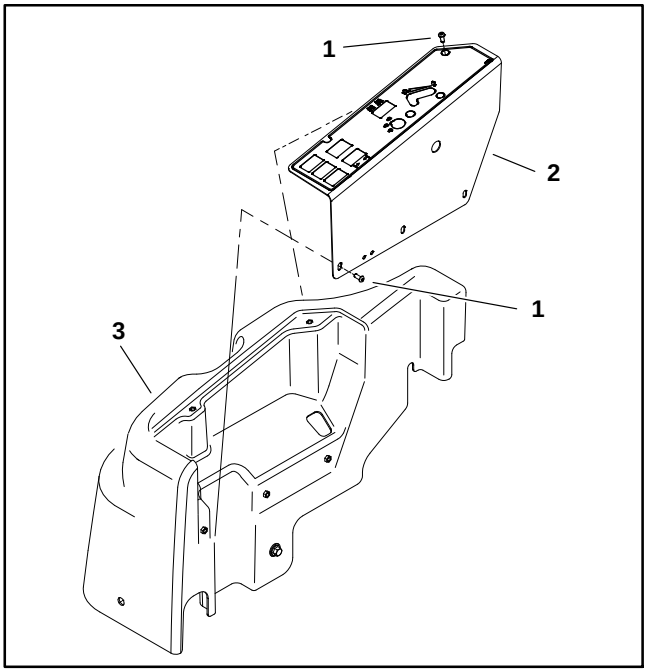

Figure 53

1. **Screw (5)**
2. **Control panel**
3. **Hydraulic tank cover**

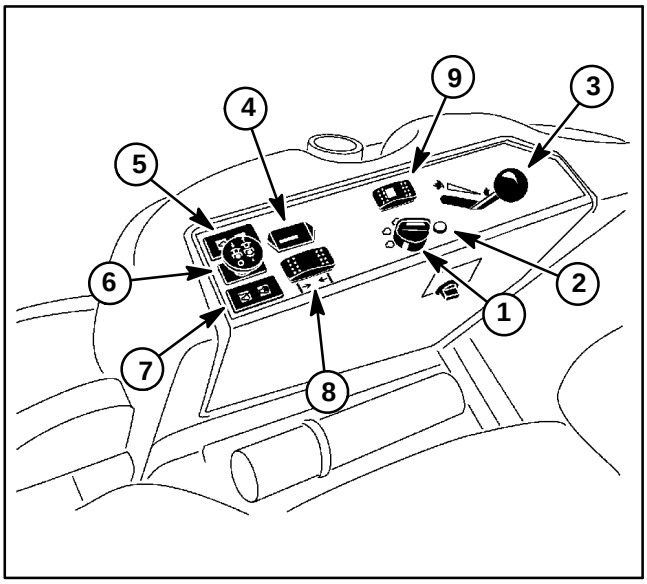

Figure 54

1. **Ignition switch**
2. **4WD diagnostic light**
3. **Throttle control lever**
4. **Hour meter**
5. **Oil pressure/alternator**
6. **PTO switch**
7. **High temp/glow plugs**
8. **Lift/lower switch**
9. **4WD steering switch**

Storage Compartment (Machines without Operator Cab)

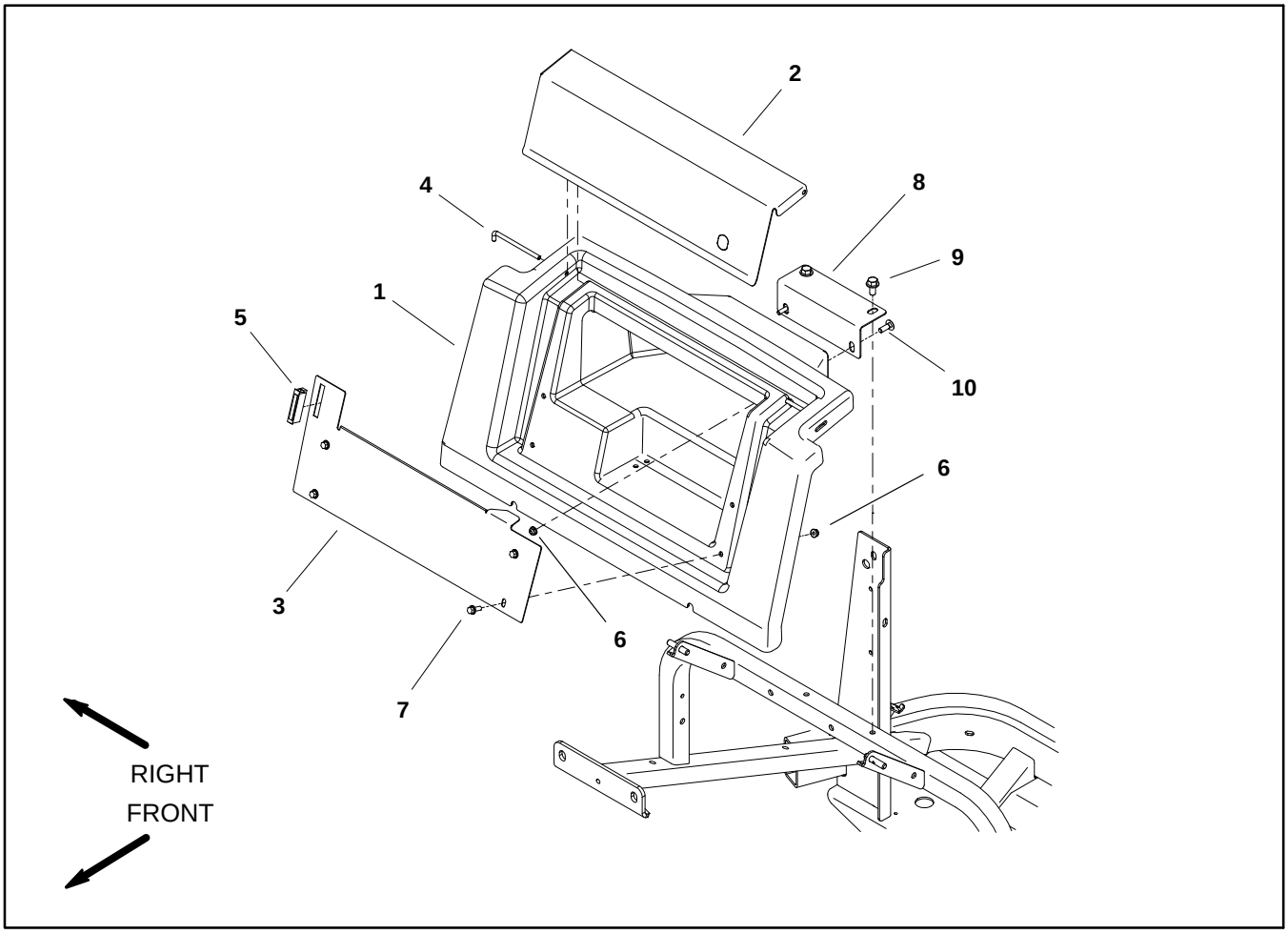

Figure 55

1. **Storage compartment**
2. **Cover**
3. **Lower panel**
4. **Hinge (2)**
5. **Magnetic catch**
6. **Flange nut (6)**
7. **Flange head screw (4)**
8. **Support**
9. **Flange head screw (2)**
10. **Carriage screw (2)**

Removal (Fig. 55)

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

2. Unlatch and raise operator seat.

3. Remove two (2) flange head screws (item 9) that secure storage compartment to frame.

4. Lift storage compartment assembly to separate it from the two (2) shoulder bolts that retain lower edge of housing to frame.

5. Remove storage compartment assembly from machine.

6. If necessary, remove components from storage compartment using Figure 55 as a guide.

Installation (Fig. 55)

1. Secure all removed components to storage compartment using Figure 55 as a guide.

2. Align notches in storage compartment with two (2) shoulder bolts in machine frame and slide compartment onto bolts.

3. Install two (2) flange head screws (item 9) to secure storage compartment to frame.

4. Lower and latch seat.

Operator Seat

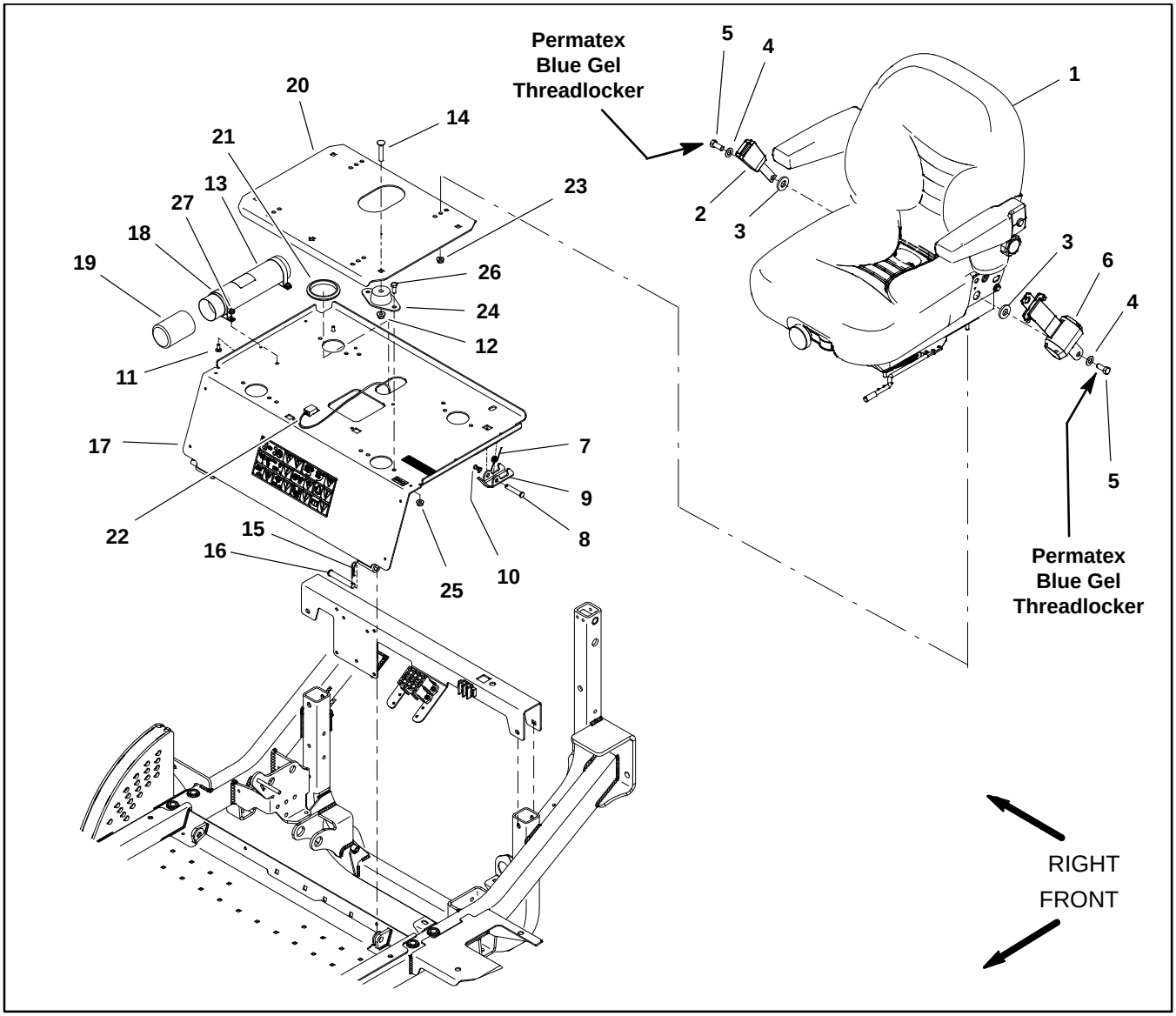

Figure 56

1. Operator seat (non−cab shown)
2. Seat belt latch
3. Flat washer (2)
4. Flat washer (2)
5. Cap screw (2)
6. Seat belt
7. Torsion spring
8. Clevis pin
9. Seat latch
10. Cotter pin
11. Carriage screw (2)
12. Flange nut (4)
13. Manual tube
14. Carriage screw (4)
15. Hair pin (2)
16. Clevis pin (2)
17. Seat plate
18. R−clamp (2)
19. Manual tube cover
20. Upper seat plate
21. Grommet
22. Seat switch wire harness
23. Flange nut (4)
24. Mount (4)
25. Flange nut (2 per mount)
26. Cap screw (2 per mount)
27. Flange nut (2)

Removal (Fig. 56)

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

2. Unlatch and raise operator seat.

WARNING

If seat switch service is necessary, remove seat from seat plate to access switch. To prevent injury, DO NOT attempt to reach switch through openings in seat plate.

3. Disconnect machine wire harness electrical connector from the seat wire harness connector (Fig. 57). Note routing of seat wire harness for assembly purposes.

4. Support seat and upper seat plate (item 20) to prevent them from shifting during seat removal.

5. Remove four (4) carriage screws (item 14) and flange nuts (item 12) that secure seat and upper seat plate assembly to seat plate (item 17). Remove seat and upper seat plate assembly from machine.

6. Remove seat parts and seat plate (item 17) as necessary using Figure 56 as a guide.

Installation (Fig. 56)

1. Install all removed seat parts using Figure 56 as a guide.

   A. If seat belt (item 6) or seat belt latch (item 2) were removed from seat assembly, apply Permatex Blue Gel Thread locker (or equivalent) to threads of cap screw (item 5) before installing screw.

2. If seat plate (item 17) was removed, secure seat plate to machine using Figure 56 as a guide.

3. Position seat and upper seat plate assembly to seat plate. Secure assembly with four (4) carriage screws (item 14) and flange nuts (item 12).

4. Connect wire harness electrical connector to the seat switch harness (Fig. 57).

5. Lower and latch seat.

6. Check operation of operator seat switch.

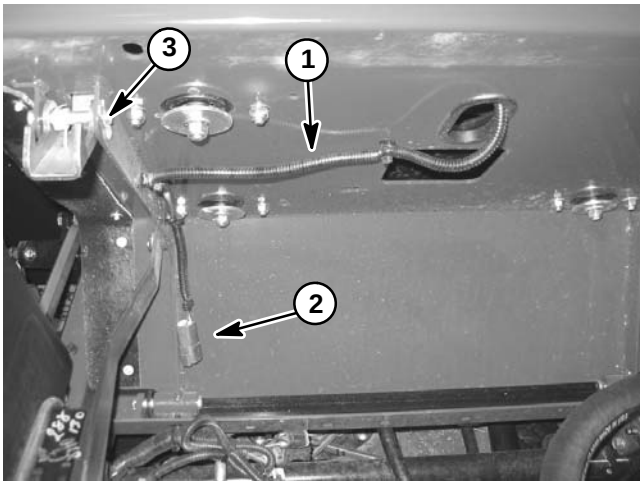

Figure 57

1. **Seat wire harness**
2. **Seat harness connector**
3. **Seat latch**

Operator Seat Service (Machines without Operator Cab)

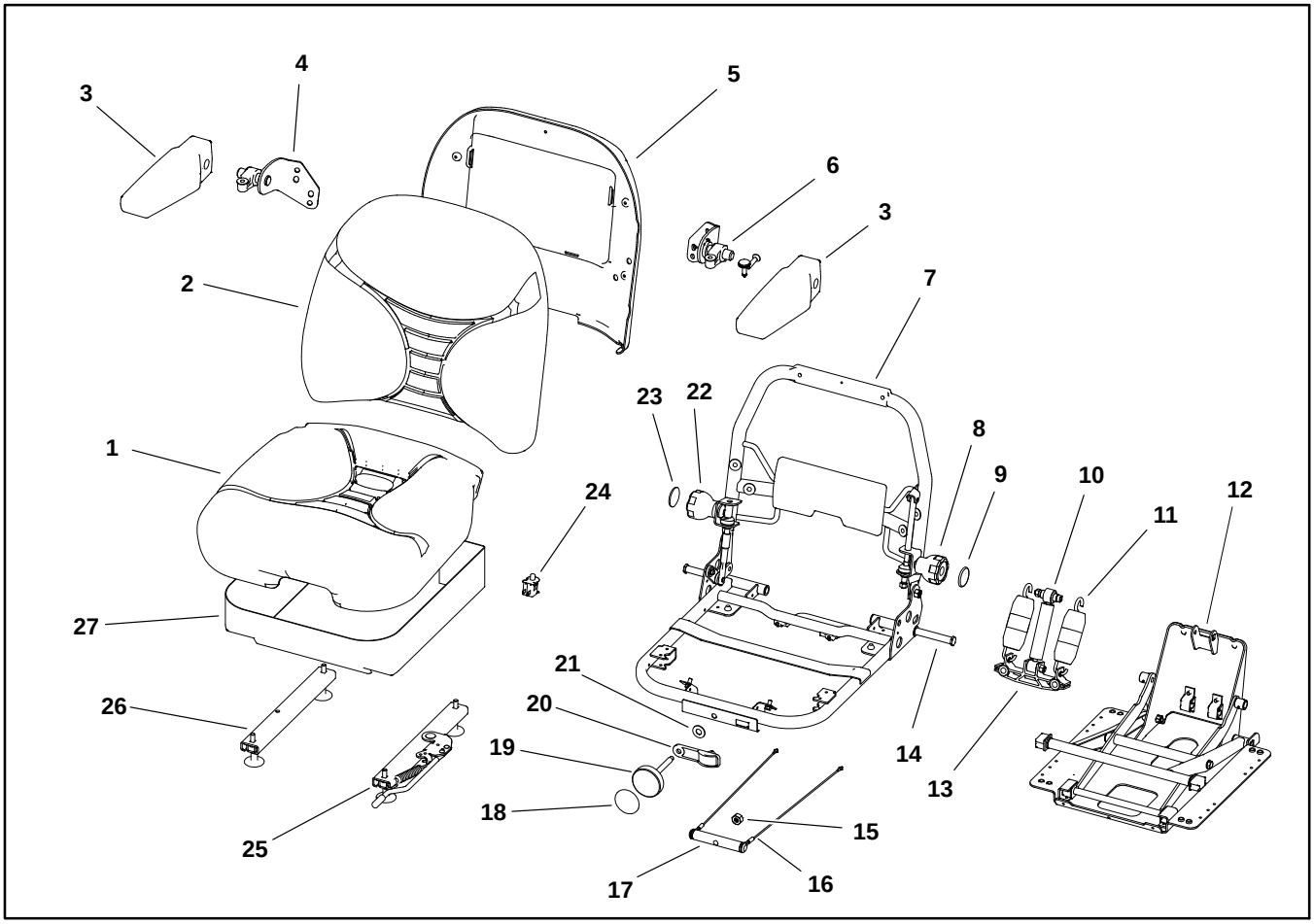

Figure 58

1. Bottom cushion
2. Back cushion
3. Armrest
4. RH armrest mount assembly
5. Back panel
6. LH armrest mount assembly
7. Seat frame assembly
8. Lumbar support knob
9. Label
10. Shock absorber assembly
11. Suspension spring (2)
12. Suspension base
13. Spring saddle
14. Bearing shaft
15. Hex nut
16. Cable (2)
17. Weight adjust bar
18. Label
19. Weight adjustment knob
20. Weight indicator
21. Washer
22. Back rest knob
23. Label
24. Seat switch
25. Seat adjuster
26. Seat adjuster (slave)
27. Seat boot

Removal (Fig. 58)

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

2. Remove armrest assemblies and then back panel from back of seat.

3. Carefully peel label from back rest knob (Fig. 59). Remove nut and knob from seat frame.

4. Remove six (6) clips that secure back cushion to seat frame. Remove back cushion.

5. Remove two (2) cap screws that secure bottom cushion to seat frame. Remove bottom cushion.

6. Remove hex nut that secures weight adjustment knob to weight adjust bar. Remove adjustment knob from weight adjust bar to remove cable tension. Remove cables from spring saddle.

7. Remove eighteen (18) clips from seat frame to separate seat boot from frame.

8. Remove two (2) roll pins that secure bearing shafts to seat frame. Remove bearing shafts and split nylon bushings from frame.

9. Lift seat frame from suspension base.

10. Remove nut and bolt that secure top of shock absorber to suspension base.

11. Slide spring saddle from spring arm while disengaging springs at top of suspension base.

12. Remove springs from spring saddle. Pay close attention to orientation of springs and spring saddle for assembly purposes.

13. Remove nut and bolt that secure bottom of shock absorber to spring saddle. Remove shock absorber.

Installation (Fig. 58)

1. Secure bottom of shock absorber to spring saddle with nut and bolt.

2. Attach springs to spring saddle in the same orientation noted during removal.

3. Position spring saddle on spring arm and slide down. Hook spring ends on top of suspension base.

4. Using the suspension base as a pry point, place a pry bar on the top of the spring saddle and push saddle down to elongate springs enough to allow installation of the bolt to the top of shock absorber and suspension base. Secure bolt in position with nut.

5. Position seat frame to suspension base.

6. Align bearing blocks on frame with receivers on suspension base and guide frame into place. Insert two (2) bearing shafts and split nylon bushings to suspension base and frame. Secure bearing shafts with two (2) roll pins.

7. Position cables under the seat frame bars and on top of suspension base. Insert cable ends in spring saddle slots.

8. Pass weight adjustment knob shaft through weight indicator, washer and seat frame hole. Thread knob shaft into weight adjust bar. Install hex nut on knob shaft.

9. Position seat boot to seat frame and secure with eighteen (18) clips.

10. Position bottom cushion to seat frame and secure with two (2) cap screws.

11. Position back cushion to seat frame and secure with six (6) clips.

12. Assemble back rest knob to seat and secure with nut. Apply label to knob.

13. Assemble back panel and then armrest assemblies to seat.

14. Install operator seat on machine (see Operator Seat Installation in this section).

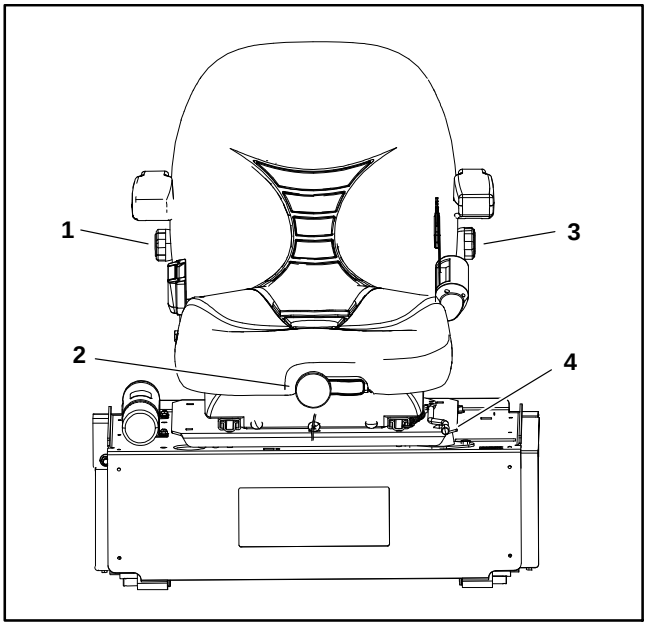

Figure 59

1. **Back rest knob**
2. **Seat suspension knob**
3. **Lumbar support knob**
4. **Seat position lever**

Operator Seat Service (Machines with Operator Cab)

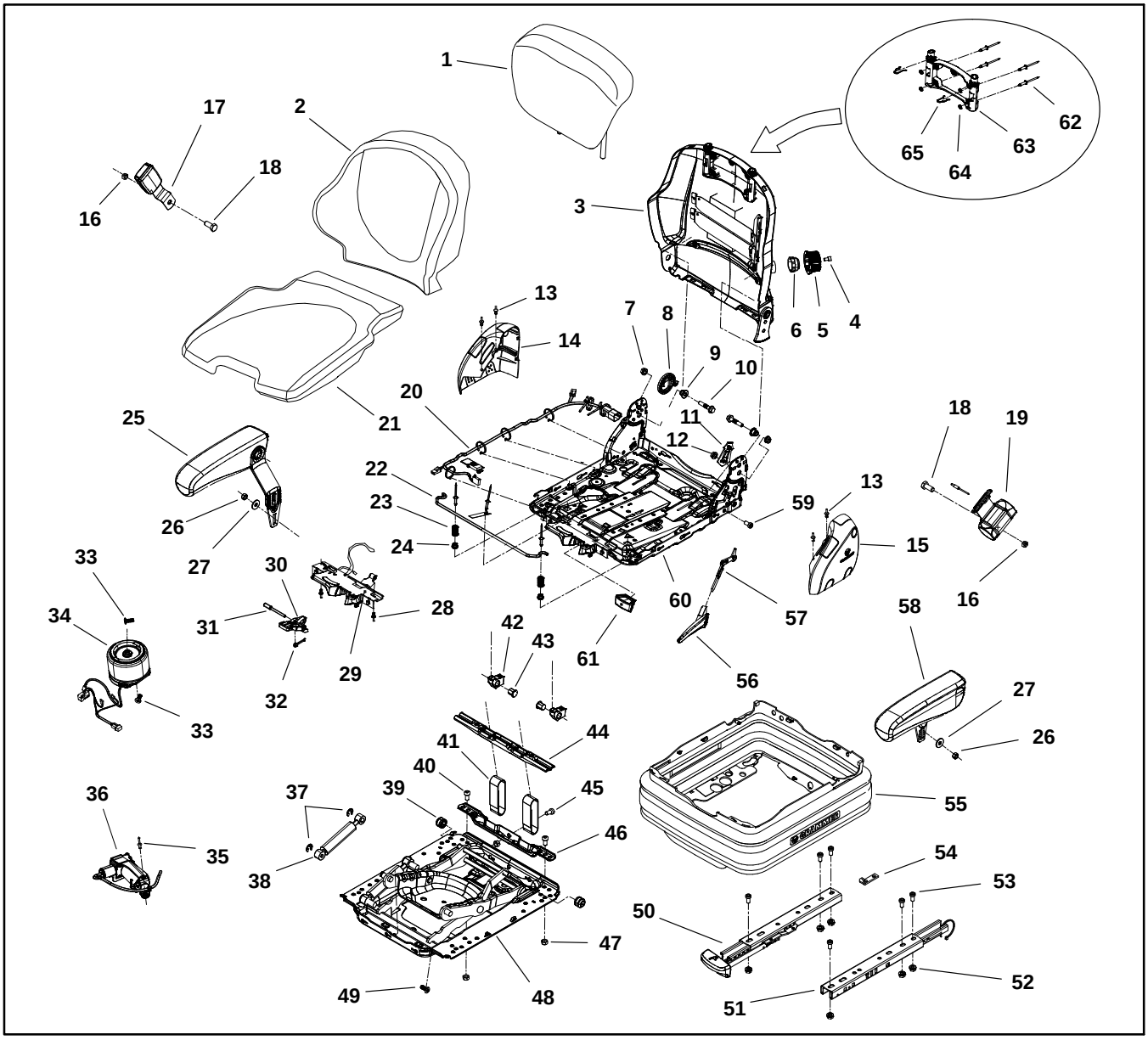

Figure 60

1. Back extension
2. Back cushion
3. Back panel
4. Screw
5. Handle
6. Knob
7. Flange nut
8. Spring
9. Bushing
10. Screw
11. Bracket
12. Nut
13. Rivet
14. RH cover
15. LH cover
16. Nut
17. Seat belt latch
18. Bolt
19. Seat belt
20. Seat wire harness
21. Seat cushion
22. Adjuster rod
23. Spring
24. Spring seat
25. RH armrest
26. Nut
27. Washer
28. Rivet
29. Handle assembly
30. Lever
31. Pin
32. Spring
33. Torx screw
34. Air spring assembly
35. Rivet
36. Compressor assembly
37. Retaining ring
38. Shock absorber
39. Suspension pivot bushing
40. Socket head screw
41. Band
42. Suspension pivot
43. Bushing
44. Bracket
45. Cap screw
46. Bracket
47. Nut
48. Suspension assembly
49. Screw
50. RH seat adjuster
51. LH seat adjuster
52. Flange nut (6)
53. Screw (6)
54. Bracket
55. Bellows
56. Backrest handle
57. Backrest lever
58. LH armrest
59. Screw
60. Seat base assembly
61. Handle
62. Rivet
63. Extension bracket
64. Washer
65. Clip

NOTE: Refer to your parts catalog for operator seat components that are available.

Disassembly (Fig. 60)

1. Remove operator seat from machine if desired (see Operator Seat Removal in this section).

2. Disassemble operator seat as necessary using Figure 60 as a guide.

Assembly (Fig. 60)

1. Assemble operator seat using Figure 60 as a guide.

2. If operator seat was removed from machine, secure seat to machine (see Operator Seat Installation in this section).

Hood

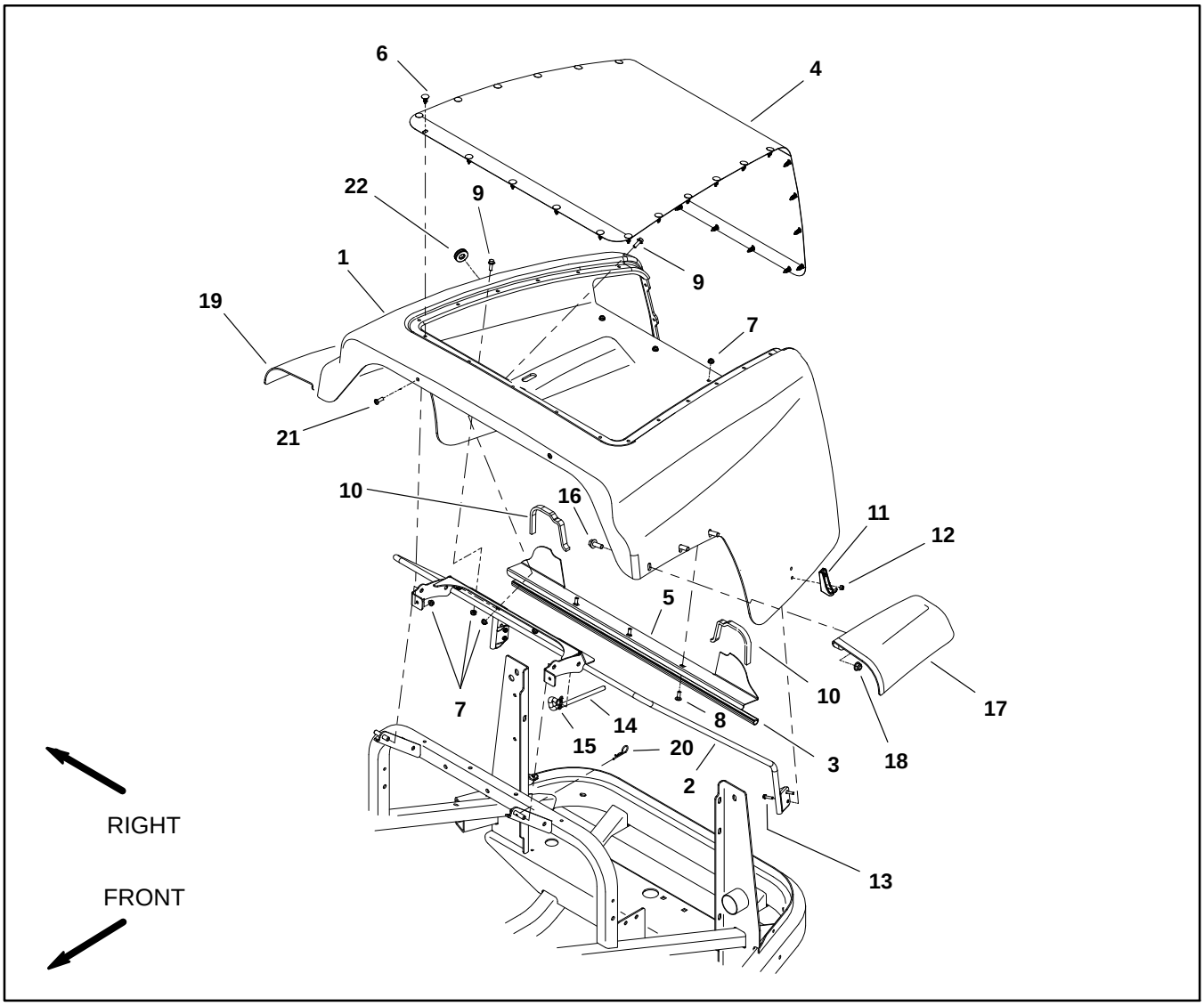

Figure 61

1. Hood
2. Hood mount
3. Bulb seal
4. Screen
5. Hood seal
6. Plug (29)
7. Flange nut (11)
8. Carriage screw (3)
9. Flange head screw (8)
10. Foam seal (2)
11. Latch (2)
12. Lock nut (2 per latch)
13. Screw (2 per latch)
14. Prop rod
15. Cotter pin
16. Flange head screw (6)
17. LH rear fender
18. Flange nut (6)
19. RH rear fender
20. Hair pin
21. Screw (2)
22. Grommet

Removal (Fig. 61)

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

2. Unlatch and raise hood.

3. Remove hair pin (item 20) from frame rod to allow hood removal.

4. Slide hood to left side of machine to free hood support from frame rods.

5. Remove hood from machine.

6. If necessary, remove hood components using Figure 61 as a guide.

7. Check condition of all seals on frame and hood. Replace damaged or missing seals.

IMPORTANT:If there is a significant amount of debris on radiator, verify the sealing of the radiator area.

Installation (Fig. 61)

1. Install all removed hood components using Figure 61 as a guide. If intake screen was removed from hood, make sure that hood seal (item 5) and hood mount (item 2) are attached to hood before installing screen. Secure screen to hood with plugs.

2. Check that no gaps exist between hood components and hood. If necessary, seal gaps with silicone caulk.

3. Position hood to machine and slide hood support onto frame rods.

4. Install hair pin (item 20) to retain hood.

5. Close and latch hood.

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Chapter 7

Cutting Deck

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General Information

Cutting Deck Specifications

Several cutting decks are available for the Groundsmaster 360. Refer to the Operator's Manual for specifications and optional accessories for the cutting deck used on your Groundsmaster.

Operator's Manual

The 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.

Factors That Can Affect Cutting Performance

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” 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 and turf conditions.

Factor	**Possible Problem/Correction**
1. Maximum governed engine speed.	Check maximum governed engine speed. Adjust engine speed to specifications if necessary (see Chapter 3 − Kubota Diesel Engine).
2. Blade speed.	All cutting deck blades should rotate at the same speed.
3. Tire pressure.	Check air pressure of all tires including castor tires. Adjust to pressures specified in Operator’s Manual.
4. Blade condition.	Sharpen blades if their cutting edges are dull or nicked. Inspect blade sail for wear or damage. Replace blade if needed.
5. Mower housing condition.	Make sure that deck cutting chamber is in good condition. Keep underside of deck clean. Debris buildup will reduce cutting performance.
6. Height−of−cut.	Adjust deck as specified in the Operator’s Manual. Effective (actual) height−of−cut will be different than the bench set height−of−cut.
7. Cutting deck alignment and ground following.	Check lift arms for wear, damage or binding. Also, inspect for bent or damaged pivot shafts. Cutting deck adjustment should allow the rear of the blade plane to be 5/16” (8 mm) higher than the front of the blade plane.
8. Anti−scalp roller condition.	All anti−scalp rollers should rotate freely. Replace rollers or roller shafts if worn or damaged.
9. Grass conditions.	Mow when grass is dry for best cutting results. Also, remove only 1” (25 mm) or 1/3 of the grass blade when cutting.

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WARNING

Do not start the engine and engage the PTO switch when the PTO drive shaft is disconnected from the cutting deck. If the engine is started and the PTO shaft is allowed to rotate, serious personal injury and machine damage could result. If the PTO drive shaft is disconnected from the cutting deck, disconnect PTO solenoid coil connector from wire harness to prevent unintentional engagement of the PTO clutch.

CAUTION

Never work on the cutting deck with the engine running. Always stop engine and remove key from ignition switch first.

Blade Stopping Time

The blades of the cutting deck should come to a complete stop in less than seven (7) seconds after the PTO switch is disengaged.

NOTE: When checking blade stopping time, make sure the deck is lowered onto a clean section of turf or hard surface to avoid dust and debris.

To verify blade stopping time, have a second person stand back a safe distance from the machine and watch the blades on the cutting deck. When the machine operator disengages the cutting deck, record the time it takes for the blades to come to a complete stop. If this time is greater than seven (7) seconds, the PTO brake assembly in the transmission should be inspected.

Cutting Deck Removal and Installation

Deck Removal

1. Park machine on a level surface with the cutting deck in the **fully raised** position. Stop engine, engage parking brake and remove key from the ignition switch.

NOTE: When the cutting deck is in the raised position, pull link torsion spring tension is reduced making it much easier to disconnect pull links from machine.

2. Disconnect pull link from each side of machine (Fig. 1):

CAUTION

Be careful when disconnecting the pull links. The pull link torsion springs may cause some rotation of pull links during the removal process.

A. Remove shoulder screw that secures retainer pin to carrier frame.

B. Carefully slide retainer pin from carrier frame and pull link.

3. Note location of HOC pin in HOC bracket for assembly purposes (Fig. 2). Remove HOC pin from HOC bracket.

NOTE: If cutting deck is lowered onto suitable furniture dollies, removal from under the machine is simplified.

4. Start engine and fully lower cutting deck. Stop engine and remove key from the ignition switch.

WARNING

Do not start the engine and engage the PTO switch when the PTO drive shaft is disconnected from the cutting deck. If the engine is started and the PTO shaft is allowed to rotate, serious personal injury and machine damage could result. If the PTO drive shaft is disconnected from the cutting deck, disconnect PTO solenoid coil connector from wire harness to prevent unintentional engagement of the PTO clutch.

5. To prevent unintentional engagement of the PTO clutch, disconnect the wire harness electrical connector from the PTO solenoid valve coil connector (Fig. 3).

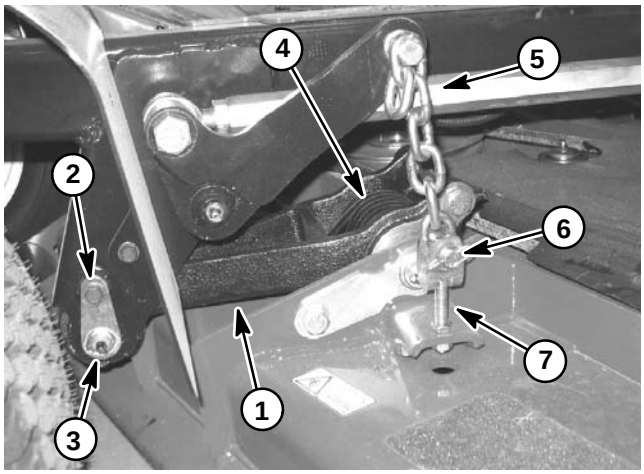

Figure 1

1. **Pull link (deck raised)**
2. **Shoulder screw**
3. **Retainer pin**
4. **Torsion spring**
5. **Deck lift chain**
6. **Clevis pin**
7. **Adjustment clevis**

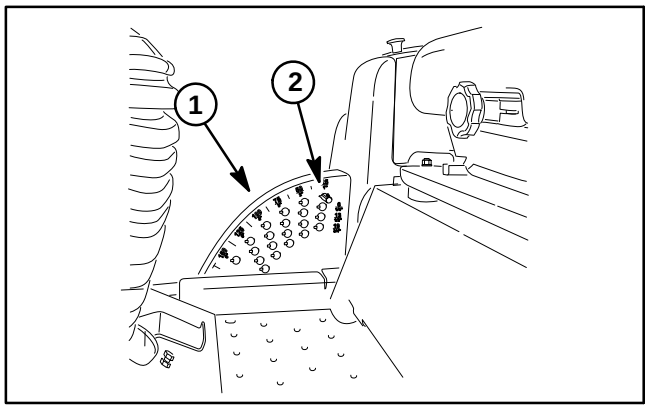

Figure 2

1. **HOC bracket**
2. **HOC pin**

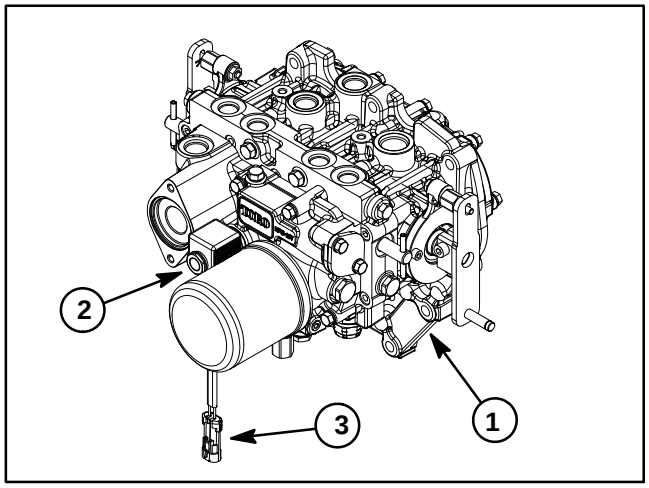

Figure 3

1. **Transmission**
2. **Solenoid valve and coil**
3. **Coil connector**

6. Disconnect end yoke of PTO drive shaft from cutting deck gearbox shaft (see PTO Drive Shaft Removal in the Service and Repairs section of Chapter 6 − Chassis). Position and support drive shaft end away from deck gearbox.

7. Remove four (4) ring pins and clevis pins that secure deck lift chains to adjustment clevises on cutting deck (Fig. 1).

8. Slide cutting deck away from machine.

Deck Installation

1. Slide cutting deck under carrier frame of machine.

2. Install four (4) clevis pins and ring pins to secure deck lift chains to adjustment clevises on cutting deck (Fig. 1).

3. Connect end yoke of PTO drive shaft to cutting deck gearbox shaft (see PTO Drive Shaft Installation in the Service and Repairs section of Chapter 6 − Chassis).

4. Start engine and fully raise cutting deck. Stop engine and remove key from the ignition switch.

CAUTION

Be careful when connecting the pull links to the machine. The pull link torsion springs may cause some rotation of pull links during installation.

5. Align pull link to carrier frame and attach link with retainer pin. Secure retainer pin to frame with shoulder screw (Fig. 1).

6. Install HOC pin into HOC bracket to allow desired height−of−cut (Fig. 2).

7. Connect the wire harness electrical connector to the PTO solenoid valve coil connector (Fig. 3).

Idler Assembly

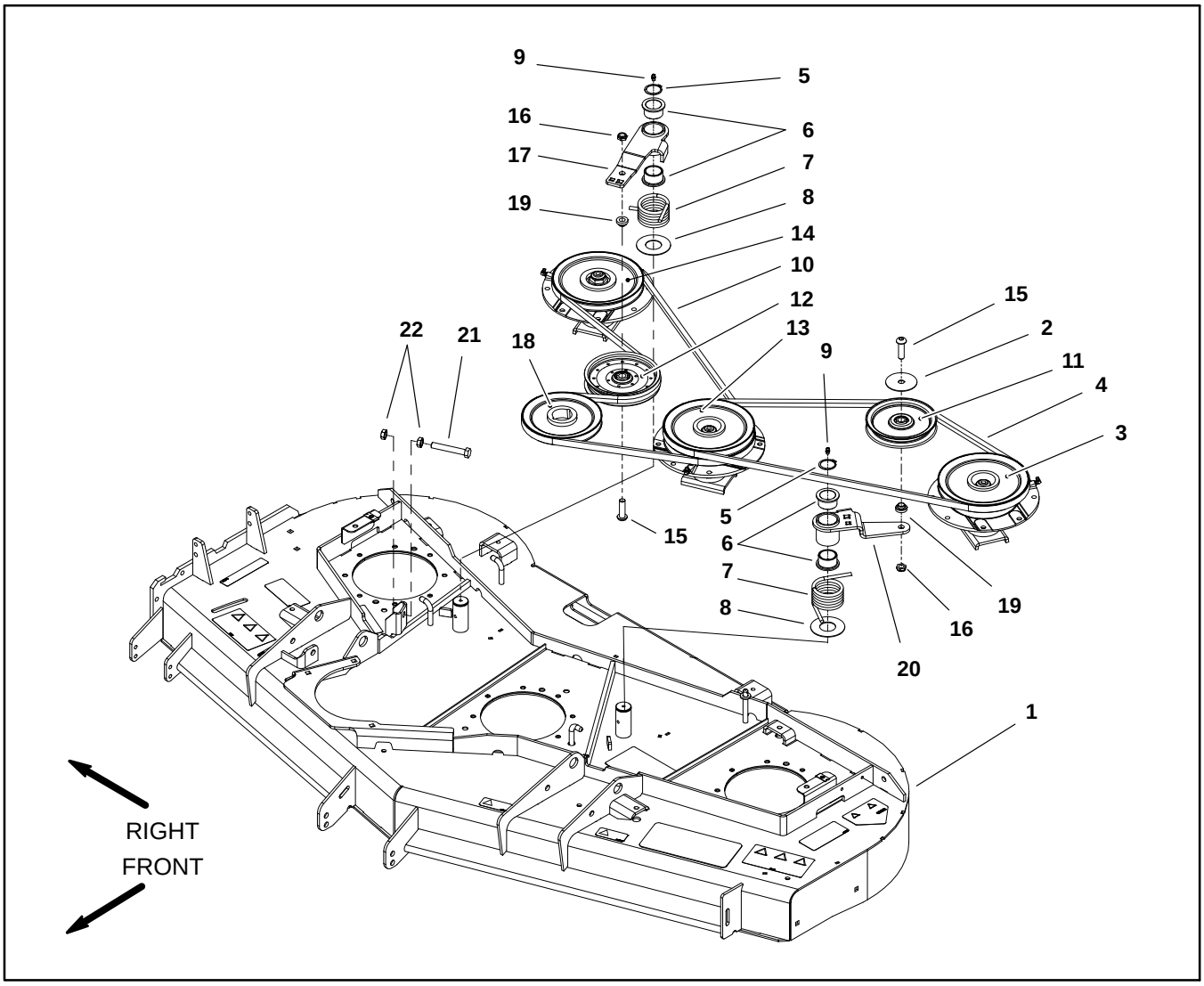

Figure 4

1. Cutting deck
2. Flat washer
3. LH spindle assembly
4. Drive belt
5. Snap ring
6. Flange bushing (2 per idler)
7. Torsion spring
8. Washer
9. Grease fitting
10. Drive belt
11. Idler pulley
12. Idler pulley
13. Center spindle assembly
14. RH spindle assembly
15. Socket head screw
16. Lock nut
17. RH idler arm
18. Drive pulley
19. Idler spacer
20. LH idler arm
21. Stop bolt
22. Jam nut

Removal (Fig. 4)

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

2. Lift the footrest, exposing the top of the cutting deck. Support the footrest with prop rod.

3. Remove deck covers from top of cutting deck.

4. On right side idler arm, loosen jam nuts (item 22) that secure idler stop bolt (item 21) to cutting deck to allow clearance between idler and stop bolt.

5. Remove drive belts from deck pulleys.

6. Insert nut driver or small piece of pipe onto the end of the torsion spring for the idler arm.

CAUTION

Be careful when removing tension from the idler arm torsion spring. The spring is under heavy load and may cause personal injury.

7. Carefully push the torsion spring end down and away from the idler arm to unhook the spring from the arm.

8. Remove snap ring that retains idler arm assembly to cutting deck.

9. Remove idler components as needed using Figure 4 as a guide.

Installation (Fig. 4)

1. Install removed idler components using Figure 4 as a guide. Secure idler arm assembly to cutting deck with snap ring.

2. Insert nut driver or small piece of pipe onto the end of the torsion spring for the idler arm.

CAUTION

Be careful when applying tension to the idler arm torsion spring. The spring is under heavy load and may cause personal injury.

3. Carefully push down on the torsion spring end to get the spring under the idler arm mounting plate. Then release the spring slowly to lock it into place.

4. Install drive belts to pulleys.

5. If idler arm on right side of cutting deck was removed, check that clearance between idler arm and stop bolt is from **0.100" to 0.160" (2.5 to 4.0 mm)** (Fig. 5). If necessary, adjust jam nut location on stop bolt to allow proper clearance.

6. Install deck covers to cutting deck. Lower the footrest.

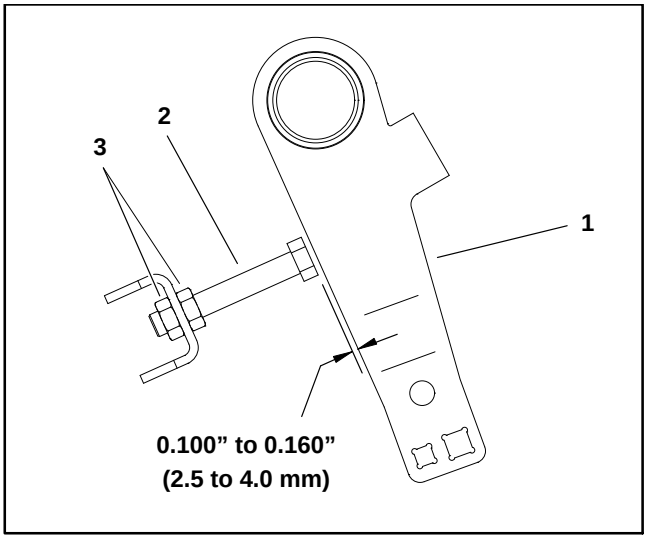

Figure 5

1. **Idler arm**
2. **Stop bolt**
3. **Jam nut (2)**

Blade Spindle

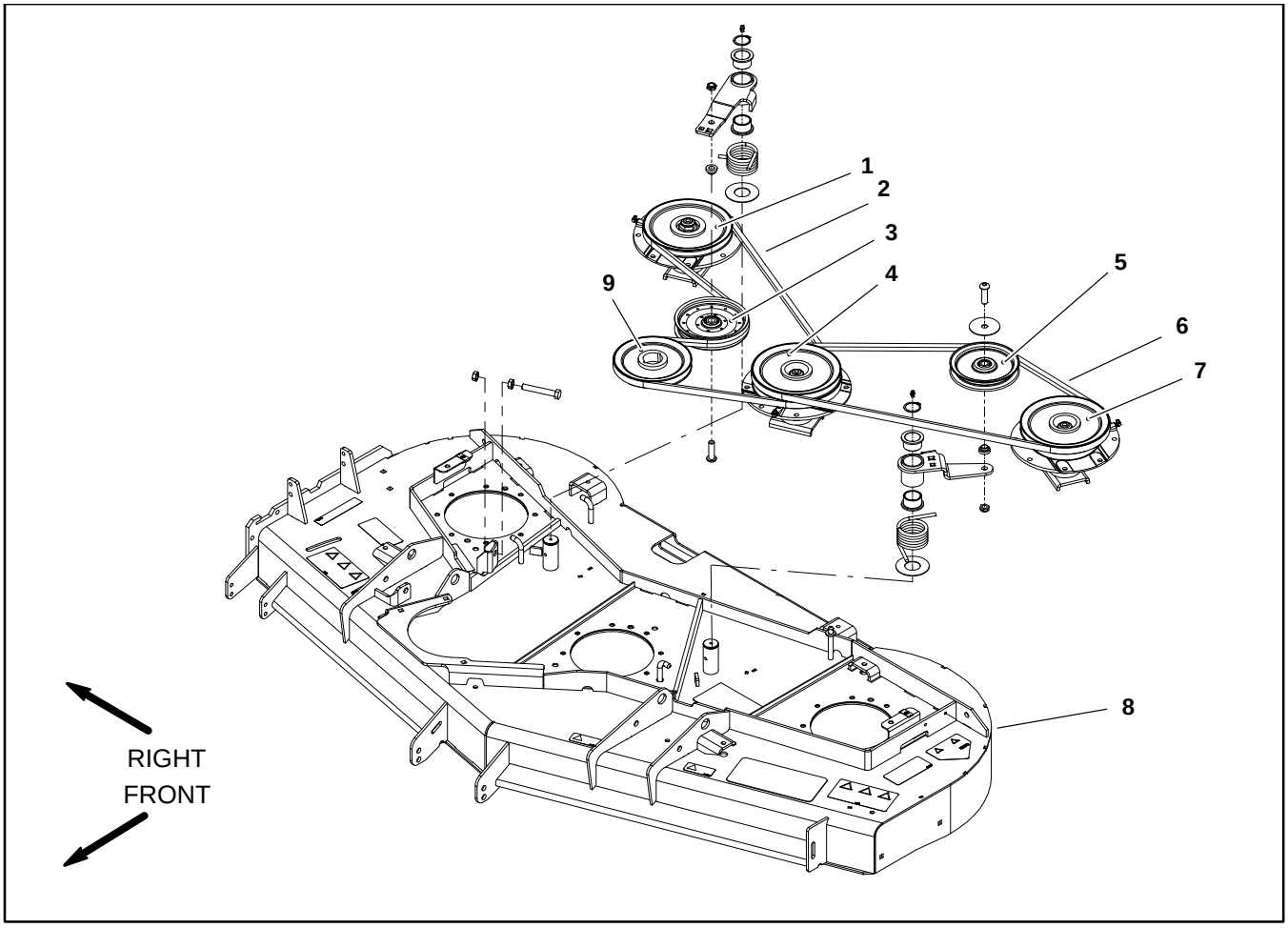

Figure 6

1. **RH spindle assembly**
2. **Drive belt**
3. **Idler pulley**
4. **Center spindle assembly**
5. **Idler pulley**
6. **Drive belt**
7. **LH spindle assembly**
8. **Cutting deck**
9. **Drive pulley**

Removal (Fig. 6)

1. Park machine on a level surface with cutting deck raised. Stop engine, engage parking brake and remove key from the ignition switch. Support the cutting deck so it cannot fall accidentally.

2. Lift the footrest, exposing the top of the cutting deck. Support the footrest with prop rod.

3. Remove belt covers from top of cutting deck.

NOTE: When removing deck drive belt, use breaker bar in idler arm square drive holes to rotate idler pulley away from belt (Fig. 7).

4. Remove drive belt from deck pulleys (see Operator's Manual).

5. Remove cutting blade, anti−scalp cup and blade bolt from spindle to be serviced (Fig. 8).

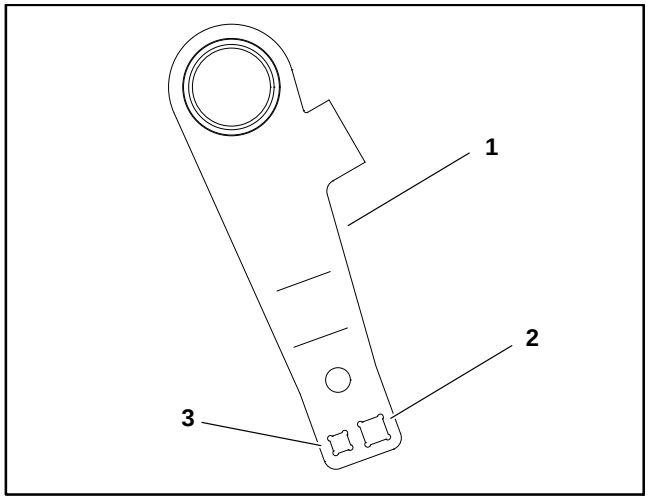

Figure 7

1. **Idler arm (RH shown)**
2. **1/2" square drive**
3. **3/8" square drive**

6. Remove spindle assembly from deck (Fig. 8).

   A. On decks before serial number 314000000, remove eight (8) flange head screws and flange nuts that secure spindle assembly to deck. Remove spindle assembly.

   B. On decks after serial number 314000000, remove eight (8) flange nuts that secure spindle assembly to deck. Ribbed neck bolts are pressed into spindle housing. Remove spindle assembly and doubler ring.

7. If ribbed neck bolts are removed from spindle housing (serial number above 314000000), make sure that bolts are pressed into housing so that the underside of the head is squarely seated against the housing after installation.

Installation (Fig. 6)

1. Position spindle on cutting deck noting orientation of grease fitting (Fig. 9). Secure spindle assembly to deck with removed fasteners.

2. Install cutting blade, anti−scalp cup and blade bolt (Fig. 8). Tighten blade bolt from **88 to 108 ft−lb (119 to 146 N−m)**.

3. Slowly rotate cutting blades to verify that blades do not contact any deck component(s).

4. Install drive belt to pulleys.

5. Lubricate spindle grease fittings.

6. Install belt covers to cutting deck. Lower the footrest.

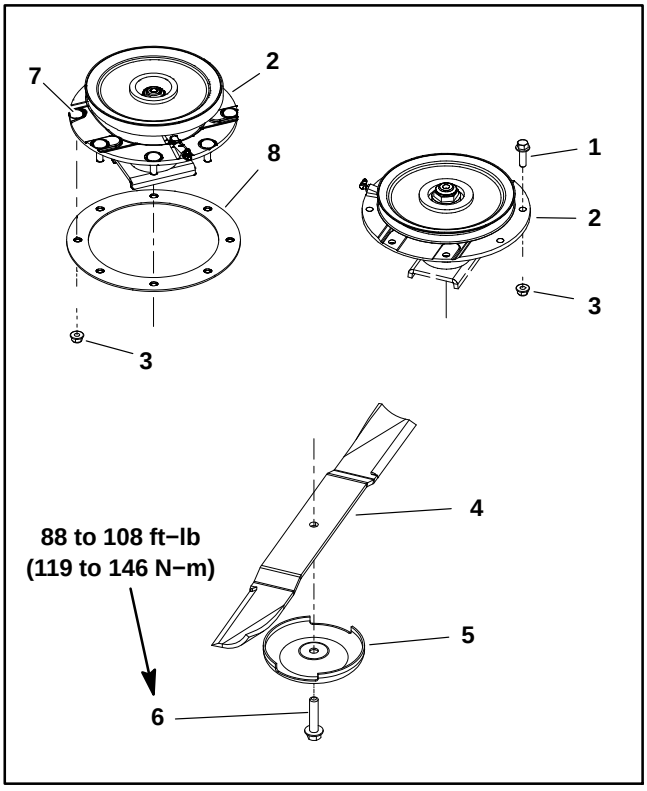

Figure 8

1. **Flange screw (8)**
2. **Spindle assembly**
3. **Flange nut (8)**
4. **Blade**
5. **Anti−scalp cup**
6. **Blade bolt**
7. **Ribbed bolt (8)**
8. **Doubler ring**

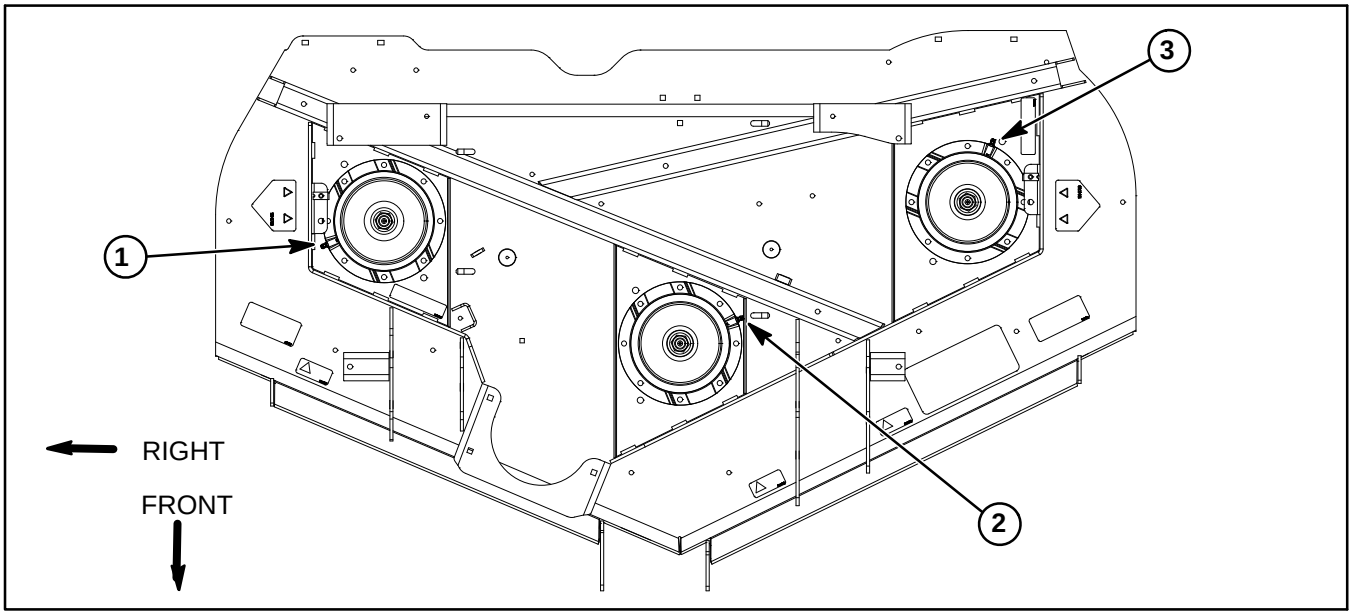

Figure 9

1. **RH spindle grease fitting**
2. **Center spindle grease fitting**
3. **LH spindle grease fitting**

Blade Spindle Service

Disassembly (Fig. 10)

1. Remove lock nut from top of spindle shaft.

2. Remove special hardened washer and pulley from 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. Remove oil seals from spindle housing.

5. Remove the bearing cones, O−ring, inner bearing spacer and spacer ring from 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. 10)

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. 11). These parts cannot be purchased separately. Also, do not mix bearing set components from one deck spindle to another.

NOTE: A replacement bearing spacer set includes the inner spacer and outer spacer (items 4 and 5 in Fig. 11). Do not mix bearing spacers from one deck spindle to another.

IMPORTANT: If new bearings are installed into a used spindle housing, it may not be necessary to replace the original large snap ring. If the original snap ring is in good condition with no evidence of damage (e.g. spun bearing), leave the snap ring in the housing and discard the snap ring that comes with the new bearings. If the large snap ring is found to be damaged, replace the snap ring.

1. If large snap ring was removed from spindle housing, install snap ring into housing groove. Make sure snap ring is fully seated in housing groove.

2. Install outer spacer into top of spindle housing. The spacer should fit against the snap ring.

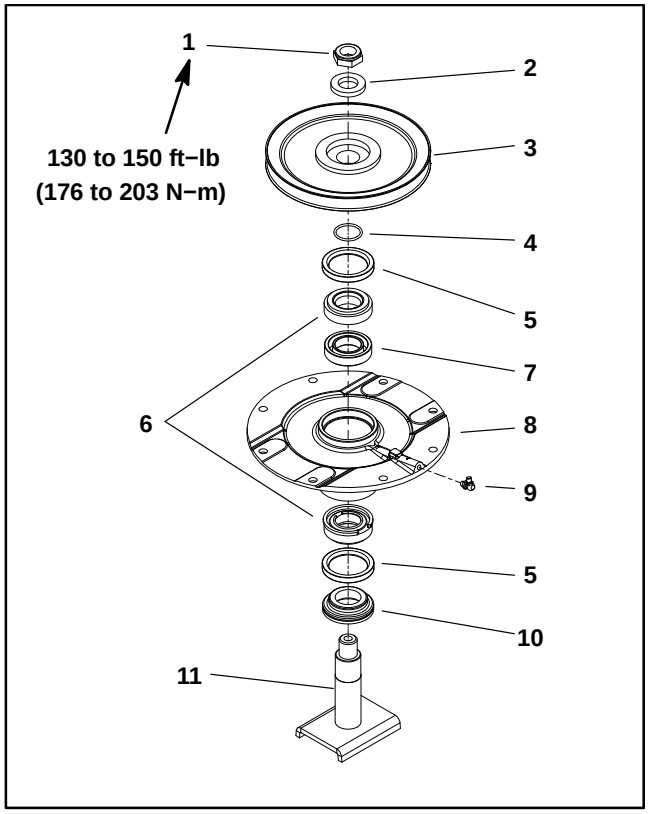

Figure 10

1. **Lock nut**
2. **Special hardened washer**
3. **Pulley**
4. **O−ring**
5. **Oil seal**
6. **Bearing set**
7. **Spacer set**
8. **Spindle housing**
9. **Grease fitting**
10. **Shaft spacer**
11. **Spindle shaft**

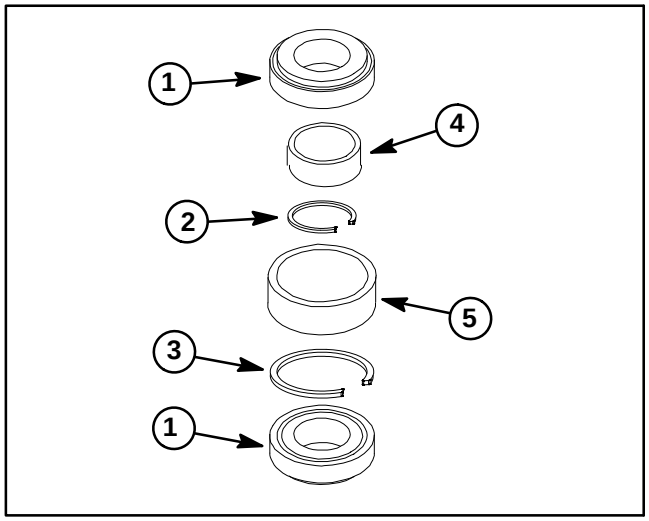

Figure 11

1. **Bearing (2)**
2. **Spacer ring**
3. **Large snap ring**
4. **Inner spacer**
5. **Outer 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 spacer previously installed, and the bottom bearing cup must contact the snap ring. Make sure that the assembly is correct by supporting the first bearing cup and pressing the second cup against it (Fig 12).

4. Pack the bearing cones with grease. Apply a film of grease on lips of oil seals and O−ring.

5. Install lower bearing cone and oil seal into bottom of spindle housing. **NOTE:** The bottom seal must have the lip facing out (down) (Fig. 13). This seal installation allows grease to purge from the spindle during the lubrication process.

IMPORTANT: If bearings are being replaced, make sure to use the spacer ring that is included with new bearing set (Fig. 11).

6. Slide spacer ring and inner bearing spacer into spindle housing, then install upper bearing cone and oil seal into top of housing.

NOTE: The upper seal must have the lip facing in (down) (Fig. 13). Make sure upper seal is flush to 0.080" (2.0 mm) recessed to housing surface.

7. Inspect the spindle shaft and shaft spacer to make sure there are no burrs or nicks that could possibly damage the oil seals. Lubricate the shaft and spacer with grease.

8. Install spindle shaft spacer onto shaft. Place thin sleeve or tape on spindle shaft splines to prevent seal damage during shaft installation.

9. Carefully slide spindle shaft with spacer up through spindle housing. The bottom oil seal and spindle spacer fit together when the spindle is fully installed.

10. Install O−ring to top of spindle shaft (Fig. 14).

11. Install pulley (hub down), special hardened washer and lock nut to spindle shaft (Fig. 14). Tighten lock nut from **130 to 150 ft−lb (176 to 203 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.

12. Attach a hand pump grease gun to grease fitting on housing and fill housing cavity with grease until grease starts to come out of lower seal.

13. Rotate spindle shaft to make sure that it turns freely.

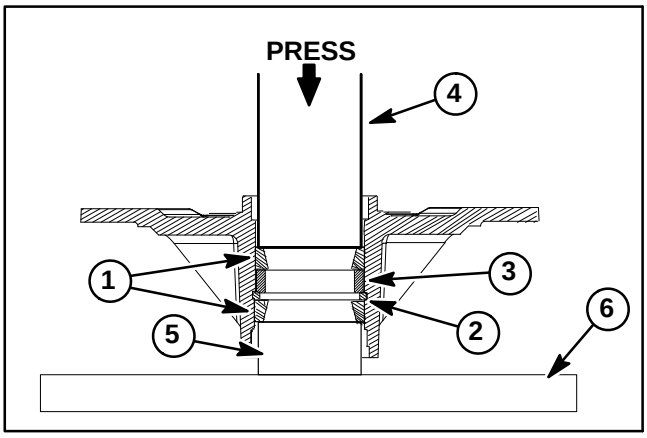

Figure 12

1. **Bearing cup**
2. **Large snap ring**
3. **Outer spacer**
4. **Arbor press**
5. **Support**
6. **Arbor press base**

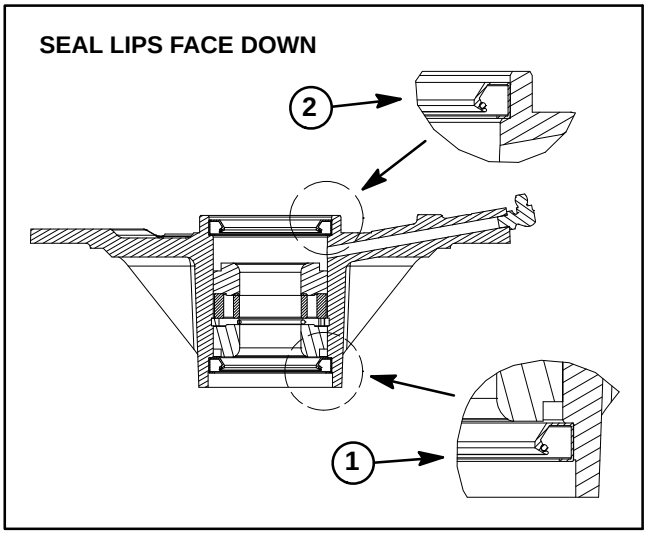

Figure 13

1. **Bottom seal installation**
2. **Upper seal installation**

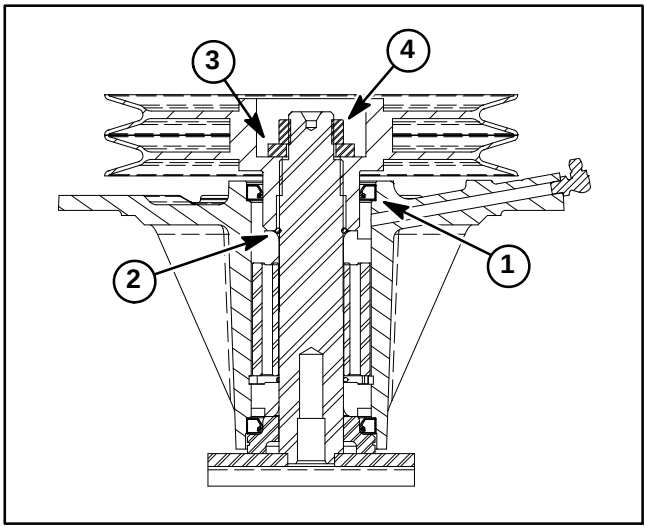

Figure 14

1. **Upper seal**
2. **O−ring**
3. **Flat washer**
4. **Lock nut**

Gearbox

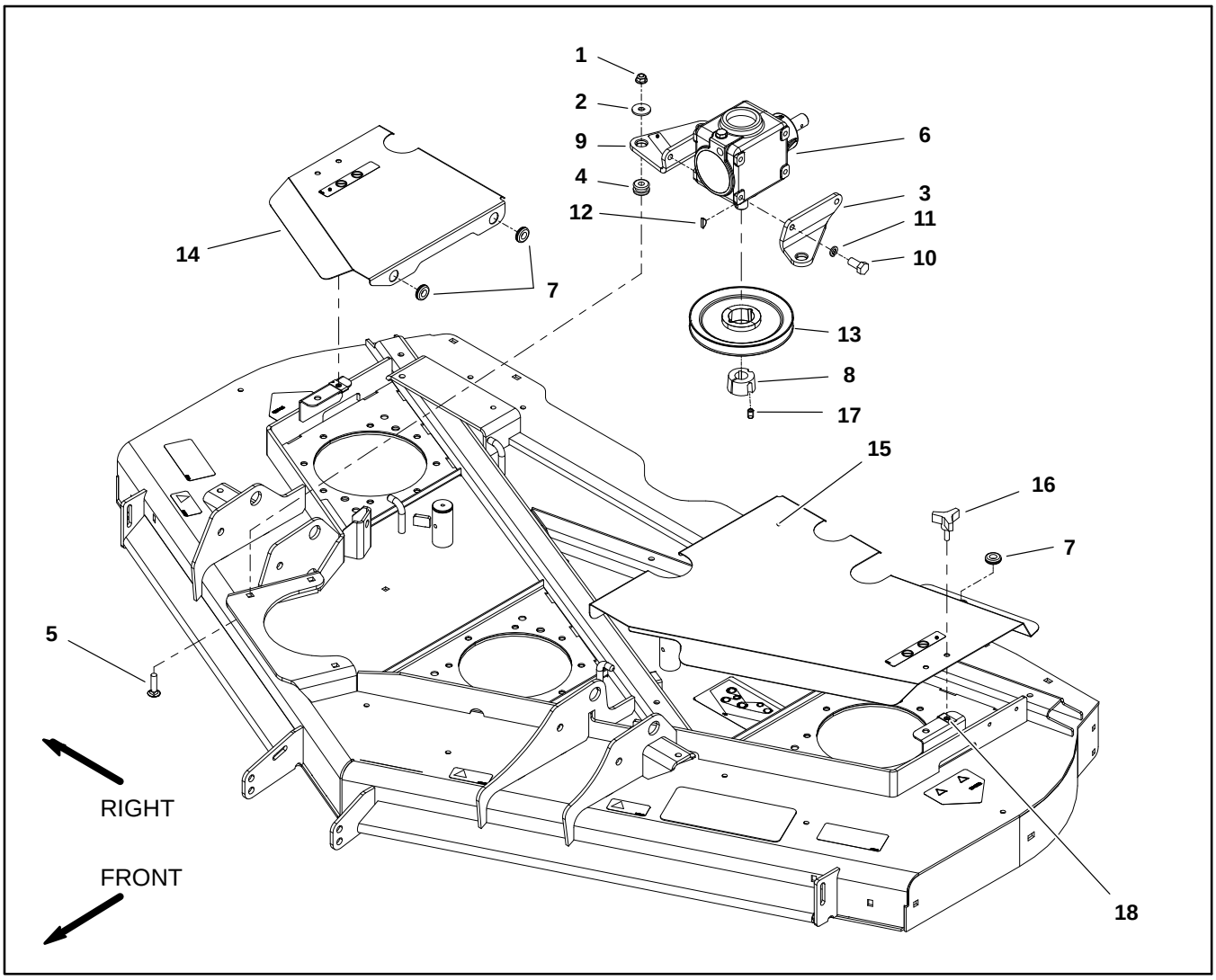

Figure 15

1. **Flange nut (3)**
2. **Washer (3)**
3. **LH gearbox bracket**
4. **Mount (3)**
5. **Carriage screw (3)**
6. **Gearbox**
7. **Grommet (5)**
8. **Taper−lock bushing**
9. **RH gearbox bracket**
10. **Cap screw (4)**
11. **Lock washer (4)**
12. **Woodruff key**
13. **Deck drive pulley**
14. **RH deck cover**
15. **LH deck cover**
16. **Knob (2)**
17. **Set screw (2)**
18. **Retainer nut (2)**

Removal (Fig. 15)

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

2. Lift the footrest, exposing the top of the cutting deck. Support the footrest with prop rod.

3. Remove belt covers from top of cutting deck.

4. Remove drive belt from deck pulleys.

WARNING

Do not start the engine and engage the PTO switch when the PTO drive shaft is disconnected from the cutting deck. If the engine is started and the PTO shaft is allowed to rotate, serious personal injury and machine damage could result. If the PTO drive shaft is disconnected from the cutting deck, disconnect PTO solenoid coil connector from wire harness to prevent unintentional engagement of the PTO clutch.

5. Disconnect end yoke of PTO drive shaft from cutting deck gearbox shaft (see PTO Drive Shaft Removal in the Service and Repairs section of Chapter 6 − Chassis). Position and support drive shaft end away from deck gearbox.

6. Remove four (4) cap screws (item 10) and lock washers (item 11) that secure gearbox assembly to gearbox brackets.

7. Remove fasteners that secure left side gearbox bracket (item 3) to deck mounting plate. Remove bracket from deck.

8. Remove gearbox assembly, with drive pulley attached, from deck. Drain lubricant from gearbox.

9. Remove two (2) set screws that secure taper−lock bushing to drive pulley on gearbox shaft.

10. Thread one of the removed set screws into threaded hole of bushing (Fig. 16). Tighten set screw to loosen bushing from pulley hub.

11. Slide bushing and pulley from gearbox shaft. Locate and retrieve woodruff key.

12. If necessary, remove and replace oil seals and oil caps in gearbox (Fig. 17).

NOTE: If internal gearbox wear or damage occurs, gearbox replacement is necessary. Internal gearbox components are not available.

Installation (Fig. 15)

1. Clean gearbox output shaft, pulley ID and taper−lock bushing thoroughly.

2. Position woodruff key, pulley and then taper−lock bushing to gearbox output shaft. Slide bushing to shoulder on shaft. Align threaded holes of pulley with non−threaded holes of bushing.

3. Lightly oil threads of set screws and install screws into threads of pulley (Fig. 16). Alternately and evenly tighten set screws to a torque from **180 to 250 in−lb (20 to 28 N−m)**.

4. Fill allen recess in set screws and bushing threads with grease to prevent dirt from packing into crevices.

5. Position gearbox assembly, with drive pulley attached, to deck.

6. Position and secure left side gearbox bracket (item 3) to deck mounting plate.

7. Secure gearbox assembly to gearbox brackets with four (4) cap screws (item 10) and lock washers (item 11).

8. Connect PTO drive shaft to gearbox (see PTO Drive Shaft Installation in the Service and Repairs section of Chapter 6 − Chassis). Make sure that wire harness is connected to PTO solenoid coil after drive shaft installation.

9. Install drive belt and deck covers to cutting deck.

10. Torque plug in gearbox to **175 in−lb (19.8 N−m)**. Fill gearbox with approximately 12 fluid ounces (355 ml) of SAE 80W90 gear lubricant.

11. Lower the footrest.

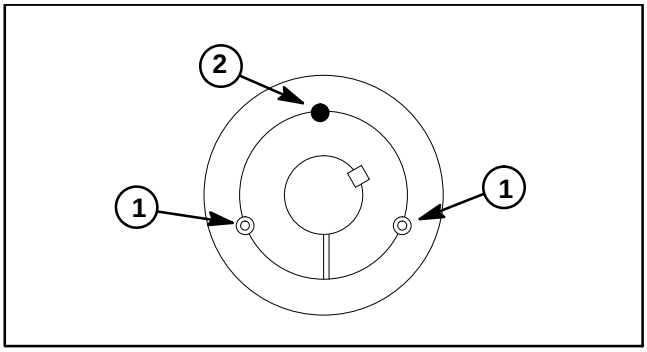

Figure 16

1. **Set screw − installation position**
2. **Set screw − removal position**

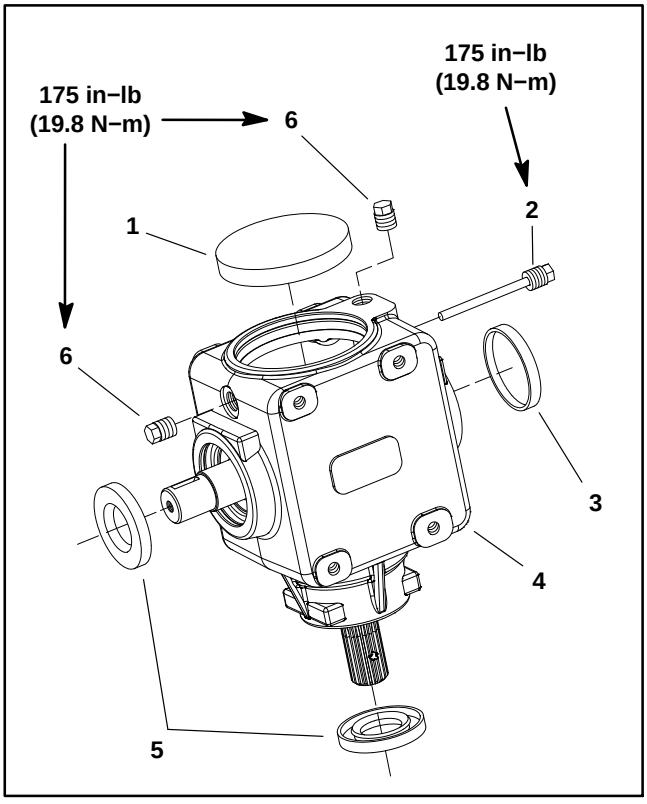

Figure 17

1. **Oil cap**
2. **Dipstick**
3. **Oil cap**
4. **Gearbox**
5. **Oil seal (2)**
6. **Plug (2)**

Cutting Deck Pull Links

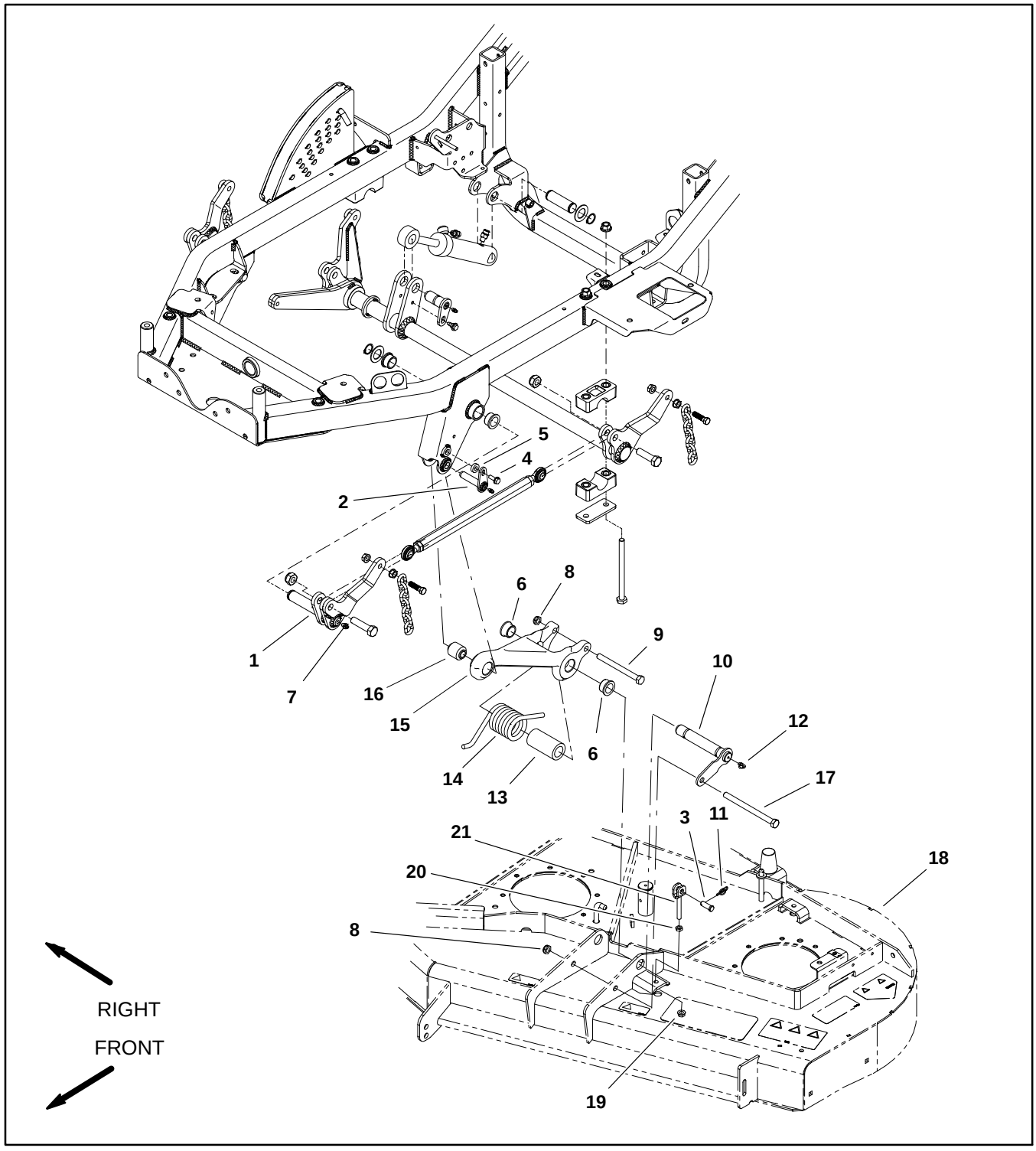

Figure 18

1. LH lift arm
2. Retainer pin
3. Clevis pin
4. Flange head screw
5. Spacer
6. Flange bushing (2)
7. Grease fitting
8. Lock nut
9. Cap screw
10. Pivot pin
11. Ring pin
12. Grease fitting
13. Spacer
14. Torsion spring
15. Pull link assembly
16. Bushing
17. Cap screw
18. Cutting deck
19. Flange nut
20. Jam nut
21. Adjustment clevis

Disassembly (Figs. 18 and 19)

1. Remove cutting deck from machine (see Cutting Deck Removal and Installation in this section).

CAUTION

Be careful when removing the pull links from the cutting deck. The pull link torsion springs may cause some rotation of pull links during the removal process.

2. To allow removal of pivot pin (item 10) from cutting deck and pull link, remove adjustment clevis from deck:

   A. Remove flange nut (item 19) that secures adjustment clevis to deck.

   B. Remove adjustment clevis from deck.

3. Remove lock nut (item 8) and cap screw (item 17) from deck and pivot pin (item 10).

4. Slide pivot pin (item 10) from deck and pull link.

5. Remove pull link with torsion spring and spacer from deck.

6. Inspect bushings (items 6 and 16) in pull link. Replace bushings if worn or damaged.

Assembly (Figs. 18 and 19)

1. Place spacer inside torsion spring and then fit spring and spacer into pull link. Make sure that torsion spring end is below cap screw (item 9) in pull link.

2. Position pull link to cutting deck.

3. Slide pivot pin (item 10) through cutting deck, pull link and spacer.

4. Insert cap screw (item 17) through pivot pin and holes in deck. Make sure that torsion spring end is below screw. Secure cap screw with lock nut.

5. Install adjustment clevis to deck and secure with flange nut.

6. Install cutting deck to machine (see Cutting Deck Removal and Installation in this section).

7. Lubricate pull link grease fittings.

8. Check cutting deck mismatch and pitch. Adjust if necessary.

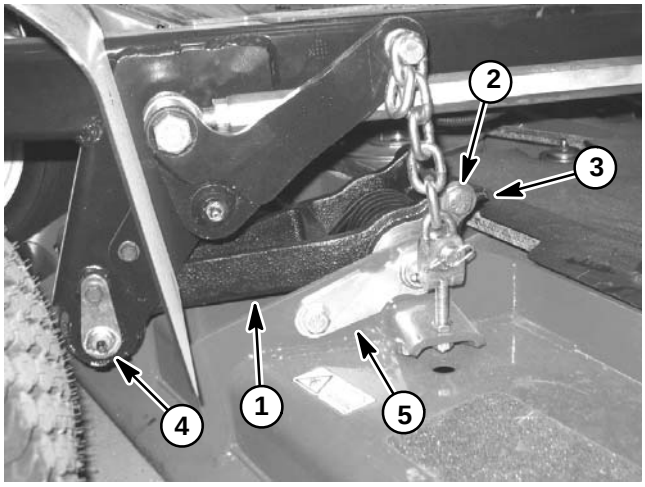

Figure 19

1. **Pull link (raised)**
2. **Cap screw**
3. **Torsion spring end**
4. **Retainer pin**
5. **Pivot pin**

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Chapter 8

(Serial Number Below 315000000)

Operator Cab

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VALEO COMPRESSOR SERVICE MANUAL

General Information

The information in this chapter pertains to Groundsmaster 360 machines with serial number below 314999999 that are equipped with an operator cab.

Operator's Manual

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

Electrical Components and Schematic

Information regarding Groundsmaster 360 electrical cab components (switches and relay) is included in Chapter 5 − Electrical System. The electrical schematic and harness drawings for the operator cab are included in Chapter 9 − Foldout Drawings.

Air Conditioning System

The air conditioning system used on the Groundsmaster 360 consists of the following components:

1. A compressor mounted on the engine and driven by a v−belt.

2. A condenser and condenser fan located on the top of the cab.

3. A drier−receiver, an expansion valve and an evaporator (combined with the heater core) mounted in the headliner of the cab.

4. The necessary hoses and tubes that connect the system components.

5. A fan motor that provides air movement through the evaporator and into the cab. The fan motor is located in the cab headliner and is also used for the cab heater system.

6. Operator controls to turn the air conditioning on, to adjust the fan speed and to control the cab air temperature.

7. A heater shut−off valve at the engine thermostat housing that allows engine coolant to the heater core to be blocked in hotter ambient temperatures. This feature maximizes air conditioner capacity during the summer.

Cab Heater System

The cab heater system used on the Groundsmaster 360 consists of the following components:

1. A heater core (combined with the A/C evaporator) located in the cab headliner.

2. Hoses to allow a circuit for engine coolant to circulate through the heater core. The heater core (combined with the A/C evaporator) is located in the headliner of the cab.

3. A fan motor that provides air movement through the heater core and into the cab. The fan motor is located in the cab headliner and is also used for the air conditioning system.

4. Operator controls to adjust the fan speed and to control the cab air temperature.

General Precautions for Removing and Installing Air Conditioning System Components

CAUTION

The air conditioning system is under high pressure. Do not loosen any system fitting or component until after the system has been completely discharged by a certified A/C service technician.

WARNING

Always wear safety goggles or a face shield when working with air conditioning system components. Also, do not allow refrigerant contact with your skin or eyes as there would be the possibility of serious injury.

CAUTION

Never use compressed air to leak test or pressure test the air conditioning system. Under certain conditions, pressurized mixtures of refrigerant and air can be combustible.

1. Before servicing any air conditioning system components, park machine on a level surface, apply parking brake, lower cutting deck or attachment and stop engine. Remove key from the ignition switch.

2. Clean machine before disconnecting, removing or disassembling any air conditioning system components. Thorough cleaning will prevent system contamination while performing service procedures.

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

4. Before loosening or removing any air conditioning system hose or other component, have a certified air conditioning service technician recover the system refrigerant and then evacuate the air conditioning system completely. It is illegal to vent refrigerant to the atmosphere.

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

6. If compressor is removed from machine, keep compressor in the same orientation as the installed position. This will prevent compressor oil from filling the compressor cylinders.

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

8. Always use a DOT approved tank for storing used and recycled refrigerants.

9. The Groundsmaster 360 air conditioning system uses R134a refrigerant. DO NOT use other refrigerants in the system. A/C system capacity is 1.13 pounds of R134a refrigerant.

10. Refrigerant containers (either full or empty) are under pressure that will increase if the containers are heated. DO NOT expose refrigerant containers to high heat sources or flame.

11. Be sure the work area is properly ventilated to prevent any accumulation of refrigerant or other fumes.

12. Make sure that caps are always placed on the pressure hose ports. These caps prevent refrigerant leakage from the system.

13. The drier−receiver component is used to collect moisture that will reduce air conditioning performance. If the air conditioning system is opened for component repair or replacement, drier−receiver replacement is recommended.

14. After installing air conditioning components, have a certified air conditioning service technician evacuate the air conditioning system completely, properly recharge the system with R134a refrigerant and then leak test the system.

Air Conditioning Compressor

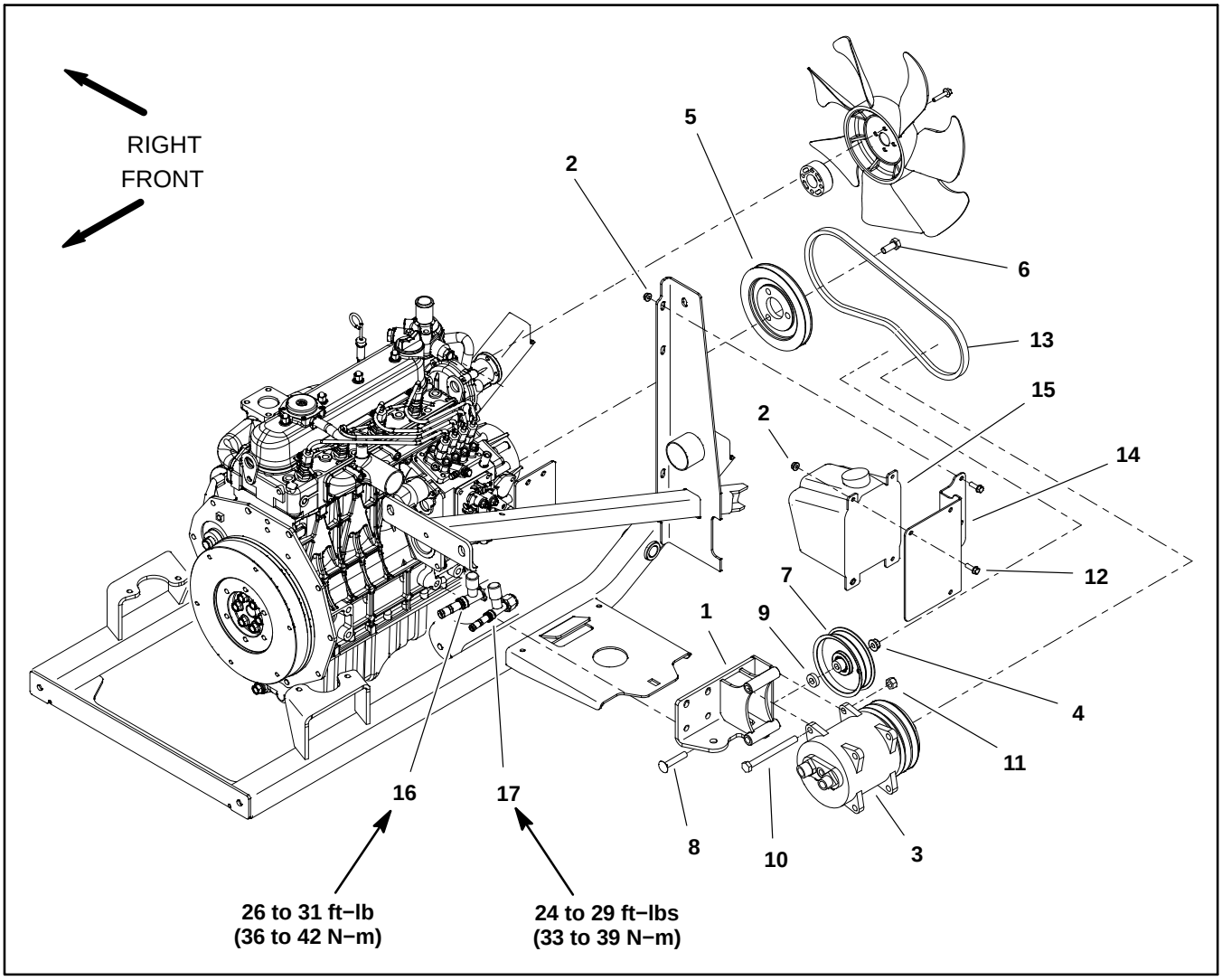

Figure 1

1. A/C compressor mount bracket
2. Flange nut (4)
3. Air conditioning compressor
4. Flange nut
5. Pulley
6. Cap screw (3)
7. Idler pulley
8. Carriage screw
9. Spacer
10. Cap screw (2)
11. Lock nut (2)
12. Screw (4)
13. V−belt
14. Reservoir bracket
15. Windshield washer reservoir
16. A/C hose (from evaporator)
17. A/C hose (to condenser)

Removal (Fig. 1)

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

2. Raise hood to allow access to engine.

3. Loosen flange nut that secures idler pulley. Move pulley to loosen A/C compressor drive belt. Remove drive belt from A/C compressor pulley.

4. Inspect compressor drive belt for glazing or damage. Replace belt if necessary.

5. Disconnect compressor electrical connector from machine wire harness.

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

CAUTION

The air conditioning system is under high pressure. Do not loosen any system fitting or component until after the system has been completely discharged by a certified A/C service technician.

7. Have refrigerant evacuated from air conditioning system by a certified A/C service technician.

8. Label and remove hoses from compressor. Immediately cap hoses and fittings to prevent moisture and contaminants from entering the system.

9. Support compressor to prevent it from shifting or falling.

NOTE: There may be shims mounted between compressor and compressor arm. When removing compressor, note shim location and quantity for assembly purposes.

10. Remove fasteners and spacers that secure compressor to compressor mount bracket.

IMPORTANT: To prevent compressor oil from filling the compressor cylinders, keep compressor in the same orientation as the installed position.

11. Carefully remove compressor from engine and machine.

NOTE: The replacement of the drier−receiver is recommended whenever A/C compressor is removed from the system (see Heater and Evaporator Assembly in this section).

NOTE: For air conditioning compressor repair procedures, see the Valeo TM80−16 Compressor Service Manual.

Installation (Fig. 1)

1. Position compressor to compressor mount bracket.

2. The clearance between the compressor mounting flanges and mount bracket must be less than **0.004" (0.10 mm)**. If necessary, install shims between compressor flanges and bracket to adjust clearance. See your Parts Catalog to identify shim kit part number.

3. Secure compressor to compressor bracket with removed fasteners. Do not fully tighten fasteners.

IMPORTANT: After the compressor has been installed, make sure to rotate the compressor drive shaft several times to properly distribute oil in the compressor. Compressor damage due to oil slugging can occur if this procedure is not performed.

4. Manually rotate the compressor drive shaft at least ten (10) revolutions to make sure that no compressor oil is in the compressor cylinders.

5. Place drive belt onto compressor pulley.

6. Tension compressor drive belt with idler pulley. Make sure to tighten flange nut to secure belt adjustment.

7. After belt has been adjusted, fully tighten fasteners to secure compressor to mount.

8. Remove caps that were placed on hoses and fittings during the removal process. Using labels placed during removal, properly secure hoses to compressor. Tighten hose fittings to torque values shown (Fig. 1).

9. Connect compressor electrical connector to machine wire harness.

10. Have a certified air conditioning service technician evacuate the air conditioning system completely, properly recharge the system with R134a refrigerant and then leak test the system. A/C system capacity is 1.13 pounds of R134a refrigerant.

11. Lower and secure hood.

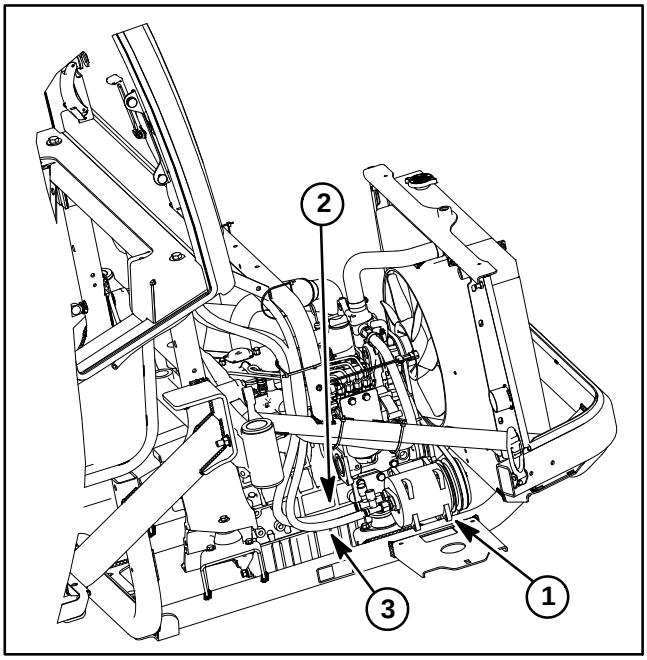

Figure 2

1. **A/C compressor**
2. **Hose from evaporator**
3. **Hose to condenser**

Roof Assembly

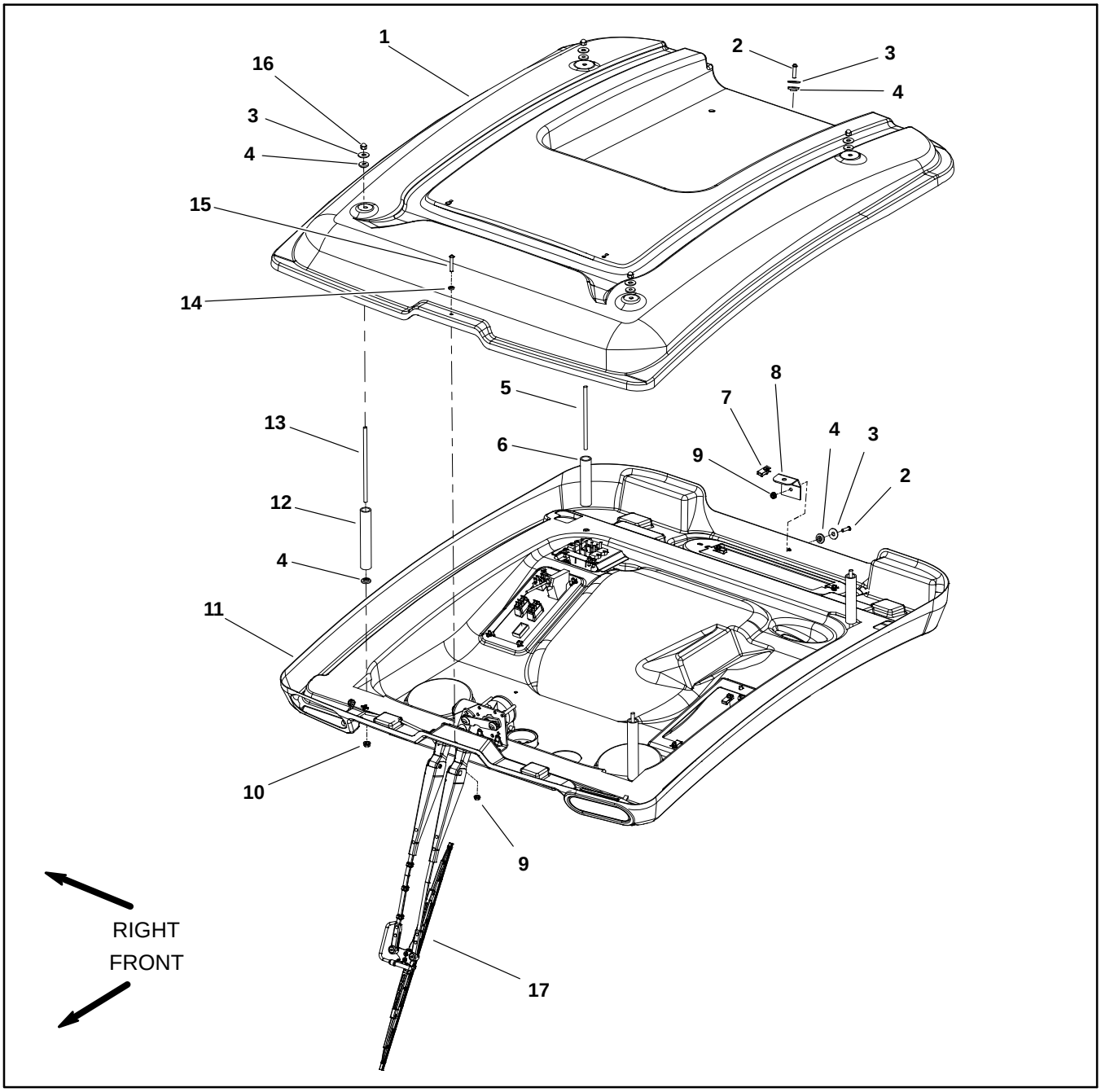

Figure 3

1. **Roof panel**
2. **Screw (2)**
3. **Flat washer (6)**
4. **Bushing (10)**
5. **Rear fastener (2)**
6. **Rear spacer (2)**
7. **Panel nut**
8. **Roof mount**
9. **Flange nut (2)**
10. **Flange nut (4)**
11. **Headliner**
12. **Front spacer (2)**
13. **Front fastener (2)**
14. **Rubber washer**
15. **Cap screw**
16. **Hex nut (4)**
17. **Windshield wiper assembly**

To gain access to the heater core and air conditioning components that are located under the cab roof, the roof panel can be loosened, raised and supported.

NOTE: When following this procedure, the air conditioning hoses will remain connected.

Removal (Fig. 3)

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

2. Remove screw (item 2), flat washer (item 3) and bushing (item 4) that secure the rear of the roof to the roof mount.

3. Remove the cap screw (item 15), rubber washer (item 14) and flange nut (item 9) that secure the front of the roof.

4. Remove four (4) hex nuts (item 16), flat washers (item 3) and bushings (item 4) that secure roof to front and rear fasteners.

5. Carefully lift front of roof while leaving rear of roof against headliner. Support front of roof in the raised position to allow access to heater and air conditioning components.

Installation (Fig. 3)

1. Make sure that all components in headliner and roof are installed and secure.

2. Remove support and carefully lower roof into position.

3. Secure roof to headliner with all removed fasteners.

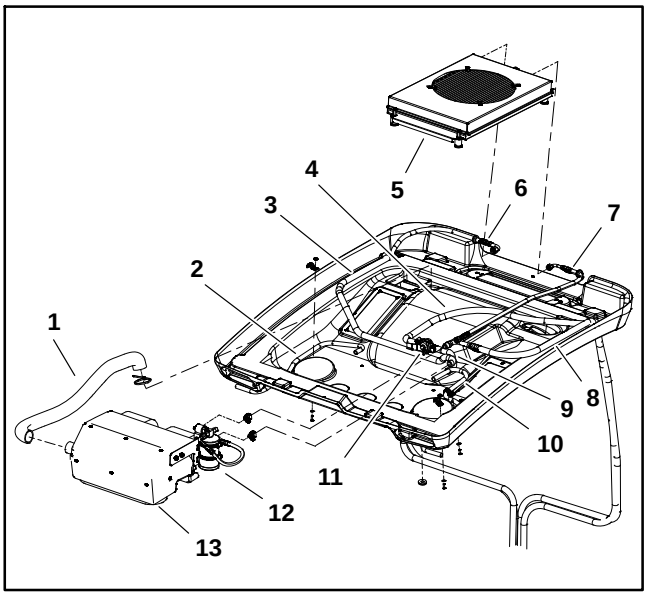

Figure 4

1. **Air duct hose**
2. **RH drain hose**
3. **Heater hose (heater to water pump)**
4. **Heater hose (thermostat to heater valve)**
5. **Condenser assembly**
6. **A/C hose (compressor to condenser)**
7. **A/C hose (condenser to drier)**
8. **A/C hose (evaporator to compressor)**
9. **Heater hose (heater valve to heater)**
10. **LH drain hose**
11. **Heater valve**
12. **A/C hose (evaporator to drier)**
13. **Heater/evaporator assembly**

Air Conditioning Condenser Assembly

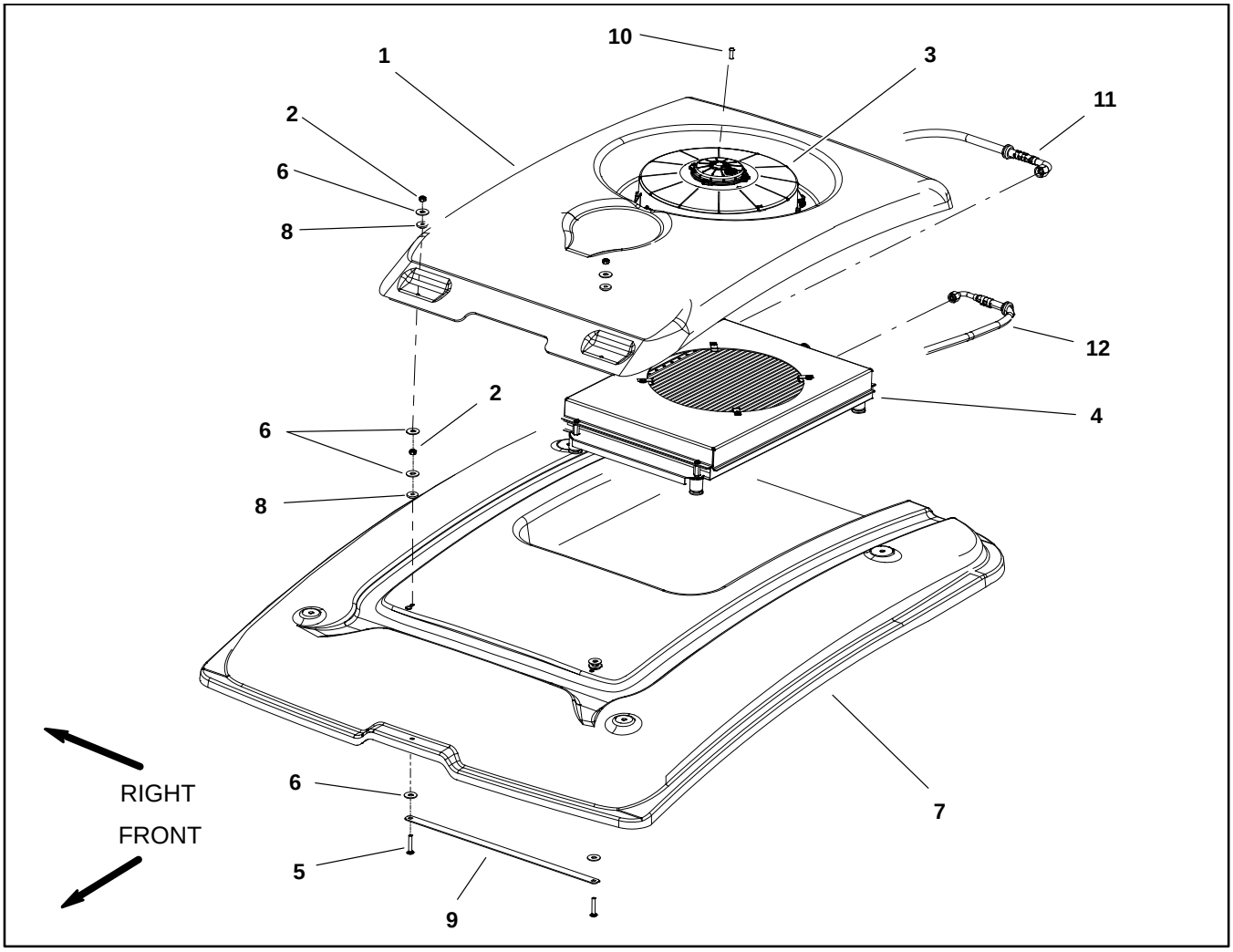

Figure 5

1. **Condenser cover**
2. **Lock nut (4)**
3. **Condenser fan**
4. **Condenser coil assembly**
5. **Carriage screw (2)**
6. **Flat washer (8)**
7. **Roof**
8. **Bushing (4)**
9. **Mounting strap**
10. **Button head screw (4)**
11. **Hose (compressor to condenser)**
12. **Hose (condenser to drier)**

Removal (Fig. 5)

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

2. Remove fasteners that secure roof in place. Raise and support roof to allow access to condenser assembly (see Roof Assembly Removal in this section).

3. Disconnect wire harness connector from condenser fan motor.

4. Remove button head screws (item 10) that secure condenser fan and cover to condenser coil.

5. Remove fasteners (items 2, 6 and 8) that secure front of condenser cover to roof. Lift condenser fan and cover from roof.

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

CAUTION

The air conditioning system is under high pressure. Do not loosen any system fitting or component until after the system has been completely discharged by a certified A/C service technician.

7. Have refrigerant evacuated from air conditioning system by a certified A/C service technician.

8. Label and remove hoses from condenser coil. Immediately cap hoses and fittings to prevent moisture and contaminants from entering the system.

9. Remove condenser coil from roof using Figure 6 as a guide.

NOTE: The replacement of the drier−receiver is recommended whenever the air conditioning system is opened (see Heater/Evaporator Assembly in this section).

Installation (Fig. 5)

1. Install condenser coil to roof using Figure 6 as a guide.

2. Remove caps that were placed on hoses and fittings during the removal process. Using labels placed during removal, properly secure hoses to condenser coil.

3. Position condenser cover and condenser fan to roof. Secure cover and fan with removed fasteners (items 2, 6 and 8).

4. Secure condenser fan to condenser coil with button head screws (item 10).

5. Connect wire harness connector to condenser fan motor.

6. Make sure that all machine air conditioning components are installed and secure.

7. Have a certified air conditioning service technician evacuate the air conditioning system completely, properly recharge the system with R134a refrigerant and then leak test the system. A/C system capacity is 1.13 pounds of R134a refrigerant.

8. Lower and secure roof assembly (see Roof Assembly Installation in this section).

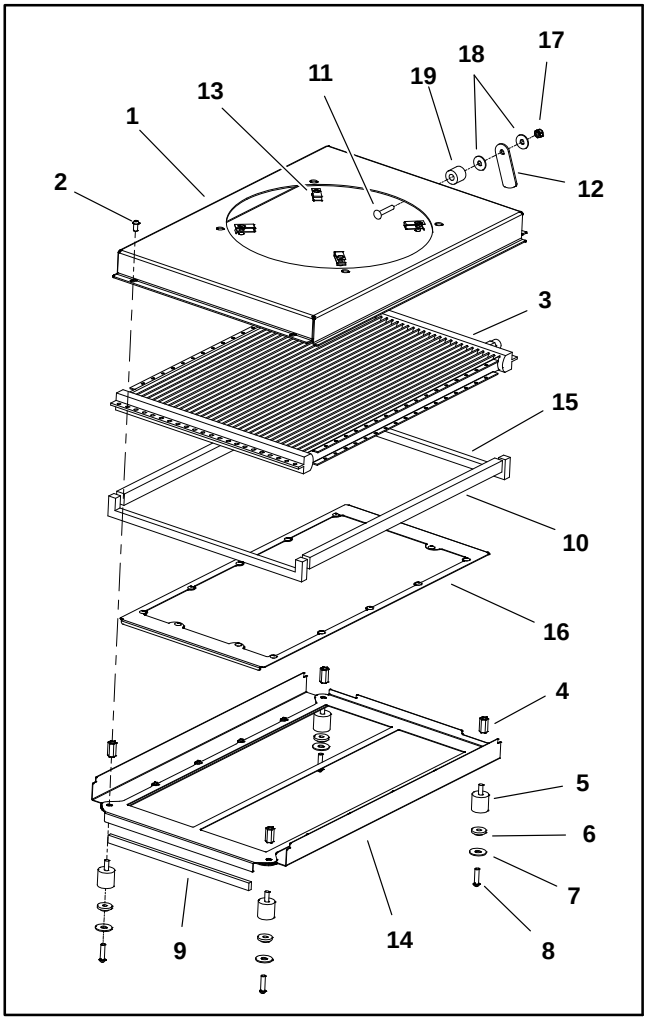

Figure 6

1. **Condenser fan shroud**
2. **Screw (4)**
3. **Condenser coil**
4. **Coupler nut (4)**
5. **Isolator mount (4)**
6. **Bushing (4)**
7. **Flat washer (4)**
8. **Screw (4)**
9. **Tray foam**
10. **Side foam (2)**
11. **Carriage screw**
12. **Latch plate**
13. **Panel nut (4)**
14. **Screen frame**
15. **End foam (2)**
16. **Screen tray**
17. **Lock nut**
18. **Friction washer (2)**
19. **Spacer**

Heater/Evaporator Assembly

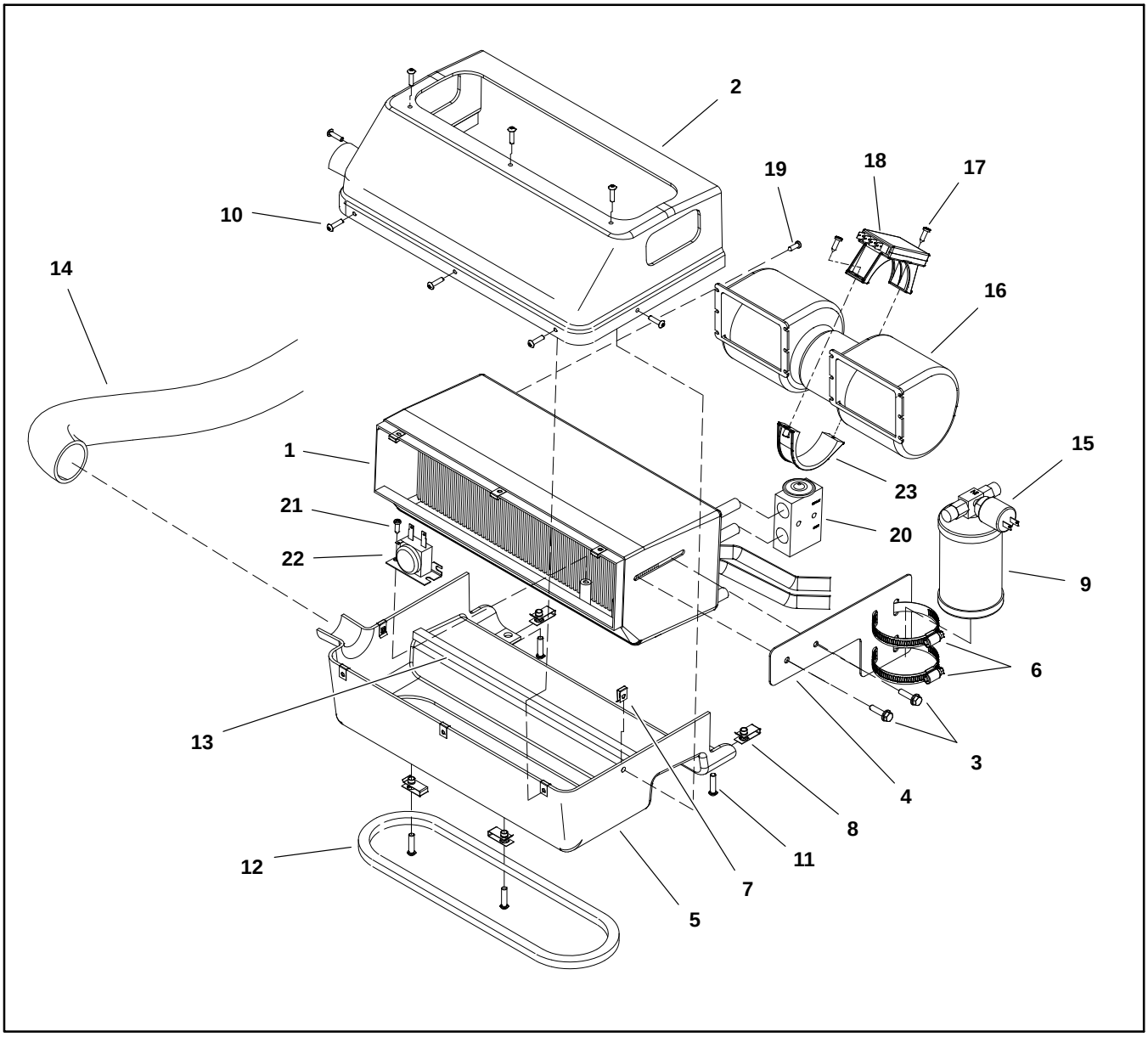

Figure 7

1. **Heater/evaporator assembly**
2. **Top cover**
3. **Flange head screw (2)**
4. **Drier−receiver mount**
5. **Bottom cover**
6. **Hose clamp (2)**
7. **Panel nut (8)**
8. **Panel nut (4)**
9. **Drier−receiver assembly**
10. **Screw (8)**
11. **Screw (4)**
12. **Seal**
13. **Seal**
14. **Air duct hose**
15. **Binary switch**
16. **Blower fan assembly**
17. **Screw (2)**
18. **Resistor**
19. **Screw (12)**
20. **Expansion valve**
21. **Screw (2)**
22. **Freeze switch**
23. **Clamp**

Removal (Fig. 7)

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

2. Remove fasteners that secure roof in place. Raise and support roof to allow access to heater/evaporator assembly (see Roof Assembly Removal in this section).

3. Disconnect wire harness connectors from fan motor and binary switch on drier−receiver.

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

CAUTION

The air conditioning system is under high pressure. Do not loosen any system fitting or component until after the system has been completely discharged by a certified A/C service technician.

5. Have refrigerant evacuated from air conditioning system by a certified A/C service technician.

6. Label and remove hoses from heater core, evaporator and drier−receiver. Immediately cap hoses and fittings to prevent moisture and contaminants from entering the system.

7. Remove cable tie that secures air duct hose to heater/evaporator assembly covers. Slide hose from covers.

8. Remove screws that secure top cover to bottom cover. Remove top cover to access heater/evaporator assembly.

9. Disassemble heater/evaporator assembly using Fig. 10 as a guide.

NOTE: The replacement of the drier−receiver is recommended whenever the air conditioning system is opened.

Installation (Fig. 7)

1. Assemble heater/evaporator assembly using Fig. 7 as a guide. Make sure that expansion valve is covered with insulating tape to prevent condensation issues. Also, make sure that evaporator fins are clean for best performance.

2. Position heater/evaporator assembly into bottom cover in headliner. Secure top cover to bottom cover with removed screws.

3. Slide air duct hose onto heater/evaporator assembly covers and secure with cable tie.

4. Remove caps that were placed on hoses and fittings during the removal process. Using labels placed during removal, properly secure hoses to heater core, evaporator and drier−receiver.

5. Make sure that condensation hoses are secured to bottom housing of heater/evaporator assembly and are routed to cab frame for proper draining of condensate.

6. Connect wire harness connectors to fan motor and binary switch on drier−receiver.

7. Make sure that all machine air conditioning components are installed and secure.

8. Have a certified air conditioning service technician evacuate the air conditioning system completely, properly recharge the system with R134a refrigerant and then leak test the system. A/C system capacity is 1.13 pounds of R134a refrigerant.

9. Operate the heater system to make sure that no engine coolant leaks exist.

10. Lower and secure roof assembly (see Roof Assembly Installation in this section).

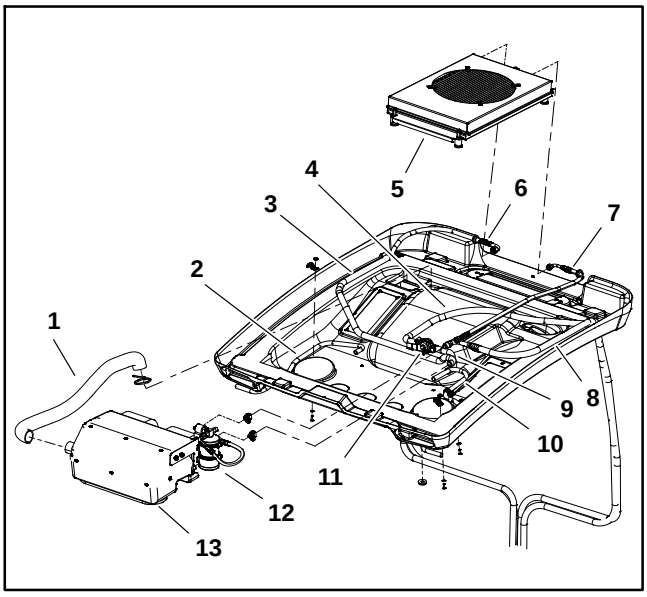

Figure 8

1. **Air duct hose**
2. **RH drain hose**
3. **Heater hose (heater to water pump)**
4. **Heater hose (thermostat to heater valve)**
5. **Condenser assembly**
6. **A/C hose (compressor to condenser)**
7. **A/C hose (condenser to drier)**
8. **A/C hose (evaporator to compressor)**
9. **Heater hose (heater valve to heater)**
10. **LH drain hose**
11. **Heater valve**
12. **A/C hose (evaporator to drier)**
13. **Heater/evaporator assembly**

Windshield Wiper

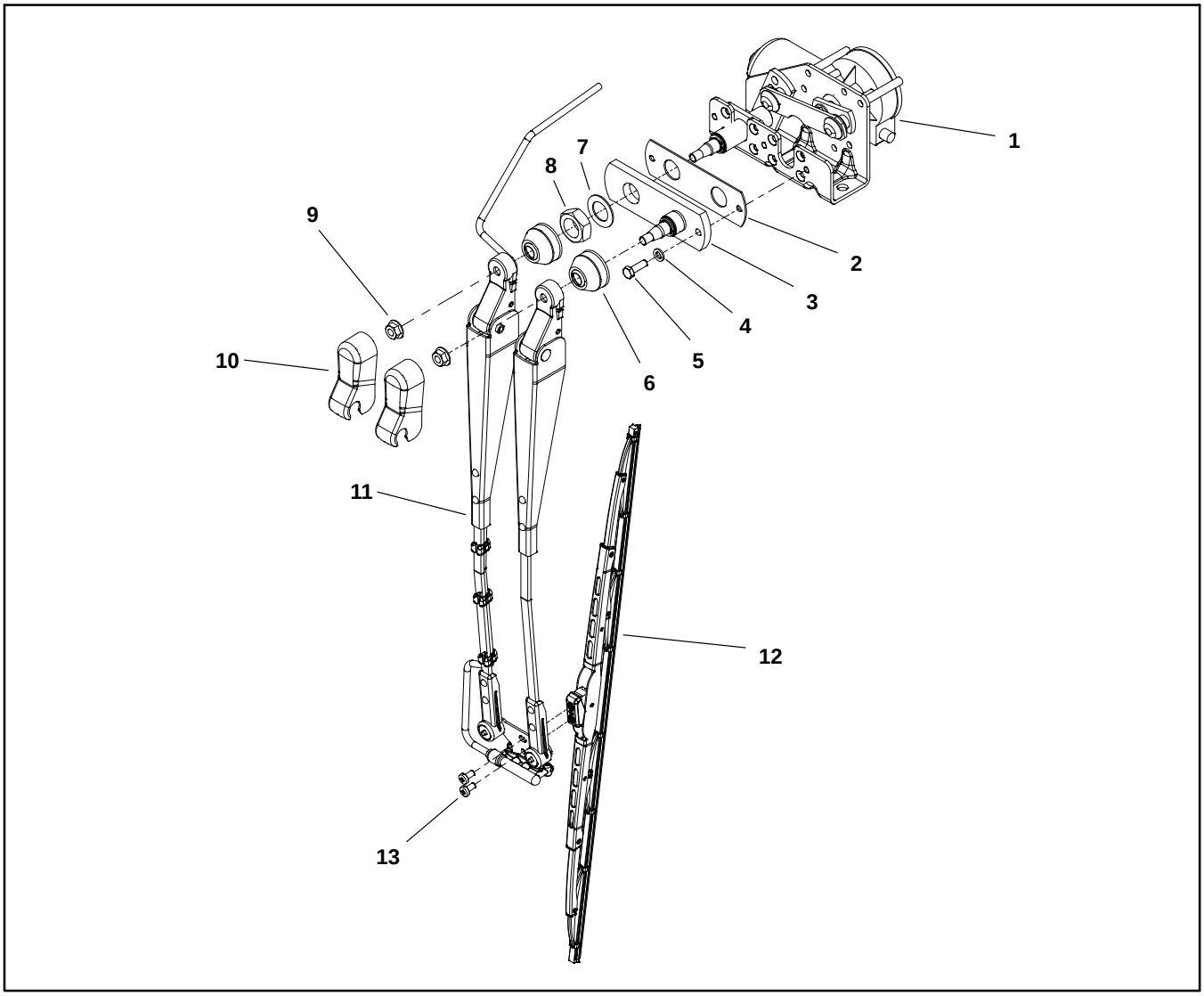

Figure 9

1. **Wiper motor**
2. **Gasket**
3. **Linkage bracket**
4. **Lock washer**
5. **Cap screw**
6. **Cap (2)**
7. **Washer**
8. **Nut**
9. **Flange nut (2)**
10. **Cover (2)**
11. **Wiper arm assembly**
12. **Wiper blade**
13. **Screw (2)**

Disassembly (Fig. 9)

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

2. If access to wiper motor is necessary, remove fasteners that secure roof in place. Raise and support roof to allow access to condenser assembly (see Roof Assembly Removal in this section).

3. Remove windshield wiper components as needed using Figure 9 as a guide.

Assembly (Fig. 9)

1. Assemble windshield wiper components using Figure 9 as a guide.

2. If roof was raised, lower and secure roof assembly (see Roof Assembly Installation in this section).

Storage Compartment

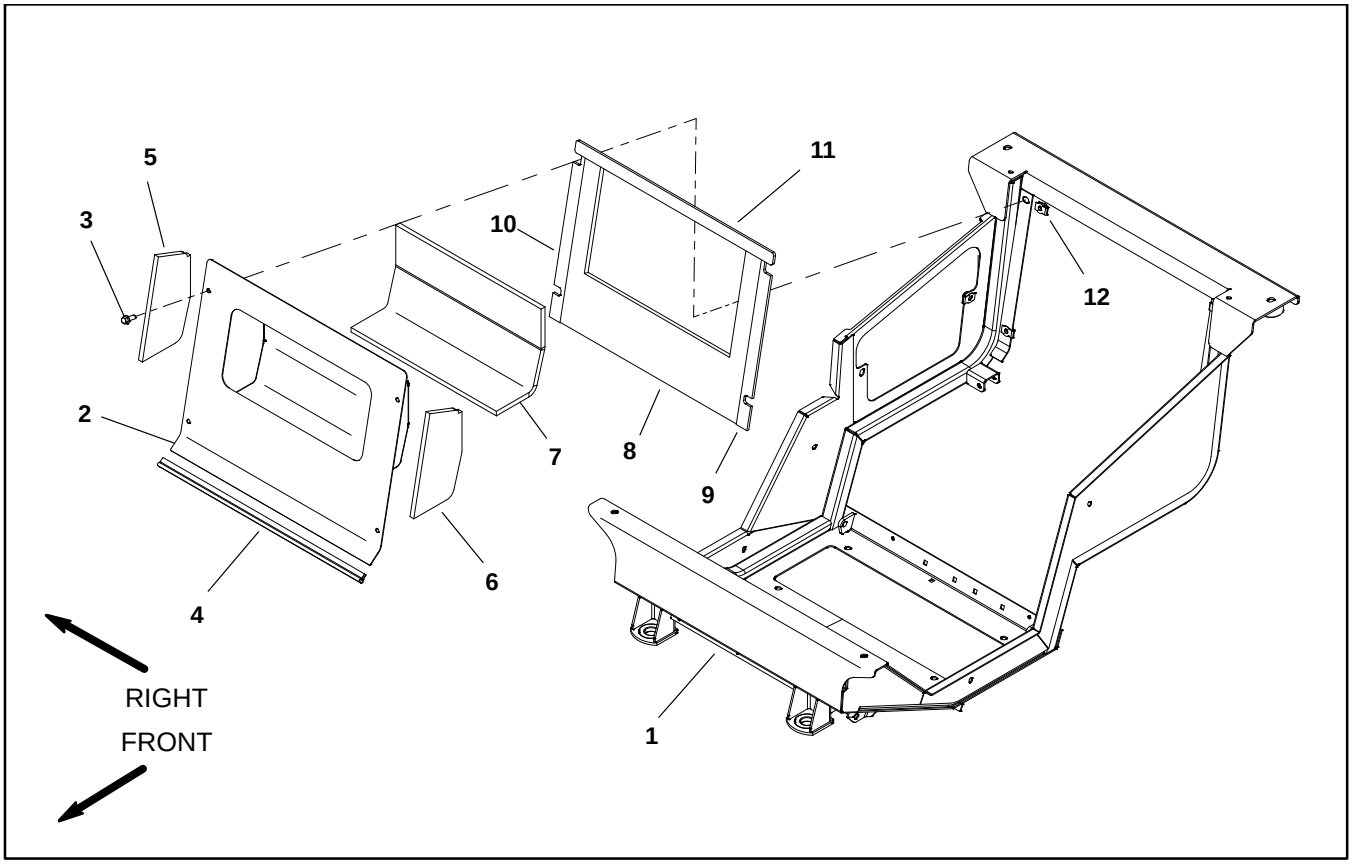

Figure 10

1. **Cab platform**
2. **Storage compartment**
3. **Flange head screw (4)**
4. **Bulb seal**
5. **RH foam**
6. **LH foam**
7. **Foam**
8. **Foam**
9. **LH foam**
10. **RH foam**
11. **Foam**
12. **Tinnerman nut (4)**

Removal (Fig. 10)

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

2. Unlatch and raise operator seat.

3. Remove four (4) flange head screws (item 3) that secure storage compartment to cab platform.

4. Remove storage compartment assembly from machine.

5. Inspect all sealing components on storage compartment and cab platform. Replace all seals that show evidence of damage.

Installation (Fig. 10)

1. Position storage compartment assembly to cab platform. Secure storage compartment to cab platform with four (4) flange head screws (item 3).

2. Lower and latch seat.

Chapter 8.1

(Serial Number Above 315000000)

Operator Cab

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VALEO COMPRESSOR SERVICE MANUAL

General Information

The information in this chapter pertains to Groundsmaster 360 machines with serial number above 315000000 that are equipped with an operator cab.

Operator's Manual

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

Electrical Components, Schematics and Wire Harness Drawings

Information regarding Groundsmaster 360 operator cab electrical components (switches and relays) is included in Chapter 5 − Electrical System. The electrical schematic and wire harness drawings for the operator cab are included in Chapter 9 − Foldout Drawings in this manual.

Air Conditioning System

The air conditioning system used on the Groundsmaster 360 consists of the following components:

1. A compressor mounted on the right side of the engine and driven by a poly v−belt.

2. A condenser assembly and two (2) condenser fans located at the rear of the cab roof assembly.

3. An evaporator core, a drier−receiver and an expansion valve mounted in the headliner of the cab.

4. The necessary hoses and tubes that connect the A/C system components.

5. A blower fan motor that provides air movement through the evaporator and into the cab. The fan motor is a component of the mixing box located in the cab headliner. The fan motor is also used for the cab heating system.

6. Operator controls to turn the air conditioning on, to adjust the fan speed and to control the cab air temperature.

Cab Heater System

The cab heater system used on the Groundsmaster 360 consists of the following components:

1. A heater core mounted in the headliner of the cab.

2. Hoses to allow a circuit for engine coolant to circulate through the heater core.

3. A blower fan motor that provides air movement through the heater core and into the cab. The fan motor is a component of the mixing box located in the cab headliner. The fan motor is also used for the air conditioning system.

4. Operator controls to adjust the fan speed and to control the cab air temperature.

Air Conditioning System Performance

There are a number of factors that can affect the performance of the Groundsmaster 360 air conditioning system. To ensure the best system operation, inspect the following components.

1. Make sure that the heater control fully closes the heater valve in the cab headliner.

2. Make sure that the condenser and evaporator fins are clean.

3. Verify that refrigerant charge quantity and system operating pressures are correct.

4. Make sure that exposed metal surfaces inside cab are insulated.

5. If ambient temperatures exceeds 110F (43C), apply additional window tinting to lower solar heat load to cab.

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General Precautions for Removing and Installing Air Conditioning System Components

CAUTION

The air conditioning system is under high pressure. Do not loosen any system fitting or component until after the system has been completely discharged by a certified A/C service technician.

WARNING

Always wear safety goggles or a face shield when working with air conditioning system components. Also, do not allow refrigerant contact with your skin or eyes as there would be the possibility of serious injury.

CAUTION

Never use compressed air to leak test or pressure test the air conditioning system. Under certain conditions, pressurized mixtures of refrigerant and air can be combustible.

1. Before servicing any air conditioning system components, park machine on a level surface, lower cutting deck or attachment and stop engine. Remove key from the ignition switch.

2. Clean machine before disconnecting, removing or disassembling any air conditioning system components. Thorough cleaning will prevent system contamination while performing service procedures.

3. Before loosening or removing any air conditioning system hose or other component, have a certified air conditioning service technician recover the system refrigerant and then evacuate the air conditioning system completely. It is illegal to vent refrigerant to the atmosphere.

4. Put caps or plugs on any air conditioning system lines, fittings or components left open or exposed to prevent moisture and contaminants from entering the system

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

6. If compressor is removed from machine, keep compressor in the same orientation as the installed position. This will prevent compressor oil from filling the compressor cylinders.

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

8. Always use a DOT approved tank for storing used and recycled refrigerants.

9. The Groundsmaster 360 air conditioning system uses R134a refrigerant. DO NOT use other refrigerants in the system. A/C system capacity is 3.44 pounds of R134a refrigerant.

10. Refrigerant containers (either full or empty) are under pressure that will increase if the containers are heated. DO NOT expose refrigerant containers to high heat sources or flame.

11. Be sure the work area is properly ventilated to prevent any accumulation of refrigerant or other fumes.

12. Make sure that caps are always placed on the pressure hose ports. These caps prevent refrigerant leakage from the system.

13. The A/C drier−receiver component is used to collect moisture that will reduce air conditioning performance. If the air conditioning system is opened for component repair or replacement, make sure that the drier−receiver ports are plugged to prevent damage to the drier−receiver. If either the compressor or A/C expansion valve is replaced, replacement of the drier−receiver is also recommended.

14. After installing air conditioning components, have a certified air conditioning service technician evacuate the air conditioning system completely, properly recharge the system with R134a refrigerant and then leak test the system.

Air Conditioning Compressor

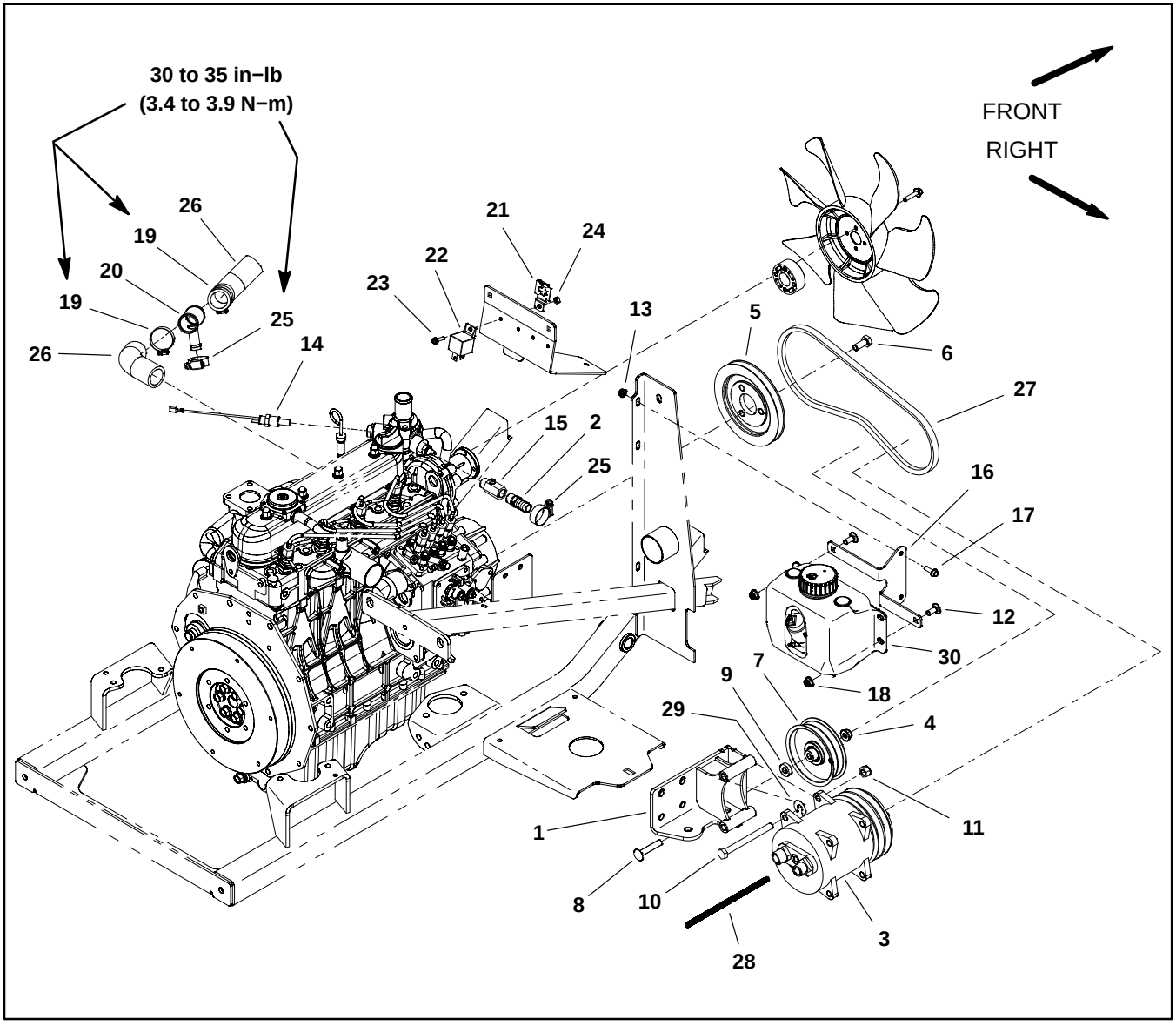

Figure 1

1. Compressor mount bracket
2. Straight fitting
3. AC compressor
4. Flange nut
5. Pulley
6. Cap screw (3)
7. Idler pulley
8. Carriage bolt
9. Spacer
10. Cap screw (2)
11. Lock nut (2)
12. Carriage screw (2)
13. Flange nut (4)
14. Dual temperature switch
15. Ball valve
16. Washer bottle bracket
17. Washer head screw
18. Flange nut (2)
19. Hose clamp (2)
20. Radiator fitting
21. Fuse clip
22. Relay
23. Washer head screw
24. Lock nut
25. Hose clamp (2)
26. Lower radiator hose (2)
27. Drive belt
28. Wire conduit
29. Shim (as needed)
30. Washer fluid bottle

Removal (Fig. 1)

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

2. Raise and support hood to allow access to engine and air conditioning compressor.

3. Loosen flange nut that secures idler pulley. Move pulley to loosen A/C compressor drive belt. Remove drive belt from A/C compressor pulley.

4. Disconnect AC compressor electrical connector from machine wire harness.

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

CAUTION

The air conditioning system is under high pressure. Do not loosen any system fitting or component until after the system has been completely discharged by a certified A/C service technician.

6. Have refrigerant evacuated from air conditioning system by a certified A/C service technician.

7. Label and remove hoses from compressor. Immediately cap hoses and fittings to prevent moisture and contaminants from entering the system.

8. Support compressor to prevent it from shifting or falling.

NOTE: There may be shims (item 29) mounted between the compressor mounting flanges and the compressor mount. When removing compressor, note shim location and quantity for assembly purposes.

9. Remove cap screws, shims (if used) and lock nuts that secure compressor to compressor mount bracket.

IMPORTANT: To prevent compressor oil from filling the compressor cylinders, keep compressor in the same orientation as the installed position.

10. Carefully remove compressor from engine and machine.

NOTE: The replacement of the A/C drier−receiver is recommended whenever A/C compressor is serviced or replaced.

NOTE: The air conditioning compressor used on the Groundsmaster 360 is an Valeo model TM−08HS. For air conditioning compressor repair procedures, see the Valeo Compressor Service Manual.

Installation (Fig. 1)

1. Position compressor to compressor mount on machine frame.

2. The clearance between the compressor mounting flanges and the compressor mount must be less than 0.004” (0.10 mm). If necessary, install shims (item 29) between compressor flanges and mount to adjust clearance.

3. Secure compressor to compressor mount with removed cap screws, shims (if needed) and lock nuts. Do not fully tighten fasteners.

IMPORTANT: After the compressor has been installed, make sure to rotate the compressor drive shaft several times to properly distribute oil in the compressor. Compressor damage due to oil slugging can occur if this procedure is not performed.

4. Manually rotate the compressor drive shaft at least ten (10) revolutions to make sure that no compressor oil is in the compressor cylinders.

5. Place drive belt onto compressor pulley and then tension compressor drive belt with idler pulley. Make sure to tighten flange nut to secure belt adjustment.

6. After belt has been adjusted, fully tighten fasteners to secure compressor to mount.

7. Remove caps that were placed on hoses and fittings during the removal process. Using labels placed during removal, properly secure hoses to compressor. Torque suction hose (larger fitting) from **26 to 31 ft−lb (36 to 42 N−m)** and discharge hose (smaller fitting) from **24 to 29 ft−lb (33 to 39 N−m)**.

8. Connect compressor electrical connector to machine wire harness.

9. Have a certified air conditioning service technician evacuate the air conditioning system completely, properly recharge the system with R134a refrigerant and then leak test the system. A/C system capacity is 3.44 pounds of R134a refrigerant.

10. Lower and secure hood.

Roof Assembly

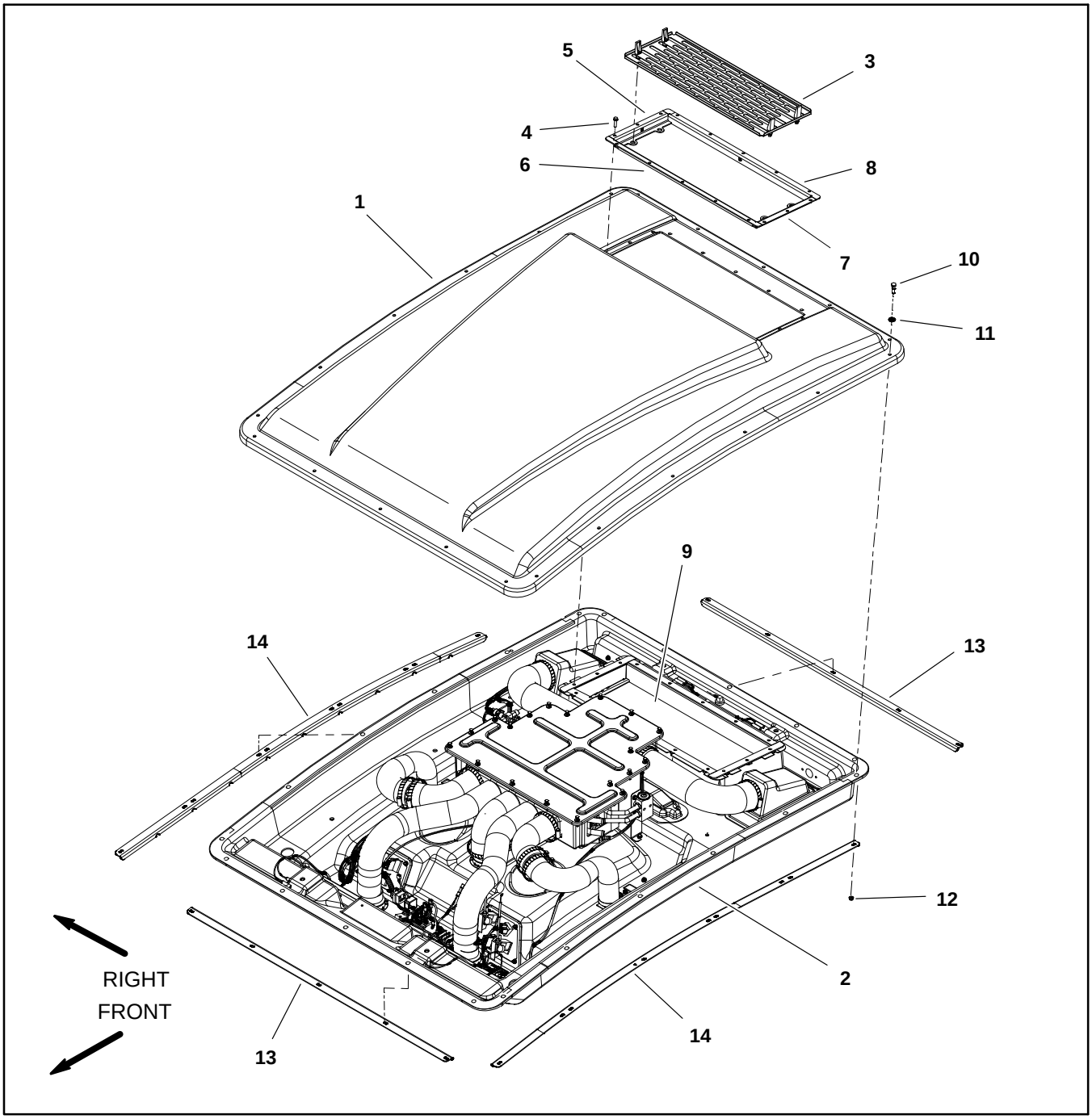

Figure 2

1. **Roof panel**
2. **Headliner assembly**
3. **Condenser screen**
4. **Flange head screw (16)**
5. **RH condenser seal**
6. **Front condenser seal**
7. **LH condenser seal**
8. **Rear condenser seal**
9. **Condenser assembly**
10. **Shoulder screw (22)**
11. **Flat washer (22)**
12. **Flange nut (22)**
13. **Front/rear cab strap (2)**
14. **Side cab strap (2)**

To gain access to heater and air conditioning components, the roof panel needs to be removed.

Removal (Fig. 2)

1. Park machine on a level surface, lower cutting deck or implement and stop engine. Remove key from the ignition switch.

2. Release swell latches and lift condenser screen (item 3) from roof assembly.

3. Remove flange head screws that secure condenser seals (items 5, 6, 7 and 8) to roof and A/C condenser assembly.

4. Remove shoulder screws, washers and flange nuts that secure the roof and cab straps to the headliner.

5. Carefully lift roof from headliner and cab.

Installation (Fig. 2)

1. Make sure that all components in headliner are installed and secure.

2. Position roof onto headliner. Make sure that all roof mounting holes are properly aligned with headliner and A/C condenser assembly.

3. Secure roof to headliner with removed shoulder screws, flat washers, cab straps and flange nuts.

4. Secure condenser seals to roof and A/C condenser assembly with removed flange head screws.

5. Install and secure A/C screen to roof assembly with swell latches.

Heating and Air Conditioning Components

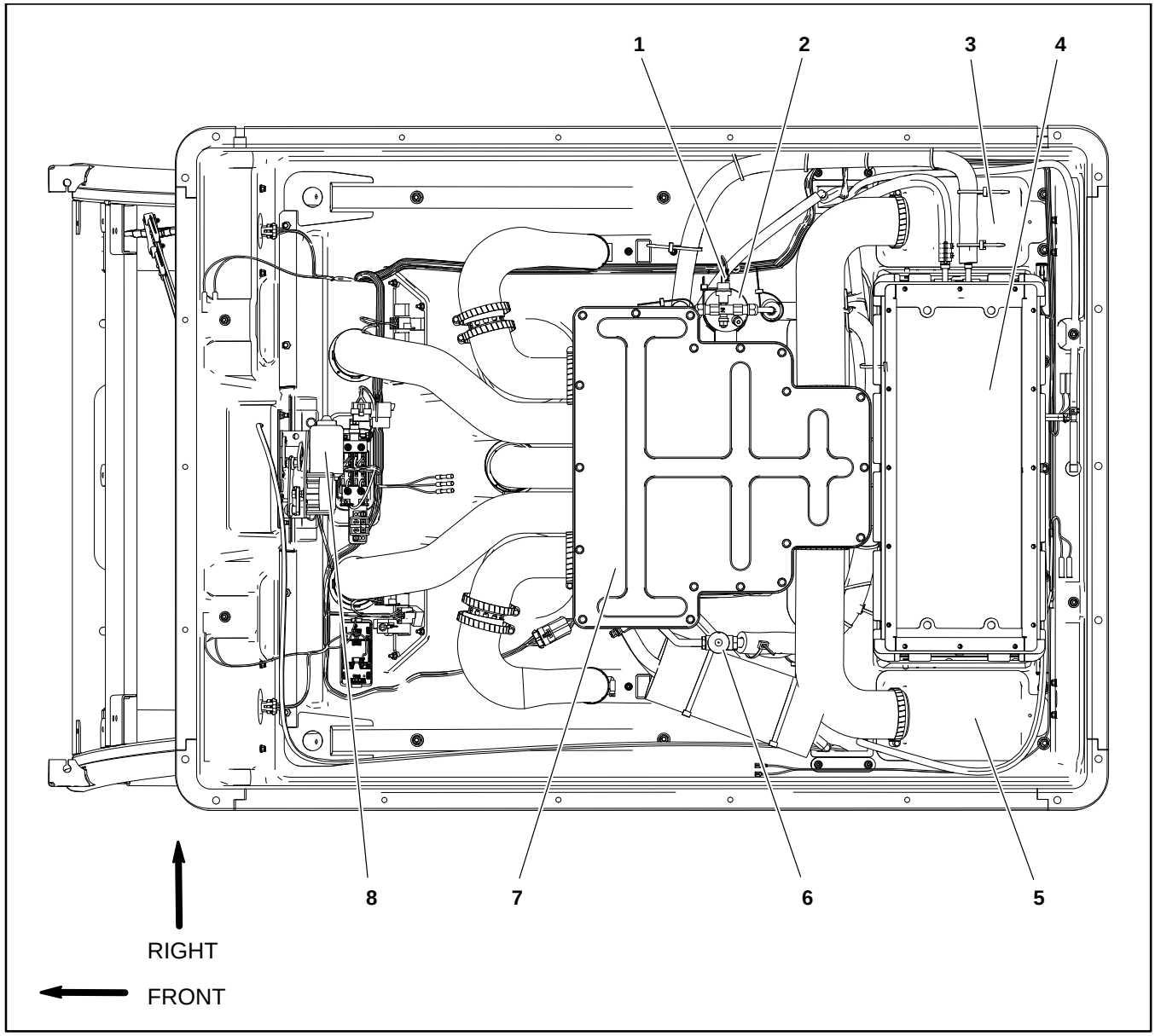

Figure 3

1. **A/C binary switch**
2. **A/C drier−receiver**
3. **RH intake air filter**
4. **A/C condenser assembly**
5. **LH intake air filter**
6. **A/C expansion valve**
7. **Heat and A/C mixing box assembly**
8. **Wiper motor assembly**

Access to cab heating and air conditioning components can be obtained by removing the cab roof. Once the cab roof is removed, the illustrations in Figures 3 and 4 can be used to identify the components used for heating and cooling the operator cab.

NOTE: Figure 4 shows the heat and A/C mixing box assembly with the mixing box cover removed.

NOTE: A/C system capacity is 3.44 pounds of R134a refrigerant.

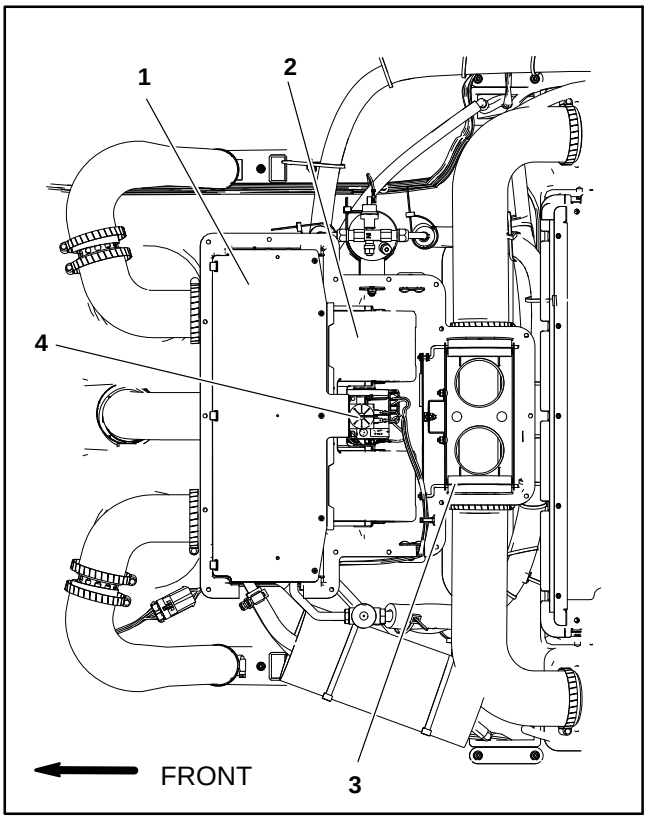

Figure 4

1. **Evaporator/heater cores**
2. **Blower fan**
3. **Air diverter assembly**
4. **A/C freeze switch**

A/C Condenser Fan Assembly

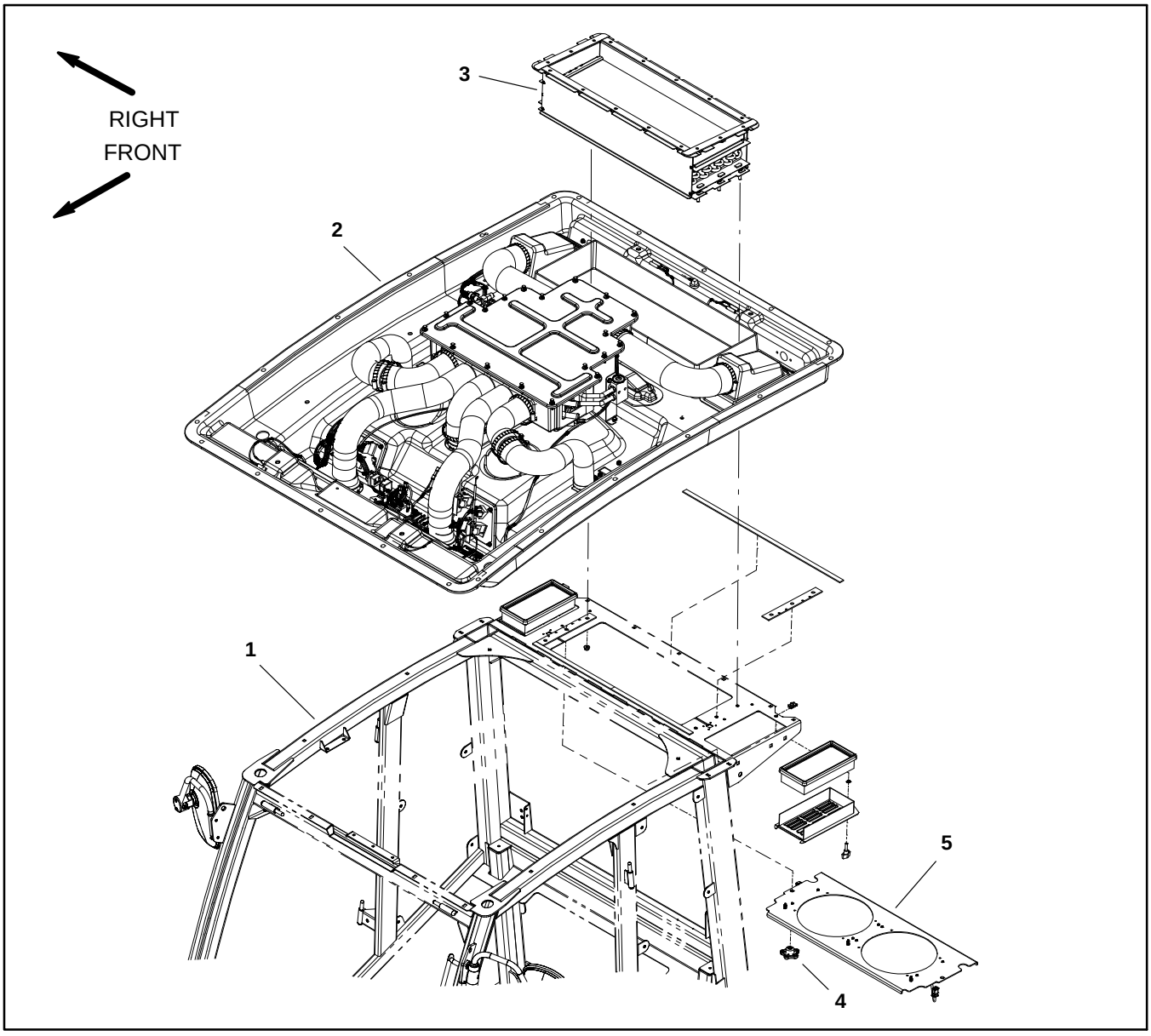

Figure 5

1. **Cab frame**
2. **Cab headliner assembly**
3. **A/C condenser assembly**
4. **Knob (2)**
5. **Condenser fan assembly**

Removal (Fig. 5)

1. Park machine on a level surface, lower cutting deck or implement and stop engine. Remove key from the ignition switch.

2. Locate A/C condenser fan assembly which is secured to the frame under the rear of the cab headliner.

3. Disconnect the two (2) condenser fan plugs from the wire harness connectors attached to the cab frame (Fig. 6).

4. Support the condenser fan assembly to prevent it from falling.

5. Remove two (2) knobs that secure condenser fan assembly to machine (Fig. 6).

6. Lower condenser fan assembly from machine.

7. If necessary, disassemble condenser fan assembly using Figure 7 as a guide.

Installation (Fig. 5)

1. If condenser fan assembly was disassembled, use Figure 7 as a guide to secure fans to fan mount plate.

2. Raise and support fan assembly to cab frame.

3. Secure fan assembly to machine with two (2) knobs.

4. Connect the two (2) condenser fan plugs to the wire harness connectors attached to the cab frame.

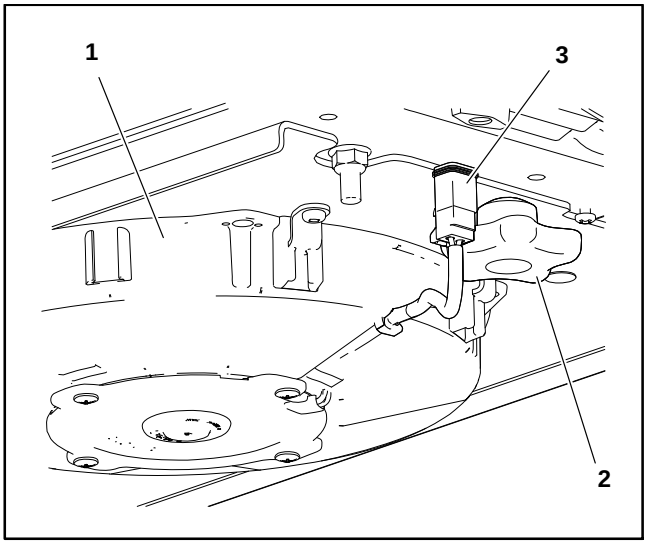

Figure 6

1. **Condenser fan (2)**
2. **Knob (2)**
3. **Fan plug (2)**

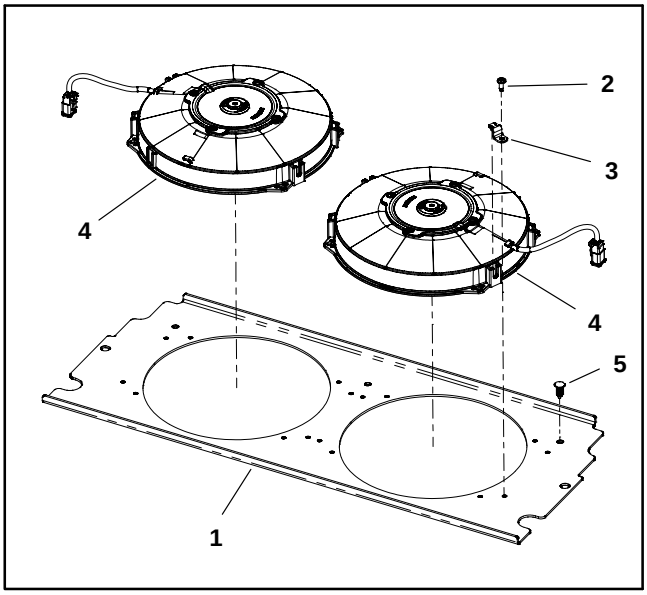

Figure 7

1. **Fan mount plate**
2. **Screw (4 per fan)**
3. **Fan tab (4 per fan)**
4. **Condenser fan (2)**
5. **Plug (3)**

A/C Condenser Assembly

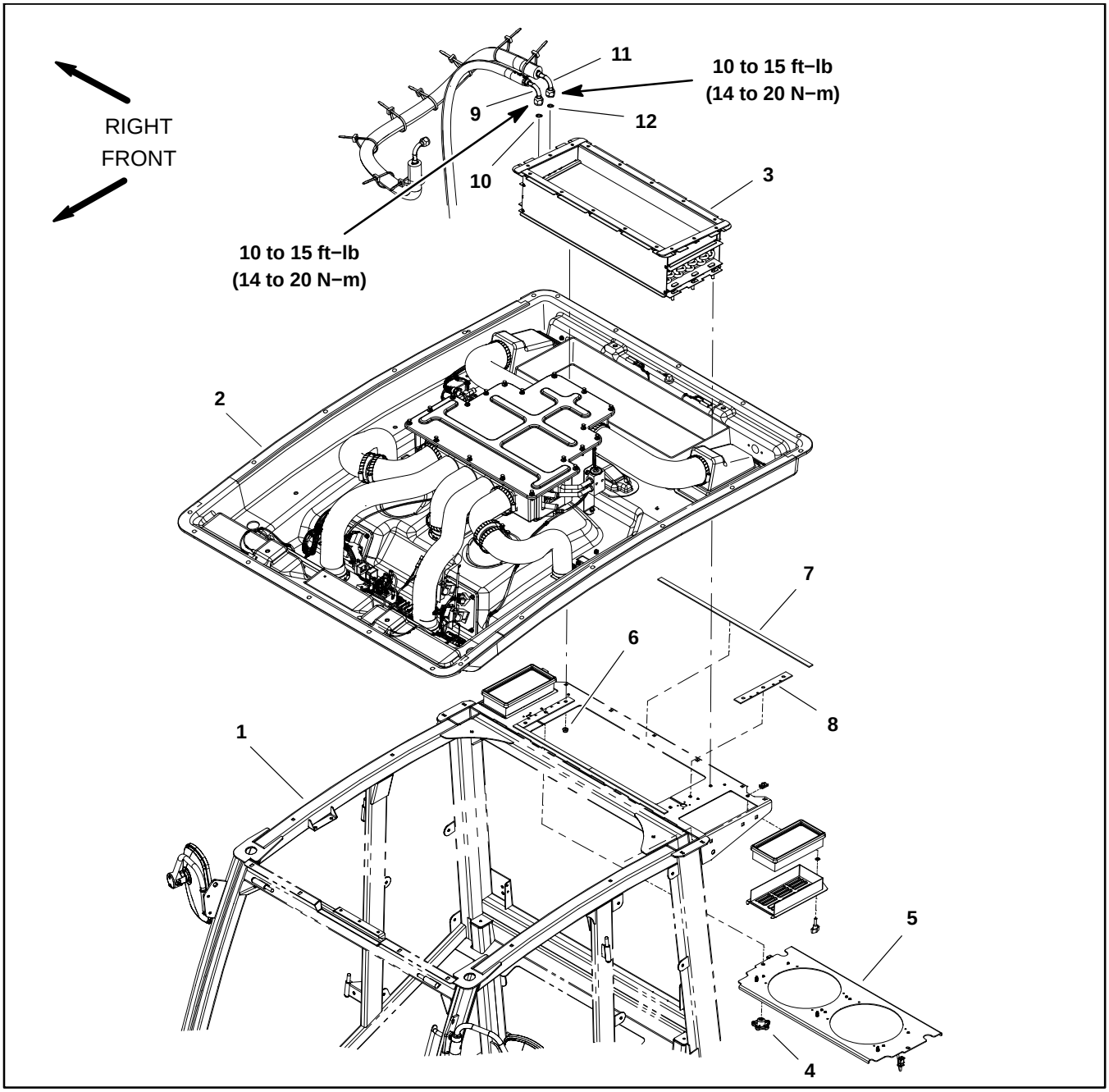

Figure 8

1. Cab frame
2. Cab headliner assembly
3. A/C condenser assembly
4. Knob (2)
5. Condenser fan assembly
6. Flange nut (4)
7. Strip seal (2)
8. Edge seal (2)
9. AC hose (from compressor)
10. O−ring
11. AC hose (to drier−receiver)
12. O−ring

Removal (Fig. 8)

1. Park machine on a level surface, lower lower cutting deck or implement and stop engine. Remove key from the ignition switch.

2. To access A/C condenser assembly, remove roof panel from top of cab (see Roof Assembly in this section).

3. Remove condenser fan assembly from machine (see A/C Condenser Fan Assembly in this section).

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

CAUTION

The air conditioning system is under high pressure. Do not loosen any system fitting or component until after the system has been completely discharged by a certified A/C service technician.

5. Have refrigerant evacuated from air conditioning system by a certified A/C service technician.

6. Label and disconnect hoses from condenser core. Immediately cap hoses and fittings to prevent moisture and contaminants from entering the system.

7. Remove four (4) flange nuts that secure A/C condenser assembly to cab frame.

8. Carefully raise condenser assembly from headliner and remove from machine.

9. Inspect seals (items 7 and 8 in Fig. 8) on top of cab frame for wear or damage and replace if needed.

10. If necessary, disassemble condenser assembly using Figure 9 as a guide. Inspect seals on top of condenser assembly walls (items 8 and 9 in Fig. 9) for wear or damage and replace if needed.

Installation (Fig. 8)

1. If condenser assembly was disassembled:

   A. To properly seal condenser core, apply RTV sealant to all mating surfaces of walls, lower legs and condenser core before assembly.

   B. Assemble all condenser assembly components using Figure 9 as a guide. Make sure that strip and edge seals are in good condition after assembly.

2. Carefully lower the A/C condenser assembly through headliner and onto cab frame.

3. Secure A/C condenser assembly to cab frame with four (4) flange nuts.

4. Remove caps that were placed on hoses and fittings during the removal process. Using labels placed during removal, properly secure hoses to condenser core. While holding condenser fittings with a second wrench, torque hose swivels from **10 to 15 ft−lb (14 to 20 N−m)**.

5. Secure condenser fan assembly to machine (see A/C Condenser Fan Assembly in this section).

6. Make sure that all machine air conditioning components are installed and secure.

7. Have a certified air conditioning service technician evacuate the air conditioning system completely, properly recharge the system with R134a refrigerant and then leak test the system. A/C system capacity is 3.44 pounds of R134a refrigerant.

8. When all service in cab headliner is completed, secure roof panel to top of cab (see Roof Assembly in this section).

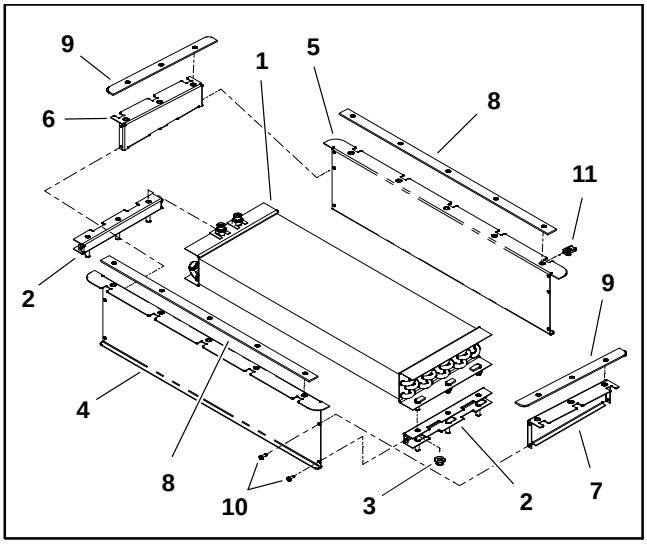

Figure 9

1. **Condenser core**
2. **Lower leg (2)**
3. **Hex nut (6)**
4. **Front wall**
5. **Back wall**
6. **Right side wall**
7. **Left side wall**
8. **Strip seal (2)**
9. **Edge seal (2)**
10. **Screw (12)**
11. **Clip (16)**

Mixing Box Assembly

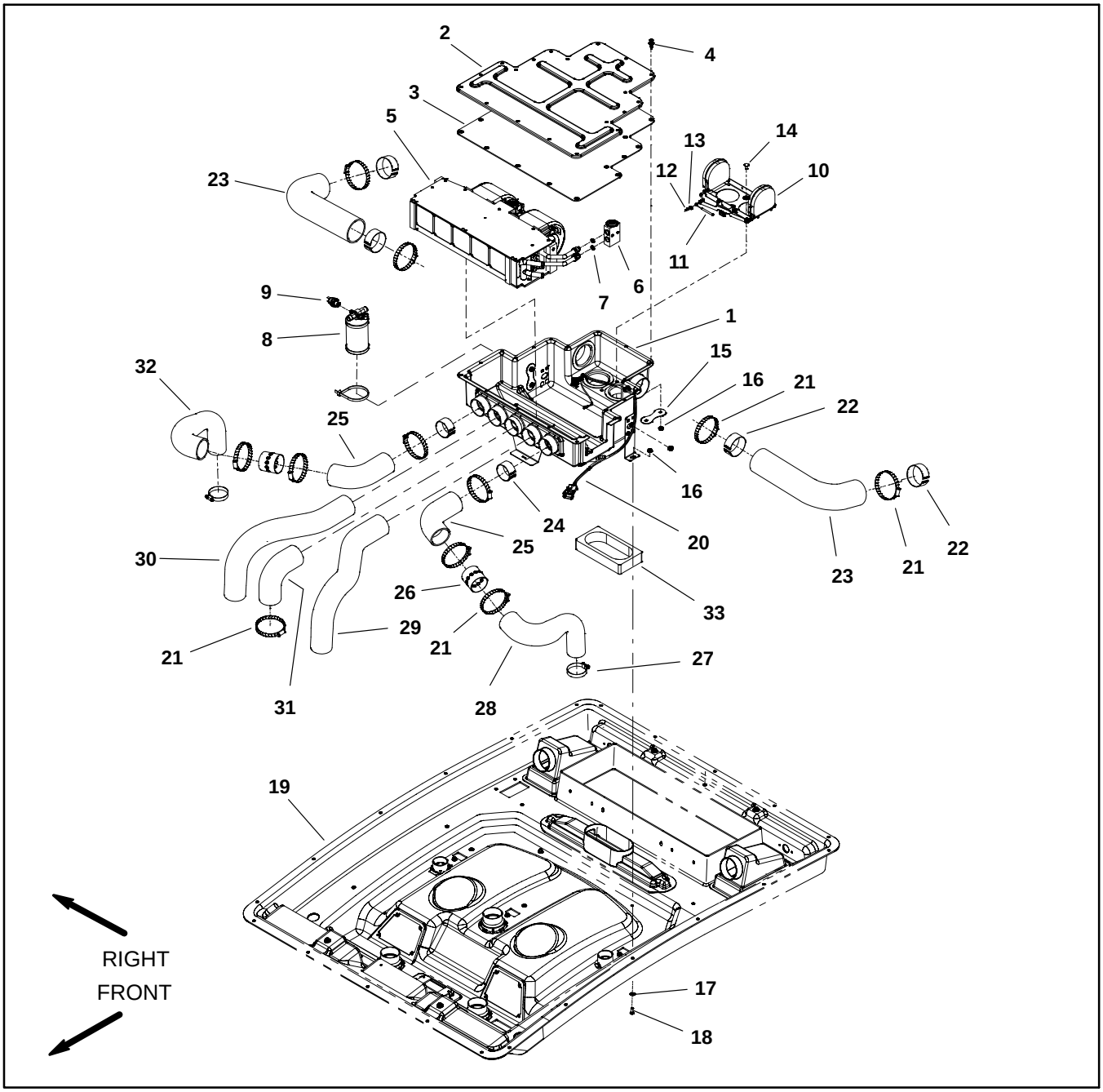

Figure 10

1. Mixing box
2. Mixing box cover
3. Cover insulation
4. Rivet (19)
5. Heater core/AC evaporator/fan assy
6. Expansion valve
7. O−ring (2)
8. A/C drier−receiver
9. Binary switch
10. Air diverter assembly
11. Control cable
12. Hairpin
13. Flat washer
14. Carriage screw (2)
15. Support plate
16. Flange nut (4)
17. Flat washer (2)
18. Button head screw (2)
19. Cab headliner
20. Mixing box wire harness
21. Hose clamp (11)
22. Tube support (4)
23. Vent hose (2)
24. Tube support (2)
25. Vent hose (2)
26. Adapter (2)
27. Hose clamp (2)
28. Vent hose
29. Vent hose
30. Vent hose
31. Vent hose
32. Vent hose
33. Mixing box inlet foam

Removal (Fig. 10)

1. Park machine on a level surface, lower cutting deck or implement and stop engine. Remove key from the ignition switch.

2. To access mixing box assembly, remove roof panel from top of cab (see Roof Assembly in this section).

3. Remove cover from mixing box assembly:

   A. Carefully use a small pry bar to raise head of pin in center of each rivet that secures mixing box cover.

   B. Lift rivets from cover and mixing box.

   C. Remove mixing box cover.

NOTE: If heater core, AC evaporator core or blower fan need to be removed from mixing box, the box does not have to be removed from the cab headliner. See Heater and A/C Evaporator Cores or Blower Fan in this section for information on removing and installing these components.

4. Disconnect electrical connectors from mixing box wire harness and binary switch on drier−receiver.

5. Read the General Precautions for Removing and Installing Air Conditioning System Components at the beginning of the Service and Repairs section of this chapter. Make sure that these instructions are followed if any air conditioning hoses are loosened or if any air conditioning components are to be removed from cab headliner.

CAUTION

The air conditioning system is under high pressure. Do not loosen any system fitting or component until after the system has been completely discharged by a certified A/C service technician.

6. Remove mixing box components as necessary using Figures 10, 11 and 12 as guides.

NOTE: The replacement of the A/C drier−receiver is recommended if the expansion valve is replaced.

Installation (Fig. 10)

1. Install all removed mixing box components using Figures 10, 11 and 12 as guides. Make sure that expansion valve is covered with insulating tape to prevent condensation issues. Also, use torque specifications shown in Figure 12 to properly tighten hoses connected to the expansion valve and drier−receiver.

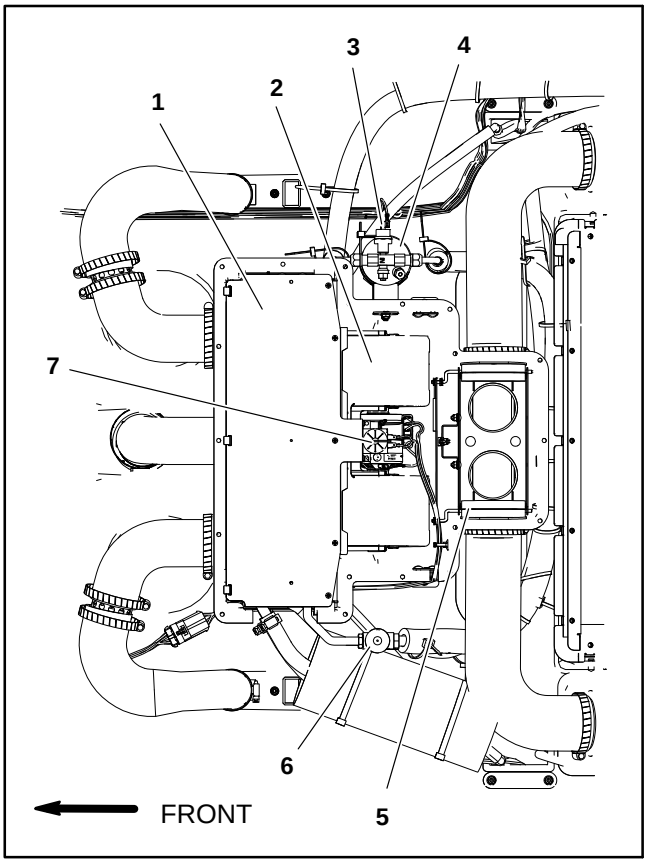

Figure 11

1. Evaporator & heater core
2. Blower fan
3. A/C binary switch
4. A/C drier−receiver
5. Air diverter assembly
6. A/C expansion valve
7. A/C freeze switch

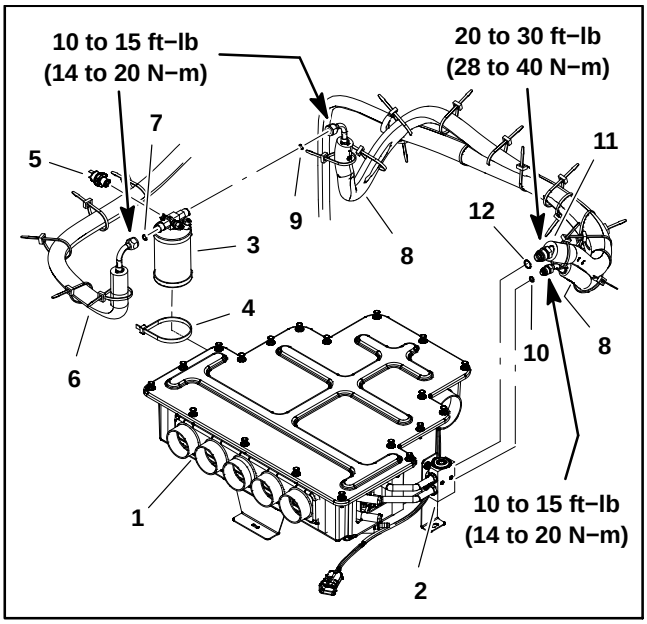

Figure 12

1. Mixing box assembly
2. A/C expansion valve
3. A/C drier−receiver
4. Cable tie (2)
5. A/C binary switch
6. Hose (from condenser)
7. O−ring
8. Hose (from drier)
9. O−ring
10. O−ring
11. Hose (to compressor)
12. O−ring

2. Make sure that condensation hoses are secured to the drain fittings on the bottom of mixing box assembly. Also, route hoses to cab frame for proper draining of condensate.

3. Make sure to connect electrical connectors from mixing box wire harness and binary switch on A/C drier−receiver.

4. If any A/C system components were removed from cab headliner, make sure that all machine air conditioning components are installed and secure. Then, have a certified air conditioning service technician evacuate the air conditioning system completely, properly recharge the system with R134a refrigerant and then leak test the system. A/C system capacity is 3.44 pounds of R134a refrigerant.

5. Secure cover to mixing box assembly:

   A. Position mixing box cover to mixing box. Make sure that wire harness is routed through recess in side of mixing box.

   B. With the rivet pin in a raised position, insert rivets through cover and into hole in mixing box. Press pin into rivet to secure rivet in place.

6. Operate the heater system to make sure that no coolant leaks in cab headliner exist.

7. When all service in cab headliner is completed, secure roof panel to top of cab (see Roof Assembly in this section).

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Heater and A/C Evaporator Cores

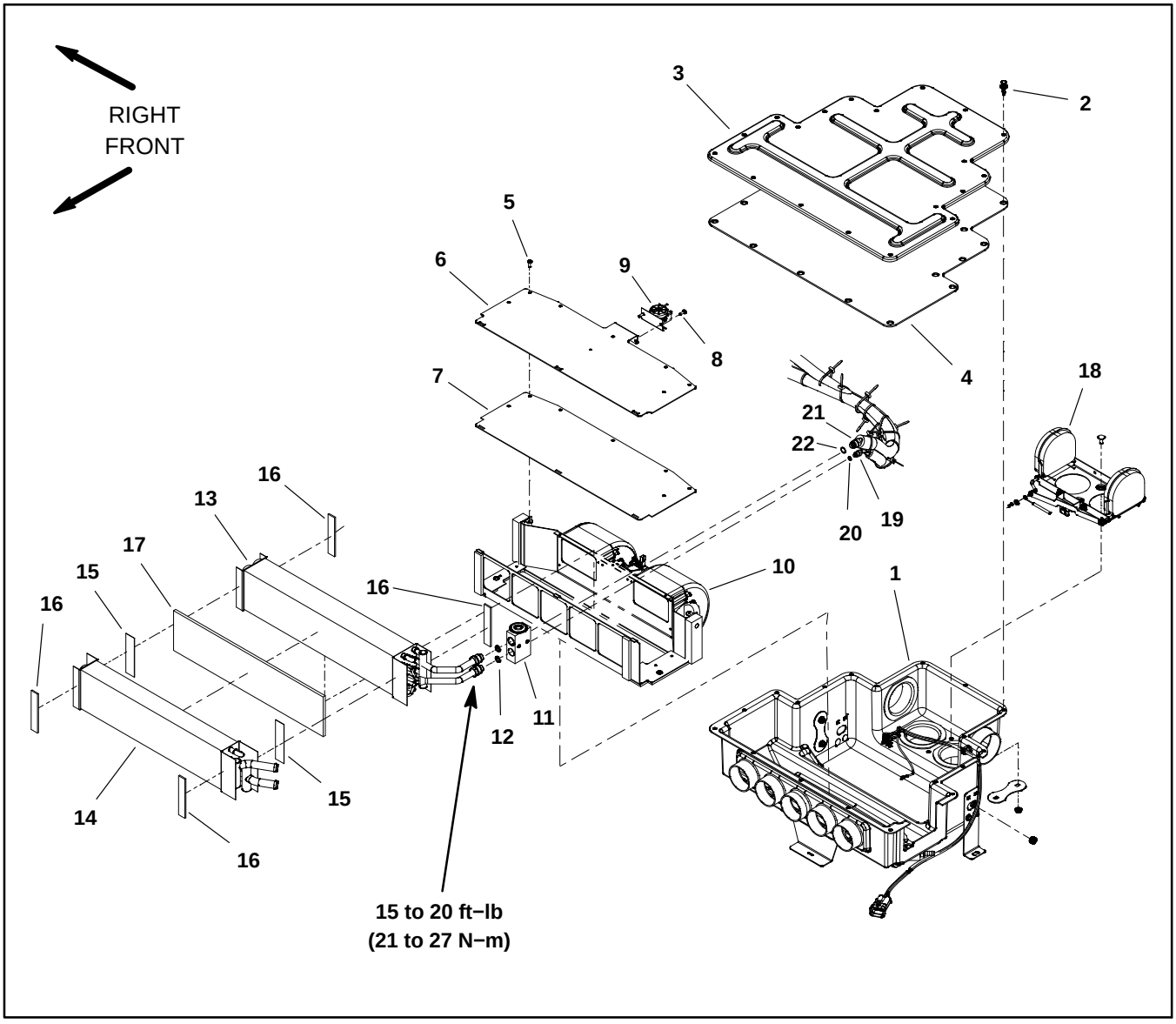

Figure 13

1. **Mixing box**
2. **Rivet (19)**
3. **Mixing box cover**
4. **Cover insulation**
5. **Screw (5)**
6. **Mount bracket cover**
7. **Cover gasket**
8. **Screw (2)**
9. **Freeze switch**
10. **Mount bracket (shown with fan)**
11. **Expansion valve**
12. **O−ring (2)**
13. **A/C evaporator core**
14. **Heater core**
15. **Double sided tape (2)**
16. **Gasket (4)**
17. **Condensation catch foam**
18. **Air diverter assembly**
19. **AC hose (from drier−receiver)**
20. **O−ring**
21. **AC hose (to AC compressor)**
22. **O−ring**

NOTE: The heater and evaporator cores can be removed and installed with the mixing box (item 1 in Figure 13) attached to the cab headliner.

Removal (Fig. 13)

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

2. To access heater and A/C evaporator cores, remove roof panel from top of cab (see Roof Assembly in this section).

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

CAUTION

The air conditioning system is under high pressure. Do not loosen any system fitting or component until after the system has been completely discharged by a certified A/C service technician.

4. Have refrigerant evacuated from air conditioning system by a certified A/C service technician.

5. Disconnect both evaporator core swivel fittings from front ports of expansion valve. Immediately cap tubes and expansion valve ports to prevent moisture and contaminants from entering the system. Position expansion valve with attached hoses away from the mixing box.

6. Label heater hoses for assembly purposes. Loosen hose clamps and disconnect both heater hoses from tubes on heater core.

7. Remove mixing box cover:

   A. Carefully use a small pry bar to raise head of pin in center of each rivet that secures mixing box cover.

   B. Lift rivets from cover and mixing box.

   C. Remove mixing box cover.

8. Locate wire from freeze switch that is inserted into A/C evaporator core through mount bracket cover. Carefully pull wire from cover and position it away from cover.

9. Remove screws (item 5) that secure mount bracket cover to mount bracket. Lift cover and position it away from mount bracket taking care to not damage freeze switch or wires connected to the switch.

10. Carefully lift heater and A/C evaporator core assembly from frame.

11. Separate heater and A/C evaporator cores as needed using Fig. 13 as a guide. The cores are secured to each other with double sided tape (item 10).

12. Inspect seals, gaskets and insulation in mixing box assembly for tears or other damage. Replace all damaged sealing components.

Installation (Fig. 13)

1. Assemble heater and A/C evaporator cores using Fig. 13 as a guide.

2. Carefully install heater and A/C evaporator core assembly into frame in mixing box.

3. Position mount bracket cover to mount bracket taking care to not damage freeze switch or wires connected to the switch. Secure cover to mount bracket with removed screws (item 5).

4. Insert wire from freeze switch into A/C evaporator core through mount bracket cover. The wire should be inserted 2 inches (51 mm) past the cover.

5. Secure cover to mixing box assembly:

   A. Position mixing box cover to mixing box. Make sure that wire harness is routed through recess in side of mixing box.

   B. With the rivet pin in a raised position, insert rivets through cover and into hole in mixing box. Press pin into rivet to secure rivet in place.

6. Using labels placed during disassembly, connect both heater hoses to tubes on heater core and secure with hose clamps.

7. Remove caps that were placed on evaporator core tubes and expansion valve ports during the removal process. Position expansion valve with attached hoses to the evaporator core tubes. Properly secure evaporator core swivel fittings to front ports of expansion valve. Torque fittings from **15 to 20 ft−lb (21 to 27 N−m)**.

8. Make sure that all machine air conditioning components are installed and secure.

9. Make sure that expansion valve is covered with insulating tape to prevent condensation issues.

10. Have a certified air conditioning service technician evacuate the air conditioning system completely, properly recharge the system with R134a refrigerant and then leak test the system. A/C system capacity is 3.44 pounds of R134a refrigerant.

11. Operate the heater system to make sure that no coolant leaks in headliner exist.

12. Secure roof panel to top of cab (see Roof Assembly in this section).

Blower Fan

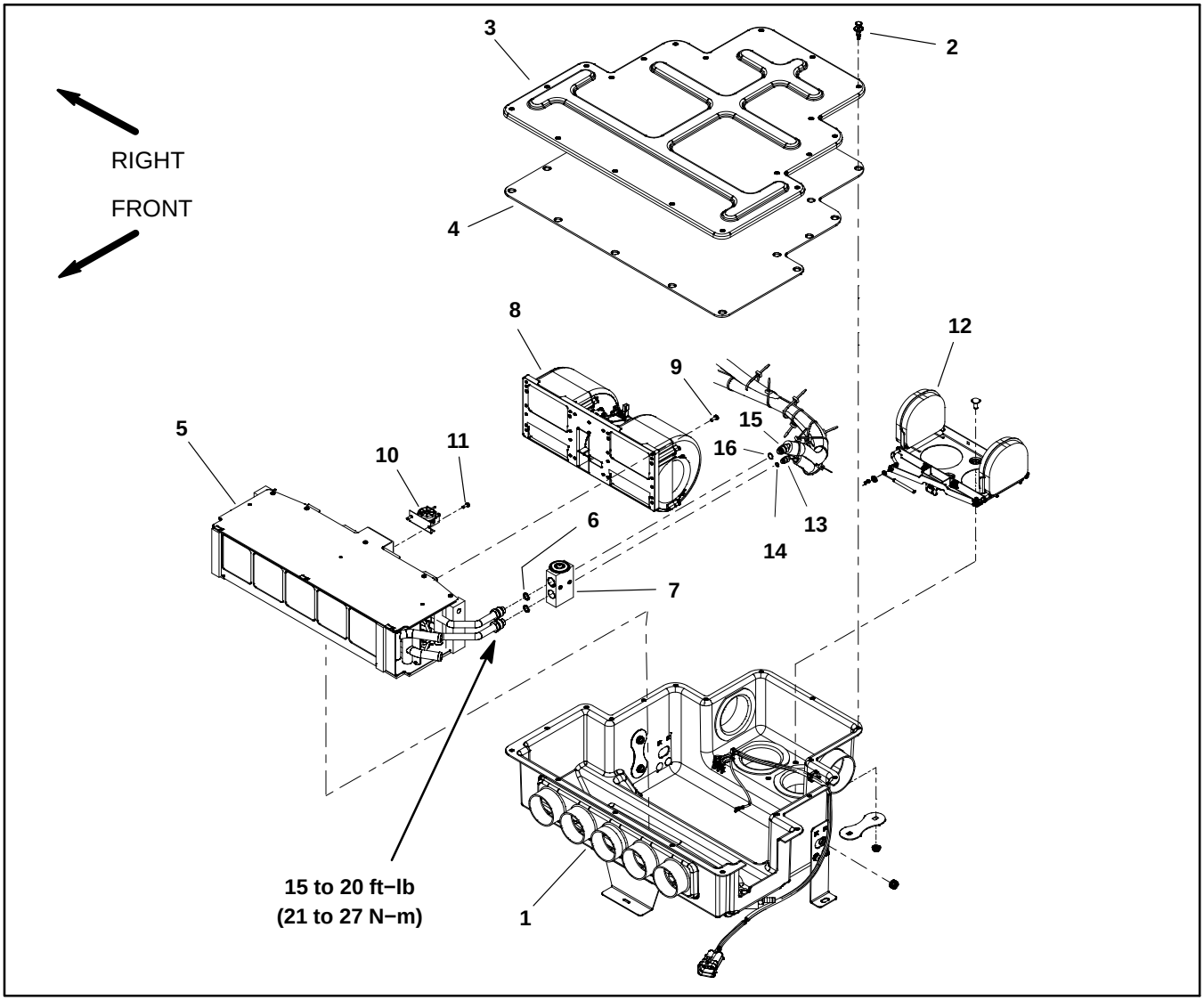

Figure 14

1. **Mixing box**
2. **Rivet (19)**
3. **Mixing box cover**
4. **Cover insulation**
5. **Heater core/AC evaporator assembly**
6. **O−ring (2)**
7. **Expansion valve**
8. **Blower fan**
9. **Screw (6)**
10. **Freeze switch**
11. **Screw (2)**
12. **Air diverter assembly**
13. **AC hose (from drier−receiver)**
14. **O−ring**
15. **AC hose (to AC compressor)**
16. **O−ring**

NOTE: The blower fan can be removed and installed with the mixing box (item 1 in Figure 14) attached to the cab headliner.

Removal (Fig. 14)

1. Park machine on a level surface, lower cutting deck or implement and stop engine. Remove key from the ignition switch.

2. To access blower fan, remove roof panel from top of cab (see Roof Assembly in this section).

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

CAUTION

The air conditioning system is under high pressure. Do not loosen any system fitting or component until after the system has been completely discharged by a certified A/C service technician.

4. Have refrigerant evacuated from air conditioning system by a certified A/C service technician.

5. Disconnect both evaporator core swivel fittings from front ports of expansion valve. Immediately cap tubes and expansion valve ports to prevent moisture and contaminants from entering the system. Position expansion valve with attached hoses away from the mixing box.

6. Label heater hoses for assembly purposes. Loosen hose clamps and disconnect both heater hoses from tubes on heater core.

7. Remove mixing box cover:

   A. Carefully use a small pry bar to raise head of pin in center of each rivet that secures mixing box cover.

   B. Lift rivets from cover and mixing box.

   C. Remove mixing box cover.

8. Note location of wire harness connectors on freeze switch and blower fan assembly (Fig. 15). Disconnect wire harness connectors from switch and fan.

9. Carefully raise heater core/AC evaporator assembly with attached blower fan from mixing box.

10. Remove six (6) screws that secure blower fan to heater core/AC evaporator assembly. Remove blower fan.

Installation (Fig. 14)

1. Position blower fan to heater core/AC evaporator assembly and secure with six (6) screws.

2. Carefully lower heater core/AC evaporator assembly with attached blower fan into mixing box.

3. Connect wire harness connectors to freeze switch and blower fan assembly (Fig. 15).

4. Secure mixing box cover:

   A. Position mixing box cover to mixing box. Make sure that wire harness is routed through recess in side of mixing box.

   B. With the rivet pin in a raised position, insert rivets through cover and into hole in mixing box. Press pin into rivet to secure rivet in place.

5. Using labels placed during disassembly, connect both heater hoses to tubes on heater core and secure with hose clamps.

6. Remove caps that were placed on evaporator core tubes and expansion valve ports during the removal process. Position expansion valve with attached hoses to the evaporator core tubes. Properly secure evaporator core swivel fittings to front ports of expansion valve. Torque fittings from **15 to 20 ft−lb (21 to 27 N−m)**.

7. Make sure that all machine air conditioning components are installed and secure.

8. Have a certified air conditioning service technician evacuate the air conditioning system completely, properly recharge the system with R134a refrigerant and then leak test the system. A/C system capacity is 3.44 pounds of R134a refrigerant.

9. Operate the heater system to make sure that no coolant leaks in headliner exist.

10. Secure roof panel to top of cab (see Roof Assembly in this section).

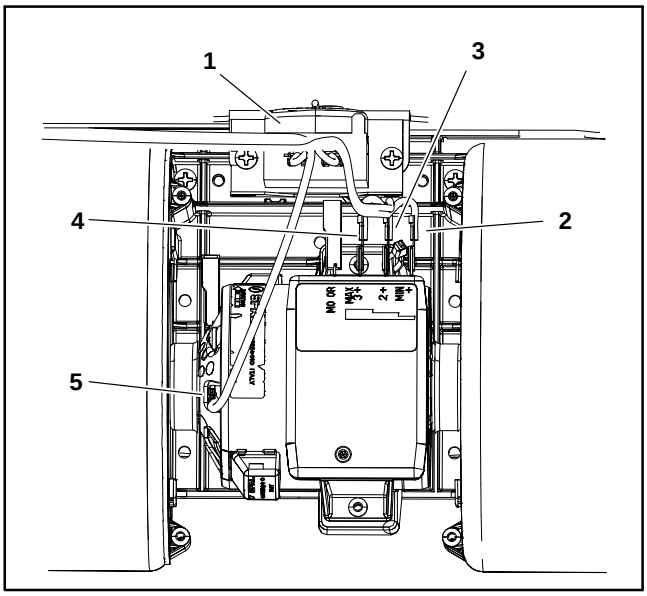

Figure 15

1. **Freeze switch**
2. **MIN terminal (violet)**
3. **Terminal 2 (brown)**
4. **Terminal 3 (orange)**
5. **Ground terminal (black)**

Windshield Wiper Assembly

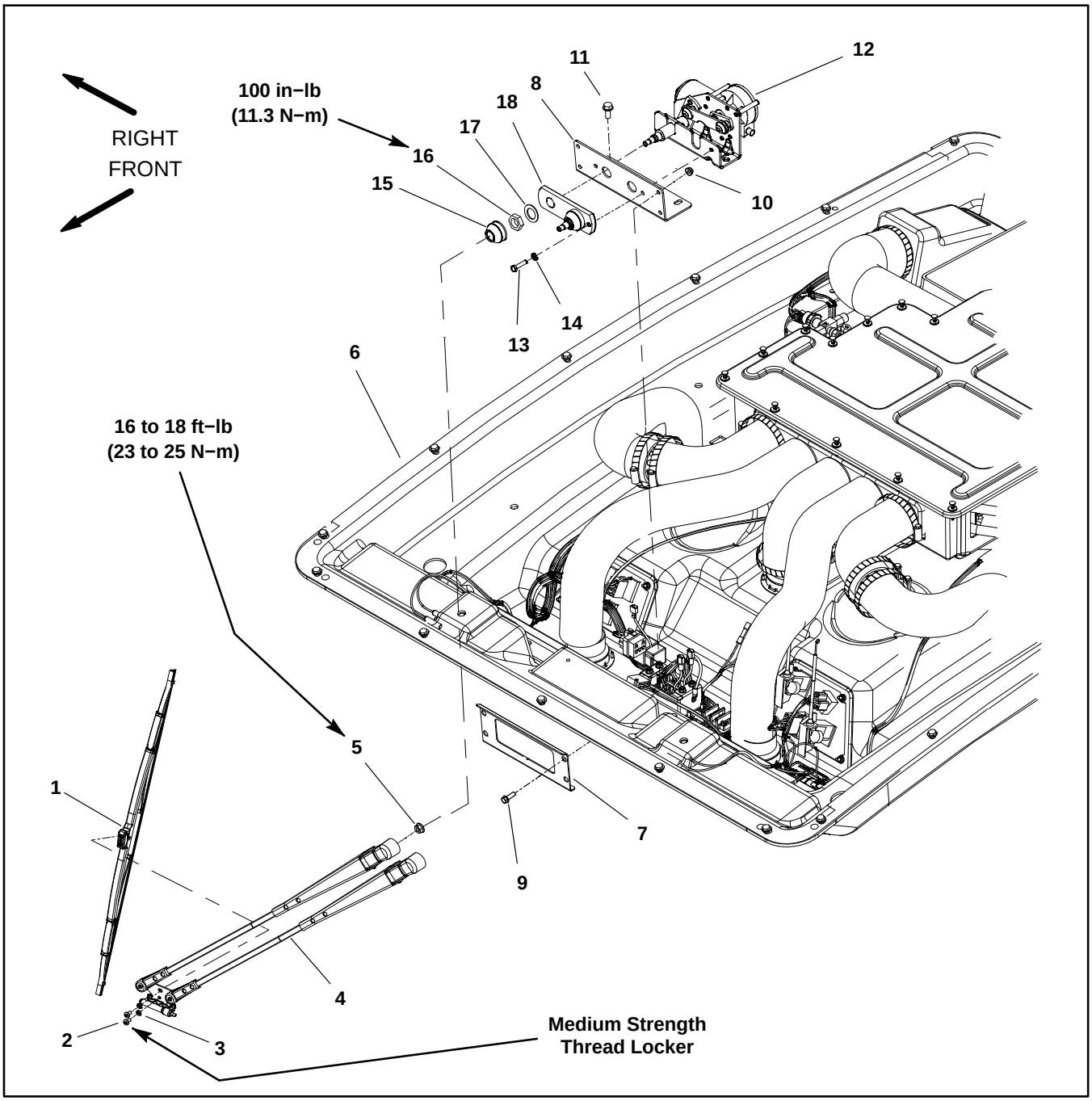

Figure 16

1. Wiper blade
2. Cap screw (2)
3. Lock washer (2)
4. Wiper arm assembly
5. Flange nut (2)
6. Cab headliner
7. Washer plate
8. Wiper bracket
9. Washer head screw (4)
10. Flange nut (4)
11. Washer head screw (3)
12. Wiper motor
13. Cap screw
14. Lock washer
15. Cover
16. Jam nut
17. Star washer
18. Wiper motor plate

Disassembly (Fig. 16)

1. Park machine on a level surface, lower cutting deck or implement and stop engine. Remove key from the ignition switch.

2. To remove wiper blade, remove two (2) cap screws and lock washers that secure wiper blade to wiper arm assembly.

3. If necessary, remove wiper arm assembly:

   A. Disconnect washer hose from wiper assembly.

   B. Lift caps at top of wiper arms and remove flange nuts that secure wiper arms to wiper motor.

   C. Use suitable puller to remove tapered wiper arm sockets from wiper motor shafts.

4. If access to wiper motor is necessary, remove roof panel from top of cab to allow access to wiper motor assembly (see Roof Assembly in this section). Remove wiper motor components using Figure 16 as a guide.

Assembly (Fig. 16)

1. If required, install removed wiper motor components using Figure 16 as a guide.

   A. If wiper bracket (item 8) was removed, apply bead of RTV sealant around wiper opening on inside of headliner before installing bracket.

   B. If jam nut (item 16) was removed, torque jam nut to **100 in−lb (11.3 N−m)** during assembly.

   C. Make sure that wiper motor electrical connector is secured to cab wire harness.

   D. Secure roof panel to top of cab (see Roof Assembly in this section).

2. If wiper blade was removed, apply medium strength thread locker to threads of cap screws (item 2). Secure blade to wiper arm assembly with two (2) cap screws and lock washers.

3. If wiper arm assembly was removed:

   A. Clean tapered wiper arm sockets and wiper motor shafts.

   B. Run the wiper motor for one (1) cycle to allow the motor to return to the normal OFF position.

   C. Slide wiper arm sockets onto wiper motor shafts so that the bottom of the wiper blade is 3 inches (76 mm) from the right side window trim (Fig. 17).

   D. Secure wiper arm sockets to motor shafts with flange nuts. Torque nuts from **16 to 18 ft−lb (23 to 25 N−m)**.

   E. Install wiper arm caps over flange nuts.

   F. Connect washer hose to wiper assembly.

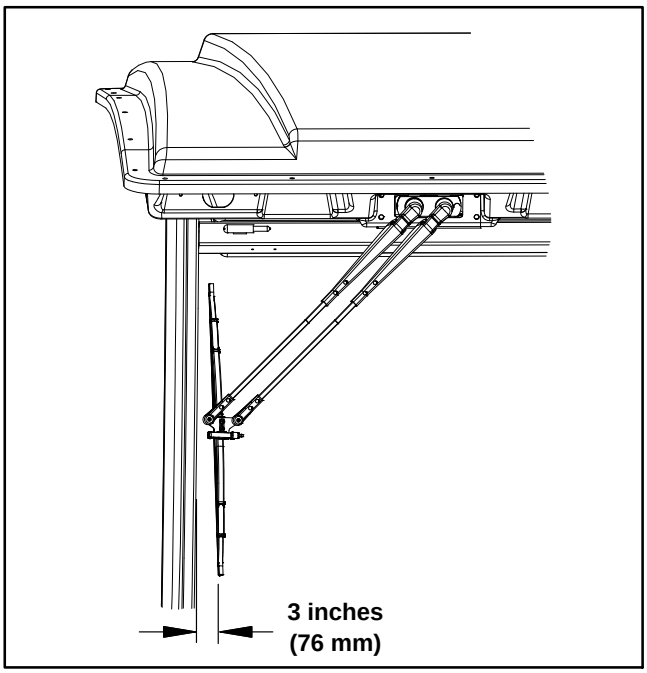

Figure 17

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Chapter 9

Foldout Drawings

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Electrical Drawing Designations

NOTE: A splice used in a wire harness will be identified on the wire harness diagram by SP. The manufacturing number of the splice is also identified on the wire harness diagram (e.g. SP01 is splice number 1).

Wire Color

The following abbreviations are used for wire harness colors on the electrical schematics and wire harness drawings in this chapter.

ABBREVIATION	COLOR
BK	BLACK
BR or BN	BROWN
BU	BLUE
GN	GREEN
GY	GRAY
OR	ORANGE
PK	PINK
R or RD	RED
T	TAN
VIO	VIOLET
W or WH	WHITE
Y or YE	YELLOW

Numerous harness wires used on Toro machines include a line with an alternate color. These wires are identified with the wire color and line color with either a / or _ separating the color abbreviations listed above (e.g. R/BK is a red wire with a black line, OR_BK is an orange wire with a black line).

Wire Size

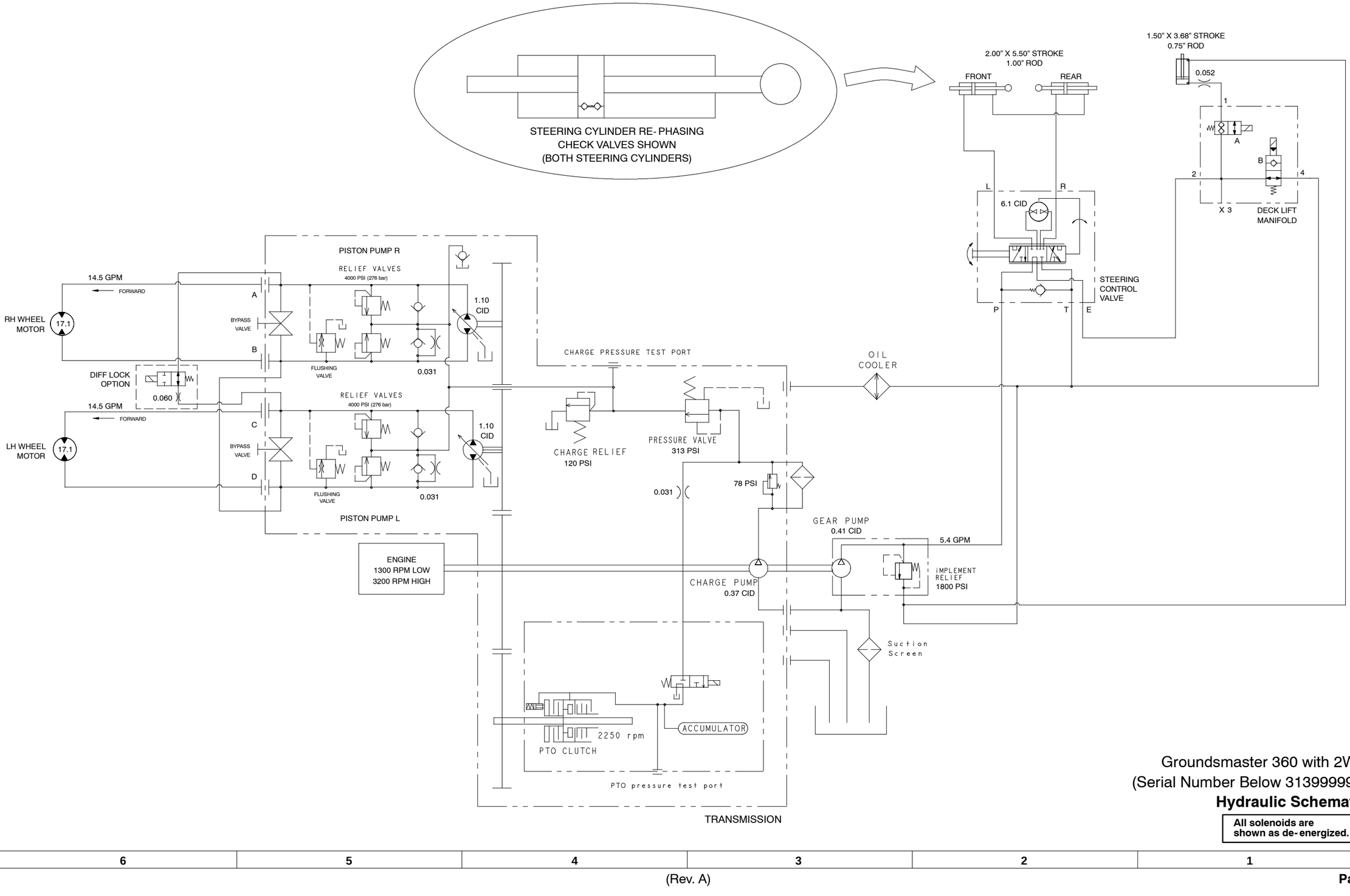
The individual wires of the electrical harness diagrams in this chapter identify both the wire color and the wire size.

Examples:

16 BK = 16 AWG (American Wire Gauge) wire that has a black insulator

050 R = 0.5 mm metric wire that has a red insulator (AWG equivalents for metric wire appear in the following table)

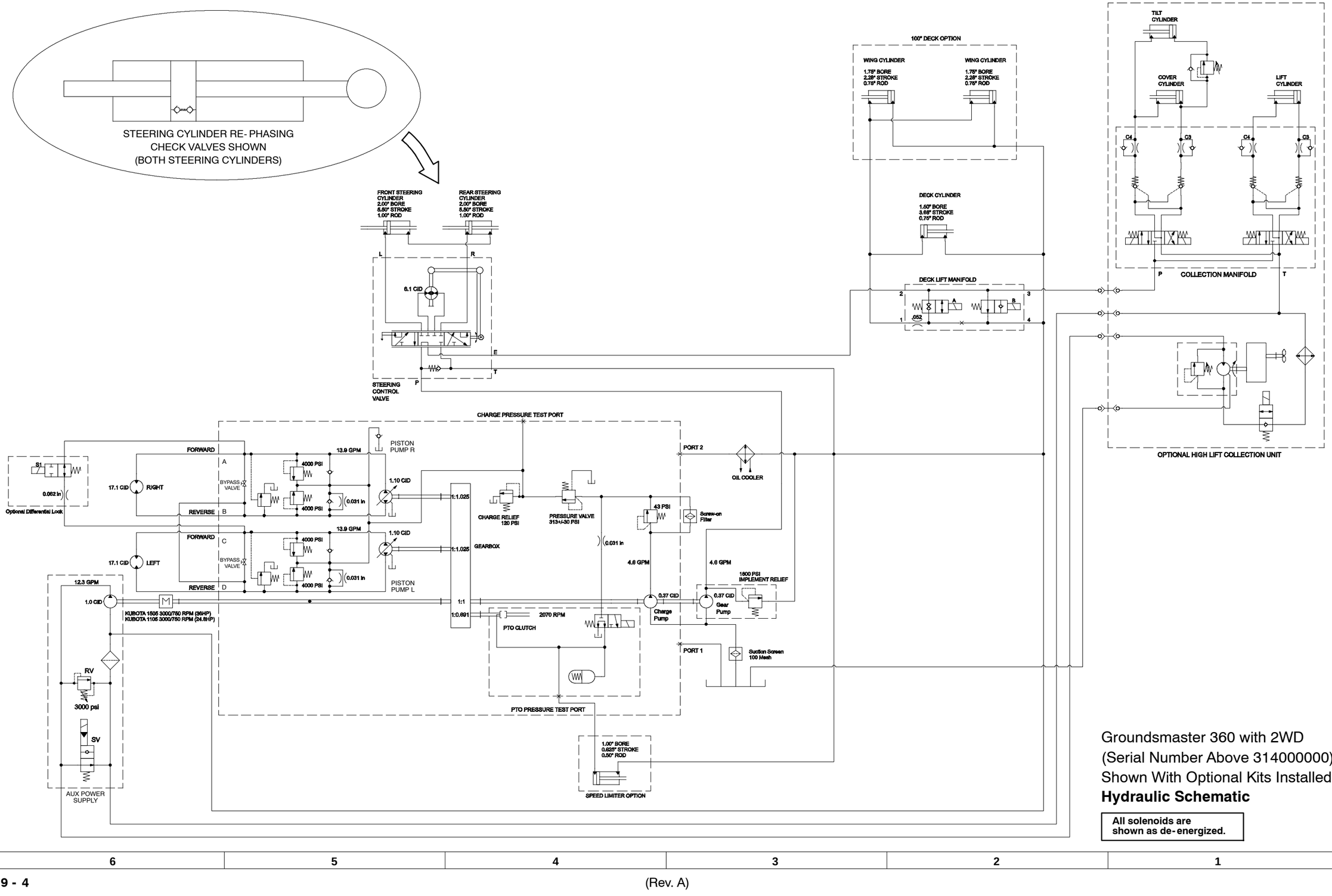
AWG EQUIVALENTS FOR METRIC WIRE		
DIAGRAM LABEL	METRIC SIZE	AWG EQUIVALENT
050	0.5 mm	20 GA
175	0.75 mm	18 GA
100	1.0 mm	16 GA
150	1.5 mm	14 GA



Groundsmaster 360 with 2WD
(Serial Number Below 313999999)

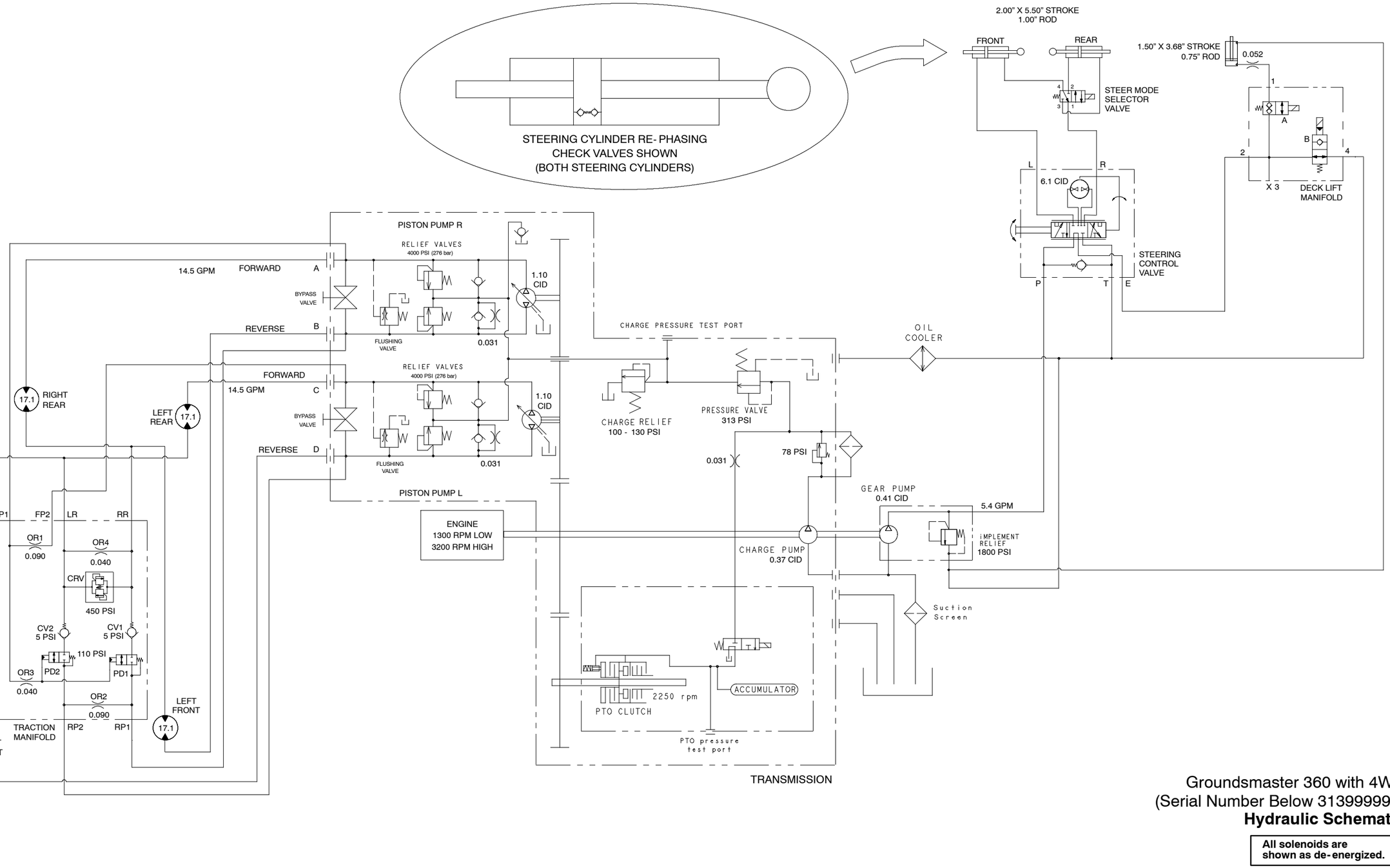
Hydraulic Schematic

All solenoids are shown as de- energized.



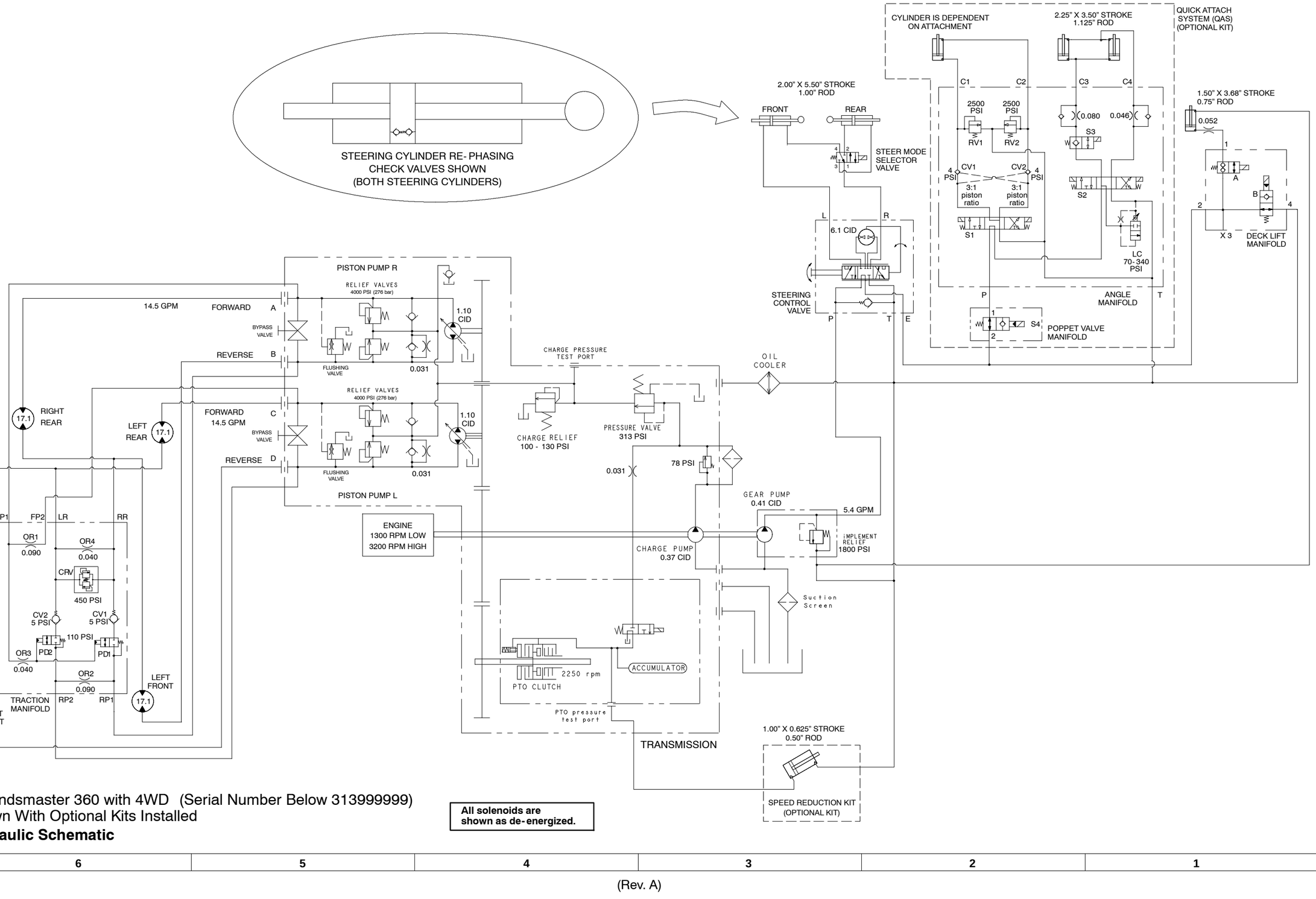
Groundsmaster 360 with 2WD
(Serial Number Above 314000000)
Shown With Optional Kits Installed
Hydraulic Schematic

All solenoids are shown as de- energized.



Groundsmaster 360 with 4WD
(Serial Number Below 313999999)
Hydraulic Schematic

All solenoids are shown as de-energized.

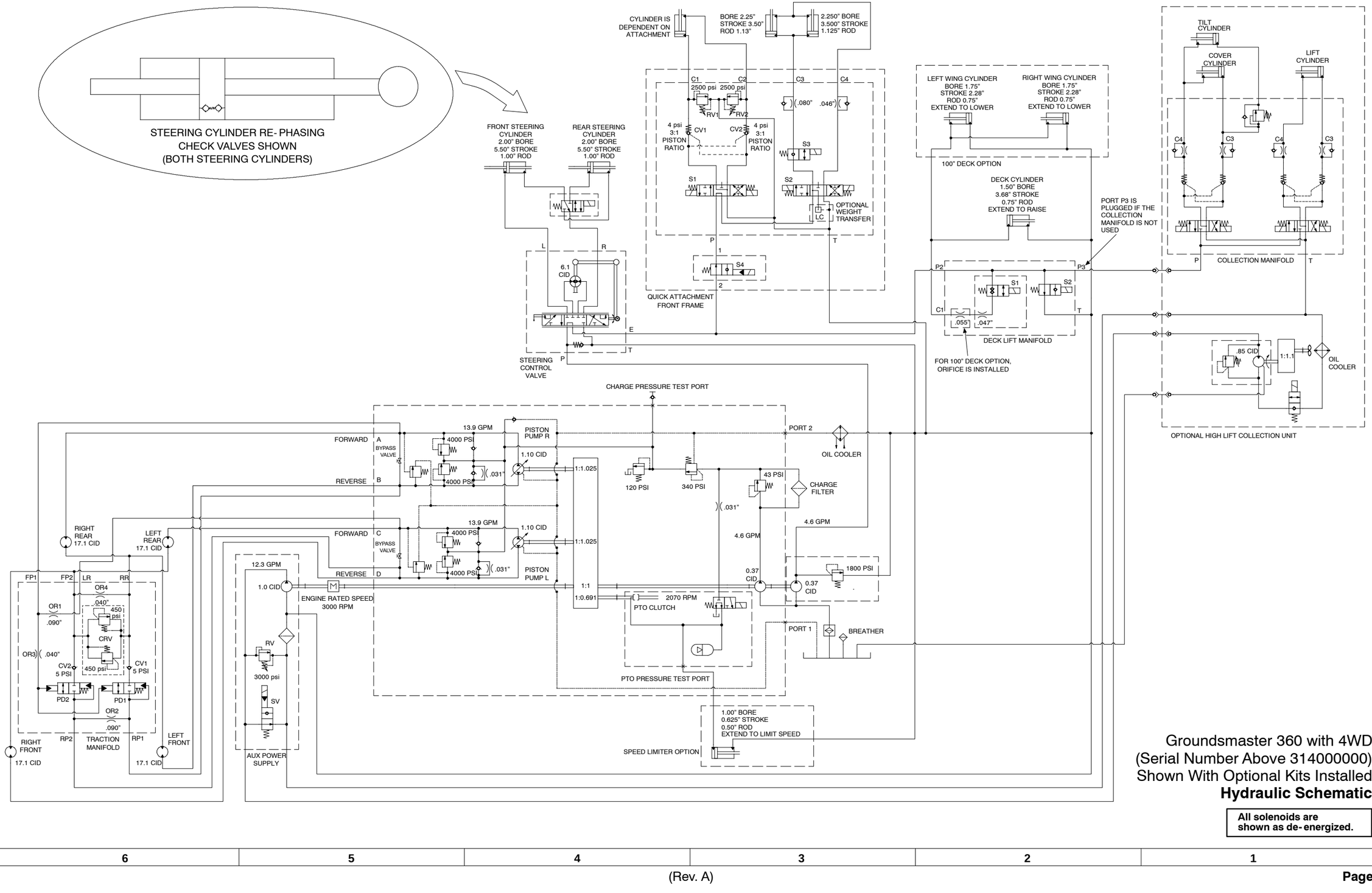


Groundsmaster 360 with 4WD (Serial Number Below 313999999)
Shown With Optional Kits Installed

Hydraulic Schematic

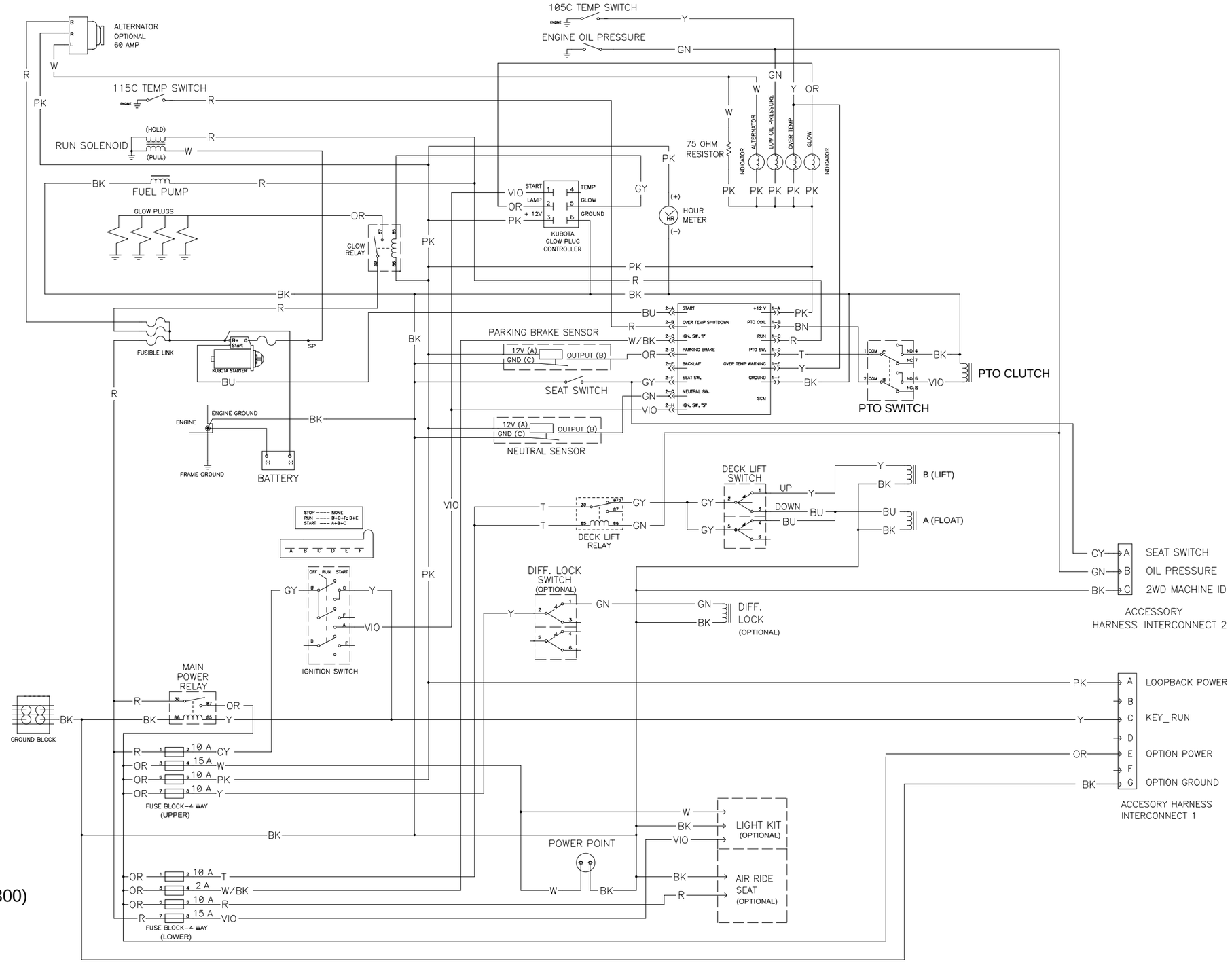
All solenoids are shown as de- energized.

STEERING CYLINDER RE- PHASING
CHECK VALVES SHOWN
(BOTH STEERING CYLINDERS)



Groundsmaster 360 with 4WD
(Serial Number Above 314000000)
Shown With Optional Kits Installed
Hydraulic Schematic

All solenoids are shown as de- energized.



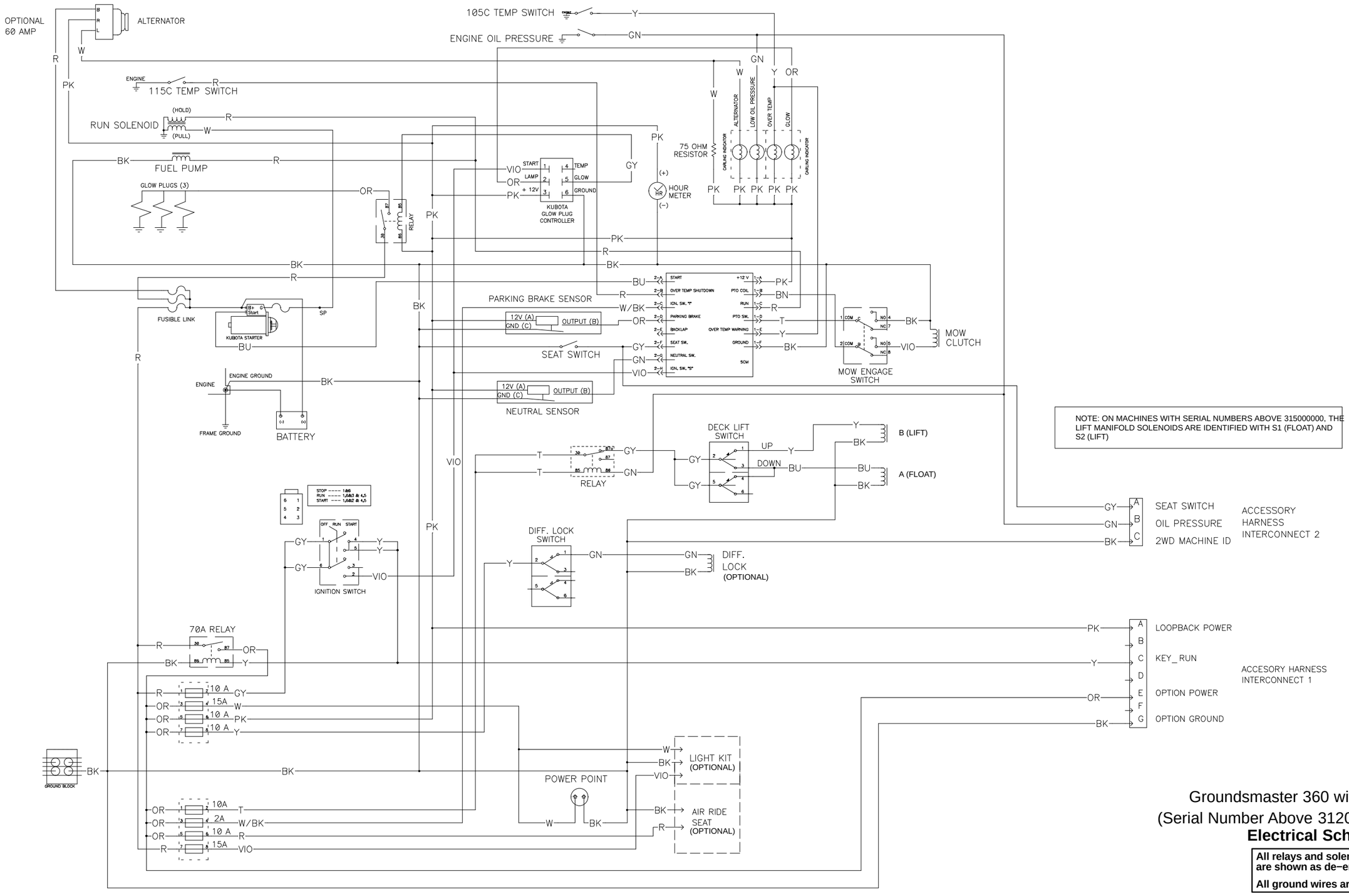
Groundsmaster 360 with 2WD

(Serial Number Below 312000300)

Electrical Schematic

All relays and solenoids are shown as de-energized.

All ground wires are black.



NOTE: ON MACHINES WITH SERIAL NUMBERS ABOVE 315000000, THE LIFT MANIFOLD SOLENOIDS ARE IDENTIFIED WITH S1 (FLOAT) AND S2 (LIFT)

Groundsmaster 360 with 2WD
(Serial Number Above 312000300)
Electrical Schematic

All relays and solenoids are shown as de-energized.

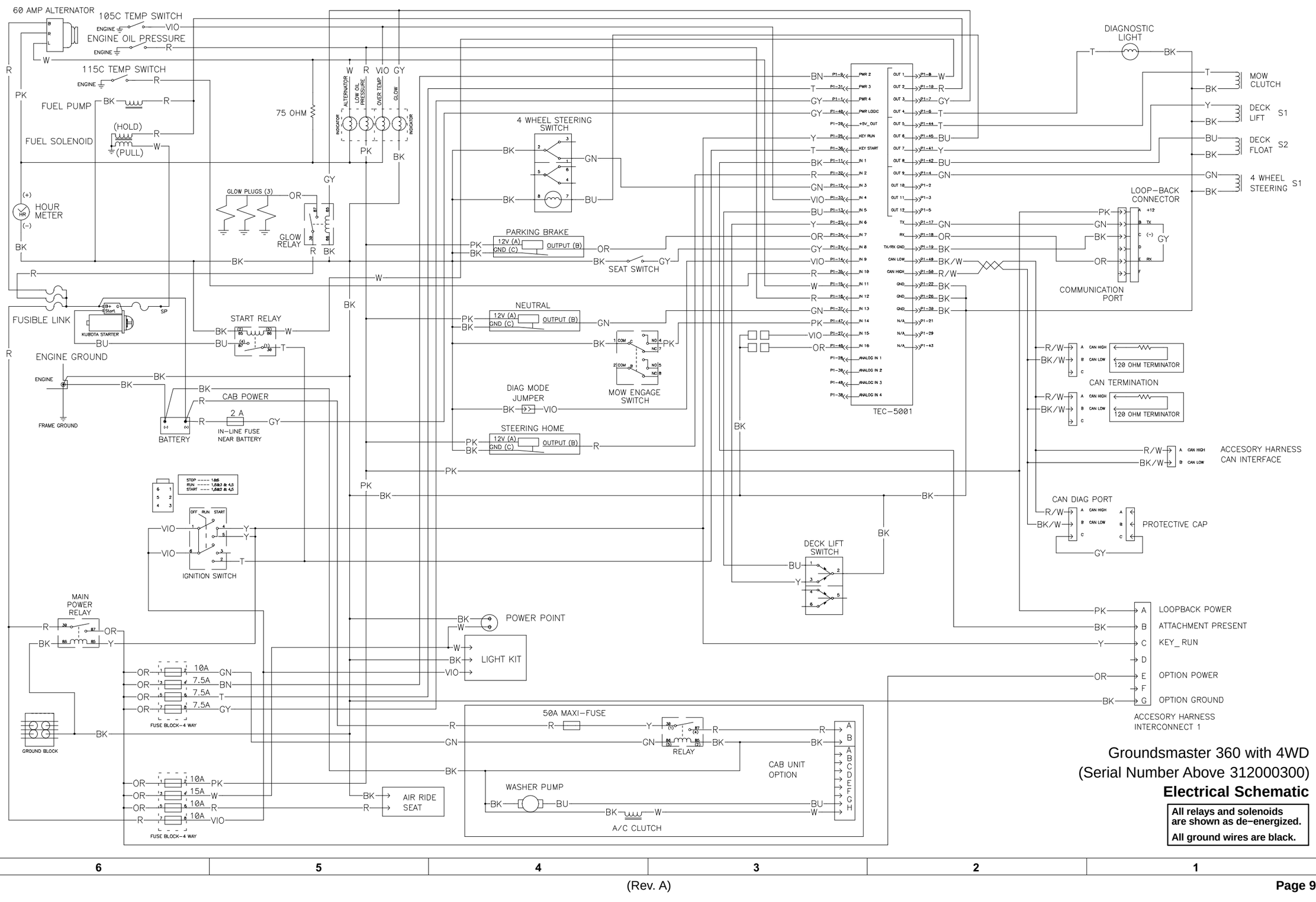
All ground wires are black.

Groundsmaster 360 with 4WD (Serial Number Below 312000300)

Electrical Schematic

All relays and solenoids are shown as de–energized.

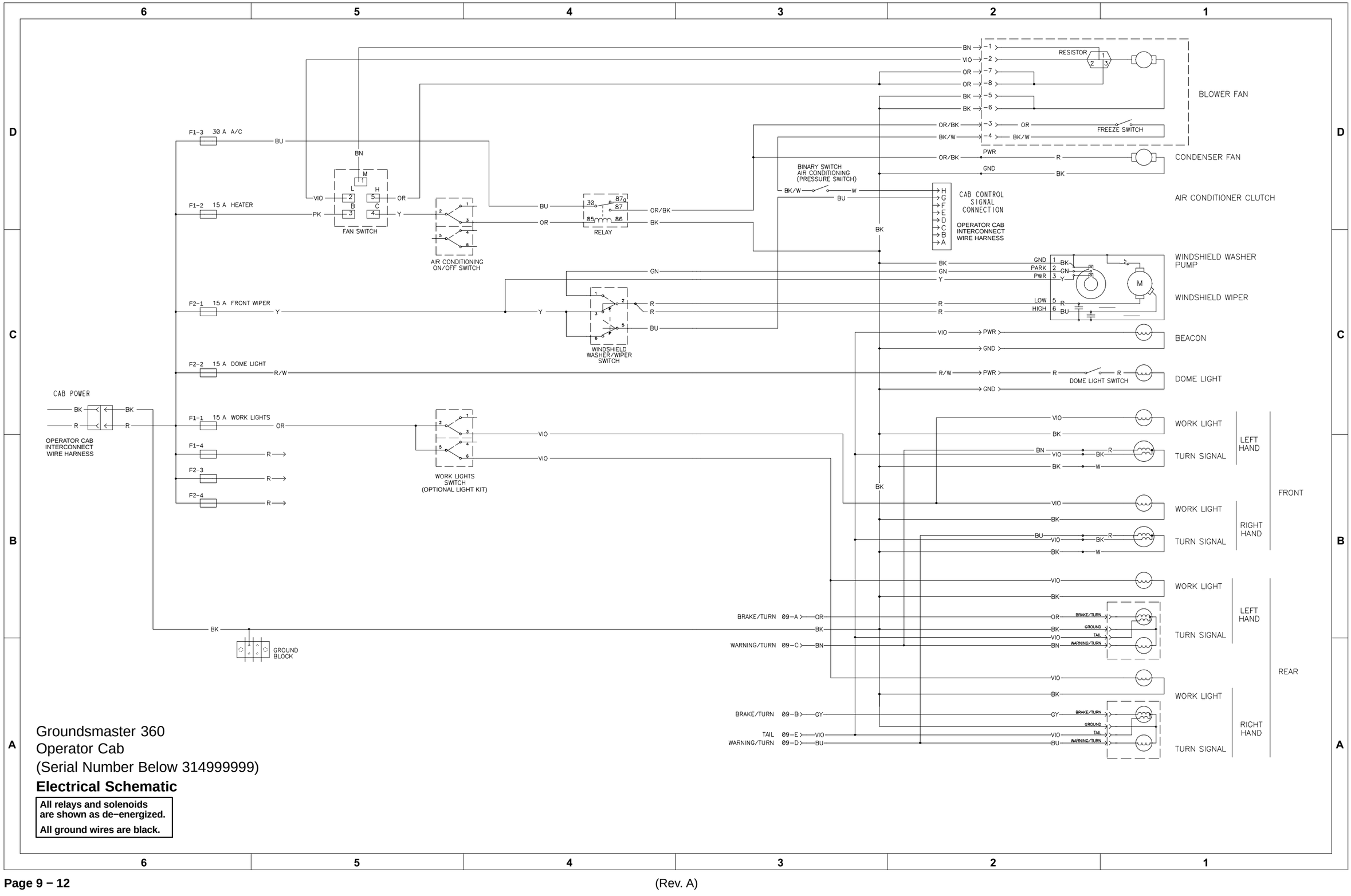
All ground wires are black.



Groundsmaster 360 with 4WD
(Serial Number Above 312000300)
Electrical Schematic

All relays and solenoids are shown as de-energized.

All ground wires are black.



Groundsmaster 360
Operator Cab
(Serial Number Below 314999999)

Electrical Schematic

All relays and solenoids are shown as de−energized.

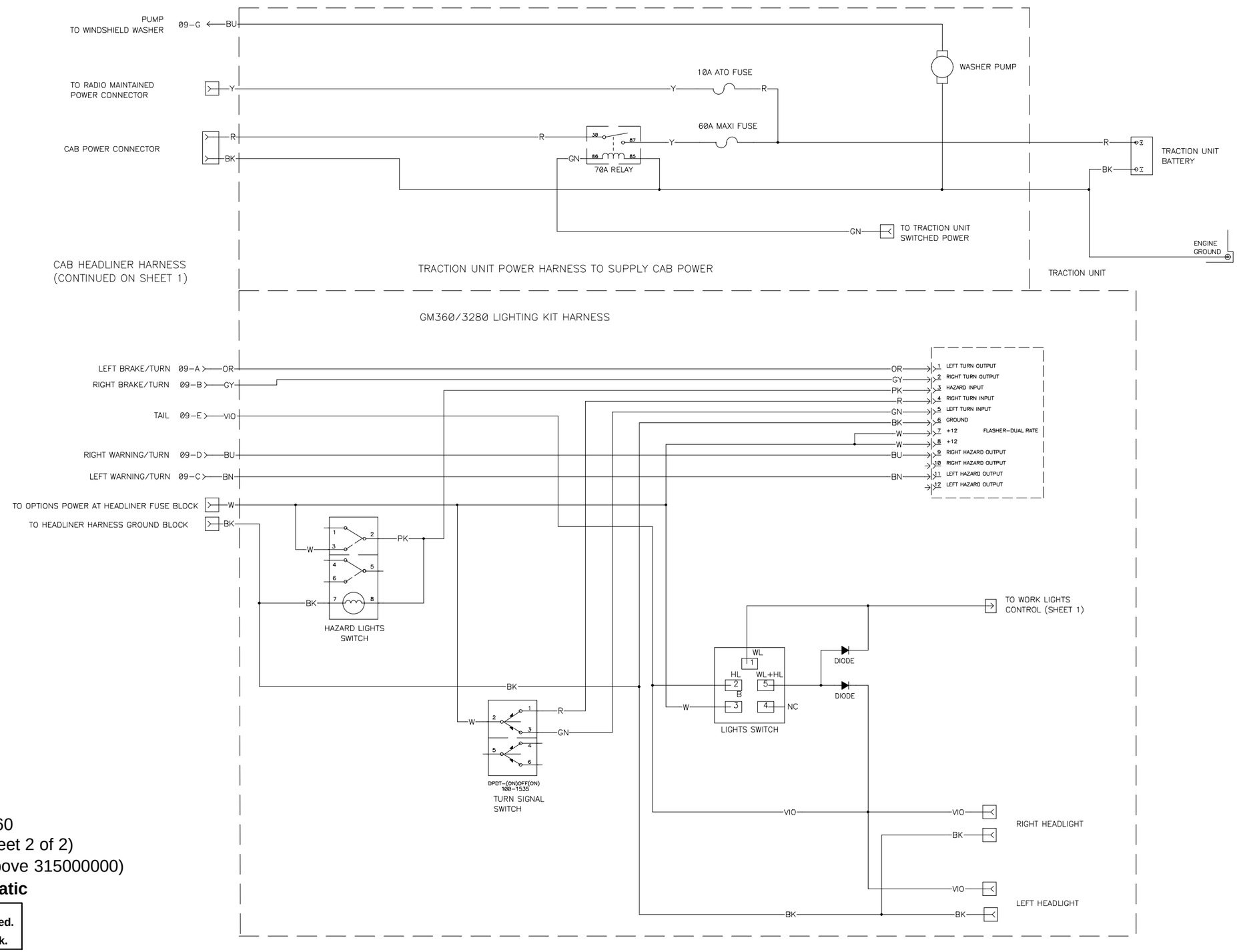
All ground wires are black.

1F 3 30 A A/C
1F 2 25 A HEATER
2F 1 15 A FRONT WIPER
2F 2 15 A DOME LIGHT/BEACON
1F 1 20 A WORK LIGHTS
1F 4
(15A POWER POINT KIT)
2F 4
(25A LIGHT KIT)
2F 3
(10 A RADIO)
(FUSE NOT INSTALLED)
FAN SWITCH
AIR CONDITIONING ON/OFF SWITCH
RELAY
BINARY SWITCH AIR CONDITIONING (PRESSURE SWITCH)
WINDSHIELD WASHER/WIPER SWITCH
WORK LIGHTS SWITCH
BEACON SWITCH
WORK LIGHTS CONTROL (SHEET 2)
CAB POWER CONNECTOR
CAB RADIO MAINTAINED POWER CONNECTOR
RADIO WIRING (FLYING LEADS WITH SPLICES ATTACHED)
GROUND BLOCK
OPTIONS POWER
SWITCHED POWER
GROUND
MAINTAINED POWER
TO AIR CONDITIONER CLUTCH
TO WINDSHIELD WASHER PUMP
BLOWER FAN
RESISTOR
FREEZE SWITCH
CONDENSER FANS
WINDSHIELD WIPER
BEACON
DOME LIGHT
DOME LIGHT SWITCH
WORK LIGHT
TURN SIGNAL
LEFT HAND
RIGHT HAND
FRONT
REAR
LEFT BRAKE/TURN 09-A
LEFT WARNING/TURN 09-C
RIGHT BRAKE/TURN 09-B
TAIL 09-E
RIGHT WARNING/TURN 09-D

All relays and solenoids are shown as de-energized.

All ground wires are black.

Groundsmaster 360
Operator Cab (Sheet 1 of 2)
(Serial Number Above 315000000)
Electrical Schematic

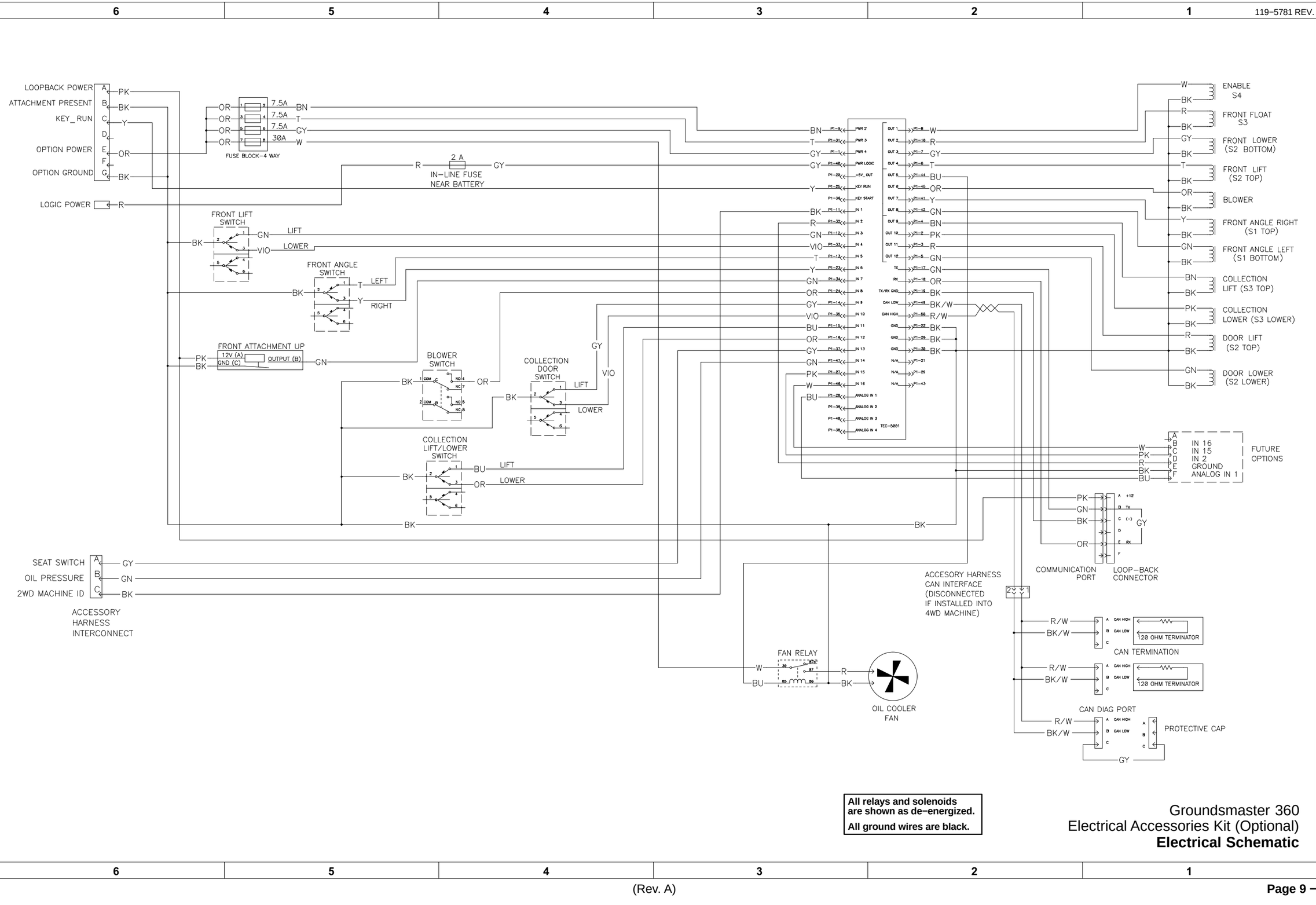


Groundsmaster 360
Operator Cab (Sheet 2 of 2)
(Serial Number Above 315000000)

Electrical Schematic

All relays and solenoids are shown as de-energized.

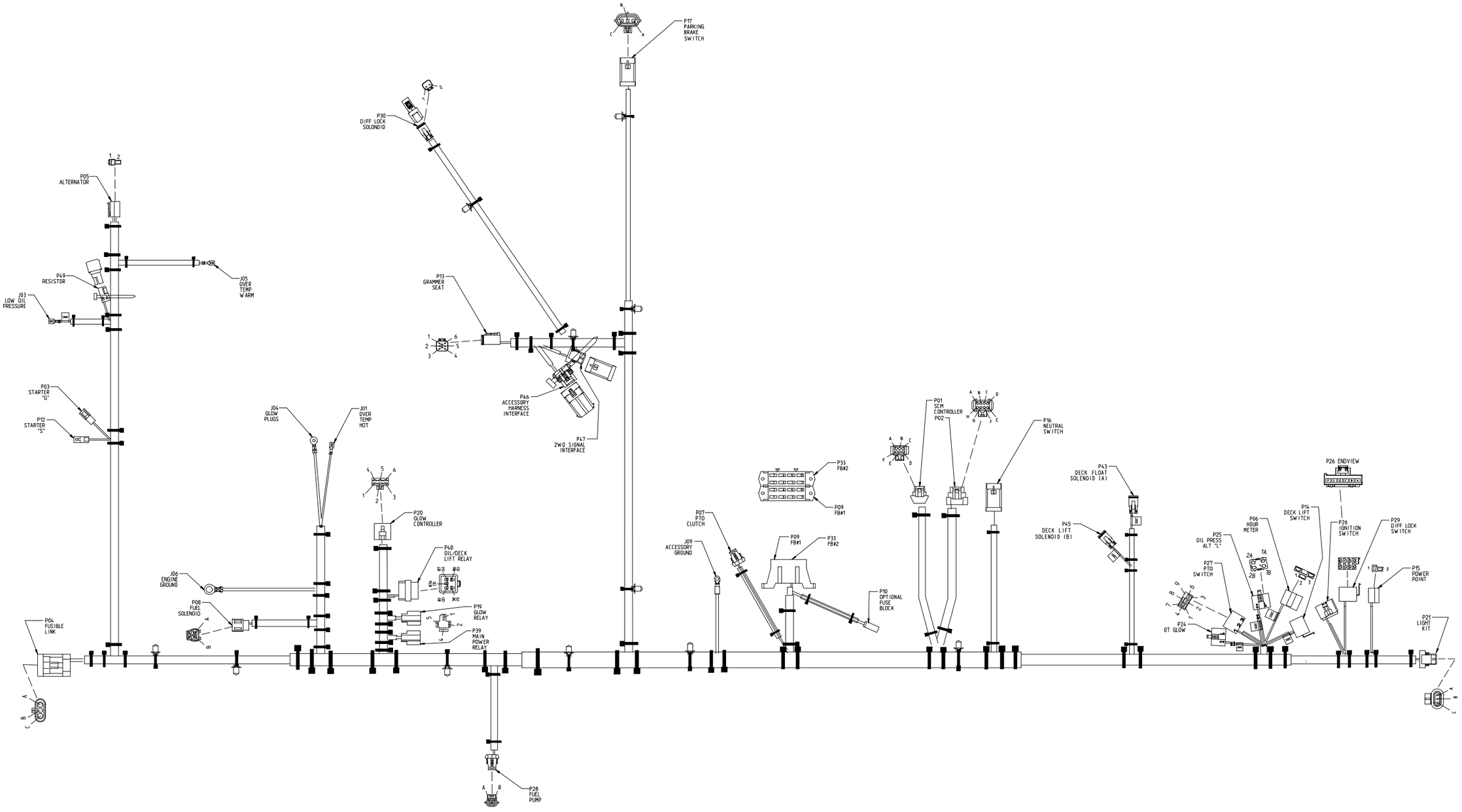
All ground wires are black.



All relays and solenoids are shown as de-energized.

All ground wires are black.

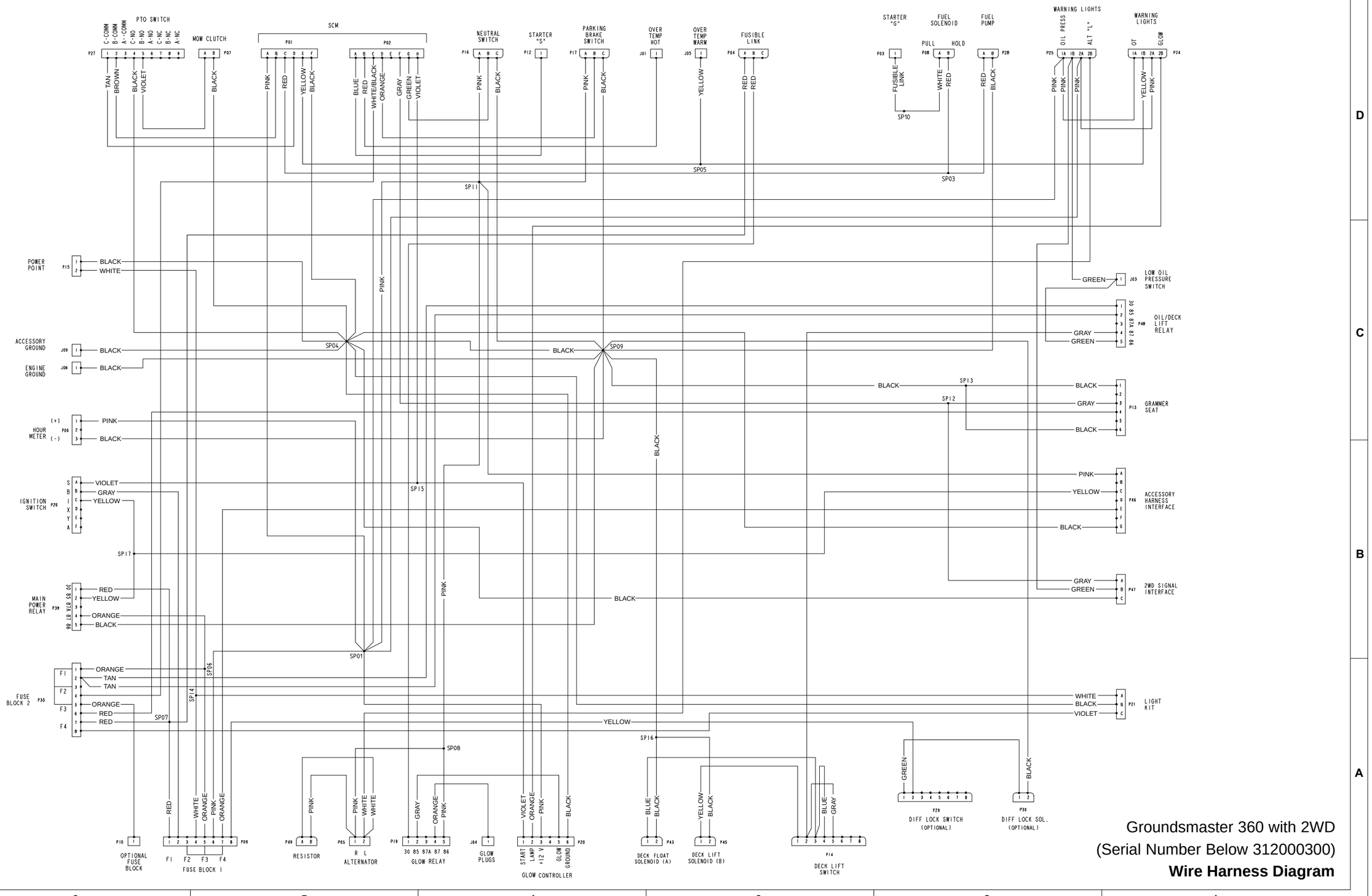
Groundsmaster 360
Electrical Accessories Kit (Optional)
Electrical Schematic



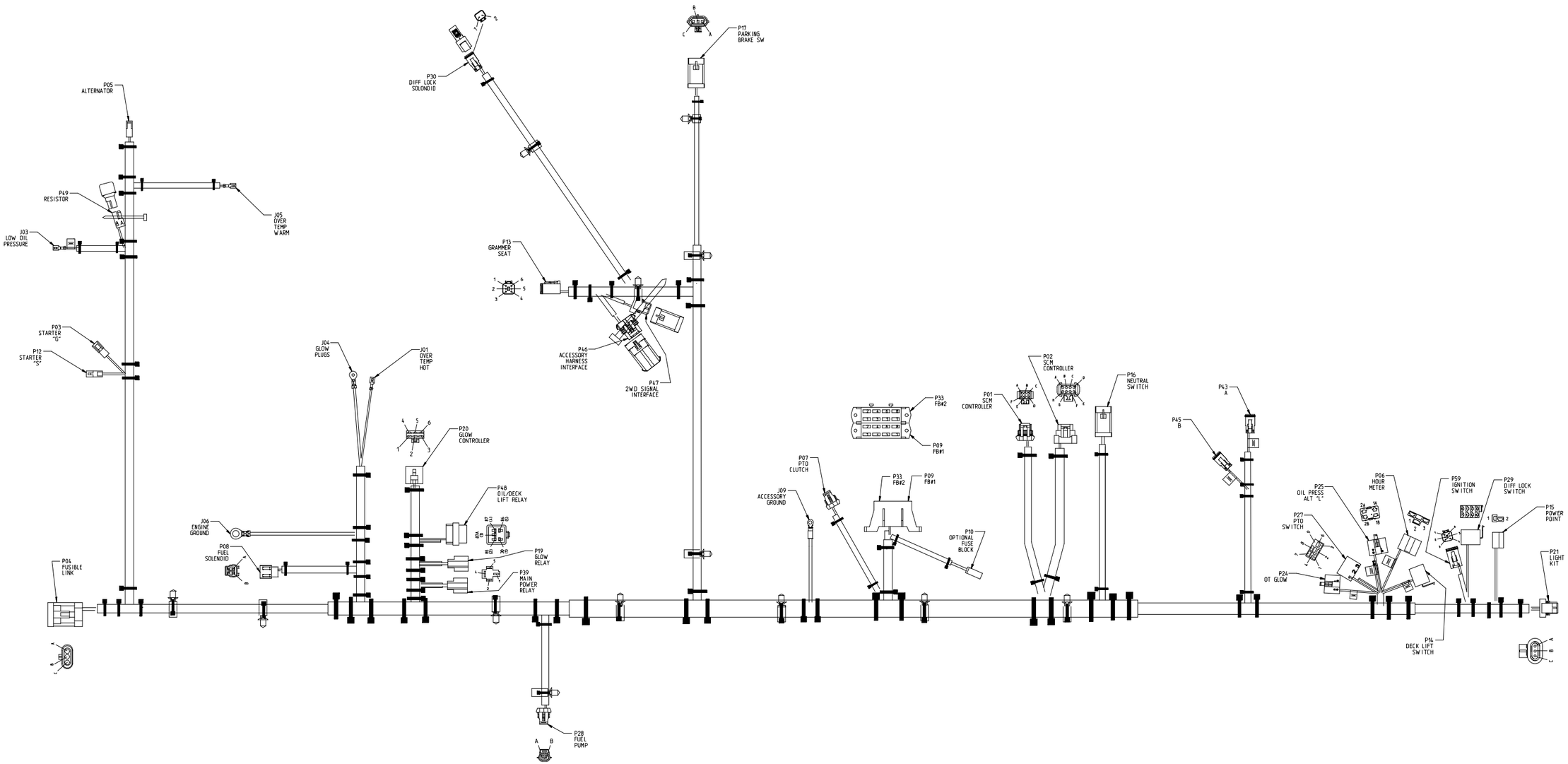
Groundsmaster 360 with 2WD

(Serial Number Below 312000300)

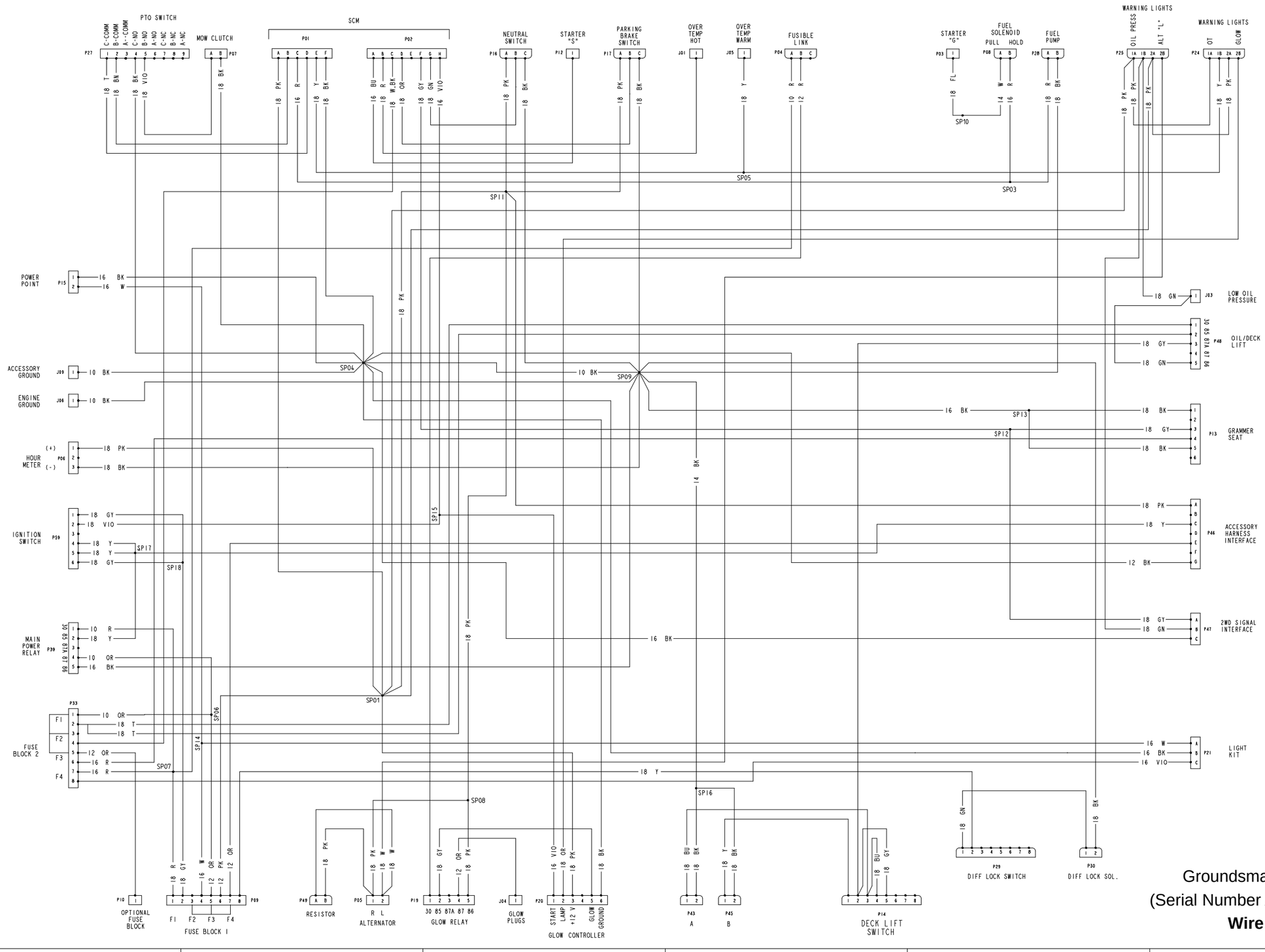
Wire Harness Drawing



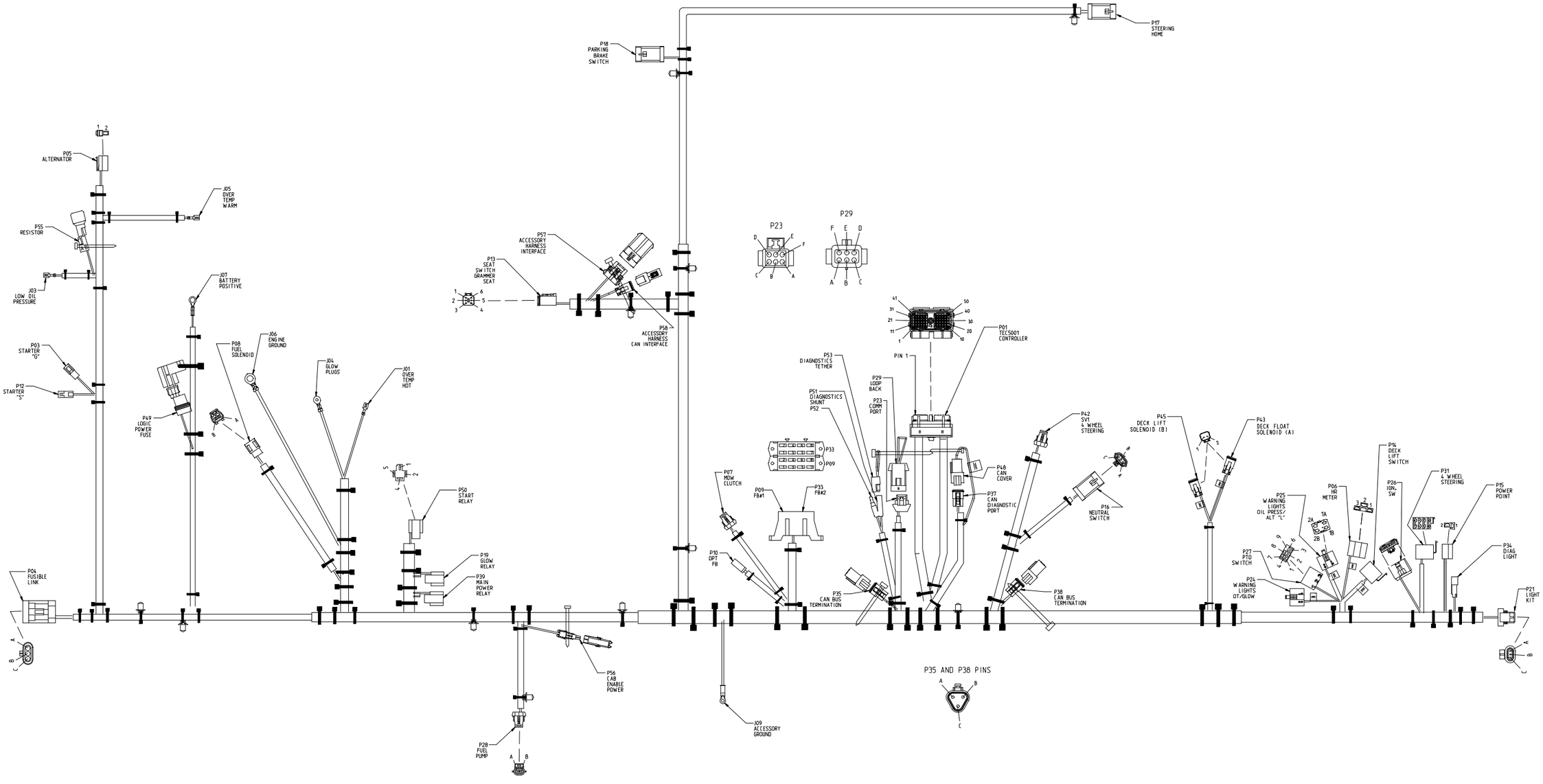
Groundsmaster 360 with 2WD
(Serial Number Below 312000300)
Wire Harness Diagram



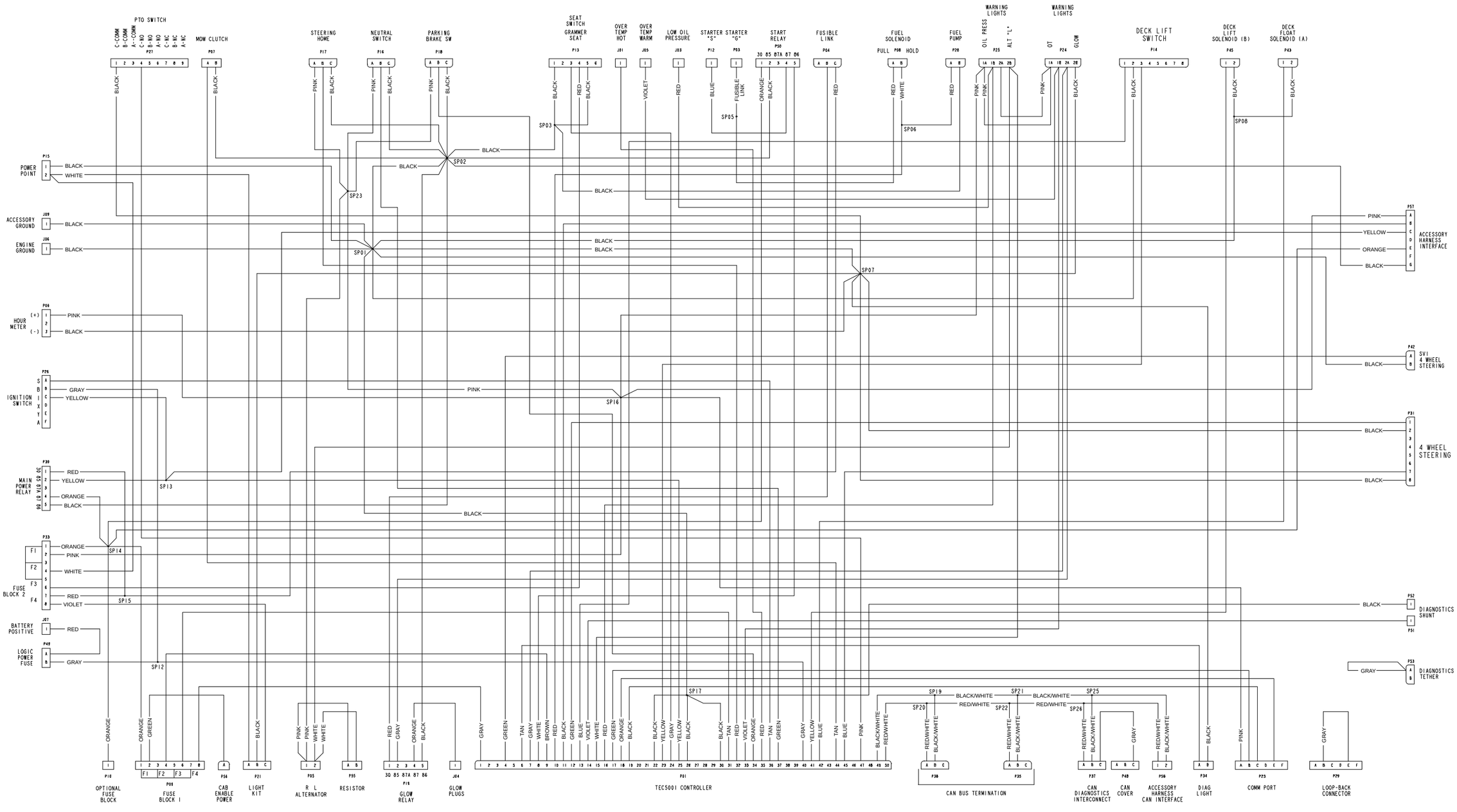
Groundsmaster 360 with 2WD
(Serial Number Above 312000300)
Wire Harness Drawing



Groundsmaster 360 with 2WD
(Serial Number Above 312000300)
Wire Harness Diagram



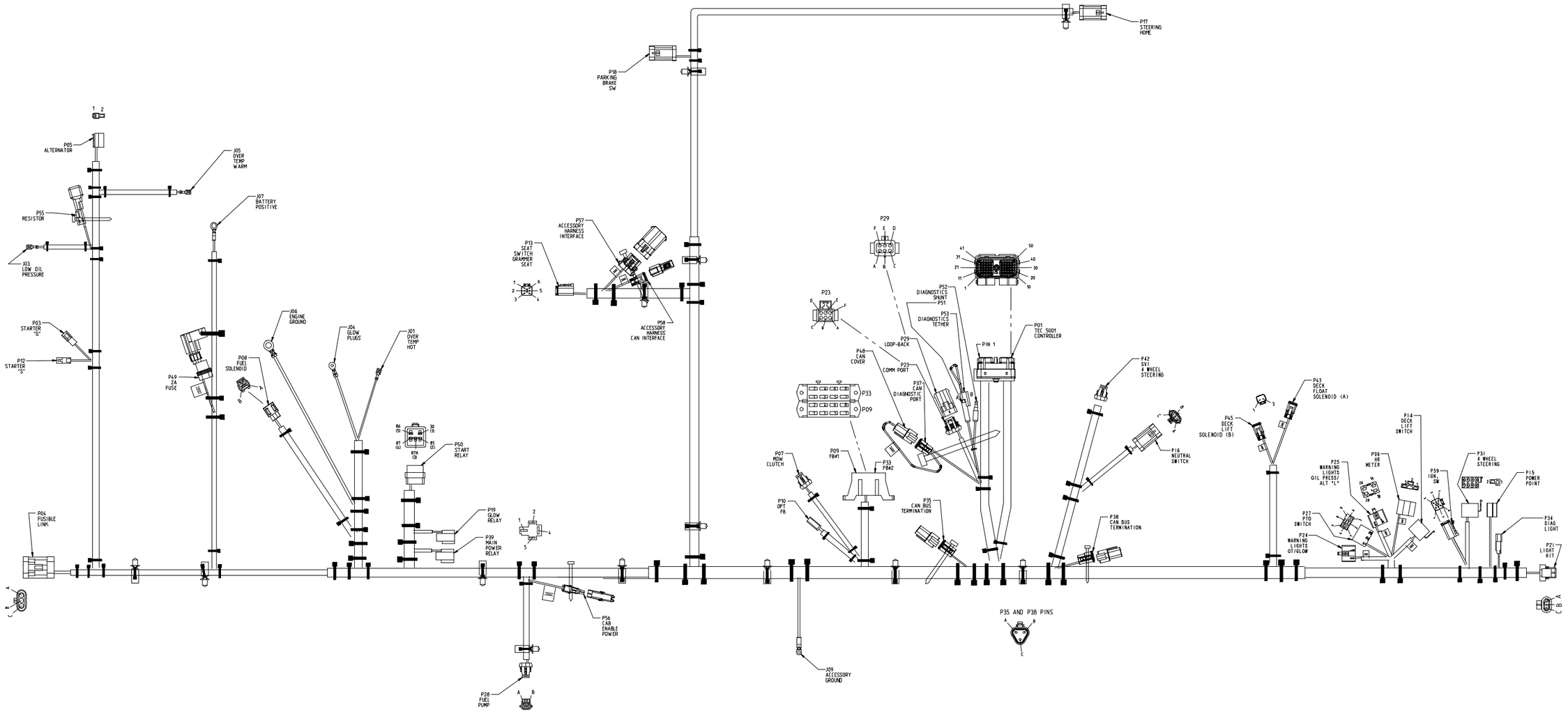
Groundsmaster 360 with 4WD
(Serial Number Below 312000300)
Wire Harness Drawing



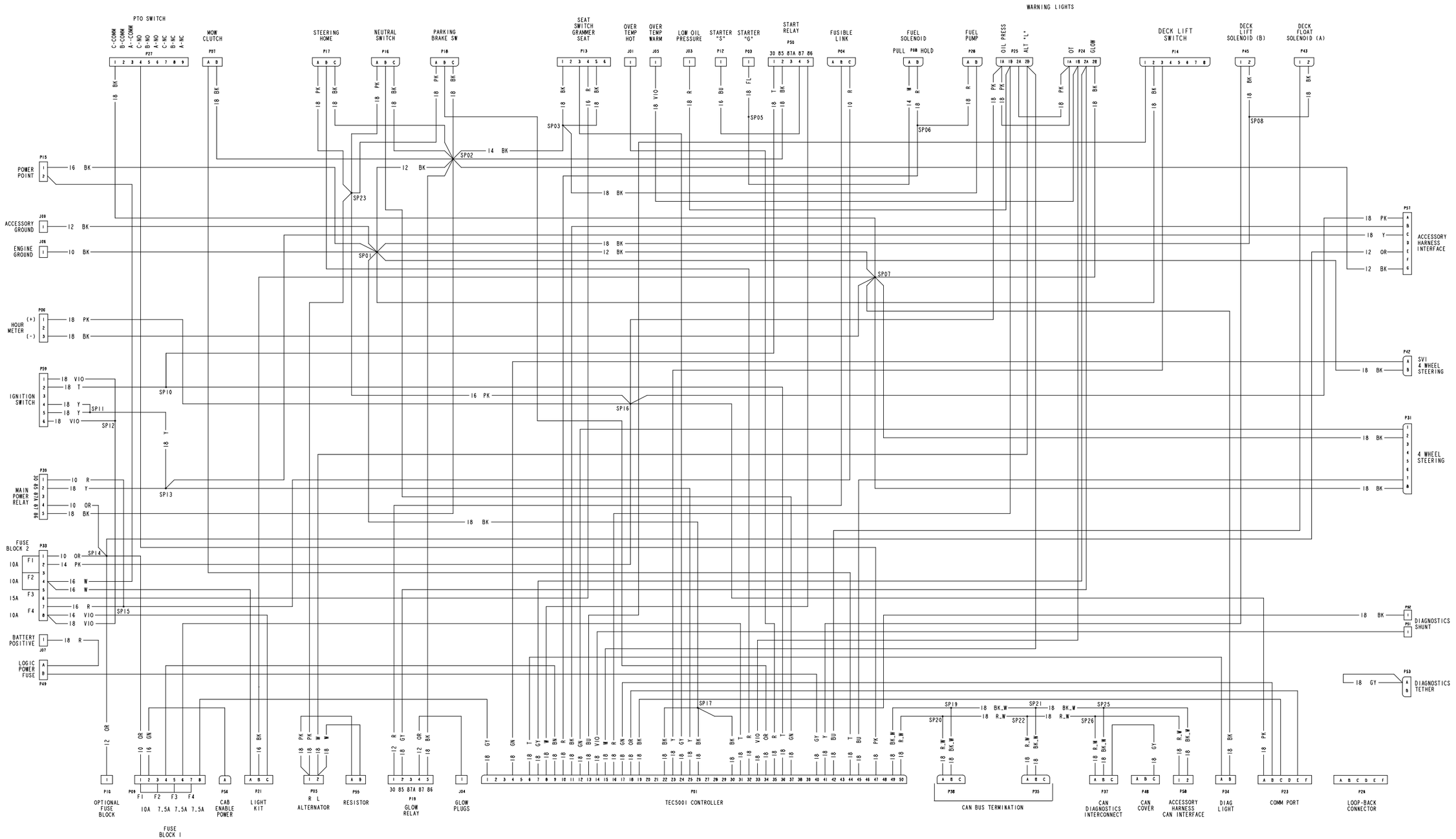
Groundsmaster 360 with 4WD

(Serial Number Below 312000300)

Wire Harness Diagram



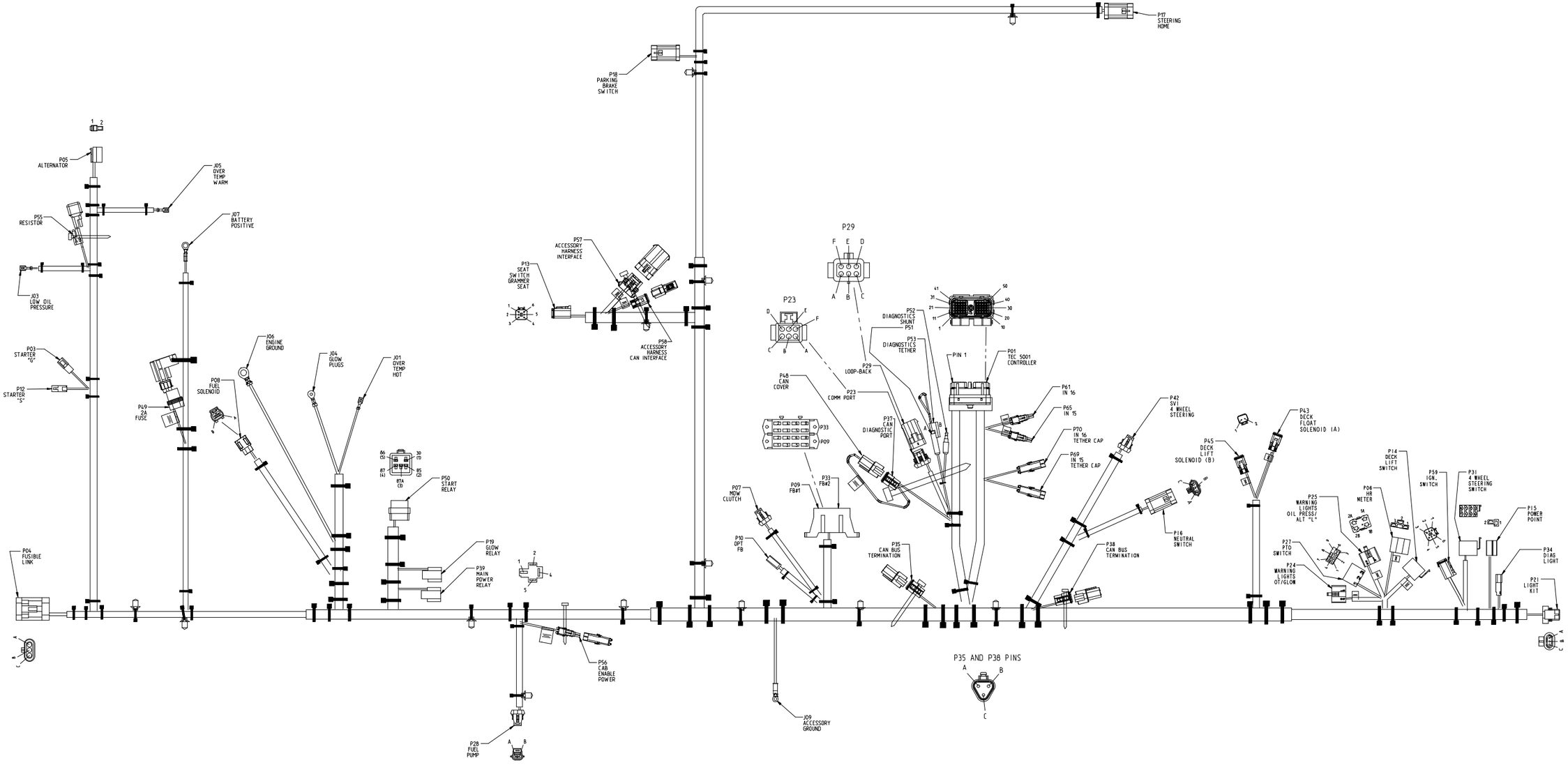
Groundsmaster 360 with 4WD
(Serial Number From 312000301 to 313999999)
Wire Harness Drawing



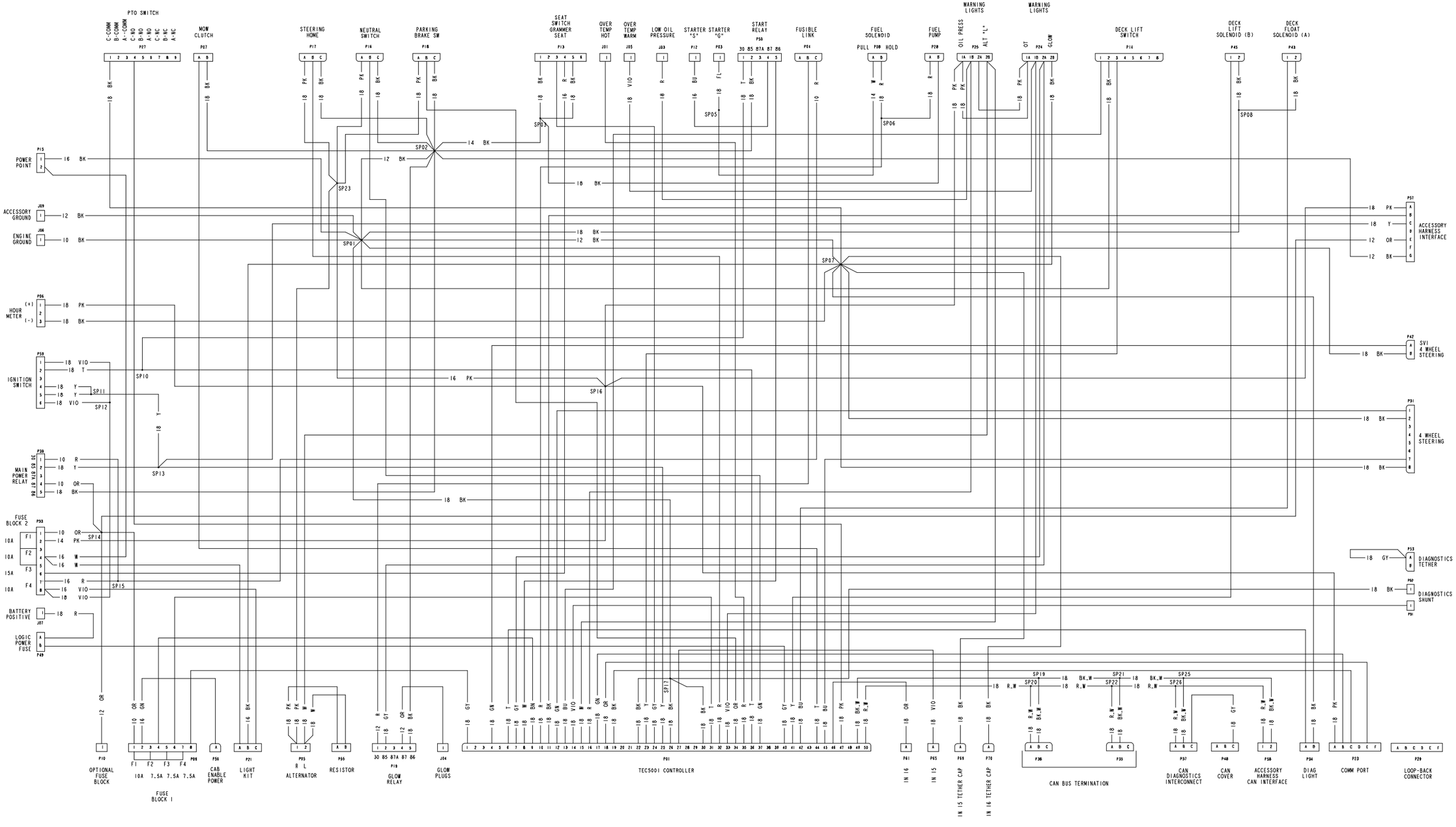
Groundsmaster 360 with 4WD

(Serial Number From 312000301 to 313999999)

Wire Harness Diagram



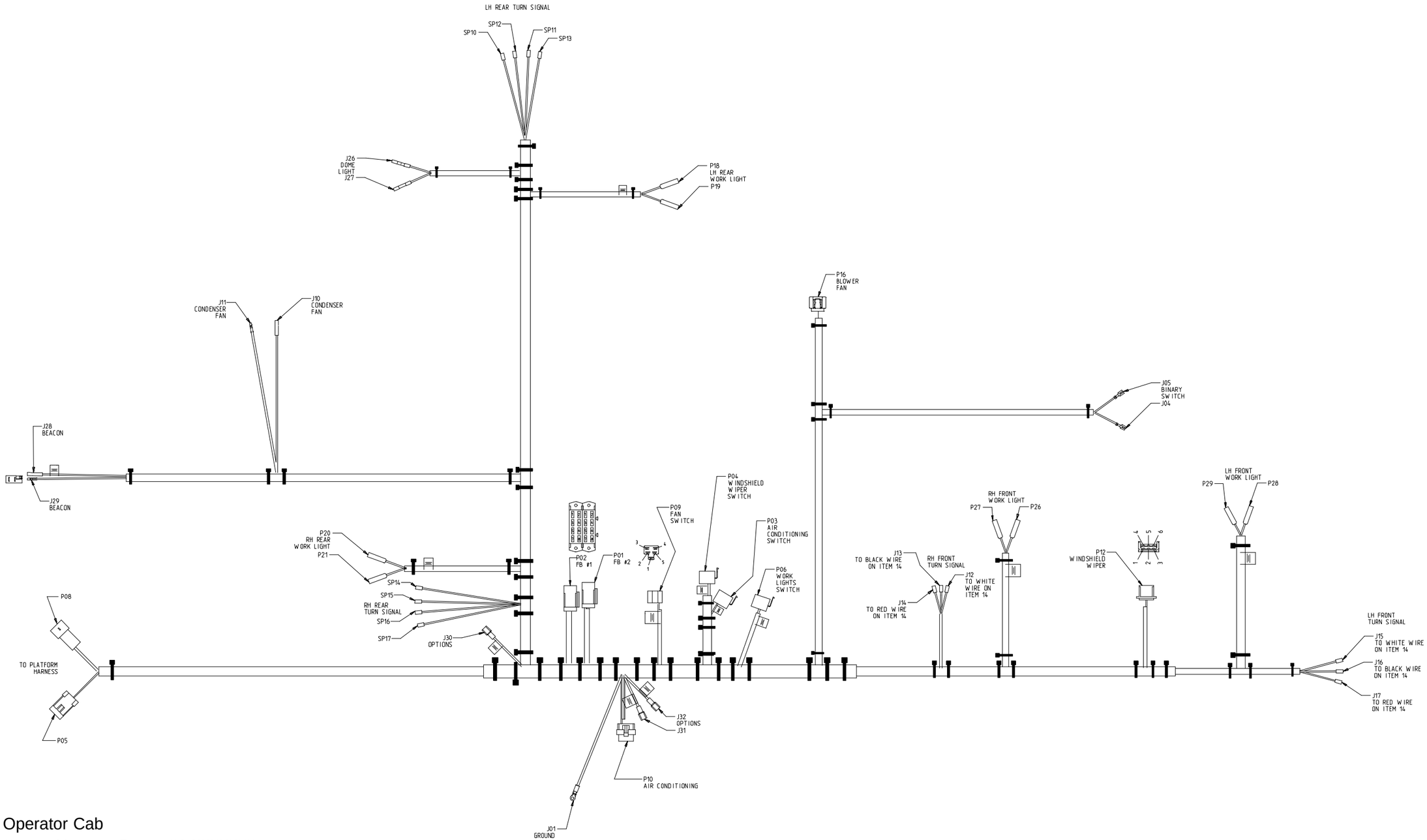
Groundsmaster 360 with 4WD
(Serial Number Above 314000000)
Wire Harness Drawing



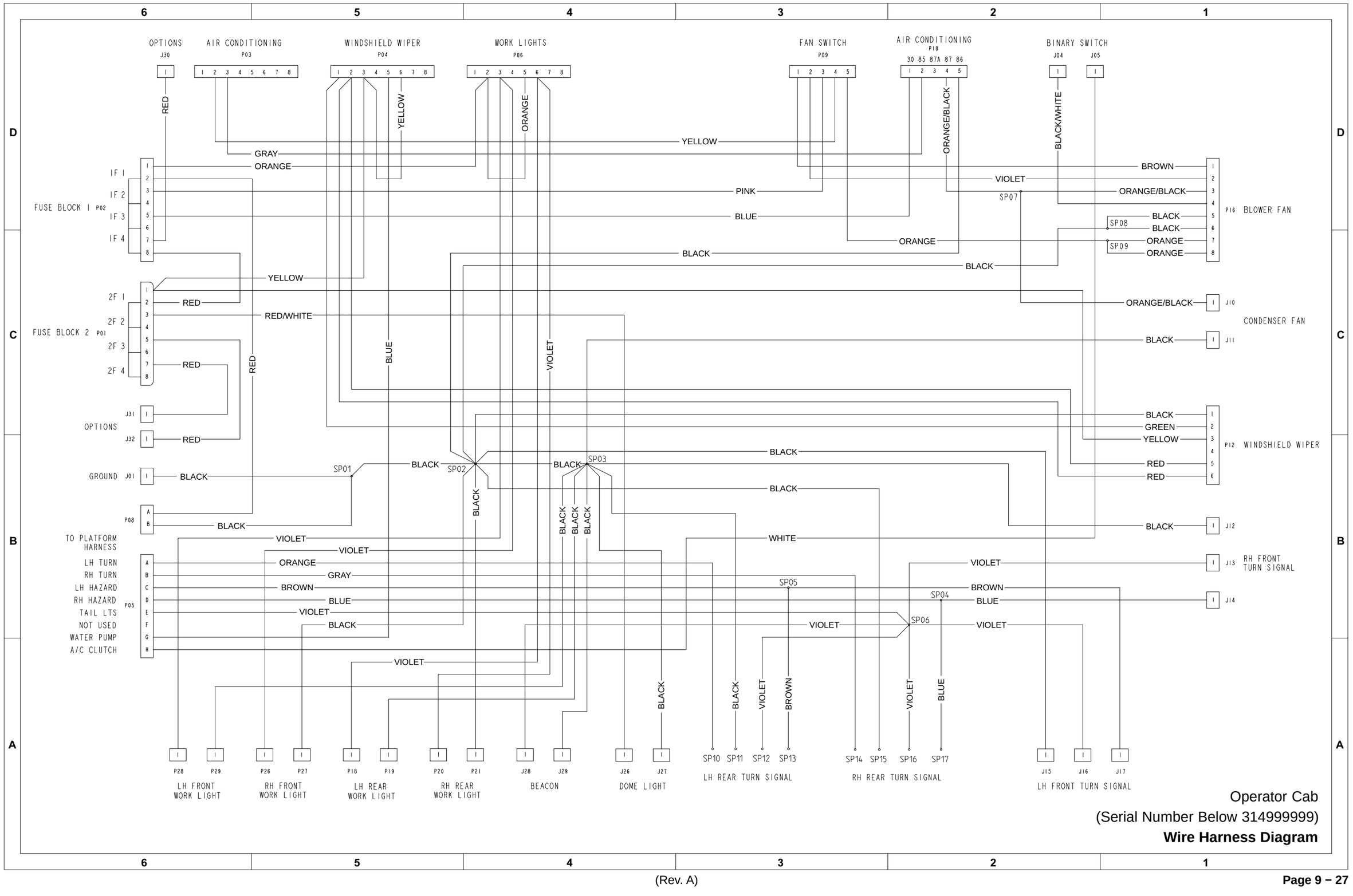
Groundsmaster 360 with 4WD

(Serial Number Above 314000000)

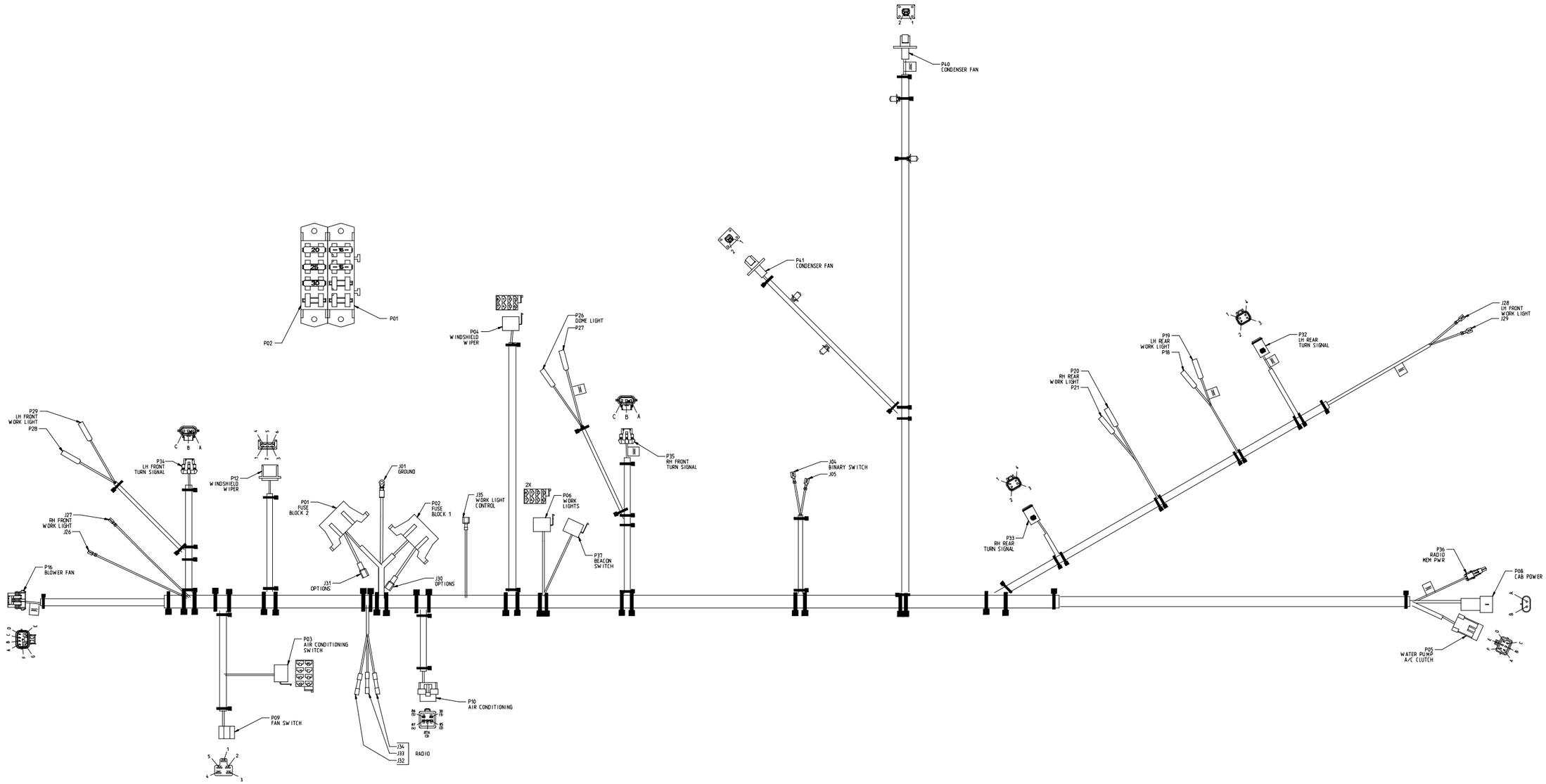
Wire Harness Diagram



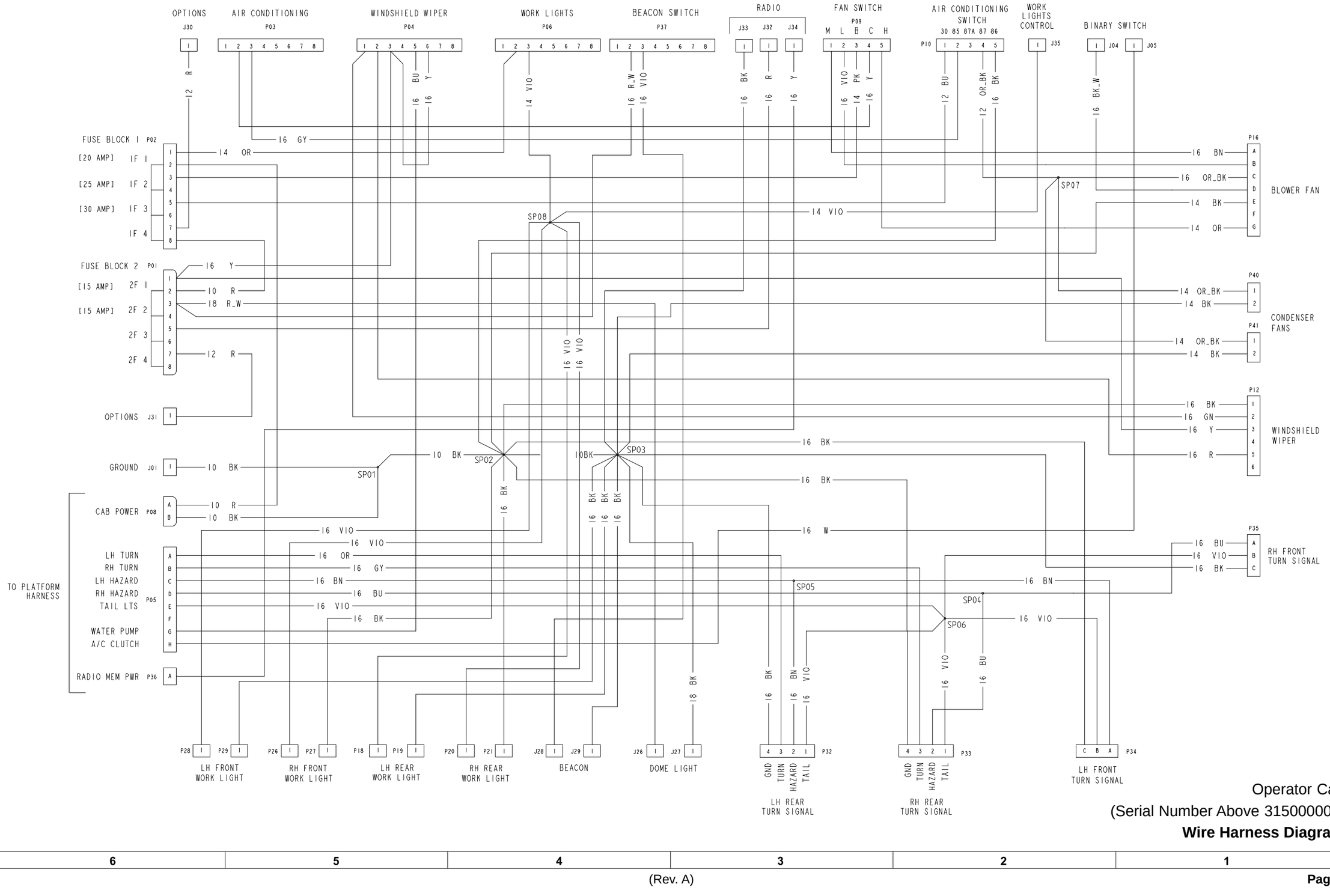
Operator Cab
(Serial Number Below 314999999)
Wire Harness Drawing



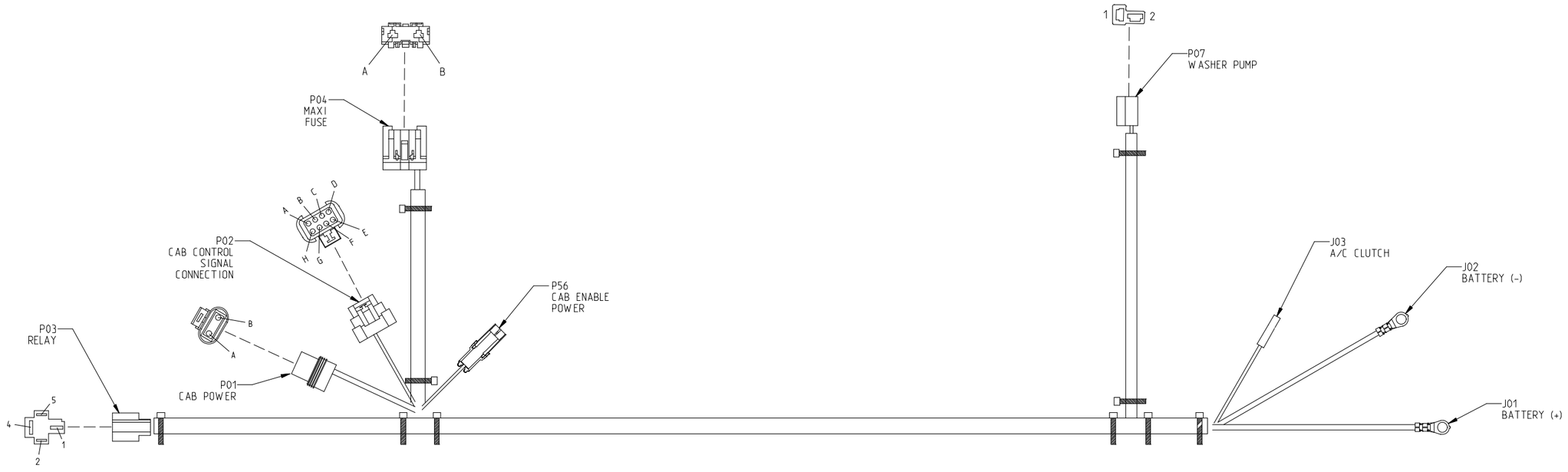
Operator Cab
(Serial Number Below 314999999)
Wire Harness Diagram

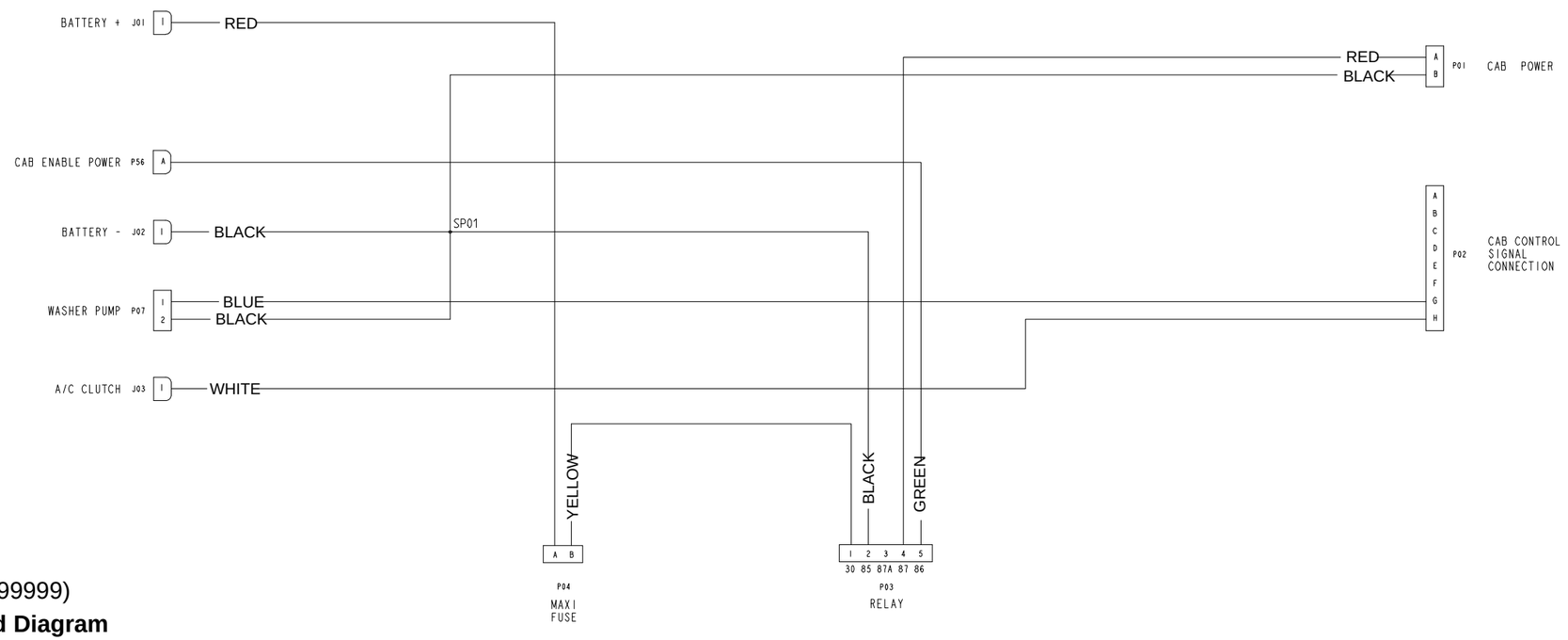


Operator Cab
(Serial Number Above 315000000)
Wire Harness Drawing

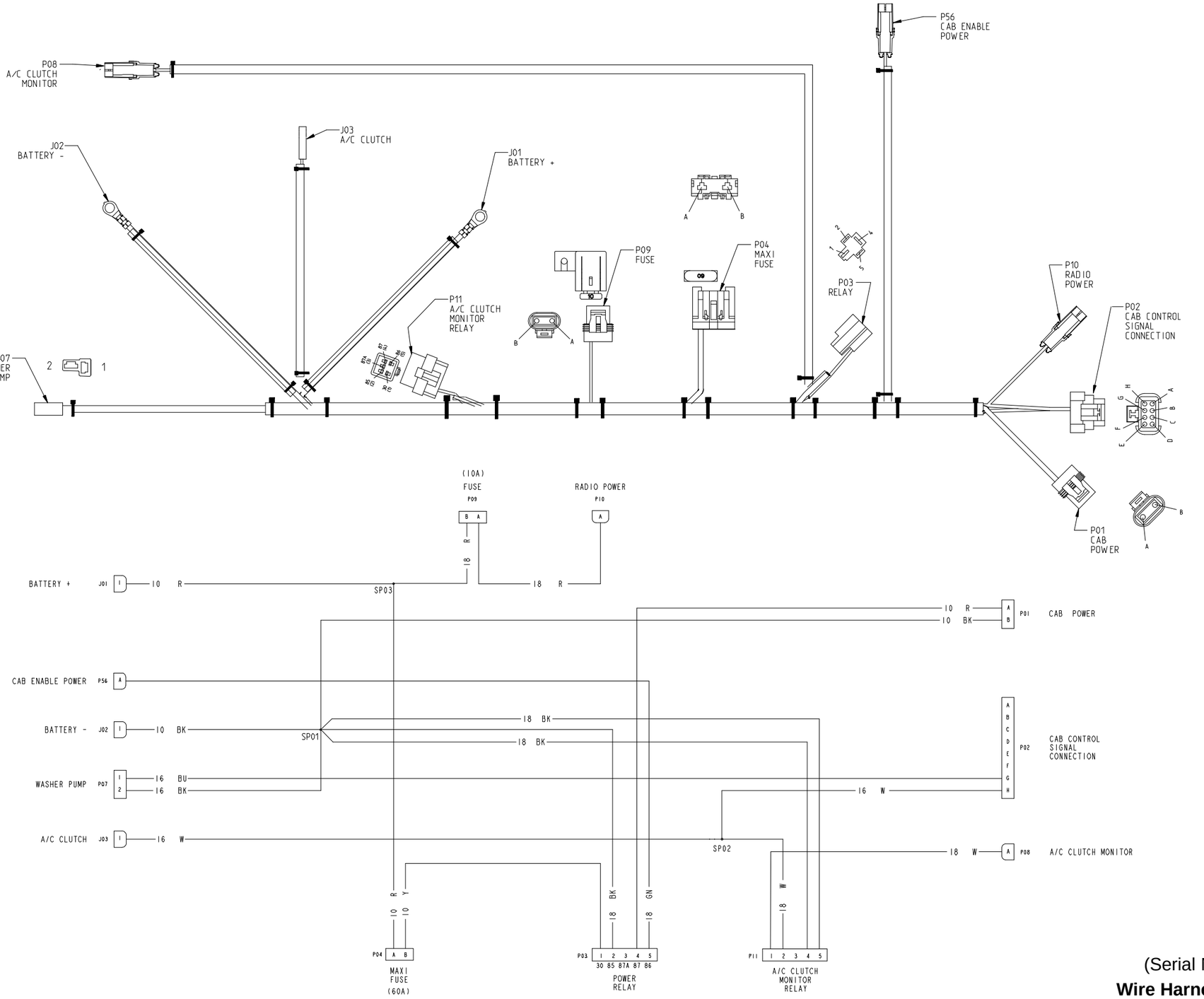


Operator Cab
(Serial Number Above 315000000)
Wire Harness Diagram

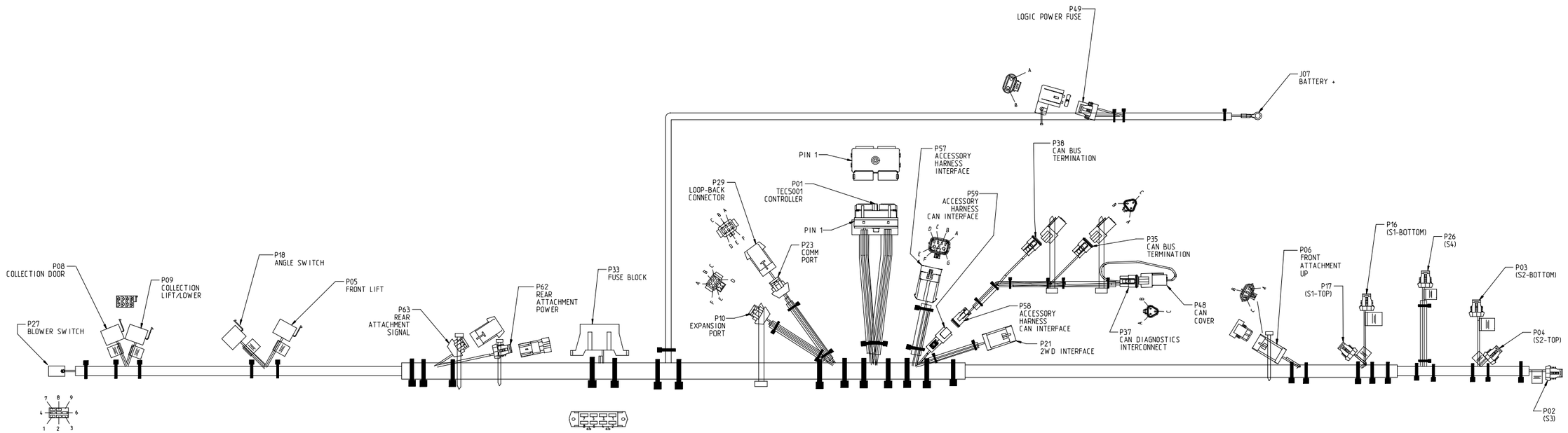




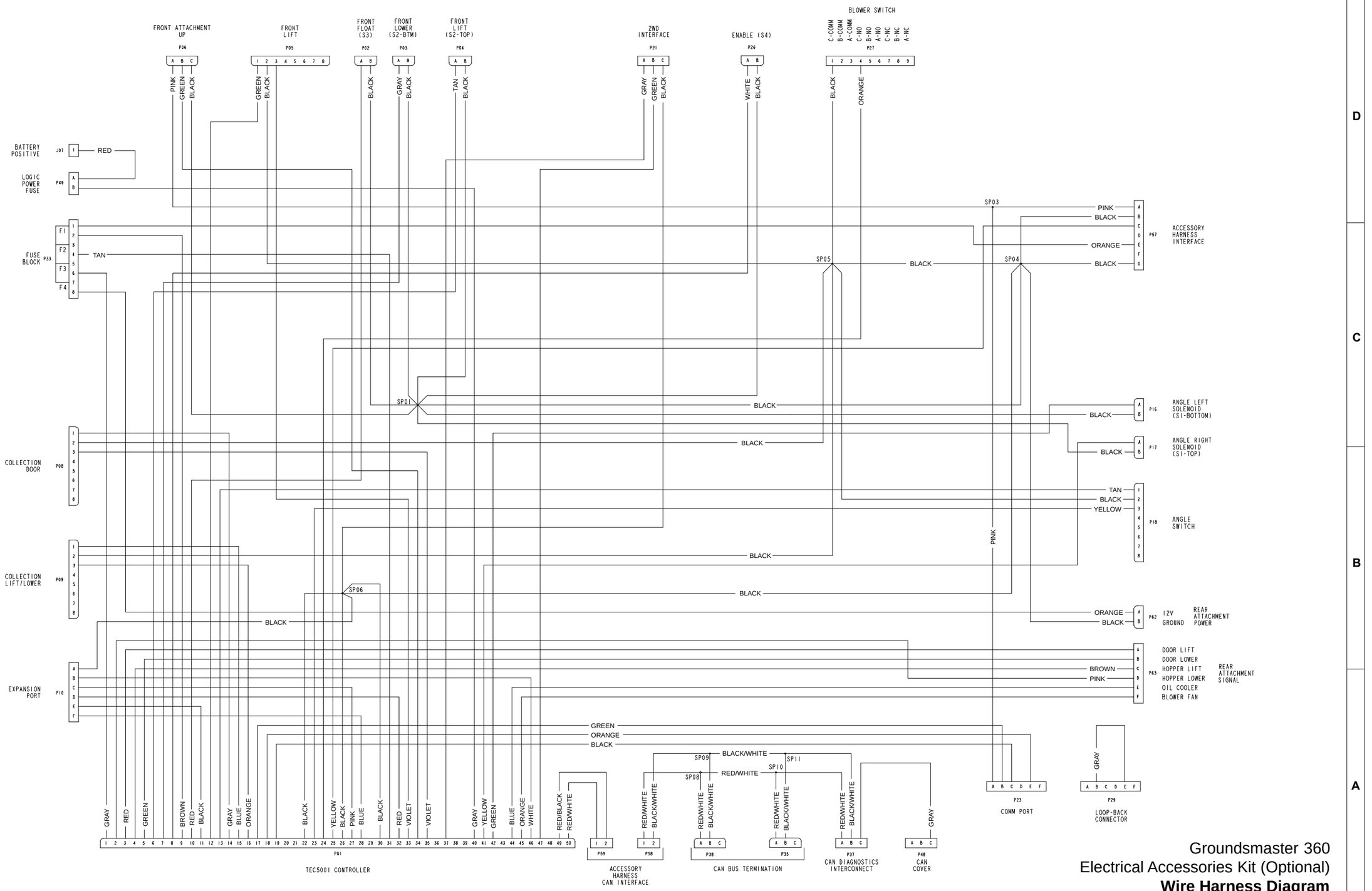
Operator Cab Interconnect
(Serial Number Below 314999999)
Wire Harness Drawing and Diagram



Operator Cab Interconnect
(Serial Number Above 315000000)
Wire Harness Drawing and Diagram



Groundsmaster 360
Electrical Accessories Kit (Optional)
Wire Harness Drawing



Groundsmaster 360
Electrical Accessories Kit (Optional)
Wire Harness Diagram